spurs and grooves are expressions of lapies. These karst-induced differences in relief are perpetuated, and indeed accentuated, by reef growth, but reef growth per se has little to do with the resulting configuration.

It follows from this hypothesis that similar events should be recorded in the geologic record, and it is therefore interesting to note that facies relations among some supposed fossil reefs are depositionally incompatible unless an intervening period of subaerial exposure is assumed.

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Geologic Occurrence of Oil and Gas in Miocene of Gulf Coast of United States

Miocene sands have produced, through 1967, approximately 6.76 billion bbl of oil and 35 Tcf of gas in about 650 fields in coastal and offshore Louisiana and Texas. More than 80% of the production has come from fields in the Louisiana segment, where all 19 giant Miocene oil fields are located.

The Miocene sediments of coastal and offshore Louisiana and Texas form a seaward-dipping and thickening wedge of interbedded marginal-marine sandstone and shallow-marine shale with maximum thickness at any locality of about 25,000 ft. A composite section in the Gulf Coast geosyncline is at least 45,000 ft thick.

Rapid sedimentation in large deltas, where there were prolific organic production and accumulation and where the organic material was preserved by rapid burial, made possible the many large Miocene petroleum accumulations. These favorable conditions were confined mainly to the Louisiana coastal and adjacent offshore areas that subsided at a faster rate than the coastal interdeltaic regions on the east and west, and confined the Miocene Mississippi River to that part of the northern Gulf basin. Downward movement along faults that bound the deeply buried salt-filled grabens also took place as the major deltas prograded, causing diapiric structures and "rollover" anticlines to form where organic-rich deltaic mud, silt, and sand were deposited.

The tectonic-sedimentation history of the Gulf Coast Miocene clearly demonstrates the close relation between depositional environments and petroleum occurrence.

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Discontinuity Surfaces in Beaverhill Lake Group (Devonian) Limestones, Alberta

More than 300 individual occurrences of discontinuity surfaces were examined in well cores of limestone of the Beaverhill Lake Group in the Swan Hills area of central Alberta. Planar to bumpy surfaces with truncated shells, organic borings, and associated pyrite, glauconite, and intraclasts grade morphologically into bedding planes. Irregular reentrants, up to 15 cm deep and infilled with sediments lithologically similar to the overlying rocks, can be interpreted as burrows and/or solution cavities. Many of the discontinuity surfaces are present within burrowed carbonate mudstone of the Waterways Formation, which contains a brachiopod-gastropod-echinoderm-ostracod fauna typical of normal-marine, subtidal environments. Although only few Waterways surfaces can be correlated in adjacent wells, 2 extensive surfaces are significant in that they form the upper and lower boundaries of the House Mountain–Deer Mountain reef complex (Swan Hills Formation).

The presence of discontinuity surfaces within subtidal, sub-wave-base limestone beds suggests that they are products of submarine lithification and erosion (mechanical, chemical, and biologic). These processes must have acted periodically to form hard clean areas of tens to hundreds of square miles of sea floor. Change in the normal circulation pattern of currents possibly triggered these processes and led to formation of discontinuity surfaces. A discontinuity surface at the upper contact of the reef complex indicates that rapid submergence, rather than emergence, probably terminated reef growth in the House Mountain–Deer Mountain area. The discontinuity surface just below the reef complex shows that reef growth was initiated from a hard surface.

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Characteristics of Shoreface Sediments

Sedimentary structures in shoreface deposits are in marked contrast with those of laterally equivalent facies. Whereas sediments of the beach and offshore areas consist of clean sands inhabited by relatively few species of burrowing organisms, the shoreface is characterized by an abundant and diverse fauna inhabiting detritus-rich, muddy sand. Principal sedimentary structures of shoreface deposits are those produced by biogenic reworking, whereas in the laterally equivalent beach and offshore sediments, structures which reflect physical energy are more abundantly represented. Examples of ancient nearshore sediments indicate that these characteristic features of the shoreface are valid facies indicators in the sedimentary record.

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A New Look at Old Provinces

The oil industry, like the historian, glorifies the pioneer exploring glamorous new frontiers. A new exploratory look at old or mature producing provinces may be equally challenging and even more rewarding. A successful search needs the same optimism, resourcefulness, and skill, and even more tenacity than required to conquer virgin basins.

Obvious advantages of mature producing provinces are commonly overlooked. Mature provinces supply explorationists sufficient data to truly delineate significant causal geologic relations of oil production. Available data allow an intelligent focus of meaningful exploration effort. Ready markets furnish immediate return from oil and gas discoveries that would be uneconomic in new frontiers.

Numerous facets of old provinces merit new looks. Units a few hundred feet below commonly accepted pay zones are as unexplored as many new frontiers. Multitudinous subsurface controls, and even potentially productive wells, which were abandoned as dry holes, may provide evidence for the presence of prolific shallower zones. Careful analysis of productive trends can indicate major new projections. Extending old trends can be especially rewarding if they were terminated at well-known geographic boundaries, such as rivers, county, and province or state lines. Reanalysis may reveal near-similar parallel trends or similar unexplored geologic environments. Subsurface data from structural provinces may delineate more lucrative stratigraphic accumulations. Major unconformities can mask lucrative undiscovered structural or stratigraphic trends. Uneconomic fields often stand for years as lonely signposts indicating major new trends.

New looks at old provinces must shun prejudice as though it were the plague. Not only must one surmount entrenched management or client prejudice but, more important, those prejudices residing in one's own mind. All basic data must be reanalyzed to eliminate half-truths and ferret out new clues buried in voluminous data. Computer techniques facilitate handling the voluminous data of mature provinces, but should never replace an inquisitive geologic mind. Subsurface data should be integrated with the available but oft-ignored surface geology. Modern, stacked, seismic data, when integrated with up-to-date geologic models, prove many established concepts fallacious and indicate new concepts. Maps should integrate all available geophysical as well as geologic data. All geologic exhibits, even work maps, should show production causally related to the parameters portrayed. Regional maps should include related productive areas wherever possible.

Illustrations from various areas prove that the above techniques reward the explorationist who takes a new look at old provinces.

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Structural Setting of Black Sea

In the spring of 1969 a geologic and geophysical study of the Black Sea was made by the Woods Hole Oceanographic Institution. Echo-sounding profiles taken during the expedition, supplemented by published information, indicate that the continental shelf has its greatest development south of Odessa where it is more than 200 km wide. Elsewhere the shelf is less than 20 km wide. The continental slopes are about 1,800 m high, and are deeply entrenched by submarine canyons, except for the slope seaward of the Danube which is only about 1,000 m high and is relatively smooth. Seaward, the Danube fan has buried most of this slope and has prograded across the abyssal plain that occupies the central part of the Black Sea.

Continuous seismic profiles across the continental slopes generally show extensions of land structure, especially along the east coast, where ridges possibly related to the Caucasus Mountains trend across the shelf and slope. Some diapirs were observed off the Russian coast. Records from the abyssal plain generally showed it to be featureless, except near the continental slopes where considerable evidence of faulting and slumping was found.

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Sedimentation and Reef Development in Turbid-Water Areas of Fanning Lagoon

The term "coral reef" invokes, for most people, a vision of clear-water tropical seas. The clear water of this vision is not necessarily true. In Fanning Island Lagoon (3°54′N, 159°20′W) extensive thickets of *Acropora* and muddy sediments coexist at depths of 35 ft in water so turbid that a diver is not visible for more than 10–15 ft.

Three narrow passes connect the lagoon with the open ocean. A network of linear reefs divides the lagoon into several nearly isolated ponds. Lagoon waters are turbid except for an area around 1 of the passes. Coral abundance in the turbid-water area does not differ markedly from that in the clearer water. However, the corals of the clear water are mostly massive forms, while the turbid-water corals are ramose. Lush coral growth is present along the sides of the linear reefs as well as in thickets in the interreef ponds.

Linear reefs wider than about 50 ft have medial sand areas and there is a medium- to coarse-grained sand in the ponds along the reef edges. However, the major sediment in the lagoon is medium silt. The sediment particles are the result of physical and biologic abrasion of corals, mollusks, and calcareous red algae. Unlike many lagoons, Foraminifera and *Halimeda* are not important sediment contributors in Fanning Lagoon.

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Correlation of Mean Sizes Obtained from Size Measurement by Thin-Section and Loose-Grain Methods

Wicksell's or Krumbein's corrections based on probability of sectioning spherical grains at random can be used to yield loose-grain size moments from the observed thin-section size moments. Mathematical theory and experimental results clearly demonstrate that the probability of slicing spherical grains is directly proportional to their diameters (Wicksell's assumption) and not equal for all sizes as assumed by Krumbein. Therefore, correlating thin-section and loose-grain mean sizes (made dimensionless by dividing by 1 mm) by Wicksell's procedure and linearizing the equation by applying phi-transformation ($\phi = \log_2$) to both sides, one obtains

$$\begin{aligned}\phi(phm)_{n\,(\text{or } w)} &= \phi(c)_{n\,(\text{or } w)} + \phi(\overline{B})_{n\,(\text{or } w)} \\ &\quad + \phi(R.B.)_{n\,(\text{or } w)}, \cdots\end{aligned} \tag{1}$$

where subscripts n and w represent number and weight (volume) frequency, respectively; where $R.B.$ is the residual bias

$$R.B. = \left[\left(\frac{\overline{D}}{\overline{B}} \times \frac{phm}{\phi hm}\right)\left(\frac{\bar{A}}{\overline{D}} \times \frac{dhm}{\delta hm}\right)\right];$$

hm is the harmonic mean; bar above letter indicates arithmetic mean; capital and small letters refer to loose-grain and thin-section sizes, respectively; Roman and Greek letters refer to sample and population values, respectively; P, p are projection (equal projection area and nominal sectional) diameters; A, a are long (circumscribing circle) diameters; B, b are short (inscribed circle) diameters (B is actually loose-grain intermediate diameter); Δ, D, δ, d are spherical diameters; $\phi(c)_n$ and $\phi(c)_w$ are Wicksell's correction constants having phi-values of 0.651 and 0.179, respectively. Nine multivariate linear correlation equations can, in general, be established between $\phi(Phm)$, $\phi(\bar{a})$, $\phi(\bar{b})$, and $\phi(\overline{P})$, $\phi(\bar{A})$, $\phi(\overline{B})$; where $\phi(c)_{n(\text{or } w)}$ is a constant. The correlation equation between $\phi(\bar{a})$ and $\phi(\bar{A})$, for example, is: $\phi(\bar{a})_{n(\text{or } w)} = \phi(c)_{n(\text{or } w)} + \phi(\bar{A})_{n(\text{or } w)} + \phi(R.B.)_{n(\text{or } w)} + \phi(\overline{B}/\bar{A})_{n(\text{or } w)} - \phi(phm/\bar{a})_{n(\text{or } w)}$.

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(No abstract submitted)