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Timescales of Oceanic Lithosphere Hydration: Constraints from Rodingites, Apennines, Italy

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Serpentinites assume a critical role in geochemical and geophysical cycles, from recycling fluid into the sub-arc mantle to facilitating exhumation within subduction zones. Rodingite dikes can be used as a passive marker to investigate the hydration of the oceanic lithosphere as their development is synchronous with serpentinization. In addition, whereas serpentinites lack sufficient mineral phases for geochronology, rodingite dikes are rich in andradite and grossular garnet, which are potentially amenable for geochronology[1]. This research seeks to constrain the timescales and duration of hydration of the oceanic lithosphere within the Alpine Tethys oceanic basin, and associated serpentinization, by examining Apennines rodingites from the Internal Ligurides (Italy). These rocks experienced seafloor hydrothermal alteration and were obducted onto the continental margin during Alpine orogenesis. As a result, they are ideal for studying seafloor metasomatism as they were not affected by prograde subduction zone metamorphism and dehydration. Sr isotopic and trace-element profiles were constructed across two rodingite-serpentinite transects, revealing a complex, multi-stage hydration history consisting of 1) Initial serpentinization and gabbroic intrusion, 2) Primary rodingitization, and 3) Late-stage localized fluid infiltration. Serpentinites locally display radiogenic crustal/sedimentary isotopic signatures (with $^{87}Sr/^{86}Sr$ above seawater values), whereas rodingitization fluids are characterized by lower $^{87}Sr/^{86}Sr$ between initial gabbro and seawater values. Evidence for late-stage fluid infiltration is preserved in spikes of elevated $^{87}Sr/^{86}Sr$ and Eu/Sm, and depletions in REE and Zr suggesting a radiogenic fluid capable of mobilizing REE and Zr. U-Pb geochronology on rodingite garnet produced an age of 96 Ma, which is likely representative of the main rodingitization phase. This is much younger than the age of primary gabbro emplacement (ca. 162 Ma)[2] and suggests that fluid infiltration responsible for rodingitization occurred off axis, and likely during incipient subduction and obduction.

[1] Haws et al., 2021
[2] Tribuzio et al., 2016