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Preliminary Comments on Linear Sand-Surface Features, Onslow Bay, North Carolina Continental Shelf: Problems in Making Detailed Sea-Floor Observations*

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Introduction

This is a preliminary report on the occurrence, characteristics, and probable origin of sedimentary features observed in Onslow Bay off North Carolina. Data from a surface vessel and those collected by diver-scientists are compared, for it is believed that a better understanding of sedimentary processes taking place on the sea-floor would result from detailed studies that incorporate firsthand observation techniques. Surface vessels have been used for extensive sampling of sediments on the continental shelf off the east coast of the United States, but relatively few observations have been reported by diver-scientists. The recent upsurge in submersible studies, however, will undoubtedly yield new and useful information about sedimentary processes on the sea-floor.

During demonstration dives with the North American Rockwell Corporation's "Swimmer Sled" in June, 1968, a distinct linear pattern of coarse and fine sediments was observed at depths of about 20 metres in Onslow Bay. Thirteen subsequent two-man SCUBA dives were completed in this area. A marked cord, metre stick, and standard diving compass were used to measure the sedimentary structures. Detailed sediment sampling in the same area was carried out in November, 1968, using a Pierce Box dredge aboard R/V Eastward. Loran A and Decca JM969 were employed for navigational purposes.

Onslow Bay Sediments

Onslow Bay is located between Cape Lookout and Cape Fear on the North Carolina continental shelf, where the seaward boundary of the shelf occurs at depths of about 50 to 80 metres. Onslow Bay is subjected to a low rate of sedimentation because it is protected from lateral transport by the bounding shoals associated with each cape, and because no larbe Piedmont rivers discharge into this bay (Cleary and Pilkey, 1968; Meade, 1969). The sediments are mainly residual or relict, and their areal distribution and textural and mineralogical characteristics tend to be patchy (Milliman et al, 1968). The average $CaCO_3$ content in Onslow Bay is 25%, but in general, outer shelf sediments are more highly calcareous than central and inner shelf sediments (Milliman et al, 1968).

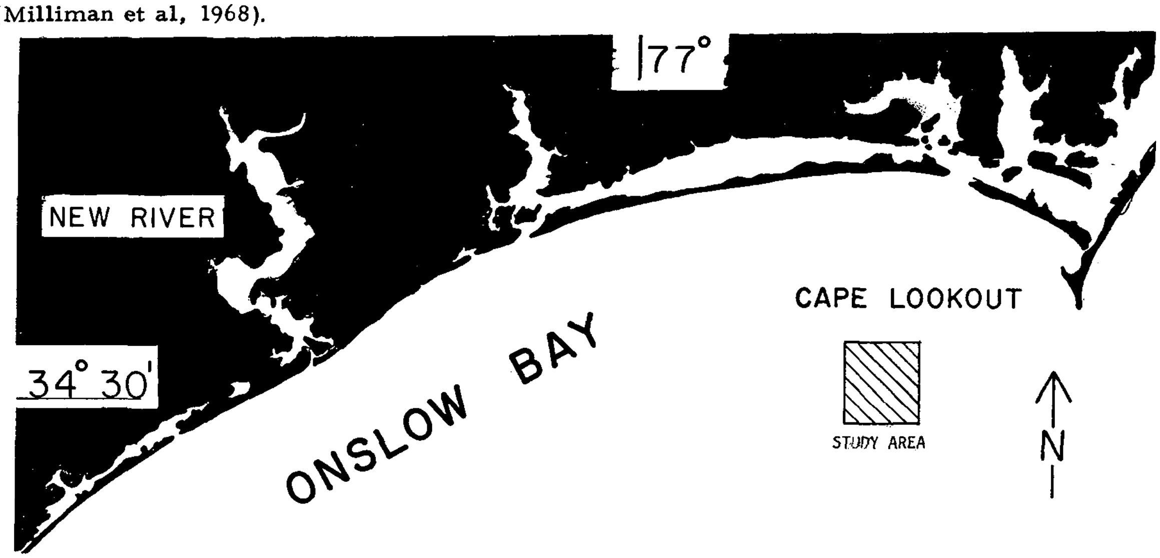

Fig. 1 Index map showing location of study area in Onslow Bay, off North Carolina.

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TABLE I - Characteristics of Rippled and Non-rippled Sediments in Study Area

Area	Sample	M_z*	δ_I*	% Carbonate
Coarse Rippled Sands	Crest	0.66	1.15	66.0
	Crest	1.23	0.91	49.3
	Crest	0.56	1.29	24.0
	Trough	0.78	1.13	54.5
	Trough	0.88	1.18	58.9
Fine Unrippled Sands		2.30	0.64	19.5
		2.08	0.81	32.3
		2.30	0.73	18.9
		2.18	0.73	25.4

*M_z--Graphid Mean; δ_I--Inclusive Graphic Standard Deviation (after Folk, 1961).

Observations

A series of generally north-south trending bands, or elongated, generally slightly depressed patches ("channels" about 20 metres wide) of coarse calcareous sediments were observed to cut across finer, less calcareous sands in the study area (Fig. 1). The spacing between the channels ranges from 60 to more than 100 metres. During one dive, a distinct bifurcation of a channel was noted. The coarser material of the channels consists of medium- to gravel-size carbonate grains (molluscs, ooliths, barnacles, benthonic foraminifera, and echinoderms) that are commonly bored, waterworn, and iron-stained and fine to coarse quartz grains with small amounts of feldspar. These sediments have a well-developed ripple pattern in which wavelengths from 30 to 50 cm and amplitudes of 5 to 9 cm were recorded for the large symmetrical ripples. The ripples trend generally northwesterly or perpendicular to the trends of the channels. Sediments from these channels generally have a coarse-sand mean size, are poorly sorted, and are rich in carbonate components (Table I).

Material flanking the coarser bands contains components identical to those in the coarser sediments, but it is finer (fine-sand mean size), better sorted (moderately well sorted to moderately sorted) and has less calcareous material than do the channel sediments (Table I). The small, disorganized ripple marks observed in these fine sediments in June were absent in July and August; and only surface features related to infaunal burrowing activity were present.

During July, observations along a transect west of the channel area (Fig. 2) showed that only fine unrippled sand was present in depths less than 18 metres and coarse, rippled sand was noted in deeper water to the south (wavelength, 40-65 cm; amplitude, 5-9 cm; trend, northwest to northeast). Thus the channels may be very restricted in depth range.

Throughout the three-month diving period bivalves were noted to be preferentially concave up on both coarse and fine sediments. A thin fillamentous algal cover and the abundant burrows and trails observed in the sediment during later dives indicated the lack of major sediment disturbances during this period of investigation. Compared with the June observations, a noticeable decrease in sharpness of ripple crests was observed in the coarse sands in July and August, and ripple marks in the fine sand were entirely obliterated.

Origin of the Channels

To date, no information on bottom currents has been collected from the study area. However, two hypotheses for the formation of the bands of coarse sediment are being considered: (1) that they are areas of winnowing produced by the channelling of bottom currents that are

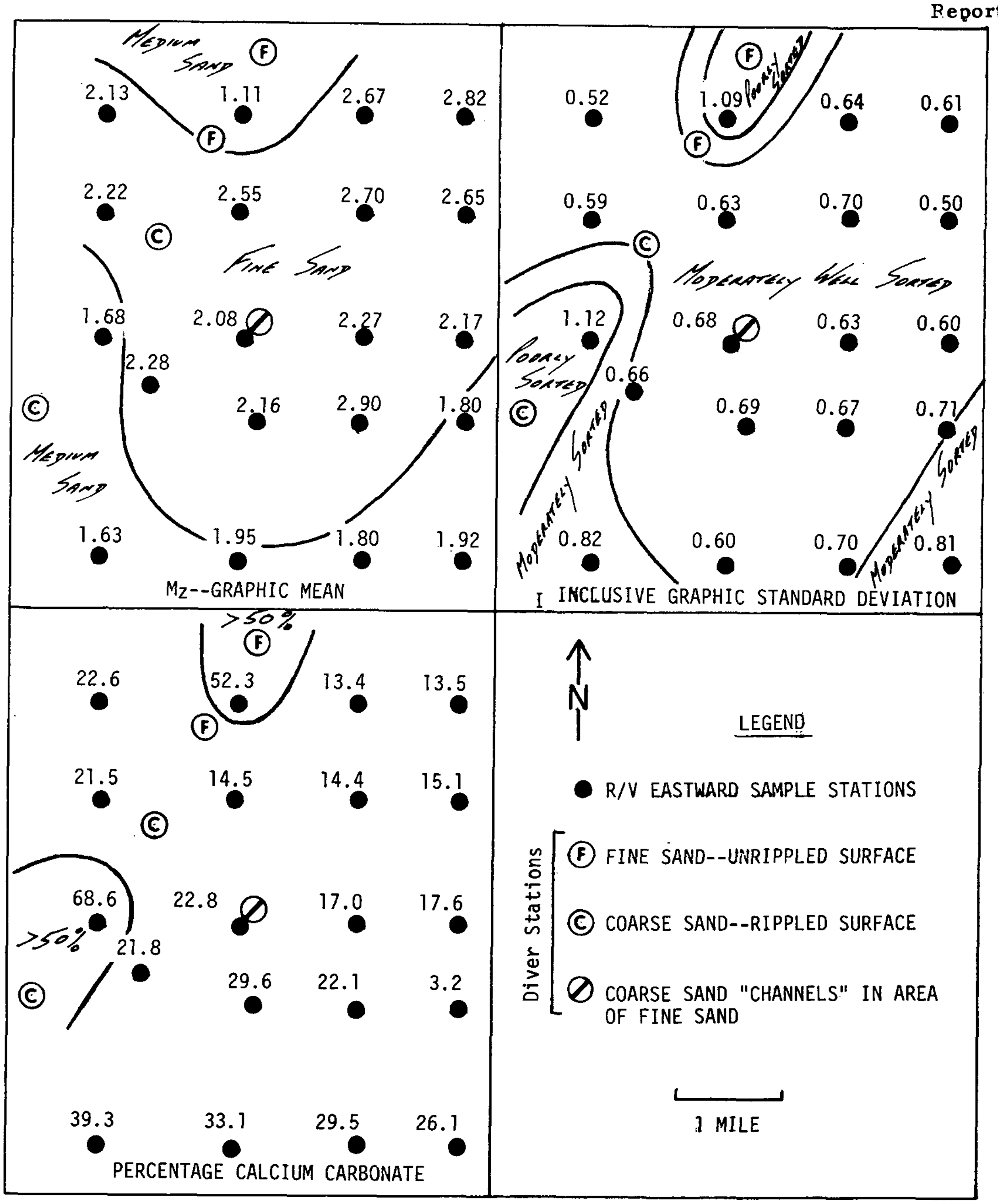

Fig. 2 Comparison of data collected aboard R/V Eastward and observations by diving area shown in Figure 1.

related to storm surge reflux, which results from water piled on the inner shelf by local storm activity (primarily related to the strength and direction of the winds associated with these storms); and (2) that finer, nearshore, "equilibrium" sediments are transgressing over the coarser, relict shelf sediments under the influence of intermittent bottom currents probably related to local storm activity. Under these circumstances, the leading edge of the fine sediments could consist of a series of linear sand patches, between which the coarse, relict sediment is exposed in elongated channel features. This hypothesis is further supported by the observation of coarse sediments underlying fine sediment adjacent to the channels and by the absence of a change in texture with depth in the coarse channel sediments. In either case, the linear sediment pattern indicates a distinct channelling of bottom currents.

A single event probably is responsible for the channels because a storm surge reflux would not affect the same channel locations during successive storms. Since the channels and associated features were clearly defined during the initial dive in June, and gradually deteriorated thereafter, it may be that Hurricane Abbey was the responsible event; Hurricane Abbey passed to the south of the study area on June 7 and 8, and caused unusual tidal and wave activity.

The symmetrical ripples in the coarser sediment are not related to short-period waves produced during local storms, but were induced by long-period (> 8 seconds) storm waves generated a considerable distance off shore. Bivalve orientation, preferentially concave up, further supports the wave-origin of ripple marks. It is suggested that under the influence of long-period storm waves, large, symmetrical ripples probably are formed on the sea floor off North Carolina. Later turbulence from short-period waves and bottom currents destroys these ripples in the finer sediments, but coarser sediments are left undisturbed. A similar sedimentary process was reported south of Plymouth, England (Flemming and Stride, 1967), where elongated, sand patches having small, irregular ripples are deposited along the paths of tidal currents. Gravel patches in the same area are not disturbed by these tidal currents, and therefore preserve large, symmetrical, ripple marks caused by winter storm waves.

Comparison of Diver and Shipboard Observations

One significant aspect of this study is the lack of correlation between the results of firsthand observations by diving and those of detailed sampling from a surface vessel. Data from the R/V Eastward survey show a very general increase in size and carbonate content, and a decrease in sorting in sediments from the southern part of the study area. This change might indicate a southward transition into the coarse rippled sands. Only two stations, however, have parameters similar to those of the coarse rippled sands recorded in Table I. One of these stations might be in a channel of coarse sand, as it is located between two SCUBA stations where only fine unrippled sands were observed. Further, bottom samples gave no indication of channelling. From this comparison it seems apparent that only very general interpretations can be made concerning sedimentary processes or the distribution of sediment on the sea floor even on the basis of very closely spaced sampling from a surface vessel. A detailed study of a small area of the continental shelf, such as that in Onslow Bay, would require both surface-vessel operations and firsthand observations. An Asdic survey would reveal the major sediment surface features of the area, and this survey could be supplemented by firsthand measurements and sample collecting. In addition, reference buoys would be necessary for accurate positioning.

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