Name: G. URQUHART

Thesis Title: MAGNETITE DEPOSITS of the SAVAGE RIVER - ROCKY RIVER REGION, TASMANIA

DEPARTMENT: DEPARTMENT OF GEOLOGICAL SCIENCES

DEGREE: MSc.

DATE: 5TH APRIL, 1965.

COPY: 1

MAGNETITE DEPOSITS OF THE SAVAGE RIVER - ROCKY RIVER REGION, TASMANIA

by

G. URQUHART

B.Sc. Natal

A thesis submitted to the Faculty of Graduate Studies and Research of McGill University in partial fulfilment of the requirements for the degree of Master of Science.

Department of Geological Sciences,
McGill University,
Montreal.

April 1965

S T A T E M E N T

AUTHOR: G. URQUHART

TITLE of THESIS: MAGNETITE DEPOSITS of the SAVAGE RIVER - ROCKY RIVER REGION, TASMANIA.

The largest known magnetite deposits in Australia are present in three areas of the Savage River - Rocky River region in northwestern Tasmania. Magnetite is associated with amphibolite or disseminated in meta- sediment.

Folded, steeply-dipping Precambrian Whyte Schist underlies most of the region and encloses bodies and concordant linear sheets of amphibolite, which may be genetically related to a Cambrian serpentinized basic and ultrabasic complex. A Devonian granitic stock and flat-lying Tertiary sediments are also present.

Silica, feldspar and/or carbonate metasomatism is generally associated with magnetite deposits. Widely separated exposures of magnesite rock in meta-sediment may represent a deposit of substantial reserve.

Structural control of magnetite deposition, texture and structure of the ore, wall rock alteration, gangue minerals and paragenesis strongly suggest a magmatic hydrothermal origin for magnetite.

MAGNETITE DEPOSITS OF THE SAVAGE RIVER - ROCKY RIVER REGION, TASMANIA.

ACKNOWLEDGEMENTS.

The writer wishes to acknowledge the assistance rendered by members of the Department of Mines in various aspects of the compilation of this report. Mr. B. Cox prepared thin and polished sections of minerals and rocks from the area and selected from drill core. Mr. R. Jack assisted greatly with the apparatus used in photographing various slides and sections and in developing the glass plates. Mr. G. Everard, department petrologist, gave advice on mineral identification in a number of thin sections. Mr. K. Kendall of the drawing office and his staff were responsible for the compilation of plans and sections from base maps. Mr. W. St. C. Manson, Chief Chemist and Metallurgist, and his staff assayed or chemically analysed the various samples submitted to the Mines Department Laboratory in Launceston. In addition, the writer benefited by advice and ideas suggested in discussions with officers of the Mines Department.

A special word of thanks is accorded Mr. W. Pitulej, prospector and companion, whose assistance in the field during the course of the investigation was invaluable.

Permission to use the work on the deposits as the subject of a thesis was very kindly granted by the Director of the Department of Mines.

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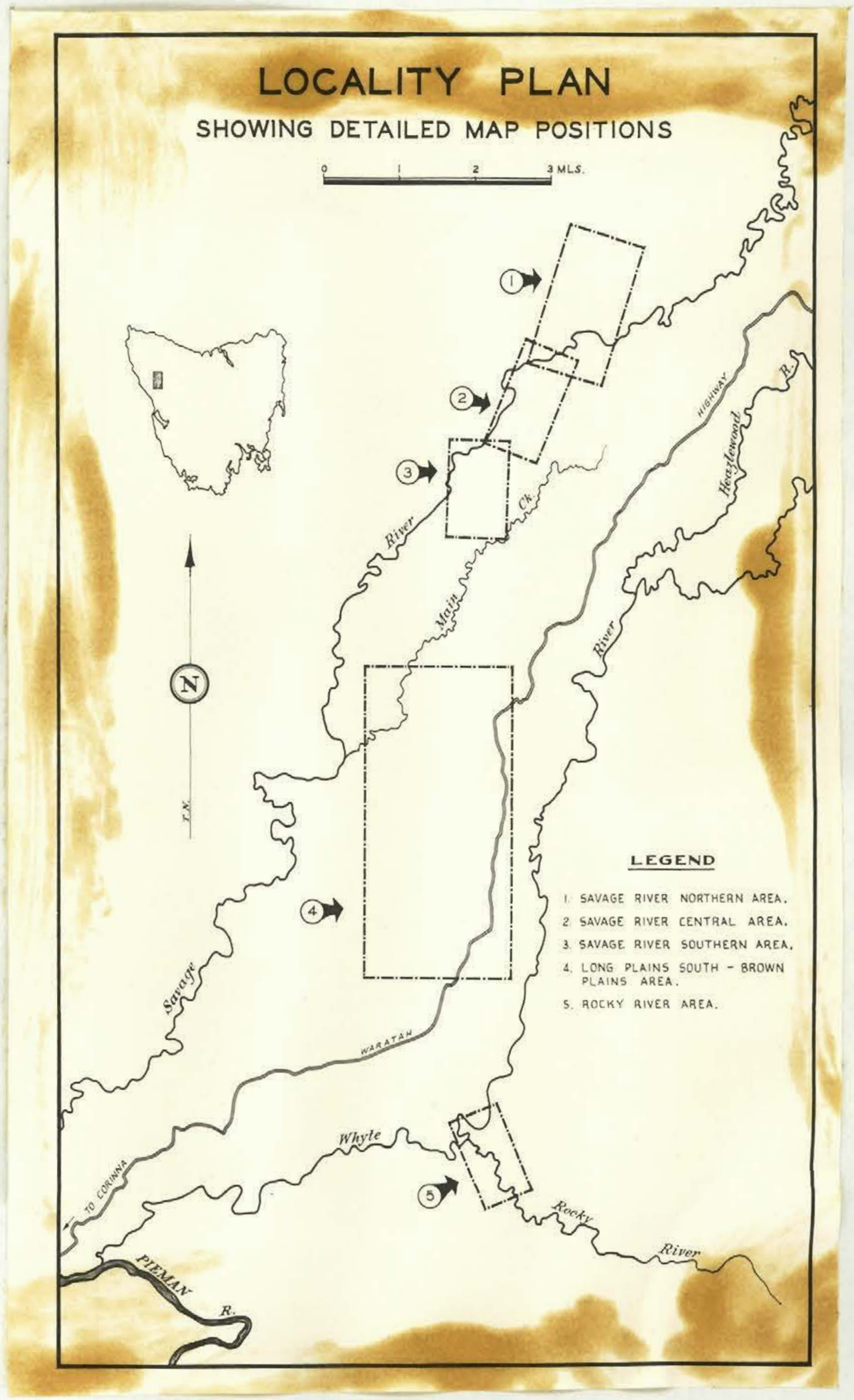
PART I.

G E O L O G Y

OF THE

SAVAGE RIVER - ROCKY RIVER REGION.


LOCALITY PLAN
SHOWING DETAILED MAP POSITIONS
0 1 2 3 MLS.
LEGEND
1. SAVAGE RIVER NORTHERN AREA.
2. SAVAGE RIVER CENTRAL AREA.
3. SAVAGE RIVER SOUTHERN AREA.
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5. ROCKY RIVER AREA.
Savage River
Main Ck.
Hellyer
River
HIGHWAY
WARATAH
Whyte
Rocky River
PIEMAN R.
TO CORINNA
N

Fig. 1

I. INTRODUCTION.

I. Purpose of Investigation.

The regional and detailed geological survey of the Savage River- Rocky River area in 1963 and 1964 was undertaken as a result of renewed interest in the magnetite deposits of the region after the lifting of the embargo on the export of iron ore from Australia by the Commonwealth Government in December, 1960.

The ban on the export of iron ore was relaxed in order to stimulate interest in the search for new deposits and to encourage more detailed investigation of known deposits in Australia.

2. Location of Area

The Savage River magnetite deposits occur in the isolated northwest part of Tasmania (Fig. 1). The only route of approach is along the Waratah-Corinna gravel road which terminates at Corinna on the Pieman River, 40 miles southwest of Waratah.

Mineralization is present in three separate areas within a distance of 13½ miles, extending from the Savage River to a point south of the Rocky River. The Savage River deposit straddles the Savage River roughly midway between Waratah and Corinna about 2½ miles west of the Corinna road. The other magnetite deposits along this belt occur in the Long Plains South-Brown Plains area and in the Rocky River area. The intervening terrain between the Savage River deposit, Long Plains-Brown Plains deposit and Rocky River deposit is barren or sparsely mineralized.

3. Size of Area.

The regional geological map (Fig. 2) includes the area bounded on the west by the Savage River, on the east by the Corinna-Waratah road, on the south by the Whyte and Rocky rivers, and in the north by an arbitrary line about 1½ miles north of traverse G.8. in the northern area of the Savage River deposit.

The uninhabited, undeveloped tract of country bounded by these features is about 15 miles long by 2 miles wide, occupying part of sheet C/4 of the Magnet Quadrangle, and part of sheets A/2, A/4, and C/2 of the Corinna Quadrangle. Access by vehicle is possible but restricted to one or two roads in the area.

The geology to the east of the Waratah-Corinna road is also represented in an area which is not readily accessible. The geology, based on rock exposure in the headwaters of the Rocky River has been deduced from photo-interpretation, mainly to show the granite boundary, bearing in mind the possible significance of granite as a source of mineralization.

4. Method of Investigation.

Initially the area was regionally mapped using air photos (scale 1: 23760) wherever geographical features could be pinpointed on roads and rivers. The geological and survey data were plotted on topographic sheets (scale 1: 15840) of the Magnet and Corinna Quadrangles, which served as base maps for the area. Roads were surveyed by their intersection with traverse lines or by compass and tape measurements. The individual deposits were mapped in greater detail along traverse lines cut for the Bureau of Mineral Resources (B.M.R.), using their contoured magnetic anomaly maps for reference. The ground geophysical work of the B.M.R. extended from the Brown Plains area to an area north of the Savage River, the distance of the single continuous baseline being in the order of 11 miles, cut in heavily timbered terrain. An aneroid barometer was used on traverse lines for altitude readings where the pegs were obliterated or missing.

The detailed geology of the southern, central, and northern areas of the Savage River deposit was plotted on maps (scale 1 inch = 200 ft.) of the surveyed base and traverse lines, originally compiled by the Bureau of Mineral Resources to show the magnetic anomalies of these areas.

In the Rocky River deposit existing traverse lines cut by Rio Tinto Australian Exploration in 1959 were recut and surveyed by officers of the department. A ground magnetometer survey and a geological survey of part of the area were subsequently made.

Traverses along river beds, creek beds and bulldozed roads yield more geological information than traverses along cut lines, thus the geological boundaries of the various map units were defined mostly from outcrops observed along exposed sections. Adits were mapped by the use of tape and compass, and bulldozed trenches by the use of a theodolite.

The area was investigated in the field seasons of 1963 and 1964, and diamond drill cores were examined and logged in the winter of 1963.

5. History of Discovery, Geological Work and Exploration.

The deposits were originally discovered by Surveyor General Sprent in the seventies of the last century during one of his early expeditions to the West Coast. Early references to the deposits, first known as the Rio Tinto deposits, included those by Jones (1898) and Twelvetrees (1900,1903,1908). Reid (Twelvetrees and Reid, 1919) gave the first description of the Savage River deposits and a calculation of iron ore reserves. Magnetite deposits in the Whyte River and Rocky River areas were the subject of a report by Reid in 1924. Woolnough (1939), after a cursory examination, was unimpressed with the Savage River deposits, partly through lack of outcrops and the expense necessary to obtain undoubted geological information.

Exploration work before the turn of the century consisted of shafts, adits and trenches excavated by various gold and silver mining companies in the belief that precious metal and base metal sulphides existed at depth. The companies were short-lived, as results from the exploratory work did not reach expectations. The deposits were investigated as a source of iron in 1926 by the Hoskins Iron and Steel Company but work ceased after shaft sinking and tunneling revealed pyritic magnetite.

A revival of interest in these deposits within the last 10 years, especially by Japanese steel industrialists, has resulted in a systematic programme of exploration and geological mapping. The area was reserved from occupation under the Mining Act on the 31st of August 1955, to enable the Department of Mines to assess the area.

The Bureau of Mineral Resources, at the request of the Department of Mines made an airborne magnetometer survey during May, 1958, which proved so encouraging that the Bureau of Mineral Resources agreed to make a comprehensive ground magnetometer survey. A pack track was cleared into the area and magnetic surveys were conducted under the direction of Keunecke in 1957, Sedmik in 1960 and Eadie in 1961 and 1962.

Preliminary geological maps of the Savage River and Long Plains South deposits accompanied reports by Hughes in 1957 and Tetlow in 1959.

After the initial ground magnetometer and geological surveys were completed in 1957, two diamond drillholes were bored in the northern area to test the deposit. Camping and drilling equipment was transported by helicopter. The completion of test drilling in June 1958, followed by ore dressing investigations of the core, marked the end of the first stage in the exploration of the area.

Rio Tinto Australian Exploration Pty. Ltd; (R.T.A.E.), not connected with the earlier Rio Tinto holding, held areas adjacent to the Savage River deposit under a Special Prospecting Licence until 1961. In 1959 this company diamond drilled a hole (R.T.A.E. 1) in the Long Plains South deposit.

The second stage of exploration commenced in 1959 with the construction of an access road from the Corinna-Waratah road to the central area of the Savage River deposit. Diamond drillholes 3 to 10 were bored by the Department of Mines in the central Savage River area. In 1961 an Exploration Licence was granted to Mr. E.R. Hudson of Industrial and

Mining Investigations, Pty., Ltd., who undertook to continue diamond drilling, to arrange smelting tests, and to investigate the possibilities of an integrated steel plant in Tasmania. On completion of drillhole I6, iron ore reserves based on borehole sections were calculated by Symons (1962) for the area between Magnetite Creek and the Savage River.

Mineragraphic investigations of Savage River magnetite were made by Baker and Edwards (1958) Edwards (1960) and Williams and Edwards (1960); officers of the Commonwealth Scientific and Industrial Research Organisation.

Ore dressing and smelting tests proved the ore suitable for steel production but the absence of suitable coking coals in Tasmania and the availability of large local Hydro-electric resources focussed interest in the Strategic-Udy electric smelting process. A parcel of material representing crude ore and concentrate was sent with a parcel of Tasmanian coal to the United States Strategic Study plant at Niagara Falls for testing. The tests were successful and demonstrated that both pig iron and specification grade carbon steel could be produced from Savage River iron ore.

The iron ore is also amenable to pelletizing. If the deposits are to be exploited using this process it is envisaged that the ore would be pulverized at the site and transported by pipeline to a port where the pulp would be beneficiated and converted to pellets.

II. GEOGRAPHY.

1. Access.

The only route of approach to the deposits is from Waratah along a gravel road which terminates at Corinna on the Pieman River, 40 miles to the southwest. Access to the Savage River central deposit is by a jeep road 4 miles long which leaves the gravel road at a point 21 miles from Waratah. (fig. 2). The jeep road continues into the northern area as far as traverse GOO on the baseline. Access to the southern area of the Savage River deposits is along a bulldozed track which connects with the Long Plains South deposit. The track is negotiable only by four-wheel drive vehicles at the driest time of the year.

Ingress to the Long Plains South-Brown Plains deposit is achieved by three access roads which have been bulldozed at different points along the main Waratah-Corinna gravel road (fig. 2). The road branching off the main road at a point 31 miles from Waratah serves the Long Plains South deposit and ultimately reaches the central Savage River area.

The jeep road to the Rocky River deposit turns off the main gravel road about 34 miles from Waratah and descends over a distance of 2 miles to the Whyte River. The road terminates at the river which can be crossed on foot when the water level is low, and by a cage slung between the banks when it is in flood. The easiest route to the deposits south of the Whyte River is along the old water race.

Plate 1. View southwest across Savage River valley from the northern area.

2. Topography.

The last 20 miles of the road to Corinna traverses the watershed between the Whyte River to the east and the Savage River to the west. The greatest relief is 800 ft. (pl. 1), provided by the deep valleys which have been rapidly eroded by the two rivers. Relief decreases with distance from the major valleys and Brown Plains and Little Plains in the south of the map are still preserved from headward erosion at an altitude ranging from 750 ft. to 800 ft. The maximum altitude is about 1200 ft. in the area of the Savage River deposit, and decreases to about 900 ft. in the area of the Rocky River deposit. The gradient is 1 in 4 for a distance of half a mile west of the southern Savage River deposit. In many places the grade is steeper over a shorter distance.

The incised meanders of the Whyte and Savage rivers are aligned roughly parallel to the strike of the country rocks. The rivers flow in a south or southwesterly direction as far as their confluence with the Pieman River. Tributary rivulets and creeks are superimposed and generally transect the strike of the country rock. Headward erosion acting outwards from the tributaries has produced a trellis drainage pattern, controlled by the structure of the underlying metamorphosed sedimentary rock.

The overall topography is that produced by active dissection of an inclined coastal surface, the Henty Surface, remnants of which are preserved beneath overlying younger igneous and sedimentary rocks at an altitude ranging from 750 ft. in the southwest of the map to 1200 ft. in the northern area.

3. Climate and Vegetation.

Rainfall ranges from 80 to 100 inches a year; precipitation is greatest in winter from May until September. Fog at night and early in the day is frequent in Autumn and Spring.

The areas of the magnetite deposits are thickly forested with rain-forest vegetation. Myrtle, sassafras and giant manferns grow in profusion. Stands of blackwood, dogwood, leatherwood and candlewood grow in patches. Celery-top pine is present in a few places. Horizontal scrub and bauera is so dense in certain areas that progress on foot is greatly retarded. The ground is strewn with fallen timber and mantled with decaying vegetation. Bracken fern, mosses and lichen thrive in the moist climate. Long Plains, Brown Plains, West Plains and Little Plains are covered with button grass. Drainage is poor and these areas are generally sodden or marshy.

4. Rock Exposures and Topography of the deposits.

The best record of the relation of the host rock to mineralization, and of changes which take place in the host rock, is preserved in drill core from the inclined boreholes. The average depth of weathering is 100 ft. so unweathered rock is exposed only in deeply incised sections. Fresh rock crops out in the Whyte, Rocky and Savage rivers, in a few of the more deeply dissected creeks, and along sections of bulldozed road. Outcrops are highly weathered in many of the smaller creeks with steep gradients; or the bed of the creek may be filled with material washed in from positions up slope. The proportion of the surface occupied by fresh rock outcrops

Plate 2. View south to central Savage River area.

is estimated at less than 5 per cent, the remaining area is covered with grey or brown clay soil.

In the areas where the central and northern Savage River deposits and the Rocky River deposit occur, the linear magnetite bodies and mineralized zones form crests, ridges and scarps (pl.2). The most pronounced scarp in the central area of the Savage River deposit is formed by a face of oxidized iron about 60 ft. in height at 450 ft. west on traverse 250 S (fig. 4). Other pronounced scarp faces and ridges of iron ore occur on traverses A,B, COB8 and between 2000 S and 2500 S in the central area (fig. 4) and on traverses D20 to E5 in the northern area. (fig.3). The scarps are faces of vertical lodes and are not related to faulting. The ridges are generally mantled with iron boulder scree and/or red soil which may indicate the presence of an iron lode concealed beneath overburden.

Minor scarp faces and boulder strewn ridges 5 ft. to 40 ft. wide and up to 10 ft. in height in the southern, central and northern Savage River deposits mark some underlying lodes. The ridges can be traced for distances up to 500 ft. Exposures of lode iron in the Savage River deposits are confined to trenches and adits; to the few places where scarps are formed of iron ore; and to the section of the deposit on the north bank of the Savage River. Elsewhere in the area mineralization can be reasonably inferred from boulder strewn ridges but relatively few lodes are represented on the surface in this manner. Much of the magnetite is concealed beneath scree or decaying vegetation. Diamond drilling, deep trenching by bulldozer, bulldozed roads and the re-opening of caved adits for inspection have yielded exposures, intersections and contacts of country rock and iron ore which have aided in the detailed mapping of the deposits.

Topographic expression of the iron deposits is less evident in the Long Plains South-Brown Plains deposit. The geology has been mapped from relatively few exposures in creeks and along road sections. Widths are indefinite because of scattered insignificant outcrops of iron ore. The most reliable evidence of width and grade of mineralization is from geological log and assay results of the core from drill hole R.T.A.E.1. The largest exposure of iron and scree is between traverses 11000N and 11500N (fig. 6) where the iron has been uncovered by a bulldozed road. Iron ore is also exposed in a few creek beds, and in jeep roads which have been bulldozed along the baseline.

Geological boundaries in the Rocky River deposit are fairly easy to map from rock exposures in the Whyte and Rocky rivers which transect the strike of the country rock. Fresh rock exposed in Cataract Creek and Nolan Creek confirm the geological boundaries. Iron lodes are exposed only on the centre line, line 4S, line 12S, and in Cataract Creek upstream from the water race. (fig.7). Dimensions of lodes, which are in the form of minor scarps and blocks 5 ft. to 10 ft. high on the hillslopes, are difficult to estimate because of rubble associated with the outcrops. The width of the mineralized zone exposed in Cataract Creek below the waterfall is 40 feet.

A magnetite-bearing zone forms the ridge extending from the Whyte River to the Rocky River. The ridge is underlain by red soil derived from the weathering of sedimentary schist.

III GEOLOGY.

1. Introduction.

The outstanding features of the geology are shown on fig.2 and in the table on page 15. The metamorphosed rocks of "Lower" Precambrian Whyte Schist form meridional belts in the region between the Whyte River and Savage River (fig.2). Less metamorphosed "Upper" Precambrian sediments are shown in the southwestern portion of the map and probably underlie the region to the west of the Savage River, extending southwards to the Pieman River area.

Amphibolite bodies and sheets, possibly Cambrian in age, are emplaced along the general strike of the psammitic and pelitic beds which constitute the Whyte Schist. The amphibolite is considered to be of igneous origin. Magnetite deposits in the Savage River, Long Plains South- Brown Plains and Rocky River areas are inclosed in amphibolite. The widths of these amphibolite bodies are variable. In the Rocky River area meta-sediments of the Whyte Schist are mineralized adjacent to amphibolite.

Magnesite and "dolomite" lenses in amphibolite and meta-sediments in the proximity of magnetite deposits appear to have formed by replacement of the host rock, and an origin related to that of the iron deposits is suggested.

Cambrian ultrabasic rock, including serpentinite, is shown in the northeast of the map. It occupies a large area to the north of the map area.

Cambrian? cataclasite (possible a sheared quartz diorite), a dyke-like body, separates amphibolite and Whyte Schist in the Rocky River area.

Devonian granite flanks the Whyte Schist formation to the east of the Whyte River where it forms a range of hills and mountains.

Tertiary basalt and sediments form plateaux in widely separated areas.

Recent alluvial deposits in the valleys of the Savage River, Whyte River, Rocky River and Main Creek have been economically important in the past.

Summary of exposed rock formations in the Savage River - Rocky River area.

Age	Rock Unit and Character	Thickness in feet	Economic value.
Quaternary	Iron scree	0-15	High grade iron.
	River banks and terraces of gravel and alluvium	0-20	Carries gold, chromite and osmiridium
	Gravel overlying Whyte Schist	0-5	Has been worked for gold.
Tertiary	Basalt	0-15	No recognized mineral value
	Conglomerate, gravel, grit, siltstone, mudstone and lignite	0-40	Tin and traces of chromite and gold have been recovered in Brown Plains area.
	Unconformity		
Devonian	Meredith Granite—granite, porphyry, aplite, etc.		Probable source of tin.
	Intrusive relationship		
Cambrian?	Rocky River Cataclasite—sheared quartz diorite, slightly recrystallized	100-200	No recognized mineral value.
	Fine -, and medium to coarse - grained amphibolite in Whyte Schist	Variable	Host rock to magnetite in Savage River, Long Plains South and Rocky River areas.
Cambrian	Bald Hill Complex —— serpentinized basic and ultrabasic complex	?	Source of chromite, osmiridium and possibly gold. Contains magnetite
	Intrusive Relationship?		
"Upper" * Precambrian(?)	Corinna Slate—slate and argillite	?	No recognized mineral value.

Summary of exposed rock formations in the Savage River - Rocky River area (contd.)

Age	Rock Unit and Character	Thickness in feet	Economic value.
"Lower" * Precambrian(?)	Whyte Schist—pelitic and psammitic rocks	?	Gold in pyrite-graphite zones in Main Creek area? Magnetite-bearing chlorite schist in Rocky River deposit.

* The "Lower" and "Upper" divisions of the Precambrian represent metamorphosed and less metamorphosed rocks. The terms have been retained to comply with previous nomenclature used by the Tasmanian Department of Mines although the field relationship of the rocks is not certain.

2. Stratigraphy and Petrology.

2.1 Sedimentary and Metamorphosed Sedimentary Rocks.

2.1.1. "Lower" Precambrian Whyte Schist.

The first record of metamorphosed Precambrian rocks in the area is by Twelvetrees in 1903, describing the assemblage between Main Creek and Long Plains. Long Plains Schist was the name given to the formation by Twelvetrees in 1908. Spry (1962a, p.110) termed the rock exposed in the Pieman and Whyte Rivers the Whyte Schist formation.

The Whyte Schist is distributed in a belt between the Savage and Whyte rivers, which were the arbitrary boundaries selected for mapping.

Extension of the Whyte Schist beyond the map limits towards the west and north is very likely and continuation of the Whyte Schist to the south is indicated in the reports of Spry and Ford (1957) and Spry (1964) who traced the formation in an arc extending from the Pieman River to the West Coast.

The Whyte Schist is divided into two rock units: -

(a) a psammitic assemblage of silty shale, siltstone, mica-quartz schist, graphite and black pyrite schist, quartzite; containing phyllite and minor intercalated bands of chlorite schist.

(b) A dominantly pelitic assemblage of argillite, clay shale, phyllite, and chlorite-muscovite schist. Bands and zones of siltstone, mica-quartz schist and quartzite are intercalated in the succession.

The pelitic and psammitic assemblages are conformable, but

Plate 3. Faulted pelitic and psammitic Whyte Schist contact. Long Plains South area.

Plate 4. Graphitic schist and phyllite. Whyte Schist exposed on the Waratah-Corinna road.

the steep attitude and isoclinal folding of the rocks, (fig.14) and paucity of top and bottom features, make the determination of relative age uncertain. The pelitic rocks lie below psammitic rocks in one exposure of the contact (pl. 3).

Rock units (a) and (b) are shown as separate map units. The phyllite in the psammitic assemblage is characteristically lustrous, the silver-grey sheen of the fresh rock being imparted by muscovite and sericite. The psammitic sediments are grey or white and the assemblage as a whole is pale in colour. Quartz veins, stringers and augen are visible in outcrops of sericitic phyllite and muscovite schist (pl.4) but banding parallel to foliation can only be detected microscopically in chlorite schist.

The pelitic sediments are greenish-black or pale green and weather to a brown clay.

The distribution of the two rock units is in parallel belts. Not only lithology but soil cover and topography differentiate the rocks at their contact. On the access road to the Savage River deposit the boundary between the psammitic (silty) and pelitic (argillaceous) units is marked by a difference in altitude of about 100 ft. The same difference in altitude marks the boundary between the two units on the access road to the Long Plains South deposit. The psammitic unit is more resistant to erosion and underlies the higher ground. The relief between the two units decreases southward and the contact is not sharply demarcated, possibly because the boundary is gradational.

Under the microscope the structure of phyllite is seen to be banded, imparted by original layer to layer differences in

Plate 5. Microphotograph showing quartz-feldspar porphyroblasts, lenses and bands in schist(X65)

Plate 6. Flat-lying Tertiary conglomerate above vertical Precambrian Whyte Schist.

composition of quartz, albite and platy minerals (pl. 5). Augen-shaped or subhedral individual crystals of albite, or aggregates 0.4 to 0.6 mm. in size are present as porphyroblasts. Many of the larger albite porphyroblasts are carlsbad-twinned and carry inclusions of muscovite, quartz, epidote, and dolomite in strings parallel to the schistosity. Quartz crystals, discrete or in aggregates, show undulose extinction. Chlorite in small amount is generally interleaved with muscovite. Sphene, magnetite, and epidote are accessory minerals.

Thin sections of chlorite schist under the microscope show a similar structure and texture. Albite crystals up to 1 mm. in size, many of them carlsbad-twinned, and/or lenses of quartz aggregates produce the porphyroblastic texture. Schistose structure is due to preferred orientation of platy minerals. Albite shows sieve structure caused by inclusions of sphene, epidote, chlorite and magnetite parallel to schistosity. One or two albite crystals have been rotated and the strings of inclusions are not parallel to the host schistosity. Chlorite shows anomalous birefringence and strong pleochroism (green→brown). Fine lamellae of highly birefringent pleochroic mica (biotite?) is characteristic of the chlorite schist. Strings of sphene in chlorite are parallel to the schistosity.

The metamorphic grade of Whyte Schist corresponds to the albite-muscovite-chlorite subfacies of the Greenschist Facies. Albite porphyroblasts in chlorite schist and in muscovite-chlorite phyllite increase in size toward the south. In the Savage River area albite is absent or very sparse, and fine grained in schist or phyllite. In the Rocky River area they reach a maximum diameter of about 1.5 mm. in chlorite schist. Albite porphyroblasts in phyllite and schist of the psammitic assemblage are smaller in the same area.

Bedding schistosity is dominant in Precambrian rocks. Axial plane schistosity in folded incompetent (phyllite) beds is prominent but does not obliterate bedding schistosity. Cross-bedding and graded bedding have been recorded from very few places. Top and bottom determinations in the isoclinally folded rocks have been identified in one or two places along the main road. Thickness of the different facies in the respective rock units is variable because of rapid facies changes and facies intercalations. Phyllite is generally thinly-bedded in layers one eighth of an inch to half an inch thick in a homogeneous section, but many exposures show rhythmic alternations of phyllite with phyllite of slightly different composition, with siltstone, or with one of the other facies of the unit. Single beds of mica-quartz schist, siltstone, and quartzite range from a few inches to about 20 ft. in thickness. The thickness of quartzite west of the baseline in Main Creek is much greater but isoclinal folding complicates the determination of thickness. The section exposed for 200 to 300 yards from the turn off on the Savage River road is one of the longest continuous sections that can be seen.

The source of these rocks, which are the oldest in Tasmania, is not known. Deposition of clay, shale, silt and sandstone beds fluctuated rapidly in a basin which was later uplifted to form a geanticline. The green chlorite schist facies and meta-pelite possibly were originally from volcanic ash.

The contact between the two rock units of the "Lower" Precambrian formation is best exposed on the access road to the Savage River where it is gradational in a 100 ft. section from quartz schist and phyllite into brown weathering green clay, argillite and schist. In the Long Plains area one observed contact of the two units is conformable and sharp between quartz-mica schist and green and black chlorite schist. The contacts have been offset by three parallel reverse faults (pl.3).

The relation of "Lower" Precambrian Whyte Schist to "Upper" Precambrian Corinna Slate is obscure. The crucial contact section along the Waratah-Corinna road approx. 5 miles from Corinna is covered with Tertiary sediments.

Air-photo study of the area west of the Savage River not accessible to the writer indicates a change in the regional strike of rocks of presumable "Upper" Precambrian age. Steeply-dipping fold patterns suggest a different order of folding. An unconformity or fault on this evidence may therefore exist. The difference in altitude between "Upper" and "Lower" Precambrian rocks in the area west of Brown - and Little Plains between the Corinna road and the Savage River is about 350 ft. and may be due to a fault.

Flat-lying plains and plateaux of Tertiary sediment and basalt overlie steeply-dipping Whyte Schist, with a 70 to 85 degree structural discordance.

The schistose sedimentary rocks of the area were thought to be pre-Silurian in age by Twelvetrees (1900) because of the metamorphic grade. In 1908 he described the Long Plains schist and Rocky River schist as Precambrian formations.

Spry and Ford (1957) described the Precambrian lithology in the Corinna-Pieman Heads area, and Spry (1962a; 1964) differentiated between "older" and "younger" Precambrian rocks from the same area. However dense vegetation and poor exposure obscure the structural relationship.

The Precambrian rocks in the Savage River - Rocky River area represent the northward extension of the Whyte Schist described in the lower Pieman River, and are similar to them in lithology, metamorphic grade and structure.

2.1.2. "Upper" Precambrian Corinna Slate.

Spry (1964) termed the rocks which crop out for 5 miles along the road into Corinna "Corinna Slate". Exposures are poor away from the road. Brown weathering argillite, greenish slate and micaceous siltstone are exposed in a few places on the road section from Little Plains to Corinna. Part of the western contact of Whyte Schist with these rocks of presumed "Upper" Precambrian age is sharp, with a difference in elevation as much as 350 ft., but contacts elsewhere are not so easy to define. Bedding attitudes near the contact are similar. The difference in outcrop elevation may be due to differential weathering or a fault.

Spry (1964, p.39) described the Corinna Slate as thinly-bedded and weakly cleaved at an angle to the bedding. Microscopically the rock is fine-grained and consists chiefly of quartz, sericite and a little chlorite. Accessories are sphene, tourmaline or iron ore. On the Corinna road the difference in lithology from Whyte Schist is readily apparent as the slate-argillite assemblage does not contain quartz augen and stringers. Corinna Slate has been included in the "younger" Precambrian by Spry (1964, p.29).

2.1.3. Tertiary Sediments.

Flat-lying beds of mudstone, silt, grit, gravel and conglomerate form Brown Plains, Little Plains and West Plains 5 to 7 miles distant from Corinna. A basalt cap has preserved a thin bed of sediments from erosion in the region of the Savage River deposit, but basalt and the sediments have been removed by erosion in other places. Where seen in contact with the steeply-dipping Whyte Schist, the contrast is striking and the contact is clearly a great unconformity (pl.6).

The thickness of Tertiary sediments on Brown Plains, on the track to the Rocky River,ranges from 1 ft. up to a maximum of about 40 ft. The thickness of an individual bed may vary a great deal from place to place.

Scott (1926) recorded a depth of about 2 feet of soil and rubble overlying schist in holes drilled in the vicinity of tin workings on Brown Plains. On Little Plains the aggregate thickness of sediment and rubble ranges from 1ft. to 6ft.

The thickness of Tertiary sediment beneath basalt in the Savage River area is much less than in the Brown Plains area.

The beds of mudstone, silt, grit, pebble and conglomerate interfinger and coalesce. Cross-bedding in the finer clastic sediments is common.

Mudstone bands are white or grey but have been darkened within a few feet of the surface by organic- rich water draining the button grass plains, and converted to a dark carbonaceous mudstone. Silt and grit layers have similarly been affected in favourable areas. No fossils have been observed in the fine clastic sediments.

Beds of unconsolidated, poorly-sorted subangular to rounded pebbles consist mainly of opaque white quartz, but include black and grey chert, grey quartzite, tourmaline granite, pale sandstone, and schist. The quartz pebbles (aver. size 2 inches) are set in a finer matrix of silica grains and grit. At the base cobbles and boulders 6 inches to 1 foot in size, fill scour depressions.

The succession is variable, in places any one of the beds may rest unconformably on schist and so form the base of the sediments.

Conglomerates, the lithified equivalents of pebble beds, can be seen in different exposures. Some may rest directly on schist (pl. 5). Others, probably not the same, appear near the top of the succession of Tertiary sediments.

A flat-lying bed of lignite 6 ft. thick, overlain by Tertiary gravel and siltstone, is exposed in a road cut about 4 miles from Corinna.

Leaf impressions in lignite and ligneous clays from the Waratah district were described by Johnston (1888) as belonging to the genera Eucalyptus, Quercus, Laurus, Cycadites and Ulmus.

Most of the white opaque pebbles in the pebble beds and conglomerate are locally derived from vein material in Whyte Schist. The presence of a few tourmaline granite fragments suggests a derivation from the Meredith Granite area to the east.

The sediments were deposited before basalt vulcanism. Elsewhere in Tasmania basalt has also been reported between Tertiary sediments.

Montgomery (1894 a, p.29,30) regarded gravels at about 800 ft. above sea level north of the Pieman River as marine and formed on a plain of marine erosion. Waterhouse regarded the gravels as fluviatile and Twidale (1957, p.12,13) considered the gravels to be marine or fluvio-glacial. The writer considers the lack of fossils, the presence of lignite and the lithology and structure of the beds as evidence of rapid sedimentation in a shallow terrestrial basin.

The Tertiary sediments have previously been worked for tin. Scott (1926) reported the presence of chromite and gold. Panning of the sediments by W. Pitulej showed that scours 5 ft. to 10 ft. deep in the schist, filled with poorly-sorted gravel, are favourable sites for tin deposition. Much of the tin in bygone days was won from creeks draining the plains in which the tin had been concentrated. The economic prospects today are poor unless buried leads can be traced, perhaps by trenching or geophysical prospecting.

2.1.4. Quaternary Deposits.

Quaternary deposits can be classified as follows: -

(i) Recent gravel deposits forming terraces, pebble banks and alluvium in the beds and along the banks of the main rivers and creeks.

(ii) Unsorted beds of detritus, from 1 ft. to 5 ft. in thickness, mostly quartz weathered from the siliceous Whyte Schist assemblage.

Gold was recovered from the Savage and Whyte rivers and a few of their tributaries from 1880 onwards (Reid, 1921, p.65-67). Osmiridium found with the gold was discarded until the turn of the century because of a lack of demand for the metal. Chromite, osmiridium, and magnetite (as fine concentrate and boulders) in the bed of the Savage River, both upstream and downstream from the magnetite deposit, can be traced to the Bald Hill serpentinite and ultrabasic body.

The source of gold, which was also recovered from the weathered detritus overlying Whyte Schist, is more puzzling as the mother lode has not been found. Twelvetrees (1903, p.5) suggested that the gold may be derived from pyritic lodes in the Whyte Schist. Black pyrite-graphite lodes in Whyte Schist have been seen in two different localities by the writer. A sample did not assay any gold, and only a trace of copper. (0.04 percent).

2.2 Igneous and Metamorphosed Igneous Rocks.

Five periods of igneous activity are represented by the metamorphic and igneous rock types: -

(i) Intrusion of ultrabasic and basic magma in late? Cambrian time, forming rocks which are represented in Bald Hill area by pyroxenites, peridotites, serpentinites and gabbros.

(ii) Subsequent intrusion of basic magma in the Cambrian(?)

represented by amphibolite which is host to magnetite mineralization. (Age of amphibolite discussed in III. 2.2.1.2. (b) Pt. 1.).

(iii) Intrusion of acidic magma in the Rocky River area (as the final stage of Cambrian igneous activity?)

(iv) Intrusion of acidic rocks in the Devonian, represented by the Meredith Granite.

Granite in Tasmania was emplaced as a late phase or after the dominant Devonian Tabberabberan Orogeny, and has been dated at 350 million years. (Confidential personal communication Australian National University).

(v) Extrusion of basalt in Tertiary time.

Basalt, in adjacent areas of Tasmania, overlies sediments containing fragments of marsupial animals and flowering plants of Tertiary time.

2.2.1. Cambrian Plutonic and Intrusive Rock.

2.2.1.1. Bald Hill Peridotite, Pyroxenite, Serpentinite and Gabbro.

Early reports on the geology of Bald Hill area included those by Twelvetrees (1913) and Reid (1921).

Twelvetrees and Reid stated that Bald Hill is near the northern end of a strip of serpentine extending about 30 miles in a southeasterly direction, and from 1 to 5 miles wide. Serpentine has been traced 7 miles north of the Waratah-Corinna road.

The lithology of the Bald Hill complex has been given by Reid in describing serpentinized rocks of the peridotite, pyroxenite and gabbro series. Rock from the Corinna road at the 19 mile hut, which is almost on the boundary of the serpentinized ultrabasics, has been described by Reid (1921, p.3) as a dark mottled harzburgite considerably serpentinized and containing magnetite.

Reid in his description of the pyroxenite series stated that bronzitite from Bald Hill is olive-green and coarsely crystalline, containing blebs, streaks and irregularly shaped bunches of magnetite, and more rarely chromite. An analysis of a sample of this rock, taken by Reid and analysed in the Geological Survey Laboratories showed the composition to be: -

	Percent.
S_iO_2	55.16
MgO	28.05
FeO	10.70
Al_2O_3	3.50
CaO	Nil
Total	97.41

Common accessory minerals in the gabbro series are described by Reid (p.26) as idiomorphic magnetite and chromite. The Bald Hill ultrabasic complex is similar to other ultrabasic masses at Adamsfield, Anderson Creek and Argent Tunnel and probably belongs to the same Cambrian tectonic phase.

The magnetite content of the different rock types comprising the Bald Hill serpentinized complex is regarded as significant when considering an origin for magnetite deposits in the Savage River - Rocky River area.

2.2.1.2. Amphibolite.

Amphibolite bodies in Whyte Schist are closely associated with magnetite in the Savage River deposit, Long Plains South - Brown Plains deposit and the Rocky River deposit. The occurrence of amphibolite in the intervening area between the three deposits is not continuous, contrary to the belief expressed in some of the earlier reports; nor are the amphibolite bodies so wide as previously thought. The distinction in the field between weathered amphibolite, and weathered schist and phyllite is difficult, except in some river and creek sections where fresh rock may be exposed. This, no doubt, has been the reason for the greater extent assigned to the rock by previous workers. The topographic expression of amphibolite does not distinguish it from meta-sediments of the Whyte Schist, except perhaps that trellis drainage patterns characteristic of underlying schist are not formed on areas underlain by amphibolite.

Criteria used in the field to differentiate between weathered amphibolite and weathered meta-sediment were:-

(i) Weathered sedimentary schist is generally silty compared to the greasy "feel" of amphibolite when scratched with a geological pick.

(ii) Detrital quartz grit from quartz pods in phyllite overlies brown soil in a few places. Soil derived from amphibolite may contain iron oxide scree but does not contain quartz grit.

(iii) Unweathered fine-grained phyllite is difficult to recognize from schistose amphibolite in a number of outcrops. Elongate quartz lenses which may be present in phyllite, up to half an inch in length, distinguish between meta-sediment and amphibolite.

(iv) Much of the amphibolite away from the ore zones is fairly massive and characteristically weathers in blocky irregular fragments quite different to the platy fragments of schist and phyllite.

The amphibolite bodies from the Savage River area to the Rocky River area are disposed along the general line of strike in Whyte Schist. The amphibolite body containing the Savage River deposits increases in width from the southern to the northern area, and is aligned roughly parallel to an adjacent amphibolite body on the western side in which magnetite is not deposited. Amphibolite is fairly massive in outcrop, the schistosity in many places being only faintly discernible. The foliated amphibolite (greenschist) is best seen in the diamond drill core as zones in amphibolite. Field exposures of amphibolite in most places indicate a greenish-grey dense fine-grained rock which is generally feebly magnetic. Grey, foliated fine-grained rock grades into the normal grey-green amphibolite about 300 ft. below the confluence of Halls Creek and the Savage River. Foliation is well marked in both rock types, especially the grey variety, which appears to be a flaser rock derived from an igneous rock by shearing. Magnetic foliated amphibolite is also exposed in the lower reaches of Halls Creek near the junction with the Savage River.

Fragments of grey, glossy, highly-cleaved rock between the deposit and the Savage River in the central area may be similarly sheared and recrystallized. Highly-altered igneous rock with ramifying carbonate veinlets and stringers is exposed west of the central area in the bed of the Savage River.

The greenish colour of amphibolite is due to the abundance of chlorite, actinolite, tremolite and epidote minerals. Thin section study of amphibolite under the microscope shows that the mineral assemblage consists of plagioclase feldspar, chlorite, actinolite, epidote, sphene, quartz, apatite, magnetite and pyrite (slides 64-104; 64-102; 64-91; 64-90). Percentages of minerals differ in the slides, chlorite and actinolite forming perhaps 40 to 60 percent by volume; feldspar 35 to 50 percent; epidote and sphene 10 to 20 percent; and quartz, apatite and opaque minerals 5 to 10 percent. Microscopically the structure in thin section is schistose, imparted to the rock by the parallel alignment of amphibole, chlorite, epidote and sphene crystals.

The plagioclase is mostly albite-oligoclase and occurs as shapeless, irregular grains in the fabric of the rock. Isolated grains are albite - and carlsbad-twinned. Much of the albite-oligoclase is poikiloblastic, containing inclusions of other minerals, mainly epidote, sphene and actinolite. The minerals form zones of inclusions concentrated toward the perimeter of individual feldspar grains in slide 64-104. Actinolite crystals are generally imperfectly terminated in bladed crystals and slender prisms intimately associated with and surrounded by chlorite. The mineral is strongly pleochroic, pale brown or green to deep blue-green. Chlorite is pale green in irregular masses enclosing residual actinolite. The mineral is of low birefringence and contains sphene. Epidote in colourless grains and elongate prisms 0.02 to 0.05 mm. in size parallels the schistosity in slide 64-102. Quartz and apatite occur in minor amount. Sphene grains and clusters up to 1 mm. in size lie parallel to the schistosity in slide 64-90. The opaque minerals consist of magnetite and pyrite in well-formed crystals up to 1 mm. in size in the shape of octahedra, squares, triangles and rhombs. A few of the magnetite crystals are cut by fractures.

Greenschist derived from amphibolite is prominent in the alteration zones around some magnetite concentrations and will be described more fully in the section on ore deposits. The minerals of green schist rock consist mainly of chlorite and tremolite (or actinolite), and accessory epidote and sphene.

The texture, structure and most of the minerals in amphibolite rock have been formed by metamorphic reconstitution. The metamorphic grade of amphibolite is given by the mineral association of chlorite, epidote and actinolite, and the absence of biotite, indicating regional low grade metamorphism of the Greenschist Facies, rather than the Epidote- Amphibolite Facies.

The amphibolite body which is host to magnetite concentrations in the area north of the Savage River can be traced over a width of about 4500 ft., but it tapers rapidly southward to a width of about 100 ft.

In the Long Plains South-Brown Plains deposit the width of the dyke-like amphibolite body which can be traced from traverse 3500N to traverse 13000N, is between 300 and 500 ft. (fig.6). Dyke-like bodies of lesser width have also been noted.

Width of amphibolite ranges from 900 ft. to 1200 ft. in an area between the Whyte and Rocky rivers.

Discordant and concordant amphibolite dykes have been reported from the lower Pieman River by Spry and Ford (1957) and Spry (1964). The rocks are petrographically similar but it is questionable whether the amphibolite is continuous between exposures noted in the Rocky River area and the Pieman River.

Medium-to coarse-grained amphibolite crops out on the north and south banks of the Savage River on traverse H 1, approx. 400 ft. west of the baseline (fig.3); on the track from the central area down to the river (fig. 4) and on the track north of the river. Exposures of weathered, medium-grained amphibolite have been mapped on track sections mainly by textural differences when compared to the structureless weathered form of the fine-grained amphibolite. The best evidence of more coarsely textured amphibolite is obtained in diamond drillholes 3,4,5,6,7,8,14,15,16,18 and 20 from core intersections of medium-and coarse-grained amphibolite within the mass of fine-grained amphibolite (fig.19). Dimensions of the more coarsely textured amphibolite bodies are variable from bands a few inches thick up to a maximum core intersection of about 220 ft. in drillhole 14. The detailed maps of the central and northern areas (fig. 3 and 4) show the inferred geological boundaries of the medium-to coarse-grained amphibolite from core intersections. The boundaries on surface are not generally evident, except in a few places.

Certain diamond drill cores of the grey-green medium to coarse-grained amphibolite show a dolerite texture. Magnetite content, like that in the fine-grained amphibolite, is variable. The core may be magnetic in a section perhaps 5 ft. long, and this may alternate with sections showing feeble magnetism or none at all.

In thin sections the mineral assemblage are seen to consist of chlorite, actinolite, epidote, albite, sphene, quartz, magnetite and pyrite, roughly in order of abundance, about the same as in the fine-grained amphibolite, but the schistose structure and equi-grained texture is less marked. In slide 92-64 epidote and chlorite are in roughly equal amount and make up 70 to 80 per-cent of the slide. Actinolite has been mostly converted to chlorite but residual blades and needles are still evident. Simple twinning resembling carlsbad twinning is present in a few feldspar crystals, commonly filled with inclusions. Epidote is present as granular aggregates up to 1 mm. in size. Sphene is present in grains or dark clustered aggregates, and granular clusters surround magnetite crystals in slide 94-64. Magnetite and pyrite are sparse but show well-developed crystal outlines. The average size of the opaque minerals is 0.1 mm.

Three different types of contact between fine and more coarsely textured amphibolite have been noted.

(i) The transition between the two amphibolite rock types is abrupt and in places discordant where the contact is a plane in the core along which the core readily splits. A contact such as this appears to be intrusive but the medium - to coarse-grained amphibolite which would be the intrusive rock, does not show chilled margins.

(ii) The contact between the amphibolite rock types is sharp but not separated by a well-defined plane. The crystals are intergrown at the contact, and the core does not split readily along the plane. This type of contact may result from the injection of a magma into an igneous mass of similar composition still partially fluid. Thin section study of one contact did not yield information on the origin or relative age of the rock types, because alteration was too great.

The sharp contacts described in (i) and (ii) between the differently textured amphibolite rock types are preserved in relatively few drill cores. Commonly the core has been broken and ground away by the rotation of the drill bit or the contacts have been sheared and converted into schist zones.

(iii) The change from fine-grained amphibolite is gradational. In many places progressive change of rock type over a continuous distance ranging from about 5 ft. to 20 ft. suggests formation in place without successive injection. The chemical analysis of medium - grained amphibolite (cf. Table II) does not show any marked increase in salic constituent or decrease in femic constituent when compared to analyses of fine-grained amphibolite. Not much compositional differentiation has occurred.

Transition of the contact of type (iii), from fine-grained amphibolite into medium-grained amphibolite is seen in the core from drillholes 3,4,5, 7 and 8. Sharp contacts described in (i) and (ii) above can be seen in medium - to coarse - grained amphibolite core from drillhole 7, intersected at a depth between 175 and 228 ft. The upper contact (at 175 ft.) is intrusive into fine-grained amphibolite and corresponds to type (i). Narrow bands of fine-grained amphibolite which alternate over a distance of about 2 ft. with more coarsely textured amphibolite constitute the lower contact and correspond to type (ii).

The textural and structural variations of the three types of contact suggest that the more coarsely textured amphibolite formed largely in place but intruded some parts of the fine-grained magma which had crystallized more rapidly.

2.2.1.2 (a) Origin of Amphibolite.

The origin of amphibolite is of importance when considering the source of magnetite, and must influence any theories of ore genesis proposed for the deposits. It has been suggested that amphibolite is a metamorphosed sedimentary rock and that magnetite, associated with amphibolite might be derived from sediments.

The writer believes the amphibolite to be a metamorphosed igneous rock for the following reasons: -

(i) The lithology and form of field exposures of amphibolite is quite distinct from that of Whyte Schist. Amphibolite outcrops are generally massive; the meta-sediments are highly schistose.

(ii) Microscope study of thin sections shows that banding of quartz and feldspar in Whyte Schist is ubiquitous and that quartz augen and albite porphyroblasts have formed in the rock (pl. 5). The fabric in amphibolite is not layered or banded (pl. 22). Quartz augen and feldspar porphyroblasts have not formed in these masses during metamorphism.

(iii) Amphibolite and adjacent sediments have the same metamorphic grade, but the sediments do not contain amphibole. Actinolite and tremolite in amphibolite clearly show retrogressive metamorphism by alteration to chlorite. Metamorphism in the sediments is progressive.

(iv) The transition from fine-grained amphibolite into medium-and coarse-grained amphibolite is gradual, or sharp and in places discordant.

(v) The bodies of amphibolite are concordant with Whyte Schist in the Savage River-Rocky River area, but Spry (1964,p.24) records some which are discordant to the foliation of the Whyte Schist.

The writer concludes from the foregoing evidence that the amphibolite has been derived from igneous rocks.

The intrusive or extrusive nature of the magma has not been established. Amphibolite is very fine-grained, which suggests that the original rock may have been extrusive, but pillow lava, amygdaloidal and vesicular rock or other features associated with extrusive rocks have not been seen.

A narrow sheet of amphibolite concordant with the adjacent sedimentary schist is exposed in a creek in the Long Plains South - Brown Plains deposit at 6500N, 300E (approx.).(fig.6).

TABLE I.

	1	2	3	4	5	6	7	8	9
SiO_2	48.48	41.16	43.16	50.92	36.32	44.78	44.44	54.64	48.38
Al_2O_3	15.68	15.94	16.12	16.83	5.39	13.44	17.97	15.22	14.52
Fe_2O_3	3.92	2.57	2.89	1.11	7.34	2.41	1.74	1.17	5.87
FeO	10.98	18.35	14.86	9.78	4.83	16.22	8.32	7.81	9.21
MgO	5.72	4.21	5.89	7.99	32.08	7.01	4.74	5.39	5.07
CaO	8.37	12.12	10.22	9.87	2.90	9.12	9.42	7.96	7.20
Na_2O	2.47	1.17	1.63	1.15	0.08	1.65	2.86	1.69	2.22
K_2O	1.17	0.21	0.32	1.12	0.03	0.47	3.04	2.23	1.50
H_2O-	0.10	0.04	0.18	0.14	0.58	0.07	0.26	0.02	0.49
H_2O+	1.42	2.31	2.68	0.96	9.67	1.58	3.53	2.85	3.40
MnO	0.21	0.32	0.24	0.18	0.15	0.36	0.22	0.13	0.18
TiO_2	0.80	2.00	2.00	0.60	0.10	2.81	3.00	0.68	2.20
P_2O_5	Nil	0.18	0.12	0.02	Nil	0.40	0.72	0.10	0.22
FeS_2	-	-	-	-	-	-	-	-	-
Cr_2O_3	-	-	-	-	0.45	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
	99.32	100.58	100.31	100.67	99.92	100.32	100.26	99.89	100.46

Older Precambrian Igneous Rocks. (Spry 1962a p.280-281).

Analyst W. St. C. Manson.

1. Amphibolite, hornblende rich; lower Forth River.
2. Amphibolite, garnet rich; lower Forth River.
3. Amphibolite Kelly basin, Port Davey, No. 4956.
4. Eclogite, Lyell Highway, No.5851.
5. Tremolite-Chlorite schist; lower Forth River.
6. Amphibolite, Raglan Range.

TABLE I (CONTD.)

6. (contd).

Younger Precambrian Igneous Rocks (Spry 1962a, p.280-281)

Analyst W. St. C. Manson

7. Coarse dolerite (Cooee) Burnie No. 4864

8. Dolerite (Cooee) Detention River No. 4861.

9. Dolerite (Interview River Dyke Swarm) Pieman River.

TABLE II.

	10	11	12	13	14	15	16	17	18
	Savage River				Lower Pieman			Cambrian Basic	
SiO_2	36.82	48.12	49.12	48.02	49.20	62.64	48.38	50.01	48.35
Al_2O_3	12.64	13.76	12.81	12.73	13.59	13.87	11.52	15.38	16.82
Fe_2O_3	4.51	3.70	6.19	3.77	2.78	1.18	7.05	4.86	2.85
FeO	9.24	8.95	7.42	11.19	10.98	3.17	7.15	9.21	10.21
MgO	20.91	7.66	6.93	6.93	6.66	6.33	7.11	5.85	4.46
CaO	5.86	9.68	9.40	8.42	8.13	6.16	7.10	6.35	9.55
Na_2O	0.61	2.50	3.30	3.00	3.18	4.99	4.43	4.77	3.78
K_2O	0.05	0.56	0.60	0.10	0.08	0.93	0.30	0.40	0.42
H_2O-	0.10	0.11	0.16	0.13	0.05	Nil	0.06	0.23	0.32
H_2O+	7.65	2.95	2.60	3.07	3.28	1.12	2.50	2.60	2.32
MnO	0.17	0.20	0.19	0.32	0.21	0.11	0.22	0.21	0.10
TiO_2	1.15	1.44	1.34	1.66	1.63	0.10	2.02	0.23	0.78
P_2O_5	0.11	0.14	0.12	0.19	0.21	Nil	0.12	.09	N.D.
FeS_2	-	-	-	-	-	-	2.00		
Cr_2O_3	Nil	Nil	Nil		-	-			
CO_2	Nil	Nil	Nil	0.20	-	-			
	99.82	99.77	100.18	99.73	99.98	100.60	99.96	100.82	99.96

Savage River Amphibolite.

Analyst W. St. C. Manson.

10. Greenschist. DDH.4. 650 652 ft.

11. Fine-grained Amphibolite. DDH.14. 399-402½ ft.

12. Med-coarse grained amphibolite. DDH.14. 494-495½ ft.

13. Fine-grained amphibolite. Savage River, above bridge.

TABLE II (CONTD.)

13. (contd.)

Lower Pieman-Whyte River amphibolite (Spry 1962a, p.280-281)

Analyst W. St. C. Manson.

14. Amphibolite, Lower Pieman.

15. Amphibolite, Rocky-Whyte River junction No. 5795.

16. Glaucophane amphibolite, Lower Pieman River.

Cambrian Basic Lavas (Spry 1962a, p.280-281).

17. Spilite, King Island, Scott.

18. Spilite, Grooms Slip, Scott.

Larger bodies of amphibolite can be seen in Magnetite Creek (central Savage River area); on traverses 9000S and 10,000S west of the baseline in the southern area, (fig.5) and in the Long Plains South-Brown Plains deposit (fig. 6). Elsewhere amphibolite is emplaced as wide belts of rock, which show neither intrusive nor extrusive rock structures. Metasediments adjacent to amphibolite bodies are not contact-metamorphosed and altered to hornfels-type rock; therefore a low temperature for the igneous rock is inferred.

2.2.1.2.(b). Correlation and Age of Amphibolite.

(i) Chemical Composition.

Table I lists the chemical analyses of "older" (Lower) and "younger" (Upper) Precambrian rocks from Tasmania. Analyses of Savage River amphibolite, Lower Pieman amphibolite and Cambrian basic lavas are given in Table II to show the chemical affinities of rock types from different regions, which may aid in correlating the igneous rocks.

In tentatively correlating the Savage River amphibolite as Cambrian in age, the Na_2O: K_2O ratio and Na_2O percent composition are figures which have been cited as similar. The Savage River amphibolite (excluding No. 10 which is greenschist) is comparable with amphibolite from the Lower Pieman area in having a Na_2O content greater than 2.5 percent and the Na_2O: K_2O ratio greater than 5:1 (except for assay No.11). The maximum Na_2O content is 3.3 percent in the Savage River amphibolite and 4.99 percent in Lower Pieman River amphibolite. The maximum Na_2O: K_2O ratio for these rocks is 30:1 and 40: 1 respectively.

Analyses of Cambrian basic igneous rocks (two only are shown as examples) most closely resemble analyses of amphibolite from the Savage River, Whyte River and Pieman River areas. The Na_2O content in most assays is greater than 2.5 percent and the Na_2O: K_2O ratio is generally greater than 5: 1.

The chemical analyses of "older" and "younger" Precambrian rocks listed in Table I show, by contrast, that the Na_2O content in the "older" Precambrian rocks does not exceed 2.5 percent and the Na_2O: K_2O ratio is less than 5: 1. The Na_2O percent is variable in "younger" Precambrian rocks but the Na_2O: K_2O ratio is consistently less than 5: 1. In assays Nos. 7 and 8 the K_2O percent is in fact greater than the Na_2O percent.

Though Spry (1962a) tentatively assigned an older Precambrian age to amphibolites within the Whyte Schist, the writer suggests a Cambrian age, based on similarities of chemical composition in these and other Tasmanian igneous rocks. However, the degree of alteration of amphibolite compared with these rocks makes the correlation uncertain.

(ii) Mineralogy and texture.

Textural differences of "younger" Precambrian dolerite, and amphibolite in Whyte Schist would appear to preclude correlation of the two rock types. Spry (1962a, p.256) has stated the mineral assemblage of intrusive doleritic dykes to be actinolite, chlorite, albite, epidote, prehnite etc., which is similar to the Savage River amphibolite, but rock textures are notably different. The younger Precambrian dolerite dykes still retain their original textures whereas amphibolite in Whyte Schist has been recrystallized, the igneous texture destroyed, and a metamorphic structure imposed.

The mineral composition of igneous rock attributed to the "older" Precambrian may represent a higher metamorphic grade of these rocks and denote a greater age. Garnet and pyroxene have been identified (Spry, 1957b, 1958) which distinguish these amphibolites from the Savage River type.

Thus the amphibolites in the Whyte Schist cannot be correlated with younger Precambrian on textural evidence nor are they similar mineralogically to some older Precambrian rocks reported from Tasmania. Chemically they may be related to Cambrian basic igneous rocks but dating metamorphic rocks on chemical analysis is uncertain.

(iii) Magnetic Anomalies.

The regional aeromagnetic contours of the northern area of the map sheet indicate that the minimum value in gammas over amphibolite is much the same as the value over the ultrabasic complex and serpentinite at Bald Hill. Correlation of amphibolite with the Cambrian Bald Hill igneous complex is tenuous on this evidence, but Reid (section III.2.2.1.1.) in describing the Bald Hill igneous complex, noted that magnetite was ubiquitous, and segregated in blebs and streaks in one specimen of pyroxenite. Magnetite upstream from the Savage River deposit is obtained in every pan concentrate of river sediment. Pebbles and boulders of magnetite are seen as far up the river as the diversion tunnel at Burnt Spur. The pebble and boulder magnetite very probably came from Nineteen Mile Creek which drains an area of the Bald Hill complex and is a tributary of the Savage River. The equal abundance of magnetite boulders and pebbles in the Savage River channel above and below the intersection of the lode indicates that magnetite must also be concentrated in the Cambrian ultrabasic rocks and serpentinite. This fact is stated as further evidence of a possible correlation of Savage River amphibolite with the Cambrian Bald Hill ultrabasic suite.

(iv) Alteration.

The alteration of amphibolite (pt. 2. Sect. III 2.2) involving albitization, chloritization, carbonation and silicification adjacent to or near the magnetite bodies is characteristic of Cambrian lavas and igneous rocks elsewhere in Tasmania.

The similarity of amphibolite with Cambrian igneous rock in chemical composition, alteration, and magnetic anomaly, and the differences between amphibolite and Precambrian igneous rocks in texture, mineralogy and chemical composition is not conclusive of a Cambrian age for the rock when these characteristics are compared individually. However the overall similarities suggest a Cambrian age for amphibolite.

2.2.1.3. Rocky River Cataclasite.

The sheared, metamorphosed, fine-to medium-grained rock described as cataclasite crops out in the Whyte and Rocky rivers (fig. 7). The greyish-white crystalline rock is present as a regionally conformable dyke-like body between 100 ft. and 200 ft. wide, separating amphibolite and silvery-grey lustrous schist of the Whyte Schist formation to the west of the mineralized belt.

The rock is difficult to trace in the area between exposures in the main river channels because of vegetation and overburden. A friable, decomposed igneous (?) rock exposed in the section of the water race between the centre line and line 8S (fig.7) is thought to be an altered equivalent of the cataclasite, but the weathered form of the rock may be misleading.

In thin section the mineral assemblage is seen to consist of feldspar (oligoclase-andesine), quartz, amphibolite, epidote, chlorite, muscovite, and sphene. Feldspar constitutes about 80 percent of the rock in grains up to 2 mm. in size. The rock is sheared, but not markedly schistose. The matrix consists of a fine-grained, equigranular recrystallized aggregate of feldspar, and quartz showing undulose extinction. Amphibole (probably actinolite) constitutes 10 to 20 percent of the rock as unoriented elongate crystals partly altered to chlorite in the matrix of the rock. The plagioclase feldspar shows albite - and carlsbad twinning and contains many small rod-like inclusions of high relief mineral (actinolite?) aligned parallel to the albite twin plane, and concentrated in the centre of a few feldspar crystals, suggesting that the crystals may be zoned. Muscovite and clusters of sphene are accessory minerals. The mineral composition suggests that the original rock may have been a quartz diorite.

The contacts of cataclasite with amphibolite are not clearly exposed, but the rock forms a narrow bar across the Whyte River and a waterfall about 5 ft. high in the Rocky River. The cataclasite crops out as irregular discordant bodies of rock in the fine-grained amphibolite, but no visible textural, structural, or mineralogical changes near the contacts indicate that the rock is intrusive.

The cataclasite is possibly equivalent in age to rocks described by Nye (1923) from an area in the vicinity of Bald Hill between the Heazlewood and Whyte Rivers where syenite and diorite dykes intrude the ultrabasics and their serpentinized derivatives. Nye assigned a Devonian age to all these rocks, but the ultrabasic rocks are now considered to be Cambrian. Gabbroic rocks in the Waratah district described by Groves and Solomon (1964, p.9) have a similar mineral assemblage and have been classed as Cambrian.

The three metamorphosed and igneous rock types represented in the Cambrian, viz. ultrabasics and serpentinite at Bald Hill, amphibolite in the Savage River- Rocky River area, and cataclasite (quartz diorite?) in the Rocky River deposit, may represent successive intrusive stages in the differentiation of a subterranean basic or ultrabasic magma reservoir. The age and space relationship of the ultrabasic complex and amphibolite is not clear, but cataclasite is discordant and apparently intrusive into amphibolite in the Whyte and Rocky Rivers. Nye (1923, p.40,41) reported dykes of syenite and diorite intruding ultrabasic rock and serpentinite of the Bald Hill complex. The cataclasite may therefore represent a late stage of differentiation.

2.2.2. Devonian Igneous Rock.

Meredith Granite.

The Meredith Granite boundary has been represented on the map sheet to the east of the Whyte River, (fig.2) but the field mapping of this rock unit was prevented by lack of access. The granite stock of the Meredith range crops out over an area of about 120 sq. miles, extending from Parsons Hood in the south to within two miles of Waratah (Groves and Solomon 1964, p.11). The rock types constituting the stock have been described by Reid (1921), as granite, granite-porphyry, aplite, and quartz tourmaline.

Near Waratah the rock types are adamellite and associated quartz-feldspar porphyries.

The tin, silver, lead and zinc mineralization in the Waratah district are ascribed by Groves and Solomon (1964) to hydrothermal and pneumatolytic action of the acid igneous rocks. Accessory minerals characteristic of Devonian granite mineralization include fluorite, monazite, topaz, bismuthinite and wolframite, which are not present in the Savage River - Rocky River area.

2.2.3. Tertiary Volcanism.

Tertiary basalt forms a plateau in the northern and southern areas of the Savage River deposits (figs. 3 and 5); between traverses 25000N and 29000N to the south of the southern Savage River area (fig. 2); and is exposed in a small belt about 300 ft. long on the road to Corinna at the edge of Little Plains. The rock overlies the Henty Surface at an altitude ranging from 750 ft. to 1300 ft. The shapes of the basalt caps are irregular owing to headward erosion of streams draining the flat-lying areas.

Basalt, under the microscope, is seen to consist of

Plate 7.

Tertiary basalt scarp; southern Savage River area.

Plate 8.

Vertically plunging folds in graphitic Whyte Schist on access road to Savage River.

euhedral phenocrysts of olivine and augite in a fine-grained groundmass which consists of twinned feldspar laths, augite, magnetite granules, serpentine and possibly tremolite. The augite is fresh, but olivine is altered to idingsite and serpentine in varying degrees. Pseudomorphs of these alteration products after olivine are noted in some crystals.

The basalt ranges from 1 to 15 ft. in thickness. Plate 7 illustrates the scarp boundary of the basalt on the baseline at 9000S in the southern area of the Savage River deposit (fig. 5). In most places the basalt boundary is not so clearly delineated, especially the western boundary in the northern Savage River area, where it is difficult to distinguish between underlying weathered amphibolite soil and weathered basalt soil. The basalt overlies flat-lying Tertiary gravel, siltstone or mudstone, which may be 3 or 4 ft. thick. Basalt estimated to be 5 or 6 ft. thick, partly covers the magnetite-bearing ore zones in the northern and southern areas. The magnetic anomalies are generally weaker beneath the basalt areas.

The dating of Tasmanian basalts is still uncertain but correlation into two main types (Spry, 1962a, p.274) can be made on composition:

(i) The saturated olivine basalts, or augite-olivine basalts which contain about 50 percent silica.

(ii) The unsaturated olivine basalts. These are much lower in silica, contain titanaugite and are commonly alkaline.

A comparison of the mineral assemblage and texture of Savage River basalt with types (i) and (ii) shows that it is similar to a saturated olivine basalt at Waratah.

Basalt of the Savage River area cannot be dated accurately at present, except that it is earlier than Upper Pleistocene, when the Henty Surface on which the basalt lies, was dissected (Banks and Ahmad, 1959). Tasmanian basalts include some that are older than Upper Oligocene and others that are younger than Middle Miocene (Banks, 1962a, p.241).

IV GEOLOGIC STRUCTURE

1. Precambrian Rocks.

The Whyte Schist formation trends north from the Rocky River deposit and ranges in strike from N. 10° W to N.20°E (fig. 2). The beds dip steeply to the east at an angle between 70 degrees and vertical. The regional strike changes to a direction about N. 20° E roughly midway between the southern Savage River deposit and the Long Plains South- Brown Plains deposit, but the steep dip of the rock remains unchanged.

The pelitic and psammitic units of the "Lower" Precambrian Whyte Schist are conformable in exposures of the contact along the access road into the Savage River deposit and along the jeep track north of the Long Plains South- Brown Plains deposit at 16000N; 2000E approx (fig. 2).

The western boundary of "Lower" metamorphosed Whyte Schist with "Upper" less metamorphosed Precambrian Corinna Slate shown only in the southwest corner of the map sheet (fig. 2) is inferred as a fault contact.

Amphibolite rock of Cambrian (?) age is found in the pelitic unit of the Whyte Schist and is generally bounded on the western side by silty sediments of the psammitic unit.

Cataclasite rock separates amphibolite from Whyte Schist on the western side in the Rocky River deposit.

One of the unsolved problems in the Precambrian geology of Tasmania is whether the indisputably metamorphosed and relatively unmetamorphosed rocks can be divided into "older" (lower) and "younger" (upper) formations respectively, on differences of metamorphic grade and structural style. Both the indisputably metamorphosed and relatively unmetamorphosed rocks have a similar range of lithologies and an unconformity between them has not yet been found.

Spry distinguishes between indisputably metamorphosed "older" Precambrian rock and relatively unmetamorphosed "younger" Precambrian rock from different areas of Tasmania on their structural styles.

Foliation.

According to Spry (1962a, p.120,121) one or more foliations are present in the metamorphosed rocks. Most phyllites and schists contain two or three distinct foliations and the bedding is commonly obliterated.

The foliation of the "unmetamorphosed" sediments is less marked. Many quartz sandstones do not possess cleavage, and many pelites contain only axial plane cleavage. A bedding plane foliation is present in many rocks.

The present writer observed two distinct foliations of Whyte Schist in the Savage River - Rocky River area. A dominant bedding schistosity which is well preserved, and secondary axial plane cleavage more marked in phyllite than silty layers. Corinna slate is weakly foliated or lacks foliation in argillite.

Bedding:

According to Spry, (1962a, p. 120) bedding is recognized in the "unmetamorphosed" sediments by textural and compositional banding. Sedimentary structures are well preserved.

In metamorphosed rocks, bedding and lithologic structures are only preserved in structurally protected parts of the rock.

The present writer readily recognized bedding of the Whyte Schist in the Savage River - Rocky River area by textural and compositional banding. Cross bedding and graded bedding were seen in a few places.

Lineation.

Spry (1962a, p.121) states that lineation in metamorphosed rocks appears as ribbing in quartzite; corrugations of foliation; quartz rods; boudins; fold mullions; parallelism of prisms of hornblende, zoisite, elongate quartz and muscovite; and intersections of foliations. The lineations are parallel or nearly parallel to the axes of minor folds.

Some "unmetamorphosed" sediments do not show lineation, others do show it by crenulations, joint drags or by the intersection of axial plane cleavage with bedding.

The present writer recorded lineation in Whyte Schist by elongate quartz pods in the plane of schistosity parallel to the axes of minor folds, by crenulations and corrugations of foliation, and by the intersection of axial plane cleavage with bedding.

Folds.

According to Spry (1962a, p.121) isoclinal folds which range in size from hundreds of feet across down to microscopic dimensions are most distinctive of the metamorphosed rocks. The "unmetamorphosed" sediments generally show rather open concentric folds with radial joints in the quartzites and tighter concentric or similar folds in the pelites.

The present writer detected isoclinal folds in the Savage

River- Rocky River area on a scale which is restricted to the size of the road cuts where they are exposed. The folds range in size from 2 or 3 ft. across down to an inch or less (pl. 8). Isoclinal folds of much greater wavelength are inferred from photo interpretation in the change of strike area east of the Corinna road (fig. 2).

Micro-fabric.

Spry (1962a, p. 121) states that quartzites range from massive varieties with crushed, "mortar" texture, to platy rocks composed of flattened and elongated grains. Schists contain rolled garnet prophyroblasts and albite with helicitic structures.

In the "unmetamorphosed" Precambrian sediments some quartzites show crushed texture but most of the quartz grains retain their clastic shape and are bonded by an undeformed silica cement.

The present writer has not seen garnet in rocks from the Savage River - Rocky River area. Albite porphyroblasts do show rotation in certain crystals but in most the lines of inclusions are parallel to the schistosity.

Subdivision of the Precambrian has also been suggested on the grade of regional metamorphism. Spry (1962a, p.124) describes the Frenchman Orogeny separating the "older" and "younger" Precambrian " ... as that metamorphic and tectonic event which produced garnet, mica and albite schists". However Burns (1962a, p.316) suggests that " ... at least on the North Coast the difference in metamorphic grade and tectonic style may be the result of an early Cambrian deformation along localized shear belts and that the two associations are approximately the same age".

In the Savage River - Rocky River area the tectonic style of the Whyte Schist formation compared to the tectonic styles of the "older" and "younger" Precambrian of Spry is not distinctive of either one or the other, so that subdivision is uncertain on these criteria. Observation of tectonic style in Corinna Slate ("younger" Precambrian of Spry) is hampered by poor exposure along the Corinna road. The rock does not appear to show the same degree of tectonism as the Whyte Schist. The regional structure of "younger" Precambrian rocks (including Corinna Slate) in the area of the Pieman River between the Whyte River and Pieman Heads is composed of open folds and a series of smaller folds which are more complex (Spry 1964, p.40, fig. 4).

The inferred large scale isoclinal folds and the small scale isoclinal folds in Whyte Schist therefore appear dissimilar to the more open type of folding in the "younger" Precambrian rocks described by Spry from the lower Pieman River.

The metamorphic grade of Whyte Schist is not distinctly different from some "younger" Precambrian rocks in the area described by Spry (1964, p.44), who states that "All belong to the lowest sub-facies of the Greenschist Facies and contain members of the assemblage, quartz, albite, epidote, chlorite, muscovite, actinolite, magnetite and calcite". In the Savage River- Rocky River area the metamorphic grade of Whyte Schist containing albite is higher than that of Corinna Slate in which albite has not been seen.

Subdivision of the Precambrian in Tasmania generally, and in the Savage River- Pieman River area particularly, is difficult because the metamorphosed and "unmetamorphosed" rocks have a similar range of lithologies and the metamorphic grade is fairly similar. The regional and detailed tectonic styles of Whyte Schist and "unmetamorphosed" Precambrian rock appear to differ.

The metamorphosed sediments contain amphibolites and greenschists; the "unmetamorphosed" sediments contain basic sills and dykes (Spry, 1962a, p.256). No indisputable unconformity between metamorphosed and "unmetamorphosed" sediments has been found in Tasmania, but a thrust plane or fault (inferred in the Savage River - Rocky River area) generally delineates the boundary between the two rock types.

At localities in Tasmania where metamorphosed and "unmetamorphosed" Precambrian rocks are adjacent, the "unmetamorphosed" sediments are upper and probably younger. The relationship is obscure in the Savage River area but to conform with previous practice, the terms "Lower" and "Upper" have been retained for the metamorphosed and less metamorphosed rocks.

The writer suggests that Precambrian rock in the Savage River- Rocky River area was faulted in the late Precambrian along a line which is the present contact between "Lower" and "Upper" Precambrian rocks. An elongated narrow block, thrust against a larger competent mass of Precambrian rock was more deformed than the adjacent rock. Tectonic style and metamorphic grade characteristic of the Whyte Schist formation was imposed in the area, possibly by the Penguin Movement which has been defined by Spry (1962a, p.124) as the tectonic event in later Precambrian time separating "unmetamorphosed" Precambrian rock from Cambrian rock.

The tectonic style of Whyte Schist has been compared to the general tectonic style of the metamorphosed and "unmetamorphosed" Precambrian rocks in Tasmania. These structural features in the Savage River - Rocky River area are discussed more fully below.

1.1. Folding.

Small scale inclined isoclinal folds with a wavelength ranging from an inch or less to about 3 ft. and amplitude about twice the wavelength, (pl. 8) plunge in opposite directions in road exposures of Whyte Schist in the northern and southern areas of the map sheet (fig. 2), indicating a regional anticlinal structure with an E-W axis.

Isoclinal folds having a greater wavelength and amplitude are inferred but cannot be seen in the small exposures provided by the road cuts.

Two foliations have been observed in Whyte Schist, a dominant bedding schistosity, and secondary axial plane cleavage which is shown by a few outcrops. Rarely, in an exposure of interbanded phyllite and siltstone the phyllite displays perfect axial plane cleavage which is lacking in the siltstone unit. The secondary axial plane foliation can be identified when it is inclined to the bedding schistosity. The strike of the two foliations may differ by 30 or 40 degrees in some small outcrops which are concluded to represent truncated sections of large scale plunging isoclinal folds.

Lineations in the plane of schistosity such as corrugations, elongate quartz lenses up to 2 inches in size, crenulations of the bedding schistosity (which produce a tectonic ripple-like structure in some quartz-mica schist), and intersections of axial plane cleavage with bedding, reflect the plunge of small isoclinal folds, drag folds, and probably major folds as well. The axes of folds are aligned parallel to the schistosity and general trend of the formation; the plunge of folded rock ranges from horizontal to vertical and is variable over short distances of the road section. Measurements of plunge are not recorded from many exposures away from road sections owing to lack of outcrop.

The small scale isoclinal folding and the inferred larger scale isoclinal folding of Whyte Schist has resulted from E-W compression, probably in the Precambrian. Solomon (1962a, p.317) states that the structural form and tectonic styles of Precambrian rocks are related to pre-Ordovician movements.

The regional anticlinal structure superimposed on isoclinally folded Whyte Schist along the section of the Corinna road from the 20 mile peg to the 34 mile peg may be an upward bulge due to greater mobility in the central part of the arch during the main folding, or may result from the doming of the sediments by granite intrusion after the Devonian Tabberabberan Orogeny because: -

E-W foliation resulting from N-S compression has not been observed in the Whyte Schist.

The crest of the regional anticlinal flexure-fold lies near the regional change of strike which possibly originated by lateral thrusting aside of sediments by granite.

A dominantly E-W tensional joint pattern, dipping steeply to the north and south is present in some competent siliceous rock units, but axial plane foliation in the same direction is absent in phyllite and incompetent units.

1.2. Faulting.

The escarpment between "Upper" and "Lower" Precambrian rock may be due to a fault but lack of outcrop makes this difficult to establish.

Faults do not show clearly on aerial photographs and are difficult to observe in the field, probably because many are strike faults. A faulted rock face is exposed on the jeep road in the area between Long Plains south and the southern Savage River deposit at approx. 16000N; 2000E (fig.2). Plate 3 illustrates the exposure where two faults and possibly three have displaced the conformable contact between quartz-mica schist of the psammitic assemblage and greenschist of the pelitic assemblage. The displacement is 10 ft. in the upper fault and 2 ft. in the middle fault. The direction of movement is recorded at N. 45°E. The parallel faults strike N. 13° E and dip at angle between 50 and 60 degrees to the east. The geometric solution of the fault pattern shows that it is a reverse fault having a net slip vector with the following measurements: -

Plunge 36 degrees in a direction N. 45° E.

Rake 47 degrees.

Length 13 ft.

Strike slip 10 ft.

Dip slip 9½ ft.

The fault at this locality is the only one in the Savage River-Rocky River area which is so clearly shown and for which the net slip can be defined. Other faults, including the major fault inferred at the contact of "Lower" and "Upper" Precambrian rock, may be similar in type.

1.3. Jointing.

Joints trending in an easterly direction and dipping steeply to the north and south are recorded along the Corinna road in sandstones, siltstones and quartz-mica schists of the psammitic Whyte Schist assemblage. Some joints are closely spaced but not associated with any secondary foliation of the rock in the same direction. The joint patterns may have originated by doming of the sediments by granite.

2. Cambrian(?) Amphibolite.

Amphibolite is emplaced in sheets and masses along the general trend of the Whyte Schist, and is host rock to most of the magnetite. The rock is absent, or present only as small dykes and bodies in areas separating the main magnetite deposits. The small amphibolite bodies e.g. those between 17000N and 18000N, do not appear to be associated with magnetite. Thickness of the rock is variable, from a large body centred on the Savage River deposit to small linear sheeted bodies in the Long Plains South-Brown Plains deposit and Rocky River deposit.

Amphibolite in places separates belts of chlorite-rich phyllite and schist from belts of muscovite -, quartz -, and sericite-rich phyllite and schist. An apparent lithologic control for the rock therefore exists but a structural control as the axis of an overturned tightly folded syncline or anticline seems likely. Evidence of this is difficult to find in the field.

The medium- to coarse-grained amphibolite straddles the Savage River in the northern and central areas of the Savage River deposit where it is best exposed in the channel of the Savage River and at depth in boreholes extending north from drillhole 4 to drillhole 20 in the northern area. Exposure of the more coarsely grained amphibolite is poor at higher altitudes and the rock may be present only at depth, aligned roughly parallel to the strike of the deposits and the main body of fine-grained amphibolite. Medium- to coarse-grained amphibolite has not been seen in the Rocky River or Long Plains South deposits.

2.1. Folding.

Folding in amphibolite is suspected from oddly shaped structures preserved in a few cores but field evidence of the scale and nature of folding is hard to find. Open folding in talc-bearing greenschist is seen north of the bridge over the Savage River in a 40 ft. long road section where the structure is preserved by talc zones and lenses up to an inch or two in width. Evidence of folding was also seen in a boulder of "dolomite" in the Savage River which had preserved earlier isoclinal folds in greenschist having an amplitude of 6 inches and a wavelength of about 4 inches.

Folding in the rocks indicates that deformation occurred after schistosity had been imposed.

2.2. Joints.

Certain exposures of amphibolite are highly cross-jointed e.g. where medium-grained amphibolite and fine-grained amphibolite crop out together in the Savage River. The attitude of joint patterns recorded by compass are unreliable in the area where magnetism is great. Vertical jointing in an easterly direction was recorded below Halls Creek, and in a northerly direction upstream from the bridge. Plans of the Savage River adits (fig. 10 to 13) show that the main joints are aligned in northwest, southwest or north-trending patterns.

Joint patterns are not mineralized and were probably formed after magnetite was deposited. Some joint patterns in amphibolite are similar in direction to joint patterns in Whyte Schist.

2.3 Schistosity and Cleavage.

Schistosity in amphibolite is considered a major structural control of mineralization and will be described in greater detail in the section on mineral deposits. The amphibolite host of the different deposits displays schistosity to a greater or lesser extent in directions which are parallel or sub-parallel to the schistosity in Whyte Schist.

Measurement of the attitude of amphibolite schistosity in the Savage River indicates that it is variable, dipping steeply east or west. The schistosity is considered to be due to shearing and recrystallization of near-vertical zones in amphibolite. The number of schistose zones decreases upstream from the bridge to the boundary of amphibolite and the rock appears to be more massive with distance from the mineralized zone. Downstream from the bridge, below the confluence of Halls Creek and the Savage River, highly cleaved rock is exposed in one outcrop which shows a lens of uncleaved amphibolite about 1 ft. in size oriented in the schistosity.

2. 4. Faulting.

Brecciated fault zones or faults of large displacement have not been recorded in amphibolite. Slickensides indicative of movement between adjacent zones of competent amphibolite and incompetent greenschist are exposed in Halls Creek adit (fig. 10) and were seen in serpentinized planes in the drill core. Displacements of any magnitude in places show as mylonitized zones, evident in the northern area of the Savage River deposit on the road between traverses D14A and D18A (fig.3); or shear zones along which carbonate rock is formed in places, e.g. "dolomite" in the face of Halls Creek adit and in the Savage River upstream and downstream from the bridge (pl.9). Faulting and shearing are discussed in greater detail in the section on ore deposits.

V. GEOLOGIC HISTORY

Deposition of the Precambrian sediments in deep water, possibly a miogeosyncline, is suggested by the scarcity of cross-bedded structures and absence of a conglomerate unit, at least in the "Lower" division of the Precambrian. Conglomerate units are present in rocks of the lower Pieman River area (Spry, 1964), which indicate a fluctuating basin of deposition. With the onset of compression from east and west, part of the geosyncline was faulted into a narrow elongate basin, less competent and thus more easily deformed than the adjoining stable block to the west. A progressive rise with shortening possibly accompanied deformation, but shearing was not active. Deformation ended with the uplift of the folded rocks at the close of the Precambrian, to form the southern extent of the Rocky Cape Geanticline. During lower Paleozoic time the folded Precambrian rocks of the Rocky Cape Geanticline supplied material to shallow rapidly fluctuating basins of deposition between the geanticlinal land masses in Tasmania. Basic and ultrabasic magnetite-chromite-osmiridium, and gold-bearing ? igneous rocks invaded Cambrian sediments in the Bald Hill area, and basic magnetite-bearing rocks (amphibolite), very similar in composition to Cambrian basic lavas elsewhere in Tasmania were intruded along lithologic and probably structural boundaries in Precambrian rock. Parallel and curving fracture zones in the amphibolite were subsequently recrystallized into greenschist zones, along which magnetite was later introduced possibly as the end product of differentiation. Cambrian? acid igneous rock (quartz diorite?) was intruded as a dyke separating Precambrian schist and amphibolite in the Rocky River area. The rock may represent a late stage differentiate ~~differentiation~~ of a basic magma.

The area of Precambrian rock continued to supply sediment until the lower Devonian. The Tabberabberan Orogeny between lower and middle Devonian was a major orogeny in Tasmania and folding, jointing and probably faulting can be attributed to this period of mountain building. The last phase of this activity was the intrusion of large plutonic bodies of granite (Meredith Granite) and related igneous rocks into inferred anticlinal axes of arcuate folds which were roughly parallel to the geanticlinal margins. Elsewhere in Tasmania thin marine and terrestrial sedimentation recommenced in the late Carboniferous or Permian but sediments of this age, if they ever were deposited, have not been preserved in the Savage River-Rocky River area. The region was denuded between the Devonian and late Cretaceous and a peneplain formed in the early Cainozoic.

Tertiary terrestrial sediments containing tin, gold and chromite were transported from the north and east and deposited in shallow fresh water lakes. The sedimentary phase was succeeded by Tertiary basalt flows which were probably of far greater extent than the present outcrops indicate. The peneplain was disrupted by uplift in the late Tertiary and dissection, which commenced in the Pleistocene, has resulted in the youthful stage of topography evident today.

Recent alluvial deposits in the major rivers and creeks carry gold, osmiridium, chromite and tin but the deposits are no longer economically significant.

1. Structural Evolution.

1.1. Precambrian Rock.

The structure of "Lower" and "Upper" Precambrian rock is insufficiently known to enable one to state anything very definite about the origin. The writer suggests that "Lower" and "Upper" Precambrian rocks were contemporaneous but different facies in the Savage River - Rocky River area, not separated by an orogeny. Isoclinal folds in Whyte Schist formed by E-W compression and were possibly controlled by major faults which appear to separate "Upper" and "Lower" Precambrian rock. The "Lower" Precambrian Whyte Schist, in the form of a narrow, elongate, downfaulted? block, was less competent than the adjoining large block of "Upper" Precambrian rock to the west, which acted as a buttress. Compression which may have taken place in a series of pulses, imposed the small scale isoclinal folds and inferred large scale isoclinal folds in the Whyte Schist but formed broad open folds in the "Upper" Precambrian rock. Subsequent amphibolite intrusion into the Whyte Schist was apparently controlled by the lithology of the formation or possibly by a major overturned anticlinal or synclinal fold axis. The regional structure was further modified when the Meredith Granite thrust aside and domed the Whyte Schist, causing a regional change of strike and a broad anticline to form on the Corinna road section.

1.2. Geomorphology.

The most striking physiographic feature in the

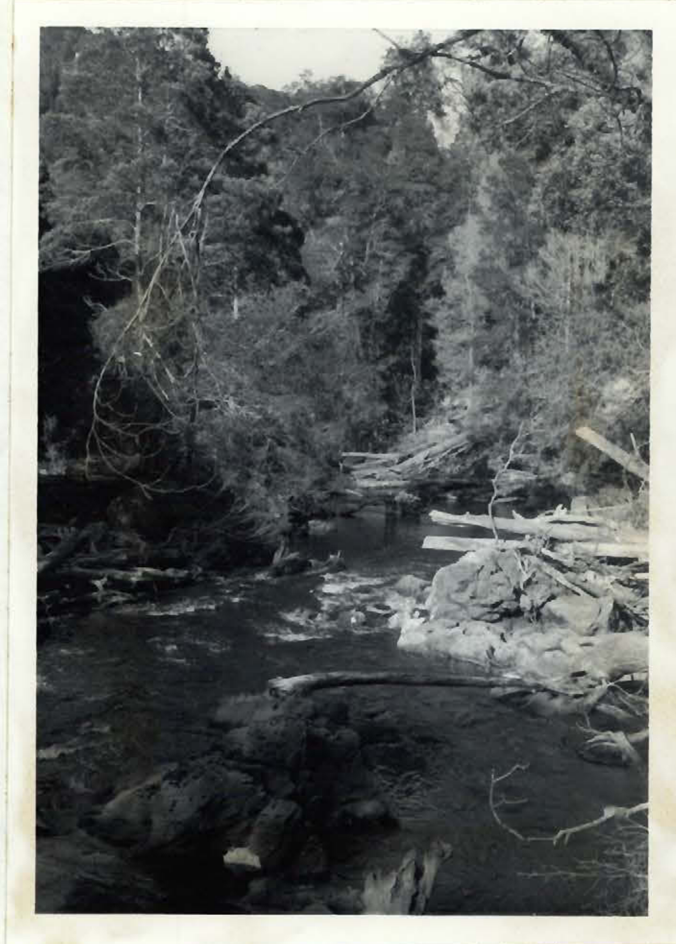


Plate 9. "Dolomite" below bridge over the Savage River.

Plate 10. Henty Surface. View northwest from northern Savage River area.

Savage River - Rocky River area is the level but highly dissected surface of sub-aerial erosion first described by Gregory in 1903 as the Henty Peneplain on the West Coast. In the north of the map sheet the Henty Surface or Lower Coastal Surface is formed at an altitude of 1200 ft. (pl.10) but slopes gently southwest where the remnants of the surface are still preserved at an altitude between 900 and 950 ft.

The landscape due to erosion predominates over structural features although these have controlled the pattern of erosion which is in a stage of youth. The surface truncates Whyte Schist, amphibolite and the ore zones with no marked change of relief. Davies (1959) and Scott (1960) attribute the land forms in Tasmania to uplifted sub-aerial erosion levels, with the possible exception of the Henty Surface which might be of marine origin. The writer considers that the non-fossiliferous Tertiary gravels on the Corinna road, overlying a lignite bed in one place, indicate a sub-aerial origin for the surface.

Davies (1959) suggested that landscape in Tasmania was derived from a mid- to late Tertiary uplift of a single peneplain which had been derived from an early (Eocene-Oligocene) period of planation, but the exact age of the different surfaces is a matter of conjecture. Dissection of the Henty Surface after uplift, is thought to have taken place in the Pleistocene (Davies, 1962, p.244).

The height of the Henty Surface relative to sea level was perhaps 100 ft. greater than it is today. Blake (1939) records that a bore in the lower Savage River intersected

135 ft. of river sediments before reaching bedrock, which indicates that the lower Savage and Pieman rivers have drowned valley systems.

VI. SUMMARY AND CONCLUSIONS.

The Precambrian Whyte Schist formation is represented as two conformable rock units, one a metamorphosed psammitic assemblage consisting of quartzite, sandstone, siltstone, quartz-mica schist and phyllite, in which chlorite schist and pelitic beds are sparsely intercalated. The other rock unit consists dominantly of a greenish pelitic assemblage of argillite and chlorite-quartz schist and phyllite, interbedded with psammitic sediments in places.

The Whyte Schist formation is tightly folded in small scale folds and inferred large scale folds, and dips steeply to the east.

The tectonic styles and metamorphic grades of Precambrian metamorphosed and relatively unmetamorphosed sediments in Tasmania have provided a basis for their classification into "older" and "younger" rock even where an undoubted unconformity cannot be seen. The metamorphic grade and tectonic style of Whyte Schist are not such as to identify this formation as either "older" or "younger" Precambrian, and it is classed rather as "Lower" Precambrian. It is in contact with less deformed and metamorphosed "Upper" Precambrian Corinna Slate over a small area, but the relations are obscure. A major fault appears to separate Whyte Schist and Corinna Slate.

Amphibolite is the host rock for magnetite. It occurs as concordant linear bodies and masses in Whyte Schist. Field and microscope study of the rock and its relationship to the more coarsely textured amphibolite strongly suggest an intrusive igneous origin. The age of the amphibolite is uncertain; the Na_2O content and Na_2O/K_2O ratio, differ from those of "older" and "younger" Precambrian amphibolites and basic igneous rocks elsewhere in Tasmania, and the mineralogy and textures are also different. The chemical composition resembles most closely those of extrusive Cambrian rocks. It should be noted also that Cambrian ultrabasic rock and serpentinite in the Savage River - Rocky River area contain significant amounts of primary magnetite, but it is not known whether these amounts are abnormally high. A Cambrian age may also be indicated by the silica, feldspar, and carbonate metasomatism of Savage River and Rocky River amphibolite, an alteration in the rock which is characteristic of Cambrian basic igneous rocks in Tasmania.

Cataclasite, possibly a sheared quartz diorite, appears to be partly intrusive into amphibolite in the Rocky River area, but its age is uncertain. The rock has been tentatively assigned to the Cambrian as a late stage differentiate of basic igneous rock.

The Meredith Granite stock of Devonian age, to the east of the deposits was inaccessible for mapping except in the headwaters of the Rocky River. The boundaries were delineated by aerial photo interpretation. The granite was supposedly emplaced in the trough between geanticlinal land masses of Precambrian rock as a late stage in the cycle of mountain building known in Tasmania as the Tabberabberan Orogeny.

Tertiary rocks include conglomerate, grit, gravel, siltstone, mudstone and lignite deposited on a plain of erosion known as the Henty Surface which formed after denudation between the Carboniferous and Cretaceous periods. Tertiary basalt overlies the sediments in places.

The peneplain was uplifted in the late Tertiary and dissected in Pleistocene and Recent times to a youthful stage. Recent alluvial deposits in the Whyte and Savage rivers carry gold, osmiridium and chromite, partly derived from the Cambrian serpentinized ultrabasic complex. Tin, derived from deposits associated with Meredith Granite is found in Tertiary sediments and alluvial deposits farther to the south.

P A R T   2.

MINERAL DEPOSITS OF THE SAVAGE RIVER - ROCKY RIVER REGION

I. GEOLOGY OF THE DEPOSITS

1. Introduction.

The magnetite deposits are classified into three types, based on field and core evidence: -

(i) The Savage River type is the dominant one in the northern and central areas of the Savage River deposit, but is also found in deposits to the South. Magnetite is located within schistose, or originally schistose zones of the amphibolite mass.

(ii) The Savage River South and Long Plains South - Brown Plains type in which magnetite is localized at the contact of a linear amphibolite body and a meta-sediment, or is within the amphibolite.

(iii) The Rocky River type in which magnetite is mainly disseminated in chlorite schist, a metamorphosed sediment adjacent to amphibolite. Wall rock alteration and gangue mineral introduction may be absent or show a much smaller number of minerals than in type (i).

The classification is based mainly on the relationship of magnetite to host rock and not on the genesis of metallization because the processes of ore formation are not fully understood in all three areas.

2. Lithology.

2.1. Whyte Schist.

Figs. 3,4,5 and 6 illustrate the distribution of Whyte Schist in areas adjacent to magnetite deposits in the Savage River and Long Plains South areas.

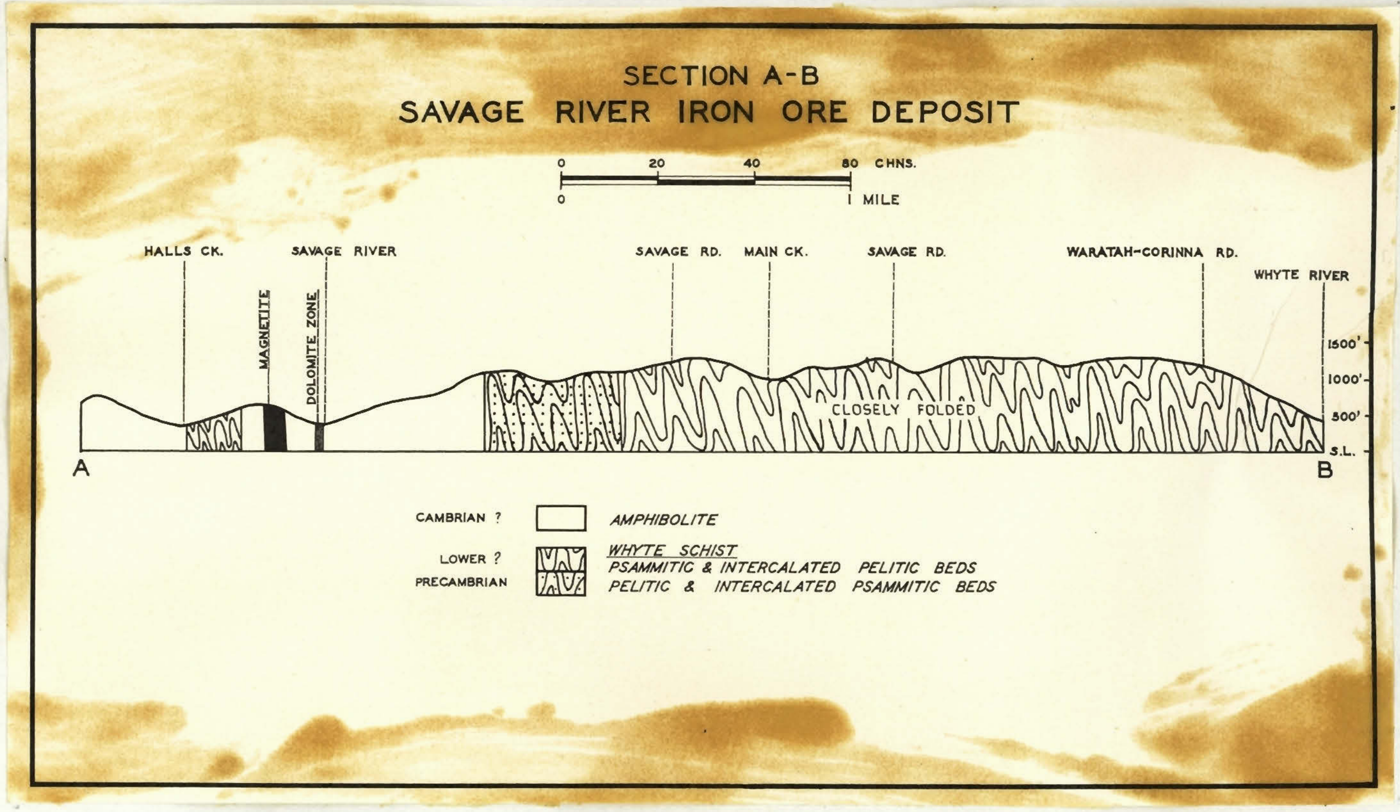

SECTION A-B
SAVAGE RIVER IRON ORE DEPOSIT
0
20
40
80 CHNS.
0
1 MILE
HALLS CK.
SAVAGE RIVER
MAGNETITE
DOLOMITE ZONE
SAVAGE RD.
MAIN CK.
SAVAGE RD.
WARATAH-CORINNA RD.
WHYTE RIVER
1500'
1000'
500'
S.L.
CLOSELY FOLDED
A
B
CAMBRIAN ?
AMPHIBOLITE
LOWER ?
PRECAMBRIAN
WHYTE SCHIST
PSAMMITIC & INTERCALATED PELITIC BEDS
PELITIC & INTERCALATED PSAMMITIC BEDS

Fig. 14

The assemblage to the west of the amphibolite bodies comprises grey mica-quartz-albite (chlorite) schist and phyllite, quartz schist, silty shale and siltstone. The contacts with amphibolite are poorly exposed and the boundaries represented are approximate.

The assemblage on the eastern side of the amphibolite bodies is more argillaceous and consists of chlorite-quartz-sericite schist and phyllite, argillite, and minor intercalated silty and sandy beds.

Whyte Schist in the Rocky River area (fig. 7) is a lustrous silvery-grey schist, or phyllite.

The sedimentary greenschist ridge to the east of amphibolite is the host rock for magnetite and corresponds to the hematite schist described by Reid (1924).

The rock is 600 ft. to 800 ft. thick. The western contact with amphibolite can be ascertained in Cataract Creek, Nolan Creek and farther south in the Rocky River. The eastern contact with grey schist and phyllite is not clear; in one creek section greenschist and grey schist appear to be intercalated in the contact zone.

The Whyte Schist pelitic and psammitic rocks in each of the deposits dip to the east or northeast at consistently steep angles ranging from about 70 degrees to vertical (figs.14 15).

2.2. Amphibolite

The distribution of amphibolite and its altered equivalents within the ore zone is shown on fig. 19 which is a vertical representation of the rock types intersected by diamond drillholes in the central and northern areas; and by drillhole R.T.A.E.1 in the Long Plains South deposit.

Amphibolite in the core is a blue-grey or greenish fine-grained massive looking rock, in places fractured or having an incipient schistosity. Drill cores generally show variable magnetism from weak to fairly strong. Assays indicate that the Fe content in magnetite ranges from about 2 to 5 percent. Amphibolite of this type is recorded in the logs of the cores as "barren" country rock to distinguish it from magnetite-bearing rock having a higher iron content.

In the Long Plains South-Brown Plains deposit amphibolite, conformable in steeply-dipping chlorite schist of the meta-pelite assemblage, is well exposed over a width of about 300 ft. in Bowry Creek between traverses 12000N and 13000N(fig.6). A section through the amphibolite body is poorly exposed in the creek between traverses 6000N and 7000N where the rock is estimated to be 200 ft. to 300 ft. wide. Outcrops of amphibolite elsewhere along the line of the deposits are masked or poorly exposed. In general the width of the magnetic anomaly in the Long Plains South-Brown Plains area appears to be directly related to the width of the host amphibolite rock.

In the Rocky River area, a division of amphibolite into massive or foliated rock, and sheared metasomatized (altered) amphibolite is shown on the geological map (fig.7). The boundaries are transitional and represent the general distribution of amphibolite and altered amphibolite in rocks exposed mainly in the Whyte and Rocky rivers and along the dry water race over a width of about 900 ft. Zones of massive amphibolite do occur in the metasomatized and sheared amphibolite but cannot be delineated as mappable units.

Fine-grained amphibolite from the Savage River, Long Plains South-Brown Plains, and Rocky River deposits is megascopically uniform in colour, texture and structure. The mineral composition is similar, and the chemical composition of amphibolite from the Savage River, from the Rocky River, and from the lower Pieman River does not differ very much (c.f. Table II, p.40, Pt. 1)

2.3. Greenschist.

Dark-green greenschist zones in amphibolite can be distinguished in the drill core but cannot be widely delineated by surface mapping. Magnetite in many sections is concentrated within these zones which are variable in width, ranging from a hairline to a core intersection of about 100 ft. in drillholes 2 and 14.

The distinction between amphibolite and greenschist in many sections of drill core is an arbitrary one based on the relative schistosity of the rock; the contacts shown on the geological sections of the drillholes (fig.19) are therefore not necessarily sharp ~~[illegible]~~; the greenschist zone may include relatively massive widths of amphibolite. In many of the core sections the transition from amphibolite into greenschist is gradual from massive-looking amphibolite through rock having incipient schistosity into foliated greenschist. Some core sections show a sharp contact between the two rock types but such are not numerous.

Core from drillhole R.T,A.E.1, collared between traverses 11,000N and 11,250N in the Long Plains South deposit (fig.6) shows that amphibolite is massive between magnetite-bearing schistose (greenschist) zones.

Foliated zones occur in the massive amphibolite of the Rocky River deposit but are difficult to map as separate units.

2.4. Metasomatic Amphibolite Schist.

Wall rock alteration of amphibolite and greenschist within the zone of the deposit intersected by diamond drilling in the central and northern Savage River areas (fig.19) has resulted in rocks which have been classified as carbonate greenschist (and amphibolite); quartz-feldspar-(carbonate) amphibolite schist, and carbonate rock; included under the general heading of metasomatic amphibolite schist. The limits of metasomatized rock have been drawn to show the extent of alteration, but variable thicknesses of unaltered amphibolite and greenschist are included.

The metasomatized zones are best revealed in the drill core; from which their geological boundaries are represented by projection to surface on maps of the northern and central areas (figs. 3 and 4). Drilling ceased in many of the holes in the central area shortly after penetrating the altered rocks situated 200 ft. to 300 ft. west of the line of the deposits, consequently the width of these is unknown. Metasomatized rock in the northern area trends almost parallel to the deposit on the western side from the Savage River to traverse D18A(fig.3).

The trend apparently crosses that of the magnetite between traverses D18A and D34A because altered rock has been recorded from drillholes 1 and 2 on the eastern side of the deposit. The width of metasomatized amphibolite ranges from about 20 ft. to 400 ft. (approx.).

(i) Carbonate Greenschist and Amphibolite.

Carbonate greenschist in hand specimen is distinctly schistose. Magnetite and pyrite are disseminated along the schistosity in places. Calcite (or dolomite) is aligned parallel to the schistosity in streaks, lenses and films.

The petrology is much the same as that described for greenschist (Sect. II 1.3. Pt. 2), but calcite grains 0.1 to 0.3 mm. in size replace chlorite and in section (64-86)are bordered by an alteration to talc about 0.1 mm. wide. The schistosity is crenulated in one or two thin sections.

Amphibolite altered by carbonate metasomatism shows in thin section that amphibole and chlorite of the groundmass are preferentially replaced by carbonate.

(ii) Quartz-Feldspar - (carbonate) Amphibolite Schist.

Quartz-feldspar-(carbonate) amphibolite schist is a banded rock in hand specimen, the individual bands generally up to an inch in width, composed of quartz, feldspar, (carbonate), and separated by greenschist layers of approximately the same width. Carbonate (calcite) is interstitial to the quartz and feldspar in some rocks.

Thin sections of the rock under the microscope show layers consisting dominantly of quartz and feldspar aggregates, alternating with layers consisting of chlorite, actinolite, sphene and epidote. Amphibole may be completely altered to chlorite or remain only as vestigial crystals. The quartz, feldspar, (carbonate) minerals form a granulose structure, in which the feldspar (albite-oligoclase) may be carlsbad - and albite-twinned, or untwinned. The feldspar does not generally contain inclusions; where inclusions are present they consist of chlorite or calcite in a disordered arrangement. Sphene and epidote occur mostly in the chlorite-amphibole layers. Magnetite and pyrite are equally dispersed through the rock or they may be concentrated in the dark, chlorite-rich bands.

Thin section study of the feldspar in these rocks indicates differences from the feldspars of unmetasomatized amphibolite and meta-sediments, which show less twinning of the crystals, and crystals commonly containing inclusions in an ordered arrangement which may be parallel or transverse to the schistosity. These differences suggest a later origin for the banded quartz-feldspar aggregate in which metamorphism and recrystallization is not so intense.

The maximum core width of metasomatized amphibolite is 470 feet in drillhole 25. (fig.19).

(iii) Carbonate Rock.

The occurrence of carbonate rock (mainly magnesium-rich "dolomite", also calcite and magnesite) with magnetite bodies, or in close proximity to them in the Savage River area, Long Plains South - Brown Plains area, and the Rocky River area suggests that the formation of carbonate rock is associated in some way with iron mineralization.

Carbonate rock, (mostly "dolomite") is exposed along the bed of the Savage River between traverse C28D and the bridge (fig. 3); in scattered outcrops upstream from the bridge for about 1400 feet, and in the end of Halls Creek adit over a length of 35 feet (fig.10). "Dolomite" was also intersected by drillhole 14 between 257 feet and 278 feet, 282 feet and 285½ feet, 302½ feet and 303 feet, and 439 feet to 442 feet.

Exposures of "dolomite" in the river below the bridge are irregular in size and shape (pl. 9). An outcrop about 25 feet wide on the northern bank supports the bridge. Highly talcose schist separates this outcrop from one a little farther up the road which is 25 feet wide and 10 feet high. "Dolomite" in the river section below the bridge is greyish-white, fine- to coarse-grained, talcose and sheared. In places the rock is seamed with talc to such an extent that the rock becomes a dolomitic talc schist. In Halls Creek adit a transition can be seen from dark greenschist, through yellowish talc dolomite schist, into white finely crystalline carbonate rock.

Thin section study of fine-grained "dolomite" from the adit shows that grain size is variable from 0.1 mm. to 0.5 mm. in slides 97-64 and 99-64; crystals are subhedral to euhedral and twinned parallel to both diagonals in a few crystals. Fine-grained recrystallized aggregates occupy zones of micro-shearing. Schistose structure is imparted by talc streaks and bands up to 2 mm. wide; or talc may be in veinlets or disseminated in the interstices between carbonate crystals.

Sheared "dolomite" in the adit is separated from medium grade ore by a major shear zone up to 1 foot wide (fig.10).

An assay (analyst W. St. C. Manson) of carbonate rock from Halls Creek adit showed the percentage composition as: -

SiO_2	Fe_2O_3	CaO	MgO	CO_2	Total
5.39	2.54	25.60	22.5	43.5	99.53

"Dolomite" intersected in the boreholes is white or faint pink and fine-grained. Under the microscope chlorite is seen as wisps in the carbonate matrix, and magnetite appears to replace carbonate. Core contacts are not well preserved but "dolomite" is associated with magnetite, carbonate greenschist, or separates fine and more coarsely textured amphibolite.

"Dolomite" is exposed in narrow vertical lenses and bands in schistose amphibolite at three different sites upstream from the bridge. The most clearly observed outcrop is in the river between traverses D9A and D4 (fig. 3) where the contact of "dolomite" and amphibolite is exposed in the rocky channel. The "dolomite" forms a 20 ft. wide band parallel to the schistosity of the amphibolite host rock. The eastern contact is exposed in the rock bank; the western contact with amphibolite is below water. The transition from foliated amphibolite into "dolomite" is evident over 5 feet, from hard amphibolite into soft carbonate greenschist containing augen of "dolomite" one eighth of an inch long aligned in the schistosity. The carbonate greenschist changes imperceptibly into talc schist which forms a selvage up to half an inch thick at the "dolomite" contact. The outer zone of "dolomite" is very irregular and typical of schistose amphibolite which has been invaded, replaced and assimilated by carbonate rock. Lenses, pods and irregular pockets of "dolomite" ranging in

Plate 11.

"Dolomite" -

greenschist contact;

Savage River.

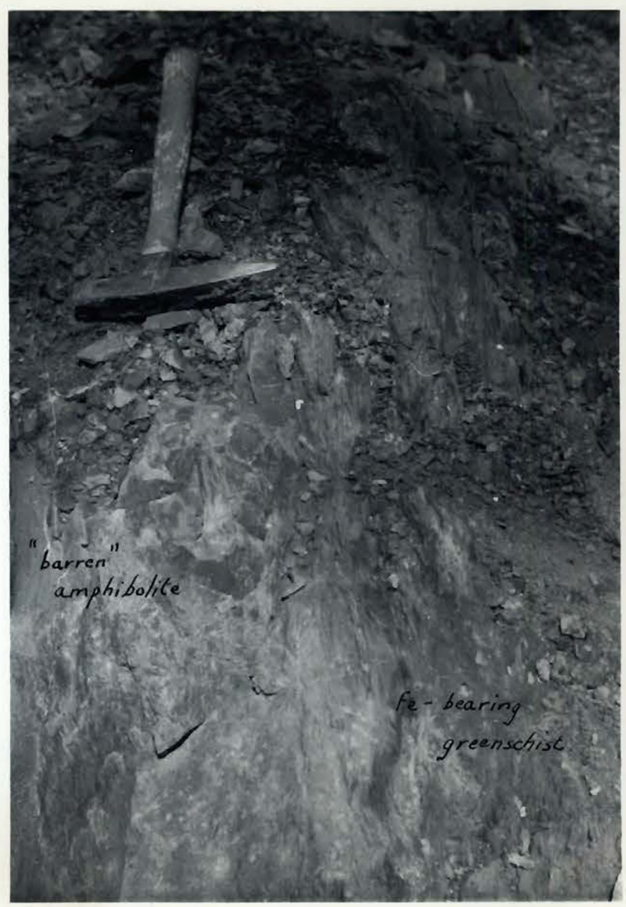


Plate 12.

Foliated magnetite-

bearing greenschist

grading into "barren"

amphibolite.

size from one or two inches up to 2 feet in length are embodied in a talcose schist matrix and constitute a sharply defined eastern contact (pl. 11). The bodies coalesce over a distance of about 2 feet from the contact to form the 20 ft. wide "dolomite" zone, which is free from altered amphibolite but carries irregular ridges and masses of opaline silica.

The chemistry of the change from amphibolite into "dolomite" is not fully understood. Bain (1924) indicated the reactions which take place between ferromagnesian minerals and solutions containing water, silica and carbon dioxide to form replacement magnesite deposits,

e.g. $$\underset{\text{forsterite}}{9\,(MgO)_2\,SiO_4} + 3SiO_2 + 12H_2O = \underset{\text{serpentine}}{6H_4\,Mg_5\,Si_2\,O_9}$$

$$6H_4\,Mg_5\,Si_2O_9 + 3CO_2 = 3MgCO_3 + 5H_4Mg_5\,Si_2O_9 + 2SiO_2 + 2H_2O$$

$$3MgCO_3 + 3CaCO_3 = \underset{\text{dolomite}}{3(CaCO_3 \cdot MgCO_3)}$$

Possibly similar reactions between ferromagnesian minerals of greenschist in shear zones of the amphibolite and solutions containing carbon dioxide and water were not carried to completion and resulted in the replacement "dolomite" deposits of the Savage River.

Dolomitic rock in the Savage River, and in core from drillhole 14 indicates a zone about 200 feet wide and 1800 feet long in which irregular bodies and lenses of "dolomite" occur sporadically (fig. 3). The zone lies 600 feet on the eastern side of the magnetite deposits and is parallel to the trend.

The small lenses of "dolomite" in the core of drillhole 14 represent the southern extent of the rock, beyond which it has not been traced on surface or from core of holes drilled in the central area. "Dolomite" in Halls Creek adit does not lie within the "dolomite" zone and may be an isolated lens adjacent to the magnetite orebody.

Metasomatic alteration into quartz-feldspar amphibolite schist or carbonate greenschist is not evident in the core of drillhole R.T.A.E.1 in the Long Plains South-Brown Plains deposit, but "dolomite" was intersected at the end of the hole. Magnesite deposits occur in the area (Sect. I.4. Pt .2).

The broad boundaries of metasomatized rock (quartz-feldspar-(carbonate) amphibolite schist) in the Rocky River area are shown in fig. 7. The sedimentary greenschist is also altered (silicified and feldspathic) in a few places.

A thin band of dolomite 2 ft. to 3 ft. wide is exposed on the western bank of the Rocky River about 20 ft. upstream from the junction with Nolan Creek. The occurrence, localized in a zone of schistosity in amphibolite, is similar to "dolomite" in the bed of the Savage River and presumably originated in the same way.

2.5 Tertiary Sediments.

A layer of Tertiary gravel and grit, probably no more than 2 ft. or 3 ft. thick underlies the basalt in the southern Savage River area. The white quartz gravel is rounded, up to half an inch in diameter, and is seen in a few places on the jeep track to the Long Plains South area (fig. 5).

Scattered boulders of conglomerate in the area between

Magnetite Creek and 4700 S (fig. 5) are exposed on the hillslopes, but distribution is irregular. It is not certain that all the exposures of conglomerate represent bedrock; some of the conglomerate has possibly been transported downslope. Large blocks are exposed between traverse 4500 S and the creek about 200 feet to the south. (fig. 5). The constituents of conglomerate in one or two exposures in this area are poorly-sorted and poorly rounded, and represent basal conglomerate occupying depressions in the original plain of erosion. Boulders of grey quartzite up to 1 foot in size comprise part of the rock. Elsewhere the angular constituents are white vein quartz and grey quartzite between 1 and 2 inches in size, set in a matrix of quartz grains and grit. The basal conglomerate resembles the poorly-sorted material occupying scour depressions in Whyte Schist in the Brown Plains area. The constituents indicate a derivation from the east.

The basal conglomerate is not mineralized and panning (by W. Pitulej) of the streams draining the area in which conglomerate occurs does not indicate the presence of gold, tin or chromite.

Iron ore in the Long Plains South- Brown Plains deposit is masked by a veneer of partly redistributed Tertiary grit and gravel extending from traverse 3000 S to traverse 00 on the Corinna road (fig. 6). The magnetic anomalies are present beneath alluvium which ranges from less than 1 foot to about 5 feet thick.

An unknown thickness, (probably no more than two feet) of gravel, grit and siltstone underlies basalt in the northern

Savage River area. A weaker magnetic anomaly is evident beneath the Tertiary rocks capping the magnetite lodes.

Blocks of Tertiary conglomerate 10 ft. to 20 ft. in size are scattered in the bed of the Savage River over a distance of 800 ft. upstream from the bridge.

In the Rocky River area, grit and gravel forms a veneer 2 ft. or 3 ft. thick over sedimentary greenschist on the eastern side of the deposit north of Cataract Creek. (fig. 7).

2.6 Tertiary Basalt.

Basalt in the northern Savage River area is exposed as a cliff face 12 ft. to 15 ft. high on traverse F7 east of the map area, but thickness decreases over the line of lode where it may be 5ft. thick. The basalt thickness to the north probably decreases over the line of lode.

Basalt in the southern Savage River deposit underlies an irregular shaped area shown on fig. 2. The eastern boundary of the basalt is generally indistinct; the western boundary in many places is marked by a change in relief of about 10 feet. The best exposure of basalt is seen on traverse 9000 S east of the baseline (fig.5) where the boundary is a scarp face up to 10 feet high (pl.7). The basalt thickness is variable however; no marked change in topography is apparent west of the baseline on traverse 9000 S owing to a gradual decrease in thickness westward along the traverse.

A weak 10,000 gamma magnetic anomaly (corresponding to the mineralized zone) shows up beneath the basalt between traverses 7000 S and 8000 S west of the baseline.

2.7 Recent Deposits.

Hematite, magnetite and limonite scree ranging from shingle (aver. size 1 inch) up to blocks 2 ft. or 3 ft. across, is ubiquitous in the vicinity of the magnetite lodes in the northern Savage River area and hinders the surface mapping of the deposits. Iron scree is plentiful in the area between traverses D34A and F7 (fig. 3) where it may be as much as 3 ft. thick.

Recent deposits include river terraces and banks consisting of alluvium and pebbles. The raised terraces are 5 ft. to 10 ft. thick in places and have been trenched and pitted by the early prospectors in their search for gold and osmiridium.

Iron ore scree in the form of gravel, shingle, pebbles, cobbles and boulders is widespread in the central area, associated with magnetite lodes. The distribution of the iron ore scree indicated in the trench profiles (figs. 16,17 and 18) is very irregular and varies from pockets about 15 ft. deep along the trench walls to places with little scree cover, or none at all. Pebbles and cobbles (aver. size 2 inches) are consolidated into breccia and conglomerate by a ferruginous cement on the track leading to the adit west of drillhole 12 (fig.4).

Iron scree is associated with magnetite deposits of the southern Savage River area and the Long Plains South area, but is less widespread than in the central and northern Savage River areas. Detritus shed from the deposits is masked by vegetation and humus. Such conditions make it difficult to know, without the aid of the magnetic anomaly maps, that the areas contain magnetite deposits.

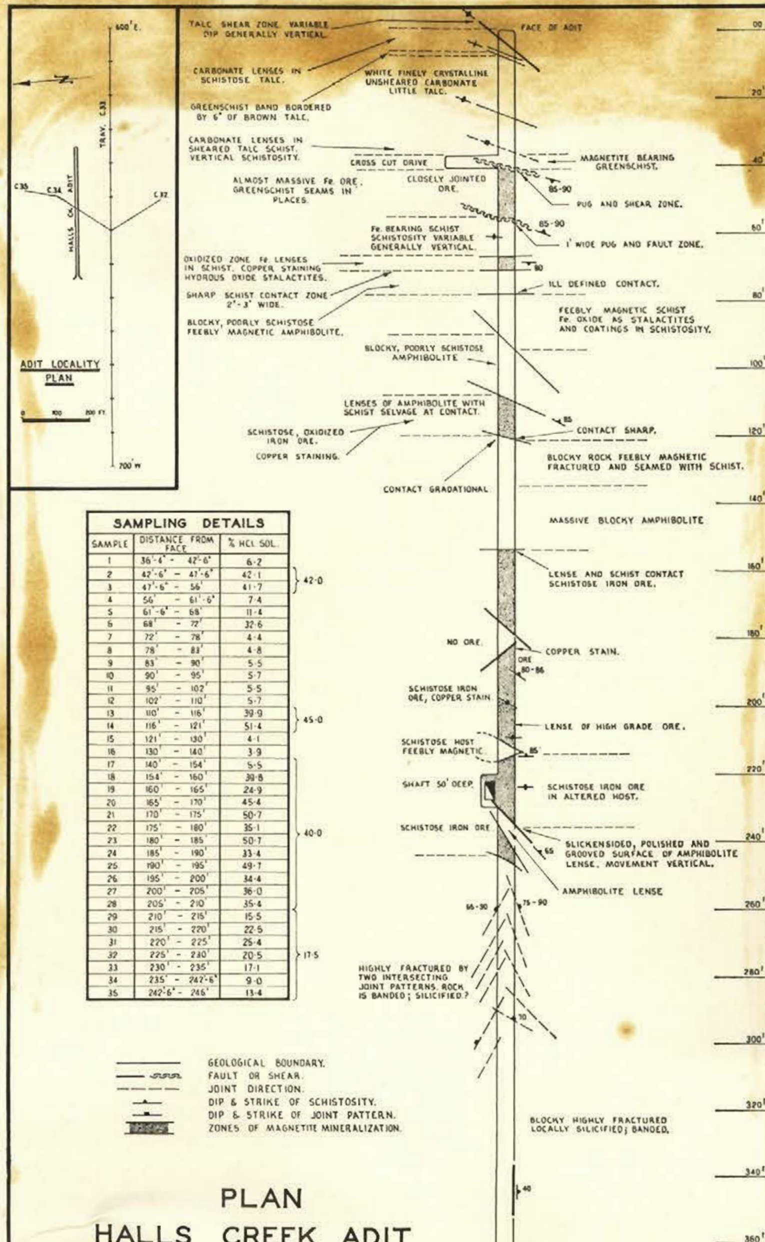
3. Rock Structure and Structural Control of Mineralization.

(i) Schistosity.

Schistose zones in amphibolite, and magnetite concentrated along the schistosity are evident in the core from practically all the drillholes in the Savage River deposits. This structural control of mineralization is also shown by an outcrop of "barren" amphibolite grading into magnetite-bearing greenschist (pl.12), exposed beyond drillhole 16 on the track leading to Magnetite Creek (fig. 4).

Halls Creek adit, driven in fresh rock, displays the relationship of ore lode to country rock in three dimensions and confirms core evidence that magnetite in many places follows the schistosity of the host rock. Magnetite commonly occupies vertical or steeply-dipping zones of schistosity (greenschist) which may grade into massive blocky amphibolite or terminate sharply in a clearly demarcated contact. Mineralization ceases at or near the contact with massive amphibolite. Small lenses of amphibolite about 1 ft. wide are present in places in the schist near the amphibolite contact. Narrow zones of schist (bearing magnetite) curve around these lenticular and planar amphibolite bodies. The large amphibolite lens 235 ft. from the face in Halls Creek adit (fig.10) shows vertical slickensided markings indicating the direction of differential movement.

Zones of schistosity controlling magnetite emplacement are not so well shown in the trench sections, possibly because



SAMPLING DETAILS

SAMPLE	DISTANCE FROM FACE	% HCL SOL.	
1	36'-4" - 42'-6"	6·2	
2	42'-6" - 47'-6"	42·1	42·0
3	47'-6" - 56'	41·7	
4	56' - 61'-6"	7·4	
5	61'-6" - 68'	11·4	
6	68' - 72'	32·6	
7	72' - 78'	4·4	
8	78' - 83'	4·8	
9	83' - 90'	5·5	
10	90' - 95'	5·7	
11	95' - 102'	5·5	
12	102' - 110'	5·7	
13	110' - 116'	39·9	45·0
14	116' - 121'	51·4	
15	121' - 130'	4·1	
16	130' - 140'	3·9	
17	140' - 154'	5·5	
18	154' - 160'	39·8	
19	160' - 165'	24·9	
20	165' - 170'	45·4	
21	170' - 175'	50·7	
22	175' - 180'	35·1	40·0
23	180' - 185'	50·7	
24	185' - 190'	33·4	
25	190' - 195'	49·7	
26	195' - 200'	34·4	
27	200' - 205'	36·0	
28	205' - 210'	35·4	
29	210' - 215'	15·5	
30	215' - 220'	22·5	
31	220' - 225'	25·4	
32	225' - 230'	20·5	17·5
33	230' - 235'	17·1	
34	235' - 242'-6"	9·0	
35	242'-6" - 246'	13·4	

GEOLOGICAL BOUNDARY.
FAULT OR SHEAR.
JOINT DIRECTION.
DIP & STRIKE OF SCHISTOSITY.
DIP & STRIKE OF JOINT PATTERN.
ZONES OF MAGNETITE MINERALIZATION.

PLAN
HALLS CREEK ADIT

0 20 40 60 FT.

G. URQUHART
GEOLOGIST 1963

Fig. 10

the host rock is deeply weathered.

Evidence from Halls Creek adit especially, from the Savage River adits, from mineralized cores and isolated fresh exposures of magnetite concentrated in greenschist, indicates that schistosity of the host rock is the major structural control of mineralization.

The amphibolite probably yielded to stress by microbrecciation and formed linked, sheeted and dilation shear zones. Stress in amphibolite was also relieved within the zones of shearing by recrystallization to greenschist, which for the most part has obliterated any evidence of microbrecciation.

Sections through the drillholes (Appendix 3) show the attitudes and distribution of the magnetite lodes within zones of original shearing which extend over about 700 feet in the section of drillholes 8 and 9.

The alternating magnetite-bearing zones, amphibolite - and greenschist zones are represented as planar features on the diagrammatic sections to facilitate computation of reserves. Correlation of the ore-, amphibolite - and greenschist zones between adjacent boreholes is difficult on plan and suggests that zones of schistosity curve, ramify, interconnect, narrow and widen in the main mass of the amphibolite, along both strike and dip of the deposit.

(ii) Faulting.

Major faults in the central and northern Savage River areas are poorly exposed and have been inferred from fault breccia scree or change in attitude of the country rock. An E-W fault is inferred in the northern area between traverses D14A and D18A (fig. 3) to account for the termination of mineralization south of the inferred fault, and for the change in strike of mylonite schist from a northerly to an easterly direction.

Weathered silty schist crops out to the east of drillhole 25 (fig.3) but cannot be traced on traverses to the south of D18A, possibly because of a fault displacement.

Brecciation and shearing of "dolomite" in the Savage River below the bridge indicates dislocation along a line which trends north, parallel to the magnetite deposits. This is one of the few places where evidence of rupture can be seen.

Blocks of silicified and brecciated ferruginous rock lie on the track to Long Plains about 400 feet north of the basalt knoll (fig.4). A fault in this locality may account for the abrupt decrease in width of the mineralized zone south of Magnetite Creek, but a traverse of the creek did not show a major fault. Exposure of faults in the central and northern areas is too scanty for conclusions to be made on their directions, displacements or relative ages.

Post-ore dislocation and deformation as shears and faults in magnetite are seen in the adits (figs. 10 to 13). The minor dislocations trend in a northerly direction parallel to the line of the deposits. In Halls Creek adit (fig.10) a 15 ft. wide ore zone at the crosscut is a faulted block bounded by two near vertical shear zones about 1 ft. wide.

Joint patterns in the ore observed in different adits are in three directions: -

(a) In a northerly direction roughly parallel to the post-ore shear direction (c.f. Savage River adit fig. 11).

(b) In northeasterly and southeasterly directions. The dip of the joints ~~patterns~~ varies from 40 degrees to vertical.

(iii) Folding.

Small scale folding in drill core has been noted but is not characteristic of the amphibolite or greenschist. Large scale open folding in talcose greenschist has been observed north of the bridge over the Savage River, but fold structures localizing magnetite cannot be proved. Irregular terminations of ore zones between traverses 500 S and 1000 S in the central area (fig. 4) between traverses C1 and CX near the Savage River and between traverses D14A and D18A in the northern area (fig. 3) suggest that fold structures in greenschist (and faulting?) might account for the broad, non-linear patterns of the magnetic anomalies over these areas.

Surface mapping of the southern Savage River and Long Plains South-Brown Plains areas shows that magnetite deposits are apparently restricted to linear bodies of amphibolite 100 ft. to about 500 ft. wide, or their contacts with meta-sediment. The amphibolite bodies are aligned in the general trend of the meta-sediments.

Core from drillhole RTAE1 (Long Plains South; fig.6) indicates that schistose magnetite-bearing zones within the mass of amphibolite are similar to schistose magnetite-bearing zones in amphibolite of the central and northern Savage River areas.

A slab-like body of iron rich rock 5 ft. to 10 ft. wide, about 200 ft. long and in places up to 20 ft. high is exposed along the baseline north from traverse 4500 N (fig.6), and forms an unusual topographic feature. The iron-rich body appears to be formed at or near the eastern contact of amphibolite with sedimentary schist; farther east magnetite is disseminated in a friable silty matrix and may represent mineralization of sedimentary schist adjacent to amphibolite.

In the creek crossing the baseline at 6250N in the Long Plains South - Brown Plains area (fig. 6). isoclinal drag folds in black pyrite-graphite schist plunge 50 - to 70 degrees to the south.

A 4 inch long piece of core from drillhole RTAE1 shows a band of magnetite which appears to replace a pre-existing isoclinal fold structure in the schistose host rock.

The rocks trend in a northerly direction in the Whyte and Rocky rivers and dip steeply to the east. Strike and dip attitudes of rocks exposed on the steep hillslopes are not everywhere consistent with the regional structure. The variations are most likely due to soil creep.

Magnetite deposits in amphibolite are localized along vertical or steeply-dipping zones of schistosity.

Large scale tight isoclinal folding in meta-sediment is inferred from changes in the direction of dip in the Whyte River section but cannot be seen in outcrop. Some hand specimens of sedimentary greenschist and metasomatized amphibolite show tight isoclinal folding on a small scale, the folds having an amplitude of 2 or 3 inches and a wave

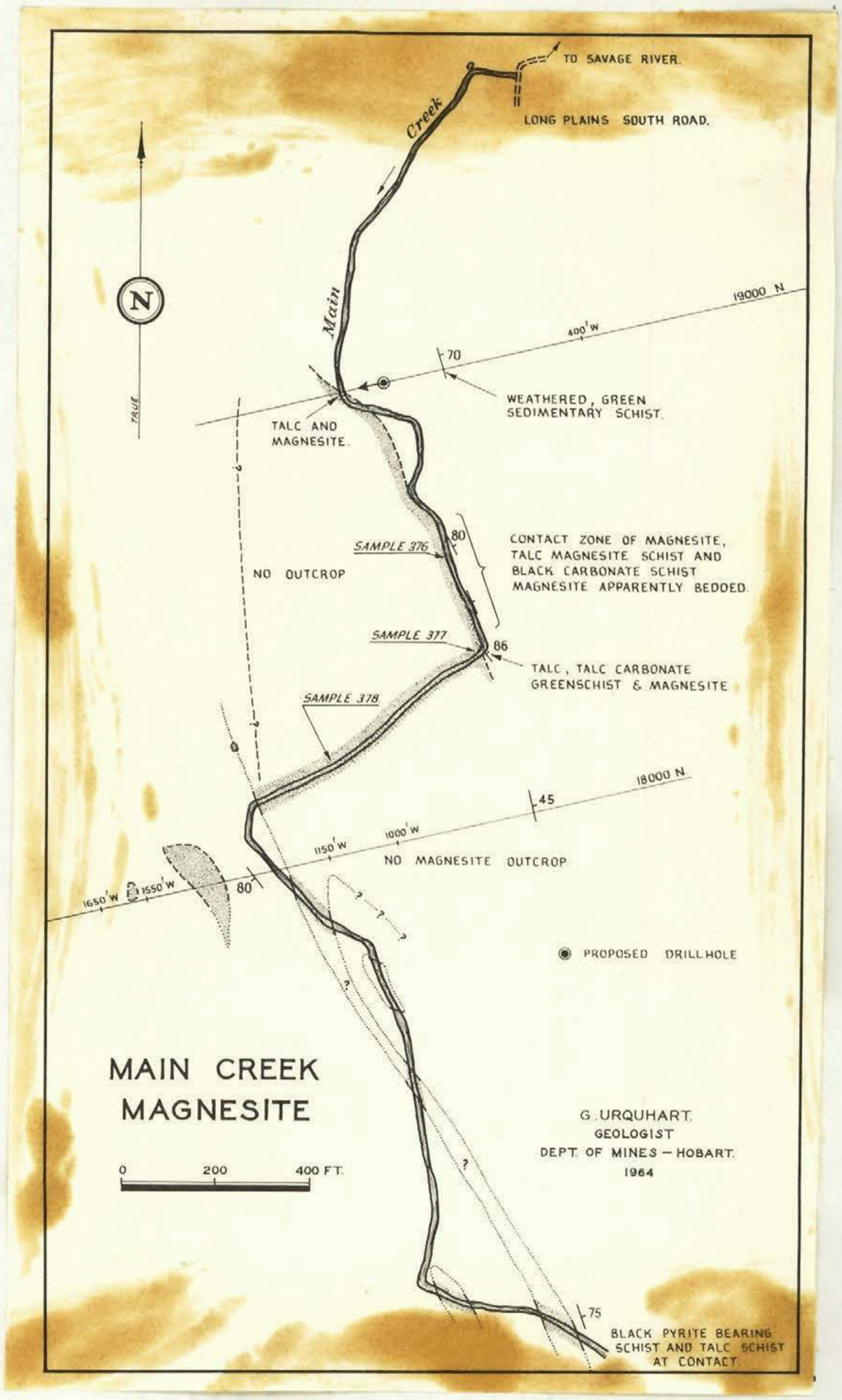

TO SAVAGE RIVER.
LONG PLAINS SOUTH ROAD.
Main Creek
N
TRUE
19000 N
400'W
70
WEATHERED, GREEN SEDIMENTARY SCHIST.
TALC AND MAGNESITE.
SAMPLE 376
80
CONTACT ZONE OF MAGNESITE, TALC MAGNESITE SCHIST AND BLACK CARBONATE SCHIST MAGNESITE APPARENTLY BEDDED.
NO OUTCROP
SAMPLE 377
86
TALC, TALC CARBONATE GREENSCHIST & MAGNESITE
SAMPLE 378
18000 N
45
1000'W
1150'W
NO MAGNESITE OUTCROP
1650'W
1550'W
80
PROPOSED DRILLHOLE
MAIN CREEK MAGNESITE
0
200
400 FT.
G. URQUHART.
GEOLOGIST
DEPT. OF MINES — HOBART.
1964
75
BLACK PYRITE BEARING SCHIST AND TALC SCHIST AT CONTACT.

Fig. 9

length of half an inch or less. Tight folding such as this in homogeneous rock is difficult to observe in outcrop.

Disseminated magnetite in sedimentary greenschist gives rise to the main anomaly in the Rocky River deposit (fig.8) but the major structural control of mineralization is obscure. An obvious and evident structural control is the foliation of the greenschist along which magnetite is dispersed, but the reason for the linear epigenetic mineralization over a restricted width within the rock is not understood. A large scale tight fold structure, fault, or shear zone may be the major structural control of mineralization in these rocks. Displacement due to faulting, fault breccia, or other evidence of faulting, has not been seen.

4. Magnesite Deposits

4.1. Main Creek

Magnesite was first recorded from Main Creek by Rowe (1962) who included an assay of the rock in his report. The writer, accompanied by D.I. Groves, Department of Mines geologist, examined the magnesite deposit previously reported on Traverse 18000 N, between 1350 feet and 1600 feet west of the baseline. In the course of the investigation a larger magnesite body was found in the bed of Main Creek between traverses 18000 N and 19000N (fig.9). A subsequent survey of Main Creek south of traverse 18000 N indicated lenses and bands of magnesite cropping out in the channel as far as traverse 17000 N, beyond which the country rock becomes arenaceous. Bedded quartzite crops out in the creek about 700 feet downstream from the last magnesite occurrence.

Plate 13. Magnesite in Main Creek.

The main body of magnesite is exposed in the channel of Main Creek which is dissected to a depth between 300 feet and 500 feet below the level of the Henty Surface. The bed of the creek in places is a rock channel cut in magnesite to a depth of 10 feet (pl.13). The small magnesite body to the west of Main Creek, described by Rowe, is situated in the valley side between 20 feet and 90 feet above Main Creek but apart from this all the field exposures of deposits are in deeply dissected tributaries draining to the Savage River. Traverses across the strike of the deposits away from creek beds do not show outcrops of magnesite.

The magnesite in Main Creek is cryptocrystalline; a fresh surface is white, grey or greyish-white and a weathered surface pinkish or flesh-coloured. The surface may be fluted, indented and grooved or it may weather to a form resembling "elephant hide". In one 10 ft. long section on the western rock bank, a magnesite "conglomerate" is evident, formed by rounded and subangular nodules of pinkish, cryptocrystalline magnesite 2 to 4 inches in size, set in greyish-white, fine-to medium-grained magnesite, less resistant to weathering than the nodules. Elsewhere in the rock channel the texture of the mineral is heterogeneous, formed by irregular blebs and shreds of white or grey, medium-grained magnesite, less than an inch long, in pinkish cryptocrystalline magnesite. The mineral is dense, compact and brittle and breaks with a hackly, sub-conchoidal fracture.

The structure of the deposit differs across and along strike. In the section across strike i.e. sub-parallel to the direction of traverse 18000 N, the outcrop is massive and unbedded though joints and crystalline seams give a spurious bedded appearance to the rock.

Main Creek is entrenched approximately along the eastern contact of the magnesite deposit for a distance of 600 feet south of the intersection with traverse 19000 N. In this section the magnesite is mottled blue and grey, and bands are intercalated with yellowish talc schist and green and black talc-carbonate-chlorite schist. Pyrite is finely disseminated in the talcose zone which appears to be 10 to 20 feet wide, grading eastward into silty talc schist and ultimately into green and grey chlorite-muscovite schist and phyllite of the Whyte Schist pelitic assemblage.

In one section of the rock channel about 100 feet north of the elbow bend in the creek the bedded nature of the magnesite is indicated by a succession of parallel bands of silica up to half an inch thick which form ridges up to 3 inches high in the magnesite host.

In the northern extremity of the deposit near traverse 19000 N, slickensided talc seams up to 6 inches in width ramify through and enclose pods of magnesite.

The relationship of magnesite to country rock is obscure in Main Creek south of traverse 18000 N owing to lack of rock exposure. The magnesite lenses mapped in this section may not represent the true widths of the lodes. Wall rock alteration to black pyrite-bearing schist and yellow talc schist is found adjacent to the most southerly magnesite lense.

In thin section under the microscope the mineral is seen to consist of a granoblastic aggregate of anhedral magnesite grains (average size .015 mm) cut by intersecting veinlets of coarser grained carbonate mineral composed of subhedral and, more rarely, euhedral crystals up to 0.1 mm. in size. In some hand specimens the veinlets and patches of recrystallized carbonate (magnesite or possibly dolomite) are more coarse-grained.

The analyses of magnesite (Analyst W. St. C. Manson) listed below show the composition of composite samples from localities indicated on the map. (fig.9).

	Sample 376	Sample 377	Sample 378	A
S_iO_2	9.4	1.3	0.5	0.80
Al_2O_3	1.1	0.1	Trace	0.23
Fe_2O_3	3.5	3.5	1.7	1.00
MnO	0.2	0.1	Trace	0.11
TiO_2	Trace	Trace	Trace	Nil
CaO	3.6	1.7	1.8	2.65
MgO	40.3	43.4	44.8	44.6
Ignition Loss	42.2	50.0	51.1	50.5
P_2O_5	-	-	-	Trace
SO_2	-	-	-	Nil
S	-	-	-	Nil
	100.3	100.1	99.9	99.89

A. Sample of magnesite on traverse 18000 N, west of Main Creek by S. Rowe.

Structure.

Strike and dip attitudes of magnesite are clearly seen in the bed of Main Creek in the eastern contact zone, which is aligned in a NNW direction parallel to the regional strike and dip of schist and phyllite country rock. The maximum width of the magnesite body intersected by Main Creek is almost 600 feet; the maximum length between traverses 19000 N and 18000 N is about 800 feet but mineralization extends (probably discontinuously) over a total length of 2000 feet. The dip of the magnesite body and of the country rock over this distance ranges from 75 degrees in an ENE direction to nearly vertical. Dip and strike attitudes are similar in mica-quartz schist and quartzite on the western side of the deposit. The magnesite deposit is therefore conformable in a horizon at or near the transition from chlorite-muscovite-quartz schist and phyllite into an arenaceous assemblage consisting of mica-quartz schist and quartzite.

The outcrop pattern of magnesite on traverse 18000 N and south in Main Creek to traverse 17000 N strongly suggests that the deposits may be lenticular and irregular in width, length, and depth.

Calculations of reserves in the present state of knowledge of the deposits are preliminary estimates subject to alteration after drillholes have been bored. The proposed site of the first drillhole is shown on the map; the result of this drilling will indicate whether the 600 feet width of magnesite exposed in Main Creek is continuous to traverse 19000 N. A preliminary estimate of magnesite reserve, assuming this to be so, is 30,000 short tons/ft. depth, allowing a 10 per-cent dilution factor. Magnesite is exposed to a depth of 10 feet in places along the creek channel, thus a possible reserve of 300,000 tons is inferred for an area roughly 600 feet square bounded by traverse 19000 N to the north, and by Main Creek to the east and south.

4.2. Bowry Creek.

A magnesite occurrence very similar to the Main Creek deposit was found in Bowry Creek between traverses 12000 N and 12500 N in the Long Plains South- Brown Plains area (fig. 6). The creek, a small tributary of the Savage River, is deeply dissected exposing pinkish-white very fine-grained massive magnesite situated between 550 ft. and 850 ft. west of the baseline. The deposit is not clearly revealed and magnesite may not be continuous over the 300 ft. wide section. The country rock upstream to the baseline consists of greenish-chlorite-rich sedimentary schist and phyllite, in places containing lenses of carbonate rock up to 1 foot long in the schistosity. The meta-sediments west of the deposit are greyish and more sandy. The country rock on either side of the magnesite body dips steeply (80 to 90 degrees) in an easterly direction. Wall rock alteration to talc and pyrite-bearing schist is not evident and the bedded nature of the massive magnesite can only be inferred.

A chemical analysis of a composite sample (analyst W.St.C. Manson) gave the following result: -

SiO_2	0.51
Fe	2.17
CaO	1.94
MgO	42.90
Ignition loss	
	47.52

4.3. RTAE1

Carbonate rock (presently being assayed) very similar to the colour and texture of magnesite was intersected in drillhole RTAE 1 sited at 11085 N; 345 E, between a depth of 606 feet and 639 feet and succeeded intersections of magnetite-bearing amphibolite (fig.19). The contact between amphibolite and carbonate rick is not preserved in the drill core. The hole terminated in carbonate rock and the width is consequently unknown. Should the assay prove the rock to be magnesite, carbonate mineralization only evident at depth in borehole core or in deeply-eroded creek sections is present over a distance of 8000 feet, extending from traverse 11000 N to 19000 N (fig. 2). If the width of the magnesite bodies revealed in creek sections is maintained along strike a reserve of 240,000 tons/ft. depth of magnesite may be present.

A small outcrop of carbonate rock, probably magnesite, 10 feet long and 3 feet wide is exposed in the bed of a creek at approximately 3900 N on the baseline in the Long Plains South-Brown Plains area (fig. 6). Host rocks are amphibolite and greenschist.

4.4. Origin of Magnesite.

Bain (1924) described the characteristics of types of magnesite deposits listed below -

Magnesite as a sedimentary rock.

Magnesite as an alteration of serpentine.

Magnesite as a vein filling.

Magnesite as a replacement of limestone and dolomite.

Features which together suggest that magnesite may have formed by the replacement of sedimentary limestone or dolomite are: -

(i) The concordance of magnesite with the adjacent meta-sediments. Magnesite is stratified with silica layers and talcose zones at one contact. The talcose rocks appear to grade into phyllite and schist.

(ii) Magnesite forming the deposits is massive, and differs from sedimentary magnesite in which the impurity is caused by beds of clastic material.

(iii) The host rocks of the Bowry Creek and Main Creek deposits are meta-sediments. Serpentine rock or altered ultrabasic rock has not been seen.

(iv) Magnesite forming vein-filled deposits is highly ferruginous. (Bain 1924, p.420). The average iron content of magnesite in Bowry Creek and Main Creek does not indicate this type of deposit.

(v) Talc in the wall rock of contact zones in Main Creek may be an alteration of limestone or dolomite by hydrothermal magnesia solutions. Bain (1924, p.426) listed a series of reactions involving calcite, dolomite, and magnesia-bearing solutions which produced talc and other ferromagnesian minerals and culminated in the formation of magnesite. The process appears to have been carried to completion in the Main Creek deposit because intermediate minerals of the reactions have not been observed away from the contact zones.

The magnesia-bearing solution may have been derived from basic magma which formed the amphibolite rock.

The carbonate rock in the core of drillhole RTAE 1 succeeds intersections of amphibolite and magnetite. The origin of the rock may be similar to that of "dolomite" in the Savage River.

II MAGNETITE DEPOSITS.

1. Central and northern Savage River areas.

1.1. Magnetic anomalies and Form.

The magnetic anomaly in the northern area extends from the Savage River to traverse F20(fig.3). The anomaly is very weak and narrow between traverses D9A and D18A where mineralization is probably negligible. Anomalies greater than 50,000 gammas were recorded between the Savage River and traverse D4, between traverses D18A and D23A, and between D30 and E7.

The main magnetic anomaly in the central area extends from Magnetite Creek to the Savage River. Anomalies greater than 50,000 gammas were inconsistently recorded over this length and show as elongate disconnected areas on the magnetic contour map.

The diamond drillhole (D.D.H) sections in Appendix 3 represent diagrammatic sections of lodes intersected by diamond drillholes. The magnetic anomaly above each section has been drawn from the contoured magnetic anomaly maps of the central and northern areas produced by the Bureau of Mineral Resources. The core intersection of magnetite-bearing zones and the core schistosity apparent in the zones has been plotted along the length of each inclined borehole. The zones of mineralization were then correlated with the magnetic anomalies on surface and drawn on the sections according to the interpretation of anomalies suggested by Eadie (1962) who gave examples of four types as follows: -

(i) A narrow anomaly with steep gradients due to a magnetic body of small width close to the surface. Although the anomaly may have a large amplitude, its narrowness indicates that the body is of small width and probably of minor economic significance. An example is the anomaly on traverse 2500 S with a peak at 225 feet E (D.D.H 16 Appendix 3).

(ii) A broad anomaly of high amplitude and steep gradients due to a wide deposit of magnetic material at, or close to, the surface. The continuation of such a deposit to depth is indicated by a gradual rise in the anomaly before the steep gradients commence. Examples are the anomalies above the sections of drillholes 1 and 2. (Appendix 3).

(iii) A broad anomaly of moderate amplitude and low gradients, due to magnetic material at depth; represented by the anomaly between 1500 W and 2100 W on the section of drillholes 8 and 9, and by the anomaly between 00 and 500 feet west on the section of drillhole 15.

(iv) An anomaly with very irregular features indicating a highly disturbed magnetic field. This type of anomaly usually occurs in a region of extensive outcrop. The irregularities tend to mask the contribution to the anomaly of magnetic materials at greater depth. Anomalies of this type are shown on the sections of drillholes 5 and 6, and on the section of drillhole 7.

The dip of a magnetic body influences the gradient of the corresponding anomaly. The gradient of an anomaly due to an easterly dipping magnetite body will be more gradual to the east of the anomaly maximum as represented on the section of drillhole 4 between 600 feet west and 1000 feet west. Eadie (1962) also gives the anomaly on traverse 6000 S as an example.

Eadie states (1962, p.3) that the amplitude alone of a magnetic anomaly is not of great significance and that an assessment of the importance of an anomaly depends also on a consideration of its width, and its gradient, which in turn is related to the grade of a magnetite body. An arbitrary division into low grade magnetite (less than 40 percent HCl soluble iron) and medium-high grade magnetite (greater than 40 percent HCl soluble iron) is shown on the borehole sections and the core logs of drillholes (fig.19).

Outcrops of high grade magnetite generally correspond to areas on the contoured magnetic anomaly map greater than 50,000 gammas. Low grade iron deposits near surface are related in places to a magnetic anomaly in the range 20,000 to 30,000 gammas. Maximum values of anomalies (up to 122,000 gammas) have been recorded in the three areas of the Savage River deposits.

Interpretation of the attitude of magnetite bodies in drillhole sections has also been influenced by: -

Surface outcrops and core intersections of magnetite-bearing zones which can be correlated in a few sections.

The grade of the magnetite-bearing zones in the borehole beneath the anomaly.

The structure evident in core, i.e. schistosity of magnetite relative to the core axis, plotted along the length of the borehole.

The amplitude, width, gradient and shape of the magnetic anomaly.

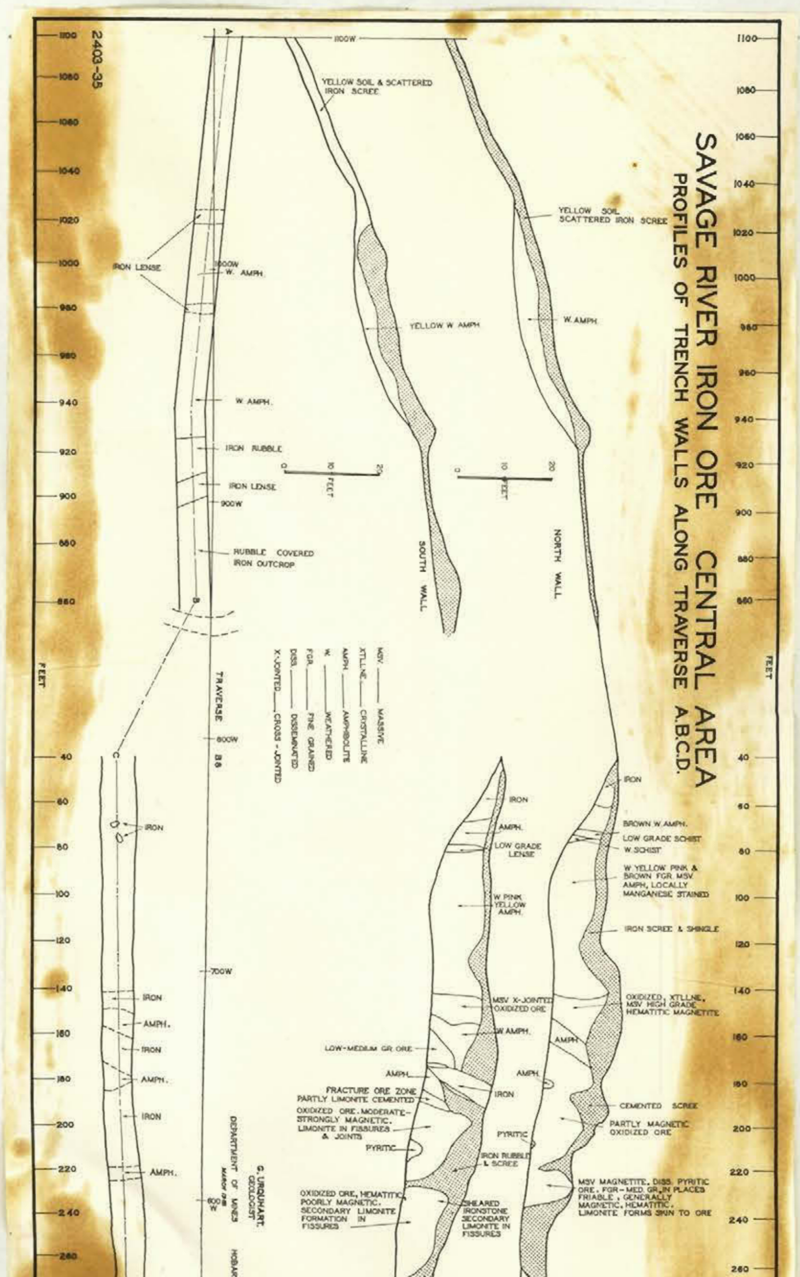
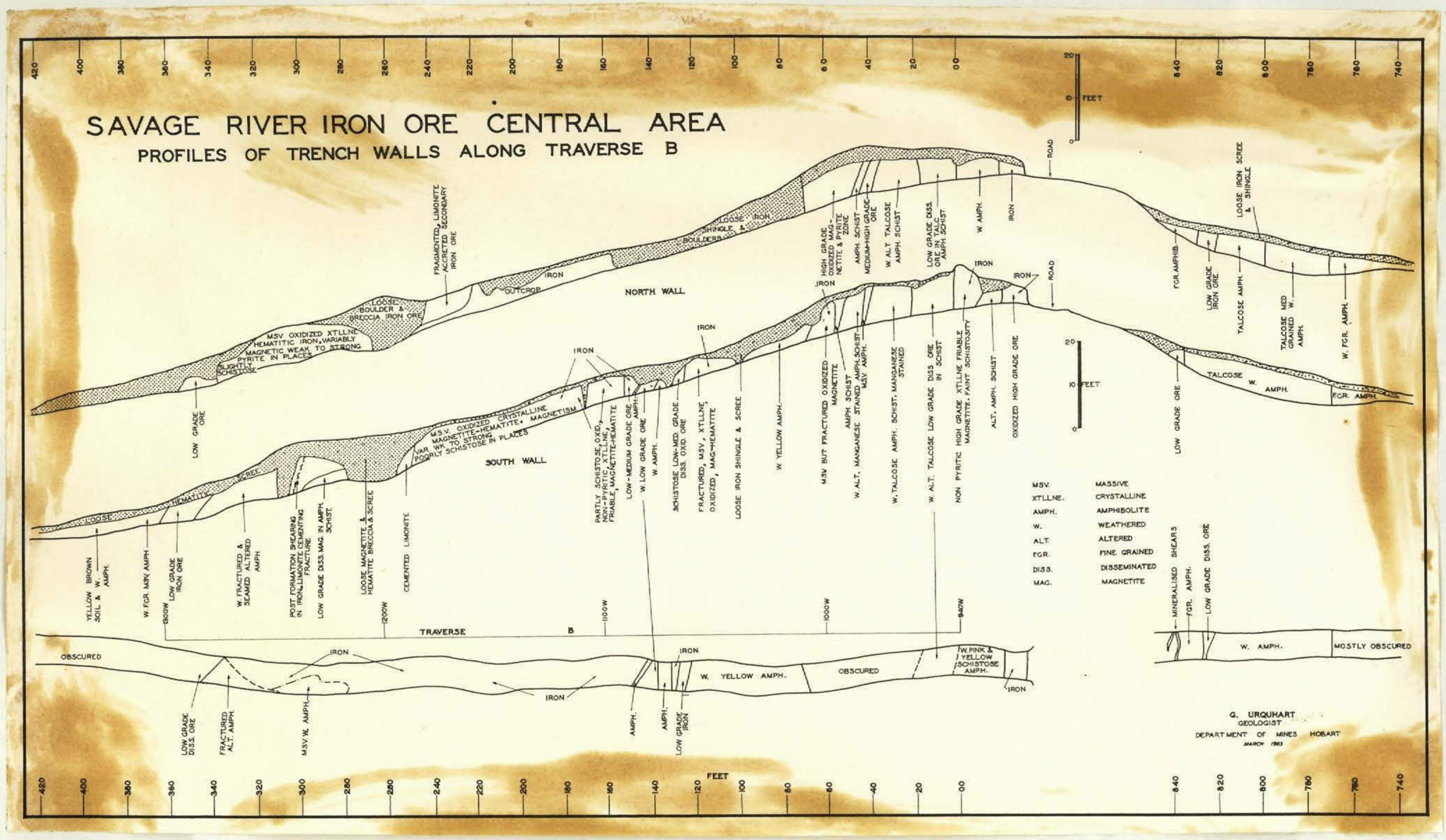

SAVAGE RIVER IRON ORE CENTRAL AREA
PROFILES OF TRENCH WALLS ALONG TRAVERSE A.B.C.D.
NORTH WALL
SOUTH WALL
MSV. — MASSIVE
XTLLNE. — CRYSTALLINE
AMPH. — AMPHIBOLITE
W. — WEATHERED
FGR. — FINE GRAINED
DISS. — DISSEMINATED
X-JOINTED — CROSS-JOINTED
G. URQUHART. GEOLOGIST
DEPARTMENT OF MINES HOBART
2403-35

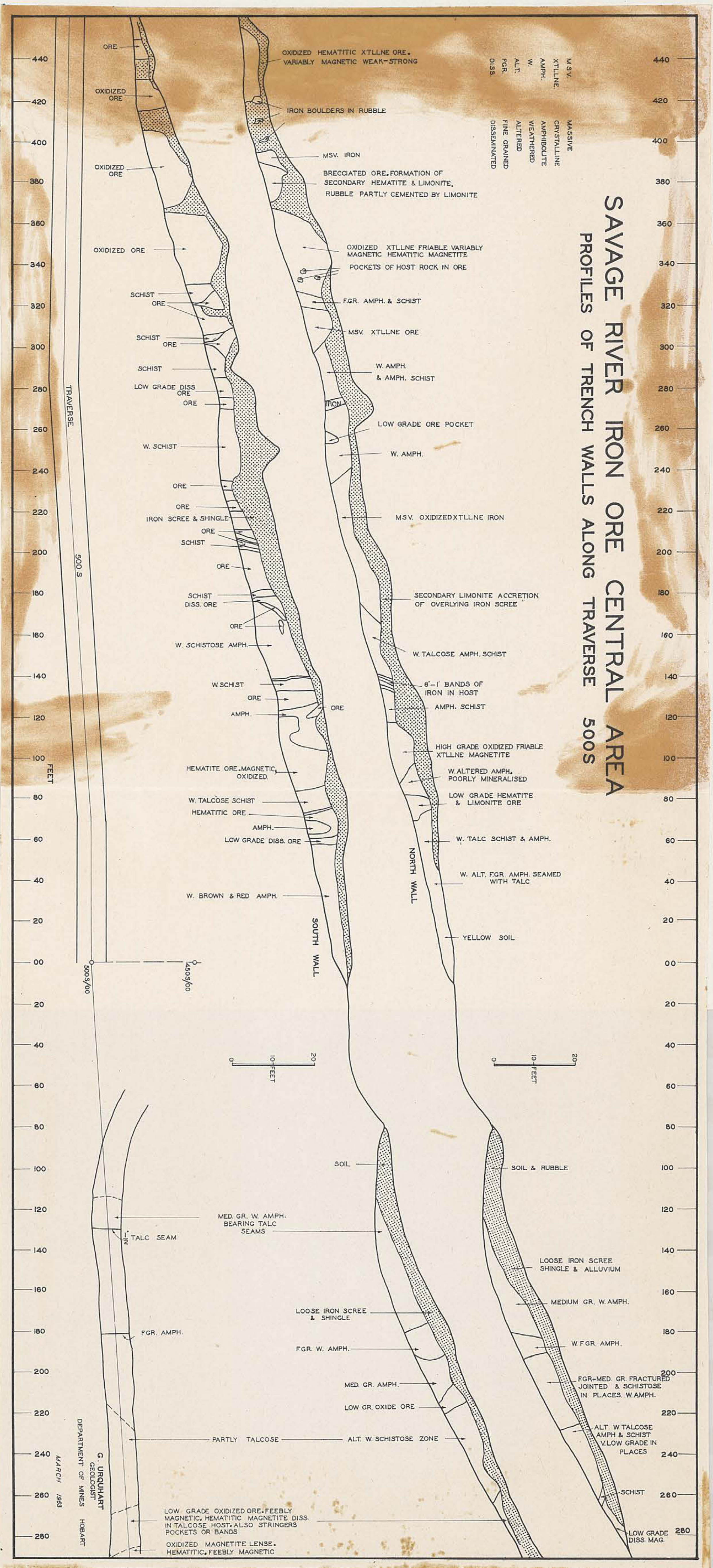
Fig. 16



SAVAGE RIVER IRON ORE CENTRAL AREA
PROFILES OF TRENCH WALLS ALONG TRAVERSE B
NORTH WALL
SOUTH WALL
TRAVERSE B
1300W
1200W
1100W
1000W
940W
FEET
LOOSE BOULDER & BRECCIA IRON ORE
MSV OXIDIZED XTLLNE HEMATITIC IRON, VARIABLY MAGNETIC WEAK TO STRONG PYRITE IN PLACES
SLIGHTLY SCHISTOSE
LOW GRADE ORE
FRAGMENTED, LIMONITE ACCRETED SECONDARY IRON ORE
OUTCROP
IRON
LOOSE IRON SHINGLE & BOULDERS
HIGH GRADE OXIDIZED MAGNETITE & PYRITE ZONE
AMPH. SCHIST
MEDIUM-HIGH GRADE ORE
W. ALT TALCOSE AMPH. SCHIST
LOW GRADE DISS. ORE IN TALC AMPH SCHIST
W. AMPH.
ROAD
F.GR. AMPHIB.
LOW GRADE IRON ORE
TALCOSE AMPH.
LOOSE IRON SCREE & SHINGLE
TALCOSE MED GRAINED W. AMPH.
W. FGR. AMPH.
M.S.V. OXIDIZED CRYSTALLINE MAGNETITE-HEMATITE. MAGNETISM VAR. WK. TO STRONG POORLY SCHISTOSE IN PLACES
LOOSE
HEMATITE
SCREE
YELLOW BROWN SOIL & W. AMPH.
W. F.GR. MSV. AMPH
LOW GRADE IRON ORE
W. FRACTURED & SEAMED ALTERED AMPH.
POST FORMATION SHEARING IN IRON, LIMONITE CEMENTING FRACTURE
LOW GRADE DISS. MAG. IN AMPH. SCHIST
LOOSE MAGNETITE & HEMATITE BRECCIA & SCREE
CEMENTED LIMONITE
PARTLY SCHISTOSE, OXID., NON-PYRITIC, XTLLNE, FRIABLE, MAGNETITE-HEMATITE
LOW-MEDIUM GRADE ORE
W. LOW GRADE ORE
W. AMPH.
SCHISTOSE LOW-MED GRADE DISS. OXID. ORE
FRACTURED, MSV, XTLLNE, OXIDIZED, MAG-HEMATITE
LOOSE IRON SHINGLE & SCREE
W. YELLOW AMPH.
MSV BUT FRACTURED OXIDIZED MAGNETITE
AMPH SCHIST
W. ALT. MANGANESE STAINED AMPH. SCHIST
MSV. AMPH.
W. TALCOSE AMPH. SCHIST, MANGANESE STAINED
W. ALT. TALCOSE LOW GRADE DISS ORE IN SCHIST
NON PYRITIC HIGH GRADE XTLLNE FRIABLE MAGNETITE. FAINT SCHISTOSITY
ALT. AMPH. SCHIST
OXIDIZED HIGH GRADE ORE
TALCOSE W. AMPH.
F.GR. AMPH.
MSV. MASSIVE
XTLLNE. CRYSTALLINE
AMPH. AMPHIBOLITE
W. WEATHERED
ALT. ALTERED
F.GR. FINE GRAINED
DISS. DISSEMINATED
MAG. MAGNETITE
OBSCURED
LOW GRADE DISS. ORE
FRACTURED ALT. AMPH.
MSV. W. AMPH.
AMPH.
LOW GRADE IRON
W. YELLOW AMPH.
W. PINK & YELLOW SCHISTOSE AMPH.
MINERALISED SHEARS
F.GR. AMPH.
LOW GRADE DISS. ORE
W. AMPH.
MOSTLY OBSCURED
G. URQUHART
GEOLOGIST
DEPARTMENT OF MINES HOBART
MARCH 1963

Fig. 17

Fig. 18



SAVAGE RIVER IRON ORE CENTRAL AREA
PROFILES OF TRENCH WALLS ALONG TRAVERSE 500S
M.S.V. MASSIVE
XTLLNE. CRYSTALLINE
AMPH. AMPHIBOLITE
W. WEATHERED
ALT. ALTERED
F.G.R. FINE GRAINED
DISS. DISSEMINATED
OXIDIZED HEMATITIC XTLLNE ORE. VARIABLY MAGNETIC WEAK-STRONG
IRON BOULDERS IN RUBBLE
MSV. IRON
BRECCIATED ORE. FORMATION OF SECONDARY HEMATITE & LIMONITE. RUBBLE PARTLY CEMENTED BY LIMONITE
OXIDIZED XTLLNE FRIABLE VARIABLY MAGNETIC HEMATITIC MAGNETITE
POCKETS OF HOST ROCK IN ORE
F.G.R. AMPH. & SCHIST
MSV. XTLLNE ORE
W. AMPH. & AMPH. SCHIST
LOW GRADE ORE POCKET
W. AMPH.
MSV. OXIDIZED XTLLNE IRON
SECONDARY LIMONITE ACCRETION OF OVERLYING IRON SCREE
W. TALCOSE AMPH. SCHIST
6"-1' BANDS OF IRON IN HOST
AMPH. SCHIST
HIGH GRADE OXIDIZED FRIABLE XTLLNE MAGNETITE
W. ALTERED AMPH. POORLY MINERALISED
LOW GRADE HEMATITE & LIMONITE ORE
W. TALC SCHIST & AMPH.
W. ALT. FGR AMPH. SEAMED WITH TALC
YELLOW SOIL
NORTH WALL
SOUTH WALL
ORE
OXIDIZED ORE
OXIDIZED ORE
OXIDIZED ORE
SCHIST
ORE
SCHIST
ORE
SCHIST
LOW GRADE DISS ORE
ORE
W. SCHIST
ORE
ORE
IRON SCREE & SHINGLE
ORE
SCHIST
ORE
SCHIST
DISS. ORE
ORE
W. SCHISTOSE AMPH.
W. SCHIST
ORE
AMPH.
ORE
HEMATITE ORE. MAGNETIC, OXIDIZED
W. TALCOSE SCHIST
HEMATITIC ORE
AMPH.
LOW GRADE DISS. ORE
W. BROWN & RED AMPH.
TRAVERSE
500 S
FEET
500S/00
450S/00
0 10 FEET 20
0 10 FEET 20
SOIL
SOIL & RUBBLE
MED. GR. W. AMPH. BEARING TALC SEAMS
TALC SEAM
LOOSE IRON SCREE SHINGLE & ALLUVIUM
MEDIUM GR. W. AMPH.
LOOSE IRON SCREE & SHINGLE
FGR. AMPH.
FGR. W. AMPH.
W. FGR. AMPH.
MED. GR. AMPH.
FGR-MED. GR. FRACTURED JOINTED & SCHISTOSE IN PLACES. W. AMPH.
LOW GR. OXIDE ORE
PARTLY TALCOSE
ALT. W. SCHISTOSE ZONE
ALT. W. TALCOSE AMPH & SCHIST V. LOW GRADE IN PLACES
SCHIST
LOW GRADE OXIDIZED ORE. FEEBLY MAGNETIC. HEMATITIC MAGNETITE DISS IN TALCOSE HOST. ALSO STRINGERS POCKETS OR BANDS
OXIDIZED MAGNETITE LENSE. HEMATITIC. FEEBLY MAGNETIC
LOW GRADE DISS. MAG.
G. URQUHART GEOLOGIST
DEPARTMENT OF MINES HOBART
MARCH 1963
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
00
20
40
60
80
100
120
140
160
180
200
220
240
260
280

Plate 14. Magnetite lode in weathered amphibolite.
Traverse B trench; central Savage River area.

Plate 15. Magnetite needles in asbestos fibres.

The tabular form and planar dimensions of the magnetite bodies in the drillhole sections (Appendix 3) are idealized sections through the deposit. A knowledge of the structural control of mineralization along zones of schistosity which may widen and narrow, separate and coalesce along the dip and strike, indicates the difficulty in representing the true form of magnetite bodies in the mineralized zones.

Surface maps of the medium and high grade magnetite bodies in the southern, central and northern areas were partly compiled from outcrops of oxidized magnetite, which however are scanty or else small and liable to be confused with boulders of iron rubble. The distribution of the medium and high grade zones beneath the soil and rubble cover has been mainly inferred from the magnetic anomaly maps and the drillhole sections.

The trenches recently excavated by bulldozer on traverses B8, B, and 500S in the central area (figs.16,17 and 18) afford a comparison between the magnetic anomaly and the oxidized magnetite bodies exposed in the trenches. The distribution of medium to high grade lodes (pl.14) does correspond with magnetic anomaly contours, at least in the trenches.

Magnetite-bearing zones were intersected by drillholes 8 and 9 over a maximum horizontal width of 700 feet in the central Savage River area (D.D.H. 8 and 9, Appendix 3).

The width intersected by drilling in the northern area is less and ranges from 100 feet to about 300 feet. The deepest hole drilled (drillhole 14 in the northern area fig. 3)

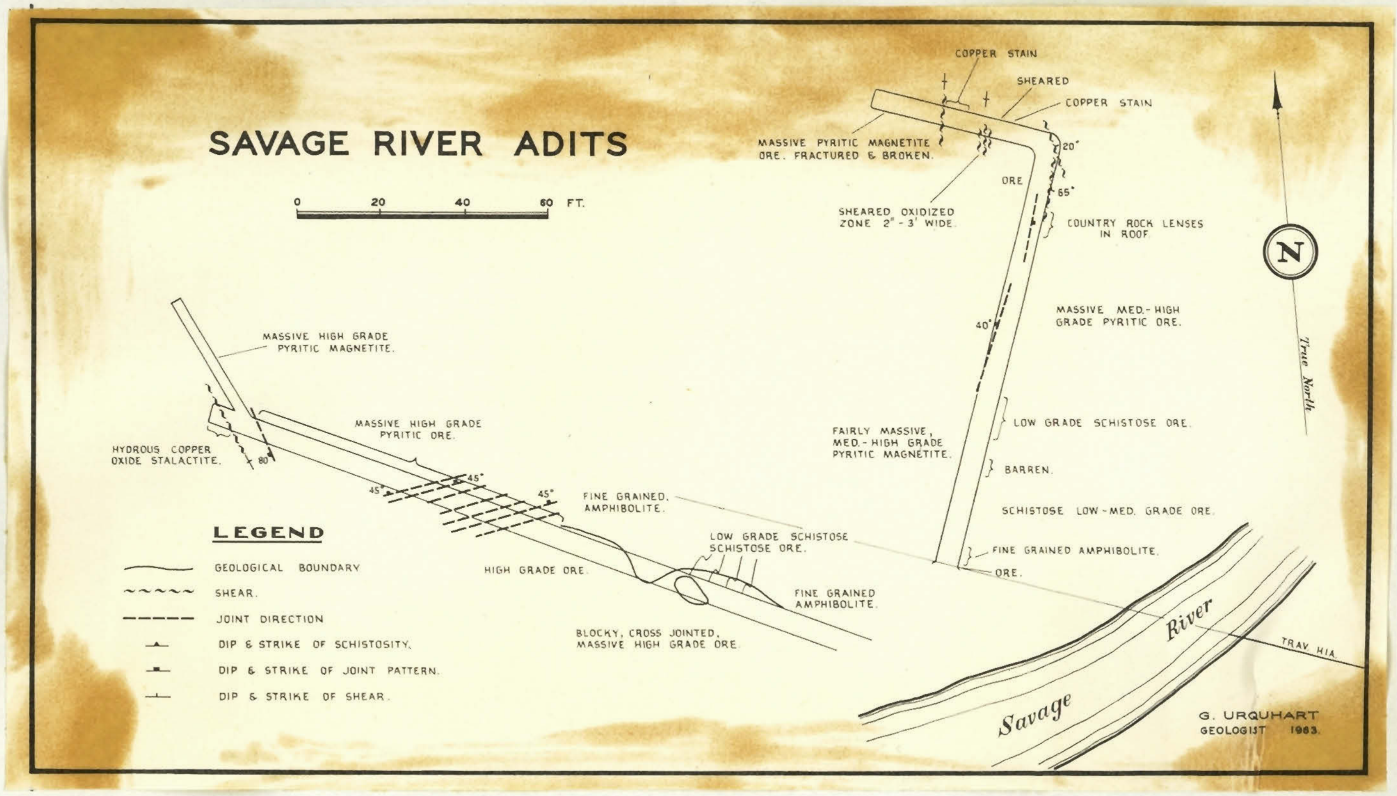
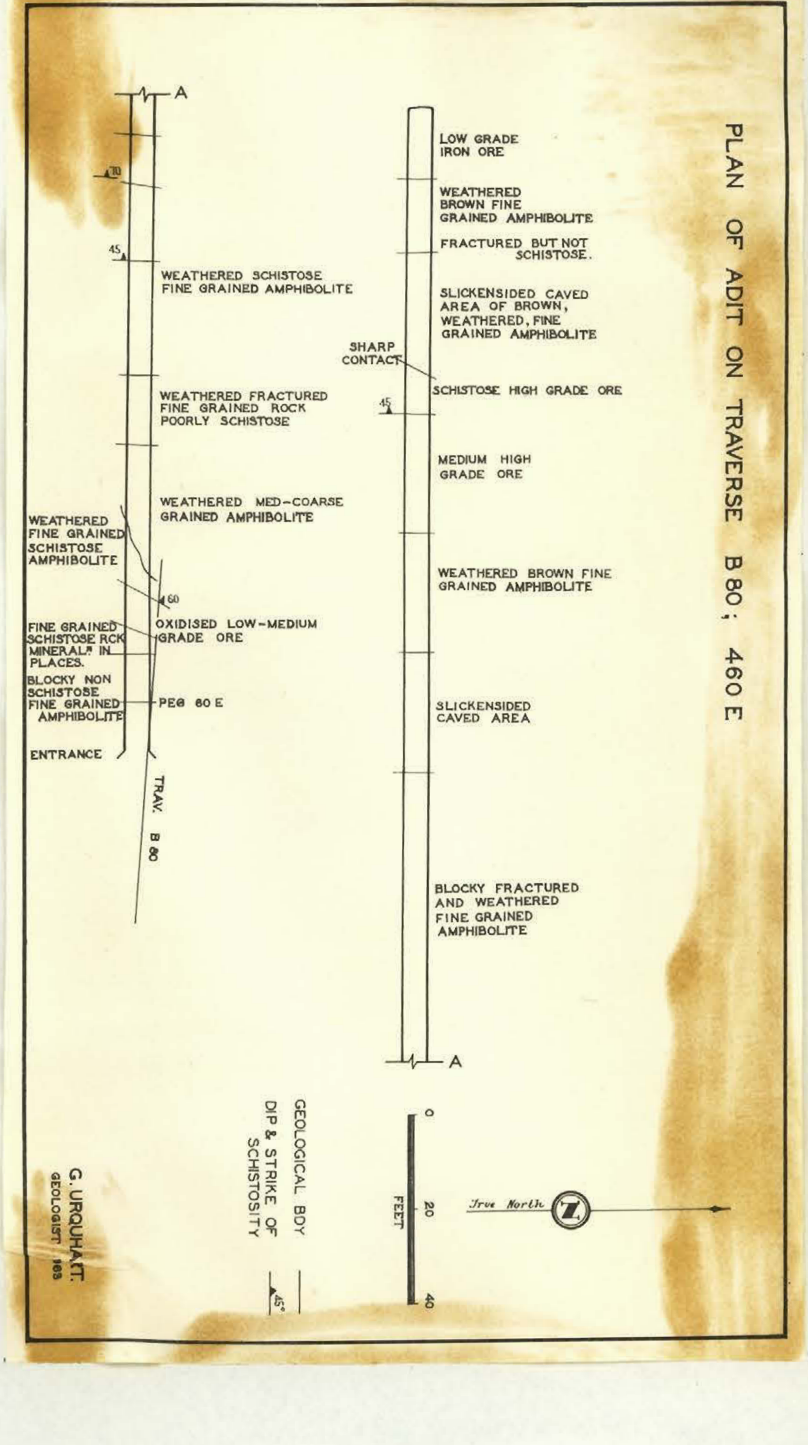

SAVAGE RIVER ADITS
0 20 40 60 FT.
COPPER STAIN
SHEARED
COPPER STAIN
MASSIVE PYRITIC MAGNETITE ORE. FRACTURED & BROKEN.
20°
ORE
65°
SHEARED OXIDIZED ZONE 2" - 3' WIDE.
COUNTRY ROCK LENSES IN ROOF
MASSIVE MED.- HIGH GRADE PYRITIC ORE.
40°
True North
MASSIVE HIGH GRADE PYRITIC MAGNETITE.
LOW GRADE SCHISTOSE ORE.
FAIRLY MASSIVE, MED.- HIGH GRADE PYRITIC MAGNETITE.
MASSIVE HIGH GRADE PYRITIC ORE.
HYDROUS COPPER OXIDE STALACTITE.
80°
BARREN.
45°
45°
45°
FINE GRAINED. AMPHIBOLITE.
SCHISTOSE LOW - MED. GRADE ORE.
LOW GRADE SCHISTOSE SCHISTOSE ORE.
FINE GRAINED AMPHIBOLITE.
ORE.
LEGEND
GEOLOGICAL BOUNDARY
SHEAR.
JOINT DIRECTION
DIP & STRIKE OF SCHISTOSITY.
DIP & STRIKE OF JOINT PATTERN.
DIP & STRIKE OF SHEAR.
HIGH GRADE ORE.
FINE GRAINED AMPHIBOLITE.
BLOCKY, CROSS JOINTED, MASSIVE HIGH GRADE ORE.
River
TRAV. H1A
Savage
G. URQUHART
GEOLOGIST 1963.

Fig. 11



PLAN OF ADIT ON TRAVERSE B 80 ; 460 E
A
LOW GRADE IRON ORE
WEATHERED BROWN FINE GRAINED AMPHIBOLITE
FRACTURED BUT NOT SCHISTOSE.
SLICKENSIDED CAVED AREA OF BROWN, WEATHERED, FINE GRAINED AMPHIBOLITE
SHARP CONTACT
SCHISTOSE HIGH GRADE ORE
MEDIUM HIGH GRADE ORE
WEATHERED BROWN FINE GRAINED AMPHIBOLITE
SLICKENSIDED CAVED AREA
BLOCKY FRACTURED AND WEATHERED FINE GRAINED AMPHIBOLITE
45
70
WEATHERED SCHISTOSE FINE GRAINED AMPHIBOLITE
WEATHERED FRACTURED FINE GRAINED ROCK POORLY SCHISTOSE
WEATHERED MED-COARSE GRAINED AMPHIBOLITE
WEATHERED FINE GRAINED SCHISTOSE AMPHIBOLITE
60
OXIDISED LOW-MEDIUM GRADE ORE
FINE GRAINED SCHISTOSE RCK MINERAL" IN PLACES.
BLOCKY NON SCHISTOSE FINE GRAINED AMPHIBOLITE
PEG 60 E
ENTRANCE
TRAV. B 80
0
20
40
FEET
True North
GEOLOGICAL BDY
DIP & STRIKE OF SCHISTOSITY
45°
G. URQUHART.
GEOLOGIST 1963

Fig. I2

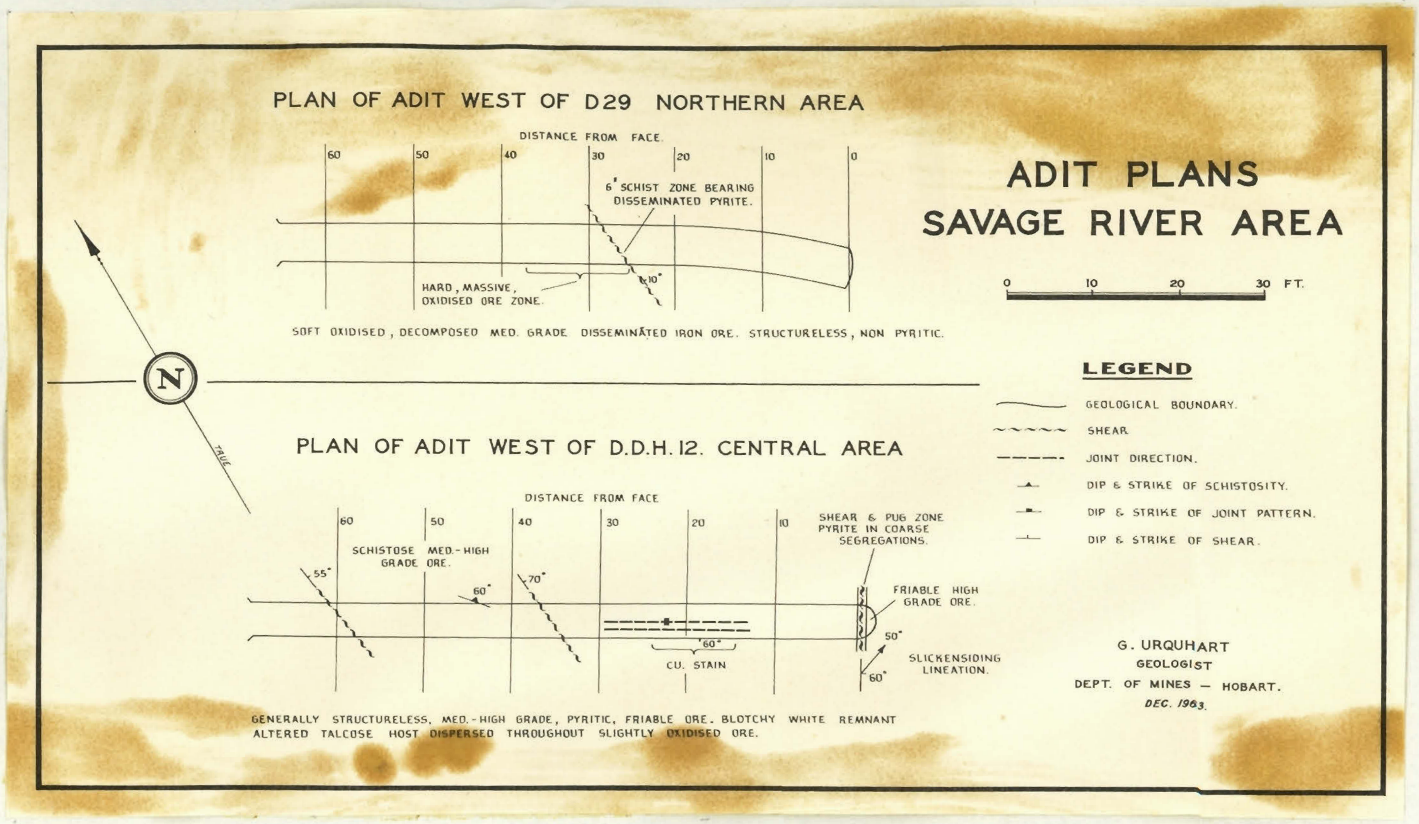

ADIT PLANS
SAVAGE RIVER AREA
PLAN OF ADIT WEST OF D29 NORTHERN AREA
DISTANCE FROM FACE
60 50 40 30 20 10 0
6" SCHIST ZONE BEARING DISSEMINATED PYRITE.
HARD, MASSIVE, OXIDISED ORE ZONE.
10°
SOFT OXIDISED, DECOMPOSED MED. GRADE DISSEMINATED IRON ORE. STRUCTURELESS, NON PYRITIC.
N
TRUE
PLAN OF ADIT WEST OF D.D.H. 12. CENTRAL AREA
DISTANCE FROM FACE
60 50 40 30 20 10
SCHISTOSE MED.-HIGH GRADE ORE.
55° 60° 70°
60°
CU. STAIN
SHEAR & PUG ZONE PYRITE IN COARSE SEGREGATIONS.
FRIABLE HIGH GRADE ORE.
50°
60°
SLICKENSIDING LINEATION.
GENERALLY STRUCTURELESS, MED.-HIGH GRADE, PYRITIC, FRIABLE ORE. BLOTCHY WHITE REMNANT ALTERED TALCOSE HOST DISPERSED THROUGHOUT SLIGHTLY OXIDISED ORE.
0 10 20 30 FT.
LEGEND
GEOLOGICAL BOUNDARY.
SHEAR.
JOINT DIRECTION.
DIP & STRIKE OF SCHISTOSITY.
DIP & STRIKE OF JOINT PATTERN.
DIP & STRIKE OF SHEAR.
G. URQUHART
GEOLOGIST
DEPT. OF MINES — HOBART.
DEC. 1963.

Fig. 13

intersected the main magnetite lodes of the ore zone over a horizontal width of about 260 feet, at a depth below the bed of the Savage River ranging from 600 feet to 960 feet. The drillhole indicates that the magnetite deposits are present at depth without decreasing in width.

In sections through the deposit, the mineralized belt comprises a succession of vertical or steeply-dipping lodes of low,medium and high grade magnetite alternating with variable widths of amphibolite or greenschist (figs.10,11,12,13). The linear ridge of magnetite 5 ft. to 10 ft. high in the central area between traverses 2000S and 2500S (fig.4) appears to be formed along the eastern contact of sediment and amphibolite.

The horizontal width of medium to high grade magnetite deposits ranges from seams less than an inch thick to a maximum lode width of about 200 feet illustrated in the section of drillhole 3 (Appendix 3). In many sections the majority of lodes are up to 100 feet wide. Individual medium to high grade lodes generally contain minor bands of country rock which do not reduce the average grade below 40 percent iron.

The classification of mineralized rock in many borehole sections as low grade ore containing less than 40 percent iron, is due to thinner bands of medium to high grade magnetite more widely distributed in amphibolite, yielding an average low grade zone over the aggregate width. Magnetite in some uniformly low grade zones without many intersections of amphibolite, is generally disseminated in distinctly foliated greenschist, in places partly altered to talc.

Individual high and low grade magnetite lodes and country rock bands cannot be correlated with certainty between adjacent drillholes owing to great lateral variation in width and grade of the mineralized zones. Variation in grade and width is also rapid in a vertical direction, best indicated in the section of drillholes 5 and 6 (Appendix 3) which were bored from the same collar but at different inclinations. The width of the medium to high grade zone in drillhole 5 is much reduced in drillhole 6. Variation in grade over a greater vertical distance is shown also in the lode intersected by drillhole 22 near surface and the same lode at depth intersected by drillhole 3 (Appendix 3).

1. 2. Mineralization and Structure.

The origin of structure in the amphibolite body of the central and northern Savage River area has previously been discussed (Section I, 3 (i), Pt. 2). A sheeted succession of parallel, sub-parallel and coalescing greenschist zones in amphibolite appear to have formed in zones of microbrecciation in amphibolite. Plastic deformation and metamorphic reconstituion resulted in a greenschist mineral assemblage and obliteration of microbrecciation and shearing in most zones.

The permeability of greenschist, or host rock was a structural control in the deposition of magnetite, which in the initial phase is localized along or between chlorite folia, or more rarely along fibres of asbestos. Plate 15 illustrates magnetite needles in asbestos which has formed from the alteration of amphibolite. Magnetite pervasively replaces host rock (greenschist or amphibolite) with more intense mineralization.

Plate 16. Magnetite and pyrite finely dispersed along schistosity of cleaved amphibolite.

Plate 17. Banded pyrite and magnetite in schistose host. Pyrite partly fills fracture at right end of core.

Plate 18. Medium - to high grade ore. Pyrite partly
filling interstitial areas of host rock.

Plate 19. Magnetite replacing host rock(g).
Pyrite in magnetite.

The replacement of country rock by magnetite to varying degrees, depending upon the intensity of mineralization, results in different grades of ore, having a texture and structure generally characteristic of each grade.

In low grade ore, corresponding to the first phase of iron mineralization, magnetite is diffusely disseminated in the greenschist or cleaved amphibolite along the schistosity (pl.16). With increasing intensity of mineralization magnetite is deposited outward from the margins of the greenschist zones and may replace fairly massive amphibolite.

Texture and structure of the ore depends upon the nature of the original rock i.e. whether the rock was a foliated greenschist or a structureless amphibolite. Magnetite centres have segregated in the cleavage planes of poorly mineralized cleaved or schistose rock. The magnetite centres have joined and replaced the host in more intensely mineralized rock.

All stages in the formation of low to high grade ore can be seen from magnetite and pyrite diffusely disseminated in schistose rock (pl.16), to magnetite centres disseminated along the schistosity. The centres coalesce to form magnetite stringers and bands in altered greenschist (pl.17). Finally a stage is reached where stringers and bands merge, and magnetite extensively replaces the host rock which is evident only as a remnant matrix in the ore (pl.18,19). The schistosity apparent in some exposures of the lode on surface (pl.20) and in certain cores of medium-high grade magnetite is therefore a relic structure inherited from the

Plate 20. Schistose iron ore; vicinity drillhole RTAE 1, Long Plains South.

Plate 21. Low - to medium grade ore. Pyrite in patches of host rock (g) within magnetite (m).

original rock (cf. cleavage of core in pl.18).

The structure patterns described above, corresponding to successive stages of magnetite replacement in schist do not result when fairly massive amphibolite is mineralized. Magnetite progressively replaces amphibolite from multiple centres of growth with increasing intensity of mineralization or as a massive front (Bateman 1950, p. 143). The ore is not schistose.

Pyrite is the most common and readily observed metallic mineral closely associated with magnetite. Veinlets and disseminations of pyrite in greenschist free from magnetite have not been seen in many cores.

Magnetite in low grade ore (less than 40 percent Fe) is disseminated along the cleavage as irregular segregations, wisps, shreds or blebs, or in thin bands. Pyrite is generally associated with the magnetite disseminations in a mutual boundary relationship or magnetite may be moulded onto pyrite (pl.29). Alternatively pyrite and magnetite may be successively banded in thin layers (pl.17).

In medium grade ore (an arbitrary classification of magnetite containing 40-55 percent HCl soluble iron), mineralization is more extensive and pyrite selectively replaces the remnant host rock in the ore (plates 21,19,18) or the contact between host rock and magnetite, but magnetite itself is not a centre for pyrite replacement. Ore of this grade is blotched, mottled or more rarely, banded with pyrite, depending upon the pattern of magnetite replacement in the original host rock.

In high grade ore containing more than 55 percent iron, magnetite replacement is almost complete and pyrite selectively replaces the remnant interstitial host rock uniformly interspersed in the magnetite. The ore is speckled with fine disseminations of pyrite, (pl.18), or may be massive and almost free of pyrite. In general high grade, massive, finely crystalline magnetite contains less pyrite than low and medium grade ore.

Summarizing the evidence of mineralization in hand specimens of different grades of ore, it may be stated that: -

(i) In low grade ore, magnetite and pyrite are closely associated, and apparently formed at the same time. Structure in the host rock influenced the initial replacement by magnetite and pyrite, but the sequence of mineralization is not clear.

(ii) In medium grade ore, pyrite selectively replaces areas of host rock, or is emplaced along the contact between magnetite and host rock.

(iii) In high grade ore pyrite replaces the remnant interstitial host rock matrix of the ore. The matrix is scanty, consequently pyrite content of the ore is low.

1.3 Petrology.

The petrology of amphibolite has been discussed (Sect. III 2.2.1.2. Pt. 1). Euhedral magnetite and pyrite (pl.22) are considered to be relic minerals of the original magma. ~~The crystals, some of which have fractured and moved apart, retain crystal outlines because of their strong force of crystallization.~~

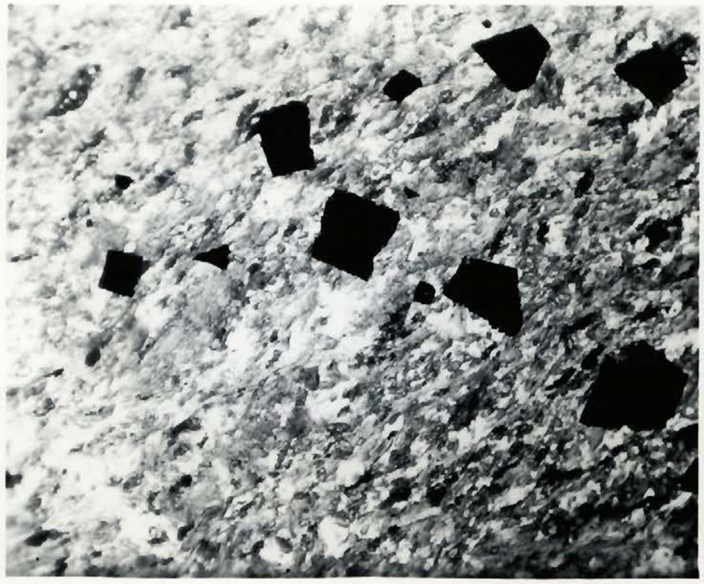


Plate 22. Primary magnetite in amphibolite (x70)

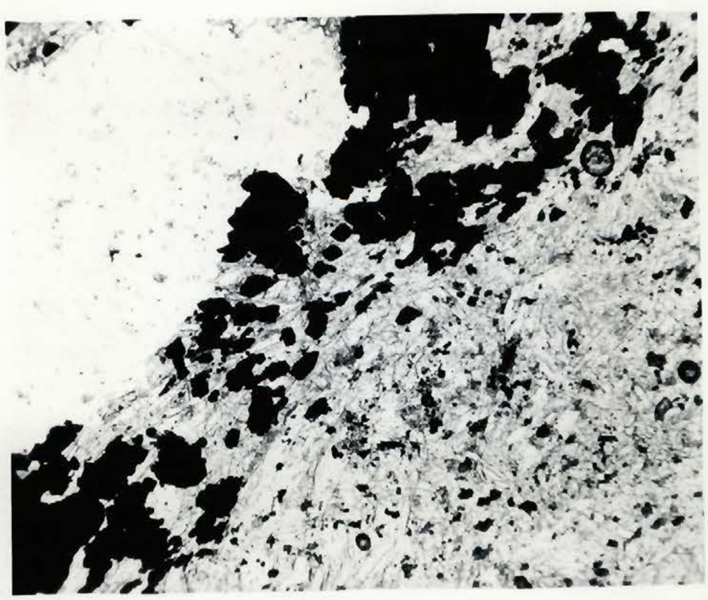


Plate 23. Magnetite in greenschist preferentially replacing chlorite-rich band (x70)

Thin sections of low grade mineralized greenschist show under the microscope that the groundmass consists mainly of chlorite, tremolite, sphene, opaque minerals (magnetite and pyrite); and talc, carbonate, accessory apatite, rutile and epidote in some slides. Bladed tremolite crystals 0.1 mm. to 0.2 mm. long in some thin sections form a fine-grained aggregate in a groundmass altered to chlorite. The crystals show weak pleochroism compared to the blue-green actinolite in amphibolite rock. Irregular grains of magnetite up to 0.1 mm. in size are preferentially distributed in chlorite-rich bands up to 0.5 mm. wide containing scattered residual blades of tremolite (pl.23). Sphene in granular clusters and strings is also preferentially formed in the chlorite layers. Calcite in slide 64-86 is present as irregular patches 0.1 mm. to 0.3 mm. in size surrounded by a talc selvage, and as thin films between chlorite folia. Magnetite replaces carbonate in some slides.

The study of these slides is noteworthy for showing that diffuse magnetite and pyrite is more concentrated in the chlorite-rich zones of the host rock, in which most of the amphibole is tremolite.

Microscopic study of more highly mineralized low grade schistose rock shows magnetite and pyrite in a groundmass consisting mainly of chlorite which may contain scattered relic blades of tremolite. Talc is associated with the opaque magnetite, either filling interstices between grains or as an alteration halo surrounding or close to irregular shaped disseminations and segregations of magnetite and pyrite.

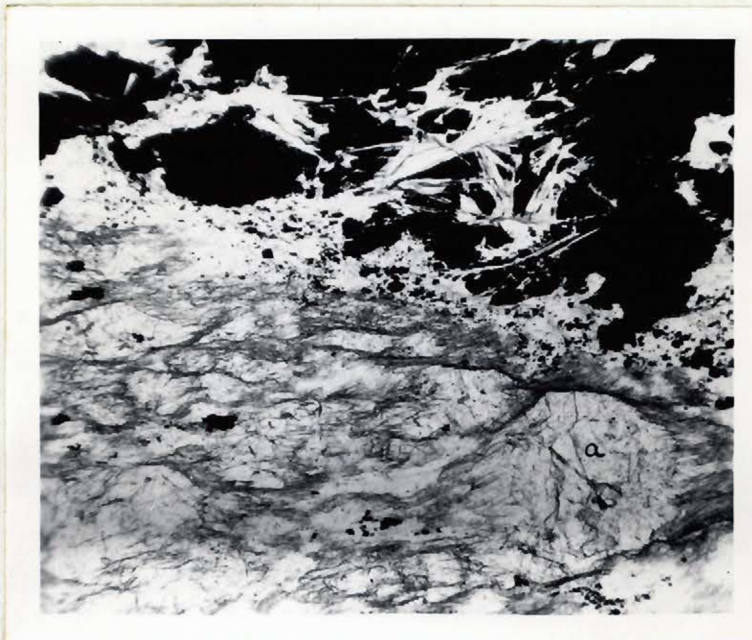


Plate 24a. Chlorite, talc, serpentine alteration
intergrown with magnetite, pyrite and apatite(a)
(x 68)

Plate 24b. Same area, crossed nicols, showing talc (x 68)

A mineral identified as serpentine is sparsely distributed in parallel elongate shreds in the groundmass of slides 64-70 and 64-71 and with chlorite lamellae, is intergrown in the margins of opaque minerals, mainly pyrite, producing a serrated outline of the grain (plates 24,33).

In slides 64-70 and 64-72 magnetite and pyrite, comprising an estimated 30 to 40 percent area of each slide, exist together and show mutual boundary relationships. In slide 64-71 however, pyrite and magnetite exist as discrete, shapeless segregations in the groundmass. Chlorite lamellae in this slide are also intergrown with apatite, containing inclusions of talc, at the margins (pl. 24).

Noteworthy in the slides examined of this grade of mineralization, is the extensive chloritization of the groundmass; the association of talc with pyrite and magnetite; and the intergrown form of chlorite and serpentine with pyrite, magnetite, and apatite at the grain boundaries.

Thin sections of medium to high grade ore, in which magnetite and pyrite constitute 50 percent or more of the rock, show under the microscope that the opaque minerals are shapeless grains up to 2 mm. in size, enclosing a matrix in which chlorite is ubiquitous. Various slides show different associations of minerals; in slide 64-85 the interstitial minerals are chlorite, calcite, apatite, and albite which contains inclusions of calcite. In slide 64-85 the matrix to the metallic minerals consists of chlorite and apatite; in slide 64-80 interstices are filled with chlorite, dolomite and sparse apatite, and in slide 64-63 with chlorite, intergrown in the grain boundaries of magnetite. Magnetite in the hand specimen of this slide is in subhedral grains between 1 and 2 mm. in size. In the slides indicated above, pyrite fills some of the interstices between magnetite grains.

A thin section (64-77) of carbonated amphibolite under the microscope shows dolomite replacing blades and needles of actinolite and tremolite arranged in a schistose pattern. Dolomite veinlets also transect the carbonated groundmass and an area of gangue quartz. Weak pyrite mineralization consists of a few scattered grains preferentially disposed in carbonate or carbonated amphibole, or the contact of amphibolite with introduced quartz gangue. The study of this slide indicates that carbonate is present in two phases, one later than quartz and also that pyrite is apparently later than quartz and preferentially replaces carbonate.

The groundmass in slide 64-75 consists of a structureless aggregate of carbonate and albite intersected by veinlets of dolomite up to 0.3 mm. wide. Opaque minerals, which consist mostly of magnetite in irregular patches and well-formed crystals in the groundmass, terminate against the dolomite veinlets which seem to cut through them. The study of the thin section shows that magnetite appears to replace the earlier one of the two carbonate phases.

1.4 Texture of Magnetite and Pyrite in the core.

Magnetite and pyrite grains in "barren" amphibolite have well-formed crystal outlines which in thin section show as cubes, rhombs, and triangles (pl.22). In places the crystals (up to 0.5 mm. in size) are fractured and angular fragments have moved some distance apart.

Magnetite and pyrite in low grade rock are generally disseminated in wisps, shreds, blebs, and bands without any particular shape. In places subhedral magnetite centres of growth are up to 2 mm. in size.

Magnetite in medium and high grade ore varies from fine-to coarse-grained, with a maximum grain size in coarsely crystalline ore of about 2 mm. The grains of magnetite show both poorly formed and well-formed crystal outlines (pl. 27). Unoxidized high grade ore (up to 66 percent iron), is generally fine-grained and massive in appearance. It may be friable, like the ore exposed in the adit to the west of drillhole 12, or densely coherent.

The shapes of pyrite segregations in medium and high grade ore are controlled by areas of interstitial host rock in which pyrite is dispersed. Pyrite in places occupies minor open fractures (pl.17) in which it may be coarsely segregated in well-formed grains.

1.5 Oxidized Iron Ore.

The depth of weathering determined by diamond drilling ranges from 30 feet to 120 feet. The average depth of weathering is 100 feet. Ore within the oxidized zone is composed of magnetite, hematite and limonite and is enriched to a grade ranging from about 60 to 67 percent iron. Pyrite is weathered and leached from the magnetite, leaving vugs and cavities in the limonitic ore. Lodes intersected in the trenches (figs. 16,17,18) show that much of the magnetite is oxidized to ore which ranges in magnetism from strong to weak, or is non-magnetic.

Limonite in places forms a "skin" up to half an inch thick coating hematite and magnetite, or may fill fissures and pockets in the ore. Hematite and limonite are pseudo-stratified above limonite-coated magnetite in a 5 ft. high lode outcrop in the northern area east of E5.(fig. 3).

Williams and Edwards (1958) described two polished sections of ore from the oxidized zone of the Savage River deposit. In one section magnetite had been almost completely altered to hematite (martite) and limonite. Ilmenite and rutile, as lamellae in the original magnetite grains, and as irregular shaped particles in the grain boundaries remain as residuals in hematite. Limonite occurs as irregular areas in the hematite and appears to have formed from the alteration of hematite close to the surface. In the other polished section of ore which was strongly magnetic, magnetite was almost unaltered and was associated with ilmenite, rutile and hematite.

2. Southern Savage River; Long Plains South - Brown Plains areas.

The results of geophysical work in these areas are given in reports by Keunecke (1958), Sedmik (1961) and Eadie (1962 and 1963).

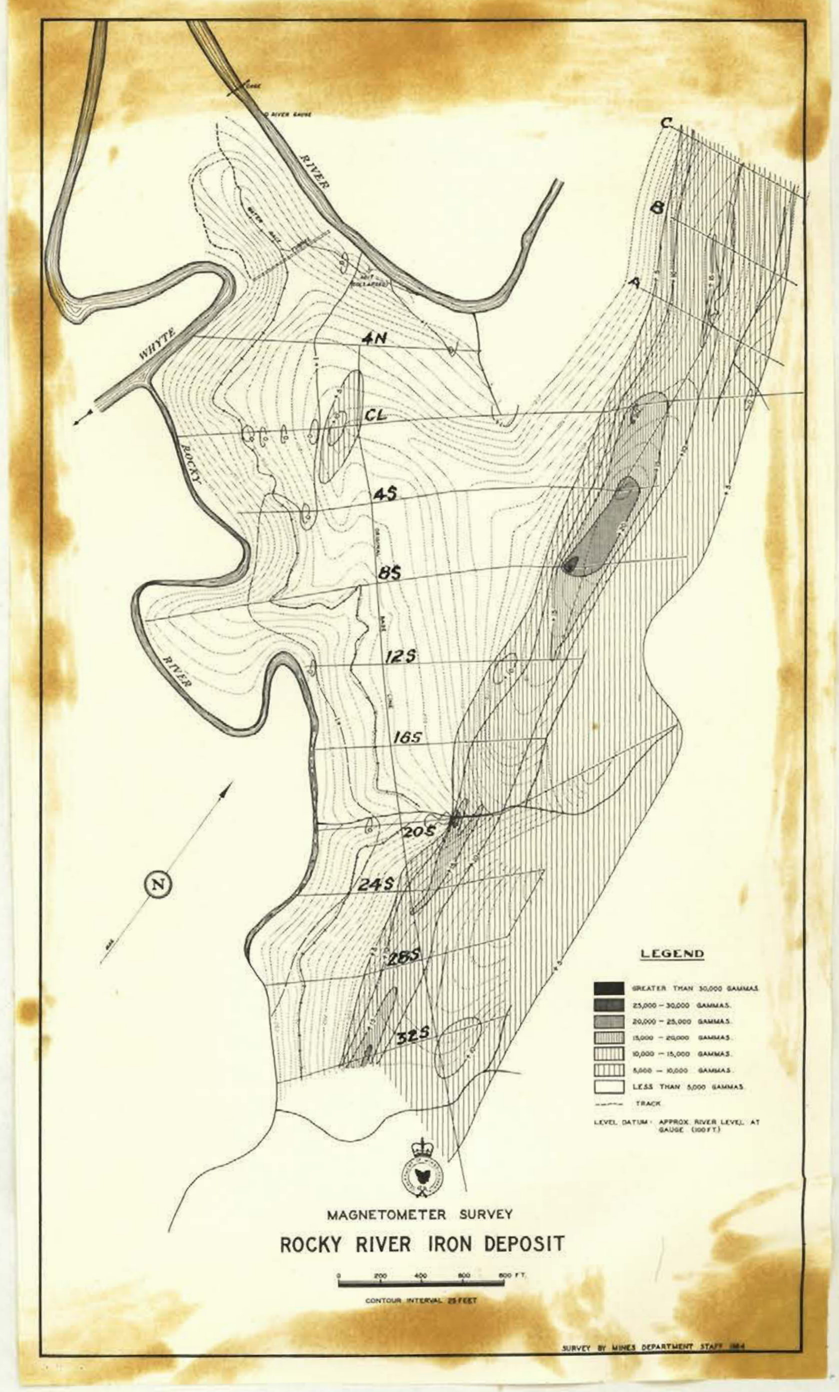
The magnetic anomaly in the southern Savage River area extends from Magnetite Creek to traverse 6500 S (fig. 5), having a value greater than 50,000 gammas between traverses 5400 S and 6000 S. The anomaly is weak or absent between traverse 6500S and traverse 8500 S, but is strong as a 50,000 gamma anomaly between 9000 S and 9500 S. **Width** of the anomaly in the southern area ranges from 200 feet to about 400 feet.

The magnetic anomaly in the Long Plains South area trends continuously from traverse 250N near the Waratah-Corinna road, to traverse 11,500 N (fig. 6) where it ceases abruptly. The anomaly indicates mineralization over a width ranging from about 40 feet to a maximum of 600 feet between traverses 1100 N and 11,500 N, where the greatest amplitude of the vertical magnetic field shown on the section (Eadie 1963, pl.9) is 158,000 gammas. Eadie interprets the contour and profile anomalies as representing elongate magnetite lenses dipping to the east. The mineralized zone in this deposit is narrower than that in the central and northern Savage River areas.

No significant magnetic anomalies are recorded in the area between traverse 11,500 N in the Long Plains South deposit and the southern end of the Savage River deposits; a distance of about 3½ miles.

The form of the deposits is not defined by exposures in trenches or adits. A shaft was sunk on traverse 6500 S in the southern area many years ago, and a drillhole (RTAE 1) bored by Riotinto Australian Exploration Pty. Ltd., in 1959, at a point approximately 11,085 N, 345 E. in the Long Plains South deposit (fig. 6).

The horizontal width of the main, steeply dipping magnetite zone intersected by drillhole RTAE 1 is 120 feet.



WHYTE
RIVER
ROCKY
RIVER
4N
CL
4S
8S
12S
16S
20S
24S
28S
32S
A
B
C
N
LEGEND
GREATER THAN 30,000 GAMMAS
25,000 – 30,000 GAMMAS.
20,000 – 25,000 GAMMAS.
15,000 – 20,000 GAMMAS.
10,000 – 15,000 GAMMAS.
5,000 – 10,000 GAMMAS.
LESS THAN 5,000 GAMMAS
TRACK
LEVEL DATUM: APPROX. RIVER LEVEL AT GAUGE (100 FT.)
MAGNETOMETER SURVEY
ROCKY RIVER IRON DEPOSIT
0 200 400 600 800 FT.
CONTOUR INTERVAL 25 FEET
SURVEY BY MINES DEPARTMENT STAFF

Fig. 8

(Appendix 3); this figure may represent the average width of low-or medium-to high grade, lenticular magnetite bodies along the length of the deposit. The magnetite cropping out in the road near the drillhole is distinctly schistose and dips steeply to the east (pl. 20).

The impurity content of magnetite from the Long Plains South deposit is quantitatively and qualitatively similar to the impurities in magnetite from the Savage River deposit (cf. Appendix 3).

3. Rocky River area.

Magnetite in the Rocky River area and in deposits to the south were mentioned as a source of iron by Twelvetrees and Reid (1919). Reid (1924) reported on the mineralized areas after a brief examination. Atkinson (1960) did not consider deposits in the Rocky River area large enough or of sufficiently high grade to encourage further exploration.

Early in 1964 the Department of Mines re-examined the area. Old traverses were re-cut and cleared, and topographic, magnetometer and geological surveys were made by officers of the Department of Mines. The results of the investigations are shown on figs. 7 and 8.

The main magnetic anomaly (fig. 8) aligned in the sedimentary chlorite schist has a maximum value between 30,000 and 35,000 gammas on traverse 8S, 1000 ft. east of the old water race which was used as a baseline for the survey.

The magnetic field of intensity less than 15000 gammas, is continuous along the strike of the chlorite schist over a

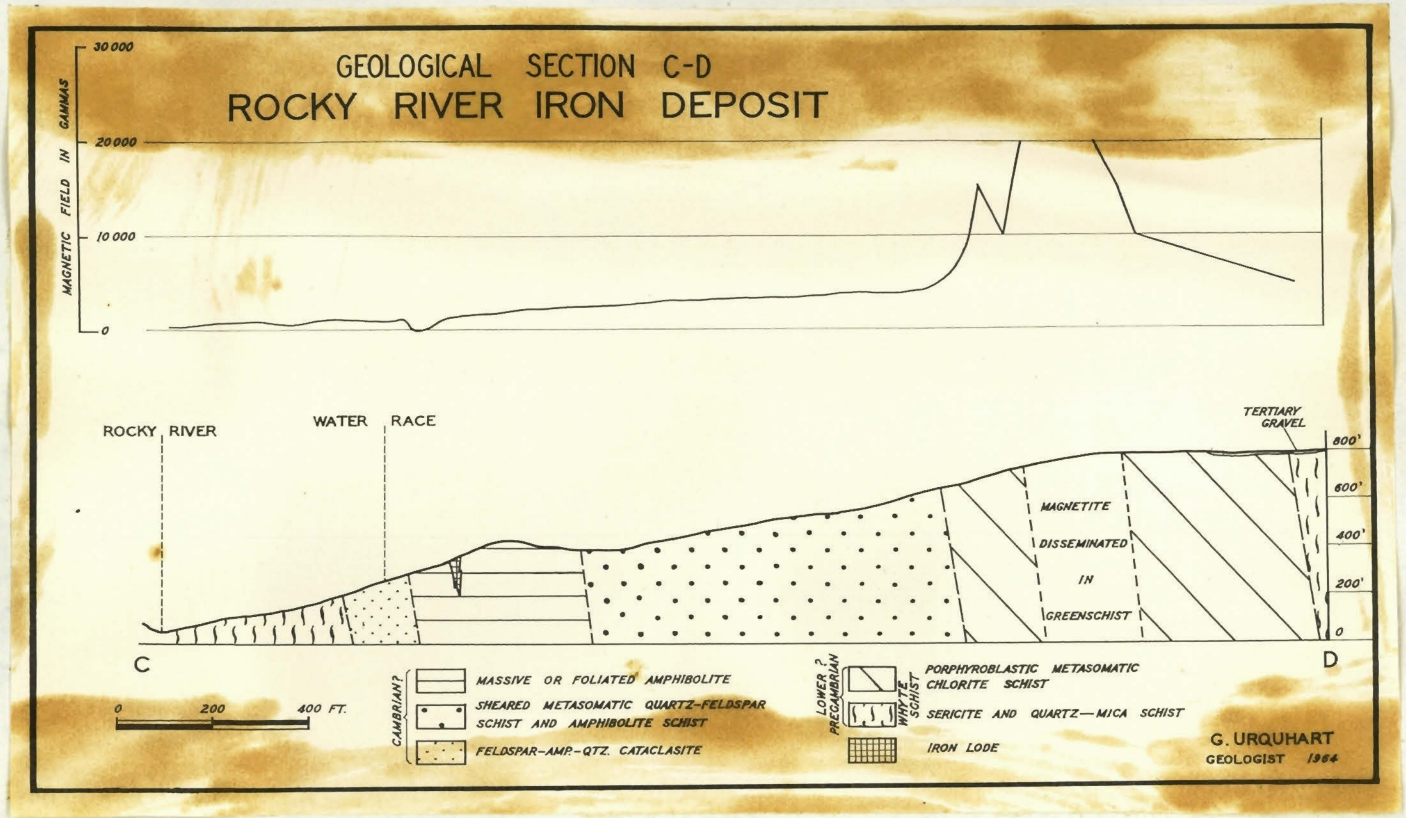

GEOLOGICAL SECTION C-D
ROCKY RIVER IRON DEPOSIT
MAGNETIC FIELD IN GAMMAS
30 000
20 000
10 000
0
ROCKY RIVER
WATER RACE
TERTIARY GRAVEL
MAGNETITE DISSEMINATED IN GREENSCHIST
800'
600'
400'
200'
0
C
D
0
200
400 FT.
CAMBRIAN?
MASSIVE OR FOLIATED AMPHIBOLITE
SHEARED METASOMATIC QUARTZ-FELDSPAR SCHIST AND AMPHIBOLITE SCHIST
FELDSPAR-AMP.-QTZ. CATACLASITE
LOWER ? PRECAMBRIAN
WHYTE SCHIST
PORPHYROBLASTIC METASOMATIC CHLORITE SCHIST
SERICITE AND QUARTZ—MICA SCHIST
IRON LODE
G. URQUHART
GEOLOGIST 1964

Fig. 15

distance of about 1 mile; contours (at 5000 gamma intervals) of the magnetic field greater than 15000 gammas intensity, form isolated areas of higher anomaly along the strike. The width of the + 10,000 gamma anomaly ranges from 150 ft. in the south to a maximum of about 350 ft. on traverse CL. The average width of mineralization is estimated to be 200 ft. The profile of the anomaly on section CD (fig.15) indicates a more gradual gradient on the eastern side of the maximum, and weak magnetite mineralization is probably conformable to the foliation in the steep easterly dipping chlorite schist. A separate, weak, magnetic anomaly having a peak magnetic field of more than 10,000 gammas is shown on traverse CL over an area underlain by massive or foliated amphibolite.

The anomalies formed over sedimentary chlorite schist and amphibolite correspond to two different types of magnetite deposit: -

(i) Magnetite disseminated along the foliation of green, sedimentary chlorite schist or dispersed equally through the rock.

(ii) Magnetite lodes in amphibolite, formed in zones of greater schistosity.

In type (ii) which corresponds to mineralization in the Savage River and Long Plains South areas, the surface magnetite lodes on traverses CL, 4 S and 12 S (fig. 7) are variably oxidized and altered to hematite and limonite with a grade assaying greater than 60 percent HCl soluble iron. The oxidation of these shallow seated (?) bodies of magnetite and conversion to non-magnetic hematite and limonite probably accounts for the weak, in places non-existent, magnetic anomaly associated with this type of deposit.

The adit on the Whyte River was driven prior to 1900 and crosscuts from it intersected a lenticular body of unoxidized magnetite over a distance of nearly 800 ft. The maximum width of the lode according to Twelvetrees (1900) was 30 ft. The adit has collapsed at a point 200 ft. from the entrance, and ingress is prevented. The ore is generally fine-grained and similar in texture, structure and wall rock alteration to Savage River magnetite. An assay of the unweathered lode material dumped from the adit (Atkinson 1960, p.7) indicated a composition of: -

Percent.

HCl sol. Fe	T_iO_2	S_iO_2	Mn	P_2O_5	S	Al_2O_3
55.8	0.35	5.46	0.04	0.17	4.71	0.53

which conforms to the iron and impurity content of medium - to high grade Savage River magnetite.

The 40 ft. unweathered mineralized section exposed at the base of the first waterfall upstream from the water race in Cataract Creek (fig.7) was sampled over a 25 ft. and 15 ft. section by Atkinson (p.9). The 25 ft. section assayed 16.6 percent Fe and the 15 ft. section as follows: -

Percent

HCl sol. Fe	T_iO_2	S_iO_2	Mn	P_2O_5	S	Al_2O_3
32.8	0.44	37.9	0.19	0.13	0.61	4.39

Magnetite in the creek section is a massive lode 2 to 3 ft. wide, and is also dispersed in cleaved, silicified, schistose altered rock, probably highly sheared amphibolite. The original nature of the rock is difficult to see. Barytes as pockets in the cliff wall of the waterfall is an uncommon gangue mineral.

In mineralization of type (i), magnetite is disseminated in irregular small masses and lenses up to half an inch in size along the foliation of green porphyroblastic (albite), chlorite schist in which feldspar and quartz appear to be introduced minerals. Magnetite is also present as layers and bands up to 3 inches wide along the schist foliation. On traverse 32 S near the western boundary of sedimentary chlorite schist and amphibolite, magnetite is dispersed in perfect octahedral equigranular crystals through the foliated chlorite schist. The crystals are as much as one tenth of an inch in size and constitute perhaps 20 to 30 percent of the rock.

Magnetite in chlorite schist, in the various ways described above, constitutes low grade ore which can be expected in the mineralized zone; however, individual hand specimens of fairly high grade ore can be found. Pyrite is not a common constituent of the sedimentary chlorite schist and is not associated with low grade ore in many places on surface.

In thin section study of magnetite-bearing chlorite schist, the minerals under the microscope are seen to consist of strongly pleochroic (green → pale green)chlorite containing fine lamellae of strongly birefringent mineral tentatively identified as biotite. Bands and irregular patchy areas

Plate 25. Magnetite grain emplacement localized by chlorite in sedimentary greenschist (x 68)
qf = quartzo - felspathic aggregate.

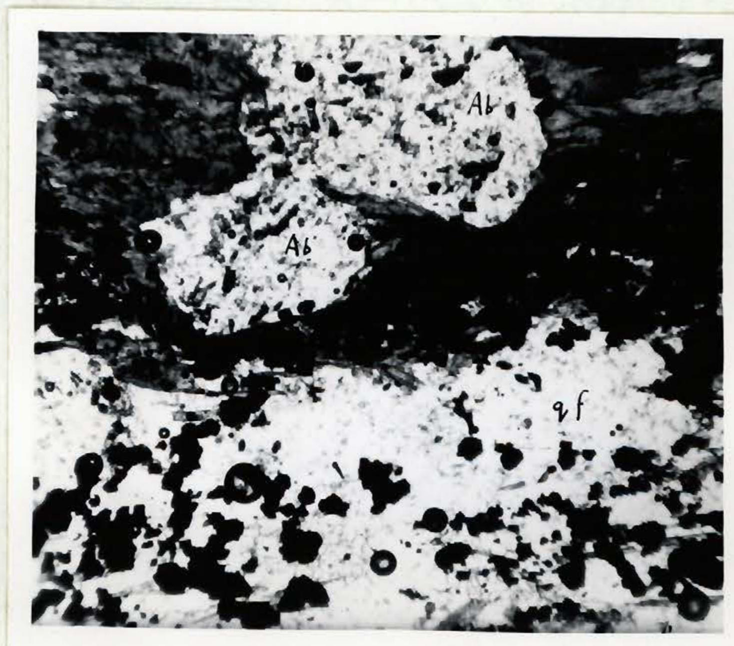


Plate 26. Magnetite grains in chlorite formed around porphyroblastic albite crystals (Ab) and in quartz - feldspar aggregate (qf) (x 66).

composed of mosaic aggregates of strained quartz and untwinned feldspar (refractive index greater than balsam) are aligned in the schistosity of the rock. Subhedral to euhedral albite porphyroblasts, a few crystals carlsbad-twinned and carrying inclusions of chlorite, magnetite, feldspar or quartz are present in the chlorite layers. The parallel lines of inclusions in some of the albite porphyroblasts are slightly rotated in relation to the schistosity of the rock. Magnetite in rounded irregular grains preferentially replaces chlorite areas (pl.25). Chlorite wisps and shreds in the grain boundaries of the quartz-feldspar aggregate similarly are loci for magnetite deposition (pl. 25,26). Magnetite grains in plate 26 replace chlorite around the crystal outlines of an albite porphyroblast. The study of the slides also suggests that quartz and feldspar forming mosaic aggregates were introduced after the porphyroblasts had formed. Magnetite in one thin section is concentrated in chlorite-free areas of quartz and feldspar which it replaces outward from grain boundary fractures.

Summarizing the evidence of microscope and hand specimen study of mineralized rock it may be stated that: -

Magnetite preferentially replaces chlorite, but may also replace quartz and feldspar from open spaces between grains.

Magnetite was introduced after the albite porphyroblasts had formed, and after quartz and feldspar had been introduced.

Quartz and albite-oligoclase feldspar were probably introduced after albite porphyroblasts had formed. The rock is silica and feldspar impregnated in places.

No evidence of wall rock alteration to talc, serpentine and epidote was observed. Apatite, the common gangue mineral associated with magnetite elsewhere has not been observed, but barytes gangue is present in one place.

III. MINERALOGY AND PARAGENESIS.

1. Mineralography.

1.1 Metallic minerals.

Mineragraphic investigations of Savage River ore from drillholes 1 and 3 by the Commonwealth Scientific and Industrial Research Organisation are given in reports, No. 736 by Baker and Edwards, No. 806 by Edwards and in report No. 746, by Williams and Edwards. The results of their polished section examinations are summarized below.

The eight core specimens selected for investigation (Report No. 736) were taken at depths between 322 and 623 ft. from mineralized rock in which magnetite was the dominant opaque mineral and pyrite ranged from a trace amount to 5 percent. The size of the magnetite grains ranged from .05 mm. to 2 mm. Ilmenite, rutile and hematite are associated with the ore, but are absent from the wall rock.

Ilmenite is present in magnetite in the form of lamellae about 0.005 mm. long by 0.001 mm. wide in the (111) planes of magnetite. The ilmenite lamellae are so small in places that they can scarcely be identified.

Rutile lamellae (or rods) which are larger than ilmenite but not as numerous, are also aligned in the (111) planes of magnetite. They average 0.02 mm. long by 0.002 mm. wide but attain a size up to .05 mm. wide and .003 mm. long.

Exsolution rods or lamellae in a few grains lie at right angles to one another, as though oriented in the (100) planes of magnetite, but Baker and Edwards conclude that the exsolved mineral is ilmenite and not ulvospinel. The rectangular orientation may be due to the orientation of the magnetite crystal in relation to the plane of the polished section.

Interstitial Ilmenite, Rutile and Hematite.

Interstitial grains of ilmenite, rutile, and hematite are larger and generally complex. Ilmenite grains 0.3 to 0.4 mm. in size occur along grain boundaries of magnetite, or fill interstices between them and invariably contain minute exolution bodies of hematite aligned in the (0001) planes of ilmenite.

Patches of hematite up to 0.04 mm. across containing exsolved ilmenite were seen in magnetite.

Rutile patches are present in the grain boundaries, or interstices of magnetite, and rutile, intergrown with hematite is enclosed in magnetite in a few places.

Micro-graphic and sub-graphic intergrowths of the three minerals with each other and with magnetite also exist.

The intergrowths consist of : -

Rutile and magnetite.

Rutile and hematite, in ilmenite.

Rutile, ilmenite, and magnetite.

Rutile, hematite and magnetite, some intergrowths enclosed by ilmenite.

Rutile, ilmenite, hematite and magnetite intergrowths forming cores to ilmenite crystals.

A suite of 44 specimens representative of the core from drillhole 3 between 31 ft. and 920 ft. was also examined and discussed in report No. 806 by Edwards. The results are summarized as follows: -

The magnetite grains (0.5 mm. to 2 mm. in size) in many of the specimens have been midly sheared to form prominent networks of parting planes, or have been closely fractured. Silicate and carbonate fill the parting planes and some fractures. Rutile in places accompanies the carbonate; ilmenite is more scarce. Gangue also tends to form thin films in the grain boundaries of the magnetite crystals.

Rutile and a uniaxial carbonate mineral which may be siderite, occur interstitially to magnetite, or fringing it in fine sub-graphic intergrowths from 0.1 mm. to 0.5 mm. in size. The intergrowths are locally abundant and constitute 1 to 2 percent of the ore. More coarsely grained rutile, as much as 0.8 mm. across, is present in a few areas.

Hematite is present in the oxidized zone where the magnetite grains have been converted to hematite (martite) along the grain boundaries, but patches of hematite are rare at depth.

Sulphide Minerals.

Pyrite is the predominant sulphide mineral forming irregular grains which do not exceed 3 mm. across in many areas. Pyrite occurs in gangue areas, or at the margins of gangue areas; and is ophitically intergrown with small blades of actinolite or tremolite. A proportion of the pyrite is intergrown in coarser areas of magnetite where the age relationship is obscure. Some areas of pyrite are studded with inclusions of magnetite, in other areas the magnetite probably occurs in grain boundaries and interstices of pyrite. Pyrite may be moulded on magnetite aggregates; elsewhere magnetite is moulded on pyrite and in places the two minerals are finely intergrown.

Baker and Edwards conclude from this evidence, which is supported by the lack of cross-cutting pyrite veins, that magnetite and pyrite are contemporaneous.

Chalcopyrite is generally restricted to pyrite areas where it occurs as "bleb-like" inclusions; as small interstitial patches, and as discontinuous seams in grain boundaries and at the contacts of pyrite and magnetite, or pyrite and gangue. Chalcopyrite veinlets fill fractures in pyrite, but do not extend beyond pyrite into gangue or magnetite.

A few grains of chalcopyrite are fringed with films of chalcocite (digenite) up to 0.005 mm. wide.

Traces of bornite associated with blue chalcocite were presumed by Baker and Edwards to have formed during the alteration of chalcopyrite to chalcocite, but minute amounts of primary bornite in chalcopyrite were also noted. The authors also observed covellite fringing chalcopyrite, and minute bodies of cubanite (possibly pyrrhotite) and sphalerite.

Magnetite.

The study and indentification by the writer of some of the minerals and textures of polished sections, especially those containing a high percentage of magnetite, was hampered by the pitted surface of the ore. The magnetite is susceptible to plucking along the parting planes (pl. 30), and ilmenite, rutile, hematite, silicate and carbonate were not identified in these planes. Plate 27 shows a well-formed magnetite crystal about 2 mm. long in a groundmass of finer grained magnetite, which suggests that magnetite is of two generations. In this

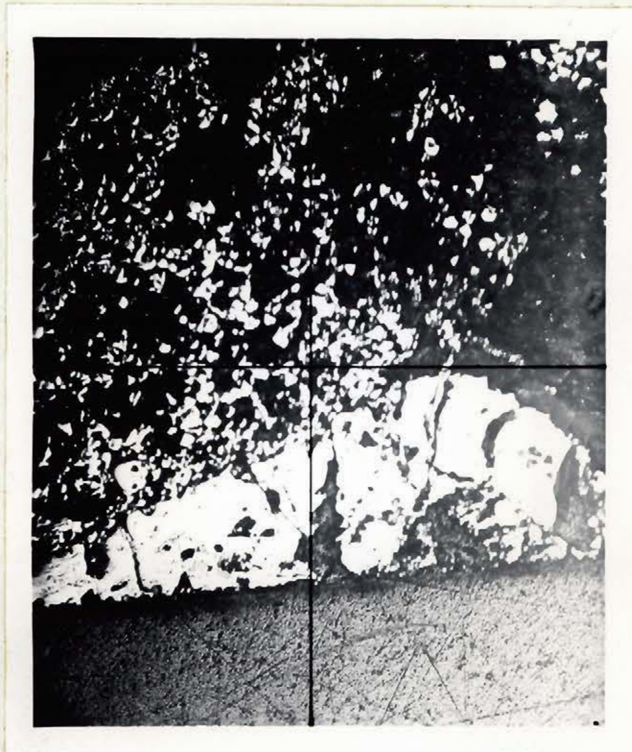


Plate 27.

Magnetite of two generations (x 44)

Plate 28.

Magnetite-ilmenite intergrowths in gangue (x65)

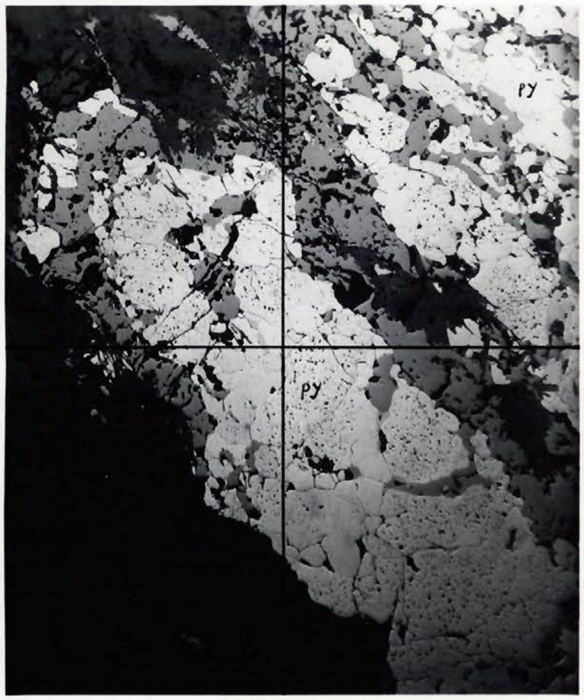


Plate 29.

Magnetite peripheral to pyrite (py) and internally replacing pyrite (x 42)

Plate 30.

Chalcopyrite (cp) in the contact between pyrite (py) and magnetite, bordered by blue chalcocite (cc) adjacent to magnetite (x 68)

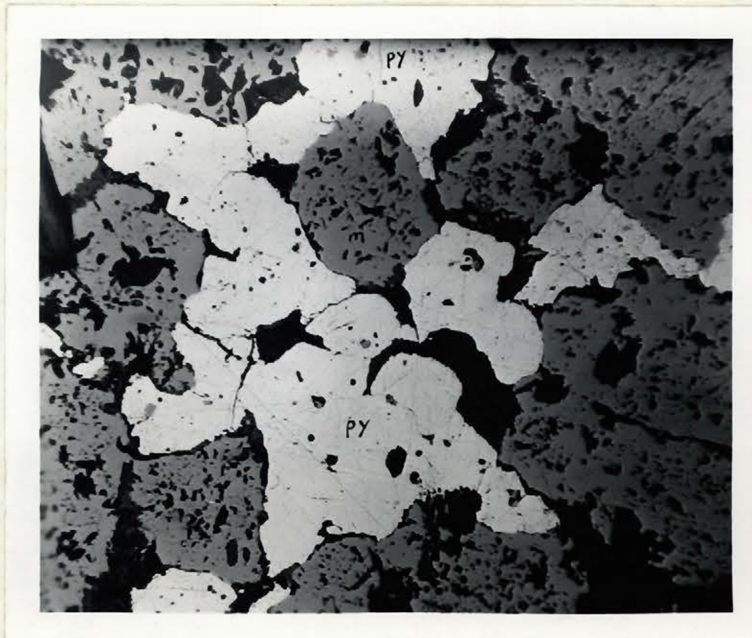


Plate 31. Pyrite (py) replacing gangue around magnetite (m) crystals (x 70)

Plate 32. Chalcopyrite (cp) in pyrite (py). Bladed gangue (g) intergrown with magnetite and pyrite (x 56)

polished section (No. 64-66), the finer grained magnetite is also moulded round a euhedral pyrite grain and is formed in a fissure of the pyrite. Pyrite therefore appears to be earlier than at least one magnetite generation.

Plate 28 shows ilmenite, containing fine exsolved magnetite lamellae (not visible in plate) in gangue areas moulded partly onto the enclosing magnetite. The polished section illustrates the interstitial ilmenite-magnetite-hematite-rutile types of intergrowth described by Baker and Edwards.

Plate 29 shows magnetite on the periphery of pyrite areas, and internally replacing pyrite along grain boundaries producing in places an intergrown texture. A small area of bladed gangue in magnetite can be seen in the upper centre of the plate, and less clearly in the magnetite areas of plates 30 and 33.

Pyrite and Chalcopyrite.

Pyrite in plates 30 and 31 occupies and partly fills areas of host rock and is partly formed around some magnetite crystals which in plate 31 have poorly-formed crystal outlines. The pyrite areas in plates 31 and 33 are studded with a few rounded magnetite grains.

Blebs of chalcopyrite are enclosed in pyrite (Plate 30) and two areas of chalcopyrite are formed between the grain boundary of magnetite and pyrite. A border of blue-grey chalcocite separates chalcopyrite from magnetite; apparently a reaction product between the two minerals. Larger chalcopyrite areas in pyrite (pl. 32) are concentrated at the margins of pyrite grains or along pyrite grain boundaries and do not

Plate 33. Bladed gangue intergrown with pyrite (py), and less markedly with magnetite (m). (x 70).

extend far into the host rock.

Bladed host rock minerals (chlorite, serpentine, possibly tremolite and actinolite), are intergrown at the margins of some pyrite areas but also form intergrowths within pyrite in a few places. (pl. 33, 24).

Summarizing the age relationships indicated by the writer's study of polished sections it may be said that: -

Magnetite in places is intergrown at the margins with bladed host rock minerals (mainly chlorite and serpentine) characteristic of the greenschist mineral assemblage. Magnetite was therefore deposited after the original amphibolite rock was converted into greenschist.

Magnetite in part seems to be of two different ages; one phase at least is post pyrite deposition.

The magnetite-ilmenite-hematite-rutile types of intergrowth are partly localized in patches of interstitial host rock enclosed by magnetite, and may have formed after magnetite was emplaced or at the same time.

Magnetite and pyrite in much of the low grade ore has mutual boundary relationships and the sequence of deposition cannot be discerned. Magnetite in some low grade ore is peripheral to pyrite areas and therefore later in age. Veins of magnetite or pyrite have not been seen. Pyrite intergrown with secondary host rock minerals, generally at the margins of crystals, indicates that it was introduced during or after the alteration of amphibolite minerals into greenschist minerals.

Pyrite in medium- to high grade ore is generally restricted to interstitial films, wisps and patches of host rock separating magnetite grains and appears to have formed after magnetite was introduced. (cf. Sect. II 1.2. (ii) and (iii) and from plates 18,19,21 Pt. 2).

The age relationship of pyrite and magnetite is not consistent. The minerals were probably deposited contemporaneously with phases of one mineral locally preceding the other.

Chalcopyrite is closely associated with pyrite, in many places localized along pyrite grain boundaries and more rarely, at the contact of magnetite and pyrite. Chalcopyrite deposition is consequently later than pyrite and probably also later than magnetite, but the chalcopyrite-magnetite sequence is obscure.

2. Petrology.

2.1 Gangue minerals.

Introduced non-metallic gangue minerals include quartz-feldspar aggregates, calcite and dolomite, which form the altered metasomatized amphibolite schists and dolomitic rocks to the west and east respectively of the mineralized belt in the central and northern Savage River area.

The gangue minerals observed in some thin sections in more direct association with magnetite include apatite, quartz, albite, calcite and dolomite in combinations of one or more minerals with altered wall rock to form the host rock to magnetite and pyrite. The sequence of gangue minerals, and their age relationship to mineralization are not quite clear.

Quartz and feldspar in combined mosaic aggregates in metasomatized rock indicate a contemporaneous origin, but the minerals also occur separately in the ore zones. Pyrite is concentrated at the grain boundary of quartz and carbonated amphibolite (slide 64-77), which suggests that it is later than quartz. Some crystals of vein albite contain inclusions of carbonate but the feldspar-carbonate sequence has not been established.

Two generations of dolomite have been seen (slides 64-75; 64-77). Dolomite veinlets of the later generation transect gangue quartz, which has formed earlier than at least one of the dolomite phases. Magnetite has formed later than dolomite (and calcite) which it preferentially replaces.

Reid, (Twelvetrees and Reid, 1919 p.84) noted that large bodies of crystalline dolomite in the northwest of the State are associated with basic igneous rock (subsequently assigned to the Cambrian age) either in the rock or at the contact with sedimentary formations. Occurrences of replacement dolomite in basic igneous rock were noted at the Comet and South Comet Mines; at Dundas; in the Madame Melba and Kapi Mines; at the Magnet silver-lead mine, in the Victory Mine (Arthur River) and in the Rocky River mine. Reid stated that the association of dolomite with ultrabasic rocks appeared to be general in Tasmania.

The characteristic alteration of Cambrian lavas (and intrusive rocks) consists of albitization, chloritization, carbonation and silicification; processes which Bradley (1954) considered to be of Devonian age. Groves and Solomon (1964,p.11) considered the alteration to be Cambrian and albite in rocks of the Waratah district to be primary and/or deuteric in origin.

The age of silica, feldspar, calcite, dolomite and magnesite metasomatism in the Savage River- Rocky River area is not known, but these minerals and other gangue minerals associated with the magnetite deposits or near them are considered by the writer to have been emplaced in the period of iron mineralization.

Thin section studies of Savage River rocks suggest that feldspar, quartz, and the carbonate minerals precede magnetite formation. The age relationship of apatite is not clear, except that it is intergrown with chlorite at the grain boundaries of a few crystals (pl. 24), similar to intergrowths of chlorite, serpentine and tremolite with pyrite and magnetite at grain boundaries. Apatite crystals occur in areas of host rock adjacent to magnetite; enclosed in the interstices of magnetite crystals or enclosing grains of magnetite.

Barytes in the vicinity of magnetite mineralization in the Rocky River deposits has previously been mentioned as a gangue mineral which has not been observed elsewhere.

2.1.1. Impurities in Ore.

The iron and impurity contents of averaged assays of drill core are shown in Appendix 3.

Impurities consist of silica, alumina, titanium, manganese, phosphorus, sulphur, and vanadium. The maximum content of these impurities in averaged assays of core are shown below:-

S_iO_2	40
Al_2O_3	12.0
T_i	1.29

Mn	0.19
P	0.44
S	15.0
V	0.43

Some individual assays of shorter lengths of core show impurity contents greater than those listed above.

Buddington, Fahey and Vlisidis (1955) regard titanium in titaniferous magnetite, which constitutes the Savage River ore, as becoming an important element in geologic thermometry for temperature ranges between 550°C and 1000°C and in the interpretation of the physicochemical history of many rocks. They consider that rocks metamorphosed in the lower part of the temperature range for the amphibolite facies have magnetite with 1 to 3 percent T_iO_2 and that rocks reconstituted in the garnetiferous granulite facies or in the higher temperature range of the amphibolite facies commonly have magnetite with 3 to 4 percent T_iO_2. Much experimental work, however, remains to be done before the titanium content of magnetite is accepted as a standard in geologic thermometry.

2.2. Wall Rock Alteration.

Wall rock alteration on a large scale indicated by the detailed maps of the central and northern areas has formed metasomatized rock (including carbonate greenschist, quartz-feldspar (carbonate) amphibolite schist and "dolomite" rock) within and adjacent to the belt of magnetite deposits.

"Dolomite", in the northern Savage River area occurs discontinuously to the east of the deposit; the metasomatized amphibolite schists in the central and northern areas occur to the west of the magnetite deposits.

Wall rock alteration adjacent to magnetite deposits on a small scale indicated by microscopic examination of thin sections indicates that: -

Chloritization varies with the intensity of mineralization. In tenuously mineralized or low grade ore, chlorite is associated with other minerals to form the host rock. In higher grades of ore chlorite is commonly the only gangue mineral.

Two chlorite minerals are present in some thin sections. One mineral consists of unorientated, thick and thin tabular crystals which are irregularly terminated (slide 64-79). It is colourless and has very weak birefringence. The other mineral, in places adjacent to pyrite, is yellowish brown, non-pleochroic and shows Berlin blue interference colours. The crystal habit is indistinct in the patchy areas occupied by this mineral because of the fine grain. Some crystals appear scaly; others tabular.

The amphibole present in the groundmass of sparsely mineralized rock is tremolite, as distinct from the amphibole of amphibolite rock which is actinolite.

Talc is closely associated with magnetite and pyrite in the chlorite groundmass of low-to medium grade ore (pl. 24) where it apparently forms by alteration of chlorite, but is not prevalent in the highest grades of ore.

Alteration halos of talc in places surround carbonate mineral, e.g. "dolomite" in the Savage River.

The microscopic study of wall rock alteration in some medium - to high grade ore shows mainly chlorite and talc (plus minor tremolite and serpentine) associated singly or together with one or more introduced gangue minerals consisting of apatite, albite, quartz, calcite or dolomite. Asbestos in places is also an alteration of wall rock preceding iron mineralization.

Thin sections of narrow, fairly massive amphibolite bands between ore lenses show variable textures and mineral assemblages.

The mineral composition, texture and structure of slide 64-330 is very similar to the normal unaltered amphibolite. The minerals consist of highly chloritized amphibole, feldspar, epidote, sphene, opaque minerals and accessory quartz. Scattered magnetite grains show well-formed angular crystal outlines characteristic of the normal amphibolite. Epidote content is greater and appears to have formed at the expense of feldspar.

The mineral assemblage of another amphibolite band between magnetite lenses is seen under the microscope to consist of highly chloritized amphibole and epidote in equal proportion forming about 90 percent of the rock. Sphene is the accessory mineral. Magnetite in irregular scattered poorly formed grains is generally associated with sparse feldspar crystals, which it partly replaces. Thin section study of this rock (slide 64-331) suggests that magnetite was mobilized and that epidote formed from the breakdown of feldspar.

Some drillhole intersections adjacent to mineralized zones,

Plate 34. Poorly mineralized propylitized amphibolite.

Plate 35. Poorly mineralized propylitized amphibolite.

show core which in hand specimen is blotchy, mottled greenish-grey rock, generally altered to chlorite and epidote (plates 34, 35). The rock represents amphibolite which has probably been altered by hot carbonated solutions in the process known as propylitization. Magnetite introduced subsequently into the rock follows a very irregular pattern of replacement indicated in the plates.

The information in the section on wall rock alteration is partly a review of pertinent parts of the petrology of the mineralized rocks.

The paragenesis suggested for mineral deposition in the Savage River area is: -

Quartz and feldspar; carbonate mineral; apatite; successive phases of pyrite and magnetite; rutile - ilmenite-hematite-magnetite intergrowths; chalcopyrite; and other copper, iron, zinc and nickel? sulphides.

IV. ORE GENESIS.

Any origin proposed for the main magnetite deposits of the central and northern Savage River areas must take into consideration the nature of mineralization in deposits to the south.

Different origins for magnetite which have been suggested or considered are: -

Sedimentary

Magmatic segregation

Metamorphic

Hydrothermal magmatic

(i) Sedimentary.

The sedimentary origin proposed for magnetite would need to show that the host rocks are sedimentary derivatives.

Magnetite deposits in the Savage River- Rocky River area are not considered to be sedimentary iron formations because amphibolite, for reasons stated in Section III, 2.2.1. 2 - 4 Pt. 1, resembles more closely a metamorphosed igneous rock. The magnetite in sedimentary greenschist of the Rocky River deposit has every indication of an epigenetic, replacement origin.

Sedimentary iron formations are characteristically banded and finely laminated. The end members of the iron formation facies consist of sulphide, carbonate, silicate, and oxide, (James 1954). The ore deposits in the Savage River - Rocky River area in no way resemble iron formation in structure or lithology.

(ii) Magmatic segregation.

The consideration of a magmatic source for the deposits is seemingly over-ruled by the occurrence of magnetite in sedimentary rock of the Rocky River deposit.

The types of magmatic deposit described by Bateman (1950) include early and late disseminations, segregations and injections of magnetite associated with igneous rocks. An early magmatic origin in which magnetite crystallized first and segregated from the parent magma, has been suggested for the main Savage River deposits, but study of mineralization in the field, in drill core, and in thin and polished sections shows that magnetite crystallized late and replaced silicate minerals formed in shear zones. The volume of amphibolite in the southern Savage River area and Long Plains South - Brown Plains area would also militate against a theory of early crystallization differentiation and gravity accumulation of magnetite. Deposits ascribed to early magmatic segregation are generally associated with large bodies of plutonic igneous rock e.g. the titaniferous magnetite, chromite, nickel and platinum lenses and layers occurring near the base of the Bushveld Igneous Complex (Hall 1932).

Evidence to-day is incontrovertible that iron and titanium in certain types of basic magma are concentrated in the residual magma during crystallization. Magnetite may accumulate and crystallize as the last mineral to form, and parallel the primary igneous structure in the host rock. Alternatively if the rocks are tectonically disturbed during crystallization the iron-rich liquid in the residual magma may be forced or filter pressed into consolidated portions of the parent magma or into overlying rock. The injected nature of these deposits distinguish them from late magmatic segregations in place.

Osborne (1928) described deposits of this type from the Adirondacks and elsewhere in which titaniferous magnetite is concentrated in differentiated intrusive rock invading the host rock.

Magnetite in the central and northern Savage River areas is not intrusive as dykes or lodes, nor is it associated with differentiated intrusive rocks. The medium to coarse-grained amphibolite in the centre of the area shows both intrusive contacts and gradual transitions into fine-grained amphibolite, but it is not differentiated, nor is magnetite enriched in the rock.

Fine-grained amphibolite sheets host to mineralization in the southern Savage River and Long Plains South deposits, are texturally and petrographically similar to the main amphibolite body in the Savage River area, and do not represent differentiated intrusives. Magnetite in amphibolite is not considered to be an early or late magmatic segregation of the parent rock.

(iii) Metamorphic Origin.

Edwards (1956) and Hawley (1956) have written papers reviewing theories of ore deposition and comparing metamorphic and magmatic origins of ore deposits. The subject is exceedingly complex inasmuch as criteria which are distinctive of a metamorphic origin are difficult to separate from those associated with a magmatic origin.

Metamorphic deposits are generally the result of heat and pressure driving rock minerals towards equilibrium with a new environment. The processes include local melting, recrystallization, ionic diffusion in the solid and dry state, or diffusion with the aid of water and possibly other volatiles and the expression of these liquids during orogenic and epeirogenic movements (Hawley 1956 - p.5). The ore constituents may be in a highly disseminated state or in a concentrated state.

Hawley states that, as far as he is aware " no one ... has yet secured or assembled the data necessary to make a thorough analysis of all conditions requisite for the mobilization and later concentration of common ore metals." The collector mechanism and transport of ore minerals in magmatically derived deposits on the other hand has been proved in the field and shown experimentally by different workers including Morey (1922) and Goranson (1931).

Host rock as a source of magnetite ore was suggested by Hagner, Collins and Clemency (1963) for deposits in the Sterling Lake District of N.Y. state. Their conclusions were based on a wealth of analytical data on pyroxene amphibolite which is host to magnetite. These deposits are similar in some respects to the Savage River magnetite; the geology and results of analytical work are accordingly summarized as a means of comparison: -

No visible "openings" or channelways such as shear zones, faults or zones of brecciation were found along which ore forming material might have moved.

All of the constituents found in the ore bodies were available in the host rock.

Where massive ore has developed, all of the host rock minerals decrease in amount, but where the ore is lower grade, magnetite has apparently formed largely at the expense of plagioclase and some pyroxene.

Titrimetric, optical emission spectrographic and fluorescent X-ray analyses show that the percentage of iron in the mafic silicates and total rock decreases with proximity to the ore zone.

The authors conclude that highly dispersed material was released from amphibolite and concentrated into ore bodies. Magnetite replaced pyroxene amphibolite along a low pressure zone where the structure of the host rock changes markedly. Movement of material was largely along foliation, lineation and grain boundaries.

Energy required to activate and move the elements from the mafic silicates is believed to have been supplied by temperature and pressure changes during metamorphism and by the introduction of replacement gneiss and pegmatite.

In the Savage River deposits channelways for the ore minerals were provided by greenschist zones, probably formed by shearing and recrystallization.

Most of the constituents of the ore zones, including chlorite, carbonate, serpentine, talc, apatite, introduced quartz and feldspar, and asbestos are not the normal constituents of amphibolite.

Magnetite in very low grade ore selectively replaces chlorite. Chloritization is extensive in higher grades of ore.

Quantitative work on the host rock adjacent to magnetite-bearing zones has not been done, but thin section study indicates that some rocks are highly altered to chlorite and epidote and that the primary magnetite constituent of amphibolite was apparently mobilized. The rock is propylitized in some sections adjacent to ore zones.

Wall rock alteration and gangue mineral introduction could be explained by the secondary hydrothermal solutions proposed by Schneiderhöhn (1954), made available by metamorphic processes accompanying orogenies or tectonically by dynamic metamorphism, to remobilize disseminated primary ore.

Insufficient analytical work has been done to show whether the Savage River magnetite replacement deposits could have originated by metamorphism and regeneration, but they do show significant differences in the structural control of mineralization, wall rock alteration and gangue minerals when compared to the Sterling Lake metamorphic-metasomatic magnetite deposits.

Hydrothermal Origin.

The main differences outlined above are considered by the writer to be indicative of a hydrothermal origin for the ore, with magnetite forming by deposition in permeable greenschist channelways and replacement outward from these zones. The paragenesis of mineralization in which gangue minerals were introduced first, followed by alternating phases of magnetite and sulphide with magnetite predominantly early in medium-high grade ore, strongly indicates a hydrothermal magmatic origin. The normal paragenesis of gangue, oxide and sulphide in magmatic deposits is difficult to explain in metamorphic derived deposits. Hawley (1956 p.7) mentions Uitenbogaardt (1953) as affirming that exsolution intergrowths, such as titanhemite and Fe_2O_3 - bearing ilmenite in amphibolitic rocks, could only have developed from solid solutions formed under magmatic conditions.

The writer considers that the magnetite deposits are genetically related to the primary magnetite-bearing amphibolite rocks and possibly also to the Bald Hill magnetite-bearing ultrabasic and serpentinite body, which is Cambrian in age. The amphibolite may be a derivative from a widespread underlying basic reservoir rock; intruded along a structural line of weakness. Differentiation of the reservoir rock and intrusion possibly formed the Bald Hill complex. Iron was concentrated, segregated and purified in the magma reservoir prior to forming replacement deposits in the Savage River - Rocky River area.

The Kiruna magnetite deposit in Sweden, ascribed to a late magmatic segregation and injection origin, indicates that iron can be concentrated elsewhere and purified to a high degree before emplacement. Shand (1947) has indicated a process by which this can be accomplished, namely, the oxidation of a ferrous hydroxide hydrosol.

$$\text{e.g. } 3Fe(OH)_2 = Fe_3O_4 + 2H_2O + H_2$$

1. Age of Mineralization.

Compana and King (1963, p.48) consider the minerals of the Cambrian metallogenetic epoch in western Tasmania to consist essentially of chalcopyrite, pyrite, galena and sphalerite, with barytes in the gangue and gold in the sulphides as mineralogical characteristics which are unusual.

Nickeliferous sulphide, osmiridium and chromite mineralization, such as that found at Bald Hill, are regarded as basic derivatives of pre-Ordovician basic and ultrabasic rocks, belonging to the Cambrian Metallogenic Epoch. The writer would also include disseminated magnetite of the Bald Hill complex in this group.

Devonian mineralization in northwestern Tasmania consists of silver-lead-zinc deposits, and cassiterite-bearing veins associated with the Meredith Granite or pyrrhotite - cassiterite bodies associated with porphyry. Accessory minerals characteristic of Devonian granitic rocks are stated to be fluorite, monazite, topaz, bismuthinite, wolframite and tourmaline. Contact metasomatic pyritic magnetite deposits are formed where the granite is in contact with basic igneous rocks e.g. Tenth Legion Mine.

A consideration of metallization in the two epochs suggests to the writer that magnetite deposits in the Savage River - Rocky River area belong to the Cambrian Metallogenic epoch. The accessory minerals characteristic of Devonian granite mineralization are not present in the area, conversely barytes which is characteristic of Cambrian mineralization is present in the Rocky River area.

REFERENCES AND BIBLIOGRAPHY.

Atkinson, W.J., 1960 Report on the Rocky River area iron deposits, N.W. Tasmania: (Unpublished Company Rep.),11 pp.

Bain, G.W., 1924. Types of magnesite deposits and their origin: Econ. Geol., V.19, pp.412-433.

Baker, G., and Edwards, A.B., 1958. Iron ore from the Savage River, Tasmania: Mineragr. Investig. Rep. Comm. Sci. Ind. Res. Org. 736 (Unpublished)., 6 pp.

Banks, M.R., and Ahmad, N., 1959. Notes on the Cainozoic history of Western Tasmania - "Malanna Glaciation" Pap. Roy. Soc. Tasm., v.93, pp.117-127.

Banks, M.R., 1962a: in The geology of Tasmania: J. Geol. Soc. Aust., v.9. pt. 2.

Bateman, A.M., 1950. Economic mineral deposits, 2d. ed., John Wiley and sons., pp.68-163.

Bateman, A.M., 1951. The formation of late magmatic oxide ores; Econ. Geol., v. 46, pp.404-426.

Blake, F., 1939. Corinna alluvial goldfield: Rep. Dep. Min.Tas. (Unpublished)., 21 pp.

Bradley, J., 1954. The geology of the West Coast Range, Part I: Pap. Roy. Soc. Tasm., v.88, pp.193-243.

Buddington, A.F., Fahey, J., and Vlisidis, A., 1955. Thermometric and petrogenetic significance of titaniferous magnetite: Amer. J. Sci., v.253, pp.497-532.

Burns, K.L., 1962a; in The geology of Tasmania: J. Geol.Soc.Aust., v.9, pt. 2.

________________ 1964. Devonport. Explan. Rep. Geol. Surv. Tas., 1-mile Geol. Map. ser. K/55-6-29.

Campana, B., and King D., 1963. Palaeozoic tectonism, sedimentation and mineralization in West Tasmania : _J. Geol. Soc. Aust._, v.10, pt. 1, pp.1-53.

Davies, J.L., 1959a. High level erosion surfaces and landscape development in South-Eastern Tasmania: _Aust. Geogr._, v.7, pp.193-203

______________ 1962a; _in_ The geology of Tasmania: _J.Geol.Soc.Aust._, v.9, pt. 2.

Eadie, E.N., 1962. Savage River geophysical surveys, Tasmania 1960-61. _Rec. Bur. Miner. Resour. Aust.,1962/66._ (_Unpublished_), 8 pp.

__________________1963. Long Plains magnetic survey, Tasmania 1961-62: _Rec. Bur. Miner. Resour. Aust.,1963/52_. (_Unpublished_)., 8 pp.

Edwards, A.B., 1956. The present state of knowledge and theories of ore genesis: _Australasian Inst. Min. and Metall. Proc._, v.177, pp.69-116.

_______________1960. Iron ore from the Savage River, Tasmania, Pt. 3, DDH 3 and 4 : _Mineragr. Investig. Rep._ Comm. Sci. Ind. Res. Org. 806 (unpublished).,8 pp.

Evrard, Pierre, 1949. The differentiation of titaniferous magmas: _Econ. Geol._, v. 44, pp.210-232.

Goranson, R.W., 1931. The solubility of water in granite magmas: _Amer. J. Sci._, 5 Ser., v.22, pp.481-502.

Gregory, J.W., 1903. Some features in the geography of North-Western Tasmania: _Proc.Roy.Soc. Vic._, v.16, pp.177-183.

Groves, D.I., and Solomon, M., 1964. The geology of the Mt. Bischoff district: Pap. Roy. Soc. Tasm., v.98, pp. 1-22.

Hagner, A.F., Collins, L.G., and Clemency, C.V., 1963. Host rock as a source of magnetite ore, Scott Mine, Sterling Lake, N.Y.: Econ. Geol., v.58, pp.730-768.

Hall, A.L., 1932. The Bushveld Igneous Complex, Transvaal: South African Geol. Surv. Mem. 28.

Hawley, J.E., 1956. The magmatic versus metamorphic source of ores: Royal Soc. Canada. Tran., v.50, ser.3, pp. 1-18.

Hughes, T.D., 1958. Savage River iron ore deposits: Tech.Rep.Dep. Min. Tas., no.2, pp.32-41.

__________ 1960. Savage River iron: Tech. Rep. Dep. Min. Tas., no. 4, pp.57-59.

__________ 1961. Savage River iron deposits - progress report: Tech. Rep. Dep. Min. Tas., no.5, pp.162-179.

James, H.L., 1954. Sedimentary facies of iron formation: Econ.Geol., v. 49, pp.235-293.

Johnston, R.M., 1888. Systematic account of the geology of Tasmania: Gov't. Print., Hobart.

Jones, D., 1898. An extensive iron formation: Trans. Instit. Eng., v.5.

Keunecke, O., 1958. Savage River iron ore deposits, northwestern Tasmania: Rec. Bur. Miner. Resour. Aust.,1958/39 (Unpublished)., 9 pp.

Lewis, A.N., 1927. Note on the isostatic background of Tasmanian physiography: Pap. Roy.Soc. Tasm.,(1926), pp.1-24.

Manson, W.St. C., 1959. Savage River iron ore and magnetite; beneficiation by magnetic separation: R.236 Tech. Rep. Dep. Min.Tas., no.3, pp.181-185.

__________ 1960. Savage River magnetite; beneficiation by magnetic separation: R. 355-R359. Tech.Rep.Dept. Min.Tas., no.4, pp.164-171.

__________ 1962. Savage River magnetite; beneficiation by magnetic separation: R.369. R.370. A.383. Tech. Rep.Dept. Min.Tas., no.6, pp.160-170.

Montgomery, A., 1894a. Report on the Corinna gold field: Rep.Secy. Min. Tasm.

Morey, G.W., 1922. The development of pressure in magmas as a result of crystallization: J.Wash.Acad. Sci., 12, pp.219-230.

Nye, P.B., 1923. The silver-lead deposits of the Waratah district: Bull. Geol. Surv. Tasm., no.33, 187 pp.

Osborne, F.F., 1928. Certain titaniferous magnetite deposits and their origin: Econ. Geol., v.23, pp.724-761, 895-922.

Radtke, A.S., 1964. Geology and mineralogy of the Buena Vista iron ores, Churchill County, Nevada: Econ. Geol., v. 59, pp.279-290.

Reid, A.M., 1921. Osmiridium in Tasmania: Geol. Surv. Bull., no.32, 121 pp.

__________ 1924. Preliminary report on the occurrence of iron ore at Meredith, Paradise, Rocky and Whyte rivers: Rep.Dep.Min.Tas.(Unpublished)., 13 pp.

Rowe, S.M., 1962. Dolomite deposit in Main Creek, Savage River area: Tech. Rep.Dep.Min.Tas., no.7, p.48.

Schneiderhöln, Hans, 1954. La position génétique des gîtes métallifères post-Triassiques de l'Afrique du Nord Française: Int. Geol.Congress. Algiers.1952. Sec. XII, 1954, pp.73-90.

Scott, Barry, 1960b. Erosion surfaces in western Tasmania: Rec. Q.Vict.Mus., new series, no.13, 11 pp.

Scott, J.B., 1926. Report on Brown and Little Plains, Rocky River district: Rep.Dep.Min.Tas.(Unpublished).

Sedmik, E.C.E.,1961. Savage River magnetic survey, Tasmania 1960: Rec. Bur.Miner.Resour.Aust.,1961/138. (Unpublished)., 9 pp.

Shand, S.J., 1947. The genesis of intrusive magnetite and related ores: Econ.Geol., V.42, No.7, p.634-636.

Solomon, M., 1962a; in The geology of Tasmania: J. Geol. Soc.Aust., v. 9, pt. 2.

Spry, A.H., and Ford, R., 1957. Reconnaissance of the Corinna-Pieman Heads area: Proc.Roy.Soc.Tas., v.91, pp.1-7.

Spry, A.H., 1957a. Precambrian rocks of Tasmania, part 1. Dolerites of the North-West Coast: Pap.Roy.Soc. Tasm., v.91, pp.81-93.

______________ 1957b. Precambrian rocks of Tasmania, part II. Mt. Mary area: Pap.Roy.Soc.Tasm., v.91, pp.95-108.

______________ 1958. Precambrian rocks of Tasmania, part III. Mersey-Forth area: Pap.Roy.Soc.Tas., v.92, pp.117-137.

Spry, A.H., 1962a: in The geology of Tasmania: J. Geol.Soc. Aust. v.9, p.t.2.

__________ 1963. Chronology of crystallization and deformation of some Tasmanian Precambrian rocks: J. Geol.Soc.Aust., v.10, pt.1, pp.193-208.

__________ 1964. Precambrian rock of Tasmania, part VI, the Zeehan-Corinna area: Pap.Roy.Soc.Tasm., v.98, pp.23-48.

Symons, J.G., 1959. Progress report on the exploration of the Savage River iron ore deposits: Tech.Rep.Dep. Min.Tas., no.3, pp.151-158.

__________ 1962. Progress report on the exploration of the Savage River iron ore deposits: Tech.Rep.Dep. Min.Tas., no.7, pp.113-133.

Tetlow, Peter, 1960a. The Long Plains South iron ore deposits: Tech.Rep.Dep.Min.Tas., no.4, pp.102-105.

__________ 1960b. Savage River iron: Tech.Rep.Dep.Min.Tas., no.4, pp.106-113.

Twelvetrees, W.H., 1900. Report on the mineral fields between Waratah and Corinna: Secretary for Mines Report., 71 pp.

__________ 1903. Report on mineral fields between Waratah and Long Plains: Secretary for Mines Report., 38 pp.

__________ 1908. Ann.Rept.Sec.Mines.

__________ 1913. Bald Hill osmiridium field: Bull.Geol. Surv. Tasm., no.17, 41 pp.

__________ and Reid, A.M., 1919. Iron ore deposits of Tasmania: Geol.Surv.Min.Resour., no.6, 112 pp.

Twidale, C.R., 1957. A reconnaissance of the Corinna-Pieman Heads area - Geomorphology: Pap.Roy.Soc.Tasm., v.91, pp.9-16.

Uitenbogaardt, W., 1953. The opaque mineral constituents in a series of amphibolitic rocks from Norra Storfjället, Västerbotten, Sweden: Arkiv.Min. Geol., v.1, pp.19, 527-543.

Whitten, E.H.T., 1959. Tuffisites and magnetite tuffisites from Tory Island, Ireland, and related products of gas action: Am.J.Sci., v.257, pp.113-137.

Williams, K.L., and Edwards, A.B., 1958. Oxidised iron ore from Savage River Tasmania: Mineragr. Investig. Rep. Comm. Sci. Ind. Res. Org. 746 (Unpublished)., 2 pp.

Woolnough, W.G., 1939. Iron ore deposits of Tasmania: Rep.Dep.Min.Tas.(Unpublished)., 8 pp.

APPENDIX 1.

History of Exploration and Mining.

1. History of Exploration and Mining.

The suggestion by Sprent that the Savage River ore-bodies might be cappings of enormous tin bodies was soon disproved after the deposits were discovered in the 1870's. The Corinna Goldfield then was being mined by a work force which at one time totalled 500 men.

Prospectors naturally turned their attention to the deposits in the Savage River as a possible source of gold. In 1891 the Savage River Company drove a crosscut south of the Savage River to intersect the lode at a depth of about 400 ft., and the Huzza Company drove two adits on the north bank of the river.

In 1895 the Rio Tinto Company N.L. (no connection with Rio Tinto Australian Exploration) was formed and continued operations for a few years, during which a total of 1550 feet is reported to have been driven in the unsuccessful search for gold and copper. This is the last recorded exploratory mining work on the Savage River deposits trying to prove economic quantities of precious and base metal sulphides.

Published company assays show appreciable gold and silver values but these are considered to be unreliable estimates. Assays of the core recovered from diamond drilling the deposit and of a surface pyrite sample in the Rocky River deposit have not indicated the presence of gold or silver. Nickel, cobalt,gold and silver, if they exist are thought to be minutely disseminated in the amphibolite bodies.

The Rocky River area was also explored before 1900. Twelvetrees (1903) reported on a number of adits that had been driven to intersect pyritic iron ore lodes in the search for gold, silver and copper. (The adit shown on the map of the Rocky River deposit (fig.7) is 800 ft. long, but cannot be penetrated beyond 200 ft. because of caving). The investigation by the early prospectors of the Rocky River deposits as a source of precious and base metal sulphides was also unsuccessful.

Reid in 1919, first reported on the Savage River deposits (known then as the Rio Tinto lodes) as a source of iron ore. He divided the ore into five main lenses shown on his map, and a number of smaller lenses. He concluded that the ore consisted mainly of magnetite and hematite with pyrite apparently separated in bands. The ore reserves were estimated at 20 million tons. Reid, after a brief survey in 1924, described iron ore occurrences between the Meredith and Whyte rivers and reported on the nature and extent of the ore bodies and relationship to the country rock.

The Hoskins Iron and Steel Company excavated sixteen trenches on the Savage River deposit in 1926; the first exploratory work done to test the deposits as a source of iron, but found that the ore was too pyritic. Woolnough (1939) after a cursory investigation, concluded that Reid's estimate of ore reserves had been optimistic, that the nature and quality of the ore rendered it unattractive for blast furnace smelting according to world practice at that time, and that future investigation would need to be conclusive and therefore expensive. Woolnough's report marked the end of an era, during which geologists and prospectors had no recourse to modern aids in exploration and geological mapping. They were guided only by their observations of surface features, which are so scant that many conclusions based on these features are uncertain. Exploration and investigation of the Savage River - Rocky River area, dating from 1956, has been more scientific. The results have aided the writer in the compilation of the maps and report.

The early history of mining, detailed above, indicates the change in geological thought regarding the deposits over a span of about 70 years. Their economic significance during this time was never fully realized, partly because they were so inaccessibly located and poorly exposed. Modern exploration techniques in delineating ore bodies had not yet evolved; but composition of magnetite was probably the greatest single factor detracting from its use as ore. Technologic science had not advanced to the stage where impurities in the ore could be removed or controlled. To-day such techniques are known, and ore of the type found in the Savage River- Rocky River area is no longer considered refractory.

APPENDIX 2.

ORE RESERVES.

1. Savage River area.

1.1. Central Area.

Calculation of the total ore reserves in the southern, central a nd northern areas of the Savage River deposit is not possible at this stage because the length, width and depth of the ore bodies have not been ascertained by drilling in the southern area; and have been indicated only along part of the length in the northern area. Working costs are not sufficiently known at present to determine the average cut-off grade for mining operations. Knowledge of the cut-off grade would influence the dimensions of the open pit excavation of the ore-bodies and impose a limit to the depth of magnetite that could be profitably mined.

The number of drillholes bored in the central Savage River area is enough to enable some estimates of ore reserves to be made, based on grade of the intersected ore. Symons (1962) calculated the ore reserve from an open pit designed to extract ore to a depth of approximately 400 ft. below the surface over a length of approximately one mile. The ore reserve is: -

82 millions tons of ore averaging 43.8 percent iron.

17 millions tons of low grade ore averaging 17.3 percent Fe.

The writer independently compiled an estimate of ore reserves based on a plan and set of sections supplied by Picklands, Mather Co. Ltd., to the Department of Mines. The ore reserve was calculated to be: -

99 million tons averaging 37.6 percent iron

The ratio of waste/ore by weight = 1 : 1.48)
The ratio of waste/ore by volume = 1 : 1.09) Open pit extraction.

Details of the calculations used in obtaining an overall average grade are listed below: -

A R E A S.

Section	Based on DDH No.	Ore Zone Sq. ft.	Total Open Cut Sq. ft.	Fe % HCl soluble
2500S	16	94,520	167,965	33.1
2000S	15	143,740	257,000	35
1500S	13	165,800	333,875	39.8
750S	10 and 23	253,640	451,025	41.0
250S	11 and 12	204,150	413,535	44.2
TRAV A	8 and 9	157,475	428,108	38.0
B	4	195,200	489,175	40.5
B8	3,21 and 22	289,975	400,200	35.4
CO	5 and 6	112,775	203,950	28.5
G 12	7	27,775	48,250	34.1

The overall average grade of the deposit was derived by weighting the average grades of the ore in each borehole section with their respective areas and the half distances to adjacent boreholes. The average grade of the deposit using this method of calculation was 37.6 percent Fe.

Average areas and volumes calculated for the derivation of tonnage were: -

Block bounded by Sections.	Aver. Area (sq.ft.) Ore Block	Open Cut	Volume (cu.ft.) Ore Block x 1000	Open Cut x 1000
Magnetite Creek				
-DDH 16	47,260	83,982	18,904	33.593
DDH 16 -DDH 15	119,130	212,482	55,991	99,866
DDH 15 -DDH 13	154,770	295,437	80,480	153,627
DDH 13 - DD10 & 23	209,720	392,450	136,318	255,093
DDH 10 & 23 - DDH 11 & 12	228,895	432,280	82,402	155,621
DDH 11 & 12 -DD8 8 & 9	180,812	420,821	65,092	151,495
DDH 8 & 9 - DDH 4.	176,337	458,641	93,459	243,080
DDH.4.-DDH,3,21 & 22	242,587	444,687	155,256	284,600
DDH.3,21 & 22-DDH 5 & 6	201,375	302,075	118,825	178,245
DDH.5 & 6 -DDH.7.	70,275	126,100	61,139	109,707
		Total	867,866	1,665,428

The Specific Gravity of ore grading 37.6 percent iron was taken to be 4.1 from tests on different grades of ore in the Department of Mines Laboratory, Launceston.

A tonnage factor of 8¾ cu.ft. of ore to the long ton was accordingly derived.

Ore dressing tests on Savage River ore by Manson (1959, 1960,1962) indicated that fine grinding and magnetic separation of 39.8 percent Fe grade ore yielded a magnetite concentrate assaying 68.3 percent Fe and weighing 56.6 percent of the ore.

Ore of grade 37.6 percent Fe is calculated to yield a magnetite concentrate assaying about 68.0 percent Fe, and weighing 53.5 percent of the ore. Ore in the central area may therefore be estimated at 53 million tons after beneficiation, assaying about 68.0 percent iron. Allowing a loss of 10 percent due to mining hazard the ore reserve would then be approximately 48 million tons. The calculation of ore reserves is better summarized in figures: -

Specific Gravity of 37.6 percent Fe grade ore = 4.1

$$\text{Tonnage factor } \frac{2240}{4.1 \times 62.5} = 8\tfrac{3}{4} \text{ cu.ft./ ton.}$$

$$\text{Tonnage } \frac{867,866,500 \text{ cu.ft.}}{8.75 \text{ cu.ft./ton}} = 99,184,692 \text{ tons of grade 37.6 percent Fe.}$$

Ore is oxidized to an average depth of 100 ft. below the surface, and enriched to a grade generally between 60 and 66 percent Fe. The tonnage of enriched ore may range from 20 million tons to about 24 million tons.

$$\text{Magnetite concentrate of ore reserve} = \frac{53.5}{100} \times 99 \times 10^6 \text{ tons}$$

$$= 53 \times 10^6 \text{ tons of grade approx 68.0 percent Fe}$$

less 10 percent mining hazard

$$= 47.7 \times 10^6 \text{ tons of approx. 68.0 percent Fe.}$$

Calculation of Waste Tonnage.

Specific Gravity of amphibolite = 3.0

$$\text{Tonnage factor} = \frac{2240}{3 \times 62.5} = 11.9 \text{ cu.ft./ton}$$

$$\text{Tonnage} = \frac{(1,665,427,850 - 867,866,560) \text{ cu.ft.}}{11.9 \text{ cu.ft./ton}}$$

$$= 67 \times 10^6 \text{ tons of waste rock.}$$

Impurities.

The average impurity in the ore was calculated using the percentages given by Symons (1962,pp.128,129) for low and medium grade ore.

	Percent.
Titanium	0.42
Phosphorus	0.15
Sulphur	4.7
Vanadium	0.27

1.2 Northern Area.

Reserves are based on the following boreholes, to a maximum depth below surface of 400 ft.

Section based	Ore Zone	Percent HCl. Sol. Fe.
On DDH. No.	Sq. ft.	
14	28,800	45
18	72,000	30
19	48,000	35.8
20	12,000	27.0
17	48,000	38.5
Total	208,800	

Overall grade of the ore zone was derived by weighting the average grades of ore in each borehole section with their respective areas. Overall average grade = 35.3 percent Fe.

1	68,000	40.6
2	100,000	44.1
Total	168,000	

Aver. grade of ore zone between DDH 1 and DDH 2 = 42.8 percent Fe.

Tonnage.

Block bounded by sections	Aver. Area sq. ft.	Volume cu.ft. x 1000	
Savage River - DDH.14	14,000	2.800	
DDH.14-DDH.18	50,400	27.720	Tonnage = 93,520,000 cu.ft. / 9 cu.ft./ton
DDH.18-DDH.19	60,000	30,000	
DDH.19-DDH.20	30,000	15,000	= 10,391,111 tons @ 35.3
DDH.20-DDH.17	30,000	18,000	percent Fe
	Total	93,520	
DDH.1-DDH.2	84,000	50,400	Tonnage = 5,800,000 tons @ 42.8 percent Fe

The reserve of ore indicated by drilling in the northern area is thus about 16 millions tons. An ore reserve of about 14 million tons may be proved by additional drilling, constituting a total reserve of about 30 million tons of ore.

1.3 Southern Area.

The orebody has not yet been drilled, consequently the estimate of 15 million tons of ore to a depth of 400 ft. based mainly on the geophysical anomaly, is liable to modification.

2. Long Plains South - Brown Plains area.

Drillhole RTAE1, the only one in the area, enables the ore reserve to be roughly estimated by extrapolating the grade and width of ore intersected in the hole along the strike length of the deposit. The ore reserve to a depth of 400 ft. below surface is calculated to be 40 to 50 million tons of medium grade ore.

3. Rocky River area.

Magnetometer and geological surveys show low grade mineralization in a zone approximately 200 ft. wide, and over a mile long. The corresponding reserve of low grade ore (perhaps no more than 15 percent Fe) to a depth of 400 ft. below surface would possibly be 40 to 50 million tons.

The estimated ore reserves are summarized as follows: -

Savage River	Central Area	=	99 million tons
	Northern Area	=	30 million tons (approx).
	Southern Area	=	15 million tons (inferred)

Total 144 million tons of low to medium grade ore.

Long Plains South - Brown Plains = 40 to 50 million tons of low to medium grade ore.

Rocky River area = 40 to 50 million tons of low grade ore.

APPENDIX 3.

ANOMALY PROFILES, CORE ASSAYS AND SECTIONS OF DRILLHOLES 1 TO 25; RTAE 1.

DIAMOND DRILL BOREHOLE NO. 1

LOCATION: TRAV. E.00 W.300'

R.L. 1515' BEARING 103° DIP OF HOLE 41°

Depth From	Depth To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol)	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
400	421	)		52.2	11.2		1.38	0.12	trace	0.98	
421	440	)		58.1	6.9		1.12	0.12	0.02	0.23	
440	471	)		51.9	12.2		1.09	0.12	0.02	0.18	
471	487	)		28.3	29.5		0.76	0.13	0.03	1.61	
487	508	)		59.3	14.1		1.13	0.12	trace	0.43	
508	515	)		13.6							
515	520	)	43·5	20.5	29.6		0.43	0.08	.01	0.84	
520	540	)		43.1	15.4		0.79	0.11	.01	0.83	
540	563	)		41.3	16.5		0.82	0.11	.01	0.69	
563	572	)		28.3	23.0		0.78	0.09	.05	1.31	
572	595	)		51.1	10.3		1.1	0.13	.03	0.92	
595	611	)		46.9	12.6		0.96	0.14	0.10	1.21	
611	631	)		44.5	14.4		0.45	0.14	0.5	0.98	
Bore depth 668 ft.											

DIAMOND DRILL BOREHOLE NO. 2

LOCATION TRAV. E 5, E 241' Bore depth 863 ft.

R.L. 1630' BEARING 260^{o} DIP OF HOLE . 45^{o}

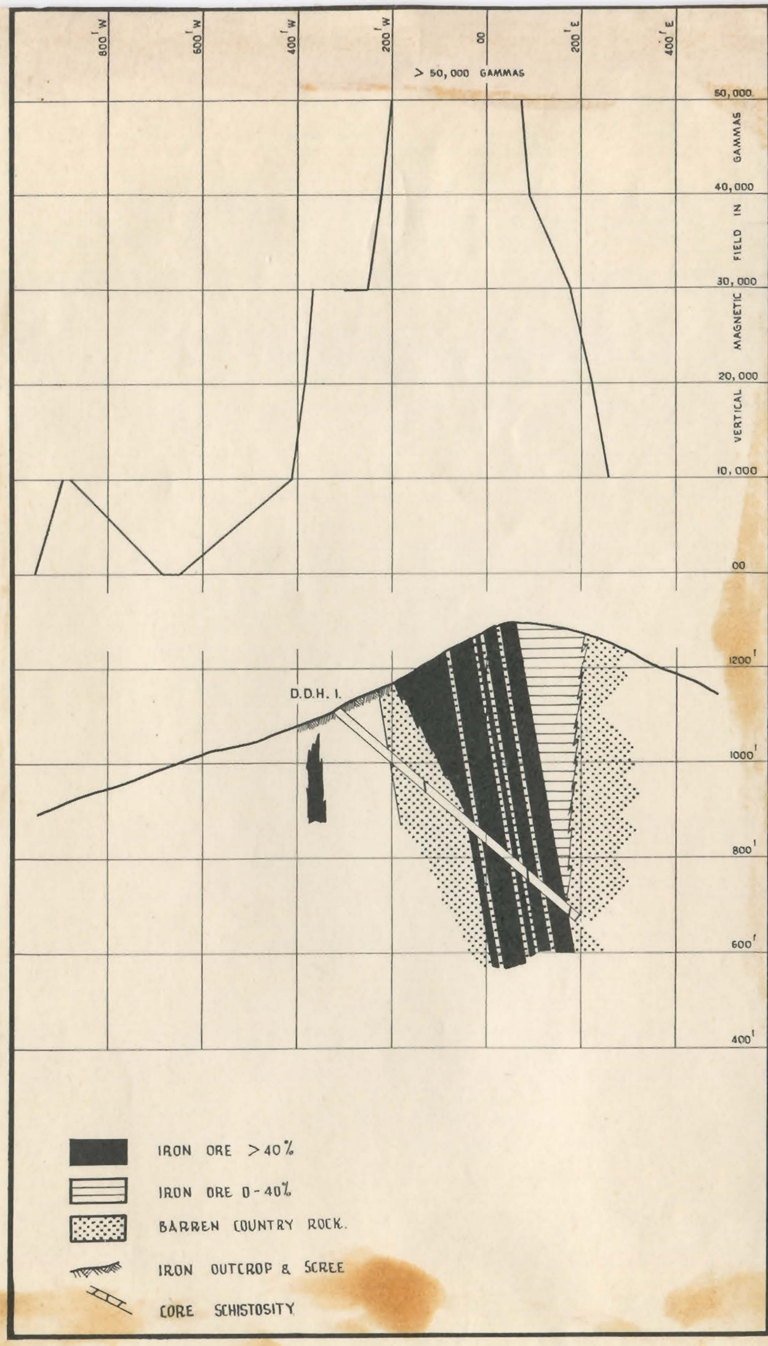
Depth From	To	Inter-Section Feet	Core Recovery	Fe (HCl Sol)	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
313	337	24	)	44.6	13.8		0.99	0.10	0.02	0.27	
337	370	33	)	43.0	16.7		1.01	0.10	0.01	0.40	
370	388	18	)	56.3	8.1		1.12	0.11	0.05	0.57	
388	408'6"	20' 6"	)	45.2	12.4		0.98	0.13	0.09	0.94	
408' 6"	430'6"	22	)	24.9	25.1		0.86	0.11	0.08	0.95	
430' 6"	457'	26' 6"	)	53.8	9.6		1.13	0.12	0.03	0.38	
457'	479	22' 0"	) 93.7	42.2	16.2		1.01	0.11	0.05	0.44	
479	502	23'	)	45.1	13.3		0.87	0.10	0.03	0.14	
502	512	10'	)	21.8	29.8		0.58	0.08	0.02	0.96	
512	538	26	)	50.1	11.4		1.12	0.15	0.02	0.45	
538	560	22	)	50.3	11.0		1.01	0.10	0.02	0.21	
560	581	21	)	53.1	9.3		1.22	0.10	0.02	0.11	
581	605	24	)	46.9	13.1		1.24	0.14	0.04	0.27	
605	617	12	)	9.1	41.6		0.93	0.14	0.06	0.46	
617	637	20	)	50.2	10.7		1.30	0.17	0.03	0.18	
637	651	14	)	54.7	8.1		1.39	0.17	0.02	0.17	

DIAMOND DRILL BOREHOLE NO.2 (CONTD.)

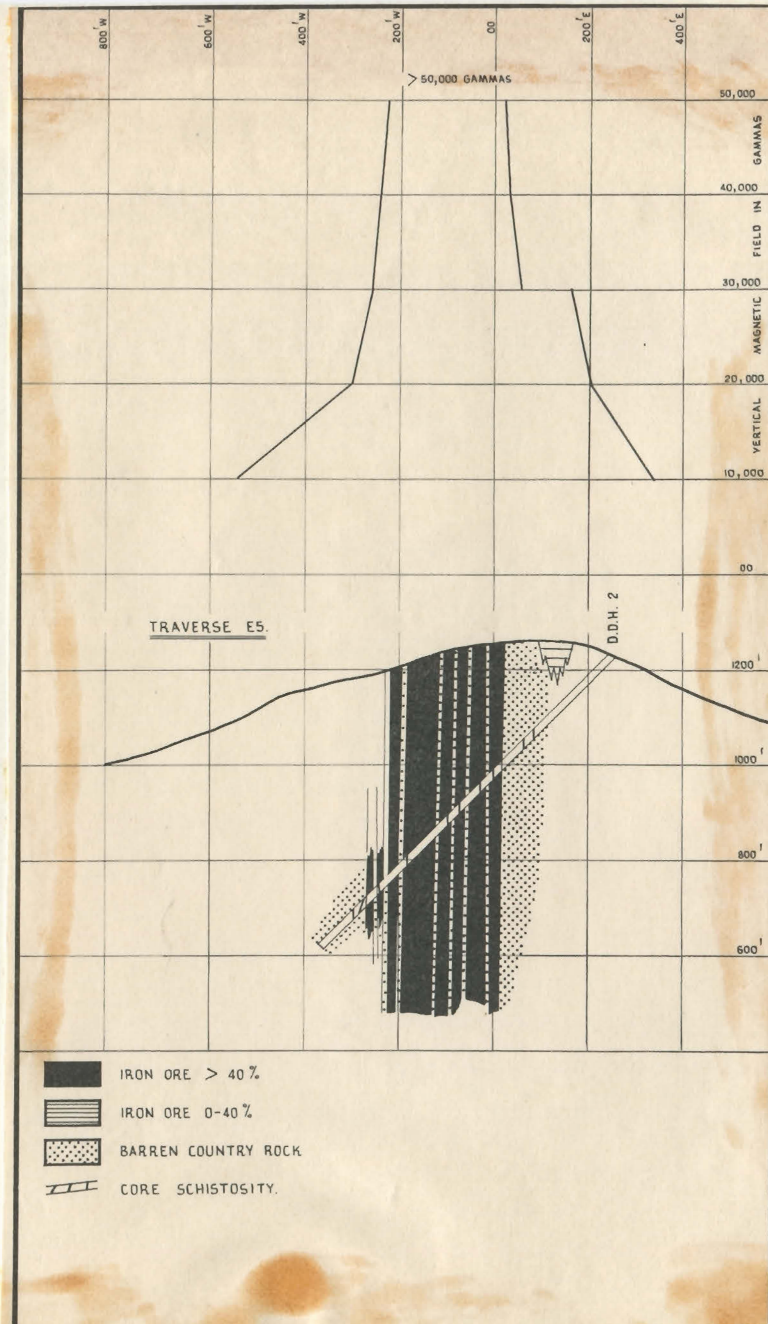
LOCATION TRAV. E 5, E 241' Bore depth 863 ft.

R.L. 1630' BEARING 260° DIP OF HOLE 45°.

Depth From	To	Inter-Section Feet	Core Recovery	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V
651	669	18	)	27.1	24.5		0.88	0.09	0.02	0.28	
669	696	27	)93.7	46.3	13.0		1.18	0.14	0.04	0.63	
696	718'6"	22'6"	)	44.5	14.1		1.26	0.16	0.03	0.43	



800' W
600' W
400' W
200' W
00
200' E
400' E
> 50,000 GAMMAS
50,000
40,000
30,000
20,000
10,000
00
VERTICAL MAGNETIC FIELD IN GAMMAS
D.D.H. 1.
1200'
1000'
800'
600'
400'
IRON ORE >40%
IRON ORE 0-40%
BARREN COUNTRY ROCK.
IRON OUTCROP & SCREE
CORE SCHISTOSITY



800' W
600' W
400' W
200' W
00
200' E
400' E
> 50,000 GAMMAS
50,000
40,000
30,000
20,000
10,000
00
VERTICAL MAGNETIC FIELD IN GAMMAS
TRAVERSE E5.
D.D.H. 2
1200'
1000'
800'
600'
IRON ORE > 40%
IRON ORE 0-40%
BARREN COUNTRY ROCK
CORE SCHISTOSITY.

DIAMOND DRILL BOREHOLE NO. 3

LOCATION Traverse B8, 414' W

R.L. 975' **BEARING** 271° **DIP OF HOLE** 45°

Depth			Inter-Section Feet	Core Recovery %	Fe (H.C.1 Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
From		To										
				0-50 4								
0	-	325	325	50-325 65	52.0	5.7	0.9	0.19	0.12	0.10	3.6	
325	-	345	20	95	32.9			0.37		0.29	8.1	
345	-	525	180	83	16.2			0.31		0.22	5.6	
525	-	590	65	82	43.1	11.6	2.9	0.65	0.15	0.26	4.7	
590	-	645	55	70	15.4			0.59		0.08	1.6	
785	-	825	40	85	20.9)							
					)	8.9	1.4	0.62	0.05	0.07	3.9	
825	-	920	95	87	48.3)			0.55		0.02	4.7	

DIAMOND DRILL BOREHOLE NO.4

LOCATION Traverse BOO, 850' W

R.L. 1130' **BEARING** 263° **DIP OF HOLE.** 45°

Depth From		To	Inter-Section Feet	Core Recovery %	Fe (H.C.1. Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
100	-	115	15	67	26.9	27.0	3.1	0.53	0.06	0.02	2.0	
115	-	235	120	90	48.9	9.1	2.0	0.30	0.06	0.07	4.3	
235	-	248	13	85	20.7	28.3	0.4	0.11	0.03	0.29	3.4	
258	-	266.5	8.5	100	14.7)							
270	-	275	5	26	8.1)	33.8	2.4	0.21	0.09	0.10	4.2	
285	-	293	8	73	13.2)							
331	-	339	8	100	54.8	5.3	1.4	0.20	0.08	0.06	4.7	
343.5	-	360.5	27	97	52.5	6.0	1.3	0.29	0.13	0.07	5.2	
379	-	392.5	13.5	92	56.7	4.2	0.8	0.29	0.13	0.11	4.3	
412	-	475.5	63.5	100	43.1	9.7	1.1	0.37	0.19	0.10	7.1	
521	-	590.7	69.7	97	48.8	5.4	1.7	0.83	0.17	0.09	8.6	
676	-	688	12	100	43.9	9.7	2.3	0.76	0.06	0.15	4.6	
708.5	-	717.3	9	83	55.4	5.5	1.6	1.06	0.07	0.03	3.8	

DIAMOND DRILL BOREHOLE NO. 21

LOCATION H.16 E 285', S9'

R.L. 1025' (approx.) BEARING 270^{o} DIP OF HOLE. 47^{o} at collar.

Depth From	To	Inter-Section Feet	Core Recovery	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
+	- 31' 5"	31' 5"	)	51.6			)		)	)	
31'5"	- 64' 6"	33'	)	9.6			)		)	)	
64'6"	- 79' 6"	15	)	47.9			)		)	)	
79'6"	- 93' 6"	14	)	6.9			)		)	)	
93'6"	- 128'6"	35	)75	45.2			)0.55		).09	)4.18	
128'6"	- 152'7"	24	)	24.2			)		)	)	
152'7"	- 165'6"	13	)	44.3			)		)	)	
165'6"	- 172'2"	6'8"	)	25.9			)		)	)	

Bore depth = 172' 2"

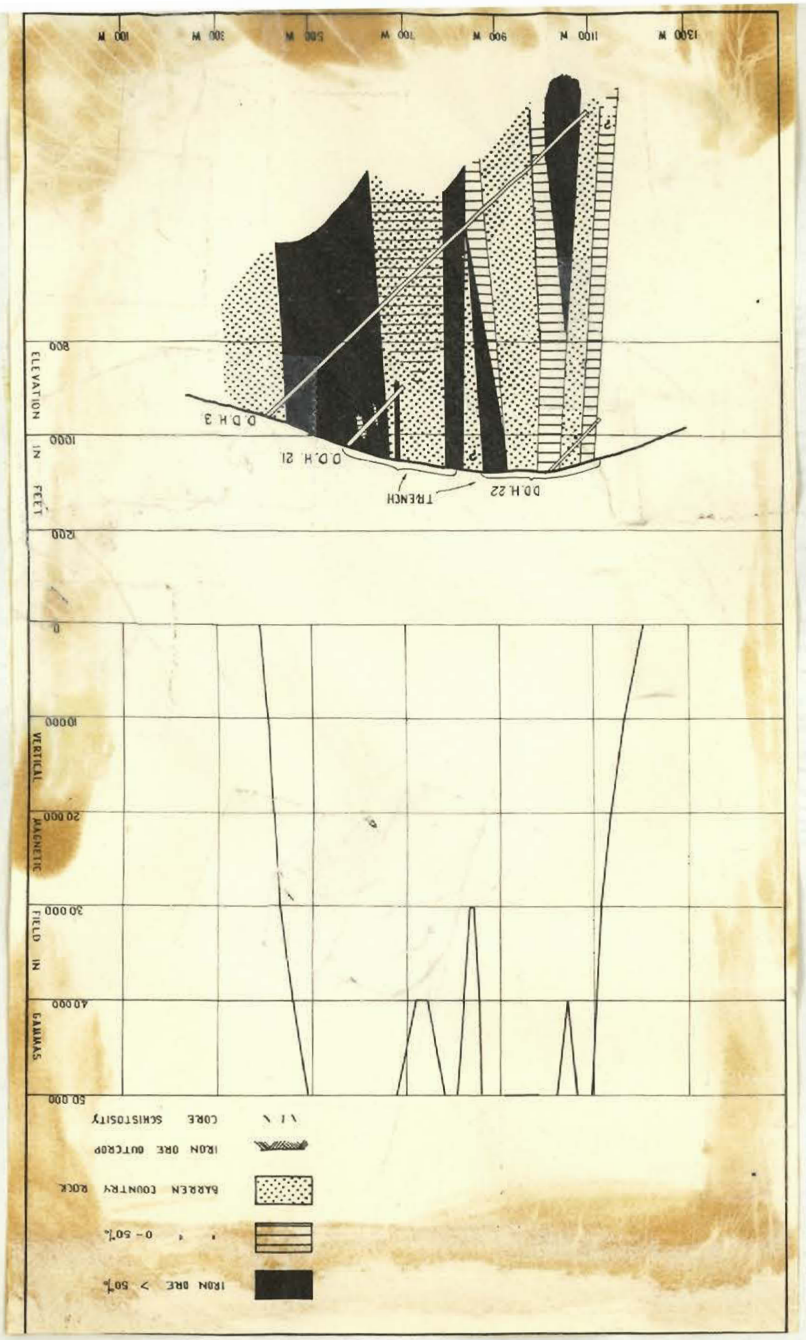
DIAMOND DRILL BOREHOLE NO. 22

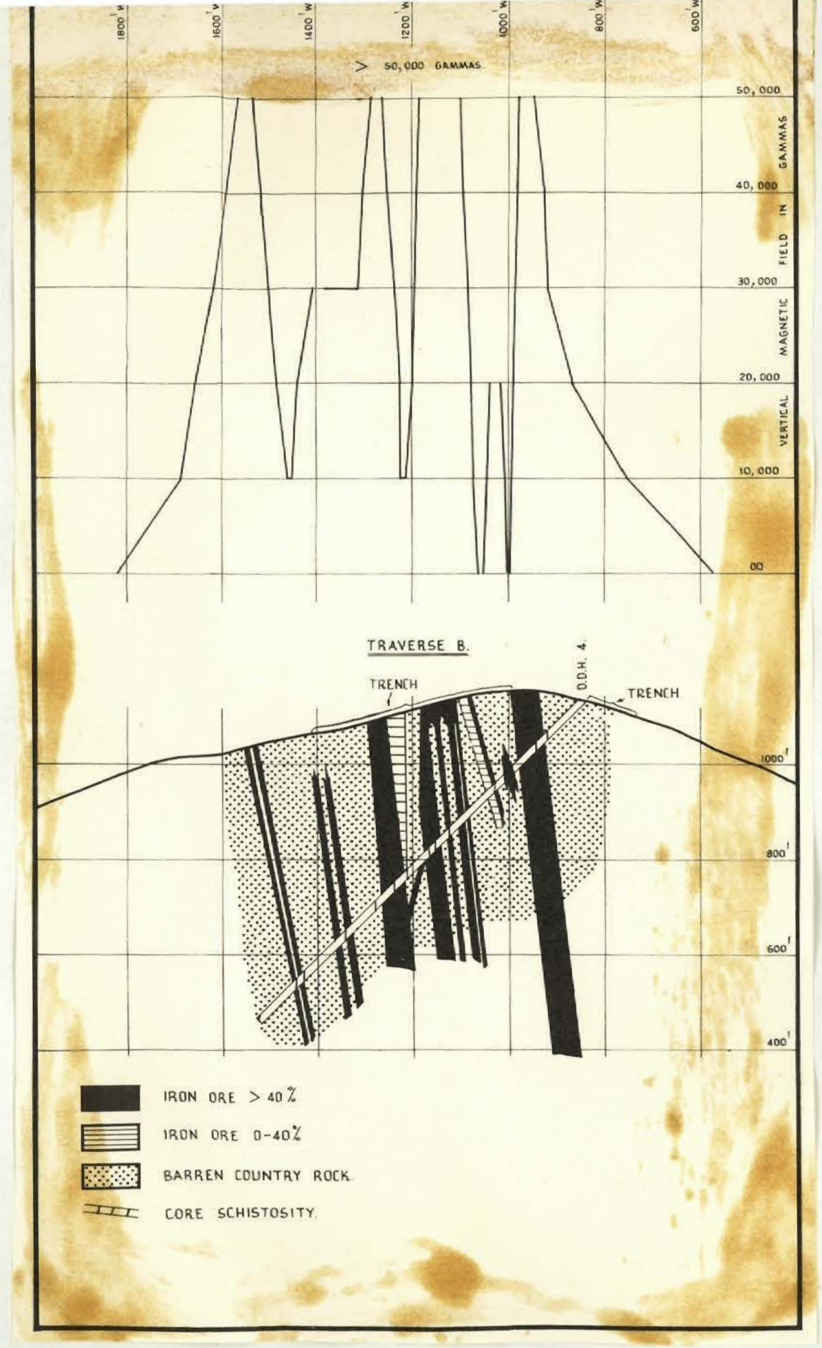
LOCATION TRAV B8 570' W of DDH3

R.L. 1075' **BEARING** 270° **DIP OF HOLE.** 45°

Depth From		Depth To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
0	-	30	30	30	47			)		)	)	
10	-	69	59	20	20			)1.53		)0.03	)0.15	
112'9"	-	131'3"	18'6"	-	-			0.55		0.21	4.1	
131'3"	-	147'	15'9"	-	-			0.55		0.05	1.5	
114'6"	-	154'4"	-	-	18							

Bore depth = 159' 7"


IRON ORE > 50%
" " 0 - 50%
BARREN COUNTRY ROCK
IRON ORE OUTCROP
CORE SCHISTOSITY
VERTICAL MAGNETIC FIELD IN GAMMAS
50 000
40 000
30 000
20 000
10000
0
ELEVATION IN FEET
1200
1000
800
D.D.H. 3
D.D.H. 21
TRENCH
D.D.H. 22
100 W
300 W
500 W
700 W
900 W
1100 W
1300 W


1800' W
1600' W
1400' W
1200' W
1000' W
800' W
600' W
> 50,000 GAMMAS
50,000
40,000
30,000
20,000
10,000
00
VERTICAL MAGNETIC FIELD IN GAMMAS
TRAVERSE B.
TRENCH
D.D.H. 4.
TRENCH
1000'
800'
600'
400'
IRON ORE > 40%
IRON ORE 0-40%
BARREN COUNTRY ROCK.
CORE SCHISTOSITY.

DIAMOND DRILL BOREHOLE NO.5

LOCATION Traverse COO, 450' W

R.L. 840' BEARING 271° DIP OF HOLE 60°

Depth From	Depth To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
36	73	37	55	21.2	27.8	6.3	0.50	0.12	0.18	3.3	
224	336.5	112.5	98	20.9	26.0	2.9	0.29	0.10	0.34	4.6	
336.5	549.5	213	96	46.7	10.3	2.1	0.33	0.08	0.12	4.6	
605	763	158	89	36.2	17.7	4.7	0.46	0.06	0.07	4.1	
818.5	871.2	52.7	99	22.8	31.1	7.3	0.61	0.08	0.03	1.0	

DIAMOND DRILL BOREHOLE NO. 6

LOCATION Traverse COO 450' W

R.L. 840' BEARING 91° DIP OF HOLE. 40°

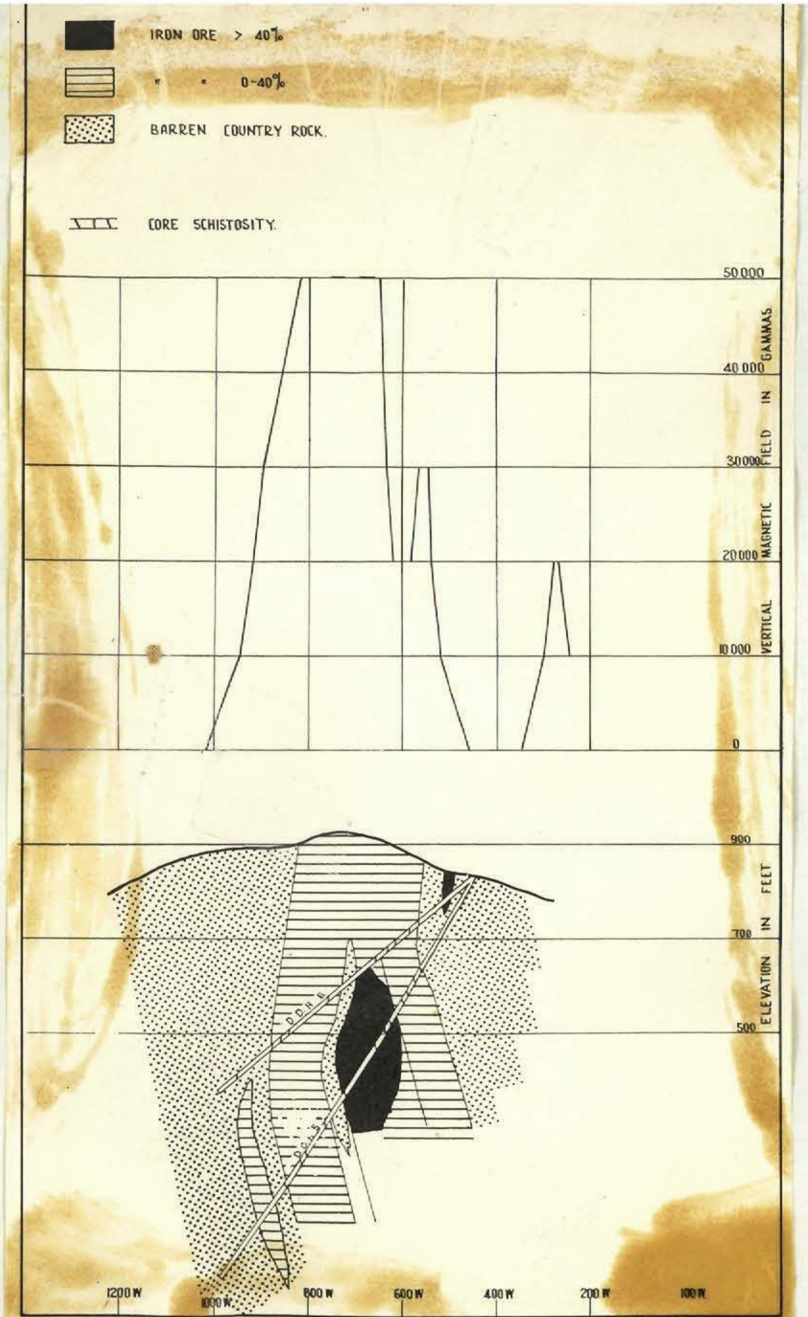
Depth From	To	Inter-Section Feet	Core Recovery	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
52 -	87	35	40	44.0	15.8	3.0	0.41	0.10	0.21	4.6	
146 -	169.5	23.5	79	42.0	14.8	0.5	0.17	0.06	0.23	4.8	
169.5 -	316	146.5	77	15.0	33.1	7.9	0.56	0.12	0.11	3.0	
316 -	322.5	6.5	96	56.3	5.7	1.1	0.74	0.05	0.09	3.6	
373 -	386.5	13.5	100	54.7	11.4	2.0	0.73	0.12	0.04	3.0	
386.5 -	462.5	76	97	10.9	37.3	9.2	0.51	0.12	0.06	1.4	
462.5 -	487.5	25	98	55.3	7.7	2.1	0.81	0.11	0.09	1.1	
487.5 -	559.5	71.8	95	26.7	28.9	5.3	0.44	0.10	0.19	3.6	

DIAMOND DRILL BOREHOLE NO.7

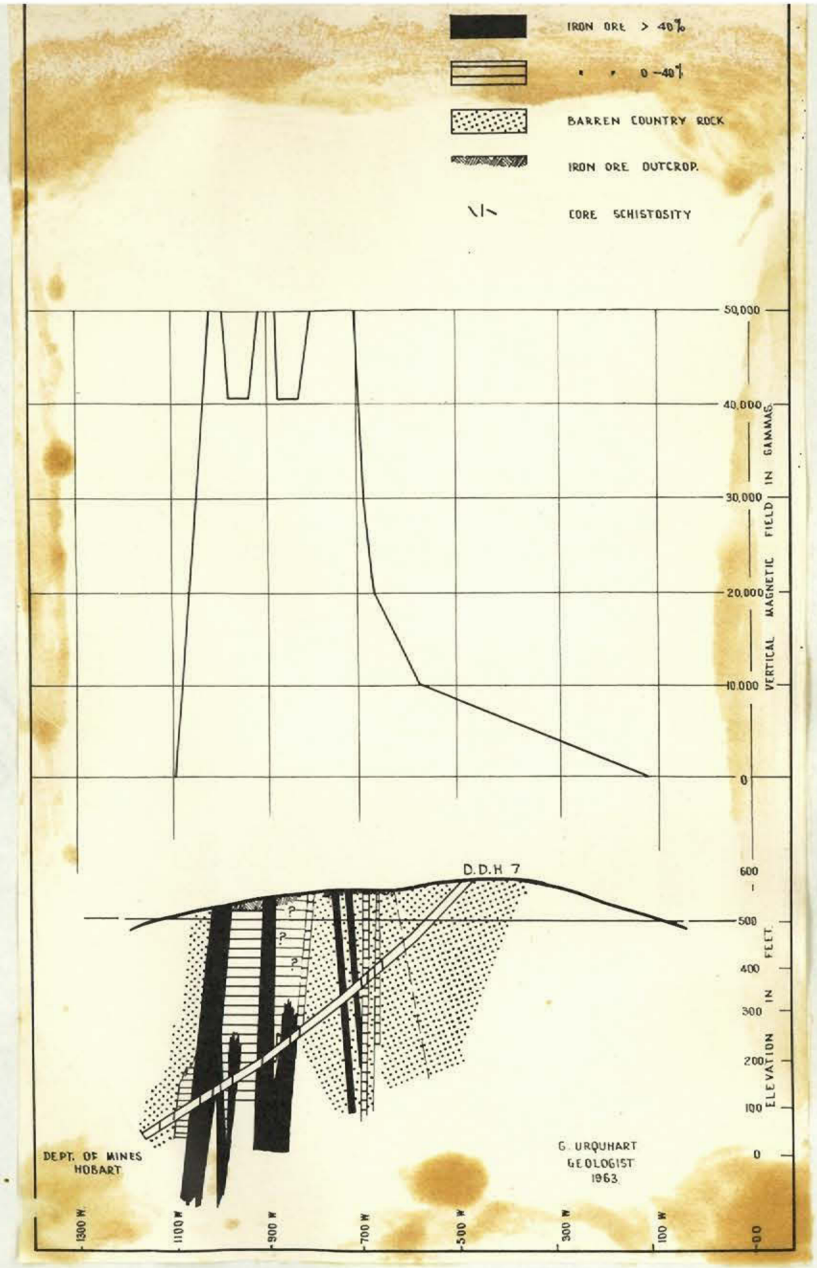
LOCATION Traverse C12, 500'W

R.L. 580' BEARING 253^{o} DIP OF HOLE . 45^{o}

Depth From	To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
254	- 321	67	100	26.5	21.5	4.6	0.34	0.08	0.31	4.8	
343	- 360	17	100	39.7	13.7	0.4	0.21	0.07	0.22	3.9	
461	- 477	16	98	13.4	30.7	5.8	0.25	0.13	0.33	5.9	
477	- 520.3	43.3	98	48.2	7.3	0.8	0.32	0.11	0.15	5.9	
520.3	- 554.5	34.2	100	49.8	6.9	0.7	0.42	0.09	0.03	5.9	
554.5	- 579	24.5	100	31.6	13.9	1.6	0.26	0.02	0.07	11.6	
579	- 632	53	99	10.9	31.1	12.6	0.53	0.08	0.14	3.5	
632	- 652	20	100	55.9	4.0	0.9	0.37	0.08	0.20	4.5	
652	- 680	28	100	45.0	12.6	5.4	0.55	0.07	0.04	3.1	
680	- 702.5	22.5	96	48.7	8.8	0.7	0.09	0.06	0.02	4.9	
702.5	- 751	48.5	100	62.0	1.5	0.4	0.08	0.06	0.05	4.1	
751	- 782	31	100	29.5	21.8	7.4	0.60	0.09	0.44	3.8	



IRON ORE > 40%
" " 0-40%
BARREN COUNTRY ROCK.
CORE SCHISTOSITY.
50 000
40 000
30 000
20 000
10 000
0
VERTICAL MAGNETIC FIELD IN GAMMAS
900
700
500
ELEVATION IN FEET
D.D.H. 6
D.D.H. 5
1200 W
1000 W
800 W
600 W
400 W
200 W
100 W



IRON ORE > 40%
" " 0-40%
BARREN COUNTRY ROCK
IRON ORE OUTCROP.
CORE SCHISTOSITY
50,000
40,000
30,000
20,000
10,000
0
VERTICAL MAGNETIC FIELD IN GAMMAS
D.D.H 7
600
500
400
300
200
100
0
ELEVATION IN FEET
DEPT. OF MINES HOBART
G. URQUHART GEOLOGIST 1963
1300 W
1100 W
900 W
700 W
500 W
300 W
100 W
00

DIAMOND DRILL BOREHOLE NO. 8

LOCATION Traverse A 1600'W

R.L. 1085' **BEARING** 89° **DIP OF HOLE** . 40°

Depth From		To	Inter-Section Feet	Core Recovery %	Fe (HC1 Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
85	-	101	16	98	14.2	23.7	4.3	0.15	0.07	0.31	11.3	
174.5	-	182	7.5	47	23.9	21.7	3.3	0.19	0.06	0.16	11.7	
233	-	279.5	46.5	75	7.9	40.9	9.0	0.71	0.14	0.09	2.0	
279.5	-	307.5	28	59	18.6	33.7	9.1	0.84	0.15	0.05	2.5	
316	-	321	5	90	31.4	23.5	6.8	0.34	0.13	0.29	7.1	
330	-	340	10	96	25.5							
340	-	380.5	40.5	88	11.5	33.3	9.0	0.33	0.14	0.10	3.9	
448	-	471.5	23.5	100	35.1	12.7	2.0	0.27	0.05	0.35	11.3	

DIAMOND DRILL BOREHOLE NO. 9

LOCATION Traverse A, 1600' W

R.L. 1085' BEARING 269^{o} DIP OF HOLE. 45^{o}

Depth From	To	Inter-Section Feet	Core Recovery %	Fe (HC1 Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
0 -	154	154	1	50.3	19.1	1.8	0.25	0.05	0.06	1.8	
154 -	178	24	50	7.0	39.6	13.2	0.53	0.18	0.09	2.5	
178 -	231	53	43	54.2	4.9	2.4	0.28	0.07	0.04	6.4	
268 -	497	229	88	46.9	8.3	2.0	0.62	0.15	0.14	7.0	
542 -	548	6	22	47.7)	12.6	3.5	1.04	0.16	0.01	2.5	
562.5 -	563	0.5	100	38.7)							
582 -	586	4	63	47.6)							
603 -	611	8	55	51.9)							

DIAMOND DRILL BOREHOLE NO.10

LOCATION Traverse 750S (27'N) 75'E

R.L. 1015' BEARING 269° DIP OF HOLE 45°

Depth From		To	Inter-Section Feet	Core Recovery %	Fe (HC1 Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
95.5	-	114	18.5	34	55.1	6.6	2.3	0.41	0.05	0.08	3.4	
124	-	276	15.2	78	52.0	7.3	2.5	0.30	0.10	0.11	4.7	
293.5	-	303	9.5	50	53.0	8.7	2.5	0.38	0.11	0.12	2.3	
318	-	331	13	83	44.7	12.9	3.0	0.34	0.12	0.16	2.8	
359	-	438	79	91	44.6	12.8	3.8	0.40	0.12	0.13	4.0	

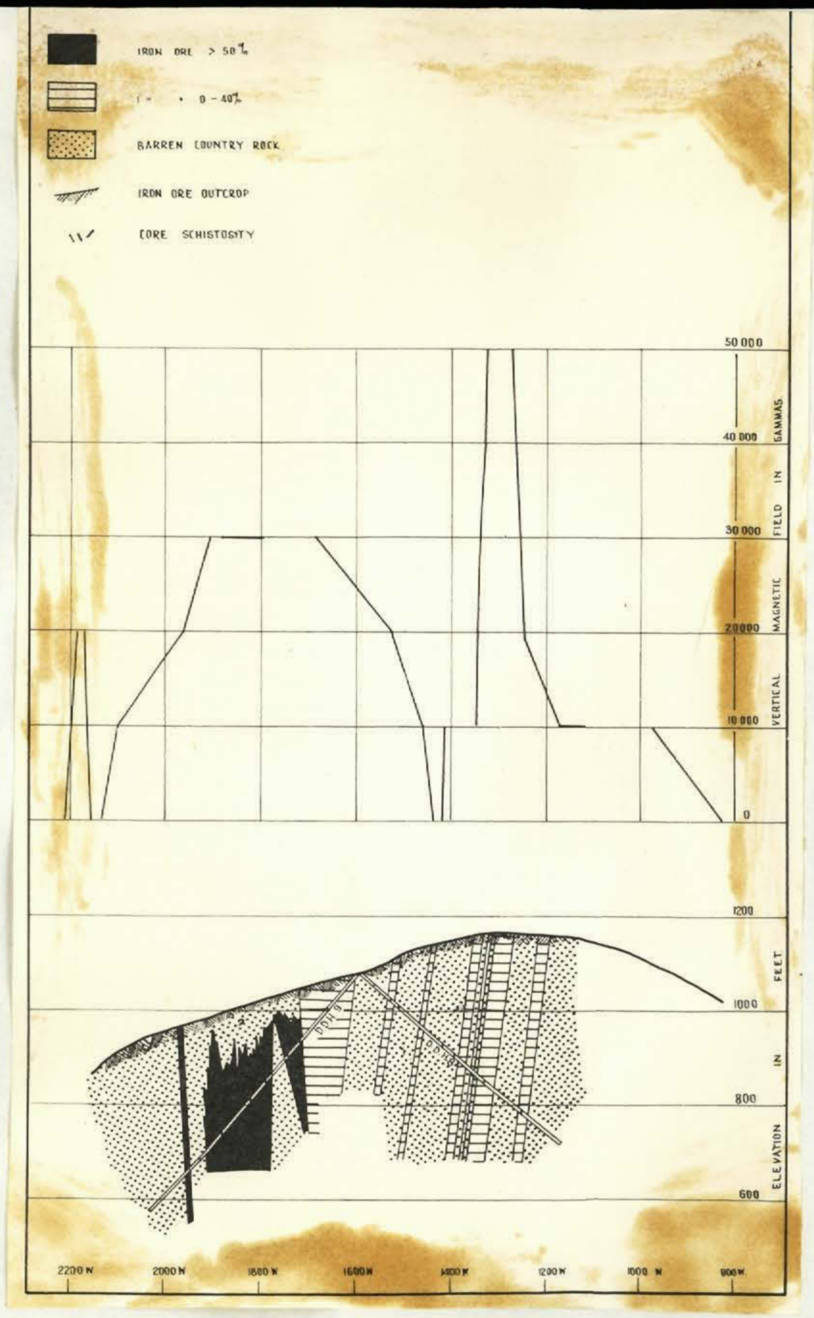
DIAMOND DRILL BOREHOLE NO. 23

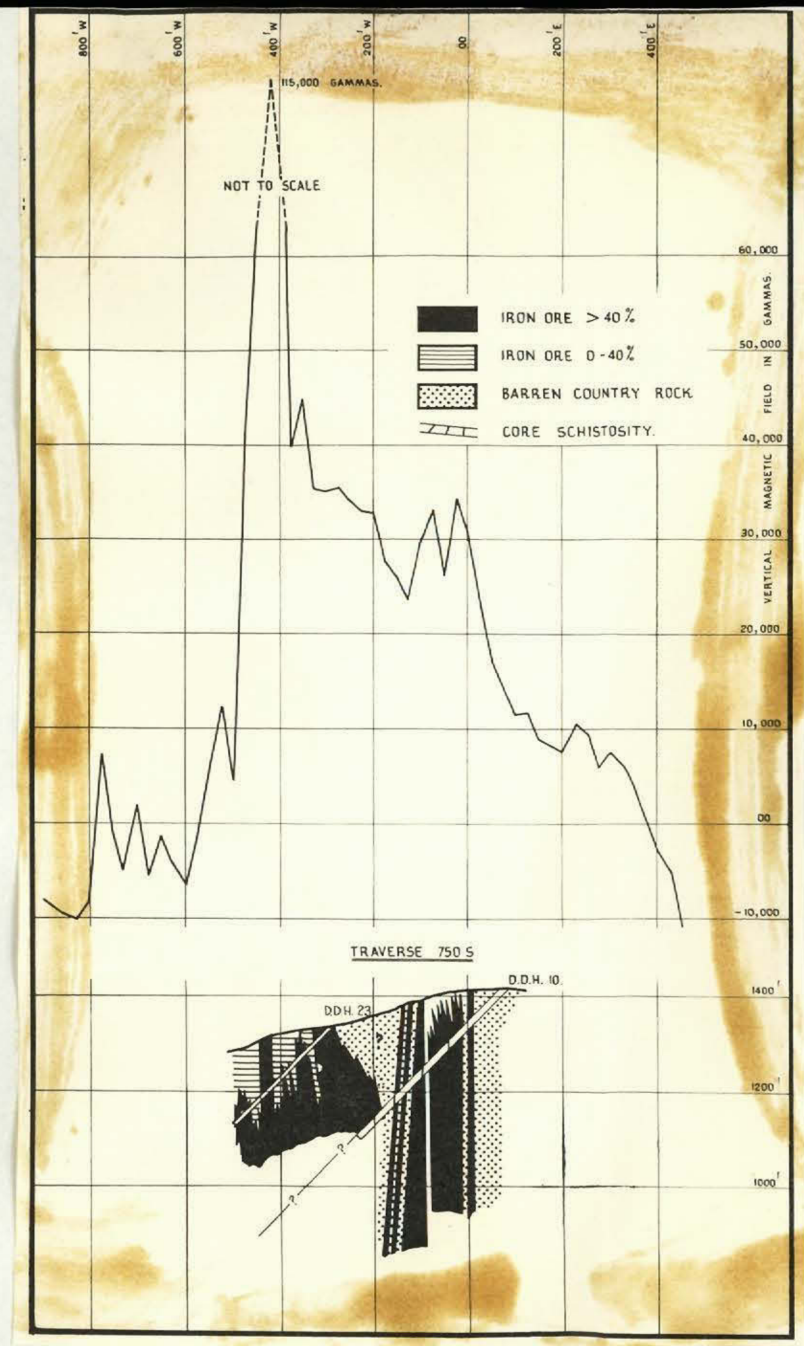
LOCATION TRAV. 750; W275; N25'

R.L. 925' BEARING WEST DIP OF HOLE. 47°

Depth From		To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
2	-	53	51	58	58.7			0.26		0.12	1.84	
53	-	72'3"	19'3"	-	8.39							
72'3"	-	105'3"	33	44	49.8			0.19		0.12	6.51	
105'3"	-	221'6"	116'3")	62	28.6							
221'6"	-	239'	17'6")		22.1							
106'	-	223'6"	117'6"					0.55		0.08	4.5	
227	-	292'6"	65'6"					0.63		0.07	4.0	
239	-	292'6"	53'6"	56	43.4							

Bore depth = 297'


IRON ORE > 50%
" " 0 - 40%
BARREN COUNTRY ROCK
IRON ORE OUTCROP
CORE SCHISTOSITY
50 000
40 000
30 000
20000
10 000
0
VERTICAL MAGNETIC FIELD IN GAMMAS
1200
1000
800
600
ELEVATION IN FEET
2200 W
2000 W
1800 W
1600 W
1400 W
1200 W
1000 W
800 W


800' W
600' W
400' W
200' W
00
200' E
400' E
115,000 GAMMAS.
NOT TO SCALE
IRON ORE > 40 %
IRON ORE 0 - 40%
BARREN COUNTRY ROCK
CORE SCHISTOSITY.
60,000
50,000
40,000
30,000
20,000
10,000
00
-10,000
VERTICAL MAGNETIC FIELD IN GAMMAS.
TRAVERSE 750 S
D.D.H. 10.
DDH 23
1400'
1200'
1000'

DIAMOND DRILL BOREHOLE NO. 11

LOCATION Traverse 250S 80'E

R.L. 1030' BEARING 265° DIP OF HOLE 55° to 200'

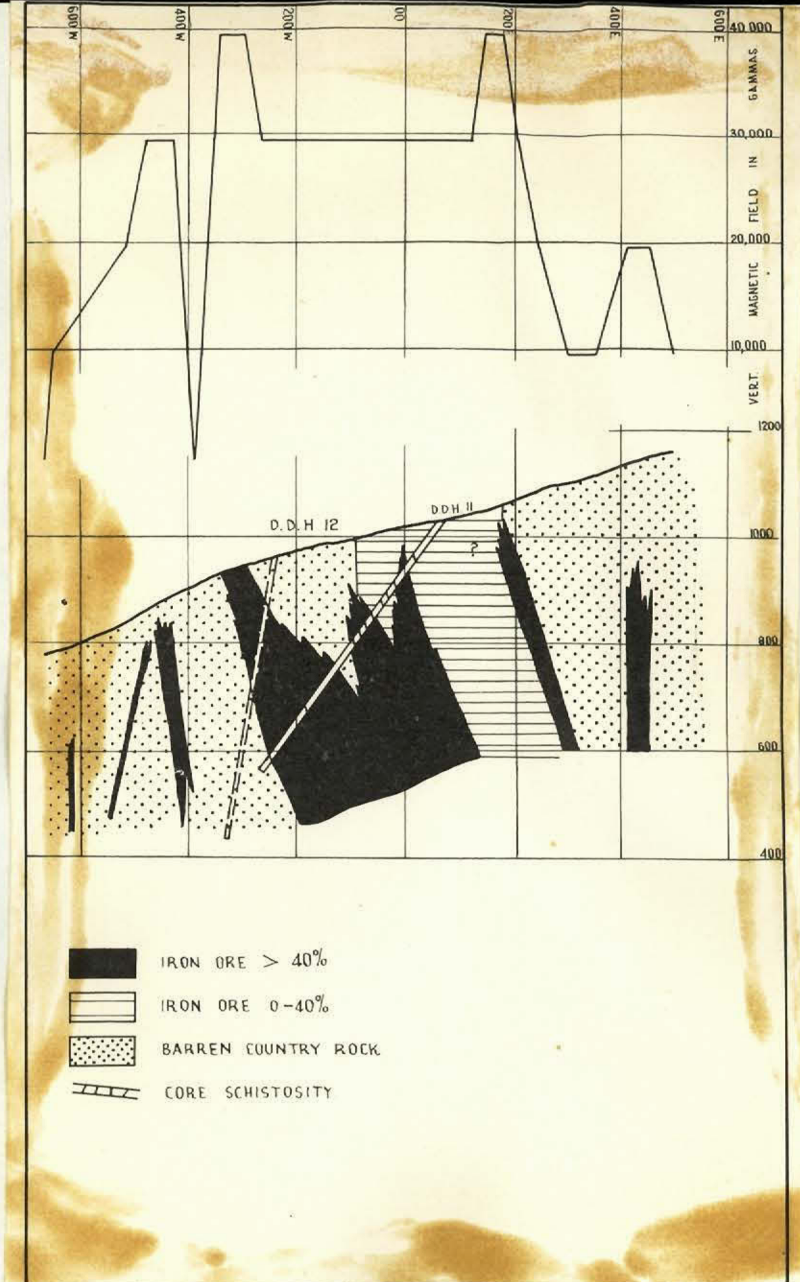
Depth From		To	Inter-Section Feet	Core Recovery %	Fe (HC1 Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
0	-	190	190	24	59.6	2.4	1.5	0.41	0.09	0.06	3.07	0.43
190	-	205	15	70	8.3	35.8	12.4	0.84	0.12	0.09	1.04	0.07
205	-	307	102	80	45.3	10.5	3.4	0.56	0.12	0.09	5.79	0.34
307	-	358	51	74	4.7	46.6	15.2	1.14	0.13	0.06	0.31	0.07
358	-	362	4	25	56.0	7.4	2.0	0.94	0.14	0.15	4.96	0.42
375	-	450	75	85	53.9	5.4	2.0	1.03	0.13	0.13	5.26	0.41
450	-	473	23	87	8.9	46.2	11.8	1.03	0.14	0.09	0.81	0.11
473	-	526	53	37	53.5	8.5	2.4	1.29	0.07	0.08	1.84	0.43

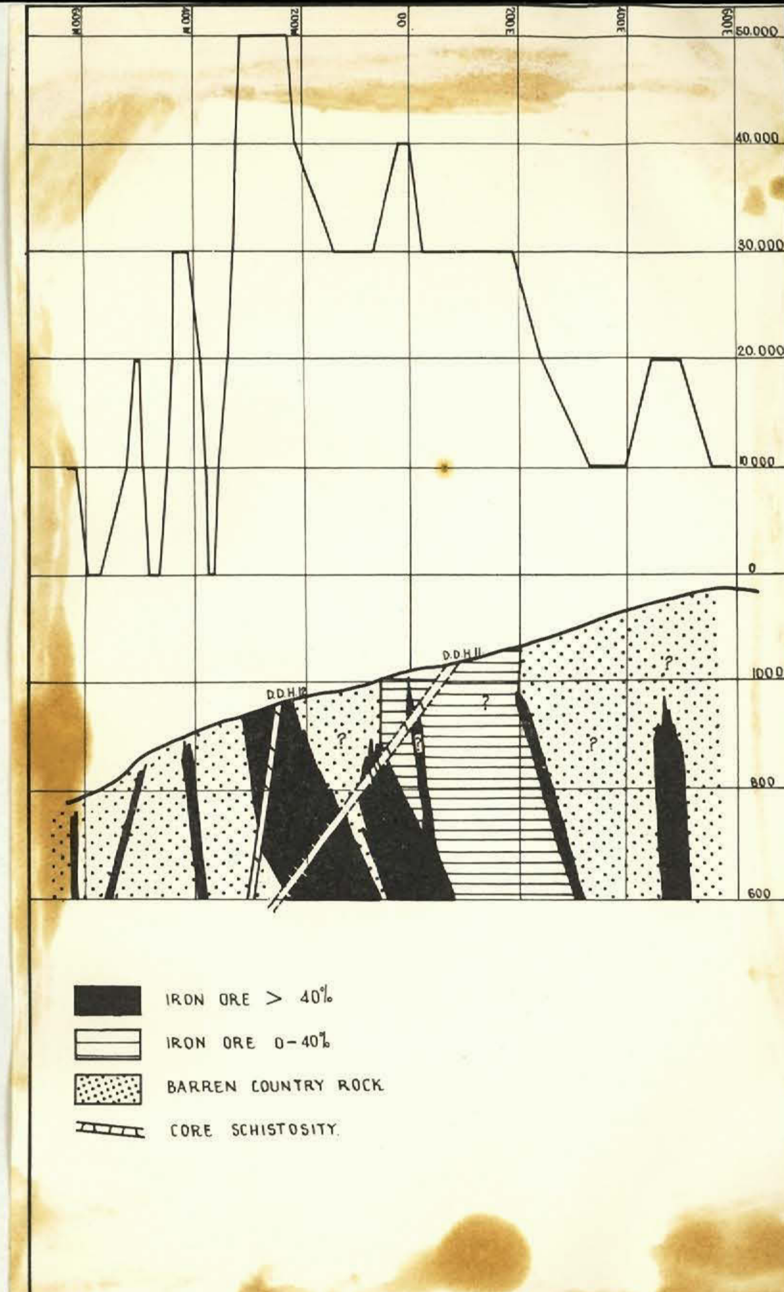
DIAMOND DRILL BOREHOLE NO. 12

LOCATION. Traverse 250S, 270'W

R.L. 960° BEARING 266° DIP OF HOLE 82°

Depth From		To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
0	-	261	261	62	56.6	3.4	2.1	0.25	0.09	0.14	3.8	0.42
334	-	338	4	)	36.6	)36.6	9.2	1.02	0.04	0.12	0.7	0.16
340	-	350	10	)90	14.0	)						


600W
400W
200W
00
200E
400E
600E
40,000
30,000
20,000
10,000
VERT. MAGNETIC FIELD IN GAMMAS
1200
1000
800
600
400
D.D.H 12
DDH 11
?
IRON ORE > 40%
IRON ORE 0-40%
BARREN COUNTRY ROCK
CORE SCHISTOSITY


600W
400W
200W
00
200E
400E
600E
50,000
40,000
30,000
20,000
10,000
0
1000
800
600
D.D.H 12
D.D.H 11
?
IRON ORE > 40%
IRON ORE 0-40%
BARREN COUNTRY ROCK
CORE SCHISTOSITY.

DIAMOND DRILL BOREHOLE NO. 13

LOCATION

R.L. BEARING DIP OF HOLE

Depth From	To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
129	- 186	57	43	61.0	2.9	1.9	0.32	0.10	0.25	3.1	0.37
350	- 372	22	100	33.1	15.9	3.6	0.27	0.07	0.27	7.8	0.19
461	- 502	41	94	40.7	13.8	3.9	0.40	0.05	0.11	7.3	0.17
502	- 566	64	100	16.6	22.2	5.4	0.25	0.05	0.26	11.9	0.06
566	- 678.5	112.5	100	51.2	6.1	1.5	0.48	0.14	0.08	6.7	0.38
678.5	- 690	11.5	83	3.7)	22.0	4.4	0.67	0.14	0.20	5.8	0.19
690	- 708	18	95	43.1)							
708	- 741.5	33.5	83	5.8	44.7	12.5	0.94	0.08	0.09	0.6	0.07
741.5	- 816	74.5	100	49.7	5.0	1.2	0.83	0.15	0.24	7.9	0.32
816	- 1011	195	82	40.7	12.8	2.8	0.87	0.13	0.05	6.6	0.25

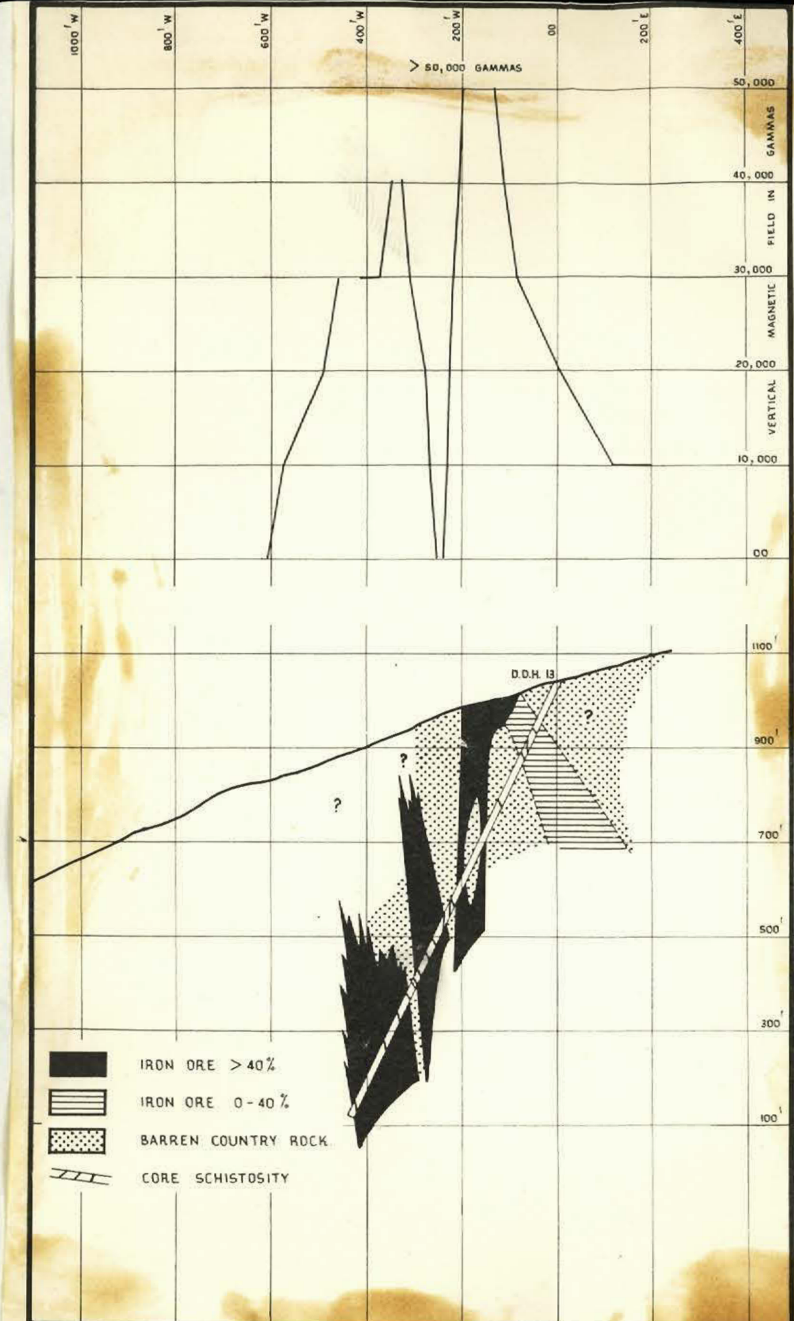
DIAMOND DRILL BOREHOLE NO. 14

LOCATION H1 - 00

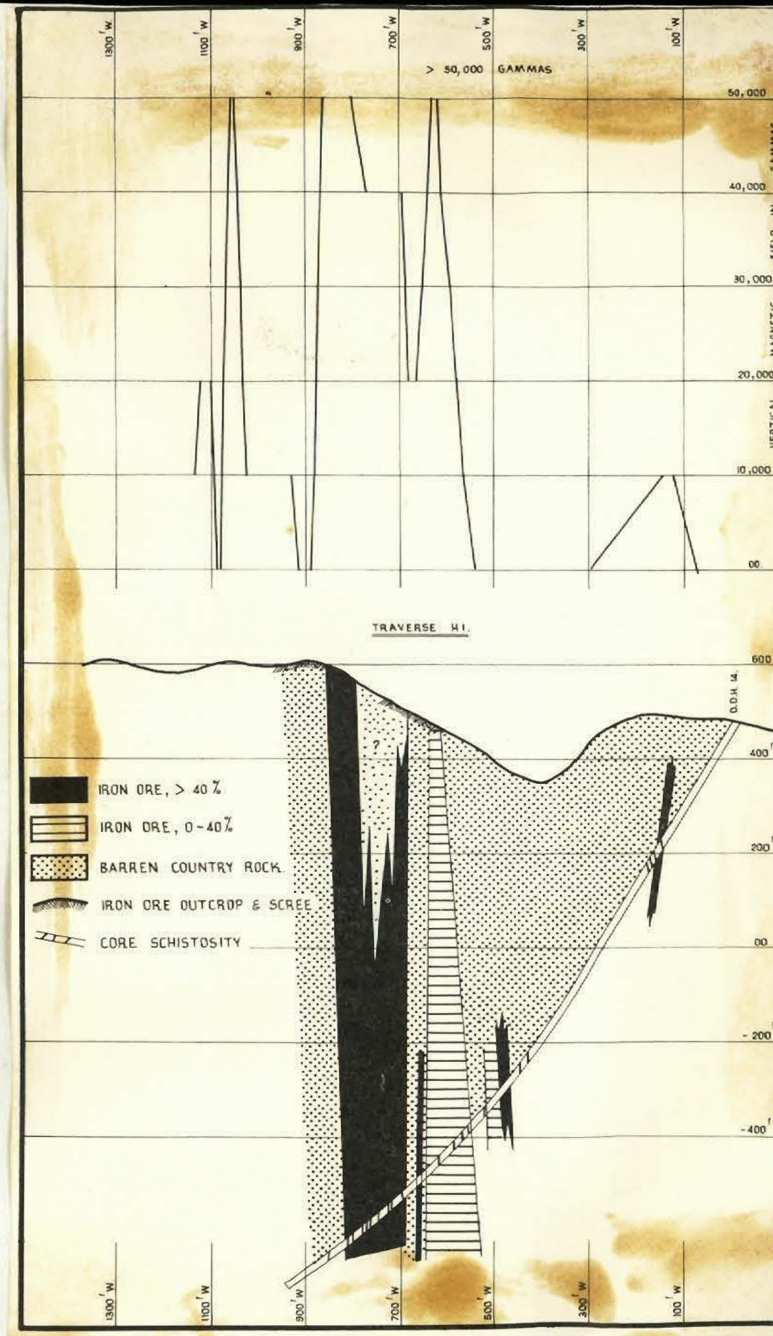
R.L. 475 ft. **BEARING** 274° **DIP OF HOLE.** 60°

From	Depth To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol.)	Si %	Al %	Ti %	Mn %	P %	S %	V %
50	59		22	52	2.3	1.1	0.37	0.07	.06	2.42	0.44
279	283'	3"	100	49.5	2.7	0.21	0.02	0.09	.06	3.19	0.02
291	300'	6"	100	50.6							
848	955		100	32.5	7.46	1.05	0.29	0.08	0.24	4.52	0.21
1004	1145		100	37.1	6.9	0.59	0.30	0.07	0.22	5.0	0.24
1145	1169		92	15.2	15.4	5.1	0.57	0.10	0.12	2.2	0.12
1210	1370		95	45	5.02	1.43	0.44	0.08	0.10	5.2	0.28

Borehole depth 1541 ft.



1000' W
800' W
600' W
400' W
200' W
00
200' E
400' E
> 50,000 GAMMAS
VERTICAL MAGNETIC FIELD IN GAMMAS
50,000
40,000
30,000
20,000
10,000
00
1100'
900'
700'
500'
300'
100'
D.D.H. 13
?
IRON ORE > 40%
IRON ORE 0-40%
BARREN COUNTRY ROCK
CORE SCHISTOSITY



1300' W
1100' W
900' W
700' W
500' W
300' W
100' W
> 50,000 GAMMAS
VERTICAL MAGNETIC FIELD IN GAMMAS
50,000
40,000
30,000
20,000
10,000
00
TRAVERSE H1.
600'
400'
200'
00
-200'
-400'
D.D.H. 14.
?
IRON ORE, > 40%
IRON ORE, 0-40%
BARREN COUNTRY ROCK
IRON ORE OUTCROP & SCREE
CORE SCHISTOSITY

DIAMOND DRILL BOREHOLE NO.15

LOCATION Traverse 2000S 70'E

R.L. 1030' BEARING 293° DIP OF HOLE 50°

Depth From	To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
173 -	261	88	93	23.7	20.5	4.0	0.45	0.09	1.19	5.9	0.15
261 -	286	25	100	32.6	11.1	3.2	0.25	0.06	1.23	7.3	0.16
286 -	325	39	99	35.8	20.1	1.2	0.14	0.05	0.58	6.1	0.18
325 -	415	90	78	56.4	3.8	1.3	0.24	0.08	0.14	5.1	0.41
421 -	435	14	46	28.3	17.1	3.4	0.63	0.06	0.11	8.3	0.15
540 -	708	168	93	32.5	10.7	3.3	0.58	0.10	0.08	5.0	0.34
721 -	725	4	86	48.3	9.0	2.1	1.08	0.04	Tr	6.8	0.31
732.5 -	734	1.5	86	53.7	7.0	2.0	1.14	0.07	Tr	5.3	0.35

DIAMOND DRILL BOREHOLE NO.16

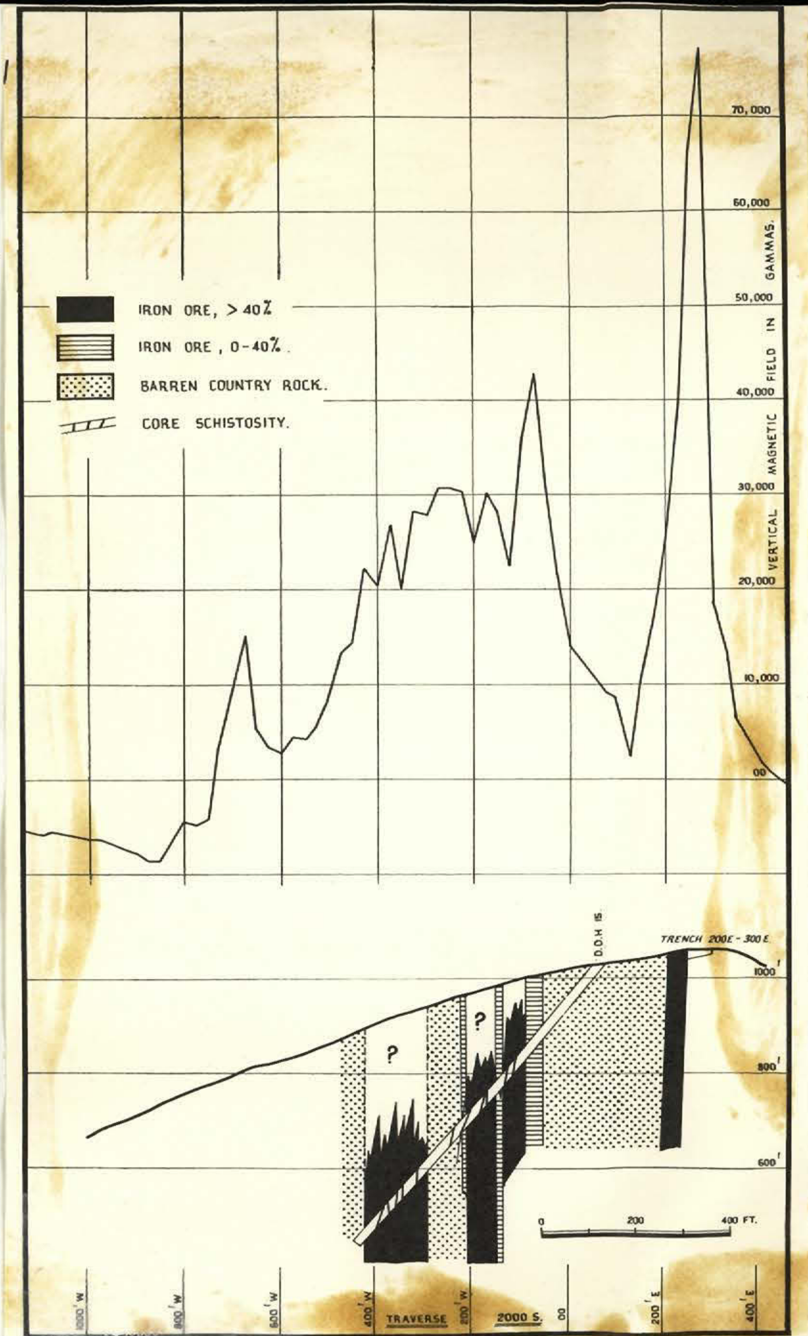
LOCATION Traverse 2500S, 66W

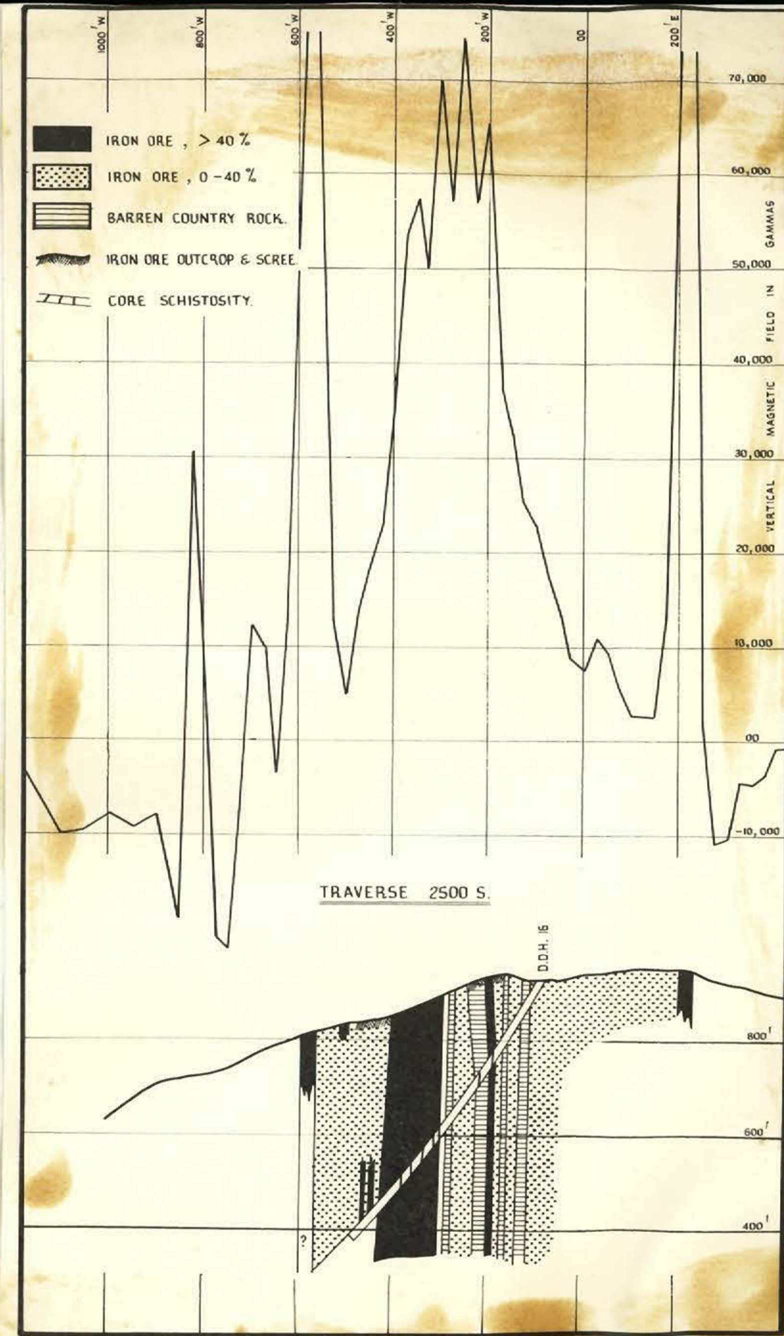
R.L. 940'

BEARING 289°

DIP OF HOLE. 60°
500' 57°
600' 57°
700' 56°

Depth From		Depth To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
80	-	117	37	40	18.3	17.6	2.8	0.20	0.05	1.03	15.4	0.05
176	-	190	14	20	29.6	21.8	3.1	0.65	0.07	0.45	5.5	0.16
215	-	291	76	63	30.0	17.8	3.1	0.34	0.09	0.22	5.2	0.17
380	-	398	18	100	28.5	22.3	6.5	0.84	0.09	0.16	3.6	0.21
418	-	494	76	90	36.4	15.9	3.1	0.42	0.08	0.12	2.9	0.25
494	-	617	123	86	54.9	4.5	1.1	0.45	0.11	0.13	5.7	0.37
640	-	653	13	77	47.9	11.1	3.1	1.19	0.12	0.02	6.12	0.31
669	-	673	4	75	44.6							


IRON ORE, > 40%
IRON ORE, 0-40%.
BARREN COUNTRY ROCK.
CORE SCHISTOSITY.
VERTICAL MAGNETIC FIELD IN GAMMAS.
70,000
60,000
50,000
40,000
30,000
20,000
10,000
00
D.D.H. 15
TRENCH 200E - 300E
1000'
800'
600'
0
200
400 FT.
1000' W
800' W
600' W
400' W
TRAVERSE 2000 S.
200' W
00
200' E
400' E


IRON ORE, > 40%
IRON ORE, 0-40%
BARREN COUNTRY ROCK.
IRON ORE OUTCROP & SCREE.
CORE SCHISTOSITY.
1000' W
800' W
600' W
400' W
200' W
00
200' E
70,000
60,000
50,000
40,000
30,000
20,000
10,000
00
-10,000
VERTICAL MAGNETIC FIELD IN GAMMAS
TRAVERSE 2500 S.
D.D.H. 16
800'
600'
400'

DIAMOND DRILL BOREHOLE NO.17

LOCATION D.7, W190'

R.L. 670' BEARING 270^{o} DIP OF HOLE . 67^{o}

Depth From		Depth To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
4	-	60	56	21	63			1.5		.01	0.3	
70	-	79	9	-	63.4			1.6		.02	0.3	
120	-	183	63	73	50			1.3		.02	0.9	
183	-	203	20	88	19.7							
203	-	215	12	90	5							

Bore depth = 215 ft.

DIAMOND DRILL BOREHOLE NO. 18

LOCATION, TRAV. C28A, W100'

R.L. 510'

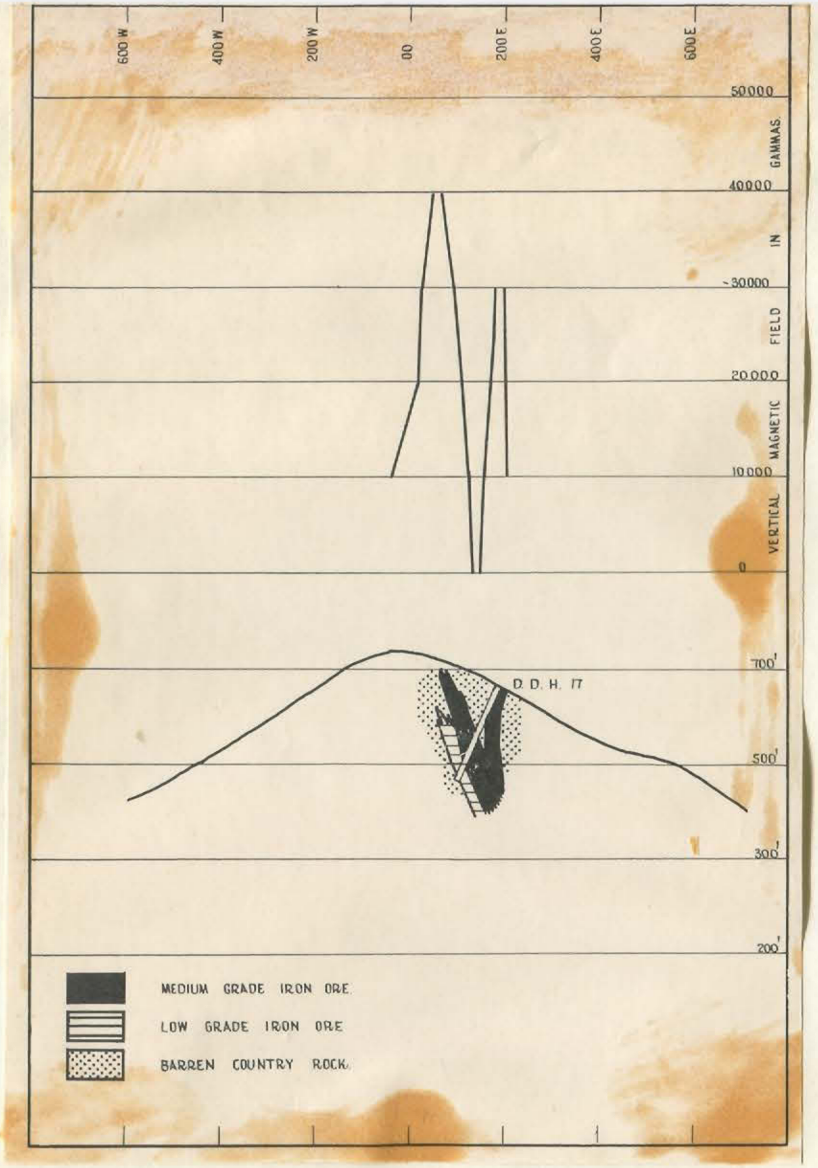
BEARING 270°

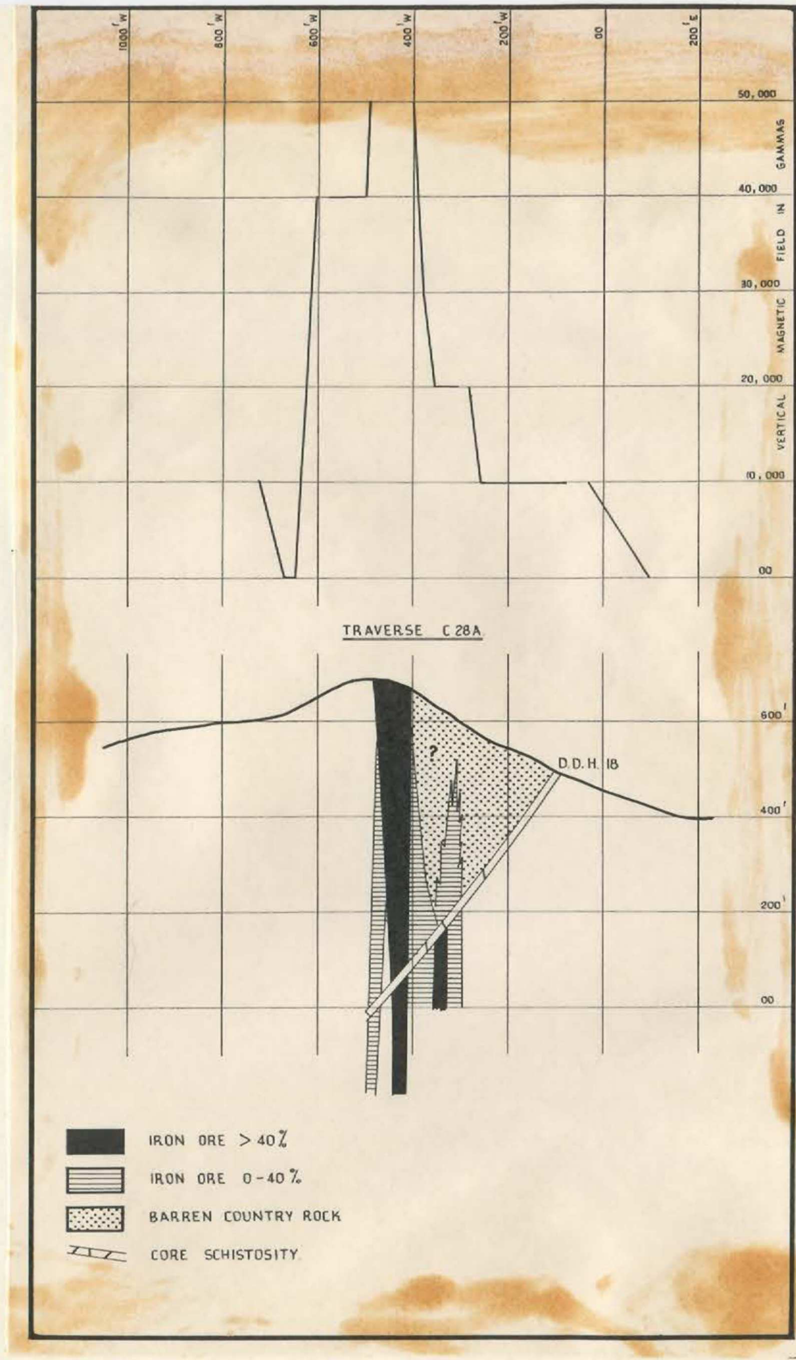
DIP OF HOLE.

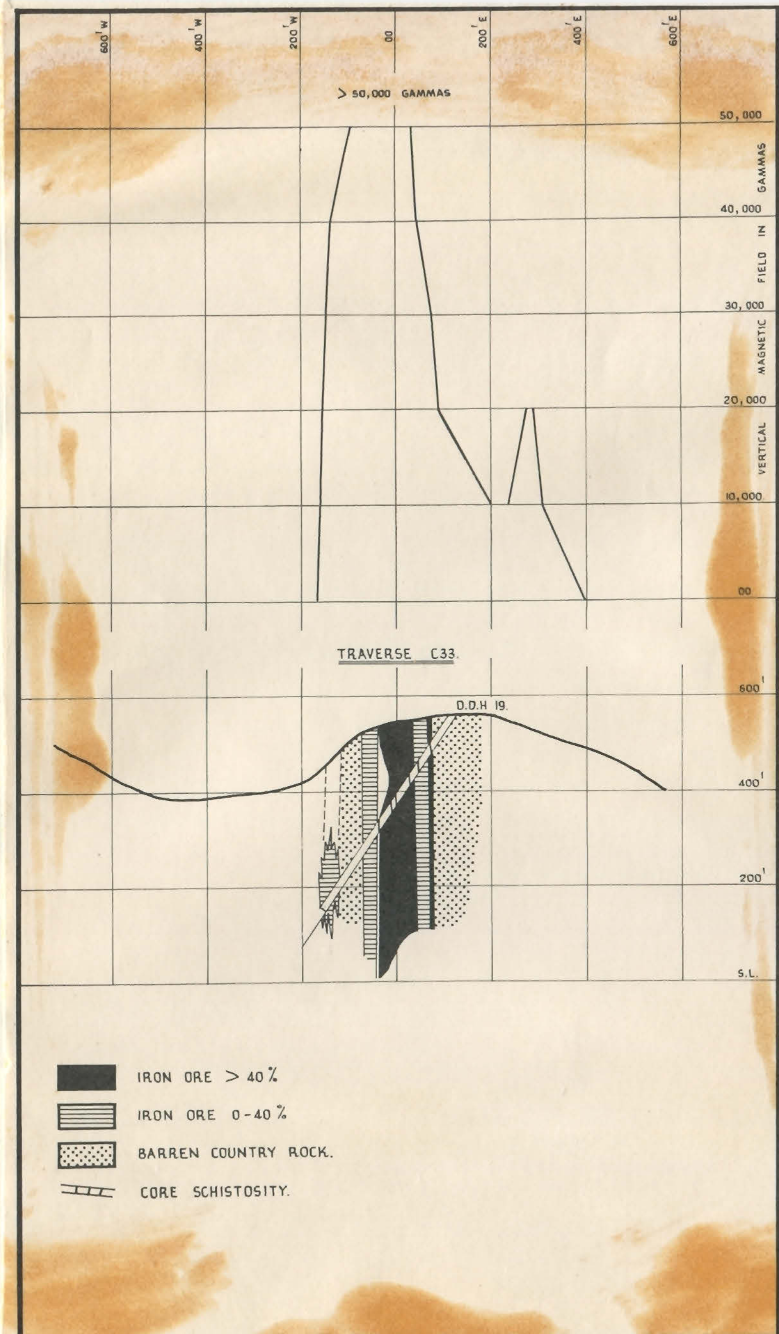
0 - 100' = 55°
200' = 53°
400' = 51°
600' = 49°

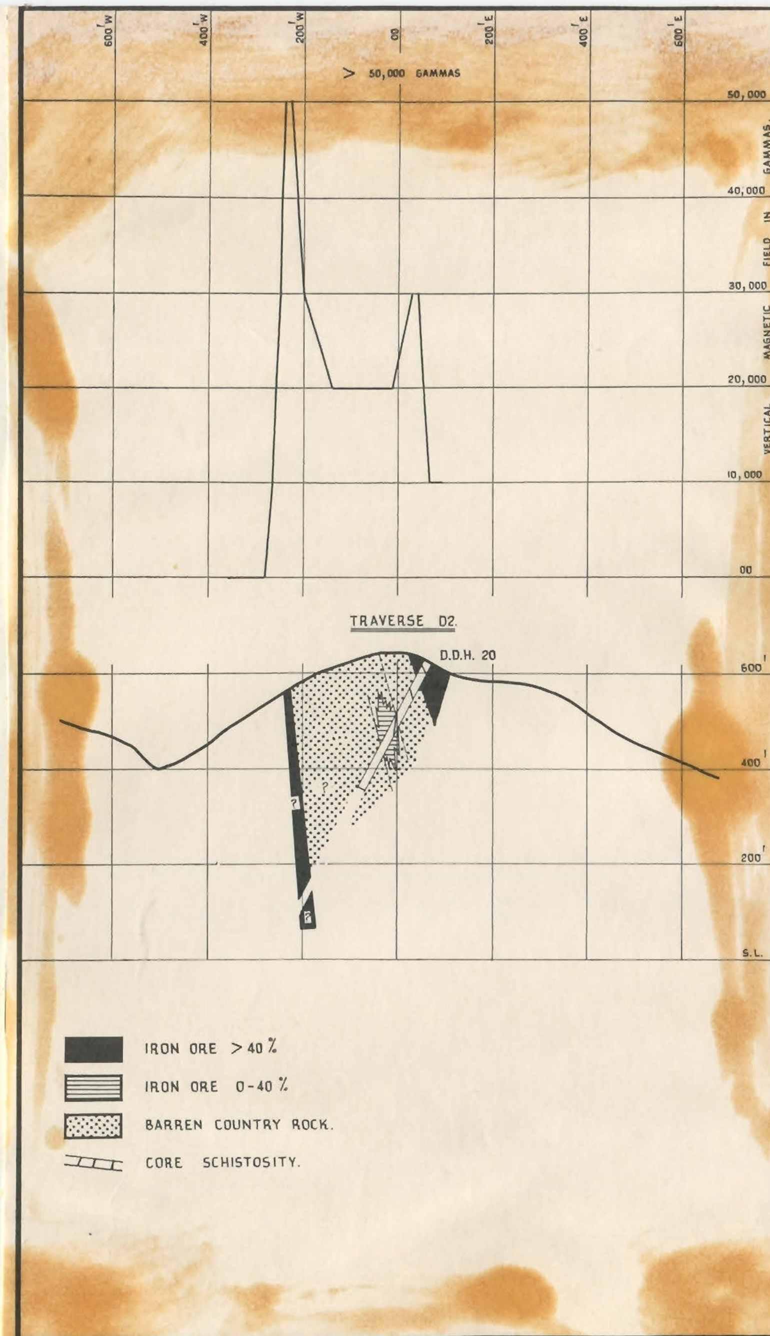
Depth From	To	Inter-Section Feet	Core Recovery %	Fe (HC1 Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
257	- 262	5	100	27.6			0.3		1.4	9.6	0.14
325	- 382	57	93	25.0			0.3		0.2	3.8	0.09
382	- 426	44	100	43.0			0.3		0.46	8.1	0.27
426	- 507	81	100	13.2			0.5		0.3	7.5	0.19
507	- 557	50	88	45			0.6		0.09	8.9	0.26
557	- 562	5	100	20			0.3		0.2	15.3	0.10

Bore depth = 634 ft.


600 W
400 W
200 W
00
200 E
400 E
600 E
50000
40000
-30000
20000
10000
0
VERTICAL MAGNETIC FIELD IN GAMMAS
700'
500'
300'
200'
D. D. H. 17
MEDIUM GRADE IRON ORE
LOW GRADE IRON ORE
BARREN COUNTRY ROCK.


1000' W
800' W
600' W
400' W
200' W
00
200' E
50, 000
40, 000
30, 000
20, 000
10, 000
00
VERTICAL MAGNETIC FIELD IN GAMMAS
TRAVERSE C 28A
600'
400'
200'
00
D.D.H. 18
?
IRON ORE > 40%
IRON ORE 0-40 %
BARREN COUNTRY ROCK
CORE SCHISTOSITY.


600' W
400' W
200' W
00
200' E
400' E
600' E
> 50,000 GAMMAS
50,000
40,000
30,000
20,000
10,000
00
VERTICAL MAGNETIC FIELD IN GAMMAS
TRAVERSE C33.
D.D.H 19.
600'
400'
200'
S.L.
IRON ORE > 40 %
IRON ORE 0 - 40 %
BARREN COUNTRY ROCK.
CORE SCHISTOSITY.


600' W
400' W
200' W
00
200' E
400' E
600' E
> 50,000 GAMMAS
50,000
40,000
30,000
20,000
10,000
00
VERTICAL MAGNETIC FIELD IN GAMMAS.
TRAVERSE D2.
D.D.H. 20
600'
400'
200'
S.L.
IRON ORE > 40 %
IRON ORE 0 - 40 %
BARREN COUNTRY ROCK.
CORE SCHISTOSITY.

DIAMOND DRILL BOREHOLE NO .19

LOCATION. TRAV C33. E 100'

R.L. 530' **BEARING** 270 **DIP OF HOLE.** 0 - 100' = 60°
200' = 56°
300' = 55°
400' = 54°
490' = 53°

Depth From	To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
67 -	81	14	70	47.3			0.51		0.56	7.1	
87' 8" -	101' 8"	14	99	30.7			0.39		0.03	10.2	
106' 8" -	114' 8"	8	100	35.9			0.55		0.04	7.9	
140' 6" -	278'	138	97	43.0			0.68		0.09	8.4	
87' 8" -	140'6"	53	100	20							
278 -	335	57	85	10							
427 -	489	62	65	15							

Bore depth = 492 ft.

DIAMOND DRILL BOREHOLE NO. 20

LOCATION TRAV D2. E 60'

R.L. 610'

BEARING 270°

DIP OF HOLE. 0 - 200' = 63° 298' = 62°

Depth From		To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
0	-	30'6"	30'6"	± 30	63			0.5		0.55	0.06	
116	-	117'3"	1'3"		45			0.48		.02	6.0	
121	-	140	19'	95	40			0.36		0.9	5.7	
140	-	195	55'	69	22			-		-	-	
121	-	195	74'	75	27			0.30		0.75	5.5	

Bore depth = 298 ft.

DIAMOND DRILL BOREHOLE NO. 24

LOCATION TRAV.B08)E 20'
)S 79'

R.L. 1125 BEARING Vertical DIP OF HOLE. Vertical

Depth From	Depth To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	Ti %	Mn %	P %	S %	V %
0 -	73	73	94	55.5			0.15		0.14	0.47	

Bore depth = 73 ft.

DIAMOND DRILL BOREHOLE NO. 25

LOCATION TRAV 18D. E 460'; S 20'

R.L. 710' BEARING 270° DIP OF HOLE. 0 - 500' = 65°; 600' = 64°; 700' = 64°

Depth From	To	Inter-Section Feet	Core Recovery %	Fe (HCl Sol).	SiO_2 %	Al_2O_3	Ti %	Mn %	P %	S %	V %
0 -	19'6"	19'6"	56	60.8							
19'6" -	310'9"	291'3"	71	9.48							
0 -	85						0.53		.09	0.93	
142'6" -	169'6"						0.16		0.17	2.68	
215'6" -	258'						0.42		0.12	0.97	
310'9" -	336'	25'3"	96	56.2			1.53		Nil	0.31	
641 -	646'6"	5'6"	80	32.8							
661 -	662			27.0							
682 -	684			33.7							
731 -	733			21.6							

Bore depth = 749 ft.

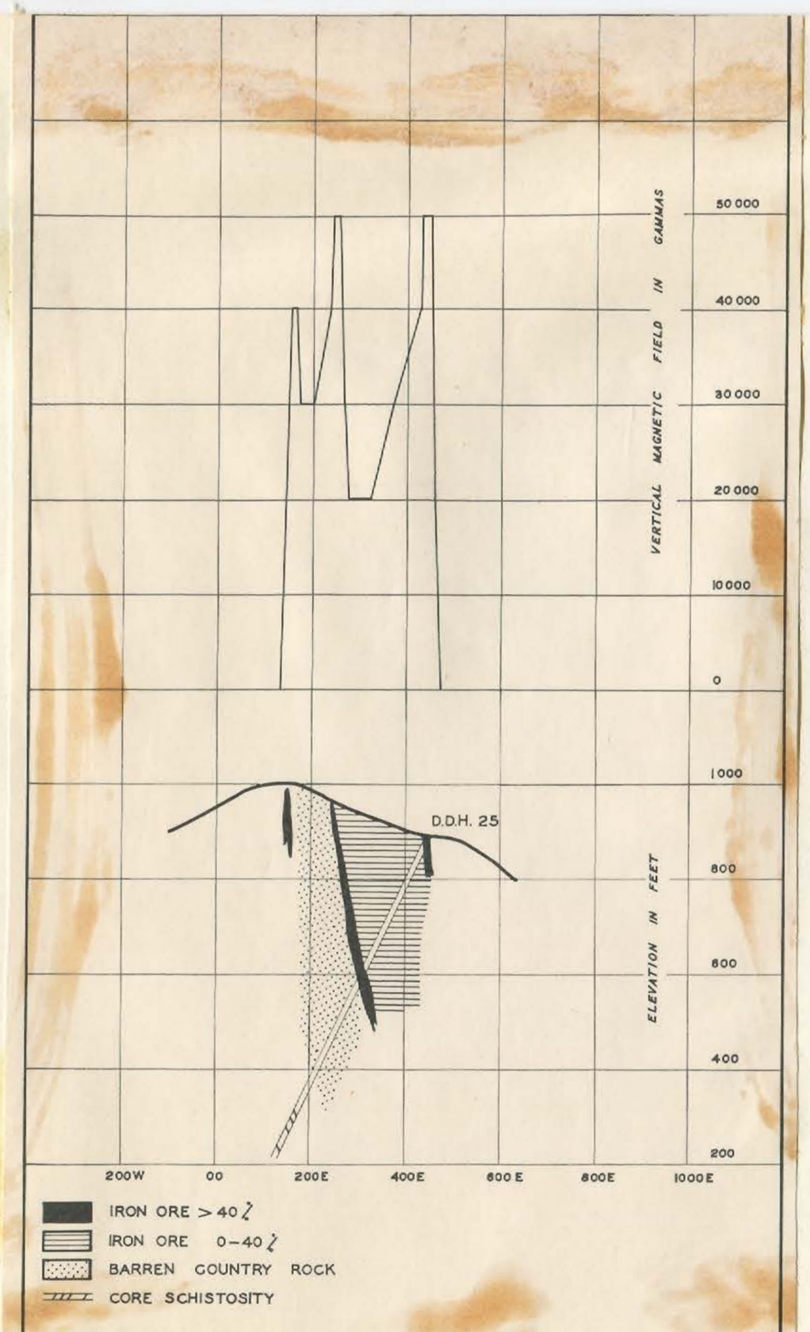
DIAMOND DRILL BOREHOLE NO. RTAE1

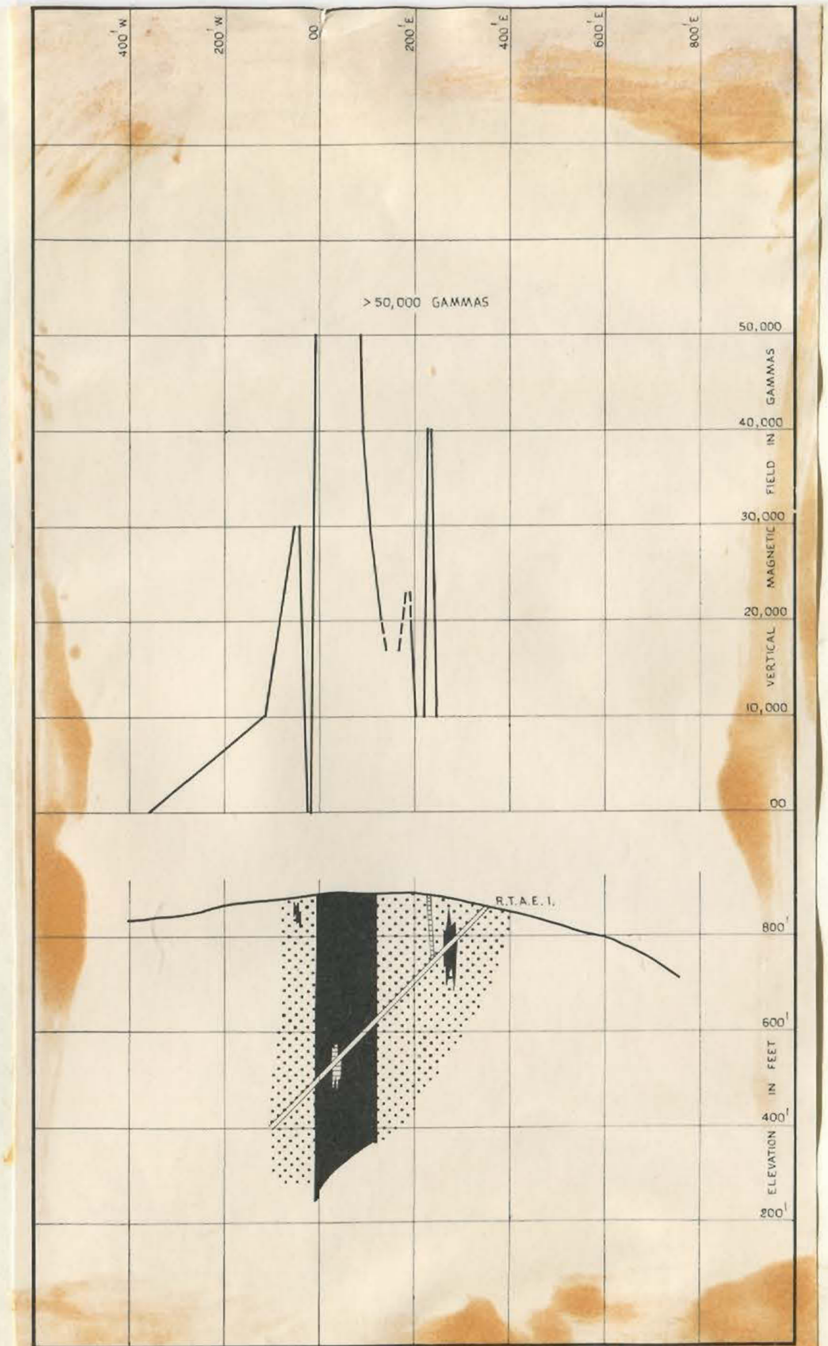
LOCATION: Long Plains South

R.L. 905 ft. **BEARING:** West **DIP OF HOLE.** 45°

Depth From	Depth To	Inter-Section Feet	Core Recovery	Fe (HCl Sol).	SiO_2 %	Al_2O_3 %	TiO_2 %	Mn %	P_2O_5 %	S %	V %
79	116		50	56.6	6.07		1.54	0.09	0.08	1.64	
315' 3"	498		53	49.1	7.57		0.95	0.06	0.07	7.64	

Borehole depth = 639 ft.


VERTICAL MAGNETIC FIELD IN GAMMAS
50 000
40 000
30 000
20 000
10 000
0
1000
800
600
400
200
ELEVATION IN FEET
D.D.H. 25
200W
00
200E
400E
600 E
800E
1000E
IRON ORE > 40 %
IRON ORE 0–40 %
BARREN COUNTRY ROCK
CORE SCHISTOSITY


400' W
200' W
00
200' E
400' E
600' E
800' E
> 50,000 GAMMAS
50,000
40,000
30,000
20,000
10,000
00
VERTICAL MAGNETIC FIELD IN GAMMAS
R.T.A.E. 1.
800'
600'
400'
200'
ELEVATION IN FEET

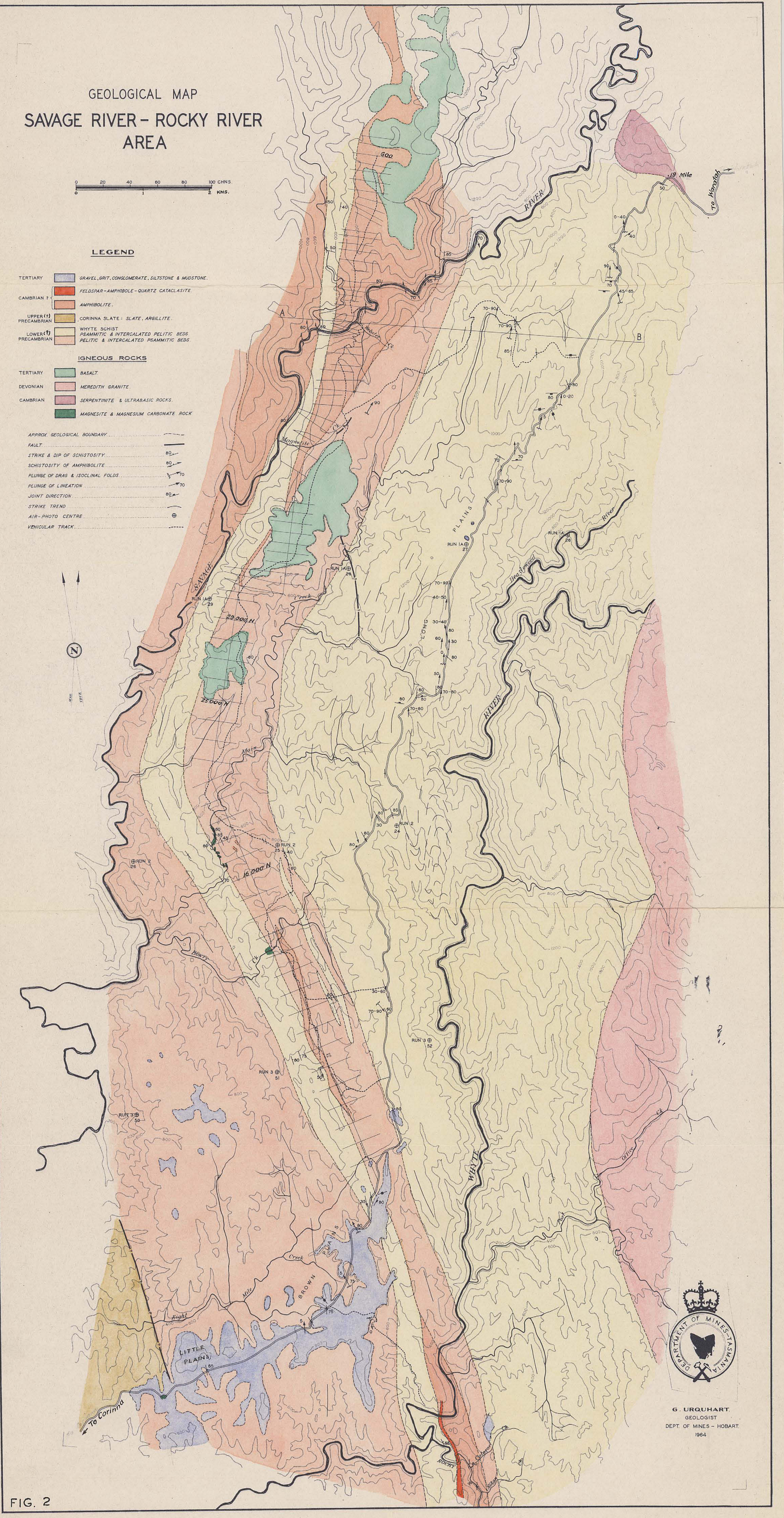

GEOLOGICAL MAP
SAVAGE RIVER - ROCKY RIVER AREA
0 20 40 60 80 100 CHNS.
0 1 2 KMS.
LEGEND
TERTIARY
GRAVEL, GRIT, CONGLOMERATE, SILTSTONE & MUDSTONE.
CAMBRIAN ?
FELDSPAR-AMPHIBOLE-QUARTZ CATACLASITE.
AMPHIBOLITE.
UPPER (?) PRECAMBRIAN
CORINNA SLATE: SLATE, ARGILLITE.
LOWER (?) PRECAMBRIAN
WHYTE SCHIST
PSAMMITIC & INTERCALATED PELITIC BEDS.
PELITIC & INTERCALATED PSAMMITIC BEDS.
IGNEOUS ROCKS
TERTIARY
BASALT.
DEVONIAN
MEREDITH GRANITE.
CAMBRIAN
SERPENTINITE & ULTRABASIC ROCKS.
MAGNESITE & MAGNESIUM CARBONATE ROCK
APPROX. GEOLOGICAL BOUNDARY
FAULT
STRIKE & DIP OF SCHISTOSITY
SCHISTOSITY OF AMPHIBOLITE
PLUNGE OF DRAG & ISOCLINAL FOLDS
PLUNGE OF LINEATION
JOINT DIRECTION
STRIKE TREND
AIR-PHOTO CENTRE
VEHICULAR TRACK
N
SAVAGE RIVER
19 Mile
To Waratah
LONG PLAINS
WHYTE RIVER
LITTLE PLAINS
BROWN PLAINS
To Corinna
ROCKY
29,000 N
25,000 N
16,000 N
A
B
DEPARTMENT OF MINES - TASMANIA
G. URQUHART.
GEOLOGIST
DEPT. OF MINES - HOBART.
1964

FIG. 2

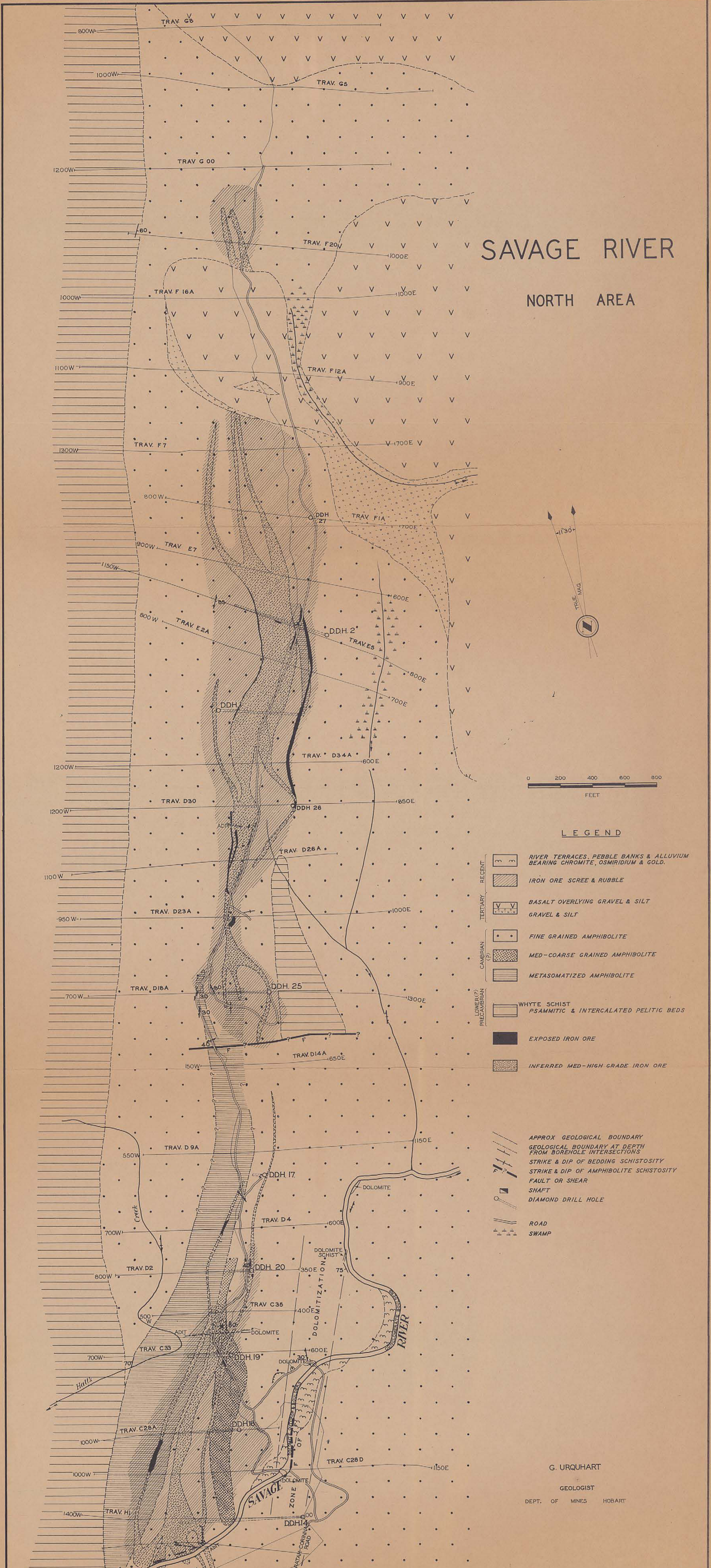
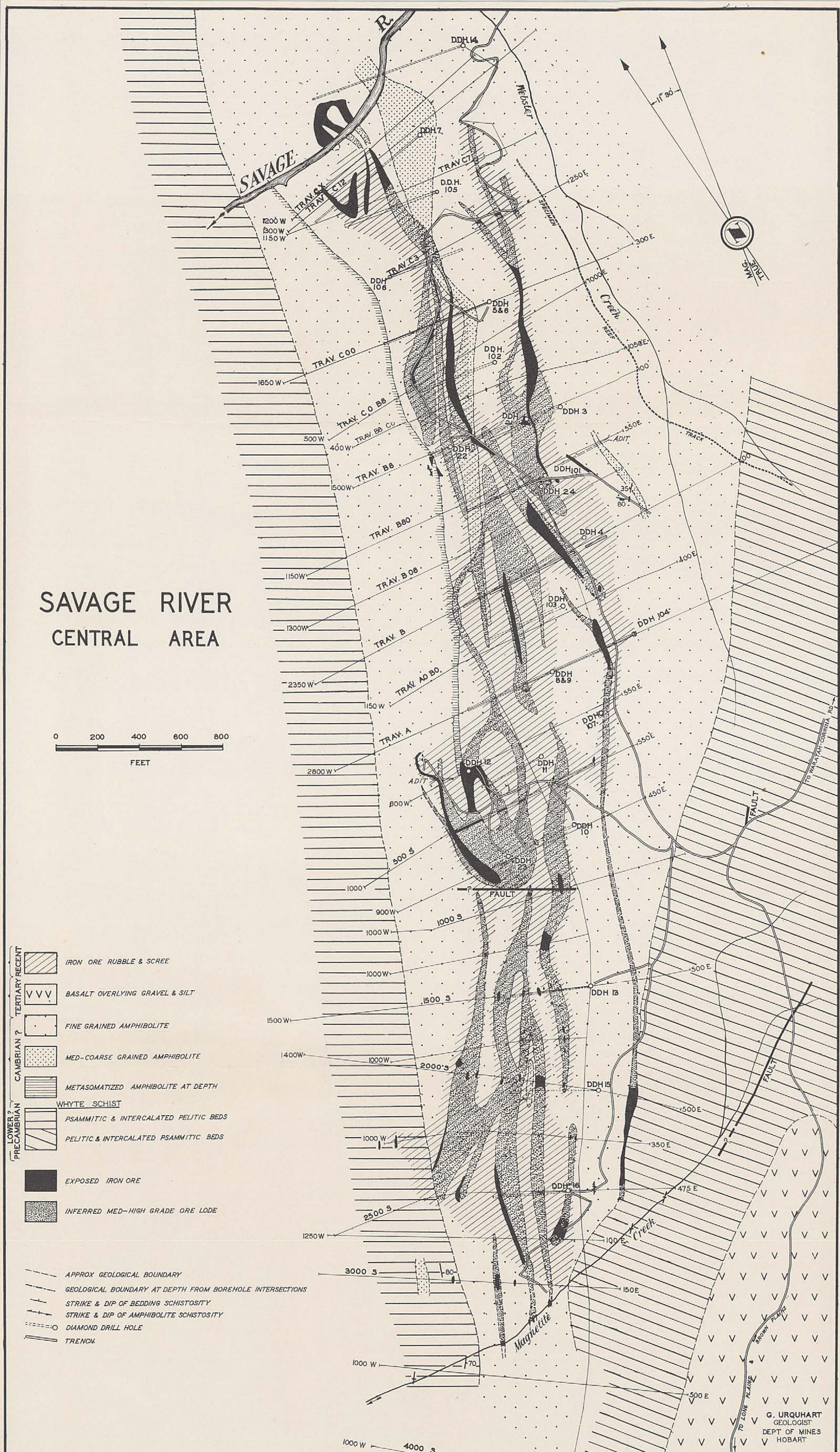

SAVAGE RIVER
NORTH AREA
TRUE
MAG
11°30'
0 200 400 600 800
FEET
LEGEND
RECENT
RIVER TERRACES, PEBBLE BANKS & ALLUVIUM BEARING CHROMITE, OSMIRIDIUM & GOLD.
IRON ORE SCREE & RUBBLE
TERTIARY
BASALT OVERLYING GRAVEL & SILT
GRAVEL & SILT
CAMBRIAN (?)
FINE GRAINED AMPHIBOLITE
MED-COARSE GRAINED AMPHIBOLITE
METASOMATIZED AMPHIBOLITE
LOWER (?) PRECAMBRIAN
WHYTE SCHIST
PSAMMITIC & INTERCALATED PELITIC BEDS
EXPOSED IRON ORE
INFERRED MED-HIGH GRADE IRON ORE
APPROX GEOLOGICAL BOUNDARY
GEOLOGICAL BOUNDARY AT DEPTH FROM BOREHOLE INTERSECTIONS
STRIKE & DIP OF BEDDING SCHISTOSITY
STRIKE & DIP OF AMPHIBOLITE SCHISTOSITY
FAULT OR SHEAR
SHAFT
DIAMOND DRILL HOLE
ROAD
SWAMP
G. URQUHART
GEOLOGIST
DEPT. OF MINES HOBART
TRAV. G8
TRAV. G5
TRAV. G 00
TRAV. F20
TRAV. F 16A
TRAV. F12A
TRAV. F7
TRAV. F1A
TRAV. E7
TRAV. E2A
TRAV. E5
TRAV. D34A
TRAV. D30
TRAV. D26A
TRAV. D23A
TRAV. D18A
TRAV. D14A
TRAV. D9A
TRAV. D4
TRAV. D2
TRAV. C35
TRAV. C33
TRAV. C28A
TRAV. C28D
TRAV. H1
TRAV. CX
DDH 27
D.D.H. 2
DDH 1
DDH 28
DDH. 25
DDH. 17
DDH. 20
DDH. 19
DDH. 16
DDH 14
ADIT
DOLOMITE
DOLOMITE SCHIST
DOLOMITIZATION
ZONE OF
SAVAGE
RIVER
Halls
Creek
TOWNWATAH-CORINNA ROAD

FIG. 3



SAVAGE RIVER
CENTRAL AREA
0 200 400 600 800
FEET
TERTIARY RECENT
IRON ORE RUBBLE & SCREE
BASALT OVERLYING GRAVEL & SILT
CAMBRIAN ?
FINE GRAINED AMPHIBOLITE
MED-COARSE GRAINED AMPHIBOLITE
METASOMATIZED AMPHIBOLITE AT DEPTH
LOWER ? PRECAMBRIAN
WHYTE SCHIST
PSAMMITIC & INTERCALATED PELITIC BEDS
PELITIC & INTERCALATED PSAMMITIC BEDS
EXPOSED IRON ORE
INFERRED MED-HIGH GRADE ORE LODE
APPROX GEOLOGICAL BOUNDARY
GEOLOGICAL BOUNDARY AT DEPTH FROM BOREHOLE INTERSECTIONS
STRIKE & DIP OF BEDDING SCHISTOSITY
STRIKE & DIP OF AMPHIBOLITE SCHISTOSITY
DIAMOND DRILL HOLE
TRENCH
SAVAGE R.
Webster Creek
Magnetite Creek
TRAV. C00
TRAV. C.0 B8
TRAV. B8
TRAV. B80'
TRAV. B 08
TRAV. B
TRAV. A0 B0.
TRAV. A
TRAV. C3
TRAV. C7
TRAV. C12
DDH 14
DDH 7
D.D.H. 105
DDH 106
DDH 5&6
DDH 102
DDH 3
DDH 22
DDH 101
DDH 24
DDH 4
DDH 103
DDH 104
DDH 8&9
DDH 107
DDH 12
DDH 11
DDH 10
DDH 23
DDH 13
DDH 15
DDH 16
ADIT
TRACK
FAULT
TO WARATAH-CORINNA RD.
TO LONS PLAINS
BROWN PLAINS
MAG.
TRUE
11° 30'
G. URQUHART
GEOLOGIST
DEPT OF MINES
HOBART

FIG. 4

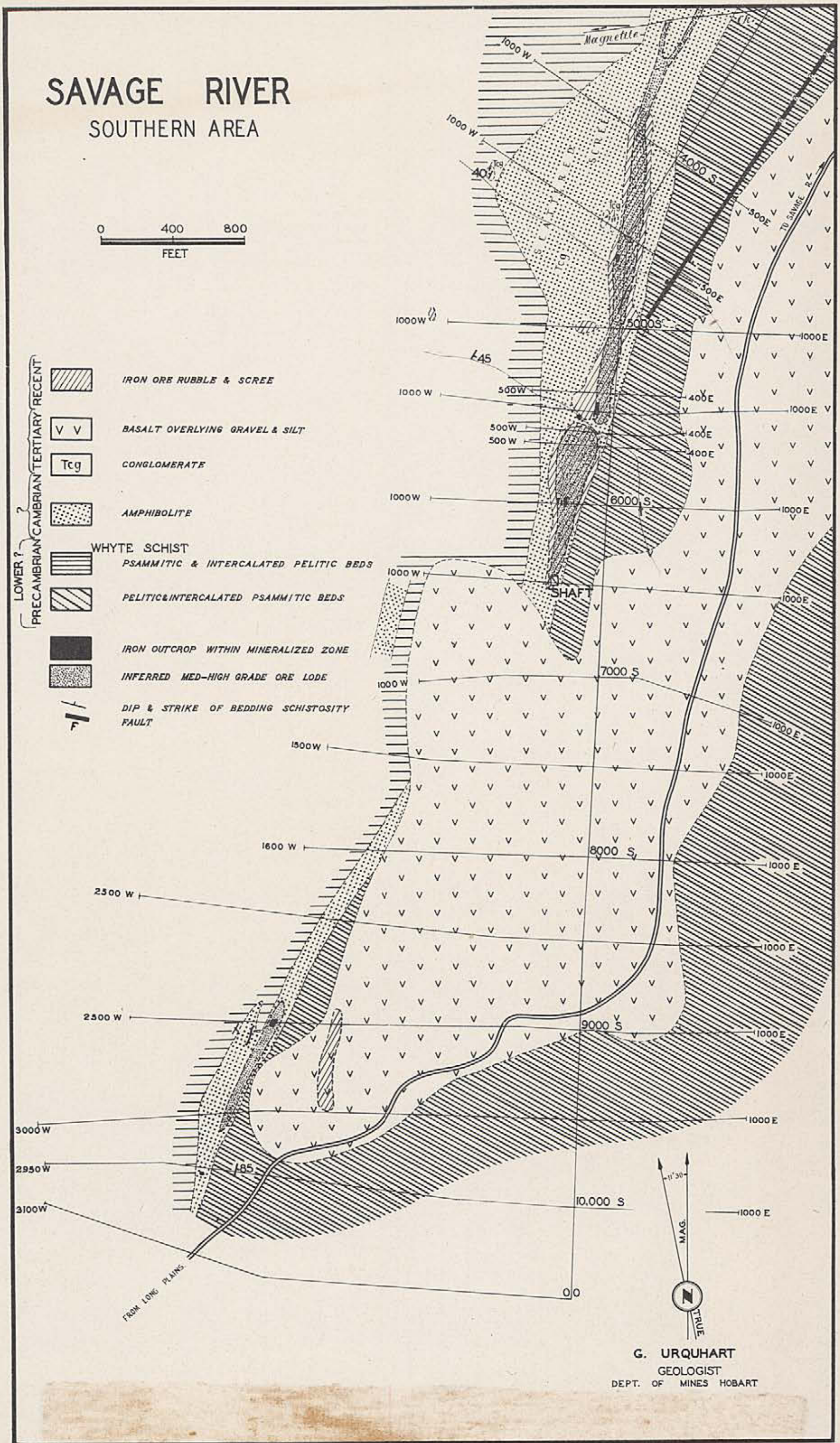

SAVAGE RIVER
SOUTHERN AREA
0 400 800
FEET
LOWER ? PRECAMBRIAN
CAMBRIAN
TERTIARY
RECENT
IRON ORE RUBBLE & SCREE
BASALT OVERLYING GRAVEL & SILT
Tcg
CONGLOMERATE
AMPHIBOLITE
WHYTE SCHIST
PSAMMITIC & INTERCALATED PELITIC BEDS
PELITIC & INTERCALATED PSAMMITIC BEDS
IRON OUTCROP WITHIN MINERALIZED ZONE
INFERRED MED-HIGH GRADE ORE LODE
DIP & STRIKE OF BEDDING SCHISTOSITY
FAULT
Magnetite
4000 S
5000 S
6000 S
7000 S
8000 S
9000 S
10,000 S
SHAFT
TO SAVAGE R.
FROM LONG PLAINS
MAG.
TRUE
N
0|0
G. URQUHART
GEOLOGIST
DEPT. OF MINES HOBART

FIG. 5

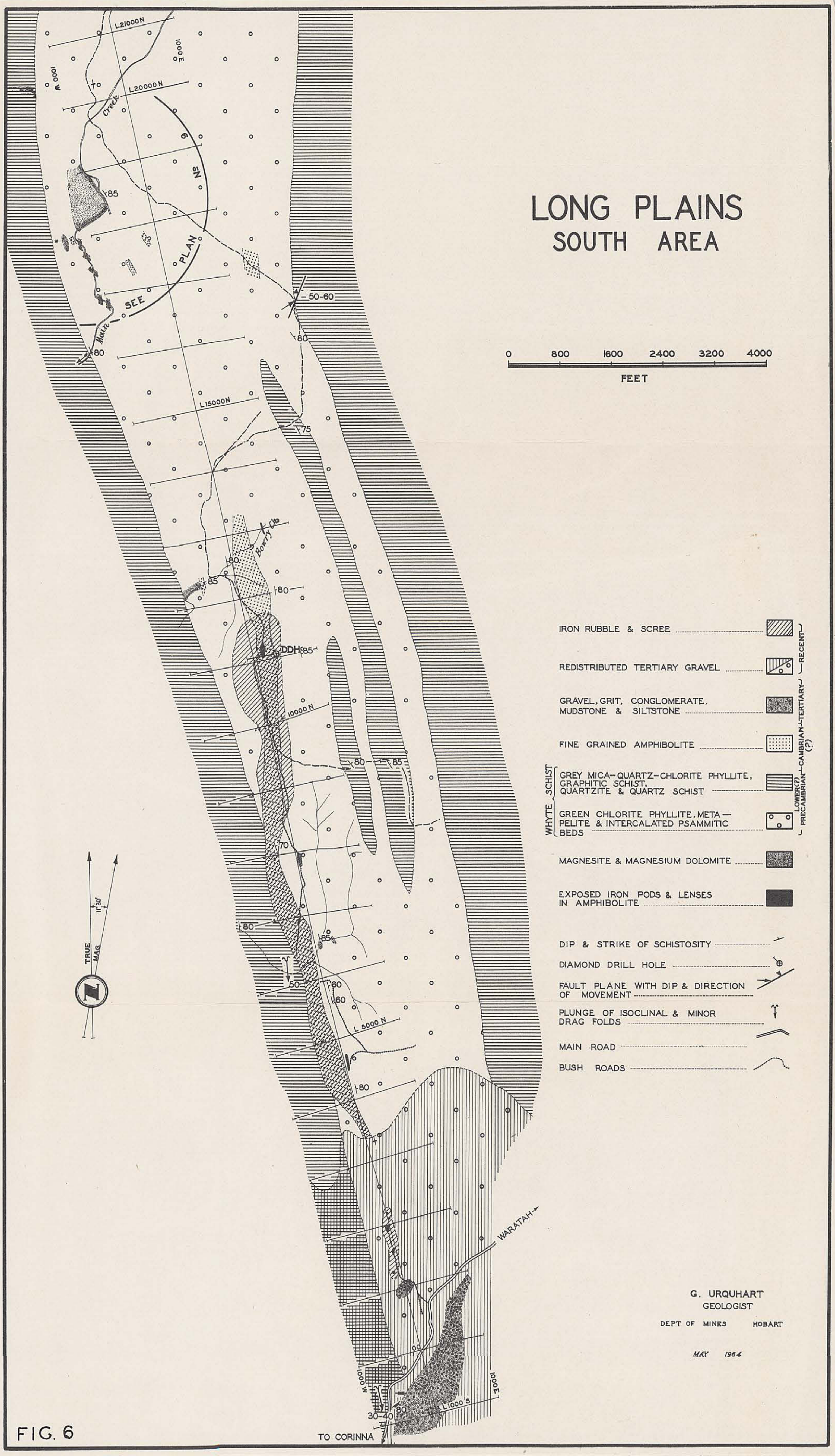

LONG PLAINS
SOUTH AREA
0 800 1600 2400 3200 4000
FEET
L21000N
L20000N
L15000N
10000 N
L 5000 N
L1000 S
1000 E
1000 W
SEE PLAN Nº 9
Main Creek
Bowry Ck.
DDH
WARATAH
TO CORINNA
TRUE
MAG
11° 30'
IRON RUBBLE & SCREE
REDISTRIBUTED TERTIARY GRAVEL
RECENT
GRAVEL, GRIT, CONGLOMERATE, MUDSTONE & SILTSTONE
TERTIARY
FINE GRAINED AMPHIBOLITE
CAMBRIAN (?)
WHYTE SCHIST
GREY MICA–QUARTZ–CHLORITE PHYLLITE, GRAPHITIC SCHIST, QUARTZITE & QUARTZ SCHIST
GREEN CHLORITE PHYLLITE, META–PELITE & INTERCALATED PSAMMITIC BEDS
LOWER (?) PRECAMBRIAN
MAGNESITE & MAGNESIUM DOLOMITE
EXPOSED IRON PODS & LENSES IN AMPHIBOLITE
DIP & STRIKE OF SCHISTOSITY
DIAMOND DRILL HOLE
FAULT PLANE WITH DIP & DIRECTION OF MOVEMENT
PLUNGE OF ISOCLINAL & MINOR DRAG FOLDS
MAIN ROAD
BUSH ROADS
G. URQUHART
GEOLOGIST
DEPT OF MINES HOBART
MAY 1964

FIG. 6

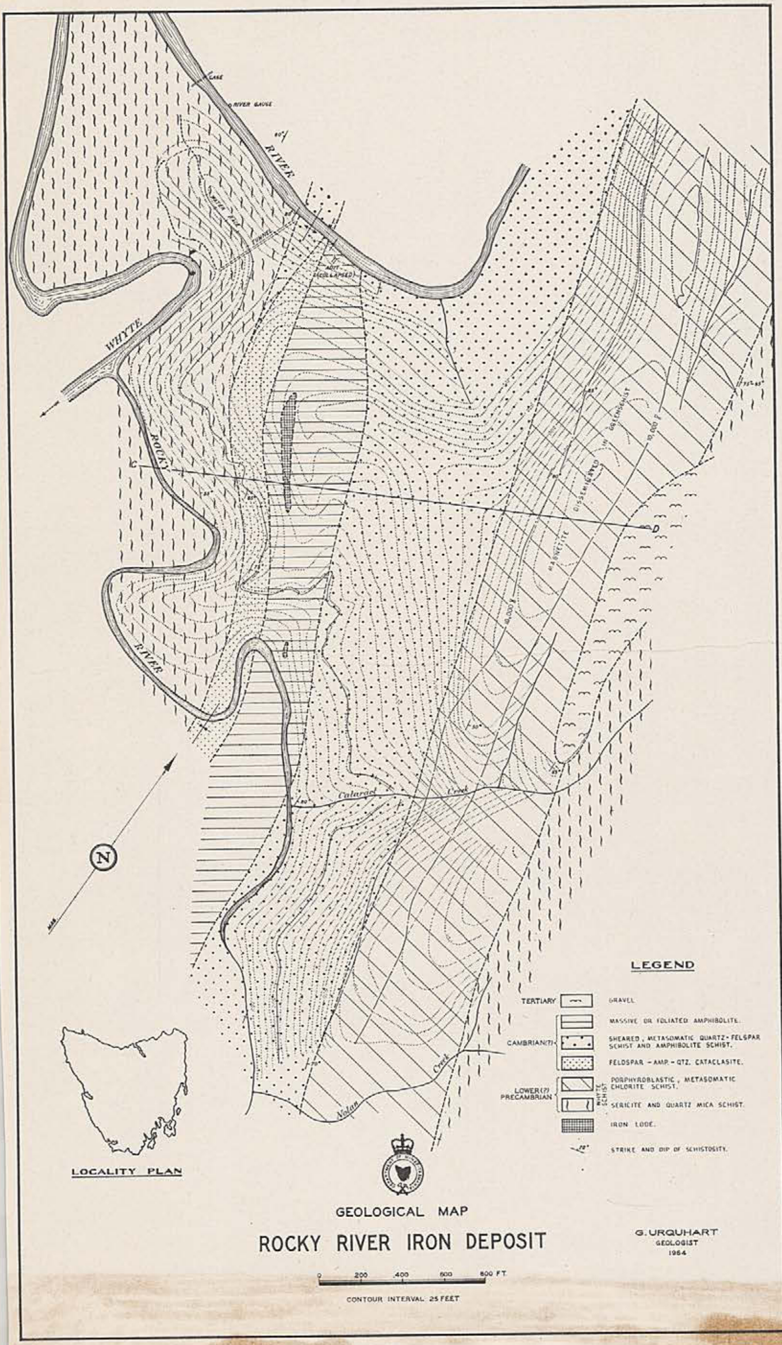
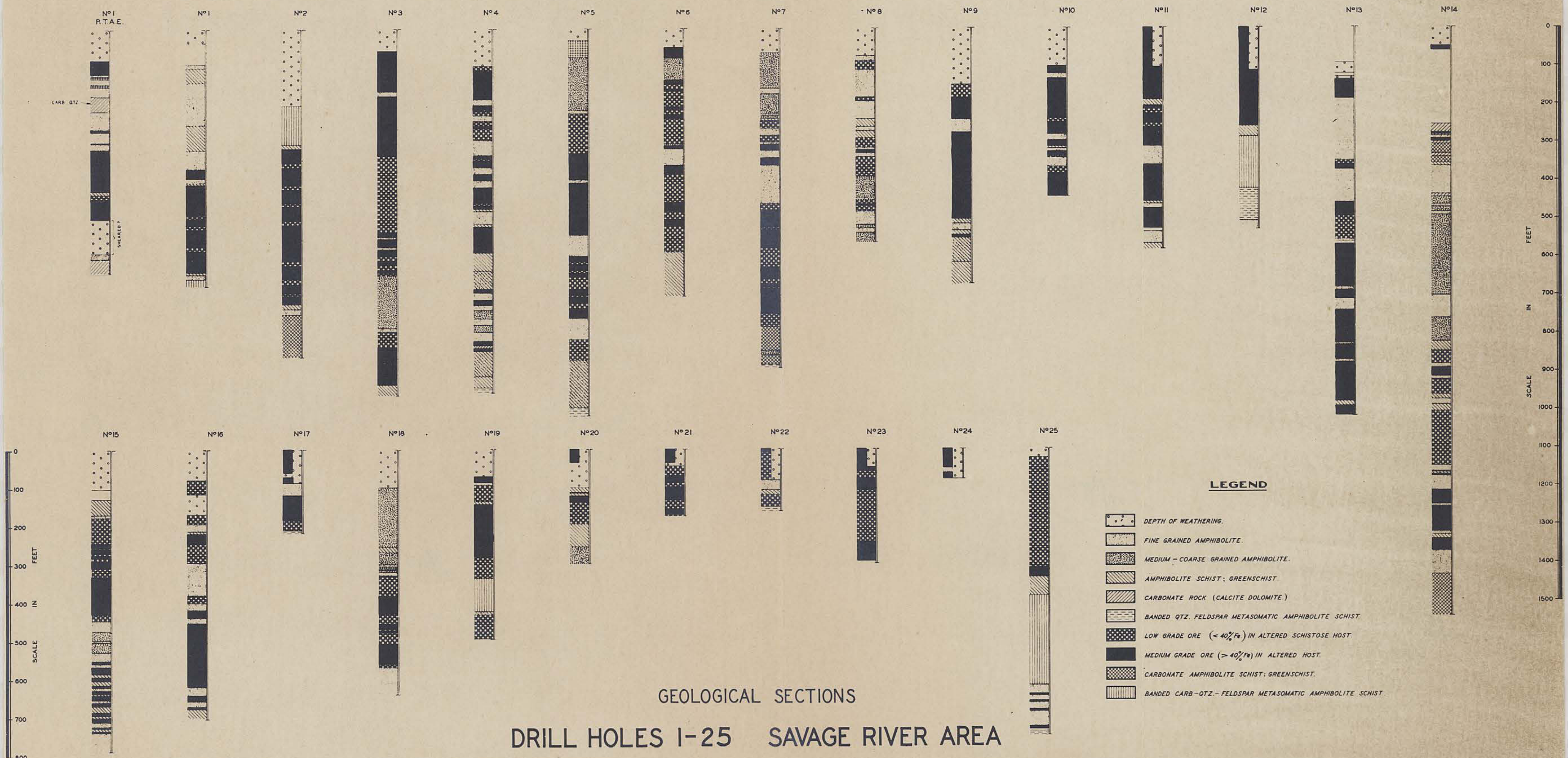

RIVER GAUGE
RIVER
WHYTE
ADIT (COLLAPSED)
ROCKY
RIVER
C
D
MAGNETITE
DISSEMINATED IN GREENSCHIST
Cataract
Creek
Nolan
Creek
N
LEGEND
TERTIARY
GRAVEL.
CAMBRIAN(?)
MASSIVE OR FOLIATED AMPHIBOLITE.
SHEARED, METASOMATIC QUARTZ-FELSPAR SCHIST AND AMPHIBOLITE SCHIST.
FELDSPAR - AMP. - QTZ. CATACLASITE.
LOWER(?) PRECAMBRIAN
WHYTE SCHIST
PORPHYROBLASTIC, METASOMATIC CHLORITE SCHIST.
SERICITE AND QUARTZ MICA SCHIST.
IRON LODE.
STRIKE AND DIP OF SCHISTOSITY.
LOCALITY PLAN
GEOLOGICAL MAP
ROCKY RIVER IRON DEPOSIT
G. URQUHART
GEOLOGIST
1964
0 200 400 600 800 FT
CONTOUR INTERVAL 25 FEET

FIG. 7



GEOLOGICAL SECTIONS

DRILL HOLES 1-25 SAVAGE RIVER AREA

G. URQUHART
GEOLOGIST
DEPT. OF MINES – HOBART

1964

FIG. 19