evaporite units is controlled primarily by environments of deposition and the diagenetic overprints. Sabkha, lagoonal, and basinal environments, for example, are excellent for organic-matter preservation. Vadose and freshwater phreatic diagenetic environments are not favorable for organic preservation. The marine-phreatic diagenetic environment, however, is favorable for preservation of organic matter.

The upward-shoaling cycles, which are the buildup blocks of the carbonate-evaporite sequences, provide for source-reservoir couplets. The base of a cycle generally includes the potential source rocks. The top of a cycle contains the leached and/or primary porosities which provide the reservoir potential.

Synchronous and post-sedimentary tectonic events also seem to have a positive influence on the source-rock potential of carbonate and evaporite rocks. Rapidly subsiding shelves would place the organic-bearing carbonate units below the destructive influence of the freshwater phreatic zone. Late structural movements could produce the microfracture systems which would form the avenues for petroleum migration from source to reservoir rocks.

Geochemical data on ancient rocks strongly suggest that sabkha evaporites should be seriously considered as possible source rocks for petroleum.

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Models for Interpretation of Micromorph Faunas in Washita Group

Micromorph faunas typically are found in limonitic, pyritic, or phosphatic black shales. They consist of individuals that are smaller than those in normal faunas. These faunas are primarily the consequence of stunting, transportation, juvenility, and paedomorphosis. Probable specific factors that might lead to stunting are abnormal salinities, low food supply, and low oxygen. The winnowing out and concentration of smaller individuals of an assemblage can produce a transported fauna. Juvenility is the result of large-scale fluctuations in immature ecosystems. Evolution resulting in paedomorphosis is a response of populations to environmental factors such as instability or substrate fluidity. Faunal and sedimentologic characteristics which are potentially diagnostic of these mechanisms can be recognized. Models defined by expected conditions of the criteria were established for each mechanism.

To test the usefulness of the models for distinguishing micromorph faunas in the Washita Group, a fauna described as micromorph was studied. The small size of fossils in the Grayson Formation of Texas, Oklahoma, and Mexico has been attributed to excessive iron concentrations, anaerobic conditions, and seasonal fluctuations. Comparison of the faunal and sedimentologic characteristics of the Grayson fauna with those of the established models indicates that the small shell size of some of the Grayson oysters and ammonoids is probably an adaptive strategy evolved by these organisms for survival in a soft-substrate environment. The small size may be a consequence of paedomorphosis. Pyritized Grayson specimens are probably a result of microreducing environments that developed within individual shells in the soft mud.

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Possible Biogenic Origin for Some Sedimentary Dolomite

A rather simple biochemical system comprising seawater, algae, and urease-producing bacteria could form microenvironments favoring the formation of sedimentary dolomite. Calcium and magnesium ions are supplied by seawater. Algae, like most plants, produce urea in the ornithine cycle; the urea [$(NH_2)_2CO$] is, in turn, hydrolyzed, producing abundant CO_2 and NH_3. This hydrolysis of urea is catalyzed at ambient temperatures by the enzyme urease, which is produced by several bacterial species as well as by certain plants. Urease-producing bacteria have been found in the world's oceans and in bottom sediments.

Although other biochemical reactions may also favor dolomite formation, the hydrolysis of urea appears to be preeminently important. This is because hydrolysis ultimately produces 1 mole of H_2CO_3 and 2 moles of NH_4OH per mole of urea. Consequently, the solution becomes increasingly basic as CO_2 continues to be produced, which means that the alkalinity also increases. Because of the increased basicity and carbonate content, as HCO_3^- or $CO_3^=$ depending on pH, carbonate minerals, especially dolomite, may form. Experiments by Gebelein and Hoffman illustrated the importance of NH_3 and CO_2, and experiments by Medlin at elevated temperatures and pressures demonstrated the importance of urea hydrolysis.

Thus, the burial of dead, proteinaceous marine organisms, especially algae, and associated urease-producing bacteria may produce conditions favoring the formation of dolomite or at least promoting dolomitization. Stromatolites are a case in point; their organic-rich laminae commonly contain dolomite, and the inorganic interlayers commonly contain calcite. Furthermore, the feasibility of this, or a similar, system was recently demonstrated (unintentionally) by a male dalmatian who produced uroliths of ordered dolomite in his urinary bladder.

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Shallow-Water Upper Jurassic Rocks Dredged from Bering Sea Continental Margin

Rocks recently dredged along the Bering Sea continental slope include fossiliferous, gray-green arkosic sandstone of Late Jurassic age. The sandstone was recovered from acoustic basement at water depths ranging from 1,500 to 2,800 m. These arkosic rocks were sampled at nine sites along a segment of the Beringian margin that extends about 550 km northwest of the Pribilof Islands toward eastern Siberia. Preliminary lithologic and petrographic examination of the feldspathic sandstone and lesser amounts of siltstone indicates that these rocks are equivalent to units in the Naknek Formation, which is exposed in southern Alaska and along the Alaska Peninsula. The megafossil *Buchia rugosa* was found in quantity in one dredge haul. This Late Jurassic pelecypod implies that the rocks were deposited in a neritic or shallow-water environment. These Jurassic strata are overlain unconformably by diatomaceous mudstone or sandstone as old as late Eocene or early Oligocene.

Geophysical work indicates that the Jurassic rocks were recovered from an acoustic basement complex that can be traced northwestward from near the western tip of the Alaska Peninsula to Siberia, a distance of nearly 1,250 km. The Mesozoic basement complex consists structurally of a series of interconnected ridges that underlie the outer shelf and crop out along the adjacent continental slope. Previous theories on the tectonic evolution of the Bering Sea implied that the continental margin should be underlain either by (1) deformed Mesozoic trench or slope deposits that were structurally accreted to the margin by oblique convergence between the Kula(?) and North American plates or (2) by disrupted fragments of Mesozoic slope beds deposited along a transform or strike-slip boundary that separated the two plates. However, rocks dredged from the margin now indicate that a belt of shallow-water Upper Jurassic sandstone underlies the Beringian margin between southwestern Alaska and eastern Siberia. This belt, which structurally may include younger rocks, subsided in early Tertiary time to form the existing Beringian margin. Collapse along the margin was more than 3 or 4 km; in some areas beneath the outer shelf, the Mesozoic framework may have subsided more than 10 km.

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Distribution of Salt Structures in Gulf of Mexico

Known collectively as "salt domes," slender diapiric stocks, broad massifs, anticlinal masses, low-relief swells, and pillowy lobes of Middle to Upper Jurassic salt dominate the structural fabric of large parts of the continental margins and deep basin of the Gulf of Mexico.

In the northern Gulf of Mexico, large salt structures are concentrated on the Texas-Louisiana slope west of the Mississippi fan and on the Rio Grande slope east of Brownsville, Texas. Salt stocks dot the continental shelf off Louisiana, around the DeSoto Canyon off the Florida Panhandle, and across the upper Mississippi fan between the Sigsbee and Florida Escarpments. At the foot of the continental slope, an almost continuous wall of coalesced salt structures abuts relatively undeformed strata of the continental rise along the Perdido and Sigsbee Escarpments marking the seaward boundary of the northern gulf salt-dome province.

In the central gulf, the almost featureless Sigsbee Plain is interrupted by the surface expressions of but a few of the more than 50 large salt diapirs that pierce thousands of meters of abyssal strata along a narrow belt parallel with the northwestern face of the Campeche Escarpment. Seismic reflection data between the Sigsbee Knolls and the Campeche Escarpment record the undulating surface and undeformed base of the mother-salt layer and indicate updip pinchout at the base of the Campeche platform.

In the southwestern gulf, knolls and open basins on the slope are underlain by masses of diapiric and nondiapiric material thought to be salt. Though similar to the northern gulf slope in topographic character and to some extent in internal structure, the Golfo de Campeche slope includes a considerable number of broad, linear hillocks composed of thick sections of slope and abyssal strata that were uplifted, folded, and faulted by tectonic events apparently unrelated to salt mobility.

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Facies and Reservoir Characteristics of Shelf Sandstone, Hartzog Draw Field, Powder River Basin, Wyoming

Hartzog Draw field is a stratigraphically controlled oil reservoir which produces from the Upper Cretaceous Shannon Sandstone at depths from 9,000 to 9,600 ft (2,700 to 2,880 m). The producing interval consists of a large, midshelf sand-bar complex deposited below effective normal wave base more than 100 mi (160 km) from shore. The productive interval in the bar complex has a maximum thickness of 65 ft (19.5 m), is over 21 mi (34 km) long, and up to 3.5 mi (5.6 km) wide. Over 170 wells have been completed on 160-acre (64 ha.) spacing since its discovery in 1975, and ultimate oil recovery may exceed 100 million bbl.

The reservoir is completely enveloped in shale, has a solution-gas drive, no water table, and no produced formation water. Even zones calculated from logs to have water saturations of over 65% do not produce water. Net pay is primarily a product of porosity, permeability, and thickness of the sandstone, and is directly related to sedimentary facies. Of six facies observed in cores, only the central bar facies—a high angle, trough-cross-bedded, glauconitic quartz sandstone—is a consistently high-quality reservoir. Two others, the bar-margin facies, a ripple to trough cross-bedded sandstone with abundant shale and siderite clasts, and the interbar facies, a rippled, interbedded sandstone and shale, generally are marginal-quality reservoirs.

Data from three cores indicate the central bar facies to have a significantly better average porosity and permeability (12.7%, 6.5 md) than either the bar-margin facies (8.1%, 3.7 md) or interbar facies (6.2%, 2.1 md). In addition, wells with a thick central bar facies appear to maintain higher reservoir pressures. Recognition of the facies, and understanding their distribution and interrelations are prerequisites to developing a program which will maximize oil recovery from the field.

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Independent Geologists—Endangered Species

During the last 5 years, while constantly complaining about a supposed lack of competition in the extractive industries, the U.S. Congress and administrative regulatory agencies have focused their power to make this