Mineralogic signatures of low temperature alteration in Atlantis Massif serpentinites?

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Low temperature hydration and alteration of ultramafic rocks (serpentinization) is of interest because of the potential to support an in-situ subsurface biosphere with Fe redox transformations controlling the generation of energy rich H_2 gas. The nature of the water/rock reactions and chemistries of product phases vary with protolith lithology, temperature, fluid chemistry, and water:rock. Low temperature systems are thought to incorporate more Fe into serpentine at the expense of magnetite (e.g. [1-3]). Yet, pinpointing the mineral assemblages and chemistries diagnostic of H_2-producing, low temperature alteration remains challenging.

Access to suitable samples for interrogation, a first challenge, was recently addressed by IODP Exp. 357 [4], which drilled ultra(mafic) mantle rocks of the Atlantis Massif that have undergone alteration at temperatures estimated to range from ~50-280C [5-9]. The Fe mineralogy/chemistry of a complex suite of drill core samples, many showing a range in extent and type of alteration at the thin section scale, was investigated to unravel a possible low temperature signature. Integrated Raman hyperspectral, quantitative elemental (EPMA-WDS), and x-ray absorption (sensitive to Fe oxidation state) spectral images and point analyses were collected. Samples appear to have undergone multiple episodes of water/rock interaction, producing a variety of alteration textures and phases including multiple chemically distinct serpentine phases. Olivine in mesh cores is surrounded by either Fe-rich serpentine or Fe-poor serpentine plus magnetite. Larger scale serpentine veins crosscut mesh textures and are often enriched in Fe, consistent with a later episode of lower temperature alteration. The ferric component of all serpentines ranges from Fe^{3+}/Fe_{Total} ~40-80%, suggesting H_2 could have been produced during serpentine formation. Correlating variations in mineralogy and Fe chemistry with interpretations of reaction timing and conditions will aid in determining the possible signatures of low temperature processes. [1] Evans et al., 2009. *Am.Min.* 94:1731-1734 [2] Andreani et al., 2013. *Lithos*. 178:70-83. [3] Bonnemains et al., 2016. G3. 10.1002/2016GC006321 [4] http://dx.doi.org/10.14379/iodp.proc.357.101.2017 [5] Fruh-Green et al., 2003. *Science*, 301:495-498. [6] Allen and Seyfried, 2004. *GCA*, 68:1347-1354. [7] Proskurowski et al., 2006. *Chem.Geo*. 229:331-343. [8] Boschi et al., 2008, *GCA*, 72:1801-1823. [9] Rumejon et al., in review