

Geological, Mineralogical, and Fluid Inclusion Constraints on the Xarxar and Garadag Porphyry Copper Systems, Lesser Caucasus, Azerbaijan

Anar Valiyev¹, Stephen John Westhead¹, Arzuman Rizvaonoghlu¹, Sabuhi Mammadov¹, Aydin Bayramov¹, Javid Ibrahimov¹

¹Azerbaijan International Mining Company (subsidiary Of Anglo Asian Mining), Gadabay, Azerbaijan

The Xarxar and Garadag porphyry Cu deposits are located within the Lök-Qarabağ (Lok-Karabakh) volcanic arc and the Gedabek-Garadag volcanic-plutonic belt, representing a Middle Jurassic-Early Cretaceous calc-alkaline magmatic arc system. Both deposits are genetically linked to multiphase intrusions of the Atabey-Slavyanka plutonic complex, emplaced into volcano-sedimentary sequences and controlling porphyry-style mineralization.

At Xarxar, mineralization is primarily hosted by granitic porphyry forming the main intrusive stock, with subordinate diorite and monzonite dykes distributed throughout the system. Hydrothermal alteration is well developed and vertically zoned. Advanced argillic alteration (kaolinization) affects the upper levels, while phyllic (quartz-sericite-pyrite ± chlorite) and propylitic (clinochlore-albite-quartz-sericite) assemblages dominate the intermediate and peripheral zones, respectively. Local potassic alteration (K-feldspar ± biotite) near the porphyry core indicates preservation of primary alteration zonation.

The Garadag deposit exhibits similar geological and mineralization characteristics, centered on a multiphase quartz diorite-granodiorite intrusion with well-developed potassic-phyllic-propylitic zonation. Copper mineralization occurs mainly as chalcopyrite with subordinate rare molybdenite, consistent with a typical arc-related porphyry Cu-Mo system.

Core logging reveals a dense stockwork vein system (0.2 cm to 0.5 m), dominated by A-type veins (quartz-chalcopyrite ± covellite) and D-type veins (quartz-pyrite ± chalcopyrite), whereas B-type veins are less common. Vertical zonation is well defined, transitioning from hypogene chalcopyrite to supergene enrichment (chalcocite-covellite ± bornite), and upward into an oxidized zone (malachite-azurite).

Fluid inclusion data indicate a high-temperature (195 to >400°C), saline magmatic-hydrothermal system. Coexisting liquid-rich, vapor-rich, and halite-bearing inclusions (up to 43 wt.% NaCl eq.) provide evidence for fluid boiling and phase separation as key mechanisms of copper precipitation.

Overall, both deposits represent well-preserved calc-alkaline porphyry Cu-Mo systems formed from magmatic-derived hydrothermal fluids in a Middle Jurassic-Early Cretaceous arc setting.