

101-11 - TRANSPORT OF MID-CRUSTAL FLUIDS TO THE UPPER CRUST THROUGH BRITTLE FAULT NETWORKS AS REVEALED BY STABLE ISOTOPE RATIOS OF TOURMALINE-MINERALIZED FAULT SURFACES, WEST ANTARCTICA



Monday, September 23, 2024



8:00 AM - 5:30 PM



Hall D (Anaheim Convention Center)

Booth No. 263

Abstract

Stable isotope ($\delta^{18}\text{O}$, δD , $\delta^{11}\text{B}$) ratios of fault surface and shear zone minerals sampled from Marie Byrd Land in the West Antarctic rift system (WARS) provide opportunity to monitor potential fluid transport across multiple levels of the crust during active rifting. In the upper crust, high-angle brittle faults in the southern Ford Ranges display tourmaline-mineralized surfaces at Mt. Douglass, Mt. Dolber, and Lewisohn Nunatak. Tourmaline are strongly aligned with fault striae indicating mineralization during normal-oblique and strike-oblique displacement, with dilatancy allowing fluid infiltration of fault surfaces. Tourmaline's refractory nature preserves isotopic compositions, which serve as a proxy for fluid sources and water-rock ratios. We compare tourmaline isotopic ratios with those of muscovite and quartz that occupy progressively deeper, kinematically linked fault-shear networks, and high-grade sillimanite-garnet-quartz±biotite associations, with the objective of characterizing potential fluid sources, relative depths of fluid interactions, and eventual estimation of volume of migrated fluids.

Tourmaline $\delta^{18}\text{O}$ values range from 9.1 and 10.4 ± 0.2 ‰ VSMOW (avg. = 9.8 ‰; st.dev. = 0.6), with intrasample reproducibility from 0.9 ‰ to 1.2‰, either as the result of variation in fluid sources or minor fluctuations in temperature during tourmaline formation. Quartz $\delta^{18}\text{O}$ ratios range from 11.1 to 10.3 ± 0.2 ‰ (avg. = 11.0‰; st.dev. = 0.64), with paired $\Delta_{\text{Qtz-Tu}}$ values lower than quartz calculated to be in equilibrium with tourmaline at 450°C. Calculated qtz-tur temperatures exceed values reasonable for brittle crust ($>700^\circ\text{C}$), indicating tourmaline grew rapidly or quartz has undergone subsolidus reequilibration. Fluids calculated to be in equilibrium with tourmaline at 450°C range from 8.2 to 9.5‰. Tourmaline $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology in progress yields Early Cretaceous dates, indicating mineralization coincided with rifting onset. Very rapid development of the WARS and high thermal gradients during ENE- WSW transtension promoted upward movement of fluids in equilibrium with magmatic bodies or dehydrating metamorphic or sedimentary protolith. Tourmaline of Mt. Douglass and Mt. Dolber yield δD values of -60 and -64‰; these values confirm the role of fluids derived from mid crustal sources transported to the upper crust through fault-shear network.

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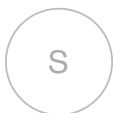
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