Tourmaline boron isotopic evidences of fluid mixing in IOCG deposits in the Kangdian district, China

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The sources of ore-forming fluids of iron oxide-copper-gold (IOCG) deposits remain highly debated. Alternative models invoke either magmatic origin or circulation of basinal brines, and some studies suggest that ore fluids of IOCG deposits might have more than single source. Boron isotopes of tourmaline, having large variation at different reservoirs, potentially provide an approach to unravel this problem.

Three types of tourmaline have been identified in the IOCG deposits of Kangdian region. Type 1 tourmaline occurs in the cement of breccia body associated with the orebody. Type 2 tourmaline is disseminated grain in massive Fe ores. Type 3 occurs as barren veins in albitite country rocks nearby the Cu-Fe orebodies. The $\delta^{11}B$ values of the three types of tourmaline, analyzed by LA-MC-ICPMS, span from -15.4‰ to +19.5‰. Type 1 tourmaline yields $\delta^{11}B$ values from -15.4‰ to -4.6‰, within the range of tourmaline of pegmatite and granite worldwide, indicating a magmatic source. In contrast, type 3 tourmaline has $\delta^{11}B$ values from +10.8‰ to +19.5‰ with an average value of +16.7‰, indicating a source from marine evaporate or basinal brine. Type 2 tourmaline from massive Fe ores has intermediate values from -2.5‰ to +0.6‰, which are plotted between the Type 1 and Type 3 tourmaline and are hence interpreted as mixing of fluids from the magmatic and marine-derived sources.

Our work highlights that the incorporation of external fluids may act as key triggers for formation of IOCG deposits and the utility of tourmaline B isotopes as indicator of fluid sources.