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Source vs. magma contamination in the Plio-Quaternary magmatism in Italy: oxygen and radiogenic isotope constraints

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Plio-Quaternary magmatism in Italy exhibits an extremely variable composition that covers almost entirely the spectrum of magmatic rocks occurring world-wide. Magmatism in the peninsular Italy is dominantly potassic to ultrapotassic, with a few calc-alkaline rocks; the Aeolian arc mostly consists of calc-alkaline and shoshonitic volcanics, with a few leucite-bearing potassic alkaline rocks. Rocks in the Aeolian arc and the Italian peninsula have high LILE/HFSE ratios, a feature that is typical of subduction-related magmas. Volcanic rocks in Sicily, Sicily Channel and Sardinia range from tholeiitic to Na-alkaline and have major and trace element signatures typical of anorogenic magmas. Most volcanoes show variable degrees of magma evolution, with felsic compositions dominating over mafic ones (Peccerillo, 2005).

Italian Plio-Quaternary magmatism shows a continuous regional variation of isotopic signatures, with a northward increase of $^{87}Sr/^{86}Sr$ and a decrease of $^{143}Nd/^{144}Nd$ and Pb isotopes. Oxygen isotopic ratios are also variable, although to a lesser degrees than radiogenic isotopes for most volcanoes. $\delta^{18}O$ in the mafic rocks from Sicily, the Aeolian arc and from several volcanoes in the Italian peninsula have typical mantle values (i.e., $\delta^{18}O_{SMOW} \sim$ +5.5 to + 6 per mil). However, the mafic rocks from some monogenetic volcanoes in the inner Apennines (i.e., San Venanzo, Cupaello) have very high oxygen isotopic compositions, with $\delta^{18}O \sim$ +12 to + 14 per mil for both whole rocks and separated olivine and clinopyroxene phenocrysts. These magmas also have very similar incompatible element abundances and ratios, and radiogenic isotope

(Sr, Nd, Pb, Hf) signatures as the large volcanoes of the Roman Province (e.g., Alban Hills, Vulsini). This suggests that, whereas both Roman and Intra-Apennine volcanoes come from a mantle source that was affected by the same type and intensity of metasomatism, the Intra-Apennine magmas also suffered intensive contamination by sedimentary wall rocks. Shallow level contamination, rather than mantle processes, is likely responsible for the occurrence of carbonate-rich pyroclastics, whose carbonate component has δ^{18}O as high as +22 to +26 per mil. Intra-Apennine volcanoes sit over thick carbonate sedimentary sequences, making contamination of the very small batches of very hot magmas that fed monogenetic centres, a very likely, if not unavoidable, process.

When Italian volcanoes are considered separately, one can detect important δ^{18}O variations for the single centres, indicating that magma contamination process had important roles in the evolution at local scale. Such a process, however, is unable to explain the regional petrological and geochemical variations that require strongly heterogeneous mantle sources. These were contaminated by variable amounts and types of crustal material (including pelites and marls) during at least two stages of subduction, occurred during the Oligocene to Present geodynamic evolution of the Central Mediterranean area (Peccerillo, 1999).

Bibliography

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