fundamentally unlike their Pennsylvanian ancestors. The apical pore, which was probably the germination point, was retained.

Beginning in Late Jurassic and continuing through the Recent, conditions were more favorable throughout the world for charophyte growth and many different forms evolved. The utricle coverings of the gyrogonite, apical rosettes, peripheral groves, thinned apical areas, basal structures, nodes, and variations in structure of the spiral units evolved as their abundance apparently increased and ecologic niches became more abundant and varied.

The ontogeny of the Tertiary forms also reflects this change. There is some enigma about the modern types because they are not as diverse as one might expect with the modern geologic setting of high continents and abundance of fresh- and brackish-water environments. Large collections containing many variations of growth stages are of greatest importance in the study of phylogenetic and ontogenetic characters. Because of this, selection of types commonly is misleading in taxonomic studies of the Charophyta.

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Sespe Formation—Example of Arid Climate Redbed

Examination of sedimentological aspects of the Sespe Formation, a late Eocene to early Miocene redbed unit of southern California, indicates that the formation was deposited under generally arid conditions. Evidence for this interpretation includes: (1) presence of arid-climate sedimentary features; (2) absence of intense weathering products among the detrital mineral suite, including the feldspars, ferro-magnesium minerals, iron oxides, and clay minerals; and (3) presence of an evaporite mineralogical suite including gypsum, borate minerals, and "corrensite," and abnormal formation-water content.

Although at variance with earlier interpretations based on scanty faunal remains and the primary detrital model of redbed sedimentation, arid conditions of Sespe deposition can be reconciled readily into a consistent regional climatic picture.

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Operational Classification of Unconformities

Differences in unconformities suggested by earlier classifications are more fancied than real. The criteria of scale, either areal or temporal, and concordance-discordance do not serve as practical bases for classification. Moreover, the aim of a nomenclature should be to answer the question which is, in the case of unconformities, "what is the evidence?", *not* "what is the kind?"

Examples demonstrate that evidences for unconformities are: (1) truncation of allochems and stylolites; (2) occurrence of encrusting organisms; (3) cement-supported detritus; (4) cement discontinuities; (5) megascopic erosional relief and bed truncation; and (6) truncation of faults and lithostratigraphic and biostratigraphic units on maps and cross sections.

These evidences fall into the following operational categories: I—*petrographic;* II—*macrographic;* and IIIa—*lithocartographic* and IIIb—*biocartographic unconformities.*

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Bay Marchand-Timbalier Bay-Calliou Island Salt Complex, Louisiana

This salt complex, more than 27 mi long and up to 13 mi wide, may be part of a much longer salt feature that extends both east and west. The mother salt bed of probably Late Triassic-Early Jurassic age is buried presently to depths of 40,000–50,000 ft, whereas the tops of the individual domes along the trend rise to depths only 2,000–3,000 ft below the surface.

Production to date on this three-field complex has been in excess of 700 million bbl of oil. Oil reserves are estimated to range from 750 million to 1 billion bbl. In addition, significant gas reserves are present.

Accumulations occur in Pleistocene sandstone as shallow as 1,000 ft to late Miocene sandstone deeper than 20,000 ft. A wide variety of traps is found, including superdomal arching shale and salt truncations, stratigraphic traps, and those associated with faults.

Production was discovered on this complex in 1930, and in 1966 about 75 million bbl was produced.

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Petroleum Reservoirs Among Evaporitic Rocks of Western Canada and Northern United States

In the sedimentary basins of the Great Plains province of the United States and western Canada, large amounts of rock, broadly described as evaporitic, are either themselves petroleum-bearing or so situated in their geological association with petroleum that evaporite geology bears directly on the petroleum occurrence.

Two general evaporite facies suites can be distinguished: (1) coastal shoal/salt-flat suite, and (2) reef/salt-basin suite.

1. Desert-zone coastal salt-flats, now widely called *sabkhas* (*sebkas*), have the outstanding peculiarity of a geochemical regime which transforms carbonate mud and carbonate sand to microdolomite, and simultaneously generates sheets of nodular anhydrite above high tide level. The permeability changes thus effected make stratigraphic traps for oil. Fossil sabkhas among Mississippian strata of the Williston basin and the Late Devonian of the Western Canada basin hold large reserves of petroleum and sulfur.

2. Salt deposits are extensive in the Devonian, some in shallow-shelf ("megasabkha") positions and others in salt basins where the evaporites overlie a reef-bearing formation. The evaporites surround the reef masses though they are not in stratigraphic-facies relation with them. Large petroleum reserves exist in the reefs of one basin, though not in the largest one. The Devonian salt basin deposits have analogs in the Delaware and Zechstein basins.

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Physical and Chemical Properties of Mississippi River Alluvial Valley and Delta Clays

Areal distributions of clay suites of the central Gulf of Mexico area have been studied mainly by X-ray diffraction, using peak-height ratios as an index to the nature of clays. This approach alone yields little information regarding effects of depositional environments. The present study couples geochemical techniques with analysis of other environmental indicators and emphasizes effects of organic and inorganic processes associated with deposition and early diagenesis. Undisturbed samples from both active environments and deep borings were utilized. Samples from fresh-water alluvial valley and upper deltaic-plain environments were compared with others from brackish and saline environments of the lower delta. Laboratory techniques included X-ray radiography, X-ray diffraction, X-ray spectrography, atomic absorption spectrophotometry, and microsteam distillation.

Clays deposited in channel and natural levee environments show little modification from the basic transported suite carried by the Mississippi (predominantly montmorillonite with appreciable amounts of illite and kaolinite). Minor differences attributed to seasonal fluctuations in flow regimes of major tributaries are detectable in suspended load and bottom samples. Percent organic C and cation-exchange capacities tend to decrease toward the river mouth.

In the lower delta, properties of delta-front and prodelta clays show distinct gradients, reflecting velocity decrease, water-depth increase, salinity increase, and mixing with shelf clays. Clays become more kaolinitic, less calcium saturated, and more sodium saturated seaward from distributary mouths. In these environments high soluble salt content is associated with a distinct texture and lamination produced by salt flocculation.

Integrated intensity ratio logs of montmorillonite-plus-illite/kaolinite from deep lower-delta borings not only exhibit trends related to delta progradation, but also show clay-mineral zonation resulting from shifting delta lobes. This zonation has been useful particularly in solving stratigraphic problems associated with diapiric mud-lump structures.

Clays are introduced into upper deltaic plain fresh-water basins largely by overbank flow from the main distributaries. Paludal and lacustrine environments are characterized by low rate of detrital introduction, high rates of organic and inorganic chemical deposition, high pH ($>$8.0), and warm, stagnant water. Despite the fact that secondary minerals (siderite, calcium carbonate, pyrite, vivianite, *etc.*) in the form of nodules and cementing agents are abundant and form rapidly, the basic nature of the clay remains unaltered even after burial for several thousand years.

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Anatomy of a Giant—Oklahoma City Field

Oklahoma City field, Oklahoma County, Oklahoma, was discovered in 1928 by the drilling of a wildcat well on a mapped 100-ft surface closure. Today this field ranks among the largest 10 oil fields in the United States. Its structural growth is allied closely to the stages of evolution of the Anadarko basin. Growth probably commenced in Cambrian time, and definitely took place from Ordovician through Early Pennsylvanian time as a result of subsidence in the Anadarko basin. This subsidence caused faulting and compressional folding, the most pronounced of which took place near the northeast rim of the basin. In that area, folds and faults in the Anadarko basin intersected the southern end of a buried mobile basement feature, the Nemaha ridge. The presence of this ridge not only influenced the position of the Oklahoma City field structure, but also its size, shape, and structural complexity.

The structure was folded, faulted, and truncated more or less contemporaneously. Approximately 2,000 ft of Ordovician-Pennsylvanian sediments was removed from the top; Pennsylvanian sediments above the unconformity overlie rocks as old as Ordovician. The trap is big—12 mi long, and having 1,000 ft of closure. A 2,000-ft, down-to-the-east fault prevented lateral migration of oil from the fold. The Pennsylvanian above the unconformity allowed only limited upward migration. Relief was so prominent and growth so continuous, even after truncation and burial, that the fold provided an ideal environment for development and trapping of oil and gas in the numerous shallow Pennsylvanian sandstones on the irregular surface of the fold. Traps within the Pennsylvanian sandstones include pinchouts, fault traps, and channel deposits.

The discovery well produced from Ordovician Arbuckle dolomite, the oldest pre-Pennsylvanian rocks on the crest of the structure beneath the unconformity. The most prolific production has been from the Wilcox Sand (basal Simpson) on the lowest part of the structure along the west flank, nearest the common water table. More than 20 different zones are productive from Ordovician Arbuckle to Late Pennsylvanian. Arbuckle and lower Simpson oil zones have a water drive.

Production from the Wilcox Sand was 350 million bbl of oil and 820 Bcf of gas through 1939, at which time the pressure in the Wilcox zone was reduced to atmospheric. Since 1939 the natural water drive has not been effective and natural gravity drainage has resulted in the production of an additional 186,370,000 bbl of oil. Estimated Wilcox oil in place is 1,072,000,000 bbl.

This field is unique in that it has been for 40 yr a model and proving ground for exploration techniques and producing technology; for modern proration rules and laws; for drilling and testing techniques in deep rotary wells; and for establishing the standards for formation evaluation and reserve estimates. Developments within a major city furnished the excitement caused by many "wild" wells like "Wild Mary Sudik," but joy accrued to the economic infusion which came during the worst days of the depression.

It is a billion-barrel field, having already produced more than that amount of oil and oil-equivalent gas. Of additional importance is the influence which this field has had in the finding and development of great quantities of oil and gas in adjacent areas of Oklahoma and throughout the world.

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Oil and Gas Accumulation in Recôncavo Basin, Brazil

The Recôncavo basin, on the Atlantic coast near the city of Salvador, includes about 3,850 sq mi and is the principal petroleum province of Brazil. Since