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Gas monitoring at colombian active volcanoes

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Abstract. Gas sampling routinely is carried out in fumaroles, thermal waters and soils at colombian active volcanoes. Acid gases from fumaroles and thermal springs are trapped in alcaline solutions and later analyzed in the laboratory at Manizales Observatory by means of classical methods like volumetry, titration and electrodically. Soil gases like radon-222 and carbon dioxide are trapped in several isotopic stations around nevado del Ruiz, Purace and Galeras volcanoes and regional faults intersecting the volcanoes edifices.

Since 1997 is tested a gas telemetrical system from two fumaroles at Galeras volcano. Every 6 s are received the data of some parameters, like fumarole temperature, fumarole pressure, radon-222, carbon dioxide and sulfur dioxide.

Ten Colombian volcanoes have fumaroles with temperatures ranging between 60°C and 425°C. Only Purace, Galeras and Cumbal volcanoes have fumaroles with temperatures superior to 100°C.

1 Introduction

In Colombia, were started studies of some volcanic gases in three geothermal exploration projects developed from 1982 to 1984. Gas monitoring of CO_2, SO_2, H_2S and HCl for volcanological purposes began in 1984 and more continuous surveillance started between 1991 and 1995 at nevado del Ruiz, Galeras and Purace volcanoes. Gas measurements are made in fumaroles and in some thermal springs.

In a Multiparameter Station project that its developing from 1996 between the Federal Institute for Geosciences and Natural Resources – BGR of Germany and INGEOMINAS of Colombia, its being designed and tested a gas-telemetrical system on fumaroles at Galeras volcano in Colombia (Faber et al., 2003).

Soil gases like radon and carbon dioxide are measured from 1995 in isotopic stations installed around the edifices of Galeras, Purace and nevado del Ruiz volcanoes (Garzon, 1996; Gonzalez and Garzon, 2001).

At the present time there is a laboratory in the Volcanological and Seismological Observatory at Manizales – INGEOMINAS, dedicated exclusively in gas analyses for volcanic samples; and a laboratory in INGEOMINAS – Bogotá for chromatographic analyses of soil gases like carbon dioxide.

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2 Methodology

In agreement with their nature and sampling site, studied gases in colombian active volcanoes can be classified into two groups: (1) Gases from fumaroles and thermal springs; and, (2) Soil gases.

Acid fumarolic gases, like carbon dioxide, sulfur dioxide, hydrogen sulfur and hydrogen chloride; as well as dissolved gases in thermal waters are analized by means of classical methods. Carbon dioxide is measured by volumetric techniques after it oxydation with hydrogen peroxide; total sulphur (SO_2 + H_2S) is determined gravimetrically as a precipitate of barium sulfate; and hydrogen chloride is measured electrodically as chloridric acid (Alfaro, 1999). Those analyses are carried out routinely in the geochemical laboratory at Volcanological Observatory in Manizales city.

Radon gas is determined directly in the ground, within tubes of PVC trapping gases in the natural soil horizont (Diago et al., 2001). For this purposes is used Eperm (Electret Passive Environmental Radon Monitor) system proposed by Kotrappa et al. (1988). Carbon dioxide is trapped in the natural soil horizon in aluminum tubes; weekly, with a syringe is taken a sample and transported in vacutainer tubes to INGEOMINAS laboratory, where is analyzed in a gas chromatograph Varian Vista 6000, by isothermal method of double column (Moran et al., 2001).

3 Results and discussion

In Colombia in their active craters, have fumarole manifestations the next ten volcanoes: (1) Cumbal, (2) Azufral, (3) Galeras, (4) Sotará, (5) Puracé, (6) Huila, (7) Machín, (8) Tolima, (9) Santa Isabel and (1) Ruiz. Surficial temperatures of fumaroles in colombian active volcanoes are given in Table 1.

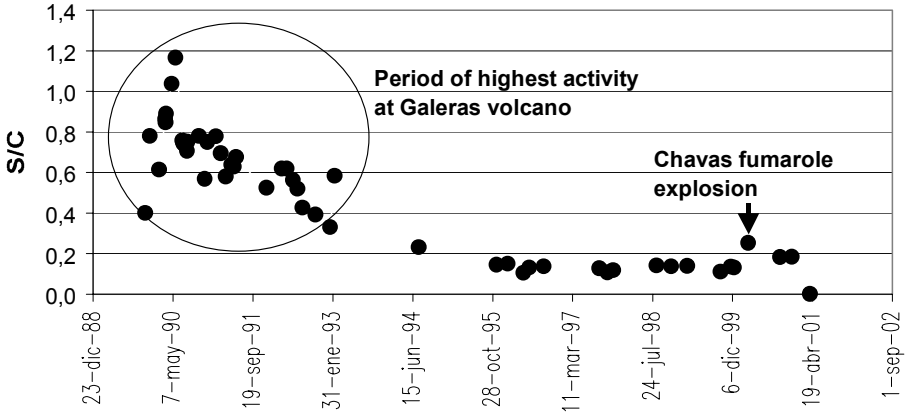

Fig. 1. Relation between more magmatic dissolved gases (S) and more volatile gases from magmas (C) at Galeras volcano.

Table 1. Fumarole temperatures at colombian active volcanoes

Volcano	Number of fumarolic Fields	Temperature range (°C)
Cumbal	10	85 – 350
Azufral	1	60
Galeras	8	90 – 425
Sotará	1	85
Puracé	1	135
Huila	3	130
Machín	1	87
Tolima	2	83
Santa Isabel	1	87
Ruiz	4	83

Gas sampling in fumaroles are routinelly carried out in the next six active colombian volcanoes: (1) Cumbal; (2) Galeras; (3) Sotará; (4) Puracé; (5) Machín; and, (6) Ruiz.

An important relation between more dissolved gases in magma, expresed in terms of total sulfur (SO_2 + H_2S) and less dissolved gases in magma, expresed in terms of CO_2 + CO against volcano activity is given in the Fig. 1. The period of highest activity at Galeras volcano from 1988 to 1993 showed a S/C relation superior to 0,4. In March 2000 occurred a small explosion in Chavas fumarole, and S/C relation was of 2,5. For many years Chavas fumarole had a surficial temperature between 350 to 425°C. One day before the explosion was measured an unbelievable temperature of 1135°C. Real rock temperature around the Chavas fumarole was perhaps stable, but a possible flux of hydrogen gas from the Earth's interior affected the termopar material of termocouple. It is known the exotermic process in which hydrogen gas can catalytically dissociate on metal surfaces, following the next reaction:

$$H_2(g) \longrightarrow 2H \cdot + Q \quad (1)$$

Perhaps the unbelievable measured temperature one day before the explosion in the Chavas fumarole was produced by the exotermic atomic dissociation of hydrogen gas onto metallic surface of termocouple.

4 Conclusions

In Colombia there are 24 fumaroles distributed in 10 active volcanoes with temperatures between 60°C and 425°C.

In a large period of time it is clear a positive correlation between S/C contents in fumarolic gases and the activity of Galeras volcano. When the S/C relation is below 0,2 the activity of Galeras volcano had been low.

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