



Redox processes at the slab-mantle interface: clues from slab-derived fluids

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The redox processes taking place in the portion of the mantle on top of the subducting slab are poorly investigated and the redox budget of crust-derived fluid phases is still poorly constrained. A case study of supra-subduction mantle affected by metasomatism from crust-derived fluid phases is the Maowu Ultramafic Complex (China) deriving from harzburgite precursors metasomatised at ~ 4 GPa, 750-800°C by a silica- and incompatible trace element-rich fluid phase (Malaspina et al., 2006; Chen et al., 2017). This metasomatism produced poikilitic orthopyroxene and inclusion-rich garnet porphyroblasts. Solid multiphase primary micro-inclusions in garnet display negative crystal shapes and infilling minerals (spinel, \pm orthopyroxene, amphiboles, chlorite, \pm talc, \pm mica) occur with constant modal proportions, indicating that they derive from trapped solute-rich aqueous fluids. To constrain the possible mode of precipitation of daughter minerals a single-crystal X-ray diffraction experiment has been performed by synchrotron radiation at Diamond Light Source (Malaspina et al., 2015). Results demonstrated the epitaxial relationship between spinel and garnet and between some hydrous minerals. Moreover, FT-IR hyper spectral imaging analyses and micro-Raman spectroscopy, together with X-ray microtomography performed on single inclusions, indicate that liquid water is still preserved at least in some inclusions.

To investigate the redox budget of these fluid phases, the Fe³⁺ concentration of the micron-sized precipitates of the multiphase inclusions has been measured for the first time using EELS on a TEM. Results indicate that spinel contains up to 12% of Fe³⁺/ΣFe, amphibole about 30%, while the ratio in inclusion phases such as chlorite and phlogopite may reach 70%. The Fe³⁺ fraction of the host garnet is equal to that measured in spinel as also confirmed by Flank Method EPMA measurements.

Forward modelling fO_2 calculations indicate that the garnet orthopyroxenites record $\Delta FMQ = -1.8 \div -1.5$, resulting apparently more reduced with respect to metasomatised supra-subduction garnet-peridotites. On the other hand, oxygen mass balance, performed both on the Maowu hybrid orthopyroxenite and on metasomatised supra-subduction garnet peridotites, indicate that the excess of oxygen (nO_2) is the same (10 mol m⁻³). An oxygen mass balance of the crust-derived fluids also indicates that the fluid precipitates are more oxidised than the host rock, reaching up to 400 mol m⁻³ of nO_2 . This suggests that even after their interaction with the metasomatic orthopyroxenites, the residual fluid phases could be potentially carrier of oxidised components when escaping the slab-mantle interface.

References:

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