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The nephelinitic–phonolitic volcanism of the Trindade Island (South Atlantic Ocean): Review of the stratigraphy, and inferences on the volcanic styles and sources of nephelinites

Gustavo Luiz Campos Pires [a, *], Everton Marques Bongiolo [b]

[a] Programa de Pós–graduação em Geologia – PPGL, Universidade Federal do Rio de Janeiro – UFRJ, CEP 21941–916, Rio de Janeiro, Brazil
[b] Instituto de Geociências, Universidade Federal do Rio de Janeiro – UFRJ, CEP 21941–916, Rio de Janeiro, Brazil

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ABSTRACT

Trindade Island is located in the South Atlantic Ocean, 1170 km from the Brazilian coast, and represents the eastern end of the E–W Vitória–Trindade Chain. It shows the youngest plume-induced (ca. 3.7 to <0.17 Ma) subaerial volcanism on the South American plate, associated with the Trindade plume activity. Almeida (1961) recognized five volcanogenic successions at Trindade (in decreasing age): the Trindade Complex (TC, >2.4 Ma) and the Desejado (DF, ~2.4 to 1.5 Ma), Morro Vermelho (MV, <0.17 Ma), Valado (VF, no age) and Paredão (PF, no age) formations, composed of effusive–pyroclastic deposits and subvolcanic intrusions associated with nephelinite–phonolite volcanic episodes. We revised the original Almeida's (1961) stratigraphy with additional field work and petrography to recognize eruptive styles and processes within the nephelinite–phonolite volcanism. Also, available geochemical databases were used to improve the stratigraphic correlation between nephelinites from different units and to characterize their mantle sources.

The nephelinitic volcanism may represent Strombolian and Hawaiian–type activity of low viscosity and volatile–rich lavas interlayered with pyroclastic successions (fall–out deposits). Phonolitic deposits record explosive Vulcanian–style episodes of volatile–rich and higher–viscosity lavas interlayered with pyroclastic deposits (mostly pyroclastic flows). Geochemical data allowed the individualization of nephelinites as follows: (1) MV olivine–rich nephelinites and all olivine–free varieties are low K_2O/Na_2O, K_2O/TiO_2 and intermediate CaO/Al_2O_3 that may be derived from N–MORB and HIMU mantle components; (2) the VF olivine–rich nephelinites have high K_2O/Na_2O, K_2O/TiO_2 and CaO/Al_2O_3 that indicates both EM and HIMU mantle sources and; (3) the PF olivine–rich nephelinites show high K_2O/TiO_2 similar to those from VF, and intermediate CaO/Al_2O_3 as nephelinites from MV rocks, suggesting a mixed source with EM + HIMU > N–MORB components.

We suggest that the HIMU and EM mantle types resulted from metasomatic episode(s) in the peridotitic mantle beneath the Trindade Island during the Brasiliano Orogeny and later, as previously pointed out by Marques et al. (1999). Thus, the major HIMU component would relate to recycled oceanic crust or lithospheric mantle (mostly CO_2–eclogites) whereas the less important EM component to recycled marine or continental sediments.

1. Introduction

Trindade Island is located in the South Atlantic Ocean, ca. 1170 km from the Brazilian coast (between 20° 29′ and 20° 32′ S parallels/29° 17′ and 29° 21' W meridians). It corresponds to the eastern end of the submarine E–W Vitória–Trindade Chain– VTC that represents the Trindade plume track on the South American plate during Cenozoic time (e.g., Gibson et al., 1997; Thompson et al., 1998; Almeida, 2006; Fig. 1A). This island shows the youngest and more preserved set of volcanic structures in the Brazilian territory (ca. 3.7 to <0.17 Ma; Cordani, 1970).

Its magmatism is considered as the youngest plume–induced alkaline manifestation beneath the South American plate. The plume activity is associated with the Gondwana break–up and the South Atlantic Ocean opening during the Mesozoic (e.g. Hawkesworth et al., 1999; Gibson et al., 2006). Its activity evolved from onshore (e.g. Iporá, Alto Paranaíba and Serra do Mar alkaline

* Corresponding author.
E-mail address: gpiresgeologia@gmail.com (G.L.C. Pires).

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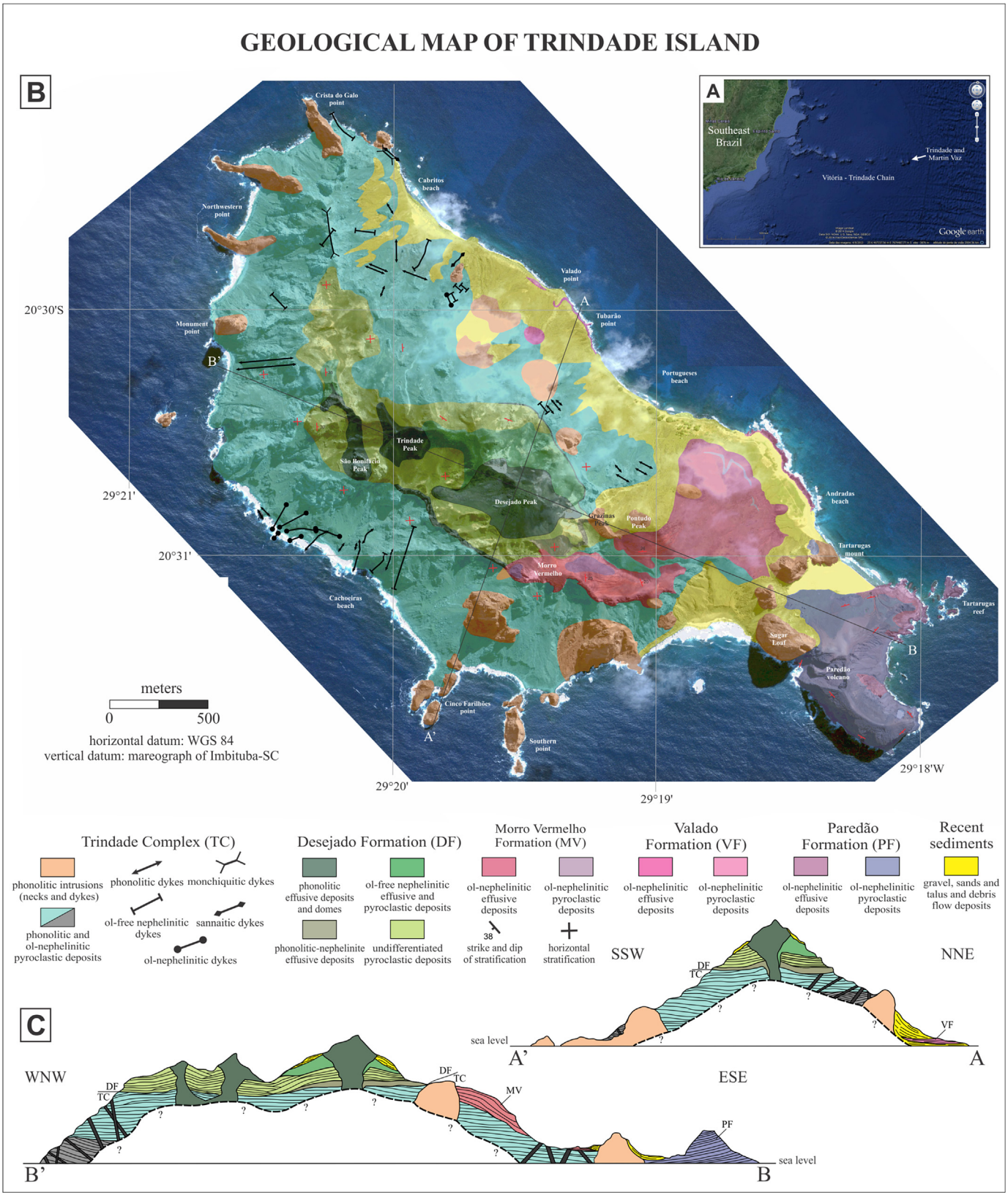

Fig. 1. A – South Atlantic Ocean adjacent to the Brazilian coastline. It shows the location of the Trindade and Martin Vaz Islands at the eastern end of seamounts, guyots and volcanic edifices of the Vitória–Trindade Chain, interpreted as the magmatic track of the Trindade plume on the South American plate since the Eocene. B – Geological map of Trindade Island, after Almeida (1963). The map was georeferenced, and contacts were adjusted using field work and eighty high–resolution Quickbird satellite images. Nomenclature of the stratigraphic units of Almeida (1961) was reviewed according to the Brazilian Stratigraphic Code (Petri et al., 1986). C – Idealized SSW–NNE and WNW–ESE cross–sections of the volcanic successions that crop out in the Trindade Island.