

Nano- to micron-particulate gold hosted by magnetite in the giant Beiya gold deposit: A product of gold scavenging by bismuth melts

Haoyang Zhou*, Xiaoming Sun

*School of Earth Sciences and Engineering, Sun Yat-sen University, Guangzhou, China, Email: zhouhaoy@mail2.sysu.edu.cn

A comprehensive understanding of the host minerals for gold is critical to optimize Au recover, as well as for constraining ore-forming processes. In hydrothermal ores, gold is generally hosted by sulfide minerals due to its affinity for reduced sulfur. By contrast, the occurrence of gold in oxide minerals remains poorly documented and incompletely understood. In this study, we demonstrate that magnetite can be a significant host mineral for gold. The Beiya deposit, located in the eastern Tibetan Plateau, southwest China, is a giant porphyry-skarn gold deposit (10.4 Moz Au at 2.47 g/t), which contains significant volumes of massive Au-bearing magnetite ores. Chemical analyses of separated minerals in the skarn ores from the Beiya gold deposit show that magnetite hosts at least 14% of the total Au resources. Native gold and electrum are hosted by magnetite as nano- to micron-sized inclusions (10 nm to 10 μm in size) and as infill of microfractures in the Fe-oxides. The inclusions have Ag contents varying from 1.7 to 13.5 wt.% and occur in magnetite as randomly disseminated blebs, or concentrated in dense patches. Sometimes these inclusions are located along the outer layers or growth zones of magnetite. Electrum grains filling microfractures are generally coarser and contain up to 26.0 wt.% Ag. In addition, a range of bismuth minerals (e.g., native bismuth, maldonite and bismuthinite) are present within the same assemblage. Of these, native bismuth and bismuthinite are the most abundant. It is also common to observe native bismuth occurring in the core of magnetite, whereas bismuthinite is present in the rim of magnetite.

Textural and mineralogical studies as well as thermodynamic modeling indicate that Bi melts scavenged Au from hydrothermal fluids during magnetite precipitation. Fluctuation in $f\text{O}_2(\text{g})$ led to fractionation of Bi melts, which successively refined gold from hydrothermal fluids. Subsequently, as sulfur content increased and/or temperature dropped, sulfidation of native bismuth to bismuthinite resulted in the formation of nano- and micro-particles of native gold. Hence, this study shows that the association of Au and magnetite is the result of the Au concentration via the liquid bismuth collector model, with the reduction of Bi in solution most probably linked to the oxidation of aqueous Fe(II) to form magnetite. Fluctuations in $f\text{O}_2$ and increase in sulfur content (either externally or internally driven), as well as cooling, resulted in the modification of the Au-Bi mineralogy, obscuring many of the original textures. Exploration for comparable Au-bearing magnetite-dominant systems should aim at identifying deposits or regions in which elevated concentrations of Bi are present.