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Orogen scale shear zone development in partially Variscan molten crust. The critical role of water-present melting in metagranite inducing strain localization.

Jonas Vanardois, Pierre Trap, and Didier Marquer
Université de Bourgogne-Franche-Comté, UMR 6249 Chrono-Environnement, Besançon, France (jonas.vanardois@univ-fcomte.fr)

The causes for heterogeneous deformation with strain partitioning into kilometre-scale shear zone within the partially molten crust and the spatiotemporal feedback relationships between strain localization and melt organization still remain unclear. In order to tackle these questions and unravel the strain localization in a partially molten crustal scale shear zone, we used field observations and thermodynamic modelling in the Eastern Variscan Shear Zone (EVSZ) located in the Aiguille-Rouge massif (Western Alps). The EVSZ is an orogen scale, 10 km wide and 600 km long, transpressional high strain corridor recognized in the French External Crystalline Massifs. The EVSZ affected the partially-molten late Variscan crust during late Carboniferous times (340-300 Ma). In this contribution we present a detailed field-map survey of the mid- and lower crusts focussed on the partitioning and strain pattern in the Aiguille-Rouge EVSZ. Detailed mapping revealed that high-strain deformation domains and orthogneiss occurrences are spatially related. New petrological, thermobarometrical and LA-ICP-MS dating also better constrain the P-T-t-D evolution of the partially molten crust along the EVSZ. Field observations and P-T pseudosection calculations show that among the three dominant lithologies forming the mid- and lower-crusts, i.e. metapelite, metagreywacke and orthogneiss, the latter is the most fertile if considering H2O-fluid-saturated melting. During prograde evolution at pressure between-12-15 kbar, orthogneisses reached the solidus at lower temperature and produced higher melt fraction than the metasedimentary rocks. The water-present melting in the orthogneisses may have initiate strain localization at the end of the prograde evolution. Thus, the favoured localization of the shear zone within the metagranites is explained by a higher melt fraction than in the metapelites and metagreywackes. PTDt path and thermobarometrical modelling suggest that these transpressional deformation conditions occurred under suprasolidus conditions from at least 12 kbar to 4 kbar during a near isothermal decompression. During this cooling path, while crystallization of anatectic melts might have provoked strain hardening in the orthogneisses, a strength decrease might be controlled by a higher proportion of micas in metapelites and metagreywackes as suggested by forward modelling of modal proportion of mica. This change in the nature of the weakest phase, starting with melt in metagranites and followed by micas in metasedimentary rocks, seems to control the progressive localization and broadening of the crustal scale shear zone during clockwise P-T-t path. Our results suggest that H2O-fluid-saturated melting of metagranites has a

first order rheological impact on the birth and growth of the orogen scale shear zone in the lower continental crust.