The role of carbon dioxide from recycled sediments in the genesis of ultrapotassic magmas from lithospheric mantle

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The central-western Mediterranean is one of the most important areas on Earth for studying subduction-related potassic and ultrapotassic magmatism derived from partial melting of lithospheric supra subduction mantle. In the circum-Tyrrhenian area leucite-free (i.e., lamproite) and leucite-bearing (i.e., kamafugite, leucitite, and plagioleucitite) ultrapotassic rocks occur in association with shoshonites and high-K calc-alkaline volcanic rocks. Four different magmatic associations are then recognised. Eastward and then south-eastward migration of magmatism with time occurred following rollback of the subducting plate. Leucite-free silica-rich lamproite are restricted to the early stages of magmatism, associated with shoshonites and high-K calc-alkaline volcanic rocks. Present day volcanic activity is restricted to the Neapolitan district where ultrapotassic rocks with contrasting geochemical and isotopic characteristics occur. Ultrapotassic rocks are strongly enriched in incompatible trace elements with variable fractionation of Ta, Nb, and Ti with respect to Th and Large Ion Lithophile Elements. Mafic ultrapotassic rocks are also variably enriched in radiogenic Sr and Pb and unradiogenic Nd. The main geochemical and isotopic signatures result from sediment recycling within the upper mantle via subduction. Selected trace element ratios suggest that high temperatures are required to generate sediment-derived melts. Recycling of carbonated pelites play an important role in the Roman province controlling the genesis of leucite-bearing magmas.

Large volumes of a metasomatic component are predicted to be accommodated within a vein network in the sub-continental lithospheric mantle. Partial melting of the pure vein mineralogy is likely to generate ultrapotassic magmas of either lamproitic or kamafugitic nature. Over time, increased interaction between the metasomatic vein lithology and the surrounding mantle dilutes the alkaline component producing shoshonites and high-K calc-alkaline rocks. The addition of a further subduction-related component shortly before magma generation is required to explain the isotopic composition of rocks from the Neapolitan district. In the last phases of circum-Tyrrhenian evolution, a within-plate component appears within south-eastern Italy. This component is evident at Vulture volcano, in the Lucanian Magmatic province (SE Italy) and at Ustica Island (SW Tyrrhenian Sea).

Sources of Fe to the North Atlantic: Insights from Fe isotopes

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Iron (Fe) is an important micronutrient in marine biogeochemical cycles, with dissolved Fe concentrations significantly influencing both nitrogen fixation and photosynthesis by phytoplankton throughout the surface ocean. Constraints on the marine iron cycle are therefore key to our understanding of the global carbon cycle. Dissolved Fe isotope measurements (δ^{56}Fe) are a new parameter which provide a unique opportunity to discriminate between the various sources, sinks and processes controlling Fe distribution within the oceans, in a way that is not possible with measurements of Fe concentration alone.

Utilising a new method for the simultaneous extraction of dissolved Fe, Zn and Cd from seawater, followed by analysis by double-spike plasma mass spectrometry, we present the first basin-scale study of δ^{56}Fe. Multiple high-resolution depth profiles from the GEOTRACES A03 North Atlantic Zonal Transect (Lisbon to Woods Hole, via Cape Verde) allow us to isotopically fingerprint different sources of Fe and assess the relative contribution of each to the dissolved Fe pool in the North Atlantic.

Close to the Mauritanian margin, where a pronounced oxygen minimum is present at depth, light δ^{56}Fe values (~0 to -0.5 ‰) provide evidence for a small but significant contribution of light reduced sedimentary Fe to the dissolved Fe pool, mixed with heavy Fe (+0.5 to +0.7 ‰) released from dissolving aerosols under the Saharan dust plume. Relatively homogenous heavy δ^{56}Fe values (+0.3 to +0.5 ‰) throughout the water column in the deep western basin suggests that dissolution of aerosol Fe is the dominant source of dissolved Fe to the North Atlantic ocean. The homogeneity of δ^{56}Fe values lends support to the idea that ligand-controlled exchange between the dissolved and particulate pools is important in controlling both dissolved Fe concentration and δ^{56}Fe in the North Atlantic.

We also present the first direct measurements of dissolved δ^{56}Fe in a buoyant hydrothermal plume, where values from the TAG Mid-Atlantic Ridge site (-1.3 ‰) indicate that hydrothermal vents are a source of isotopically light Fe to the oceans.

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