Canaries

The Canary Islands Hot Spot

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The Canary archipelago comprises seven main volcanic islands and several islets that form a chain extending for ~ 500 km across the eastern Atlantic, between latitudes 27°N and 30°N, with its eastern edge only 100 km from the NW African coast (Figures 1 & 2). The Canary Islands developed in a geodynamic setting characterized by Jurassic oceanic lithosphere formed during the first stage of opening of the Atlantic at 180-150 Ma and lying close to a passive continental margin on a very slow-moving tectonic plate – the African plate. In addition, the archipelago lies adjacent to a region of intense active deformation comprising the Atlas mountains, a part of the Alpine orogenic belt.

the shield-building stages, trachytes and phonolites are very common in the declining stages, while the rejuvenation stages produced essentially basanites and nephelinites.

Total alkali vs. silica (TAS) diagrams of volcanic rocks from the Canary Islands (Figure 17) show that they fall in the alkaline, silica-undersaturated field. There is a generally bimodal grouping into basalt-basanite and trachyte-phonolite compositions. Figure 17 also shows that most samples correspond to moderately alkaline (alkali basalt-trachyte) or highly alkaline (basanite-phonolite) rocks.

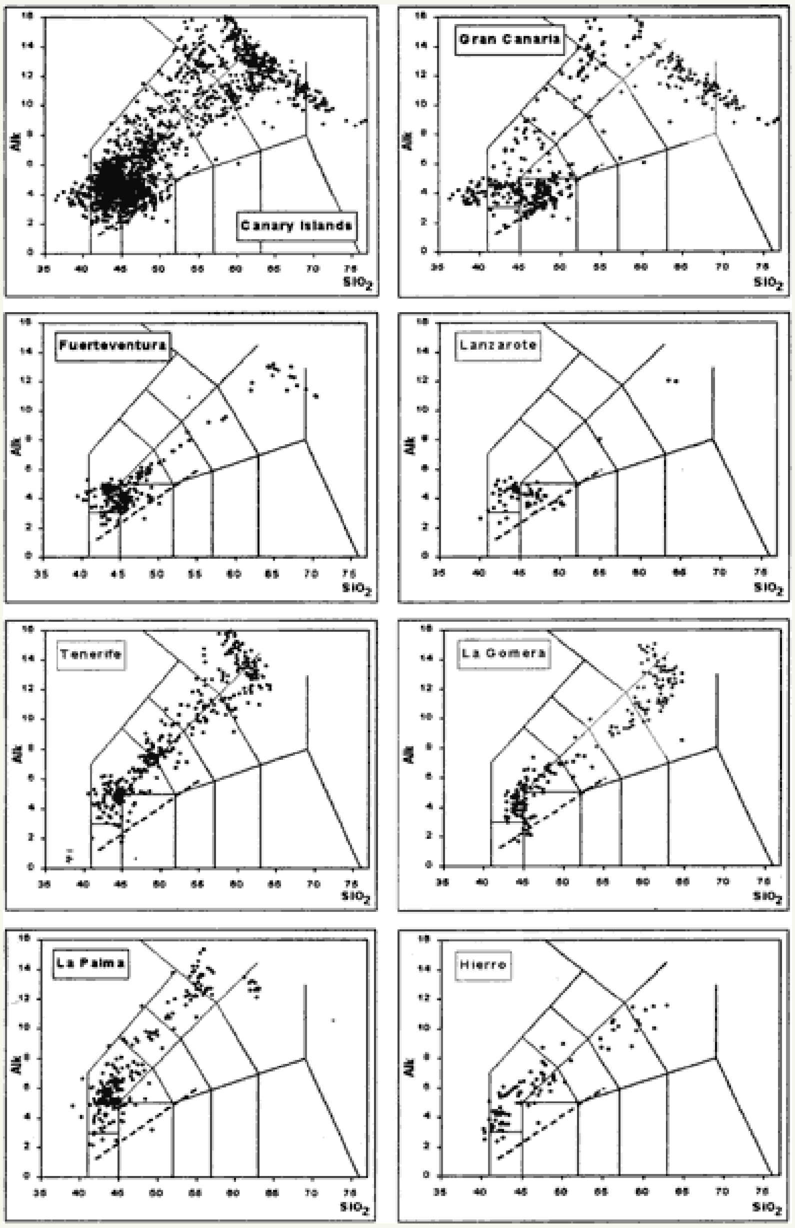

Figure 17: Total alkali versus silica diagrams (TAS) with analyses of Canaries volcanic rocks (Carracedo et al., 2002).

Rocks of tholeiitic affinity have been recognized only in the oldest units of Gran Canaria and in the most recent lavas of Lanzarote. Ultra-alkaline rocks appear mainly in Gran Canaria (ol-melilitites and nephelinites) and Fuerteventura (ol-nephelinites), corresponding to the rejuvenation stage. There are notable differences in the alkalinity and abundance of rock types between the islands. Gran Canaria has rocks embracing all compositions from the most to the least alkaline, whereas in the other islands the alkalinity of lava flows is mostly homogeneous. The most alkaline is La Palma, whereas Tenerife is less so, being on the boundary between highly and moderately alkaline. El Hierro, La Gomera, Fuerteventura and Lanzarote show the least overall alkalinity – all are moderately alkaline. The islands with the least abundance of felsic rocks (< 1%) are Lanzarote and El Hierro, with ~ 3% on La Palma, La Gomera and Fuerteventura, and the central islands (Gran Canaria and Tenerife) having the largest abundance (>10%).

Mg variation diagrams of Canarian rocks show similar trends in all the islands (Figure 18), with decreasing MgO in basic rocks (basalts, basanites; < 6%) and the trachytic-phonolitic rocks (MgO < 1%). Both CaO and FeO decrease slightly, while Al_2O_3 rises considerably and TiO_2 has a tendency to increase slightly.

Trace-element data show the most incompatible elements increasing from the basalts to the trachybasalts and basaltic trachyandesites, with a reduction in Ti and P, possibly due to Fe-Ti oxides and apatite crystallization (Figure 19). The trace- and radiogenic-isotope contents are characteristic of HIMU OIBs, although with some variations depending on the age of the various units (*Weaver*, 1991; *Hoernle et al.*, 1991; *Thirwall et al.*, 1997).

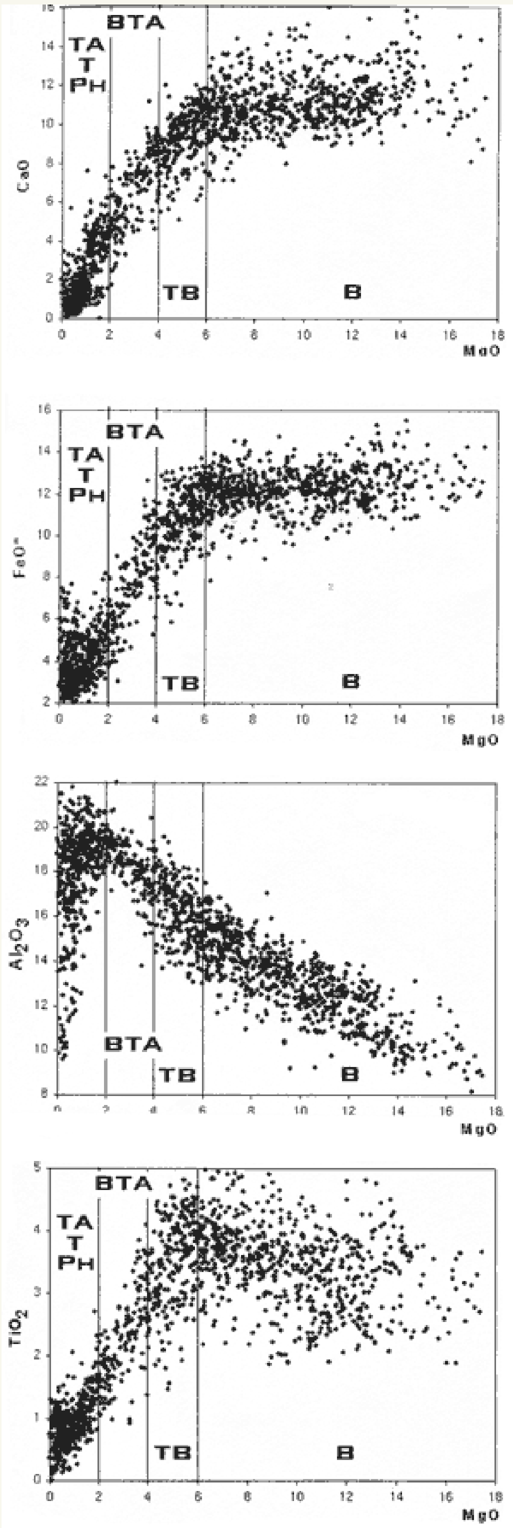

Figure 18: Plots of MgO vs. major oxides from Canary Islands volcanic rocks (Carracedo et al., 2002).

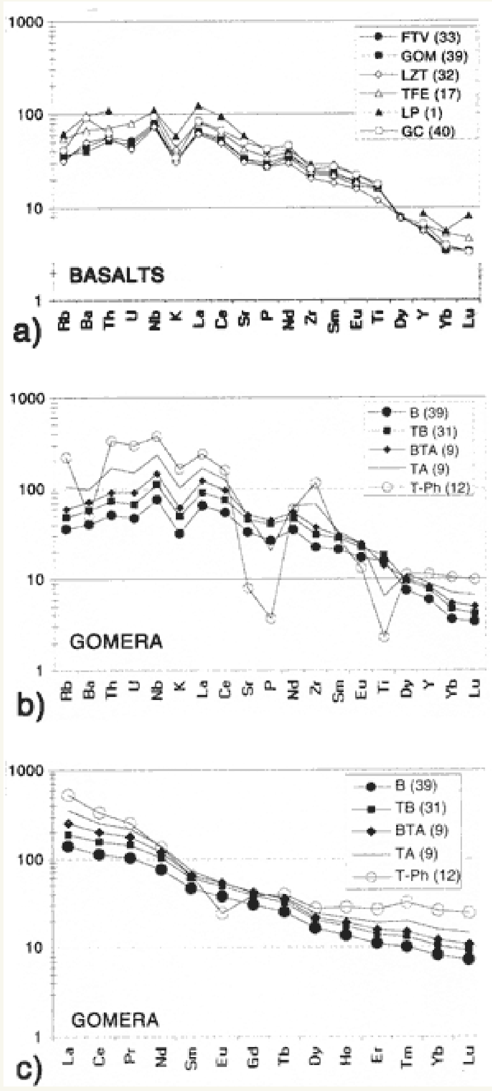

Figure 19: Plots of incompatible trace elements normalized to primitive mantle (Carracedo et al., 2002).

Sr-Nd-Pb isotopic analyses have been interpreted as indicating that the magmas of the Canary Islands represent a multicomponent mixture of different reservoirs – a HIMU component and a second end-member with lithospheric (EM), asthenospheric (DM) and additional HIMU components (*Cousens et al.*, 1990; *Hoernle & Tilton*, 1991; *Hoernle et al.*, 1991; *Hoernle & Schmincke*, 1993; *Neuman et al.*, 1995).

Summary

The Canary archipelago developed at a passive continental margin, on Jurassic oceanic lithosphere and a slow-moving tectonic plate. There are several genetic hypotheses for the Canary Islands, including a propagating fracture, a local extensional ridge, uplifted tectonic blocks and an unifying model but it is generally assumed that the archipelago originated from residual old plume material in the upper mantle. The first alkaline magmatic manifestations of this hot spot occurred at Fuerteventura during the Upper Cretaceous (~ 70 Ma), submarine volcanism started in the Eocene-Oligocene (~ 39 Ma) and subaerial volcanism in the Miocene (~ 20.6 Ma). There is a general progression of the oldest volcanism, thought to be induced by westward motion of the African plate and thus El Hierro island has the oldest dated subaerial Quaternary (~ 1.1 Ma) volcanism. The chain has been active along its entire length during the last million years, however.

Canary Island volcanism involves submarine stages, followed by shield-building, declining, erosive and rejuvenation stages. Three groups of islands are currently in the rejuvenation stage – Fuerteventura, Lanzarote, Gran Canaria and Tenerife. La Gomera is in the erosional stage, and La Palma and El Hierro are in the declining stage.

The Canary Islands show some interesting differences with other oceanic islands such as the formation of central stratovolcanoes, island tectonics that include ductile shears and compressional structures, and small or zero subsidence.

For more information about the geology of the Canary Islands, see:

Carracedo, J.C., Pérez, F.J., Ancochea, E., Meco J., Hernán, F., Cubas C.R., Casillas, R., Rodriguez, E. and Ahijado, A., 2002. Cenozoic volcanism II: The Canary Islands. In: *The Geology of Spain*. Ed. Gibbons, W. and Moreno, T., *Geological Society of London*, 439-472.

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