Geochemistry, Sulfur Isotopes, and Fluid Inclusion Characteristics of the Neoarchean Gold Deposits of the Tati and Vumba Greenstone Belts of NE Botswana

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The Tati Greenstone Belt (TGB) and the Vumba Greenstone Belt (VGB) are Neoarchean terranes located in northeastern Botswana, along the southwestern margin of the Zimbabwe Craton. These belts are composed mostly of mafic and ultramafic meta-volcanic rocks intruded by granitoids; they host several gold deposits and minor Ni-Cu-PGE deposits. Despite early discoveries in the 1800s, research on the fluid evolution and genesis of gold mineralization within the TGB and VGB remains limited. This study aims to constrain the genesis of gold mineralization in the Mupane and Golden Eagle gold deposits in the TGB, as well as the White Pidgeon and Somerset gold deposits in the VGB, based on sulfide geochemistry, sulfur isotopes, and fluid inclusion characteristics. Gold-bearing sulfide ores in both belts are mainly observed as disseminations in strongly altered schist and amphibolite host rocks and in quartz-calcite veins that crosscut these rocks. Native gold and electrum in the TGB deposits mainly occur as inclusions or intergrowths in arsenopyrite and sphalerite. In contrast, in the VGB, both native gold and electrum occur as inclusions within arsenopyrite and are occasionally intergrown with chalcopyrite and pyrrhotite. The $\delta^{34}S$ values of pyrrhotite, arsenopyrite, and pyrite from the studied deposits range from -0.7 to +4.0 ‰, suggesting a potential magmatic origin of sulfur. Quartz-hosted primary fluid inclusions are classified into single-phase carbonic, two-phase aqueous, and three-phase aqueous-carbonic inclusions; the aqueous inclusions homogenize at 120 to 346 ºC and their salinity ranges from 1.3 to 10.5 wt.% NaCl equivalent. The coexistence of the three fluid inclusion types in the same quartz crystals suggests coeval entrapment of likely immiscible fluids. Bulk gas analysis of fluid inclusions in quartz and calcite revealed that H_2O (59.6 to 95.2 mol%) is the dominant component, with elevated contents of CO_2 (0.92 to 39.9 mol%) and CH_4 (0.33 to 4.33 mol%).