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Phenocrysts and megacrysts of olivines from ultramafic lamprophyres of the Chadobets and Il'bokich uplifts, Southwestern Siberia

Maria Smirnova (1,2), Lyudmila Sazonova (1,2), Anna Nosova (2), Alexey Kargin (2), and Vasiliy Shcherbakov (2)

(1) Lomonosov Moscow State University, Moscow, Russia, petitmx@gmail.com, (2) Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry, Moscow, Russia, nosova@igem.ru

The study of composition and zoning of olivines from ultramafic lamprophyres of the SW Siberian craton allowed us to distinguish their main types (phenocrysts and megacrysts) and to estimate the possible P-T conditions of phenocryst crystallization. The studied rocks occur as sills and dikes in the Chadobets and Il'bokich uplifts of the Irkeneeva-Chadobets trough. The ultramafic lamprophyres of these uplifts are spaced around 80 km apart and differ in age by more than 150 Ma. The rocks of the Il'bokich Uplift are dated at Devonian, while the age of the Chadobets Complex is restricted to the Triassic. The episodes of these complexes formation were separated by the large flood basalt event. According to classification (Tappe et al., 2005), the studied rocks are aillikite and damtjernite.

Olivine phenocrysts from the rocks of the Il'bokich and Chadobets complexes are represented by sub- and euhedral grains. They are composed of core, transitional zone, and rim. Olivine cores in the aillikites of the Il'bokich Complex are characterized by Mg# 89; CaO – 0.13-0.14 wt %; TiO_2 around 0.03 wt %, Al – 200-380 ppm, and Cr - 130-340 ppm. The cores of phenocrysts from the Chadobets lamprophyres have Mg# 85-87, CaO varying within 0.1-0.2 wt %, and TiO_2 – 0.02-0.05 wt %. The megacrysts differ from the phenocrysts of these rocks in the lower Mg# 83-84 and CaO – 0.08-0.14 wt % at higher TiO_2 – 0.04-0.05 wt %. Al – 100-700 ppm, Cr – 20-65 ppm.

The most striking difference between olivines of the two complexes is observed between their Mg#-Ni relations. The cores of olivine phenocrysts from the Il'bokich lamprophyres are characterized by the high Mg number (Mg# = 89) and Ni content (2800-3000 ppm), whereas olivine cores of the Chadobets aillikites have higher contents of Ni (3000-3500 ppm) at lowered (Mg# = 86-88). These characteristics reflect the compositions of their protolith.

The temperature was estimated using monomineral olivine thermometer based on the contents of Cr and Al in olivine (De Hooge et al., 2010). This geothermometer was calibrated for a wide compositional range, including kimberlites, and correspondingly, may be used for alkaline-ultrabasic lamprophyres. At pressures above 4 GPa, olivine phenocrysts fall in the field of olivine-kimberlite melt equilibrium (Girnis et al., 1995). The Il'bokich olivine phenocrysts were formed at higher temperature than the Chadobets phenocrysts: from 1240 to 1340_oC for the Il'bokich rocks and from 1080 to 1225_oC for the Chadobets rocks.

In the P-T diagram showing the geotherm of 40 mV/m^2, olivines from the Il'bokich and Chadobets lamprophyres lie to the right of the geotherm, which excludes the presence of xenogenic lithospheric mantle olivine in these rocks.

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