New data on evolutive trends of Third Magmatic Cycle (Post-Roque Nublo Group) volcanism in Gran Canaria (Canary Islands, Spain)

Nuevos datos de evolución geoquímica del Ciclo Magmático III (Grupo Post-Roque Nublo) de Gran Canaria (Islas Canarias, España)

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ABSTRACT

This note exposes preliminary data (petrography, TAS classification) obtained from a 44-samples study of lavas corresponding to the Third Magmatic Cycle of Gran Canaria island. These samples has been chosen from a 120 studied set, taking into account good preservation and specific geologic situation in order to obtain a new K/Ar systematic geochronology of recent volcanic rocks of the island. We can remark a good agreement with published available results (including older ones); in despite of this, the simultaneous knowledge of correct ages allows new interpretations of the recent geologic history of Gran Canaria island. The most prominent new evidence is that evolved rocks corresponding to the end of Roque Nublo Cycle are coeval during a relatively broad span of time (3.6-2.9 Ma) with the pristine (basanitic) terms of rift volcanism (initial volcanism of Third Magmatic Cycle).

Key words: *Gran Canaria, Third Magmatic Cycle, TAS classification, geological evolution*

RESUMEN

Esta nota recoge los resultados preliminares (petrografía, clasificación TAS) recientemente obtenidos en el estudio de 44 muestras del volcanismo correspondiente al Tercer Ciclo Magmático de la isla de Gran Canaria que han sido elegidas sobre una base de más de 120, tanto por su específica situación geológica como por su estado de conservación, de cara a la datación sistemática K/Ar realizada en paralelo. Destaca la coincidencia en resultados en líneas generales con los disponibles para estas rocas (incluso los más antiguos) si bien el conocimiento paralelo de su correcta edad permite alguna lectura totalmente nueva de la historia geológica reciente de Gran Canaria, entre la que destaca la coexistencia (3.6-2.9 Ma) de los términos más evolucionados del final del Ciclo Roque Nublo con términos primitivos, esencialmente basaníticos, del volcanismo de rift (inicio del Tercer Ciclo Magmático).

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Introduction

Basic knowledge on recent volcanism at Gran Canaria has been greatly improved in the last fifhteen years. Initial studies were developed in the sixties and seventies by the Madrid school. A great progress was associated to the systematic geologic mapping of the island, as well as to the development of specific studies (see ITGE 1992, Hoernle & Schmincke 1993, Meco et al. 2002, and references therein). In despite of this, it remains as the part of the volcanic geology of Gran Canaria less studied. This note offers the first data obtained by a triennial project devoted to the update of knowledge on post-Roque Nublo Cycle, including relationships with Roque Nublo Cycle, the geochronology of the several events, and the composition, importance relative and petrogenesis of the more evolved terms.

Geological background

The building of Gran Canaria is associated to three main magmatic stages: the initial one, is the shield (and underlying seamount) stage, and mainly extends from about 14 to 10 Ma; the second is the subaerial pyroclastic and lavic Roque Nublo Cycle; and finally the Third Magmatic stage can be further divided in initial rift volcanism with vents mainly placed on a NW-SE linear trend and subsequent more sparse recent pyroclastic and lavic volcanism. There is a clear gap in volcanic activity and an associated erosive period between shield stage and Roque Nublo Cycle (around 4 Ma), and a similar but less extended gap (about 0.5 Ma) has been largely postulated taking into account geochronological data (see van den Bogaard and Schminke,1998, and references therein). This later gap has been submitted to discussion by Perez Torrado et al. (1995) and definitely rejected by Guillou et al (2002) with a large set of new geochronological data.

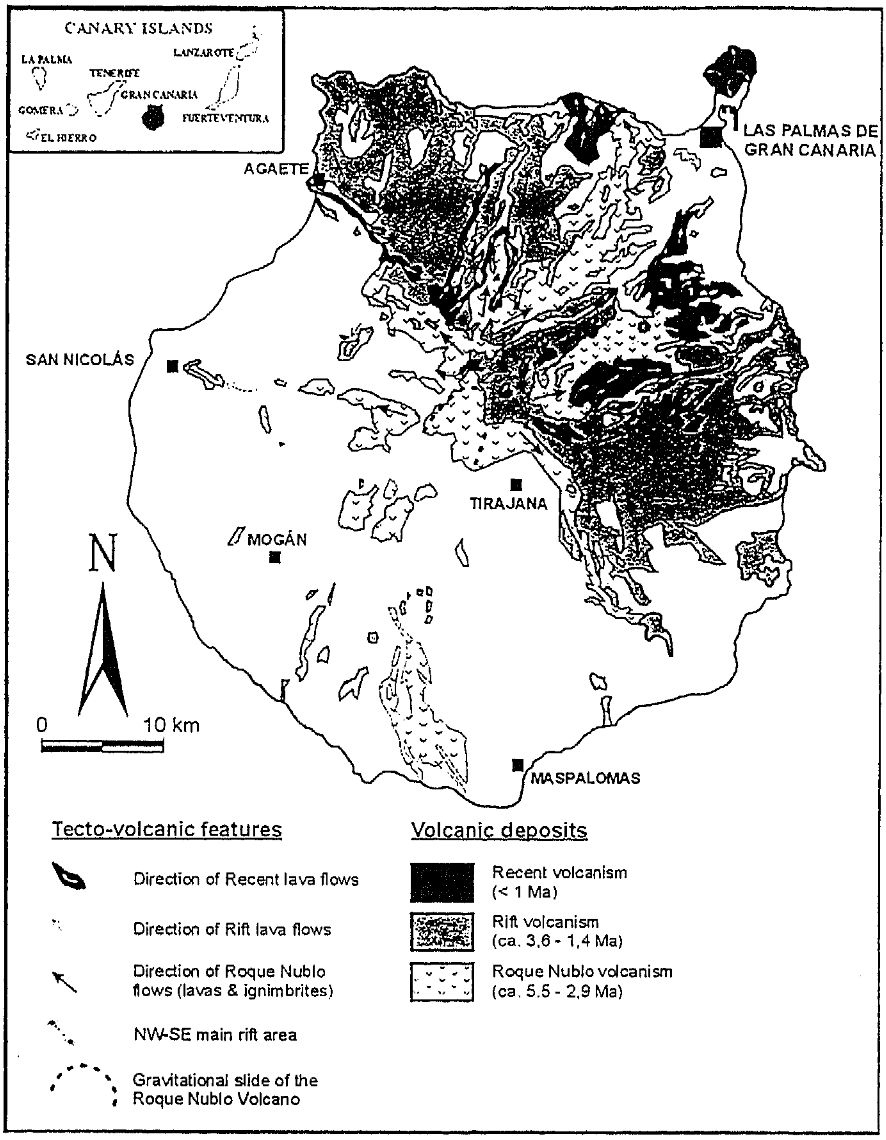

Fig. 1.- Geológical sketch of Roque Nublo and Post-Roque Nublo volcanic groups of Gran Canaria (modified from ITGE, 1992), with related geochronological information

Fig. 1.- Mapa geológico simplificado de los Grupos Volcánicos Roque Nublo y Post-Roque Nublo de Gran Canaria (modificado de ITGE, 1992), con indicación de datos geocronológicos.

The current note use this new data in order to classify the dated rocks and to show the basic petrological geochemical data referred to coeval Roque Nublo Cycle and Third Magmatic Cycle, as well as the main evolutive trends of the later.

Petrography and geochemistry. A complete set of some 120 lavic samples have been studied in order to acquire basic knowledge on the volcanic succession and to select the set of 44 samples suitable for geochronological study (Guillou et al. 2002; these 44 rocks are studied in this note). Thin slides of each sample were prepared and studied with petrographic methods. Some selected samples are currently studied by EMPA. All samples were pulverised in steel and agate mortars separately, in order to use it to analyse major and trace elements respectively.

Whole-rock XRF major and trace element analysis were performed using a sequential X-ray spectrophotometer XPhillips PW2400 at Serveis Científico-Tècnics of University of Barcelona (the reader can request a complete table of major element contents to D.G.). Major elements are determined on lithium tetraborate pearls at a dilution 1/20; the pearls were obtained by triplicate in Pt meltpots and collecter dishes, using LiI as a viscosity corrector, and were determined two times (original and duplicate, the third pearl has a cleaning function of the meltpot; furthermore the meltpot was regularly cleaned with nitric acid). Trace elements were determined by duplicate on powder pressed pellets (6 gr of sample treated with Elvacite resin in an Al recipient on a base of boric acid). Na was determined on pearl and pellets, as well as by AAS on some inner standards as a control (10 % of analysed samples); we used in this study only the results obtained with lithium tetraborate pearls.

The spectrometer was calibrated using a set of most than 60 international standards (more details are available at http://www.sct.ub.es/serveis/01030202/udoc_003.htm). We used a separate set of international standards provided by the Geologic Survey of Japan as a inner control of the quality of results. All the samples were carefully treated at 130 ° in pyrex recipients during 48 hours prior to any other manipulation. We consider the valour of loss on ignition (LOI) of 1 gr of sample obtained in ceramic meltpots running 2 h at 950 °C on an air furnace; this means that we must keep in mind that an oxidant environment can favour uptake of oxygen by ferrous iron during ignition and therefore provide an observed LOI lesser than real total content of volatiles (Lechler & Desilets 1987); in addition we must remember that Gran Canaria pristine rocks are characterised by elevated contents of F (Hoernle & Schmincke 1993) not necessarily released during the ignition process.

Major element geochemistry has been used in order to classify the samples using the TAS diagram following the indications of IUGS (Le Maître et al. 1989). Thus, recalculed samples on a free-volatile basis have been plotted and CIPW norms have been used in order to discriminate between rocks of basanitic and tephritic affinity (above and below of a threshold of 10 % normative olivine, respectively). Iron recalculation for CIPW norms have been determined following ratios as suggested by Middlemost (1989). These arithmetic operations originate minor displacements of sample projections that can be critical in some cases for the rock classification (i.e. in samples plotted near the boundary of foidite and tephrite/basanite fields). Norms have been calculated with the newpet program (Clarke1987-1990). In the case of basaltic samples we consider the empirical boundary between alkaline and subalkaline rocks as provided by Macdonald and Katsura (1964) All these data have been crossed with petrographic information taking particular care of detection of alteration of the rocks and eventual disagreement between chemical and petrographic classification of the rocks.

Most of studied samples show

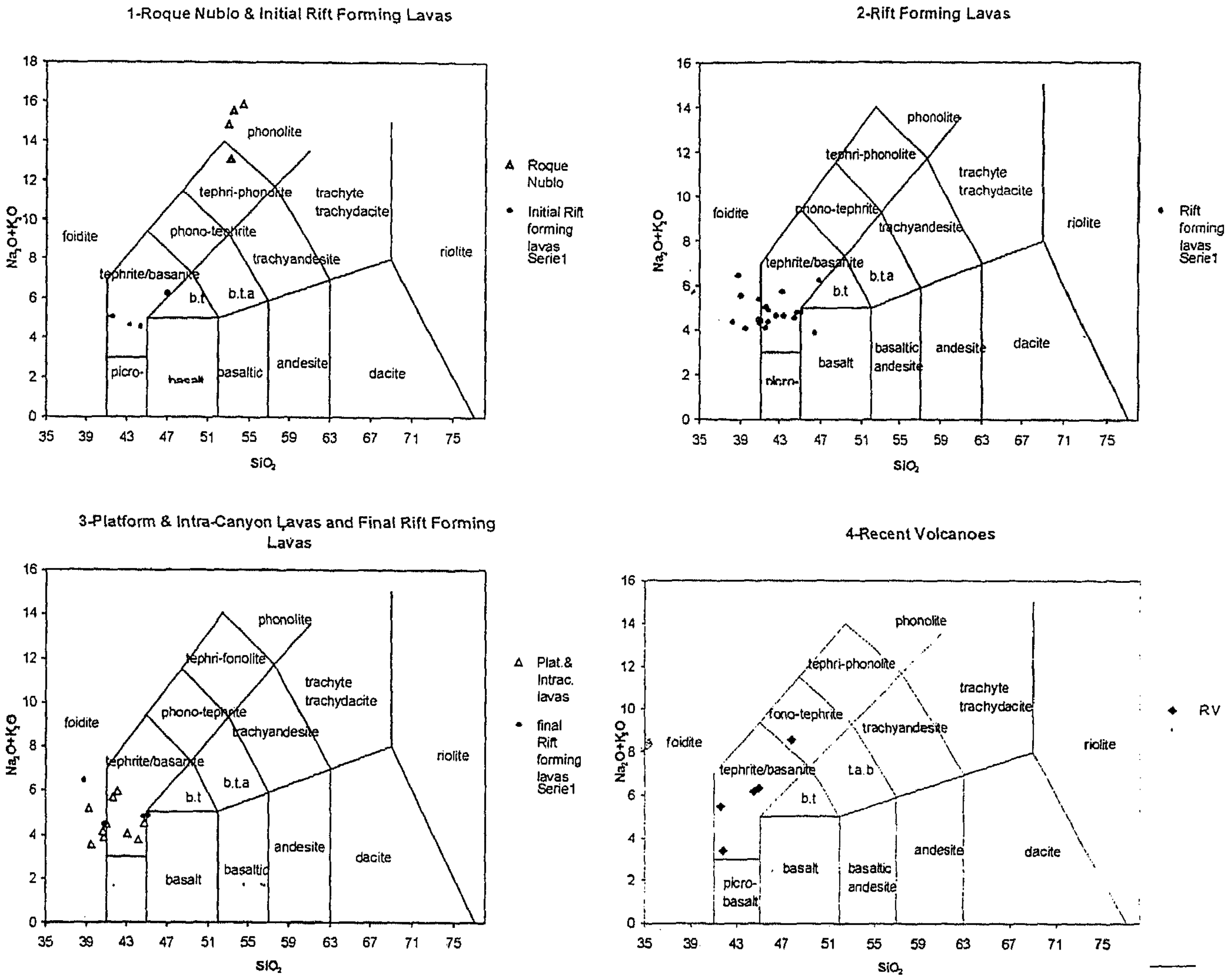

Fig. 2.- TAS classification of studied rocks arranged form older to recent ones (2.1 to 2.4, see text for explanation)

Fig. 2.- Clasificación de las rocas estudiadas en el diagrama TAS, ordenadas según edad decreciente (2.1 a2.4, ver texto para mayor explicación)

aphanitic and porphyritic textures with a microcrystalline to hipohyaline groundmass. We can note also that a great number of samples are vesicular, a fact that is significant to our purposes because in some samples the vesicular textures turns to amigdalar by early crystallisation of analcite or late precipitation of carbonates. In despite of this, evidence of pervasive zeolitization in the groundmass of these lavas is extremely rare. The studied rocks shows low silica contents, even if we consider that might be pristine rocks; this is a fact well know in Canary Islands volcanism. Most of the dated samples plot in foidite and tephrite/ basanite fields. All these rocks contain clinopyroxene as main phase, both as phenocrysts and in the groundmass (microphenocrysts and elongated laths or microlites). Olivine is also an ubiquitous phase, mainly as phenocrysts in this case. Microphenocrysts to minute cubic crystalls of opaque iron ore are also very common in the groundmass, but became less abundant with samples showing an increase of alkalies. Foidites are characterised by a groundmass with poikilitic anhedral nepheline patches mainly containing clinopyroxene and, in a lesser degree, opaque minerals. These patches became less frequent and smaller and contain a number sensibly larger of mafic minerals near the basanite/tephrite boundary in the TAS diagram. Nefeline patches in the samples plotted in the basanite/tephrite field are very rarely distinguishable under the microscope. On other hand, samples that plot at the basanite-tephrite field but very near to the trachybasalt, basalt and phonotephrite boundaries are characterised by the presence of microliths of plagioclase in the groundmass, a fact that is not evidenced in rocks classified as foidite and rare in basanite.

Results. When we consider new geochronological data it is possible to classify the studied rocks in three groups: Roque Nuble Cycle, Rift Volcanism (and associated Platform and Intra-Canyon lavas) of the Third Magmatic stage and Recent Volcanism of the Third Magmatic stage (see fig. 1). There exists a 3.6-2.9 Ma period of coexistence of late products of Roque Nublo very evolved in composition with pristine ones (basanites) from Third Magmatic stage (see figs. 1 and 2.1)

We can note some trends in the petrological evolution of the studied rocks considering time evolution. All samples are of alkaline affinity (fig. 2.1 to

2.4). The Roque Nublo Cycle (fig. 2.1) comprises two set of samples, the first corresponding to pristine rocks plotted in the tephrite/basanite field (older, not represented in fig. 2.1) and the second corresponding to evolved rocks mainly situated in the phonolite field. This gap in composition is not characteristic of Roque Nuble Cycle (see Perez Torrado 2000 and references therein). The tephrifonolite and phonolite samples show a paragenesis compatible with an evolution through fractionate crystallisation, ranging from sodalite-sanidine-green clinopyroxene-titanite-oxidized kaersutite-iron ore to sodalite-sanidine-(clinopyroxene-nepheline-iron ore).

The Rift Forming lavas (fig. 2) mainly correspond to basanites, with foidites and minor tephrites. Subsequent Platform and Intra-Canyon lavas are also of dominant basanitic composition, with minor foidite (fig. 2.3). Coeval rocks of Rift-Forming and Intra-Canyon lavas are basanitic in composition but seem to develop parallel trends (fig. 2.3). Finally Recent Volcanoes shows a dominant basanitic composition but cover a broader portion of the TAS diagram that Rift Forming and Intra-Canyon Rocks reaching phonotephritic compositions (fig.2.4) and suggesting mechanisms of magmatic evolution through fractionate crystallisation (crystallisation of kaersutite phenocrysts and plagioclase microlites).

If we compare with available data on major element geochemistry of Third Magmatic stage (see ITGE 1992, and references therein) there is a good coincidence of results including older data, a fact that must be remarked in homage to Prof. Fúster's school pioneer work. It is also significant that older data set includes more evolved rocks that the studied here, so we keep in mind that the set of samples is somewhat biased and not fully representative of the entire cycle.

Therefore the most significant contribution of this work must be referred to a better comprehension of spatial and temporal distribution of volcanism and confirmation of the coeval character of very contrasted rocks corresponding to Roque Nuble and Third Magmatic stage of Gran Canaria. On other hand, this is only a preliminary work supporting geochronological one and a part of the comprehensive study of recent volcanism we are conducting.

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