Origin of amphibole in peridotite mylonite from an oceanic transform fault

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Abyssal peridotites recovered from St. Paul's Rocks, islets which lie within the St. Paul Transform Fault (Mid-Atlantic Ridge) contain an unusually high amount of amphibole (~12 vol.%) compared to other abyssal peridotites. In addition, the islets consist entirely of highly deformed mylonties, thought to originate at the base of faults in the brittle-ductile transition zone. To investigate whether the water required to form the amphibole originated from a mantle or oceanic (or combination) source, we conducted EMPA and stable isotope analyses on several samples.

EMPA reveals that the amphiboles are Ti-pargasite, a phase that contains high wt.% Na_2O and Cl compared to other Ca-amphiboles; stable hydrogen isotope analyses yield a range of values (-62 to -25‰), including values too high to have originated from a mantle water source alone (δD>-40‰). Additionally, preliminary thermometry yields closure temperature of amphiboles between 700 and 950°, too high to for seafloor alteration, yet too low for mafic melts.

Based on i) the unusually high percentage of amphibole, ii) the high relative wt.% Na_2O found in the amphiboles, and iii) the relatively high δD values, it is plausible that seawater was involved in the petrogenesis of St. Paul's Rocks mylonites. While the 600°C isotherm is traditionally considered to be the limit of brittle deformation, our observations suggest that seawater can penetrate to depths below the 600°C isotherm, in agreement with recent seismisity observations from the East Pacific Rise.

Penetration of seawater to depths associated with T > 600°C implies that i) the 600°C isotherm is not the limit of brittle deformation, or ii) the BDTZ may vary in depth, a property which my be linked to the seismic cycle. Regardless of the above implications, the presence of such a large amount of amphibole indicates that portions of the oceanic lithospheric mantle can be more water rich than storage in nominally anhydrous minerals alone would imply.