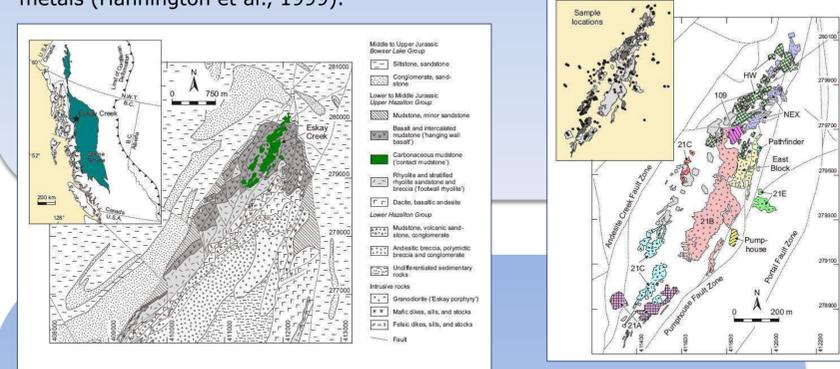


Introduction

The Eskay Creek massive sulfide deposit, located in the Iskut River area of northwestern British Columbia, is not adequately constrained by the classic massive sulfide ore deposit model due to unusually high precious metal concentrations (avg. **48.4 g/t Au** and **132.3 g/t Ag**), a geochemical footprint more reflective of epithermal environments, low sulfide/sulfosalt deposition temperatures (<200°C), and the graded nature of the mudstone-hosted clastic ore (Roth et al., 1999). Eskay Creek is considered a type example of a new group of volcanic-hosted gold deposits that formed in relatively shallow-water submarine environments where hydrothermal fluid phase separation represents an important control over the precipitation of metals (Hannington et al., 1999).



Geology

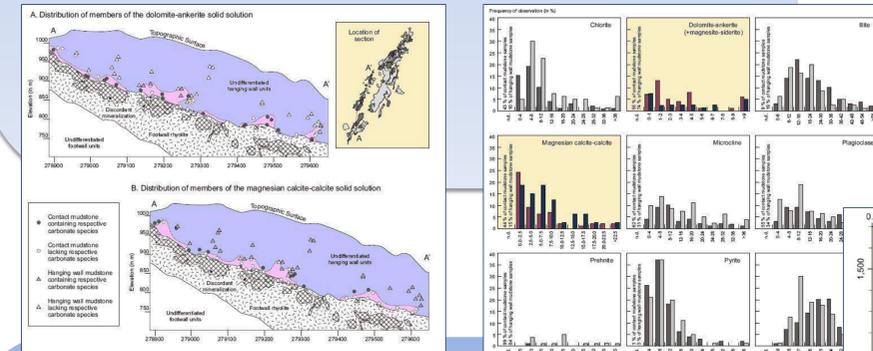
The Eskay Creek deposit is located in the Iskut River area at the western margin of the allochthonous Stikine terrane of the northern Canadian Cordillera (*above left, inset*) which is composed of Middle Jurassic submarine and subaerial volcanic and sedimentary rocks (181 and 172 Ma; Childe, 1996). Host rocks are folded into a shallowly north plunging and trending anticline (*above, left*). Stratiform mineralization occurs on the western limb of the fold, near the fold closure, and dips gently 30 to 45° to the west. The metamorphic grade in the mine area is lower greenschist (Roth et al., 1999).

The 100 m (maximum) thick, rhyolitic stratigraphic footwall to mineralization exhibits secondary potassium feldspar alteration and moderate silicification peripheral to the stratiform ore and in deeper parts of the footwall. Immediately underlying the mineralization, however, the intrusive/extrusive rhyolite displays a more intense, tabular zone of pervasive chlorite and white mica formation. The carbonaceous mudstones that overlie the rhyolite footwall is <1 m to >60 m thick and host sulfide and sulfosalt mineralization. The pyrite-rich marine mudstones contain abundant fine-grained volcanoclastic material. Carbon content decreases towards the top. A series of basalt sills and dikes, locally exceeding 150 meters in thickness, define the overlying hanging wall unit. The basalt occurs throughout the carbonaceous mudstone unit and appears to have intruded mudstone while still wet and unconsolidated.

Purpose of Research

Precious and base metal mineralization occurs as laterally discontinuous, locally barren, stratiform, clastic ore lenses hosted by a thick mudstone interval, bound by underlying felsic volcanic and overlying basalts (*1st column, left image*). Given the absence of readily recognizable alteration in the fine-grained mudstone, previous research has focused largely on the footwall rhyolite alteration pattern (Barrett and Sherlock, 1996). Thus, it is currently not known whether trends within the ore-bearing mudstone can be used for target vectoring at Eskay Creek and elsewhere.

This research, therefore, aims to **characterize geochemical trends within the ore-hosting carbonaceous mudstone**. 180 mudstone samples were selected (*left, inset*) from exploration drill core, surface and underground exposures at variable distance (0 to ~4.4 km) from ore. **Contact mudstone** samples are those proximal to ore occurring above the footwall rhyolite and below the lowest hanging wall basalt. More peripheral **hanging wall mudstone** samples are collected from mudstone intervals that occur in further up stratigraphy. Mineralogy was determined by X-ray diffraction and quantitative phase analysis via the Rietveld method. Major and trace element analysis for 62 chemical components was completed via XRF spectroscopy and inductively-coupled plasma-MS.



Univariate Geochemistry

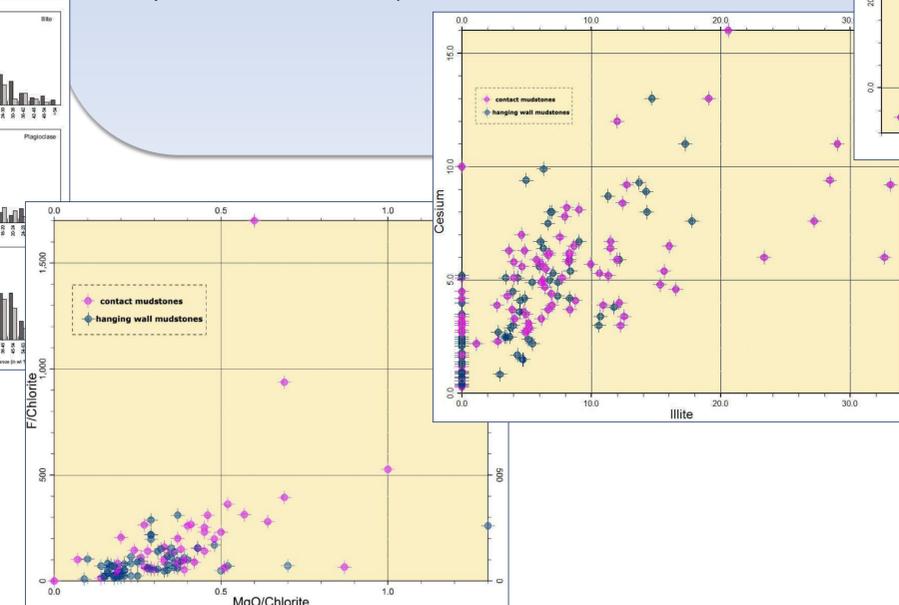
Exploratory univariate analysis of mudstone compositional data reveals important trends among carbonate mineral phases. Carbonate concentrations appear correlated to distance from the rhyolite footwall. Histogram plots of modal **dolomite [CaMg(CO₃)₂]-ankerite [CaFe(CO₃)₂] and magnesite [MgCO₃]-siderite [FeCO₃] solid solutions (*above, right*) clearly demonstrate higher abundance in the mineralized contact mudstones, suggesting these phases are restricted to areas of overlying upflow zones of mineralizing hydrothermal fluids and associated discordant mineralization in the footwall rhyolite (*above, left*). **Calcite [CaCO₃]** solid solution members show divergent behavior. Calcite is increasingly abundant in peripheral hanging wall samples, whereas calcite with a magnesite component occurs in proximal hanging wall mudstones. Current research indicates that carbonate alteration zonation may be the most reliable vector of proximity to hydrothermal upflow zones within tens to hundreds of meters of mineralized zones.**

Principal Component Analysis

PCA for a component suite that includes 89 minerals, elements and chemical variables yields a number of important factor loadings:

- **Galena, Chalcopyrite, Sphalerite, Ag, Cd, Cu, Sb, Pb, Te, Zn** – this group reflects a hydrothermal signal. The element suite identified is not unlike those of epithermal deposits.
- **Pyrite, Total Sulfur, Fe₂O₃, Mo** – this group does not correlate with the above group supporting their predominantly diagenetic origin.
- **Chlorite, MgO, F** – chlorites closer to the rhyolite footwall have higher Mg and F concentrations (*below left*), reflecting a hydrothermal source.
- **Organic C, Ni, V** – reflects Ni/V substitution for Mg in residual chlorophyll porphyrins from decaying photosynthetic organism in the marine water column (*right*).
- **Muscovite, Illite, Cs, F, Rb** – the 2 primary mudstone phyllosilicates show strong cesium and fluorine incorporation, but substitution ratios appear to vary closer to the footwall rhyolite (*below, right*).

Other potentially useful factor loadings point to 1) Th, Ta, Nb, Hf, Be enrichment in accessory phases such as zircon; 2) REE (except Eu) enrichment in sulfide-bearing samples; 3) Sr and Mn substitution in calcite; and 4) Eu enrichment in fluorapatite.



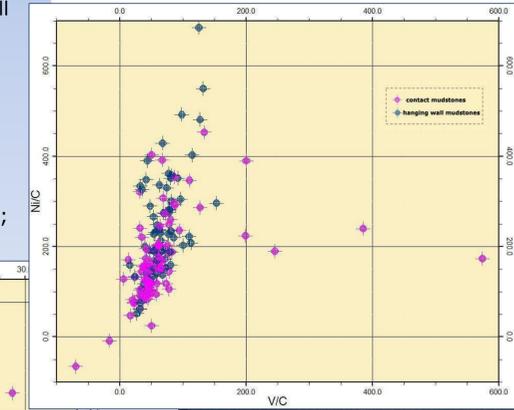
Acknowledgements

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Potential Vectors to Ore

The following minerals and component concentrations all increase with increasing alteration intensity proximal to mineralization, and will be further studied:

- Ankerite and kaolinite (end-member calcite increases in distal rocks)
- Mg and Fe concentrations in all carbonates
- As concentrations in pyrite
- Mg and F ratios in chlorite
- Cs (and possibly Rb) substitution ratios in illite
- Vanadium/organic carbon ratios



References

- Barrett, T. J., and Sherlock, R. L., 1996, *Geology, lithogeochemistry and volcanic setting of the Eskay Creek Au-Ag-Cu-Zn deposit, northwestern British Columbia*: Exploration and Mining Geology, v. 5, p. 339-368.
- Childe, F., 1996, *U-Pb geochronology and Nd and Pb isotope characteristics of the Au-Ag-rich Eskay Creek volcanogenic massive sulfide deposit, British Columbia*: Economic Geology, v. 91, p. 1209-1224.
- Hannington, M. D., Poulsen, K. H., Thompson, J. F. H., and Sillitoe, R. H., 1999, *Volcanogenic gold in the massive sulfide environment*: Reviews in Economic Geology, v. 8, p. 325-356.
- Roth, T., Thompson, J. F. H., and Barrett, T. J., 1999, *The precious metal-rich Eskay Creek deposit, northwestern British Columbia*: Reviews in Economic Geology, v. 8, p. 357-373.