

A new perspective on the geochemical signature of Mt. Etna alkaline magmas

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The occurrence of LREE enrichment and HREE fractionation ($La_N/Yb_N = 18$) led many authors to hypothesize the presence of residual phases in the source of Etnean alkaline magmas that preferentially retain HREE, such as garnet. The occurrence of garnet was commonly bounded to lherzolites, thus implying the onset of partial melting at depth greater than 80 km. This would indicate the occurrence of a thermal regime related to an asthenospheric plume-like structure, whose evidence is still matter of debate. On the other hand, if such a structure does not occur, the melting process should be mainly under the control of slight pressure changes induced by regional lithospheric stretching at more shallow depth. Recent work has shown that partial melting of a source composed of both spinel lherzolite and garnet pyroxenite can produce sub-alkaline magmas, which can preserve a garnet signature at more shallow depth. Here, we investigate the role that partial melting of a heterogeneous metasomatized source, constituted of spinel lherzolite and garnet pyroxenite, can have in producing a trace element signature consistent with that observed for Etnean alkaline magmas. Xenoliths of deep provenance found in the Hyblean area indicate that silicate melts, and related metasomatic fluids, may have intruded a spinel lherzolite mantle to give origin to a garnet-bearing pyroxenite. As a result, the spinel lherzolite mantle is veined by garnet pyroxenite where phases related to metasomatizing agents, such as amphibole and phlogopite, have been stabilized. Mass balance calculations have been performed for simulating partial melting of such a source. Results have been compared with three representative mantle-equilibrated magmas, calculated by adding an ultramafic assemblage to compositions of the prehistoric lavas of Mt. Maletto, and of the 1763 and 2005 eruptions. Different proportions of spinel lherzolite and garnet pyroxenite, along with variable modal contents of metasomatic phases, can account for the trace element signature of the large spectrum of Etnean alkaline magmas and for their geochemical variability through time.

Xenolith evidence for anatexis of hydrothermally modified mafic crust (Hyblean area, Italy): Implications for primary origin of some trachytoid magmas

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Extensive fractional crystallization from primitive mafic magmas is one of the most common mechanisms to explain the origin of alkaline felsic volcanic rocks at ocean islands, often associated to the dominant basaltic ones. Nevertheless, this process fails to justify in some instances extreme basalt-trachyte bimodal magmatism and its odd volumetric relationships. Here, we focus on some hydrothermally-modified gabbroic xenoliths coming from the Hyblean Plateau (Southern Italy), which are considered to represent portions of a fossil, deeply altered, oceanic core-complex underlying the area. The hydrothermal mineral assemblage consists of Na-rich alkali feldspar, clay minerals (C/S interlayers), zeolites, aegirine-augite, titanite and rare hydrothermal zircon. Perfectly isotropic and clear glass blebs, which derive from xenoliths partial melting, make also peculiar the texture. Glasses exhibit perlitic microfracture sets and a lot of fluid inclusions having, sometimes, KCl daughter mineral. On the whole, the chemical composition of such a metasomatic rock shows higher contents in alkalis, Zr, Hf, U, Th, volatiles and lower CaO, MgO, FeO with respect to the pristine tholeiite gabbro.

The new dataset of major (EMPA) and trace elements (SIMS) has been obtained on the above-mentioned glass patches. Compositions display a mildly peralkaline character, with FeO_{tot}/Al_2O_3 ratios clustering at the boundary between the pantelleritic trachyte and comenditic trachyte fields. Na_2O/K_2O ratio is about 2.2, chlorine varies from 800 to 2500 ppm and fluorine is about 550 ppm. Trace element distribution is consistent with other natural trachytoid magmas, as evidenced by the comparison with trachytes from the neighboring occurrences of Pantelleria and Etna, and from various oceanic islands (i.e. Socorro Island, Ascension, Hawaii, Kerguelen, French Polynesia). Since high halogen fugacity dramatically decreases the melting point of various rock-forming minerals, anatexis of altered oceanic crust may be accounted for the origin of some trachytoid magmas.