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Rodingites as Recorders of Fluid–Rock Interaction: Stable Isotope Geochemistry and Titanite U–Pb Ages from the Dun Mountain Ophiolite, New Zealand

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Rodingites represent metasomatic interaction of mafic protoliths with high-pH, Ca-rich fluids occurring alongside serpentinization, and contain petrogenetic indicator minerals useful for determining the conditions and timing of metasomatism. The Dun Mountain Ophiolite (DMO) of Aotearoa/ New Zealand is hypothesized to represent forearc lithosphere within a supra-subduction zone formed between ca. 278 to 268 Ma [1]. In the Whakatū/ Nelson region, rodingite dikes cross-cut the serpentinized peridotites of the DMO lower crustal and mantle sections and provide opportunity to constrain the timing, fluid sources, and tectonic setting of rodingite formation, and by proxy, serpentinization.

Petrography, whole rock and mineral geochemistry, LA-ICP-MS U-Pb ages of rodingite-hosted titanite, and rodingite mineral stable isotope ratios help determine (1) stages of progressive rodingitization, (2) sources and fluid-rock ratios of metasomatizing fluids, and (3) the timing of metasomatism in the DMO and associated mélanges.

Garnet and pyroxene $\delta^{18}O$ ratios (2.3 to 7.3‰; n=31) suggest fluid-rock interaction between mafic rocks and seawater at varying temperatures; likewise, $^{87}Sr/^{86}Sr$ ratios (0.70340 to 0.70505) suggest interaction between gabbroic protoliths and seawater with relatively low fluid-rocks ratios. Garnet and pyroxene $\delta^{44/40}Ca$ values resemble global mafic rocks (−1.38 to 2.88‰; n=15), and intrasample heterogeneity may indicate differences in grain-size controlled diffusion or progressive rodingitization. Petrographic and in-situ EPMA analyses show dominant mineralogies vary from early-stage grossular and pyroxene to late-stage andradite and vesuvianite, suggesting varying degrees of rodingitization across the region.

In-situ titanite U-Pb analyses yield complex ages with individual samples seemingly preserving multiple stages of titanite formation, with general age populations of ca. 270 Ma, ca. 244 Ma, and ca. 217 Ma emerging. These data may indicate multiple metasomatic events that post-date the DMO's interpreted Permian formation and pre-date the ca. 173 Ma minimum age of obduction determined in southern segments [2], and are consistent with tectonic models that propose oblique obduction along the margin of Gondwana [3].

[1] Jugum, D., et al. (2019) *Geological Society London, Memoirs* 49, 75-92.

[2] Palmer, M.C. et al. (2023), *Earth and Planetary Science Letters* 614, 1-11.

[3] Robertson, A.H.F., et al. (2019) *Geological Society London, Memoirs* 49, 331–372.