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Potassic to ultrapotassic and silica-poor magmatism: a key to unravel the nature of the metasomatised subcratonic lithospheric mantle

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The lithospheric mantle is characterized by millimetric to kilometric mineralogical, geochemical and isotopic heterogeneities, due to long-lasting histories of melt extraction and re-fertilization processes. The relatively cold and rigid nature of this shell limits vigorous stirring, which is reflected in the extremely variable compositions of partial melts derived therefrom. Low to moderate partial melting degrees of these lithospheric mantle regions can produce liquids with compositions that depart from classical basaltic magma characteristics, such as potassic to ultrapotassic and silica-poor magmas. An extremely rare potassic/ultrapotassic rock group is represented by kamafugites, kalsilite-bearing rocks that usually exhibit a K_2O, MgO and CaO enrichments, coupled with Al_2O_3 and Na_2O depletion. Of the only three known localities where these magmas have been recognised, the Italian variants are compatible with derivation from a subduction-modified mantle, while the other two, cropping out in Uganda and Brazil, indicate intraplate-like compositions.

Petrographic and mineral chemical data (e.g., the identification of kalsilite and primary calcite), geochemical (e.g., ultrabasic compositions, with high LILE and REE) and isotopic constraints (radiogenic $^{87}Sr/^{86}Sr$ and $^{206}Pb/^{204}Pb$, coupled with low $^{143}Nd/^{144}Nd$ isotopic ratios and heavy $\delta^{11}B$) bear out the importance of mantle metasomatism for the formation of such rare lithologies. Carbonated metasomatism, coupled with the presence of K-rich metasomatic agents, would result in a laterally heterogeneous and veined lithospheric mantle. Partial melting of these metasomes as well as variable and limited interaction with the surrounding peridotitic matrix can produce all the main features observed in kamafugite rocks.

Partial melting experiments on phlogopite clinopyroxenite (± olivine) and clinopyroxene glimmerite carried out at 1250-1550 °C and 2.7-5 GPa produced glasses resembling natural kamafugites, partially overlapping for most of the major oxides. Clinopyroxene- and phlogopite-rich lithologies, variably enriched in olivine and accessory phases (apatite, oxides, titanite) probably occur as veins pervading the subcratonic lithospheric peridotitic matrix, and their partial melting, especially at high degrees, may be a plausible explanation for the genesis of SiO_2-poor, K_2O- and CaO-rich compositions.