and marine and shoreline grasses. The assemblages are controlled by tidal drainage.

Landward from the primary strandlines, inundated river valleys contain few fossils either in bed-load or floodplain deposits. Major valleys near the primary strandlines contain extensive fresh-water swamps, bearing grasses, shrubs, and herbs characteristic of Recent marsh environments together with vertebrate bones and teeth. Estuarine environments as reflected by oysters, and mixed marine and fresh-water assemblages are of minor aerial extent, and usually are buried by sediments deposited in a deltaic environment.

Considering Miocene and Pleistocene sequences up to 20 mi seaward of the primary strandline, only about 10 percent of their associated rock units were formed in continental environments. Bedload and floodplain environments are represented by less than 1 percent. Estuarine environments comprise 3–5 percent and deltaic environments about 5–7 percent. Approximately 90 percent of the associated rock units were formed in marine environments of which 20–25 percent is basal transgressive sand, 15–20 percent littoral-sublittoral sand-silt, and 45–55 percent barrier island and marsh. Considering the Recent, the continental shelf is floored by a basal transgressive sand; little sand-silt and few barrier-island-marsh sequences are present.

CRAIG, D. H., Marathon Oil Co., Littleton, Colo., AND G. R. SCHOONMAKER, Marathon Oil Co., Findlay, Ohio

YATES OIL FIELD, PECOS COUNTY, TEXAS

The Yates field, discovered in October 1926, is extraordinary in amount of oil produced, size of original oil accumulation, and well productivity. During the 41 years since discovery, it has produced more than 500 million bbl of oil. Material balance calculations, based on past performance of the Yates field reservoir, indicate an oil-in-place of between 3.7 and 4.3 billion bbl. It has been estimated that ultimate recovery from the reservoir will be betweeen 1.5 and 2 billion bbl. The Yates field reservoir, mostly dolomite, may be the largest single oil accumulation ever found in a North American carbonate. It occurs as a gentle dome with structural closure in excess of 350 ft and covers an area of about 21,700 acres. The principal marker in the reservoir is found at depths ranging from approximately 1,000 ft to about 1,900 ft. Nearly a third of the 637 wells potentialed for more than 10,000 bbl of oil per day, and 26 potentialed for volumes ranging from 80,000 to 205,000 bbl per day. Cavernous and high matrix porosity in the reservoir contributes significantly to the remarkable productivity of some wells in the field. The cavernous porosity probably is related to subaerial erosion.

Both the Yates field reservoir and its seal are of middle Permian age. The reservoir is largely marine bioclastic dolomite equivalent to the San Andres-Grayburg. It also includes sandstone approximately equivalent to the Queen, between the Grayburg and Seven Rivers anhydrite, the latter forming the reservoir seal.

The huge Yates field reservoir oil accumulation probably resulted from favorable location relative to coarse beds and regional migration routes. The trap, a local and regional structural high, adjoins basinal strata on two sides and is situated at the southern tip of the northward-tilted Central Basin platform.

CUTBILL, JOHN L., Dept. of Geology, Sedgwick Museum, Cambridge, England

TECHNICAL AND THEORETICAL OBSTACLES TO CONSTRUCTION OF ADEQUATE CLASSIFICATION OF FUSULINID FORAMINIFERA

Progress in the classification of fusulinid Foraminifera is hampered by difficulties of access to the original observations on which the numerous taxa are based. An estimate has been made of the work involved to collect a suitable new data base for a classification of the whole group.

A reasonably full description of a single fusulinid test needs serial sections and involves about 800 measurements and about 40 descriptive terms. A satisfactory classification could be based on morphological information from approximately 50,000 individuals taken from 500 rock samples. A data base for determining the stratigraphical distribution of taxa would need information from an additional 100,000 individuals from about 50 major stratigraphical sequences. In all, 150,000 individuals must be serial sectioned and more than 100,000,000 measurements made.

Using available techniques for the serial sectioning of rocks to 250-micron intervals and for semiautomatic measurement of morphological features, it would be possible to collect the data in about 40 man-years of laboratory work. Spread through a 5-yr period this is well within the resources now deployed on the study of fusulines. The outstanding obstacles are the coordination of the collection and communication of the data, and the obtaining of some measure of agreement on what to collect. However, it is not necessary to decide on a method of constructing a classification before making the observations. Indeed if such a large data base was available readily, a classification in the conventional sense would no longer be needed for many purposes. Moreover the data-processing system which would be necessary to manage the data also would enable multiple classifications to be maintained should this be necessary.

DAVIES, DAVID K., Dept. of Geology, Texas A & M University, College Station, Texas

SELECTIVE DISPERSAL OF QUARTZ

Polycrystalline, undulatory, and nonundulatory quartz extinction varieties are characterized during transport by differing degrees of resistance to degradation. Polycrystalline quartz, the most unstable variety, is the first to be broken down and, in the examples discussed, is not modified significantly during transport. Undulatory quartz is being reduced continually in size during transport, and within a particular grain size there will be a concomitant enrichment in the more resistant nonundulatory variety.

Such a selectivity in the dispersal of quartz extinction types characterizes Pleistocene sediments of the Mississippi cone and Sigsbee Deep of the Gulf of Mexico. Proximal to input source (the Mississippi) the sediments have 8 percent less nonundulatory quartz than distal sediments on the western edge of the Sigsbee Deep. This variation is attributed to the differing degree of resistance to degradation of each of the monocrystalline quartz varieties. The westerly increase in nonundulatory quartz is not, however, a simple linear trend. Within the grain-size limits of this study (74–37μ), there is no marked enrichment of nonundulatory quartz along the whole of the Missis-

sippi cone. However, from east to west of the Sigsbee Deep, the degree of enrichment is marked. It is postulated that this difference is a result of contrasted flow regimes between the two physiographic provinces. The cone, because of its slope and high sedimentation rate (compared with the deep), was characterized by both slumping (low-velocity mass transfer of sediment) and high-velocity turbidity currents. The latter supplied the main source of sediment to the Sigsbee Deep. Once the break in slope was encountered, velocities diminished rapidly. Such a velocity diminution resulted in the Sigsbee Deep constantly being supplied by currents representative of the lower flow regime. Thus the selective and relatively rapid degradation of undulatory quartz is more marked in that physiographic province dominated by traction currents.

Other sample traverses in fluvial, shallow-marine, and deltaic complexes confirm the relative instability of undulatory quartz. The total quartz extinction assemblage also is affected by variations in hydrodynamic conditions between environments within such a complex, yielding an additional tool for the reconstruction of paleoenvironments.

DAVIS, RICHARD A., JR., Dept. of Geology, Western Michigan University, Kalamazoo, Michigan

"CANADIAN-OZARKIAN" UNCONFORMITY IN UPPER MISSISSIPPI VALLEY

In 1924, E. O. Ulrich described an unconformity at the boundary between his Ozarkian and Canadian systems in the upper Mississippi Valley. This systemic boundary was based on physical and paleontological data, and occurs within the Prairie du Chien Group ("Lower Magnesian" of earlier years) which had been accepted as Ordovician in age.

Prairie du Chien strata have been problematical to stratigraphers for many years, primarily because of a lack of systematic regional study. Most investigators denounced Ulrich's unconformity but a few workers reported local evidences of erosion between the lower Oneota Formation and the upper Shakopee Formation.

Recognition and investigation of rock-stratigraphic boundaries presuppose recognition of the units themselves, which has been the major problem in Prairie du Chien stratigraphy. Once this had been accomplished the presence of an unconformity on the upper surface of the Oneota Formation was obvious.

Physical criteria for erosion at this horizon are (1) local truncation of bedding; (2) irregular upper surface of the Oneota Formation; (3) basal conglomerate of chert pebbles and/or Oneota-type lithology in the lowermost Shakopee Formation; and (4) truncation of grains at contact as seen in thin section.

This unconformity can be recognized throughout the outcrop belt of Prairie du Chien strata. Erosion took place after lithification and seemingly after dolomitization of the Oneota. It may have been subaqueous erosion and probably does not represent the great period of time postulated by Ulrich.

DELLWIG, LOUIS F., AND ROBERT EVANS, Dept. of Geology, University of Kansas, Lawrence, Kansas

DEPOSITIONAL PROCESSES IN SALINA SALT OF MICHIGAN AND NEW YORK

The contrast between the salt section exposed in mines at Retsof, New York, and Detroit, Michigan, can be explained by differences in the environment of deposition. Where local recrystallization has occurred, primary bedding or laminations have not necessarily been destroyed; the major changes are enlargement of grains, the expulsion of insolubles from within crystals, and the consequent destruction of primary crystal structure. Primary features dominate both sequences.

Alling and Briggs (1961) presented evidence of water depth of more than 300 ft 25 mi inside the fringing Niagaran reefs of the Michigan basin. Throughout the Detroit mine, laminations are uniformly spaced, a feature documented by Richter-Bernburg (1953) and others as characteristic of deep-water deposition. Deposition apparently was at a depth sufficiently great to prevent the disturbance of primary bedding structure by turbulence in the basin water.

In contrast to the typical "normal" anhydrite-dolomite laminae (Jahresringe) exposed in the Detroit mine, bedding in the Retsof, New York, mine is expressed as contrasting bands of light and dark, uniformly sized halite crystals through which insoluble material is diffused. Contrast in bands is a function of insoluble content, the separation being gradational rather than abrupt. Primary structures offer additional substantiating evidence of shallow-water deposition in New York.

The differences in physical characteristics of the salt point to less turbulence (greater water depth) in the Michigan segment of the Salina evaporite basin. Increased turbulence and consequently bottom disturbance not only would have disrupted primary bedding features but also would have destroyed or prevented the development of density stratification in the basin waters.

Although the problem of defining depth in absolute terms may remain, characteristic features can be identified for "deep" and "shallow" environments of halite deposition. It seems more appropriate to consider bedded salt as a normal marine sediment than as a "chemical freak."

DICKINSON, KENDELL A., U. S. Geological Survey, Denver, Colo.

CLAY-MINERAL FACIES IN UPPER JURASSIC ROCKS IN NORTHEASTERN TEXAS AND ADJACENT PARTS OF LOUISIANA AND ARKANSAS*

X-ray analyses of rotary-drill cuttings and cores of Upper Jurassic rocks show a distinct relation between clay-mineral suites and environments of deposition.

Offshore marine shale and lagoonal-mudflat evaporitic mudstone contain chlorite and illite in a ratio of about 1:7. The chlorite is predominantly a high-iron variety in the marine shale and a low-iron variety in the lagoonal evaporitic mudstone. In most nonmarine mudstone there is no chlorite, but the rock contains kaolinite and illite in a ratio of about 1:7. Nearshore marine and transitional nonmarine shale and mudstone contain chlorite, kaolinite, and illite in ratios of 1:1:12. The degree of crystallinity of illite in the lagoonal-mudflat evaporitic mudstone is greater than in any of the shale or other mudstone.

* Publication authorized by Director, U.S. Geological Survey.