A series of maps constructed from seismic data trace the late Pleistocene and Holocene development of Corpus Christi Bay. The seismic data consists of 320 km of older sparker data, 80 km of older Uniboom data, 160 km of recent ORE Geopulse data, plus some 3.5 kHz Datasonics data.

Seismic facies and the principal sedimentary features are mapped. Main unconformities such as the Holocene/Pleistocene erosional unconformity and the thickness of Holocene fill are contoured.

Vertically stacked channels indicate that the ancestral Nueces River meandered across the same geographic area during the late Quaternary. Seismic signatures suggest extensive distribution of sand as channel fill, bars and spits, and reworked older deposits. Numerous moundlike structures are interpreted to be ancient oyster banks, which occupy areas in the bay where no living oyster reefs exist today. Holocene evolution indicates progressive widening of the estuary and filling from both the Nueces River and the landward migrating barrier islands.

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Cambrian Trilobites with Siberian Affinities, Southwestern Alaska

Cambrian trilobites occur in two levels (about 7 m apart) in the core of a large, complex anticlinal structure in the area between the Taylor Mountains and the Hoholitna River in southwestern Alaska. The lower collection contains *Erbia, Macannaia* (a species close to Soviet forms described as *Pagetia ferox* Lermontova), two species of *Kootenia* (including one perhaps conspecific with forms from the central Brooks Range), and several species of ptychoparioid trilobites. It is clear that biogeographic affinities are with the transitional facies of the eastern Siberian platform and the south Siberian foldbelt. In Soviet terms, the age of the collection falls in a disputed interval called latest Early Cambrian (Tojonian) by some authors, and earliest Middle Cambrian (Amgan) by others. In North American terms, *Macannaia* is known only from early Middle Cambrian beds. The younger collection contains abundant agnostids, a variety of conocoryphids, *Paradoxides*, and several species of ptychoparioid trilobites. This is an assemblage of undoubted late Middle Cambrian age, comparable to faunas described from the Maya Stage of the Siberian platform and the *Paradoxides paradoxissimus* Stage of the Baltic region. Both faunas are from ocean-facing or outer shelf environments. None of the key non-agnostid or non-pagetiid elements have been seen previously in deposits of Cambrian North America.

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Fluvial Sand Shapes: Effects of Tributary Mixing

Similarities and differences in gross shapes of fluvial quartz sand grains contain information useful for interpretation of sediment transport history. The shapes of sand grains in a given river depend on the source, or sources, of sand within the drainage basin and on the abrasion and shape sorting that has occurred during transport. It is highly unlikely that 2 major streams will carry precisely similar-shaped grain suites. Therefore, when 2 streams join, the resulting sand can be recognized, on the basis of shape, as being mixtures of the 2 input streams.

The multiple rotations method of quantitative shape analysis characterizes sets of grain shapes with 5 or 6 numerical factor loadings, and individual grains are described by 5 or 6 factor scores. Trends of shape changes, such as those that occur along the length of a river, show up well on bivariate-factor score plots. These trends are interrupted and offset by mixing of sands contributed by tributary streams. Shapes of sands obtained from the Missouri River above the junction with the Platte River in Nebraska are different from those from below the Platte; but when Platte River sand shapes are subtracted, the remaining differences are insignificant. Farther downstream, sands from the Kansas River show the same relationships. The relative contributions of sand from a river and its tributaries, and the rates of mixing of the sands, can be estimated from quantitative shape analysis of several samples.

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Paleopedogenesis in Lower Cretaceous Hensel Formation, Central Texas

The extensive matrix facies of the Hensel Formation consist of calcretized (calichified) red mudstone, and thin, sheet sandstone, interpreted as paleosols and overbank deposits. Framework facies include cross-stratified lenses of conglomerate and sandstone that represent low-sinuousity to meandering streams of small fluvial systems. These systems were active during the transgression that resulted in deposition of Glen Rose and Fredericksburg Group carbonates. The pervasive development of calcrete, desiccation cracks, and pseudo-anticlines within the Hensel paleosols, as well as the overall depositional style of the unit, suggest an arid to semiarid, seasonal climate.

Paleopedogenesis resulted in the formation of authigenic kaolin and illite, intense red-orange coloration, and various types of calcrete. Paleocalcrete within the mudstone facies commonly assumed a nodular habit. It is frequently observed to be coalesced into honeycomb structures. Locally calcretized, thin-bedded sandstone and mudstone were buckled into pseudo-anticlines. These structures were partly produced by fluctuating ground water and other inferred soil-forming processes. Paleocalcrete accumulated in the sandstone facies as undulating hardpans and vertically oriented rhizoliths. Microscopic textures characteristic of all these calcretes include low-magnesian calcite, crystallaria, and circumgranular cracks.

Carbon and oxygen isotopic values from each type of calcrete confirm a pedogenic origin for the authigenic calcite. A "heavier" oxygen isotopic value in the dolomite, peculiar to the pseudo-anticline calcrete, denotes enrichment of meteoric ground water by extreme evaporation. These conditions would have existed near a continental playa, an environment compatible with the seasonal, arid to semiarid climate.

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Timing of Syntaxial Cement

Echinodermal fragments are commonly overgrown in ancient limestones, with large single crystals growing in optical continuity over their skeletal hosts (i.e., syntaxial overgrowths). Such syntaxial cements are usually considered to have precipitated from meteoric pore waters associated with a later stage of subaerial exposure. Although several examples have been reported from ancient carbonates where petrographic relationships may indicate an early submarine formation of syntaxial cement, no occurrences have been noted in Holocene submarine-cemented rocks.

Syntaxial cements of submarine origin have been found in Bermuda beachrock where isopachous high-magnesian calcite cements merge with large optically continuous crystals growing on echinodermal debris. Examination of other Holocene sediments cemented by magnesian calcite indicates that echinodermal fragments are not always overgrown syntaxially, but may be rimmed by microcrystalline calcite. The reason for this difference is not clear, although it may be a function of the spacing of nucleation sites and rates of crystal growth.

A review of syntaxial cements from several localities in ancient carbonate sequences reveals that many are best interpreted as having formed in the submarine setting, whereas it is more clear that others formed from meteoric precipitation. These occurrences suggest that care should be exercised in inferring meteoric diagenesis from syntaxial overgrowths and that the possibility of submarine formation should be considered.

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Recognition of Two Distinctive Diagenetic Facies Trends as Aid to Hydrocarbon Exploration in Deeply Buried Jurassic Smackover Carbonates of Southern Alabama and Southern Mississippi

Petrologic investigations from wells drilled in the southern Mississippi Interior Salt basin and in the northern Gulf Coast Salt basin have revealed regionally predictable diagenetic-facies trends within the deeply buried (19,000-22,500 ft) Smackover Formation. Within deeply buried Smackover trends, calcitic facies and dolomitic facies are recognized.

The calcitic facies is areally widespread and exhibits diagenetic intensities ranging from well-preserved grainstones to pervasive neomorphism. Petrographic evidence of multistage cementation, solution compaction, replacement fabrics, and cement-occluded secondary porosity is common. The calcitic facies is characterized by low porosity and low permeability.

The dolomitic facies is less abundant, and its distribution can be related to the Jurassic paleotopography. The Wiggins uplift, a prominent basement element extending across southern Alabama and southern Missis-

sippi, exerted significant control on the areal distribution of this facies. Porous and permeable intervals in the deeply buried Smackover are restricted to this facies. The most significant textural parameter of the dolomitic facies is crystal size. Finely crystalline dolostone is normally of low porosity and low permeability, whereas coarsely crystalline dolostone exhibits more-favorable reservoir properties.

The distribution of these diagenetic facies has important implications on future hydrocarbon exploration in the deeply buried Smackover Formation.

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Visual Kerogen Assessment of Thermal History

The microscopic particulate organic matter occurring in sedimentary rocks is referred to as visual kerogen when examined by use of strew slides prepared from a kerogen concentrate. Examination under a high-powered microscope in transmitted light yields information on both the organic matter type present and the level of organic metamorphism (LOM). This presentation concentrates on the LOM aspects of visual kerogen and addresses it from a utilization point of view.

The color of the kerogen, preferably plant cuticle fragments or pollen and spores, is used to determine the level of organic metamorphism. Various scales have been proposed to reflect this change in coloration. The TAI scale is most commonly used. Visual kerogen assessment is considerably less precise than vitrinite reflectance. It is a subjective call made by the analyst. Additionally, the equivalent reflectance range broadens as higher LOMs are attained. However, the ability to visually discern differences in the suite of organic material present can override its drawbacks in precision. Caved versus indigenous populations can be recognized, as can recycled versus primary vitrinite. Thermal history can also be established in sections that are barren of vitrinite. As is the case with nearly all organic geochemical techniques, reliable interpretations can be make if the limitations of the method are considered and the results are cross-correlated with other methods.

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Geochemical Investigation of Australian and New Zealand Crude Oils

Australian and New Zealand oils are derived predominantly from terrestrial source material. Relatively sparse information exists in the geochemical literature on the distribution of biomarkers in terrestrially derived crude oils. A detailed geochemical investigation of oils from a number of basins in this region has revealed interesting and unusual distributions of biomarkers. The compound classes that were analyzed included sesquiterpenoids, diterpenoids, triterpenoids, and steranes. From the information obtained, it has been possible to correlate the oils from several basins, in particular the Gippsland, Surate, and Carnarvon, into a number of source-related families. Evidence was also obtained that indicated a contribution from coal-like source material for many of the New Zealand oils.

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Emplacement Mechanism and Trapping Potential of Gravity-Driven Allochthons

Gravity-slide blocks of Paleozoic carbonate detached from the Snake River Range show evidence of episodic emplacement into the Salt Lake group (Mio-Pliocene) in the Palisades reservoir area near Alpine, Wyoming. The allochthons lie in a large graben system created by the Grand Valley listric normal fault, a reactivated thrust that soles into a ramp in the underlying Absaroka thrust. In the Alpine 7½-min quadrangle, one of the detached blocks is 2½ mi (4 km) by 1 mi (1.6 km) in map view and contains the Ferry Peak thrust as well as other Laramide structures. Structures and formations of the Alpine allochthon may be matched to those in the range to restore approximate predetachment position. Very low-angle westward translation at or near the surface moved the blocks across the Grand Valley fault into the graben. The current location and attitude of these allochthons are due to subsequent movement and rotation on the Grand Valley fault. The allochthons occur at different stratigraphic levels in the Salt Lake group, each level corresponding to the time of a specific emplacement event.

Catastrophic emplacement of a fractured allochthon, a potential reservoir, into a lacustrine or other source rock depocenter creates a unique and potentially predictable type of petroleum occurrence. Paleogeographic reconstruction may explain anomalous occurrence of discrete allochthons in structurally low areas where it can be shown that a gravitational potential existed for detachment and sliding. The resulting trap would consist of allochtons encased in autochthonous source rock.

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Geochemistry of an Insular Phosphate Deposit, Nauru, Equatorial Pacific

The world's largest insular phosphate deposit is found on Nauru, an uplifted coral atoll in the western equatorial Pacific. This deposit, which is draped over a dolomitized karstic surface, has an earthy pelletal texture; it is oolitic at its base and structureless in its upper part. The only phosphate mineral found is a carbonate fluorapatite with the stoichiometry $Ca_{10}(PO_4)_{5.6}(CO_3)_{0.6}F_{1.6}(OH)_{1-x}$. This mineral is slightly depleted in F^- and CO_3^{2-}, relative to PO_4^{3-}, to be considered a true francolite.

Abundant specimens of corals and micromollusks within the dolomite are representative of two contrasting atoll environments: a coral reef and a deep-water lagoon. The biostratigraphy has not been determined. Radiometric dates give a minimum age of 200,000 yr.

The source of the phosphorus is bird guano. The $\delta^{18}O$ and $\delta^{13}C$ values of the apatite and dolomite suggest that phosphatization occurred in meteoric water, possibly within and above a Ghyben-Herzberg lens; whereas dolomitization occurred in hypersaline water that refluxed from the lagoon when it became isolated from the open ocean during uplift. This interpretation is supported by the occurrence of as much as 15% gypsum in lagoonal sediments.

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Log-Analysis Problems Associated with Bimodal Pore System, Interlake Formation, North Dakota

The Interlake Formation is a Silurian-age sequence of dolostones, which produces hydrocarbons in the Williston basin. Log analysis of numerous Interlake wells from the Nesson anticline reveals that both water-productive and hydrocarbon-productive zones commonly have calculated water saturations in excess of 60%. These high calculated water saturations, in zones that produce water-free hydrocarbons, appear to be the result of a bimodal pore system.Non-fabric selective vugular pores are the major type of porosity seen in visual examination of Interlake cores. These vugs have been interconnected by fracturing and are responsible for most of the hydrocarbon production. The matrix that separates the vugs is composed of small equant dolomite crystals and also contains large amounts of intercrystalline microporosity, which is interconnected by pore throats less than 0.5 μm across. These small pore throats result in low permeability and high capillary pressures; thus the microporosity is capable of holding 100% irreducible water, whereas the vugular pores produce water-free hydrocarbons. Because it composes up to 50% of the total porosity, this microporosity drastically reduces the resistivity of the formation.

Recognition that a formation contains a significant amount of microporosity is important not only in preventing bypassed production, but also in determining reserves and exploration economics. Determination of the percentage of effective porosity cannot be made using electric log or conventional core analysis. A combination of special core analysis and petrographic techniques is needed to better define the amount of effective porosity.

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Cenozoic and Upper Cretaceous Sedimentary Facies of New Jersey Continental Slope and Rise