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Relating Directional Current Structures of Modern Sediments to the Direction and Velocity of Tidal Current Systems, Five Islands Tidal-Flat Complex, Nova Scotia*

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During July and August, 1965, the first phase of a larger study relating directional properties of modern sediments to depositional current systems was undertaken in the Five Islands intertidal zone complex of Nova Scotia under the sponsorship of Hudson Laboratories. The purpose of the study at Five Islands was to (1) determine morphology, sediment composition, and texture of modern tidal-flat sediments, (2) map the surficial geology of the tidal-flat complex to form a geological basis for comparison with acoustical data obtained concurrently with a side-looking sonar by DR. JOHN E. SANDERS (see report in this issue), (3) map the orientation of directional current structures, (4) map the direction of flow of bottom-scouring current systems and relate these to directional properties in the sediments, and (5) determine the velocity and depth of bottom-scouring currents and relate these data to the size of sedimentary bedforms.

The Five Islands intertidal zone complex was selected because of easy access to sedimentary features at low tide, and easy occupation of buoyed stations at high tide. The project area was mapped by combined use of aerial photographs taken from a helicopter made available to the writer by the BEDFORD INSTITUTE OF OCEANOGRAPHY and plane-table and transit surveys in critical areas selected from analysis of aerial photographs.

Navigation was accomplished by mooring buoys at low tide and locating their position with a transit. These buoyed stations were

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occupied at high tide for measurements of current direction and velocity with Pritchard vanes.

Preliminary results (See also KLEIN, 1966): In the Five Islands intertidal area, the direction of flow of ebb current systems controls the orientation of cross-stratification, megaripples (wave lengths from 1 to 20 feet) and sand waves (wave length in excess of 20 feet). Low-tide sheet run-off prior to uncovering of the bottom controlled the orientation of superimposed current ripples (wave lengths less than 1 foot), micro-cross-laminae and flute markings. No directional properties were found to be oriented more than 30° from the direction of flow of the ebb current systems or the last-stage sheet run-off.

Times of flow reversals of tidal currents locally varied considerably from the predicted time of change from flood to ebb stages. In the northwest lee of islands, backflow phenomena caused a time lag of about 2 hours in shift of tidal current directions from east (flood direction) to west (ebb direction). Because of associated depth changes, orientation of directional properties and the wave length of the rippled bedforms were determined by these lag currents.

The wave length of the sediment bedforms depended more on depth than on current velocity: sand waves migrated only when depths of water exceeded 20 feet; megaripples, in water depths between 3 and 20 feet; and current ripples, in water depths of 2 inches. Significantly, current velocities were observed not to change during the critical depth change which controlled the migration of the different sizes of bedforms. In this case, depth is of greater significance in controlling wave lengths of rippled bedforms than velocity. Laboratory investigations will determine whether particle-size distributions are also a controlling factor, as has been shown in flume experiments (SIMONS et al, 1965). During a second field season, these changes will be monitored again, and in situ temperature observations will be completed to evaluate the role of temperature changes in sedimentary bedforms.

The distribution of particle sizes appears to be controlled by the same depositional processes which are generally characteristic of tidal-flat sedimentation, reported earlier (VAN STRAATEN and KUENAN, 1958; KLEIN, 1963, 1964).

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Study of Continental Shelf and Slope on the Coasts of Long Island, N.Y., and New Jersey*

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In conjunction with the research program at HUDSON LABORATORIES OF COLUMBIA UNIVERSITY into the relationships between acoustic properties and ocean-bottom geology, the writer began an investigation in 1965 into the grain-size, environment of deposition, and chemical properties of associated waters of bottom sediments on two profiles across the continental shelf and upper slope south of Long Island and southeast from New Jersey.

Two weeks were spent at sea in July, 1965, aboard the USS Allegheny (a modified sea-going rescue tug of the ATA class), equipped with Decca navigation system and Westrex Mark Xa Precision Depth Recorder. Decca positions were plotted on special Decca Charts with a scale of 2 in. = 1 mile made at Hudson Laboratories for this project. In addition to the continuous topographic traverses, 83 bottom samples were collected from 83 stations made at 2-mile intervals, using a bucket dredge; and 30 cores were collected from 22 stations using either compressed-air vibro-corer or gravity-drop corer: 10 vibro-cores ranging in length from 5.1 to 31.8 cm came from 9 stations on the Long Island profile, and one from the New Jersey profile; and 19 gravity-drop cores from 11 stations on the Long Island profile, and from one station on the New Jersey profile. Cores were collected in plastic liners, which also brought up a sample of the bottom water. Cores were handled and stored in the vertical position, or as nearly vertical as was possible.

At each coring station the Eh and pH of samples of ocean-surface water, ocean-bottom water, and sediment interstitial water were measured aboard ship. Electrodes were inserted through holes drilled in the sealed plastic liner tubes in order to measure the properties of the bottom water and interstitial water. Smaller water samples were bottled for later measurements at Hudson Laboratories of salinity (by induction salinometer) and sodium (electrode) and magnesium ions (by optical

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