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Textural, compositional and sulfur isotope variations of multistage pyrite in the Bengge gold deposit, southwestern Yunnan, China: Implications for ore genesis

Lili Jiang*, Zengqian Hou, Xuanxue Mo, and Chuandong Xue

State Key Laboratory of Geological Processes and Mineral Resources, School of Earth Sciences and Resources, China University of Geosciences, Beijing, China, *e-mail, Lily.Y.Jane@hotmail.com

The Yushu-Yidun arc, located in the eastern margin of the Tibetan Plateau, was generated by southwestern subduction of Ganze-Litang ocean during which numerous arc-related calk-alkaline intrusions (215~230 Ma) formed. The Bengge gold deposit, hosted by ultrapotassic syenite, is a recently identified gold deposit in the belt containing ~10t of Au reserve with grade of 1-20 g/t. The ultrapotassic syenite was derived from partial melting of the enriched lithospheric mantle, triggered by back-arc extension and subsequent asthenosphere upwelling. Due to the lack of research on the deposit, geology and genesis of the deposit is still unclear.

Our investigations in this study show that gold mineralization in the deposit mainly occurs as veins (e.g., gold-polymetallic sulfide-telluride, gold-sulfides veins) within faults and as disseminations in pyrites in the host rocks. The host rock suffered moderately replacement by the phyllic-type alteration assemblage of quartz-sericite-carbonate. Four stages of veins have been recognized: I.K-feldspar-quartz-barite-pyrite; II. sheeted quartz-carbonate-K-feldspar-trace pyrite; III. auriferous pyrite-sericite-tetrahedrite- telluride; Ⅳ.quartz-carbonate-stibnite. Economic gold is mainly hosted in pyrite in stages II and III veins. Fluid inclusion microthermometry of quartz from Stage II indicates that ore fluids are in low salinity (2-6 wt% NaCl equiv), containing a few to 90 mole percent volatile species. Laser Raman spectroscopy confirms that the vapor phase is dominated by CO_2 and trace N_2. The variable phase ratios are consistent with fluid immiscibility during ore formation. These fluid inclusions are estimated to be formed at temperature of 180~320°C and pressure of 57~89MPa.

Three stages of pyrites are recognized in this study: (1) fine-grained pyrite (Py1) in the K-feldspar-quartz-barite-pyrite vein, (2) a coarse pyrite stage (Py2) in carbonate-altered syenites that contains inclusions of K-feldspar and telluride, and (3) a fine polygonal pyrite (Py3) occurring in the auriferous stage III pyrite-sericite-tetrahedrite- telluride vein. Py2 grains are generally fractured and deformed by microshearing and crushed or brecciated, with fine polygonal pyrite grains (Py3) typically being as halos surrounding Py2. In such cases some Au-telluride and tetrahedrite occur in the matrix between the pyrite grains. Aggregates of small pyrite grains look as if they have been partially resorbed and recrystallized and have assumed a “foam texture” indicated by the presence of 120° triple junctions between small grains. In situ sulfur isotopic analysis using SHRIMP II show a decreasing trend of $\delta^{34}S$ values, from Py1 (+0.37‰~+2.70‰), through Py2 (-1‰~ -3‰) to Py3 (-2.29‰~+2.62‰), which is consistent with the auriferous fluid originating from a oxidized magma.

LA-ICP-MS analysis confirms high gold concentrations for the pyrites with clustered telluride inclusions and/or showing “foam texture” in the microshearing and fracturing/brecciation. Pyrite grains containing clustered inclusions is interpreted as coupled dissolution-reprecipitation reaction between pyrite and fluids. Syn-deformational grain-scale mobilization of gold and other elements took place leading to a portion of the gold being recrystallized within fractures and microshears.