are very similar in both lithologic character and sequence to those of the compound sedimentation unit of the Stairway Sandstone. However, because of the many thousands of square miles covered by the facies of the Stairway Sandstone, both modern models are considered to be inadequate. Therefore a more hypothetical model of epeiric-sea sedimentation also is considered. Though having the disadvantage that there is no known present-day counterpart, this model nevertheless warrants some consideration. It is possible to explain many of the features of the Stairway Sandstone (and perhaps other formations) by its use.

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PALYNOMORPHS AS INDICATORS OF NEARSHORE AND OFFSHORE FEATURES IN MODERN SEDIMENTARY BASINS

Distribution of pollen, spores, cuticles, tracheids, as well as dinoflagellates, hystrichospheres, microforaminifers, and certain other microplankton, may be used within certain limitations to identify or assist in determining sedimentary environments and ancient paleogeographic patterns.

Special consideration is given to the modifying influence of marine circulation, currents, tides, *etc.* on patterns of distribution. Configuration and restrictions of basin and shorelines, patterns of surface or near-surface circulation resulting from prevailing wind regimes (resulting in localized areas of upwelling in different seasons), submarine canyons, and other such agencies and features cause significant modifications on distribution patterns of palynomorphs.

Direction, strength, and season of prevailing winds and storms exert some control in distribution of pollen and spores. Down-wind distribution areas show decreasing frequency from source areas.

Dilution of palynomorph concentrations in the vicinity of deltas and channels, where an abundant supply of terrigenous sediments is accumulating, seems to lower absolute frequencies of palynomorphs only in main channels and very near the shore.

Differential susceptibility to decay, which characterizes these entities, makes it difficult to depend on the presence or absence of particular pollen of plants which make up the communities on the coastal plains to identify nearshore position.

Use of total number of spores and pollen in sediments, to determine positions of former shorelines, should be amplified with a consideration of type of sediment at the sampling site and the nature of thanatocoenoses of marine faunas and algae.

Cuticles and tracheids are extremely abundant in fine sediments near the shore and decrease offshore. Cuticular fragments greater than 1 millimeter in diameter usually are not carried or are destroyed within a few miles of shore; tracheids greater than 50μ and finer cuticles are deposited in decreasing numbers 50–100 miles offshore.

Some kinds of palynomorphs increase in relative frequency, compared with total pollen and spores, with increasing distance offshore. Mangrove and pine are typical of this group. Herbaceous pollen generally is more abundant near the shore.

Comparison is made of results of studies of palynomorphs in modern bottom sediments in the Gulf of California, Gulf of Paria, Mediterranean Sea, Sea of Okhotsk, and Gulf of Mexico for the purpose of indicating proximity to shorelines and deltas.

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THEME: STRATIGRAPHY GUIDES STRUCTURE: (A) INTERRELATION BETWEEN STRATIGRAPHY AND STRUCTURE (*Crowell*); (B) VENTURA BASIN, EXAMPLE OF THEME (*Paschall*)

INTERRELATION BETWEEN STRATIGRAPHY AND STRUCTURE

Earth deformation initially delineates basins and, together with climate and provenance, guides the distribution of sediments. In geosynclines and mobile belts the rise and fall of welts and troughs influence the facies sharply. Even in cratonic regions, tectonic control of sedimentation is clear. Crustal deformation also occurs after deposition, and the positionings and geometric details of structures are controlled by the mechanical properties and inhomogeneities of the strata. In such cases stratigraphy clearly has guided structure. In many regions, however, deformation and deposition have occurred together, and an interplay continues intermittently for long periods of time. As a result, deformation guides deposition which in turn guides deformation *et cetera*. Such an interrelated continuum regulates the movements of fluids, including oil and gas, within the strata.

Modern analysis of basin history requires a careful reconstruction of the interplay between deformation and deposition. The analysis is most effective if one begins with the present and works backward in time, sorting out the geological events and their effects one by one. Knowledge gained recently of modern depositional environments and the geometry and distribution of sedimentary facies within them provides the geologist with reference models of the appearance of his study area in the past. It is not sufficient to visualize static strata as having been deformed suddenly after deposition and lithification. Instead the geologist must find techniques which permit him to reconstruct the panorama of continuous changes not only of the stratigraphy through time, but also the folding, faulting, and movements of fluids within the strata. (*Crowell*)

VENTURA BASIN, EXAMPLE OF THEME

The sediments of the Ventura basin are more severely deformed than those of most oil-producing provinces. This circumstance, in combination with the narrow linear aspect of the basin and the abundance of outcrops, yields more conspicuous examples of structural-stratigraphic relations than usually are encountered.

The basin's early history reveals a characteristic common to all depositional areas, *i.e.*, the manner in which basin and basin-margin structure affected sedimentation. A second feature of basin history that is not so conspicuous elsewhere is the manner in which stratigraphy affected later deformation of the basinal sediments, as well as oil accumulation in them.

Major high-angle reverse faults now exist locally along the north and south boundaries of the main Pliocene basin. The very thick (world-record) Pliocene section not only thins toward these faults, but also typically has a notable decrease in permeable sandstone percentage.

The fault zones contain fine-grained terrigenous clastic rocks and siliceous shale, which served as a lubricant for fault movements. The fault zones probably also served as intermittent avenues for migration of sub-fault oil into producing structures above the fault. (*Paschall*)

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PETROLOGY OF BUCKNER MEMBER OF HAYNESVILLE FORMATION IN ADJACENT PARTS OF TEXAS, LOUISIANA, AND ARKANSAS

The Buckner Member of the Haynesville Formation is an evaporitic mudstone unit of Late Jurassic age that is present only in the subsurface around the margin of the Gulf Coast embayment. It has been divided informally into two parts, lower and upper.

The most common rock types in the Buckner are nodular anhydritic mudstone and nodular anhydrite. The nodules consist of swirls of lathy anhydrite in a matrix of blocky to anhedral crystals. The mudstone matrix consists of a red or gray non-laminated or poorly laminated mixture of silt and clay minerals. The clay minerals are mostly illite and chlorite. The next most common rock type is light gray crypto- to micrograined laminated anhydrite that is largely confined to the lower part. This type contains scattered minute rounded dolomite grains, clay mineral grains, and fine-grained sand and silt. Some less common rock types in the Buckner are oölitic and detrital limestone, oölitic-micritic and detrital-micritic limestone, rock salt, micrograined dolomite, and medium-grained dolomite.

The member was deposited around the margin of the Gulf Coast embayment in linear basins. Contemporaneously growing salt-cored anticlines along the seaward margin caused restricted circulation with the open sea. The lower part was deposited mainly in standing bodies of water and the upper part was deposited on a tidal mud flat that was, from time to time, flooded by both marine and non-marine water. The sea generally was regressing during deposition of the Buckner.

Micrograined anhydrite is associated with rock salt and is considered to be primary. Nodular anhydrite is associated with brackish-water fossils and was probably deposited as gypsum.

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GEOMORPHIC EVOLUTION OF CONTINENTAL MARGINS

Continental margins are important realms of gas and oil accumulation; 20 per cent of United States production already is offshore. It is necessary, therefore, to try to understand the genesis of continental margins and their subsequent geomorphic evolution. The writer suggests that continental margins are young (generally not older than mid-Mesozoic) and may be classified into two types: (1) accretionary margins caused by the collapse of continental rises and the associated accretion of new fold belts to the continents (Pacific-type); and (2) modified rift scars remaining after continental drift (Atlantic type). Most of the margins around the Atlantic and Indian Oceans are of the latter type but the bulge of Africa and the bight of North America are regarded as Pacific type. One can expect the two types to develop somewhat differently insofar as sedimentary modification and geomorphic evolution are concerned. They are either sites of mountain building and hence uplift, or are subsiding isostatically and accumulating a capping wedge of sediments and a thick continental-rise prism. These two elements (the terrace wedge and the rise prism) are "living" examples of the miogeosyncline and the eugeosyncline, respectively. Continental-rise prisms probably are petroliferous, but the petroleum is lost through metamorphism when the rise is collapsed into a eugeosyncline; terrace wedges also are petroliferous, and this petroleum is not lost with time because the presence of sial beneath prevents intense metamorphism. In equating terrace wedges with miogeosynclines, it is to be noted that both have a wedge-shape rather than the form of a syncline. This is regarded as a natural consequence of continental-margin sedimentation. In the search for oil in miogeosynclines, geologists should be aware that they were not closed basins but one-sided "basins" open toward the sea. Thus, instead of basin deposits, one finds mainly those sediments deposited during the prograding and retrograding of paralic-zone sediments.

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PROCESSES OF SUBMARINE EROSION IN LA JOLLA FAN-VALLEY AND THEIR RELATION TO SEDIMENT-DISTRIBUTION PATTERNS

Observations from *Deepstar*, a research submersible, indicate that submarine erosional processes are actively modifying the main channel of La Jolla fan-valley. Internal terraces, slump scars, scour depressions around isolated erratic boulders up to 3 feet across, and a lack of talus deposits at the base of the steep walls of the main channel indicate an over-all downslope movement of the sedimentary fill on slopes of less than 1° in depths to about 4,000 feet. Cobble beds, probably deposited as part of the La Jolla fan in depths greater than 2,000 feet, presently are being eroded. The redistribution of the eroded products is evident in box cores which contain rounded balls of semi-consolidated deep-sea clay in a coarse sand matrix. The patchy distribution of different types of sediment along the axis of the fan-valley indicates that the processes currently active in moving coarse-grained sediment down the canyon were not a continuous event. The occurrence of a 2–4-inch-thick layer of fine-grained silt and clay overlying a medium- to coarse-grained sand indicates an abrupt change in the type of sedimentation active in the fan-valley approximately 1,100 years ago.

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DEPOSITIONAL ENVIRONMENTS OF SALEM LIMESTONE (MISSISSIPPIAN) OF SOUTH-CENTRAL INDIANA

Five major environments of deposition were present along the outcrop trend of the Salem Limestone in south-central Indiana. These environments are based on lithic and biologic distributions.

Three separate regions existed during deposition of lower and middle Salem sediments. The northern region was restricted, as indicated by the presence of argillaceous, dolomitic, bryozoan calcarenite. This was a shallow sea which connected with the Michigan basin where evaporite deposition was occurring. The central outcrop region was one of open circulation where algal-mollusk and echinoderm-bryozoan sparry calcarenite was deposited. Distribution of the calcarenite indicates a regression toward the south. The Indiana building stone is quarried mainly from this facies. The southern region was the site of extensive large-scale (30 feet of relief) sparry calcarenite sand bars as indicated by the existence of macro-cross-beds.