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A new felsic cone-sheet swarm in the Central Atlantic Islands: The cone-sheet swarm of Boa Vista (Cape Verde)

Eumenio Ancochea [a,*], María José Huertas [a], Francisco Hernán [b], José Luis Brändle [a]

[a] Dpto. Petrología y Geoquímica, Fac. Ciencias Geológicas, Universidad Complutense, 28040 Madrid, Spain
[b] Dpto. Edafología y Geología, Universidad de La Laguna, 38206 La Laguna, Tenerife, Spain

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ABSTRACT

The island of Boa Vista is one of the oceanic islands with the largest amount of felsic rocks reported in the world (50% of the total outcropping igneous rocks of Boa Vista). The felsic rocks are trachytes and phonolites generated within the second main stage of the volcanic activity that lasted about four million years.

Three consecutive felsic episodes are distinguished: the first occurred between 14.5 Ma and 13.5 Ma, the second between 13.6 Ma and 12.0 Ma, and the third and last between 12.0 Ma and 10.4 Ma. Their geochemical composition reveals the presence of crystal fractionation processes with participation of feldspars and amphibole as well as different accessory phases involved in each episode.

The Boa Vista felsic cone-sheet swarm, the youngest third episode, is formed by several hundreds of peralkaline ne-phonolitic sheets distributed within a circular surface about 11 km in radius. The cone-sheets conform a single general pattern characterized by a decreasing dip outward the structure, together with a constant dip of each individual sheet. The average inclination of sheets is around 40° in the sectors next to the centre of the structure whereas it is only about 30° next to its periphery. The magmatic focus of the sheets is located over 3 km deep almost coinciding with the convergence centre of a contemporary basic radial dike swarm.

1. Introduction

The study of dike systems representing hypabissal roots of major volcanoes is a helpful method in order to understand their structural and volcanological evolution (i.e.: Anderson, 1936; Richey, 1939; Anderson, 1951; Le Bas, 1971; Phillips, 1974; Nakamura et al., 1977). The reconstruction of deeply eroded volcanic edifices sometimes involves great difficulties; nevertheless, these edifices often exhibit a large number of exposed dikes that facilitate a better comprehension of their evolution.

The original morphology of young (Upper Pliocene or Pleistocene) volcanic edifices in oceanic islands is rather well preserved and, consequently the erosion degree is normally insufficient to expose their deep feeding roots. Only extraordinary events, as a caldera collapse or a giant flank failure, allow us to observe the dikes then exposed, either in the caldera walls or at the headwall of the lateral collapse. The detailed study of these particular dikes, in both cases, is crucial to get to know either the pre-caldera or the pre-slide state, and also to be able to analyze the role played by the dikes themselves in any of these alternative catastrophic processes (i.e.: Carracedo, 1994; Walker, 1999). In the Central Atlantic archipelagos some of the studies focused in this matter are remarkable as, for example, those on the Taburiente caldera, La Palma (Staudigel et al., 1986; Ancochea et al., 1994), Las Cañadas caldera, Tenerife (Marti et al., 1995; Ancochea et al., 1999) and Cha das Caldeiras, Fogo (Day et al., 1999).

When dealing with older (Medium and Upper Miocene or Lower Pliocene) volcanoes, apart from possible catastrophic events, the prolonged erosion has strongly obliterated most of their primitive morphological characters but simultaneously uncovered their deepest structural levels. In this particular case, the study of well exposed dike swarms becomes a helpful tool in order to deduce the original shape of volcanic edifices. Several examples are found in the Canary Islands: in Fuerteventura (Feraud et al., 1985; Stillman, 1987; Ancochea et al., 1996; Ahijado et al., 2001; Fernández et al., 2006); Gran Canaria (Schmincke, 1967; Hernán, 1976; Schirnick et al., 1999) Tenerife (Marinoni and Gudmundsson, 2000; Walter and Schmincke, 2002) and La Gomera (Ancochea et al., 2003, 2008). In Cape Verde, this kind of studies is more recent and up to now limited to the island of Sao Vicente (Huertas et al., 2006; Ancochea et al., 2010; Hernán et al., 2011), the islet of Branco (Ancochea et al., 2006) and the island of Boa Vista (Ancochea et al., 2012). Most of the dike systems in these islands are linear (rift zones), radial (in major central volcanoes) or both (superimposed three-armed rifts and radial dike swarms) (i.e.: Dieterich, 1988; Carracedo, 1994; Walker, 1999).

Cone-sheet complexes are rather less frequent, but very interesting since their geometry records and reports the local stress field surrounding their source during their time of emplacement (i.e. Anderson, 1936; Nakamura et al., 1977; Gautneb and Gudmundsson, 1992;

* Corresponding author.
E-mail addresses: anco@ucm.es (E. Ancochea), huertas@ucm.es (M.J. Huertas), fhernan@ull.es (F. Hernán).

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Chadwick and Dieterich, 1995). Most cone-sheets, basic or intermediate in composition, are known in the North Atlantic: in the British Tertiary Province (i.e.: Richey and Thomas, 1930) or in Iceland (i.e.: Walker, 1958; Gautneb et al., 1989). Although more scarce in some other regions, basic cone-sheets have been mentioned for example in Japan (Geshi, 2005) or in Galápagos Islands (Chadwick and Howard, 1991).

Felsic cone-sheet swarms are even rarer, almost exclusively cited in the Canary Islands. The largest in size is found in Gran Canaria (Schmincke, 1967; Hernán, 1976; Schirnick et al., 1999), followed by the one existent in La Gomera (Rodríguez Losada, 1987, 1988; Ancochea et al., 2003). A third much less important example has been cited in Tenerife (De la Nuez et al., 1989; Ancochea et al., 1999). A new felsic cone-sheet swarm of large dimensions, identified for the first time in Boa Vista, is described and characterized in this work. This is the fourth cone-sheet complex reported in the Central Atlantic archipelagos and the first one in Cape Verde.

On the other hand, the island of Boa Vista differs from most of the oceanic islands in its abundant amount of felsic rocks. In spite of this, specific studies on the Boa Vista felsic rocks lacked so far. The

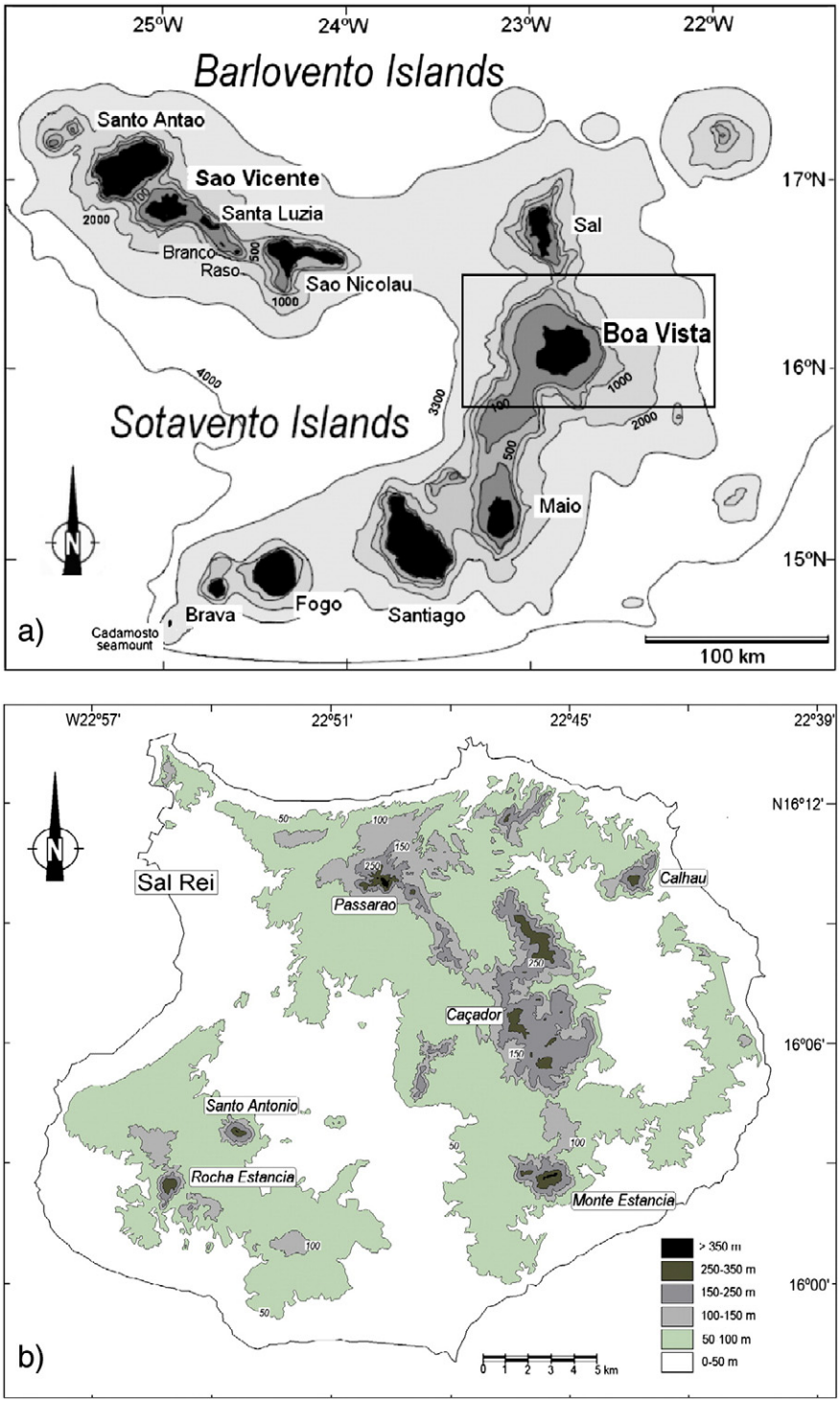

Fig. 1. a) Location and bathymetric map of the Cape Verde Islands (Ancochea et al., 2010; modified after Holm et al., 2008). b) Schematic topographic map of Boa Vista and main relieves.