PETROGRAPHY, GEOCHEMISTRY AND DIAGENESIS OF CORAL DEPOSITS OF KAVARATTI AND MINICOY ISLANDS, LAKSHADWEEP, INDIA

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by

ANANDARAJ. N

Department of Marine Geology and Geophysics
School of Marine Sciences
Cochin University of Science and Technology
Kochi - 682 016

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CERTIFICATE

This is to certify that the thesis entitled **"Petrography, geochemistry and diagenesis of coral deposits of Kavaratti and Minicoy islands, Lakshadweep, India"** is an authentic record of research work carried out by Mr. N. Anandaraj under my supervision and guidance at the Department of Marine Geology & Geophysics, Cochin University of Science & Technology, under the Faculty of Marine Sciences and no part thereof has been presented for the award of any degree in any university/ Institute.

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Dr.P.Seralathan, Professor & Head
Department of Marine Geology & Geophysics
Cochin University of Science & Technology
Cochin-682 016

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

Coral refers to coelenterates secreting a massive calcareous skeleton, particularly of the order Scleractinia (class Anthozoa). Scleractinian corals are divided into two groups: the ahermatypic (non reef building) and the hermatypic (reef building). Structurally these two groups are similar, but the major differences between them lie in the presence of endosymbiotic zooxanthallae in the hermatypic corals, and the extent of their distribution in the seas. The ahermatypic corals are widely distributed at all latitudes, down to several thousand meters depth, whereas the hermatypic corals are stenotypic, limited to warm saline waters, essentially between the tropics of Cancer and Capricon, where minimum water temperatures do not fall below 20°C.

Coral reefs are one of the most ancient ecosystems, dating back to about 225 million years ago. Modern reefs can be as much as 2.5 million years old. Coral reefs thrive mainly in shallow waters, particularly in tropical marine ecosystems and are known for their high rate of biological productivity. The reefs are also sites for rich living and non-living resources.

Coral reefs are generally classified into three main types:

(i) Fringing reefs (shore reefs): develop nearshore where favourable environmental conditions exist such as firm bottom, ideal temperature and salinity and low turbidity (e.g. adjoining the shores of Red Sea).

(ii) Barrier reefs: separated from the shore by a lagoon (e.g. Great Barrier Reef). The width of the lagoon varies considerably along the coasts and with the progressive narrowing of the lagoon, a barrier reef may become fringing.

(iii) Atolls: These are annular reefs that develop at or near the surface of the sea. These can be further sub divided into deep-sea atolls and shelf atolls. Deep sea atolls are isolated with varying sizes (eg. many Indo-Pacific atolls). Shelf atolls are those found on the continental shelf (eg. NW coast of Australia).

The minor types of coral reefs include table reefs, faros, micro atolls, knolls and patch reefs.

Maxwell (1968) has classified the reefs into oceanic and shelf reefs. The oceanic reefs consist of (a) embryonic colony, (b) fringing reef, (c) barrier reef and (d) atolls. The shelf reefs are divided into (1) embryonic colony, (2) platform reef, (3) lagoonal platform, (4) elongated platform reef, (5) wall reef, (6) cuspate reef, (7) prong reef, (8) composite apron reef, (9) open ring reef, (10) open mesh reef, (11) closed ring reef, (12) closed mesh reef, (13) plug reef and (14) resorbed reef.

Although coral reefs cover only a tiny fraction (less than 0.2%) of the ocean bottom, coral reefs capture about half of the Ca added to the ocean every year, fixing it into $CaCO_3$ at very high rates. Coral reefs release CO_2 to the atmosphere due to $CaCO_3$ precipitation. The release of C to the atmosphere in the form of CO_2 from coral reefs is rather very small (less than 100 million tons of C per year) relative to emissions due to fossil fuel combustion (about 5.7 billion tons of C per year). Coral reefs store very little organic carbon and are not very effective "sinks" for CO_2 from the atmosphere.

Coral reefs are among the most endangered ecosystems on earth. Coral reefs in 93 countries (out of 109) have been damaged or destroyed by human activities. This may cause directly or indirectly the death of 5-10% of the world's living reefs, and if continued another 60% could be lost in the next 20-40 years. The most important threats to coral reefs are sedimentation (from poor land use pattern and dredging), eutrophication (over-fertilization and sewage pollution), and overfishing.

Physical damage to coral reefs by tourists would probably be a minor threat if the number of visitors to reefs is restricted to moderate levels. However, large numbers of tourists can cause extensive physical damage. Coral reefs of the major tropical region of the world have been bleached white during the mass bleaching events of the 1980's. Bleaching depresses coral growth rates and in some cases result in mass coral mortality. Bleaching is caused by a number of factors, including siltation, changes in salinity resulting from poor land use pattern, pollution, and slight increase in temperature. Coral reefs may bleach even more extensively if global warming continues unabated.

In India, coral reefs are heavily exploited for coral sand and rock. The extensive collection of ornamental shells, gorgonians, seaweeds, holothuroids and lobsters lead to considerable damage to coral reefs. However, mining of coral and sand are considered to be major problems, particularly in the Gulf of Kutch and as a result some reefs have totally vanished. Apart from anthropogenically caused damages, excess sedimentation to the coral reef areas through fluvial and coastal processes are considered as the greatest threat to the reef areas. Industrial and oil pollution have caused significant damage in the Gulf of Mannar and Palk Bay. Blast fishing and other destructive practices are persistent problems in many areas.

1.2 Coral reefs of the world

The coral reefs of the world cover an estimated area of 6 X 10^5 km^2, equivalent to 0.2% of the world ocean area. Over half of this (54%) lies in the Asiatic Mediterranean and Indian Ocean. Of the remaining, Pacific reefs account for 25%, Atlantic reefs for 6%, Carribbean reefs for 9%, Red Sea reefs for 4% and Persian Gulf reefs for 2% (Smith 1978). Majority of the coral reefs is concentrated along the western part of the three major oceans (Scheer 1984).

1.3 Corals and coral reefs of India

1.3.1 Indian main land

Coral growth along the coast of Indian Peninsula is very limited, most of them are of fringing type and found mainly in Palk Bay and Gulf of Mannar of the Tamil Nadu coast and Gulf of Kutch, Gujarath (Fig. 1.1). There are about 20 small islands and many reefs in the Gulf of Mannar southwest of the Mandapam Peninsula and Rameswaram Island. The scarcity of reefs in the nearshore

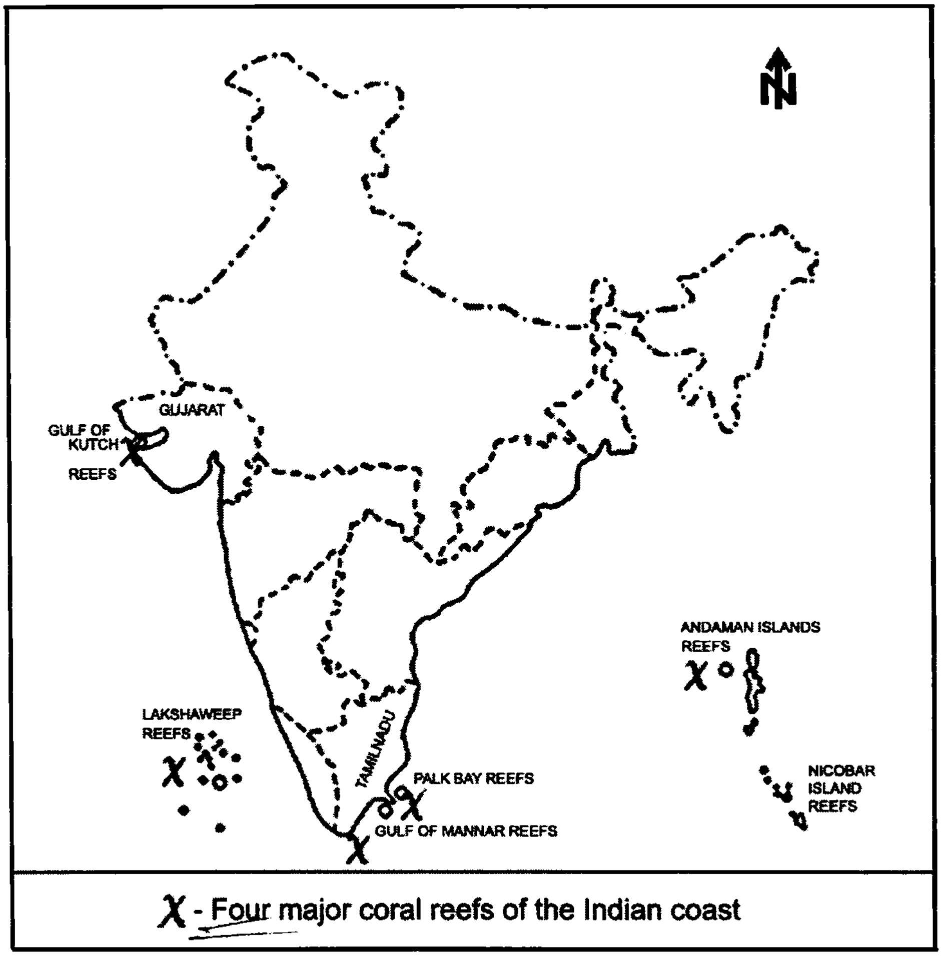

Fig. 1.1 Distributions of coral reefs in India

waters of the Indian coast is principally due to major rivers systems and the sedimentary regime of the continental shelf. About 207 coral species belonging to 55 genera are recorded from the Indian main land reefs.

1.3.2 Indian Island groups

The Andaman and Nicobar Islands in the Eastern Indian Ocean and the Lakshadweep Islands off the southwest coast of India are the Island group of coral reefs. The Andaman and Nicobar groups consist of many hundreds of high islands with extensive fringing reefs. These grow immediately offshore from the mountainous islands and are often several hundred meters wide, extending up to 1000 m in the Nicobars. The Lakshadweep group comprises of 36 islands (most of them are well developed atolls), four large submerged reefs and five big submerged banks. These have the most luxuriant coral growth in India. The Lakshadweep belongs to oceanic group of reef as per the classification of Maxwell (1968).

1.4 Study area

Two islands namely, Minicoy and Kavaratti are selected from Lakshadweep Archipelago for the present study (Fig. 1.2). As the two islands are located hundreds of kilometers apart it is expected to have differences in their mineralogy, geochemistry and their origin. Therefore, Kavaratti (as a representative for the northern block) and Minicoy are selected. Further, a considerable literature is available for Kavaratti while Minicoy is rarely studied. The name Lakshadweep is derived from the two Sanskrit words namely laksha

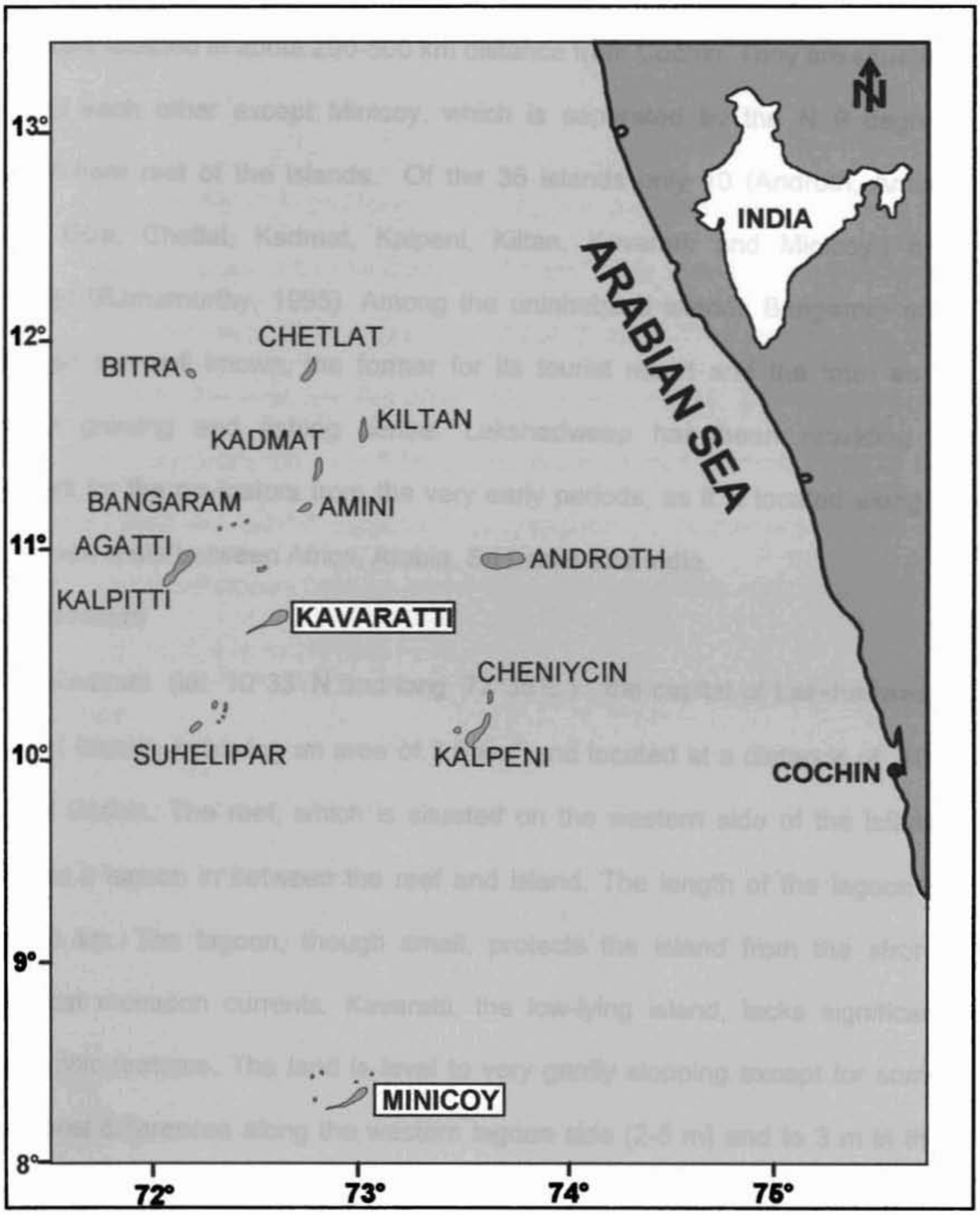

Fig. 1.2 Location of Kavaratti and Minicoy Islands, Lakshadweep

(means hundred thousand) and dweep (means the isles). The synonymous name of Lakshadweep is Laccadive. Lakshadweep islands cover an area of just 32 km^2 (08°00' N to 12°30' N lat. and 71°00' E to 74°00' E long.) (Fig.1.2). These islands are situated in about 200-500 km distance from Cochin. They are situated close to each other except Minicoy, which is separated by the N 9 degree channel from rest of the islands. Of the 36 islands only 10 (Androth, Amini, Agatti, Bitra, Chetlat, Kadmat, Kalpeni, Kiltan, Kavaratti and Minicoy.) are inhabited (Ramamurthy, 1995). Among the uninhabited islands Bangaram and Suhelipar are well known, the former for its tourist resort and the later as a coconut growing and fishing centre. Lakshadweep has been providing a landmark for the navigators from the very early periods, as it is located along a direct trade route between Africa, Arabia, Sri Lanka and India.

1.4.1 Kavaratti

Kavaratti (lat. 10°33' N and long. 72°38'E) , the capital of Lakshadweep group of Islands, is having an area of 3.6 km^2 and located at a distance of 404 km off Cochin. The reef, which is situated on the western side of the island, encloses a lagoon in between the reef and island. The length of the lagoon is about 6 km. The lagoon, though small, protects the island from the strong southwest monsoon currents. Kavaratti, the low-lying island, lacks significant geomorphic features. The land is level to very gently slopping except for some elevational differences along the western lagoon side (2-5 m) and to 3 m in the eastern storm side. The island is oriented in a NE-SW direction. The strong wave during the southwest monsoon beat and breaks the coral reefs on the western side of the atoll and the debris are carried eastward by the ocean currents and deposited along the eastern fringe of the atoll. The smoothly formed sandy beach on lagoon side (western) gives an indication of gradual deposition through time by coral sands.

1.4.2 Minicoy

Minicoy (lat. 08°17'N and long. 73°04' E) is at a distance 398 km away off Cochin. The area covered by this island is 4.4 km^2. The island has a very large lagoon on the western side measuring about 6 km^2. The lagoon has two entrances, one in the west and the other in the northern end. This large lagoon protects the island from the fury of the southwest monsoon currents. The 12 km long island does not exhibit significant geomorphologic differences except for micro level relief differences on the north. The elevation of the island from mean sea level is about 3-4 m in the east.

1.4.3 Climate

Lakshadweep has a warm and humid climate. The temperature starts rising from March and reaches its peak in May (29°C). The temperature then starts falling due to the monsoonal effects and reaches the lowest level in August (27°C).

a) Wind: The winds experienced in the Lakshadweep are those of the two monsoons, influenced in the north by the proximity of the Indian coast and affected in the south by the equatorial winds. The northeast monsoon usually set in the Lakshadweep during October- December and continues until the end of

January. During this period a more or less northerly wind prevails together with long calms, but a little or no heavy weather. The southwest monsoon in the Lakshadweep is rather longer, the southwest wind usually becoming definitely set towards the end of May and continuing regularly until September. The maximum wind speed during June is about 36 km/h.

b) Waves and currents: During SW monsoon the direction of wave approach is from SW- W directions whereas in the pre-monsoon (Feb-Mar) the wave approach is from N-NE directions. As a result of the above the littoral currents in Lakshadweep is S to N during SW monsoon period and N to S during NE monsoon and even during the pre-monsoon period. The Kavaratti and Minicoy belong to micro-tidal regime (Davies and Marshall, 1980). Hurricanes are liable to occur in the Arabian Sea during pre and post monsoon months. During pre-monsoon months (April-June) a number of storms or severe storms usually occur due to disturbances in Lakshadweep Sea. In the post monsoon, cyclonic storms usually occur in October- November due to disturbances in Bay of Bengal. According to India meteorological report (1964) nearly 10 storms occurred each in the year 1893, 1926 and 1930. The decade frequency of storms in the Arabian Sea is as follows: 15 during 1891-1910 and 9 during 1951-1960. A hurricane, which occurred in 1847, eliminated 1150 inhabitants out of 1600 from the island of Kalpeni and 2400 people out of the 3000 from Androth.

c) Rainfall: For the entire Lakshadweep islands, rainfall-recording stations are located at Minocy, Amini, Androth and Agatti. Rainfall data available from these islands are considered as representative to the adjoining islands. The average annual rainfall generally decreases from south to north of the Lakshadweep group of islands. At Minicoy the average rainfall is over 250 cm per annum, the greater part of which falls during the first month of the south-west monsoon. On an average, the number of rainy days (days with more than 2.5 mm rain) in a year at Minicoy and Kavaratti are around 90 during the SW monsoon period ie, June to September. In 1964, Minicoy experienced a high shower of 225 mm in a single day. Heavy showers of short duration are frequent in December i.e. during NE monsoon.

1.5 Population

In Kavaratti Island the population is 8677 and the population density is 2410/km^2 (1991 census) whereas in Minicoy, the population is 8320 and the corresponding density is 1890/km^2 (1991census). In both the islands, the thick population is found in and around the areas of higher relief as it sustains a relatively stable freshwater lens. It is this freshwater which acts as prime mover in the diagenesis of carbonate sediments as discussed in chapter 5.

1.6 Geology and Geomorphology

The Lakshadweep group islands form the northern part of the Chagos – Laccadive ridge which is trending in a NS direction over a distance of about 2500 km (Fig. 1.3). The ridge rises from a depth of 2000-2700 m along the eastern front and about 400 m along the western side in the Lakshadweep area (Eremenko and Dutta,1968). The eastern flanks of the ridge is much steeper compared to the western part. Except Minicoy, most of the coral islands are

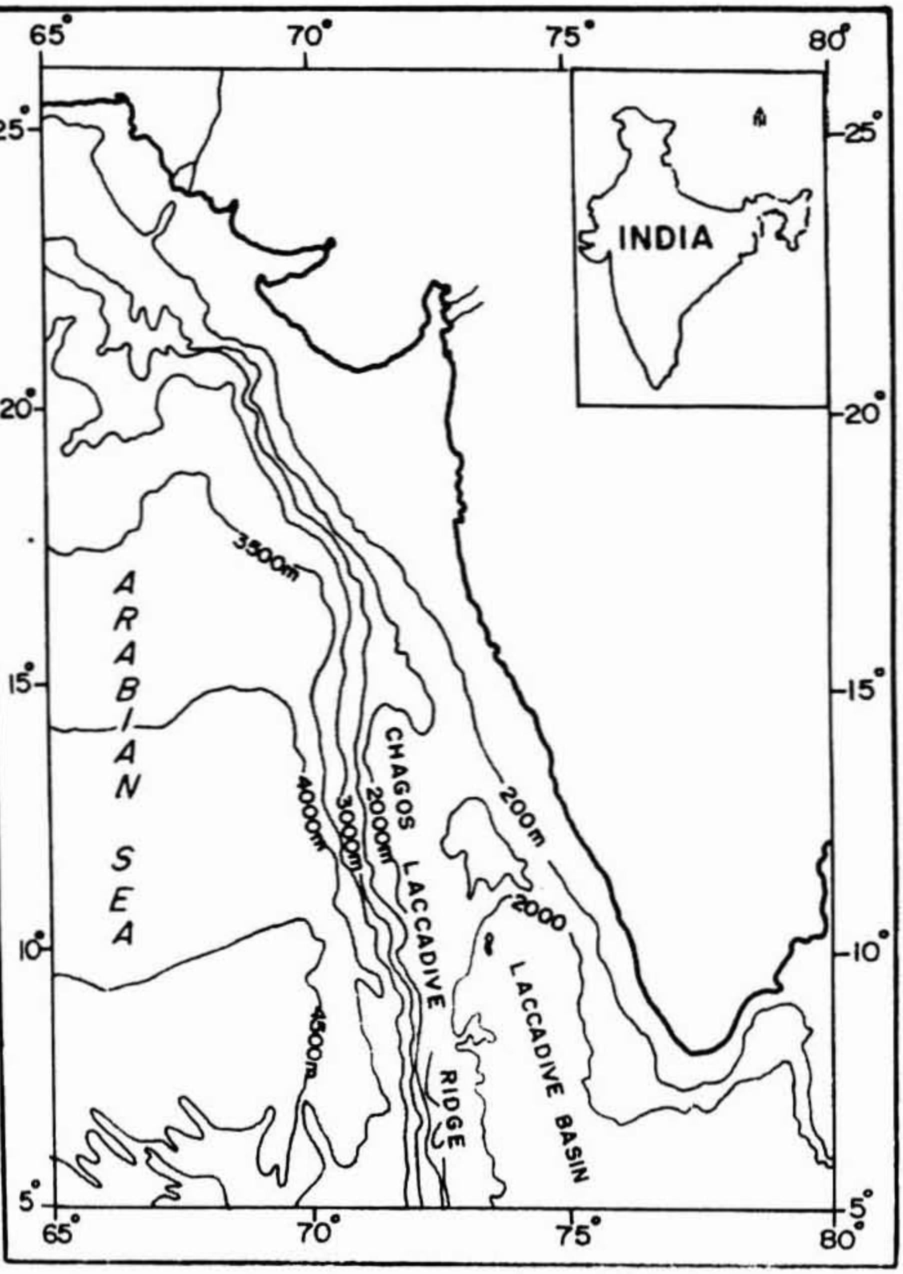

Fig. 1.3 Chagos-Laccadive ridge

concentrated on the north. The N 9° channel separates the Minicoy Island from the rest. The origin of Chagos- Laccadive ridge is a debatable one. According to Eremenko and Dutta, (1968) the ridge is of basaltic origin capped by coral reefs of recent origin. However, Narain et al., (1968) opined that the ridge forms the transition between the oceanic crust in the west and continental crust towards the east. More recently Zutshi et al., (1995) have indicated that the Lakshadweep islands form part of a highly splintered continental mass impregnated with large quantities of oceanic basalt.

There are several theories for the formation of coral reefs of the Lakshadweep islands. One of the theories of the origin of the coral islands of Lakshadweep is that submarine ridge has provided a stable platform over which the corals could grow. The upward growth of coral has kept pace with the relative sea level changes resulting in thick sequence of reef or atoll and the associated sediments in the lagoon and island proper. The lagoons, the beaches and the island proper are covered by nearly 1-5 m thick layer of either calcareous sand or pebbles and gravels (Muraleedharan and Kumar, 1995). Cemented layers are reported to have occurred sporadically within the islands either at the surface or at variable depths (Nair, 1982; Mallik, 1985). In Kavaratti a 10-20 cm thick cemented layer occurs 0.5 m above the water table while in Chetlat island the cemented layer occurs at the surface itself over a larger area. The cementation is due to percolation of fresh water and the dynamics of fresh water is controlled by the variation in permeability.

Most of the islands are more or less elongated and oriented in a NS direction with a lagoon on the western side and a steeper rocky shore on the eastern side. Androth is an exception which is aligned in a East-West direction and has no lagoon. The lagoon is separated by coral reefs, the width vary from 0.5 to 1.5 km. Srivastava et al., (1978) has proposed a three stage model of reef development for the Lakshadweep islands. The reefs of Chetlat and Kiltan and possibly Androth are in an advanced stage of development while Kalpeni, Kavaratti , Agatti and Kadmath are in an intermediate stage. The uninhabited island Suheli is in a primary stage. The occurrence of wave cut platforms and several submarine terraces from the eastern shelf region of the island have been reported by Siddique (1975).

1.7 Accessibility

The Lakshadweep Islands can be visited for scientific purpose only after getting prior permission from the island authorities. The Lakshadweep administration has put strict rules for outsiders in view of less accommodation facilities, very small size of the islands and the scarcity of fresh water. The most frequent mode of transport to Lakshadweep islands is by ships, which are being operated from the ports of Kochi, Beypore and Mangalore. Inter-island transporting system is available among the tourist centres and inhabited islands. Agatti airport links Lakshadweep islands with the mainland.

1.8 Review of Literature

Experimental studies on corals have started in 1910 (Goreau, 1961). Silliman (1953) has studied the chemical composition of corals. Chave (1954) has studied the biogeochemistry of Mg in Medreporarain and Alcypnarian corals and other calcareous marine organisms. Thompson and Livingston (1970) have carried out Ca, Sr and U concentrations and various trace elements of the modern hermatypic and ahermatypic corals. Amiel et.al., (1973 a & b) have carried out studies on the distribution and nature of incorporation of Sr, Mg, Na, K and U in modern aragonitic corals. Weber (1973) has conducted an extensive study on several well-characterized corals from seventeen localities to understand the incorporation of Sr in corals. Weber (1974) has also carried out a detailed study on different varieties of corals to find out the relationship between Mg content and water temperature, water depth, genetic factors and the rate of Mg removal from seawater by corals in reef environment. St. John (1974) has estimated the amount of Cu, Fe, Zn, Co, Cd, Pb and Ni for 265 varieties of corals from the reef of Capricorn group. He has also reported the relationship between trace elements in corals and oceanographic parameters. Goreau (1977b) has discussed in detail the physiological and environmental regulation of trace metals and stable isotopes of corals.

Yamanouchi (1980, 1982,1984, 1988, 1993 and 1998) and Yamanouchi and Hasegawa (1988) have studied the distribution of sandy sediments around coral reefs and beaches of the coral islands of Japan. Alexanderson (1978), Brand and Veizer (1980) and Al-Asam and Veizer (1986) have studied the diagenetic stabilization of aragonite and low-Mg calcite. The petrogenesis of Cenozoic temperate water calcarenites of Southern Australia has been carried out by James and Bone (1989). The diagenesis of carbonate sediments from deep sea and coral islands has been studied by several workers (Bathrust, 1975; Land and Moore, 1980; Macintyre, 1977, 1984 & 1988; Marshall 1983a & 1983b; James and Choquettee, 1983). The geochemistry of the modern carbonate of the Australian region has been investigated extensively by Rao (1981a, 1981c, 1986, 1989, 1990a, 1990b & 1992). Gischler and Lomando (1999) and Kench (1997), have studied the composition of unconsolidated, shallow-marine carbonates. Chevillon (1996) has studied the depositional patterns, pathways and the zonation of reefal and lagoonal sediments. The importance of *Halimeda* bioherms has been undertaken by Roberts et al. (1988). Furukawa et al. (1997) have investigated compositional studies and early diagenesis of sediments. Grossman and Fletcher (1998), Calhoun and Fletcher (1996), Fletcher and Jones (1996), Athens and Ward (1991) have conducted several studies on various aspects of carbonate sand and their age in Pacific localities. Holocene sea levels and shoreline evolution, sedimentation histories have been studied by Roy (1991), Harris et al. (1990) and James et al. (1994). Davies and Marshall (1985) have studied the accumulation of Halimeda bioherms. Harney et. al (1999) have studied the age and composition of Kailua beach, Hawaii.

The Lakshadweep archipelago is of considerable scientific interest, but unfortunately not many studies have been made earlier. The first detailed study on the islands has been conducted by Gardiner (1903-1906) and he published his book "Fauna and Geography of Maldive and Laccadive Archipelago" in two volumes. His study is more linked to the fauna and flora of the atolls. Only in recent years much work has been done on many aspects. Sankaranarayanan

(1973) has studied the chemical parameters such as salinity, pH, total alkalinity, dissolved oxygen, inorganic phosphate, total phosphorous, chlorophyll and particulate organic carbon of the lagoon and the sea around Kavaratti. Naquvi and Reddy (1979) have studied the variation of Ca in the waters of Lakshadweep. According to Pillai (1977) seventy species of hermatypic corals representing 26 genera are found in the Lakshadweep region. Siddique and Mallik (1973) have conducted detailed bathymetric surveys and sediment sampling and indicated that Lakshadweep atolls are marked by shallow lagoons with depths ranging from 1-16 m. The bathymetric surveys conducted by Siddique (1975) reveals the presence of three submerged terraces (10-15 m, 21-36 m and 43-47 m) off the islands of Kadmat and Bangaram. Subsequent study by Nair and Quasim (1978) also reveals the existence of coral banks in several regions of Lakshadweep. The study of Chauhan (1986) and Chauhan and Chaubey (1990) also brought to light the presence of three terraces at depths of 45 m, 69 m and 82 m off the islands of Lakshadweep. The morphology and sediment characteristics of northern part of Trans- Lakshadweep ridge has been studied by Kalluraya et al., (1989). Vinithkumar et al., (1999) and Ramanujam and Mukesh (1999) have studied the geochemistry of coral reef sediments of the Mannar Islands off the Tamil Nadu coast.

The textural characteristics of the carbonate sands of beach and lagoonal environments of the Agatti atoll have been investigated by Hardas (1987). Sanil kumar et al., (1986), Adiga (1989) and Prakash and Suchindan (1994) have investigated the topographic variation, sediment characteristics and beach erosion of the Lakshadweep coral islands. Mallik, (1979, 1981 and 1985) conducted a series of investigations on the sedimentological and biological aspects as well as on the effect of coral sand mining on Kavaratti and Kalpeni atolls. The grain size variation in the Kavaratti lagoon sediments has been studied by Mallik (1976). Siddique (1980) has studied the age of the storm beaches of certain islands of the Lakshadweep by radiocarbon methods. Based on the mineralogical and sedimentological aspects of the surficial sediments and with the support of radio carbon dates, Siddique (1980) opined that there have been stormier conditions in the Arabian sea around 3000-5000 years ago. Mascarenhas et.al., (1980) studied the distribution of Sr and Mg in corals from reef to the island of the Minicoy.

1.9 Objectives of the present study:

1. To study the textural characteristics of the beach and inland sediments of Kavaratti and Minicoy islands
2. To investigate the mineralogical constituents of coral deposits using X-ray diffraction studies.
3. To estimate the concentration of selected major and trace elements (Na, K, Ca, Mg, Sr, Fe, Mn, Cu, Co, Ni, Cr, and Zn) of the carbonate sediments so as to decipher the geochemical characteristics of the coral deposits and
4. To study the diagenetic changes of the coral deposits

Chapter 2

MATERIALS AND METHODS

2.1. Introduction

This chapter deals with the various techniques and procedures adopted in sample collection, processing and analysis of the data collected for this work. The methodology involves three parts, viz : (a) field survey and sampling, (b) laboratory investigation and (c) data processing and interpretation. Various procedures employed in the work are briefly given below.

2.2. Field survey and sampling

Field survey and sampling were done systematically from the beach and within the islands. Beach profiles (7 from Kavaratti and 8 from Minicoy) were carried out on the lagoon side of the islands in the month of April 1998 and April 1999. Since the storm side beach is mainly composed of pebbles, cobbles and boulders no beach profiles were carried out the storm side. Beach profile study help us to understand the variations in beach morphology, the erosional and depositional patterns of the beach (i.e., volume change of the beach sediments) and direction of sediment transport. Different beach profile methodologies are adopted depending on the objective of the study. In the cross-shore direction, generally the elevation of the beach is measured at every 5m interval. But at places where a sharp change in the beach slope is observed, the elevation changes can be recorded at smaller cross-shore intervals less than 5m.

In order to unravel the grain size variations along and across the beach of the islands 14 stations were selected from the Kavaratti island and 18 stations in Minicoy. At each station 2 samples namely foreshore and backshore were collected. Since the storm side mainly consists of pebbles, cobbles, boulders and coral rock pieces and therefore only at selected localities sediments were collected in foreshore and backshore (Plates 2.1, 2.2, 2.3, 2.4, 2.5, 2.6 & 2.7). For a comparative study of the sediment characteristics of beach with that of the adjoining lagoon, 10 bottom samples (5 from each lagoon) were collected from the lagoon area of Kavaratti and Minicoy. In addition, beach profiles were taken to understand the erosion/ depositional history of the islands.

In order to assess the variability in sedimentation pattern, mineralogy, geochemistry and the diagenesis within the islands, sediment samples were collected at close intervals from 18 dug wells and 12 pits respectively from Kavaratti and Minicoy islands (Figs. 2.1 & 2.2). Due to environmental restriction (Plates 2.8 & 2.9) imposed by Government of India, the samples have been collected from the available dug wells and pits. Thus within the islands 81 samples from Kavaratti and 83 from Minicoy were collected. The depth of the dug wells and pits varies from 175 to 490 cm in Kavaratti (Plates 2.10 & 2.11), 35 to 110 cm in Minicoy (Plate 2.12) respectively. Since hard basement rock is encountered at a shallow depth in the Minicoy, sampling was possible only to a depth of around 110 cm. Four live coral samples (2 from each island) from the reef area of Kavaratti and Minicoy (Figs. 2.1 & 2.2) were collected in order to compare the mineralogy of the samples with that of the inland sediment samples.

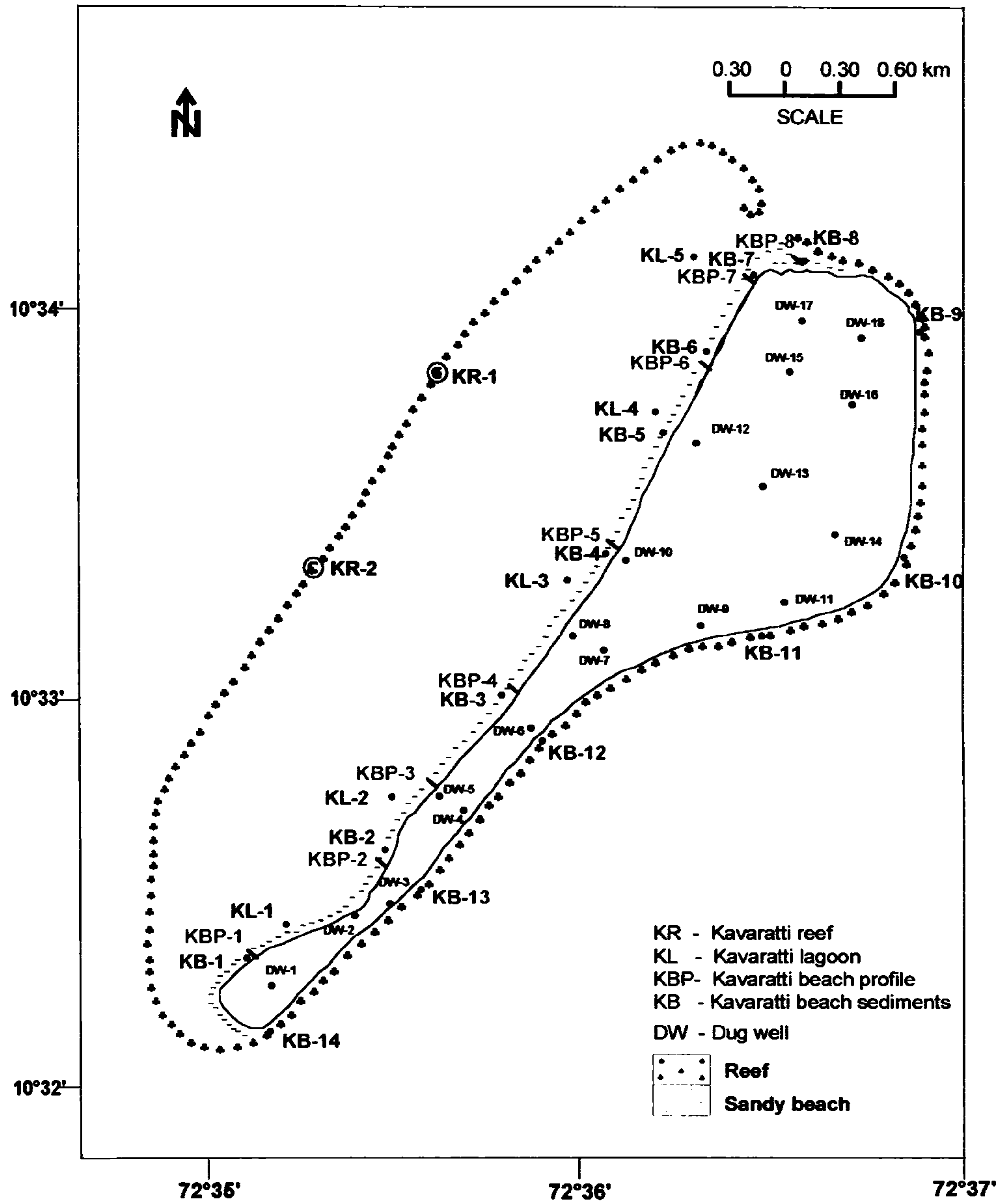

Fig.2.1 Beach profile and sampling stations in Kavaratti Island

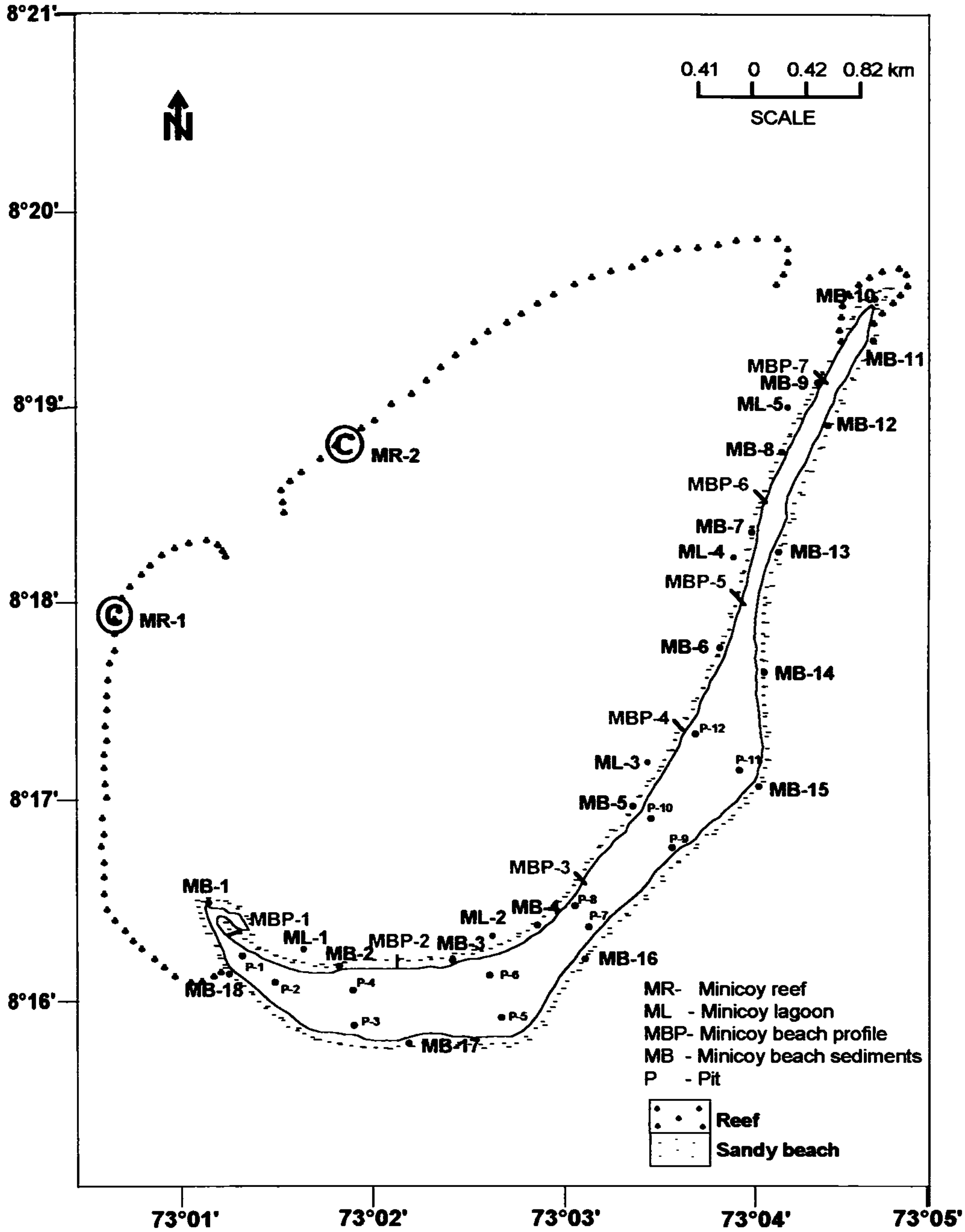

Fig.2.2 Beach profile and sampling stations in Minicoy Island

Plate 2.1. A pebble beach of the storm side of the Kavaratti island.

Plate 2.2. An emerged conglomerate platform of the storm side beach of the Kavaratti. The reef flat with coral rubble, exposed during low tide is also shown.

Plate 2.3. An exposed reef flat at low tide of the storm side beach iof Minicoy.

Plate 2.4. A close view of the reef flat of the storm side beach of Minicoy.

Plate 2.5. A gentle rubble beach of the storm side of Minicoy. The modern and earlier pebble sequences are shown here.

Plate 2.6. A steep pebble beach of the storm side of the Minicoy.