The important role of incipient melting in the compositional and petrological evolution of the mantle

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Small amounts of C-O-H volatiles depress the melting point of mantle peridotite by 150-400˚C, depending on pressure and oxidation state. However, the percentage of melt that is produced remains very low until temperatures around the dry solidus, thus distinguishing between an *incipient melting* regime [IMR] controlled by the action of volatiles, and *major melting* where volatiles lose their influence [1].

The composition of melts produced in the IMR varies greatly depending on pressure and especially oxidation state. At relatively high fO_2, CO_2 and H_2O mixtures dictate that melts are SiO_2-poor and carbonate-rich, corresponding to a continuum between carbonatite and ultramafic lamprophyre (UML; [2]). At low fO_2, the action of CH_4-H_2O mixtures on melt compositions is poorly known, but they are probably close to silica-saturation and to melts produced with H_2O alone, because CH_4 merely dilutes H_2O. Incipient melts will persist over extensive temperature intervals. They are highly mobile due to their low viscosities, making them exceptionally effective metasomatic agents refertilizing depleted peridotites, forming dykes of pyroxenite, in some cases containing phlogopite and amphibole. Many of these modified rocks are stored in the lithosphere over long periods of time, substantially expanding the range of potential source rocks for the diverse melts observed at the Earth's surface.

Mantle fO_2 is strongly heterogeneous and has evolved through time. Redox melting and freezing processes occur wherever blocks with contrasting fO_2 are juxtaposed. Subduction zones are sites of great fO_2 variation and may have become more oxidized as the Earth evolved. Rejuvenation of refertilized mantle sections is a function of geodynamic setting, and commonly occurs where rifts break continents apart. Newly formed lithosphere is also reactivated during post-orogenic relaxation, producing potassic melts that did not occur until extensive redistribution in the IMR had taken effect.

[1] D.H. Green, T.J. Falloon (1998) in The Earth's Mantle (ed. I. Jackson), 311-378.
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