Fluid Inclusion Studies of the Cunqian Copper Polymetallic Deposit, Jiangxi Province, China

WANG Qiang\textsuperscript{1}, XIAO Yuanfu\textsuperscript{1}, HAO Zhemin\textsuperscript{1}, ZHAO Han\textsuperscript{1}, GONG Tingting\textsuperscript{1}, HE Jiale\textsuperscript{2}

\textsuperscript{1} Chengdu University of Technology, Chengdu 610059, China; \textsuperscript{2} Chengdu Institute of Geology and Mineral Resources, Chengdu, China, 610081

1 Ore-forming Condition

The Cunqian copper polymetallic deposit is located in the combining site between Yangtze plate and Cathaysian plate, which is called Qinhang metallogenic belt, and southeast of the Yi Feng-Jing Dezhen deep fracture. It is under the Jurisdiction of the Gao An city Cunqian town and Yi Feng county Xin Zhuang village. And it is known as a copper polymetallic with mainly skarn mineralization.

Most parts of the diggings are covered by humus layers of Quaternary system, whose bedrocks are not exposed. According to the information provided by the drilling and mining engineering, the layers in the orefield respectively are Neoproterozoic Shuangqiaoshan Formation (Pt\textsubscript{3}sh), Huanglong Formation – Chuanshan Formation of Upper Carboniferous (C\textsubscript{2}h-C\textsubscript{2}c), Lower Permian Qixia Formation (P\textsubscript{1}q), Upper Triassic An’yuan Formation (T\textsubscript{3}a), Upper Cretaceous Hekou Formation (K\textsubscript{2}h) and Quaternary according to the order from old to young. The host stratum deposit is Huanglong Formation – Chuanshan Formation of Upper Carboniferous (C\textsubscript{2}h-C\textsubscript{2}c). Lithologic association is limestone, lime-dolomite and dolomite while skarnization and marbleization are located in the contact part of rock bodies. The main ore-bearing rock body is biotite granite porphyry which has the characteristics of repetitious invasion with close relationship to mineralization. The main ore-controlling structure is the Cunqian reverse plunging anticline and wings, as well as Upper Carboniferous Huanglong - Chuanshan Formation (C\textsubscript{2}h-C\textsubscript{2}c) with Neoproterozoic Shuangqiaoshan Formation (Pt\textsubscript{3}sh) angular unconformity interface.

According to the distribution of ore space, the mining area is divided into four ore belts and eight orebodies, of which the II3 ore body is the main ore, which is produced in the main rock contact zone and the unconformity between Huanglong - Chuanshan Formation and Shuangqiaoshan Formation. The second main contact zone is the footwall and carbonate rocks layers in Huanglong - Chuanshan Formation among fracture zones.

2 Types and Characteristics of Fluids Inclusions

The samples for observation and test analysis of fluid inclusions are taken from II3 ore in Cunqian deposit, which contain pyrite, chalcopyrite, quartz veins cemented massive pyrite - chalcopyrite ore of late calcite. No inclusions could be observed in the calcite without containing minerals from a transmission polarizing microscope while many primary inclusions could be observed in quartz veins bearing ore with size of 5.5~13.9\mu m. Inclusions are mainly divided into gas-liquid two phases and gas-liquid-solid three phases, a small amount of pure liquid phase and pure gas phase, mostly distributed in groups.

3 The Ore-forming Fluid Properties

3.1 Homogenization temperature

The authors tested 41 groups of primary homogenization temperature in ore bearing quartz veins, in which the lowest temperature is 249.6°C, the highest temperature is 416.5°C, which are mainly distributed in the range of 250°C~340°C, 360°C~380°C and the average temperature is 321.8°C. Temperature range is relatively concentrated, which represents the metallogenic temperature of quartz sulfide mineralization stage. There are 18 groups’ inclusions containing sub-halite crystals and the authors tested 16 groups of the crystal melting temperature whose lowest temperature and highest temperature are 199.2°C and 328.9°C. There are three situations between crystal melting temperatures of
inclusions and the temperatures of bubble disappear: ① the halite is melted before the disappear of bubbles; ② the halite is melted nearly at the same time with the disappear of bubble (only one inclusion); ③ the halite is melted after the disappear of bubbles.

3.2 Pressure
By observing and recording the sub-crystal melting temperatures contain halite inclusions by melt method test, the authors calculated the pressure range is between 1.12~8.99Mpa according to the pressure calculation formula by Bischoff J L et al (1991). The pressure value of the inclusion which the halite is melted before the disappear of bubbles is 1.12~5.55Mpa, and mainly distributed in 1~2Mpa; the pressure value of the inclusion that the halite is melted nearly at the same time with the disappear of bubble is 3.49 Mpa; the pressure value that the halite is melted after the disappear of bubbles is between 2.74~8.99MPa, and mainly distributed in 7~8MPa. Pressure values obtained were far below the minimum pressure homogenization temperature correction 25MPa, which means the homogenization temperature, regarded as its capture temperature, does not need to correct at atmospheric pressure.

3.3 Salinity
(1) Inclusions without containing sub-crystal in halite: The inclusions’ freezing temperature concentrated in the range of -4.5 ℃ ~ -9.9 ℃ by freezing test. According to the formula of Potter et al. (1978), it calculates that the salinity range is 7.17%~13.83% of excluding sub-crystal in halite, with an average of 10.08%.

(2) Inclusions containing sub-crystal in halite: The authors measured the melting temperature of sub-crystal in inclusion by heating method according to the formula of DL Hall et al (1988), which calculates the salinity range was 31.83% ~ 41.05%, with an average of 36.73%. The salinity of inclusion in quartz is 7.17% ~41.05% with an average 28.62% by freezing method and melting method.

3.4 Density
(1) Inclusions without containing sub-crystal in halite: The authors calculated the density which the inclusion’s salinity is less than 25% with containing quartz veins by homogeneous temperature and salinity (Keenan et al., 1978). The fluid density is 0.70 g/cm3~0.92 g/cm3, which falls into a small range.

(2) Inclusions containing sub-crystal in halite: The melting temperature of the sub-mineral is measured by heating method (Bischoff J L et al., 1991), and the fluid of this kind of inclusion is 1.07 g/cm3~1.11 g/cm3 with a small range. The fluid of the ore is 0.70g/cm3~1.11 g/cm3 an average of 1.00 g/cm3 with a narrow range of variation by these two methods.

4 Discussions and Conclusions
(1) Inclusions observed containing ores in quartz veins are mainly divided into gas-liquid two phases and gas-liquid-solid three phases, a small amount of pure liquid phase and pure gas phase. All of them are primary inclusions and mostly are distributed in groups.

(2) The mineralization temperature of quartz-sulphide, belongs to a medium-high temperature condition, in the main mineralization is 249.6 ℃ ~416.5 ℃ with an average of 321.8 ℃. Mineralization pressure is 1.12 ~ 8.99Mpa, mainly concentrated in 7MPa ~ 8MPa belonging to a low-light environment. The salinity, high fluid of salinity, of ore-forming is 7.17%~41.05% with an average 28.62%. The density in a narrow range of variation is 0.70g/cm3 ~1.11 g/cm3 with an average 1.00 g/cm3.

(3) With the decrease of mineralization temperature, the fluid salinity and pressure shows that the trend is increasing at first and then decreasing gradually. The process of ore-formation is the evolution of the fluids from unsaturated solution to saturated solution with the decreasing of temperature and promoting the precipitation of mineral.

References