EXPLORATION WORK
QUILL CREEK MINES LTD. PROP.

N.T.S. 115-G-5 & 6

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REPORT ON EXPLORATION WORK CARRIED OUT ON THE QUILL CREEK MINES LTD. PROPERTY WHITEHORSE M. D., Y. T.

During 1966 and 1967

61° 25' N 139° 26' W

N. T. S. 115 - G - 5 & 6

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Date: February, 1968.

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INTRODUCTION

This report contains a complete summary of exploration work carried out by Newmont Mining Corporation of Canada Limited, on claims situated in the drainage areas of Quill Creek, Tatamagouche Creek, Arch and Wade Creeks in the southwestern part of the Yukon Territory (Fig. 1). The claims are located within the National Topographic Reference sections 115 - G - 5 & 6, and the cartographic reference is approximately 61° 25' N and 139° 26' W.

PROPERTY

Quill Creek Mines Ltd., a private company, was formed under agreement between Peter Versluce and Newmont Mining Corporation of Canada Ltd. in October 1966. At the time of formation, property owned by the company consisted of three contiguous groups of claims staked by P. Versluce, H. Versluce, and W. Green:-

(i)	Ram Group;	Ram 1 - 4)	Total
(ii)	Jay Group;	Jay 1 - 80)	94
(iii)	Linda Group;	Linda 1 - 10)	claims

Subsequently, three other groups of claims were added to the property:-

(i)	Go Group;	Go 1 - 82)	
(ii)	Kew Group;	Kew 1 - 49)	Total
		Kew 51 - 62)	153
(iii)	Vug Group;	Vug 1 - 10)	claims

The distribution of these claim groups is shown in Fig. 2. Some claims in the Kew Group extend into areas of previously staked and validly located ground.

SUMMARY and CONCLUSIONS

The Newmont exploration programme on the optioned Quill Creek claims was completed during the summer season of 1967 and included detailed geological mapping, a geochemical stream sediment survey, an air-borne magnetic survey, bulldozer trenching, rock sampling and diamond drilling.

Several copper occurrences were examined in detail. High grade mineralization was found in these showings but the extent of the mineralization in each showing is limited.

The geochemical survey was successful in locating numerous additional areas of mineralization, but, on examination, these occurrences were found to be very small.

The airborne magnetic survey did not identify any features which are correlatable with the copper mineralization. Distinct anomalies are present in areas of known copper-nickel mineralization and a number of possible deeply buried intrusives are indicated.

As a result of the season's work, no additional exploration work could be recommended and under the terms of the option, the property was returned to the owners on October 1st, 1967.

LOCATION and ACCESS

Quill Creek, a tributary of the Kluane River, crosses the Alaska Highway at mile 1112, 196 miles by road northwest of Whitehorse. A fair gravel road leaves the Alaska Highway at mile 1111 and follows Quill Creek westerly for 8 miles to the tributary of Nickel Creek, and continues for a further two miles along the Nickel Creek valley to the Wellgreen property of the Hudson Bay Mining and Smelting Company (Fig. 2). Near the mouth of Nickel Creek, a tote road leaves the Hudson Bay road and follows the Quill Creek valley to a point approximately one-half mile west of the Quill Creek - Tatamagouche Creek watershed and then turns northwards along Ram Creek into the area of the copper showings. The tote roads along Quill Creek and Ram Creek were constructed in 1966 and maintained during 1967. Older tote roads follow Linda, Fossil 1 and Fossil 2 Creeks for variable distances. All tote roads require continuous maintenance during the spring runoff and during periods of heavy rainfall.

An all-weather airstrip is maintained by the D. O. T. at Burwash Landing (mile 1095) and float planes can land on Kluane Lake at Burwash Lodge at mile 1093.

DESCRIPTION OF THE QUILL CREEK AREA

The Quill Creek valley drains a section of the Kluane Range bordered on the east by the Shakwak Valley and on the west by the Donjek River. The Shakwak Valley is a major physiographic feature in the southwestern Yukon marking the boundary between the Yukon Plateau of the Central Yukon and the St. Elias physiographic region in the southwestern section of the Yukon. The major peaks of the St. Elias Range occur to the west and south of the Donjek River, and the northwesterly trending Kluane mountains form the front range of the St. Elias Mountains.

The Kluane mountains rise steeply from the Shakwak Trench to a maximum elevation of about 8,500 feet. This represents a total relief variation of between 5,500 and 6,000 feet.

The majority of the higher peaks are permanently covered by snow and ice. Valley glaciers are present only in headwater regions and, generally, the ice cover is very small when compared with the extensive ice development in the Centennial and Icefield Ranges, 50 miles to the west.

Tree growth is limited to areas lying below 4,000 feet and good stands of timber are present only in the more sheltered valleys and on the Shakwak slope. Brush cover is also limited and the most common vegetation type on the mountain slopes is tough, wiry grass. The higher ridges and peaks, when bare of ice and snow, are formed of rugged rock outcrops, frost-shattered expanses and spectacular screes. Generally slopes are steep, but only precipitous in areas of alpine glaciation. River valleys are well defined and the volume of water in the rivers and tributaries fluctuates considerably throughout the year. Maximum run-off is in the spring, but because of the rain-shadow influence of the main St. Elias Mountains, the smaller tributaries and creeks often become dry during the summer months when the winter snows have melted. Total precipitation for the region is approximately 20 inches per annum.

Muller (1967) has identified four periods of glacial advance during the Pleistocene history of the Kluane Region. The first ice advance, the Nisling Ice Sheet, was the most extensive and covered the whole of the Kluane Range below an elevation of 6,000 feet. The movement of the ice was generally northwesterly. No extensive glacial deposits were left by the Nisling ice, and evidence for its extent is derived mainly from a study of topographic features and the distribution of erratic blocks.

The second recognized ice advance, the Ruby Ice Sheet, was less extensive and lateral morraines associated with this advance are located at about 5,000 feet in the Quill Creek region. Extensive glacial deposits, which were formed at this time, occur in the Shakwak and along the major drainages in the Kluane Range. Cirque glaciation was active at elevations in excess of 5,000 feet modifying the Nisling surface.

The two latest glacial advances were restricted to the deeper valleys. The St. Elias glacial advance extended along the Donjek, Duke River, and Slims River valleys to the margins of the Shakwak Trench. Sub-recent advances were restricted to individual glaciers only along the Donjek and Klutlin valleys. With the exception of the current surge conditions in the Steele Glacier, all valley glaciers in the Kluane - St. Elias Ranges are presently receding.

Permafrost is extensive throughout the Shakwak and Quill Creek areas.

HISTORY

The copper deposits covered by the Quill Creek Mines claims occur in andesitic and basaltic volcanic rocks of Upper Triassic Age referred to as the Mush Lake Group. Mush Lake volcanics are extensively exposed in the southwest Yukon extending from the British Columbia border near Mush Lake in the south, to the Alaskan border in the vicinity of Snag. This is a distance of approximately 200 miles. Copper mineralization is widespread in the Mush Lake rocks and the deposits consist almost wholly of copper-bearing minerals principally chalcocite, bornite and native copper with relatively minor chalcopyrite. Associated pyrite and pyrrhotite mineralization is extremely rare.

Native copper was known to the Indians before the advent of white man. The first recorded occurrence was noted in 1892 by Hayes in gravels on Kletsan Creek. The abundance of native copper nuggets in river gravels was noted by many early prospectors searching for gold. In the North Kluane Range, native copper nuggets were found in association with gold in Burwash, Tatamagouche and Arch Creeks, and, farther north, spectacular nuggets were found in the White River area. All these streams drain areas of Mush Lake volcanics.

Probably the first in situ copper mineralization was staked in the Upper Canyon of the White River in 1905. The occurrence consisted of native copper in amygdaloidal andesites. Subsequent exploration identified bornite and chalcocite.

Several occurrences of copper have been staked since 1908 in Mush Lake amygdaloidal lavas northeast of Tatamagouche Creek and the head of Quill Creek. The discovery of the Kennecott deposits immediately west of the International Boundary in the first decade of the 1900's focussed attention on the Mush Lake volcanics. The Nicolai volcanics underlying the limestones containing the Kennecott deposits closely resemble the Mush Lake group and are believed to be equivalent.

Despite these early discoveries, no significant mining developments were launched on any copper showings in the Kluane - White River areas. In 1952 the copper-nickel mineralization along Nickel Creek was identified and staked by W. Green and C. Aird. The claims were acquired by Hudson Bay Mining and Smelting Company who expanded the holdings and began development work in 1953. The nickel-bearing mineralization is associated with ultrabasic bodies intrusive into the Mush Lake volcanics and older rocks. Following this discovery, prospecting interest in the area was again revived and several minor discoveries were made and numerous claims staked on or near peridotite bodies along the length of the Kluane Range.

The Hudson Bay Mining and Smelting Company holdings in the Quill Creek area exceeded 500 claims. These claims extended into the headwater regions of Quill Creek and extended over the whole area presently covered by the Linda, Jay and Ram claims. Although Hudson Bay concentrated most of their efforts on the Nickel Creek showings, exploration work was carried out on their claim holdings to the south.

The ultrabasic rocks associated with the Nickel Creek occurrence were traced southeastwards into Linda Creek and several drill holes were put down in the lower sections of this valley to investigate pyrrhotite-chalcopyrite mineralization located along a narrow vein structure paralleling the contact of the peridotite body. In addition, three copper showings in Mush Lake volcanics were located. Two of these, situated at a high elevation near the extreme headwaters of Linda and Fossil 1 Creeks were sampled. A third showing, exposed in the bed of Ram Creek, was sampled and diamond drilled. No records of the Hudson Bay work have been made available, but it is understood that their results were interpreted as being indicative of small areas of mineralization and further work was not recommended.

Subsequently, the Hudson Bay claims north of Quill Creek were allowed to lapse. Work on the Nickel Creek showing consisted of extensive underground work and diamond drilling which outlined 728,000 tons of ore containing 2.05% Ni, 1.42% Cu, 0.073% Co, 0.005 oz. Au, 0.038 oz. Pt, and 0.027 oz. Pd per ton. Exploration work was suspended in 1956 because of metallurgical difficulties and limited ore reserves.

In late 1965 and early 1966, P. Versluce and associates located previously unknown copper mineralization in the basin of Ram Creek and staked claims to cover their discovery and also the other mineral occurrences examined by Hudson Bay. During the summer of 1966, prospecting and trenching was carried out exposing and extending the mineralized zones.

Newmont Mining Corporation of Canada Limited optioned the Versluce properties in October 1966, and Quill Creek Mines Ltd. was formed under the terms of the option.

GENERAL GEOLOGY

The general geology of the Kluane Lake region is described in the recent G. S. C. Memoir by J. E. Muller (1967).

The Shakwak Trench extending NW-SE through Kluane Lake separates the distinctly different rock groups of the Yukon Plateau from those of the St. Elias Range to the southwest. The Kluane mountains overlook the Shakwak Trench and are composed of rocks varying in age from late Palaeozoic to

Tertiary. The Triassic, Mush Lake volcanics are folded, with older and younger rocks, along northwesterly trending axes. Intrusions of peridotite (Permo-Triassic), granodioritic (Cretaceous) and granitic (Tertiary) rock suites complicate the geology. Later Tertiary volcanics and minor sediments overlie the older rocks with marked unconformity and are themselves folded along parallel axes. Very recent volcanic activity is evidenced by the occurrence of volcanic ash in present day soils and possible centres of eruption have been described.

The Shakwak valley marks the location of a major regional dislocation allied to the Rocky Mountain Trench, The Tintina Trench and other linear physiographic zones common throughout northwestern North America. The true nature of the fault zone is unknown, but a steeply dipping structural zone is indicated with considerable lateral and vertical displacement.

To the southwest of the Trench, Muller has mapped several thrust faults extending several tens of miles, consistent with compressional forces from the southwest. These thrust faults intersect the youngest Tertiary rocks mapped and have apparently been formed during the orogenic movements accompanying the formation of the St. Elias mountains.

In detail, throughout the Kluane and St. Elias Ranges the complications of folding and faulting renders the geology extremely complex.

NEWMONT EXPLORATION PROGRAMME

In addition to staking additional claims, the Newmont exploration programme can be conveniently summarized as follows:-

(1) Detailed geological mapping of the Ram Creek drainage basin and sections of the Linda, Fossil 1, Fossil 2, and the Tatamagouche drainage areas. This mapping extended over all the most important copper showings in the area.

(2) Bulldozer trenching in the vicinity of the copper showings.

(3) Geochemical stream sediment reconnaissance survey of the whole of the area covered by Quill Creek Mines Ltd. claims, extending into adjacent areas.

(4) Surveying and sampling of all exposed mineralized occurrences.

(5) Diamond drilling of selected occurrences.

Camp and geochemical analytical facilities were established at the junction of Ram and Quill Creeks.

DETAILED GEOLOGY OF QUILL CREEK MAP AREA

Fig. 3 is a detailed geological map covering the most important copper showings in the Quill Creek area. These showings may be listed as follows:-

Copper Showing	Location
Ram Showing	Ram #1, 2, 4
Hudson Bay Showing	Ram #2
Linda Showing	Jay #12
Fossil 1 Showing	Jay #21
Fossil 2 Showing	Jay #21

According to Muller, the headwaters of Quill Creek drain a section of the northern limb of a major easterly plunging synclinal structure trending in a west-north-west direction. The youngest rocks exposed in the central part of this structure are sediments of the Dezadeash Group (Upper Jurassic - Lower Cretaceous). These are underlain by a limestone member in the Upper Triassic Mush Lake Group which overlies the basalts and andesites representing the typical Mush Lake volcanics. Cache Creek rocks (Permian) form the older rocks on the northern flank of the syncline. These are divided into an upper sedimentary group containing limestone, argillite, sandstone, grit, conglomerate and chert and an older, predominantly volcanic group consisting of basic lavas, cherty tuffs, volcanic breccias, schists, greywacke, argillite and limestone.

The southern limb of the syncline has been overridden by a thrust block containing Cache Creek, Mush Lake and intrusive rocks. The thrust plane outcrop has been mapped along the length of Tatamagouche Creek extending northwestwards to the south of Quill Creek.

Muller recognized the absence of rocks of Upper Permian and Lower Triassic age in the Kluane area but notes that there is no evidence of an angular discordance. This he interprets as indicating a period of uplift during the history of the St. Elias geosyncline unaccompanied by folding.

The detailed mapping covers only part of the northern limb of the synclinal structure and extends over areas of Cache Creek sediments and Mush Lake volcanics. The detailed work, however, indicates structural relations which are at variance with those described by Muller.

Tremblay's mapping (Fig. 3) indicates the presence of two important rock groups:-

(a) A succession of sedimentary rocks (Units 1, 1A, 1B, 1C and 1D) exposed along the crest of a ridge extending across the area from Jay 19 through and beyond Jay 34.

(b) A sequence of volcanic rocks with minor sediments (Units 2, 2A, 3, 3A, 4, 5, and 5A) directly underlying the sedimentary sequence forming the valley floor and valley slopes of the Ram Basin.

Within the boundaries of Jay 34, the volcanic sequence is continuous across a low pass in the ridge and can be traced downslope to the north into the valley of Linda Creek. The sedimentary - volcanic contact can be traced across the ridge crest in this area and the spatial relationships suggest a flat-lying contact as illustrated in section C-D (Fig. 3). The presence of a nonconformity is indicated by the fact that the units within the sedimentary sequence dip southwards and the volcanic-sedimentary contact dips gently to the north.

Conglomerate along sections of the volcanic-sedimentary contact suggests the presence of an erosional unconformity. However, the discontinuity of the conglomeratic bed and the large discordance of dip between the volcanic-sedimentary contact and the sediments could also be interpreted as indicating a tectonic contact. Further evidence of a tectonic contact is provided by observed intense brecciation within limestone unit 1A along the volcanic contact in the vicinity of both the Linda and Fossil showings.

From Muller's descriptions, the sedimentary sequence is typical of the Cache Creek (Permian) group. Coral limestone is unique within this group and well represented in the Ram Creek area. All volcanics within the area of detailed mapping are part of the same unit and outcrop both north and south of the sediments. The rock types and associated mineralization are typical of the Upper Triassic Mush Lake volcanics. If these comparisons are valid, Permian rocks overlie Upper Triassic rocks - a situation supporting evidence for a tectonic contact.

Throughout this discussion of Ram Creek geology, all volcanics will be considered as being of Mush Lake (Upper Triassic) age and the sedimentary sequence of limestones, argillites and conglomerates as being of Cache Creek (Permian) age. The contact between these two groups is tectonic and very likely a thrust fault. Both these rock sequences are cut by intrusive rocks of noritic and gabbroic composition. The norite occurs as a sill in the Mush Lake volcanics and the gabbroic intrusives are characteristically associated with the Cache Creek succession.

Rock Types

Individual rock types are described by J. H. Tremblay as follows:--

Unit 1 (Sub-units 1A, 1B, 1C, 1D)
(Sedimentary succession, Cache Creek, Permian)

This unit outcrops in the northern part of the mapped area and consists of highly incompetent beds of fossiliferous and massive limestone, argillite, shale, conglomerate, chert and minor tuff. Facies changes along strike are common and faulting and folding is locally complex.

Four sub-units are recognizable:--

Sub-unit 1A is a grey, massive to well bedded, fossiliferous, silty limestone up to 60 feet in thickness. This unit is locally highly fractured and folded especially in proximity to the volcanic - sedimentary contact. The Fossil 1 and Linda copper showings are located in the volcanic rocks structurally below the limestone unit.

Sub-unit 1B overlies unit 1A and consists of argillite together with minor shale, chert and limestone. These rocks are complexly fractured and drag folded. The contact with sub-unit 1A dips southerly at angles of up to 40°.

Sub-unit 1C overlies the argillite (1B) and consists of a thin bed of grey coral limestone. It is a distinctive marker - horizon.

Sub-unit 1D succeeds the coral limestone and is a brown-weathering chert-pebble conglomerate. It is in contact with the Mush Lake Group of Triassic volcanics. The trace of the contact between this sub-unit and the volcanics suggests a shallow dip to the north of approximately 20°.

Unit 2 (Andesitic, Mush Lake Volcanics, Triassic)

This unit contains all of the larger copper occurrences. The volcanic rocks are predominantly andesitic, consisting of red to green weathering tuffs and flows. Porphyritic, aphanitic and amygdaloidal types are represented. Bedding structures are poorly preserved and the unit is strongly sheared and chloritized. Sheared, amygdaloidal volcanics are commonly present in areas of higher grade mineralization.

Sub-unit 2A is a massive, dark grey-green, porphyritic andesitic tuff which contains sparsely disseminated native copper.

Unit 3 (Bedded andesite - basalt, Mush Lake Volcanics, Triassic)

The rocks within this unit include dark green to purple, porphyritic, massive and amygdaloidal andesites and basalts. Individual massive units occur up to 100 feet in thickness. Calcite and zeolites are common amygdular fillings, and quartz and epidote are common as fracture fillings. Native copper and malachite occur associated with the amygdular fillings and quartz epidote veins in sub-unit 3A.

Unit 4 (Sedimentary unit within Mush Lake Volcanics)

This unit consists of a thin band of sedimentary

rocks occurring in partial fault contact with 3A. It is highly folded and steeply dipping, and consists of interbedded argillite, chert, shale and grey crinoidal limestone.

Unit 5 (5A) (Andesite tuff and agglomerate, Mush Lake Volcanics, Triassic)

Unit 5 is very similar to 2. It is a relatively massive, green to purple andesite tuff. Green chloritized fragments occur as inclusions.

Sub-unit 5A is a reddish coloured agglomerate with large basaltic inclusions.

Unit 6 (Gabbro Intrusive)

This unit is intruded as a sill between the sedimentary unit 4 and volcanic unit 5. This sill is a dark green, massive, fine to coarse-grained gabbro. Phenocrysts of pyroxene are prominent.

Unit 7 (Norite Intrusive)

Unit 7 occurs as sills within the sedimentary unit 1. Porphyritic orthopyroxene is recognizable in the brown weathering rock which approaches noritic composition. These intrusives are believed to be of early Triassic age.

Structure

The structural setting of the Ram Creek area and the possible thrust relationship between the Mush Lake volcanics and the Cache Creek sediments have been discussed.

Minor folding is prevalent in the two sedimentary rock units 4 and 1. The axes of these folds parallel the major trends and follow a west-north-west direction with a general easterly plunge of less than 10^{o}. In the vicinity of the Fossil 1 and Linda showings, the limestone is draped over the volcanics in an intermediate sized open anticlinal structure. Folding within the volcanic rocks is not readily recognizable because of the monotonous nature of the succession and lack of marker horizons.

High angle faulting within the Ram Creek area also reflects the regional trend. West-north-west faults and shears are vertical to steeply northerly dipping and are readily recognizable when they displace both volcanic and sedimentary rocks north of the Linda showing and south of the Fossil 1 showing. An important steeply dipping structure is also mappable through the Hudson Bay showing and a parallel structure may be localizing the Ram showing. It is very likely that structures other than those mapped do occur in the featureless volcanics.

Cross faults, trending northerly to northwesterly are also quite prominent. The trace of these structures to the west and northwest of the Ram showing and east of the Fossil 1 showing indicate near vertical or high easterly dips. All are believed to be normal faults.

MINERALIZATION

Mineral occurrences within the map area all occur within volcanic rocks and consist primarily of copper minerals. Pyrite is extremely rare and essentially absent in the majority of the showings. Chalcocite is the most important sulphide and is accompanied by relatively small amounts of bornite and, very locally, minor chalcopyrite. Native copper occurs in fine disseminations. Oxide minerals include malachite, azurite and cuprite. This mineral suite represents a high copper, low iron, low sulphur geochemical assemblage and in this respect resembles other mineral provinces in N. W. T. and Michigan where copper also occurs in andesitic to basaltic volcanic sequences. The close association of copper mineralization with the Mush Lake volcanic rocks suggests a syngenetic origin. Regional metamorphism, tectonic activity, igneous intrusion and hydrothermal activity have very likely caused redistribution of the copper to produce the majority of the better showings throughout the volcanic assemblage.

Four types of copper occurrences are recognizable:-

1. Copper occurring as dispersed chalcocite in amygdules in andesites in association with quartz, calcite and zeolites. (Units 2 and 3A).

2. Native copper occurring in massive andesites as fine grained specks and fibres. These occurrences are prevalent in unit 2A.

3. Copper occurrences associated with quartz, calcite and epidote veining and alteration in shear zones and amygdaloidal volcanic units (Unit 3A). These occurrences ordinarily contain native copper, chalcocite, malachite and in some instances chalcopyrite, cuprite, bornite and azurite. These are the commonest occurrences in the area but are very limited in extent.

4. Occurrences which illustrate many of the features of all the types of mineralization described above and, in addition, are associated with chloritic and serpentine alteration in crumpled andesitic tuffs and amygdaloidal andesites. They exhibit some form of structural or stratigraphical control and include all occurrences of importance in the area. Common copper minerals include chalcocite in a fine-grained "sooty" form, and, less frequently, as veinlets, minor bornite and minor chalcopyrite. Malachite is a common oxide mineral.

The five major copper occurrences in the Quill Creek area, the Ram, Hudson Bay, Linda, Fossil 1 and Fossil 2 showings fall into category 4. All other occurrences are either small or extremely widely dispersed and of no economic significance.

Ram Showing

The Ram mineralization was discovered by P. Versluce and associates in poor exposures in the basin of Ram Creek. Some hand trenching was carried out on the showing in 1965 and 1966 and this was followed by bulldozer trenching. The majority of the bulldozer work was completed in the 1967 season and the distribution of the trenches is shown in Figs. 3 and 4.

The mineralization occurs in chloritic, slightly serpentinized amygdaloidal volcanics and is probably located along a zone of shearing parallel to one of the major structural trends in the area. Sulphides present are predominantly chalcocite with some bornite and chalcopyrite. Malachite is a common secondary oxide mineral occurring with minor cuprite. Disseminated pyrite is present along the northern border of the richest copper zone in Trench #1. The better grade copper mineralization is located in disturbed volcanics but minor disseminated bornite is present in more massive volcanics exposed elsewhere in the trenches.

The assay plan (Fig. 4) indicates that, in subsurface outcrop, the mineralization is irregular in width and grade, although continuity is indicated over a distance of 1,000 feet and possibly 1,600 feet.

Diamond drill hole Q-1 was drilled at -45° on a bearing S 15° W for 196 feet. The purpose of this hole was to intersect the Ram showing at depth. Two mineralized zones were intersected averaging 0.30% Cu between 59 and 78 feet and 0.89% Cu between 161 and 169 feet. The deeper zone is tentatively correlated with 10 feet of 0.92% Cu present in Trench #4 indicating a 68° N dip to mineralized zone. The detailed log of this hole is included with this report and a section through the drill hole is shown in Fig. 5.

Linda Showing

The Linda showing is located at a high elevation on M. C. Jay 12 (Fig. 3). Copper mineralization occurs in volcanics immediately below the possible thrust contact with Cache Creek sediments. The mineralization resembles that described in the Ram showing. Sampling has proved that the copper has a patchy distribution. (Fig. 6). A steeply dipping west-north-west foliation is prominent in the andesites containing the mineralization. Foliation or faulting paralleling this direction is present in all mineralized areas, and is believed to be an important localizing control.

Fossil No. 1 Showing

The Fossil No. 1 showing is located approximately 1,600 feet west of the Linda showing in a similar geologic and topographic situation. Steep slopes and abundant scree necessitated hand trenching of this showing and the copper content of samples from these trenches and from available outcrops are shown in Fig. 7. Best sections of continuous mineralization averaged 1.80% Cu over 20 feet and 0.80% Cu over 85 feet. Generally the mineralization is irregularly distributed within a zone 450 feet by 100 feet within a short distance of the tectonic contact between sediments and volcanics. Mineralization is restricted to the volcanics and does not extend to the actual contact. A high angle fault has been traced over a section of this contact and parallel shearing within the mineralized zone is believed to be the most important feature localizing the copper. Flat-lying structures paralleling the possible thrust plane may have influenced the location of the mineralization, although the steeply dipping structures are more dominant.

Fossil No. 2 Showing

This showing is relatively small and again lies close to a steeply-dipping tectonic contact between sediments and volcanics. Because of the small size of this zone (120' X 40') only a limited amount of bulldozer trenching was done in the area (Fig. 3). The mineralization is located entirely in volcanics and once again believed controlled by high angle west-north-west faulting. The most significant sulphide is chalcocite with associated malachite and minor cuprite.

A diamond drill hole was collared in limestone between the Fossil No. 1 and Fossil No. 2 showings to probe the volcanics lying beneath the possible thrust plane immediately west of the No. 1 showing. Considerable difficulty was experienced with this drilling. Three holes were attempted but each had to be abandoned before the objective was reached. The deepest hole extended to 191 feet below the collar (Fig. 8). Core recovery was very poor because of the broken nature of the ground. The general geology encountered in the holes is shown in Fig. 8.

Hudson Bay Showing

The details of the drill programme conducted by Hudson Bay Mining on this showing were not made available to Newmont. It is believed that at least two holes were collared on the north side of the exposed mineralization and drilled at -60° or -45° to the south or southwest.

Geological mapping has indicated the showing strikes parallel to the main tectonic direction and is located along a fault. The same fault may be continuous eastwards through to Trench No. 8 where copper mineralization is present adjacent a parallel fault. A sample taken along the strike of the Hudson Bay Showing assayed 2.02% Cu over a distance of 132 feet. The geology and mineralogy of the zone closely resembles that of the Ram showing.

The copper mineralization in all the showings described is extremely variable in grade and erratically distributed. High grade sections are small in size and the showings have no indicated economic potential. Similar mineralized bodies may occur in the area, although the likelihood that they are any larger and more extensive than the ones described is small. There is no evidence of mineralization in the limestones within the mapped area.

GEOCHEMICAL SURVEY

A geochemical stream sediment sampling programme was completed over the whole area of the Quill Creek Mines claims. The samples were analysed for total copper and total nickel and the results are shown in Figs. 9 and 10.

The Kluane Range environment is characterized by strong relief, low rainfall, a limited stream water flow and a relatively high pH of 7.5 to 8.0. These conditions tend to restrict the mobility of nickel and copper in the secondary environment and increasing dilution becomes more important with increasing relief. The absence of appreciable iron sulphides with the relatively high grade chalcocite-bornite mineralization also tends to restrict the dispersion of copper in solution because no local acidic conditions are generated during the oxidation of this mineralization which would promote the formation of the copper ion. Consequently, the four factors of topography, low rainfall, high pH and lack of sufficient iron sulphides in association with the chalcocite-bornite will combine to produce limited copper dispersion and low contrast anomalies.

Careful sampling in the vicinity of known showings indicated that values in excess of 90 ppm Cu were significant. Average background values in areas of basic volcanic host rocks varied between 45 and 85 ppm. The highest copper value detected in the vicinity of the Quill Creek showings is 400 ppm.

In contrast, geochemical anomalies derived from oxidizing copper-nickel mineralization on the Linda claims are very pronounced. This is because of the presence of oxidizing pyrrhotite which generates acidic conditions favouring the stability of copper and nickel ions in solution. Nickel and copper values in stream sediments in the vicinity of copper-nickel sulphide occurrences in the Linda basin generally exceed 400 ppm.

In order to obtain detailed information on the distribution of copper over the Quill Creek claims, samples of active stream sediment were collected at 500 and 1,000 feet intervals.

Numerous anomalous zones were indicated by this survey. (See Figs. 9 and 10). Several of these zones are correlatable with mineralized zones already described:-

A -- Ram Showing
B -- Fossil 1 Showing
C -- Linda Showing
D -- Fossil 2 Showing
E -- Hudson Bay Showing

Anomalous values in the Ram Creek tributary immediately east of the Ram Showing reflect mineralization exposed in Trench #8. Malachite float in the creek bed of the neighbouring anomalous tributary of Tatamagouche Creek indicates that this mineralization is continuous eastwards.

The anomalous values in tributaries of Fossil 2 Creek (Area G) are related to copper-bearing calcite stringers containing chalcocite, native copper, bornite, chalcopyrite and malachite. The stringers are small, widely scattered and less than 3 inches in width.

Area H is coincident with the easterly extension of unit 3A in the area of detailed geological mapping. Copper minerals associated with calcite and epidote are present in this unit but occurrences are small and widely scattered.

Area I is underlain by volcanics containing at least two limestone bands. Chalcopyrite in small amounts, associated with calcite and epidote is present in volcanics near, but not adjacent, the limestones. A high grade showing 5 feet wide and 20 feet long occurs on strike to the east of the highest copper value in this area, containing massive bornite, chalcocite and chalcopyrite.

Area J is covered by the Mary claims. A high grade bornite occurrence is correlatable with the very high copper value in this area. The bornite is restricted to an 18 inch silicified zone in volcanics and assays up to 33% copper have been recorded (Muller 1967).

Area K lies to the west of Area I. Minor chalcopyrite and malachite is present in fracture fillings and along slip planes associated with calcite and epidote. The host rocks are chloritized volcanics. Mineralized occurrences are small and very sporadic.

Area L is in the headwaters of the Shakwak drainage. The rocks within this basin include Mush Lake volcanics, Permian shales and limestones and intrusive peridotites. A reconnaissance examination of this area identified malachite in sheared volcanics in the extreme headwaters associated with some pyrite. Minor pyrrhotite was also noted in outcrops of peridotite. This amount of mineralization is sufficient to explain the anomalous conditions in this area.

Area M is on a low divide between Fossil 1 and Linda Creeks. The distribution of values indicates the mineralized source is of limited extent. Some malachite associated with volcanics was noted in the anomalous drainage.

Areas N and F are distinctly anomalous for both copper and nickel. The easterly continuation of the Nickel Creek peridotite body extends through this area and Hudson Bay Mining completed some diamond drilling in Area F. Nickel and copper sulphides were encountered in a shear zone adjacent the peridotite body but the mineralization was dismissed as being too small. To the east, peridotite can be traced over the divide separating Linda Creek from the Shakwak drainages. In this region, the peridotite body splits up into a series of steeply dipping dykes varying in strike from due easterly to north-easterly. Pyrrhotite is present in the peridotite dykes but generally constitutes much less than 1% of the rock. Near location N, the most southerly dyke has an easterly strike. Fine disseminated chalcopyrite is present in sheared sericitic sediments adjacent the contact and the total sulphide content (pyrrhotite and chalcopyrite) within the intrusive locally exceeds 2% by volume.

The nickel content of the stream sediments in the Linda Creek area is contributed by weathering sulphides and by silicate minerals.

Area O on the south slope of the Quill Creek valley is characterized by widespread, mildly anomalous copper values. A large section of this area is covered by the Vug claims. Mineralization occurs along fractures in Mush Lake volcanics and chalcopyrite is the most prominent sulphide mineral. These occurrences are small and of no economic significance.

The block of Kew claims was staked in high country (Area P), six miles west-north-west of the Ram Basin. Mineral showings were discovered in this area by Mr. H. Versluce and examined by J. H. Tremblay.

Chalcocite and native copper occur in very small mineralized pockets in quartz-calcite veins along the crest of a cirque near the centre of the claim block. The country rock in this area is an andesitic crystal tuff containing distinctive patches of volcanic glass. One 12 inch vein with chalcopyrite in a quartz-barite vein was also noted in the same area. This mineralization, again, is minor. Malachite-bearing quartz-calcite float is present in scree near the western margins of the claim block. No mineralization was found in place, but the fragments resemble the scattered mineralization noted elsewhere in the general area.

There is a good correlation between the distribution of known mineralization and the mildly anomalous geochemical values.

The most important anomalous zones have been described. Additional anomalous values for copper and nickel do occur, but the majority are singular occurrences, and, after comparison with other anomalous areas, obviously do not indicate any mineralization of major significance. In the Tatamagouche drainages in particular, the geochemical samplers noted several isolated occurrences of malachite-bearing float and small areas of copper staining in areas of outcrop. Such occurrences could readily explain the geochemical patterns detected.

AIRBORNE MAGNETIC SURVEY

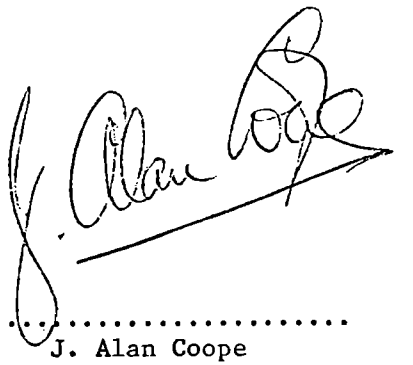
The airborne survey was conducted using the Newmont instrument mounted in a G3-B1 helicopter. The results and interpretation of this survey by W. M. Dolan are shown in Fig. 11 and 12. Dolan's notes on this interpretation are as follows:-

"Generally, an attempt has been made to accommodate the magnetically expressed features with Muller's geologic mapping (G. S. C. map 1177 A). However, in view of the fact that the volcanics and sediments exhibit little or no magnetic expression, the effort of correlating with geology has been largely confined to the igneous features.

A deep seated (> 2000') acid stock, about 2½ miles in diameter, is suggested to occur in the approximate center of the area.

Crudely satellitic about the suspected stock are a series of basic and ultrabasic plugs. In no instance do they appear to be dike-like as suggested by the geologic mapping. Note, however, that extremely narrow dikes (less than 50') are not likely to be reflected on the airborne magnetometer.

A number of contacts are deduced by low level magnetic variations, but only those having an apparent igneous association are tentatively identified."



J. Alan Coope

QUILL CREEK MINES LIMITED

)ND DRILL HOLE RECORD

DDH Q-1

DIP TEST		
FOOTAGE	ANGLE RECORDING	ANGLE CORRECTED

LEVEL	
LOCATION	Ram #1
ELEVATION	
LATITUDE	
DEPARTURE	
HORIZONTAL COMPONENT	
VERTICAL COMPONENT	
BEARING	195° -45°
LENGTH	196'
DATE FINISHED	July 31, 1967
HOLE No.	DH-Q-1
SHEET No.	
LOGGED BY	
PURPOSE	
TOT. RECOVERY	41%

GRAPHIC LOG	FOOTAGE FROM	FOOTAGE TO	EST. SUL. PHIDE	ROCK TYPE	DESCRIPTION	ASSAYS SAMPLE No.	FROM	TO	Length	Cu %	RECOVERY	SHORT
	0	18		Andesite	Bx casing - 25% core recovery. Andesite tuff, fine grained ground mass with feldspar and minor quartz phenocrysts							
	18	35		Andesite	Ax casing (28') - 70% core recovery, andesite tuff, grey-green, fine grained ground mass with chlorite fragments and chlorite -- calcite amygdular fillings. General shearing prominent occurring at 35 - 70° to the core axis.							
	35	54		Fault	AQ - WL - 5% core recovery. Fault zone - andesite tuff, fine grained porphyritic as above (18 - 35')							
	54	59		Andesite	AQ - WL - 60% core recovery. Andesite tuff as in 18 - 35'	C 0401	54	59	5.0'	.06		
	59	68		Andesite	AQ - WL - 59 - 63 95% core recovery, 63 - 68 68% core recovery. Mineralized andesite tuff - 59 - 63 massive grey - green fine grained to porphyritic. Good sulphide mineralization occurs in this section as chalcopyrite, bornite, minor cuprite and malachite. 63 - 68 as above with minor chalcocite - malachite mineralization.	C 0402 C 0403	59 63	63 73	4.0' 10.0'	.27 .31		
	68	78			AQ - WL - 50% core recovery. Mineralized andesite tuff light to dark green, fine grained to porphyritic. Copper mineralization includes chalcocite, bornite and malachite. Best mineralization occurs from 73 - 78'.	C 0404	73	78	5.0'	.31		

ND DRILL HOLE RECORD

DIP TEST		
FOOTAGE	ANGLE RECORDING	ANGLE CORRECTED

LEVEL		HORIZONTAL COMPONENT	HOLE No. DH - Q - 1
LOCATION	Ram Showing	VERTICAL COMPONENT	SHEET No. 2
ELEVATION		BEARING 195° -45°	LOGGED BY H. Tremblay
LATITUDE		LENGTH 196'	PURPOSE
DEPARTURE		DATE FINISHED July 31, 1967	TOT. RECOVERY 40%

GRAPHIC LOG	FOOTAGE FROM	FOOTAGE TO	EST. SULPHIDE	ROCK TYPE	DESCRIPTION	ASSAYS SAMPLE NO.	FROM		Length	Cu %	RECOVERY	SHORT
	78	90		Andesite	AQ - WL - 45% core recovery. Andesite tuff as above containing malachite along shear planes in section 79 - 80'	C 0405	78	88	10'	.05		
	90	114		Andesite	AQ - WL - 40% core recovery. Shear zone - silicified, brecciated, mylonitized andesite tuff which has been chloritized and epidotized.							
	114	161		Andesite	AQ - WL - 114 - 128 60% core recovery 128 - 130 nil in mud 130 - 143 - 45%, 143 - 150 - 60% 150 - 161 - 35%. Andesite tuff - grey-green, fine grained to porphyritic with minor <1% pyrite occurring in sections	C 0406	151	161	10'	.03		
	161	169		Andesite	AQ - WL - 161 - 165 80% core recovery, 165 - 169 - 40% core recovery. Andesite - porphyritic to fine grained grey-green, sheared containing chalcocite, cuprite and malachite mineralization.	C 0407	161	169	8'	.89		
	169	179		Andesite	AQ - WL - 40% core recovery. Andesite tuff - grey-green sheared porphyritic with rounded quartz phenocrysts Minor chalcopyrite occurs with the quartz in this section.	C 0408	169	179	10'	.01		
	179	196		Andesite	AQ - WL - 179 - 184 - 50% core recovery. 184 - 196 nil in mud. Shear zone - light to dark green sheared brecciated. Very minor chalcopyrite occurs in zone 179 - 184'							

[illegible] CREEK [illegible] LIMITED

DRILL [illegible]

DDH [illegible]

DEPARTURE	
Bearing [illegible]	[illegible] 192 X 245°
Date [illegible]	July 31, 1967
Logged by	[illegible]

Graphic Log	Footage From	Footage To	Core Size	Rock Type	Description	Sample No.	From	To	Length	Cu %
	0	18		Andesite	Bx casing - 25% core recovery. Andesite tuff, fine grained ground mass with feldspar and minor quartz phenocrysts					
	18	35		Andesite	Ax casing (28') - 70% core recovery. Andesite tuff, grey-green, fine grained ground mass with chlorite fragments and chlorite - calcite amygdular fillings General cleavage prominent occurring at 35 - 70° to the core axis.					
	35	54		Fault	AQ - WL - 5% core recovery. Fault zone - andesite tuff, fine grained porphyritic as above (18 - 35')					
	54	59		Andesite	AQ - WL - [illegible]% core recovery. Andesite tuff as in 18 - 35'	[illegible] 0401	54	59	5.0'	.06
	59	68		Andesite	AQ - WL - 59 - 63 95% core recovery, [illegible] - 68 68% core recovery. Mineralized andesite tuff - 59 - 63 massive grey - green, fine grained to porphyritic. Good sulphide mineralization occurs [illegible] section as chalcocite, bornite, [illegible] and malachite. [illegible] - [illegible] with minor chalcocite [illegible] malachite mineralization.	[illegible] 0402	59	63	[illegible]	.27
						[illegible] 0403	63	73	10.0'	.31
	68	78			AQ - WL - 50% core recovery. Mineralized andesite tuff light to dark green, fine grained to porphyritic. Copper mineralization includes chalcocite, bornite and malachite. Best mineralization occurs from [illegible] - 70'.	[illegible] 0404	73	78	5.0'	.31

DRILL HOLE RECORD

DIP TEST			LEVEL	HORIZONTAL COMPONENT	HOLE NO. DH - Q - 1
FOOTAGE	AZIMUTH RECORDING	AZIMUTH CORR.	LOCATION Ram Showing	VERTICAL COMPONENT	SHEET NO. 2
			ELEVATION	BEARING 195° -45°	LOGGED BY H. Tremblay
			LATITUDE	LENGTH 196'	PURPOSE
			DEPARTURE	DATE FINISHED July 31, 1967	TOT. RECOVERY 40%

GRAPHIC LOG	FOOTAGE FROM	FOOTAGE TO	EST. GOLD PRICE	ROCK TYPE	DESCRIPTION	ASSAYS SAMPLE NO.	FROM	TO	Length	Cu %	RECOVERY RUN	RECOVERY SHORT
	78	90		Andesite	AQ - WL - 45% core recovery. Andesite tuff as above containing malachite along shear planes in section 79 - 80'	C 0405	78	88	10'	.05		
	90	114		Andesite	AQ - WL - 40% core recovery. Shear zone - silicified, brecciated, mylonitized andesite tuff which has been chloritized and epidotized.							
	114	161		Andesite	AQ - WL - 114 - 128 60% core recovery 128 - 130 nil in mud 130 - 143 - 45%, 143 - 150 - 60% 150 - 161 - 35%. Andesite tuff - grey-green, fine grained to porphyritic with minor <1% pyrite occurring in sections	C 0406	151	161	10'	.03		
	161	169		Andesite	AQ - WL - 161 - 165 80% core recovery, 165 - 169 - 40% core recovery. Andesite - porphyritic to fine grained grey-green sheared containing chalcocite, cuprite and malachite mineralization.	C 0407	161	169	8'	.89		
	169	179		Andesite	AQ - WL - 40% core recovery. Andesite tuff - grey-green sheared porphyritic with rounded quartz phenocrysts Minor chalcopyrite occurs with the quartz in this section.	C 0408	169	179	10'	.01		
	179	196		Andesite	AQ - WL - 179 - 184 - 50% core recovery. 184 - 196 nil in mud. Shear zone - light to dark green sheared brecciated. Very minor chalcopyrite occurs in zone 179 - 184'							