The contribution of bismuth (tellurium) melts to gold mineralization: a case study from the Baolun gold ore deposit in Hainan Province of South China

Deru Xu[1,2], Qiang Shan[2], Qinyi Huang[2,3], Guoxiang Chi[4], Teng Deng[1,2]

[1]State Key Laboratory for Nuclear Resources and Environment, East China University of Technology, Nanchang 330013, China, xuderu@gig.ac.cn
[2]CAS Key Laboratory of Mineralogy and Metallogeny, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Guangzhou 510640, China
[3]University of Chinese Academy of Sciences, Beijing 100049, China
[4]Department of Geology, University of Regina, Regina S4S 0A2, Canada

The Baolun gold (Au) deposit, with a proven reserve of > 80 t Au at an average grade of 10.3 g/t Au, is a large-scale, high-grade Au deposit located in Hainan Island, South China (Fig. 1). The mineralization occurs mainly as sheeted Au-quartz veins, with a minor amount in altered cataclasite. The orebodies are developed within a swarm of NNW-trending fracture zones in Lower Silurian meta-volcaniclastic sedimentary rocks of greenschist to lower-amphibilite facies, which were intruded by Triassic granitoids (Fig. 1). Gold mainly occurs as native Au, which is associated with a variety of Au- and Bi (Te)-bearing minerals. However, there has been debate on ore genesis of the Baolun deposit, with respect to the contribution of either magmatic-hydrothermal or metamorphic fluids to the Au mineralization.

To elucidate the issue, fifty-two sheeted Au-quartz vein samples from the Baolun deposit were selected for the present study. Bulk-rock analyses on ore-forming elements of the collected samples were performed by Perkin-Elmer Elan 6000 inductively coupled plasma mass spectrometer (ICP-MS). Polished thin-sections of the samples were investigated by optical microscopy and back-scattered electron (BSE). *In-situ* chemical compositions of the representative ore- and gangue minerals were carried out through spot analysis and X-ray elemental mapping using SHIMADZU EPMA-1720 electron microprobe analysis (EMPA) equipped with four wavelength-dispersive spectroscoies (WDS).

The hydrothermal system is divided into six stages (Fig. 2), including a pre-mineralization stage (stage-I) characterized by barren quartz, four syn-mineralization stages with different Au-Bi (Te) ore mineral assemblages (stage-II: native Au; stage-III: native Au – pyrrhotite – arsenopyrite – pyrite – chalcopyrite; stage-IV: maldonite – native Bi – Au-Bi symplectite (native Au + native Bi); stage-V: bismuthinite – native Au – jonassonite – joséite-B – galenobismuthite), and a post-mineralization stage (stage-VI) characterized by barren quartz, calcite and pyrite. The occurrence of auriferous Bi-rich blebs in stage-IV and stage-V ores, together with the positive correlations between Au and Bi (and Te), suggests that Bi melt may have played an important role in the formation of the Baolun Au deposit. This can be supported by that the stages II and III mineralization had a primary ore-fluid temperature of 545-329 ºC, higher than the melting point of 271 ºC for native Bi (bismuth).

Based on the spatial-temporal relationship between the deposit and granitic intrusions and temperature – fO_2 – fS_2 conditions deduced from mineral assemblages, we propose that the deposit formed from a magmatic-hydrothermal system (with potential contributions from metamorphic and other fluid sources). In the early stages of mineralization (stages II and III), Au was oversaturated whereas Bi and Te was undersaturated, and so native gold was precipitated with pyrrhotite, chalcopyrite, arsenopyrite and pyrite but without Bi- and Te-bearing minerals. In the later stages (IV and V), Bi and Te become oversaturated and Bi melt was developed, thus resulting in abundant Bi-Te minerals such as native Bi, maldonite, bismuthinite and joséite-B. Bi melt scavenged Au from the hydrothermal solution which was undersaturated with Au (due to precipitation in the early stages), thus contributing to Au mineralization by preventing total loss of the remaining Au with the spent fluid.

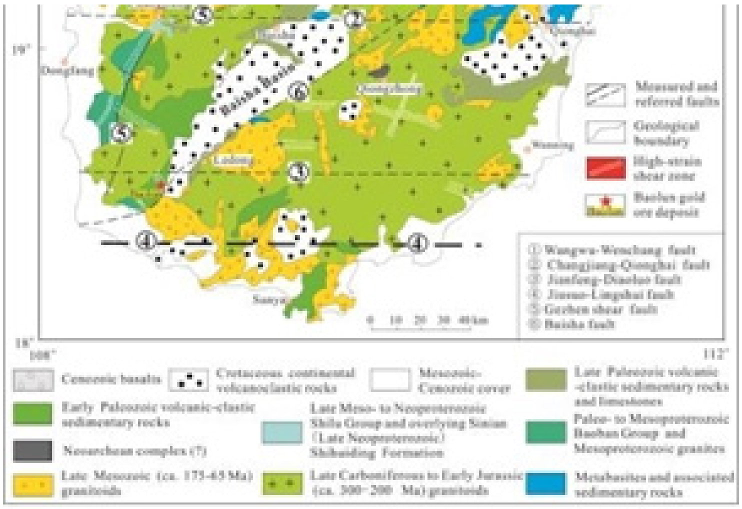

Figure 1. (a) Location map and (b) simplified map showing the main stratigraphic and magmatic units, and the Baolun gold ore deposit in Hainan Island, South China.

Figure 2. Paragenesis of ore- and gangue minerals in the Baolun Au ore deposit.