



SULPHURETS MAP AREA
(104A/05W, 12W; 104B/08E, 09E)

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KEYWORDS: Regional geology, Sulphurets, Hazelton Group, island arc, porphyry copper-molybdenum, epithermal veins, gold, silver, Stikinia.

INTRODUCTION

This paper summarizes preliminary results of the Sulphurets project based on fieldwork from July 23 to September 15, 1987. The Sulphurets map sheet covers 1000 square kilometres roughly centred on Brucejack Lake, 60 kilometres north-northwest of Stewart (Figure 1-18-1). The area is under active exploration for precious metals. New mine developments are underway at Brucejack Lake West zone (Newhawk Gold Mines Ltd.) and at the Goldwedge deposit (Catear Resources Ltd.). A 2-year mapping project begun this year has the following objectives:

- Produce 1:50 000 and 1:20 000-scale geology maps.
- Establish a regional stratigraphic column.
- Examine mineral deposits and major mineral occurrences.
- Expand and update the ministry's mineral inventory file (MINFILE).
- Collect samples for assay, platinum group element and whole-rock analyses, dating and fossil studies.

The project is part of a long-term study of the geology and mineral deposits of the Iskut district in the Southern Boundary Ranges. Ultimately mapping will cover 3500 square kilometres, extending from Bowser Valley west to Jekill River and from Iskut River south to the United States border (Figure 1-18-1). Sulphurets map sheet adjoins the recently released Salmon River sheet (Alldrick, 1987).

Access to the area is by helicopter from Stewart or the Tide Lake airstrip. A tractor road and barge link with Highway 37 is under construction (Figure 1-18-1).

EXPLORATION HISTORY

The Unuk River and its tributaries, including Sulphurets Creek, have been known as a source of placer gold since the 1880s (Wright, 1907). Placer gold was worked on Sulphurets Creek as early as 1895 but no production records are available. Modest work on gold-silver-lead veins was reported in the early 1900s but, from 1904 until the advent of helicopters in the 1950s, the area received scant attention. Prospectors penetrated this remote region to discover large gossans in the vicinity of Treaty Glacier in 1929, lead-zinc-copper deposits at Tom MacKay Lake in 1932, and broad areas of disseminated copper mineralization between Mitchell and Sulphurets creeks in 1935.

The discovery of the Granduc deposit in 1953 renewed interest in exploration for massive and disseminated base

metal deposits. Regional geological, geophysical and geochemical surveys conducted by Granduc Mines Limited and Newmont Mines Ltd. from 1960 to 1975 resulted in the discovery of numerous copper, molybdenum, lead, zinc, gold and silver showings. The main copper-molybdenum prospects were tested by drilling. Exploration activity in the area peaked again during the molybdenum boom of the late 1970s. Since 1980 interest in precious metals has brought exploration activity to unprecedented levels resulting in discoveries of both low-grade, high-tonnage disseminated deposits and high-grade vein deposits of gold and silver.

PREVIOUS AND CURRENT WORK

Earliest geological coverage of part of the present map area was published by the Geological Survey of Canada in 1957 as part of "Operation Stikine" (1:250 000). R.V. Kirkham (1963) completed an M.Sc. thesis that included mapping the area between Brucejack Lake and Mitchell Glacier (1:12 000). E.W. Grove (1971, 1986) mapped the entire area (1:100 000) between 1964 and 1970, incorporating the regional geological mapping (1:25 000) conducted by Newmont Mines Ltd. between 1960 and 1964. More recent thesis studies in the area include work by Egan (1981), Simpson (1983) and Gunning (1986). Other sources of data include the ministry's annual reports, property file and assessment reports. A series of unpublished geological reports and detailed maps by Esso Minerals Canada Ltd. cover the area between Brucejack Lake and the Mitchell Glacier (Bridge *et al.*, 1981; Bridge and Melnyk, 1982, 1983; Britten, 1983; Lomenda, 1983; Melnyk, 1983).

Current research includes a litho-geochemical study of the large alteration zones within the Sulphurets map area by S.B. Ballantyne, D.C. Harris and R.V. Kirkham of the Geological Survey of Canada, Ottawa. The joint federal/provincial Regional Geochemical Survey sampling program completed coverage of NTS 104B this year. R.G. Anderson at the Geological Survey of Canada, Vancouver, is presently mapping the entire Iskut River map sheet (104B) at 1:250 000.

To the west of the Sulphurets map sheet, D.V. Lefebvre and M.H. Gunning of the British Columbia Geological Survey Branch, Smithers, mapped 140 square kilometres in the Bronson Creek area (104B/10, 11) at 1:25 000 scale (Figure 1-18-1). Mineral properties within this map area include the Reg (Mount Johnny), Snip, Inel and Gossan prospects.

Traverse data for the Sulphurets project were recorded on 1:10 000 airphoto enlargements and then compiled on 1:20 000 and 1:50 000 base maps.

GEOLOGICAL SETTING

Sulphurets map area is situated in the rugged Boundary Ranges of the Coast Mountains physiographic belt. It lies

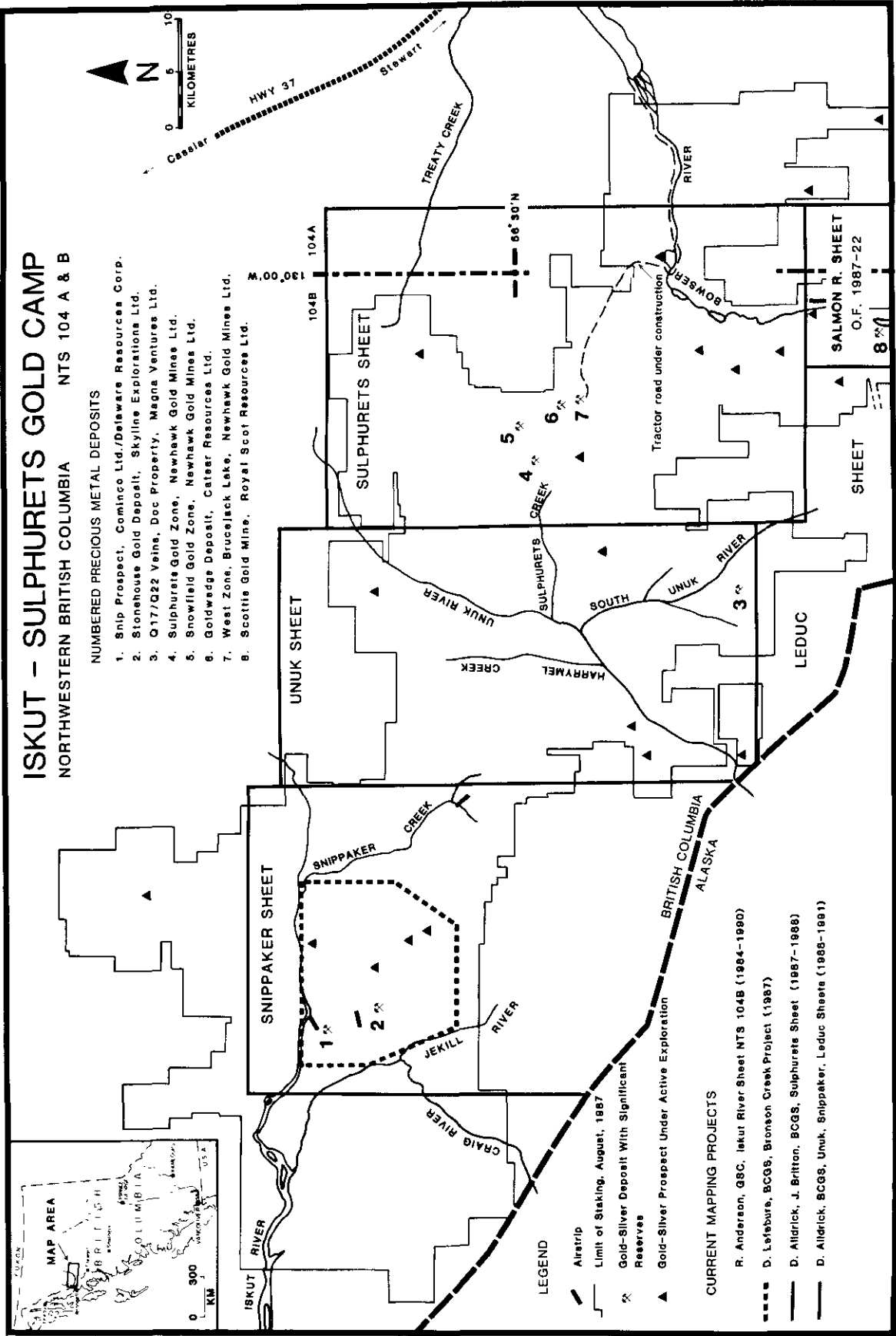


Figure 1-18-1. Iskut-Sulphurets gold camp: precious metal deposits and current mapping projects.

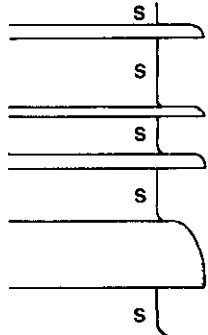
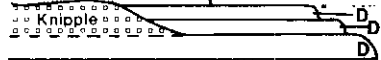
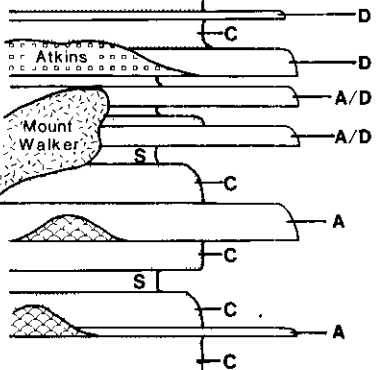
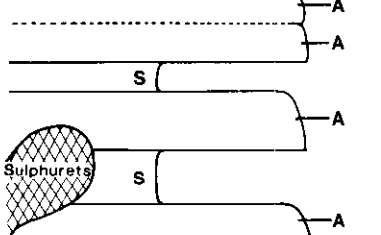
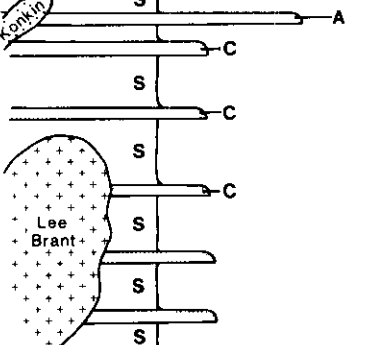
SCHEMATIC STRATIGRAPHY	MAP UNIT, FORMATION, THICKNESS, and AGE	LITHOLOGIES * indicates diagnostic features	MINERAL OCCURRENCES
	<p align="center">UNIT 4</p> <p align="center">SALMON RIVER FORMATION</p> <p align="center">> 1000 m</p> <p align="center">Toarcian to Bajocian</p>	<p>* Black siltstones with lesser thick-bedded sandstones and minor limestone lenses.</p> <p>* Basal fossiliferous and pyritic wackes.</p>	
	<p align="center">UNIT 3: MOUNT DILWORTH FORMATION</p> <p align="center">75 m to 150 m</p> <p align="center">Toarcian</p>	<p>* Felsic pyroclastics and flows. Tuff breccias, lapilli tuffs, ash tuffs, and dust tuffs. Local *welded ash flows and *agglomeratic tuff breccias.</p> <p>* Chalcedonic veins.</p>	<p align="center">KNIP</p>
	<p align="center">UNIT 2</p> <p align="center">BETTY CREEK FORMATION</p> <p align="center">700 m to 1200 m</p> <p align="center">Pliensbachian to Toarcian</p>	<p>Interbedded volcanic tuffs, flows, and *hematitic sedimentary rocks.</p> <p>* Purple to maroon conglomerates, wackes, siltstones and mudstones. Basaltic to dacitic tuffs and flows. *Pillow lavas, crystal and lithic tuffs.</p> <p>* Columnar jointed units. Minor black fossiliferous siltstone sequences.</p>	<p align="center">TREATY ISLAND</p> <p align="center">GOLD WEDGE</p> <p align="center">SHORE, RED RIVER</p>
	<p align="center">UNIT 1B</p> <p align="center">UPPER UNUK RIVER FORMATION</p> <p align="center">1000 m to 1500 m</p> <p align="center">Hettangian to Pliensbachian</p>	<p>Volcanic strata with lesser black siltstone members</p> <p>* Two feldspar porphyry (hornblende (Premier Porphyry), *hornblende porphyry, and *bedded airfall crystal tuff. Minor fossil occurrences.</p>	<p align="center">GOSSAN HILL</p> <p align="center">WEST IRON CAP</p> <p align="center">SNOWFIELD</p> <p align="center">SPINE, ELECTRUM, 367</p> <p align="center">4-J's</p>
	<p align="center">UNIT 1A</p> <p align="center">LOWER UNUK RIVER FORMATION</p> <p align="center">> 1000 m</p> <p align="center">Norian to Hettangian</p>	<p>Mixed sedimentary strata with minor tuff units.</p> <p>* Black siltstones, heterolithic pebble to cobble conglomerates and wackes.</p> <p>* Hornblende feldspar crystal tuffs. Minor fossil occurrences.</p>	<p align="center">KERR KONKIN</p>





Figure 1-18-2. Schematic stratigraphy. Sulphurets map area. A = andesitic volcanics; D = dacitic volcanics; S = siltstones; C = conglomerates; stipple = sandstones.



Figure 1-18-3. Geology and mineral deposits, Sulphurets map area.





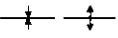




LEGEND

INTRUSIVE ROCKS

-  Lee Brant Stock
-  Mount John Walker Porphyry
-  Mitchell-Sulphurets Intrusions: monzonite (M), syenite (S), and granite (G)
-  Potassium-feldspar-plagioclase-hornblende porphyry trachyandesite

-  VOLCANIC AND SEDIMENTARY ROCKS: Units 1-4

SYMBOLS

- Phyllite belt 
- Gossan 
- Fault (U = up; D = down) 
- Contact 
- Syncline; anticline 
- Bedding; foliation 
- Mine under development 
- Prospect 
- Access road under construction 

	MINERAL OCCURRENCES	COMMODITY
	NAME	
A	Konkin	Au, Cu, Pb, Zn
B	Treaty	Gossan
C	Iron Cap	Cu, Au
D	Mitchell	Cu
E	Kirkham	Cu
F	Snowfield	Au, Mo
G	Sulphurets	Cu, Mo, Au
H	Hanging Glacier	Au, Ag
I	Kerr	Au, Cu
J	Goldwedge	Au, Ag
K	Red River	Au, Ag
L	Shore Zone	Au, Ag, Pb, Zn
M	West Zone	Au, Ag, Pb, Zn
N	Spine Zone	Au
O	Knip	Ag, Pb, Zn
P	Delta	Ag, Pb, Zn
Q	Tribe	Au
R	Gamma	Ag, Pb, Zn

along the western margin of the Intermontane tectonic belt and, according to terrane concepts, is entirely within Stikinia (Wheeler and McFeely, 1987). The area is underlain by Lower to Middle Jurassic Hazelton Group volcanic and sedimentary rocks (Grove, 1986) that have been folded, faulted and weakly metamorphosed, mainly during Cretaceous time (Alldrick *et al.*, 1987). Strata are cut by at least three intrusive episodes that produced small synvolcanic plutons, satellite stocks of the Coast plutonic complex and minor dykes and sills. Intrusive activity spans Jurassic to Tertiary time.

The geology is typical of an island arc setting. Formations have characteristics that persist on a regional scale, but individual members show little lateral continuity due to rapid facies changes and the simultaneous operation of volcanic and sedimentary processes.

VOLCANIC AND SEDIMENTARY ROCKS

Hazelton Group volcanic and sedimentary rocks can be divided into four lithostratigraphic map units (Figures 1-18-2, 1-18-3). Informal names in current use (Grove, 1986; Alldrick, 1987) are given in parentheses for comparison with earlier work.

MAP UNIT 1 (UNUK RIVER FORMATION, ANDESITE SEQUENCE)

Unit 1 consists of a thick sequence of interbedded sedimentary and volcanic rocks. Sedimentary rocks include immature sandstones (wackes), fine-grained conglomerates, rhythmically bedded siltstones (turbidites) and mixed epiclastic-pyroclastic rocks (tuffites of Schmid, 1981); limestone and chert are absent. Most coarse clastic rocks are quartz-poor lithic or arkosic wackes. Lithic fragments are commonly volcanic. Grain size roughly correlates with the physical appearance of outcrop: coarse clastic rocks are dull, rusty buff-brown to grey and form rubbly, ribbed outcrops; siltstones form rusty, dark grey, smooth or scree-covered exposures. Sedimentary sequences tend to be recessive relative to volcanic rocks (Figure 1-18-2).

Volcanic rocks are intermediate pyroclastics: andesitic tuffs, lapilli tuffs and breccias with subordinate flows and bedded air-fall tuffs. Plagioclase phenocrysts are ubiquitous; hornblende occurs in more mafic rocks and pyroxene was seen only in tuff-breccia clasts in two outcrops. Near the top of Unit 1 potassium feldspar, plagioclase and minor hornblende occur as phenocrysts, both in tuffs and in apparently coeval hypabyssal intrusions. Potassium-feldspar-bearing units may be trachyandesite. Typical volcanic outcrops are medium green, massive and fairly resistant to weathering.

Unit 1 can be subdivided into a lower, predominantly sedimentary sequence, including tuffites, and an upper, predominantly volcanic sequence (Figure 1-18-2). Within the upper sequence, rhythmically bedded carbonaceous siltstones are the principal sedimentary component amid rather massive, poorly bedded, volcanic accumulations.

Thickness is not known but must exceed 2000 metres. No base was observed. Lower and upper sections appear to form one conformable depositional sequence although lacunae doubtless exist. The contact with overlying Unit 2 is exposed

south of Brucejack Lake and is conformable on outcrop scale. Unit 1 is best exposed from Atkins Glacier south through the McTagg, Mitchell and Sulphurets drainages before passing beneath the Frank Mackie Icefield. Few fossils were found in Unit 1.

MAP UNIT 2 (BETTY CREEK FORMATION, COARSE CLASTIC SEQUENCE)

Unit 2 consists of heterogeneous pyroclastic and epiclastic rocks, distinguished by brightly coloured red, green and purple units. Bedded sedimentary rocks are characteristically hematitic. Common rock types include crystal and lithic tuff, lapilli tuff, tuff breccia, tuffite, hematitic mudstone, siltstone and sandstone. Minor conglomerate, pillow lavas and flows occur locally. Generally this unit has well-developed compositional layering but, where it is massive, it can be distinguished from other volcanic units by the presence of hematitic mudstone seams. Massive volcanoclastic sequences tend to weather light green; massive sediments are light grey.

Volcanoclastic rocks are of intermediate to felsic composition; most are feldspar-phyric dacite. Air-fall lapilli tuffs are common. Clasts are subangular to subrounded and include variable amounts of accidental fragments. Sedimentary rocks are, on the whole, less abundant than pyroclastic rocks. They tend to be better sorted than sediments of Unit 1 and generally consist of fine-grained feldspathic wackes and siltstones.

Unit 2 is estimated to be from 700 to 1200 metres thick. Its lower and upper contacts are conformable and locally may be gradational. Widespread hematite implies that much of Unit 2 was deposited subaerially or else in shallow, oxygenated water. Typical sections occur in the Treaty Glacier area, on the flanks of Mount John Walker and in the Bowser Valley around Canoe Glacier. The few fossils found in Unit 2 include gastropods, molluscs and bivalves.

MAP UNIT 3 (LOWER SALMON RIVER FORMATION, FELSIC VOLCANIC SEQUENCE)

Unit 3 consists of light-weathering, predominantly felsic pyroclastic rocks, including welded tuffs. Sedimentary rocks are absent; flows are rare. Composition is dacitic to rhyodacitic. Rocks locally carry quartz phenocrysts in addition to the usual plagioclase. The unit forms a relatively thin but persistent marker throughout the map area. Locally, as at Knipple Lake and Treaty Glacier, the unit is strongly pyritic, giving rise to prominent gossans which have long drawn the attention of prospectors. Previously included as part of the lower Salmon River formation (Grove, 1986), this unit was identified as a mappable regional marker in the Stewart area by Alldrick (1987).

Unit 3 is from 75 to 150 metres thick. It conformably overlies Unit 2, but may paraconformably underlie Unit 4. It represents an interval of explosive felsic eruptions, perhaps a result of evolving magma compositions beneath the island arc complex.

Good exposures are found around the toe of Treaty Glacier, midway along Knipple Glacier and immediately north of

Mitchell Glacier (Plate 1-18-1). No fossils were found in this unit.

MAP UNIT 4 (SALMON RIVER FORMATION, SILTSTONE SEQUENCE)

Unit 4 consists of dark grey siltstone and fine-grained sandstone. It is distinguished by lithologic uniformity, good bedding and complex disharmonic folding.

At its base the unit has coarse pyritic sandstone and fossil accumulations, overlain by rhythmically bedded (turbiditic) siltstone sequences that contain limy lenses, concretions and thin pyritic layers. The strata represent renewed marine sedimentation following subsidence of the arc complex at the end of volcanism.

Unit 4 is at least 1000 metres thick in the map area. In most exposures it conformably overlies Unit 3 except at Knipple Lake where there is a marked angular unconformity (Figure 1-18-2). The best exposures are in the northeast corner of the map area and in the Bowser Valley around Knipple Lake. Fossils found in the basal wackes include belemnites, bivalves and gastropods. Ammonites were seen in one exposure. R.G. Anderson (personal communication, 1987) considers the basal sediments to be of Toarcian age.

INTRUSIVE ROCKS

Intrusive rocks are not extensive within the map area but are important due to their apparent spatial or temporal association with the main mineral occurrences.

The largest intrusive is the Lee Brant stock located west of the Frank Mackie Icefield. The main mass of the pluton, which crops out over 40 square kilometres, lies just west of the map area. It is a fresh, coarse-grained, leucocratic, hornblende-biotite quartz monzonite, with large potassium-feldspar phenocrysts. Contacts with sedimentary country rocks are discordant, sharp but unchilled. Zones of low-grade hornfels occur along the contacts. Grove (1986) suggested a Tertiary age for this stock. On the basis of textural and mineralogical similarities to the Texas Creek batholith and the Summit Lake stock (Alldrick, 1986), it is probably Jurassic.

A wide variety of syn and post-volcanic hypabyssal stocks is concentrated in the vicinity of the Sulphurets and Mitchell glaciers. They range from monzodiorite to monzonite to quartz monzonite and granite. Typically they are quartz-poor and have alkaline affinities. Porphyritic textures are common with phenocrysts of plagioclase, potassium feldspar, hornblende and biotite set in an aphanitic to microcrystalline groundmass. Synvolcanic plutons tend to be compositionally and texturally similar to the extrusive rocks. A good example is potassium feldspar + plagioclase-phyric trachyandesite that forms small intrusive bodies cutting Unit 1 around the toe of Freegold Glacier. Compositionally this rock is the same as bedded air-fall tuffs exposed at the east end of Brucejack Lake. In other exposures, where crosscutting relationships are obscured, it is not possible to determine if the rock is intrusive or extrusive.

Post-volcanic intrusions tend to be more phaneritic. They clearly intrude their hosts and do not have compositions or textures equivalent to extrusive rocks. Examples are

hornblende feldspar porphyry monzonite exposed along the east side of Sulphurets Glacier and leucomonzonite on Mitchell-Sulphurets ridge. Some of these are associated with disseminated copper and gold mineralization. Another post-volcanic stock underlies the head of Freegold Glacier, including the summit of Mount John Walker. It is a homogeneous, coarse, plagioclase-phyric rock with crowded porphyry texture and fine-grained phaneritic groundmass. A distinctive feature is the presence of numerous fine-grained dioritic (apparently cognate) xenoliths. The unit appears to cut host rocks at a very low angle and may be a sill. Contacts are sharp and unchilled. This intrusive does not appear to be associated with mineral occurrences.

Dykes, including diabase, andesite, biotite lamprophyre and keratophyre, also cut rocks in the Sulphurets – Mitchell Glacier area.

In addition to the Lee Brant stock, two rock types previously mapped as Tertiary intrusions by Grove (1986), have been reinterpreted. One, north of Atkins Glacier, consists of stratabound, hornblende feldspar porphyry, and is thought to be a Jurassic flow or crystal tuff ("Atkins" in Figure 1-18-2). The other, at Knipple Lake, consists of coarse, white, glomeroporphyritic plagioclase set in a dark grey dacitic groundmass ("Knipple" in Figure 1-18-2). Up to boulder-sized clasts of this rock occur in overlying conglomerates and wackes at the base of Unit 4, indicating a Jurassic age. No intrusive contacts were seen in this rock. Field examination did not resolve whether it is a flow or an unusual tuff.

STRUCTURE

FOLDS

Folds are best revealed in sedimentary rocks; most volcanic strata are too massive to give useful structural data. Unit 4 displays complex, tight, disharmonic folding; it appears crumpled against more rigid volcanic rocks. This is due to competency contrasts and the extreme planar anisotropy of the strata. Unit 1 sediments in McTagg drainage display less intense deformation with only moderate warping. Fold amplitudes are less than 100 metres and wavelengths are several hundred metres long. Crenulation folds were found only in phyllite and some foliated rocks in alteration zones. Primary folds and other soft-sediment deformation structures were seen in most siltstone sequences.

On a regional scale, the northern and northeastern part of the map area consists of a northeast-facing homocline. In the west, the Sulphurets syncline of Grove (1986) is now interpreted as a major anticline exposing the deepest members of Unit 1. Along the Bowser River on the east and southeast of the map area, major synclines preserve pockets of Unit 4. Fold axes strike roughly northwest. The southwest part of the sheet was not mapped.

FAULTS

Only one growth or syndepositional fault was observed (at Tim Williams nunatak) but this type of fault may be important in controlling the distribution of rock types within Units 1 and 2. Growth faults may account for some of the abrupt lithologic changes seen on Brucejack Plateau.

Northerly striking, steep normal faults with several hundred metres displacement were seen in the Bowser Valley and Mitchell Glacier areas. The Mitchell Glacier faults may be extensions of the prominent Brucejack lineament which extends from Sulphurets Icefield to Freegold Glacier. The Brucejack lineament is a subvertical structure, the trace of which is a narrow trough. Apparent displacement across this structure is rather small for such a pronounced feature, in the order of tens of metres. Other regional breaks include a northeast-striking reverse fault that extends from Mitchell Glacier to Treaty Glacier and a northwest-striking normal fault that parallels Knipple Glacier.

Minor thrust faults are fairly common in more deformed parts of Unit 4. West-dipping thrust faults with perhaps a few hundred metres displacement were seen between Sulphurets Creek and the north side of Mitchell Glacier (Plate 1-18-1). Thrust faults appear to predate at least some of the displacement along normal faults, but postdate mineralization and alteration.

Minor faults with only tens of metres displacement abound in the map area. These may be very important in the exploration and exploitation of ore deposits.

METAMORPHISM

Metamorphic grade throughout the area is, at most, lower greenschist. Metamorphism has produced typical propylitic assemblages: chloritized mafic minerals and saussuritized plagioclase. Mineralogical transformations are most evident in intermediate to mafic volcanic rocks. On the whole, textural changes are slight, amounting to minor recrystallization.

In the Sulphurets and Mitchell Glacier area, large zones of argillic and phyllic alteration have been subjected to moderate dynamic metamorphism. The resultant rock, commonly termed sericite (or talc) schist in mining reports, is in fact a foliated to schistose pyrite-quartz-sericite rock with variable amounts of carbonate. Relict textures such as lapilli and phenocrysts can be discerned in zones where alteration is weak to moderate. Dynamic metamorphic effects are not confined to altered rocks. Stretching, flattening and re-orientation of lapilli, creation of secondary foliations at all angles to primary layering, and incipient transposition of bedding are widespread on Brucejack Plateau.

Between upper Sulphurets Glacier and Ted Morris Glacier a band of true phyllites is locally developed from pelitic and tuffaceous protoliths. In this area transposition of bedding is all but complete. Small folds are tight to isoclinal. Gradations from unfoliated rocks to phyllites are quite rapid, in the order of a few tens of metres. The genesis and limits of this northerly trending belt of phyllitic rocks are not yet known.

Regional foliations strike north-northwest and dip steeply to the east. Near Freegold and Mitchell glaciers most strikes are easterly, with steep northward dips.

MINERAL DEPOSITS

Prior to this project only 13 mineral occurrences were listed for the Sulphurets map area in the ministry's mineral inventory file (MINFILE). Information on more than 60 additional occurrences has been collected from published

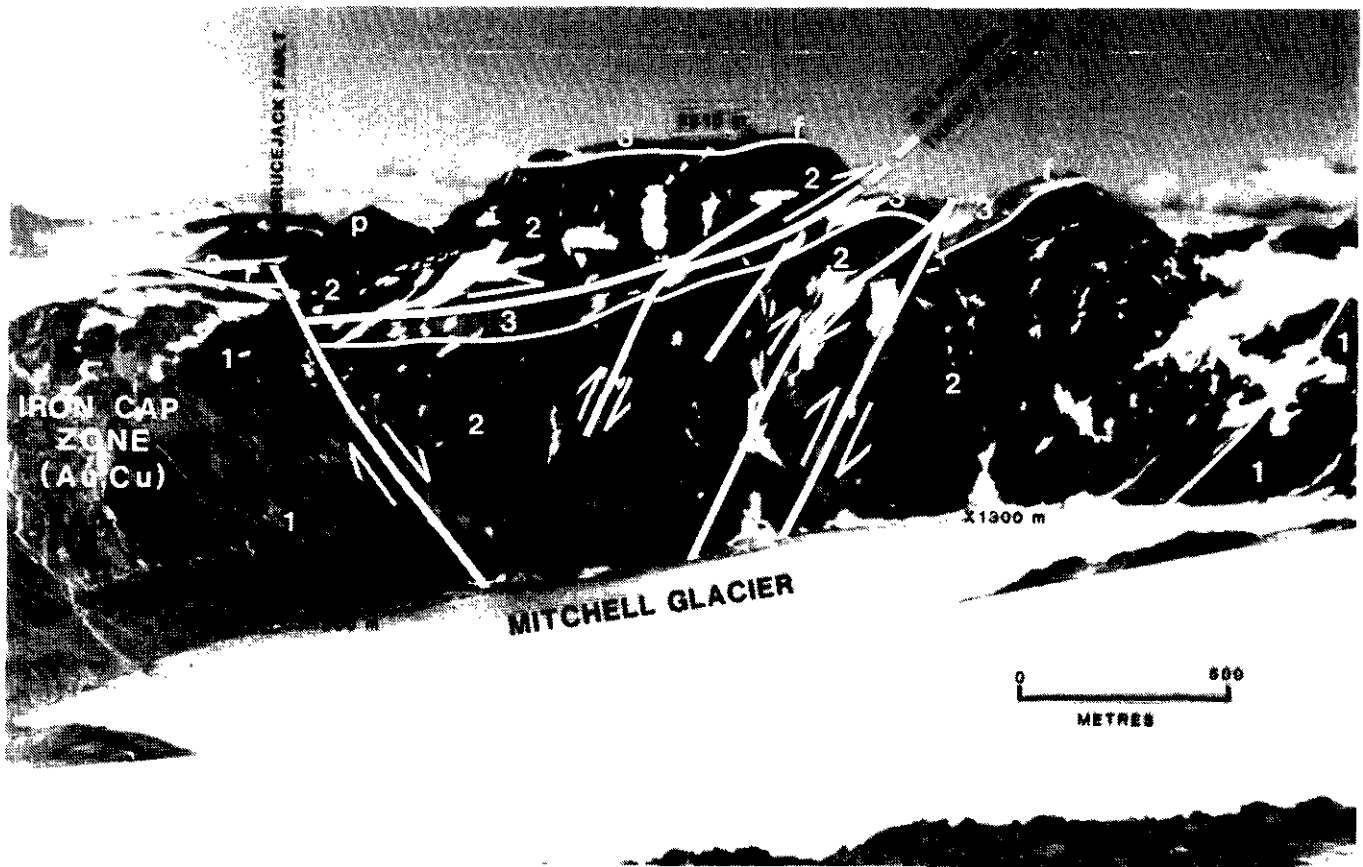


Plate 1-18-1. Stratigraphic and structural relationships, north side of Mitchell Glacier. (1, 2, 3 = Units 1, 2, 3; p = pillow lava; f = *fiammé* in welded ash-flow tuff; F = fossil occurrence; thin lines = contacts; thick lines = faults with relative displacement indicated by arrows; x = spot elevation in metres).

and unpublished reports and discussions with company geologists.

The map area is notable for major gossans ranging up to 20 square kilometres in size. Copper, molybdenum, gold and silver mineralization found within these gossans has affinities to both porphyry and meso to epithermal types of deposits. There appears to be overprinting of ore types and multiple generation of alteration and vein assemblages. Much work remains to be done before proposing a working hypothesis that accounts for the diversity of ore and gangue mineralogy, alteration types and structural characteristics.

Most mineral deposits occur in the upper members of Unit 1 or in the lower members of Unit 2. Using a simple, nongenetic scheme, mineral occurrences can be grouped into four main categories: veins, disseminations, intrusive contacts and stratabound.

VEINS

Six main types of veins occur in the map area. They can be classified on the basis of metal content and gangue mineralogy. Most exposed veins are thin (<1 metre) and short (<50 metres). In parts of intensely altered areas, veins may form more than 25 per cent of outcrop and may grade imperceptibly into strongly silicified host rocks.

The six vein types (with examples) are:

- (1) Base metal quartz veins (Brucejack Plateau).
- (2) Silver-rich base metal veins (Knip claim).

- (3) Precious and base metal quartz veins (Brucejack Lake West zone).
- (4) Precious metal quartz veins (Goldwedge deposit).
- (5) Carbonate veins (Atkins Glacier).
- (6) Barite veins (Brucejack Lake peninsula).

Base metal quartz veins consist of thin stringers of quartz \pm carbonate which carry zones of disseminated to massive pyrite \pm galena \pm sphalerite. They are found locally around the Brucejack Plateau outside the main areas of alteration. Individual veins may be strongly gossanous.

TABLE 1-18-1
PUBLISHED RESERVES IN THE
SULPHURETS GOLD CAMP

Mineral Deposit	Reserve Category	Tonnes	Gold g/tonne	Silver g/tonne
West Zone	Drill indicated	486 046	11.38	722.06
	Inferred	436 331	11.38	722.06
TOTAL WEST ZONE		922 377	11.38	722.06
Shore Zone	Inferred	489 685	9.02	933.69
Gossan Hill Zone	Inferred	25 074	66.51	120.34
TOTAL BRUCEJACK LAKE (Newhawk)		1 437 136	11.54	783.78
Snowfield Zone (Newhawk)	Inferred	7 000 000	2.57	
Goldwedge (Catcar)	Inferred	69 854	18.17	138.52

Silver-rich base metal veins occur mainly in the south-eastern quadrant of the map sheet. Locally they give spectacular assays in silver (>3000 grams per tonne) but virtually no gold (<1 gram per tonne). Pyrite, galena, sphalerite, tetrahedrite and minor chalcopyrite in quartz and calcite is a typical assemblage (Cremonese, 1985; Gallop, 1981).

Precious and base metal veins are polymetallic stockworks of thin veins and fracture fillings. Tension-gash structures are common. The veins show complex crosscutting relationships that indicate repeated fracturing and filling as the host rocks underwent brittle deformation. Precious metal mineralization may be confined to one particular episode of veining, and not necessarily the same episode as base metal mineralization. The best exposed example of this type of quartz \pm calcite vein system is the West zone at Brucejack Lake which contains pyrite, ruby silver, tetrahedrite, electrum, argentite, galena and sphalerite as its main metallic minerals (Bridge *et al.*, 1983; Tribe, 1987).

Precious metal veins are essentially pyrite + electrum in quartz or quartz + calcite veins. Arsenopyrite may occur peripherally in the host rocks. Locally these veins give very high assays with generally low gold to silver ratios (roughly 1:1 to 1:5). A well-exposed example is the Goldwedge deposit (Kruckowski, 1987).

Rusty weathering carbonate veins, weakly mineralized with pyrite, form thin discontinuous stringers in most parts of the map area, but near the toe of Atkins Glacier they are significantly thicker and more continuous. They are not known to carry precious metal values but sampling has been limited. They appear to be emplaced later than most quartz veins.

Barite veins were first discovered by Bruce and Jack Johnstone, prospectors from Ketchikan, Alaska (Minister of Mines Annual Report, 1935). They occur near the outflow of Brucejack Lake and appear restricted to that area. They consist of coarsely crystalline barite with minor quartz, carbonate and sulphides.

DISSEMINATIONS

GOSSANS

Gossans ranging up to 20 square kilometres in area have long drawn the attention of prospectors. They occur around Mitchell, Freegold, Sulphurets and Treaty glaciers, as well as Sulphurets Icefield and consist essentially of pyrite disseminated in argillic and phyllic alteration zones. Detailed prospecting in some of these has revealed copper, molybdenum, gold and silver mineralization (discussed below). The size of these zones, their tectonic fabric, intensity of alteration and coincidence of several mineral or metal associations make them attractive for exploration but difficult to interpret. All of these gossans are much larger than the hypabyssal plutons that may lie within them. None is centred on a major pluton. Most are a product of fault and fracture-controlled hydrothermal activity that has affected large volumes of rock over long periods of time. At the Treaty nunatak, the presence of native sulphur and alunite (R. M. Britten, personal communication, 1987) indicates that this zone is acid-sulphate alteration characteristic of high levels of epithermal systems. Plutons are not exposed at surface but may well exist at depth.

COPPER-MOLYBDENUM

Porphyry-type disseminated pyrite + chalcopyrite \pm molybdenite mineralization occurs in volcanic and sedimentary rocks and within subalkaline porphyritic intrusions, including monzodiorite, monzonite, syenite and granite. Examples include the Kirkham zone, Mitchell zone and Sulphurets Copper zone located at the toe of Mitchell Glacier and on Mitchell-Sulphurets ridge. Mineralization consists of disseminations and fine quartz stringers carrying pyrite, chalcopyrite, magnetite and malachite. Grades of 1.5 per cent copper have been reported. Molybdenite occurs as thin coatings on foliation planes in pyrite-quartz-sericite rocks (Malcolm, 1962).

GOLD

Gold (and silver)-bearing zones occur within large alteration areas. However, gold zones do not necessarily coincide with copper-molybdenum mineralization. An example is the Snowfield zone, located between Mitchell and Freegold glaciers, which is estimated to contain 7 million tonnes grading 2.57 grams per tonne gold (McLeod, 1986). The mineralization extends over an area of 240 by 120 metres. Molybdenite is found only in trace amounts and chalcopyrite is absent (Lomenda, 1983).

INTRUSIVE CONTACTS

A new discovery, the Konkin zone, was announced in early September by Teuton Resources Corporation (press release, September 10, 1987). Gold-bearing skarn mineralization (magnetite-hematite-chalcopyrite-pyrite-quartz-calcite veinlets in chlorite-diopside-garnet-bearing rock) occurs in Unit 1 strata intruded by a diorite stock. Native gold (electrum) occurs locally as coarse arborescent bands. Gold assays of chip and trench samples ranged up to 10 grams per tonne over 6 metres. The discovery chip sample assayed 960 grams per tonne gold over 1.3 metres.

Several minor occurrences of pyrrhotite and chalcopyrite are located around the margin of the Lee Brant pluton. These zones may be similar to gold-bearing pyrrhotite-pyrite veins that are emplaced peripheral to Jurassic plutons in the Stewart area (Alldrick, 1985, page 337). No assays are known for the Lee Brant mineralization.

STRATABOUND

Stratabound mineralization consists almost exclusively of pyritic zones, lenses and seams contained within a particular stratum or restricted set of strata. Typically they are confined to a single formation. Examples include: disseminated pyrite (up to 15 per cent) in Unit 3 felsic volcanic rocks exposed on the west side of Treaty Glacier; millimetre-thick seams of massive pyrite in bedded siltstones of the lowermost 50 metres of Unit 4 exposed in the Bowser Valley; and disseminated to massive pyrite in dacite porphyry and its overlying sediments located at the toe of Knipple Glacier. None of these stratabound pyrite occurrences is known to have associated precious metal values.

SUMMARY

The map area is underlain by lower to middle Jurassic volcano-sedimentary arc-complex lithologies, capped by

middle Jurassic marine-basin turbidites. All rocks are members of the Hazelton Group. Syn to post-volcanic intrusions predate middle Jurassic turbidites. Tertiary plutons are few and of limited extent. The rocks record a protracted and complex history of fracturing, faulting and folding. A correct interpretation of this history may be critical in understanding the distribution and types of mineral deposits.

Strata of upper Unit 1 and lower Unit 2 contain most of the major vein and disseminated deposits. Although these deposits are epigenetic they appear to share the same geological history as their host rocks. Mineral and alteration zones are therefore probably middle Jurassic rather than Tertiary.

The area is heavily staked (Figure 1-18-1), but few companies are currently active. It warrants much more intensive prospecting and exploration. The potential for discovering bonanza-type and bulk-tonnage precious metal deposits is excellent.

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