

The contribution of ultramafic veins in alkaline and non-alkaline mafic magmatism

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It is a well-known "fact" that the generation of basaltic melts is caused by partial melting of peridotite in the upper mantle. This paradigm, which was cemented in place to a large extent by extensive experimental studies of the partial melting of peridotites in the late 1960s and 1970s, reigns on despite the appearance of numerous lines of evidence pointing to mixed source rocks in the upper mantle. Many contributions on "mantle heterogeneity", reinforced by the identification of isotopic end-members in the mantle, discussed how much chemical leeway could be compatible with peridotite mineralogy. Many alkaline rock types were investigated experimentally in an attempt to find the mixture of volatile components that must be added to peridotite to explain their exotic compositions. It was slowly realized that no mixture of volatile components added to peridotite could explain their origin, which has left a legacy of experimental results which are useful in characterizing source regions, but are widely ignored because they produced a negative result for their intended purpose.

It is now widely recognized that strongly alkaline melts must be derived from mixed source regions consisting of ultramafic veins in peridotite, but these are still viewed as exotic exceptions to peridotite melting. Given that ultramafic veins are essential for alkaline magmatism, their influence in more voluminous rock types should be investigated more deeply as an alternative to melting of peridotite alone. Recycling of ocean crust may lead to the involvement of eclogite or pyroxenite material in voluminous melt types such as continental flood basalts and MORB, and these concepts have challenged the purity of previously accepted isotopic end-members, suggesting that these too may be mixtures.

Ultramafic veins are common in the lower lithosphere, and their mineralogy differs as a function of the volatile contents, the conditions during vein crystallization, and the conditions during re-melting. Examples include silica-rich melts in stable continental lithosphere, carbonate-rich melts in zones of incipient rifting (particularly of cratonic roots), and volatile-poor melts in the regions of ocean crust recycling. Prime examples of the products of mixed sources are K-rich picrites in flood basalt provinces, in which veins can explain the otherwise enigmatic enrichment in incompatible trace elements. Ultramafic veins provide the special chemical flavours for many igneous rock types, whereas melts derived from peridotite dilute these chemical signals so that they are too often overlooked.