Mg-metasomatized Fe-rich dunites from the Thaba Putsoa kimberlite, Lesotho: Headstones in a kimberlite graveyard

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Megacrysts of olivine and mosaic-porphyroclastic dunites from the Thaba Putsoa kimberlite in Lesotho represent variably deformed and recrystallized members of the Cr-poor megacryst suite. Olivine compositions are readily divided into two groups, one of which is rich in Mg and Ni (molar Mg/(Mg+Fe) = 0.835-0.882, 0.25-0.39 wt% NiO). In the other, olivine is more Fe-rich (molar Mg/(Mg+Fe) = 0.772-0.820), substantially lower in nickel (0.05-0.13 wt% NiO) and associated with ilmenite. These two groups are equivalent to those of the Cr-poor olivine megacryst population at the nearby Monastery Mine in South Africa. At Thaba Putsoa, olivine neoblasts in several of the samples from the Fe-rich group are significantly enriched in Mg and Ni relative to porphyroclasts and are similar in composition to olivines of the Mg-rich group and to olivines in associated (and genetically related) igneous-textured ilmenite orthopyroxenites. Batches of magma, parent to the Cr-poor megacrysts but in different stages of differentiation (crystallization), must have been closely associated in space and time, allowing more primitive (magnesian) magmas to infiltrate and metasomatize earlier crystallization products (Fe-rich olivines and dunites). Rods and blebs of Ni-bearing sulfides in the most Fe-rich olivine megacrysts of the magnesian group at Monastery are evidence of development of an immiscible sulfide magma that caused Ni to be partitioned into the sulfide phase, resulting in dramatic depletion of Ni in subsequently formed Fe-rich olivines at both Monastery and Thaba Putsoa.