

Mineralization, Geochemistry, and Fluid Inclusion Constraints on the Asgat Ag-Sb Polymetallic Deposit, Western Mongolia

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The Asgat Ag–Sb polymetallic deposit, located within the Mongolian Altai orogenic belt, represents a significant silver-bearing hydrothermal system developed in a back-arc tectonic setting. This study integrates whole-rock geochemistry, REE and trace element systematics, petrography, mineral chemistry, and fluid inclusion data to constrain the evolution of the ore-forming system.

The deposit is hosted by both Late Devonian granitoid intrusions and coeval Devonian volcano-sedimentary sequences of the Khatugol Formation. The granitoids, composed of quartz, plagioclase, K-feldspar, and biotite, plot within the granite–granodiorite field and are spatially associated with mineralization. The sedimentary host rocks, including sandstone, siltstone, and carbonaceous shale, provide favorable structural and geochemical traps due to their permeability contrasts and redox reactivity.

Geochemically, mineralized samples exhibit strong LREE enrichment, relatively flat HREE patterns, and pronounced negative Eu anomalies, indicating feldspar fractionation and hydrothermal alteration. Primitive mantle-normalized spider diagrams show enrichment in LILE and depletion in HFSE, consistent with subduction-related felsic magmatism.

Fluid inclusion data indicate that ore-forming fluids were NaCl–CaCl₂-dominated aqueous solutions with moderate to high salinity (7–36 wt.% NaCl equiv.), homogenization temperatures of ~180–600 °C, and trapping pressures of ~120–450 bar. The presence of CO₂–CH₄-bearing phases and coexisting inclusion populations suggests a complex fluid regime involving magmatic fluid input, fluid immiscibility (boiling), and fluid mixing. Boiling and pressure fluctuations are interpreted as key mechanisms for metal precipitation.

Ore mineralization is structurally controlled by major fault systems and occurs as veins, veinlets, and locally stockwork zones. The ore assemblage includes pyrite, arsenopyrite, chalcopyrite, tetrahedrite-tennantite, freibergite, galena, stibnite, and Bi-bearing phases.

The Asgat deposit is interpreted as a multi-stage magmatic-hydrothermal system involving Late Devonian magmatic metal sourcing and Early Mesozoic hydrothermal reactivation, with fluid evolution, structural control, and host rock reactivity jointly governing high-grade Ag-Sb mineralization.