Experiments and eclogites: constraints on element recycling in subducted crust.

J. HERMANN[1]

[1] Research School of Earth Sciences, ANU, Canberra 0200; joerg.hermann@anu.edu.au

Deeply subducted crust now exposed at the surface provides an excellent natural laboratory to study subduction processes. While subducted oceanic crust contains mainly information on fore-arc processes, continental crust can reach ultra-high pressure (UHP) conditions corresponding to sub-arc depth in subduction zones. By combining the study of natural rocks with experiments, important constraints on element recycling can be obtained.

The phase assemblages in mafic to felsic rocks are very different at low pressures. In contrast, at UHP conditions they converge to an assemblage with different proportions of coesite, garnet, clinopyroxene, phengite, and kyanite as major minerals and rutile, zircon, apatite and allanite or monazite as accessory minerals. In such a mineral assemblage most of the relevant trace elements are hosted by minor or accessory phases. LILE are controlled by phengite, LREE, Th and partly U by allanite, Ti, Nb and Ta by rutile, Zr, Hf and partly U by zircon and P by apatite for most cases. The stability and composition of phengite is of particular interest because this mineral hosts the most fluid mobile elements. In experiments, phengite is stable up to 1000°C at 45 kbar and such high temperature phengite is characterised by TiO_2 contents up to 2 wt.%.

The interaction of the key minerals with a fluid phase determines element recycling during subduction. Evidence from experiments and natural rocks indicates that aqueous fluids liberated at the blueschist to eclogite facies transition are diluted and do not extract significant amounts of major and trace elements from the residue. Because the wet solidi for granitic, pelitic and mafic rocks are very similar, the critical temperature interval where solubilities strongly increase in subducted crust is at 700-750°C at a sub-arc depths of 100-150 km. At such conditions, there is a small temperature range of approximately 50-100°C, where transitional solute-rich fluids (often labelled “supercritical fluids”) exist. At higher temperatures, fluid present melting takes place and hydrous felsic melts enriched in trace elements are able to significantly deplete the residue in incompatible elements. There is increasing evidence from polyphase inclusions in peak minerals, that such hydrous felsic melts were present during diamond facies metamorphism of crustal rocks. In these unique rocks there is also textural and trace element evidence that hydrous carbonate melts can form and sulfide melts might be present at these extreme conditions.