THE MINERALOGY AND GEOLOGY OF THE AKAITCHO AREA, YELLOWKNIFE, NORTHWEST TERRITORIES

BY

ALBERT HEDLEY MANIFOLD.

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ABSTRACT

The Akaitcho property borders the northern claims of the Giant Yellowknife property. Diamond drilling has revealed an ore body lying along a terrace in a steeply-dipping mineralized shear zone. The shear is contained in Pre-cambrian volcanic rocks all of which have been more or less regionally metamorphosed. Adjacent to the ore, the rocks contain much introduced quartz, calcite, and pyrite. Sulphide mineralization is sparse but the ore is quite complex with an abundance of pyrite, arsenopyrite, stibnite, and sulpho-salts present. The gold is very fine-grained, the largest particle observed microscopically being 150 microns in diameter. It is disseminated in a quartz-carbonate gangue and is also closely associated with sulphides especially arsenopyrite and veinlets of sulpho-salts. Based upon the mineral assemblage, the alteration zone, and the general nature of the ore, the deposits would be classed as mesothermal.

ACKNOWLEDGMENTS

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INTRODUCTION

General Statement:

A rapidly developing mining area in Canada to-day is that of Yellowknife, Northwest Territories. While the Negus and Con gold mines have been established there since 1938 it was not until the recent discovery of the ore-bodies of the Giant Yellowknife Gold Mines that the area gave promise of large tonnage mining. Since that time much exploration work has been carried on. One of the most interesting properties being developed now is that of the Akaitcho Gold Mines, Limited. Diamond drilling since the latter part of 1944 has indicated an ore-body, which, although not having anything like the dimensions of the Giant ore-bodies, should prove to be profitable.

The main purpose of this investigation is to study the Akaitcho ore in polished section to determine the various minerals present and their relation to each other. Along with this investigation is a petrographic study of some of the main rock types in the area and of the altered wall-rocks of the deposit.

Location and Transportation:

The Akaitcho property lies approximately four miles north of the town of Yellowknife. The southern portion borders the Giant property. A serviceable road constructed in the summer of 1946, runs through the property to Yellowknife.

Physiography:

The low relief and many lakes of the country are typical features of Pre-cambrian topography. Great Slave Lake has an elevation of 495 feet while the highest hill in the immediate vicinity of Yellowknife is 865 feet. Maximum relief is afforded mainly by fault-line scarps and bodies of intrusive rocks. Much of the drainage is conformable to the major fault systems and general trend of the formations. One of the chief characteristics of the area is the large amount of bare outcrop. Between the outcroppings are drift-covered areas of muskeg.

History of the Akaitcho Property:

The property was originally known as the A.E.S. group and consisted of twenty-four claims staked in 1936 for the Aerial Exploration Syndicate, Limited. Frobisher Exploration Company optioned the property in 1944 and later in that year organized the Akaitcho Gold Mines, Limited, to carry on development work. To the present date diamond drilling has been carried on and has revealed a promising gold-bearing zone.

ECONOMIC GEOLOGY

General Statement:

Total production of gold from the Yellowknife district has amounted to over fifteen million dollars. This has been principally from the Con mine of the Consolidated Mining and Smelting Company of Canada and the Negus mine of Negus Gold

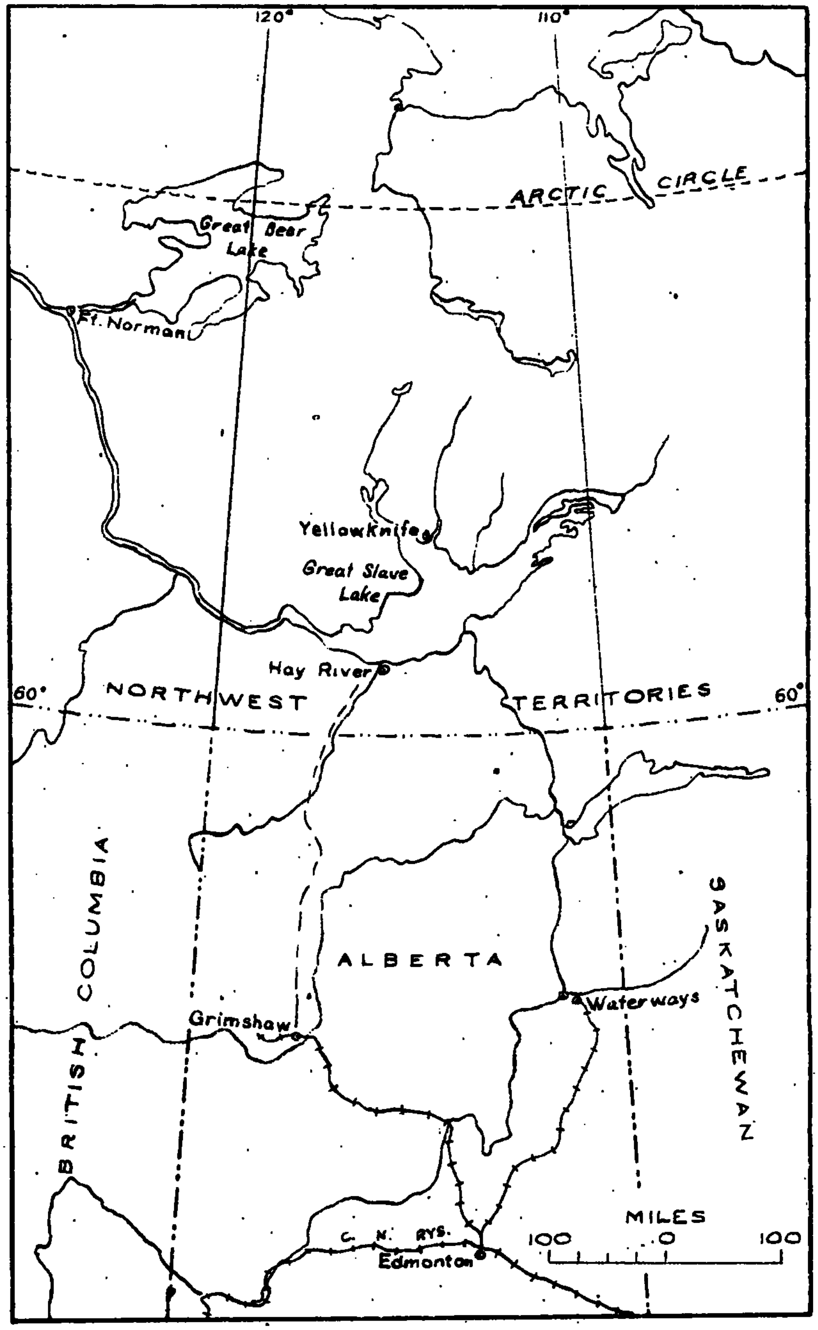


FIGURE I - MAP SHOWING LOCATION OF YELLOWKNIFE

Mines, Limited. These two mines began producing in 1938 and 1939 respectively. Several other mines such as the Thompson-Lundmark, Camlaren, and Ptarmigan have produced for short periods. The last mentioned mines have been idle for some time but in the latter part of 1946 the Thompson-Lundmark was being dewatered in preparation for further development and production.

Production and Power:

The two main producers each treat about one hundred tons of ore per day, although the production has been increased lately. Operating costs vary from fourteen to nineteen dollars per ton with the grade of ore being approximately 0.8 ounces of gold per ton. The Giant Yellowknife property intends to mill 2000 tons per day and with such a tonnage should reduce operating costs considerably.

Both diesel and hydro-electric power are used by the mines. Diesel oil is obtained by barge from Fort Norman and electricity is obtained from a hydro-electric plant owned by the Consolidated Mining and Smelting Company of Canada and located about fifteen miles north of Yellowknife at the head of Prosperous Lake. A new hydro-electric plant is now being constructed on the Snare River about 120 miles from Yellowknife. The first part should be completed in 1948 and will supply 8000 horse-power. Further development is planned and the project will eventually result in the production of an estimated 25,000 horse-power.

Types of Deposits:

Gold deposits in the district can be classified as two general types.

(a) Deposits in volcanic rocks

Examples: Con Mine, Negus Mine, Giant Yellowknife Gold Mines, Limited., Akaitcho Gold Mines, Limited, and Crestaurum Gold Mines, Limited.

(b) Deposits in sedimentary rocks

Examples: Camlaren Mines, Limited, Thompson-Lundmark Gold Mines, Limited, and Ptarmigan Mines, Limited.

The gold of the deposits in volcanic rocks is contained in quartz-carbonate veins or masses of veinlets within steeply dipping shear zones. Ore-bodies of the Negus and Con mines have mining widths up to twenty feet but some of those of the Giant mine are up to forty feet or more. Metallic content of the ore zones is small but a wide variety of minerals is represented.

Most of the gold of the deposits in sedimentary rocks occurs in veins or lenses of fairly pure quartz. Some veins are found parallel to the bedding and some crossing the bedding. One vein of the Camlaren Mines forms a saddle-reef at the crest of a fold. Other veins and lenses are found associated with drag folds and axial planes of folds.

The gold deposits in the volcanics have proven up to the present to be more extensive and by far the most important. It is probable the volcanics fracture and shear more so than the sediments and thus are more favorable host rocks.

GENERAL GEOLOGY

Volcanics:

The Yellowknife area is underlain completely by Precambrian rocks. Volcanic and sedimentary formations of the Yellowknife Group, classified as Archean in age, are the oldest exposed rocks. The volcanics consist mainly of andesitic flows many of which exhibit pillow structure. Some of the flows are massive and fairly coarse-grained while others show vesicular or amygdular structures. A few flows are of a spherulitic or variolitic nature.

Sediments:

There are two general types of sediments termed locally "hot" and "cold". The "hot" sediments consist of quartz-mica schist, knotted schist, slate and phyllite bordering intrusive granitic bodies. They grade outward to comparatively unaltered areas of arkose, slate, and greywacke, the so-called "cold" sediments.

Intrusives:

Present in the area are numerous granitic intrusions two of which now are definitely known to be different in age. The older type is a uniform, fairly coarse-grained granodiorite containing considerable amounts of biotite and hornblende while the younger type is a muscovite-biotite granite accompanied by many tourmaline-bearing pegmatite dykes.

There are also many minor intrusives of a dioritic or gabbroic nature appearing in some cases to be in the form of sills.

Cutting the volcanics are large numbers of basic dykes rarely over twenty-five feet in width. They have a composition similar to the flows and are distinguished in the field only by careful examination. The writer has noticed them only in areas of volcanic rocks. Presumably they were formed during the period of vulcanism and may represent feeders for some of the later flows.

Another type of dyke is one that has been locally termed "bird porphyry". It is a fairly late dyke cutting the type mentioned in the previous paragraph and also cutting the diorite-gabbro intrusives. However, in all cases observed the "bird porphyry" has been cut by diabase dykes.

Considered to be the youngest consolidated rocks of the area are the late quartz-diabase and olivine-diabase dykes which cut all other formations. The C4 shear zone of the Con mine is cut by an unaltered and unsheared diabase dyke. (7, p. 108)

STRUCTURAL GEOLOGY

Faults:

The most striking structural feature of the area near Yellowknife is the system of north-striking, steeply-dipping faults. A large vertical diabase dyke shows a total displacement of approximately eleven miles across the zone with the relative displacement along the individual faults being generally the east side to the north. Plainly visible from the air is the West Bay Fault with a horizontal displacement

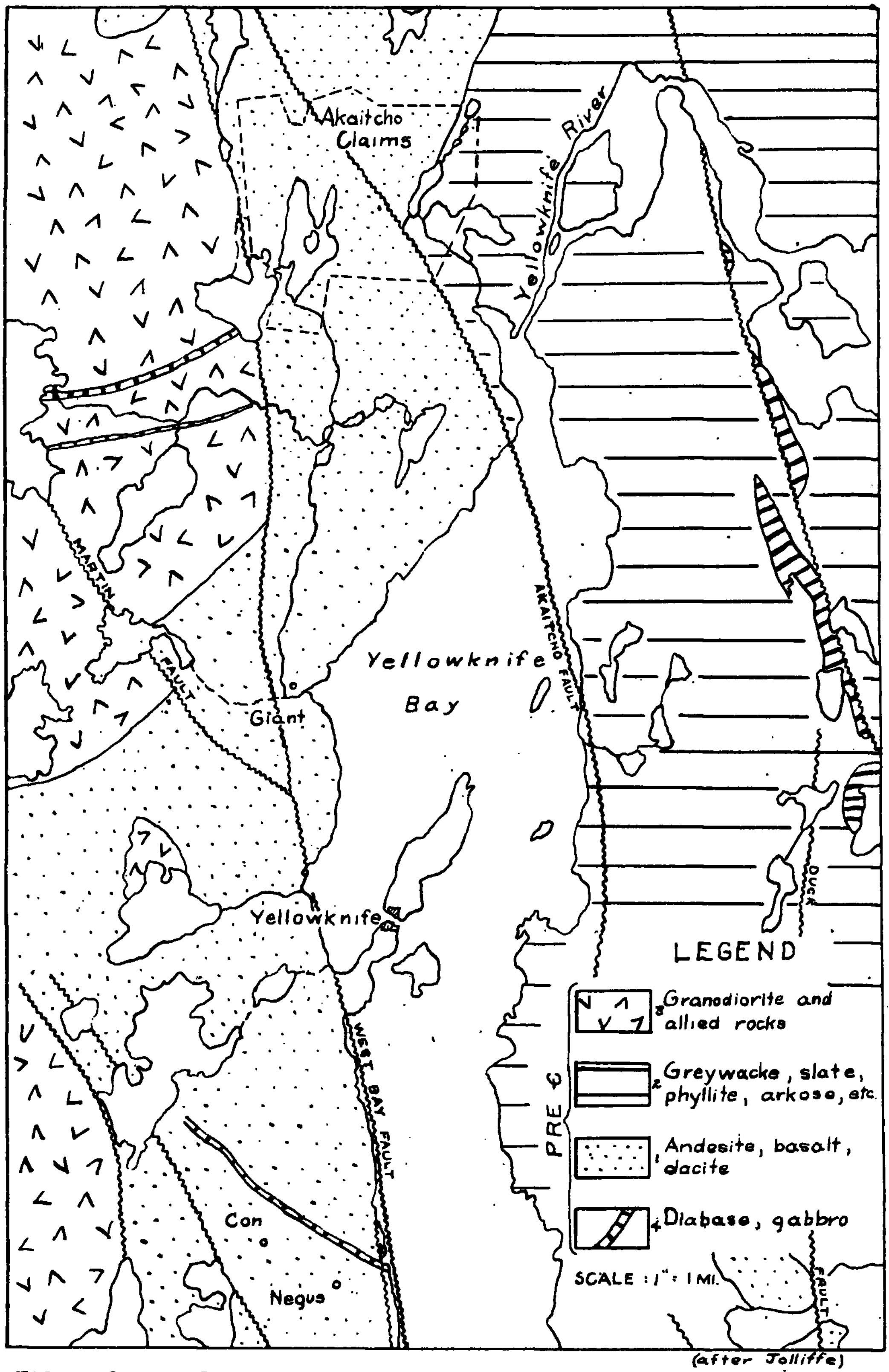


FIGURE 2 - MAP SHOWING GENERAL GEOLOGY OF YELLOWKNIFE DISTRICT

of five miles. The vertical displacement, though not proven, is believed to be quite small. Crossing the Akaitcho property and running into the West Bay Fault from the east is the Akaitcho Fault with a left-hand horizontal displacement of about 5000 feet. Shear zones along the faults are quite narrow considering the amount of displacement. All the evidence of the West Bay Fault as seen in drill cores from the Giant property is several inches of gouge. The age of major faulting cannot be placed any more definitely than post-diabase and pre-Pleistocene.

Shear Zones:

The main known ore-bodies lie in shear zones adjacent to the West Bay Fault. These zones have a general north-south strike and varying dips. The general belief of competent geologists who have studied the area is that the ore-bodies are offset by the fault. It is possible the stresses that finally resulted in the fault first produced the shear zones. The en echelon arrangement of the shears and their proximity to the fault support this supposition.

Formations:

Within the area underlain by volcanics, the flows, interbedded tuffs and chert bands have north-easterly strikes and steep dips with the tops, where determined, to the south-east. On the Akaitcho property drill core sections show that the flows dip from forty-five to sixty degrees at the surface but tend to flatten several hundred feet underground.

Akaitcho Ore Body:

The general structure of the mineralized shear zone on the Akaitcho property may be seen in the accompanying block diagram. The shear as closely as can be interpreted from diamond drill cores more or less parallels the dip of the flows. In its southern part the shear dips steeply to the east at the surface and then at a depth of 400 feet it flattens to a terrace. It then continues at a shallow dip. The approximate outline of the ore body itself is shown on the block diagram. It can be seen to occur where the shear zone flattens. Where the terrace is most pronounced the ore body attains its maximum thickness and value. This feature seems to be the main structural control. If at greater depth the shear zone flattens again ore may be encountered there.

DETAILED GEOLOGY

General Statement:

The rocks examined represent a fairly low grade type of regional metamorphism in which the minerals albite, epidote, sericite, chlorite, and calcite are produced. Occasionally minor amounts of quartz and calcite have been introduced in the form of small veinlets. These with veinlets of epidote could be attributed to late volcanic effects.

Some of the main rock types have been chosen for examination and a field and microscopic description of each is given.

Rock Types:

(a) Flows:

(1) Light Colored Pillow Lava:

This lava as seen in the field weathers a light grey color. Pillow structure while almost obliterated is distinguishable in several places. Within the pillows but near the borders are numerous amygdules consisting of quartz with varying amounts of chalcopyrite and pyrrhotite.

Microscopically the rock is seen to consist of amygdules up to several mm. in diameter in a fine-grained matrix of epidote, sericite, carbonate, albite, and a little chlorite. There are some large grains up to 1.5 mm. in length that appear to have been feldspar but are now completely altered to carbonate and sericite. The amygdules consist of coarse grains of quartz, calcite, epidote, and sericite with pyrrhotite and chalcopyrite being present in a few of them. Some of the amygdules show concentric bands towards the outer edges.

The writer had considered this type as more acidic than an andesite but there is very little quartz in it and a sodium cobalt nitrate staining test proved no potassium compounds present. The original lava was likely andesitic but the presence of minor chlorite indicates an initial small percentage of ferromagnesian minerals.

(2) Dark Green Pillow Lava:

The lava has a dense fine-grained appearance and weathers a dark green purplish color. Pillow structure is present but is not so prominent as in other types.

The rock is very fine-grained with the largest grain observed, a feldspar lath, being o.35 mm. in length. Some smaller grains of hornblende are present but they are largely altered to chlorite. There is considerable feldspar in the form of albite. Calcite is present in about the same quantity as feldspar. There are minor amounts of sericite. Magnetite is seen as masses of small grains and a few larger euhedral grains. Pyrite also occurs as large euhedral grains. Much of the magnetite is in its original form but some is probably from alteration of hornblende.

The dark color of the lava is due to the large amounts of chlorite, magnetite, and pyrite. This lava likely represents an originally basic type.

(3) Light Green Pillow Lava:

This type is by far the most widespread. The pillows vary in size from one foot in diameter up to six feet in certain instances. Centres of the pillows have a hard glassy appearance. The borders are quite thick and weather a brown color. No amygdules were observed in this type.

Elongated pillows in light-green lava

The main constituents of the lava are chlorite and basic andesine feldspar each being present in about equal amounts. Some of the feldspar has been altered to clinozoisite. Present in minor amounts are small irregular grains of carbonate and a few euhedral grains of magnetite.

Quartz has been introduced in the form of veinlets up to 0.1 mm. in width and also as masses of fine grains.

(4) Variolitic Lava:

Several horizons of this type of lava occur in the area. As seen in the field the variolites, individually measuring up to an inch or more, are found in groups up to several feet in diameter.

Photograph showing a cluster of variolites

The matrix is mainly a mass of fine-grained andesine feldspar, a few small grains of hornblende, considerable amounts of chlorite, calcite, and some epidote. The variolites have a similar composition but are finer-grained. Masses of extremely fine-grained epidote cloud the outer parts of the variolites. Numerous euhedral grains of magnetite up to 0.15 mm. in diameter are seen in the matrix but only occasionally in the variolites.

Crossing one section is a small veinlet of epidote 1.5 mm wide with grains elongated perpendicular to the vein walls. The grains have been bent and fractured parallel to the vein walls showing some movement has taken place.

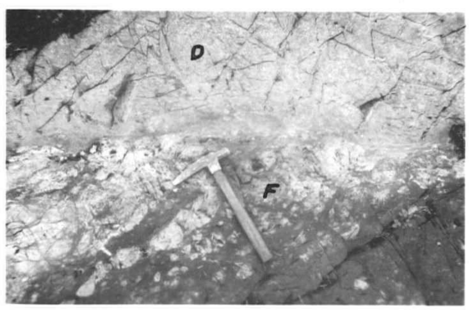
Also cutting across the section are small veinlets of quartz and calcite up to 0.5 mm. in width.

It may be noted that in the "light-colored" and "basic" flows the feldspar is predominantly albite while in the "variolitic" and "light-green" flows the feldspar is andesine

The first two types represent a higher grade of metamorphism. This is borne out by the fact that both are near mineralized shear zones.

(b) Diorite - Gabbro Intrusives:

These are bodies up to several hundred feet in width and several thousand feet in length. While sill-like in appearance they can be seen to cut across the flows in numerous places. The rock is fairly coarse-grained and presents a mottled weathered surface.



Contact of diorite (D) cutting across a flow (F)

Two of these intrusives were examined microscopically. Hornblende is the most abundant constituent with andesine feldspar in almost the same amount. Much of the hornblende has been altered to chlorite while the feldspar has been partly altered to sericite, calcite, and epidote. In one of the rocks there are a few grains of quartz. In both sections small amounts of an opaque mineral are present showing a leucoxene-type of alteration. One of the rocks has a few small cross-fibre veinlets of actinolite up to 0.1 mm. in width.

(c) Bird Porphyry Intrusives:

These are dark green rocks generally in the form of dykes with numerous clusters of white phenocrysts. Individual phenocrysts vary in size up to an inch or two in diameter and generally lack good crystal boundaries.

The main constituent of the groundmass is hornblende. Its short blocky appearance indicates it has been derived from pyroxene. It is partly altered to a few small flakes of biotite and chlorite. Labradorite feldspar is the next mineral in abundance. Much of it is clouded with sericite and epidote. Apart from the phenocrysts the dykes have a typical gabbroic texture.

The white phenocrysts were probably all feldspar but they have been completely altered to zoisite, epidote, a little sericite and carbonate. Little shreds of chlorite projecting into the edges of the phenocrysts indicate the reaction of the groundmass with the earlier crystallized phenocrysts either before or after consolidation.

A little magnetite and hematite are present in the matrix.

~~Barlowe~~ Barlow, in the Ottawa Naturalist, 1895, has given an excellent description of an almost identical type of dyke occurring near Algoma in the Lake Huron District. At that time the phenocrysts were known as "Huronite".

In memoir 166 (3, p. 143) reference was made to a similar type of dyke at Matachewan, Ontario. The dykes have the same porphyritic character but alteration of the phenocrysts is from labradorite feldspar to kaolin and sericite. At Matachewan the dykes were classified as pre-Cobalt in age.

(d) Diabase Dykes:

The diabase dykes as seen in the field weather to a characteristic reddish-brown color. The specimen used in this study is from the large dyke showing the horizontal offset of the West Bay Fault. This dyke is about 400 feet in width being very coarse-grained in the centre.

A small lake along a diabase dyke. The depression was probably caused by plucking of the ice in Pleistocene times.

Observed in thin section the rock is seen to have typical ophitic texture. The two main constituents are large crystals of pigeonite up to 3 mm. in diameter moulded around laths of labradorite feldspar. Considerable magnetite is present partly as large euhedral grains up to three mm. in diameter and as small grains and shreds within altered crystals of hornblende and pigeonite. Some of the feldspar is altered to epidote and sericite while the hornblende is partly altered to chlorite and biotite. A few small grains of hematite are present within the rock.

The feldspars and ferromagnesian minerals in the diorite-gabbro, bird porphyry, and diabase intrusives just considered do not exhibit the same grade of metamorphism seen in the flows. Being much later than the flows, the intrusives were not affected by the regional metamorphism.

MINERALOGY

General Statement:

In the study of the Akaitcho ore two factors are soon noted. These are: first, the sparse mineralization and second the fine texture of the ore minerals. The total metallic content of the ore zone does not average more than five per cent. Figure one is representative of the type of mineralization. Many different minerals are present in the ore but due to the fine texture their exact identification is very difficult. No doubt further examination of the ore will reveal numerous minerals not mentioned in this report.

Samples of ore for this investigation were obtained from core sections of diamond drill holes 54 and 72. The location of the drill holes, which are all vertical may be seen in figure three. The actual sampling of hole 54 was as follows:

Table 1. Samples of Hole 54.

Sample No.	Footage	Assay - oz / ton
1	368.6 - 370.6	trace
2	371.6 - 373.3	0.01
3	373.3 - 375.2	0.60
4	375.2 - 377.2	0.43
5	377.2 - 379.4	0.80
6	379.4 - 380.4	0.10
7	380.4 - 381.4	0.01

Five samples were taken from hole 72 along a core-length of 4.2 feet averaging 0.5 ounces of gold per ton, the highest individual assay being 0.9 ounces.

Identification of the various minerals was based upon optical and physical properties, etch reactions, microchemical analyses, and in some cases spectrographic analyses. To establish the identity of bournonite an X-ray powder photograph was taken by Dr. R.M. Thompson of the University of Toronto.

Metallic Minerals:

Pyrite is one of the most abundant minerals in the ore. It is very euhedral occurring in the form of cubes and pyritohedrons. Occasionally it is intimately associated with arsenopyrite and as such it loses its euhedral character. The pyrite grains are found isolated in the quartz-carbonate gangue and also as clusters forming small veinlets. Figure one shows a few grains of pyrite with arsenopyrite along small veinlets parallel to shearing in the ore zone. Many fractures in pyrite are filled with gangue minerals.

Arsenopyrite is present in the ore in almost the same quantity as pyrite and occurs in much the same manner. It is very euhedral being generally in the form of diamond-shaped crystals or elongated needle-like crystals. Arsenopyrite and pyrite where occurring together are irregular in outline. However, in one case a diamond-shaped crystal of arsenopyrite was found completely surrounded by massive pyrite. The crystal grains of arsenopyrite are scattered with random orientation throughout the quartz-carbonate gangue. Occasionally the grains are fractured and veined by quartz and carbonate but this feature is less frequent than in pyrite.

Stibnite is a fairly common mineral being present in most of the sections examined. It occurs as irregularly shaped grains in the gangue minerals. These grains consist of numerous differently oriented crystals. Where occurring as isolated particles it occasionally has minute inclusions of a whiter mineral. These particles are much too small to test adequately so the identity of the mineral is still unknown. Figure two represents the type of occurrence. Some stibnite forms very fine veinlets in fractured quartz. It is most abundant, however, in veinlets of massive grey sulphides where it is intimately associated with jamesonite and other sulpho-salts. Where it occurs as last described it contains minute inclusions of gold. A more complete description will be given later when the veinlets of grey sulphides are considered.

Chalcopyrite is not very abundant but is present in the sections from both diamond drill holes. In the samples from hole 54 it occurs as small irregularly shaped particles closely associated with stibnite. The chalcopyrite grains border the outside boundaries of much larger stibnite grains. In the ore from hole 72 chalcopyrite has quite a different manner of occurrence. In sample four it is closely associated with pyrrhotite and pyrite. It is also present as exsolution blebs in sphalerite. Figure three shows this type of occurrence and also grains of chalcopyrite and pyrrhotite with smooth boundaries.

Sphalerite is a comparatively rare mineral. In sample four of hole 54 a few small isolated grains are found scattered throughout the quartz-carbonate gangue. More of the mineral is present in samples four and five of hole 72. Here it is closely associated with pyrite and chalcopyrite. In sample five it occurs as separate grains and also as blebs in chalcopyrite.

Pyrrhotite is only in footwall samples from hole 72. It occurs as massive grains in a quartz gangue. Partly, however, it is found as loosely-knit grains in masses of small opaque non-metallic particles that appear to be an alteration product of some original constituent of the rock. In both cases it is often associated with chalcopyrite. Figures three and four represent the two types of occurrence.

Sulpho-salts:

Tetrahedrite is present in samples two and three of hole 54. In sample two it occurs with bournonite and pyrite in a matrix of quartz surrounded by altered wall rock. Around the borders of the tetrahedrite are a few particles of gold. In sample three tetrahedrite borders a grain of arsenopyrite. Within this grain are clusters of fine particles of gold. This is seen in figure five.

While the mineral has been referred to as tetrahedrite microchemical analyses prove the presence of small amounts of arsenic. The mineral probably represents an isomorphous mixture of tetrahedrite and tennantite although tetrahedrite is by far the major constituent.

<u>Bournonite</u> is around the borders of tetrahedrite apparently replacing it. The identification of the mineral was confirmed by Dr. R.M. Thompson. He states that, although only very small amounts of mineral were obtained for an X-ray powder photograph, three distinct lines for bournonite were observed. Twinning can be noticed in the bournonite. Figure six shows the effect of etching by potassium-cyanide. Bournonite is negative while tetrahedrite stains a light brown with the polishing scratches becoming pronounced.

Occasionally found in the ore are pockets and small veinlets of grey sulphides. The constituent minerals are mainly a mixture of jamesonite, other sulpho-salts, and stibnite. Several spectrographic analyses showed the presence of silver, gold, lead, iron, and antimony. The minerals seem to be antimonides entirely for in no spectrographic or microchemical analysis was any arsenic present. Gold is present as small particles at the boundaries of the various minerals in the veinlets and also as blebs within the minerals. The source of the silver is not definitely known but in the jamesonite are small inclusions of a different mineral. This mineral is negative to potassium-hydroxide, distinguishing it from jamesonite, and gives strong reactions with potassium-cyanide and mercuric-chloride. These tests along with others indicate the presence of a silver mineral but the inclusions are too small to isolate and test conclusively.

Gold is characterized by: first the smallness of the particles and second, its wide variety of occurrences. A fairly large particle of visible gold was noted in sample three hole 54. Generally the gold can only be detected by microscopic examination. The largest particle observed microscopically is 150 microns in diameter. Figure seven shows a grain measuring thirty microns in diameter.

All the gold is a deep yellow color so it contains very little silver.

Its general manners of occurrence are as isolated grains, and associated with various sulphides. When occurring alone it is found as very small particles within quartz grains and scattered throughout a matrix of quartz and carbonate. Commonly it is at the borders of carbonate and quartz grains but never wholly within the carbonate. Sample five, hole 54, is from a two-foot section of core assaying 0.8 ounces of gold per ton but the only gold noted in the section is fine grains disseminated in a quartz carbonate gangue. The sulphide content of this part of the core section is very low compared to other parts that did not have as high assays.

Pyrite and arsenopyrite commonly have gold in or close to them. Figure eight shows a particle of gold within a grain of pyrite. Figure nine shows gold and arsenopyrite while figure ten shows gold at a boundary of carbonate and quartz close to both arsenopyrite and pyrite.

The association of gold with the sulpho-salts and stibnite is much more intimate than its association with pyrite and arsenopyrite. As previously mentioned, gold occurs as clusters of small particles and blebs within tetrahedrite, as small grains within and at the borders of different minerals in the veinlets of grey sulphides.

In examining drill core in the field, sections containing these grey sulphide minerals are thought to be indicative of good assays. The reason for this is readily seen when the ore is examined microscopically.

Altaite (?) occurs with stibnite in sample four, hole 72. The mineral cannot be stated definitely to be altaite but it has the characteristic properties and etch reactions. Microchemical analyses and a spectrographic analysis show the presence of tellurium and lead so it is presumed to be altaite. Figure eleven shows this mineral in contact with stibnite.

Non-metallic Minerals:

Quartz and calcite are the two main gangue minerals both being generally fine-grained though some coarse crystals are present. On the whole they are present in the zone in about equal proportions but the central part of the ore zone has a little greater proportion of quartz. Even here the rock appears as a mass of intermixed fine quartz and calcite crystals.

There are various ages of both quartz and calcite as small veinlets may be seen cutting across other areas of these same minerals.

Chlorite is in varying proportions in every sample. It is only present as a few widely scattered shreds in the centre of the ore zone but these shreds become coarser and more numerous as either wall is approached.

Sericite is found mainly as narrow veinlets and clusters of small crystals closely associated with the metallics.

Paragenesis:

The following table shows the proposed sequence of deposition of the various minerals. It is difficult to place several minerals because of their limited occurrence. Also there may be several ages of mineralization. Pyrrhotite may form a separate stage of mineralization as it is unusual to find it and stibnite so closely associated.

Pyrite and arsenopyrite appear to be the earliest crystallized minerals. Intermixed masses of the two minerals indicate a simultaneous deposition. Grains of massive pyrite can be seen formed around euhedral grains of arsenopyrite but the reverse is also true. Quartz was deposited early with pyrite and arsenopyrite but its deposition much later.

After much of the pyrite and arsenopyrite were deposited there was a period of fracturing followed by further deposition of quartz and carbonate.

Pyrrhotite is an early mineral but it is later than some quartz as irregular grains of it are seen formed around euhedral edges of quartz crystals. There is no evidence to show that pyrrhotite was deposited in a different period of mineralization. Some chalcopyrite was formed at approximately the same time as pyrrhotite. Some of it was much later being more closely related to the first deposition of stibnite.

Exsolution blebs of chalcopyrite are seen in sphalerite and exsolution blebs of sphalerite are seen in chalcopyrite so the two minerals were deposited at approximately the same period. No chalcopyrite bordering stibnite has any associated sphalerite.

It is difficult to place tetrahedrite in the sequence for it has few associations. However, it is seen to be later than pyrite, quartz, and some calcite. Bournonite replaces tetrahedrite so is later.

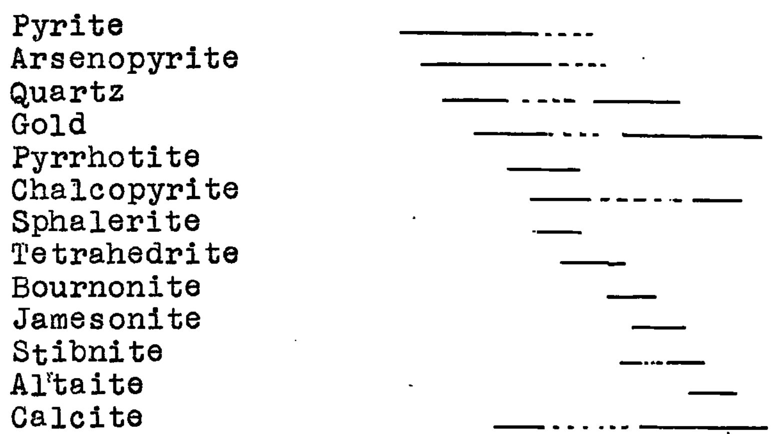
Stibnite appears to have two periods of deposition. Its first was as isolated grains and veinlets in a quartz-carbonate gangue. The later deposition was simultaneous with that of jamesonite and other sulpho-salts within the veinlets of grey sulphides previously described.

Altaite (?) appears to be later than stibnite but due to its rare occurrence and the small size of the particles it is difficult to place accurately.

Gold appears to have several deposition periods or at least a very long single period. It is found with early quartz and in pyrite and arsenopyrite grains. These facts in themselves do not prove early gold, but in this respect, the problem is similar to that of many other properties such as Hedley B.C. (9, p.5) In such occurrences gold is considered to be an early mineral.

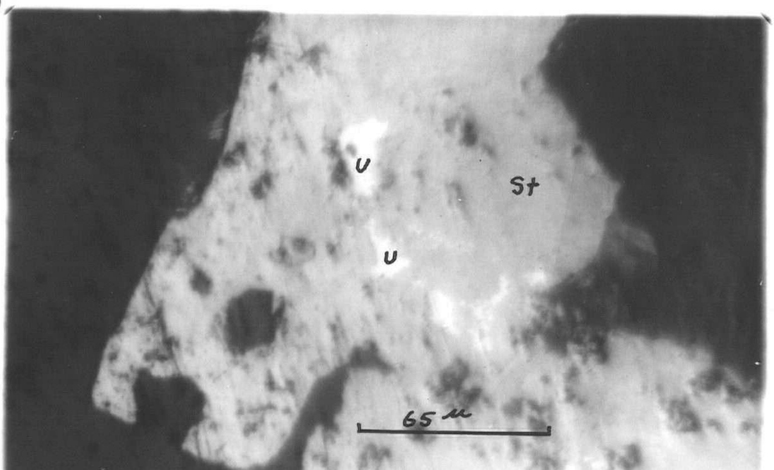
Gold is deposited later at approximately the same time as tetrahedrite. Still later was its deposition with sulphosalts in veinlets of grey sulphides.

TABLE 2. MINERAL SEQUENCE



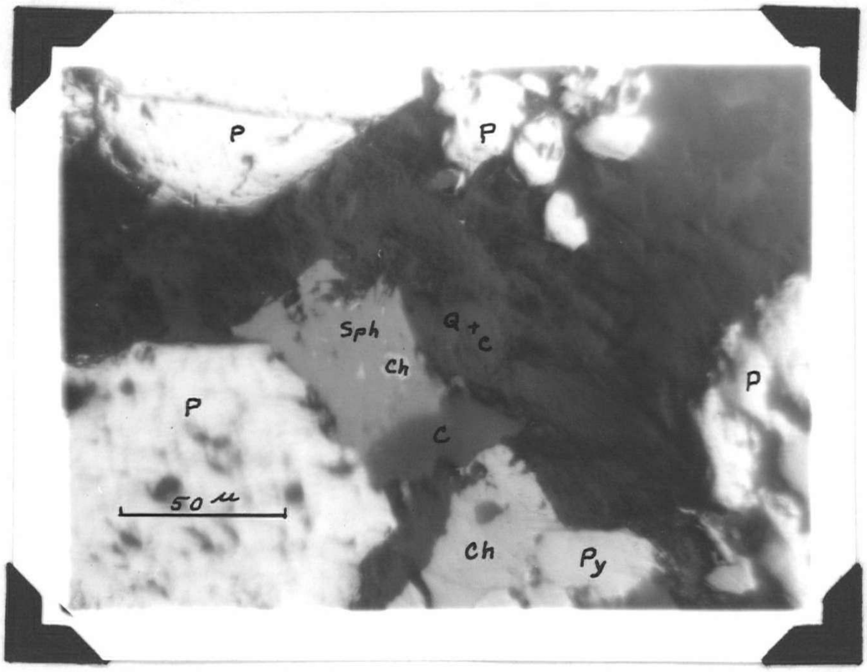
X 50

Plate 1. Photomicrograph showing the general character of the mineralization. Pyrite (P), Arsenopyrite (A), Quartz (Q), and Carbonate (C)



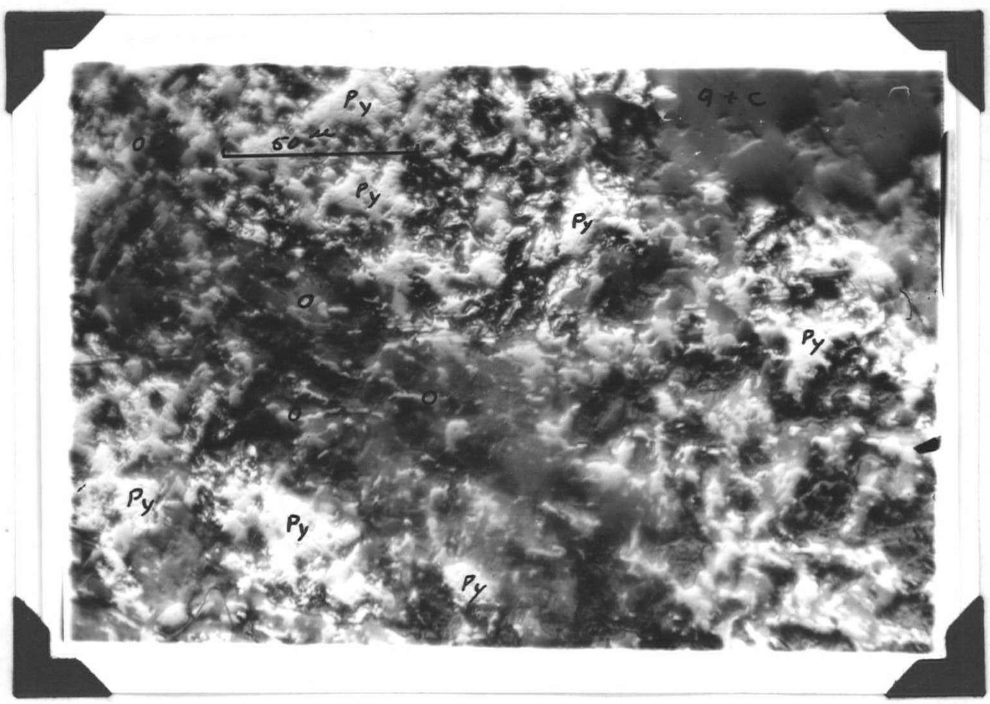
X 350

Plate 2. Stibnite (St) with unknown inclusions (U)



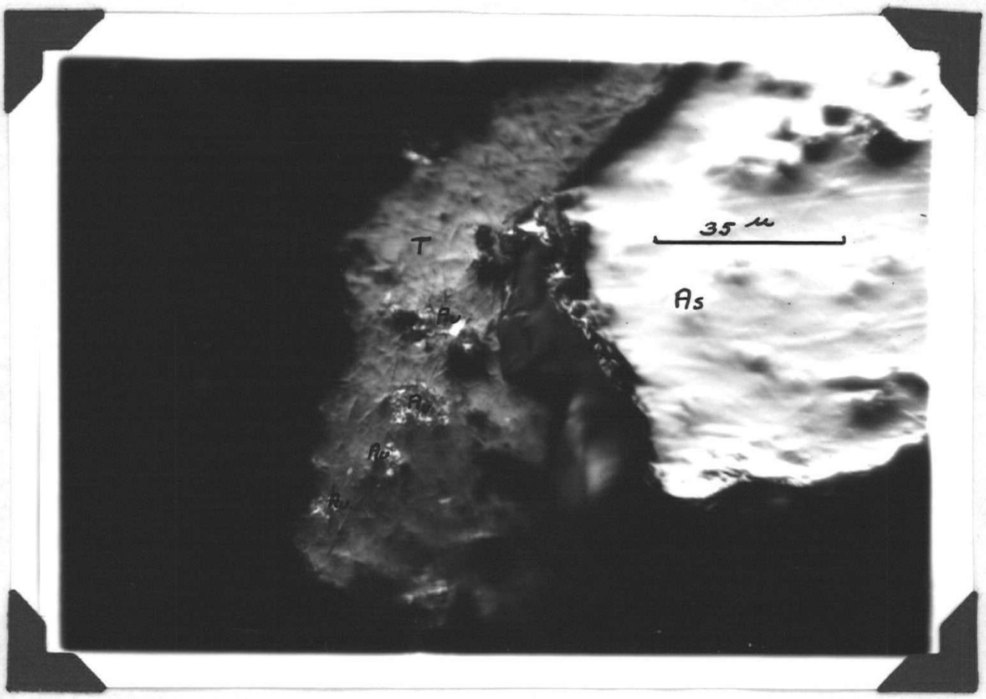
X 400

Plate 3. Chalcopyrite blebs (Ch) in sphalerite (Sph) and Chalcopyrite bordering pyrrhotite (Py) Pyrite (p)

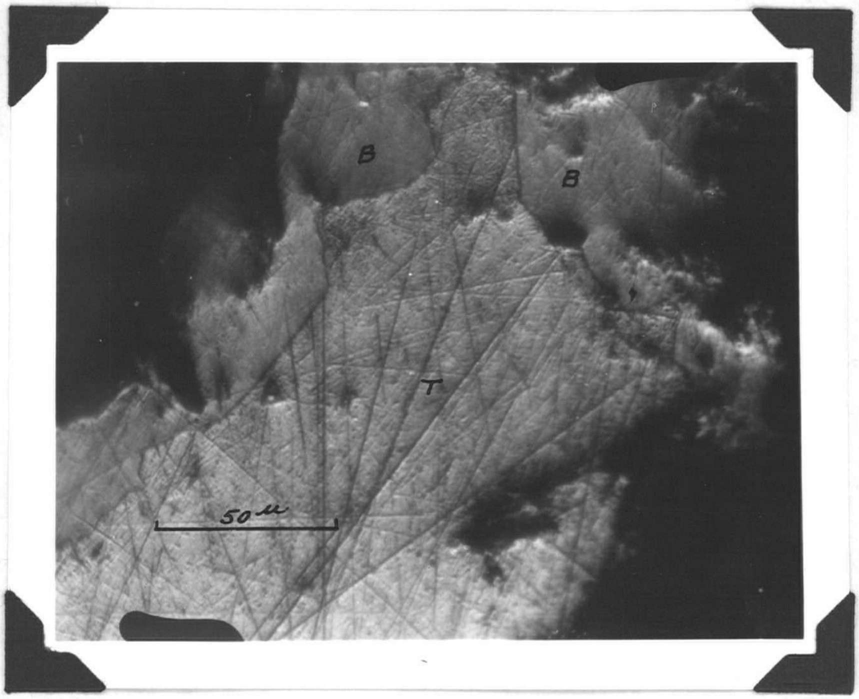


X 450

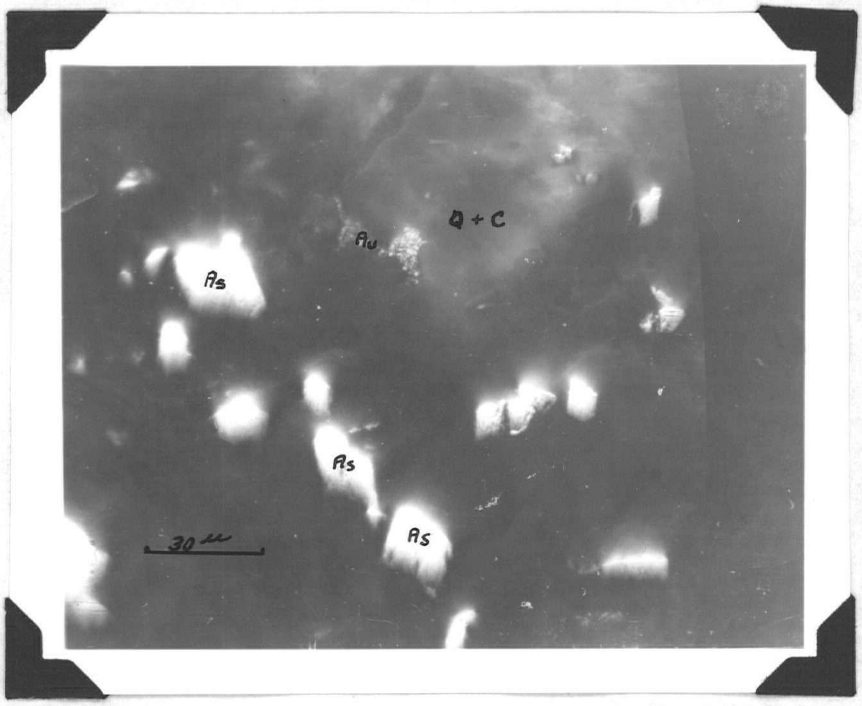
Plate 4. Heterogeneous mass of pyrrhotite and small grains of an unknown opaque mineral (O) in quartz (Q) and carbonate (C)



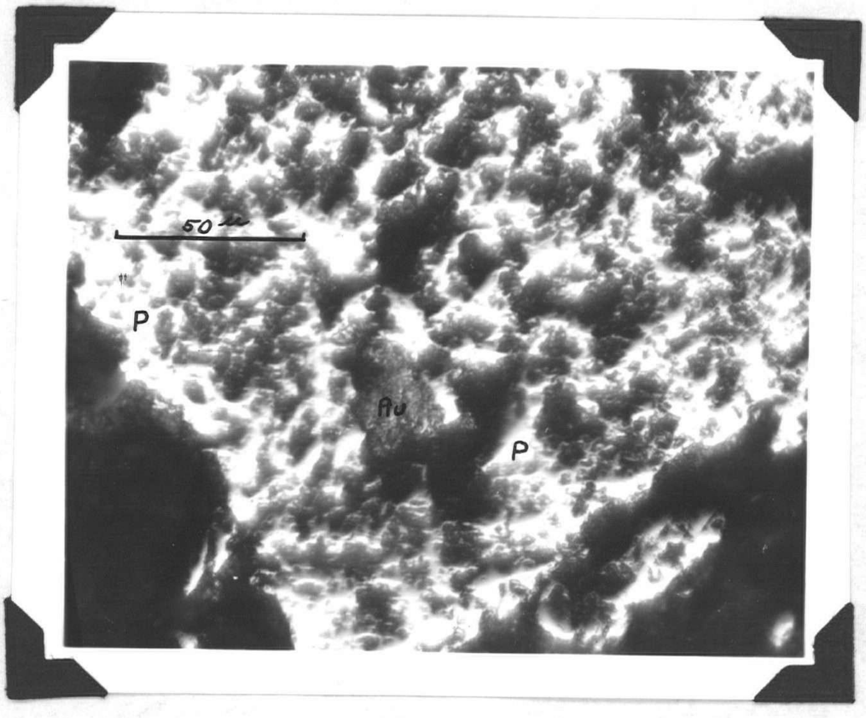
X 1000
Plate 5. Tetrahedrite (T) with minute inclusions of gold (Au)



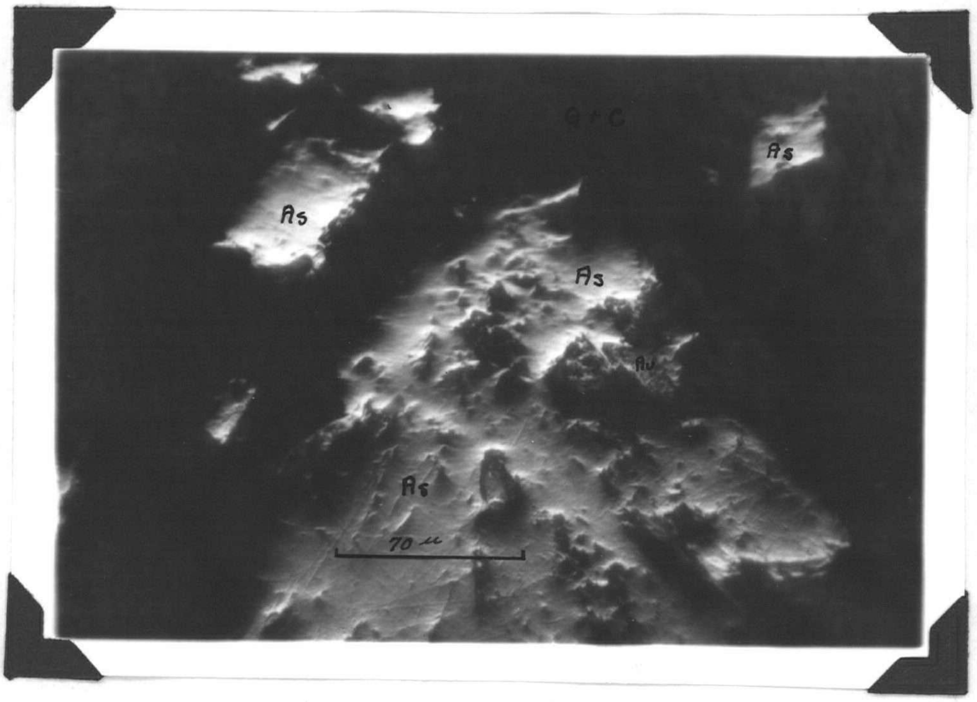
X 450
Plate 6. Bournonite (B) replacing tetrahedrite (T). The tetrahedrite has been etched with KCN



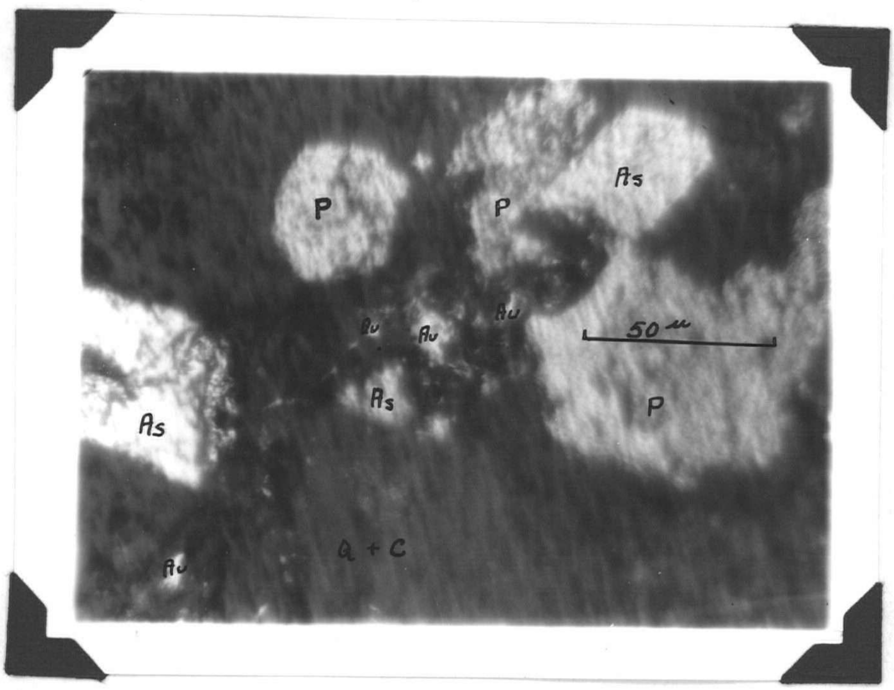
X 570
Plate 7. Fine gold (Au) with arsenopyrite (As) in a quartz-carbonate gangue.



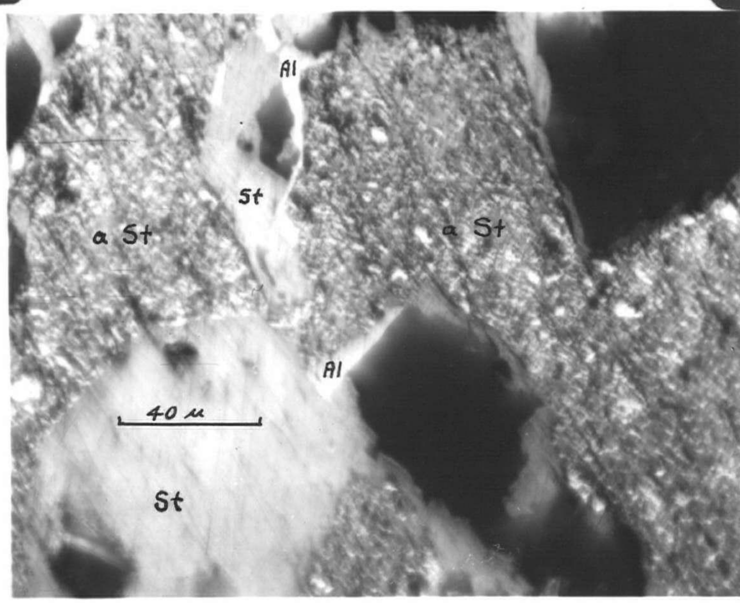
X 475
Plate 8. A particle of gold (Au) in pyrite (P)



X 350
Plate 9. Gold (Au) bordering Arsenopyrite (As)

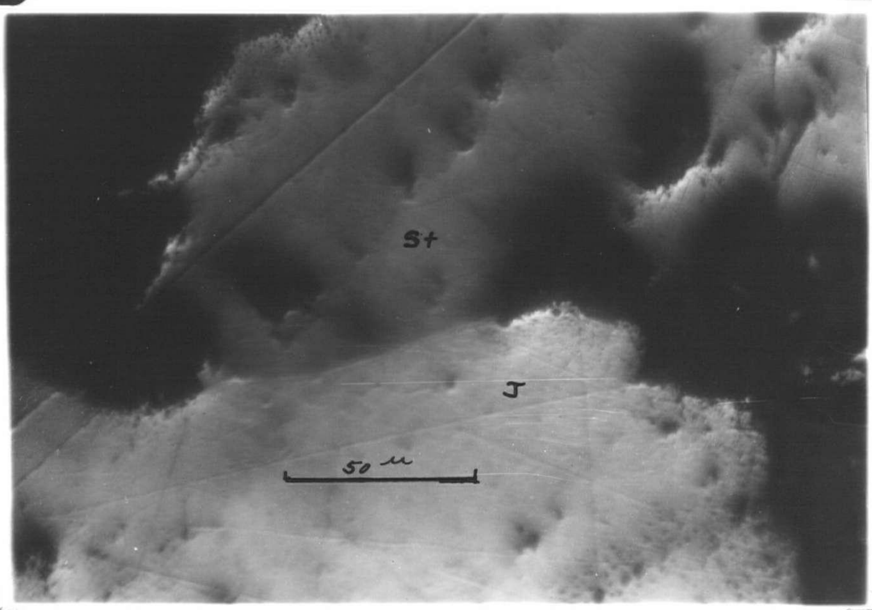


X 500
Plate 10. Typical occurrence of fine particles of gold (Au) with pyrite (P) and arsenopyrite (As)



X 450

Plate 11. Altaite (Al) in a matrix of stibnite (St) and altered stibnite (A.St)



X 450

Plate 12. Jamesonite (J) and stibnite (St) with smooth boundaries in the veinlets of grey sulphides. The stibnite has been etched with KCN.

Mineralizing Solutions:

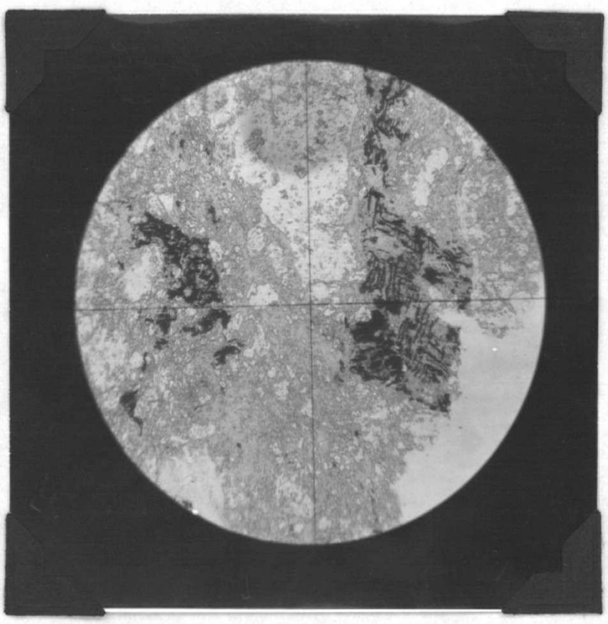
The medium of the ore and gangue minerals may be considered to be hot aqueous solutions containing the elements Fe, As, Au, Si, Cu, Zn, Pb, Sb, Ca, S, and Te. When precipitated from solution the elements combined to form the various minerals deposited in the sheared zones of the host rocks. Although there is little evidence of replacement by the precipitating minerals much of the sheared material in the ore zone must have been dissolved. Initially much arsenic, silica, and iron were precipitated. Later the precipitating minerals showed an increase of antimony but a sharp decrease in the content of arsenic.

WALL ROCK ALTERATION

The wall rocks have been little altered by the ore solutions. Previous to ore deposition, as borne out in chapter five, the rocks were probably altered largely to albite, chlorite, epidote, and calcite. Calcite and quartz have been introduced hydrothermally in large quantities and near the sulphides there has been much sericitization. Chlorite shreds may be seen in the ore itself gradually increasing in quantity away from the ore until they become a major constituent of the rock. One core sample was taken nine feet away from the edge of the ore on the hanging wall side and another was taken four feet away from the ore on the footwall side. Both specimens show much calcite and quartz in fine-grained masses and some coarse grains. In some cases these have been cut by later veinlets of quartz and calcite.

Feldspar is present in the form of albite some crystals also being fractured and veined by calcite. Much of the chlorite is in shred-like form. This has likely been formed by shearing action rather than hydrothermal solutions.

A very interesting feature may be noted in the wall rock. At the property the appearance of numerous greyish-brown flecks in the drill core is taken as indication of proximity to the ore zone. A similar type of occurrence has been noted at the Giant property. There it is referred to as "snowflake alteration". The close-spaced flecks are generally less than one-eighth of an inch in length. They have an irregular outline and random orientation.



X 35

Plate 13. Photomicrograph of a thin section from sample 7, hole 54, showing "snowflake alteration". Note the mesh of intersecting shreds (black) within a matrix of quartz, calcite, and chlorite.

Observed microscopically the flecks are seen to consist of small shred-like particles that suggest an original crystal outline. Plate thirteen shows a network of shreds within a single fleck. The general form is rhombic but it is difficult to surmise just what the original mineral was. Under the high power objective lens the shreds exhibit a fine crystalline form possessing a high birefringence. In polished sections the flecks look much like small grains of sphalerite. Some of them contain numerous small crystals of a metallic mineral possibly magnetite. A spectrographic analysis proved no titanium to be present, thus eliminating the possibility of leucoxene. However, the proximity of these grain masses to the ore zone suggests hydrothermal alteration of some original constituent of the rock to a type of clay mineral.

TYPE OF DEPOSIT

The following points seen in this examination would tend to classify the deposit as mesothermal:

1. The general mineral assemblage such as pyrite, arsenopyrite, chalcopyrite, sulpho-salts, and their paragenesis are characteristic of mesothermal deposits.
2. No vugs or comb structure were noticed in the sections examined.
3. There is no abundance of high temperature minerals and no characteristic low temperature minerals.
4. The alteration zone seems to be typical of mesothermal deposits.

Pyrrhotite, considered to be a high temperature mineral is present only in one place and in small amounts. The presence of stibnite and altaite could be explained as a precipitation at a late stage when the solutions were cooler.

AGE OF DEPOSIT

There is little evidence upon which to base the age of mineralization. Genetically related to the Akaitcho ore body are those of the Con, Negus, and Giant mines. In the Con mine, the shearing in which Vein 17 is formed is younger than a late diabase dyke. (5 (b) p.39). Also in the Con mine the C4 shear zone is cut by an unaltered late diabase dyke (7, p. 108) These dykes are considered to be late Proterogoic in age. It appears as though the mineralizing solutions were introduced towards the end of diabase intrusion.

Joliffe (5 (b), p. 41) proposed that channelways for the ascent of ore solutions were provided by the major faults. In many places, especially near the Giant mine, the fault zones are very narrow to permit the passage of solutions. Also, the same type of mineralization in the ores would be expected to occur in the faults but this is not the case. There is a possibility, then, of some other channelways for the ore-forming solutions.

CONCLUSIONS

In writing conclusions to this report a comparison is made with neighboring deposits. The mineral assemblage of the Akaitcho ore is very similar to that of the Giant, Negus, and Con mines. The fine texture of the minerals, the quartz-carbonate-chlorite-sericite gangue, and the veinlets of grey sulphides are common to each ore. All the deposits are in shear zones close to the West Bay Fault. The Giant property with its numerous ore bodies is just to the south of the Akaitcho property. In the opinion of the writer it seems reasonable to expect that, providing favorable structure is present, other ore bodies will be found on the Akaitcho property.

The Giant ore-bodies have been proven to a depth of over 500 feet while those of the Con mine have been proven to approximately 2000 feet. It is not improbable that those of the Akaitcho will also continue to similar depths.

The fine texture of the gold, generally - 200 mesh, and the presence of arsenic and antimony are factors to be considered in milling the ore.

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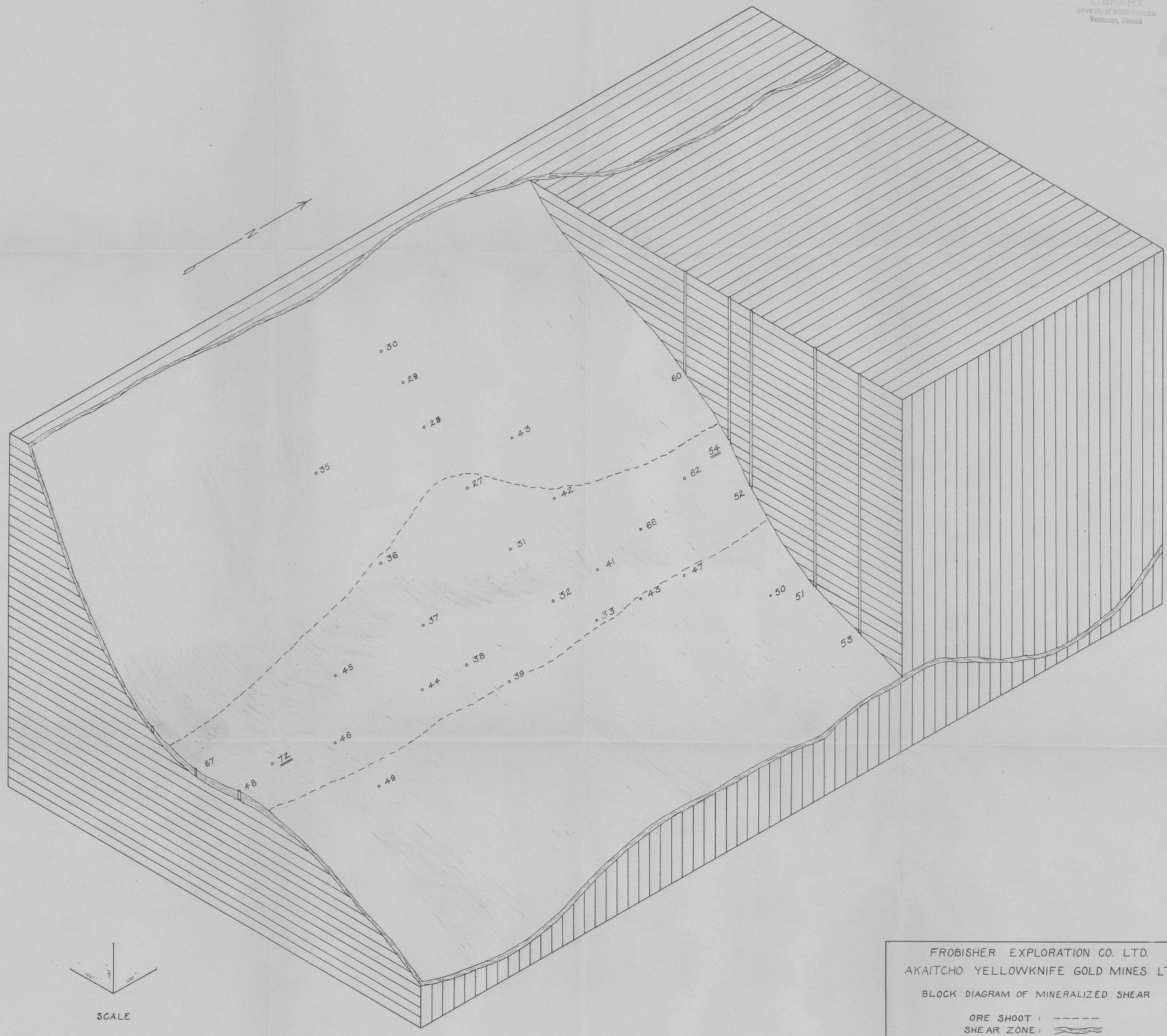

FROBISHER EXPLORATION CO. LTD.
AKAITCHO YELLOWKNIFE GOLD MINES LTD.
BLOCK DIAGRAM OF MINERALIZED SHEAR

ORE SHOOT : -----
SHEAR ZONE :

A. MANIFOLD — COURTESY OF J. MacLEOD