

Gas monitoring of volcanic-hydrothermal plumes in a tropical environment: the case of La Soufrière de Guadeloupe

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Background

- La Soufrière de Guadeloupe is a andesitic composite volcano in the Lesser Antilles arc.
- Highly fractured dome
- Low-T fumarolic system ($T < 130^{\circ}\text{C}$) in a tropical environment (7 - 10 mm of rain fall/year)
- Ongoing unrest since 1992.
- Peak of activity in April 2018

Methods

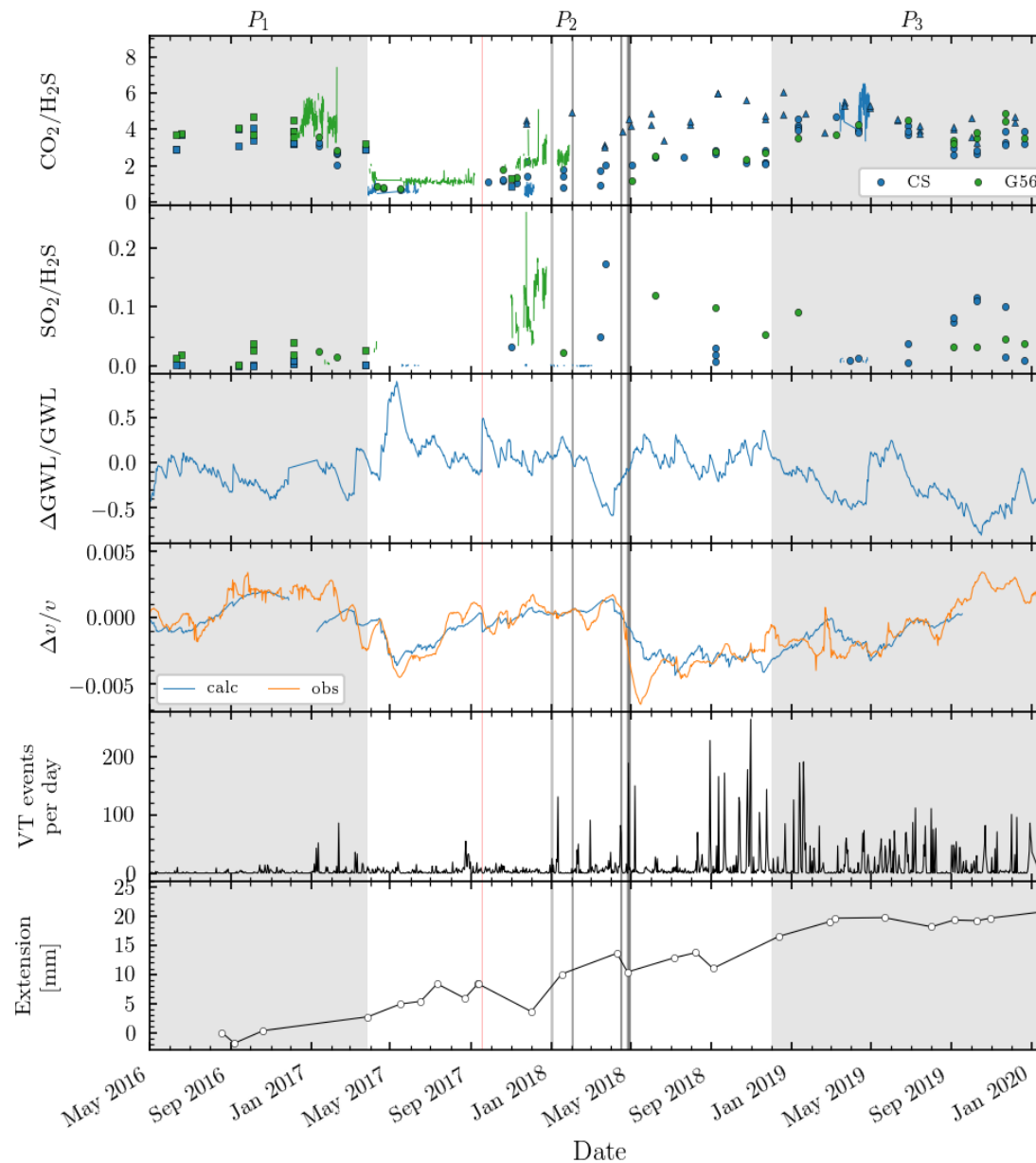
4-year long study involving :

- MultiGAS measurements from permanent (|) and portable (•) instruments ($\text{CO}_2/\text{H}_2\text{S}$ and $\text{SO}_2/\text{H}_2\text{S}$)
- Giggerbach bottles (▲)
- Water table level (dGWL/GWL)
- Observed seismic velocity anomaly ($\Delta v/v_{\text{obs}}$), which measures the effect of water saturation on the transmission of seismic signal
- Modelled seismic velocity anomaly based on the water table level ($\Delta v/v_{\text{calc}}$)
- VT events per day
- Extensometry

Key Questions

- How can we explain the observed chemical compositional variability?
- How can unrest signals be best deciphered for the case of volcanic hydrothermal systems?
- How can we decouple shallow and deep forcing effects?

Key Results



- 3 contrasted periods: P1, P2, P3

- P1: **Gas-water-rock reactions** → deposition of S → enrich the gas phase in CO_2 vs S → development of an impermeable S seal.

- P1/P2 : Drastic decrease in $\text{CO}_2/\text{H}_2\text{S}$ all over the dome + negative anomaly of $\Delta v/v$ + decrease of density in the dome (Le Gonidec et al. 2019) → T increase, steam production increase, overpressure, flushing the hot fluids in fractures → **Seal failure, increase of permeability**, liberation of the S accumulated, more H_2S degassing.

- P2: High extension rate + Major VT felt + negative anomaly of $\Delta v/v$ + increase SO_2 & CO_2 → arrival of a **major magmatic gas pulse from the deep** system in April 2018 (Moretti et al., 2020). Perturbation of the system until Dec. 2018

- P3: Back to “background” : extensive S loss to the hydrothermal system → seal + Numerous VT swarms under the dome since Sept. 2018 → **high circulation of fluids in a sealing state**

Lowest water table level : higher SO_2 concentration: **External forcing effects**