



## **Hydrogeochemical variations in groundwater periodically sampled at El Hierro (Canary Islands) and its relationships with the recent eruptive and unrest periods**

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On 10 October 2011, a submarine volcanic eruption started 2 km south El Hierro Island (Canary Islands, Spain). Since July 2011 a dense multiparametric monitoring network was deployed all over the island by Instituto Geográfico Nacional (IGN). By the time the eruption started, almost 10000 earthquakes had been located and the deformation analyses showed a maximum deformation of more than 5 cm. After the end of the submarine eruption and up to now, several volcanic unrest processes have taken place in the island. The most relevant ones started on June 2012 and March 2013. Each of these periods has been evidenced by intense seismicity and ground deformation.

In the framework of this volcanic surveillance program, the IGN team started to periodically sample five groundwater sampling sites. Some parameters have been determined directly in the field (temperature, pH, electric conductivity and alkalinity) and collected samples have been analysed in the laboratory for major (Na, K, NH<sub>4</sub>, Ca, Mg, SO<sub>4</sub>, Cl, HCO<sub>3</sub>, CO<sub>3</sub>, NO<sub>3</sub>, NO<sub>2</sub>, PO<sub>4</sub>, SiO<sub>2</sub>, Br, F) and trace elements (Be, Al, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Mo, Ag, Cd, Ba, Hg, Tl, Pb, Th, U) contents. In a few cases samples for the chemical analysis of dissolved gases and for the determination of the isotopic composition of He have been collected at two of the sites. Significant increases in alkalinity have been recorded in all sampling sites correlated both to the eruptive period and also to the following unrest episodes. Such increases are probably related to the dissolution of magmatic CO<sub>2</sub> exsolved from the rising magma batches. The magmatic contribution can be confirmed by the isotopic composition of dissolved He showing values in the range from 7.76 to 8.91 R/Ra.

Since July 2011, only one important CO<sub>2</sub> soil degassing anomaly has been detected. This anomalous flux (620 g/m<sup>2</sup>.d) was measured in a small area (0.36 km<sup>2</sup>) before the beginning of the submarine eruption and has not been detected again after the eruption onset. In addition, continuous CO<sub>2</sub> measurements in the atmosphere of two galleries of the island have not shown any relevant changes since the beginning of the volcanic unrest. Taking into account this absence of significant CO<sub>2</sub> fluxes along the whole studied period, it could be hypothesized that almost all the CO<sub>2</sub> separated from the magma during its ascent to the surface along the different unrest processes has been dissolved in the aquifers of the island.

Such finding emphasizes the important contribution that hydrogeochemical data can provide to the volcanic surveillance program of El Hierro Island.