CHARACTERISTICS AND ORIGIN OF FLUID INCLUSIONS IN THE TONGSHANKOU PORPHYRY-SKARN Cu-Mo DEPOSIT, HUBEI PROVINCE, P. R. CHINA

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The Tongshankou Cu-Mo deposit is located in the Edongnan-Ganxibei Iron–copper-gold Metallogenetic Belt (EIMB) in the Middle–Lower Yangtze River region, China. The deposit is hosted within the Tongshankou granodiorite porphyry stock (146-132 Ma) and the surrounding Triassic carbonate rocks that belong to Forth to Sixth Group of Daye Supergroup. The geometry of the Tongshankou granodiorite porphyry and associated Cu-Mo mineralization is controlled by the NE-trending, nose-shaped, Tongkuangshan anticline and the Tiantaishan NNW-trending fault. The alteration and mineralization in the deposit show distinct zonation from the core of the stock to the wall rock and undergone four paragenetic stages of formation as below:

Stage I K-feldspar±biotite±magnetite occurring as porphyroblast;

Stage II Quartz ± K-feldspar ± molybdenite ± pyrite ± magnetite ± pyrrhotite ± anhydrous skarn minerals (garnet, diopside, wollastonite) occurring as K-feldspar+quartz veins, Mo-bearing quartz veins or massive skarn with weak mineralization;

Stage III Quartz±sericite±pyrite±chalcopyrite±bornite±molybdenite±hydrous skarn minerals (epidote, phlogopite, chlorite, serpentine, tremolite, actinolite) occurring as veins and stockworks accounting for majority of Cu and Mo mineralization in the deposit;

Stage IV Quartz±serpentine±chlorite±calcite±pyrite±fluorite±galena±sphalerite.

Five types of fluid inclusions (Type Ia, Ib, Ic, II and III) were recognized in the minerals associated with the alteration-mineralization at Tongshankou. The microthermometric data of fluid inclusions indicate that the Stage I alteration mineral assemblage formed from low density magmatic vapor at temperature range of 380-560□, and the Stage II alteration and Mo mineralization occurred at 360-430□ with fluid salinity of 6-10 NaCl wt % equiv., the Stage III alteration and Cu mineralization at 300-385□ with fluid salinity of 4.2-45.8 NaCl wt % equiv., and the Stage IV alteration and Pb-Zn mineralization at 160-220□ with 2-8 NaCl wt % equiv.

The fluid of Stage I is high temperature super-critical water vapor containing a minor amount of CO_2, N_2, and CH_4 and it was likely exsolved from melt of the Tongshankou granodiorite stock. The Stage I fluid process has resulted in extensive K-feldspar-biotite alteration and early skarn formation. The Stage II hydrothermal fluid had generated K-feldspar-quartz-molybdenite veins. The fluid has a minor amount of CO_2 and CH_4 and is rich in Na, K and Cl ions than the Stage I fluid. During the Stage II alteration, the first boiling of fluid in near critical condition occurred due to phase separation of the fluid as evidenced by the variation in salinity and composition of the fluid. The phase separation has likely caused not only molybdenite precipitation in fractures together with K-feldspar and quartz, but also the spatial-temporal separation of copper and molybdenum mineralization. Bulk fluid chemical data by Crush-Leached Liquid Chromatographic and Atomic Absorption Spectroscopic methods show that increasing content of Ca, Mg, and HCO_3^- ions and decreasing of Na, K, and Cl ions in the Stage III fluid inclusions, relative to the earlier Stage fluid inclusions. Hydrogen-oxygen isotope data indicate that ore-forming fluid of the Stage III had two different sources, magmatic and meteoric water. Close coexistence of daughter mineral-bearing Type III fluid inclusions and lower salinity Type Ia and Ib fluid inclusions in quartz-sericite-chalcopyrite-molybdenite-pyrite and chlorite-serpentine-pyrite veins implies that Cu deposition was probably caused by the second boiling of ore-forming fluid during early Stage III, which is considered to have formed by sudden decrease of pressure due to fracturing of the host rock. Mixing of low temperature and low salinity meteoric water and magmatic fluid during the late Stage III was also triggered the Cu precipitation accompanied by cooling of the entire hydrothermal system and lowering of the salinity of the ore fluid. Stage IV fluid is dominantly composed of meteoric water and is rich in Ca, Mg and SO_4^{2-} ions by exchange reaction with the carbonate wall rock and carried the Zn, Pb and Ag mineralization outward into the sedimentary wall rock away from the stock.