

Pyroxene and olivine exsolution textures in majoritic garnets from the Mir kimberlitic pipe (Yakutia)

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Majoritic garnets are widely abundant as inclusions in diamonds worldwide [1]. Pyroxene exsolution textures were registered in garnets from mantle xenoliths in kimberlites [2, 3], as well as in rocks of ultrahigh-pressure metamorphic complexes [4], which provides evidence for their crystallization at pressures >7–8 GPa. We studied three large (>5 mm) garnet xenocrysts (Samples 317, 559 and 563) from the Mir pipe (Yakutia) containing regularly oriented pyroxene and olivine lamellae with angles of 71–72° between them. Garnets of all samples are pyrope-rich (75.1–78.6 mol %), with medium CaO (4.5–5.8 wt %) and low Cr₂O₃ (up to 0.59 wt %) concentrations. Clinopyroxene lamellae are enriched in diopside component (89.9–94.4 mol %). Olivines are characterized by the high Mg# (up to 0.96) and extremely high NiO concentration (1.6 wt % in Sample 559; 2.79 wt % in Sample 317). According to the data of 3D X-ray tomography using a scanner SkyScan1172 and 3D analysis (CT-An software), garnet (Sample 317) contains 9 vol % pyroxene and 0.5 vol % olivine lamellae. Calculation of the compositions of primary garnets demonstrated that Si content in them exceeded 3 f. u. (3.084 in Sample 317; 3.088 in Sample 559; 3.094 in Sample 563) providing evidence for incorporation of majoritic component. The formation of such garnets occurred at pressures >7.5 GPa and high temperatures (Ni in majoritic garnet and olivine). Subsequent decrease of *PT* parameters to 3.0–3.1 GPa and 950–1000°C [5] resulted in pyroxene and Ni-olivine exsolution in former majoritic garnet.

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Effects of organic ligands and temperature on the kinetics and mechanisms of olivine carbonation

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The slow dissolution kinetics of Mg-rich silicates has become a critical issue for the geologic CO₂ sequestration in basic rocks. Previous batch carbonation studies on San Carlos olivine performed in CO₂ saturated water (at 90°C and PCO₂=280 bar) have focused on the role that secondary phases, such as amorphous silica layers (SiO₂ (am)), have on the transport of reactants from and to the reactive surfaces. The fluid composition remained roughly constant over the duration of the experiment, close to saturation with respect to amorphous silica and with a [Mg²⁺]/[SiO₂ (aq)] ratio close to stoichiometric release, suggesting a passivation of the olivine surface by the silica layer.

In order to accelerate the dissolution process, organic ligands such as citrate and acetate were added to the solutions and tested at 1M and 0.1M concentrations in similar batch experiments. An intrinsic increase of the dissolution rate of olivine was expected prior to the formation of a passivating silica layer.

Preliminary results confirm this idea since Mg was released in non-stoichiometric proportions with respect to SiO₂ (aq) (found to be in equilibrium with SiO₂ (am)).

Similarly, a slight increase of temperature (from 90°C to 120°C) accelerated the reaction kinetics as well, possibly impacting the textural properties of SiO₂ (am). Current TEM investigations are directed to confirming a possible link between the observed increase of the rate and textural properties of secondary phases. In addition, because carbonate minerals have a retrograde solubility, thermodynamical modelling suggests that this temperature increase should allow the fluid to reach saturation with respect to carbonates before reaching saturation with respect to SiO₂ (am). Enough Mg can therefore be released to initiate the formation of carbonates before the silica precipitates and passivates the olivine surface.