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Quaternary sealevel changes and coastal evolution of the Island of Trindade, Brazil

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ABSTRACT

The present work presented the first dated paleosealevel indicators and new paleogeographic reconstructions of the Island of Trindade. All evidence for Holocene sealevels point to the elevations higher than the present in the age interval between 5.06 ka and 0.55 ka. The altitude and ages of the reconstructions are in good agreement with hindcast model curves and the empirical sealevel envelope for the mainland eastern and northeastern Brazilian coast. However, the position of paleo vermetid-reef indicates that sealevel was lower than eustatic elevation, suggesting an effect of island subsidence. In contrast to the Brazilian mainland coastal zone, where conspicuous evidences of Pleistocene highstands were recorded, no evidence of sealevels predating the Holocene has ever been observed on the island. This could be attributed to intense coastal erosion and log-term island subsidence.

A volcanic edifice rising more than 5500 m above the ocean floor was built by magmatic activity that extended over the late Pliocene and early Pleistocene. After the cessation of volcanic build up, the island started to shrink due to subaerial and marine erosion. During Pleistocene sealevel lowstands, alluvial fans were formed beyond the present limits of emerged areas. They were enclosed within and preserved from erosion by the Middle to Late Pleistocene lava flows and pyroclastic deposits. During Late Pleistocene sealevel highstand, intense coastal erosion removed the distal parts of the alluvial fans. It is very likely that at that time the entire coast of the island experienced intense erosion and subsidence as deduced from the absence of Pleistocene coastal deposits, which are widespread along mainland Brazilian coast.

The east coast of the island was dominated by high sea cliffs sculpted into volcanic rocks. A volcanic cone was subsequently formed, when the sealevel was lower than present during the Late Pleistocene to early Holocene. During the mid to late Holocene sealevel highstand the volcanic cone was partially eroded and a bay formed, where vermetid-reefs grow and sand beach deposits prograded until the bay was infilled. During the sealevel maximum, wave-cut terraces were formed and sea cliffs were active. During the lowering of the sealevel, cliffs became inactive and vermetid-reefs were eroded. Beach erosion and aeolian deflation presently prevails, indicating a low sediment supply.

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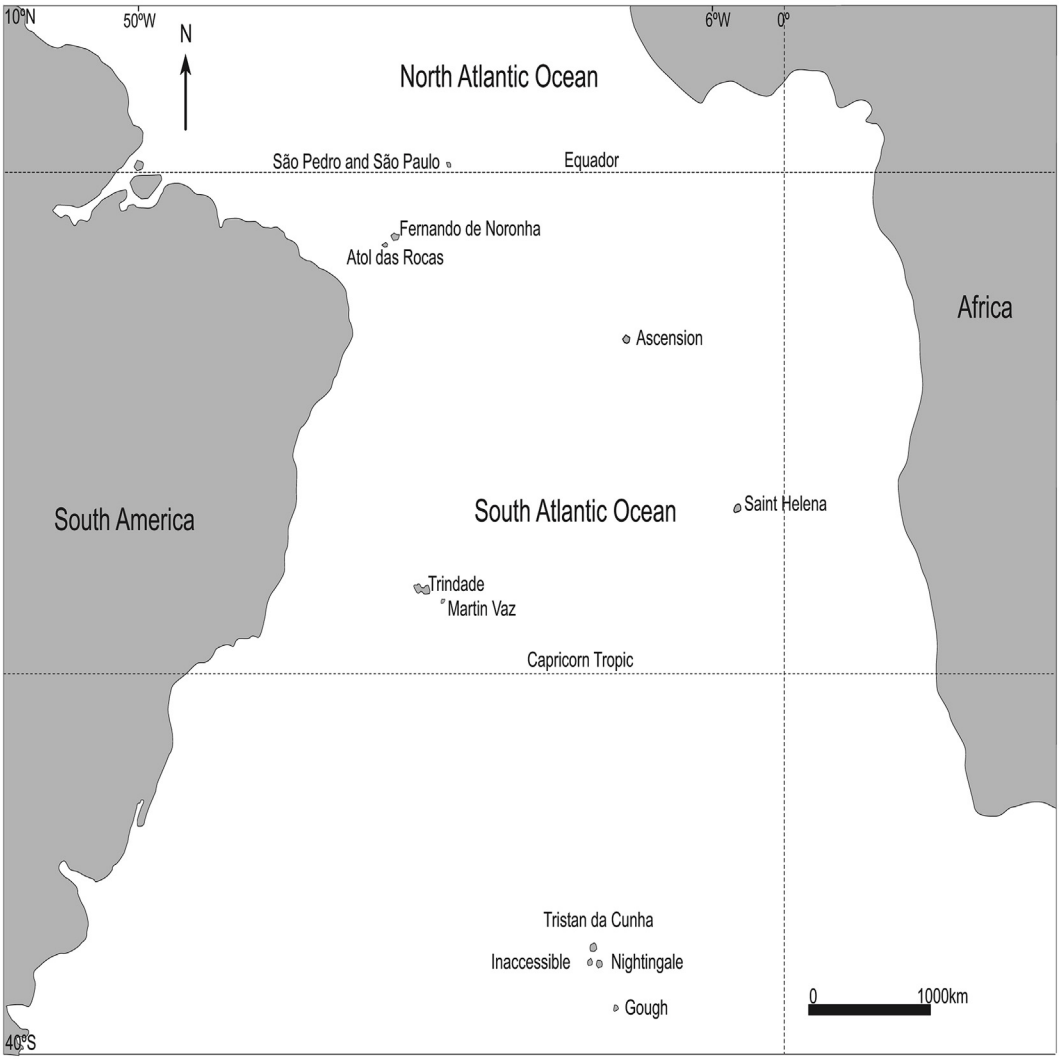

Fig. 1. South Atlantic oceanic islands between 0.9°N and 40.4°S.

1. Introduction

Evidence of sealevel changes obtained from remote oceanic islands are useful for reconstructing and for contributing to the understanding of global sealevel changes during the Quaternary and could help to solve issues related to the management of these islands. Until present the only references about sealevel changes and morphological and palaeogeographic IT evolution during the Quaternary are at the classic description of the geology written by Almeida (1961). There were recent advances in the studies of the recent geological past and sealevel changes on the other Brazilian oceanic islands, (i.e. Angulo et al., 2013 for Fernando de Noronha Archipelago and Angulo et al., 2013 for São Pedro and São Paulo Archipelago. The aim of the present work is to contribute to the understanding of Quaternary sealevel changes and to elucidate the coastal evolution of this isolated South Atlantic Ocean Island.

2. Study area

The Island of Trindade was discovered during the first decade of the 16th century (Lobo, 1919) and was occupied rarely and discontinuously until 1957, when the Brazilian Navy established a permanent base (Mayer, 1957).

The Trindade is a remote island located at 20.5°S, 29.3°W and 1140 km away from the Brazilian coast, except for Martin Vaz Island, 48 km away at 20.47°S, 28.51°W. The nearest islands are Fernando de Noronha (1870 km away at 3.85°S, 23.24°W), Atol das Rocas (1905 km, 3.87°S, 33.83°W), São Pedro and São Paulo (2370 km, 0.9°N, 29,4°S), Ascension (2125 km, 5.7°S, 7.9°W), Santa Helena (2540 km, 16.0°S, 5.7°W) and Tristan da Cunha (2475 km, 37.1°S, 12.3°W) (Fig. 1). With the exceptions of São Pedro and São Paulo, which are formed of a megamullion of mantle mylonitized rocks (Hekinian et al., 2000) all these islands are volcanic in origin (Darwin, 1839; Almeida, 1955, 1961; Gass, 1967; Nunn, 1984).

The classic description of the geology of the Island was written by Almeida (1961), and includes a 1:10,000 geological chart and extended petrographic data. According him, the islands of Trindade and Martin Vaz form the eastern end of the 1100 km long volcanic Vitória-Trindade submarine range (Fig. 2), and IT corresponds to the emergent portion of a Cenozoic alkaline volcanic edifice more than 5500 m high built up above the ocean floor. In the emergent portion, five volcanic units have been recognized: the Trindade Complex, the Desejado Sequence, the Morro Velho Formation, the Valado Formation, and Vulcão do Paredão. The Trindade Complex consists of Pliocene (Cordani, 1970) pyroclastic rocks, phonolite necks and intrusions of trachyandesites, nephelinites and alkaline ultrabasic rocks. The edifice presents four volcanic centres (Desejado, Morro Vermelho, Valado and Paredão) constituted by volcanic to subvolcanic subsaturated sodic–alkaline rocks (Almeida, 1961). The Desejado rocks yields K/Ar ages between 2.63 and 1.50 Ma and the Morro Vermelho ones ages lower than 170 ka (Cordani, 1970).