Geochemistry and fluid circulation at the Tenorio volcanic complex (Costa Rica)

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Tenorio (10.673°N, 85.015°W) is a complex basaltic-andesitic volcano belonging to the Guanacaste Chain (NW Costa Rica) and consists of a series of NNW-ESE volcanic structures and two twin-craters (sometimes reported as a separated volcano named Montezuma) (Alvarado, 1993). It is located south-east of the active volcano Rincón de la Vieja and the geothermal field of Miravalles volcano. Volcanic activity is not recorded in historical time although a legend tells about an eruption (never documented) in 1816 (Alvarado, 1993).

The Tenorio volcanic complex lies on a Pre-Pleistocene regional basement composed by andesite and basaltic lavas plus continental sedimentary rocks. The eruptive sequence of Tenorio consists of up to few hundreds meters alternate deposits of lavas and pyroclastic rocks (Herrera Cabezas, 1990).

Geothermal investigations of the area are underway since the late 80´s by ICE (Instituto Costarricense de Electricidad). Exploratory wells (up to about -2200 m) were drilled in the south-western flank of the volcanic structure with no promising results although temperatures between 230-250°C were expected (Mainieri and Robles; Mainieri, 2000).

In the framework of a collaboration between the Volcanological and Seismological Observatory of Costa Rica in Heredia, and the Department of Earth Sciences of Florence (Italy) an extensive study of the fluid manifestations in Costa Rica has started since 1998.

The present work reports the geochemical results gathered from thermal and cold water and discharges, mainly located in the eastern part of the volcanic area of Tenorio.

The collected water samples have temperatures between 16 and 94°C with pH values from 2.05 to 7.20. Ca-SO_4 and Ca-Cl-SO_4 chemical facies predominate, while waters with Ca-HCO_3, Na-Cl-HCO_3 and Na-Ca-HCO_3 composition are less abundant.

In the north-eastern flank of the volcanic complex, at the confluence of two creeks, sub-fluvial springs discharge at temperatures of about 25°C. The inputs of these springs possible cause the formation of a milky suspended material (colloidal sulphur, amorphous silica and carbonates) which imparts a sky blue colouration to the waters. The milky material covers cobbles, pebbles and organic debris that are on the river bed. Suspended matter in the Celeste River waters was sampled filtering the river water with a 0.45 µm filter for SEM-EDS analyses. The available physical-chemical data suggest that the sky-blue colouration of Celeste River cannot be attributed to the presence of particular chemical species but we hypothesise that the blue colour is due to light-scattering caused by the colloidal material suspended in the water.

The Tenorio lake, previously considered as a crater lake, has to be regarded as by meteoric water. Furthermore, it does not feed the rivers on the volcano flanks such as

Celeste River, Roble River, tributaries of Tenorio River, etc. Regarding the gas composition of the thermal discharges of the area, CO_2 is the main gas compound (from 86.78 to 91.03%), followed by N_2 and H_2S (0.18-0.33% and 0.11-0.36%, respectively), CH_4O_2, Ar, H_2, CO, He and Ne are present only in low quantities, always lower than 0.1%. N_2/Ar ratio is always between air (82) and air saturated water values (38). Carbon isotope ratios in CO_2, ranging between -5.46 to -3.01 °/oo $\delta^{13}C$, are lower with respect to those of the Miravalles Geothermal Field and Rincón de la Vieja volcano. A conceptual model of the fluid circulation in the eastern flank of the Tenorio volcanic complex is presented.

References

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