Petrophysical and experimental investigations of fluxed-melting processes in the mantle wedge

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Petrological models [1] suggest that orthopyroxene-rich peridotites from the sub-arc lithospheric mantle can originate from melting of hybrid, silica-rich sources. However, several processes can account for the silica-rich nature of these sources, such as modal modifications of lherzolite before melting (e.g. pyroxenite formation) or continuous enrichment mechanisms during melting (e.g. fluid-fluxing).

We present the results of petrophysical investigations (electron backscatter diffraction, EBSD) of new sub-arc mantle spinel harzburgites from Papua New Guinea (PNG) and high-pressure melting experiments in piston-cylinders (1-2.5 GPa) of model silica-rich sources with controlled fO_2 and H_2O. Sub-arc mantle harzburgites from PNG record orthopyroxene enrichment for a variety of melting conditions below 2.5 GPa (isobaric batch melting but also polybaric decompression fractional melting). EBSD orientation maps show that orthopyroxene enrichment is coeval with deformation under high-temperature, low-stress and low to moderate hydrous conditions. These results suggest melt- and fluid-rock interactions during deformation in the asthenosphere, and confirm those of earlier EBSD studies of sub-arc mantle peridotites [2]. High-pressure melting experiments of silica-rich sources consistently reproduce Si- and Mg-rich melt compositions. These melts are experimentally reproduced in equilibrium with residues enriched in orthopyroxene and are higher in normative quartz and hypersthene than those derived from hydrous lherzolite.

Our results suggest that orthopyroxene enrichment in sub-arc mantle peridotites occurs during melting with peritectic reactions of peridotite with silica-rich, slab-derived fluids or melts at high pressure-temperature conditions, likely through porous flow. Mass balance models (ABS4) reproduce orthopyroxene-rich peridotites as melting residues for a range of arc magmas observed at modern subduction zones; these rocks are possibly key indicators of the occurrence of fluxed-melting in the mantle wedge.

[1] Bénard et al. (2017) *GCA* **199**, 287-203. [2] Soustelle et al. (2010) *JPet* **51**, 363-394.