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Textural and compositional variations of beach sands along the coast of South Andaman Island: Implications for provenance and depositional history

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Abstract:

The study of petrography is a primary step in provenance research of beach sand sediments. The data set needs to be analyzed for this study is based on their mineralogical compositions and structure. The study of sediments in the present-day depositional environment is important to find out the nature of sediments to reconstruct the history of rock including information about the origin of its constituent particles, the method and distance of sediment transport and the nature of the place where the grains eventually came to rest i.e. the environment of deposition. In the present study the beach sand sediments of five beaches viz Corbyn's cove, Chiriyatapu, Wandoor, Radhanagar beach, Havelock and Lakshmanpur beach, Neil Island were analyzed to throw some light on to the sediment characteristics of the South Andaman Island. For the present study 40 Sand samples were collected, eight from each beach and thin section slides were prepared. The slides were studied under the petrographic microscope to study the textural and compositional characteristics of the sediments. It was found that the beaches are composed of sediments of two different types, viz silisiclastic and carbonate nature. The sediments are deposited under shallow marine environment which is influenced by tidal, river, wave and oceanic currents, which play a role in the dispersion of sediments. The sedimentation in this environment can be dominated by alternating episodes of siliciclastic and carbonate deposition.

1. Introduction

Beach is a transitional environment which contains sediments derived from more than one source. They may be from terrigenous sources like fluvial supply, cliff

erosion or from marine sources like seabed erosion and marine biogenic production. A shoreline is also characterized by energetic wave and current action and the sediments delivered to the sea can be reworked repeatedly to produce sand or gravel beach. At any point of time, the geographic setting and the environmental condition determine the nature of sediment that is deposited in a sedimentary environment. Some kinds of sediments originate and deposit in the same place whereas some accumulate in the faraway place from where they originated. The study of sediments in the present-day depositional environment is important to find out the nature of sediments to reconstruct the history of rock including information about the origin of its constituent particles, the method and distance of sediment transport and the nature of the place where the grains eventually came to rest i.e. the environment of deposition. Approximately 40% of the global coastline is formed by non-consolidated sediments like sand and gravel (Bird, 2000). Beach sediments reveal features like weathering, abrasion and sorting. Their textural, compositional, and geochemical variation are influenced by various factors like wave, wind, longshore currents, relief, climate, and source information (Folk, 1974; Komar, 1976; Ibbeken and Schleyer, 1991; Carranza-Edwards and Rosales-Hoz, 1995; Carranza-Edwards, 2001; Kasper Zubillaga and Carranza-Edwards, 2005). In addition, the geomorphological features in the coast may also have control on the grain size, composition, and the geochemistry of the beaches (Le Pera and Criteli, 1997). Moreover, the provenance of the beach sands is sometime related to different tectonic setting (Klitgord and Mammerickx, 1982; Nesbitt and Young, 1982; Carranza Edwards et al., 1994; Kasper-Zubillaga et al., 1999). Sufficient supply of material is essential for the maintenance of beach as there is a continuous movement of beach sediment by waves and near shore currents over suitable substrate to a final accommodation (Woodroffe 2003).

It is quite clear that the origin of the beach sediment can only be determined through the petrographic analysis of the materials. Despite the strength of research on beach sediment sources through analysis of mineral composition (e.g. Komar and Wang 1984; Clemens and Komar 1988) comparable work on carbonate-dominated coast is relatively scarce (cf. Komar 1998). Several works on beach sedimentation have done either with siliciclastic sands (e.g. Bryant 1982; Davis 1985; Sagga 1992; Guillén and Hoekstra 1996; Guillén and Palanques 1996; Carranza-Edwards et al. 1998; Anthony and Héquette 2007) or, in tropical environments, with calcareous sands of marine origin (e.g. Kench 1997; Beanish and Jones 2002; Smith and Cheung 2002; Kennedy et al. 2002; Hewins and Perry 2006).

A very limited works has been done in Indian context. Srivastav, Chandra, & Shastry, 2004 worked on the High-Ti type N-MORB parentage of basalts from South Andaman Ophiolite Suite. The geo-chemical data of the exposed basalt along the southern part of the South Andaman Island reveals that these basalts were derived from magma which is like N-MORB and was emplaced in the mid-oceanic ridge

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tectonic setting. Allen, et al., 2007 aimed to provide a better understanding of uplift history of the accretionary prism and provenance of the sedimentary rocks. Moreover, geochemical investigations and provenance analysis of sediments and sedimentary/ meta-sedimentary rocks include studies from Himalaya to Great Nicobar Islands and Nicobar and Bengal Fans (Ingersoll and Suczek 1979; Garzanti and Van Haver 1988; Bhat and Ghosh 2001; Islam et al. 2002; Rashid 2002; Raza et al. 2002; Absar et al. 2009; Ghosh et al. 2012a, b; Garzanti et al. 2013a).

Nevertheless, there has hardly been any attempt to study the petrography of unconsolidated sediments from the Andaman–Nicobar convergent margin accretionary Island arc though Andaman represents a good field laboratory for assessing the interaction between carbonate and siliciclastic sedimentation, and the related controls on beach sediment sources and patterns of beach facies evolution. Petrographic analysis using a geological microscope is a classical methodology. Identifying a particular number of grains in a sample is the fundamental process in this present study. When the percentage of different compositional material are known, it is easy to perform the interpretation and determine the sediment source areas and the depositional environment. Studies of this type were published through out the twentieth century but have increased in frequency over the last 50 years (Galehouse 1971; Dickinson 1985; Zuffa 1985; Kasper-Zubillaga and Dickinson 2001; von Eynatten et al. 2003; Affolter and Ingersoll 2019; among others, J. Mangas et al 2023). Against this background, specific questions addressed in this paper include (1) what types of sediments characterise beaches of South Andaman Island and how are these distributed along the coast, (2) what the sources for different sediment types are.

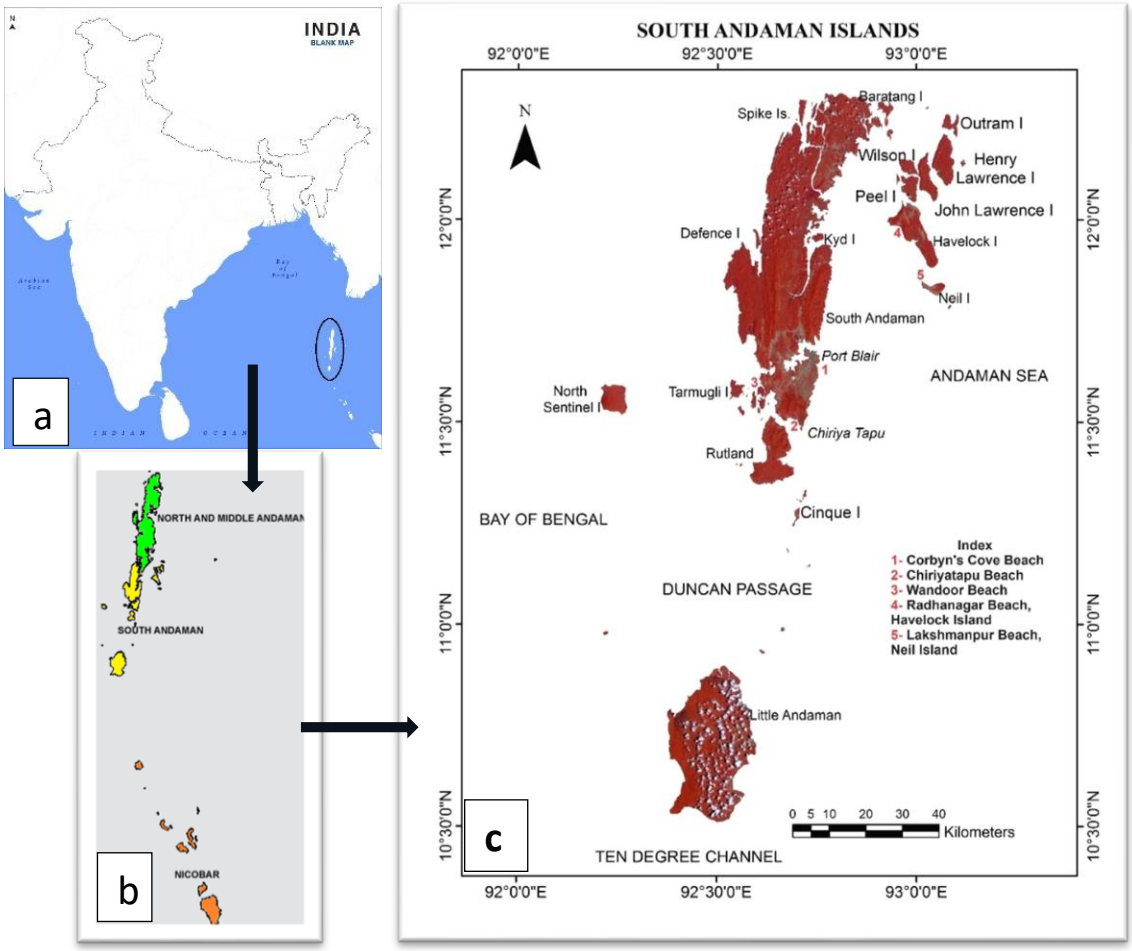
Therefore, the principal objectives of the study are to characterise the textural and compositional variations of the beach sediment and to recognize the provenance and sedimentary environment of the sediments.

2. Methods and Materials

2.1 Study Area

Great Andaman comprises the five largest islands of the Andaman Group: Baratang, Rutland, North, Middle and South Andaman Islands. South Andaman Island is the southern most island of the Great Andaman chain in the Bay of Bengal. The study was conducted at five beaches of South Andaman Island. The Island is located between 10^{o} 31’ to 12^{o} 17’ N latitude and 92^{o} 12’ to 93^{o} 8’ E longitude (Fig 1). The Andaman–Nicobar archipelago forms the western margin of the Andaman Sea. The island is a sediment dominated accretionary wedge formed along the obliquely subducting eastern margin of the Indo-Australian oceanic lithospheric plate. Rink (1847) suggested that the deep-sea ocean sediments have been uplifted and formed the ridge and consisted partly of the stratified deposits occupying the bottom of the sea. As per his initial statement, the modern concept of upliftment of ocean floor

sediments resulted in the formation accretionary prism. The geology (Fig 2) and



structure of the ridge reflect the complexity of the evolving tectonics and stratigraphy of an accretionary wedge. Pre-Cretaceous meta-sedimentary rocks, Upper Cretaceous ophiolites and Palaeogene–Neogene sedimentary formations indicate rapid, spatial and temporal changes in lithology, sedimentology, sedimentary and tectonic environments, and paleogeographic setting. Geomorphologically, the island shows a broad complex system of hills and valleys. The east west profile of the island shows the eastern side of the island contains most of the relief while the western side also formed of parallel ridges but of lower elevation.

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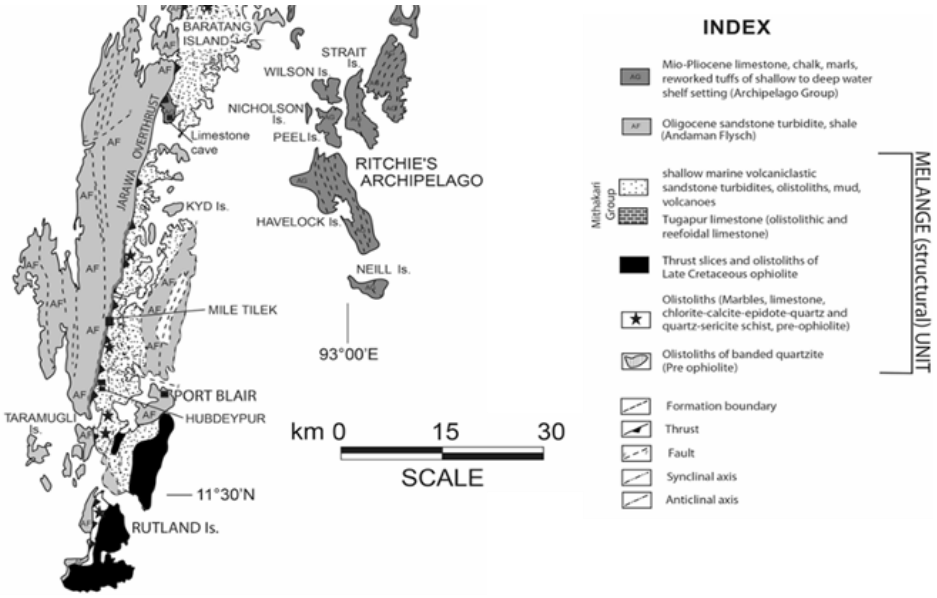

Fig. 2. Geological map of the South Andaman Islands showing the main geological units and structural features (after Bandyopadhyay and Carter 2017)

2.2 Sample Site Selection and Sample Collection

For the present study 40 sand samples were collected from the beaches of Corbyn's cove, Chiriyatapu and Wandoor, Lakshmanpur beach of Neil Island and Radhanagar beach of Havelock Island and analyzed in terms of grain size, shape, sorting and composition.

Sand sampling sites were chosen considering coastal areas near small embayment like the Corbyn's cove and coastal areas directly exposed to the open sea like Radhanagar beach of havelock island to observe the petrographic and geochemical trends. Approximately 200 grams of sand samples were collected by hand from the uppermost centimeter of the following beaches:

1) Corbyn's cove, 2) Chiriyatapu and 3) Wandoor, 4) Lakshmanpur beach of Neil Island, 5) Radhanagar beach of Havelock Island. The samples were collected from inter tidal zones. Sampling was done in section across the beach and the spacing between two sample is 20 meters. The locations of the sample section are shown in Fig 3. For each of the selected beach, 2 sections were chosen randomly for analysis. Overall, 40 samples from 10 sections were studied under the microscope. Beach profiles were surveyed using a stadia, rod, and level. Distance measurements along the beach profile were performed using tape with one centimeter precision.

2.3 Thin Section Preparation

The collected samples were stored in the laboratory prior to their processing. Before impregnation, samples were opened and placed in polypropylene containers to dry at

room temperature for 2-4 weeks. All the information on the sample (sample code, location, etc.) are reported on the container. When the sample became dry, a mix of polyester resin, styrene monomer and a hardener is pored on the sample progressively. The resin rises progressively by capillarity towards the top of the sample. When the top of the block is wet with resin, the sample is fully immerged in resin then placed in a vacuum chamber. The use of a vacuum chamber and the application of a light vacuum improve the penetration of the resin to the heart of the sediment block by sucking the air out without disturbing the sediment microstructure. After 4 hours in the vacuum chamber, the block is left at room temperature for 24 hours then placed in a temperature controlled ventilated cabinet for at least a week.

When the resinated sample is fully cured, the block is cut with a water-cooled saw into slices of 0.5-1cm thick. The slice of indurated sediment is trimmed to the dimensions of the final thin section.

The sample slice is mounted on a 2 mm glass by spreading resin mixed with a hardener on the sample and glue it to the glass, then place the slide under a press overnight. Next morning the sample is cleaned from the excess of resin that spread under the press. The objective of first grinding is to obtain a perfectly flat and smooth surface prior to final grinding. Second grinding is the most crucial step of the process as it will determine the quality of the thin section. The third grounding is being done to achieve the required thickness. Every grounding is alternated with mounting process. After final grinding, the slides were thoroughly wiped to remove all the oil and the thin section slides are ready to analyse.

2.3 Petrographic Study

The thin sections or grain mounts were studied in the laboratory with a petrographic microscope. Petrographic analyses performed using a geological microscope with samples of sediments are a classical research methodology. Optical mineralogy is used to identify mineralogical composition of geological materials to help reveal their origin. Petrographic analyses were carried out using Leica DM 4500P polarizing microscope attached with Leica DFC420 camera (Figure 3) and Leica Image Analysis software (LAS- v4.6, Wetzlar, Germany) at the Department of Geology, University of Calcutta, Kolkata. The grain size measurements were performed with the help of micrometer provided in the eye piece.

Optical Microscopy and digital image analysis are used for determination of particle size distribution. There are three major steps in image analysis: image acquisition and enhancement, object detection, and measurement. The first step, image acquisition is easily phrased as taking a photograph of the slide. Second step includes object detection, and the final step is computation of the desired parameters for particle size and shape of each particle. The average size of most of the grains were considered to classify the sample. The shape of the individual grain was studied

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under the microscope by examining the nature of an individual grain boundary. Sorting is determined by analysing the measure of range or variation in grain sizes present in a sample.

The identification criteria of biogenic fragments are those described in Tinoco (1989).

2.4 Statistical Analysis

Finally, the calculation of textural grain-size parameters followed the percentile statistical method proposed by Folk & Ward (1957) using the GRADISTAT software package. Some statistical parameters like skewness, kurtosis was determined by using the software to characterise textural parameters of the unconsolidated beach sediments. Skewness evaluates the symmetry of sediments distribution i.e., prepotency of coarser and finer material. Kurtosis (KG) ascertains the peak distribution which depicts the mixed (coarse and fine) sediment population distribution.

3. Results

3.1 Sediment characteristics of Corbyn's Cove Beach

The grain-size analyses reveal that the sediments of the Corbyn's Cove beach situated in the main island are characterised by fine to coarse sands. The mean grain size of all samples combined is 2.15±0.81 phi (Table 1), the coarsest sediment having a mean grain size of 0.6±0.02 phi in the most exposed sectors of the pocket beach. The finest sediment (Sample 315) has a mean grain size of 2.87±0.04 phi, being associated with a pocket beach on the eastern side of the South Andaman Island. Most of the grains having angular and/or subangular shapes. According to the analyses, 70% beach sediment is composed of siliciclastic materials. Most of the grains are formed of quartz, other components been identified are feldspar, iron oxides and rutile, 15% intraclasts of crystalline carbonate, 8% fossil fragments of corals and other invertebrates and 7% elliptical pelloids of micritic carbonates are found. Overall, the beach sediments are moderately sorted (35.9% of all locations) or moderately well sorted (32.8%), the sorting generally decreases as the proportion of bioclasts in the sediment increases. Most of the grains having irregular and/or subangular shapes. Grains are very much assorted in nature, siliciclastic dominate over

Table 1 Descriptive grain size and textural parameters for the five beaches of the study area carbonate sediments. Thus, it is deposited in siliciclastic shelf environment where sediments are of both continental and marine in origin.

	Grain size (Phi)	Sorting (Phi)	Skewness	Kurtosis	Siliciclast %	Carbonate %
Corbyn's cove						
Mean	2.15	0.93+-0.25	-0.14	1.01	68.7	31.3
Min	2.87	0.44	-0.45	0.74	64.8	35.2
Max	0.6	1.45	0.24	1.66	70.3	29.7
Chiriyatapu						
Mean	0.75	0.82+-0.30	-0.08	1.04	18.3	81.7
Min	1.89	0.39	-0.31	0.79	16.3	83.7
Max	0.67	1.59	0.24	1.5	20.2	79.8
Wandoor						
Mean	0.44	0.87+-0.22	-0.11	1.02	59.2	40.8
Min	1.33	0.47	-0.36	0.75	58.6	41.4
Max	0.8	1.36	0.23	1.51	60.5	39.5
Radhanagar, Havelock						
Mean	1.13	0.89+-0.19	-0.15	1.03	4.4	95.6
Min	1.67	0.38	-0.39	0.77	3.6	96.4
Max	0.79	1.42	0.25	1.62	5.1	94.9
Lakshmanpur, Neil						
Mean	0.73	0.91+-0.27	-0.09	1.04	0.67	99.33
Min	1.93	0.41	-0.33	0.74	0.87	99.13
Max	0.71	1.47	0.26	1.64	1.1	98.9

3.2 Sediment characteristics of Chiriyatapu Beach

The beach sediments of the Chiriyatapu beach (sample number 177 and 198) are on average medium to coarse grained than those of the Corbyn's cove beach, with mean grain sizes ranging from 0.67±0.22 to 1.89±0.01 phi. Overall, the sediment is moderately sorted (0.82phi), 40.7% being moderately well sorted and 55.6% evenly split between moderately sorted and very poorly sorted while considering the southernmost beach of the island. In terms of composition, the sediments along the Chiriyatapu beach are mainly made up of coarse-grained carbonate intraclasts (35%), Fossil fragments (25%), Pelloids (20%) and Siliciclastic (20%) grains.

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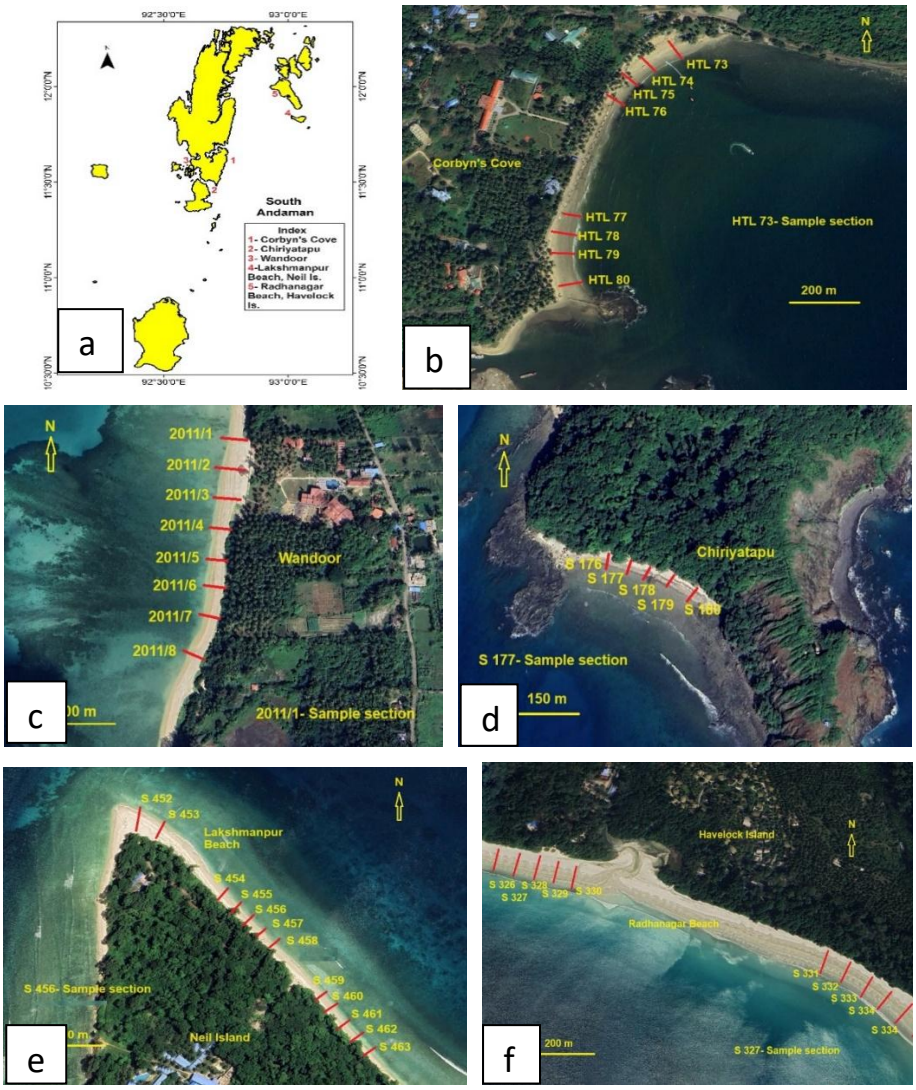

Fig 3 a. Key map, b. Sample section at Corbyn's Cove beach, c. Sample section at Wandoor beach, d. Sample section at Chiriyatapu beach, e. Sample section at Lakshmanpur beach, Neil Island, f. Sample section at Radhanagar beach, Havelock Island

Intraclasts are mostly composed of crystalline limestone. Most of the fossils are planktonic foraminifera and a few grains are benthonic colonial coral. Pelloids are sub elliptical and micritic in composition. Few grains of glauconite are also found in composition. Siliciclastic grains are angular sand sized and are made up of quartz and feldspar. A trace amount of heavy minerals of rutile, magnetite and ilmenite are found which are fine grained. Sediments are deposited in a mixed siliciclastic to carbonate shallow marine environment.

3.3 Sediment characteristics of Wandoor Beach

In contrast to the Chiriytapu, the sediments of the Wandoor beach are on average somewhat fine to coarse, mean grain sizes ranging from fine (1.33±0.22 phi to 0.80±0.01 phi). The beach is made up of silisiclastic fragments (60%). Among the non clastic carbonate materials more than 85% is intraclasts, 10% is fossil fragments and 5% is pelloids. Most of the intraclasts are composed of crystalline carbonates or spary calcite. Few grains are made up of micro-crystalline muddy carbonate and micrite. Fossil fragments contain coral, foraminifera and other invertebrates which are mostly sub rounded in shape. Very few fine grained opaque (ferric oxides) minerals are also present in trace amount. The beach sediment is highly assorted and angular in nature. Presence of shallow marine organisms (foraminifera) and high carbonate materials indicate deposition in shallow marine condition. High proportion of angular siliciclastic materials indicates a mixed environment (i.e, transition between continental and marine). High angularity of the siliciclastic materials within the sediment indicates a small channel or stream Bourne sediments in a shelf environment.

3.4 Sediment characteristics of Radhanagar Beach, Havelock Island

The beach sediments of Radhanagar beach of Havelock Island are made up of carbonate particles mostly fine grained (1.67±0.22 phi) sediments. The beach sediments of the island are on average fine to coarse graine sizes ranging from 1.67±0.22 phi to 0.79 ±0.01 phi. Most of the grains are intraclasts (55%) of both micrite and sparite. Ooids and pelloids are found with few micro fossils of various shapes. Ooid and pelloid are mostly composed of micrite and sparite. In some places, micrites are brownish in colour which indicates presence of ferrugenious carbonates. Grains are moderately well sorted. Size of ooids and pelloids are similar and mostly fine grained but most fossil fragments are comparatively variable in size and shape. Fossil fragments (40%) of both planktonic and benthic origin have been found which are mostly foraminifera and colonial coral. Very few (< 5%) fine siliciclastics are presents (quartz and feldspar) which are angular in shape. The overall beach sediment is angular to sub angular in shape. A trace amount of heavy mineral of magnetite and ilmenite found (fine grained and opaque). Presence of ooids, pelloids, planktonic foraminifera indicate a shallow marine environment. Proportion of carbonate clasts and orthochem are greater than 95% and siliciclastics are less than 5%. This composition of the sediment indicates carbonate shelf environment. Presence of ooid and greater proportion of sparite material indicates a high energy condition where sediments are deposited.

3.5 Sediment characteristics of Lakshmanpur Beach, Neil Island

In contrast to Havelock Island, the sediments of Lakshmanpur Beach of Neil Island vary widely in size and shape with mean grain sizes ranging from 0.71±0.22 to 1.93±0.01 phi. Allochemical components have three parts and share 75% of the total

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material. Intraclasts (90%) are medium to coarse grained, moderately well sorted. They are sub-angular in shape and made up of sparites. Pelloids (<5%) are very few in number. They have an elliptical shape and made up of muddy carbonate and are medium grained. In certain places intraclasts and pelloids are

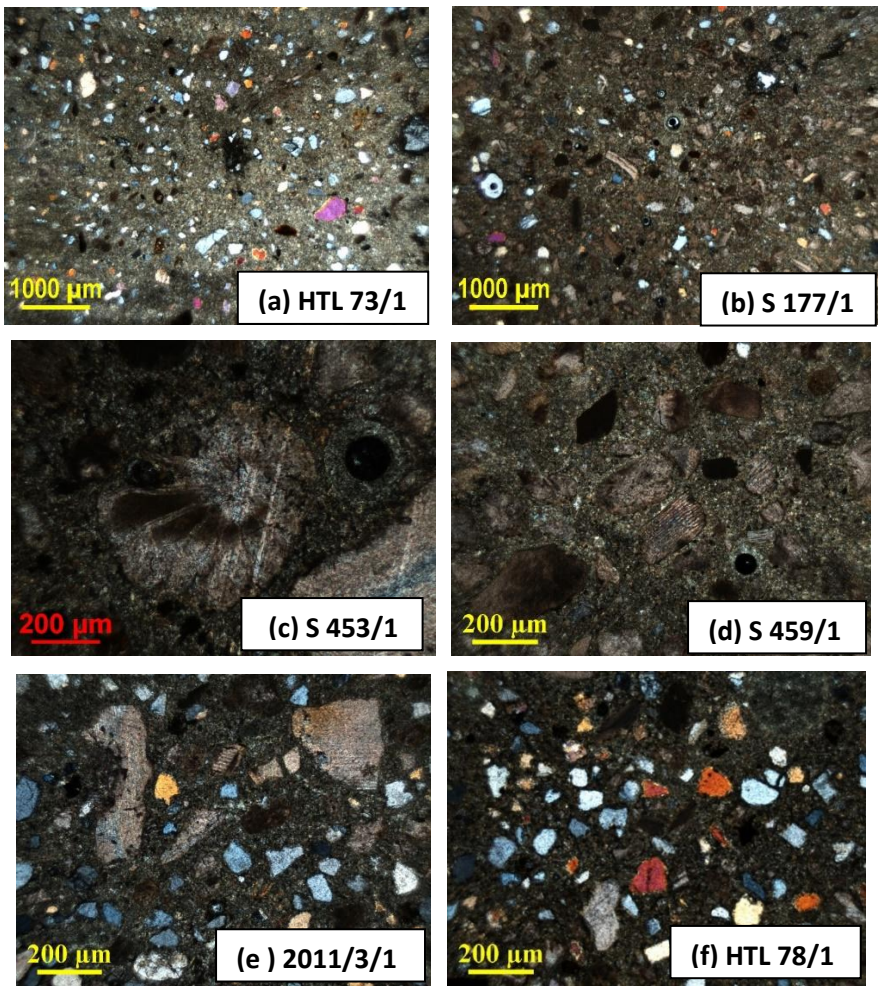

Fig 4. Microscopic images of beach sediments from different beaches of the study area, (a) Corbyn's cove, (b) Chiriyatapu, (c) Neil Island, (d) Neil Island, (e) Wandoor beach, (f) Chiriyatapu

composed of glauconite. The proportion of fossil fragments is less than 1% (hardly one or two in number). Fossils (70-75%) of coral, foraminifera and other invertebrates are common which are made up of micritic as well as spary calcites. They are mainly coral fragments. Trace amount of fine angular siliciclastic materials is found. Overall sediments are poorly sorted, and the shape varies from angular to sub angular. Sediments are almost carbonated in composition. It varies in size from fine to coarse grained and is mostly made up of sparites. The proportion of fossil fragments is very few and is shallow marine benthic in origin. Ooids are completely

absent thus the sediments are deposited in a carbonate shelf environment where wave action is restricted.

4. Discussion

Grain size studies of beach sediments provide a wealth of information on the intrinsic properties of sediments and their depositional environment. Further, they help to delve into the nature and energy flux of the different agents transporting the sediments. According to Friedmann (1961) the textural characters of the sediments are associated to the nature of the depositional medium, particularly its viscosity, density as well as the energy conditions of the environment. In general the attributes of grain size distribution are interpreted in three different ways: (1) the characteristics of the size distribution are explained in terms of hydrodynamics of the depositional processes as recommended particularly by Friedmann (1967) and Visher (1969), (2) the grain size distribution is largely the product of the generative processes of sediments so that the characteristics of a clastic sediment are attributed to the source material (Smalley 1966) and (3) an empirical study of the grain size characteristics of a sediment, with reference to the various geomorphic environment, establishes the relationship, if any, between them (Friedmann 1961).

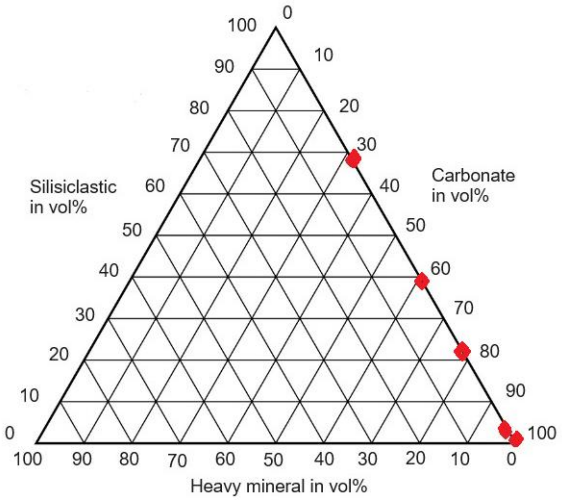

Fig 5. Ternary diagram displaying mineral composition of investigated samples. Composition is separated into siliciclastic, carbonate and heavy mineral in volume%.

The beach sand sediments of the South Andaman Island were mainly medium to coarse grained, poorly sorted. Fine to coarse grain sand is common the beaches of Corbyn's cove, Wandoor and Radhanagar beach of Havelock Island whereas medium to coarse sized materials are commonly found at the beaches of Chiriyatapu and Lakhshmanpur beach of Neil Island. Coarser size of the sediments indicates they have not been transported very far because during the transportation process the grains may become reduced in size due to abrasion. Continuous abrasion results in

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the eventual rounding off the sharp corners and edges of the grains. The angular to sub angular shape of the grains of the study area gives a clear clue to the amount of time the sediment has been in the transportation cycle. Angular shape of the materials is common in Chiriyatapu and Wandoor beaches. Materials are angular to sub angular in Corbyn's cove and Havelock Island. More angularity of the sediments indicates less amount of time they were in the transportation cycle, and they have not been transported very far from their source region or they were deposited in high energy environment. Finally, the highly assorted and moderate to poorly sorted sediments of Corbyn's cove, Chiriyatapu and Wandoor beach indicates that little time has been involved in separating larger fragments from smaller fragments.

The beach sediments of the South Andaman Island were mainly clubbed into two types, siliciclastic and carbonate sediments. Siliciclastic sediments are mainly silica-based (quartz) sediments which are formed from the breakage, transportation and redeposition of terrigenous materials or are transported through long shore currents. Carbonate sediments, on the other hand can originate from a variety of sources including coral and algal reef debris, mixed skeletal material including broken shells, planktonic foraminifera, ooids and pelloids. Mainly the beaches of Corbyn's Cove and Wandoor are dominated by silisiclastic sediments. Because of the ongoing erosion of the adjoining continents the shallow marine environment receives huge quantities of land derived sediments. Other three beaches of Chiriyatapu, havelock and Neil are dominated by carbonate sands. In the tropical regions the influx of carbonate rich mud may be the predominant sediment. Most of these materials consist of the skeletal debris of carbonate secreting organisms mixed with inorganic precipitates. In some cases, the depositional environment is characterised by the introduction of clastic sediments onto the shelf, which is then dispersed by various currents and eventually escapes over the shelf edge into the deep ocean basin. This environment is influenced by tidal, river, wave and oceanic currents, which play a role in the dispersion of sediments. The sedimentation in this environment can be dominated by alternating episodes of siliciclastic and carbonate deposition. A very negligible amount of heavy minerals was found in the sediments of Choriyatapu and havelock. The concentrations of heavy minerals depends on the hydrodynamic conditions like sediments influx from the hinterland, wave energy and velocity, long shore current and wind speed which control littoral transport, sorting and deposition of placer minerals in suitable locales (P. Behra, 2003). A ternary diagram (Fig. 5) is applied to show the compositional data. It plots relative proportion of silica-based sediments, carbonate sediments and heavy minerals whose summation is 100%. The three corners of the triangle represent siliciclastic, carbonate and heavy minerals—i.e., 100% concentration, and the side opposite to a corner represents zero concentration of that component. The studied samples plot mainly indicates a weak concentration of heavy minerals whereas the diagram shows a carbonate and silica concentration in most of the samples are common in the study area. Carbonated sand

s are common in Chiriyatapu, Havelock and Neil islands and the silica based samples are commonly found in Wandoor and Corbyn's Cove due to the presence of river channels.

5. Conclusion

The aim of this research concerns the characterisation of the beach sediment and to bring out the provenance and the sedimentary environment of the materials. The review of the petrographic data from 5 beaches in the South Andaman Islands and their contextualization in their respective geographic and geological environments, has allowed us to determine the nature of the sand grains, their relative abundance and the variability of their different sources and their depositional environment.

Based on the results of interpretation and discussion, it can be concluded:

1. All the sediments were deposited in the shallow marine environment. Sediments are of two distinct provenances. i) siliciclastic sediments found in the study are mainly terrigenous in origin and secondary weathering products. and ii) purely carbonate shelf sediments, which are deposited by the direct precipitation of inorganic chemical components from water. These sediments are called Authigenic Sediments as they form within the basin but are locally reworked. The islands from Ritchie's Archipelago are mainly of this type. Some of the samples show mixed type which signifies that they are deposited in both siliciclastic and carbonate shelf environment. Geologically, the materials are deposited in the shallow marine mixed facies. Generally, they are deposited under marine transgressive and regressive condition.
2. The sediments collected are of Mixed Marine Facies where both siliciclastic and carbonate particles are found. The siliciclastic sediment component enters the depositional site via longshore transport and the carbonate sediments are formed in place and mix via nearshore marine processes and are distributed in a narrow belt of sandy beaches encircling the islands.
3. Because of the shallow water nature of the deposits, micro fossils are not much significant. The deposits contain benthic foraminifera which became useful in understanding the paleo environmental conditions.

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