The Discussion on the Ore Genesis of Yangla Copper Deposit, Yunnan, China

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1 Introduction

The Yangla copper deposit is located in the Jinshajiang metallogenic belt of the middle part of the Sanjiang Tethys metallogenic domain. It is one of the important and large deposits occurring between the approximate NS-trending Yangla fault and Jinshajiang fault. Ore bodies occur in the interlayer fissure of stratum as typically layered or bedded form, closely related to the granodiorite and skarn. Therefore, they are controlled by the combination of the pluton, strata and structures. Many researches about lithogeochemistry, diageneric mineralization chronology, fluid inclusion and isotope have been carried out. However, the ore genesis remains unresolved. The research of geochemistry, spatial-temporal relationship between the characteristics of mineral, rock and stratum could provide powerful restriction to define the deposit type correctly.

2 The Characteristics of Mineral and Ore Genesis Discussion

2.1 The characteristics of pyrrhotite

The pyrrhotite ores are the main sulfide ores type in Yangla copper deposit. It is associated with chalcopyrite and pyrite. The pyrrhotite appears massive and disseminated structure. Locally, the pyrrhotite is cut by quartz-pyrite-chalcopyrite-calcite vein, and the chalcopyrite occurs as droplet or foliaceous shape intergrown with sphalerite. The pyrrhotite in the Yangla copper deposit, has the Fe content of 59.247%-59.247% (average of 59.706%), and S content of 39.095%-39.973% (average of 39.521%). Hence, the chemical formula is Fe₆S₇-Fe₈S₉. The average value of crystal cell parameters is similar, α=11.912, β=6.859, γ=12.813, and the crystal powder X-ray diffraction profiles of pyrrhotites showed It suggests that the monoclinic pyrrhotites is primary. Accordingly, the hexagonal pyrrhotite turns into monoclinic pyrrhotite when in the sulphur-rich, rapid cooling and non-uniform stressed conditions. During this process, the sulfur of pyrrhotite was as the form of S₂⁻, the content of the iron in pyrrhotite lattice reduced and the electronegativity of Fe₁-xS increased slightly, so the reducibility increased. In the Fe-S phase diagram, pyrrhotite locates in the monoclinic pyrrhotite-pyrite zone, which indicates the ore-forming temperature is about 250°C, it means that ore bodies were formed in the sulphur-rich, reductive and non-uniform stress environment.

2.2 Ore genesis discussion

Spatially, the ore bodies are typically layered or bedded in the interlayer fissure of stratum. The roof are mainly marble and sandy sericite slates. The floor are sandy slates. The ore block with contact with Indosinian pluton, is hosted in the skarn, metamorphic quartz sandstone and marble, and far away from the Hercynian volcanic rocks, which have little relation with mineralization.

The Co and Ni contents of pyrrhotite are often used to discriminate the deposit types. Chen (1995) concluded the characteristics of Co and Ni in pyrrhotite from totally 102 different copper deposits, China, and considered that different genetic types of ore deposits might concentrate in a certain range. Based on the recognition, Yangla copper deposit is located in the margin of skarn deposit field. In the primitive mantle-normalized spider diagram of granodiorite, trace element of the intrusion is similar to that of the copper ores (Yang et al., 2011). The oxygen isotopic compositions of skarn may be inherited from acidic pluton directly, and the carbon isotopic compositions indicate that it derives from magma and marble (Chen et al. 2013), indicating that the ore-forming fluids are from the mixture of mantle and lower crust, and assimilated surrounding rock (marble). With the aid of meteoric water, the mixed magma cooled rapidly, then congealed and filled in the
fissure around ore bearing structures. It makes the open and atmospheric environment gradually becoming a closed high-pressure environment. However, the transformation of tectonic stress fields induced form a large accumulation of ore-forming metal elements (Yang et al., 2003). The features show that Yangla copper deposit is skarn type.

However, to determine the time of mineralization events and duration of the mineralization events, it is important to understand the ore genesis and identify relevant geological events thoroughly (Yang et al., 2014). For Yangla area, the igneous rock has formed at Hercynian (Wei et al., 1999). The granodiorite formed in the Indosinian (234-236 Ma), based on the molybdenite Re-Os isotope model age of 230.9±3.2 Ma (Yang et al., 2011). However, according to field trip investigation, the molybdenite hosted in quartz veins cut through the ore block. In other words, the age of molybdenite mineralization may could not represent the ore-forming age. If molybdenite, chalcopyrite, pyrite and pyrrhotite is formed in the same stage (Indosinian), molybdenite is the production of late stage and the Re-Os ages could represent the mineralization age. However, it would be also possible that the mineralization occurred in Hercynian and molybdenite was formed in Indosinian, which is suggested by the molybdenite veins cutting through the ore block. Therefore, In order to obtain the exact age of mineralization, the study of Re-Os isotope geochronology of chalcopyrite, pyrite or pyrrhotite directly is necessary. If all age data are in Indosinian, the Yangla copper deposit could not be VMS or complex genetic type. If some or all of the ages are in Hercynian, it could be a compound and superimposed deposits. Therefore, the study on mineralization age has significant effect on correctly defining the genetic type of Yangla copper deposit.

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Reference