Sediment melts at sub-arc depth.

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Arc lavas and continental crust are enriched in LILE and LREE with respect to MORB and it is generally accepted that these elements represent a slab component in subduction zone magmas. Subducted sediments are the main host of these elements and thus phase and melting relations in metapelites are of first order importance to constrain trace element recycling in subduction zones.

Here we present results from an experimental study on a trace element doped, hydrous (2-7 wt.% H_2O), synthetic pelite composition in the range from 22-45 kbar and 600-1050°C, i.e conditions relevant for the slab at sub-arc depth. The main mineral assemblage over the investigated range consists of phengite, quartz/coesite, garnet, omphacite and minor kyanite, and accessory rutile, apatite, allanite or monazite and occasionally zircon. At 25 kbar amphibole is present up to 800°C instead of omphacite and biotite is stable from 750°C-900°C. The solidus has been determined at 675°C, 22 kbar and at 700°C 25 kbar. At 750°C, 35 kbar and at 800°C, 45 kbar glass was present in the experiments indicating that at such conditions a hydrous melt is stable. In contrast, at 700°C, 35 and 45 kbar, a solute-rich aqueous fluid was present. This indicates that the solidus is steeply sloping in P-T space. Although the second critical point in this system is not yet determined, the experiments show that at T<700°C solute-rich aqueous fluids and at T>750°C hydrous granitic melts are the stable fluid phase responsible for trace element transfer from the subducted sediments to the mantle wedge. Phengite is the main host of LILE in the residue and is stable up to 800°C, 25kbar; 950°C 35kbar and 1000°C, 45 kbar, confirming earlier studies indicating that liberation of LILE must be related to fluid present conditions in the slab. Also phengite is present to high degrees of partial melting (up to 40%) and thus will buffer the K content of the fluids/melts and control LILE recycling. The produced hydrous melts display systematic changes with increasing temperature. At 750-800°C Na_2O is higher than K_2O whereas at higher temperatures it is the opposite. K_2O/H_2O changes strongly as a function of temperature and nature of the fluid phase. It is about 0.002-0.01 in the aqueous fluid, and then increases gradually from about 0.1 at 750°-800°C to about 1 at 1000°C in the hydrous melt. Primitive subduction related magmas have typically K_2O/H_2O of ~0.1 indicating that hydrous melts rather than aqueous fluids are responsible for element transfer in subduction zones and that top slab temperatures at sub arc depths are approximately 800°C.