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Magma-carbonate interaction at Vesuvius, Italy documented through oxygen isotopes in skarn xenoliths

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It has been proposed that limestone assimilation and skarn recycling are important processes at Vesuvius affecting magma composition and gas output of the volcanic system [1]. Such processes have recently been identified in several other volcanic systems emplaced within carbonate crust [2, 3]. Vesuvius was chosen as a case study to investigate the interaction between shallow ($<$ 6 km) magma chambers and the local carbonate wall rock [4], through investigation of the calc-silicate (skarn) xenoliths ejected during volcanic eruptions.

Skarn xenoliths have been found in several eruptive deposits at Vesuvius but have not yet been described systematically. In order to understand the processes of magma carbonate interaction and quantify the amount of carbonate that is assimilated, we determined the δ^{18}O value of a variety of rock types including felsic pumices, syenites, carbonate, marble and skarn xenoliths from the 472 AD (Pollena) and the 79 AD (Pompeii) sub-plinian and plinian eruptions.

The oxygen isotope data show that each rock type defines a distinct isotopic composition. The pumices (n = 2) and syenites (n = 2) have δ^{18}O = 9.34 – 9.69‰ and δ^{18}O = 10.28 – 10.77‰ respectively. These values are similar to those reported in the literature [4, 5]. Carbonate (n = 2) and marble (n = 10) have δ^{18}O similar values to the carbonate wall rocks (17.15 – 31.53 ‰) [1, 6], whereas skarn xenoliths (n = 39) show a large range in oxygen isotope values (δ^{18}O = 7.53 - 24.73‰) that span between the igneous and the carbonate isotope data ranges.

These results can interpreted to show that the high oxygen isotope values obtained for carbonates and marbles (av. 23.6‰) are increasingly lowered in skarn samples by progressive decarbonation, resulting, from interaction with magma and thus reflecting increasingly more lava-like values [7, 8]. The skarn xenoliths δ^{18}O values, that extend all the way between country rock and magma, imply that significant contamination has taken place, raising the δ^{18}O in the magmas. In order to explain the oxygen isotope ratios of the pumices and syenites, approximately 15 to 21 wt.% carbonate-derived ^{18}O needs to be incorporated during magma-carbonate interaction processes. If this consideration is correct, decarbonation of host rocks and associated skarn formation will have liberated CO_2[1, 5, 6] and must have occurred at Vesuvius. As a result of such processes, significant crustal volatiles may have been released and could have influenced the eruptive behaviour of Vesuvius in the past and is likely to do so in the future.

[1] Del Moro et al., 2001, **JVGR**, 2001, 112: 15-24; [2] Freda et al., 2008, **Lithos**, 101:397-415; [3] Chadwick et al, 2007, JP, 48:1793-1812; [4] Del Pezzo et al., 2006, **PEPI**, 157: 257-268; [5] Fulignati et al., 2005, **NJb.Miner.Abh**, 181: 53-66; [6] Gilg et al., 2001, **Miner.Petrol.**, 73: 145-176; [7] Turi et al., 1976, **Contrib.Minerol.Petrol.**, 55:1-31; [8] Bowen, N. L. 1928, **Princ.Univ.Press**, p.334.