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What olivine, the forgotten mineral, tells us about kimberlite petrogenesis

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We report here the results of a petrographic and geochemical study of kimberlite samples from Greenland and Slave province in Canada. The samples contain between 5 and 45% of olivine which occurs as rounded "nodules" 1 to 5 mm in diameter. Some consist of single crystals but the majority are polycrystalline aggregates with well-rounded margins. Olivine compositions vary widely from nodule to nodule (from Fo 81-93) but within individual nodules the composition is constant. A thin rim of high-Ca olivine with intermediate composition (Fo 87-88) surrounds many nodules. Deformation structures in olivine in the nodules and in the matrix demonstrate a xenocrystic origin of these grains, presumably from the lithospheric mantle; only the high-Ca olivine in the thin rims is thought to have crystallized from the kimberlite magma. Combination of this olivine composition with whole-rock major-element data shows that the kimberlite compositions are controlled by the addition of xenocrystic olivine into a parental magma that contained only about 12-15% MgO.

The monomineralic, dunitic, character of the olivine nodules raises a problem because dunite is a rare rock in the lithospheric mantle. The source of the xenocrystic olivine apparently lacked both pyroxene and an aluminous phase, minerals that make up about half of normal mantle-derived rocks. It appears that these minerals were removed from that part of the lithospheric material that became the source of the nodules, perhaps during the passage of magmas or fluids that immediately preceded the kimberlites.

We accept Khazam & Fialko's (2005, G-cubed, vol 8 No 10) suggestion that the geochemical characteristics of kimberlites result from diffusive reaction with the mantle, either in the asthenosphere or the lithosphere. The elimination of pyroxene and garnet

may have been part of this process; what happens to diamond in the affected material is an open question.