An Analysis of Stone Tool Use in the Maya Coastal Economies of Marco Gonzalez and San Pedro, Ambergris Caye, Belize

William James Stemp
Department of Anthropology
McGill University, Montréal
February, 2000

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements of the degree of Doctor of Philosophy

0-612-64672-6

It was the best of times, it was the worst of times…

- C. Dickens, A Tale of Two Cities

ABSTRACT

The Maya sites of Marco Gonzalez and San Pedro are located on the southern end of Ambergris Caye, a limestone-based coral island off the coast of modern-day Belize. When combined, the archaeological settlements at these sites represent some of the longest occupations in coastal Belize. Evidence suggests the earliest occupation occurred at Marco Gonzalez in the Late Preclassic and extended into the Late Postclassic, while San Pedro's population thrived well into the Historic period. An analysis of the stone tools recovered from excavations at Marco Gonzalez and San Pedro and a study of the use-wear patterns on these artifacts has revealed that the Maya from both sites were primarily engaged in subsistence-based activities with a limited amount of small-scale craft production. Use-wear evidence suggests that the majority of these activities focused on the exploitation of local resources necessary in everyday Maya life. The activities included the acquisition of seafoods such as fish and molluscs, and the preservation and/or processing of fish and other marine by-products, such as shell, coral, and stingray spines for both local use and trade. As consumer sites, the Caye inhabitants offered many of these products in exchange for stone tools produced in mainland workshops, such as Colha, in the 'chert-bearing zone' of Northern Belize. In addition to the local and regional trade of marine resources and salt, the sites of Marco Gonzalez and San Pedro served as transshipment points for the long-distance exchange of valuable wealth or prestige goods along the coast. The large inland site of Lamanai likely served as ally and trade partner with these sites based on archaeological evidence for socioeconomic and sociopolitical ties between this mainland centre and the smaller Caye settlements. This relationship assisted the Maya from southern Ambergris Caye in surviving the breakdown in trade relations and depopulation that plagued other Maya centres in the Late to Terminal Classic periods and to continue well into the Late Postclassic.

RESUME

Les sites mayas de Marco Gonzalez et San Pedro sont situés au bout sud d'Ambergris Caye - une île de corail à base de pierre à chaux sur la côte du Bélize. Dans l'ensemble, ces colonies archéologiques représentent une des plus longues occupations sur la côte du Bélize. L'évidence suggère que l'occupation le plus tôt a eu lieu à Marco Gonzalez dans la période tard du Préclassique et s'est prolongée jusqu'à la période tard du Postclassique. La population de San Pedro a bien prospéré jusqu'à la période Historique. Une analyse des outils en pierre récupérés au cours des fouilles à Marco Gonzalez et San Pedro et une étude des traces d'usure sur ces artefacts ont révélé que les Mayas des deux sites se sont engagés essentiellement dans les activités de subsistance accompagnées de métiers artisanaux à petite entreprise. Les traces d'usure suggèrent que la majorité des activités étaient concentrées sur l'exploitation des ressources locales nécessaires à la croissance quotidienne des Mayas. Les activités comprennaient l'acquisition des fruits de mer tel que les poissons et les mollusques, ainsi que la conservation et/ou le traitement des poissons et des autres produits de la mer comme la coquille, le corail, et les dards de raies pour l'usage local aussi bien que pour le commerce. Etant donné que ces sites étaient ceux de consommation, les habitants du Caye ont échangé leurs produits pour les outils en pierre fabriqués dans les ateliers situés dans la 'zone de silex corné' du nord du Bélize, comme Colha. On se servaient des sites de Marco Gonzalez et San Pedro comme points de transport situés sur la côte pour l'échange à longue distance des produits de valeur ou de prestige, aussi bien que pour le commerce local et régional des ressources maritimes et le sel. Le grand site terrestre de Lamanai a probablement servi d'allié ou comme associé de commerce avec les plus petits sites du Caye selon l'évidence archéologique des liens économiques et politiques entre ces endroits. Sans doute, ce rapport a permit aux Mayas au bout sud d'Ambergris Caye à survivre l'effondrement de commerce et la réduction de population connu aux autres centres mayas dans les périodes tard et final du Classique, et les ont permis de continuer jusqu'à la période tard du Postclassique.

ACKNOWLEDGEMENTS

Like so many others who have toiled to finish a thesis, I have been assisted by a great many people. Some I have known what seems like forever, others I have never met face to face. I would like to thank those whose contributions to my work and to my life have allowed me to complete this thesis. In the next paragraphs, I hope I do not neglect to mention any who have helped me along the way, but I'm sure I will. If I forget you, I'm sorry.

In my personal life, I would like to thank all of my family and friends who took the time to ask: "How's it going?" even when you really didn't understand what I was doing. I would especially like to thank my wife, Jennifer, for her patience during absences when I was in the field or away teaching and for my many sleepless nights. When I was engrossed in my work, she understood me well enough to leave me alone and was supportive when I would rant and rave about my research. Unbeknownst to her, many of her remarks made me think of new ways to approach old problems. I would also like to thank my parents, Donald and Heather, for supporting me in my decision to take the road less traveled and for allowing me to take out numerous loans with 'The Bank of Mom and Dad'.

In terms of my academic and archaeological life, there are numerous people to thank. I will attempt to do so in some organized chronological fashion. While an undergraduate at the University of Toronto, two people took more than a passing interest in me. One of my first TA's, Julian Siggers, encouraged my interest in lithics and stone tool production. Tim Kaiser allowed me to undertake the analyses of two of his lithic assemblages from Croatia. To both of you I owe much gratitude. During this period, I was also indoctrinated into the world of Maya archaeology by Jaime Awe and Mark Campbell. Like so many students, I was enchanted with the archaeology, the beauty and the people of Belize and decided this was where I wanted to work.

For my Master's degree, I decided to leave Canada for the pomp and pageantry of Oxford University. Upon my arrival, I discovered that I had enrolled in the wrong program. Enter Derek Roe. Dr. Roe allowed me to attend his lectures and offered to be my supervisor, even though I had not formally been transferred into the program. For his generosity, his teaching and the tireless efforts he made on my behalf, I owe him much more than I could ever repay. Dr. Roe forced me to learn more than I ever had before and made the entire experience enjoyable … except for the examinations.

Following a brief reprieve from academic life, I enrolled at McGill to begin my doctoral degree. After five and a half long years, I have learned much from my supervisors Mike Bisson and Bruce Trigger. Professor Trigger astounded me with his depth and breadth of knowledge about pretty much everything and I found his sharing of ideas (and patience with mine) to be very generous. Professor Bisson is in every aspect my type of supervisor. He is frank and fair in his judgment of my work and allowed me just a little less rope than I needed to hang myself. Instead of constantly imposing his ideas on me, he commented favourably (or unfavourably) on my research and offered excellent alternative approaches or suggestions. He made my doctoral experience less stressful, more interesting and fun. And that has made all the difference in the world.

During my time at McGill, I returned to Belize to work with Gyles Iannone whom I had met years earlier while at Cahal Pech with Jaime Awe. Gyles re-introduced me to Maya fieldwork and along the way has become a good friend. In addition to Gyles, I also met a whole new group of fellow archaeologists or rekindled old friendships from years before. Most of these people have shared my adventures with me and lived to tell the tale. This list of colourful characters includes: Sonja Schwake, Josalyn Ferguson, Jim Conlon, Nadine Gray, Mark Hoeltzel, Norbert Stanchly, Terry Powis, David Valencia, Jaime Awe, Everald Tut, Joe Martinez, and most of the students and crews from the Belize Valley Archaeological Reconnaissance and Social Archaeology Research Program projects over the years. A special thanks to Christophe Helmke for his excellent illustrations of the formal tools included in my thesis.

I would also like to thank Elizabeth Graham and her husband David Pendergast for allowing me to use the lithics they excavated from Marco Gonzalez and San Pedro for my doctoral research. Not only have they provided me with much of the information about the excavations of the sites, they have offered excellent suggestions, ideas and criticisms that have shaped the final version of this thesis. They welcomed me into their world at the Royal Ontario Museum and for this too, I am grateful.

At the ROM, I would also like to thank Mima Kapches, Head of Anthropology, for allowing me to use the facilities and for lab space to continue my research. Norbert Stanchly, John Tomenchuk and Heidi Ritscher also helped me by locating information, offering suggestions, or simply sharing a coffee or beer with me. I am further indebted to Fred Wicks, Head of Earth Sciences at the ROM, for the unrestricted use of his microscopic and photographic equipment which enabled me to complete my use-wear analysis.

A special thanks to Tom Hester from the University of Texas at San Antonio and Sal Mazzullo from Wichita State University, both of whom I have never met, and to Payson Sheets from the University of Colorado, Boulder. Their generosity with ideas and information via e-mail and fax machines enabled me to pick their brains and access documents that were unavailable to me.

Much gratitude is owed to my brother Michael, whose expertise in materials engineering and the mechanics of wear have allowed us both to investigate new possibilities for archaeological use-wear and has allowed me a much more complete understanding of the processes of mechanical and chemical wear on stone tool surfaces. With the assistance of some of his colleagues at the Swiss Federal Institute of Technology in Lausanne, Switzerland, we have approached the question of quantitative use-wear analysis from a slightly different angle.

To make this thesis complete, I also required the assistance of Mike Giesser and Eamon O'Toole from Site 85 and Pamela Lipson, a doctoral student in the French Department at McGill University. Mike and Eamon allowed me to use their scanner and computer equipment and assisted in the formatting of this thesis, while Pamela agreed to edit the French version of my thesis abstract. Thanks to all of you.

Finally, I would like to thank the Department of Archaeology in Belmopan, Belize for allowing me to undertake my doctoral research on the Maya material culture excavated in Belize.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

Introduction

Lithic technology was an essential component in the lives of the ancient Maya. At the most basic levels of subsistence, exploitation and manipulation of their diverse environments, the Maya employed stone tools. Traditionally, lithics, specifically cherts, were not viewed as contributing to the study of the fundamental questions of the rise of Lowland Maya states (Adams 1977; Rathje 1971; Sabloff and Willey 1967; Sharer 1992; Webster 1977; except Potter 1991a), the 'collapse' of the Classic Maya (Culbert 1973, 1988a; Marcus 1995), or political, social and economic systems in operation in Mayan Central America (Culbert 1988b, 1991; Demarest 1992; Demarest and Foias 1993; Fedick 1989; Marcus 1976, 1983, 1993; Rice 1987; Sabloff and Andrews V 1986). However, as the study of the ancient Maya has evolved, archaeologists have come to recognize that this prehistoric culture was characterized by complex integrated social, political, and economic systems that transcended territories, site hierarchies, and environmental zones. Therefore lithics, as fundamental components in these dynamic systems, have come to assume much greater importance in Maya studies (Gibson 1986, 1989; McAnany 1986, 1989a, 1992, 1993a, 1993b; McAnany and Isaac 1989; McSwain 1989, 1991a; Mitchum 1994; Santone 1993, 1997). Like most prehistoric populations, the inhabitants of Ambergris Caye employed stone tools in the performance of tasks necessary to their existence. By focusing on the use of lithics by the populations from Marco Gonzalez and San Pedro, this thesis will contribute to reconstructing the Maya economies of these sites throughout their lengthy occupations. In Chapter 1, the history of stone tool studies in the Maya area is provided as an introduction to the lithic research presented in this thesis.

Chapter 2 contains descriptions of both Marco Gonzalez and San Pedro and summarizes their occupation histories. The sites of Marco Gonzalez and San Pedro are located on the southern end of Ambergris Caye; an island approximately 20 kilometres off the coast of mainland Belize. They represent some of the earliest offshore occupations by Maya populations. Evidence for activity at least as early as the Late Preclassic was found at Marco Gonzalez, while burials dated to the Late Classic occur at San Pedro (Graham and Pendergast 1989; Pendergast 1990; E. Graham, pers. comm. 1998). While occupation at Marco Gonzalez seems to have continued uninterrupted until the 13th to 14th centuries AD with intermittent occupation extending into the Colonial era, the latest evidence recovered from San Pedro suggests the Maya were there at the time of Spanish contact circa the 16th century AD (Graham and Pendergast 1989; Graham and Pendergast 1987: 4; Pendergast and Graham 1987; Pendergast 1990). Both sites appear to have survived well into the Postclassic period when other Maya settlements suffered abandonment or massive depopulation. Given their location and duration of occupation, these sites represent successful adaptations to conditions, both social and environmental, that were much different from those of the majority of the mainland Maya sites throughout the Lowlands, but are possibly representative of coastal sites elsewhere.

Numerous elements of their sociopolitical and socioeconomic systems must be examined in order to reconstruct the use of chipped stone tools in the coastal economies of Marco Gonzalez and San Pedro. Questions pertinent to the acquisition of lithic raw materials, the production of artifacts, the tool types recovered from these sites, and the evidence of tool use all require study. In Chapter 3 of this thesis, the tool typology used for the analysis of the lithic artifacts excavated from Marco Gonzalez and San Pedro is presented based on the lithic sequence established for Colha. Chapter 4 describes the lithic raw material types excavated from both sites and discusses processes such as chemical and thermal alteration that can damage stone. While Chapters 5 and 6 describe the lithic artifacts recovered from Marco Gonzalez and San Pedro, in Chapter 7 their spatial and chronological distributions are examined.

Crucial to reconstructing lithic use in the coastal economies of Marco Gonzalez and San Pedro is an understanding of the criteria important in the determination of tool performance, tool efficiency and raw material consumption as they relate to task completion. In Chapter 8, design theory, lithic technology and technological change are discussed, while Chapter 9 explores the concepts of curation, expediency and opportunistic behaviour as it relates to the Maya from the coastal sites on Ambergris Caye.

Of great importance to this research is the role of lithics in the trade relationships between the inhabitants of Marco Gonzalez and San Pedro and the other communities within Northern Belize. Models for trade and exchange, reconstructions of subsistence, regional and long-distance trade, and the economics of lithic production, consumption and exchange as they relate to Marco Gonzalez and San Pedro are all discussed in Chapter 10.

The determination of tool use patterns at Marco Gonzalez and San Pedro is based on the types of tools used by the Maya at these sites, as well as on the identification of use-damage generated on these tools. In Chapter 11, the background and history of use-wear analysis is presented, in addition to the mechanics of polish formation on stone tools. Chapter 12 provides the methodology employed in the analysis of use-wear and examines the different use-related damage traits identified on stone tools. By implementing a combined program of low-power edge damage identification (Tringham et al. 1974; Hayden 1979a; Odell 1977, 1979, 1981a; Odell and Odell-Vereecken 1980) and high-power polish recognition (Anderson-Gerfaud 1981, 1982, 1983 [Anderson 1980a]; Keeley 1980; Lewenstein 1987; Unger-Hamilton 1988; Vaughan 1981, 1985) on these lithic artifacts, it is possible to determine the nature of the activities performed by the coastal Maya.

An understanding of the range of exploitable resources available in the local environment of the coastal Maya can further increase the precision of the analysis of a population's economy. In Chapter 13, data from a variety of sources have been combined to permit a determination of the different animal and plant species likely exploited by the inhabitants of Ambergris Caye. Certain activities are suggested that most probably produced the wear patterns observed on the lithic artifacts.

In Chapters 14 and 15, the use-wear analysis of the lithics from Marco Gonzalez and San Pedro is discussed in terms of tool types, raw material types, and spatial and chronological distribution patterns. In conjunction with the environmental data, this information is used to recognize specific patterns in the coastal resource exploitation and craft production activities occurring over time and makes it possible to more accurately reconstruct the complex picture of life on Ambergris Caye.

The History of Maya Lithic Studies

The analysis of lithic artifacts has only become a standard branch of Maya research within the past fifty years. As Gibson (1986:16) stated: "Lithic artifact analysis was often ignored or delegated to the role of a postscript or general description of 'non-ceramic' artifacts". In the past, emphasis was placed on more visible and exotic architectural features, and the aesthetically more interesting Maya hieroglyphics, sculpture, and ceramics (Shafer 1983; Sheets 1977). Early papers (Franks 1877; Gann 1918; Gray 1916; Joyce 1932; Ricketson 1937; see Pendergast 1993a:4) were primarily devoted to eccentrics or individual stone tool specimens from Central America, while later reports merely illustrated a few specimens (Gann and Gann 1939; Ricketson 1929; Thompson 1939), providing little descriptive information, if any at all (Hester 1976; Rovner and Lewenstein 1997:6). Only later did lithic artifacts receive attention as a possible source of chronological trends, thanks in part to Merwin and Vaillant's (1932) chronological ordering of ceramics at Nohmul which, in turn, provided the basis for a culture historical sequence for Maya stone tools (Gibson 1986; Hester 1976; Shafer 1983; Sheets 1977). Chert and other cryptocrystalline artifacts have traditionally been overlooked until relatively recently because of the wealth of information concerning trade routes, exchange networks, highland/lowland interaction, and socioeconomic systems and elite control derived from studies of obsidian. Much of this information has been acquired through the use of trace element analyses (Asaro et al. 1978; Braswell and Glascock 1992; Dreiss 1988; Dreiss and Brown 1989; Fowler et al. 1989; Hammond 1976; Hammond et al. 1984; Healy et al. 1984; McKillop and Jackson 1989; Michels 1976; Moholy-Nagy et al. 1984; Rice et al. 1985; Sheets et al. 1990; Stross et al. 1983)

Publications on lithic research in the Maya area have been reviewed by Hester (1976) and Sheets (1977). Both authors note the increased importance of non-obsidian-based lithic studies in Maya research, yet also cite the lack of a standardized terminology for this field as being very problematic. The growing interest in Maya stone tool studies is undoubtedly stimulated by developments in lithic technology research on such topics as fracture mechanics, experimental studies, trace-element analyses, and use-wear (Shafer 1983).

Although E.B. Ricketson (1937) utilized a standardized method for the study of lithics from Uaxactun based on an earlier classification system developed by A.V. Kidder, the initial development of a descriptive and functional terminology for Maya lithics was accomplished by Kidder himself (1947) in his analysis of lithics from Uaxactun (Gibson 1986:17). The problem with this system, however, was Kidder's decision to implement a ceremonial-utilitarian distinction, as inferred from spatial context, as the highest ranked taxonomic criterion. This adversely affected almost every other study concerned with the analysis of Maya lithic assemblages that followed. Decisions relative to function were made without any testable basis (Johnson 1996:160; Sheets 1977). Although Kidder excluded this highest-order functional classification from his later analyses of lithic material from Zacualpa, Kaminaljuyu and Nebaj (Kidder 1948; Kidder et al. 1946:135-140; Shook and Kidder 1952; Smith and Kidder 1951:50-51), others incorporated Kidder's functional taxonomy in their analyses. Fortunately, Woodbury and Trik (1953) incorporated Kidder's terminology for the chipped stone assemblage from Zacaleu, but, excluded the ceremonial-utilitarian dichotomy as their highest-level taxonomic criterion. W. Coe (1959) and Proskouriakoff (1962) accepted Kidder's functional distinction for their respective studies of lithics from Piedras Negras and Mayapan; however, both expressed concerns with regard to this system. W. Coe (1959:11) stated: "For anyone preferring functional sources cut and dried, the presence of four choppers in a probable sub-stela cache ... is disconcerting", while Proskouriakoff (1962:356) noted that "... the distinction between ritual and utilitarian ..." was not clear at Mayapan. Gordon Willey also incorporated Kidder's functional taxonomy for the Barton Ramie lithics from the Belize River Valley (Willey et al. 1965:410-451). For the reports from Altar de Sacrificios and Seibal, Willey (1972, 1978) continued to follow the descriptive system established earlier for Uaxactun with additions from his Belize River Valley study, but abandoned the ceremonial-utilitarian classification. The work undertaken by Rovner (1975) in his doctoral thesis greatly altered the manner in which Maya lithicists assessed their stone tool assemblages. His contribution was the incorporation of the concept of lithic industries in Maya stone tool studies related to both raw material types and production techniques. He emphasized the classification of assemblages based on technological and morphological characteristics rather than a tool's inferred function (Rovner and Lewenstein 1997:9).

In April 1976, a symposium for Maya lithic studies was held in Orange Walk Town, Belize (Hester and Hammond 1976a, 1976b:v) to address the problem of a lack of common terminology in the discipline, to outline the necessity for greater technological and functional studies in the Maya Lowlands, and to define data gaps in the field of Maya lithics. Such concerns were already being addressed elsewhere in the archaeological world (Hester 1976; Hester and Shafer 1991a: vii; Sheets 1976). This was the first major collective step by Maya archaeologists to solve the problems extant in Maya lithic studies. The symposium proved to be a catalyst for Maya research and created new interest in fundamental lithic analysis.

Of incalculable assistance in solving the problems outlined at the symposium was the research undertaken at the massive chert workshop site of Colha in the Corozal District of Northern Belize. Although this site was first discovered in 1973 by the joint Cambridge University-British Museum Corozal Project under Norman Hammond (1973), and was in fact the impetus for the first Maya lithics conference (Hester and Hammond 1976a; Potter 1993:284), the most relevant information was collected by Hester and Shafer's Colha Project (Hester 1979, Hester et al. 1980). It furnished crucial information concerning Maya chert tool production and craft specialization in Northern Belize, as well as providing data on the massive regional industrial complex of chert tool manufacture from Middle Preclassic to Early/Middle Postclassic periods (Hester 1985; Hester and Shafer 1984; Shafer and Hester 1983). At Colha, entire production sequences are present for each period and their study has provided a greater understanding of the formal tool inventory in both intersite and intrasite consumption spheres of the Southern Maya Lowlands. Evidence for standardized tool production by craft-specialists is demonstrated in the debitage recovered from the workshops at this site (Hester 1985; Hester and Shafer 1984, 1991a; Shafer and Hester 1983, 1986).

Following the 1976 symposium and contemporaneous with the research at Colha, were a number of other major lithic research projects at sites including Cerros, Cuello, Tikal and other areas in the Peten, Pulltrouser Swamp, Nohmul, Becan, Chichen Itza and Copan. Given the growing sophistication of lithic research and the increasing number of lithic projects undertaken, a second Maya lithic conference was held in October 1982 at Casa San Jose in San Antonio, Texas (Hester and Shafer 1991a: vii). Papers presented at this second conference demonstrated that the field of Maya lithics had matured, incorporating use-wear studies (Aldenderfer 1991, Lewenstein 1991), technology and manufacturing sequences (Clark and Bryant 1991a; Fedick 1991; Hester et al. 1991), and ethnographic work (Clark 1991).

All of these areas of research have been expanding in Maya studies. Use-wear analysis, for example, has evolved from Kidder's (1947) early functional observations based on visible traces of wear and chipping, through early microwear studies at Tikal (Puleston 1969), Seibal (Wilk 1978), Kaminaljuyu (Hay 1978), Beleh (Hester 1975) and El Mirador (Fowler 1987) in Guatemala; Petroglyph Cave (Shafer n.d.), Cuello (Shafer et al. n.d.), Barton Ramie (Wilk 1976a), Colha (Shafer 1979), Kichpanha (Hester 1982), Pulltrouser Swamp (Shafer 1983), and coastal sites from the Stann Creek District in Belize (Graham 1994); Chalchuapa (Sheets 1978a) and Zapotitan (Sheets 1983) in El Salvador; La Libertad (Clark 1988) in Mexico; and at Copan in Honduras (Aoyama 1995; Mallory 1984). More recent high-power microscopic use-wear analyses of lithic assemblages have been done in the Southern Lowlands of Belize (Gibson 1986), Cerros (Lewenstein 1987, 1991); the Sacred Cenote at Chichen Itza (Sievert 1992), Mexico; Copan (Aoyama 1995), and La Entrada, Honduras (Aoyama 1993; see Aoyama 1989); and the Peten Lakes region of Guatemala (Aldenderfer 1990, 1991; Aldenderfer et al. 1989). Ethnographic studies in Highland Mexico and Guatemala (Deal and Hayden 1987; Hayden 1987b; Hayden and Cannon 1983; Hayden and Nelson 1981) and observations of the modern Lacandon Maya (Clark 1991a, 1991b; Nations and Clark 1983; Tozzer 1907) have also expanded the overall knowledge of lithic use and discard patterns in Mayan Mesoamerica.

CHAPTER 2

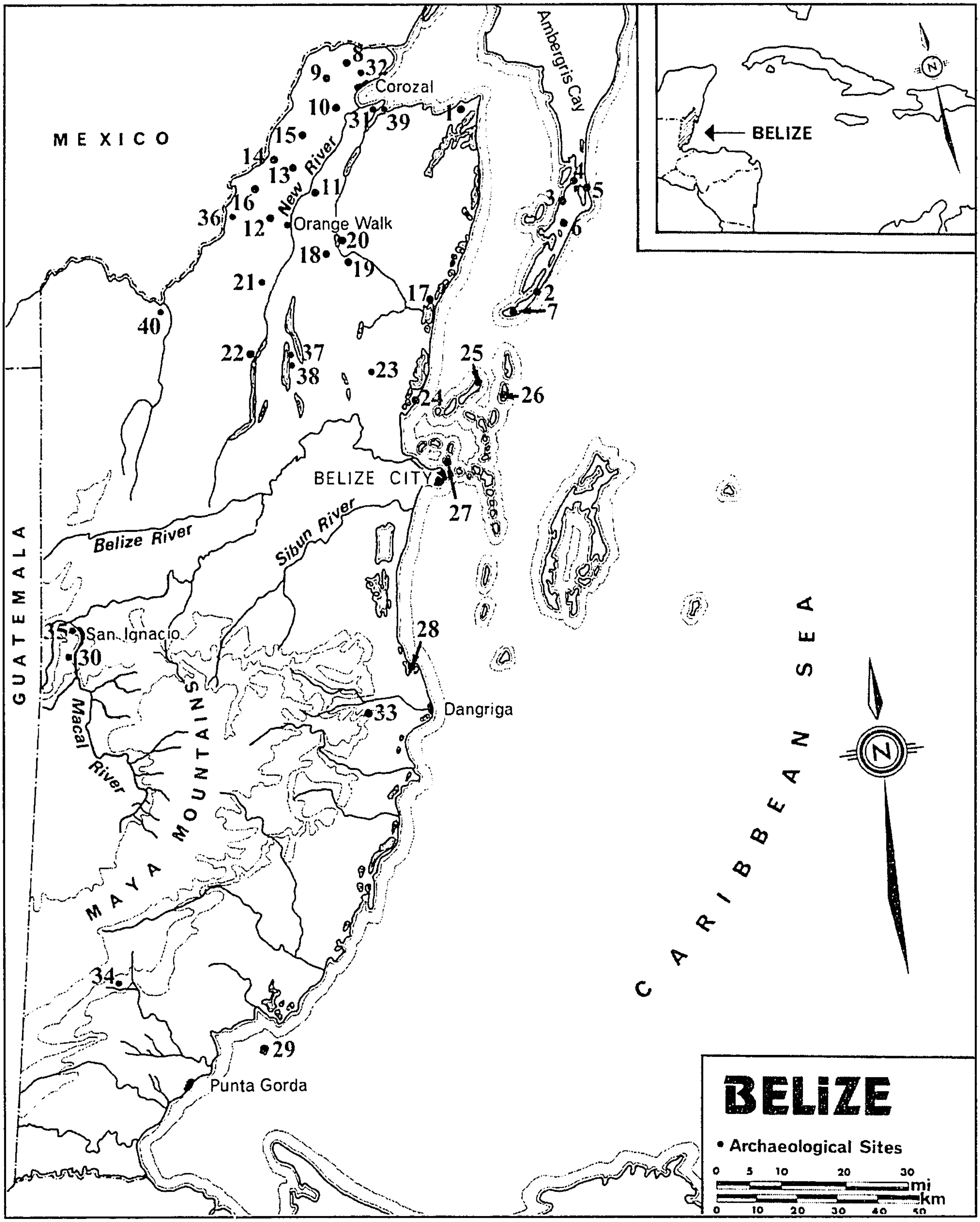
The Occupation Histories of Marco Gonzalez and San Pedro

Marco Gonzalez:

The site of Marco Gonzalez [Department of Archaeology, Belmopan, Belize site designation #39/197-1] is located approximately eight km south of the town of San Pedro at the approximate centre of a small westward-trending portion of Ambergris Caye south of Laguna de Boca Chica [Figure 1]. It was named for the fourteen year-old boy who led archaeologists there in 1984 (Graham and Pendergast 1989; Pendergast and Graham 1987). Excavations at the site were initially undertaken in April and May of 1986 and continued in 1989, 1991, and 1992. Based on ceramic and stratigraphic evidence, the excavations document long-term activity from around 100 BC to the 15th century AD (Graham and Pendergast 1989; Pendergast and Graham 1990). At present, Marco Gonzalez is a small area of elevated terrain roughly 355 metres by 185 metres with a maximum elevation above mean sea level of 3.6 metres, surrounded by mangrove swamp or *mangal* (Dunn and Mazzullo 1993:122; Graham and Pendergast 1989:3). The site is distinguished from its *mangal* surroundings by coconut palms, some broadleaf forest and a landscape vegetation indicative of past human activity such as land-clearing, refuse disposal, and artificial infilling of portions of the site. The dominant vegetation on and among the site structures comprises gumbolimbo [*Busera simaruba* L.] and white poisonwood trees or 'chechem' [*Cameraria belizensis* Standl.], saltwater or silver palmettos [*Thrinax* sp.], a small number of cabbage palms [*Roystorea oleracea*], and other vines, sedges and grasses, with a few scattered coconut palms from a former coconut plantation at Marco Gonzalez (Graham and Pendergast 1989; Pendergast and

Figure 1: Map of Archaeological Sites in Northern Belize (adapted from Graham and Pendergast 1989)

1. Sarteneja
2. San Pedro
3. San Juan
4. Chac Balam
5. Ek Luum
6. Basil Jones
7. Marco Gonzalez
8. Chan Chen
9. Patchchacan
10. Aventura
11. San Estevan
12. Cuello
13. Pulltrouser Swamp
14. Nohmul
15. Louisville
16. San Antonio
17. Northern River Lagoon
18. Kichpanha
19. Colha
20. Laguna de On
21. El Pozito
22. Lamanai
23. Altun Ha
24. Rocky Point
25. Hick's Cay
26. Cay Chapel
27. Moho Cay
28. Colson Point
29. Wild Cane Cay
30. Tipu
31. Cerros
32. Santa Rita Corozal
33. Mayflower
34. Lubaantun
35. Cahal Pech
36. Albion Island
37. Crooked Tree
38. Chau Hiix
39. Catfish Bight
40. Blue Creek


MEXICO
GUATEMALA
CARIBBEAN SEA
BELIZE
Corozal
Orange Walk
BELIZE CITY
San Ignacio
Dangriga
Punta Gorda
Ambergris Cay
New River
Belize River
Sibun River
Macal River
MAYA MOUNTAINS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
BELIZE
• Archaeological Sites
0 5 10 20 30 mi
0 10 20 30 40 50 km

Graham 1987). Further alteration of this site has occurred due to a rise in sea level of approximately sixty centimetres in the last 2000 years. Whereas a rise in sea level is responsible for the inundation of early cultural material, accretion on the windward side of the Caye now separates Marco Gonzalez from the Caribbean by a wide stretch of beach sand (Dunn and Mazzullo 1993; Graham and Pendergast 1989).

Marco Gonzalez is composed of 49 identified structures encompassing a total area of 6.6 hectares [Figure 2]. While structures at the north end of the site are mostly arranged in a formal pattern with occasional plazuela groupings, in other areas the site plan is more informal. This present configuration is likely due to the obscuring of some very low structure platforms by *mangal* encroachment. All of the structures are low platforms that range in height from 30 centimetres to 4.2 metres, with no architectural evidence of larger-scale ceremonial buildings as seen at larger Maya centres and at some of the island's leeward sites. Whereas the primary construction materials for the platform cores at Marco Gonzalez include irregular blocks of reefstone and enormous quantities of shell and midden refuse, the platform facings were made from reefstone and some limestone slabs obtained from mainland quarries (Dunn and Mazzullo 1993; Graham and Pendergast 1989). Graham and Pendergast (1989:4) note that construction practices at Marco Gonzalez appear to be a variation of those reported on other cayes such as Cay Chapel and Wild Cane Cay.

From collected evidence, it seems the site was permanently occupied from around 100 BC and was not simply a temporary fishing or shellfish collection station. Although a ceramic jar recovered from a burial in Structure 12 provides a reliable Classic date (AC 200-250), the detection of any substantially earlier activity is limited by the fact that

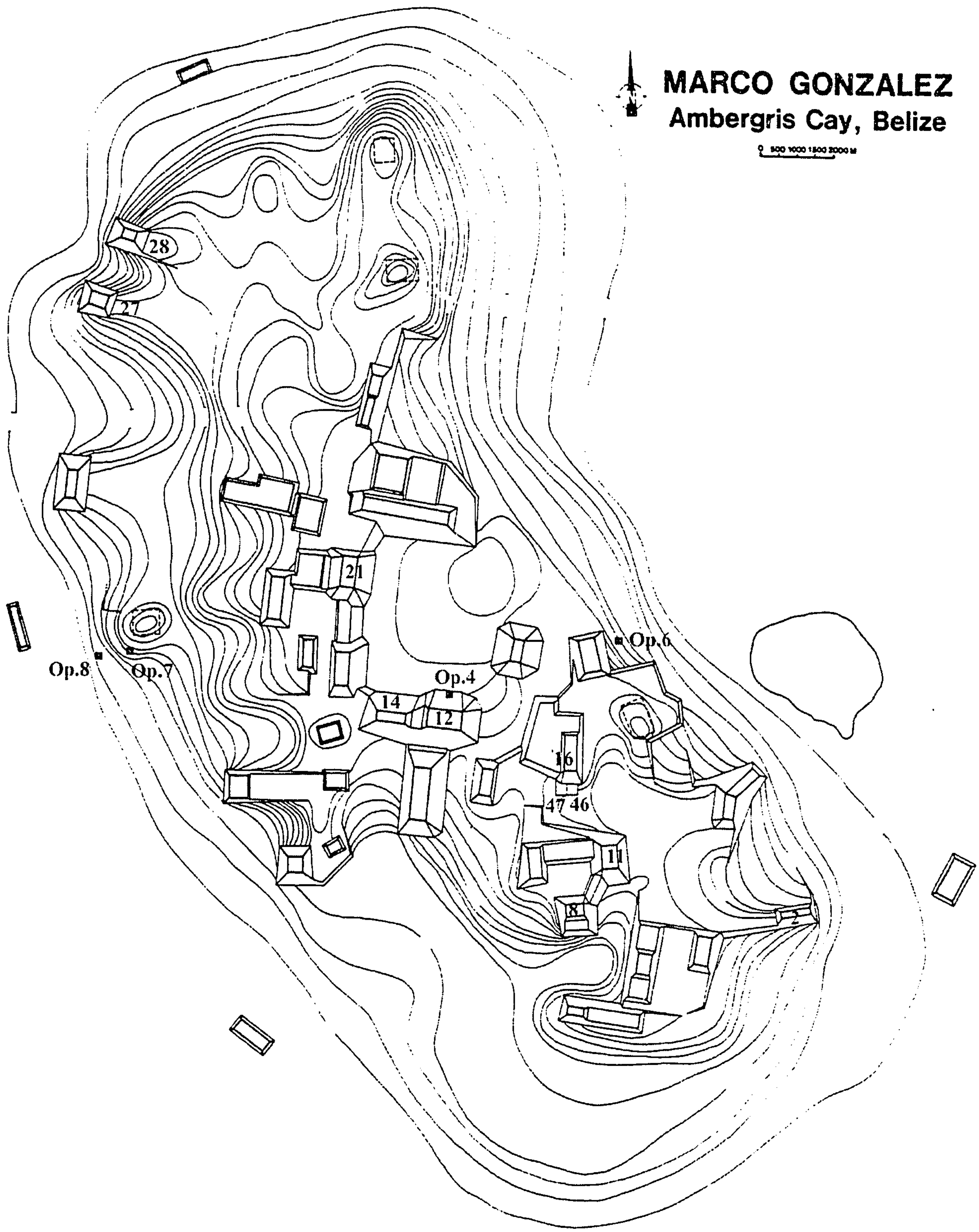


Figure 2: Plan View Map of Marco Gonzalez
(adapted from Graham and Pendergast 1989)

archaeological material from earlier periods lies in submerged deposits (Graham and Pendergast 1989). In addition to some early marine resource exploitation, there is evidence of a fairly intensive salt processing industry in Late Classic times (circa AC 600-800). Layers of charcoal intermixed with sherds from thin, crudely made and poorly fired shallow bowls and dishes were recovered from Structure 12. This type of charcoal and related ceramic evidence is associated with the process of saltwater evaporation (Andrews 1983:16) from other saltmaking sites in the Maya area such as Colson Point, as well as present-day highland saltmaking (Graham and Pendergast 1989:7; Reina and Monaghan 1981:23-29). According to Andrews (1983:46-47), the only known salt sources on Ambergris Caye were two salt lagoons located on the northern end of this island at Boca Bacalar Chico. These lagoons were harvested in the Postclassic during the dry season and the 10 to 50 annual tons of salt collected likely supported the needs of the local populations, with minimal trade perhaps to Sarteneja and Cay Caulker in Belize, and Xkalak, Mexico.

By the late 10th to 11th century AC, evidence of trade contacts at Marco Gonzalez further strengthen this site's continued importance. Tohil Plumbate wares and an orange-variant Plumbate button-faced jar from Burial 11/7 from the site share widespread similarities with ceramic material from El Pozito, Quirigua, and along the Yucatan-Campeche coast (Ball 1978:115-116), as well as, Copan, Honduras; Hacienda Nueva, Tenancingo, El Salvador; Monte Alban, Oaxaca; Huixotla, Mexico; and an unspecified Mexican locale (Graham and Pendergast 1989:7). San Jose V redware bowls and basins, widespread Terminal Classic forms in Belize, were found at Marco Gonzalez and provide excellent evidence of Terminal Classic/Early Postclassic continuity; such continuity was also documented at Lamanai (Graham and Pendergast 1989:7; Pendergast 1986:227-234). As well, there is a substantial increase in construction and site utilization in the 12th century AC, similar to the pattern at Lamanai. There appears to be evidence that every structure at this caye site experienced either construction or use from the mid-11th to the end of the 12th centuries AC. Through the 12th to the 13th centuries, Marco Gonzalez experienced its greatest construction activity and maximum population level. Based on its location and the presence of other imported goods such as gray obsidian, Pachuca green obsidian, jade, chert, granite, limestone, haematite, and the ceramic types discussed above, Marco Gonzalez likely served as a hub in a trade network for both coastal and inland communities (Graham and Pendergast 1989; Pendergast and Graham 1990).

After the apogee at Marco, the site experienced a decline and the end of construction activity sometime between AC 1300 and AC 1400, but still maintained links with Lamanai (Graham and Pendergast 1989:13-14; Pendergast 1990:176-177, 1993b:112). From AC 1450 to the arrival of the Spanish in 1544, it appears the site was abandoned. It has been suggested that Marco Gonzalez inhabitants moved to the present location of San Pedro town by approximately AC 1400 because of deterioration in environmental quality including beach sand accretion and sedimentation (Dunn and Mazzullo 1993; E. Graham, pers. comm. 2000; Graham and Pendergast 1989; Pendergast and Graham 1990).

San Pedro:

In many respects, the site of San Pedro, located on the windward side of Ambergris Caye, is anomalous when compared to most ancient Maya settlements. Lacking any formal architecture, this site was essentially a village or series of villages of thatched structures that now lies under the modern fishing and resort town of the same name.

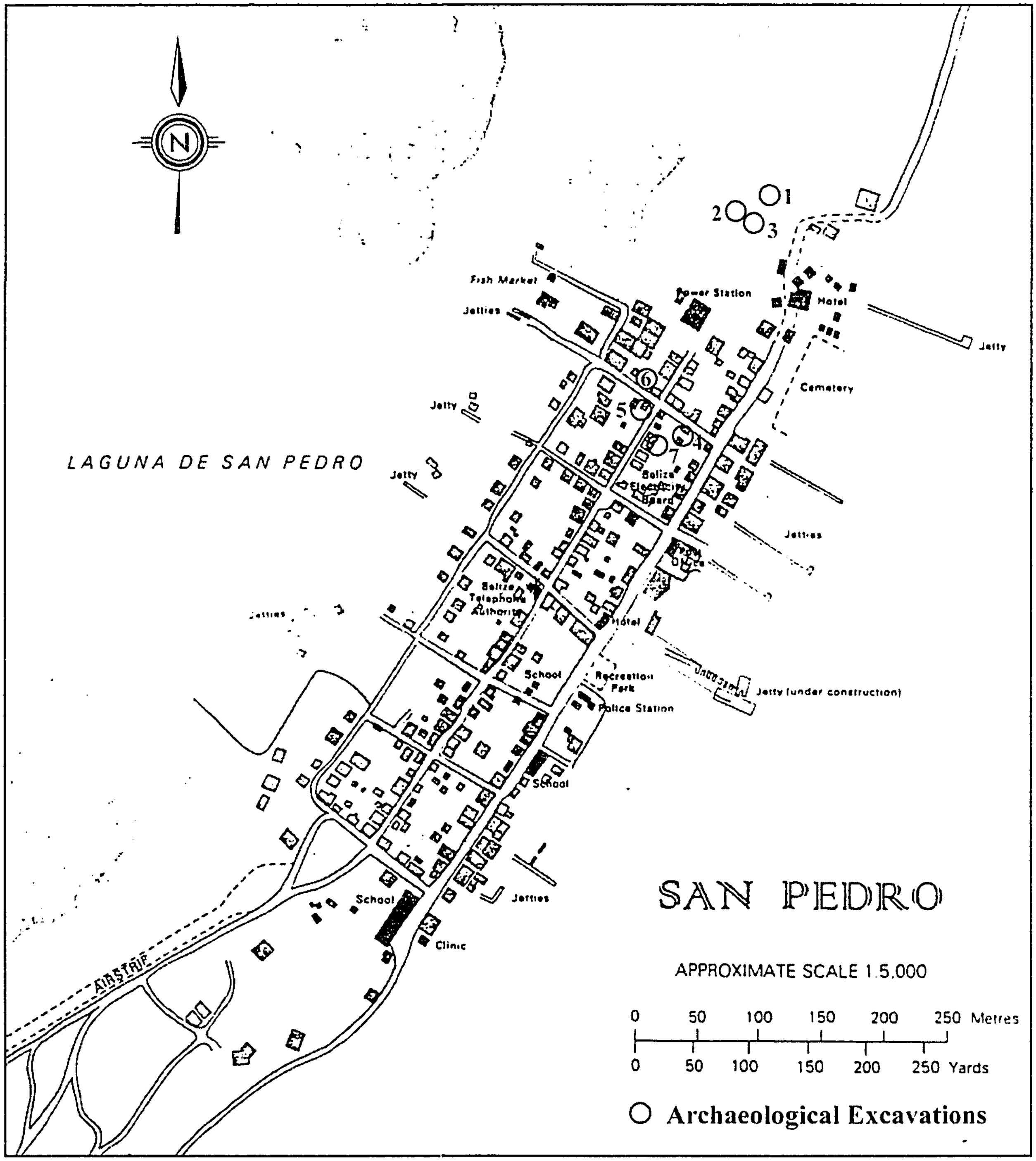
David Pendergast (pers. comm. 1999) has suggested that the widely distributed excavations throughout the modern town of San Pedro have likely unearthed occupations from various periods that may not necessarily represent a chronologically continuous occupation sequence [Figure 3]. The remains of Late Classic plaster house floors and salt processing evidence from the Rosalita and Holiday properties may represent a completely separate phase of occupation at the northern end of San Pedro, while the other locations such as the Nuñez, Alamilla, and Sands Hotel and Parham properties dated from the Late Postclassic and Historic periods may therefore have been later occupations.

The San Pedro excavations in 1990 and 1991 were primarily salvage operations from three construction sites on the caye. Evidence from foundation trenches and backdirt piles originally indicated that San Pedro was settled circa AD 1400 and occupied into the Historic period with the arrival of the Spanish. However, evidence for earlier occupations was also recovered, suggesting the Maya were at this site at least as early as the Late Classic. Much like Marco Gonzalez did in earlier periods, San Pedro shared artifact similarities with Lamanai. On Eddie Holiday's property, the upper part of a midden yielded 12th and 13th century pottery similar to that recovered from Marco Gonzalez and Lamanai (Pendergast and Graham 1991:2). Other ceramic evidence in the form of pieces of Spanish olive jars indicates that the period of Maya occupation extended after 1544, although the village site of San Pedro does not appear in any known Spanish records (Pendergast 1993b:106; Pendergast and Graham 1991:1).

Problems in deciphering the Maya occupation history resulted from the amount of modern hotel construction in San Pedro and the disturbance of the soil through activities such as 'rototilling' on the Rosalita property (Pendergast and Graham 1991:2). The

Figure 3: Map of San Pedro

1. Holiday's property
2. Rosalita's property
3. Nuñez property
4. Alamilla property
5. Elvi's property
6. Elvi's (Averiano Rivera) property
7. Sands Hotel/ Parham property



N
LAGUNA DE SAN PEDRO
Fish Market
Jetties
Power Station
Hotel
Jetty
Cemetery
Jetty
Jetty
Belize Electricity Board
Jetties
Post Office
Belize Telephone Authority
Jetties
Hotel
School
Recreation Park
Jetty (under construction)
Police Station
School
Jetties
School
Clinic
AIRSTRIP
SAN PEDRO
APPROXIMATE SCALE 1:5,000
0 50 100 150 200 250 Metres
0 50 100 150 200 250 Yards
Archaeological Excavations

mixed debris, such as that in the first excavated area on Parham's property, could include Victorian refuse, material from 19th and 20th century garbage pits, Spanish olive jar sherds, English earthenware and bits of glass, Late Postclassic Maya artifacts and a house floor with packed sand perimeter that capped a burial of a very young infant (Pendergast and Graham 1991:3).

What was quite remarkable in the excavations from San Pedro were the number of Late Classic and Postclassic burials encountered. These burials were distinguished by the fact that in almost all cases, the interred individuals were not accompanied by any grave goods. Many burials, perhaps a dozen, were excavated on the Nuñez property, while an additional five, seven and nine burials were recovered from the Rosalita property, the Holiday property and the second area of Parham's property respectively. In the occupied areas, burials were generally associated with packed earthen floors such as those found at Rosalita's and Holiday's, but disturbance from successive occupations was so great that little remains to interpret these features with certainty.

Due to the difficulties in deciphering the occupation history at San Pedro, questions such as population size at any one period and the relationship between the early and later components at the site are difficult to answer. Depending upon the time of occupation at the central and more northerly portions of the town, and whether occupation occurred throughout the unexcavated area that is now under modern San Pedro, D. Pendergast (pers. comm. 1999) believes population estimates could range anywhere between 1,000 to 4,000 Maya. Some evidence for salt production occurred on the Rosalita property, as did ceramics and possibly burials from the Early to Middle Postclassic. Most burials from all areas were Late Postclassic or Early Historic. Given the disturbed nature of the evidence, all that can be said is that the inhabitants of the area that is now San Pedro engaged in the same range of activities as did the occupants of Marco Gonzalez, although perhaps to different degrees. Evidence noted above also suggests the later occupations in the centre of San Pedro at Elvi's, Alamilla's and Sands/Parham may represent Maya from Marco Gonzalez who moved to an area more accessible to the sea sometime in the later Postclassic period.

CHAPTER 3

Tool Typology for Lithics from Marco Gonzalez and San Pedro

Most of the formal tool forms recovered from Marco Gonzalez and San Pedro are identical to the tool types produced at the workshops at Colha on the Belizean mainland [Figure 4]. They were manufactured from the 'chert-bearing zone' cherts surrounding Colha. Because the typology established for Colha is so widely applied in modern lithic assemblage classifications for sites in Northern Belize (Hester 1985; Hester and Shafer 1984, 1991b; Hester et al. 1991; Hult and Hester 1995; Lewenstein 1987; McAnany 1986, 1989b; Masson 1993; Michaels 1989; Mitchum 1991, 1994; Potter 1991b; Roemer 1991; Shafer 1983, 1985; Shafer and Hester 1983), I have chosen to use to it in most cases. Instances in which a different classification has been employed relate primarily to tools made from flakes, or to varieties of smaller bifaces that have traditionally been classified as knives or projectile points. In lieu of this classification based on inferred function, a more descriptive and, arguably less ambiguous, terminology has been employed [i.e. small, thin stemmed biface].

The lithic typology established for the Colha sequence (Hester 1985; Hester and Shafer 1984; Shafer and Hester 1983) will be used to establish a general chronology for the excavations at Marco Gonzalez and San Pedro. However, given the natural and cultural disturbance at these sites, it is understood that lithic artifacts, irrespective of their classification in the Colha typology, can occur in deposits of varying dates. In such instances, lithic traits are secondary to archaeological context, specifically in relation to ceramics and architectural features.

Figure 4: Tool Typology from Lithic Assemblages at Colha (adapted from Hester 1980)

The sequence of tool types by lithic assemblage is presented by chronological period.

Lower Left Corner: Burins on blade and 'early' form adze [T-form] (Middle Preclassic and probably Early Preclassic)

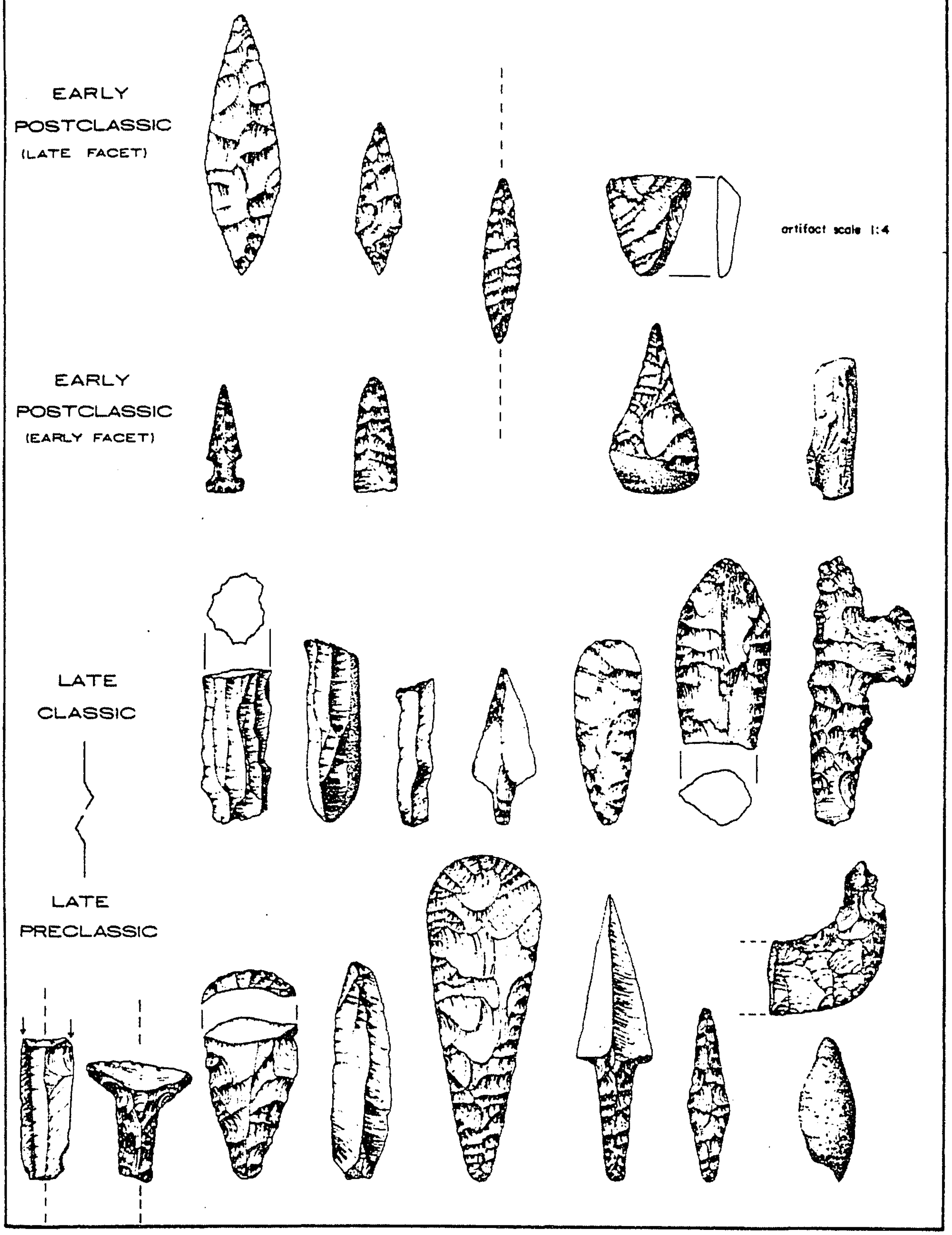
Late Preclassic: Tranchet-bit adze and tranchet flake; macroblade; large oval biface; stemmed macroblade; stemmed biface; eccentric fragment (upper); hammerstone (lower).

Late Classic: Polyhedral chert blade core; unifacial (tabular) chert blade core; blade; stemmed blade; celt; general utility biface; eccentric.

Early Postclassic ('Early' facet): Stemmed (side-notched) point; triangular point (preform?); tapered biface; antler percussor (both of the latter continue into the 'Late' facet).

Early Postclassic ('Late' facet): Lenticular biface, large form; lozenge biface; lenticular biface, small form; triangular adze.

LITHIC ASSEMBLAGES AT COLHA



The Colha Lithic Chronological Sequence

Middle Preclassic

In the Middle Preclassic at Colha, two lithic sub-assemblages divided into four main tool types are present: a blade sub-assemblage consisting of macroblades (see Macroblades) and a biface sub-assemblage consisting of the T-shaped adze, the wedge-shaped biface, and the celtiform biface (Potter 1991b).

T-form adzes:

The T-form adze makes its first appearance in Maya tool assemblages at Colha [Operation 2012] in the Middle Preclassic (Potter 1982, 1991b:23, Fig.2c). According to Potter (1991b:24-25), this tool form was typically made on a large macroblade. These adzes are distally-beveled on an expanding bit-end and are primarily trapezoidal in cross-section. Significant portions of the original macroblade blank are normally present on the interior aspect directly adjacent to the beveled bit. The distal or steep-angled bit end is chipped from the striking platform end using hard-hammer percussion (Potter 1991b:27).

Wedge-form bifaces:

In addition to the T-shaped biface, elongated triangular 'wedge-form' bifaces made on macroblades are also diagnostic of the sub-assemblage from this period (Potter 1991b:26, Fig.4b). Although, the production technique for the characteristic single facet dorsal bevel on the distal end of these tools that gives them a 'tranchet'-like appearance has been difficult to determine, Potter (1991b:25,27) states that Glen Goode

> ...has suggested that the distinctive "T" and "wedge-shaped" tools were struck from specially prepared cores. The core-scores would have had the large size typical of macroblade cores and would have had a pentagonal shape. Blades detached from such cores and intended as tool blanks were driven off so that the terminus of the blade trimmed off the obtuse "shoulder" angie of the pentagonal core, thus producing the characteristic bevel required for these distinctive tools.

In addition to Colha, wedge-form and T-shaped tools have also been recovered from early deposits at Cuello (Hammond et al. 1979: Fig. 5) and share certain similarities with the Jenny Creek assemblage from Barton Ramie, specifically one plano-convex adze form with an expanding bit (Willey et al. 1965: Fig. 274b, 433).

Celtiform bifaces:

A celtiform biface made primarily on macroblades is another tool type diagnostic of this period (Potter 1991b:23, Fig.2a, 25). Some of these tools possess small flat facets or cortical surfaces on their proximal ends which have been interpreted as remnants of the macroblade striking platforms. Furthermore, some celtiform bifaces reveal flaking patterns described as 'atypical'. In these examples, the flake scars do not originate on the tool's lateral edges extending into the interior of the tool as biface thinning flake scars do. Instead, the flake scars extend down the length of the celt much like the scar patterning expected on a macroblade. Despite the fact that the majority of these celts were manufactured from macroflake blanks, a small number were bifacially flaked from small cobbles (Potter 1991b:27).

Late Preclassic

In the Late Preclassic (ca. 400 BC-AD 250), the workshops at Colha were manufacturing five main tool forms: oval bifaces, tranchet-bit tools, stemmed macroblades, bipointed bifaces, and eccentrics (Shafer 1985:282, 1991:31; Shafer and

Hester 1983:524, 525, Fig.4). The oval biface and tranchet-bit tools were manufactured on macroflake blanks which were typically larger than 30 cm in length (Shafer 1979:58, 1985: Fig. 12.5; Shafer and Hester 1983:524).

Large oval bifaces:

The large oval bifaces are characteristically teardrop-shaped with a bit-end that ranges from straight to convex in plan view and whose edges taper to a narrow, rounded butt end (Mitchum 1991:46; Shafer 1991:33, 34, Fig.2; Shafer and Hester 1983:526, Fig.5a). Typically, these tools are lenticular in cross-section with one face, usually the exterior, more convex than the other (Mitchum 1994:64). Although there may be some patches of cortex on the butt of these tools, the wider bit is bifacially retouched to an angle between 60- 80 degrees. In terms of size, these tools usually have a length that is 2.5 times the width and range from roughly 18 - 30 cm long, 8 - 12 cm wide, and 2 - 3 cm thick. Although some oval bifaces are reduced from stone cores, the majority are produced from large flake blanks. These tools are made entirely by hard-hammer percussion. Removal of bifacial thinning flakes from the lateral edges was done with elongated siliceous limestone cobble hammerstones (Roemer 1991:57; Shafer 1979:54-60, 1985, 1991:33; Shafer and Hester 1983:524). The edges vary from straight to sinuous in profile and in certain instances are slightly ground. The majority of these edges possess small hinge-shaped retouch scars along their margins which are most pronounced on the bit (Mitchum 1991:46). Nash (1980) notes that the striking platforms for retouching are accomplished by beveling the entire length of a lateral edge to produce a platform angle close to 90 degrees. Much like the general-utility bifaces (see below), oval bifaces of reduced size and slightly different form may be found throughout the lithic sequence at Lowland Maya sites.

Tranchet-bit bifaces:

Similar to the oval biface, the tranchet-bit tool is also manufactured from a macroflake or macroblade blank. These tools range in outline from triangular to triangular-ovate with more or less plano-convex cross-sections that are either unifacially or bifacially flaked (Mitchum 1991:46; Shafer 1991:33). The size of tranchet-bit adzes ranges from 7.1 - 13.5 cm in length, 3.1-6.9 cm in width, and 1.6-3.1 cm in thickness (Shafer 1991:33). While the butt is rounded, the bit-end is produced by a side-struck blow which removes a transverse or 'tranchet' flake from across the wider end of the blank, thus creating an edge-angle at the intersection with the interior surface measuring between 65 - 70 degrees. Shafer (1991:33; see Bordes 1968:248) believes this process is similar to the procedure for creating cleaver bits on Middle Palaeolithic tools from the Middle East. To accomplish the removal of the tranchet flake, the platform end of the macroblade was unifacially trimmed to form a convex end designed to properly guide the side-struck blow across the face of the tool blank. To assist in this procedure, the bulbar portion of the blank is deliberately retained to serve as the interior face of the tool at the bit end. Shafer (1983; Shafer and Hester 1983:524) explains that the bulbar swelling on the interior surface assists in the production of a more perpendicular bit angle for the completed tranchet-bit tool and the resulting flake removal creates the feather-terminated flake scar that is the tranchet bit across the distal exterior end of the preform. To remove the tranchet-bit or 'orange-peel' flake (Shafer 1976:22, Fig.1, 24, Fig.2, 1991:36, Fig. 4a, b), a unifacial notch was chipped into the bulbar surface on one edge of the preform that intersected the retouched end. This notch or spur was abraded or blunted and used as the striking platform for the subsequent removal of the tranchet flake (Shafer 1976:32, Fig.6, 33, 1985:302-303; Shafer and Hester 1983:524). Once the transverse flake is removed, the preform is bifacially reduced to its finished form. Although Wilk (1976b) originally proposed that the tranchet flake was a new form of scraper, this is no longer viewed as a viable proposition.

While at least one tranchet-bit flake was tentatively identified in the field by the excavators, a re-evaluation determined that this was not the case.

Stemmed macroblades:

The Late Preclassic also witnessed the introduction of the stemmed macroblade. Large stemmed macroblades; also referred to as 'daggers' or tanged macroblades, are known from such Northern Belize sites as: Ambergris Caye, Cuello, Colha, Kichpanha, Laguna de On, Northern River Lagoon, Pulltrouser Swamp, San Estevan, Nohmul, Chan Chen, Cerros Beach, Cerros, San Jose, Louisville, Sarteneja, Boom and Santa Rita Corozal (Andresen 1976; Dockall and Shafer 1993; Hester 1982; Hester et al. 1991; Hult and Hester 1995; Lewenstein 1987; McAnany 1986, 1989b; Masson 1993; Mitchum 1986, 1991; Mock 1994; Potter 1993; Rovner 1975; Shafer 1982, 1991; Shafer and Hester 1983:524). Similar points, some only unifacially worked at the stem, have been reported from both Haiti and Jamaica, and may represent an island and coastal adaptation that is not solely Maya in origin (Coe 1957: 280). Examination of specimens from Pulltrouser Swamp have shown use as spear points and knives (Shafer 1983), while those recovered from an Early Classic offertory cache at Holmul reveal no evidence of use (Gibson 1986, 1989:122).

The modified macroblade occurs in various shapes, but the only formal macroblade tools are those whose stems are bifacially chipped and account for one third of the total tool length (Shafer 1991:35). The smallest forms of this tool may not possess bifacially retouched stems (Mitchum 1991:46). Examples of outline variation are the rounded shoulder, slightly tapering stemmed macroblades from Cerros (Mitchum 1991:46), and the contracting stem variety from El Pozito (Hester et al. 1991:72). The tool's cross-section is described as lenticular to slightly convex in shape (Shafer 1991:38). The stem is usually bifacial and plano-convex in cross-section (Gibson 1989:122).

Like the oval bifaces and tranchet-bit tools, stemmed macroblades are made on macroblade or, less commonly, on macroflake blanks and are manufactured by hard-hammer percussion (Gibson 1989:122; Shafer 1991:38). The majority of these tools were made on larger blades from opposed platforms of larger prepared cores. The striking platform of the blade was reworked into the stem of the macroblade (Mitchum 1991:46).

Early Classic

In the Early Classic period (AD 250-550), the frequency of stemmed macroblade production declines (Shafer and Hester 1983:529), yet there is very little significant change in the nature of the lithic assemblage at Colha.

Late Classic

There was a definite continuity in the lithic manufacturing traditions from the Preclassic into the Late Classic (AD 550-850) at Colha, although a change in the formal tool assemblage occurred. The large oval bifaces, tranchet-bit tools, and macroblades were still produced, but in significantly reduced numbers and with some changes in morphology (Hester 1985; Shafer and Hester 1983:529). Macroblade production was essentially replaced by mass production of blades and stemmed blades and new biface forms were manufactured for the first time (Shafer 1985:309; Shafer and Hester 1983:525, Fig.4). Evidence of this blade production technology included the recovery of blade cores [tongue-shaped and polyhedral], core preparation blades [ridge blades], aborted blades, core rejuvenation flakes [core tablets], rejected blade artifacts, and blades themselves (Roemer 1991:59, Fig.1, 60, Fig.2, 61, Fig.3, 62, Fig.4a,b; Hester and Shafer 1983:529, 531).

Stemmed blades:

Stemmed blades, usually much smaller and less well made than the Late Preclassic macroblades, appear in Northern Belize at sites such as Colha, Cuello, Northern River Lagoon, Lamanai, Kichpanha, San Jose (Hester 1982:199), El Pozito (Hester et al. 1991:74), Pulltrouser Swamp (McAnany 1989b: 335) and coastal sites on Ambergris Caye (Potter 1993:285). At the Operation 2007 workshop from Colha, the stemmed blades average 71 mm in length, 25 mm in width, and 8 mm thick (Roemer 1991:58). However, Shafer and Hester (1983:531) noted that these artifacts varied in length from 6 to 12 cm. Most of the stemmed blades possess only one exterior ridge and are plano-convex in cross-section (Roemer 1991:58). These points are most likely knives and projectiles (probably spears or lances), but their reduced size leads one to suggest a possible use as atlatl [*hulche* in Maya (Landa 1937:16)] dart points (Hester and Shafer 1987:250; Roemer 1991:58). Both size, and perhaps more importantly, weight should be considered when evaluating the probability of darts and atlatls in the Classic period, as well as the probable absence of the bow and arrow during these same times (Coe 1965:597).

Early Postclassic

With the beginning of the Early Postclassic (AD 900-1150), came the widespread appearance of new formal tool forms and the increased use of chalcedony to manufacture some of these tool types (Shafer and Hester 1983:531). At Colha, evidence suggests a break from the earlier lithic traditions of the Preclassic and Classic periods with the disappearance of blade technology and most bifaces of celt form (Hester 1982:201), although small oval biface celts were still being produced (Hester and Shafer 1991b:156). There is an accompanying shift in technology to soft-hammer production (Shafer and Hester 1983:531).

Workshop deposits at Colha are subdivided into "Early" [i.e.: Operation 2010] and "Late Facets" [i.e.: Operation 2001] of the Early Postclassic based on Fred Valdez's ceramic data proposing that the "Late Facet" represents the Middle Postclassic at the site (Hester and Shafer 1991b:156, Shafer and Hester 1983:531). Diagnostic lithics of the "Early Facet" assemblage include chert and chalcedony side-notched projectile points, tapered bifaces, hand-held triangular bifaces, and antler billets (Hester 1982:201; Hester and Shafer 1991b:156; Michaels 1989:151; Shafer and Hester 1983:525, Fig.4, 533, Fig.10c,d,e).

<u>Side-notched points or thin bifaces:</u>

The side-notched points are particularly significant because they are identical in morphology to contemporary varieties at Chichen Itza from "late... Mexican periods or later", Altun Ha and Lamanai (Hester 1982:201; Hester and Shafer 1991b:156). Other varieties of both thick and thin side-notched points similar to Terminal Classic/Early Postclassic forms come from Seibal and the Cenote of Sacrifice at Chichen Itza (Coe

1965:598,fig.2s-t; Sheets 1991:171). They are seemingly representative of an Early Postclassic movement of Yucatan Maya into Northern Belize. Proskouriakoff (1962:424-425) suggests that lithics from Chichen Itza, with their predominance of atlatl dart points, are evidence for a Toltec domination of weaponry. Rovner believes (1976:47) that notched points are "clearly a Postclassic-equivalent period occurrence".

Lenticular, lozenge and bipointed bifaces:

The "Late Facet" heralds the disappearance of side-notched points at Colha, and the bipointed lenticular ['lozenge', 'laurel leaf'] bifaces become the dominant lithic type, along with small triangular bifaces and an oddly-shaped tapered biface (Hester and Shafer 1983:525, Fig.4, 533, Fig.10a,b,f,g; Michaels 1989:151; Shafer 1985:282). Many of these tools, primarily the lenticular and lozenge bifaces made of chalcedony and chert, were finely flaked using soft-hammer percussion. It has been generally assumed that the finished specimens served as dart points (Hester and Shafer 1991b:156; Michaels 1987, 1989:151; Shafer 1985; Shafer and Hester 1983:531). Lozenge and lenticular bifaces are noted from Lamanai. Andresen (1976:169, Fig.11d) reports a laurel leaf biface from Patchchacan identical to Colha's lozenge specimens, but believes it to be a ceremonial tool dated to the Late Postclassic. Hester (1982:202) considers it Early Postclassic in form. Still other large lanceolate bifaces of general laurel leaf shape [two varieties: incurvate and ovate] from Chichen Itza are similar to those at Colha (Sheets 1991:175).

Late Postclassic

Small side-notched projectile point (SSNP):

The small side-notched points recovered in the Late Postclassic (AD 1150-1500) were not a product of the workshops at Colha and therefore do not represent a technological phase in the Colha typology. Nevertheless, this tool type is viewed as a temporal marker in lithic assemblages throughout the Maya Lowlands. According to Proskouriakoff (1962:360), in the Late Postclassic period Maya weaponry concentrated heavily on the bow and arrow. Numerous tiny points averaging approximately three grams each were found at Mayapan, and were unlike any previous points discovered at any other Maya site (Coe 1965:598,fig.2x-z; Hassig 1992:254). Tiny triangular obsidian or chert side- and basal-notched points made on flakes or blade segments became widespread throughout the Maya region in the Late Postclassic. The retouch on these artifacts was minimal and often poorly executed. These lithics were usually unifacially flaked, although some bifacial examples exist (Simmons 1995). These 'points' were not labour intensive like other earlier tool forms recovered in the Maya area. A great majority were recovered from humus layers or as surface finds at sites such as Colha, Lamanai, Santa Rita, Tipu, Corozal Beach, Chan Chen, El Pozito, Barton Ramie, and Cahal Pech in Belize, and Rio Bec, and Dzibilchaltun in Mexico, where both flat and round based points are known (Andresen 1976:164,Fig.8a,f; Hester 1982:202; Hester et al. 1991:74; Rovner 1975:94-95; Simmons 1995; Stemp 1992: Fig.17). According to Rovner (1975:295), this projectile point type should be considered a new introduction based on the fact that it bears no morphological or technological relationship to notched points of the Early Postclassic (and, possibly, the Toltec invasion).

Additional Lithic Tool Classes at Marco Gonzalez and San Pedro

In addition to the tool types identified from the Colha chronology and the Late Postclassic, other lithic artifact classes from Marco Gonzalez and San Pedro have been recognized. These consist of both bifacial and unifacial tool types and the waste material from tool manufacture, repair and recycling.

Bifaces

Bifaces are described as lithic artifacts with flake scarring occurring on both the exterior and interior faces of the blank (Crabtree 1972).

General-utility bifaces:

Often referred to as 'celts', 'chopping tools' or 'choppers' (Kidder 1947:Fig.61; Rovner 1975; Rovner and Lewenstein 1997:19; Thompson 1991:147; Willey 1972:157-161, 1978:105-108; Willey et al. 1965:423), these thick bifaces are both chronologically and spatially wide-spread throughout the Maya Lowlands, occurring in various forms at sites such as Uaxactun (Kidder 1947), Nohock Ek (Coe and Coe 1956), Piedras Negras (Coe 1959), Mayapan (Proskouriakoff 1962), Barton Ramie (Willey et al. 1965), Altar de Sacrificios (Willey 1972), and Tikal (Becker 1973; Moholy-Nagy 1976). They also occur at Aventura, Santa Rita, Chan Chen, and Patchchacan (Andresen 1976), Seibal (Willey 1978), Colha (Shafer and Hester 1983), Pulltrouser Swamp (Shafer 1983), San Antonio (Shafer and Hester 1986), Becan (Thompson 1991), El Pozito (Hester et al. 1991), Altun Ha (pers. observ.), Ambergris Caye (Hult and Hester 1995), Laguna de On (Masson 1993, 1997) among others, and are therefore not used as temporal indicators. Their dimensions are variable, but they are usually thicker and heavier tools than the oval bifaces. Usually the distal or bit ends are much more severely damaged than other tool edges. At Marco Gonzalez and San Pedro, these bifaces are heavily used and re-used, or recycled into a variety of other tools, most of which are hammerstones or pounding/crushing tools (see below).

Biface preforms:

These are lithic pieces that represent any stage in the manufacturing process of a specific biface form after the initial or most preliminary modification of the flake/blade blank or nodule (Muto 1971; see Callaghan 1979). Preforms were typically not continued to their final form due to flaws in the raw material, a non-repairable manufacturing error (see Shafer and Oglesby 1980: Figs.5, 13), accidental loss, or intentional discard.

Re-used and recycled bifaces:

These are tools that would have originally been classed as other biface types, but that have experienced either a change in function or more obviously, a change in form. In most cases if the original tool type was identifiable, the artifact was classed in that category. The secondary, tertiary, etc. uses were also documented based on observable characteristics. Use-wear analysis of these tools was documented separately. Tools that are considered expedient or *ad hoc* may fall into this category (see Dockall and Shafer 1993; McAnany 1986). These tools were typically either exhausted for their primary task, broken during use, or recovered after accidental loss or intentional discard [i.e. cached]. *Ad hoc* or recycled tools may have been used to perform tasks other than those for which they were originally designed, or used as sources of raw material. Most of the tools in this category were recycled into hammerstones.

Stemmed thin bifaces:

Stemmed thin bifaces are bifacially flaked complete tools or proximal fragments thereof that are less than 1.5 cm in thickness and possess a long or tapered stem for hafting purposes. Some of these forms may resemble lozenge-shaped bifaces from Colha (see above).

Stemmed thick bifaces:

Similar to the stemmed thin bifaces, this class of tools includes bifacially flaked complete tools or proximal fragments thereof. However, the artifacts in this class measure more than 1.5 cm in thickness and possess a long or tapered stem for hafting purposes.

Shouldered thin bifaces:

Shouldered thin bifaces are bifacially flaked complete tools or fragments thereof that are less than 1.5 cm in thickness and are shouldered or possess gradually contracting proximal ends for hafting purposes.

Shouldered thick bifaces:

Much like the shouldered thin bifaces, this category of lithics includes bifacially flaked complete tools or fragments thereof, that are shouldered or possess gradually contracting proximal ends for hafting purposes.

Bipointed thin bifaces:

As the name suggests, artifacts in this category have contracting edges or points at both their proximal and distal ends. In most cases, the striking platform from the proximal end has been completely flaked away. These bifacial tools are less than 1.5 cm in thickness.

Miscellaneous bifaces and biface fragments

This is a catch-all category for those bifacial tools that either do not fit the criteria for any other identified biface category or that have been modified or damaged to such an extent that their original form is no longer recognizable.

Miscellaneous thin biface fragments:

This category of tools is composed of those fragments of bifaces less than 1.5 cm thick that cannot be accurately assigned to any other tool category. In all cases, these fragments represent either a medial edge fragment, a distal tip fragment, or the stem section of broken tools that have been traditionally classified as projectile points, knives or lanceolate bifaces.

Miscellaneous thick biface fragments:

Much like the miscellaneous thin biface category, this is a catch-all tool class for medial edge fragments, distal tip fragments and biface stems thicker than 1.5 cm that were not complete enough to be included in any other tool category. Many of these fragments were probably edges from oval or general-utility bifaces.

Biface edge fragments:

These primarily thick edge flakes were either failed attempts at bifacial thinning, resharpening flakes on large bifaces, or the result of use-related impact. They possess a smooth interior surface with a pronounced bulb of percussion sometimes including an éraillure scar, and end in a feather termination. The striking platform for these flakes is located on one of the original faces of the biface from which they were removed. Often a ring-crack is observed on the biface surface where impact occurred and suggests that the resharpening attempts were undertaken using a hard-hammer percussor. The exterior surface of these flakes is covered in flake scars from earlier bifacial thinning events on the tool. The edge where originally the interior and exterior surfaces met usually possesses heavy crushing, as well as both step and hinge termination scars.

Hammerstones

Chert hammerstones are not restricted to any temporal period, and may be found throughout the chronological range of artifacts in the Maya Lowlands. These hammerstones usually appear as either battered nodules or recycled cores with heavy battering on one or more of their edges (Mitchum 1991:50; Shafer 1991:40). Shafer (1991:40) asserts that chert hammerstones are likely associated with the earlier stages of the reduction process, and may also be used for the removal of difficult areas in these early stages.

In the assemblages from Marco Gonzalez and San Pedro, a significant number of exhausted or broken thick biface fragments have been recycled into 'expedient' hammerstones or crushing/ pounding tools. Hammerstones have been identified based on extensive crushing or pitting of one or more surfaces or edges. This seems to conform to other extreme biface reduction patterns from Pulltrouser Swamp (McAnany 1989b; Shafer 1983) and Ambergris Caye (Hult and Hester 1995), despite Mitchum's (1994:52) argument that evidence of previous bifacial use is required to prove that similar types of discoidal hammerstones were not simply manufactured directly from macroflake blanks.

No limestone hammerstones, similar to the ones from Colha described by Shafer (1991: Fig. 8; Shafer and Oglesby 1980: Fig. 9), were recovered from the excavations at either of the sites from the southern end of the Caye. Furthermore, there were no antler billets similar to those from the Early Postclassic deposits at Colha found at either site (Hester and Shafer 1991: Fig. 1; Michaels 1987, 1989; Shafer 1991).

Flakes and flake tools

<u>Cortical and non-cortical flakes:</u>

Flakes were removed from tools, cores, other larger flakes, or blades. They can generally possess any combination of length and width, but are usually thin in cross-section. In order to be classified as a flake, a piece must be unretouched and possess one or more of the following technological features: a striking platform, a bulb of percussion, an éraillure scar, concentric rings on the interior surface [Hertzian cone (Tsirk 1979)] (Crabtree 1972:64, Muto 1971:124). Distal ends of flakes will possess either feather, step, hinge, or snap terminations (Cotterell et al. 1979). Flakes are usually discarded as waste material in the lithic manufacturing process, but they can be used as *ad hoc* tools or modified into other tool forms. Flakes were identified as whole if they were at least 90% complete. In most instances, incomplete whole flakes were missing part of the distal tip, the striking platform, or one lateral edge.

Non-cortical flakes possess none of the original cortex or stone rind on their exterior surface (McSwain 1989:117). In this analysis, non-cortical flakes have been termed 'tertiary' and are coded 103 [see Appendix A] (Magne 1989:17; Odell 1989:195; Sullivan and Rozen 1985:756). They are generally considered to be products of later phases in tool production.

Cortical flakes possess one or more of the technological features described above, in addition to some cortex on their exterior surface (McSwain 1989:117, Sheets 1975:375). The percentage of cortex on the exterior surface can range from 100% [total coverage] to less than 1%. While the amount of cortex retained by a flake has been used to determine its stage in the reduction process of lithic tool manufacture (Collins 1975; Sheets 1975; Muto 1971), factors such as the original shape of the stone nodule, and the type of tool manufacture [i.e. soft-hammer bifacial thinning vs. hard-hammer flake production] can affect the amount of cortex possessed by a flake. It has also been noted that "... assemblages produced by the reduction of large nodules into bifaces may show wider flake-size ranges and more cortex than those resulting from the manufacture of these same forms from large flakes" (Rozen and Sullivan 1989:172; see Shafer 1985). Although it is understood that percentage of cortex is not solely restricted to a specific stage in reduction, studies have revealed that cortex in any amount is overwhelmingly present in early reduction stages and only rarely in others (Magne 1985, 1989:17; Mauldin and Amick 1989:67). According to Tomka (1989:141, Fig. 2), while the highest percentage of flakes with 1-50% cortex are produced by core reduction with no specific pattern of decortication, biface production produces the highest aggregate percentage of flakes with variable cortex coverage.

In this analysis, a flake possessing 100% cortex on its exterior surface is termed 'primary' and was coded 101. Flakes possessing between 99 and 1% cortex are termed 'secondary' (Magne 1989:17; Odell 1989:195; Sullivan and Rozen 1985:756). Secondary cortex flakes are coded 102/2 if they possess less than 50% cortex on the exterior surface and 102/3 if they possess between 50 to 99% cortical covering on the exterior surface. Tools coded 101 are believed to be the earliest phase of reduction, while those coded 102/3 and 102/2 are considered to be subsequent, but not necessarily ordinal reduction stages.

Although there are other methods for the definition of reduction sequences, including individual flake weight, flake size distribution, or dorsal scar count (Amick et al. 1988; Magne 1985; Stahle and Dunn 1982), assemblage analysis such as Sullivan and Rozen's (1985; see Prentiss 1998; Prentiss and Romanski 1989) 'distinctive assemblage' typology, or mass analysis (Ahler 1989a), I have chosen cortex cover based on ease of recognition and the fact that smaller debris or shatter was either not recovered or selectively recovered from the Ambergris Caye sites. It is understood that classification of reduction into stages is not as definitive as some believe due to factors such as raw material type and/or availability, core size, the intensity of reduction, the nature of regional raw material procurement and reduction systems, and stylistic and functional factors (Sullivan and Rozen 1985:756). However, cortical flake categories can be utilized to determine the general reduction patterns occurring in the assemblages. The subdivision of cortical flakes into stages is done for ease of technological analysis, since tool manufacture actually occurs as a continuous process (Muto 1971; Sheets 1975; Shott 1996a).

Macroflakes:

Macroflakes are typically larger than 30 cm in length (Shafer 1979:58, 1985: Fig. 12.5; Shafer and Hester 1983:524) and may be cortical or non-cortical. In the Maya lithic industry of Northern Belize, they usually serve as blanks for the manufacture of other tool forms such as large bifaces, but may be used as *ad hoc* tools.

Bifacial thinning flakes or resharpening flakes:

These pieces are primarily thin flakes removed from bifacial tools in an attempt to modify, reshape, repair, or resharpen the original tool. Bifacial thinning flakes may possess various amounts of exterior surface cortex, although they are usually restricted to categories 102/2 and 102/3 ('secondary') and 103 ('tertiary') flakes, and represent later stages in the reduction process. Two main types of bifacial thinning flake have been identified in this assemblage based primarily on the possession of part of the bifacial edge of the original biface (Shafer 1983; McAnany 1986, 1989b). Category A includes those that conform to a more traditional billet or soft-hammer percussion technique. Flakes in this category predominantly possess the lipped striking platforms similar to those recovered from the Early Postclassic workshop deposits at Colha (Shafer 1979; Shafer and Hester 1983:531, Fig.6b, f; see Ahler 1989b:210; Callaghan 1979; Crabtree 1972; Frison 1968:149; Hayden and Hutchings 1989:247) and often correspond to the Distinctive Expanding Billet flake variety described by Hayden and Hutchings (1989:246, Fig.6). Category B includes 'harder'-hammer percussion flakes (Callaghan 1979; Hayden and Hutchings 1989:249) possessing striking platforms that are beveled at right angles to the tool surface. These platforms usually exhibit conelike fractures indicative of a small contact surface, as well as, ring-cracks that characterize flakes recovered primarily from Preclassic and Late Classic deposits at Colha (Shafer and Hester 1983:524, Fig.6a, c-e). This category also includes thinning flakes that share the characteristics of both traditional hard-hammer and soft-hammer percussion. It has been observed that some of these flakes possess the diagnostic lipping occurring on the billet flakes, instead of the more beveled right-angled edge more typical of hard-hammer percussion, or beveled edges with less pronounced cone-like fractures and fewer ring-cracks (see Callaghan 1979:24). It is believed that Category B flakes may have been produced using a 'softer' or less-dense hammerstone of a material such as limestone (Shafer 1991:40). However, the irregularity of some of these flakes, the larger size of the platforms, and the pronounced interior features, suggest that either a heavy or less experienced hand produced these flakes or perhaps, a chert hammerstone was substituted for the limestone tool. Bifacial thinning flakes can be used as *ad hoc* tools, however they were rarely modified into other tool forms.

<u>Retouched flakes:</u>

These may be cortical or non-cortical flakes that have been deliberately retouched through percussion- or pressure-flaking and may have been modified into another tool form. There is no specific shape or size for the individual tools, nevertheless, those that are classed together will share certain morphological and/or technological similarities.

Denticulated flakes:

These cortical or non-cortical flakes usually possess at least one edge that has been unifacially flaked or retouched into a 'sawtooth'-like profile. Although, bifacial denticulation is possible, it is rare.

Blades and blade tools

Blades:

Blades are defined as any flake that possessed a length at least twice its width (Crabtree 1972) and that was produced using a prepared core and blade technique (Crabtree 1968). These tools were mostly either triangular or trapezoidal in cross-section, but with some possessing more than two exterior ridges. Blades are typically long and parallel-sided (Crabtree 1972:42). Complete blades or proximal blade fragments possessed technological features similar to flakes including: striking platforms, ring-cracks, éraillure scars, a bulb of percussion, and concentric rings [Hertzian cone (Tsirk 1979)]. Some medial and distal fragments also possessed concentric rings, while distal fragments primarily ended with feather terminations (Cotterell et al. 1979). In some instances, step, hinge and outre-passé terminations were also possible. Blades are smaller than macroblades, usually measuring less than 10 cm in length (Shafer 1979:63). Blades may be used as *ad hoc* tools or modified into other tool forms. Prismatic blades are also included in this tool category, however, most chert blades seem to have been produced by either direct or indirect percussion as opposed to the production of prismatic obsidian blades using pressure as described by Crabtree (1968) and Sheets (1975:377). Some blades may retain portions of cortex, but this is rather rare.

Retouched blades:

These are blades that possess one or more sections that have been deliberately modified primarily by pressure-flaking, or less frequently by percussion flaking. The blades have not necessarily been changed into another specific tool form, but have retained their general shape. Backed blades are included in this tool category. Blades that were unifacially retouched on the proximal end resembled examples from the Late Classic deposits at Colha and were classed as stemmed blades. Unifacial distal retouch produced a point on these tools (Roemer 1991). Similar to tools on flakes, the blades or blade fragments could also be deliberately modified into other tool forms. Comparable tool forms are not necessarily standardized, but usually possess similar shapes or features.

Microblades:

There does not appear to be a well-developed or widespread microblade or bladelet component in the lithic assemblages recovered from Colha and sites that rely on its workshops to provide lithic tools. For the purposes of this analysis, whole microblades or bladelets are less than 5 cm in length and less than 2 cm in width.

Macroblades:

The term macroblade is used to distinguish the larger blade production in the later Middle and Late Preclassic from the smaller prismatic blade production in the Late Classic. The macroblades from Middle Preclassic deposits at Colha are large and wide (averaging 15 cm long by 6.5 cm wide) with a simple single facet or cortical platform. They were produced using the hard-hammer percussion method and may be modified by further retouch, often unifacial, to produce other tool forms or as parent cores for the removal of burin spalls (Potter 1991b:21,23, Fig.2f,g, 24). Macroblades were also used as the blanks for the manufacture of other tool types diagnostic of the Middle Preclassic found in the biface sub-assemblage. Smaller blade forms (circa 3 cm long) that were typically either backed or burinated in a manner identical to the *burin sur troncature retouchée concave*, were also produced (Potter 1991b:24; see Sonneville-Bordes and Perrot 1953). Macroblade blanks from the Late Preclassic have been described as "... large prismatic flakes, usually ranging between 100 and 300 mm long, which were systematically removed from a specially prepared core. Their length tends to be over twice the width and one or more medial ridges are found on the dorsal surface ..." (Shafer 1979:63; see also Shafer 1991:33; Shafer and Hester 1983:529). The technology for the macroblade was similar to the Middle Eastern Levallois points, having a peaked *chapeau-de-gendarme*-shaped striking platform, or a faceted platform similar to the Western European Levallois technique (Hester and Shafer 1987:244-245; Shafer 1985:305, 1991:38; Shafer and Hester 1983:529). Macroblades usually served as blanks for the production of stemmed macroblades, however, some may have been used as tools themselves.

<u>Retouched macroblades:</u>

These are macroblades that have been intentionally retouched on one or more edges. Retouched macroblades have not necessarily been modified into other identifiable tool forms, as such tool forms are included under other tool classes.

Drills (microdrills) and borers on blades or flakes:

These tools are produced on the distal ends of blades or flakes. Typically, the distal sections of the blades are unifacially retouched on the exterior aspect to form a point. There may be some minor retouch on the interior surface but, this is uncommon. Microdrills are produced on small flakes or microblades.

Blocky fragments:

This category of artifacts is essentially a catch-all classification for those lithics that are not included in any of the other categories. In the majority of instances, blocky fragments are manufacturing or refurbishing debitage or tool fragments that no longer retain identifiable technological characteristics that permit placement in another lithic category. Often a single interior surface is not identifiable. Their shapes and sizes vary considerably as does their stage in the reduction processes. Some blocky fragments do possess cortex. Some were used as *ad hoc* tools.

Burin spalls:

These are usually small, elongated flakes that were produced during the manufacture of a burin or burinated tool, although Andresen (1976:170) also describes them as "... the by-products of trimming and finishing activities ...". Their interior surface is produced when a piece is removed transversely from the longitudinal edge of another flake, blade or tool. This technique is used to create a right angle on the parent piece with the burin spall being the debitage or waste material. The burin spall was rarely employed as an *ad hoc* tool or modified into another tool form, but its use as a drill bit for drilling shell has been documented in the Middle Preclassic (Iannone and Lee 1996; Hohmann and Powis

1996). Although a single burin spall was initially identified from San Pedro, after re-examination this artifact was classified as another tool type.

Heat spalls or heat-fractured fragments:

These lithic pieces are produced when an artifact is heated or burnt (Mandeville 1973; Purdy 1974). They do not possess any of the technological characteristics of flake production and exist in two forms. The true spalls or 'pot lids' usually possess a smooth bulbar interior surface that has literally popped off its parent piece. The other heat-fractured fragments usually possess very coarse, uneven interior surfaces revealing evidence of heat fracture and heat-crazing or cracking. Due to the heat modification of the internal composition of these pieces, they are not used as tool themselves or modified into any other form.

Flake and blade cores and core fragments:

These are the remnant lithic masses or parent pieces of stone from which flakes and blades are removed. Cores and fragments thereof may be produced by random, multidirectional blows with little attention paid to the appearance of the resultant flakes or blades or they may be produced in specific ways to manufacture flakes or blades of specific shapes or dimensions [i.e.: prismatic blade cores].

The formal core types included in this analysis included: polyhedral blade cores, polyhedral bladelet cores, pyramidal flake cores, discoidal flake cores, macroflake cores, blade cores, and macroblade cores.

However, almost all of the chert cores and core fragments from Marco Gonzalez and San Pedro were basic flake cores with little evidence for standardization or planned core reduction. No formal chert blade cores were recovered from either site. However, this is not surprising given the number of obsidian blades and some exhausted polyhedral obsidian blade cores that were found. Many of the tasks likely requiring blades were performed using the obsidian artifacts. Often exhausted cores and core fragments are discarded as waste materials, however, they may serve as *ad hoc* tools such as hammerstones or be modified into other tool forms.

Core tablets or platform rejuvenation flakes:

Core tablets are produced when a blade core, typically a polyhedral blade core, is struck a side blow perpendicular to the long axis to remove the proximal or platform end of the core. This technique is employed to create a new striking platform for the removal of more blades on nearly exhausted cores or those with damaged or reduced striking platforms (Crabtree 1972:60). Although a chert platform rejuvenation flake was initially identified in the field by the excavators of Marco Gonzalez, this determination was rejected after re-examination.

Other tool types

Burins, gravers/incisors, perforators, scrapers, whittlers:

In the lithic assemblages from Marco Gonzalez and San Pedro, very few tool forms or shapes such as burins, gravers/incisors, perforators, and scrapers were originally produced for the execution of such tasks. Most of these tools are secondarily produced on already existing tools or flakes and seem much more expedient or *ad hoc* in use. They were therefore classified based on their original morphological type (see Retouched flakes). Most of the *ad hoc* tools were identified through use-wear analysis.

Burinated tools are either flakes or blades, or fragments thereof, that have been deliberately produced by the removal of an edge with a transverse blow. This transverse blow creates the right angled longitudinal flake-scar that intersects with the other transverse tool edge or breakage plane to form the burin.

The tools classified as scrapers were identified by the presence of at least one edge that was retouched to a minimum 55 degree angle. Many of the *ad hoc* scraping and whittling tools were produced on flakes or blocky fragments with minimal retouch and possessed edge angles less than 55 degrees.

Special tools/finds

The artifacts in this category are all formal tools or fragments of formal tools that possess certain raw material, manufacturing and/or morphological characteristics that are rare or absent from other tool groups. They possess interesting or unique features that differentiate them from other tools and suggest a non-utilitarian usage.

CHAPTER 4

Lithic Raw Material Types from Marco Gonzalez and San Pedro

Lithic Raw Material Types

The lithic assemblages from Marco Gonzalez and San Pedro consist primarily of a variety of cryptocrystalline silicates including cherts and chalcedonies, with limited amounts of quartzite and slate.

Chert-bearing zone (CBZ) chert:

No naturally occurring sources of chert are known on Ambergris Caye (S. Mazzullo, pers. comm. 2000), consequently, the overwhelming majority of artifacts are made of 'Colha-like' chert from the mainland. This identification is based on visual similarities to the grain and the range of characteristic colours and patterns of cherts found at the massive production site of Colha, Orange Walk District, Belize (Hester and Shafer 1984:164; McAnany 1989b:334; Mitchum 1986:105; Shafer 1983:214). The high quality material from the geographically-restricted 'flint bearing soils' (Wright et al. 1959) or 'chert-bearing zone' [CBZ] (Hester and Shafer 1984:158) of central Northern Belize [Figure 5], north of the Belize River at Colha has been described as a usually opaque, fine grained cryptocrystalline silicate that ranges in colour from gold or yellow banded, honey brown to grayish brown, and banded and/or mottled tan and gray (Hester and Shafer 1984:164; Mitchum 1991:45, 1994:54; Shafer and Hester 1983:521; see McAnany 1989b:334). The Marco Gonzalez and San Pedro chert is referred to as 'Colha-like' based on the fact that other workshops exist in Northern Belize, mostly in the Late Classic period [Altun Ha, Chicawate, Kunahmul, Maskall, and Sand Hill] (Hester and Shafer 1984:159), and that sources of this fine-grained cryptocrystalline silicate exist throughout

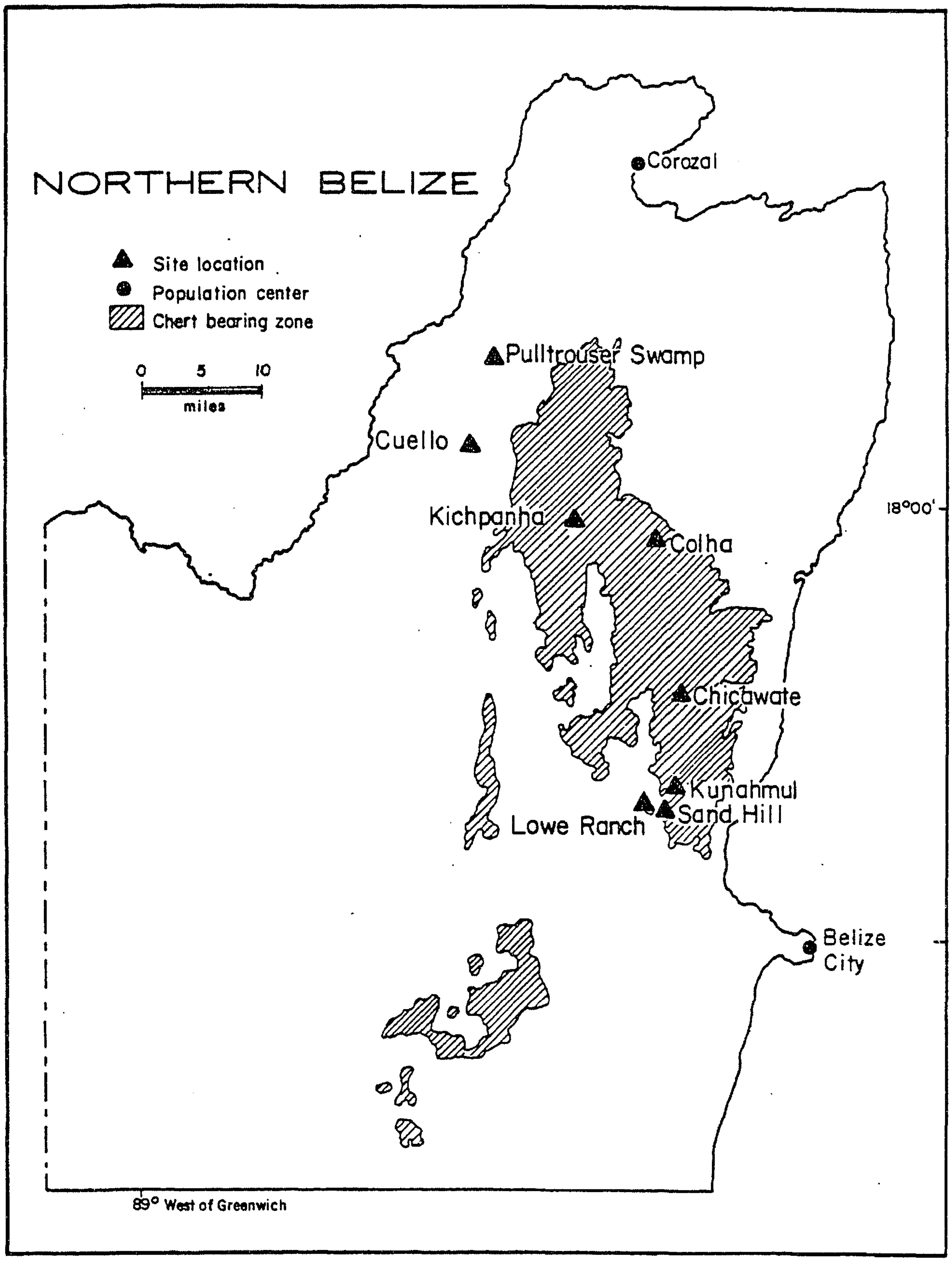


Figure 5: Map of Chert-Bearing Zone in Northern Belize (from Hester 1980)

a fairly extensive area in Northern Belize. Although, trace element analysis would appear to be the best way of determining the amount of Colha material recovered at sites throughout Northern Belize, archaeologists working in this region have infrequently pursued this type of research. The reasons for the disinterest in the application of such a technique include cost and the high degree of success in the visual identification of the CBZ cherts. Neutron activation analysis by Cackler et al. (1999) has demonstrated that the chert-bearing zone is chemically a single homogeneous source and that it is not possible to distinguish between cherts from different locations within it.

Table 1: Percentage of CBZ Chert Formal Tools from Sites in Northern Belize

Site	Percentage of CBZ Chert	Reference
Northern Ambergris Caye (San Juan, Ek Luum, Chac Balam)	87	Hult and Hester 1995
Pulltrouser Swamp	94	McAnany 1989b
El Pozito	82	Hester et al. 1991
Kichpanha	76	Shafer 1982
Cerros	87	Mitchum 1994
Laguna de On	37.5	Masson 1993
San Pedro	91.9	Stemp (thesis) 2000
Marco Gonzalez	85.5	Stemp (thesis) 2000

Table 2: Percentage of CBZ Chert Debitage from Sites in Northern Belize

Site	Percentage of CBZ Chert	Reference
Santa Rita	74.8	McAnany 1989b
Pulltrouser Swamp	75.7	McAnany 1989b
Laguna de On	21.6	Masson 1997
San Pedro	75.4	Stemp (thesis) 2000
Marco Gonzalez	81	Stemp (thesis) 2000

What primarily renders these data significant is the fact that, Laguna de On is the only site in these tables that engaged in regular tool production from locally available raw materials, in addition to importing tools from the chert-bearing zone.

'Black' chert:

A second raw material type encountered at sites on the southern end of the Caye was the controversial 'black' chert. Many sites have reported the presence of 'black' chert including: Moho Cay (Hester and Shafer 1994), Wild Cane Cay (McKillop1987), Albion Island (Shafer and Hester 1990), Ambergris Caye (Hult and Hester 1995), Catfish Bight (Mitchum 1994), Cerros (Mitchum 1986, 1994), Chau Hiix (Pyburn 1993), Crooked Tree (Barrick and Mitchum Chiarulli 1997), Northern River Lagoon (Mock 1994), and Sarteneja (Boxt and Reedy 1985).

Until recently, there was debate over whether black chert was really a naturally occurring variety of this stone type or whether it is caused by a chemical reaction resulting in manganese oxidation of 'Colha-like' or other cherts exposed to, or submerged in, salt water for extended periods of time (Hester and Shafer 1989, 1994; Shafer and Hester 1990:281). Although many lithicists make reference to the oxidation of chert exposed to salt water (Cackler et al. 1999; Luedtke 1992; Mitchum 1994; Shafer and Hester 1990), the best explanation to date is provided by Dr. D. Lewis, who states:

> Black coatings on lithic artifacts, bone, limestone, and chert or flint are very often composed of manganese oxides or a mixture of manganese oxides and iron oxides. The manganese compounds in the soil or dissolved in surface waters in the reduced state (Mn^{+2}) are colorless or faint pink. Oxidation produced by chemical reactions, or catalyzed by bacteria, forms black insoluble manganese oxides which deposit on, and adhere firmly to, silica surfaces.
>
> One factor which is especially important for the deposit of manganese oxide on the surface of chert is the presence of iron compounds in the reacting medium. The combination of iron manganese oxides forms an especially adherent series of layers of deposit. The iron ions in solution readily form hydrous iron oxides in alkaline neutral, or even slightly acidic, environments. Manganese is selectively co-precipitated to form a ferromagnesian coating which is nucleated by the silica surface to form an adherent deposit. (1994 manuscript on file, Texas Archaeological Research Laboratory, University of Texas at Austin)

Mitchum (1994:57-58) has cited numerous reasons to refute this explanation of 'black' chert, including:

1. Black chert is found at sites, such as Cerros (Scarborough 1991), Sarteneja (Boxt and Reedy 1985), Catfish Bight, and Chau Hiix (Pyburn 1993), where there appears to have been little if any exposure to salt water.

2. Unworked black chert nodules have been found at Chau Hiix (Pyburn 1993).

3. Some of the black chert is found in terrestrial contexts.

4. Not all of the chert artifacts recovered from submerged salt-water contexts are black [However, at the waterlogged site of Wild Cane Cay, chert artifacts from deeper deposits are darker than those recovered above them].

5. The black coloration does not appear as a coating or rind around the artifacts, but instead, the interior of the lithics are completely black as well.

6. Chert exposed to salt water at other coastal locations, such as Florida, does not demonstrate the same black coloration.

Ultimately, the proposed source of naturally occurring 'black' chert somewhere on the mainland opposite Moho Cay has yet to be identified and a source at Chau Hiix or Crooked Tree seems doubtful (Mitchum 1994:56; Pyburn 1993; Shafer and Hester 1990:281). According to T. Hester (pers. comm. 1998), there is no outcrop of black chert in Belize. He therefore asserts that all the black chert recovered is the result of manganese oxidation due to immersion in salt water (Hester and Shafer 1994).

Examples of 'black' chert recovered from Marco Gonzalez and San Pedro demonstrate characteristics that primarily conform to the explanation provided by Lewis, Hester and Shafer. Some artifacts possess areas that are both 'Colha' gray and black. There is a division between the two colours, as if only one end of the lithic were submerged in salt water. Furthermore, on some fractured 'blackened' chert fragments and flakes, a cross-section of the raw material indicates that the stone is not completely black in colour, but, that the darker discoloration is mainly restricted to the outermost surface with a variable depth penetration into the core of the cryptocrystalline silicate. Generally, the thickness of the black layer on a tool is thin and relatively uniform. The majority of the black chert specimens discussed above were excavated at Marco Gonzalez from conch midden deposits (lots 200, 221, 222 from Operation 6 and lots 167, 168, 174 from Operation 8) whose lowest levels were flooded with sea water

Cackler et al.'s (1999:394-396; see Tobey 1986) NAA studies confirm that the 'black' chert is indistinguishable from other cherts in the chert-bearing zone and that the discoloration of the recovered lithics is due to a weathering process. However, they express certain doubts as to whether the manganese oxidation process is the source of the black colour. Because the black surface does not exist as a built-up layer, they argue that manganese oxidation may not be occurring.

Other chert:

The final category of chert raw material established for Marco Gonzalez and San Pedro exists as a type of default classification for artifacts that are recognized as neither chert-bearing zone material nor chalcedony. Lithics found in this category include cherts whose source is other than the CBZ and those materials that have been burnt or patinated to such a degree that their original colour and/or texture cannot be reliably determined. The reasons that identification of these lithics is so difficult are provided by the processes of stone alteration due to burning and patination described below.

For the unaltered raw materials classified in this category, the most that can reliably be said of them is that they are not 'Colha-like' cherts. Unfortunately, the sources or outcrops of these cherts are at present not known. The non-chert-bearing zone raw materials are most likely from some local mainland location, as long-distance transport of these comparatively low quality raw materials seems doubtful. Although other sources of cryptocrystalline raw material have been documented, there has been no positive identification of the other sources of some the cherts from Marco Gonzalez and San Pedro. It is possible that some of the lower quality chert may be from a locally available source of inferior quality stone around New River Lagoon (Mock 1997), a local chert source near Rocky Point in Northern Belize (Kelly 1982), a yellowish-gray chert from Midwinter Lagoon (S. Mazzullo, pers. comm. 2000) and/or coarse and low-grade cherts recovered from Laguna de On (Masson 1993, 1997; Oland 1999a, 1999b).

Chalcedony:

The second type of siliceous stone found at Marco Gonzalez and San Pedro was chalcedony. It ranged in grain-size from medium-coarse to fine and was mostly ivory/white/gray, honey/yellow, and various shades of brown in colour. Chalcedonies were most easily identified by their translucent to semi-translucent appearance (Mitchum 1991:45). For example, chalcedony recovered from Pulltrouser Swamp is described as " ... [o]paque to translucent white ... with lacy, porous cortex ..." (McAnany 1989b:334), while material recovered from Kichpanha exhibits " ... brownish, reddish and yellowish semitranslucent hues; some [with] tree-like banded patterns" (Shafer 1982:168). Similar to chert, there are no sources of chalcedony found on the Caye. Therefore, the chalcedony recovered at these sites is most likely from the limestone facies north of the 'chert-bearing zone', across the Freshwater Creek and New River faults (Hester and Shafer 1984:158). The Progresso area has been identified as one specific chalcedony source (Mitchum

1991:45), however, the raw material was originally misidentified as red, brown and gray cherts by Hazelden (1973:77) and later by Andresen (1983:278). Another source of this type of stone is Richmond Hill near Orange Walk Town, Orange Walk District. Although both Hammond and Miller (1976) identified the raw material found here as chert, Hester and Shafer (1984:160), in addition to other lithicists that have worked at Colha, believe it to be a chalcedony. There is also the possibility that a source of the chalcedony recovered from the southern end of Ambergris Caye originated at Kichpanha. It is not known whether Colha controlled this potential chalcedony source. If the source was in actuality the site of Kichpanha, it is logical to assume some level of interaction or control given the relative proximity of these two locations [12.1 km] in Northern Belize. If the source was not Kichpanha, and some other Mayan community was in control of chalcedony tool production and trade, then the relatively low overall use of chalcedony at Colha would seem logical (Michaels 1989:163).

There are nine sources of chalcedony and chalcedony-quartz blend materials around Laguna de On (Oland 1999a:105, Table 1, 1999b), with at least one possible chalcedony quarry or core reduction area identified. These chalcedony types are of a grayish colour similar to some of the material recovered from San Pedro and Marco Gonzalez. Few chalcedony pieces were recovered from either site, indicating that chalcedony was not a major raw material consumed on the Caye. Shafer's experiments with chalcedony from Richmond Hill suggested that the internal voids frequently encountered within the nodules would make it difficult to produce usable bifaces. Although some flakes and blades may be produced, the internal structure of this silicate may explain its limited use throughout the Lowlands (Hester and Shafer 1984:160).

Quartzite and slate:

In addition to the cherts and chalcedonies recovered from Marco Gonzalez and San Pedro, small amounts of other modified lithic raw materials have been recovered. Although the quartzite and slate pieces represent very small percentages of the total raw material recovered from these sites, their presence on Ambergris Caye is significant. There are no known sources of quartzite or slate on the caye, therefore the presence of these stone types is due to human action. No formal tools are manufactured from these raw materials and the recovered lithics consist of informal blocky fragments or simple flakes. This, nevertheless, demonstrates some form of deliberate alteration due to cultural processes. Use of slate has been studied at the site of Pacbitun (Healy et al. 1995).

Damage to Lithic Raw Materials

Many of the factors that rendered the identification of some of the cherts difficult, also affected my ability to observe use-wear polishes on their surfaces. Patination and burning of cryptocrystalline silicates both chemically and physically alter their stone structures and pose many problems for lithicists.

Chemical alteration, patination and 'bright spots':

There are two main explanations for the alteration of surface textures and the appearance of non-use-related polishes on the surfaces of chert tools: chemical alteration (patination), or friction.

A 'patina' is generally defined as a surface alteration of a material due to some form of chemical interaction with the surrounding atmospheric, aquatic or soil environment (Hurst and Kelly 1961; Plisson 1983; Plisson and Mauger 1988; Purdy and Clark 1987:211). Andersen and Whitlow (1983:471-472), Rottländer (1975, 1976), and Stapert

(1976:11-12) supported this view with the discovery that archaeological implements from certain alkaline [basic] or acidic soils experienced a form of chemical dissolution or possessed amorphous silica layers. The chemical process creates two types of macroscopic surface alteration: white patination and glossy patination (Hurcombe 1992:75). These are both caused by the same chemicals, but the areas that are affected differ (see Rottländer 1975 for a description of the different patina formation conditions).

During patination, specific elements and/or ions are selectively removed from the stone. The patina comprises the layer of stone from which these have been removed or depleted. If the chemical reaction with the surrounding environment or matrix is strong, the fissures in the chert surface will be attacked. The holes that are created in the surface scatter the light and a white patina is created. Both Anderson-Gerfaud (1981:39) and Keeley (1980:29) report that extremely well-developed 'white patina' on an archaeological specimen can prevent use-wear analysis due to the increased surface porosity which destroys wear polishes and striations, or because the light refracted from the patinated tool surface makes it impossible to examine microscopically. If the chemical reaction is very weak, however, then the surface ridges and higher topography are more likely to be chemically attacked and the higher surface material re-deposited in the fissures forming a glossy patina . The lack of colour in the patina layer is due in part to the leaching out of pigmenting impurities from the material (Hurcombe 1992:75; Purdy and Clark 1987:232). 'Glossy patina' exists as a uniform sheen or luster covering the whole surface of cryptocrystalline raw materials (Keeley 1980:29; Stapert 1976:12). It is possible to overcome surface interference from white patina by taking an acetate peel replica of the surface (d'Errico 1985; Knutsson and Hope 1984; Plisson 1983; Unrath and Lindemann 1985).

Vaughan (1981) noted two types of naturally forming polishes on chert. 'Flat' polish forms "... by dissolution and then the subsequent formation of a layer of an amorphous silica gel", while 'raised' polish forms by the "... slow precipitation of silicates from a silica-saturated solution in the sediments"(Anderson-Gerfaud 1981:336).

Similar to Anderson-Gerfaud and Moss, Lévi-Sala (1986:230, 240, see 1993) believed that the sheen observed all over stone tools and to a greater extent on the edges and prominent parts of the artifacts was due to the prolonged movement of flint implements in soil sediments. She made a distinction between general 'sheen' on lithic tools [see above i.e.: 'glossy patina' Rottländer (1975:101), 'gloss patina' (Stapert 1976:11-12), 'surface sheen' (Plisson and Mauger 1988)], and 'bright spots' which she described as a smooth highly reflective polish that is simply localized or found in clusters. The friction was created by the action of flints rubbing in the presence of water (Lévi-Sala 1986:231).

Some of the lithic artifacts recovered from Marco Gonzalez and San Pedro exhibit varying degrees of patination and frictional damage or 'bright spots'. This type of alteration of the chert tools primarily manifests itself as white patination, with the characteristic development of an opaque white or whitish-gray surface layer or rind. While some lithic pieces are completely patinated in this way, the majority display varying levels of white patina, ranging from completely opaque patination in extreme cases, to scattered and thin cloudy or semi-translucent whitish-gray patches. Heavy white patina renders it impossible to accurately detect use-wear polishes on affected surfaces due to its porous nature and the fact that it refracts incident light. Glossy patina is not as common in the assemblages from these sites, however there are examples of rounded, shiny flake surfaces with rather worn dorsal spines and ill-defined flake scars. In such instances, this damage is not due to friction, but appears as a dissolution of the higher surface topography. 'Bright spots' on stone tools from Marco Gonzalez and San Pedro appear as clustered, relatively restricted, patches of smooth polish. These friction patches are visible to the human eye as small, shiny spots on tool surfaces. Under magnification, these same spots appear as very flat, uniform areas of very bright polish, similar to heavy stone or abrasive sand polish, that is located away from tool edges.

Thermal alteration of stone:

When considering ease of flakeability of various raw material types, heat-treatment of stone should be considered an important factor. This variation on traditional techniques of lithic tool production was first described by Crabtree and Butler (1964). The deliberate heating of chert before tool manufacture is undertaken because heat-treated cherts and most related cryptocrystalline silicates usually become less grainy, smoother in texture, less tough, more brittle, and thus easier to flake (Mandeville 1973:191; Purdy 1975:135; Schindler et al. 1982:532; Whittaker 1994:72). Tixier et al. (1980:16) report that very few thermally tested materials are not improved by heat-treatment. Although the results of heat-treatment are generally recognized, what actually occurs during this process is not entirely understood.

There are many hypotheses for explaining what actually occurs to cryptocrystalline silicate structures when they are heated (Cotterell and Kamminga 1990; Domanski and Webb 1992; Luedtke 1992:104; Mandeville 1973; Purdy and Brooks 1971; Whittaker 1994:72). The primary models for explaining heat treatment and alteration in lithic microstructure involve: 1. the movement of water into microvoids within the stone (Griffiths et al. 1987; Purdy and Brooks 1971; Mandeville 1973); 2. the melting and fusion of microscopic silica crystals or fibres resulting in a recrystallization of the material into a more homogeneous raw material (Crabtree and Butler 1964; Domanski and Webb 1992); 3. the fusion of the surfaces of crystal grains accomplished through the impurities among these grains acting as a flux (Purdy and Brooks 1971:323); and 4. the creation of microscopic cracks in the stone that weaken its structure, thus breaking up the silica crystal and enabling it to fracture more readily and evenly (Flenniken and Garrison 1975; Luedtke 1992:104; Weymouth and Mandeville 1975; see Schindler et al. 1982:535). All the models of heat-treated stone fracture are possible and do not necessarily occur independently of one another.

Regardless of the chemical and/or physical properties of heat-treated cryptocrystalline silicates, in particular chert, the recognition of this material in the archaeological record is not difficult. The heat-treatment of good quality chert gives it a very smooth, glossy fracture with an almost 'soapy' or 'greasy' feel (Bordaz 1970:68; Mandeville 1973:183). The colour of chert and jasper will often change as well, becoming both brighter and redder, as iron oxide ($HFeO_2$) impurities or geothite within the raw material are oxidized into hematite, a ferrous iron oxide (Fe_2O_3) (Mandeville 1973:197; Schindler et al. 1982:529; Whittaker 1994:73). Another distinctive feature of heated silicates is the appearance of potlid fractures (which always occur during the heating process, never during the cooling process and are thus the result of expansion) and crazing (Luedtke 1992:106; Purdy 1975:136,140). However, if the raw material is exposed to high temperatures beyond those required for thermal alteration, the entire inner structure of the stone becomes 'dead' and consists of hundreds of superimposed potlid fractures (Purdy 1975:139; Purdy and Brooks 1971:324). Finally, burnt chert may be identified by weight loss (Luedtke 1992:101). This is due to the release of chemically bound water at 300 and 400 degrees Celsius and the loss of carbon dioxide (CO_2) from carbonates between 600 and 700 degrees Celsius (Mandeville 1973:190,197). If none of these characteristics are observed on a lithic sample, Crabtree and Butler (1964:2) claim that an electron microscope can be employed to distinguish heat treated material from normal stone due to the detection of 'islands' of the original crystallization (also see Purdy and Brooks 1971:323).

Given these observations, several of the manufacturing advantages of heat treated cryptocrystalline implements may not prove to be as advantageous in terms of tool use. For example, Purdy (1974) noticed that thermally altered stone experienced a reduction in the tensile strength of stone of approximately 45-60% and an increased attrition rate for a tool's edge. Olausson and Larsson (1982; see Seitzer-Olausson 1983), emphasized that the effect of thermal alteration on edge damage and surface wear may have been undesirable for some stone tool classes. Sievert (1992) discovered a series of problems in her experimentally burned chert tools. According to her, burned tools seemed to possess greater edge rounding, cause residues that cover use-wear traces, and have damage such as potlid fractures, heat crazing, and edge friability which render it much more difficult to determine the tool use. For these reasons, the inclusion of heat-treated specimens in use-wear reference collections is recommended.

CHAPTER 5

The Lithic Assemblage from San Pedro

The majority (334 or 77%) of the 434 lithic artifacts recovered from San Pedro were manufactured from CBZ chert. Of those tools not made from this Colha-like raw material, 75 (17.3%) were other cherts, 11 (2.5%) were brown and honey-coloured chalcedonies, 9 (2.1%) were gray chalcedonies, 3 (0.7%) were quartzite, 1 (0.2%) was black chert, and 1 (0.2%) was slate [see Appendix B]. The two pieces of flint used to manufacture the gunflint [SP 177/37] and the strike-a-light fireflint [SP 142/7] were not included in any calculations, as they are believed to be of European origin.

The Lithic Artifacts

A total of 19 oval or general-utility bifaces or biface fragments were excavated from San Pedro; 16 (84.2%) of these tools were manufactured from CBZ chert, while 3 (15.8%) were made from other cherts.

Oval bifaces:

The oval bifaces and fragments of oval bifaces recovered from deposits at San Pedro were all representative of the smaller, thicker tool forms similar to later Classic and Postclassic varieties described from Colha, as opposed to the more finely worked Late Preclassic oval bifaces (Shafer and Hester 1983, Hester and Shafer 1984). Four (80%) of the five oval bifaces or fragments were manufactured from CBZ chert, while only 1 (20%) was made from other chert.

There was only 1 whole oval biface recovered from the San Pedro project [Figure 6a]. The oval biface from Parham's collection [PC2], unfortunately, does not have a reliable provenience other than San Pedro town. It was manufactured from banded and speckled light and dark gray CBZ chert. It possesses a cortical butt-end that may have initially been part of the striking platform for the macroflake blank. There is edge crushing and some step and hinge termination flake scars on the medial edges. These medial edges indicate moderate use and/or repair. What appears as a crude tranchet-blow from one edge of the tool is likely the accidental result of a distal-end impact fracture from a side-struck blow. The removal of this diagonally transverse flake may also be a crude, but deliberate attempt to rejuvenate the used active end. It was difficult to make an accurate determination of further use of the tool after the removal of this flake from the distal end because the subsequent removal of small step and hinge terminated flakes have removed the original surface. Some step and hinge flaking on the interior surface in the distal left corner may indicate initial preparation of a striking area for the deliberate removal of a flake or flakes to resharpen the distal edge. This tool was not as heavily used as other San Pedro bifacial artifacts seem to be.

There were also 3 medial fragments [SP 62/3, SP 77/4, SP 79/2] recovered from the San Pedro excavations. The medial fragment SP 62/3 was made from a dark gray chert that does not seem to be from the chert-bearing zone and possesses a section of coarser textured chert along the exterior surface. The broken ends of this fragment indicate a tri-modal breakage pattern. Based on the fact that the lateral edges of the fragment are relatively acute with no crushing, this tool was not heavily used. If not broken during use, it may have been fractured during a local attempt at manufacture or repair. There is some evidence of use after breakage. On the interior surface near the distal end of the breakage plane, there is some flake removal, while at the proximal end, flake removal scars are visible on the break surface.

The medial oval biface fragment SP 77/4 was made from dark gray CBZ chert with minimal brown banding on the proximal end. Although the left half of the tool appears to be part of the original biface's profile, the exterior surface of the right edge appears to be an earlier fracture episode caused by an attempt to modify the tool for additional use. It may also be possible that the original biface was manufactured on a damaged or asymmetrical preform. Both edges possess small step and hinge termination scars, however, this damage is more prevalent on the left edge of the tool.

The medial oval biface fragment SP 79/2 was made of banded brownish and light gray CBZ chert. There is little evidence of use on the right lateral edge of the fragment, and small step and hinge termination scars are exclusively on the exterior aspect. Both breakage planes reveal an interesting fracture pattern. Whereas the distal break surface possesses a well-defined striking surface ring fracture/cracking on the exterior face and a visible bulb of percussion, the proximal break is a complete flake scar with a visible negative bulb of percussion. Some form of impact directed at the exterior surface is responsible for the fracture of this biface. There is little evidence of use of this fragment after breakage.

The distal oval biface fragment SP 80/3 is manufactured from an oddly speckled and mottled light and dark gray chert that appears to be CBZ. The edges of this tool fragment are heavily used as demonstrated by the edge crushing and substantial step and hinge termination scars on both the interior and exterior surfaces. Given the slightly misshapen bit end and flake scarring, it appears this tool experienced a number of resharpening events. There is evidence for impact-related damage in the form of a long flake scar on the interior surface near the bit end of the tool. There is no evidence for the re-use of this fragment after initial breakage.

General-utility bifaces:

Of the 9 general-utility bifaces or fragments recovered from San Pedro, 7 (77.8%) were manufactured from CBZ chert and 2 (22.2%) were made from other cherts.

The only whole general-utility biface [PC1] is made from mottled light and dark gray and green CBZ chert [Figure 7a]. Similar to oval biface PC2, the provenience for this artifact is known only to be somewhere from San Pedro town. On the distal end of the tool, a flake has been transversely removed likely due to use-related impact. Around this flake scar is evidence of further flake removal after the transverse break that seems use-related. Along the steep edges of the tool there is heavy crushing that is sometimes composed of multiple stacked step and hinge termination flake scars. There is some grinding damage on areas of the surface topography on both the exterior and interior surfaces. This tool continued to be heavily used for pounding or crushing activities after removal from its haft.

Manufactured from dark gray speckled CBZ chert, proximal biface fragment SP 80/5 likely originated as a general-utility tool. A vein of cortical-like impurity through this tool's longitudinal midline may have been a structural flaw that contributed to tool breakage. Although, there is no evidence of tool recycling, there is some crushing and some step and hinge terminated flake scars on the lateral edges from earlier use and some resharpening events. Along the proximal end there is a transverse flake removal that may be related to initial tool breakage. Along the exterior surface, a flake scar originating from the proximal end extending the length of the tool appears impact-related. This does

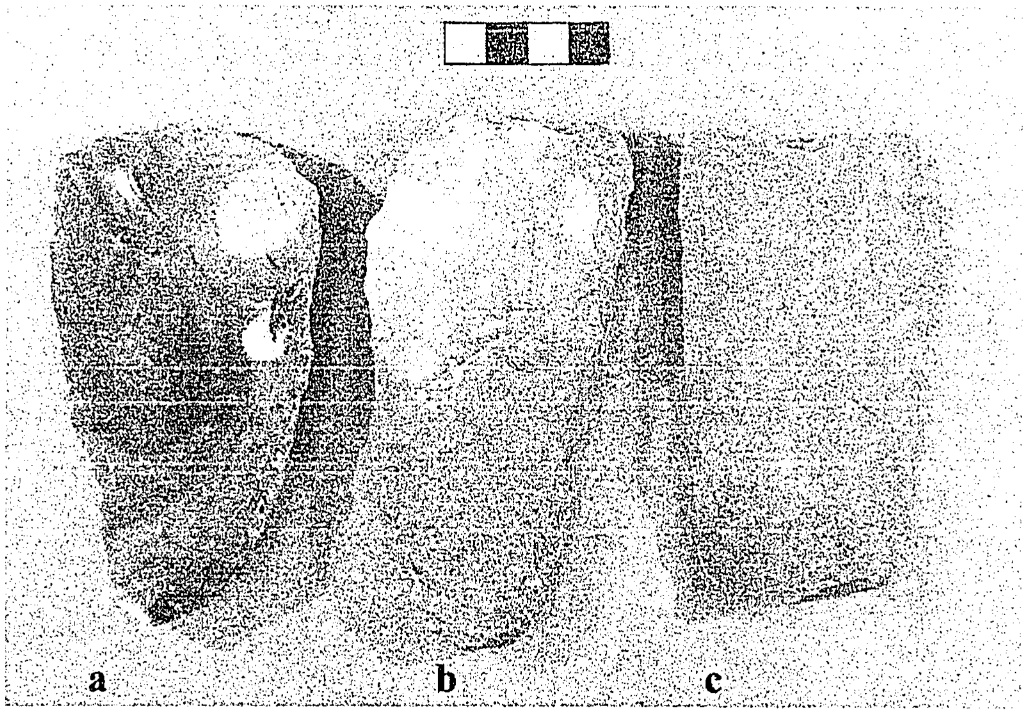


Figure 6: Oval Bifaces from Marco Gonzalez and San Pedro (a.PC2 b.MG 196/2 c.MG 114/6)

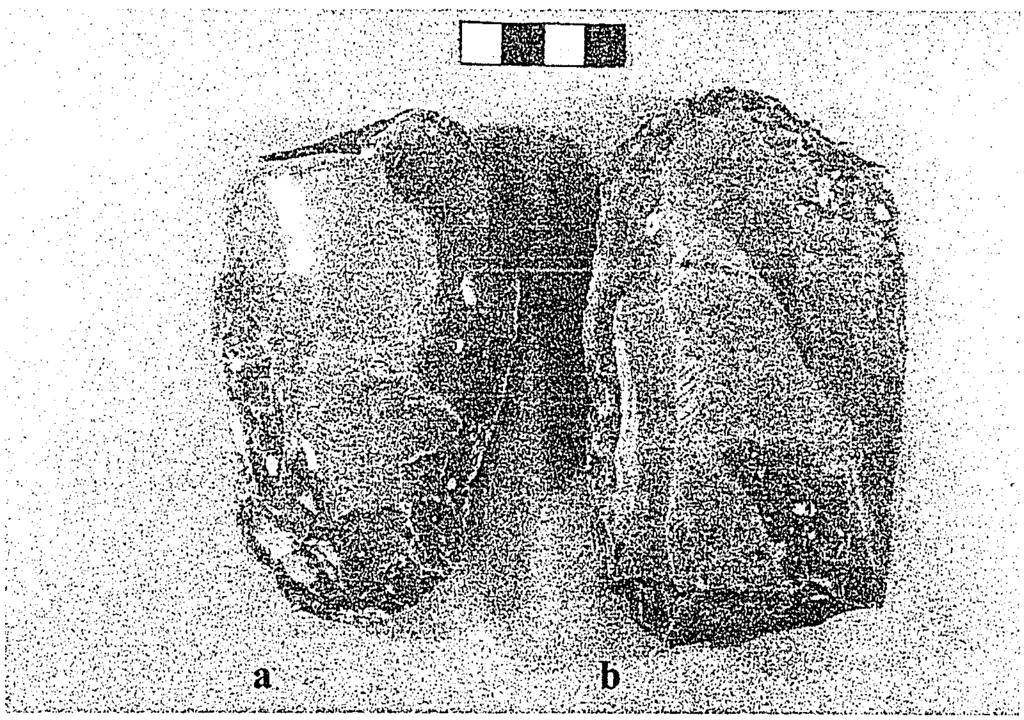


Figure 7: General Utility Bifaces from Marco Gonzalez and San Pedro (a.PC1 b.MG 76/3)

not look like an end shock breakage, but rather more similar to a type of bending fracture.

The light gray medial biface fragment SP 77/5 does not appear to be made of CBZ chert. The fragment likely originated from a large general-utility biface. There are numerous heavy step and hinge terminated flake scars on the right lateral edge. The distal breakage plane of this biface fragment is heavily re-worked, with little, if any, of the original break surface remaining. There are multiple flake removals near the platform edge and some stacked step fractures and tiny hinge fractures that appear use-related.

Medial fragment SP 79/1 is from a general-utility biface manufactured from speckled dark gray CBZ chert. It may have been broken during initial use and demonstrates evidence of a classic tri-modal breakage pattern (McAnany 1982). Evidence for use after breakage includes small step and hinge terminated scars and additional flake removals from the distal end breakage surface, as well as a few step and hinge termination flake scars on the proximal end break. Near the proximal end, on the interior surface, there is also evidence of flake removal after the initial fracture of the biface into fragments.

Given the amount of modification of biface fragment SP 62/2, it is difficult to determine whether this was the distal end of the tool or a heavily reworked medial section. Based on its light gray colour and coarse raw material texture, it does not appear to be made from CBZ chert. Although the damage to the lateral edges consists of many small step and hinge termination flakes, the greatest degree of modification is present on the heavily reworked distal interior surface in the form of numerous step and hinge flake scars. Despite the indication of use-related damage and reworking, there is no crushing along any of the tool edges. At the proximal end break, there is evidence of additional flake removal with one large hinge termination that occurred after initial tool breakage. On both faces of the tool there are multi-directional flake removals. The tool cross-section is askew from uneven tool resharpening on the left and right sides of the exterior surface.

Artifact SP 31/11 is a distal fragment from a general utility biface manufactured from mottled and speckled light and dark gray CBZ chert. The bit-end is characterized by some edge crushing and small, stacked step and hinge termination scars indicative of use. After initial breakage, there is evidence of further flaking on the proximal breakage plane in the form of multiple multi-directional flake removals ending in deep step and hinge terminated flake scars. On one tool face, there are multiple ring cracks indicative of repeated impact near the proximal break perhaps indicative of attempts to further remove flakes from the tool fragment and/or remodel it into another usable tool form.

The medial general-utility biface fragment SP 178/7 is manufactured from dark gray CBZ chert. There are cortex patches on both the exterior and interior surfaces, as well as evidence of severe burning [stacked potlids, pink discoloration, heat crazing and cracking]. This burning rendered the tool useless either as a tool or as a source of raw material. Along the right edge of the tool, there is evidence of use-related crushing and some step and hinge termination flake scars. On the exterior surface of the left edge, there is some hinge scarring which occurred prior to the burning of this tool fragment. Breakage of this biface preceded the burning.

Medial fragment RCS2 is from a general-utility biface and was manufactured from banded dark gray CBZ chert. It shows evidence of burning in the form of potlidding, heat fracture, slight red discoloration around a potlid and a waxy feel along both the proximal and distal breakage planes. Because the right edge of the tool reveals almost no evidence of use or resharpening at all, it is believed this biface was broken very soon after acquisition. The heat-related damage to the tool surface makes it difficult to determine whether initial breakage was due to use or heating/burning. What appears to have occurred are two separate events. First, the biface was broken during some use event. Then, additional damage was inflicted on the tool when it was burnt. The heating removed some of the areas of the tool that resulted from the initial breakage event. However, the burning damage is primarily restricted to the left edge and exterior surface of the tool, with some minor damage to the interior surface, thus the right side of the tool still retains some of the evidence for tool breakage due to use. Because the tool had been burnt, this likely rendered it too brittle for other uses.

For both the oval bifaces and the general-utility bifaces, as well as some of the miscellaneous thick biface fragments that were once parts of biface tools and the recycled bifaces, original tool manufacture was accomplished using a 'soft' hammerstone, possibly limestone. Based on the deeper step and hinge-flake scars on the bifaces, it appears many attempts at tool repair were undertaken using a 'harder'-hammer technique. Not only is this evidence for a different technique for tool manufacture and repair on the Caye, but, it may also serve as a testament to the reduced skill of the local tool-makers.

Re-used and recycled bifaces:

The banded and speckled brown and dark gray CBZ chert tool SP 204/2 likely originated as a general-utility biface that has since been heavily used and recycled [Figure 9d]. It now possesses an awkward cordiform shape with evidence of crushing around the edges and multiple step and hinge termination flake scars. There are multiple, multi-directional flake removal scars on both faces suggesting that there was only a minor attempt to maintain its original bifacial shape. Instead the tool was modified to obtain as many usable edges as possible. There is also surface crushing visible on the exterior and interior faces which, in conjunction with the edge crushing, suggests the tool was used as a hammerstone following its use as a biface and possibly an *ad hoc* core. At several sites throughout Northern Belize, including the northern end of Ambergris Caye (Hult and Hester 1995), Cerros (Lewenstein 1987; Mitchum 1991), Kichpanha (Shafer 1982), Laguna de On (Masson 1993), Pulltrouser Swamp (McAnany 1989b, 1993; Shafer 1983), Northern River Lagoon (Mock 1994), and Santa Rita Corozal (Dockall and Shafer 1993), archaeologists noted a similar conversion of bifaces and biface fragments into flake cores.

SP 33/4 is the proximal end of an oval biface manufactured from light gray CBZ chert [Figure 9h] . The edges of this tool fragment are heavily crushed with some step and hinge termination flake scars. The edges of the distal breakage plane are also severely crushed almost completely around the circumference of the break suggesting that this tool continued to be used as a hammerstone or crushing tool after the distal portion broke off.

Fragment SP 42/2 [Figure 9g] is a medial section that conjoins with artifact SP 033/4. It possesses steep edge angles with numerous step and hinge termination flake scars. Along the lateral edges there is heavy crushing indicative of its conversion into a hammerstone or pounding/crushing tool. Along the distal end break, there is heavy edge crushing and step and hinge termination flake removals on the breakage plane indicative of re-use after the tool was fractured.

The distal end fragment SP 80/1 was from a general-utility biface made from banded and speckled dark gray CBZ chert. The impact point where this fragment was removed from the distal end of its parent biface is easily visible. It is difficult to determine whether this fragment was the result of a failed attempt to rejuvenate the end of the biface, the blow having landed too far into the centre of the tool, or whether this was the deliberate removal of a large piece of chert from the biface. Nevertheless, along the distal end of the fragment there is evidence of heavy edge crushing with step and hinge termination flake scars on both faces of the plano-convex profile. The distal end of the fragment was thoroughly exhausted and used as a hammerstone or other pounding tool. Evidence of use after this fragment was broken from the parent biface exists on the proximal breakage plane.

Lenticular bifaces:

Only 1 medial biface section [SP 220/7,8,9,10] from a lenticular biface was recovered from San Pedro. It is actually composed of 4 smaller conjoining fragments that were heat-fractured. This medial section was manufactured from dark gray CBZ chert that was badly burnt, primarily on the interior surface where the greater evidence for heat damage occurs. Red discoloration, stacked potlids, and heat fracture occur on this surface, while a single potlid and some pink discoloration is observable on the exterior surface. Not only do both the distal and proximal ends of the conjoined tool reveal heat fracture scarring, each of the individual fragments possesses heat fracture on its conjoining breakage planes. This lenticular biface was not modified or resharpened before breakage, and was not reworked after the burning event. Based on the fine flaking on both surfaces, the shape of the remaining edge profile and the tool thickness, this biface fragment was produced using soft-hammer percussion. Again, it appears the burning of the tool rendered it useless for any further activities.

Miscellaneous thin biface fragments

The thin biface fragments recovered appear to be from tools that were originally produced using soft-hammer percussion, such as that associated with antler or wooden billets and/or some finer pressure flaking. Most fragments were originally parts of thin bifaces traditionally referred to as points or knives. Two distal thin biface fragments and two medial edge fragments from thin bifaces recovered from San Pedro were all manufactured from CBZ chert.

One distal end [SP 64/4] of a thin biface was manufactured from dark gray CBZ chert. The distal tip of this fragment has snapped off and the proximal end break appears to be a snap fracture. At first glance, the tool itself appears crudely made by percussion as demonstrated by the asymmetrical right edge profile and the number and size of the step and hinge termination scars. However, many of these scars may be due to subsequent attempts to reshape or resharpen the tool edges. Only a small section of the left edge reveals finer pressure flaking. This tool does not appear to have been modified after breakage.

Both of the medial edge fragments SP 175/13 and SP 221/4 were manufactured from dark gray CBZ chert. They represent edges of thin bifaces. After initial breakage, neither fragment was used again.

Miscellaneous thick biface fragments:

The miscellaneous thick biface fragments generally exhibit similar reduction techniques to those associated with the large, thick bifaces, particularly the oval and general-utility tools. Based on the original bifacial scarring on these fragments, tool production was accomplished using percussors that were 'light' or 'softer' hard-hammers such as the limestone hammers described above. Before tool breakage, most of these thick fragments were parts of oval or general-utility bifaces. All of the 14 fragments in this tool class were made from CBZ chert.

Artifact SP 61/5 was a small medial, biface edge fragment of dark gray CBZ chert. The edge is crushed with tiny stacked step and hinge termination scars. There has been some flaking on the exterior surface of the breakage planes after initial tool breakage.

The medial edge fragment SP 170/12 probably formed part of an oval biface made from gray and brownish banded CBZ chert. The edge possesses small step and hinge termination scars. What has been interpreted as the exterior surface has a patch of white cortex extending down the longitudinal midline of the artifact. Some edge flaking on the exterior aspect of both the proximal and distal breaks indicates the possibility of use after the biface was broken.

The medial cross-sectional fragment SP 85/4, likely from a small oval biface, was made from dark gray speckled CBZ chert. Although the left lateral edge is missing, the right lateral edge demonstrates some tiny step and hinge termination scars. This fragment was definitely re-used after initial breakage. Along the exterior surface/proximal break plane there is crushing and micro-flaking, while similar damage appears on the interior surface/distal break plane. A possible rust stain occurs on the ventral surface near the intact edge and rust speckling has been observed on the break surfaces. Modern or late Historic period iron was found in some deposits associated with lithics at San Pedro

The medial fragment SP 13/15 was most likely from a general-utility biface. Although it is dark gray in colour, some patination and heat damage make it difficult to identify this as specifically CBZ chert. There is evidence of re-sharpening of the tool edges in the form of step and hinge terminated flake scars, but there is no edge-crushing present. The tool does not seem to have been re-used or recycled after breakage, most likely due to thermal alteration.

Artifact SP 220/1 is a lateral medial fragment, probably from a general-utility biface. The raw material is light and dark gray CBZ chert that is both partially patinated and discoloured due to heat damage. The edges are well-used, possessing some crushing and evidence of step and hinge terminated flake removals. There is no good evidence for the re-use or recycling of this tool fragment after breakage [possibly heat fracture], however, it is believed that the heating or burning of the raw material may have compromised the integrity of the stone matrix and rendered the tool too weak for future tasks.

The medial biface edge fragment SP 79/3 was manufactured from light gray CBZ chert. There is little evidence of use-related edge damage. A fracture plane on the exterior surface suggests that impact to this aspect may have been responsible for tool breakage. Some deliberate unifacial step and hinge terminated flaking on an exterior surface fracture plane indicates possible tool use [i.e. notching] after breakage.

Medial fragment SP 85/3, manufactured from dark gray speckled and mottled CBZ chert, is a lateral edge from a small oval biface. The intact edge demonstrates some small step fracture flakes and minor edge crushing. The three fracture planes of this fragment all possess additional edge damage in the form of tiny step and hinge termination flake scarring related to use after initial tool breakage. Some specks of rust are embedded in the tiny flake scarring of the fracture planes. Although some of the fractured edges possess damage that resembles the 'nibbling' seen on gunflints, the evidence is not as definitive as that seen on other lithic pieces from this assemblage.

The distal biface fragment SP 80/4 was made from light gray and dark banded CBZ chert. The break on the proximal end appears to have been due to a bending fracture. Although, this tool was resharpened a number of times before breakage, as demonstrated by the irregular edge shape and the step termination flake scars, there is no evidence of further modification or use after breakage.

Artifact SP 62/4 is the left or right medial edge fragment from a thick biface manufactured from dark gray CBZ chert. The edge of this tool possesses some crushing damage, as well as some step and hinge flaking. The interior face of the fragment possesses some larger and deeper hinge termination scars, perhaps from earlier use-related activity or earlier attempts at edge rejuvenation. The distal portion of the fragment ends in a mild hinge termination. Use-related microscarring of the left edge of this flake indicates tool use after the removal of this piece from its parent biface.

Biface edge fragments:

All 8 of the biface edge fragments recovered from San Pedro were manufactured from CBZ chert and appear to have originally been parts of thick bifaces such as oval or general-utility tools. The edges of these biface fragments demonstrate damage in the form of step and hinge termination scars and varying degrees of edge crushing. Although it is possible these fragments were removed from their parent bifaces during some type of activity such as chopping or digging/hoeing, they may also be failed attempts to modify or repair the tools. The fragments were likely produced when attempts to rejuvenate the larger biface edges were struck too far into the centre of the tool. On three of these fragments, there is a well-defined striking surface and bulb of percussion consistent with hard-hammer percussion. Based on some damage to the exterior and interior surfaces near the distal end fracture plane, it appears that some fragments were used after breakage.

Flakes:

A total of 191 flakes were excavated from San Pedro; 7 (3.7%) were primary, 8 (4.2%) were secondary 3, 50 (26.2%) were secondary 2, and 126 (66%) were tertiary. Therefore, 34% of the flakes were cortical. The few primary and secondary 3 flakes recovered from San Pedro indicate that very little first stage reduction was being performed there. Furthermore, the high percentage of tertiary flakes and minimal number of secondary 2 cortex flakes indicates that most of the lithic reduction performed here was later stage work, possibly final stage production, but more likely, maintenance, resharpening, and recycling activities. This last conclusion is supported by the number of bifacial thinning flakes and biface edge flakes and the lack of any preform tools from any stages prior to completed forms, and the few standard flake core fragments recovered (see below).

The highest percentage of raw material recovered from San Pedro was CBZ chert (74.9%), followed by, other cherts (17.8%), brown and honey-coloured chalcedony (3.7%), gray chalcedony (2.1%), black chert (0.5%), slate (0.5%), and quartzite (0.5%). The vast majority of the lithic raw material in flake production was chert from the 'chert-bearing zone' of mainland Northern Belize. These CBZ chert flakes were most likely from the San Pedro formal tools originally produced at the workshops at Colha. The faceted platforms on the regular flakes may indicate failed attempts to remove bifacial thinning flakes from these tools and stand as testaments to the reduced skill of the tool manufacturers on the Caye. Support for this may be in the fact that 20 of 59 (33.9%) whole and proximal tertiary CBZ chert flakes possessed faceted platforms, while none of the other chert or black chert tertiary flakes and only 3 of the 37 (8.1%) CBZ and other chert secondary 2 and 3 cortical flakes did. This lower skill level may also be demonstrated by the number of hinge and step terminations on the whole and distal tertiary CBZ chert flakes (15 of 63 or 23.8%) (see McAnany 1986). The 14 other chert and black chert whole and distal tertiary flakes had 5 (35.7%) hinge terminations.

Given the number of flakes for each class for both the CBZ chert and other chert categories, it appears that two different forms of reduction were occurring, however the small number of other chert flakes may not render these observations mathematically significant. For the CBZ cherts, only 1.4% of the flakes were primary, while 11.8% of the other chert flake were primary. The flakes possessing exterior surfaces that were only partially covered by cortex were divided as follows: 4.9% secondary 3 CBZ chert flakes and 2.9% secondary 3 other chert flakes, 25.2% secondary 2 CBZ chert flakes and 32.3% secondary 2 other chert flakes. Of the 143 CBZ chert flakes recovered 68.5% were tertiary, while only 52.9% of the other chert flakes belonged in this category. It appears that the majority of the reduction involving tertiary flakes (77.8% of all raw materials) was CBZ chert, while only 14.3% of the tertiary flakes at San Pedro were other cherts. These percentages, in conjunction with the number of bifacial thinning flakes from this site and core fragments (see below), reveal that reduction sequences for the CBZ chert were primarily centred on tool repair and curation or recycling, while core reduction and simple flake production seem to be the reduction sequences associated with the other, lower quality cherts. Nevertheless, it would be presumptuous to assume that absolutely no reduction other than repair and recycling-oriented activities occurred with CBZ chert. It seems likely that some small proportion of this raw material arrived on the Caye in unfinished form such as quarried nodules or partially reduced cores for the production of flakes and/or simple flake tools.

Bifacial thinning flakes:

A total of 72 bifacial thinning flakes were recovered at San Pedro. The greatest number of bifacial thinning flakes were tertiary (60 or 83.3%), 10 or 13.9% were secondary 2, 2 or 2.8% were secondary 3, and none were primary. Not surprisingly, 84.7 % of the raw material was CBZ chert, 6.9% was other cherts, 4.2% was brown and honey-coloured chalcedony, and 4.2% was gray chalcedony. Although there are flakes and bifacial thinning flakes of chalcedony, no chalcedony formal tools or core fragments were recovered from this site.

Flat platforms on some (16 of 66 or 24.2%) of the tertiary and secondary whole and proximal bifacial thinning flakes may indicate reduced ability in biface thinning. The majority of the bifacial thinning flakes recovered from San Pedro were classed as Category B flakes. Of the 66 whole and proximal bifacial thinning flakes recovered, 24 (36.4%) possessed evidence of having been produced by either hard-hammer percussion and 15 (22.7%) possessed a combination of both soft- and hard-hammer reduction traits. Only 12 (18.2%) of these flakes were classed as Category A bifacial thinning flakes. Usually, the hard-hammer flakes were slightly thicker than the soft-hammer bifacial thinning flakes [average thickness ratio (mm) of whole hard-hammer to soft-hammer bifacial thinning flakes 7.2:4.4]. The inability to remove thin faceted flakes from bifacial tools may have contributed to the more rapid conversion of some biface forms into other tools. Furthermore, the presence of hinge terminations on the 10 of 54 (18.5%) whole flakes and distal flake fragments of CBZ and other chert may also serve as evidence of the lower level of stone tool manufacturing ability of the Caye inhabitants.

Most of the bifacial thinning activity produced tertiary flakes of CBZ chert (88.3% of all raw materials), whereas only 5% of the tertiary bifacial thinning flakes at San Pedro were other cherts, 3.3% were brown and honey-coloured chalcedony, and 3.3% were gray chalcedony. It is apparent from these data that the majority of biface resharpening and repair was performed on tools manufactured from CBZ chert. This information corresponds to the fact that almost all of the bifaces and fragments thereof recovered from San Pedro were manufactured from CBZ chert and were most likely arriving on the Caye in finished form from the workshops at Colha. Only 7 of 61 (11.5%) of all the CBZ chert bifacial thinning flakes were secondary 2, and just 1 (1.6%) secondary 3 flake from this class was recovered, indicating that very little early to middle stage biface production of CBZ chert tools was completed on the Caye. Most of these bifacial thinning flakes were produced by tool rejuvenation. The importance of tool resharpening and recycling in the San Pedro assemblage is also emphasized by the fact that 72 of all 275 flakes and flake fragments (26.2%) recovered were thinning or edge rejuvenation flakes.

Retouched flakes:

A total of 10 retouched flakes were recovered from San Pedro. Eight were made from CBZ chert, while two were other cherts. The retouch on the edges of these flakes is not technologically uniform, as some flakes were produced by percussion, while others were pressure flaked. Furthermore, the invasiveness of the retouch varied.

Artifact SP 31/10 was a large secondary 2 flake made from CBZ chert that revealed excellent evidence for tool modification after initial flake production. The fact that the retouched edge cut through the original patinated surface of this flake is indicative of tool reuse or possibly delayed curation (see below).

Denticulated flakes:

Only 1 flake [SP 111/1] from the other chert category was deliberately altered into a denticulated tool. Except for the retouched flakes above, most of the flakes in this lithic assemblage were used without any modification of their shapes or edges. The flake tools from San Pedro were primarily used in an *ad hoc* manner.

Burinated flakes:

A single [SP 42/3] CBZ chert tertiary bifacial thinning flake fragment was classed as a burin. The fractured distal end of this proximal flake fragment was transversely struck to create a burinated edge.

Large flake hammerstones:

The whole flake tool SP 10/3; manufactured from speckled dark gray CBZ chert, was likely not a full biface given the absence of flake scars on the central portion of the ventral surface. There is relatively heavy crushing along the edges of this tool, especially on the striking platform, accompanied by multiple step and hinge termination scars around the edges on both faces of the tool. Evidence for the re-use of this macroflake tool is based on the presence of fresh, non-patinated step and hinge flake scars that cut through the original patinated surface of the tool. It is believed that this tool was re-used after initial abandonment and post-patination and may represent evidence of scavenging or delayed curation.

Blades:

Three whole blades, one proximal blade fragment, and three medial blade fragments were recovered from excavations at San Pedro. Six (85.7%) of the 7 blades or fragments recovered were CBZ chert, while the other fragment was made from other chert.

Blade SP 42/1 was made from dark gray banded CBZ chert, while blade RSC4 was manufactured from a dark gray CBZ chert and blade SP 88/2 was made from speckled dark gray CBZ chert. Both SP 42/1 and RSC4 blades retain patches of cortex; SP 42/1 has cortex on the proximal end and the striking platform, whereas RSC4 has cortex on the exterior surface at its distal end. These blades were produced by hard-hammer percussion and possess a more crude appearance than the other blade fragments recovered. Blade SP 42/1 had a flat striking platform, while RSC4's platform was faceted and SP 88/2's platform was faceted and lipped. The overall appearance of these tools leaves the impression that they are more like flake-blades that were not removed from well-prepared blade cores. Furthermore, the distal end of blade SP 88/2 possesses a deep hinge termination and there are multi-directional flake scars on its exterior surface. Based on their less-standardized method of manufacture and overall appearance, I believe these blades were produced on the Caye by the local Maya.

The proximal blade fragment SP 61/2 was manufactured from dark gray CBZ chert that is now heavily patinated. The blade has a flat platform and appears to have been produced using a 'softer' percussor than the whole blades based on the blade dimensions and the less-pronounced bulb of percussion. The trapezoidal cross-section of this blade suggests that it was struck from a prepared blade core.

Two of the three medial blade fragments were manufactured from CBZ chert: both SP 13/17 and SP 37/19 were dark gray CBZ chert, whereas SP 65/3 was a light gray chert that cannot be positively identified as originating in the chert-bearing zone of northern Belize. Based on the tool dimensions and trapezoidal cross-sections of blades SP 37/19 and SP 65/3, and the triangular cross-section of blade SP 13/17, these blades were struck from prepared blade cores.

No blade cores or blade core fragments were recovered from San Pedro.

Retouched blades:

A single proximal retouched blade fragment [SP 102/4] was recovered from San Pedro. It was manufactured from light and dark gray mottled CBZ chert. Although only a partial flat striking platform remains, it appears this tool was produced using a percussion method. Retouch along the medial edges is bifacial. The manner in which some of the retouch encroaches upon the edges of the distal breakage plane indicates that some of this modification occurred after the distal end was removed from this segment of the blade. The triangular cross-section and overall dimensions of this blade segment indicate that it was produced from a prepared blade core.

Stemmed blades:

One almost whole stemmed blade [SP 37/1] was recovered from San Pedro. The whole blade was manufactured from speckled dark gray CBZ chert and was retouched on both the proximal and distal ends. The proximal retouch was in the form of unifacial stemming on the exterior surface of both tool edges. Although the majority of the tool's stem has snapped off, enough of the stemmed section remains to classify this tool. The distal retouch occurs exclusively on the exterior surface and shapes the distal end into a point. The trapezoidal cross-section is indicative of a blade produced on a prepared blade core.

Microblades:

Only one bladelet or microblade [SP 87/2] has been identified from San Pedro. This tool, made from dark gray CBZ chert, was classified as a bladelet due primarily to its length and width dimensions. The bladelet resembles a long thin flake-blade that was not removed from a deliberately prepared bladelet core. The cortical platform and the distinct ripples on the interior surface indicate hard-hammer percussion. This was not a deliberate bladelet removal, but more likely a flake removal that resembles a bladelet. Like the whole blades above, it is believed this tool was produced by the Caye Maya and not imported in this form.

No bladelet cores or bladelet core fragments were found at San Pedro.

Macroblades:

The distal end of a single macroblade [SP 31/7] recovered from San Pedro was manufactured from light gray CBZ chert that is partially patinated. The trapezoidal cross-section and evidence for previous blade removals on the exterior surface indicate removal from a prepared macroblade core. The distal tip of the tool has been snapped off in what appears to be a twisting fracture. There is damage along the medial edges related to use. Some tiny step and hinge termination flakes near the interior surface of the proximal breakage plane may be indicative of use after the initial breakage of the tool.

No macroblade cores or macroblade core fragments were recovered from San Pedro.

Blocky fragments:

A total of 74 blocky fragments were recovered from San Pedro of which 50 (67.6%) were CBZ chert, 20 (27%) were classified as other cherts, 2 (2.7%) were quartzite, 1 (1.4%) was brown or honey-coloured chalcedony and 1 (1.4%) was gray chalcedony. Despite the fact that there were considerably more CBZ chert fragments than other chert fragments recovered, the other cherts possessed 568.3 grams more material than the CBZ chert. The larger amount of other chert from San Pedro was primarily provided by two unaltered large fragments [SP 114/4 and SP 174/4] that could have served as sources of lower quality chert for flake production. At least two blocky fragments [SP 173/8 and SP 202/4] were converted into hammerstones or pounding tools, identified by zones of edge and surface crushing. Fragment SP 173/8 was made from other chert and fragment SP 202/4 was made from CBZ chert.

The largest blocky fragments [SP 114/4, 174/4, 173/8], weighing a total of 1,994.2 grams, are of a lower quality chert compared to the raw materials that were used to produce many of the formal tools and were not identified as CBZ material. They are composed of heterogeneous zones of raw material of varying textures and colours of light and dark gray, with inclusions, cortical veins, awkward fracture planes and, in one instance [SP 114/4], a vein/shelf of quartzite-like stone. I contend that the Caye Maya at San Pedro may have acquired lower quality raw material from mainland Northern Belize to supplement the finished tools they were importing from Colha before the Late Postclassic. This stone may have been material of inferior quality that was not used by the tool producers at Colha, but that was of value to the Caye Maya. With lithic resources becoming strained or scarce, a shift to use accessible stone, even that of lower quality, may have been unavoidable for the production of more usable flakes.

At least some of the blocky fragments recovered were probably once part of other formal tool forms. However, the lack of discernible features that would identify them as such are absent from these lithic fragments.

Core fragments:

Of the five core fragments excavated at San Pedro, four fragments were made from CBZ chert, while only one recovered fragment was manufactured from other chert. All fragments appear to represent standard flake cores. Aside from the random, multi-directional flake scars on their surfaces, there is nothing else noteworthy in the reduction of these lithic fragments. The largest of the core fragments [SP 6/19] is a very large cobble of gray banded CBZ chert weighing approximately 1.7 kilograms. With a source of raw material of this size, it would have been possible for the Caye Maya to manufacture a large biface. Instead, the core fragment bears evidence of simple large flake removals from one end of the stone. It was difficult to determine whether the speckled light gray CBZ chert artifact SP 174/3 was originally a core fragment or not. Due to burning, there was heat-induced fracture of this fragment. Although there is no edge-crushing and few step fractures, there are multiple, multi-directional flake removal scars. If this was a bifacial tool, at some point it became a source of raw material for further flake production.

In addition to the core fragments described above, three other core fragments were recycled into hammerstones or pounding tools. Two of the fragments were CBZ chert [SP 7/2 and SP 46/1], while the third [SP 143/9] was manufactured from other chert. Similar to the blocky fragments converted into hammerstones, these tools were recognized based on the zones of crushing along the tool edges and surfaces. A strike-a-light stone [SP 177/62] manufactured from CBZ chert appears to have been modified from a core fragment similar to those described above and was therefore classed in this tool category.

Cores:

Only one standard flake core manufactured from CBZ chert [SP 6/18] was recovered from deposits at San Pedro. It was identified based on the random pattern of flake scars on its surface and a few areas with impact rings [Hertzian cones]. This core was transformed into a hammerstone or pounding tool much like the three core fragments discussed above and possessed areas of extensive crushing along the tool edges and flake ridges.

Heat spalls and potlids:

There were 16 heat spalled fragments or potlids recovered from San Pedro. Nine (56.3%) of these fragments were CBZ chert, six (37.5%) were other chert types, and one (6.3%) was identified as gray chalcedony. None of these fragments was used or modified into any other tool form.

Scrapers:

Only one medial scraper fragment [SP 68/1] was recovered from deposits at San Pedro. Its edge was mildly convex and unifacially flaked into a steep (74 degrees) angle. Although, other flakes and blocky fragments were used for scraping or other transverse activities such as planing or whittling, little effort was made to modify these lithics to improve their function.

The Weight of Raw Materials from San Pedro

Given that the number or counts of lithic pieces by tool type or raw material category may be misleading in terms of the actual amount of raw material in each group, I have recorded the weights of all the lithics from San Pedro and sub-divided them by tool and raw material types in order to better understand raw material consumption at this Caye site. First, it should be noted that only 14,613.3 grams of worked CBZ chert, other chert, black chert, brown and honey-coloured chalcedony, gray chalcedony, quartzite and slate were excavated from San Pedro [see Appendix C]. The largest proportion of all the raw material from San Pedro was CBZ chert weighing 9920.6 grams (67.9%). In addition, there were 4116.9 grams (28.2%) of other chert, 345.9 grams (2.4%) of gray chalcedony, 128.7 grams (0.9%) of quartzite, 76.9 grams (0.5%) of brown and honey-coloured chalcedony, 16 grams (0.1%) of black chert, and 8.3 grams (less than 0.1%) of slate.

Table 3: The Weight (grams) of Tool Categories by Raw Material Type at San Pedro

Tool Category	CBZ Chert	Other Chert	Black Chert	Chalc. (b/h-c)	Chalc. (g)	Quartz.	Slate
Formal thick and thin biface tools and fragments	2173.1 (84.1%)	409.8 (15.9%)	0	0	0	0	0
Blade and macroblade tools and fragments	178.4 (94.4%)	10.6 (5.6%)	0	0	0	0	0
Bifacial thinning flakes	950.1 (83%)	150.9 (13.2%)	0	33.4 (2.9%)	9.8 (0.9%)	0	0
Retouched and unretouched flakes	2455 (75.3%)	493.2 (15.1%)	16 (0.5%)	41.5 (1.3%)	229.2 (7%)	15.3 (0.5%)	8.3 (0.3%)
Blocky fragments	1267 (32.6%)	2407.5 (62%)	0	2 (<0.1%)	93.5 (2.4%)	113.4 (2.9%)	0
Flake cores and fragments	2752.4 (85.2%)	478.8 (14.2%)	0	0	0	0	0

A pattern of raw material use becomes apparent when certain tool classes are compared. Most of the raw material associated with formal tools and formal tool reduction and repair was CBZ chert. This is not surprising because the majority of the formal tools on the Caye were produced in the workshops at Colha and that reduction techniques for the preservation of these bifaces and biface fragments should produce considerable amounts of raw material. A significant proportion of the informal technology seems to be supplied by non-CBZ chert raw materials. In contrast to the usual pattern of raw material use, there is a reversal in the consumption of other cherts which accounted for 2407.5 grams (62%) of this tool class. The use of these lower grade, more coarse textured cherts for basic flake production, and its collection in the form of large blocky fragments for projected flake or simple tool production, would appear sensible given the lack of any lithic raw material sources on Ambergris Caye, the reduced skill level of the Caye inhabitants, and the costs associated with acquiring greater amounts of CBZ chert for simple tool manufacture. This less skillful reduction of bifaces is well-represented by the tertiary and secondary 2 flakes (2025.8 grams or 62.2% of all raw materials). The high percentage of formal core and core fragment weight compared to that of the other cherts is curious. One would expect a greater amount of non-CBZ chert cores at San Pedro if the informal or *ad hoc* component of the assemblage was locally manufactured on lower grade cryptocrystalline silicates. Nevertheless, perhaps the acquisition of any raw material, whether it was CBZ chert or other cherts, was crucial in this lithic-poor environment. If the San Pedro Maya had the opportunity to access CBZ chert in unfinished form, undoubtedly they would have done so.

Lithic Evidence of Spanish Contact

In addition to traces of Spanish contact from artifacts such as olive jars and other ceramics (Pendergast and Graham 1991) at San Pedro, there is also lithic evidence. Unfortunately, little information is available concerning Spanish gun- and fireflints. Therefore much of the information is based on English and French examples (Brain 1988; Hamilton 1979; Hamilton and Fry 1975). In North America in the 17th and 18th centuries, the only flake gunflints were French (Brain 1988:210).

Artifact SP 177/37 has been identified as a gunflint manufactured from a translucent black and mottled gray non-local chert or flint, possibly from a European source. It fulfills the criteria outlined by Hamilton and Fry (1975:121-122):

1. a used fireflint has concave edges, sides or back, depending upon the particular area used in striking. It is impossible using a firesteel (i.e., strike-a-light) to maintain a straight edge on the flint.

2. In seeking the best shower of sparks there is a tendency to turn the flint over from time to time to get a sharper edge. This results in a bifacial striking edge.

3. In forming the concave bifacial striking edge only a few large flakes are removed, and those are incidental. Instead, many minute flakes are removed by the firesteel, giving the striking edge a sort of mottled appearance.

What had initially been identified as a translucent black and mottled gray lithic fragment [SP 142/7] is made of the same non-local raw material as the gunflint [SP 177/37]. Interestingly, it possesses the same minute flaking on some of the edges and what appear to be rust stains. These rust stains may be related to areas where the hammer struck the flint to produce a spark. Although it was first believed the stains were related to the flintlock used to hold the stone in place, the flints were usually placed in a leather cradle before being clamped in place.

The final lithic example of Spanish influence at San Pedro is a curious mixture of local and foreign culture. The strike-a-light stone SP 177/62 is manufactured from locally available gray chert from the 'chert-bearing zone' that is now substantially patinated. Interestingly, its concave striking edge is unifacial, although the many minute flakes removed correspond to the description for fireflints provided above. It is hypothesized that either the native Maya population may have been taught to create sparks on flint by the Spanish directly or learned this skill indirectly through observation and mimicry. It is also possible that the Spanish, requiring additional lithic material, made use of local stone. The slightly different procedure of unifacial or unidirectional striking for producing these sparks may be evidence for the first supposition. Like the flint fragment above, this lithic piece also possessed some rust staining that may be related to use or a byproduct of secondary contact with metal objects in the same archaeological deposit. This strike-a-light stone or fireflint was modified from another broken tool form or core fragment, thus providing further evidence of lithic recycling on the Caye.

CHAPTER 6

The Lithic Assemblage from Marco Gonzalez

A total of 1495 lithic artifacts were recovered during excavations at Marco Gonzalez. The greatest number of tools were made from CBZ chert (1220 or 81.6%). The remaining tools in the assemblage were manufactured from other cherts (235 or 15.7%), black chert (18 or 1.2%), brown and honey-coloured chalcedonies (12 or 0.8%), gray chalcedonies (9 or 0.6%), and slate (1 or less than 0.1%) [see Appendix D].

The Lithic Artifacts

There were 56 oval and general-utility bifaces, biface fragments or biface preforms recovered from Marco Gonzalez. The greatest number of these (51 or 91.1%) were manufactured from CBZ chert, while 4 (7.1%) were made from other cherts and 1 (1.8%) was a black chert tool fragment.

Oval bifaces:

Similar to the oval bifaces recovered from San Pedro, most of these bifacial tools are the smaller, thicker forms usually associated with Late Classic deposits or later (Shafer and Hester 1983, Hester and Shafer 1984). All of the 13 oval bifaces and fragments from Marco Gonzalez deposits were manufactured from CBZ chert. Two whole bifaces, three proximal fragments, six medial fragments and two distal fragments constitute the oval biface collection from this site.

Many of the tools and tool fragments recovered show evidence of heavy use in the form of steep tool edges, edge crushing and the re-use of tools after breakage for other activities or as *ad hoc* flake cores.

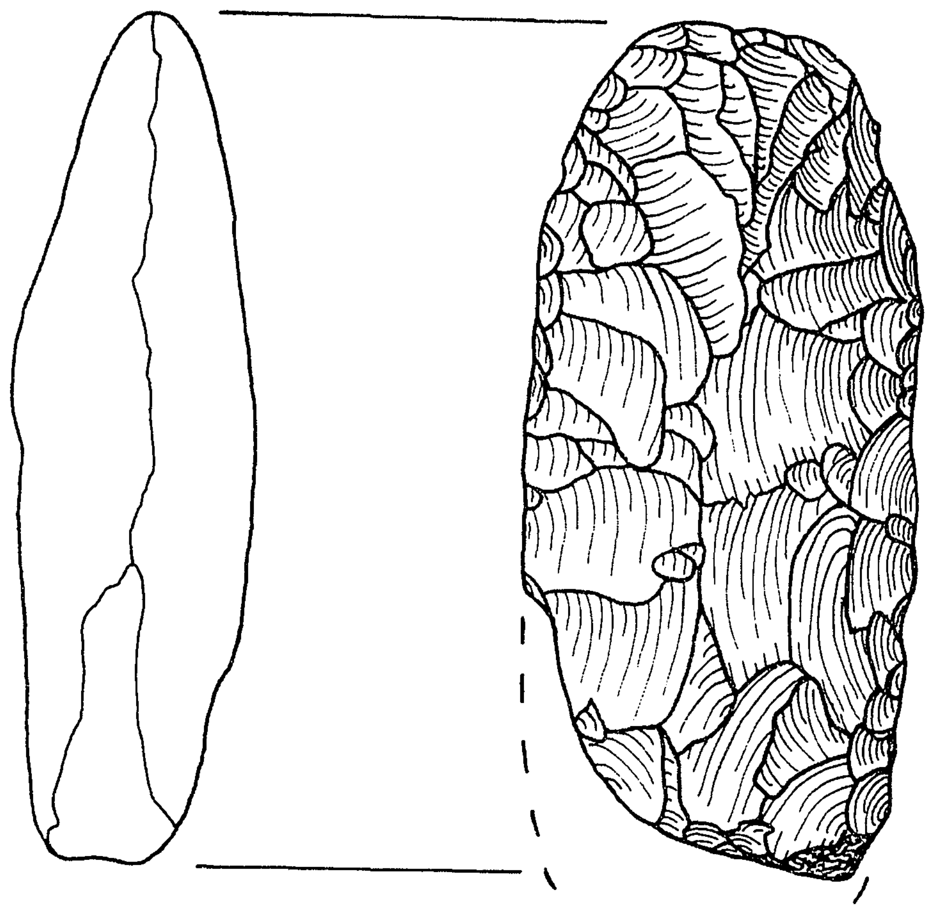
MG 226/3 is a coarser grained, banded gray CBZ chert medial oval biface fragment. The tool is thicker than the traditional Late Preclassic variety from Colha and appears to have had minor lateral edge modification, perhaps related to hafting. The breaks at both ends suggest fracture during use. There is little evidence the fragment was modified after use.

Artifact MG 77/4 is the distal end of an oval biface manufactured from banded dark gray CBZ chert. There is step and hinge flake scar damage on the distal end, with a stepped flake scar that appears to be a resharpening event. The proximal break is a bending/twisting fracture likely related to use as a biface. There is little evidence that this tool was reuse after breakage.

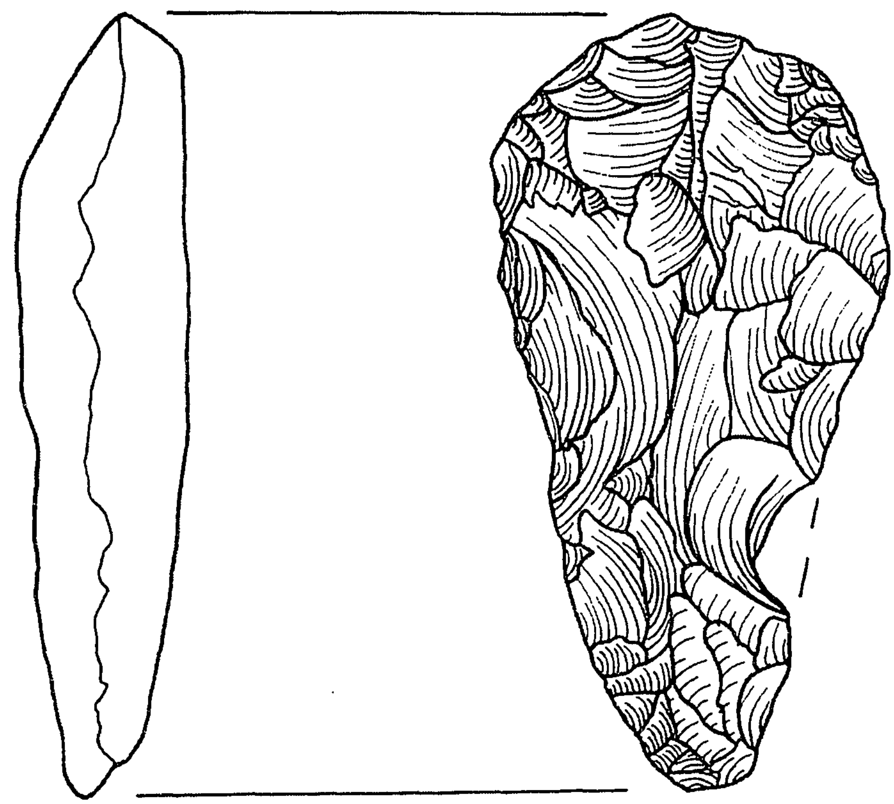
MG 114/6 is the medial fragment from an oval biface made from dark gray, slightly coarser grained CBZ chert [Figure 6c]. It appears similar in dimensions to the thinner Late Preclassic versions of this tool type from Colha. There are bending fractures at both the proximal and distal ends of this tool fragment. It is likely it broke while hafted during the execution of some task and was not used or reworked after breakage.

MG 26/2 is a small heavily reworked oval biface made from banded light and dark gray CBZ chert [Figure 8b]. Its reduced size and the large number of flake scars with and without step and hinge terminations on both surfaces indicate much resharpening and reshaping of this tool. A deep flake scar on the right ventral edge of the tool may have rendered it impossible to re-haft properly. It appears to be a reworking event that went awry.

Oval biface MG 196/2 was manufactured from banded and speckled gray CBZ chert [Figure 6b]. Its distal end possesses multiple step and hinge flake scars related to heavy

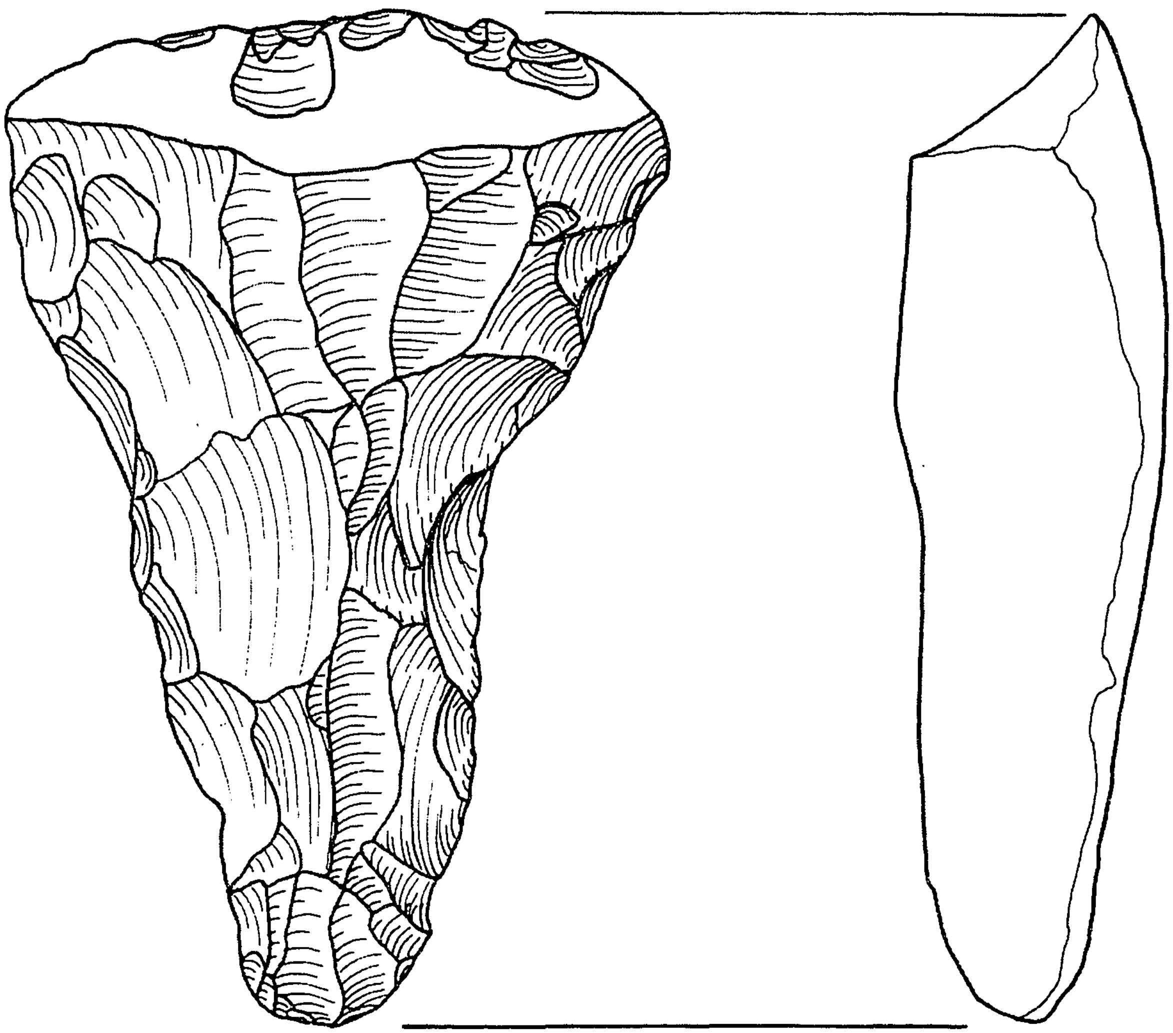


a.MG 196/4

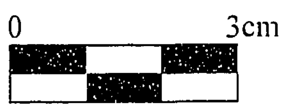


b.MG 26/2

Figure 8: Illustrations of Bifaces from Marco Gonzalez



c. MG 76/1



use and some longer flake scars that indicate either edge resharpening or flake removals due to heavy impact, The tool seems to have been abandoned or went into disuse before breakage. It appears it was still serviceable or could have been modified for a different function.

General-utility bifaces:

All 22 of the general-utility bifaces or fragments at Marco Gonzalez were made from CBZ chert. Like the oval bifaces, the majority of these tools demonstrate extensive use in the form of steep edge angles, edge crushing, and multiple reworking events. There were three whole tools, one proximal tool fragment, twelve medial tool fragments and six distal tool fragments found. Some of the fragments have been re-used after initial breakage of the larger complete biface and became hand held tools, most likely used for chopping or pounding/crushing activities. Other tool fragments were re-used as sources of raw material as demonstrated by the flake removal scars on their exterior and interior surfaces, in some cases, proof of re-use after breakage is manifested as flake removals from the fractured end of a tool fragment. Like the tools from San Pedro, it appears much of the repair/recycling work and flake removal on the lithics on the Caye was accomplished using a hard hammerstone, whereas it appears initial production, or at least finishing of the tools was done using a soft-hammer.

Two of the distal general-utility biface fragments recovered are heavily 'blackened' but have retained enough of their original colour and stone pattern to be identifiable as dark gray CBZ chert. MG 221/1 is slightly mottled with damage to the distal end that indicates impact. MG 174/1 also possesses distal end damage consistent with use on hard materials and possesses evidence for burning in the form of heat crazing. Neither tool was recycled or reused after breakage. The MG 221/1 fragment has a fracture patterns on the proximal end consistent with a tri-modal breakage caused by use-related impact, while MG 174/1 may have been subject to heat-related fracture.

The medial general-utility biface fragment MG105/1 was heavily modified after initial breakage. This CBZ chert fragment possesses multiple flake removal scars on the proximal break plane and numerous deep step and hinge terminated flake scars on the distal break plane. The flake scars seem too small to be evidence for use of this biface fragment as a source of raw material. Likely, the tool's shape was modified for some other use. Ring-crack impact cones on the exterior surface indicate the fragment was either struck repeatedly, or struck something else repeatedly.

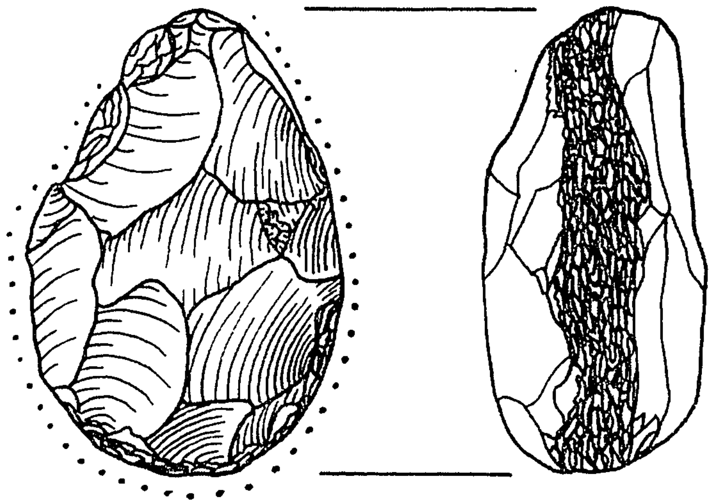
Artifact MG 131/3 is a large general-utility biface manufactured from mottled and speckled dark gray CBZ chert. There are a some small patches of cortex on the exterior surface. The distal end of the tool was heavily used, based on crushing and the removal of small step and hinge terminated flakes. The proximal end seems to have been deliberately reshaped because of the presence of some hinge flake scars. It was also used for some pounding or crushing based on limited areas of edge crushing. Strong evidence for resharpening of this tool exists in the form of two bifacial thinning flake scars near the distal end of the tool. One flake was removed from the exterior surface and one flake was removed from the interior surface.

MG 175/2 is the distal fragment from a general-utility biface of speckled and mottled gray and greenish CBZ chert. There is heavy damage on the distal end in the form of crushing and mostly step flake scars. Evidence for reuse as a source of raw material after breakage may be the flake scars present on the proximal break end.

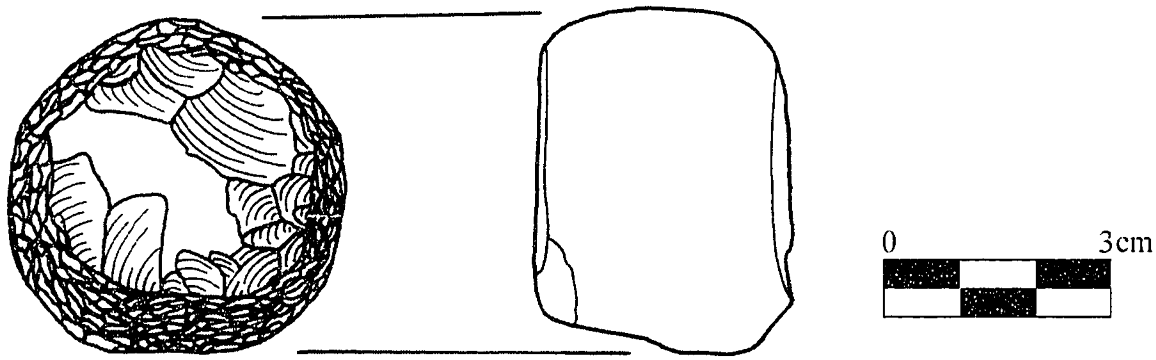
MG 236/1 is the distal end of a heavily used and reworked general-utility biface manufactured from banded light gray CBZ chert. The exterior surface possesses surface crushing consistent with use as a pounding tool on the crown of the tool midline. There is also a large flake scar that would be consistent with the removal of a biface edge. The interior surface is covered in multidirectional flake removal scars that correspond to bifacial thinning, reshaping, and possibly the removal of flakes for expedient use. A number of the flake scars end in hinge terminations. The distal edge of the tool has some crushing and both step and hinge flake scars associated with impact. There is evidence for the removal of hinge terminated flakes from the proximal break surface after the biface was fractured.

MG 236/23 is the distal end of another heavily used general-utility biface [Figure 9i]. This tool was made from banded gray CBZ chert but has some reddish discoloration due to burning. Heat-crazing and potlidding on the tool surface also attest to the thermal alteration. The tool was burnt after breakage and reuse. The distal edge possesses crushing damage and numerous step and hinge flake scars associated with impact. Some step and hinge flake scars on the exterior and interior surfaces suggest the tool was resharpened a number of times before breakage. Crushing along the right edge indicates that the tool continued to be used for pounding activities after initial breakage. There are flake scars on the proximal break surface indicating modification after initial tool fracture.

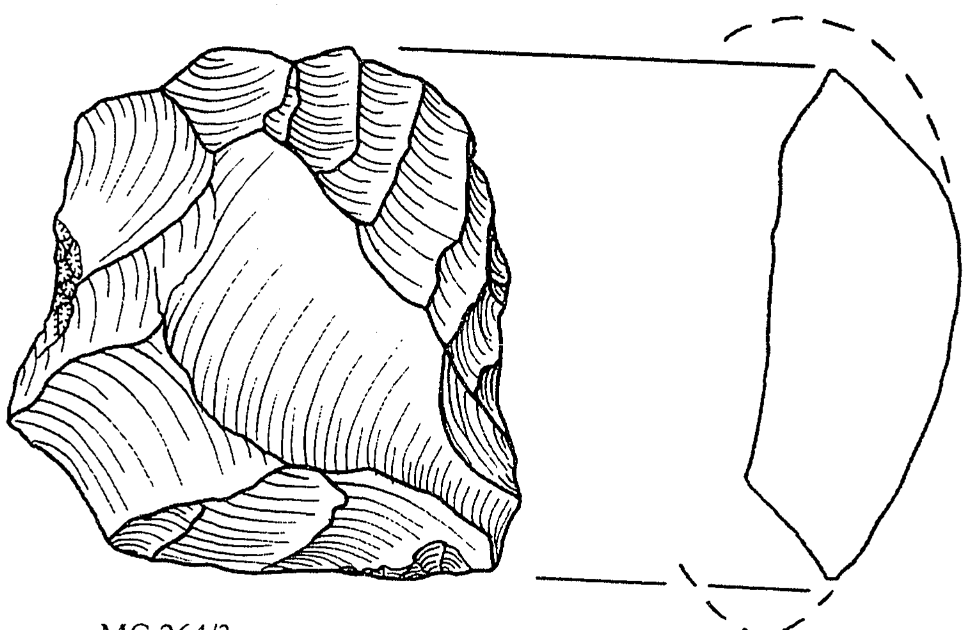
This is the medial fragment of a general-utility biface made from dark gray and reddish CBZ chert. MG 264/3 has been heavily flaked after breakage [Figure 9c]. Although the exterior surface has not been modified, the interior surface has been flaked along both



a. MG 129/3

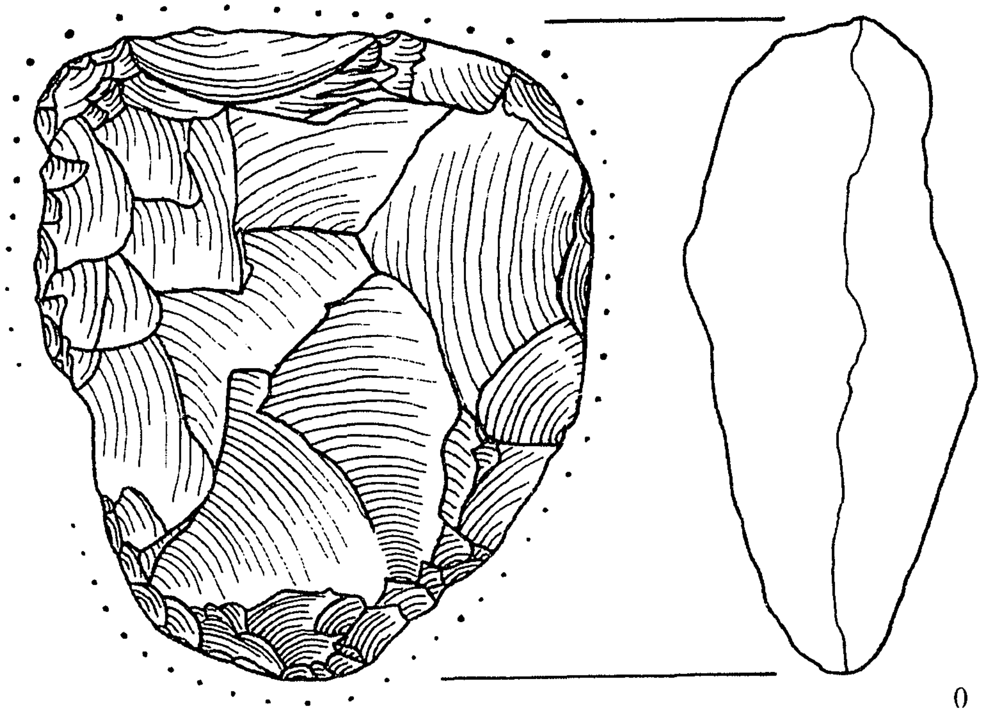


b. MG 26/4

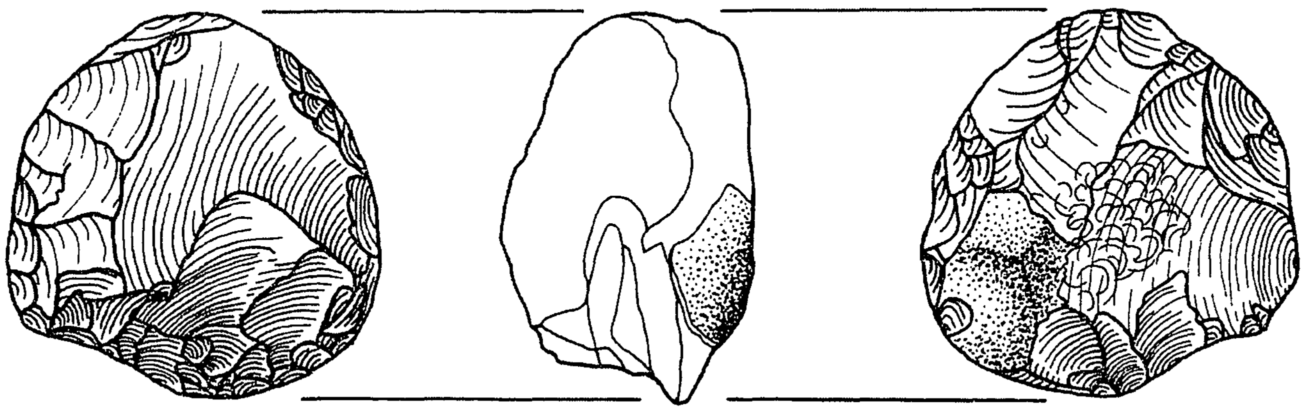


c. MG 264/3

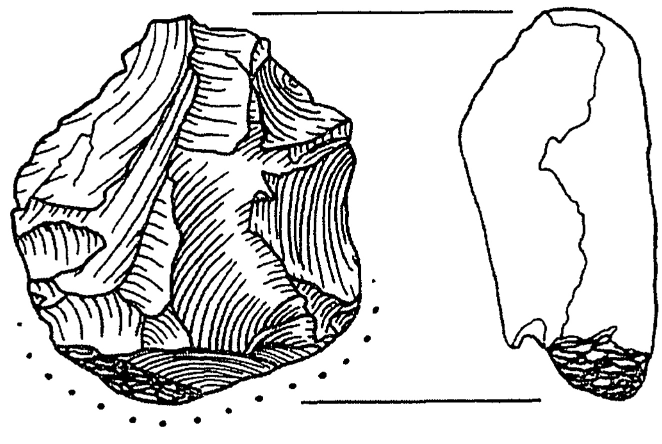
Figure 9: Illustrations of Biface Fragments and Recycled Bifaces from Marco Gonzalez and San Pedro



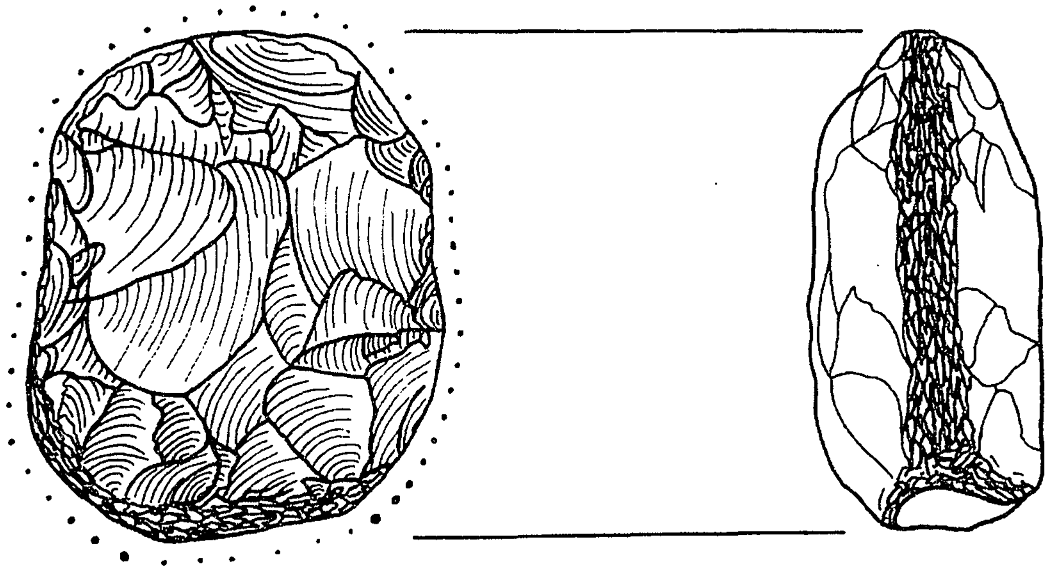
d. SP 204/2



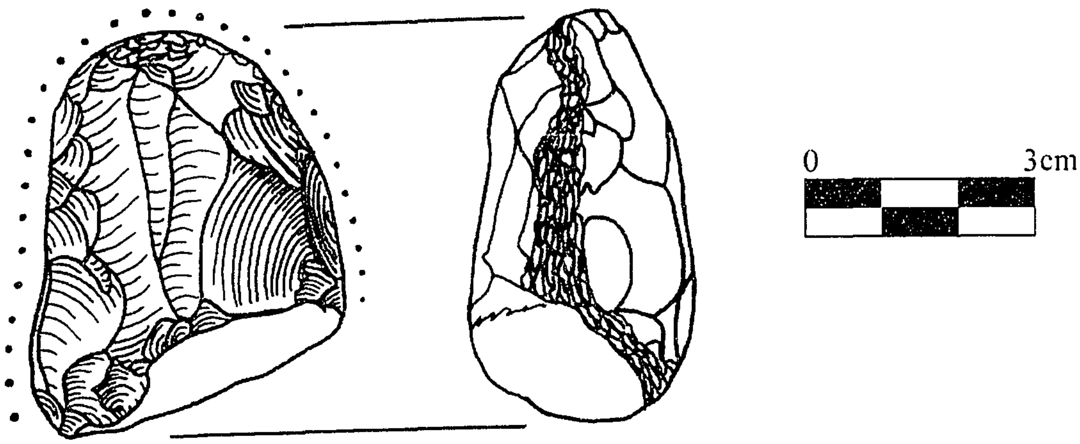
e. MG 75/1



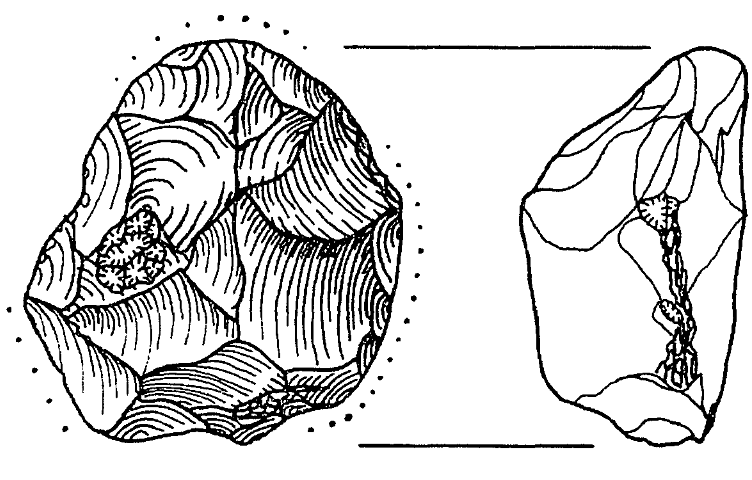
f. MG 260/1



g. SP 42/2



h. SP 33/4



i. MG 236/23

Note (Figure 9): Edge crushing is represented by the dotted lines around the edges of the artifacts (....). Heavy edge crushing is represented by large dots, while lighter crushing is represented by smaller dots.

breakage planes and along the left edge of the tool the flake scars are relatively small and some end in hinge terminations. Given the shape and size of the flake scars, it seems doubtful this tool fragment was used as a source of raw material. It appears to have been modified for some other purpose.

Artifact MG 196/4 is an almost whole general-utility biface made from mottled and speckled dark gray CBZ chert [Figure 8a]. The proximal or hafted end possesses what can best be described as a 'peeling' fracture that runs across the width of the tool. Based on the type and orientation of the break, the biface was hafted as an axe. When the axe head contacted its target, a fracture was initiated near the base of the closest edge of the biface and 'rolled' or 'peeled' through the body of the tool as the blow was followed through. The distal end has some minor crushing and some small step and hinge fractures consistent with chopping activity, as well as a longer step-terminated flake scar on the interior surface from resharpening. The tool may have been reused after breakage as both the left and right medial edges have crushing and step and hinge flake scars primarily on the interior surface.

Biface preforms:

Unlike the lithic assemblage from San Pedro, the collection of stone tools from Marco Gonzalez included two crudely flaked bifacial tools that were classed as preforms. In both cases, it is difficult to determine for certain whether these were true attempts at biface manufacture or whether these tools simply represent the bifacial removal of flakes from large pieces of stone. It appears the skill required to reduce these preforms was not adequate to the task, as the profile of the flake scars indicates flakes that were removing substantial portions of stone instead of 'thinning' the tool.

One [MG 273/1] whole other chert biface and one [MG 137/3] medial fragment manufactured from gray CBZ chert were found at this site. If these tools were, in fact, local attempts at biface manufacture, they serve as excellent examples that the Maya at Marco Gonzalez did not possess the necessary knowledge and/or the skill to execute this type of tool production. A second possible explanation may be that, with dwindling raw material resources, the tool-makers at this site were attempting to produce large bifacial tools on cores or blanks that were not of the proper size, shape or stone quality to succeed.

Re-used and recycled bifaces:

There were 6 bifaces or biface fragments manufactured from CBZ chert excavated from this site. Of the biface/hammerstones recovered all possess very steep, heavily crushed edges. On the dorsal and ventral surfaces of these tools there is evidence of flake scars on their original bifacial aspects. Although, I have referred to these tools as hammerstones, they were not necessarily used to manufacture other tools. Some of the bifaces may have been used to pound or crush other materials such as shell (see below).

MG 26/4 appears to be a medial fragment from a general-utility biface of speckled dark gray CBZ chert that was very heavily used as a hammerstone [Figure 9b]. The entire profile of the tool is completely crushed from hammering or pounding activity. The only evidence that this was once a biface are the remnants of flake scarring on the exterior and interior surfaces.

Artifact MG 75/1 is the distal end of a heavily used general-utility biface made from gray banded CBZ chert [Figure 9e]. Although most of the crushing damage is on the distal end, there is significant crushing on the lateral edges and some crushing and many step and hinge flake scars on the interior surface of the proximal fracture plane. On the exterior surface, near the spine there are numerous ring-cracks associated with impact where this stone was used to pound other hard materials.

The general-utility biface MG 151/1 was made from gray CBZ chert. The pattern of edge crushing attests to its function, however, earlier flake removals suggest that this tool may have been modified or used as a source of flakes before conversion into a pounding tool. It still retains patches of cortex on both the exterior and interior surfaces, primarily down the midline of each face.

Although artifact MG 260/1 is classified as a whole biface that was recycled into a hammerstone, it may actually be a medial fragment [Figure 9f]. The ends of this banded light gray CBZ chert tool have been heavily worked, therefore it is difficult to make an accurate assessment. The distal end possesses evidence of edge crushing and numerous flake scars indicating flake removal from the exterior face of the tool. A number of these are step and hinge terminated flake scars. The proximal end looks like a breakage surface that has been heavily used as a pounding or crushing tool based on the development of the edge crushing. Many tiny step and hinge flake scars are associated with this edge.

CCH was a whole general-utility tool made from dark gray CBZ chert and possesses evidence of resharpening in the form of step and hinge flake scars on both faces. The crushing along the tool edges is heaviest on the distal and proximal ends. Damage due to impact is also recognized by the step and hinge flake scars associated with the crushed edges.

A sequence of intense biface use and reduction from Marco Gonzalez is almost identical to that described by Hult and Hester (1995: Fig.84) from the northern sites of

Ambergris Caye. Large general-utility bifaces and some oval bifaces were transformed from their original forms through various stages of recycled tools, until they finally become much smaller hammerstone or crushing tools [see Figure 9b].

T-form adzes:

A single whole T-shaped adze [MG 76/1] manufactured on a large macroflake of speckled gray CBZ chert was recovered from this site [Figure 8c]. In terms of its morphology, it is almost identical to those described from the workshops at Colha. Although, there is damage to the distally beveled end indicative of use related to impact, this tool is in excellent condition compared to the rest of the larger bifaces from the assemblage. There is no evidence that this tool has been reworked or used for any other tasks. In an environment where complete bifaces and raw material are at a premium, it is curious that this tool was left intact. Because this morphologically Preclassic tool was recovered from a Postclassic context, it may be evidence of delayed curation at Marco Gonzalez (see below).

Lenticular bifaces:

Of the 12 lenticular biface fragments recovered, 8 were made from CBZ chert, 3 were made from other chert, and 1 was manufactured from black chert. There were 8 medial fragments, 2 proximal fragments and 2 distal fragments from Marco Gonzalez.

MG 157/1 is a medial lenticular biface fragment manufactured from brown, honey-coloured and gray CBZ chert. Typical of most fragments, its proximal end tapers to where the proximal point would have been. Based on the uneven appearance of the tool edges and the flake scars along the right interior and left exterior edges, at least one side of the tool was flaked after initial manufacture. This is both repair and use-related.

The medial lenticular biface fragment MG 107/9 is manufactured from other chert and is gray and black in colour. Much of this discoloration is due to the extreme burning of the tool as demonstrated by the colour change, potlidding, and heat fracture of the proximal and distal ends. There is no evidence this tool was used after burning.

MG 222/1 is the distal fragment of a 'black' chert lenticular biface. There are numerous steep flake scars on the distal and lateral edges of the tool. It appears resharpening or reshaping activities were undertaken by individuals that were not able to successfully modify the tool.

Artifact MG 5/15 is the proximal fragment of a lenticular biface made from dark gray CBZ chert. The butt end retains part of the cortical striking platform. The tool is completely covered with white patina. Some post-depositional edge damage occurs along the edges that is not use-related.

Stemmed thin bifaces:

There were 9 stemmed thin bifaces or fragments recovered from this site. All of the tools were either whole or proximal fragments. Similar to the miscellaneous thin biface category, these artifacts were produced by soft-hammer percussion and/or pressure flaking. The stemming on the tools suggests that they were initially designed as hafted knives or points. Eight (88.9%) of these bifaces were made from CBZ chert, while only 1 (11.1%) was manufactured from other chert.

MG 148/1 is a very small medial stemmed biface manufactured from other chert. It was finely pressure flaked, but has been severely burnt as demonstrated by numerous potlids and dark gray and white coloration.

Three similar proximal stemmed thin biface fragments were recovered at the site. MG 129/1 is a speckled dark gray CBZ chert fragment, MG 174/4 is a speckled dark gray CBZ chert fragment, and MG 216/1 is a banded dark gray CBZ chert fragment. They do not appear to have been reworked, although they may have been used, after breakage.

MG 5/4 is a stemmed biface [point] made on either a blade or flake that is completely retouched on the exterior face with interior retouch of the stem and along the edges [Figure 10e]. It was made of brown CBZ chert. The distal section of the stem is missing due to heat fracture. Evidence of heat damage exists in the form of a partial potlid on the interior surface of the tool stem. A transverse fracture of the distal tip reveals some resharpening.

MG 18/1 is a thin stemmed biface manufactured from speckled brown and dark gray CBZ chert [Figure 10a]. The distal tip of this tool has snapped off in a possible twisting motion. There is no evidence of any recycling of this biface.

MG 135/5 is the proximal fragment from a stemmed thin biface [point] made from speckled dark gray CBZ chert. The distal tip has been snapped off. There is no evidence for further modification of this tool fragment after breakage.

Artifact MG 233/2 is a thin stemmed biface [point] manufactured from dark gray CBZ chert. While the proximal end possesses a small bending fracture, the distal tip has been snapped off. Based on the coloration of the raw material at the tip, this was a post-depositional fracture. There is no evidence for the recycling of this tool.

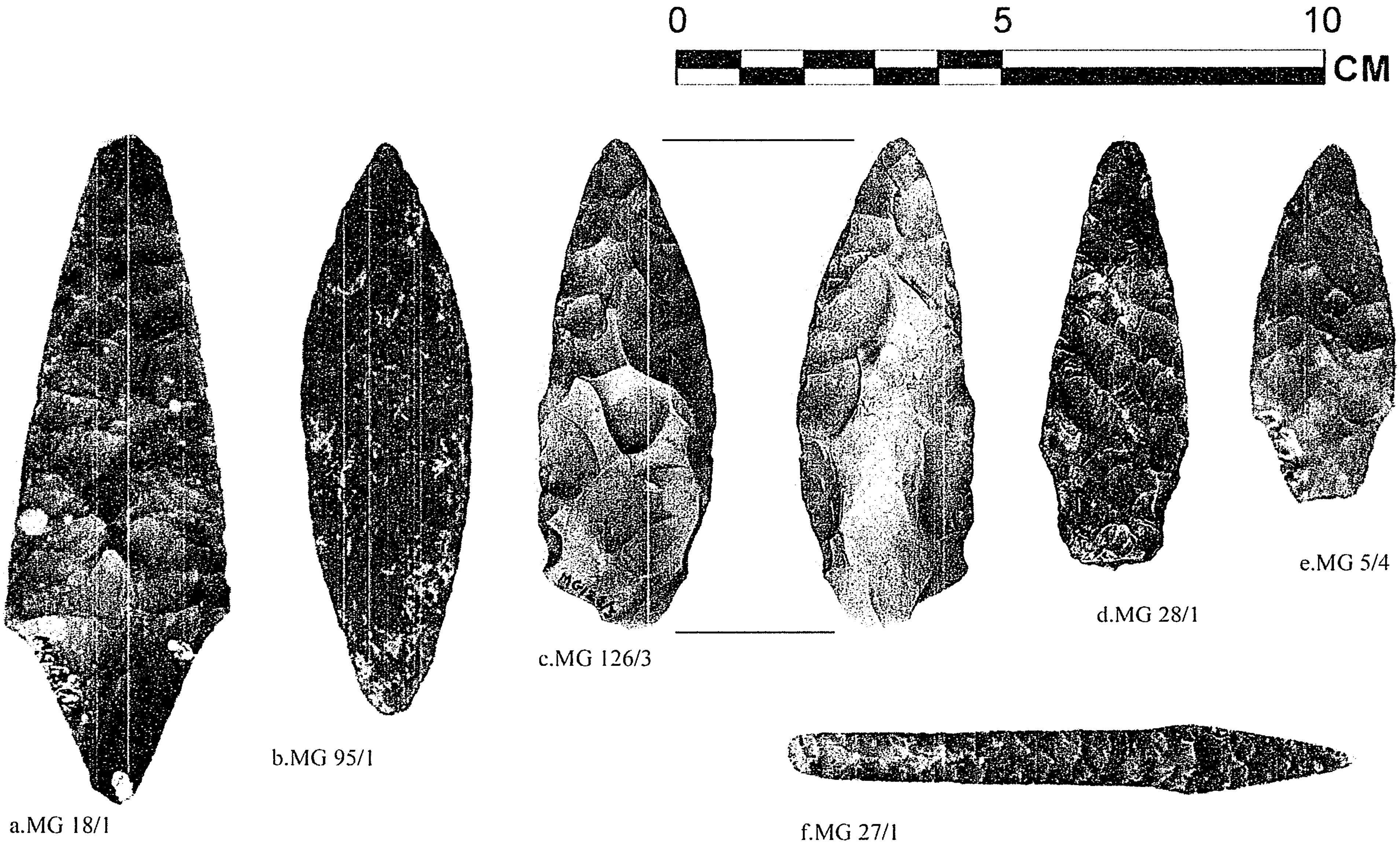


Figure 10: Thick and Thin Bifaces from Marco Gonzalez

Shouldered thin bifaces:

Two whole shouldered thin CBZ chert bifaces [MG 5/3 and MG 28/1] were found at the site. They were manufactured using pressure flaking techniques. The contracting proximal ends on these tools suggest that they were designed to be hafted tools.

MG 5/3 is a thin shouldered biface [point] manufactured from dark gray CBZ chert. The proximal base is missing, likely due to burning fracture, and the tool is extensively burnt with some dark gray to black discoloration. Although this tool experienced some resharpening, there is no indication of further use after the breakage/ burning event(s).

MG 28/1 is a thin, shouldered biface [point] manufactured from brown and dark gray mottled CBZ chert [Figure 10d]. The distal tip of the tool is snapped off, while the proximal end and proximal left edge have also been fractured/removed. The tool demonstrates no recycling.

Shouldered thick bifaces:

Of the two whole thick shouldered bifaces recovered from the site, one [MG 107/2] was made from CBZ chert, while the second [MG 135/3] was made from other chert. Both were manufactured using percussion methods. Based on the contracting ends of these tools they were likely hafted.

Artifact MG 107/2 is a thick shouldered biface [point] manufactured from light and dark gray CBZ chert. The distal tip of this biface has been snapped off. The edges of the tool possess multiple step and hinge termination flakes indicative of use and some edge rejuvenation episodes.

MG 135/3 was manufactured from a coarse grained dark gray, speckled chert that is not from the CBZ. Based primarily on the damage [step and hinge termination scars] on the exterior left edge and the outline asymmetry with the right edge of the tool, it appears this biface was heavily used and resharpened. There are also step and hinge termination scars on the exterior right edge, and damage to the distal tip. Most of the modification of this tool was accomplished through unifacial flaking of the exterior left edge.

Bipointed thin bifaces:

Only 2 whole tools made from CBZ chert [MG 95/1 and MG 189/1] were recovered from Marco Gonzalez. Both exhibit evidence of pressure-flaking reduction.

MG 95/1 is a bipointed thin biface or point on a blade, manufactured from a brown translucent stone that is likely CBZ chert [Figure 10b]. The proximal portion of this tool is bifacially flaked, while the medial and distal interior sections of this artifact retain some of the original unretouched interior surface of the blade. There is no evidence for reuse or recycling of this tool.

Artifact MG 189/1 is a thin bipointed biface manufactured from speckled greenish-dark gray CBZ chert with red and brown banding on the interior proximal surface. The proximal end possesses a bending fracture. There is a potlid on the interior surface of the left lateral edge. Some step and hinge termination scars are evidence of some minor modification of the tool edges.

Side-notched thin bifaces:

Only one whole biface of this type was excavated from Marco Gonzalez. MG 192/2 is likely a point made from light and dark gray CBZ chert. This is a classic example of an 'Early' facet Early Postclassic point from Colha. The side-notching is mildly asymmetrical. There appears to be little modification of this biface.

Small side-notched points (SSNP):

One proximal point fragment was recovered from Marco Gonzalez. Artifact MG 135/1 is a classic example of a side-notched projectile point made on a blade or blade fragment dated to the Late Postclassic. Although it is made from dark gray chert, it is not believed to be CBZ raw material. Both the stem and the blade of the point are bifacially retouched, although this flaking does not completely cover the exterior or interior surfaces. The side-notching is asymmetrical and was bifacially produced. This is a flat-based point whose distal tip break indicates a bending fracture. This tool was not altered after being damaged.

Miscellaneous thin biface fragments:

The miscellaneous thin biface fragments from this site, like those recovered from San Pedro, are more finely flaked than the thicker variety. Likely, these are fragments from points or knives that were produced by soft-hammer percussion and/or pressure flaking. Of the 35 tools and fragments in this category, 23 (65.7%) were made from CBZ chert, 11 (31.4%) were other cherts and 1 (2.9%) was honey-brown chalcedony. All but two of the tools were medial or distal fragments. This is partly due to the fact that, whole tools or proximal ends were possibly classified in other categories based on the retention of more classifiable traits. A significant number (22 or 62.9%) of the thin biface fragments were burnt.

MG 5/14 is the distal fragment of a thin biface [point] made from dark gray CBZ chert. The proximal breakage plane of the tool exhibits heat fracture. The tool itself appears heavily burnt with some potlidding on both aspects, heat crazing, cracking and darker gray discoloration of the distal end. There is no evidence for tool recycling.

Artifact MG 107/1 is the distal fragment from a thin biface [point] manufactured from dark gray CBZ chert. The break on the proximal end appears to be caused by heat damage as shown by some heat cracking and crazing on the break plane. Further evidence of burning includes a waxy feel of the tool surface, some potlidding on the interior aspect, dark gray discoloration and heat crazing. On the right edge of the interior surface is evidence of a unifacially chipped notch. It is believed this notching occurred after the biface was originally fractured, therefore indicating some recycling into another tool form, the colour of the fracture plane is lighter than the notch.

MG 126/3 is a distal fragment from a thin biface [point] manufactured from a greenish gray CBZ chert with red patches of color [Figure 10c]. This specimen suffered moderate thermal damage. The step and hinge termination scars on the tool edges are indicative of use. There was no modification of this tool after the breakage of the proximal end. The heating of this tool is less severe than that encountered on other artifacts. Only the exterior aspect demonstrates any heat modification. The lateral edge of this tool are rounded and very smooth to the touch. Whether this is a product of the heating of the artifact or some other process [water-rolling] is not known.

Miscellaneous thick biface fragments:

The miscellaneous thick biface fragments at Marco Gonzalez are very similar to the oval biface and general-utility biface tools in terms of manufacturing technique. Like the fragments from San Pedro, these lithics probably originated as oval or general-utility bifaces. The total number of thick biface fragments is 18, 17 (94.4%) of which were manufactured from CBZ chert, while only 1 (5.6%) was other chert.

Artifacts MG 196/3 and MG 202/1 are both proximal ends of thick bifaces. Based on the triangular cross-sections of both artifacts, I believe they were once parts of adzes or adze-like bifaces. Both tools are manufactured from CBZ chert and seem to have been broken during use and likely while still in their hafts. MG 202/1 does not appear to have been used after breakage. The retouch along the edges of MG 196/1 may have been performed to rehaft the tool into another handle before the tool was finally broken. Based on the extensive use-wear on this tool, I suspect the rehafting after some slight modification of this end was poorly done and that the tool moved a great deal in the new handle.

Biface edge fragments:

A total of 26 biface edges were recovered at Marco Gonzalez of which 23 (88.5%) were manufactured from CBZ chert and 3 (11.5%) were made from other chert. Twenty-three of these edges had no cortex, while there were two edges with less than 50% cortical coverage and one with more than 50% cortical coverage on the exterior surface. All of these fragments appear to have once formed part of larger bifaces such as oval or general-utility biface tools. Like the tools from San Pedro, these biface edges possess damage ranging from severe edge crushing to varying degrees of step and hinge terminated flake scars. They are most likely the result of failed attempts to renew tool edges, wherein the blow was struck too far into the body of the tool. Based on use-wear analysis, most biface edges appear to have originated on larger tools used to chop or adze wood or dig in the ground. Use-wear polishes on break surfaces indicate the use of these edges after initial tool breakage.

Biface edge MG 98/14 was manufactured from banded brown and gray CBZ chert. The distal edge is crushed and possesses both step and hinge flake scars related to impact. The presence of two percussion ring cracks on the tool surface near the point of percussion that removed this edge from its parent biface indicates three attempts to remove part of the stone from the biface. I believe this is strong evidence for a failed attempt at rejuvenating the biface edge. The retouch along the exterior surface of the fracture plane suggests this lithic was modified for use after initial breakage.

Biface edge fragment MG 76/4 was made from speckled and mottled gray CBZ chert. Based on the crushing damage observed on the distal end and the accompanying deep hinge flake scars, this fragment was part of a heavily used biface. Evidence from the point of impact on the interior surface of the fragment does not clarify whether the removal of this edge was due to an attempt at edge repair or rejuvenation or whether it is the result of use-related impact.

Flakes:

Of the 834 unmodified flakes and flake fragments recovered from Marco Gonzalez, 11 (1.3%) were primary, 43 (5.2%) were secondary 3, 207 (24.8%) were secondary 2, and 573 (68.7%) were tertiary. Although, 31.3% of the flakes were cortical, only 6.8% were primary or secondary 3 flakes, indicating that early stage reduction was hardly occurring at Marco Gonzalez. In fact, the number of flakes by cortex-retention category at this site is very similar to the numbers from San Pedro, where it appears most of the lithic reduction performed was likely end-stage work, specifically maintenance and recycling activities. This same conclusion can be drawn at Marco Gonzalez based on the recovery of other lithic artifacts such as biface edges and considerable numbers of bifacial thinning flakes, the recovery of only two possible biface preforms, and few flake cores or core fragments.

The number of flakes by raw material type at Marco Gonzalez are: 670 (80.3%) CBZ chert, 139 (16.7%) other chert, 1 (1.3%) black chert, 7 (0.8%) brown/honey-coloured chalcedony, and 7 (0.8%) gray chalcedony. The percentages of raw material at this site are similar to those from San Pedro, although there is a slightly higher percentage of CBZ chert flakes at Marco Gonzalez. Much of the CBZ chert material may be from the bifaces originally traded to the site. The flakes with faceted platforms may represent failed attempts at repairing the large bifacial tools resulting in thicker and flatter flakes than those usually associated with biface maintenance. Of the 268 whole and proximal tertiary CBZ chert flakes, 66 (24.6%) possessed faceted platforms, while 13 of 45 (28.9%) of other and black chert tertiary flakes and 24 of 151 (15.9%) CBZ and other chert secondary 2 and 3 flakes did. Although the percentage of faceted platforms on the tertiary CBZ chert flakes is quite high, the discrepancy seen in the San Pedro lithic assemblage flake platforms is not repeated at this site. Part of this explanation may be that there are substantially more black chert artifacts at this site and one distal fragment from a large biface. The data for the other chert category, however, does not provide information that would support this argument as strongly at Marco Gonzalez as it does at San Pedro.

The number of hinge terminations on the whole and distal tertiary CBZ flakes was 87 of 299 (29.1%), while the other chert and black chert whole and distal tertiary flakes possessed 10 of 46 (21.7%). With relatively high numbers of hinge terminations on these flakes, it is likely that the tool-users at Marco Gonzalez did not possess the same ability to work stone as the craft-specialists from locations such as Colha.

As at San Pedro it appears that two different tool reduction strategies are in operation at Marco Gonzalez,. The percentage of primary cortex flakes of CBZ chert was 0.6% and the percentage of the same other chert flakes was 4.3%. Although the total percentages of these flakes at Marco are lower than those at San Pedro, the ratios between them are comparable. At San Pedro, the percentage ratio for CBZ chert to other chert primary flakes is 1:8.4, while at Marco Gonzalez it is 1:7.2. The secondary flakes were divided as follows: 4.0% secondary 3 CBZ flakes and 10.1% secondary 3 other chert flakes, 22.8% secondary 2 CBZ flakes and 31.9% secondary other chert flakes. The number of tertiary CBZ chert flakes at this site was 486 of 670 flakes or 72.5%, while only 75 of 138 or 54.3% of the other chert flakes were tertiary. The majority 83.2% of the tertiary flakes produced at Marco Gonzalez were CBZ chert, whereas only 13.6% were other chert.

The difference in reduction strategy is similar to that observed at San Pedro. As at San Pedro, the Marco Gonzalez assemblage represents two different lithic patterns. The CBZ chert is much more heavily represented by end-stage or maintenance debitage and the other chert seems to indicate a pattern of reduction that includes early through to end stage reduction. Once again, it appears the data from this site suggest the major component of the lithic assemblage of CBZ chert was produced by tool curation and maintenance practices of the formal tools, with a very small early-to-end stage component associated with basic flake production, while the other chert reduction strategy reflects flake production practices including the decortication of chert cobbles or nodules.

Macroflakes:

One large flake or macroflake [MG 104/5] manufactured from other chert was found at Marco Gonzalez. It has a partial cortical covering and has been classified as a secondary 2 flake. There is no evidence of use. It is not large enough to have been a tool blank for the production of a large biface.

Bifacial thinning flakes:

There were 169 bifacial thinning flakes excavated from Marco Gonzalez. Of these, 143 (or 84.6%) were tertiary and 26 (or 15.4%) were secondary 2. No secondary 3 or primary bifacial thinning flakes were found. The raw material categories included: 89.3 % CBZ chert, 6.5% other cherts, 2.4% brown and honey-coloured chalcedony, 1.2% black chert, and 0.6% gray chalcedony. Although there are flakes and bifacial thinning flakes of chalcedony at this site, the only formal tool was a thin biface fragment.

A reduced ability to bifacially flake tools effectively is suggested by the number of flat striking platforms on some (39 of 158 or 24.7%) of the tertiary and secondary whole and proximal bifacial thinning flakes. Most of the bifacial thinning flakes recovered from San Pedro were classified as Category B flakes. There were 83 of 158 (or 52.5%) whole and proximal bifacial thinning flakes that possessed evidence of having been produced by hard-hammer percussion and 18 (11.4%) flakes with a combination of both soft- and hard-hammer reduction traits. Only 14 (8.9%) of these flakes were classed as Category A bifacial thinning flakes. As at San Pedro, the hard-hammer flakes were slightly thicker than the soft-hammer bifacial thinning flakes [average thickness ratio (mm) of whole hard-hammer to soft-hammer bifacial thinning flakes is6.0:4.2] at Marco Gonzalez. This elevated number of hard-hammer reduction flakes suggests a lack of skill being able to remove thin faceted flakes from bifacial tools and probably caused the more rapid reduction of large bifacial tools such as oval bifaces and general-utility bifaces. Hinge terminations on the 16 of 133 (12%) whole flakes and distal flake fragments of CBZ and other chert may serve as additional evidence of the lower level of stone tool manufacturing skill by the Maya from Marco Gonzalez.

Most of the bifacial thinning flakes produced were tertiary flakes of CBZ chert (91.6% of all raw materials), while just 5.6% of this artifact category from Marco Gonzalez were other cherts, 1.4% was brown and honey-coloured chalcedony, and 1.4% was black chert. Based on this information, the greatest amount of biface resharpening and repair was performed on CBZ chert lithics. This seems accurate since the vast majority of the bifaces and biface fragments excavated from Marco Gonzalez were made from 'chert-bearing zone' chert. The source of the completed bifaces being traded to the Caye was likely Colha. Only 20 (13.2%) of all (151) the CBZ chert bifacial thinning flakes recovered from this site were secondary 2 , proving that very little, if any early to middle-stage biface production of CBZ chert tools was completed here. The majority of the CBZ chert bifacial thinning flakes were produced during tool maintenance or recycling. The significance of tool maintenance and recycling activities at Marco Gonzalez is emphasized by the fact that 169 of all 997 flakes and flake fragments (17%) recovered were thinning or edge rejuvenation flakes. However, this is almost 10% less than the percentage at San Pedro, where substantial Late Postclassic and Historic period deposits existed at a time when tools and raw material available from Colha were essentially non-existent.

Retouched flakes:

A total of 34 retouched flakes were recovered from Marco Gonzalez. There were 32 (94.1%) CBZ chert retouched flakes and two (5.9%) other chert flakes. The retouch evident on the edges of these flakes is not technologically uniform as some flakes were produced by percussion, while others were pressure flaked. As well, the invasiveness of the retouch varied. Some flakes were retouched to create a steeper edge for transverse activities such as scraping or whittling, while others were used for sawing or cutting.

Blades:

Two whole blades, three proximal blade fragments, six medial blade fragments and two distal blade fragments were excavated from Marco Gonzalez. Of the 13 blades or fragments, 10 (76.9%) were CBZ chert, while the other 3 (23.1%) were other cherts. Some of the blades and fragments appear to be locally made. In some instances, the blades have the appearance of long, thin flakes.

MG 174/2 is the proximal fragment of a thick blade made from mottled dark gray CBZ chert. Although the striking platform is missing, the bulb of percussion suggests that this blade was produced by a hard-hammer blow. A patch of cortex extends along the distal half of the right edge. Although some of the edge damage is post-depositional, there is evidence of some use-related damage on both edges. Based on the pattern of patination, there was no use of this blade after the proximal platform and the distal end were removed from this tool.

The unretouched blade fragments MG 74/6 and MG 77/65 were likely produced from raw material on the Caye itself. Both blades look like long, thin flakes that were not struck from prepared blade cores. MG 74/6 was burnt and has been classed as other chert, while MG 77/65 is made from brown CBZ chert and possesses substantial cortical covering along the left exterior surface of the tool.

There were a number of fragments from thicker blades recovered from Marco Gonzalez. Medial fragments MG 82/1 and MG 129/42 are both thick blade segments with triangular cross-sections. It is my opinion that these blades were not produced on the Caye, however the severity of the burning of these two fragments has masked areas of the tools that might provide more evidence for this assumption. Given their size, both were likely produced by a direct percussion method. MG 82/1 was classified as CBZ chert, while MG 129/42 was classified as other chert.

Another relatively thick proximal blade fragment was MG 255/7. It is more crudely made than some of the other blades in the assemblage and possesses a partially faceted striking platform and a bulb of percussion indicating that it was produced by a percussion blow. Although it possesses a trapezoidal cross-section, there is a pattern of flake scarring on the exterior surface that I believe is consistent with removal from a more crudely fashioned core than those of the other blades. This blade may have been produced at Marco Gonzalez.

Whole blade MG 217/1 was made from mottled light and dark gray CBZ chert. It possesses a faceted striking platform and a reduced bulb of percussion consistent with production by indirect percussion. This evidence, along with the curvature of the blade and the triangular cross-section indicate that it was likely produced in a workshop on the mainland.

Medial blade fragment MG 167/1 was made from speckled gray CBZ chert. The trapezoidal cross-section of this tool suggests removal from a blade core and was probably not produced on the Caye. Edge damage on the fragment could be related to use prior to tool breakage, although some use damage may have occurred after the fragment was broken from the rest of the blade.

Artifact MG130/4 is a proximal blade fragment of dark gray CBZ chert. Its partially flat and punctiform striking platform and éraillure scar indicate that it was struck with a direct percussion blow. Furthermore, its triangular cross-section and crude appearance reveal a tool that was produced at Marco Gonzalez and not necessarily struck from a prepared blade core. Heat crazing and heat fracture of the distal end reveal that this tool was quite heavily burnt.

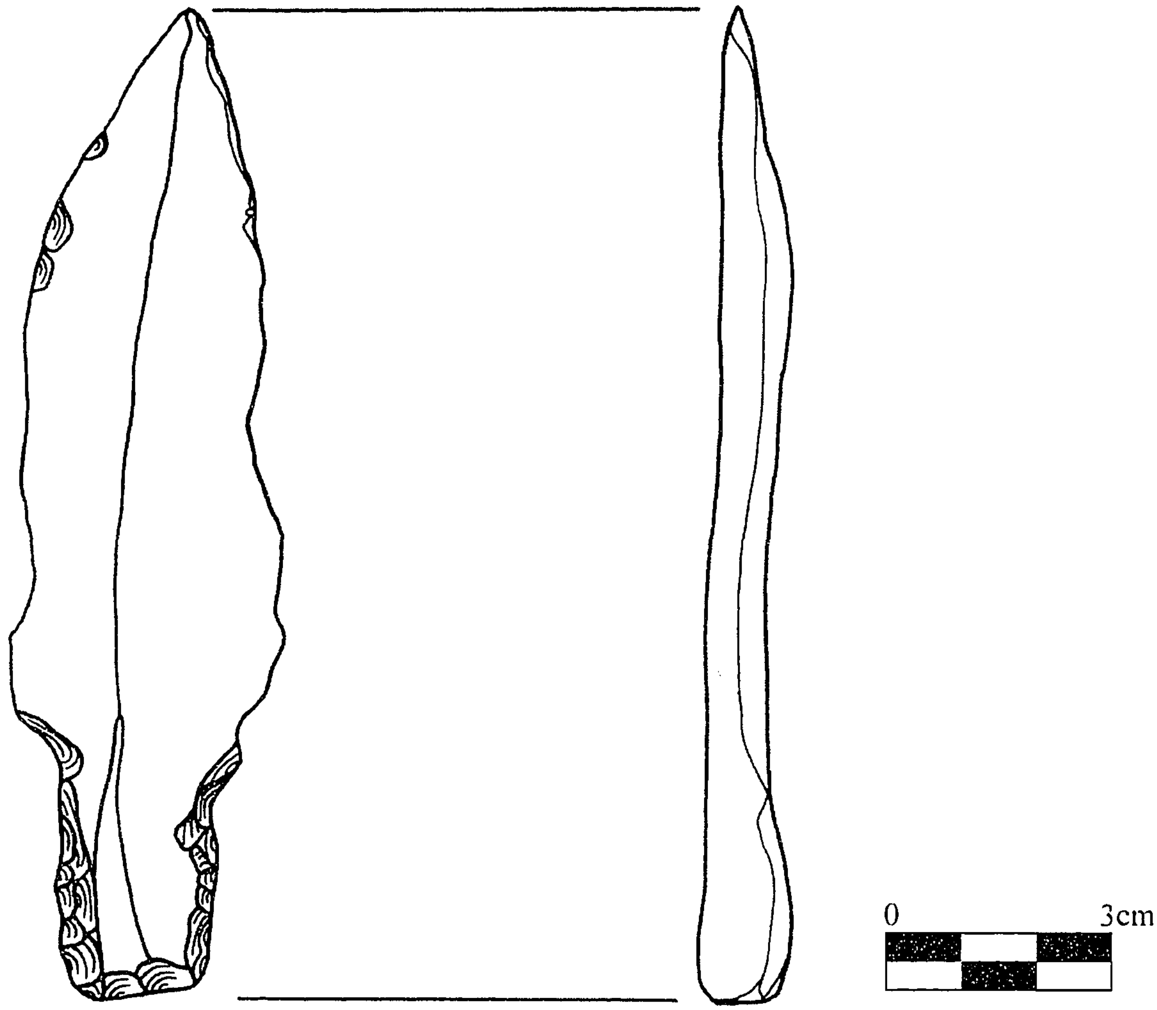
No blade cores or blade core fragments were recovered from Marco Gonzalez

Stemmed blades:

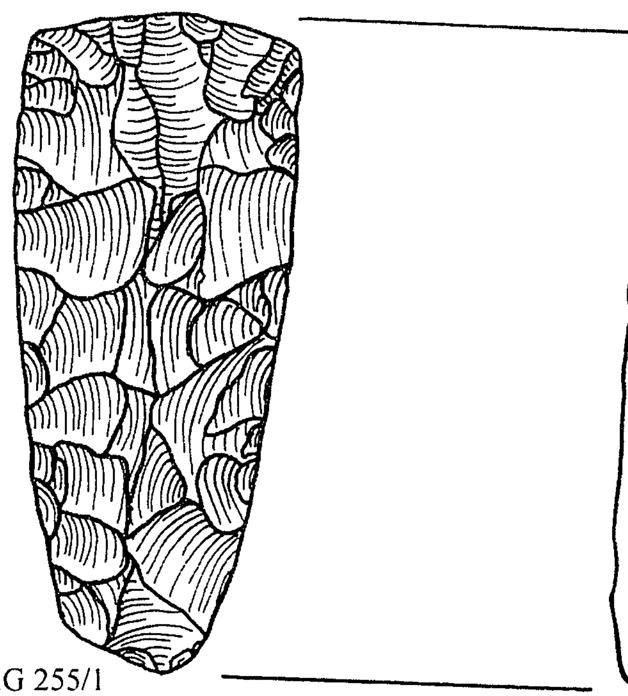
All of the stemmed blades or fragments were CBZ chert: four whole tools, four proximal fragments, and one medial fragment.

Stemmed blade MG 129/9 is made from dark gray CBZ chert [Figure 11a]. All retouch on the tool is unifacial on the exterior aspect. The stem section is retouched and sections of the distal portion of the blade possess some minor retouch on both the left and right edges. The striking platform on the proximal end of the tool is intact and possesses excellent evidence of hard-hammer percussion [pronounced bulb of percussion, ring-crack]. This tool was not modified or recycled.

MG 160/1 is the proximal fragment of a stemmed blade manufactured from speckled dark gray CBZ chert. The distal end has been snapped off. Based on the partial ring-crack, the éraillure scar below the platform, and the bulb of percussion, this blade was produced using hard-hammer percussion. The retouch is unifacial on the exterior surface



a.MG 129/9



b. MG 255/1

Figure 11: Illustrations of Other Tools from Marco Gonzalez

with a reworked stem and some lateral retouch of the blade edges. There is no evidence for recycling of this tool after breakage.

MG 53/2 is a proximal stemmed blade fragment made from speckled dark gray CBZ chert. The distal end of the blade possesses a snap fracture. The left side of the stem is unifacially flaked on the interior surface, while the right side of stem is bifacially flaked. The blade portion of the tool possesses no deliberate retouch. There is no evidence of tool recycling after breakage.

MG 160/1 is a proximal stemmed blade fragment made of dark gray CBZ chert. The stem is unifacially flaked on the exterior surface. There is retouch along the blade section of the fragment that is unifacial on the exterior surface. Based on the bulb of percussion and the accompanying éraillure scar, this blade was produced by hard-hammer percussion. the striking platform itself has been removed.

Four stemmed blades and fragments from this site represent different types of blades possessing different reduction strategies. MG 226/4 is a whole stemmed blade made from light and dark gray CBZ chert. Stemming occurs as minor unifacial retouch on the interior surface. The majority of the right edge of the tool is cortex. This tool resembles a long, thin flake instead of a blade removed from a prepared core. I believe this tool was manufactured on the Caye. Blades MG150/1 and MG 194/2 appear to have been struck from blade cores using direct percussion. MG 150/1 is made from mottled gray CBZ chert with a triangular cross-section that possesses mostly unifacial stemming retouch on the interior surface, with some bifacial flake removal producing a rounded distal end. The striking platform and éraillure scar on the pronounced bulb of percussion indicate a direct percussion removal. Some of the stepped flakes on the exterior surface at the distal end may be caused by blade production that is similar to bipolar reduction. MG 194/2 is a slightly thicker mottled dark gray CBZ chert medial blade fragment. The stemming is accomplished through unifacial flaking of the right edge of the exterior surface and unifacial flaking of the right edge of the interior surface. There is minimal unifacial flaking of the exterior surface near the distal end. Although the striking platform is missing, the pronounced concoidal fracture ripples suggest direct percussion removal. This fragment has moderate thermal damage. Artifact MG 113/8 is a proximal stemmed blade fragment manufactured from banded light and dark gray CBZ chert, Unlike the other stemmed blades described, the stem of this artifact is bifacially flaked. In this instance, stemming was not accomplished through pressure retouch but through percussion flaking. The remaining platform suggests a direct percussion removal of a relatively large blade or long flake blank. The remaining edges of the blade section itself are bifacially chipped. The distal end has snapped off.

Retouched blades:

One whole retouched blade, one proximal fragment, nine medial fragments, and two distal fragments were excavated from the site. Eleven (84.6%) of the tools were manufactured from CBZ chert, one was made from other chert and one was made from black chert.

MG 255/2 is a retouched proximal blade fragment manufactured from banded gray CBZ chert. The ring crack impact scar on the flat striking platform and the large éraillure scar on the bulb of percussion all indicate production by direct percussion. The unifacial retouch on the exterior surface occurs on both tool edges. This retouch is very steep and resembles backing retouch.

MG 26/11 is the distal end of retouched blade made from speckled dark gray CBZ chert. The fragment was unifacially flaked on the exterior surface to form a point, with minor retouch on the interior surface. The blade is trapezoidal in cross-section and appears to have been struck from a prepared blade core. The proximal end break is due to a bending fracture.

MG 174/6 is an almost complete medial retouched blade fragment made from banded CBZ chert that is dark gray and black in colour. It may have been subjected to some manganese oxidation. The proximal end and distal tip have been removed from this blade, which was retouched to a point. Most of the retouch is unifacial on the exterior surface, however, there is some interior retouch on the right edge near the proximal end. Although the proximal platform is missing and the tool has a trapezoidal cross-section, this blade is more crudely made than others recovered in the assemblage. The interior surface possesses ridges from hard concoidal fracture and one of the blade scars on the right side of the exterior surface was removed in the opposite direction from that of the blade. This blade may have been removed from what could best be described as an *ad hoc* blade core.

MG 221/2 is a medial retouched blade segment classified as black chert. Although this tool is classed with the other 'blackened' tools, the raw material appears to be a naturally semi-translucent black or very dark gray stone. The breakage planes of this tool confirm that it is the same colour and grain size throughout. It is definitely not CBZ chert, nor does the colour appear to be due to oxidation. The fragment is bifacially pressure flaked on the exterior left/interior right edge and unifacially flaked on the interior left edge.

Based on the trapezoidal cross-section, this tool was struck from a prepared blade core and was not produced on the Caye.

Macroblades:

All of the macroblade artifacts recovered from Marco Gonzalez were medial fragments. Of the four fragments recovered, three were CBZ chert and one was other chert. No macroblade cores or core fragments were found at Marco Gonzalez.

Two medial unretouched macroblade fragments MG 107/17 and MG 131/1 were both made from light and dark gray CBZ chert and both possess trapezoidal cross-sections that indicate they were removed from prepared macroblade cores. It is believed these tools arrived on the Caye in finished form and were not manufactured by the Maya from Marco Gonzalez.

Stemmed macroblades:

Although no whole stemmed macroblades were recovered from the site, there were two medial fragments and four stems in the assemblage. All of the fragments were CBZ chert. It is believed that these tools were imported in finished form from mainland production centres. Because the tools are so fragmentary, they may not all be examples of Late Preclassic stemmed macroblades as described from Colha. Although based on their size and morphology they are classed as stemmed macroblades, they may be later versions of this tool type.

The four proximal fragments in this category were all bifacially worked macroblade stems were from CBZ chert. MG 157/2, MG 234/2 and MG 264/1 are all shorter and thicker than MG 129/4. Although not all of the stems may be of the Late Preclassic stemmed macroblade variety, they were finely manufactured and likely arrived on the Caye as complete, finished lithics.

The most complete stemmed macroblade recovered from Marco Gonzalez is the medial fragment MG 95/3. It was manufactured from light gray CBZ chert. The remaining stem section was bifacially flaked, although this flaking was not completely intrusive and did not cover the entire midline of the stem. The right interior edge of the stem sustained little retouch. The blade portion of the fragment was unifacially flaked along the edges of the interior surface. Evidence for thermal damage to the tool is seen in the heat fracture of the proximal end of the stem. The distal end of the blade possesses a bending fracture. This tool was imported to the Caye as a finished stemmed macroblade and was not produced there.

Retouched macroblades:

There were two medial fragments and a single distal fragment from retouched macroblades in this assemblage. Two fragments were made from CBZ chert ,while the other was made from other chert.

The distal retouched macroblade fragment MG 26/9 was manufactured on light gray CBZ chert. Given its trapezoidal cross-section, it was struck from a well-prepared macrocore. Based on this evidence, I suggest that it is not the product of local manufacture, but was imported in finished form from the mainland lithic workshops.

The burnt macroblade fragment MG 236/11 was manufactured from light and dark gray CBZ chert. Given that the tool was made on a prepared macroblade core, it is therefore suggested that it was imported to the site in finished form. The bending fracture on the proximal end of the macroblade may have been caused during use.

Drills on blades or flakes:

This is the distal end of a tertiary CBZ chert flake [MG 94/5] that was deliberately pressure flaked to a solid point on the distal end. This tool is classified as a drill on a flake because it appears its intended initial use was for drilling. Other tools that were used for drilling or boring activities in this assemblage appear to have been originally designed for another purpose or were not deliberately modified to serve as drills. Most tools were used as is, with little additional modification to render them more amenable to the task.

Blocky fragments:

Of the 210 blocky fragments from Marco Gonzalez, 159 (75.7%) were CBZ chert, 47 (22.4%) were classified as other cherts, 2 (1%) were black chert, 1 (0.5%) was gray chalcedony, and 1 (0.5%) was slate. The largest fragment [MG 237/2] was a 688.8 gram chunk of dark gray CBZ chert that could have been used to manufacture more flakes at Marco Gonzalez.

There were five blocky fragments that were converted into hammerstones or pounding tools at the site. Four fragments were made from CBZ chert, while the other fragment [MG 200/2] was made of black chert. At least some of the blocky fragments from Marco Gonzalez were parts of other formal tool forms, most likely, cores or larger bifaces. But discernible features that would identify them as other tool types are no longer present on the blocky fragments.

Core fragments:

There were 10 standard flake core fragments and 3 pyramidal flake core fragments recovered from this site. All of the standard flake core fragments were made from CBZ chert, as were all of the pyramidal flake core fragments. The standard flake core fragments possessed random, multi-directional flake scars on their surfaces. The pyramidal flake core fragments all demonstrate evidence of flaking in mostly a single direction with the flake scars originating from one end of the fragments and converging in irregular patterns at the other. There appears to be some effort at regularity or greater control of flake removals on these fragments which may represent attempts by the Maya at this site to maximize the number of usable flakes removed from each core fragment

In addition to the standard flake and pyramidal flake core fragments at Marco Gonzalez, one CBZ chert core fragment [MG 173/11] possesses surface and edge crushing suggesting it was recycled into a hammerstone or pounding tools.

Cores:

Only one standard flake core manufactured from CBZ chert [MG 231/6] was excavated from the Maya site of Marco Gonzalez. It was identified based on the random pattern of flake scars on its surface and a few areas of impact rings [Hertzian cones].

In addition to this flake core, two CBZ chert flake cores [MG 80/1 and MG 161/36] and one other chert flake core [MG 114/1] from the site were modified into hammerstones. These cores were transformed into hammerstones or pounding/crushing tools in a manner similar to the core fragment discussed above and also possessed areas of extensive crushing along the tool edges and surficial flake ridges.

Heat spalls and potlids:

There were 17 heat spalled fragments or potlids excavated from Marco Gonzalez. Of these fragments, 11 (64.7%) were CBZ chert and six (35.3%) were other chert types. None of these fragments was modified into another tool form.

Scrapers:

Four scraper fragments manufactured from gray CBZ chert were found at the site. The two medial fragments [MG 231/2 and MG 255/17] and two distal fragments [MG 82/20 and MG 161/16] possess steep unifacial retouch on the exterior surfaces. Based on the steep retouch and the fact that the tools appear to have been retouched prior to fracture [i.e.: no flake scars on the fracture planes], they were included in this tool category. Similar to the drill on flake, other tools were used for scraping activities at Marco Gonzalez, but do not appear to have been initially designed for this type of activity. Those lithics are primarily *ad hoc* tools that may have been selected because of a naturally occurring steep edge or were slightly retouched.

Special tools/finds:

There were two 'special' artifacts from Marco Gonzalez that were difficult to classify based on the existing tool classes. Although they are both thin bifaces, their manufacture and morphology make them unique in the assemblage.

Artifact MG 27/1 is a thin long-stemmed biface [point] made from semi-translucent honey-coloured chert [Figure 10f]. It was very finely pressure-flaked from stem to tip. Given the length and fragility of the stem, it is likely this tool was never intended for a practical function. It was most probably originally designed to serve some decorative or ritual function, as there is no evidence of use.

The second special artifact [MG 255/1] was made on a flake or blade [Figure 11b]. It is a thin convex-ended hatchet-like biface of speckled gray CBZ chert. There is no observable edge damage related to use. I believe this was also a tool designed for some ritual or ceremonial purpose.

The Weight of Raw Materials from Marco Gonzalez

Similar to the assemblage from San Pedro, I believe that the number or counts of lithic pieces by tool type or raw material category at Marco Gonzalez may be misleading in terms of the actual amount of raw material in each category. Therefore, I have recorded the weights of all the stone tools from this site and have sub-divided them by tool and raw material types in an attempt to reconstruct lithic raw material use. There was a total of 27,169.6 grams or roughly 27 kilograms of artifact stone recovered from Marco Gonzalez [see Appendix E]. The amount of CBZ chert, other chert, black chert, brown and honey-coloured chalcedony, gray chalcedony, and slate was almost twice the amount of raw material recovered from San Pedro. As at San Pedro, the largest percentage of all the raw material from Marco Gonzalez was CBZ chert weighing 21,209.3 grams (78.1%). In addition, there were 5593.2 grams (20.6%) of other chert, 176.6 grams (0.6%) of black chert, 82.9 grams (0.3%) of brown and honey-coloured chalcedony, 75 grams (0.3%) of gray chalcedony, and 32.6 grams (0.1%) of slate. The greater percentage of 'chert-bearing zone' chert and lower percentages of other raw materials at Marco Gonzalez than at San Pedro may be indicative of slightly better access to the higher quality CBZ stone. Part of the explanation for this difference may be the more substantial Late Postclassic and Historic period occupation at San Pedro than at Marco Gonzalez. During this period the production workshops at Colha no longer existed and trade for finished tools or simple CBZ raw material may have been more difficult.

Table 4: The Weight (grams) of Tool Categories by Raw Material Type at Marco Gonzalez

Tool Category	CBZ Chert	Other Chert	Black Chert	Chalc. (b/h-c)	Chalc. (g)	Quartz.	Slate
Formal thick and thin biface tools and fragments	5882.9 (77.9%)	1604.1 (21.3%)	47.9 (0.6%)	13.5 (0.2%)	0	0	0
Blade and macroblade tools and fragments	682.3 (85.8%)	104.3 (13.1%)	8.5 (1.1%)	0	0	0	0
Bifacial thinning flakes	1358.4 (91.1%)	74.3 (5%)	18.3 (1.2%)	29.9 (2%)	9.8 (0.9%)	0	0
Retouched and unretouched flakes	7329 (80.3)	1641 (18%)	51.2 (0.6%)	39.5 (0.4%)	60.7 (0.7%)	0	0
Blocky fragments	3440.3 (74.7%)	1125.2 (24.4%)	4.4 (<0.1%)	0	4.5 (<0.1%)	0	32.6 (0.7%)
Flake cores and fragments	1582.4 (74.3%)	547.6 (25.7%)	0	0	0	0	0

Similar to the assemblage composition at San Pedro, the greatest percentage of formal tools and lithic fragments that are related to formal tool reduction and repair were made from CBZ chert. The difference in percentages between the formal tool component at San Pedro and Marco Gonzalez would be much greater if the preform category were omitted from weight calculations. Interestingly, 83.5% or 1339.5 grams of the other chert category is represented by the single large biface preform. The weights for the raw materials in the formal biface tool category without the preforms would be: 5752.4 (94.8%) grams of CBZ chert and 264.6 (4.4%) grams of other cherts. Once again, this is not surprising given that almost all of the formal tools on the Caye were produced in the workshops at Colha and that reduction techniques for the preservation of these primarily CBZ chert bifaces and biface fragments would likely produce large amounts of this higher quality stone. The overwhelming majority of the bifacial thinning flakes were manufactured from CBZ chert, supporting the conclusion that most of the repair and recycling of formal tools was based on the maintenance of the large CBZ chert bifaces. However, a smaller informal technology component produced on non-CBZ chert raw materials occurs at Marco Gonzalez than at San Pedro. I suggest that much better access to CBZ chert for the inhabitants of Marco Gonzalez accounts for the significantly higher weight percentage than that for the same tool classes at San Pedro. Unlike the blocky fragments from San Pedro, those from Marco Gonzalez represent a pattern of raw material distribution that demonstrates that the inhabitants of the site had better access to the higher quality stone. However, as at San Pedro, the lower grade, more coarse textured cherts are used for basic flake production at this site. But there is a greater amount of CBZ chert in the assemblage that was not necessarily intended for use as informal technology. I contend that CBZ chert was employed for some simple flake tool manufacture at Marco Gonzalez based on the high percentage of formal core and core fragment weights compared to that of the other cherts. I also argue that greater numbers of formal tools were acquired and carefully conserved by the Maya at Marco Gonzalez than by the inhabitants of San Pedro, thus possibly producing a higher number of flakes related to conservation or repair practices. Nevertheless, there was still a premium on any lithic raw material on Ambergris Caye, so the Marco Gonzalez Maya, like those from San Pedro, were not averse to using any lithic raw material they could acquire to manufacture their own simple flake tools. Much as the San Pedro Maya did, the Marco Gonzalez inhabitants did employ CBZ chert as unmodified flake, or more rarely core, tools.

Thermally Altered Lithics From San Pedro and Marco Gonzalez

Substantial portions of the lithic raw material from San Pedro (154 of 434 lithic artifacts or 35.5%) and Marco Gonzalez (448 of 1489 artifacts or 30.1%) were thermally altered. Of the thermally altered raw materials excavated from San Pedro, 99 (64.3%) were CBZ chert, 48 (31.2%) were other cherts, 3 (1.9%) were brown and honey-coloured chalcedony, 3 (1.9%) were gray chalcedony, and 1 (0.6%) was quartzite. Of the thermally altered raw materials from Marco Gonzalez, 305 (68.1%) were CBZ chert, 138 (30.8%) were other cherts, 3 (0.7%) were black chert, 1 (0.2%) was brown and honey-coloured chalcedony, and 1 (0.2%) was gray chalcedony.

Based on his work at sites such as Colha and Pulltrouser Swamp, Shafer (1983:232) confirms that there is no solid evidence for the deliberate heating of chert to take advantage of manufacturing benefits in Belize lithics. This is likely because obsidian and other very fine grained stones such as the highest grades of chert are most effectively worked in their natural untreated states (Crabtree and Butler 1964:1).

The burnt cherts from Marco Gonzalez and San Pedro demonstrate some and/or all of the characteristics for the heat alteration of cryptocrystalline silicates, notably potlids, heat cracking, heat crazing, pink and red discoloration, and a 'soapy' texture. In severe cases of burning, the integrity of the Colha chert matrix is completely destroyed with a 'scaling' effect occurring in conjunction with changes in colour varying from shades of grays to completely white. The extremely burnt raw materials were usually unsuitable for tool production due to their brittleness and inability to hold an edge. Although a substantial number of the lithics from Marco Gonzalez and San Pedro have been identified as thermally altered, not all have been burnt so severely that their initial colour and source were unidentifiable. Based on the statements by Shafer (1983) and Crabtree and Butler (1964) and my own observations, I believe the fine-grained cryptocrystalline silicates from Marco Gonzalez and San Pedro were not deliberately thermally altered in order to improve their flaking characteristics. Based on the quality of the CBZ cherts and the chalcedonies, the severity and uncontrolled nature of the burning in some instances, and the fact that tool burning crosscuts almost all the established tool categories, it is my contention that tool burning was accidental or incidental to other activities. Such burning may have occurred at some point in the prehistoric past or much more recently. Irrespective of the time, the thermal alteration of these lithics was most likely the result of some cultural processes unrelated to deliberate efforts to improve their flaking qualities.

However, it is interesting to note that, although CBZ chert comprised the greatest percentage of the burnt lithic raw material from San Pedro, only 29.6% or 99 of all (334) the CBZ chert was thermally altered. In comparison, 58 of 75 or 77.3% of the other cherts was thermally altered. A similar pattern of burning exists for the lithics from Marco Gonzalez where 305 of 1213 (25.1%) CBZ chert artifacts and 138 of 235 (58.7%) other chert lithics were thermally altered. The number of other chert pieces that were burnt may be somewhat inflated given the fact that some of the raw material in this category was so badly altered that it could not be positively identified as CBZ chert. Some of this material may in fact have been CBZ chert.

I have hypothesized that lower grade lithic materials may have been treated differently than the CBZ chert in terms of both the formal tool component and informal component as well. It is plausible that some of the lower grade cherts, which comprise a significant proportion of the informal technology at San Pedro, were perhaps deliberately heated to improve their flaking qualities. Whether any chert tools were thermally altered or not may not have been a conscious concern of the Caye Maya. Nevertheless, it is interesting to note that in comparing the bifacial thinning flakes and the blocky fragments from San

Pedro and Marco Gonzalez, there exists a significant dichotomy in thermal alteration percentages. Whereas, 9 of 73 (12.3%) bifacial thinning flakes were thermally altered, 41 of 75 (54.7%) blocky fragments were heat-modified at San Pedro. At Marco Gonzalez, 18 of 169 (10.7%) bifacial thinning flakes were thermally altered, while 122 of 210 (58.1%) blocky fragments possess evidence of burning damage.

In the majority of cases, despite varying degrees of burning, the raw material type could be identified. Nevertheless, the same process that, at times, rendered raw material type difficult to determine also contributed to difficulties in use-wear identification when tools were substantially to severely burnt and could create false polishes as well ['greasy lustre'] (Purdy and Brooks 1971).

Patinated Lithics from San Pedro and Marco Gonzalez

Much like heat alteration, patination sometimes complicated raw material identification. Most patinated tools were only partially affected and complete patination was rare. Only the completely patinated tools were problematic in terms of designating them to a specific material category. There were 103 (23.7%) of 434 tools from San Pedro and 189 (12.7%) of 1489 tools from Marco Gonzalez that were patinated to some degree. In some cases, segments of the same lithic artifact were thermally altered and patinated. Whereas patination was not a major complicating factor in raw material identification, it did pose some problems for use-wear analysis. Heavily patinated surfaces greatly affected tool polish identification and could even produce 'pseudo-polishes' (see Keeley 1980:Pl. 11).

Chalcedony at San Pedro and Marco Gonzalez

Much like other sites in Northern Belize, almost all of the chalcedony artifacts recovered from San Pedro and Marco Gonzalez were flakes and blocky fragments that could have been employed as 'expedient' or 'opportunistic' tools. According to Hester and Shafer (1984:160, 164) chalcedony nodules were used for building fill and to manufacture crude stone tools at Cuello, while chalcedony was restricted to flakes and expedient tools at both El Pozito and Kichpanha. At Cerros (Shafer 1983:219), few formal tools recovered from the site were manufactured from chalcedony and at Laguna de On, in the Early and Late Facets of the Postclassic, chalcedony and other lower-quality raw materials represent expedient flake tools and cores (Oland 1999a, 1999b). Dockall and Shafer (1993:175) report that the local chalcedonies at Santa Rita Corozal were "... amenable to only modest core technology".

The presence of such small percentages of chalcedony flakes at these sites on the southern end of Ambergris Caye is therefore puzzling. There are some bifacial thinning flakes, but no large bifaces and only one medial fragment from a miscellaneous thin biface which is likely part of a lenticular tool. Such a supposition seems accurate given that chalcedony constitutes 18.7% of the lithic assemblage in Early Postclassic period at Colha [versus 81.3% chert] and that the largest amount of chalcedony [56.10%] was used in the manufacture of lenticular bifaces, followed by lozenge bifaces [30.49%] (Michaels 1989:153).

There may be a couple of explanations for the chalcedonies recovered. The first may be that, in addition to providing the finished tools for the Maya on the Caye, the tool-makers at Colha also provided other lithic materials, such as debris, to the chert-poor environment on the Caye. A second possibility is that Maya from San Pedro and Marco Gonzalez may have acquired this raw material during excursions to the mainland for any raw materials when stone became scarce, primarily in the Late Postclassic and Historic periods at San Pedro after the demise of the workshops at Colha. It does not seem plausible that the Caye Maya were importing chalcedony to manufacture their own tools. Evidence suggests they likely did not possess the ability to make tools such as lenticular bifaces, and the type and amount of chalcedony recovered seems much too small to indicate any tool reduction activity.

CHAPTER 7

The Lithics in Context: Spatial and Chronological Distributions

Lots, Deposits and Chronology

The chronology for the deposits at Marco Gonzalez was established based on excavation, architectural and ceramic evidence, whereas that for the excavations at San Pedro was determined primarily using excavation and ceramics. Because there is debate over the date range of Buk ceramics, I have provided the dates for the Terminal Classic to Late Postclassic used in this analysis. The Terminal Classic to Early Postclassic extended from approximately AD 900 to 1200, while the Middle Postclassic began around AD 1200 and the Late Postclassic began around AD 1400 (E. Graham, pers. comm. 2000; see Graham 1987b). The assignment of chronological dates at both sites was rendered difficult by numerous factors. Therefore, in some cases, lots could only be given a general period. Some of the surface accumulation and overburden soil contained artifacts from mixed contexts, whereas core fill in the architecture could represent material that dated to the architectural period or earlier in some instances (see below). Excavations at both sites were recorded using a lot system [see Appendices E and F]. The lots were assigned at the discretion of the excavators and represent distinct archaeological deposits, including the soil matrix, any architectural features, and artifacts excavated from a single location. The number and types of lithics from both sites were calculated using combined lot information and were analyzed by both location and period to determine any patterns in the stone tool sub-assemblages.

Natural and Cultural Processes and Artifact Context on Ambergris Caye

Despite whether cultural and/or natural processes are viewed as transforming the material record (Schiffer 1983, 1987) or as a basic component of site formation (Binford 1981), the lithics recovered from these sites have been modified by destructive processes. Such processes affect the contexts of the lithics at both Marco Gonzalez and San Pedro, rendering the determination of both temporal and spatial placement challenging. The combination of natural transformation processes such as bioturbation due to tree root action and crab burrowing (E. Graham, pers. comm. 1998; N. Stanchly, pers. comm. 1998; Butzer 1982:113; Carr 1984:132; Foley 1981:173; Hofman 1986:169; Wood and Johnson 1978:328), sea level rise and submergence of lower levels at Marco Gonzalez (Dunn and Mazzullo 1993; Graham and Pendergast 1989:3), and the moving sand matrix (see Gifford 1978) all affect the distribution of artifacts.

Natural processes have been shown to produce variable vertical displacement in different soils based on their texture and penetrability or 'permeability' (Gifford 1978:82-83; Nielsen 1991:484; Schiffer 1983:679). However, there is still no consensus as to the correlation between artifact size, weight, density and vertical displacement (Gifford-Gonzalez et al. 1985:811; Hofman 1986:167; Villa and Courtin 1983:277; see 'size effect' Baker 1978 for surface artifact representation). In terms of horizontal displacement, Villa and Courtin (1983:277; Nielsen 1991:490) observed that "the most displaced pieces are light while heavy pieces moved little" but "there is no obvious linear correlation between horizontal displacement and weight...". Nevertheless, Nielsen (1991:492; Foley 1981:173) notes that large bulky objects are kicked and scuffed instead of trodden upon, and consequently, will move more quickly and systematically to stable positions in zones marginal to main activity areas.

Cultural factors such as reuse and recycling of implements in the past, general curation behaviour (Binford 1973), locations of tool use and discard (Gould 1977; Schiffer 1995; Yellen 1977), and the treatment of lithic waste and its disposal (Clark 1991b; Deal and Hayden 1987; Hayden 1987b; Hayden and Cannon 1983) affected the distribution of lithic artifacts in the past. However modern activities - such as looting at Marco Gonzalez, the collection and removal of artifacts primarily from the populated areas of San Pedro, pedestrian traffic and construction activity in San Pedro (E. Graham 1998: pers. comm.) - have all contributed to the movement of stone tools within the matrix.

In the past it is likely that discarded implements were reintroduced into the tool inventory at some unidentifiable point after initial disposal or loss. For example, broken tool fragments and the debris from tool manufacture and repair at one point in time may become the stockpile of usable material at a later time (McAnany 1988, 1992:205, 1993b:82; Nelson 1991:82). Such reuse or recycling may have occurred right after one or more activities or may have occurred after a substantial period of stasis. The limited access to lithic raw material and population movement among Marco Gonzalez, San Pedro, and likely other sites on the north end of Ambergris Caye may have resulted in the scavenging of tools and raw material (chert) from one site and re-use at another (Schiffer 1987:106-114). Curation at the time of site abandonment (Binford 1977:34) is also a common factor affecting the composition of abandoned artifact assemblages. Stevenson

(1982) suggested that anticipation of return is an additional factor conditioning the curation and caching of artifacts at the time of abandonment.

Based on Schiffer's (1987:106-114) observation that many forms of scavenging involve the removal of artifacts discarded as secondary refuse at permanently abandoned sites, Tomka (1993) contends that delayed curation should be considered a distinct process. He states: "Delayed curation operates between a site's last occupation and its permanent abandonment. It impacts the entire formerly active assemblage cached at these sites rather than only artifacts discarded as *de facto* or secondary refuse"(Tomka 1993:21). Artifact scavenging through this delayed curation process would potentially be the primary mechanism responsible for generating an observed decrease in the lithic assemblage size at a source site. Based on his observations of transhumant agro-pastoralists from Estancia Copacabana, Tomka (1993:16) noted that, at least during the early stages of abandonment, delayed curation does not usually involve the removal of the entire assemblage at once. Instead, family members select individual items or groups of items non-randomly for return to the main or agricultural residences. Such may be the case for the selective removal of chert tools and possibly other materials from Marco Gonzalez to San Pedro in Late Postclassic and Historic times. The chronology of site occupation supports this potential secondary movement of chert from Marco Gonzalez to certain Late Postclassic and Historic dated deposits at San Pedro [14^{th}-16^{th} century] such as Parham/Sands Hotel.

The San Pedro Lithic Assemblage by Location/Property

For the locations of lithic tool recovery at San Pedro, there do not appear to be any patterns in terms of the production or use of tools that indicate either tool production, or specialized craft- or other manufacturing and processing activities [see Appendix H]. At many locations, there were too few tools to be certain of the activities performed. There is the possibility that the recovery of small numbers of tools indicates that little activity related to lithic tool production, repair, or tasks requiring stone tools were performed at these locations. It must be remembered that raw counts of tools from different sites were affected by the amount of excavation performed in each location. For example, the greatest number of tools recovered at locations such as Rosalita's property and the Sands Hotel/Parham's property were also the locations where the most excavation was undertaken. The types of tools and raw materials, although not evenly distributed on the different properties at San Pedro, may still provide good evidence for the types of activities occurring throughout this Maya community. At locations where there are enough tools to reconstruct probable activities, both differences and similarities have been recorded.

<u>Alamilla property:</u>

On the Alamilla property , no formal tools were recovered and the recovery of a recycled core and core fragment, some flakes, and blocky fragments indicate the simple *ad hoc* production of flakes for use. Some other chert, chalcedony and quartz flakes and blocky fragments reveal the use of other raw materials in this basic core and flake production. The fact that the percentage (55.7%) of CBZ chert was lower than the average for the site hints at a greater dependence on lower quality raw materials. This dependence on these other types of stone may be less a matter of location than of chronological period (see below).

Elvi's property:

At Elvi's, no large bifaces were recovered and the majority (76.3%) of the lithics were CBZ chert. The biface edge and small number of bifacial thinning flakes indicate the repair or modification of larger tools, but the only formal tools were two blades.

Nuñez property:

The artifacts from the Nuñez property reveal little about activities that were likely occurring. The presence some flakes and bifacial thinning flakes of CBZ chert, other chert and chalcedony and the absence of large bifaces, indicate that perhaps some repair or maintenance work was done here.

Rosalita's property:

At Rosalita's, the number of oval bifaces (4.3%), general-utility bifaces (6.4%), biface edges (6.4%), and bifacial thinning flakes (7.5%) indicate that large biface tools were heavily used and repaired or curated at this location, as they together represent 24.6% of the Rosalita property lithic assemblage. Furthermore, the number of thick biface fragments (6.4%) supports the inference that the larger biface tools were heavily used and reworked here.

The ratio of tertiary, secondary 2, and secondary 3 flakes of CBZ chert is 27:5:1 or 81.8%, 15.2%, and 3% indicating most reduction was end-stage or repair work and that some minimal flake production from the recycled flake core fragments likely occurred here. The few flakes of other chert render it difficult to determine the reduction pattern for this type of raw material accurately. Nevertheless, the small amount of other chert (15.7%), and the lack of any chalcedony, quartz or slate raw material indicates that reliance on CBZ chert was still high. The importance of other chert is suggested, however, by the number of general-utility and oval biface fragments (30% of these tool types) at the site. There is no evidence that these other chert formal tools were manufactured at Rosalita's

The ratio of CBZ chert tertiary flakes compared to that of CBZ chert tertiary bifacial thinning flakes was 5:1, suggesting that recycling was an important practice at this site, whereas flake production may have been an activity of lesser importance.

Sands Hotel/ Parham property:

At the Sands Hotel/ Parham property the assemblage pattern is quite different in terms of tool and raw material composition. The percentage of the assemblage represented by large bifaces, biface fragments and biface edges and bifacial thinning flakes was 18.5%. Perhaps more important, 79.5% of these tools were represented by bifacial thinning flakes with few bifaces recovered and no biface edges at all. This would seem to indicate that there was even greater emphasis on repair and recycling of the available tools.

The relationship between CBZ chert tertiary, secondary 2, secondary 3, and primary flakes is 59:27:6:2 or 62.8%, 28.7%, 6.4%, and 2.1%. This pattern is different from that observed at Rosalita's and suggests a greater emphasis on core or cobble reduction based on a similar percentage (1.1%) of core fragments of CBZ chert at this site. The relationship among the other chert flakes was 12:10:0:4 or 46.2%, 38.5%, 0%, and 15.4%, indicating the reduction of this raw material type from early stage through to end stage. The recovery of a core fragment and a core fragment recycled into a hammerstone that were both made of other chert support a complete reduction sequence for the production of flakes and simple flake tools.

At this site, there is a much greater proportion of non-CBZ chert stone types. Other cherts represented 21.1% of the assemblage, along with black chert (0.4%), brown and honey-coloured chalcedony (3.3%), gray chalcedony (0.4%) and slate (0.4%). Only 73.7% of the raw material from this site was CBZ chert.

The increased importance of thinning flakes in the assemblage at the Sands Hotel/ Parham's property is seen in the ratio of tertiary CBZ chert flakes compared to the number of tertiary CBZ bifacial thinning flakes 59:39 or 1.5:1. A greater proportion of the reduction of stone at the site involves the reworking or repair of bifaces suggesting greater attempts or needs to modify and preserve these tools at this location.

The San Pedro Lithic Assemblage by Chronological Periods

The lithic assemblage patterns from the different locations at San Pedro have provided evidence for differential patterns of tool distribution and raw material consumption [see Appendix I]. However, it should be noted that the two main locations providing this data also represent different periods of occupation at the site. Occupation at Rosalita's is restricted to the Late Classic, Terminal Classic, Middle Postclassic periods, while the deposits from Sands Hotel/Parham's property all date to the Late Postclassic and Historic. I believe that the differences observed between these two areas are not necessarily the result of spatial factors, but rather explained by time period, especially regarding access to formal tools. The pivotal point in the difference in lithic distribution patterns occurs with occupations between the Middle Postclassic and the Late Postclassic when large-scale lithic production ceases at Colha.

Late Classic to Middle Postclassic:

In the Late Classic, Terminal Classic and into the Middle Postclassic periods, raw material at San Pedro was not abundant, and conservation and recycling of stone are clearly evident. The average assemblage percentage of large bifaces, biface fragments, bifacial thinning flakes, and biface edges from these periods is relatively high at 31.9% for all raw materials [29.1% CBZ chert, 2.9% other chert]. Only 13.4% of the assemblage was represented by bifaces indicating access to a small number of tools, with the rest (18.6%) comprised of miscellaneous fragments, bifacial thinning flakes and biface edges. This is indicative of a concerted effort to maintain the bifaces as long as possible. This is further emphasized by the number of tools recycled into hammerstones such as the 3 large bifaces and the one core fragment. The ratio of tertiary to secondary 2 to secondary 3 to primary flakes (28:5:1:0 or 82.4%, 14.7%, 2.9% and 0%) manufactured from CBZ chert reveals little flake reduction that was early stage and a heavy emphasis of end-stage or repair reduction. The recovery of one recycled flake core fragment of CBZ chert suggests a minimal level of flake production during these periods. The ratio of other chert from San Pedro during this time was 1:1:0:0 or 50%, 50%, 0%, and 0%. Along with the fact that no cores or core fragments of other chert were excavated from these periods, the minimal number of flakes suggests very little reduction of other cherts. In addition to this, the blocky fragments from these periods are all CBZ chert which supports the idea that there was minimal reduction of other cherts here. The fact that the majority (4 of 7 or

57.1%) of the other chert artifacts were finished formal tools including an oval biface, general-utility bifaces and a blade also supports this notion.

The ratio of tertiary CBZ chert flakes to tertiary CBZ chert bifacial thinning flakes was 28:7 or 4:1 indicating that biface thinning or resharpening constituted a significant proportion of the reduction waste produced during these periods.

Finally, the types of raw materials at San Pedro during the Late Classic, Terminal Classic and Middle Postclassic periods reveal a concentration on CBZ chert (91.3% of the assemblage), with minimal use of other chert (8.7%). No other lithic raw materials were recovered from the excavations. Although the amount of raw material at San Pedro at this time was not excessive, it appears the Maya were able to exist in that environment through the combination of tool use strategies that involved the import of finished tools from the mainland, heavy curation of these tools, and minimal reliance on basic local flake production from CBZ raw material.

<u>Late Postclassic to Historic:</u>

Occupation during the Late Postclassic and Historic periods at San Pedro reveals a different pattern of tool use, curation and raw material consumption than observed from earlier periods. After the cessation of large-scale tool production at Colha near the end of the Middle Postclassic, lithic distribution patterns and reduction strategies indicate an even greater degree of tool maintenance and recycling than in previous periods and the exploitation of a wider range of lower quality raw materials. In the Late Postclassic and Historic periods, CBZ raw material at the site is even less abundant than before, while conservation activities, opportunistic use of flakes and other debris, and local flake production all increase. The average percentage of large bifaces, biface fragments, bifacial thinning flakes, and biface edges is 22.6% of all raw materials [21.1% CBZ chert, 1.5% other chert]. However, a mere 1.2% of the lithics recovered from the site during these periods were bifaces, with the rest (20.4%) comprising miscellaneous fragments, bifacial thinning flakes and biface edges. Not only do these data reveal the great effort to maintain the bifaces as long as possible, they further document that substantially fewer bifaces and fragmentary bifaces were available to the Late Postclassic and Historic Maya. The level of curation of these tools is also indicated by the CBZ chert cores, bifaces, core fragments and blocky fragments and the other chert core fragments and blocky fragments recycled into hammerstones. The ratio of tertiary to secondary 2 to secondary 3 to primary flakes (68:31:5:2 or 64.2%, 29.2%, 4.7% and 1.9%) produced from CBZ chert suggests that a significant proportion of flake reduction was end-stage or repair reduction, but evidence for some early stage, core reduction was also present. With the excavation of one recycled standard flake core, one recycled flake core fragment and four flake core fragments of CBZ chert, there appears to have been more reliance on the local production of flakes for expedient/opportunistic use than in earlier periods. Based on the ratio of other chert from Late Postclassic and Historic San Pedro (15:10:1:4 or 50%, 33.3%, 3.3%, and 13.3%) and the fact that no finished formal tools manufactured from other cherts were recovered, the overwhelming majority of the other chert raw material was used for the production of simple flakes or flake tools. The recovery of one core fragment and one recycled core fragment of other chert supports the notion that core reduction was performed here. The blocky fragments from these periods comprised 19% of the entire assemblage (12% CBZ chert, 5.8% other chert, 0.5% brown and honey-coloured chalcedony, 0.2% gray chalcedony, and 0.5% quartzite) indicating that the local reduction of cores and biface fragments of CBZ and other cherts generated a substantial proportion of the assemblage.

The ratio of tertiary CBZ chert flakes to tertiary CBZ chert bifacial thinning flakes was 68:47 or 1.4:1. This ratio confirms the importance of biface repair and recycling as a major activity during these periods, notably in relation to the greater percentage of miscellaneous thick biface fragments, flakes and edges compared to the actual bifaces and bifaces fragments recovered.

The raw material types excavated from San Pedro during the Late Postclassic and Historic periods document a changing pattern of stone use. Of the total assemblage of lithics from these periods, 72.5% were CBZ chert, 19.9% were other chert, 3.4% were brown and honey-coloured chalcedony, 2.8% were gray chalcedony, 0.9% were quartzite, 0.3 % were slate, and 0.3% were black chert. It appears that the Maya at San Pedro during the Late Postclassic and the Historic periods were desperately trying to conserve the limited number of bifaces they possessed through substantial curation and recycling. The importance of other lithic raw materials increased as access to finished formal tools decreased. The Maya made much greater use of informal technology during these periods and were more involved in the acquisition of cores of both 'chert-bearing zone' and other cherts for the production of simple flakes to complete their tasks on the Caye. This pattern of tool production reveals a greater reliance on the opportunistic use of the byproducts of biface reduction and repair and the increased importance of *ad hoc* core reduction or expedient/opportunistic use of locally produced flakes. This greater reliance on simple flake tools may furthermore be evidence of the lack of skill or knowledge possessed by the Caye Maya in terms of biface production and economical reduction.

Whereas the total assemblage from San Pedro indicates a focus on maximum use and conservation of raw materials, in the Late Postclassic and Historic periods this seems even more important with the recovery of fewer bifaces and fragments, more thinning flakes, more flake cores and fragments and greater evidence for *ad hoc* flake production. With the Colha workshops gone by this point, the San Pedro Maya were unable to produce these tools themselves nor were they able to acquire the amount of CBZ chert they required. They therefore began exploiting alternative sources of lithic raw material to meet their needs.

Through all periods where enough artifacts are available to reconstruct tool patterns, the San Pedro Maya seem to possess generalized tool kits for subsistence and the exploitation of their local environment for low-level craft production. This successful exploitation of resources on the Caye was partially determined by the implementation of a maintainable technology that was heavily curated, and the opportunistic use of the by-products of this curation as tools themselves. The Maya used any lithic raw material available to them and engaged in the *ad hoc* production of basic tools themselves.

The Marco Gonzalez Lithic Assemblage by Location/Structure

Much like the pattern of tool distribution by location at San Pedro, the recovery of lithic artifacts at Marco Gonzalez presents little evidence to support tool production areas or locations of any craft production beyond the needs of the local inhabitants [see Appendix J]. Once again the differential distribution of tools recovered from different structures or operations rendered some intrasite comparisons difficult. Much of this difference seems again to be related to the amount of excavation undertaken at each location. Substantial excavation in Structures 2, 12, and 14 and at Operations 6, 7, and 8 have provided the greatest numbers of tools, therefore most comparisons in tool distribution patterns and the performance of activities involve these areas.

Structure 2:

At Structure 2, there seems to be evidence suggesting little use of large bifaces with only 6% of the assemblage represented by an oval biface, thick biface fragments, a biface edge, and a lenticular biface. Nevertheless, the fact that 15% of the assemblage here is represented by bifacial thinning flakes indicates conservation and recycling of available biface tools. The 4 blades and blade tools (6%) recovered suggest that these tools were used, but not in any substantial number and that the overall range in tool types was small.

CBZ chert constituted 79.2% of the raw material, while 18% was other chert. The ratio of tertiary, secondary 2, and secondary 3 CBZ flakes is 23:8:2 or 69.7%, 24.2%, 6.1%, suggesting an emphasis on end-stage reduction. This pattern indicates the possibility of some middle-stage reduction, perhaps associated with some simple flake production; however, no cores or fragments were recovered at this structure.

The ratio of CBZ chert tertiary to tertiary bifacial flakes recovered was 3.8:1 indicating a significant reliance on biface repair and recycling.

Structure 12:

For Structure 12, there was a broad range of different tool types suggesting a range of activities were likely performed here. Only 6% of the artifacts recovered from this structure were large bifaces or biface fragments, indicating limited activity requiring these large tools such as chopping wood or digging. However, the fact that 14.9% of the lithics were bifacial thinning flakes and that the ratio of CBZ chert tertiary flakes to tertiary bifacial thinning flakes was 3:1 indicates that tool maintenance and repair were actively pursued. The three bifaces transformed into hammerstones or pounding tools are extreme examples of this type of tool reuse and recycling. The presence of some thin bifacial tools (5%) and fragments and some blade tools and fragments (3%) indicates there was little use of formal tools to complete tasks. The numerous flakes (57.5%) appear to have been adequate for use as *ad hoc* tools. The numbers may also suggest limited access to formal tool types at Structure 12 at certain periods.

As at Structure 2, the majority of the raw material (82.4%) was CBZ chert with some (15.4%) other cherts. The ratio of tertiary, secondary 2, secondary 3, and primary CBZ chert flakes similarly represents (67:22:4:1 or 71.2%:23.4%:4.3%:1.1%) an emphasis on end-stage reduction likely due to maintenance activities. Although it is suggested that some simple flake production probably occurred at this structure, there were no cores or fragments recovered.

The absence of any large bifaces of other cherts, the low percentage of other chert bifacial thinning flakes (1%), and the ratio of tertiary, secondary 2, and secondary 3 other chert flakes (14:6:2 or 63.6%:27.3%:9.1%) indicates that the minimal amount of reduction that may have occurred here was primarily middle-to-end stage flake production. However, as with the CBZ chert, no cores or fragments of other chert were recovered.

The special find (MG 27/1) was not produced here and was likely not used for any utilitarian purpose. It may have been an artifact deposited for some ritual purpose or represented a wealth/prestige object.

Structure 14:

Structure 14 in the site core presents a large assemblage of lithic tools composed of a variety of tool types. But the numbers of tools per type is generally similar to the patterns established at Structures 2 and 12. Although there was a total of 47 CBZ chert general-utility bifaces, oval bifaces, a T-form adze, lenticular bifaces, biface edges, bifaces recycled into crushing/pounding tools or fragments of these tools, together they only represented 5.3% of the total assemblage. The percentage of CBZ chert bifacial thinning flakes is 9.9% of the tools at this structure. The ratio of tertiary CBZ chert flakes to tertiary bifacial thinning CBZ chert flakes was 3.7:1. The combination of low numbers of tools and a high flake/bifacial thinning flake ratio emphasizes the concentration on tool maintenance and repair here.

The low percentages of CBZ and other chert thin bifacial tools (3.3%) and blades or blade tools (2.3%) reflect the same limited access to formal tools seen at the other locations.

Although only two bifaces were recycled into hammerstones, 2 flake cores and 3 blocky fragments were used as pounding/crushing tools, demonstrating further modification of tools into other usable forms.

The ratio of CBZ chert tertiary, secondary 2, secondary 3, and primary flakes was 256:82:14:1 or 72.5%:23.2%:4%:0.3%. This represents a reduction pattern heavily weighted by end-stage flaking. Like earlier ratios, the emphasis appears to be on maintenance and tool curation. The interpretation that some of the flake production was due to the reduction of simple flake cores is strengthened here by the recovery of 8 core fragments and a recycled core.

The percentage of raw material from Structure 14 is approximately 78.6% CBZ chert, 17.8% other chert, 0.6% black chert, 1.2% brown and honey-coloured chalcedony, 0.9% gray chalcedony, and 0.1% slate. The slightly higher percentage of raw materials other than CBZ chert may be less a factor of location than a chronological one (see below).

Because only 0.2% of the tool assemblage was represented by one other chert thick biface fragment and one other chert lenticular biface fragment, and there were only 5 bifacial thinning flakes of other chert, there is almost no evidence for other chert biface use or recycling at this structure. The ratio of tertiary, secondary 2, secondary 3, and primary other chert flakes (44:23:8:3 or 56.4%:29.5%:10.3%:3.8%), coupled with the recovery of a recycled other chert flake core presents strong evidence that the pattern of reduction associated with the majority of the other chert at Structure 14 was simple flake production, as opposed to the primarily tool maintenance practices associated with CBZ chert.

A proportion of the flake debitage recovered from this structure was also probably associated with the two failed attempts at locally manufacturing bifaces. The CBZ chert and other chert preforms recovered from this location represented aborted bifaces. It is likely the two preforms produced a proportion of both the cortical and non-cortical simple and bifacial thinning flakes from Structure 14.

Between Structures 12 and 14:

The area between Structures 12 and 14, which also includes some areas of both buildings, represents a slightly different pattern than those previously determined for earlier structures. The location between these two structures may represent artifacts that were displaced to a greater degree than those encountered previously.

Only 1 oval biface of CBZ chert was recovered here, and there was minimal evidence for bifacial flaking (5 flakes). There were 3 thin bifaces or fragments and only 1 macroblade fragment recovered.

The small number of flakes of CBZ chert were represented by 10 tertiary flakes and 5 secondary 2 flakes. What is striking about this location, and strengthens the interpretation that much of this material may be a collection of artifacts in a secondary deposit, is the fact that 2 CBZ chert pyramidal core fragments are associated with only 15 flakes of the same raw material. If core reduction were occurring at this location, one would expect more flakes from all stages.

The percentage of other chert (23.9%) is higher than that reported from Structures 12 and 14 and seems to represent an anomalous pattern with only 10 artifacts from a range of classes.

I believe that the artifacts found at this location were originally associated with activities at Structure 12 and/or 14, but that it is now impossible to determine which artifacts were specifically associated with which structure.

Structure 16:

The lithics from Structure 16 present a different pattern from that established for the earlier structures. The CBZ chert large bifaces and biface fragments, consisting of 4 general-utility bifaces, one miscellaneous fragment, one oval biface and one biface edge, constitute 13.1% of the assemblage, while only 3.7% of the assemblage were bifacial thinning flakes of the same raw material. Furthermore, the ratio of CBZ chert tertiary flakes to CBZ chert tertiary thinning flakes is slightly greater than at other locations

(6.5:1). This combined evidence indicates that less recycling and reworking of bifaces seems to have occurred here.

There was also a greater percentage of blades and blade tools (13.1%) at this location than elsewhere.

The lower number of CBZ flakes: 13 tertiary, 3 secondary 2, 0 secondary 3 and 1 primary (76.5%:17.6%:0%:5.9%) nevertheless represent a reduction pattern that is primarily related to end-stage activities. The low overall number of flakes and the lack of any CBZ chert cores indicate that tool or flake production of any kind was likely not occurring here.

The small number of other chert flakes (7) indicates there was little use of this raw material at Structure 16 even though it did represent 13% of the stone recovered from this location in the site core.

<u>Structures 11, 21, 27, and 28:</u>

There were insufficient numbers of artifacts recovered from the minimal excavations at these locations to make any solid determinations about the lithic assemblages.

<u>Operation 4 (Structure 12):</u>

As with the excavations from Structures 11, 21, 27, and 28, the small number (7) of lithics from a variety of tool categories rendered any analysis of the assemblage from this deposit very difficult. The most that can be observed from the artifacts recovered is that CBZ chert constituted 85.7% of the lithic assemblage at this operation.

<u>Operation 6:</u>

At Operation 6 in the eastern peripheral zone of Marco Gonzalez, there is quite a variety of tools in the lithic assemblage. Few bifaces or fragments were recovered from excavations here. Only 2 general-utility bifaces and one miscellaneous large biface fragment are represented here and constitute only 3.4% of the lithic assemblage. The 6 CBZ chert bifacial thinning flakes seem to indicate minimal edge rejuvenation or other curation practices. The ratio of CBZ chert tertiary flakes to CBZ chert tertiary bifacial thinning flakes was 5.8:1 indicating a pattern of maintenance that might seem reduced from other sites. However, given the few large bifaces at this location, the rate of conservation of the formal tools was relatively high. Further evidence of tool curation is demonstrated by the CBZ chert flake core transformed into a hammerstone and the black chert blocky fragment converted into a pounding/crushing tool.

The few large bifaces and thinning flakes coupled with the presence of only 6 other formal tools (6.6% of all tools in the assemblage), seems to indicate an emphasis on the more informal component of the assemblage at Operation 6.

The ratio of CBZ chert flakes, with 29 tertiary, 8 secondary 2, 0 secondary 3, and 0 primary or 78.4%:21.6%:0%:0%, indicates once again a strong pattern of end-stage reduction probably associated with tool repair or recycling activities and the conservation of raw material. The recovery of a flake core recycled into a hammerstone lends credence to the notion that some of these flakes were the result of the production of *ad hoc* tools.

The other cherts constituted 10.2% of the lithic material from this excavation and represented a variety of tool types. There does not appear to be any clear indication of tool production or maintenance here.

The recovery of 5 black chert tools from this operation is significant, not so much for the types of tools themselves, but because the lowest level deposits at this location from which most of these tools originate, was submerged in sea water as the sea level rose around the Caye. This information lends further support for the manganese oxidation of chert.

Despite the patterns of tool use and maintenance observed, most of the deposits here are secondary and probably represent the dumping of site rubbish from the core (see above). The fact that a substantial proportion of the excavations uncovered conch midden deposits strengthens this view. Therefore many of the patterns recognized from all of the peripheral operations at Marco Gonzalez may represent the accumulation of formal lithics and reduction debris from numerous locations throughout the site. Any conclusions drawn from these areas should be done with this caveat in mind.

Operation 7:

Operation 7 primarily consisted of the excavation of a conch midden located in the western periphery of the site. It possesses a greater number of formal tools than Operation 6, but fewer flakes. The formal component of CBZ chert is represented by whole tools or fragments of an oval biface (2.5% of the assemblage), a biface edge (2.5%), a miscellaneous thick biface fragment (2.5%), and 2 general-utility bifaces (5%). There were no CBZ chert bifacial thinning flakes recovered from this location. This observation may be the result of a secondary context for these tools, or possibly the fact that no repair work producing thinning flakes occurred here. Some recycling evidence occurs with the conversion of a core fragment into a hammerstone or crushing tool.

There were only 16 CBZ chert flakes from Operation 7; however, the percentage of flakes from the two areas is similar [Operation 6: 42.5%, Operation 7: 40%]. The flake types were divided as follows: 7 tertiary, 8 secondary 2, and 1 secondary 3 or 43.8%:50%:6.3%. Although the total number of flakes may render this pattern less significant, it nevertheless, is more indicative of middle-to-end stage reduction of basic flake cores. The recovery of the two flake core fragments from this operation would tend to support this conclusion.

The other chert from this location represented a significant proportion of raw material (22.5%). However, this may be due more to the time period represented by the deposits at Operation 7 than its location.

Operation 8:

Operation 8, located in the western periphery of the site, was a unit west of Operation 7 in the same conch midden. It could be argued that, together, the artifacts from both operations represent the same series of occupations or activities. Like the other operations, however, the artifacts from this location represent secondarily deposited material (E. Graham, pers. comm. 2000).

The 9 large bifaces or fragments of these bifaces of CBZ chert represent 4.5% of the tool assemblage at Operation 8; a pattern of fewer large bifaces similar to Operation 6. There are 21 (10.6%) bifacial thinning flakes of CBZ chert from this location and the ratio of CBZ chert tertiary flakes to CBZ chert tertiary bifacial thinning flakes is 4:1. The lower percentage of large bifaces, and the number and ratio of bifacial thinning flakes indicate a pattern of tool use and consumption that involves a significant degree of tool maintenance, repair and recycling. The conversion of a single blocky fragment into a hammerstone or crushing tool also contributes to this pattern of tool modification into new forms.

The other CBZ chert formal tools from the site including blades and blade tools and a thin stemmed biface represent only 3.5% of the stone tools from this excavation.

The number of CBZ tertiary, secondary 2, secondary 3 and primary flakes was 80:16:6:1 or 77.7%:15.5%:5.8%:1%. This pattern, like most of the others, represents flaking activity primarily related to end-stage tool production, such as repair and recycling. Undoubtedly, a certain percentage of the CBZ chert flakes were the product of simple core reduction, yet no cores or core fragments were recovered here.

The approximate proportions of raw material excavated from the site were sub-divided as follows: 90.8% CBZ chert, 5.5% other chert, 3.5% black chert.

The small number of other chert flakes and blocky fragments reveal little about the use of this raw material at this operation. Nevertheless, the absence of any formal tools of thinning flakes indicates that other cherts were not involved in production or maintenance practices.

The low percentage of black chert may not seem significant at first, but similar to the recovery of black chert from Operation 6, the 7 black chert lithics were recovered from submerged deposits.

The Marco Gonzalez Lithic Assemblage by Chronological Periods

As at San Pedro, the distribution of lithics by chronological period at Marco Gonzalez was more significant in terms of access to raw material and finished tools, tool reduction and curation strategies than tool locations [see Appendix K]. The tools recovered from deposits dating from before the Late Classic to the Terminal Classic, those from the Early Postclassic and those from the Middle Postclassic, and Middle to Late Postclassic all represent slightly different assemblage patterns.

Late to Terminal Classic:

At Marco Gonzalez, the large bifaces, biface fragments, biface edges and bifacial thinning flakes from deposits from before the Late Classic to the Terminal Classic represent 20% of the assemblage [17.1% CBZ chert, 2.9% other chert]. This percentage, although substantially lower than the percentage of similar artifacts from the same period at San Pedro, suggests that access to these tools was relatively restricted in the Classic period. The fact that only 5.7% of the assemblage was represented by whole or fragmentary large bifaces and that 14.3% was debris or flakes from bifaces indicates that tool curation was already well-established at this time. The recovery of one biface recycled into a hammerstone places more emphasis on the practice of recycling tools.

The ratio of tertiary to secondary 2 to secondary 3 to primary flakes of CBZ chert (22:6:1:0 or 75.9%:20.7%:3.4%:0%) reflects reduction strategies that were primarily producing end-stage flakes most likely associated with biface maintenance and recycling activities. The flake core and two flake core fragments excavated from these deposits further indicate that there was some simple flake production of CBZ chert.

The other cherts represented 12.7% of the raw material at Marco Gonzalez during this time period indicating an early reliance on raw material from sources other than the 'chert-bearing zone'. Access to CBZ chert appears to have already been restricted based on the need to use other lower-quality raw materials. Although the number of other chert flakes was low, the flake distribution (2 tertiary: 2 secondary 2: 2 secondary 3: 0 primary or 33.3%:33.3%:33.3%:0%) seems to indicate that reduction to produce simple flakes was occurring from middle to end-stages during these periods. Because no formal tools or cores of other cherts were recovered during the Classic periods, it appears the use of other cherts was minimal and that CBZ chert was the source of all the formal tools.

With the ratio of CBZ tertiary flakes to tertiary bifacial thinning flakes being 23:7 or 3.3:1, it appears the maintenance of recycling of large bifaces was an important raw material conservation practice in these periods.

The distribution of raw material types at Marco Gonzalez, with CBZ chert constituting 84.5% of the assemblage, other cherts representing 12.7% and 2.8% being brown chalcedony, reveals that CBZ chert was the primary source of all stone tools during the period extending from before the Late Classic and in the Terminal Classic. The distribution of formal tools and flake types indicates that the formal component of the assemblage was imported from the mainland in finished form, that tool use strategies emphasized conservation of raw material through maintenance and recycling, and that both CBZ chert and some other cherts were minimally used to produce simple flakes for opportunistic/expedient use on the Caye. The percentage of blocky fragments (9.9%) during this period suggests that there was a considerable amount of stone-working occurring. Most of this waste material appears to be due to the breakage of bifaces during maintenance activities, the reduction of cores to produce flakes, and a very limited amount of bipolar flaking.

Early Postclassic:

In the Early Postclassic at Marco Gonzalez, the general pattern of tool use and curation observed earlier continues with a few notable changes. Although new types of tools such as the stemmed and side-notched thin bifaces and the lenticular bifaces produced in the mainland workshops appear on the Caye at this time, they seem to have been easily incorporated into the tool use patterns at Marco Gonzalez. Emphasis is still placed on the curation of the larger bifaces, with minimal modification of the smaller formal tool types.

The large bifaces, biface fragments, biface edges and bifacial thinning flakes from Early Postclassic deposits represent 14.4% of the total lithic assemblage, with 12.9% CBZ chert, 1.2% other chert, and 0.3% black chert. This percentage suggests that access to these large biface tools was restricted to an even greater extent than in the previous period. Part of the explanation for this reduction may have been the shift in tool production strategies at Colha and other workshops in the Early and Middle Postclassic from large, thick bifaces to smaller, thinner bifaces (Shafer and Hester 1983). Because merely 2.9% of the total Early Postclassic assemblage were whole or fragmentary large bifaces and that 11.5% were miscellaneous thick fragments, biface edges and bifacial thinning flakes, tool reworking and recycling activities were performed quite heavily. With one flake core, one flake core fragment and one blocky fragment all recycled into pounding or crushing tools, there is strong evidence for the recycling of tools. The ratio of tertiary to secondary 2 to secondary 3 to primary flakes of CBZ chert was 120:32:7:1 or 75%:20%:4.4%:0.6%. Like the pattern established for the earlier periods at Marco Gonzalez, this represents reduction strategies that were primarily producing end-stage flakes and that were associated with tool curation and the extension of tool use-life. The single flake core recycled into a hammerstone, the flake core fragment recycled into a hammerstone and the flake core fragment recovered from the site during this period reveal that some simple flake production of CBZ chert occurred here.

The other cherts at Marco Gonzalez during the Early Postclassic indicate a similar reliance on raw material from sources other than the 'chert-bearing zone' as in the Classic periods. The distribution of flake types was as follows: 12 tertiary, 4 secondary 2: 2 secondary 3: 3 primary or 57.1%, 19%, 9.5%, 14.3%. Unlike the pattern established for the Classic periods, in this instance the flake distribution indicates that the production of simple flakes covered the whole range of reduction from the earliest through to the end stages. Although one thin biface, a retouched blade and a macroblade are the only finished tools of other chert represented in the assemblage, the presence of what has been interpreted as a non-CBZ chert biface preform may account for some of the flaking during this period and may suggest the stress in terms of available tools placed on the inhabitants of Marco Gonzalez. Nevertheless, the lack of large bifaces or cores of other cherts from the Early Postclassic, seems to indicate that the use of other cherts was minimal and that CBZ chert was the source of all the formal tools.

The ratio of CBZ tertiary flakes to tertiary bifacial thinning flakes was 120:25 or 4.8:1, suggesting that there was still a need to maintain and curate tools in the Early Postclassic in order to conserve tools for as long as possible and to maximize the use of available raw material.

In the Early Postclassic at Marco Gonzalez the distribution of raw material types was 85.9% CBZ chert, 10% other cherts, 3.5% black chert, 0.3% brown chalcedony, and 0.3% gray chalcedony. Again CBZ chert was the primary source of all stone tools during this period and the distribution of formal tools and flake types indicates that the formal component of the assemblage arrived in finished form from the mainland sources. The pattern of conservation of primarily CBZ chert through the curation of the assemblage and the minimal use of CBZ chert and other cherts for the production of simple flakes and flake tools, is very similar to that seen in earlier periods with a reduction in the number of available large bifaces and a minor increase in evidence for flake production. This reduction in the percentage of recovered large bifaces seems to correlate with an increase in the blocky fragments (18.3%) during the Early Postclassic. There is evidence for more fragments from what are suspected to have been bifaces, a greater local production of flakes, and more bipolar reduction of available stone. The notable reduction in the number of bifaces, and the implementation of a less standardized tool kit may be related to social and economic shifts throughout Northern Belize following decreases in population and power at some centres and resulting shifts in exchange relationships and trade routes associated with 'collapses'.

One of the most notable differences between this period and earlier ones, is the appearance of black chert. This is likely not a function of time, but rather of place. Both Operations 6 and 8, which contained the greatest percentages of black chert at the site, were dated to the Early Postclassic. I believe that, based on the grain size of the 'black chert' recycled blocky fragment and the distal lenticular biface fragment, these lithics were originally CBZ chert tools that lay in submerged deposits.

Postclassic periods:

In the Middle to Late Postclassic periods at Marco Gonzalez, there is evidence for minor changes in the distribution of stone tools from that witnessed in the Classic and Early Postclassic periods. In the following section of the thesis, I have subdivided my analysis of the artifacts into two different sections from secure contexts: the Middle Postclassic and the Middle to Late Postclassic periods.

In addition to these chronological classifications, there exists another sub-assemblage termed 'Postclassic'. Although the majority of the artifacts from Marco Gonzalez that have been designated 'Postclassic' in date were likely from Middle Postclassic deposits, there is the possibility that earlier period material, predominantly Early Postclassic, and possibly some Late Postclassic/Historic material is mixed in with these deposits. The tools designated 'Postclassic' will therefore be discussed separately to ensure the greatest precision possible in determining pattern of tool consumption and modification. Nevertheless, the data from this period will be used to partially support some of the conclusions drawn concerning the lithics from the Middle to Late Postclassic contexts.

Middle Postclassic:

The Middle Postclassic assemblage at Marco Gonzalez is similar to the artifacts from the Early Postclassic deposits. The large bifaces, biface fragments, biface edges and bifacial thinning flakes from these contexts represent 20.2% of the assemblage [18.9% CBZ chert, 1.4% other chert, and 1.4% black chert]. Only 4.1% of the assemblage was represented by whole or fragmentary large bifaces and 16.2% were miscellaneous thick fragments, biface edges and bifacial thinning flakes. As in the earlier periods, tool curation continued to be a primary concern for the Middle Postclassic Maya. The ratio of tertiary to secondary 2 to secondary 3 to primary flakes of CBZ chert (23:8:2:0 or 69.7%:24.2%:6.1%:0%) reflects reduction strategies that were primarily producing end-stage flakes likely associated with biface maintenance and recycling activities and a minimal amount of middle-stage flaking. Although no flake cores or core fragments were recovered there was likely some simple flake production of CBZ chert.

With only 6 other chert flakes in the Middle Postclassic assemblage, it is difficult to draw accurate conclusions about reduction patterns. Nevertheless, the limited number of flakes, first suggests minimal use of this raw material type and a distribution of 3 tertiary flakes, 3 secondary 2 flakes, and no secondary 3 or primary flakes (50%:50%:0%:0%) seems to indicate that reduction to produce simple flakes was occurring from middle to end-stages in this period. Since only a lenticular biface fragment and a retouched macroblade fragment were recovered, it appears the use of other cherts was minimal and that CBZ chert was the primary source of the formal tools as in earlier periods.

The ratio of CBZ tertiary flakes to tertiary bifacial thinning flakes was 23:6 or 3.8:1, indicating that the maintenance of recycling of large bifaces continued to be practiced in the Middle Postclassic.

In this period, the distribution of raw material types at Marco Gonzalez was 82.4% CBZ chert, 16.2% other cherts, and 1.4% black chert. Inasmuch as CBZ chert was the still the primary source of all stone tools during the Middle Postclassic period and tool use strategies emphasized conservation of raw material through maintenance and recycling, in conjunction with the production of simple flakes for opportunistic/expedient use, there is a slight reduction in the amount of CBZ chert at Marco Gonzalez during this period. This may be a harbinger of further reductions in access to CBZ chert as seen in the assemblage from San Pedro. Once again, there appears to be a correlation between an increase in the percentage of large bifaces and a decrease in the percentage of blocky fragments. There are fewer pieces that possess evidence of bipolar flaking than seen in the Early Postclassic.

<u>Middle to Late Postclassic:</u>

Occupations in the Middle to Late Postclassic periods at Marco Gonzalez document some changes in the number of large formal biface tools. These tool types represented 20.5% of all the lithics in these periods with 4.8% being large biface or biface fragments and the remaining 15.7% miscellaneous thick biface fragments, biface edges and thinning flakes. The ratio of tertiary to secondary 2 to secondary 3 to primary flakes of CBZ chert was 85:34:8:2 or 67.5%:34%:6.3%:1.6%. This is indicative of a lithic strategy more heavily reliant on the middle stage of reduction than previously encountered in other periods. Although there is evidence for production of end-stage flakes likely associated with biface maintenance and recycling activities, the greater percentage of secondary 2 and 3 flakes is viewed as better evidence for the reduction of CBZ chert cobbles to produce *ad hoc* flake tools. One core fragment of CBZ chert was recovered from these periods.

The few other chert flakes were distributed as follows: 22 tertiary, 7 secondary 2, 2 secondary 3, 0 primary (71%, 22.6%, 6.5%, 0%). Once again this evidence suggests mostly end-stage reduction to produce simple flakes. Because only one blade fragment was excavated from the Middle to Late Postclassic deposits, the use of other cherts for formal tools again appears minimal.

The ratio of CBZ tertiary flakes to tertiary bifacial thinning flakes was 85:35 or 2.4:1, suggesting an increase in the importance of recycling large bifaces in the Middle to Late Postclassic periods as access to tool decreased with the cessation of tool production at Colha.

The distribution of raw material types at Marco Gonzalez was 82.1% CBZ chert, 16% other cherts, 0.3% black chert, 0.6% brown chalcedony and 1% gray chalcedony. Although CBZ chert was the still the primary source of all lithics in the assemblage from these periods, there was another slight reduction in the amount of CBZ chert at Marco

Gonzalez. Nevertheless the curation of large bifaces accompanied by simple flake production continued as the main reduction practices.

<u>'Postclassic':</u>

In the period designated 'Postclassic', the large bifaces, biface fragments, biface edges and bifacial thinning flakes account for a reduced percentage of the assemblage (16.6% [14.7% CBZ chert, 1.4% other chert, 0.5% brown chalcedony, and 0.2% gray chalcedony]) relative to the Middle or Late Postclassic periods. With 2.9% of the assemblage represented by whole or fragmentary large bifaces, this pattern is similar to that established in the Late Postclassic and Historic periods at San Pedro. The percentage of miscellaneous thick fragments, biface edges and bifacial thinning flakes (13.8%) and the 2 bifaces, 1 flake core and 1 blocky fragment recycled into hammerstones indicate a continued heavy reliance on tool curation.

The ratio of tertiary to secondary 2 to secondary 3 to primary flakes of CBZ chert (223:67:8:1 or 74.6%:22.4%:2.8%:0.3%) adheres to the pattern of reduction strategies that were producing end-stage flakes primarily associated with biface maintenance and curation, in addition to evidence for limited middle-stage flake production associated with local core reduction to produce simple flakes. This is supported by the recovery of 7 CBZ chert core fragments.

The other chert flake distribution pattern (34 tertiary: 26 secondary 2: 8 secondary 3: 3 primary or 47.9%:36.6%:11.3%:4.2%) seems to indicate that reduction to produce simple flakes was occurring from early to end-stages during these periods. The other chert flake core recycled into a hammerstone supports this conclusion.

With the ratio of CBZ tertiary flakes to tertiary bifacial thinning flakes being 223:47 or 4.7:1, it appears the maintenance of recycling of large bifaces was an important raw material conservation practice in these periods. This ratio is likely higher during this period due to the increase in the overall number of simple flakes being produced for use as tools compared to earlier periods.

The distribution of raw material types at Marco Gonzalez, with CBZ chert constituting 78.16% of the assemblage, other cherts representing 19.2% and 1.1% being brown chalcedony, 0.8% gray chalcedony and 0.2% slate is much more similar to the Late Postclassic/Historic period raw material percentages from San Pedro. With primarily Middle Postclassic, some Late Postclassic, and the possibility of a limited amount Historic period deposits represented in the 'Postclassic', accessing finished tools of CBZ chert and the raw material itself was increasingly difficult following the end of tool production at the mainland workshops. Tool use strategies emphasized conservation of raw material through maintenance and recycling, and both CBZ chert and other cherts were increasingly used to produce simple flakes for opportunistic/expedient use. There is also a renewed increase in the percentage of blocky fragments (14.3%) which correlates with greater heavy reduction of bifaces and an increase in the number of artifacts with evidence of bipolar reduction. If the lithic data designated 'Postclassic' could be reliably integrated with the lithic assemblage information from the Middle Postclassic and Late Postclassic periods, I believe it would support the trends in reduction of access to finished tools, reduction in access to CBZ chert, as well as, increases in percentages of other raw materials and the greater use of informal technology over time at Marco Gonzalez.

Marco Gonzalez and San Pedro Lithic Assemblages Summary

It is argued that the small number of formal tools and formal tool fragments, specifically the larger and smaller bifaces and finished blade tools at these sites, is a product of limited access to raw material on the Caye, and the control of tool production at sites geographically removed from Marco Gonzalez and San Pedro. The heavy reuse and recycling of available tools may have represented limited access to these tools by Colha, Lamanai, or other trading partners, and was also the result of a breakdown in supply networks in the later periods. The low number of total formal tools and the variety of tool types encountered at these sites seem indicative of a generalized tool inventory that permitted the effective completion of a range of diverse tasks and met the local needs of a relatively small coastal population. The lack of large numbers of task-specific tools, such as oval bifaces or drills, appears to indicate that the Maya were not engaged in any type of specialized production such as agricultural activity or bead manufacture. The extreme use and reworking of formal biface tools, leads one to believe that these people were attempting to maximize the amount of use available in their lithic tools and that they were, therefore, treating their tools as a maintainable lithic technology. The constant modification and reworking of the formal tools allowed for the less efficient performance of tasks for which the tools were originally designed, as well as, the execution of new tasks that would have constantly arisen. In this instance, raw material scarcity placed an emphasis on the need for a maintainable technology in order to maximize the output from available formal tools. Curation of the tool assemblage in general, in conjunction with the opportunistic use of what may be considered *ad hoc* flake tools, was likely the best way of adapting to a lithic-poor resource zone, while maximizing the extraction, use, and exchange of resources available in their coastal environment. Informal tools, mostly flakes, bifacial thinning flakes and some blocky fragments were primarily unmodified in any way. It is likely that stone was not the sole source of tool raw material. The Maya on the Caye employed other materials such as wood, bone, and shell in their daily life.

As a larger site than San Pedro and as one that was heavily involved in trading activity from at least the Classic into the Middle Postclassic periods, Marco Gonzalez was able to marshal greater resources to exchange for lithic raw material and finished tools from the mainland. There were notable differences in the amount of small-sized debitage recovered from the two sites. Much of this lithic material is associated with tool edge maintenance activities, as opposed to simple flake production. Throughout most reliably dated periods at Marco Gonzalez, there was a significantly lower percentage of large bifaces, biface fragments and bifacial thinning flakes than at San Pedro. One reason for this difference may be linked to more successful attempts at preserving the size and shape of bifacial tools and reducing the frequency of tool replacement. A greater number and variety of other smaller biface types and blade tools at Marco Gonzalez may have also decreased the need for more large bifaces at this site.

CHAPTER 8

Lithic Technology and Technological Change

Introduction

New technologies may be introduced into a society via trade with external partners or through the physical movement of peoples. What must not be overlooked, however, is the possibility of technological change occurring internally, as new innovations [morphologies and methods of manufacture] are developed (Rouse 1986:7). Oswalt (1973) contends that major and minor technological developments may be plotted with considerable precision based on the fact that, after conception and production, changes occur largely as step-by-step attribute modifications. The process of change in lithic technology should theoretically be observable as initial attributes change into new forms. Such observations could be documented archaeologically in the assemblages from Marco Gonzalez and San Pedro if lithic technology experienced either gradual internal changes, or adopted, modified, and produced new forms to meet demands in the coastal environment of the Caye. This creation of modified or new tool forms may also include the alteration of existing tool morphologies due to curation practices.

Technological Change

Certain aspects of technological change must be considered to comprehend the implications of the manufacture of new forms fully. Schiffer and Skibo (1987) have documented certain observations concerning technological change as it relates to the shift from Archaic to Woodland ceramic technologies in the Southeastern United States. Some of their theoretical statements are equally applicable to Maya lithic technology. The authors recognize three possible sources of technological change.

Functional field:

The fundamental source of change is defined by the 'functional field' of an artifact, which responds to changes in basic lifeway and social organization (Rice 1984; Schiffer and Skibo 1987:598). Because a society's current technologies may be unable to supply the required items to cover an altered functional field, new technological advances may be developed internally or adopted and/or modified, resulting in either innovation or deletion of artifacts. I believe the modification or recycling of tools into new tool forms to perform different tasks or to extend original tool use-life qualifies in this instance. Because the lithic tools acquired by the inhabitants of Marco Gonzalez and San Pedro eventually became unable to perform their functions as they were exhausted, modified recycled tools were required to fulfill additional needs. At the root of this problem, however, may not have been the lack of an adequate technology but, rather, an insufficient number of stone tools available to the Maya at a specific time. This was probably not a question of inadequate response to demand as much as it may have been economic restrictions that prevented the Ambergris Caye Maya from acquiring all the finished tools they required for optimal resource procurement and processing. Nevertheless, technological change on a small, localized scale was being implemented within restricted time frames to meet specific local needs. These technological changes are not permanent additions to the overall development of Maya lithic technology and may not have contributed to greater lithic innovations beyond the Caye environment. Interestingly, other sites on the north end of Ambergris Caye (Hult and Hester 1995) and on the mainland (McAnany 1989b, 1992; Mitchum 1994; Lewenstein 1987; Shafer 1983) exhibited similar reduction and recycling techniques. Although it may be argued that the composition of the tool assemblages at these sites was ultimately determined by the variability of their environments or environmental zones they exploited (Gould 1980; Perlès 1993:268), the fact that similar reduction and conservation patterns of lithic materials were observed at sites in different environments, performing different activities [i.e. large-scale agriculture at Pulltrouser Swamp vs. coastal exploitation on Ambergris Caye] suggests that other economic and/or social factors were involved in the 'lithic behaviour' of the Maya. This is good evidence that "... a multi-dimensional causality within a web of systemic relations ..." is responsible for the creation of the lithic artifacts recovered, instead of simple unilinear modeling (Gould 1980:50-51).

Feedback:

A second source of technological change is feedback from use-related contexts, whereby function is primarily a constant and performance is tested to discover a better or superior artifact design (see below). In cases where entire technologies and classes of successful artifact forms are adopted by a society, it is likely that feedback based on use and manufacture will instigate even further technological modifications (Schiffer and Skibo 1987:598).

Producer pressure:

Finally, 'producer pressure' is cited as a main cause of technological change, as manufacturers compete for profit in expanding markets or survival in decreasing ones (Horsfall 1987:333). This may not have been directly applicable to the exclusive lithic production based in the lithic workshops of the 'chert-bearing zone'. Within the Colha sphere of influence there was very little need for change in tool technology and therefore change in tool form. Although new formal tool types are documented at different periods at Colha and surrounding consumer sites in Northern Belize, this is not the result of 'producer pressure'. Tool type changes seem to be related to the tasks performed and the other sources of technological change noted above, in addition to the influence of 'Mexica' in the Postclassic period who introduced lenticular and triangular bifaces, dart points and small, side-notched projectile points (Hester 1985; Hester and Shafer 1991; Masson 1997; Michaels 1987).

Technical choices, tool properties, and behaviour:

Regardless of the source of technological change, every technological process involves a sequence of behaviours that is the result of specific technical choices, which are responsible for the determination of the formal properties or attributes of artifacts (Hayden 1998; Torrence 1986, 1989:2). These formal properties influence the performance characteristics required by an artifact to realize its specific design functions and may also be subject to constraints such as material type (Bamforth 1986:39-40; Hayden 1998:7; Jelinek 1976:23; Jochim 1989:107). Considerations of manufacturing cost-benefit and tool efficiency must be factored into any decisions concerning the choice of tool design, especially when different implements may perform the same task with similar degrees of success and rates of energy expenditure (Bamforth 1986; Bleed 1986; Hayden 1998:2; Jochim 1983; Torrence 1989). This may include decisions relating to varieties of formal tool design or the use of expedient versus standardized technology (Bamforth 1986; Boydston 1989; Jochim 1989). The underlying assumption in this instance is that the choice of tool design is primarily determined by some functional criterion such as reliability, maintainability, or portability, which may not necessarily be true. Other motivating factors such as information exchange, social status, or raw material constraints may have been responsible for decisions related to tool design (Aldenderfer 1990; Bleed 1986; Gero 1989; Hayden 1998; Hayden et al. 1996; Wiessner 1983; Wobst 1977).

Since each technological choice may modify more than one formal attribute and performance characteristic, such as ease of manufacture, durability, edge sharpness, maintenance, and repair, a choice may elicit a negative effect, whereby some performance characteristics are enhanced while others are degraded (Bleed 1986; Schiffer and Skibo 1987). Given the absence of a direct correlation between a single technological option and a single resulting performance characteristic, and the prevalence of negative or 'polar' effects, it remains difficult to design an artifact that optimizes every performance characteristic. Consequently, finished artifacts will usually represent the best or most efficient compromise among a variety of possible forms (Isaac 1977; Schiffer and Skibo 1987) due to the fact that "... an artifact's performance characteristics cannot all achieve high values in every use activity" (Schiffer 1995:29). However, based on her study of design theory, Horsfall (1987) challenges the notion of a best solution to design constraints, claiming most decisions represent only one of a number of 'satisfactory' technological responses or different morphological/ technological solutions to the same functional problem (Jelinek 1976; Jochim 1983:163, 1989; Sackett 1977, 1982). This array of 'satisfactory' technological solutions may make possible the concept of style in lithic artifact manufacture, and such stylistic differences may translate into evidence of either cultural differences among lithic tool assemblages (Flenniken 1985; Young and Bonnichsen 1984, 1985) or of individual decisions by a tool-maker based on technical knowledge, skill, and available raw materials (Gunn 1975; Perlès 1993:269).

Technological change may reflect adaptive change manifested as an increase in 'goodness of fit' between an artifact and its formal attributes or performance characteristics (Alexander 1964; Horsfall 1987). According to Alexander (1964:20): "Goodness of fit can be positively defined as the limits of acceptable variability, although it is more commonly perceived as the absence of a misfit, or the absence of unacceptable characteristics".

Obviously, it is extremely difficult to determine the exact cause of technological change in a specific artifact class. Schiffer and Skibo (1987) realize the inherent problems with this type of interpretation, emphasizing the necessity of compromise in the design process as it relates to a simplified framework to explain technological change. Their approach supposes that change can be expressed as the replacement of one tool form by another. Based on this explanation, reworked or recycled [curated] tools created to satisfy the new tasks of a tool's functional field would qualify as technologically altered.

'Design Theory' and Stone Tools

'Design theory' considers the manner by which different technological approaches can be employed to deal with various constraints in solving specific problems (Horsfall 1987; Pye 1964; see Aldenderfer 1990). Horsfall (1987:333) defined it as: "a means of creating or adopting the forms of physical objects to meet functional needs within the context of known materials, technology, and social and economic conditions". This incorporates such concepts as technological change to satisfy 'functional fields'. For the lithics from Marco Gonzalez and San Pedro, important constraints for tool function included task performance, availability and cost of raw materials, tool use-lives and the cost to repair, recycle or replace them. Hayden et al. (1996:10) note that tools that share the same or similar characteristics will be classed into "distinctive lithic production and resharpening strategies". Such strategies can be used to determine how a prehistoric population used technology to cope with their specific environments and economic and social structures. However, it should be noted that a global assemblage approach for the analysis of this technology may not be viable. Because all tools in the assemblage were not used at the same time to perform the same tasks in the same way, Hayden (1998:10) suggests that different tool properties and conservation practices may have been more important for some portions of an assemblage than for others. For example, the reduced number of blades recovered from Marco Gonzalez and San Pedro and the fact that there is little evidence for blade tool recycling (see above), is likely due to the use of obsidian blades. These tools were likely better suited for the performance of some tasks than were blades made from chert. For heavier tasks requiring larger bifaces, obsidian, due to its brittle structure, would not be a viable alternative.

Given the relatively restricted access to chert and chalcedony on the Caye, one would expect a series of strategies that would maximize the use of available raw material. Although most tools arrived on the Caye in finished form, the manner in which these tools were used and maintained is crucial to our understanding of the economic adaptation to this raw-material deprived coastal environment. If raw material is difficult to obtain, fewer 'situational' tools, fewer large single platform cores, more bipolar flaking, and more evidence of materials such as utilized biface reduction flakes should be expected in lithic assemblages. Tools should be less expedient, they should be less specialized, more multi-purpose, and those deposited should be highly fragmentary (Magne 1989:22).

Stone tool design strategies on Ambergris Caye:

The design strategies recognized at Marco Gonzalez and San Pedro primarily include a biface strategy, followed by an expedient, opportunistic flake/core strategy (see below), and rarely a bipolar core strategy. Different lithic strategies seem to be used collectively to maximize the use of raw materials as tools are always in the process of being transformed. This evolution of tools into different types is not restricted to specific temporal and spatial contexts, and the relationship of one tool form to another is not constant, but changes as the tools are transformed through use and re-use at different rates (O'Brien et al. 1998:495). As Hayden (1998) noted, no single pattern of lithic use is universally applicable as reduction techniques and conservation practices vary with tool type and need at different times. The one constant that affects the majority of the tools in the assemblage is limited access to raw material.

The biface strategy extends the use-life of individual 'formal' tools and produces usable bifacial thinning or resharpening flakes. After tool recycling, exhaustion or breakage, either the expedient core strategy or the bipolar core strategy is employed to further extend the use-life of the raw material in the form of 'non-standardized' flakes.

Expedient/opportunistic flake/core strategies can be used to conserve raw material. The bifacial thinning flakes or 'billet flakes' (see Hayden et al. 1996:19) from tool production or rejuvenation could be used for additional tasks. Use-wear analysis of these flakes can be employed to determine their degree of use. A lower percentage of such flakes exhibiting use-wear would be expected for design strategies that emphasize a biface strategy supplemented by the opportunistic use of waste flakes for additional 'expedient' tasks.

Given the many possible uses of bifacial tools themselves [specifically general utility and oval bifaces] (Bamforth 1991; Johnson 1987; Nelson 1991) and the production of potentially usable resharpening flakes (Kelly 1988; Nelson 1991), Nelson (1991:74) states:

> Disk or bifacial cores maximize tool material; they provide a variety of flake forms for use as tools, yet these can be thin while having extensive, usable edge length (high edge-to-weight ratio) ... In addition, the biface can be changed to a variety of forms and resharpened with minimal reduction of the stone ...

Therefore, a biface strategy would be one of the most successful economic approaches to deal with a limited or reduced availability of raw material. Despite the importance placed on the bifacial thinning and/or resharpening flakes as sources of expedient/opportunistic tools in this reduction model, non-biface core flakes should also be a significant part of the tool inventory utilized by the Maya on the Cayes. At Marco Gonzalez and San Pedro, the Maya were in fact employing a more traditional non-standardized reduction strategy to produce usable expedient/opportunistic flake tools that served to supplement this biface strategy. The maximization of potential tools actually includes almost all lithic forms with the exception of a few notable examples [stemmed macroblades, stemmed blades, and thin lenticular and lozenge bifaces].

Although in the Central Peten Lakes Region, there is evidence for the bipolar reduction of stone to produce *ad hoc* flakes and fragments, this technique was primarily used upon coarse or medium-grained cherts (Aldenderfer 1991:126; see Forsman 1976; Hayden 1980). There is minimal evidence for bipolar reduction of lithic material from Marco Gonzalez or San Pedro. This is partially due to the fact that in order for this technique to work effectively, a raw material with a grain or cleavage planes works best. Colha or

CBZ chert, which constitutes the majority of the raw material at these sites, is too fine for bipolar flaking to work effectively. A second reason for not using this technique is the fact that there was such a premium placed on lithic raw material at theses sites, that bipolar reduction would be too wasteful of stone in terms of the useable flakes produced.

Tool Forms, Functions and Characteristics

A crucial analytical problem is the equation of formal or morphological tool classes with single, distinct functions. Terms familiar to all archaeologists, such as 'projectile point' or 'hide scraper', imply that each formal tool class served a single unique purpose in a cultural system. This equation contains two premises: that morphology and function are coterminous, and that each formal class possessed only a single function (see Meltzer 1981). However, this is not the case, as many archaeologists have proven.

Both archaeological (Ahler 1971; Dibble 1984; Frison 1968; Odell 1981b; Semenov 1970) and ethnographic (Gould 1978; Hayden 1977) studies have demonstrated that the simple equation of function and gross morphology in stone tools is not universally valid. In many cases, specific functional attributes of tools may be more important than gross morphology in determining the uses to which they are put (Parry 1983). It is becoming apparent as well that some morphological tool classes often grouped under single functional headings may include tools used for a wide variety of purposes, effectively precluding their identification with a single function (Shott 1986:15). Some classificatory systems based on morphology may also erroneously group similar looking artifacts from different cultural or temporal contexts (Flenniken and Raymond 1986).

Dibble (1984, 1985, 1987) has formulated a reduction model to account for transformations in the form of Middle Palaeolithic flake tools as they proceed through a reduction process. He has argued convincingly that morphological distinctions between specimens correspond to stages in the reduction process, such as re-use and recycling through curation behaviour. Shafer (1983:214) notes that the form and function of tools will significantly change based on the distance from the tool production source and how this affects the amount of reduction due to use, retouch and recycling.

Task-related characteristics:

Task-related characteristics, such as reliability, flexibility, maintainability, multifunctionality, transportability, and versatility, will affect rate and pattern of consumption of lithic tools and will contribute to patterns of tool design, tool use-life, curation, and rate of replacement. Obviously each characteristic will possess a variety of elements that will be more or less amenable to effective task-completion in different situations. It is essential to determine which combinations of characteristics were the most efficient for the Maya from Marco Gonzalez and San Pedro.

Unfortunately, attempts to define the characteristics desired in the stone tools from the Cayes are hampered by multiple meanings of the same terminology by different lithic specialists. In many instances, it is difficult to isolate a specific definition for a single term. Inasmuch as I have decided to adhere as closely as possible to the definitional system established by Nelson (1991), some explanation of the use of these terms is required.

Reliability:

Reliable tools are suitable for maximizing tool use because they are specially designed to perform a limited range of tasks very well. But, they are costly in terms of raw material consumption, manufacture and maintenance time. Nelson (1991:67-68; Aldenderfer 1990) notes that considerable 'downtime' is necessary for initial tool manufacture and maintenance prior to and after the completion of a task or tasks. In a reliable tool system, manufacture, repair and tool use would be differentiated, separately scheduled and each may be undertaken by different personnel (Torrence 1989). Given these criteria, it is doubtful the Caye Maya concentrated their efforts on a reliable tool system due to the scarcity of raw material and the level of skill required for adequate maintenance.

Maintainability:

Maintainable tools are designed to work easily under a variety of circumstances (Bleed 1986). Manufacture, repair and tool use are all performed continuously and almost simultaneously, and the use-life of tools is extended over the period during which the tools are required (Torrence 1989:63). Many archaeologists equate flexibility with maintainability (Camilli 1986; Goodyear 1989; Morrow 1987; Nelson 1991; Parry and Kelly 1987; Shott 1986). Although Shott (1986:19) defined flexibility with regard to the range of possible tool uses without reference to changes in tool morphology, Nelson (1991:70) modified Shott's (1986:19, 35) original definition of 'flexibility' by emphasizing that these tools are subject to a change in form to accomplish multifunctional tasks much as maintainable tools experience alteration in morphology as they are continuously reworked and repaired.

Maintainable tools may be considered of serial design if they are used in anticipation of the order of various future tasks, thus changing form in a sequence, or of modular design which allows a random order to future tasks, employing replaceable working parts (Nelson 1991:70). In theory, this type of sequential reduction should result in the deposition and/or discard of relatively few tool forms which mostly consist of the end products of a reduction sequence. This pattern is seen in some of the lithic forms at Marco Gonzalez and San Pedro. Nevertheless, lithic artifacts may break and become flawed at various points in the sequence, thus resulting in the deposition in the archaeological record of representatives of various reduction/recycling stages. This has also been noted in the assemblages from Ambergris Caye.

Interestingly, McAnany (1982) argues that sequential reduction of Classic period bifaces in Mayan contexts in Belize represents conservation of a tightly controlled raw material, but is not necessarily related to design flexibility. Based on the bifaces from Marco Gonzalez and San Pedro, I believe that McAnany's explanation for the conservation of a limited resource is only partially accurate. I believe that the use of bifaces as maintainable tools permits their use for a variety of activities and therefore may reduce the need for other tools that are specially designed for other specific activities. Use of flexible tools contributes to a reduced need for greater varieties of tools designed for specific activities, permits easier resharpening and re-use of stone tool components, and creates stone flakes that may be used as expedient or opportunistic tools (see below), thus collectively increasing the use-life of tools and raw material, which all contribute to decreasing the demand for the raw material.

After breakage, however, the reduction processes for flexible or maintainable tools change from serial to modular design at Marco Gonzalez and San Pedro. Once the original integrity of the tool form has been compromised through breakage, or otherwise significantly altered, the Maya attempted to use the fragments in the best manner possible, even if this modification strayed from the expected sequence of reduction forms notable in serial design. This sequence of forms included the continuous resharpening and reduction of a biface until it was no longer suitable for use as a hafted tool. Subsequent use as a hand-held chopping tool and/or hammerstone occurred with a continued reduction in tool size until the tool was no longer effective for this activity. Emphasis is placed on material and functional maximization, in lieu of morphological continuity.

Flexibility, versatility, and multifunctionality

A bifacial or disk core is often cited as a form possessing design flexibility (Binford 1979; Kelly 1988; Morrow 1987; Nelson 1991; Parry and Kelly 1987). Flakes of various shapes and sizes can be produced from a bifacial or disk core as the core changes form during reduction (Binford 1979:262; Frison and Bradley 1980:21; Morrow 1987:142; Nelson 1991:72; Parry and Kelly 1987). In this instance, Nelson's (1991:70) versatile tools - those which are maintained in a generalized form to meet a variety of needs - equate with Shott's flexible tools. Shott's (1986:19; see also Ammerman and Feldman 1974) definition of versatility refers to the number of task applications to which a tool class could be applied. Whereas Shott (1986:19) coined the term 'versatility' to refer to the number of different tasks to which tool classes could be applied, both Bleed (1986) and Nelson (1991) consider this attribute to be 'maintainability' based on its measurement of a tool's ability to satisfy a variety of tasks. Hayden et al. (1996) prefer the term 'multifunctionality' for this characteristic.

In the lithic assemblages studied here, formal tools are generally shapes that may be considered multifunctional. These include primarily oval bifaces, general utility bifaces, and some other recycled biface forms. Because multifunctionality is encouraged by limited access to raw material, the fewer the tools, the greater the number of tasks in which each is used. That is, as technological diversity declines, versatility per tool is likely to increase (Shott 1986:27). At these Caye sites, there is a fairly limited number of different tool forms. This is no doubt partially a reflection of the multifunctionality of the imported tool forms. The minimal number of tool forms is also heavily influenced by the amount of tool curation through maintenance (see above) due to limited access to raw material.

It is possible for maintainably designed tools to be versatile rather than flexible (Nelson 1991:71). However, generalized tools designed to be versatile consume more work time for many tasks than using tools possessing edge forms that are more specially designed to perform the specific tasks. In essence, having maintainable tools that are of both flexible and versatile design (Nelson 1991:71) permits a greater range of tool-use options because they possess a generalized edge form or several functional edges. The large biface exemplifies these generalized design features. Although the biface, or the flakes removed from it, may not perform a given task in the most mechanically efficient manner, these artifacts can be used for a wide variety of activities (Johnson 1987). When employing tools from classes with versatile design, one should expect to see differing use-wear traces based on the variety of tasks performed by tools in that class (Nelson 1991:73).

Technology Theory

Technology and environment:

Binford (1973, 1977; Binford and Binford 1966) first used the concept of functional variability as a strategy to understand a specific instance of lithic assemblage variation based on the performance of different activities at different places. More general technological strategies are now employed to weigh social and economic concerns with respect to environmental conditions. According to Nelson (1991:58), such strategies are viewed as problem-solving processes that are responsive to conditions created by the interplay between humans and their environment (Binford 1973, 1977, 1978, 1979; Bleed 1986; Kelly 1988; Koldehoff 1987; Parry and Kelly 1987; Shott 1986; Torrence 1989; Wiessner 1982, 1983; see Hayden 1998; Kleindienst 1975 for design theory). Furthermore, Bleed and Bleed (1987:189) state: "environmental pressures interact with human behavior to favor some technological alternatives at the expense of others". Humans, as decision-makers within a variable environment whose ultimate behaviour is determined by the conditions of their environmental/ecological context, will attempt to solve their problems with a certain level of technological expertise at their disposal (Nelson 1991:60). As such, Glynn Isaac (1986:237) has said that in order to understand past adaptations in ways that are more than reflections of ourselves, we must integrate "a knowledge of ecology and an understanding of alternative strategies for exploiting the economy of nature". Environmental aspects that dictate technological organization can include: resource predictability, distribution, periodicity, productivity, mobility (Bamforth 1986; Binford 1978, 1979, 1980; Bleed 1986; Nelson 1984; Shott 1986; Torrence 1983), size and productivity of resource areas (Binford 1979, 1980), and potential hazards (Binford 1977, Nelson 1991:60). Alternatively, Sackett (1982) argues that choices tool makers make between such alternatives are 'socially bound' or dictated in large part by traditions of a social group rather than by external selective pressures such as environment. Although environment may be a determining factor in tool design, Hodder (1977; see Gould 1980) notes that items will always convey some form of social information, even if their roles are primarily utilitarian.

CHAPTER 9

Lithic Consumption in a Complex Society

The Curation Conundrum

Introduction:

The term 'curation' as used by archaeologists remains an elusive concept. Presently, many archaeologists seem unable to agree on its definition (Bamforth 1986; Binford 1973, 1979; Hayden 1976, 1987b:223; Kuhn 1992; McAnany 1988:3; Nash 1996; Nelson 1991; Odell 1996) and still others have advocated the abandonment or a moratorium on the use of this term (Hayden et al. 1996; Nash 1996). The concept of 'curated technology' was initially introduced by Binford (1973:242-244) in an attempt to explain how tools were used and discarded in the Mousterian. In his view, this 'technology' incorporated the transportation, efficient use and preservation of stone tools for some future activity. Binford (1976:338) later added the concept of recycling of worn or broken tools.

Curation criteria:

Bamforth (1986:39) and others created a list of five basic criteria that define a curated tool or technology:

1. Production of implements in advance of use (see also Binford 1979:269; Kuhn 1992:189; Nelson 1991:62-63; Torrence 1983:11-13 for workshops and caches; see Binford 1977:35; Keeley 1982:798-799; Shott 1986:39). Shott (1996a:264) believes this is a characteristic shared by all tools and should therefore not be specifically related to defining 'curation'.

2. Design of implements for multiple uses (see also Binford 1979:262; Kelly 1988 and 'versatility', 'flexibility', 'multifunctionality' above).

3. Transport of implements from location to location (see also Binford 1973, 1979; Nelson 1991:65; Kuhn 1992:189; Shott 1989a:288, see also Shott 1986 for 'carrying costs', see Shott 1996a:264 for transport and distance).

4. Tool recycling (see also Binford 1977:33-34; see Schiffer 1987; Shott 1996a:265 for recycling as extension of tool use beyond original design or purpose [maximum utility] and see raw material below).

5. Tool maintenance (see also Shott 1986:40, 1989b:24; see Bleed 1986 for tool 'maintainability' and see raw material below).

In many instances, tools and associated behaviours only fulfill some of the criteria for curation as it is outlined above. Therefore it remains difficult to judge degrees or levels of curation within and between different tool assemblages, locations, or populations.

It would appear that when investigating questions pertaining to the concepts of curation that a certain bias needs to be addressed first. The vast majority of published work on this concept considers it in relation to hunter/gatherer [collector or forager] organizational systems. This is not surprising given the fact that Binford's (1973, 1979) initial introduction of curation was to just such types of population sizes and organizational structures [Mousterian, Nunamiut, Alyawara]. Consequently, most models of curation relate primarily to factors of tool utilization and the behavioural traits of prehistoric or modern hunter/gatherer groups. Unfortunately, curation and expediency are not restricted to 'simple' hunter/gatherer populations, but rather, apply to any level of organizational and social complexity. The models often place emphasis on certain criteria such as mobility that may not be appropriate to much more complex societies like the Classic Maya. Therefore, some of the defining criteria must be re-examined in terms of their universal applicability and may need to be modified in situations of greater organizational complexity.

Curation, Expediency, and Opportunistic Behaviour on The Caye

Introduction:

It is generally assumed that " ... prepared core reduction strategies are characteristic of curated technologies, while *ad hoc* reduction strategies are characteristic of expedient technologies" (Nash 1996:88) and that expedient, informal or *ad hoc* stone tools are "... made with little or no production effort" (Andrefsky 1998:xxiii) and are "... produced when needed and are discarded after use" (Binford 1979:269). Even though these statements seem accurate for the hunter-gatherer population groups that have traditionally been the basis for conclusions concerning curated and expedient behaviour, this strict dichotomy does not necessarily reflect the behaviour demonstrated by the Maya of Marco Gonzalez and San Pedro.

Expediency vs. opportunistic behaviour:

The lithic assemblages from both these sites reveal a much more complex interaction between traditional curation in the form of preservation of tool forms and raw material, and the extension of raw material use-life through the implementation of what are considered traditional concepts of formal and non-standardized tools. In this instance, 'expedient' lithic behaviour is not the product of an adaptation to unlimited or unrestricted access to stone, but a complementary, conservative 'opportunistic' approach to gain more use in the form of 'waste' from the curated tools in the "...immediate context of use" (Binford 1976:341). In this instance, the formal chert biface tools can be considered the prepared cores that are being reduced and conserved through curation. These bifaces/cores are also the source of non-standardized or expedient flakes. This is not simply *ad hoc* reduction, but a concerted attempt to preserve the stone bifaces as long as possible and to use the largest flakes removed as tools.

The complicating element of this explanation of the basic concepts of curation and expediency is Nelson's (1991:62) introduction of a third use strategy which is applicable to the lithic behaviour at the Ambergris Caye sites. Opportunistic behaviour, which has been referred to as 'situational' because of the situational nature of manufacture and use (Binford 1979; Johnson 1987), is considered a sub-set of expediency, although it possesses a defining element that I believe renders it a different behavioural adaptation to lithic availability. Both opportunistic behaviour and expediency use simple flake tools that are discarded after use. Perhaps the most important distinction between these different categories of tool use behaviour and reduction strategies is that opportunistic behaviour is a response to raw material scarcity and the unanticipated at its most basic level. Traditional technological expediency is behaviour that is possible where adequate supplies of raw material are accumulated for some anticipated future use (Nelson 1991:81). Because expediency is favoured under conditions in which access to material is not a major concern, there should theoretically be minimal effort invested in tool design or preparation in contrast to more labour-intensive curation practices (Binford 1979:267). Since opportunistic behaviour also produces simple tools with a minimum of time and labour investment or consideration of future use, it superficially resembles expediency. However, by its very nature, opportunistic behaviour does not necessitate any earlier planning such as stockpiling a source of raw material and is more reliant on the lithic material on hand such as the by-products or debris from curated or recycled tools. Despite this difference, for both expediency and opportunistic behaviour, "minimally effective products should be expected" (Nelson 1991:84).

Lithic behaviour on the Caye:

Despite the explanation presented above, it appears that the artifact data from Marco Gonzalez and San Pedro do not exactly satisfy either opportunistic behaviour or expediency. Although the inhabitants of these Caye sites were using the flakes from biface reduction as tools, I do not believe this was completely unanticipated. I contend this falls into a complex strategy for the maximum use of the bifacial tools themselves and the raw materials available to them. The Maya anticipated or planned on using the flakes from reduction and recycling of formal core tools just as they planned on using a maintainable technology.

With expediency, theoretically, there should exist some core preparation based on the initial stockpiling of material for future use. With opportunistic behaviour as defined by Nelson (1991), there should not be any core preparation because use is not anticipated and core preparation should not be undertaken in the same location as use. Yet, there is excellent evidence for a type of core preparation through the reduction of the bifacial tools at the Caye sites. The maintenance flakes that are removed from the biface tools are deliberately struck from the core tool to minimize the removal of stone from the tool and in anticipation of further use of that tool and the removal of more flakes. Even after tool breakage, there are examples of the 'opportunistic' use of broken tools and the removal of more flakes from these tool fragments.

Although, theoretically, preparation should not occur in a residence or camp location because the supply of usable raw material is stored there, this expedient model is designed for hunter-gatherer societies. Because Marco Gonzalez and San Pedro are state-level, sedentary sites with limited access to chert, there will not necessarily be any storage of raw material, nor special core preparation, because tools arrive in finished form from the workshops at Colha. The chert tools at these sites are both used and repaired at the site centres, as well as in peripheral areas away from the sites themselves. Whereas, Lewenstein (1987:157) notes that the location of tool breakage, loss, or discard, is more often distant from the house mounds at Cerros, this does not seem to be the case for Marco Gonzalez and San Pedro.

It appears the lithic strategies implemented by the Maya at Marco Gonzalez and San Pedro are neither fully opportunistic nor completely expedient; instead they contain elements of both. The strategies are opportunistic in the sense that the flakes from the reworking and resharpening of bifaces are used for some activities. They are not necessarily expedient because there is a premium on stone and this raw material is not stockpiled for future use. Furthermore, the opportunistic behaviour on the Caye incorporates a type of core preparation, unlike that expected for expedient flake production, that attempts to preserve the shape, and consequently function, of the bifaces and other formal tools for as long as possible through the use of systematic reduction strategies.

On Ambergris Caye, both the concepts of curation and opportunistic behaviour seem dependent upon the conservation of stone. It would appear that the Maya at these sites were taking advantage of attempts to extend the use-life of the formal tools by opportunistically using many of the waste flakes as tools as well. Inasmuch as it could be argued that their conservation 'plan' anticipated the 'opportunistic' use of these waste flakes, this was not true 'expedient' behaviour because there was no ready source of raw material available and there was a concerted effort to use core preparation and maintenance [bifacial reduction] to conserve raw material and tool [core] forms for as long as possible. Whereas, traditional expedient technology is wasteful of raw material, opportunistic behaviour in this specific situation appears to be a conservation-oriented by-product of biface maintenance.

This combination of technological strategies was effectively employed by the Maya populations at Marco Gonzalez and San Pedro on Ambergris Caye. In effect, there was a transition of design strategies from a biface to an expedient/opportunistic core reduction strategy, whereby curation and expediency can be viewed as transitional, ordinal options at different stages of a tool's extended use-life or may have co-existed [i.e. biface reduction and use of biface flakes as tools]. Related to this interpretation, Shott (1996a:268) questions the concept of 'expedient' technology as opposed to 'curated' technology. He concludes that expediency is actually 'low curation' and that all tools are in fact curated to varying levels or degrees. Following this argument, there appears to be no specific dichotomy or boundary between curation and expediency, but rather a transition from low to high curation. Nevertheless, I believe that instances in which there is actual change in reduction technique can be seen as a specific change in the strategy of tool production and therefore a true change in the conscious thought process and intent. For example, if a strategy such as bipolar reduction can be applied after all possibility of curation or 'opportunistic/expedient' reduction has ceased [i.e. exhausted formal tools], this would qualify as a conscious change in tool production strategy. Although this constitutes a deliberate, observable technological change in stone tool production, all strategies of curation, expediency, and opportunistic behaviour can be used collectively to extend the overall time a tool remained operational within its cultural context (Ammerman and Feldman 1974; Odell 1996:53; Schiffer 1976:60; Shott 1989b). Based on these observations, I agree with Nelson (1991:65) when she asserts that "...it is crucial that curation and expediency not be perceived as mutually exclusive systems, but as planning options that suit different conditions within a set of adaptive strategies".

Curation and raw material:

In his examination of curation, it is intriguing to observe the manner in which Odell (1996) emphasizes the difference between the practice of curation and the restricted availability of raw material; a concept many other researchers simply gloss over or blend together (see Nash 1996:85 for curation and transportation of raw material for anticipated future use). According to Odell (1996:74, Fig.8), curation can include all five of the criteria proposed by Bamforth (1986), whereas 'scarcity-induced economizing activity' shares the practice of tool conservation (tool recycling and maintenance). This further includes a series of practices intended to maximize the production or extend the use-life of tools or components thereof from limited raw material. These include core-bashing, bipolar reduction, extreme tool breakage, extreme tool exhaustion, and extreme use intensity (Parry and Kelly 1987:301). This maximization or economizing of rare or scarce raw material in many cases involves the adoption of an expedient, non-standardized or 'opportunistic' design strategy (see above). In situations where access to raw material is reduced or restricted, the available raw material would be expected to be used much more intensively.

The notion of risk management and raw material availability are inextricably linked at the Caye sites. The inhabitants of Marco Gonzalez and San Pedro were more apt to choose the least costly stone that would adequately perform their required tasks. In effect, these inhabitants were adopting a primarily maintainable stone tool strategy which necessitated the use of raw material that was relatively easily repaired and/or recycled into other tools [i.e. oval and general utility bifaces]. Based on Goodyear's (1979) conclusions, the Caye dwellers should choose higher quality, homogeneous, siliceous raw material types that may not be found in their immediate local environment and may be costly to obtain. Based on the overall positive cost/benefit return of using this raw material for tool performance and ease of maintenance, the time and energy and economic costs inherent in obtaining this stone were viewed as worth the additional investment. This appears to be the situation observed at Marco Gonzalez and San Pedro as the greatest percentage of raw material was acquired from the Colha workshop sites as finished tools. However, one problem with this primarily 'hunter-gatherer' oriented model being applied to the Maya of Northern Belize was the existence of a major craft-specialization/stone tool production centre from the Late Preclassic through to the Early Postclassic. Many other economic and political factors affecting the acquisition and transfer of goods are not known for the exchange/indirect procurement strategies employed by the inhabitants of Ambergris Caye. The conflicting arguments surrounding the effects of stone material availability on tool and toolkit design are numerous, as are the possible explanations for why raw material under certain circumstances is difficult to obtain (Bamforth 1986; Binford 1979; Binford and Stone 1986; Gould 1978; Gould and Saggers 1985; Jelinek 1976; Nelson 1991:76). For example, Bamforth (1986) implies that the availability of stone material is the primary determinant of technological organization in his statement that maintenance and recycling are "closely related to raw material availability and not directly or solely to settlement organization or the time limits on the activities for which tools are used" (Bamforth 1986:40). Essentially, he believes that tools will only be maintained and recycled when raw material is limited in its availability and, therefore, when it is more costly to replace a tool than to rework it. On the other hand, Nelson (1991:77) argues that decisions concerning social and economic factors are the main conditions affecting tool design and that raw material scarcity is secondary in determining maintenance and recycling practices. However, a pertinent question to be considered is: How is scarcity defined? It may be due to such economic or social problems as transportation cost, the relationship between supplier and consumer(s), or the control of trade by the elite.

Curation and use-life:

An added problem to curation is the relationship to 'use-life' (Shott 1996b). It exists as an abstract term in many ways because it is very much dependent upon the tool itself. For example, an expedient or low curation tool may possess a relatively shorter use-life than a highly curated tool, but it has fulfilled its full potential in that time limit. In addition, many tools are intended for different purposes and degrees of use and, as such, can compromise the applicability of use-life as a universally comparative term.

Nevertheless, 'use-life' according to Schiffer (1976:60), simply refers to the length of service of tool classes in systemic context [i.e. number of strokes (Gallagher 1977:411; Hayden 1979b), number of specific uses (firing projectile - Odell and Cowan 1986), or a function of time (Shott 1989b:10)]. Yet, this characteristic is difficult to identify in archaeological context due to behaviours such as recycling and curation. The relationship as it exists between 'use-life' and curation may be condensed to mean a reduction in utility (see Ammerman and Feldman 1974 for 'dropping rate' and Roebroeks et al. 1988:22 for equating curation with degree of reduction). Following Shott (1989b:24; see 1995, 1996b), curation is " ... the degree of use or utility extracted, expressed as a relationship between how much utility a tool starts with - its maximum utility - and how much of that utility is realized before discard". The main concern with this definition is how do we determine the 'maximum utility' of a tool? It necessarily must be an ambiguous value as opposed to a specific or finite number. And how do high curation, low curation and/or expediency relate to maximum utility? When is a tool no longer 'useful', either technologically, socially, or ritually?

Some of the possible measures of 'maximum utility' enumerated by Shott are similar to 'use-life' measures presented by Schiffer (1976:60) above: 1. The amount of usable material possessed by a tool before use compared to the amount removed following use ['realized utility']; 2. The number of useful strokes of a tool per unit weight or volume of used stone (Gould and Saggers 1985:131); and 3. The average maximum use life of individual tools in a tool class [maximum utility] compared to each individual tool's actual period of use [realized utility] (Shott 1996a:270).

One of the critical factors in determining use-life is the process of discard. This process may include: 1. Breakage in tool production, as tools may be used after breakage for activities not necessarily related to their initial function; 2. Abandonment during or after production; 3. Loss or breakage in use; 4. Recycling [the use of a tool for purposes other than those originally intended (Schiffer 1976:38)]; 5. Abandonment in use; and 6.

Depletion (see Shott 1989b:17-19). It must be noted that tools that are eventually discarded by one population group in a specific context, may be re-introduced into the systemic record through the process of scavenging by yet another group, thereby artificially extending use-life (Schiffer 1972, 1987; Tomka 1993). However, this extension of use-life will be removed in both temporal and cultural context from initial tool use and therefore would not constitute a continuation of the primary use event. In situations where tools have been scavenged and their initial potential was not used by the individuals in possession of the lithics in the present archaeological context, it is extremely difficult to distinguish between use events, and consequently use-lives, related to pre- and post-scavenging activities.

Because artifact use-life is one of the most important variables determining the frequency of tool discard, the extent of curative behaviour, and other variables related to the formation of an archaeological assemblage, it is crucial to determine what factors contribute to the extension or, conversely, the cessation of use-life (Schiffer 1972, 1976, 1978; Binford 1973). Variables potentially related to use-life include the replacement cost in time, energy, skill, and raw material (Schiffer 1978), and change in tool efficiency and use as it relates to reworked and resharpened tools [tools become less efficient with steeper edges, smaller size, smaller usable face/surface] (Bleed and Bleed 1987). Nelson (1991:74-75; Lewenstein 1987:167) has noted that a large number of small resharpening flakes, a high index of thickness to length within a single tool class [i.e. bifaces], and the presence of very steep edge retouch within a tool class are characteristic of extended toolkit use-life.

Conservation and curation:

At Marco Gonzalez and San Pedro, we are observing conservation and maximization of tool use potential in the form of 'recycling'; which occurs when a used item is remanufactured into a new item, 'secondary use'; which takes place when an unmodified item is employed in a different activity, 'lateral cycling'; which occurs when an object is transferred, without change in form or use, from one user to another (Schiffer 1972:159, 1977:32-33), and 'conservation processes' or collecting behavior which bring about a change in the use of an object to facilitate its preservation (Schiffer 1976:39, 1977:33-34; Schiffer et al. 1981). These multiple uses of lithic material are observable in the reduced and re-shaped morphologies of formal tools, and the overlapping and different use-wear observed on single tools. Furthermore, recycling may also be determined through changes in artifact size. Based on the expectations derived from the Frison Effect (Jelinek 1976:22), recycled lithic artifacts become progressively reduced due to the mechanics of stone tool production and conservation behaviour (Dibble 1987; Schiffer 1983, 1995:175). Depleted tools are often much smaller in size after frequent resharpening events, and there will probably be observable changes in general morphology, weight, and/or length. However, Odell and Cowan's (1986:205) experimental results suggest that artifact size and use-life are not strongly correlated. The degree of breakage, curation and recycling will have direct effects on tool size that may not relate directly to the degree of use-life extracted from or remaining in said tool [i.e. discard or loss]. Nevertheless, as Shott (1989b:24) asserts "... as [a] tool is reduced progressively, its utility should decline in corresponding fashion". Therefore, it may be beneficial to develop a stage analysis (see Muto 1971) for tool reduction and recycling. Dibble and Pelcin (1995) suggested a possible method for 'quantifying' lithic curation based on the experimental reconstruction of original flake mass from hard-hammer lithic production systems. Their method, which utilizes external platform angle and striking platform thickness, was criticized by Davis and Shea (1998) because their experimental program demonstrated that Dibble and Pelcin's method underestimated flake mass.

Tool maintenance or recycling is most easily observed in the archaeological record through tool retouch (Odell 1996:60; see Hayden 1987a for criticism). A second possible method for the recognition of such activity in the archaeological record is Shott's (1986) 'ratio of total length: haft length' for hafted tools. According to Shott (1986:44):

> ... the shorter a tool is in relation to the length of its haft, the more it has been resharpened and reduced from its original size. Therefore, as resharpening and reduction increase, the resharpening ratio declines; lower values of the ratio are associated with greater resharpening.

The obvious problem with this measure of tool use and recycling is that in almost all cases, Maya stone tools are recovered without their hafts. Exceptions to this are conditions of extraordinary preservation such as those associated with the Puleston axe and some of the artifacts from the Cenote of Sacrifice at Chichen Itza (Puleston 1976; Shafer and Hester 1990, 1991:91, Fig.5; Coggins and Ladd 1992:254, 255, 256, 262, Figs. 8.27, 8.28, 8.29, 8.30, 8.37).

Conservation can take the form of minimizing waste during reduction or resharpening of implements and the maximization of tools and fragments of that are still useful. Additionally, design strategies for bifacial tools as cores can maximize tool material and produce a variety of flake forms for use as tools, namely flakes with high edge-to-weight ratios (Binford 1979; Bradley 1976; Goodyear 1989; Morrow 1987). Hayden et al.

(1996:25; Hayden 1987a) note that the use of billet or soft-hammer reduction assists in preventing the rapid consumption of raw material and maintains relatively low, and therefore, still serviceable edge angles on bifaces. One drawback of a biface strategy is the 'cost' in terms of manufacturing time, effort expenditure and the relatively high skill level required of the tool-makers. Arnold (1987) argues that specialized tool-makers will make fewer errors in tool production. What may be of interest in the Maya lithic assemblages is that the skill of the tool-users at Marco Gonzalez and San Pedro may have been relatively low indicated by the number of step and hinge flake scars on their tools (McAnany 1991:281). This fact may, in some manner, counteract the benefits noted by Hayden (1987a) if the Maya from these sites were not, in fact, fully maximizing the raw material and were not achieving the maximum potential tool use-life. Their inability to remove the greatest number of billet or bifacial thinning flakes and to maintain a relatively low edge angle on their bifaces would suggest a tool reduction strategy that may not have been as economical as theoretically possible. In terms of the number of bifaces and biface fragments expected at these sites, numbers should be relatively low based on long use-lives and the potential use of these tools away from the sites themselves. However, tool breakage and recycling could artificially inflate the perceived number of tools present (Hayden et al. 1996:26). When considering the importance of curation to a lithic assemblage it is crucial to consider the negative evidence at a site. Curated tools are those artifacts that are the least likely to be recovered. It is therefore often necessary to rely on other indicators of curation practices (Binford 1973; Nash 1996:90; see Sackett 1982:90-94).

Table 5: Criteria of Evidence of Extreme Biface Use

Bifaces	Flakes
1. very steep edge angles	1. tertiary, bifacial thinning/resharpening flakes
2. heavily crushed edges	2. thick biface edge flakes (with crushing)
3. numerous, large step and hinge flake scars	3. thinning flakes with use-wear on dorsal surfaces and below striking platforms
4. removal of flakes from the breakage surfaces	4. high percentage of small resharpening flakes
5. reduction in overall tool size	
6. change in tool morphology	

<u>Curation and transport:</u>

When dealing with concepts of curation, expediency, and opportunistic use, it is important to determine the source of raw materials and mode of transportation to the location(s) of use (Binford 1979; Keeley 1982; Nelson 1991:73; Parry and Kelly 1987; Shott 1986). Because the lithics at Marco Gonzalez and San Pedro are arriving on the Caye in finished form from specialist workshop sites at Colha, the source of the chert and its transportation are important factors. The Maya on the Caye are not manufacturing their own tools, but are definitely using and conserving them as much as possible. They are practicing varying forms of curation, expediency and opportunistic behaviour strictly as consumers, and therefore most of the criteria that constitute the general behaviour associated with these terms are very much applicable in this particular instance. Their successful adaptation to the coastal environment is heavily reliant on the conservation practices of curating generalized or maintainable tools manufactured from relatively rare stone.

The tools that were transported to Marco Gonzalez and San Pedro were used extensively before replacement and discard. Such replacement, however, was dependent upon various contingencies, such as access to more material, cost of acquisition and efficiency and skill in tool repair. Binford (1979), Torrence (1983), and Ebert (1986) argue that transportable tools will be brought back to residences to be maintained and reworked in order to recover the cost in manufacturing time. Bamforth (1986) argues that curated or transported tools will be returned to residences for repair only if raw material for making new tools is scarce. Bamforth's argument applies mainly to non-hafted tools. For a hafted tool, there are considerations of time invested in making a haft, removing a tool from a haft, and replacing it (Nelson 1991:78-79). Because the Maya from the Caye sites were not actually making their own tools from local sources of stone, it seems that their concern for the transport of raw material was of paramount importance in explaining their tool-use patterns.

CHAPTER 10

Marco Gonzalez, San Pedro and Coastal Trade

Maya Coastal Trade

Introduction:

The economies of the majority of sites in the Maya Lowlands were not limited to the immediate geographic vicinity of the settlement and did not exist in isolation from the complex political, social and ritual systems that were interwoven to form the fabric of ancient Maya life. In many instances, the relationships between different elites, populations, geographic locations, and environmental zones defined the economic role a site played within its local, regional and inter-regional contexts. The interpretation of coastal trade networks and the importance of marine-based exchange for the Maya over time has been heavily discussed within the larger framework of economic systems (Andrews 1983, 1991; Berdan 1978; Dreiss 1988; Freidel 1978, 1979; Freidel and Scarborough 1982; Graham 1985, 1987a, 1989; Guderjan and Garber 1995b; Hammond 1972, 1976; McKillop 1984, 1987, 1995a, 1995b, 1996; McKillop and Healy 1989; McKillop and Jackson 1988; Mock 1997; Rathje 1971; Rubio B. 1985; Sabloff and Rathje 1975; Santone 1997).

The roles of Maya coastal trade: a summary:

In the Preclassic period, coastal-based exchange systems were believed to be fundamental to the development of the Lowland Maya civilization, with sites such as Cerros already operating as an inter-regional trading port (Freidel 1978, 1979; Garber 1985, 1989; Guderjan and Garber 1995b; Rathje 1972, Robertson and Freidel 1986; see Powis et al. 1999). Although information from this period is limited, this fact may suggest that coastal trade, specifically long-distance exchange, was limited in terms of the distribution of trade routes and the number of sites involved. Coastal trade and exchange networks were also considered important for the growth of economic and social systems integral to the development of lowland city centres and the interaction between Maya populations in the Classic period (Rathje 1971). Although basic commodities and utilitarian resources, such as salt (Andrews 1983), were needed to fulfill the requirements of everyday existence, emphasis on trade models had been placed on exotic materials that were desired by the Maya elites. In the Classic period, Sabloff (1977) believed that trade overwhelmingly involved the transfer of such exotic, elite goods as jade and obsidian. However, some archaeologists (Graham 1987a:762-763; Guderjan and Garber 1995b:190; Rice et al. 1985:603) suggest that many of these goods, like obsidian, had become commodities more accessible to the general population by the end of the Classic period. Graham (1987a) has noted the various fallacies in theories emphasizing exotics by pointing out that the term 'exotic' is a relative one. Obsidian is not exotic to any highland site and many so-called 'exotics' were proximate to lowland sites. Nevertheless, according to Sabloff (1977), such trade only fully developed in the Postclassic period with the creation of trading ports like Cozumel. Thompson's (1970) contention that the Putun Maya from the Gulf Coast of Mexico may have taken control of the coastal trade routes and continued to dominate trade throughout the Postclassic has been debated, with some scholars suggesting a slower development of trade routes and partnerships and a greater emphasis on the relationship between Maya sites in the mainland interior and with other external exchange partners (Adams 1970; Andrews and Robles 1985; Sabloff et al. 1982). It has further been suggested that Postclassic coastal Maya trade developed partially in response to the abandonment of Classic period inland cities and the shift of Maya populations to coastal locations (Ball 1977; Mock 1997; Sabloff 1977; Thompson 1970). In addition to this population movement, the expansion of the Itza in the northern Yucatan Peninsula may have also been a factor contributing to a more gradual expansion of coastal maritime trade in the Postclassic (Andrews 1991:161). In essence, coastal trade and exchange permeated many aspects of ancient Maya life and were important throughout much of Maya existence.

Trade and Exchange Models

Introduction:

Traditionally, in complex societies exchange occurs in market centres using some recognized, universal unit of exchange, and the roles of purchaser, processor and seller are usually well established. Reciprocity and redistribution are more common in simpler societies (Polanyi 1957). In the resource distribution and allocation system of the Maya in Northern Belize, exchange was less structured than a formal market exchange network as seen among the Aztec (Hassig 1985). Because of the importance of social hierarchies and elite domination at major city centres, the control of trade may have resided in the hands of a series of interrelated individuals or elites scattered across a large geographic expanse. In such a situation, larger elite-dominated centres would control the long-distance acquisition and regional redistribution of trade items.

Several mechanisms for coastal trade in the Maya region have been suggested including: down-the-line exchange (Renfrew 1977), ports-of-trade (Polanyi et al. 1957), or some form of 'middleman' position at trading ports. Middle-man trading ports enabled the distribution of exotic or long-distance trade items such as pottery and obsidian within the regional coastal network, instead of the restricted exchange of such goods solely between the elites (McKillop 1996:50).

Down-the-line exchange model:

In a down-the-line exchange model, goods were exchanged from relations or partners in one community to others in other adjacent communities. This is typical of less-complex societies than the Classic period Maya. This classic distance-decay model documents the ever-decreasing amount of exchanged material recovered from sites as distance from the source increases (Hodder and Orton 1976:98-126; Renfrew 1977:72). This model is not applicable to Maya exchange because their trade system was both preferential and non-homogeneous (see Sidrys 1976 for central place redistribution). Down-the-line exchange does not make allowance for diachronic variations in patterns of distribution resulting from political, social and/or economic relationships between members of a procurement system like that of the lowland Maya. The main methods of exchange and distribution for the Maya incorporate Clarke's (1978:426) notion of hierarchical diffusion, in which dispersion occurs via social, economic, or political hierarchies and such "... exchange could be vertical (between two levels of the hierarchy) or horizontal (between two sites on the same level) [with] ... different commodities moved by different mechanisms" (Marcus 1983:477). Consequently, the expected regression curve for the distribution of exotic goods such as obsidian in a distance-decay exchange system does not follow the expected exponential decline from the source to the consumer locations (Sidrys 1976, 1977). Related to this, some archaeologists have also tried to implement a modified central place model for long-distance trade to coastal Belize with questionable success (Vail 1988:112).

'Port-of-trade' model:

A 'port-of-trade' is defined by Polanyi (1968:238) as a: "... neutrality device ... capable of dealing with the security requirements of trade under early state conditions" and by Chapman (1957:115-116) as a trade location

> ... whose specific function was to serve as a meeting place of the foreign traders. The word 'port' as employed here need not imply a coastal or riverain setting, although ports of trade were usually thus situated. ... Prior to modern days, the port of trade should therefore be regarded as the main organ of long-distance commerce.

One of the principal inconsistencies with applying the 'port-of-trade' model to the Maya coastal exchange network incorporates the concept of neutrality. The vast majority of Maya coastal sites involved in coastal trade, including Marco Gonzalez, shared some degree of sociopolitical alliance with larger mainland centres (Berdan 1978:197). With long-distance trade of elite goods exchanged at fixed prices by foreign elite groups or representatives thereof, port-of-trade models should also restrict the access to exotic goods by non-elites, thus rendering any regional distribution of exotic items very difficult (Polanyi et al. 1957; McKillop 1987, 1989, 1996). The fact that significant amounts of 'exotic' materials - those that possess social or ritual significance, economic value, and/or are difficult to access based on environmental distribution, primarily distance from the source (see Graham 1987a)- are not restricted to elite contexts at large inland centres, and that exotics have been recovered from other than elite contexts at numerous sites of varying size throughout the lowlands also demonstrates the inapplicability of the 'port-of-trade model' (Hammond 1975; Rice 1984; Rice et al. 1985; Sidrys 1977; see Vail 1988). Furthermore, these much more 'historic' models that were heavily reliant upon documentary sources have proven extremely difficult to identify archaeologically (Chapman 1957).

Middle-man and 'transshipment point' models:

Still others (Graham 1987a; Hammond 1972, 1976; Healy et al. 1984; McKillop 1987, 1995b, 1996; Rathje et al. 1978; Rovner 1976; Sheets 1978b; Sidrys 1977, 1979) have suggested that Maya exchange of exotic, long-distance trade goods may have been much less rigidly bound in terms of social or political commitments. By incorporating the notion of 'rational choice', the coastal Maya may have increased the potential for acquiring greater amounts of goods for regional systems than previously seen in 'down-the-line' or 'port-of-trade' models. The analysis of artifact material from Wild Cane Cay suggested the possibility that this location was dually employed as a long-distance way station and as the regional distributor for exotic goods along the southern coast of Belize (McKillop 1996). Freidel (1981; Sabloff and Freidel 1975:378-379, 402) believes that coastal shrines and/or pilgrimage fairs, such as those documented ethnohistorically at Cozumel, may have further contributed to increasing the volume of trade through increased numbers of exchange participants in Maya trading networks by combining economic activities with ritual events. With more political independence, greater control over the economic transactions that occurred in its port, no specific relationship to, and minimal dependency on any larger inland centre, Wild Cane Cay likely served as a 'coastal transshipment port' or 'transshipment point' for the off-loading of exotic goods for local distribution and the on-loading of locally supplied or produced goods for long-distance trade (Andrews 1991:165-166; Andrews et al. 1986; Guderjan 1995a:7; McKillop 1996). Such sites are described by Andrews (1991:165; see Hammond 1972,

1976) as "... nodes not only for coastal trade, but also as points from which long-distance goods were diverted to inland communities". Other transshipment ports suggested by Guderjan (1995a:7) include: Isla Cerritos, Ecab, El Meco, Cancun, Xcaret, Tulum/Tancah, Moho Cay, Point Placencia, and Ambergris Caye (Guderjan et al. 1988, 1989; see Andrews et al. 1986). Unlike Wild Cane Cay, most of these coastal sites fostered stronger sociopolitical and socioeconomic relationships with at least one primary inland site. The strength of these relationships and the independence of the coastal sites undoubtedly varied based on the types of involvement between mainland and coast.

Marine-based Subsistence and Coastal Trade

Marine resources:

The economies of Marco Gonzalez and San Pedro primarily combined a marine-based subsistence adaptation (Andrews 1991:162) with participation in both the regional economic systems focused at large inland Maya centres in Northern Belize and in the long-distance coastal trade network. Due in part to their poor agricultural potential, the economic activities documented at Marco Gonzalez and San Pedro reflect Hamblin's (1984:47; see Scholes and Roys 1948:170-171) statement that "... the chief occupations along the coast were said to be fishing, salt-gathering, and commerce". Ample evidence for reliance on marine resources for local subsistence needs is provided by the faunal remains recovered from Marco Gonzalez [see Chapter 13] and artifacts such as notched ceramic and stone net weights and pumice floats (Boxt 1984:12; Emery 1990:51; Graham 1994:305, 309; Hamblin 1984:41-42; McKillop 1984; Pohl 1976; Rubio B. 1985:53-54; Vail 1988:66). Lange (1971) has noted that marine resources were a substantial part of the diet of inhabitants of coastal and off-shore sites. Whether these marine products, such as salted fish, and/or other marine by-products, were used as trade goods with other inland communities is a much more difficult question to answer. Lange's (1971) suggestion that the ancient Maya at inland sites may have been partially supported by imported marine foodstuffs contributes to the belief that regional trade for seafood was an important factor in the economic relationship between coastal/supply sites and inland/demand sites. Furthermore, Graham (1994:330) notes:

> The locations of offshore cays make it reasonable to assume that much of the processing of fish and shellfish was carried out at the cays before the catch was brought inland. The circumstances in which the offshore cays and atolls might have served as trade stations would of necessity have been very special ones, and if such circumstances did arise they probably involved trade in processed fish and shellfish.

This need for additional food sources by large mainland centres may have provided the impetus for long-term reliance on exchange relationships with otherwise lower status/level, smaller sites like Marco Gonzalez and San Pedro. However, archaeological evidence supporting this hypothesis is rather ephemeral. Due to poor preservation of organic materials such as bone in the tropics, and research strategies that have primarily focused on monumental architecture, there is relatively little archaeological evidence of ancient Maya diet (McKillop 1995b; N. Stanchly, pers. comm. 1998; but see Powis et al. 1999).

Evidence for the importance of marine food resources at inland sites has been reported from Altun Ha, Cahal Pech, Colha, Dzibilchaltun, Lamanai, and Lubaantun (Emery 1990:95; McKillop 1984, 1985; Pendergast 1979:7; Powis et al. 1999; Scott 1982; Wing 1975a, 1977; Wing and Steadman 1980). The marine fish remains from Lubaantun include those from reef and deep-water species such as parrotfish, frigate mackerel, tuna and shark (Wing and Hammond 1974), while all of the identifiable fish remains from

Early Postclassic Colha were represented by 13 marine species (Scott 1982: 203-205). The marine fish remains from Cahal Pech included parrotfish, grouper and *Lutjanidae* (Powis et al. 1999). The limited amount of seafood remains at sites such as Tipu (Graham 1991), combined with isotopic studies of human skeletal remains at sites such as Lamanai (White and Schwarcz 1989) and Tikal (Rice 1978), however, suggest that use of these resources at inland centres may have been restricted to small amounts. Based on the isotopic studies, some believe these small quantities of seafood may have been consumed exclusively by the elites (see McKillop 1995b:219). Osteological evidence for sharks and rays is reported from Lamanai and Tipu (Emery 1990:186, Appendix A). In most instances, marine by-products imported to inland sites were restricted to elite or ceremonial contexts (McKillop 1994b; MacKinnon and Kepecs 1991; Pohl 1983; Rice 1978; Valdez and Mock 1991; White and Schwarcz 1989).

Graham (1989:152; 1994:254) believes that faunal evidence for the export of marine resources to inland centres, such as the split tuna vertebrae from Colson Point along the central coast of Belize, could potentially contribute to the determination of the importance of exchange for marine foodstuffs by inland sites. The split vertebrae, interpreted as evidence for drying of fish, have as yet not been recovered from any inland sites, therefore making it difficult to prove the existence of exchange of salted or dried fish.

Nevertheless, additional evidence supporting the need to preserve fish is provided by Emery (1990:50): "Trade of maritime resources is hampered by rapid deterioration in the heat, and it is most likely that species traded in from the coastlines would have been dried or salted prior to travel" and Hamblin (1984:47): "That fishing was an important industry in aboriginal Yucatan is emphasized by Landa, who reported that the catch was salted, dried in the sun, or roasted, depending on the type of fish, and traded over considerable distances (Tozzer 1941:190)". Vail (1988:114) has noted that, in addition to salting or drying fish, "... some fish (and shellfish) were filleted before transporting. If this were the case, no evidence of this trade would be preserved in the archaeological record". Based on the recovery of faunal evidence for marine fish species from Cahal Pech in the Cayo District of Belize which is about 100 km west of the coast and the recovery of other marine remains from inland sites, Powis et al. (1999:374) concur that the Maya preserved fish through drying or possibly smoking processes. Hamblin (1984:19) has suggested that fish drying or preservation might be deduced from the absence of skull bones at sites, since heads are usually removed during these preservation techniques. However, the recovery of marine fish skulls has led researchers at Cahal Pech to conclude that fish were being transported whole (Powis et al. 1999:368). It is likely these fish were gutted to prevent spoilage and then preserved.

In response to some of the previous statements, N. Stanchly (pers. comms. 1998 and 2000) has documented the presence of thousands of fish bones from Lamanai. He is of the opinion that fish resources played a much more important role in the diet of the Maya at Lamanai than previously reported. Although the majority of the identified bones are from fresh-water species, a small percentage are from marine species such as jackfish (*Caranx* sp.). This research may provide better dietary data for the inhabitants of Lamanai than the isotopic research undertaken by White and Schwarcz (1989) and may prove that the elite were not the only segment of the population from inland sites to consume fish.

The presence of manatee remains at Marco Gonzalez suggests that hunting of this marine mammal was practiced by the Ambergris Caye inhabitants, much as it was by the

Moho Cay, Wild Cane Cay, and Colson Point Maya (Gann 1911:78; Graham 1994:255; Hammond 1981:181; Healy and McKillop 1980; McKillop 1984:25, 1985). The extent to which the hunting of manatee was incorporated into the exchange relationships between Marco Gonzalez and inland sites is difficult to determine. However, the recovery of a carved manatee rib from Altun Ha (Pendergast 1979, 1981b:10) indicates that these may have been important to the inhabitants of these sites.

In addition to manatee hunting, the inhabitants of Ambergris Caye may have been producers of dyes for trade. Guderjan (1988) has suggested that the Caribbean mud conch [*Melongena melongena*] may produce a purple dye similar to that produced by the Pacific species *Purputa patula* and that this dye was a potentially important trade item for ritual use because *Melongena melongena* shells are common artifacts recovered from numerous coastal sites. Vail (1988:114) cautioned that the presence of mud conch shells may simply be due to the fact that this species was popular in the Maya diet. The importance of some molluscs to the Maya may have also been for the fulfillment of religious ceremonies, based on their representation of the Earth, the Underworld and the realm of the dead (Rubio B. 1985:54; Thompson 1970:49) or use as musical instruments (Hamblin 1985:155; Tozzer 1941:49). The Underworld deity known as Mam [God N] is generally associated with a conch motif, while Underworld deity God G1 is often portrayed wearing thorny oysters over his ears (Moholy-Nagy 1985).

Regional and Long-distance Maya Trade on Ambergris Caye

Marine resources:

By supplying inland sites with fish and other marine foods and by-products such as shell tools, shell ornaments, shark's teeth, stingray spines (Vail 1988:114), dye (Guderjan

1988), and corals, the Maya from Marco Gonzalez and San Pedro may have been involved in a type of secondary specialization that Schwartz (1963:75) termed 'scrambling'. McAnany (1991:278) describes it as "... the production and exchange of items that are not, strictly speaking, fundamental to subsistence needs". Although the Maya from these sites were reliant upon marine products for their own subsistence needs, 'scrambling' would have been possible given a surplus in the marine foodstuffs and by-products collected. In this instance, excess food acquisition for exchange purposes would have been probable under the first 'scrambling' sub-type: "specialization based on microecological variation, such as proximity to sago swamps or rich fishing grounds" (McAnany 1991:278; see Schwartz 1963). According to Roys (1943:41), "fish have always been good and abundant in Yucatan waters, and the people of the coast devoted most of their energy to fishing, both for their own consumption and for sale to the inhabitants of the interior".

Salt:

In addition to supplying inland sites with seafoods and other marine by-products, trade in salt from sources along the coast of Belize (MacKinnon and Kepecs 1989; Graham and Pendergast 1989; McKillop 1995b) is known, and the need for salt by large inland populations for dietary purposes is well-recognized (Andrews 1983; Coe 1987). Some ethnohistoric evidence for trade in salt has been documented by Edwards (1978:206):

> The canoe seen by Sandoval near the Golfo Dulce entrance was carrying salt. This was a high bulk, relatively low cost cargo, probably not subject to frequent loading and unloading or passing through the hands of many traders. ... there may have been a fairly large number of relatively modest entrepreneurs engaged in lengthy carriage of the less glamorous and costly cargoes.

Based on the recovery of more than one metre of stratified layers of charcoal and pottery sherds representing thin, crudely manufactured and, poorly fired shallow bowls, it is believed the Classic period Marco Gonzalez inhabitants were engaged in the extraction of salt from sea water using the *sal cocida* method (Andrews 1983; Graham and Pendergast 1987:3, 1989:7; Pendergast and Graham 1987:40; Reina and Monaghan 1981:23-29). Such activities may have been practiced by the Caye Maya as part-time household industries to supplement local subsistence needs (Moholy-Nagy 1997:309; Santley and Kneebone 1993).

Middle-man and long-distance trade:

In addition to these primarily local resources, the location of these sites on the Caye almost certainly afforded them an intermediary role in the exchange of other long-distance trade goods such as obsidian, ceramics, jade and other foodstuffs being transported from producers to consumers along the coast. This location may have afforded the Maya a secondary specialization opportunity. Another 'scrambling' sub-type as defined by McAnany (1991:278; see Schwartz 1963) is: "... specialization of access practiced by settlements strategically located at points of exchange". There is evidence for a relationship not only with mainland Maya sites such as Lamanai, but also between Marco Gonzalez, San Pedro and population groups in Mexico. Evidence for social, political and economic interaction between Lamanai and Marco Gonzalez includes:

1. a locally and less skillfully carved peccary humerus recovered among human bones from a looter's pit at Structure 8 at Marco Gonzalez that was similar to a 15th century carved bone from Lamanai (Graham and Pendergast 1989:11; Pendergast 1981b:10).

2. Buk Phase ceramics at Postclassic Lamanai, similar to locally produced versions on the Caye (Graham 1987b; Graham and Pendergast 1989:11).

3. Chen Mul Modeled censers similar to those from Mayapan and variations from Lamanai (Graham and Pendergast 1989:13).

4. a Diving God bowl and fragments stylistically similar to vessels from Lamanai and Tipu dated to the Historic period (15th century AD) (Graham and Pendergast 1989:13).

5. partially excavated low platforms [Structures 46 and 47 from Marco Gonzalez], and several cleared but not excavated structures that share identical construction techniques with 15th century or later structures from Lamanai (Graham and Pendergast 1989:14).

Further evidence for a link between Lamanai and Marco Gonzalez and San Pedro may exist in the form of unique 'frog' burials. This burial practice involves the body being interred face down with its legs crossed or tied behind. Less concrete evidence for a Terminal Classic/ Early Postclassic relationship between Marco Gonzalez and Lamanai may exist with the recovery of Tohil Plumbate wares [early Buk phase] (late 10th to 11th centuries) from the Caye site and a single sherd from the mainland centre (E. Graham pers. comm. 1998). Interestingly, the presence of quartz-based sand in the temper of some locally-produced Late Classic Coconut Walk salt-mold pottery may also be evidence of a link to the mainland. According to S. Mazzullo (E. Graham, pers. comm. 1998), quartz sand is not local to Ambergris Caye and was brought from mainland Northern Belize to be used in the ceramics produced there.

Lithic evidence for trade relations with Mexico is based on the recovery of Pachuca green obsidian from Marco Gonzalez and San Pedro (Graham and Pendergast 1989:12; Pendergast 1990:176). Further evidence of Postclassic contact with population groups in the Yucatan is demonstrated by the recovery of ceramic vessels believed to be from Chichen Itza and other locally produced vessel forms that were copies of those produced by the Yucatecans (Pendergast and Graham 1990:4) from San Pedro and locally-produced Tulum-style ceramics (15th century) from Marco Gonzalez (Graham and Pendergast 1989:7, 14; Pendergast 1990:176).

Marco Gonzalez likely functioned as a middle-man in a larger coastal exchange network. This conclusion is based on its relationship with Lamanai, the lack of evidence for any type of craft production facilities beyond the needs of the local population [save salt production in the Classic period], the location of the site at the mouths of the Rio Hondo, the New River, and lagoon-river systems like the Northern River Lagoon, and its access to the Caribbean (Graham and Pendergast 1989:12; Pendergast 1990:176). However, the role of Marco Gonzalez in the trade relationship between Ambergris Caye, larger sites in Northern Belize, and those even further removed was not that of a 'port-of-trade' (Andrews 1991; Sabloff and Rathje 1975; Tourtellot and Sabloff 1972). Although, a port-of-trade facilitated the completion of exchanges and economic transactions in lieu of any institutionalized market system and provided fundamental food and raw material resources for its inhabitants, Marco Gonzalez not only lacked evidence of market places or storage facilities (see Sabloff and Freidel 1975:371 for Cozumel) but presents no evidence that its population exceeded the local food production potential of the Caye. Much like Cozumel, however, Marco Gonzalez and San Pedro were forced to import lithic raw material because of the lack of stone sources on the Caye and some foodstuffs such as maize flour. Due to the strong evidence that Marco Gonzalez was affiliated with the larger centre of Lamanai, primarily in the Postclassic and Historic periods, and the fact that it was involved in the regional exchange systems of Northern Belize and the long-distance trade routes throughout the Maya territories, it seems more likely this site served as a 'transshipment point' for exotic materials such as black, gray and green obsidians, ceramics and jades (see Graham 1987a:762 for association of 'long-distance trade' with 'elite or prestigious goods'). Marco Gonzalez may have served as a transshipment point for the export of regional products manufactured in Northern Belize and the import of long-distance trade goods such as obsidian, much like Preclassic Cerros (Garber 1981:244; Vail 1988:22).

Marco Gonzalez: Coastal port:

Marco Gonzalez likely served as a 'coastal transshipment port' (Andrews 1991:166) for mainland sites such as Lamanai through the Postclassic period (Graham and Pendergast 1989; Pendergast 1981a). Although there is solid evidence for Marco Gonzalez's role as a 'transshipment port', it is not known for certain whether the trade contacts were direct or indirect through other intermediary sites. Graham and Pendergast (1989:15) suggest that the previously noted similarity in artifact remains between Marco Gonzalez and Lamanai is a strong indicator of an important economic, and possibly sociopolitical, bond between them. It is possible that San Pedro may have also played a role in the trade and exchange of goods in the Postclassic, however, I believe it acted in consort with Marco Gonzalez.

Marco Gonzalez is geographically well-situated to act as a transshipment point and trading seaport for an inland centre such as Lamanai (Hammond 1972, 1976; Andrews 1991) and the volume of exotic trade goods recovered from this small site is significant, but not as overwhelming as might be expected. This fact may serve to strengthen the argument that most of the exotic material that did arrive on the southern end of Ambergris Caye was quickly transported to the mainland. Nonetheless, Graham (1989:152) believes that there has not been sufficient excavation at Marco Gonzalez to determine whether jade and obsidian were used for internal circulation by the elite Maya of Ambergris Caye or were a product of redistributive functions at a large inland centre such as Lamanai.

The original position of Marco Gonzalez on the windward side of the Caye and the fact that it is believed to have possessed a harbour made it an ideal location for a transshipment point (see Sabloff and Freidel 1975:376 for Cozumel; see McKillop 1996:54 for Wild Cane Cay). It is possible that Marco Gonzalez was accessible from the sea on both the windward and leeward sides, however, due to beachfront accumulation over time, water access from the windward side no longer became possible (E. Graham, pers. comm. 2000). Furthermore, it is often difficult to identify Maya coastal or maritime trade archaeologically due to the fact that such trade did not necessitate any specific structures to service trading canoes or for the storage of exchange goods. Furthermore determination of the adequacy of a location for trade may be hampered by landscape modifications due to sea-level changes, the intrusion of mangrove vegetation and the effects of hurricanes (Mock 1997:167). Such modifications can result in the inundation of sites such as Moho Cay, Cerros, and sites on Ambergris Caye [Marco Gonzalez, San Juan and Yalamha] (Dunn and Mazzullo 1993; Graham and Pendergast 1989; Guderjan 1988; Scarborough 1991), and render the reconstruction of original coastline or harbour modifications by the Maya extremely difficult.

The Economics of Lithic Production, Consumption and Exchange: Evidence from Marco Gonzalez and San Pedro

<u>Stone tool production in Northern Belize:</u>

Given what is known about the subsistence base at the southern sites on Ambergris Caye and their likely role in local, regional and long-distance exchange networks, what remains to be determined is the nature of stone tool exchange between the production site of Colha and the consumers at Marco Gonzalez and San Pedro. The 'chert-bearing zone' tool workshops based at Colha in the Orange Walk District of Belize included production, distribution, and consumption components. All of these different components, or stages in the economic system, occupied specific positions in the overall operation of a large lithic trade network in Northern Belize. The stone tool industry at Colha was embedded not only in an economic system, but was tightly bound in intricately interconnected Mayan political and social systems (D'Altroy and Earle 1985; McAnany 1989a, 1993a, 1993b; Marcus 1983; Potter 1993; Trigger 1974) and was constrained by its surrounding environment (Arnold 1975; Graham 1987a; Rice 1981). Accordingly, I concur with Potter (1993:278) that:

> … the patchy distribution and variable quality of lowland cherts acted as 'limiting factors' in Lowland Maya lithics economics. While we do not at present fully understand how Late Classic Maya economic systems were organized …, it is clear that lithic economies were conditioned in part by local and regional factors of demand, access, control, and utilization of lithic resources and lithic production.

The key processes involved in the organization of lithic production at this site included the natural distribution of raw materials in the chert-bearing zone, the nature of the technology itself, the demand for finished products, and the skill and training of the craftspeople (Costin 1991:2; Michaels 1989; Potter 1993:283; Yerkes and Kardulias 1993:108-109; van der Leeuw 1977; see Torrence 1981). The craftspeople at Colha must be considered lithic specialists based on the volume of manufacturing debitage at the workshops (Gibson 1986; Hester and Shafer 1984; Masson 1989; Roemer 1991:64; Shafer and Hester 1983, 1991). In addition, the majority of the lithic tools used in Northern Belize at sites such as Cerros, Cuello, El Pozito, Kichpanha, Lamanai, the

Pulltrouser Swamp complex, San Estevan, Santa Rita, Altun Ha, Laguna de On, and Ambergris Caye (Dockall and Shafer 1993; Pendergast 1979, 1982; Hester 1985; Hult and Hester 1995; Lewenstein 1987, McAnany 1986, 1989b, 1991; McSwain 1989, 1991b; Masson 1993, 1997; Mitchum 1986, 1991, 1994, Shafer 1982, 1983) were manufactured from 'chert-bearing zone' chert and adhered to the well-recognized, standardized formal tool morphologies from their workshops. Because such a broad region was consuming this homogeneous product, this is considered good evidence for concentrated production (Costin 1991:42; Roemer 1991:64; Torrence 1981). At Colha, there was other microcontextual evidence of workshops including tool production residues such as reduction debitage, preforms, tools broken at various stages of manufacture, and exhausted production implements such as hammerstones, antler billets, and edge abraders (Hester and Shafer 1991b:156, Fig.1; Shafer and Hester 1983:523, 535; see Mallory 1986). Furthermore, technological evidence of production efficiency, production standardization, low rates of errors in the manufacturing process, standard techniques for recovering from errors, and standardized tool kits were also observed at the Colha workshops (Michaels 1989; Roemer 1982, 1991:64; Shafer 1982:32-34; Yerkes and Kardulias 1993:108-109).

Stone tool consumption and exchange at Marco Gonzalez and San Pedro:

Almost all the criteria that identify Colha as a stone tool production centre are absent from Marco Gonzalez and San Pedro. There are only two possible tool preforms, no tools broken during initial manufacture, no formal blade cores, no macroflake blanks, few flake cores, and few cortical or primary cortex flakes; an assemblage pattern similar to other consumer sites [sites that had no direct access to lithic resources (Potter 1993:281)] such as Cerros (Mitchum 1986, 1991) and Pulltrouser Swamp (Shafer 1983; McAnany 1986, 1989a, 1989b). It has been noted that the paucity of cores or large nodules of chert and cortical flakes at Marco Gonzalez and San Pedro is not definitive evidence against these sites as production locales, given the primary reduction of cores at quarry locations (McSwain 1991a:346; Potter 1982:113, 117; Shafer and Hester 1983:521). However, McAnany (1986:231) has suggested that the ratio of flakes to cores at a site may be used as a gross indicator of the degree of primary reduction, with a low ratio being indicative of a primary assemblage in which there are few flakes compared to the number of cores. At sites such as Pulltrouser Swamp and Santa Rita Corozal, the Colha chert flake: core ratios were 46:1 and 74:1, indicating that the Colha chert assemblages at these sites were not produced by early stage reduction (Dockall and Shafer 1993:170). At Marco Gonzalez, the unretouched CBZ chert flake: whole core ratio was 221:1, while the unretouched CBZ chert flake: whole core and core fragments ratio was 39:1. At San Pedro, the unretouched CBZ chert flake: whole core ratio was 144:1, while the unretouched CBZ chert flake: whole core and core fragments ratio was 21:1. The problem with using the number of core fragments in this equation is that one fragment does not necessarily correspond to a single core and core fragments that were similar in stone colour and texture could not be properly refitted due to the amount of modification. Based on the data calculated above, there appears to be little support for early stage reduction at Marco Gonzalez or San Pedro.

Another method for determining whether a site is producing its own tools or importing tools for consumption focuses on the percentage of non-cortical lithic debitage recovered which is determined by the amount of cortex on the exterior surface of a flake. Consumer sites should possess high percentages of non-cortical debitage as flakes with substantial cortical covering are generally associated with the earlier or primary stages of tool production (McAnany 1986:226-227; Dockall and Shafer 1993). Most tools from consumer sites in Northern Belize adhere to this trend.

Table 6: Percentage of Non-Cortical Debitage from Consumer Sites in Northern Belize

Site	Percentage of Non-cortical Debitage	Reference
Pulltrouser Swamp	89	McAnany 1986
Santa Rita Corozal	71.7	Dockall and Shafer 1993
Northern Ambergris Caye [Ek Luum, Chac Balaam, San Juan]	86	Hult and Hester 1995
Laguna de On	72.8	Masson 1993
Marco Gonzalez	71.4	Stemp (thesis) 2000
San Pedro	70.7	Stemp (thesis) 2000

The lower percentages of non-cortical debitage from all the lithic raw materials at Laguna de On and Marco Gonzalez and San Pedro have two likely explanations. First, at Laguna de On there is good evidence for the production of formal tools from locally available raw materials such as lower-quality mainland cherts and chalcedonies (Masson 1993; Oland 1999a). This may account for some of the cortical material recovered at the site. Second, substantial occupations from these sites date to the Middle Postclassic or later when tool production at Colha was beginning to decline and finally cease in the Late Postclassic. In reaction to this occurrence, Marco Gonzalez occupations from the Middle Postclassic through to the Late Postclassic revealed increases in cortical debitage, especially with regard to other cherts. A similar pattern is observed at San Pedro in the occupations dated to the Late Postclassic/Historic periods. It is believed that an increased reliance on locally manufactured simple flakes and flake tools from cherts brought back to Ambergris Caye from mainland sources is partially responsible for this increase. Many of the other consumer sites in Northern Belize with higher percentages of non-cortical debitage were not substantially occupied in these later periods.

Further evidence suggesting that biface manufacture was not performed at the Caye sites is provided by my experimental large biface production data (see Table 7) and is supported by data from an experiment by Cox and Ricklis (1999) at Blue Creek. I found that the reduction of a single chert core to produce a general utility biface created a substantial amount of lithic debris in the form of whole and fragmentary cortical and non-cortical simple and bifacial thinning flakes. The amount of lithic material created through the experimental production of one biface would constitute a substantial portion of all the flakes recovered from both sites and is far in excess of the flake types to bifaces and fragments ratio from Marco Gonzalez. Although it can be argued that bifaces manufactured from macroflakes would produce less debris, specifically cortical flakes, the percentage of biface production by-products would still be high compared to the mass of raw material recovered at the Caye sites. It must be noted that all of the chert flakes and fragments recovered from Marco Gonzalez and San Pedro were used in the calculations, whereas none of the biface fragments were included. If we logically assume that a portion of the flakes recovered during excavations were the result of *ad hoc* core reduction to produce simple flakes and were not involved in biface production, and that the number of bifaces at the site, as represented by the large biface fragments, was actually higher than the number of whole tools used for the calculations, the ratio of flakes to bifaces presented below would be even lower. Based on the low numbers at Marco Gonzalez, I believe bifaces were not produced at the site.

Table 7: Experimental Manufacture of Bifaces and Produced Debris

* The estimated debris ratio from Marco Gonzalez is calculated in terms of the total number of cortical and non-cortical flakes and blocky fragments recovered from the site divided by the total number of large whole bifaces (i.e. - for each biface there were 0.1 primary flakes = a ratio of 1 biface: 0.1 primary flakes)

	Experimental Proximally-contracting biface (Cox and Ricklis 1999)	**Experimental General-utility biface**	**Estimated debris ratio [large whole bifaces: whole simple and bifacial thinning flake types] from Marco Gonzalez***
Original core dimensions (cm)	14x12x5	16.2x13.2x8 (rectangular core)	NA
Biface dimensions (cm)	10.5x6x4.4	9.9x6.8x5.8	NA
Primary flakes	5 (7%)	6 (8%)	0.1 (0.3%)
Secondary (3) flakes	24 (34%) [secondary 2 & 3 combined]	11 (14%)	1 (2.6%)
Secondary (2) flakes		18 (23%)	9.8 (25.4%)
Tertiary flakes	42 (56%)	45 (56%)	27.7 (71.8%)
Blocky fragments	4	7	15.9
Flake fragments	33	29 (13 cortical)	43.5 (12.7 cortical)

Furthermore, because there does not appear to be any standardized method of reshaping tools, and there is ample evidence for hinge and step terminated flakes and flake scars on tools, the Maya at these sites demonstrated a relatively low level of skill in stone tool production or repair (Costin 1991:32). This strengthens the conclusion that CBZ tools were acquired in finished form by the inhabitants of these sites and were not primarily being manufactured at either Marco Gonzalez or San Pedro. McSwain (1991a:349, see McAnany 1986:266-267) suggests that the source of Colha's power or wealth lay not solely in the access to raw material itself, but instead, in the restricted access to the technical skill required by flintknappers to produce tools such as the large oval bifaces and tranchet-bit adzes such as that described for 'partially commercialized' exchange systems (Torrence 1986:84). Because stone tools were provided in finished form, inhabitants of consumer sites may have lost the manufacturing skills required to maintain and refurbish them locally (McAnany 1991:280).

Given the lack of a chert source on the cayes, the relative proximity of the Colha workshops and the lack of manufacturing evidence on the southern end of the Caye, it is clear that trade for finished lithic products was the primary method of stone tool acquisition for the inhabitants of Marco Gonzalez and San Pedro. Nevertheless, a relatively small amount of CBZ chert and chert from other sources that arrived on the Caye was reduced into flakes and cores for opportunistic/expedient use. Although, it remains difficult to accurately identify what goods were offered by these Maya populations in exchange for lithic tools, the evidence presented above suggests that probable trade goods included rare marine resources such as shells, shark's teeth, stingray spines, and corals, foodstuffs such as fish and shellfish, and, at least in the Classic period, salt (Graham 1989:150, Pendergast and Graham 1987:39). The producer-consumer relationship between Marco Gonzalez and Colha during the Classic period (6^{th} -7^{th} century AD) may have been similar to that proposed for Northern River Lagoon (NRL) and Colha in the Late to Terminal Classic. During this time, Mock (1997:165) has suggested the exchange of salt, salted fish, and other marine resources for stone tools at Northern River Lagoon.

Whereas Mock (1997:165, Valdez and Mock 1991) has argued for "... sudden shifts in settlement or economic strategies to peripheral coastal communities such as NRL during the Late to Terminal Classic period ... precipitated by an imbalance between population and resources, environmental deterioration, and the breakdown of the socioeconomic and political matrix of many inland communities", there is evidence for occupation at Marco Gonzalez as early as the Late Preclassic and at San Pedro at least as early as the Late Classic (Graham 1989; Graham and Pendergast 1989; Pendergast and Graham 1987). The reasons for initial settlement of these sites were different from those proposed for a site such as NRL as these towns likely existed as marine-based subsistence communities with certain ties to exchange networks far earlier than the Terminal Classic. Nevertheless, the importance of Marco Gonzalez and perhaps San Pedro as trading locations in the overall exchange network during later periods may have increased due to economic associations with inland sites such as Lamanai (Graham and Pendergast 1989:13-14; Pendergast 1990:176; 1993b:112).

The possibility that Marco Gonzalez was a transshipment point for chert tools from Colha to other sites further afield in the same manner that it served as a way station for other more valuable or exotic materials flowing inland from the coast or that it manufactured tools for export is not supported by the lithic evidence at this site. As yet no communal disposal areas of lithic debris indicative of specialist production are known (Arnold et al. 1993: 184). Although it has been argued that such waste dumps might not exist in the archaeological record because the Maya often moved their garbage into areas of 'secondary context' based on its perceived value, the hazard it posed and the principle of the least effort for disposal (Clark 1991b:72; Hayden and Cannon 1983:117; Moholy-Nagy 1997:309), other evidence supports this hypothesis. The few tools recovered and the heavy use and recycling of these tools at Marco Gonzalez and San Pedro, all indicate that the supply of these artifacts was restricted to local use (see Mitchum 1991). The volume of stone recovered from these sites is far below that of a production centre. Much like other sites within Colha's interaction sphere in Northern Belize (McAnany 1989a, 1989b, 1993a; Santone 1997), the inhabitants of Marco Gonzalez were strictly consumers of chert tools.

The control and organization of lithic craft-specialization in Northern Belize:

Based on excavations and surface collections at Colha, Kunahmul (also known as New Boston or Canton farm), Chicawate (or Rockstone Pond road No. 2), Maskall, Kichpanha and Sand Hill (Hester 1982; Shafer 1982; Shafer and Hester 1983:534, 1991; Shafer et al. 1980), lithic raw material from the 'chert-bearing zone' of Northern Belize was heavily exploited from roughly 1000 BC to roughly AD 1300 for the production of both blade and biface tools, with the first 'industrial-level' mass production beginning circa 300 BC (Shafer and Hester 1983:519). Shafer (1991:31) has suggested that lithic production at Colha experienced a change from "... an individualized and cottage-level industry ..." in the Middle Preclassic "... to more of a community-wide lineage guild craft specialization..." in the Late Preclassic. Because of ethnographic similarities to New Guinea stone axe-makers, Shafer and Hester (1991) suggest that the control of CBZ formal tools at Colha in these early periods may have been in the hands of the craftspeople themselves. At this time, it is believed that Colha served as the independent lithic producer in Northern Belize. The workshops increased in production output as demand grew. As important centres of powerful elites evolved in Northern Belize, the regional monopoly of tool production at Colha likely fell under the control of more powerful sites. Shafer (1982:180; Potter 1993:284; Shafer and Hester 1983:532-534) believes that the small but extremely wealthy site of Altun Ha controlled Colha in the Late Classic period. Although exactly how the specialized lithic craft industry centered around family units at Colha was administrated is not known, it has been suggested that the partially commercialized-administered solar system defined by C. Smith (1976) is a possibility. During the Late and Terminal Classic at Colha, two types of lithic exchange systems may have existed; the exchange of primarily intercommunity utilitarian lithic tools, and trade in higher status or elite stone tools such as the stemmed macroblade (Hester and Shafer 1994:52). In the Late Classic, other lithic production centres also appeared throughout the 'chert-bearing zone', including Chicawate, Kichpanha, Kunahmul, Maskall and Sand Hill (Gibson 1986:63; Shafer and Hester 1991). During the Early Postclassic, Michaels (1989:176-177) has posited that Colha existed as a production hamlet under the control of a larger 'political entity' like Lamanai or Nohmul. In addition to this relationship, the establishment of new marine and riverine trade routes in the Early Postclassic period and the formation of new, temporary redistributive 'cartels' (Freidel 1986), permitted Colha to engage in the trade of lithics throughout its northern distribution sphere of the Maya Lowlands. Undoubtedly, many of the lithic consumers throughout Northern Belize had difficulty acquiring tools due to the cessation of tool production at Colha in the Late Postclassic and Historic periods. According to Tom Hester (pers. comm. 1999):

> There was no occupation at Colha during the Late Postclassic or the Historic Maya eras. We find a few typical triangular side/base notched Late Postclassic arrow points, and at Op. 2012, pilgrimages to burn and smash incensarios of Late Postclassic date. In the Early and Middle Postclassic, there is major lithic production at Colha, albeit at a much smaller scale than earlier times. The workshop debris is usually mixed with household debris, rather than solely in workshops as in the Classic and Late Preclassic. The Early and Middle Postclassic populations represent intrusive populations, with different diets, settlement patterns, pottery, lithic technology, etc. Early Postclassic dart points are side notched, per those at Chichen Itza; Middle Postclassic dart points are lozenge/bipointed, and are found at Ambergris, Lamanai, Chau Hiix, Honey Camp (Laguna de On). Curiously, the Early/Middle Postclassic knappers also imported chalcedony to Colha

though local cherts were also used. ... in short, there are no Late Postclassic/Historic lithic workshops at Colha...nor anywhere else in N. Belize that I have ever heard of. ...it was back to household production...given the ease with which the Late Postcl[assic] arrowpoints could be made.

The inability to access the same finished tools from Colha likely forced the Ambergris Caye Maya to conserve their formal tools as long as possible and to possibly adopt a much more informal tool technology than before.

Lithic Exchange in Northern Belize

<u>Local and utilitarian vs. long-distance and prestige goods:</u>

The trade of chert tools in Northern Belize was dominated by one main source throughout most of the occupation of Marco Gonzalez, and was primarily regional and local exchange. Because of the volume of raw material recovered, and because this raw material was primarily, but not exclusively [i.e. eccentrics (Iannone 1993; Iannone and Conlon 1993; Pendergast 1979], traded as a utilitarian commodity, many of the existing long-distance exchange models developed for the Maya region do not accurately explain the unique trade situation that existed at Marco Gonzalez and San Pedro (Cowgill 1993; Freidel 1979; Marcus 1983; Rathje 1971; Sluyter 1993; Tourtellot and Sabloff 1972; Sidrys 1977; Zeitlin 1982:261).

Specifically, the chert formal tools from mainland workshops were products of a certain technological complexity, manufactured by skilled craftspeople (Brumfiel and Earle 1987; Costin 1991; Peregrine 1991), although they were not considered wealth/ prestige goods or luxury items as were jade, greenstone, green obsidian, haematite, decorated ceramics, seashells and stingray spines. With the exception of chert eccentrics and possibly stemmed macroblades, they did not, in effect, possess 'political currency' for

Maya elites (Hester and Shafer 1994; McAnany 1993a, 1993b; Shafer and Hester 1991). Therefore, they were not used in the same manner as wealth/ prestige goods in establishing and maintaining political power, legitimizing social status, or reinforcing social obligations, and were not viewed as fundamental components in competitive consumption (Blanton et al. 1996; Brumfiel 1987; Brumfiel and Earle 1987; Hayden 1998; Hendon 1991; Hirth 1992; Hodder 1982; LeCount 1999; McAnany 1993b; Peregrine 1991; Smith 1976). Consequently, elite control of the local and intraregional exchange in formal lithics and the mechanisms involved in lithics trade were likely quite different from those established for interregional long-distance trade of the much more valuable goods.

Comparatively shorter distance trade for locally consumed, utilitarian chert tools may have been less dependent on sociopolitical relationships. Perhaps local and intraregional trade for utilitarian wares and foodstuffs was much more economically driven within the social systems already established by trade partners. This could account, at least in part, for some degrees of autonomous production in lower levels of the Maya economy. Although superior economic returns may have been achieved through the implementation of social transactions, they were not completely reliant upon them. In this respect, an economic relationship between the Caye population and the mainland probably depended, at least partially, on some level of sociopolitical integration between the two parties. This takes into consideration some degree of elite involvement in stone tool production and exchange (Freidel 1981), but strays away from a formalized system of direct control and vertical obligation to the elite concentrated on utilitarian goods (see McAnany 1993b:67). This is likely due to the fact that the social power of the elite lay not specifically in the economic value of certain 'prestige' objects, but instead on their symbolic value and their necessity in ritual performance (see above).

The strength of the exchange network in terms of the number and/or level of communities involved and access to goods flowing through it may have increased the participation of the offshore Maya in the overall social and political environment of this northern region, even though they were physically more isolated from the production centre at Colha or the larger political or ceremonial centres such as Altun Ha and Lamanai. For the Caye Maya, access to stone tools was one motivating factor, while the mainland Maya required marine foodstuffs and salt for consumption, dyes, stingray spines, and shark teeth for ritual purposes, and use of the port or harbour facilities to access long-distance trade goods. For both coastal and mainland Maya, the need to secure access to products or raw materials that were limited or inaccessible in their own local environment may have solidified their non-economic contact with others, thus creating an unevenly balanced system of economic dependency within a larger social framework.

I find this reconstruction of stone tool exchange between Marco Gonzalez, San Pedro and the mainland plausible in light of McKillop's (1996:52) statement:

> Implicitly, at least, many Maya researchers now tend to perceive that the ancient Maya economy worked under similar principles as modern society. Specifically, the ancient Maya were reacting to forces of supply and demand, based on the concepts of rational choice, scarcity, and maximization, even without a modern, market place economy.

Due to this independent and adaptable nature for Marco Gonzalez and the fact that the site was well-placed to supply a community such as Lamanai, lithic trade and exchange may have occurred in a much more occasional, informal or *ad hoc* system when trading canoes would arrive on the Caye. Such transactions may have also included variations of reciprocal exchange on a reduced scale compared to larger market or exchange locations at the larger centres on the mainland. McAnany (1986) suggests that a barter-based system may have been used to circulate goods such as lithics.

Stone tool transport and exchange:

Whereas the exchange of finished tools from Colha is an undeniable fact in the reconstruction of the trade relations for the Ambergris Caye communities, the exact nature of tool transport and exchange locations is not as clear. It is not known in this instance who moved to either supply or acquire the lithic tools, whether the transactions necessary for trade were initiated by the supplier of the tools directly or if the Ambergris Caye dwellers retrieved the tools they needed from the workshops themselves or indirectly through another party or parties. This exchange may also have been affected by other factors such as seasonality of exchanged marine products.

Although the water-based trade routes established for obsidian exchange in the Maya Lowlands (Hammond 1972, 1976, 1981; Dreiss 1988:92-93; Healy et al. 1984; see Drennan 1984a, 1984b) demonstrate the importance of transport of any trade goods by canoe (Thompson 1951) and the restrictions on transport to and from the off-shore locations, the exact mechanisms of transport, the economic and/or social value of goods, and the routes that have been proposed for long-distance trade do not necessarily reflect the same trade situation as that between Marco Gonzalez and the chert workshops at Colha (Lewenstein 1987:24, Santone 1997, see Graham 1987a, Sluyter 1993). For example, whereas the obsidian blade network encompassed 87,000 square kilometres, the size of Colha's chert tool network was less than 3,000 square kilometres (McAnany 1991:286, Table 2).

CHAPTER 11

Use-wear Analysis: History and Background

Techniques for the Determination of Lithic Tool Function

Archaeologists have employed a number of techniques to determine the function of lithic tools recovered from their excavations, including: ethnographic analogy, experiments, microwear analysis, residue analysis, and quantification of microwear (Kimball et al. 1995:6, Vaughan 1981).

Ethnographic analogy:

The earliest systematic attempt at a classification of stone tools using functional attribution through analogy with ethnographic and metal implements was undertaken by Nilsson (1838) (Olausson 1980:48; Vaughan 1981:6; 1985:3). This attempt to determine lithic functions employed what can be referred to as the 'speculative functional approach', which proved to be one of the most common ways of extrapolating tool use in the late 19th and early 20th centuries (Hayden and Kamminga 1979:3). Essentially, it was a "... method of assigning 'functional' names and qualities to prehistoric stone tools [and] was basically that of untested analogy to known uses of similarly shaped tools" (Vaughan 1981:7). Early practitioners of such functional analogy included: Boucher de Perthes (1847-1864), Lartet and Christy (1864), Lubbock (1872), Evans (1872), and Pfeiffer (1912, 1920). Despite the advances in lithic analysis, in particular Semenov's (1964) contribution (see below), more recent uses of this non-experimental approach were incorporated into the work of Bordes (1950, 1961), Tixier (1963), Sankalia (1964), Mauser (1965), Binford and Binford (1966), Hole and Flannery (1967:262-264), S.

Binford (1968), Hole et al. (1969:76), Bordaz (1970), L. Binford (1973), Braidwood (1975), and Brézillon (1977) (Vaughan 1981, 1985).

Experiments:

The incorporation of experimental studies in the determination of tool function took two main forms. 'Efficiency studies' tested stone tools with the intention of determining their ability to perform certain function(s) based, primarily, on tool morphology (Rau 1869; Evans 1872; Leguay 1877; Knowles 1880; Smith 1892; Muller 1903; Pope 1923; Moir 1926; Sandkleff 1934; Cox 1936; Over 1937; Ray 1937; Browne 1940; Steensberg 1943; Clark and Thompson 1953; Woodbury 1954; Iversen 1956; Nero 1957; Harlan 1967). 'Direct verification', in which only a minimal number of tests were performed in order to accept or reject hypothesized function(s) for a certain stone tool type, based primarily on the comparison of the use-wear patterns on the experimental and archaeological implements was also employed (Spurrell 1884, 1892; Quente 1914; Vayson 1919; Martin 1923; Patte 1927; Curwen 1930, 1935; Barnes 1932; Nero 1948; Verheyleweghen 1951; Witthoft 1955; Clark 1958; see Hayden and Kamminga 1979:2; Keeley 1974:329; Kimball et al. 1995:6; Tringham et al. 1974:171-172,175; Vaughan 1981:15-27, 1985:3-4; Yerkes and Kardulias 1993:100).

Microwear analysis:

1. Early practitioners:

True use-wear analysis began in the late 19th and early 20th centuries in conjunction with ethnographic analogy both with and without experimentation. The first recognition of actual use-wear on stone implements dates to the mid-nineteenth century (Vaughan 1981:6, Unger-Hamilton 1988:27). In addition to his work with ethnographic analogy, Nilsson (1838-1843) also undertook the "... macro-examination of the edges of stone tools ..." without recourse to experimental comparisons (Olausson 1980:48). During this period, William Greenwell, Canon of Durham, also observed that some of the Palaeolithic end-scrapers ['thumb-flints'] he had found on the Yorkshire wolds revealed smoothed and rounded edges (Cotterell and Kamminga 1990:158; Hayden and Kamminga 1979:3; Vaughan 1981:11). Although Lubbock (1872), Smith (1894), Rau (1864), Gillespie (1877), Evans (1872), Pfeiffer (1912), Peyrony and Noone (1938), Peyrony et al. (1949), and Tixier (1955, 1958-1959) all made further contributions to lithic use-wear studies through their speculations about possible tool functions, none of these researchers employed any experiments to validate their claims.

Although the overwhelming majority of such early use-wear observations were restricted to a macroscopic level, several researchers did progress to the use of a magnifying glass (Leguay 1877; Quente 1914; Martin 1923; Patte 1927). While Woodbury (1954) made use of a 10X hand lens, Witthoft (1955) and Sonnenfeld (1962) both incorporated a stereoscopic microscope used at low magnifications [10-30X] to study their lithic tools. In addition to the implementation of macro- and microscopic aids for viewing stone tools, some analysts employed such technology to photograph their implements. Notable among them were Curwen (1930, 1935) and Clark (1932), both of whom employed magnifications of 2X, as well as Sonnenfeld (1962) whose magnification levels are unknown (Unger-Hamilton 1988:43; Vaughan 1981).

2. Semenov's traceology:

Semenov revolutionized use-wear studies with the publication of *Prehistoric Technology* (1964). This English translation of his work on traces of wear upon stone tools from the Upper Palaeolithic and later periods 'popularized' use-wear analysis and solidified its world-wide recognition (Coles 1973:119; Keeley 1977; Kimball et al. 1995:6, Unger-Hamilton 1988:27; Vaughan 1981:37; Yerkes and Kardulias 1993:100). Semenov's approach focused on essentially low-power microscopy (between 20X-40X) using both stereo- and incident-light binocular microscopes to identify tool function through the comparison of wear traces such as edge damage, polish, smoothing, rounding, and predominantly, striations on archaeological and experimental stone tools. He emphasized the use of striations to reconstruct the 'kinematics' of stone tool use (Semenov 1964:3-4, 16-21) based essentially on 'direct verification'. He also incorporated a preponderance of other factors such as use-motion, tool position during use, the raw material type and inherent properties of his implements, the physical characteristics of the worked materials, duration of use, resharpening, and possible secondary uses in his studies. Together these lent his traceological approach a much greater depth of analysis (Levitt 1979:28). What may arguably be Semenov's greatest contribution to trace-wear analysis was his insistence on the absolute necessity of systematic experimentation to determine tool functions. His experiments, along with those of later Russian traceologists from the Leningrad Academy of Science, such as Korobkova, Shchelinski, Filippov and Matiukhin, helped to solidify the role of use-wear analysis in modern experimental archaeology (Levitt 1979:29-33; Vaughan 1981:38). Nevertheless, Semenov's 'traceological' approach was criticized for a number of reasons, including failure to disclose sampling methods employed to find tools with wear traces, thus compromising the representativeness of his results (Bordes 1967:38,51; Thomson in

Semenov 1964:xii) and failure to provide the specific experimental features used to determine basic tool functions (Vaughan 1981:40).

3. Keeley and the 'High-Power' approach:

The 'High-Power' approach [named by Odell and Odell-Vereecken 1980] initially developed in response to some of the deficiencies that Keeley noted (1973) in Semenov's work. Keeley's method of use-wear analysis (Keeley 1974, 1976, 1977, 1978, 1980, 1982) employed high-power microscopy [magnifications between 50X and 400X] and concentrated almost exclusively on use-wear polish because he believed it to be distinct, often unique, depending upon the specific type of material worked. Although he primarily focused on the development of lithic tool polish, lithic raw material, contact material, action, duration of use, edge angle, contact angle, and intentional retouch were also investigated. This method of tool polish identification enabled him to accurately locate the areas of use on a tool, classify the materials on which the implement was used, and, to a lesser degree, identify the type of action undertaken (sawing, cutting, scraping). These conclusions were based on the reflectivity or 'brightness' (Keeley 1978:170, 1980) of the polish, the tool's surface texture, topographical features on the tool surface, and the distribution/extent of use-wear micropolishes. Vaughan (1981:129) also added volume of polish and degree of linkage. Most 'high-power' use-wear analysts followed Keeley's method (Anderson 1980; Anderson-Gerfaud 1981, 1982, 1983; Beyries 1982; Cahen et al. 1979; Gysels 1980, 1981; Kajiwara and Akoshima 1981; Moss 1983a; Plisson 1982a, 1982b; Serizawa et al. 1982) to varying degrees, agreeing with the concept that micropolishes were distinct according to the worked material and, generally, with the characteristics of the polishes described by Keeley.

However, Grace (1989, 1990), Newcomer et al. (1986, 1987, 1988), and Unger-Hamilton (1988) did not support Keeley's concept of individual polishes for different worked materials. Instead, they contend that all polishes look identical in the beginning [polishing higher topographical tool surface features first] and gradually develop differently over time. These researchers also acknowledge Vaughan's (1981, 1985) overlapping micropolishes between worked materials of similar 'hardness' and even suggest that such overlapping occurs to a much greater degree than previously acknowledged (Grace 1989:59, Fig.32; Grace et al. 1985; see Unrath et al. 1986 for 'blind tests').

To lend further credence to his method, Keeley and Newcomer (1977) initiated a series of blind tests whose results seemed to validate Keeley's method. More tests were undertaken by other researchers in an attempt to successfully support this method of use-wear analysis (Moss 1983a:54-73, 1987; Newcomer and Keeley 1979; Newcomer et al. 1986:204-216; Unrath et al. 1986; see Bamforth et al. 1990 for 'ambiguous traces'; Holley and Del Bene 1981).

Unfortunately, two series of tests seemed to darken the overall image and scientific reliability of the 'High-Power Approach'. The first of these was a 'reliability test' undertaken by Vaughan (1981:102-104, 1985:17-18) in which the author re-examined some of his own experimental tools after simulating post-depositional damage by accidental and natural agencies believing he would have forgotten their original use following a four month hiatus. Vaughan (1985) claimed his test was more accurate than those performed by others, based on the fact that he simulated an 'archaeologically realistic situation'. The second surrounds the controversy of Moss' accusation

(1987:474) that Newcomer et al. (1986) designed a blind test specifically to discredit some of the participants and "... to disprove the distinctiveness of polish types ..." primarily because they believed that polishes are described based on dubious subjective observations and that if polishes are unique and material-specific, they should be objectively quantifiable (for further criticism and rebuttal see Bamforth 1988; Hurcombe 1988; Newcomer et al. 1988). More recent support for the high-power approach comes from Bamforth et al. (1990) who reported blind tests with 77.2% correct identification of worked material.

4. The 'Low-Power' approach:

Whereas Keeley (1980), Moss (1983a), and Vaughan (1981, 1985) concentrated on high-power magnification identification of primarily polishes and striae, an earlier study focused on the formation of edge damage as an indicator of tool use in lieu of polish. The 'Low-Power Approach' [magnifications between 10X to 50X] first attained widespread archaeological attention with Tringham et al.'s (1974) published article *Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis*. Tringham et al.'s (1974:178) hypothesis was that:

> A tool made of a specific raw material, whose edge is activated in a specific direction across a specific worked material will develop a distinctive pattern of edge-damage ['microflaking'] of a kind that is recognizable on the edges of prehistoric tools.

Through the implementation of a battery of tests on 105 experimental flint tools, Tringham et al. (1974) discovered that both the direction, location and morphology [i.e. - size, depth and shape of the scar] of microflaking varied according to the specific action and that the relative 'hardness' of the worked materials. Consequently, they concluded that this low-power magnification of microflake scars could successfully determine the action and the relative hardness of the materials worked when applied to archaeological tools. It was unable to accurately specify the exact movement of the tool [cutting, sawing] or the exact nature of the worked material [wood, dry hide] (Tringham et al. 1974:195).

Along with Tringham et al. (1974), Odell (1977, 1979, 1980b, 1981a) was instrumental in the further development of edge damage use-wear analysis by testing its reliability experimentally (Odell 1977, 1979, 1980a) and utilizing this technique to analyze a Mesolithic assemblage from Bergumermeer, Holland (Odell 1977, 1980b, 1981b).

Like Keeley's method, the reliability of this 'Low-Power Approach' was blind-tested by Odell and Odell-Vereecken (1980) with successful results. They believed that the flake scar shapes were indicative of the worked material and that flake scar size increased relative to the increased hardness of the contact material (Odell and Odell-Vereecken 1980:101). Odell (1981a:198) further claimed that the results obtained using basalt as a raw material were also applicable to flint, chert, chalcedony and quartz given the universal nature of fracture mechanics. Although Odell and Odell-Vereecken (1980:117) believed edge-damage due to factors other than use was distinct and identifiable, they acknowledged Keeley and Newcomer's (1977:35) statement that: "... utilization damage ... cannot usually be distinguished on retouched edges".

Like Odell and Odell-Vereecken (1980), Roy (1982) claimed that she was able to distinguish between use-related edge-damage and accidental and/or natural edge-damage on unretouched blades and flakes. However, Roy (1982) further claimed, in opposition to Tringham et al. (1974) and Odell and Odell-Vereecken (1980), the ability to recognize both the action and the precise worked material by developing more precisely defined hardness categories. Considering the ambiguity in determining contact materials based on relative hardness already implied by several high-power proponents, this attempt at more specific classifications of worked materials is far too subjective. In his experimental quantification of edge flakes, Akoshima (1987) also noted that specific flake scar types were not associated with specific worked materials. He (Akoshima 1987:73) concluded: "... that a certain scar cannot be a definitive clue to functional determination and the features of flaking scars on the edge *as a whole* should be the unit of analysis and interpretation".

In her examination [magnification of 50X] of the edges of 72 experimental tools manufactured from three flint types and used on 9 materials, Unger-Hamilton (1988) made several interesting observations. Unger-Hamilton (1988:41) concluded that edge damage, in the form of microflaking patterns, edge rounding and surface polish "... are all largely due to attrition of the tool and are therefore interrelated and should be viewed together...". Unger-Hamilton (1988:41-42; see Brink for 1978a:120 rejuvenation of scraper edges) also commented on the fact that where edge damage occurs, that area of the polished edge is removed, thus compromising a proper identification of tool use.

Many of the papers presented at a conference in Vancouver, Canada in March 1977 were published in *Lithic Use-Wear Analysis* (Hayden 1979a), while other sources investigating archaeological microflake analysis include: Coqueugniot (1983), Elster (1976), Hayden (1979b), Kamminga (1982), Lewenstein (1981), Olausson (1983), Seitzer (1977-1978), and Roy (1982, 1983).

<u>Scanning electron microscopy [SEM] and residue analysis:</u>

Based on Keeley's original 'High-Power Approach' to use-wear analysis and his use of scanning electron microscopy (Keeley 1977; see Brothwell 1969), Anderson-Gerfaud

(Anderson 1980; Anderson-Gerfaud 1981, 1982, 1983; see also Mansur 1982; Mansur-Franchomme 1983a, 1983b) undertook extremely high-power magnification [500X to 10,000X] microwear studies employing scanning electron microscopy [SEM]. In 1980, Anderson-Gerfaud (1981:100) sparked archaeological interest in SEM techniques by publishing research that revealed microscopic residues from worked materials could become embedded in the edges of flint tools. Anderson-Gerfaud was not only able to identify the material worked by a stone tool through the recognition of microscopic non-organic residues incorporated in the stone tool polish, but, also provided an hypothesis explaining the mechanism of polish formation on lithic implement surfaces. Since then, the two main SEM use-wear analysts; Anderson-Gerfaud (Anderson 1980b; Anderson-Gerfaud 1981, 1982, 1983) and Mansur-Franchomme (1983a) have attempted to identify the exact worked material using both organic and inorganic components of substances (Vaughan 1981:50, 1985:36).

According to Vaughan (1981:91; see Briuer 1976; Broderick 1979; Cotterell and Kamminga 1990; Gurfinkel and Franklin 1988; Hyland et al. 1990; Shafer and Holloway 1979):

> Under certain ideal conditions of preservation, organic residues such as vegetal fibres or amino acids may be left adhering to prehistoric stone tools and can be studied by relatively straight methods of chemical or physical examination.

In some cases, such as blood residues whose detection only requires low-power magnification [12-30X] and test strips for serum albumin, residue analysis can be quite inexpensive and less time-consuming than other techniques (Hurcombe 1992:18).

In the majority of cases, however, microscopic analyses are required to locate and identify residues adhering to archaeological stone tools. Although Briuer (1976) was the first to truly investigate the possibility of residue recognition on the edges of stone tools, since his initial investigations, many more archaeologists have engaged in similar work attempting to identify animal residues such as blood, hair, feathers, collagen, muscle tissue, periosteum, bone, antler, and cartilage (Anderson 1980b; Briuer 1976; Loy 1983, 1985, 1986, 1987, 1993; Loy and Hardy 1993; Loy and Nelson 1987; Loy and Wood 1989), and plant fibres, plant cell residues, and phytoliths (Anderson 1980b; Anderson-Gerfaud 1981, 1986, 1990; Briuer 1976; Hardy 1994; Hardy and Garufi 1998; Hurcombe 1988, 1992; Loy et al. 1992; Shafer and Holloway 1979) and stone (Unger-Hamilton 1988).

Residue analysis has also been performed by a number of researchers with mixed results. While Anderson-Gerfaud observed residues from bone and phytoliths from siliceous plants 'melting' onto polished tools surfaces [or into the precipitating amorphous silica gel], Vaughan (1985:44) detected the residues of antler, bone, dried beef, and limestone from a hammerstone on his tool edges. Masson et al. (1981) debated the possible presence of plant phytoliths in a thin amorphous silica layer based on their study of 'silica gloss' on burnt blades from Mureybet.

Although it was believed that residues that are not embedded in a 'colloidal silica' layer were removed using hydrochloric acid [HCl] (Vaughan 1985:44), Tuross and Dillehay (1995:104) discovered blood residue remaining on the surface of tools from Monte Verde following cleaning with hydrochloric acid [HCl] and sodium hydroxide [NaOH]. Work by Cattaneo et al. (1993; see Grace 1996) are skeptical of this type of evidence, as well as that provided by Loy involving blood residues. In addition to the location and identification of non-organic residues, scanning electron microscopy has been employed to analyze tool striations (see Mansur-Franchomme 1983b).

SEM techniques have also contributed to the attrition vs. deposit debate for microwear polish formation. The presence of the residues are seen by advocates of additive use-polish as evidence that use-wear polish forms as a result of the formation of an amorphous silica deposit in which residues from worked materials become embedded in the tool surface (Keeley 1980:43; Moss 1983a:16-17; Vaughan 1981:179). In addition to residue analysis, Knutsson (1983, 1988; see also Knutsson and Hope 1984; Plisson and Mauger 1988; Unrath and Lindeman 1985) used SEM in conjunction with acetate peels of stone tool surfaces to study the wear patterns [primarily edge-damage and striations] on 28 experimental quartz tools. Because most sample preparations require a coating of graphite or gold to improve the conductivity of the tool surface, the main drawbacks to using the SEM are the need for expert knowledge, cost, and time (Hurcombe 1992:17; Knutsson 1988:26).

Quantification of microwear:

Additional attempts have been undertaken to modify the 'High-Power Approach' to use-wear analysis through mechanization. These attempts at objective quantification instead of the more subjective observational approaches include techniques such as computer digitization and texture analysis (Grace 1989, 1996; Grace et al. 1985, 1987), interferometry (Dumont 1982), profilometry (Akoshima 1981; [Knutsson] Grace 1989:46-47), atomic force microscopy (Kimball et al. 1995) and fractal analysis (Stemp and Stemp 1999). Grace (1989; Grace et al. 1985, 1987) undertook the quantification of microwear polishes using computerized image-processing techniques of histograms to study tool surface textures. Dumont (1982) attempted to quantify microwear polishes by converting the visual image to an interference image. This technique, however, never developed to the stage whereby the interference images could be actually quantified. Both Akoshima (1981) and Knutsson experimented with the technique known as profilometry; the quantification of micropolish topographies (see Beyries et al. 1988). Unfortunately, the profilometer lacked the required precision to accurately record such minute changes on tool surfaces. A similar approach employing digital scanning and histograms of tool surface textures was attempted by Knutsson et al. (1988). They chose texture features that best discriminated between polishes produced by use on different materials rather than basing quantification criteria on the texture measures used by analysts to distinguish polishes microscopically (see above). Kimball et al. (1995) employed atomic force microscopy [AFM] to determine that experimental micropolishes on four different contact materials were quantitatively distinct. The newest methodology to document use-wear quantitatively incorporates the concept of fractals. Although this work is still in its infancy, promising results have been provided by researchers that demonstrate the ability to distinguish between different contact materials (Rees et al. 1991; Russ 1993, 1994; Stemp and Stemp 1999). In addition to methods designed to quantify use-wear data, Grace (1989, 1993, 1996) has developed a computerized 'expert' system - FAST [functional analysis of stone tools] - that assimilates information obtained from used lithic tools and predicts which activities and contact materials would have most likely produced the observed wear pattern. A similar type of program called WAVES [wear analyzing and visualizing expert system] has also been developed (see Grace 1996).

Mechanics of Polish Formation

When using high-power microscopy to examine micropolish on stone implements, one must consider how such use-wear traces can be diagnostic of a specific worked material. Essentially, there are three individual hypotheses to explain polish development (Vaughan 1985:13): 1. polish that is due to attrition ['abrasion model' (Dauvois 1977; Del Bene 1979; Diamond 1979; Grace 1996; Kamminga 1979; Masson et al. 1981; Meeks et al. 1982)], 2. polish that is some form of additive deposit ['frictional-fusion theory'] (Witthoft 1955:23, 1967), and 3. the 'amorphous silica gel' model (Anderson 1980b; Anderson-Gerfaud 1981, 1982; Bamforth et al. 1990; Bradley and Clayton 1987; Mansur-Franchomme 1983b; Plisson 1983). Most of the initial polish formation models were based on investigations of sickle sheen on lithic implements (Anderson 1980b; Meeks et al. 1982).

Attrition: The 'Abrasion' model:

According to Del Bene (1979:172): "... polish is produced by the gradual loss of surficial material (wearing down) and smoothing of those surfaces" (see also Dauvois 1977, Kamminga 1979). Diamond (1979:165) believed polishing was "... a special type of abrasive wear formed under low load and comparatively high speed conditions and is caused by the removal of material from the surface ...". He (Diamond 1979:164) argued that the process of attrition was likely due to a combination of factors including: 1. mild abrasive wear, 2. fatigue, 3. breakage wear, and 4. surface fatigue wear. Support for this view was based on the 'wear scratches' observable on the polished surfaces of used lithic implements likely due to the presence of abrasive particles such as dust, grit, sand and/or microchips (see below).

Both Masson et al. (1981) and Meeks et al. (1982) presented evidence to disprove additive micropolish formation based on some form of tool-surface deposit as support for an attrition model. Using X-ray diffraction, Masson et al. (1981) did not observe any evidence for a layer of amorphous silica and/or phytoliths [amorphous organic opal-A and opal-CT] as proposed by Anderson-Gerfaud (1982, 1983) or Bradley and Clayton (1987). Nevertheless, Masson et al. (1981) did admit that a very thin surface layer of dissoluted amorphous silica may be absorbed onto the tool surface. Using SEM techniques, Meeks et al. (1982) studied micrographs of sectioned edges of flint tools, but failed to detect any evidence of an additive deposit on used tool surfaces.

The main problem with the abrasion model for micropolish formation is that the large number of striations that are expected on the polished surface have not been observed, even with the use of very high-power magnification [5000X-6000X] (Anderson 1980b:188; Del Bene 1979:173; Hayden 1979:192). However, Hurcombe (1992:14) suggests that work done by Rabinowicz (1968:92) may provide a possible explanation for the inability to observe the striations. Simply put, if the abrasion on the surface of the tool 'acts on a small enough scale', the light that strikes the surface will be reflected such as it would from an undamaged smooth surface and would therefore be undetectable. This type of scratching would have to occur at the molecular level to be undetectable by high-power microscopy (see Kimball et al. 1995).

Additive: The 'Frictional-Fusion' theory:

This explanation for the development of micropolish is based on Witthoft's (1955:23, 1967:384-385; see Vaughan 1981:90, 1985:13) theory that intense localized heat from tool surface/worked material-friction melts or fuses silica onto the tool surface itself.

Based on the 'glazed polish' found on sickle blades, hoe blades and maize milling stones, Witthoft (1967:383-384) suggested a type of rubbing with softer polishing agents similar to that of lapidary polishes. He explains that with cryptocrystalline materials, the silica from the tool surface is melted by frictional heat and hardens as a supercooled liquid which is 'softer' than the crystalline material of cherts and flints [6 vs. 6.5-7 on the Mohs Scale] and possesses close to 15% more volume. Consequently, when a lithic tool surface contacts substances [grasses] containing hydrated non-crystalline opal present in the plant cell walls, the opal acts as a polishing agent due to the fact that it is softer than the cryptocrystalline raw materials and fused silica, and "... molecules of opal are dehydrated and fused to the surface of the flint, building up a thicker and thicker zone of fused silica gloss" (Witthoft 1967:385).

Diamond (1979:164) argued that "... high surface temperatures most likely are not generated in the polishing wear process of non-metals ...", and Del Bene (1979:174, see also Anderson-Gerfaud 1981:105) questioned whether: "... the heats generated by utilization are sufficient to melt the tool stone".

Similar to Witthoft, Kamminga (1979) and Del Bene (1979) also proposed forms of chemical bonding to explain polish formation (see Anderson below). The explanation of Kamminga's 'phytolith polish' was analogous to the chemical interaction theory devised in the late 1950's for optical glass polishing. (Hurcombe 1992:14; Kamminga 1979:151).

Somewhat contrary to Kamminga's description above, Knutsson (1988) surmised the following explanation based on his research into residues on quartz tools examined under a scanning-electron microscope. He stated:

> A well known feature of wear in tribological research is what is called build-up layers [BUL]… . In an area of the tool surface less affected by friction or in a zone between high and low friction, chunks of material, displaced by mechanical action, may accumulate. Successively worn material slides backwards from the edge from which it has been torn and becomes permanently fixed to the surface in the zonal area between high and low friction … At points of lower friction these splinters overcome the tangential forces and start accumulating, ultimately forming a BUL … the splinters are embedded in an amorphous opal layer formed on the quartz surface. … We know from laboratory experiments that quartz particles which are subjected to grinding develop a highly reactive surface layer which binds water to the surface, creating a thin opal or silica gel layer (Knutsson 1988:80-81).

Del Bene (1979:171) agreed that phytoliths existed in the form of a layered deposit on the implement's surface, in what Vaughan (1981:62) provisionally termed the 'adhering layer' model. Phytoliths attached themselves to an implement by filling the interstitial voids between crystals of the tool's raw material. In addition to the attachment of phytoliths to tool surfaces by filling in the gaps between stone crystals, Hurcombe (1992:14) also suggests that the 'cohesive forces' between the phytoliths enable other phytoliths to attach themselves to those already bonded to the lithic tool. However, Del Bene (1979:172, Fig.5) argued against the fusion of this layer to the actual tool surface based on a micrograph that revealed the exfoliation of such a layer from the tool surface. Instead, he suggested that the polish layer was a separate entity adhering to the tool surface (Del Bene 1979:172). It has subsequently been suggested that the exfoliating layer witnessed by this researcher was in fact a thin layer of gold coating used for the SEM that began to peel away from the tool surface (Anderson-Gerfaud 1981:104). Based on this and similar other observations, Hurcombe (1992:15) posits the existence of two types of additive polishes: 1. permanently bonded polishes, and 2. more loosely-attached polishes that may be removed from a tool's surface with chemical treatment or ultra-sonic cleaning equipment. Despite this possibility, Both Anderson-Gerfaud (1986) and Keeley (1980) think the polish bonding is permanent.

Additive: The 'Amorphous Silica Gel' model:

Similar to Hayden and Kamminga's (1979) 'translocation' explanation in which the semi-plastic dissolution of a stone tool's surface is transported in solution to other parts of the tool, the 'amorphous silica gel' model ['colloidal silica' (Hurcombe 1992:15)] is based on observations of 'inflated'-looking polish on used edges of experimental tools viewed under a light microscope (Anderson-Gerfaud 1982) and of diagnostic residues from worked materials [bone, phytoliths from siliceous plants] sinking into or melting onto the dissolved tool surface on tools viewed under an SEM (Anderson 1980b; Anderson-Gerfaud 1981). It was suggested that localized dissolution of silica on a stone tool surface and a subsequent precipitation of an amorphous silica gel layer on that contact surface occurred when plants were worked (Anderson-Gerfaud 1982:152-153; Mansur-Franchomme 1983a; Unger-Hamilton 1984, 1988; Vaughan 1981:62, 1985:13; see also Anderson and Whitlow 1983, Grace 1996:211). While Anderson-Gerfaud (1982) thought the silica gel deposit formed around plant phytoliths (also see above), Bradley and Clayton (1987) concluded that the depositional formation on flint surfaces was due to the redeposition of amorphous silica in the interstices around the lepispheres and quartz grains of the raw material [flint/chert]. For such a process to occur, Anderson (1980a:184), Unger-Hamilton (1988:50) and Vaughan (1981:90, 1985:13) all suggest a complex chemical reaction necessitating several factors to raise the silica concentration in the water on the tool surface above the critical level of 115 parts per million. This chemical reaction is dependent upon high temperature [friction], abrasion by intrusive particles, silica concentration in water, the structure and 'hardness' of the tool material, a pH level over 9 [basic], certain plant acids, colloidal silica, solid amorphous silica like that in plants, and nonsiliceous crystal substances such as calcium oxalate.

Bamforth et al. (1990) believe that the freeing of silica from both the lithic tool and the material's contact surface are combined with water to form a gel. This resultant gel then solidifies as a 'noncrystalline' coating on the used surface of the tool. Despite this conclusion, Yamada (1993, see Grace 1996:211) has determined, based on his scanning electron microscopy experiments, that no silica gel actually forms. Polish formation is the progressive smoothing by abrasive action.

Additional Use-Wear Traits

Edge-rounding:

This type of use-wear is "[t]he rounding of edges and ridges and the smoothing of adjacent surface areas of used stone edges ..." (Vaughan 1985:12). Edge-rounding has been observed macroscopically (Greenwell 1865; Evans 1872; Tixier 1958-1959; Bruijn 1958-1959; Rigaud 1977), as well as microscopically, and seems to be due to the type of contact material and the tool action. Experimentally, it has been shown that abrasives increase the rate and degree of tool edge-rounding (Brink 1978a; Keeley 1980; Mansur-Franchomme 1983b; Shackley 1974; Vaughan 1985:26).

The difference in edge-rounding of tool surfaces [interior vs. exterior] have been employed to determine tool motion. With transverse actions, the interior or contact surface is more rounded than the exterior or non-contact surface (Anderson-Gerfaud 1981; Keeley 1980). It appears that the causes of edge-rounding are similar to those of micropolish formation (see above). According to Tringham et al. (1974:188), all transverse actions cause considerable edge rounding with little microflake removal on the interior surface. Brink (1978a, 1978b), Odell and Odell-Vereecken (1980:90) and Unger-Hamilton (1988:138) conclude that edge rounding is diagnostic of scraping. Vaughan (1981: 125, 1985:26) found that in 63% of his observations, transverse action-edge rounding was usually greater on the edge surface facing the contact material. But, when the contact angle increased, rounding of the edge can become equal on both tool surfaces [4%] or, sometimes, greater on the exterior or non-contact surface [15%]. Tools used for longitudinal actions often revealed this characteristic on both surfaces [62% of observations], although rounding could be greater on one surface than another [11%] if the angle of prehension varied too greatly from 90 degrees.

Vaughan's (1981:125, 1985:26) experiments defined three general trends related to edge rounding: 1. increased rounding with increased length of use except on edges that are intentionally retouched or excessively microchipped, 2. fine-grained flint edges become rounded more rapidly than coarse-grained ones used for the same tasks, and 3. the harder the contact material, the more quickly the edge is rounded. Rounding on intentionally used tools is usually restricted to specific working edges, however, accidental/natural rounding of lithics can occur on any tool surface or projection (Vaughan 1985:26).

<u>The 'Edge-row' attribute:</u>

This attribute of microscopic edge damage refers to "... the row of small step- or hinge-type microscars which often occur within the proximal region of larger scars along a used or crushed edge" (Vaughan 1981: 101, 1985:17). It has also been observed and reported by Hester et al. (1973:93), Keller (1966:508), and Rosenfeld (1970:178).

Weight loss and edge damage:

Brink (1978a:83) also attempted to correlate weight loss in his experimental tools with the formation of edge damage on tools used to work various materials. He concluded that the majority of weight loss was due to abrasion; not specifically edge microflaking (Brink 1978a:107, 1978b; see Semenov 1964:14 for reduced volume). In her experiments on goat hide, Lévi-Sala (1993: Fig.16) noted that microflakes detached from the tool edge contributed to the tool abrasion/polishing process. Although I attempted to document weight loss after use, my observations did not prove conclusive. Weight loss on the order of hundredths of a gram were recorded, but whether it was primarily due to edge microflaking is not known. It is believed wear polish caused by attrition of the used surface was also a possible cause of some weight loss (see Grace 1996:212, Lévi-Sala 1993).

Table 8: Weight (grams) of Tools Before and After Use

Tool type	Motion/ Contact Material	Duration (minutes)	Weight before use (grams)	Weight after use (grams)
unretouched flake	saw/ antler	5	14.02	13.93
unretouched flake	cut/ dry hide	5	7.71	7.70
unifacially retouched flake	scrape/ wood	5	10.65	10.63

My experiments (see Chapter 12) involved the use of fine-grained chert from Cristo Rey, Cayo District, Belize. The experimental tools were washed in warm water before use and were then soaked in a 15% solution HCl acid bath for 15 minutes and rinsed in warm water after use.

Abrasives and edge damage:

Based on his experiments of tool use with the deliberate addition of silt to bone- and hide-scraping activities, Brink (1978a) concluded that microflaking on tool edges is very rare, only occurring at the beginning of an activity. This may be due to the possibility that abrasion caused by silt may remove suitable striking platforms for subsequent flaking. In general, the addition of silt did not affect the working efficiency of hide-scraping tools (Brink 1978a:109).

Although, I did not intentionally add abrasives while performing my experiments, some of my fine-grained Cayo District chert tools were deliberately walked over while lying in sandy soil to simulate accidental or occasional damage. It was found that even after minimal trampling, numerous deep, multi-directional striations occurred on the higher topographic points of the tools.

Striations:

Striations are defined as: "... any kind of linear depressions in the flint surface, which is not a feature of the flint itself" (Moss 1983a:74, see Semenov 1964). Classification of striations has been accomplished based on morphology, in particular depth and width (Dauvois 1977:283; Fedje 1979; Kamminga 1979:148; Keeley 1980:23; Vaughan 1981:86, 1985:12).

Most microwear analysts agree with Semenov (1964) that striations are indicative of both the location of use-wear on a tool and the tool motion during use. In terms of longitudinal actions, these features are usually parallel and/or diagonal to the used edge, whereas striations are typically perpendicular and /or diagonal with transverse actions (Vaughan 1981:121). The characteristics of striations can also be used to recognize tools used for one-way longitudinal actions. Any type of ridge or differential topographic feature on a tool surface will be striated differently with the higher on-coming surface being more deeply grooved (Vaughan 1981:168-169).

However, there is much debate concerning what other information can be derived from striations. While Keeley (1980:23; see Moss 1983a:76; Vaughan 1981:121) argued that the worked material itself, more specifically its structure, could produce characteristic striations, Mansur (1982) considered the worked material to be only indirectly involved in striation formation. Fedje (1979) asserted even more vociferously that striation morphology did not reflect the worked material. Vaughan (1981:122) and Moss (1983a:75) also noted that striations are often absent on used tool surfaces. In general, it appears that researchers are not all in agreement about the relationship between characteristic striations and specific worked materials, but do seem to recognize the general fact that the number of striations on a tool surface is a reflection of the number of abrasive particles present (Del Bene 1979; Fedje 1979:187; Knutsson 1988:71-72; Mansur 1982:225; Moss 1983a:74-75, Unger-Hamilton 1988:59; Vaughan 1981:121). Lawn and Marshall (1979) recognized a possible difference in striation or abrasion damage based on whether or not the abrading particles were fixed or free. Free particles only contact a very limited area of the tool surface and this 'point' contact creates an abrasion pattern that appears as a "... randomly distributed array of discrete point-load indentations" (Lawn and Marshall 1979:79, fig.13). Fixed particles will produce more continuous and possibly 'linear' striations (Knutsson 1988:91-92). An exception to this general rule exists for dry-hide scraping which does produce a diagnostic abrasion pattern (Hayden 1979b:224-225; Hurcombe 1992:10; Keeley 1980:113; Semenov 1964:88).

A partial explanation for the lack of certainty concerning striations as indicators of worked material is based on the mechanics of their formation. Most researchers believe that as the tool is used, lithic microflakes detached from the tool's edge scratch the tool surface (Del Bene 1979; Fedje 1979; Hurcombe 1992:9; Kay 1996; Lévi-Sala 1993; Mansur-Franchomme 1983a, 1983b; Knutsson 1988; Odell 1975:229; Witthoft 1955, 1967:384). Unger-Hamilton (1988:58) observed that the quantity of striations produced correlated positively to the hardness of the worked material, while Knutsson (1988:73-74) further noted that the force of contact and the surface topography at the point of contact with the lithic specimen can affect striation frequency and morphology.

The second proposed cause of tool striations is the accidental presence or intentional addition of an abrasive substance [dust, grit, mud, sand, ochre, dirty hands, fine debris from manufacture] during tool use (Brink 1978a:34-35; Fedje 1979; Frison 1979:263-264; Kamminga 1979:152, fig.7; Keeley 1974:126-127,330, 1980; Knutsson 1988; Korobkova 1980; Meeks et al. 1982:337-338; Moss 1983a:75; Phillips 1988:351; Semenov 1964:15; Unger-Hamilton 1988:58).

Whereas additive substances can contribute to the formation of striations, in some situations, a lubricant such as water, blood, fat, or sap may cause a decrease in the number of striations and the level of abrasion (Broadbent and Knutsson 1975:121; Brose 1975; Hurcombe 1992:9). These fluids may also decrease striation formation by softening the abrading substances (Knutsson 1988:93).

Finally, Del Bene (1979) suggests that striation formation on stone implements may be due to 'adhesive wear'; a process relating these features to polish formation. According to this researcher, "This kind of wear is caused by the transferal of fragments from the surface of one material onto the surface of another and vice-versa. This is due to the strong adhesive forces that are established whenever atoms come close together" (Del Bene 1979:169).

Generally, it appears the presence and pattern of striations on stone implements is dependent upon the hardness of the worked material, the presence of abrasives, and possibly the structure of the worked material itself [fibrous materials such as sheep's wool, shell and fallow deer antler (Unger-Hamilton 1988:59)].

CHAPTER 12

Experimentation and Use-Wear Analysis

Experimental Use-Wear: Replication of Materials and Mechanics

The vast majority of use-wear analysts are convinced of the necessity of experimental testing prior to any functional use-wear analysis of archaeological stone tool assemblages (Anderson-Gerfaud 1981:6-12; Keeley 1980:5-7; Moss 1983a:54-56; Unger-Hamilton 1988:29-30; Vaughan 1981:78-82). Keeley (1980:5) believes experiments must be "... relevant a, to the ecological situation and other general conditions of the site and sites from which the study materials originate, b, to the likely worked materials (hide, bone, meat and so on), and c, to the rock types from which the archaeological implements are made". In support of this last point, Moss (1983a) is emphatic about the duplication of archaeological lithic raw materials in use-wear experiments.

Moss (1983a:55) is critical of the replication of stone tool use itself, in terms of prehension, angle of use, pressure, and discusses whether use-wear experiments should be performed mechanically in order to keep variables constant (see Tringham et al. 1974) or whether a human approach to tool use [the various ways we hold and use tools] would be more natural or realistic (see Keeley 1980:8; Vaughan 1981:95-96). Unger-Hamilton (1988:30, 122-205) employed a combination of human and mechanical approaches.

Finally, Hartmann (1980) raises the valid criticism that prehistoric stone tools were most likely used to complete a specific task or series of tasks instead of working one material in one way. Therefore, although such concerns about the proper use of tools and the experimental formation of comparative polish types for different contact materials and for different actions is necessary for use-wear analysis, it is crucial to recognize that the fact that the artificial nature and ideal conditions created in experimentation do not necessarily reflect the reality of performing prehistoric tasks, and therefore that polishes may not be as diagnostic as researchers might expect (see Holley and Del Bene 1981:339).

Methodology

Equipment:

Two different microscopes were used in this lithic analysis: a binocular Nikon LABOPHOT (model Y-2) polarizing microscope from the Archaeology Lab at McGill University and a binocular Leitz-Wetzlar ORTHOPLAN-POL polarizing microscope from the Earth Sciences Department at the Royal Ontario Museum. Although both were slightly different, they possessed incident light (light-field) capabilities and offered combined ranges of magnification from 10X to 500X. A Bausch & Lomb stereoscopic microscope with magnification capabilities ranging from 7X to 30X was infrequently employed to investigate areas of edge damage that were not clearly observable using the other high-power microscopes.

Preliminary scans of stone tool surfaces to locate use-wear were initially performed at 40X to 100X magnification in order to quickly divide the lithic assemblages from Marco Gonzalez and San Pedro into 'used' or 'possessing surface damage indicative of use' and 'unused' tools. It is understood that some tools were likely used by the Caye Maya for some activities, but bore wear that could not be detected, primarily due to burning or patination. Higher magnifications of 200X and 500X were implemented to identify and photograph the used portions on stone tools.

It was found that light-field illumination was much more productive in the observation and recognition of use-related polishes and at higher magnifications (100X and above), while a modified form of dark-field illumination was superior for isolating and identifying topographical features such as striations and edge flake damage or anomalies related to textural changes in lithic surface morphology at much lower magnifications (20X, 40X, 80X). In light-field illumination "... the light is focused onto the observed surface by the objective: light strikes the subject at an angle 90 degrees to the focal plane" (Keeley 1980:13). By contrast, in dark-field illumination "... the light is directed onto the observed surface from all around, striking it at an angle of 45 degrees to the focal plane" (Keeley 1980:13; see Lewenstein 1987:81). For my use-wear analysis, the dark-field illumination was accomplished using one or two external light sources, that could be positioned around the lithic at slightly different angles.

For photomicrographs the Leitz-Wetzlar ORTHOPLAN-POL microscope was fitted with an AFMD double camera mount with 2 Nikon M-35D 35 mm cameras attached. All the photographs were taken using Kodak TMAX (TMX-135) 100 speed black and white film.

<u>Cleaning procedures:</u>

Although most use-wear analysts cleaned their stone tools before analysis, there does not appear to be a single 'proper' or universally accepted cleaning process. Along with Unger-Hamilton (1988) and Rodon Borras (1990), I believe it is important to outline the tool-cleaning strategy so that possible removal or alteration of use-wear damage [particularly micropolish] due to chemical treatment may be: 1. considered when final results are presented, or 2. possibly avoided, and to provide accurate information for those use-wear analysts attempting to duplicate experimental work or re-examine archaeological specimens.

All of the lithic material from the sites of Marco Gonzalez and San Pedro were cleaned in a similar fashion. The lithics were initially washed in cold water to remove any excess dirt or sand that was adhering to them. Subsequently, all of the raw materials were subjected to a warm 15% hydrochloric acid (HCl) solution bath to remove the calcium carbonate and other carbonaceous substances adhering to the tools and their by-products (see Keeley 1980; Hurcombe 1992; Unger-Hamilton 1988).

Given the extreme variability of the amount of carbonaceous residues on the lithics, the acid bath procedure was closely monitored, so that clean tools were removed and immediately rinsed in cold water, and not left in the hydrochloric acid solution longer than necessary. In instances where some of the chert implements were almost entirely covered in calcium carbonate, acid baths could last up to 25 minutes. The average length of each bath session was between 3 to 5 minutes.

Because the tools were also going to be examined for use-wear polish traces, there was concern over the use of sodium hydroxide (NaOH) in the cleaning process. The chemical patination of silicates, especially chert, from sodium hydroxide (Anderson-Gerfaud 1981; Kay 1996; Keeley 1980) and the fact that very few of the adhering substances on the lithics were organic seemed to render the use of this solution impractical. Basically, acidic solutions are used to remove non-organic materials and residues, while alkaline solutions are employed for organic residue removal (Keeley 1980; Vaughan 1981). An ultrasonic cleaner as described by Rodon Borras (1990) was not used, nor required, to clean the artifacts.

Generally, oils from handling or plasticene mounts may be removed from tool surfaces using soapy water (Unger-Hamilton 1988:65) or methyl alcohol (Kay 1996:320) and acetone (Vaughan 1981:97, 1985:16). Kay (1996:320) also used latex surgical gloves to protect tools from finger grease while handling specimens. When viewing my tools under the microscopes, methanol (CH_3OH) was applied with 'Q-tips' to remove any grease from human fingers or the plasticene specimen mounts.

In order to clean hafting residues (wax, sinew, cellulose adhesive [Uhu]) from lithic implements, Unger-Hamilton (1988:66) was required to use White Spirit because acetone would combine with these substances, especially Uhu, to form 'acetone bloom' on tool surfaces. I found this practice odd, given the strenuous objections by other lithicists to preserve any hafting traces where possible. When hafting residues were encountered on the archaeological tools from my assemblages, the areas with residue traces were not cleaned at all.

My experimental program:

The purpose of engaging in my own experimental use-wear testing was to familiarize myself with edge damage patterns, polishes, and striations. There were a hundred documented experiments using five varieties of chert [CBZ chert, fine-grained Cristo Rey chert, Onondaga chert, Kettlepoint chert, and coarse-grained Cristo Rey chert] to work twenty different contact materials [see Appendix L]. In some cases, more experiments were performed than are documented here. The reason for their omission from the thesis is due to less rigid controls during the experiments that resulted in a reduced accuracy and reliability than that desired for the comparative sample. For example, some implements were used repeatedly to observe the development of use-wear on an edge until they were no longer able to perform their task. No attempts were undertaken in these early experiments to actually document these changes since these observations served primarily to establish general damage traits and flake scar characteristics. The use-wear experiments also provided a comparative sample for specific contact materials not extensively used by other researchers and that were pertinent to the coastal environment of the two sites on Ambergris Caye. The information I collected was further used to complement the descriptions and photomicrographs presented by other use-wear analysts. In this manner, published information was combined with my own experimental results to provide use-wear data that is more applicable to the environment of Marco Gonzalez and San Pedro. This accumulated database thus provides the foundation for the analysis of use-related wear on the archaeological lithics. For some contact materials, the use-wear observed on the specimens from Ambergris Caye was not as well-defined as that found on the experimental examples or photomicrographs

Low-Power Microscopy: Edge Damage Traits by Motion

Longitudinal actions: Cutting, slicing (one-way movement), and sawing (reciprocal movement):

The experimental program I undertook revealed that the distribution of flake scars along the worked edge of the cutting tools generally appears uneven, but not completely random. This observation is similar to those of other researchers (Tringham et al. 1974:188; Odell and Odell-Vereecken 1980:98; see Akoshima 1987). Similar to the observations reported by Tringham et al. (1974:188), I found that cutting does not produce any specific scar type, size or definition, but the range of scar variation is relatively small on a single tool edge. Odell (1980b), Odell and Odell-Vereecken

(1980:98), Tringham et al. (1974) and Unger-Hamilton (1988; also see Lewenstein 1987) all noted bifacial microflaking when the tool is held at a 90 degree angle, however, Unger-Hamilton (1988:38) observed that such edge damage could become nearly unifacial as the angle between the tool and the worked material becomes more acute. In my edge damage experiments, I noted that the angled prehension of a flake did produce more flaking on the edge nearer the contact material. Other features observed on longitudinal tool edges included striations parallel to the cutting/sawing edge when the tool is held at a 90 degree angle (see Semenov 1964:19). The striations became diagonal as contact angle became more acute. Whereas Tringham et al. (1974:188) and Unger-Hamilton (1988:38) reported a lack of noticeable edge rounding, Vaughan (1985:26) noticed that rounding was equal on both tool edges [62% of observations, p.147,Table 2.11] when the implement was held at a 90 degree angle, while tools held at a more acute angle exhibited more rounding on the edge in contact with the material closest to the material [11% of observations]. I noticed greater edge rounding when contact materials were hard but pliable, such as dry hide and wood.

In general, the scar distribution and scar morphological characteristics for sawing actions were the same as those for cutting. Tringham et al. (1974:188) noted that sawing at a 90 degree angle produces a greater density of scars along the tool edge and creates an even distribution of flake scars on both tool surfaces; a pattern which I also noted in my experiments. In his experiments, Vaughan (1981:108-109, 1985:20) found that on 65% of edges, microchipping was bifacial, while 17% was unifacial for longitudinal actions, and only 66% of that microflaking was discontinuous (uneven) scarring. Unifacial flaking in a few cases involved the cutting of softer materials and, rarely, sawing. However, Vaughan makes no reference to tool angle when citing these statistics. Although Tringham et al. (1974:188-189) and Odell and Odell-Vereecken (1980:98-99) claimed edge-row scarring was bifacial for longitudinal actions, Vaughan (1981:110, 1985:21) noted that only 2% of his observations followed this distribution, while 15% did not. Furthermore he (Vaughan 1985:25) noticed that 54% of his tools used longitudinally did not show striations. The appearance of striations on my tools depended primarily on the hardness of the contact material and the intensity of use.

Transverse actions: Scraping, shaving, planing, and whittling:

With transverse actions, the majority of microflakes occurred on the exterior (non-contact) surface. It has been suggested that the pattern of edge modification/damage is dependent on the direction of one-way movement (toward or away from the tool-user), the shape of the trailing surface of the tool (i.e.: plano-convex vs. concavo-convex), and the angle of tool use (Lewenstein 1987:105; Odell 1981a:201; Odell and Odell-Vereecken 1980:99; Tringham et al. 1974:188-189; Unger-Hamilton et al. 1988:38). Because contact with the worked material was primarily restricted to the very edge of the tool, microflake scars were very densely distributed in a continuous line along the leading edge, particularly when planing or whittling activities were performed. On the tool edges, the scars possessed a uniform shape and size. Tringham et al. (1974:189) observed that triangular and trapezoidal scars were rare, while the majority of scars were semi-circular - scalar or step scars. I noted a similar range of scar types, but a greater percentage of hinge scars. Vaughan (1981:108-109, 1985:20) noticed that 46% of his edge damage observations were not unifacial on the non-contact surface for transverse actions. Other analysts also observed microflaking on the interior or contact surfaces of their tools

(Odell 1977: Appendix F4; Broadbent and Knutsson 1975:119; Fiedler 1979:69, 100; Gould et al. 1971:159; Keeley 1980:36). It was noted that the scarring on my experimental tools used transversely primarily occurred on harder contact materials, although lithics with retouched edges experienced less hinge flaking than flakes with unretouched edges.

In terms of the 'dense' distribution of microflakes for transverse actions, Vaughan (1981:109, 1985:20) found that only 32% of his test sample seemed to conform to this pattern, whereas 52% failed to follow it (see Lewenstein 1987). Although most researchers lump all transverse actions together, Odell (1981a:201-202) emphasizes the fact that scraping, shaving and whittling will all result in different types of edge flaking. I noticed a greater density on edges that were used to whittle and shave than on scraping tools. However, in my experiments the tools used to whittle and shave mostly possessed unretouched edges.

For edge-row scarring, Tringham et al. (1974:188-189) and Odell and Odell-Vereecken (1980:98-99) concluded that this distinctive feature should only occur unifacially on the non-contact [exterior] tool edge. Lewenstein (1987:105; Odell 1981a) found one to three tiers of microscars in a discontinuous distribution pattern on the edge of scrapers. However, evidence for edge-row damage seemed to contradict the observations above with only 16% occurring on the correct tool edge surface and 11% occurring elsewhere (Vaughan 1981:110, 1985:21). According to Brink (1978a:68), edge-crushing never occurred on wood-scraping tools. No edge crushing was found on my wood-scraping tools and limited edge-row scarring did occur on the ventral surface

Striations were oriented perpendicularly or diagonally to the leading edges of my flakes, and usually they formed slowly on the ventral surface of the tool as was observed by Tringham et al. (1974:189) and Vaughan (1985:25) in 74% of his observations. When tools were used for planing or whittling, there were more striations observed on the dorsal edge. For transverse actions, Vaughan (1985:25) also noted that 20% of his experimental tools did not possess striations on the used surface. The number and rate of striation formation increased with the brittleness of the stone used in my experiments.

Circular actions: Boring, drilling, piercing, and perforating:

Edge damage on both boring and drilling tools occurred as microflakes with a distinctive trapezoidal shape, predominantly on the sides of the point/projection of the implement instead of on the contact tip (see Tringham et al. 1974:189). The damage on a drilling or boring tool's tip consisted of crushing and abrading, and occasional tip fracture when tools were used for extended periods, much like the damage reported by Odell (1981a:205) and Yerkes (1983:504, 507). I noted a higher incidence of tip fracture on tools used to drill shell than any other contact material. This usually occurred early in the drilling process when the purchase of the tip was not well-established. The point would slide out of the shallow pit or groove and break on the shell surface or the table top. A 'hangnail projection' is a very diagnostic breakage pattern on tools utilized as drill bits (Odell 1981a:205; Yerkes 1983:508). Most abrasion is distributed along the edges and surfaces of the tool with striations appearing perpendicular to and slightly down from the point/projection as noted by Lewenstein (1987:94), Tringham et al. (1974:189), and Yerkes (1983:507). Semenov (1964:18) notes that striations on hand-held drills are not as perpendicular to the tool point, nor are they as parallel to one another given the tilting of this instrument in the hands of the artisan. Similarly, Yerkes (1983) stated that only his experiments with a bow-drill, as opposed to hand-turned drills, produced a regular striation pattern.

Chopping, adzing, digging, and hoeing:

The tools used for experimental chopping, adzing and hoeing activities were all large hafted bifaces. Axes possess two distinctive sets of features. Assuming the blade-edge is parallel to the axis of the handle, bifacial and diagonal arrangements of striations are produced by blows in which both faces of the blade impact the wood with uniform resistance (Odell 1981a:206; Semenov 1964:124-125). For example, the Puleston axe possesses striations that are generally perpendicular with a slight oblique orientation indicative of chopping activity with a variable contact angle of use from direct to oblique (Shafer and Hester 1990:283). Typically, the observed edge damage takes the form of 'stacks' of microflakes with step fracture terminations that are discontinuously distributed along the tool edge usually with an asymmetrical pattern of occurrence on the interior and exterior surfaces depending on with which hand the axe is swung or whether the blow is a side-stroke or a down-stroke. On an experimental axe, the distribution of the stacked microflakes extended to roughly 1 mm on the less damaged tool surface and up to an average of 3 mm on the more heavily damaged face much as Lewenstein (1987:87, see 1991:246, Fig.3) describes.

Adzes, tools fixed in their handles with the blade-edge at right angles to the handle, have use-wear that is greater on the exterior face because this surface encounters the contact material to a greater extent than the interior surface. Most of the flake scarring occurs on this exterior aspect (Keeley 1980: 39-40; Lewenstein 1991:246, Fig.3, Odell

1980b). Lewenstein (1987:87) notes that these flakes extended approximately 1 mm from the edge on her wood-working tools, although there were some minor scalar, feather-terminated microflaking on the interior face. I found that striations on both faces are mostly perpendicular to the cutting edge (see Semenov 1964:124-125), although there can be some striae that are diagonal to the tool bit (see Lewenstein 1987:87). Odell (1981a:206) further noted that twisting of an axe or adze once imbedded in the contact material will result in more extensive edge fracturing; primarily causing hinge and step-flake scars, due to bending stresses on the tool.

Much like the distribution of use-wear on adzes, hoes have greater and longer traces on their exterior rather than interior surfaces. On her experimental tools, Lewenstein (1987:96) noted microchipping in 1-5 tiers of scalar scars with step and feather terminations that were asymmetrically distributed along the tools' working edges. The striations are not always parallel, but may criss-cross relative to the changing direction of the tool's contact with the soil. The criss-crossing nature of these striations in my experimental tools was one of the most recognizable features of soil digging or hoeing, particularly sandy soil. The diagnostic 'scour grooves' associated with soil contact were always present in great numbers on my tools (Lewenstein 1987:96; Semenov 1964:21,133; Shafer 1983; Sonnenfeld 1962). According to Semenov (1964:129), the intensity of use-polish and striations on a hoeing tool render the identification of subsequent use-wear from other actions [i.e.- adzing] impossible to recognize. I found that chopping wood set on the ground produced many 'scour grooves' when the axe blade accidentally struck the soil. Under the microscope, the multi-directional striations seemed to mask any good evidence of wood chopping.

Low-Power Microscopy: Edge Damage Traits by Contact Material

General observations:

Regardless of the type of material worked, the first microflakes removed from a tool edge leave scalar-shaped scars. The rate of flake removal and the size and depth of the microflake scars all increase with the hardness of the worked material (see Odell 1983:18 for 'échelle de résistence'; Akoshima 1987:73). With material classified as 'hard', scalar flakes are detached very rapidly, producing a weakened tool edge which essentially results in the removal of microflake 'hinge fractures' creating short and steep 'step scars' (Tringham et al. 1974).

Given the great variability of microchipping attributes between and within each material category, any correlation of proximal flake scar cross-sections to 'hardness' of worked material was deemed unreliable by Vaughan (1981:112, Table 7, 1985:22), In addition to this, and despite the observations made by Tringham et al. (see above), Vaughan (1981:112-113, 1985:22) concludes there is an extremely wide range of scar sizes within the hardness categories of each worked material. Nevertheless, I found that working harder materials did seem to produce larger flake scars, working 'medium' materials left smaller microscars, and working 'soft' materials also produced small microscars. Furthermore, work by Tomenchuk (1988) contributes to questions concerning the reliability of direct association between edge damage and the hardness of the contact material. Inasmuch as the types of damage incurred by tools working different materials may not be as greatly affected, the size of the resulting edge damage flakes is a product of the rate of loading or the amount of force applied to the implement to complete its task.

Soft materials (meat, fresh and dry hide, skin, fish scales):

Tringham et al. (1974:189) stated that soft contact materials only produced scalar-shaped scars. My experimental data reveals such materials could also remove step-shaped scars in much lesser quantities, as Unger-Hamilton (1988:38; Akoshima 1987) claimed. If flake scar cross-sections are considered, Odell and Odell-Vereecken (1980:101; see Odell 1980b) noted that edges used on 'soft' and 'medium-soft' materials possessed feathered distal terminations (see Lewenstein 1987:105 for hide-scrapers; see also Vaughan 1985:21). Lewenstein (1987:101) disagrees with the above statements, saying that there is no specific pattern of flake scar type associated with hide cutting, but flakes occur in a single row. I found that scraping of medium-soft hides produced a wider range of flake scars than suggested by Odell and Odell-Vereecken (1980). Scraping produced slightly larger scars than cutting, however, both had a 'slight nibbling' appearance when viewed macroscopically.

Tringham et al. (1974:189) determined that fish scales; being more resistant than mammal flesh or skin, created larger and better defined microflake scars. Unger-Hamilton (1988) noted that the microscars that developed were fish-scale-shaped. I found that microflaking of the tool edge occurred rapidly when fish were scaled and that this damage developed into edge crushing after prolonged use. Both Semenov (1964:107) and Hester and Follett [at 75X] (1976:10) noticed a blunting and crushing of the edges of tools used to cut fish. Moss (1983a:105,1983b:151) did not detect the same edge dulling or crushing on her flint tools.

Medium to hard materials (tanned hide, woody plants, soft and fresh woods):

I observed that working wood produced various types of scalar scars ranging from semi-circular to triangular and trapezoidal in shape (Lewenstein 1987:91; Tringham et al. 1974:191; see Keeley 1980:24-25). Usually, these scalar scars are smaller and shallower than those occurring as a result of working hard materials and are characterized by a finely abraded edge. They give the scars what Tringham et al. (1974:191) describe as a 'fuzzy appearance'. On his wood-working tools, Brink (1978a:120) observed considerable microflaking on the tool edges which may be similar to the 'fuzzy appearance' mentioned above (see Keeley and Newcomer 1977). I found that if harder woods are worked for an extended period of time, some step-scarring usually develops. In most instances, this scarring occurs on a more reduced scale on medium-hard materials compared to scarring on hard materials and is associated with heavier tasks such as sawing (Tringham et al. 1974:191). Similarly, Odell and Odell-Vereecken (1980:101) found hinge-type distal terminations on microscars produced from working 'medium-hard' materials.

Hard materials (antler, bone, stone, shell, ceramic, metal, hard wood):

In my experiments, microflakes detached quite rapidly when hard materials were worked, producing scalar and crescent and/or rectangular step-scars (Akoshima 1987:76; Brink 1978a; Odell and Odell-Vereecken 1980:101; Tringham et al. 1974:188; see Keeley 1980:43 for sawing bone). Lewenstein (1987:99) also notes some half-moon flake removals with snap terminations on bone-sawing tools. I observed half-moon microscarring primarily on thinner tool edges used to work hard materials in longitudinal motions such as sawing or cutting. Most of my experimental tools used on hard materials developed numerous step and hinge flake scars. Vaughan (1981:111, 1985:21) points out that 63% of his observations demonstrated an association between hinge/step-scars and hard materials, although 15% also revealed feathered terminations. Brink (1978a:84) and Tringham et al. (1974:189) observed that the back edges of both the scalar and step-scars were well-defined and that the sides of the scars were heavily abraded and crushed. Scraping bone often caused the "... complete modification of macro and micro-morphology ..." of the tool edge (Brink 1978a:82), while longitudinal actions created irregular edges with numerous projections from the original tool edge. When I worked bone, it produced larger and longer scalar scars that extended further into the tool edge, while antler's scarring pattern, albeit more destructive, is restricted to the tool edge (Brink 1978a:83; Tringham et al. 1974:189). Whereas working dry antler produced a greater number and size of edge scars than soaked antler (Odell and Odell-Vereecken 1980:102; Unger-Hamilton 1988:39, Vaughan 1981:114), the same does not seem to be true for bone, in that soaking does not 'soften' the material. Antler-scraping produces edge rounding, but not necessarily smooth edges, similar to dry hide-polish (Brink 1978a:121; Keeley and Newcomer 1977:39). Although both Hurcombe (1992:10) and Tringham et al. (1974:191; see Akoshima 1987) state that trapezoidal scars are only produced by wood-working activities, scars that were nearly trapezoidal were produced after one dry antler sawing experiment. Based on experiments with wood, antler, bone, and shell, I observed true trapezoidal scarring only on those tools used to work wood. Vaughan (1985) notes that occasionally hard materials did not cause chipping scars, however, all of my experiments on hard materials produced some observable edge damage. Even very brief use caused the removal of microflakes from my experimental tools.

Although Tringham et al. (1974:188) contend that extended tool use on hard materials will dull the tool edge [step scars obliterate scalar scars] thus greatly reducing the tool's efficiency, Brink (1978a:120) noted that scraping bone often resulted in what he termed a 'rejuvenation' of the edge and this flaking tended to reduce the formation of edge rounding and edge polishing. Brink (1978a:84, 120-121) further explained that the removal of microflakes from the interior surface of bone-working tools was very diagnostic of scraping action (see Broadbent and Knutsson 1975:119).

Based on observations of the Puleston axe, Shafer and Hester (1990:283; see also Lawrence 1979) did not notice point initiation fractures which are evidence of direct impact with hard materials that usually crush tool edges. However, several of the biface edge fragments from both Marco Gonzalez and San Pedro possessed well-defined point initiation fractures of one surface from either repeated chopping activities or repeated attempts to deliberately retouch the tool edge.

Edge-rows distributed along the entire used edge almost always occurred on tools working hard materials, while partial edge-rows were found on tools used to work materials of medium-hardness (also see Lewenstein 1987:110 for microflake scarring three or more tiers deep on stone-working implements). Overall, only about 20% of tools working 'medium-hard' materials, and roughly 50% of tools used on 'hard' materials actually possessed edge rows according to Vaughan's experiments (1985:22).

Working shell and ceramic (pottery) always produced striations on the tool edges. Those from shell-cutting were usually more evenly spaced and parallel one to the others than those produced by ceramic cutting or sawing. Notching activities on these materials caused edge scarring and striations that seemed to combine traces of both scraping and sawing motions. Thinner sections of tool edges often developed half-moon scarring, while the thicker edges developed more step and hinge terminations. When thicker edged tools such as bifaces and core tools are used for limestone-working, use-wear occurs as bit crushing and the removal of large microflakes with step and hinge terminations from exterior and interior surfaces (Lewenstein 1987:61-63; see Abrams 1984:41 at Copan). Damage such as edge crushing due to pounding or hammering activities was not included in the microwear analysis section (below). This type of damage was documented in the description of the tools themselves. Furthermore, other factors affecting the development of edge damage on stone tools are discussed in Appendix M.

'High-power Approach': Characteristics of Experimental Micropolishes

General observations:

Given the fact that most high-power microscopy use-wear analysts believe use-polish to be diagnostic of the contact materials, what follows is a breakdown of use-wear characteristics by material types encompassing researchers' observations. It should be noted that Grace (1989), Newcomer et al. (1986, 1987), and Unger-Hamilton (1984, 1988) are not convinced of the diagnostic exclusivity of micropolishes (see also Moss and Newcomer 1982; Serizawa et al. 1982:86), disagreeing with Keeley's (1980:83) statement: "The most important discovery made in the course of these experiments is that the microwear polishes formed by various worked materials have distinctive appearances and are, indeed, distinguishable from one another". Instead, they believe polishes from contact with different materials can overlap [Vaughan 1985:46 - Venn diagrams], that, in the early stages of development, many polishes are indistinguishable, and that other variables can affect the appearance of polishes [see Appendix N]. Consider Vaughan's

(1981:133-139, 1985:28-31) observations that polishes develop gradually with the rate of development varying by the worked material, as well as the raw material type [grain size] of the stone implement. Polishes that are not fully developed may look very similar in their early stages:

1. The initial stage of polish or 'generic-weak' polish is described as: "dull, stuccolike or lightly terraced surface, more or less flat, difficult to distinguish from natural bright spots on flint surface and from soil sheen" (Vaughan 1985:30; see also Mansur-Franchomme 1983a:94-99 for 'micropoli indifférencié'). This class of polish is not detected on medium-coarse grained flints.

2. The second stage of development or 'smooth-pitted' polish is described as: "small smooth polish components separated by pitted linkage polish and darker interstitial spaces; may appear with areas of generic weak polish in lesser affected portions of the flint edge" (Vaughan 1985:31). This stage of polish does not last long and eventually develops into the last/final stage of distinct microwear polish. 'Smooth-pitted' polish resembles those polishes found on implements used to saw anisotropic materials like antler, bone, reeds and wood (Anderson-Gerfaud 1981:61-62; Vaughan 1985:29).

Generally, when the worked material is very hard [i.e. - antler, bone, stone], the tops of the microtopography of the stone are completely flattened. When the worked material is 'medium-hard' [i.e. - wood, dry hide, some plants], the stone will acquire a 'pitted' or 'reticular'-looking polish because only the tops of the microtopography are polished. The entire surface of the stone, including the depressions, will be polished when the worked material is classified as 'soft' [i.e. - meat, fresh hide, some plants] (Unger-Hamilton 1988).

Initially, micropolish begins to form on the very crest of a stone tool's contact edge. The higher topographical features in this area, and likely, the surface ridges and more elevated regions are polished next. After this occurs, the next area to be polished is the lower topographical region of the regular tool surface. This is gradually followed by the progressive micropolishing of the higher and then lower topography of the tool surfaces further from the working edge of the tool (Vaughan 1981:137, 1985:29; see also Tomenchuk 1988).

Much like the determination of use direction from striations on tool surfaces, certain specific polish distributions can be very revealing in the same manner. For example, only transverse actions can produce a polish bevel, longitudinal actions create a triangular pattern and 'polish shadows' relative to surface features are only found on cutting/slicing [one-way direction] tools (Vaughan 1981:168-169). Finally, Hurcombe (1992:34) reminds use-wear analysts that not all tool polishes pass through the same polish stages at the same rate and that some polish types, such as meat polish, may never progress past a certain stage of development.

Experimental Worked Materials

Wood:

I found that wood polish initially developed on the higher points of microtopography and subsequently appears on lower surfaces, transforming from an initial bright lustre into a very bright polish that has been aptly termed 'domed' by many other analysts (Keeley 1980:35; Lewenstein 1987:84; Vaughan 1981:147, 1985:33; Yerkes 1983:504). As Keeley (1980:35) notes, these "...domes gradually enlarge, as work progresses, and link up". Generally, this linking up creates a distribution of wood polish that is termed 'reticular' [high degree of horizontal linkage of polish] (Moss 1983a:91). Although Vaughan noted the characteristics of wood polish, he described polish development from 'full polish domes' to 'bulging and sagging domes' to an 'undulating polish cover', to finally, a 'smooth polish blanket' (Vaughan 1981:147, 1985:33).

The undulations I observed on wood polish can often be useful in determining the direction of tool use, for example, as Vaughan noted (1985:33), 'valleys' in transverse polishes can be used to determine direction of use.

Keeley (1980:36) referred to quantitative differences in polishes between working 'dense' woods and 'less dense' woods. Much like Anderson-Gerfaud (1981:48-49; Hayden and Kamminga 1973:4; Kamminga 1977:207), I observed that soft and hard wood polishes are qualitatively identical, yet, 'softer' woods create considerably more polish than 'harder' woods used for the same length of time. As well, fresh wood possessed a 'brilliant' polish, while hard dry wood had a 'duller', 'sparse', 'localized' polish. Similarly, Unger-Hamilton (1988:69) noted that the 'reticularity' of wood polish varied with the hardness of the wood, the grain size of the stone, and the applied pressure, while the brilliance and amount of 'liquid'-looking polish depended upon the wood's moisture content. In general, wood polish has a wide distribution along the tool edge although this is dependent on tool action. For example, scraping wood often produces a continuous line of polish or 'bevel' along the scraping edge. Unger-Hamilton (1988:69) suggests it is likely a buildup of amorphous silica. Vaughan (1981:148, 1985:33-34) states that sawing wood polish never really develops past a bright, smooth-pitted polish. Transverse actions create a band of polish along the edge [in lieu of a true bevel]. Wood-boring/drilling leaves polish on the lateral edges and on the dorsal ridges of the implement.

I found that striations were infrequently observed on my experimental wood-working stone tools (Moss 1983a:91), but were quite frequently observed on lithics from the archaeological assemblages. Unger-Hamilton (1988:69, Mansur 1982) believes the lack of striations is due to the fact that the striations become filled with amorphous silica [polish deposit]. Striations could be parallel, broad and shallow (Bueller 1983:109; [15 microns] Keeley 1980:35; Moss 1983a:91) and long, narrow and deep (Lewenstein 1987:84). Anderson-Gerfaud (1981:52) emphasized the fact that Semenov (1964) discovered more striations on whittling tools than on those used for any other activities, while Yerkes (1983:504, 505,Fig.2A) noted a lack of striations on drilling tools.

In a few instances, experimental wood polish can be mistaken for antler polish, as well as some under-developed bone polish (see Keeley and Newcomer 1977:55; Moss 1983a; Unger-Hamilton 1988:69).

Bone:

I noted a greasy, semi-bright, 'pitted' polish localized near the tool edge that ended abruptly and did not gradually fade away like other polishes, especially with longitudinal actions like sawing (Anderson-Gerfaud 1981:58-59; Bueller 1983:109; Lewenstein 1987:97; Keeley 1980:43; Moss 1983a:92, pl. 6.4:g). Vaughan (1981:140) described bone polish as characterized by 'micropits', 'pit depressions', and 'interstitial spaces'. Anderson-Gerfaud (1981:58-59) did not observe the 'pitting' after treatment with HCl, but noticed wide depressions [10-20 microns] on the tool surface which I found to be much less common. Although Moss (1983a:92) did not observe the micropitting described by Keeley (1980), she did find the depressions mentioned by Anderson-Gerfaud (1981). Similar to other analysts, dried bone polish looked 'pitted' and 'matte' [little accumulation of amorphous silica] (Unger-Hamilton 1988:70), while fresh and cooked bone produced the more brilliant polish which I observed more frequently.

Like wood-working, I found the actions involved often affected bone polish appearance. A very bright polish bevel with a truncated cross-section surface and a flat edge only occurred on tools used for transverse actions (Vaughan 1981:140, 1985:33). Within the bevel, Vaughan (1985:31) noted directional features he termed 'comet-tails'. This same polish, unbeveled, occurred on grooving implements. A 'smooth-pitted' lattice of polish scored with grooves and troughs was present on sawing tools (Vaughan 1981:140-141, 168, 1985:31-32). Anderson-Gerfaud (1981:58-59) noted this brighter polish especially with longitudinal actions like sawing. I found that drills used on deer bone possess pitted polish that is restricted to the higher surface topography of the lateral edges of the tool (see Yerkes 1983:504, 505,Fig.2D). Yerkes (1983:504, 505,Fig.2C) observed similar polish formation on tools employed to drill turtle shell. The drilling of bear canine teeth produced a dull, pitted polish on the edges of the implement used.

Although I noticed fewer striations on experimental tools than on the archaeological examples, the bone working striations were generally shorter, wider and slightly deeper than those observed on the wood-working tools. There appears to be disagreement among other analysts about striations in bone polish. No striations are associated with bone working according to Bueller (1983:109), whereas Keeley (1980:43) stated that striations in the form of parallel tracks were common on bone-working tools. Lewenstein (1987:97) described her bone-sawing striations as shorter and wider than those appearing on her wood-working tools. Unger-Hamilton's (1988:70-71) striations are mostly deep and narrow, usually appearing on bone-sawing polishes, but not with scraping or planing actions, although polish bevels on scraping edges appeared to be lined. Moss (1983a:92, Pl.6.4:f) failed to notice any bone-polish bevel, as reported by other use-wear analysts on experimental tools, but noticed a flat bevel on archaeological specimens.

I occasionally confused bone-sawing polish with wood-sawing polish (Anderson-Gerfaud 1981:61; Bueller 1983:109) and like Unger-Hamilton (1988:71), I noted that bone polish bevels were similar to wood- or antler-scraping or grooving bevels. Similar to Keeley (1980:56; see Gendel and Pirnay 1982), Moss (1983a:92) and Vaughan (1981:135, 1985:31), I sometimes found bone- and antler-sawing polishes to be very similar.

Fresh hide:

On my experimental tools, fresh hide polish was moderately bright to matte-looking and 'greasy' with a 'reticular' distribution pattern when hides were scraped (Anderson-Gerfaud 1981:53-56; Hayden 1979:224; Keeley 1980:43, 49; Moss 1983a:86). In many cases, the brighter polish was restricted to near the tool edge and on the higher microtopography of the tool. Keeley (1980a:49; see Brink 1978b) observed that polishes varied depending upon the moisture and fat contents of hides, whereas Lewenstein (1987:101) noted that hide polish "... varies from bumpy to greasy on fresh animal skins like deer or jaguar ... to a smoother, nongreasy variety that resulted from contact with snakeskins ...".

There were few striations on my experimental tools used to cut/slice fresh hide, although scraping activities tended to produce some faint and thin striations in the direction of use.

Edge-rounding is also a feature of hide-working implements. Hayden (1979b:224) hypothesizes the increased amount of wear on the non-contact surface of scraping tools may be due to the 'semiplastic' quality of animal skin.

I sometimes had difficulty distinguishing between the cutting or slicing of fresh hide and meat polishes, which may explain why both Anderson-Gerfaud (1981:53) and Vaughan (1981:160, 1985:38) combined hide and meat polish categories. Although Keeley (1980), Moss (1983a:86), and Unger-Hamilton (1988:72) believed them to be distinct from one another, I only found this distinction simple when transverse actions were involved. Whereas Moss (1983:86, see also Gysels and Cahen 1982:Figs.2, 3) thought moist hide polish and the 'reticularity' of this polish could be confused with wood polish, I did not find this to be true. Usually, the wood polishes were brighter.

Dry hide:

Dry hide has a polish that is less bright and more matte and micropitted than fresh hide polish (Anderson-Gerfaud 1981:53-56; Bueller 1983:108; Moss 1983a:86; Vaughan 1981:159, 1985:37). According to Keeley (1980:43, 49) because dry hide is less yielding than fresh hide, it caused a polish that appeared 'pitted' [5 microns wide or smaller] and bright (1980:43, 49). However, when hides are fully dry or tanned, the polish is 'dull'. Vaughan's (1981:159, 1985:37) description of the polish as 'rugose' is very appropriate for the dry hide polish I observed on the experimental tools.

Like Keeley (1980:50, Bueller 1983:109, Lewenstein 1987:101), I observed many "diffuse shallow linear features" on my hide-scraping tools in the direction of tool use. I also noted some deeper striations removed from the immediate tool edge. Unger-Hamilton (1988:71) noted that striations were rarely produced when hide was cut, however, dry hide cutting produced a series of long and thin striations in the direction of use on my experimental tools. If an abrasive is added, dry hide polish will contain many perpendicular and diagonal striations, as well as, 'microcraters' (see Vaughan 1981:159, 1985:37).

Edge rounding occurred on scraping tools that were used for a substantial period of time (Bueller 1983:109: Hayden 1979b; Lewenstein 1987:101; Moss 1983a:86; Moss and Newcomer 1982:Fig.1) and Vaughan (1981:159, 1985:37) further noted that, in addition to substantial rounding of the contact edge, there was also rounding of the surface ridges near the edge of the tool.

In some cases, I confused under-developed dry hide scraping polish with transverse wood polishes when edge rounding was not well-developed. Unger-Hamilton (1988:72) found that the 'reticular' distribution of dry hide polish and wood [dry reed] were similar and hide and antler polishes were sometimes confused.

<u>Antler:</u>

As did most lithic analysts, I observed a distinct difference in antler polishes that were used with or against the grain (see Hurcombe 1992:47). Differences in antler polishes are linked to the anisotropic nature of this contact material, as well as, to longitudinal versus transverse actions. Like Keeley (1977:44, 1980:56), I observed that 'rough and pitted' polish occurred when sawing deer antler (see also Anderson-Gerfaud 1981:61-62; Moss

1983:a87; Vaughan 1981:143, 145), while scraping produced a 'bright', 'smooth' highly-linked polish marked by diffuse depressions which afford it a very characteristic 'melting snowbank' appearance. Vaughan (1981:144) noted a 'domed' appearance on tools used to work soaked antler, especially when it was scraped or planed. Anderson-Gerfaud (1981:61-62; Moss 1983a:87 [10-20 microns in diameter]) noted the presence of micropits roughly 10 microns in diametre. Unger-Hamilton (1988:72) did not notice the same 'pitting' seen by others. Although Moss (1983a:87) observed the same restricted distribution or 'band' of this polish to the very tool edge as did (Vaughan 1981:144), she further observed patches of polish that gradually tapered away into the unpolished tool surface.

I found it extremely difficult to work old, dry antler, and discovered that it needed to be soaked in water to be used at all. Antler cannot be worked efficiently unless it is fresh or soaked in water (Vaughan 1985:33). Unger-Hamilton (1988:72) discovered that the general distribution or pattern of soaked antler polishes were wide, bright and reticular [similar to wood polish]. Yerkes (1983:504) described a bright, pitted polish with less doming on drills used on soaked antler. Dry antler polish looked 'matte' and less reticular.

Even though striations are uncommon, sometimes short, narrow, moderately deep ones occur (Keeley 1980:56). Working dry antler seemed to produce deeper and narrower striations that were not usually observed on tools used on soaked antler (Vaughan 1985:33). Yerkes (1983:504, 505,Fig.2E) noted that small narrow striations that are perpendicular to the long axis of the tools are observable on drills. Unger-Hamilton's (1988:72) tools used to saw antler revealed considerable striating of the flint surface, while transverse actions caused polish 'bevels' that were similar to those that I observed. According to Vaughan (1981:144-145, 1985:32), the edge bevel is rounded in cross-section with a gently undulating flow along the edge and is almost completely devoid of 'comet tails'. Rubbing tools against antler created a polish with a 'streaky' distribution and a flattening of the raw material surface (Unger-Hamilton 1988:73).

I sometimes confused smooth antler polish from transverse actions with wood polish based on the presence of a developed band of polish instead of a real bevel on the contact edge, as did Keeley and Newcomer (1977:55), Unger-Hamilton (1988:73) and Vaughan (1981:144, 1985:32). Similar to my observations, Unger-Hamilton (1988:73) and Vaughan (1981:135, 145) also found that antler-sawing and bone-sawing polish could be indistinguishable, and also noted that antler- and bone-scraping 'bevels' could appear similar, although Keeley (1980:56) doubted this. Moss (1983a:87) mentioned that the appearance of antler polish was similar to bone polish, but its distribution was more like that of wood polish. Unger-Hamilton (1988:73) observed a similarity between under-developed antler polish and dry hide polish.

Horn:

I did not experiment with horn polish. However, according to Unger-Hamilton (1988:73), working soaked horn results in very little polish development with only a few areas of relatively flat polish and a few short striations. The flint edges of the tool, however, are blunted. Pawlik (1993:223) further described this polish as bright and reticular and possessing some micropits. The reason for Unger-Hamilton's belief that working soaked horn produced little polish may be due to Pawlik's (1993) observation that this type of polish developed more slowly than bone, antler or wood polishes. Unger-

Hamilton (1988:73) thought horn-scraping polish could be confused with weak hide or antler polish. Based on photomicrographs, I found horn polish to be very similar in appearance to antler polish.

Fish:

In my experiments, I found fish polishes to be quite different one from another depending upon the motion and the part of the fish that was used. Similar to some of my observations, Unger-Hamilton (1988:74) noticed that there was rarely any polish created when fish was gutted. I also found there was little polish if the fish meat was cut longitudinally and the bones were avoided. Crude and not very successful attempts to fillet fish also left few polish traces. While Unger-Hamilton (1988:74) and Anderson-Gerfaud (1981:54) observed a bright polish line at the tool edge that was accompanied by a flattened polish that was well-developed and 'greasy', this only occurred in my experiments when I cut through flesh, skin, bone and/or spines/fins. Moss (1983a:105,1983b:151) did not observe the 'greasy' look in her dull polish band. When fish was scaled, Moss (1983a:105,1983b:151) observed a distinctive 'cross-hatching' pattern at 140x magnification. Although I noted polish development on my experimental fish scaling tools, I found it difficult to detect Moss' wear pattern in my archaeological assemblage. Instead, the fish-scaling polish on my tools was more similar to the diagnostic streaky polish oblique to the tool edge described by Unger-Hamilton (1988:74).

My observations of the striations on tools also varied with the part of the fish affected and the motion involved. Cutting produced some fine striations that were mostly parallel to the tool edge if skin, flesh and bones were cut (see Semenov 1964:107; Unger-

Hamilton 1988:74). Anderson-Gerfaud (1981:54) observed polish with long [20-30 microns], wide striations. On her tools, Moss (1983a: Pl.6.8:g) noticed a groove from 50 to 100 microns long and 20-30 microns wide that appeared in the centre of most of the polish bands. I did not observe this same long groove in the centre of my tools. Perhaps her manner of scaling fish was different from my own.

I had trouble distinguishing between meat and fish polishes when they were under-developed, when fish were gutted or when only fish flesh was cut. Variable striation patterns also made identification of fish polishes difficult at times, although fish scaling was distinctive. Unger-Hamilton (1988:74) warns that the absence of the streaky scaling polish does not necessarily eliminate fish as a possible worked material. Van Gijn (1986) believes there is a lack of visible fish polish on her flint tools because clay particles in the soil matrix 'preferentially attack' them.

Shell:

In my experiments, shell-working polish was primarily restricted to the areas of higher microtopography on the tool surface and gradually spread to areas of lower topography (Lewenstein 1987:11; Unger-Hamilton 1988:75). Similar to Lewenstein (1987:113) and Yerkes (1983:504), I found shell polish to be bright and not quite perfectly smooth. Unger-Hamilton (1988:75) aptly described it as being flattened to a greater degree than bone, but to a lesser degree than stone. Moss (1983a:104, Pl.6.8a, 1983b:151) observed that shell boring produced a dull polish, which is quite different from my shell polishes. Yerkes (1983:504) found that drilling shell [marine or fresh-water] created an extensive polish "... with a pattern of cracking or crazing on the smoothed microtopography of the tool that is similar to egg white spread on a broken mirror", however, I found it difficult to determine whether or not my shell-drilling polishes fit this description. Like Lewenstein (1987:115), I observed that polishes were restricted to the very edges of my tools due to the resistance of the worked material.

Shell polish was always accompanied by fine bundles of striations on my experimental tools (see Unger-Hamilton 1988). Lewenstein (1987:115; Yerkes 1983) noted that striations on drills are perpendicular and diagonal to the tip and are narrow, deep and vary from medium to long in length. Moss (1983a:104, Pl.6.8a, 1983b:151) described regularly-spaced, parallel striations that appear similar to a 'ploughed field' that are perhaps caused by seasonal growth rings [> 200X].

Unger-Hamilton (1988:75) believes shell use-wear polish may be confused with antler, bone or stone (see Moss 1983a:104) polishes only if striations are present.

Meat:

Like Keeley (1980:53-54), I found that meat polish could develop with variable brightness, and possessed a 'pronounced greasy luster'. Although Bueller (1983:108) characterized this polish as having a 'dull lustre' that initially formed on the higher sections of the surface microtopography of an implement, he claimed that meat never caused true polish formation. Moss (1983a:93) described meat polish as bright and smooth, but thought "... that 'greasy lustre' [was] not apt". I found her description of a brighter polish appropriate, but noted a definite 'greasy' polish on my experimental tools used on meat. According to Moss (1983a:93, 1983b:147; Moss and Newcomer 1982:Fig.1) there is a difference in meat and fresh hide polish based on their distribution. Meat produces a polish band approximately 2-3 mm away from the cutting edge, while fresh hide polish is restricted to the tool edge crest and is more widely distributed.

Meat polish formed slowly on my experimental tools, and unless well-developed appeared as a very weak polish (see Vaughan 1981:161-162, 1985:38). Prolonged tool use will result in the formation of a thin band of bright, smooth polish restricted to the crest of the working edge. Both Keeley (1980:53-54) and Unger-Hamilton (1988:74) noted that meat polishes possess little amorphous silica deposit.

Any variation in polish could be dependent upon tool contact with bone or tendon and/or the use of a wooden cutting board. While bones and tendons caused bright striations, wood polish in isolated patches resulted from tool edge contact with the cutting board (Unger-Hamilton 1988:74). While butchering carcasses may also produce isolated smooth-pitted polish possessing some parallel troughs and lines of bone residue, this is dependent upon the amount of contact with harder materials such as bone (Vaughan 1985:38).

In most cases, striations were quite rare on my experimental stone tools, however those that did occur were usually long and fine. Although, most analysts also observed that the few striations on their tools were fine and suggest one reason for this may be the lack of abrasive particles (Anderson-Gerfaud 1981:54; Semenov 1964:21; Keeley 1980:53-54; Moss 1983a:93), Bueller (1983:108) describes meat striations as minute, short and deep and Lewenstein (1987:108) observed that the most common type of striation was long, deep and narrow, but long, shallow and narrow striations and other types also occur on her tools. The presence of animal fat may act as a lubricant and reduce the number of striations produced (Brose 1975).

In my experiments, I found that weak meat polish was very similar to fresh hide polish, and that some fish gutting and longitudinal cutting polishes looked like weak meat polishes. Whereas Anderson-Gerfaud (1981,Vol.1:53) and Vaughan (1981:66, 1985:38) were unable to distinguish between meat and fresh hide polish, both Moss (1983a) and Unger-Hamilton (1988:74) stated that meat and hide polishes were distinct and could be differentiated on experimental implements - even though Unger-Hamilton (1988:74) experienced a great deal of difficulty detecting meat polish on coarse-grained flints.

Stone:

My stone polishes were quite distinct, consisting of bright spots that either occurred on the higher microtopography of tool surfaces (see Lewenstein 1987:11; Unger-Hamilton 1988:76) or appeared to completely shear off or wear down the stone in affected areas. Anderson-Gerfaud (1981:44) noted the presence of 'bright, linear spots' when her lithic implements came into contact with other stone, and Keeley (1980:28) observed hammerstone 'smears' that he described as "broad, very flat bright areas", likely the result of some amorphous silica deposit. According to Vaughan (1981:170-171) when a hammerstone contacts a core, it creates a slight beveling and a 'dull-bright' polish described as 'bumpy' with "deep, wide grooves".

Like all of the other analysts, striations were always present when stone was worked with my experimental tools, except in some rare cases of accidental rubbing when the tops of the higher topography projections were sheared off. Striations occurred in variable lengths, depths and patterns. Striations on Lewenstein's (1987:110) stone-working implements were short and shallow and could be either narrow or wide. While, Moss (1983a:103, pl.6.8c) found that stone polish was always characterized by numerous striations, she also noted, based in part on Harding's experiments, that the addition of water greatly reduces the production of micropolish and striations on stone contact materials. Unger-Hamilton's (1988:76) stone polish was accompanied by bundles of striations. She also found that differing tool actions did not seem to have any affect on polish formation, however, the worked stone type can affect polish appearance. Unger-Hamilton (1988:76) notes that working softer stones creates a more diffuse-looking polish characterized by a finely scratched tool surface.

Unger-Hamilton (1988:76) confused stone [malachite] polish with sand and pottery polish. Although damage from hammerstones is usually distinct, it may be the main reason use-wear identification mistakes are made on scraping tools (Unger-Hamilton 1988:76). I found this last statement to be true, when some of the hammerstone polishes on my experimental tools looked like well-developed scraping polishes or bevels that could be mistaken for heavily striated wood or bone polishes.

Pottery (Ceramic):

The polish on my sherd-working tools is bright and diffuse (see Unger-Hamilton 1988:76) and, as Lewenstein (1987:116) describes, progresses from a 'highly reflective smoothing' of the higher microtopography in the early stages of tool use to a much greater extent after longer use.

Striations are always observed on well-developed polishes and are usually long, ranging from either fine and narrow or wide and shallow or deep (Lewenstein 1987:116; Unger-Hamilton 1988:116). On her tools, Unger-Hamilton (1988:76) noted that sometimes pottery residues still adhered to the tool edge even after cleaning. I found that this only occurred with any regularity when sherds with softer tempers, such as ash, were worked.

Unger-Hamilton (1988:76) could not distinguish between pottery and sand polish (see pottery residues above), and found a similarity to soft stone polish. Although, my stone polishes could appear similar to sherd polishes, contact with stone usually created a brighter and flatter polish, that, in cases of accidental contact, was distanced from the tool edge.

Feather:

Although I did not experiment with feathers, Unger-Hamilton (1988:77) performed one experiment in which the quill of a pigeon feather was cut. The resulting polish appeared as a thin, indistinct band along the implement edge.

Plants:

Like Vaughan (1981:154-155), I observed that plant polishes usually formed more slowly than those of other harder materials. Because of this slower development, plant ~~polish passes through a number of stages from what he described as 'generic-weak'-~~ looking polish to eventual macroscopic sickle gloss (see Moss 1983a:95). Like Unger-Hamilton (1988), Keeley (1980:60) and Vaughan (1981:155, 1985:36), I note that polish can be very widespread and invasive, and that infilled striations or comet-shaped pits can occur within it. Although most plant polishes can appear 'buoyant', Unger-Hamilton (1988:78) noted considerable variation due to plant hardness and stem width.

In terms of its distribution, this polish is very invasive affecting the whole microtopography of the tool edge, but only affecting the tops of the microtopography as one moves away from the edge (Anderson-Gerfaud 1981:45-46).

Generally, I found fresh plants produced more brilliant polish at a faster rate than dried plants. According to Unger-Hamilton (1983, 1988:79), this is likely due to the greater moisture content. She further noted that the distribution of wear polishes did not vary between wild and domesticated plants of similar species (Unger-Hamilton 1988:79). In describing lowland tropical fibre polish, Lewenstein (1987:118) states that it is bright and similar to that seen on wood-working tools. Given the pliable nature of this material, the polish extends quite broadly from the tool edge.

The striations I observed on my experimental tools proved very useful in identifying the direction of use and developed relatively rapidly as long and narrow features (see Anderson-Gerfaud 1981). I also found that cutting dried plant material produced many more striations than cutting fresh plants (see Moss 1983a). Lewenstein (1987:121) noted that striations caused by tropical plant fibres are long, narrow and of variable depth.

Anderson-Gerfaud (1981:46, 1982, 1983:90-91) observed that water content [green vs. dried plants] affected polish formation; fresh plant polish developing more rapidly and appearing more intense. According to some analysts (Diamond 1979; Kamminga 1979; Witthoft 1967), while cutting plants growing in water failed to produce any striations in the tool surface polish, the harvesting of plants from loose soil produced striations, comet-shaped pits and micro-pitting that looked "... like the effect of sandblasting ..." (Unger-Hamilton 1988:79; see Kamminga 1979:145; Korobkova 1980:331).

Unger-Hamilton (1988:79-80) believes that strong macroscopic gloss on tool surfaces renders the majority of plant polishes easy to distinguish, but warns plant polishes themselves are not exclusively distinct. Dry plant and well-developed wood polishes could be confused (Keeley 1980:61, Fig.19; Vaughan 1981:155).

<u>Reed and woody plants:</u>

I found that the well-developed reed polishes that formed on my experimental stone tools were very similar to those described by Vaughan (1981, 1985). When cutting reedy plants, the polish was very bright with a strongly linked pattern of 'domed' polish with interstitial spaces. I found that whittling and planing motions could create two types of polishes. The first polish was similar to that of wood on the contact surface, with a bumpy polish on the opposite surface and occurred mostly when harder stemmed plants were worked. The second type of polish was a flat, smooth and very bright polish bevel on the contact surface edge with the bumpy polish on the non-contact surface, and, on the areas with more developed polish, "... an extensive cover of smooth, very bright, gently undulating polish with diffuse depressions in the polish surface"(Vaughan 1981:150-153, 1985:35).

Unger-Hamilton (1988:78-79) observed that while hard stemmed plants [reeds, einkorn] produced a 'reticular' polish, very soft plants [bullrushes] polished the entire tool surface. This 'reticular' polish was similar to the 'woody' polishes described above. She (Unger-Hamilton 1988:78-79) further noted that thick-stemmed plants [reeds, bullrushes] produced wide, quite even polish on tool surfaces, medium-stemmed plants [cereals, hollow cane] left a concentrated band of polish on the very edge of the implement accompanied by weaker polish slightly removed from the edge. I found this distinction was most evident when reedy plants were cut or sawed. Transverse action polishes were not usually affected by the width of the contact materials.

On harder reedy plants, striations formed rather quickly and were long and both narrow and wide. The striations were deeper on the stone tools that worked harder reeds as opposed to those used on softer rushes. The striations on my experimental tools used on softer reedy plants, when they developed, were primarily long and narrow with occasional wider lines.

I noticed that early stages of reedy plant-cutting polish looks similar to that of wood cutting and sawing and that the 'smooth' polish on the edge of reed-planing tools is similar to antler- or wood-scraping or planing polish (Vaughan 1981:151, 1985:34; see also Gysels and Cahen 1982:Fig.4). Unger-Hamilton (1988:80) also found that reed polish was similar to fresh wood polish, but is rarely striated.

Hafting traces:

In general, hafting traces, such as polish and striations, are controversial elements of use-wear analysis. There is much debate and disagreement among researchers as to the exact nature and occurrence of these features.

Semenov (1964:115; see also Cauvin 1973) concluded that "... proof of the use of bone or wooden handles can be seen in the sharp demarcation between the polished and mat surfaces ..." on lithic implements, a statement with which I am in agreement. Although Keeley (1980; see Cahen et al. 1979:681) believed a properly hafted tool would not be loose, and that there is no simple discrete wear pattern that can be called 'haft wear', he claimed to have positively identified, not only hafting traces, but, also the raw material of the hafts themselves based on these traces (see Bueller 1983:114-124). In most cases, the haft polish appearing on tools from the archaeological assemblages from Marco Gonzalez and San Pedro was similar to wood polishes with occasional dry hide polish appearing as well.

I recognized haft traces on my experimental tools based primarily on polish location and the combination of wear polish traces and striations indicating direction of use. Haft polish usually manifests itself as bright and smooth patches on tool ridges and raised sections of the microtopography. With continued use, the tool develops linear polished zones along the use/directional axis of the tool. According to Lewenstein (1987:127,130), this type of polish development is dependent on factors such as length of use, surface morphology of the implement and the quality of the binding.

In addition to polish that appeared as localized rounding on lateral edges and/or on dorsal ridges caused by the friction of a stone tool in a loose haft, Odell (1977) investigated diagnostic edge damage on the hafted sections of implements.

Anderson-Gerfaud (1981:,Vol.1:41) noted traces of hafting on her tools from the Mousterian of southwest France based on their location on parts other than the used sections of the implements. Some of the traces she describes include:

1. linear abrasion and plant polish on the ventral surfaces of tools accompanied by the rounding of parts of the implements' lateral edges and dorsal retouch scars.

2. the presence of two different and localized patterns of surface wear on tools, perhaps indicative of the past presence of a now decayed haft that left a 'fresher looking' polish; less affected by soil sheen (see also Keeley 1978:78, 1982).

3. very localized areas of wood polish.

4. a smoothing of the bulb of percussion, of the striking platform of a tool (also see Jenson 1982:325), traces of abrasion and parallel striations on lateral edges and on the proximal end of a tool.

5. morphological tool characteristics due to intentional modification to fit in a haft/handle such as thinning retouch on the proximal end (see also Keeley 1978:78 for thinner scrapers), notches on both lateral edges or accidental breakage of hafted tools such as torsion breaks (see Rigaud 1977:20, 37, Fig.19 for 'type B' breaks *par flexion inverse*).

Whereas some archaeologists acknowledge the presence of haft traces on their stone tools and have even managed to determine the hafting materials, others are not as convinced of the ability to detect such traces on their used stone tools and relied more heavily on the preservation of hafting residues on their tools (see Brink 1978a; Moss

1983a:101-102; Moss and Newcomer 1982; Plisson 1982a, 1982b:285; Unger-Hamilton 1988:80-81). Moss (1983a:102) advocates the use of criteria such as tool shape, frequency of tool resharpening or the actual recovery of the hafts themselves to determine ancient hafting practices.

Prehension traces:

Although Odell and Odell-Vereecken (1980) reported prehension traces in the form of edge damage, and numerous other researchers (Keeley 1982:807; Semenov 1964:14, 107; Vaughan 1981:164-165, 1985:39) documented polish and striations caused by prehension with dirty/gritty fingers as evidence of hand-held implements, both Moss (1983a:102) and Unger-Hamilton (1988:81) believe, due to the inconsistency of such traces, that identification of prehension traces is highly speculative and unlikely. In opposition to this statement, Owen and Unrath (1989) believe that prehension traces are identifiable on lithic implements. The pattern of wear produced is dependent upon factors such as: applied pressure, duration of use, tool surface topography, the presence of dirt/grit and relative humidity. Given that the archaeological assemblages I analyzed had been subjected to considerable gritty soil and/or sand contact and the ephemeral nature of prehension traces themselves, I did not feel confident in my ability to reliably recognize them on the lithics from Marco Gonzalez and San Pedro.

Additional Factors Affecting Use-wear Patterns at Marco Gonzalez and San Pedro

Use-wear and tool re-use and recycling:

Based on the numerous natural and cultural processes affecting the tools deposited in the archaeological record of the Caye, activity-related polishes and striations were sometimes difficult to segregate from background surface modification. It appears as though tools were employed for a variety of different tasks before being discarded, incorporating the concept of 'task-specific discard rates' for the analyst. In many instances, efforts to predict tool disposal patterns in the archaeological record based on quantitative estimates do not consider that tools used for different tasks will have different exhaustion rates (Ammerman and Feldman 1974; Hildebrand 1978; Hurcombe 1992; Shott 1989b). A basic fact known to most analysts is that some activities will produce higher rates of discard than others. Nevertheless, where lithic raw material is scarce such as on Ambergris Caye, these discard rates may be substantially reduced through re-use and recycling. It is this type of conservation that increases the likelihood that the incidence of use-wear traces on the lithics will be higher and that the stone tools being studied will possess much more complex use-histories consisting of a single task with numerous use-sets or a series of quite different tasks (Hurcombe 1992:67-68). Whereas, the analyst should be able to use the series of use-sets to reconstruct a task, some *ad hoc* tools will never be discovered because they will not have been used enough for distinctive microtraces to develop (Aldenderfer 1990:67). Furthermore, if a later task produces much heavier or more developed use-wear, the previous polishes from earlier activities may not be identifiable. Similarly, if re-sharpening, re-use or re-cycling of the tool occurs, the previously utilized edges may be removed from the tool rendering identification of earlier task performance much more difficult (see Lewenstein 1987:167). This is especially true if the re-sharpening or modifying flakes are not recovered from the archaeological record (Hurcombe 1992:68, 97).

Use-wear and lithic raw material:

Attempts to draw accurate conclusions concerning patterns of use-wear by raw material type may prove difficult with these lithic assemblages. Whereas burnt, patinated or manganese-oxidized tools were, whenever possible, identified as either CBZ chert, black chert, chalcedony or other chert based on the identification of unmodified areas of raw material, identification of use-wear on burnt or patinated tools was not as simple. To determine the presence of use-wear on these altered tools is a much more dubious process because, although few tools were completely burnt or patinated, particular areas that were used to perform a task may have been hidden or destroyed by the burning or patination processes. Therefore, heavily burnt, patinated tools that were classified as other cherts are also likely to be those tools whose use-wear traces were not detected. Consequently, the percentage of other chert tools possessing evidence of use-related polishes and striations will likely be lower than those that were actually used, while most of the tools manufactured from CBZ chert that possess use-wear traces will be identified and the type of use in terms of motion and contact material documented.

A second possible explanation for the greater number of CBZ chert tools with use-wear traces may be due in part to the raw material itself. The CBZ chert is generally finer grained than many of the cherts classified as 'other'. As such, use-wear polishes and striations would have developed much more rapidly on the finer grained raw material from the 'chert bearing zone' of Northern Belize than on the coarser grained stone from outside this region. Although tools from the two raw material classes may have been used to perform the same tasks for comparatively similar lengths of time, polish would have formed much more quickly and more visibly on the finer grained stone.

A third possibility for the resulting use-wear patterns may also be the product of Maya behaviour at San Pedro and Marco Gonzalez. The inhabitants of these Caye sites may have deliberately and preferentially chosen the CBZ raw material for physical properties such as edge sharpness, ease of retouch and repair, or some other characteristic. Although this is considered a plausible explanation, I believe the number of burnt and patinated tools in the other chert tools category, as well as, the coarse grain of the lithics classified as 'other' are more reliable reasons for the discrepancies in use-wear on the lithics in these assemblages.

CHAPTER 13

Environmental Exploitation: Flora and Fauna

Determining how the Caye Maya exploited their coastal environment requires knowledge of the composition of natural resources available to them and the different ways in which they acquired both subsistence and craft or trade goods. Although the inhabitants of Marco Gonzalez and San Pedro exploited a wide range of plants and animals, they were much more dependent on some species than others.

Faunal Remains

Fish:

Evidence of the extensive exploitation of fish is provided by the faunal material from Level 21 at Structure 27 from Marco Gonzalez [see Appendix O]. Given the variety of fish remains recovered, it appears numerous techniques were employed to catch both shallow water reef fish and deep water varieties. Fishing techniques included line fishing, net fishing, spearing, harpooning, and pot fishery (Coe 1987; Graham 1994:257; Vail 1988:66). Reef herbivores such as parrotfish and surgeonfish could be caught using fish traps or pots. It is possible that aquatic turtles could be caught in the same way (Seymour 1990:15, 1991:22; Wing and Reitz 1982). Fishing with nets is not typically practiced inside the reef, because the nets can snag on corals. Nevertheless, nets may have been employed to catch some species such as snook, although they can also be caught using hook and line (Seymour 1990; Wing and Reitz 1982). Unretouched chert flakes were used by the Maya to recycle potsherds into net weights or *mariposas,* especially during the Late Postclassic period. Hundreds of these shaped and notched sherds have been recovered from the coastal sites of Cerros, northern Ambergris Caye, Kakalche and

Watson's Island (Garber 1995; Graham 1994:308; Lewenstein 1987:63; see Pohl 1990:156), as well as from Marco Gonzalez.

Many carnivorous fish species can be caught using hook and line, including catfish, jacks, groupers, snappers (Wing and Reitz 1982) and barracudas (Seymour 1990, 1991:20). Fishhooks have been excavated from Altar de Sacrificios (Willey 1972) and from Barton Ramie (Willey 1965), while line weights have been recovered from Postclassic Macanche and from Barton Ramie (Bullard 1973). It is also likely that similar paraphernalia would be necessary to successfully fish for sharks. Although sharks were important to the coastal Maya as both sources of food and raw materials, faunal evidence is rare, primarily because shark skeletons are entirely composed of cartilage or calcified cartilage (Lange 1971). Hamblin (1984:24) notes, however, that because the vertebral centra of these fish can become calcified and their teeth are usually well-preserved, shark remains can be identified in the faunal assemblages. Seymour (1990:9, 1991:11) has identified chondrichthyean vertebrae at Marco Gonzalez that are likely from 4 species of sharks, but which may also represent skates or rays.

In addition to fishing for subsistence purposes, the Maya relied on fish to acquire items essential for ritual or ceremonial piercing of the tongue, lips, cheeks, nose, ears, and penis (Coe 1987; Hamblin 1985:169). The caudal spine of the surgeonfish, and the dorsal spine of the trigger fish were both used in this manner (Hamblin 1984:38; Vail 1988:67, Table 2). While researching the types of animals used by the Maya, I wondered whether the spines recovered for ritual purposes were deliberately sought after or whether their acquisition was incidental to capture of these fish for dietary purposes. In answer to this question, Vail (1988:67, Table 2) stated that parrotfish were probably not a food source and were likely caught for ritual or ornamental use. Similarly, many archaeologists (Thompson 1966:218; Tozzer 1941:190-191; Borhegyi 1961; Lange 1971; Wing 1977:50-51) have suggested that stingrays were probably not captured for food, but that their spines were desired by the Maya as implements in ceremonial scarification and bloodletting. Furthermore, because there seems to be a strong correlation between the occurrence of shark teeth and stingray spines in ritual caches, burials or ceremonial offerings (Wing and Steadman 1980), Borhegyi (1961) posits that whole, unperforated shark teeth recovered from these contexts at Maya sites may have been similarly employed for bloodletting and mutilation ceremonies. Graham (1994:259) further suggests that tarpon (*Megalops atlanticus*) scales may have been employed for decorative purposes.

Marine molluscs:

In the 1970's, there were several studies published such as those by Bailey (1975), Osborn (1977) and Parmalee and Klippel (1974) suggesting that shellfish including crabs, echinoderms, and molluscs, were primarily used as marginal resources that were only consumed as a food of last resort or to supplement regular sources. However, more recent publications (Glassow and Wilcoxon 1988; Meehan 1982; Perlman 1980; Yesner 1980) have recognized the potential importance of shellfish in the diets of prehistoric populations. These authors have emphasized that there exist specific cultural and/or environmental circumstances in which shellfish would constitute "a viable alternative to terrestrial resources" (Erlandson 1988:102). While Yesner (1980:733) has noted the economic advantages of shellfish collecting in areas where they are relatively abundant, based on the ease of the task and their predictable location, Glassow and Wilcoxon

(1988:47) point out that marine resources, particularly shellfish, become extremely important in regions, such as coastal environments, where "...'large package' terrestrial resources such as deer are not abundant enough to supply a human population's needs".

It is likely that shellfish played a major role in the coastal Maya diet based on an estimate of more than 50,000 large shells from conchs excavated from only three structures at Marco Gonzalez (Seymour 1990:16, 1991:23), and the recovery of shells in peripheral midden zones. Shells used as platform cores in construction at this site included *Strombus gigas* (queen conch), *Turbinella angulata* (West Indian shank), *Cassis madagascariensis* (emperor helmet), *Melongena melongena* (brown conch), *Fasciolaria tulipa* (tulip), *Antigona listeri* (Princess venus), as well as tellins, chiones and donax (Seymour 1990:10-11, 1991:15; Graham and Pendergast 1989:4). Because marine molluscs inhabit reef, estuarine, and inshore environments, they are easily obtained. Inasmuch as modern-day fishermen in Belize commonly travel to the offshore cayes and surrounding islands to collect shellfish, this activity is also well-documented in the Prehispanic period (Hamilton 1987; Vail 1988:69). According to Vail (1988:66), species such as brown conch, mud conch (*Melongena corona*), fighting conch (*Strombus pugilis*), and queen conch were the most intensively exploited by prehistoric peoples along the Belizean coast. Supporting evidence for this may be the presence of chert-crushing or pounding tools recovered from Marco Gonzalez and San Pedro. It has been suggested that chert-chopper/pounders from the Middle Classic Period midden on Moho Cay may have been used in this type of butchering activity. The battered and crushed edges on some of the tools indicate they were perhaps used to break holes in large conch shells to remove the meat inside (McKillop 1984:32). At Ek Luum, Shaw (1995:180) noted that very few conch shells possessed breaks consistent with the removal of the mollusc meat.

Although this may seem difficult to prove, I believe that a careful examination of conch shells from midden deposits may reveal a pattern of breakage indicative of deliberate impact on specific areas of the shells to facilitate the removal of the animal. A second possibility for determining whether the Maya used pounding tools on shells, could be the presence of microscopic shell fragments or traces of calcium carbonate from shells embedded in the cracks of the pounding surfaces of the lithic tools. In support of McKillop's (1984) statements, McGuimsey (1956:156; see Voorhies 1978:13) has also suggested that grinding tools were associated with the processing of shellfish.

In addition to supplying food for the Maya, the shells from molluscs also served as an additional source of raw material for tool production. Retouched chert burin spalls that were used for conch trumpet manufacture have been discovered at Colha (Dreiss 1982:214-215, 180; Lewenstein 1987:66). Many drilled shell disks and other decorative pieces were recovered from Marco Gonzalez (E. Graham, pers. comm. 1998) and numerous shell scoops, perforators, scrapers, fish-hooks, pendants, and/or tinklers were recovered from coastal sites such as Tulum (Rubio B. 1985) and from sites on the north end of Ambergris Caye (Garber 1995). Shell artifacts have been recovered from numerous ritual and burial contexts at sites such as Tikal and Altun Ha (Moholy-Nagy 1985; Pendergast 1979). It has further been suggested that some molluscs may have been used to produce dyes (see above).

Other marine animals:

Other marine resources commonly exploited by coastal inhabitants include crabs, shrimp, turtles and manatees (McKillop 1984:25; Vail 1988). Crabs could be captured using baited traps, hand lines, dip nets, and spears, or simply by hand (Hamblin 1985:167). Sea turtles were likely caught with dragnets or when they went ashore to lay their eggs (Hamblin 1985:167; Wing 1975b:187). Even though turtles have not been reported as a primary subsistence source in the coastal Maya sites of Belize, the presence of their remains at Cerros (Carr 1986), Lamanai (Emery 1990), Moho Cay (McKillop 1984), and Colson Point (Graham 1994) identify them as possible secondary dietary resources. Based on a re-analysis of some of the faunal material from Lamanai, N. Stanchly (pers. comm. 1999) reports that the number of turtle remains is much higher than previously reported. He has identified burning on the outer shell surface that he believes is due to turtles being cooked whole (see Hamblin 1985:166). The greater number of turtle elements and the burning on the shell fragments leads Stanchly to the conclusion that turtle may have been far more important to the Maya than previously suspected. In conversations, he hypothesized that, despite the paucity of supporting archaeological evidence at Maya sites, turtle eggs may have been a rich source of protein for the coastal Maya. In addition to their use as food, turtles' shells could have been used as containers, drums, or possibly shields (Healy 1988:27; Vail 1988:70). In the Historic period, Landa (Tozzer 1941:190) noted that manatee were not only hunted for their meat, but were used to make lard for the cooking of food. It has further been suggested that manatee may have been hunted for their oil, which burns relatively cleanly (E. Graham, pers. comm. 1998).

Terrestrial animals and birds:

Seymour (1990) has identified four terrestrial animals (white-tailed deer, brocket deer, hispid cotton rat, and iguana) and one bird (cormorant) from the Caye (see Appendix B). Although deer were a staple in the Maya diet (Hamblin 1984:138), the few remains from Marco Gonzalez suggest that deer was not a primary food source on the Caye. Much like the island of Cozumel (Hamblin 1984:141), deer likely did not naturally inhabit Ambergris Caye, and were probably imported or traded from the mainland (Shaw 1995:180). Hamblin (1984:162) further suggests that the hispid cotton rat was most likely another intrusive animal. The iguana and cormorant are animals that are native to the coastal Belize and the cayes.

The recovery of perforated jaguar teeth and dog teeth also indicate non-native species or elements thereof that were imported or traded to Marco Gonzalez.

Although a full faunal analysis has not been undertaken on the remains from San Pedro, a preliminary examination has identified skeletal elements from *Felidae* [SP 124], *Crocodylus* [SP 116, 176], *Aves* [SP 115], and *Osteichthyes* [SP 165], specifically barracuda, triggerfish, and sand shark.

Plant Use

Evidence for agriculture?:

Although agriculture, the deliberate land clearance and modification of the landscape for the planting of specific vegetable foods, was widespread throughout mainland Maya territories, there is debate as to whether or not it occurred in coastal environments, or more specifically, on the Cayes. Although Rice (1974:16-18) correctly noted that the coastal plain is largely unsuitable for milpa agriculture, some evidence has been offered to suggest that agriculture was practiced. Because Gann recovered a number of metates from the site of "San Pedro", he posited that corn was grown on the high ground of the Caye (see Vail 1988:77). In addition to this, Hamman-Hollander (1984) documented the presence of what she referred to as prehistoric "imported earth" gardens near the sites of San Pedro and San Juan. Based on this evidence, she hypothesized that humus-rich soil may have been transported from the mainland sites of either Sarteneja or Bomba to increase agricultural productivity on Ambergris Caye. However, when Guderjan et al. (1987) examined these areas, an alternative explanation was that the humus-rich soil was the result of refuse accumulation and not imported agricultural soil from the mainland (Vail 1988:77-78).

But, Guderjan (1995b; Guderjan et al. 1987; see Freidel and Sabloff 1984; Vail 1988) also identified potential 'field markers' near the site of Basil Jones on the northerly end of the Caye which consisted of what they classified as a series of low stone walls. Although this may suggest that the Mayan inhabitants from other sites on the Caye may have been engaged in some agricultural production, there is no evidence for such activity from Marco Gonzalez or San Pedro.

The only possible evidence for some agricultural activity at these sites could be the lithic tools. There is the belief that large core tools such as oval bifaces and/or general-utility bifaces were used as celts for agricultural purposes based on their recovery from locations such as the channelized-field context at San Antonio (Palacio 1976), at Colha (Shafer 1979), or as hoes and/or mattocks for ground-working at Cuello (Shafer 1983:226). Lewenstein (1987:35) writes that archaeologists such Bullard and Bullard (1965:28), Stoltman (1978:21), Wilk (1978:139), and Willey et al. (1965:426) believe that oval bifaces were used prehistorically for forest clearing associated with swidden agriculture and also for controlling weeds and clearing underbrush in planted fields and around residential zones. Other Mayanists (Thompson 1939; Coe 1959; Bullard 1965; Rovner 1975; see Thompson 1991:147) also support the notion that celts were used for land-clearing of lowland hardwood forest.

Kidder (1947:5) and Stoltman (1978) believe that celts were used for activities such as digging, hoeing, or other agricultural tasks based on use-wear polish, however, Rovner (1975) and Wilk (1978) disagree with this conclusion. Along a similar line, Potter (1991b:27) refers to "hoe-polish" from 'soil-working tasks' on celts.

The fact that few large bifaces were recovered from Marco Gonzalez or San Pedro suggests to me that there was little, if any, agricultural activity comparable to that at Pulltrouser Swamp, and minimal forest clearance compared to what must have occurred at much larger inland Maya centres such as Cerros. I suggest that the heavily used general-utility bifaces and wood and soil/sand use-wear polishes on the tools indicate that they were employed for a variety of other tasks on the Caye (see below). I suggest that fewer oval and general utility bifaces occur on the Caye compared to the numbers recovered from Pulltrouser or Cerros because no specific large-scale agricultural activities, forest clearance or canal digging was undertaken here. It also seems that fewer of these tool types were recovered due to very high rate of tool curation observed at these sites.

Other plant use:

Although I do not feel that agriculture *per se* was practiced at either site, I do believe that the Maya at Marco Gonzalez and San Pedro did take advantage of products from plants that were native to their coastal environment. Marcus (1982:Tables 3 & 4) and Steggerda (1941) have noted the 16th century use of palms by the Maya for both food products such as heart of palm and kernels for flour, as well as for other products like oil from kernels, leaves for thatching, stems for construction and wood. The recovery of two fragments of a large mano from Marco Gonzalez may have been used to process palm kernels. Other wood was used for handles and hafts for stone, and likely some shell, tools. Palm fronds and other long leaves may have been used to weave mats, as containers, or as roofing materials. However, no archaeological evidence for this has survived at either Marco Gonzalez or San Pedro.

Tree-cropping:

McKillop (1994:134) also suggests the practice of tree-cropping for sites located on the cayes based on pit, seed and wood evidence from Wild Cane Cay. At different periods on Wild Cane, the Maya were probably exploiting plants such as: mamey (*Pouteria mammosum*), nance or crabbo (*Byrsonima crassifolia*), hogplum (*Spondias* sp.), avocado (*Persea americana*), 2 species of fig (*Ficus* sp.), calabash trees (*Crescentia cujete*), red mangrove (*Rhizophora mangle*), and native palms, including: cohune (*Obignya cohuna*), coyol (*Acrocomia mexicana*), and coconoby (*Bactris major*) (McKillop 1994; Stoddart et al. 1982) for food and drink, fuel, construction materials, tools, and possibly medicines. She also noted the remains of corn cobs (*Zea mays*) from Classic period deposits that likely arrived on the site from some mainland source.

Based on similarities in some of the native plant species found on both Ambergris Caye (Graham and Pendergast 1989) and Wild Cane Cay (McKillop 1994) one could make the logical inference that the Maya from Marco Gonzalez and San Pedro were also using such plants. However, there is no evidence for deliberate tree-cropping at either site, and any suppositions about the types of plants exploited by the Maya at these sites would be speculative because no good botanical or palynological data were recovered during the excavations. Only use-wear analysis provides some clues as to the general types of plants that may have been used.

CHAPTER 14

San Pedro Tools with Use-Wear

This chapter summarizes the results of the use-wear analysis of the lithics recovered from excavations at San Pedro. The findings for each individual artifact with use-wear traces are included in Appendix P.

Use-wear Analysis, Raw Material and Tool Types at San Pedro

A significant proportion of the lithic assemblage excavated from San Pedro retained evidence of use-wear. Of the 434 lithic artifacts recovered from the site, 182 or 41.9% possess some use-related microwear in the form of polish and/or striations. Chert-bearing zone chert was the most abundant raw material with use-wear traces.

Table 9: Tools with Use-wear by Raw Material Type from San Pedro

	CBZ chert (%)	Other chert (%)	Black chert (%)	Chalc. (%)	Quartz. (%)	Slate (%)	Total (%)
Number of Tools with Use-wear Polish	162 (89)	12 (6.6)	0 (0)	8 (4.4)	0 (0)	0 (0)	182 (100)

In terms of the total number of artifacts by raw material category, 48.5% of the CBZ chert tools, 16.0% of the other chert tools, and 40% of the chalcedony tools retained use-related microwear traces. Most of the artifacts recovered possessed only one used edge or surface, however a significant percentage (19.8%) of the lithic assemblage included tools with more than one used edge or surface..

Table 10: Number of Used Edges/Surfaces on Tools from San Pedro

	1 Used Edge/ Surface (%)	2 Used Edges/ Surfaces (%)	3 Used Edges/ Surfaces (%)	Total (%)
Number of Tools	146 (80.2)	32 (17.6)	4 (2.2)	182 (100)

At San Pedro, 48 of 72 (66.7%) bifacial thinning flakes have use-wear. This is strong evidence for use of bifacial flakes for the performance of tasks and also indicates that resharpening and recycling events produced flakes for 'opportunistic' use. Of these, 14 of 72 (19.4%) demonstrate use-wear on dorsal surfaces consistent with previous activities such as digging, chopping, adzing and haft polish performed by bifaces. With the reduction of bifaces, flakes will retain evidence of the initial use-related polishes. The recovery of bifacial thinning flakes with this pattern of polish suggests evidence for repair or recycling of bifaces instead of tool production. There were only 58 bifacial thinning flakes in the entire assemblage on which dorsal surface use-wear traces of this type were not identified. This number of flakes is considered quite low for biface production evidence considering number of bifaces and biface fragments recovered from San Pedro, but more consistent with resharpening and recycling activities.

Use-related polishes also occurred on 72 of 191 (37.7%) flakes and 10 of 74 (13.5%) blocky fragments. This high percentage of raw material with use wear traces is due to two main factors. The first is the heavy use of available chert. The second is the idea that most of the tool reduction is not primary tool manufacture, but rather tool repair and some expedient flake production. Therefore, the assemblage is missing a substantial percentage of the smaller lithic manufacture debitage that would likely not be used as tools. If this primary production 'waste' material were included, I believe the percentage of tools with use-wear traces would be significantly lower at San Pedro.

Use-Wear, Location and Time of Occupation

There was a notable difference in the total percentage of tools with use-wear traces in Late Classic, Terminal Classic and Middle Postclassic periods (54.3%) versus those from the Late Postclassic and Historic periods (38%). This is partially due to the reduction in the number of formal tools in the later periods and more early and middle stage lithic debris created by the reduction and manufacture of flakes and simple flake tools. The greater percentage of non-CBZ raw materials in these periods is also considered good evidence for the reduced number of tools that demonstrate use-wear polishes. The last reason for which the Late Postclassic and Historic periods have a lower percentage of tools with use-wear traces is that the majority of tools with multiple used edges or surfaces are from this period. All four of the tools with three used edges or surfaces and 21 of 32 (65.6%) of the tools with two used edges or surfaces were excavated from these deposits. The Late Classic to Middle Postclassic deposits account for only 31.3% of the tools with two used edges or surfaces in the lithic assemblage from San Pedro.

Table 11 is a summary of the traces of use-wear by contact material data presented in Appendix P. The percentages in parentheses in the 'secure identification, 'probable identification' and 'total' columns represent the proportion of tools from the whole assemblage of used tools that were used on a specific contact material. Use-wear that is classified as 'secure identification' indicates that polish was developed to the extent that identification was certain. Use-wear that is classified as 'probable identification' indicates that there was insufficient polish development to be able to absolutely assign a contact material polish or that polish was affected by processes such as patination, burning, or other forms of surface damage unrelated to use. Polishes classified as 'probable identification' in a specific category possessed the greatest number of identifying features associated with one or sometimes two closely related contact materials. Polishes identified as 'undetermined' indicate that there is evidence that the tool was used, but there is insufficient polish development to determine contact material type (see Vaughan's (1981) 'generic-weak' polish).

Table 11: Number of Used Edges or Surfaces by Contact Material Type from San Pedro

Contact material type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	66 (26.6)	15 (6)	81 (32.7)
meat (fish)	14 (5.6)	7 (2.8)	21 (8.5)
meat (fish) and bone (butchering)	9 (3.6)	0 (0)	9 (3.6)
bone	10 (4)	9 (3.6)	19 (7.7)
soil/sand	16 (6.5)	0 (0)	16 (6.5)
plant	10 (4)	11 (4.4)	21 (8.5)
fresh hide	2 (0.8)	4 (1.6)	6 (2.4)
ceramic (pottery)	3 (1.2)	2 (0.8)	5 (2)
dry hide	5 (2)	3 (1.2)	8 (3.2)
metal	6 (2.4)	1 (0.4)	7 (2.8)
stone	12 (4.8)	4 (1.6)	16 (6.5)
shell	2 (0.8)	3 (1.2)	5 (2)
antler	0 (0)	2 (0.8)	2 (0.8)
fish scales	0 (0)	1 (0.4)	1 (0.4)
soft	3 (1.2)	6 (2.4)	9 (3.6)
hard	1 (0.4)	3 (1.2)	4 (1.6)
undetermined	18 (7.3)	0 (0)	18 (7.3)
Total	**177 (71.4)**	**71 (28.6)**	**248 (100)**

Spatial distribution of use-wear evidence:

At San Pedro, there were 221 (50.9%) motions/actions documented on 434 tools. The distribution of motion types at the different locations throughout San Pedro indicates that similar activities were being performed in relatively equal numbers [see Appendix Q]. However, because some motions occur in such small numbers in some locations such as at the Alamilla and Nuñez properties, it is difficult to determine whether or not they accurately reflect the number or range of activities performed. In general, motions such as cutting/slicing, digging/hoeing, scraping, chopping/adzing are the most common and widespread throughout San Pedro. Other activities such as drilling/boring, scaling, whittling, incising and notching seem far less numerous or widespread. Spatial distribution at these locations indicates a similar pattern of activity performance that is quite generalized, incorporating percentages of motions that seem consistent with assemblages devoted to subsistence and local exploitation of natural resources. There do not appear to be any specific locations that represent much greater percentages of motion types that one would associate with craft-production or other processing on a elevated scale. For example there are no locations with substantial deposits of drilling, incising or whittling that might be associated with the production of shell or bone tools or ornaments on a large scale. The low percentage of motion types mentioned above could represent the notching of sherds for use as net weights, and the whittling and incising of bone for hooks.

Much like the pattern of motions at the various locations throughout San Pedro, the use-wear data seem to represent a generalized use of raw materials [see Appendix R]. Most areas with substantial numbers of tools with use-wear were employing a wide variety of products. Wood-working is consistently high throughout the site, representing 28.6% of the use polishes at Elvi's, 28.6% at Nuñez's, 34.3% at Rosalita's and 30.2% at the Sands Hotel/Parham's. Furthermore, percentages of contact with bone, meat (fish) and plant are relatively high and roughly equivalent, while soil/sand contact is lower, and contact with hides, shell, ceramic, antler and fish scales are much lower and less consistently distributed throughout the site. Once again the pattern of distribution supports a generalized, subsistence-based exploitation within a coastal environment based on the presence of ceramic sherd-notching, shell-working, meat or fish processing, and minimal evidence of fish scaling.

In terms of some specialization of activities by location, it may be possible to suggest slightly more fish processing activity at Elvi's, and perhaps proportionately more plant and wood processing at Nuñez's. One pattern of use-wear that is definitely significant is the greater percentages of stone working, and metal contact at the Sands Hotel/Parham property. The only evidence for use-related metal contact occurs here. This is undoubtedly due to the fact that the greatest percentage of Historic period deposits were excavated at this location and metal contact on chert is, in most cases, due to the use of fire-flints.

Chronological distribution and use-wear:

There are some notable motion type changes documented in the use-wear damage from the different chronological periods at San Pedro [see Appendix S]. Primary among these is a reduction in chopping/adzing, digging/hoeing, and haft polishes. In the Late Classic, Terminal Classic, and Middle Postclassic deposits, these types of motions represent 26.2% of all activities, while only 12.9% of the use-wear associated with these motions occurs in the Late Postclassic and Historic period deposits. Interestingly, the tools that would normally be associated with these motion types; the large bifaces, appear much less frequently in the deposits from this later period than they do in the Late Classic to Middle Postclassic periods. Even with a reduction in the percentage of bifaces and other formal tools from Colha, there does not appear to be a comparable change in the contact materials. Specifically, wood still constitutes approximately the same percentage of the use-wear patterns from all periods, even though the types of motion change. This suggests a different pattern of tool use between the earlier and later periods. In the later periods, sawing constitutes 13.1% of the motions, while only 2.9% of the motions are sawing in the early periods. Another obvious difference in motion types in the assemblages occurs in the rub/strike category. Only 3.6% of the motion types from Late Classic deposits are represented by this activity, while 13.1% of the activities in the Late Postclassic and Historic periods were represented by this motion type. A partial explanation for this difference is undoubtedly the introduction of flint and steel technology for fire production in the Historic period.

The types of contact materials examined by chronological sequencing at the site reveal similar patterns to the spatial distribution [see Appendix T]. The fact that wood-working is strongly represented throughout the sequence of occupation is not surprising (31% in the Late Classic, 38.5% in the Late to Terminal Classic, 33.3% in the Middle Postclassic, 29.8% in the Late Postclassic, and 30.7% in the Late Postclassic/Historic). The distribution of other contact material polishes during periods where there is a substantial degree of identified use-wear all seem to represent the same generalized pattern consisting of a wide range of exploited raw materials that satisfy what appear to be primarily subsistence-based and local needs. Once again no specific period demonstrates an unusual concentration on a specific or series of related materials, except for the Late Postclassic and Historic periods when metal makes a sudden appearance. The use-wear traces are related to the introduction of gunflints and strike-a-lights for fire production that were likely introduced by the Spanish.

CHAPTER 15

Marco Gonzalez Tools with Use-wear

Similar to Chapter 14, this chapter summarizes the results of the use-wear analysis of the lithics recovered from excavations at Marco Gonzalez. The data for each individual artifact with use-wear traces are included in Appendix U.

Use-wear Analysis, Raw Material and Tool Types at Marco Gonzalez

Use-related polish and/or striations occurred on 520 of the 1495 (34.8%) lithic artifacts from Marco Gonzalez. A partial explanation for the reduced percentage of used tools at this site compared to San Pedro may be the greater amount of smaller flakes and debitage at Marco Gonzalez. This smaller lithic material was less likely to be used as tools. Artifacts made from CBZ chert possessed the greatest amount of microwear traces.

Table 12: Tools with Use-wear by Raw Material Type from Marco Gonzalez

	CBZ chert (%)	Other chert (%)	Black chert (%)	Chalc. (%)	Quartz. (%)	Slate (%)	Total (%)
Number of Tools with Use-wear Polish	485 (93.3)	29 (5.6)	4 (0.8)	2 (0.2)	0 (0)	0 (0)	520 (100)

Consequently, 39.8% of the CBZ chert tools, 12.3% of the other chert tools, 22.2% of the black chert, and 9.5% of the chalcedony tools possessed use-related microwear traces. As at San Pedro, the majority of tools (86.2%) had only one edge/surface that retained any use-related polish.

Table 13: Number of Used Edges/Surfaces on Tools from Marco Gonzalez

	1 Used Edge/ Surface (%)	2 Used Edges/ Surfaces (%)	3 Used Edges/ Surfaces (%)	4 Used Edges/ Surfaces (%)	Total (%)
Number of tools	448 (86.2)	64 (12.3)	6 (1.2)	2 (0.4)	520 (100)

The number of bifacial thinning flakes with use-related polishes or striations from Marco Gonzalez is 102 of 169 (60.4%). As at San Pedro, this is considered good evidence for the opportunistic/expedient use of bifacial thinning flakes for the performance of tasks. There were 37 of 169 (21.9%) of these flakes with use-wear on their exterior surface, consistent with the use of bifaces for digging, chopping, and adzing, as well as haft polish. Thinning flakes from the large bifaces that possessed evidence of these types of use-related polishes are considered good evidence for repair or recycling of bifaces instead of tool production. Given the relatively low number of bifacial thinning flakes lacking exterior polish (132) compared to the number of bifaces and biface fragments in the Marco Gonzalez assemblage, there is strong evidence that the production of bifacial thinning flakes at this site was primarily due to the maintenance and recycling of these tools, as opposed to actual biface manufacture.

Use-related polishes also occurred on 282 of 834 (33.8%) flakes and 15 of 210 (7.1%) blocky fragments. As at San Pedro, the high percentage of raw material with use wear traces is due to the heavy use of all available stone and the fact that the majority of tool reduction is not primary tool manufacture.

Use-wear, Location and Time of Occupation

Similar to the patterns established at San Pedro, there were differences in the total percentages of tools with use-wear traces in the Classic periods (43.7%), the Early Postclassic (31.5%), the Middle Postclassic (32.4%), the Middle to Late Postclassic (36.5%), and the 'Postclassic' (34.4%) at Marco Gonzalez. Once again, there seems to be a combination of factors affecting this pattern of used tool distribution. Part of the reason for the difference between the earlier Classic periods and the later Postclassic periods is the minor reduction in the number of formal tools in the later periods and the increase in early and middle stage lithic debris produced from the manufacture of flakes and simple flake tools of both CBZ chert and other cherts. These secondary 3 and primary flakes which possess greater cortical covering are less likely to be chosen for use as *ad hoc* tools. In addition to the differences in the types of tools in these periods, the presence of more non-CBZ chert raw materials in these later periods is viewed as support for the reduced number of tools that exhibit use-wear polishes. There are two main reasons for this supposition. The first is based on the preferential selection of the finer grained CBZ chert for tool use. The second is that use-wear polishes develop less rapidly on the coarser grained other cherts and therefore use events of short duration would not produce enough use-wear polish to be detected as easily as polishes on CBZ chert. The last reason why there is a greater number of Classic period tools possessing use-wear traces than the lithics from the later periods is based on the distribution pattern of multiple use tools in the assemblage. This distribution pattern shares certain similarities with the pattern of multiple use tools from San Pedro. For example, at Marco Gonzalez only 6.3% of the tools with two used edges or surfaces date to the Classic periods. However, 20.3% of the tools with 2 used edge/surfaces and 22.2% of the tools with 3 used edges/surfaces occurred in the Early Postclassic period, while 34.4% of the tools with 2 used edge/surfaces, 50% of the tools with 3 used edges/surfaces and all of the tools with 4 used edges/surfaces occurred in the Middle and Late Postclassic periods. In the 'Postclassic' period, 34.4% of the tools possessed 2 used edges/surfaces.

Table 14 is a summary of the traces of use-wear by contact material data presented in Appendix U. The percentages in parentheses in the 'secure identification, 'probable identification' and 'total' columns represent the proportion of tools from the whole assemblage of used tools that were used on a specific contact material. Use-wear that is classified as 'secure identification' indicates that polish was developed to the extent that identification was certain. Use-wear that is classified as 'probable identification' indicates that there was insufficient polish development to be able to absolutely assign a contact material polish. Polishes classified as 'probable identification' in a specific category possessed the greatest number of identifying features associated with one or sometimes two closely related contact materials. Polishes identified as 'undetermined' indicate that there is evidence that the tool was used, but there is insufficient polish development to determine contact material type (see Vaughan's (1981) 'generic-weak' polish).

Table 14: Number of Used Edges or Surfaces by Contact Material Type from Marco Gonzalez

Contact material type	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
wood	152 (23.3)	71 (10.9)	223 (34.3)
meat (fish)	24 (3.7)	23 (3.5)	47 (7.2)
meat (fish) and bone (butchering)	19 (2.9)	5 (0.8)	24 (3.7)
bone	31 (4.8)	21 (3.2)	52 (8)
soil/sand	49 (7.5)	1 (0.2)	50 (7.7)
plant	33 (5.1)	20 (3.1)	53 (8.1)
fresh hide	12 (1.8)	12 (1.8)	24 (3.7)
ceramic (pottery)	15 (2.3)	6 (0.9)	21 (3.2)
dry hide	10 (1.5)	18 (2.8)	28 (4.3)
metal	0 (0)	0 (0)	0 (0)
stone	33 (5.1)	1 (0.2)	34 (5.2)
shell	9 (1.4)	6 (0.9)	15 (2.3)
antler	1 (0.2)	1 (0.2)	2 (0.3)
fish scales	0 (0)	2 (0.3)	2 (0.3)
soft	15 (2.3)	12 (1.8)	27 (4.1)
hard	19 (2.9)	16 (2.5)	35 (5.4)
undetermined	14 (2.2)	0 (0)	14 (2.2)
Total	**436 (67)**	**215 (33)**	**651 (100)**

Spatial distribution and use-wear evidence:

Evidence of motions/actions was identified on 607 (40.6%) of the 1495 tools excavated from Marco Gonzalez. Like the spatial distribution pattern of motion types at San Pedro, those from Marco Gonzalez reveal that similar activities were being performed in relatively equal numbers at the different structures and operations throughout the site [see Appendix V]. At locations where there are reasonable numbers of tools with use-wear, cutting/slicing, digging/hoeing, scraping, and chopping/adzing are the most common and widespread. Once again, activities like drilling/boring, scaling, whittling, incising and notching seem far less numerous or widespread. For example, at Structure 12, there is more piercing and notching than other locations, while the only evidence for scaling occurred at Structure 14. The distribution of these motions seems to reveal the overall performance of general tasks and includes a variety of motions one would associate with lithic assemblages primarily involved in subsistence and the exploitation of local natural resources. There do not appear to be any specific locations that represent significantly elevated percentages of particular motion types that one would associate with craft-production or large-scale resource processing activities. Much like the spatial distribution of motion types from San Pedro, no structures or operations possess strong evidence for drilling, incising and/or whittling possibly associated with shell or bone working on the scale indicative of craft-production beyond local needs. These lower percentages of drilling, incising or whittling at locations such as Structures 2, 12, 14 and Operations 6, 7, 8 could represent the production of fishing gear such as pottery net weights, pumice floats and bone fish hooks.

At Marco Gonzalez, most locations yielded substantial numbers of tools with use-wear traces representing a wide range of worked materials [see Appendix W]. Evidence of wood-working is consistently high throughout the site, including 34.6% of the contact materials from Structure 2, 33.3% from Structure 12, 43.5% from the area between Structures 12 and 14, 33.1% from Structure 14, 34.5% from Operation 6, 30.8% from Operation 7, and 32% from Operation 8. The percentages of tools with evidence of contact with other materials appear to be fairly uniformly distributed throughout Marco Gonzalez, although there do appear to be some locations that demonstrate minor concentrations on one or more types of raw material compared to other locations. These minor concentrations include: soil/sand (11.5%) and dry hide (7.7%) at Structure 2; plant (11.8%), ceramic (6.5%), and shell (2.2%) at Structure 12; bone (13%) and antler (4.3%) between Structures 12 and 14; shell (3.1%) at Structure 14; plant (17.2%) and soil/sand (10.3%) at Operation 6; stone (11.5%), soil/sand (11.5%), and soft (11.5%) at Operation 7; and stone (9.3%) and soil/sand (12%) at Operation 8. As with the pattern of contact material types by location, the distribution of lithics with wear traces at Marco Gonzalez reflects a generalized, subsistence-based economy in which wood, plants, meat, bone, and hide were commonly exploited. In addition, there was a specialization in the exploitation of coastal resources represented by the presence of polish evidence for cutting fish, some ceramic and shell, as well as a couple of traces of fish scale polish.

Chronological distribution and use-wear:

The relative uniformity in the large biface, biface fragment, and biface curation by-product distribution pattern throughout the sequence of occupation at Marco Gonzalez seems to be reflected in the consistency of motions or actions usually attributed to this tool type [see Appendix X]. Hafting polish, chopping/adzing and digging/hoeing traces are almost the same from the earliest to latest periods. The percentages of these motion types were 21% in the period extending from before the Late Classic to the Terminal Classic, 24.6% in the Early Postclassic, 20.7% in the Middle Postclassic, 19.9% in the Middle to Late Postclassic, and 22% in the 'Postclassic'. Although there was a substantial reduction in these activities associated with a reduction in the percentage of large bifaces over time in the assemblages at San Pedro, this was not occurring at Marco Gonzalez. Once again, I suggest that the Late Postclassic and Historic period occupations at San Pedro may have experienced greater difficulty in acquiring finished formal tools from the mainland than the people who inhabited the Caye in earlier periods. I further suspect that the leadership at Marco Gonzalez was likely more economically and socially capable of acquiring the desired finished artifacts from the mainland than the smaller, later occupation at San Pedro. Similar to the motions associated with the large bifaces, cutting/slicing activities remained relatively consistent over time at Marco Gonzalez, ranging from 24.7% in the Middle to Late Postclassic to 28.9% in the Classic. Exceptions to this trend include increased concentrations of this motion type in the Middle Postclassic (41.1%) and 'Postclassic' (38.4%) periods. Inasmuch as other motions vary slightly from period to period, there is no discernible pattern of change over time. The majority of these differences are related to minor variations in the performance of subsistence oriented activities.

The types of contact materials examined by chronological period at Marco Gonzalez reveal some similarities to the distribution from the different structures and operations [see Appendix Y]. Wood polish constitutes the highest percentage of all the polishes throughout the occupation period at the site, comprising 29.3% of the micropolishes in the Classic periods, 30.7% in the Early Postclassic, 40% in the Middle Postclassic, 36.2% in the Middle to Late Postclassic, and 35.7% in the 'Postclassic'. Although, there is slight variation in each period, the working of wood for a variety of subsistence and local craft activities shows no directional change. Use-wear evidence from contact with other raw materials throughout the occupation of the site reveals that there was little difference in the performance of activities over time. Despite the slight variations in the use of some materials, the use-wear patterns from all periods document the exploitation of a similar range raw materials.

CHAPTER 16

Summary and Conclusions

The lithic assemblages from Marco Gonzalez and San Pedro are both fascinating and multi-faceted. Although the excavations at Marco Gonzalez represented only the first phase of a research project that anticipated a return to the site and those from San Pedro primarily consisted of rescue operations within the town centre, the lithic material recovered presented a number of interesting research possibilities.

The analysis of the mostly chert and chalcedony chipped stone tools from these two sites was undertaken to determine the economic activities and behaviour of the coastal Maya. Based on the location of the sites on the southern end of Ambergris Caye and the data already acquired, primarily architecture, ceramics, and other trade materials such as obsidian and jade (Graham 1989; Graham and Pendergast 1987, 1989; Pendergast 1990; Pendergast and Graham 1987, 1990; 1991), initial interest in the lithics concerned the possibility of craft-specialization for trade purposes. Faunal reports (Seymour 1990, 1991) further strengthened the belief that marine resources, such as fish and shellfish, likely played an important role in trade activities and may have been the focus of craft-production. Moreover, it was believed this information would also be crucial to an understanding of the subsistence practices and environmental exploitation of the Maya specifically in relation to stone tool use.

The research methodology employed in the thesis consisted of two complementary strategies for the analysis of the lithic material. The first stage in the analysis involved the determination of tool types and production techniques. Emphasis was placed on what types of tools were used on the Caye and whether there was any notable concentration on specific tools for the execution of certain tasks. Further analysis of the debitage recovered from Marco Gonzalez and San Pedro was done to determine reduction strategies, and to determine locations for the manufacture or use of tools for specific purposes through intrasite comparisons.

The second stage of lithic analysis incorporated a program of use-wear examination that employed both low- and high-power microscopic techniques. By using both approaches together the determination of use-wear had a much greater degree of accuracy. All the cryptocrystalline chipped stone from Marco Gonzalez and San Pedro was examined for traces of use, specifically edge-damage, striations, and micropolishes (Keeley 1980; Moss 1983a; Odell 1977, 1981a; Vaughan 1981, 1985; Unger-Hamilton 1988). It was suspected that intrasite variation in the distribution of tools with use-wear traces could also be used for the determination of activity locations throughout the sites and again be useful in determining areas of specialized production. To assist in the determination of some aspects of economic activity at these sites, Suzanne Lewenstein's (1987) models of community production were incorporated into the thesis.

The information acquired through the analysis of the lithic assemblages from Marco Gonzalez and San Pedro has revealed a great deal about the behaviour of the Maya on Ambergris Caye and has made it possible to reconstruct aspects of the coastal economy at these sites. The formal tool component from both Marco Gonzalez and San Pedro was relatively small compared to those from other sites in Northern Belize. Large bifaces, lenticular bifaces, smaller bifaces, and blades were very fragmentary, with few complete artifacts appearing in any tool class. It is believed that circumstances affecting consumer sites such the limited availability of tools, the extreme use of tools and the heavy curation of certain tool forms were the primary factors contributing to the state of the lithic assemblage. The use of some larger bifaces as sources of raw material for the production of 'opportunistic' or 'expedient' tools after breakage, some *ad hoc* flake production, and a minimal amount of bipolar reduction further contributed to an overall increase in flake tool numbers and a reduction in the number of formal tools.

Explanations for why some tools were heavily recycled whereas other tools from the same or different classes were not, is likely dependent upon tool supply or availability and immediate need. The recovery of some broken bifaces that have not been reduced any further may indicate that at that specific period in time, lithic resources at the respective community were adequate. Other explanations for the lack of reuse of some tools may be as simple as tool loss or discard or some social reason why a certain tool could not be or was not refurbished.

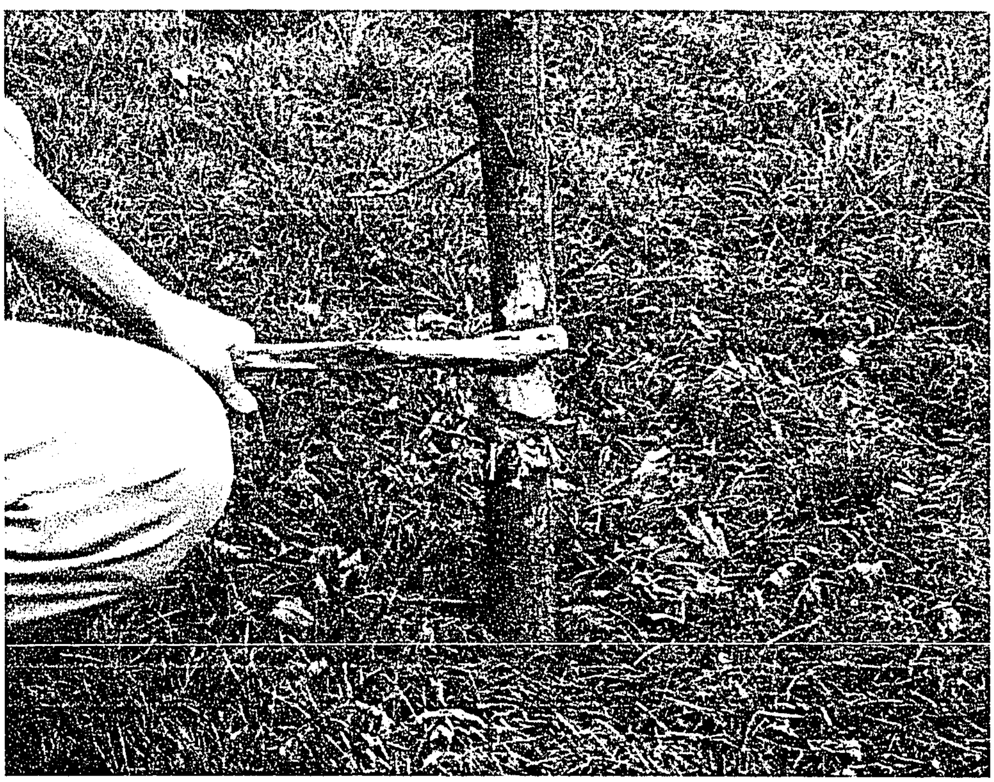
Interestingly, both the lithic assemblage composition and the use-wear data from Marco Gonzalez and San Pedro change very little over time. The combination of activities observed from the microwear traces at both sites suggests a generalized subsistence-based economy with numerous tasks related to the acquisition and processing of foodstuffs and local environmental exploitation of raw materials related to construction, and some minor craft production. The majority of use-wear data recorded for these sites adheres to the subsistence and subsistence manufacture-based use-contexts described in the classification system developed by Sievert (1992:27-45). Although, Sievert believes (1990:152, 1992:45) that contact materials such as meat, wood, bone and shell are indicators of greater ceremonial and special-elite manufacture activity, these are also the same materials I would expect to be well-represented in a subsistence and subsistence

Figure 12: Reconstruction of Activities Performed by the Maya on Ambergris Caye

a. Scaling fish with stone flake

b. Making bone fishhook with stone flake

c. Making a conch trumpet with stone flake



d. Chopping wood with stone hatchet

manufacture-based use-context in a coastal environment where shell, fish and wooden implements would be in daily use [Figure 12].

The assemblages from Marco Gonzalez and San Pedro also differ from Sievert's (1992) model when considering the quality of raw material and the origin of this stone. Although she believes local, lower-quality raw material should be the primary stone for the tools in subsistence and subsistence manufacture use-contexts, a unique situation exists on Ambergris Caye. No source of suitable stone exists on the Caye, and the proximity and extensive production of lithics in the 'chert-bearing zone', in conjunction with the socioeconomic relationship between Marco Gonzalez, San Pedro and the mainland at sites such as Colha, Altun Ha, or Lamanai, would change the importance of raw material quality suggested in Sievert's system.

The artifact microwear evidence also meets the criteria established for a subsistence-oriented economic model as proposed by Lewenstein (1987). In this instance, the diversity of both tool actions and contact materials is quite high with no solid evidence for a concentration on, or specialization in, one or more activities. Although a high reliance on wood is present at Marco Gonzalez and San Pedro, Lewenstein herself provides a very good explanation for extensive wood-working at the community level. Regarding wood use at Preclassic Cerros, Lewenstein (1987:198) notes:

> During the course of village life at Cerros, the Precolumbian occupants routinely used chipped stone tools to: clear fields for milpas; clear bush around the community in order to minimize the rodent and insect populations in residential zones; chop and shape lumber for building houses, furniture, and fences; shape wooden implements such as clubs, digging sticks, spear shafts, brooms, hardwood drill bits, and stoneworking chisels; manufacture shafts, hafts, and handles for stone and bone tools; make canoes, rafts, and barges; form wooden bowls, carvings, and articles of adornment.

Whereas half of the tools at Cerros were used for wood-working (Lewenstein 1987:197), and 44% of tools from Bergumermeer, Belgium and 52% of tools from La Libertad in Preclassic Chiapas possess wood polishes (Clark 1979: 269-273, Odell 1980b:408-409), I have considered the possibility that the Caye environment may not have had as much accessible wood as these mainland sites, therefore the number of tools in both the San Pedro (32.7%) and Marco Gonzalez (34.3%) assemblages with wood polish would likely have been lower. I also suspect that the total number of formal biface tools and fragments at San Pedro (9.4% of the assemblage) and at Marco Gonzalez (6.7%) contributes to the lower percentage of total wood-working use-wear compared to a site such as Cerros. With fewer bifaces, actions involving the chopping and adzing of wood would occur less frequently throughout the entire occupation of the site.

Given the presence of digging/hoeing and sand/soil polish, primarily on large bifaces, biface fragments or on the exterior surfaces of bifacial thinning flakes at both Marco Gonzalez (6.9% and 7.7%) and San Pedro (4.8% and 6.5%), heavy work in soil and/or sand on the Caye is evident. Whereas in most mainland contexts there would be the tendency to attribute any soil-related activity to agricultural practices, I do not believe this is the case on Ambergris Caye. The are numerous other activities that would produce these polish types on large bifaces including land clearance for site construction and land modification for harbour construction and maintenance. In my use-wear experiments, it was observed that an axe that missed its mark and struck the ground, would rapidly develop soil polish. Although there is the possibility that individual households may have engaged in some gardening or simple horticultural practices, the low percentages of use-wear provide little support for larger scale agricultural activity. Furthermore, there do not appear to be any areas on the largely mangrove Caye amenable to agriculture. The sandy soil on the Caye would not support the growth of many Mesoamerican domesticates, and there is no good botanical evidence to suggest intensive agricultural practices.

Although the main source of trade goods for the Caye Maya was the sea, the percentage of tools with use-wear polishes associated with marine resource exploitation seems low. The use-wear data recovered from both sites, specifically related to meat/fish, shell, and fish scales suggest little evidence for large-scale economic specialization.

However, I have noted that evidence for economic specialties such as salt production, fish preservation and the collection of marine resources for trade would not necessarily be heavily represented by substantial percentages of microwear traces on lithic tools. Because there are many methods to prepare fish for preservation in the tropics, variable amounts of micropolish related to this activity could have been produced. If fish and/or other marine animals were being gutted and gilled or beheaded before salting and/or drying, then traces of meat (fish) and bone polish would be produced. Unless you are cutting through the head, fin spines, or vertebrae of a fish during this process, there would be little bone polish produced from the rest of the skeleton. Furthermore, it is possible to dry and/or salt fish without removing fins, bones or scales. The reason for a low percentage of fish scaling wear could be attributed to the fact that the process of salting or drying fish did not require the removal of the scales. Fish could be preserved with the exterior skin still intact. In my experiments, it was difficult to distinguish between cutting different types of meat such as land mammal, bird and fish unless the fish was scaled. Therefore, the few examples of fish scaling likely indicate that the removal of fish scales was not integral to the preservation process.

The collection of shells, corals, and other marine resources could be accomplished without stone tools. Netting, pot-trapping, fishing with hooks, or simply picking up marine animals with your hands would produce no use-wear traces. The greatest percentage of use-related polish would have been produced during processing to create finished products. Although, thousands of tiny shells and fragments modified into disks, beads, and larger shell pendants have been recovered primarily from ritual contexts at Marco Gonzalez, there is little lithic use-wear evidence recovered to date that large-scale craft specialization related to shell bead or disk production was in operation at either site. It is possible that areas where these activities may have been performed were not excavated. Moreover, the perforation of shells to make beads or discs may have been accomplished by grinding using sand, water and a wooden drill. Similar techniques have been suggested for the fabrication of jade artifacts.

By incorporating the lithic data from Marco Gonzalez and San Pedro into Lewenstein's (1987:26-27, Table 1) 'Models of Community Production', it is possible to suggest the type of community production at these sites [Table 15].

The spatial distribution of tool types and tools with use-related polishes throughout these sites, although subject to post-depositional disturbance, reveals little discernible variability in terms of the locations for activity performance. There are no concentrations of specific tool types or use-wear patterns that might be indicative of any specialized activity perhaps related to craft production. Given the overall range of activities and this lack of concentration on any specific contact materials, there appears to be little specialized production other than that necessary for the local population. Although the possibility for some low level craft specialization could be argued for some wood, bone

Table 15: Models of Community Production Related to the Occupations at San Pedro and Marco Gonzalez

Model	Archaeological Predictions	Presence/Absence
1. Full-time specialization in a variety of commodities	Not all loci will yield tools necessary for subsistence tasks (fishing, agriculture, hunting)	Absent
	Spatial clusters of specialized tools corresponding to many different craft activities will be represented. Not every locus will have tools appropriate for more than one specialized processing or manufacturing task.	Absent
	Tool kits for each specialization may be partially clustered into district neighbourhoods or barrios	Absent
	Loci of specialized tool kits (and production) may be associated with public architecture.	Absent
2. Village-wide specialization in a product for exchange	Each locus is expected to have basic subsistence tools.	Present
	Tools designed for one specialized product will be represented in most household loci; these tools will occur in numbers in excess of that necessary to supply household or local consumption.	Absent
3. Low-level specialization in processing and manufacture	Each locus will have subsistence tools.	Present
	Tool kits associated with nonsubsistence activities will be widespread; may occur at each locus.	Possible(?)
	There will be clusters of nonsubsistence tools in one or more loci which are considered larger than frequencies of these same toolkits in other households	Absent
4. Subsistence-oriented; no specialized production beyond the domestic unit	Little variability in distribution of subsistence-oriented tools between residential loci	Present
	Use-wear reflects complete range of village activities	Present

or shell products, there is little to support this conclusion based on the criteria of Lewenstein's model; specifically, there are no "... clusters of non-subsistence tools in one or more loci which are considerably larger than frequencies of these same tool kits in other households (Lewenstein 1987:Table 1)". In no concentrated areas or periods is there evidence for the production of goods for trade or export beyond fish processing and preservation and perhaps some shell artifact production at Marco Gonzalez and San Pedro.

From the Early Classic period to the Late Postclassic and Historic periods, lithic deposits continuously reflect activities related to basic marine-based subsistence and limited craft production. Although there are some minor differences in behaviour based on lithic evidence occurring at both sites over time, the main similarity appears to be a reduction in the amount of CBZ chert in the later periods. In the Late Postclassic and Historic periods at San Pedro and in the later Middle and Late Postclassic periods at Marco Gonzalez, there is less 'chert-bearing zone' chert than in earlier periods, fewer formal tools; specifically large bifaces, and an increase in *ad hoc* flake production of both CBZ and other cherts. There appears to be a direct correlation in the reduction of both high-quality raw material and formal tools on the Caye and the production activity at Colha. Once this site ceased tool production in the later Postclassic, there was a comparable decrease observed at the consumer sites on the southern end of Ambergris Caye.

Although many of the specific details regarding trade and exchange at Marco Gonzalez and San Pedro are not known, the lithic material from these sites was primarily acquired through the indirect procurement of finished tools from Colha (CBZ), with some procurement of other lithic raw material types. Once tools were acquired, they were used for the completion of tasks on the Caye and were not traded elsewhere. These generalized tool assemblages, in conjunction with the use-wear evidence from both sites suggests the main activities performed on the Caye were subsistence-based with minimal craft production. Foodstuffs and material for this craft-production were overwhelmingly provided by the sea. Most of the products the residents from Marco Gonzalez and San Pedro offered for trade were preserved fish, salt, shell tools and ornaments, and ritual items such as stingray and fish spines, shark's teeth, and possibly dyes. A role as a 'transshipment point' or 'seaport' for a larger site such as Lamanai further contributed to the economic roles of the Caye Maya. Exchanges at Marco Gonzalez and San Pedro that involved long-distance trade goods possessing ritual or prestige power no doubt contributed to the socioeconomic and sociopolitical ties with Lamanai and other larger inland sites. These relationships likely aided in the acquisition and maintenance of both wealth and status for the Ambergris Caye populations.

I believe that more excavation in some of the smaller structures and in areas peripheral to the site core at Marco Gonzalez would provide additional information required to answer questions related to craft-production locations and output at the site. I further suspect that Marco Gonzalez played an even more intricate role in the socioeconomy of Northern Belize than that reconstructed from the lithic evidence to date. Given its location off the coast of Belize, the importance of sea trade to the Maya and other prehistoric populations, and the survival of these sites into later periods, there is still a great deal to be learned about the complexity of life on Ambergris Caye.

REFERENCES CITED

Abrams, E.M.
1984 Replicative Experimentation at Copan, Honduras: Implications for Ancient Economic Specialization. Journal of New World Archaeology 6: 39-48.

Adams, R.E.W.
1970 Suggested Classic Period Occupational Specialization in the Southern Mayan Lowlands. In Monograph and Papers in Mayan Archaeology, edited by W.R. Bullard, Jr., pp. 487-502, Peabody Museum of Archaeology and Ethnology Papers 61, Harvard University, Cambridge.

1977 (ed). The Origins of Maya Civilization. University of New Mexico Press, Albuquerque.

Ahler, S.A.
1971 Projectile Point Form and Function at Rodgers Shelter, Missouri. In Missouri Archaeological Society Research Series 8, edited by W.R. Wood, Missouri Archaeological Society and the University of Missouri-Columbia, Columbia.

1989a Mass Analysis of Flaking Debris: Studying the Forest Rather than the Trees. In Alternative Approaches to Lithic Analysis, edited by D.O. Henry and G.H. Odell, pp. 85-118, Archaeological Papers of the American Anthropological Association No.1, Tulsa.

1989b Experimental Knapping with KRF and Midcontinent Cherts: Overview and Applications. In Experiments in Lithic Technology, edited by D.S. Amick and R.P. Mauldin, pp. 199-234, BAR International Series 528, Oxford.

Akoshima, K.
1981 An Experimental Study of Microflaking - Report of Tohoku University Microflaking Research Team (English summary). Kokogaku Zasshi 66: 1-27.

1987 Microflaking Quantification. In The Human Uses of Flint and Chert: Papers from the Fourth International Flint Symposium. edited by G. de G. Sieveking and M. Newcomer, pp. 71-79, Cambridge University Press, Cambridge.

Aldenderfer, M.S.
1990 Defining Lithics-using Craft Specialties in Lowland Maya Society through Microwear Analysis: Conceptual Problems and Issues. In The Interpretive Possibilities of Microwear Studies, edited by B. Graslund, H. Knutsson, K. Knutsson, and J. Taffinder, pp. 53-70, Societas Archaeologica Upsaliensis, Uppsala.

1991 Functional Evidence for Lapidary and Carpentry Craft Specialists in the Late Classic of the Central Peten Lakes Region. Ancient Mesoamerica 2: 205-214.

Aldenderfer, M.S., L.R. Kimball, and A. Sievert
1989 Microwear Analysis in the Maya Lowlands: The Use of Functional Data in a Complex-Society Setting. Journal of Field Archaeology 16: 47-60.

Alexander, C.
1964 Notes on the Synthesis of Form. Harvard University Press, Cambridge.

Amick, D.S., R.P. Mauldin, and S.A. Tomka
1988 An Evaluation of Debitage Produced by Bifacial Core Reduction of a Georgetown Chert Nodule. Lithic Technology 17: 26-36.

Ammerman, A.J.
1985 Plow-zone Experiments in Calabria, Italy. Journal of Field Archaeology 12: 33-40.

Ammerman, A.J. and M. Feldman
1974 On the "Making" of an Assemblage of Stone Tools. American Antiquity 39: 610-616.

Andersen, H. and H. Whitlow
1983 Wear Traces and Patination on Danish Flint Artefacts. Nuclear Instruments and Methods in Physics Research 218: 468-474.

Anderson, P.C.
1980a A Microwear Analysis of Selected Flint Artefacts from the Mousterian of Southwest France. Lithic Technology 9: 33.

1980b A Testimony of Prehistoric Tasks: Diagnostic Residues on Stone Tool Working Edges. World Archaeology 12: 181-194.

Anderson-Gerfaud, P.C.
1981 Contribution méthologique: l'analyse des microtraces d'utilisation sur les outils préhistoriques. Thèse de Troisième Cycle no.1607, Institut du Quatenaire, Université de Bordeaux 1, Bordeaux.

1982 Comment préciser l'utilisation agricole des outils préhistoriques? Cahiers de l'Euphrate (Lyon) 3: 149-164.

1983 A Consideration of the Uses of Certain Backed and 'Lustred' Stone Tools from Late Natufian Levels of Abu Hureyra and Mureybet (Syria). In Traces d'utilization sur les outils néolithiques du Proche Orient, edited by M.-C. Cauvin, pp. 77-101, GIS-Maison de l'Orient, Lyon.

1986 A Few Comments Concerning Residue Analysis of Stone Plant-Processing Tools. In Technical Aspects of Microwear Studies on Stone Tools, Part II, edited by L. Owen and G. Unrath, pp. 69-81, Early Man News, Tubingen.

1990 Aspects of Behaviour in the Middle Paleolithic: Functional Analysis of Stone Tools from Southwest France. In The Emergence of Modern Humans, edited by P. Mellars, pp. 389-418, Cornell University Press, Ithaca.

Andrefsky, W.
1998 Lithics Macroscopic Approaches to Analysis. Cambridge University Press, Cambridge.

Andresen, J.
1976 Notes on the Pre-Columbian Chert Industry of Northern Belize. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp.151-176, Special Report No.4, Center for Archaeological Research, University of Texas at San Antonio.

1983 Chert Artifacts. In Archaeological Excavations in Northern Belize, Central America, edited by R.V. Sidrys, pp. 277-293, Monograph XVII, Institute of Archaeology, University of California, Los Angeles.

Andrews, A.P.
1983 Maya Salt Production and Trade. University of Arizona Press, Tucson.

1991 The Role of Trading Ports in Maya Civilization. In Vision and Revision in Maya Studies, edited by F.S. Clancy and P.D. Harrison, pp. 159-167, University of New Mexico, Albuquerque.

Andrews, A.P. and F. Robles C.
1985 Chichen Itza and Coba: An Itza-Maya Standoff in Early Postclassic Yucatan. In The Lowland Maya Postclassic, edited by A.F. Chase and P.M. Rice, pp. 62-72, University of Texas Press, Austin.

Andrews, A.P., T. Gallareta N., F. Robles C., R. Cobos, and P. Cerrera R.
1986 Isla Cerritos Archaeological Project. A Report of the 1985 Season. Committee for Research and Exploration, National Geographic Society, Washington, D.C.

Aoyama, K.
1989 Estudio Experimental acerca de las Huellas de Uso sobre Material Litico de Obsidiana y Silex. Mesoamerica 17: 185-214.

1993 Experimental Microwear Analysis on Maya Obsidian Tools: Case Study of the La Entrada Region, Honduras. In Traces et fonction: Les Gestes Retrouvés, edited by P.C. Anderson, S. Beyries, M. Otte, and H. Plisson, pp. 423-432, Collège International de Liège, Editions Eraul, vol.50, Centre de Recherches Archéologiques du CNRS, Etudes et Recherches Archéologiques de l'Université de Liège, Liège.

1995 Microwear Analysis in the Southeast Maya Lowlands: Two Case Studies at Copan, Honduras. Latin American Antiquity 6: 129-144.

Arnold, D.
1975 Ceramic Ecology of the Ayacucho Basin, Peru: Implications for Prehistory. Current Anthropology 16: 183-205.

Arnold, J.E.
1987 Technology and Economy: Microblade Core Production from the Channel Islands. In The Organization of Core Technology, edited by J.K. Johnson and C.A. Morrow, pp. 207-238, Westview Press, Boulder.

Arnold II, P.J., C.A. Pool, R.K. Kneebone, and R.S. Santley
1993 Intensive Ceramic Production and Classic Period Political Economy in the Sierra de los Tuxtlas, Veracruz, Mexico. Ancient Mesoamerica 4: 175-191.

Asaro, F., H.V. Michel, R. Sidrys, and F. Stross
1978 High-Precision Chemical Characterization of Major Obsidian Sources in Guatemala. American Antiquity 43: 436-443.

Bailey, G.N.
1975 The Role of Molluscs in Coastal Economies: The Results of Midden Analysis from Australia. Journal of Archaeological Science 2: 45-62.

Baker, C.M.
1978 The Size Effect: An Explanation of Variability in Surface Artifact Assemblage Content. American Antiquity 43: 288-293.

Ball, W.J.
1977 An Hypothetical Outline of Coastal Maya Prehistory: 300 B.C.-A.D. 1200. In Social Process in Maya Prehistory, edited by N. Hammond, pp. 167-196, Academic Press, New York.

1978 Archaeological Pottery of the Yucatan-Campeche Coast. Middle American Research Institute, Publication 46, Tulane University, New Orleans.

Bamforth, D.
1986 Technological Efficiency and Tool Curation. American Antiquity 51: 38-50.

1988 Investigating Microwear Polishes with Blind Tests: The Institute Results in Context. Journal of Archaeological Science 15: 11-23.

1991 Technological Organization and Hunter-Gatherer Land Use: A California Example. American Antiquity 56: 216-234.

Bamforth, D.M., G.R. Burns and C. Woodman
1990 Ambiguous Use-traces and Blind Test Results: New Data. Journal of Archaeological Science 17: 413-430.

Barnes, A.
1932 Modes of Prehension of Some Forms of Upper Paleolithic Implements. Proceedings of the Prehistoric Society 7: 43-56.

Barrick, S. and B. Mitchum Chiarulli
1997 Patterns of Lithic Production on the Western Lagoon, Northern Belize. Paper presented at the 62nd Annual Meeting of the Society for American Archaeology, Nashville.

Becker, M.
1973 Archaeological Evidence for Occupational Specialization Among the Classic Period Maya at Tikal, Guatemala. American Antiquity 39: 396-406.

Berdan, F.F.
1978 Ports of Trade in Mesoamerica: A Reappraisal. In Mesoamerican Communication Routes and Cultural Contacts, edited by T.A. Lee and C. Navarrete, pp. 187-198, Papers of the New World Archaeological Foundation No. 40, Brigham Young University, Provo.

Bergman, C.A., R.N.E. Barton, S.N. Colcutt, and G. Morris
1983 La fracture volontaire dans une industrie du Paléolithique Supérieur tardif du Sud de l'Angleterre. l'Anthropologie 87: 323-337.

Beyries, S.
1982 Comparaison des traces d'utilisation sur différentes roches siliceuses. In Tailler! pour quoi faire: Préhistoire et technologie lithique II, edited by D. Cahen, pp. 235-240, Studia Praehistorica Belgica 2, Musée royal de l'Afrique centrale, Tervuren.

Beyries, S., Delamare, F. & Quantin, J.-C.
1988 Tracéologie et regosimétrie tridimensionelle. In Industries lithiques: tracéologie et technologie, Vol. 2, edited by S. Beyries, pp. 115-132, BAR International Series 411, Oxford.

Binford, L.R.
1973 Interassemblage Variability- The Mousterian and the 'Functional' Argument. In The Explanation of Culture Change, edited by C. Renfrew, pp. 227-254, Duckworth, London.

1976 Forty-seven Trips: A Case Study in the Character of Some Formation Processes of the Archaeological Record. In Contributions to Anthropology: The Interior Peoples of Northern Alaska, edited by E.S. Hall, pp. 299-351, National Museum of Man, Mercury Series 49, Ottawa.

1977 Forty-seven Trips: A Case Study in the Character of Archaeological Formation Processes. In Stone Tools as Cultural Markers, edited by R.V.S. Wright, pp. 24-36, Australian Institute of Aboriginal Studies, Canberra.

1978 Nunamiut Ethnoarchaeology. Academic Press, New York.

1979 Organization and Formation Processes: Looking at Curated Technologies. Journal of Anthropological Research 35: 255-273.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. American Antiquity 45: 4-20.

1981 Behavioral Archaeology and the "Pompeii Premise". Journal of Anthropological Research 37: 195-208.

Binford, L.R. and S.R. Binford
1966 A Preliminary Analysis of Functional Variability in the Mousterian of Levallois Facies. American Anthropologist 68: 239-295.

Binford, L.R. and N.M. Stone
1986 "Righteous Rocks" and Richard Gould: Some Observations on Misguided "Debate". American Antiquity 50: 151-154.

Binford, S.R.
1968 Variability and Change in the Near Eastern Mousterian of Levallois Facies. In New Perspectives in Archaeology, edited by L.R. Binford and S.R. Binford, pp. 313-341, Aldine, Chicago.

Blanton, R., S. Kowalewski, and P. Peregrine
1996 A Dual-Processual Theory for the Evolution of Mesoamerican Civilization. Current Anthropology 37: 1-14.

Bleed, P.
1986 The Optimal Design of Hunting Weapons: Maintainability or Reliability. American Antiquity 51: 737-747.

Bleed, P. and A. Bleed
1987 Energetic Efficiency and Hand Tool Design: A Performance Comparison of Push and Pull Stroke Saws. Journal of Anthropological Archaeology 6: 189-197.

Bordaz, J.
1970 Tools of the Old and New Stone Age. Natural History Press, Garden City.

Bordes, F.
1950 Principes d'une méthode d'étude des techniques de débitage et de la typologie du Paléolithique ancien et moyen. L'Anthropologie 54: 19-34.

1961 Typologie du Paléolithique ancien et moyen. Publications de l'Institut de Préhistoire de l'Université de Bordeaux, Mémoire No.1, Delmas, Bordeaux.

1967 Considérations sur la typologie et les techniques dans le Paléolithique. Quartaer 18:25-55.

1968 The Old Stone Age. McGraw-Hill, New York.

Borhegyi, S.F. de
1961 Shark Teeth, Stingray Spines, and Shark Fishing in Ancient Mexico and Central America. Southwest Journal of Anthropology 17: 273-296.

Boucher de Perthes, J.
1847-1864 Antiquités celtiques et antédiluviennes. Mémoire sur l'industrie primitive et les arts. Vols. 1-3, Paris.

Boydston, R.A.
1989 A Cost-Benefit Study of Functionally Similar Tools. In Time, Energy and Stone Tools, edited by R. Torrence, pp. 67-77, Cambridge University Press, Cambridge.

Boxt, M.A.
1984 The Archaeology of Hick's Caye, Belize. Belizean Studies 12: 10-19.

Boxt, M.A. and C.L. Reedy
1985 Preliminary Thin Section Studies of Chert Artefacts from Northern Belize. Journal of New World Archaeology 5: 13-23.

Bradley, B.A.
1976 Experimental Lithic Technology, with Special Reference to the Middle Paleolithic. Ph.D. Thesis, Cambridge University, Cambridge.

Bradley, R. and C. Clayton
1987 The Influence of Flint Microstructure on the Formation of Microwear Polishes. In The Human Uses of Flint and Chert: Papers from the Fourth International Flint Symposium, edited by G. de G. Sieveking and M. Newcomer, pp. 81-89, Cambridge University Press, Cambridge.

Braidwood, R.J.
1975 Prehistoric Men. 8th edition, Scott, Foresman, Glenview.

Brain, J.P.
1988 Tunica Archaeology. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 78, Harvard University, Cambridge.

Braswell, G.E. and M.D. Glascock
1992 A New Obsidian Source in the Highlands of Guatemala. Ancient Mesoamerica 3: 47-49.

Brézillon, M.
1977 La dénomination des objets de pierre taillée. Centre National de la Recherche Scientifique, Paris.

Brink, J.W.
1978a An Experimental Study of Microwear Formation on End Scrapers. National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper No. 83, Ottawa.

1978b The Role of Abrasives in the Formation of Lithic Use-wear. Journal of Archaeological Science 5: 363-371.

1978c Notes on the Occurrences of Spontaneous Retouch. Lithic Technology 7: 31-33.

Briuer, F.L.
1976 New Clues to Stone Tool Function: Plant and Animal Residues. American Antiquity 41: 478-484.

Broadbent, N.D. and K. Knutsson
1975 An Experimental Analysis of Quartz Scrapers, Results and Applications. Fornvannen 20: 113-128.

Broderick, M.
1979 Ascending Paper Chromatographic Technique in Archaeology. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 375-383, Academic Press, New York.

Brose, D.S.
1975 Functional Analysis of Stone Tools: A Cautionary Note on the Role of Animal Fats. American Antiquity 40: 86-94.

Brothwell, D.
1969 The Study of Archaeological Materials by Means of the Scanning Electron Microscope; an Important New Field. In Science in Archaeology, edited by D. Brothwell and E. Higgs, pp. 564-566, Thames and Hudson, London.

Browne, J.
1940 Projectile Points. American Antiquity 5: 209-213.

Bruijn, A.
1958-1959 Technik und Gebrauch der Bandkeramischen Feuersteingeraete. Palaeohistoria 6-7: 213-224.

Brumfiel, E.
1987 Elite and Utilitarian Crafts in the Aztec State. In Specialization, Exchange, and Complex Societies, edited by E. Brumfiel and T.K. Earle, pp. 102-118, Cambridge University Press, Cambridge.

Brumfiel E. and T.K. Earle
1987 Specialization, Exchange, and Complex Societies: An Introduction. In Specialization, Exchange, and Complex Societies, edited by E. Brumfiel and T.K. Earle, pp. 1-9, Cambridge University Press, Cambridge.

Bueller, H.
1983 Methodological Problems in the Microwear Analysis of Tools Selected from the Natufian Site of El Wad and Ain Mallaha. Traces d'utilization sur les outils néolithiques du Proche Orient, edited by M.-C. Cauvin, pp. 107-113, GIS-Maison de l'Orient, Lyon.

Bullard, W.R., Jr.
1965 Stratigraphic Excavations at San Estevan. Occasional Paper No.9, Royal Ontario Museum, Toronto.

Bullard, W.R., Jr. and M.R. Bullard
1965 Late Classic Finds at Baking Pot, British Honduras. Royal Ontario Museum Occasional Papers, No. 8, University of Toronto, Toronto.

Butzer, K.W.
1982 Archaeology as Human Ecology: Method and Theory for a Contextual Approach. Cambridge University Press, Cambridge.

Cackler, P.R., M.D. Glascock, H. Neff, H. Iceland, K.A. Pyburn, D. Hudler, T.R. Hester, and B. Mitchum Chiarulli
1999 Chipped Stone Artefacts, Source Areas, and Provenance Studies of the Northern Belize Chert-bearing Zone. Journal of Archaeological Science 26: 389-397.

Cahen, D. and J. Gysels
1983 Techniques et fonctions dans l'industrie lithique du groupe de Blicquy (Belgique). In Traces d'utilisation sur les outils néolithiques du Proche Orient, edited by M.-C. Cauvin, pp. 38-52, GIS- Maison de l'Orient, Lyon.

Cahen, D., L.H. Keeley, and F.L. Van Noten
1979 Stone Tools, Tool Kits and Human Behaviour in Prehistory. Current Anthropology 20: 661-683.

Callahan, E.
1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flint Knappers and Lithic Analysts. In Archaeology of Eastern North America 7: 1-179.

Camilli, E.L.
1986 Prehistoric Use of Landscapes and the Archaeological Surface Distribution. Paper presented at the 50th Annual Meeting of the Society for American Archaeology, Denver.

Carr, C.
1984 The Nature of Organization of Intrasite Archaeological Records and Spatial Analytic Approaches to their Investigation. In Advances in Archaeological Method and Theory, Vol. 7, edited by B. Schiffer, pp. 103-222, Academic Press, New York.

Carr, H.S.
1986 Preliminary Results of Analysis of Fauna. In Archaeology at Cerros, Belize, Central America, Vol. 1, An Interim Report, edited by R.A. Robertson and D.A. Freidel, pp. 127-146, Southern Methodist University, Dallas.

Cattaneo, C., K. Gelsthorpe, P. Phillips, and R. Hedges
1993 Blood Residues on Stone Tools: Indoor and Outdoor Experiments. World Archaeology 25: 29-35.

Cauvin, M.-C.
1973 Problèmes d'emmanchement des faucilles du Proche-Orient: les documents de Tell Assouad (Djezireh, Syrie). Paléorient 1: 103-106.

Chapman, A.M.
1957 Port of Trade Enclaves in Aztec and Maya Civilization. In Trade and Market in the Early Empires: Economics in History and Theory, edited by K. Polanyi, C.M. Arensberg, and H.W. Pearson, pp. 114-153, Free Press, New York.

Clark, J.E.
1979 A Method for the Analysis of Mesoamerican Lithic Industries: An Application to the Obsidian Industry of La Libertad, Chiapas, Mexico. M.A. Thesis, Brigham Young University, Provo.

1988 The Lithic Artifacts of La Libertad, Chiapas, Mexico: An Economic Perspective. Papers of the New World Archaeological Foundation, No.52, Brigham Young University, Provo.

1991a Modern Lacandon Lithic Technology and Blade Workshops. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.H. Hester and H.J. Shafer, pp. 251-265, Monographs in World Archaeology No.1, Prehistory Press, Madison.

1991b Flintknapping and Debitage Disposal Among the Lacandon Maya of Chiapas, Mexico. In The Ethnoarchaeology of Refuse Disposal: Archaeological Research Papers 42, edited by E. Staski and L.D. Sutro, pp. 63-78, Arizona State University, Tempe.

Clark, J.E. and D. Bryant
1991 The Production of Chert Projectile Points at Yerba Buena, Chiapas, Mexico. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp.85-102, Monographs in World Archaeology No.1, Prehistory Press, Madison.

Clark, J.G.D.
1932 The Curved Flint Sickle Blades of Britain. Proceedings of the Prehistoric Society 7, pt.1: 67-81.

1958 Some Stone Age Woodworking Tools in Southern Africa. South African Archaeological Bulletin 13: 144-152.

Clark, J.G.D., and M. Thompson
1953 The Groove and Splinter Technique of Working Antler in Upper Palaeolithic and Mesolithic Europe. Proceedings of the Prehistoric Society 20: 148-160.

Clarke, D. L.
1978 Analytical Archaeology. 2nd edition, Methuen and Co., London.

Coe, M.D.
1987 The Maya. 4th edition, Thames and Hudson, London.

Coe, W.R.
1957 A Distinctive Artifact Common to Haiti and Central America. American Antiquity 22: 280-282.

1959 Piedras Negras Archaeology: Artifacts, Caches, and Burials. Museum Monographs, University Museum, University of Pennsylvania, Philadelphia.

1965 Artifacts of the Maya Lowlands. In Handbook of Middle American Indians, Vol. 3: Archaeology of Southern Mesoamerica, pt.2, edited by R. Wauchope and G.R. Willey, pp.594-603, University of Texas Press, Austin.

Coe, W.R. and M.D. Coe
1956 Excavations at Nohock Ek, British Honduras. American Antiquity 21: 370-382.

Coggins, C.C. and J.M. Ladd
1992 Wooden Artifacts. In Artifacts from the Cenote of Sacrifice, Chichen Itza, Yucatan, edited by C.C. Coggins, pp. 235-344, Memoirs of the Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge.

Coles, J.
1973 Archaeology by Experiment. Hutchinson and Co., Ltd., London.

Collins, M.B.
1975 Lithic Technology as a Means of Processual Inference. In Lithic Technology: Making and Using Stone Tools, edited by E. Swanson, pp. 15-34, Mouton, The Hague.

Coqueugniot, E.
1983 Analyse tracéologique d'une série de grattoirs et herminettes de Mureybet, Syrie. In Traces d'utilisation sur les outils néolithiques du Proche Orient, edited by M.-C. Cauvin, pp. 163-172, GIS- Maison de l'Orient, Lyon..

Costin, C.L.
1991 Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production. Archaeological Method and Theory, Vol.3, edited by M.B. Schiffer, pp. 1-56, University of Arizona Press, Tucson.

Cotterell, B. and J. Kamminga
1990 Mechanics of Pre-industrial Technology. Cambridge University Press, Cambridge.

Cotterell, B., B. Hayden, J. Kamminga, M. Kleindienst, R. Knudson, and R. Lawrence
1979 The Ho Ho Classification and Nomenclature Committee Report. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 133-135, Academic Press, New York.

Cowgill, G.L.
1993 Comments on Andrew Sluyter "Long-distance Staple Transport in Western Mesoamerica: Insights through Quantitative Modeling". Ancient Mesoamerica 4: 201-203.

Cox, I.
1936 The Indian Spoon. American Antiquity 1: 317-320.

Cox, K.A. and R.A. Ricklis
1999 A Preliminary Assessment of the Organization of Lithic Technologies in the Blue Creek Region. In The Blue Creek Project: Working Papers from the 1997 Season, edited by W.D. Driver, H.R. Haines and T.H. Guderjan, pp. 85-93, Maya Research Program, St. Mary's University, San Antonio.

Crabtree, D.E.
1968 Mesoamerican Polyhedral Cores and Prismatic Blades. American Antiquity 33: 446-478.

1972 An Introduction to Flintworking. Occasional Papers No.28, Idaho State University Museum, Pocatello.

Crabtree, D.E. and B.R. Butler
1964 Notes on Experiments in Flintknapping: 1. Heat Treatment of Silica Minerals. Tebiwa 7: 1-6.

Culbert, T. P.
1973 (ed.) The Classic Maya Collapse. University of New Mexico Press, Albuquerque.

1988a The Collapse of Classic Maya Civilization. In The Collapse of Ancient States and Civilizations, edited by N. Yoffee and G.L. Cowgill, pp. 69-101, University of Arizona Press, Tucson.

1988b Political History and the Decipherment of Maya Glyphs. Antiquity 62: 135-152.

1991 Classic Maya Political History. Cambridge University Press, Cambridge.

Curwen, E.C.
1930 Prehistoric Flint Sickles. Antiquity 4: 179-186.

1935 Agriculture and the Flint Sickle in Palestine. Antiquity 9: 62-66.

D'Altroy, T. and T.K. Earle
1985 Staple Finance, Wealth Finance, and Storage in the Inka Political Economy. Current Anthropology 26: 187-206.

Dauvois, M.
1977 Stigmates d'usure présentés par les outils ayant travaillé l'os. Premiers résultats. In Méthodologie appliquée à l'Industrie de l'os préhistorique, pp. 275-292, CNRS colloques internationaux 568, Centre National de la Recherche Scientifique, Paris.

Davis, Z. and J.J. Shea
1998 Quantifying Lithic Curation: An Experimental Test of Dibble and Pelcin's Original Flake-Tool Mass Prediction. Journal of Archaeological Science 25: 603-610.

Deal, M. and B. Hayden
1987 The Persistence of Pre-Columbian Lithic Technology in the Form of Glassworking. In Lithic Studies Among the Contemporary Highland Maya, edited by B. Hayden, pp. 235-331, University of Arizona Press, Tucson.

Del Bene, T.A.
1979 Once Upon a Striation: Current Models of Striation and Polish. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 167-177, Academic Press, New York.

Del Bene, T.A. and P. Shelley
1979 Soapstone Modification and its Effect on Lithic Implements. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 243-257, Academic Press, New York.

Demarest, A.A.
1992 Ideology in Ancient Maya Cultural Evolution: The Dynamics of Galactic Polities. In Ideology and Pre-Columbian Civilization, edited by A.A. Demarest and G.W. Conrad, pp. 135-157, School of American Research Press, Santa Fe.

Demarest, A.A. and A.E. Foias
1993 Mesoamerican Horizons and the Cultural Transformations of Maya Civilization. In Latin American Horizons, edited by D.S. Rice, pp. 147-191, Dumbarton Oaks, Washington, D.C.

d'Errico, F.
1985 Traces d'usure sur l'industrie lithique: Approche méthodologique et proposition d'une technique. L'Anthropologie 89: 439-456.

Diamond, G.
1979 The Nature of So-Called Polished Surfaces on Stone Artifacts. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 159-166, Academic Press, New York.

Dibble, H.L.
1984 Interpreting Typological Variation of Middle Paleolithic Scrapers: Function, Style or Sequence of Reduction? Journal of Field Archaeology 11: 431-436.

1985 Technological Aspects of Flake Variation. American Archaeology 5: 236-240.

1987 The Interpretation of Middle Palaeolithic Scraper Morphology. American Antiquity 52:109-117.

Dibble, H.L. and A. Pelcin
1995 The Effect of Hammer Mass and Velocity on Flake Mass. Journal of Archaeological Science 22: 429-439.

Dockall, J.E. and H.J. Shafer
1993 Testing the Producer-Consumer Model for Santa Rita Corozal, Belize. Latin American Antiquity 4: 158-179.

Domanski, M. and J.A. Webb
1992 Effect of Heat Treatment on Siliceous Rocks Used in Prehistoric Lithic Technology. Journal of Archaeological Science 19: 601-614.

Dreiss, M.L.
1982 An Initial Description of Shell Artifacts from Colha, Belize. In Archaeology at Colha, Belize: The 1981 Interim Report, edited by T.R. Hester, H.J. Shafer and J.D. Eaton, pp. 208-224, University of Texas at San Antonio and Centro Studi e Ricerche Ligabue, Venice, San Antonio.

1988 Obsidian at Colha, Belize: A Technological Analysis and Distributional Study Based on Trace Element Data. Papers of the Colha Project, Vol. 4, Texas Archaeological Research Laboratory, University of Texas at Austin and Center for Archaeological Research, University of Texas at San Antonio, Austin.

Dreiss, M.L. and D.O. Brown
1989 Obsidian Exchange Patterns in Belize. In Prehistoric Maya Economies of Belize, edited by P.A. McAnany and B.L. Isaac, pp. 57-90, Research in Economic Anthropology, Supplement 4, JAI Press, London.

Drennan, R.D.
1984a Long-Distance Transport Costs in Prehispanic Mesoamerica. American Anthropologist 86: 105-112.

1984b Long-Distance Movement of Goods in the Mesoamerican Formative and Classic. American Antiquity 49: 27-43.

Dumont, J.V.
1982 The Quantification of Microwear Traces: A New Use for Interferometry. World Archaeology 14: 206-217.

Dunn, R.K. and S.J. Mazzullo
1993 Holocene Paleocoastal Reconstruction and its Relationship to Marco Gonzalez, Ambergris Caye, Belize. Journal of Field Archaeology 20: 121-131.

Ebert, J.I.
1986 Distributional Archaeology: Nonsite Discovery, Recording and Analytic Methods for Application to the Surface Archaeological Record. Ph.D. Thesis, University of New Mexico, Albuquerque.

Edwards, C.R.
1978 Pre-Columbian Maritime Trade in Mesoamerica. In Mesoamerican Communication Routes and Cultural Contacts, edited by T.A. Lee and C. Navarrete, pp. 199-209, Papers of the New World Archaeological Foundation No. 40, Brigham Young University, Provo.

Elster, E.
1976 The Chipped-Stone Industry of Anzabegovo. Monumenta Archaeologica 1, Institute of Archaeology Press, University of California at Los Angeles.

Emery, K.
1990 Postclassic and Colonial Period Subsistence Strategies in the Southern Maya Lowlands: Faunal Analyses from Lamanai and Tipu, Belize. M.A. Thesis, University of Toronto, Toronto.

Erlandson, J.M.
1988 The Role of Shellfish in Prehistoric Economies: a Protein Perspective. American Antiquity 53: 102-109.

Evans, J.
1872 The Ancient Stone Implements, Weapons and Ornaments of Great Britain. Appleton, New York.

Fedick, S.
1989 The Economics of Agricultural Land Use and Settlement in the Upper Belize Valley. In Prehistoric Maya Economies of Belize, edited by P.A. McAnany and B.L. Isaac, pp. 215-253, Research in Economic Anthropology, Supplement 4, JAI Press, Greenwich.

1991 Chert Tool Production and Consumption among Classic Period Maya Households. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp. 103-118, Monographs in World Archaeology No.1, Prehistory Press, Madison.

Fedje, D.
1979 Scanning Electron Microscopy Analysis (?) of Use-Striae. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 179-187, Academic Press, New York.

Fiedler, L.
1979 Formen und Technik neolithischer Steingeraete aus dem Rheinland. Rheinische Ausgrabungen 19: 53-190.

Flenniken, J.J.
1985 Reduction Techniques as Cultural Markers. In Stone Tool Analysis: Essays in Honor of Don E. Crabtree, edited by M. Plew, J. Woods, and M. Pavesic, pp. 265-276, University of New Mexico Press, Albuquerque.

Flenniken, J.J. and E.G. Garrison
1975 Thermally Altered Novaculite and Stone Tool Manufacturing Techniques. Journal of Field Archaeology 2: 125-131.

Flenniken, J.J. and J. Haggarty
1979 Trampling as an Agent in the Formation of Edge Damage: An Experiment in Lithic Technology. Northwest Anthropological Research Notes 13: 208-214.

Flenniken, J.J. and A.W. Raymond
1986 Morphological Projectile Point Typology: Replication Experimentation and Technological Analysis. American Antiquity 51: 603-614.

Foley, R.
1981 Offsite Archaeology: An Alternative Approach for the Short-Sighted. In Pattern of the Past: Studies in Honour of David Clarke, edited by I. Hodder, G. Isaac and N. Hammond, pp. 157-183, Cambridge University Press, Cambridge.

Forsman, M.R.A.
1976 Bipolar Stone Working Technology. In Primitive Art and Technology, edited by J.S. Raymond, B. Loveseth, C. Arnold, and G. Reardon, pp. 16-26, University of Calgary Archaeological Association, Calgary.

Fowler, W.R., Jr.
1987 An Analysis of the Chipped Stone Artifacts of El Mirador, Guatemala. Notes of the New World Archaeological Foundation No.5, Brigham Young University, Provo.

Fowler, W.R., Jr., A.A. Demarest, H.V. Michel, and F.H. Stross
1989 Sources of Obsidian from El Mirador, Guatemala: New Evidence on Preclassic Maya Interaction. American Anthropologist 91: 158-168.

Franks, Mr.
1877 Some Stone Implements from Honduras and Turks and Caicos Islands. Journal of the Anthropological Institute of Great Britain and Ireland 6: 37-40.

Freidel, D.A.
1978 Maritime Adaptation and the Rise of Maya Civilization: The View from Cerros, Belize. In Prehistoric Coastal Adaptations, edited by B.L. Stark and B. Voorhies, pp. 239-265, Academic Press, New York.

1979 Culture Areas and Interaction Spheres: Contrasting Approaches to the Emergence of Civilization in the Maya Lowlands. American Antiquity 44: 36-55.

1981 The Political Economics of Residential Dispersion Among the Lowland Maya. In Lowland Maya Settlement Patterns, edited by W. Ashmore, pp. 371-382, University of New Mexico Press, Albuquerque.

1986 Terminal Classic Lowland Maya: Successes, Failures, and Aftermaths. In Late Lowland Maya Civilization: Classic to Postclassic, edited by J.A. Sabloff and E.W. Andrews V, pp. 409-430, University of New Mexico Press, Albuquerque.

Freidel, D.A. and J.A. Sabloff
1984 Cozumel: Late Maya Settlement Patterns. Academic Press, New York.

Freidel, D.A. and V.L. Scarborough
1982 Subsistence, Trade, and Development of the Coastal Maya. In Maya Subsistence: Studies in Memory of Dennis E. Puleston, edited by K.V. Flannery, pp. 131-155, Academic Press, New York.

Frink, D.S.
1984 Artifact Behavior Within the Plow Zone. Journal of Field Archaeology, 13: 403-418.

Frison, G.C.
1968 A Functional Analysis of Certain Chipped Stone Tools. American Antiquity 33: 149-155.

1979 Observations on the Use of Stone Tools: Dulling of Working Edges of Some Chipped Stone Tools in Bison Butchering. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 259-268, Academic Press, New York.

Frison, G.C. and B. Bradley
1980 Folsom Tools and Technology at the Hanson Site, Wyoming. University of New Mexico Press, Albuquerque.

Gallagher, J.P.
1977 Contemporary Stone Tools in Ethiopia: Implications for Archaeology. Journal of Field Archaeology 4: 407-414.

Gann, T.W.F.
1911 Explorations carried out in British Honduras during 1908-1909. Annals of Archaeology and Anthropology from the University of Liverpool Institute of Archaeology 4: 72-87.

1918 The Maya Indians of Southern Yucatan and Northern British Honduras. Bureau of American Ethnology Bulletin No.64, Washington, D.C.

Gann T.W.F and M. Gann
1939 Archaeological Investigations in the Corozal District of British Honduras. Bureau of American Ethnology Bulletin 123, Anthropological Papers No.7, Smithsonian Institution, Washington, D.C.

Garber, J.F.
1981 Material Culture and Patterns of Artifact Consumption and Disposal at the Maya Site of Cerros, in Northern Belize. Ph.D. Thesis, Southern Methodist University, Dallas.

1985 Long Distance Trade and Regional Exchange at the Maya Community of Cerros in Northern Belize. Mexicon 7: 13-16.

1989 Archaeology at Cerros, Belize, Central America, Vol. II: The Artifacts. Southern Methodist University, Dallas.

1995 The Artifacts. In Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize, edited by T.H. Guderjan and J.F. Garber, pp. 113-137, Maya Research Program and Labyrinthos, Lancaster.

Gendel, P.A. and L. Pirnay
1982 Microwear Analysis of Experimental Stone Tools: Further Test Results. In Tailler! pour quoi faire: Préhistoire et technologie lithique II, edited by D. Cahen, pp.251-265, Studia Praehistorica Belgica 2, Musée royal de l'Afrique centrale, Tervuren.

Gero, J.M.
1989 Assessing Social Information in Material Objects: How Well Do Lithics Measure Up? In Time, Energy and Stone Tools, edited by R. Torrence, pp. 92-105, Cambridge University Press, Cambridge.

Gibson, E.C.
1986 Diachronic Patterns of Lithic Production, Use and Exchange in the Southern Maya Lowlands. Ph.D. Thesis, Harvard University, Cambridge.

1989 The Organization of Late Preclassic Maya Lithic Economy in the Eastern Lowlands. In Prehistoric Maya Economies of Belize, edited by P.A. McAnany and B.L. Isaac, pp. 115-138, Research in Economic Anthropology, Supplement 4, JAI Press, Greenwich.

Gifford, D.P.
1978 Ethnoarchaeological Observations of Natural Processes Affecting Cultural Materials. In Explorations in Ethnoarchaeology, edited by R. Gould, pp. 77-101, University of New Mexico Press, Albuquerque.

Gifford-Gonzalez, D.P., D.B. Damrosch, D.R. Damrosch, J. Pryor, and R.L. Thunen
1985 The Third Dimension in Site Structure: An Experiment in Trampling and Vertical Dispersal. American Antiquity 50: 803-818.

Gillespie, Dr.
1877 On Flint Cores as Implements. Journal of the Royal Anthropological Institute of Great Britain and Ireland 6: 260-263.

Glassow, M.A. and L.R. Wilcoxon
1988 Coastal Adaptations Near Point Conception, California, with Particular Regard to Shellfish Exploitation. American Antiquity 53: 36-51.

Goodyear, A.C.
1979 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Palaeo-Indian Groups of North America. University of South Carolina Institute of Archaeology and Anthropology Research Manuscript Series156.

1989 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleoindian Groups of North America. In Eastern Paleoindian Lithic Resource Use, edited by C.J. Ellis and J.C. Lothrop, pp. 1-9, Westview Press, Boulder.

Gould, R.A.
1977 Ethno-archaeology or Where Do the Models Come From? In Stone Tools as Cultural Markers, edited by R.V.S. Wright, pp. 162-168, Australian Institute of Aboriginal Studies, Canberra.

1978 Beyond Analogy in Ethnoarchaeology. In Explorations in Ethnoarchaeology, edited R.A. Gould, pp. 249-293, University of New Mexico Press, Albuquerque.

1980 Living Archaeology. Cambridge University Press, Cambridge.

Gould, R. and S. Saggers
1985 Lithic Procurement in Central Australia: A Closer Look at Binford's Idea of Embeddedness in Archaeology. American Antiquity 50: 117-136.

Gould, R., D. Koster and A. Sontz
1971 The Lithic Assemblage of the Western Desert Aborigines of Australia. American Antiquity 36: 149-169.

Grace, R.
1989 The Quantification and Computerization of Microwear Analysis. BAR International Series 474, Oxford.

1990 The Limitations and Applications of Use Wear Analysis. In The Interpretive Possibilities of Microwear Analysis, edited by B. Graslund, H. Knutsson, K. Knutsson, and J. Taffinder, pp. 9-14, Societas Archaeologica Upsaliensis, Uppsala.
1993 The Use of Expert Systems in Lithic Analysis. In Traces et fonction: Les Gestes Retrouvés, edited by P.C. Anderson, S. Beyries, M. Otte, and H. Plisson, pp. 389-400, Collège International de Liège, Editions Eraul, vol.50, Centre de Recherches Archéologiques du CNRS, Etudes et Recherches Archéologiques de l'Université de Liège, Liège.

1996 Review Article: Use Wear Analysis: The State of the Art. Archaeometry 38: 209-229.

Grace, R., Graham, I. D. G. and Newcomer, M. H.
1985 The Quantification of Microwear Polishes. World Archaeology 17: 112-120.

1987 The Mathematical Characterization of Wear Traces on Prehistoric Flint Tools. In The Human Uses of Flint and Chert: Papers from the Fourth International Flint Symposium, edited by G. de G. Sieveking and M. Newcomer, pp. 63-69, Cambridge University of Cambridge Press, Cambridge.

Graham, E.
1985 Facets of Terminal to Postclassic Activity in the Stann Creek District, Belize. In The Lowland Maya Postclassic, edited by A.F. Chase and P.M. Rice, pp. 215-230, University of Texas Press, Austin.

1987a Resource Diversity in Belize and its Implications for Models of Lowland Trade. American Antiquity 54: 753-767.

1987b Terminal Classic to Early Historic Period Vessel Forms from Belize. In Maya Ceramics: Papers from the 1985 Maya Ceramic Conference, edited by P.M. Rice and R.J. Sharer, pp. 73-98, BAR International Series 345 (Part i), Oxford.

1989 Brief Synthesis of Coastal Site Data from Colson Point, Placencia, and Marco Marco Gonzalez, Belize. In Coastal Maya Trade, edited by H. McKillop and P.F. Healy, pp. 138-154, Trent University Occasional Papers in Anthropology No.8, Peterborough.

1991 Archaeological Insights into Colonial Period Maya Life at Tipu, Belize. In Columbian Consequences, Vol. 3, edited by D.H. Thomas, pp. 319-335, Smithsonian Institution Press, Washington, D.C.

1994 The Highlands of the Lowlands: Environment and Archaeology in the Stann Creek District, Belize, Central America. Monographs in World Prehistory No. 19, Prehistory Press, Madison.

Graham, E. and D.M. Pendergast
1987 Cays to the Kingdom. Royal Ontario Museum, Archaeological Newsletter, Series II, No.18: 1-4.

1989 Excavations at the Marco Gonzales Site, Ambergris Cay, Belize 1986. Journal of Field Archaeology 16: 1-16.

Gray, St. G.
1916 On a Chipped Flint Implement Found in British Honduras. Man 16: 154-155.

Greenwell, W.
1865 Notices on the Examination of Ancient Grave-mills in the North Riding of Yorkshire. Archaeological Journal 22: 97-117.

Greiser, S.T. and P.D. Sheets
1979 Raw Material as a Functional Variable in Use-Wear Studies. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 289-296, Academic Press, New York.

Griffiths, D.R., C.A. Bergman, C.J. Clayton, K. Ohnuma, G.V. Robins, and N.J. Seeley
1987 Experimental Investigation of the Heat Treatment of Flint. In The Human Uses of Flint and Chert: Papers from the Fourth International Flint Symposium, edited by G. de G. Sieveking and M.H. Newcomer, pp. 43-52, Cambridge University Press, Cambridge.

Guderjan, T.H.
1988 Maya Maritime Trade at San Juan, Ambergris Caye, Belize. Ph.D. Thesis, Southern Methodist University, Dallas.

1995a The Setting and Maya Maritime Trade. In Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize, edited by T.H. Guderjan and J.F. Garber, pp. 1-8, Maya Research Program and Labyrinthos, Lancaster.

1995b Settlement Patterns and Survey Data. In Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize, edited by T.H. Guderjan and J.F. Garber, pp. 9-30, Maya Research Program and Labyrinthos, Lancaster.

Guderjan, T.H. and J.F. Garber (eds.)
1995a Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize. Maya Research Program and Labyrinthos, Lancaster.

1995b Maya Maritime Trade, Settlement, and Populations on Ambergris Caye. In Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize, edited by T.H. Guderjan and J.F. Garber, pp. 183-190, Maya Research Program and Labyrinthos, Lancaster.

Guderjan, T.H, J.F. Garber and H.A. Smith
1987 Trans-shipment Points and Facilities on Northern Ambergris Cay, Belize. Paper presented at 52nd Annual Meeting of the Society for American Archaeology Conference, Toronto.

1988 San Juan: A Maya Trade Transshipment Point on Northern Ambergris Caye, Belize. Mexicon 10: 35-37.

1989 Maritime Trade on Ambergris Caye. In Coastal Maya Trade, edited by H. McKillop and P.F. Healy, pp.123-134, Occasional Papers in Anthropology, No.8, Trent University, Peterborough.

Gunn, J.
1975 Idiosyncratic Behaviour in Chipping Style: Some Hypotheses and Preliminary Analysis. In Lithic Technology: Making and Using Stone Tools, edited by E. Swanson, pp. 35-62, Mouton Publishers, The Hague.

Gurfinkel, D.M. and U.M. Franklin
1988 A Study of the Feasibility of Detecting Blood Residue on Artifacts. Journal of Archaeological Science 15: 83-97.

Gysels, J.
1980 Microwear Analysis: Experiments and Observations (abstract). Lithic Technology 9:33.

1981 Experimenteel gebruikssporen der zoek van het lithische materiaal van het epipaleolithische site Elkab en he neolithische site Blicquy. Thesis, Katholieke Universiteit te Leuven, Belgium.

Gysels, J. and D. Cahen
1982 Le lustre des faucilles et les autres traces d'usure des outils en silex. Bulletin de la Société Préhistorique Française 79: 221-224.

Hamblin, N.L.
1984 Animal Use by the Cozumel Maya. University of Arizona Press, Tucson.

1985 The Role of Marine Resources in the Maya Economy: A Case Study from Cozumel, Mexico. In Prehistoric Lowland Maya Environment and Subsistence Economy, edited by M. Pohl, pp. 159-173, Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 77, Harvard University, Cambridge.

Hamilton, R.
1987 The Archaeological Mollusca of Cerros, Belize. Paper presented at 52nd Annual Meeting of the Society for American Archaeology Conference, Toronto.

Hamilton, T.M.
1979 Guns, Gunflints, Balls and Shot. In Tunica Treasure, edited by J.P. Brain, pp. 206-216, Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 71, Harvard University, Cambridge.

Hamilton, T.M. and Bruce W. Fry
1975 A Survey of Louisbourg Gunflints. National Historic Parks and Site Branch, Occasional Papers in Archaeology and History, Vol. 12, pp. 101-128, Ottawa.

Hamman-Hollander, C.
1984 The Hearthrites of Akabchen: Cultural Justification for an Evaluation of Dietary Patterns in a Traditional Maya Population. M.A. Thesis, Florida Atlantic University, Boca Raton.

Hammond, N.
1972 Obsidian Trade Routes in the Mayan Area. Science 178: 1092-1093.

1973 British Museum-Cambridge University Corozal Project, 1973 Interim Report. Cambridge University, Cambridge.

1975 Lubaantun: A Classic Maya Realm. Monographs of the Peabody Museum of Archaeology and Ethnology, No.2, Harvard University, Cambridge.

1976 Maya Obsidian Trade in Southern Belize. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp. 71-81, Special Report No.4, Center for Archaeological Research, University of Texas, San Antonio.

1981 Classic Maya Canoes. The International Journal of Nautical Archaeology and Underwater Exploration 10: 173-185.

Hammond, N., M.D. Neivens and G. Harbottle
1984 Trace Element Analysis of Obsidian Artifacts from a Classic Maya Residential Group at Nohmul, Belize. American Antiquity 49: 815-820.

Hammond, N., D. Pring, R. Wilk, S. Donaghey, F.P. Saul, E.S. Wing, A.V. Miller, and L.H. Feldman
1979 The Earliest Maya? Definition of the Swasey Phase. American Antiquity 44: 92-110.

Hardy, B.L.
1994 Investigations of Stone Tool Function Through Use-Wear, Residue and DNA Analyses at the Middle Paleolithic Site of La Quina, France. Ph.D. Thesis, Indiana University.

Hardy, B.L. and G.T. Garufi
1998 Identification of Woodworking on Stone Tools through Residue and Use-Wear Analyses: Experimental Results. Journal of Archaeological Science 25: 177-184.

Harlan, J.R.
1967 A Wild Wheat Harvest in Turkey. Archaeology 20: 197-201.

Hartmann, N.
1980 A Preliminary Microwear Analysis of Obsidian from Santa Rita Corozal (Belize). MASCA Journal 1: 136-140.

Hassig, R.
1985 Trade, Tribute, and Transportation: The Sixteenth Century Political Economy of the Valley of Mexico. University of Oklahoma Press: Norman.

1992 War and Society in Ancient Mesoamerica. University of California Press, Berkeley.

Hay, C.A.
1978 Kaminaljuyu Obsidian: Lithic Analysis and the Economic Organization of a Prehistoric Maya Chiefdom. Ph.D. Thesis, Pennsylvania State University, University Park.

Hayden, B.
1976 Curation: Old and New. In Primitive Art and Technology, edited by J.S. Raymond, B. Loveseth, C. Arnold, and G. Reardon, pp. 47-59, Archaeological Association, University of Calgary, Calgary.

1977 Stone Tool Functions in the Western Desert. In Stone Tools as Cultural Markers, edited by R.V.S. Wright, pp. 178-188, Humanities Press, Atlantic Highlands.

1979a Lithic Use-Wear Analysis. Academic Press, New York.

1979b Snap, Shatter, and Superfractures: Use-wear of Stone Skin Scrapers. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 207-229, Academic Press, New York.

1980 Confusion in the Bipolar World: Bashed Pebbles and Splintered Pieces. Lithic Technology 9: 2-7.

1987a From Chopper to Celt: The Evolution of Resharpening Techniques. Lithic Technology 16: 33-43.

1987b Past to Present Uses of Stone Tools and Their Effects on Assemblage Characteristics in the Maya Highlands. In Lithic Studies among the Contemporary Highland Maya, edited by B. Hayden, pp. 160-234, University of Arizona Press, Tucson.

1998 Practical and Prestige Technologies: The Evolution of Material Systems. Journal of Archaeological Method and Theory 5: 1-55.

Hayden, B. and A. Cannon
1983 Where the Garbage Goes: Refuse Disposal in the Maya Highlands. Journal of Anthropological Archaeology 2: 117-163.

Hayden, B. and W. K. Hutchings
1989 Whither the Billet Flake? In Experiments in Lithic Technology, edited by D.S. Amick and R.P. Mauldin, pp. 235-257, BAR International Series 528, Oxford.

Hayden, B. and J. Kamminga
1973 Gould, Koster and Sontz on "Microwear": A Critical Review. Lithic Technology 2: 3-8.

1979 An Introduction to Use-Wear: The First CLUW. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 1-14, Academic Press, New York.

Hayden, B. and M. Nelson
1981 The Use of Chipped Lithic Material in the Contemporary Maya Highlands. American Antiquity 46: 885-898.

Hayden, Brian, N. Franco and J. Spafford
1996 Evaluating Lithic Strategies and Design Criteria. In Stone Tools: Theoretical Insights into Human Prehistory, edited by G. Odell, pp. 9-45, Plenum Press, New York.

Hazelden, J.
1973 The Soils and Geology of the Orange Walk and Corozal Districts. In Corozal Project Interim Report, edited by N. Hammond, pp. 74-85, Centre for Latin American Studies, Cambridge University, Cambridge.

Healy, P.F.
1988 Music of the Maya. Archaeology 41: 24-31.

Healy, P.F. and H. McKillop
1980 Moho Cay, Belize: A Preliminary Report on the 1979 Archaeology Season. Belizean Studies 8: 10-16.

Healy, P.F., J.J. Awe, G. Iannone, and C. Bill
1995 Pacbitun (Belize) and Ancient Maya Use of Slate. Antiquity 69: 337-348.

Healy, P.F., H. McKillop, and B. Walsh
1984 Analysis of Obsidian from Moho Cay, Belize. Science 225: 414-417.

Hendon, J.
1991 Status and Power in Classic Maya Society: An Archaeological Study. American Anthropologist 93: 894-918.

Hester, T.R.
1975 The Obsidian Industry of Beleh (Chinuatla Viejo), Guatemala. Actas del XLI Congreso Internacional de Americanistas: 473-478.

1976 Belize Lithics: Forms and Functions. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp.11-20, Special Report No.4, Center for Archaeological Research, University of Texas at San Antonio.

1979 The Colha Project, 1979: A Collection of Interim Papers. edited by T.R. Hester, Center for Archaeological Research, University of Texas, San Antonio.

1980 The 1980 Season at Colha, Belize: An Overview. In The Colha Project Second Season, 1980 Interim Report. edited by T.R. Hester, J.A. Eaton, and H.J. Shafer, pp. 1-14, Center for Archaeological Research, University of Texas at San Antonio and Centro Studi e Ricerche Ligabue, Venezia, San Antonio.

1982 The Maya Lithic Sequence in Northern Belize. In Archaeology at Colha, Belize: The 1981 Interim Report, edited by T.R. Hester, H.J. Shafer and J.D. Eaton, pp. 39-59, University of Texas at San Antonio and Centro Studi e Ricerche Ligabue, Venice, San Antonio.

1985 The Maya Lithic Sequence in Northern Belize. In Stone Tool Analysis: Essays in Honor of Don E. Crabtree, edited by M.G. Plew, J.C. Woods, and M.G. Pavesic, pp. 187-210, University of New Mexico Press, Albuquerque.

Hester, T.R. and W.I. Follett
1976 Yurok Fish Knives: A Study of Wear Patterns and Adhering Salmon Scales. In Contributions of the University of California Archaeological Research Facility No. 33, pp. 3-23, University of California, Berkeley.

Hester, T.R. and N. Hammond (eds.)
1976a Maya Lithic Studies: Papers from the 1976 Belize Field Symposium. Special Report No.4, Center for Archaeological Research, University of Texas, San Antonio.

1976b Preface. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp. v-vii, Special Report No.4, Center for Archaeological Research, University of Texas, San Antonio.

Hester, T. R. and H. J. Shafer
1984 Exploitation of Chert Resources by the Ancient Maya of Northern Belize, Central America. World Archaeology 16: 157-173.

1987 Observations on Ancient Maya Core Technology at Colha, Belize. In The Organization of Core Technology, edited by J. Johnson and C. Morrow, pp. 239-257, Westview Press, Boulder.

1991a Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, Monographs in World Prehistory No.1, Prehistory Press, Madison.

1991b Lithics of the Early Postclassic at Colha, Belize. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp.155-162, Monographs in World Prehistory No.1, Prehistory Press, Madison.

1994 The Ancient Maya Craft Community at Colha, Belize and Its External Relationships. In Archaeological Views from the Countryside: Village Communities in Early Complex Societies, edited by G.M. Schwartz and S.E. Falconer, pp. 48-63, Smithsonian Institution Press, Washington, D.C.

Hester, T.R., J.A. Eaton, and H.J. Shafer (eds.)
1980 The Colha Project Second Season, 1980 Interim Report. Center for Archaeological Research, University of Texas, San Antonio, and Centro Studi e Ricerche Ligabue, Venezia.

Hester, T.R., D. Gilbow, and A. Albee
1973 A Functional Analysis of 'Clear Fork' Artifacts from the Rio Grande Plain, Texas. American Antiquity 38: 90-96.

Hester, T.R., H.J. Shafer and T. Berry
1991 Technological and Comparative Analyses of the Chipped Stone Artifacts from El Pozito, Belize. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp. 67-83, Monographs in World Archaeology No.1, Prehistory Press, Madison.

Hildebrand, J.A.
1978 Pathways Revisited: A Quantitative Model of Discard. American Antiquity 43: 274-279.

Hirth, K.
1992 Interregional Exchange as Elite Behaviour: An Evolutionary Perspective. In Mesoamerican Elites: An Archaeological Assessment, edited by D.Z. Chase and A.F. Chase, pp. 18-29, University of Oklahoma Press, Norman.

Hodder, Ian
1977 The Distribution of Material Culture Items in the Baringo District, West Kenya. Man 12: 239-269.

1982 Symbols in Action: Ethnoarchaeological Studies in Material Culture. Cambridge University Press.

Hodder, I. and C. Orton
1976 Spatial Analysis in Archaeology. Cambridge University Press, Cambridge.

Hofman, J.L.
1986 Vertical Movement of Artifacts in Alluvial and Stratified Deposits. Current Anthropology 27: 163-171.

Hohmann, B. and T. Powis
1996 The 1995 Excavations at Pacbitun, Belize: Investigations of the Middle Formative Occupation in Plaza B. In Belize Valley Preclassic Maya Project: Report on the 1995 Field Season, edited by P.F. Healy and J.J. Awe, pp. 98-127, Trent University Occasional Publications in Anthropology No.12, Peterborough.

Hole, F. and Flannery, K.
1967 The Prehistory of Southwest Iran: A Preliminary Report. Proceedings of the Prehistoric Society 33: 147-206.

Hole, F., K. Flannery, and J. Neeley
1969 Prehistory and Human Ecology of the Deh Luran Plain. Memoirs of the Museum of Anthropology, University of Michigan No.1, Museum of Anthropology, Museum of Anthropology, Ann Arbor.

Holley, G. and Del Bene, T.
1981 An Evaluation of Keeley's Microwear Approach. Journal of Archaeological Science 8: 337-352.

Holmes, D.L.
1987 Problems Encountered in a High-Power Microwear Study of Some Egyptian Predynastic Lithic Artifacts. In The Human Uses of Flint and Chert: Papers from the Fourth International Flint Symposium, edited by G. de G. Sieveking and M. Newcomer, pp. 91-96, Cambridge University Press, Cambridge.

Horsfall, G.
1987 Design Theory and Grinding Stones. Lithic Studies Among the Contemporary Highland Maya, edited by B. Hayden, pp. 332-377, University of Arizona Press, Tucson.

Hult, W. and T.R. Hester
1995 The Lithics of Ambergris Caye. In Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize, edited by T.H. Guderjan and J.F. Garber, pp. 139-161, Maya Research Program and Labyrinthos, Lancaster.

Hurcombe, L.
1988 Some Criticisms and Suggestions in Response to Newcomer et al. (1986). Journal of Archaeological Science 15: 1-10.

1992 Use Wear Analysis and Obsidian: Theory, Experiments and Results. Sheffield Archaeological Monographs 4, J.R. Collis Publications, University of Sheffield, Sheffield.

Hurst, V.J. and A.R. Kelly
1961 Patination of Cultural Flints. Science 134: 251-256.

Hyland, D.C., J.M. Tersak, J.M. Adovasio, and M.I. Siegel
1990 Identification of the Species of Origin of Residual Blood on Lithic Material. American Antiquity 55: 104-112.

Iannnone, G.
1993 Ancient Maya Eccentric Lithics: A Contextual Analysis. M.A. Thesis, Trent University, Peterborough.

Iannone, G. and J.M. Conlon
1993 Elites, Eccentrics and Empowerment in the Maya Area: Implications for the Interpretation of a Peripheral Settlement Cluster near Cahal Pech, Cayo District, Belize. Papers for the Institute of Archaeology 4, pp. 77-89, Institute of Archaeology, University College London, London.

Iannone, G. and D. Lee
1996 The Formative Period Chipped Stone (Chert) from Cahal Pech, Belize: A Preliminary Analysis. Paper presented at the 61st Annual Meeting of the Society for American Archaeology Conference, New Orleans.

Isaac, G.Ll.
1977 Olorgesailie: Archeological Studies of a Middle Pleistocene Lake Basin in Kenya. University of Chicago Press, Chicago.

1986 Foundation Stones: Early Artefacts as Indicators of Activities and Abilities. In Stone Age Prehistory: Studies in Memory of Charles McBurney, edited by G.N. Bailey and P. Callow, pp. 221-241, Cambridge University Press, Cambridge.

Iversen, J.
1956 Forest Clearance in the Stone Age. Scientific American 234: 36-41.

Jelinek, A.J.
1976 Form, Function and Style in Lithic Analysis. In Culture Change and Continuity, edited by C.B. Cleland, pp. 19-33, Academic Press, New York.

Jenson, J.H.
1982 A Preliminary Analysis of Blade Scrapers from Ringkloster, a Danish Late Mesolithic Site. In Tailler! pour quoi faire: Préhistoire et technologie lithique II, edited by D. Cahen, pp. 323-327, Studia Praehistorica Belgica 2, Musée royal de l'Afrique centrale, Tervuren.

Jochim, M.A.
1983 Optimization Models in Context. In Archaeological Hammers and Theories, edited by J.A. Moore and A.S. Keene, pp. 157-172, Academic Press, New York.

1989 Optimization and Stone Tool Studies: Problems and Potential. In Time, Energy and Stone Tools, edited by R. Torrence, pp. 106-111, Cambridge University Press, Cambridge.

Johnson, J.K.
1987 Cahokia Core Technology in Mississippi: The View from the South. In The Organization of Core Technology, edited by J.K. Johnson and C.A. Morrow, pp. 181-206. Westview Press, Boulder.

1996 Lithic Analysis and Questions of Cultural Complexity: The Maya. In Stone Tools: Theoretical Insights into Human Prehistory, edited G. Odell, pp. 159-179, Plenum Press, New York.

Joyce, T.A.
1932 The "Eccentric Flints" of Central America. Journal of the Royal Anthropological Institute 62: 17-26.

Kajiwara, H. and K. Akoshima
1981 An Experimental Study of Microwear Polish on Shale Artifacts (English summary). Kokogaku Zasshi 67:1-36.

Kamminga, J.
1977 A Functional Study of Use-Polished Eloueras. In Stone Tools as Cultural Markers, edited by R. Wright, pp. 205-212, Humanities, New Jersey.

1979 The Nature of Use-Polish and Abrasive Smoothing on Stone Tools. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 143-157, Academic Press, New York.

1982 Over the Edge: Functional Analysis of Australian Stone Tools. Occasional Papers in Anthropology 12, University of Queensland, Brisbane.

Kay, M.
1996 Micro Wear Analysis of Some Clovis and Experimental Chipped Stone Tools. In Stone Tools: Theoretical Insights into Human Prehistory, edited G. Odell, pp. 315-344, Plenum Press, New York.

Keeley, L.H.
1974 Technique and Methodology in Microwear Studies: A Critical Review. World Archaeology 5: 323-336.

1976 Microwear on Flint: Some Experimental Results. In Second International Symposium on Flint, edited by F. Engelen, pp. 49-51, Nederlandse Geologische Vereniging, Maastricht.

1977 The Functions of Palaeolithic Flint Tools. Scientific American 237: 108-126.

1978 Microwear Polishes on Flint: Some Experimental Results. In Lithics and Subsistence: The Analysis of Stone Tool Use in Prehistoric Economies, edited by D.D. Davis, pp. 163-178, Publications in Anthropology No. 20, Vanderbilt University, Nashville.

1980 Experimental Determination of Stone Tool Uses: A Microwear Analysis. University of Chicago Press, Chicago.

1982 Hafting and Retooling: Effects on the Archaeological Record. American Antiquity 47: 798-809.

Keeley, L.H. and M.H. Newcomer
1977 Microwear Analysis of Experimental Flint Tools: A Test Case. Journal of Archaeological Science 4: 29-62.

Keller, D.
1979 Identifying Edge Damage on Surface Occurring Lithic Artifacts: Some Comments. Lithic Technology 8:15-17.

Keller, C.M.
1966 The Development of Edge Damage Patterns on Stone Tools. Man 1: 501-511.

Kelly, R.L.
1988 The Three Sides of a Biface. American Antiquity 53: 717-734.

Kelly, T.C.
1982 The Colha Regional Survey. In The Archaeology at Colha, Belize: The 1981 Interim Report, edited by T.R. Hester, H.J. Shafer and J.D. Eaton, pp. 85-97, Center for Archaeological Research, University of Texas at San Antonio and Centro Studi e Ricerche Ligabue, Venezia, San Antonio.

Kidder, A.V.
1947 The Artifacts of Uaxactun, Guatemala. Publication 576, Carnegie Institution of Washington, Washington, D.C.

1948 The Artifacts of Zacualpa. In Excavations at Zacualpa, Guatemala, edited by R. Wauchope, pp. 158-163, Publication 14, Middle American Research Institute, Tulane University, New Orleans.

Kidder, A.V., J. Jennings and E. Shook
1946 Excavations at Kaminaljuyu, Guatemala. Publication 561, Carnegie Institution of Washington, Washington, D.C.

Kimball, L.R., J.F. Kimball, and P.E. Allen
1995 Microwear Polishes as Viewed Through the Atomic Force Microscope. Lithic Technology 20: 6-28.

Kleindienst, M.
1975 Comment. Current Anthropology 16: 382-383.

Knowles, W.
1880 Portstewart and Other Flint Factories in the North of Ireland. Journal of the Royal Anthropological Institute of Great Britain and Ireland 9: 320-328.

Knutsson, K.
1983 Yttopografiska studier av forhistoriska stenredskap, 1. Plastavtryck for dokumentation och analys av notningspar. Tor 19 (1980-1982), Uppsala.

1988 Patterns of tool use: Scanning electron microscopy of experimental quartz tools. Societas Archaeologica Upsaliensis, Uppsala.

Knutsson, K. and R. Hope
1984 The Application of Acetate Peels in Lithic Usewear Analysis. Archaeometry 26: 49-61.

Knutsson, K., B. Dahlquist and H. Knutsson
1988 Patterns of Tool Use; the Microwear Analysis of the Quartz and Flint Assemblage from the Bjurselet Site, Vasterbotten, Northern Sweden. Industries lithiques: tracéologie et technologie, Vol.1, edited by S. Beyries, pp. 253-294, BAR International Series 411, Oxford.

Koldehoff, B.
1987 The Cahokia Flake Tool Industry: Socio-Economic Implications for Late Prehistory in the Central Mississippi Valley. In The Organization of Core Technology, edited by J.K. Johnson and C.A. Morrow, pp.151-185, Westview Press, Boulder.

Korobkova, G.H.
1980 Ancient Reaping Tools and their Productivity in the Light of Experimental Tracewear Analysis. In The Bronze Age Civilization of Central Asia. Recent Soviet Discoveries, edited by P. Kohl, pp. 325-349, Sharpe, New York.

Kuhn, S.L.
1992 On Planning and Curated Technologies in the Middle Palaeolithic. Journal of Anthropological Research 48: 185-214.

Landa, F.D. de
1937 Yucatan Before and After the Conquest. 2nd edition, translated by W. Gates, The Maya Society, Baltimore.

Lange, F.W.
1971 Marine Resources: A Viable Subsistence Alternative for the Prehistoric Lowland Maya. American Anthropologist 73: 619-636.

Lartet, E. and H. Christy
1864 L'homme fossile dans le Périgord. In Appendice à l'ancienneté de l'homme, edited by C. Lyell, pp. 135-177, Paris.

Lawn, B.R. and D.B. Marshall
1979 Mechanics of Micro-Contact Fracture in Brittle Solids. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 63-82, Academic Press, New York.

Lawrence, R.A.
1979 Experimental Evidence for the Significance of Attributes Used in Edge-Damage Analysis. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 113-131, Academic Press, New York.

LeCount, L.J.
1999 Polychrome Pottery and Political Strategies in Late and Terminal Classic Lowland Maya Society. Latin American Antiquity 10: 239-258.

Leguay, L.
1877 Les procédés employés pour la gravure et la sculpture des os avec les silex. Bulletin de la Société d'Anthropologie de Paris, 2ième série, 12: 280-296.

Lévi-Sala, I.
1986 Use Wear and Post-depositional Surface Modification: A Word of Caution. Journal of Archaeological Science 13: 229-244.

1993 Use-Wear Traces: Processes of Development and Post-Depositional Alterations. In Traces et fonction: Les Gestes Retrouvés, edited by P.C. Anderson, S. Beyries, M. Otte, and H. Plisson, pp. 401-416, Collège International de Liège, Editions Eraul, vol.50, Centre de Recherches Archéologiques du CNRS, Etudes et Recherches Archéologiques de l'Université de Liège, Liège.

Levitt, J.
1979 A Review of Experimental Traceological Research in the USSR. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 27-38, Academic Press, New York.

Lewark, D.E. and M.J. O'Brien
1981 The Expanding Role of Surface Assemblages in Archaeological Research. In

Advances in Archaeological Methods and Theory, Vol.4, edited by M.B. Schiffer, pp. 297-342, Academic Press, New York.

Lewenstein, S.
1981 Mesoamerican Obsidian Blades: An Experimental Approach to Function. Journal of Field Archaeology 8: 175-188.

1987 Stone Tool Use at Cerros: The Ethnoarchaeological Use-Wear Analysis. University of Texas Press, Austin.

1991 Edge Angles and Tool Function Among the Maya: A Meaningful Relationship? In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp. 239-250, Monographs in World Archaeology No.1, Prehistory Press, Madison.

Linde, K.
1986 Scanning Electron Microphotographs of Quartz, Flint and Obsidian Grains after Experimental Glacial, Subaqueous or Aeolian Transportation. In The Scientific Study of Flint and Chert, edited by G. de G. Sieveking and T. Hart, pp. 209-219, Cambridge University Press, Cambridge.

Loy, T.H.
1983 Prehistoric Blood Residues: Detection on Tool Surfaces and Identification of Species of Origin. Science 220: 1269-1271.

1985 Preliminary Residue Analysis: AMNH Specimen 20.4/509. In The Archaeology of Hidden Cave, Nevada, edited by D.H. Thomas, pp. 224-225, Museum of Natural History, New York.

1986 Recent Advances in Blood Residue Analysis. In Proceedings of the 24th International Archaeometry Symposium, edited by J. Olin and J. Blackman, pp. 57-65, Smithsonian Institution Press, Washington, D.C.

1987 Appendix: Elk Creek Lake Project: Residue Analysis of 50 Artifacts from Three Sites. In Data Recovery at Sites 35JA27, 35JA59, and 35JA100, Elk Creek Lake Project, Jackson Co., Oregon, Volume 2, edited by R. Pettigrew and C. Lebow, pp. I.1-I.7, Infotec, Eugene.

1993 The Artifact as Site: An Example of the Biomolecular Analysis of Organic Residues on Prehistoric Tools. World Archaeology 25: 44-63.

Loy, T.H. and B.L. Hardy
1993 Residue Analysis of 90,000-Year-Old Stone Tools from Tabun Cave, Israel. Antiquity 66: 24-35.

Loy, T.H. and D. Nelson
1987 Potential Applications of the Organic Residues on Ancient Tools. In Archaeometry: Further Australasian Studies, edited by W. Ambrose and J. Murray, pp. 179-185, The Australian National University, Canberra.

Loy, T.H. and A.R. Wood
1989 Blood Residue Analysis at Çayönu Tepesi, Turkey. Journal of Field Archaeology 16: 451-460.

Loy, T.H., M. Spriggs and S. Wickler
1992 Direct Evidence for Human Use of Plants 28,000 Years Ago: Starch Residues on Stone Artifacts from the Northern Solomon Islands. Antiquity 66: 898-912.

Lubbock, J.
1872 Pre-Historic Times. 3rd edition, Williams and Norgate, London.

Luedtke, B.E.
1992 An Archaeologist's Guide to Chert and Flint. Archaeological Research Tools 7, Institute of Archaeology, University of California, Los Angeles.

McAnany, P.A.
1982 Pulltrouser Swamp Lithics: Analysis of a Six Stage Recycling Sequence and Documentation of Post-Breakage Role Diversification in Oval Biface Fragments. Paper presented at the Second Maya Lithic Conference, San Antonio Texas.

1986 Lithic Technology and Exchange Among Wetland Farmers of the Eastern Maya Lowlands. Ph.D. Thesis, University of New Mexico, Albuquerque.

1988 Effect of Lithic Procurement Strategies on Tool Curation and Recycling. Lithic Technology 17: 3-11.

1989a Economic Foundations of Prehistoric Maya Society: Paradigms and Concepts. In Prehistoric Maya Economies of Belize, edited by P.A. McAnany and B.L. Isaac, pp. 347-372, Research in Economic Anthropology, Supplement 4, JAI Press, Greenwich.

1989b Stone-Tool Production and Exchange in the Eastern Maya Lowlands: The Consumer Perspective from Pulltrouser Swamp, Belize. American Antiquity 54: 332-346.

1991 Structure and Dynamics of Intercommunity Exchange. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp. 271-293, Monographs in World Archaeology No.1, Prehistory Press, Madison.

1992 Agricultural Tasks and Tools: Patterns of Stone Tool Discard Near Prehistoric Maya Residences Bordering Pulltrouser Swamp, Belize. In Gardens of Prehistory: The Archaeology of Settlement Agriculture in Greater Mesoamerica, edited by T.W. Killion, pp. 184-213, University of Alabama Press, Tuscaloosa.

1993a Resources, Specialization, and Exchange in the Maya Lowlands. In The American Southwest and Mesoamerica: Systems of Prehistoric Exchange, edited by J.E. Ericson and T.G. Baugh, pp. 213-245, Plenum Press, New York.

1993b The Economics of Wealth Among Eighth-Century Maya Households. In Lowland Maya Civilization in the Eighth Century A.D., edited by J.A. Sabloff and J.S. Henderson, pp. 65-89, Dumbarton Oaks, Washington, D.C.

McAnany, P.A. and B.L. Isaac (eds.)
1989 Prehistoric Maya Economies of Belize. Research in Economic Anthropology, Supplement 4, JAI Press, Greenwich.

McBrearty, S., L. Bishop, T. Plummer, R. Dewar, and N. Conard
1998 Tools Underfoot: Human Trampling as an Agent of Lithic Artifact Edge Modification. American Antiquity 63: 108-129.

McGuimsey, C.R. III
1956 Cerro Mangote: A Preceramic Site in Panama. American Antiquity 22: 151-161.

McKillop, H.
1980 Moho Cay, Belize: Preliminary Investigation of Trade, Settlement and Marine Resource Exploitation. M.A. Thesis, Trent University, Peterborough.

1984 Prehistoric Maya Reliance on Marine Resources: Analysis of a Midden from Moho Cay, Belize. Journal of Field Archaeology 11: 25-35.

1985 Prehistoric Exploitation of the Manatee in the Maya and Circum-Caribbean Areas. World Archaeology 16: 337-353.

1987 Wild Cane Cay: An Insular Classic Period to Postclassic Period Maya Trading Station. Ph.D. Thesis, University of California, Santa Barbara.

1989 Coastal Maya Trade: Obsidian Densities at Wild Cane Cay. In Prehistoric Maya Economies of Belize, edited by P.A. McAnany and B.L. Isaac, pp. 17-56, Research in Economic Anthropology, Supplement 4, JAI Press, London.

1994a Ancient Maya Tree Cropping: A Viable Subsistence Adaptation for the Island Maya. Ancient Mesoamerica 5: 129-140.

1994b Traders of the Maya Coast: Five Fieldseasons in the Swamps of South Coastal Belize. Mexicon 16: 115-119.

1995a The Role of Northern Ambergris Caye in Maya Obsidian Trade: Evidence from Visual Sourcing and Blade Technology. Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize, edited by T.H. Guderjan and J.F. Garber, pp. 163-174, Maya Research Program and Labyrinthos, Lancaster.

1995b Underwater Archaeology, Salt Production, and Coastal Maya Trade at Stingray Lagoon, Belize. Latin American Antiquity 6: 214-228.

1996 Ancient Maya Trading Ports and the Integration of Long-Distance and Regional Economies: Wild Cane Caye in South-Coastal Belize. Ancient Mesoamerica 7: 49-62

McKillop, H. and P. Healy
1989 (eds.) Coastal Maya Trade. Trent University Occasional Papers in Anthropology, No.8, Peterborough.

McKillop, H. and L. Jackson
1988 Ancient Maya Obsidian Sources and Trade Routes. In Obsidian Dates IV, edited by C. Meighan and J. Scalise, pp. 130-141, Institute of Archaeology, University of California, Los Angeles.

1989 Maya Obsidian Sources and Trade Routes. In Coastal Maya Trade, edited by H. McKillop and P.F. Healy, pp. 59-78, Trent University Occasional Papers in Anthropology, No.8, Peterborough.

MacKinnon, J.J. and S.M. Kepecs
1989 Prehispanic Maya Saltmaking in Belize: New Evidence. American Antiquity 54: 522-533.

1991 Prehistoric Saltmaking in Belize: A Reply to Valdez and Mock and to Marcus. American Antiquity 56: 528-530.

McSwain, R.
1989 Production and Exchange of Stone Tools Among Preclassic Maya Communities: Evidence from Cuello, Belize. Ph.D. Thesis, University of Arizona, Tucson.

1991a A Comparative Evaluation of the Producer-Consumer Model for Lithic Exchange in Northern Belize, Central America. Latin American Antiquity 2: 337-351.

1991b Chert and Chalcedony Tools. In Cuello: An Early Maya Community in Belize, edited by N. Hammond, pp. 160-173, Cambridge University Press, Cambridge.

Magne, M.P.R.
1985 Lithics and Livelihood: Stone Tool Technologies of Central and Southern Interior British Columbia. National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper No. 133, Ottawa.

1989 Lithic Reduction Stages and Assemblage Formation Processes. In Experiments in Lithic Technology, edited by D.S. Amick and R.P. Mauldin, pp. 15-31, BAR International Series 528, Oxford.

Mallory, J.K.
1984 Late Classic Maya Economic Specialization: Evidence from the Copan Obsidian Assemblage. Ph.D. Thesis, Pennsylvania State University, College Park.

1986 'Workshops' and 'Specialized Production' in the Production of Maya Chert Tools: A Response to Shafer and Hester, American Antiquity 51: 152-158.

Mallouf, R.
1982 An Analysis of Plow-Damaged Chert Artifacts: The Brookeen Creek Cache (41HI86), Hill County, Texas. Journal of Field Archaeology 9: 79-98.

Mandeville, M.D.
1973 A Consideration of the Thermal Pretreatment of Chert. Plains Anthropologist, 18: 177-202.

Mansur, M.E.
1982 Microwear Analysis of Natural and Use Striations: New Clues to the Mechanism of Striation Formation. In Tailler! Pour quoi faire: Préhistoire et technologie lithique II, Studia Prehistorica Belgica, 2, edited by D. Cahen, pp. 213-233, Musée royal de l'Afrique centrale, Tervuren.

Mansur-Franchomme, M.E.
1983a Traces d'utilisation et technologie lithique: Exemples de la Patagonie. Thèse de doctorat, Université de Bordeaux I, Bordeaux.

1983b Scanning Electron Microscopy of Dry Hide Working Tools: The Role of Abrasives and Humidity in Microwear Polish Formation. Journal of Archaeological Science 10:223-230.

Marcus, J.
1976 Emblem and State in the Classic Maya Lowlands: An Epigraphic Approach to Territorial Organization. Dumbarton Oaks, Washington, D.C.

1982 The Plant World of the Sixteenth- and Seventeenth-Century Lowland Maya. In Maya Subsistence, edited by K.V. Flannery, pp. 239-273, Academic Press, New York.

1983 Lowland Maya Archaeology at the Crossroads. American Antiquity 48: 454-488.

1993 Ancient Maya Political Organization. In Lowland Maya Civilization in the Eighth Century A.D., edited by J.A. Sabloff and J.S. Henderson, pp. 111-183, Dumbarton Oaks, Washington, D.C.

1995 Where is Lowland Maya Archaeology Headed? Journal of Archaeological Research 3: 3-53.

Martin, H.
1923 Recherches sur l'évolution du Mousterien dans le gisement de la Quina (Charente), Vol.2, Mémoires de la Société Archéologique et Historique de la Charente, Vol.14, Société Archéologique et Historique de la Charente, Angoulême.

Masson, A., E. Coqueugniot, and S. Roy
1981 Silice et traces d'usage: Le lustré des faucilles. Nouvelles Archéologiques du Musée d'Histoire Naturelle de Lyon 19:43-51.

Masson, M.A.
1989 Lithic Production Changes in Late Classic Maya Workshops at Colha, Belize: A Study of Debitage Variation, M.A. Thesis, Florida State University, Tallahassee.

1993 Changes in Maya Community Organization from the Classic to Postclassic Periods: A View from Laguna de On, Belize. Ph.D. Thesis, University of Texas at Austin, Austin.

1997 Cultural Transformation at the Maya Postclassic Community of Laguna de On, Belize. Latin American Antiquity 8: 293-316.

Mauldin, R.P. and D.S. Amick
1989 Investigating Patterning in Debitage from Experimental Bifacial Core Reduction. In Experiments in Lithic Technology, edited by D.S. Amick and R.P. Mauldin, pp. 67-88, BAR International Series 528, Oxford.

Mauser, P.
1965 Die Interpretation steinzeitlicher Silexwerkzeuge nach modernen technologischen Gesichtspunkten. Fundberichte aus Schwaben 17: 29-42.

Meehan, B.
1982 Shell Bed to Shell Midden. Australian Institute of Aboriginal Studies. Canberra.

Meeks, N., G. Sieveking, M. Tite, and J. Cook
1982 Gloss and Use-Wear Traces on Flint Sickles and Similar Phenomena. Journal of Archaeological Science 9: 317-340.

Meltzer, D.J.
1981 A Study of Style and Function in a Class of Tools. Journal of Field Archaeology 8: 313-326.

Merwin, R.E. and G.C. Vaillant
1932 The Ruins of Holmul, Guatemala. Memoirs of the Peabody Museum of Archaeology and Ethnography, Vol.3, No.2, Harvard University, Cambridge.

Michaels, G.H.
1987 A Description of Early Postclassic Lithic Technology at Colha Belize. M.A. Thesis, Texas A & M University, College Station.

1989 Craft Specialization in the Early Postclassic of Colha. In Prehistoric Maya Economies of Belize, edited by P.A. McAnany and B.L. Isaac, pp. 139-183, Research in Economic Anthropology, Supplement 4, JAI Press, Greenwich.

Michels, J.W.
1976 Some Sociological Observations on Obsidian Production at Kaminaljuyu, Guatemala. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp. 109-118, Special Report No.4, Center for Archaeological Research, University of Texas, San Antonio.

Miller, A.V.
1976 Arti-Fact or Fiction? The Lithic Objects from Richmond Hill, Belize. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp. 119-136, Special Report No.4, Center for Archaeological Research, University of Texas, San Antonio.

Mitchum, B.A.
1986 Chipped Stone Artifacts. In Archaeology at Cerros, Belize, Central America: Volume I, An Interim Report, edited by R.A. Robertson and D.A. Freidel, pp. 105-115, Southern Methodist University Press, Dallas.

1991 Lithic Artifacts from Cerros, Belize: Production, Consumption, and Trade. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp. 45-53, Monographs in World Archaeology No.1, Prehistory Press, Madison.

1994 Lithic Artifacts from Cerros, Belize: Production, Consumption, and Trade. Ph.D. thesis, Southern Methodist University, Dallas.

Mock, S.B.
1994 The Northern River Lagoon Site (NRL): Late to Terminal Classic Maya Settlement, Saltmaking, and Survival on the Northern Belize Coast. Ph.D. Thesis, University of Texas, Austin.

1997 Monkey Business at NRL: A Coastal-Inland Interaction Sphere in Northern Belize. Ancient Mesoamerica 8: 165-183.

Moholy-Nagy, H.
1976 Spatial Distribution of Flint and Obsidian Artifacts at Tikal, Guatemala. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp. 91-108, Special Report No.4, Center for Archaeological Research, University of Texas, San Antonio.

1985 The Social and Ceremonial Uses of Marine Molluscs at Tikal. In Prehistoric Lowland Maya Environment and Subsistence Economy, edited by M. Pohl, pp. 147- 158, Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 77, Harvard University, Cambridge.

1997 Middens, Construction Fill, and Offerings: Evidence for the Organization of Classic Period Craft Production at Tikal, Guatemala. Journal of Field Archaeology 24: 293-313.

Moholy-Nagy, H., F. Asaro and F. Stross
1984 Tikal Obsidian: Source and Typology. American Antiquity 49: 104-117.

Moir, J.
1926 Experiments in the Shaping of Wood with Flint Implements. Nature 117: 655-656.

Montet-White, A.
1968 The Lithic Industries of the Illinois Valley in the Early and Middle Woodland Period. Museum of Anthropology, University of Michigan, Anthropological Papers, No. 35, Ann Arbor.

Morrow, C.A.
1987 Blades and Cobden Chert: A Technological Argument for their Role as Markers of Regional Identification During the Hopewell Period in Illinois. In The Organization of Core Technology, edited by J.K. Johnson and C.A. Morrow, pp. 119-150, Westview Press, Boulder.

Moss, E.H.
1983a The Functional Analysis of Flint Implements: Pincevent and Pont d'Ambon: Two Case Studies from the French Final Palaeolithic. BAR International Series 177, Oxford.

1983b A Microwear Analysis of Burins and Points from Tell Abu Hureyra, Syria. Traces d'utilisation sur les outils néolithiques du Proche Orient, edited by M.-C. Cauvin, pp. 143-157, GIS-Maison de l'Orient, Lyon.

1983c Some Comments on Edge-Damage as a Factor in a Functional Analysis of Stone Artefacts. Journal of Archaeological Science 10: 231-242.

1987 A Review of "Investigating Microwear Polishes with Blind Tests". Journal of Archaeological Science 14: 473-481.

Moss, E.H. and M.H. Newcomer

1982 Reconstruction of Tool Use at Pincevent: Microwear and Experiments. Tailler! pour quoi faire: Préhistoire et technologie lithique II, edited by D. Cahen, pp.289-312, Studia Praehistorica Belgica 2, Musée royal de l'Afrique centrale, Tervuren.

Muller, H.

1903 Essais de taille du silex, montage et emploi des outils obtenus. l'Anthropologie 14: 417-436.

Muto, G.R.

1971 A Stage Analysis of the Manufacture of Stone Tools. Great Basin Anthropological Conference 1970: Selected Papers, edited by C.M. Aikens, pp. 109-118, University of Oregon Anthropological Papers 1, Eugene.

Nash, S.

1996 Is Curation a Useful Heuristic? In Stone Tools: Theoretical Insights into Human Prehistory, edited G. Odell, pp. 81-99, Plenum Press, New York.

Nash, M.A.

1980 An Analysis of a Debitage Collection from Colha, Belize. In The Colha Project: Second Season, 1980, Interim Report, edited by T.R. Hester, J.D. Eaton and H.J. Shafer, pp. 333-352, Center for Archaeological Research, University of Texas at San Antonio, and Centro Studi e Ricerche Ligabue, Venezia, San Antonio.

Nations, J.D. and J.E. Clark

1983 The Bows and Arrows of the Lacandon Maya. Archaeology 36: 36-43.

Nelson, M.C.

1984 Ladder Ranch Research Project: First Season. Maxwell Museum, University of New Mexico, Occasional Papers No.1, Albuquerque.

1991 The Study of Technological Organization. Archaeological Method and Theory, Vol.3, edited by M.B. Schiffer, pp. 57-100, University of Arizona Press, Tucson.

Nero, R.

1948 Primary Flake Implements. Wisconsin Archaeologist 29: 23-27.

1957 A "Graver" Site in Wisconsin. American Antiquity 12: 300-304.

Newcomer, M.H.
1976 Spontaneous Retouch. In Second International Symposium on Flint. Staringia, No.3, edited by F. Engelen, pp. 62-64, Nederlands Geologische Vereniging, Maastricht.

Newcomer, M.H. and L.H. Keeley
1979 Testing a Method of Microwear Analysis with Experimental Flint Tools. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 195-206, Academic Press, New York.

Newcomer, M.H., R. Grace, and R. Unger-Hamilton
1986 Investigating Microwear Polishes with Blind Tests. Journal of Archaeological Science 13: 203-217.

1987 Microwear Polishes, Blind Tests and Texture Analysis. In The Human Uses of Flint and Chert: Papers from the Fourth International Flint Symposium, edited by G. de G. Sieveking and M. Newcomer, pp. 253-263, Cambridge University Press, Cambridge.

1988 Microwear Methodology: A Reply to Moss, Hurcombe and Bamforth. Journal of Archaeological Science 15: 25-33.

Nielsen, A.E.
1991 Trampling the Archaeological Record: An Experimental Study. American Antiquity 56: 483-503.

Nilsson, S.
1838- Skandinaviska Nordens Urinvanare. In Berlingska Boktryckeriet, Lund.
1843 (English edition): The Primitive Inhabitants of Scandinavia. London, 1868)

O'Brien, M. J., R.L. Lyman and R.D. Leonard
1998 Basic Incompatibilities between Evolutionary and Behavioral Archaeology. American Antiquity 63: 485-498.

Odell, G.H.
1975 Microwear in Perspective: A Sympathetic Response to Lawrence H. Keeley. World Archaeology 7: 226-240.

1977 The Application of Micro-wear Analysis to the Lithic Component of an Entire Prehistoric Settlement: Methods, Problems, and Functional Reconstructions. Ph.D. Thesis, Harvard University, Cambridge.

1979 A New and Improved System for the Retrieval of Functional Information from Microscopic Observations of Chipped Stone Tools. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 239-244, Academic Press, New York.

1980a Butchering with Stone Tools: Some Experimental Results. Lithic Technology 9: 38-48.

1980b Toward a More Behavioral Approach to Archaeological Lithic Concentrations. American Antiquity 45: 404-431.

1981a The Mechanics of Use-Breakage of Stone Tools: Some Testable Hypotheses. Journal of Field Archaeology 8: 197-209.

1981b The Morphological Express at Function Junction: Searching for Meaning in Lithic Tool Types. Journal of Anthropological Research 37: 319-342.

1983 Problèmes dans l'étude des traces d'utilisation. Traces d'utilisation sur les outils néolithiques du Proche Orient, edited by M.-C. Cauvin, pp.17-24, GIS-Maison de l'Orient, Lyon.

1989 Experiments in Lithic Reduction. In Experiments in Lithic Technology, edited by D.S. Amick and R.P. Mauldin, pp. 163-198, BAR International Series 528, Oxford.

1996 Economizing Behavior and the Concept of "Curation". In Stone Tools: Theoretical Insights into Human Prehistory, edited G. Odell, pp. 51-80, Plenum Press, New York.

Odell, G.H. and F. Cohen
1986 Experiments with Spears and Arrows on Animal Targets. Journal of Field Archaeology 13: 195-212.

Odell, G.H. and F. Odell-Vereecken
1980 Verifying the Reliability of Lithic Use-Wear Assessments by "Blind Tests": The Low Power Approach. Journal of Field Archaeology 7: 87-120.

Oland, M. H.
1999a Lithic Raw Material Sources at the Southern End of the Freshwater Creek Drainage: A View from Laguna de On, Belize. Lithic Technology 24: 91-110.

1999b Preliminary Analysis of Lithics from Caye Coco, Caye Muerto, and the shores of Progresso Lagoon 1998, In Belize Postclassic Project 1998: Investigations at Progresso Lagoon, edited by M.A. Masson and R.M. Rosenswig, pp. 145-156, Institute of Mesoamerican Studies Occasional Papers No.3, The University at Albany - SUNY, Albany.

Olausson, D.S.
1980 Starting from Scratch: The History of Edge-wear Research from 1838 to1978, Lithic Technology 9: 48-60.

1983 Flint and Groundstone Axes in the Scanian Neolithic: An Evaluation of Raw Material Based on Experiment. Regiae Societatis Humaniorum Litterarum Lundensis, Scripta Minora 2, Archaeological Institute, University of Lund, Lund.

Olausson, D.S. and L. Larsson
1982 Testing for the Presence of Thermal Pretreatment of Flint in the Mesolithic and Neolithic of Sweden. Journal of Archaeological Science 9: 275-285.

Osborn, A.J.
1977 Strandloopers, Mermaids, and Other Fairy Tales; Ecological Determinants of Marine Resource Utilization-The Peruvian Case. In For Theory Building in Archaeology, edited by L.R. Binford, pp. 157-205, Academic Press, New York.

Oswalt, W.H.
1973 Habitat and Technology. Holt, Reinhart, and Winston, New York.

Over, W.
1937 The Use of the Thumb-Scraper. American Antiquity 2: 208-209.

Owen, L.R. and G. Unrath
1989 Microtraces d'usure dues à la préhension. l'Anthropologie 93: 689-704.

Palacio, J.
1976 Archaeology in Belize. Cubola Productions, Benque Viejo del Carmen.

Parmalee, P.W. and W.E. Klippel
1974 Freshwater Mussels as a Prehistoric Food Resource. American Antiquity 39:421-434.

Parry, W.J.
1983 Chipped Stone Tools In Formative Oaxaca, Mexico: Their Procurement, Production, and Use. Ph.D. Thesis, University of Michigan, Ann Arbor.

Parry, W.J. and R. Kelly
1987 Expedient Core Technology. In The Organization of Core Technology, edited by J.K. Johnson and C.A. Morrow, pp. 285-313, Westview Press, Boulder.

Patte, E.
1927 Sur les traces d'usage observées sur les outils préhistoriques. Bulletin de la Société Préhistorique Française 24: 103-108.

Pawlik, A.
1993 Horn Experimentation in Use-Wear Analysis. In Traces et fonction: Les Gestes Retrouvés, edited by P.C. Anderson, S. Beyries, M. Otte, and H. Plisson, pp. 211-224, Collège International de Liège, Editions Eraul, vol.50, Centre de Recherches Archéologiques du CNRS, Etudes et Recherches Archéologiques de l'Université de Liège, Liège.

Pendergast, D.M.
1979 Excavations at Altun Ha, Belize 1964-1970. Vol. 1, Royal Ontario Museum, Toronto.

1981a Lamanai, Belize: Summary of Excavation Results, 1974-1980. Journal of Field Archaeology 8: 29-53.

1981b An Ancient Maya Dignitary: A Work of Art from the ROM's Excavations at Lamanai, Belize. Rotunda 13: 5-11.

1982 Excavations at Altun Ha, Belize 1964-1970. Vol. 2, Royal Ontario Museum, Toronto.

1986 Stability through Change: Lamanai, Belize, from the Ninth to the Seventeenth Century. In Late Lowland Maya Civilization: Classic to Postclassic, edited by J.A. Sabloff and E.W. Andrews V, pp. 223-249, University of New Mexico Press, Albuquerque.

1990 Up From the Dust: The Central Lowlands Postclassic as Seen From Lamanai and Marco Gonzalez, Belize. In Vision and Revision in Maya Studies, edited by F.S. Clancy and P.D. Harrison, pp. 169-177, University of New Mexico Press, Albuquerque.

1993a The Center and the Edge: Archaeology in Belize, 1809-1992. Journal of World Prehistory 7: 1-33.

1993b Worlds in Collision: The Maya/Spanish Encounter in Sixteenth and Seventeenth Century Belize. Proceedings of the British Academy 8: 105-143.

Pendergast, D.M. and E. Graham
1987 No Site Too Small: The ROM's Marco Gonzales Excavations in Belize. Rotunda 20: 34-40.

1990 An Island Paradise (??): Marco Gonzalez, 1990. Royal Ontario Museum, Archaeological Newsletter, Series II, No.41.

1991 The Town Beneath the Town: Excavations at San Pedro, Ambergris Caye, Belize. Royal Ontario Museum Archaeological Newsletter, Series II, No.45.

Peregrine, P.
1991 Some Political Aspects of Craft Specialization. World Archaeology 23: 1-11.

Perlès, C.
1993 Ecological Determinism, Group Strategies, and Individual Decisions in the Conception of Prehistoric Stone Assemblages. In The Use of Tools by Human and Non-human Primates, edited by A. Berthelet and J. Chavaillon, pp. 267-277, Clarendon Press, Oxford.

Perlman, S.M.
1980 An Optimum Diet Model, Coastal Variability, and Hunter-Gatherer Behaviour. In Advances in Archaeological Methods and Theory, Vol.3, edited by M.B. Schiffer, pp. 257-310, Academic Press, New York.

Peyrony, D. and H. Noone
1938 Usage possible des micro-burins. Bulletin de la Société Préhistorique Française 35: 108-110.

Peyrony, D., H. Kidder, and H. Noone
1949 Outils en silex émoussés du Paléolithique supérieur. Bulletin de la Société Préhistorique Française 46: 298-301.

Pfeiffer, L.
1912 Die Steinzeitliche Technik. G. Fischer, Jena.

1920 Die Werkzeuge des Steinzeitmenschen. G. Fischer, Jena.

Phillips, P.
1988 Traceology (Microwear) Studies in the USSR. World Archaeology 19: 349-356.

Plisson, H.
1982a Une analyse fonctionnelle des outillages basaltiques. In Tailler! pour quoi faire: Préhistoire et technologie lithique II, edited by D. Cahen, pp. 241-244, Studia Praehistorica Belgica 2, Musée royal de l'Afrique centrale, Tervuren.

1982b Analyse fonctionnelle de 95 micro-grattoirs "tourassiens". In Tailler! pour quoi faire: Préhistoire et technologie lithique II, edited by D. Cahen, pp. 279-287, Studia Praehistorica Belgica 2, Musée royal de l'Afrique centrale, Tervuren.

1983 De la conservation des micropolis d'utilisation. Bulletin de la Société Préhistorique Française 80: 74-77.

Plisson, H. and M. Mauger
1988 Chemical and Mechanical Alteration of Microwear Polishes: An Experimental Approach. Helinium 28: 3-16.

Pohl, M.E.D.
1976 Ethnozoology of the Maya: An Analysis of Fauna from Five Sites in the Peten, Guatemala. Ph.D. Thesis, Harvard University, Cambridge.

1983 Maya Ritual Faunas: Vertebrate Remains from Burials, Caches, Caves and Cenotes in the Maya Lowlands. In Civilization in the Ancient Americas, edited by R. Leventhal and A. Kolata, Peabody Museum and University of New Mexico Press, Albuquerque.

1990 Ancient Maya Wetland Agriculture: Excavations on Albion Island, Northern Belize. Westview Press, Boulder.

Polanyi, K.
1957 The Economy as Instituted Process. In Trade and Market in the Early Empires: Economics in History and Theory, edited by K. Polanyi, M. Arensberg, and H.W. Pearson, pp. 243-270, Free Press, New York.

1968 Primitive, Archaic and Modern Economies; Essays of Karl Polanyi. edited by G. Dalton, Anchor Book, Garden City.

Polanyi, K., M. Arensberg, and H.W. Pearson (eds.)
1957 Trade and Market in the Early Empires: Economics in History and Theory. Free Press, New York.

Pope, S.
1923 A Study of Bows and Arrows. University of California Publications in American Archaeology and Ethnology 13: 329-414.

Potter, D.R.
1982 Some Results of the Second Year of Excavation at Operation 2012. In Archaeology at Colha, Belize: The 1981 Interim Report, edited by T.R. Hester, H.J. Shafer, and J.D. Eaton, pp. 98-122. Center for Archaeological Research, University of Texas at San Antonio and Centro Studi e Ricerche Ligabue, Venezia, San Antonio.

1991a Colha and the Origins of Maya Civilization. Ph.D. Thesis, Harvard University, Cambridge.

1991b A Descriptive Taxonomy of Middle Preclassic Chert Tools at Colha, Belize. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp.21-29, Monographs in World Archaeology No.1, Prehistory Press, Madison.

1993 Analytical Approaches to Late Classic Maya Lithic Industries. In Lowland Maya Civilization in the Eighth Century A.D., edited by J.A. Sabloff and J.S. Henderson, pp. 273-298, Dumbarton Oaks, Washington, D.C.

Powis, T.G., N. Stanchly, C.D. White, P.F. Healy, J.J. Awe, and F. Longstaffe
1999 A Reconstruction of Middle Preclassic Maya Subsistence Economy at Cahal Pech, Belize. Antiquity 73:364-376.

Prentiss, W.C.
1998 The Reliability and Validity of a Lithic Debitage Typology: Implications for Interpretation. American Antiquity 63: 635-650.

Prentiss, W.C. and E.J. Romanski
1989 Experimental Evaluation of Sullivan and Rozen's Debitage Typology. In Experiments in Lithic Technology, edited by D.S. Amick and R.P. Mauldin, pp. 89-99, BAR International Series 528, Oxford.

Proskouriakoff, T.
1962 The Artifacts from Mayapan. Mayapan, Yucatan, Mexico, edited by H.E.E. Pollok, R.L. Roys, T. Proskouriakoff, and A.L. Smith, pp.321-442, Carnegie Institution of Washington, Publication 619, Washington, D.C.

Pryor, J.H.
1988 The Effects of Human Trample Damage on Lithics: A Model of Crucial Variables. Lithic Technology 17: 45-50.

Puleston, D.E.
1976 The Rio Hondo Project, Northern Belize. Katunob 9: 29.

Puleston, Olga
1969 Functional Analysis of a Workshop Tool Kit from Tikal. M.A. Thesis, University of Pennsylvania, Philadelphia.

Purdy, B.A.
1974 Investigations Concerning the Thermal Alteration of Silica Minerals: An Archaeological Approach. Tebiwa 17: 37-66.

1975 Fractures for the Archaeologist. In Lithic Technology: Making and Using Stone Tools, edited by E. Swanson, pp. 133-144, Mouton Press, The Hague.

Purdy, B.A. and H.K. Brooks
1971 Thermal Alteration of Silica Minerals: An Archaeological Approach. Science173: 322-325.

Purdy, B.A. and D.E. Clark
1987 Weathering of Inorganic Materials: Dating and Other Applications. Advances in Archaeological Method and Theory, Vol.11, edited by M.B. Schiffer, pp. 211-253, Academic Press, New York.

Pyburn, K.A.
1993 When a House is not a Household: Variation among the Ancient Maya Communities of Northern Belize. Paper presented at the 58th Annual Meeting of the Society for American Archaeology, St. Louis.

Pye, D.
1964 The Nature of Design. Studio Vista, London.

Quente, P.
1914 Steinzeitliche Ackerbaugerate aus der Ostpignitz. Erdhacken und Pfluge, und ihre Schaftungsmoglichkeit. Praehistorische Zeitschrift VI: 180-187.

Rabinowicz, E.
1968 Polishing. Scientific American 218: 91-99.

Rathje, W.L.
1971 The Origin and Development of Lowland Classic Maya Civilization. American Antiquity 36: 275-285.

1972 Praise the Gods and Pass the Metates: A Hypothesis of the Development of Lowland Rainforest Civilizations in Mesoamerica. In Contemporary Archaeology: A Guide to Theory and Contributions, edited by M.P. Leone, pp. 365-392, Southern Illinois University Press, Carbondale.

Rathje, W.L., D.A. Gregory and F. Wiseman
1978 Trade Models and Archaeological Problems: Classic Maya Examples. In Mesoamerican Communication Routes and Cultural Contacts, edited by T.A. Lee, Jr. and C. Navarrete, pp. 145-175, New World Archaeological Foundation, Brigham Young University, Provo.

Rau, C.
1864 Agricultural Implements of the North American Stone Period. In Annual Report of the Smithsonian Institution for 1863, pp. 379-380, Smithsonian Institution, Washington, D.C.

1869 Drilling in Stone Without Metal. In Annual Report of the Smithsonian Institution for 1868, pp. 392-400, Smithsonian Institution, Washington, D.C.

Ray, C.
1937 Probable Uses of Flint End-scrapers. American Antiquity 37:303-306.

Rees, D., G.G. Wilkinson, R. Grace, and C.R. Orton
1991 An Investigation of the Fractal Properties of Flint Microwear Images. Journal of Archaeological Science 18: 629-640.

Reina, R.E. and J. Monaghan
1981 The Ways of the Maya: Salt Production in Sacapulas, Guatemala. Expedition 23: 13-33.

Renfrew, C.
1977 Alternative Models for Exchange and Spatial Distribution. In Exchange Systems in Prehistory, edited by T.K. Earle and J.E. Ericson, pp. 71-90, Academic Press, New York.

Rice, D.S.
1974 The Archaeology of British Honduras: A Review and Synthesis. Katunob Occasional Publications in Mesoamerican Archaeology No.6, Museum of Anthropology, University of Northern Colorado, Greeley.

Rice, P.M.
1978 Population Growth and Subsistence Alternatives in a Tropical Lacustrine Environment. Prehistoric Maya Agriculture, edited by P.D. Harrison and B.L. Turner II, pp. 35-61, University of New Mexico Press, Albuquerque.

1981 Evolution of Specialized Pottery Production: A Trial Model. Current Anthropology 22: 219-240.

1984 Change and Conservatism in Pottery-Producing Systems. In The Many Dimensions of Pottery: Ceramics in Archaeology and Anthropology, edited by S.E. van der Leeuw and A.C. Pritchard, pp. 231-288, Universiteit van Amsterdam, Amsterdam.

1987 Economic Change in the Lowland Maya Late Classic Period. In Specialization, Exchange, and Complex Societies, edited by E.M. Brumfiel and T.K. Earle, pp. 76-85, Cambridge University Press.

Rice, P.M., H.V. Michel, F. Asaro, and F. Stross
1985 Provenience Analysis of Obsidians from the Central Peten Lakes Region, Guatemala. American Antiquity 50: 591-604.

Ricketson, E.B.
1937 Part II: The Artifacts. In Uaxactun, Guatemala, Group E - 1926-1931. Publication 477, Carnegie Institution of Washington, Washington, D.C.

Ricketson, O.G., Jr.
1929 Excavations at Baking Pot, British Honduras. Publication 403, Carnegie Institution of Washington, Washington, D.C.

Rigaud, A.
1977 Analyses typologiques et technologiques des grattoirs magdaléniens de la Garenne à Saint-Marcel (Indre). Gallia Préhistoire 20: 1-43

Robertson, R.A. and D.A. Freidel
1986 Archaeology at Cerros, Belize, Central America: Volume 1, An Interim Report, Southern Methodist University Press, Dallas.

Rodon Borras, T.
1990 Chemical Process of Cleaning in Microwear Studies: Conditions and Limits of Attack. Application to Archaeological Sites. In The Interpretive Possibilities of Microwear Studies, edited by B. Graslund, H. Knutsson, K. Knutsson, and J. Taffinder, pp. 179-183, Societas Archaeologica Upsaliensis, Uppsala.

Roebroeks, W., J. Kolen and E. Rensink
1988 Planning Depth, Anticipation and the Organization of Middle Palaeolithic Technology: The "Archaic Natives" Meet Eve's Descendants. Helinium 28: 17-34.

Roemer, E.R., Jr.
1982 Investigations at Four Lithic Workshops at Colha, Belize: 1981 Season. In Archaeology at Colha, Belize: The 1981 Interim Report. edited by T.R. Hester, H.J. Shafer and J.D. Eaton, pp. 75-84, Center for Archaeological Research, University of Texas at San Antonio and Centro Studi e Ricerche Ligabue, Venezia, San Antonio.
1991 A Late Classic Workshop at Colha, Belize. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp.55-66, Monographs in World Archaeology No.1, Prehistory Press, Madison.

Roper, D.C.
1976 Lateral Displacement of Artifacts Due to Plowing. American Antiquity 41: 372-375.

Rosenfeld, A.
1970 The Examination of the Use Marks on Some Magdalenian End-scrapers. British Museum Quarterly 35: 176-182.

Rottländer, R.
1975 Formation of Patina on Flint. Archaeometry 17:106-110.

1976 Some Aspects in the Patination of Flint. In Second International Symposium on Flint, edited by F. Engelen, pp. 54-56, Nederlandse Geologische Vereniging, Maastricht.

Rouse, I.
1986 Migrations in Prehistory: Inferring Population Movement from Cultural Remains. Yale University Press, New Haven.

Rovner, I.
1975 Lithic Sequences from the Maya Lowlands. Ph.D. Thesis, University of Wisconsin, Madison.

1976 Pre-Columbian Maya Development of Utilitarian Lithic Industries: The Broad Perspective from Yucatan. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp.41-53, Special Report No.4, Center for Archaeological Research, University of Texas at San Antonio.

Rovner, I. and S.M. Lewenstein
1997 Maya Stone Tools of Dzibilchaltun, Yucatan, and Becan and Chicanna, Campeche. Middle American Research Institute Bulletin 65, Tulane University, New Orleans

Roy, S.
1982 Méthodologie pour l'étude des traces d'utilisation sur les lames et éclats bruts: Recherche expérimentale d'après un niveau épinatufien de Mureybet. Cahiers de l'Euphrate 3: 165-176.

1983 Traces d'utilisation sur les outils *a posteriori* de Mureybet: Méthode d'étude. In Traces d'utilisation sur les outils néolithiques du Proche Orient, edited by M.-C. Cauvin, pp. 25-29, GIS-Maison de l'Orient, Lyon.

Roys, R.L.
1943 The Indian Background of Colonial Yucatan. Publication 548, Carnegie Institution of Washington, Washington, D.C.

Rozen, K.C. and A.P. Sullivan III
1989 Measurement, Method, and Meaning in Lithic Analysis: Problems with Amick and Mauldin's Middle Range Approach. American Antiquity 54: 169-175.

Rubio B., A.
1985 Littoral-Marine Economy at Tulum, Quintana Roo, Mexico. In The Lowland

Maya Postclassic, edited by A.F. Chase and P.M. Rice, pp. 50-61, University of Texas Press, Austin.

Russ, J.C.
1993 Light Scattering from Fractal Surfaces. Journal of Computer-Assisted Microscopy 5: 171-189.

1994 Fractal Surfaces. Plenum Press, New York.

Sabloff, J.A.
1977 Old Myths, New Myths: The Role of Sea Traders in the Development of Ancient Maya Civilization. In The Sea in the Pre-Columbian World, edited by E. Benson, pp. 67-95, Dumbarton Oaks Research Library and Collection, Washington, D.C.

Sabloff, J.A. and E.W. Andrews V (eds.)
1986 Late Lowland Maya Civilization: Classic to Postclassic. University of New Mexico Press, Albuquerque.

Sabloff J.A. and D.A. Freidel
1975 A Model of a Pre-Columbian Trading Center. In Ancient Civilization and Trade, edited by J.A. Sabloff and C.C. Lamberg-Karlovsky, pp. 369-408, University of New Mexico Press, Albuquerque.

Sabloff, J.A. and W.L. Rathje
1975 The Rise of a Maya Merchant Class. Scientific American 233: 72-82.

Sabloff, J.A. and G.R. Willey
1967 The Collapse of Maya Civilization in the Southern Lowlands: A Consideration of History and Process. Southwestern Journal of Anthropology 23: 311-336.

Sabloff, J.A., R.L. Bishop, G. Harbottle, R.L. Rands, and E.V. Sayre
1982 Analysis of Fine Paste Ceramics. Memoirs of the Peabody Museum of Archaeology and Ethnology, Vol. 15, Harvard University, Cambridge.

Sackett, J.R.
1977 The Meaning of Style in Archaeology: A General Model. American Antiquity 42: 369-380.

1982 Approaches to Style in Lithic Archaeology. Journal of Anthropological Archaeology 1: 59-112.

Sandkleff, A.
1934 Are Scandinavian Flint Saws to be Considered as Leaf Knives? Acta Archaeologica 5: 284-290.

Sankalia, H.
1964 Stone Age Tools. Deccan College, Poona.

Santley, R.S. and R. Kneebone
1993 Craft Specialization, Refuse Disposal, and the Creation of Spatial Archaeological Records in Prehispanic Mesoamerica. In Prehispanic Domestic Units in Western Mesoamerica: Studies of the Household, Compound, and Residence, edited by R.S. Santley and R. Kneebone, pp. 37-63, CRC Press, Boca Raton.

Santone, L.
1993 Demand Structure, Transport Costs, and Patterns of Intraregional Exchange: Aspects of the Prehistoric Lithic Economy of Northern Belize. Ph.D. Thesis, University of Texas, Austin.

1997 Transport Costs, Consumer Demand, and Patterns of Intraregional Exchange: A Perspective on Commodity Production and Distribution from Northern Belize. Latin American Antiquity 8: 71-88.

Scarborough, V.C.
1991 Archaeology at Cerros, Belize, Central America, Vol. III: The Settlement System in a Late Preclassic Maya Community. Southern Methodist University, Dallas.

Schiffer, M.B.
1972 Archaeological Context and Systemic Context. American Antiquity 37: 156-165.

1976 Behavioral Archaeology. Academic Press, New York.

1977 Toward a Unified Science of the Cultural Past. In Research Strategies in Historical Archaeology, edited by S. South, pp. 13-40, Academic Press, New York.

1978 Methodological Issues in Ethnoarchaeology. In Explorations in Ethnoarchaeology, edited by R.A. Gould, pp. 229-247, University of New Mexico Press, Albuquerque.

1983 Toward the Identification of Formation Processes. American Antiquity 48: 675-706.

1987 Formation Processes of the Archaeological Record. University of New Mexico Press, Albuquerque.

1995 Behavioral Archaeology: First Principles. edited by J.M. Skibo, Foundations of Archaeological Inquiry, University of Utah Press, Salt Lake City.

Schiffer, M.B. and J.M. Skibo
1987 Theory and Experiment in the Study of Technological Change. Current Anthropology 28: 595-622.

Schiffer, M.B., T.E. Downing and M. McCarthy
1981 Waste Not, Want Not: An Ethnoarchaeological Study of Reuse in Tucson, Arizona. In Modern Material Culture: The Archaeology of Us, edited by R.A. Gould and M.B. Schiffer, pp. 67-86, Academic Press, New York.

Schindler, D.L., J.W. Hatch, C.A. Hay, and R.C. Bradt
1982 Aboriginal Thermal Alteration of a Central Pennsylvania Jasper: Analytical and Behavioural Implications. American Antiquity 47: 526-544.

Scholes, F.V. and R.L. Roys
1948 The Maya Chontal Indians of Acalan-Tixchel. Publication 560, Carnegie Institution of Washington, Washington, D.C.

Schwartz, T.
1963 Systems of Areal Integration. Anthropological Forum 1:56-97.

Scott, R.F. IV
1982 Notes on the Continuing Faunal Analysis for the Site of Colha, Belize: Data from the Early Postclassic. In Archaeology at Colha, Belize: The 1981 Interim Report, edited by T.R. Hester, H.J. Shafer and J.D. Eaton, pp. 203-207, Center for Archaeological Research, University of Texas at San Antonio and Centro Studi e Ricerche Ligabue, Venezia, San Antonio.

Seitzer, D.J.
1977-1978 Form vs. Function: Microwear Analysis and its Application to Upper Palaeolithic Burins. Papers of the Archaeological Institute, University of Lund 2: 5-20.

Seitzer-Olausson, D.J.
1983 Experiments to Investigate the Effects of Heat Treatment on Use-Wear on Flint Tools. Proceedings of the Prehistoric Society 49:1-13.

Semenov, S.A.
1964 Prehistoric Technology. Barnes and Noble, New York.

1970 The Forms and Functions of the Oldest Tools. Quartaer 21:1-20.

Serizawa, C.H., H. Kajiwara, and K. Akoshima
1982 Experimental Study of Microwear Traces and its Potentiality (English summary). Archaeology and Natural Science 14: 67-87.

Seymour, K.
1990 Interim Faunal Report Marco Gonzalez Site (39/197-1), Structure 27, Ambergris Cay, Belize. Royal Ontario Museum, Toronto, unpublished manuscript.

1991 Final Faunal Report Marco Gonzalez Site (39/197-1), Structure 27, Ambergris Cay, Belize. Royal Ontario Museum, Toronto, unpublished manuscript

Shackley, M.
1974 Stream Abrasion on Flint Implements. Nature 248: 501-502.

Shafer, H. J.
n.d. Lithic Artifacts from Petroglyph Cave, Belize. manuscript on file, Department of Anthropology, Texas A&M University, College Station.

1976 Belize Lithics: "Orange Peel Flakes" and Adze Manufacture. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp. 21-34, Special Report No.4, Center for Archaeological Research, University of Texas, San Antonio.

1979 A Technological Study of Two Maya Lithic Workshops at Colha, Belize. In The Colha Project, 1979: A Collection of Interim Papers, edited by T.R. Hester, pp. 28-78, Center for Archaeological Research, San Antonio.

1982 A Preliminary Report on the Lithic Technology at Kichpanha, Northern Belize. In Archaeology at Colha, Belize: The 1981 Interim Report, edited by T.R. Hester, H.J. Shafer, and J.D. Eaton, pp. 167-181. Center for Archaeological Research, University of Texas, San Antonio.

1983 The Lithic Artifacts of the Pulltrouser Area: Settlements and Fields. In Pulltrouser Swamp: Ancient Maya Habitat, Agriculture, and Settlement in Northern Belize, edited by B.L. Turner II and P.D. Harrison, pp. 212-245, University of Texas Press, Austin.

1985 A Technological Study of Two Maya Lithic Workshops at Colha, Belize. In Stone Tool Analysis: Essays in Honor of Don E. Crabtree, edited by M.G. Plew, J.C. Woods and M.G. Pavesic, pp. 277-315, University of New Mexico Press, Albuquerque.

1991 Late Preclassic Formal Stone Tool Production at Colha, Belize. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp. 31-44, Monographs in World Archaeology No.1, Prehistory Press, Madison.

Shafer, H.J. and T.R. Hester
1983 Ancient Maya Chert Workshops in Northern Belize, Central America. American Antiquity 48: 519-543.

1986 Maya Stone-Tool Craft Specialization and Production at Colha, Belize; Reply to Mallory. American Antiquity 51: 148-166.

1990 The Puleston Axe: A Late Preclassic Maya Hafted Tool from Northern Belize. In Ancient Maya Wetland Agriculture: Excavations on Albion Island, Northern Belize, edited by M.D. Pohl, pp. 279-294, Westview Press, Boulder.

1991 Lithic Craft Specialization and Production Distribution at the Maya Site of Colha. World Archaeology 23: 79-97.

Shafer, H.J. and R.G. Holloway
1979 Organic Residue Analysis in Determining Stone Tool Function. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 385-400, Academic Press, New York.

Shafer, H.J. and F.M. Oglesby
1980 Test Excavations in a Colha Debitage Mound: Operation 4001. In The Colha Project Second Season, 1980 Interim Report, edited by T.R. Hester, J.A. Eaton, and H.J. Shafer, pp. 195-219, Center for Archaeological Research, University of Texas at San Antonio, and Centro Studi e Ricerche Ligabue, Venezia, San Antonio.

Shafer, H.J., T.R. Hester and T.C. Kelly
n.d. An Analysis of Lithic Artifacts from Cuello, Belize. manuscript on file, Center for Archaeology, University of Texas at San Antonio, San Antonio.

1980 Notes on the Sand Hill Site. In The Colha Project Second Season, 1980 Interim Report, edited by T.R. Hester, J.A. Eaton, and H.J. Shafer, pp. 233-240, Center for Archaeological Research, University of Texas at San Antonio, and Centro Studi e Ricerche Ligabue, Venezia, San Antonio.

Sharer, R.J.
1992 The Preclassic Origin of Lowland Maya States. In New Theories on the Ancient Maya, edited by E.C. Danien and R.J. Sharer, pp. 131-136, University Museum University of Pennsylvania, Philadelphia.

Shaw, L.C.
1995 Analysis of Faunal Material from Ek Luum. In Maya Maritime Trade, Settlement, and Populations on Ambergris Caye, Belize, edited by T.H. Guderjan and J.F. Garber, pp. 175-181, Maya Research Program and Labyrinthos, Lancaster.

Shea, J.J. and J.D. Klenck
1993 An Experimental Investigation of the Effects of Trampling on the Results of Lithic Microwear Analysis. Journal of Archaeological Science 20: 175-194.

Sheets, P.D.
1975 Behavioural Analysis and the Structure of a Prehistoric Industry. Current Anthropology 16: 369-391.

1976 Islands of Lithic Knowledge Amid Seas of Ignorance in the Maya Area. In Maya Lithic Studies: Papers from the 1976 Belize Field Symposium, edited by T.R. Hester and N. Hammond, pp. 1-9, Special Report No.4, Center for Archaeological Research, University of Texas, San Antonio.

1977 The Analysis of Chipped Stone Artifacts in Southern Mesoamerica: An Assessment. Latin American Research Review 12: 139-158.

1978a Artifacts. In The Prehistory of Chalchuapa, El Salvador, Vol.2, Artifacts and Figurines, edited by R.J. Sharer, pp. 1-131, Museum Monographs, University Museum, University of Pennsylvania, Philadelphia.

1978b From Craftsman to Cog: Quantitative Views of Mesoamerican Lithic Technology. In Papers on the Economy and Architecture of the Ancient Maya, edited by R. Sidrys, pp. 40-71, Institute of Archaeology, Monograph 8, University of California, Los Angeles.

1983 Chipped Stone from the Zapotitan Valley. In Archeology and Volcanism in Central America: The Zapotitan Valley of El Salvador, edited by P. Sheets, pp. 195-223, University of Texas Press, Austin

1991 Flaked Lithics from the Cenote of Sacrifice, Chichen Itza, Yucatan. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp.163-188, Monographs in World Archaeology No.1, Prehistory Press, Madison.

Sheets, P.D., K. Kirth, F. Lange, F. Stross, F. Asaro, and H. V. Michel
1990 Obsidian Sources and Elemental Analyses of Artifacts in Southern Mesoamerica and the Northern Intermediate Area. American Antiquity 55: 144-158.

Shook, E. and A.V. Kidder
1952 Mound E-III-3, Kaminaljuyu, Guatemala. Publication 596, No. 53, Carnegie Institution of Washington, Washington, D.C.

Shott, M. J.
1986 Technological Organization and Settlement Mobility: An Ethnographic Examination. Journal of Anthropological Research 42: 15-51.

1989a Diversity, Organization, and Behavior in the Material Record: Ethnographic and Archaeological Examples. Current Anthropology 30: 283-301.

1989b On Tool-Class Use Lives and the Formation of Archaeological Assemblages. American Antiquity 54: 9-30.

1995 How Much is a Scraper? Uniface Reduction, Assemblage Formation and the Concept of "Curation". Lithic Technology 20: 53-72.

1996a An Exegesis of the Curation Concept. Journal of Anthropological Research 52: 259-280.

1996b Mortal Pots: Use Life and the Formation of Ceramic Assemblages. American Antiquity 61: 463-482.

Shousboe, B.
1977 Microscopic Edge Structures and Microfractures in Obsidian. Lithic Technology 6: 14-21.

Sidrys, R.
1976 Classic Maya Obsidian Trade. American Antiquity 41: 449-464.

1977 Mass-Distance Measures for the Maya Obsidian Trade. In Exchange Systems in Prehistory, edited by T. Earle and J. Ericson, pp. 91-108, Academic Press, New York.

1979 Supply and Demand among the Classic Maya. Current Anthropology 20: 594-597.

Siegel, P.E.
1985 Edge Angle as a Functional Indicator: A Test. Lithic Technology 14: 90-94.

Sievert, A.K.
1990 Postclassic Maya Ritual Behavior: Microwear Analysis of Stone Tools from Ceremonial Contexts. In The Interpretive Possibilities of Microwear Studies, edited by B. Graslund, H. Knutsson, K. Knutsson, and J. Taffinder, pp. 147-158, Societas Archaeologica Upsaliensis, Uppsala.

1992 Maya Ceremonial Specialization: Lithic Tools from the Sacred Cenote at Chichen Itza, Yucatan. Monographs in World Prehistory No.12, Prehistory Press, Madison.

Simmons, S.E.
1995 Maya Resistance, Maya Resolve: The Tools of Autonomy from Tipu, Belize. Ancient Mesoamerica 6: 135-147.

Sluyter, S.
1993 Long-Distance Staple Transport in Western Mesoamerica: Insights Through Quantitative Modeling. Ancient Mesoamerica 4: 193-199.

Smith, A. and A.V. Kidder
1951 Excavations at Nebaj, Guatemala. Publication 594, Carnegie Institution of Washington, Washington, D.C.

Smith, C.
1976 Exchange Systems and the Spatial Distribution of Elites: The Organization of Stratification of Agrarian Societies. In Regional Analysis, Volume II, Social Systems, edited by C.A. Smith, pp. 309-374, Academic Press, New York.

Smith, G.V.
1892 The Use of Flint Blades to Work Pine Wood. In Annual Report of the Smithsonian Institution for 1891, pt.1, pp. 601-605, Smithsonian Institution of Washington, Washington, D.C.

Smith, W.G.
1894 Man the Primeval Savage. Stanford, London.

Sonnenfeld, J.
1962 Interpreting the Function of Primitive Implements. American Antiquity 28: 56-65.

Sonneville-Bordes, D. de, and J. Perrot
1953 Essai d'adaptation des méthodes statistiques au Paléolithique supérieur. Premiers résultats. Bulletin de la Société Préhistorique Française 50: 323-333.

Spurrell, F.
1884 On Some Palaeolithic Knapping Tools and Modes of Using Them. Journal of the Royal Anthropological Institute of Great Britain and Ireland 13: 109-118.

1892 Notes on Early Sickles. Archaeological Journal 49:53-59.

Stahle, D.W. and J.E. Dunn
1982 An Analysis and Application of Size Distribution of Waste Flakes from the Manufacture of Bifacial Stone Tools. World Archaeology 14: 84-97.

Stapert, D.
1976 Some Natural Surface Modifications on Flint in the Netherlands. Palaeohistoria 18: 7-41.

Steensberg, A.
1943 Ancient Harvesting Implements. In Nationalmuseets Skrifter, Arkeo-Historisk Raekke, No.1, Nationalmuseet, Copenhagen.

Steggerda, M.
1941 The Maya Indians of Yucatan. Publication No. 531, Carnegie Institution of Washington, Washington, D.C.

Stemp, W. J.
1992 Qualitative and Quantitative Analysis of the Lithic Assemblage from the 1991 Fieldseason at Cahal Pech. Undergraduate thesis. University of Toronto.

Stemp, W.J. and M.C. Stemp
1999 UBM Laser Profilometry and Lithic Use-Wear Analysis: Preliminary 1998 Experimental Results. Paper presented at 64th Annual Meeting of the Society for American Archaeology Conference, Chicago.

Stevenson, M.G.
1982 Toward an Understanding of Site Abandonment Behavior: Evidence from Historic Mining Camps in Southwest Yukon. Journal of Anthropological Archaeology 1: 237-265.

Stoddart, D.R., F.R. Forsberg, and D.L. Spellman
1982 Cays of the Belize Barrier Reef and Lagoon. Atoll Research Bulletin No. 256, Smithsonian Institution, Washington, D.C.

Stoltman, J.B.
1978 Lithic Artifacts from a Complex Society: The Chipped Stone Tools of Becan, Campeche, Mexico. Middle American Research Institute, Occasional Papers No.2, Tulane University, New Orleans.

Stross, F.H., P. Sheets, F. Asaro, and H.V. Michels
1983 Precise Characterization of Guatemalan Obsidian Sources and Source Determination of Artifacts from Quirigua. American Antiquity 48: 323-346.

Sullivan III, A.P. and K.C. Rozen
1985 Debitage Analysis and Archaeological Interpretation. American Antiquity 50: 755-779.

Thompson, M.
1991 Flaked Celt Production at Becan, Campeche, Mexico. In Maya Stone Tools: Selected Papers from the Second Maya Lithic Conference, edited by T.R. Hester and H.J. Shafer, pp. 143-154, Monographs in World Archaeology No. 1, Prehistory Press, Madison.

Thompson, J.E.S.
1939 Excavations at San Jose, British Honduras. Publication 506, Carnegie Institution of Washington, Washington, D.C.

1951 Canoes and Navigation of the Maya and their Neighbours. Journal of the Royal Anthropological Institute 79: 69-78.

1966 The Rise and Fall of Maya Civilization. 2nd edition, University of Oklahoma Press, Norman

1970 Maya History and Religion. University of Oklahoma Press, Norman.

Tixier, J.
1955 Les abris sous roche de Dakhlat es-Saâdane (commune mixte de Ben-Saada). I- industries en place de l'Abri B. Libyca 3: 81-125.

1958-1959 Les industries lithiques d'Ain Fritissa (Maroc). Bulletin d'Archéologie Marocaine 3: 107-248.

1963 Typologie de l'Epipaléolithique du Maghreb. Mémoires du Centre de Recherches Anthropologiques, Préhistoriques et Ethnographiques No.2, Centre de Recherches Anthropologiques, Préhistoriques et Ethnographiques, Algers.

Tixier, J., M.-L. Inizan, and H. Roche
1980 Préhistoire de la pierre taillée: 1. Terminologie et technologie. Cercle de recherches et d'études préhistoriques, Antibes.

Tobey, M.H.
1986 Trace Element Investigation of Maya Chert from Belize. Papers of the Colha Project Volume 1, Center for Archaeological Research, University of Texas at San Antonio, San Antonio.

Tomenchuk, J.
1988 Effects of Loading Rate on the Reliability of Engineering Use-Wear Models. In Industries lithiques: tracéologie et technologie, Vol. 2, edited by S. Beyries, pp. 115-132, BAR International Series 411, Oxford.

Tomka, S.A.
1989 Differentiating Lithic Reduction Techniques: An Experimental Approach. In Experiments in Lithic Technology, edited by D.S. Amick and R.P. Mauldin, pp. 137-161, BAR International Series 528, Oxford.

1993 Site Abandonment Behavior Among Transhumant Agro-pastoralists: The Effects of Delayed Curation on Assemblage Composition. In Abandonment of Settlements and Regions: Ethnoarchaeological and Archaeological Approaches, edited by C.M.

Cameron and S.A. Tomka, pp. 11-24, Cambridge University Press, Cambridge.

Torrence, R.
1981 Obsidian in the Aegean: Towards a Methodology for the Study of Prehistoric Change. Ph.D. Thesis, University of New Mexico, Albuquerque.

1983 Time Budgeting and Hunter-Gatherer Technology. In Hunter Gatherer Economy in Prehistory: A European Perspective, edited by G. Bailey, pp. 11-22, Cambridge University Press, Cambridge.

1986 Production and Exchange of Stone Tools: Prehistoric Obsidian in the Aegean. Cambridge University Press, Cambridge.

1989 Retooling: Towards a Behavioural Theory of Stone Tools. In Time, Energy and Stone Tools, edited by R. Torrence, pp. 57-66, Cambridge University Press, Cambridge.

Tourtellot, G. and J.A. Sabloff
1972 Exchange Systems Among the Ancient Maya. American Antiquity 37: 126-139.

Tozzer, A.M.
1907 A Comparative Study of the Maya and the Lacandones. Macmillan Co., New York.

1941 Landa's Relacion de las Cosas de Yucatan: A Translation. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol. XVIII, Cambridge.

Trigger, B.G.
1974 The Archaeology of Government. World Archaeology 6: 95-106.

Tringham, R., G. Cooper, G. Odell, B. Voytek, and A. Whitman
1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. Journal of Field Archaeology 1: 171-196.

Tsirk, A.
1979 Regarding Fracture Initiations. In Lithic Use-Wear Analysis, edited by B. Hayden, pp. 83-96, Academic Press, New York.

Tuross, N. and T.D. Dillehay
1995 The Mechanics of Organic Preservation at Monte Verde, Chile, and One Use of Biomolecules in Archaeological Interpretation. Journal of Field Archaeology 22: 97-110.

Unger-Hamilton, R.
1983 An Investigation into the Variables Affecting the Development and the Appearance of Plant Polish on Flint Blades. In Traces d'utilisation sur les outils néolithiques du Proche Orient, edited by M.-C. Cauvin, pp. 243-256, GIS- Maison de l'Orient, Lyon.

1984 The Formation of Use-Wear Polish on Flint: Beyond the "Deposit vs. Abrasion" Controversy. Journal of Archaeological Science 11:91-98.

1988 Method in Microwear Analysis: Prehistoric Sickles and Other Stone Tools from Arjoune, Syria. BAR International Series 435, Oxford.

Unrath, G. and W. Lindeman
1985 Reproductionsstoffe in der Micro-gebrauchspurenforschung. Early Man News 7/8: 61-80.

Unrath, G., L.R. Owen, A. Van Gijn, E.H. Moss, H. Plisson and P. Vaughan
1986 An Evaluation of Use-wear Studies: A Multi-analyst Approach. Early Man News 9/10/11, Part 1: 117-175.

Vail, G.
1988 The Archaeology of Coastal Belize. BAR International Series 463, Oxford.

Valdez, F., Jr., and S.B. Mock
1991 Additional Considerations of Prehispanic Saltmaking in Belize. American Antiquity 56: 520-525.

van der Leeuw, S.E.
1977 Towards a Study of the Economics of Pottery Making. In Ex Horreo, edited by B.L. van Beek, R.W. Brandt and W. Groenman-van Waaterange, pp. 68-76, Cingvla 4, Albert Egges Van Giffen Instituut Voor Prae-En Pro Protohistorie, Universiteit van Amsterdam, Amsterdam.

Van Gijn, A.
1986 Fish Polish, Fact and Fiction. Early Man News 9/10/11: 13-27.

Vaughan, P.C.
1981 Lithic Microwear Experimentation and the Functional Analysis of a Lower Magdalenian Stone Tool Assemblage. Ph.D. Thesis, University of Pennsylvania, Philadelphia.

1985 Use-Wear Analysis of Flaked Stone Tools. University of Arizona Press, Tucson.

Vayson, A.
1919 Faucille préhistorique de Solférino. L'Anthropologie 29: 303-422.

Verheyleweghen, J.
1951 La lamelle magdalénienne à dos rabattu et son utilisation. Bulletin de la Société Préhistorique Française 48: 354-364.

Villa, P. and J. Courtin
1983 The Interpretation of Stratified Sites: A View from Underground. Journal of Archaeological Science. 10: 267-281.

Voorhies, Barbara
1978 Previous Research on Nearshore Coastal Adaptations in Middle America. In Prehistoric Coastal Adaptations: The Economy and Ecology of Maritime Middle America, edited by B. L. Stark and B. Voorhies, pp. 5-21, Academic Press, New York.

Webster, D.
1977 Warfare and the Evolution of Maya Civilization. In The Origins of Maya Civilization, edited by R.E.W. Adams, pp. 335-371, University of New Mexico Press, Albuquerque.

Weymouth, J. and M.P. Mandeville
1975 An X-Ray Diffraction Study of Heat-Treated Chert and its Archaeological Implications. Archaeometry 17: 61-67.

White, C.D. and H.P. Schwarcz
1989 Ancient Maya Diet: As Inferred from Isotopic and Elemental Analysis of Human Bone. Journal of Archaeological Science 16: 451-474.

Whittaker, J.C.
1994 Flintknapping: Making and Understanding Stone Tools. University of Texas Press, Austin.

Wiessner, P.
1982 Beyond Willow Smoke and Dogs' Tails: A Comment on Binford's Analysis of Hunter-Gatherer Settlement Systems. American Antiquity 47: 171-178.

1983 Style and Social Information in Kalahari San Projectile Points. American Antiquity 48: 253-276.

Wilk, R.
1976a Microscopic Analysis of Chipped Stone Tools from Barton Ramie, British Honduras. Estudios de Cultura Maya 10: 53-68.

1976b Superficial Examination of Structure 100, Colha. In Archaeology in Northern Belize. British Museum-Cambridge University Corozal Project 1974-75 Interim Report, pp. 152-173, Cambridge University, Cambridge.

1978 Microscopic Analysis of Chipped Flint and Obsidian. In Excavations at Seibal, Department of Peten, Guatemala, Vol. 1: The Artifacts, edited by G.R. Willey, pp. 139-145, Memoirs of the Peabody Museum of Archaeology and Ethnology 14, Harvard University, Cambridge.

Willey, G.R.
1972 The Artifacts of Altar de Sacrificios. Papers of the Peabody Museum of Archaeology and Ethnology 64, Harvard University, Cambridge.

1978 Excavations at Seibal, Department of Peten, Guatemala. Artifacts. Memoirs of the Peabody Museum of Archaeology and Ethnology 14, Harvard University, Cambridge.

Willey, G.R., W.R. Bullard, Jr., J.B. Glass, and J.C. Gifford
1965 Prehistoric Maya Settlements in the Belize Valley. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 54, Harvard University, Cambridge.

Wilmsen, E.N.
1968 Functional Analysis of Flaked Stone Artefacts. American Antiquity 33: 156-161.

Wing, E.S.
1975a Animal Remains from Lubaantun. In Lubaantun: A Classic Maya Realm, edited by N.D. Hammond, pp. 379-383, Monographs of the Peabody Museum of Archaeology and Ethnology No.2, Harvard University, Cambridge.

1975b Vertebrate Faunal Remains. In Archaeological Investigations on the Yucatan Peninsula, edited by E.W. Andrews IV, pp. 186-188, Middle American Research Institute, Publication 31, Tulane University.

1977 Factors Influencing the Exploitation of Marine Resources. In The Sea in the Pre-Columbian World, edited by E. Benson, pp. 47-66, Dumbarton Oaks Research Library and Collection, Washington, D.C.

Wing, E. and N. Hammond
1974 Fish Remains in Archaeology: A Comment on Casteel. American Antiquity 39: 133-134.

Wing, E.S. and E.J. Reitz
1982 Prehistoric Fishing Economies of the Caribbean. Journal of New World Archaeology 5: 13-22.

Wing, E.S. and D. Steadman
1980 Vertebrate Faunal Remains from Dzibilchaltun, Yucatan. In Excavations at

Dzibilchaltun, Yucatan, edited by E.W. Andrews IV and E.W. Andrews V, pp. 326-331, Middle American Research Institute Publication 48, Tulane University, New Orleans.

Witthoft, J.
1955 Worn Stone Tools from Southeast Pennsylvania. Pennsylvania Archaeologist 35: 16-31.

1967 Glazed Polish on Flint Tools. American Antiquity 32: 383-388.Witthoft

Wobst, M.H.
1977 Stylistic Behavior and Information Exchange. In Papers for the Director: Research Essays in Honor of James B. Griffin, edited by C. Cleland, pp. 317-342, Academic Press, New York.

Wood, W.R. and D.L. Johnson
1978 A Survey of Disturbance Processes in Archaeological Site Formation. Advances in Archaeological Method and Theory, Vol.1, edited by M.B. Schiffer, pp. 315-381, Academic Press, New York.

Woodbury, R.
1954 Prehistoric Stone Implements of Northeastern Arizona. Peabody Museum of American Archaeology and Ethnology, Vol.34, Harvard University, Cambridge.

Woodbury, R. and A. Trik
1953 The Ruins of Zacaleu, Guatemala. Byrd Press, Richmond.

Wright, A.C.S., D.H. Romney, R.H. Arbuckle, and V.E. Vial
1959 Land Use in British Honduras: Report of the British Honduras Land Use Survey Team. Colonial Research Publication 24, HMSO, London.

Wylie, H.G.
1975 Tool Microwear and Functional Types from Hogup Cave, Utah. Tebiwa 17: 1-31.

Yamada, S.
1993 The Formation Process of "Use-Wear Polishes". In Traces et fonction: Les Gestes Retrouvés, edited by P.C. Anderson, S. Beyries, M. Otte, and H. Plisson, pp. 433-445, Collège International de Liège, Editions Eraul, vol.50, Centre de Recherches Archéologiques du CNRS, Etudes et Recherches Archéologiques de l'Université de Liège, Liège.

Yellen, J.E.
1977 Archaeological Approaches to the Present: Models for Reconstructing the Past. Academic Press, New York.

Yerkes, Richard W.
1983 Microwear, Microdrills, and Mississippian Craft Specialization. American Antiquity 48: 499-518.

Yerkes, R.A. and P.N. Kardulias
1993 Recent Developments in the Analysis of Lithic Artifacts. Journal of Archaeological Research 1: 89-119.

Yesner, D.R.
1980 Maritime Hunter-Gatherers: Ecology and Prehistory. Current Anthropology 21: 727-750.

Young, D.E. and R. Bonnichsen
1984 Understanding Stone Tools: A Cognitive Approach. Peopling of the Americas Process Series, Vol.1, Center for the Study of Early Man, University of Maine at Orono, Orono.

1985 Cognition, Behavior, and Material Culture. In Stone Tool Analysis: Essays in Honor of Don E. Crabtree, edited by M.G. Plew, J.C. Woods, and M.G. Pavesic, pp. 91-131, University of New Mexico Press, Albuquerque.

Zeitlin, R.N.
1982 Toward a More Comprehensive Model of Interregional Commodity Distribution: Political Variables and Prehistoric Obsidian Procurement in Mesoamerica. American Antiquity 47: 260-275.

APPENDICES A-AA

Appendix A: Lithic Tool Classification for Marco Gonzalez and San Pedro

Cores (00-):
001- polyhedral, blade
002- polyhedral, bladelet
003- pyramidal
004- discoidal
005- basic flake
006- macrocore
007- core tablet
008- core fragment
009- blade
010- macroblade

Blades/Bladelets (20-):
201- blade
202- stemmed macroblade
203- retouched blade-tool
204- macroblade
205- stemmed blade
206- bladelet

Thin Bifaces, Drills, etc. (40-):
401- drill
402- microdrill
403- graver/incisor
404- perforator
405- burinated tool
406- thin bifacial tool, miscellaneous
407- thick bifacial tool, miscellaneous
408- thin bifacial tool, stemmed
409- thick bifacial tool, stemmed
410- thin bifacial tool, shouldered
411- thick bifacial tool, shouldered
412- side-notched thin biface
413- small side-notched point [SSNP]
414- scraper
415- thin bifacial tool, bipointed

Flakes (10-):
101- primary
102- secondary
103- tertiary
104- bifacial thinning
105- citrus slice
106- tranchet-bit (orange peel)
107- miscellaneous flake tool
108- macroflake
109- biface edge

Large Bifaces (30-):
301- oval
302- general utility
303- preform
304- recycled tool
306- ground-bit celt
307- tranchet-bit adze
308- wedge-shaped adze
309- T-shaped adze
310- bipointed
311- lenticular/lanceolate

Debitage (50-):
501- flake (unretouched)
502- burin spalls
503- irregular blocky fragments/shatter

Hammerstones (60-):
601- hammerstone
602- tools recycled into hammerstone

Thermally Produced Pieces (90-):
901- heat spalls/potlids

Special Finds (999)

w: whole tool **p:** proximal fragment **m:** medial fragment **d:** distal fragment

Appendix B: San Pedro Lithic Assemblage by Raw Material Type

Tool type	CBZ chert	Black chert	Other chert	Chalc. (brown/ honey)	Chalc. (gray)	Quartz.	Slate	Total
Bifaces:								
Oval bifaces								
whole	1	0	0	0	0	0	0	1
proximal	0	0	0	0	0	0	0	0
medial	2	0	1	0	0	0	0	3
distal	1	0	0	0	0	0	0	1
General-utility bifaces								
whole	1	0	0	0	0	0	0	1
proximal	1	0	0	0	0	0	0	1
medial	3	0	2	0	0	0	0	5
distal	2	0	0	0	0	0	0	2
Lenticular bifaces								
whole	0	0	0	0	0	0	0	0
proximal	0	0	0	0	0	0	0	0
medial	1	0	0	0	0	0	0	1
distal	0	0	0	0	0	0	0	0
Miscellaneous thin biface fragments								
proximal	0	0	0	0	0	0	0	0
medial	2	0	0	0	0	0	0	2
distal	2	0	0	0	0	0	0	2
Miscellaneous thick biface fragments								
proximal	0	0	0	0	0	0	0	0
medial	13	0	0	0	0	0	0	13
distal	1	0	0	0	0	0	0	1
Flakes:								
Primary								
whole	2	0	2	0	0	0	1	5
proximal	0	0	1	0	0	0	0	1
medial	0	0	0	0	0	0	0	0
distal	0	0	1	0	0	0	0	1
Secondary (2/3)								
whole	26/3	0/0	4/0	1/0	1/0	0/0	0/0	32/3
proximal	2/1	0/0	1/0	1/0	0/0	0/0	0/0	4/1
medial	3/1	0/0	1/0	0/0	0/0	0/0	0/0	4/1
distal	5/2	0/0	5/1	0/0	0/0	0/0	0/0	10/3
Tertiary								
whole	41	1	9	0	2	1	0	54
proximal	18	0	2	1	0	0	0	21
medial	17	0	3	2	1	0	0	23
distal	22	0	4	2	0	0	0	28
Bifacial Thinning								

Flakes								
Secondary (2/3)								
whole	5/1	0/0	1/1	1/0	1/0	0/0	0/0	8/2
proximal	2/0	0/0	0/0	0/0	0/0	0/0	0/0	2/0
medial	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
distal	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Tertiary								
whole	41	0	2	2	2	0	0	47
proximal	6	0	1	0	0	0	0	7
medial	3	0	0	0	0	0	0	3
distal	3	0	0	0	0	0	0	3
Retouched Flakes								
Secondary (2/3)								
whole	1/0	0/0	0/0	0/0	0/0	0/0	0/0	1/0
proximal	0/1	0/0	0/0	0/0	0/0	0/0	0/0	0/1
medial	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
distal	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Tertiary								
whole	1	0	0	0	0	0	0	1
proximal	0	0	0	0	0	0	0	0
medial	3	0	1	0	0	0	0	4
distal	2	0	1	0	0	0	0	3
Biface Edge Flakes								
whole	8	0	0	0	0	0	0	8
Denticulated Flakes								
whole	0	0	0	0	0	0	0	0
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	1	0	0	0	0	1
Burinated Flakes								
whole	0	0	0	0	0	0	0	0
proximal	1	0	0	0	0	0	0	1
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Scrapers								
whole	0	0	0	0	0	0	0	0
proximal	0	0	0	0	0	0	0	0
medial	1	0	0	0	0	0	0	1
distal	0	0	0	0	0	0	0	0
Blocky Fragments								
whole	50	0	20	1	1	2	0	74
Heat Spalls								
whole	6	0	1	0	0	0	0	7
proximal	0	0	0	0	0	0	0	0
medial	0	0	1	0	0	0	0	1
distal	3	0	4	0	1	0	0	8
Standard Flake Cores (recycled into hammerstones)								
whole	1	0	0	0	0	0	0	1

Core Fragments								
whole	4	0	1	0	0	0	0	5
Bifaces Recycled into Hammerstones								
whole	1	0	0	0	0	0	0	1
proximal	1	0	0	0	0	0	0	1
medial	1	0	0	0	0	0	0	1
distal	1	0	0	0	0	0	0	1
Blades								
whole	3	0	0	0	0	0	0	3
proximal	1	0	0	0	0	0	0	1
medial	2	0	1	0	0	0	0	3
distal	0	0	0	0	0	0	0	0
Retouched Blades								
whole	0	0	0	0	0	0	0	0
proximal	1	0	0	0	0	0	0	1
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Macroblades								
whole	0	0	0	0	0	0	0	0
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	1	0	0	0	0	0	0	1
Stemmed Blades								
whole	1	0	0	0	0	0	0	1
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Bladelets								
whole	1	0	0	0	0	0	0	1
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Core Fragments Recycled into Hammerstones								
whole	2	0	1	0	0	0	0	3
Blocky Fragments Recycled into Hammerstones								
whole	1	0	1	0	0	0	0	2
Large Flakes Recycled into Hammerstones								
whole	1	0	0	0	0	0	0	1
Total	**334**	**1**	**75**	**11**	**9**	**3**	**1**	**434**

Appendix C: Weights (grams) of Raw Materials from San Pedro

Tool type code numbers	CBZ chert	Other chert	Black chert	Chalc. (b,h/g)	Slate	Quartz.	Total
501/101	60.3	51.4	0	0/0	8.3	0	**120**
501/102(2)	773.2	117.2	0	30.1/ 17.7	0	0	**938.2**
501/102 (3)	128.6	4.5	0	0/0	0	0	**133.1**
501/103	1209.8	293.4	16	11.4/ 211.5	0	15.3	**1757.4**
104/102 (3)	60.1	52.9	0	0/0	0	0	**113**
104/102 (2)	379.4	59.4	0	21.7/ 7.2	0	0	**467.7**
104/103	498.2	38.6	0	11.7/ 2.6	0	0	**551.1**
107/102 (3)	34.1	0	0	0	0	0	**34.1**
107/102 (2)	40.1	0	0	0	0	0	**40.1**
107/103	88.4	14.9	0	0	0	0	**103.3**
109/103	95.9	0	0	0	0	0	**95.9**
110/103	0	11.8	0	0/0	0	0	**11.8**
201	117.6	10.6	0	0/0	0	0	**128.2**
203	5.6	0	0	0	0	0	**5.6**
204	36.3	0	0	0	0	0	**36.3**
205	17.3	0	0	0	0	0	**17.3**
206	1.6	0	0	0	0	0	**1.6**
301	406.5	108.1	0	0	0	0	**514.6**
302	780.9	301.7	0	0	0	0	**1082.6**
304/602	544.7	0	0	0	0	0	**544.7**
311	51.6	0	0	0	0	0	**51.6**
901/101	4.9	0	0	0	0	0	**4.9**
901/102 (3)	0	83.1	0	0/13.4	0	0	**96.5**
901/102 (2)	2.3	7.3	0	0/0	0	0	**9.6**
901/103	113.2	75.7	0	0/0	0	0	**188.9**
406	26.9	0	0	0	0	0	**26.9**
407	266.6	0	0	0	0	0	**266.6**
503	1232.6	1829.1	0	2.0/ 93.5	0	113.4	**3270.6**
503/601	34.4	578.4	0	0	0	0	**612.8**
501/601	120.5	0	0	0	0	0	**120.5**
405/104	12.4	0	0	0	0	0	**12.4**
414	24.2	0	0	0	0	0	**24.2**
008	1800.2	252.8	0	0	0	0	**2053**
008/601	569.7	226	0	0	0	0	**795.7**
005/602	382.5	0	0	0	0	0	**382.5**
Total	**9920.6**	**4116.9**	**16**	**76.9/ 345.9**	**8.3**	**128.7**	**14613.3**

Appendix D: Marco Gonzalez Lithic Assemblage by Raw Material Type

Tool type	CBZ chert	Black chert	Other chert	Chalc. (brown/ honey)	Chalc. (gray)	Quartz	Slate	Total
Oval bifaces								
whole	2	0	0	0	0	0	0	2
proximal	3	0	0	0	0	0	0	3
medial	6	0	0	0	0	0	0	6
distal	2	0	0	0	0	0	0	2
General-utility bifaces								
whole	3	0	0	0	0	0	0	3
proximal	1	0	0	0	0	0	0	1
medial	12	0	0	0	0	0	0	12
distal	6	0	0	0	0	0	0	6
Biface Preforms								
whole	0	0	1	0	0	0	0	1
proximal	0	0	0	0	0	0	0	0
medial	1	0	0	0	0	0	0	1
distal	0	0	0	0	0	0	0	0
Biface fragments recycled into hammerstones								
whole	4	0	0	0	0	0	0	4
proximal	0	0	0	0	0	0	0	0
medial	1	0	0	0	0	0	0	1
distal	1	0	0	0	0	0	0	1
T-form adzes								
whole	1	0	0	0	0	0	0	1
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Lenticular Bifaces								
whole	0	0	0	0	0	0	0	0
proximal	2	0	0	0	0	0	0	2
medial	5	0	3	0	0	0	0	8
distal	1	1	0	0	0	0	0	2
Flakes								
Primary								
whole	1	0	2	0	0	0	0	3
proximal	0	0	0	1	0	0	0	1
medial	1	0	3	0	0	0	0	4
distal	2	0	1	0	0	0	0	3
Secondary (2/3)								
whole	79/10	2/1	19/10	1/0	0/0	0/0	0/0	101/21
proximal	28/4	0/1	7/0	1/0	0/0	0/0	0/0	36/5
medial	23/6	0/0	10/1	0/0	1/0	0/0	0/0	34/7

distal	23/7	3/0	8/33	2/0	0/0	0/0	0/0	36/10
Tertiary								
whole	178	3	29	2	2	0	0	214
proximal	90	0	13	0	0	0	0	103
medial	103	0	20	0	2	0	0	125
distal	115	1	13	0	2	0	0	131
Blocky fragments	159	2	47	0	1	0	1	210
Bifacial Thinning Flakes								
Tertiary								
whole	99	1	6	2	0	0	0	108
proximal	23	1	1	0	0	0	0	25
medial	4	0	0	0	0	0	0	4
distal	5	0	1	0	0	0	0	6
Secondary (102/2)								
whole	19	0	2	2	1	0	0	24
proximal	0	0	1	0	0	0	0	1
medial	0	0	0	0	0	0	0	0
distal	1	0	0	0	0	0	0	1
Biface edges								
Tertiary								
whole	20	0	3	0	0	0	0	23
Secondary (2/3)								
whole	2/1	0/0	0/0	0/0	0/0	0/0	0/0	2/1
Burnt fragments								
Tertiary								
whole	11	0	4	0	0	0	0	15
Secondary (102/2)								
whole	0	0	2	0	0	0	0	2
Blocky fragments recycled into hammerstones								
whole	4	1	0	0	0	0	0	5
Flake cores								
whole	1	0	0	0	0	0	0	1
Flake cores recycled into hammerstones								
whole	2	0	1	0	0	0	0	3
Flake core fragments recycled into hammerstones								
whole	1	0	0	0	0	0	0	1
Pyramidal flake core fragments								
whole	3	0	0	0	0	0	0	3
Drill on a flake								
Tertiary								
whole	0	0	0	0	0	0	0	0
proximal	0	0	0	0	0	0	0	0

medial	0	0	0	0	0	0	0	0
distal	1	0	0	0	0	0	0	1
Retouched flakes								
Tertiary								
whole	5	0	0	0	0	0	0	5
proximal	2	0	0	0	0	0	0	2
medial	12	0	1	0	0	0	0	13
distal	4	0	1	0	0	0	0	5
Secondary (102/2)								
whole	4	0	0	0	0	0	0	4
proximal	0	0	0	0	0	0	0	0
medial	2	0	0	0	0	0	0	2
distal	2	0	1	0	0	0	0	3
Miscellaneous thin biface fragments								
whole	1	0	0	0	0	0	0	1
proximal	0	0	1	0	0	0	0	1
medial	16	0	8	1	0	0	0	25
distal	6	0	2	0	0	0	0	8
Miscellaneous thick biface fragments								
whole	0	0	0	0	0	0	0	0
proximal	3	0	0	0	0	0	0	3
medial	14	0	0	0	0	0	0	14
distal	0	0	1	0	0	0	0	1
Stemmed thin bifaces								
whole	4	0	0	0	0	0	0	4
proximal	4	0	1	0	0	0	0	5
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Bipointed thin bifaces								
whole	2	0	0	0	0	0	0	2
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Shouldered thin bifaces								
whole	2	0	0	0	0	0	0	2
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Shouldered thick bifaces								
whole	1	0	1	0	0	0	0	2
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0

Side-notched thin bifaces								
whole	1	0	0	0	0	0	0	1
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Small side-notched points								
whole	0	0	0	0	0	0	0	0
proximal	0	0	1	0	0	0	0	1
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Scrapers								
whole	0	0	0	0	0	0	0	0
proximal	0	0	0	0	0	0	0	0
medial	2	0	0	0	0	0	0	2
distal	2	0	0	0	0	0	0	2
Blades								
whole	2	0	0	0	0	0	0	2
proximal	2	0	1	0	0	0	0	3
medial	4	0	2	0	0	0	0	6
distal	2	0	0	0	0	0	0	2
Stemmed Macroblades								
whole	0	0	0	0	0	0	0	0
proximal	4	0	0	0	0	0	0	4
medial	2	0	0	0	0	0	0	2
distal	0	0	0	0	0	0	0	0
Retouched blades								
whole	1	0	0	0	0	0	0	1
proximal	1	0	0	0	0	0	0	1
medial	7	1	1	0	0	0	0	9
distal	2	0	0	0	0	0	0	2
Retouched macroblades								
whole	0	0	0	0	0	0	0	0
proximal	0	0	0	0	0	0	0	0
medial	1	0	1	0	0	0	0	2
distal	1	0	0	0	0	0	0	1
Macroblades								
whole	0	0	0	0	0	0	0	0
proximal	0	0	0	0	0	0	0	0
medial	3	0	1	0	0	0	0	4
distal	0	0	0	0	0	0	0	0
Stemmed blades								
whole	4	0	0	0	0	0	0	4
proximal	4	0	0	0	0	0	0	4
medial	1	0	0	0	0	0	0	1
distal	0	0	0	0	0	0	0	0
Flake core								

fragments								
whole	10	0	0	0	0	0	0	10
Special finds								
whole	2	0	0	0	0	0	0	2
Macroflakes								
Secondary (102/2)								
whole	0	0	1	0	0	0	0	1
proximal	0	0	0	0	0	0	0	0
medial	0	0	0	0	0	0	0	0
distal	0	0	0	0	0	0	0	0
Total	1220	18	235	12	9	0	1	1495

Appendix E: Weights (grams) of Raw Materials from Marco Gonzalez

Tool type Code Number	CBZ chert	Other chert	Black chert	Chalc. (b,h/g)	Slate	Quartz.	Total
501/101	66.2	51.6	0	5.5/0	0	0	**123.3**
501/102(2)	2247	708	31.6	23.7/6.7	0	0	**3017**
501/102 (3)	389	241.5	6.1	0/0	0	0	**636.6**
501/103	4188.3	624.7	13.5	10.3/54	0	0	**4890.8**
501/402	11.2	0	0	0/0	0	0	**11.2**
104/102 (2)	275.5	23.2	0	18.7/9.8	0	0	**327.2**
104/103	1082.9	51.1	18.3	11.2/0	0	0	**1163.5**
107/102 (2)	194.8	10.7	0	0/0	0	0	**205.5**
107/103	232.5	4.5	0	0/0	0	0	**237**
109/103	185.1	15.1	0	0/0	0	0	**200.2**
109/102(2)	26	0	0	0/0	0	0	**26**
109/102(3)	8.6	0	0	0/0	0	0	**8.6**
201	126.8	33.4	0	0/0	0	0	**160.2**
202	150.1	0	0	0/0	0	0	**150.1**
203	109	18.4	8.5	0/0	0	0	**135.9**
204	91.5	23.3	0	0/0	0	0	**114.8**
205	133.9	0	0	0/0	0	0	**133.9**
207	71	29.2	0	0/0	0	0	**100.2**
301	1160.5	0	0	0/0	0	0	**1160.5**
302	2312.6	0	0	0/0	0	0	**2312.6**
303	130.5	1339.5	0	0/0	0	0	**1470**
304/602	712.7	0	0	0/0	0	0	**712.7**
309	322.7	0	0	0/0	0	0	**322.7**
311	220.7	91.6	47.9	0/0	0	0	**360.2**
901/102 (2)	0	4.5	0	0/0	0	0	**4.5**
901/103	56.4	16.3	0	0/0	0	0	**72.7**
406	231.4	105.6	0	13.5/0	0	0	**350.5**
407	344.8	2.2	0	0/0	0	0	**347**
408	125.6	1.9	0	0/0	0	0	**127.5**
410	28.4	0	0	0/0	0	0	**28.4**
411	28.7	46.1	0	0/0	0	0	**74.8**
412	10.9	0	0	0/0	0	0	**10.9**
413	0	2.1	0	0/0	0	0	**2.1**
414	100.1	0	0	0/0	0	0	**100.1**
415	33.7	0	0	0/0	0	0	**33.7**
503	3440.3	1125.2	4.4	0/4.5	32.6	0	**4607**
503/601	738.6	0	46.3	0/0	0	0	**784.9**
108/102(2)	0	475.9	0	0/0	0	0	**475.9**
999	38.9	0	0	0/0	0	0	**38.9**
008	750.1	0	0	0/0	0	0	**750.1**
008/003	223	0	0	0/0	0	0	**223**
005	112.3	0	0	0/0	0	0	**112.3**
008/601	62.2	0	0	0/0	0	0	**62.2**
005/602	434.8	547.6	0	0/0	0	0	**982.4**
Total	**21209.3**	**5593.2**	**176.6**	**82.9/75**	**32.6**	**0**	**27169.6**

Appendix F: San Pedro Lots

Lot Number:	Period:
SP 6 - Alamilla Property	Late Postclassic/ Early Historic
SP 7 - Elvi's Property	Late Postclassic
SP 10 - Elvi's Property (Averiano Rivera)	Middle to Late Postclassic
SP 13 - Nuñez Property	Late Postclassic to Late Historic
SP 14 - Rosalita's Property	Middle Postclassic or earlier
SP 15 - Nuñez Property	Late Postclassic/ Historic
SP 31 - Rosalita's Property	Middle Postclassic
SP 33 - Rosalita's Property	Late Classic
SP 34 - Holiday's Property	Late Classic
SP 35 - Elvi's Property	Late Postclassic
SP 37 - Elvi's Property	Late Postclassic
SP 42 - Rosalita's Property	Late Classic or later (mixed)
SP 46 - Rosalita's Property	Late Classic or later (mixed)
SP 48 - Rosalita's Property	mixed (bulldozer pile)
SP 49 - Rosalita's Property	Late Classic or later
SP 58 - Rosalita's Property	Late Classic and Late Postclassic (mixed)
SP 59 - Rosalita's Property	Middle Postclassic
SP 61 - Rosalita's Property	Middle Postclassic
SP 62 - Rosalita's Property	Late Classic
SP 63 - Rosalita's Property	Late Classic
SP 64 - Rosalita's Property	Late Classic
SP 65 - Rosalita's Property	Late Classic
SP 67 - Rosalita's Property	Middle Postclassic
SP 68 - Rosalita's Property	Middle Postclassic
SP 75 - Rosalita's Property	Terminal Classic or earlier
SP 77 - Rosalita's Property	Late Classic
SP 79 - Rosalita's Property	Late Classic
SP 80 - Rosalita's Property	Late to Terminal Classic
SP 82 - Rosalita's Property	Late Classic
SP 83 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 85 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 86 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 87 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 88 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 89 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 90 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 95 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 98 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 102 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 103 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 111 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 112 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 113 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 114 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 116 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 118 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 119 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 121 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 122 - Sands Hotel/ Parham's Property	Late Postclassic

SP 126 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 127 - Sands Hotel/ Parham's Property	Late Postclassic
SP 132 - Sands Hotel/ Parham's Property	Late Postclassic
SP 140 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 141 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 142 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 143 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 144 - Sands Hotel/ Parham's Property	Late Postclassic
SP 149 - Sands Hotel/ Parham's Property	Late Postclassic
SP 153 - Sands Hotel/ Parham's Property	Postclassic
SP 159 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 163 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 165 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic (mixed)
SP 167 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 169 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 170 - Sands Hotel/ Parham's Property	Late Postclassic
SP 171 - Sands Hotel/ Parham's Property	Late Postclassic
SP 173 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 174 - Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 175- Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 176- Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 177- Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 178- Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 179- Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 183- Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 184- Sands Hotel/ Parham's Property	Late Postclassic/ Historic
SP 185- Sands Hotel/ Parham's Property	Late Postclassic
SP 194- Sands Hotel/ Parham's Property	Late Postclassic
SP 195- Sands Hotel/ Parham's Property	Late Postclassic
SP 202- Sands Hotel/ Parham's Property	Late Postclassic
SP 204- Sands Hotel/ Parham's Property	Late Postclassic
SP 206- Sands Hotel/ Parham's Property	Late Postclassic
SP 208- Sands Hotel/ Parham's Property	Late Postclassic
SP 209- Sands Hotel/ Parham's Property	Late Postclassic
SP 210- Sands Hotel/ Parham's Property	Late Postclassic
SP 211- Sands Hotel/ Parham's Property	Late Postclassic
SP 212- Sands Hotel/ Parham's Property	Late Postclassic
SP 213- Sands Hotel/ Parham's Property	Late Postclassic
SP 214- Sands Hotel/ Parham's Property	Late Postclassic
SP 215- Sands Hotel/ Parham's Property	Late Postclassic
SP 216- Sands Hotel/ Parham's Property	Late Postclassic
SP 219- Sands Hotel/ Parham's Property	Late Postclassic
SP 220- Sands Hotel/ Parham's Property	Late Postclassic
SP 221- Sands Hotel/ Parham's Property	Late Postclassic
SP 223- Sands Hotel/ Parham's Property	Late Postclassic
SP 224- Sands Hotel/ Parham's Property	Late Postclassic
PC (Parham Collection)	no provenience
RSC (Rosario Surface Collection)	no provenience

Appendix G: Marco Gonzalez Lots

Lot Number:	Period:
MG 5 - STR. 28	Middle Postclassic
MG 16 - STR. 12	Classic or Postclassic
MG 18 - STR. 11	Middle Postclassic
MG 21 - STR. 27	Classic or Middle Postclassic
MG 26 - STR. 12	Late Postclassic
MG 27 - STR. 12	Early Postclassic
MG 28 - STR. 11	Middle Postclassic or later
MG 44 - STR. 12	Terminal Classic or earlier
MG 53 - STR. 11	Middle Postclassic
MG 73 - STR. 12	Postclassic
MG 74 - STR. 12	Late Classic or Early Postclassic
MG 75 - STR. 12	Classic
MG 76 - STR. 14	Postclassic
MG 77 - STR. 14	Postclassic
MG 78 - STR. 13	Late Classic
MG 79 - STR. 21	Late Classic or later
MG 80 - STR. 14	Middle Postclassic or later
MG 81 - STRS. 12 (mostly) & 14	Postclassic
MG 82 - STR. 12	Postclassic
MG 84 - STR. 12	Postclassic
MG 94 - STR. 14	Postclassic
MG 95 - STR. 14	Postclassic
MG 98 - STR. 14	Postclassic
MG 104 - STR. 14	Postclassic
MG 105 - STR. 14	Postclassic
MG 107 - STRS. 12 & 14	Late Postclassic
MG 110 - STR. 12	Late Postclassic
MG 113 - STR. 14	Postclassic
MG 114 - STR. 14	Postclassic
MG 118 - STR. 12	Late Classic
MG 119 - STR. 14	Terminal Classic/ Early Postclassic
MG 120 - STR. 12	Postclassic
MG 122 - STR. 14	Postclassic
MG 123 - No context	?
MG 124 - STR. 12	Postclassic
MG 126 - STR. 14	Early Postclassic
MG 128 - STR. 14	Early Postclassic
MG 129 - STR. 14	Middle to Late Postclassic
MG 130 - STR. 14	Late Classic
MG 131 - STR. 14	Late Classic
MG 135 - STR. 14	Postclassic
MG 137 - STR. 14	Postclassic
MG 147 - STR. 12	Early Postclassic
MG 148 - STR. 12	Postclassic
MG 150 - STR. 14	Early Postclassic
MG 151 - STR. 12	Postclassic
MG 156 - STR. 14	Early Postclassic and later
MG 157 - STR. 14	Postclassic
MG 158 - STR. 14	Postclassic

MG 160 - OP. 6 (conch midden)	Early Postclassic
MG 161 - OP. 6 (conch midden)	Early Postclassic
MG 163 - OP. 6 (conch midden)	Early Postclassic
MG 164 - OP. 6 (conch midden)	Early Postclassic
MG 165 - OP. 6 (conch midden)	Early Postclassic
MG 166 - OP. 7 (conch midden)	Early Postclassic
MG 167 - OP. 8 (conch midden)	Early Postclassic
MG 168 - OP. 8 (conch midden)	Early Postclassic
MG 169 - OP. 7 (conch midden)	Early Postclassic
MG 170 - OP. 7 (conch midden)	Early Postclassic
MG 171 - OP. 8 (conch midden)	Early Postclassic
MG 173 - OP. 7 (conch midden)	Early Postclassic
MG 174 - OP. 8 (conch midden)	Early Postclassic
MG 175 - OP. 7 (conch midden)	Early Postclassic
MG 177 - STR. 14	Postclassic
MG 189 - STR. 12	Postclassic
MG 190 - STR. 14	Postclassic
MG 192 - STR. 14	Early Postclassic
MG 194 - STR. 14	Terminal Classic/ Early Postclassic
MG 195 - STR. 14	Postclassic
MG 196 - STR. 12	Late to Terminal Classic
MG 200 - OP. 6 (conch midden)	Early Postclassic
MG 202 - STR. 14	Postclassic
MG 204 - STR. 14	Postclassic
MG 205 - STR. 14	Postclassic
MG 206 - STR. 14	Postclassic
MG 209 - STR. 14	Early Postclassic
MG 211 - STR. 14	Postclassic
MG 212 - STR. 14	Postclassic
MG 214 - STR. 14	Postclassic
MG 215 - STR. 14	Postclassic
MG 216 - STR. 12 & 14	Postclassic
MG 217 - STR. 14	Postclassic
MG 221 - OP. 6 (conch midden)	Early Postclassic
MG 222 - OP. 6 (conch midden)	Early Postclassic
MG 224 - STR. 14	Postclassic
MG 226 - STR. 14	Terminal Classic/ Early Postclassic
MG 228 - STR. 14	Late Classic
MG 229 - STR. 14	Late Classic or earlier
MG 230 - STR. 14	Classic
MG 231 - OP. 4 (STR. 12)	Early Classic to Late Classic
MG 233 - STR. 14	Postclassic
MG 234 - STR. 2	Middle Postclassic
MG 235 - STR. 14	Terminal Classic
MG 236 - STR. 16	Late Postclassic
MG 237 - STR. 12 & 14	Late Postclassic
MG 238 - STR. 14	Postclassic
MG 239 - STR. 12	Postclassic
MG 240 - STR. 12	Late Postclassic
MG 241 - STR. 14	Late Postclassic
MG 250 - STR. 14	Postclassic
MG 251 - STR. 14	Early Postclassic
MG 255 - STR. 16	Late Postclassic
MG 256 - STR. 14	Postclassic
MG 258 - STR. 14	Postclassic

MG 260 - STR. 14	Postclassic
MG 262 - STR. 14	Postclassic
MG 264 - STR. 16	Late Postclassic
MG 266 - STR. 14	Postclassic
MG 269 - STR. 14	Postclassic
MG 273 - STR. 14	Early Postclassic
CCH (Caribbean Club House)	surface

Appendix H: San Pedro Lithic Assemblage by Location/Property

The figures in parentheses are the percentages of each tool type by raw material for each property/location.

Alamilla Property

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
005/602	1 (5.6)	0	0	0	0	0	0
008	1 (5.6)	0	0	0	0	0	0
501/103	3 (16.7)	2 (11.1)	0	0	2 (11.1)	1 (5.6)	0
501/102(2)	3 (16.7)	0	0	0	0	0	0
503	2 (11.1)	0	0	0	1 (5.6)	2 (11.1)	0

Elvi's Property

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
008/601	1 (4.8)	0	0	0	0	0	0
104/103	4 (19)	0	0	0	0	0	0
104/102(3)	0	1 (4.8)	0	0	0	0	0
109/103	1 (4.8)	0	0	0	0	0	0
201	1 (4.8)	0	0	0	0	0	0
205	1 (4.8)	0	0	0	0	0	0
501/103	5 (23.8)	0	0	0	0	0	0
501/102(2)	1 (4.8)	0	0	0	0	0	0
501/102(3)	0	1 (4.8)	0	0	0	0	0
503	2 (9.5)	2 (9.5)	0	0	0	0	0
901/102(3)	0	0	0	0	1 (4.8)	0	0

Elvi's (Averiano Rivera) Property

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/601	1 (100)	0	0	0	0	0	0

Nuñez Property

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
104/103	4 (30.8)	1 (7.7)	0	0	0	0	0
104/102(2)	0	0	0	1 (7.7)	0	0	0
104/102(3)	1 (7.7)	0	0	0	0	0	0
201	1 (7.7)	0	0	0	0	0	0
407	1 (7.7)	0	0	0	0	0	0
501/103	2 (15.4)	1 (7.7)	0	0	0	0	0
501/102(2)	0	0	0	1 (7.7)	0	0	0

Rosalita's Property

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
008/601	1 (1.1)	0	0	0	0	0	0
501/103	27 (28.7)	3 (3.2)	0	0	0	0	0
107/103	4 (4.3)	1 (1.1)	0	0	0	0	0
302	4 (4.3)	2 (2.1)	0	0	0	0	0
204	1 (1.1)	0	0	0	0	0	0
109/103	6 (6.4)	0	0	0	0	0	0
107/102(2)	1 (1.1)	0	0	0	0	0	0
901/101	1 (1.1)	0	0	0	0	0	0
104/103	6 (6.4)	0	0	0	0	0	0
503	9 (9.6)	0	0	0	0	0	0
304/602	3 (3.2)	0	0	0	0	0	0
201	2 (2.1)	1 (1.1)	0	0	0	0	0
405/104	1 (1.1)	0	0	0	0	0	0
501/102(2)	5 (5.3)	1 (1.1)	0	0	0	0	0
104/102(2)	1 (1.1)	0	0	0	0	0	0
501/102(3)	1 (1.1)	0	0	0	0	0	0
407	6 (6.4)	0	0	0	0	0	0
301	3 (3.1)	1 (1.1)	0	0	0	0	0
901/103	1 (1.1)	0	0	0	0	0	0
406	1 (1.1)	0	0	0	0	0	0
414	1 (1.1)	0	0	0	0	0	0

Holiday's Property

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (100)	0	0	0	0	0	0

Parham's Collection

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
301	1 (50)	0	0	0	0	0	0
302	1 (50)	0	0	0	0	0	0

Rosario Surface Collection

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	2 (28.6)	0	0	0	0	0	0
302	1 (14.3)	0	0	0	0	0	0
407	1 (14.3)	0	0	0	0	0	0
201	1 (14.3)	0	0	0	0	0	0
109/103	1 (14.3)	0	0	0	0	0	0
107/102(3)	1 (14.3)	0	0	0	0	0	0

Sands Hotel/Parham's Property

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	59 (21.2)	12 (4.3)	1 (0.4)	5 (1.8)	1 (0.4)	0	0
104/103	39 (14)	2 (0.7)	0	2 (0.7)	2 (0.7)	0	0
407	6 (2.2)	0	0	0	0	0	0
901/103	5 (1.8)	4 (1.4)	0	0	0	0	0
501/102(2)	27 (9.7)	10 (3.6)	0	1 (0.4)	1 (0.4)	0	0
503	37 (13.3)	18 (6.5)	0	1 (0.4)	0	0	0
201	1 (0.4)	0	0	0	0	0	0
008	3 (1.1)	1 (0.4)	0	0	0	0	0
406	3 (1.1)	0	0	0	0	0	0
107/103	2 (0.7)	1 (0.4)	0	0	0	0	0
203	1 (0.4)	0	0	0	0	0	0
104/102(2)	6 (2.2)	1 (0.4)	0	0	1 (0.4)	0	0
110/103	0	1 (0.4)	0	0	0	0	0
501/102(3)	6 (2.2)	0	0	0	0	0	0
901/102(2)	2 (0.7)	1 (0.4)	0	0	0	0	0
901/102(3)	0	1 (0.4)	0	0	0	0	0
008/601	0	1 (0.4)	0	0	0	0	0
501/101	2 (0.7)	4 (1.4)	0	0	0	0	1 (0.4)
503/601	1 (0.4)	1 (0.4)	0	0	0	0	0
302	1 (0.4)	0	0	0	0	0	0
304/602	1 (0.4)	0	0	0	0	0	0
311	1 (0.4)	0	0	0	0	0	0
206	1 (0.4)	0	0	0	0	0	0

Appendix I: San Pedro Lithic Assemblage by Chronological Periods

The figures in parentheses are the percentages of each tool type by raw material for each period.

No provenience, surface and mixed assemblages

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
301	1 (9.1)	0	0	0	0	0	0
302	2 (18.2)	0	0	0	0	0	0
501/103	2 (18.2)	2	0	0	0	0	0
407	1 (9.1)	0	0	0	0	0	0
201	1 (9.1)	0	0	0	0	0	0
109/103	1 (9.1)	0	0	0	0	0	0
107/102(3)	1 (9.1)	0	0	0	0	0	0

Late Classic/Terminal Classic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
304/602	2 (10)	0	0	0	0	0	0
201	1 (5)	0	0	0	0	0	0
405/104	1 (5)	0	0	0	0	0	0
501/103	6 (30)	0	0	0	0	0	0
501/102(2)	2 (10)	0	0	0	0	0	0
008/601	1 (5)	0	0	0	0	0	0
503	1 (5)	0	0	0	0	0	0
501/102(3)	1 (5)	0	0	0	0	0	0
107/103	0	1 (5)	0	0	0	0	0
301	1 (5)	0	0	0	0	0	0
302	1 (5)	0	0	0	0	0	0
407	2 (10)	0	0	0	0	0	0

Late Classic and Late Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
104/102(2)	1 (100)	0	0	0	0	0	0

Late Classic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz	Slate
501/103	11 (31.4)	1 (2.9)	0	0	0	0	0
304/602	1 (2.9)	0	0	0	0	0	0
107/103	3 (8.6)	0	0	0	0	0	0
104/103	2 (5.7)	0	0	0	0	0	0
301	2 (5.7)	1 (2.9)	0	0	0	0	0
302	1 (2.9)	2 (5.7)	0	0	0	0	0
407	3 (8.6)	0	0	0	0	0	0
901/103	1 (2.9)	0	0	0	0	0	0
501/102(2)	1 (2.9)	0	0	0	0	0	0
406	1 (2.9)	0	0	0	0	0	0
503	2 (5.7)	0	0	0	0	0	0
201	0	1 (2.9)	0	0	0	0	0
109/103	2 (5.7)	0	0	0	0	0	0

Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/102(3)	1 (50)	0	0	0	0	0	0
104/103	0	1 (50)	0	0	0	0	0

Middle to Late Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/601	1 (100)	0	0	0	0	0	0

Middle Postclassic or earlier

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (50)	0	0	0	0	0	0
107/103	1 (50)	0	0	0	0	0	0

Middle Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	10 (28.6)	0	0	0	0	0	0
302	2 (5.7)	0	0	0	0	0	0
204	1 (2.9)	0	0	0	0	0	0
109/103	4 (11.4)	0	0	0	0	0	0
107/102(2)	1 (2.9)	0	0	0	0	0	0
901/101	1 (2.9)	0	0	0	0	0	0
104/103	4 (11.4)	0	0	0	0	0	0
503	6 (17.1)	0	0	0	0	0	0
501/102(2)	2 (5.7)	1 (2.9)	0	0	0	0	0
407	1 (2.9)	0	0	0	0	0	0
201	1 (2.9)	0	0	0	0	0	0
414	1 (2.9)	0	0	0	0	0	0

Late Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	26 (25.5)	4 (3.9)	0	3 (2.9)	1 (1)	0	0
008/601	1 (1)	0	0	0	0	0	0
503	9 (8.8)	5 (4.9)	0	1 (1)	0	0	0
501/102(2)	5 (4.9)	2 (2)	0	0	1 (1)	0	0
501/102(3)	0	1 (1)	0	0	0	0	0
201	1 (1)	0	0	0	0	0	0
109/103	1 (1)	0	0	0	0	0	0
104/103	16 (15.7)	0	0	1 (1)	1 (1)	0	0
104/102(3)	0	1 (1)	0	0	0	0	0
901/102(3)	0	0	0	0	1 (1)	0	0
205	1 (1)	0	0	0	0	0	0
901/103	4 (3.9)	0	0	0	0	0	0
901/102(2)	1 (1)	0	0	0	0	0	0
104/102(2)	3 (2.9)	1 (1)	0	0	1 (1)	0	0
407	3 (2.9)	0	0	0	0	0	0
503/601	1 (1)	0	0	0	0	0	0
304/602	1 (1)	0	0	0	0	0	0
501/101	0	2 (2)	0	0	0	0	1 (1)
311	1 (1)	0	0	0	0	0	0
406	1 (1)	0	0	0	0	0	0

Late Postclassic/Historic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	42 (18.7)	11 (4.9)	1 (0.4)	2 (0.9)	2 (0.9)	1 (0.4)	0
501/102(2)	26 (11.6)	8 (3.6)	0	1 (0.4)	0	0	0
008	4 (1.8)	1 (0.4)	0	0	0	0	0
005/602	1 (0.4)	0	0	0	0	0	0
503	32 (14.2)	15 (6.7)	0	0	1 (0.4)	2 (0.9)	0
407	4 (1.8)	0	0	0	0	0	0
201	2 (0.9)	0	0	0	0	0	0
104/103	31 (13.8)	2 (0.9)	0	1 (0.4)	1 (0.4)	0	0
104/102(3)	1 (0.4)	0	0	0	0	0	0
501/102(3)	5 (2.2)	0	0	1 (0.4)	0	0	0
104/102(2)	3 (1.3)	0	0	1 (0.4)	0	0	0
901/103	1 (0.4)	4 (1.8)	0	0	0	0	0
206	1 (0.4)	0	0	0	0	0	0
406	2 (0.9)	0	0	0	0	0	0
107/103	2 (0.9)	1 0.4)	0	0	0	0	0
203	1 (0.4)	0	0	0	0	0	0
110/103	0	1 (0.4)	0	0	0	0	0
901/102(2)	1 (0.4)	1 (0.4)	0	0	0	0	0
901/102(3)	0	1 (0.4)	0	0	0	0	0
008/601	0	1 (0.4)	0	0	0	0	0
501/101	2 (0.9)	2 (0.9)	0	0	0	0	0
503/601	0	1 (0.4)	0	0	0	0	0
302	1 (0.4)	0	0	0	0	0	0

Appendix J: Marco Gonzalez Lithic Assemblage by Location

The figures in parentheses are the percentages of each tool type by raw material for each location.

Structure 2

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	23 (34.3)	3 (4.5)	0	0	0	0	0
301	1 (1.5)	0	0	0	0	0	0
407	1 (1.5)	0	0	0	0	0	0
503	5 (7.5)	4 (6)	0	0	0	0	0
104/103	6 (9)	0	1 (1.5)	0	0	0	0
104/102(2)	3 (4.5)	0	0	0	0	0	0
109/102(3)	1 (1.5)	0	0	0	0	0	0
107/103	1 (1.5)	0	0	0	0	0	0
201	1 (1.5)	0	0	0	0	0	0
202	1 (1.5)	0	0	0	0	0	0
205	1 (1.5)	0	0	0	0	0	0
501/102(2)	8 (11.9)	3 (4.5)	0	0	0	0	0
501/102(3)	2 (3)	0	0	0	0	0	0
311	0	1 (1.5)	0	0	0	0	0
207	0	1 (1.5)	0	0	0	0	0

Structure 11

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
205	1 (33.3)	0	0	0	0	0	0
408	1 (33.3)	0	0	0	0	0	0
410	1 (33.3)	0	0	0	0	0	0

Structure 12

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	67 (33.2)	14 (6.9)	0	0	0	0	0
301	4 (2)	0	0	0	0	0	0
302	2 (1)	0	0	0	0	0	0
304/602	3 (1.5)	0	0	0	0	0	0
406	5 (2.5)	2 (1)	0	0	0	0	0
503	16 (7.9)	2 (1)	0	0	0	0	0
104/103	22 (10.9)	1 (0.5)	0	1 (0.5)	0	0	0
104/102(2)	5 (2.5)	1 (0.5)	0	0	0	0	0
107/102(2)	2 (1)	0	0	0	0	0	0
901/103	1 (0.5)	3 (1.5)	0	0	0	0	0
203	2 (1)	0	0	0	0	0	0
207	1 (0.5)	0	0	0	0	0	0
204	1 (0.5)	0	0	0	0	0	0
501/102(2)	22 (10.9)	6 (3)	0	1 (0.5)	0	0	0
501/102(3)	4 (2)	2 (1)	0	0	0	0	0

501/101	1 (0.5)	0	0	0	0	0	0
407	2 (1)	0	0	0	0	0	0
414	1 (0.5)	0	0	0	0	0	0
109/103	1 (0.5)	0	0	0	0	0	0
201	1 (0.5)	1 (0.5)	0	0	0	0	0
415	1 (0.5)	0	0	0	0	0	0
408	1 (0.5)	1 (0.5)	0	0	0	0	0
107/103	0	1 (0.5)	0	0	0	0	0
999	1 (0.5)	0	0	0	0	0	0

Structure 14

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	256 (32.7)	44 (5.6)	1 (0.1)	2 (0.3)	5 (0.6)	0	0
302	9 (1.1)	0	0	0	0	0	0
309	1 (0.1)	0	0	0	0	0	0
311	5 (0.6)	1 (0.1)	0	0	0	0	0
406	12 (1.5)	7 (0.9)	0	1 (0.1)	0	0	0
407	9 (1.1)	1 (0.1)	0	0	0	0	0
503	72 (9.2)	36 (4.6)	0	0	1 (0.1)	0	1 (0.1)
104/103	70 (8.9)	4 (0.5)	1 (0.1)	1 (0.1)	0	0	0
109/103	14 (1.8)	3 (0.4)	0	0	0	0	0
107/103	11 (1.4)	1 (0.1)	0	0	0	0	0
501/102(2)	82 (10.5)	23 (2.9)	1 (0.1)	2 (0.3)	1 (0.1)	0	0
301	5 (0.6)	0	0	0	0	0	0
104/102(2)	8 (1)	1 (0.1)	0	2 (0.3)	1 (0.1)	0	0
901/103	6 (0.8)	1 (0.1)	0	0	0	0	0
201	5 (0.6)	1 (0.1)	0	0	0	0	0
203	4 (0.5)	0	0	0	0	0	0
008	8 (1)	0	0	0	0	0	0
601/503	3 (0.4)	0	0	0	0	0	0
501/102(3)	14 (1.8)	8 (1)	2 (0.3)	0	0	0	0
601/005	1 (0.1)	1 (0.1)	0	0	0	0	0
501/402	1 (0.1)	0	0	0	0	0	0
415	1 (0.1)	0	0	0	0	0	0
202	3 (0.4)	0	0	0	0	0	0
501/101	1 (0.1)	3 (0.4)	0	1 (0.1)	0	0	0
107/102(2)	2 (0.3)	1 (0.1)	0	0	0	0	0
108/102(2)	0	1 (0.1)	0	0	0	0	0
205	5 (0.6)	0	0	0	0	0	0
901/102(2)	0	2 (0.3)	0	0	0	0	0
304/602	2 (0.3)	0	0	0	0	0	0
408	3 (0.4)	0	0	0	0	0	0
411	0	1 (0.1)	0	0	0	0	0
413	0	1 (0.1)	0	0	0	0	0
303	1 (0.1)	1 (0.1)	0	0	0	0	0
204	1 (0.1)	0	0	0	0	0	0
412	1 (0.1)	0	0	0	0	0	0
109/102(2)	2 (0.3)	0	0	0	0	0	0

Between Structures 12 and 14

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	10 (23.8)	2 (4.8)	0	0	0	0	0
008/003	2 (4.8)	0	0	0	0	0	0
411	1 (2.4)	0	0	0	0	0	0
503	4 (9.5)	1 (2.4)	0	0	0	0	0
104/103	3 (7.1)	1 (2.4)	0	0	0	0	0
104/102(2)	2 (4.8)	0	0	0	0	0	0
204	1 (2.4)	0	0	0	0	0	0
501/102(2)	5 (11.9)	4 (9.5)	0	0	0	0	0
301	1 (2.4)	0	0	0	0	0	0
406	1 (2.4)	1 (2.4)	0	0	0	0	0
408	1 (2.4)	0	0	0	0	0	0
107/102(2)	1 (2.4)	0	0	0	0	0	0
311	0	1 (2.4)	0	0	0	0	0

Structure 16

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	13 (24)	2 (3.7)	0	0	0	0	0
302	4 (7.4)	0	0	0	0	0	0
406	1 (1.9)	0	0	0	0	0	0
407	1 (1.9)	0	0	0	0	0	0
503	8 (14.8)	0	0	0	0	0	0
109/103	1 (1.9)	0	0	0	0	0	0
107/102(2)	1 (1.9)	0	0	0	0	0	0
201	2 (3.7)	0	0	0	0	0	0
202	2 (3.7)	0	0	0	0	0	0
207	1 (1.9)	0	0	0	0	0	0
501/102(2)	3 (5.6)	3 (5.6)	0	0	0	0	0
414	1 (1.9)	0	0	0	0	0	0
104/103	2 (3.7)	0	0	0	0	0	0
107/103	2 (3.7)	0	0	0	0	0	0
901/103	1 (1.9)	0	0	0	0	0	0
203	1 (1.9)	0	0	0	0	0	0
501/101	1 (1.9)	0	0	0	0	0	0
999	1 (1.9)	0	0	0	0	0	0
301	1 (1.9)	0	0	0	0	0	0
501/102(3)	0	2 (3.7)	0	0	0	0	0

Structure 21

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (100)	0	0	0	0	0	0

Structure 27

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
311	1 (100)	0	0	0	0	0	0

Structure 28

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
311	1 (20)	0	0	0	0	0	0
406	2 (20)	0	0	0	0	0	0
408	1 (20)	0	0	0	0	0	0
410	1 (20)	0	0	0	0	0	0

No provenience, surface and mixed assemblages

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
304/602	1 (33.3)	0	0	0	0	0	0
104/103	1 (33.3)	0	0	0	0	0	0
008	1 (33.3)	0	0	0	0	0	0

Operation 4 (Structure 12)

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (14.3)	0	0	0	0	0	0
414	1 (14.3)	0	0	0	0	0	0
107/103	1 (14.3)	0	0	0	0	0	0
005	1 (14.3)	0	0	0	0	0	0
008/003	1 (14.3)	0	0	0	0	0	0
501/102(2)	1 (14.3)	1 (14.3)	0	0	0	0	0

Operation 6

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
205	1 (1.1)	0	0	0	0	0	0
501/103	29 (33.3)	4 (4.6)	0	0	0	0	0
414	1 (1.1)	0	0	0	0	0	0
503	18 (20.7)	0	0	0	0	0	0
104/103	5 (5.7)	2 (2.3)	0	0	0	0	0
104/102(2)	1 (1.1)	0	0	0	0	0	0
107/103	4 (4.6)	0	0	0	0	0	0
601/005	1 (1.1)	0	0	0	0	0	0
501/102(2)	8 (9.2)	0	2 (2.3)	0	0	0	0
107/102(2)	1 (1.1)	0	0	0	0	0	0
302	2 (2.3)	0	0	0	0	0	0
407	1 (1.1)	0	0	0	0	0	0
406	1 (1.1)	1 (1.1)	0	0	0	0	0
203	0	1 (1.1)	1 (1.1)	0	0	0	0
501/101	0	1 (1.1)	0	0	0	0	0

601/503	0	0	1 (1.1)	0	0	0	0
311	0	0	1 (1.1)	0	0	0	0

Operation 7

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	7 (17.5)	3 (7.5)	0	0	1 (2.5)	0	0
301	1 (2.5)	0	0	0	0	0	0
109/103	1 (2.5)	0	0	0	0	0	0
501/102(2)	8 (20)	1 (2.5)	0	1 (2.5)	0	0	0
406	1 (2.5)	0	0	0	0	0	0
107/103	3 (7.5)	0	0	0	0	0	0
901/103	1 (2.5)	0	0	0	0	0	0
407	1 (2.5)	0	0	0	0	0	0
503	1 (2.5)	1 (2.5)	0	0	0	0	0
008/601	1 (2.5)	0	0	0	0	0	0
302	2 (5)	0	0	0	0	0	0
008	1 (2.5)	0	0	0	0	0	0
501/102(3)	1 (2.5)	0	0	0	0	0	0
104/102(2)	0	1 (2.5)	0	0	0	0	0
201	0	1 (2.5)	0	0	0	0	0
204	0	1 (2.5)	0	0	0	0	0
501/101	0	1 (2.5)	0	0	0	0	0

Operation 8

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	80 (40.4)	2 (1)	3 (1.5)	0	0	0	0
503	35 (17.7)	3 (1.5)	2 (1)	0	0	0	0
104/103	20 (10.1)	0	0	0	0	0	0
107/102(2)	1 (0.5)	0	0	0	0	0	0
901/103	2 (1)	0	0	0	0	0	0
201	1 (0.5)	0	0	0	0	0	0
501/102(2)	16 (8.1)	3 (1.5)	2 (1)	0	0	0	0
501/102(3)	6 (3)	2 (1)	0	0	0	0	0
302	3 (1.5)	0	0	0	0	0	0
311	1 (0.5)	0	0	0	0	0	0
104/102(2)	1 (0.5)	0	0	0	0	0	0
109/103	3 (1.5)	0	0	0	0	0	0
203	4 (2)	0	0	0	0	0	0
205	1 (0.5)	0	0	0	0	0	0
407	2 (1)	0	0	0	0	0	0
601/503	1 (0.5)	0	0	0	0	0	0
501/101	1 (0.5)	1 (0.5)	0	0	0	0	0
408	1 (0.5)	0	0	0	0	0	0
107/103	1 (0.5)	0	0	0	0	0	0

Appendix K: Marco Gonzalez Lithic Assemblage by Chronological Periods

The figures in parentheses are the percentages of each tool type by raw material for each period.

Classic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	3 (33.3)	0	0	0	0	0	0
304/602	1 (11.1)	0	0	0	0	0	0
503	1 (11.1)	0	0	0	0	0	0
107/102(2)	1 (11.1)	0	0	0	0	0	0
501/102(3)	1 (11.1)	0	0	0	0	0	0
104/103	2 (22.2)	0	0	0	0	0	0

Classic or Middle Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (33.3)	0	0	0	0	0	0
311	1 (33.3)	0	0	0	0	0	0
901/103	0	1 (33.3)	0	0	0	0	0

Late Classic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
201	1 (3.3)	0	0	0	0	0	0
008	1 (3.3)	0	0	0	0	0	0
501/102(2)	4 (13.3)	0	0	0	0	0	0
501/102(3)	1 (3.3)	1 (3.3)	0	0	0	0	0
501/103	9 (30)	0	0	0	0	0	0
503	2 (6.7)	1 (3.3)	0	0	0	0	0
104/103	4 (13.3)	1 (3.3)	0	1 (3.3)	0	0	0
107/103	2 (6.7)	0	0	0	0	0	0
302	1 (3.3)	0	0	0	0	0	0
204	1 (3.3)	0	0	0	0	0	0

Late Classic or earlier

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	2 (22.2)	0	0	0	0	0	0
901/103	1 (11.1)	0	0	0	0	0	0
414	1 (11.1)	0	0	0	0	0	0
107/103	1 (11.1)	0	0	0	0	0	0
005	1 (11.1)	0	0	0	0	0	0
008/003	1 (11.1)	0	0	0	0	0	0
501/102(2)	1 (11.1)	1 (11.1)	0	0	0	0	0

Late Classic or later

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (100)	0	0	0	0	0	0

Late/Terminal Classic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	6 (31.6)	2 (10.5)	0	0	0	0	0
301	1 (5.3)	0	0	0	0	0	0
302	1 (5.3)	0	0	0	0	0	0
407	1 (5.3)	0	0	0	0	0	0
503	3 (15.8)	0	0	0	0	0	0
104/103	1 (5.3)	0	0	0	0	0	0
104/102(2)	1 (5.3)	1 (5.3)	0	0	0	0	0
501/102(2)	0	1 (5.3)	0	0	0	0	0
501/102(3)	0	1 (5.3)	0	0	0	0	0

Terminal Classic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (50)	0	0	0	0	0	0
501/102(2)	1 (50)	0	0	0	0	0	0

Terminal Classic or earlier

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (50)	0	0	0	0	0	0
501/102(2)	0	0	0	1 (50)	0	0	0

Late Classic or Early Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	7 (28)	1 (4)	0	0	0	0	0
301	1 (4)	0	0	0	0	0	0
406	1 (4)	0	0	0	0	0	0
407	1 (4)	0	0	0	0	0	0
503	1 (4)	0	0	0	0	0	0
104/103	2 (8)	1 (4)	0	0	0	0	0
201	0	1 (4)	0	0	0	0	0
501/102(2)	5 (20)	2 (8)	0	0	0	0	0
501/102(3)	2 (8)	0	0	0	0	0	0

Terminal Classic/Early Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	4 (23.5)	0	0	0	0	0	0
407	1 (5.9)	0	0	0	0	0	0
503	1 (5.9)	0	0	0	0	0	0
104/103	5 (29.4)	0	0	0	0	0	0
205	2 (11.8)	0	0	0	0	0	0
501/102(2)	1 (5.9)	0	0	0	0	0	0
301	1 (5.9)	0	0	0	0	0	0
302	1 (5.9)	0	0	0	0	0	0
406	1 (5.9)	0	0	0	0	0	0

Early Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
406	3 (0.9)	1 (0.3)	0	0	0	0	0
201	2 (0.6)	1 (0.3)	0	0	0	0	0
501/103	120 (35.3)	12 (3.5)	3 (0.9)	0	1 (0.3)	0	0
503	55 (16.2)	5 (1.5)	2 (0.6)	0	0	0	0
205	3 (0.9)	0	0	0	0	0	0
414	1 (0.3)	0	0	0	0	0	0
104/103	25 (7.4)	3 (0.9)	0	0	0	0	0
104/102(2)	2 (0.6)	0	0	0	0	0	0
107/103	8 (2.4)	0	0	0	0	0	0
601/005	1 (0.3)	0	0	0	0	0	0
501/102(2)	32 (9.4)	4 (1.2)	4 (1.2)	1 (0.3)	0	0	0
301	1 (0.3)	0	0	0	0	0	0
109/103	4 (1.2)	0	0	0	0	0	0
107/102(2)	2 (0.6)	0	0	0	0	0	0
901/103	3 (0.9)	0	0	0	0	0	0
501/102(3)	7 (2.1)	2 (0.6)	0	0	0	0	0
302	7 (2.1)	0	0	0	0	0	0
311	1 (0.3)	0	1 (0.3)	0	0	0	0
203	4 (1.2)	1 (0.3)	1 (0.3)	0	0	0	0
407	4 (1.2)	0	0	0	0	0	0
204	0	1 (0.3)	0	0	0	0	0
501/101	1 (0.3)	3 (0.9)	0	0	0	0	0
601/503	1 (0.3)	0	1 (0.3)	0	0	0	0
008/601	1 (0.3)	0	0	0	0	0	0
408	1 (0.3)	0	0	0	0	0	0
008	1 (0.3)	0	0	0	0	0	0
412	1 (0.3)	0	0	0	0	0	0
303	0	1 (0.3)	0	0	0	0	0
999	1 (0.3)	0	0	0	0	0	0

Early Postclassic and later

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	1 (50)	0	0	0	0	0	0
104/103	1 (50)	0	0	0	0	0	0

Middle Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	23 (31.1)	3 (4.1)	0	0	0	0	0
301	1 (1.4)	0	0	0	0	0	0
311	1 (1.4)	1 (1.4)	0	0	0	0	0
407	1 (1.4)	0	0	0	0	0	0
503	5 (6.8)	4 (5.4)	0	0	0	0	0
104/103	6 (8.1)	0	1 (1.4)	0	0	0	0
104/102(2)	3 (4.1)	0	0	0	0	0	0
109/102(3)	1 (1.4)	0	0	0	0	0	0
107/103	1 (1.4)	0	0	0	0	0	0
201	1 (1.4)	0	0	0	0	0	0
202	1 (1.4)	0	0	0	0	0	0
207	0	1 (1.4)	0	0	0	0	0
205	2 (2.7)	0	0	0	0	0	0
501/102(2)	8 (10.8)	3 (4.1)	0	0	0	0	0
501/102(3)	2 (2.7)	0	0	0	0	0	0
406	2 (2.7)	0	0	0	0	0	0
408	2 (2.7)	0	0	0	0	0	0
410	1 (1.4)	0	0	0	0	0	0

Middle Postclassic or later

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	6 (24)	1 (4)	1 (4)	0	0	0	0
311	1 (4)	0	0	0	0	0	0
406	1 (4)	0	0	0	0	0	0
503	2 (8)	2 (8)	0	0	0	0	0
104/103	2 (8)	0	0	0	0	0	0
104/102(2)	1 (4)	0	0	0	0	0	0
109/103	1 (4)	0	0	0	0	0	0
601/005	1 (4)	0	0	0	0	0	0
601/503	1 (4)	0	0	0	0	0	0
501/102(2)	4 (16)	0	0	0	0	0	0
410	1 (4)	0	0	0	0	0	0

Middle/Late Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	29 (28.2)	7 (6.8)	0	0	2 (1.9)	0	0
302	1 (1)	0	0	0	0	0	0
304/602	1 (1)	0	0	0	0	0	0
406	2 (1.9)	1 (1)	0	0	0	0	0
407	1 (1)	0	0	0	0	0	0
408	1 (1)	0	0	0	0	0	0
503	12 (11.7)	4 (3.9)	0	0	1 (1)	0	0
104/103	11 (10.7)	0	0	0	0	0	0
104/102(2)	1 (1)	0	0	0	0	0	0
109/103	1 (1)	0	0	0	0	0	0

107/103	2 (1.9)	1 (1)	0	0	0	0	0
901/103	1 (1)	0	0	0	0	0	0
201	0	1 (1)	0	0	0	0	0
202	1 (1)	0	0	0	0	0	0
203	1 (1)	0	0	0	0	0	0
205	1 (1)	0	0	0	0	0	0
008	1 (1)	0	0	0	0	0	0
601/503	1 (1)	0	0	0	0	0	0
501/102(2)	10 (9.7)	2 (1.9)	0	1 (1)	0	0	0
501/102(3)	5 (4.9)	0	0	0	0	0	0

Late Postclassic

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	50 (27.2)	14 (7.6)	0	0	0	0	0
301	3 (1.6)	0	0	0	0	0	0
302	6 (3.3)	0	0	0	0	0	0
304/602	1 (0.5)	0	0	0	0	0	0
406	5 (2.7)	3 (1.6)	0	0	0	0	0
503	15 (8.2)	2 (1.1)	0	0	0	0	0
104/103	22 (12)	1 (0.5)	0	1 (0.5)	0	0	0
104/102(2)	4 (2.2)	0	0	0	0	0	0
107/102(2)	2 (1.1)	0	0	0	0	0	0
901/103	2 (1.1)	2 (1.1)	0	0	0	0	0
203	3 (1.6)	0	0	0	0	0	0
207	2 (1.1)	0	0	0	0	0	0
204	2 (1.1)	0	0	0	0	0	0
501/102(2)	20 (10.9)	5 (2.7)	0	0	0	0	0
501/102(3)	1 (0.5)	2 (1.1)	0	0	0	0	0
501/101	2 (1.1)	0	0	0	0	0	0
411	1 (0.5)	0	0	0	0	0	0
407	1 (0.5)	0	0	0	0	0	0
109/103	1 (0.5)	0	0	0	0	0	0
201	2 (1.1)	0	0	0	0	0	0
202	2 (1.1)	0	0	0	0	0	0
408	1 (0.5)	0	0	0	0	0	0
999	1 (0.5)	0	0	0	0	0	0
414	1 (0.5)	0	0	0	0	0	0
107/103	2 (1.1)	1 (0.5)	0	0	0	0	0
311	0	1 (0.5)	0	0	0	0	0

Postclassic (mostly Middle, some Early and Late material)

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
501/103	223 (34.6)	34 (5.3)	0	2 (0.3)	3 (0.5)	0	0
301	5 (0.8)	0	0	0	0	0	0
302	5 (0.8)	0	0	0	0	0	0
501/101	1 (0.2)	3 (0.5)	0	1 (0.2)	0	0	0
309	1 (0.2)	0	0	0	0	0	0
311	4 (0.6)	1 (0.2)	0	0	0	0	0
406	8 (1.2)	6 (0.9)	0	1 (0.2)	0	0	0
503	62 (9.6)	29 (4.5)	0	0	0	0	1 (0.2)

104/103	47 (7.3)	3 (0.5)	1 (0.2)	0	0	0	0
109/103	13 (2)	3 (0.5)	0	0	0	0	0
415	2 (0.3)	0	0	0	0	0	0
107/103	7 (1.1)	0	0	0	0	0	0
205	1 (0.2)	0	0	0	0	0	0
501/102(2)	67 (10.4)	26 (4)	1 (0.2)	1 (0.2)	1 (0.2)	0	0
501/102(3)	8 (1.2)	8 (1.2)	2 (0.3)	0	0	0	0
107/102(2)	3 (0.5)	1 (0.2)	0	0	0	0	0
104/102(2)	8 (1.2)	1 (0.2)	0	2 (0.3)	1 (0.2)	0	0
901/103	4 (0.6)	1 (0.2)	0	0	0	0	0
901/102(2)	0	2 (0.3)	0	0	0	0	0
201	4 (0.6)	0	0	0	0	0	0
203	3 (0.5)	0	0	0	0	0	0
008	6 (0.9)	0	0	0	0	0	0
601/503	1 (0.2)	0	0	0	0	0	0
008/003	2 (0.3)	0	0	0	0	0	0
414	1 (0.2)	0	0	0	0	0	0
501/402	1 (0.2)	0	0	0	0	0	0
202	2 (0.3)	0	0	0	0	0	0
108/102(2)	0	1 (0.2)	0	0	0	0	0
109/102(2)	2 (0.3)	0	0	0	0	0	0
601/005	0	1 (0.2)	0	0	0	0	0
408	3 (0.5)	1 (0.2)	0	0	0	0	0
411	0	1 (0.2)	0	0	0	0	0
413	0	1 (0.2)	0	0	0	0	0
303	1 (0.2)	0	0	0	0	0	0
304/602	2 (0.2)	0	0	0	0	0	0
407	7 (1.1)	1 (0.2)	0	0	0	0	0

No provenience, surface and mixed assemblages

Tool type	CBZ chert	Other chert	Black chert	Chalc. (brown)	Chalc. (gray)	Quartz.	Slate
304/602	1 (33.3)	0	0	0	0	0	0
104/103	1 (33.3)	0	0	0	0	0	0
008	1 (33.3)	0	0	0	0	0	0

Appendix L: Use-wear on Experimental Tools (adapted from Lewenstein 1987)

Tool No.(g)	EA	Mo	CM	SS	DP	DST	DSO	DSE	DFST	DFSD	DFSS	N of T	VP	VST	VSO	VSE	VFST	VFSD	VFSS	N of T
CH1 (fg)	38	cut	soft wood	y	y	1	1,8	1	1,2	2	2.4	1	y	1	1	1	1,2	2	1.6	1
CH3 (fg)	29	cut	hard wood	y	y	1	1,3,7	1	2	2	1.4	1	y	1	1,3	1	1,2	2	0.8	1
CH49 (cg)	37	cut	soft wood	n	y	5	1	1	1	3	0.4	1	?	5	1	1	1	4	0.3	1
CH70 (fg)	32	cut	hard wood	y	y	1	1,3,7	1	1,2	2	1.2	1	y	1	1,3,7	1	1,2	2	1	1
CH7 (fg)	26, 39	whittle	hard wood	n	y	1	2,3	1	1,2	2	0.2	1	y	1	2,3	1	1,2,8	4	0.2	1
CH20 (cg)	29, 43	whittle	soft wood	n	n	n	n	n	1	4	0.1	1	y	1	2	1	1,8	4	0.2	1
CH71 (fg)	28,38	whittle	soft wood	n	y	1	2,3	1	1	4	0.2	1	y	1	2	1	1,8	4	0.4	1
CH32 (fg)	26, 30	cut/whittle	soft wood	n	y	1,2	1	1	1,2,6	5	1.6	2	y	1,2	1	2	1	3	0.8	1-2*
CH72 (fg)	24,33	cut/whittle	soft wood	n	y	1,2	1	1	1,2	5	1.4	2	y	1,2	1	2	1	3	1	2*
CH2 (fg)	53-65	chop	soft wood	y	y	2	2	1,2	3,7	1	1.1	2,3	y	2	2	1,2	3,7	1	0.8	1-3*
CH25 (fg)	55-65	chop	hard wood	n	y	n	n	n	1,3,4	4	1.4	2	?	n	n	n	1,3	4	2	1-2*
CH73 (fg)	60-68	chop	soft wood	n	y	2	2	1	3	2	2.2	2	y	2	2	1,2	3,7	1	1.8	1-3*
CH96 (cg)	58-64	chop	hard wood	n	y	n	n	n	1,3,4	4	0.9	1-2*	y	n	n	n	1,3	4	1.1	1-2*
CH8 (fg)	46	saw	soft wood	y	y	1	1,3	1	1,2,8	3,4	1.6	1	y	n	n	n	1,2	4	1.4	1
CH41 (fg)	44	saw	soft wood	y	y	1	1,3	1	1,2,8	2	1	1	y	1	1,3	1	1,2,8	2	1.1	1
CH59 (fg)	48	saw	soft wood	y	y	n	n	n	1,2	4	1	1	y	1	1,3	1	1,2	4	1	1
CH74 (cg)	40	saw	hard wood	n	y	1	1,3	1	1,2	4	0.6	1	y	1	1,3	1	1,2	4	0.5	1
CH4 (fg)	64-72	plane	soft wood	n	y	1,2	2,3	1	3,8	1	2.4	2	y	1,2	2,3	1	3	1	1	1
CH23 (fg)	70-75	plane	hard wood	n	?	n	n	n	3,7	2	1.6	2	y	1	2,3	1	3,8	1	0.7	1-2*
CH87 (fg)	68-75	plane	hard wood	n	y	n	n	n	3,7	2	1.4	1-2*	y	1	2,3	1	3,8	1	0.6	1-2*
CH37 (fg)	53-60	adze	soft wood	n	y	2	2,3	1	3,7	4	1.7	1-2*	n	n	n	n	1,3	4	0.7	2
CH76 (fg)	50-57	adze	soft wood	n	y	2	2,3	1	3,7	4	2	1-2*	y	n	n	n	1,3	4	0.5	2
CH60 (fg)	45-55	drill/bore	soft wood	n	y	1	2	3	1	3	0.3	1-2*	y	1	2	3	1	3	0.3	1-2*
CH77 (cg)	48-52	drill/bore	hard wood	n	y	n	n	n	1	3	0.2	1	?	1	2	3	1	3	0.1	1-2*
CH5 (fg)	n/a	haft polish	soft wood	n	y	2	2,3	n/a	n/a	n/a	n/a	n/a	y	2	2,3	n/a	n/a	n/a	n/a	n/a

CH29 (fg)	n/a	haft polish	soft wood	n	?	2	4	n/a	n/a	n/a	n/a	n/a	?	2	3,4	n/a	n/a	n/a	n/a	n/a
CH86 (cg)	n/a	haft polish	soft wood	n	y	2	4	n/a	n/a	n/a	n/a	n/a	?	2	3,4	n/a	n/a	n/a	n/a	n/a
CH13 (fg)	37	saw	bone	y	y	1	1,3	1	2	4	0.6	1	y	1	1,3	1	1,4	4	0.9	1
CH31 (cg)	39	saw	bone	n	?	n	n	n	1,2	4	0.3	1	y	n	n	n	1,2	4	0.1	1
CH79 (fg)	34	saw	bone	n	?	n	n	n	2	4	0.5	1	y	1	1,3	1	1,4	4	0.7	1
CH30 (fg)	41	cut	bone	y	y	n	n	n	1,2	4	0.3	1	y	n	n	n	1,2,4	4	0.2	1
CH80 (fg)	29	cut	bone	y	y	1	1,3	1	1,2	4	0.3	1	y	n	n	n	1,2	4	0.3	1
CH21 (fg)	57	scrape	bone	n	n	n	n	n	1,3	4	0.1	1	y	2	2	1	1	4	0.2	1
CH26 (fg)	68	scrape	bone	n	?	n	n	n	1	4	0.1	1	y	2,3	2,3	1	1	4	0.1	1
CH81 (cg)	66	scrape	bone	n	y	n	n	n	1	4	0.1	1	y	2	2	1	1	4	0.1	1
CH27 (fg)	29, 41	whittle	bone	n	y	3	2,3	1	1,3,7	3	0.3	1-2*	y	2	2,3	1	1,3	4	0.4	1-2*
CH82 (fg)	32,38	whittle	bone	n	y	n	n	n	1,3	3	0.3	2	y	2	2,3	1	1,3	4	0.3	2
CH33 (fg)	>90	incise	bone	y	y	1	2,3	1	1	4	0.2	1	y	1	2,3	1	1	4	0.1	1
CH16 (cg)	72	drill/bore	bone	n	?	2	2,3	1	4	4	0.1	1	?	5	2,3	1	1?	4	0.1	1
CH83 (fg)	66	drill/bore	bone	n	y	n	n	n	4	4	0.1	1	y	5	2,3	1	4	4	0.1	1
CH17 (fg)	41	saw	antler	y	?	1,3	1	2	1,2,3	4	0.2	1	y	1,3	1	2	1,2	4	0.2	1
CH84 (fg)	43	saw	antler	y	y	1,3	1	2	1,2	4	0.2	1	y	1,3	1	2	1,2	2	0.3	1
CH22 (fg)	65	scrape	antler	n	n	n	n	n	1,3	4	0.1	1	y	2	2,3	1	1	4	0.2	1
CH93 (fg)	69	scrape	antler	n	?	n	n	n	1,3	4	0.1	1	y	2	2,3	1	1	4	0.1	1
CH18 (fg)	37	cut	tanned hide	n	?	5	1	2	1	2	0.8	1	n	5	1	2	1	2	0.6	1
CH44 (fg)	29	cut	tanned hide	n	y	1	1,3	1,2	1,4	1	0.5	1	y	1,5	1,3	1,2	1,4	2	0.4	1
CH78 (fg)	32	cut	tanned hide	y	y	5	1,3	1,2	1,4	1	0.5	1	y	1,5	1,3	1,2	1	2	0.5	1
CH15 (fg)	45-55	scrape	tanned hide	n	n	n	n	n	1,2,3	4	0.6	1	y	5	2	1	1	4	0.2	1
CH24 (fg)	62-67	scrape	tanned hide	n	n	n	n	n	1,3	4	0.4	1	y	5	2,3	1	1	4	0.2	1
CH75 (fg)	60-68	scrape	tanned hide	n	?	n	n	n	1,3	4	0.6	1	y	5	2,3	1	1	4	0.3	1

CH34 (fg)	76	perforate	tanned hide	n	n	1	2,3	3	n	n	n	n	n	1	2,3	3	3	5	0.6	1
CH6 (cg)	32	cut	fresh hide	n	n	n	n	n	1	4	2	1	?	n	n	n	1	4	2.2	1
CH28 (fg)	29	cut	fresh hide	n	y	n	n	n	1	4	2.3	1	y	5	1	1	1	4	2	1
CH88 (fg)	27	cut	fresh hide	n	y	n	n	n	1	4	1.9	1	y	5	1	1	1	4	1.8	1
CH12 (fg)	38-44	scrape	fresh hide	n	?	n	n	n	1,2	3	0.4	2	y	n	n	n	1	4	0.4	1
CH42 (fg)	60-70	scrape	fresh hide	n	n	n	n	n	1	4	0.2	1	y	n	n	n	n	n	n	n
CH43 (fg)	58-64	scrape	fresh hide	n	y	n	n	n	1,3?	4	0.4	1-2*	y	n	n	n	1	4	0.2	1
CH14 (fg)	32	cut	meat	y	y	n	n	n	1	4	3	1	y	n	n	n	1	4	2.6	1
CH35 (fg)	30	cut	meat	y	y	5	1	1	1	4	3.2	1	y	5	1	1	1	4	2.9	1
CH57 (cg)	38	cut	meat	n	?	n	n	n	n	n	n	n	?	n	n	n	1	4	0.7	1
CH46 (fg)	35	cut	fish flesh	y	y	5	1	1	1,3?	4	2.4	1	y	5	1,3	1	1,3?	4	2.1	1
CH89 (fg)	30	cut	fish flesh	n	y	n	n	n	1,3	4	2	1	y	n	n	n	1,3	4	2	1
CH19 (fg)	32	cut	meat & bone	y	y	1,6	1,3	1	1,2,3	4	1.3	1	y	1	1,3	1	1,2	4	1	1
CH45 (fg)	36	cut	meat & bone	y	y	1	1	1	1,2	4	0.9	1	y	1	1	1	1,2	4	0.7	1
CH94 (cg)	36	cut	meat & bone	n	?	n	n	n	1	4	0.2	1	?	5	1	1	1	4	0.4	1
CH11 (fg)	64-67	scrape	meat & bone	n	y	2	2	1	1,3	3	0.4	1-2*	y	n	n	n	1	4	0.5	1
CH47 (fg)	70	scrape	meat & bone	n	y	2	2	1,2	1,3	4	0.4	1	y	1,2	2,3	4	1	4	0.4	1
CH38 (fg)	28-33	cut	fish & bone	n	y	n	n	n	1	4	0.5	1	y	1	1	4	1,2	4	0.3	1
CH 90 (cg)	30-33	cut	fish & bone	n	y	n	n	n	1	4	0.7	1	y	1?	1?	4?	1,2	4	0.6	1
CH39 (fg)	54-58	scale	fish scales	n	y	1	2,3	1	1	2	0.3	1	y	5	2,3	1	1	2	0.4	1
CH51 (fg)	60-62	scale	fish scales	n	y	1	3	1	1	2	0.4	1	y	n	n	n	1	2	0.6	1
CH48 (fg)	69-75	dig/hoe	soil/sand	n	y	1,2,6	2,3	1-3*	3,4,7	1	2.7	3	y	1,2,6	2,3	1,2	3,4,7	1	5.3	3-4*
CH91 (cg)	70-74	dig/hoe	soil/sand	n	y	1,2	2,3	1,2	3,7	1	2	2	y	1,2	2,3	1,2	3,4,7	1	3.9	3-4*
CH10 (fg)	29	saw	shell	y	y	1	1-3*	1	2	1	1.9	1	y	1	1-3*	1	2	1	1.8	1
CH50 (fg)	34	saw	shell	y	y	1	1,3	1	2,4	1	1.3	1	y	1	1,3	1	2,3	1	1	1
CH52 (cg)	29-32	saw	shell	y	y	1,5	1,3	1	2,3	2	1	1	y	1	1,3	1	2,3,4	1	1	1

CH53 (fg)	56	incise	shell	y	y	n	n	n	2,4	3?,4	1.1	1	y	5	1,3	1	2,4	4	1.2	1
CH92 (fg)	60	incise	shell	y	y	5	1,3	1	2,4	4	1.3	1	y	5	1,3	1	2,4	4	1.1	1
CH56 (cg)	49-54	drill/bore	shell	n	n	1	2	1	2, 5?	3	1.7	1	?	1	2	1	2	3	1-2.2	1-2*
CH85 (fg)	55-57	drill/bore	shell	n	y	1	2	1	2,5	3	2	1	y	1	2	1	2,5	3	2.5	2
CH54 (fg)	32	saw	ceramic	y	y	1,2	1	1	1,2	1	1.5	1	y	1,2	1	1	1,2,3?	1	1.1	1
CH55 (fg)	40	saw	ceramic	y	y	1	1,3	1	1,2,3	1	1.1	1-2*	y	1	1,3	1	1,2,3	1	1	1
CH67 (fg)	38	saw	ceramic	y	y	1	1,3	1	1,2,3	1	1.2	1-2*	y	1	1,3	1	1,2,3?	1	1.2	1
CH58 (fg)	36-39	notch	ceramic	n	y	1,2	2	1	2,4	1	1.2	1	y	1,2	2,3	1	2,4,3?	1	1.2	1
CH9 (fg)	33	cut	plant	y	y	1	1	1	2	4	1.3	1	y	1	1	1	2	4	0.9	1
CH36 (cg)	38	cut	plant	y	?	n	n	n	1	4	0.1	1	?	n	n	n	1	4	0.1	1
CH61 (fg)	29	cut	plant	y	y	6?	1,3	1	2	2	0.3	1	y	6?	1,3	1	2	2	0.4	1
CH95 (cg)	32	cut	plant	y	?	n	n	n	1	4	0.2	1	y	1	1	1	2	4	0.3	1
CH40 (fg)	56	scrape	plant	n	y	3,5	2,3	1	1,2	3	1.2	1	y	1,5	2,3	1,2	1,2?	4	1	1
CH62 (fg)	52-60	scrape	plant	n	?	5?	2,3	1	1,2,3	3	0.6	1	y	1	2,3	1,2	1	4	0.5	1
CH65 (fg)	54-60	scrape	plant	n	y	3,5	2,3	1	1,2	3	1.1	1	y	3,5	2,3	1,2	1,2	4	1	1
CH63 (fg)	38	cut	reedy plant	y	y	1	1,3	1,2?	1,2	2	1.1	1	y	1	1,3	1	1,2	2	1	1
CH97 (cg)	42	cut	reedy plant	n	y	5	1	1	1	3	0.3	1	y	5	1	1	1	3	0.3	1
CH99 (fg)	38	cut	reedy plant	y	y	1	1,3	1	1,2	2	0.8	1	y	1	1,3	1	1	2	0.8	1
CH64 (fg)	28-32	cut	plant fibre	y	y	1	1	1	1,2	2	0.3	1	y	1	1	1	1,2	2	0.2	1
CH66 (cg)	27	cut	plant fibre	y	y	n	n	n	2	2	0.6	1	y	n	n	n	2	2	0.6	1
CH100 (fg)	30-33	cut	plant fibre	y	?	n	n	n	1,2	2	0.2	1	y	1	1	1	1,2	2	0.2	1
CH69 (cg)	35-38	saw	stone	y	y	1,2,6	1,3	1	2,3,4?	1	0.2	2	y	1,2,6	1,3	1	2,3,4?	1	0.3	2-3*
CH68 (fg)	42-46	notch	stone	n	y	2,6	2	1	2,3	2	0.4	1-3*	y	2,6	2	1	1?,2	3	0.5	1
CH98 (cg)	n/a	rub/strike	metal	n	y	2,6	2	1	n/a	n/a	n/a	n/a	y	2,6	2	1	n/a	n/a	n/a	n/a

Lithic Coding System for Use-wear

Tool No. (g): The number of the experimental chert tool and the raw material grain size: (fg) = fine-grained, (cg) = coarse-grained. All of the fine-grained chert was 'chert-bearing zone' chert from Orange Walk District, Belize, except CH1, 15, 29, 32, 37, 46, 51, 59, 73, 76, 87 which was chert from 'road cobbles' from Cristo Rey, Cayo District, Belize, and CH 2, 25, 29, 43, 44, 54, 61 which was Onondaga chert from the Port Colborne area on the shore of Lake Erie, Ontario, Canada. All of the coarse-grained chert was chert from 'road cobbles' from Cristo Rey, Cayo District Belize, except CH 16, 36, 69, 77, 86, 91 which was Kettlepoint chert from southern Ontario, Canada.
EA: The edge angle of the tool measured in degrees with a goniometer.
Mo: The type of tool motion.
CM: The type of contact material.

Contact Materials:
soft wood: date palm, white pine
hard wood: mahogany, maple
bone: domestic pig, cow
antler: white-tailed deer
tanned hide: cow
fresh hide: domestic pig
meat: domestic pig, chicken
fish flesh: red snapper
meat & bone: domestic pig
fish & bone: red snapper
fish scales: red snapper
shell: queen conch
ceramic: ash-tempered pottery, sand-tempered pottery
plant: heart of palm, palm fronds, dry sedge grass
reedy plant: soaked wicker, rushes
plant fibre: hemp twine/cord
stone: coarse-grained Cristo Rey chert
metal: steel

SS: The presence of scar symmetry.
DP or VP: The presence of dorsal or ventral microwear polish.
DST or VST: Dorsal or ventral striation type: 1. Long, narrow, deep; 2. Short, wide, deep; 3. Intermittent; 4. Wide, shallow; 5. Long, narrow, faint; 6. Long, wide, deep.
DSO or VSO: Dorsal or ventral striation orientation: 1. Parallel to margin/edge; 2. Perpendicular; 3. Diagonal.
DSE or VSE: Dorsal or ventral striation extent: 1. Close to margin/edge; 2. Distant from margin/edge; 3. 1 centimetre down from tip.
DFST or VFST: Dorsal or ventral flake scar type: 1. Scalar, feather termination; 2. Half-moon, snap termination; 3. Step termination; 4. Deep scalar; 5. Irregular; 6. Triangular; 7. Hinge termination; 8. Trapezoidal.
DFSD or VFSD: Dorsal or ventral flake scar distribution: 1. Continuous; 2. Almost continuous; 3. Clusters; 4. Discontinuous; 5. Continuous overlapping scars.
DFSS or VFSS: Dorsal or ventral scar size (mm).
N of T: Number of tiers of flake scars.

Note: All of the experimental tools were used between 18-20 minutes, except for the chopping and adzing tools and those with haft traces which were used for 22-25 minutes, and the fish scaling tools which were used long enough to scale one small fish.

Appendix M: Other Factors Affecting Edge Damage Formation

Use-wear analysts who primarily relied on edge damage alone claimed the ability to distinguish between use-related edge damage and non-use edge damage (Odell and Odell-Vereecken 1980:96-97; Roy 1982:108; Tringham et al. 1974:181), while those analysts concentrating on polish and striations were often incapable of such a distinction (Keeley 1980:83; Moss 1983a:76; Vaughan 1981:116-120). Many other factors, in addition to the tool motion and contact material can affect edge damage patterns on stone tools.

Raw material:

One can hypothesize that different patterns of edge damage formation are not necessarily attributable to use itself based on the different physical properties of amorphous and cryptocrystalline raw materials such as chert, flint, quartz and obsidian (Greiser and Sheets 1979:285; Odell 1981a:198; see Kamminga 1982; Lewenstein 1981). The type of stone used for experimentally reproduced tools should therefore be the same or similar to that of archaeological tools (Tringham et al. 1974: 178; Unger-Hamilton 1988:39). Although most archaeologists (see Moss 1983a) advocate the use of comparable raw materials for experimental tools, Vaughan (1981:107-108) observed that "... in the majority of cases [17 out of 21] the factor of lithic raw material was not found to exert a significant influence in causing the differences noted among scarring patterns on the three varieties of flint ...". However, raw material was at the root of the decision by many researchers to rely on scar cross-section in lieu of outline for identification purposes (Vaughan 1981:100). Although she failed to mention the raw material sources for experimental implements, Anderson-Gerfaud (1981:6, 37; Anderson 1980b:190) recognized a relationship between the grain structure of flint and the dissolution of the tool edge. Raw material, specifically chert, exhibits an increased propensity to edge fracture when it has either recrystallized naturally (Bradley and Clayton 1987) or has been thermally altered (Bradley and Clayton 1987; Seitzer-Olausson 1983).

Spine-plane angle:

"The spine-plane angle is measured from the plane of the ventral surface of a flake to the plane of the dorsal surface which is nearest the edge in question" (Tringham et al. 1974:179), and corresponds to Wilmsen's (1968:156-161) 'edge-angle' and Hayden and Kamminga's (1979:7) 'production angle'. Through the observation of this tool cross-section, one may be able to predict the potential use/action of a tool . For example, Wilmsen (1968:156; see also Anderson-Gerfaud 1983:92; Cahen and Gysels 1983) suggested that more acute angles [26 - 35 degrees] were effective for cutting activities, while wider angles [46 - 55 degrees] were better for tasks such as hide scraping. Although the degree of microflake damage inflicted on a tool edge was primarily task-related, Tringham et al. (1974:180) believed that a tool edge with a more obtuse spine-plane angle would not be as severely damaged as an acutely angled tool performing the same action on the same material. Vaughan (1981:114, 1985:22, 141,Table 2.2) supports this view, stating that tools with thicker edges used for transverse actions did not scar as readily. Generally, it appears that as the tool spine-angle (see Tringham et al. 1974:178, Fig.1) becomes steeper, there is an increase in the amount of step and hinge-scarring on the tool edge with a concomitant decrease in the frequency of feather-terminated microscars (Del Bene and Shelley 1979:254; Siegel 1985; see Keeley (1980) below for 'edge angle' and edge damage).

Edge angle:

According to Tringham et al. (1974:178, Fig.1; Grace 1989:75, Fig.40), the edge angle is the angle between the ventral surface of the tool and the flaked edge or edge-damaged surface of the tool. Unger-Hamilton (1988:39) noted that both the acuteness and the steepness of the edge angle affected the overall frequency and type of scars produced, concluding that steeper edges had fewer microflake scars. This change in flake scar type is explained by Lawrence (1979:119-120). The first and largest flakes removed from an edge possess feather terminations. It is the removal of these initial flakes which increases the edge angle and causes the flakes subsequently removed to be shorter and possess hinge terminations. Del Bene and Shelley (1979:246; Hurcombe 1992; Siegel 1985) suggest that the previous flake terminations inhibit the propagation of additional flakes which creates edges composed of stacked hinge and step terminated flakes [crushing]. Keeley (1980:140-142) further notes that edge angle can be related to the number of step flake scars produced and that there is a threshold angle above which no edge damage will be produced. Beyond this angle there is only the appearance of tool edge abrasion. If the tool raw material is altered, so too will the threshold angle for edge damage to occur. The more resistant the material, the higher this specific angle will be (see Hurcombe 1992:7). However, when attempting to detect use-related microchipping on intentionally retouched tools, many researchers (Brink 1978a:57f; Fiedler 1979:69-70; Keeley and Newcomer 1977:35; Odell 1977:204, 297, 300, 316, 382) experienced great difficulty in distinguishing between the smaller retouch scars and those microscars due to the use of the retouched edge. Tringham et al. (1974:181) and Odell (1977:148-151) tried to differentiate between the two based on relative flake size and scar patterning.

Edge shape:

Moss (1983a:76, 1983c:236-237) and Unger-Hamilton (1988:39) observed that tools with straight edges received very little microflake damage, even when these edges were used to work hard materials. Tringham et al. (1974:180,Fig.3) noted that protrusions from a straight tool edge received more damage, while concave areas along the edge hardly made contact with the worked material. Grace (1989:79) refers to this trait as 'edge profile'.

Surface curvature

This variable "... refers to a convexity or concavity of the surface of a flake when viewed edge on, presuming that the norm is one in which the edge would appear horizontal" (Tringham et al. 1974:180). Although Tringham et al. (1974) and Hurcombe (1992:8) appear to be the only researchers concerned with this factor, Odell (1975:233, Fig.17) does acknowledge that the convexity and/or concavity of a tool edge is important in the formation of edge damage. When the action is longitudinal, Tringham et al. (1974:179,Fig.2) observed that a reduced surface area of the tool edge contacts the material being worked, therefore edge damage is restricted to that roughly straight section of the tool. Generally, the convex side will possess fewer scars than the concave face, but a greater number of these convex side scars will end in step or hinge terminations (Hurcombe 1992:8). Hurcombe (1992:8) further noted that edge shape or curvature can also provide tool-use evidence because certain shapes cannot be effectively used on some substances to perform some actions. In essence, the edge morphology will not be able to predict which functions can be performed by a specific tool, however, it can define what actions a tool is incapable of successfully accomplishing. If both the edge shape and the surface curvature are not straight, then the applied force will not be evenly distributed across the tool surfaces and differential edge damage will result due to different strengths of force acting on different sections of the tool.

Tool contact angle:

The overwhelming majority of researchers (Kamminga 1982; Keeley 1980; Moss 1983a; Odell and Odell-Vereecken 1980; Tringham et al. 1974; Unger-Hamilton 1988; Vaughan 1981) concluded that the contact angle between the tool edge and the worked material affected the formation of microflake edge damage. The general consensus is that tools held at right angles to the material produce bifacial retouch with longitudinal motions, while those used at an acute angle may only develop unifacial edge damage (Tringham et al. 1974:188; Unger-Hamilton 1988:39).

Duration of action:

Generally, it appears that the longer a tool is used, the greater the damage inflicted on the edge (Unger-Hamilton 1988:40). Eventually, however, a tool will reach a point when it no longer becomes effective for its specific tasks and the dulled edge can no longer be damaged (Tringham et al. 1974). Although, Tringham et al. (1974:191) noted substantial differences in the rate of edge damage formation, they emphasized the fact that tools used on different materials will never develop the same edge wear pattern regardless of the length of time used. Tringham et al. (1974:191) noted that the type and size of microflake scars removed during tool use did not seem to be affected by length of use.

Spontaneous retouch:

Spontaneous retouch generally encompasses all forms of tool edge damage due to manufacture (Brink 1978a:146-147, 1978c; Keeley 1978:164, 1980:25-28, Newcomer

1976). Endscraper retouch can occur when a flake is struck from a core. This is more likely to happen if the debitage from the initial blow is cushioned by the flintknapper's hand.

Accidental retouch:

This type of retouch is usually assigned to tools that have been dropped or knocked from a desk or table top, struck during excavation, and/or damaged while screening. Not only did Unger-Hamilton (1988:41) find that 'single blow' tools [i.e. - blade segments and notched tools] could be created by accidental dropping, she was also unable to distinguish unintentionally created implements from intentionally shaped tools. In contrast, Bergman et al. (1983) suggest the possibility of making a distinction between accidental and intentional breaks on blades without recourse to microscopy.

Transport:

Both Hayden and Kamminga (1973:4) and Vaughan (1981:86) believe the transportation of lithic implements can result in considerable damage to the working edges of the tools. According to Hayden and Kamminga (1973:4):

> ... the full complement of fracture types, including 'terminated' flake scars are found on edges of choppers, scrapers, saws, and even unused adze flakes that were kept by Aboriginal informants in bags at their shelter. In examining these, we have noticed that the average frequency of 'generally terminated' flake scars ... for one bag of unused adze flakes was about the same as on used tools.

In their experiment 16 of the Tubingen blind test, Unrath et al. (1986) carried a flint flake in a leather bag with various other objects to simulate tool transport.

Trampling:

Edge damage can be due to trampling. Based on their trampling experiments, Tringham et al. (1974:192) noted that the resulting edge damage consisted of microflake scars randomly distributed around the flake perimetre on the downward-facing surface. The scars revealed a random pattern of orientation and size, with the majority characterized by a marked elongation (Tringham et al. 1974:182, Fig.6, 192) and "... no localization of scarring as was observed with those flakes used by human beings" (Tringham et al. 1974:191). Pryor (1988) agreed with Tringham et al. (1974) that there is a distinction between use-damage and trampling, and that scarring on tool edges is random and sparse. In his experiments, Vaughan (1985; see Wylie 1975:17 for 'laboratory wear'; Shousboe 1977) combined trampling, dry-screening, and bag storage to replicate non-use edge damage. Although not all damage could be solely attributed to trampling, results were similar to those reported by Tringham et al. (1974) with randomness in unifacial and bifacial surface distribution, in scar cross-section, and in size on flake perimetres. He (Vaughan 1985:23) also noted that acute edges possessed more microscarring than obtuse tool edges. A different conclusion concerning trampling damage was reached by Flenniken and Haggarty (1979). Their trampling tests using obsidian in four types of soil matrices revealed well-patterned macro- and microscopic microchipping of the flakes' edges (see Keeley 1980:34 for both random and clustered edge damage; Mansur-Franchomme 1983a:179). Pryor (1988) agrees with Flenniken and Haggarty (1979; see Nielsen 1991) that scarring is not elongate and occurs bifacially on trampled flakes. Gifford-Gonzalez et al.'s (1985) trampling experiments of two assemblages of 1,000 obsidian flakes in two different soil types revealed that scars are not randomly oriented and that the number of elongate scars varies with substrate or soil type. In their trampling experiments with flint flakes, Shea and Klenck (1993) noticed unevenly distributed broad flake scars. McBrearty et al. (1998) studied the effects of raw material, substrate and artifact density on trampling damage to lithic artifacts and found that compactness of substrate type was the major contributor to edge damage, followed by artifact density and raw material type. They found that randomness of scar location was not a good indicator of trampling activity and that low numbers of scars are quite randomly distributed. However, numerous scars become contiguous and flakes can resemble formal tool types. They (McBrearty et al. 1998:123-124) further noted that edge damage flakes were consistently broad in shape, but that more elongate flakes occurred on flakes in sandy, as opposed to, loam soil and that scars were not randomly oriented on the edge, but were more likely to be perpendicularly aligned (see Gifford-Gonzalez et al. 1985).

In terms of lithics from surface sites, Keller (1979) observed that the edge damage produced primarily by animal trampling was very close to that found on intentionally-used experimental stone tools. In addition to the creation of artificial use-wear traces, Shea and Klenck (1993) observe that trampling can obliterate previous use-wear damage.

Ploughing (agricultural activities):

Lithic artifacts are not only displaced by ploughing activity (Roper 1976), but may also be damaged by the plow itself. Mallouf (1982:84, Table 1, 86-95, figs. 7-9; see Ammerman 1985; Frink 1984:357; Lewark and O'Brien 1981:316; Tringham et al. 1974:182, Fig.6, 192) has described twelve categories of such lithic tool damage and breakage.

Water-rolling:

Both Tringham et al. (1974) and Unger-Hamilton (1988) performed experiments water-rolling stone implements. In their experiments, Tringham et al. (1974:183, Fig.7, 191-192) found that edge damage consisted of a random bifacial distribution of microflakes along the entire flake perimetre. The scars were randomly oriented with no standardized scar size or shape on any of the flakes. In her experiments, Unger-Hamilton (1988:41) discovered that most of the recovered implements exhibited regular retouch, particularly on acute edge angles. Such observations were quite different from those reported by Tringham et al. (1974) and could prove considerably more problematic for use-wear analysts. One explanation for the differing results may be due to the time factor for the experiments. Generally, it appears water rolling or stream action produces various types of edge damage on stone flakes. Different degrees of abrasion from contact with other stones or a sandy stream bed can occur, as well as, a noticeable rounding of the tool's surface ridges (Hurcombe 1992; Linde 1986; Shackley 1974).

Soil matrix:

According to Vaughan (1985:25): "In addition to rounding the edges and ridges of flints and producing a general sheen over the stone tools, the soil also causes striae which are sometimes heavily developed enough to be noticeable with the unaided eye". Keeley (1980:32) also recognized 'white striations' from contact with the soil. The movement of lithic artifacts in the soil can also cause 'bright spots' (see above).

Appendix N: Other Sources of Microwear Polish

Although I did not include all of the following criteria when I performed my own use-wear experiments, the information presented below was duly noted and carefully considered while I was documenting my use-wear observations on the experimental tool kit, as well as, the observations of use-related polishes on the lithics from the assemblages from Marco Gonzalez and San Pedro. It was noted that many factors can contribute to the appearance of polishes on stone tools.

Raw material types:

According to Hurcombe (1992:67), different raw material types may possess varying grain size and lithology which can affect the rate of wear formation on tools. Based on experimental results, Vaughan (1981:131-132) noticed that polish formation had a relatively similar process of development and appearance, yet observed (1981:129-130, 184, 1985:27; see Holmes 1987) a quantitative [level of development, size of polished surface area] rather than qualitative [diagnostic characteristics] difference in polish formation based on raw material grain size. For example, polish on larger-grained tools developed more slowly, possessed polished areas more restricted in size, and was not as connected.

Although Keeley (1980:16) stated that the flint type had no effect on the formation or appearance of microwear traces, in another context (Keeley 1977:39), he mentioned that the distribution of wood polish varied with the texture of the flint surface. Vaughan (1981:132, 1985:28) also warns of polish differences based on variable grain size in the same lithic implement. Whereas other researchers suggested a relationship between polish development and tool grain size, Unger-Hamilton (1988:88) found that on patinated flint the development rate and appearance of polish varied independently of grain size.

Duration of work/action:

Hurcombe (1992:67) was quite adamant about the total use-time of an implement. It is possible that a tool or flake was not used long enough for any polish to form on its surface, or flakes may show some use-wear, but, not of a distinctive nature. In situations where weak polish has formed, post-depositional factors may then affect the use-wear. Therefore, if tools have been used intensively, but not to the point of exhaustion, use-wear analysis cannot be employed to accurately determine the tool's function.

Vaughan (1985:41) noted that by using two co-varying criteria; polish development and edge rounding, the 'effective use duration' (see Hayden 1979a:17) of a tool could be determined. Basically, the greater the polish on a tool, the greater the rounding of the edge, and consequently, the longer it was used.

Keeley (1980) barely mentioned different durations of work because he believed that polish intensity [or brightness] was an indicator of a specific worked material. In contrast, Moss (1983a:88) felt the measure of polish intensities or reflectivity only served to complicate polish identification.

Tool action:

Although there are no definitive conclusions about the degree, intensity or rate of polish formation as it relates to specific tool uses, there are many observations by researchers of the differences in polishes formed by different tool actions [i.e. - longitudinal vs. transverse].

According to Keeley (1977:37), different tool actions affected the location and extent of polished areas on tool surfaces. Moss (1983a:3, 95) concluded there were differences between longitudinal and transverse action polish formation, and also added a description of specific use-wear on projectile points and barbs ("microscopic linear impact traces" [MLIT]). Once again, she emphasizes the necessity of reproducing experimental tool actions as closely as possible to archaeological tool uses. She recommends the recording of the exact tool action for each experimental tool in all use-wear reports (1983a:55).

Unger-Hamilton's experimental results (1988:92) demonstrated variability in polish formation due to longitudinal and transverse actions on anisotropic materials [antler, bone] similar to those of other researchers (see above). These differences were much less evident on reeds and wood than Vaughan (1981:135) had claimed. Unger-Hamilton (1988:92) also found that mechanical drilling as opposed to hand-boring wood created different polishes with the former producing a completely smooth polish with very few striations on the tool tip, and the latter producing only isolated polished zones with numerous striations on the tool tip.

Vaughan (1981:167-170) referred to "Types of Actions in Intentional Use" to describe variable polish formations based on tool action. In particular, he (Vaughan 1981:135) noted that sawing-polishes from materials such as antler, bone, reeds and wood only developed to the 'smooth-pitted' stage [different terminology than Keeley].

<u>Tool edge shape:</u>

Keeley (1980:59) overlooked the variable of tool shape and believed there was no change in polish appearance with variations in tool edge angle. However, Moss (1983a:55; Moss and Newcomer 1982) was convinced that the "... morphology of the piece, particularly the working edges, should be duplicated experimentally". Like Moss, Unger-Hamilton (1988) thought tool edge influenced the polish distribution on her experimental tools. She further noted that edge shape [cross-section] affected polish distribution with polish formation primarily on the higher surface of an uneven edge.

Pressure:

Unger-Hamilton (1983, 1988) experienced mixed results while testing the effects of pressure on tool polish formation. Experiments cutting reed seemed to demonstrate no correlation between pressure and polish formation, whereas experiments in which materials were rubbed using different pressures produced different amounts of tool polish (Unger-Hamilton 1983, 1988). Vaughan (1981:82) simply stated that the amount of pressure used was 'standardized' to what was required "... to execute the task in an efficient, non-exerting manner".

Tool contact angle:

This term refers to the angle between the closest tool surface and the contact material when the edge of the tool is touching the contact material. Unger-Hamilton (1988:93) observed differences in polishes on her experimental tools related to tool angles. When wood was scraped at a 90 degree angle to the worked material, polish was restricted to the very edge of the tool, while scrapers held at a 45 degree angle had extremely polished ventral surfaces [polish extended away from the edge].

Moisture content:

Anderson-Gerfaud (1981, 1982, 1983:89; Anderson 1980b:181), Cahen and Gysels (1983), Gysels and Cahen (1982), Keeley (1980:36, 44, 49), Mansur-Franchomme (1983b), Unger-Hamilton (1988:84, 93-94), and Vaughan (1981:145-146) all noted that polishes varied with the moisture content of worked materials like antler, bone, hide and wood. Moist or soaked contact materials produced a greater degree of micropolish than their dry counterparts. Mansur-Franchomme (1983b) studied the effect of moisture content on dry hide scrapers under SEM and noted a relationship between moisture content of the worked materials and striation formation. Basically, the more moisture in the material, the smoother the striations.

Specific identification of contact materials:

Keeley (1980) stated that he observed no difference in polishes attributable to a specific species regardless of whether dealing with antler, bone, hide, or wood. Nevertheless, he did mention the possibility of quantitative differences in polish formation based on, for example, whether one was cutting 'dense' or 'less dense' wood (1980:36). Based on her experiments, Anderson-Gerfaud (1983:88-89) found that plant polishes varied with species of worked material and that siliceous herbaceous plants such as sedges, 'true rushes', and reedmace or cattail can produce 'sickle gloss' like that caused by harvesting grasses. Although Unger-Hamilton (1988:83-86) also discovered that polish formation varied with plant species, she further noted (1988:68-70, 72-73, 94) slight variations in the nature of polishes on materials such as reindeer and fallow deer antler and different woods which she attributed to differences in the structure and density of the materials. Vaughan (1981:154-155) concluded plant polishes varied with worked material species, however, (1985:37) animal hides or skins did not.

Abrasives (soil/grit contact):

Many experiments have documented that the intentional or accidental addition of some form of abrasive material increased the rate of tool edge rounding (Brink 1978a; Mansur-

Franchomme 1983b; Vaughan 1981). Furthermore, the amount of abrasive [grit, sand] added will directly affect the polish appearance. A great deal of abrasive additive will destroy existing polishes, while a small amount will simply add more grooves and striations (Brink 1978a, 1978b; Mansur-Franchomme 1983b; Vaughan 1985:38). Lévi-Sala (1986, 1993) did substantial work on this topic (see above). Accordingly, Keeley (1980:29) referred to this as a 'glossy patina'. Lewenstein (1987:79) described this type of surface damage as a "... dull polish, abrasion tracks on ridges, and 'white scratches' [wider and deeper than most use striae], especially on bulbar surface". Vaughan (1981:173-174, 1985:42) describes two types of polish from contact with soil or grit:

1. 'smooth-type grit polish': "very bright polish spots in the shape of raised domes with a surface that is smooth but for a groove which sometimes passes through the center".

This polish forms on the elevated microtopography of tool surfaces and on edges, ridges and projections.

2. 'rough-type grit/soil polish': "... the brilliant sheen which entirely covers flints that have been obviously rolled in streams or soliflucted layers. ... a uniform cover of dull-bright (at 280X), very pitted, flat or gently undulating polish ...".

Vaughan (1981:124) also notes that striations will tend to be randomly distributed, often, on non-use-related surfaces, and that they will often cross-cut the ridges, crests or other higher topography of tool surfaces.

Edges of tools contacting abrasives will also reveal a 'chewed-up' appearance on the crest (1981:163-164, 1985:39). Unger-Hamilton (1988:95) agreed with Vaughan's statement (above) based on her drilling experiments both with and without abrasives [sand or sand and water]

Intentional retouch:

Use of a hammerstone creates patches of a dull-bright, flat polish with an uneven surface texture which usually possesses perpendicular or diagonal grooves on the contact lithic raw material. The contact edge of this raw material will also demonstrate some beveling.

Bone and antler billets or batons will leave variously-sized patches of lightly-linked, bright, smooth pitted polish scored with directional grooves from the blow. Pressure flaking with these implements produces very few use-related traces.

The use of wooden implements for percussion or pressure flaking only leaves 'generic weak' polish with very small wood polish domes on the crest of the retouched edge (Vaughan 1981:170-171, 1985:41).

Appendix O: Identified Faunal Material from Marco Gonzalez, Structure 27, Level 21

This level represents a midden dating from AD 1000 to 1200 in the Buk Phase of the Postclassic period (Graham 1987b, Seymour 1991:7). Only a small sample of shells was kept due to the large number recovered (Seymour 1990:4, 1991:8). There were 1500 unidentified elements from class *Osteichthyes* (Seymour 1991:9). Of the 633 identified bones: 586 (94.2%) were *Osteichthyes*, 17 (2.7%) were *Reptilia*, 15 (2.4%) were *Mammalia*, 4 (0.6%) were *Chondrichthyes*, and 1 (0.2%) was *Aves* (Seymour 1991:9).

All table data is from Seymour (1991).

Class	Genus species	Common Name	Quantity of Bones
Mammalia	*Odocoileus virginianus*	white-tailed deer	9 (80%)
	Mazama americana	brocket deer	3 (20%)
	Sigmodon hispidus	hispid cotton rat	2 (13%)
	Homo sapiens	human	1 (7%)
Reptilia	*Iguana iguana*	iguana	11 (65%)
	Dermatemys mawii	Central American river turtle	5 (29%)
	Crocodylus sp.	crocodile	1 (6%)
Aves	*Phalarocorax olivaceus*	cormorant	1 (100%)
Osteichthyes	*Sphyreana* sp.	barracuda	69 (11.6%) MNI:11
	Scarus sp.	parrotfish	34 (5.8%) MNI:12
	Calamus sp.	porgy	39 (6.6%) MNI:12
	Caranx sp.	jackfish	157 (26.4%) MNI:28
	Acanthurus sp.	surgeonfish	18 (3.0%) MNI:9
	Sparisoma sp.	parrotfish	14 (2.4%) MNI: see above
	Lutjanus sp.	snapper	98 (16.5%) MNI:19
	Balistes sp.	triggerfish	11 (1.8%) MNI:7
	Lachnolaimus	hogfish	7 (1.2%) MNI:6
	Haemulon sp.	grunt	26 (4.4%) MNI:6
	Centropomus sp.	snook	10 (1.7%) MNI:2
	Epinephelus sp.	grouper	91 (15.3%) MNI:15
	Halichoeres	wrasse	2 (0.3%) MNI:8
	Mycteroperca sp.	grouper	13 (2.2%) MNI: see above
	Arius sp.	sea catfish	1 (0.2%) MNI:1
	Trachinotus sp.	pompano	2 (0.3%) MNI:1
	Gerres sp.	mojarra	2 (0.3%) MNI:2
	Rachycentron	cobia	1 (0.2%) MNI:1
Decapoda	[Family: *Gecarcinidae*]	land crab	154 claw fragments (62.1%)
	?*Cardisoma* sp.	great land crab	3
	[Family: *Xanthidae*]	mud crab	74 (29.4%)
	Menippe mercenaria	stone crab	49
	[Family: *Portunidae*]	swimming crab	17 (6.9%)

	Callinectes sp.	blue or common edible crab	11
	[Family: *Majidae*]	spider crab	3 (1.2%)
	Mithrax spinosissimus	spiny spider crab	3
Mollusca	*Epitonium lamellosum*	Lamellose wentletrap	3 (27.3%)
	Melongena corona	crown conch	2 (18.2%)
	Certhium atratum	Florida cerith	2 (18.2%)
	Modulus modulus	Atlantic modulus	1 (9.1%)
	Polonices lacteus	milk moon snail	1 (9.1%)
	Nassarius albus	variable nassa	1 (9.1%)
	chione cancellata	cross-barred Venus	1 (9.1%)

*chondrichthyean vertebrae - presumably 4 species of sharks, but maybe skates, or rays (Seymour 1990:9, 1991:11)

Appendix P: Lithic Tools with Microwear Traces from San Pedro

The presence of a lone question mark [?] in a motion or contact material category indicates that use-wear has been detected on the tool, but it is not identifiable beyond presence/absence. The presence of a question mark following a motion or contact material [i.e. scraping(?) or meat/fresh hide(?)] indicates that these are the most 'probable' identifications.

ID#	Tool type/ Raw material	Magnification	Motion	Contact material	Striations
PC#1	302w/c	200x	haft polish	wood	n
PC#2	301w/c	200x	1. chop/adze 2. haft polish	1. wood 2. wood	1. n 2. y
6/13	501/102w/c	200x	scrape	hard	y
6/16	501/102w/c	200x	scrape/plane	wood	y
6/20	501/103w/c	200x	scrape/plane	wood	n
7/1	501/103w/c	200x	?	weak polish	n
13/13	501/103w/c	200x	saw	hard (stone?)	y
13/14	501/102w/ch	200x	cut/slice	plant fibre?	n
13/16	104/102w/ch	200x	slice/strip	weak polish (plant?)	y
13/33	501/103w/c	200x	cut/slice	wood	n
13/35	104/103w/o	200x	scrape	meat (fish?) & bone	y
14/1	107/103m/c	200x	scrape	plant/soft wood (?)	y
15/1	104/103w/c	1. 200x 2. 200x	1. cut/slice 2. scrape	1. wood 2. bone	1. y 2. y
31/3	109/103w/c	1. 200x 2. 200x	1. chop/adze 2. ?	1. wood 2. weak polish (soft)	1. y (faint) 2. n
31/4	501/103d/c	1. 100x 2. 200x	1. cut/slice (?) 2. cut/slice	1. soft (plant?) 2. meat(fish?)	1. n 2. n
31/6	109/103w/c	1 200x 2. 200x	1. chop/adze 2. dig/hoe	1. wood 2. soil/sand	1. n 2. y
31/7	204d/c	200x	scrape	weak polish (hard?)	y
31/8	503w/c	200x	transverse cut/slice	meat (fish?)	y
31/10	107/102w/c	200x	scrape	meat (fish?) & plant	n
31/11	302d/c	200x	?	?	n
33/1	501/103p/c	200x	transverse (cut?)	stone	y
33/2	107/103m/c	1. 200x 2. 200x	1. haft polish 2. scrape	1. wood 2. soft	1. y 2. y
33/4	304/602p/c	200x	haft polish	wood	y
35/1	503w/c	200x	sawing	bone	n
37/1	205w/c	1. 200x 2. 200x 3. 200x	1. haft polish 2. cut/slice 3. cut/slice	1. wood 2. meat & hide	1. y 2. y 3. y

				3. bone & wood (?)	
37/5	104/103w/c	200x	cut/slice	meat (fish?)	n
37/6	104/103w/c	200x	chop/adze	wood	y
37/7	104/103w/c	200x	cut/slice	plant fibre	y
37/8	109/103w/c	200x	drill/bore	wood	n
37/11	501/103p/c	200x	cut/chop	meat (fish?) & bone	y
37/12	104/103w/c	200x	cut/slice (?)	weak polish (meat/fresh hide?)	n
42/1	201w/c	100x	cut/slice	medium (wood?)	n
42/2	304/602m/c	200x	crush/pound	stone	y
42/3	405/104p/c	200x	incise	wood (?)	n
46/2	501/103d/c	200x	notch	ceramic/ston e (?)	y
46/4	501/102w/c	200x	scrape	weak polish (bone?)	n
49/1	501/103w/c	200x	?	soil/sand	y
49/3	501/103p/c	100x	?	weak polish	n
58/1	104/102w/c	200x	cut/slice	weak polish (wood/bone?)	n
61/2	201p/c	1. 200x 2. 200x	1. cut/slice 2. saw	1. wood 2. shell (?)	1. y 2. y
61/4	104/103w/c	200x	?	weak polish	n
61/6	109/103w/c	200x	chop/adze	wood	y
62/2	302d/o	200x	dig/hoe	soil/sand	y
62/4	407m/c	1. 200x 2. 100x	1. chop/adze 2. cut/slice	1. wood 2. soft (meat /fresh hide?)	1. n 2. n
63/1	107/103m/c	1. 200x 2. 200x	1. haft polish 2. pierce	1. wood 2. dry hide	1. y 2. y
63/2	501/103w/c	200x	?	weak polish	n
64/3	501/102w/c	200x	notch	ceramic	y
64/4	406d/c	1. 200x 2. 200x	1. saw 2. scale (?)	1. wood 2. fish scales (?)	1. y 2. y
64/7	501/103w/c	200x	?	weak polish (soft?)	n
65/1	503w/c	200x	scrape/plane	wood (?)	n
65/2	107/103d/c	200x	scrape	hide	y
65/3	201m/o	200x	cut/slice	weak polish (plant?)	n
65/4	501/103w/c	500x	cut/slice	meat (fish?)	n
65/5	501/103p/c	200x	cut/slice	meat/hide	n
67/2	104/103w/c	200x	dig/hoe	soil/sand	y
67/4	501/103w/c	100x	?	weak polish (hard?)	n
68/3	501/103d/c	200x	scrape	wood (faint)	y
68/4	503w/c	200x	cut/slice	plant fibre	y (faint)
68/5	302d/c	200x	haft polish	wood (& dry hide ?)	y
68/9	501/102m/c	200x	whittle	wood	y

77/1	109/103w/c	200x	dig/hoe	soil/sand	y
77/2	407m/c	200x	?	soft (?)	n
77/4	301m/c	100x	haft polish	wood	y
79/1	302m/c	1. 200x 2. 200x	1. dig/hoe 2. chop/adze	1. soil/sand 2. wood	1. y 2. y
79/3	407m/c	200x	cut/slice (?)	weak polish	n
80/1	304/602d/c	1. 200x 2. 200x	1. chop/adze 2. scrape/plane	1. wood 2. wood	1. y 2. y
80/4	407d/c	200x	?	weak polish	n
80/5	302p/c	200x	haft polish	wood	y
80/6	407m/c	200x	scrape	dry hide	n
82/1	501/103w/c	200x	cut/slice	wood	y
82/2	104/103p/c	100x	?	weak polish	n
85/1	501/103d/c	100x	?	weak polish	n
85/3	407m/c	200x	dig/hoe	soil/sand	y
85/4	407m/c	200x	rub/strike	metal (possible rust stains)	y
85/5	104/103w/c	1. 200x 2. 200x	1. whittle 2. haft polish	1. wood 2. wood	1. y 2. y
86/1	501/103w/c	200x	cut/slice	weak polish (soft?)	n
87/1	503w/c	200x	cut/slice	plant fibre	y
88/1	501/103p/c	200x	rub/strike	stone	y
88/2	201w/c	1. 200x 2. 200x	1. whittle 2. rub	1. wood 2. stone/metal (?)	1. y 2. y
88/3	501/103w/c	1. 200x 2. 200x	1. cut/slice 2. scrape	1. meat (fish?) 2. bone/ shell (?)	1. n 2. y
89/1	104/103w/c	1. 200x 2. 200x	1. saw 2. saw	1. bone 2. shell	1. n 2. y
98/1	501/102w/c	1. 200x 2. 200x	1. cut/slice 2. cut/slice	1. wood 2. wood	1. n 2. n
98/2	501/102w/c	200x	?	weak polish (soft?)	n
98/3	104/103w/c	1. 200x 2. 200x	1. cut/ scale (?) 2. cut/ scale (?)	1. meat (fish?) & bone 2. meat (fish?) & bone	1. y 2. y
98/4	104/103w/c	200x	saw	shell	y
98/5	501/102w/c	200x	whittle	wood	y
98/6	503w/c	100x	drill/bore	hard (?)	n
102/2	501/103w/c	1. 200x 2. 100x	1. cut/slice 2. cut/slice	1. meat (fish?) 2. meat (fish?)	1. n 2. n
102/3	406d/c	1. 200x 2. 200x	1. haft polish 2. abrasion	1. wood 2. soil/sand	1. n 2. y
102/4	501/102p/c	200x	?	weak polish	n

				(soft?)	
102/5	501/103m/o	200x	?	plant (?)	n
102/6	501/103w/c	200x	chop/adze (?)	wood & soil/sand	y
102/7	104/103w/c	200x	rub	stone	y
102/8	104/103w/c	200x	?	wood	n
102/9	203p/c	1. 200x 2. 100x	1. cut/slice 2. ?	1. wood (soft) 2. weak polish	1. n 2. n
102/10	107/103m/c	1. 200x 2. 200x	1. haft polish 2. saw	1. wood 2. bone	1. y 2. n
102/13	501/103w/c	200x	cut/slice	soft (?)	n
102/14	104/103w/c	200x	dig/hoe	sand/soil	y
103/2	501/103w/c	200x	cut/slice	meat (fish?)	n
103/3	104/103w/c	200x	cut/slice	bone	n
103/4	501/102w/c	200x	rub	stone	n
103/5	104/102w/c	200x	whittle	wood	y
103/6	501/103d/c	1. 100x 2. 200x	1. rub 2. cut/slice	stone meat (fish?) & bone	1. n 2. y
103/7	104/103w/c	200x	cut/slice	meat (fish?)	y
103/8	501/103p/c	200x	cut/slice	fresh hide (?)	y
103/9	501/103w/c	200x	?	?	n
111/1	110/103d/o	1. 200x 2. 200x	1. saw 2. cut/slice	1. wood 2. wood	1. y 2. n
111/2	104/103m/c	200x	whittle	wood	y
113/3	501/102m/c	200x	cut/slice	plant	y
121/2	008w/c	200x	rub	stone	y
121/3	503w/c	200x	rub	stone	y
140/4	104/103w/c	1. 200x 2. 200x 3. 200x	1. haft polish 2. plane 3. cut/slice	1. wood 2. wood 3. dry hide	1. y 2. y 3. y
141/1	501/102p/c	200x	cut/slice	plant	n
142/7	008w/o	200x	rub/strike	metal	y
142/17	901/102d/c	200x	?	weak polish (meat/fish?)	n
142/18	501/103d/c	1. 200x 2. 200x 3. 200x	1. scrape 2. scrape 3. rub	1. meat (fish?) & bone 2. wood or bone? (bevel) 3. dry hide	1. y 2. y 3. y
142/22	501/103d/c	200x	saw	ceramic	y
143/1	501/103d/ch	200x	cut/slice	plant	n
143/2	104/103p/c	200x	?	weak polish	n
143/3	104/103w/c	200x	?	plant (?)	n
143/23	501/102w/c	200x	cut/slice	hard (bone?)	n
143/30	501/103d/c	200x	saw (?)	stone	y
144/3	501/103w/c	200x	cut/slice	soft wood/plant(?)	y
153/5	104/103w/o	200x	chop/adze	wood & sand/soil	y
159/1	501/103m/c	100x	?	weak polish	n
159/2	501/102w/c	1. 200x	1. saw	1. wood	1. y

		2. 200x	2. cut/slice	2. plant (coarse)	2. y
165/2	501/103p/c	200x	?	weak polish	n
165/4	501/103m/c	200x	scrape/whittle	wood	y
167/4	501/102w/c	1. 200x 2. 200x	1. haft polish 2. cut/slice	1. wood 2. meat (fish?) & bone	1. y 2. y
167/6	104/103w/c	200x	chop/adze	wood	y
170/9	501/103d/c	200x	cut/slice	soft wood/plant (stems?)	y
170/10	501/103w/c	1. 500x 2. 200x	1. saw 2. cut/slice (?)	1. ceramic 2. soft	1. y 2. n
170/12	407m/c	200x	rub/strike	metal (& rust)	y
171/2	104/103p/c	200x	cut/slice	meat (fish?)	n
173/2	104/103w/c	1. 200x 2. 200x	1. dig/hoe 2. cut/slice	1. soil/sand 2. wood	1. y 2. y
173/5	104/103w/c	200x	chop/adze	wood	n
175/14	501/102w/c	200x	scrape	weak polish	n
177/35	104/103w/c	200x	cut/slice	weak polish (wood?)	n
177/36	104/102w/c	1. 200x 2. 200x	1. dig/hoe 2. scrape	1. soil/sand 2. wood	1. y 2. n
177/37	503w/o	200x	rub/strike	metal	y
177/40	501/103w/c	200x	incise	wood	n
177/48	407m/c	200x	?	weak polish	n
177/50	503w/c	200x	rub/strike	metal (& rust)	y
177/52	501/103m/c	1. 200x 2. 200x	1. scrape 2. rub/strike	1. bone 2. stone	1. y 2. y
177/53	501/102w/o	200x	?	weak polish	n
177/62	008/503w/c	200x	rub/strike	metal	y
177/63	501/103m/c	200x	cut/slice	meat (fish?)	n
178/1	501/103p/c	200x	saw	stone or ceramic (?)	y
178/3	501/103d/c	200x	scrape	wood	y
178/4	104/103w/c	200x	cut/slice	meat (fish?) & bone	y
178/6	501/102d/c	200x	whittle	wood	n
178/9	104/103w/c	200x	chop/adze	wood	y
179/6	501/102w/o	200x	saw	wood	n
184/3	104/103w/o	200x	scrape/whittle	bone (& meat?)	y
194/5	104/102w/o	200x	saw	shell (?)	y
195/1	503w/c	200x	saw(?)	hard (wood?)	y
202/2	104/103w/c	1. 200x 2. 200x	1. cut/slice 2. whittle	1. plant 2. wood (soft)	1. y 2. y
204/2	304/602w/c	100x	crush/pound	stone	n
204/3	501/103m/ch	200x	cut/slice	meat (fish?) & bone	y

206/1	501/103w/c	100x	cut/slice (?)	weak polish	n
208/1	104/103m/c	1. 200x 2. 200x	1. saw 2. scrape	1. bone 2. meat or fresh hide(?)	1. y 2. n
209/9	104/103w/ch	200x	dig/hoe	soil/sand	y
209/10	501/102w/c	200x	scrape/whittle	wood	y
209/14	104/103w/c	200x	cut/slice	weak polish (plant?)	n
210/2	104/103w/c	100x	?	weak polish	n
211/1	501/102w/c	200x	cut/slice	bone	y
211/2	501/103w/c	200x	scrape	wood	y
212/10	501/103m/ch	200x	pierce	soft wood/dry hide(?)	y
213/1	104/103m/c	200x	scrape/shape	stone	y
214/1	501/103m/ch	200x	transverse slice	meat (fish?)	n
215/1	104/102p/c	200x	cut/slice	soft (plant?)	n
215/2	104/103w/c	200x	saw	bone	y
216/3	104/102w/c	200x	scrape	wood/bone/antler (?)	n
220/3	104/103w/c	1. 200x 2. 200x 3. 200x	1. haft polish 2. chop/adze 3. cut/slice	1. wood 2. wood 3. plant fibre	1. y 2. n 3. y
220/4	501/102w/ch	200x	saw	wood	y
220/6	501/103m/c	200x	cut/slice	meat (fish?)	n
220/7-10	311m/c	200x	haft polish	wood (& dry hide?)	?
221/1	104/103d/c	200x	scrape/plane	bone/antler/ wood(?)	y
RCS1	109/103w/c	200x	chop/adze	wood	n
RCS2	302m/c	200x	dig/hoe	soil/sand	y
RCS4	201w/c	200x	scrape (?)	hard (bone/wood?)	y
RCS5	407m/c	200x	dig/hoe	soil/sand	y

Appendix Q: Number of Used Edges or Surfaces by Motion by Location at San Pedro

The percentages in parentheses are computed for each property/location.

Alamilla Property

Motion type	Secure Identification (%)	Probable Identification (%)	Total (%)
scrape	1 (33.3)	0 (0)	1 (33.3)
scrape/plane	2 (66.7)	0 (0)	2 (66.7)

Elvi's Property

Motion type	Secure Identification (%)	Probable Identification (%)	Total (%)
undetermined	1 (9.1)	0	1 (9.1)
saw	1 (9.1)	0	1 (9.1)
haft polish	1 (9.1)	0	1 (9.1)
cut/slice	4 (36.4)	1 (9.1)	5 (45.5)
chop/adze	1 (9.1)	0	1 (9.1)
drill/bore	1 (9.1)	0	1 (9.1)
cut/chop	1 (9.1)	0	1 (9.1)

Nuñez Property

Motion type	Secure Identification (%)	Probable Identification (%)	Total (%)
saw	1 (14.3)	0	1 (14.3)
cut/slice	3 (42.9)	0	3 (42.9)
slice/strip	1 (14.3)	0	1 (14.3)
scrape	2 (28.6)	0	2 (28.6)

Rosalita's Property

Motion type	Secure Identification (%)	Probable Identification (%)	Total (%)
chop/adze	6 (9.8)	0	6 (9.8)
undetermined	11 (18)	0	11 (18)
cut/slice	10 (16.4)	2 (3.3)	12 (19.7)
scrape	8 (13.1)	0	8 (13.1)
dig/hoe	5 (8.2)	0	5 (8.2)
transverse cut/slice	1 (1.6)	1 (1.6)	2 (3.3)
haft polish	6 (9.8)	0	6 (9.8)
crush/pound	1 (1.6)	0	1 (1.6)
incise	1 (1.6)	0	1 (1.6)
notch	2 (3.3)	0	2 (3.3)
saw	2 (3.3)	0	2 (3.3)

pierce	1 (1.6)	0	1 (1.6)
scale	0	1 (1.6)	1 (1.6)
scrape/plane	2 (3.3)	0	2 (3.3)
whittle	1 (1.6)	0	1 (1.6)

Parham's Collection

Motion type	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
haft polish	2 (66.7)	0	2 (66.7)
chop/adze	1 (33.3)	0	1 (33.3)

Rosario Surface Collection

Motion Type	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
chop/adze	1 (25)	0	1 (25)
dig/hoe	2 (50)	0	2 (50)
scrape	0	1 (25)	1 (25)

Sands Hotel/Parham Property

Motion Type	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
undetermined	15 (11.4)	0	15 (11.4)
dig/hoe	5 (3.8)	0	5 (3.8)
rub/strike	15 (11.4)	0	15 (11.4)
whittle	7 (5.3)	0	7 (5.3)
haft polish	7 (5.3)	0	7 (5.3)
cut/slice	36 (27.3)	2 (1.5)	38 (28.8)
saw	14 (10.6)	2 (1.5)	16 (12.1)
cut/scale	0	2 (1.5)	2 (1.5)
drill/bore	1 (0.8)	0	1 (0.8)
chop/adze	5 (3.8)	1 (0.8)	6 (4.5)
plane	1 (0.8)	0	1 (0.8)
scrape	10 (7.6)	0	10 (7.6)
scrape/whittle	3 (2.3)	0	3 (2.3)
incise	1 (0.8)	0	1 (0.8)
crush/pound	1 (0.8)	0	1 (0.8)
pierce	1 (0.8)	0	1 (0.8)
scrape/shape	1 (0.8)	0	1 (0.8)
transverse	1 (0.8)	0	1 (0.8)
cut/slice			
scrape/plane	1 (0.8)	0	1 (0.8)

Appendix R: Number and Percentage of Contact Material Types by Location at San Pedro

The percentages in parentheses are computed for each property/location.

Alamilla Property

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
hard	1 (33.3)	0	1 (33.3)
wood	2 (66.7)	0	2 (66.7)

Elvi's Property

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
undetermined	1 (7.1)	0	1 (7.1)
bone	1 (7.1)	1 (7.1)	2 (14.3)
wood	3 (21.4)	1 (7.1)	4 (28.6)
meat (fish?)	2 (14.3)	1 (7.1)	3 (21.4)
fresh hide	1 (7.1)	1 (7.1)	2 (14.3)
plant	1 (7.1)	0	1 (7.1)
meat (fish?) & bone	1 (7.1)	0	1 (7.1)

Nuñez Property

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
stone	0	1 (14.3)	1 (14.3)
plant	1 (14.3)	1 (14.3)	2 (28.6)
wood	2 (28.6)	0	2 (28.6)
meat (fish?) & bone	1 (14.3)	0	1 (14.3)
bone	1 (14.3)	0	1 (14.3)

Rosalita's Property

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	18 (26.9)	5 (7.5)	23 (34.3)
soft	2 (3)	2 (3)	4 (6)
plant	3 (4.5)	2 (3)	5 (7.5)
meat (fish?)	4 (6)	2 (3)	6 (9)
soil/sand	6 (9)	0	6 (9)
hard	0	2 (3)	2 (3)

undetermined	6 (9)	0	6 (9)
stone	2 (3)	1 (1.5)	3 (4.5)
ceramic	1 (1.5)	1 (1.5)	2 (3)
bone	0	2 (3)	2 (3)
shell	0	1 (1.5)	1 (1.5)
fresh hide	1 (1.5)	1 (1.5)	2 (3)
dry hide	3 (4.5)	1 (1.5)	4 (6)
fish scales	0	1 (1.5)	1 (1.5)

Parham's Collection

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	3 (100)	0	3 (100)

Rosario Surface Collection

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	1 (20)	1 (20)	2 (40)
soil/sand	2 (40)	0	2 (40)
bone	0	1 (20)	1 (20)

Sands Hotel/Parham Property

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
undetermined	11 (7.4)	0	11 (7.4)
soil/sand	8 (5.4)	0	8 (5.4)
metal	6 (4)	1 (0.7)	7 (4.7)
wood	37 (24.8)	8 (5.4)	45 (30.2)
soft	1 (0.7)	4 (2.7)	5 (3.4)
plant	7 (4.7)	6 (4)	13 (8.7)
stone	10 (6.7)	2 (1.3)	12 (8.1)
meat (fish?)	9 (6)	3 (2)	12 (8.1)
bone	8 (5.4)	5 (3.4)	13 (8.7)
shell	3 (2)	1 (0.7)	4 (2.7)
meat (fish?) & bone	7 (4.7)	0	7 (4.7)
hard	0	1 (0.7)	1 (0.7)
fresh hide	0	2 (1.3)	2 (1.3)
dry hide	2 (1.3)	2 (1.3)	4 (2.7)
ceramic	2 (1.3)	1 (0.7)	3 (2)
antler	0	2 (1.3)	2 (1.3)

Appendix S: Number of Used Edges or Surfaces by Motion by Chronological Period at San Pedro

The percentages in parentheses are computed for each period.

No provenience, surface, mixed deposits

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	2 (28.6)	0	2 (28.6)
chop/adze	2 (28.6)	0	2 (28.6)
dig/hoe	2 (28.6)	0	2 (28.6)
scrape	0	1 (14.3)	1 (14.3)

Late Classic

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	4 (14.3)	0	4 (14.3)
dig/hoe	3 (10.7)	0	3 (10.7)
chop/adze	2 (7.1)	0	2 (7.1)
scrape	2 (7.1)	0	2 (7.1)
scrape/plane	1 (3.6)	0	1 (3.6)
undetermined	4 (14.3)	0	4 (14.3)
cut/slice	5 (17.9)	1 (3.6)	6 (21.4)
notch	1 (3.6)	0	1 (3.6)
rub/strike	1 (3.6)	0	1 (3.6)
saw	1 (3.6)	0	1 (3.6)
transverse cut/slice	0	1 (3.6)	1 (3.6)
pierce	1 (3.6)	0	1 (3.6)
scale	0	1 (3.6)	1 (3.6)

Late/Terminal Classic

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	1 (8.3)	0	1 (8.3)
chop/adze	1 (8.3)	0	1 (8.3)
scrape	2 (16.7)	0	2 (16.7)
scrape/plane	1 (8.3)	0	1 (8.3)
undetermined	3 (25)	0	3 (25)
crush/pound	1 (8.3)	0	1 (8.3)
notch	1 (8.3)	0	1 (8.3)
incise	1 (8.3)	0	1 (8.3)
cut/slice	1 (8.3)	0	1 (8.3)

Late Classic and Late Postclassic

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
cut/slice	1 (100)	0	1 (100)

Middle Postclassic or earlier

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
scrape	1 (100)	0	1 (100)

Middle Postclassic

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
dig/hoe	2 (10)	0	2 (10)
chop/adze	3 (15)	0	3 (15)
scrape	3 (15)	0	3 (15)
undetermined	4 (20)	0	4 (20)
cut/slice	3 (15)	1 (5)	4 (20)
whittle	1 (5)	0	1 (5)
saw	1 (5)	0	1 (5)
transverse cut/slice	1 (5)	0	1 (5)
haft polish	1 (5)	0	1 (5)

Postclassic

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
chop/adze	1 (100)	0	1 (100)

Late Postclassic

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	3 (6.8)	0	3 (6.8)
dig/hoe	1 (2.3)	0	1 (2.3)
chop/adze	2 (4.5)	0	2 (4.5)
scrape	3 (6.8)	0	3 (6.8)
scrape/plane	1 (2.3)	0	1 (2.3)
undetermined	2 (4.5)	0	2 (4.5)
cut/slice	14 (31.8)	3 (6.8)	17 (38.6)
crush/pound	1 (2.3)	0	1 (2.3)
whittle	1 (2.3)	0	1 (2.3)
scrape/whittle	1 (2.3)	0	1 (2.3)
saw	7 (15.9)	0	7 (15.9)

drill/bore	1 (2.3)	0	1 (2.3)
cut/chop	1 (2.3)	0	1 (2.3)
pierce	1 (2.3)	0	1 (2.3)
scrape/shape	1 (2.3)	0	1 (2.3)
transverse cut/slice	1 (2.3)	0	1 (2.3)

Late Postclassic/Historic

Motion Type	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	5 (4.7)	0	5 (4.7)
dig/hoe	4 (3.7)	0	4 (3.7)
chop/adze	3 (2.8)	1 (0.9)	4 (4.7)
scrape	10 (9.3)	0	10 (9.3)
scrape/plane	2 (1.9)	0	2 (1.9)
undetermined	14 (13.1)	0	14 (13.1)
cut/slice	29 (27.1)	0	29 (27.1)
whittle	6 (5.6)	0	6 (5.6)
strike/rub	14 (13.1)	0	14 (13.1)
cut/scale	0	2 (1.9)	2 (1.9)
plane	1 (0.9)	0	1 (0.9)
scrape/whittle	2 (1.9)	0	2 (1.9)
saw	10 (9.3)	1 (0.9)	11 (10.3)
slice/strip	0	1 (0.9)	1 (0.9)
drill/bore	1 (0.9)	0	1 (0.9)
incise	1 (0.9)	0	1 (0.9)

Appendix T: Number and Percentage of Contact Material Types by Chronological Period at San Pedro

The percentages in parentheses are computed for each period.

No Provenience, Surface and Mixed Deposits

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	4 (50)	1 (12.5)	5 (62.5)
soil/sand	2 (25)	0	2 (25)
bone	0	1 (12.5)	1 (12.5)

Late Classic

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
stone	1 (3.4)	0	1 (3.4)
soft	1 (3.4)	2 (6.9)	3 (10.3)
wood	8 (27.6)	1 (3.4)	9 (31)
soil/sand	3 (10.3)	0	3 (10.3)
meat (fish?)	1 (3.4)	2 (6.9)	3 (10.3)
fresh hide	1 (3.4)	1 (3.4)	2 (6.9)
dry hide	2 (6.9)	0	2 (6.9)
undetermined	3 (10.3)	0	3 (10.3)
ceramic	1 (3.4)	0	1 (3.4)
fish scales	0	1 (3.4)	1 (3.4)
plant	0	1 (3.4)	1 (3.4)

Late/Terminal Classic

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	3 (23.1)	2 (15.3)	5 (38.5)
stone	1 (7.7)	1 (7.7)	2 (15.3)
ceramic	0	1 (7.7)	1 (7.7)
bone	0	1 (7.7)	1 (7.7)
soil/sand	1 (7.7)	0	1 (7.7)
undetermined	2 (15.3)	0	2 (15.3)
dry hide	1 (7.7)	0	1 (7.7)

Late Classic and Late Postclassic

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	0	1 (50)	1 (50)
bone	0	1 (50)	1 (50)

Postclassic

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	1 (50)	0	1 (50)
soil/sand	1 (50)	0	1 (50)

Middle Postclassic

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	7 (33.3)	0	7 (33.3)
soft	1 (4.8)	0	1 (4.8)
plant	2 (9.5)	1 (4.8)	3 (14.3)
meat (fish?)	2 (9.5)	1 (4.8)	3 (14.3)
soil/sand	2 (9.5)	0	2 (9.5)
hard	0	2 (9.5)	2 (9.5)
undetermined	1 (4.8)	0	1 (4.8)
shell	0	1 (4.8)	1 (4.8)
dry hide	0	1 (4.8)	1 (4.8)

Middle Postclassic or earlier

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	0	1 (50)	1 (50)
plant	0	1 (50)	1 (50)

Late Postclassic

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
undetermined	3 (5.3)	0	3 (5.3)
bone	4 (7)	3 (5.3)	7 (12.3)
wood	10 (17.5)	7 (12.3)	17 (29.8)
meat (fish?)	5 (8.8)	2 (3.5)	7 (12.3)
fresh hide	1 (1.8)	2 (3.5)	3 (5.3)
plant	3 (5.3)	4 (7)	7 (12.3)
meat (fish?) & bone	2 (3.5)	0	2 (3.5)
ceramic	1 (1.8)	0	1 (1.8)
soft	1 (1.8)	0	1 (1.8)
metal	1 (1.8)	0	1 (1.8)
shell	0	1 (1.8)	1 (1.8)
stone	2 (3.5)	0	2 (3.5)
soil/sand	1 (1.8)	0	1 (1.8)
dry hide	0	2 (3.5)	2 (3.5)
antler	0	2 (3.5)	2 (3.5)

Late Postclassic/Historic

Contact Material Type	Secure Identification (%)	Probable Identification (%)	Total (%)
hard	1 (0.9)	1 (0.9)	2 (1.8)
wood	33 (28.9)	2 (1.8)	35 (30.7)
stone	8 (7)	3 2.6)	11 (9.6)
plant	5 (4.4)	4 (35)	9 (7.9)
meat (fish?) & bone	7 (6.1)	0	7 (6.1)
bone	6 (5.3)	3 (2.6)	9 (7.9)
undetermined	9 (7.9)	0	9 (7.9)
soil/sand	6 (5.3)	0	6 (5.3)
metal	5 (4.4)	1 (0.9)	6 (5.3)
soft	0	4 (3.5)	4 (3.5)
meat (fish?)	6 (5.3)	2 (1.8)	8 (7)
shell	2 (1.8)	1 (0.9)	3 (2.6)
fresh hide	0	1 (0.9)	1 (0.9)
dry hide	2 (1.8)	0	2 (1.8)
ceramic	1 (0.9)	1 (0.9)	2 (1.8)

Appendix U: Lithic Tools with Microwear Traces from Marco Gonzalez

The presence of a lone question mark [?] in a motion or contact material category indicates that use-wear has been detected on the tool, but it is not identifiable beyond presence/absence. The presence of a question mark following a motion or contact material [i.e. scraping(?) or meat/fresh hide(?)] indicates that these are the most 'probable' identifications.

ID#	Tool type/ Raw material	Magnification	Motion	Contact material	Striations
5/13	406m/c	1. 200x 2. 200x	1. haft polish 2. cut/slice	1. wood 2. soft	1. n 2. n
18/1	408w/c	1. 200x 2. 200x	1. saw(?) 2. saw(?)	1. wood 2. wood	1. n 2. n
21/15	311d/c	1. 200x 2. 200x	1. saw 2. saw	1. stone 2. stone	1. y 2.y
26/3	302p/c	1. 200x 2. 200x	1. haft polish 2. chop/chisel(?)	1. wood 2. wood	1. y 2. y
26/5	406d/c	1. 200x 2. 200x	1. pierce 2. pierce	1. meat(fish?)? 2. meat(fish?)?	1. y 2. n
26/8	406d/c	1. 200x 2. 200x	1. pierce 2. haft polish	1. meat(fish?) & bone 2. wood	1. n 2. n
26/9	207d/c	200x	scrape	dry hide	y
26/11	203d/c	200x	drill/bore	wood	y
26/13	104/103p/c	200x	cut/slice	weak polish (plant?)	n
26/14	104/103w/c	1. 200x 2. 200x 3. 200x	1. scrape 2. whittle/plane 3. scrape	1. bone 2. bone (?) 3. faint (wood?)	1. n 2. n 3. n
26/17	501/102w/c	200x	cut/slice	soft	n
26/18	104/103w/c	200x	cut/slice	weak polish (meat/fish?)?	n
26/19	104/103p/c	200x	cut/slice	meat(fish?)	n
26/23	104/103w/c	200x	dig/hoe	soil/sand	y
26/26	501/103d/c	200x	cut/slice	wood (?)	y
26/27	104/103w/c	200x	cut/slice	meat(fish?) & bone(?)	y
26/28	104/103w/c	1. 200x 2. 200x 3. 200x	1. cut/slice 2. cut/slice 3. dig/hoe	1. plant (stems?) 2. plant (stems?) 3. soil/sand	1. n 2. y 3. y
26/31	501/102w/c	200x	cut/slice	weak polish (soft?)	n
26/33	104/103w/c	200x	dig/hoe	soil/sand	y
26/35	501/103w/c	200x	saw	shell	y
26/38	501/103w/c	1. 200x 2. 200x	1. dig/hoe 2. notch	1. soil/sand 2. ceramic (?)	1. y 2. y
26/40	104/103w/c	200x	saw	hard (bone?)	n
26/44	104/103p/c	200x	cut/slice	meat(fish?) & bone	y
26/45	501/102w/c	200x	scrape	wood	y
26/47	501/103w/c	200x	dig/hoe	soil/sand	y
26/49	501/102w/c	200x	cut/slice	wood	y

26/52	501/103w/c	200x	rub	stone	n
26/58	501/103d/c	200x	saw	plant (stems?)	y
26/61	501/102p/c	200x	?	weak polish (hard?)	y
26/67	501/103m/c	200x	saw	ceramic	y
26/68	301m/c	1. 200x 2. 200x	1. chop/adze 2. haft polish	1. wood 2. wood	1. y 2. n
26/70	503w/c	200x	cut/slice	plant	y (faint)
26/72	501/103d/c	200x	scrape	weak polish (wood?)	y
26/75	501/102w/c	200x	?	weak polish (soft?)	n
26/83	501/102m/c	200x	scrape/whittle	bone	y
26/87	104/103w/c	200x	chop/adze	wood	y
26/91	501/103w/c	200x	?	hard	n
26/96	104/103w/c	200x	saw	ceramic	y
74/1	301m/c	1. 200x 2. 200x	1. haft polish 2. haft polish	1. wood 2. wood(?)	1. n 2. y
74/5	501/103p/c	200x	notch	ceramic	y
74/9	501/102m/c	200x	notch	ceramic	y
74/16	501/103w/c	200x	cut/slice	weak polish (meat(fish?) & bone?)	y
74/20	501/102w/c	200x	cut/slice	wood/woody plant	n
74/21	501/102m/c	200x	rub	stone	y
74/22	501/102d/c	200x	? (parallel & diagonal)	wood (?)	y
74/23	501/102w/c	200x	cut/slice	wood & plant	y
75/4	501/103w/c	200x	scrape/rub	dry hide	y
76/1	309w/c	1. 200x 2. 200x	1. adze 2. haft polish	1. wood 2. wood	1. y 2. n
76/3	302w/c	200x	chop/adze	wood (?)	n
76/4	109/103w/c	1. 200x 2. 200x	1. chop/adze 2. saw/whittle	1. wood & soil/sand 2. wood	1. y 2. y
76/7	501/103p/c	200x	cut/slice	meat(fish?)/fresh hide	n
76/12	501/102w/c	200x	cut/slice	weak polish (soft?)	n
76/13	501/103p/c	200x	saw	wood	y
76/17	104/103m/c	200x	chop/adze	wood	y
76/19	501/102w/c	200x	cut/slice	plant fibre	y
76/25	501/103d/c	200x	?	weak polish (hard?)	n
76/28	501/103m/c	200x	?	meat(fish?) ?	n
76/34	501/103d/c	200x	cut/slice (?)	weak polish (hide?)	n
76/38	501/103p/c	200x	chop	wood	n
76/41	501/102w/c	200x	saw/shape	stone	y
76/43	104/103w/c	200x	whittle/scrape	hard (wood?)	y
76/44	501/103d/c	200x	saw/shape	stone	y
76/45	501/103w/c	200x	cut/slice	meat(fish?) & bone	y (faint)
76/46	501/102w/c	200x	saw	bone	n

77/2	501/103w/c	200x	cut/slice	meat(fish?)	n
77/4	301d/c	200x	dig/hoe	soil/sand	y
77/5	501/103m/c	200x	dig/hoe	soil/sand	y
77/12	501/103d/c	200x	?	wood(?)	n
77/13	501/103d/c	200x	saw	ceramic	y
77/16	501/103w/o	200x	cut/slice	wood	y
77/18	203m/c	200x	scrape	wood	n
77/25	107/103d/c	200x	scrape	hard (faint)	n
77/31	501/103w/c	200x	cut/slice	wood (?)	y
77/32	104/103p/c	1. 200x 2. 200x	1. cut/slice 2. chop/adze	1. soft(?) 2. wood	1. y 2. n
77/33	501/103d/o	200x	cut/slice	soft (meat/fish?)?	n
77/37	104/103p/c	100x & 200x	cut/slice	dry hide	y (faint)
77/38	501/103w/c	200x	cut/slice	wood	y
77/40	104/103w/c	200x	cut/slice	weak polish (plant?)	n
77/41	503w/c	200x	scrape(?)	dry hide (?)	n
77/44	501/103w/c	200x	saw	wood	n
77/46	501/102w/o	200x	?	weak polish (hard?)	n
77/52	501/103w/c	200x	chop/adze	wood	y
77/53	311m/c	200x	haft polish	wood	y
77/61	501/102w/c	200x	cut/slice	plant fibre	y
77/62	104/103w/c	200x	chop/adze	wood	y
77/63	104/103w/c	200x	cut/slice	plant (stems?)	y
77/71	501/103p/c	200x	whittle	wood	n
77/73	501/103w/c	1. 200x 2. 200x	1. whittle 2. cut/slice	1. wood 2. meat(fish?) & bone	1. y 2. y
80/2	501/103p/c	200x	cut/slice(?)	soft(?)	n
80/8	501/103m/c	200x	scrape	wood	y
80/11	501/102w/c	200x	scrape/plane	bevel (wood/bone?)	y
80/13	104/103w/c	100x	drill/bore	bone (& meat/fish?)?	y
80/14	501/103m/c	200x	cut/slice	meat(fish?) & bone	n
80/16	104/102w/c	200x	scrape/whittle	wood	n
80/19	501/102p/c	200x	scrape(?)	plant (stems?)	y
80/20	501/103d/c	200x	cut/slice	meat(fish?) & bone	n
80/22	104/103w/c	200x	?	weak polish (soft?)	n
80/23	109/103w/c	1. 200x 2. 200x	1. haft polish 2. chop	1. wood 2. bone	1. y 2. n
80/24	406m/c	200x	plane/whittle	wood(?)	y
81/4	501/103w/c	200x	whittle/scrape(?)	wood(?)	y
82/5	501/103w/c	200x	chop/adze	weak polish (wood?)	n
82/8	109/103w/c	200x	chop(?) & dig (?)	wood(?) & soil(?)	y
82/11	501/102w/o	200x	scrape	meat(fish?) & bone	y
82/20	414d/c	200x	scrape	fresh hide	n

82/22	501/103p/c	200x	whittle/plane(?)	bone	n
84/2	104/103w/c	1. 200x 2. 200x	1. ? 2.scrape/ plane(?)	1. weak polish (hard?) 2. bevel (wood?)	1. n 2. n
94/2	501/103w/c	200x	cut/slice	soft (plant?)	n
94/5	501/402d/c	200x	perforate/bore	bone	y
94/6	008w/c	200x	perforate(?)	hard (wood/bone?)	y
95/3	202m/c	1. 200x 2. 200x	1. haft polish 2. scrape	1. wood 2. wood	1. y 2. y
95/14	104/102w/c	200x	cut/slice(?)	wood(?)	n
95/15	501/103p/c	200x	whittle/plane	wood	y
95/18	501/103w/c	1. 200x 2. 200x	1. cut/slice 2. cut/slice	1. weak polish (hard?) 2. hard (wood?)	1. n 2. n
95/20	501/102d/c	200x	cut/slice	meat (fish?) & bone	y
95/21	107/103m/c	200x	transverse	meat(fish?)?	y (faint)
95/26	104/103w/c	1. 200x 2. 200x	1. chop/adze 2. cut/slice	1. wood 2. hard (wood?)	1. y 2. n
95/29	501/103w/c	200x	cut/slice(?)	hard(?)	n
95/30	311m/c	200x	saw(?)	bone	y
95/34	104/103w/c	200x	dig/hoe	soil/sand	y
95/35	501/103w/c	1. 200x 2. 200x	1. saw 2. saw(?)	1. wood 2. weak polish (wood?)	1. n 2. y
95/36	104/103w/o	200x	cut/slice	soft	n
95/44	501/103d/c	200x	scrape/whittle	bone (& meat/fish?/fresh hide?)	n
95/46	501/103p/c	200x	cut/slice(?)	hard	n
95/47	501/103d/c	200x	whittle/plane	antler	n
95/48	501/102w/c	200x	saw	bone	n
95/52	501/103p/c	200x	cut/slice	bone	y
95/56	109/103w/c	200x	chop/adze	wood	n
95/57	501/102w/c	200x	cut/slice	weak polish (plant?)	n
95/62	501/102w/c	200x	cut/slice	meat(fish?)	n
95/65	104/103w/c	1. 200x 2. 200x	1. saw 2. dig/hoe	1. wood 2. soil/sand	1. y 2. y
95/68	501/102w/o	200x	scrape	bone	y
98/1	501/103w/c	200x	cut/slice	wood	y
98/5	104/103w/c	200x	whittle	wood	y
98/7	501/103w/c	200x	dig/hoe	soil/sand	y
98/8	104/103w/c	1. 200x 2. 200x	1. dig/hoe 2. cut/slice	1. soil/sand 2. soft (meat/fish?)?	1. y 2. n
98/11	501/103m/c	200x	dig/hoe	soil/sand	y
98/12	501/102p/c	200x	rub/shape	stone	y
98/14	109/103w/c	200x	chop/adze	wood	n
104/2	501/102m/c	200x	saw	ceramic	y
104/8	501/102w/c	200x	scrape	wood	y
104/12	501/103p/c	200x	rub (?)	fresh hide	n
104/16	501/103w/c	200x	cut/slice	plant	n
104/17	104/102w/c	1. 200x	1. cut/slice	1. weak polish	1. n

		2. 200x	2. cut/slice	(soft) 2. weak polish (soft)	2. n
104/20	501/103m/c	200x	saw	wood	y
104/21	501/103m/c	200x	cut/slice	weak polish (hard?)	n
104/22	302m/c	200x	haft polish	wood	y
105/1	302m/c	200x	dig/hoe	soil/sand	y
105/2	406p/o	200x	haft polish (?)	wood (?)	n
105/5	501/103p/c	200x	gouge/incise	soft wood/plant	y
105/9	104/103w/c	1. 200x 2. 200x	1. cut/slice 2. scrape	1. meat(fish?) 2. bevel (bone?)	1. n 2. y
105/10	104/103p/c	200x	cut/slice	plant fibre	y
105/11	104/103w/c	200x	dig/hoe	soil/sand	y
105/14	104/103w/c	200x	chop/adze	wood	n
105/15	501/103d/c	200x	scrape	fresh hide	n
105/16	104/103w/c	200x	cut/slice	wood/dry hide (?)	n
105/17	501/103d/c	200x	saw	bone	n
107/1	406d/o	1. 200x 2. 200x	1. ? 2. scrape	1. soil/sand 2. wood	1. y 2. y
107/2	411w/c	1. 100x 2. 200x	1. haft* 2. ?	1. residue 2. meat(fish?)	1. n/a 2. n
107/3	104/103p/c	1. 200x 2. 200x	1. whittle 2. chop/adze	1. wood 2. wood	1. n 2. n
107/4	104/103p/c	200x	?	meat(fish?)	n
107/5	501/103w/c	200x	cut/slice	weak polish (hard)	n
107/13	501/103p/c	200x	whittle	wood	y
107/16	501/102m/c	200x	scrape	wood	y
107/21	104/102w/c	200x	scrape	bevel (bone/antler?)	y
110/2	501/103p/c	200x	scrape	bevel (hard/wood?)	n
113/8	205p/c	200x	haft polish(?)	wood(?)	n
113/10	107/103w/c	1. 200x 2. 200x	1. ? 2. ?	1. wood/dry hide (?) 2. wood/dry hide (?)	1. y 2. y
114/5	501/103w/c	200x	rub	stone	y
114/6	301m/c	200x	haft polish (?)	wood (?)	n
114/11	501/103w/c	200x	hammerstone	stone	y
114/12	501/103w/c	200x	hammerstone	stone	y
114/14	109/102w/c	200x	slice	meat(fish?)	n
114/15	501/103w/c	200x	cut/slice	plant stems	y
114/17	008w/c	200x	chop	weak polish (soft?)	n
114/19	501/103d/c	1. 200x 2. 200x	1. chop/adze 2. cut/slice	1. wood 2. wood	1. y 2. n
114/21	104/103p/c	200x	cut/slice	wood	y
114/31	501/102w/c	200x	cut/slice	weak polish (meat/fish?)?	n
114/36	501/102d/c	200x	cut/slice	wood	y
114/37	104/103w/c	200x	cut/slice	meat(fish?)	n
118/1	501/103m/c	200x	cut/slice	plant	n

120/1	501/102w/c	200x	scrape	bone	y
122/1	501/103d/c	200x	saw	stone	y
122/3	501/103p/c	200x	scraping (?)	weak polish (wood?)	n
124/3	104/102w/c	1. 200x 2. 200x	1. cut/slice 2. cut/slice	1. meat(fish?)/ fresh hide 2. meat(fish?)/ fresh hide	1. n 2. n
124/5	501/102d/c	200x	cut/slice	weak polish (wood/ woody plant?)	n
128/1	201m/c	200x	scrape/ shape	stone	y
129/1	408p/c	200x	haft polish	wood	y
129/3	304/602w/c	1. 200x 2. 200x	1. haft polish 2. dig/hoe	1. wood 2. soil/sand	1. y 2. y
129/4	202p/c	200x	haft polish (?)	wood (?)	n
129/5	107/103w/c	200x	scrape	dry hide (?)	y
129/6	302m/c	1. 200x 2. 200x 3. 200x 4. 200x	1. haft polish 2. haft polish 3. haft polish 4. haft polish	1. dry hide 2. dry hide 3. wood 4. wood	1. n 2. n 3. n 4. n
129/9	205w/c	1. 200x 2. 200x	1. cut/slice 2. haft polish	1. soft (meat/fish?)? 2. wood	1. n 2. n
129/10	104/103w/c	1. 200x 2. 200x	1. saw 2. scrape/whittle	1. wood 2. wood	1. y 2. n
129/11	501/102d/c	200x	whittle	wood	n
129/12	501/103p/c	200x	cut/slice	plant fibre (?)	y
129/15	501/102d/c	200x	?	weak polish (wood?)	n
129/18	104/103w/c	1. 200x 2. 200x	1. chop & dig/hoe 2. scrape/scale (?)	1. wood & soil/sand 2. fish (?)	1. y 2. y
129/23	501/103w/c	200x	cut/slice	weak polish (hard)	n
129/25	503w/c	200x	hammerstone	stone	y
129/34	501/103d/c	200x	scrape	meat(fish?) (& bone ?)	n
129/37	501/103m/c	200x	cut/slice	wood	n
129/39	501/103m/c	1. 200x 2. 200x	1. cut/slice 2. saw	1. meat(fish?) 2. hard (shell?)	1. n 2. y
129/40	104/103p/c	1. 200x 2. 200x	1. cut/slice 2. rub/ haft polish (?)	1. wood/ woody plant 2. fresh hide (?)	1. n 2. n
129/48	501/103d/c	200x	whittle	woody plant	y
129/51	107/103m/o	200x	saw	hard (shell?)	y
129/52	501/102m/c	200x	?	weak polish (?)	n
129/53	501/102w/c	1. 200x 2. 200x 3. 200x 4. 200x	1. cut/slice (?) 2. scrape 3. scrape 4. haft polish	1. atypical bone 2. meat(fish?) & bone (& fresh hide?) 3. bone 4. wood	1. y 2. n 3. y 4. n
129/57	501/103m/c	200x	cut/slice (?)	weak polish (?)	n

129/59	501/102w/c	200x	scrape/whittle	wood	y
129/61	501/103d/c	200x	cut/slice	plant	n
129/64	501/102p/c	200x	dig/hoe	soil/sand	y
129/65	203m/c	200x	scrape/plane	wood	y
129/68	501/103d/c	200x	saw & plane	wood	y
129/72	109/103w/c	1. 200x 2. 200x	1. saw 2. dig/hoe	1. shell 2. soil/sand	1. y 2. y
129/77	501/103w/c	200x	saw	bone	y
129/79	501/103w/c	200x	chop/adze	wood	n
129/80	107/103p/c	200x	cut/slice	meat(fish?)	n
129/85	104/103p/c	200x	scrape/notch	hard (ceramic/ shell?)	y
129/86	104/103w/c	100x	cut/slice	wood	n
129/87	104/103w/c	200x	rub	stone	n
129/88	501/103w/c	200x	cut/slice	bone	n
129/92	406m/o	200x	cut/slice	dry hide (?)	n
129/94	104/103w/c	1. 200x 2. 200x	1. cut/slice 2. chop/adze	1. plant fibre 2. wood	1. n 2. n
129/95	501/102p/c	200x	cut/slice	meat(fish?) & bone	y
129/96	501/103p/c	200x	cut/slice	fresh hide	n
129/97	104/103p/c	1. 200x 2. 200x	1. notch 2. cut/slice	1. ceramic 2. meat(fish?)	1. y 2. n
129/98	501/103m/c	200x	notch	stone	y
129/101	104/103m/c	200x	cut/slice	bone	n
129/103	501/103w/o	200x	saw (?)	shell (?)	y
130/5	503m/c	200x	rub	stone	n
130/7	104/103w/c	200x	?	weak polish (meat/fish?)?	n
130/8	107/103m/c	200x	scrape	fresh hide	y
130/10	501/102p/c	200x	chop	wood	y
130/12	501/103m/c	200x	notch	ceramic	y
130/13	501/102m/c	200x	scrape/cut	dry hide	n
131/1	204m/c	200x	saw (?)	weak polish (hard?)	y
131/2	501/103w/c	1. 200x 2. 200x	1. dig/hoe (?) 2. haft polish	1. sand/soil 2. wood	1. y 2. n
131/3	302w/c	1. 200x 2. 200x	1. haft polish 2. ?	1. wood 2. stone	1. y 2. y
131/7	501/103w/c	200x	scrape/whittle	woody plant (reed?)	y
131/11	104/103w/c	1. 200x 2. 200x	1. saw/ shape 2. cut/slice	1. stone 2. weak polish	1. y 2. y
131/13	501/103m/c	100x	cut/slice	meat (fish) (?)	n
135/1	413p/c	1. 200x 2. 200x	1. haft polish 2. cut/slice	1. wood 2. bone	1. y 2. n
135/4	104/103w/o	200x	cut/slice	wood	n
135/5	408p/c	200x	cut/slice	soft (meat/fish?)?	n
135/6	501/102w/c	200x	saw/shape	stone/ ceramic (?)	y
135/8	501/103d/c	200x	scrape/cut	meat(fish?) & bone	y
135/11	501/103p/c	200x	chop (?)	wood	n
135/12	104/103w/c	1. 200x	1. chop/adze	1. wood	1. n

		2. 200x	2. dig/hoe	2. soil/sand	2. n
135/13	501/102m/c	200x	drill	hard (shell?)	y
135/14	501/102p/c	200x	saw	hard (ceramic?)	y
135/17	501/102w/c	200x	cut/slice	plant	n
135/20	501/103d/c	200x	cut/slice	dry hide	n
135/25	104/103p/c	200x	saw	ceramic	y
135/32	104/103w/c	1. 200x 2. 200x	1. chop/adze 2. cut/slice	1. wood 2. weak polish (wood?)	1. n 2. n
135/36	501/103w/c	200x	scrape	wood (?)	y
135/37	104/102w/ch	200x	saw	bone	n
135/39	501/102p/c	200x	saw	wood	y
137/5	501/103d/c	200x	scrape	bevel (bone or wood?)	y
137/7	104/103w/c	100x	chop/adze	wood	n
137/8	501/103d/c	200x	cut/slice	weak polish (meat/ fish?)?	n
137/16	501/103w/c	200x	cut/slice	plant	y
137/21	501/103w/o	200x	cut/slice	wood	n
137/26	501/103w/c	200x	cut/slice	dry hide (?)	n
137/27	104/103w/c	1. 200x 2. 200x	1. cut/slice 2. cut/slice	1. plant 2. plant	1. y 2.n
147/2	501/103m/c	200x	saw	hard (ceramic?)	y
147/3	501/103d/c	200x	cut/slice	hard	n
147/6	501/103w/o	200x	dig/hoe	soil/sand/stone	y
147/7	501/103d/c	200x	scrape	soft	n
150/1	205w/c	200x	?	weak polish (soft?)	n
151/1	304/602w/c	200x	pound/crush	stone	y
157/2	202p/c	200x	haft polish	weak polish (wood)	n
157/3	104/102w/c	200x	cut/slice	dry hide	y
157/7	501/103d/c	200x	cut/slice	plant	y
157/8	104/103w/c	200x	cut/slice	meat(fish?) [& bone?]	n
157/9	104/102w/ch	500x	saw	wood	y
157/10	503w/c	200x	saw/shape	stone	y
157/11	501/103w/o	200x	saw/notch(?)	ceramic	y
157/12	501/103/c	200x	accidental rubbing	stone	n
157/14	501/103p/c	200x	cut/slice	wood/ woody plant(?)	n
157/19	104/103w/c	200x	cut/slice	weak polish (wood?)	n
157/20	501/103p/c	200x	cut/saw	weak polish (hard?)	y
157/21	501/102w/c	200x	cut/slice	dry hide	y
157/27	501/102w/o	200x	?	weak polish	n
157/29	104/103w/c	200x	haft polish	wood	n
157/32	501/103p/c	200x	cut/slice	fresh hide (meat/fish?)?	n
157/33	501/103m/o	200x	saw	hard (shell?)	y
157/34	109/103w/c	200x	scrape	hard (wood?)	n
158/1	501/103w/c	200x	dig/hoe	soil/sand	y
158/5	501/103p/c	200x	whittle/notch	hard (ceramic?)	y (faint)

158/7	501/103w/c	200x	cut/slice	weak polish (hard)	n
161/7	501/103w/c	200x	cut/slice	hard (wood?)	n
161/9	501/103w/c	200x	scrape	wood	y
161/13	107/103m/c	200x	whittle/scrape	weak polish (wood)	n
161/15	501/103d/c	200x	?	weak polish	n
161/16	414d/c	200x	scrape	fresh hide or meat(fish?)?	n
161/18	501/103p/c	200x	cut/slice	plant	y (faint)
161/19	501/103w/o	200x	cut/slice	weak polish	n
161/22	104/103w/c	200x	whittle	wood	n
161/29	104/103d/o	1. 200x 2. 200x	1. scrape 2. chop/adze	1. wood 2. wood	1. y 2. y
161/31	104/102w/c	200x	cut/slice(?)	meat(fish)?	n
161/35	104/103w/c	200x	dig/hoe	soil/sand	y
161/39	501/103w/c	200x	scrape	wood	y
161/44	107/103w/c	200x	whittle	bone	y
161/49	501/103m/c	200x	saw	wood	y
164/1	501/103w/c	200x	cut/slice	plant fibre(?)	n
164/2	501/103p/c	200x	cut/slice	plant	n
165/1	107/102d/c	200x	scrape/plane	weak polish (wood?)	n
166/1	501/103w/c	200x	scrape & saw	stone	y
166/2	301p/c	200x	haft polish	wood	y
166/3	501/102w/c	200x	cut/slice	meat(fish?) & bone	n
166/4	501/102m/c	200x	cut/slice	meat(fish)?	n
166/6	109/103w/c	200x	chop/adze	sand/soil/wood	y
166/8	104/102w/o	200x	cut/slice(?)	weak polish (soft)	n
167/1	201m/c	200x	saw	bone	n
167/3	501/103m/c	200x	?	stone	y
167/5	501/103d/c	200x	rub/shape	stone	y
167/7	501/103m/c	200x	rub(?)	fresh hide	n
167/9	501/103d/c	200x	cut/slice	plant(?)	y
167/10	503w/c	200x	scrape/plane	wood(?) or dry hide(?)	n
167/12	501/102w/c	200x	?	weak polish	n
167/13	104/103w/c	200x	cut/slice	plant(?)	y
167/15	501/103w/c	200x	dig/hoe	soil/sand	y
167/19	501/103w/bl	1. 200x 2. 200x	1. saw 2. rub	1. wood 2. stone	1. y 2. n
167/22	501/103m/c	1. 200x 2. 200x	1. cut/slice 2. cut/slice	1. meat(fish?) 2. meat(fish?) [and bone?]	1. n 2. n
167/28	501/103w/c	200x	rub/scrape	fresh hide	y (few)
167/30	104/103p/c	200x	cut/slice	bone	n
167/35	501/103w/c	200x	dig/hoe	soil/sand	y
167/38	501/103w/c	200x	?	weak polish (hard?)	n
167/42	104/103d/c	200x	saw	shell	y
167/43	503w/c	100x & 200x	transverse (slice)	fish scales (?)	n?
167/44	501/102d/bl	200x	cut/slice	meat(fish?) & bone	n

167/47	501/103m/c	200x	cut/slice	weak polish (dry hide?)	y (faint)
167/49	501/102d/c	200x	cut/slice	meat(fish?)	n
167/57	104/103w/c	200x	chop/adze [& dig/hoe?]	wood & soil/sand	y
167/58	501/102w/c	200x	perforate/bore	dry hide(?)	n
167/59	104/103w/c	1. 200x 2. 200x	1. chop/adze 2. whittle	1. wood 2. wood	1. y 2. y
167/64	501/102w/c	200x	whittle/plane	wood(?)	y
167/67	503w/c	200x	cut/slice	soft wood or plant stems	n
167/72	104/103w/c	200x	dig/hoe	soil/sand	y
167/73	107/102d/c	1. 200x 2. 200x	1. scrape/whittle 2. scrape/whittle	1. wood 2. wood	1. n 2. n
167/77	104/103w/c	1. 200x 2. 200x	1. dig/hoe 2. chop/adze	1. sand/soil 2. wood	1. y 2. y
168/1	311p/c	1. 200x 2. 200x	1. cut/slice 2. cut/slice(?)	1. meat(fish?) & bone(?) 2. meat(fish?) & bone(?)	1. n 2. n
168/15	203m/c	200x	?	dry hide(?)	n
168/16	109/103w/c	200x	chop/adze	wood	n
168/28	501/103d/c	200x	cut/slice	weak polish (hard?)	n
168/32	501/103d/c	200x	cut/slice	plant	n
168/33	501/102w/c	200x	whittle	wood	y
168/36	104/103d/c	200x	saw	wood	y
168/41	109/103w/c	1. 200x 2. 200x	1. ? 2. saw	1. wood(?) 2. bone	1. n 2. n
169/1	107/103d/c	200x	cut/slice	fresh hide(?)	y
169/2	406d/c	1. 200x 2. 200x	1. ? 2. scrape/ whittle(?)	1. soft 2. hard	1. n 2. y
171/8	501/102w/c	200x	scrape	soft(?)	n
171/10	501/103d/c	200x	dig/hoe	soil/sand	y
171/11	503w/c	200x	chop/adze	wood	y
171/14	501/102d/c	200x	?	weak polish (?)	n
171/15	501/103m/c	200x	scrape/plane	hard (wood/bone?)	n
171/16	501/103m/c	200x	whittle/slice	wood (?)	y
171/22	501/103m/c	200x	rub/shape	stone	y
171/23	501/103p/c	200x	cut(?)	soft (hide?)	n
171/25	501/103p/c	1. 200x 2. 200x 3. 200x	1. chop/adze 2. dig/hoe 3. chop/adze	1. wood 2. soil & stone 3. wood	1. y 2. y 3. y
171/26	501/103w/c	200x	cut/saw	shell	y
171/33	501/102w/c	200x	scrape/whittle	wood(?)	n
173/1	107/103w/c	200x	scrape	hard (bone?)	y
173/2	501/103d/c	200x	?	soft (meat/fish?)?	n
173/3	501/103w/c	200x	chop/adze	wood	y
173/4	501/103d/ch	200x	surface damage	sand	y
173/5	501/103d/c	1. 200x 2. 200x	1. rub 2. cut/slice	1. stone 2. wood	1. n 2. y
173/7	501/102w/c	200x	cut/slice	soft	n

173/9	501/102m/c	200x	incise	wood	y
173/10	503w/c	200x	dig/hoe	soil/sand	y
173/11	008/601w/c	200x	scrape	wood	y
174/3	501/102w/c	200x	scrape/plane	hard(?)	y
174/6	203m/c	200x	cut/slice	soft (meat/fish?)?/ fresh hide(?)	n
174/12	501/103m/c	200x	?	stone	n
174/17	501/103w/bl	200x	whittle/plane	bone	n
174/22	104/103w/c	1. 200x 2. 200x	1. dig/hoe 2. whittle	1. soil/sand 2. wood(?)	1. y 2. y
174/27	501/103p/c	200x	scrape/shape	stone	y
174/32	109/103w/c	1. 200x 2. 200x 3. 200x	1. chop/adze & dig/hoe 2. chop/adze 3. ?	1. wood & soil/sand 2. wood 3. hard	1. y 2. y 3. n
174/33	503w/c	200x	chop/adze	wood	y
175/1	008w/c	200x	scrape(?)	hard	n
175/2	302d/c	1. 200x 2. 200x	1. chop/adze 2. dig/hoe	1. wood 2. soil/sand	1. s 2. s
175/3	501/102p/c	200x	cut/slice	plant	n
175/5	501/102m/c	1. 200x 2. 200x	1. cut/slice 2. cut/saw	1. dry hide 2. stone	1. n 2. y
175/7	302m/c	200x	chop/adze(?)	wood(?)	n
189/1	415w/c	200x	pierce(?)	bone	n
189/2	104/102w/c	200x	cut/slice	weak polish (wood?)	n
194/2	205m/c	200x	cut/slice	soft	n
194/4	104/103w/c	200x	dig/hoe	soil/sand	y
194/6	104/103w/c	200x	cut/slice	meat(fish?)	n
194/7	501/103d/c	200x	saw	shell	y
194/8	501/103m/c	200x	whittle	wood(?)	y
194/9	501/102d/c	200x	plane	wood	y
194/11	501/103m/c	200x	saw	weak polish (hard?)	n
195/1	406m/c	200x	haft polish	wood (& dry hide?)	y (faint)
195/2	104/103p/c	200x	dig/hoe	soil/sand	y
195/3	203m/c	200x	cut/slice	soft (plant?)	y
195/7	501/103p/c	200x	saw	shell	y
195/13	104/103w/c	200x	dig/hoe	soil/sand	y
195/14	501/103m/c	200x	cut/slice	soft (fresh hide?)	n
195/15	104/103w/c	200x	cut/slice	plant	n
196/1	501/103p/c	200x	cut/slice	wood	y
196/2	301w/c	1. 200x 2. 200x	1. haft polish 2. chop(?)	1. wood 2. wood	1. y 2. n
196/3	407p/c	200x	haft polish	wood	y
196/4	302w/c	200x	chop	wood & soil/sand	y
196/5	503w/c	200x	cut/slice	plant	y
196/7	501/102w/o	200x	?	weak polish (hard?)	n
196/10	104/102d/c	200x	cut/slice	meat(fish?)	n
196/13	501/103d/o	200x	saw	wood	y
196/14	104/102p/o	200x	saw	ceramic	y

196/16	104/103w/c	200x	saw/whittle	woody plant	y
196/17	501/103d/c	200x	scrape	wood(?)	n
196/19	503w/c	200x	notch	shell	y
202/1	407p/c	200x	haft polish	wood	n
202/3	501/102d/c	200x	saw	shell	y
202/7	501/103w/c	200x	cut/slice	weak polish (plant?)	n
202/12	501/103m/c	200x	saw	ceramic	y
202/14	501/103w/c	200x	cut/slice	wood(?)	n
202/16	501/103d/c	200x	scrape/plane(?)	weak polish (soft & hard)	y
202/18	501/103p/c	200x	?	hard	n
202/20	501/103m/c	200x	saw	wood	y
202/22	109/103w/c	200x	chop/adze	wood	y
202/27	501/103d/c	200x	cut/slice	fresh hide/meat(fish?)(?)	n
202/29	501/102p/c	200x	cut/slice	wood(?)	n
202/32	109/103w/c	200x	dig/hoe	soil/sand	y
202/35	104/103w/c	1. 200x 2. 200x	1. cut/slice 2. dig/hoe	1. wood 2. soil/sand	1. n 2. y
202/46	501/103d/c	200x	scrape	hard (bone?)	y
202/49	501/102d/c	200x	?	weak polish (soft?)	n
202/60	501/103p/c	200x	scrape	weak polish (plant?)	y
202/63	109/103w/o	200x	chop/adze	wood	y
204/1	107/103w/c	200x	perforate/bore	hard (bone/wood?)	y
204/7	104/102w/o	200x	cut/saw(?)	weak polish (wood/dry hide?)	y
205/5	501/102p/c	200x	cut/slice	weak polish (soft?)	n
205/7	501/103w/c	200x	scrape/whittle	bone	n
205/8	407m/c	200x	scrape	bone	y
205/9	501/102w/c	200x	cut/slice	wood	n
206/1	501/102w/c	200x	cut/slice	plant	n
206/3	203w/c	200x	cut/slice	weak polish	n
206/5	109/102w/c	200x	cut/slice	bone	y
206/7	008w/c	200x	cut/slice	plant (stems?)	n
206/8	201d/c	1. 200x 2. 200x	1. cut/slice 2. cut/slice	1. meat(fish?) & bone 2. meat(fish?) & bone	1. n 2. n
211/1	501/103w/c	200x	transverse (scrape?)	soft (plant?)	n
211/2	107/103m/c	200x	saw	wood	y
212/1	501/103d/c	200x	cut/slice(?)	hard	n
214/1	501/103p/c	200x	?	weak polish	n
215/1	501/103m/c	200x	cut/slice	weak polish (dry hide?)	y
216/2	301d/c	200x	adze	wood	y
216/4	501/103p/c	200x	transverse slice	meat(fish?) & bone(?)	y
216/5	501/102w/c	200x	cut/slice	bone(?)	n

216/6	107/102w/c	200x	scrape/plane(?)	wood(?)	y
216/7	104/103w/c	200x	saw	bone(?)	y
216/9	501/103d/c	200x	scrape	dry hide(?)	n
216/12	501/103p/c	200x	cut/slice(?)	weak polish	n
216/13	501/103w/c	200x	cut/slice	soft (plant?)	n
217/1	201w/c	200x	scrape	fresh hide	n
221/1	302d/c	200x	?	hard	n
221/8	501/103m/c	200x	cut/slice	plant stems (reed?)	y
221/9	501/103w/c	200x	dig/hoe	soil/sand	n
221/12	501/103p/c	200x	dig/hoe	soil/sand	y
221/14	107/103m/c	200x	cut/slice	meat(fish?) & bone	y
221/20	501/103w/c	200x	scrape	bevel (bone/wood?)	n
221/23	203m/o	200x	transverse cut(?)	soft(?)	n
222/2	503w/c	200x	cut/slice	dry hide/woody plant(?)	n
226/2	406m/c	200x	cut/slice	weak polish (soft)	n
226/4	205w/c	200x	cut/slice(?)	weak polish (soft)	n
229/1	501/103w/c	200x	cut/slice	hard (bone?)	n
230/2	104/103w/c	200x	cut/slice	meat(fish?)	n
230/3	501/103m/c	200x	cut/slice	weak polish (hard)	y
230/4	104/103p/c	200x	saw	shell	y
231/2	414m/c	200x	scrape	weak polish (hard)	n
231/3	107/103m/c	200x	incise(?)	wood(?)	y
234/3	407p/c	200x	haft polish	wood (& dry hide?)	n
234/7	501/103w/c	200x	dig/hoe	soil/sand	y
234/9	501/103d/c	200x	?	soil/sand	n
234/10	501/103m/c	1. 200x 2. 200x	1. cut/slice 2. cut/slice	1. wood 2. hard (wood?)	1. y 2. n
234/17	501/103d/c	200x	whittle/plane(?)	weak polish	n
234/19	501/102w/c	200x	cut/slice	hard (bone?)	n
234/20	501/103d/c	200x	cut/slice	weak polish (hard)	n
234/25	104/102w/c	200x	scrape/transverse slice (?)	fresh hide/meat(fish?) (?)	n
234/26	104/103w/c	200x	cut/slice	wood (?)	y
234/28	104/103w/c	200x	saw	meat(fish?) & bone	n
234/30	104/103w/bl	200x	chop/adze	wood	n
234/31	501/103m/c	200x	cut/slice	weak polish	n
234/32	104/103w/c	200x	chop/adze	wood	y
234/33	501/103m/c	200x	cut/slice	soft (meat/fish?)?	n
234/36	104/102w/c	200x	whittle	wood	y
234/41	501/103w/c	200x	cut/slice	wood	y
234/45	107/103d/c	1. 200x 2. 200x	1. plane 2. cut/slice(?)	1. wood 2. weak polish	1. y 2. n

				(dry hide?)	
234/46	501/103w/o	200x	scrape	bone(?)	y
234/53	501/103p/o	200x	saw	ceramic	y
234/54	104/103w/c	200x	dig/hoe	soil/sand	y
234/63	501/102w/c	200x	cut/slice	soft	n
234/64	501/102m/c	200x	cut/slice & scrape	meat(fish?) & bone	y
235/1	501/102p/c	200x	saw	hard (bone/wood?)	y
235/2	501/103p/c	200x	cut/slice	weak polish (meat/fish(?)/fres h hide)?	n
236/4	109/103w/c	200x	chop/adze(?)	wood(?)	y
236/17	201w/c	1. 200x 2. 200x	1. saw 2. saw	1. wood 2. wood	1. y 2. y
236/20	406m/c	200x	?	hard (wood?)	n
236/23	302m/c	200x	chop/adze	wood	n
237/1	501/102w/c	1. 200x 2. 200x 3. 100x	1. scrape 2. cut/slice 3. scrape	1. wood 2. meat(fish?) & bone 3. wood(?)	1. y 2. n 3. y
240/1	408w/c	200x	?	wood(?)	n
240/2	501/103p/c	200x	scrape/shape	stone	y
240/6	501/103w/c	200x	saw(?)	weak polish (hard?)	y
241/2	501/103w/c	200x	whittle(?)	wood	n
250/3	501/103w/c	200x	cut/slice	weak polish (wood?)	n
250/6	501/102w/c	200x	cut/slice	hard	n
250/8	407m/c	200x	chop	wood	y
250/13	501/103m/c	200x	saw	ceramic	y
251/1	104/103w/c	1. 200x 2. 200x 3. 200x	1. dig/hoe 2. cut/slice 3. cut/slice	1. soil/sand 2. soft (plant?) 3. soft (plant?)	1. y 2. n 3. n
255/3	107/103m/c	200x	scrape(?)	wood(?)	n
255/4	107/103m/c	200x	saw	wood	y
255/12	501/103d/c	200x	scrape	weak polish (hard?)	n
255/13	501/103d/c	200x	saw	wood	n
255/17	414m/c	200x	scrape	hard	n
258/1	301p/c	200x	haft polish	wood	n
258/2	501/103w/c	200x	cut/slice	soft	n
262/3	104/103w/c	200x	chop/adze	wood	y
264/6	503w/c	200x	cut/slice	bone	n
264/9	104/103w/c	200x	saw	ceramic	y
266/1	501/102w/o	200x	cut/slice	wood	n
266/2	501/103d/c	200x	scrape/plane	weak polish	n
266/3	501/103p/c	200x	cut/slice	weak polish (wood?)	n

Appendix V: Number of Used Edges or Surfaces by Motion by Location at Marco Gonzalez

The percentages in parentheses are computed for each location.

Structure 2

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	1 (4)	0	1 (4)
dig/hoe	2 (8)	0	2 (8)
undetermined	1 (4)	0	1 (4)
cut/slice	10 (40)	1 (4)	11 (44)
whittle/plane	0	1 (4)	1 (4)
scrape/transverse slice	0	1 (4)	1 (4)
saw	2 (8)	0	2 (8)
chop/adze	2 (8)	0	2 (8)
whittle	1 (4)	0	1 (4)
plane	1 (4)	0	1 (4)
scrape	2 (8)	0	2 (8)

Structure 11

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
saw	0	2 (100)	2 (100)

Structure 12

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	7 (8)	0	7 (8)
chop/chisel	0	1 (1.1)	1 (1.1)
pierce	3 (3.4)	1 (1.1)	4 (4.5)
scrape	12 (13.6)	0	12 (13.6)
drill/bore	1 (1.1)	0	1 (1.1)
cut/slice	23 (26.1)	0	23 (26.1)
whittle/plane	1 (1.1)	1 (1.1)	2 (2.3)
dig/hoe	5 (5.7)	1 (1.1)	6 (6.8)
saw	7 (8)	1 (1.1)	8 (9.1)
notch	4 (4.5)	0	4 (4.5)
rub	2 (2.3)	0	2 (2.3)
undetermined	7 (8)	0	7 (8)
chop/adze	4 (4.5)	2 (2.3)	6 (6.8)
scrape/whittle	1 (1.1)	0	1 (1.1)
scrape/plane	0	1 (1.1)	1 (1.1)
pound/crush	1 (1.1)	0	1 (1.1)
saw/whittle	1 (1.1)	0	1 (1.1)
scrape/shape	1 (1.1)	0	1 (1.1)

Between Structures 12 & 14

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
scrape	6 (27.3)	0	6 (27.3)
cut/slice	4 (18.2)	1 (4.5)	5 (22.7)
saw	1 (4.5)	0	1 (4.5)
undetermined	3 (13.6)	0	3 (13.6)
chop/adze	2 (9)	0	2 (9)
scrape/whittle	0	1 (4.5)	1 (4.5)
scrape/plane	0	1 (4.5)	1 (4.5)
whittle	2 (9)	0	2 (9)
transverse slice	1 (4.5)	0	1 (4.5)

Structure 14

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
chop/adze	26 (7.8)	1 (0.3)	27 (8.1)
haft polish	21 (6.3)	5 (1.5)	26 (7.8)
saw/whittle	1 (0.3)	0	1 (0.3)
cut/slice	112 (33.6)	9 (2.7)	121 (36.3)
saw	35 (10.5)	5 (1.5)	40 (12)
undetermined	16 (4.8)	0	16 (4.8)
saw/shape	5 (1.5)	0	5 (1.5)
whittle/scrape	7 (2.1)	0	7 (2.1)
dig/hoe	22 (6.6)	1 (0.3)	23 (6.9)
scrape	21 (6.3)	5 (1.5)	26 (7.8)
whittle	6 (1.8)	1 (0.3)	7 (2.1)
scrape/plane	3 (0.9)	1 (0.3)	4 (1.2)
drill/bore	2 (0.6)	0	2 (0.6)
plane/whittle	3 (0.9)	0	3 (0.9)
perforate/bore	2 (0.6)	1 (0.3)	3 (0.9)
rub/shape	8 (2.4)	1 (0.3)	9 (2.7)
gouge/incise	1 (0.3)	0	1 (0.3)
scrape/shape	1 (0.3)	0	1 (0.3)
scrape/scale	0	1 (0.3)	1 (0.3)
plane	2 (0.6)	0	2 (0.6)
notch	5 (1.5)	1 (0.3)	6 (1.8)
scrape/cut	2 (0.6)	0	2 (0.6)

Structure 16

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	1 (10)	0	1 (10)
cut/slice	2 (20)	0	2 (20)
saw	3 (30)	0	3 (30)
chop/adze	1 (10)	0	1 (10)
scrape	2 (20)	1 (10)	3 (30)

Structure 27

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
saw	2 (100)	0	2 (100)

Structure 28

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	1 (50)	0	1 (50)
cut/slice	1 (50)	0	1 (50)

Operation 4 (Structure 12)

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
incise	0	1 (50)	1 (50)
scrape	1 (50)	0	1 (50)

Operation 6

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
cut/slice	8 (30.8)	1 (3.8)	9 (34.6)
scrape	5 (19.2)	0	5 (19.2)
whittle/scrape	1 (3.8)	0	1 (3.8)
undetermined	2 (7.7)	0	2 (7.7)
whittle	2 (7.7)	0	2 (7.7)
chop/adze	1 (3.8)	0	1 (3.8)
dig/hoe	3 (11.5)	0	3 (11.5)
saw	1 (3.8)	0	1 (3.8)
scrape/plane	1 (3.8)	0	1 (3.8)
transverse cut	0	1 (3.8)	1 (3.8)

Operation 7

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
cut/slice	7 (26.9)	1 (3.8)	8 (30.8)
scrape	3 (11.5)	1 (3.8)	4 (15.4)
whittle/scrape	0	1 (3.8)	1 (3.8)
undetermined	2 (7.7)	0	2 (7.7)
chop/adze	3 (11.5)	1 (3.8)	4 (15.4)
dig/hoe	2 (7.7)	0	2 (7.7)
saw	2 (7.7)	0	2 (7.7)
haft polish	1 (3.8)	0	1 (3.8)
rub	1 (3.8)	0	1 (3.8)
incise	1 (3.8)	0	1 (3.8)

Operation 8

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
saw	6 (8.7)	0	6 (8.7)
undetermined	8 (11.6)	0	8 (11.6)
rub/shape	3 (4.3)	1 (1.4)	4 (5.8)
cut/slice	13 (18.8)	2 (2.9)	15 (21.7)
scrape/plane	3 (4.3)	0	3 (4.3)
dig/hoe	8 (11.6)	1 (1.4)	9 (13)
transverse slice	1 (1.4)	0	1 (1.4)
chop/adze	10 (14.5)	0	10 (14.5)
perforate/bore	1 (1.4)	0	1 (1.4)
whittle	3 (4.3)	0	3 (4.3)
whittle/plane	2 (2.9)	0	2 (2.9)
scrape/whittle	3 (4.3)	0	3 (4.3)
scrape	2 (2.9)	0	2 (2.9)
whittle/slice	1 (1.4)	0	1 (1.4)
scrape/shape	1 (1.4)	0	1 (1.4)

Appendix W: Number and Percentage of Contact Material Types by Location at Marco Gonzalez

The percentages in parentheses are computed for each location.

Structure 2

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	7 (26.9)	2 (7.7)	9 (34.6)
dry hide	0	2 (7.7)	2 (7.7)
soil/sand	3 (11.5)	0	3 (11.5)
undetermined	2 (7.7)	0	2 (7.7)
bone	0	2 (7.7)	2 (7.7)
hard	1 (3.8)	0	1 (3.8)
fresh hide	0	1 (3.8)	1 (3.8)
meat(fish?)	0	2 (7.7)	2 (7.7)
meat & bone	2 (7.7)	0	2 (7.7)
ceramic	1 (3.8)	0	1 (3.8)
soft	1 (3.8)	0	1 (3.8)

Structure 11

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	2 (100)	0	2 (100)

Structure 12

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	18 (19.4)	13 (14)	31 (33.3)
meat(fish?)	4 (4.3)	3 (3.2)	7 (7.5)
meat & bone	3 (3.2)	2 (2.2)	5 (5.4)
dry hide	2 (2.2)	0	2 (2.2)
plant	9 (9.7)	2 (2.2)	11 (11.8)
bone	5 (5.4)	2 (2.2)	7 (7.5)
soft	1 (1.1)	2 (2.2)	3 (3.20
soil/sand	6 (6.5)	1 (1.1)	7 (7.5)
shell	2 (2.2)	0	2 (2.2)
ceramic	5 (5.4)	1 (1.1)	6 (6.5)
stone	4 (4.3)	0	4 (4.3)
hard	1 (1.1)	4 (4.3)	5 (5.4)
fresh hide	3 (3.2)	0	3 (3.2)

Between Structures 12 and 14

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	7 (30.4)	3 (13)	10 (43.5)

soil/sand	1 (4.3)	0	1 (4.3)
meat(fish?)	2 (8.7)	0	2 (8.7)
hard	1 (4.3)	0	1 (4.3)
bone	0	3 (13)	3 (13)
antler	0	1 (4.3)	1 (4.3)
meat & bone	1 (4.3)	1 (4.3)	2 (8.7)
dry hide	0	1 (4.3)	1 (4.3)
undetermined	1 (4.3)	0	1 (4.3)
plant	0	1 (4.3)	1 (4.3)

Structure 14

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	83 (23.1)	36 (10)	119 (33.1)
soil/sand	24 (6.7)	0	24 (6.7)
meat(fish?)	13 (3.6)	15 (4.2)	28 (7.8)
fresh hide	7 (1.9)	7 (1.9)	14 (3.9)
soft	9 (2.5)	8 (2.20	17 (4.7)
plant	19 (5.3)	12 (3.3)	31 (8.6)
hard	10 (2.8)	8 (2.2)	18 (5)
stone	17 (4.7)	1 (0.3)	18 (5)
meat & bone	10 (2.8)	0	10 (2.8)
bone	20 (5.6)	10 (2.8)	30 (8.4)
ceramic	8 (2.2)	5 (1.4)	13 (3.6)
dry hide	7 (1.9)	10 (2.8)	17 (4.7)
antler	1 (0.3)	0	1 (0.3)
fish scales	0	1 (0.3)	1 (0.3)
shell	5 (1.4)	6 (1.7)	11 (3.1)
undetermined	7 (1.9)	0	7 (1.9)

Structure 16

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	5 (41.7)	3 (25)	8 (66.7)
hard	1 (8.3)	1 (8.3)	2 (16.7)
bone	1 (8.3)	0	1 (8.3)
ceramic	1 (8.3)	0	1 (8.3)

Structure 27

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
stone	2 (100)	0	2 (100)

Structure 28

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	1 (50)	0	1 (50)
soft	1 (50)	0	1 (50)

Operation 4 (Structure 12)

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
hard	1 (50)	0	1 (50)
wood	0	1 (50)	1 (50)

Operation 6

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	6 (20.7)	4 (13.8)	10 (34.5)
undetermined	2 (6.9)	0	2 (6.9)
fresh hide	0	1 (3.4)	1 (3.4)
meat(fish?)	1 (3.4)	1 (3.4)	2 (6.9)
plant	3 (10.3)	2 (6.9)	5 (17.2)
soil/sand	3 (10.3)	0	3 (10.3)
bone	1 (3.4)	1 (3.4)	2 (6.9)
hard	1 (3.4)	0	1 (3.4)
meat & bone	1 (3.4)	0	1 (3.4)
soft	0	1 (3.4)	1 (3.4)
dry hide	0	1 (3.4)	1 (3.4)

Operation 7

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
stone	3 (11.5)	0	3 (11.5)
wood	7 (26.9)	1 (3.8)	8 (30.8)
meat & bone	1 (3.8)	0	1 (3.8)
meat(fish?)	1 (3.8)	1 (3.8)	2 (7.7)
soil/sand	3 (11.5)	0	3 (11.5)
soft	3 (11.5)	0	3 (11.5)
fresh hide	0	1 (3.8)	1 (3.8)
hard	2 (7.7)	0	2 (7.7)
bone	0	1 (3.8)	1 (3.8)
plant	1 (3.8)	0	1 (3.8)
dry hide	1 (3.8)	0	1 (3.8)

Operation 8

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
bone	4 (5.3)	2 (2.7)	6 (8)
stone	7 (9.3)	0	7 (9.3)
fresh hide	2 (2.7)	2 (2.7)	4 (5.3)
plant	1 (1.3)	3 (4)	4 (5.3)
wood	16 (21.3)	8 (10.7)	24 (32)
dry hide	0	4 (5.3)	4 (5.3)
undetermined	2 (2.7)	0	2 (2.70
soil/sand	9 (12)	0	9 (12)
meat(fish?)	3 (4)	1 (1.3)	4 (5.3)
hard	1 (1.3)	3 (4)	4 (5.3)
shell	2 (2.7)	0	2 (2.7)
fish scales	0	1 (1.3)	1 (1.3)
meat & bone	1 (1.3)	2 (2.7)	3 (4)
soft	0	1 (1.3)	1 (1.3)

Appendix X: Number of Used Edges or Surfaces by Motion by Chronological Period at Marco Gonzalez

The percentages in parentheses are computed for each period.

Classic

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
scrape	1 (25)	0	1 (25)
cut/slice	2 (50)	0	2 (50)
saw	1 (25)	0	1 (25)

Classic or Middle Postclassic

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
saw	2 (100)	0	2 (100)

Late Classic

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
cut/slice	3 (18.8)	0	3 (18.8)
rub	1 (6.3)	0	1 (6.3)
undetermined	2 (12.5)	0	2 (12.5)
scrape	1 (6.3)	0	1 (6.3)
chop/adze	1 (6.3)	0	1 (6.3)
notch	1 (6.3)	0	1 (6.3)
scrape/cut	1 (6.3)	0	1 (6.3)
saw	0	1 (6.3)	1 (6.3)
dig/hoe	0	1 (6.3)	1 (6.3)
haft polish	2 (12.5)	0	2 (12.5)
scrape/whittle	1 (6.3)	0	1 (6.3)
saw/shape	1 (6.3)	0	1 (6.3)

Late Classic or earlier

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
cut/slice	1 (33.3)	0	1 (33.3)
scrape	1 (33.3)	0	1 (33.3)
incise	0	1 (33.3)	1 (33.3)

Late Classic or Early Postclassic

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
haft polish	2 (22.2)	0	2 (22.2)

notch	2 (22.2)	0	2 (22.2)
cut/slice	3 (33.3)	0	3 (33.3)
rub	1 (11.1)	0	1 (11.1)
undetermined	1 (11.1)	0	1 (11.1)

Late/Terminal Classic

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
cut/slice	3 (23.1)	0	3 (23.1)
haft polish	2 (15.4)	0	2 (15.4)
chop/adze	1 (7.7)	1 (7.7)	2 (15.4)
undetermined	1 (7.7)	0	1 (7.7)
saw	2 (15.4)	0	2 (15.4)
saw/whittle	1 (7.7)	0	1 (7.7)
scrape	1 (7.7)	0	1 (7.7)
notch	1 (7.7)	0	1 (7.7)

Terminal Classic

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
saw	1 (50)	0	1 (50)
cut/slice	1 (50)	0	1 (50)

Terminal Classic/Early Postclassic

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
cut/slice	3 (33.3)	1 (11.1)	4 (44.4)
dig/hoe	1 (11.1)	0	1 (11.1)
saw	2 (22.2)	0	2 (22.2)
whittle	1 (11.1)	0	1 (11.1)
plane	1 (11.1)	0	1 (11.1)

Early Postclassic

Motion Types	Secure Identification (%)	Probable Identification (%)	Total (%)
scrape/shape	2 (1.6)	0	2 (1.6)
saw	10 (7.9)	0	10 (7.9)
cut/slice	29 (23)	4 (3.2)	33 (26.2)
dig/hoe	14 (11.1)	1 (0.8)	15 (11.9)
scrape	11 (8.7)	1 (0.8)	12 (9.5)
undetermined	13 (10.3)	0	13 (10.3)
whittle/scrape	4 (3.2)	1 (0.8)	5 (4)
whittle	5 (4)	0	5 (4)
chop/adze	14 (11.1)	1 (0.8)	15 (11.9)
scrape/plane	4 (3.2)	0	4 (3.2)
haft polish	1 (0.8)	0	1 (0.8)
rub/shape	4 (3.2)	1 (0.8)	5 (4)

transverse cut/slice	1 (0.8)	0	1 (0.8)
perforate/bore	1 (0.8)	0	1 (0.8)
whittle/plane	2 (1.6)	0	2 (1.6)
whittle/slice	1 (0.8)	0	1 (0.8)
incise	1 (0.8)	0	1 (0.8)

Early Postclassic and later

Motion Types	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
dig/hoe	1 (33.3)	0	1 (33.3)
cut/slice	2 (67.7)	0	2 (67.7)

Middle Postclassic

Motion Types	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
haft polish	2 (6.9)	0	2 (6.9)
dig/hoe	2 (6.9)	0	2 (6.9)
undetermined	1 (3.4)	0	1 (3.4)
cut/slice	11 (37.9)	1 (3.4)	12 (41.4)
whittle/plane	0	1 (3.4)	1 (3.4)
scrape/transverse slice	0	1 (3.4)	1 (3.4)
saw	2 (6.9)	2 (6.9)	4 (13.8)
chop/adze	2 (6.9)	0	2 (6.9)
whittle	1 (3.4)	0	1 (3.4)
plane	1 (3.4)	0	1 (3.4)
scrape	2 (6.9)	0	2 (6.9)

Middle Postclassic or later

Motion Types	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
cut/slice	2 (16.7)	1 (8.3)	3 (25)
scrape	1 (8.3)	1 (8.3)	2 (16.7)
scrape/plane	1 (8.3)	0	1 (8.3)
drill/bore	1 (8.3)	0	1 (8.3)
scrape/whittle	1 (8.3)	0	1 (8.3)
undetermined	1 (8.3)	0	1 (8.3)
haft polish	1 (8.3)	0	1 (8.3)
chop/adze	1 (8.3)	0	1 (8.3)
plane/whittle	1 (8.3)	0	1 (8.3)

Middle/Late Postclassic

Motion Types	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
haft polish	8 (13.3)	2 (3.3)	10 (16.7)
dig/hoe	4 (6.7)	0	4 (6.7)
scrape	4 (6.7)	0	4 (6.70
cut/slice	16 (26.7)	2 (3.3)	18 (30)

saw	6 (10)	1 (1.7)	7 (11.7)
scrape/whittle	2 (3.3)	0	2 (3.3)
whittle	2 (3.3)	0	2 (3.3)
undetermined	2 (3.3)	0	2 (3.3)
chop/adze	3 (5)	0	3 (3.3)
scrape/scale	0	1 (1.7)	1 (1.7)
rub	2 (3.3)	0	2 (3.3)
scrape/plane	1 (1.7)	0	1 (1.7)
plane	1 (1.7)	0	1 (1.7)
notch	3 (5)	0	3 (5)

Late Postclassic

Motion Types	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
haft polish	3 (4.1)	0	3 (4.1)
chop/chisel	0	1 (1.4)	1 (1.4)
pierce	3 (4.1)	0	3 (4.1)
scrape	13 (17.6)	1 (1.4)	14 (18.9)
drill/bore	1 (1.4)	0	1 (1.4)
cut/slice	15 (20.3)	0	15 (20.3)
whittle/plane	1 (1.4)	0	1 (1.4)
dig/hoe	5 (6.8)	0	5 (6.8)
saw	10 (13.5)	1 (1.4)	11 (14.9)
notch	1 (1.4)	0	1 (1.4)
rub	1 (1.4)	0	1 (1.4)
undetermined	8 (10.8)	0	8 (10.8)
chop/adze	4 (5.4)	1 (1.4)	5 (6.8)
scrape/whittle	1 (1.4)	0	1 (1.4)
whittle	2 (2.7)	1 (1.4)	3 (4.1)
scrape/shape	1 (1.4)	0	1 (1.4)

Postclassic (mostly Middle to Late)

Motion Types	**Secure Identification (%)**	**Probable Identification (%)**	**Total (%)**
chop/adze	23 (9.4)	2 (0.8)	25 (10.2)
haft polish	10 (4.1)	3 (1.2)	13 (5.3)
saw/whittle	1 (0.4)	0	1 (0.4)
cut/slice	88 (35.9)	6 (2.4)	94 (38.4)
saw	25 (10.2)	3 (1.2)	28 (11.4)
undetermined	11 (4.5)	0	11 (4.5)
saw/shape	4 (1.6)	0	4 (1.6)
whittle/scrape	3 (1.2)	1 (0.4)	4 (1.6)
dig/hoe	15 (6.1)	1 (0.4)	16 (6.5)
scrape	18 (7.3)	3 (1.2)	21 (8.6)
whittle	3 (1.2)	0	3 (1.2)
scrape/plane	1 (0.4)	3 (1.2)	4 (1.6)
whittle/plane	2 (0.8)	1 (0.4)	3 (1.2)
perforate bore	2 (0.8)	1 (0.4)	3 (1.2)
transverse	1 (0.4)	0	1 (0.4)
rub/shape	5 (2)	1 (0.4)	6 (2.4)
gouge/incise	1 (0.4)	0	1 (0.4)

scrape/cut	1 (0.4)	0	1 (0.4)
drill	1 (0.4)	0	1 (0.4)
pound/crush	1 (0.4)	0	1 (0.4)
notch	1 (0.4)	1 (0.4)	2 (0.8)
pierce	0	1 (0.4)	1 (0.4)
transverse slice	1 (0.4)	0	1 (0.4)

Appendix Y: Number and Percentage of Contact Material Types by Chronological Period at Marco Gonzalez

The percentages in parentheses are computed for each period.

Classic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
dry hide	1 (25)	0	1 (25)
meat(fish?)	1 (25)	0	1 (25)
hard	1 (25)	0	1 (25)
shell	1 (25)	0	1 (25)

Classic or Middle Postclassic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
stone	2 (100)	0	2 (100)

Late Classic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
plant	2 (12.5)	0	2 (12.5)
stone	3 (18.8)	0	3 (18.8)
meat(fish?)	0	2 (12.5)	2 (12.5)
fresh hide	1 (6.3)	0	1 (6.3)
wood	3 (18.8)	0	3 (18.8)
ceramic	1 (6.3)	0	1 (6.3)
dry hide	1 (6.3)	0	1 (6.3)
hard	0	1 (6.3)	1 (6.3)
soil/sand	1 (6.3)	0	1 (6.3)
undetermined	1 (6.3)	0	1 (6.3)

Late Classic or earlier

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
bone	0	1 (33.3)	1 (33.3)
hard	1 (33.3)	0	1 (33.3)
wood	0	1 (33.3)	1 (33.3)

Late Classic or Early Postclassic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	3 (27.3)	2 (18.2)	5 (45.5)
ceramic	2 (18.2)	0	2 (18.2)

meat & bone	0	1 (9.1)	1 (9.1)
plant	2 (18.2)	0	2 (18.2)
stone	1 (9.1)	0	1 (9.1)

Late/Terminal Classic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	6 (42.9)	1 (7.1)	7 (50)
soil/sand	1 (7.1)	0	1 (7.1)
plant	2 (14.3)	0	2 (14.3)
hard	0	1 (7.1)	1 (7.1)
meat(fish?)	1 (7.1)	0	1 (7.1)
ceramic	1 (7.1)	0	1 (7.1)
shell	1 (7.1)	0	1 (7.1)

Terminal Classic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
bone	0	1 (25)	1 (25)
wood	0	1 (25)	1 (25)
meat(fish?)	0	1 (25)	1 (25)
fresh hide	0	1 (25)	1 (25)

Terminal Classic/Early Postclassic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
soft	3 (33.3)	0	3 (33.3)
soil/sand	1 (11.1)	0	1 (11.1)
meat(fish?)	1 (11.1)	0	1 (11.1)
shell	1 (11.1)	0	1 (11.1)
wood	1 (11.1)	1 (11.1)	2 (22.2)
hard	0	1 (11.1)	1 (11.1)

Early Postclassic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
stone	12 (8.8)	0	12 (8.8)
ceramic	0	1 (0.7)	1 (0.7)
hard	5 (3.6)	3 (2.2)	8 (5.6)
soil/sand	16 (11.7)	0	16 (11.7)
soft	4 (2.9)	3 (2.2)	7 (5.1)
wood	29 (21.2)	13 (9.5)	42 (30.7)
undetermined	4 (2.9)	0	4 (2.9)
fresh hide	2 (1.5)	4 (2.9)	6 (4.4)
meat(fish?)	5 (3.6)	3 (2.2)	8 (5.6)
plant	5 (3.6)	5 (3.6)	10 (7.3)
bone	5 (3.6)	4 (2.9)	9 (6.7)

meat & bone	3 (2.2)	2 (1.5)	5 (3.6)
dry hide	1 (0.7)	5 (3.6)	6 (4.4)
shell	2 (1.5)	0	2 (1.5)
fish scales	0	1 (0.7)	1 (0.7)

Early Postclassic or later

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
soil/sand	1 (33.3)	0	1 (33.3)
plant	0	2 (66.7)	2 (66.7)

Middle Postclassic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	10 (33.3)	2 (6.7)	12 (40)
dry hide	0	2 (6.7)	2 (6.7)
soil/sand	3 (10)	0	3 (10)
undetermined	2 (6.7)	0	2 (6.7)
bone	0	2 (6.7)	2 (6.7)
hard	1 (3.3)	0	1 (3.3)
fresh hide	0	1 (3.3)	1 (3.3)
meat(fish?)	0	2 (6.7)	2 (6.7)
meat & bone	2 (6.7)	0	2 (6.7)
ceramic	1 (3.3)	0	1 (3.3)
soft	2 (6.7)	0	2 (6.7)

Middle Postclassic or later

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
soft	0	2 (14.3)	2 (14.3)
wood	3 (21.4)	2 (14.3)	5 (35.7)
bone	2 (14.3)	1 (7.1)	3 (21.4)
meat(fish?)	0	1 (7.1)	1 (7.1)
meat & bone	2 (14.3)	0	2 (14.3)
plant	1 (7.1)	0	1 (7.1)

Middle/Late Postclassic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	17 (27)	3 (4.8)	20 (31.7)
soil/sand	4 (6.3)	0	4 (6.3)
dry hide	2 (3.2)	2 (3.2)	4 (6.3)
meat(fish?)	4 (6.3)	1 (1.6)	5 (7.9)
plant	3 (4.8)	2 (3.2)	5 (7.9)
fish scales	0	1 (1.6)	1 (1.6)
hard	1 (1.6)	0	1 (1.6)
stone	3 (4.8)	0	3 (4.8)

bone	5 (7.9)	1 (1.6)	6 (9.5)
shell	1 (1.6)	4 (6.3)	5 (7.9)
fresh hide	1 (1.6)	2 (3.2)	3 (4.8)
undetermined	2 (3.2)	0	2 (3.2)
meat & bone	2 (3.2)	0	2 (3.2)
ceramic	1 (1.6)	1 (1.6)	2 (3.2)

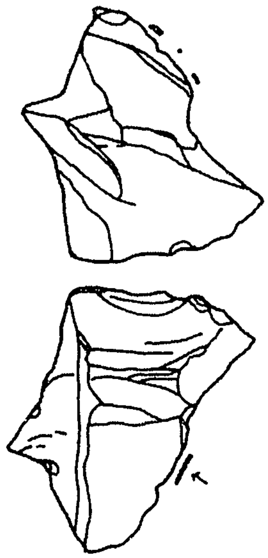
Late Postclassic

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	21 (28)	9 (12)	30 (40)
meat(fish?)	3 (4)	3 (4)	6 (8)
meat & bone	3 (4)	1 (1.3)	4 (5.3)
dry hide	1 (1.3)	0	1 (1.3)
plant	4 (5.3)	1 (1.3)	5 (6.7)
bone	3 (4)	3 (4)	6 (8)
soft	1 (1.3)	2 (2.7)	3 (4)
soil/sand	6 (8)	0	6 (8)
shell	1 (1.3)	0	1 (1.3)
ceramic	3 (4)	1 (1.3)	4 (5.3)
stone	2 (2.7)	0	2 (2.7)
hard	3 (4)	3 (4)	6 (8)
antler	0	1 (1.3)	1 (1.3)

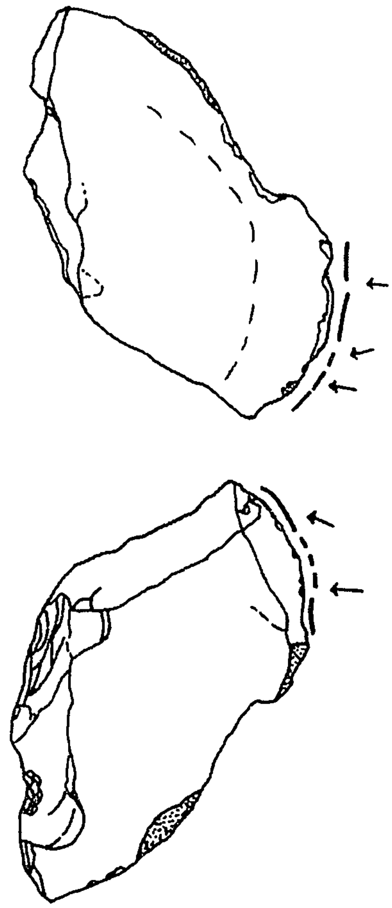
Postclassic (mostly Middle, some Early and Late)

Contact Material Types	Secure Identification (%)	Probable Identification (%)	Total (%)
wood	59 (22.2)	36 (13.5)	95 (35.7)
soil/sand	16 (6)	1 (0.4)	17 (6.4)
meat(fish?)	9 (3.4)	10 (3.8)	19 (7.1)
fresh hide	8 (3)	4 (1.5)	12 (4.5)
soft	5 (1.9)	5 (1.9)	10 (3.8)
plant	14 (5.3)	10 (3.8)	24 (9)
hard	7 (2.6)	7 (2.6)	14 (5.3)
stone	10 (3.8)	1 (0.4)	11 (4.1)
meat & bone	7 (2.6)	1 (0.4)	8 (3)
bone	16 (6)	8 (3)	24 (9)
ceramic	6 (2.3)	3 (1.1)	9 (3.4)
dry hide	4 (1.5)	9 (3.4)	13 (4.9)
antler	1 (0.4)	0	1 (0.4)
shell	2 (0.8)	2 (0.8)	4 (1.5)
undetermined	5 (1.9)	0	5 (1.9)

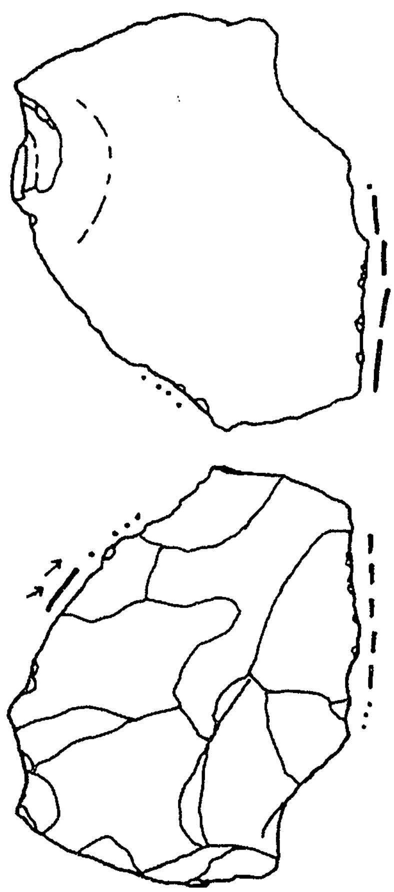
Appendix Z: Illustrations of Used Tools from Marco Gonzalez and San Pedro



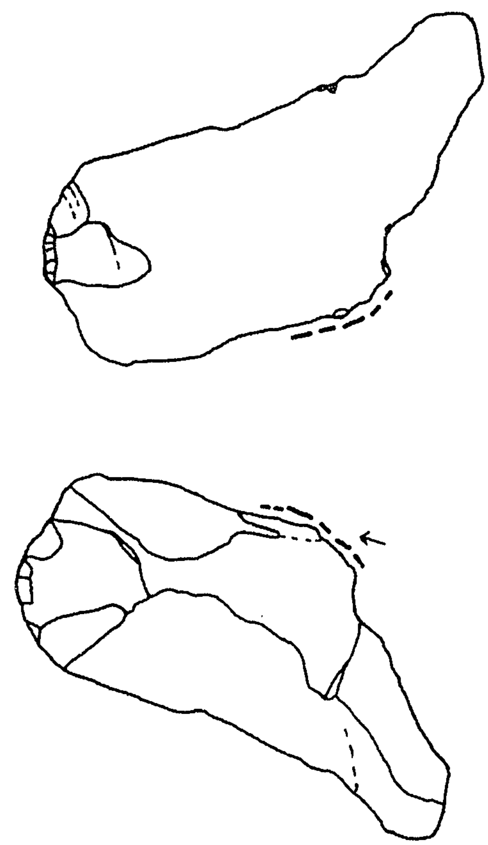
SP 31/8



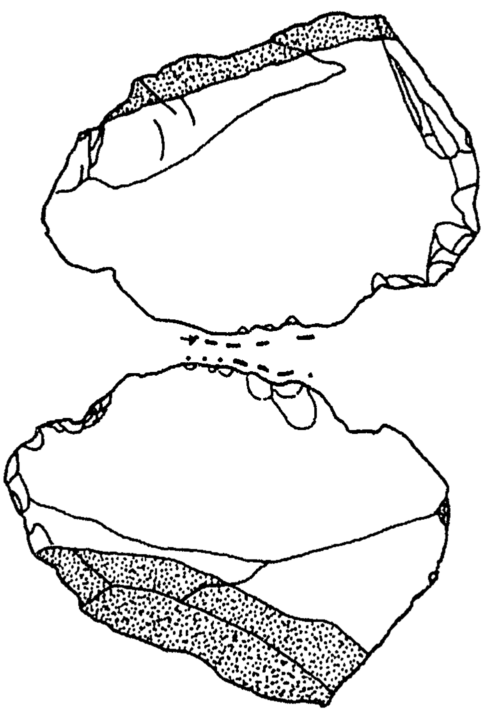
SP 64/3



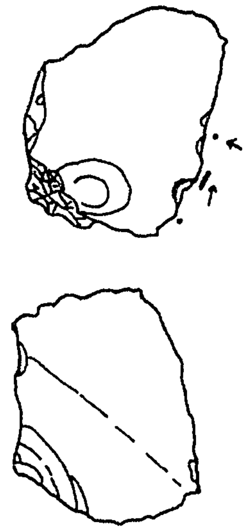
SP 208/1



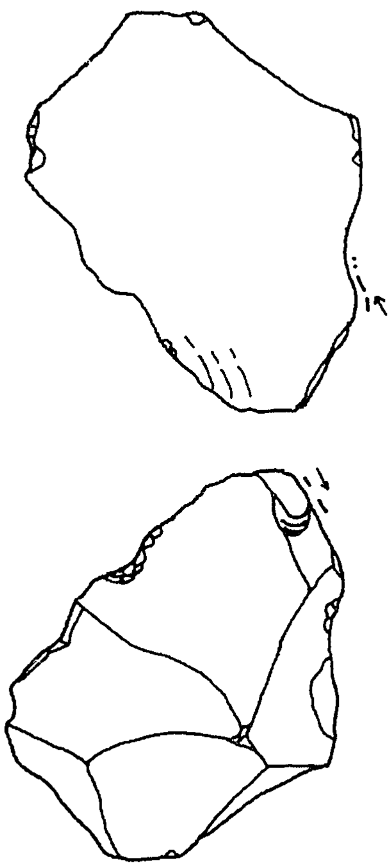
SP 103/7



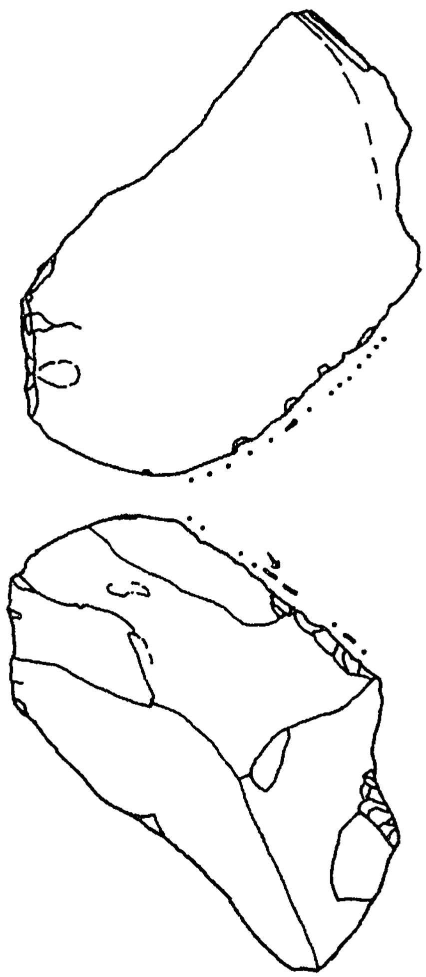
MG 26/49



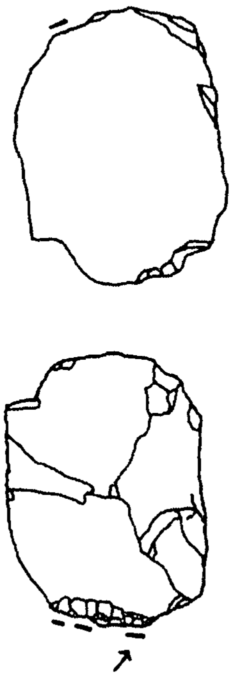
SP 142/22



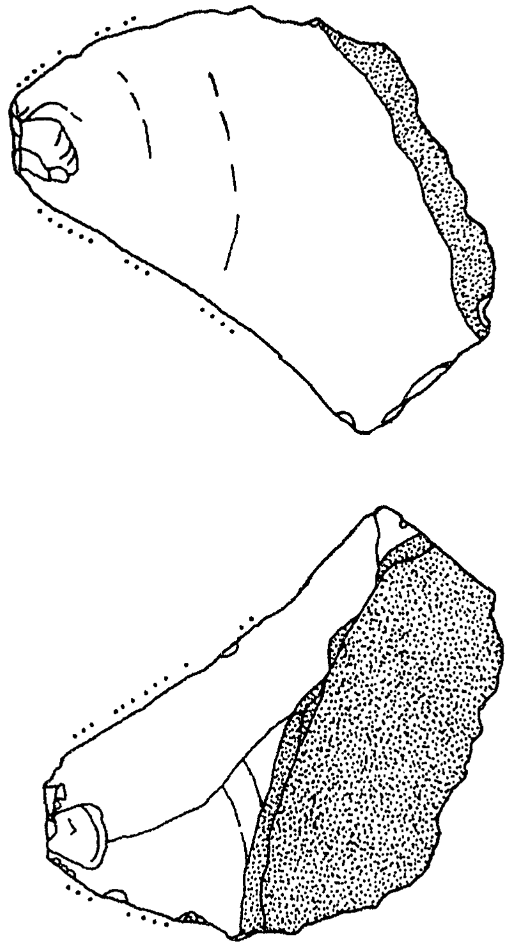
MG 26/35



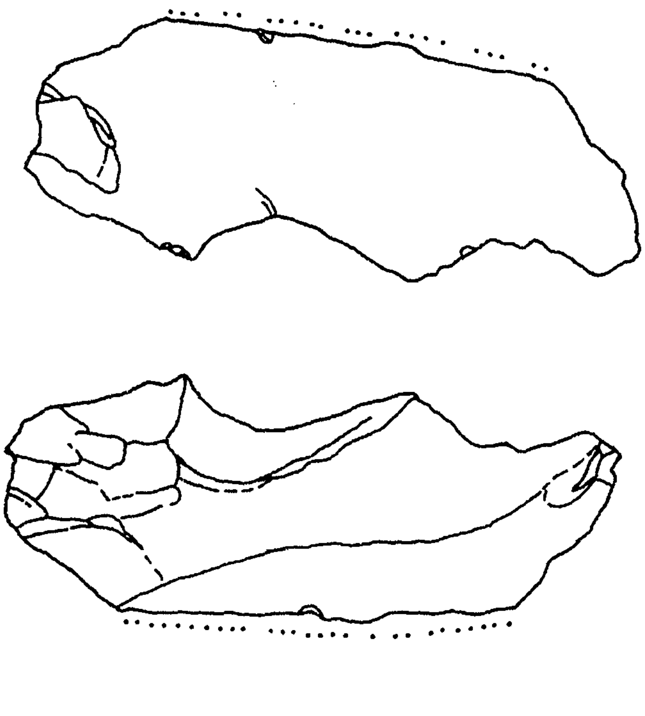
SP 144/3



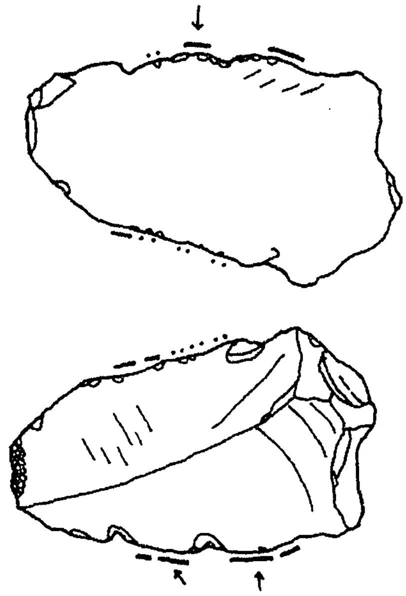
SP 14/1



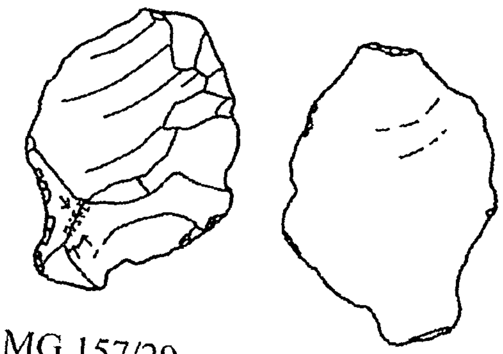
MG 104/17

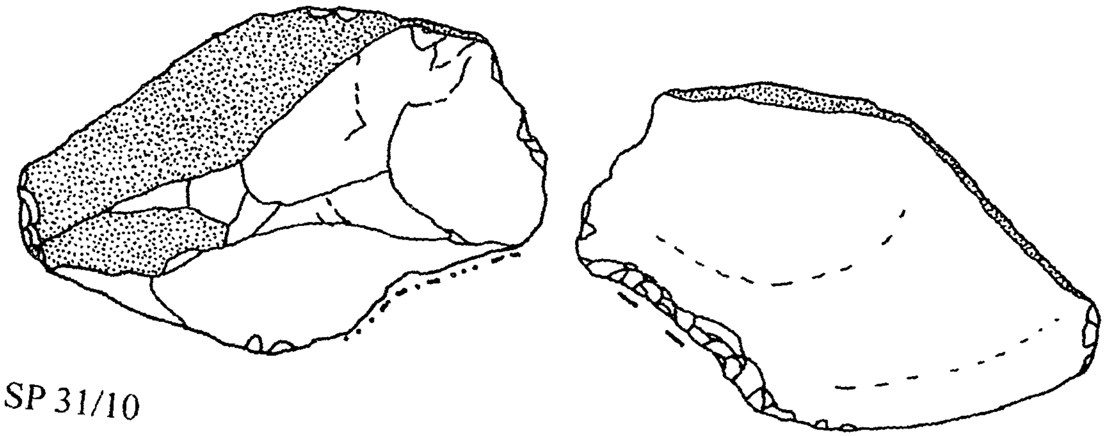


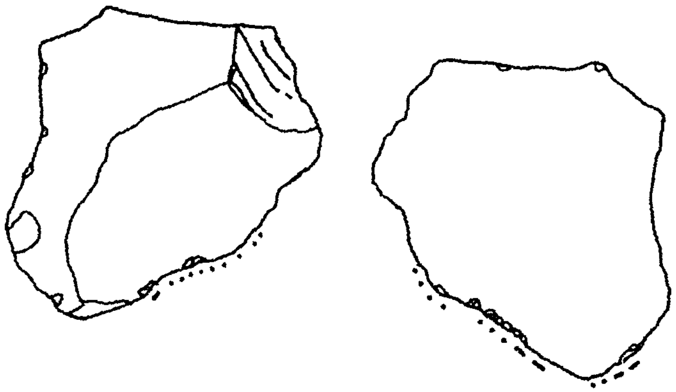
SP 65/4

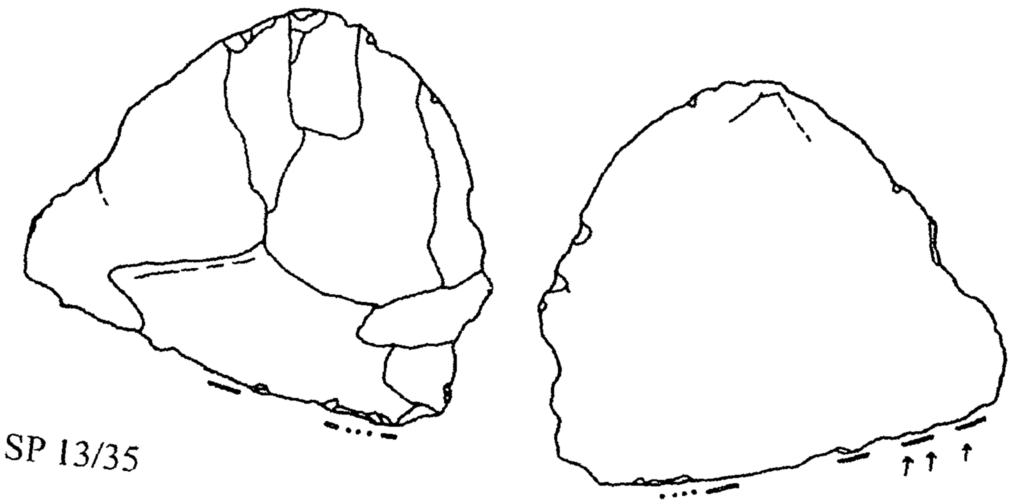


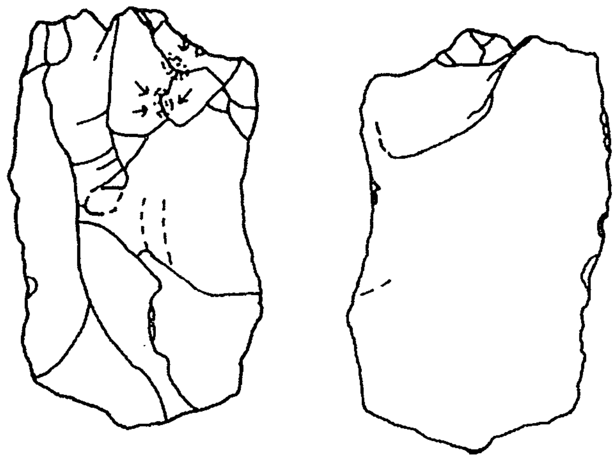
MG 105/9


MG 157/29

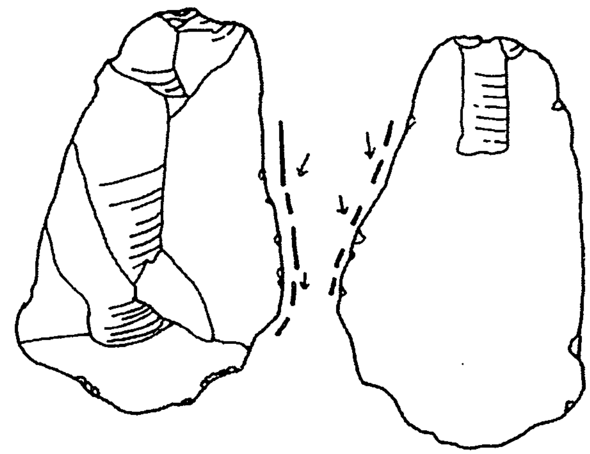

SP 31/10


SP 31/4

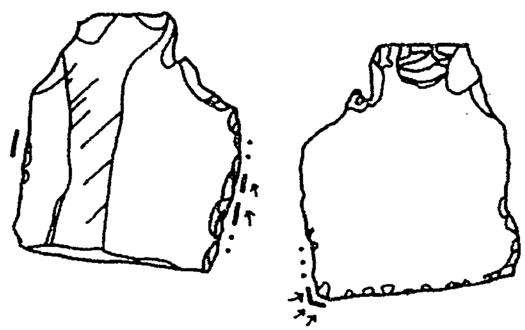

SP 13/35



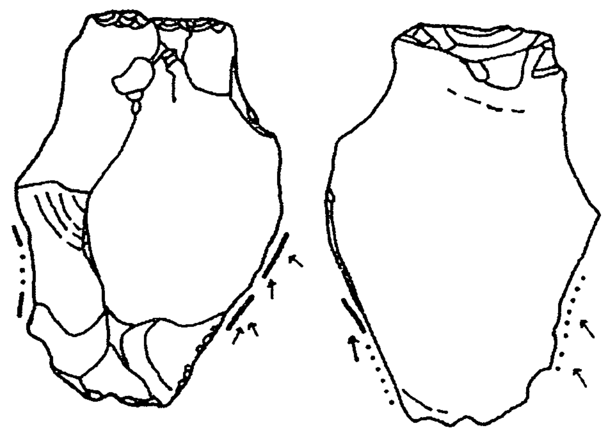
MG 194/4



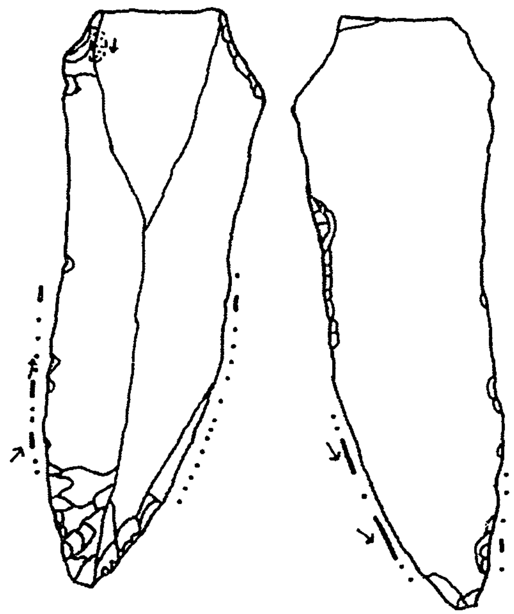
MG 77/63



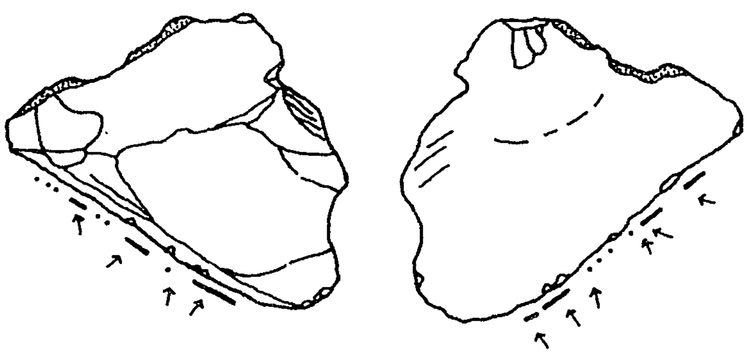
SP 61/2



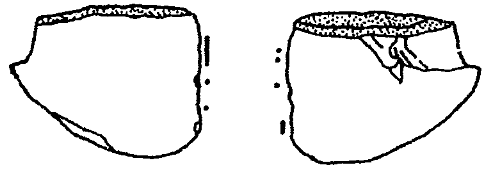
SP 82/1



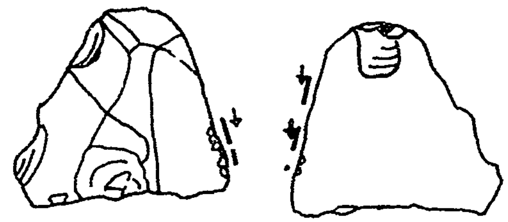
SP 37/1



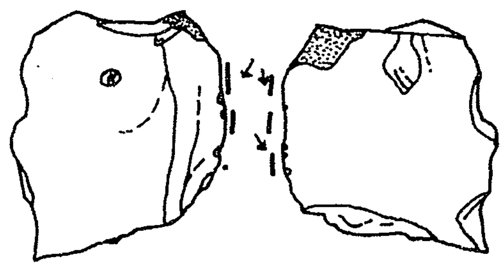
MG 80/11



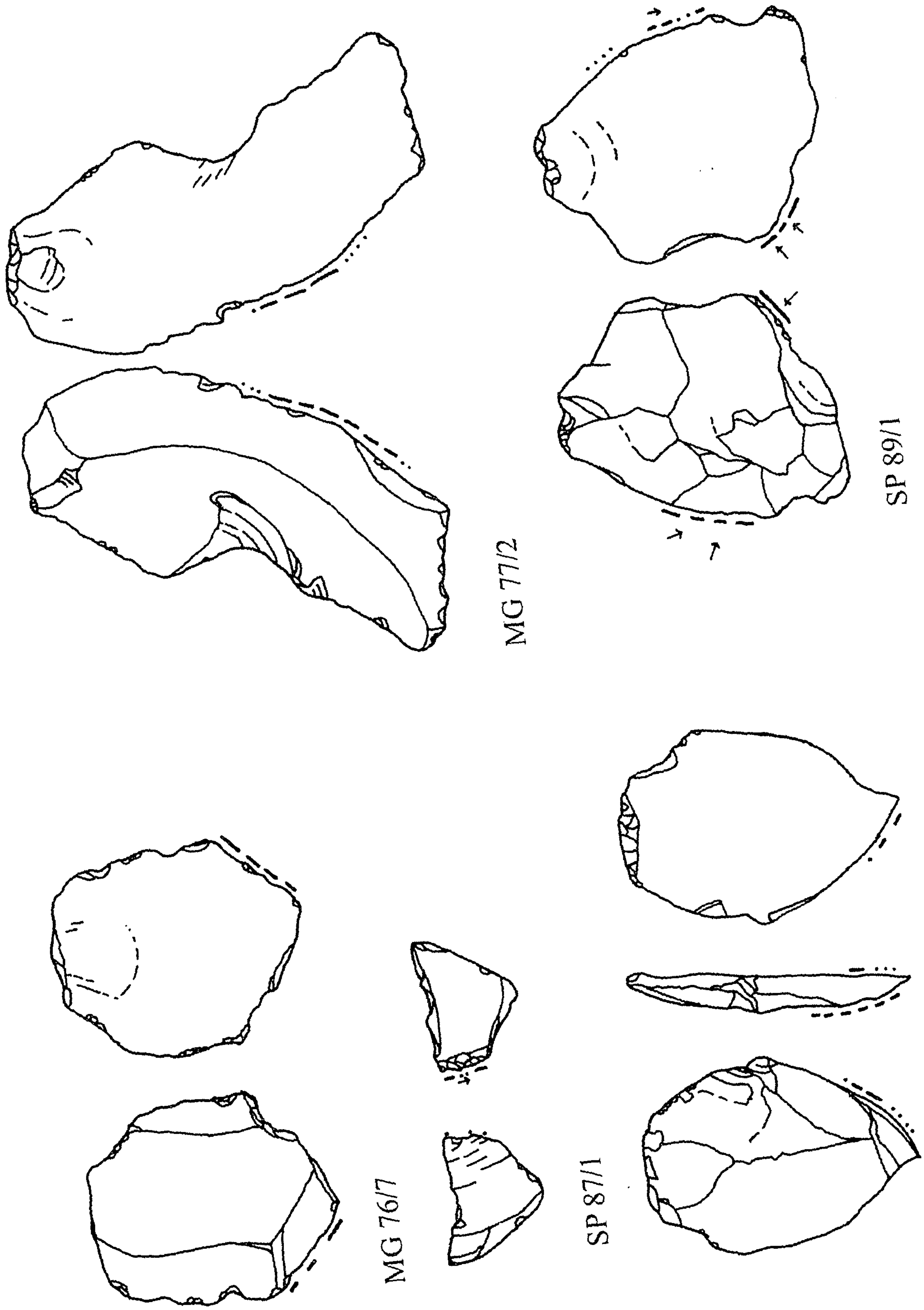
MG 95/62

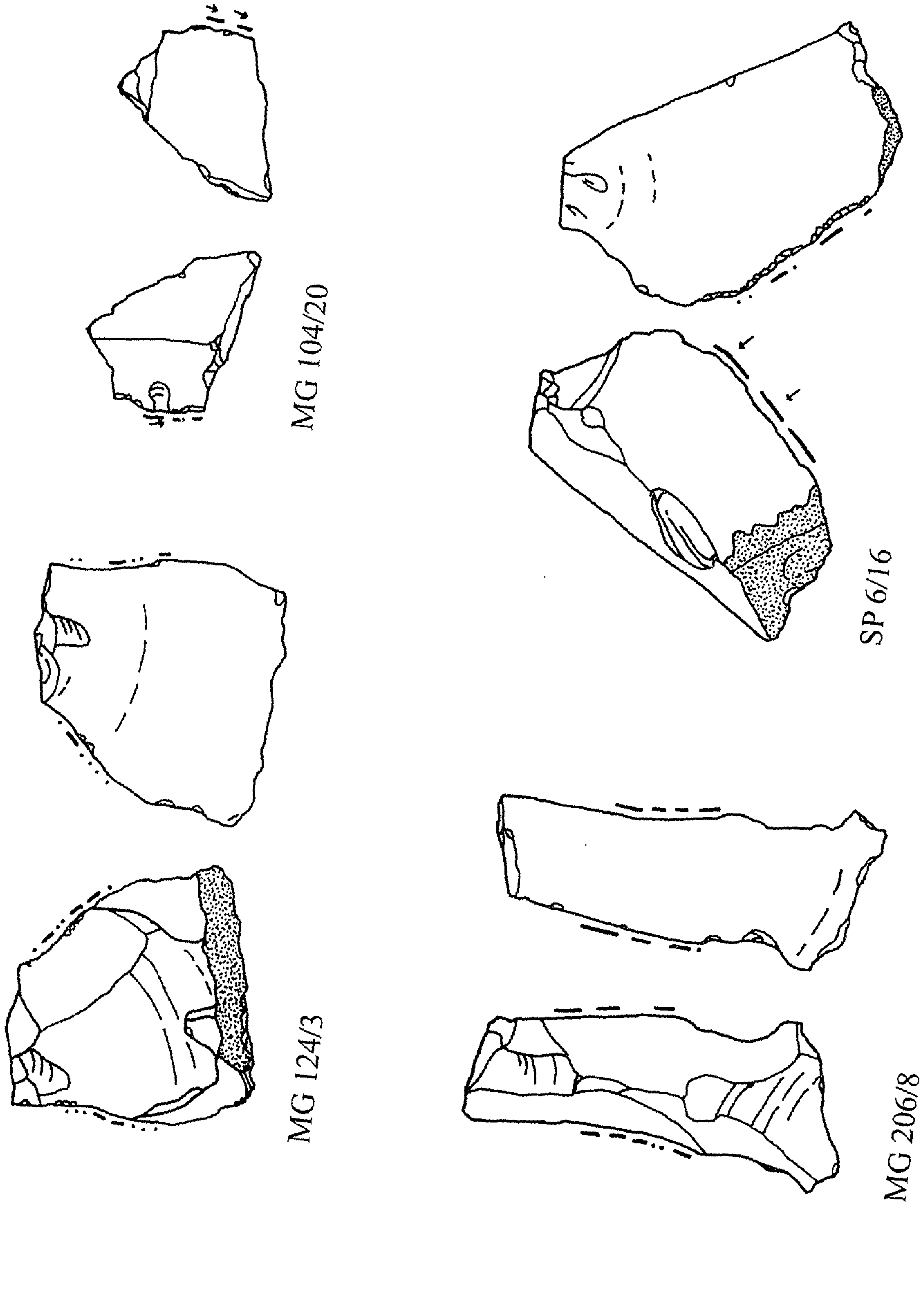


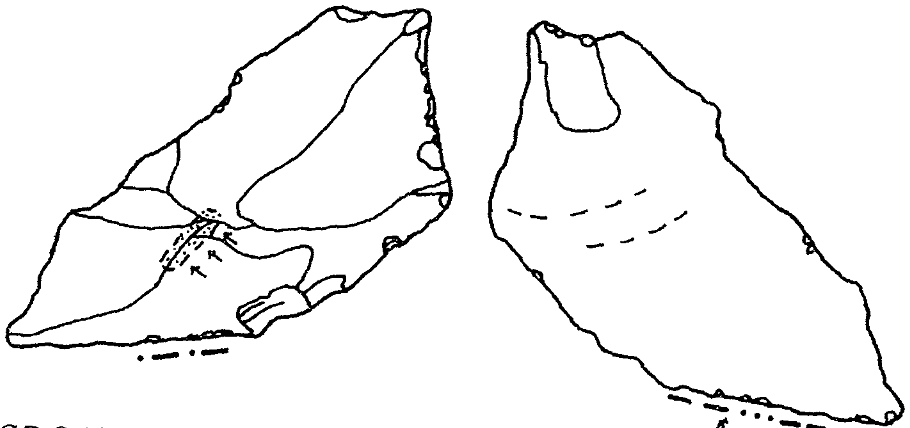
MG 19/57



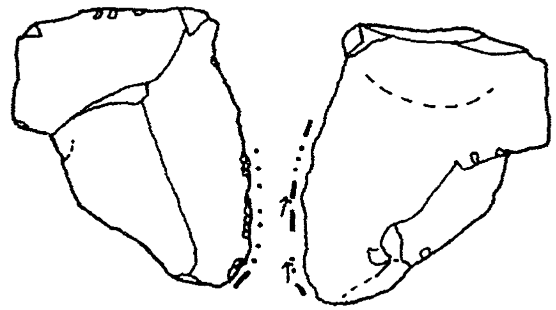
MG 135/14


MG 77/2
SP 89/1
MG 76/7
SP 87/1
SP 42/3

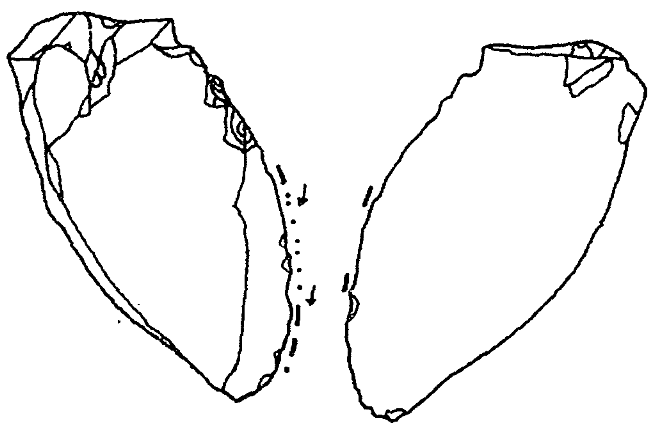

MG 104/20
SP 6/16
MG 124/3
MG 206/8



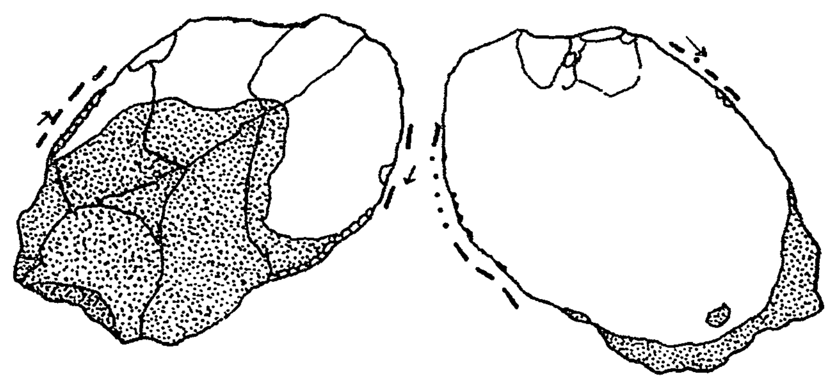
SP 85/5



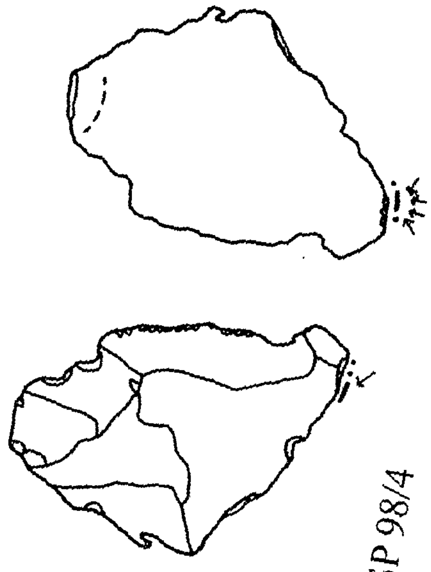
SP 170/10



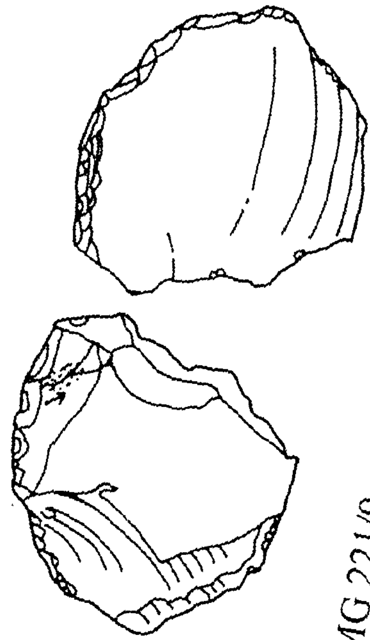
SP 103/8



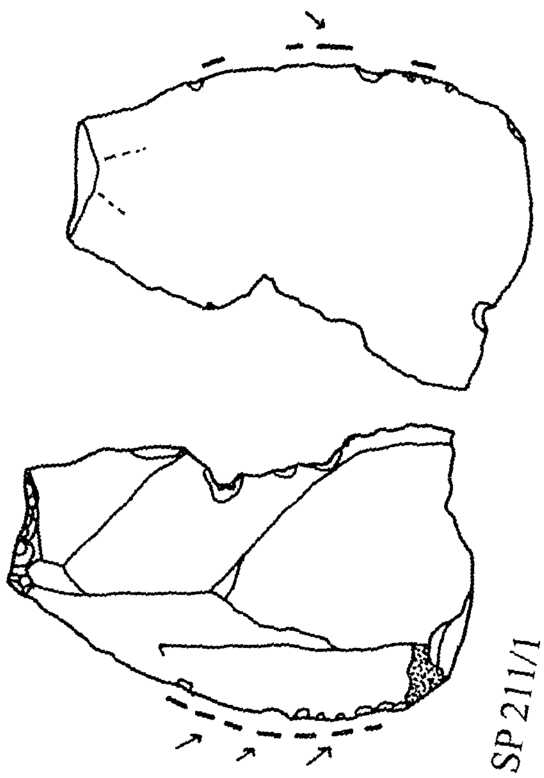
SP 159/2



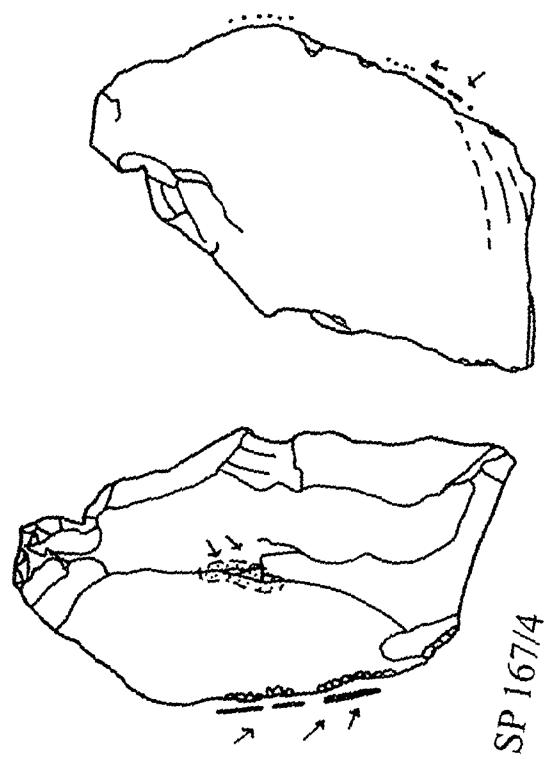
SP 98/4



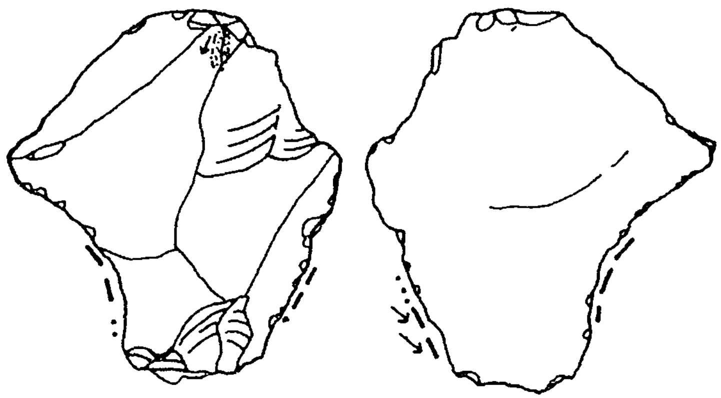
MG 221/9



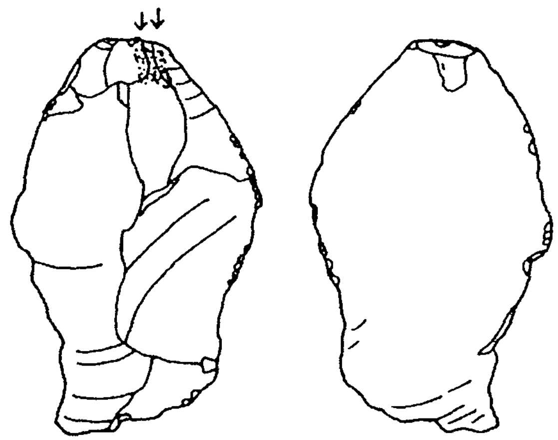
SP 211/1



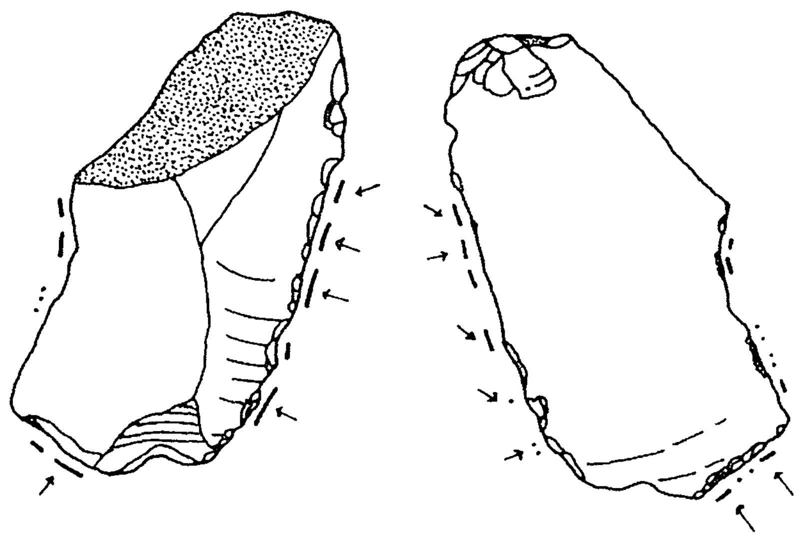
SP 167/4



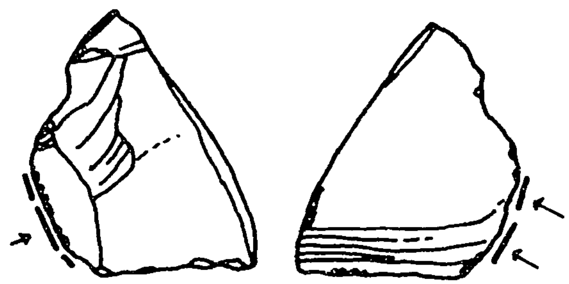
MG 251/1



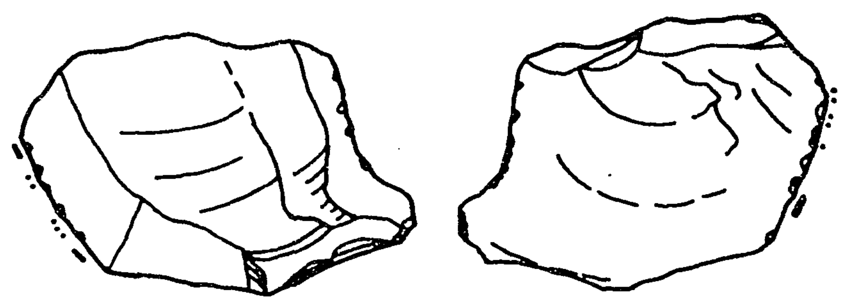
MG 262/3



MG 237/1

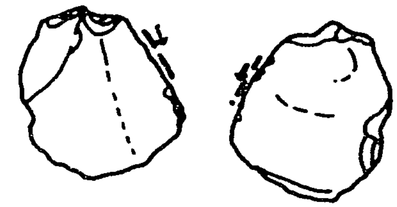


MG 129/34

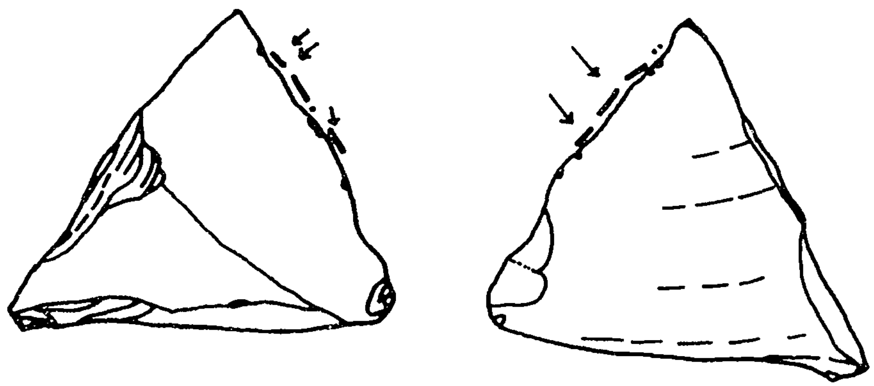


MG 194/11

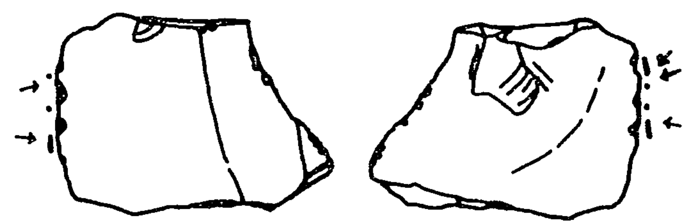
MG 234/33



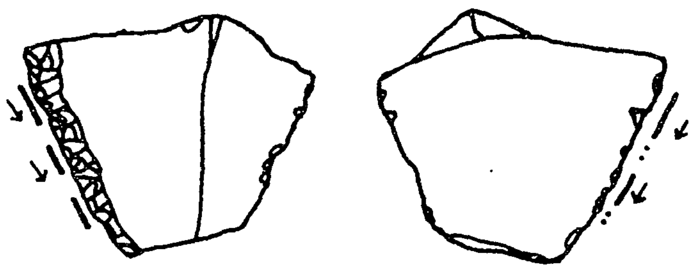
MG 171/26



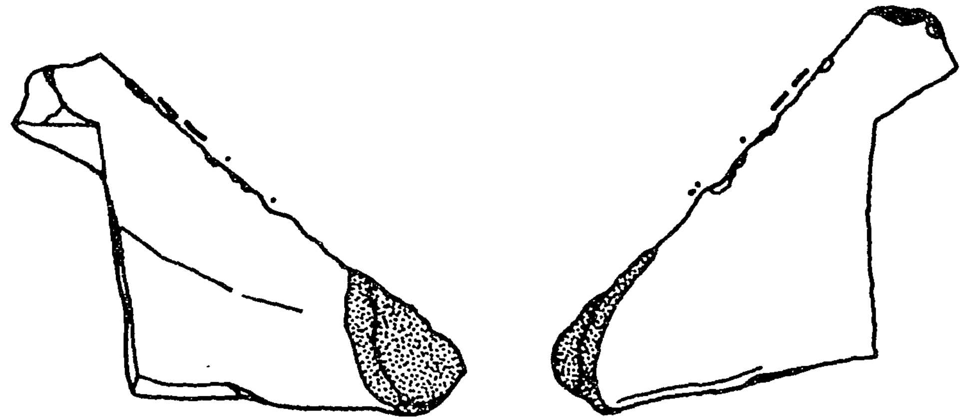
MG 129/68



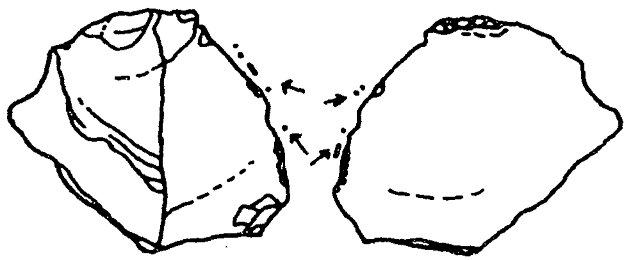
MG 174/27



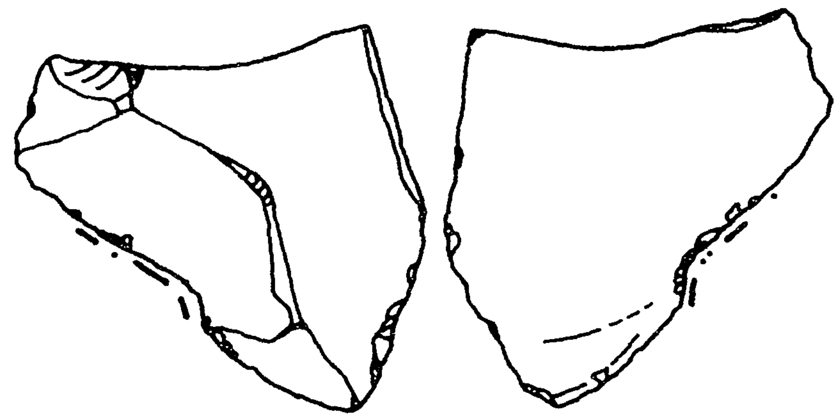
MG 211/2



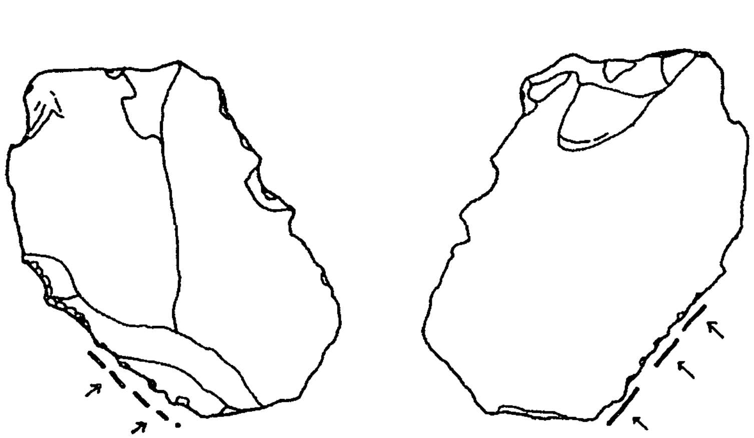
MG 189/2



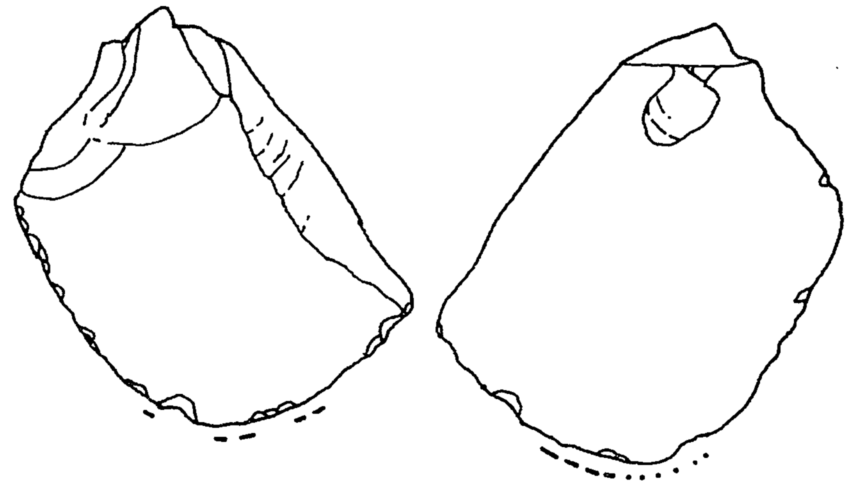
MG 230/4



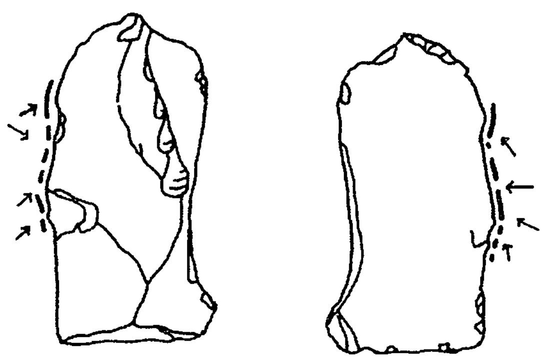
MG 202/27



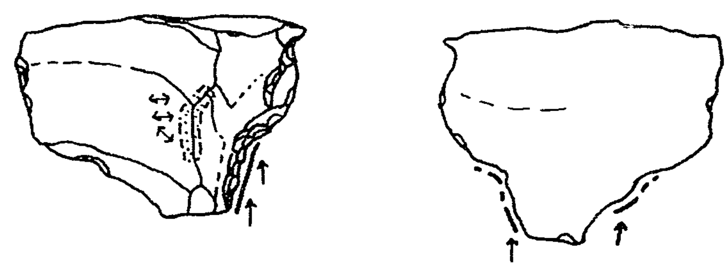
SP 111/2



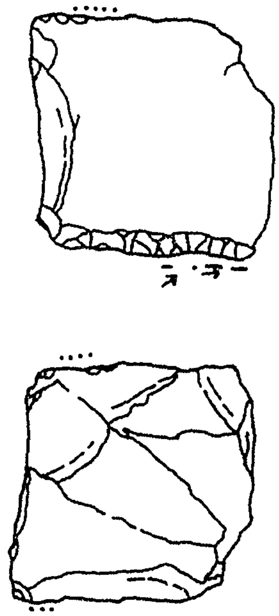
SP 6/20



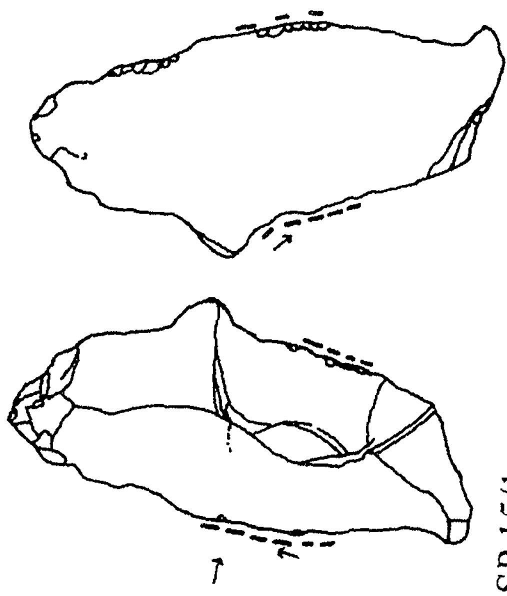
SP 178/1



SP 61/3

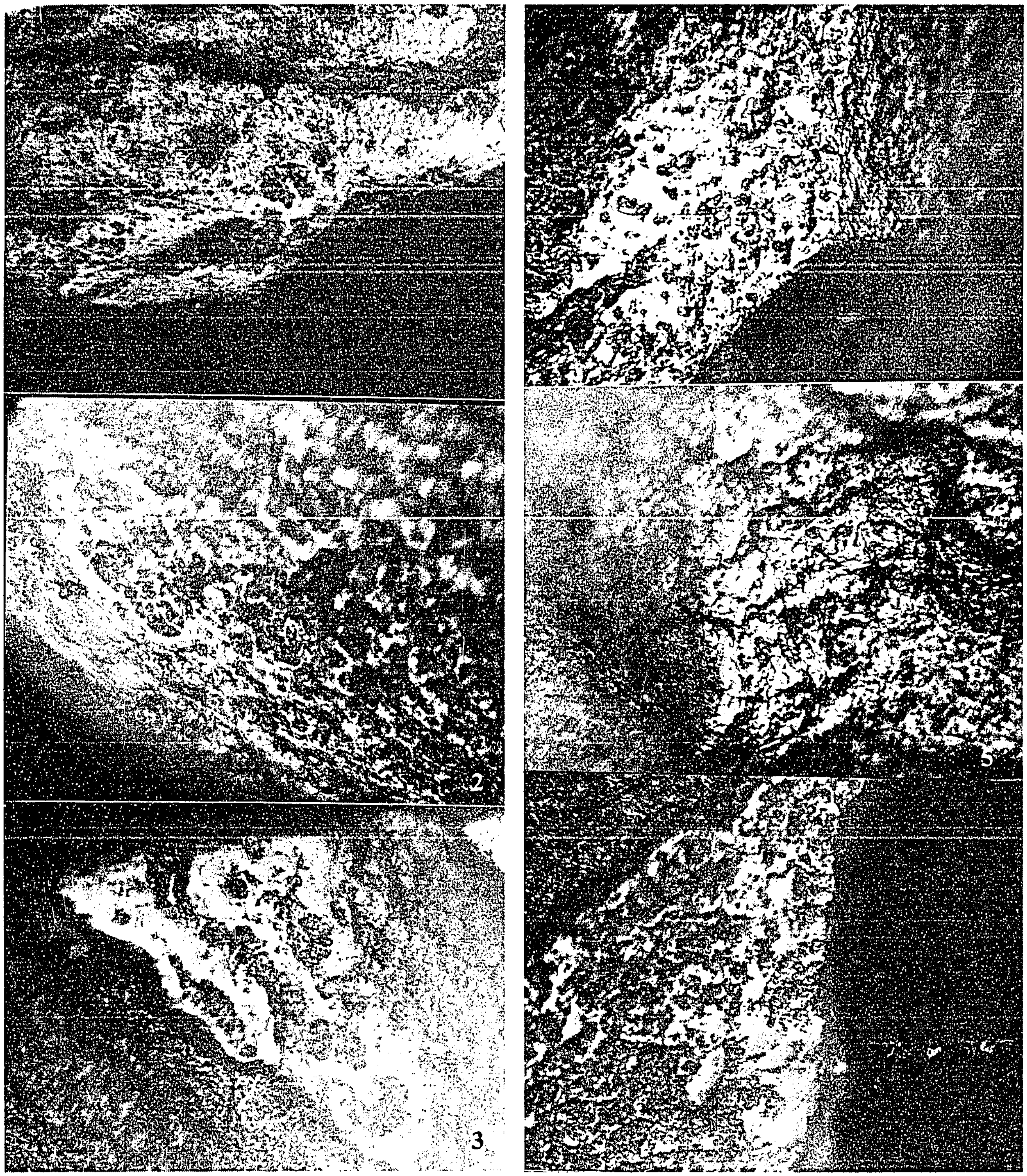


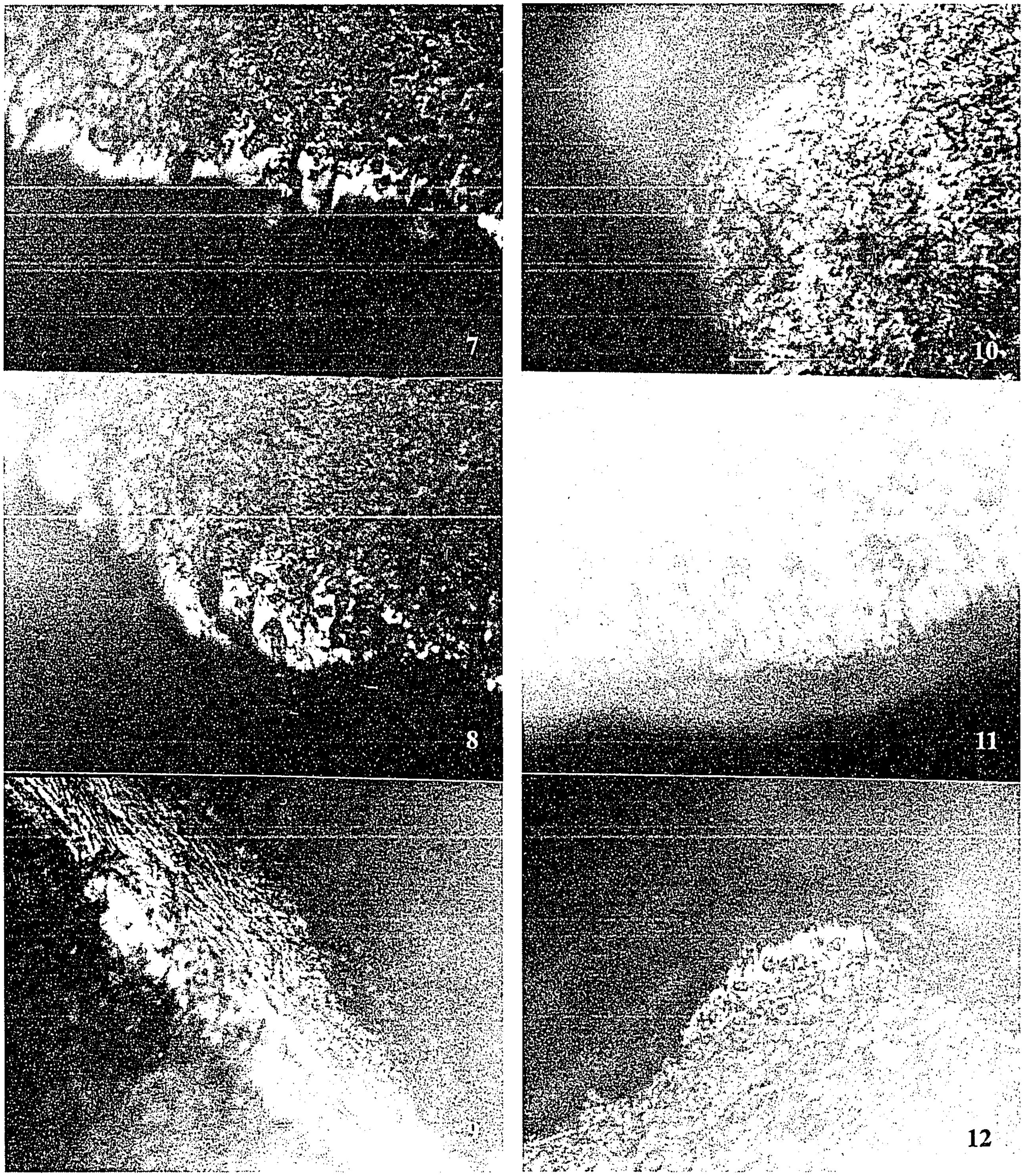
SP 33/2

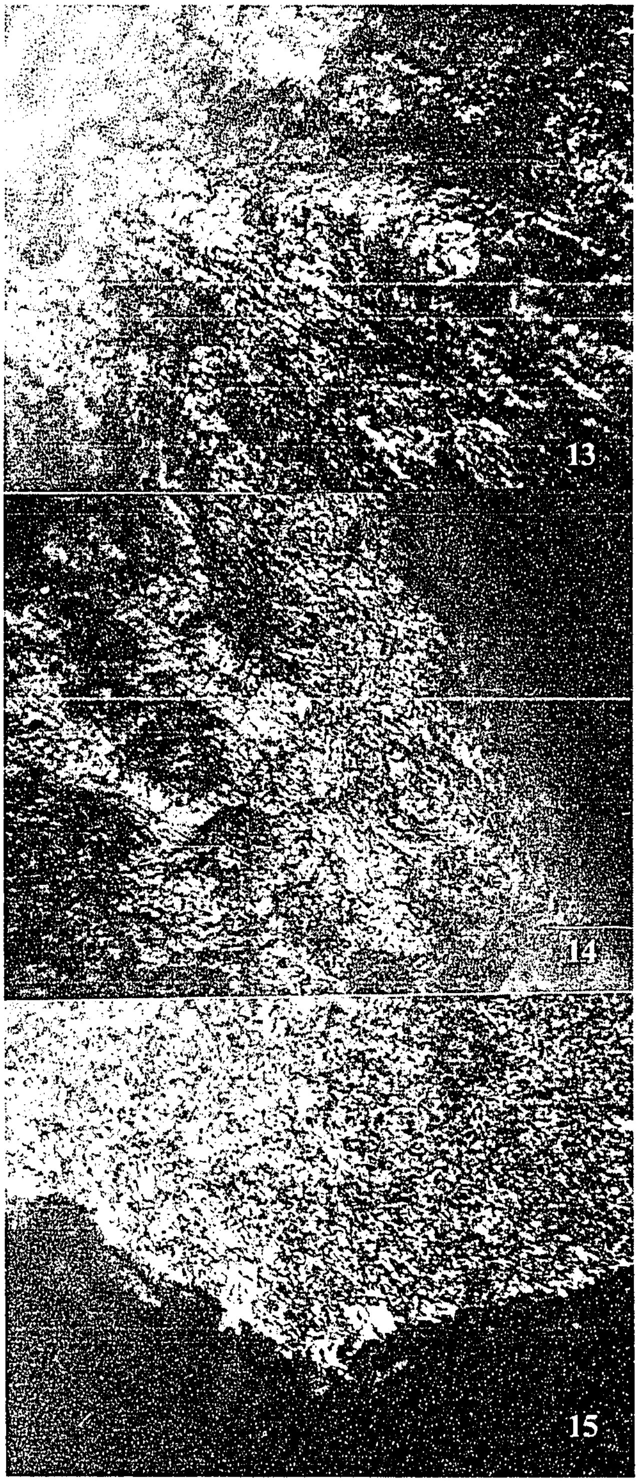


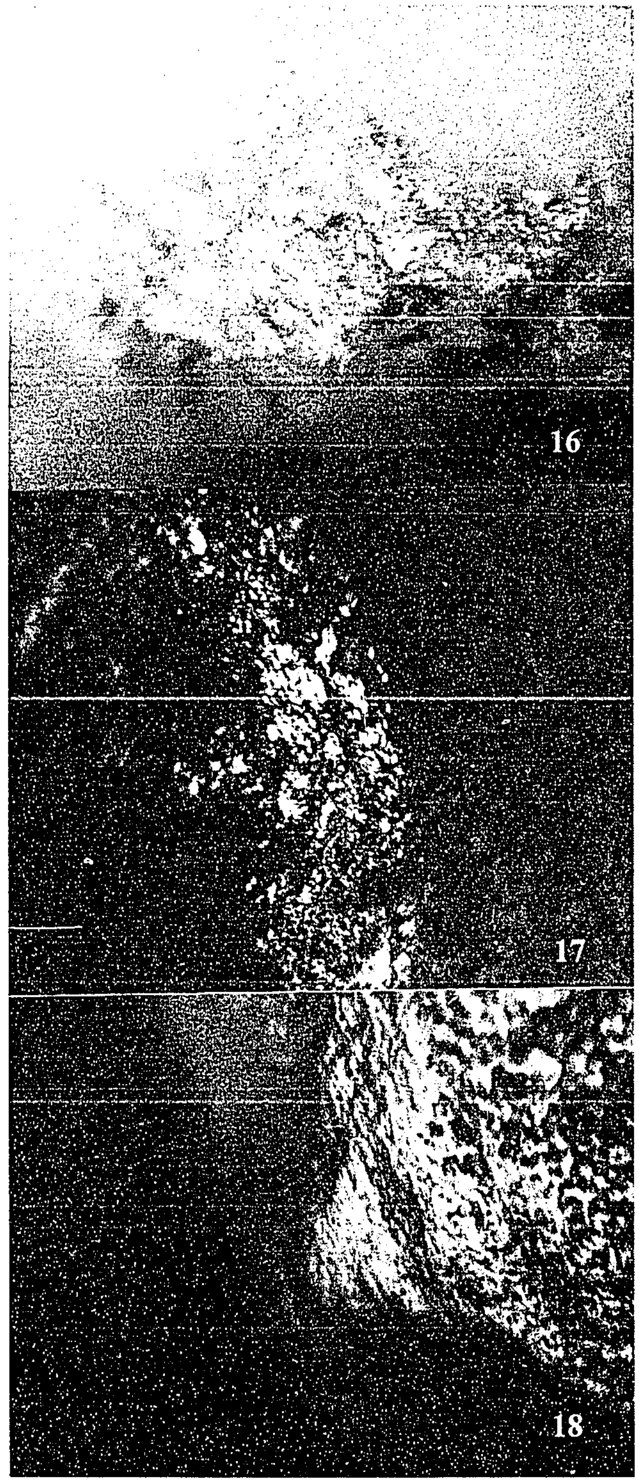
SP 15/1

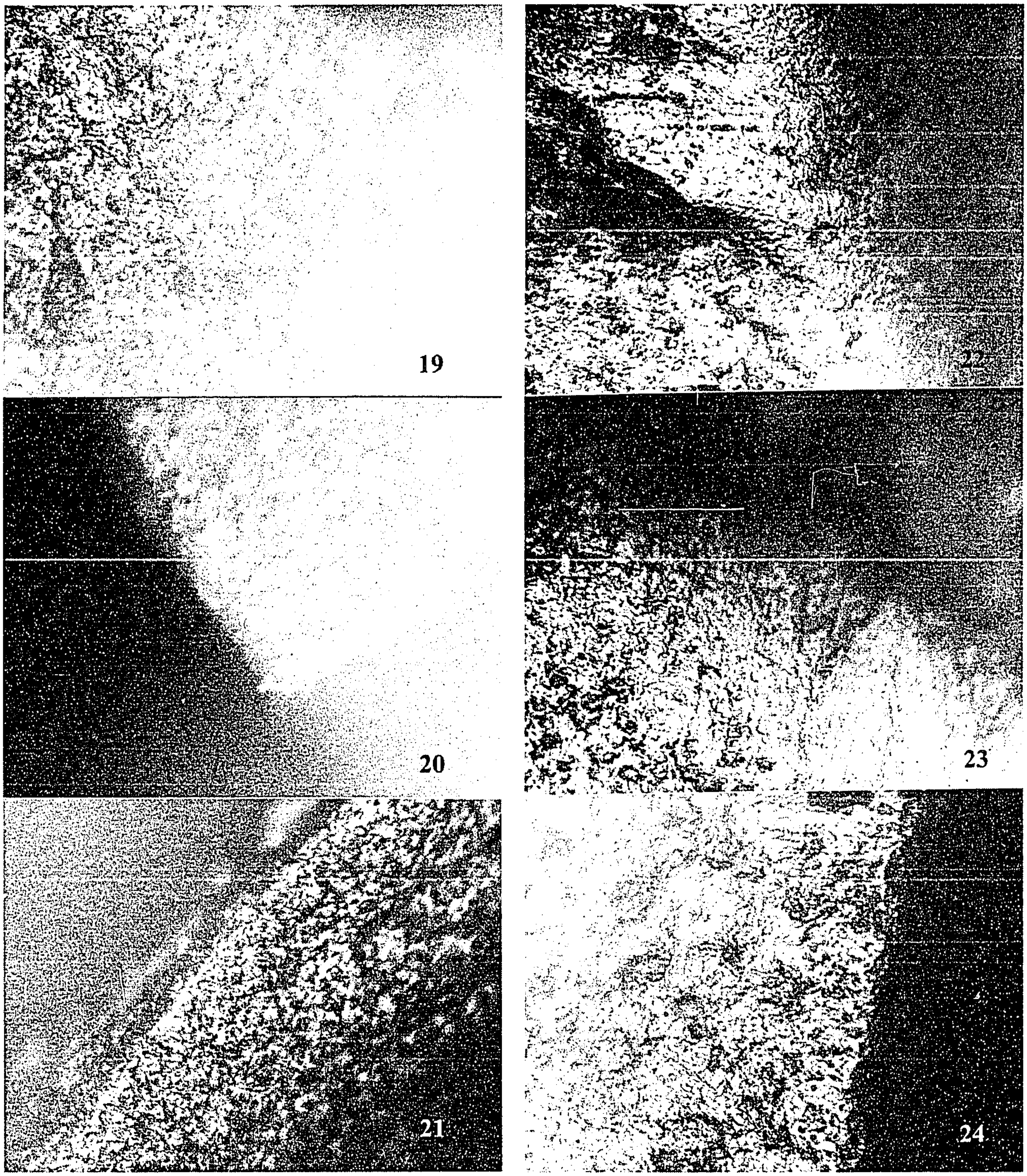
Appendix AA: Photomicrographs of Use-wear Damage on Experimental and Archaeological Tools.

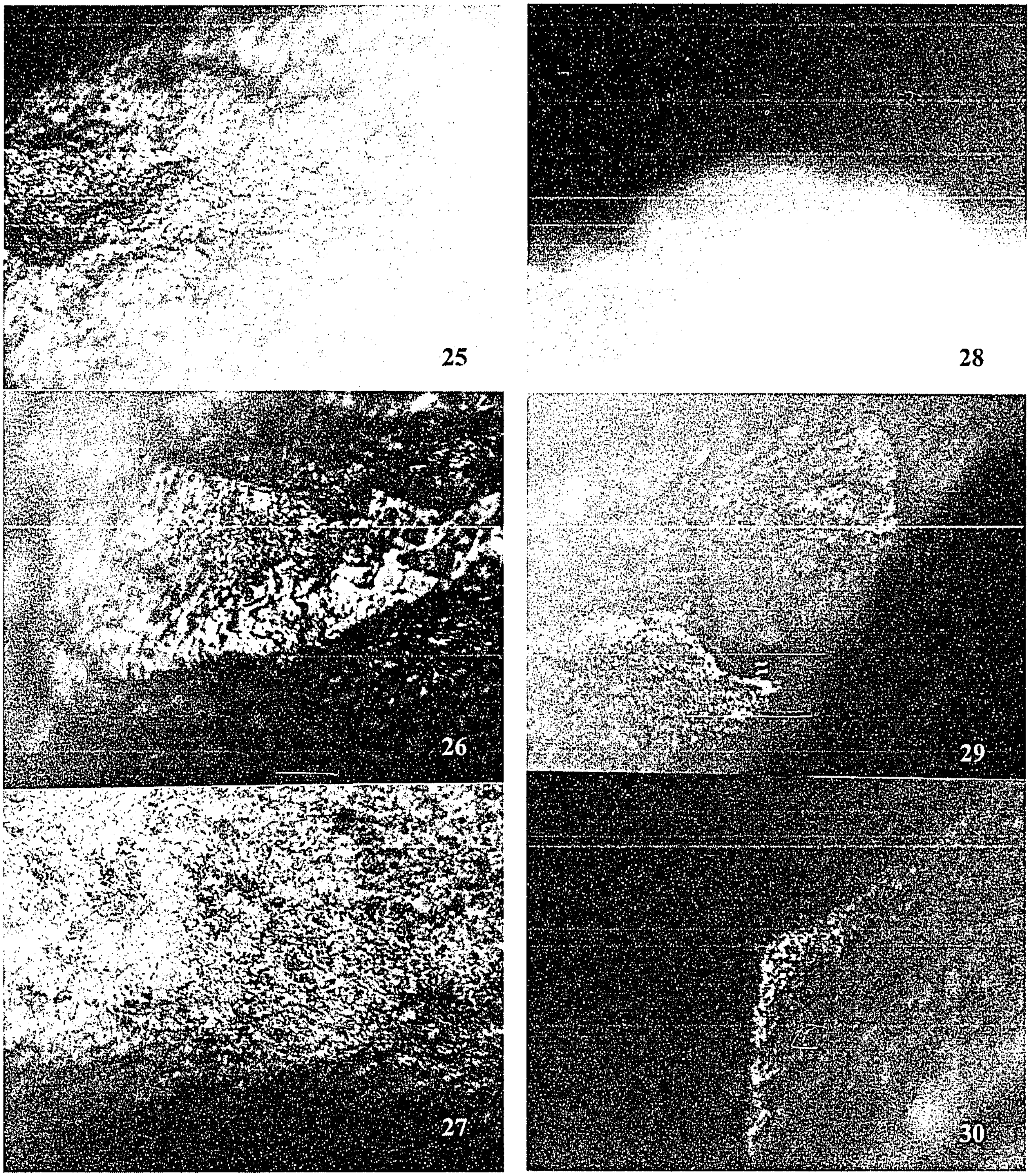


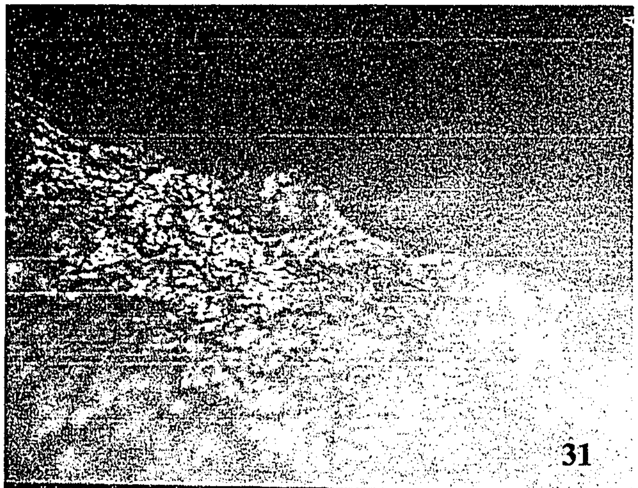

7
10
8
11
12


13
14
15


16
17
18

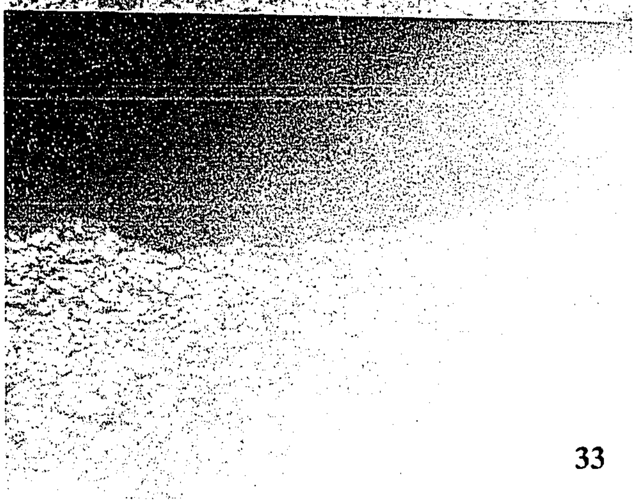

19
20
21
22
23
24


25
28
26
29
27
30

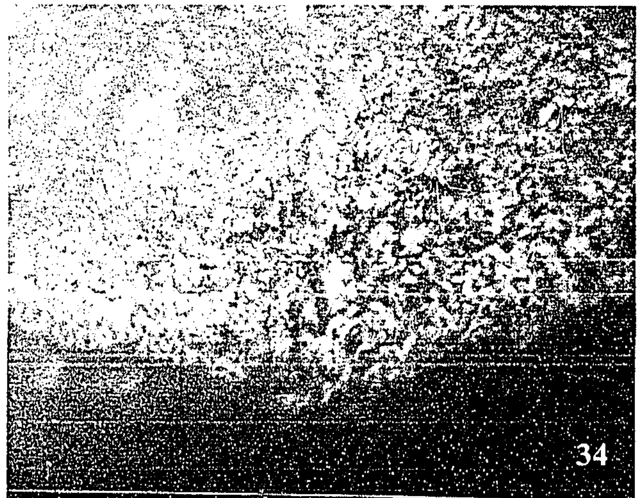


31

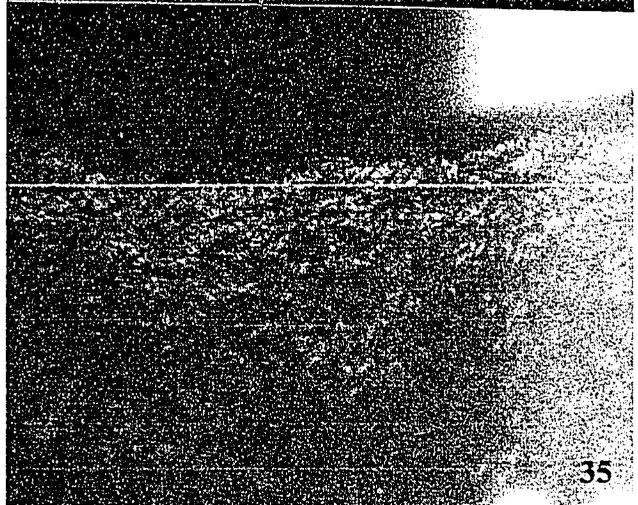
32



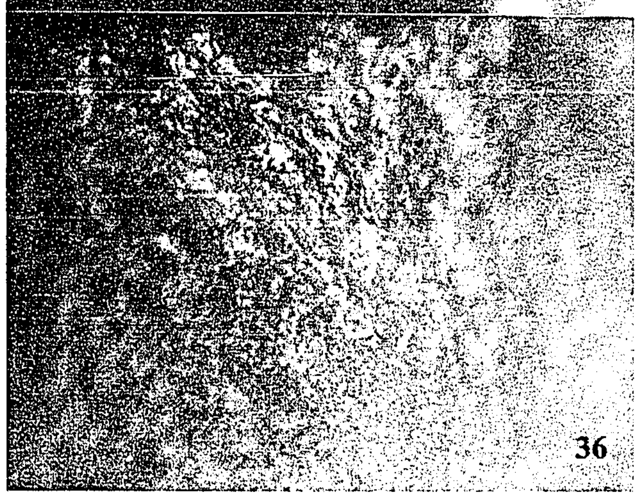
33



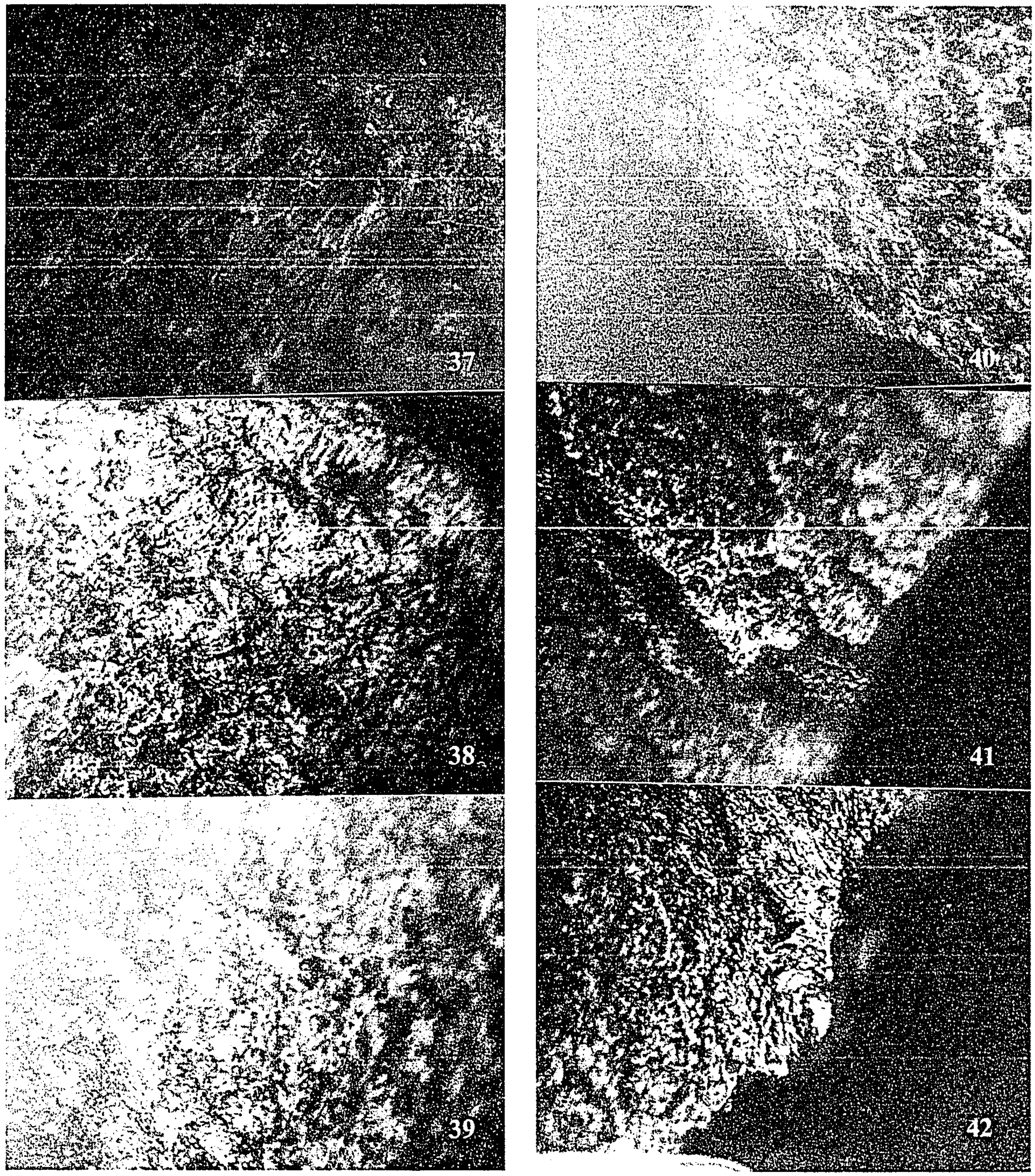
34

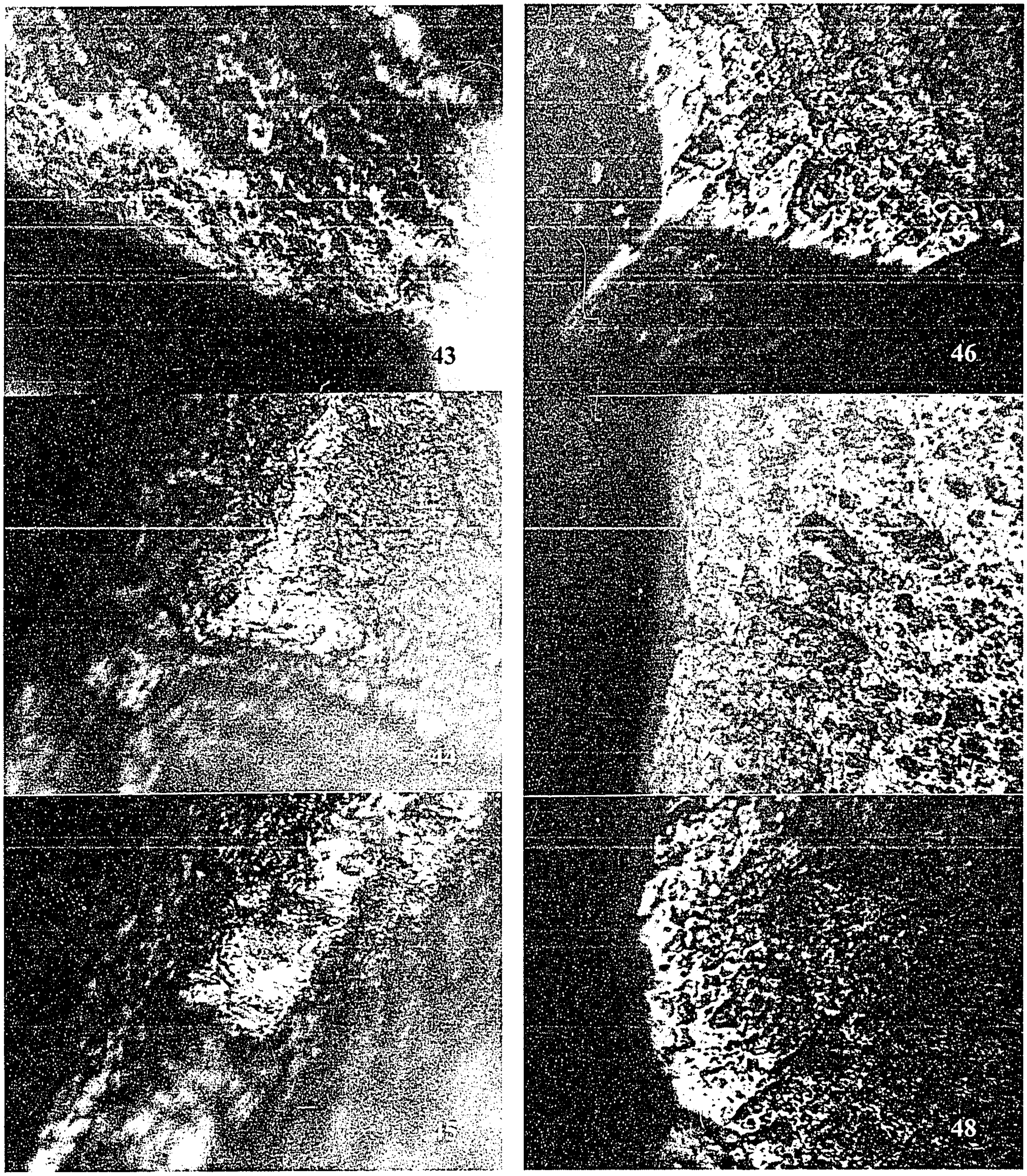


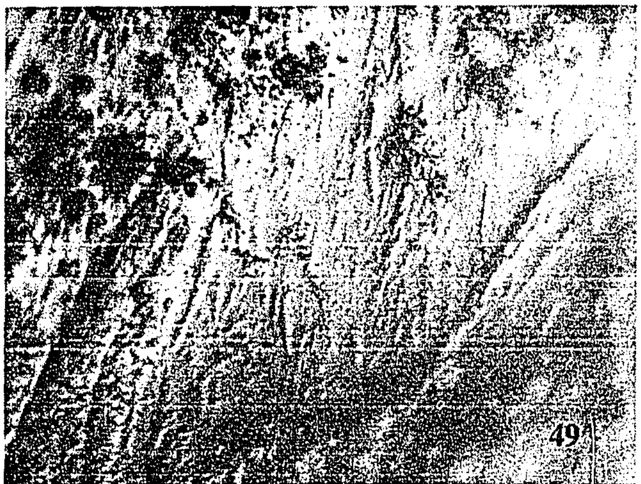
35

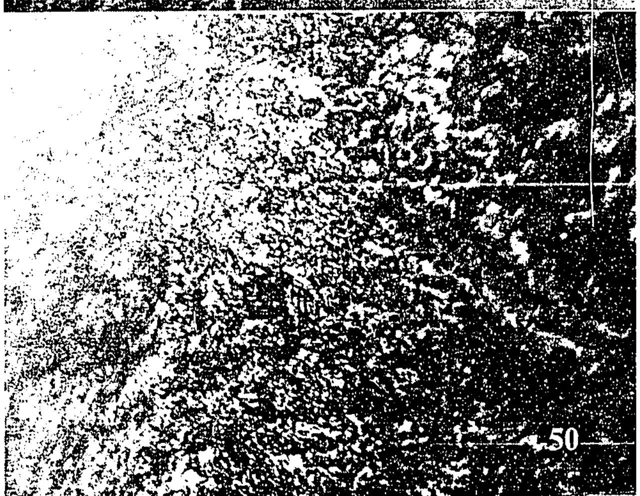


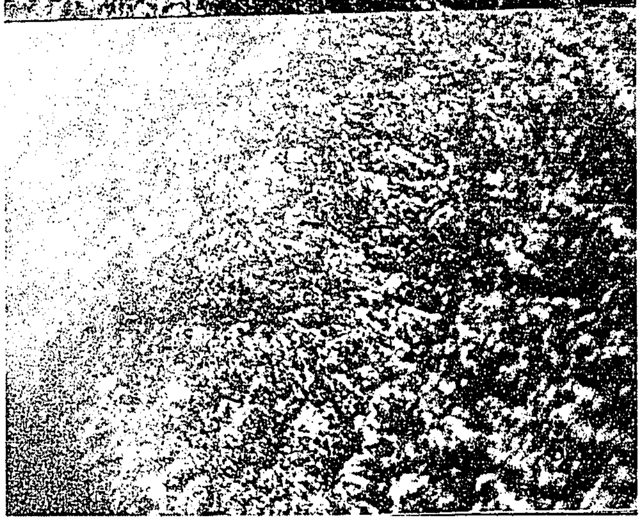
36

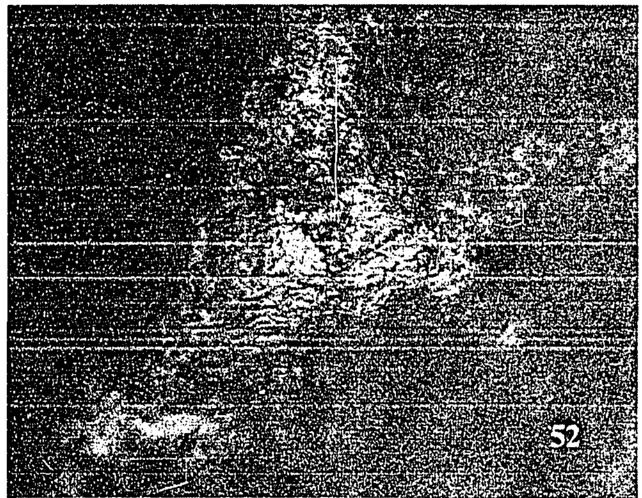

37
38
39
40
41
42

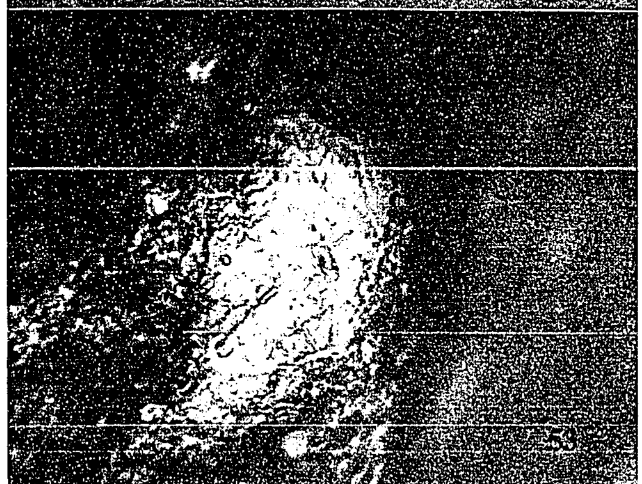

43
46
48

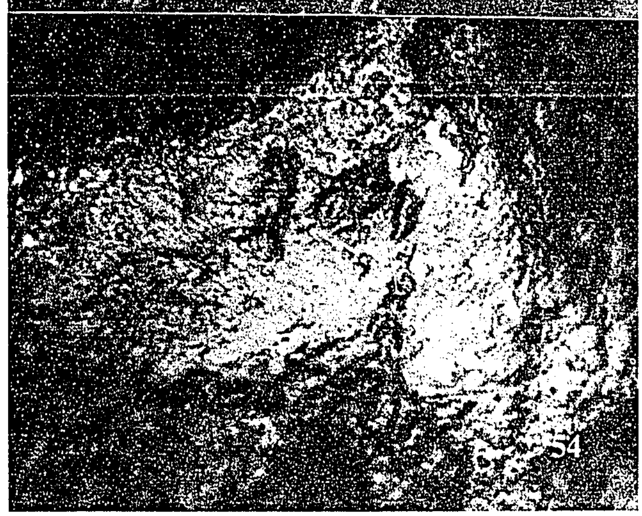

49

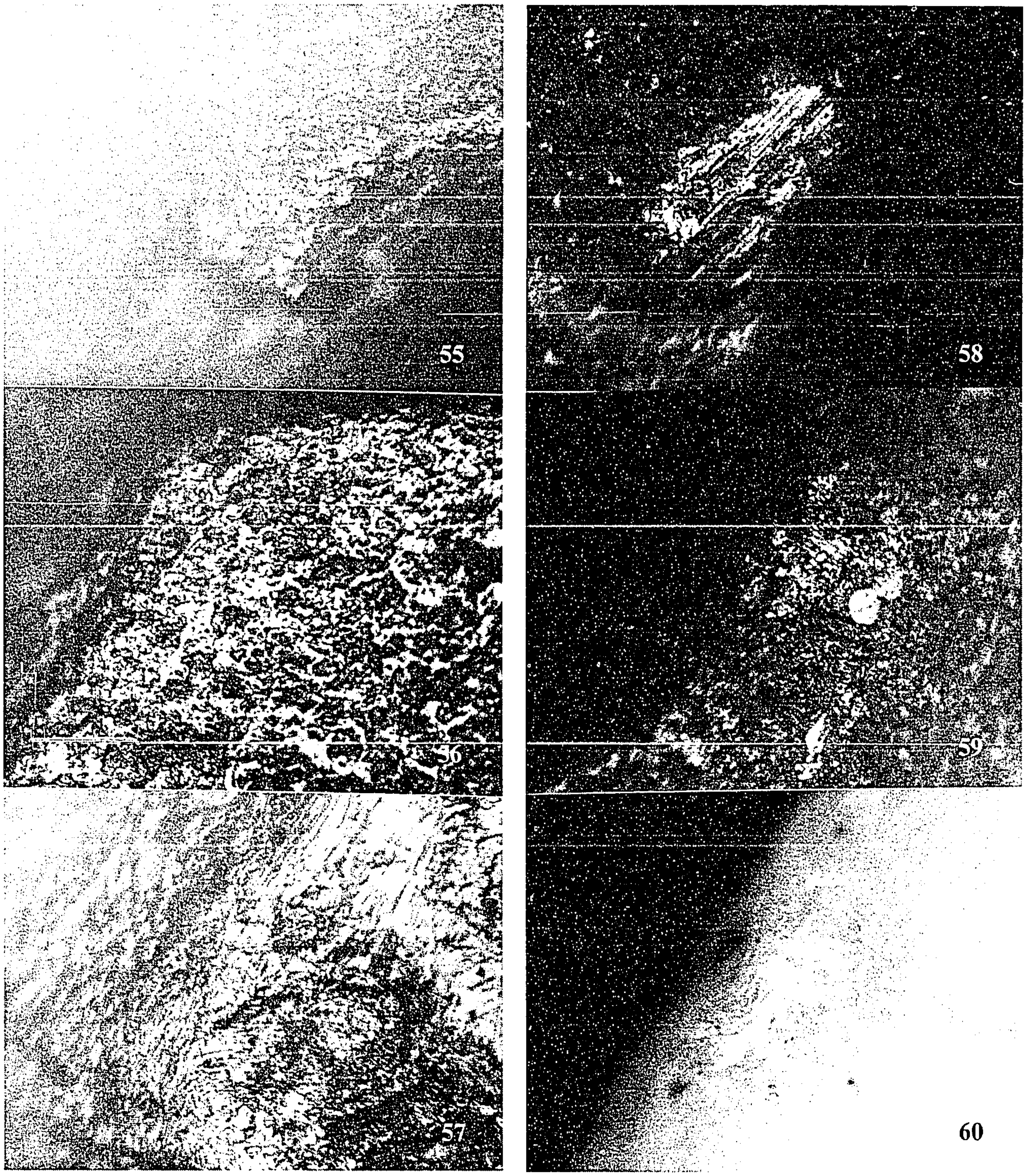

50

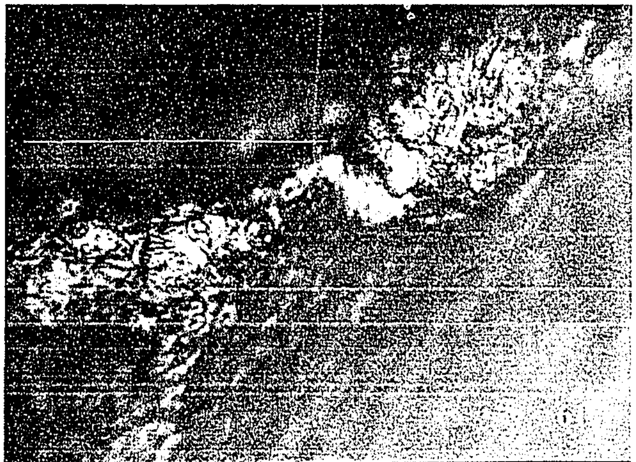



52


53

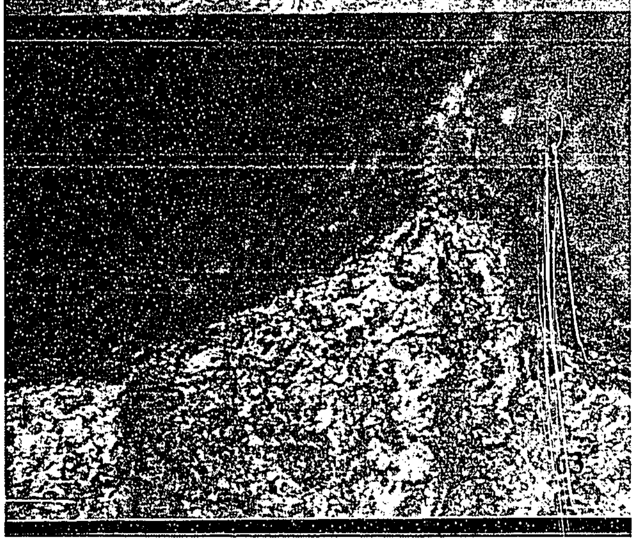

54


55 56 57 58 59 60

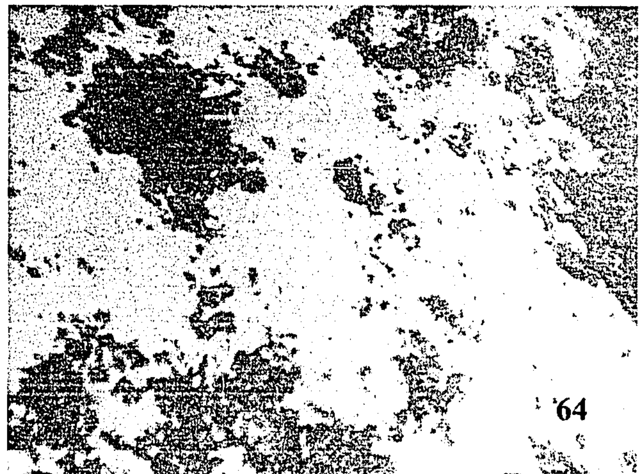


61

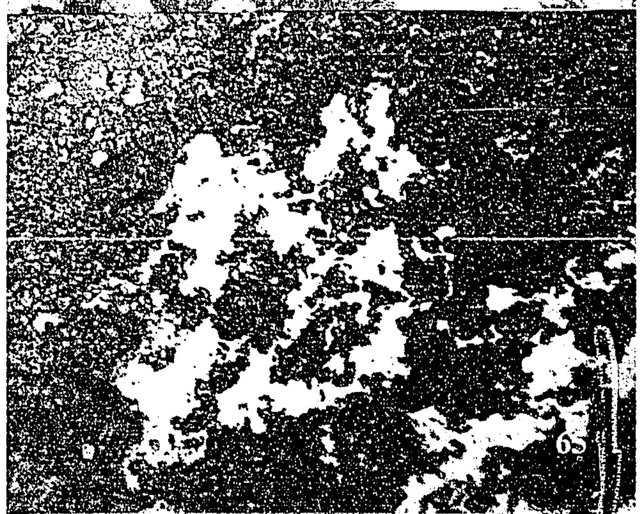
62



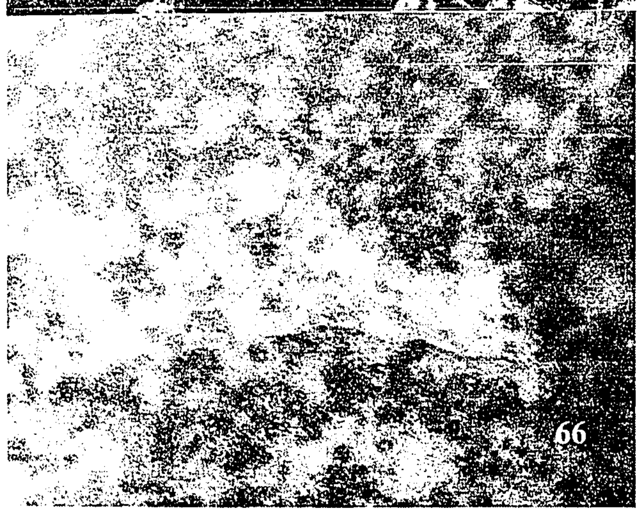
63



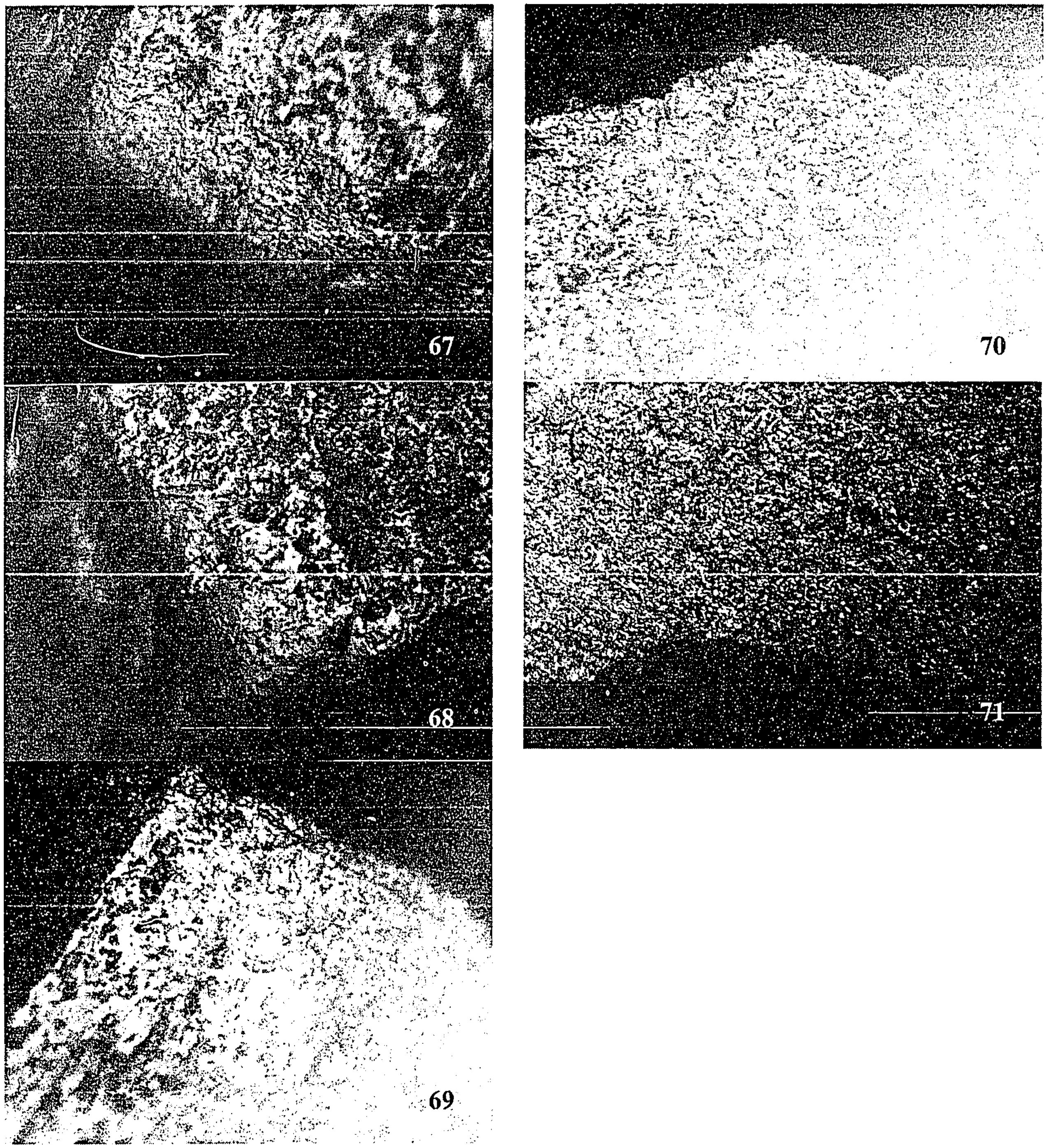
64



65



66


67
70
68
71
69

Use-wear Motions and Contact Materials

1. MG 173/11- scrape, wood (200X)
2. MG 255/13- saw, wood (200X)
3. Exp. CH 8- saw, wood (200X)
4. MG 77/71- whittle, wood (200X)
5. MG 107/3- whittle, wood (200X)
6. MG 135/4- cut/slice, wood (200X)
7. Exp. CH 26- scrape, bone (200X)
8. Exp. CH 21- scrape, bone (200X)
9. MG 26/90- saw, pottery [ceramic] (200X)
10. MG 129/88- cut/slice, bone (200X)
11. MG 82/22- whittle/plane(?), bone [well-developed, atypical polish] (200X)
12. MG 174/17- whittle/plane, bone (200X)
13. MG 202/12- saw, pottery [ceramic] (200X)
14. Exp. CH 55- saw, pottery [ceramic] (200X)
15. SP 177/37- rub/strike, metal (200X)
16. SP 177/50- rub/strike, metal [and rust stains] (200X)
17. Exp. CH 98- strike, metal (200X)
18. MG 157/21- cut/slice, dry hide (200X)
19. Exp. CH 42- scrape, fresh hide (200X)
20. Exp. CH 28- cut, fresh hide (200X)
21. SP 103/8- cut/slice, fresh hide(?) (200X)
22. MG 75/4- scrape, dry hide (200X)
23. MG 130/13- scrape and cut, dry hide (200X)
24. MG 217/1- scrape, fresh hide [interior] (200X)
25. MG 217/1- scrape, fresh hide [exterior] (200X)
37. SP 33/4- haft polish, wood (200X)
38. MG 129/6- haft polish, dry hide (200X)
39. SP 208/1- scrape, meat(fish?)/fresh hide(?) (200X)
40. Exp. CH 63- cut, reedy plant (200X)
41. MG 167/30- cut/slice, bone (200X)
42. MG 129/34- scrape, meat(fish?) [and bone?] (200X)
43. Exp. CH 23- plane, wood (200X)
44. MG 80/13- drill/bore, bone [and meat/fish?] (200X)
45. MG 130/10- chop, wood (200X)
46. Exp. CH 22- scrape, antler (200X)
47. Exp. CH 17- saw, antler (200X)
48. MG 95/47- whittle/plane, antler (200X)
49. MG 196/3- haft polish, wood (200X)
50. Exp. CH 61- cut, plant (200X)
51. MG 114/15- cut/slice, plant [stems] (200X)
52. MG 26/3- haft polish, wood (200X)
53. MG 157/29- haft polish, wood (200X)
54. Exp. CH 5- haft polish, wood (200X)
55. MG 118/1- cut/slice, woody plant (200X)
56. Exp. CH 63- cut, reedy plant (200X)
57. MG 26/38- dig/hoe, soil/sand (200X)
58. Exp. CH 50- saw, shell (200X)
59. MG 202/3- saw, shell (200X)
60. SP 89/1- saw, shell (200X)
61. MG 26/11- drill/bore, wood (200X)

26. MG 26/8- pierce, bone and meat (fish?) (200X)
27. MG 77/37- cut/slice, dry hide (200X)
28. SP 65/5- cut/slice, meat/fresh hide (200X)
29. MG 129/18- scrape/scale(?), fish scales(?) (200X)
30. Exp. CH 51- scale, fish scales (200X)
31. SP 98/3- cut/scale(?), meat(fish?) and bone (200X)
32. Exp. CH 14- cut, meat (200X)
33. MG 29/19- cut/slice, meat(fish?) (200X)
34. Exp. CH 19- cut, meat and bone (200X)
35. MG 76/19- cut/slice, plant fibre (200X)
36. SP 111/2- whittle, wood (200X)

62. MG 95/48- saw, bone (200X)
63. Exp. CH 31- saw, bone (200X)
64. Exp. CH 103- rub, stone ['bright spots'] (200X)
65. MG 26/52- rub, stone ['bright spots'] (200X)
66. SP 103/9- white patina (200X)
67. Exp. CH 24- scrape, dry hide (200X)
68. MG 80/8- scrape, wood (200X)
69. SP 208/1- saw, bone (200X)
70. SP 102/2- cut/slice, meat(fish?) (200X)
71. Unused chert surface (200X)