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Refining the Geodynamic Setting of the Twangiza Gold Deposit (South Kivu, D.R. Congo): Insights from Zircon and Apatite U-Pb Geochronology and Pyrite Geochemistry

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The Twangiza gold deposit is a world-class Au system with an estimated endowment of ~6 Moz, located in the eastern Democratic Republic of the Congo. It is hosted within the Itombwe synclinorium, a Neoproterozoic half-graben rift basin formed during the breakup of the Rodinia supercontinent. Previous geochronological studies based on Rb-Sr dating of hydrothermal muscovite yielded mineralization ages of ca. 520 Ma, linking gold deposition to tectonothermal events associated with Gondwana assembly. However, the reliability of these ages is limited due to the mobility of Rb and Sr during hydrothermal alteration, which may result in partial isotopic resetting rather than recording the true timing of mineralization. Here, we provide more robust temporal constraints using zircon and apatite geochronology, which are more resistant to alteration and isotopic disturbance. Gold mineralization is spatially associated with porphyry albitite intrusions and, higher-grade zones concentrated within proximal alteration halos adjacent to these magmatic bodies. Zircon from porphyry albitite provided the age of ~333 Ma and apatite record the age of ~325 Ma. This study constrains the timing of the magmatic suite that contributed to the emplacement of the Twangiza gold deposit, indicating that mineralization occurred during the post-Pan-African tectono-magmatic event associated with the progressive breakup of the Gondwana supercontinent. Pyrite geochemical proxies (Co/Ni<1) further suggest that the ore-forming components were predominantly transported by hydrothermal fluids derived from the Neoproterozoic metasedimentary sequences of the Itombwe synclinorium. In contrast, sulfur isotope compositions ($\delta^{34}S \approx +4.75‰$) indicate a magmatic sulfur source originating from a deep subcontinental lithospheric mantle (SCLM) reservoir. These results collectively imply that magmatic intrusions at Twangiza acted as a primary sulfur contributor to the mineralizing system, while the metal budget was largely sourced from sediment-hosted hydrothermal fluids. High As/Sb ratios (>100) and low Co/Ni (<50) in pyrite indicate that fluid boiling and fluid-rock interaction were the main drivers of Au precipitation. These signatures suggest that gold mineralization at Twangiza was emplaced during the Carboniferous (Paleozoic) within an extensional tectonic regime linked to the breakup of Gondwana. This interpretation contrasts with earlier models that relate mineralization to the Pan-African collisional event at ca. 520-530 Ma.



