MIXED-ORIGIN SERPENTINITES RECORD THE EVOLUTION OF THE DUN MOUNTAIN OPHIOLITE BELT, NEW ZEALAND

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Abstract

This study investigates serpentinites from New Zealand's Dun Mountain Ophiolite (DMO) and associated mélange belts to identify their origin and tectonic evolution using the geochemistry of whole rocks, relict clinopyroxene (cpx), relict spinel, and O and H isotopes. Undeformed DMO serpentinites typically have depleted and U-shaped chondrite-normalized rare earth element (REE) patterns consistent with mantle wedge peridotites. Sheared DMO serpentinites have enriched and flat REE patterns with fluid-mobile element ratios suggesting they were primarily enriched by sediment-derived fluids in a subduction zone. Relict cpx in DMO samples have Al- and Cr-depleted compositions suggesting a mantle wedge origin, but light-REE (LREE)-depleted patterns consistent with an abyssal origin. The incongruent composition of these cpx indicates the protolith experienced melt-rock interactions. DMO spinel have cores with low Mg# (23.1-64.5), high Cr# (40.4-86.8), and highly Fe^{3+}- and Cr-enriched rims that further support that the protolith experienced melt-rock interactions. A single undeformed DMO sample has whole-rock, cpx, and spinel compositions all consistent with an abyssal origin, which may represent a less melt-depleted DMO protolith. O and H isotopes show the DMO protolith was serpentinized by seawater at temperatures varying from 175°C to 260°C. Mélange serpentinites have either depleted LREEs, negative Ce-anomalies, or highly enriched REEs that are consistent with abyssal and subducted serpentinites. Mélange protoliths were serpentinized by seawater at lower temperatures of 175°C to 200°C. We conclude that the mix of abyssal and mantle wedge characteristics of DMO serpentinites suggests that the DMO protolith originated in an abyssal setting but was later emplaced in a mantle wedge by subduction initiation. The DMO protolith then experienced extensive melt-rock interactions from supra-subduction melts to form harzburgites displaying varying degrees of melt depletion. Mélange protoliths formed and serpentinized in a distal abyssal setting and were later incorporated into the basal mélange adjacent to the DMO mantle wedge. Slab-derived fluids then serpentinized the DMO mantle wedge and enriched some serpentinites in trace elements, particularly where shearing facilitated higher fluid fluxes.

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