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REPORT ON 1977 EXPLORATION

MM/JJ PROPERTY

Watson Lake Mining District

Yukon Territory

N.T.S. 105 F - 7

Latitude: 61° 27' N

Longitude: 132° 40' W

By:

J. Mortensen

CYPRUS ANVIL MINING CORPORATION

February 20, 1978.

Field Work Done From June 7/77 - Sept 9/77.

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REPORT ON 1977 EXPLORATION

MM/JJ PROPERTY

INTRODUCTION

The MM and contiguous JJ claim groups are located in the core of the Selly Mountains on N.T.S. map sheet 105 F-7 at approximate co-ordinates 61° 27' latitude and 132° 40' longitude (Figure 1). The property, comprising 76 MM and 81 JJ mineral claims in good standing until 1984, lies 36 miles south of Ross River and 14 miles east of the South Canol Road in the Watson Lake Mining District (Figure 2). The claim groups are largely above treeline in alpine terrain between 4000 and 6500 feet elevation. Access to the property is by helicopter. A tote road(in generally poor condition) through the Seagull Creek Valley and connecting with the South Canol Road at Groundhog Creek ends approximately 3 miles northeast of the claim groups.

The MM and JJ claims (Figure 2) were staked by Anvil Mining Corporation Ltd. during the 1973 field season to cover a stratiform Zn/Pb occurrence formerly held by Sparton Explorations (Archer, Cathro and Associates Ltd, 1972). The occurrence also coincides with an isolated high on the Federal Aeromagnetic Map of the Quiet Lake map area, (Department of Mines and Technical Surveys, 1961). Geological, geochemical, geophysical, and diamond drilling programs (2815 feet total drilling) were carried out on the property in 1973 and 1974. Grid soil sampling outlined several highly anomalous areas, most of which are apparently related to known sulphide showings. Results of geophysical surveys were generally inconclusive, largely due to the extremely rugged terrain on much of the claim groups. Mineralization of sub-economic grade was encountered in drill hole 74-MM-02.

.... 2

No field work was carried out in 1975. The 1976 field work consisted of 5505 feet of diamond drilling, accompanied by a limited amount of structural interpretation and surface mapping in the immediated vicinity of the drill holes. Narrow, but promising, sulphide intersections were made in several of the 1976 drill holes, and the drilling equipment was left on the property at the end of the field season.

Work carried out during the 1977 field season included 5388 feet of diamond drilling, minor geochemical fill-in sampling, and detailed (1" = 100') re-mapping of outcrop in the immediate vicinity of the main showings, in order to obtain better stratigraphic and structural control for the mineralization. Drilling equipment and crew were contracted from Arctic Diamond Drilling, Ltd. Drilling was terminated on August 25, 1977, and the drill crew mobilized off the property. The drill equipment remained on the property for a further 20 days, awaiting assay results on an earlier drill hole. These results proved of insufficient grade to warrant further drilling at present, and the equipment was mobilized off the property in mid September. Mapping was continued until September 7, when weather conditions made further field work impossible.

REGIONAL GEOLOGY

Two contrasting sequences of strata have been recognized by Tempelman-Kluit, (1976) within the Pelly Mountains, based on regional mapping. These are:

a) an autochthonous miogeoclinal sequence ranging in age from Late Proterozoic to Triassic, and including shales, sandstones, and carbonate platform rocks, with minor acid volcanic flows and pyroclastics high in the section; and

b) an allochthonous Upper Paleozoic metamorphosed eugeoclinal assemblage of ultramafic rocks, basalts, siliceous tuffs, and cherts (Tempelman-Kluit, 1976, p.97).

The autochthonous succession is imbricated by large northeasterly directed thrust faults, and the allochthonous assemblage is cut by steep normal and strike-slip faults. Both successions are arched over two northwesterly-trending anticlines which were the locus of relatively high heat flow accompanied by intrusion of Mid-Cretaceous granitic batholiths and injection migmatites. These structures constitute a metamorphic core zone termed the North Big Salmon Complex (Jennings, 1976). Transcurrent movement along Tintina Fault occurred shortly after the intrusion of the batholiths.

Outcrop of the allochthonous sequence within the Pelly Mountains is restricted to an area southwest of the MM claim block, immediately north and east of Quiet Lake, where it forms two large, fault-bounded klippen. Elsewhere, the underlying miogeoclinal strata have been exposed by uplift and erosion.

Regional stratigraphy within the miogeoclinal assemblage is summarized in Figure 3. Two breaks in sedimentation are depicted, one above the Windermere to Lower Cambrian sequence that forms the depositional base for much of the Northern Omineca Belt rocks, and one during Late Silurian and Early Devonian time.

The Upper Cambrian to Ordovician section consists of calcareous phyllites and black slates that are equivalent both to the Kechika Group (Gabrielse, 1963,

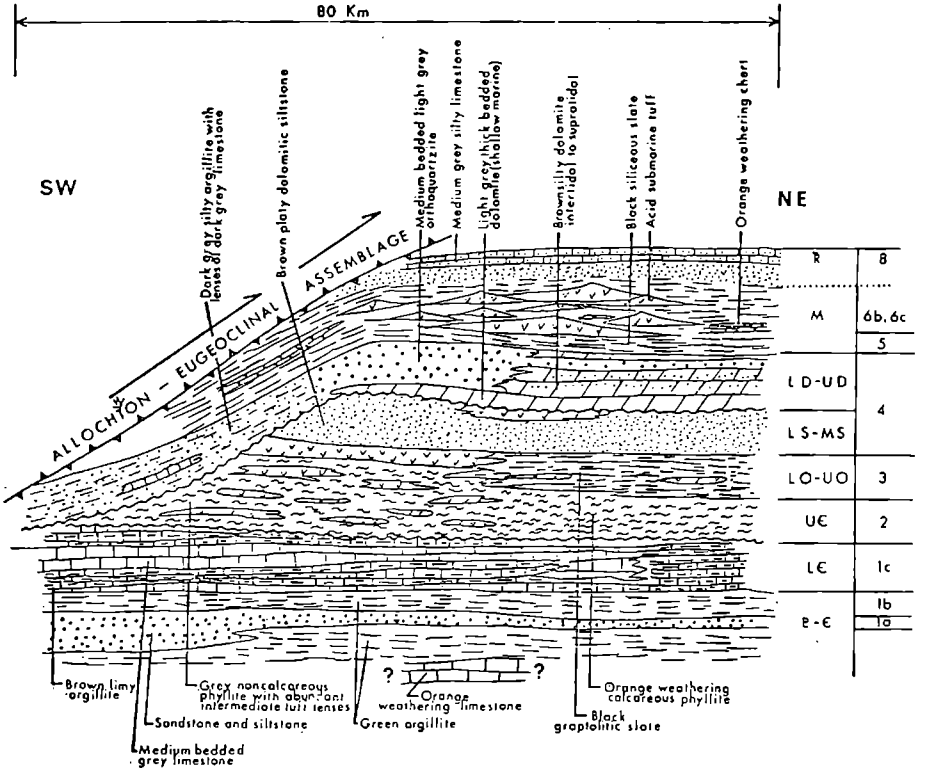


Figure 21.1. Schematic diagram of facies relations in miogeoclinal strata of the Pelly Mountains. The ages of rock units and their correlation with the map-units of Wheeler *et al.* (1960a, b) are indicated on the right.

FIGURE 3 "AFTER TEMPELMAN-KLUIT, 1976."

and Tempelman-Kluit, 1976), and the phyllite unit of the Anvil District. The uppermost depositional break is a disconformity throughout most of the Pelly Mountains, but to the southwest it becomes an angular unconformity, and large portions of Lower to Middle Paleozoic strata are absent, presumably having been removed by erosion.

Immediately overlying the unconformity is a sequence of thick-bedded dolomite, thin-bedded silty dolomite, dolomitic mudstone, and medium-grained orthoquartzite, comprising up to 9,000 feet total thickness (Tempelman-Kluit, 1976, p. 98). These units represent intertidal, supratidal, and beach environment deposits. Mississippian black siliceous slates with minor greywacke and thinly laminated barite lenses overlie the carbonate sandstone sequence. Total thickness of this unit is roughly 1500 feet. The slate is overlain in the northeast and southwest of the region by 300 feet of orange weathered, thin-bedded, pale green tuffaceous chert. In the case of the Pelly Mountains, the chert unit grades laterally into intermediate to acid, submarine explosive volcanic rocks with intercalated black slate. Several small syenite plugs are also present in the acid volcanic pile, and presumably represent subvolcanic equivalents of the extrusive rocks. The pile is made up of a number of coalescing sheets of ejecta from several main centres (Tempelman-Kluit, 1976,p. 99), and comprises a total thickness of approximately 3,000 feet.

Overlying the chert/volcanic package is more than 1,000 feet of laminated, strongly bioturbated shale and siltstone, which is itself overlain by as much as 1,600 feet of silty to sandy, thin-bedded limestone containing Middle to Upper Triassic conodonts (Tempelman-Kluit, 1976, P. 99).

Metamorphic grade of the allochthonous units is generally higher than that in the autochthonous rocks (Tempelman-Kluit, 1976). Within the autochthonous succession, metamorphism and structural complexity is greatest near the North Big Salmon Complex and appears to drop off to the northeast, although steep faulting greatly intensifies in the region between the Porcupine Thrust and Tintina Trench.

GEOLOGY OF THE MM CLAIM BLOCK

TABLE I STRUCTURAL/STRATIGRAPHIC COLUMN FOR THE MM PROPERTY

Unit 7	(AGE UNKNOWN)	
	:	- highly altered basaltic(?) dyke rock.
Unit 6	(MISSISSIPPIAN TO UPPER TRIASSIC)	
	: 6a :	- calcareous graphitic quartz-muscovite schist.
	: 6b :	- calc-silicate schist, quartz-muscovite-biotite-corundum schist, and bioclastic marble.
Unit 5	(MISSISSIPPIAN ?)	
	: 5a :	- variably pyritic and pyrrhotitic pelitic schist.
	: 5b :	- locally pyritic, graphitic quartz-muscovite schist.
	: 5c :	- fine-grained andesite to rhyodacitic volcanic extrusives (and associated volcaniclastics).
	: 5d :	- "distal-type" massive to thinly-bedded, pyrite- and sphalerite-rich sulphide lenses.
Unit 4	(MISSISSIPPIAN ?)	
	: 4a :	- massive trachyte/rhyolite.
	: 4b :	- coarse-grained rhyolitic agglomerates or breccias.
	: 4c :	- variably pyritic quartz-alkali feldspar-muscovite schist (acid tuff).
	: 4d :	- "proximal-type" massive and banded sulphide lenses.
Unit 3	(AGE UNKNOWN - POSSIBLY UPPER PALEOZOIC ?)	
		- undifferentiated assemblage of sepentinites, quartz-feldspar-cordierite schist, and chlorite-tremolite schist.
Unit 2	(LOWER DEVONIAN - LOWER MISSISSIPPIAN ?)	
	: 2a :	- fine-grained limy dolomite.
	: 2b :	- variably calcareous and carbonaceous orthoquartzite.
	: 2c :	- fine-grained graphitic quartz-muscovite schist.
Unit 1	(UPPER CAMBRIAN TO ORDOVICIAN)	
		- limy phyllites and minor calc-silicate schists.

DISCUSSION OF STRATIGRAPHY

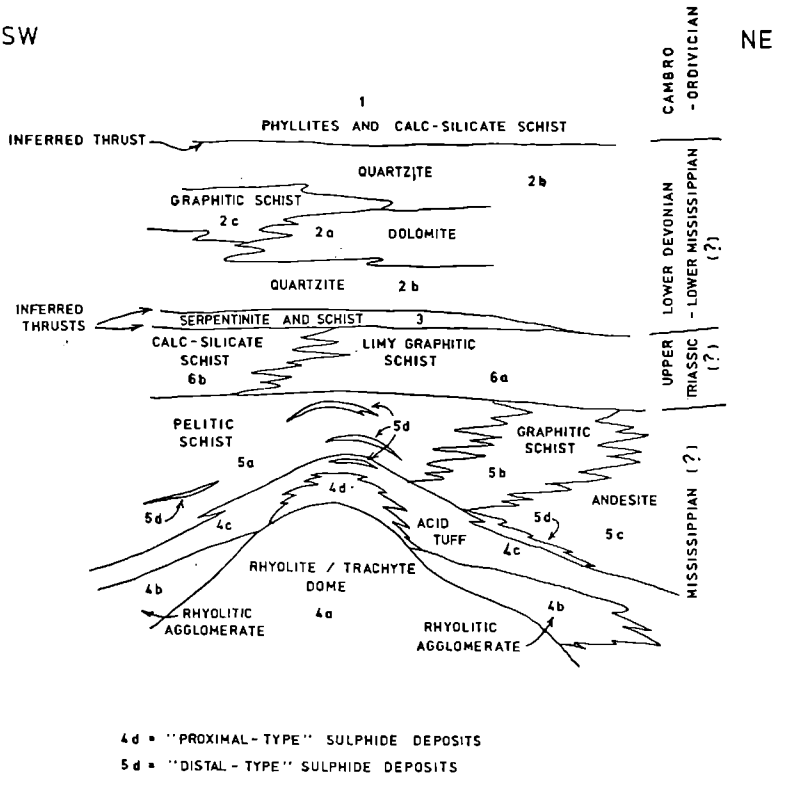
A detailed time-space plot of the various lithologies mapped on the MM property during the 1977 field season is shown as Figure 4. This plot must be considered as preliminary, and applies only to the immediate area of detailed mapping and drilling. Inferred ages and regional tectonic settings of the units are adapted from Tempelman-Kluit (1976, 1977). Individual units are discussed in detail below.

Unit 1: The oldest rocks exposed on the property are lustrous, medium grey-brown limey phyllites and minor calc-silicate schists of Upper Cambrian to Ordovician age (Unit 1). These rocks consist of muscovite, quartz, calcite, and biotite, with minor chlorite and epidote, and small relict grains of red-brown spinel and zircon. They are well foliated, and, in thin section, show composition banding defined by mica-rich and mica-poor layers. This unit is considered to be part of the Kechika Group (Tempelman-Kluit, 1976, and Jennings, 1976).

Unit 2: Structurally underlying the phyllite unit is a package of shallow marine/platformal strata of Lower Devonian to Lower Mississippian (?) age. This package is collectively termed Unit 2, and has been further sub-divided into Units 2a, 2b, and 2c. Unit 2a consists of medium-to dark-grey, fine-grained limey dolomite, with minor interbands of recrystallized coarse-grained limestone.

A distinctive lithology within Unit 2a is a highly fossiliferous, fine-grained carbonaceous dolomite containing disarticulated Brachiopod fragments (Brachiopod "chowder" of Jennings, 1976). This rock type forms a discontinuous lens that is intersected by two drill holes (74-MM-02 and 77-MM-01), in which the maximum thickness reached is about 55 feet, but does not outcrop anywhere on the property. In general, the dolomite is massive-weathering,

IDEALIZED TIME-SPACE PLOT OF LITHOLOGIES AND FACIES RELATIONS FOUND IN MM STRATIGRAPHY



4d = "PROXIMAL-TYPE" SULPHIDE DEPOSITS

5d = "DISTAL-TYPE" SULPHIDE DEPOSITS

FIGURE 4

and locally shows abundant quartz-dolomite-calcite veining.

Unit 2b is made up of light to medium-grey, medium-grained, variably calcareous orthoquartzite. The rock contains abundant clinozoisite (locally to 40% by volume) and trace amounts of carbonate (mainly calcite). Narrow, diffuse, discontinuous, carbonaceous interbands are seen throughout much of the unit, often occurring with minor amounts of muscovite, biotite and chlorite. Neither graded bedding nor cross-bedding have been seen within the quartzites.

Unit 2 is a graphitic quartz + muscovite ± biotite schist. It occurs as a narrow lens in the north-central part of the map area and also outcrops on the ridge on the western edge of the map area.

Unit 2 carbonate and quartzites were probably deposited in intertidal, supratidal, and beach (or bar) environments. Jennings (1976) suggests that the Brachiopod "chowder" is indicative of deposition at or near wave base. Carbonaceous bands within the quartzite may represent algal mat material from a tidal flat environment. The graphitic schist indicates the presence of small, near-shore, reducing basins.

Exact stratigraphic relations within Unit 2 have not been worked out as yet, due to structural complexities. The probability of transgressive/regressive series, producing rapid lateral facies changes, further complicates the problem. A crinoid stem collected from a highly calcareous interband in the quartzite has not yet been dated; this and other microfossil evidence from the units, however, should help to determine age relations in the package.

Unit 3: Structurally underlying the quartzite-carbonate package is an undifferentiated assemblage of serpentinites and schists which make up Unit 3 (equivalent to Unit 7 of Jennings, 1976).

Three main rock types have been identified in the unit. These are:

1) a fine-grained felted mass of chlorite ± talc surrounding long prismatic crystals and columnar aggregates of tremolite, and often containing large euhedral porphyroblasts of pyrite.

2) a medium-grained aggregate of subhedral plagioclase (An_{29-35}) and cordierite(?) in a fine-grained groundmass of tremolite, chlorite, calcite, and minor talc. Epidote appears as abundant inclusions in both the coarse-grained and fine-grained material.

3) fine-grained serpentinite (dominantly antigorite) containing rare relict olivine grains. Magnetite is finely disseminated throughout, probably as a product of serpentinization of original olivine.

Jennings (1976) has also included minor chert in this unit.

Unit 3 forms narrow discontinuous lenses that structurally overlie the Mississippian(?) volcanic package over much of the property. It was intersected in all of the 1977 drill holes, with a maximum thickness of 60 feet (in drill hole 77-MM-03). The rock is strongly sheared, and locally highly brecciated. Its origin is problematical, since this assemblage has not been recognised elsewhere in the autochthonous terrain of the Pelly Mountains. It is unlikely that the serpentinites represent altered ultramafic extrusives, since such rocks are unknown during Phanerozoic time (K. C. McTaggert, 1977, pers. comm). The only serpentinites documented in the area are from the allochthonous eugeoclinal assemblage. Tempelman-Kluit (1976, p. 103) suggests that the lower contact of the allochthon is highly imbricated, and may involve slices of the over-ridden platform. It is possible, therefore, that the serpentinites exposed on the MM were, in fact, originally part of the allochthon, and the phyllite and

quartzite/carbonate packages are imbricate thrust slices contained within the lower portion of the allochthon.

Unit 4: The lowermost structural package found on the property is a sequence of Mississippian (?) acid to intermediate volcanics and volcaniclastics intercalated with, and overlain by, pelitic and graphitic schists (Units 4 and 5). These units are themselves overlain by carbonaceous limestones and locally bioclastic marbles and calc-silicate (Unit 6).

Unit 4 consists of a pile of acid volcanics and related volcaniclastics, and contains one of the major mineralized horizons discovered to date. The unit can be subdivided as follows:

1) very fine-grained trachyte (Unit 4a) composed almost entirely of sub-parallel laths of Carlsbad twinned alkali feldspar, with minor quartz, muscovite, and nosean, and traces of biotite, chlorite and calcite. Quartz content is quite variable, and locally the rock is rhyolitic in composition, with up to 15% (by volume) of quartz. Immediately underlying the mineralized horizon intersected by drill hole 77-MM-03, the trachyte contains approximately 10% (by volume) of hornblende, chlorite, and partly-chloritized biotite. The trachyte apparently forms a dome that underlies the central part of the map area, but which does not outcrop anywhere on the property.

2) rhyolitic breccia/agglomerate (Unit 4b) consisting of highly deformed fragments of medium-grained rhyolite in a fine-grained schistose groundmass of muscovite with minor alkali feldspar, quartz, biotite, and calcite. This unit was intersected in two drill holes (77-MM-02 and 77-MM-04), and is also exposed on the main cirque wall. It apparently forms small discontinuous deposits flanking the main dome.

3) a fine-grained, variable pyritic alkali feldspar-quartz-muscovite schist (Unit 4c) forms a laterally extensive layer overlying the dome and agglomerate units. The rock also contains

minor hornblende, chlorite, and calcite, and locally shattered fragments of sphalerite. Pyrite occurs as cubes and as irregular fragments. The bulk composition of the rock is approximately that of a rhyolite, suggesting that it represents a tuff related to explosive activity on the dome. Extensive interbanding of the tuff and overlying schist of Unit 5 would indicate an episodic nature for this activity.

4) structurally and stratigraphically overlying the trachyte/rhyolite dome, and interbanded with acid tuffs and minor Unit 5 schists, is a lens of massive and banded sphalerite and pyrite, with minor chalcopyrite, pyrrhotite, and galena (Unit 4d). This lens was intersected only in drill hole 77-MM-03. A rough metal zonation is evident within the lens, grading from Zn-rich at the top to Cu-rich at the bottom (see Figure 5). Total vertical thickness of the massive part of the lens (as intersected by the drill hole) is about 11 feet, with lower-grade banded and vein type sphalerite and chalcopyrite, with abundant clean quartz extending for another 31 vertical feet down the drill hole. Banding within the sulphides is roughly perpendicular to the core axis, so the thicknesses quoted are probably close to true thicknesses. Assay results for this intersection are given in the drill log.

Locally small rounded "clasts" of rhyolitic composition are seen within the massive sulphides. A detailed polished section study of the sulphides has not been undertaken as yet; in drill core, however, pyrite occurs as cubic grains and grain aggregates in a groundmass of sphalerite and galena. Where banding is evident in the sulphides, it is roughly conformable to compositional layering in the tuffs and Unit 5 schists. It is probable, therefore, that the massive and banded sulphides, were formed as a chemical precipitate on top of the dome, and that deposition was periodically interruped by phreatomagmatic explosions on or near the surface of the dome (this will account for both rhyolitic "clasts" within the massive sulphides, and for shattered sphalerite seen in the tuff units). The "vein-type" sphalerite and chalcopyrite may

represent epigenetic deposition within the upper part of the dome itself, and in some of the overlying tuffs.

Unit 5: All holes drilled in 1977 intersected a thick unit of pelitic schist (Unit 5a), immediately overlying the acid volcaniclastics. The maximum thickness of schist intersected was 500 feet. The rocks composed of chlorite, biotite, muscovite, garnet, and quartz, with minor amounts of calcite, alkali feldspar, epidote, blue amphibole, and zircon. Thinly banded sphalerite and minor galena and calcopyrite are present in discrete intervals (Unit 5d), and pyrite and pyrrhotite occur in varying amounts throughout (locally to 15% by volume). The schist is thought to represent a pelitic sediment with minor distal exhalative-type sulphides (Ridler's terminology, 1970) interbanded within it. The presence of blue amphiboles may be significant, since these minerals (glaucophane-crossite) are often indicative of metamorphism under considerably higher P/T conditions than are indicated by other mineral assemblages in the map area; this may have important tectonic implications.

A distinctive rock type within the pelitic schist is an extremely fine-grained carbonaceous quartzite with abundant banded pyrite and pyrrhotite, that occurs as well-defined, conformable, discontinuous layers with a maximum thickness of about 10 feet. This rock is probably a recrystallized graphitic and pyritic chert.

The pelitic schist grades laterally(to the northeast) into fine-grained, variably graphitic, locally pyritic quartz-muscovite-chlorite-biotite schist (Unit 5b). This unit forms rusty outcrops on the main cirque wall immediately above the upper mineralized horizon, and contains minor interbands of pyritic quartz-muscovite-feldspar schist throughout.

In the vicinity of the upper mineralized horizon on the main

cirque wall, the graphitic schist either grades laterally into, or pinches out and is overlain by, a series of andesite to rhyodacite flows (Unit 5c), possibly with associated volcaniclastics. These rocks are locally amygdaloidal, and form massive, non-foliated, dark grey-brown weathering outcrops. They consist of fine-grained masses of plagioclase feldspar (anorthite content not determined), quartz alkali feldspar, biotite, muscovite, calcite, and chlorite with minor amounts of epidote and zircon throughout. Quartz content is quite variable (from 5 to 20% by volume), and locally as much as 5% by volume of fine-grained anhedral garnet is contained in the rock. Interflow contacts are not distinguishable, but a roughly-aligned amygdaloidal zone in the andesite just below the collar of the drill hole 76-MM-06 (i.e. at station A-27-A) may represent a flow top; this occurs about 60 feet from the inferred bottom of the flow and suggests of flow thickness of approximately 60 feet. Pillow structures are not seen in outcrop on the property. Narrow layers of similar composition to the andesite were intersected in drill holes 74-MM-02 and 77-MM-02, and may connect (to the southeast) with the body of andesite exposed on the main cirque wall.

The mineralized zones that outcrop on the southwest wall of the main cirque form thin, discontinuous, conformable lenses (Unit 5d) that closely parallel the lower contact of the andesite unit. The horizon containing the mineralized lenses can be traced along the andesite contact over the entire cirque wall, and everywhere carries at least trace amounts of sphalerite and/or galena, along with high pyrite contents. The lenses themselves are banded, pyritic and pyrrhotitic massive sulphide deposits with interbands of felsic and pelitic schist. Thickness of the lenses is quite variable, reaching a maximum of about 15 feet, but averaging less than 5 feet. The maximum strike length exposed in outcrop is about 250 feet. Pyrite is the dominant sulphide present (locally to 50% by volume) with lesser amounts of

sphalerite and pyrrhotite, and traces of galena and chalcopyrite. On the eastern edge of the map area, the lenses become more baritic in composition. In the showing immediately north of drill holes 76-MM-02 and 76-MM-03, approximately 25 to 30% of barite is present, and on the southerly extension of this horizon (at Station C-14), only massive barite outcrops, with less than 10% pyrite and trace amounts of sphalerite and galena.

Since this mineralization occurs at or near the top of the acid tuff unit (Unit 4c) and is locally associated with pelitic schist, it is thought to be a time equivalent of the thinly-banded sulphides contained in the lower part of the pelitic schist (Unit 5a) to the southwest. (While it is possible (probable?) that those sulphides represent later-stage products of the same processes that produced the massive sulphides that directly overlie the trachyte/rhyolite dome, their different stratigraphic settings require that they be considered separately.)

Unit 6: Two units that have been intersected by the 1977 drilling apparently overlie the Mississippian package, and are truncated by, or pinch out against, the contact with Unit 3 serpentinite and chlorite schist. Unit 6a consists of well foliated, variable calcareous, graphitic quartz-muscovite schist with minor biotite and chlorite. To the southwest, this unit is gradational into, and locally interbanded with Unit 6b, an assemblage of calc-silicate schist, quartz-muscovite-biotite-corundum schist, and bioclastic siliceous marble. The marble characteristically shows a "spotted" texture, with small, white, quartz-rich "spots" in a chloritic (± actinolite?) groundmass. Locally, undeformed shell fragments are visible in drill core (e.g. drill hole 77-MM-03 - 308.0 ft).

The age of Unit 6 is uncertain. Tempelman-Kluit has recognized an Upper Triassic sequence which includes bioclastic limestones interbedded with sandy and silty limestones, and which conformably overlies Mississippian volcanics in several localities in the

eastern Pelly Mountains (Templeman-Kluit, 1977, Unit $\mathcal{R}$ SC). Unit 6 may correlate with this sequence.

Unit 7: Two narrow discontinuous dykes are found cutting the quartzites and carbonates on the extreme western edge of the map area. These dykes trend northeast-southwest and dip vertically, with a maximum thickness of about 10 feet. The rock is medium grey-green on fresh surfaces, and weathers pale green. It consists of irregular plagioclase phenocrysts set in a very fine-grained groundmass of calcite and feldspar microlites. Minor epidote, chlorite, and opaques are also present.

Age of emplacement of these bodies is uncertain, although they certainly post-date the Lower Devonian to Lower Mississippian (?) carbonated and quartzites.

STRUCTURAL GEOLOGY

Detailed mapping generally supports the structural interpretation presented by Jennnings (1976) and Dean (1976). This interpretation is summarized below in slightly modified form.-

The oldest recognizable fabric element in the MM pile is a penetrative metamorphic foliation (S_1) which is axial planar to large-scale isoclinal F_1 structures. The foliation is defined by phase assemblages indicative of upper greenschist facies regional metamorphism. Composition layering parallels S_1 except in F_1 fold hinges (where these can be identified in the field, e.g. at Station D-4). In these regions a weak axial plane foliation is seen to cut across composition layering, while a well-developed flow cleavage parallels the layering. Inspection of Figure 6 suggests an original northwest-southeast strike, and sub-vertical dip for S_1.

S_1 is deformed by a younger foliation, S_2, which generally has a northwest-southeast strike and a shallow northeast dip. This element is axial planar to second phase (F_2) folds, forming as a crenulation foliation with varying degrees of transposition of S_1 into the S_2 plane. Phase assemblages associated

with S_2 are again indicative of upper greenschist facies metamorphism. The major F_2 structure in the area of detailed mapping is a large, nearly recumbent synform closing to the east. Numerous small-scale F_2 folds can be mapped on the southwest wall of the main cirque, particularly in the quartzite and carbonate units (in which a major F_2 hinge zone outcrops). F_2 folding is sensibly co-axial to the F_1 deformation, as documented by Jennings (1976), but axial surfaces of the two phases are roughly perpendicular to each other.

Both S_1 and S_2 are refolded about megascopic, east-west trending, third phase (F_3) folds. An axial plane foliation for this event is not generally recognizable in the map area; in the northwest corner of the area of detailed mapping, however, F_2 minor structures in Units 1 and 2 are deformed about later (F_3) minor structures, and an incipient axial plane foliation is locally developed. Axial surfaces for the F_3 structures strike northwest-southeast, and dip shallowly to the northeast.

Although a detailed geometric analysis of the MM structural data has not been undertaken as yet, inspection of Figure 6 shows that the main structures on the southwest wall of the main cirque are F_1 isoclines with axial surfaces wrapping around a major F_2 hinge. Note that the direction of closure of the F_1 structures is opposite to that suggested by Dean (1976). Near the bottom of the cirque wall, F_1 folds become shallower and more open (see Cross-Section A - A', and B - B'). Further to the southwest, the folding dies out, resulting is simple "layer cake" stratigraphy (as intersected by 1977 drilling). In this region, abundant small-scale F_2 (+ F_1?) deformation is seen within individual units, but apparently folding involving unit contacts is minimal. Still farther southwest (near the western edge of the map area), units are structurally thickened by F_3 minor folds.

The co-axial nature of F_1 and F_2, and the identical metamorphic grade associated with them strongly suggests a close interrelationship, possibly resulting from a simple shift in stress field orientation as suggested by Jennings (1976).

The volcanic stratigraphy in the Mississippian (?) pile is upright, and is

overlain by Lower Devonian to Lower Mississippian (?) platformal sequences with no evidence of an intervening fold repeat. This is taken as good evidence of at least one thrust fault between the Mississippian pile and the platform rocks on the MM property. The presence of a basic (ultrabasic?) lens (Unit 3) between the two packages is seen as further support for imbrication within the MM pile, since, on compositional grounds, this lens would appear to be a detached part of the allochthonous eugeoclinal sequence. If this interpretation is correct, the lens would be expected to be fault bounded both above and below. Proof of this has not been found in the field but certainly rocks contained in the lens are strongly sheared and locally highly brecciated as would be expected in a very narrow thrust slice.

Unit 1 phyllites are shown by Tempelman-Kluit (1977) to be in thrust contact with the structurally underlying quartzites and carbonates of Unit 2. Although no evidence for thrusting is seen on the property, the inversion of stratigraphy on a regional scale, and the (probable) presence of thrusts lower in the pile lend some support to this idea.

F_1 deformation can be no older than Mississippian since it affects strata of presumed Mississippian age. Bioclastic limestones and marbles, and graphitic schists of Unit 6 are affected by F_2 deformation. Since these units may be as young as Upper Triassic (as suggested earlier), F_2 may be Upper Triassic or later. F_1 and F_2 are probably closely related in time, and it is suggested that both events occurred during Mesozoic uplift in the North Big Salmon Complex. It is further postulated that the inferred thrusts that cut the MM pile are the result of gravity sliding off this uplift, and that F_1 and F_2 are nappe structures developed during the thrusting. Mapping to date has not provided evidence for deformation of the lowermost thrust by F_1, but this contact is certainly deformed by F_2. The contact between Units 1 and 2 has not been mapped in sufficient detail to establish whether evidence for thrusting is present, or what the time relationships between such thrusting and the folding events might be.

F_3 is thought to be a later-stage regional folding event unrelated to the previous two.

SUMMARY AND CONCLUSIONS

Surface mapping and drilling carried out during 1977 has provided a detailed picture of local stratigraphy and facies relations on the MM claim block, and has enhanced the understanding of structural geology within the map area. In particular, the Mississippian (?) volcanic/sedimentary assemblage is seen to be stratigraphically upright over much of the property. Lithologies present within the pile suggest deposition in relatively shallow water, under locally reducing conditions (as evidenced by the abundance of graphitic schist). The sulphide deposits are thought to have formed as chemical precipitates from metal-bearing exhalations related to the emplacement of a rhyolite-trachyte dome. Phreatomagmatic explosive activity produced an extensive tuff (and minor agglomerate) blanket that overlies both the dome and the strata intruded by the dome. Continuing exhalations resulted in narrow, discontinuous, pyritic sulphide lenses interlayered with tuffs and facies equivalent sediments at higher levels in the pile. Waning of the exhalative activity was followed by extrusion of andesitic lavas from a vent located (presumably) east or northeast of the known sulphide deposits, forming thin flows that overlie the acid tuffs in the area of the main cirque. These flows were apparently not extensive enough to cover the earlier dome, which is instead overlain by more than 500 feet of pelitic sediments.

It is suggested that relatively shallow water conditions were maintained for a considerable period of time after formation of the sulphide deposits, perhaps as late as Upper Triassic (as evidenced by the presence of bioclastic limestones and marbles of Unit 6 which overlie pelitic schists in the western portions of the map area).

Two co-axial phases of folding, possibly related to nappe development during gravity sliding off the North Big Salmon Complex uplift resulted in several structural repeats of the mineralized horizon on the southwest wall of the main cirque. To the southwest (and possibly to the northeast) of this area, structural complexity is much reduced, and a relatively simple gently dipping stratigraphy is encountered. Outcrop patterns are locally complicated by a third folding event which trends roughly perpendicular to earlier deformation,

and which has produced megascopic warps of all previous structural elements.

Two distinct types of sulphide mineralization have been intersected by 1977 drilling. These are:-

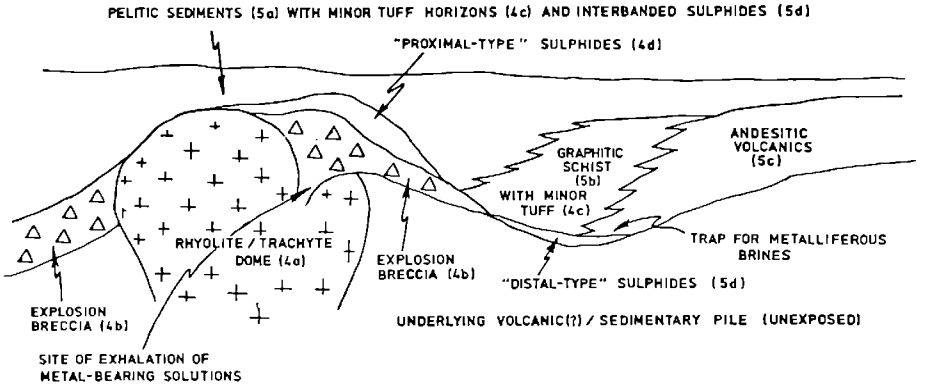
a) "distal-type" thinly-banded sphalerite and pyrite, with minor pyrrhotite, galena, and chalcopyrite, occurring interlayered with pelitic schists and/or felsic schists of rhyolitic compositon.

b) "proximal-type" massive sphalerite and pyrite, with minor pyrrhotite, galena, and chalcopyrite, occurring within felsic schists that immediately overlie a rhyolite/trachyte dome, and passing downward first into more chalcopyrite and quartz-rich felsic schist and finally into massive trachyte.

"Proximal-type" sulphides were only intersected by drill hole 77-MM-03, and apparently occur as a lens of relatively small areal extent (although still open to the northwest). "Distal-type" sulphides intersected to date are generally of sub-economic grade, although they are potentially of greater aerial extent than the "proximal-type".

Sulphide lenses outcropping on the main cirque wall are locally quite massive (e.g. the showing at Station A-29), but are apparently not associated with massive trachyte or rhyolite. Instead, they occur near the upper contact of felsic schists and agglomerate, and are overlain by andesitic flow rocks. These deposits probably formed distally to the main source of metal-bearing solutions, in areas where small local "traps" allowed metal-rich brine pools to accumulate.

The sulphide deposits in the MM pile closely resemble Kuroko-type deposits, in terms of host rock lithologies, and composition and character of the sulphides themselves. The environment envisaged for sulphide deposition on the MM is shown diagramatically below:-



SUGGESTED MODEL FOR FORMATION OF SULPHIDE DEPOSITS ON THE MM PROPERTY (MODIFIED AFTER SATO, 1974).

It's of considerable interest that the andesite flow rocks mapped on the property were apparently extruded from a vent lying east or northeast of the known sulphide deposits. This suggests that other such deposits, related to other volcanic centers, may exist in the immediate vicinity of those discovered to date. In particular, the stratigraphy on the DD claim block (northeast of the MM/JJ group) should be examined in detail to evaluate this possibility.

PROPOSED EXPLORATION

The drilling and surface geologic mapping completed during 1977 has established good stratigraphic control in the area of the showings on the MM. This detailed stratigraphic picture must now be extended over the balance of the claim group, a mapping job which will require about 2 months of field work during the summer of 1978. Little further work remains to be done in the immediate vicinity of the known sulphide bodies, which appear to be sub-economic in size, and the main hope for the property lies in the possibility that longer, non-outcropping sulphide lenses may occur elsewhere around the acid volcanic dome. The Mississippian stratigraphic package which hosts the deposits extends to the northwest in a belt at least a half mile wide and 2 miles long, underlying part of the MM claims and most of the DD. The proposed geologic mapping will determine if the sulphide bearing stratigraphic horizons occur within this belt, and will help to evaluate geochemical and geophysical anomalies on the DD claim group.

Respectfully submitted,

J. Mortensen.

February 20, 1978.

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1977 DRILL PROGRAM

SUMMARY OF 1977 MM DRILL PROGRAM

The MM drill program in 1977 consisted of four holes totalling 5388 feet. Drill logs with assay data have been prepared for each drill hole, and the basic geology encountered in each hole is summarized in visual drill logs (Figures 9, 10, 11 and 12).

DRILL HOLE 77-MM-01 (total depth 1,498 feet; vertical) intersected 500 feet of quartzites and carbonates, 580 feet of pelitic schist with sporadic banded sphalerite throughout, and 320 feet of pyritic acid tuffs and rhyolite.

DRILL HOLE 77-MM-02 (total depth 1,268 feet; vertical) was collared 1,250 feet south of 77-MM-01 and encountered 190 feet of quartzites and carbonates, 140 feet of graphitic schists and carbonates, 130 feet of pelitic schist with very minor amounts of banded sphalerite, and bottomed in inter-banded pelitic schists, acid tuffs, and flows and fragmental volcanics of acid to intermediate composition.

DRILL HOLE 77-MM-03 (total depth 1,477 feet; vertical) was collared 700 feet southwest of 77-MM-01. Two hundred and fifty feet of quartzites were intersected, followed by 100 feet of calc-silicate schist, 150 feet of graphitic pelitic schist, 170 feet of interbanded pelitic schist and acid tuff (including an 11 foot thick massive sphalerite-galena lens underlain by 18 feet of lower-grade Cu-Zn mineralization), and 270 feet of pyritic acid tuffs. The hole bottomed in massive rhyolite.

DRILL HOLE 77-MM-04 (total depth 1,145 feet; -60°; bearing 320°) was collared 350 feet south of 77-MM-03, and intersected 430 feet of quartzite, 130 feet of calc-silicate schist and graphitic-marble, 520 feet of pelitic schist with minor interbanded acid tuff, and bottomed in rhyolite agglomerate. One intersection consisting of 14 feet of 3 to 4% banded sphalerite was encountered in this hole.

All drill core from the 1977 program has been trucked to the core storage facility at the Faro mine site, with the exception of certain Askin Group sections. These are of little further use and were left on the property. Casing has been left in all drill holes, and all holes are capped.

Figures 9 to 12 and the detailed drill logs follow.