Ugandan kamafugites: Re-melting of a variable enriched veined subcontinental lithospheric mantle

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Ugandan kamafugites occur in the Toro-Ankole province along the Western Branch of the East African Rift within a Proterozoic-Archean basement complex of the Tanzanian craton. Our comprehensive geochemical study explains the origin of the potassic-ultrapotassic kamafugites by re-melting of a variably, and episodically enriched veined lithospheric mantle characterized by highly variable supra-chondritic radiogenic Os. Impregnation of the source region by carbonititic and/or highly alkaline silicate melts resulted in the introduction of modal phlogopite and enrichment in Fe and Re.

The extreme silica-undersaturation (SiO_2=31.8-41.8 wt%) of kamafugites, their high MgO (up to 22.5 wt%), low Al_2O_3 (< 8.0 wt%), and high CaO contents (up to 16.6 wt%) are reflected in the presence of modal kalsilite, leucite, melilite and perovskite. Their primitive features such as high Mg# olivines (up to 91.1), high whole-rock Mg# (up to 80.2), and high Ni (up to 1066ppm), Cr (up to 1560ppm) and Os (up to 1.45ppb) are in strong contrast to their extreme enrichment in LILE, HFSE, and LREE. Isotopic signatures ($^{87}Sr/^{86}Sr$=0.7046-0.7054, ε_{Nd}=0.08 to -4.70, and ε_{Hf}=3.64 to -8.84, γOs = 16-290) tend to much higher superchondritic γOs (γOs=16-290) than oceanic island basalts. Kamafigutes exhibit numerous signs of mixing, both mineralogical and geochemical (e.g. complexly zoned olivines; three generations of clinopyroxene; inverse trends on γOs vs. Mg#, Ni [ppm], Cr [ppm], Os [ppb] and $^{87}Sr/^{88}Sr$ ratios; linear trends on γOs vs. 1/Os [ppb], $^{187}Re/^{188}Os$ ratios, ε_{Nd} & ε_{Hf}).

Changes in kamafugite compositions are controlled by the mineralogy of vein assemblages, by vein-wall-rock melting processes, and by changes in CO_2/H_2O, alkalinity, f_{O_2}, and f_{S_2} conditions during ascent. Partial melting of alkali clinopyroxenites, xenolithic material as found in the same volcanic field, are thought to represent the source material of katungites, whereas mafuritic to uganditic compositions require the incorporation of peridotite wall-rock material, and hence higher degrees of partial melting.