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Framework of Mississippi Fan, Gulf of Mexico

The Mississippi fan is a broad, arcuate Pleistocene accumulation of displaced shallow-water sediments. The fan consists of elongate fan lobes that shift position at the onset of each active sedimentation event, probably related to the lowering of sea level and the outbuilding of the shelf. Isopach and structure maps, based on eight acoustical reflectors of regional extent, demonstrate this shifting as well as changes in the location of the source area, and a progradation basinward.

The youngest fan lobe is a suitable model for the underlying ones. It can be divided into four major morphologic units: (1) canyon—the Mississippi canyon resulted from retrogressive slumping during the late Wisconsin and was nearly filled thereafter; (2) upper fan lobe—a large, nearly filled erosional channel with low levees and a recent active central channel; (3) middle fan lobe—convex upward in cross section with a sinuous 3-km (2-mi) wide migratory and aggradational channel on its apex; (4) lower fan lobe—the central channel becomes smaller, less sinuous, shifts position periodically (as indicated by the indistinct abandoned channels), bifurcates, and terminates.

Fan lobes are primarily channel-levee-overbank complexes, erosional in the upper fan and aggradational basinward. The channel is an active conduit; deposition in the channel took place during and after an active transport period. Accumulation rates on the middle and lower fan are high, ranging from 6 to 12 m/1,000 yr (20 to 40 ft/1,000 yr). A major portion of the sand is transported to the lower fan area.

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Variety of Geologic Silhouette Shapes Distinguishable by Multiple Rotations Method of Quantitative Shape Analysis Text

Silhouette shapes are two-dimensional projections of three-dimensional objects such as sand grains, gravel, and fossils. Within-the-margin markings such as chamber boundaries, sutures, or ribs are ignored. Comparisons between populations of objects from similar and different origins (i.e., environments, species or genera, growth series, etc) is aided by quantifying the shapes. The Multiple Rotations Method (MRM) uses a variation of "eigenshapes," which is capable of distinguishing most of the subtle variations that the "trained eye" can detect. With a video-digitizer and microcomputer, MRM is fast, more accurate, and more objective than the human eye. The resulting shape descriptors comprise 5 or 6 numbers per object that can be stored and retrieved to compare with similar descriptions of other objects. The original-shape outlines can be reconstituted sufficiently for gross recognition from these few numerical descriptors. Thus, a semi-automated data-retrieval system becomes feasible, with silhouette-shape descriptions as one of several recognition criteria.

MRM consists of four "rotations": (1) rotation about a center to a comparable orientation; (2) a principal-components rotation to reduce the many original shape descriptors to a few; (3) a VARIMAX orthogonal-factor rotation to achieve simple structure; and (4) a rotation to achieve factor scores on individual objects. A variety of subtly different shapes includes sand grains from several locations, ages, and environments, and fossils of several types. This variety illustrates the feasibility of quantitative comparisons by MRM.

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Depositional Setting and History of an Eocene Lacustrine Deposit, Brewster County, West Texas

Thick, massive beds of nonmarine limestone are exposed in the Elephant Mountain quadrangle, Brewster County, Texas. This Eocene carbonate ranges from 1 to 70 m (3 to 230 ft) in thickness, and is intercalated with the three lowermost formations of the Buck Hill volcanic group: the Pruett tuff, the Crossen Trachyte, and the Sheep Canyon Basalt. The Pruett Formation (Eocene), which is composed mainly of volcanic tuff and tuffaceous nonmarine limestone, unconformably overlies the

Boquillas limestone (Cretaceous). These interbedded tuffs, and intercalating lavas of the lower Buck Hill group represent several interruptions during the formation of this lacustrine deposit.

The carbonate rocks consist primarily of pure to impure silty limestones with no appreciable dolomite or evaporite content. The unit contains charophytes, ostracodes, algal stromatolites, oncolites, possibly *Equisetum*, silicified wood, stromatolitic tufa, and fresh-water gastropods. These features probably represent a shallow, low energy, sublittoral to littoral marginal facies which were deposited in a relatively humid environment. The thick lower beds of this nonmarine limestone were most likely deposited in a drainage basin formed by block faulting in the Late Cretaceous to early Tertiary. In contrast, the thinner beds in the upper portion of this deposit may have accumulated in local depressions formed in the surrounding volcanic flows.

The true size of the lake basin is unknown due to the lack of exposure, but the Pruett tuff interbedded with limestone has been found in the subsurface approximately 90 km (56 mi) northwest of the study area.

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Experimental Determination of Smectite Hydration States Under Diagenetic Conditions

Knowledge of the hydration state of smectite under burial diagenetic conditions is necessary for the interpretation of the smectite to illite transformation, abnormal fluid pressure development, and reservoir properties. Simple changes in fluid composition, pressure, or temperature have been thought to affect the number of layers of water associated with smectite at depth.

The hydration state of smectite while in contact with brine, at pressures and temperatures that simulate burial diagenetic conditions, has been determined by X-ray diffraction analysis. A heated high-pressure X-ray cell was used to determine the basal spacing from oriented mounts. The hydration state of the smectite was monitored by determining the 2θ positions of the 003 and 005 reflections.

Two layers of water ($d_{001} = 15.8\text{\AA}$) are retained by Cheto montmorillonite in 1 molal NaCl solution under 15.1 MPa (2,200 psi) pressure, to at least 175°C, and in the same solution under 3.4 MPa (500 psi) to 125°C. Two layers of water are also retained by Cheto montmorillonite in 5 molal NaCl solution to 200°C under pressures of 4.83 MPa (700 psi) and 46.2 MPa (6,700 psi).

This experimental evidence contradicts the previously suggested mechanism for generating fluid overpressuring in shales by simple thermal dehydration of smectite under burial conditions.

Experiments done with dilute NaCl solutions demonstrate the effect of concentration on the swelling of smectite at depth, while experiments with KCl solutions illustrate the effect of the interlayer cation on the hydration state of the clay.

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Algal Origin of Peloids, Peloidal Intraclasts, and Structure Grumeluse in Paleozoic Limestones: Evidence from Cow Head Group, Western Newfoundland

Deep-water carbonate strata of Cambro-Ordovician age in western Newfoundland are composed of interstratified conglomerates and thinly bedded calcarenites, lime mudstones, and shales. Early lithification has preserved an abundant but simple algal flora in shallow-water clasts within both conglomerates and deep-water slope sediments. Large boulders contain sheets of *Girvanella* and arborescent clusters of *Epiphyton*, but only *Girvanella* as intraclasts, rafts of intertwined tubules, single tubules, and oncolites can be distinguished in calcarenites.

Preservation of *Girvanella* in boulders varies from distinct tubules to "structure grumeluse" (clotted fabric) in which patches of micrite mask any evidence of former algal structure. Comparison of *Girvanella* in boulders and calcarenite grains indicates that much carbonate sand consists of broken and abraded *Girvanella* sheets. In contrast, *Epiphyton* thalli appear to be comminuted to form silt- and sand-size micrite peloids.

An extension of these findings is that many peloids, peloidal intraclasts, and much structure grumeluse in early Paleozoic carbonates, both shallow and deep water, are derived from calcareous algae. These

algae may have been just as important for producing carbonate sediment during the early Paleozoic as codiacean algae are in the modern ocean. This algal contribution is difficult to recognize in most ancient sediments probably because absence of early interparticle cementation, allows compaction, filling of tubules with micrite cement, or micritization.

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Diagenesis of Upper Cretaceous Teapot Sandstone, Powder River Basin, Wyoming

The Upper Cretaceous Teapot sandstones of Well Draw field, Converse County, Wyoming, are turbidite fan deposits bounded stratigraphically by marine shales. They presently occur from 6,360 to 7,200 ft (1,920 to 2,195 m), dipping to the northwest.

Cored samples selected from nonbioturbated *A* bedsets show that the sandstones are fine to very fine-grained feldspathic litharenites. Major authigenic minerals include carbonate cement, quartz overgrowths, and clay minerals.

The clay minerals originated either as alteration rims on detrital silicates or as precipitates from pore fluids. Alteration rims typically consist of illite, smectite, mixed layer illite/smectite, and lesser chlorite. Feldspars are altered to kaolinite. Precipitated clays occur as (1) thin, unoriented, grain coating chlorite and kaolinite, (2) pore lining mixed layer illite/smectite and lesser chlorite oriented with (001) normal to the pore wall, and (3) unoriented, poorly crystalline, pore filling chlorite.

The diagenetic sequence is (1) compaction and limited quartz overgrowth development, (2) complete calcite cementation and precipitation of grain-coating clays, (3) dissolution of carbonate cement, (4) precipitation of pore lining and later pore filling clays, and (5) development of second stage quartz overgrowths. Development of silicate alteration rims occurred throughout the diagenetic history.

Dissolution of carbonate cement produced the majority of present-day porosity; however, this secondary porosity was reduced by precipitation of clay minerals. In the downdip sandstones, hydrodynamic flow and an increase in the abundance of detrital labile grains have caused an increased abundance of clay mineral precipitates, reducing the reservoir potential. The pore fluids which controlled sandstone diagenesis were likely provided by dewatering and diagenesis of enclosing shales.

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Porosity Distribution in Wolfcamp Strata, Palo Duro Basin, Texas Panhandle: Implications for Deep-Basin Ground-Water Flow

Average-porosity distributions in the Wolfcamp deep-basin aquifer are critical to discernment of the geographic trends in effective-porosity in the Palo Duro basin. Precise data are used to improve resolution of porosity values for computer-simulated areal ground-water modeling. Assessing vertical distributions of lithology and porosity in each well studied involves analysis of crossplotted neutron- and density-porosity log responses. This method more accurately identifies lithology and porosity than does the commonly employed crossplotted neutron-porosity and sonic (interval traveltime) responses. Log-derived average-porosity distributions yield information about effective pore volume (i.e., movable water) in the Wolfcamp aquifer and enhance the accuracy of estimates of traveltimes and velocities of brines in basinwide traverses. Mathematical analysis of average traveltime and total effective pore volume yield estimates of the rates of annual discharge from the Wolfcamp aquifer in the Palo Duro basin. Based on average flush rates between 2.2 and 1.5 m.y., annual discharge rates from the Wolfcamp aquifer, across the northern and eastern basin boundaries, are about $3.6 \times 10^5 \text{ m}^3 \text{ year}^{-1}$ to $5.3 \times 10^5 \text{ m}^3 \text{ year}^{-1}$.

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Geophysical and Geologic Studies of Ross Sea Continental Margin, Antarctica

In February 1984, the U. S. Geological Survey conducted geophysical and geologic investigations of the Ross Sea Shelf and outer continental

margin of Antarctica aboard the research vessel *S. P. Lee*. The geophysical data included 24-channel seismic-reflection, high-resolution seismic-reflection, sonobuoy seismic, gravity, magnetic-gradiometer, bathymetry, and heat-flow measurements. Sea-floor samples were collected for geologic and geochemical studies, using 3-m gravity corer, box corer, and rock dredge.

Principal survey areas were along the southern and western Ross Shelf, near Cape Adare and Islin Bank, and along the central outer continental margin. These areas lie adjacent to those covered by earlier multichannel-seismic-reflection surveys made by France, West Germany, and Japan.

Three north-south-trending sedimentary basins, containing as much as 5 km (16,404 ft) of Cenozoic sediment, lie beneath the Ross Sea Shelf and extend seaward beyond the continental shelf edge. These basins are separated by basement ridges and are bounded on the west by the Transantarctic mountains and on the east by mountain ranges of Marie Byrd Land. Seismic stratigraphy, crustal-thickness measurements, and rock samples from the Ross Sea region indicate that the three basins may have formed initially by crustal rifting during the middle and Late Cretaceous time and have subsequently filled with early Tertiary(?) as well as Oligocene and younger glacial marine sediment. Sedimentary thicknesses, heat-flow values, and geochemical analyses indicate that some parts of the Ross Sea Shelf may have favorable conditions for the generation of hydrocarbons.

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Implementation of Graphical Layout Editor for Geologic Applications

The increasing availability and sophistication of data processing technology have given geologists new insights into the interpretation and evaluation of geological data. In many instances, however, software and hardware limitations have prevented geologists from effectively combining the graphical results from many of these specialized packaged procedures. At Aramco, the emphasis has been toward providing geologists and geological technicians with a convenient, user-friendly approach to effectively merging the graphical results of the various software packages.

Initially designed for an IBM graphics workstation, the graphics layout editor (GLE) offers the user a method of quickly merging or compositing the graphical results of the most frequently used geological software packages in a menu-driven, interactive environment. Applications of GLE technology not only allow the user to produce expanded or enhanced variations on the original graphical output, it also gives geologists the flexibility to conveniently experiment with combinations of graphical results which would otherwise be cost prohibitive owing to drafting complexities. To support final design and presentation, GLE in an interactive mode also provides high-quality text capability, allowing the cartographer to quickly build and annotate presentation quality composites. GLE techniques of graphical overlay, insertion, and interactive editing provide geologists with an infinite series of perspectives into geologic problem solving.

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Shear and Compressional-Wave Surface and Downhole Tests in Southern Louisiana

Shear- and compressional-wave seismic tests using the Vibroseis system were performed near a well in south-central Louisiana to study acquisition, processing, and interpretation problems typically encountered in low-velocity, relatively uncompacted Gulf Coast sediments. The primary objectives envisioned for these tests were to improve S-wave data quality by studying surface noise patterns to optimize source and receiver arrays, provide a direct correlation of P- and S-wave seismic data by using vertical seismic profiles (VSP), and measure the decay of P- and S-wave seismic energy with depth by using a downhole geophone.

To achieve these objectives, an expanding reflection profile (ERP), a walkaway noise analysis, and a VSP were recorded with both S- and P-wave sources. The S-wave ERP shows reasonable data quality although it was very band-limited (5-12 Hz). In contrast, the P-wave data quality is excellent. The difference in data quality is primarily due to strong, source-