https://doi.org/10.7185/gold2025.28348

Diversity in olivine crystal-fabrics in the uppermost mantle of oceanic lithosphere: An example from the Horoman Peridotite Complex

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The Horoman peridotite complex, located on the collisional zone of two island-arc systems[1], was originally derived from a mid-ocean ridge basalt source mantle[2]. Therefore, it potentially offers valuable insights into the evolution of the oceanic lithosphere from initial upwelling to eventual exposure. We introduce new findings from crystal-fabric analysis and combine them with earlier geological and petrological studies to provide fresh perspectives on the lithospheric mantle processes.

We employed the SEM-EBSD method to measure the crystallographic preferred orientations (CPOs) of olivine in more than 50 oriented peridotite samples. The collected data was statistically analyzed and quantified as CPOs.

Observation using a polarizing microscope unveiled diverse microstructures within the peridotites, including mylonitic, porphyroclastic, and granular textures. The mineral assembly correlated with specific microstructures: spinel-bearing harzburgite and lherzolites typically displayed mylonitic to porphyroclastic textures, whereas plagioclase-bearing lherzolites exhibited granular textures. In quantitative analyses, four types of olivine CPOs were identified and found to be distributed in a specific order from south to north (from the bottom to the top of the complex): E, A, D, and AG types. Mylonitic and porphyroclastic textures were predominantly associated with the E type, whereas granular textures were more frequently observed with the AG type.

The development of the E type CPOs may be associated with dehydration from the Pacific slab[3], whereas the AG type CPOs are thought to be a remnant of thermal events and/or melt-rock interactions within the upper part. The AG type showed a distribution of [100] and [001] axes in an oblique girdle pattern relative to the foliation. The observed features were consistent with findings from the experimental studies[4], suggesting that these patterns resulted from the melt segregation and strain partitioning. As a consequence, the development of olivine CPOs in the upper part of the Horoman peridotite complex was primarily influenced by processes involving melt separation or melt-rock interactions.

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