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Formation conditions and genesis of gold and silver minerals in the Jiama polymetallic system, southern Tibet

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The Jiama deposit, a giant polymetallic deposit in the eastern Gangdese porphyry copper belt, contains early porphyry Cu-Mo, skarn Cu-polymetallic, hornfel-hosting Cu-Mo and late-stage high-sulfidation epithermal Cu-Au mineralization. The skarn ore bodies and high-sulfidation epithermal mineralization are the mainly reservoirs of gold and silver. The analytical results for different types of ores show that the skarn-type bornite ores are enriched in Au (up to 54.1 g/t), Ag (up to 1140 g/t) and Bi (up to 2.22 wt.%) and the tetrahedrite ores associated with high-sulfidation epithermal mineralization are characterized by high Au (up to 54.3 g/t), Ag (up to 1100 g/t), As (up to 4.35 wt.%), Sb (up to 20.3 wt.%) and Te (up to 2320 ppm) contents. Au and Ag contents of the bornite ores positively correlate with the Bi concentrations. The tetrahedrite ores enriched in Au and Ag exhibit high Sb, significantly higher than As.The microscopic observations show that hessite (Ag2Te) and electrum (AgAu) are spatially related to bornite and wittichenite (Cu3BiS3). The mineral assemblage of electrum + hessite + wittichenite + bornite + vaesite indicates that the forming temperatures range from 244℃ to 210℃, log(Te2) from -15.0 to -11.2 and log(S2) from -10.9 to -7.3. Electrum, hessite and sylvanite(AuAgTe4) occurring as intergrowth in the tetrahedrite, chalcostibite and tetrahedrite ores, implies that the enrichment of Au and Ag are associated with Sb. The mineral assemblage of electrum + hessite + sylvanite + petzite + enargite +luzonite-famatinite + chalcostibite + tetrahedrite indicates that the forming temperature is about 210℃, log(Te2) ranges from -15.2 to -12.3 and log(S2) from -16.8 to -12.1. It is suggested that the temperatures, log(Te2) and log(S2) decrease with the evolution of the Jiama porphyry copper-polymetallic system.Previous studies have shown that bornite solid solution contains high Bi, which efficiently extract gold from the hydrothermal fluid during the skarn ore-forming process. The wittichenite (mainly Bi-mineral) is exsolved from the bornite solid solution, causing precipitation of gold and silver in wittichenite and bornite. Experimental studies indicate that Au, and Ag are transported as HS- complexes in low temperature. The precipitation of Sb with S causes destabilization of Au(HS)- and Ag(HS)- and precipitation of Au and Ag in tetrahedrite and chalcostibite.Our study suggests that the elevated Bi content in bornite plays an important role in enriching gold and silver during the skarn ore-forming process at early stage, and the precipitation of Sb causes the precipitation of Au and Ag during the high-sulfidation epithermal mineralization at late stage.