Grain-size analysis shows a composition of very fine sand with a large silt and clay component. Studies of sand-size distribution throughout the 53-ft core did not reveal graded bedding, thus excluding turbidity currents as a depositional mechanism. Analysis of the benthic fauna within the sand unit indicates that the sands and thin-bedded shales were originally deposited on the inner to middle shelf. The occurrence of bathyal shale above and below the productive unit suggests that the shallow-water sands were transported basinward into a slope environment.

Regional paleobathymetric maps indicate that there was a progradation of the shelf edge during deposition of the sand unit. This evidence, along with the fine-grained character of the sands, suggests that a deltaic complex was developing updip of the field.

The depositional environment is very similar to that described by J. M. Coleman and others near the modern Mississippi River Delta. The processes that are moving shallow-water sands across the shelf, stimulating mass movement and shelf-ridge slumping, were also active around ancient deltas.

Based on the modern analog, it is interpreted that the field sand is part of a debris flow initiated by shelf-edge failure. The geometry of the sand unit also supports this hypothesis.

KOPASKA-MERKEL, DAVID C., Shell Western Exploration and Production Inc., New Orleans, LA

Texture and Reservoir Potential of Micritized Ooids

Micritized ancient ooids are important to hydrocarbon exploration because they may be reservoirs for gas or bound water. Porosity within micritized ooids may exceed 15%. Porosity and permeability in micritized ooids are greatest where micrite crystals are euhedral, relatively large, and uniform in size. A study of the massive Cotton Valley limestone in east Texas indicated that intra-ooid porosity, with permeabilities up to about 1 md, may constitute a significant reservoir for gas. Accordingly, a survey of ancient ooids was conducted to assess the nature and variability of their crystal fabric. Micritized ooids of Mesozoic and Paleozoic age were collected from outcrops and well cuttings. Most are composed of euhedral to subhedral 1-5 μm calcite rhombs. Crystal size and shape are most uniform within a single ooid and most variable between localities. Subsequent diagenesis (excluding leaching or replacement) produced either coarser anhedral crystals or cemented the rhombs with micropoikilotopic overgrowths. Micritized ooids from 13 samples exhibit a common fabric and may have been altered by a common process. Nearly all recent ooids are aragonitic, and most ancient ooids, including those examined in this study, were probably aragonitic as well. Mineralogical stabilization from aragonite to calcite is suggested as the micritizing process.

KORNFELD, I. E., Texaco U.S.A., New Orleans, LA

Depositional Environments and Sedimentology of Vinita Beds, Richmond Basin, Virginia

The Carnian (middle to late Middle Triassic Age) Richmond basin of northeast Virginia is the oldest of the exposed Newark rift basins of the eastern seaboard. These basins formed during the Mesozoic divergence of the continents. As presently defined, the Richmond basin is a large synclinal feature measuring 32 mi (53 km) long by 8 mi (13 km) wide, and is located west of Richmond, Virginia, and east of Amelia, Virginia. Sediments of the Richmond basin have been assigned to the Richmond Group and have been stratigraphically subdivided into the following informal units, oldest to youngest: coarse boulder breccias, coal measures, Vinita Beds, and Otterdale Sandstone.

The Vinita Beds are composed of arkosic sandstones, shales, siltstones, and minor amounts of coal, and are mineralogically immature. They are composed of angular to subrounded rock fragments, quartz, and feldspars, and are highly micaceous and kaolinitic. In places, feldspars make up as much as 50% of the rock. Sandstones and conglomerates are crossbedded and channeled, and shales and siltstones are thinly laminated. The Vinita Beds are rich in fossil fish, branchiopods, and plant fragments. These rocks were deposited in braided streams as well as in paludal and possible lacustrine environments in a humid and heavily vegetated setting.

KORNFELD, ITZCHAK E., Texaco, U.S.A., New Orleans, LA

Depositional Environments and Hydrocarbon Occurrence of Upper Jurassic Cotton Valley Sandstones, Mississippi, Louisiana, and Texas

The sandstones of the Kimmeridgian (Jurassic) upper Cotton Valley Formation of Mississippi, northern Louisiana, and eastern Texas were deposited on a stable subsiding shelf. These sands are regressive and are part of a complex of deltaic and marine systems. They are quartz-rich and exhibit a variety of sedimentary structures. Cotton Valley fluvial-deltaic systems drained Paleozoic and younger highlands to the north and northwest, depositing sands on the shelf where they were subsequently reworked.

Three depositional environments have been interpreted for these sands in Mississippi: (1) a constructive delta in the west-central part of the state, (2) a destructive delta in the east-central part of the state, and (3) an interdeltaic system in central Mississippi between the other systems. In northern Louisiana and northeastern Texas, the following environments have been interpreted: a proximal destructive delta system in northwest Louisiana and northeast Texas and another delta system in northeastern Louisiana with an interdeltaic system consisting of barrier beaches and barrier bars located centrally between them.

Production is controlled by porosity and permeability barriers, fault traps, and salt- and basement-induced structures.

KOSTERS, ELISABETH C., Louisiana Geol. Survey, Baton Route, LA, and ALAN BAILEY, Univ. Southwestern Louisiana, Lafayette, LA

Fine-Grained Sediments of an Interdistributary Basin, Mississippi Delta

A considerable portion of fine-grained sediments of the Mississippi Delta can be found in large-scale interdistributary basins that are located between distributary channels of different delta lobes of the same delta system. Because of their size, these basins are prone to filling with fine-grained material. Thus, the central basin is devoid of coarser influxes from the surrounding levees. Barataria basin (about 150 × 50 km in size) is such a basin bordered by the modern Mississippi River and the abandoned Bayou Lafourche. Ninety-five vibracores, 3-10 m deep, form the basis for this study. Correlation between cores along cross sections is based on lithology and organic matter content. X-ray radiographs show common occurrences of massive homogeneous and fine parallel-laminated sequences. Small-scale cross-lamination, lenticular bedding, and faunal bioturbation are rare, the latter most likely because of oxygen-starved conditions. Subtle facies differences can be detected between levees, basin drainage channels, lacustrine areas, submerged marsh bottoms, and various peats. Early diagenesis occurred throughout the basin in the form of heavy pyritized and/or calcite-rich zones. From examination of thin sections, both by light microscopy and SEM, it appears pyrite is most abundant in marsh sediments with intermediate (about 30-70%) organic matter content. These marshes contain sufficient iron (from clays) and sulfur (associated with decaying plant matter) to give rise to pyrite formation.

Detailed analyses of a basin of this kind are important in predicting and understanding geometry, continuity, and diagenetic features of deltaic shales. In addition, when reworked, these materials form possible source beds for hydrocarbons found in continental shelf and slope settings.

KRAUS, MARY J., Univ. Colorado, Boulder, CO

Using Paleosols to Elucidate Episodic Sedimentation in Alluvial Rocks

Ancient alluvial deposits are believed to be incomplete because floodplains undergo relatively infrequent episodes of sedimentation for which the cumulation of time is geologically limited. However, many alluvial sequences contain superposed paleosols that preserve not only the record of deposition but also the geologically lengthier record of nondeposition and nonerosion. The only time that is not represented in an alluvial sequence with paleosols is that time represented by sediments and paleosols that have been eroded. Erosion can reflect channel migration, which produces coarse sediment filled scours and is a process common to both degrading and aggrading fluvial systems. In contrast, deep and laterally extensive scours, filled dominantly by fine sediments, are evidence for lengthy periods of degradation. This second type of scour, whose recognition is enhanced by color differences between paleosols developed on the scoured and scour-fill deposits, is a valuable indicator of climatically and/or tectonically controlled base level changes in continental basins. Because paleosols preserve the record of nondeposition and nonerosion and are useful in identifying periods of degradation, their analysis is essential to reconstructing the complete geologic history of alluvial sediments.

KRIEG, EDWARD A., E. A. Krieg & Assoc., Inc., New Orleans, LA, ARTHUR A. MEYERHOFF*, Consultant, Tulsa, OK, and IRFAN TANER, Consultant, Tulsa, OK

Puerto Rico Trench: Site of a Shallow-Water Tertiary Basin and Regional Tectonic Implications

Until late Eocene time, the Bahamas platform extended to the present Virgin Islands, as demonstrated by magnetic, gravity, and refraction data. This interpretation is confirmed by the presence of widespread outcrops of middle Cretaceous through early Pliocene shallow-water bank carbonates below 5,200 m depth in the trench. Crustal thickness beneath this bank is 18-25 km. Igneous and metamorphic rocks from the base of the trench's southern slope are chemically very different from subduction-zone rocks.

Waters of the carbonate bank (300 × 100 km in size) transgressed southward after early Eocene time. During late Eoene time, the bank's southern margin was near today's shoreline where down-to-the-north growth faults formed. Along the bank's northern margin, block faulting produced a graben above the site of the modern Puerto Rico Trench. During middle Eocene to early Pliocene time, shallow-water deposition extended from a position presently 5,200 m deep in the trench to central Puerto Rico, an exceptionally stable block at least 100 km wide.

During middle Eocene time, the Beata Ridge dextral shear cut the trench off north of Hispaniola. In early Pliocene time, the Mona Canyon dextral fault zone cut across the trench, and strong northward tilting commenced. The trench's present southern slope is mainly a dip slope, inclined about 5°. The Puerto Rico Outer Ridge formed by lateral and upward movements of mantle materials that withdrew from beneath the sinking trench. Petroleum prospects presently are limited to the Tertiary (4,000 m thick) and to a coastal zone 20-25 km wide (to 2,000 m water depth). Traps are mainly fault seals and stratigraphic pinch-outs.

KRYSTINIK, KATHERINE B., U.S. Geol. Survey, Denver, CO, and H. EDWARD CLIFTON, U.S. Geol. Survey, Palo Alto, CA

Expert System for Computer Interpretation of Beach and Nearshore Facies

A user-friendly, rule-based expert system has been designed for interpretation of lithofacies characteristics of beach and nearshore depositional environments. Recently, similar expert systems have been widely applied in medicine, business, and mineral exploration.

The expert system runs on a VAX 780 (trade name). By incorporating knowledge and understanding of an expert, the system can interact with a user the way an expert consultant would. Interaction consists of a series of questions about lithology, sedimentary structures, and bioturbation of the lithofacies observed in outcrop or core. Uncertain responses are allowed and incorporated into the reasoning. Dialogue varies in different consultations because questions asked by the system depend on users' responses to previous questions. The result is an evaluation of the likelihood that the deposit under consideration is actually a beach or nearshore deposit. Significant lithofacies characteristics, the reasoning used in reaching the conclusion, and pertinent references are provided.

Expert systems for other depositional environments are being designed. As their availability increases, geologists without easy access to experts on a particular depositional environment will have expert consultants as close as a computer terminal. Also the ability of the system to explain its reasoning and provide references lends the system to instructional uses.

KRYSTINIK, LEE F., Champlin Petroleum, Englewood, CO, SARAH ANDREWS, Angus Petroleum, Golden, CO, and STEVEN G. FRYBERGER, McAdams, Roux & Assoc., Denver, CO

Impact of Early Diagenesis of Eolian Reservoirs, Great Sand Dunes National Monument, Colorado

Dune and associated alluvial and playa deposits at Great Sand Dunes National Monument, Colorado, provide an excellent opportunity to study early diagenetic development of vertical and horizontal permeability barriers in recent eolian deposits (> 10 ka). Cements observed include calcite, aragonite, protodolomite(?), amorphous silica, iron hydroxide, smectite, trona, and halite. Cementation is controlled by the availability of water, with several hydrologic subenvironments producing different cements.

Evaporative cementation in dunes adjacent to playas is commonly dominated by trona and halite, but calcite, aragonite, and amorphous silica also bind the sediment. These cements are generally most concentrated in fine laminations where capillary action has pulled water into dunes. Iron hydroxides, calcite, and amorphous silica precipitate at the interface between ground water and streams or lakes, where the pH gradient may exceed 5 pH units (pH 5.7-11.5). Subsequent movement of the ground-water table can result in cross-cutting cement zones.

Early cementation in dunes prevents deflation and provides a mechanism for preservation of the reservoir unit. Intense cementation may permanently occlude porosity, or leaching may reestablish well-interconnected porosity. An understanding of the extent and composition of early cement zones can be used to improve hydrodynamic models for production and enhanced recovery.

KUGLER, RALPH L., Univ. Texas at Austin, Austin, TX

Source Rock Characteristics, Los Molles and Vaca Muerta Shales, Neuquen Basin, West-Central Argentina

Major hydrocarbon-producing trends of the Neuquen basin occur along its northeastern margin (Eastern Shelf) and along an east-west-trending structural high in the southern half of the basin (Neuquen Dorsal). Sediment thickness increases northward from the Neuquen Dorsal and westward from the Eastern Shelf into the Neuquen Embayment, a region that has been relatively unproductive for hydrocarbons.

Major source rocks are the Lower to Middle Jurassic Los Molles Formation and the Upper Jurassic to Lower Cretaceous Vaca Muerta Formation. Los Molles shales are immature to moderately mature on the Neuquen Dorsal: vitrinite reflectance (R_o) = 0.3-0.8%; thermal alteration index (TAI) = 1+ to 2; total organic carbon (TOC) = 2.0-5.0%. However, they are severely altered in the deepest part of the Neuquen Embayment (R_o = 2.5-3.0%; TAI = 3+ to 4; TOC = 1.1%). Organic matter is woody on the Neuquen Dorsal but is coaly in the Neuquen Embayment. Clay minerals are smectite and mixed layer illite-smectite on the Neuquen Dorsal whereas illite and chlorite are present in the Neuquen Embayment.

Similarly, Vaca Muerta shales are immature on the Neuquen Dorsal and along much of the Eastern Shelf (R_o = 0.3-0.5%; TAI = 1 to 2−), but are mature throughout the Neuquen Embayment (R_o = 0.7-1.3%; TAI = 2-3). The lower part of the unit is a bituminous black shale (TOC = 2.5-6.5%). The dominant visual kerogen type is amorphous (AI). Clay minerals change from smectite to mixed layer illite-smectite with decreasing expandability toward the deepest part of the Neuquen Embayment.

The lack of correlation between areas of source rock maturity and major hydrocarbon production suggests long-distance fluid transport out of deep portions of the basin.

KVENVOLDEN, KEITH A., U.S. Geol. Survey, Menlo Park, CA

Geochemical Conditions in Sediment Containing Gas Hydrates of Active and Passive Continental Margins

Two sites of the Deep Sea Drilling Project in contrasting geologic settings provide a basis for comparison of the geochemical conditions associated with marine gas hydrates in continental margin sediments. Site 533 is located at 3,191 m water depth on a spitlike extension of the continental rise (Blake Outer Ridge) on a passive margin in the Atlantic Ocean. Site 568, at 2,031 m water depth, is in upper-slope sediment of an active accretionary margin (Middle America Trench) in the Pacific Ocean. Both sites are characterized by high rates of sedimentation (greater than 30 m/m.y.), and the organic carbon contents of these sediments generally exceed 0.5%. Anomalous seismic reflections that crosscut reflections from sedimentary layers and parallel reflections from the sea floor suggested the presence of gas hydrates at both sites. During coring, small samples of gas