carbonates, bears no relation to sedimentary facies; to the contrary, it is demonstrably joint-controlled. This evidence, together with the near absence of "dedolomite," indicates a late and sustained source of magnesium in excess of that expected from an evaporite-bearing assemblage.

Water samples from Keuper "salinas" (salt-producing evaporating pans) show that meteoric water descending through the Keuper evolves into a brine with Mg:Ca ratios locally 4:1, despite the abundance of gypsum and anhydrite. Samples of Keuper subjected to simple solution in the laboratory liberate Ca:Mg in the ratio of 3:2, which is probably sufficient for dolomitization under reasonable subsurface temperature-salinity conditions. X-ray analysis indicates chlorite as a source of the magnesium, the solubility of which probably reflects diagenetic fixing in the Keuper evaporite basin. The composition of Keuper water, aided prior to unloading by geothermal gradient, is thought to be responsible for Muschelkalk dolomitization.

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PROGRESS IN ICHNOLOGY—STUDY OF ANIMAL SPOOR

Trace fossils—the tracks, trails, burrows, borings, and other spoor made by ancient organisms—are difficult to identify and classify phylogenetically but can be assigned relatively easily to various taxonomical, behavioral, and preservational categories. Analyses of these aspects of spoor can yield considerable information that is potentially very useful in geology.

The most significant contribution of spoor to date has been in paleoecology and environmental reconstructions, including recognition of local and regional-temporal facies changes and documentation of individual paleoecologic parameters. Spoor are potentially valuable indicators of bathymetry, currents, food supplies, aeration, rate of deposition, depositional history, and substrate stability; they also may be useful to some extent in establishing ancient temperature and salinity regimes.

The chief contribution of spoor to paleontology is partial resolution of "the problem of the incomplete fossil record." This includes, inasmuch as possible, the identity, behavioral patterns, and certain evolutionary trends among ancient organisms not otherwise represented in the fossil record. Reconstruction of diversity and trophic relations is important and generally feasible.

Trace-making animals are important sedimentologically because they destroy previous sedimentary structures and fabrics and produce new structures and fabrics. Spoor have certain potential even in biostratigraphy and local correlations. Many trace fossils are excellent geopetals.

Ichnology—the study of spoor—has developed slowly relative to other branches of geology, but the subdiscipline is now on the threshold of widespread acceptance and considerably increased application.

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THE GEOLOGICAL ATTITUDE

Geological ideas from the beginning have clustered on a succession of concerns which can be related generally to social and industrial pressures. Some concerns, in response to contemporary stimuli, swelled explosively into well-defined constellations of activity to which names such as "creation," "evolution," and "conservation" apply. Other culminations of geological activity, more limited in their reference, relate to changes in technical capability, and seem to last about a quarter of a century.

Always present in geological thought, there has existed an attitude of special relationship to the earth; the geologist is an intermediary between his culture and its physical substructure. The actions of geologists in our civilization have profoundly altered concepts of secular time, the church, man, and the balance of nature. In the last, social pressure must be near its peak.

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BUILDING NEW MARSHES AND ESTUARIES IN COASTAL LOUISIANA THROUGH CONTROLLED SEDIMENTATION

Coastal Louisiana wetlands are a product of Mississippi River delta building that has occurred over a period of 3,000–5,000 years. The building processes were very nearly balanced. In modern times man's use of the area (flood control, navigation improvement, exploitation of petroleum and other minerals, road building, *etc.*) has seriously altered the natural balance. As a result, overbank flooding has been virtually eliminated and river flow is confined to channels discharging into the outer shelf area. Most transported sediment is now deposited in the deep Gulf of Mexico or along the continental shelf. Saltwater encroachment in the deltaic estuaries has been detrimental to fauna and flora. Even though considerable sediment deposition has resulted from the historic Atchafalaya River diversion and growth of subdeltas, comparative map studies indicate a net land loss rate of 16.5 sq mi/year during the last 25–30 years. Land loss is only one symptom of general environmental deterioration.

A dynamic management plan is necessary for better utilization of combined freshwater discharge–dissolved solid and transported sediment input of the Mississippi River. Controlled flow into estuaries will reduce salinity encroachment and supply needed nutrients. Large areas of new marshland and estuarine habitat can be built by controlled subdelta diversion. Studies of natural subdeltas indicate that these systems are amenable to environmental management; salinities and sediment deposition may be manipulated to enhance desired conditions.

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SEDIMENTOLOGY AND ECOLOGY OF HOLOCENE CARBONATE FACIES MOSAIC, CAPE SABLE, FLORIDA

The Holocene carbonate sediments of Cape Sable, Florida, form a facies mosaic in which facies are controlled by frequency and duration of flooding. The 4 following zones occur:

1. Flooding 0–5% of the time (*supratidal*)—massive to crudely bedded sandstone or siltstone, abundant birdseye, low species diversity, high abundance of single species with uniform-sized individuals.

2. Flooding 5–25% of the time (*high intertidal*)—low domal and flat laminated algal stromatolites, desiccation cracks and flat laminated pebbles, low species diversity, low abundance of individuals, microscopic invertebrates only.

3. Flooding 25–90% of the time (*low intertidal*)—

massive burrow-mottled silts, moderate species diversity, moderate abundance of individuals, mainly microscopic, with a wide size range among individuals.

4. Flooding > 90% of the time (*subtidal*)—massive pelletal silts and clays, highly burrow-mottled, high species diversity, high abundance and wide size range of individuals within species, many macroscopic invertebrates. Areas of high intertidal and supratidal sediments where ponding of waters occurs for extended periods are characterized by single or multiple algal and sediment laminae much thicker than in areas where waters drain rapidly.

Sedimentation in zone 1 forms thin beds, derived from sediment-laden waters driven over the area during storms. In Zone 2, sediments are deposited in thin laminae; sedimentation is controlled by the trapping of particles carried by tidal currents and binding them onto mats of blue-green algae. Sedimentation in zone 3 occurs mainly in the form of thin beds deposited during storms and subsequently reworked by organisms. In zone 4, deposition occurs by settling of (1) *in situ* sediments; (2) particles carried into the area by tidal currents; and (3) particles from sediment-laden storm waters.

Measurement of production of calcareous sediment within the Cape Sable area, measurements of the net transport of sediment into the area by tidal currents, and measurement of the volume of sediment deposited in the area since its opening to the sea in the 1920s allow the following calculations to be made. Since 1920, 4% (0.01 cm/yr) of the total deposit has been derived from *in situ* production, 34% (0.28 cm/yr) by net transport into the area on tides, and 62% (0.50 cm/yr) by storms.

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Effect of Three Different Depositional Environments on Dipmeter Results

Many dips that appear on a high-resolution dipmeter plot reflect environmental energy conditions existing at the time of deposition rather than structural dip. Beds deposited in a high-energy marine environment tend to exhibit a great scatter of dip magnitudes. Conversely, low energy environments cause "layer-cake" deposition and uniform dip magnitudes. Recent studies have identified 3 distinct environments from dip plots.

The first environment lies between the bench and the seaward edge of the continental shelf. This shoreward energy band shows dip magnitude scatter which can be divided into high, medium, or low dips corresponding to deposition in high-, medium-, or low-energy environments. Most of the energy is supplied by wave and current action.

The second environment lies between the seaward edge of the continental shelf and the abyssal zone. This seaward energy band shows dip magnitude scatter similar to the shoreward energy band. Its high-energy zone is found on the upper slope and the medium-energy zone on the lower slope. Most of the energy is supplied by gravity. Dip patterns are more cyclic in this environment.

The third environment is near an active delta. The rules for water depth identification in the other energy bands do not apply. Beds deposited in such an environment show mainly "current patterns" on the dip plot. The direction of dip of these "current patterns" defines the direction of transport and the dip pattern magnitude indicates the most probable shape of the distributary-front sand body.

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Landward Movement of Carbonate Mud: New Model for Regressive Cycles in Carbonates

Repeated regressive cycles are characteristic of the Paleozoic shallow-water carbonates of North America; similar cycles are present, although less abundant, in Mesozoic and Cenozoic strata worldwide. Several of these cyclic carbonates contain major hydrocarbon reservoirs: Permian, Central Basin platform; Mississippian, Saskatchewan; Ordovician and Silurian, Montana. Studies of comparable recent deposits in Florida, the Bahamas, and the Persian Gulf suggest an alternative to the accepted tectonic explanation of these cycles.

The Florida Bay lagoon and the tidal flats of the Bahamas and Persian Gulf are traps for fine sediment produced on the large adjacent open platforms or shelves. The extensive source areas produce carbonate mud by precipitation and by the disintegration of organic skeletons. The carbonate mud moves shoreward by wind-driven, tidal or estuarinelike circulation, and deposition is accelerated and stabilized by marine plants and animals.

Because the open marine source areas are many times larger than the nearshore traps, seaward progradation of the wedge of sediments is inevitable. This seaward progradation gives a regressive cycle from open marine shelf or platform to supratidal flat. As the shoreline progrades seaward the size of the open marine source area decreases; eventually reduced production of mud no longer exceeds slow continuous subsidence and a new transgression begins. When the source area expands so that production again exceeds subsidence a new regressive cycle starts.

The seaward progradation suggested by this model should be observable in ancient deposits.

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Slide-Block Geology, Coyanosa and Adjacent Areas, Pecos and Reeves Counties, Texas

A large-scale submarine slide occurred in early Wolfcampian (Permian) time in the Coyanosa and adjacent areas of the southeastern Delaware basin of West Texas. The slide, which bisects the Coyanosa field, comprises all rocks above the Upper Devonian Woodford Shale, the surface of detachment. Maximum dimensions were 16 mi from east to west, 9 mi north to south, and 2,000 ft thick. Lateral displacement from east to west was about 7 mi.

Wildcat and development drilling in the area has revealed many paradoxical structural and stratigraphic conditions in the Mississippian through Wolfcamp interval. These sequences include repeated sections, exotic blocks, displaced facies, and abrupt stratigraphic hiatuses.

The sole of the allochthonous plate was a thick, competent Mississippian limestone. Thick Permo-Pennsylvanian conglomerates shed from the rising Central Basin platform on the eastern side of Coyanosa, coupled with steepening of the flexure on the western and southwestern flank of Coyanosa, triggered the slide.