shore wind regimes rather than simply ancient trade-wind circulations.

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FACIES AND DEVELOPMENT OF THE COLORADO RIVER DELTA IN TEXAS

The Recent delta of the Colorado River of Texas is an exceptional model for analyzing sediment and faunal facies relationships in environments associated with deltas. The small size facilitates close spacing of cores, which is essential for detailed facies study. Moreover, air photographs document growth from a straight shoreline to the lobe-shaped deposit formed prior to artificial channeling of the river through a barrier island. A 6- to 8-foot platform of deltaic sediments now dividing Matagorda Bay was deposited in the 6-year period following removal of an upstream log jam. Continuous cores (37) and borings (10) define the deltaic facies complex and the underlying bay facies in the northeastern section of the delta, which is unaffected by man-made modifications. The sequence of facies and environments encountered in sections is: (1) clays and silts, 1 to 5 feet thick (delta plain), including silty clays and clayey silts containing numerous roots and root fibers (natural levee), silty clays with roots and "algal-encrusted" washout pans (marsh), and massive to burrowed clays (channel fill); (2) sands, 2 to 6 feet thick, characterized by small-scale cross bedding (delta front); (3) laminated silty clays, 1 to 5 feet thick, (prodelta); and (4) laminated to burrow-mottled silty clays and clayey silts, 10 to 14 feet thick (bay), unconformably overlying the Pleistocene. Color variations, together with X-ray radiographs recording laminations and burrows, are most useful in distinguishing between facies of bay and prodelta environments. The faunas characterizing the facies and environments are more variable than are the sediments; juvenile and small mollusks, less than $\frac{1}{4}$ inch, seem more definitive of environments here than do Foraminifera. Subsidence of 1 to 2 feet is estimated to have resulted from compaction since initial delta formation.

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SEDIMENTARY ENVIRONMENTS IN THE MALACCA STRAIT, MALAYSIA

A preliminary investigation of the waters and bottom sediments in the Malacca Strait and southern portion of the Andaman Sea, made in 1961 by the U. S. Naval Oceanographic Office, resulted in the collection of bottom sediments as well as salinity, temperature, and water transparency observations at 23 stations. Current measurements were made at selected sites for periods of 24 to 36 hours. The Malacca Strait is a narrow, shallow passage between the Malay Peninsula and Sumatra with oceanographic and bottom sediment characteristics closely related to the strong currents, debouching rivers, climatic variation, and the close proximity of bordering land masses. The strait assumed its present configuration as a result of the post-glacial rise of sea level which drowned the Sunda Shelf. The strait is located in a typical equatorial climate although the monsoonal effects are not as severe as in the more open neighboring areas. A northwest current flow, essentially tidal, prevails in the strait throughout the year, and is largely responsible for the hydrographic and oceanographic conditions in the area. Surface salinities and temperatures are found generally to be lower than in the surrounding seas. A wedge of cold, high-salinity bottom water extends from the Andaman Sea into the Strait. Bottom sediments primarily consist of muddy sands, with large areas of mud occurring in the vicinity of debouching rivers and in the Andaman Sea Basin. Calcium carbonate, primarily in the form of mollusk shells and foraminiferal tests, and organic carbon are found only in minor amounts in the Strait. Higher concentrations of calcium carbonate generally were associated with the finer sediments of the Andaman Sea, while the higher concentrations of organic carbon were found in the vicinity of debouching rivers. The noncalcareous detrital fraction is dominated by quartz, with minor amounts of orthoclase and plagioclase feldspars. The heavy mineral suite is complex due to the varied geology of the bordering land areas. The heavy minerals present consist primarily of leucoxene, ilmenite, magnetite, biotite, and amphiboles.

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PALEOCURRENTS AND OCEANOGRAPHY

The rationale of paleocurrent studies suggests that directional current structures identify the provenance, transport direction, basin architecture, and paleoslope of sedimentary sequences. Numerous examples from fluvial deposits have reinforced this view.

In marginal marine environments, directional current structures are fashioned by a combination of tidal, wave, and wind-driven currents which flow randomly with respect to slope and sediment source. Directional structures formed by these currents are oriented perpendicular or parallel to both slope and sediment source. The resulting structures, therefore, reveal only the direction of transport of the last current to act upon the sediments prior to burial.

The direction of flow of bottom-scouring currents in continental shelves and deep ocean basins is determined by changes in density, temperature, and salinity, by wind action, and by the rotation of the earth. Such changes tend to drive currents in random directions in the ideal case, but because of the earth's rotation, most ocean currents flow parallel to topographic strike. Resulting directional current structures of shelf and deep marine sediments cannot define paleoslope or provenance, but they do define topographic strike.

Because the direction of flow of ocean currents depends on many variables, several combinations of current systems can be recognized, including converging systems, diverging systems, and stratified systems. Where two currents converge, one system will override the other system because of differences in density. Converging directional data have been reported from ancient turbidites, indicating that similar converging current systems existed in the past. These data also suggest that many "turbidite" directional criteria were formed by bottom scouring ocean currents.

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ATTENUATION OF SEISMIC WAVES IN THE MANTLE

Field and laboratory measurements of attenuation in metals, non-metals, and rocks over a wide range of frequencies indicate that the specific attenuation factor, $1/Q$, is substantially independent of frequency in homogeneous material, whereas it varies as the first power of frequency in liquids. This suggests that the mechanism

for attenuation in solids is substantially different from that in liquids; a non-linear mechanism for attenuation has been proposed.

An inversion method can be used to compute the intrinsic Q in shear of the earth's mantle from available data on attenuation of the surface waves and free oscillations. The restrictions and assumptions in the calculation are: (1) Q must be positive; (2) Q is assumed to be independent of frequency; and (3) the mechanism of energy dissipation is through a complex modulus.

The results show that, in shear, the upper mantle has a much higher attenuation than the lower mantle. Q for the upper mantle, from the surface to a depth of 650 km., is estimated at 110; for the lower mantle, below 650 km., it is much higher than this, but the exact value cannot be estimated with precision. There are indications of fine variations of Q in the upper mantle, but present accuracy of the data and the assumptions used do not permit the literal use of these indications. Partial melting in a low velocity layer at shallow depth is considered and a small amount of partial melting is not inconsistent with the above result and the data.

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MINERALOGICAL COMPOSITION AND TEXTURAL PROPERTIES OF RIVER SEDIMENTS FROM BRITISH HONDURAS

An investigation of the mineralogical and textural properties of channel sediments from certain selected rivers of British Honduras, Central America, indicates that the material carried by the northern rivers is distinctly different from that in the southern ones.

The northern rivers contain mainly a carbonate sediment of cryptocrystalline grains and mollusk fragments. A multiple origin for these cryptocrystalline carbonate grains is proposed. Undoubtedly, some grains are recrystallized mollusk fragments. Other grains are rock fragments, while still others appear to have been indirectly precipitated by blue-green algae. The noncarbonate grains have been derived from Pleistocene stream deposits. Abrasion of the heavy minerals and quartz grains appears to be lacking.

The southern rivers contain mainly silici-clastic sediments. The size distributions of bed-load samples plot as approximately straight lines on phi probability paper with a deviation near +2 phi. This deviation is real and has been attributed to an abrasional mechanism. The heavy mineral suites from the southern rivers indicate a more metamorphic provenance than is seen in outcrop in the source areas. The primary provenance has been interpreted to be the metamorphic belts in Guatemala. Petrographic work also indicates a more metamorphic source to the south. The river detritus, if indurated, would appear as lithic graywackes or subgraywackes, depending on the percentage of detrital matrix.

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THE RELATIONSHIP BETWEEN INTERNAL AND EXTERNAL STRUCTURE IN GULF COAST SALT DOMES

Internally, salt stocks consist of isoclinal, attenuated, vertically-plunging, complex folds and resemble a handkerchief drawn vertically through a small ring. They appear to have developed by intermittent and shifting movements which may have been controlled largely by strain hardening of halite crystals and varying rates of sedimentation. These movements must have strongly affected external structures and oil migration. External structures, like grabens and faults, may be related to internal structures like zones of shearing and differential movement (faulting?). Close cooperation among petroleum geologists, geophysicists, and salt-fabric geologists is needed if we are to decipher the origin of salt massifs, salt spines, overhangs, and intermittent salt movements.

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SEDIMENTS AND FAUNA OF THE RHONE DELTA, FRANCE

The Rhone delta is an example of a rapidly growing delta, prograding over a relatively steep slope into the essentially tideless, highly saline Mediterranean. Detailed studies of the sediments and microfaunas by the author and his colleagues have shown that rate of deposition, even more than depth, is the primary factor controlling the nature of the sediments and faunas offshore. Our classification of deltaic-marine environments is accordingly based on rates and depth of deposition.

These studies, supplemented by earlier work in the land part of the delta (Kruit, 1955), have provided the basis for the interpretation of 26 core holes drilled to the top of the Pleistocene "basement." A clearcut distinction can be made between the *onlap complex* of coastal-plain sediments formed under conditions of rising sea level during the late Pleistocene—middle Holocene and the *offlap delta* consisting of marine sediments laid down under conditions of stable sea level since 5,500 B.P.

All core holes through the offlap delta reveal a transgressive-regressive sequence. Those sequences with a typical fluviomarine regressive development consist of (in upward direction):

1) a thin slow-deposition basal bryozoa bed;
2) moderate-deposition distal-fluviomarine clays;
3) rapid-deposition proximal-fluviomarine clays and silts; and
4) rapid-deposition fluviomarine-barrier sands.

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A MICRO-ORGANIC AND ECOLOGIC INVESTIGATION OF RECENT SEDIMENTS FROM TWO GULF COAST CORES

The relationship between the recoverable microorganic remains and the depositional environment of Recent sediments in two cores from the Gulf Coast area was studied.

One continuous $3\frac{3}{4}$-foot core from Matagorda Delta was sectioned and studied every three inches in order to detect minute vertical variations. The second core from Galveston Bay was 63 feet long, but not continuous. Nine samples were studied, each sample representing an interval of two to three feet of sediment.

The detailed analysis of the Matagorda core indicates three distinct depositional environments within the few feet of core. In descending order, these are marine, less marine, and more marine. In the 63 feet of Galveston core, analysis of samples gave an over-all picture of depositional environments, in descending order: marine, less marine, more marine, and continental. Therefore, the environments detected in the very detailed analysis of the continuous samples represent minor fluctuations in what shows up as a single environment in the longer core.

The calcium carbonate content decreases with depth