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Geochemical Patterns Classification of recent Mt. Etna Volcanic Products based on a synopsis of Kohonen Maps and Fuzzy Clustering.

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During the last two decades Mt. Etna experienced many summit and flank eruptions with different styles of activity, ranging from quiet lava effusion to explosive activity consisting of Strombolian explosions and/or spectacular fire fountains. This complex picture entails the presence of a complex plumbing system where magma dynamics strongly controls both the eruptive style and magma differentiation.
All these eruptive events have furnished volcanic products on which systematic petrographic and geochemical analyses have been carried out since the mid 1990s. In particular, the content of major and trace elements of lavas is a key-point to characterize the composition of a magma emitted during an eruption. Petrologic investigations are traditionally based on the interpretation of compositional patterns described by selected oxides and/or elements in binary and ternary petrologic systems. This kind of analysis provides useful information about the magmatic processes occurring in the plumbing system. In this presentation we investigate whether the quality of petrologic investigations is improved by the application of more sophisticated analytical techniques based on the use of a relatively large number of parameters. To this purpose, we selected 13 components, i.e., SiO2, K2O, CaO/Al2O3, Mg#, Th, La, Nb, Nd, Sr, Tb, Cr, Ni and Rb/Nb. This choice brings along the problem of designing a suitable statistics and a convenient visualization of the results. As a way out, we propose advanced concepts of multivariate classification based on a synopsis of Kohonen Maps and Fuzzy Clustering, and apply them to the study of volcanics erupted from Mt. Etna between 1995 and 2005.
Lavas erupted during the fire fountains (in 2000) and during the flank eruptions (2001, 2002-03) represent the most primitive products erupted from Mt. Etna in the investigated period. The literature data suggest that during the 2001 and 2002-03 eruptions two magmas with different geochemical characteristics were contemporaneously erupted. One magma type ascended from a deep portion of the plumbing system (> 5 km), and was emitted from the so called “Lower” (2001) and “Southern” vents (2002-03). Another one rose from a shallower reservoir (<5 km) and was erupted from the so called “Upper” (in 2001) and “Northern” vents (in 2002-03).
In our analysis the “Lower” and “Southern” vent lavas are assigned to the same cluster ID and are grouped together also in the Kohonen Map. On the other hand, “Upper” vent lavas and “Northern “ vent lavas are clearly distinguished from each other as well as from the afore mentioned products. Volcanics emitted by the South-East crater during the fire fountains in 2000 belong to the same fuzzy cluster as the “Lower” and “Southern” vent lavas, however, a neat distinction with respect to 2001 and 2002-03 lavas becomes evident in the Kohonen Map. Besides this we observe differences in the seismic signal characteristics between the fire fountain events and flank eruptions, supporting the hypothesis that various eruptive sources were active on Mt Etna in 2000, 2001 and 2002-03.
The relation of the products to eruptive sources is less clear in the time span between 1995 and 1999, when essentially only the summit craters were active.