occluded by later equant intergranular cements. Grainstones in each sequence were subject to at least 2 phases of facies-selective dolomitization. The earliest phase mimicked the preexisting texture, whereas the later phase was texture-destructive with rhombic dolomite crystals.

Dolomitized grainstones have highest porosities and permeabilities resulting from calcite dissolution and physical compaction. Calcite dissolution within ooids occurred after the second dolomitization phase; thus, oomoldic porosities are not related to meteoric leaching during or after Smackover deposition. Subsequent physical compaction enhanced permeability. Later, partial porosity occlusion was by anhydrite calcite.

Dolomitization was caused by refluxing brines during deposition of the overlying Buckner evaporites. Dolomite $\delta^{13}C$ values are compatible with Smackover/Buckner seawater; $\delta^{18}O$ values become lighter with time, a probable function of dolomitization during progressive burial. A change to coarse clastic sedimentation coupled with syn-Buckner faulting modified the hydraulic regime of the area. This may have been the stimulus for calcite dissolution and hence porosity development within the Smackover grainstones.

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Structural Characteristics and Evolution of Vicksburg Formation: Javelina and East McCook Fields, Hidalgo County, Texas

The major structure at Javelina and East McCook fields is a decollement surface on the Jackson Formation. Movement along this glide plane was contemporaneous with sedimentation and has resulted in extreme rollover (up to 50°) and great vertical and horizontal displacement of overlying Vicksburg sediments. Changing rollover trends observed in dip logs of lower Vicksburg strata, and structure of this glide plane surface demonstrate its listric nature both updip and along strike.

Structure within the Vicksburg Formation is dominated by 3 major listric, normal growth faults. The faults penetrate the entire Vicksburg section, which is over 8,000 ft (2,438 m) thick. These faults have significantly affected Vicksburg deposition, as the entire section expands more than 40% or 2,500 ft (762 m) across the field. Expansion ratios for individual units are higher. Structural displacement and complexity of the section increase with depth, with stratigraphic throws greater than 2,000 ft (610 m) in deeper Vicksburg beds. Fault drag is commonly observed in dip logs. Antithetic faulting is conspicuously absent.

Structural evolution of the Vicksburg was controlled by formation of a diapiric shale ridge updip early in Vicksburg deposition. Diapiric uplift resulted in evolution of a major growth fault on the basinward shoulder of the ridge. Once initiated, the fault maintained itself throughout Vicksburg deposition and resulted in decollement on, or within, Jackson shales. Development of this fault aided in formation of the other 2 growth faults. Formation of these faults was also related to movement along the glide plane, shale diapirism, and sediment-loading stresses.

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Thermal and Hydrocarbon Maturation Models for Coastal California

Hydrocarbon maturation models for coastal California must consider thermal and geochemical constraints imposed by plate tectonics, diagenetic reactions, and the sedimentation history of the region.

Plate tectonism drastically effects the thermal history of California basins in many ways. Initially, temperatures in the crust of coastal California are suppressed during subduction of the Farallon plate. With the passage of the Mendocino triple junction, subduction ceases and a void is created into which asthenosphere moves. This elevates temperatures in the basins in a complex manner depending on the time of passage of the Mendocino triple junction and the location of a specific basin. Finite-difference numerical models were developed to approximate the thermal effects of subduction and lithospheric upwelling.

Diagenetic reactions and sedimentation history affect both the maturation model and thermal history of a basin. Diagenetic reactions through time in the Miocene Monterey Formation may change thermal conductivity values by 70%. Facies changes also have an important effect on sediment thermal conductivity and hence sediment temperatures.

Maturation models indicate varying levels of maturity depending on the method used. Models using the Time Temperature Index of Lopatin indicate the lowest level of maturity. Tissot and Espitalie's method, which uses multiple activation energies and varying constants for the kerogen types, results in an intermediate level of maturity. The highest level of maturity results from the use of the Tissot and Espitalie method modified by using a single activation energy of 178.69 kJ $mole^{-1}$ and a constant of 4.92×10^{13} $hour^{-1}$ as reported by M. D. Lewan for shale from the Phosphoria Formation.

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Origin of High-Permeability Reservoirs in Upper Minnelusa Sandstone (Permian) Powder River Basin, Wyoming and Montana

Petrographic analysis of samples from 8 Minnelusa cores from Campbell County, Wyoming, and Powder River County, Montana, reveals that high-permeability reservoirs (up to 3,200 md) are the result of extensive dissolution of early precipitated gypsum or anhydrite cement. The Minnelusa reservoirs are in eolian sandstones (dune and interdune facies) that are very fine to coarse-grained, moderately to bimodally sorted quartzarenites, subarkoses, and sublitharenites. Dune and interdune sandstones exhibit differences in detrital mineralogy that are the result of postdepositional dissolution of labile grains.

The most common cements in the sandstone are anhydrite (0-30%), quartz overgrowths (0-10%), dolomite (0-10%), kaolinite (< 5%), and illite (< 1%). Most cementation occurred during the pre-Jurassic when the sandstones were buried less than 1,500 ft. The porosity network within the sandstone is a combination of primary and secondary porosity created by the dissolution of anhydrite cement. Burial history curves suggest that anhydrite dissolution occurred during the Late Jurassic to Early Cretaceous, when the top of the sandstones was still near the surface. During this time, 3 periods of uplift and erosion occurred in which meteoric waters undersaturated in calcium sulfate may have flowed through the sandstones. The distribution of the reservoirs is probably controlled by the regional structure during the periods of flushing.

Dune sandstones are the most productive facies in the high-permeability reservoirs. Porosity in the dune facies averages 21% compared with an average of 9% in the interdune facies. This difference is the result of both lower depositional porosity and greater quartz and dolomite cementation in the interdune sandstones. Porosity loss due to mechanical compaction is similar for both facies.

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Joint Geosat-NASA/JPL Test Case Program: Field Evaluation of Future Geological Satellite Remote-Sensing Systems

The principal industrial users of land-observation satellite systems are several hundred oil and gas, mining, and engineering or environmental companies worldwide. The primary system used is Landsat/MSS (Multispectral Scanner), the data from which are now used operationally as an improved geologic mapping tool to help direct more expensive geophysical surveying and drilling, thus assisting exploration decision making. Use is also made of SKYLAB photography, SEASAT and SIR-A (Shuttle Imaging Radar) radar, and the new Landsat/TM (Thematic Mapper) data. Industrial use will soon be made of data from France's SPOT (1985), India's IRS (1986), the European Space Agency's ERS (1987), Canada's RADARSAT (1990), and Japan's JERS (1991) remote-sensing satellites.

Data representing these systems were evaluated during the 7-yr, $10-million joint Geosat Committee-NASA/JPL Test Case Program. Begun in 1977, the objective of this program was to assess, in known geologic areas, the value of existing and potential satellite remote-sensing methods for petroleum exploration, mineral exploration, and engineering geology applications. The published study includes an evaluation of sensors, data-processing techniques, and interpretation methods.

Some conclusions include the following. The Landsat/TM combines the visible and very near Infrared (IR) spectral bands of the MSS, with the shortwave IR 1.6-2.2 μm band region, which can indicate the presence of clays, carbonates, and sulfates. This system allows greater rock and soil discrimination than the MSS alone. Similarly, the TM bands demonstrate numerous, as yet little understood, geobotanical anomalies clearly related to leaking gas over oil and gas deposits. Landsat data, as well as that 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.

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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.

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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.

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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.