The influence of potassium on nickel partitioning between olivine and silicate melt

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Nickel contents in magnesian magmatic olivine are widely used to indicate mantle source lithology [1]. This approach however does not cover highly potassium mantle derived rocks because of lack of experimental data on Ni partition between olivine and such melts. While numerous experiments were conducted in order to investigate Ni partitioning between olivine and silicate melt [2-4], most of them have very restricted range of K_2O contents in the melt. Due to shortage of experimental data the liquidus temperature and chemical composition of high K_2O magmas are poorly predicted when using the existing olivine-melt thermometers [5,6]. The difference between experimental and predicted temperatures is becoming higher with the increase of the K_2O contents. Thus the existing models cannot be applied to the high-potassium rocks like lamproites and need to be refined.

In this paper we present results of a set of experiments (at 1 atm total pressure, 1300-1550°C, fO_2=NNO) with K_2O in the melt ranging from 1 to 9 wt.% to investigate the influence of potassium on nickel partitioning between olivine and melt. Experiments were carried out on vertical furnace with controlled oxygen fugacity at Vernadsky Institute, Moscow. Quenched runs were analyzed by EPMA at ISTerre, Grenoble, France. The loss of potassium was observed during high temperature experiments using conventional classic loop technique (50-57% in 20h experiments and 11-36% in 6h). To minimize this effect we used the crucible supported loop technique [7-9], which allows maintaining high K_2O concentrations in silicate melt at high temperatures.

The experimental olivines and glasses were found to be compositionally homogeneous in major and trace elements indicating that equilibrium was reached. A strong positive correlation between the Ni partition coefficient and potassium contents in the melts was detected. The results obtained were used to constrain quantitative model of olivine-melt Ni partition as function of phase compositions and equilibrium temperature.

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