Paroxysmal degassing at Mt. Etna in 2011-12

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Between January 2011 and April 2012, Mt. Etna produced a series of 25 paroxysmal lava fountaining events, representing a significant change in its eruptive style. Understanding the causes and impacts of this activity is crucial for improved hazard assessment at Etna, and for refinement of models of the volcano's magma plumbing system. Sulfur dioxide (SO_2) emissions associated with most of these paroxysms were measured by the ultraviolet (UV) Ozone Monitoring Instrument (OMI) on NASA's Aura satellite and the Atmospheric Infrared Sounder (AIRS) sensor on the Aqua satellite. The ground-based OPGC VOLDORAD 2B L-band Doppler radar system, operated in cooperation with INGV-CT, also detected the associated ash plumes, providing accurate constraints on the timing and duration of the lava fountains. We present a comprehensive analysis of the OMI and AIRS SO_2 data for the Etna paroxysms in 2011-12. Back trajectory analysis of the observed SO_2 clouds using the HYSPLIT trajectory model indicates that SO_2 emissions generally coincided with the peak lava fountain intensity detected by VOLDORAD. By combining the UV OMI and IR AIRS SO_2 measurements we constrain the SO_2 loss rate in the Etna SO_2 clouds, many of which were tracked for several days after emission. Using SO_2 loadings corrected for the time of emission, we observe a correlation between SO_2 production and inter-paroxysm repose time. Comparison of the erupted magma mass estimated from the radar data and the SO_2 loadings also indicates a vast excess of gas in the emissions. Of the two models typically invoked for explosive basaltic eruptions (the rise speed dependent (RSD) and collapsing foam (CF) models [1]) we propose that our dataset supports the CF mechanism as the predominant driver for paroxysms at Etna in 2011-12. Satellite data indicate low or undetectable ash content in the drifting eruption clouds, suggesting efficient separation of ash and gas in the eruption column, with implications for aviation hazards.

[1] Parfitt (2004) *J. Volcanol. Geotherm. Res.* **134**, 77-107.

Dissolved gases and radioactivity in spring waters of southeast Brazil

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Twenty two spring water samples from spas located at São Paulo and Minas Gerais states, southeast Brazil, have been sampled and analyzed for temperature (T), conductivity (C), pH, redox potential Eh, dissolved gases O_2, CO_2, H_2S and radionuclides ^{228}Ra, ^{220}Rn and ^{222}Rn. The samples provided from different geological contexts, i.e. Paraná sedimentary basin, Poços de Caldas alkaline massif and high grade metamorfic suites. The RAD7 portable detector (Durridge Co.) has been used for ^{220}Rn and ^{222}Rn analyses, as well traditional potentiometric/colorimetric methods and radiochemical steps followed by gamma ray spectrometry through NaI(Tl) scintillation detector.

The following data range has been found: T=21.7-28.4 °C; C=0.04–4.73 $mS.cm^{-1}$; pH=5.56–9.38; Eh=-115–122 mV; O_2 =1.3–9.0 $mg.L^{-1}$; CO_2=<1.0–800 $mg.L^{-1}$; H_2S=<1.0 – 3064 $\mu g.L^{-1}$; ^{228}Ra=<5.4–123.2 $mBq.L^{-1}$; ^{220}Rn=<0.1–23.4 $pCi.L^{-1}$; ^{222}Rn=0.6–2020 $pCi.L^{-1}$. Such great variability of values reflects the different lithologies, mineralogy of the rock matrices, discharge and climatic conditions, among others factors.

According to the Brazilian Code for Mineral Waters (BCMW) established by Register 7841 published on 8/8/1945, in terms of T values, the springs analyzed are cold (<25°C) and hypothermal (25-33°C). Several significant correlations were found involving the parameters analyzed, for instance: Eh and pH (r=-0.58), H_2S and C (r=0.64), T and ^{222}Rn (r=-0.61), T and ^{220}Rn (r=-0.42), ^{222}Rn and ^{220}Rn (r= 0.59). Neither O_2 nor CO_2 and H_2S exhibited significant correlation with T, as expected, however, this scenario may modify if an expanded database including values for mesothermal, isothermal and hyperthermal waters is taken into account. According to the BCMW, in terms of radiological aspects, the springs analyzed can not be considered thoriferous as the ^{220}Rn activity concentration is lower than 26.9 $Bq.L^{-1}$. One spring may be classified as weakly radioactive, as exhibited ^{222}Rn activity concentration between 67.2 and 134.5 $Bq.L^{-1}$. Most of the ^{228}Ra activity concentration data were below the detection limit, whereas one spring exhibited a value exceeding the guideline value of 0.1 $Bq.L^{-1}$ established by the Brazilian Health Ministry Register 2914 published on 12/12/2011. Therefore, the acquired data are relevant for the appropriate management and use of the studied spring waters.

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