Hypersaline ore fluids and orogenic gold: New boron stable isotope data from hydrothermal tourmaline in the Loulo mining district, West Africa*

Corresponding author: James S. Lambert-Smith, Kingston University London, J.S.Lambert-Smith@kingston.ac.uk

Co-authors:
Alexander Rocholl, Helmholtz-Zentrum, alexander.rocholl@gfz-potsdam.de
Wolfgang Müller, Royal Holloway University of London, wolfgang.muller@rhul.ac.uk
David M. Lawrence, Randgold Resources, David.Lawrence@randgold.com
Peter J. Treloar, Kingston University London, Peter.Treloar@kingston.ac.uk

The 2.1 Ga Kédougou-Kéniéba Inlier in West Africa hosts outstanding mineral wealth, with some 45 Moz of gold and 630 Mt of iron ore hosted along the Senegal-Mali Shear Zone (SMSZ). To the west of the SMSZ the Falémé Volcanic Belt (FVB) is comprised of calc-alkaline volcaniclastic rocks, lavas, and plutons. The FVB hosts iron ore in a series of magnetite-apatite skarns. To the east, the Kofi series is comprised of clastic basin sedimentary rocks and peraluminous granites. A >400 ppm boron in soil anomaly characterises >100 km of the strike length of the SMSZ with orogenic Au mineralization, hosted along its eastern margin, spatially associated with epigenetic tourmaline alteration. Hypersaline fluid chemistries and petrological characteristics imply a magmatic influence on Au deposit genesis. However, stable isotope studies to date (O, C, and S from hydrothermal silicate, carbonate, and sulfide minerals) show no strong evidence to support this theory. Furthermore, U-Pb dating of magmatic zircons from nearby igneous bodies by LA-ICP-MS shows a time gap between magmatism and mineralization.

Isotopically heavy δ34S values (+25 ‰) from diagenetic pyrite may indicate the former presence of evaporites in the Kofi metasedimentary rocks. New boron isotope data have been collected using a state-of-art Cameca 1280-HR SIMS from: 1) pre-, syn- and post-mineralization hydrothermal tourmaline at Au ore bodies in the Kofi series and 2) pegmatite-hosted tourmaline from the nearby Gamaye pluton. The data show that tourmaline from pegmatite dykes in the Gamaye pluton display values typical of magmatic tourmaline (δ11B from -18.3 to -15 ‰). Conversely, hydrothermal tourmaline from within the Au ore bodies displays δ11B values indicating derivation from devolatization of marine carbonate rocks and dissolution of marine evaporites (δ11B between -4.6 and +19.8 ‰).

Hypersaline fluids are not commonly associated with orogenic gold provinces, being more widely reported in IOCG, porphyry, or skarn systems. The data presented here adds a further layer of complexity to the orogenic gold model, showing that metamorphic processes can give rise to hydrothermal fluid systems with highly variable chemistries.