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Barometric pressure forcing on radon-222 and temperature in fumarolic gases: a tool to describe flow-rate dynamics

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We propose two conceptual models for the dynamics of fumarolic gases, during their ascent through the volcano plumbing, based on radon-222 and temperature data collected on fumaroles of La Soufrière volcano (Guadeloupe, FWI) together with local barometric pressure, and on a new interpretation of older data collected on Merapi volcano[1] (Indonesia). All these in-situ measurements prove that the diurnal (24h, S_1 barometric wave) and semidiurnal (12h, S_2 barometric wave) variations in radon concentration are clearly observable, and positively or negatively correlated with barometric pressure variation. Two models are used to interpret this correlation. The first model, called "Accumulation mode", is characterized by an initial and negligible deep radon-222 source and by a major contribution of radon-222 from conduit walls and connected fractures (emanation and exhalation mechanisms) during the gas ascent through the fumarolic system. This model is substantiated by a positive correlation between radon and pressure in the Merapi fumaroles. The second model, or "Decay mode", is exemplified by a negative correlation between radon and pressure as measured in fumaroles at La Soufrière volcano. It is characterized by radioactive decay of a strong initial radon-222 source generated by a deeper reservoir (hydrothermal system or magmatic chamber) whereas contribution by conduit walls and connected fractures to the total radon-222 activity in the fumarole is comparatively minor during the transit time of the gas. In these two modes, it is possible to infer that, for transit times longer than *ca.* 21 days, the barometric pressure does not modulate the radon signal. Thus, the simultaneous monitoring of radon-222, temperature and barometric pressure provides a precise fumarole flowmeter. In addition, it is a tool to decipher shallow versus deep feeding of volcanic fumaroles that should prove useful for volcano monitoring.

[1]Zimmer, M. & Erzinger, J. Continuous H_2O, CO_2, ^{222}Rn and temperature measurements on Merapi Volcano, Indonesia. J. Volcanol. Geoth. Res. **125**, 25-38 (2003).