

Photo-Geomorphologic Study of Representative Islands of Lakshadweep

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ABSTRACT

The Lakshadweep group of islands is scattered in the Arabian Sea about 200 to 400 km off the west coast of Kerala. The general topography of islands is hummocky to flat with steeper shore on the east. The coralline islands are fringed by beach material all around the island. They are largely composed of coarse sand, disintegrated corals, shell fragments and uncemented pebbles, shingles, cobbles and boulders. The western side of most of the islands are fringed by coralline reef enclosing the lagoon. The erosion is more pronounced towards the eastern side. In case of Kavaratti island, the sediment concentration is more towards the northeast and southwest part of the lagoon. The average width of the reef is about 200-300 m. The uppermost part of the reef is punctured by spurs, grooves and scour channels and they are basically erosive in origin. The direction of spurs and grooves suggest paleo-winds and currents from southeastern direction. Two to three submarine terraces were mapped from the aerial photographs. These might have been formed due to eustatic changes of the sea level.

INTRODUCTION

The islands of the Lakshadweep group are irregularly scattered in the Arabian Sea between 8° and 12°30' N latitude and 71° to 74° E longitude, and are away from Kozhikode by about 200 km to 400 km (Fig. 1). There are in all twenty seven islands and a number of sunken banks, open reef and sand banks. Only ten islands are inhabited, of which Kavaratti, Agatti, Kalpeni, Minicoy, Androth, Amini, Kadmat, Kiltan etc. are larger islands. The geographical area of Lakshadweep is 32 km².

Though several researchers have concentrated on corals and other kinds of bio-

logical studies, very limited work has been reported on the geomorphological aspects of these islands. A few studies carried out are topographic and sedimentary characteristics (Kumar, *et al.*, 1986), and geomorphic configuration of Kavaratti island (Adiga, 1989) sea level rise prediction (Pathak and Kotnala 1990), shoreline dynamics (Chandramohan. *et al.*, 1993) *etc.* This paper describes general physiography and geological set-up of Lakshadweep islands and provides geomorphology of the prominent islands in general and Kavaratti island in particular.

GEOLOGICAL SET-UP

The Lakshadweep Group of atolls lie

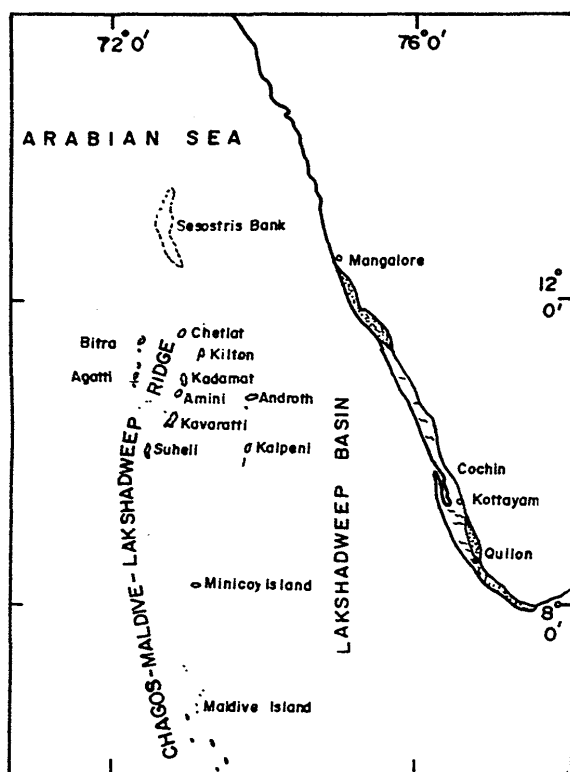


Fig. 1. Location map for Lakshadweep Islands.

on the prominent N-S Lakshadweep ridge and the alignment appears to be a continuation of the Aravalli strike of Rajasthan. Based on this, many geologists have speculated that the islands are a buried continuation of the Aravalli mountain chain and that the Deccan Traps have been faulted down in the sea along the West coast of India. A great thickness of traps and associated sediments occur to the west. Based on seismic study, (Ermenko and Datta, 1968), it is inferred that the Indian shield (continental crust) extends as far as to the Lakshadweep. The transition zone separating the continental and oceanic crust occurs to the west of the Lakshadweep. Further, using seismic refraction measurements

(Francis and Shor, 1966), it was postulated that 1.5 km to 2 km thick volcanic rocks lie below the sea floor on the Lakshadweep ridge. Initial reports of the Deep Sea Drilling project, indicate possible connection with western and through this to the eastern shelf of India. Other evidence indicated that the ridge was faulted down in Lower Eocene when the Lakshadweep sea was formed and the ridge was separated from the peninsular India.

The Lakshadweep ridge runs for a distance of 2000 km from Lakshadweep Islands at 14°N latitude to Chagos Islands at 6°N latitude. The ridge rises from the deep sea, from depth of 2000-2700 m in Lakshadweep sea and 1000 m in Arabian sea. The eastern flank of the ridge appears to be steeper than the western one. The ridge is composed of oceanic basalt and capped by recent coral reefs in the form of atolls and coral banks. These atolls and coral banks rise steeply from sea bottom with depth varying from 1500 m to 3000 m and their average surface elevation is 5-10 m above mean sea level.

MATERIAL AND METHOD

An uncontrolled mosaic of black and white aerial photographs (1:25,000 approx.) of the islands was prepared by matching the images of the overlapped portion. Photographs were studied under the mirror stereoscope and the geomorphic features were visually interpreted and transferred on koda-trace sheets. Later, sheets were compiled to produce photo-geomorphological maps for major islands. Essential field checks were carried out to confirm geomorphic features. Land-sat image was visually analysed for studying geomorphic features and sediment plumes.

GEOMORPHOLOGY OF ISLANDS

The detailed aerial photo study of the Lakshadweep group of islands reveals that general geomorphic set-up is somewhat similar and is as described below:

The individual islands have their longer axes parallel to N-S trend, only exception being Androth island which is roughly E-W. The islands are long, narrow land masses rising to about 2-3 m above the sea level. They are generally flat topped with some undulation either due to excessive sediments supply by storm waves or by differential tectonic movement. The islands are encircled by 3 to 10 m wide sparkling white carbonate sand beaches. Most of the inhabited islands are thickly vegetated by coconut tree. The lagoonal shores of the island consist of a sandy beach though at places, beach rock is exposed at the low tide mark.

The reefs are of 'atoll type' and are prominent in the west and south of the islands. The tropical climate, under currents and waves are providing excellent conditions for the growth of the reef. The reefs are forming semicircle along the island. They are closer towards the northern and southern ends while wider at the centre. The reefs on the eastern side, though present have a stunted growth probably due to shallow rocky terrain and breakers. The fore-reef side of the slope is gradual. Well defined wave-cut platforms are present up to a water depth of 100 m.

The lagoons are saucer shaped closed water bodies generally confined on the western side of the islands. They are wide in size, extend from 7-10 km in length and 1 - 4.5 km in width. The Bangaram lagoon is the biggest with horse-shoe type of reef and chain of small islands in the centre. The

water depth of the lagoon varies between 1 - 5 m. The corals are generally confined in the outer margins, with some sprinkling in the lagoon floor. Towards the island, there is a luxuriant growth of sea weeds and calcareous algae. The atolls show various stages of development of the islands. The reefs at Cheriya-panniyam, Perumalpar and Suheli represent, the earliest stage while Kalpani, Kavaratti, Agatti and Kadmat are in intermediate stage. Cheltan and Kiltan are in an advanced or mature stage of development. Lagoons of Kiltan and Chetlat islands are growing at a very fast rate, lagoons are likely to be filled up with sediments in a decade or so.

The islands are surrounded by milky white carbonate sand beaches of varying width. They are wide with gentle slope on the western side, gradually merging with the lagoon. The eastern seaward shore in almost all the islands (except Kadmat, Agatti, Bangaram and Cheriya-kara) is marked by storm beaches. These consist of coral pebbles and boulders piled up well above high tide mark. The islands in the centre of the lagoon *i.e.*, Bangaram and Cheriya-kara and others do not have storm beaches and their shores are largely sandy on all sides.

GEOMORPHOLOGY OF KAVARATTI ISLAND

Kavaratti is the third largest island in the Lakshadweep Archipelago and most of the geomorphic features and trends detected over other islands are visible in the aerial photographs of this island. Hence, geomorphology of Kavaratti island represents geomorphology of the other islands as well. Kavaratti island lies along 10° 32' - 10° 35' N latitude and 72° 35' - 72° 37' E longitude (Fig. 2.). It is situated on the eastern side of

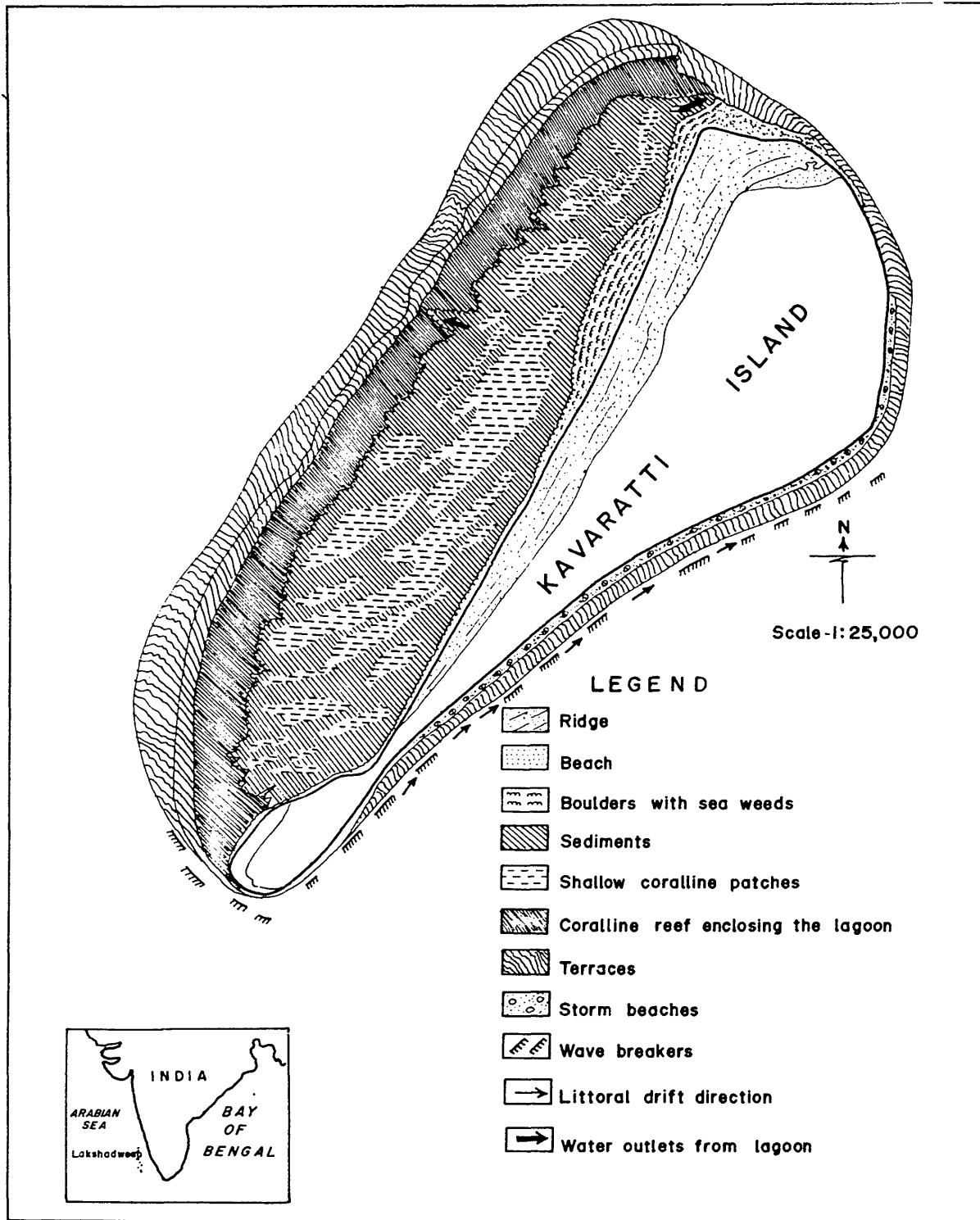


Fig. 2. Photo-geomorphological map of Kavaratti Island, Lakshadweep.

the lagoon. Island is almost spade shaped, trending in a NNE-SSW direction. It is 4.3 km long, 0.8 km to 1.5 km wide with land area of about 3.45 km². The broader side of the island is to the northeastern end, whereas it tapers down towards the southwestern end. The general slope of the island is towards the northwestern side. Lineament like features trending in NW-SE and NE-SW direction can also be marked on the photographs. These lineaments are manifested as incised fractures. Aerial photographs show white toned disintegrated coral soil covering the island. The general topography is hummocky to flat with a slightly elevated ridge round the periphery of the island. Towards the western side, the ridge is more wider and elevated than the rest part of the island. It bears narrow elongated old sandy ridges parallel to the coast, perhaps representing the old strand lines. Some of these are far inland from the present shoreline indicating the pro-gradation of the island. These ridges parallel to the present coastline indicate that the coast has not changed its trend but has advanced parallel to the original coastline. Whereas, the eastern side is subjected to direct fury of the waves causing the erosion of the eastern coast. Many coconut plants and other trees along this coast lean towards the ocean, some have already been uprooted and fallen to the beach.

Beach

On the aerial photographs, the white toned beach can be seen as a narrow strip lining the island. The island is marked by storm beaches on the eastern seaward shore and sandy gently sloping beaches on the lagoonal shores. Storm beaches extend for a considerable distance; they are largely comprised of pebbles, shingles, cobbles and boulders *etc.* These are of presumably of older corals

reefs. They usually rise to a height of 1m to 2 m and extend with minor breaks over a distance of 5 km to 6 km (Siddiquie. 1980). Towards the western side, the beach material is mostly coarse sand, coral debris of recent corals and shell fragments. Beach is 50 m to 100 m wide and normally gentle. Discontinuous ridges probably of beach-rock have been mapped along the beach.

Lagoon

The northwestern side of the island is fringed by a NE-SW trending coral reef enclosing an oblong shaped lagoon. It is about 4.5 km long and 1.2 km wide average depth is 1.5 m and maximum depth is about 3 m (Siddiquie and Mallik, 1975). Due to less depth and crystal clear water the lagoon topography is clearly visible in aerial photographs. Towards the northeastern side of the lagoon, the water depth is more whereas towards the central and western side, it is shallower due to the presence of uneven reef patches. In deeper part of the lagoon accumulation of coarse sandy material takes place. These sediments must have been derived from the disintegration of the coralline material. During the low tide the outflow of the water from the lagoon is mainly towards northeast and northwest outlets. Sediment concentration is more towards the northeast and southwest part of the lagoon. Distribution of sediment pattern reflects the water movement in the lagoon due to waves and currents. Towards the eastern margin, the lagoon is fringed by boulder deposits with thick growth of sea weeds. They show dark grayish black tone in aerial photographs. A few patchy reef, as well as boulders arranged in ENE-WSW linear way occur in the lagoon. Linear accumulation of boulders are generally attributed to wave induced forces and storm surge effects.

Reef

Bordering the western margin of the lagoon, there is a ring shaped coralline reef having average width of about 250 m, except at the southwest part where it is more than 400 m wide. The reef margins are well defined. A gap of about 60 m wide towards the southwestern side forms the main navigational entrance to the lagoon. In addition to this, few more narrow channels have been mapped on the reef. Some of these have been closed up as a result of frontal reef growth and have thus been isolated in the reef platform. At low tides the reef is always exposed and the lagoon begin to look isolated from the surrounding sea, excluding the navigational entrance and few irregular pits and pools on the reef. The uppermost part of the reef front is punctured by spurs and grooves and these are oriented normal to the reef. Many workers belief that the spurs and grooves are basically erosional in origin. Scour channels are generally formed due to strong erosive currents and spurs and grooves due to forward and backward thrust of the waves at the reef front. The direction of spurs and grooves suggest paleo-winds and currents from southeast direction. In aerial photographs the reef edge looks like a stepped pavement of terraces of different heights and gently slopping towards the open sea. Of these, two to three terraces can be mapped from the aerial photographs. The widest being towards the southwestern side. These submarine terraces might have been formed due to eustatic changes of the sea level.

Turbidity

Aerial photographs are also used to study the distribution and transport of nearshore turbid water plumes and hence indirectly the direction of nearshore currents. The distribution and dispersion of turbid waters on

the western continental shelf using Landsat images has been already studied (Wagle, 1985). Similar study using aerial photographs and Landsat image indicate that all round the Kavaratti island, the water is clear except on the eastern side very close to the coast, the water shows slight turbidity due to the removal of the fine loose material from the coast. Prom the movement of turbid water, the near-shore drift appear to be in the northeast direction.

CONCLUSION

Interpretation of satellite image and aerial photographs of the island has brought out certain facts which have a direct bearing on the development of the island. Due to extensive reef flats on the western side, there is less possibility of islands being eroded along this coast. Whereas, the eastern sector of the island is subjected to the direct furry of the wave action causing the erosion. Study indicates that the island is quite stable for a considerable time and it will continue to remain stable provided proper steps are taken to prevent the erosion. Strict control has to be established on the construction of the coastal engineering structures unless the preliminary research on the possible influence of such structures on coastal geomorphological features is performed. Similarly, it is also important to ban all human activities that may adversely affect the barrier reef. It is also most important to establish strict control over disposal of waste waters into the coastal zone. Any unplanned man-made disturbances of the coastal landforms will be a major step in wrong direction.

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