Halogen contents and Pb isotopes of olivine-hosted melt inclusions: mantle source heterogeneity for South Tyrrhenian magmas revealed.

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Transfer of volatile elements from subducting slab to mantle beneath arc volcanoes through the mantle wedge, triggers partial melting and ultimately produces island arc lavas. However, due to scarcity of arc lavas representing primary compositions, much of the evidence for this coupled volatile enrichment/flux melting model has been derived indirectly from the compositional systematics of the end products, i.e. erupted volcanic rocks with evolved compositions. Thus, the models of arc magma genesis often depend intimately on the interpretation of compositional systematics that have been influenced by shallow–level contamination and differentiation processes. Alternatively, silicate melt inclusions trapped in early–formed phenocrysts during their growth can partly overcome this difficulty; olivine, the first liquidus phase in many basalts, may isolate early liquids which can provide direct information about primary magmas. It is now proven that H_2O can diffuse out of olivine–hosted inclusions at magma chamber conditions (e.g. Hauri, 2002; Portnyagin et al., 2008; Chen et al., 2011; Gaetani et al., 2012). On the contrary, due to their higher solubility in mafic melts compared with CO_2 or H_2O (Webster, 2004) and their late degassing during magma ascent (Spilliaert et al., 2006), F and Cl abundances often remain unchanged in melt inclusions, while H_2O, CO_2, and S show depletion trends (e.g. Vigouroux et al., 2008). Thus, the halogens have the potential to preserve their primitive abundances in the inclusions (Le Voyer et al., 2010; Metrich et al., 2010).

We worked on nineteen olivine–hosted melt inclusions from seven volcanoes (Etna, Stromboli, Vulcano, Ustica, Alicudi, Marsili and Vavilov) from the Southern Italy region. They were analyzed for abundances of major, trace, and volatile elements, along with Pb isotope ratios ($^{207}Pb/^{206}Pb$, $^{208}Pb/^{206}Pb$ and $^{206}Pb/^{204}Pb$). The systematics of primary volatile (in particular F and Cl) compositions and Pb isotopes identify three main geochemically distinct mantle sources for this region: (1) a component with radiogenic Pb ($^{207}Pb/^{206}Pb$ =0.780) and low volatile element abundances typified by the Etnean melt inclusions, (2) a component with moderately radiogenic Pb ($^{207}Pb/^{206}Pb$ =0.798) and high volatile abundance mainly associated with Sommata magmas, and (3) a component with moderate volatile abundances associated with a MORB–like $^{207}Pb/^{206}Pb$ (0.830).

Using the F/Nd–Cl/Nb systematics, we rule out the presence of recently subducted, altered oceanic crust for this radiogenic Pb source. The low F/Nd of this radiogenic component results from (i.e. is the residue of) slab dehydration processes.