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# Carbon Geochemistry and Mineralogy of Serpentinized Mantle Peridotites at the Atlantis Massif (IODP Expedition 357)

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Serpentinization is a fundamental process that controls geophysical properties of the oceanic lithosphere and has major consequences for geochemical cycles and microbial activity in a wide variety of environments. International Ocean Discovery Program (IODP) Expedition 357: Atlantis Massif Serpentinization and Life used two seabed drills to core 17 shallow holes at 9 sites to better understand the role of serpentinization in driving hydrothermal systems, in sustaining microbiological communities, and in the sequestration of carbon in ultramafic rocks (Früh-Green et al., 2017). Our study aims to better understand hydration and carbonation processes in the altered mantle peridotites from the Atlantis Massif and to evaluate how, when and where the formation of abiotic vs biotic carbon compounds is favoured in serpentinizing environments. Petrological and stable isotope studies are used to characterize the speciation and source of carbon and the distribution of carbonates, and to identify different carbonate veins and organic compounds in the IODP Exp. 357 drill cores.

Samples from all drill sites at the Atlantis Massif have a measurable carbon content, sometimes in low concentrations only. Serpentinites in deeper sections from the central part of the Atlantis Massif have higher carbon concentrations. The total organic carbon (TOC) content is, in general, lower than the total inorganic carbon (TIC) content and varies between 46 ppm and 5000 ppm (avg. 360 ppm), the total inorganic carbon varies between $<$LOD and 120000 ppm (avg. 6000 ppm). The $\delta^{13}$C values of carbonate (measured as TIC) range from +3 ‰ and -13 ‰ and $\delta^{13}$C values of TOC range between -20 ‰ and -29 ‰

Observed carbonate phases are aragonite, calcite (mainly in deeper parts of cores from the central sites), and locally dolomite as a high-temperature phase. The carbonates are located in cores of olivine relicts, in veins and on the surface of open cracks. Carbonate veins and single crystals show different textures and luminescence, which indicate different generations of carbonate precipitation. The carbonates can be divided into two types. Type I carbonates have $\delta^{13}$C values of less than -3 ‰ and $\delta^{18}$O less than -6 ‰ which correspond to precipitation temperatures from 50 ˚C to 170 ˚C. The more negative $\delta^{13}$C values point to a non-seawater component and possibly reflect mantle-derived carbon or a contribution from biological methane. Type II are seawater-derived carbonates, characterized by $\delta^{13}$C values $>$ -2 ‰ $\delta^{18}$O $>$ -6 ‰ and precipitation temperature $<$ 50 ˚C. Optical microscope investigations show that carbonate veins of Type II crosscut minerals and other veins, which indicate that they are the latest veining event. Spinel-rich serpentinized peridotites that have a Si-rich metasomatic overprint often show higher total organic carbon contents (TOC $>$ 500 ppm) and a higher concentration of Type I carbonate. These observations maybe indicate a high-temperature process associated with spinel-rich serpentinized peridotites which potentially binds reduced carbon.

REFERENCES

Früh-Green, G. L., et al. (2017), Atlantis Massif Serpentinization and Life, Proceedings of the International Ocean Discovery Program, College Station, TX http://dx.doi.org/10.14379/iodp.proc.357.2017