Magma degassing episodes and volcanic unrest periods in quiescent volcanoes

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Long time series of fumarolic chemical and isotopic compositions, at Solfatara (Campi Flegrei) and Vulcano highlight the occurrence of mixing processes among magmatic and hydrothermal fluids. At Solfatara temperatures of about 360°C of the hydrothermal system are inferred by methane chemical-isotopic geoindicators and by the H2/Ar geothermometer. These high temperatures are representative of a deep zone where magmatic gases flash hydrothermal liquid forming a gas plume where the kinetically fast reactive species (H2 and CO) re-equilibrate at temperatures of 200-240°C. The stable isotope compositions of the two dominant species, i.e. H2O and CO2, shows that sampled effluents are mixture between magmatic fluids and the vapor generated at about 360°C by the vaporization of hydrothermal liquids of meteoric origin. Similar mixing processes between magmatic fluids and a hydrothermal component of marine origin have been recognized at Vulcano high temperature fumaroles. In both the system a typical 'andesitic' water type composition and high CO2 contents characterizes the magmatic component. Our hypothesis is that pulsing injections of these CO2-rich magmatic fluids at the bottom of the hydrothermal systems trigger the bradyseismic crises, periodically affecting Campi Flegrei, and the periodical volcanic unrest periods of Vulcano. At Campi Flegrei a strong increase of the fraction of the magmatic component, marked in fact the bradyseismic crisis of 1982-84 and four minor episodes occurred in 1989, 1994 and 2000 and 2006. Increases of the magmatic component in the fumaroles of Vulcano were recorded in 1979-1981, 1985, 1988, 1996, 2004 and 2005 concurrently with anomalous seismic activity localized in the crater area. Physical-numerical simulations of the injection of hot, CO2 rich fluids at the base of a hydrothermal system, asses the physical feasibility the process. Ground deformations, gravitational anomalies and seismic crisis can be well explained by the complex fluid dynamic processes caused by magma degassing episodes. Data on the fumaroles of other volcanoes, for example Vesuvio, Panarea, Nisyros (Greece), Mammoth (California), suggest that magma degassing episodes frequently occur in dormant volcanoes causing volcanic unrest processes not necessarily linked to magma movement but rather to pulsating degassing processes from deep pressurized, possibly stationary, magma bodies.