KCl metasomatism in the lower crust: Nature and experiment

D.E. HARLOV

GeoForschungsZentrum Potsdam, Telegrafenberg, D-14473 Potsdam, Germany (dharlov@gfz-potsdam.de)

The occurrence of Kfs micro-veins along Plg-Qtz and Plg-Plg grain boundaries in high-grade mafic, felsic gneisses has been interpreted as evidence for migrating alkali-rich fluids in the deep crust which have been proposed to be responsible for melt-absent dehydration of high-grade rocks from amphibolite to granulite facies (Harlov and Förster 2002, J Petrol, 43, 769; Montanini and Harlov, 2004, Eos Trans. AGU, 85(47), V31A-1410). Additional evidence includes Plg grains metasomatised in a K-rich fluid; Mnz and/or Xn inclusions in the FAp grains; Bt enriched in Ti, F, and Cl; and FAp enriched in Cl and F. These features are not seen in the "source" amphibolite facies terrane along the same traverse. When log(fHF/fH_2O) for either Bt or FAp is plotted as a function of the distance from the fluid/heat source, a uniform decrease in log(fHF/fH_2O) is observed across the granulite to amphibolite facies traverse suggesting the presence of a uniform low H_2O activity uniform fluid front.

Dehydration experiments (900 °C; 1000 MPa; 3 weeks; Au capsule; quenched) involving a cylinder of natural tonalitic Bt gneiss (Plg, Qtz, Bt) (220 mg) and a concentrated KCl brine (20-30 \% H_2O; 70-80 \% KCl) (8 mg) placed at the base of the cylinder have been conducted in the piston cylinder apparatus (CaF_2 setup). Micro-veins primarily of Kfs, with some evidence of partial melting, formed along Qtz/Plg grain boundaries though only where Bt and Qtz were in contact. Here the Bt reacted with Qtz to form numerous small Opx and Cpx grains + minor Ilm. The two principle reactions responsible for both the formation of the Kfs micro-veins as well as the pyroxenes include: (1) An (in Plg) + Qtz + KCl (in fluid) = Kfs + $CaCl_2$ (in fluid) and (2) Bt + Qtz = Opx + Kfs + H_2O. In the case of a concentrated NaCl brine or a CO_2-rich fluid, micro-veins with a granitic composition resulted along Qtz/Plg grain boundaries with Opx + minor Ilm forming along Bt/Qtz grain boundaries.

Channelization of subduction zone fluids during devolatilization

JAY J. AGUE

Department of Geology and Geophysics, Yale University, P.O. Box 208198, New Haven, CT 06520-8109 USA (jay.ague@yale.edu)

The geochemistry and flow pathways of subduction zone fluids have important implications for arc magma genesis, seismicity, and the global cycling of elements. This study examines fluid flow and mass transfer that occurred during Cretaceous-Eocene high-pressure/low-temperature (HP-LT) metamorphism of carbonate rocks from Tinos and Syros islands, Greece. Much of the sequence appears to have undergone limited fluid-rock interaction. However, mass balance analysis indicates that fluid infiltration along high-permeability conduits including fractures and lithologic contacts produced strong metasomatic alteration of metacarbonate rocks resulting in the destruction of aragonite and the widespread growth of omphacite, glaucophane, garnet, and epidote. Fluid infiltration increased Si, Al, Na, U/Th, Yb/La, and Sr/Y, and stripped out K, Ba, and Rb for rocks in and adjacent to the conduits. The infiltrating fluids were almost certainly derived from meta-mafic/metapelitic sequences on Tinos, and meta-ultramafic melange for the Syros example. Estimates of time-integrated fluid flux (qTI) based on Al concentrations in fluids (Manning, 2004) and Al mass balance (Ague, 2003) give qTI as large as ~10^4 m^3 m^{-2}. Assuming that the maximum qTI that can locally be generated from the subducted slab and metasediments is ~10^3 m^3 m^{-2}, the estimated conduit fluxes suggest strong channelization. Assuming 10 vol. % conduit, a reasonable estimate based on field observations, numerical simulations of flow show that channelization of a 10^3 m^3 m^{-2} devolatilization flux into ~10 vol. % conduit is sufficient to produce conduit qTI of order 10^4 m^3 m^{-2}. This result requires that conduits be ~100 times more permeable than the surrounding rocks, such that the conduits would carry over 90% of the total fluid flux. The field and model results suggest that fluid flow can be highly channelized in subduction zones such that much of the rock mass undergoes relatively little fluid-rock interaction. Fluid fluxes concentrated into conduits will most likely be transferred to melange and/or the mantle wedge.

References

Ague, J.J., (2003), *Am. J. Sci.* **203**, 753-816.

Manning, C.E., (2004), *Earth Planet. Sci. Lett.* **223**, 1-16.