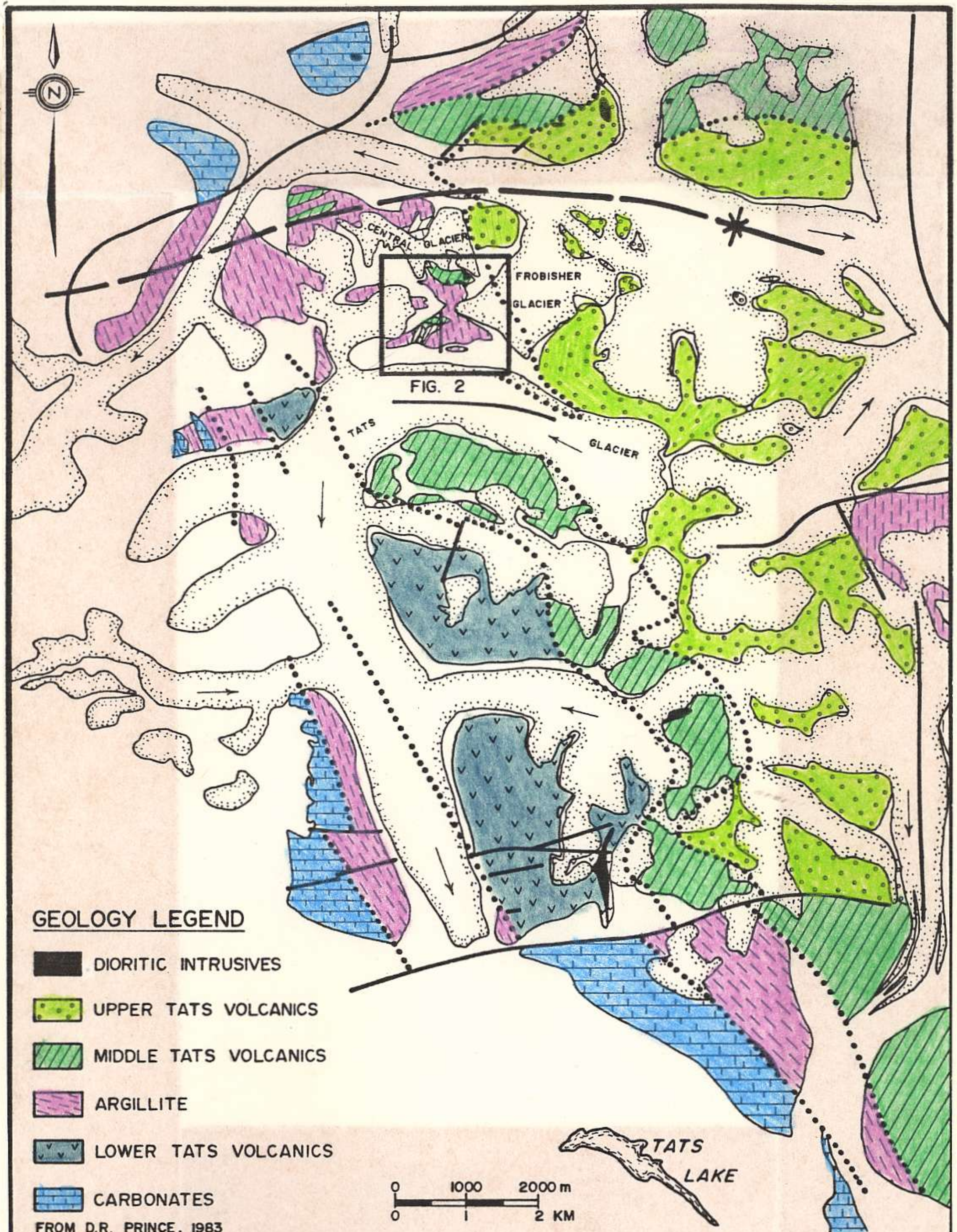
676058
114P/13



OUTLINE GEOLOGICAL MAP OF WINDY CRAGGY/TATS LAKE AREA

Gammon and Chandler, 1986

Geology in the Real World – the Kingsley Dunham Volume
IMM 1986 RW Nesbitt + I. Nichol eds
p131–141

Exploration of the Windy Craggy massive sulphide deposit, British Columbia, Canada

J.B. Gammon B.Sc., Ph.D., M.I.M.M.
Exploration Manager, Falconbridge Limited, Delta, B.C., Canada
T.E. Chandler B.Sc.
Project Geologist, Falconbridge Limited, Delta, B.C., Canada

SYNOPSIS

The Windy Craggy massive sulphide deposit is located within the St. Elias Mountains in the northwestern corner of British Columbia. Access is at present limited to helicopter. Most of the deposit is covered by glacial ice and snow fields and exploration work is difficult, challenging and expensive.

Sulphide bearing boulders were discovered in 1958, follow-up led to the discovery of outcrops and staking of the deposit. As the result of an agreement between Falconbridge Limited and Geddes Resources Limited an intensive exploration programme has been carried out during the period 1980-83.

The deposit lies near the contact of extensive pillow basalts and a dominantly sedimentary sequence composed of black argillaceous siltstones and limestones which are interbedded with minor intermediate volcanic units. The age relationships of these rocks are presently poorly understood. Recent work by the Geological Survey of Canada on conodont faunal assemblages has established a Norian age for sediments in the vicinity of the deposit.

Drilling and mapping to date have demonstrated the presence of sulphide mineralization over an apparent strike length of at least 1800 metres. The sulphide body is grossly comformable to the enclosing volcanic and sedimentary units. The adjacent wall rocks are characterized by both sediments and volcanics. Stringer type sulphide mineralization is found within this altered assemblage on both sides of the massive sulphides. Detailed mapping at the northern end of the zone has succeeded in identifying two phases of folding deforming the sulphides and adjacent wall rocks.

The sulphide body exhibits gross mineralogical and chemical zonation. An encouraging gold intersection was encountered in DDH 14-83 which assayed 9.2 g/t over 61.23 metres. Much work remains to be done to evaluate the significance of this intersection, the structural complexity, stratigraphy, metal zonation and tenor and the overall economic significance of this intriguing deposit.

LOCATION, TOPOGRAPHY AND ACCESS

The deposit is located at Latitude 59 degrees 44'N and Longitude 137 degrees 44'W in the northwestern section of British Columbia (Figure 1), known as the Alsek area after the main drainage system in the region. This is one of the most rugged parts of Canada and is at least 50% covered by ice fields and glaciers. Both Mount Logan, the highest mountain in Canada, which reaches an elevation of 5,852 metres and Mount Fairweather the highest point in British Columbia, which rises rapidly out of the Pacific Ocean to a height of 4,633 metres are in this region. The relative relief of these impressive peaks to their surroundings rivals that of Mount Everest. It is perhaps not surprising that exploration activities in this region have lagged behind other areas of the Canadian Cordillera.

There are no settlements in the Alsek south of the Yukon border. Whitehorse, in the Yukon Territory, is the nearest large population centre in Canada and has been used as the staging and

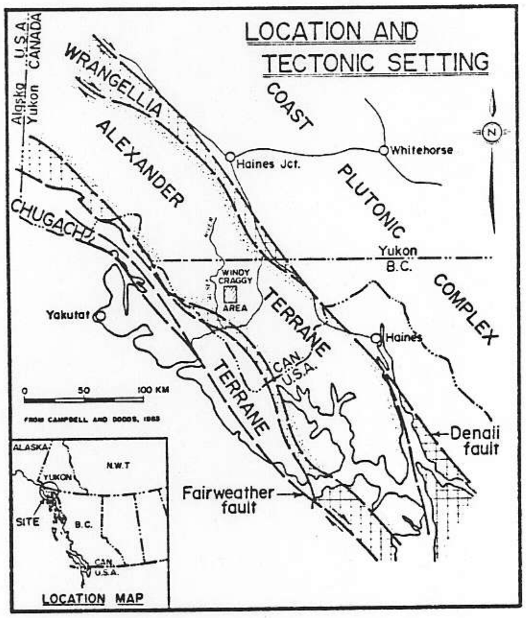


Fig. 1. Location and tectonic setting of the Windy Craggy area.

supply base for exploration activities in the region. It lies about 200 air kilometres north-east of Windy-Craggy and has a wide range of services available. Fuel and supplies were flown in from Whitehorse by fixed wing aircraft to support exploration during the 1958-83 period.

The nearby Alaskan coastal communities of Haines and Yakutat both offer port facilities which could be used for concentrate shipments should the property be brought into commercial production. Linkage of the deposit area to the existing highway systems serving these communities will need the usual careful engineering studies required for northern mountainous areas.

HISTORY OF EXPLORATION

A brief aerial reconnaissance was carried out in 1957 by J.J. McDougall of Falconbridge who spotted potential landing sites in the area and noted possible signs of mineralization.

During the summer of 1958, a regional prospecting programme was carried out using two Piper Cub aircraft supplemented by a Bell G2 helicopter. During this period a reconnaissance geological map of the region was prepared, topographic names were given to the most prominent features and some forty mineralized prospects were located, and staked including the Windy and Craggy claims. Reconnaissance geological observations were made and chip samples were taken over the exposed mineralization on the east flank of Windy Craggy mountain, which assayed 0.9% Cu, 0.2 ozs/t Ag over 168 m including 30 m which ran 1.41% Cu.

In 1959 float running up to 4% Cu was located beneath mineralized, but inaccessible outcrops, to the north of the chip sampled zone. Additional sampling was carried out and 5 short packsack drill holes, totalling 93 metres were put down over a strike length of 61 metres. The best intersection was 2% Cu over 3.3 metres in DDH 4/59.

In 1960 work concentrated on the southern section of the zone. An additional 14 packsack drill holes, totalling 173 metres were drilled and included 5 collared in the glacial ice covering part of the zone. A transit controlled geological survey was made of all the accessible portions of the mineralized zone. These structures were believed to be plunging to the north.

In 1965 a programme of 3 AX holes totalling 364 metres was completed (Figure 2). The best intersection obtained (DDH 3/65) was 1.51% Cu over 42.7 metres. These indications were considered to be interesting enough to warrant maintaining the property in good standing. However, the isolated location, severe climate, glacial cover and steep topography suggested that the indicated copper grades were not sufficiently high to warrant commercial exploitation in the forseeable future. The property remained in Falconbridge's inventory for the next 15 years.

During the period 1977-79 the Geological Survey of Canada was active in the St. Elias Mountains and Alsek region and produced a preliminary geological map.[1] The Windy-Craggy deposit lies within the unit mapped as the Kaskawulsh Group which was considered at the time to be a local thin accumulation of pillow lava and breccia of Cambro-Ordovician age within an Ordovician carbonate and greywacke sequence.

In 1979 and 1980, the Thornhill labs of Falconbridge examined samples of the 1965 drill core. Electron probe measurements indicated that pyrrhotite and coexisting pyrite contained cobalt values in the ranges of 0.1% to 0.5%. The host rock was described as spilitic pillow basalt.

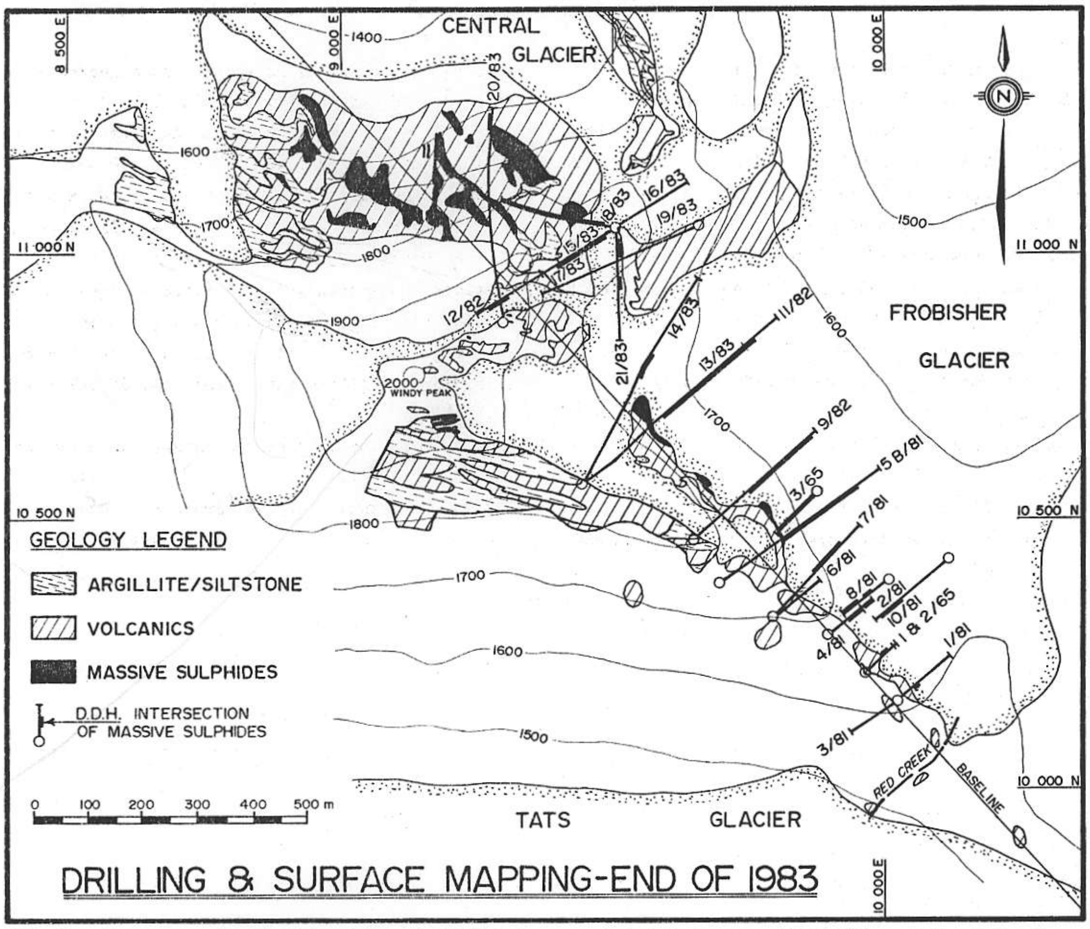


Fig. 2. Outcrop geology and location of drill holes completed during the 1965-1983 period. Holes have been projected vertically upwards to the topographic surface.

The sulphide minerology of the Windy-Craggy zone was considered possibly related to the vent area of a volcanogenic sulphide zone.

In 1981, Falconbridge entered into an agreement with Geddes Resources Limited and staked additional claims in the area. The area of interest was covered by a DIGHEM helicopter mag/EM survey. A major drilling programme, managed by Falconbridge, was carried out in that year with 10 holes totalling 2541 metres using 2 long-year Fly 38 machines. This drilling suggested a continuous zone over a strike length of 400 metres with mineralization to a depth of at least 492 metres. The northernmost hole completed that year (DDH 5B/81) returned an encouraging 1.23% Cu over 165.2 metres.

In 1982, one of the Fly 38 drilling machines was replaced with a Longyear 44 for its better depth capacity. Drilling proceeded northwards from DDH 5B/81 with holes 9/82, 11/82 and 12/82 being drilled for a total of 1364 metres. Further encouraging results were obtained with DDH 11/82 returning 2.78% Cu over 112.8 metres and DDH 12/82 returning 1.8% Cu and 17g/t Ag over 162.8 metres including a section assaying 3.1% Cu over 52.7 metres. Drilling in 1982 and 1983 was totally helicopter supported due to the topographic positions of the collars. Available drill set-ups were very limited. The expenditures incurred by Geddes Resources Limited during the 1981-1982 period were sufficient to earn them a 49% Joint Venture interest with Falconbridge on the property.

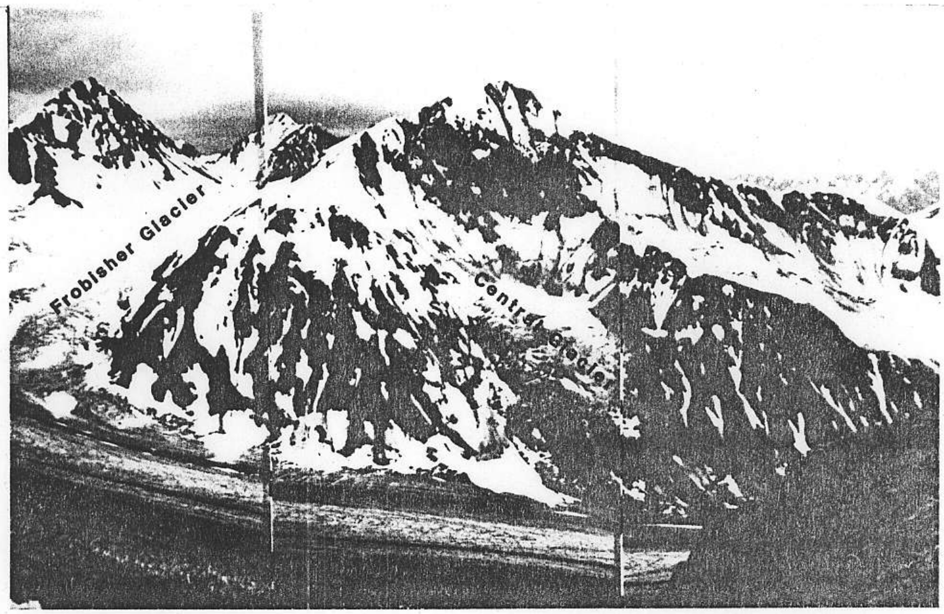


Fig. 3. North Face of Windy Craggy showing the area of sulphide outcrops above the Central Glacier.

The 1983 drill programme was designed to attempt to obtain more complete information in the vicinity of holes 11/82 and 12/82. A further 9 holes were completed that year, for an aggregate metreage on the property of 8,410 metres. The 1983 programme was jointly funded by Geddes Resources and Falconbridge in accordance with their respective equity interests in the Joint Venture.

The holes drilled in 1983 confirmed mineralized widths and copper grades. However, the sulphide zone was distinctly thinner in the area between holes DDH 11/82 and DDH 12/82. The main hole testing this area was DDH 14/83. Assay results for this hole, however, revealed the presence of an interesting gold zone with values of 9.6 g/t Au and 1.22% Cu over 61.2 metres. Within this interval 38.7 metres averaged 12.8 g/t Au and the best 6 metre section averaged 28.8 g/t Au.

The resulting pattern of drill holes at the end of 1983 is shown on Figure 2. The north face of Windy Craggy, above the Central Glacier, is seen on Figure 3. Float collected from the glacial debris suggested that the mineralization continued across this face. The DIGHEM helicopter EM results also indicated a strike extension of the main sulphide body in this area. To gain critical information, a team of mountaineering geologists, from Dihedral Exploration Limited, was engaged to map and sample the North Face. The work confirmed the presence of this hypothesized zone and mapped two phases of folding affecting the mineralized zone and the enclosing wallrocks. Mapping results are also summarized in Figure 2.

In late 1983 Falconbridge conveyed title to the property to Geddes Resources in return for a carried 22.5% interest in the net proceeds of production following recoupment of capital. Geddes Resources have announced plans to undertake a financing to raise sufficient funds to drive an exploration adit to assess the area of indicated gold mineralization and higher copper grades by further underground exploration drilling.

REGIONAL GEOLOGY

As indicated on Figure 1, the Windy Craggy area is located within the Alexander Terrane, one of the "suspect terranes" which are considered to have been accreted to the west coast of North America as a result of Pacific sea floor spreading during the Mesozoic. Recent geological mapping [2] indicates this area is underlain by complexly deformed Paleozoic clastics

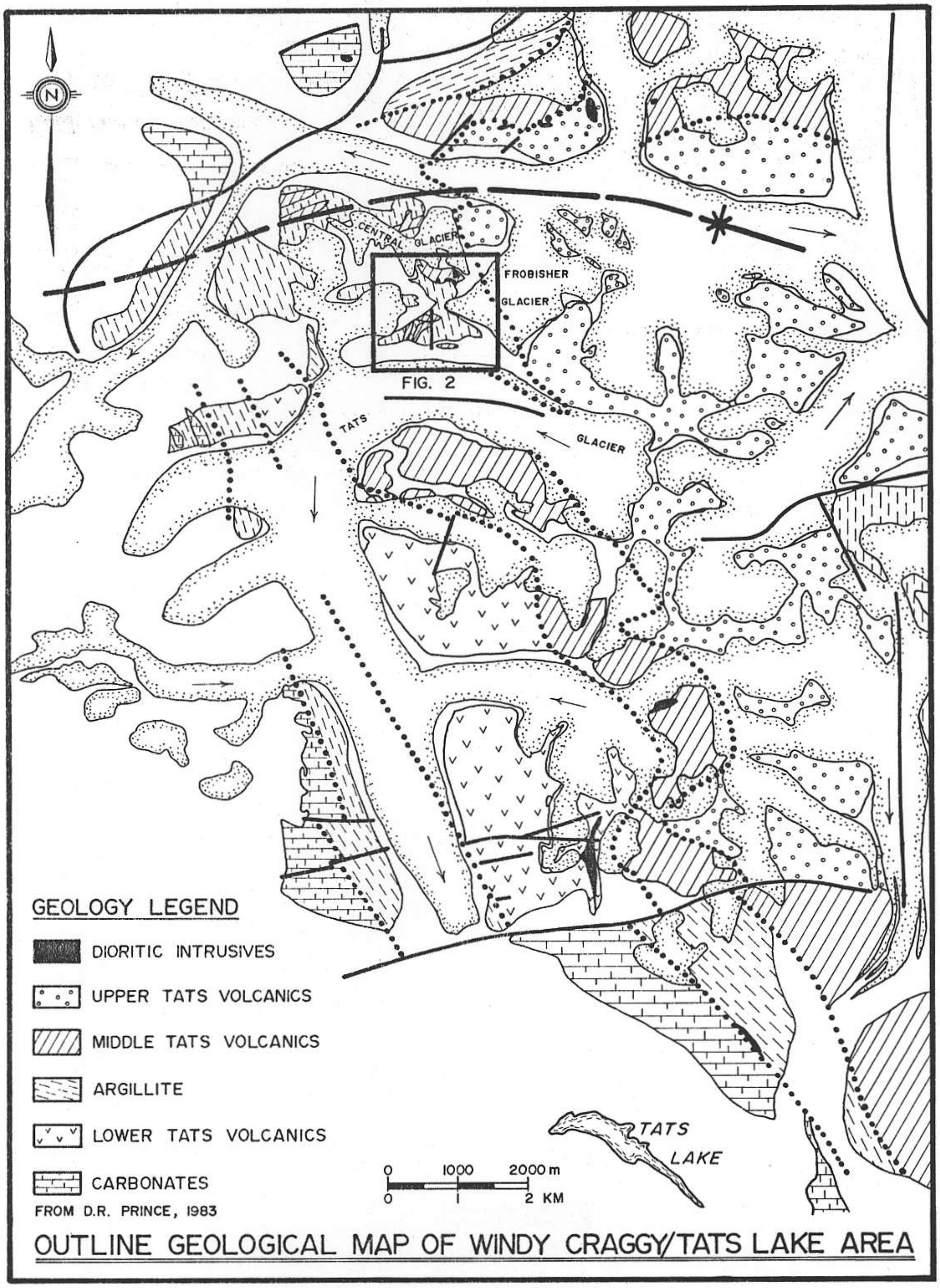


Fig. 4. Distribution of main rock units in the vicinity of Windy Craggy.

and carbonates of relatively low metamorphic grade.

The property is underlain by an extensive monotonous sequence of black graphitic shales and argillites with occasional intercalated volcanic flows. These are in contact with a large volcanic complex, herein termed the Tats Complex, which consists of intermediate to mafic flows, pillow basalts and minor sediments. Reconnaissance mapping by D. Prince in 1983[3] (Figure 4) combined with visits from government geologists[4-5] has helped define a broad but useful stratigraphic section. Five major subdivisions can be derived as follows:

Upper Tats Complex	- Age uncertain (Late Triassic?) - mainly pillow basalt
Middle Tats Complex	- Upper Triassic - Mixed shales, argillites, pillowed and massive flows.
Lower Tats Complex	- Age?: intermediate to mafic flows diorite sills.
Graphitic Shale Unit	- Age?: Limy graphitic shale, argillites, limestone.
Limestone Unit	- Siluro-Devonian? - Grey platy limestones.

Large scale block and strike-slip faulting disrupt this stratigraphy to the south and east and may be prevalent elsewhere. The Lower Tats Complex appears to be spatially restricted to the central portion of the property due in part to faulting and possible lateral facies changes. The sequence appears to be upright generally with steep dips and facing directions toward the NE. Reversal of dips and tops directions on the North end of the property suggests a broad synclinal fold structure plunging easterly with its axis running generally E-W along the Frobisher glacier to the north. Elsewhere folding varies markedly in style and complexity and is chiefly governed by the competence of the major lithologies. The sediments undergo plastic deformation when in contact with only mildly warped massive volcanic units.

The Middle Tats Complex which forms the host rocks for the Windy Craggy deposit can be traced in outcrop as well as by a low resistivity DIGHEM response from North of Tats Lake to the Tats glacier. The Lower Tats Complex has been faulted off, or grades out by facies changes, with the result that the Middle Tats Complex changes towards the SW by decreasing volcanic content into the graphitic shale unit.

The Middle Tats Complex has been dated in the vicinity of the deposit by the Geological Survey of Canada[4] using conodont faunal assemblages collected from limy sediments in both drill core and surface samples. Ages obtained are consistently Norian or Upper Triassic. Calcareous shale and argillite units of identical appearance have been intersected on both sides of the main stratiform sulphide zone suggesting that the mineralization may be coeval and Triassic in age.

The Upper Tats Complex is a thick unit of dominantly pillowed basaltic volcanics. Facing directions obtained from pillows confirm the broad synclinal fold structure mapped at the north of the property.

DEPOSIT GEOLOGY

General

Surface geology is shown on Fig. 2 and includes the results of surface and structural mapping carried out on the North Face by Dihedral Exploration in 1983. Surface outcrop is limited by extensive snow, ice and talus cover. Difficult topography limits conventional access to the steeper portions of the mountain. This specialist crew of geologists has extensive rope climbing experience. Further surface mapping will probably require geologists of similar background.

Lithologies

The major lithologies in the deposit area consists of mixed graphitic shales and argillites and intermediate to mafic massive and pillowed flows. Sediments tend to dominate in the south and western portions with volcanics increasing in abundance and importance towards the NE. Pillowed volcanics have been identified on the north side of the deposit and grade northwards into the massive pillow basalts of the Upper Tats Complex. Volcanics interbedded with the argillaceous rocks tend to be massive amygdaloidal flow and sill units of intermediate to mafic composition.

Chloritic alteration of volcanics increases with proximity to the mineralization culminating in chlorite schist. The lithological classification on the maps and sections is based on broad groupings of similar rocks and is based on field classification only. Summary descriptions follow:

Argillites
Dominantly dark grey to black calcareous, graphic shales, siltstones and lesser grey to buff impure limestones. A slaty cleavage is well developed in most members and is axial planar to F1 isoclinal folding. "Nodular" argillites are locally abundant and contain ellipsoidal boudins of light grey calcareous siltstone and limestone with long axes oriented parallel to the prominent cleavage. Thin primary pyritic beds are often observed within the shales.

Volcanics
Intermediate to mafic massive flows and tuffs, with minor columnar jointed and pillowed basalts. Individual units vary from less than one meter to more than 50 meters in thickness and are laterally continuous over observed strike lengths of from 100 to 400 meters. These units often pinch and terminate abruptly within the sediments, and some of them may represent sill units. Thinner vesicular flows, ash tuffs and breccias have been observed in drill core.

The suite of intermediate to mafic volcanics is altered to greenstones and chlorite schists. Chloritic alteration is most common but carbonatized and silicified volcanics are locally abundant. These altered volcanics are commonly in close proximity or adjacent to the massive sulphides. Stringer and disseminated pyrite and pyrrhotite are commonly associated, with pyrrhotite dominating near massive sulphide contacts. The large expanse of altered volcanics found along the ridge at the location of DDH 19/83 has been positively identified as pillow basalts with pillows stretched and deformed along the prominent schistosity. Wavy and crenulated cleavage has been observed attesting to a secondary folding event at nearly right angles to the S1 axial cleavage.

Basic Dykes
Gabbroic mafic dykes are of limited occurrence. They are medium grained and generally with abundant felted hornblende phenocrysts in a calcite-chlorite-epidote matrix.

Cherty Zones
Cherts of presumed chemical precipitate origin, together with carbonate facies "iron formation" containing an assemblage of siderite, dolomite and calcite. The carbonates have textures indicating co-precipitation with sulphide minerals. Thin bedded pyritic and magnetite bearing units are also prevalant in this zone together with thin volcaniclastic units. This package of rocks hosts the gold mineralization encountered in DDH 14/83.

Sulphides
Includes semi-massive sulphides. Gangue minerals include fragments of chlorite schist, silicified or dolomitized argillite and a fine grained matrix of quartz, siderite or ferroan dolomite and calcite. Stilpnomeland and gypsum commonly coat fractures or line cleavage faces.

Structure
Severe fold deformation in the deposit area has been suspected since the 1982 season. Until then the SE portion of the deposit had been regarded as a simple tabular body dipping steeply towards the NE. Drill intersections in 1982 and surface mapping results suggested a tight synclinal fold structure plunging moderately to the NW. A second folding event was suspected from indirect evidence of folded S1 cleavage planes.

Mapping on the North Face during 1983 proved exceptionally useful in tying down the structural complexities. Primary F1 isoclinal folds trending NW and WNW are in turn deformed by secondary F2 open folds trending N to NNE. F1 folds are often overturned towards the SW and plunge moderately (30°-50°) towards the NW. The plunge of F1 axes varies due to the influence of the steeply North plunging F2 folds. The interplay between these deformation events is further influenced by the interface with the steep topography resulting in a complex outcrop pattern as shown on Fig. 2. The sulphide exposures on the North Face are

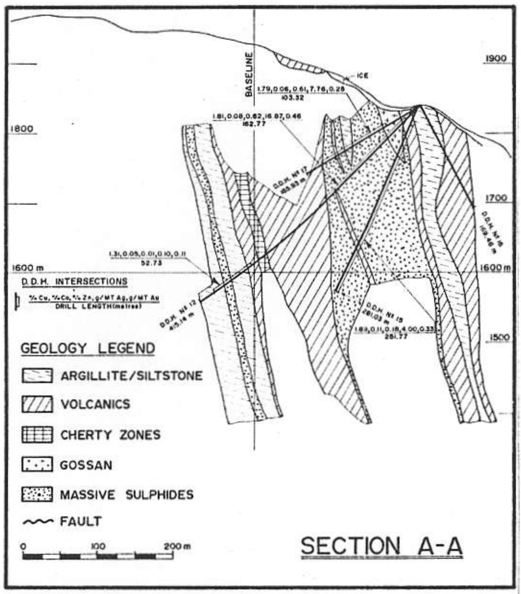


Fig. 5. Interpreted geology of Section A-A.

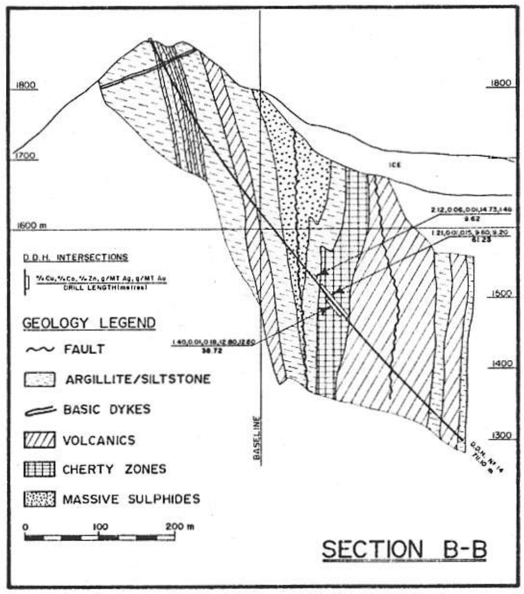


Fig. 6. Interpreted geology of Section B-B.

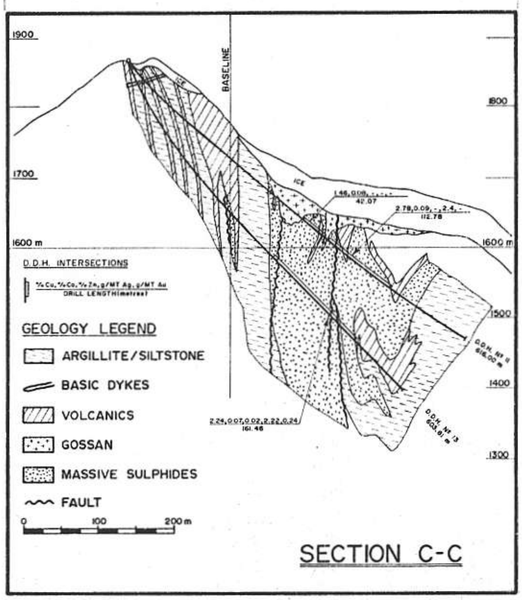


Fig. 7. Interpreted geology of Section C-C.

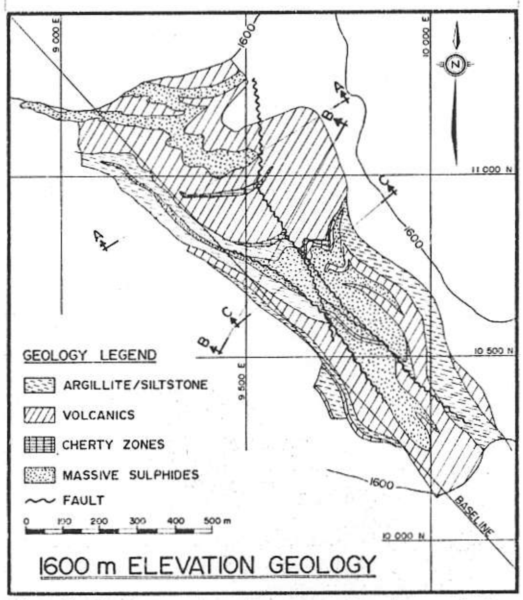


Fig. 8. Interpreted geology, at the plane of the 1600 m. elevation, showing the locations of the sections shown in Figs. 5-7.

covered by mixed volcanics and shales with only minor alteration. These could be regarded as a hanging wall sequence.

Extrapolation of this structural history to the SE was impossible from surface information alone due to the poor outcrop exposure. Geological information compiled from total drilling to date has been used to construct level plans, long sections and pseudo-sections, in an attempt to define the geometry of the deposit.

THE SULPHIDE ZONE

The strike extent of the mineralization indicated on Fig. 2 is approximately 1800 metres from Red Creek in the south to the Central Glacier in the North. Over this distance the character of the mineralization changes. At the southern end of the zone pyrrhotite is the dominant iron sulphide present, copper grades are usually about 1% or less and cobalt is present in the range of 0.05% to 0.25%. In the section of the zone between holes 5B/82 and 13/83 pyrite predominates over pyrrhotite as the dominant iron sulphide, copper grades increase to a range of 1% to 2.5% and cobalt values decrease to around 0.05%. Proceeding northwards, in the vicinity of hole 14/83 the sulphide zone decreases greatly in width. The copper values also decrease to around 1%. However this is the same interval that contains the promising gold values referred to above.

In the vicinity of hole 12/82, the zone widens up again, copper values are in the range of 2% to 3% and are accompanied by some silver and zinc, cobalt is low. North of this area, in the North Face area mapped by Dihedral Exploration, there are some indications of a lateral transition to a more sphalerite rich mineralogy hosted by argillite.

Each season of drilling has advanced progressively towards the NW along the mineralized zone. Nevertheless drill cross sections remain wide spaced, generally separated by intervals of 100 meters or more, due to the tremendous strike length of sulphide mineralization. To further complicate interpretation many sections are restricted to a single hole and many of the 1983 sections were forced to depart from a uniform cross sectional bearing due to limited drill site availability and deviations in the strike of the sulphide zones. This situation made necessary construction of level plans at five arbitrarily chosen elevations to assemble the data into a possible model. Figs. 5 through 7 show possible generalized geological interpretations across three sections through the zone. Fig. 8 shows a plan view of the deposit geology at the 1600 m elevation. The geology as shown in complex due to the interplay of the two phases of folding and resulting variance in strike of lithological units.

Interpretation of the deposit geology envisages two distinct sulphide bodies isoclinally folded, cross folded, faulted and separated by a thick altered pillowed volcanic unit. The SE deposit is composed dominantly of pyrrhotite and tapers to a narrow semi-massive to stringer sulphide zone in the extreme southeast. This body is deformed by several isoclinal F1 folds which are apparently overturned to the southwest. The F1 fold axes are in turn warped by steep northeasterly plunging open folds which probably induce variable plunge attitudes along F1 axes. The major portion of the deposit occupies a synclinal fold plunging to the WNW and is cut by a prominent fault zone trending sub-parallel to the fold axis. The central, pyrite bearing zone in the massive sulphides plnnges northwesterly and is intersected in DDH 11 and 13 on cross-section C-C (Fig.7) where it occupies the core of the syncline west of the medial fault. Pyrite content increases proportionally upwards with DDH 11 intersecting primarily pyritic sulphides. East of the medial fault on this section pyritic sulphides are thrown into a complicated fold pattern interpreted to plunge towards the northwest. The intense isoclinal folding exhibited could be attributed to proximity to massive, competent, altered volcanics immediately to the northwest and the presence of abundant incompetent argillaceous host rocks. The gold-bearing cherty horizon intersected in DDH 14, section B-B (Fig. 6) may, if stratiform, overlie the folded pyritic sulphides and plunge steeply northwest beneath the volcanics.

The altered, foliated, pillowed volcanic sequence overlying the SE sulphide body is folded into a broad syncline. The axial trace of this fold passes near the collar of DDH 19 and extends through the synclinal fold closure in the NW sulphide body at the location of DDH 12, 15, 16 and 17 on cross-section A-A (Fig. 5). These holes cut the folded sulphide body at an oblique angle. DDH 18 was drilled down the dip and plunge of the fold; it effectively represents a longitudinal section through the sulphides and returned an assay of 1.93% Cu over an impresive 415 metres.

The second, lower sulphide intersection in DDH 12 in 1982 has been extrapolated upwards to form a thin lateral strike extension of the SE sulphide body. This zone consists primarily of

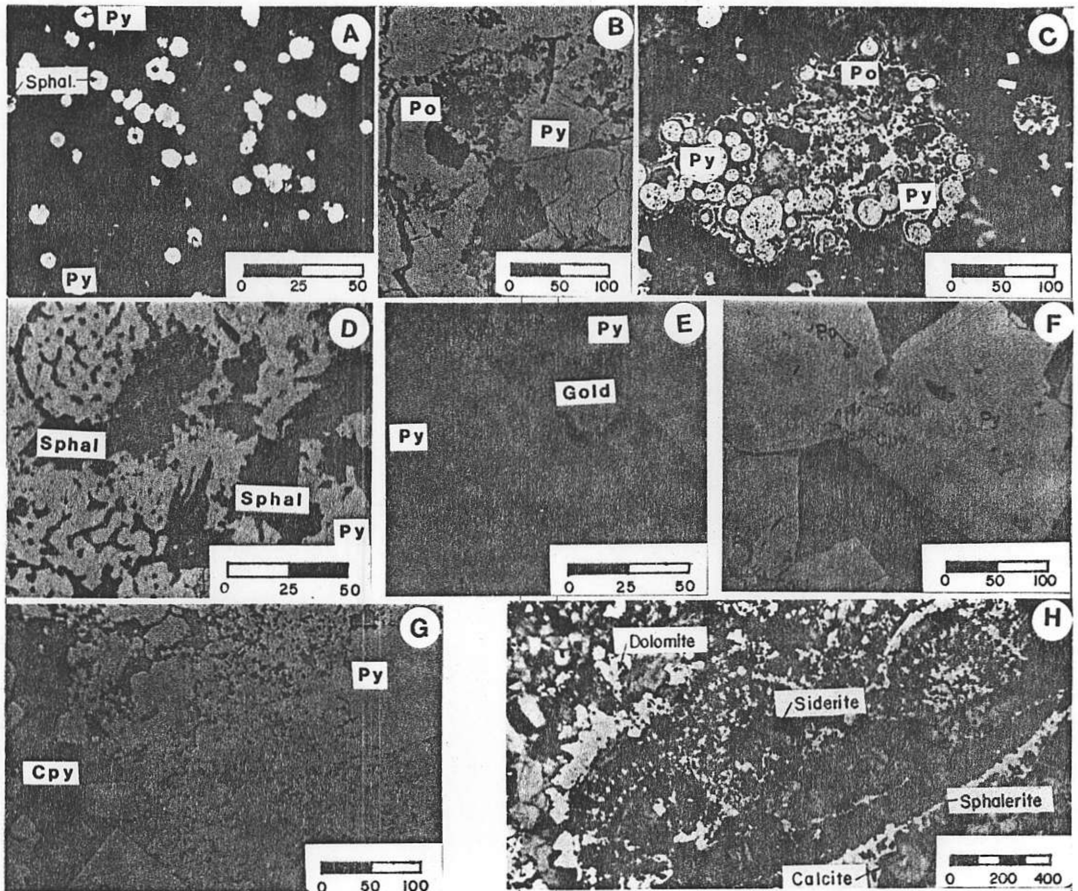


Fig. 9. Range of textures associated with the Windy Craggy mineralization. (Scale bar in all cases is in microns). A. - Pyrite framboids with nuclear core of sphalerite. B. - Pyrite framboids enclosed in massive pyrite-pyrrhotite. C. - Possible transition between the textures shown in A and B. D. - Circular structure of (?) organic origin imbedded in a pyrite-sphalerite mixture. E. - Gold associated with pyrite. F. - Gold associated with pyrite, pyrrhotite and chalcopyrite. G. - Euhedral and subhedral pyrite in a matrix of chalcopyrite, pyrrhotite and spongy pyrite. H. - Apparent co-precipitation texture of carbonates (calcite, dolomite and siderite) with sulphides (sphalerite and pyrite) in the host rocks to the gold mineralization in hole 14/83.

pyrrhotite in altered silicified argillites and volcanics. The surface expression of the zone may sub-crop west of the collar of DDH 20, which was drilled essentially down dip and plunge of the altered volcanic unit, intersecting minor patchy sulphide concentrations. A pyrrhotite-rich intersection at depth in hole 20 may represent a deep cut at part of the NW sulphide body.

Hangingwall rocks overlying the NW sulphide body are relatively unaltered mixture of volcanics and argillites. They are superficially similar in appearance to the argillite/volcanic package south of the SE sulphide body. The immediate underlying footwall rocks to both sulphide bodies are primarily chloritic, mafic and sometimes pillowed volcanics bearing disseminated and stringer sulphides. A notable exception occurs in the intensely folded pyrite zone at the northwest terminus of the SE sulphide body, in the vicinity of DDH 11 and 13 on cross-section C-C. In this portion the sulphides are enclosed for the most part by dominantly argillaceous sediments.

Regional stratigraphic observations can be related to the present interpretation of the deposit geology to propose a genetic model to guide further exploration. The known deposits are underlain by mafic volcanics, including pillow basalts, near their contact with a graphitic shale sequence characterized by decreasing volcanic content downsection. It would appear that deformational episodes had little effect on the massive volcanics of the Tats Complex with intense folding restricted to the sedimentary package. The entire section may represent a slice of deep ocean crust with sulphide bodies originating from "black smoker" vent areas adjacent to an active basaltic spreading centre. The abundance of pelitic sediments suggests rapid concurrent sedimentation perhaps analogous to the Guaymas area in the Gulf of California.[6]

Acknowledgement

The permission of Falconbridge Limited and Geddes Resources Limited to publish this material is gratefully acknowledged. Many members of Falconbridge field crews actively contributed to the achievement of the results documented here, we would particularly like to acknowledge the contribution of J.J. McDougall, discoverer of Windy Craggy, and manager of programmes during the 1958-1981 period and to Denis Prince, Exploration Manager with United Keno Hill Mines Limited who joined our team in 1983 and produced the geological map on which Figure 4 is based. R.L. Buchan of Lakefield Research Limited contributed greatly to our understanding of the deposit through his petrographic studies.

The contributions of geologists from the Geological Survey of Canada (R. Campbell, C. Dodds, K. Dawson and M. Orchard) and the BC Department of Mines, Energy and Petroleum Resources (D. MacIntyre) are also gratefully acknowledged.

References

1. Campbell, R.B. and Dodds, C.J.: Operation Saint Elias, British Columbia, in Current Research, Pt. A. Geological Survey of Canada Paper 79-1A, pp. 17-20, 1979.

2. Campbell, R.B. and Dodds, C.J.: Geology, Tatshenshini Map Area (114P), Geological Survey of Canada, Open File 926, 1983.

3. Prince, D.R.: Report on Reconnaissance Geological Mapping of the Windy Craggy area, B.C. NTS 114P, Falconbridge Limited, Internal Report, September 1983.

4. MacIntyre, D.G.: A Comparison of Stratiform Massive Sulphide Deposits of the Gataga District with the Midway and Windy-Craggy Deposits, Northern British Columbia, B.C. Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1982, Paper 1983-1, pp. 149-170, 1983.

5. MacIntyre, D.G.: Geology of the Alsek-Tatsenshini Rivers Area (114P), B.C. Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1983, Paper 1984-1, pp. 173-184, 1984.

6. Scott, S.D., Lonsdale, P.F., Edmond, J.M. and Simoneit, B.R. (1983): Guaymas Basin, Gulf of California: Example of a Ridge-crest Hydrothermal System in a Sedimentary Environment (Abstract), Geological Association of Canada Program with Abstracts, Vol. 8, Victoria, 1983.