resulting from future satellite and airborne systems, must be utilized in an interactive manner with field geology and spectrometer measurements and computer-processing techniques to obtain the optimum integrated geologic, geophysical, and geochemical information contained in these data. Successful applications of satellite remote sensing requires a realistic understanding of the earth's surface and its relationship to the exploration models being used. As originally recommended by the Geosat Committee, the addition of the shortwave IR TM spectral bands, higher spatial resolution (10-20 m), and Synthetic Aperture Radar in the present and planned systems, combined with the Landsat/MSS system, will substantially improve these systems as a whole for more efficient geologic mapping and improved exploration success worldwide.

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Reservoir Characteristics of Lower Wilcox Sandstones, Lobo Trend, Webb and Zapata Counties, Texas

To date, over 340 bcf of gas have been produced from the Lobo sandstones in the Laredo field area at depths of less than 10,000 ft (3,050 m). Gas accumulation is controlled by faulting and erosional truncation. The resulting structural complexity has made accurate prediction of reservoir sandstones difficult. Cored sections display repetitive ordered sequences of sedimentary structures and textural and compositional gradations indicative of turbidity-current deposits. The reservoir sandstones were deposited as constructional channels having vertical and lateral variation from channel-fill to channel-margin to overbank deposits. Channel-fill units are 2-10 ft (0.61-3.05 m) thick and composed of AB, AE, and ABE bedsets. Channel-margin units are 1-3 ft (0.31-0.92 m) thick and contain thinner, more complete ABC, ABE and ABCE sequences. Overbank deposits consist of highly bioturbated, thinly interbedded sandstones and shales. Sandstones are feldspathic litharenites that have 15% matrix and 15% calcite cement. Porosities average 16% and permeabilities range from 0.54 to 12 md, decreasing with increased matrix, cement, and bioturbation. The channel-fill sandstones are linear, dip-trending bodies less than 3,000 ft (915 m) wide, which bifurcate downdip into distributary channels. High-intensity, small-scale, soft-sediment deformation indicates the sandstones were deposited in an unstable outer-shelf to upper-slope environment. A slumped, dip-trending channel-fill interpretation for the Lobo sandstones provides a mechanism for sediment transport beyond the present downdip limits of the trend.

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Deposition and Diagenesis of Flippen Limestone (Wolfcampian), Fisher and Jones Counties, Texas

The Flippen carbonate (Wolfcampian) was deposited during a high stillstand of sea level under subtidal to intertidal conditions. Eleven cores in Fisher and Jones Counties have been subjected to megascopic and petrographic analysis with special interest given to the Alkali Creek SW field in Fisher County. Five distinctive limestone facies, designated according to their most outstanding characteristics are: (1) constructional phylloid algal buildups, (2) crestal boundstones, (3) flanking bed packstone-wackestone, (4) foremound pelloidal grainstone, and (5) capping grainstones.

Early diagenesis occurred after deposition of the sediments in the marine environment. This is evident in micritization, submarine cements, and effects attributed to binding and encrusting habits of algae, particularly *Archaeolithoporella* and *Tubiphytes*.

Primary intergranular and intrabiotic porosity is best developed and preserved in biograinstones along the shallow flanks of the constructional mound. Stabilization and lithification of originally deposited sediments began early during subaerial exposure and subsequent freshwater diagenesis. Secondary porosity was formed by the dissolution of aragonitic phylloid algae and pelecypods, forming hollow micrite envelopes or biomolds. Aragonitic lime mud was replaced by calcite micrite and microspar. Calcitization and dissolution resulted in the precipitation of crusts of calcite scalenohedra in primary and secondary voids. Dolomite cement crusts also line primary and secondary voids, and these rhombs subsequently were dedolomitized. Precipitation of blocky equant nonferroan calcite, ferroan calcite, and ferroan dolomite cements partially to completely filled primary and secondary voids. A late stage of dissolution, which presumably occurred at depth, enhanced existing primary and secondary porosity. No cementation followed the late stage of diagenesis.

HICKS, BRIAN D., DAVID W. HOUSEKNECHT, and KENNETH R. APPLIN, Univ. Missouri at Columbia, Columbia, MO

Crystallographic Influences on Pressure Solution in a Quartzose Sandstone

The solubility of quartz differs with crystallographic direction. A universal stage was used to measure the orientations of the optic axes and contact planes of 160 pairs of quartz grains in the Bromide Formation (Simpson Group) of Oklahoma. These quartz grains exhibit long, sutured, and concave-convex contacts. Results indicate that the geometry of a pressolved contact is independent of the crystallographic orientation of opposing grains. However, given a concave-convex contact, the optic axis of the concave grain tends to lie at a higher angle to the contact plane than the optic axis of the convex grain. We conclude that the extent and type of pressure-solution contacts in quartzose sandstones are not significantly influenced by crystallographic orientation. Other factors, such as grain size and clay content, are probably more important in controlling the pressure-solution features.

Geometric etch pits, which form at the point of emergence of crystal defects, were produced by hydrothermally etching quartz crystals, quartz sand, and quartzose sandstones. The abundance, nature, and distribution pattern of crystal defects inherited from source rocks might be more important factors in affecting pressure solution of quartz grains than differences in quartz solubilities arising solely from variations in Si-O bond strengths. The extent of etch-pit formation on quartz cement may also serve as a qualitative indicator of the dissolved silica saturation in pore fluids.

HIGH, LEE R., JR., Mobil Oil Corp., Dallas, TX

Evaluation of Potential Hydrocarbon Sources in Lacustrine Facies of Newark Supergroup, Eastern United States

Lacustrine rocks are a significant component of many rift-valley sequences. Comparisons of both active and ancient rift valleys indicate that the lacustrine facies are commonly rich in organic matter and may be important sources for oil. For example, Holocene sediments in Lake Tanganyika and Cretaceous lacustrine rocks in west Africa contain as much as 12% and 20% TOC, respectively.

The Newark Supergroup contains abundant lacustrine rocks. The widespread occurrence of "black shales," the general similarity to known organically rich rift systems, and a few isolated geochemical analyses have caused some speculation about the potential of the Newark Supergroup to be an effective source of oil and gas.

Sufficient geochemical analyses are available from lacustrine rocks in the Newark, Connecticut, and Deep River basins to evaluate their potential as hydrocarbon sources. In general, both the quantity and quality of organic matter in these rocks are less than that required for potential source rocks. Some samples do qualify as potential sources, but the total generative capacity of lacustrine rocks within these basins is relatively small.

Despite these results, the numerous unexplored buried Newark rift basins retain some potential for containing significant hydrocarbon source rocks. Analyses of the lacustrine rocks from the Newark basin indicate that the original sediments were rich in oil-prone organic matter. However, the unusual water chemistry of this lake resulted in the almost complete destruction of the organic matter by sulfate-reducing bacteria. Slight changes in water chemistry in other Newark lakes could have resulted in large volumes of organically rich sediment being preserved in these unexplored basins.

HIGH, LEE R., JR., Mobil Oil Corp., Dallas, TX

Regional Geology of Georges Bank Basin—OCS Sale 42 Drilling Results

Industry bid aggressively in OCS Sale 42, spending $816 million. Eight wildcats were drilled in 1981-82 to test 5 major plays. All wells were dry; no potential reservoir or source rocks were found.

The tectonic-stratigraphic framework of the Georges Bank basin is that of an Atlantic-type plate margin. Two major unconformities divide the section into prerift, synrift, and postrift sequences. The prerift sequence consists of Paleozoic metasediments in basement fault blocks. Synrift sediments consist of Newark Group equivalents: the Argo Salt and the Iroquois Formation. The postrift sequence consists of Mohican red beds overlain by progradational wedges, with the carbonate Abenaki Formation at the base.

The objective in 4 of the 8 wildcats was the Iroquois Formation. Mobil 312-1 and Shell 357-1 were drilled into a seismic anomaly interpreted to be a reef. This structure was found to be a complex carbonate mound. Exxon 975-1 was drilled on a seismic amplitude anomaly variously interpreted to be the result of salt, coal, or porous carbonates. This anomaly proved to be caused by a salt bed. The objective in Shell 410-1R was carbonate banks over a basement horst block. No significant zones of porosity were found.

The remaining 4 wildcats were drilled on Abenaki prospects. Mobil 273-1, Tenneco 187-1, and Conoco 145-1 were drilled for possible carbonate banks over a salt structure. Only thin oolitic grainstone intervals were found. Exxon 133-1 was based on a seismic anomaly interpreted to be a patch reef. This feature was found to be a volcanic cone.

HODGKINSON, KENNETH A., Exxon Co., U.S.A., New Orleans, LA, ALLAN W. H. BÉ (deceased), and CHRISTOPHER GARVIE, Long Branch, NJ

Eocene Euthecosomatous Pteropoda (Gastropoda) of North America

Thirty-four species of Eocene pteropods (minute, shell-bearing, planktonic gastropods) are added to the 11 previously known from North America. They can, on occasion, be used effectively for global correlation of synchronous strata. As pteropods receive further attention, the number and accuracy of these correlations will increase.

Pteropods are one of the most abundant and ubiquitous members of the plankton community in modern oceans. They were just as diverse and abundant in Eocene seas. There are about 28 modern euthecosome species. We have identified 45 Eocene species in North America, 7 of which were already known in England and Europe; 27 are new. They were collected from outcrops in Texas and Alabama and from exploratory wells in Louisiana and the Nova Scotian shelf.

All euthecosomatous pteropods have aragonitic shells but there are at least 3 different kinds of microstructure: (1) most spirally coiled species (family Spiratellidae) have crossed-lamellar microstructure, (2) straight or bilaterally symmetrical shells (family Cavoliniidae and Creisidae) have a helical microstructure, and (3) the Eocene species, *Plotophysops bearnensis* Curry (family Spiratellidae), has both crossed-lamellar and helical microstructure.

Helical microstructure, first described in pteropods by Bé, MacClintock, and Chew-Currie in the modern species, *Cuvierina columnella* Rang, is not known to exist in other molluscan groups. The helical rods are nested in such a manner as to give maximum strength to the thin fragile shell, a decided advantage for an organism with a planktonic life style.

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Secondary Porosity in Miocene Sandstones of Louisiana Gulf Coast and Its Significance in Reservoir Properties

Petrographic examination of Louisiana Gulf Coast Miocene sandstones recovered from depths ranging from 9,600 to 20,100 ft indicates that considerable porosity enhancement has occurred. Dissolution of authigenic calcite and dolomite is the primary mode of porosity enhancement. Relatively minor but locally significant secondary porosity is formed by dissolution of framework feldspars, rock fragments, and bioclasts or their replacements. Siderite dissolution is negligible.

The degree of porosity enhancement is determined largely by the original textural and compositional characteristics of a sediment. Relatively coarse-grained, well-sorted, matrix-free sands are subject to early diagenetic pervasive carbonate cementation and replacement. Sandstones later affected by extensive dissolution of pervasive carbonate cement and replacements contain excellent pore networks and exhibit maximum deliverability. Poorly sorted, fine-grained, matrix-rich (e.g., bioturbated) sands undergo little effective porosity enhancement. Consequently, "dirty" sands retain inferior reservoir characteristics.

Compaction and cementation generally diminish reservoir quality with increasing burial depth and aside from simple porosity loss, reservoir productivity and recovery efficiency are affected adversely by secondary pore geometry modification accompanying deep burial. Pore interconnection decreases and pore-throat geometry declines from tabular to lamellar with increasing depth. Pore to pore-throat ratios increase with depth, particularly in sandstones containing abundant secondary moldic and over-sized pores. Premature production decline in ultra-deep reservoirs can, in places, be attributed to reservoir-stress sensitivity associated with lamellar pore throats, very large pore to pore-throat ratios, and high overburden pressure.

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Geostatistical Analysis of Devonian Shale Production in Southwestern West Virginia

The success rate for Devonian shale wells in southwestern West Virginia is greater than 90%, yet the geologic factors determining hydrocarbon distribution are poorly understood. Initial potentials (IP) vary, but are generally low. Siting a new well may have little more justification than proximity to successful wells with acceptable to high open flows. Such a procedure can be made objectively through the use of geostatistics that measure the degree of randomness in the distribution of dry penetrations and the spatial variation in IP's.

Semivariograms were calculated to show (1) average difference in success between wells relative to the distance separating them, and (2) average difference in open flow between wells relative to distance. The semivariogram for gas IP showed a large degree of noise, but some spatial autocorrelation. Similarly, dry penetrations were found to be clustered. Success probability and gas IP contoured from kriged estimates exhibit clustering of dry penetrations and nonrandom patterns in IP's, in particular, linear highs and lows paralleling structural features. Highest flows correspond to flanks of known anticlines. One linear trend in IP follows a lineament that might represent a cross-strike structural discontinuity. Significant correlation between IP at each well site with that predicted from surrounding wells demonstrates the efficacy of the geostatistical approach.

HOLLIDAY, VALERIE, and JAMES M. PARKS, Lehigh Univ., Bethlehem, PA

Mechanisms of Deposition of a Carbonate Mud Spit: Ramshorn Spit, Eastern Florida Bay

The turtle grass (*Thalassia testudinum*) community has a significant influence on sedimentation in Florida Bay, but the roles other processes may play in the buildup of mud bank and spit sediments are poorly understood. Samples from cores taken from Ramshorn Spit and Ramshorn Shoal were classified into 4 basic types on the basis of particle size distribution, organic content, and faunal assemblages. In order of increasing volumetric importance they are: (1) very thin, discontinuous shelly packstones, representing overbank or storm deposits; (2) thin, continuous basal shelly packstones, the initial marine deposit on the Pleistocene bedrock surface; (3) muddy wackestones, of variable thickness, deposited in the presence of a seagrass community; (4) very thick, faintly laminated fine mudstones, with very sparse fauna, representing weak current-transported sediments settling out of suspension. Discriminant function analysis confirms the classifications and shows that these sediment layers are indeed correlatable between cores.

Interpretation of the core logs from Ramshorn Spit indicates a definite change in stratigraphy southwestward from the spit and bank junction to the tip of the spit itself. The different sediment layers show a small but significant inclination to the southwest. Throughout its depositional history, Ramshorn Spit seems to have been actively accreting outward into the surrounding "lake" by means of a current-transported fine mud fraction. After settling out at the growing tip of the spit, the sediments are subsequently stabilized at some later time by a turtle-grass cover.