Origin of vesuvianite-bearing ultramafic layers from the Raspas Complex, Ecuador

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Serpentinized ultramafic rocks from the Raspas Complex (Ecuador) are spatially associated with eclogites and high-pressure metapelites and assumed to have experienced similar peak P-T conditions (1.8-2.0 GPa at 600 °C) [1,2]. Their compositions vary from low Al_2O_3 (<1wt.%) typcial for harzburgites to high Al_2O_3 (up to 15 wt.%) and CaO (up to 16 wt.%) contents. Some of the Ca-rich ultramafic layers contain pargasitic amphibole, vesuvianite and, very rarely, relicts of Ca-rich garnet. The aim of this study is to test whether the hydrous ultramafic assemblages can provide P-T estimates that confirm, or disprove, peak P-T conditions similar to the associated eclogites. Moreover, the origin of the layers in terms of mantle processes vs. fluid influx during subduction zone metamorphism will be evaluated.

Pseudosection calculations using the THERIAK software reveal that vesuvianite has, for most compositions, a wide stability field in P-T space. However, to stabilize Ca-rich garnet in the garnet-bearing sample, temperatures in excess of 550°C are required. This points to peak P-T conditions overlapping those of the eclogites and hence a similar subduction path.

For the Ca-rich ultramafic layers, the elevated Al_2O_3 and CaO contents and correlations between Ni and MgO are similar to pyroxenite layers in orogenic ultramafic massifs [3]. Chondrite-normalized REE patterns have La_N/Yb_N ratios <1, suggesting derivation from a depleted source, similar to the Al-poor peridotites [2]. Initial Sr isotope ratios (0.7025-0.7028) also point to a depleted mantle signature without significant effects of alteration or subduction zone metasomatism. These observations, combined with up to 10x chondritic REE abundances, indicate that these ultramafic layers represent former pyroxenite layers within an orogenic peridotite massif.

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En echelon volcanic chains at hotspots as probes of the deep mantle

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Systematic differences have been identified in the isotopic composition of lavas from the geographically distinct Loa and Kea trend volcanoes at Hawaii, with lavas from the southern (Loa) trend having higher $^{208}Pb^*/^{206}Pb^*$ and lower ε_{Nd} than lavas from the northern (Kea) trend [1,2]. This inter-trend difference has been interpreted as reflecting geochemical zonation within the conduit of the Hawaiian plume. Here we report on the existence of similar inter-trend isotopic differences in lavas from both the Samoa and the Marquesas hotspots. As with Hawaii, both of these hotspots are located on the Pacific plate and feature volcanism organized into en echelon trends. In Samoa, lavas from the southern (Malu) trend are found to have higher $^{208}Pb^*/^{206}Pb^*$ and lower ε_{Nd} than lavas from the northern (Vai) trend. Similarly, lavas from the southern (Motu) trend in the Marquesas have higher values of $^{208}Pb^*/^{206}Pb^*$ at a given value of ε_{Nd} than lavas from the northern (Nuku) trend volcanoes. In addition, the average isotopic compositions of lavas from these three hotspots show a geographic variation on a large scale that is consistent with the inter-trend. In particular, the southernmost hotspot (Samoa) has the highest $^{208}Pb^*/^{206}Pb^*$ and lowest ε_{Nd} while the northernmost hotspot (Hawaii) has the lowest $^{208}Pb^*/^{206}Pb^*$ and the highest ε_{Nd}.

Geodynamic models have demonstrated that the azimuthal distribution of heterogeneity within the thermal boundary layer (TBL) at the base of a plume is preserved within the plume conduit itself [3]. We propose that the observed inter-trend and inter-hotspot isotopic variations reflect the large-scale distribution of heterogeneities within the TBL at the base of the mantle, from which the respective plumes originate. Comparison of the observed isotopic compositions to seismic shear-wave velocity (v_s) in the lowermost mantle [4,5] at these locations reveals that the high $^{208}Pb^*/^{206}Pb^*$, low ε_{Nd} component correlates well with the large region of low v_s known as the Pacific superplume.

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