

Hydrothermal - magmatic interactions driving phreatic eruptions

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Many phreatic eruptions are the result of a complex interplay and relationship between magmatic and hydrothermal contributions. The eruptions tend to be sudden, sometimes with few precursors. As a result, the eruptions are not usually forecast, which poses a serious problem for people in the vicinity including nearby inhabitants, scientists, civil defense personnel, and tourists. An improved understanding of how the deeper magmatic system is connected to the shallower hydrothermal system (or systems) is needed. At some volcanoes which exhibit summit degassing and also have flank hydrothermal systems, phreatic eruptions may be preceded by changes in gas chemistry at both summit and hydrothermal fumaroles. Another key issue is to better understand the locations and timescales of sealing processes which can pressurize the subsurface prior to a phreatic eruption. Such seals may form around a deeper crystallizing and degassing magma (e.g., Ohba et al., 2019) and also at shallower levels within or above the hydrothermal system (e.g., de Moor et al., 2019). The timescales of sealing appear to vary widely, from longer timescales of months to years to shorter timescales of days to weeks (Fig. 1). We need to understand the detailed mechanisms and processes which determine timescales. To address these issues, we are currently working on two approaches. First, we are building a new type of MultiGas instrument which will be able to assess magmatic and hydrothermal inputs in real time. The instrument will measure CO₂, H₂O, CH₄, H₂S, and H₂, with the main goal of measuring CO₂/CH₄ (Chiodini 2009) in real time (Fig. 2). Second, we will measure $\delta^{13}\text{C}$ of both CO₂ and CH₄ on a near real-time basis using portable mass analyzers, in order to constrain the sources of the gases and their inter-relationships. Magmatic-hydrothermal gases can be plotted in ternary space, as shown in Figure 3. The S-CO₂ join reflects the variable composition of gases associated with active volcanic systems. The CO₂-CH₄ join indicates quiescent systems with variable inputs of magmatic and hydrothermal gases.

References cited

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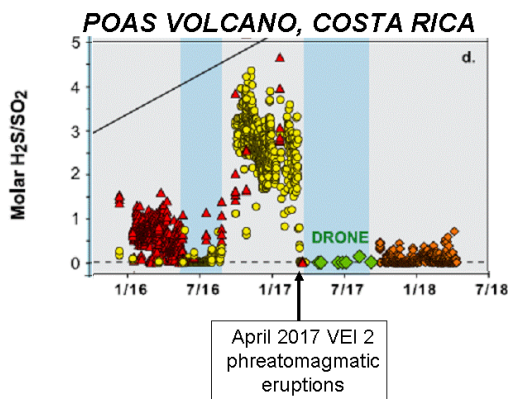


Figure 1: H₂S/SO₂ at Poás, 2016-2018

MAGMATIC-HYDROTHERMAL MULTIGAS

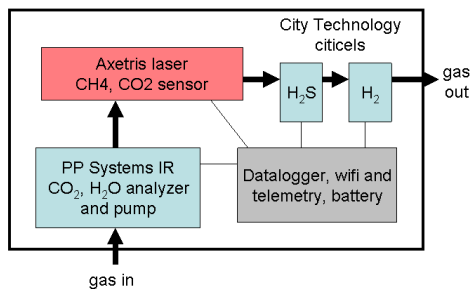


Figure 2: Schematic view of CO₂-CH₄ MultiGas

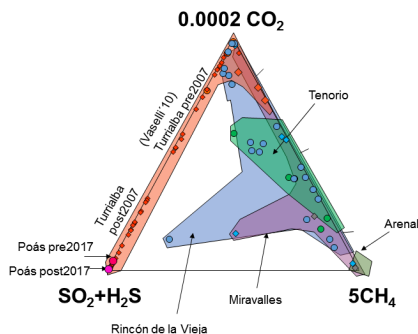


Figure 3: Ternary depiction of S - CO₂ - CH₄ for gases at Costa Rican volcanoes