Geochemistry of groundwater from Graciosa Island (Azores): A contribution to the hydrothermal system conceptual model

M.R. CARVALHO[1], P.M. CARREIRA[2], J.M. MARQUES[3], G. CAPASSO[4], F. GRASSA[4] AND J.C. NUNES[5]

[1]Universidade de Lisboa, Faculdade de Ciências, Depart. Geologia/CeGUL, Portugal
[2]Instituto Tectonológico e Nuclear, Lisboa, Portugal
[3]Instituto Superior Técnico, Lisboa, Portugal
[4]Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo, Palermo, Italy
[5]Universidade dos Açores & INOVA Inst., Azores, Portugal

Graciosa island is located in the Azores Archipelago, along the so-called Terceira Rift, a major tectonic structure that makes the NE boundary of the Azores Plateau. In general terms, it includes a basaltic plataform on the NW and a silicic poligenetic volcano with caldera on the SE, the Graciosa Caldera Volcano. This volcano has produced significant tephra falls, pyroclastic flows, lahars, and lava flows, both of basaltic s.l. and trachitic s.l. composition.

The hydrothermal system shows fumarolic emissions inside the volcano caldera and thermal springs located along the shoreline. This system is exploitated in a thermal building through shallow and deep (110 m) boreholes, near the coast.

In Graciosa two types of Na-Cl groundwater systems can be identified: 1) a cold one emerging at springs and exploited by wells for public water supply, and 2) a hydrothermal system with temperatures around 40-44 ºC. The cold groundwaters have pH higher than 7 and different degree of mineralization, according to the proximity to the sea. The thermal waters show mixing with seawater, pH varying between 6.20 and 6.94, 166 mg/L of SiO_2, and significant concentration of metals, such as Mn, Fe, Co, Ni, Cu and Zn. The thermal water mineralization varies strongly, showing EC from 8.87 mS/cm (shallow water) to 47.4 mS/cm (deeper water). The higher mineralized water is rich in CO_2(g), with 2130 mg/L of total dissolved CO_2. Geothermometers application reveals aquifer temperature ≈ 167 ºC and immature/mixed waters, not reaching complete equilibrium with reservoir rock.

The geochemistry of the thermal waters indicates the occurrence of seawater/host rock interaction processes at high temperature and slightly acid conditions, favored by CO_2(g) input, and a different degrees of mixing with cold and shallow groundwaters.

Geochemistry of S-type granitic rocks from the Valongo area (Northern Portugal)

P.C.S. CARVALHO[1]*, A.M.R. NEIVA[1], M.M.V.G. SILVA[1] AND F. CORFU[2]

[1]Geoscience Centre and Department of Earth Sciences, University of Coimbra, 3000-272 Coimbra, Portugal (*correspondence: paulacscarvalho@gmail.com)
[2]Department of Geosciences, University of Oslo, PB1047 Blindern, N-0316, Norway

Variscan peraluminous granitic rocks crop out at the eastern limb of the Valongo anticline, located about 18 km at east of Oporto, in the Dúrico - Beirão region, northern Portugal and Central Iberian Zone of the Iberian Massif.

The medium- to coarse-grained porphyritic biotite>muscovite granite (G1) intruded Ordovician and Silurian metasediments and produced a contact metamorphic aureole. The medium-grained porphyritic biotite ≈ muscovite granodiorite (G2) intruded the earlier granite and the contact is by faulting. The fine-grained porphyritic biotite>muscovite granodiorite (G3) intruded the other two granitic rocks. Granite G1 and granodiorite G2 are late-D3, whereas granodiorite G3 is post-D3. The U-Pb ages for zircon and monazite, obtained by ID-TIMS, are 309.6±1.0 Ma for G1, 307.0 ± 3.2 Ma for G2 and 305.1± 0.4 Ma for G3 and 587 Ma for inherited zircon cores from G2 and G3. Variation diagrams show that G3 has higher TiO_2, total FeO, MgO, CaO, Zr, Ba, Th, Ce contents and lower SiO_2, Li, Rb contents than G1 and they define independent trends. G2 is not related to G1. Granite G1 and granodiorite G3 have similar $(^{87}Sr/^{86}Sr)_i$ of 0.7085, εNd_T -6.64 (G1) and -6.92 (G3) and $\delta^{18}O$ 11.36 ‰ (G1) and 10.90 ‰ (G3). Therefore, they are derived by partial melting of the same metasedimentary materials, containing Neoproterozoic detritus, but G3 results from a higher degree of partial melting than G1. Granodiorite G2 results from a distinct granitic magma and is derived by partial melting of metasedimentary materials containing Neoproterozoic detritus, as it has $(^{87}Sr/^{86}Sr)_{307}$ of 0.7080, εNd_{307} of -7.06 and $\delta^{18}O$ of 11.31 ‰. The three granitic rocks are of S-type.