

## Clay mineral distribution from Bhimunipatnam to Pudimadaka along central eastern continental shelf of India

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Received 25 April 1988; revised 2 February 1989

Forty eight sediment samples, collected from 50-100 m depth, have been analysed for their clay mineral composition and distribution. Kaolinite with chlorite (K + C) is the predominant mineral followed by illite and montmorillonite. K + C and illite appear to originate from the coastal red sediments and from the nearby Precambrian khondalites while montmorillonite is supplied by river Godavari from its drainage basin (Basaltic Deccan Traps) dispersed towards north by NE directed SW monsoon currents.

Studies on the clay mineralogy of shelf sediments from different areas of Bay of Bengal were made.<sup>1-3</sup> Subramanian<sup>4</sup> studied the clay mineralogy of the suspended loads and Naidu *et al.*<sup>5</sup> the bed loads of major rivers including Ganges, Brahmaputra, Mahanadi, Godavari, Krishna and Narmada. The objective of this paper was to identify the source and to study the distribution of clay minerals in the area.

The continental shelf from Bhimunipatnam to Pudimadaka has an average width of 40 km and shelf break occurs at about 200 m depth. Three minor rivers Gostani, Sarada and Tandava flow in the region. Major Peninsular rivers Godavari and Krishna flow to the south of the study area while Vamsadhara and Nagavalli to the north. The sediments in the study area consist of sands up to a depth of 30 m followed by clays and silty clays extending up to 60 m at Visakhapatnam and 80 m at Bhimunipatnam (> 20%). Further offshore, on the outershell they are (relict) mixed elastic and calcareous sediments with < 20% clay.

The coastal hinterland in the study area is covered by eastern ghats comprising Precambrian khondalites, granulites and charnockites and their weathering products<sup>6</sup>. Red sediments are present along the coast from Bhimunipatnam to Visakhapatnam. These red sediments being loamy deposits with ferruginous clay and silt as matrix yield easily to rainfall. The red sediments are prominent between the coast and the nearby khondalite hill range between Visakhapatnam and Bhimunipatnam.

### Materials and Methods

During the 129 cruise of *R V Gaveshani*, 44 sediment samples were collected by Peterson grab along

6 profiles (Fig. 1). Four samples on one profile off Pentakota were collected during the 156 cruise of *R V Gaveshani*. In all 48 samples were analysed for this study. These samples were collected from a depth range of 50 to 100 m. Representative subsamples of each grab sample were oven dried at 60°C and following Folk<sup>7</sup>, < 2 µm fraction of the clay was separated and made free of calcium carbonate and organic carbon by treating with acetic acid and hydrogen peroxide, respectively. Oriented clay samples were prepared by pipetting the clay solution on the glass slides and were allowed to air dry. These were scanned from 3° to 30° at 2°2θ/min on a Philips X-ray diffractometer using Ni filtered Cu Kα radiation. Standard tests were carried out for confirmation for montmorillonite by glycolation<sup>8</sup> and rescanned with the same instrumental settings. Major clay minerals were identified<sup>9</sup> and the areas of the principal peaks of the clay minerals were measured

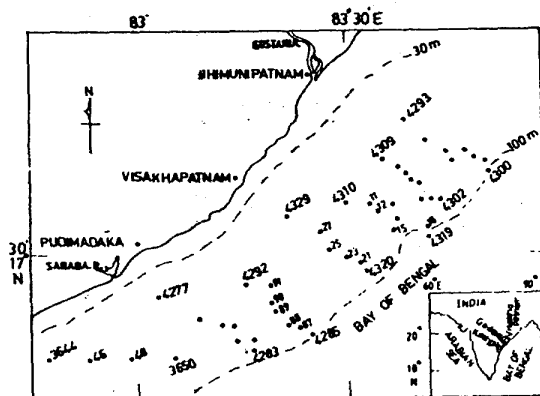


Fig. 1—Sample location

above the baseline from the glycolated X-ray diffractogram and the abundances were calculated<sup>10</sup>.

**Results and Discussion**

Clay minerals found in the area (Fig. 2a) are kaolinite plus chlorite (K + C), illite and montmorillonite. K + C is the predominant mineral (30-60%) in the study area (Fig. 2b). Its distribution parallel to the coast shows that it is more abundant off the river mouth i.e. on the shelf where river Gostani joins the sea than in the other area. Perpendicular to the shore a gradual decrease is found towards offshore. The source for K + C may be the drainage areas of red sediments, Precambrian khondalites, granulites and charnockites and their weathering products in tropical humid climate brought by various small rivers and streams. Apart from the river source, strong current and wave action on the red sediments along the coast also contribute to the K + C content. Clays from red sediments are kaolinite rich with appreciable amounts of illite and traces of smectite and chlorite. Longshore drift and current action up to a depth of 30 m do not allow the finer sediments to settle, therefore, higher concentrations of K + C is noted in the finer sediments thereafter in the inner-shelf. K + C content decreases further on the mid shelf.

Illite content varies from 20 to 50% and is high towards offshore (Fig. 2c). Rao *et al.*<sup>3</sup> have suggested that the Ganges-derived sediment does not reach the shelf off the peninsular rivers. The illite content in the bed loads of rivers Godavari and Krishna<sup>3</sup> is far low compared to the values in the study area. Therefore it may be that illite has its origin along with K + C from the coastal red sediments and hinterland Precambrian khondalites. In the red sediments as reported by Rao and Raman<sup>11</sup> feldspars are converted into illite in the presence of gibbsite and the increase of illite off Bhimunipatnam can best be explained due to these red sediments. Comparatively low values towards Pentakota may be due to the mixing of the sediments with influx from Godavari, dispersed towards north by northeast flowing SW monsoon currents<sup>12</sup> and due to lack of coastal red sediments in this area.

Montmorillonite content varies from 10 to 50%. It is found in higher concentrations from Pentakota to Pudimadaka further decreasing towards Bhimunipatnam (Fig. 2d). In the study area the contribution of montmorillonite must have been derived mainly by the river Godavari from where values as high as 80% have been reported from the bed loads and its predominance is most likely related to the dominance of basalts of Deccan Traps of the drainage basin and the pedological processes in the semi

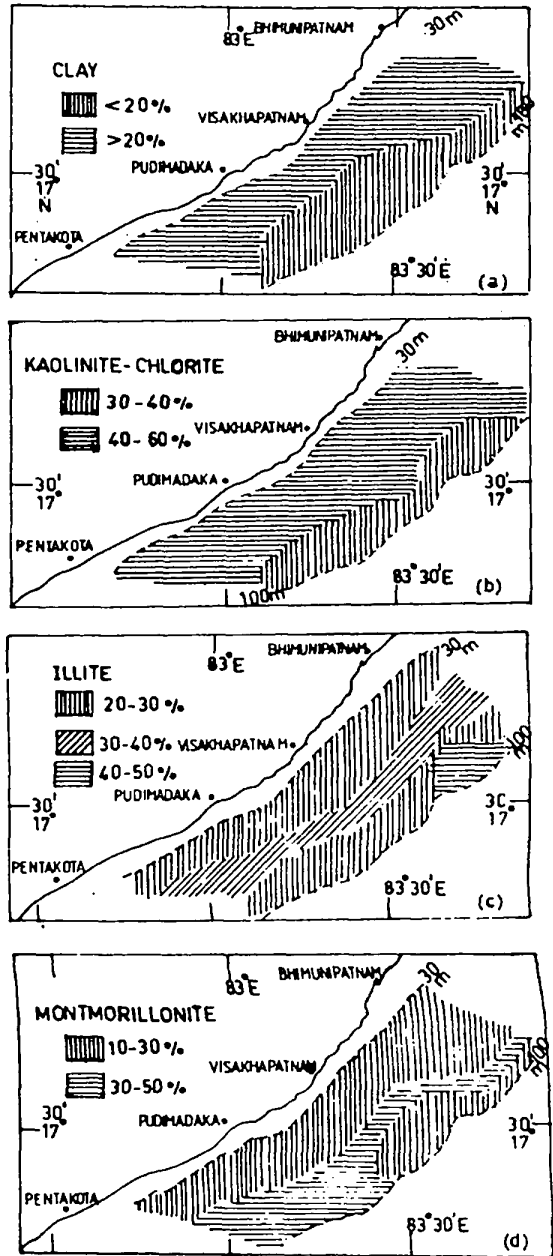


Fig. 2—Percentage distribution of clay (a)kaolinite + chlorite (b), illite (c) and montmorillonite (d)

arid climatic conditions<sup>7</sup>. Northeast directed currents of SW monsoon play a major role in the dispersal of these sediments<sup>12</sup>. The influence is maximum up to Pudimadaka and reduces further north as seen from the distribution of montmorillonite. Rama Sastry and Bakaramanurthy<sup>13</sup> from their thermal

field studies have reported that in the upper 30 m surficial layer of water an irregular current pattern is noticed. In the north of the Godavari river confluence the surface currents are directed towards north while south of the Godavari confluence they are directed towards south. From this it can be deduced that the supply of material is mainly from Godavari. The montmorillonite tends to remain in suspension longer and the coarser fractions of the clay minerals settle to bottom at a rate faster than the finer fractions and the final result is a size segregation<sup>14</sup>. Therefore, the montmorillonite is being carried further north by the currents while the illite and kaolinite are settled early.

Gibbsite being a common product of laterite along with kaolinite in humid tropic zones<sup>15</sup> is absent in the area, may be due to its alteration to kaolinite in the source rocks i.e. red sediments and laterite capped khondalites<sup>11</sup>.

Therefore it may be concluded that the source for K + C and illite is attributable to coastal red sediments and khondalites in the study area while montmorillonite is being supplied by the Godavari, aided by NE flowing SW monsoon currents.

### Acknowledgement

The authors are thankful to Dr. B.N. Desai, Director, Dr. T.C.S. Rao, Mr. P.S.N. Murthy and Mr. R.R. Nair for their encouragement.

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