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Mineralogy of Tourmaline in Dahongshan Deposit, SW China: Implications for the Origin and Evolution of Hydrothermal IOCG System

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Tourmaline could be used to constrain the nature and evolution of ore-forming fluids precisely due to their refractory nature, chemical diversity and widespread occurrences in most hydrothermal deposits (Slack and Trumbull, 2011; van Hinsberg et al., 2011a and references therein). Moreover, tourmaline grains are usually growth-zoned, providing valuable insights into the evolution of hydrothermal system (van Hinsberg et al., 2011b; Marschall and Jiang, 2011; Trumbull et al., 2011 and references therein).

The Dahongshan deposit, the largest one in the Kangdian Fe-Cu metallogenic province, SW China, has been recently considered as an IOCG deposit (Zhao and Zhou, 2011). It was formed in Late Paleoproterozoic and underwent lower amphibolite-facies metamorphism during Neoproterozoic. Extensive metamorphic overprint made it difficult to investigate the nature of ore-forming fluid. However, the deposit has widespread tourmaline alteration in country rocks. The tourmaline alteration is closely associated with mineralization and provides an opportunity to study the origin and evolution of the ore-forming system.

Two types of tourmaline have been distinguished in Dahongshan deposit according to their field occurrence and associated mineral assemblages. Type 1 tourmalines occur as euhedral granular, columnar grains or massive aggregates in veins, cement of barren gabbro-related breccia and as disseminated crystals associated with magnetite in mineralized meta-sedimentary rocks, whereas type 2 have porphyroblastic and prismatic crystals within anthophyllite-biotite-garnet schist or anhedral grains in the cracks of pragasite which formed between the contact zone of dolerite dyke and the carbonate rocks. Detailed petrographic observations suggest that type 1 tourmaline is mineralization-related tourmaline (MIT), and the type 2 is metamorphic (MET) in origin.

Both types of tourmalines have multiple and complex zonings under the microscope. EMPA analyses suggest that they all belong to alkali group in the nomenclature of Hawthorne and Henry (1999). MIT grains have compositions of schorl (Mg/Mg+Fe between 0.25 and 0.39 in veins or magnetite-accreted ones) to dravite (Mg/ Mg+Fe between 0.50 and 0.69 from the barren breccia). Most analyses have ^{Z}Al content less than 6 *apfu* and become more Al-deficient from the core to rim, which suggests minor substitution of ^{Z}Al for Fe^{3+} and/or Ti^{4+} and thus, the increasing f_{O2} in hydrothermal system. Notably, the rims of zoned MIT show compositional increase in Ti, Ca, Mg and relevant decrease in Fe, Al, K, plotting within the range of the MET grains. These trends imply the recrystallization of MIT tourmaline in regional Neoproterozoic metamorphic event. The MET ones have a relatively narrow range of composition of dravite, with the Mg/Mg+Fe between 0.50 and 0.71 for all samples, yet the observed chemical variation is much larger than the effects of inter-sector fractionation (van Hinsberg et al., 2007; Marks et al., 2013). An EMPA zoning profile in section perpendicular to tourmaline's c-axis clearly shows the dominant substitution of $[Ca(Mg, Fe)](\square,Al)_{-1}$ to $Fe(Al)_{-1}$ to $[Ca(Mg, Fe)](Na, Al)_{-1}$ from core towards rim, attesting that tourmaline is an excellent recorder for metamorphic history.

Both types of tourmalines are well zoning according to the nature of the fluid in different stages. The future studies of trace elements and B-isotope may provide further constraints on the genesis of the deposit.

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