

Vulcano's Fumaroles and Geochemical Monitoring of Volcanoes

Volcanism Seminar
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Abstract

Since gas plays an important role in volcanic activities, geochemical monitoring is crucial for understanding the processes in the magma chamber. However, a precise prediction of eruptive events solely based on chemical analysis is not possible, but requires additional geophysical methods. Furthermore, the chemical setting differs between the volcanoes and can also vary with time, so conclusions cannot be drawn from a single measurement. Stand-alone monitoring stations provide the necessary continuous recordings; thus, they are an important means to recognize trends and developments.

What Are Fumaroles?

- holes in the ground where hot gas comes out
- gas comes out of the magma chamber (where differentiation occurs)
- fumarole + groundwater = geyser

Gas Composition

- H₂O (35%-90%) (from magma or ground water, can be distinguished by isotope ratio)
- CO₂ (5%-50%)
- SO₂ (2%-30%)
- HCl
- H₂S

Influences on Solubility

- solubility in the magma depends on pressure, temperature, viscosity and chemical structure
- saturated magma ⇒ gas is released
- release order: CO₂, S, Cl, H₂O, F

Geochemical Monitoring: Why?

- to understand what happens in the magma chamber
- eruption warnings
- volcanic gas itself can be a danger

Geochemical Monitoring: How?

Continuous Monitoring:

- only few types of gas
- shortage of energy (clouds, ash covering solar panels)
- maintenance required

- measuring interval must be short

Laboratory Analysis:

- more exact
- not realtime
- not regularly
- somewhat dangerous

Measuring Methods

- gas chromatography, ion chromatography
- mass spectrometer
- chemically selective sensors
- optical methods:
 - COSPEC (CORrelation SPECtroscopy): SO₂ measurement by UV absorption
 - FTIR (Fourier Transform InfraRed spectroscopy): CO₂ measurement with an interferometer
 - LIDAR (light detection and ranging): measurement of light scattering with different wavelengths (DIAL, Differential Absorption Lidar)

Patterns for Volcanic Activity

- appearance of fumaroles in general
- rising gas temperature
- shift of the chemical equilibrium
- other atypical things like oscillation of concentration

Examples for Monitoring

- Colombia: Galeras
- Indonesia: Merapi (Java)
- France: Soufrière (Guadeloupe), Pelée (Martinique), Piton de la Fournaise (Réunion)
- USA: Kilauea (Hawaii)
- Japan: Mt Mihara

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