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TITLE: Hydration and deformation of peridotite mylonites from an oceanic transform fault

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ABSTRACT BODY: A significant portion of the global mid-ocean ridge system is offset by oceanic transform faults (OTFs), totaling greater than 16,000 km in length (Boettcher and Jordan, 2004). However, OTFs have received little attention in the literature, particularly in comparison to continental transform faults such as the San Andreas. Dredging of OTFs has recovered rocks with fabrics that reflect brittle and ductile deformation processes, but these deformed samples have been the focus of very few studies. Detailed observations of the microstructures of deformed OTF samples have the potential to provide improved constraints on the processes at transform plate boundaries.
To better understand ductile processes within OTFs, we have conducted analyses on peridotite mylonites from St. Paul's Rocks, a set of islets in the equatorial Atlantic that are the only subaerial exposure of an active transform fault along the global ridge system. These islets are also distinct in that they are almost entirely composed of peridotite mylonite, with microstructural and mineralogical variations that are distinct from most abyssal peridotites.
Microstructural analysis by electron backscatter diffraction of 27 samples from St. Paul's Rocks indicates that olivine has a pronounced lattice preferred orientation (LPO) and a mean grain size of ~5μm. At this grain size, olivine is expected to deform by diffusion creep, but the strong LPO is typically interpreted as indicating deformation by dislocation creep. In addition, compositional maps of the samples show a ubiquity of amphibole, up to 30% modally, and mm to cm wide altered gabbro veins in several samples. Electron microprobe analysis of 6 samples indicates that the amphibole phase is a chlorian, titanian pargasite, a phase uncommon in abyssal peridotites. Pargasite is a high temperature amphibole (~750oC) that requires the presence of H2O, Cl, and plagioclase to form.
To explain the observed minerals and microstructures, a two-stage model is proposed. First, trapped melt formed gabbro veins and interstitial plagioclase. In the second stage, seawater penetrated into the brittle-ductile zone by microfracturing, possibly during earthquakes, resulting in reaction of seawater with the peridotite to form pargasite. This stage was coincident with strain localization and mylonitization, indicated by olivine recrystallization and the presence of an LPO in both olivine and pargasite. Deep circulation of seawater is consistent with recent OTF observations (Roland et al., 2012). In addition, McGuire et al. (2012) recorded foreshocks beneath the Gofar transform fault at depths corresponding to temperatures greater than 600oC. Our observations suggest that seawater can penetrate deeper into the deforming upper mantle beneath OTFs than previously thought. The occurrence of a strong olivine LPO at small grain size and the abundance of pargasite suggest that the addition of hydrous phases to peridotite may expand the conditions at which dislocation creep operates.

KEYWORDS: 3039 MARINE GEOLOGY AND GEOPHYSICS Oceanic transform and fracture

zone processes, 8150 TECTONOPHYSICS Plate boundary: general.

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Additional Details

Previously Presented Material:

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