A PLEISTOCENE CYCLOTHEM IN THE ROKEL ESTUARY (SIERRA LEONE, WEST AFRICA)[1]

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ABSTRACT

Strasser-King, V. E. H. 1979 A Pleistocene cyclothem in the Rokel estuary (Sierra Leone, West Africa) – Geol. Mijnbouw 58: 337-340.

Pleistocene sediments overlie the area around the Rokel estuary of Sierra Leone. These are part of a series of Tertiary and Quaternary sediments forming the Bullom Group. Borehole samples of the Pleistocene sediments reveal a sequence of interbedded sands and clays with horizons of lignite. Repetition of the sequence is observed and has led to the establishment of a cyclothem. It is concluded that the cyclothem results from sea-level changes in the area during the Pleistocene.

INTRODUCTION

Sediments of the area around the Rokel estuary in Koya (Sierra Leone) are now of economic interest with regard to brick manufacture. Horizons of lignite occurring within them are a potential source of fuel. However, very little study of the area has so far been done; the only material available being brief mentions of the sediments in accounts of the general geology of Sierra Leone.

This investigation is aimed at obtaining details of the sedimentary sequence and depositional history of the area with a view towards laying the foundation for a more comprehensive study of the lateral extent and character of sedimentary units of economic significance as well as their provenance.

About 20 boreholes were made in the area by Banka drilling to depths averaging 30 m and samples taken at 0.5 m intervals. Sections along tidal creeks were also sampled.

Most of the conclusions arrived at were based on correlation of the borehole logs and study of the distribution of contemporary sediments in and around the estuary.

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BULLOM GROUP

Sediments in the Koya area of Sierra Leone represent part of a series of Cenozoic, mainly unconsolidated and nearly horizontal sediments forming the Bullom Group. This group extends along the entire coast of Sierra Leone forming a belt 25 to 45 km wide. It rests unconformably upon the Kasila Group and in the vicinity of Freetown upon the layered basic complex; extending seawards into the continental shelf (Fig. 1).

The sediments consist of a series of sands, clays and gravels with occasional thin beds of argillaceous limestone and calcareous grit as well as seams of lignite, and in some cases horizons of sandy clay with lateritized nodules.

The thickness of the group is variable but, according to HAWKES (1970), appears to attain a maximum of about 120 m east of Freetown. Offshore the sediments may be thicker and may exceed several thousand metres (SHERIDAN ET AL., 1969).

The sediments are believed to range in age from early Tertiary to Quaternary. A sparse fish and mollusc fauna obtained from deep boreholes suggest a probable Eocene age for some of the lower members of the Group (HAWKES, 1970), whereas radiocarbon dating for the upper parts suggests a Pleistocene age.

It is apparent from field observations that, though all these sediments are grouped as 'Bullom', the depositional history is

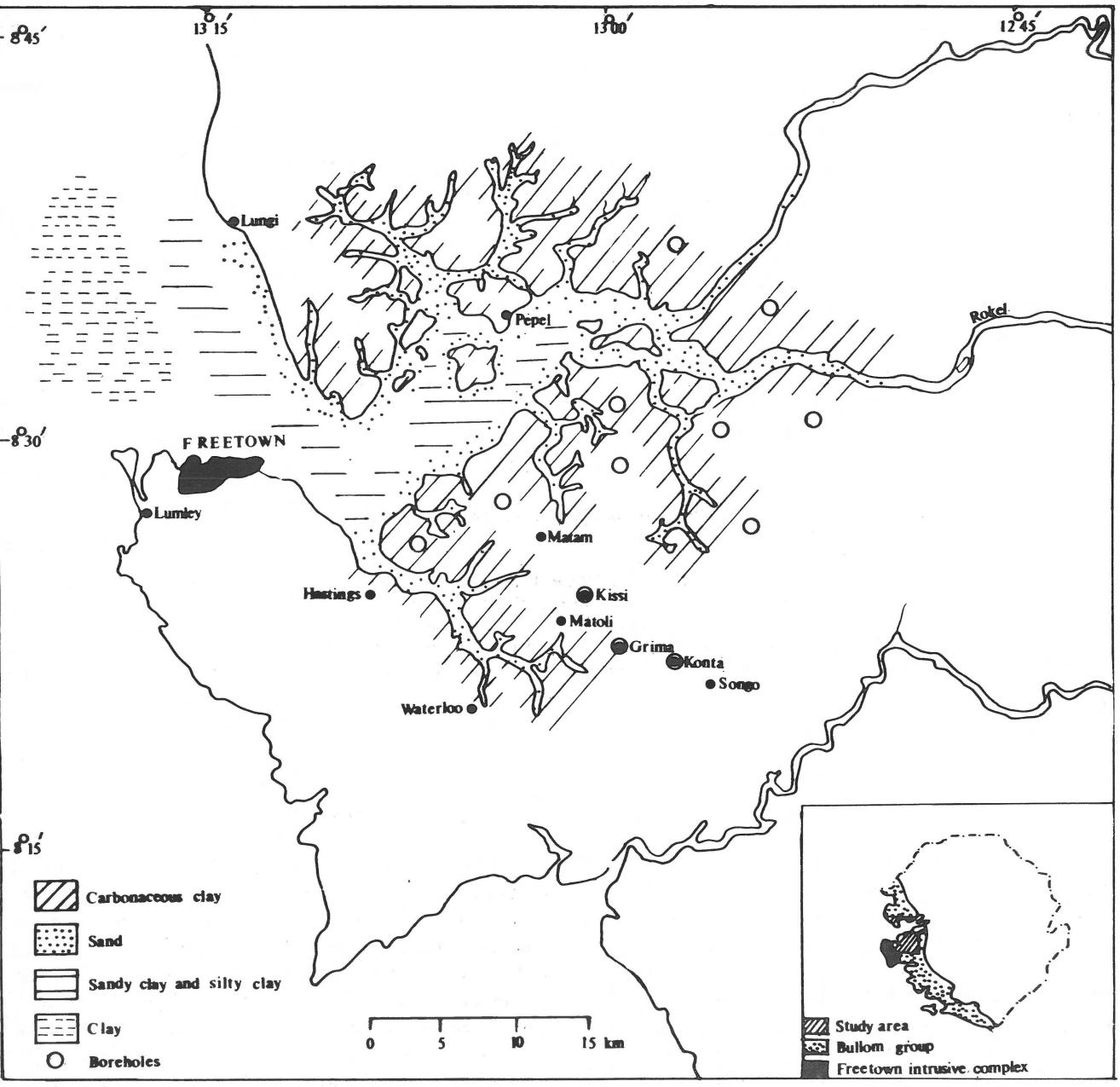

Fig. 1
Schematic representation of present day distribution of sediments in the Rokel estuary.

not identical throughout the entire group. It is hoped that detailed work will result in a subdivision of the group as different facies are recognised.

DEPOSITIONAL SEQUENCE IN THE ROKEL ESTUARY

Surface outcrops and borehole data in the area around the estuary reveal a sequence of clay, silty sand and silty clay, sand and sandy clay, silty clay and grey clay, and lignite.

Within most of the successions, repetition of the sequence was recognised (Fig. 2). On the basis of data from about twenty boreholes, an ideal sedimentation cycle (cyclothem) consisting of eight units has been constructed for the area (Table I). Only five units or less are represented in each cycle in any borehole section. The number of units present is dependent upon several factors which include: (1) the erosional history of the area; (2) the relative distribution of sediments deposited over the area; (3) the location of the borehole relative to the palaeo-morphological features of the area.

SEDIMENT DISTRIBUTION IN THE ESTUARY

The distribution of sediments in the present-day estuary serves as a guide to the depositional history of the area (Fig. 1). TUCKER (1973) recognised the following four environments of deposition in the estuary, which was later confirmed by the author.

(1) Sand bars, generally parallel to the current direction and occurring predominantly in the lower reaches of the estuary. The sand bodies occur as subtidal or intertidal sand bars within the main channel.

(2) Channel sediments, generally coarser than those of the adjourning intertidal area, reaching pebble grade with locally derived laterite clasts in the lower reaches of the estuary.

(3) Intertidal flats containing sediments of median grain size varying from clay to medium sand. The clays are generally dark grey or black in colour.

(4) Mangrove swamps occupying the upper intertidal and low supratidal environment. The sediments of the mangrove areas are generally black or dark grey muddy silts and sandy muds containing a lot of organic matter, mostly fine rootlets and thick roots of mangrove (*Rhizophora*).

MCMASTER ET AL. (1971) investigated the sediment distribution on the continental shelf off parts of West Africa north of latitude 8°. Although samples were not collected within 40 km off the Rokel estuary, it is felt that fine clays were deposited in the quiet waters within this zone (Fig. 1).

DEPOSITIONAL HISTORY

De Raaf et al. (1965) distinguished constructive facies comprising thick sediments deposited during delta progradation, from destructive facies represented by thin bioturbated siltstone beds accumulated after abandonment. The latter was described as abandonment facies by ELLIOTT (1974). Similar facies are recognised in the estuarine environment.

Table I
Ideal Koya cyclothem.

Mottled Clay		
(8) Silty sand and silty clay (7) Sand and clayey sand (6) Silty clay and grey clay		Transgressive sequence
(5) Lignite	Abandonment facies	
(4) Silty clay and grey clay (3) Sand and clayey sand	Aggradational facies	Regressive sequence
(2) Silty sand and silty clay (1) Mottled clay	Progradational facies	

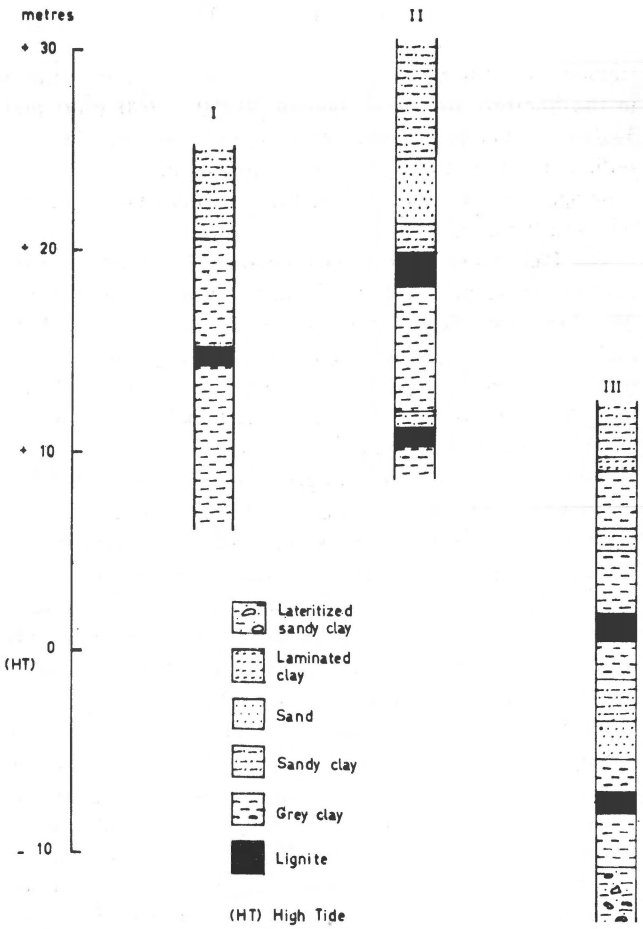

Fig. 2
Logs of three representative boreholes showing repetition of units. (1) Located at Konta (2) at Grima and (3) at Kissi (locations shown in Fig. 1).

The available evidence indicates that the pre-Pleistocene environment of the investigated area was similar to today's setting. The sedimentary sequence shown in the area is a response to the interaction of fluvial and marine processes. The cyclothem reflects shoreline progradation commencing with an interval of finely laminated clay which was deposited in quiet waters outside the estuary (Table I). It is overlain by silty sand and silty clay deposited at the mouth of the estuary. This sequence of laminated clay, silty sand and silty clay represents the 'progradational facies'.

This facies is overlain by sand and clayey sand, deposited as channel mouth bars and in tidal channels. In the tidal flats, fine sediments, moved on-shore by tidal action, were deposited. Considerable thickness of clays, silty clay and grey clay were thus built up. These sands and clays represent the 'aggradational facies'.

The clays deposited in tidal flats were subsequently invaded by plants, mainly mangrove, during periods of non-deposition. The accumulated vegetable matter gave rise to deposits of lignite, the 'abandonment facies.'

GEOLOGICAL HISTORY

Radiometric dating of two shallow lignite horizons near Lanti in the Sherbro area gave ages of 30,250 ± 690 years and 34,840 ± 1200 years (Raufub in HAWKES, 1970). Thus the sediments, at least those within the top 40 m, are of Pleistocene age. This does not include the superficial Holocene deposits in the area.

The Pleistocene sedimentary history of the area can be explained in terms of relative changes in sea level at the time. The dominant effect of the Pleistocene glaciations in West Africa had been sea-level changes during glacial and interglacial periods. EWING ET AL. (1960) have suggested that these fluctuations were stronger than was believed before ice depth surveys of Antarctica were made.

Within the cyclothem, transgressive and regressive depositional sequences were recognised. In the transgressive sequence deposits of tidal flats as well as shallow water deposits are successively overlain by sediments deposited in progressively deeper water. In the regressive sequence deeper-water sediments are successively overlain by sediments deposited in progressively shallower water (BATES, 1953; SCRUTON, 1960; LAGAAIJ & KOPSTEIN, 1964).

The causes of transgressions and regressions may be more complex than simple rise and fall in sea level. GREENSMITH & TUCKER (1973) attributed Holocene transgressions and regressions on the Essex Coast, Outer Thames estuary, to the possible complex combination of (1) variations in rates of subsidence and sediment supply, (2) alternations of wet and dry phases, (3) changes in wind direction frequencies in the North Sea, (4) eustatic changes in sea level. The latter was considered as the dominant controlling factor for four transgressive episodes. It is possible that a combination of similar factors may have contributed to the sequence observed here.

The present phase in the Rokel estuary is transgressive (Flandrian transgression), the effect of which includes drowned river channels and deltas, which existed on the shelf before its onset (Fig. 2 of MCMASTER ET AL., 1971).

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