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EXPLORATION REPORT

GEOLOGICAL INVESTIGATIONS

in the

QUEENSTOWN AREA

MICROFILMED

H.D.SMITH

November 1967

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INTRODUCTION

The following report is to outline work done and the results obtained during a mineral exploration survey of the Queenstown area, 1966-67.

A brief account is given of past mining history and the present production of the Mt. Lyell Mines. The geology of mineralization of the ore bodies at Mt. Lyell is outlined in brief.

Reconnaissance stream sediment sampling and geology of the Queenstown area (40 square miles) are given in detail.

Detailed work carried out on each of the four grid systems, established to follow-up reconnaissance survey results, is then outlined.

MINING HISTORY OF THE QUEENSTOWN AREA

Gold prospectors discovered gold in a hematite limonite ore body at the head of Linda Valley in 1885. It was realized in 1891 that this iron-gold mass was a capping to a rich copper ore body (The Iron Blow) and the "copper boom" of the Lyell Mining field began.

Although numerous small mining ventures began in the "copper rush" it was soon realized that to be economical, a large-scale mining concern was a necessity. Two large companies with dominantly British financial backing took over. These were the North Lyell and Mt.Lyell companies. The Mt. Lyell Co. established a smelter at Queenstown and railed the copper matte to the port of Strahan via its own private railway. The North Lyell Co. railed its ore via the King River Valley to Crotty where it was smelted. The copper matte was then railed to the port at Kelly's Basin.

The North Lyell Mining Co. however, after many attempts found that successful and profitable copper smelting was beyond its reach. Due to the heavy financial losses incurred and poor management they agreed to amalgamate with the Mt. Lyell Mines and the present company - Mt. Lyell Mining and Railway Company was established to control the whole of the Lyell copper field.

When the "Blow" closed down early in the 20th century due to depletion of ore, the North Lyell underground and open cut mine became the sole major producer. Early in the 1930's the Lyell Comstock, Crown Lyell, and Royal Tharsis Mines (which had been discovered earlier) were developed to augment production from North Lyell.

The first ore from the West Lyell open cut was mined in 1935. Within a few years it became the major copper producer.

During the second World War, Lyell Comstock, and Crown Lyell Mines closed down because of depletion of ore and labor shortages. The Royal Tharsis Mine closed down in 1954.

Underground mining resumed in 1959 in the Crown Lyell Mine and has been gradually expanding since. This high grade ore body (up to 25% Cu) has a high silica content and is mined at a rate to balance smelter flux requirements.

PRODUCTION

For year ended 31st December 1966:

Overburden removed	2,247,327 tons
Ore mined	2,159,453 "
(West Lyell - Razorback Open Cut 2,132,067 tons)	
(Crown Lyell Underground 23,736 tons)	
Copper produced	13,945 tons
Silver produced	49,877 ozs.
Gold produced	8,307 ozs.
Pyrite concentrate	68,077 tons
Total value of production	$13,748,053

From inception to 31st December 1966:

Copper	609,474 tons
Silver	16,190,537 ozs.
Gold	620,066 ozs.

West Lyell open cut has accounted for 77% of the total ore mined since inception.

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RESERVES:

Ore reserves at 30th June 1966, totalled 19,085,000 tons assaying 0.99% Cu, 0.177 oz/ton Ag, and 0.018 dwt/ton Au. Of this total, West Lyell Open Cut accounted for 11.9 million tons averaging 0.78% Cu.

Drilling during recent years has indicated the existence of 40-45 million tons of ore containing 1% Cu to a depth of 1250 feet below the present open cut bottom.

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MT. LYELL ORE BODIES

The following is a summary of Dr. Michael Solomon's (former Mt. Lyell Co. geologist) opinions on Lyell mineralization.

The Lyell ore bodies are classified as being not obviously related to intrusive rocks, but within volcanics (also true of the Rosebery and Hercules ore bodies). The host rock to the Lyell ore bodies are the Lyell Schists. They are a group of chlorite-sericite-quartz rocks occupying an aureole of hydrothermal alteration.

The Lyell deposits show many of the characteristics of hydrothermal alteration associated with the disseminated sulphide ore deposits of porphyry copper type.

The richest ore shoots occur where the principal E-W faults cross the N-S Great Lyell Fault Zone close to the Ordovician Conglomerate contact. Chief ot these ore bodies are -

(a) Crown - North Lyell

(b) The Blow

<u>North Lyell and Crown</u> ore bodies are a series of irregularly shaped, lenticular or pipe-like masses of chalcopyrite and bornite in gangue which may be schist, quartzite or chert. Cu content is as high as 25%

<u>The Blow</u> ore body was a banana-shaped lens of pyrite with chalcopyrite in a sericitic schist gangue. The famous Mt. Lyell bonanza which began the "copper boom" in 1891 occurred in the upper levels only. This was of 840 tons and assayed 21% Cu and 1,023 ozs/ton Ag. It contained stromeyerite, bornite and chalcopyrite. The bulk of the ore assayed approximately 1% Cu with minor gold and silver.

The remaining ore bodies occur at distances from the conglomerate up to 200 feet and average 2-3% Cu and are steeply pitching in the plane of schistosity. (e.g. Royal Tharsis and Lyell Comstock).

Those further out, such as West Lyell and Prince Lyell ore bodies are larger but of much lower grade (0.5 - 1% Cu) and represent local enrichments within the mineralized schists. These enriched shoots are elongated (in plan) along the schistosity and pitch steeply.

Solomon divides Mt. Lyell mineralization into four types -

A. Massive pyrite - chalcopyrite ores up to 1.25% Cu (Blow, South Lyell, and the Eastern orebody)

B. Disseminated pyrite-chalcopyrite ores with a higher maximum Cu content (West Lyell, Prince Lyell, Comstock)

C. Chalcopyrite-bornite ores with high Cu content (North Lyell)

D. Banded pyrite-sphalerite-galena lodes (Tasman and Crown Lyell)

Type "A" consist of massive pyrite-chalcopyrite ores containing up to 90% pyrite and nil to 1.25% Cu. This ore was previously mined as a flux at South Lyell and Eastern orebodies.

Type "B" seldom contain more than 35% sulphide minerals. They are of larger size and further from the conglomerate - schist contact, with Cu content an inverse function of the distance from the contact. The ore bodies are lenticular in plan and elongate roughly parallel to the cleavage but persist in depth for considerable distances, pitching steeply and tending to dip slightly more steeply than the cleavage; as a result they approach the contact in depth. As one ore body dies out in depth, an ore body develops en echelon further from the contact. 98% of the ore minerals are pyrite and chalcopyrite.

Mineralization has been proved to a vertical extent of over 2,300 feet below the West Lyell open cut without loss in grade.

The Royal Tharsis ore body, closer to the contact, is a fairly well-defined lens of similar type and form to the West Lyell and Prince

Lyell ore bodies though carrying 1.6% - 2.0% Cu.

The Comstock ore bodies are rich in chalcopyrite relative to pyrite, are close to the contact and contain bornite. They are therefore transitional to the bornite-chalcopyrite group.

Type "C" These bornite-chalcopyrite ores only occur significantly in the North Lyell area, which has yielded 5 million tons of ore averaging 5% Cu, 1.12 oz/ton Ag, 0.013 oz/ton Au. The ore bodies occur as irregular pipes pods or lenses that are near to and parallel to the Conglomerate-Schist contact.

Type "D" An argentiferous galena-sphalerite-pyrite-chalcopyrite-tetrahedrite lode occurs in schists east of Comstock in the Tasman and Crown Lyell workings. It is similar to the ore of the Rosebery and Hercules Mines.

ZONING:

A poorly defined zoning of sulphide assemblages occurs in the Lyell area. Massive pyrite-rich deposits dominate south of West Lyell open cut, pyrite-chalcopyrite ores dominate the central part of Philosopher's Ridge, while bornite-rich, low-pyrite ores are dominant in the Comstock-North Lyell area. Galena and sphalerite are concentrated near Comstock, at Queenstown and on Little Owen thus forming a sort of peripheral fringe.

QUEENSTOWN DISTRICT

Reconnaissance stream sediment sampling and geological mapping began early in 1966 on approximately 40 square miles of P.M.I. exploration area centred at Queenstown. Detailed investigations followed in those areas where anomalous stream sediment samples were found.

Access to Queenstown is by all weather roads from Burnie (116 miles), Hobart (158 miles) and Launceston (158 miles); by air (thrice weekly service), or sea to Strahan, thence by road to Queenstown (26 miles). Within the area, four-wheel drive tracks give access to some regions.

Rain falls in every month of the year, but is highest in the winter months (May - September). Average rainfall at Queenstown is 105 inches/year but at Lake Margaret Power Station (5 miles north) is over 140 inches/year. The dominant wind directions are north-west and south-west.

The area has a rugged relief, with steep stream valleys and steep mountains. The north-south trending West Coast Range mountains run through the centre of the area with sharp fault-line cliffs accentuated in part by Pleistocene mountain-valley glaciation. The distribution of resistant Ordovician conglomerate helps control the drainage pattern, with the major streams confined to the softer underlying or overlying sediments.

Vegetation in the immediate vicinity of Queenstown is lacking or sparse because of smelter fume poisoning. Lack of vegetation has accentuated erosion. In the deeper valleys away from

Queenstown, thick rain forest predominates; this, together with the rugged relief and swift flowing streams (subject to flash-flooding) makes stream sediment sampling slow and hazardous.

GEOLOGY:

The area consists basically of a north-south trending anticlinorium with resistant Ordovician conglomerate capping the West Coast Range, flanked by less resistant Cambrian volcanics and Siluro-Devonian sediments. These softer, less resistant sediments have been stripped off the higher levels near the fold axis.

Extensive faulting has taken place in two major earth-moving periods (Tyennan - Upper Cambrian, and Tabberabberan - Middle-Upper Devonian) to produce north-south, NW-SE, and E-W trends. These have greatly modified the physiography and may also partly control mineralization in the area. The steep east slopes of Mt. Owen and Mt. Sedgwick owe their origin to strong faulting with follow-up glaciation. The broad, open valleys of Linda and Comstock (later modified by glacial erosion) result from strong E-W faulting.

The NNW - SSE trending Great Lyell fault zone is a series of subparallel faults of thrust or reverse type with displacements up to 300 feet and probably of the dip-slip type. The Cambro-Ordovician contact in this area is part of this fault zone. Some of the Cambrian Ordovician sequence has been completely inverted.

Cambrian Volcanics

These consist of an interbedded sequence of lavas, tuffs, and agglomerates with shales and greywackes. Low grade metamorphism and metasomatism has resulted in the development of chlorite sericite schists with/without feldspar and/or quartz.

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As it has proved impossible to trace any one particular rock unit across the metamorphic aureole of hydrothermal alteration of the schists, the original nature of most of the schists can only be surmised. Past workers have had widely differing views on the origin of these schists, but they probably developed from tuffs, lavas and greywackes. (See Roaring Meg Section)

Some of the marginal schists developed by disruption and replacement of quartz-feldspar porphyries by sericite, chlorite, and carbonates, i.e. typical propylitic alteration.

Lavas are typically spilitic. Some may be shallow intrusives. Feldspar and feldspar-pyroxene porphyries (described in the Roaring Meg Section) outcrop in the East and West Queen river area north to Mt. Sedgwick and also at Roaring Meg and Lynch Creek. It has not been possible to determine whether they are extrusive or shallow hypabyssal.

Most of the tuffs, agglomerates and lavas have been subjected to some degree of shearing and metasomatism.

Ordovician Sediments

(i) Owen Conglomerate

This formation is almost entirely siliceous and is composed either of quartz pebble conglomerates or sandstones derived mainly from Precambrian rock. There is a marked decrease in grainsize upwards through the succession, the upper beds being mainly sandstones and sandy shales and much greater in extent than the underlying conglomeratic members. Hematitic sands are common throughout giving the rock a pinkish colour. It is resistant to erosion and caps the mountains of the West Coast Range.

(ii) Gordon Limestone

This formation outcrops in a thin band along the Queen and King River Valleys (and is responsible for the broad, flat nature of these). It varies from dark grey limestone to dark shales with limestone lenses. Shaley zones weather to a blue-black "pug" or clay. The limestone weathers more rapidly than contiguous formations and hence tends to occur in swampy valley floors.

Siluro-Devonian Sediments

These consist of alternating quartz sandstones and quartz shales (Eldon Group of Western Tasmania). They outcrop in synclinal basins on either side of the anticlinorium.

The Bell Shales (Devonian) in the Bull Rivulet region are pyritic, and where the water-table reaches the surface, limonitic gossan formations may occur. Gold mineralization occurs in quartz veins associated with Florence Quartzites (Upper Silurian) at the southern end of theAirport Prospect.

Permian Tillite

The only deposit of this age in the Queenstown area is a tillite on Mt. Sedgwick.

Jurassic Dolerite

A remnant of a dolerite sill caps Mt. Sedgwick.

Pleistocene Glacial Deposits

Moraines, cirques, and U-shaped valleys testify to Pleistocene glaciation. These are particularly noticeable near Mts. Sedgwick, Lyell, and Owen. Thick moraines occur West of Lake Margaret (Yolande Moraine), south of Mt. Sedgwick and south of Mt. Lyell.

STREAM SEDIMENT SAMPLING

The original reconnaissance stream sediment sampling program was followed up, from July to October 1967, by a detailed program where all streams regardless of size were sampled - generally along the Cambrian Ordovician contact. On the Roaring Meg grid, every stream north of the baseline was sampled where it was cut by a grid line.

Reconnaissance geological mapping was completed along with the stream sediment sampling.

RESULTS OF STREAM SEDIMENT SAMPLING AND RECOMMENDATIONS

High metal values in stream sediment within 2 - 3 miles of Queenstown can best be discarded because of possible smelter contamination. Other exploration methods should be used for these areas - preferably geophysical.

Isolated samples throughout the area give high values for one or more metals and these should be re-checked before any further recommendations are made.

Apart from the present grid systems which have been checked out, anomalous areas occur at -

a. Princess River

b. Far north of East and West Queen Rivers

c. Streams to West of Huxley - Owen divide.

These areas are considered to be too distant to be affected by smelter contamination.

Princess River Area

The northern part of this river system is consistently high for Zn (>100 ppm) and reasonably high for Cu.Cx (10-20 ppm) and Cu (25-50 ppm). The area immediately north of the highway over the

Princess River is also high for Cu (50 - 100 ppm) and Zn (100 ppm).

It is recommended that these streams be re-checked and if these high values persist then further work be programmed for this area.

East and West Queen River Area

The area drained by the headwaters of these streams is particularly high for Zn but also reasonably high for Pb,Cu, and Cu.Cx From the attitude of this area to the conglomerate-schist contact and the high stream sediment values obtained, it is recommended that further investigations (preferably geophysical) be carried out.

Huxley - Owen Divide

Streams draining the western valleys of the Huxley - Owen Divide are extremely high for Cu.Cx and Cu, with many high values for Pb and Zn.

It is recommended that the latter two anomalous stream sediment areas be included in the proposed Induced Polarization survey of the conglomerate-schist contact area. If the survey follows the line proposed then no further set-ups would be required.

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ROARING MEG GRID

This grid was established to investigate high copper/lead stream sediment values obtained during earlier reconnaissance traverses. It is situated between Roaring Meg Creek and the Lyell Highway, and between Queenstown township and the south-west slopes of Mt. Owen to the east.

This is the largest grid system in the Queenstown area and consists of 39.6 miles of cut and chained grid lines (400 feet spacing). Detailed geological mapping has been completed over the grid and over 2,100 soil samples taken (mostly at 100' spacing). A detailed stream sediment sampling survey was completed with samples taken whereever a stream crossed a grid line - this resulted in 220 samples.

A ground magnetic survey was completed over lines 800' apart on 80% of the present grid, using a McPhar fluxgate vertical magnetometer. A detailed magnetic survey was recently completed with a new Sharpe magnetometer over the western 40% of the grid.

In-line electromagnetic traverses are complete over the northern section of the grid and part of the southern section. Broad-side electromagnetic traverses have been completed over the western third and eastern third of the grid.

Induced Polarization surveys in 1967 totalled 19,200' of 300' dipole and 800' of 100' dipole along 5 cross lines in the western portion of the grid, north of the base line.

Between February and June 1967, 8 diamond drill holes tot-alling 2683 feet were drilled (2 holes were abandoned before they reached their target depth). These holes were restricted to the north-western section of the grid.

RESULTS OF INVESTIGATIONS

GEOLOGY:

The grid is underlain mainly by the Mt. Read volcanic sequence which strike at 150-160^{o}M and form a series of tight anticlines and synclines. These are faulted against Ordovician conglomerate to the east and north-east, and are overlain by a large area of thick morainal gravels in the north-west.

Cambrian Volcanics

These are a series of tuffs, agglomerates, porphyries, lavas and greywackes. Hydrothermal alteration has resulted in some of these being altered to low grade schists. The tuffs, agglomerates and quartz-feldspar porphyries all display some degree of schistosity and practically all the volcanics have undergone some metasomatic alteration (seritization, chloritization, albitization and silicification).

Schist Facies

These are a group of sericite-chlorite quartz rocks(known locally as the "Lyell Schists"). They outcrop widely at Roaring Meg with every type from a chlorite schist to a sericite schist being present. Their contact with tuffs and quartz-feldspar porphyries is gradational in some areas implying an origin from these parent types.

Past workers have considered the schists as being derived from:

(a) Volcanics and greywackes (Gregory 1905, Solomon 1958,1966)

(b) Intrusive porphyries (Edwards 1939, Alexander 1953)

(c) Metasomatised sediments (including Ordovician conglomerate) (Bradley 1954, 1957)

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Detailed mapping has revealed distinct lithological boundaries and enabled certain textural and compositional rock types to be traced for short distances.

(i) Quartz-Chlorite Schists

These are featureless, dark green rocks in bands up to 20 feet thick. In thin section they display a porphyritic texture due to phenocrysts in a chlorite groundmass containing some sericite. Hematite and magnetite occur as spindles, veinlets and irregular patches. The fragmental texture and embayed quartz crystals suggest that the schists may have been a crystal tuff or greywacke.

(ii) Quartz-Sericite Schists

These occur as thick bands interbedded with the relatively thin quartz-chlorite schists just described. They are much more common than the chloritic schists. They consist of an interlocking quartz mosaic of uneven grainsize. Sericite may be randomly and evenly distributed or may occur in sub-parallel planes which cause the rock to break into augen structures several cm. across. A small amount of chlorite may also occur.

A feature of these schists is the presence of "boulders" and "pebbles" from one cm. to 50 cm. across. They are irregular and sub-angular in shape and consist of quartz with some sericite and chlorite. They probably indicate an agglomeratic origin for this particular schist or they may represent nodular rhyolitic lavas.

Feldspar (albite) occurs in varying amounts in most schists of the area.

Feldspar Pyroxene Porphyry (FPP)

This is a field name given to two large massive masses of igneous rock which on ground magnetic evidence may be continuous at a

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shallow depth. They are a dark green color, weathering to a deep yellow-brown clay soil, up to several feet thick.

Petrographic study shows them to be spilites with a porphyritic texture. The phenocrysts are albite and augite lying in a fine grained leucocratic ground-mass of pyroxene and feldspar. Phenocrysts comprise 30-40% of the rock and are mainly euhedral crystals up to 5 mm in size. Some of the feldspar has been replaced by carbonate and some of the augite has been altered to chlorite and epidote and magnetite. The groundmass also contains varying amounts of actinolite fibres, sphene, pyrite and pyrrhotite with occasional, small irregular areas of quartz, white mica and apatite.

The relationship of this porphyry with the surrounding tuffs and schists is uncertain. The texture and the medium to fine grain size suggest either shallow intrusives or extrusives. Evidence from DDH RM-201 and DDH RM-202 suggests the porphyry has a shallow dip to the south (Fig.   ). This could be a shallow dyke.

Quartz-Feldspar Porphyry (QFP)

This is a spotted pale green rock exhibiting varying degrees of shearing. The phenocrysts (45-50% of the rock) are quartz and plagioclase in a groundmass of sericite and quartz. Quartz is the high temperature variety, up to 8 mm. in size and is typically disrupted into aggregates of angular fragments. Plagioclase grains are up to 5 mm. in size, and where determinations are possible, is albite.

The matrix has a foliation of fine sericite wrapping around the quartz and feldspar grains, with occasional grains of zircon and carbonate.

The rock can best be classified as a sheared quartz-feldspar porphyry (perhaps a quartz keratophyre). Its relationship with the

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surrounding tuffs and schists is in doubt. It could be an altered extrusive or shallow intrusive. The foliation zones have the same strike as the schists and tuffs (315 - 330° T.N.) and no original banding has been detected. From DDH RM-204, the contact (if straight) dips 80°E, that is, it is cut by the foliation.

The contact with the welded tuffs to the north and sub-greywackes to the south is clearly defined. The contact with the schists to the east appears to be gradational and the schists could be more severely altered quartz-feldspar porphyries.

<u>Welded Tuff</u> (TW)

This is a suite of fine grained rocks which in the field have the appearance of grey-yellow siltstones, sandstones, shales and slates. Petrographic analysis shows that they have a micro-schistose texture and are actually sericite schists derived from welded tuffs.

The curved arcuate patterns still persisting, in spite of shearing and recrystallization suggests that the matrix was originally composed of fragments of volcanic glass. The manner in which the patterns interlock and fit together producing an overall streaky appearance or eutaxitic texture infers that the glass fragments welded together and flowed to some extent creating welded tuffs or ignimbrites. They have an acid composition and probably were deposited in a subaerial rather than a subaqueous environment.

The contact of the welded tuffs with the schists and quartz-feldspar prophyry is clearly defined. Bedding in the welded tuffs is parallel to the strike of schistosity in the schists and porphyry.

A typical W-E section across the welded tuff is shown in Fig.

Microscopic examination reveals that the welded tuffs have similar compositions, and differences between types are textural only. They consist of many rock fragments, quartz and altered feldspar grains set in a matrix with a high percentage of sericite.

The rock fragments have fine textures consisting mainly of quartz and sericite whose distribution displays a eutaxitic texture. A few rock fragments contain crystals of quartz and altered plagioclase.

The quartz grains are typically angular and may contain minor inclusions and embayments full of fine grained material.

The feldspar grains are mostly obscured by sericite, but some (and maybe all) is albite.

The matrix is dominated by an alignment of sericite wisps, patches and spindles which wrap around the larger grains and fragments. Finely divided quartz with minor chlorite and carbonate also occurs. Carbonate is also present as discontinuous veins and lenses approximately parallel to the sericite alignment in the matrix.

Metasomatised Tuffs (FA) Agglomerates (V) and Breccias

In the eastern section of the grid are groups of rocks which exhibit various stages of metasomatism and differing degrees of shearing. They all appear to have originated from tuffs or agglomerates and locally they may be very similar to chlorite sericite schists due to the high degree of shearing.

Chloritization and albitization are the two most common forms of metasomatism but chloritization and silicification are also common.

One large band of sheared rock (VP) containing large, pink feldspars may have originated from a feldspar porphyry. It may even be a differentiate of the feldspar-pyroxene porphyry which it comes into contact with to the west (contact is obscured).

South of and just cutting, the base-line between 117E and 135E, are a group of coarse agglomerates (V) containing large angular to rounded pink feldspars and fine-grained leucocratic rock particles. This is fairly massive and only slightly sheared. It is interbedded with fine grained tuffs and siltstones.

In DDH-RM 201, 367' - 607', there occurred a coarse-grained, sheared volcanic breccia. This consists of large angular rock particles (ignimbrite) in a groundmass of quartz, carbonate, feldspar and chlorite. This does not outcrop at the surface but is not dissimilar to the sheared agglomerate (V) further east.

Greywacke

This outcrops in the south-west section of the grid and may be continuous with greywackes at Lynch Creek to the south

It is coherent, fine grained, slightly sheared, grey rock. It consists of a close packed framework of quartz, white mica, plagioclase and chlorite grains, and rock fragments cemented by carbonate. A few grains of tourmaline and pyrite occur. The rock is poorly sorted, and probably a sub-greywacke.

Ordovician Conglomerate

Conglomerates are faulted against Cambrian volcanics on the north-east margin of the grid. Near the Cambrian-Ordovician contact, the conglomerates are highly sheared and sericitized. The exact contact is in places impossible to discern because of their alteration to sericitic schists. At the southern end of Mt. Owen some units are completely upturned.

The formation is almost entirely siliceous and is composed of quartz pebble conglomerates and sandstones derived from Precambrian sources. Hematitic sands are common throughout and much of the cement is hematite, giving the rocks a pink-purple color.

Ordovician Limestone

There is a small patch of limestone forming an anticline with E-W strike, near the NW corner of the grid. The blue-grey fossiliferous limestone is associated with a grey-black "pug" or clay, which was originally a calcareous shale.

Pleistocene Morainal Deposits

During the Pleistocene glaciation, a small tributary glacier pushed its way up Conglomerate Creek. It left a thick deposit ($>$ 100 ft) of coarse conglomerate pebbles and boulders (up to several feet across) in a depression in the NW corner of the grid. The surface of this area is now quite flat - in marked contrast to the surrounding region.

GEOCHEMISTRY

Since soil sampling was begun at Roaring Meg in 1966 several factors affecting metal-in-soil content have been realized.

(a) Variable soil and vegetation cover

(b) Variation in soil depth

(c) Superficial contamination from Mt. Lyell smelters

(d) Varied relief, high rainfall and run-off

Variable soil and vegetation cover

Soils (Fig.) are often secondary or undeveloped. True soils ($<$ 6" deep) are confined to the feldspar-pyroxene porphyry outcrops and to the southern section of the grid. This is caused by two factors.

(i) Lack of vegetation cover over most of the northern grid brought about by sulphur poisoning from the Mt. Lyell smelters has resulted in excessive run-off and accelerated erosion rates. More recent soil development is therefore prevented.

(ii) Large areas covered by coarse morainal deposits, massive quartz scree and thick Ordovician conglomerate scree. High relief, with steep narrow valleys has caused movement of surficial materials - secondary, transported coverings on bare bedrock are common.

Most of the schist-welded tuff areas (where not hidden by thick quartz scree) have a thin layer ($\frac{1}{4}$ - 3") of decomposed bedrock overlying massive (though leached) bedrock.

Soil samples taken from Roaring Meg grid are of the following types:

(a) Well developed soil

(b) Thick, coarse moraine

(c) Decomposed bedrock

(d) Transported soils or scree.

The four types of vegetation cover at Roaring Meg which could affect metal-in-soil content are:

(a) Thick bush and undercover with several inches of decayed vegetable matter.

(b) Open grass cover with scattered schrubs

(c) Pine forest with no undercover

(d) No living vegetation at all

Smelter Contamination

The Mt. Lyell smelters are only 600' outside the north-west corner of the Roaring Meg grid boundary. Since the two dominant wind directions are from the NW and SW this corner of Roaring Meg grid would receive much of the "fall-out" from the fumes.

Test pits were dug over the north-west and central-north portion of the grid and also at Lynch Creek (18,000 feet from the smelters

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and to the south-west). The results are shown graphically in Fig. The Roaring Meg pits show that surficial contamination (Cu, Pb, Zn & AS) is marked to a depth of 6 inches. At Lynch Creek no evidence of surficial contamination is present.

Variable soil depth

The depth of soil available for sampling varies greatly - from ¼" of decomposed bedrock to several feet of good thick clay soil.

Relief and Rainfall

The effects of the varied relief and the high rainfall ($>$ 100 inches per annum) are not known, but it could cause down hill dispersion of the metals in some areas. The effect of high run-off over the non-vegetated areas must be contrasted with the much lower run-off in the vegetated areas.

Therefore, when considering soil values at Roaring Meg it must be realized that though surficial contamination is only up to 6" deep, the lack of a primary soil cover to this depth over much of the northern portion of the grid prevents satisfactory samples being taken. Where soils in this area are over 6 inches deep they consist mainly of glacial moraine.

RESULTS OF GEOCHEMISTRY:

Soil sample results at Roaring Meg can neither be related to rock types or to topographical features. High anomalous zones are widespread, but discontinuous, in the western and northern sections of the grid. This is particularly so for Pb, Cu, Zn and As. Field examination and drilling results have shown that disseminated sulphides are common throughout the area. These sulphides are more abundant in some areas than others, and these discontinuous soil "highs" could be a reflection of this. Contamination and variable soil depths and soil types may accentuate or even be the cause of some of these anomalies.

Recent checks on Pb content of samples analyzed at Perth (WA) prior to December 1966 showed that the spectrographic analyses of Pb was often highly exaggerated. This was a fault of the machine. It does, however, mean that Pb results obtained prior to December 1966 cannot be correlated with more recent results.

DRILLING RESULTS

The drill logs for all holes drilled at Roaring Meg during 1967 are enclosed. Drill holes were located with regard to all geochemical and geophysical data available. Although sulphides occur in the drill core, quantities are small and disseminated. Grades for copper, lead, zinc, silver and gold are low and uneconomic. Best grades were found in DDH RM-201, where one ten foot zone (210 - 230 ft.) analyzed 0.49 Cu and 0.3 oz/ton Ag. Two other zones (275 - 281 ft.) and (469 - 474 ft.) analyzed 0.43% Cu. All other analyses were far below these.

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It is not recommended that any more holes be drilled on the Roaring Meg grid with the present geochemical and geophysical information.

LYNCH CREEK ANOMALY

The area is 2 - 3 miles south of Queenstown and lies generally to the east of the junction of Queen River and Lynch Creek. Detailed geological mapping and soils sampling have been completed over a grid system consisting of 78,000' of lines. The terrain is rugged, the vegetation quite thick and a good soil has been developed.

Ground magnetic readings (25' spacing) have been completed on all lines. An In-line electromagnetic survey has been completed on alternate lines. One I.P. set-up (300' dipole) was made on line 144 S to check a copper/lead soil high.

INVESTIGATIONS TO DATE:

GEOLOGY

The area consists mainly of alternating Cambrian lavas, tuffs and agglomerates interbedded with shales and greywackes deposited in a eugeosynclinal environment. Low grade regional metamorphism has resulted in the development of chlorite-sericite schists with/without feldspar and/or quartz and probably originating from tuffs.

The main rock units are -

a. A fine grained grey-green spilite in the northwest which is petrographically similar to the feldspar-pyroxene porphyry at Roaring Meg.

b. A coarse grained crystal tuff extending north-south along the western margin.

c. Greywacke-shale-siltstone sequence

d. Chlorite-sericite schists.

Due to rock types merging into each other or lensing out along and across strike, no definite structures have been inferred. There is a small patch of Silurian sandstone on the northwest margin and patches of Quaternary and recent alluvials.

Crystal Tuff

This is a massive, medium grained, coherent green rock showing a crude banding in weathered outcrop (1' - 8') thick which could be bedding. The strike of this banding is 150 - 180^{o}M and dips steeply east. There are no signs of shearing or foliation.

The rock consists dominantly of crystal fragments but also many rock fragments. In thin section there is 80 - 85% of albite, augite and quartz grains with some rock fragments, often in a closely packed arrangement with the interstices filled with a fine grained groundmass. The particles are all sizes from groundmass to 3 - 4 mm. and are normally angular. Some of the augite has altered to chlorite and some of the albite to sericite. The rock fragments are generally leucocratic. The groundmass is variable in composition from quartz rich patches to others with more epidote granules, and chloritic whisps. Pyrrhotite and pyrite particles also occur.

Spilite

This rock was originally given the name "olivine porphyry" because of the large olivine phenocrysts in some areas. However, these have since proved to be rather localized and the rock is now classed as a spilite, or in the field as a feldspar-pyroxene porphyry because of its composition and texture. It is petrographically very similar to the feldspar-pyroxene-porphyry at Roaring Meg.

It is a dark green, massive, coherent rock spotted with 30-40% phenocrysts of augite (up to 7 - 8 mm) and albite (up to 4 mm) with a few rock fragments. The augite is present as subhedral crystals, sometimes having cuspate shaped inclusions. The albite is euhedral to anhedral grains with many inclusions and embayments, and the matrix is composed of an aggregate of feldspar, pyroxene, chlorite and epidote. Irregular patches of a very fine grained leucocratic rock occur which has a eutaxitic texture which suggests a volcanic origin.

Greywacke-Shale-Siltstone series

This series of rocks is composed mainly of thinly bedded greywackes with interbedded siltstones and shales. They strike 150-180°M and dip steeply to the east. The mineralogy of all three members of the series is fairly similar.

A typical greywacke specimen contains a poorly sorted, close-packed framework of angular quartz, muscovite, plagioclase and chlorite grains along with abundant rock fragments cemented by carbonate grains in the interstices. There are also a few grains of tourmaline and pyrite. As the rocks fragments exceed the feldspar grains in amount and the detrital matrix is scarcely apparent the rock can best be classified as a subgreywacke.

Chlorite-Sericite Schists

These are similar to the schists at Roaring Meg and no further description is required here. The schistosity strikes 150 - 180°M. The feldspar quartz rock mapped is similar mineralogically to the feldspar-quartz schists but is fairly massive showing little foliation.

Silurian Sandstones

These occur near the Queen River and are similar to those at the Airport Prospect which are described elsewhere. They are probably faulted against the Cambrian tuffs.

Quaternary Gravels

These are a group of coarse well rounded alluvial boulders overlying Silurian sandstone near the Queen River, about 40' above present river level. They are mainly Ordovician conglomerates.

Recent Alluvials

These cover areas where stream valleys open out. They consist of pebbles, sands and silts of Cambrian rocks of the upstream areas, and in the past many of these deposits were washed for gold.

MINERALIZATION

No surficial evidence for mineralization has been found, although old gold workings exist in the deep clays which overly the spilites.

GEOCHEMISTRY:

Lynch Creek Anomaly should be ideal for soil sampling - a thick, well developed soil and vegetation cover exists over the whole area, and as it is 3 - 4 miles from the Mt. Lyell smetlers it should not be subjected to surficial contamination - in fact test pits show this to be the case (Fig.   )

A low, but well defined anomalous area approximately coincident with the spilites occurs for Cu, Pb, Zn and Ni. Values in the remainder of the area are very low except for random isolated samples. Analysis of the rock, however, shows that it has a high background for these metals, and the anomaly is undoubtedly a reflection of this.

GEOPHYSICAL EXPLORATION

Ground Magnetics

A well defined magnetic anomaly occurs coincident with the crystal tuff to the west and as this rock contains pyrite and pyrrhotite, the anomaly is probably only a reflection of this.

There is no magnetic response over the remainder of the prospect.

AIRPORT PROSPECT

This area is situated $1\frac{1}{2}$ - 3 miles northwest of Queenstown in reasonably open, flat terrain surrounding the aerodrome. The grid was established to investigate anomalous copper/lead stream sediment values, obtained during earlier reconnaissance traverses. 77,000 feet of grid line (400' spacing) have been cut, and chained. Geological mapping and detailed soil sampling (100' intervals) has been completed. There are incomplete ground magnetic, electromagnetic, and I.P. surveys - the latter of one set-up only (300' dipole). One 262' drill hole (A-501) was drilled to check out a small copper/lead soils, and I.P. anomaly.

RESULTS OF INVESTIGATIONS

GEOLOGY:

The area is basically a shallow syncline plunging at a low angle to the west. The axial area is of Devonian shales overlying Silurian sandstones. A major E-W fault passes through the northern portion of the grid; it brings Silurian and Devonian sediments into contact with east-west striking sheared Cambrian volcanics dipping steeply to the north.

Cambrian Volcanics

These form a small strip (1000' - 1200') on the northern margin of the grid. They consist of interbedded tuffs, siltstones, greywackes which are typical of those seen at Lynch Creek and Roaring Meg. There is also a small intrusive gabbro which has weathered deeply.

Silurian Sandstone

This is part of the "Florence Sandstone" of the West Coast and consists of highly fossiliferous arenaceous sediments showing graded bedding. The rock is dominantly quartz with no signs of ore minerals.

There is however, in the south of the grid a shaft and adit which comprises the Madame Howard Mines where gold was once mined from quartz veins within the Silurian Sandstone.

Devonian Shales

These are fine dark grey shales with graded bedding. No mineralization has been seen on surface examination. The only mineralization in diamond drill hole (A-501) was a thin film of pyrite on a cleavage plane and some white quartz which came up with a roller bit from 250'. The dips of the rocks over most of the area are fairly steep. A thin layer of white quartz scree covers much of the shale.

GEOCHEMISTRY:

Because of a lack of a true soil cover over most of the grid, soil samples were mainly taken from decomposed bedrock. The area is also in direct line and close to the Mt. Lyell smelters and therefore in favorable position for surficial contamination. This seems to be proved by scratch tests for the drill core from DDH A-501, where the 0 - 19' sample contained 5 times more Cu and Pb and 3 times more Zn than the average for the remainder of the hole.

No explanation can be given for the anomalous Cu, Pb, Zn and As values present on the Airport grid other than they represent possible smelter contamination, or they may represent high natural background of the rock - this has not been substantiated.

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NORTH QUEEN RIVER PROSPECT

This area is 2 - 3 miles north of Queenstown lying generally between East and West Queen Rivers, approximately $\frac{3}{4}$ - 1 mile west of the Corridor ore body currently being developed by Mt. Lyell Mining and Railway Co. The grid was established to investigate high Cu values in reconnaissance stream sediment sampling traverses.

Geological mapping and soils sampling were completed over 39,300' of cut and chained lines (400' spacing in the north; 800' spacing in the south). 360 soils samples were obtained. Geological mapping was perfoemd by R. Lee.

An E.M. survey was attempted several times, but interference (possibly from high voltage transmission lines $\frac{1}{2}$ mile to the west) prevented this. No other geophysical work was attempted.

GEOLOGY:

The western two-thirds of the grid is covered by a thick quartz scree and bedrock beneath this is leached to some considerable depth. Basic rock types are Cambrian tuffs and agglomerates with spilitic lavas and porphyries. They strike at 160 - 170^{o}M and the sequence dips steeply east. Metasomatism (particularly albitisation and silicification) occurs on a minor scale only. Thin quartz veins (often limonitic) traverse the area and one pyritic vein is exposed in a small pit in the southern part of the grid. No other mineralization was found.

Cambrian Volcanics

The main rock type is a medium grained, grey-green, highly sheared lithic tuff. It consists of pink albite, leucocratic rock fragments and quartz in a groundmass of quartz, chlorite and sericite.

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Fine and coarse members occur as discrete lenses and interfingered units less than 100 feet wide contained in a medium grained tuff.

A spilitic lava is present in the central-east part of the grid. It is very fine grained and only 150 feet long by 6 feet wide.

A quartz porphyry (possibly shallow intrusive) 2000 feet long and 400 feet wide in the centre occurs in the south western part of the grid. The groundmass is mainly quartz and sericite with some feldspar.

Thin grey shales (less than 6 feet wide) occur in groups and isolated bands within the volcanics throughout the grid.

GEOCHEMISTRY

Nowhere at North Queen is a good topsoil developed. Where vegetation is thick an organic "A" layer occurs (the SW and NE corners of the grid). Areas covered by the thick quartz scree have a layer of sand and clay about 1 foot thick beneath the quartz. All soil samples were taken from decomposed bedrock beneath the quartz scree.

In the eastern part of the grid, a cover of transported orange clay overlies unweathered tuffs.

No continuous anomalous areas were located in the western part of the grid. A small lead and two small copper anomalies were located in the eastern third of the grid. These could be genuine reflections of hidden ore bodies or they could be due to smelter contamination (this eastern part of the grid faces the smelters 2 miles south).

The proposed I.P. survey if it eventuates, would check the authenticity of these anomalies.