Geophysical Research Abstracts
Vol. 13, EGU2011-8586, 2011
EGU General Assembly 2011

Complex degassing processes at Mt Etna as inferred by the geochemistry of peripheral and crateric gas discharges

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Several studies have been performed on the geochemistry of peripheral emissions at Mt Etna, which have allowed to recognize degassing processes of the Etnean magmas at relevant depth (>5-6 km)[1,2,3]. The peripheral sites have provided information on the episodes of deep recharge of the magmatic system and, at some extent, on the importance of these events in terms of involvement degree of the system. Nevertheless, information on magma degassing at shallower levels of the feeding system has been prevented, up to now, due to the location of the sampling sites at no more than 300 m above to sea level and far from the volcanic conduits.
Here we display the results of four-years long geochemical survey of some fumaroles at Voragine crater of Mt Etna. Such monitoring has been coupled to a synchronous monitoring of the well-studied peripheral emissions, to reveal the possible genetic relations of the released gases. For the first time at Mt Etna, the geochemical study has included abundance and isotopic composition of Ar, coupled to He, Ne and CO2 concentrations and carbon isotopes.
Once the effects of secondary shallow processes have been recognized, quantified and removed [4], the geochemistry of gas emissions at Mt. Etna volcano has provides key information about the magmatic sources and dynamics in the feeding system. Our study has in fact displayed that the peripheral gas discharges are fed by magma that degases in the range of 250-400 MPa by an open system mechanism, in agreement with previous studies [2,3]. The summit crater fumaroles are aligned along the identical degassing paths in terms of He/Ar and Ar/CO2 ratios, but they highlight minor pressure/depth of exsolution. Interestingly, the carbon isotope composition, coupled to noble gases, puts into evidence that a part of the exsolved magmatic gases at high depth interacts with gases from magma batches stored at shallow levels and modifies the compositional ratios of the main geochemical indicators of magmatic degassing. The crater fumaroles therefore result from a two-endmember mixture of magmatic gases coming from both high and shallow depth in the plumbing system. Indeed, the He isotopic compositions of the peripheral gas discharges highlight that similar processes of degassing and mixing seem likewise to occur in the deeper part of the magmatic system. Noble gases thus reveal a complex magma dynamics and even more complex evolution of the fluid phase, in agreement with recent petrologic studies on Etna volcanites of recent eruptions.
The resolution of the composition of the deep and shallow gaseous endmembers allows to understand when the deep magmatic term becomes more important, providing information on increasing volcanic activity in the middle and long term. The endmember coming from higher depth has become in fact dominant during the episodes of magma recharges which have accompanied periods of high volcanic activity, such as the 2008 eruption. The last months of the 2010 have been once more marked by the increase of such deep component. This would suggest a phase of magma recharge of the Etnean plumbing system, that is still ongoing.

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