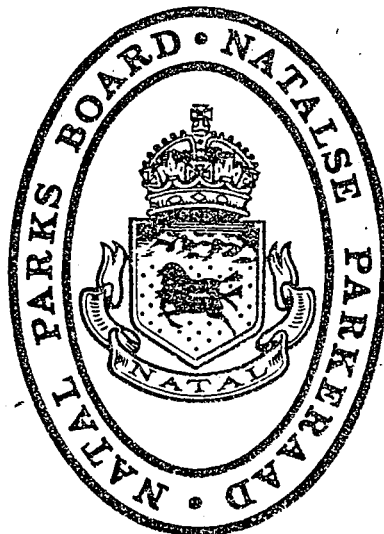


ST LUCIA DOCUMENT COLLECTION



Author ORME A R

Title ESTUARINE SEDIMENTATION ALONG THE NATAL COAST,
SOUTH AFRICA

Source 1974 U.S. OFFICE OF NAVAL RESEARCH. TECHNICAL
REPORT NO. 5.

Keywords SEDIMENTS*ESTUARIES,S.AFRICAN*GEOMORPHOLOGY*

With compliments 481
AR Orme

ESTUARINE SEDIMENTATION ALONG THE NATAL COAST, SOUTH AFRICA

BY

ANTONY R. ORME
Department of Geography
University of California
Los Angeles, California 90024

Technical Report No. 5

OFFICE OF NAVAL RESEARCH
Contract N00014-69-A-0200-4035 • Task NR 388-102
Antony R. Orme, Principal Investigator

AUGUST 1974

APPROVED FOR PUBLIC RELEASE • DISTRIBUTION UNLIMITED

ESTUARINE SEDIMENTATION

Sedimentation in selected estuaries and lagoons of Natal will now be described and analyzed in sequence from north to south (Fig. 4). Of the 60 streams of various sizes that reach the coastal zone, approximately half are either too small or too similar in terms of their sedimentation record to merit discussion. The remainder have been selected as representative of the range of sedimentary conditions to be found throughout the coastal zone. These may be broadly divided into those streams draining into the lagoons of Zululand and those flowing directly into the Indian Ocean. Two Zululand lagoon systems have been chosen for discussion, namely Lake St. Lucia and Richards Bay. The estuaries selected south of Richards Bay will be examined individually.

The St. Lucia lagoon system

Modern Lake St. Lucia is the remnant of the largest coastal lagoon brought into existence by the Flandrian transgression along the Zululand coast. Geomorphic and sedimentary evidence shows that, immediately after the main transgression some 5000 years ago, this lagoon covered 912 km² and continued south into the 253 km² Mfolozi lagoon. These water bodies

together formed the Greater St. Lucia Lagoon, measuring 1165 km² in area, 112 km in length, and up to 40 m in depth to underlying Pleistocene materials (Fig. 5). Today, after 5000 years of sedimentation, segmentation, and reedswamp encroachment, Mfolozi lagoon no longer exists and Lake St. Lucia has been reduced to a shallow lagoon averaging 312 km² in area, 40 km long, and less than 2 m deep. Lake St. Lucia receives drainage from 8900 km² of Zululand, mainly from the Mkuze (5400 km²), Msinene (700 km²), Hluhluwe (1000 km²), and Nyalazi (700 km²) watersheds. The Mfolozi swamps receive drainage from a further 10,700 km² of Zululand. A massive coastal barrier rising to 170-188 m above sea level separates the Greater St. Lucia Lagoon from the Indian Ocean. St. Lucia and Mfolozi waters drain seaward through the only gap now surviving through this barrier. Before 1952, when a separate channel was cut for the Mfolozi, both bodies of water commonly shared a single shifting outlet through the St. Lucia Estuary. When this Estuary was closed by strong littoral drift, Mfolozi waters often discharged northward into Lake St. Lucia, reducing lagoon

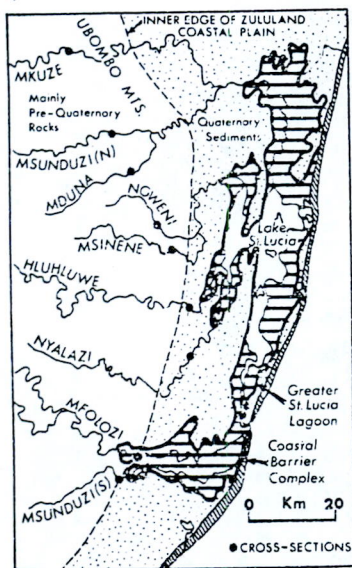


Figure 5. The Greater St. Lucia Lagoon, Zululand.

salinity but promoting sedimentation in the Narrows. The ecological consequences of events both before and since 1952 have been discussed elsewhere by this investigator (Orme, 1974a).

Mean annual rainfall over the watersheds contributing to the Greater St. Lucia Lagoon ranges from 600 to 1400 mm, about 80% falling during the summer months. Accordingly, maximum streamflows into the lagoon occur during summer, with floods reaching a high-water shoreline 1 m above sea level. At this time, Lake St. Lucia may cover 417 km². During winter,

however, mainstream discharge diminishes, smaller streams stop flowing, and effluent seepage from nearby marshes ceases. During prolonged drought, all inflow may stop, lagoon levels drop below mean sea level and, provided the Estuary remains open, high tides may push seawater through the Narrows. A 11 m fluctuation in lagoon level based on mean sea level produces a 35% variation in the area of Lake St. Lucia owing to its very gently shelving shorezone, in turn a reflection of continuing sedimentation.

River valleys draining into Lake St. Lucia and the Mfolozi swamps reveal the nature and magnitude of this sedimentation. Borehole data obtained from the Natal Roads Department, Pietermaritzburg, have been used to construct cross-profiles for several of these valley fills. These may be divided into two groups: those whose bedrock channel lies mostly above present mean sea level and in which mainly fluvial sediments are preserved; and those whose bedrock channel lies below mean sea level and in which a variety of fluvial, lagoonal, and perhaps marine deposits occur. The first group will first be examined in sequence from north to south, followed by an examination of the Mfolozi and St. Lucia Estuary records as representative of the second group.

The Mkuze, northern Msunduzi, Mduna, and Ngweni records all indicate the nature of fluvial sedimentation in bedrock channels a considerable distance inland and well above present sea level. Of these, only the Mduna is thus illustrated (Fig. 6). All four rivers have bedrock channels excavated in saprolites derived from the blue basalts of the Stormberg Series which tops out the Karroo System. The Mkuze channel lies 13 m below the overlying fluvial sands and boulders at about 150 m above sea level. The Msunduzi contains only 2 m of fluvial debris above the basalt. The Mduna channel

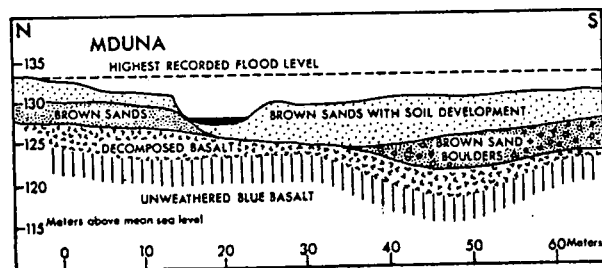


Figure 6. Cross-section through the Mduna valley (see Figure 5 for location)

bottoms in decomposed basalts 121 m above sea level and is overlain by up to 4 m of brown sand and boulders and a further 5 m of brown sands with soil development. These materials are typical of fluvial deposits in the Zululand interior but may also include debris derived from marine and eolian deposits of Quaternary age which thinly veneer this area. The Ngweni channel is cut into decomposed basalt 17 m above sea level and is overlain by brown sand and boulders, mostly of basalt, in which the present channel lies at 25 m above sea level. Farther south, the Msinene valley contains about 10 m of brown to yellow sand and boulders over an unweathered basalt surface that lies at present sea level (Fig. 7). Though these five river channel deposits are in no sense estuarine, they establish a useful control for fluvial sedimentation to be compared with estuarine sediments farther downstream. It should be noted that the highest recorded flood levels for both the Mduna and Msinene are about 10 m above the level of deepest scour associated with the base of the brown sands in which soils are developing.

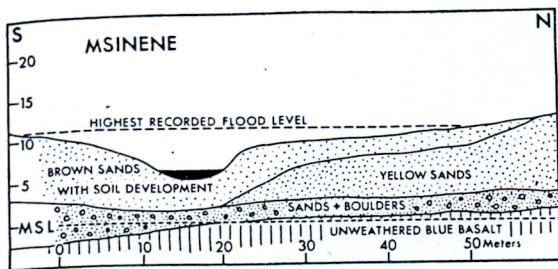


Figure 7. Cross-section through the Msinene valley (see Figure 5 for location)

The lower reaches of the Hluhluwe and Nyalazi rivers both contain sedimentary records typical of the alluvial swamps around Lake St. Lucia. The cross-sections illustrated in Figures 8 and 9 lie within the coastal plain just above the innermost reaches of the former Greater St. Lucia Lagoon through its inland arm of False Bay (Fig. 5).

The Hluhluwe cross-section lies in the floodplain just above the point where the river turns north toward False Bay. The gradient of the river between Hluhluwe Dam and the delta is only 1.1 m/km and the low velocities have ensured deposition of much fine material. Grey Upper Cretaceous limestone floors the valley at approximately mean sea level and is overlain by up to 20 m of sands and boulders, considered to be Pleistocene fluvial debris derived from pre-existing saprolites and marine deposits. The Holocene channel is cut into these sands and boulders and has in turn been filled with a succession of yellow, red, and black clays, coarse sands, and black sands in which soil has developed. The clays are deposits typical of very low velocity flows or stagnant water conditions, their coloration being in part inherited from their source materials, in part due to variable oxidation following deposition, and in part due to their organic content. In the Lake St. Lucia region, deposition of fine materials is closely linked with reedswamp encroachment associated with Phragmites communis and Cyperus papyrus so that decaying vegetal matter is readily incorporated into the sedimentary record, providing a black coloration to the sediments. The coarse sands are products of higher velocity flows while the overlying black sands are typical of floodplain deposition associated with a high content of organic debris.

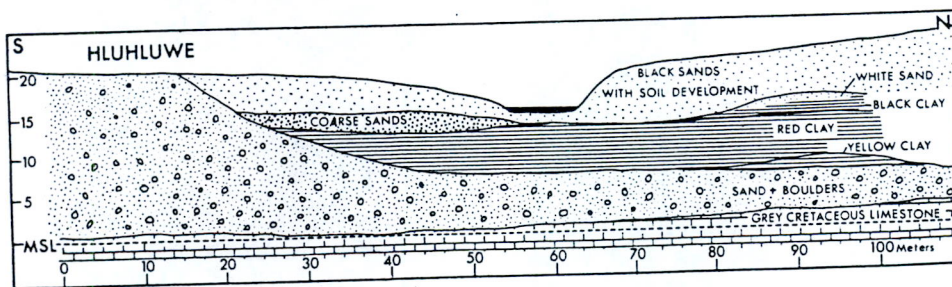


Figure 8. Cross-section across the Hluhluwe valley southwest of False Bay, Lake St. Lucia (for location see Figure 5).

The sedimentary record in the lower Nyalazi valley is similar to that of the Hluhluwe valley but the basal wad of Pleistocene sands and boulders is missing and the Holocene channel sequence lies directly on the Cretaceous (Fig. 9). The bedrock channel is cut into grey to black unweathered Upper Cretaceous limestone to just above mean sea level though brown saprolites derived from this limestone survive to both sides of the channel. Above this, a sequence of yellow and grey clays, grey sandy clay, and black sands replicates the low-energy organic-rich sedimentary environment already seen in the lower Hluhluwe valley. Indeed, for the 50 km immediately above False Bay, the Nyalazi maintains a mean gradient of only 0.57 m/km. It is seen that the highest recorded flood level coincides with the limits of the scour channel cut in the clays, a channel which has since been partly filled with organic-rich sandy fluvial deposits.

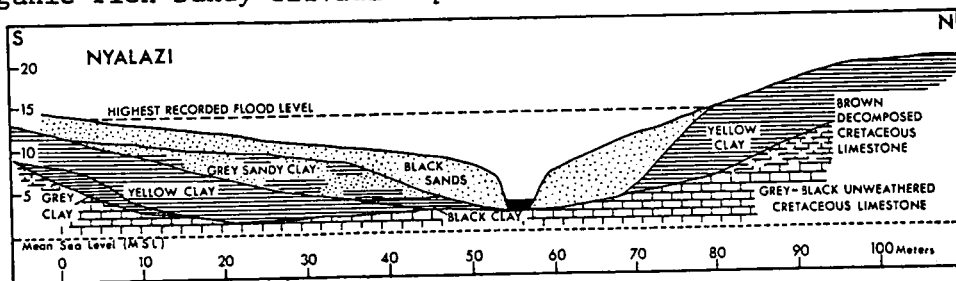


Figure 9. Cross-section through the Nyalazi valley (see Figure 5 for location)

As a result of net deposition over the past 5000 years, Lake St. Lucia has been reduced in area from 912 km² to 312 km², a 66% reduction. The percent decrease in water volume since the Flandrian transgression must be much larger, perhaps 95%, because the present lagoon bottoms out only 2.1 m below mean sea level whereas soft muds extend to at least -20 m below the floor. Using steel probes, Kriel (1965) has estimated that Lake St. Lucia and its nearby swamps contain 3,115 x 10⁶ m³ of soft muds. In the St. Lucia Estuary 4 km from the open sea, borehole data reveal a plug of clays, silty clays, and silts forming a channel fill to -20 m below mean sea level, a fill rich in organic debris (Fig. 10). Beneath these are more silty sands

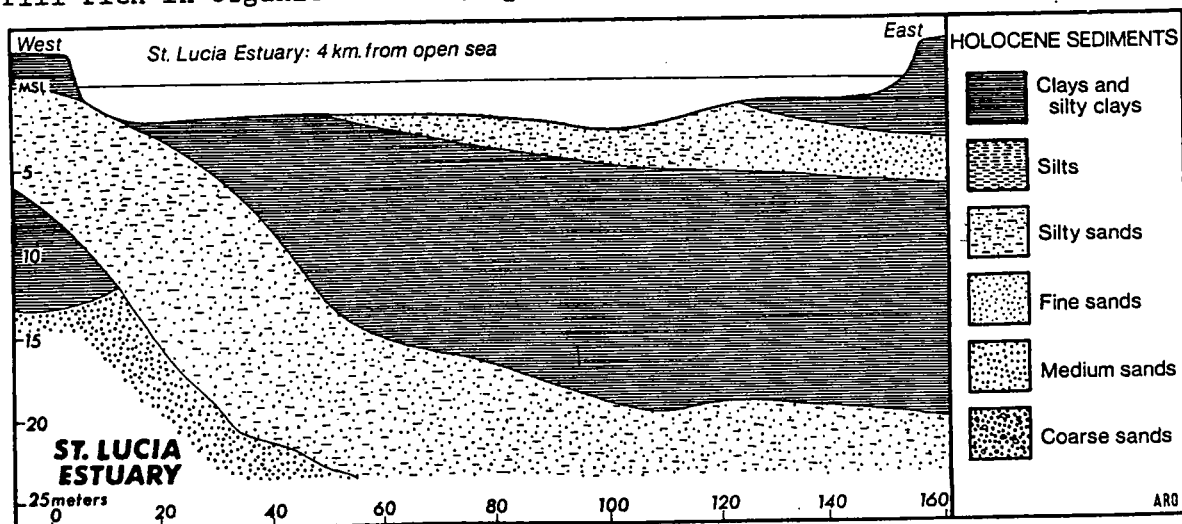


Figure 10. Cross-section through the St. Lucia Estuary, 4 km from the sea (see Figure 5 for location).

and fine to medium sands indicative of more open depositional environments, presumably before sediments from both the Lake St. Lucia and Mfolozi watersheds began constricting the Narrows. Without further detailed probing, however, the bottom geometry of the original lagoon remains conjectural.

The Mfolozi lagoon, which formerly covered 253 km², has been more or less extinguished by Holocene sedimentation, the final stages having been accelerated by man's partial reclamation of the swamps and construction of levees since 1927. The nature of this sedimentation is well illustrated by a cross-section across the Mfolozi valley 4 km SSW of Mtubatuba, 34 km by river from the Indian Ocean (Fig. 11). This cross-section occurs where the Mfolozi estuary formerly debouched into the lagoon and thus exhibits a typical alternation of fluvial and lagoonal sediments. The bedrock channel

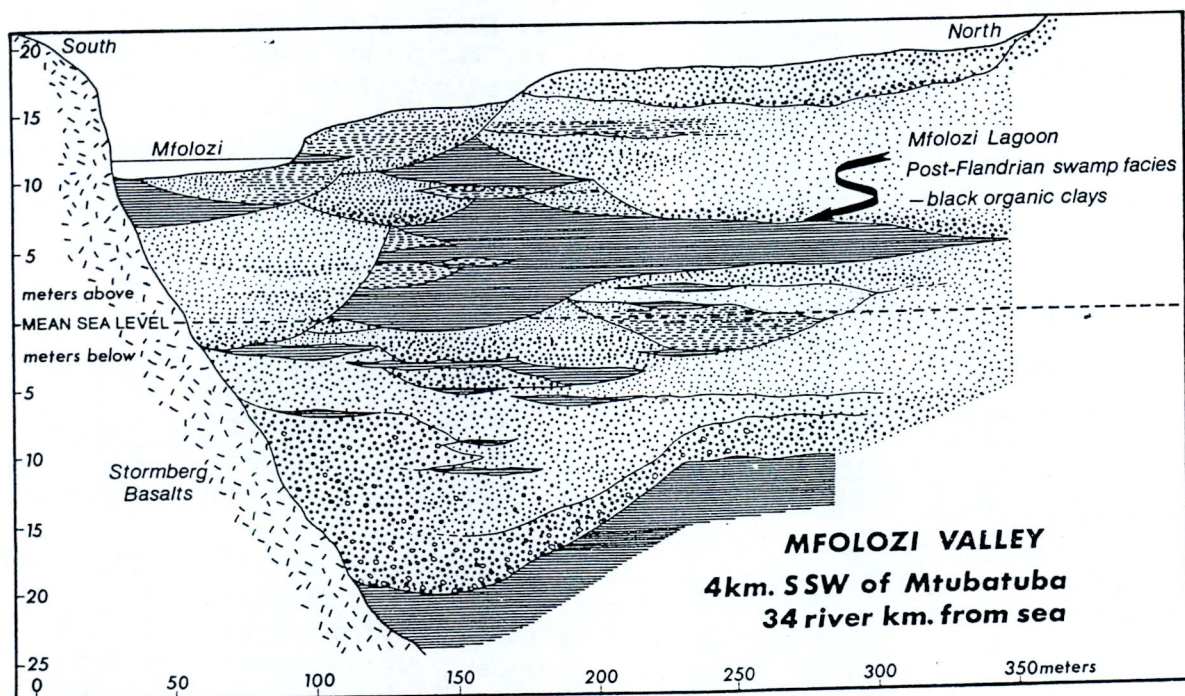


Figure 11. Cross-section through the Mfolozi valley, 4 km SSW of Mtubatuba and 34 river km from the Indian Ocean, near the head of the former Mfolozi lagoon. See Figure 10 for key to sediments.

is cut into basalts of the Stormberg Series but boreholes have failed to reach the floor of the channel at -40 m below present sea level. This is thus one of the deepest Pleistocene buried valleys in South Africa, a fact consistent with the large size and discharge of the Mfolozi watershed. The overlying sediments embrace black to grey organic-rich clays and silts typical of lagoonal swamp deposition, and grey to brown fine, medium, and coarse sands with gravels and boulders typical of fluvial deposits. Figure 11 clearly illustrates the scour-and-fill character of fluvial sedimentation, and the periodic accumulation of thick swamp deposits. The lowest of these swamp deposits probably accumulated during a stillstand in the Flandrian transgression. The thick swamp deposit toward the top of the sequence is considered to represent the last remnant of the Mfolozi lagoon before it was