

## ABSTRACT

### Geochemistry of Geothermal Systems in Saint Lucia and Dominica, Lesser Antilles: Implications for Volcanic Monitoring

Erouscilla Patricia Joseph-Ramdan

The islands of Dominica and Saint Lucia are located in the Lesser Antilles volcanic island arc. The potentially live volcanoes on these islands are associated with active volcanic hydrothermal systems. Geothermal monitoring of these hydrothermal systems was initiated in 2001, as part of an integrated volcanic monitoring programme, to geochemically characterize the systems and to establish baseline levels of activity from which changes can be detected.

The geothermal fluids of Dominica and Saint Lucia were found to be typical of those found in arc-type settings. The geothermal waters in both islands were classified as predominantly acid-sulphate type formed as a result of dilution of acidic geothermal gases being diluted in near surface oxygenated groundwater, with the gases having strong hydrothermal signatures being dominated by carbon dioxide and having hydrogen sulphide as the main sulphurous gas.

Additionally, specific acid-sulphate type mineral assemblages including

chalcedony, cristobalite, and quartz have been identified using mineral speciation software (PHREEQC1), as being in equilibrium with the geothermal reservoirs. The saturation indices of the minerals comprising these assemblages have been used as geothermometers to estimate subsurface temperatures. Reservoir temperatures of Sulphur Springs, Saint Lucia have been estimated to be ~150°C, while reservoir temperatures of Dominica geothermal systems have been estimated to range between 100 - 150°C, using water chemistry data.

In comparison equilibria temperatures of the hydrothermal systems of Dominica and Saint Lucia derived from the evaluation of molar ratios of CH<sub>4</sub>/CO<sub>2</sub> and CO/CO<sub>2</sub> revealed higher temperatures (300 – 450°C) for the gases. This suggests that the source of the gases lie deeper than the hydrothermal reservoirs themselves, and that they preserve more of their higher temperature signatures due to slower reaction kinetics and decreased solubility in water. Hence, monitoring of changes in these deeper temperatures as indicated by the gases would provide information on possible magmatic inputs to the hydrothermal systems more readily than would be reflected by the water chemistry.

Geothermal sites in both islands are used for recreational purposes including sight-seeing, bathing and drinking. Geothermal waters used for recreation were found to have concentrations of lead, cadmium, nitrite, iron and aluminum greater than was safely recommended for consumption by the USEPA. The concentration of sulphur dioxide emissions at these sites may also prove hazardous to health

with long term exposure. These concerns must be examined in greater detail for proper safety guidelines to be created and implemented for safe use of these sites for recreational activity.

**Keywords:** geothermal systems; volcanic monitoring; volcanic fluids; Lesser Antilles