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Stable isotopes in skarn xenoliths: constraining magma-carbonate interaction at Vesuvius, Italy

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It has recently been proposed that limestone assimilation and skarn recycling are important processes in volcanic systems emplaced within carbonate crust [1]. At Vesuvius, such processes have been recognised affecting magma composition and gas output [2]. Vesuvius was thus chosen as a case study to assess the interaction between shallow magma chambers and the carbonate wall rock through investigation of the calc-silicate (skarn) xenoliths. Skarn xenoliths have been found in most eruptive deposits at Vesuvius, but have not yet been described systematically. In order to understand magma-carbonate interaction and to quantify carbonate assimilation, we determined δ18O and δ13C values on bulk composition of a variety of rock types from the 472 AD (Pollena) and the 79 AD (Pompeii) eruptions.

Pumices and syenites have δ18O = 9.34 - 9.69‰ and δ18O = 10.28 - 10.77‰ respectively. Carbonate and marble xenoliths have δ18O values ranging from 17.15 to 31.53‰ similar to the carbonate wall rocks [2]. Skarn xenoliths, in turn, show a large range in oxygen isotope values (δ18O = 7.53 to 24.73‰, that spans between the igneous and the carbonate isotope values. The δ13C of carbonates and skarns show values between -4.5 and +1.34‰.

The oxygen isotope variations in the igneous-, skarn- and carbonate-samples imply that significant crustal contamination of Vesuvius magmas has taken place. The low _18O values of skarn samples, relative to carbonates and marbles, record variable degrees of magma-carbonate interaction producing progressively more lava-like values [3]. The EC-AFC model suggests that addition of partially molten crustal material to magmas undergoing concurrent crystallisation is required to explain _18O variations in pumices and syenites. On the basis of our data, we suggest that the observed magma-crust interaction processes and associated skarn formation is a continuous (i.e. ongoing) phenomenon at Vesuvius. Furthermore, skarn-formation processes release additional crustal CO_2 from mid- to shallow crustal levels into the Vesuvius magmatic system, possibly magnifying the explosivity of past, and probably future, activity.

[1] Freda et al., 2008, Lithos, 101:397-415; [2] Del Moro et al., 2001, JVGR, 2001, 112: 15-24; [3] Turi et al., 1976, Contrib.Minerol.Petrol., 55:1-31.