5697

Granisle Copper Limited

September 30, 1977

Dr. N. C. Carter
Geological Division
Energy, Mines and Resources Dept.
Victoria, B.C.

Dear Nick:

In a separate box I have sent a set of rock samples for molybdenum studies. The samples are as follows:

SAMPLE NO.	SAMPLE LOCATION
1, 2 & 3	Ore blast, north side of pit, bench 12
4	Bench 18, periphery zone of ore zone
5 & 7	Bench 11, B.F.B., ore zone
6 & 8	B.F.P. and cherty volcanic breccia, waste zone

The moly mineralization generally shows the following preferred direction:

	DIP	DIP LOCATION
1.	84	195
2.	89	225
3.	80	226

Thank you very much for your help and time.

8361

Yours sincerely,

Louis Tsang

Greatest Golfer of the World

N.C.C.

93L146-07
PROPERTY FILE

GRANISLE ● BRITISH COLUMBIA V0J 1W0 ● TELEPHONE (604) 697-2266 ● 697-2267

OFFICE OF THE CHIEF ANALYST AND A   AYER

THE GOVERNMENT OF
THE PROVINCE OF BRITISH COLUMBIA

DEPARTMENT OF MINES AND PETROLEUM RESOURCES
VICTORIA

SAMPLE RECEIVED FROM N. C. CARTER

ADDRESS Geological Division

LABORATORY No.	SUBMITTER'S MARK	LABORATORY REPORT	
		IN %	
		Mo	Cu
18546M	1	0.140	0.22
18547M	2	0.061	0.59
18548M	3	0.55	1.43
18549M	4	0.018	0.68
18550M	5	0.092	0.36
18551M	6	0.211	0.077
18552M	7	0.057	1.06
18553M	8	0.022	0.045

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FOR PROMOTIONAL OR ADVERTISING PURPOSES.

DATE March 1, 1978

W. M. Johnson
CHIEF ANALYST AND ASSAYER.

o

N.C. Carter

GEOLOGY OF GRANISLE COPPER DEPOSIT

by Keith C. Fahrni

ABSTRACT

The Granisle Copper deposit is an old property, discovered early in the century. Present operators began active development in 1955 and brought the property into production in 1966. Mineralization is chiefly chalcopyrite but appreciable bornite also occurs in the current mining area. The ore minerals occur principally in quartz veinlets filling fractures but a little dissemination occurs in coarser grained rocks. Ore fractures are concentrated in a metamorphic zone between parallel NNE trending faults at the contact of a porphyry intrusive with Takla volcanics. Geophysical studies over the ore zones have shown responses to I.P., S.P. and magnetic surveys. Geochemical surveys showed positive for copper adjacent to ore exposures or float blocks.

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93L146-07

PROPERTY FILE

GEOLOGY OF GRANISLE COPPER DEPOSIT

by Keith C. Fahrni*

Introduction

The Granisle property is a 5,000 ton-per-day open-pit copper mine and treatment plant owned by Granisle Copper Limited, which is associated with The Granby Mining Company Limited. The name "Granisle" is formed from "Granby" and "island".

The Granisle ore body and plant site are located on Copper Island (McDonald Island) in Babine Lake in north-central British Columbia. The closest town is Topley, which is on the Canadian National Railway and Highway 16, a distance of 290 miles east of Prince Rupert and 175 miles west of Prince George. Access to the property from Topley is by 35 miles of gravelled Provincial road to a ferry landing on the west shore of Babine Lake. From here the route is over a two-mile ferry crossing served by a Company-owned and-operated ferry and then by three miles of private road to the plant.

The climate of the Babine Lake area is typical of the interior of British Columbia, although the lake exerts a certain moderating influence. Winter temperatures drop to well below zero for short periods but prolonged periods of low temperature are uncommon. Annual precipitation averages about 20 inches and normal snow depth is about three feet. Babine Lake usually freezes over late in December and remains frozen until mid-May.

The elevation of the lake is approximately 2300 feet above sea level. The area has been glaciated and in general the topography is round with fairly low relief. The ore outcrop is at the highest point on Copper Island, about 300 feet above the level of the lake.

History

The earliest record of work on the copper mineralization of Copper Island is in the Annual Report to the B. C. Minister of Mines for the year 1913. Chas. Newman and H. J. McDonald were the discoverers and by that time two short tunnels, a shaft and several open cuts had been put in. The property was visited by N. W. Emmons, Provincial Mineralogist, who took several samples from the workings. Grades of around 1% copper were obtained with small values in gold and silver.

The following years give scant information but in 1927 Douglas Lay visited the property and under the name Richmond Group describes the showings in the Report to the Minister. On his recommendation the property was bonded by C. M. & S. the following year.

*Chief Geologist for The Granby Mining Company Limited

In 1928 C. M. & S. carried out a program of trenching and drilling. This work was directed on the ground by H. C. Giegerich. Several long holes were drilled to test the extent of the mineralization. Further work was planned but did not develop, possibly due to the recession of 1929. The option was dropped and the property reverted to McDonald and Newman.

The property was examined by Dr. Victor Dolmage in 1943. At that time work had been done by E. E. Campbell and the prospect was described as the Newman property. On the basis of favorable geology and mineralogy, Dolmage recommended work in spite of the obvious low tenor of the ore. The hope was that higher-grade bands, which had not been intersected by the limited earlier drilling, might be found.

Soon after Dolmage's report, a small company was organized with work being directed in the field by B. I. Nesbitt. Four holes were drilled but when it was found that the average of almost 1700 feet of core, believed in the ore zone, only came to 0.60% copper, work was stopped.

In the following years the property was examined by several companies but no further work was carried out.

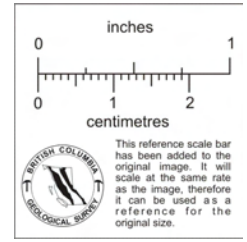
In August, 1955 the property was examined by Granby engineers. Before freeze-up additional claims had been staked and eight drill holes had been put down following a grid pattern on 200-foot centres. This work was continued as soon as winter relaxed, a larger drill being taken in over the ice in March. By summer's end a total of 49 holes had been drilled on the grid pattern and the remarkable continuity of values in copper had been demonstrated, extending far beyond the limits of previous drilling in a north-easterly direction.

In the next couple of years a drop in copper price discouraged work, but Granisle Copper Limited was formed and in 1959 further drilling was done to check continuity between the 200-foot grid holes, an additional 30 holes being drilled. In 1963 planning had advanced to the stage of mill testing and surveys for suitable mill sites.

A feasibility study was completed in April, 1964, by The Granby staff, and using a copper price of 28.5¢ U.S., (a price at which copper had been stabilized for about two years), it appeared economically attractive to place the property into production. Arrangements were made for financing and the decision to go ahead was made in February, 1965. Design of the plant was started immediately, construction was carried out during 1965 and 1966, and production started in mid-November of 1966.

Recent Mapping

During the summer of 1965 a field party was assigned to the Babine area by the Provincial Government Mines Branch. Mr. N. C. Carter under the direction of Dr. Mike Carr visited Copper Island and mapped it with much of the adjoining territory. His report with accompanying maps give an excellent



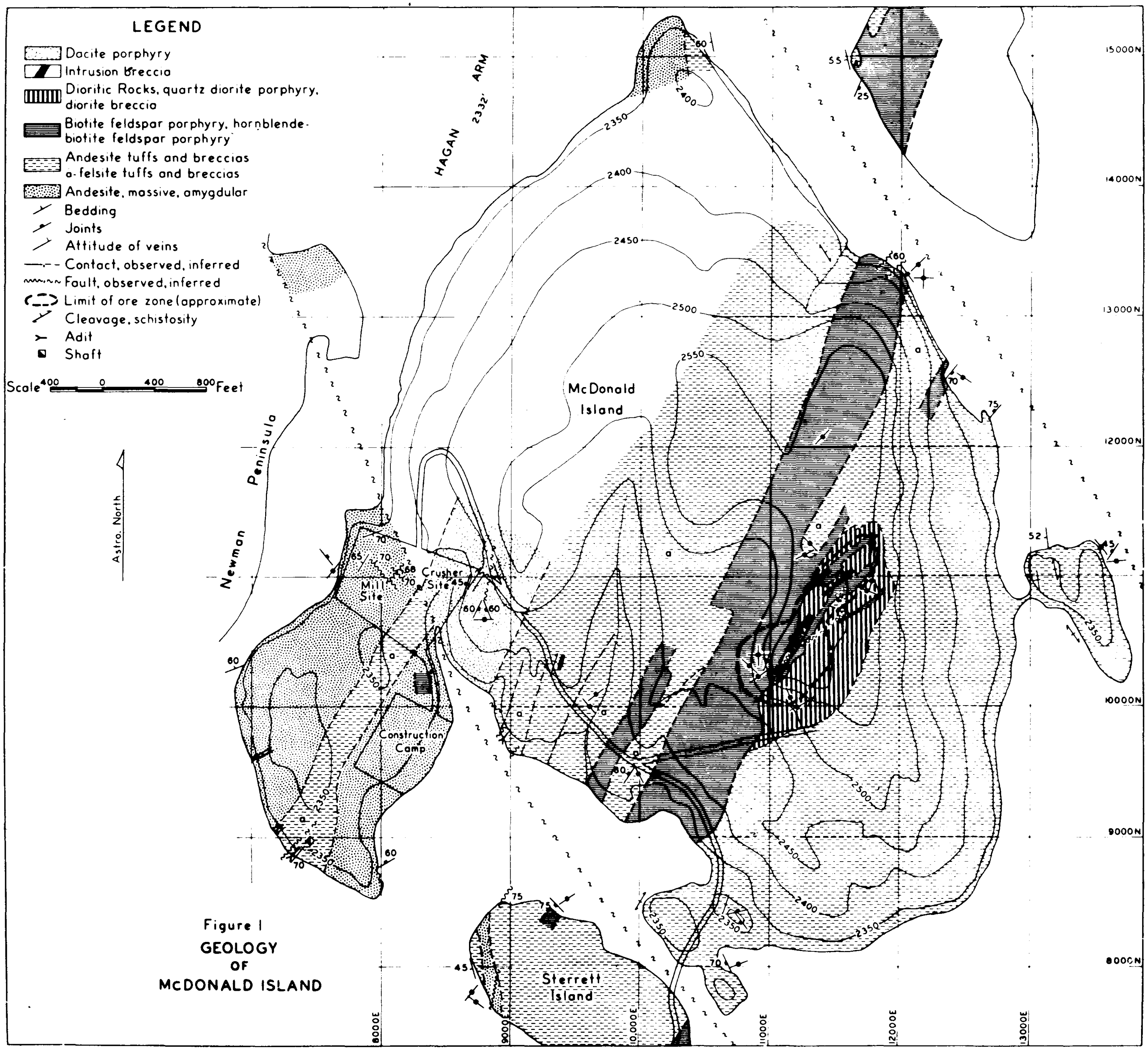


Figure 1
GEOLOGY OF McDONALD ISLAND

picture of the local geological setting of the property. It is to be found in the 1965 Report to the Minister of Mines and Petroleum Resources of B. C. The map of Copper Island accompanying Carter's report is reprinted herewith since it shows the most recent ideas of the local geology as Figure 1.

In the summer of 1966, construction at the mine was approaching completion and the entire pit area was stripped to bedrock in preparation for mining. Advantage of this ideal situation was seized and a Granby crew mapped the exposed rock surface. This map is reproduced as Figure 2. It illustrates the detailed geology in the immediate vicinity of the ore.

Regional Geology

The island upon which the ore body occurs lies between two north-westerly-trending faults, spaced about 4000 feet apart. They have been mapped by the B. C. Department of Mines geologists and are proven to extend over at least 10 miles, reaching to the north-west across Newman Peninsula.

Correlations across the faults have not been made. The south-east segment which occurs on the western tip of Copper Island and most of Sterrett Island is largely stratified, being composed of thick bedded sediments and limey tuffs with some interbedded andesitic and felsitic flows. The central segment in which the ore body occurs is largely volcanic with thick bands of felsitic and andesitic flow material. The north-east segment is not well known but thin bedded sandy and limey sediments occur in a creek exposure about a mile and a half north-east of the mine.

Rock Types

Volcanic rocks are the oldest rocks mapped. Andesitic types are generally fine-grained and fragmental texture is common. Felsitic types make well-defined contacts with the andesites and are massive fine-grained, light grey to pinkish in colour. Their strike appears to be about N 25° E. No dips were determined. The volcanics have been correlated with the Takla group of Upper Triassic system on the basis of composition.

The other rock type encountered is a system of andesine biotite porphyry intrusives, closely related to the ore occurrence. A large well-defined dyke with widths of from 400 to 600 feet and with a strike of N 15° E crosses Copper Island between the two north-westerly-trending faults which bracket the island. About midway between the two faults there is a swell in the dyke due to a bulge on the east side to give the maximum width of 600 feet. This is the centre of a radial system of smaller dykes with widths of from one to 25 feet. This point is also the centre of alteration silicification and mineralization of the volcanics and the dykes. It corresponds with the knoll which is the highest point of the island and the outcropping of the ore zone.

A metamorphic rock called "diorite" at the mine has resulted from the alteration accompanying the porphyry intrusion. This rock extends over a zone about 400 feet wide along the large porphyry-dyke contact. It shows its fine-grained origin as a volcanic under the microscope but has been re-crystallized with development of felspars a little more basic than the porphyry

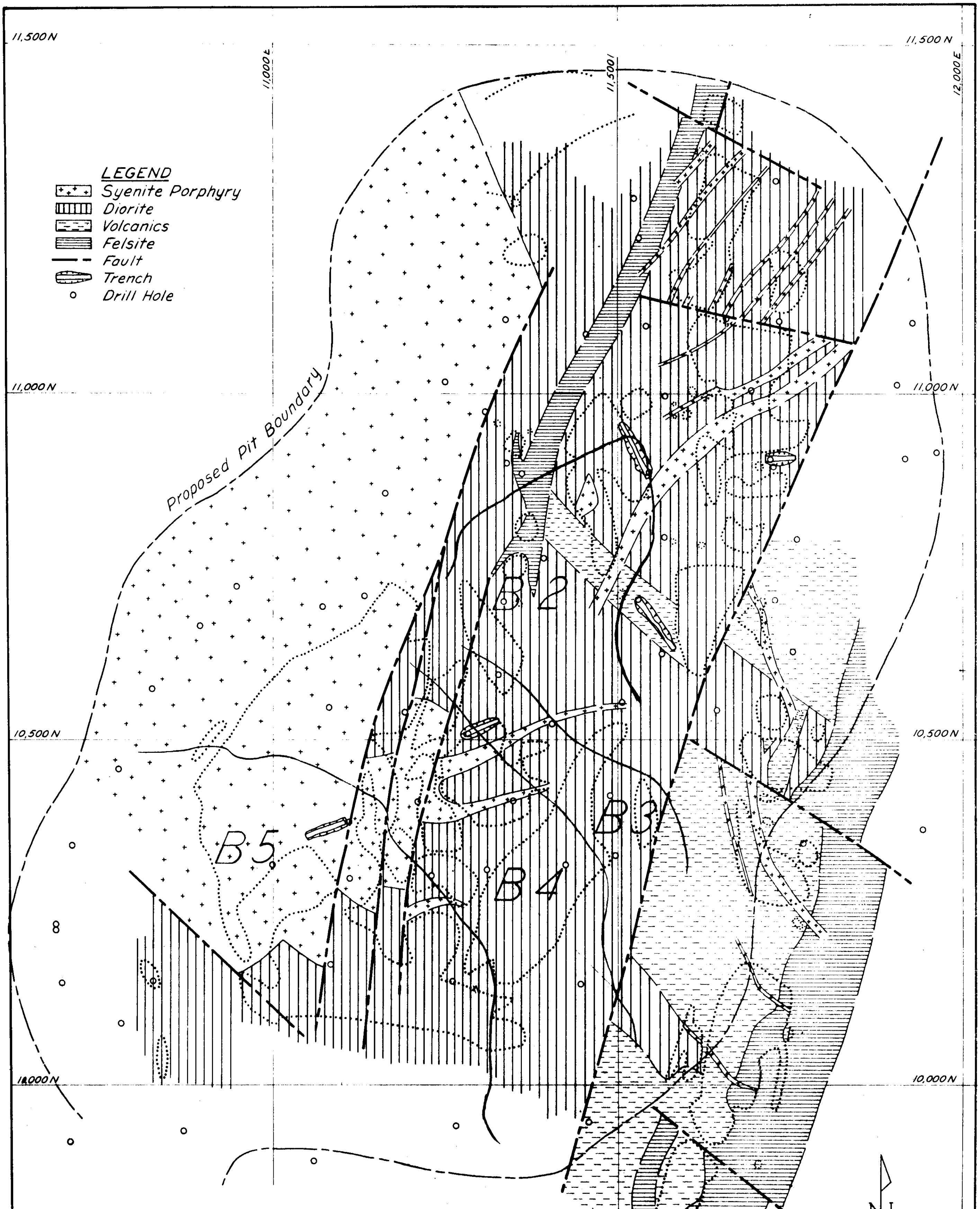


Figure 2

GRANISLE SURFACE GEOLOGY
PIT AREA

Mapped August 1966, K.C.F.

inches
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centimetres
BRITISH COLUMBIA GEOLOGICAL SURVEY
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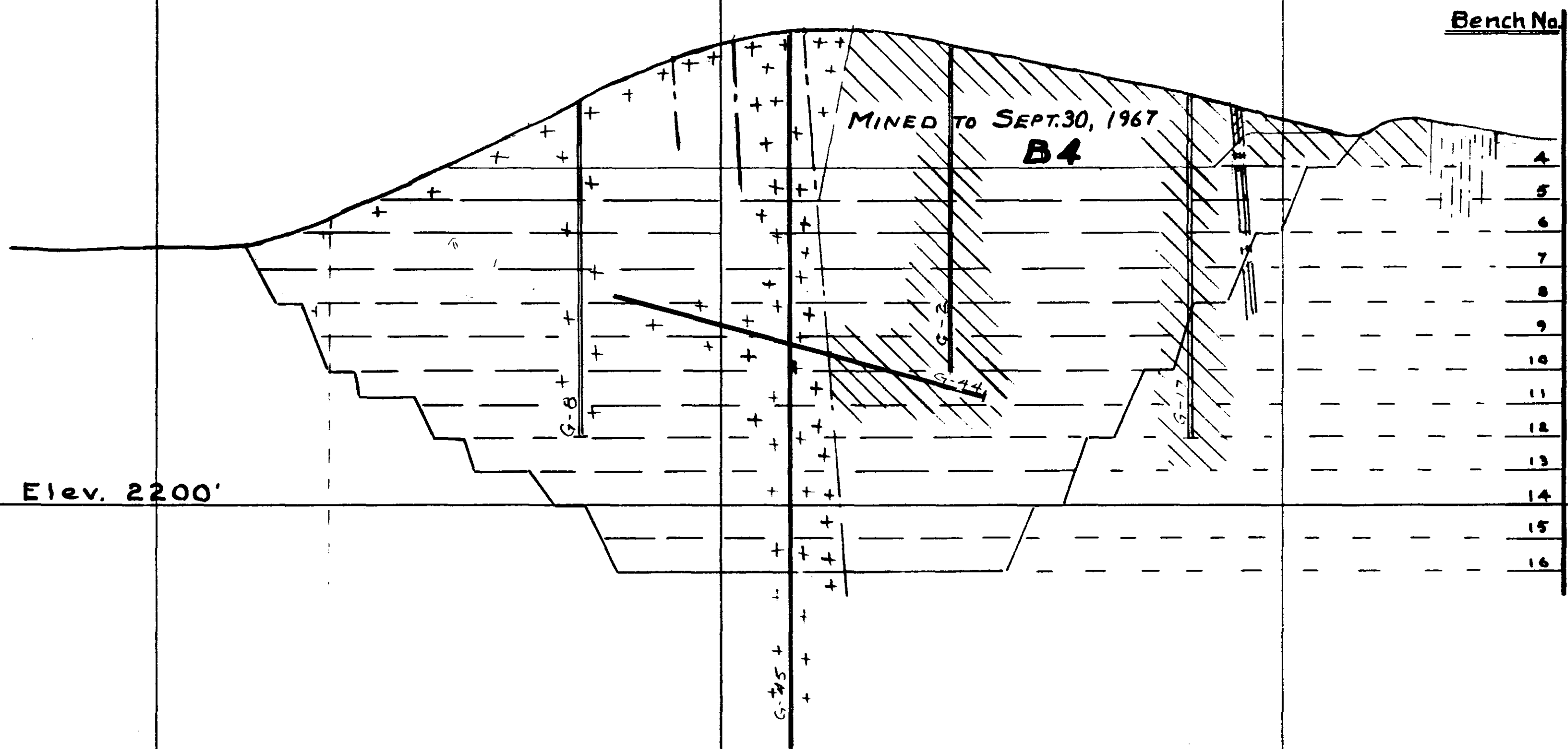
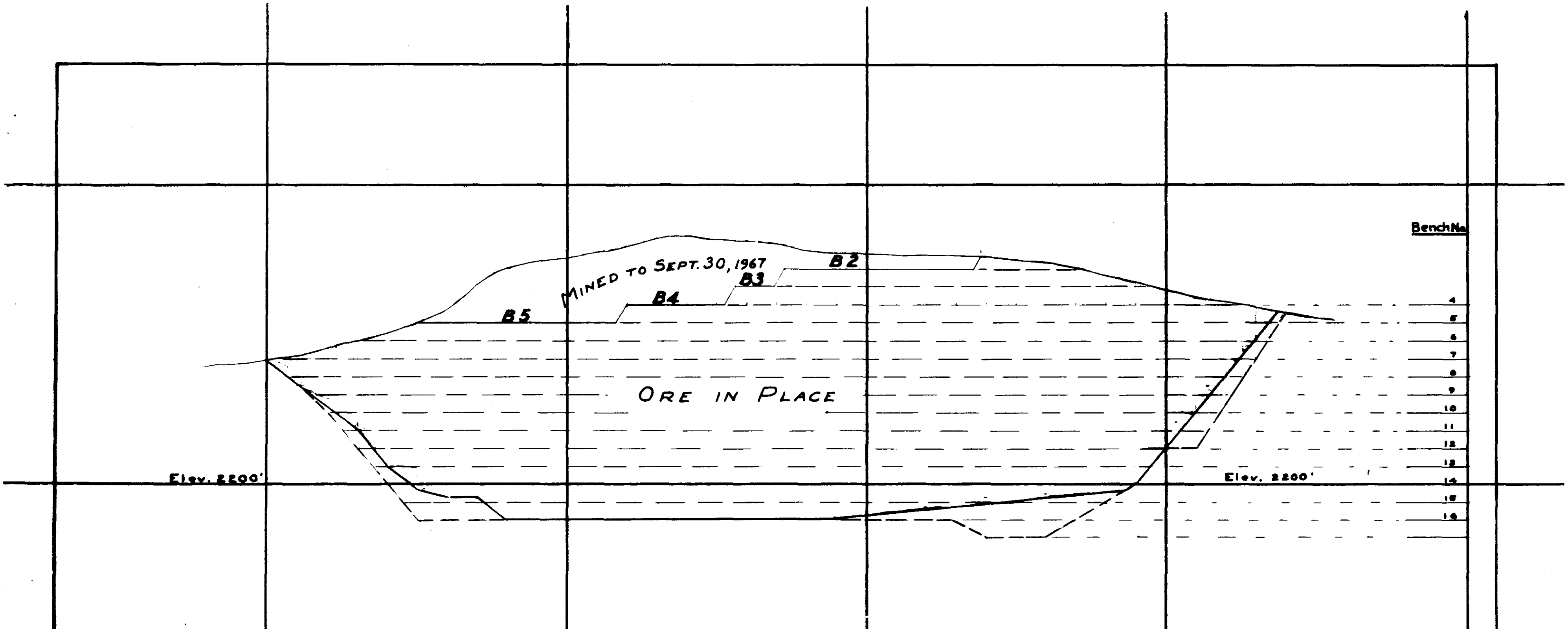


GRANISLE COPPER PIT CROSS SECTION

Figure 4

0 50 100 200 300
Scale in feet

SECTION 1150 NE
LOOKING N.E.



GRANISLE COPPER PIT
LONG. SECTION
Looking N.W.

0 50 100 200 300
Scale in Feet

Section 500 SE

Figure 3

inches
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and with a mesh work of biotite which gives it a dark brown, silky appearance in the field. Relict fragmental texture and bands of unaltered volcanics occur within the "diorite". Bands of "diorite" with related copper mineralization extend to the east from the main diorite mass as fingers along smaller porphyry dykes. Only the andesitic volcanics appear to have been subject to the dioritization since it stops abruptly at felsite contacts.

Structure

At least two periods of faulting must be part of the geological history of the area to account for dyke intrusion and discontinuities in formations. The earlier faults follow a north-east direction and the latter, a north-west direction. On a regional scale there is evidence of large displacement on the north-westerly-trending faults since no definite continuations of the large porphyry dyke have been found beyond Copper Island.

Copper mineralization is closely related to a system of quartz-filled fractures. Widths vary from knife-edge widths to several inches but in most cases they are less than one-eighth inch wide. An average of over 50 measurements suggests that there are three principal directions. The most prominent direction is N 75° W in strike with a dip of about 80° NE. This direction accounts for about 60% of the fractures measured. A less prominent set striking N 10° E and dipping 80° SE accounts for 30%. A set of horizontal fractures account for 10% of readings but is probably much more important, being poorly exposed for measurement in surface rocks. These fractures are usually well-developed veinlets but in thin sections, silicified zones can be seen where no well-defined fractures appear to the unaided eye. These ore fractures occur in all rocks so far described.

No evidence of important folding of formations has been found on Copper Island.

Mineralization

The principal economic mineral of the mine is chalcopyrite but significant bornite occurs in the upper and southern part of the ore body where the higher-grade ore which is now being produced lies. Bornite occurs under equivalent conditions with chalcopyrite and there is no indication of a secondary origin. Grains of bornite and chalcopyrite occur together with mutual boundaries in silicified areas. Gold and silver in small but significant amounts are associated with the copper minerals. Traces of molybdenite occur but amounts have been too small to consider separation in milling. Galena and sphalerite have been noted in drill-cores but the amounts of these minerals are very small. Metallic-gangue minerals occur to a limited degree with the ore. Magnetite is present, being found especially near the borders of the ore zone where it is sufficient to give a significant magnetic anomaly. This mineral occurs as vein material which may be primary in origin and as rims of magnetic grains surrounding biotite crystals which may be a metamorphic effect. Pyrite occurs as a wide halo in surrounding rocks, particularly in the felsites to the east which contain several percent. Within pit limits, the north end carries much more pyrite than the south end. The fact that copper grade drops off there may indicate a zoning effect. A corresponding pyrite zone has not been found at the south end of the ore, but faulting may have shifted it out of the range of exploration. To the west the large porphyry dyke is not significantly pyritized, but felsitic flows beyond show widespread pyrite.

Timetable of Geological Events

Epoch	Events
Omineca Intrusives	Faulting on N.W. lines with development of auxiliary N.S., E.W. ore fractures, silification and mineralization by copper.
Topley Intrusives	Faulting on NNE lines with porphyry dyke intrusion and metamorphism of volcanic rocks.
Takla	Deposition of andesites and felsites of the volcanic sequence.

Geophysics

With indications of the presence of magnetite in association with the Granisle ore, a magnetic survey of the island was run in late 1963 and early 1964. A good "thumb print" anomaly of intensity about 5,000 gammas above background was centred upon the knoll corresponding with the best part of the ore body. To the north-east where copper content decreases and increasing pyrite comes in, there is a lower intensity elongation to the magnetic contour lines.

Along the west and north-west shore of Copper Island, high magnetic values of erratic nature represent a zone of magnetite bearing amygdular andesite. This horizon may provide a marker which will assist in correlations across the faults and through covered areas as geological studies are extended from the pit area.

Electromagnetic readings were taken over the grid established for the magnetics using a small portable EM outfit. Some faint indications possibly due to conductivity of faults were obtained in the vicinity of the ore body.

Spontaneous polarization readings were taken over the Copper Island grid in the summer of 1964. Some indications seemed to be coming up but difficulties with dry ground conditions put results in question so the following year the area was surveyed by Geocal of Vancouver. This survey found eight small areas of negative polarity. All showed marked north-easterly trends. Five were grouped along the syenite porphyry contact and above the ore body. No indications were obtained elsewhere on the island.

During the past season, with an Induced Potential Survey crew and equipment in the area, several lines were run over the proven Granisle ore body. Very high readings were obtained but lines were not long enough to give background levels. This data is still to be finalized.

Geochemistry

During the 1959 field season, a geochemistry survey was carried out over the ore zone and extended across Newman Peninsula, adjoining islands and a large section of the mainland on the east shore of the lake. The rubeanic acid method of testing was used.

As would be expected, good results were obtained over the exposed ore body and adjoining drainage zone. A few other indications were obtained nearby and on Sterrett Island. These were found to be due to large transported blocks of copper-bearing material.

REFERENCES

1. Carter, N.C., - 1965 Report to Minister of Mines and Petroleum Resources of B.C. pp. 90-99.

2. Souther, J.G., and Armstrong, J.E., Geological Survey of Canada, "Tectonic History and Mineral Deposits of the Western Cordillera", Special Vol. No. 8 CIM Geological Division 1966, pp. 171-175.

3. Lay, Douglas, 1927 Report to Minister of Mines of B.C. "Richmond Group" page 149.

4. Emmons, N.W. - Report to Minister of Mines of B.C., page K113.

N.C. Carter.

GRANISLE COPPER LIMITED

December 21, 1971

TO R.P. Taylor, Manager

FROM S.J. Wilkinson, Senior Geologist

SUBJECT CONTROL OF MINERALIZATION BY FRACTURING AT GRANISLE

Introduction

A condensation of this report will be presented to the meeting of the Cordilleran branch of the Geological Association of Canada in February 1972.

REGIONAL FAULTING

Regional geology, (see map 1) is dominated by two northwesterly striking faults. All the known porphyry type ore deposits in the area are associated with these northwesterly striking faults. N.C. Carter (1972) states that these faults are steeply dipping block faults.

Neither of these faults are exposed in the pit. The southwesterly fault forms a marked topographic feature on Copper and Sterrett Islands, but outcrop is obscured by overburden. The northeasterly fault passes under the lake to the N.E. of Copper Island.

MINE FAULTS

Pit geology is controlled by a set of faults striking approximately N25°E and dipping from 90° to 70° easterly. Three faults of this system are known in the pit area, named respectively the Eastern fault, Central fault and the Western fault. In addition, other faults with a similar trend have been discovered, by surface mapping and diamond drilling elsewhere on Copper Island. Extension of the faults beyond the pit limits is not known, but they are probably terminated by the northwesterly trending regional faults. Although displacement across the faults is evident, lack of a suitable marker band has, at present, rendered any calculation of displacement impossible.

Typically, the faults are composed of kaolin and carbonate rich gouge from one to five feet thick, which are usually adjoined by a zone of crushed and bleached rock up to twenty feet thick. Stringers of pyrite and chalcopyrite have been observed in the gouge, parallel to the schistosity. In addition, broken mineralized quartz veins and sulphide stringers occur in the gouge. Copper content of the faults is usually similar to that of the walls.

The mine faults are ore controls, little ore is known east of the eastern fault, and in the northern end of the pit, the central fault forms an important ore ~~capital~~. Although good fracturing occurs to the west of the central fault, quartz veins and copper minerals are rare.

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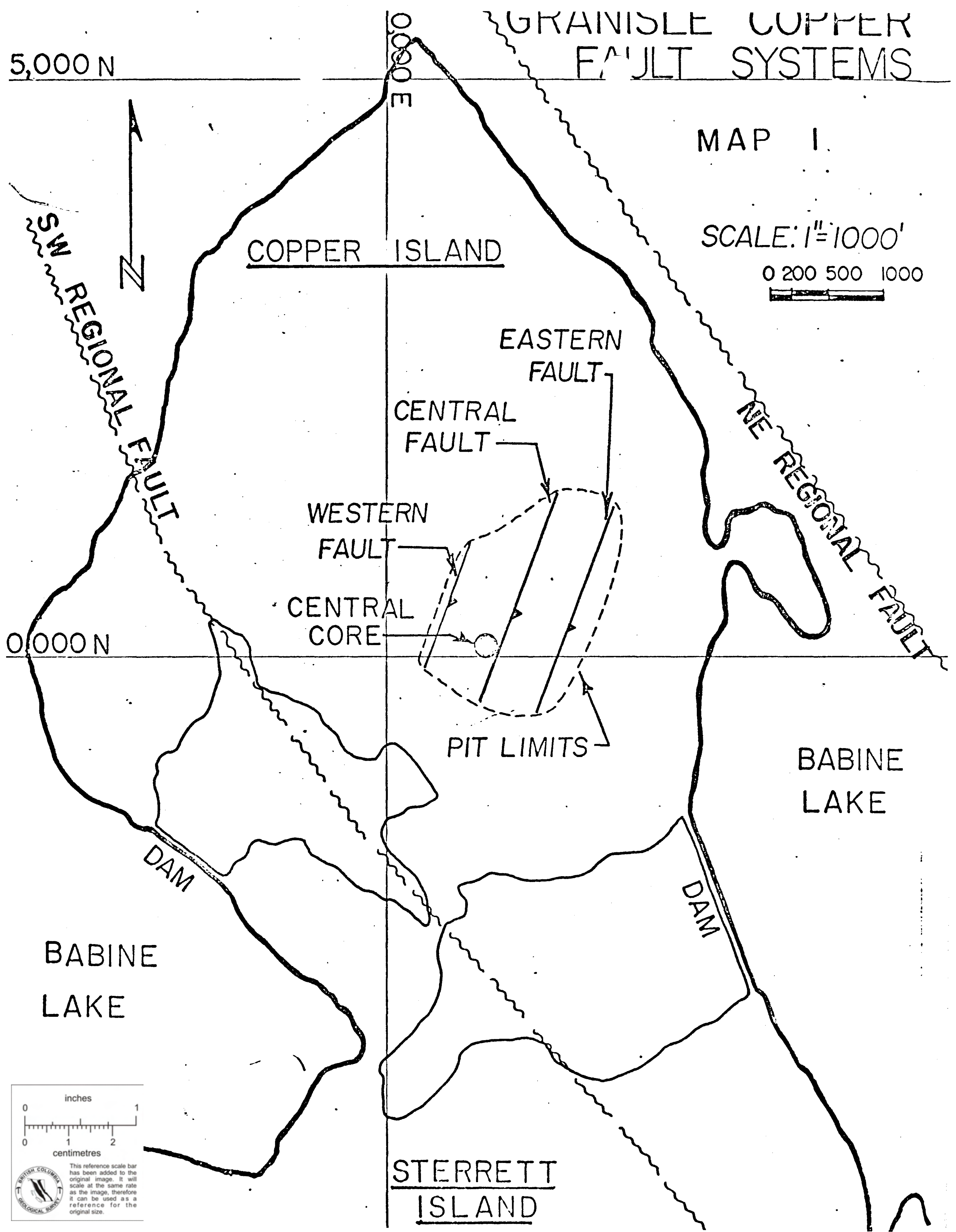
GRANISLE COPPER
FAULT SYSTEMS
MAP 1
SCALE: 1"=1000'
0 200 500 1000
5,000 N
0,000 N
0,000 E
N
COPPER ISLAND
SW REGIONAL FAULT
NE REGIONAL FAULT
EASTERN FAULT
CENTRAL FAULT
WESTERN FAULT
CENTRAL CORE
PIT LIMITS
BABINE LAKE
BABINE LAKE
DAM
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STERRETT ISLAND
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centimetres
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BRITISH COLUMBIA GEOLOGICAL SURVEY

MINERALIZATION

Sulphides at Granisle are almost entirely confined to a secondary fracturing throughout the pit, with varying intensity and direction. A statistical study of these fractures was necessary to define major trends for pit wall design.

Mineralogy of Fractures

Three sulphides are present at Granisle: chalcopyrite, pyrite and bornite. With the exception of minor sulphides replacing biotite, all the sulphides occur in healed fractures, usually with a quartz gangue. These fractures are small, usually about 2 mm wide including o.5 mm of sulphide within quartz. Copper content of any given area is proportional to the fracture density, which varies from ten to less than one per foot.

Some veinlets contain a mixture of sulphides ie: chalcopyrite and pyrite or chalcopyrite and bornite. In both cases, the sulphides are contemporaneous. Where pyrite is absent, iron sometimes occurs as oxide, magnetite, hematite or both. Calcite is a common vein material and always post-dates quartz, but is either earlier or contemporaneous to the sulphides. Some disseminated sulphide may occur within the vein quartz. Gypsum post dates sulphides in some areas of the pit. A sequence of fracturing and mineralization is shown below.

Intrusion —Fracturing→ quartz + diss. sulphide —fracturing→ ± carbonate —fracturing→ sulphides ±carbonate ±iron oxide —fracturing→ gypsum.

Rare large sulphide veins contain biotite, pyrophyllite and apatite in addition to sulphides and carbonates.

Zoning

The Granisle ore-body exhibits strong zoning around a central high grade core. Diagram 1 shows a qualitative relationship between fracture filling and distance from the central core. In addition to mineral zoning, density of ore fractures decreases away from this central core.

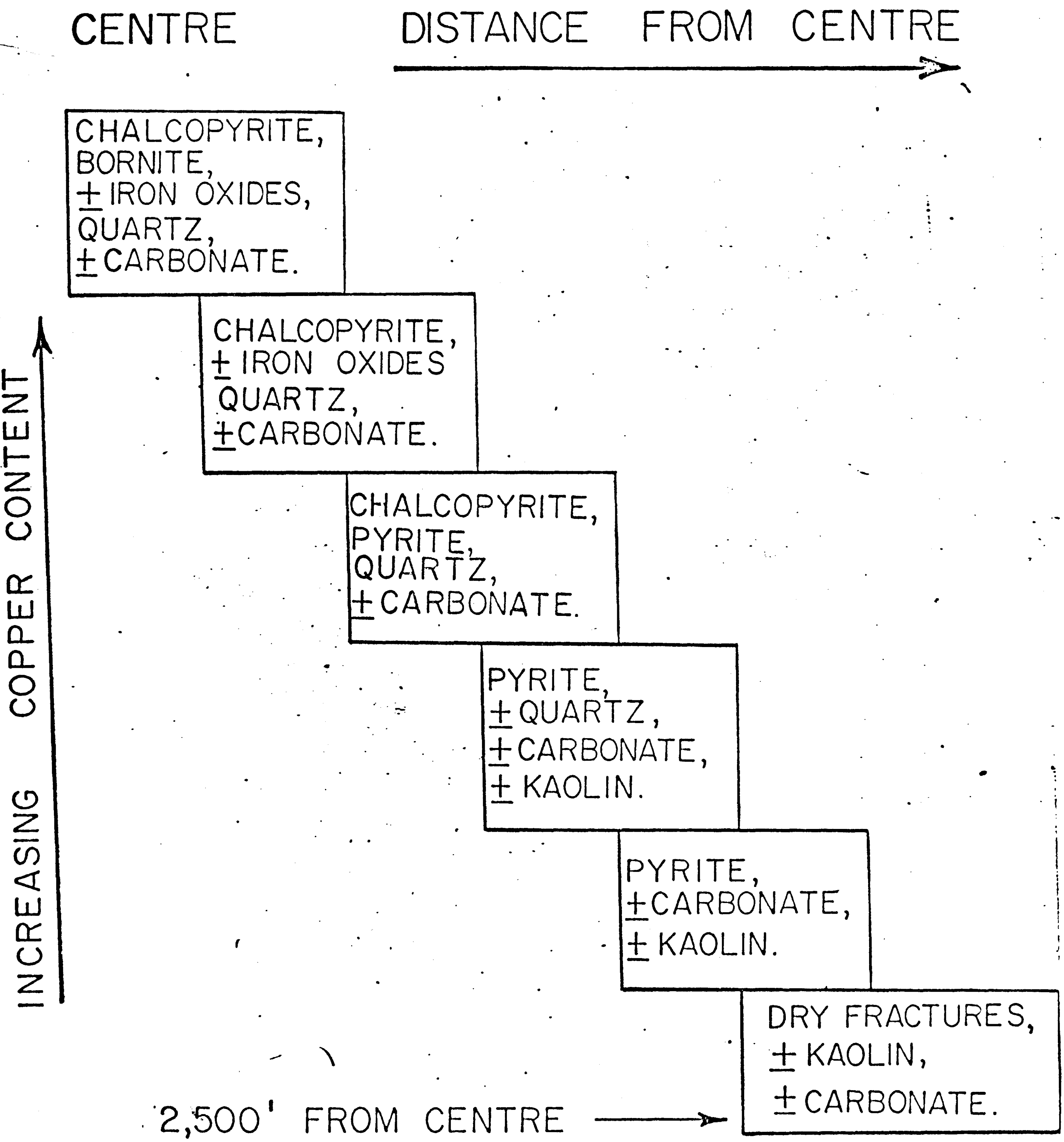
A similar, but smaller core exists in the northern end of the pit, which gives the ore-body a somewhat egg shaped appearance..

Fracture Survey

During the summer of 1971, Miss M. LeBerrurier made a joint survey in the pit. The results from this survey were computer processed by Golder, Brawner & Associates, both poles and contours were plotted on Schmidt equal area nets. Three categories were used: pyrite filled joints, chalcopyrite filled joints, and all joints (see contour and scatter nets in appendix).

The nets show a fair spread of points, but are all very similar. Three preferential orientations can be detected, shown as A,B, and C on the diagrams:

DIAGRAM I - ZONING



Orientation A - strike N25°E dip 80° westerly to 75° easterly (dominated)
- correlated with mine faults.
Orientation B - strike N45°W, dip 80°NE to 75°S (dominant)
- correlated with northwesterly regional faults
Orientation C - strike approximately E/W dip 75°S
- correlated with cross faulting within the pit.

At present, age relationships between different directions of joints are not known. Sulphides occur in joints of all attitudes, no particular set of joints has been noted as being barren to date.

DYKES & BRECCIAS

Contacts of the major intrusives are fault lines, except for the southern porphyry contact which strikes approximately N.W. These intrusions have been dated at about 52 million years by the Department of Mines. The fracturing post dates all the major intrusives, but some light coloured porphyry dykes which cut quartz fractures in the major dykes are known. These late stage intrusives however, are still cut by a few fractures, which are often mineralized.

The central high grade core is a weak (at the present level of mining) breccia, which occurs near the intersection of the Central fault and the southern contact of the main porphyry intrusive. This central core was marked by a conspicuous breccia when the early benches were mined. A similar, but smaller centre in the north of the pit is associated with the Eastern fault.

CONCLUSIONS

1) Minor fracturing is related to regional fracture patterns.

2) Mineral zoning and breccia centres are developed by fracturing.

3) Fracture filling appears to be dependant on the distance of the fracture from the central high grade core, and not on the orientation of the fracture.

4) Fracturing, intrusion and mineralization continued throughout the period of activity.

5) More joints should be surveyed.

Reference

Carter N.C. - Geology of the Northern Babine Lake Area - Granisle Excursion Guide for the International Geological Congress. 1972

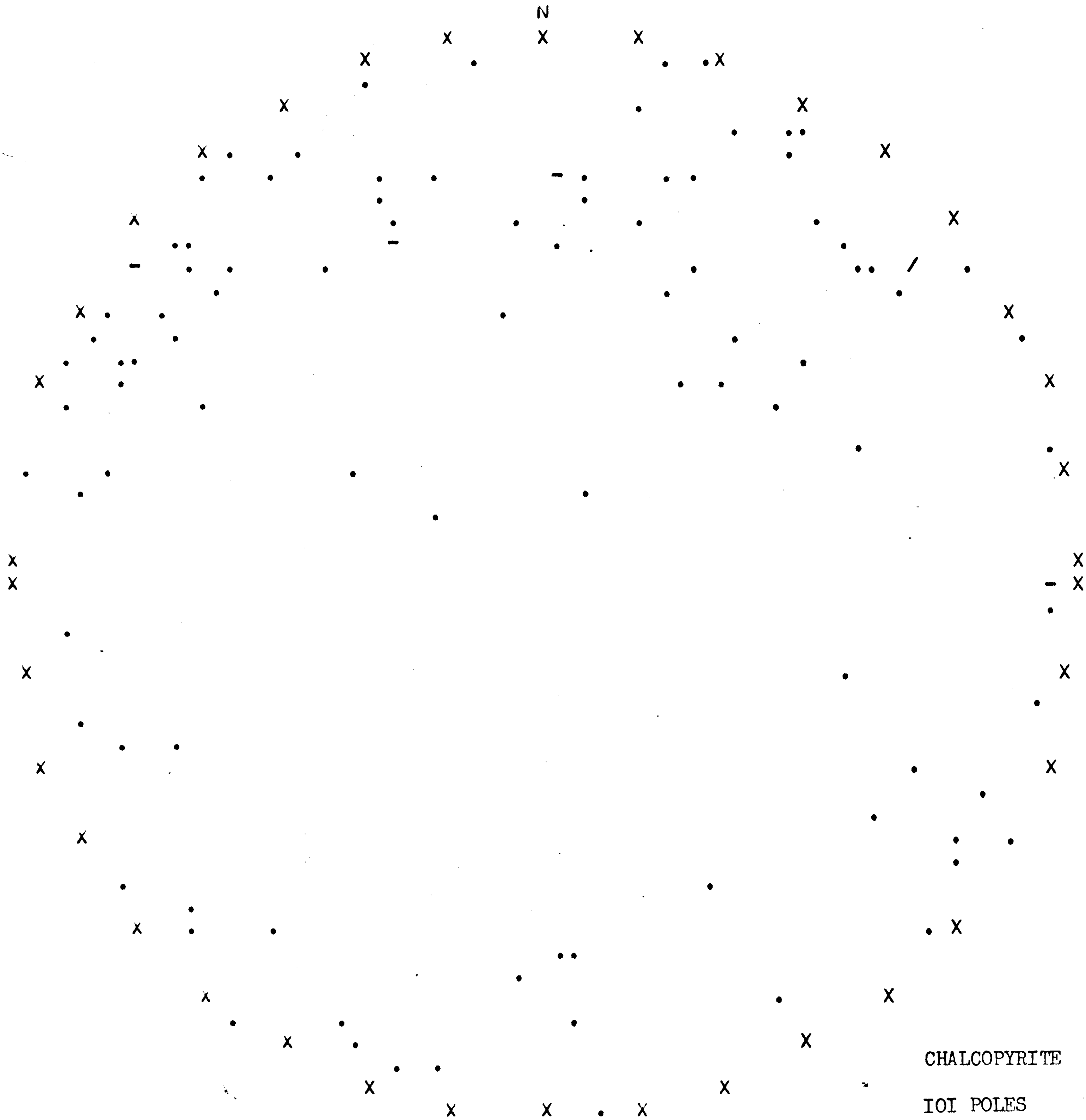
c.c. KCF
DHJ
RRM

S.J. Wilkinson
Senior Geologist

SJW:tjt

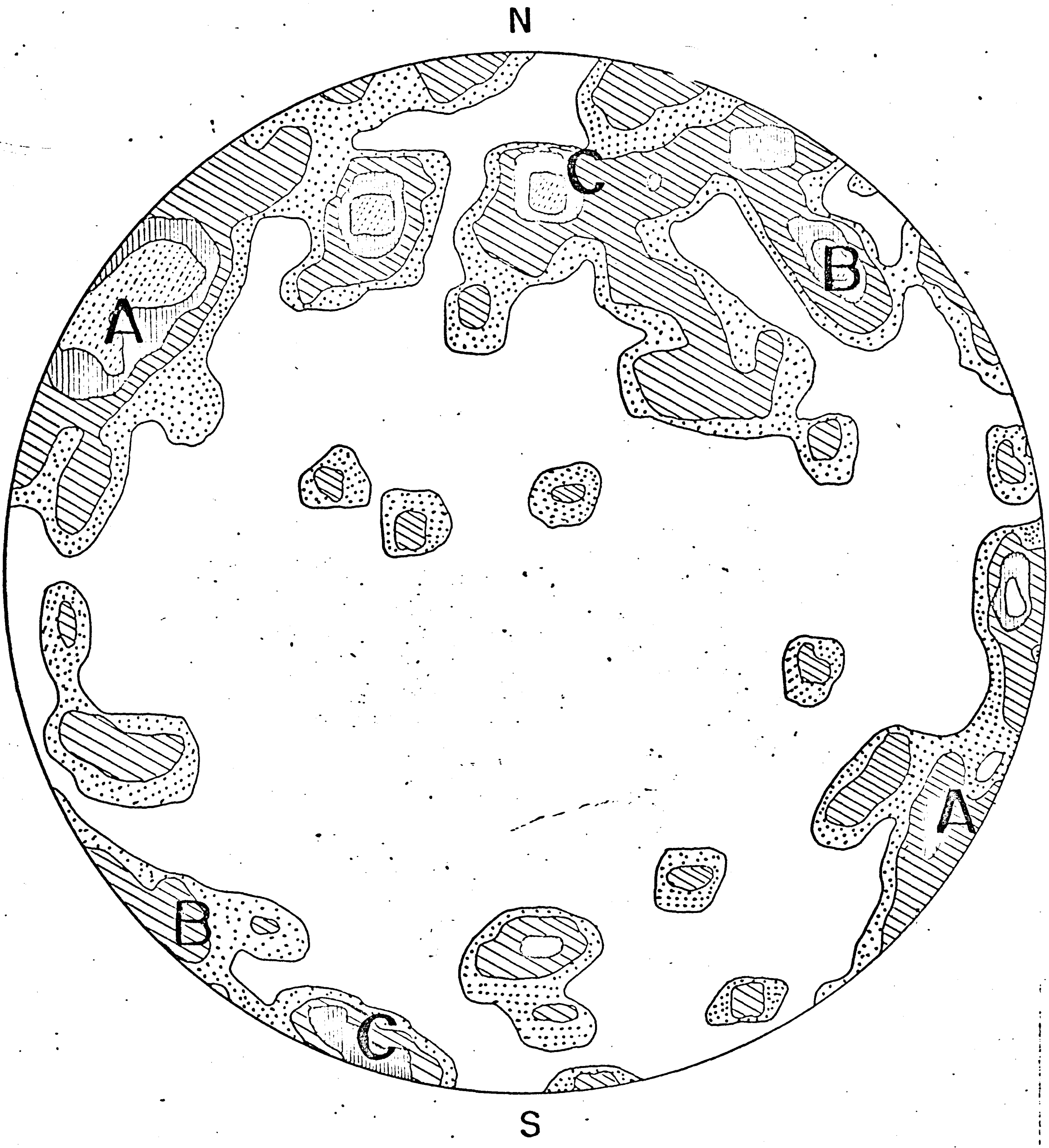
ıALOPYRITE ***
4003 BEN4004 **** LTYP 1 CONCAT TO BEN5001 BEN5002 BEN5003 BEN5004 BEN5005 BEN5006 B
N7003 BEN7005 BEN7006 LTYP 2 3 4 5 8

= 2.21+00 INC= 1.2+01 DEC= 5.1+01 CON RAD= 9.366+00



CHALCOPYRITE

IOI POLES
SCATTER DIAGRAM
LOWER HEMISPHERE
EQUAL AREA PROJECTION



SCHMIDT EQUAL AREA CHALCOPYRITE

101 POLES

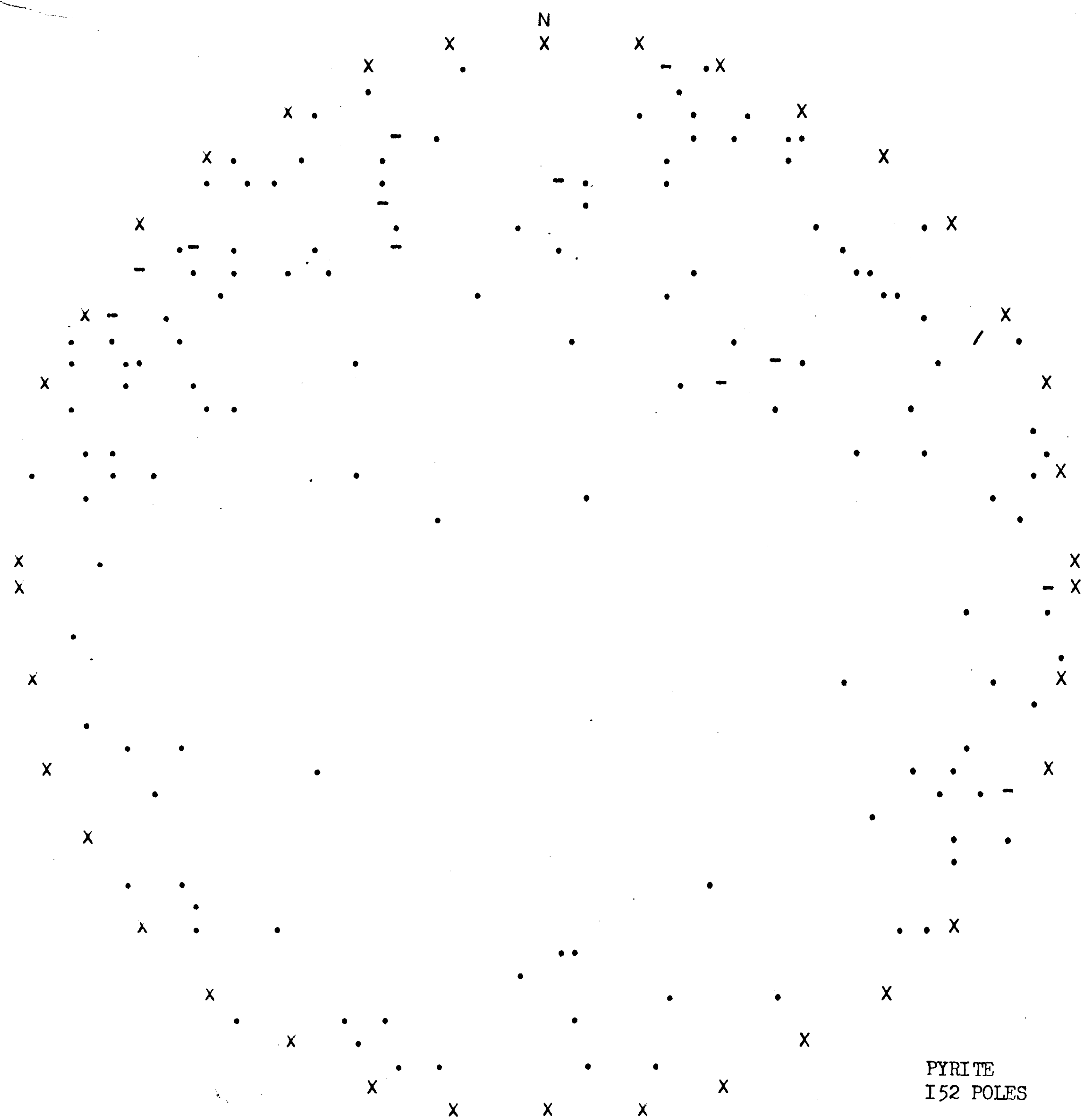
KEY: 1-2 2-4 4-6 6-8

***

N4003 BEN4004 *** LTYP 1 CONCAT TO BEN5001 BEN5002 BEN5003 BEN5004 BEN5005 BEN5006 [illegible]

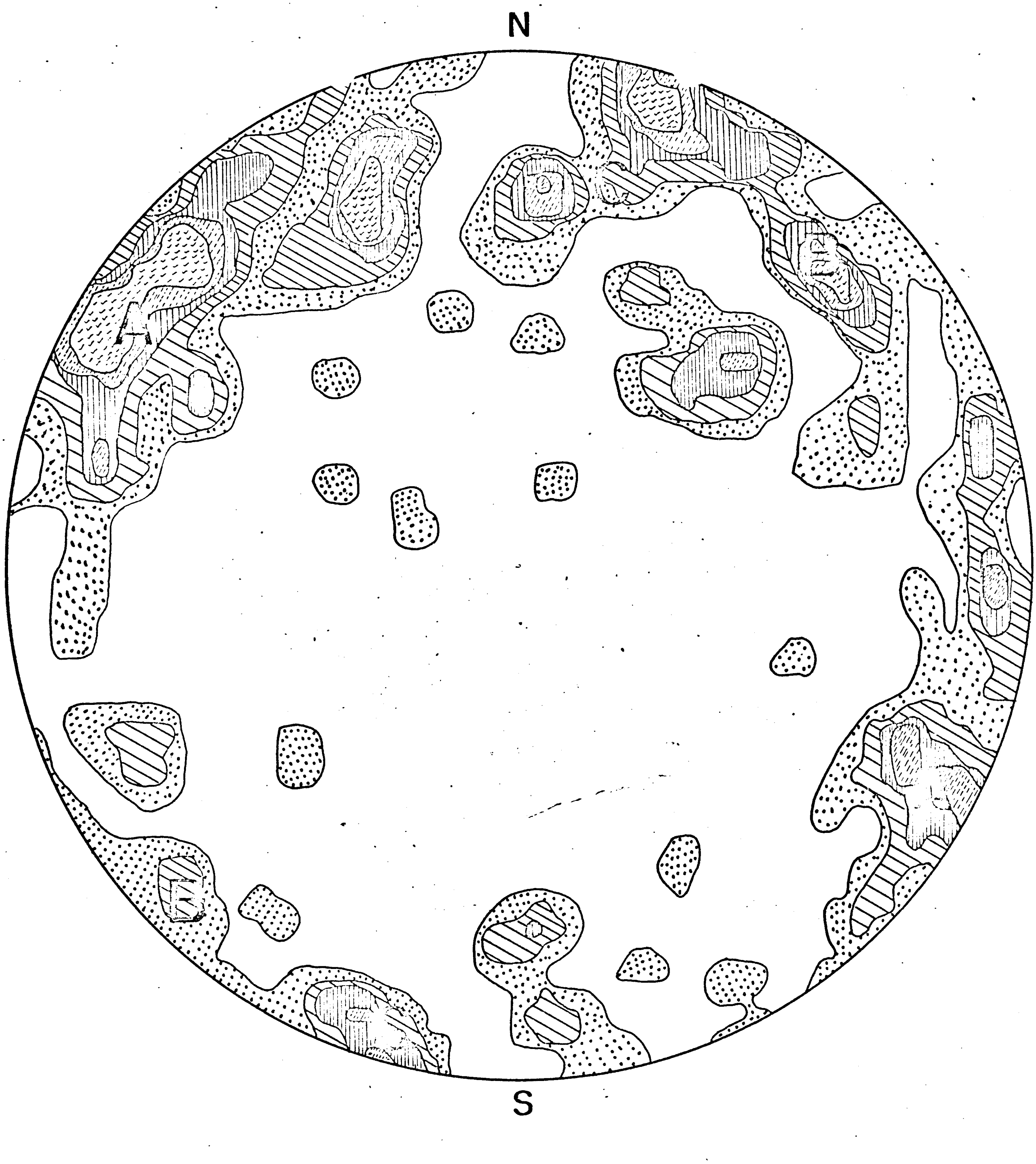
002 BEN7003 BEN7005 BEN7006 LTYP 3 5 6 8 9 CONCAT TO BEN3001 BEN3002 LTYP 1 2 5

S= 2.24+00 INC= 7.5+00 DEC= 6.1+01 CON RAD= 7.583+00



PYRITE
I52 POLES

SCATTER DIAGRAM
LOWER HEMISPHERE
EQUAL AREA PROJECTION



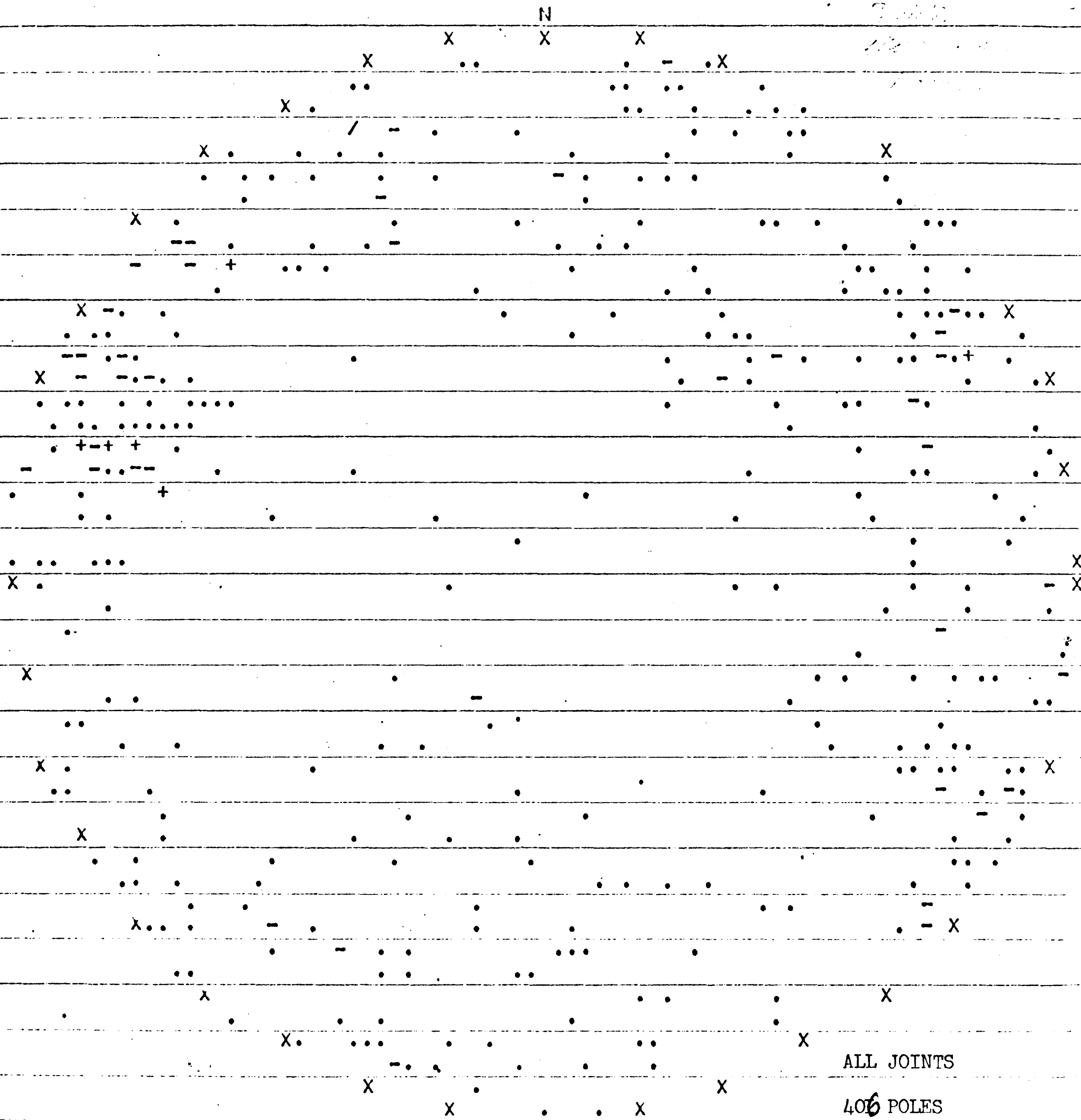
EQUAL AREA PYRITE
152 POLES

KEY: 1-2 [pattern], 2-3 [pattern], 3-4 [pattern], 4-5 [pattern], 5+ [pattern].

ALL GROUP [illegible] COMBINED
SEPT 24 1971

406POLES

E + N



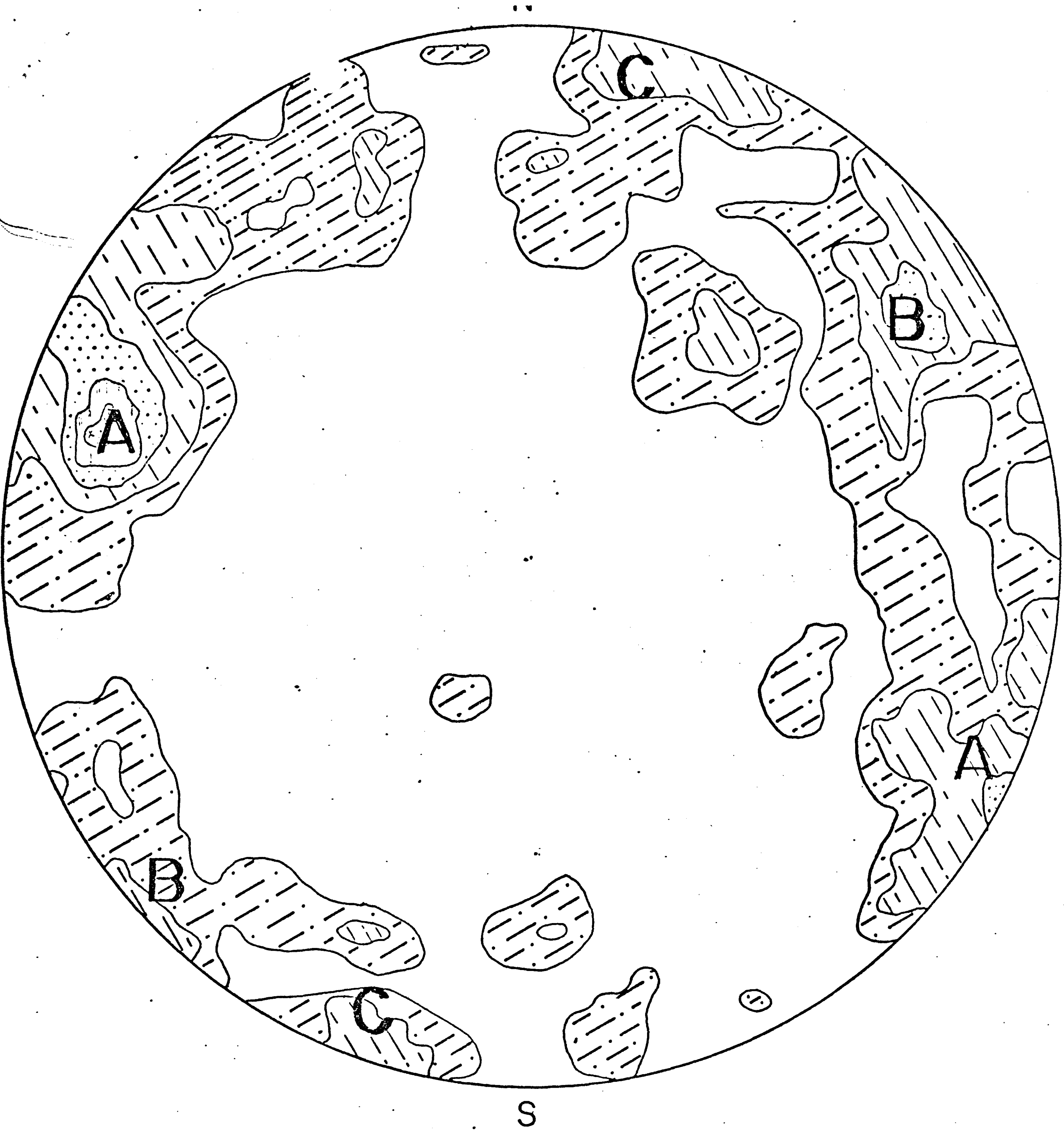
ALL JOINTS

406 POLES

SCATTER DIAGRAM

LOWER HEMISPHERE

EQUAL AREA PROJECTION



ALL JOINTS - SCHMIDT METHOD
EQUAL AREA PROJECTION - 406 POLES

KEY: 1-2 2-4 4-6 6-8 8+

CONTROL OF MINERALIZATION BY FRACTURING AT GRANISLE

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INTRODUCTION

The Granisle Copper property is situated in northern British Columbia. Mineralization occurs as fracture fillings of chalcopyrite and bornite within Tertiary porphyritic quartz diorite and granodiorite which intrude Hazelton volcanics and sediments.

REGIONAL FAULTING

Regional geology is dominated by the two northwesterly striking faults as shown on map I. N.C. Carter (1972) states these faults are steeply dipping block faults. Neither of these faults are exposed in the pit.

MINE FAULTING

Three faults, named the Eastern, Western and Central Faults respectively, control pit geology (see map I). These faults strike approximately N25^{o}E and dip 70^{o} to 90^{o} easterly. Extension of the faults beyond the pit limits is not known, but they are probably terminated by the Northwesterly regional faults which bracket the pit. Displacement across the mine faults is evident, but, at present, cannot be determined.

Typically the faults are composed of kaolin and carbonate rich gouge from one to five feet thick and are adjoined by a zone of crushed and bleached rock up to twenty feet thick. The gouge contains broken quartz and sulphide veins, but sulphide stringers have been noted parallel to the schistosity. Within the pit, the faults are ore controls.

ORE FRACTURES

Sulphides at Granisle are almost entirely confined to quartz veinlets which form a secondary fracturing system through the pit, with varying intensity and direction. A statistical study of these fractures was necessary to define major trends.

Mineralization of Fractures

Ore fractures usually contain a thin stringer (average 0.5 mm) of chalcopyrite $\pm$ pyrite or bornite, within a quartz vein, the total thickness being about 2mm. Calcite and iron oxides commonly occur as secondary minerals. Where two sulphides occur together, they are contemporaneous. Locally the veins have a filling of post-sulphide gypsum.

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Zoning

The ore body exhibits strong zoning around a central high-grade core. Diagram one shows the relation of fracture fillings to their distance from the core. In addition to this zoning of minerals, fracture density decreases away from the central core.

Fracture Survey

Poles of chalcopyrite filled, pyrite filled and all fractures were computer contoured by Golder, Brawner & Associates, on Schmidt equal area nets. All three systems show a fair spread and look very similar, but certain preferential orientations can be detected which are designated, on the nets as A, B, and C:

- Orientation A - strike N25°E, major dip 75° easterly - correlated with mine faulting.
- Orientation B - strike N45°W dipping 75°SW - correlated with regional N.W. faults
- Orientation C - strike approximately E-W dipping 75°S - correlated with cross faulting in the pit.

From work done up to the present time, it appears that sulphides are distributed in all the systems of fractures, with no obvious set of joints which are barren.

DYKES AND BRECCIAS

With exception of the southern contact of the main porphry intrusion, the contacts of the major intrusives are along fault lines. The main intrusives are pre-fracturing. However, there are some late stage dykes which cut through quartz veins in the walls, yet themselves are cut by quartz veins.

The central core is weak breccia near the intersection of the central fault and the southern contact of the main porphyry. In the northern end of the pit a similar, but weaker, centre is associated with the Eastern Fault.

CONCLUSIONS

1.) All minor fracturing in the pit can be fitted into a regional picture.

2.) Mineral zoning and breccia centres are developed by fracturing.

3.) Fracturing, intrusion and mineralization took place throughout the period of activity.

Reference

Carter N.C. : Geology of the Northern Babine Lake Area - Granisle-Excursion Guide for International Geological Congress - 1972

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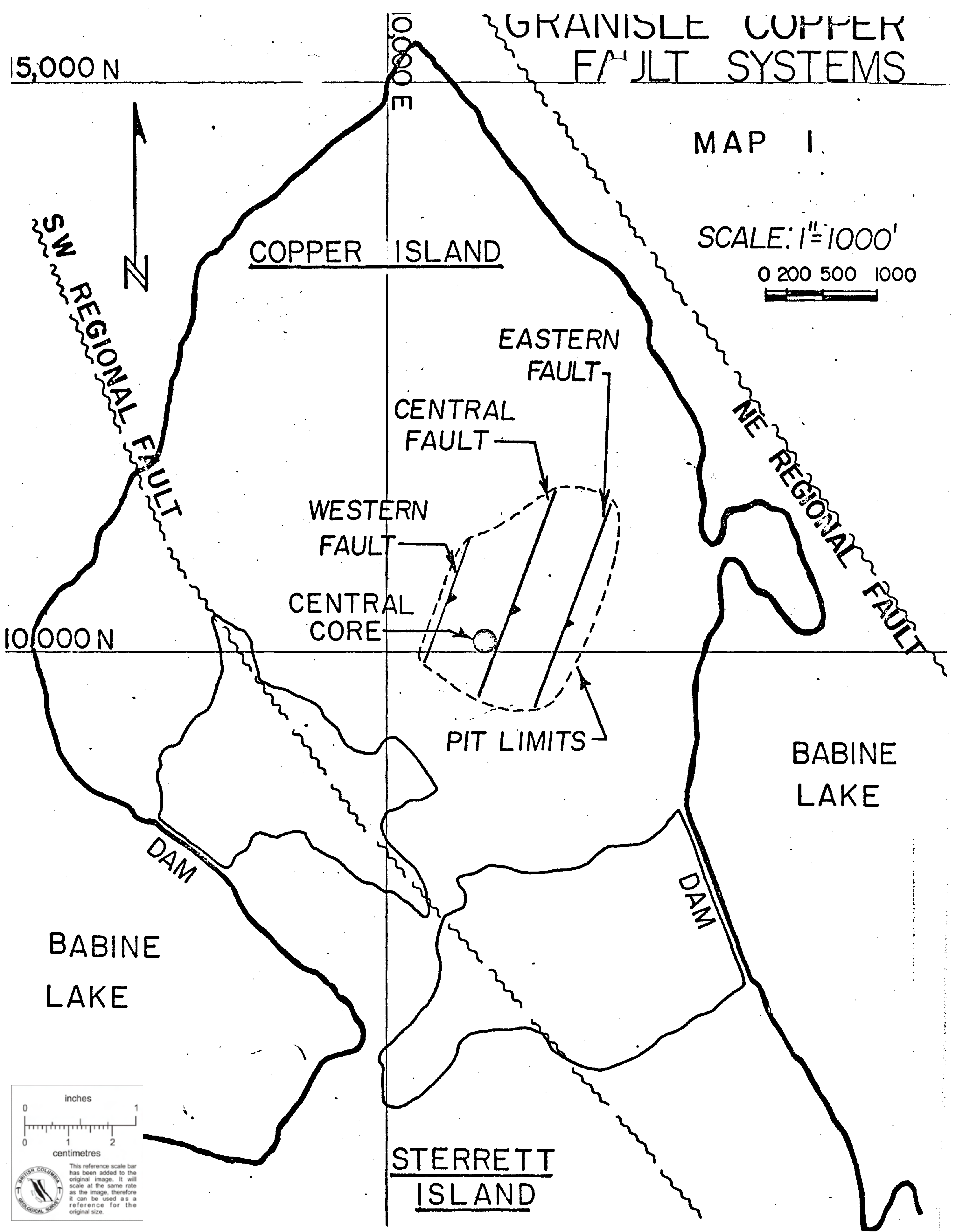
GRANISLE COPPER
FAULT SYSTEMS
MAP I
SCALE: 1" = 1000'
0 200 500 1000
15,000 N
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COPPER ISLAND
SW REGIONAL FAULT
NE REGIONAL FAULT
EASTERN FAULT
CENTRAL FAULT
WESTERN FAULT
CENTRAL CORE
PIT LIMITS
BABINE LAKE
BABINE LAKE
DAM
DAM
STERRETT ISLAND
inches
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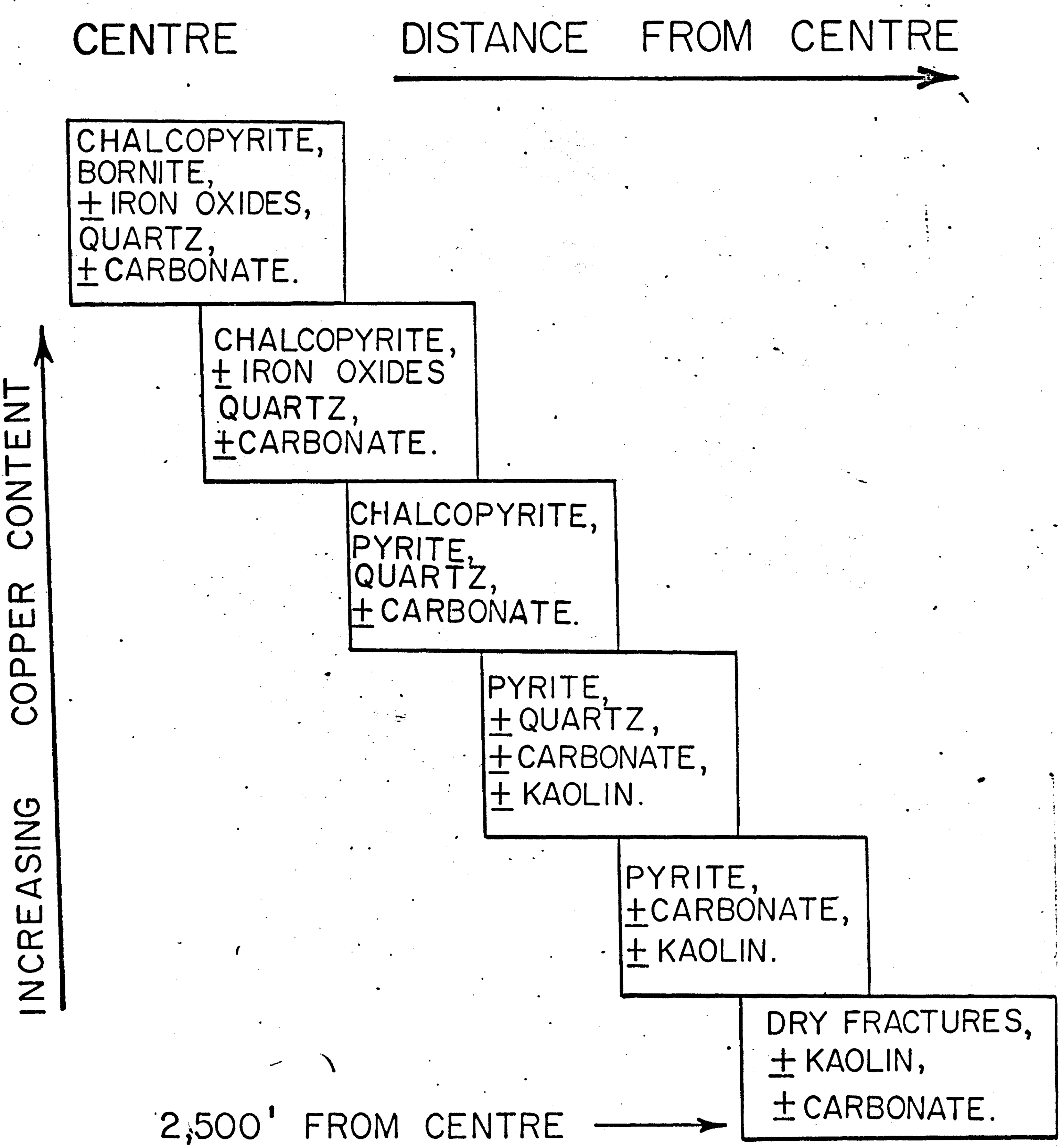
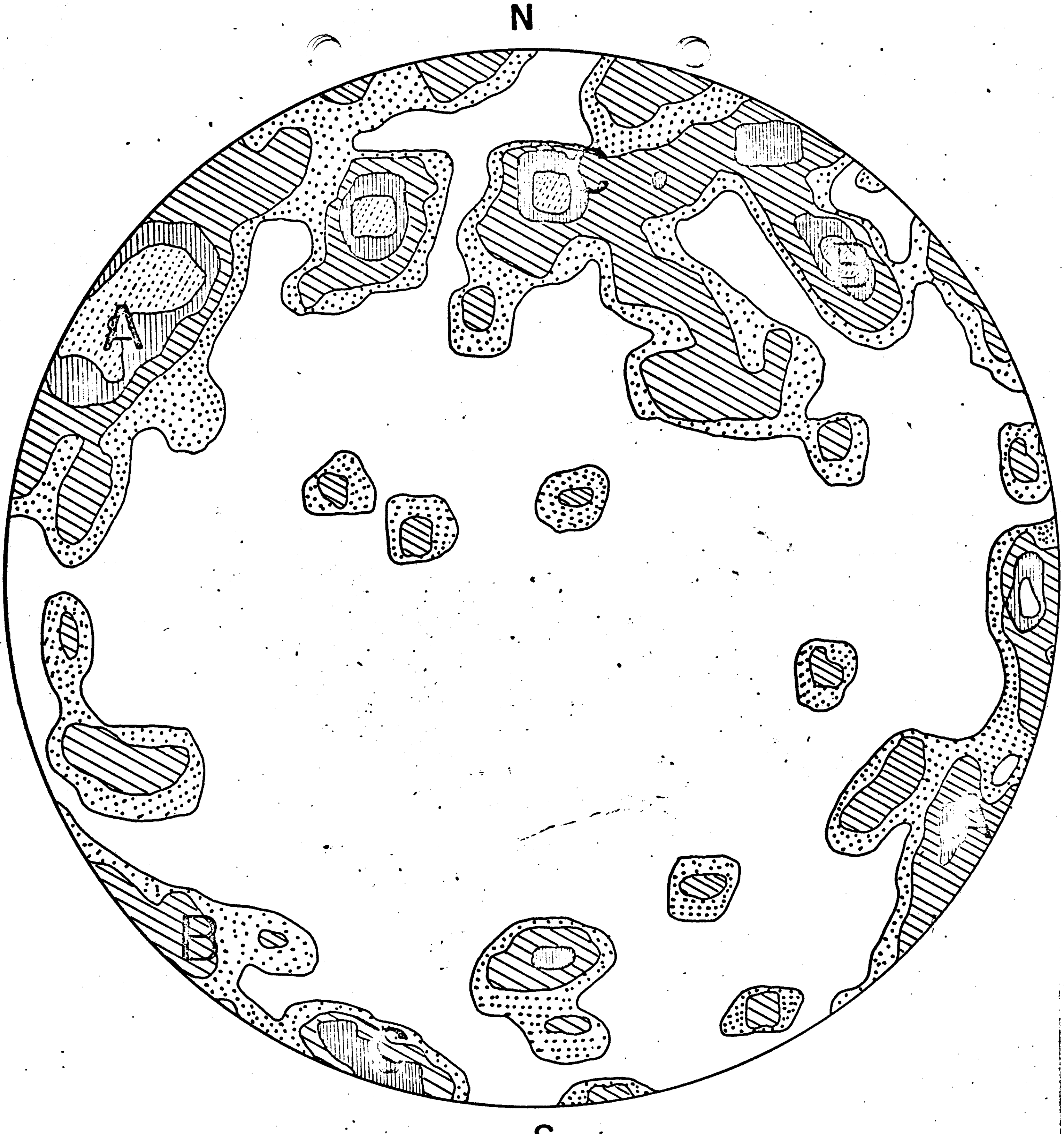
BRITISH COLUMBIA GEOLOGICAL SURVEY

DIAGRAM I - ZONING

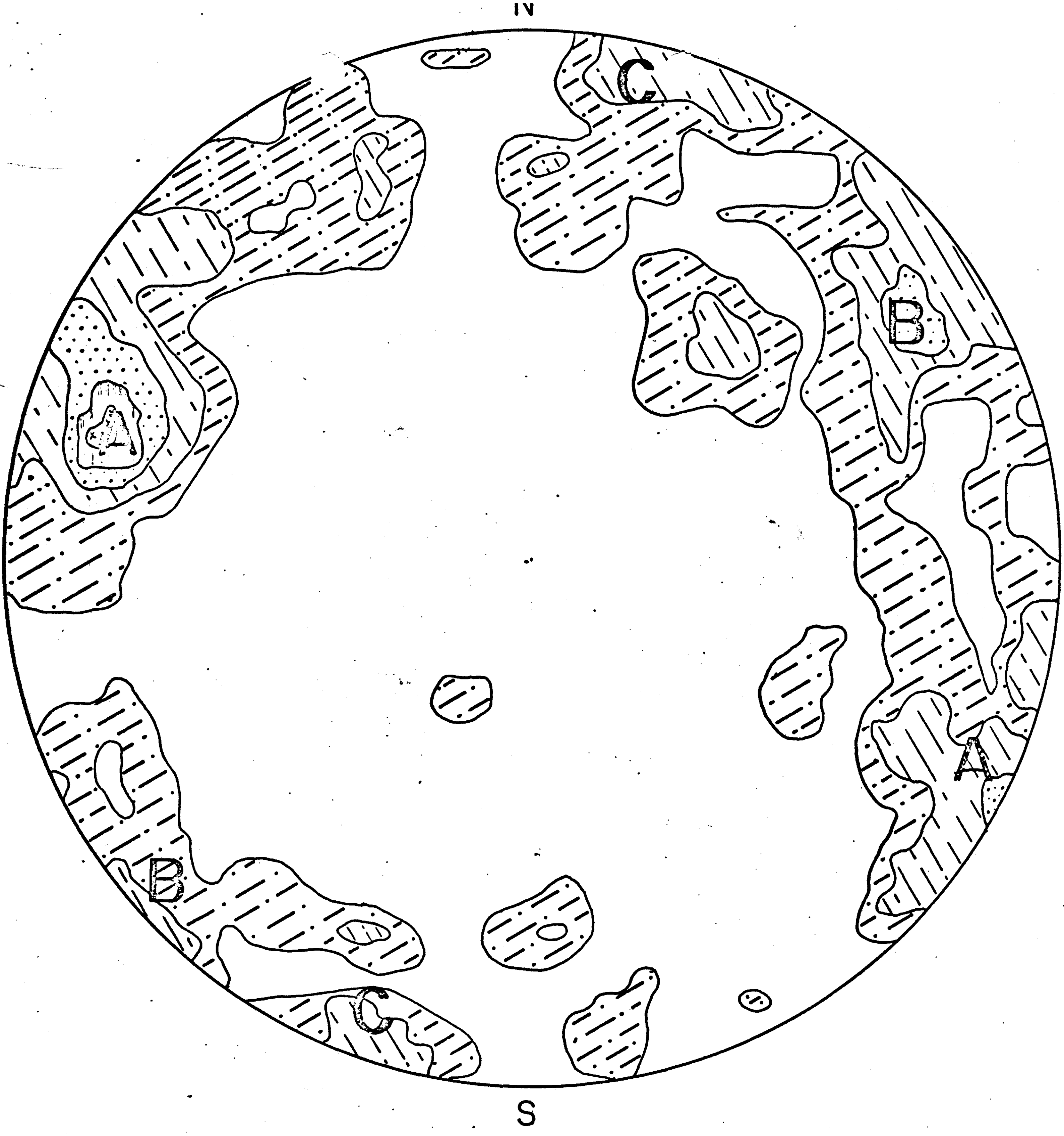




SCHMIDT EQUAL AREA CHALCOPYRITE

101 POLES

KEY: 1-2 [stippled], 2-4 [diagonal hatching], 4-6 [vertical hatching], 6-8 [fine hatching],



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GRANISLE (STERRETT ISLAND)

3. General Geology

Geological history observed in the areas studied is summarized in Table I-1. The geological map is also shown in Figure I-1.

Table I - 1

Propylitic alteration	Chloritization, carbonitization, pyrite impregnation		
Potassic alteration and mineralization	Biotitization, sericitization, silicification with chalcopyrite, molybdenite, magnetite and pyrite		
Structural disturbance	Fault movement		
McDonald intrusive rocks	quartz diorite porphyry dyke	hybrid facies	
		main facies	
		marginal facies	
	dacite dyke		
Sterrett intrusive rock	hornblende andesite dyke		
Hazelton group	B-formation	upper member	hornblende andesite lava flow, agglomerate
		middle member	amygdaloidal basalt lava flow
		lower member	dacitic muddy tuff, tuff breccia, siliceous slate and sandstone
	A-formation	upper member	andesitic agglomerate, tuff
		middle member	fossiliferous greywacke, slate, and conglomerate
		lower member	andesite agglomerate, lava flow, tuff breccia

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3.1 Stratigraphy

According to Annual Report (1965), sedimentary rocks in this district, belong to Hazelton group (possibly middle Jurassic age). In this geological survey, Hazelton group was divided into two formations named as A-formation and B-formation. A-formation is distributed in the main part of Sterrett island, and B-formation in northern peninsula of Sterrett island and in McDonald island.

These formations are bounded by a fault in the northern Sterrett island and their stratigraphic succession was not defined yet. Each formation was subdivided into three members, upper, middle and lower.

A-formation

Lower member: This member is composed of andesite lava flows, agglomerates and tuff breccias. Andesite has massive and compact feature, and its phenocrysts cannot be recognized by naked eyes. Microscopically, phenocrysts of plagioclase are in groundmass composed of plagioclase,hematite and carbonate. Some amount of fibrous chlorite is present in vesicles.

Tuff breccia contains andesite fragments with small amount of dolerite fragments. The size of these fragments are around 5.cm . Agglomerates are composed of angular to subangular blocks of andesite and tuffaceous matrix. The matrix of tuff breccia and agglomerate is sandy in some places.

Middle member: Middle member is typically distributed in the west shore of Sterrett island, and composed of fossiliferous sedimentary rocks, such as greywacke, calcareous slate, and conglomerate. They are alternated and well bedded. The fossils contained are molluscus and pieces of carbonized plant. Neither mineralization nor alteration is found in this member. Greywackes are well sorted, medium-grained and gray. Calcareous slates show dark gray to light gray, and are sandy in some places. Conglomerates contain subangular to rounded blocks mainly composed of andesite ranging 5 cm to 10 cm in size.

Upper member: This member is a succession of hornblende andesite lava flows, agglomerates, and the alternation of tuff breccia and sandy tuff. These rocks show dark reddish brown megascopically.

Hornblende andesite lava flows have phenocrysts of plagioclase, hornblende altered to opaque mineral, and hematite in a matrix of lath plagioclase, plagioclase microlites, carbonate minerals and feruginous stain. Agglomerates are composed of angular to subangular blocks of hornblende andesite, and tuffaceous matrix, but the matrix is sandy in some places. Tuff breccia and sandy tuff are distributed typically along the east shore of Sterrett island, and graded into each other. In some places, however, they are alternated.

B-formation

Lower member: Lower member is distributed from the north end of Sterrett island to the eastern McDonald island. This member is a succession of muddy tuff, tuff breccia and silliceous slate. Muddy tuff is mainly found at the nothern part of Sterrett island. It is light gray, well stratified, and contains fine quartz grains partly. Also muddy tuff changes gradually upward to tuff breccia.

Tuff breccia in this member is characterized by containing breccia of dark gray colored slate. The tuff breccia is distributed from the east side of the open pit to the east shore of McDonald island. In some places of the east shore, dissemination of pyrite is found.

Siliceous slate is observed as a small outcrop in the northern peninsula of Sterrett island, and also is found by drilling in the east side of the open pit. The rock in the neighborhood of the pit is metamorphosed to hornfels.

Middle member: This member is characterized by amygdaloidal basalt lava flows typically distributed along west shore of McDonald island. The basalt is black or dark green. Black basalt is more compact than dark green one. Microscopically phenocrysts of augite and plagioclase occur in matrix of plagioclase lath, fine-grained pyroxene and magnetite showing intergranular and/or intersertal texture.

The amygdules of the basalt are filled by fibrous chlorite, calcite, or zeolite. The basalt near the mineralized zone is strongly affected by propylitic alteration, but amygdaloidal texture is still remained.

Upper member: Because of insufficient outcrops, details of this member are not known well. In the south of the mine office in McDonald island, weakly altered acidic sandy tuff with thin sandstone beds of this member is distributed. Also some of the drill cores in the open pits show the presence of strongly altered sandy tuff, tuff breccia and agglomerate covering the andesitic lava of middle member.

3.2 Intrusive rocks

Intrusive rocks in the areas are classified into two kinds: one is intermediate in rock facies and occurs as hornblende andesite dyke only in A-formation of Sterrett island, while the other is acidic to intermediate, and mainly occurs in B-formation of McDonald island. These two kinds of intrusive rocks are named " Sterrett " and " McDonald " intrusive rocks according to their respective type localities.

(1) Sterrett intrusive rock

Several dykes of hornblende andesite are distributed in the eastern half of Sterrett island having NNW-SSE strike and making small hills.

The rock is dark gray in color megascopically. Under the microscope, it has a lot of phenocrysts of plagiclase, hornblende and magnetite. Phenocrystic plagioclase shows polysynthetic twin and zonal structure distinctly, and alters to sericite partly. Most of the hornblende phenocrysts alter to opaque minerals and partly to carbonate and chlorite. Granular crystals of magnetite reach to 0.5 mm in size and often include apatite grains. Matrix is composed of small crystals of quartz and feldspar of mosaic texture and sometimes shows a flow structure in which minute crystals of lath shaped plagioclase arrange in parallel. Carbonate minerals are formed in matrix abundantly.

Any kinds of mineralization and alteration have never been recognized arround the Sterrett intrusive rock bodies.

(2) McDonald intrusive rock

According to rock facies and occurrence, McDonald intrusives are classified into two types as follows:

Dacite dyke

Many dykes of dacite are distributed in McDonald island. Also, the rock bodies occurring in the northern peninsula of Sterrett island are thought to belong to this type.

Dacite in McDonald island is suffered from thermal metamorphism by the intrusin of quartz diorite porphyry described below, particularly in the east side of the open pit. It is metamorphosed to hornfels which contains many flakes of secondary biotite.

In the northern peninsula of Sterrett island, however, dacite is quite fresh. Under the microscope, it contains zoned and polysynthetic-twinned plagioclase, biotite and hornblende as phenocrysts. Biotite is free from any kinds of alteration, and hornblende is weakly carbonatized.

Quartz diorite porphyry dyke

Quartz diorite porphyry occurs in the central part of McDonald island intruding in the B-formation of Hazelton group and dacite dykes, and directing to NNE-SSW.

The rock body is composed of main facies, marginal facies and hybrid facies, as described below.

Main facies: Main facies occurs in the west and to the southwest of the open pit. It is to be named as biotite hornblende quartz diorite porphyry, and corresponds to biotite feldspar porphyry in Annual Report, 1965. Under the microscope, it contains phenocrystic plagioclase, biotite, hornblende, apatite and quartz. Matrix is holocrystalline and mainly composed of quartz and feldspar of mosaic, mylmekitic and microgranular textures, accompaning minute crystals of biotite and muscovite. Main facies of quartz diorite porphyry is altered widely but weakly, and contains some sulfide minerals locally.

Marginal facies: It occurs in the north of the open pit as a nothern continuance of the main facies. Marginal facies shows gradual change to main facies and does not have distinct boundary with it. It is somewhat finer-grained and more basic than main facies. The rock name of the marginal facies is hornblende biotite andesite porphyry. Under the microscope, it contains phenocrysts of plagioclase, biotite, hornblende and apatite. The groundmass generally shows felsitic or pilotaxitic texture of quartz and feldspar, but locally it is composed of glass having flow structure.

Hybrid facies: A larger rock body of hybrid facies occurs around the open pit. Other than this, two hybrid facies rock bodies of small size are found in the southwest of the open pit. The rock of hybrid facies is characterized by containing a lot of fragments of marginal facies rock, slate and dacite. Matrix part is similar to the main facies rock. Xenolithic rock fragments are metamorphosed thermally to hornfels. Main part of known mineralized zone (open pit) is located in the hybrid facies rocks.

3.3. Geological structure

The areas of Sterrett and McDonald islands are divided into two geologic blocks by a NE-SW fault which passes through the northern part of Sterrett island. In the south side of the fault, A-formation of Hazelton group is distributed, while in the north, B-formation and acidic (McDonald) intrusives are developed.

A-formation has general strike of N-S to NW-SE and dips 40 degrees to west or east. Trend of A-formation is disturbed significantly by block movement or NE-SW faulting.

B-formation shows a gentle synclinal structure in northern McDonald island, that is, the northeastern part of the island, it strikes N-S to NNW-SSE and dips 20 - 40 degrees to west, while in the northwestern part, it dips 20 - 30 degrees to east.

McDonald intrusives are elongated in the NNE-SSW direction along which faulting is developed. Furthermore, such a structurally disturbed part seems to be coincide with the location of hybridization and later mineralization.

3.4 Mineralization and alteration

Granisle copper deposit is located along and in the neighborhood of the boundary between the main and hybrid facies zones of McDonald quartz diorite porphyry. In this case, hybrid facies rock seems to be much more favorable to mineralization. From the present investigation, a kind of concentric zonal distribution was recognized.

The rock observed in the open pit is characterized by potassic alteration (biotitization, sericitization and K-feldspar formation) and metallization (chalcopyrite, bornite and pyrite deposition). Under the microscope, potassic-altered rocks have matrix consisting of secondary minute crystals of biotite, minior amount of muscovite, and some amount of sulfide grains. Hornblende phenocrysts are mostly replaced by secondary biotite, while plagioclase phenocrysts are partly sericitized. Also the rocks are penetrated by quartz veinlets which contain K-feldapar, biotite, chlorite, calcite, chalcopyrite, bornite, pyrite and rutil. A small amount of molybdenite and magnetite is also observed in the open pit area.

In the surrounding zone of the open pit area mentioned above, propyritization (chloritization and carbonatization) and pyritization are predominant. Under the microscope, mafic minerals such as hornblende and biotite are replaced by chlorite, hydromica and carbonate. In some phenocrysts of plagioclase, chlorite, epidote and carbonate are formed. Pyrite in this zone is much more abundant than the open pit area (central zone), while copper minerals are quite poor or absent in the pyritic outer zone.

As seen from the above description, mineralized part corresponds to and coincideswith the potassic alteration zone. In McDonald island, the potassic alteration zones other than the open pit area are found arround the following points:

(1) N12000, E10700 : Dacite dyke, partly silicified.

(2) N10000, E10000 : Hybrid facies rock with chalcopyrite and molybdenite impregnation.

(3) N10500, E10500 : Hybrid facies rock.

In Sterrett island, malachite films were found in tuff breccia of upper member of A-formation arround a point of N6000, E13600. The potassic-altered rocks, however, could not be found in any parts of the island.