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Silicate melt metasomatism in the lithospheric mantle beneath SW Poland

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The xenoliths of peridotites representing the subcontinental lithospheric mantle (SCLM) beneath SW Poland and adjacent parts of Germany occur in the Cenozoic alkaline volcanic rocks. Our study is based on detailed characterization of xenoliths occurring in 7 locations (Steinberg in Upper Lusatia, Księginki, Pilchowice, Krzeniów, Wilcza Góra, Winna Góra and Lutynia in Lower Silesia). One of the two major lithologies occurring in the xenoliths, which we call the "B" lithology, comprises peridotites (typically harzburgites) with olivine containing from 90.5 to 84.0 mole % of forsterite. The harzburgites contain no clinopyroxene or are poor in that mineral (eg. in Krzeniów the group "B" harzburgites contain < 1 vol. % of the mineral). They exhibit significant variation in orthopyroxene contents, which varies from 25 to 10 vol. %. Some of the xenoliths are more impoverished in orthopyroxene and have dunitic compositions. The ortho- and clinopyroxene exhibit mg# similar to that of olivine, and typically are low aluminous (Al < 0.10 atom pfu in ortho-, and < 0.20 atom pfu in clinopyroxene). The exception are xenoliths from Księginki, which contain pyroxenes characterised by negative correlation between mg# and Al. The REE patterns of both ortho- and clinopyroxene in the group "B" peridotites suggest equilibration with silicate melt.

The rocks of "B" lithology were formed due to alkaline silicate melt percolation in the depleted peridotitic protolith. The basaltic melts formed at high pressure are usually undersaturated in both ortho- and clinopyroxene at lower pressures (Kelemen et al. 1992). Because of cooling and dissolution of ortho- and clinopyroxene the melts change their composition and become saturated in one or both of those phases. Experimental results (e.g. Tursack & Liang 2012 and references therein) show that the same refers to alkaline basaltic silicate melts and that its reactive percolation in the peridotitic host leads to decrease of Mg/(Mg+Fe) ratios of olivine and pyroxenes. Thus, the variation of relative volumes of olivine and orthopyroxene as well as the decrease of mg# of rock-forming silicates is well explained by reactive melt percolation in the peridotitic protolith consisting of high mg# olivine and pyroxenes (in the area studied by us that protolith was characterised by olivine containing 90.5 – 92.0 mole % forsterite). The rocks which were subjected to significant decrease of mg# of silicates (down to 84) may be difficult to distinguish from cumulates. However, since the alkaline basaltic melts do not precipitate orthopyroxene under lithospheric pressures, their mineral composition is different than that of mantle harzburgites.

Kelemen PB, Dick HJB, Quick JE (1992) Formation of harzburgite by pervasive melt/rock reaction in the upper mantle. Nature 358: 635-641.

Tursack E, Liang Y (2012) A comparative study of melt-rock reactions in the mantle: laboratory dissolution experiments and geological field observations. Contributions to Mineralogy and Petrology 163: 861-876