Vulcano's Fumaroles and Geochemical Monitoring of Volcanoes

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Contents

1. 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

2.1 Gas Composition

- composition:
  - H_2O (35%-90%)
  - CO_2 (5%-50%)
  - SO_2 (2%-30%)
  - HCl
  - H_2S
- the atmosphere and hydrosphere are of volcanic origin

2.2 Influences on Solubility

- solubility in the magma depends on:
  - pressure
  - temperature
  - viscosity
  - chemical structure
- saturated magma $\Rightarrow$ gas is released
- release order: CO_2, S, Cl, H_2O, F

3.1 Monitoring: Why?

- to understand what happens in the magma chamber
- eruption warnings
  - geophysical methods are more common
  - several methods are combined
- volcanic gas itself can be a danger
  - Lake Nyos (Cameroun, 1986, CO_2), 1700 fatalities (suffocation)
  - Dieng Plateau (Java, CO_2)
  - Laki (Iceland, 1783, HF), >10000 fatalities (famine)

3.2 Monitoring: How?

- Continuous Monitoring:
  - only few types of gas
  - shortage of energy (clouds!)
  - maintenance required
  - measuring interval must be short
- Laboratory Analysis:
  - more exact
  - not realtime
  - not regularly
  - somewhat dangerous

3.3 Measuring Methods

- gas chromatography, ion chromatography
- mass spectrometer
- chemically selective sensors
- optical methods:
  - COSPEC (COrrelation SPECtroscopy): SO_2 measurement by UV absorption
  - FTIR (Fourier Transform InfraRed spectroscopy): CO_2 measurement with an interferometer
  - LIDAR (light detection and ranging): measurement of light scattering with different wavelengths (DIAL, DIfferential Absorption Lidar)

3.4 Patterns for Volcanic Activity

- appearance of fumaroles in general
- rising gas temperature
- shift of the chemical equilibrium:
  - rise of the ratio F/Cl and NH_4/B (= higher pressure)
  - decrease of Cl/S
  - more CO_2
  - more HCl
- other atypical things like oscillation of concentration

3.5 Examples for Monitoring

- Colombia: Galeras
- Indonesia: Merapi (Java)
- France: Soufrière (Guadeloupe), Pelée (Martinique), Piton de la Fournaise (Réunion)
- USA: Kilauea (Hawaii)
- Japan: Mt Mihara
  - increase of F, Cl, S between 17th and 30th of July 1957, eruption on 5th and 6th of August
  - ditto in the beginning of October 1957, eruption on October 13th

4. Fumaroles on Vulcano

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