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REPORT on the
MARK GROUP of claims
of Hart River Mines Ltd.
116-A-10
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1. INTRODUCTION

On August 8th and 9th, 1968, the writer examined the copper-zinc-silver-lead deposit being drilled by Hart River Mines Ltd. on it's Mark group of claims 80 miles NE of Dawson City.

The purpose of this examination was to evaluate the lithology and the structural setting of the deposit and to assess the potential of the discovery.

At the time of the examination, 25 drill holes had been completed for a total footage of about 5,400'. Regional geological mapping on a scale of 1" = 2,000' and local plane table mapping on a scale of 1" = 50' were available, and all data were being compiled on a topographical base of 1" = 500'.

2. LITHOLOGY

From top to bottom, the area of interest is underlain by a Precambrian sequence mapped by Dr. J. Usher and Geologist A. McDonald of Hart River Mines, as follows:

Palaeozic		Thickness	G.S.C. 14-1962
K.	Pale grey limestone with basal grits and calcareous sandstone; some pyrite and malachite stains. Tuff zone 1,000' above base.	1,500'	8

Late Precambrian		Thickness	G.S.C. 14-1962
J.	Green quartzites and slates	300'-400'	2
I.	Dark grey limestone, medium bedded	1,200'	2
H.	Upper dolomite, orange weathering	600'	2
G.	White quartzite, even grained, massive bedding		
F.	Ferruginous quartzite and slate, greenish purple	200'	2
E.	Upper Argillite, vari-coloured	300'	2
D.	Middle Dolomite	1,500'	2
C.	Middle Argillite		
	Upper Member, grey	1,200	2
	Lower Member, blue grey to black	400'	2
	Ore zone = in the Lower Member		
B.	Lower Dolomite, Cryptozoon reefs, limey beds and phyllitic members	3,000'	2
A.	Lower Argillites; Base not exposed -Over	4,000'	1

The Lower and Middle Argillites and Dolomites are intruded by diorite masses of two types. The Lower Dolomite exhibits medium grained hornblende diorite sills of a gabbroic type, in which hornblende is believed by the writer to replace pyroxene.

In the Middle Argillites on the Mark Group, a finer grained "andesitic" type of diorite intrudes in the form of sills or sub-sills. The most noteworthy sill is the one overlying the ore-zone; it is characterized by chilled margins and sill-like contacts.

The age of these dioritic bodies has been tentatively identified as Mesozoic by the G.S.C. on map 14-1962 (Larsen sheet), as they have a certain resemblence to the Mesozoic Mayo area sills in the Keno quartzites and schists.

As a result of an extensive field examination of these sills and masses, the writer believes that the diorites represent gabbro-sills intruded in water-bearing sediments under a relatively light load. The time of the intrusion is likely to correspond either to the period of volcanism which produced the tuffs in the Palaeozoic (Cambrian ?) limestones, or to a postulated Precambrian period of volcanism associated with the ferruginous quartzites and slates. There is strong evidence of the latter feature elsewhere along this Precambrian belt.

3. STRUCTURE

Regionally, the trend of the above formations is East-West and a number of large WNW striking thrusts several miles apart affect this sequence to the South.

Locally, the formations form a major anticlinal fold with an E-W axial plane and plunging to the West at a moderate overall angle of some 30° to 40°.

NE faults appear to be of normal type.

Due to the abundance of talus, details of contacts and of fault positions are difficult to pinpoint and most mapping has to rely on exposures along ridges 5,000' to 6,500' high and on relatively poor and scattered outcrops down to about 3,500' elevation.

Very little outcrop is available in the main Mark Creek valley, where however the overburden is not believed to exceed 50' to 100'.

Belts of strong cleavage strike in a general E-W direction with variation from N50 E. to N60 degrees West and steep dips to the S (or SE and SW respectively), and affect all formations up to the White Quartzite.

Where thrust planes involve the upper light grey limestones, they

are readily observable, but in the dolomitic and argilaceous sequence their traces are obscured and in fact the fold in the Mark showing area could be the main expression of the thrusting. In general, the North limb of the main fold lies about along the extrapolation of a thrust plane exposed several miles to the WNW.

Understanding of the structure depends mainly on a careful distinction of bedding and cleavage in mapping, and careful mapping of fault structures.

Mapping carried out by Hart River Mines personnel has revealed several key exposures which show that in small and medium folds, the south limbs of the anticlines have a gentle southerly dip, whereas the North limbs are steep to slightly overturned with competent beds, like limestone and diorite sills, being broken and showing boudinage.

This is consistent with thrusting towards the North and is also consistent with the mapped exposures of the main anticline, the South limb of which is relatively indisturbed and quite apparent in the field, whereas the North limb is poorly exposed and cannot be mapped accurately.

The relatively steep local plunge of the main anticline is not quite consistent with the overall structure and in a large area to the West (West of Mark Creek) where there are no outcrops, the anticlinal axis should rise again, i.e. exhibit an Easterly plunge. This feature may reflect some old pre-thrust structure striking Northerly or North-easterly through the main valley. Other evidence however, suggests one main period of folding only. A number of isolated outcrops of fine grained diorite trend NE, lending some support to the hypothesis of a pre-thrust major structure trending in this direction.

An added complication is the swelling and pinching of the sill-like

bodies of diorite, which also partially cross-cut the bedding.

This large structural anomaly augurs well for the size of the sulphide occurence, but it has slowed down drilling which has in general followed at relatively close spacing the mineralized structures apparent in the first half-dozen holes, some of which appear to the writer to be subsidary structures.

The initial drill results have been complemented by additional soil sampling and magnetic and electro-magnetic surveying, and a second drill can now be added advantageously for step-out work, which has also been restricted by the desirability in this talus-covered terrain, to move the drills systematically and for short distances, drilling first those locations where water becomes more difficult to obtain as the season advances.

4. MINERALIZATION

Mineralization consists of irregularly banded pyrite and pyrrhotite carrying mainly chalcopyrite, sphalerite, and minor galena. Ore grade sections consist of from 100% sulphide down to perhaps 10% sulphides; some all-sulphide sections carry only minor base metal values.

Examples of all-sulphide sections as averaged by Hart River Mines Ltd., and illustrating the type of grade encountered, are:

	Widths	Au	Ag	Cu	Pb	Zn
Good Grade hole 23	30' (about true)	.11	.54	3.87	.31	1.06
Low Grade hole 5	114'(not true)	.02	.18	.84	.08	.68

In addition, certain sections of low-sulphide mineralized argillite show near-commercial values.

Examination of the core has convinced the writer that this is a typical stratabound deposit with pronounced bedding control, lying within black argillites near the contact with a fine grained sill or near-sill of diorite.

Pronounced E-W cleavage complicates the distribution of the ore-minerals but it is too early to determine whether zones of strong cleavage across the favourable bed control the higher grade or the lower grade portions of the ore, or whether loci where bedding and cleavage are about coincident, are the more or less favourable ones.

Approximately 1½ miles away from the main showing, the writer has observed bedded massive pyrite within similar black argillites. The pyrite follows different beds, some 1/8" wide, some ½" wide.

In another location, float of siderite with chalcopyrite estimated at 1% Cu was found near a diorite contact.

These observations taken together indicate bedded sulphide deposition and localization of copper near the diorite contact.

The additional soil sampling and geophysical data are all consistent with the geological structure as mapped. The data indicate that the main base-metal bearing sulphide occurence lies near the diorite argillite contact along the crest of the main anticline and along both its limbs, for a total length of some 3,500' of which only about 20% has been drilled so far.

Within the crest of the anticline, there are two main subsidiary anticlinal wrinkles; each apparently formed by two tight folds.

The drilling completed so far has followed one of these four folds to the West of the original discovery. Subsequent drilling has started to follow the bedded formation to the SE, where a total minimum length of some 3,000' remains to be explored.

The structure suggests that a second tight fold occurs some 200' to 300' North of the area drilled initially, and the significant conductivity associated with this westerly plunging structure on line 104-West suggests

that this is a drill target of major importance.

At the time of the writer's visit, additional magnetic surveying had been started to investigate the magnetic characteristics of some of these conducting zones, but it must be remembered that the pyrite parts of the body may not be magnetic at all. On line 108-West, a significant conductor may reflect the offset of the sulphide occurence North of the NE trending postulated fault which appears to limit the main body towards the N and NE.

5. DRILLING

Practical considerations limit the mobility by helicopter of a drill in terrain of this type, and higher lying areas have to be given preference in summer when water is more easily available.

A second drill is now being moved in to do some of the step-out work while the No. 1 drill is continuing to probe the extension of the zone towards the SE, where a length of some 3,000' remains to be tested, and where spacing should be increased from 100' to 200' if at all possible.

Several targets of importance on the possible West extension into the main valley should be tested in the last part of the season, as they are the nearest to water and can be drilled efficiently even after the onset of cold weather.

The principal targets remaining to be drilled are:

A. 3 subsidary folds out of the four plunging to the W, only one having been tested so far.

B. SE extension: length of about 3,000'

C. NE extension: length of about 500'

D. Several significant conductors between camp and the main showing on the lower slopes, which may reflect the portion of the sulphide zone offset by the NE trending fault at the North end of the known discovery.

E. several significant geochemical highs located by the most recent soil sampling.

6. ORE RESERVES

It is premature at this time to endeavor to calculate ore reserves. Some drill set-ups are difficult to prepare without a cat, and drill locations have to take into account the topography. When a suitable location is found, it has been advantageous in several cases to fan out some holes in different directions, and this does not facilitate a reserve calculation, especially with respect to grade, until a broader picture of the structure has been defined.

Guided by the geological mapping, the soil sampling, the geophysical surveying and the drilling completed so far, the target area has been significantly enlarged and a conservative average estimate in the writer's opinion is that this area now represents a length of about 3,500' by a width of about 30', i.e. an area of about 10,000 tons per vertical foot of which about 15% has been explored to an average depth of about 250', mainly along a subsidiary fold, not of the indicated strike length remaining untested.

7. POTENTIAL

The ore zone is associated with a major structural anomaly consisting of a major West plunging anticline within an EW trending dome-like area of Late Precambrian clastic and dolomitic sediments with associated diorite sills and masses. Bedded sulphides occur in black argillites slightly below and at their contact with a fine-grained diortie sill which is probably some 200' thick. Bedded pyrite has been observed in the same formation about 1½ miles away from the showing. This type of stratabound occurence is one that has a high probability of forming large bodies. It is of considerable interest that the Precambrian belt of the Northern Yukon has also given much evidence of iron oxide deposition, some of it of very large extent, in approximately the same stratigraphic

position, and that there is much evidence of copper deposition throughout this belt which so far has not been explored to any significant degree.

Within the particular diorite gabbro belt, which is some 10 to 15 miles long, the Mark showing is associated with a strong structural anomaly, and may reasonable be inferred to reflect the presence of a major sulphide deposit. Bolder step-outs with the second drill are now justified, on both those structural and geophysical anomalies that suggest the possibility of good sized sulphide masses. One drill should continue to explore the SE extension.

Locations recommended for step-out work are:-

1. The southerly saddle where another double "wrinkle" is indicated.
2. The extension NE of the northerly saddle.
3. The strong electro-magnetic anomalies North West of the original discovery, on lines 104 W, 108 W and beyond.

This type of drilling should assess the potential size of the discovery relatively rapidly. A significant aspect of this deposit is the likely presence of an extensive ore sheet overlain by a 200' thickness of a partially eroded diortic sill along the crest of the major westerly plunging anticline. A number of geophysical features suggest that this is the case, and if so, there are distinct possibilities of open-pit mining a major part of the deposit if the ratio of ore to overlying waste is favourable.

Under favourable conditions of open-pit mining and of metallurgical recovery, the writer's estimate is that in this location, 15 million tons of about 1.3% Cu, plus some credits for silver and gold, are an economical objective.

The presently indicated target-size suggests, that this is a very reasonable and realistic objective, which can be tested in a relatively

short time and at relatively low-cost.

8. SUMMARY AND RECOMMENDATIONS

The Mark showing of Hart River Mines Ltd. is a stratabound massive to thin-bedded pyrite-pyrrhotite-chalcopyrite-sphalerite with minor galena.

The showings lies in Late Precambrian black argillites near the contact with a diorite sill about 200' thick. Field evidence suggests that the age of the intrusive is Late Precambrian to Cambrian, and that sulphide deposition is of the exhalative volcanic type, i.e. formed by solutions related to volcanism associated with the intrusion of the diorite sills and masses.

This type of stratabound sulphide deposit is prone to form large bodies and in the writer's considered opinion, this occurrence has a good probability of being of economic size in this location.

The minimum economic size required for an open-pit in this area, is estimated by the writer to be of the order of 15 million tons of about 1.3% Cu with good recovery characteristics.

An underground operation could be of smaller size but would require a higher grade. In view of the fact that a number of intersections have revealed grades in the 2.0 to 4.0% Cu range, the possibility of proving an economic operation of this type is also present.

As the excellent geological mapping carried out by Hart River Mines Ltd. personnel under the direction of Dr. J. Usher, has now provided a good understanding of the significant features of the deposits, it is recommended that the drill program be accelerated.

Further drilling can be done either from surface or from underground openings.

A strong argument can be made for underground drilling, as drill moves on the surface by helicopter without the benefit of a bulldozer are difficult and risky in this terrain. Maintenance of drill water for surface supply is very difficult as soon as cold weather starts, whereas a fixed water line can be provided for underground operations even in cold weather.

Experience in the Mayo area with winter roads has been very good, as the generally gentle grades of the broad valleys allow the use of trucks.

The following costs are estimated for underground drilling from an EW crosscut and NE and SE trending drifts, respectively about 500', 500' and 1,000' long and situated about 300' below the discovery saddle:

1.	Drifting, 6'x7' openings, 2,000' @ $90.00	$180,000.00
2.	Winter road from Mayo, 110 miles @ $450.00 per mile	50,000.00
3.	Freighting, 100 tons @ $100.00	10,000.00
4.	Fuel, camp construction and miscellaneous supplies	25,000.00
5.	Drilling, 15,000' @ $10.00, all inclusive	150,000.00
6.	Engineering and supervision	20,000.00
7.	Administration and consulting	20,000.00
	Total estimated cost	$455,000.00
	Contingencies, 10%	45,000.00
	TOTAL BUDGET	$500,000.00

The actual elevation of the portal below the discovery saddle should be chosen with great care.

It is essential that drifting be done under close geological control. Considerably more structural information can be gained from underground than from surface, and the drifting should be adjusted to the geological structure in such a manner that maximum advantage is gained from each drill station. Drifting and drilling should be carried out concurrently.

Respectfully submitted,

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Vancouver, B.C.
September 16, 1968.