Melting crust at extreme conditions

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A key feature of crustal melts is that they contain various amounts of water. Such hydrous melts can be produced either via fluid fluxed melting or through breakdown of hydrous phases. Fluid fluxed melting is a key process in subduction zones, where water liberated from ultramafic rocks at 80-130 km depth interacts with altered oceanic crust and sediments in order to produce hydrous rhyodacitic melts at temperatures of 700-800°C. Experiments show that these melts have high LILE contents, U>Th, enrichment of LREE over HREE and Nb<La. The K_2O/H_2O and the H_2O/Ce of these melts is very similar to primitive arc magmas and thus fluid fluxed melting of subducted crust is likely a main process to transfer a typical subduction signature from the slab to the mantle wedge, leading ultimately to the formation of new continental crust. Phengite melting at even higher pressures and temperatures of ~1000°C is documented in the diamond-bearing gneisses of the Kokchetav massif. Rare melt inclusions in peak metamorphic garnet show extreme enrichments in LREE and Th, with LREE>LILE, Th>U and H_2O/Ce that are incompatible with the subduction component in arc magmas. In both types of melting, large melt volumes can be produced over small temperature intervals, controlled by the amount of fluid added and the amount of phengite available. Therefore it is expected that this style of melting will result in a dramatic change of the rheology of the subducted crust.

Partial melting at crustal (less then 50 km) depth proceeds mainly via breakdown of muscovite, biotite and amphibole. In contrast to the subduction zones, melting occurs along continuous reactions over a much larger temperature interval, with smaller amounts of melts produced for any given temperature interval and with melt productivity likely limited by heat supply.