Petrogenesis and Mineralization of the Bengge Au Deposit, Northwestern Yunnan, China

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Here we present new constraints on the timing of the ore-related ultrapotassic syenites of the Bengge Au deposit in the northwest of Yunnan, China. New in situ U-Pb and Hf isotope dating of zircons, combined with new geochemical data, helps to precisely constrain the emplacement age and the petrogenesis of the Bengge syenites. Quartz-carbonate (chlorite) veins and related alteration of the Bengge gold deposits is associated with pyrite, sulfosalts, and base metal mineralization. The observed nature of the mineralization helps define this deposit as an intrusion-related gold deposit.

The Bengge gold deposit is located in the south of Yidun arc, on the east of the Tibetan plateau, developed between the Songpan-Garze fold belt and Qiangtang block, tectonically bounded to the east by the Garze-Litang suture and to the west by the Jinsha Jiang suture. The host rocks of the Bengge gold deposit are a suite of syenites, emplaced into Upper Triassic sedimentary rocks of the Wangchika Formation, which is mainly mudstones, shales, and metasandstones, including biotite-pyroxene syenite, biotite syenite, and porphyry syenite. Zircon LA-ICP-MS U-Pb dating results indicate that the biotite syenite and biotite-pyroxene syenite crystallized at 213.8 ± 2.1 Ma and 219.1 ± 4.7 Ma, respectively, which is within the arc-like magmatism period deduced from the Indosinian subduction of the Ganze-Litang oceanic crust. Geochemically, the syenites have very high potassium and alkaline contents, and are of shoshonitic series. They are characterized by high Mg#, Zr/Nd ratio, and Ni and Co contents, and are enriched in light rare earth and large ion lithophile elements and depleted in the high field strength elements. Based on this geochemistry, we infer that the syenites were derived from partial melting of an enrichment mantle that had been metasomatized by the fluid derived from the dehydration of the subducted oceanic slab. The $\varepsilon_{Hf\,(t)}$ of the biotite pyroxene syenite and biotite syenite mostly range from –2 to 2, indicating they are derived from an enriched mantle source involving some depleted mantle materials and/or that was contaminated by crustal components during magma evolution. Taking their tectonic location into account, these syenites were likely formed in an extensional back-arc setting related to the westward subduction of the Garze-Litang oceanic crust in the Late Triassic.

Gold-bearing pegmatite veins are associated with the emplacement of these Indosinian syenites. The veins and the disseminated ore are accompanied by intense muscovite/illite and

carbonate (phyllic) alteration. Mineralization occurs in four stages: (1) quartz-feldspar veins with minor pyrite, (2) quartz-sericite-pyrite veins, (3) base metal sulfide-gold–bearing quartz-sericite-carbonate veins, and (4) quartz-carbonate veins. Gold occurs as Au tellurides in the stage 3 sulfide-rich quartz-sericite-carbonate veins. Detailed petrography, including SEM-based observations, reveals the sulfide minerals include pyrite, arsenopyrite, tetrahedrite, galena, bournonite, and jamesonite, with rare chalcopyrite. Available geochemical data highlights that Au in the Bengge deposit is associated with Bi, W, As, Mo, Te, Sb, and low concentrations of base metals. This chemistry, combined with the observed geology, is similar to that of intrusion-related gold deposits associated with distinct alkali magmas.