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Criteria to separate kimberlite macrocrist olivines to the main genetic types

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Olivine is one of the most common kimberlite mineral. It is also the main mineral of the subcontinental lithospheric mantle (SCLM), but it may also crystallize directly from kimberlite or belong to the low-chromium megacryst association. For the correct study of the SCLM and the processes in it based on the composition of olivine from kimberlites, it is necessary to have sufficiently clear criteria to divide it in various genetic types.
[Skinner, 1989] proposes the separation of olivines into macrocrystals (more than 0.5 mm), which are xenocrystals - detached mantle rocks, and microcristals (less than 0.5 mm) - idiomorphic phenocrysts associated with kimberlites (phenocrystals). The majority of authors believe that all central parts of olivines are xenogenic, and only narrow rims on them or microscopic grains crystallize from kimberlite [Kamenetsky et al., 2008; Nielsen and Sand, 2008; Brett et al., 2009; Arndt et al., 2010; Bussweiler et al., 2015; Kamenetsky et al., 2009; Sobolev et al., 2015]. This study deals with olivines of not-kimberlitic origin - only central homogeneous parts of crystals with a size of more than 0.5 mm.
In some kimberlites there are numerous impregnations of olivine with relatively low 100*Mg/(Mg+Fe) (Mg#) - from 78 to 88 [Hart, 1977; Moore and Costin, 2016]. The compositions of these phenocrysts form a characteristic trend of direct dependence in the coordinates of Mg# - CaO. These phenocrysts do not belong to disintegrated rocks of the SCLM, since Mg# for granular peridotites is 94-90, and for deformed peridotites - 94-85.5 [Sobolev et al., 2009; Moore and Costin, 2016 and review in this work]. Such olivines are described in the kimberlites of the Monastery pipe (S.Africa) rich in large (more than 10 mm) phenocrysts of various mantle minerals and interpreted as minerals of the low-chromium megacryst association, which does not belong to either the SCLM rocks, or the kimberlites themselves [Harte 1977]. Similar in composition, but smaller olivines are described in other kimberlites, and are interpreted as smaller or crushed when introduced minerals of similar origin [Jakob, 1977; Moore 1988]. Olivines of a low-chromium megacrist association can be well separated by an inclined line in Mg# - CaO coordinates.
Experimental and natural data in peridotites show that Ca enters into structure of olivine depending on temperature [Hoog et al., 2010]. This makes it possible to divide olivines of high-temperature deformed peridotites from olivines of depleted rocks of the lithospheric mantle - low-temperature granular peridotites. Based on data from 169 peridotite xenoliths of both species from 7 kimberlite pipes of the North American and South African cratons and more than a hundred xenoliths of the Udachnaya pipe (Siberian platform [Sobolev et al., 2009]) we suggest a curved line separating more than 96% of olivines from peridotites of these species. The bending of the line makes it possible to separate rocks similar in temperature (CaO), but differing in the degree of enrichment (Mg#).
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