Gold mineralization stages at the Boroo deposit in the North Khentei gold belt, Central Northern Mongolia

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Mineral assemblages, chemical compositions of ore minerals and fluid inclusions of the Boroo deposit in the North Khentei gold belt of Mongolia were studied to define its gold mineralization stages and types. The ores of the Boroo deposit are hosted in lower Paleozoic granite and metasedimentary rocks, Mesozoic dykes, and quartz vein. Three types of mineralization are recognized: 1) disseminated and stockwork mineralization in granite, 2) disseminated and stockwork mineralization in metasedimentary rocks intruded by dykes, and 3) mineralization in quartz vein ores with about 1-5, 1-3 and 5-10 or more than 10 g/t Au grades, respectively. The main ore minerals are pyrite (pyrite-I and pyrite-II) and arsenopyrite. Moderate amounts of sphalerite, chalcopyrite, galena and tetrahedrite, and minor bournonite, boulangerite, tennantite, geerite, alloclasite, native gold and electrum are recognized. Localities, abundances and grain sizes of the ore minerals are variable in ores from different host rock. Small grains (50 µm) of native gold occur as inclusions or at grain boundaries of pyrite, arsenopyrite and sphalerite, and free native gold in granite. Native gold grains with variable sizes (30 µm to 6 mm) occur in quartz vein type ores, whereas native gold is not observed in dykes and metasedimentary rocks with mineralization.

Disseminated and stockwork mineralization in granite is divided into three stages: I) pyrite-I + arsenopyrite, II) pyrite-II + sphalerite + galena + bournonite + boulangerite + alloclasite + native gold, and III) free native gold. Disseminated and stockwork mineralization in metasedimentary rocks comprise stage I characterized by pyrite + arsenopyrite, and stage II by chalcopyrite + tetrahedrite + sphalerite. In the mineralized quartz vein, four stages are defined by I) pyrite + arsenopyrite, II) tetrahedrite-tennantite + bournonite + boulangerite + Pb-bearing mineral, III) chalcopyrite + sphalerite + geerite + native gold, and IV) electrum.

Two generations of quartz veins, that is narrow quartz veins and discrete quartz vein, in granite have been selected for fluid inclusion study. Two types of primary fluid inclusions are identified: (I) CO2-rich inclusions and (II) aqueous inclusions. Type I inclusions are abundant in veins with variable sizes (5-30 µm) hosted in granite, and subdivided into three types: (Ia) Laq+Lco2+Vco2, (Ib) Laq+Lco2 and (Ic) Lco2. Type II inclusions are small in size (5-15 µm), and common in discrete quartz vein. Homogenization temperatures of type I and II were at 317 to 362°C and 237 to 305°C, and corresponding salinities were 3 to 6 wt% and 3.6 to 5.4 wt% (NaCl equiv.), respectively.

According to geology, petrology and fluid inclusion analysis, two main gold mineralization events are proposed in the Boroo deposit: (1) early stage disseminated and stockwork mineralization caused by granite emplacement, and (2) later stage quartz vein type mineralization due to hydrothermal activity related to structural fault. Disseminated and stockwork mineralization in metasedimentary rocks was formed by metasomatic alteration due to above mineralization with two stages or to dyke intrusion in metasedimentary rocks.

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