GEOLOGICAL INVESTIGATIONS OF THE 21B DEPOSIT, ESKAY CREEK, NORTHWESTERN BRITISH COLUMBIA (104B/9W)

By R.L. Sherlock, T.J. Barrett, T. Roth, F. Childe, J.F.H. Thompson
Mineral Deposit Research Unit, U.B.C.
D. Kuran, H. Marsden
Homestake Canada Inc.
R. Allen
Volcanic Resources

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INTRODUCTION

The Eskay Creek property (56° 38'N, 130° 27'W) is located in the Iskut River area, about 80 kilometres north of Stewart, British Columbia. It is underlain by Triassic Stuhini Group and Jurassic Hazelton Group sediments and volcanic rocks described by Alldrick *et al.* (1989); Britton (1991), Lewis (1992); and Lewis *et al.* (1992). The mineral deposits of the 21 zone are hosted by a sequence of mainly bimodal volcanic rocks of Lower to Middle Jurassic Hazelton Group. The 21A and 21B zones occur within fine-grained sedimentary rocks that are underlain by rhyolite and intermediate volcanic rocks, and overlain by basalts. Studies by company geologists (Blackwell, 1990; Rye, 1992; Edmunds and Kuran 1992) have outlined the main stratigraphic, lithogeochemical and alteration characteristics at Eskay Creek, and documented the nature of the mineral deposits. Regional geological relations on the property have been described by Bartsch (1992a, 1992b, 1993a, 1993b); Roth (1992) and Roth and Godwin (1992).

The 21A and 21B zones are distinguished by their mineralogy and geochemical characteristics. For a more detailed account of the 21A deposit the reader is referred to Roth and Godwin (1992) and Roth (1992). Field work in 1993 by the Mineral Deposit Research Unit involved relogging and sampling of selected drill-holes through various styles of mineralization in the 21B zone. This report concentrates on the stratigraphy, sedimentology and mineralization of the 21B orebody. The currently defined mineable reserves in the 21B zone are 1.08 million tonnes grading 65.5 grams per tonne gold, 2930 grams per tonne silver, 5.6 % zinc, and 0.77 % copper (Homestake Canada Inc. Feasibility Report August, 1993).

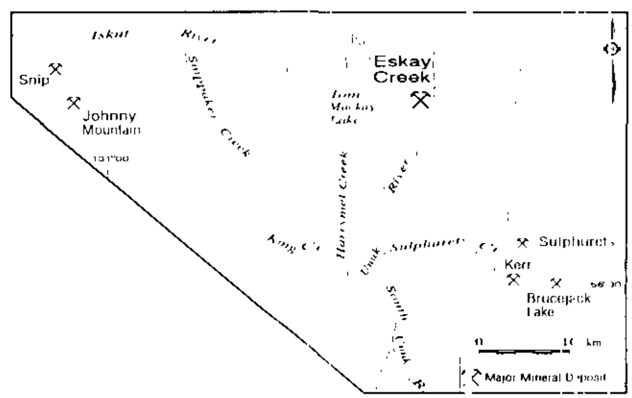


Figure 1. Location map of the Eskay Creek deposit, Iskut River Area

MINE SEQUENCE STRATIGRAPHY

FOOTWALL VOLCANIC UNIT

The footwall volcanic unit has in the past been referred to as the footwall dacite unit. It overlies marine sediments and volcaniclastic rocks, of Hettangian through late Pliensbachian age, of the lower Hazelton Group, and underlies the footwall rhyolite.

The unit comprises aphanitic flows, sills and primary to reworked volcaniclastic material. Geochemically it is quite variable, ranging from dacite to basalt (Rye, 1992). The unit is generally altered to a characteristic pink-beige colour and is cut locally by a series of quartz-pyrite ± sphalerite-galena-chalcopyrite veinlets with grey, sericitic envelopes. A distinctive marker horizon is the dacite datum which commonly contains quartz-filled or locally chlorite-filled amygdules. The footwall volcanic unit is regionally in excess of 100 metres thickness (Britton *et al.*, 1990).

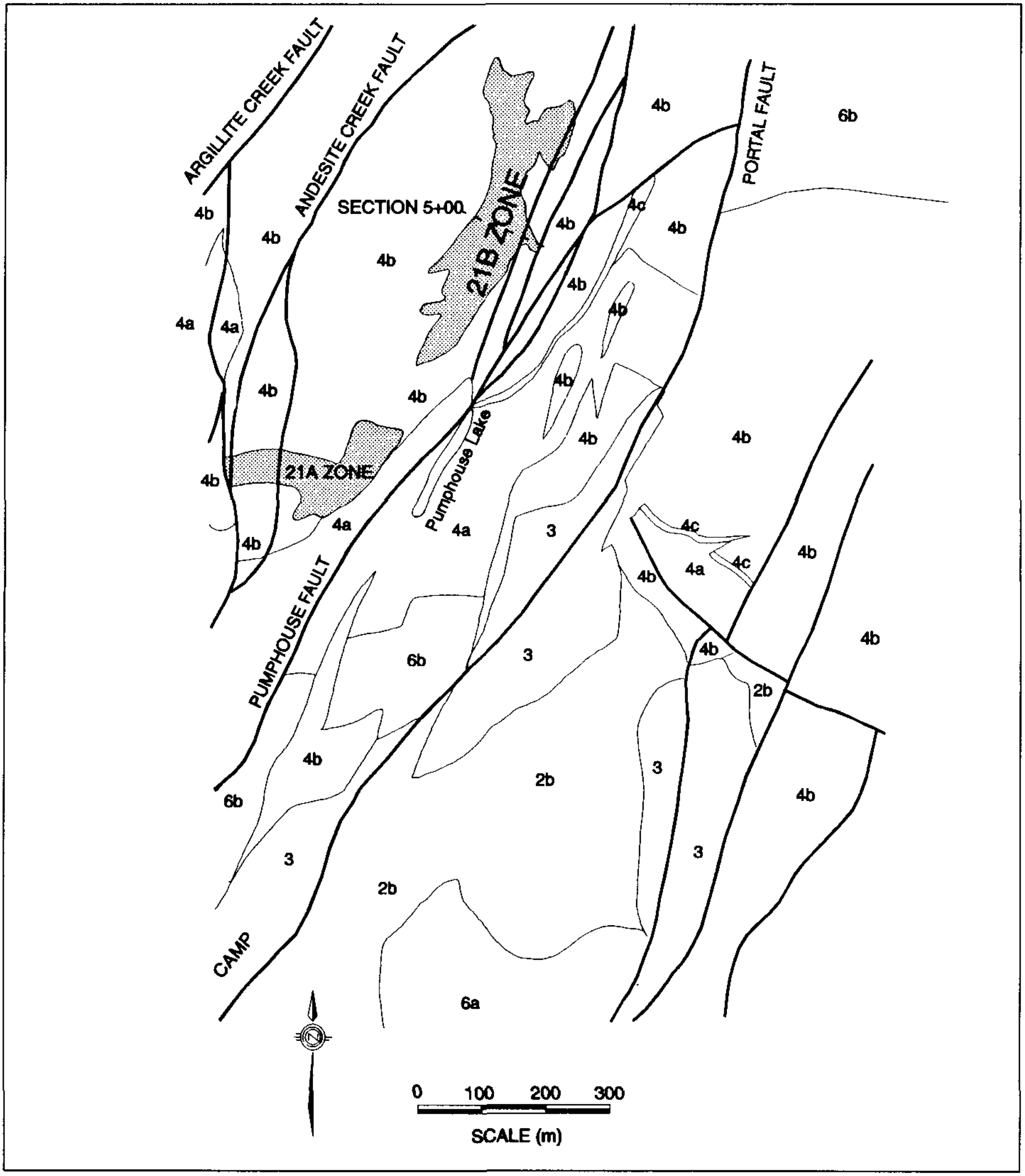


Figure 2. Geology of the Eskay Creek property. 2b, intermediate, coarse epiclastics with minor mudstone, limestone and andesite-derived conglomerates; 3, heterolithic felsic volcanic fragmentals, air fall welded tuffs, vesicular dacite fragmentals, and massive to perlitic dacite (lower volcanic unit); 4a, massive to flow-banded and autobrecciated rhyolite, with tuffs and fragmental units (footwall rhyolite); 4b, pillow basalts, hyaloclastites, debris flows, flow breccias, autobreccia with intercalated sediments, and unaltered mafic dikes (hangingwall basalt); 4c, argillite (contact zone argillite); 6a, monzodiorite; 6b, feldspar-phyric siliceous, pyritic dikes/sills (felsite). Geology based on company reports.

The footwall volcanic unit is commonly separated from the overlying footwall rhyolite by a narrow (less than 1 to 3 metres thick) black mudstone horizon, which may contain low-grade gold, silver and base metal mineralization.

FOOTWALL RHYOLITE

Rhyolite forms the immediate footwall to the 21B stratiform deposit and is the host to stringer-style discordant mineralization. This unit consists of massive to flow-banded rhyolite, flow and hydrothermal breccias, and pyroclastic deposits. Hyaloclastite and perlitic textures occur locally. Primary textures are commonly obscured by pervasive alteration. Within the mineralized zones, this unit is altered to an assemblage of quartz, potassium-feldspar, chlorite and sericite. The upper contact of the rhyolite with the argillite is commonly marked by a black-matrix breccia, consisting of matrix-supported white rhyolite fragments in a siliceous black matrix (Rye, 1992; Bartsch, 1993b; Roth, 1992). The footwall rhyolite ranges from 30 to 110 metres thick (Britton *et al.*, 1990)

CONTACT ARGILLITE (TRANSITION ZONE)

The contact argillite occurs between the rhyolite and the overlying basalt, and is the host to the stratiform sulphide-sulphosalt mineralization of the 21B zone. The unit consists of a laterally extensive, well-laminated, carbonaceous mudstone that is variably calcareous and siliceous. Radiolaria, dinoflagellates, rare belemnites and corals have been identified within it, indicating deposition in a marine environment (Roth, 1992; Nadaraju, 1993). Prehnite porphyroblasts are locally abundant in the argillite; these have been referred to as crystallites in exploration drill logs.

The basal member of the contact argillite is termed the transition zone, which comprises fine sericitic flakes in mudstone. The flakes tend to decrease in abundance away from the rhyolite. The sericite material are similar in appearance to some of the underlying altered rhyolite and were probably derived from this unit. The contact argillite ranges from less than 1 metre to more than 60 metres in thickness (Rye, 1992; Britton *et al.*, 1990).

HANGINGWALL BASALT

The hangingwall basalt occurs as both extrusive and intrusive phases, and ranges from aphanitic to medium grained with local feldspar phenocrysts. In places, basaltic sills and dikes are intrusive into the contact argillite. Elsewhere, well-preserved pillows and pillow breccias overlie the argillite. Chlorite and quartz-filled amygdules are common and tend to be concentrated at the upper contacts of flows (Rye, 1992). Thin argillite intervals are interbedded within the basalt. The unit exceeds 150 metres in thickness (Britton *et al.*, 1990).

INTRUSIVE ROCKS

Several intrusions are exposed on the property including monzodiorite (Eskay porphyry, 185 ± 5 Ma, Macdonald *et al.*, 1992), mafic intrusives (Salmon River equivalents) and the "felsite". The felsite is chemically equivalent to the Eskay rhyolite and is strongly altered to an assemblage of silica, pyrite and minor sericite forming the gossanous bluffs prominent at the Eskay camp. The felsites crosscut stratigraphy and reach their highest stratigraphic level directly below the 21 zone deposits (Edmunds and Kuran, 1992; Bartsch, 1993b).

STRUCTURE

The stratigraphy at Eskay Creek is folded about a gently plunging upright fold trending at 035°, called the Eskay anticline. The 21A and B deposits occur on the gently west-dipping, northeast-striking western limb of this fold. Faults striking north-northeast, notably the Andesite Creek, Pumphouse, Portal and East Break faults, crosscut and offset the stratigraphy (Edmunds and Kuran, 1992).

ALTERATION

Footwall alteration is dominated by pervasive silicification of the rhyolite. In the immediate footwall to the 21 zone, the alteration is marked by the development of a chlorite-sericite (± potassium-feldspar) assemblage that increases in intensity towards the rhyolite-argillite contact. The metasomatic effects are depletion of sodium, and enrichment of potassium, magnesium and commonly silica.

MINERALIZATION

Two main styles of mineralization are recognized in the 21B zone, stratiform and discordant. The relationship between the various styles of mineralization is poorly understood and is presently under investigation.

Stratiform mineralization in the 21B zone is dominated by detrital sulphide-sulphosalt beds. The stratiform segment of the zone is about 900 metres long, 60 to 200 metres wide and locally in excess of 40 metres thickness (Britton *et al.*, 1990). Individual clastic ore beds range from less than 1 centimetre to 50 centimetres in thickness and are composed dominantly of coarse-grained clasts of zoned sphalerite, with finer grained tetrahedrite, boulangerite, bournonite and minor galena and pyrite; also present are sericitized to chloritized rhyolite fragments. Gold and silver occur as electrum and in sulphosalts. In some holes, the stratigraphically lower clastic ore beds are rich in sulphide-sulphosalt cobbles and pebbles, and pass upwards into argillite containing

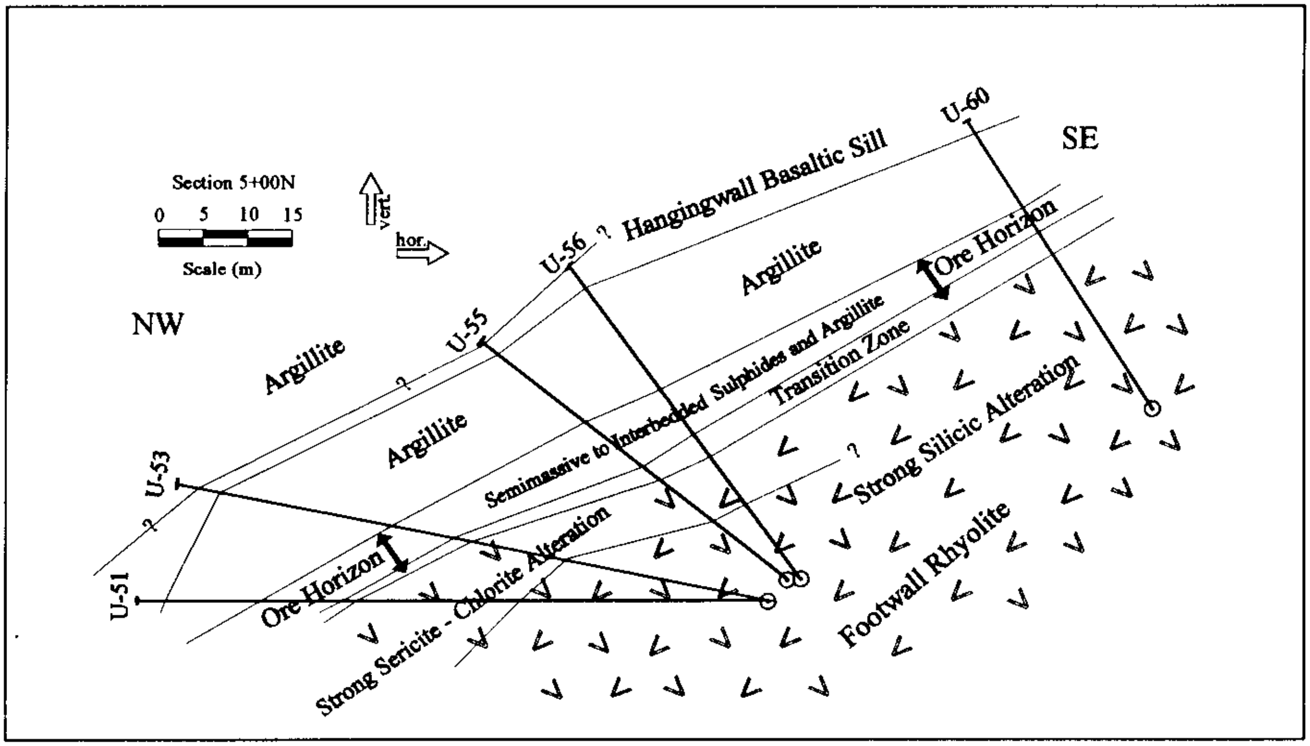


Figure 3. Cross-section through the 21B zone at section 5+00N. Based on company maps.

thinner rhythmically bedded and graded clastic ore beds. Thin, ungraded sulphide-sulphosalt beds and laminations are also present. Mineralization may have been localized in small synvolcanic seafloor depressions. The southernmost 600 metres of the 21B zone contains the highest grades and has the greatest lateral continuity; the northern 300 metres is mineralized at several stratigraphic intervals (Blackwell, 1990).

In the northern part of the 21B zone, a second interval of stratiform mineralization, termed the HW zone, is present within the contact argillite stratigraphically above the main zone of 21B stratiform mineralization. This interval is present as semimassive to massive sphalerite, galena, chalcopyrite and pyrite. The HW zone contains a much higher copper content than does the clastic ore in the lower part of the 21B zone.

Discordant mineralization occurs in the rhyolite-hosted 109 zone, which plunges down at a high angle to the rhyolite-argillite contact. The 109 zone is characterized by crustiform quartz veins and coarse-grained, zoned sphalerite, galena, minor pyrite and chalcopyrite and contains abundant carbonaceous material (Blackwell, 1990). Gold and silver occur as electrum and sulphosalts.

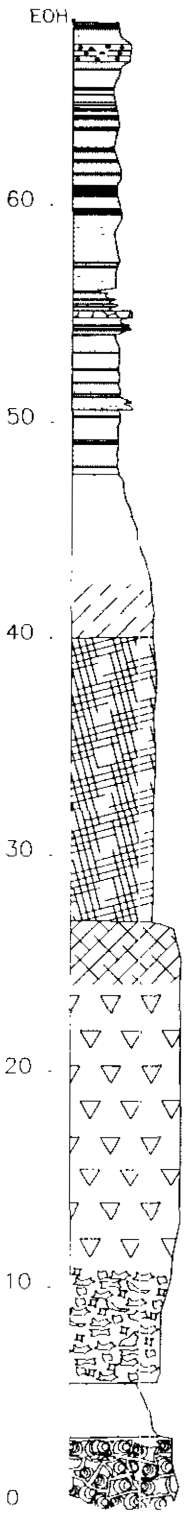
SECTIONS 5+00N & 5+25N

Although the gross stratigraphic relationships of the 21B zone are well constrained, in detail they are complex. Geological relations in the 21B zone are perhaps best examined in section 5+00N (Figure 3). Underground drilling on this section has provided high definition coverage allowing the geologic relationships to be investigated in detail. A total of eleven underground drill-holes and five surface holes penetrated the mineralized interval, although only five underground holes are shown, for clarity, in Figure 3.

In section 5+00N, the stratigraphy begins with silicified footwall rhyolite that becomes increasingly more sericitized and chloritized towards the argillite contact. The transition zone between the footwall rhyolite and the contact argillite is well developed with a variable thickness that increases to the east. The mineralized horizon comprises disseminated sulphides within the transition zone, and semimassive to thinly interbedded sulphides in the contact argillite. The contact between mineralized and overlying unmineralized argillite occurs over an interval of tens of centimetres, through a decreasing number of sulphide-sulphosalt beds. The overlying argillite is well laminated and composed of black mudstones with thin interbeds of brown ashy siltstone and grey calcareous sandstone. In section 5+00N, a basaltic sill, several metres thick, intrudes the contact argillite above the mineralized horizon.

Underground drill-hole U39, on section 5+25N, shows the stratigraphy in greater detail (Figure 4). The footwall rhyolite is divisible into several units beginning with *in situ* brecciated (hyaloclastite) and perlitically cracked rhyolite, overlain by an immature rhyolite sandstone. This is overlain by *in situ* rhyolite breccia of angular flow-banded fragments, which is probably an autoclastic flow breccia. The *in situ* breccia grades sharply into a zone of massive, waxy

U39



Mudstone, dark grey tuffaceous silt, and very fine to fine-grained sandstone

- silty to sandy laminae and beds range up to 5 cm thick within bedded intervals from 5 to 50 cm.
- fine-grained beds are khaki coloured
- 1 m sandstone interval near the end of the hole contains round to irregular calcareous concretions.

Mudstone and clastic sulphide beds

Laminated mudstone

- black mudstone containing <5% folded to crenulated, 1 to 5 cm, graded pyrite laminae and minor medium to coarse-grained volcanic sandstone beds, up to 5 cm thick, with normal grading.
- 2–3% irregular, anastomosing, fine-grained stibnite veinlets

Rhyolitic sandstone and pebbly sandstone – volcaniclastic

- sandstone is locally recognizeable through strong sericitic alteration
- moderately sorted, overall normal grading
- white sericite streaks and spots occur throughout
- up to 1% disseminated pyrite and minor sphalerite.

Sericite-chlorite altered rhyolite

- primary textures are obscured; dark grey with white patches of sericite

"Massive chlorite"

- pale green to grey, massive to mottled, waxy chlorite rock
- contains batchy cream coloured quartz-carbonate blebs up to 3 cm across, through the central 6 m of the interval. Minor to 2% pyrite and sphalerite occur disseminated and in veinlets and streaks
- primary textures are not preserved.
- lower contact is sharp; upper contact is gradational, but changes rapidly to dark grey sericite-chlorite alteration.

In situ rhyolite breccia – autoclastic breccia

- clast-supported breccia of angular, flow-banded clasts of aphyric rhyolite
- variation from preferred alignment to locally disorganized, rotated flow-banded clasts
- lower 5 m contains abundant chloritic cuspate clasts or patches suggesting possible altered glassy hyaloclastic margin
- alteration is mainly grey, pervasive to mottled quartz-sericite, partly controlled by flow bands and clast boundaries. Few thin chlorite veins occur locally
- minor disseminated pyrite occurs throughout. Minor sphalerite and tetrahedrite occur locally in thin (<2cm) veinlets with sericite or quartz-sericite.

Well sorted rhyolitic sandstone – pyroclastic deposit

- diffusely stratified, angular clasts range from 1 to 15 mm

In situ rhyolite breccia – hyaloclastite

- clast-supported breccia of broadly curved fragments containing arcuate to concentric perlitic fractures.

Figure 4. Detailed log of underground drill-hole U39, on section 5+25N.

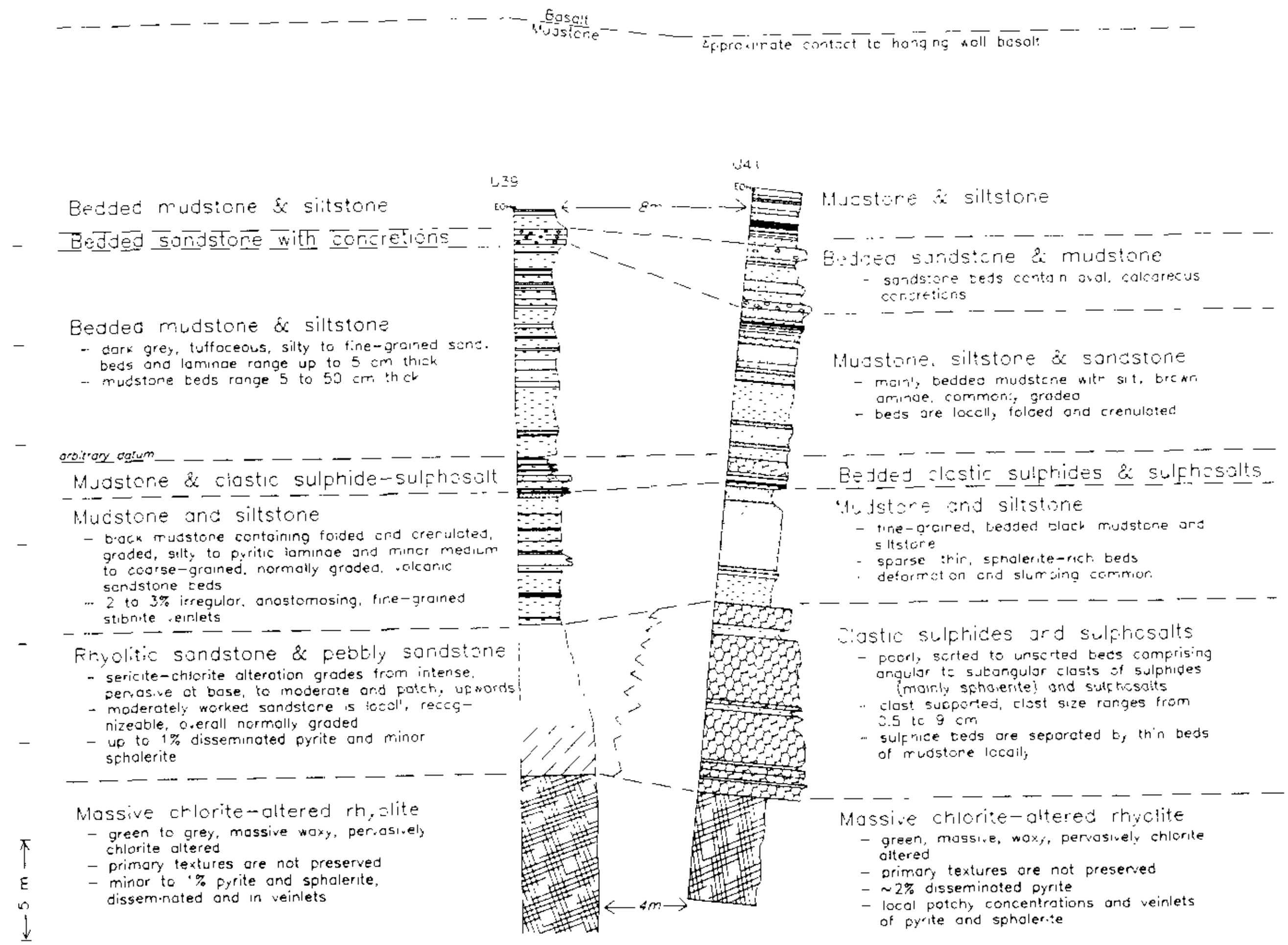


Figure 5. Detailed stratigraphy of underground drill holes U39 and U41, both from section 5+25N. Possible correlations are shown. Note the close spacing of the drill holes (4-8 metres).

green chlorite which is in turn overlain by a dark grey sericitized and chloritized rock. The actual field distinction between sericite-chlorite-altered rock and chlorite-altered rock is based on the physical appearance of the rock, not on chemical composition. This distinction may be misleading as some phases of the chlorite alteration are a pale brown colour and are often mistaken for sericite (R. Britten, personal communication, 1993). In U39, this intensely altered rock contains minor (3%) pyrite and sphalerite, disseminated and in thin veinlets. Intense sericite-chlorite alteration decreases gradually upward. Volcaniclastic rhyolitic sandstone is recognized locally at the top of the footwall. The footwall rhyolite is overlain by laminated mudstone with pyrite laminations and minor medium to coarse-grained, graded, volcanic sandstone beds. Within this interval are irregular anastomosing stibnite veinlets. The stratiform mineralized 21B horizon in hole U39 is entirely within the argillite unit, approximately 5 metres above the rhyolite-argillite contact. This mineralized horizon consists of eight clastic sulphide beds ranging between 0.5 and 25 centimetres thick; separated by mudstone beds; the total thickness of this package is 1.7 metres. Angular to subrounded clasts in the ore range from less than 1 millimetre to 3 centimetres in diameter and are generally poorly sorted to unsorted; normal grading is locally weakly developed in the thinner beds. The clasts are mainly sphalerite, tetrahedrite and fine-grained sulphosalts; specks of electrum are visible locally within the clasts. Clasts include sericite and chlorite-altered rhyolite, and local rip-up clasts of argillite with pyritic or silty laminae. These lithic clasts comprise less than 5% of the ore beds and commonly increase in abundance toward the tops of the graded sulphide-sulphosalt beds. The mineralized horizon is overlain by a variably calcareous mudstone with thin interbeds of grey tuffaceous siltstone and sandstone.

Rapid thickness variations of individual units are exhibited between U39 and U41, two closely spaced drillholes in section 5+25N (Figure 5). The drill intersections of the mineralized intervals are only 4 to 8 metres apart but are markedly different in character, even though the stratigraphy above and below the mineralized intervals is correlatable. The datum used in Figure 5 was the uppermost clastic sulphide-sulphosalt bed. This datum is preferred as it also brings into alignment the main igneous-sedimentary contacts. However, different geological interpretations are possible using a different datum. Mineralization in drill hole U41 is dominated by 8 metres of almost continuous, massive, thickly bedded, unsorted, coarse-grained, heterolithic, clastic sulphide-sulphosalt fragments which occur immediately above the pervasively chloritized interval. Minor mudstone interbeds within this sequence are less than 10 centimetres thick. Barite fragments are common near the base of the ore sequence, but decrease upward. Lithic fragments are minor. Clasts are angular to subangular and range from 0.1 to 10 centimetres across. Colloform banding of sulphides and sulphosalts observed in one large clast is sharply truncated at the clast margins.

This thick sequence of clastic ore is overlain by a sequence of mudstone and siltstone which contains thin beds and laminae of clastic sulphides and sulphosalts over another 8.5 metres; the latter beds become most prominent in the uppermost 1 metre which may correlate with bedded mineralization in hole U39. Notably, a thin zone of gouge underlies this upper zone of bedded mineralization in both drill holes, and may reflect a shallow-dipping fault which has displaced beds at this locality.

The lateral variations between individual mineralized beds in U41 and U39 probably reflect cross-strike variations in the deposition of the mineralized beds. The beds were probably deposited rapidly, perhaps as chaotic mass-flows that infilled local depressions, or as sheets of debris that paralleled the elongation of the 21B zone. Thickness variations presumably were influenced by basement topography as well as distance from source. In section 5+25N, the thick sulphide-sulphosalt sequence can be traced for at least 25 metres in other drill holes to the east of U41.

DISCUSSION

Eskay Creek represents a precious metal enriched sea-floor deposit, with well-preserved stratiform mineralization as well as footwall stringer mineralization in areas such as the 109 zone. The overall geological relationships in the Eskay Creek camp have been documented by Rye (1992) and Edmunds and Kuran (1992). The present study is part of a detailed investigation into the physical nature of the volcanic and sedimentary environments during mineralization, and the mechanisms of emplacement of the mineralized beds. Many of these beds probably represent localized debris flows derived from *in situ* accumulation of sulphide-sulphosalt material but it is not yet understood if these beds are the product of seafloor mass wasting or fragmentation during volcanic activity.

Future work by the Mineral Deposit Research Unit will focus on measuring the composition of the fluids that formed the stratiform *versus* stringer mineralization, and quantifying footwall alteration using recent lithogeochemical and X-ray diffraction methods to assess chemical and mineralogical changes. Continuing efforts are being made to constrain the age of the volcanic rocks and the lead isotopic composition of the various mineralized zones using radiogenic isotopes.

The 21B zone is a small but very attractive exploration target. Understanding the relations between footwall and stratiform mineralization through studies of fluid evolution, footwall alteration, metal-precipitating mechanisms, and ore redistribution on the seafloor may aid future exploration for these unique mineral deposits.

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