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Carbonate-derived CO2 purging magma at depth: constraints from the O-isotope geochemistry of Somma-Vesuvius mafic products

Luigi Dallai (1), Raffaello Cioni (2,3), Chiara Boschi (1), and Claudia D'Oriano (3)

(1) CNR_IGG Pisa, Pisa, Italy (dallai@igg.cnr.it, +390503152323), (2) Dip. Scienze della Terra, Cagliari, Italy, (3) INGV_Pisa, Pisa, (Italy

It has been increasingly clear that carbonate assimilation by mafic magmas occurs in volcanic systems set in carbonate basement. Experimental petrology predicts that carbonate/melt interaction modifies the chemical characteristics of the evolved magmas (Iacono Marziano et al., 2007; Freda et al., 2008; Mollo et al 2010) and drive their compositions toward silica-undersatured end-members. The effects of carbonate addition onto magma dynamics is poorly constrained, and the inevitable occurrence of CO2 degassing due to magma/heat/carbonate interaction has the potential to change the overall volatile solubility of the magma, thereby justifying the ability of magmas to rapidly rise and explosively erupt to the surface. Due to the large difference in 18O/16O ratios between sedimentary carbonate (formed in a shallow crustal environment) and mafic magmas (mantle domain) oxygen isotope systematic likely represents the most powerful tool to trace carbonate addition to near-primary melts (e.g. Dallai et al., 2004) particularly into volcanic products, as their high cooling rate prevents subsolidus requilibration and allows pre-eruptive O-isotope composition to be preserved. Based on simple mass balance calculations the amount of carbonate addition can be estimated and further constrained by melt inclusion compositions. The combined use of O-isotope and REE data of mafic phenocrysts(ante-crysts)from major eruptions at Mt. Vesuvius and the chemistry of their melt inclusions allowed bulk carbonate assimilation (physical digestion) vs. CO2/melt interaction to be resolved. Data are compatible with the hypothesis of an extensive flux of CO2-rich fluids derived from magma-carbonate interaction (thermal decomposition and carbonate assimilation) passed through the magma in the roots of the volcanic edifice. This flux is responsible for the d18O values of primary Mt. Vesuvius melts before extensive carbonate interaction occurred during magma stalling in shallow crustal reservoirs.

Refs. Dallai L. et al., 2004. CMP 148, 247-263. Freda C. et al., 2008. Lithos 101, 397-415. Iacono Marziano G., et al., 2007. CMP 155, 719-738. Mollo S. et al., 2010. Lithos 114, 503–514.