Deep fluid separation at rapid exhumation from the Tran-North China Craton Orogen: insights into scapolite behavior

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Deep crustal fluid plays a key role in the evolution of the crust and is also important for hydrothermal ore formation in the subduction zone and collision belt (e.g. Ague, 2010; Manning, 2018). However, our understating on the nature and evolution of deep crustal fluid are still insufficient. Scapolite, with formulae (Na, Ca, K)$_4$[(Al, Si)$_3$Al$_3$Si$_6$O$_{24}$](Cl, CO_3, SO_4), is good storage of fluid compositions. Major elements composition in scapolite is under control the environmental conditions (e.g. P, T and fluid composition). Trace element concentration variation on the sub-mineral scale is a confidence petrographic and geochemical criteria (e.g. REE patterns and Cl/Br ratios) to the qualitative assessment of fluid sources (Hammerli et al., 2013).

In this study, we investigated the petrology, pressure-temperature, and timing of metamorphism on centimeter-sized scapolite bearing pelitic and basic rocks in the Zhongtiao Mountains, Tran-North China Craton Orogen belt. These rocks underwent clockwise isothermal decompression from pressure of > 8 kbar to ~5 kbar at temperature of 650 to 550 °C. High-resolution CL imaging, EPMA and *in-situ* trace element analyses revealed that scapolite crystals recorded textural and chemical evolution from burial metamorphism to rapid exhumation. Scapolite growth zoning (Me% = 37 to 32, Cl = ~0.6 wt.%, Cl/Br = ~1001 to ~1878) indicated that pervasive fluid migration around mineral grains at prograde stage. The fluid-mediated partial alteration rims of scapolite show dramatical change of fluid composition(Me% = 32 to 31, Cl = ~0.7 wt.%, Cl/Br = ~425 to ~722), but have similar REE patterns with growth zoning. Phase diagram of H_2O-NaCl-CO_2 fluid system modeled by PerpleX program that pressure drop from 8 kbar to 5 kbar at 600 °C will cause deep fluid separating into three phases (salinity fluid, carbonic fluid, and halite solids). Thus, we inferred decreasing of Cl/Br ratios in the fluid was resulting from the crystallization of halite. External fluid is not required to input during rapid exhumation.

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