Recent Deep Sea Drilling Project (DSDP) coring along U.S. Geological Survey (USGS) multichannel seismic lines 25 and 35 provides direct sampling of the depositional sequences that constitute the lower continental slope and upper continental rise of New Jersey. The sedimentary record from four core sites, integrated with a closely spaced grid of multichannel seismic profiles, reveals 12 depositional sequences in the upper Campanian to Quaternary section that are bounded by erosional unconformities. Equivalent unconformity-bound depositional sequences are present on the contiguous continental shelf and upper slope; most sequences have counterparts in the Vail depositional model. Of particular interest is a complicated, stacked series of buried erosional channels dramatically displayed on seismic lines paralleling the depositional strike of the upper continental rise. The channels, which cut the upper surface of nearly every depositional sequence, probably formed during periods of low sea level. Channels on the lower Eocene surface display the greatest physiographic relief. Integration of seismic and bore-hole data suggests alternative correlations for several stratigraphically significant regional reflectors, such as A*, A^c, and A^u.

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Early Diagenetic History of Late Pennsylvanian Calclithite Beds, Hueco Mountains, El Paso County, Texas

Calclithite beds exposed on the western escarpment of the Hueco Mountains were deposited in a fan-delta system featuring fluvial channels, marine bars or beach sands, shallow-marine shale and limestone, and tidal flats and lagoons. Two distinct calclithite types occur. One is a coarse, poorly sorted gravelly sand with angular to subrounded grains. This type occurs in discontinuous or channel-shaped beds. Sedimentary structures include fining-upward sets, imbrication, and trough cross-bedding. These characteristics indicate sporadic unidirectional flow, as would be expected in ephemeral streams. The second calclithite type is fine to medium-grained well-sorted sand with very well-rounded grains. This type crops out as thin, relatively continuous units. Sedimentary structures include ripples, small-scale cross-beds, low-angle and horizontal or planar bedding.

The early diagenetic history of the calclithites reflects their depositional environment. The coarse calclithite was deposited in undersaturated freshwater conditions, shown by the absence of early cement. Early compaction of the coarse calclithite, indicated by intergranular microstylolitization and shale-clast deformation, is the most commonly observed texture. The fine-grained calclithite exhibits a markedly different diagenetic history. The first recognizable "diagenetic" event is micritization of marine-derived fossils and calclithite grains. Early cementation in the marine phreatic environment resulted in isopachous rims of fibrous aragonite and bladed Mg-calcite cement. Pore centers contain a later equant calcite cement. Little or no early compaction occurred in the fine calclithite. Freshwater flushing is indicated by the replacement of former aragonite cement rims by finely crystalline equant calcite.

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Environmental Significance of Evaporitic Textures of Mississippian Mission Canyon Formation, Williston Basin, North Dakota

The Mission Canyon evaporite wedge, the Frobisher-Alida interval, has commonly been interpreted as typical nodular or "chicken-wire" anhydrite from a sabkha depositional setting. Upon examination of over 190 cores from North Dakota and Montana, we identified a variety of evaporite textures and interpreted several distinct origins for them. The following evaporite textures were recognized: (A) precipitative or primary, (B) intraclastic, (C) evaporite cement, (D) replacement, and (E) dissolution-stage.

Depositional evaporites (A, B) form by direct precipitation in supersaturated solutions (primary texture) or by reworking of primary evaporite (intraclastic texture). Primary texture forms by direct precipitation from a supersaturated brine occurring in shallow lagoons or tidal ponds (subaqueous evaporite) or within the sediment (nodular anhydrite). Three types of subaqueous textures were identified: (1) isolated laths, (2) rosettes or clusters of laths, and (3) large "swallowtails." Intraclastic texture results from the reworking of previously precipitated evaporite. It is recognized by angularity of the clasts, size sorting, and association with carbonate intraclasts. Depositional environment of this texture is interpreted as evaporitic shallow-water lagoons, punctuated by occasional storm events.

Diagenetic textures include cementation, replacement, and evaporite dissolution. Cementation by evaporite was found primarily in carbonate grainstones and is usually poikilotopic. Replacement textures may develop early or late in the diagenetic history of the rocks. Early replacement was found in primary restricted carbonate facies. Original texture (algal laminations, bioturbation, carbonate grains) were usually preserved after replacement. Late-stage replacement was observed in more marine facies, with the original texture not preserved. Isolated nodules of fibrous anhydrite result.

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Exploration Applications of a Transgressive Tidal-Flats Model to Mississippian Midale Carbonates, Eastern Williston Basin

Midale (Mississippian) production was first indicated in 1953 in Saskatchewan, Canada. The unit was initially defined in the subsurface as the carbonate interval between the top of the Frobisher Anhydrite and the base of the Midale Anhydrite. This same nomenclature is used in this paper. In 1953, Midale production was found on the United States side of the Williston basin in Bottineau County, North Dakota. Later exploration extended Midale production westward into Burke County, North Dakota, in 1955. Cumulative production from the Midale is approximately 660 million bbl with 640 million from the Canadian side of the Williston basin.

Initially, hydrocarbon entrapment in the Midale was believed to be controlled by the Mississippian subcrop, with the Burke County production controlled by low-relief structural closure. Petrographic examination of cores and cuttings from the Midale in both Saskatchewan, Canada, and Burke and Bottineau Counties, North Dakota, indicates that production is controlled by facies changes within the unit. Stratigraphic traps are formed by the lateral and vertical changes from grain-supported facies deposited in tidal-channel, subtidal-bar, or beach settings; seals are formed by mud-rich sediments. Use of a transgressive carbonate tidal-flats model best explains current production patterns and indicates substantial potential for additional production in eastern North Dakota and South Dakota.

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Provincial Variations in Cap Rock Source Materials of Gulf Coast Salt Domes

Isotopes of strontium, carbon, and oxygen are used to model hydrocarbon, brine, and meteoric fluid interactions during cap rock evolution. Provincial isotopic variations occur between older salt domes of the east Texas (ETx) and northern Louisiana (NLa) basins and the younger domes of the Texas-Louisiana (Tx-La) coastal basin. ETx and NLa cap rocks exhibit normal, mid-Jurassic seawater values ($^{87}Sr/^{86}Sr = 0.7068$ to 0.7076), very wide $\delta^{13}C$ ranges (-5 to -49 per mil PDB) and $\delta^{18}O$ values (-6 to -11 per mil PDB) that are slightly lighter than Tx-La (-4 to -10 per mil). Tx-La domes yield remarkably high $^{87}Sr/^{86}Sr$ ratios (0.7073 to 0.7100), and their $\delta^{13}C$ values (-8 to -41 per mil) have means which are 5 to 15 per mil heavier than ETx and NLa domes.

Detailed studies of the Hockley dome (Tx-La basin) reveal chemical diversity not recognized in domes farther inland. Anhydrite from the salt stock (mid-Jurassic Louann evaporites) mixed with two separate strontium sources during calcite formation. Calcites near the dome's center formed from an intermediate Sr ratio fluid ($^{87}Sr/^{86}Sr \cong 0.7090$), which, based on heavier than average $\delta^{13}C$ values, was enriched in CO_2 relative to CH_4; peripheral calcites evolved from a high Sr ratio fluid ($^{87}Sr/^{86}Sr \cong 0.7105$) with a lower CO_2/CH_4 ratio.

High $^{87}Sr/^{86}Sr$ ratios in other Tx-La anhydrite cap rocks compared with normal mid-Jurassic type values in ETx and NLa cap rocks suggest that the Tx-La basin was periodically isolated from normal seawater during Louann deposition; radiogenic fluids, derived either from local red beds or from meteoric waters, equilibrated with seawater prior to anhydrite precipitation.

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Seismic Structure and Stratigraphy of Eastern New York–Western Vermont

A reconnaissance grid of 550 mi of Vibroseis data extending from northernmost Vermont to slightly north of Albany, New York, provides a framework for analyzing subsurface structure and stratigraphy of eastern New York and western Vermont.

Regional stratigraphic analysis based on outcrop sections indicates northward and eastward thickening of the Cambrian-Ordovician shelf sequence. Synthetic seismograms from wells in Quebec and southwestern Washington County, New York, document this change in the subsurface and correlate the seismic stratigraphy. Seismic data indicate thickening occurs north of the "Whitehall culmination," an approximately 40-mi long buttress area of Adirondack Grenville basement. Changes in thickness appear to be gradual and not fault controlled.

Foreland thrust systems of New York and Vermont relate via a displacement transfer or lateral ramp zone associated with the "Whitehall culmination." Both thrust systems accomplish final emplacement of metamorphic sheets, deform them, and transport shelf material, which is predominantly shale in New York with increased percentage of carbonates in Vermont. Deflection of several major structural elements illustrates the culmination's buttress effect.

Subsurface structural elements in New York include western graben, central horst block, and eastern fault-zone trends. No analogous trends have been identified in Vermont where predominant faulting is down-to-the-east. Significantly, in southwestern Washington County, New York, preexisting horst blocks do not serve as ramps to deflect thrusts upward. Instead, the Snake Hill-Smiths basin and Schuylerville thrusts shear off the upper sedimentary sequence of the horst and transport it westward.

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Powder River Basin, Wyoming: Structural Development, Hydrocarbon Migration, and Accumulation

The geographical location of oil accumulations in the Powder River basin, Wyoming, is closely related to present basement structure. About 70% of the basin's cumulative oil production has been obtained from only 12 fields or 23% of the total fields. Each major oil field lies in an area of a pronounced positive Bouguer gravity anomaly and in the path of preferred regional hydrocarbon migration. Powder River basin Bouguer gravity anomalies most likely are caused by a combination of present basement structure and density changes in post-Paleozoic sediments; the latter are the result of synsedimentary basement structure and/or related topographic features influencing post-Paleozoic sedimentation. Stratigraphic and structural traps occur in close interrelationships across the basin. Published geochemical data in connection with available regional subsurface data permit mapping the preferred migration paths for oil and gas across the basin. Future discoveries of major hydrocarbon fields will be made in these hydrocarbon migration paths and areas in and around regional positive Bouguer gravity anomalies. Powder River oil field distribution follows general rules known from practically all producing basins but rarely used for lack of sufficient integration of geological and geophysical data. Gas field distribution is expected to be similar to oil field distribution.

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Examples, Causes, and Consequences of Vitrinite Reflectance Suppression in Hydrogen-Rich Organic Matter—a Major Unrecognized Problem

Vitrinite reflectance (R_0) is regarded as one of the most powerful tools available to petroleum organic geochemistry. A major limitation of this method is the severe suppression of R_0 by significant exinite maceral concentrations (hydrogen-rich types I and II kerogen) in association with vitrinite macerals. This effect is not subtle, as R_0 in hydrogen-rich organic matter (OM) is suppressed at least 3-5 times from what the value would be in oxygen-rich OM (type III kerogen), and the effect extends to at least $R_0 = 4.0$. The effect has been attributed to the migration of early generated bitumen from hydrogen-rich OM into the associated vitrinite macerals with the bitumen retarding maturation of vitrinite macerals. However, this explanation for R_0 suppression is inadequate in many cases.

Suppression of R_0 is due more likely to 2 factors: (1) anaerobic conditions at deposition and diagenesis when much greater amounts of hydrogen than "normal" are incorporated into the vitrinite macerals, and (2) hydrogen-rich OM requiring significantly higher burial temperatures to attain the same maturation rank as oxygen-rich OM. Thus, all maturation indices, including R_0 and the threshold of intense hydrocarbon generation (TIHG), are suppressed in hydrogen-rich OM compared to oxygen-rich OM buried under the same conditions.

R_0 values are primarily derived from exinite-rich sediments, leading to the establishment of the R_0 value of 0.6 (± 0.1) for the TIHG in hydrogen-rich OM. Far higher R_0 values are read in oxygen-rich OM at the same regional rank for the TIHG in hydrogen-rich OM. The "oil deadline" has been defined as occurring at $R_0 = 1.35$. There is a sharp decrease in the maximal values of the hydrocarbon coefficient (mg HC/g OC) at $R_0 = 0.9$ to the very low values at $R_0 = 1.35$ in type III OM. This decrease of the hydrocarbon coefficient, previously assumed to result from the thermal destruction of C_{15+} hydrocarbons by carbon-carbon bond breakage, is actually due to a loss of C_{15+} hydrocarbons by intense primary petroleum migration by gaseous solution. This general lack of recognition of R_0 suppression and the necessity of higher burial temperatures to attain the same maturation rank in hydrogen-rich OM compared to oxygen-rich OM has led to a miscalibration of the regional ranks necessary for significant petroleum generation from hydrogen-rich OM and the oil deadline. Examples from the Los Angeles and Williston basins as well as other areas demonstrate these problems.

The consequences have staggering implications to petroleum exploration and to basinal and worldwide petroleum resource estimates.

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Controls on Pennsylvanian Algal-Mound Distribution in Mid-Continent North America

Middle (Desmoinesian) and Upper (Missourian) Pennsylvanian phylloid algal-mound distribution in Missouri, Kansas, and Oklahoma is largely controlled by subtle sea-floor topography. Topographic highs served as loci favoring initiation and continued growth of complexes. Topographic highs controlling mound distribution are the "shelf-edge rise" in northeastern Oklahoma, the "Bourbon arch" in southeastern Kansas, and the " Mine Creek prodeltaic shale buildup" in west-central Missouri.

Outcrop studies document controls on development of these mounds and reveal the potential for development of stacked mounds. This will help exploration for these features in the subsurface to the west.

The shelf-edge rise and Mine Creek prodeltaic shale buildup control the location of the Oologah algal-mound complex and an isolated algal mound in the Pawnee Limestone, respectively. These apparently were positive features only during Middle Pennsylvanian time. In contrast, the Bourbon arch apparently was controlled by basement faulting and remained high for a more-extended period of time. Both Middle and Upper Pennsylvanian algal mounds coincide with the geographic position of the Bourbon arch and result in a stacked-mound complex. Evidence suggesting that the Bourbon arch was a positive feature are (1) thinning of clastics over the feature and (2) change from anoxic, black, fissile, and phosphatic basinal shales to oxygenated, diversely fossiliferous gray shales over the arch.

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Petrology of Middle Jurassic Twin Creek Limestone, Lincoln and Sublette Counties, Southwestern Wyoming