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Interactions between deformation and reactive melt percolation in the upper mantle: Deformation-Dia and 6-ram multi-anvil experiments at high pressure and temperature

V. Soustelle, G. Manthilake, N. Walte , N. Miyajima , D. Frost , and F. Heidelbach
Bayerisches Geosinstitut, Bayreuth, D

Most experiments involving partially molten mantle rocks imply the presence of a melt in chemical equilibrium with a solid matrix. In contrast natural samples deformed in the presence of melt often display evidence for petrological reactions between the percolating melt and the surrounding minerals. These reactions occurring during deformation may be responsible for structural and textural differences observed between experimental and natural samples. This study consists of a series of deformation experiments where we used a D-Dia apparatus for uni-axial compression, and a 6-ram multi-anvil press for simple shear. All the experiments have been performed at 2 GPa and 1150 ºC on a dunite-like aggregate mixed with 10% melt in chemical disequilibrium with the solid matrix. The samples were deformed at strain rates between 10-5 and 10-4 s-1. The strain ranged from 10 to 30 %, and from a γ of 0.8 to 1.5 for uni-axial compression and simple shear experiments, respectively. The reaction between the melt and the olivine induces the precipitation of orthopyroxene and minor amounts of clinopyroxene. In all samples, melts pockets and pyroxenes are dispersed randomly in the aggregates. The analysis of the melt pockets topology and orthopyroxene shape preferred orientation displays a clear difference between the direction of the elongation of the melt pocket and orthopyroxene single crystals or aggregates. In uni-axial compression experiments, melt pockets have their long axis at 0-45º to the direction of compression, with an average around 10º, whereas the orthopyroxenes are flattened parallel to the extension plane. In simple shear experiments, the melt pockets are mostly elongated subparallel to the shear direction whereas orthopyroxene single crystal and aggregate long axis is parallel to the lineation defined by olivine elongation, which is orientated at 30º to the shear plane. Crystal preferred orientation (CPO) measurements on olivine show a maximum concentration of the [010] axes normal to the girdles formed by the [100] and [001] axes, which are parallel to the foliation. The orthopyroxene CPO displays a girdle of the [001] axes parallel to the foliation, and a maximum concentration of the [100] and [010] axes normal to the foliation, and. This observation is not consistent with orthopyroxene CPO observed in natural upper mantle samples where [100] is usually the dominant slip plane.