

Soares *et al.* (2016) - Holocene invertebrates from the Rocas Atoll: A contribution for the ecological history of South Atlantic islands. *Journal of Integrated Coastal Zone Management / Revista de Gestão Costeira Integrada*, 16(1):89-94.

DOI: 10.5894/rgci651 [Supporting Information]

Supporting Information I

Geographic Location

The Rocas Atoll (Figure I-1) is located 267 km to the northeast of Brazil and 148 km west of the Fernando de Noronha Archipelago. The mountain beneath Fernando de Noronha extends 4000 m below sea level and is a small part of an alignment of submerged east-west volcanic highs along the fracture zone, which form the Fernando de Noronha Chain (Gherardi & Bosence, 2005). In the Rocas Atoll, the seawater temperature averages 27°C, but can reach 42°C in pools, and its surface salinity varies between 36‰ and 37‰. The tide regime is semidiurnal and mesotidal, with a maximum variation of 2.7 m, leaving the reef flat and the calcarenites exposed at low tide (Gherardi & Bosence, 1999, 2001, Soares *et al.*, 2011).

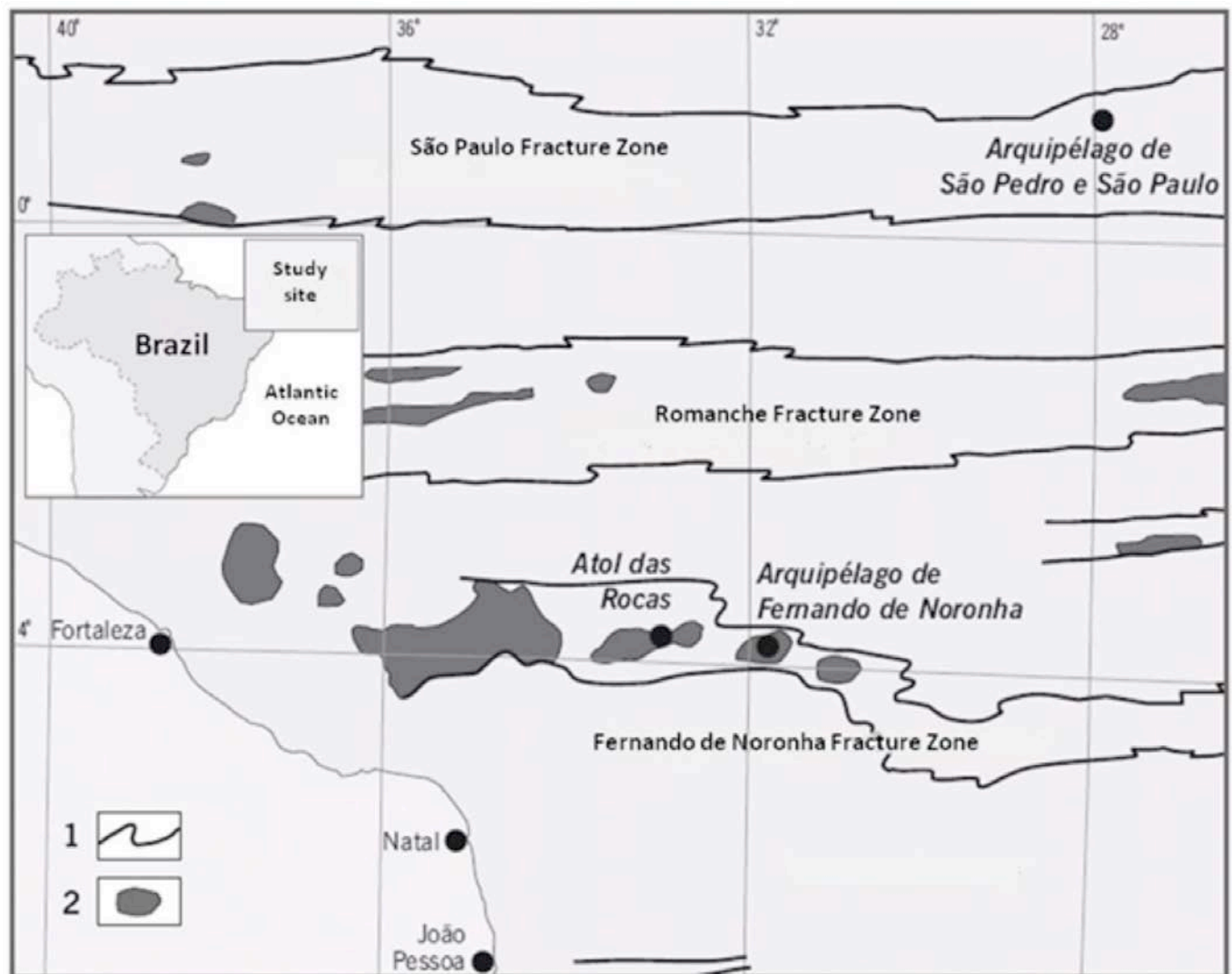


Figure I-1 – Study site (Rocas Atoll) in the South Atlantic Ocean. Modified from Pereira *et al.* (2010).

The atoll reef rim has a slightly elliptical shape, 3.5 km long (E-W) and 2.5 km wide (Figure I-2), interrupted by channel passes to the north and north-west. There are two sand cays on the atoll, Farol and Cemitério Islands, located on the leeward side and oriented SW-NE, and SE-NW, respectively. They are accumulations of bioclastic calcareous sediments, mainly coralline algal fragments, generated by mechanical and biological breakdown (Gherardi & Bosence 2001). Farol Island is the largest, with a length of 850 m and width of 250 m. Cemitério Island is 350 m long and 170 m wide. The maximum height measured on Farol Island was 3.7 m, and on Cemitério Island, 2.8 m (Figure I-3) (Kikuchi & Leão 1997).

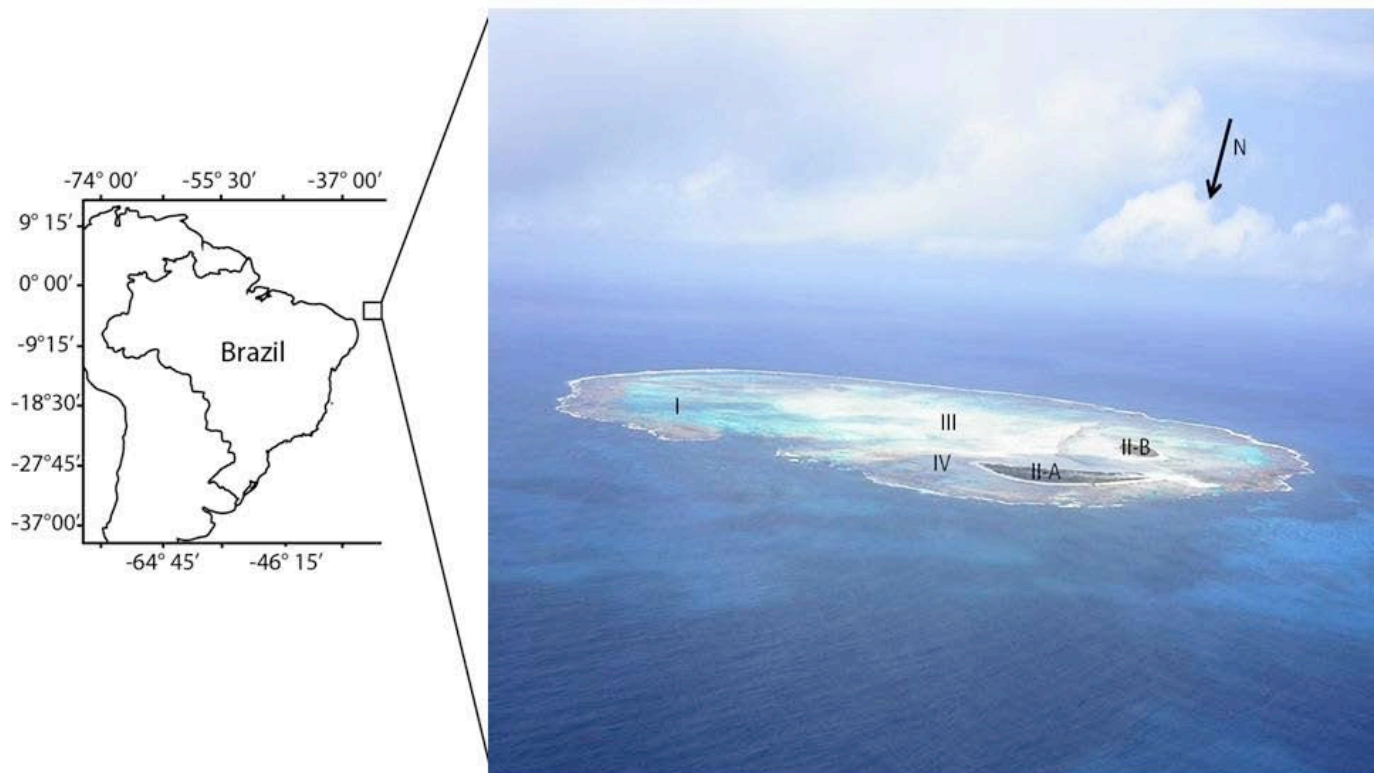


Figure I-2 - Study site (Rocas Atoll) in the South Atlantic Ocean. (I) Permanent lagoon; (II) Sand Cays: A—Farol Island, B—Cemitério Island; (III) Intertidal sand Flat; (IV) Reef-flat. Aerial image supplied by the Brazilian Air Force (FAB) at spring low tide.

On Cemitério Island, a calcarenite outcrop (Figure I-3B) with an average elevation > 2 m above the current sea level, occurs in the intertidal zone. These beach calcarenite outcrops are located on the ground of the NW, NE and S faces, and in small escarpments of approximately 1.5 m height on the NE face. The studied beach rocks consist of calcarenites (paleo-beach low angle cross-stratified bioclastic sand by classification of Angulo *et al.* (2013) with seaward-dipping low-angle ($< 10^\circ$) stratification (Figure I-3C).

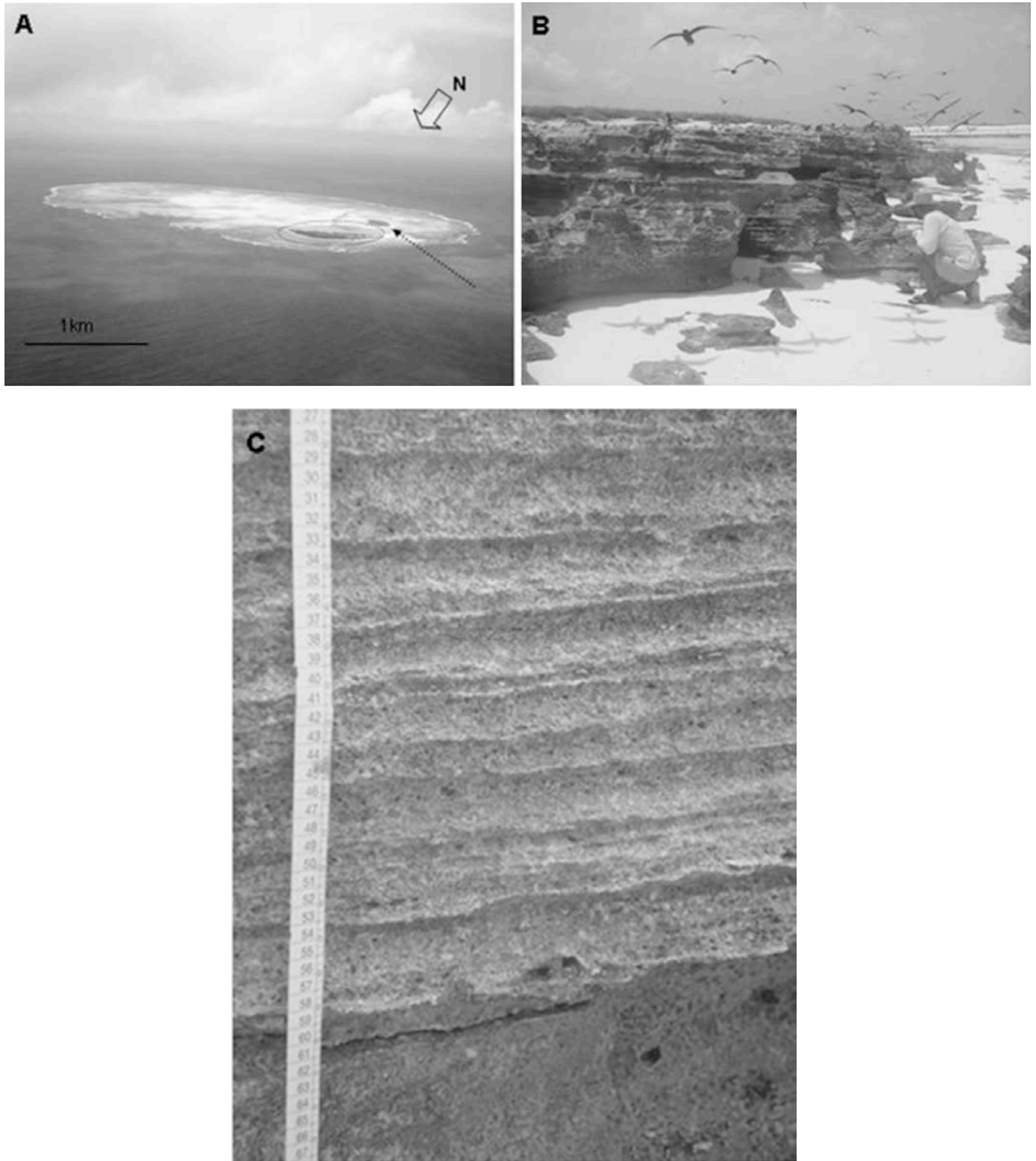


Figure I-3 – The islands and outcrops studied on the Rocas Atoll: (A) Aerial view of the Rocas Atoll showing Farol Island (marked by the elliptic form) and Cemitério Island (arrow); (B) View of the calcarenite outcrop on Cemitério Island; (C) Sedimentary layer of calcarenite showing the planar cross-bedded laminations. Photos 02A, 02B and 02C taken at low tide in January-February 2008.

References

- Angulo, R.J.; Souza, M.C.; Fernandes, L.A.; Disaró, S.T. (2013) - Quaternary sea-level changes and aeolianites in the Fernando de Noronha archipelago, northeastern Brazil. *Quaternary International*, 305:15-30. DOI: 10.1016/j.quaint.2012.12.029
- Gherardi, D.F.M.; Bosence, D.W.J. (1999) - Modeling of the ecological succession of encrusting organisms in recent coralline-algal frameworks from Atol das Rocas, Brazil. *Palaios*, 14(2):145-158. DOI: 10.2307/3515370
- Gherardi, D.F.M.; Bosence, D.W.J. (2001) - Composition and community structure of the coralline-algal reefs from Atol das Rocas, South Atlantic, Brazil. *Coral Reefs*, 19(3):205-219. DOI: 10.1007/s003380000100
- Gherardi, D.F.M.; Bosence, D.W.J. (2005) - Late Holocene reef growth and relative sea-level changes in Atol das Rocas, equatorial South Atlantic. *Coral Reefs*, 24(2):264-272. DOI: 10.1007/s00338-005-0475-5
- Kikuchi, R.K.P.; Leão, Z.M.A.N. (1997) - Rocas (Southwestern Equatorial Atlantic, Brazil): an atoll built primarily by coralline algae. In: H. A. Lessios & I. G. Macintyre (eds.), *Proceedings of the 8TH International Coral Reef Symposium*, pp.731-736, Smithsonian Tropical Research Institute, Panama City. Available on-line at [http://www.researchgate.net/publication/221965459_Rocas_\(Southwestern_Equatorial_Atlantic_Brazil\)_an_atoll_built_primarily_by_coralline_algae](http://www.researchgate.net/publication/221965459_Rocas_(Southwestern_Equatorial_Atlantic_Brazil)_an_atoll_built_primarily_by_coralline_algae)
- Soares, M. O.; Meirelles, C. A.O.; Lemos, V.B. (2011) - Reef bioconstructors of Rocas Atoll, Equatorial South Atlantic. *Biotemas (ISSN 2175-7925)*, 24:37-46, Florianópolis, Santa Catarina. Available on-line at <https://periodicos.ufsc.br/index.php/biotemas/article/download/2175-7925.2011v24n2p37/17820>

Supporting Information II

Survey of fossilized benthic invertebrates

Qualitative examination of calcarenites was conducted for two months (January and February 2008) to survey the fossilized benthic invertebrates of the Rocas Atoll. On Cemitério Island, a calcarenite outcrop with an average elevation of 2 m above the current sea level occurs in the intertidal zone. These beach calcarenite outcrops are located on the ground of the NW, NE, and S faces and on small escarpments of approximately 1.5 m height on the NE face. The studied beach rocks consist of calcarenites (paleo-beach low angle cross-stratified bioclastic sand according to the classification of Angulo *et al.*, 2013) with seaward-dipping low-angle (low 10°) stratification.

Fossil removal from the calcarenite was accompanied by photographic documentation. The specimens (corals, crustaceans, bivalves, and gastropod shells) were collected from the same layer in the calcarenite, and subsequently identified using specialized taxonomic literature for each taxon (Leão *et al.*, 2003; Rios, 1994, 2009; Hartnoll *et al.*, 2009). The specimens were compared with recent specimens deposited in the Biology Department of the Federal University of Ceará (UFC).

Two samples (gastropod shells) for radiometric dating (^{14}C) were collected from calcarenites obtained 2.0 m above mean sea level (MSL) and ^{14}C dated in the Physics Laboratory of UFC. These samples were used to measure ^{14}C with the gas proportional counting method. Gas proportional counting is a conventional radiometric dating technique that counts the beta particles (products of radiocarbon decay) emitted by a given sample. This provides the results in absolute percent modern carbon (pMC) and radiocarbon age. All samples (for taxonomic and radiometric purposes) were collected in the same stratigraphic layer on Cemitério Island.

References

- Angulo, R.J.; Souza, M.C.; Fernandes, L.A.; Disaró, S.T. (2013) - Quaternary sea-level changes and aeolianites in the Fernando de Noronha archipelago, northeastern Brazil. *Quaternary International*, 305:15-30. DOI: 10.1016/j.quaint.2012.12.029
- Hartnoll, R.G.; Broderick, A.C.; Godley, B.J.; Saunders, K.E. (2009) – Population Structure of the land crab *Johngarthia lagostoma* on Ascension Island. *Journal of Crustacean Biology*, 29(1):57-61. DOI: 10.1651/08-2992.1
- Leão, Z.M.A.N.; Kikuchi, R.K.P.; Testa, V. (2003) - Corals and coral reefs of Brazil. *Latin American Coral Reefs*, 2003:9-52. DOI: 10.1016/B978-044451388-5/50003-5
- Rios, E. C. (1994) - *Seashells of Brazil*. 481p., Fundação da Universidade do Rio Grande, Rio Grande, RS, Brazil. ISBN: 8585042362.
- Rios, E. C. (2009) - *Compendium of Brazilian Sea Shells*. 668p., Editora Evangraf, Rio Grande, RS, Brazil. ISBN: 8577271730

Supporting Information III

Fossilized benthic invertebrates from Rocas Atoll



Figure III-1 - View of the calcarenite outcrop on Cemitério Island (Rocas Atoll, NE Brazil).

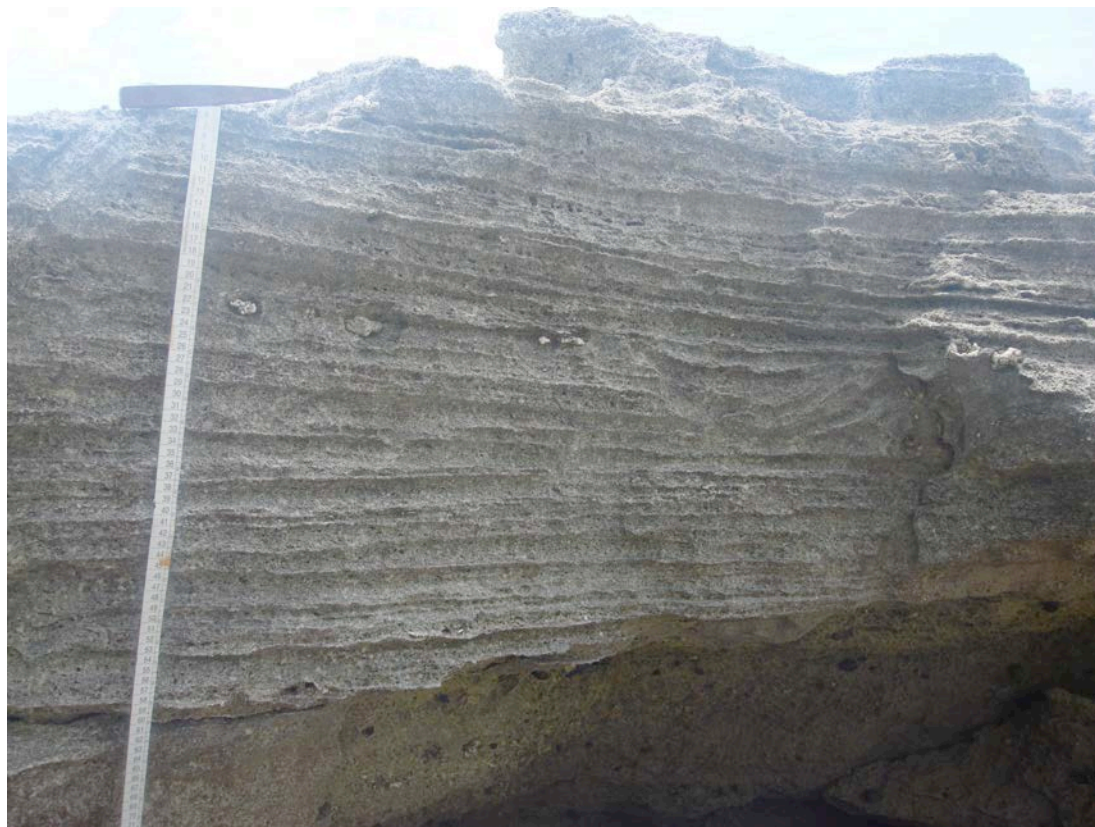


Figure III-2 - Sedimentary layer of calcarenite showing planar cross-bedded laminations.

Images of fossilized benthic invertebrates from Rocas Atoll



Figure III-3 - *Lithopoma tectum* (Mollusca: Gastropoda)



Figure III-4 - *Malea noronhensis* (Mollusca: Gastropoda)



Figure III-5 - *Codakia orbicularis* (Mollusca: Bivalvia)



Figure III-6 - *Johngarthia lagostoma* (Crustacea: Decapoda)