# Investigating temperature and origin of fluids that circulated within a brittle fault array in the West Antarctic Rift System

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Outcrops of brittle faults are rare in Marie Byrd Land, West Antarctica, because fault damage zones commonly undergo enhanced erosion and form bedrock troughs occupied by glacier ice. Where exposures do exist, faults yield information about regional strain in the West Antarctic Rift System (WARS) and may host minerals that contain a record of the temperature and chemistry of fluids during regional-scale faulting. In MBL's southern Ford Ranges, bordering Ross Sea, a distinctive fault array was sampled that hosts tourmaline and quartz, a mineral-pair that can provide temperature and composition of fault-associated fluids, using δ18O. Host rocks are tourmaline-free. At three separate sites, fault surfaces display strongly aligned tourmaline, suggesting that mineralization occurred during tectonism. One site features highly polished, or mirrored, surfaces, a characteristic that may indicate tourmaline precipitation during seismic slip. The orientation and kinematics of the high angle faults are NNW-striking: normal-slip, and WNW-ESE striking: right-lateral strike-slip. The timing of mineralization is yet to be determined, but viable possibilities are that the faults formed during broad intracontinental extension during formation of Ross Embayment in the Cretaceous, or during development of deep, narrow basins beneath the RIS grounding zone, in the Neogene (newly detected, see Tankersley et al., this meeting).

Once formed, tourmaline is resistant to chemical and isotopic re-equilibration, and therefore can retain a record of its conditions during formation. We used oxygen isotope compositions of tourmaline and quartz pairs to investigate temperatures, fluid-rock ratios, and fluid sources, with bearing on fault-localized flux of fluids and geothermal heat. Analyzed tourmaline and quartz were separated from the upper ~2mm of the fault surfaces, as well as quartz separated from host rock in the same hand samples.

Tourmaline δ18O ratios (n=4) fall within a range of +9.2 to +10.4 ± 0.1 ‰ VSMOW (average 9.7‰, StDev = 0.7). Paired quartz yield δ18O values of +11.1 to +10.3 ± 0.1 ‰. Relative isotopic homogeneity between sites suggests similar fluid conditions were present across the region and supports field evidence for that the structures form a regional fault array. ∆Qtz-Trm values fall between 1.3 and 2.0, and δ18O of quartz in faults closely resembles δ18O of host rock quartz. We tentatively determine the water oxygen isotope ratio as greater than ~7.7 ‰. Plutonic-metamorphic associations in the immediate region, and comparisons with similar faults elsewhere (e.g. Elba island, in Italy), suggest temperatures as high as 500°C for the fluids that circulated into the faults.

The data are interpreted to show that brittle faults provided pathways for hot fluids derived from mid-crustal processes to make their way to shallow crustal depths. δ18O values indicate magmatic and/or metamorphic fluid sources, with minor to no introduction of meteoric fluids. Tourmaline-quartz pairs did not attain equilibrium, likely due to tourmaline's rapid crystallization. On-going investigation includes analysis of H and B isotopes in tourmaline, which will better characterize the relationship between fault-hosted and mid-crustal fluids.