GEOLOGY OF THE AMM GOLD MINE, CADILLAC TOWNSHIP, QUEBEC

(A Thesis submitted in Partial Fulfillment of the requirements for the Degree of Master of Science).

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May, 1939.

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A C K N O W L E D G M E N T S

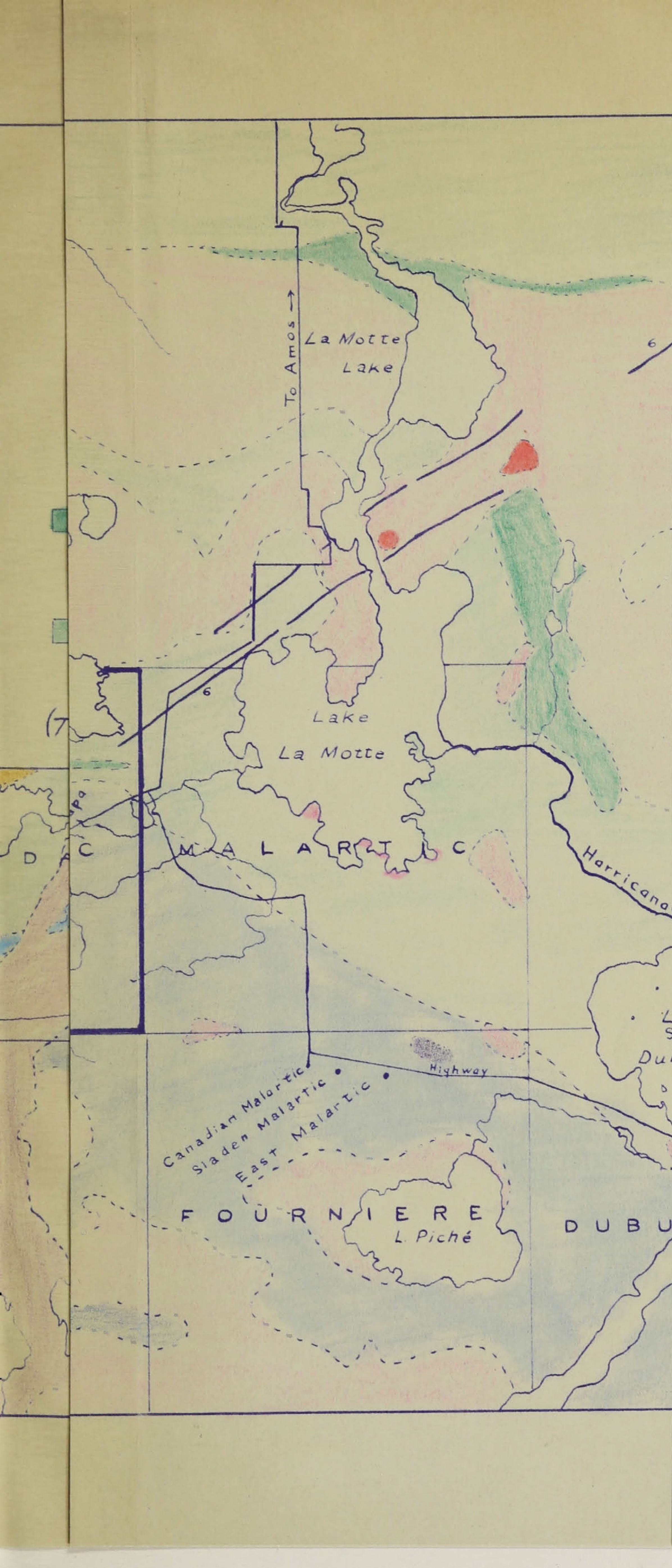
The writer wishes to acknowledge the helpful criticism and advice received from Dr. J. E. Gill of the Department of Geological Sciences, McGill University, under whose supervision this Thesis was written, and to extend his thanks to Mr. George E. Smith, Superintendent of the Amm Gold Mine, through whose co-operation it was possible to carry out the investigations and to include maps of the property.

INTRODUCTION

The property of Amm Gold Mines Limited comprises a group of seven claims in Cadillac Township, Abitibi County, Quebec. The group occupies a position near the north-south centre-line of Cadillac Township between the Noranda-Valdor high - way and the Noranda-Valdor branch of the Canadian National Railways. The claims are numbered A-584, A-585 and A-58821 to A-58825 inclusive, and have a combined area of about 370 acres. The property is bounded on the east and north by Pandora Cadillac, on the west by Pandora Cadillac, Wood Cadillac, Routhier Cadillac and Benard Cadillac, while the railway right-of-way passes within 150 feet of the most southerly point of the property. The transmission lines of the Northern Quebec Power Co. pass through the central part of the property.

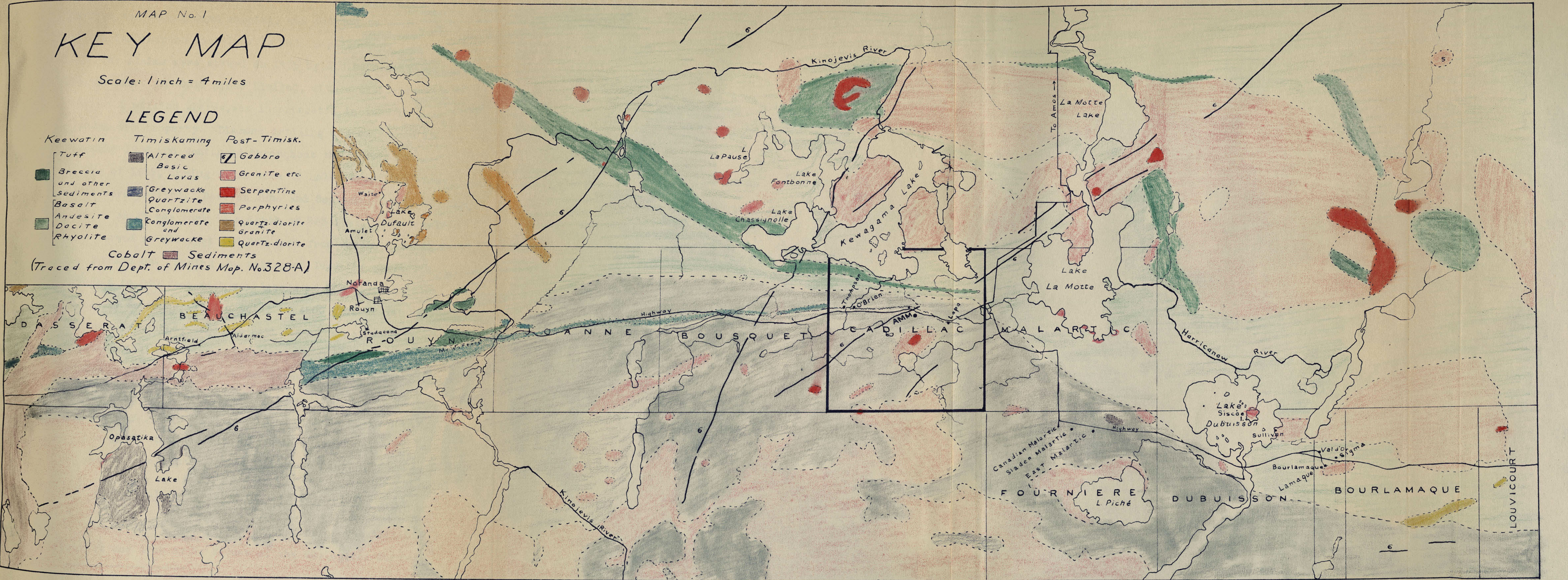
Ready access is thus afforded from Noranda and Valdor both by railway and highway and from Amos by highway. Revillart Lake, 5 miles to the east, is used both in summer and winter as a landing field for aircraft and is on the regular Montreal-Valdor-Noranda air route. The nearest railway station is at Cadillac, near the O'Brien Gold Mines, 4 miles to the west.

From December 1937 to September 1938, the writer was employed as geologist at the mine and, while engaged in


La Motte Lake
To Amos →
6
6
Lake La Motte
MALARTIC
Harricana
Highway
Canadian Malartic
Sladen Malartic
East Malartic
FOURNIERE
L. Piché
DUBU

1 a.

No. 1.


MAP No. 1
KEY MAP
Scale: 1 inch = 4 miles
LEGEND
Keewatin
Timiskaming
Post-Timisk.
Tuff
Breccia
and other
Sediments
Basalt
Andesite
Dacite
Rhyolite
Altered
Basic
Lavas
Greywacke
Quartzite
Conglomerate
Conglomerate
and
Greywacke
Gabbro
Granite etc.
Serpentine
Porphyries
Quartz-diorite + Granite
Quartz-diorite
Cobalt Sediments
(Traced from Dept. of Mines Map. No.328-A)
Kinojevis River
La Pause
Lake Fontbonne
Lake Chassignolle
Kewagama Lake
La Motte Lake
To Amos
Lake La Motte
Waite
Lake Dufault
Amulet
Noranda
Rouyn
Stadacona
McWatters
DASSERAT
BEAUCHASTEL
Arntfield
Aldermac
ROUYN
JOANNE
BOUSQUET
CADILLAC
MALARTIC
Highway
Thompson
O'Brien
AMM
Lapa
Harricanaw River
Lake Siscoe Dubuisson
Sullivan
Canadian Malartic
Sladen Malartic
East Malartic
Highway
Val d'Or
Sigma
Bourlamaque
Lamaque
BOURLAMAQUE
LOUVICOURT
FOURNIERE
L. Piché
DUBUISSON
Opasatika Lake
Kinojevis River

surface and underground mapping, was enabled to gather much of the information contained in this paper.

The claims were staked in 1935 by J.G.McChesney and George Amm. Amm Gold Mines Limited, with a capitalization of 3 million shares,was incorporated in 1936 to develop the property. Diamond drilling was commenced in December 1936 and continued throughout the winter and spring of 1937, during which time 16 holes totalling about 7000' were drilled. Between June and September 1937, a 3-compartment shaft was sunk to a depth of 285 feet, with levels established at 135 feet and 260 feet from which lateral work was carried on. During the spring of 1938 the shaft was deepened to 540 feet with new levels at 385 feet and 510 feet. By September 1938 a total of 4500 feet of lateral work was completed, together with 2000 feet of underground diamond drilling and an additional 450 feet of drilling from surface. Mill construction was begun in December 1938 and milling commenced in March 1939 at an initial rate of 150 tons per day. The mine is equipped with an up-to-date surface plant supplied with electric power. Buildings are equipped with electric lights and steam heat.

Geological Exploration of the Area---1872-1936

The earliest geological exploration of the Abitibi district was done by W. McOuat[1] of the Geological Survey

(1) G.S.C. Report of Progress, 1872

in 1872, betweem lakes Temiskaming and Abitibi. In 1901 J.F.E.Johnston (1) in a rapid reconnaissance discovered quartz veins carrying molybdenite, gold and bismuthite on the shore of Kewagama lake. These and other molybdenite occurrences of the same locality were examined in 1905 by J.Obalski, (2) Superintendent of Mines for the Province of Quebec, in 1906 by W.J.Wilson (3) of the Geological Survey, and again in 1909 by T.L.Walker. (4)

In 1910, M.E.Wilson (5) of the Geological Survey carried on systematic mapping of parts of the area between the Ontario boundary and the Harricanaw river and south of the National Transcontinental Railway. In 1911, J.A.Bancroft (6) mapped parts of the same area for the Quebec government and examined numerous properties that had been staked for gold in the vicinity of Keekeek (Bousquet) and Wabuskus (Joanne) lakes. He did not consider any of these so-called discoveries to warrant the serious attention of mining interests.

During 1924 and 1925, W.F.James and J.B. Mawdsley mapped the Clericy-Kinojevis (7) and the Lamotte-Fournière areas. (8)

(1) G.S.C. Summary Report 1901, pp. 130-143
(2) Mining Operations in the Province of Quebec, 1906 and 1907.
(3) "Exploration along the proposed line of the National Transcontinental Railway", G.S.C. Summary Report, 1906.
(4) "Molybdenite Ores of Canada", Mines Branch Mem. 93, 1911 pp. 32-38.
(5) "Kewagama-Lake, Map Area", G.S.C. Summary Report, 1911. G.S.C. Memoir 39, 1913
(6) "Geology and Mineral Resources of Keekeek and Kewagama Lakes Region". Mining Operations in the Province of Quebec, 1911, pp. 160-207.
(7) G.S.C. Summary Report 1924, Part C.
(8) G.S.C. " " 1925, " C.

Between 1924 and 1929 L.V.Bell and A.McLean (1) made a detailed study of the mining properties of Bousquet and Cadillac townships. An attempt was made to correlate the geology of several properties along the Cadillac belt. This work was supplemented by further detailed work (2) in 1930 and the publication of a map of the central Cadillac area on a scale of one inch to half a mile.

By 1934 the active development of the O'Brien, Thompson, Pandora and other properties showed the Cadillac gold deposits to have definite economic possibilities. The Geological Survey decided to re-examine the mineral belt extending from Rouyn township, through Bousquet and Cadillac into Malartic township. Accordingly, H.C.Gunning and J.W.Ambrose (3) commenced work in 1934 on a strip of territory from a half mile to a mile wide in Eastern Cadillac township, and in 1935 Gunning continued it to the westward. Detailed mapping was done on a scale of 200 feet to 1 inch from Pan Canadian to Thompson Cadillac. Subsequently the mapping was carried into Bousquet and Joanne townships. As a result of these investigations

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(1) Q.B.M. Annual Report, 1924, Part C.

(2) Q.B.M. Annual Report, 1930, Part B.

(3) "Preliminary Report on the Cadillac Belt from Pandora to Pan Canadian", G.S.C., Paper 36-9, 1936.

Gunnings reports[1] and maps have become the chief reference to the geology of the area and particularly to the gold deposits of the Cadillac belt.

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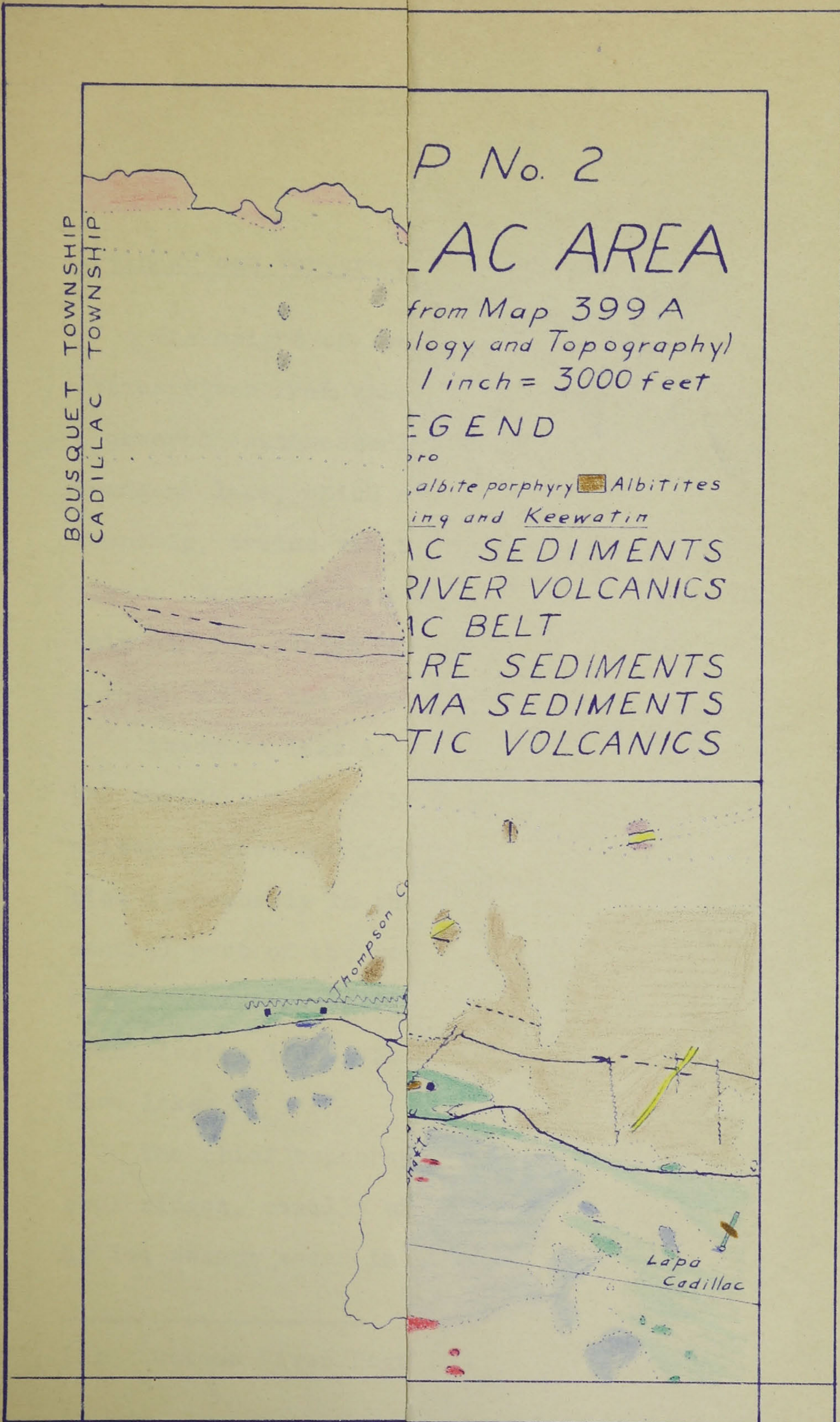
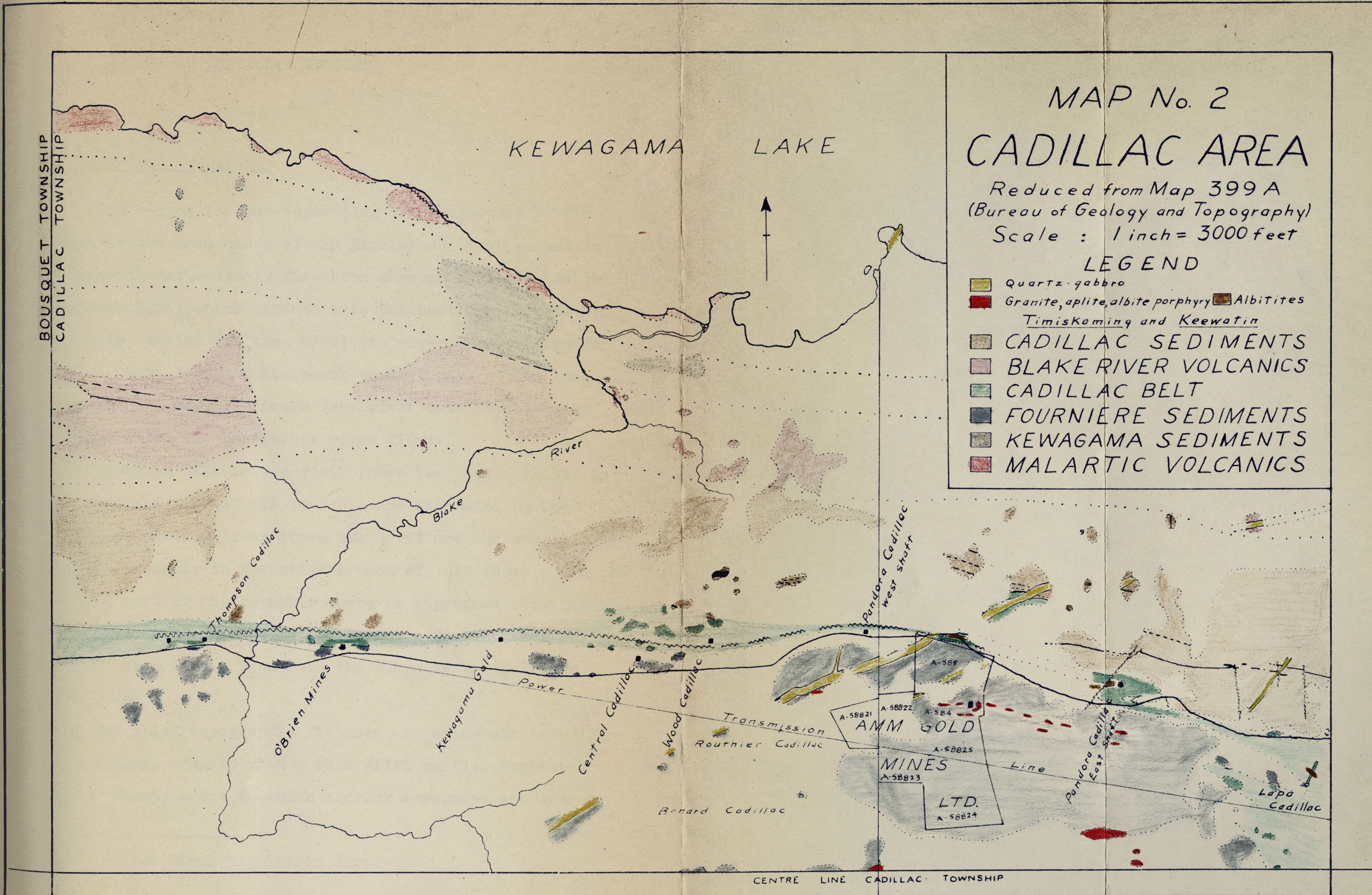
(1) Cadillac Area, Quebec. G.S.C. Memoir 206,1937. (Northern Half of Bosquet Township)


P No. 2
LAC AREA
from Map 399 A
logy and Topography)
1 inch = 3000 feet
EGEND
bro
, albite porphyry
Albitites
ing and Keewatin
C SEDIMENTS
RIVER VOLCANICS
C BELT
RE SEDIMENTS
MA SEDIMENTS
TIC VOLCANICS
BOUSQUET TOWNSHIP
CADILLAC TOWNSHIP
Thompson C
Shaft
Lapa Cadillac


MAP No. 2
CADILLAC AREA
Reduced from Map 399 A
(Bureau of Geology and Topography)
Scale : 1 inch = 3000 feet
LEGEND
Quartz-gabbro
Granite, aplite, albite porphyry
Albitites
Timiskoming and Keewatin
CADILLAC SEDIMENTS
BLAKE RIVER VOLCANICS
CADILLAC BELT
FOURNIERE SEDIMENTS
KEWAGAMA SEDIMENTS
MALARTIC VOLCANICS
KEWAGAMA LAKE
BOUSQUET TOWNSHIP
CADILLAC TOWNSHIP
Blake River
Thompson Cadillac
O'Brien Mines
Kewagama Gold
Central Cadillac
Wood Cadillac
Routhier Cadillac
Benard Cadillac
Power Transmission Line
Pandora Cadillac West Shaft
Pandora Cadillac East Shaft
AMM GOLD MINES LTD.
A-585
A-584
A-58821
A-58822
A-58825
A-58823
A-58824
Lapa Cadillac
CENTRE LINE CADILLAC TOWNSHIP

REGIONAL GEOLOGY

Drainage and Topography

The height of land separating the headwaters of the Ottawa river from those of the Harricanaw river passes in a general southwesterly direction through Cadillac township. Kewagama lake, which extends into the northern part of the township, drains via the Kinojevis river into the Ottawa river. Heva lake, in the south central part of the township has its outlet through Heva river into Lamotte lake through which the Harricanaw river flows.

Kewagama lake is 953 feet[(1)] above sea level. Hills in the northern part of the township are estimated by the writer to rise 300 feet above this level and the mean elevation is probably in the neighborhood of 1050 feet. In the central part of the township there is a gradual rise southward from Kewagama lake to the Northern Quebec Power Co.'s transmission line. From here the slope is southward to Heva lake.

The chief topographic features are east-west trending rock ridges, usually with a thin drift mantle, separated by low swampy areas in which bedrock exposures are scarce.

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(1) Ottawa River Regulation Survey.

Relation of Topography to Rock Structures

The physiographic features noted are in a large measure a result of variations in character of the underlying bedrock. The east-west ridges follow the regional strikes and schistosity and are for the most part composed of resistant sediments. A zone of faulting, localized by a band of weak volcanics and known as the "Cadillac break" is reflected (especially between Lapa Cadillac and the township centre line) by a pronounced valley between ridges of greywacke. This valley is followed by the Noranda-Valdor highway for about 5 miles in Cadillac township. Granite areas on the peninsulas of Kewagama Lake and to the north of the lake stand out as high, rounded hills. Fresh diabase dikes occasionally form prominent northeasterly trending ridges, as for example when one of these crosses the highway a short distance east of the township centre line.

Bedrock Geology

The main geologic features of the area are shown on Map No.1, accompanying this paper. All the consolidated rocks are of Precambrian age. The table of formations as presented by James Mawdsley[1] is as follows:

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(1) G.S.C. Summary Report, 1924. Part C.

Recent and Pleistocene:

(?)
Pre-Cobalt (Intrusives)

Olivine gabbro and quartz gabbro dykes

Pre-Cobalt Intrusives:

Granite, granite porphyry, granodiorite

Porphyritic syenite

Augite syenite

Amphibolite

Timiskaming

Greywacke, some arkose, and schists; basic flows

tuffs, conglomerate

Keewatin

Basalt, andesite, rhyolite, tuff and basic intrusives.

It will be observed that the Keewatin-Timiskaming contact as drawn on Map No.1, presents a continuous structural horizon from west to east across the map area. Beyond the map area this contact may be followed eastward through the townships of Vauquelin and Pershing into Haig township, where the Keewatin and Timiskaming rocks are intruded by a large body of granite gneiss. The contact thus has a continuous east-west extent of approximately 120 miles within the Province of Quebec.

It will also be noticed that most of the producing mines and active prospects are distributed along a zone in close proximity to this contact. This zone is often referred to as "The Quebec Gold Belt."

It is evident that the contact was a line of weakness along which repeated faulting took place and which afforded a means of ascent for satellitic intrusives and ore-bearing solutions, believed to have been derived from the granite batholiths which are exposed to the north and south of the belt.

Within Cadillac township the Keewatin-Timiskaming contact has not been satisfactorily defined. James and Mawdsley, in tentatively putting the contact a short distance south of Kewagama Lake, were aware that this left several bands of Keewatin-like volcanics within the Timiskaming. Since their interpretation of the structure was that of simple monoclinal folding and as they saw no evidence of unconformable relations between the Keewatin & Timiskaming, they concluded that the transition had been more or less continuous from a dominantly volcanic series to one dominantly sedimentary.

As a result of more detailed work Gunning has presented convincing evidence to show that the strata of the contact zone have been tightly compressed into a synclinal fold.(1)

To facilitate mapping and correlation and to avoid

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(1) For a more complete discussion of these problems the reader is referred to the following:
G.S.C. Mem. 166, pp. 66-69
G.S.C. Mem. 206, pp. 3-4

confusion arising from establishing a chronological boundary, Gunning divided the non-intrusive rocks of the Cadillac area into six lithologic units which are from north to south:

1. Malartic Volcanics
2. Kewagama Sediments
3. Blake River Volcanics
4. Cadillac Sediments
5. Cadillac Belt
6. Fourniére Sediments.

The field relationships of these stratigraphic divisions are shown on map No.2 accompanying this paper. For the purposes of this discussion it is only necessary to consider two of these divisions, the Cadillac belt and the Fourniére sediments.

The former is a narrow band of rocks now known to extend right across the township and beyond the township boundaries both to the east and west.

As described by Gunning (1) "The Cadillac belt is bordered on the north and south, respectively, by Cadillac sediments and Fourniére sediments, and volcanic rocks form a prominent part of it. It is further distinguished by a zone of intense shearing known as the Cadillac break along which the rocks are converted to very soft schist, and by bodies of quartz albitite, a highly sodic, intrusive rock."

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(1) Mem. 206, p.11

Economically, the belt is very important because near it are found all but one of the developed gold deposits of Cadillac township. The exception is the Amm gold mine which lies to the south in the Fournière sediments and whose known ore bodies are within 1500' of the belt. Furthermore, it is believed by the writer that the structures responsible for these orebodies are subsidiary to the structures of the Cadillac belt. This point will be discussed in dealing with the detailed geology of the mine.

South of the Cadillac belt all the non-intrusive rocks of the townships belong to the Fournière sediments which Gunning describes as "...fine-grained, bedded grey strata... consisting of argillaceous, arkosic, and quartzitic greywacke, locally converted to mica schist and, rarely, to chlorite and hornblende schist." Near their northern limit the sediments strike approximately parallel to the Cadillac belt, that is generally east and west, but farther south a number of observations show strikes ranging from N 70° E to N 75° W. Locally wide variations in strike are caused by minor folding. Dips are vertical or steeply southward.

The Fournière sediments are intruded by the Heva Lake granite, its associated aplite and albite porphyry dykes and by dykes of younger gabbro.

The Heva Lake granite body lies in the south central part of the township and is probably connected with the large batholith to the south. Specimens taken near the N-S centre-line were determined by Gunning[1] to contain 15% quartz

(1) Mem. 206, p.20

and 60% feldspar, of which albite (An_8) was in excess of microcline. The sediments adjacent to the granite are often contorted and cut by many aplite dykes.

The albite porphyry dykes are contained mainly in a zone which is first exposed about 1500 feet east of the township centre-line and which extends about 6,000 feet eastward. Where the zone crosses the Amm property it has a width of about 1,000 feet.

The dykes of younger gabbro trend in a northwesterly direction across the township. Part of Gunning's description[1] is "All thin sections examined are of quartz gabbro. Calcic labradorite, augite partially urelitized and chloritized, and quartz are the principal constituents. Magnetite is always present and there is generally some pyrite, biotite, epidote and micropegmagtite. Quartz seldom forms over 5 per cent of the rock".

The structural history of the area as interpreted by Gunning[2] may be summarized as follows:

(1) Isoclinal folding of the Archaean sediments and volcanics by forces either from the north or the south and probably related to large granite masses to the south.

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(1) Mem. 206, p.23
(2) Mem. 206, p.24

(2) Faulting and fracturing along easterly trending steeply dipping zones, such as the Cadillac break, with a tendency for beds on the north to move eastward relative to those on the south.

(3) Injection of acid differentiates of the granite masses "forming dykes whose location and form were determined to a large extent by the pre-existing structures."

(4) Shearing and fracturing of these dykes.

(5) Introduction of solutions to form the gold-bearing quartz veins.

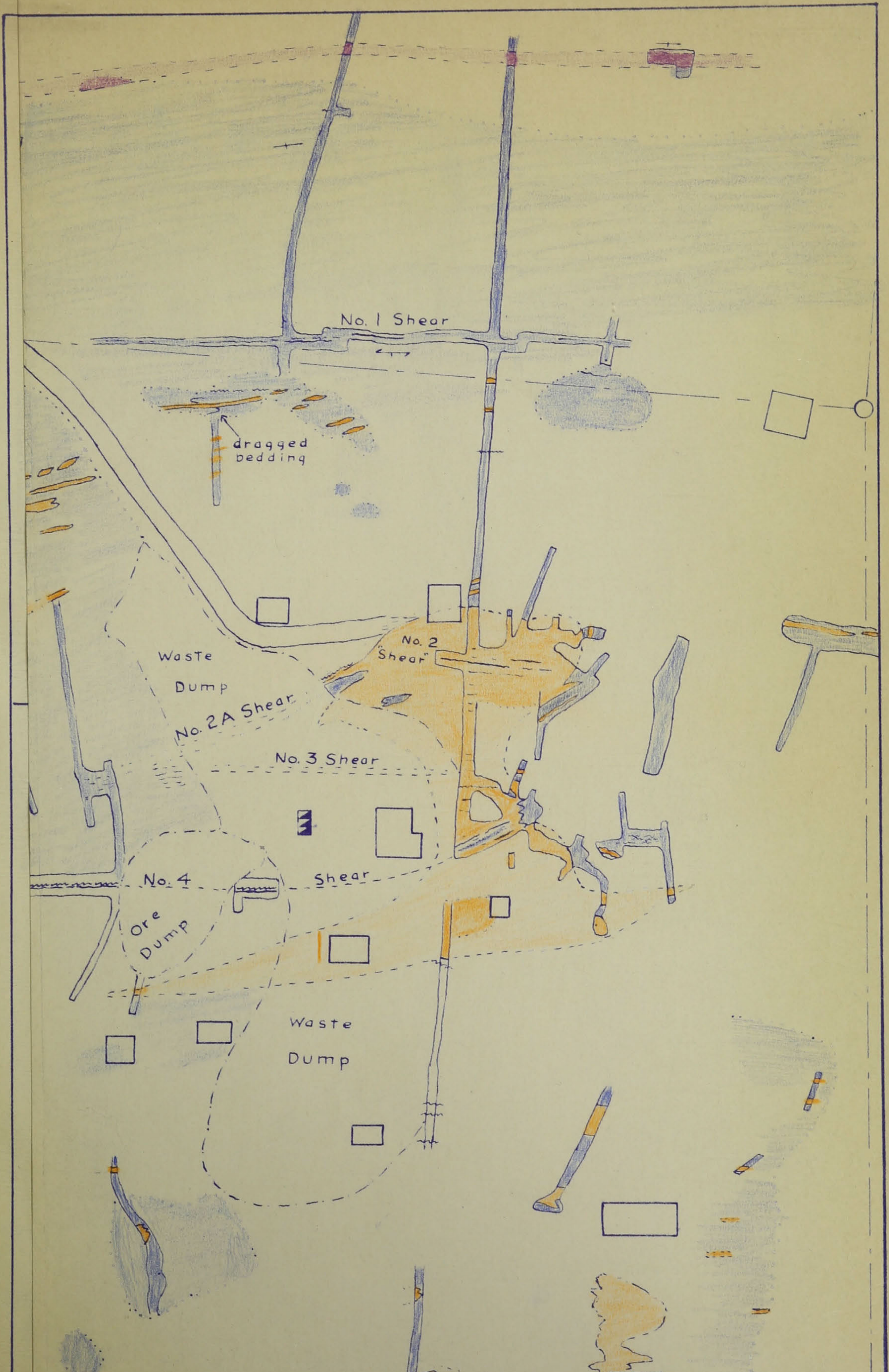
(6) Faulting along planes cutting sharply across the strike of the strata.

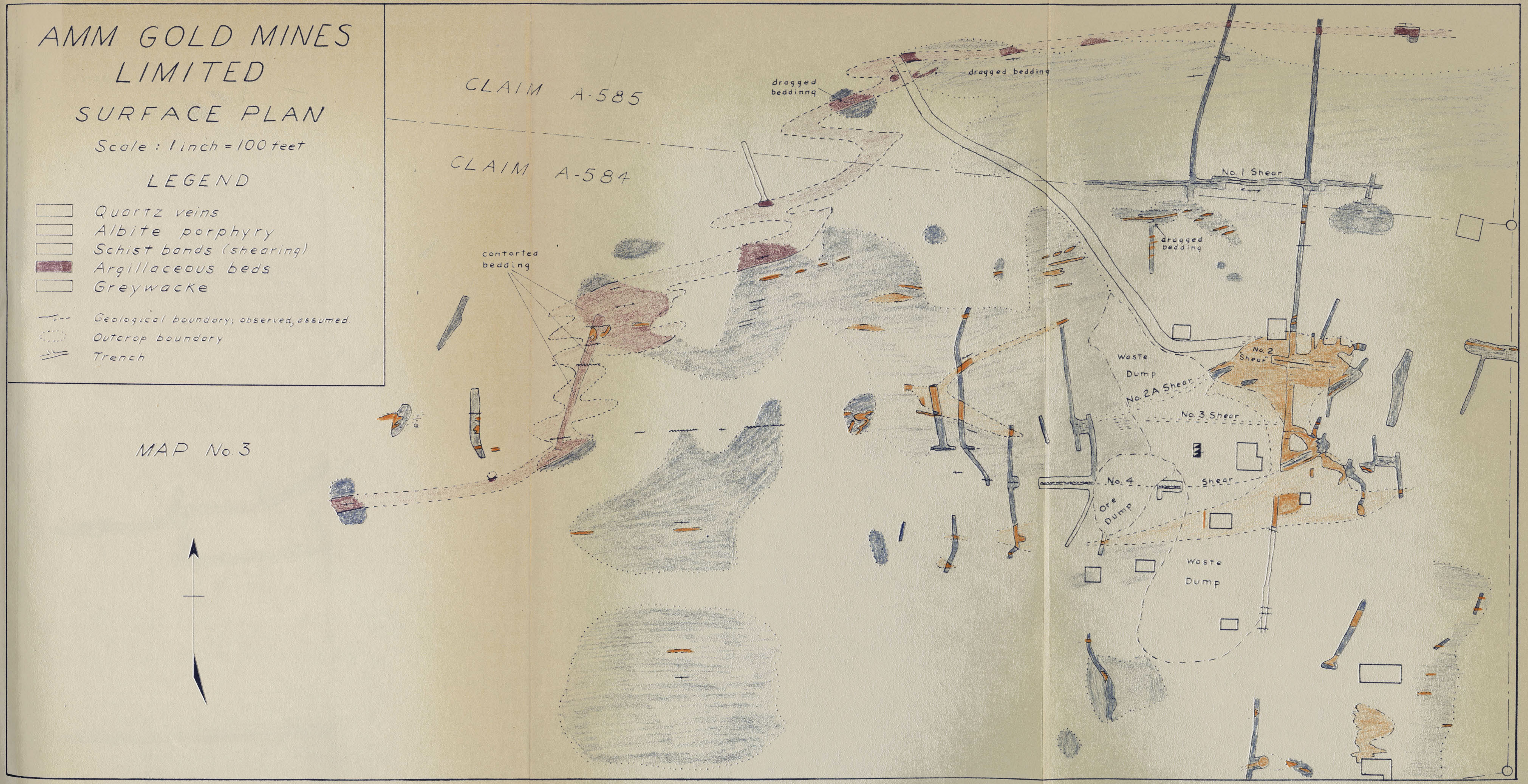
(7) Injection of gabbro dykes into northeasterly trending fissures.

(8) Erosion.

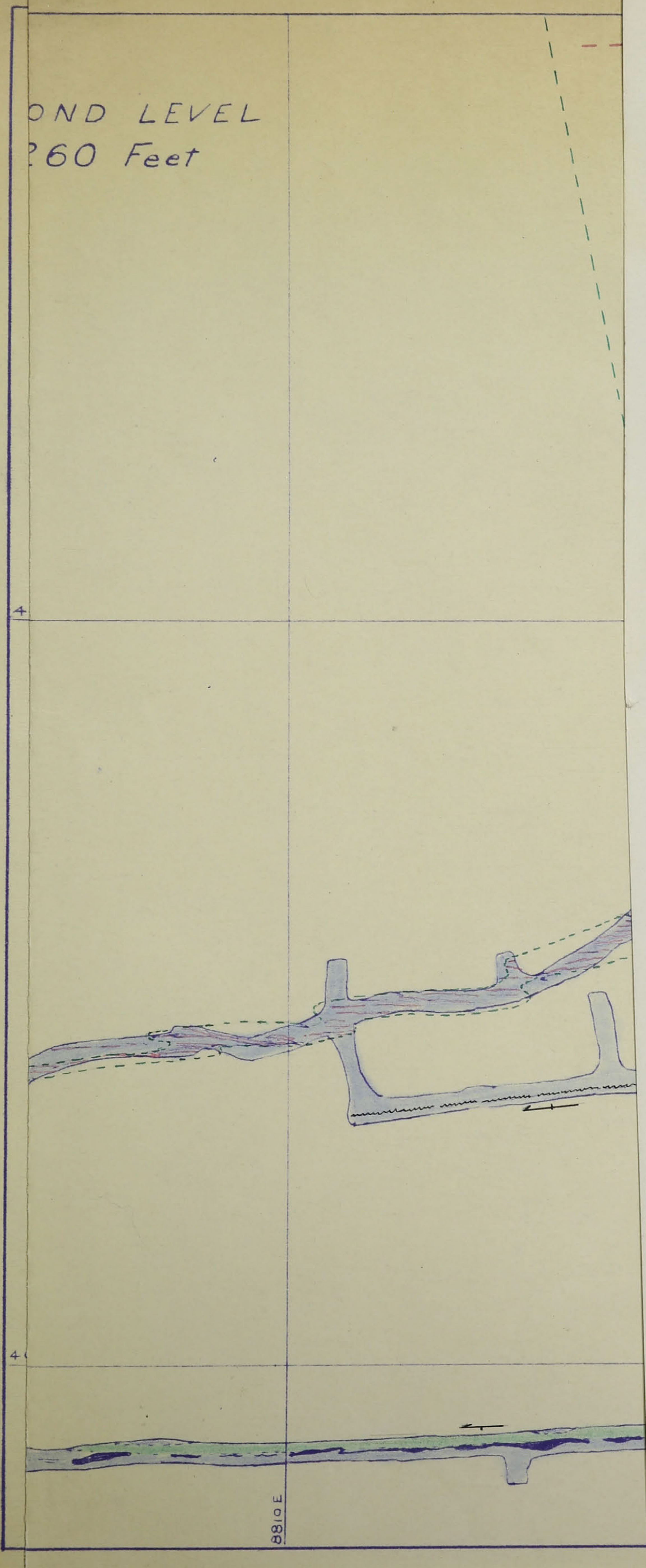
Such evidence as was collected on the Amm property and described under local geology of the mine supports the foregoing interpretation.

13. a.

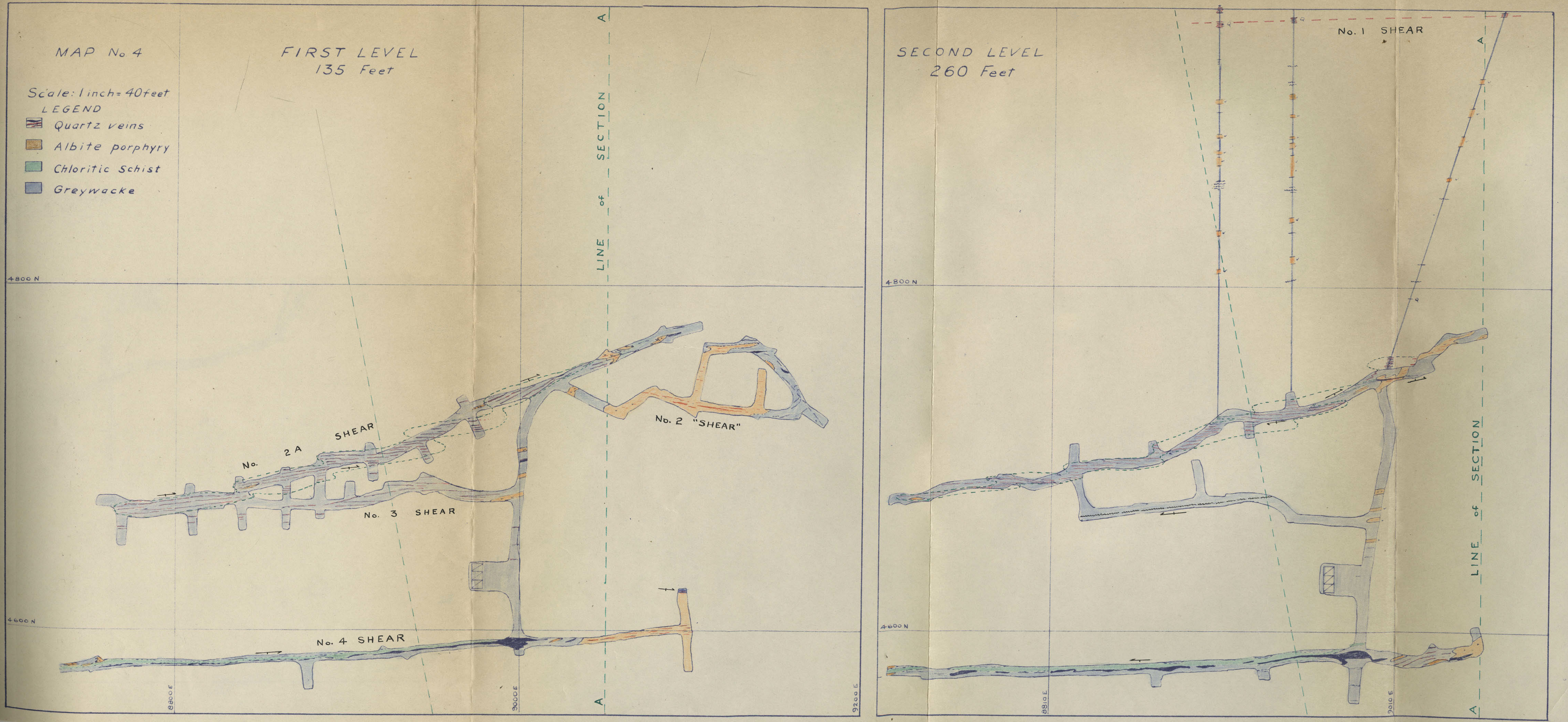

No. 1 Shear
dragged bedding
No. 2 "Shear"
Waste Dump
No. 2A Shear
No. 3 Shear
No. 4 Shear
Ore Dump
Waste Dump



AMM GOLD MINES
LIMITED
SURFACE PLAN
Scale : 1 inch = 100 feet
LEGEND
Quartz veins
Albite porphyry
Schist bands (shearing)
Argillaceous beds
Greywacke
Geological boundary; observed, assumed.
Outcrop boundary
Trench
MAP No. 3
CLAIM A-585
CLAIM A-584
dragged beddinng
dragged bedding
contorted bedding
No. 1 Shear
dragged bedding
No. 2 Shear
No. 2A Shear
No. 3 Shear
No. 4 Shear
Waste Dump
Ore Dump
Waste Dump



No. 4


MAP No. 4
FIRST LEVEL
135 Feet
Scale: 1 inch = 40 feet
LEGEND
Quartz veins
Albite porphyry
Chloritic Schist
Greywacke
LINE of SECTION
A
4800 N
4600 N
No. 2A SHEAR
No. 3 SHEAR
No. 2 "SHEAR"
No. 4 SHEAR
8800 E
9000 E
9200 E
SECOND LEVEL
260 Feet
No. 1 SHEAR
8810 E
9010 E

13. c.

No. 5


LINE
4600 N
D.D.H. 28
Fine quartz stringers + finely dissem pyrrhotite
B
9000 E
A
4400 N

MAP No. 5
THIRD LEVEL
385 Feet
Scale: 1 inch = 40 feet
LEGEND
Quartz veins
Albite porphyry
Chloritic Schist
Greywacke
No. 2A
No. 4
LINE of SECTION
4800 N
4600 N
4400 N
8800 E
9000 E
A
B
FOURTH LEVEL
510 Feet
No. 1 vein ?
DDH 25
DDH 22
DDH 27
DDH 23
DDH 31
DDH 28
DDH 26
DDH 24
Quartz
Arsenopyrite
Gold
fine quartz stringers
+
finely dissem
pyrrhotite

L O C A L   G E O L O G Y

Rocks and Rock Structures

General Statement

The property of Amm Gold Mines Limited lies entirely within the Fournière sediments with the possible exception of the extreme northwest part of Claim A-585, which may include rocks of the Cadillac belt.

The various rock types found on the property are, in order of their relative ages:

(1) Greywacke; quartzitic, with one known well-defined band of argillaceous beds; green and brown schists probably derived by shearing of the greywacke.

(2) Albite porphyry and aplite.

(3) Quartz-gabbro dykes.

Greywacke

Greywacke is the predominant country rock on the property. Although the rock was only examined in detail near the mine workings it is fairly uniform in character, so that the following description is believed to apply to the property in general. The greywacke is fine-grained, more or less visibly bedded, and weathers to light and dark shades of grey. The bedding is often indistinct, and individual bedding planes cannot usually be traced for more than a few feet on surface; whereas, underground it has been found impossible to distinguish them at all with any degree of certainty. Strikes are very variable, especially in outcrops near the shaft section, as a result of obscure folding. Dips are from vertical to steeply south. The writer was not able to make any satisfactory determination as to whether or not the strata here are overturned. No crossbedding was seen and observations of apparent gradations in grain size gave contradictory results.

Examination of thin-sections shows the greywacke to be composed chiefly of quartz and brown biotite. The quartz occurs as numerous small grains, angular to slightly rounded in shape. Biotite flakes generally have a common orientation with their long dimension paralleling the schistosity. In some sections there is a fair amount of plagioclase feldspar, chiefly as small irregular grains largely altered to sericite, but in some cases showing distinct twinning lamellae.

Plate No. 1.

Greywacke from the 1st level station. Note large grain of feldspar and quartz (light) Crossed nicols x 52

Greywacke 400 feet north of shaft.
Ordinary light x 52

Such grains as could be satisfactorily determined indicated an albite composition. Chlorite is generally abundant and in part appears to be an alteration product of biotite. Minor amounts of carbonate, sulphides and very small grains of a highly-refractive, colourless mineral are usually present.

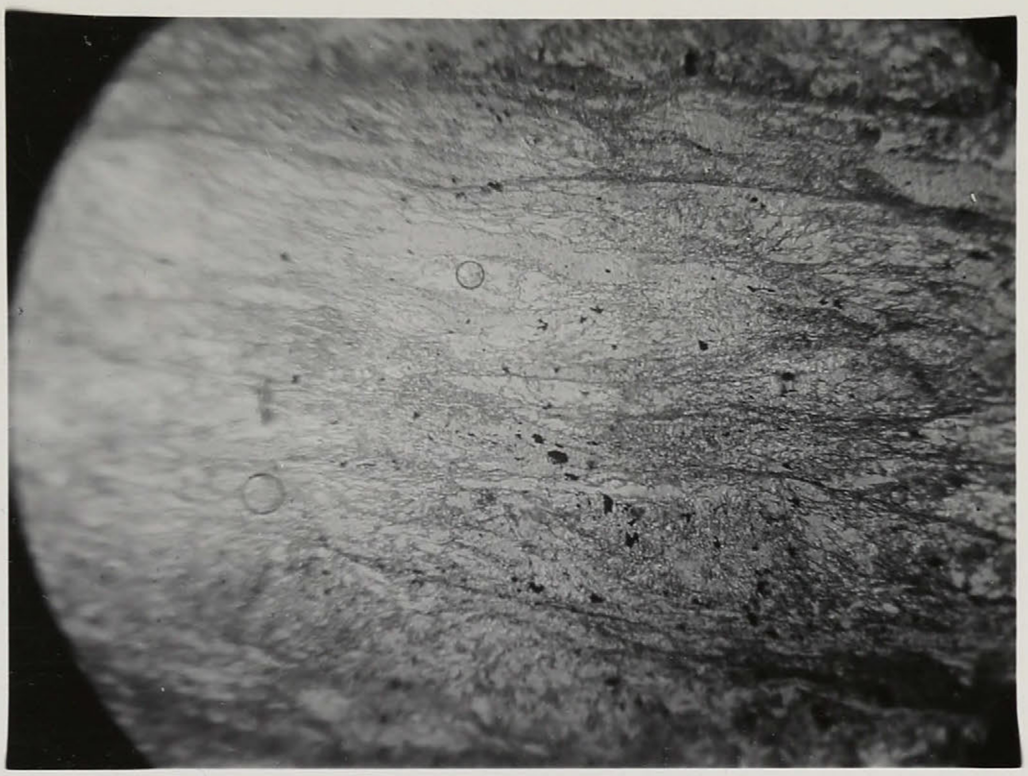
Schist

The green and brown schists occur in the greywacke as straight narrow bands of soft micaeous and chloritic material. They are usually less than a foot in width and taper gradually along their strike, which is from east-west to 15 degrees north of east. Locally they transgress the bedding at a small angle and are considered to be the result of shearing. The most important of these schist bands is that forming a part of No.4 shear which passes a short distance south of the shaft. It will be discussed more fully in connection with the vein systems of the mine.

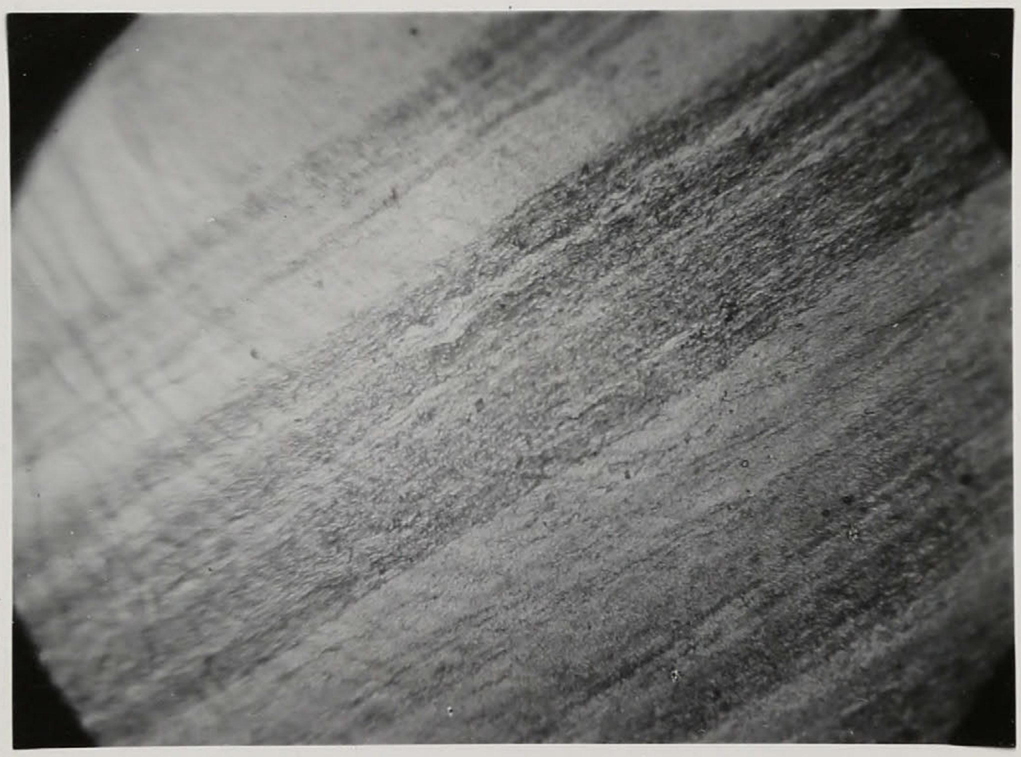
Argillite

North of the mine workings and passing within 500 feet of the shaft is a band of thinly stratified argillaceous sediments, interbedded with the greywacke. The bedding is very distinct due to alternation of light and dark laminae and this feature, together with its finer texture, make it easily distinguishable from greywacke. It has been traced for approximately 1600 feet from east to west and, being the only satisfactory horizon-marker yet discovered on the property, affords an important clue to the local structure. The band varies in true width from 20 feet in the most easterly exposure to 35 feet on the most westerly outcrop. However, complex drag folding and faulting have given the band, locally, a much greater apparent width, exceeding 100 feet in one of the westerly outcrops. Samples taken due north of the shaft were seen under the microscope to have about the same composition as the greywacke but to be for the most part much finer-grained. The dark bands consist of extremely fine-grained material of which quartz and biotite are the only recognizable minerals. Lighter bands are made up of distinctly coarser particles of quartz and biotite, the latter being relatively less abundant than in the dark bands. A few irregular grains of feldspar can be recognized. Small flakes of pale green chlorite are fairly abundant and in some bands practically all the biotite has apparently gone over to this mineral. In addition, small amounts of white mica and numerous small grains of magnetite are present.

Plate No.2.



Schist from No.4 Shear. Ordinary light x 15; light, quartz; Medium, calcite; dark lamellae, chlorite.



Argillite. Ordinary light x 15

Albitic Intrusives

No granite is known to occur on the Amm property. A few fine-textured white aplite dykes are found in the southern part of the claims, but were not studied in any detail by the writer. The zone of albite porphyry intrusives, described by Gunning,(1) has a width from north to south on Claim A-584, of 1000 to 1200 feet and appears to trend about 10° south of west. In the shaft area its northern limit is well defined by an east-west zone of faulting known as No.1 Shear. There are numerous small porphyry dykes immediately south of this shear, but only one very small dyke has been found north of it. The south boundary of the zone is not so well defined, but would appear to lie in a small valley about 800 feet south of the shaft. A few small bodies of porphyry have been exposed on the north edge of this valley, (southwest of the shaft) and on the south edge of the valley in the southeast corner of Claim A-58822.

The majority of the porphyry intrusives appear to be concordant with the bedding of the greywacke and, in the vicinity of the mine workings, they dip steeply southward. A few larger, irregular bodies transgress the bedding, while some of the intrusives may be partly concordant and partly transgressive. They may be grouped into four types as follows:

(1) Mem. 206, p. 20.

(a) Long narrow sills concordant with the bedding, having steep dips and fairly uniform widths of from 2 to 3 feet. The most continuous of these outcrops just south of the cookery and has been traced for 350 feet in a direction slightly south of west.

(b) Lenticular sills and dykes with steep dips which pinch and swell from widths of a few inches to 6 or 7 feet. Several separate lenses may occur along the same line of strike.

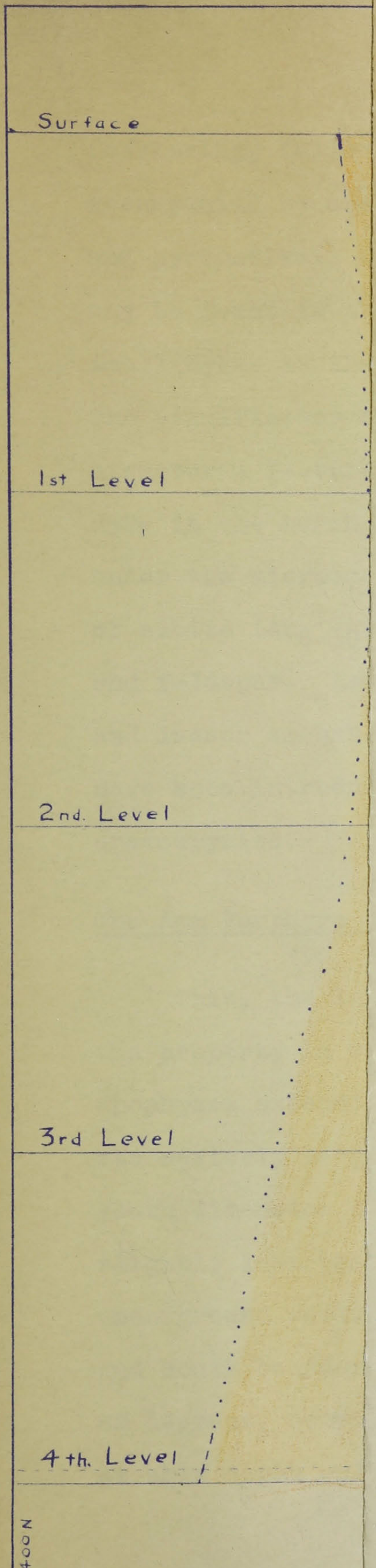
(c) Phacoliths: These are saddle-shaped intrusive bodies which appear to occur at or near the crests or troughs of folds in the greywacke. Two examples, one observed and one inferred,are shown on the surface map (No.3) about 400 feet west of the shaft. They appear to be partly concordant.

(d) Stocks: These are larger and very irregular bodies which transgress the strata. The largest and most important of these lies just east of the shaft and is here referred to as the Amm porphyry stock.

All these intrusives weather characteristically from light grey to nearly white and in most cases their porphyritic texture is quite apparent. This is particularly true of the smaller dykes, white albite phenocrysts being conspicuous in a fine-grained matrix. Nearly all have undergone considerable

MAP No. 6

VERTICAL SECTION along AA
Through
AMM PORPHYRY STOCK
Scale: 1 inch = 60 feet

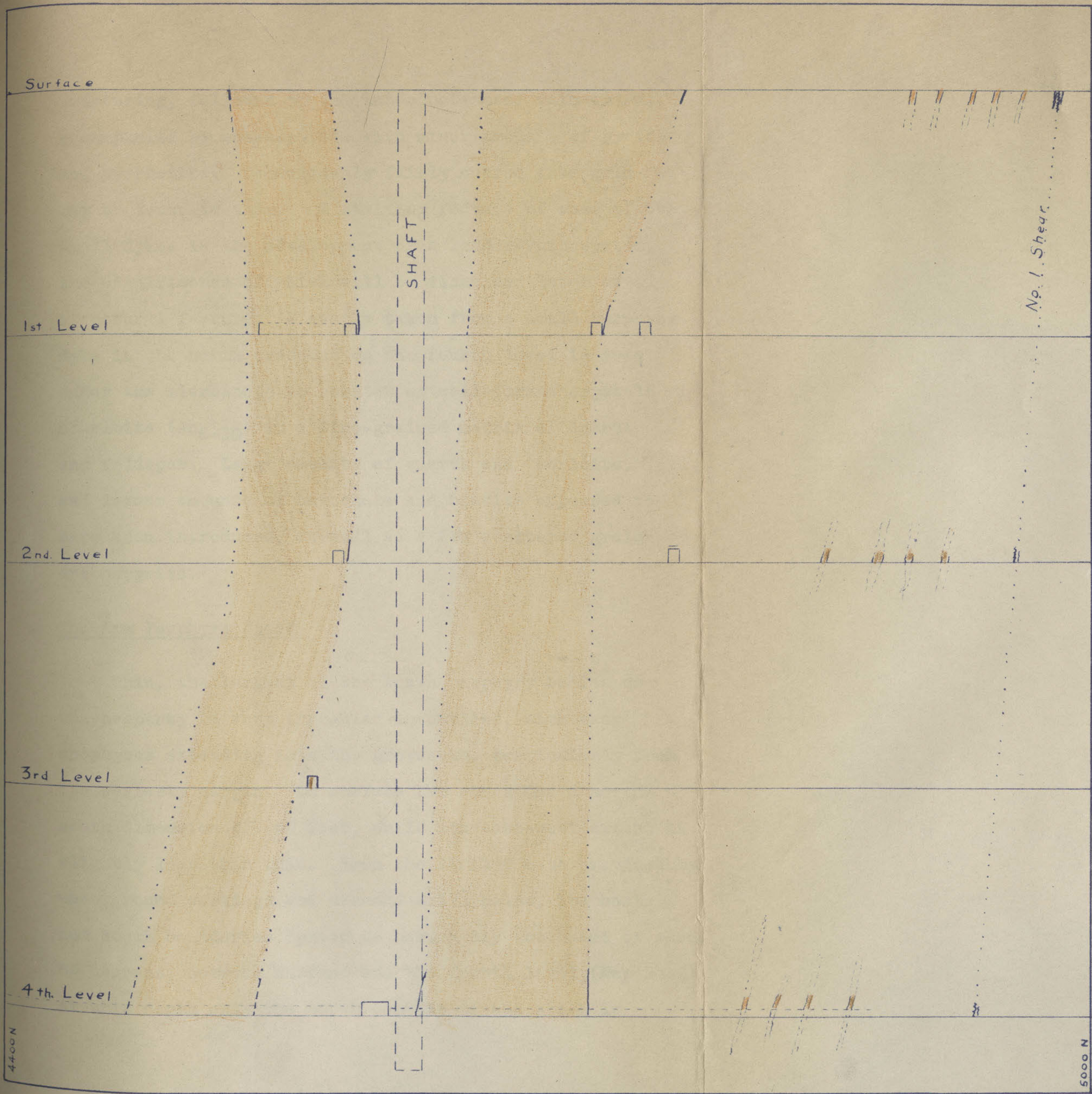


CONTACTS

/ Observed

¦ Projected to plane of section

: Assumed



MAP No. 6

VERTICAL SECTION along AA
Through
AMM PORPHYRY STOCK
Scale: 1 inch = 60 feet

CONTACTS

/ Observed

¦ Projected to plane of section

: Assumed

fracturing, followed by the introduction of vein quartz, accompanied by arsenopyrite with minor amounts of pyrite and pyrrhotite. Occasionally fairly coarse free gold may be found in them. A striking feature of some of the small dykes is the development of a ladder-vein system, the significance of which will be discussed later as a structural feature. A sample taken from a small porphyry dyke in the north crosscut on the fourth level is seen under the microscope to consist of well-formed crystals of albite (An_{8-10}) in a fine-grained matrix of quartz and feldspar. Large amounts of quartz and sericite, and lesser amounts of carbonate and biotite appeared to have been introduced, as well as a few scattered grains of arsenopyrite.

The Amm Porphyry Stock

This, the largest of the known porphyry bodies on the property is very irregular in outline, with many apophyses extending into the greywacke, particularly from its westerly margin. On surface the stock has a north-south dimension of 250 feet, while its east-west extent is slightly less than this. From the limited data provided by underground workings and diamond-drill holes, its north and south boundaries appear to have a dip southward of about 85 degrees, between surface and the fourth level,(Map No.6). At this depth only the north contact of the stock is defined, but if, as seems likely, the porphyry cut by two drill holes south of 504 drift is a part of the main stock and corresponds to the south lobe appearing on surface and on the first level, then the nearly vertical continuity in size and general shape of the Amm porphyry stock is a reasonable assumption.

The stock has undergone severe fracturing followed by the introduction of a network of veins and stringers of quartz, and a few small stringers of calcite. The veins and larger quartz stringers have a general east-west strike and dip nearly vertically, but the smaller stringers have no directional uniformity. The latter are very numerous and form such a close network throughout the stock that it is difficult to find a piece of rock the size of a hand specimen that does not show evidence of quartz veining.

A great deal of arsenopyrite has been disseminated fairly evenly throughout the stock. Minor amounts of pyrite and pyrrhotite and a few small nests of galena have also been noted. In addition to the quartz-filled fractures there are some open fractures which occasionally show slight slickensiding. On such surfaces graphite and platy pyrite commonly occurs and occasionally visible gold. In hand specimens the porphyry is a grey, porphyritic to even-grained rock, visible alteration being the addition of quartz, sericite and arsenopyrite. All the characteristics persist without apparent change from surface to the bottom level.

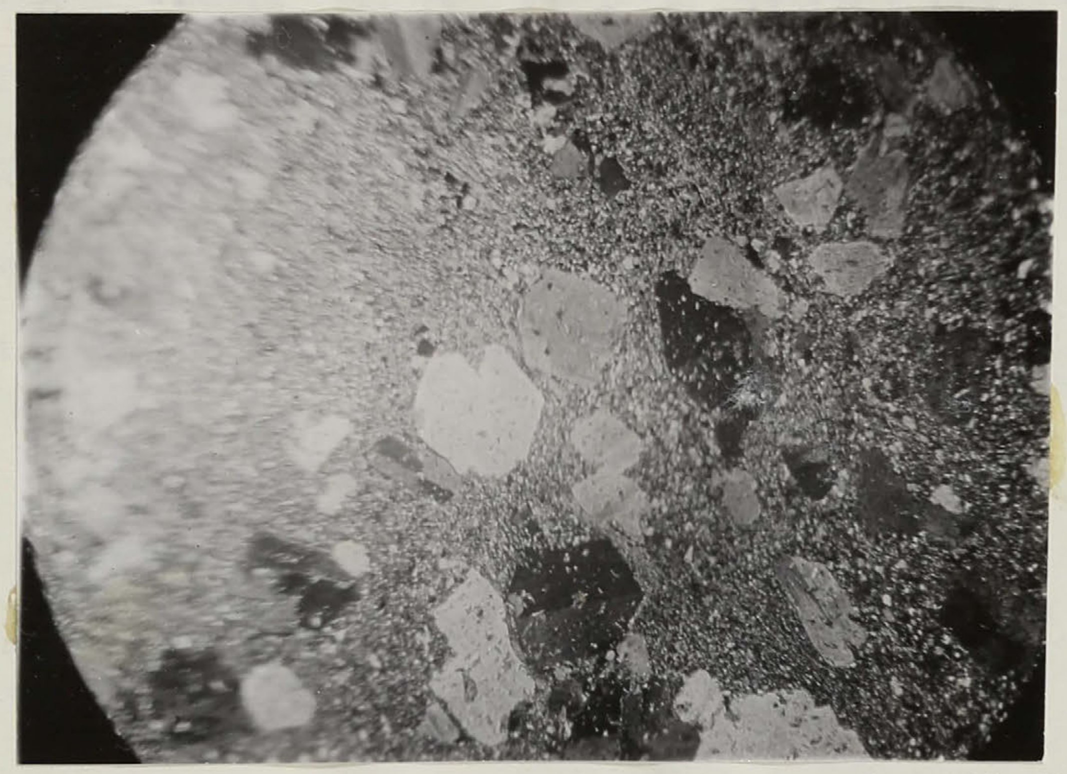
Samples taken from various parts of the intrusive are seen under the microscope to consist of well-developed crystals of feldspar up to 4 mm. in diameter with varying amounts of quartz, white mica, carbonates, arsenopyrite and biotite. All the feldspar grains that could be satisfactorily tested indicated a highly sodic plagioclase composition, even the inner parts of zoned crystals falling well within the albite range. Much of the albite appears quite fresh, whereas in other cases it is rendered cloudy by small flakes of sericite and carbonate. In some sections it was apparent that a large proportion, if not all, of the quartz had been introduced or had recrystallized. It is found chiefly as aggregates of fresh irregular grains which appear to have forced themselves between the feldspar crystals. The development of sericite and carbonate is not necessarily to be solely attributed to the break-down of feldspar, since these two minerals are not more abundant around the broken edges of feldspar crystals than within them or among the granular quartz aggregates. Very minor amounts of biotite may represent original ferromagnesian minerals or may have been introduced.

The composition of the plagioclase together with the virtual absence of potassic feldspar, ferromagnesian minerals and common accessory minerals shows the Amm porphyry stock to have a mineralogical composition very similar to the albitites (1) of the Cadillac belt.

(1) Mem. 206, p.21.

Plate No.3.

Amm porphyry stock, first level. Mainly quartz and albite (twinned). Crossed nicols x 15.



Albite porphyry from small dyke in fourth level north crosscut. Crossed nicols x 15, albite phenocrysts in a fine matrix of quartz and albite.

Since the relative amounts of original and introduced quartz are unknown, the writer does not presume to state which of the names "albitite" or "quartz-albitite" should be given to the rock. For this reason it seems advisable to retain the name "albite porphyry" used by Gunning.

Quartz -Gabbro Dykes

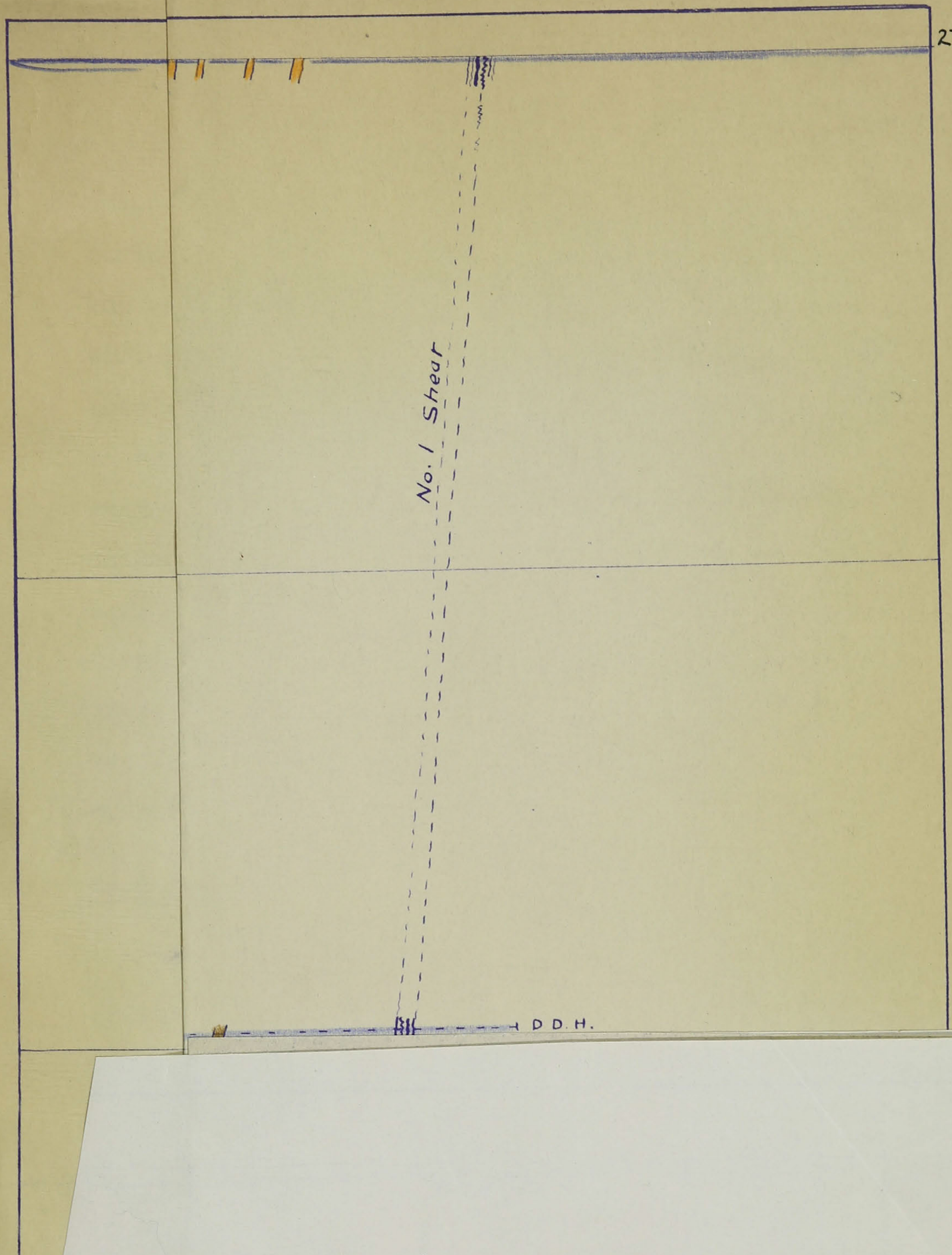
Two dykes of younger gabbro are known to occur on the property. The larger is 275 feet wide and outcrops in the northwest part of Claim A-585, while the smaller, having a width of 125 feet, is exposed in three outcrops 1000 feet to the southwest on the same claim. Both have a northeasterly trend. The petrography and structural relations of these dykes have already been discussed in connection with the regional geology.

Gold Deposits

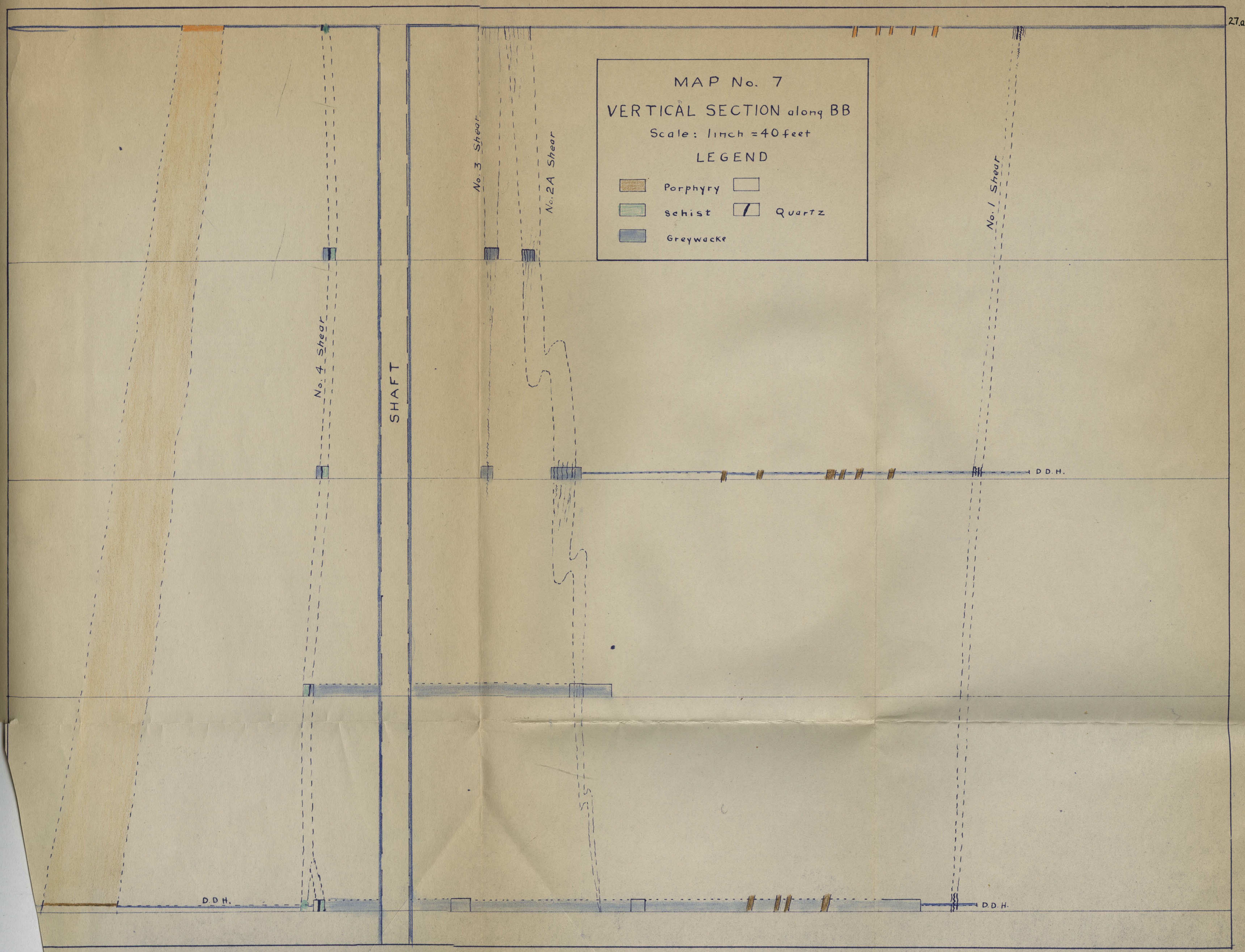
Five gold-bearing vein systems are recognized in and near the mine workings. These have been designated as shears No.1, 2, 2A, 3 and 4.

No.1.Shear

No.1 Shear marks the northern limit of the zone of porphyry intrusives. 350 feet north of the shaft the greywacke has been sheared in a due east-west direction at a small angle to the bedding, which here strikes from 10° to 20° north of east. In places the shearing has been mainly confined to narrow widths of schist and in others has been taken up on a number of parallel planes over widths of 8 feet or more. On surface the schist and accompanying vein material have been traced for 350 feet along the strike. The shear becomes obscure to the east and goes under overburden on the west. It has been tested by six surface diamond drill holes for a length of 250 feet to a depth of 50 feet. What is believed to be its downward extension has been cut by three drill holes on the second level, giving it a minimum length of 160 feet at this horizon, and by one drill hole on the fourth level. These intersections indicate the shear to have a dip of 85° to the south. The shear has been mineralized by quartz with minor amounts of carbonates in the form of discontinuous veins and stringers. Of the sulphide minerals arsenopyrite is predominant, with lesser



No. 7


27.a
MAP No. 7
VERTICAL SECTION along BB
Scale: 1 inch = 40 feet
LEGEND
Porphyry
Schist
Quartz
Greywacke
No. 4 Shear
SHAFT
No. 3 Shear
No. 2A Shear
No. 1 Shear
D.D.H.
D.D.H.
D.D.H.

amounts of pyrite and pyrrhotite. They occur as scattered nests of crystals in the quartz and schisted wallrock, and as finely-disseminated grains on the margins of stringers and on schist partings. Where found in fair amount they are usually accompanied by gold. The gold occurs free in fractures in the quartz and on schist partings, particularly the schist included by, or adjacent to, the quartz. Channel sampling on surface and samples of diamond drill core show interesting values in gold over widths up to five feet, but the erratic distribution of this metal, char- -acteristic of these and other veins of the Cadillac area, make it impossible with present information to say whether or not this vein could be profitably mined.

No.2 Shear

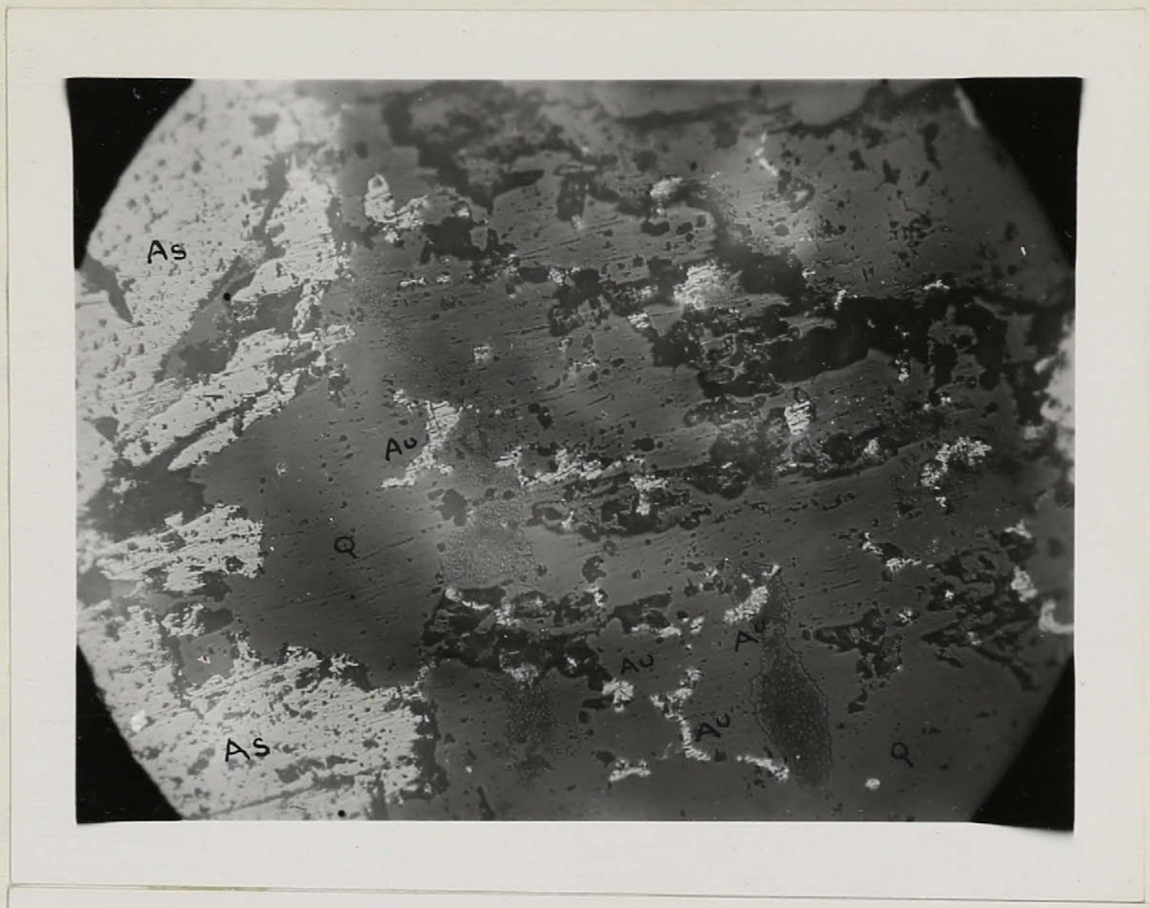
No.2 shear might be more accurately described as a fracture zone occupied by quartz veins and stringers. It lies within the main porphyry body, about 50 feet south of its north contact. Although veins are found beyond the limits of the zone on surface, they are best developed over a width of about ten feet for a length of 75 feet in a direction S. 83°E, and they dip nearly vertically. The quartz is white and has a somewhat granular texture. Just in front of the office building several pieces of fairly coarse gold occupy fractures in one of the veins, and farther east fine gold may be seen on slightly slickensided surfaces of the porphyry wall-rock. The zone has been explored by a drift and crosscuts on the first level with disappointing results, in spite of the fact that good values were obtained over a width of ten feet from a diamond drill hole passing a short distance below this horizon.

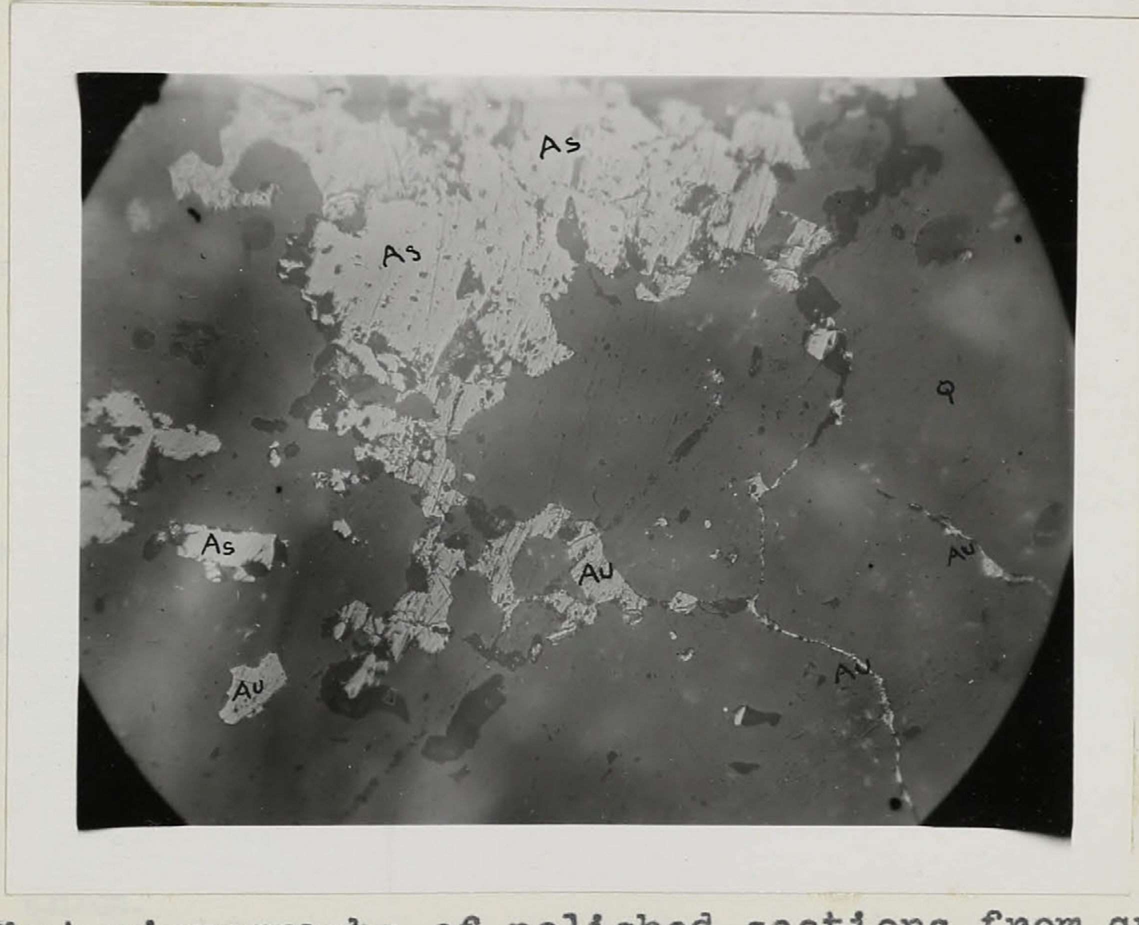
Other veins within the porphyry are known to contain gold. In a crosscut east of the shaft on the fourth level, a stringer composed chiefly of quartz and arsenopyrite from one to six inches in width has been exposed for a length of 12 feet. The strike is east-west and the dip is 80° to the south. In part it consists of a massive seam of arsenopyrite crystals, veined by quartz. Coarse visible gold and small amounts of galena occupy fractures in the quartz. Considerable gold has also been observed adhering to the slickensided surface of the porphyry footwall. Polished sections also show small amounts of carbonate to be present, chiefly as narrow bands between quartz veinlets and arsenopyrite crystals.

No.2A Shear

The vein system known as 2A shear provides nearly 70 percent of the estimated ore reserves of the mine. It consists of numerous quartz stringers in a zone of sheared and mineralized greywacke. This zone trends in a direction south 70° west from the north contact of the porphyry stock

Plate No.4





Photomicrographs of polished sections from quartz-arsenopyrite vein in porphyry, on 4th level. Quartz (Q), arsenopyrite (As), gold (Au). Magnification 100 diameters.

for about 375 feet, and has a maximum width of about 18 feet. It is best developed on the first and second levels where it has a known length of 360 feet, and reaches widths up to 13 feet of ore grade. The location of its projection to surface is partly obscured by soil and broken rock and by tongues of porphyry projecting from the main stock. However, the presence of stringers in a sheared zone near the north contact of the intrusive, to the southwest of the office building, makes it reasonable to assume that the zone extends to surface. On the third level the stringer zone has a known length of 240 feet and a maximum width of about 8 feet, while on the fourth level the shearing is much less pronounced and is accompanied by relatively little vein material.

Individual shear planes and stringers strike about S80°W, thus making an angle of about 10° with the trend of the ore zone. The strike of the latter (S70°W) is a result of its being offset in various places, as shown on the level plans, by what appears to be a succession of small drag-folds. The stringers, except for minor contortions, do not change their strike by persisting around the noses of the apparent folds but pinch out rather abruptly on reaching them.

Whereas individual shear planes appear to be vertical or inclined steeply southward, a line drawn through the centre of 2A shear as exposed in vertical cross section on the various levels has a dip of 85° northward, suggesting that in going downward the vein system is displaced to the north by drag-folding. (Map No.7).

Although positive proof in the form of visible bedding is lacking, it is the writer's opinion that the above features have been produced by steeply plunging drag-folds. Supporting evidence for this view is found in the occurrence, especially near the folds indicated on the level plans, of "S"-shaped quartz stringers. The "S" shape is seen in plan and vertical cross section (the "S" being on its side in the latter case), while longitudinal sections indicate a steep plunge, usually 75° to 80° westward.

The ore minerals which have been introduced into the shear are arsenopyrite, pyrrhotite, pyrite and native gold, in order of their relative abundance. The sulphide minerals typically occur as small grains and crystals disseminated through the schist, adjacent to and between quartz stringers. They are not usually found in abundance more than an inch or two away from a quartz stringer, but in some places as much as ten feet from the stringer zone, sheared greywacke has been liberally mineralized over widths of a few inches by fairly coarse crystals of arsenopyrite up to 6 or 7 mm. across. A good example of this is seen in the face of the second crosscut north in 202A drift west, where arsenopyrite crystals are accompanied by secondary quartz and albite. (Plate 5).

Plate No.5

Arsenopyrite (black) with pressure shadows of quartz and albite (light) in greywacke north of 2A shear on second level. Cross nicols x 15.

Quartz stringers (coarse grained) in greywacke 502AW. Crossed nicols x 15.

Sulphides and native gold are occasionally seen occupying fractures within the quartz. Much more commonly gold occurs as rather fine particles on schist partings near stringers, where it is usually accompanied by an abundance of fine sulphides. Both gold and sulphides are often covered with a film of sericite, which at times makes it difficult to distinguish between them with the naked eye.

No 3 Shear

No.3 Shear is very similar to No.2A in that it consists of similar quartz stringers in schisted greywacke, with the same sulphide minerals and gold. The zone strikes east-west and passes about 35 feet north of the shaft. It was traced by preliminary surface work from the east contact of the porphyry stock to a point 200 feet west of the shaft, where the stringers pinch out. It would appear to merge with 2A shear about 125 feet west of the shaft. In a trench northwest of the shaft, channel sampling indicated a good grade of ore over a width of 17 feet, but part of this is likely attributable to No.2A. No.3 shear apparently has a vertical dip from surface to the first level where stringers are sufficiently closely spaced for 100 feet west of the main crosscut to provide rather low grade ore over drift width. The downward extension of No.3 shear is represented on the second level only by a very narrow shear unaccompanied by vein material.

No.4 Shear

No.4 Shear provides about 30% of the estimated ore tonnage of the mine, but is expected to yield a larger percentage of the gold, since its gold content per ton is believed to be greater than that for the 2A orebody.

It consists of a band of chloritic schist accompanied by vein material, chiefly of quartz, but locally containing considerable white carbonate in addition to arsenopyrite, pyrite, galena, sphalerite, native gold and a little pyrrhotite.

On surface the shear is seen to commence as an inclusion of schist in the porphyry 120 feet east of the shaft. It strikes southwesterly to a point 35 feet south of the shaft, and from this point has been traced for a distanse of 280 feet almost due west. The dip averages about 87°south. Except for local bulges the schist has a fairly uniform width of from 2 to 3 feet on the east, tapering gradually to a width of about 10 inches in the most westerly surface exposure.

Just what happens to the schist band in the vicinity of the porphyry stock is uncertain. On surface it would appear that the schist inclusion in the porphyry, already alluded to, is the same as the schist of No.4 shear south of the shaft, but the exposure is not continuous. On the first level the schist apparently pinches out near the main crosscut; east of this point it may have been obliterated by vein replacement. Exposures on the second and third levels suggest that the schist is more or less continuous to the porphyry contact.

The schist weathers from brown to dull green and, where partly decomposed, is quite soft. Fresh specimens however are quite firm and compact owing to the presence of considerable quartz which is masked by the chlorite. Under the microscope a well-developed wavy schistosity is seen to be produced by the bending of chlorite flakes around lenticular aggregates of small quartz particles.

In addition to these minerals a considerable quantity of carbonate is present as irregular grains more or less elongated parallel to the schistosity. Small grains of sulphides, chiefly arsenopyrite, are scattered throughout and a few very small grains of a highly refractive mineral, probably apatite, are present.

The writer believes that the chloritic schist of No.4 shear has been produced by shearing and hydrothermal alteration of greywacke; and that this greywacke was essentially of the same character as that on either side of the schist band. The reasons for this opinion are as follows:

1. Shearing is indicated by the well-developed foliation of the schist and the slickensiding of adjacent greywacke.
2. Hydrothermal alteration is indicated by the large amounts of chlorite and carbonates in the schist, the carbonates occurring as large grains in part replacing chlorite and possibly quartz.

3. The quartz grains of the schist resemble those of the greywacke in size and shape and are found in sumilar proportion. The absence of biotite, feldspar and sericite in the schist can be accounted for by hydrothermal alteration.

4. It is not likely that the schist represents an altered intrusive rock, although this possibility cannot be entirely disregarded. The sharp contacts of the schist with the greywacke have brought forth the suggestion that the former may represent a basic dyke. There are two main objections to this idea in that (i) No basic dykes of pre-shearing age are known in the general vicinity of the mine, and (ii) one would expect to find in the schist some relic of minerals other than those found in the greywacke, and would not expect to find so much apparently original quartz.

It is even less likely that the schist was formed by the alteration of an albite porphyry dyke. It has already been shown that these rocks are brittle and tend to become brecciated and shot through with vein material, rather than to form a compact schist.

Vein material is found accompanying the schist of No.4 shear from the porphyry contact more or less continuously to a point about 200 feet west of the shaft, beyond which point it is not present in important amounts. This condition prevails on all four levels as well as on surface. The greatest width of quartz (7 feet) is directly south of the shaft. West of this point somewhat discontinuous veins and stringers are for the most part confined to the schist-greywacke contact although, locally, vein material may be enclosed by either of the rocks alone. East of the shaft this close association of schist and quartz does not obtain, a number of quartz stringers (and veins) being largely confined to the greywacke.

The quartz is very similar in character to that of the other vein systems of the mine, having a glassy appearance and a fairly coarse granular texture. It has undergone considerable fracturing both prior to, and following much, if not all, of the sulphide mineralization. The pre-mineral fracturing has likely been localized by thin schist inclusions oriented parallel to the vein. Along many of these the vein splits readily to reveal a thin layer of bright green chlorite, accompanied by microscopically visible grains of carbonate and sericite. The carbonate and sericite have almost certainly been introduced by hydrothermal solutions, while the chlorite, differing in colour and optical properties from the chlorite of the schist band, may have a similar origin; in which case it must be considered to have followed rather than to have localized the longitudinal fracturing. However, in the case of the larger schist inclusions there is no doubt as to their having been scaled from the walls of the veins.

The extent to which wall rock has been replaced by gangue minerals of the vein has not been studied in detail, but visible silicification of greywacke and schist is seldom encountered, and then only over very narrow widths.

The introduction of quartz into the wall rock appears to have been accomplished by the filling of clean-cut fractures rather than by molecular replacement of pre-existing minerals.

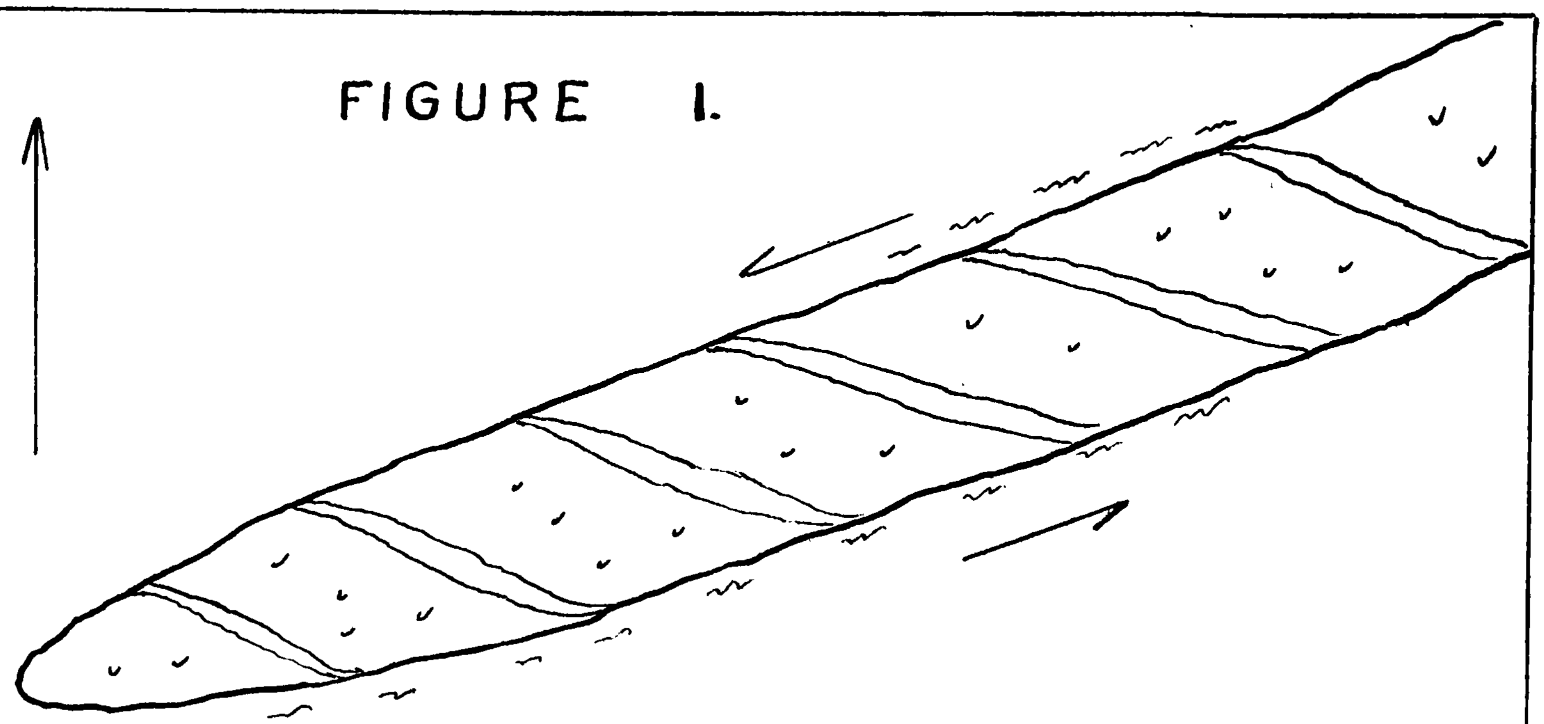
The sulphide minerals accompanying No.4 shear are less abundant than in No 2A and No.3 shears, but contain two varieties not seen in the latter; namely, galena and sphalerite. Arsenopyrite is the most abundant sulphide and, together with small amounts of pyrite and pyrrhotite, is found chiefly as disseminated grains and crystals in the schist and greywacke close to the veins. Arsenopyrite and pyrite in lesser amounts occupy fractures in the quartz. Galena and sphalerite occur in approximately equal amounts in the longitudinal fractures within the veins or near their margins. So far as is known to the writer, native gold in No.4 shear is confined to the veins and their surfaces contacting the wallrock. Gold deposition has favoured the longitudinal fractures and especially those containing the bright green chlorite. In such places the gold at times forms quite spectacular concentration, the particles being partly embedded in the quartz and partly emergent at the surface of the chlorite film. Fractures containing galena and sphalerite and/or arsenopyrite usually contain gold, but the latter is frequently found without sulphide minerals. Such mineralized fractures are most common where the vein is between the schist and the greywacke and is less than two feet in width. This condition has an important bearing on the ore-making possibilities of No.4 shear since stringers as narrow as 4 or 5 inches may contain enough gold to be profitably mined. Polished sections have shown the gold to occupy fractures in the quartz and in no case has it been observed to be directly enclosed by any of the metallic sulphides. For this reason it is the writer's opinion that there is no close association between the gold and sulphides, that they occur together chiefly because the fractures suitable for the deposition of one were also suitable for the deposition of the other; and consequently, that in the treatment of the ore, only moderately fine grinding should ne necessary to obtain a satisfactory separation of the gold.

Structural Control of Ore Deposits

An outline of the structural history of the area is given in the section of this paper dealing with the general geology. It was pointed out that, following the regional folding, horizontal movements took place along the Cadillac break, the north side moving east relative to the south side. Such movements produced Z-shaped drag-folds in the sediments and volcanics of the Cadillac belt. (The best known example of this type is that at Pandora Cadillac east shaft. See fig.4 accompanying memoir 206). Whether or not the mass of sediments lying south of the break was an active block, it was subjected to stresses tending to move it in a westerly direction. If these stresses were of unequal intensity from north to south, there would be a tendency for differential movement between various parts of the mass. Since the stresses were acting in a westerly direction, generally parallel to the strike of the bedding, it would be expected that failure would occur along bedding planes; or, where the beds were sufficiently inclined to the stresses, the more competent ones would be expected to yield by shearing and the less competent ones by drag-folding.

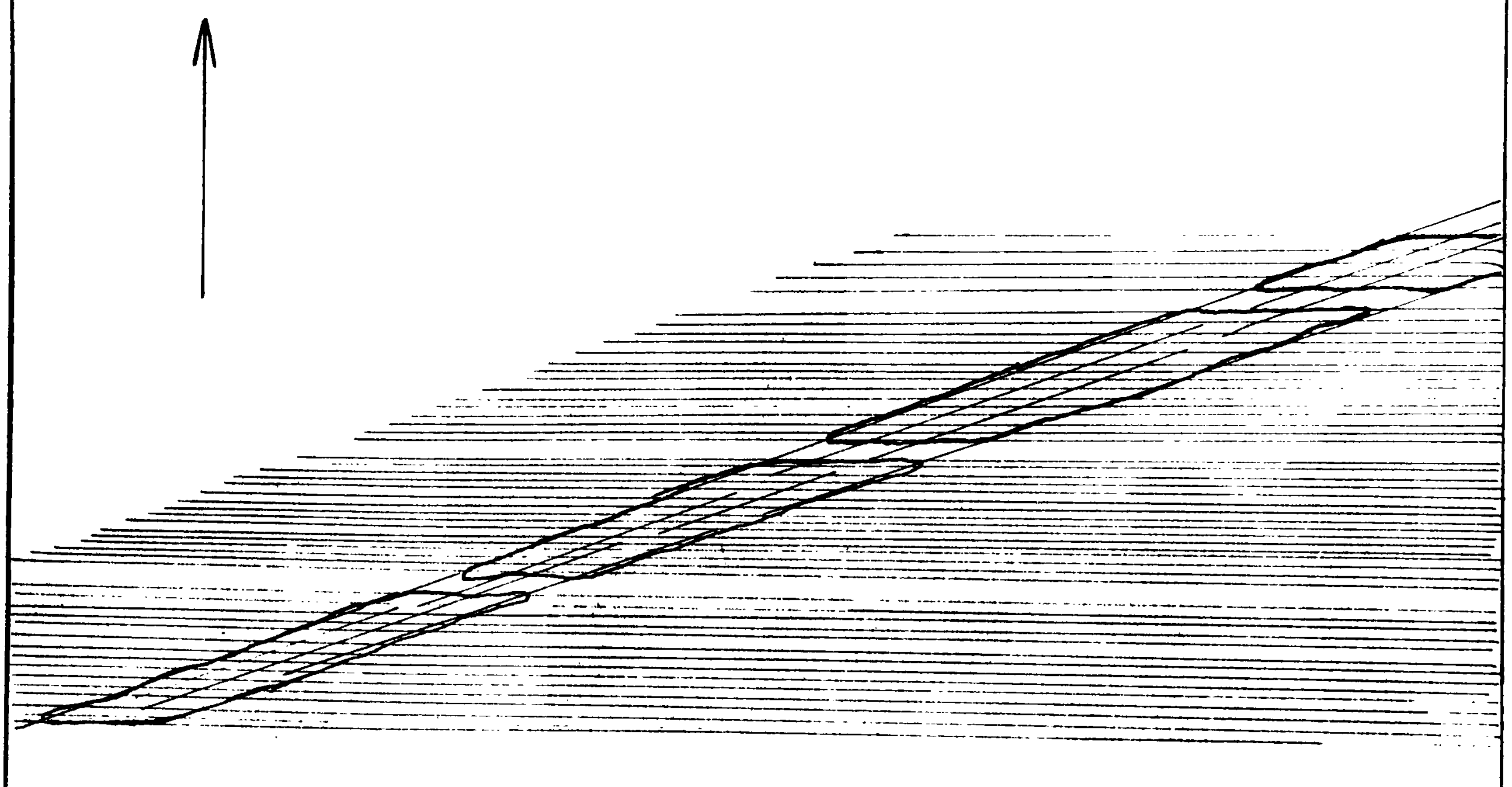
For the purpose of this discussion the mass of sediments south of the Cadillac break may be considered to have been

FIGURE 1.



Sketch illustrating ladder-vein structure produced in small porphyry dykes by shearing

FIGURE 2.



Illustrating how an ore-zone, similar in shape to 2A Shear, might be produced in the intersection area of two steeply dipping sets of shears.

moving westward. In so far as the Amm property is concerned, it may also be considered to have consisted of two blocks subjected to stresses of different intensities from the east. The boundary between the blocks, consisting in part of the Amm No.1 shear, may be taken as the north boundary of the zone of porphyritic intrusives. Of the two blocks the more active was the northerly one, lying between No.1 shear and the Cadillac break. This block moved westward relative to the south block as evidenced by the S-type drag-folding and the shortening of the argillaceous band.

The writer has taken this simple case in order to illustrate what he considers to be the origin of the shearing and the drag-folding, and to show why the drag-folds should have S-shapes in contrast to the Z-shaped folds of the Cadillac belt. It must be borne in mind, however, that the movement between these two blocks was taken up on a great number of planes, as evidenced by numerous small schist bands and slickensided fractures in the sediments. It should be realized that the sediments between No.1 shear and the Cadillac break may not form a single block, but that there may have been considerable movement between any number of blocks comprising this rock mass. At present it would seem that most of the differential movement south of the Cadillac break, in so far as the immediate area under discussion is concerned, took place along a zone about 1000 feet wide in which the porphyritic intrusives occur. Such movements would establish lines of weakness and these would undoubtedly influence the location and shape of the various porphyry bodies. Long tabular and lenticular dykes and sills entered along lines of shearing, while the very irregular stocks occupied weak zones in the folded areas.

Following the emplacement and solidification of the intrusives, further east-west movements took place. These movements caused shattering of the porphyry and probably re-opened fractures in the greywacke. The most severe shattering was suffered by the main porphyry stock, probably because of its comparatively large north and south extent which transgressed many lines of east-west shearing. That the movements were mainly north-side-west is shown by the "ladder-vein" structure developed in some of the small dykes and sills (Fig.1).

The fracturing of the porphyry allowed the introduction of the vein-forming solutions which, particularly to the west of the main stock, were forced into the adjacent sheared greywacke. That they entered under considerable pressure is evidenced by the beaded shape of many stringers caused by alternate pinching and swelling.

The shearing which admitted vein solutions into the zone known as No.2A shear has been described in a previous section as being related to drag-folding, and developed as a result of beds on the north tending to move westward relative to those on the south. It would be possible, however, for a vein-zone of approximately this shape to have been formed by shearing without drag-folding. It has been suggested that this has been accomplished by two sets of intersecting shears with steep dips, one set striking east-west and the other set about N 70° E. If vein material were introduced into the area of intersection of these two sets of shears, then a lenticular vein-zone would be formed. If the east-west shears were in groups, the gaps in the vein zone would result in a number of overlapping lenses. (Fig.2).

The foregoing hypothesis would account for the lack of vein material in No.3 shear on the second level and in 2 A drift on the fourth level, if it be assumed that, in the first case, No.3 drift is south of the intersection area of the two sets of shears, and in the second case that the intersection area does not extend to the fourth level, or is very narrow at that horizon.

While the possibility of such a condition must be kept in mind, the writer favours the view that the 2A shearing is closely related to drag-folding. Following are the reasons for this view:

1. Complex drag-folding in the band of argillite to the northwest of 2A shear shows that strong forces were applied tangentically to the bedded rocks in the vicinity of the mine.
2. Variations in strike and dip between individual shears were noted, but when classified as to attitude they did not fall into two well-defined sets.
3. Individual stringers pinch out sharply in relatively massive greywacke and not against transgressive shears.
4. The majority of the stringers strike nearly east and west, parallel to the axial planes of the postulated folds.
5. If the ore zone represents the intersection area of two sets of shears it would be expected that individual shears could be traced beyond the limits of the zone. This is seldom the case.

Origin of the Deposits

General Statement

It is the writer's opinion that a discussion of the origin of the deposits of the Amm gold mine should be based on a comparison with those of the Cadillac belt because of a certain parallelism of mineralogical and structural features.

In the light of present knowledge it must be assumed that such vein deposits were formed by ascending hydrothermal solutions which were the residual liquids of a cooling magma. The following discussion will attempt to show that the solutions which gave rise to the Amm deposits arose from the same or a very similar magma as that which gave rise to the deposits of the Cadillac belt.

To facilitate comparison, the mineralogical characteristics of veins and wall-rock of the Amm deposits have been tabulated side by side with those of the Cadillac belt as described by Gunning.

Vein Mineralization

AMM DEPOSITS	CADILLAC BELT DEPOSITS
Gangue	
<u>Quartz</u>- coarse-grained, vitreous and white. Sharp boundaries with wall-rock.	<u>Quartz</u> - dense, dark grey and blue, some is white. Sharp boundaries with wall-rock.
<u>Carbonate</u> - abundant in places, a few late calcite veins.	<u>Carbonate</u> - small amounts intergrown with quartz; more abundant as late veins.
<u>Albite</u> - Small amounts intergrown with quartz in stringers.	<u>Albite</u> - abundant with quartz as small veins.
<u>Tourmaline</u>- very little, if not entirely absent.	<u>Tourmaline</u> - not usually abundant but of widespread occurrence.
Minor amounts of chlorite and sericite.	Minor amounts of chlorite, biotite, sericite and ilmenite.
Ore	
<u>Gold</u> - native in veins and on their margins, chiefly in fractures paralleling the veins; not enclosed by sulphides.	<u>Gold</u> - native in veins and mineralized wall-rock; varies from microscopic specks to spectacular shoots. Some is enclosed by arsenopyrite.
<u>Arsenopyrite</u> - widely distributed throughout intrusives and near veins in greywacke; minor amounts in veins.	<u>Arsenopyrite</u> - common in veins and mineralized wall-rock, typically as small disseminated crystals in the wall-rock.
<u>Pyrite</u> - fairly common in mineralized greywacke, minor amounts in veins.	<u>Pyrite</u> - common in mineralized wall-rock, minor amounts in veins, forms massive seams with pyrrhotite.

AMM DEPOSITS	CADILLAC BELT DEPOSITS
	Ore (contd)
Pyrrhotite - common with arsenopyrite and pyrite as fine grains on schist partings in greywacke.	Pyrrhotite - with pyrite in veins and wall-rock.
Chalcopyrite - very little, if not entirely absent.	Chalcopyrite - small amounts with pyrite and pyrrhotite and as tiny veinlets in arsenopyrite.
Galena and Sphalerite - fairly common in No.4 vein, usually accompanied by native gold. A little galena in quartz-arsenopyrite stringers.	Galena and Sphalerite - very small amounts in some of the quartz veins. Tiny nests of galena in O'Brien No.4 vein.

Wall-Rock Alteration

"The vast majority of the many small veins in the area show no noticeable alteration in the adjoining rocks and, as noted previously, are practically devoid of metallic minerals. This is a feature worthy of note, for the known commercial deposits are accompanied by slight to very pronounced alteration, and iron sulphides and arsenopyrite are present, often in abundance." (Memoir 206. p.35)

AMM DEPOSITS	CADILLAC BELT DEPOSITS
Carbonatization - widespread but not abundant except in No.4 shear; accompanied by chlorite and sericite.	Carbonatization - most abundant and widespread, accompanied by chlorite or brown biotite or sericite.

Wall-Rock Alteration (contd)

AMM DEPOSITS	CADILLAC BELT DEPOSITS
Sericitization - abundant throughout intrusive and No.2A shear.	Sericitization - principally along veins in quartz-albitite.
Quartz - introduced as veins; albite seen to be intergrown with quartz in one instance.	Quartz and Albite - introduced into wall-rock as small veins, not by replacement.
Tourmalinization - none.	Tourmalinization - not common.
Metallization - Addition of sulphides over narrow widths.	Metallization - Addition of sulphides over considerable widths.

The foregoing comparison shows the Amm deposits to be very similar mineralogically to those of the Cadillac belt and, considering that they are only about 1500 feet from the belt and about 4,000 feet from the nearest explored deposit on the belt, (at Pandora Cadillac west shaft) it is reasonable to assume that the deposits arose from the same magma at the same stage in its differentiation. Gunning has advanced convincing arguments to show that there is a close genetic relationship between the albitites and gold-bearing veins of the Cadillac belt. Whereas the writer did not see transitions from albite-bearing quartz veins to pure quartz veins on the Amm property, it is probable that here also the vein material has a close relationship with the albite porphyry, in that the veins represent a later stage in the differentiation of the same magma.

Sequence of Mineralization

The writer has no conclusive evidence for more than one general age of mineralization. The fact that arsenopyrite is in some places veined by quartz (plate 5) and in other places occupies fractures in the quartz may be taken as an indication that both were being deposited either continuously or intermittently over a considerable period. Pyrrhotite and pyrite, in so far as observed, followed quartz, but their relation to the post-quartz arsenopyrite was not discovered. Pyrite coats many of the walls of late open fractures found in all rock types. Galena and sphalerite appear to be more or less contemporaneous although in one place sphalerite is seen veining galena. Both are seen replacing pyrite and arsenopyrite. Gold is certainly later than the bulk of the quartz as it occupies fractures in the quartz or is found adhering to the quartz at the schist contact. It is also later than galena and sphalerite. Carbonates were among the last minerals introduced but some calcite in No.4 vein may have preceded the gold. Some sericite was deposited at a very late stage as it commonly forms a coating over surfaces on which gold and sulphides were deposited.

Some Economic Considerations

1. The question has arisen as to why there are apparently

no economically valuable concentrations of gold within the Amm porphyry stock. As previously stated, the stock is traversed by a great many quartz veins and much arsenopyrite with minor amounts of pyrite is disseminated through it. At least three answers to this question may be given. They are as follows:

(a) As already indicated, gold followed the quartz. The fracturing necessary to admit the gold-bearing solutions was probably more intense in the veins within the porphyry than in those within the greywacke, which were probably cushioned to some extent. It may be that the fractures in the porphyry veins were too open to cause sufficient retardation of the gold-bearing solutions to effect precipitation, but that the more minute fractures in quartz in the greywacke were able to slow up circulation enough to cause precipitation.

(b) Such gold as was available for deposition in veins in the porphyry may have been dissipated through many channels.

(c) Chlorite is believed to be chemically active in precipitating gold from solutions. Its abundance in the sheared greywacke and scarcity in the intrusives may account for the observed preference of gold for the former rock type.

It must not be concluded, hpwever, that no economically important concentrations are to be found within the Amm porphyry stock. Further work may show that much of the gold was introduced through a limited number of channels which may have retained enough of the metal to warrant their being mined; or, certain areas of the stock may have favoured more minute fracturing of the quartz, resulting in more abundant gold deposition. The gold-bearing vein in the porphyry on the fourth level shows that where seams of arsenopyrite are veined by quartz, rich shoots may be formed. For these reasons the Amm porphyry stock deserves further exploration.

2. Whether 2A ore zone is controlled by drag-folding or by intersecting shears without drag-folding, there is no apparent reason why similar conditions should not be repeated in the vicinity of the mine, particularly below the present mine workings.

3. No.4 shear, which shows no change in general characteristics from surface to the fourth level, can

reasonably be expected to continue downward for at least several hundred feet.

4. It has already been indicated that considerable movement may have taken place between rock bodies to the north of No.1 shear. It is possible that the pronounced valley crossing claim A-585 marks a zone of weakness along which movements have taken place, and which would be suitable for the intrusion of igneous rocks and the formation of ore deposits. Because of this possibility, the bedrock underlying the valley should be explored, preferably by diamond drilling. For the same reason the gully marking the south boundary of the zone of porphyritic intrusives warrants prospecting.

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