

# ***Magmatism***

## **Movement of partial melts (*December 2006*)**

The phenomenon of partial melting is one that chemists often find hard to grasp, since it takes place inside rocks and involves contributions from several minerals according to the thermodynamic controls over multi-compound phase relations. It is a bulk process, with tiny contributions from throughout large volumes of solid hot rock. How it becomes magma baffles most geologists, because tiny amounts have to migrate and coalesce into large volumes before being able to move en masse, to intrude or be exuded at the Earth's surface. There is a popular model: that the melt fraction is channelled along mineral-grain boundaries and accumulates to migrate faster in interconnected cracks. The trouble is that any melts that remained in their parent rocks have generally crystallised before they were exhumed at the surface, obscuring all the fine detail. The other complicating aspect is that melting generally involves other fluids, mainly supercritical water and carbon dioxide, both as catalysts for and products of melting itself. They show up in fluid inclusions within minerals, but rarely relate to evidence of melting.

Occasionally igneous minerals contain glass that they trapped during crystallisation, for instance olivines sometimes include glass formed from their parental basaltic magma. Heating the minerals until the glass remelts is a simple way to look at the obverse of crystallization thereby mimicking the melting process (Schiana, P. *et al.* 2006.

[Transcrystalline melt migration and Earth's mantle](#). *Science*, v. **314**, p. 970-974; DOI: 10.1126/science.1132485). Interestingly the melt does migrate through the solid mineral, towards higher temperatures but also taking on something of the crystal form of its enclosing mineral. It is slow, around 1 to 3 nm s<sup>-1</sup>, but that is enough to get it to a grain boundary. Gas bubbles in the glass do the opposite, moving towards lower temperatures and separating from the melt to become trails of fluid inclusions in the mineral itself. Creep within the host mineral's lattice must permit this migration. This is all very interesting, and the authors ascribe portentous consequences of their observations in natural magmatic process. However, basaltic melts do not form by melting of olivine, but take up elements from pyroxenes and other minerals as well, according to the elements' different degrees of incompatibility with whatever minerals are left behind – mainly olivine in the case of mantle melting. To form the melt, the elements that comprise it first have to migrate themselves. Is there any reason why they should all meet up inside this or that mineral to form a melt of basaltic composition, rather than combine on common ground, along inter-crystal boundaries?