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Experimental constraints on the role of brines in the transformation of granulite-facies metapelites to eclogites

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A common feature of HP and UHP terranes is the subduction of lower crustal rocks to great depths. Investigations in the Bergen Area in Norway have shown that this process is triggered by fluids present during eclogite-facies metamorphism (e.g. Austrheim, 1987, EPSL, 81, 221-232). Fluid inclusions in eclogite-facies minerals range from dilute solutions to chloride-rich brines and previous studies have shown that highly saline fluids occur in subduction zones, where continental material is involved. A key example of these processes is exposed at Val Savenca of the Sesia-Lanzo Zone, Italy, where Eo-Alpine eclogite-facies metamorphism and fluid flow led to partial transformation of Hercynian amphibolite-eclogite facies metapelites (garnet + biotite + sillimanite + K-feldspar + plagioclase + quartz) to zoisite + jadeite + kyanite + phengite + quartz with associated jadeite veins. Application of the K-feldspar – jadeite – quartz barometry to the plagioclase domains yields $P - T$ conditions of 1.7 – 2.1 GPa at 600˚C and low $a(H_2O)$ of 0.3-0.6 (Tropper et al., 1999, JMG, 17, 195-209). In order to understand the role of brines in the transformation exposed at Val Savenca, we carried out piston-cylinder experiments with a fresh, natural granulite from the Moldanubic Unit in upper Austria with the assemblage garnet + biotite + K-feldspar + plagioclase + quarz. The experiments were conducted in the presence of H_2O-NaCl fluids at 600˚C and 2 GPa for 2-4 days. The fluids had the compositions $X(H_2O)$ =

1.0, 0.90, 0.80 and 0.70, and fluid/rock ratio varied from 1:1 to 1:10. Oxygen fugacity was buffered at NNO and HM in most experiments.

Preliminary data from the experiments clearly show increasing reaction progress and a change in clinopyroxene composition with increasing salinity in the fluid. In the $X(H_2O)$ = 1.0 experiments, the reaction products are much smaller, whereas in the $X(H_2O)$ = 0.7 experiments, the protolith assemblage is replaced by large (up to 100 μm long), euhedral crystals of the assemblage jadeite + phengite + quartz. Biotite and K-feldspar are the only relict phases in all experiments. In the experiments with $X(H_2O)$ = 1.0, the anorthite component of plagioclase is responsible for the formation of diopside-rich omphacites, whereas in the experiments at $X(H_2O)$ = 0.7, only jadeite occurs. Therefore, the experiments show a strong indication of Na-Ca exchange: the anorthite component of plagioclase goes readily into solution at low $X(H_2O)$, thus producing zoisite needles only upon quench. Future experiments will be conducted on fluids in the system H_2O-NaCl-$CaCl_2$ to quantify this behavior. These experiments so far show that brines highly effective promote reaction progress in subduction zone processes.