



Hydrogeochemical monitoring for volcanic surveillance at Tenerife, Canary Islands

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Tenerife Island could be considered as an unique natural-scale laboratory for hydrological studies at oceanic volcanic islands. Thousands of wells and water galleries have been drilled (1.650 Km) reaching the island volcanic aquifer at different depths and elevations. Las Cañadas aquifer is located in the central part of Tenerife and is affected by Teide volcanic-hydrothermal system. The last volcanic eruption occurred in the island was Chinyero volcano in 1909 and it is located along the NW rift-zone of Tenerife. On April, 2004, an anomalous seismic activity pattern within the island suggests the initial stage of a clear volcanic unrest for Tenerife volcanic system. This fact was the driving force to develop an ambitious hydrogeochemical monitoring program, which started on August 2004, to evaluate potential temporal variations of physico-chemical parameters in the island ground water system to strength the systematic for the early detection of geochemical signatures related to the volcanic phenomenon. This hydrogeochemical program is applied for an intensive monitoring of ground water discharges from 19 galleries after following a careful selection based on the ground water chemistry and their location as a function of volcano-tectonics and recent seismicity activity pattern. Ground water samples are collected 3 times per week for monitoring dissolved carbonate species, pH, conductivity, temperature and dissolved chloride. Ground waters are mainly $\text{Na}^+\text{-HCO}_3^-$ water type, and the HCO_3^- concentration showed a range of 100-3.500 ppm and a mean value of 1.480 ppm. Ground water pH values ranged from 6,4 to 8,8 and showed a mean value of 8,0 pH. Conductivity of these ground water samples ranged from 225 to 3.700 $\mu\text{S/cm}$ and showed a mean value of 1.600 $\mu\text{S/cm}$. Ground water HCO_3^- content and pH temporal variations at each sampling site observation seems not to be clearly related to the occurred seismic

activity from August to present. On the contrary, it has been observed a significant secular variation in the conductivity of these ground waters. Most of the observation sites showed peak conductivity values at the beginning of October, 2004, where a relatively increase of seismicity was detected at Tenerife island. Since 1999 a continuous monitoring of physico-chemical parameters of Las Cañadas ground water system is performed by the Water Resources Department of the Island of Tenerife in a borehole of 505 m depth at the base of Las Cañadas caldera. Conductivity, pH and temperature are continuously recorded at three different depths of the water column (about 60 m.) as well as the water table level. Water Resources Department scientists suggested that the observed temporal variations of these physico-chemical parameters in the borehole are basically related to rainfall at the recharge zone (Farrujia et al., 2001). However, seismic activity pattern in and around Tenerife Island has not been considered on this study. Since ground water temperature could be mainly affected by recharge, temperature gradient (ΔT) could be a useful parameter to evaluate the potential effects of the seismic activity in the ground water system. An analysis of the data showed that the higher ΔT values were mainly observed during the period of a higher level of seismic activity in and around Tenerife. An increase of ΔT values was observed since August, 2001, and maximum ΔT values were observed by the end of February, 2004, just 2 months before the recent 2004 seismic-volcanic crisis at Tenerife. These observations could represent long-term and short-term hydrochemical precursory signatures of the anomalous seismic activity that had recently occurred at Tenerife, suggesting either a mixing process between ground water and hydrothermal fluids or a mixing of ground waters with different physico-chemical signatures due to strain/stress changes related to the recent seismic activity. These observations showed the importance to continue and develop a strong hydrogeochemical monitoring network for the volcanic surveillance at Tenerife Island.

Farrujia, I., Velasco, J.L., Fernandez, J., Martin, M.C., 2004. Evolución del nivel freático en la mitad oriental del acuífero de Las Cañadas del Teide. Cuantificación de parámetros hidrogeológicos. In: VIII Simposio de Hidrogeología de la Asociación Española de Hidrogeólogos. Zaragoza. *XXVI*.