Heterogeneous magnetite nucleation in multiphase inclusions controls olivine oxidation and hydrogen production at high pressure

Nadia Malaspina[1], Marcello Campione [1], Simone Tumiati [2], Marco Scambelluri [3]

[1] Università degli Studi di Milano-Bicocca, Milano, Italy;
[2] Università degli Studi di Milano, Milano, Italy;
[3] Università degli Studi di Genova, Genova, Italy

Multiphase inclusions represent microenvironments where the interaction between fluid and host mineral is preserved during the rock geological path, but they might follow a crystallisation mechanism which is not predictable through simple equilibrium arguments. Magnetite-bearing multiphase inclusions hosted in metamorphic olivine of harzburgites from the Almirez Complex (Spain) have been interpreted as final products of the trapping of the aqueous fluid produced by the subduction-zone dehydration of former serpentinites (Scambelluri *et al.*, 2001). Microfocus single-crystal X-ray diffraction demonstrated the preferential crystallographic orientation relationships between the olivine host and the magnetite inclusion, indicating a clear epitaxial growth of magnetite on olivine (Fig. 1; Campione *et al.*, 2020).

This relationship plays a fundamental role in favouring the heterogeneous nucleation of magnetite on olivine, which in turn have an important influence on the dynamics of phase nucleation acting as driving force for olivine oxidation and H_2 production. Bulk olivine mass spectroscopic analyses reveal 6.20 ± 0.05 μmoles per rock gram that is equimolar to magnetite and homogeneously diffused in the olivine matrix. The multiphase inclusion growth is therefore a dissolution-redox-precipitation process driven by the building up of an epitaxial interface between olivine and magnetite.

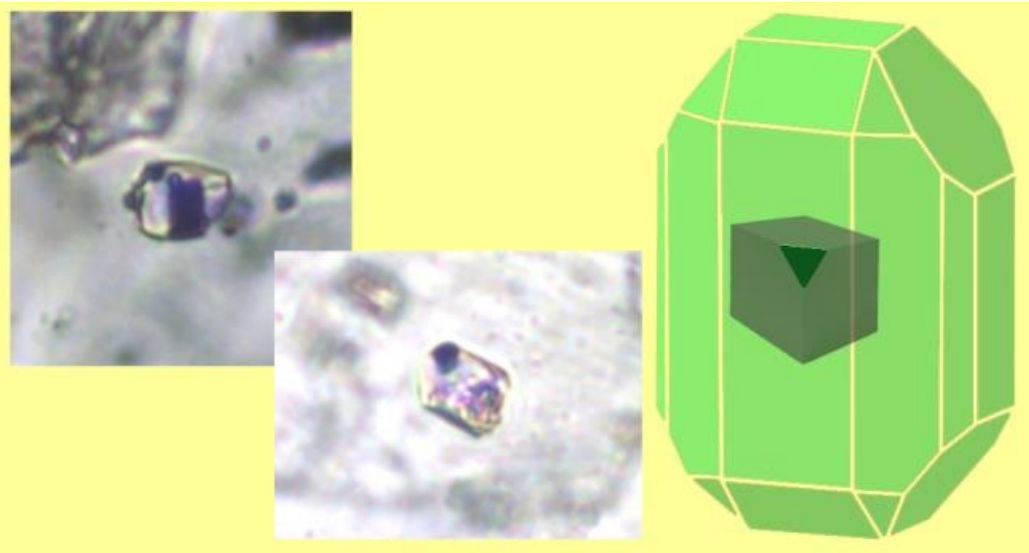

Figure 1- Epitaxial relation between magnetite micro inclusion and host olivine sharing [111] and [100] lattice faces (from Campione et al., 2020)

Campione, M., La Fortezza, M., Alvaro, M., Scambelluri, M., Malaspina, N. 2020. Commensurate growth of magnetite microinclusions in olivine under mantle conditions. ACS *Earth and Space Chemistry* 4, 825-830.

Scambelluri, M., Bottazzi, P., Trommsdorff, V., Vannucci, R., Hermann, J., Gomez-Pugnaire, M.T., Lopez-Sanchez Vizcaino, V. 2001. Incompatible element-rich fluids released by antigorite breakdown in deeply subducted mantle. *Earth and Planetary Science Letters* 192, 457-470.