Abstract

New geochemical, isotopic and geochronological data are reported for the volcanic rocks of the western Pontine archipelago (Italy). This archipelago is located near the western edge of the Italian continental shelf and is one of the most prominent submarine reliefs in the Mediterranean Sea. The western Pontine archipelago comprises the islands of Ponza, Palmarola and Zannone, which volcanic products are sub-alkaline and alkaline, and were erupted over a time span of 3 Ma in two distinct volcanic cycles in the early Pliocene (4.2-3.8 Ma) and early Pleistocene (1.7-1.1 Ma). These three islands represent the oldest and westernmost emerged termination of a E-W oriented volcano-tectonic lineament, referring to the lithospheric fault of the 41°N parallel line, whose eastern termination is constituted by the younger Campanian Campi Flegrei and Somma-Vesuvius volcanoes.

Broad isotopic and geochemical variations characterize the Pontine rocks and have been differently interpreted as the result of differentiation processes within the lower crust or of compositional heterogeneity in the upper mantle. The aim of this Master Thesis consists in providing constraints to the magmatic and geodynamics processes related to crustal contamination of mantle-derived magmas and to slab tearing.

Ponza and Zannone rhyolites erupted in the earliest (outcropping) volcanic cycle that has been referred to the syn- to late-collisional stages of the west-directed subduction of the Adria plate beneath the European plate. In this frame, the Ionian-Adria slab progressively migrated eastward and was torn along the 41°N parallel line, triggering the Tyrrhenian back-arc extension, lithospheric thinning and high heat flow. Our results show that the Ponza and Zannone rhyolites have high K calc-alkaline affinity, high LILE/HFSE ratio, negative anomalies in terms of Ba, Sr, P, Ti and Eu, as well as high $^{87}Sr/^{86}Sr$ (0.7098-0.7110 and 0.7094-0.7105 respectively), $^{206}Pb/^{204}Pb$ (18.766-18.812 and 18.790-18.799), $^{207}Pb/^{204}Pb$ (15.683-15.690 and 15.684-15.690), $^{208}Pb/^{204}Pb$ (38.954-39.018 and 38.991-39.014) and low $^{143}Nd/^{144}Nd$ (0.51217-0.51223 and 0.51216-0.51220) isotopic ratios, indicating that they essentially derive from partial melting and assimilation (up to 30%) of a lower crustal component, coupled with fractional crystallization.

Differently, Palmarola rocks show very high Rb (up to 944 ppm) and extremely low Sr (up to 9 pmm) contents, and they display lower but very scattered $^{87}Sr/^{86}Sr$ (0.7047-0.7086) and higher $^{206}Pb/^{204}Pb$ (18.790-18.825), $^{207}Pb/^{204}Pb$ (15.680-15.682), $^{208}Pb/^{204}Pb$ (39.010-39.045) and $^{143}Nd/^{144}Nd$ (0.51234-0.51236) isotopic ratios with respect to Ponza and Zannone rhyolites. They are generated by mixing between crustal and mantle-derived components, first evolving through fractional crystallization, and then undergoing minor crustal assimilation (5%), with a Sr-poor crustal component. Palmarola peralkaline rhyolites are enriched in most of the incompatible trace elements (LILE and HFSE), due to a pre-enrichment of the lithospheric mantle by recycling of crustal components and release of fluids and/or melts via subduction. Additionally, Palmarola dykes are isotopically more primitive compared to the domes,

and they are E-trending, such as the 41° parallel line, therefore we infer that they may represent a local effect of the slab tearing-related magmatism. In our interpretation, the post-collisional stages (Pleistocene) are associated with the incremental tearing of the Ionian subduction zone, where the latest magmatic activity occurred far from the slab, with a less prominent contribution of subduction-related volatiles. By their younger age, Palmarola rhyolites and Ponza trachytes correspond to the last volcanic activity of the western termination of the 41° parallel line, and the generation of alkaline products results of the magma uprising along the lithospheric tear fault.

Finally, Ponza trachytes have a shoshonitic affinity, low LILE/HFSE ratio and show the most primitive character among the western Pontine islands, displaying high $^{143}Nd/^{144}Nd$ (0.51232-0.51239), and low $^{87}Sr/^{86}Sr$ (0.7078-0.7085), $^{206}Pb/^{204}Pb$ (18.754-18.777), $^{207}Pb/^{204}Pb$ (15.680-15.683) and $^{208}Pb/^{204}Pb$ (38.963-38.993) isotopic ratios. They underwent less differentiation processes and have mixed with a more primitive mafic magma recharge, provided by the melting of the up-flowing asthenosphere.