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

N. T. Arndt[1], A. M. Boullier[1], J. P. Clement[1], M. Dubois[2], and D. Schissel[3]
[1]OSUG, Univ. de Grenoble, BP 53, Grenoble cedex 38401, France
[2]U.F.R. des Sciences de la Terre, UMR 8110 Processus et Bilans des Domaines Sédimentaires, 59655 Villneuve d'Ascq, France
[3]BHP Billiton World Exploration, Inc., 1400-1111 West Georgia Street, Vancouver, B.C. V6E 4M3, Canada

Abstract. We report here the results of a petrographic and geochemical study of remarkably well-preserved kimberlites from the Kangamiut region in Greenland. The samples contain between 5 and 45% of olivine in the form of rounded ''nodules'', each 1 to 5 mm in diameter. Most originally were single crystals but many consist of polycrystalline, monomineralic aggregates. Olivine compositions vary widely from nodule to nodule (from Fo 81-93) but are constant within individual nodules. A thin rim of high-Ca olivine of intermediate composition (Fo 87-88) surrounds many nodules. Deformation structures in olivine in the nodules and in the matrix demonstrate a xenocrystic origin for the olivine: only olivine in the thin rims is thought to have crystallized from the kimberlite magma. Using major and trace element data we show that the kimberlite compositions are controlled by the addition of xenocrystic olivine into a parental magma that contained only about 16–18% MgO.

The monomineralic character of the olivine nodules is problematic because dunite is a rare rock in the lithospheric mantle. The source of the xenocrystic olivine lacked pyroxene and an aluminous phase, which make up about half of most mantle-derived rocks. It appears that these minerals were removed from the material that was to become the nodules, perhaps by fluids that immediately preceded the passage of the kimberlites. We speculate that this mantle ''defertilization'' process was linked to interaction between CO_2-rich fluid and mantle and that this interaction controlled the geochemical and isotopic composition of kimberlites.

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