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# Structures and rheology of syn-kinematic partially molten gneiss: an experimental approach.

Ganzhorn Anne-Céline (1,2), Arbaret Laurent (3,4,5), Champallier Rémi (3,4,5), Labrousse Loic (1,2), Prouteau Gaëlle (3,4,5)

(1) Univ. Pierre et Marie Curie Paris 6, UMR 7193, ISTeP, 75005 Paris, France (anne-celine.ganzhorn@upmc.fr), (2) CNRS, UMR 7193, ISTeP, 75005 Paris, France, (3) Univ. d'Orléans, UMR 7327, ISTO, 45071 Orléans, France, (4) CNRS/INSU, UMR 7327, ISTO, 45071 Orléans, France, (5) BRGM, ISTO, UMR 7327, 45071 Orléans, France

Partial melting of the continental crust is a weakening process prone to induce ductile flow of orogens. The presence of melts indeed affects both the thermal and rheological behavior of the crust during orogeny, probably since the very first percents of partial melting. The rheological laws of the partially molten crustal rocks often refer to deformation experiments of synthetic metapelites with well-constrained composition but less realistic initial textures. This study focuses on the experimental deformation of a natural two-micas gneiss from the Western Gneiss Region, Norway, in order to constrain its rheological and textural behaviors when subjected to low temperature (750°C) water-present melting.
Two starting materials were used for Paterson experiments. Cores of a dry gneiss were prepared while others were first hydrated at room temperature and loaded in the bore furnace of an internally heated pressure vessel at 750°C and 300 MPa during 48 hours, then isobarically quenched. The partially molten gneiss contain up to 20% of hydrated glass that forms a 20 $\mu$m thick film isotropically distributed at muscovite-quartz grain boundaries. The dry gneiss submitted to similar P/T conditions remained un-melted. Thin films of melt only appear at temperature above 850°C for the same pressure. Axial deformation experiments were performed with both dry and pre-hydrated cores in a gas medium Paterson apparatus at constant 300 MPa confining pressure and two temperatures of 750°C and 850°C. Axial stress was applied perpendicularly to the mineral foliation; finite strain varied from 14% to 23%. Varying strain rates from 5x10-6 to 10-4 s-1 allowed us to determine the rheological behaviour of the hydrated gneiss. We found a shear thinning behaviour with stress at T = 750°C. In addition, the measured stress at this temperature is reduced by one order of magnitude between the dry gneiss (2.5x109 Pa) and the partially molten gneiss (<2.5x108 Pa).
SEM textural analysis reveals that all gneiss cores deformed at 750°C are affected by strain localization. The un-melted dry gneiss showed conjugate set of shear bands, oriented at 45°±5° from $\sigma 1$. They are formed of cataclased quartz and folded muscovite grains. The partially molten hydrous gneiss is affected by less abundant shear bands as only one major strain localization zone develops. Such zone are characterized by ribbons of quartz with evidences of ductile deformation, but still locally affected by minor crystal fracturing. The muscovite, along which large films of melt (<20 $\mu$m) are preserved, are reoriented parallel to the main shear zone plane. No melt concentration was observed in these bands compared to it initial homogeneous distribution.
The consequences of these results on the rheology and deformation of the partially molten continental crust during orogeny, and in particular on the Western Gneiss Region, are discussed in the prospect of previous experiments on syn-kynematic melting of metapelites..

Keywords: rheology, natural gneiss, partial melting, axial experiments.