A rare case of subduction-related metasomatism in mantle xenoliths from the Betic area (South Spain)

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Within mantle xenoliths from Tallante (South Spain) incompatible elements and Sr-Nd isotopes record in most samples widespread enrichments produced by percolation of Na-alkaline melts (by both porous flow and open-conduit mechanisms) leading to variably veined xenoliths. On the other hand, 3 samples out of 55, containing traces of amphibole and phlogopite and characterised by relatively high SiO_2 content (and high modal abundance of opx) display enrichments characterised by a completely different geochemical fingerprint. Their REE distribution is quite unusual, showing chondrite-normalised patterns characterized by pronounced enrichment in MREE (Sm_N/Yb_N up to 6.8), coupled with an Eu negative anomaly and a LREE depletion (La_N/Yb_N down to 0.69).

Modelling indicates that these peculiar patterns may be accounted for by infiltration of LREE-enriched silica oversaturated melts, with the subsequent crystallisation of opx.

With regard to Sr-Nd isotopes, most of ultramafic xenoliths from Tallante show a compositional field between DM and EM mantle end-members ($^{87}Sr/^{86}Sr$= 0.70213-0.70476; $^{143}Nd/^{144}Nd$= 0.51339-0.51250), as commonly observed for the European subcontinental mantle. On the other hand, the opx-rich xenoliths considered in this study are characterized by $^{87}Sr/^{86}Sr$= 0.70672-0.70856 and $^{143}Nd/^{144}Nd$= 0.51213-0.51211. Their composition is therefore very different from all the other recorded in the studied suite, and represents the most extreme EM isotopic signature ever found in anorogenic basic magmas and entrained ultramafic xenoliths throughout the whole Mediterranean area. These values recall those typical of the subduction-related volcanism (Miocene calc-alkaline lavas) occurred in the Betic-Alboran domain.

These opx-rich xenoliths could therefore be considered mantle material recording metasomatic effects inherited by percolation of subduction related melts.

High-pressure silicates in martian meteorites

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Many mineralogical features indicating high pressure shock metamorphism have been described in shergottites. Different high-pressure phases have already been identified using electron microscopy and X-ray diffraction, among which (K,Na,Ca)-hollandite, stishovite, majorite, ringwoodite, ilmenite, omphacite, cristobalite and a post-stishovite polymorph. Here we present a Raman spectroscopy study of shock veins and melt pockets in four martian shergottites NWA480, NWA856, NWA1068 and Zagami.

Reference Raman spectra of olivine, pyroxene and feldspar high-pressure polymorphs were obtained from three heavily shocked L6 chondrites. In all shergottites we identified both stishovite and hollandite. Stishovite shows two different aspects 1) small grains (~1µm), sometimes needle-shaped, that may be primary 2) large cristals (~100 µm) with parallel fractures crossing the mineral that could result from a back-transformation from a post-stishovite polymorph. Individual pure hollandite grains were never observed; they are always interwowen with glass. The association hollandite/stishovite is frequent in the four meteorites. Majorite was found in the three NWA meteorites, and is mainly associated with type 1 stishovite, rarely associated with hollandite or pyroxene. A few grains of ringwoodite (γ-phase) are present in Zagami and NWA1068. It is not surprising to find ringwoodite in NWA1068 as the rock contains modal olivine (NWA1068 is a picritic shergottite) but it is more difficult to explain its occurrence in Zagami.

For the melt pockets, according to the known P/T stability fields of hollandite and stishovite, one can infer a synchronous crystallisation of these two minerals at high pressure. The crystallisation of hollandite must have occurred below 24 GPa, because above this pressure it is unstable. A minimum pressure of 18 GPa is provided by the presence of ringwoodite in NWA480 and NWA856. Majorite implies a minimal crystallisation pressure of 13 GPa for the melt pockets in NWA1068 and the shock veins in Zagami.

Shergottites have a bulk basaltic-gabbroic composition. High-pressure melt assemblages found in shergottites might thus represent a model for the melting of subducting oceanic crust in the earth-mantle transition zone.