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Geological Characteristics and Metallogenesis of the Co-Cu Ore Deposits in the Northeastern Hunan Province of South China

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1 Introduction

Located on the central segment of the Jiangnan metallogenic belt, the Pingjiang-Liuyang region of the northeastern Hunan Province, South China is famous for the occurrence of a large number of Au, Cu and Co polymetallic deposits. This region has been accepted as the only location in Hunan Province where primary Co mineralization was present. Previous researches mainly focused on gold mineralization (Mao et al., 2002 and references therein) and did not pay attention to Co and Cu mineralization. The Co-Cu ore deposits of economic significance mainly include the Hengdong and the Pule Co ore deposits, and the Jingchong Cu-Co polymetallic ore deposit, and largely occurred along the NNE-trending Changsha-Pingjiang (Changping) fault zone. These deposits are commonly hosted within the altered cataclastic breccias. Here, we present the geological characteristics of the Co-Cu ore deposits in the northeastern Hunan Province, in order to provide a constraint on their metallogenesis.

2 Geological characteristics

Tectonically, the northeastern Hunan Province is situated at the central segment of the Jiangnan Orogen which generally has been regarded as the SE margin of Yangtze Block of South China. The NNE-trending Changping fault zone is the main rock- and ore-controlling structure in this region. Three main stages of tectonic development were proposed for this region since Mesozoic, i.e., from Early to Middle Jurassic shearing, via Late Jurassic to Cretaceous extension, to Cenozoic compression (Li et al., 2001). Regionally, voluminous granitic intrusions and a small amount of intermediate-acidic and mafic rocks mainly occurred during Yanshanian movement. Outcropped strata predominantly are the Mesoproterozoic Lengjiaxi Group, with local occurrence of Middle-Upper Devonian clastic sedimentary rocks. Because of multiple, complicated tectonism and magmatism, the Mesoproterozoic and Devonian rocks generally were subjected to ductile to brittle shearing and associated mylonization. Locally, these rocks were favorable of migmatization and hydrothermal alteration, especially where they are near to voluminous granitic plutons.

The NNE-trending Changping fault zone largely comprises altered cataclastic breccias which are dominated by slicification and chloritization, with subordinate sericitization and carbonatation. This zone also contains varying degree of metal mineralization depicted by ore minerals (cobaltiferous) pyrite, (cobaltiferous) pyrrhotine, chalcopyrite, arsenopyrite, and hematite.

The Co-Cu orebodies, which are hosted by altered cataclastic breccias mostly comprising the Yanshanian granitoids and the Mesoproterozoic rocks, have intimate correlation with silicification and chloritization. The ores generally show massive, veinlet-stockwork, disseminated, nodular and brecciated structures, and automorphic to hypidiomorphic, metasomatic, interstitial and cataclastic textures. Ore minerals mainly include pyrite, chalcopyrite, pyrrhotite, cobaltite, galena, sphalerite, arsenopyrite, bornite and chalcocite, predominately with quartz and chlorite as gangue minerals. Noticeably, metal Co is present mainly as isomorphism hosted in lattice of

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cobaltiferous pyrite (up to 2% for Co content), subordinately as independent sulfide such as cobaltite.

Based on mineral assemblages and paragenesis, Co-Cu mineralization in the studied region can be subdivided into three stages, i.e., the early quartz- sulfides stage, main quartz-polymetallic sulfide stage, and late supergenetic oxidation stage, respectively.

3 Metallogenesis of Co-Cu Ore Deposits

Based on the geological characteristics, this section discusses the possible metallogenesis of the Co-Cu ore deposits in the studied region, from three aspects.

(1) All the Co-Cu orebodies occurred within the Changping fault zone that was subjected to strong tectonic deformation and hydrothermal alteration. The host rocks mainly are cataclastic breccias with strong alteration of slicification and chloritization. Due to their well-developed porosity and susceptibility to brittle deformation, the lithology of the host rocks favored Co-Cu mineralization.

(2) The Changping fault zone is a favorable ore-controlling and ore-hosting structure. Accompanying its evolution, the developed secondary fractures and/or fissures might have served as favorable passageway and site for transportation and deposition of Co-Cu-bearing fluids. However, Co-Cu mineralization was most likely related to an extensional environment, based on the ore geology and the Mesozoic tectonic development.

(3) Most of the Co-Cu orebodies also occurred in the contact zones between the Yanshanian plutons (U-Pb age of ca. 160 Ma; Xu et al., 2009) and the Mesoproterozoic or Devonian metamorphic clastic sedimentary rocks. Combined with voluminous Yanshanian granitoids in the studied region, it implies that the Yanshanian magmatism had an important contribution to Co-Cu mineralization. S and O isotopic components also confirmed a magmatic origin for ore-forming metals and fluids (Yi et al., 2010).

A possible process for Co-Cu mineralization in the studied region is that post-magmatic hydrothermal fluids carrying ore metals Co and Cu were transported along favorable fissure and fracture zones, and then the ore metals were deposited when pressure, temperature and PH value changed, due to increasing meteoric water.

4 Conclusion

To sum up, the Co-Cu ore deposits in the northeastern Hunan Province of South China can be considered to be a magmatic hydrothermal fluid-related deposit-type. An extensional tectonic setting-related metallogenic model could be easily proposed to interpret Co-Cu polymetallic mineralization in the studied region.

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