

Mantle lithologies from minor elements in olivine: Cape Verde

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The Cape Verde Archipelago is known to display source heterogeneity on a 100-200 km scale, with different isotopic domains sampled in the northern islands (mixed HIMU and DMM), compared with the southern islands (mixed EM1 and HIMU). Detailed temporal studies of lavas from Santo Antão and Santiago, representing the northern and southern islands respectively, have shown that the EM1 and DMM components have uniform composition with time, whereas the HIMU component shows a synchronous decrease in ²⁰⁸Pb/²⁰⁴Pb with time throughout the Cape Verde Archipelago.

We present minor element data for primitive olivines (Fo>75%), to unravel the mantle lithologies associated with the isotopic heterogeneity in the Cape Verde archipelago.

Lavas from Santiago with low ²⁰⁶Pb/²⁰⁴Pb (18.8) and positive Δ8/4, are associated with EM1. They have olivines with Ca = 990-2040 ppm, Mn/FeO = 90-150 and Ni*FeO/MgO = 480-750. Lavas from Santiago with high ²⁰⁶Pb/²⁰⁴Pb (19.4), associated with HIMU, have Ca = 2100-2600 ppm, Mn/FeO = 106-120 and Ni*FeO/MgO = 500-640 in olivines from the old volcanics. The Ca and Mn/FeO decrease and Ni*FeO/MgO increases with time from the old volcanics to the intermediate and young volcanics.

Lavas from Santo Antão with ²⁰⁶Pb/²⁰⁴Pb of 19.2 sample local DMM and have olivines with Ca = 1900-2750 ppm, Mn/FeO = 95-110 and Ni*FeO/MgO = 305-580. Lavas from Santo Antão with ²⁰⁶Pb/²⁰⁴Pb of 19.9, representing the HIMU component, have Ca = 2100-2650 ppm, Mn/FeO = 106-116 and Ni*FeO/MgO = 540-660 in the old volcanics and lower Ca, Mn/FeO and higher Ni*FeO/MgO in the young volcanics.

The DMM of Santo Antão is peridotitic in nature, whereas the EM1 and HIMU components are sourced from mixed peridotite-pyroxenite mantle lithologies. The uniformity of the DMM and EM1 components with time shown by the isotope heterogeneity is also reflected in the mantle lithologies, i.e. dominantly peridotitic DMM and constant proportions of peridotite and pyroxenite in the EM1 source. However, the changes in ²⁰⁸Pb/²⁰⁴Pb of the HIMU component with time observed throughout the Cape Verde archipelago are also reflected by increasing proportions of pyroxenite in the source shown by minor elements in olivine. We will present modelling results of the proportions of peridotite and pyroxenite in the EM1 and HIMU sources with time.

Phosphate dissolution/precipitation controls on isotopic compositions of continental assimilants

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Partial melting and assimilation of lower and often ancient crustal rocks contribute to the chemical and petrologic evolution of continental magmas. In the past three decades, geochemical models have used isotopes and elemental abundances to improve the parameterization of thermal and mass transfer within the crust. Recent advances in microanalytical techniques have enabled the documentation of subtle isotopic and trace element variations at high spatial and temporal resolutions, allowing testing of assimilation models. Still, interpreting the geological implications of these chemical variations remains challenging, primarily due to the lack of experiments that can be used to parameterize the isotopic signatures of crustal anatexis products in existing assimilation models. Though experiments and theoretical treatments have improved the potential to assess Sr and Nd isotopic signatures of partial crustal melts, parameterization of Pb and Hf continue to be problematic. This has remained an issue because the isotopic signatures of Pb and Hf, two elements with many promising microanalytical applications, are strongly controlled by accessory phases.

To address these issues, we carried out isotopic measurements on partial melts generated experimentally at 900°C, 1 GPa by partially melting a 1.7 Ga two-mica granite. Resulting melts were rhyodacitic in composition (SiO₂ ~ 71 wt%), with elemental and isotopic measurements suggesting that with <10% melting, the Pb and Hf isotopic systems are in disequilibrium with their whole rock. Uranogenic (²⁰⁶Pb/²⁰⁴Pb ~ 23) and thorogenic (²⁰⁸Pb/²⁰⁴Pb ~ 47) Pb signatures and extraordinarily radiogenic Hf (ε_{Hf} ~ +250) suggest the melt isotopic systematics are strongly influenced by contributions from phosphates. This extremely radiogenic Hf, coupled with sluggish Hf diffusion and predictions from solubility models, provides support for the notion that ongoing dissolution and reprecipitation reactions of phosphates may play an important role in effectively redistributing radiogenic signatures of accessory phases through the melt.