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Genesis of platinum-bearing ultrabasic massifs in the plutonic chambers: evidence from melt inclusions

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Platinum-bearing ultramafic massifs occur as bodies of concentrically zonal inner structures due to the successive replacement of dunite with pyroxenite and gabbro from their cores to margins. A most important peculiarity of such massifs is their dunite cores, to which commercial Pt deposits are related. There are a different opinions about genesis of these massifs and geological, petrological, geochemical methods not always can solve this question.
We found melt inclusions in Cr-spinel from dunites of the platinum-bearing Konder and Inagli massifs (Siberian Platform) and this provides direct evidence of the participation of magmatic systems in the crystallization of ultrabasic rocks. Contents of most major chemical components in the heated and quenched melt inclusions are close to those in biotite-pyroxene picrite and this testifies dunite crystallization from ultrabasic alkaline magma.
Ion probe analyses of melt inclusions in Cr-spinel yielded relatively high water concentration in ultrabasic melts of the Konder (0.45-0.53 wt %) and Inagli (up to 0.63 wt %) massifs. These data are generally close to the water contents in magma that produced dunites of ophiolites (0.58-0.65 wt %) (Simonov et al., 2009).
The REE patterns of inclusions in Cr-spinel from the Konder and Inagli dunites show a pronounced negative slope with strong enrichment of LREE relative to HREE, as is typical of plume-related magmatic systems of oceanic islands and continental hotspots. The values of such indicator ratios as Nb/U (23.4), Zr/Nb (7.20), and Th/U (3.0) of inclusions practically exactly coincide with those of glasses from areas of continental hotspots (Naumov et al., 2010). At the Nb/Y–Zr/Y diagram the data points of the inclusions plot within the field of melts with a plume source. As a whole the patterns of trace elements and REE in melt inclusions in the Cr-spinel provide evidence that mantle plumes affected the magmatic events, that produced dunites of the studied platinum-bearing ultramafic massifs.
Our simulations on the basis of melt inclusion compositions by the PLUTON program package (Lavrenchuk, 2004) allowed to evaluate the crystallization temperature of dunites in the intrusive chambers. The most part of olivine was crystallized at 1460-1300°C and then, when the melt became less magnesian, this mineral continued to crystallize until to 1230°. The parameters evaluated with the help of another program (PETROLOG; Danyushevsky, 2001), based on data on melt inclusions, indicate that minimum temperature of the melts, from which olivine crystallized, was approximately 1230°. The model melt compositions (PLUTON program) are in good agreement with data on inclusions in Cr-spinel. For example, the calculated melt composition with 25.5 wt % MgO corresponds to 2.82 wt % 2, respectively, and melt inclusions with the same MgO (25.7 wt %) contain practically exactly coinciding K2O concentration of 2.7 wt %.