OCEANIC SERPENTINIZATION AND THE PRODUCTION OF ULTRA-REDUCED HYDROTHERMAL FLUIDS

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Serpentinized peridotites are a significant component of the seafloor in various tectonic environments. In addition to influencing the geophysical properties of the oceanic lithosphere, serpentinization produces reduced hydrothermal fluids and has major consequences for long-term, global geochemical fluxes of many elements (e.g. water, Ca, Mg, Cl, B). We present new mineralogical, geochemical and stable isotope data on oceanic serpentinites and compare these with studies from ophiolites. We further examine phase relations in altered peridotites and evaluate the conditions of formation of Fe-Ni alloys and magnetite during serpentinization and their influence on oxygen fugacity and carbon speciation in hydrothermal fluids. In contrast to ophiolites, antigorite is rare in oceanic peridotites and is generally restricted to veins and shear zones. Early phases of hydration produce talc- or amphibole-bearing assemblages after orthopyroxene; olivine alteration is dominated by assemblages of lizardite ± brucite ± FeNi alloys in serpentine mesh cores and chrysotile ± magnetite assemblages along mesh rims. Stable isotope signatures suggest that alteration occurs over a large temperature range and low fluid-rock ratios. Serpentinization above 350°C may be restricted to ridge environments where heat flow is higher. The occurrence of FeNi alloys indicates ultra-reducing conditions and plays a major role in the production of hydrogen, methane and hydrocarbons. These are major components in hydrothermal vents and are observed in higher concentrations where peridotites outcrop on the seafloor. Trace amounts of condensed hydrocarbons in serpentinites from different tectonic settings have been identified by differential thermal analyses and infrared spectroscopy.