Bouillante and Soufrière areas: (Guadeloupe, French West Indies): two hydrothermal systems with different geochemical signatures

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This study compares the fluid geochemical signatures between the hydrothermal areas of Bouillante and Soufrière, obtained from our geochemical data and numerous existing literature works. The thermal springs emerging from the Bouillante area can be divided into two groups following their salinity and chemistry:

the first group is constituted of Na-HCO_3 waters with low salinities (< 1 g/l) and emergence temperatures (< 40°C), which would be warmed in relatively superficial low temperature aquifers (< 80°C) by thermal conduction ;

the second group is represented by Na-Cl waters, with salinities higher than 1 g/l and partially constituted of the deep geothermal fluid. This Na-Cl fluid which can be collected from the geothermal production wells has salinity close to 20 g/l and results from a mixing of 58% of seawater and 42% of freshwater reacting with volcanic rocks at temperatures close to 260°C.

The fumaroles located in this area are associated with this geothermal fluid. According to the δD and $\delta^{18}O$ values, their water steam would result from vaporization at 100°C of a mixing of this fluid with surface cold freshwater. The chemical composition of their non-condensable gases (preponderance of CO_2, when the air contribution is low) is in agreement with this assumption.

The thermal springs located around the Soufrière volcano discharge low salinity (< 2 g/l) waters with different chemical compositions and for which the chemical geothermometers indicate no deep temperature higher than 90°C. Most of these waters would be meteoric waters warmed by magmatic gas escapes from the volcano. The fumaroles located in this area discharge high flux of HCl-rich water vapor and low volumes of non-condensable gases (< 7%). These gases, mainly constituted of CO_2 (60-90 vol.%) and H_2S (31- 4 vol. %), have magmatic chemical and isotopic signatures much more marked than those of the Bouillante geothermal gases, less abundant and acid, of mixed origin. Indeed, for the first gases, $^3He/^4He$ ratio is 7.9 to 8.4 times higher than the atmospheric ratio and $\delta^{13}C$ values range from -3.2 to -3.0‰, whereas for the second ones, $^3He/^4He$ ratio is 4.0 to 4.5 times higher than the atmospheric ratio and $\delta^{13}C$ values are close to -2.6‰.