JORDAN RIVER MINES Ltd.

SUNRO MINE

Annual Geological Report

1973

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JORDAN RIVER MINES Ltd SUNRO MINE

R. V. KIRKHAM

ANNUAL GEOLOGICAL REPORT

1973

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INTRODUCTION

This report summarizes the geological data collected at the Sunro Mine in 1973.

Besides original information gathered at the mine site by routine work and personnal observation, the report includes material from outside sources. In this respect, the assistance of Mr. R.V. Kirkham and K.E. Northcote (Government Geologists) for supplying published and non-published material is gratefully acknowledged. The help of Mr. B. Berthault (Pechiney Development Ltd) and Dr. M. Hedley is also gratefully acknowledged.

The first part of the Report deals with general geology and is concluded by an attempt of synthesis on a genetical model.

The second part gives recent figures on ore reserves, exploration proposals and diamond drilling statistics.

The report is to be accompanied by the following maps:

- Geological Map of 5225 Level- 1" = 100'
- Geological Map of 5325 Level- 1" = 100'
- Geological Map of 5425 Level- 1" = 20'
- Longitudinal Section of main adit- 1" = 100'

STRUCTURAL GEOLOGY

This chapter has been purposely cut down to a bare minimum, and rather than attempting to correlate all the informations on the structual pattern collected this year, only the major established facts will be presented.

I. RIVER ZONE

I. 1. Proof of Post-ore movement along the C Fault

The "River C Zone" is an elongated structure striking N. 30-35 West, with a steep dip to the north-east. It has been traced on 900 Feet long, 1100 feet high and its average width varies from about 25 Feet in the northwestern part to a few feet to the southeast.

About 365,000 Tons have been mined out from this zone, with an average grade of 1.40% Cu.

The structure is remarkably continuous on strike, although minor local changes in strike and dip, as well as mineralization discontinuity, are known.

The bulk of the ore is situated on the west side of a main break, the C Fault, which displays a few inches of gouge with a small amount of secondary Pyrite. A few small pockets of ore are known on the eastern side of the C Fault. Several offshoots, locally very rich, escape from the main body with a northwesterly direction.

A few cross fractures introduce minor local offsets of the vein ore, never exceeding a few feet. Those cross fractures are narrow gougey slips striking generally in a northerly direction.

The eastern wall of the ore (hanging wall) is usually very sharp on account of the C Fault, whereas the western wall is determined by an arbitrary cut-off line based on assay results.

As described previously, the ore consists of submassive Chalcopyrite, containing bands a few inches wide of Pyrrhotite, parallel to the local strike of the vein. Quartz crystals (usually euhedral), wall rock angular fragments and thin veinlets of secondary Pyrite are also present.

The Chalcopyrite is usually coarse in the western half of the vein, where it cements the angular wall rock fragments (breccia and pseudo breccia). In the eastern half of the vein (closer to the fault), the Chalcopyrite is very fine grained, massive, without inclusions. This much finer grain is considered as the result of a shearing effect on the sulphides: the Chalcopyrite has

been ground into a cemented dust, very much in the same way as the formation of "Steel-Galena" in lead-zinc veins.

When exposed in the development faces and stope breasts, the surface of the C Fault plane showed numerous slickensides, generally dipping only a few degrees to the south-east. However, several "layers" of slickensided rock can be peeled off, each showing a slightly different trend of grooves.

We can draw the following conclusions from the above data:

1. a. The River C Zone is actually a "vein-fault", formed by fracture-filling of an original open break and subsequently re-faulted on strike.

1. b. The eastern block has been the active one in the post-ore faulting process, moving to the southeast and slightly down. The horizontal and vertical displacements are unknown.

1. c. The faulting process has been complex and probably not uniform, as indicated by the several direction of slickensides. Although shearing obviously took place along the C Fault, accompanied by the Creation of cross-fractures which represent the complementary shear direction, a shattering movement either followed or accompanied this shearing.

I. 2. Existence of bearing surfaces in the C vein

During the development of the southeastern extension of the River C Zone in 1970, it was found that the vein pinches out on the 5400 Level. Further work indicated a low-grade area centered on Section 1300, extending from 5350 to about 5500 elevations.

Closer study recently undertaken in this area revealed the following phenomenons between Sections 1500 and 1100:

(Going along the C vein-fault from NW to SE)

- Decreasing ore widths, finally leaving only a non-mineralized break filled with shaly material (Argillite and Calcite with some quartz) and bearing water.

- At a point 20 Feet north of Section 1300, a low-angle fracture (20°) seems

to deflect the C Vein-Fault towards the southwest. This fracture has a vertical dip and carries a gouge similar to the C Vein-Fault.

- South East of this fracture, the vein-fault shows only weak mineralization with erratic higher grade pockets. The vein-fault swings back to its original strike after 10 Feet on 5375 and 100 Feet on 5405.

- To the northwest of the low-angle fracture, the C Vein-Fault dips 80 South-West, and to the southeast dips 80 Northeast.

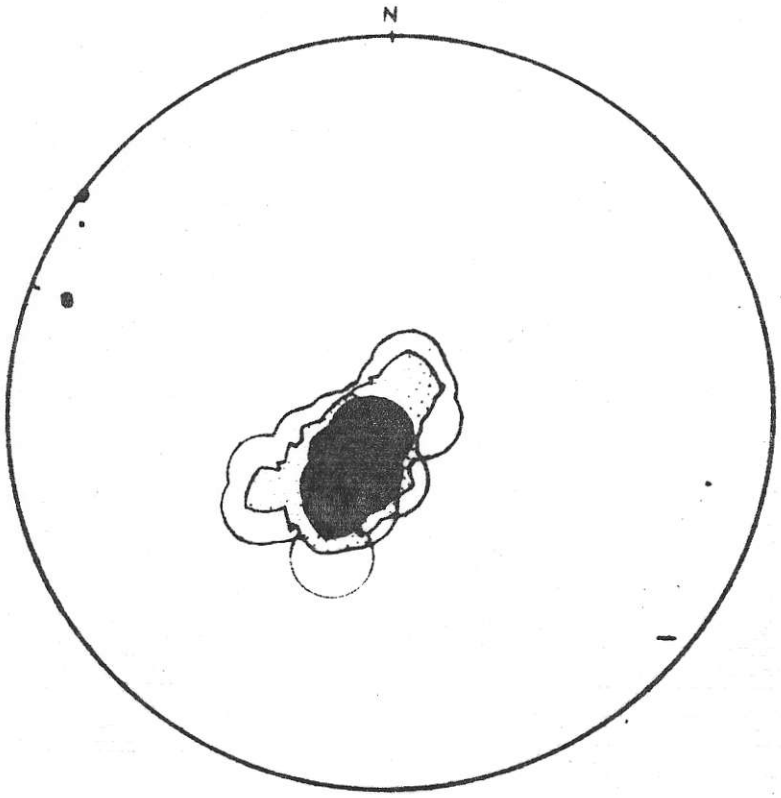
These observations indicate the presence of a bearing surface in the C Vein Fault at that point. This zone being under compression at the time of mineralization was not invaded by the solutions which deposited the sulphides in the other parts of the original fracture. This phenomenon is very similar to the ones observed at the Opemiska Copper Mine in northern Quebec.

II. CAVE ZONE

The importance of sulphide filled tension fractures had been recognized in the early stage of the Cave Zone development on 5225 Level.

Mapping of the 5425 Cave A Undercut has added data on this point. On this level, the highest grade portion of the orebody consists of closely spaced Chalco-Pyrite veins and "crackles", striking N 110 to 125 East and dipping 62 to 72 Northeast. A series of 51 such veins were carefully measured and plotted on an upper hemisphere Wulf projection (Figure II). The poles of each vein were then contoured by 1, 3 and 6 poles per 1% area. The results are a very concentrated area with an average strike of about N 115 East and a steep dip to the Northeast. Some of these veins display a fringe of Hornblende crystals (described in the Chapter on Alterations at Sunro) which are considered as a result of re-crystal-lization under stress. The average strike of the high grade veins makes a horizontal angle of about 40-45 with the strike of the East Branch Fault and about 60 with the local strike of the Cave Fault. Some of the veins are cut and offset on a few feet by the secondary faults of the West Branch type, striking N 30 East with a vertical dip.

The high grade Chalcopyrite veins described above are considered as tension fractures and the following sequence of geological events is suggested



WULF PROJECTION - 51 SULPHIDE VEINS ON 5 425

Contours 1, 3 and 6 Poles Per 1% Area

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FIGURE II

DRAWN	G.X. Meusy	SCALE	N/A
APPROVED		DATE	NOV 73

G.X MEUSY NOV 1973

for the Cave Zone:

II.1: Original replacement in the gabbro and in the volcanics close to the intrusive contact. This replacement gave a disseminated low grade ore, where Pyrrhotite is predominant over Chalcopyrite, since no major opening existed in which the solutions could circulate. This stage could be considered as an "impregnation". Pervasive hornblendization probably accompanied this period of mineralization.

II.2: System under stress, eventually resulting in fracture filling of the tension cracks, which were low-pressure areas where massive sulphides were deposited (Chalcopyrite predominant). This period of mineralization was accompanied by re-crystallization of the Hornblende into large euhedral crystals.

II.3: Shearing, following by "shattering" of the system. This resulted in the creation of the Cave Fault and its complementary shears (No 1 and 2 Branches West) and the East Branch Fault. This shearing period was possibly accompanied by minor pulses of mineralization and by grinding of the hornblende close to the major breaks.

ALTERATIONS AT SUNRO

Four types of alteration have been recognized on the rocks underlying the Sunro Property. However, much more work is required to ascertain that no other alteration is present and to fully understand the process of the known types.

The following study is a compilation of the work done by J.S. Stevenson (1950) and B. Berthault (1973) and of personal observations.

I. HORNBLENDIZATION

This alteration shows an increasing intensity as one comes closer to the

equigranular and favours sub-euhedral to euhedral crystals about one eighth of an inch long. As mentioned in the 1972 Annual Report, some of this hornblende has been granulated by later shearing movements creating an aphanitix rock composed of cemented Hornblende dust.

I.C. Re-crystallization of the Hornblende

This re-crystallization can be observed in two occurences:

- In the volcanics, development of widely spaced euhedral crystals of black Hornblende, about one quarter of an inch long.

- In the intrusive and in the volcanics, development of large black Hornblende blades along sulphide-bearing veinlets and veins.

The former occurence has been observed on 53, 54 and 55 Levels in the Cave Zone, but also on 5600 Level in the New Zone. It is apparent that this alteration does not depend on the proximity of either the intrusive body or the Hornblendite Zones. It also appears from the study of hand specimens that the growth of the phenocrystals is not controlled by fracturation or micro-fracturation of the rock: although the crystals are euhedral, their outline is irregular and they contain dark and light-grey impurities.

The latter occurence was first observed by the writer in 1970, in the River B Zone drift on 5400 Level. It was noticed at that time that some of the Chalcopyrite veins were carrying a string of euhedral black Hornblende crystals about one eight of an inch long along one of the contacts. The crystals were elongated normally to the strike of the vein. Numerous similar occurences have been observed since in the Cave Zone as well as in the River Zone. The most spectacular occurence has been mapped recently on the Cave B Crosscut on 5425 Level: the Chalcopyrite vein is about 16 inches thick, strikes N 122 E and dips 60 to 69 northeast. The string of Hornblende crystals carried on the hanging wall of the vein shows large crystals of Hornblende about one and a quarter inch long, elongated normally to the vein. Close examination of a hand specimen shows three types of mineralization associated to the hornblende:

a. A narrow fringe of Chalcopyrite under-lining the contact hostrock-hornblende crystals.

b. Chalcopyrite coatings and speckles grown in the cleavage plans (110)

c. Very few short hairy Chalcopyrite stringers cutting the crystals.

Several other similar occurences have been mapped on the 5425 Cave workings, northwestern portion. They all have a southeasterly strike and a steep dip to the northeast. Some veins (1 to 12" thick) carry their hornblende crystals string on the footwall, some on the hanging wall.

With the general knowledge about the structural pattern in the Cave Orebody and with other information collected on the 5425 Level, those veins are considered to represent a late tension direction.

Mr. Mathew Hedley recently pointed out to the writer that Hornblende with this habitus is very likely to be a "stress mineral" (like Chlorites and Micas) the growth of which has developed normally to the tension fracture. The material from which hornblende was fed is most likely the hornblende of the altered wall rock.

The two above mentioned occurences are considered as the result of a late epigenetic re-crystallisation of the hornblende developed in the early stage of alteration.

D. SUMMARY

It seems from the above data that the hornblendization process at the Sunro Mine follows a pattern of increasing intensity as one moves closer to the orebodies

Three main steps of the process are:

- Replacement of the Augite.
- Replacement of the Plagioclase's.
- Re-crystallization of the Hornblende.

The two first steps are mostly induced by a chemical action, whereas the last step seems to be controlled at least for 50% by a mechanical process.

II. SILICIFICATION

The alteration named "silicification" at the mine is not a silification "sensu stricto". It does not affect the rocks in a massive pattern, but it is shown by a development of white quartz-feldspars stringers, generally one eighth of an inch wide, invading the wall rocks in the vicinity of the orebodies and also contained in the envelopes of the orebodies.

Two types of this "white stringers" network have been recognized:

II.1. Angular Network

In this type, the white stringers are fairly straight, with very sharp contacts; they are usually distributed on the three planes of a sub-orthogonal system of extremely variable orientation. The tightness of the network is variable, ranging from one veinlet every three or four inches to one veinlet every two feet. It is very common to observe relative displacements of one veinlet direction by the orthogonal direction, but it has not been possible to outline a general pattern of these displacements. However, a detailed study of this point has never been attempted, and some information on the relative ages of those veinlets could be gained this way.

It is common to find other minerals in the largest white stringers: hornblende euhedral crystals and Chalcopyrite specks are frequent, Epidote patches are rare.

II.2. Anastomosed Network

In this case, the veinlets are much thinner (.5 to 3 millimeters). Their contact is irregular. They have a tendancy to branch off, swell and pinch out and are usually ondulated and distributed in only one plane. They have a "flowing" aspect and are sometimes refered to as "flowing quartz and feldspar stringers". The tightness of the network ranges from one stringer every quarter of an inch to one every inch. No minerals are found in those veinlets. They have usually a light greyish colour.

II.3 Spatial Relations

The first type of network seems to be controlled by an early set of joints, whereas the second type could be related to a flow phenomenon, or rather to a "slumping" which took place in the volcanics before complete consolidation. Proof of "slumping" is given by the observation of "collapse structures" very common in the volcanics (Refer to 1972 Report).

Wherever the two types of network overlap, the "flowing quartz-feldspar veinlets" are always cut and sometimes offset by the "angular veinlets", an indication that the latter type is younger than the former type.

No preferential location of the two types has been determined, although the angular type is widespread in both River and Cave Zone areas, whereas the anastomosed type is virtually absent in the River Zone. When the angular type occurs close to a major fault or a vein, it shows one direction parralel to the plane of the fault or vein and another direction at right angle.

III. ALTERATION OF ANDESINE INTO ALBITE

This alteration has been discovered recently by B. Berthault through microscopic study of thin sections cut from gabbro samples taken in the Cave Zone (On 5225 Level).

It is not fully established yet whether the predominance of Albite over Andesine in the gabbro studied is truly the result of a hydrothermal alteration or the result of a sodic differentiation.

However, there is one indication in favour of the hydrothermal genesis of this Albite: the transformation calls for an excess of Calcium and Aluminum, as illustrated below:

$$6\ SiO_2 \cdot Al_2O_3 \cdot Na_2O + An\ 30\text{-}50 \rightarrow 6\ SiO_2 \cdot Al_2O_3 \cdot Na_2O + \underline{(Ca,\ Al)}$$

(Andesine) (Albite)

It has been pointed out in earlier reports that most of the younger

faults contain a large amount of Calcite in their gouge. Also, in the Cave Zone area, numerous Calcite veinlets are known. The origin of this Calcite was sofar a mystery, but it could well be related to the excess of Calcium in the transformation of Andesine into Albite.

This argument appears to be in favour of the hydro thermal genesis of the Albite.

IV. ALTERATION OF PLAGIOCLASE INTO SCAPOLITHE

This alteration has never been observed by the writer, but has been mentioned by J.S. Stevenson in 1950 ("Report of Minister of Mines, 1950").

Stevenson stated at that time:

(The Gabbro mass) ... " in places includes patches, 6 inches to several feet across, of white altered gabbro. These patches stand out in marked contrast to the predominant dark-green unaltered gabbro. Under the microscope, rock from the patches of white gabbro is seen to consist largely of scapolite and some hornblende. The scapolite ha formed by hydrothermal alteration of plagioclase".

More work is required on this subject to ascertain the nature of this alteration. In a first approximation, it seems that such a transformation calls for an addition of either salt or calcite, according to the following reactions:

$$\left.\begin{array}{c}(\text{Albite} + \text{Anx}) + \text{NaCl} \longrightarrow \underline{3\ \text{Albite} + \text{Nacl}} \\ \text{Plagioclase} + \text{Salt} \longrightarrow \text{Marialite}\end{array}\right\}$$

$$\left.\begin{array}{c}(\text{Albite} + \text{Anx}) + \text{Ca CO3} \rightarrow \underline{3\ \text{Anorthite} + \text{Ca CO3}} \\ \text{Plagioclase} + \text{Calcite} \longrightarrow \text{Meionite}\end{array}\right\}$$

AGE OF MINERALIZATION

An excerpt of the GSC Paper 71-2 was recently communicated to the writer

by Mr. R.V. Kirkham. It contains the K-Ar datation of a rock sample taken in the Cave Zone orebody on 5100 Level. The datation was made on the Hornblende contained in the rock and is described by Mr. Kirkham as follow:

"Hornblende, K-Ar age = 44 ± 6 M.Y.

The rock consisted of about 40 to 50 per cent dark, vitreous, coarse-grained hornblende with approximately 35% Pyrrhotite 10% Chalcopyrite, and 5 to 10% carbonate, chlorite and other minerals. The sulphides occured as a reticulate network in the hornblende.

The hornblende formed as an alteration product of Eocene Metchosin basalt. Its intimate association with the sulphides and its unaltered nature indicate that the date is probably that of the period of mineralization. However, because of the unusually low potassium content of this hornblende, the sample would be very susceptible to contamination, hence, caution should be exercised in application of this date".

Another sample taken on the Willow Grouse Property, (East Sooke Peninsula) was dated by the same author and gave 31 ± 15 M.Y. (Sooke Gabbro).

In spite of the large error limits due to a very low potassium content and young age of the hornblende, those dat s seem to indicate a slight posteriority of the mineralization on the intrusion.

ORE RESERVES

The same basic principles used in previous calculations have been retained for this year end calculation.

I. CUT-OFF GRADE

In this calculation, the following basic data has been used:

Concentrate Grade	27.5% Cu.
Metal Recovery	94 % Cu.

Necessary information on Smelter Contract communicated to the writer by management.

I.1 Gross Value of Concentrate:

From the original concentrate grade, a deduction of 1.2% has to be made to allow for Smelter Loss. An average of $15.00 per short ton for precious metals (Au, Ag) has been used.

If "LME" represents the current copper price per pound, (in Can $) the Gross Value of 1 Short Ton of Concentrate is:

$$\left(2{,}000 \times \frac{27.5 - 1.2}{100} \times \text{LME}\right) + 15.00 \quad (1)$$

II.2. Refining Charge:

As explained to the writer, the refining charge depends on the LME Copper price and can be estimated by:

$$\text{Refining Charge in Canadian Dollars} = \text{LME} \times 60 \quad (2)$$

II.3. Smelting Charge:

This charge is estimated at $39.93 per dry metric ton of concentrate, or:

$$39.93 \times \frac{2000}{2204} = \$36.23/\text{Dry Short Ton} \quad (3)$$

II.4. Net Value of Concentrate:

This value is written as:

$$(1) - \left[(2) + (3)\right]$$

or: $$52\ \text{LME} + 15 - (60\ \text{LME} + 36.23)$$

LME Copper ($ 1 lb)	Net Value of Con ($ / DST)	
1.10	491.37	(4)
1.00	444.77	
.90	398.17	
.80	351.57	
.70	304.97	

II.5. Net Value of the ore:

To produce one short ton of concentrate @ 27.5%, i.e., 550 Lbs. Cu, we have to mill (taking into consideration an average metal recovery of 94%):

$$550 \times \frac{100}{94} = 585 \text{ Lbs Cu in Ore}$$

The Net Smelter Return per pound of Copper in the ore is therefore:

$$\frac{\text{Net Value of Concentrate}}{585}$$

LME Copper ($ / Lb)	Net Smelter Return ($ / Lb Cu in ore)	
1.10	.84	(5)
1.00	.76	
.90	.68	
.80	.60	
.70	.52	

The Net Smelter Return per ton of ore milled is (if t is the grade of this ore):

$$2{,}000 \times t \times (5)$$

Or:

LME Copper ($/ Lb) \ Mill Heads (% Cu)	1.20	1.10	1.00	.90	.80	.70
1.10	26.40	24.20	22.00	19.80	17.60	15.40
1.00	24.00	22.00	20.00	18.00	16.00	14.00
.90	21.60	19.80	18.00	16.20	14.40	12.60
.80	19.20	17.60	16.00	14.40	12.80	11.20
.70	16.80	15.40	14.00	12.60	11.20	9.80

II.6. Mining Costs

The following figures were communicated:

Mining & Milling = [illegible] $9.58/Ton

Overhead & Royalties = $1.94/Ton

Total = $11.52/Ton

II.7. Cut-Off Grade:

LME Copper	.70	.80	.90	1.00	1.10
Cut-Off Grade	.82	.72	.62	.52	.42

A conservative average copper price of 80¢ / lb. will be used, corresponding to a cut-off grade of .72% Cu.

II. Mining Widths

The minimum mining width for shrinkage stopes has been revised to 5 (Five) Feet instead of 4 last year. This is a result of the experience gained in mining the C Zone from 52 to 5350 levels (Refer to July 1973 Monthly Report)

The minimum mining width for longhole stopes remains at 12 (Twelve) Feet.

III. RESULTS

The results of the calculation are presented in a tabulated form next page.

EXPLORATION

Very little exploration was done in 1973, and the results were in agreement with the expectations.

From the proposals for 1974, which remain basically the same ones as last year's, it is imperative that at least three are undertaken if the mine is to be kept as a going concern.

One has to remember that it took over a year and a half of development before the first longhole blast was initiated in the Cave B Orebody; and this orebody is only 700 feet away from the mill.

I. SUMMARY OF EXPLORATION DONE IN 1973

I.a. RIVER ZONE

2,612 Feet of EX diamond drill holes (five holes) have been drilled to test the River Zone below the 5130 Level, in the south eastern portion.

This drilling outlined the River C Zone on 4900 Level on a strech of 560 Feet past the last known information, and the southeasterly hole (U-703) still cored 9' @ 2.07% Cu. In one hole (U-704), which cored 23' @ 1.06, the geological characters of the mineralization are very similar to a Cave Zone type of mineralization. One hole (U-703) cored a very high grade intersection (52' @ 1.98) on 5000 Level, which is still unexplained, although it is in the general area of the River A Zone.

I.b. CAVE ZONE

Four EX holes totalling 2,347 Feet have been drilled from the 5130 Hanna Zone Crosscut to test the Cave Orebodies below the 5130 Level to the southeast, and above the 5130 Level, to the northwest.

The results were very much in agreement with the No3 Conclusion of the theory on mineralogical zoning developed last year by the writer, which does not necessarily prove that the theory is correct:

"The lower extension of the Cave Zone is most likely very poor in copper"

The highest assay recorded in this area was 4' @ .89% Cu and .04% Ni. The highest Nickel assay was 5' @ .06% Ni (with a copper grade of .60% Cu)

It can still be argued that if the rake of the orebody flattens out to the southeast, all these diamond drill holes have missed the highest grade portion of the Zone. In my opinion, this is worth a verification, but this will call for expensive and complicated deep drilling.

II. PROPOSALS FOR 1974

Out of the three long-range exploration proposals summarized on Page 42

of last Year Report, one has to be temporarily discarded due to surface rights problems: the Proposal II.2, exploration on the Yellow Cliff-Tiger-Caulfield Zones, has to be held back until negociations with Rayonier (CPS) reach an agreement.

The reader is kindly referred to last year Report for the two other proposals II.1 and II.3 retained for 1974. In addition, two new proposals have been studied:

II.a: UPPER CAVE ZONE EXPLORATION

The ore reserves in the Cave Zone do not extend beyond the 5700 Elevation, except for a few blocks of probable ore reaching up to 5730. This leaves more than 400 Feet of unexplored ground between the upper limit of the reserves and surface.

Another important point is the fact that the Cave B Block does not warrant any drifting and/or stoping above the 5425 Level. This means that, when developing the 5525, 5670 and upper levels in this Zone, crosscuts in waste would have to be driven in order to gain the necessary information between levels for the longholes layouts. This could be a very costly and time consuming procedure (one 100 Feet Crosscut every 150 Feet on each level, i.e., five crosscuts on each level or 500 feet of drifting in waste for one level) and diamond drill holes would have to be fanned to the adjacent sections, giving a complicated and often inaccurate data.

The following proposal would solve this problem and also allow to outline the orebody from 5550 to 6000 elevations with a reasonable amount of cheap underground diamond drilling.

This proposal involves the following steps: (Refer to attached Map II.a):

From the surface access road to the River Adit, drive an adit on 5860 elevation, parallel to the projected ore outline of the Cave Zone on 5670 and at about 150 Feet from it.

The specifications of this adit would be as follow:

Collar: 12,765 N
12,760 E
5860 Elevation

Bearing: N 139° East

Grade: + 2%

Size: 8x8

Length: 600 Feet

Establish five diamond drilling stations on the western wall of the adit, as shown on Map II.a (Size of the cut-out 8' high, 9' wide and 10' deep). From each of these cut-outs, diamond drill a fan of 4 EX holes aggregating 1200 Feet (bearing of the holes: N 108° West), in order to outline the ore from 5600 to 5900 elevations.

To speed up the operation, diamond drilling should follow the advance of the adit and be performed on 3 shifts a day. Timing and budgetting would be as follow:

DRIFTING:	600 Feet @ $50.00 =	$30,000
Drilling:	6,000 Feet @ $ 4.00 =	24,000
Total Cost:		$54,000

DRIFTING:	600 Feet @ 7.5 Ft/Shift =	80 Shifts = 27 days
DRILLING:	6,000 Feet @ 35 Ft/Shift =	172 Shifts =

Only the time necessary to drill the left-over footage after completion of the adit, i.e., 1,200 Feet or 34 shifts, should be taken into consideration, giving a total time required of 27 + 11 = 38 days or about 1.7 months, say two months.

II.b. TURNBULL ZONE EXPLORATION

In the light of the theory on the mineralogical zoning, which seems to be verified by the data collected in 1973, the potential of the Turnbull Zone appears to be excellent.

However, the geology (and particularly the structural geology) of this zone is practically unknown. No trend has been found in the distribution of the mineralization, and correlating of the diamond drill holes intersections is very speculative.

Exploration on this Zone will be very tricky, since surface exposure is poor, access is difficult and structure seems to be complex.

In my opinion, it is not reasonable to recommend a major underground exploration program at the present time.

Surface work appears to be the only safe approach for 1974. The following steps could yield the necessary data to study an underground approach for 1975:

- Detailed re-mapping of the surface showings and surrounding outcrops (Recommended Scale of mapping: 1 inch = 40 ft This mapping has to be extremely accurate to allow valid comparison with the underground mapping in the mine.

- Re-sampling of the surface showings in freshly blasted trenches and pits, cross-checked by a few shallow RXT diamond drill holes (WINKIE PORTABLE DRILL).

- Indirect subsurface methods: geochemistry seems to be useless in this case, because of contamination and erratic distribution of soil, but geophysical methods could provide a good tool. An IP survey appears to be best suited.

Depending on the availibility of manpower in the Geology Department, this work could be done in two to three months (May to October is the best period).

The cost of this operation is estimated at $12,000.

III. SUMMARY

The exploration proposals recommended for 1974 are compiled in a program tabulated on the attached form.

It can be seen from this compilation that the total cost of the program is estimated at about $124,000, or $10,300 per month. In terms of cents per ton of ore milled, this is equivalent to 34¢ per ton of ore milled.

December 20th, 1973

G. X. Meany - Geologist

Ref.	Priority	Objective	DRIFTING		SURF. D.D.		U/G D.D.		Surf. Mapping		Geophysics		Remarks
			Ft	$	Ft	$	Ft	$	Area	$	Area	$	
1973 Report Prop I-a	1	Upper Cave Zone 56 → 60	600	30,000	NIL	NIL	6,000 (EX)	24,000	?	?	NIL	NIL	Surface Geology to be Checked
1972 Report Prop I-1	2	Lower River Zone 41 → 49	NIL	NIL	NIL	NIL	3,500 (BQ)	42,000	NIL	NIL	NIL	NIL	
1972 Report Prop II-3	3	Shear Zone NE of River Zone	NIL	NIL	NIL	NIL	2,000 (BQ)	16,000	NIL	NIL	NIL	NIL	
1973 Report Prop I-b	4	Turnbull Zone	NIL	NIL	200 (RXT)	800	NIL	NIL	.04 Square Mile	450	.04 Square Mile	10,750	
1972 Report Prop II-2	5	Yellow Cliff Tiger & Caulfield	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	Resume negociations with CPS to reach agreement
	Totals →		600	30,000	200	800	11,500	82,000	.04 □ Miles	450	.04 □ Miles	10,750	$ 124,000 ← TOTAL COST

EXPLORATION PROGRAM FOR 1974

drilling at maximum depth 400'; it can be handled by a small surface machine - Longyear 24 or BBS-1. Drilling water would have to be pumped from the Jordan River, which is a 250 feet head pressure.
COST: 1,650 feet @ $8. - $13,200
TIME: 2 weeks

On the Tramline bank, excavate a reconnaissance trench 100 feet long to expose the Yellow Cliff Zone, since this area is covered by a thin overvurden (the surface showing is located in the River canyon).
COST: 1,000 Cu. Ft. @ 55¢ - $550
TIME: A few days

Stage 2

If the results of Stage 1 are positive, an Adit should be started following the Yellow Cliff orezone. The muck from this adit, estimated at 8,650 Tons, could be stockpiled below the portal, or hauled to the Cave Adit 4,000 feet upstream to be dumped into the mine ore pass system; this would mean the rehabilitation of the tramline. The adit should be 800 feet long, on 5600 elevation.
COST: 800 feet of 9 x 12 drift @ $60 - $48,000
TIME: 40 days or two months

Stage 3

If Stage 2 has been completed successfully, development of the zone should follow with a raise connecting the 5130 main adit to the Yellow Cliff Adit, with an exploration drift on 5130 (as described in 1971 Report) and with diamond drilling to the Tiger Zone (See 1971 Proposal). Should the 5130 drift be driven, it is very important to extend this drift beyond the River to investigate the Caulfield - Tiger - Yellow Cliff tectonic trap itself.

COST ESTIMATE STAGE 3:

Raising:	500 feet @ $60.00	(Alimak)	-	$ 30,000
Drifting:	1200 feet @ $60.00	(9x12)	-	72,000
DD:	5000 feet @ $ 3.00	(EX)	-	15,000
		TOTAL	-	$ 117,000

SUMMARY OF EXPLORATION ON YELLOW CLIFF - TIGER - CAULFIELD

COST:	Stage 1	-	$ 17,560
	Stage 2	-	48,000
	Stage 3	-	117,000
	TOTAL	-	$ 182,560

(This cost could be lowered by the ore recovery)

OBJECTIVES:
- Indicate 250,000 Tons @ 1.6 in Yellow Cliff
- Indicate 300,000 Tons @ 1.5 in Tiger
- Mining Development on Yellow Cliff started
- Reach a good location to investigate the Yellow Cliff, Tiger, Caulfield Tectonic Trap

PROBLEMS: - The Base Metals Rights on Lot 3 do not belong to Sunro Mines Ltd., but to Rayonier.
- The muck disposal for the adit driven on 5130 is still problematic.

II - 3 - AREA NORTHEAST OF RIVER ZONE (MAP EXP II-3)

BASIC DATA: - Shear zone on surface 600' beyond River Zone
- Geological Theory according to which this shear zone could be the apex of an unknown orebody located at depth close to the gabbro intrusive.

As shown on map EXP II-3, this area can be investigated by diamond drilling from the shaft area, 4770 Level. Two holes could be drilled for a first stage, one reaching the projection of the shear zone on 4600 elevation; the other approximately 500 feet lower. The deepest hole reaching 1,150 feet, the same type of machine as in EXP II-1 should be used.

COST: 2,000 feet @ $8.00 - $16,000

II - 4 - SUMMARY OF LONG-RANGE EXPLORATION

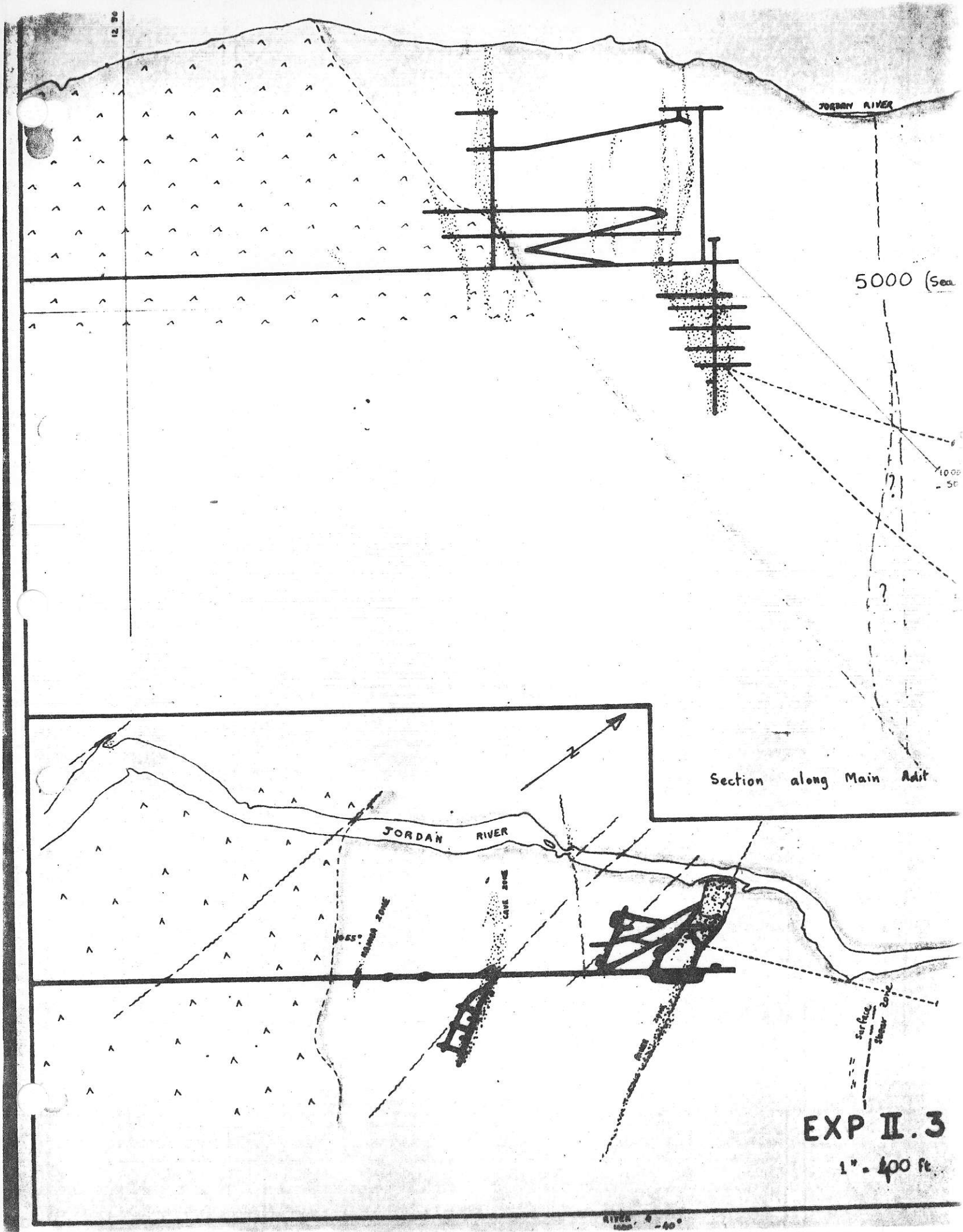
PROPOSAL	AREA	OBJECTIVE	COST	PRIORITY
II - 1	Below River Zone	800,000 Tons @ 1.00	$46,400	1
II - 2	Yellow Cliff Caulfield Tiger	550,000 Tons @ 1.50	182,560	2
II - 3	N.E. of River Zone	Indicate the presence of a new orebody	16,000	3
TOTALS		1,350,000 Tons @ 1.20 (Possible Ore)	244,960	

III - SHORT RANGE EXPLORATION

III - 1 - CAVE ZONE (MAP EXP III-1)

The Cave Zone orebodies as outlined on 5225 level are known on 750 feet long. However, both southern and northern limits of the mineralization are not established.

a) In the northern part, a drift 90 feet long has recently been driven on the extension of the B Block, according to a diamond drill hole


JORDAN RIVER
5000 (Sea
Section along Main Adit
JORDAN RIVER
EXP II.3
1" = 400 ft.

intersection indicating 10' @ 1.50 on Section 1100. Priority problems did not allow to extend this drift, and the last face is still in ore, although low grade due to an excessive amount of Pyrrhotite. There is no information at all beyond Section 1100.

The best way to reach this area is to drill a 500 foot hole @ +12° from the Hanna Zone cross-cut on 5130. A few other possibilities like drilling a downhole from station 53 - 1200 or drilling a flat hole from the switchback in the 51 - 52 Ramp would not give such a good angle of penetration.

b) In the southern part of the Cave A, a fan of short bazooka holes indicates an oreshoot apparently offset to the east of the main orebody. The last hole (U-596) indicates 12' @ .72; despite this low grade, the mineralized area is still open to the south. This area will be readily accessible when the Cave A extraction drift is completed. A minimum of 150 feet of exploration drift followed by diamond drilling should be scheduled.

III - 2 - NEW ZONE

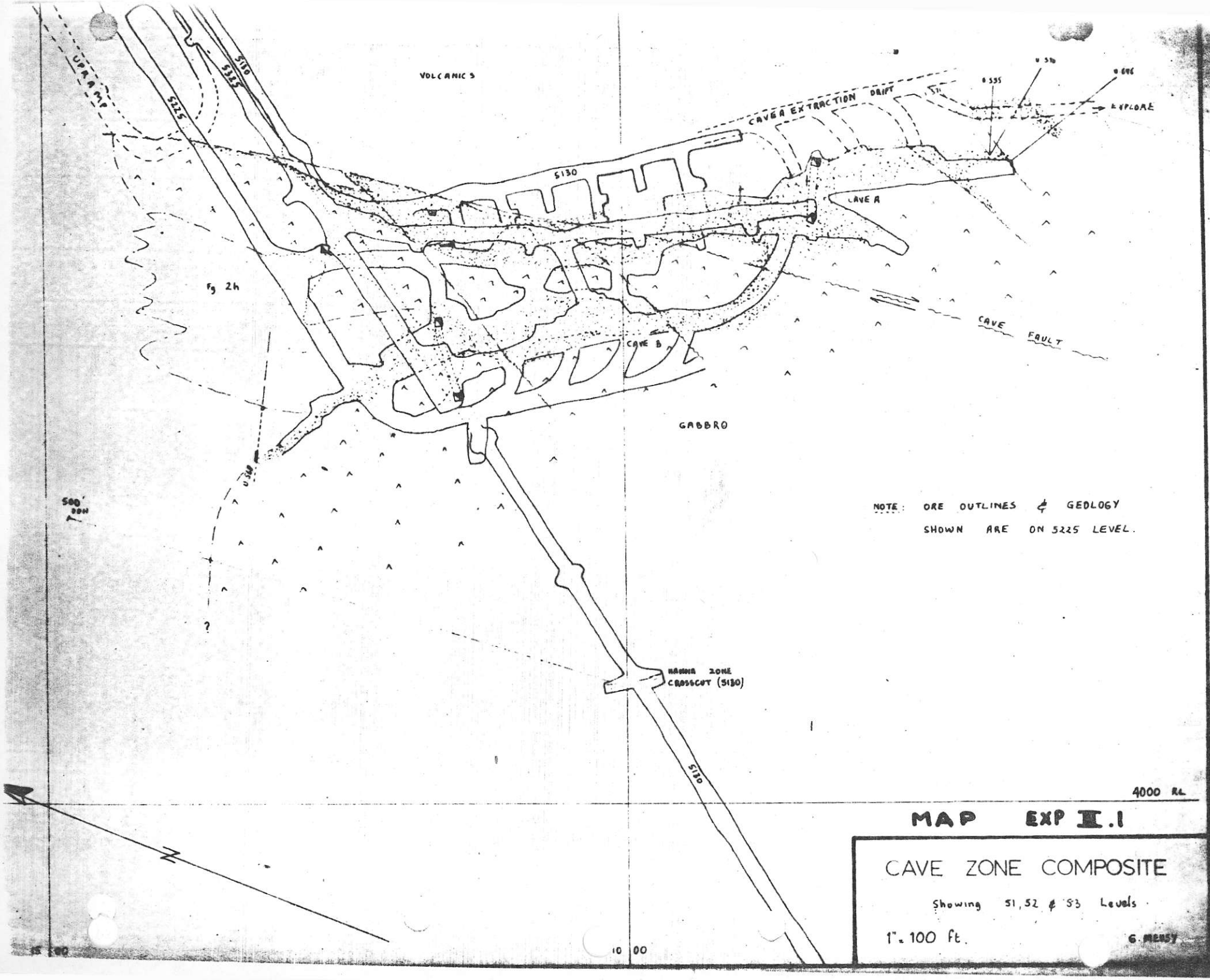
More data on the New Zone is required between 53 and 55 levels. This data will be obtained from the ramp which will connect 53 to 55. Each leg of this ramp will expose the New Zone and provide an excellent diamond drilling set-up.

III - 3 - HANNA ZONE

A few more diamond drill holes can be drilled in the southern part of the Hanna Zone from the present workings in the Cave Zone. This will be done according to the equipment and time available.

III - 4 - SUMMARY OF SHORT-RANGE EXPLORATION

PROPOSAL	AREA	OBJECTIVE	COST	PRIORITY
III - 1	Cave Zone	Establish ore limits on strike	$ 13,000	1
III - 2	New Zone	Fill-in information between 53 and 55	23,000	2
III - 3	Hanna Zone	Final reconnaissance on southern extension	3,000	3
TOTAL			$ 39,000	



MAP EXP II.1

CAVE ZONE COMPOSITE

Showing 51, 52 & 53 Levels

1" = 100 ft.

G. MENSY

PART FOUR

TECHNICAL DATA

DIAMOND DRILLING

A total of 20,693 feet of EX holes has been drilled in 10.5 months in 1972. (No drilling was done during the second period of January and during February)

I - DRILLING PATTERN

I - A - EXPLORATION HOLES

In this type of drilling (as carried out on the New and HANNA Zones), no special spacing has been respected. The greatest depth reached was 555 feet.

Whenever possible, these holes have been laid out with a bearing of N 35° E and with gentle dips from 0 to ±20°, in order to collect more data on the geological section of the mine along the Main 5130 Adit.

I - B - SAMPLING HOLES

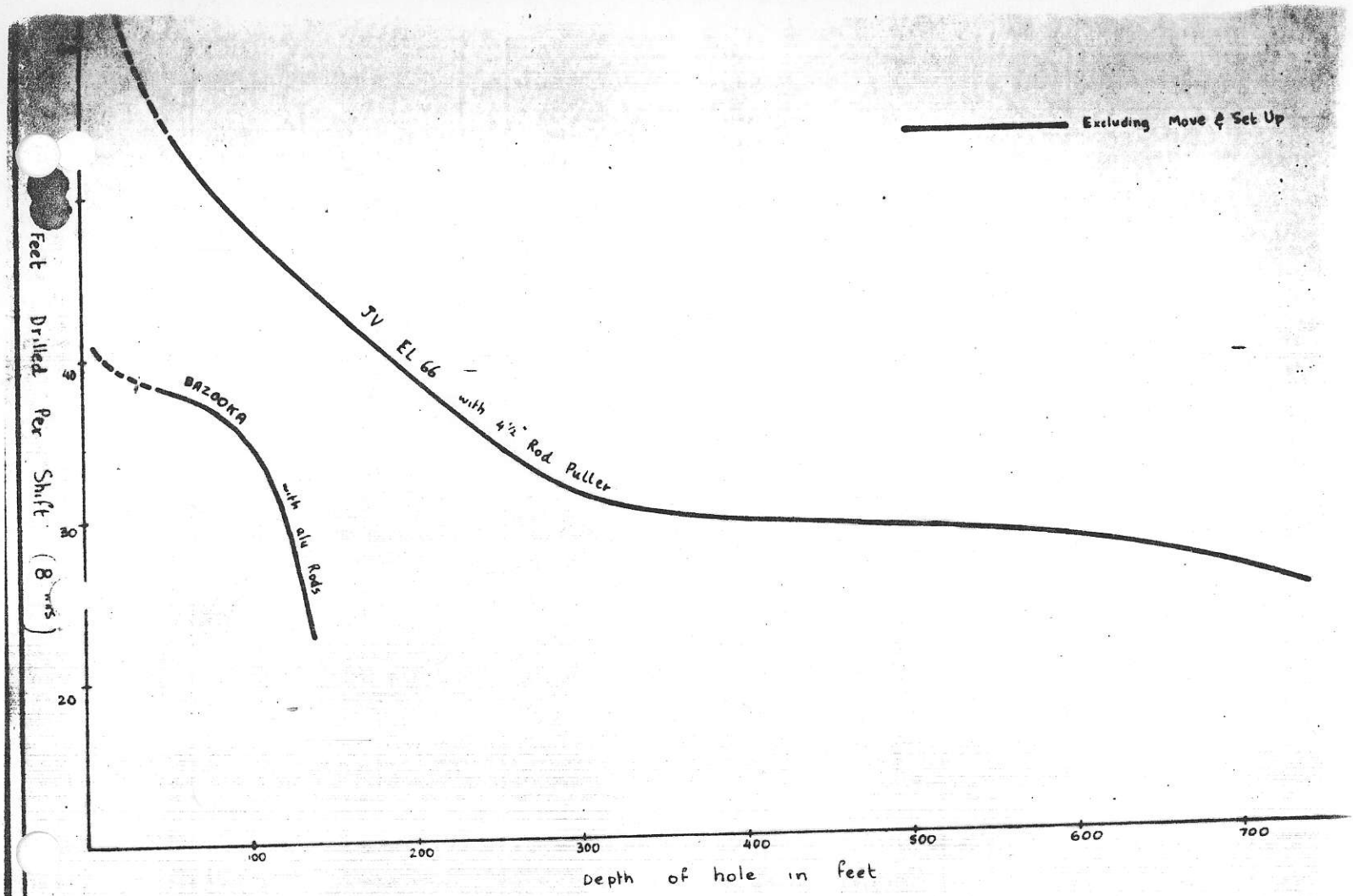
These holes drilled to outline and block out Proven and Probable Ores are shallow (from 10 to 250 feet) and represent 75% of the total footage for 1972.

The horizontal spacing used is 50 feet. The fans pattern has recently been tightened to give an intersection approximately every 25 feet. Experience has proven that this is a requirement for the longhole mining method (CAVE Zone).

II - DEVIATION AND RECOVERY

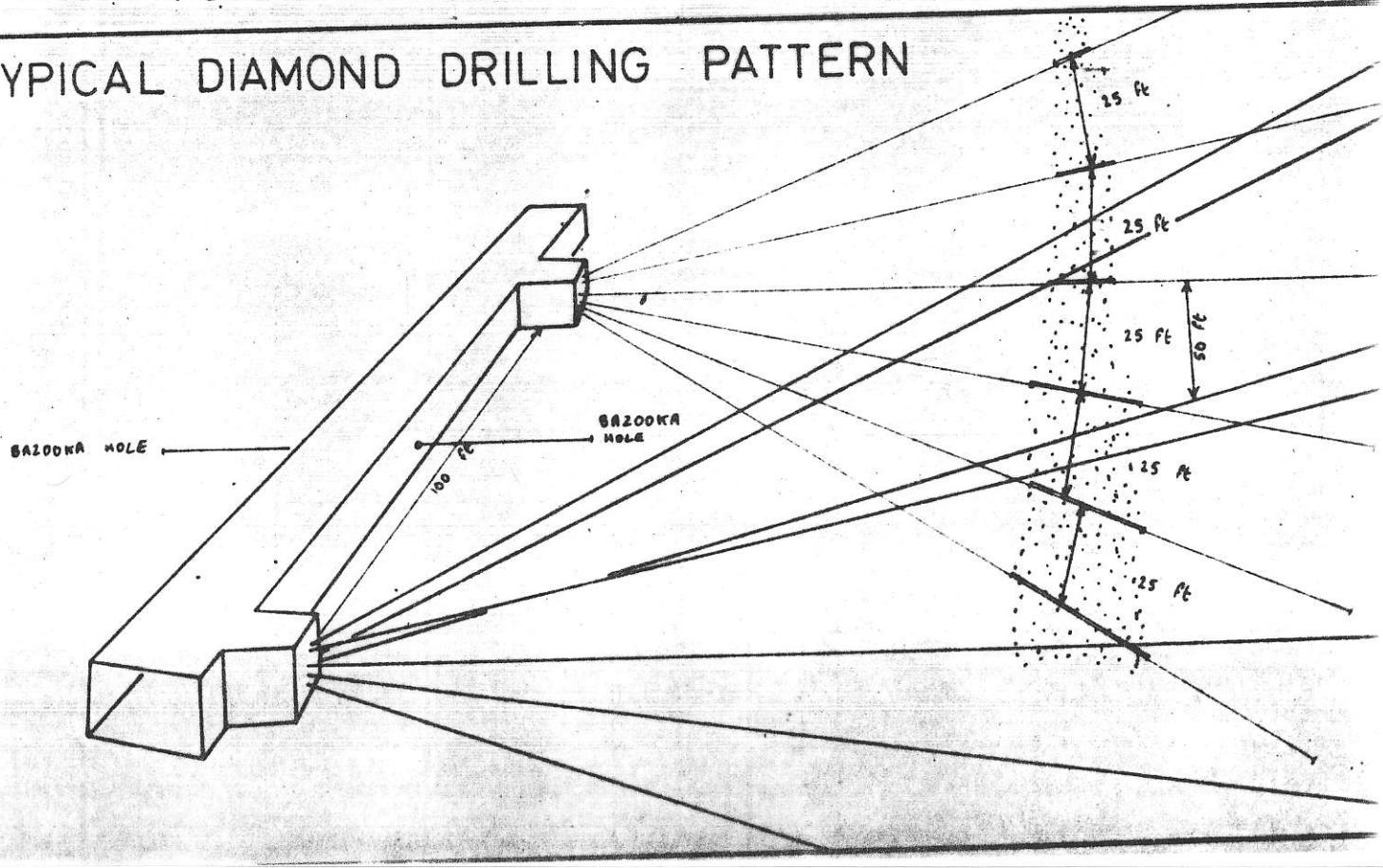
II - A - DEVIATION

Very little data on deviation is available. Four surface holes show recorded Tropari tests:



1972 DIAMOND DRILLS PERFORMANCES

TYPICAL DIAMOND DRILLING PATTERN



HOLE	LENGTH	BEARING		DIP
S 37	1,196	Collar 530' 1,000'	N 40° 50' E ? ?	-50° -48° -46°
S 38	1,259	Collar 443' 800'	N 54° E N 67° E N 65° E	-51° -44° -39°
S 39	1,060	Collar 300' 690' 1,000'	N 73° E N 71° E N 70° E N 82° E	-42° -37° -27° -23°
S 40	1,123	Collar 200' 500' 800'	N 47° E N 43° E N 53° E N 62° E	-54° -53° -50° -50°

All of these holes have been drilled in the volcanics, without penetrating the gabbro; a refraction phenomenon is to be expected on this contact.

A clinometer has recently been purchased which will allow dip tests (acid tests) in 1973.

For the time being, an average dip deviation of 1°30' per 100 feet has been used.

II - B - RECOVERY

An average core recovery of 92.20% has been maintained in 1972.

A particular feature of the Sunro drilling is that core recovery is not a problem in the ore zones. The only features which can introduce poor recovery are the major fault zones; when such a zone is penetrated, the soft gouge is generally washed away, and core can be ground on a few feet beyond the fault. One has to be careful to lay out the holes so that they penetrate these zones at an angle not smaller than 40°, or else a strong deviation takes place and the hole will follow the fault zone (like in U-521, where 42 feet of EX Casing had to be put in the hole).

These remarks are illustrated by the examples below:

U-490
Average recovery - 82.27%
Recovery in fault zone - 71.2%
Recovery past the fault - 94.7%

U-503
Average recovery - 90.14%
Recovery in ore zone - 93%
Recovery in barren fault zone - 74%

U-521

Average recovery - 59.3%
Recovery in fault zone - 47.1%
Recovery at the fault - 82.8%

Sludge samples are taken in poor recovery conditions; however, low core recovery is not a problem, since the major fault zones are devoid of economic mineralization.

II - EQUIPMENT

II - A - MACHINERY

Three Boyles diamond drills have been used in 1972, as follows:

MACHINE	FOOTAGE DRILLED	WORKING HOURS
JV 1	6,355	152 8 Hrs SHIFTS
JV 2	9,796	235 8 Hrs SHIFTS
BAZOOKA	4,542	134 8 Hrs SHIFTS

No serious breakdowns occur on any of these machines.

Since no maintenance records are available for the JV drills before 1971, the age and the total working hours are unknown. The JV 1 was apparently bought from Sheep Creek Mines in 1965; hence, it must be fairly old.

The Bazooka Drill was purchased new in March, 1971, and put at work on August 26/71. Maintenance according to the manufacturer's instructions was performed. A major overhaul for this machine is forecast for January, 1973. Throughout the 1,304 working hours, this little machine gave total satisfaction and is very useful at Sunro. Its capacity has been rated at 130 feet with EX Magnesium Zirconium diamond drill rods.

Two pumps have been used in 1972 with the JV Drills. One is an old Boyles BB-47M which was completely overhauled in October, 1971; the other is a new Canlong 315, purchased in June, 1972. This pump is a vertical quadraplex model delivering 9.5 GPM at a pressure of 700 PSI, with very little surge due to the action of the four pistons.

Experience has shown that drilling without a pump (using the mine water, pressure of approximately 90 PSI) is to be avoided, especially for upholes over 150 feet.

II - B - RODS AND CORE BARRELS

A switch to EW rods has been done progressively, and only this type is used now for the JV drills. 550 feet of EW rods are available at Sunro. The Bazooka uses EX Mag-Zirc lightweight rods (120 feet available).

EWK and EWT Double Tube Rigid Type core barrels are in use. Some have a stainless steel inner tube, which gives a slightly better core recovery and longer runs in blocky ground. Swivel type core barrels are not recommended because of their fragility. Ten foot runs are common at Sunro. Sectional core barrels have been tried out, but do not stand very long.

II - C - DIAMOND BITS

90% of the bits used in 1972 are EXT or EXK, 100 Series, Standard Matrix, with approximately 3.20 Carats of AA Grade diamonds, manufactured by WESDRILL EQUIPMENT LTD. They have two watercourses, with or without carbide inserts, according to the rock formation to be drilled. They give an average bit life of 104 feet, with a diamond loss equivalent to 33 cents per foot.

Other types of bits (heavier diamond weight, 3 watercourses, different matrix and pattern) have been tried out from several manufacturers without too much success.

1972 D.D. STATISTICS

MONTH	FOOTAGE	CREW	DIAMOND		PERFORMANCES			COSTS		
			BIT LIFE	COST /FOOT	Ft/HR	Ft/SHIFT	Ft /Cost Hour	DIRECT	TOTAL	EQUIPMENT
JANUARY (1-15)	351	1	122.30	.35	4.38	35.10	5.52	1.86	1.86	nil
FEBRUARY	No Drilling	nil								
MARCH	889	2	81.75	.36	3.49	27.96	5.65	2.18	3.29	990.51
APRIL	1,867	3	82.90	.35	3.80	30.44	5.41	2.02	2.47	837.44
MAY	2,510	4	89.96	.41	4.18	33.48	5.18	1.89	2.24	871.97
JUNE	2,583	4	92.92	.35	3.95	31.64	5.09	1.95	3.00	New Pump 2,707.
JULY	1,742	1st Period 4 2nd Period 2	94.50	.32	3.31	26.52	4.41	1.98	2.09	196.
AUGUST	1,768	2	110.28	.33	5.41	43.28	6.45	1.68	1.79	203.
SEPTEMBER	2,124	4	98.26	.32	4.53	36.28	5.68	1.81	2.01	425.
OCTOBER	2,018	1st Period 3 2nd Period 4	113.87	.31	3.38	27.04	5.12	2.22	3.06	New Ro 1,700.
NOVEMBER	2,258	4	127.09	.27	3.86	30.88	4.84	1.98	2.18	454.
DECEMBER	2,583	1st Period 4 2nd Period 3	135.53	.27	5.21	41.71	6.19	1.65	1.83	467.
Totals & Averages	20,693 (Av per Mo is 1,970)	3.14 AVG	104.48 AVG	.33 AVG	4.13 AVG	33.12 AVG	5.41 AVG	1.93 AVG	2.36 AVG	8,855. TOTAL

SAMPLING

Three types of samples are currently used at the mine.

I - CORE SAMPLES

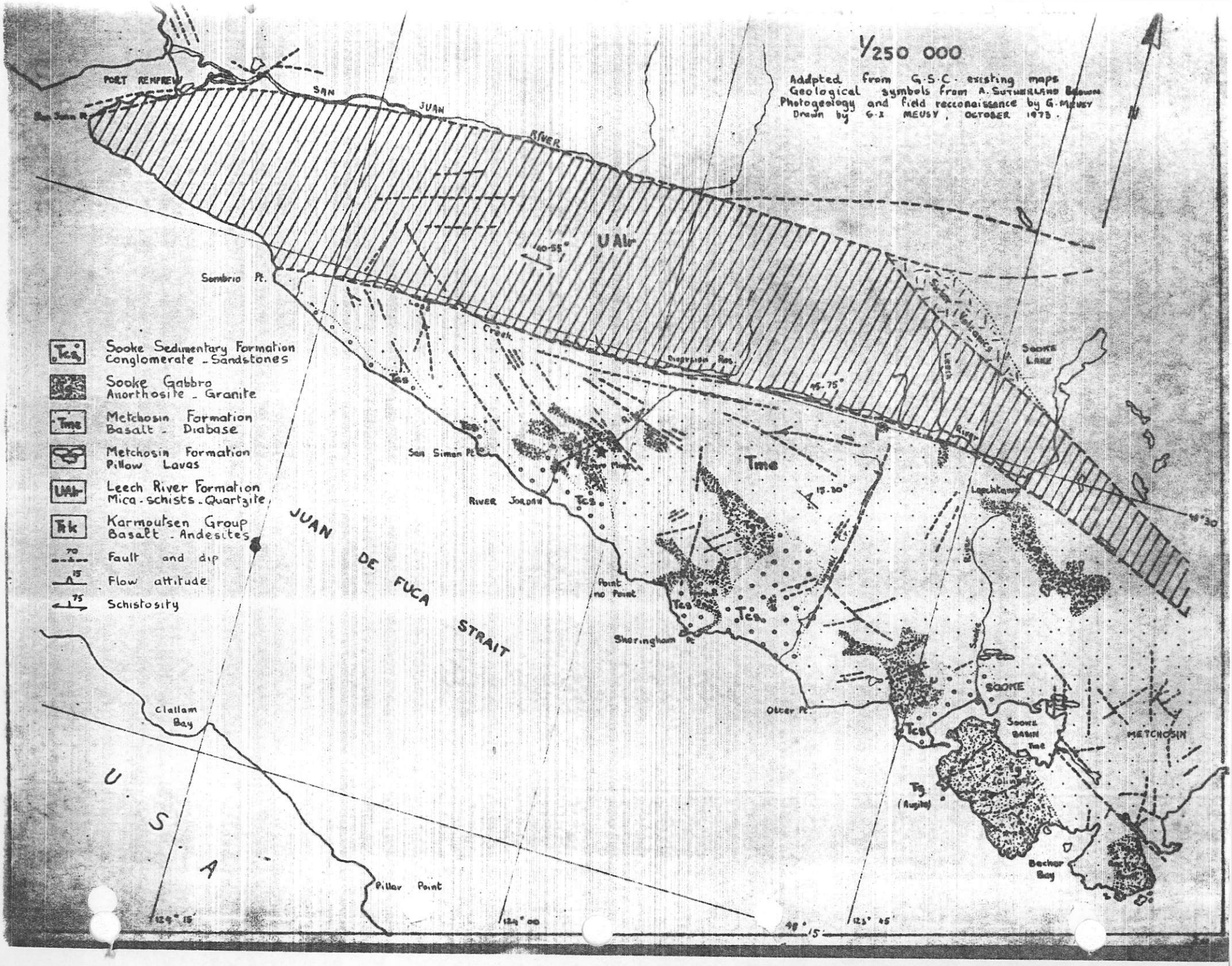
All the diamond drill core is logged; obviously barren footage is discarded, unless it is of geological interest (For the exploration holes, all the core is kept). The mineralized core is split and assayed according to the geological logs. Within the ore, core is split in 2, 4, or 8 feet according to the homogeneity of the mineralization. These samples are used for ore reserves calculations.

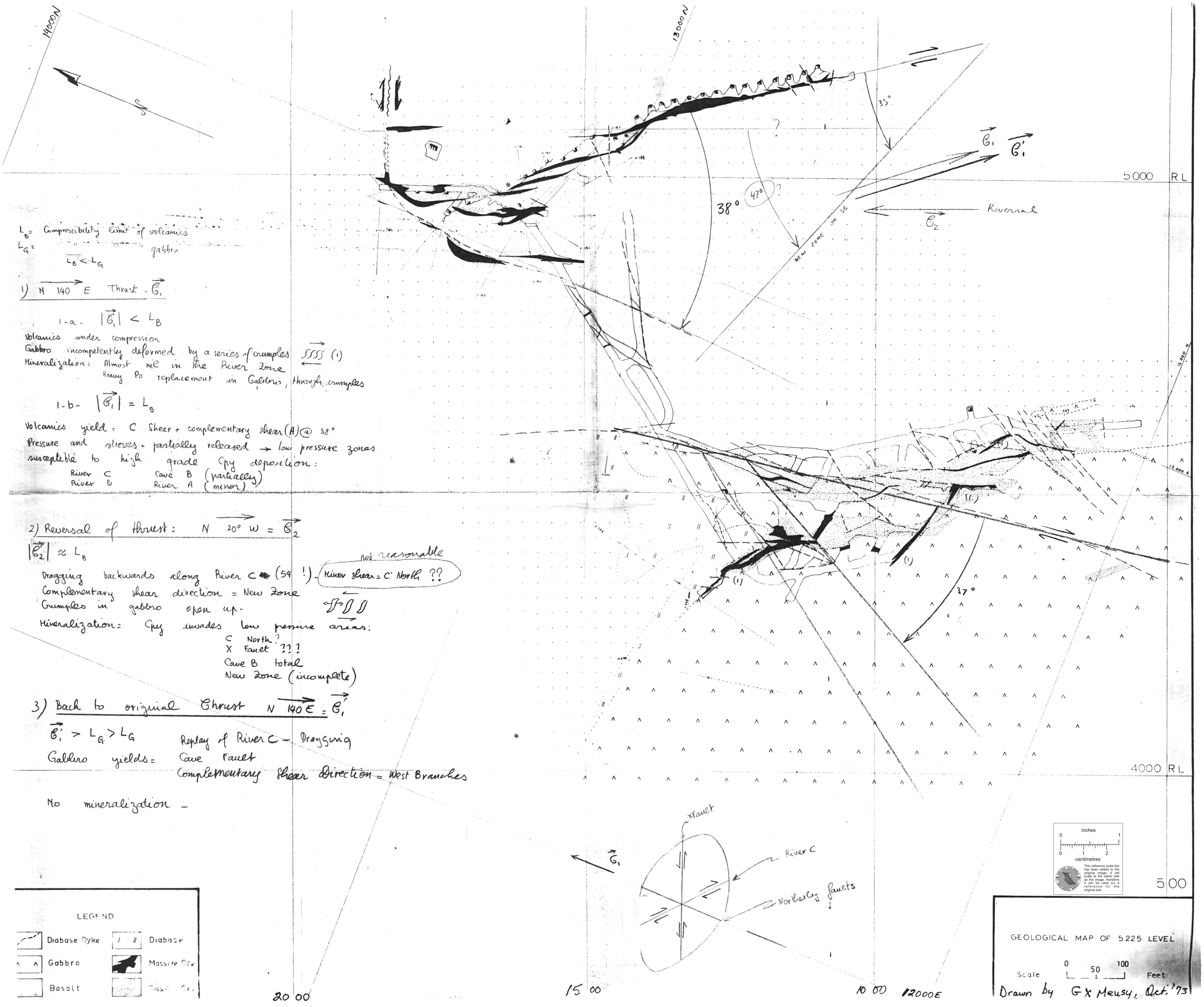
II - CHIP SAMPLES

Chip samples are taken on the faces as close as possible to the cross-section lines (every 25 feet in the River Zone, every 50 feet in the Cave Zone). Experience showed that their value is generally 10% too high, due to a systematic "salting" in the softer high grade zones. These samples are very seldom used for ore reserves calculations, and when they are used, they are cut down by 10%.

III - MUCK SAMPLES

Muck samples are taken by the development crews in the headings or by the mucking crews in the stope drawpoints. The volume of these samples has recently been increased to give approximately 10 pounds of rock. Their value is generally fairly close to the diamond drill-core values, but their location is sometimes problematic. On an average, approximately 60% of the samples are taken. These samples are used to estimate the grade of the broken muck in the headings and in the stope. They are not used for ore reserves calculation.


1/250 000
Adapted from G.S.C. existing maps
Geological symbols from A. Sutherland Brown
Photogeology and field reconnaissance by G. Meusy
Drawn by G.I. MEUSY, OCTOBER 1973.
N
Sooke Sedimentary Formation
Conglomerate - Sandstones
Sooke Gabbro
Anorthosite - Granite
Metchosin Formation
Basalt - Diabase
Metchosin Formation
Pillow Lavas
Leech River Formation
Mica-schists - Quartzite
Karmoutsen Group
Basalt - Andesites
Fault and dip
Flow attitude
Schistosity
PORT REMFREW
SAN JUAN RIVER
Sombrio Pt.
U Alr
Creek
Dispersion Res.
Sooke Lake
Lake
River
San Simon Pt.
River Jordan
Tme
Lagoon
Point no Point
Sheringham Pt.
JUAN DE FUCA STRAIT
Clallam Bay
Otter Pt.
SOOKE
Sooke Basin
Tme
METCHOSIN
Becher Bay
Pillar Point
U S A
124° 15'
124° 00'
48° 15'
123° 45'



L_B = Compressibility limit of volcanics
L_G = " " " gabbro
$L_B < L_G$

1) $\overrightarrow{N\ 140\ E}$ Thrust - $\vec{\sigma_1}$

1-a- $|\vec{\sigma_1}| < L_B$

Volcanics under compression
Gabbro incompetently deformed by a series of crumples $\overrightarrow{\text{SSSS}}$ (1) $\overleftarrow{}$
Mineralization: Almost nil in the River Zone
Heavy Po replacement in Gabbro, through crumples

1-b- $|\vec{\sigma_1}| = L_B$

Volcanics yield: C Shear + complementary shear (A) @ 38°
Pressure and stresses partially released → low pressure zones susceptible to high grade Cpy deposition:
River C — Cave B (partially)
River B — River A (minor)

2) Reversal of thrust: $\overrightarrow{N\ 20°\ W} = \vec{\sigma_2}$

$|\vec{\sigma_2}| \approx L_B$

Not reasonable
Dragging backwards along River C (54 !) - River shear = C' North ??
Complementary shear direction = New Zone
Crumples in gabbro open up. $\overleftarrow{\text{SSSS}}$
Mineralization: Cpy invades low pressure areas:
C North ?
X Fault ???
Cave B total
New Zone (incomplete)

3) Back to original Thrust $\overrightarrow{N\ 140\ E} = \vec{\sigma_1'}$

$\vec{\sigma_1'} > L_G > L_G$ Replay of River C - Dragging
Gabbro yields = Cave Fault
Complementary shear direction = West Branches

No mineralization -