Spongy textures and melt pockets in mantle xenoliths from Bailin, SE China: Records of pre-eruptive alkaline and carbonate-rich melt metasomatism

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Alkali-rich carbonated silicate melts have been predicted to be prevalent in the upper mantle by partial melting experiments. However, their role as a potent metasomatic agent and their evolution in the lithospheric mantle remain largely unexplored. A suite of mantle xenoliths in Bailin, SE China, has been studied for detailed mineralogical and geochemical signatures. The sampled spinel lherzolites can be classified into two distinct groups. Group1 xenoliths are free of spongy textures and melt pockets (S&MP), while Group2 are characterized by strong development of S&MP. Furthermore, Group2 are relatively more fertile in terms of modal compositions, mineral chemistries (lower Mg# of olivine, lower Cr# of spinel) compared with Group1. Combined with estimations of equilibration temperatures and pressures, we infer that the lower part of the lithospheric mantle is more fertile than its upper part.

The spongy rims and melt pockets have comparable mineral assemblage, mainly composed of secondary clino- and orthopyroxene, and secondary olivine and feldspar. Also, abundant accessory minerals, including chromite, apatite, sulphide, rutile, armalcolite, ilmenite, carbonate and K-Na chloride, have been identified. Both host magma-xenolith interaction and in situ partial melting cannot account for the formation of S&MP in Group2. Instead, reactive infiltration of an exotic melt, resulting dissolution-precipitation-reprecipitation on the crystal scale, is the main cause. The metasomatic melt has compound carbonate and alkali basaltic signatures, and may have evolved from a primary alkali-rich carbonated silicate melt by upward reactive porous flow shortly before host magma ascent. We further argue that most S&MP in mantle xenoliths worldwide may be related to pre-eruptive magmatic activities, especially those carbonate-rich melts. Long-term pre-eruptive metasomatism may play an important role in deep carbon cycle and tectonic initiation.