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Clay Minerals in the Sediments around the Andaman Islands

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Clay minerals in the eastern side of Andaman Islands consist of montmorillonite, kaolinite, illite and Fe-rich chlorites while on western side they consist of illite and Fe-poor chlorite with minor kaolinite and montmorillonite. These assemblages have different provenances. The Andaman sea clays are derived largely from the sediments transported by the Irrawady river, while the western side shelf sediments (on the Bay of Bengal side) are derived from the weathering products of the rocks on the Island proper and the slope samples show contribution from the Ganges. Distribution of detrital minerals such as quartz and feldspar support the above conclusions. The 2 distinct clay mineral provenances result because the Andaman Islands appear to be a barrier to the mixing of the 2 clay mineral suites.

The Paleogene Andaman Nicobar trough was thrust or overfolded to the westward as an asymmetrical anticline resulting in the emergence of Andaman Islands during Oligocene and late Miocene[1]. The early Tertiary sediments are the most dominant type and cover nearly 75% of the surface area[2]. Late Tertiary and Quaternary sedimentaries and ultrabasic and basic rock types in scattered outcrops occur in the Great Andamans but are dominant in Rutland Islands and-Nicobars.

The Andaman and Nicobar Islands separate the Bay of Bengal from the Andaman sea. The continental shelf is very much wider on the western side than on the eastern side (Fig.1). A series of coral banks and islands occurs at a distance of approximately 22 km with an average depth of 72 m along the edge of the western shelf. The eastern slopes are strongly indented, steep and in many places raised coral beaches are reported[3]. Along the eastern Andamans a series of ridges and depressions such as Alcock seamount and Narcondam Barren Basin are present. Dredged samples collected from their floors are basalts[4]. The Eastern Andaman is influenced by the Irrawady river drainage which flows through Pliocene-Pleistocene terrain and small rivers such as Salween draining through granites. Clay minerals of the sea floor sediments around the Andaman Islands are studied to provide an explanation for their distribution.

Materials and Methods

Snapper samples (17) collected during the 51st and 52nd cruises (Jan.-Feb. 1979) of *R V Gaveshani* in the vicinity of Andaman Islands were analysed for the distribution of clay minerals. The samples were from 80 to 2200 m depth (Fig.1), and shallow samples were collected from the western side.

Fractions $< 2\ \mu$m were used for the analyses. They were freed from calcium carbonate and organic matter by treating with acetic acid and hydrogen peroxide respectively. Air dried clay samples were prepared by pipetting on a glass slide. These slides were scanned from 4° to 30° at 2° 2θ.min^{-1} and 24° to 26° at 1/2° 2θ.min^{-1} on Philips X-ray diffractometer using nickel filtered Cu Kα radiation. Percentages of weighted peak area[5] of the principal reflections of clay minerals (10 Å of illite, 15 Å of montmorillonite, 7.15 Å of kaolinite and chlorite) were determined[6].

Percentage of quartz + illite and feldspar in the samples were also estimated. It may be pointed out here that the estimate of quartz + illite will not represent quartz alone, but the sum of the 100% peaks of illite (003) and quartz (101) especially when such estimates are made on pipette-on-glass slide samples.

Results and Discussion

Clay mineral distribution—Clay minerals observed in the sediment samples are montmorillonite, illite, kaolinite and Fe-rich and Fe-poor chlorites (Table 1). For convenience, the study area is divided into 4 offshore regions, viz. (i) Narcondam Barren Basin (NBB), (ii) Eastern Little Andamans (ELA), (iii) Western Great Andamans (WGA), (iv) Western Little Andamans (WLA). The name NBB is adopted from Rodolfo[4] for the Eastern Great Andamans.

Montmorillonite: This is the most abundant clay mineral group in the eastern part of the study area (Fig.2). It increases from north to south of the Eastern Andamans with high values (av. 65.5%) at Nicobar Islands and low values (av. 34.4%) at NBB and intermediate values (av. 45%) at ELA. Montmorillonite occurs in traces in the western part of the study area, except in samples 1204 and 1203A.

Illite: The most dominant mineral group off the western Andamans is illite, with an average of 49% in

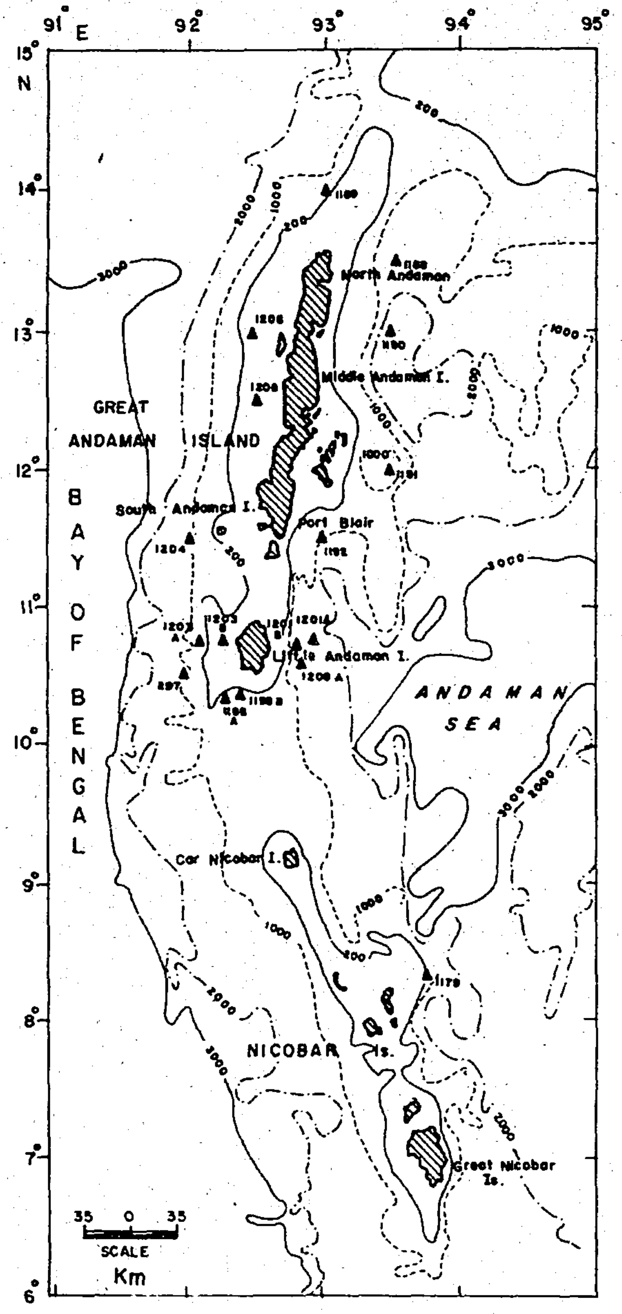

Fig. 1—Bathymetry and sample location

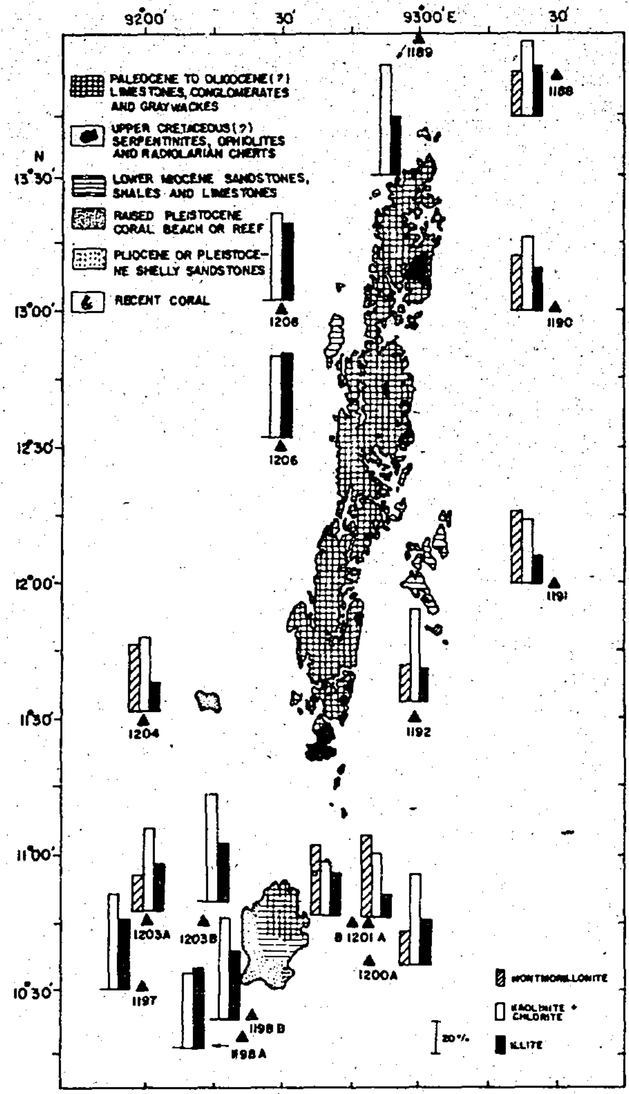

Fig. 2—Clay mineral distribution in sediments around the Andaman Islands (Island geology from Geological Survey of India, 1944)

WGA and 42.5% in WLA (Fig.2). Relatively low values at NBB (av. 24%) and ELA (av. 17%) are observed.

Kaolinite and chlorite: Abundance of kaolinite and chlorite is estimated on the basis of their peak (24.9° and 25.2° 2θ respectively) area obtained from the slow scan ($\frac{1}{2}°$ 2θ.min^{-1}) diffractogram. Their peak area ratios are given below.

Kaolinite is dominant in the NBB with average K/C of 1.2 (Table 1). It reduces to K/C of 1 in the sediments of ELA. Kaolinite is relatively low in the Western Andamans, with low K/C of 0.5 in WGA and 0.8 in the WLA.

Chlorite is more dominant off the Western Andamans than off the Eastern Andamans. Based on the intensity of basal reflections, 2 varieties Fe-rich and Fe-poor chlorites, were identified. According to Grim[7] Fe-rich chlorites show weak (001) and (003) reflections, while Fe-poor varieties have a strong (001) and (003) reflections. Fe-poor varieties are characteristics off Eastern Andamans and around Little Andamans, and Fe-rich varieties in the NBB sediments.

Clay mineral assemblages—Based on the above data 2 clay mineral assemblages, i.e. Eastern Andaman assemblage, and Western Andaman assemblage, can be distinguished. The abundance of minerals typical of one region grade into those of adjacent region in certain transitional areas.

Table 1—Distribution of Clay and Non-clay Minerals in Sediments

Sample No.	Depth (m)	Weighted peak area of			Kaolinite area / Chlorite area	Quartz & Illite %	Feldspar %
		Montmorillonite %	Kaolinite & Chlorite %	Illite %			
1189	380	T	65.5	34.1	1.8	42.9	11.2
1188	1300	25.8	45.2	28.9	1.2	26.7	7.6
1190	2150	32.9	44	23	1.2	26.3	4.4
1191	1650	43.5	39.1	17.4	1	22.4	9.1
1192	600	22	57.3	20.6	1.3	37.4	10.6
1201B	1225	42.7	32.8	24.5	0.9	25.0	8.3
1201A	1440	48	39	13	1.2	20.9	6.1
1200A	1500	19.4	53.4	27.2	0.8	26.3	6.2
1179*	300	65.6	21.5	12.8	2.4	4.5	3.2
1208	85	T	53	46.9	0.4	40.1	9.2
1206	80	T	49.2	50.8	0.6	43.2	17.3
1204	1200	39	44.3	16.7	0.4	28	1.7
1203B	140	T	64.4	35.5	1.2	41.2	8.1
1203A	825	21.4	50	28.6	0.7	33.3	4.1
1197	1300	T	58.1	41.9	0.6	43.9	10.1
1198B	470	T	60.2	39.7	0.9	44	4.9
1198A	710	T	46.2	53.7	0.5	47.4	15

*Clay mineral data not shown in Fig.2. T = Trace

Eastern Andaman assemblage is characterised by montmorillonite, kaolinite dominated clays with low illite and chlorite. Illite-chlorite rich assemblage is present on the Western Andamans with kaolinite in less abundance. Montmorillonite is present in the slope samples of the WLA.

Origin and dispersal of clay minerals—Detailed studies on the clay mineralogy of the rock groups of the Andamans have not been done. Grim[7] reported the dominance of illite and chlorite-mica and a small component of montmorillonite and kaolinite in shales, illite from limestones, chlorite from greywacks[8] and sandstones contribute kaolinite. WGA stations are shallow and the continental shelf samples therefore contain clay minerals which are derived from the weathering of Island rocks particularly the Tertiaries which are the most extensive formations on the Islands. Siddiquie[9] reported similar concentrations of illite in some of the Bay of Bengal samples close to the Islands and he has attributed their origin from the micaceous shales and sandstones found on the middle and south Andamans.

The increase of illite in the slope samples (1203A, 1203B, 1197; Fig. 2) off WLA could be due to the influence of Ganges which contributes enormous quantities of illite and quartz. High detrital mineral percentages of quartz and feldspar provide supporting evidence for the fact that these sediments are derived from the Ganges.

Distribution patterns of montmorillonite and kaolinite dominated clays (Fig.2) occurring in the Eastern Andamans particularly in the NBB are quite different. These samples are from deeper waters in this area. Chlorite in this region is the Fe-rich variety. It is evident from the above that the eastern side of the Andaman islands do not play a major role in contributing the sediments to the NBB. It could be due to the occurrence of coral reefs along the coast which may act to some extent as barriers to the transport of sediments to the deeper regions from the shelf. On the other hand it is possible that these sediments have been deposited by the river Irrawady and to some extent are the weathering products of *in situ* basalts present on the sea floor. Rodolfo[10] indicated that the NBB is dominated by montmorillonite and kaolinite clays and that their source is in the discharge of Irrawady and Salween rivers, and the weathering of the sea floor features like the Alcock seamount which are made up of basaltic rocks.

Sts 1201A, 1201B, and 1200A (Fig.1) are in the close proximity to the Little Andamans, unlike the rest which are further away from the Islands. Therefore the change from Fe-rich to Fe-poor chlorite in these samples could be due to the fact that the Little Andamans contribute Fe-poor chlorite which is transported to the continental slope and mixed with the clay minerals brought by the river Irrawady (Fig.2).

Increase of montmorillonite (Fig.2) to the south in

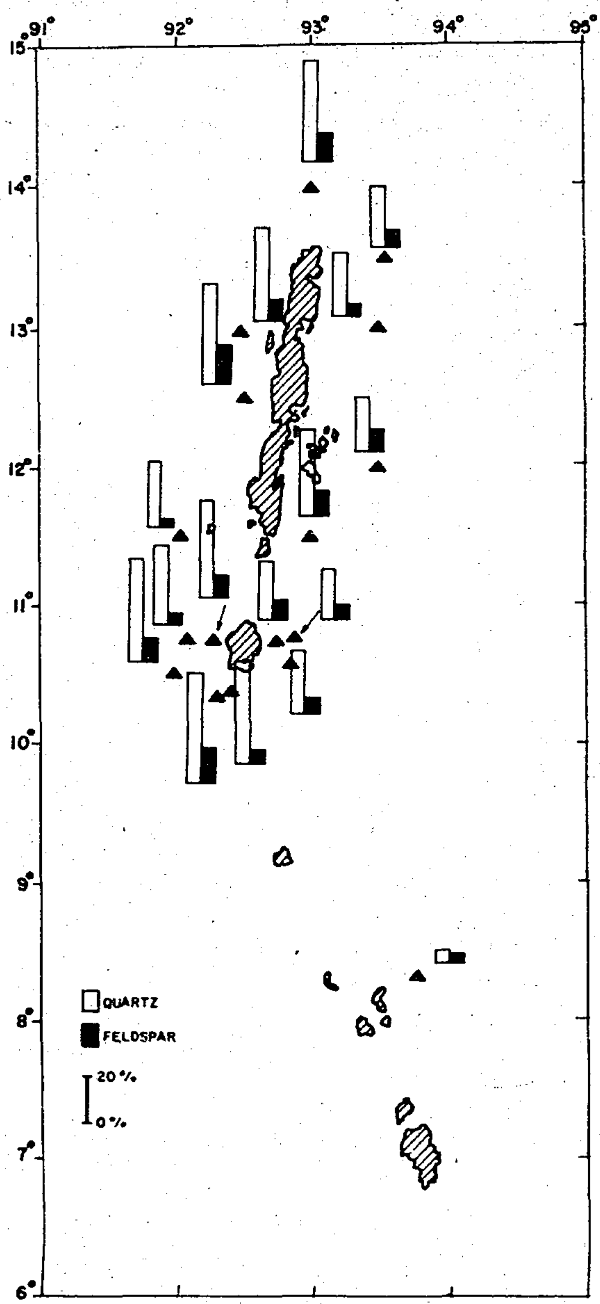

Fig. 3—Distribution of quartz and feldspar in the clay size (<2 μm) fraction of the sediments

the Andaman sea could be due to the selective size segregation of montmorillonite. This is due to the fact that montmorillonite is much smaller in size than the other clay minerals. Similar phenomena for the increase of montmorillonite from the source have been reported by Purnachandra Rao *et al.*[12] from the Kerala continental shelf and slope, Porrenga[13] in the Niger delta sediments and Gibbs[11] from the Amazon River/Atlantic Ocean. The probable source for the montmorillonite in the slope stations of the WLA might be from the Rutland Islands which are composed of serpentinites and which in turn weather to montmorillonite clays.

Montmorillonite is absent or present in trace quantities in the Western Andaman samples whereas it is always present in the Eastern Andamans. It indicates that the Andaman Nicobar Island chain acts as an effective barrier to mixing of the 2 clay mineral assemblages present in the Bay of Bengal and Andaman Sea.

Distribution of the non-clay minerals—The non-clay minerals present in the sediment samples of <2 μm size fraction are quartz and feldspar (Fig.3). Percentage of quartz + illite is high (av. 40.2%) on the Western Andamans and low (av. 25.8%) on the Eastern Andamans, while the percentage of feldspar is higher (av. 9.0%) on the Western Andamans than the Eastern Andamans (av. 7.3%; Fig.3).

It is apparent from the data (Table 1) that the distribution of quartz + illite closely follows the distribution of illite indicating that this quartz + illite is mainly influenced by illite than quartz. This is possible because the 100% basal reflection of illite (003) coincides with the 100% reflection (101) of quartz.

Lower percentages of these detrital minerals in the Andaman Sea indicates that the influence of the Andaman islands on the Andaman Sea side is less, whereas their higher percentages on the western side shows that similar to the clay minerals distribution, their source is mainly from the Islands. On the western side of the islands, the slope sediments have their source in the Gangetic Fan.

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