Extreme Pb-isotope diversity in the sources of K-rich magmas in Italy: Evidence from melt inclusions

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We present 170 SIMS (Cameca 1270) analyses of Pb-isotope ratios of homogenized melt inclusions in Fo-rich (Fo_{92-88}) olivines from primitive lavas in Central-Southern Italy. The samples cover the entire compositional spectrum of potassium-rich magma series erupted from major Pliocene-Quaternary volcanic centres in peninsular Italy.

The inclusions contain 1-140 ppm Pb. For inclusions with > 5 ppm Pb (80% of the population) in-run precision was 0.5-0.05% (2σ) for $^{207,208}Pb/^{206}Pb$, and 1.5-0.15% (2σ) for $^{206,207,208}Pb/^{204}Pb$.

Our results significantly extend the existing bulk-rock data towards more extreme compositions. A second key observation is the strong isotopic variability that appears to exist within individual volcanic centres, within magma series, and even within individual lava samples, testifying that widespread mixing in magmatic systems involved melts derived from mantle columns that are isotopically heterogeneous on small volume scales. The Pb-isotope systematics confirm that magmas were derived from mantle sources that are largely binary mixtures between components with low- and high-radiogenic $^{206,207,208}Pb/^{204}Pb$ ratios, respectively. However, extrapolation of mixing trends points to isotopic variability in each of these end-members, both in the original mantle component and in the metasomatic component that is inferred to be of upper crustal/sedimentary origin. The nature of the 'pre-metasomatic' mantle of the Roman and Campanian Provinces is distinct, the former being MORB-type, the latter showing a modest contribution of the FOZO-HIMU signature seen at Vulture and Etna. The Pb-isotopic signatures further indicate that in a transition zone (Roccamonfina-Ernici) the High-K-series melts are derived from the 'Roman' mantle, but K-series melts from the 'Campanian' mantle. Variations in the metasomatic agent are inferred to be related to (former) subduction, and reflect along-strike isotopic changes between Adriatic and Ionian domains of the plate. In conjunction with trace-element signatures of the melt inclusions, source mixing scenarios and implications for the regional geodynamic controls will be discussed.

Volcanic arc development due to intraoceanic subduction: Numerical model

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We have created a new 2D coupled geochemical-petrological-thermomechanical numerical model of retreating intraoceanic subduction associated with volcanic arc development. The model includes spontaneous slab bending, subducted crust dehydration, aqueous fluid transport, mantle wedge melting and melt extraction resulting in crustal growth. This model allows us to study influence of melt extraction intensity on the dynamics of subduction, mantle wedge plumes development and magmatic arc growth and displacement. In our numerical experiments subduction nucleates across the weak transform fault separating two oceanic plates different age. Subduction rate strongly varies with time. In all studied cases there is a deceleration period of a few Myr after the beginning of subduction, during this period subduction rates decrease from ~ 7 cm/yr to ~ 4 cm/yr. Subsequently, two scenarios can be distinguished: (1) decay and, ultimately, the cessation of subduction, (2) increase in subduction rate (to up to ~12 cm/yr) and stabilization of subduction. In scenario 1 the magmatic arc crust includes large amounts of rocks formed by melting of subducted crust atop the thermally relaxing slab. In contrast, in case of stable subduction, magmatic rocks produced by partial melting of hydrated mantle wedge clearly dominate the crust. In several numerical experiments an intra-arc extension is observed during subduction. This process results in splitting of previously formed magmatic arc crust by a newly formed spreading center. The loci of magmatic activity and intensity of crustal growth is strongly dependent on the dynamics of hydrous partially molten upwellings (cold plumes) rising from the slab.