Komatiite-anhydrite interaction experiments and exploration of Cu-Ni-PGE deposits in Finnish Lapland

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The Sakatti Cu-Ni-PGE deposit in Finnish Lapland formed as komatiitic magma assimilated anhydrite, which led to effective sulfide saturation in the presence of a reducing agent. Both komatiite and anhydrite are widespread in Lapland, hence the area has high potential for similar deposits. Mineral chemistry could be suitable for exploration as the volume of anhydrite-contaminated rocks must be several times larger compared to the associated sulfide deposits. We conducted experiments with a picrite from Lapland and a natural high-purity anhydrite from Sakatti, as starting materials. We melted the picrite to obtain a homogeneous picritic glass (16.5 wt.% MgO), which was inserted in graphite or anhydrite crucibles and enclosed in noble metal capsules for equilibrium experiments (duration 240 min). In addition, one disequilibrium experiment (duration 20 min) was conducted with picritic glass and anhydrite microxenoliths inside a graphite crucible. We used internally heated pressure vessels to conduct the experiments at 1240 °C and ca. 50 MPa. Samples without anhydrite consist of melt, olivine ($Fo_{82.9 \pm 0.8}$ with 2593 ± 222 ppm Ni), and minor Cr-spinel. Anhydrite assimilation affects the olivine composition ($Fo_{91.8 \pm 0.3}$ with 3274 ± 548 ppm Ni) and replaces Cr-spinel with Fe-Mg-spinel. In the disequilibrium experiment, anhydrite is still present and the main magmatic phases are melt, olivine ($Fo_{84.5–94.2}$ with Ni content from below detection limit to 2986 ppm), calcic clinopyroxene ($En_{46–48}Fs_{2–5}Wo_{47–52}$), sulfide, and Cr-spinel. Olivine with high Fo content and low Ni content is spatially associated with sulfides. Based on our results, anhydrite assimilation is indicated by the presence of high-Fo and high-Ni olivine and Fe-Mg-spinels. Effective sulfide saturation requires the presence of a reducing agent (graphite in our experiments and most likely shales in nature), and leads to high-Fo olivine with low Ni contents and abundant calcic clinopyroxene as observed in Sakatti.