phase I/S layers in subparallel orientations relative to each other, commonly with branching and interfingering relationships. Electron diffraction patterns of these shallower samples show very diffuse basal reflections, prominent turbostratic structure, pronounced streaking along z^*, and multiple z^* orientations in the same diffraction pattern. All of these features indicate a poorly defined interstratification of the mixed-phase I/S: the diffuse basal reflections are probably due to the presence of only a few layers in a diffraction position; the turbostratic structure is due to misalignment of individual layers relative to each other; the z^* streaking is due to stacking disorders of the layers in a direction perpendicular to the layers; and the multiple z^* orientations are due to rotational disorder of the layers about an axis parallel with the layers.

TEM lattice fringe images from deeper samples show mixed-phase I/S layers arranged in a more parallel fashion, with less branching and interfingering. Electron diffraction patterns for these deeper samples show well-defined basal reflections, and both turbostratic structure and z^* streaking are less pronounced. These relationships indicate a more regular interstratification for deeper layers: more layers are in diffraction position, the misalignment of individual layers is less evident, and the stacking disorder perpendicular to the layers is less pronounced.

X-ray powder diffractograms have been interpreted to indicate ordering of illite and smectite layers within the mixed-phase I/S. This order is first observed below the "soft" geopressure boundary (0.465 psi/ft) and is prominent below the "hard" geopressure boundary (0.7 psi/ft). However, neither the TEM lattice fringe images nor the electron diffraction patterns show ordering of illite and smectite layers within mixed-phase I/S.

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Surface Exposures of Late Cretaceous Strata at Rayburns Salt Dome, Bienville Parish, Louisiana

Surface exposures of Cretaceous strata in Louisiana are restricted to isolated occurrences associated with salt domes in the northwestern part of the state. The best known Cretaceous exposures are associated with the Rayburns salt dome in Bienville Parish. Strata exposed at this structure previously have been correlated with formations exposed in southwestern Arkansas, in particular, the Marlbrook Formation and the Saratoga Chalk.

Several distinct Upper Cretaceous lithologic units can be identified at the Rayburns locality. Detailed stratigraphic relationships of these units are obscured by the incomplete nature of the exposures and by dense vegetation. Strata on the west side of the outcrop area include a basal olive-gray marl that is locally glauconitic. This unit is thought to correlate with the Brownstown Marl in Arkansas. The basal marl is overlain in part by a massive glauconitic sandstone at the western end of the outcrop area and by a gray chalky marl at the eastern end. These lithologies are thought to correlate with the Buckrange Sand Lentil or basal Ozan Formation exposed in Arkansas. The sandstone and gray chalky marl units are directly overlain by a hard white chalk. This chalk lithology correlates faunally and lithologically with the upper Ozan and the Annona Chalk in Arkansas.

Exposures along the east side of the outcrop area, adjacent to an abandoned quarry, are blue-gray marl and chalk whose fauna and lithology correlate with the Saratoga Chalk in southwest Arkansas. The concretionary clays of the Midway Group, of Paleocene age, lie unconformably on the truncated surface of this Saratoga equivalent. The unconformity is marked by a thin layer of bored, calcareous nodules. The uppermost portions of the Navarro Group, which occur elsewhere between Cretaceous and Paleocene strata, have apparently been eroded at this locality.

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Depositional Controls on Porosity and Permeability Evolution in Upper Smackover Formation at Tubal Field, South Arkansas

Hydrocarbon production at Tubal field is from secondarily enhanced, preserved primary porosity in an interval of carbonate grainstones at the top of the Upper Jurassic Smackover Formation. These grainstones were deposited as an ooid shoal over a topographic high on the south Arkansas shelf. The degree of porosity and permeability preservation in these sediments ranges greatly and is controlled by both depositional and diagenetic processes.

Porosity and permeability are reduced mostly by pressure solution and the precipitation of late sparry cements. The chemical stability of a grain type determines its resistance to pressure solution, whereas pore size is critical to retaining porosity and permeability after cementation. Therefore, the ability of particular facies types to preserve permeability is controlled chiefly by the types, sizes, and sorting of the constituent grains. Using these parameters, pay facies (facies in which porosity and permeability are commonly preserved) can be defined and identified. Pay facies at Tubal field include the poorly sorted coarse ooid facies, the ooid-composite grain facies, and the pellet-grainstone facies. By studying the distribution of analogous modern facies, the ability to predict the distributions of upper Smackover pay facies, and thus production, can be improved.

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Oil and Gas Prospects in Arkansas Ouachitas

The Arkansas Ouachitas is a frontier area for exploration for oil and gas. To date, drilling has been so limited as to prove meaningless as far as subsurface exploration is concerned. This area provides a rare opportunity to examine various techniques, criteria, indicators, and even hunches using only foresight without the benefit of hindsight in assuming that it will be productive of oil and gas. Time will tell if these predictions are true.

Criteria that one would look for in exploration in a new province include the following in the Ouchitas: (1) sedimentary column that in its entirety exceeds 50,000 ft (15,240 m); (2) numerous oil seeps, gas shows, and residual asphaltic deposits; (3) numerous source beds, reservoir beds, and seals in the stratigraphic column; (4) potential for various entrapping mechanisms in the form of structure, faulting, stratigraphic traps, and reefing in ordovician carbonates under the overthrust; (5) a north-south seismic line that shows definite stratification of beds across the entire thrust area; and (6) Landsat interpretation which indicates areas of structural and tonal anomalies.

The next 5-10 years will witness an extensive and expensive exploration effort in this area. Only after drilling has probed the area will this story be concluded.

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Computerized Particle Size Analyzer—An Exploration Technique, Saint Mary Field, Lafayette County, Arkansas

Grain size frequency and cumulative weight percentages, mean grain size, standard deviation, and skewness provide the geologist with information necessary for studies assessing rock complexity and heterogeneity, and in some cases, depositional environment. Although grain size distribution data are important to the exploration geologist, they are not normally available in sufficient quantity or on a timely basis.

The new computerized Particle Size Analyzer (PSA) enables the explorationist to obtain grain size distribution information rapidly and economically on sidewall and conventional cores. The porosity and the measured grain size distribution, which includes silt and clay sizes, are used to "index" the quality of the reservoir rock. This quality grading or "indexing" is then used to evaluate changes in formation water saturation and/or electric log resistivity, thereby better identifying hydrocarbon productive intervals and oil-water contacts.

Data generated from conventional core samples in the Mitchell sand of the Rodessa Formation in Saint Mary field, Lafayette County, Arkansas, illustrate the use of particle size data for improved well evaluation.

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Variation in Chemical Composition of Oil Field Brines with Depth in Northern Louisiana and Southern Arkansas: Implications for Mechanisms and Rates of Mass Transport and Diagenetic Reaction

Parke Dickey has pointed out that there is a nearly linear increase in total dissolved solids (TDS) content with depth in oil field waters in areas of northern Louisiana and southern Arkansas. Similar relations exist in parts of east-central Louisiana and central Mississippi. A reexamination of brine analyses in the region shows that these linear increases in TDS are primarily the result of linear increases in sodium and chloride concentrations with depth. Other dissolved components, such as Mg, Ca, Sr, Ba, HCO_3, SO_4, and trace constituents can show more complex variations in concentration with depth.

It is proposed here that the linear gradients for sodium and chloride reflect the ongoing, steady-state mass transport of these constituents upward from thousands of feet of depth to the near surface. Sodium and chloride concentrations at depths exceeding 8,000-10,000 ft (2.5-3 km) are maintained at constant high levels by the subsurface dissolution of halite. Low dissolved salt concentrations are maintained at the near surface by recharge of meteoric waters. The mass-transport processes that could produce such nearly linear profiles are limited to molecular diffusion, thermal diffusion (Soret effect), and eddy diffusion. Preliminary estimates of fluxes and mass-transport velocities that could result from these processes suggest sodium and chloride ions could be migrating upward at velocities approaching 1 cm/year.

Nonlinear but systematic variations in the concentrations of other components with depth may reflect the presence of local stratigraphic sources and sinks of material. Zones of depletion of dissolved calcium, for example, may represent areas of active precipitation of calcite. If the mass transport coefficients for these nonconservative components can be estimated, then limits can be put on the absolute rates of ongoing diagenetic processes.

Of considerable interest is the possibility that dissolved or entrained hydrocarbons are also involved in active vertical migration. The systematic study of brine chemistry promises to provide important clues to the understanding of processes and rates of fluid migration and hydrocarbon migration in the region.

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Formulation of Development Strategy for a Rodessa Gas Play in Eastern De Soto Parish, Louisiana

A study of the Lower Cretaceous Bacon limestone (first Rodessa porosity) on the eastern edge of De Soto Parish, northern Louisiana, involving thin-section study, and the correlation of conventional core analysis with resistivity log data, has led to the successful differentiation of two sedimentary units.

Paleostructural isopachs coupled with standard isopachs of the sedimentary units has led to a more complete understanding of the depositional geometry and entrapping mechanism(s) of the pay interval (zone A).

The Bacon limestone of the Rodessa Formation is productive in several fields in De Soto Parish and the surrounding areas. The techniques and strategies used in this study may aid in the more successful development of existing plays and in the exploration for new fields.

HUGULEY, DONALD LEE, JR., Penn Resources, Inc., Dallas, TX

Petrology and Depositional Environment of Mitchell Member, Rodessa Formation (Lower Cretaceous), West Bradley Field, Lafayette County, Arkansas

Previous studies of the Lower Cretaceous Rodessa Formation in southern Arkansas have interpreted it as nearshore, transitional marine. Many of the Rodessa members are hydrocarbon productive. Cores from the Sun Whittington wells and Lake Ronel Oil Co. wells in and near the West Bradley field, Lafayette County, Arkansas, were studied to identify a model for deposition of the oil-productive Mitchell sand interval. The Mitchell is sandwiched between the upper and lower Gloyd members of the Rodessa Formation. These two limestone members are productive in other areas of the Arklatex.

A thorough investigation of the sands, using core samples, geophysical log correlation, drilling reports, thin sections, scanning electron microscopy, and x-ray diffraction yields data necessary for establishing the nature of deposition. This information will promote interest and further development of the hydrocarbon potential of the Mitchell member in the Arklatex.

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Identification of Short-Term Changes in Sediment Depositional Rates—Importance in Environmental Analysis and Impact

Large-scale urban development projects may profoundly affect erosion and depositional rates in adjacent estuaries, bays, and lagoons. The magnitude of such changes, however, is commonly ignored because of a general belief that no reliable parameters exist that will allow differentiation in sediment cores of natural versus man-caused phenomena. Though conversion of forested or agricultural land to commercial or residential use may well cause sediment erosion and depositional rates to be accelerated by up to several orders of magnitude, regulatory agencies and municipal governments have largely avoided entering into litigation with land developers over damage to adjacent water bodies because of a perceived difficulty in quantifying the amount of increased sediment yield.

A marked change in the depositional budget of a watershed, however, does produce a discernible impact on the sediments. This is especially apparent in core samples collected in D'Olive Bay, Alabama, a small arm of Mobile Bay located adjacent to an area that has undergone extensive change from largely agricultural use to commercial and residential development during the past 15 yr. In cores collected in the bay, abrupt changes in (1) sediment size parameters, (2) heavy mineral and clay mineral ratios, (3) sulfur content, and (4) zinc, copper, and vanadium percentages were noted. Each of these changes occurred at the same depth and reflected a simultaneous increase in sediment influx into the basin and the onset of urban development in the watershed. Analysis of the core data also permitted accurate estimates to be made for the rate at which the bay is becoming filled, the volume of sediment deposited since the beginning of "impact," the sources within the watershed most responsible for the increased sedimentation rates, and the efficiency loss of the bay's sediment trap.

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Domes of East Texas

Data have been collected in the last 5 yr on the 15 salt diapirs that extend upward to shallow depths (4,000 ft or 1,220 m) in the East Texas basin. These salt diapirs penetrate Jurassic and younger units and have controlled their deformation in the central part of the basin. Both primary and secondary data have been gathered. Primary data are observations of dome shape, depth, structure, and resources. Examples of primary data are depths to cap rock and salt, cross-sectional area, axial ratio, crestal area and percentage of planar crest, axial plunge, tilt azimuth and distance, structural symmetry, side convergence, and overhang azimuth and percentage, as well as a new quantitative classification of dome shape. The structural styles of strata around each dome can be described in terms of the size of the rim syncline and drag zone around the diapir, angular relations between the strata and the salt, and style of faulting.

Secondary data include deductions and inferences based on the primary data. The growth evolution developed from the pillow stage, through the diapir stage, to the post-diapir stage. Unconformities resulted from erosional breaching of the dome in the past. The structural stability and hydrologic integrity of each dome have been assessed in terms of the age of the most recent deformation. Geomorphic and hydrologic evidence for dome uplift, subsidence, or brine leakage are included in a new classification of drainage patterns above domes.

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Comparison of Clay Mineralogy of Late Quaternary Back-Barrier and Barrier Sediments, South Texas Coast

Mixed-layer illite-smectite and kaolinite are the most abundant clay minerals in five drill cores of Holocene and Pleistocene sediments from Mustang Island, Corpus Christi Bay area, Texas. The cores were bored from as deep as 60 m (197 ft) below sea level, and penetrated three deposi-