Mineralogy and Fe chemistry in Atlantis Massif serpentinites

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The Atlantis Massif, where (ultra)mafic mantle rocks are exposed to seawater, underlies Lost City, a hydrothermal vent field exuding warm temperature (~40-90°C), high pH fluids with H_2 and dissolved C-species [1]. Mineral transformations and dynamic Fe redox behaviour associated with low temperature water/rock reactions control the composition of these energy-rich fluids, thus influencing the habitability and activity of any associated subsurface biosphere. In turn, the presence of an in-situ microbial community may be recorded in the rock mineralogy and chemistry. IODP Exp. 357 recovered a complex suite of highly serpentinized, variably oxidized peridotites with Si-rich phases (e.g. talc, chlorite) [2]. For a detailed understanding of rock geochemical transformations, we employed quantitative, integrated mineralogic, elemental, and Fe oxidation state analyses of this unique sample set.

Raman imaging revealed multiple generations of serpentine, some closely associated/inter-grown with Si-rich phases. Quantitative elemental images (EPMA-WDS) revealed differing Fe content of serpentine phases. Iron redox state maps were generated from synchrotron radiation µXRF image data collected at multiple energies within the Fe K-pre-edge region, which is quantitatively sensitive to the oxidation state of Fe. Comparison to standards with known Fe redox and coordination states enabled assessment of Fe^{3+}/Fe_{Total} at every pixel. These co-registered microscale images reveal variation in Fe redox between different samples and between minerals, including different generations of serpentine, within a single sample. Comparing the mineralogic and chemical signatures of serpentinites recovered at different depths within a single core, as well as comparing across borehole transects, may unravel the many episodes of reaction and chemical overprinting and reveal the possible interplay of biotic and abiotic processes at work in this low temperature water/rock system.

[1] Kelley et al. 2005. *Science*, 307:1428-1434. [2] http://publications.iodp.org/proceedings/357/357title.html