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Sediment texture, distribution and transport on the Ayeyarwady continental shelf, Andaman Sea

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Abstract

The Ayeyarwady continental shelf is a complex sedimentary system characterized by large sediment influx (>360 million ton/yr), a wide shelf (>170 km), a strong tidal regime (7 m maximum tidal range), and incised by the Martaban Canyon. Grain size distribution on the Ayeyarwady shelf reveals three distinct areas in terms of sediment texture (i) a near-shore mud belt in the Gulf of Martaban and adjacent inner shelf (ii) outer shelf relict sands and (iii) mixed sediments with varying proportions of relict sand and modern mud in the Martaban Canyon. The bulk of the terrigenous sediment discharged by the Ayeyarwady River is displaced eastwards by a combination of tidal currents and clockwise flowing SW monsoon current and deposited in the Gulf of Martaban resulting in shoaling of its water depths. Part of the sediment discharge reaches the deep Andaman Sea via the Martaban Canyon and the rest is transported westward into the Bay of Bengal by the counter-clockwise flowing NE monsoon currents.

Keywords: sediment texture; sediment transport; Ayeyarwady river; Gulf of Martaban; continental shelf; Andaman sea

1. Introduction

River borne sediments dispersed into the coastal ocean undergo several cycles of transport, deposition and resuspension before they become part of the long-term geological record. Factors such as particle size, rate of sediment supply, oceanographic regime (waves, tides and currents) and the geometry of the shelf influence sediment dispersal and transport pattern. Asian rivers have high sediment yields as a result of high relief and rainfall in their drainage basins. Most of the larger Asian rivers like the Indus, Ganges-Brahmaputra, Yangtze and Ayeyarwady, discharge the sediment directly into macro-tidal regions. The sediment influx from these rivers is transported along the shelf by the monsoon currents or carried to the deep-sea floor through submarine canyons. In addition, more than 80% of the sediment and fresh water influx takes place during a time span of 4 months of the southwest monsoon period (May–August). Because of this combination of high tidal

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energy, monsoon related circulation and episodic sediment and freshwater influx, the sedimentary processes on the Asian shelves are different from those operating in the temperate and polar regions. Understanding the sedimentary processes in these areas is important as 30% of global river discharged sediment to the ocean is from the Asian rivers (Milliman and Meade, 1983). Study of these processes are also very important from the climate change point of view as 85% of the total global organic carbon burial rates occurs in deltaic and shelf sediments (Berner, 1982).

The Ayeyarwady River (formerly known as the Irrawaddy River) is the fifth largest in the world in terms of sediment discharge and together with the rivers Salween and Sittang discharges annually more than 360 million ton of sediment on to the Ayeyarwady continental shelf in the northern Andaman Sea (Meade, 1996; Milliman and Meade, 1983). The Ayeyarwady shelf is a complex sedimentary system characterized by a wide shelf (width>170 km) and seasonally reversing surface circulation linked to the Asian monsoon. The Ayeyarwady River debouches its sediment load directly into a macro tidal area (maximum tidal range 7 m). Very little is known about the nature of sedimentary processes on the Ayeyarwady shelf. The sparse data available on sediment distribution in the Andaman Sea was collected during the International Indian Ocean Expedition in the 1960s (Rodolfo, 1969). In April–May 2002, India and Myanmar organized a joint multidisciplinary oceanographic cruise to study oceanographic and geological aspects of the northern Andaman Sea. In a previous paper (Ramaswamy et al., 2004) we reported suspended sediment concentrations in the northern Andaman sea and oscillation of the turbid front by about 150 km, in phase with spring-neap tidal cycle in the Gulf of Martaban. In this paper, we investigate textural variation in 120 surficial samples to understand sediment distribution and transport mechanisms on the Ayeyarwady continental shelf.

2. Study area

The Ayeyarwady continental shelf is part of a complex geological setting in the Andaman Basin (Curray et al., 1979). The shelf width is about 170 km off the Ayeyarwady River mouths and increases to more than 250 km in the center of the Gulf of Martaban (Fig. 1). A complex system of N–S trending dextral strike slip faults runs through the Gulf of Maratban and the Ayeyaerwady shelf; the most prominent of these is the Sagaing Fault System that extends southwards and joins the Central Andaman Rift (Curray et al., 1979; Kamesh Raju et al., 2004). A N–S trending 120 km wide bathymetric low is present between the above fault systems and the Malay continental margin. The Martaban Canyon lies within this bathymetric low and appears to be controlled by the N–S trending fault systems (Fig. 1). Seafloor in the Gulf of Martaban and adjacent inner shelf is generally smooth whereas the outer shelf has a rough surface with relief of 2–20 m and has topographic features such as pinnacles, highs and valleys, buried channels and scarps. Bathymetric data acquired during the present study shows that the shelf break is at 110 m isobath (Fig. 1). Beyond the shelf break the depth increases rapidly to approximately 2000 m, except in the bathymetric low. The seafloor within the bathymetric low is riddled with erosion channels and "V-shaped" notches.

The Andaman Sea experiences the seasonally reversing Asian monsoon (Wyrtki, 1973). Circulation in the Andaman Sea is cyclonic during southwest monsoon (May–September) and anti-cyclonic during northeast monsoon (December–February). The Gulf of Martaban is a macro-tidal area with its highest tidal range of nearly 7 m recorded at Elephant Point (Fig. 1; Indian Tide Tables, 2002). Near the mouths of the Ayeyarwady, tidal range is between 2 and 4 m and can be classified as meso-tidal. The tides in this area are semi-diurnal with M2 (principal lunar) and S2 (principal solar) being the major components. The tidal currents are strongest during spring tide, reaching as high as 3 m/s in the Gulf of Martaban (Bay of Bengal Pilot, 1978).

The Ayeyarwady River discharges >430 km^3 of fresh water and >260 million ton of sediment annually, of which more than 80% is during the southwest monsoon (Rodolfo, 1969). The annual sediment discharge from the Salween is about 100 million ton (Meade, 1996). It may be pointed out that these estimates of run off and sediment discharge for both the rivers are not recent. We assume that these