Geophysical Research Abstracts
Vol. 19, EGU2017-4511, 2017
EGU General Assembly 2017

Real-time quadrupole mass spectrometry of hydrothermal gases from the unstable Pisciarelli fumaroles (Campi Flegrei): trends, challenges and processes

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Volcanic gases sampling and post-collection chemical determination in a laboratory may preclude any real-time continuous monitoring of volcanic activity. In this work we describe the development, and show the advantages, of a system used for the continuous monitoring of fumarolic gases discharges from the Pisciarelli site (Campi Flegrei, Southern Italy) based on a commercial quadrupole mass spectrometer (QMS-301). Although numerous technical problems were addressed due to the ephemeral emission point, coupled with the harsh environment, we also report measurements of the chemical composition of the major gas species emitted from the fumarole and a record were obtained for two different periods. The CO_2/H2S, H2S/H2, He/CO_2 and CH4/CO_2 molar ratios were investigated in order to detect magmatic and/or hydrothermal components in the system, while the N2/O_2 ratio was adopted to infer other non-volcanic processes, such as air contamination and mixing with polluted surface waters. This methodology provides continuous sampling and thus, more information on short-term gas variations, since direct sampling is often impractical and hazardous. With our method, the geochemical monitoring benefits of the real-time analysis for high sampling rates that can be made comparable to the continuous measurements of geophysical networks. This allows a better understanding of hydrothermal features, particularly of chemical fluctuations occurring on the very short-term, and is fundamental to evaluate the evolution of unrest episodes at Campi Flegrei, one of the most hazardous volcanic areas in the world.