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Fingerprint of chaos in immobile element geochemistry of Mt. Etna

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Recent history of magmatism at Mt. Etna records gradual but significant temporal increase in water contents, alkalis, Sr isotope compositions and Fluid-Mobile Elements through time, as revealed by both near primary magmas and melt inclusion compositions. The key process responsible for such progressive geochemical evolution is thought to be the addition of fluids, released by the subducting Ionian slab, into an heterogeneous mantle source. The rollback of the Ionian oceanic lithosphere with respect to the adiacent Sicilian plate, where continental lithosphere is not more able to subduct, would induce "suction" of asthenospheric material to the surface through the opening of a vertical slab window. The development of short-term geochemical variations in such a highly dynamical regime has been attributed to an increasing role of fluids in the genesis of Mt. Etna magmas.

However, when we apply the theory of chaotic dynamic systems to the geochemical variability of recent Mt. Etna magmatism, a decoupling emerges between the behavior of Fluid-Mobile Elements and other elements. We selected 220 fresh alkaline basalts (mg# $>$ 50) erupted after 1971 and arranged their geochemical compositions as a function of several key geochemical tracers, such as Fluid-Immobile Element and Nd isotope ratios, taken in a decreasing order of their values. These correlations allow to evaluate the geochemical variability of magmas with respect to selected parameters that are a fingerprint of their mantle source, independently of partial melting events and magma differentiation. The relationships among trace element ratios and Sr and Nd isotopic compositions allowed us to infer that the distribution of Fluid-Immobile Element ratios is chaotic (governed by a finite number of degrees of freedom), whereas the distribution of Fluid-Mobile Element ratios and Sr isotopic compositions appears to be random (governed by infinite degrees of freedom). Evidence for coexisting ran-

dom and chaotic structures in the same mantle source allows to suppose a scenario in which the random arrival of fluids could have metasomatized an intrinsically “self-organized” region. Thus, our study supports the influence of fluid components in the genesis of the magmatism under study, assessing they have randomly perturbed the intrinsic chaotic fingerprint of the mantle beneath SE Sicily.