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Petrological evolution of the Marlborough Ultramafic Suite, central Queensland, Australia

JULIUS PASCO[1], GIDEON ROSENBAUM[1], TERESA UBIDE[1], LUKE MILAN[2] AND CARLOS SPIER[1]

[1]The University of Queensland
[2]The University of New England

The Marlborough Ultramafic Suite is the largest exposure of ultramafic rocks in eastern Australia and a possible host for critical mineral deposits in the region. It constitutes a portion of an ophiolitic sequence that likely originated from an ocean basin along the margins of eastern Gondwana. We present new petrological and geochemical data that constrain the nature and evolution of this oceanic domain, helping refine tectonic reconstructions of the region and serve as possible markers for the exploration of critical mineral deposits. The suite comprises harzburgite, serpentinite, and high-grade serpentinite. Major and rare earth element (REE) systematics resemble residual abyssal peridotites from oceanic spreading centers. The ultramafic rocks record post-melting Si metasomatism and/or Mg loss during serpentinization, with light REE enrichment linked to fluid interaction. Metasomatic processes also account for the formation of secondary talc and tremolite, while highly forsteritic olivine in high-grade serpentinite suggests localized contact metamorphism or an artifact of subduction metamorphism. Fluid-mobile element enrichment (Cs, Li) relative to U indicates forearc serpentinization, possibly associated with subduction-related exhumation. We propose that the contrasting spreading and subduction records in the Marlborough Ultramafic Suite could be explained by one of the following evolutionary models: (1) a Neoproterozoic mid-ocean ridge setting linked to the Paleo-Pacific Ocean and breakup of Rodinia; or (2) a younger, possibly Devonian, backarc setting related to Paleozoic supra-subduction assemblages in the New England Orogen. Our results support the idea that the Marlborough Ultramafic Suite was an ancient oceanic spreading center prior to its emplacement by subduction. Altogether, the results provide critical constraints on the origin of a now-consumed oceanic domain that existed along the margin of eastern Gondwana.