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Research paper

Facies analysis and paleoenvironmental interpretation of Piacenzian carbonate deposits from the Guitar Formation of Car Nicobar Island, India

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ABSTRACT

Facies characterization of Piacenzian (late Pliocene) carbonate sediments of the Guitar Formation in Car Nicobar Island, India and the subsequent integration of paleoecological data have been applied to interpret the paleoenvironment of the coralline algal-reef deposits. Thin-section analysis reveals that *Amphiroa*, *Corallina* and *Jania* are the dominant geniculate corallines, while *Lithothamnion*, *Mesophyllum*, *Phymatolithon*, *Lithophyllum*, *Spongites* and *Lithoporella* are the major non-geniculate corallines contributing to the sedimentary facies. Numerous small and larger benthic foraminifera also dominate the biogenic assemblages. Corals, barnacle shells, echinoid spines, fragments of bryozoans, mollusks and ostracodes are the subordinate constituents. Grainstones dominate the studied facies while packstones and boundstones (with wackestone elements) are the sub-lithofacies showing a fair representation. Six carbonate facies presenting a complete reef complex have been distinguished that were deposited in shallow intertidal, back-reef shelf/lagoon, reef and deeper fore-reef shelf settings. Evidences of coralline algal and benthic foraminiferal assemblages, taphonomic signatures of abrasion and fragmentation, grain size, angularity and encrustation indicate a shallow to relatively deeper bathymetric horizon of approximately 10–60 m that corresponds to a regime of high to moderate hydrodynamic conditions.

1. Introduction

The coralline red algae (Corallinales, Rhodophyta) are significant carbonate producers present in several sedimentary facies worldwide (Rasser and Nebelsick, 2003; Checconi et al., 2007). These form important biogenic constituents of the Neogene carbonate deposits of Andaman and Nicobar Islands (Chandra et al., 1999; Ghosh et al., 2004; Saxena et al., 2005). Neogene succession of Andaman and Nicobar, including the Guitar Formation is very important in understanding the geology of India and the northern Indian Ocean because a wide array of microfossils (both calcareous and siliceous) including smaller foraminifera, radiolaria, diatoms, nanoplankton, ostracodes, silicoflagellates and pteropods have been reported from these sediments (Sharma and Srinivasan, 2007). Different varieties of microfossils in the sequence of these islands provide an opportunity for multiple microfossil zonation. As both calcareous and siliceous microfossils are present, a multiple microfossil-based biostratigraphy is possible and advantageous not only in generating accurate biostratigraphic data but also in correlation of sequences where one or more of the microfossil groups are absent (Sharma and Srinivasan, 2007). Abundant occurrence of smaller benthic foraminifera has high potential in unfolding the tectonic history of the Andaman-Nicobar region. Several foraminiferal taxa are depth dependent and therefore useful in understanding the depositional environment as well as changing paleobathymetric trends in response to sea floor tectonism through the Neogene. The Neogene microfauna of Andaman-Nicobar also bear signatures of the tectonic changes of the neighboring regions of South and Southeast Asia. Changes in the microfaunal assemblages across the Indonesian Seaway, for example, proved useful in understanding the closing and opening of the seaway during the

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late Neogene (Sharma and Srinivasan, 2007). Microfauna present evidences related to cycles of global cooling and warming. Climatic cooling results in altering the nature of microfaunal composition by bringing an increased percentage of cold water forms through surface water movement or enhanced upwelling. Therefore, the microfauna-rich Neogene sequence of Andaman-Nicobar, are ideal for analyzing paleoclimate employing various microfossils, associated ash beds, stable isotopes and sedimentological data. The sedimentology of Andaman-Nicobar can provide supportive evidence in deciphering the orogeny of Himalayas with greater discretion. Lastly, the potentiality of prospective mining and hydrocarbon exploration in the Andaman and Nicobar Group of Islands has been subject to very limited research.

Study of coralline algae from the Andaman-Nicobar basin was initiated by Gee (1927) who recorded *Lithothamnion nummulaticum* and *L. suganum* from the Middle Andaman and fragments of *Lithothamnion* from the foraminiferal limestone of Little Andaman and Wilson Islands. Considerable additions to this initial data have been substantiated later on by several workers (Narayana Rao, 1942; Chatterji and Gururaja, 1972; Badve and Kundal, 1986, 1988, 1989, 1998) who surveyed the Andamans and reported several species of coralline algae. There has been limited work on the Neogene coralline algae with a brief note on *Aetesolithon* from Little Andaman being the first document (Venkatachalapathy and Gururaja, 1984). Some partial contributions dealing with the taxonomy of coralline algae from the Guitar Formation (previously named Kakana Formation by Chandra and Saxena, 1998) of Car Nicobar Island were provided by Chandra et al. (1999) and Ghosh et al. (2004). In particular, Ghosh et al. (2004) applied modern taxonomic criteria and diagnostic anatomical features (primigenous and postigenous cell dimensions, conceptacle type and dimensions, intergenicular cell measurements) following Woelkerling (1988), Braga et al. (1993), Bassi (1998a) and Rasser and Piller (1999) for describing species of *Lithoporella*, *Lithothamnion*, *Phymatolithon*, *Mesophyllum*, *Lithophyllum* and *Amphiroa* from the Guitar Formation. However, any facies analysis and paleoenvironmental interpretation of Car Nicobar carbonate sediments was still missing prior to the present case study.

Thin-section microscopic analysis applied for distinguishing facies, facies assemblages and depositional systems has added substantial impetus to the progress of facies analysis and research. Biotic and abiotic precipitation play an important role in the formation of shallow water carbonates (Schlager, 2003) and the resultant carbonate facies are mostly defined according to the dominant fossil assemblage (Flügel, 2004; Nebelsick et al., 2005). This paper deals with the facies characterization of Piacenzian (late Pliocene) carbonate sediments of the Guitar Formation outcropping in the Kakana Cliff Section of Car Nicobar Island (Fig. 1). Facies analysis and paleoecological data have both been integrated to assess the paleoenvironmental setting. The major aims of this case study are: (1) to distinguish and describe all the facies of the Guitar Formation, (2) to provide a depositional model

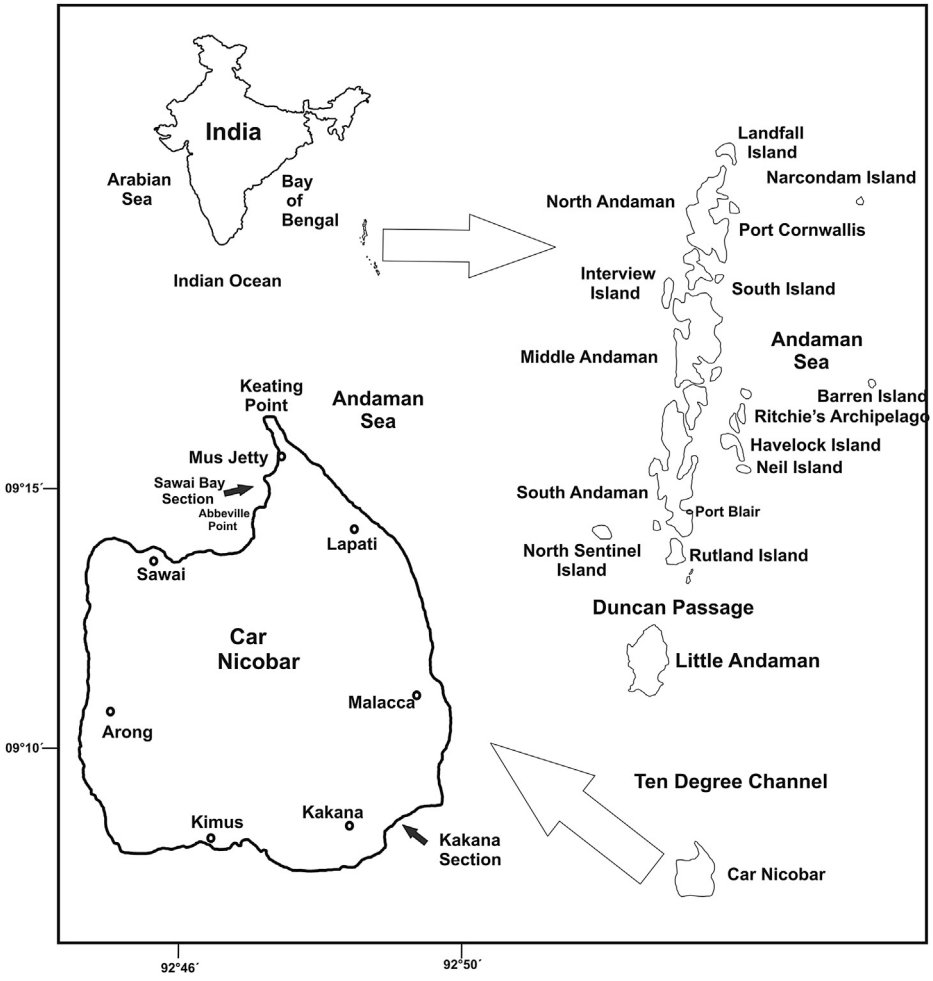

Figure 1. Map showing the location of Car Nicobar and Kakana Section with respect to the Indian mainland and the Andaman-Nicobar Group of Islands.