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Mineralogy and geochemistry of the Neo-Tethyan Orhaneli ultramafic suite, NW Turkey: Evidence for the initiation and evolution of magmatic processes in a developing crust-mantle boundary

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The eastern Orhaneli ophiolitic massif, located in NW Anatolia, Turkey, forms part of the northwestern branch of the so-called Neotethys Ocean across the Izmir-Ankara-Erzincan Suture Zone. It is comprised mainly of a well preserved ultramafic suite, dominated by voluminous dunite exposures, accompanied by subsidiary harzburgite occurrences. The entire suite is commonly cross cut by a complex network of relatively undeformed clinopyroxenite veins. Clinopyroxene and spinel compositions in harzburgites are moderately depleted, whereas their whole-rock heavy rare earth element (HREE) abundances are consistent with harzburgite formation after approximately 19% dry melting of a spinel-bearing fertile mantle protolith at an extentional geotectonic regime. Nevertheless, textural data indicate that protracted dissolution of pyroxene coupled with precipitation of olivine happened during the transformation of harzburgites to replacive dunites, containing olivine with high Fo [Fo = 100×Mg/(Mg + Fe2+)] content (91.3-94.2) and spinel with elevated Cr# [100×Cr/(Cr + Al)] values (78-82). Such highly depleted mineralogical signatures imply that dunite for harzburgite substitution occurred under hydrous melting conditions in the mantle region above a subducted oceanic slab. Enrichments in incompatible elements (e.g., Cs, Rb and Sr) and the characteristic U-shaped chondrite-normalized rare earth elements (REE) profiles exhibited by replacive dunites along with the elevated TiO_2 (0.20-0.36 wt.%) contents in their accessory spinels indicate that the reactive melt had an intermediate affinity between boninite and island arc tholeiite (IAT) regimes. The metasomatic reaction triggered an additional 8% melting of the harzburgite residue. The resultant melt fractionated (‚almost in situ‚) to crystallize cumulate dunites composed of olivine with relatively high Fo content (88.8-92.3), spinel with moderate Cr# values (62-74), as well as clinopyroxene with a depleted composition (low TiO_2 and $Al2O_3$ contents and high Mg#) identical of clinopyroxene in arc-derived peridotites. These magmatically formed dunites are rich in light rare earth elements (LREE) and commonly carry elevated Pt+Pd concentrations (up to 17.92 ppb), especially compared to replacive dunites that are almost deprived of Pt and Pd (up to 3.92 ppb). Further upward movement and differentiation of this melt caused the formation of clinopyroxenites, containing spinel similar in composition to that of cumulate dunites, with elevated Pt+Pd abundances (up to 499.75 ppb) and LREE-depleted multi-element patterns typical of crystallization from a melt with comparable composition between boninite and IAT. Overall data indicate that the studied ultramafic suite represents part of a sub-oceanic Moho transition zone, which preserves mixed mantle and cumulate characteristics.