productive well of the Golden Lane, San Diego de la Mar No. 1, was brought in with an estimated daily production of 2,500 bbl of oil. During the following years, production was found in other places by drilling near seepages and following a trend of productive fields about 50 mi long and more than 0.5 mi wide. Within the old Golden Lane is located the famous Cerro Azul No. 4 well, probably the world's largest well, which had an estimated daily production of 260,000 bbl of oil.

What is known as "the new Golden Lane" or as "the southern extension of the Golden Lane" was discovered in 1952 when the Ezequiel Ordoñez No. 1 well came in as a producer; afterward, new-field discoveries were made between 1952 and 1962. This trend includes several fields, including the giant Poza Rica field. This southern continuation of the Golden Lane had been inferred geologically but it was not until both gravity and seismic surveys were carried out and interpretative techniques were improved that "the southern extension of the Golden Lane" was identified.

At the same time, an offshore extension of the Golden Lane was suspected, and the offshore seismic surveys carried on led to the discovery of the "marine Golden Lane;" in 1963 offshore well Isla de Lobos No. 1 was completed as a producer. The "Golden Lane," as it now is interpreted, consists of a closed oval-shaped huge "atoll"-type reef about 85 mi long and 40 mi wide, the eastern part extending in the subsurface under the Gulf of Mexico.

In the course of exploitation and the discovery of new fields along its perimeter, the geologic genesis of the "atoll" of the Golden Lane is still the object of controversy; nevertheless, the most accepted theory is that it consists of a biohermal reef that started its growth in Early Cretaceous (late Neocomian) time on a late Kimmeridgian (Late Jurassic) positive element referred to as the "Isla de Tuxpan." At some localities within its inner part, evaporite, calcarenite, and dolomite occur; at others however, rudistid and miliolid limestones occur. Its periphery consists of a prominent belt of structural culminations which are made up indistinctively of rudistid and/or miliolid limestones. The Jardin No. 35 well, drilled in 1930, is the only well that ever penetrated the reef core. Its information, however, is questionable and very scarce. Notwithstanding the depositional environment attributed to rudistids (the principal component of this great reef), its morphology—regarding whether it consists of a bioherm, a biostrome, or a combination of the two—will persist as a subject of conjecture.

Golden Lane fields have produced to December 1967 more than 1.420 billion bbl of oil.

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BIOGENIC SEDIMENTARY STRUCTURES IN FACIES OF MIDDLE ORDOVICIAN BLACK RIVER GROUP OF NEW YORK STATE

This study is based on analysis of 450 large vertical slabs from eight stratigraphic sections in the Black River Group type area, the Black River valley, northwest New York State. The group is underlain by an irregular Precambrian surface, is 90–140 ft thick, and consists of three formations: the basal Pamelia, the Lowville, and the Chaumont. These represent a sequence of six nearshore sedimentologic facies. Superimposed on these are four biogenic sedimentary structure facies, each characterized by particular biogenic structures.

The Pamelia Formation consists of buff, algally laminated, fine-scale-mudcracked, supratidal dolomite characterized by rare vertical burrows like those of the succeeding Lowville Formation, and a sparse euryhaline fauna.

The lower Lowville consists of lithologic types representing two environments: (1) gray, mudcracked, ripple-marked, thin-bedded, intertidal limestone with a euryhaline fauna, and (2) dark gray, thick-bedded, laminated, subtidal limestone containing algally coated grains and a sparse stenohaline fauna. The intertidal Lowville is characterized by permanent, vertical, and U-shaped burrows which today are most common in intertidal environments. Filter feeders usually construct these burrows for protection in environments characterized by stress at the interface. The subtidal part of the lower Lowville Formation is characterized by complex, irregularly oriented, feeding burrows, and large, concentrically laminated burrows. Today these types of burrows are common in quiet subtidal environments where deposit feeders dominate.

The upper Lowville Formation represents a wave baffle formed by compound colonies of the spindle-shaped coral *Tetradium* associated with marginal zones of fallen *Tetradium*. These rocks are characterized by absence of biogenic structures, probably caused by the mechanical difficulty of burrowing into sediment with such a felted texture.

The Chaumont Formation consists of silt-size debris of a diverse stenohaline biota, and is unbedded because of thorough burrowing. It is characterized by small, horizontal, sediment-filled burrows, which today dominate in level-bottom marine environments where a thin oxidized zone favors deposit feeders which cover broad horizontal areas near the sediment surface. Thus, integration of faunal, sedimentologic, and stratigraphic data with information on recent biogenic structures allows ecologic interpretation of Ordovician structures.

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FACIES CHANGES DEVELOPED DURING FILLING OF A DEEP BASIN

A sequence of lithofacies developed during basin filling has been studied in a 150-m regression cyclothem in the Pennsylvanian of north Devon, England. The cyclothem can be divided from bottom upward into eight units.

Unit 1 (35 m) contains only black mudstone.

Unit 2 (12 m) contains 140 sharp-based, graded siltstone-turbidites, each about 2 cm thick. Sole marks indicate a wide spread of current directions, with a mean toward the south.

Unit 3 (9 m) contains regularly interbedded structureless muddy siltstone, and cross-laminated siltstone beds which usually have gradational bases. Six beds are sharp-based and bear sole marks.

Unit 4 (12 m) contains interbedded siltstone-turbidite and cross-laminated siltstone similar to those in units 2 and 3. There are also two channels at least 2 m deep and filled with thicker turbidite.

Unit 5 (18 m) is composed dominantly of muddy siltstone with irregular cross-lamination. Sharp-based siltstone-turbidite is rare, and dies out upward. Grada-

tional-based cross-laminated sandstone increases in abundance upward.

Unit 6 (47 m) contains gradational-based cross-laminated sandstone, irregularly interbedded with gray mudstone and cross-laminated siltstone. The sandstone beds become thicker and more abundant upward.

Unit 7 is a channel cut into the top of unit 6. The minimum depth is 15 m, and minimum width 100 m. The lower 5 m of fill consists of graded siltstone-turbidite, and the upper part is identical with unit 6.

Unit 8 (15 m) consists of trough-cross-bedded and cross-laminated coarse sandstone, with few thin mudstone beds. The sandstone is of nearshore, possibly estuarine, origin.

The whole sequence indicates gradual basin filling. The turbidite-filled channel near the top is cut into "shelf-type" sediments, and probably acted as a passage for turbidity currents flowing farther into the basin. There is no evidence of slumping in the cyclothem, and the turbidity currents probably originated directly from rivers carrying at flood stage a high proportion of silt and mud in suspension into the basin.

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Distribution of Glauconite-Boron Association in Continental-Shelf Sediments

Glauconite occurs in the sediments from an area on the continental shelf off the Washington-Oregon coast. The mineral is forming apparently at the present time, although some of it may be derived from Tertiary sedimentary rocks exposed on the shelf.

The glauconite-rich sediment shows a linear correlation with boron, which averages 223 ppm. Boron and potassium indicate that the mineral is a mixed-layer montmorillonite-illite. The chemical composition of the sediment is nearly the same as that reported by other investigators for glauconite-rich sediment and sedimentary rocks.

Petrographic evidence indicates several modes of origin for the glauconite including the glauconitization of specific minerals, lithic fragments, fecal pellets, and clay material within shells.

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Shale Chemistry as an Environment Indicator

Approximately 1,000 shale samples were analyzed by X-ray-fluorescence spectrography for the elements Na, Mg, Al, Si, K, Ca, Fe, Rb, and Sr. Three quarters of the samples came from two completely cored sections of mainly Upper Cretaceous shale in eastern and central Saskatchewan; most of the remainder came from cored Jurassic and Triassic sections in western Queensland, Australia. Preliminary results indicate that diadochic substitution of minor elements in the clay minerals is controlled by the chemistry of the waters in which the clays were deposited. The Rb/K ratio in particular appears to be significantly higher for marine shale than for continental shale.

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Palynological Stratigraphy and Succession of Oklahoma Pennsylvanian Coal Seams

Palynomorphs occur abundantly in Pennsylvanian coals of Oklahoma and are usable as stratigraphic indices and indicators of ecological conditions which existed in the coal swamps during their accumulation. Climatic conditions during Pennsylvanian time in Oklahoma appear from several lines of evidence to have been remarkably uniform but certain genera and species of palynomorphs have restricted stratigraphic ranges which appear not to have been entirely ecologically controlled. Certain genera, *Knoxisporites, Densosporites, Savitrisporites*, and others, are more abundant in the Upper Mississippian strata than in Pennsylvanian and do not extend higher than the Morrow or Des Moines Series. The Missouri and Virgil Series are characterized by genera and species of saccate palynomorphs. Certain specific coals are characterized by suites of fossils, by paleoecological assemblages, and/or by stages of palynomorph succession. The last factor is based on at least three stages of palynomorph abundance which may be interpreted as representing stages in the paleoecological development of coal swamps. These successive abundance levels as high as the Mineral coal in the Des Moines Series are (1) *Laevigatosporites-Lycospora*, (2) *Calamospora-Florinites-Endosporites*, and (3) *Densosporites*. Above the Mineral coal the *Densosporites* stage is absent or is replaced by a stage dominated by saccate genera. In the Missouri and Virgil Series *Lycospora* is absent and *Laevigatosporites* commonly represents the first stage of palynological succession. All areal parts of most coal seams do not contain the complete series of stages or abundance of specific assemblages. There is evidence that this variation is a function of geographic distribution of the particular coal seam and its geomorphic development. When factors of succession are combined with stratigraphic ranges of palynomorphs, greater knowledge of Pennsylvanian coal-swamp ecology is attainable.

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Lacq Gas Field, France

The Lacq gas field, France's most important, was discovered in 1951 by geophysical methods. The field is just north of the major overthrust separating the southern edge of the Aquitaine basin from the Nord Pyrenees foredeep. Directly under the field is a paleo-high flanked by two strongly subsided basins: the Arzacq basin on the north and Upper Cretaceous flysch trough on the south.

The gas is trapped in a roughly elliptical anticlinal structure in which differential subsidence has played the major role.

The gas has a 15.4 percent H_2S content and occurs under strong pressure (9,700 psi at 13,200 ft) in uppermost Jurassic dolomitic strata, Purbeckian-Wealdian sandstone, and Neocomian limestone and dolomite.

Reservoirs characteristics of these rocks are poor (5 percent porosity; 0.1 md permeability at best) and production is possible only because of intense fracturing on the upper part of the structure.

Production of the field is presently 700 MMcf per day of raw gas and in place reserves are evaluated at 8.8 trillion cu ft.