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"Sticky" Muds—Viscosity of Estuarine Sediments

Many viscosity measurements were made on samples of "fluid mud" from the Rappahannock River of the Chesapeake Bay system with an eight-speed rotational viscometer. Measurements were made directly in the core liner immediately on retrieval aboard ship; in the laboratory under various conditions of salinity, concentration, and temperature; and under conditions of slow sedimentation where the changing sediment density was simultaneously monitored with a nuclear density sensor.

Rheograms developed over a broad range of shear showed that the mud exhibits non-Newtonian behavior, usually pseudoplastic but occasionally dilatant, depending on settling time, concentration, and interstitial water salinity. At times both pseudoplastic and dilatant behavior were observed in the same sample at differing rates of shear. During increasing shear the apparent viscosity profile usually exhibited its highest values and most variable behavior. During decreasing rates of shear, the profile generally showed a hysteresis effect, indicating the mud to be thixotropic.

Differences in rheological behavior were noted between samples from the fresh, intermediate, and highest salinity reaches of the estuary. A steep decrease, followed by an abrupt increase in apparent viscosity at low shear rates, seemed to be common in intermediate-salinity reaches (2 to 8 parts per thousand), but similar behavior was rare in samples from freshwater and high-salinity reaches. This "viscosity notch" may help to explain the sudden burst of suspended sediment that has been observed as occurring off the bottom, just after slack water in intermediate-salinity reaches in the Rappahannock.

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Carbon-Isotope Measurements of Hydrocarbons Adsorbed in Near-Surface Sediments

No abstract available.

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Recent Arthropod Lebensspuren as Indicators of Ancient Flood-Plain Deposition

Despite the relatively more rare occurrence of trace fossils in nonmarine than marine rocks, insect and spider-produced burrows may have considerable local importance in distinguishing between channel, flood-plain, and upland depositional environments. The recent North American insect and spider fauna includes members of 8 orders and 31 families that make subterranean shafts (vertical or inclined), tunnels (horizontal), or cells (chambers) capable of fossilization. Many of these lebensspuren show great morphologic similarity although they were produced by taxonomically dissimilar arthropods, thus severely limiting the ability of either geologists or entomologists to relate individual lebensspuren to their makers.

Nonetheless, the density and diversity of arthropod

lebensspuren in moist flood-plain substrates appear to be much higher than in either channels or uplands. Furthermore, the probability of preservation of arthropod burrows in areas of deposition (flood plains) greatly exceeds the probability of their preservation in areas of erosion (channels and uplands). However, as yet we are unaware of any recent preservable insect or spider-produced burrow types that are confined to either flood plains on uplands; our investigation of lebensspuren in recent and ancient channel deposits is still preliminary. Conversely, we have numerous meniscate (backfilled) tunnels and shafts from an ash lens of presumed flood-plain origin in the Miocene of western Nebraska for which there appear to be no recent analogs.

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High-Resolution Seismic Work as Tool to Locate Stratigraphic Traps

The seismic reflection method is a well-established tool in the exploration for structures but is little used by the average geologist for stratigraphic analysis.

High-resolution stratigraphic profiling is a greatly scaled-down version of the technique employed in most exploration operations. A field crew consists of about six men, a small drill, a portable digital recording unit, cables, and downhole detectors. Very small dynamite shots are taken every 15 to 35 ft (5 to 10 m) along the traverse line. At each new shot point a new "pseudo" acoustic log is produced which subsequently will be correlated with borehole logs and other "pseudo" logs.

The digital recordings from each shot are then computer processed to enhance the high-frequency characteristics of the logs, compensate for variations in overlying rock velocity, and correct the logs for irregularities introduced by changes in near-surface geology and elevation along the traverse. The computer output data are integrated with borehole information prior to interpretation. Use of these seismic "pseudo" logs aids the geologists by defining more precisely the subsurface stratigraphy between boreholes and beyond wells.

The structural information derivable from the log displays includes, in addition to the location of very small faults, sand channels, and shale-outs, such information as the unique identification, thickness, and lateral persistence of particular reservoir beds.

Geologic identification of potential reservoir rock types using seismic wavelet characteristics or log-shape changes is an extremely useful supplement to the structural or purely correlative aspects of seismic-log profiling. Shape variations in the log traces can provide valuable information regarding localized depositional environments, pore-fluid characteristics, and even porosity and permeability variations across a given prospect area once a local reference has been established.

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Generation and Occlusion of Porosity in Chalk Reservoirs

Prolific hydrocarbon production from chalk reser-

voirs has stimulated detailed analysis of the generation and occlusion of porosity in these rocks. Porosities, which may exceed 45%, reflect conditions of sedimentation and subsequent diagenesis. Sedimentation rate, a function of skeletal productivity and dissolution within the water column, influences cementation at the seafloor. Intraparticle porosity is relatively rare and is found primarily within foraminiferal tests. The more abundant primary interparticle porosity is imprinted during deposition, and reflects calcareous nannofossil preservation. Highest porosities are characteristic of zones containing relatively well-preserved nannofossils. Porosity in chalk may be secondarily enhanced by fracturing.

Initial porosity is reduced by mechanical compaction (dewatering), by solution-transfer of calcite, by growth of authigenic clays, and by precipitation of silica on skeletal elements. These siliceous coatings and locally abundant chert nodules are interpreted as products of remobilization of biogenic opal. Although these observations and interpretations are based on North Sea chalk reservoirs, exploration in frontier areas should reveal chalks with similar features and comparable reservoir potential.

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Sedimentation in Mississippi Trough, Gulf of Mexico

Interpretation of high-resolution seismic data indicates that the Mississippi Trough was eroded, and then partially filled, by submarine gravity flows. These flows occurred primarily during late Quaternary stages of lowered sea level. Present-day mass transport appears to be a combination of seafloor creep and low-velocity turbid-layer flow.

An acoustically chaotic seismic facies characterizes the deeper parts of the trough fill. Visible reflectors are discontinuous, wavy, and subparallel; they commonly disappear into almost reflectorless, seismically homogeneous units. Sediments deposited lateral to the chaotic facies are commonly composed of continuous, parallel reflectors. These strong reflecting units were deposited as onlapping fill and ponded sediments, and many are confined to semienclosed depressions within the trough walls. These various seismic-facies units represent the "freezing-in" stage of submarine-canyon sedimentation, and may result from separate submarine debris flows. The deposits of the Mississippi Trough debris flows are fine-grained sediments generated by mass failures of oversteepened deposits which occurred at the mouth of the ancestral Mississippi River. High-energy gravity flows thoroughly mixed the depositional material, leaving little bedding to produce coherent seismic-reflector patterns. Debris flows generated lower velocity gravity flows, which moved independently and lateral to the main flows. The onlapping fill deposits and sediment ponding were deposited by lower velocity flows.

Recent sediments, which were sampled by piston coring along the axis of the trough, are rapidly deposited, hemipelagic, olive-gray silty clays. Sedimentary structures are limited to scattered, very thin laminae and thin beds. Clay sedimentation has been continuous during

the late Quaternary, as is revealed by the clays containing mixtures of indigenous planktonic Foraminifera, displaced shallow-water microfauna, and terrigenous mineral grains.

Large diapirs controlled the position and flow direction of the main erosional channel. Small feeder channels were eroded into the walls of the trough. Trough-wall sediments cover a steep erosional escarpment; they have moved downslope by slump and creep failure. An isopach map of the canyon fill, above erosional surfaces, outlines a linear channel-fill deposit.

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Gamma-Ray Spectral Logging Data Assist in Geologic Studies

Natural gamma-ray spectral logging in open and in older, already cased wellbores has a broad problem-solving capability in evaluation of clastics, carbonate rocks, evaporites, and igneous formations.

Geologic application of such gamma-ray spectral data on a qualitative basis includes detailed stratigraphic correlation, identification of rock types, presence of secondary porosity and natural fracture systems, recognition of the depositional environment and source-rock potential of shales, location of watered-out intervals in reservoirs under enhanced recovery, etc; and on a qualitative basis, the determination of reservoir shaliness, in-situ potash concentration, etc.

Basically, natural gamma-ray spectral logging techniques yield a calibrated, continuous record of the total natural gamma-ray radioactivity and the individual potassium, uranium, and thorium content of subsurface formation as illustrated by field studies from the United States, the North Sea area, South America, and the Middle East.

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Videotapes of Active Primary Physical and Biogenic Sedimentary Structures of Epicontinental Shelf, Northern Bering Sea

Videotapes from 23 camera stations in the northern Bering Sea provide a unique view of the formation and modification of primary sedimentary structures in the marine environment. The study area is a shallow-water (<35 m) ridge and swale terrane located west of Seward Peninsula and south of Bering Strait, Alaska. Strong, north-flowing, unidirectional currents of Alaskan coastal water dominate the region. Ancillary information collected at each station includes bottom samples, surface-to-bottom current-meter and light-transmission data, and high-resolution seismic reflection and sidescan sonar records.

Ridges exhibit 5 to 10 m of relief and are mantled by fine to medium, moderately well-sorted detrital sand. Bed forms observed on ridge crests and flanks include wave and current ripples and two populations of sand waves ($\lambda \approx 15$ m and $\lambda \approx 200$ m). Videotapes recorded atop sand ridges show modification of ripples in response to oscillatory bottom currents. Observations of