Fluid Inclusions of the Gejiu World-Class Sn-Cu Polymetallic Deposit and Implication for Ore Formation

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The Gejiu tin-copper polymetallic ore field, located at the westernmost end of the Cathaysia Block in South China, is one of the largest tin polymetallic ore fields in the world. It is associated with magmatic-hydrothermal ore-forming processes triggered by deeply seated structures and concealed granites. The ore-forming processes can be divided into four stages: skarn, greisen, sulfide, and carbonate. Five fluid inclusion types from garnet, diopside, tremolite, fluorite, quartz, and calcite were trapped at different ore-forming stages and are recognized by studies using petrography, microthermometry, and laser Raman spectrometry, which record the progressive pressure, temperature, and compositional evolution of the hydrothermal fluids that formed this world-class district.

Fluid inclusions from the skarn stage trapped a single-phase aqueous fluid, with a 6 to 15 wt % NaCl equiv salinity, at temperatures between 340°C and 570°C and pressures between 98 and 164 MPa, corresponding to depths between 6 and 8 km. During the greisenization stage, the fluid with a 9 to 16 wt % NaCl equiv salinity was present under near critical conditions and then separated into coexisting liquid and vapor phases, ascended, depressurized, sometimes further unmixed, and cooled from 530°C at 168 MPa to 286°C at 66 MPa, corresponding to depths between 4 and 8 km. The fluid that deposited the sulfide stage minerals had a salinity of 1.6 to 20 wt % NaCl equiv, was boiling and immiscible, represents a mixture of magmatic and meteoric fluid, and cooled from 275°C at 131 MPa to 136°C at 22 MPa, corresponding to depths between 2 and 6 km. The fluid inclusions in the final carbonate stage are enriched in liquid and relatively small, which may indicate the hydrothermal activity was nearly finished. Thus the ore-forming fluid evolved from high temperature with high to intermediate salinity to low temperature with low salinity.

The gases in the fluid inclusions are mainly CO_2, CH_4, and a small amount of N_2. The CH_4 component occurs mainly in the skarn and greisen stages, which implies that the ore-forming fluid originated partly from the deep crust and/or upper mantle. Fluorine and tourmaline may play an important role in tin and copper mineralization. Cassiterite and chalcopyrite were mainly deposited at 340°–570°C and 200°–400°C under pressures of 100–170 and 22–131 MPa, respectively. Immiscibility, boiling, and mixing processes are probably the main reasons for tin and copper mineral deposition. The ore-forming model and exploration strategy are constructed based on the study on the fluid inclusions combined with other geological and mineralization features.