

Origin of the Eskay Creek Precious Metal-Rich Volcanogenic Massive Sulfide Deposit: Fluid Inclusion and Stable Isotope Evidence

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Abstract

The Eskay Creek deposit is an unusual, polymetallic, Au-Ag-rich volcanogenic sulfide-sulfosalt deposit located in the Iskut River area of northwestern British Columbia, Canada. Economic concentrations of precious and base metals are contained in the 21 zone, which is divided into a number of subzones. As of December 31, 1998, total production and proven-probable reserves are 1.9 million tons (Mt) at 60.2 g/t Au, 2,652 g/t Ag, 3.2 percent Pb, 5.2 percent Zn, and 0.7 percent Cu. The 21B zone, which contains the bulk of the reserves, began production in 1995. The mineralization occurs mainly as well-preserved stratiform clastic beds of sulfide-sulfosalt debris and also as discordant footwall quartz sulfide veins.

The hydrothermal system that formed the Eskay deposit was low temperature (<200°C) with a relatively high gas content. Fluid inclusion petrography and measured gas ratios are consistent with liquid-vapor phase separation occurring in the hydrothermal system. The calculated fluid pressures, from fluid inclusion data, are variable as a result of contributions from vapor-rich fluid inclusions. Three samples gave calculated fluid pressures of ~150 bars that equate to a 1,500-m water depth. These analyses are considered the best indicators of the boiling depth since they most likely had the minimum contribution from vapor-rich fluid inclusions. Oxygen isotope ratios of quartz separates and whole-rock data suggest that the dominant hydrothermal fluid was normal seawater at temperatures of around 200°C. Fluid inclusion leachates suggest mixing between a seawater-derived fluid and a lower temperature (~100°C), more saline fluid which has high K/Na and Cl/Br ratios compared to normal seawater. The high-salinity fluid has halogen and cation ratios that are consistent with a magmatic-derived fluid. The relationship of this fluid to mineralization is uncertain. Sulfur isotope data suggest that the sulfide sulfur may have been derived from either an igneous source or by reduction of seawater sulfate. The dominant origin of the sulfate sulfur was seawater, although one barite sample may contain oxidized igneous sulfur. Mineralization at Eskay Creek is inferred to have formed at, or near, the sea floor in a relatively shallow-water setting, by fluid boiling which is an effective precipitation mechanism for gold and silver. The low solubility and ineffective precipitation mechanisms for base metals at these low temperatures resulted in mineralization with a high precious to base metal ratio. The best modern-day analogue of Eskay Creek mineralization is the JADE hydrothermal field in the Okinawa trough.