

Helium isotope geochemistry of thermal springs and volcanic gases from Guadeloupe, Lesser Antilles

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The island of Guadeloupe is located in the middle of the 850 km long Lesser Antilles island arc. Volcanic activity is concentrated in the southwestern part of the island (Basse Terre), with the active system of La Soufriere volcano. Most of the thermal manifestations are located around La Soufriere dome and in the Bouillante geothermal area. Since the last magmatic eruption in 1530, several phreatic eruptions have been recorded, with one of the most violent episode in 1976-1977. The Bouillante system, where a geothermal plant generates 15 MW of electrical power, is located a few kilometers to the northwest. Between 1995 and 2012, twenty sites, including fumaroles, bubbling gas, hot springs and production wells, were sampled on five occasions (1995 / 1996 / 1999 / 2006 / 2012) for helium isotope geochemistry in order to map their spatial distribution and temporal trends in mantle-derived ³He inputs across the region. The data set reveals helium (⁴He) concentrations in the water samples ranging from 5 to 30 (10⁻⁸ cm³ STP/g) for La Soufriere volcanic system, and up to 7300 for a submarine hot spring (- 23 m) located in the Bouillante area (Ilet Pigeon). Helium concentration in volcanic gases (fumaroles and bubbles) varies between 5.3 and 10.5 ppmv around La Soufriere, with air-corrected ³He/⁴He ratios in the range 7.9 - 8.4 Ra, coincident with the MORB ratio (³He/⁴He = 8 Ra, where Ra = air ³He/⁴He ratio). In contrast, the nearby Bouillante system is characterized by higher helium gas contents (up to 494 ppm) and much lower ³He/⁴He values (between 3.3 Ra and 4.5 Ra), indicating a substantial crustal contribution to the volatile budget of the geothermal system. No temporal change in the ³He/⁴He ratios over the last 16 years evidences a steady feeding source for both systems. A detailed discussion of the helium data set will be presented and the results will be examined in relation to the geological and tectonic framework of the island of Guadeloupe.