Regional correlations suggest that the Bradford-Balltown and Speechly (B sands of Pennsylvania Geological Survey) sands are better developed in northwestern Pennsylvania, whereas the Bayard through Gantz (D sands of Pennsylvania Geological Survey) sands are better developed in northern and central West Virginia, decreasing also in buildup toward southeastern West Virginia. The oil-bearing sandstones occur in strike trend (north-south) in north-central West Virginia connected by feeder channel sandstones with dip trends (east-west). The interpreted fluvial and tidal channels combine to represent distributary channels that supplied the sands to the barrier islands and delta front. Shoreline shifts, with regression and transgression of the ancient sea, caused corresponding changes in distal-fan accumulations with time.

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Upper Devonian Deposystems of Catskill Delta, West Virginia

The oil and gas reservoir rocks of the Upper Devonian of West Virginia were deposited as shoreline sands along a coastal plain characterized by marine-dominant deltas (Catskill delta complex). The oil-bearing sandstones occur in strike trend (north-south) in north-central West Virginia connected by feeder channel sandstones with dip trends (east-west). In outcrop, the strike-trending sandstones contain occasional marine fossils, are well sorted, and exhibit sedimentary structures that suggest depositional environments ranging from shoreface to tidal delta and back barrier. Channel sandstones with herringbone bedding suggest tidal influence. These beds change to cross-bedding of unidirectional paleoflow origin in upstream fluvial counterparts of red-bed facies. The interpreted fluvial and tidal channels combine to represent distributary channels that supplied the sands to the barrier islands and delta front. Isolith maps show anastomosing belts trending east-west with both vertical and offset stacking. Stream avulsion and stream piracy probably account for lateral shifting of tidally influenced river distributaries. Gridlike patterns of sandstone belts result from the dynamic interference of tidal-fluvial channels with wave-constructed shoreline barrier islands and bars, complicated by onlap and offlap cycles. Subsurface informally named oil and gas sands generally are multiple sandstones. Detailed correlation of individual sand units is difficult, but it supports the interpretation of a combined influence of wave and tidal-fluvial processes.

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Depositional Facies and Diagenetic History of Trenton Limestone in Northern Indiana

Subsurface cores were studied petrographically to determine the facies and diagenetic history of the Trenton Limestone on a regional scale in northern Indiana.

The Trenton Limestone is a yellowish olive-gray fossiliferous limestone, which is replaced by a light-gray dolostone in northern Indiana. Facies composing the Trenton are: (1) bryozoan-echinoderm packstone, (2) bryozoan-echinoderm grainstone, (3) bryozoan packstone to wackestone, (4) lime mudstone, and (5) dolostone. The bryozoan-echinoderm packstone is the major facies. As many as three muddying-upward (packstone to mudstone) sequences occur. Whether the muddying-upward sequences represent regional or local energy conditions is not known. Coarse-grained (1-4 mm) grainstones are typically 1 ft (30 cm) thick, have abrupt bases, and become muddy upward. They are considered storm deposits. Hardgrounds occur throughout the limestone facies, but they are most numerous toward the base. These facies indicate deposition below wave base, interrupted by periods of high energy during storms. Fossiliferous white and gray chert nodules are scattered throughout the unit. Also found in the limestone facies are prevalent stylolites and microstylolites, an indication of chemical compaction.

The dolostone facies consists of coarsely crystalline (0.4 mm) idiotopic dolomite. Rhombs have cloudy centers and thin clear rims. Pyrite is associated with the dolomite. Porosity, found only in the dolostone, is discontinuous and characterized as intercrystalline, vuggy, and moldic. Porous zones are commonly oil stained or have been plugged by poikilotopic selenitic gypsum. Minor amounts of celestite are found as cavity fillings.

The upper Trenton surface has high concentrations of pyrite and phosphate minerals and is interpreted to have been a submarine corrasion surface.

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Cyclic Sedimentation Patterns in Middle Ordovician Trenton Group in Central Pennsylvania

The carbonate facies of the Middle Ordovician Trenton Group show repetitive sequences of micrite, bioclastic limestone, and siliciclastic shale. Five repetitive patterns based on sedimentologic and paleontologic data are present (in ascending order): (1) biosparite, (2) intrabiosparite, (3) pelsparite, (4) micrite, (5) alternating micrite and shale.

The biosparite is of peritidal origin and is overlain by a stromatolitic cap. The average sequence thickness is 30-40 cm (12-16 in.). The intrabiosparite is a fining-upward sequence that grades to pelsparite with a micrite cap (total thickness averages 16 cm or 6 in.). This sequence is indicative of intershoal or shoaling conditions. Overlying the intrabiosparite sequence is pelsparite grading into a micrite cap. The pelsparite averages 8 cm (3 in.) in thickness, and is of shallow sublittoral origin. Highly burrowed micrite (2-6 cm or 0.8-2.4 in. thick), with a hardground cap, indicates periodic exposure. The upper unit is a deeper, sublittoral sequence of alternating kerogenic micrite and siliciclastic shale, ranging in thickness from 20 to 90 cm (7.9 to 35.4 in.). This pattern indicates a deepening of the carbonate shelf into a deeper, anoxic basin below wave base.

These sequences are a result of storm deposition as indicated by shell and intraclast lags, by fining-upward trends, and by abrupt contacts between individual sequences. The series of sequences is a result of the decreasing effects of these storms in the deeper water facies.

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To Drill or Not to Drill: a Synthesis of Experts' Judgments

Petroleum exploration is a costly venture that always involves much uncertainty and many unknown factors. A decision to drill could result in a giant discovery, a modest discovery, or a dry hole.

Using experts' judgments and the available information on a geologic formation, we estimate the volume of recoverable oil in a given reservoir by a method called the analytic hierarchy process (AHP).

AHP is a mathematically based modeling tool that allows an analyst to derive priorities for a set of alternatives by simple pairwise comparisons. The setting of priorities involves the solution of an eigenvalue problem in the inverse matrix of pairwise comparisons. The factors are grouped on different levels, forming a chain or hierarchy, whereby the lower level elements can be compared in pairwise matrices with respect to the next level. A process of weighting yields the overall priorities for any level, but in particular for those in the lowest level.

The factors affecting the decision are assigned numerical values using judgments of geologists and petroleum engineers. The probabilities of the outcomes are determined and the "expected value" of each decision is computed. The results of the study indicate that, when good judgments are used, one can obtain an excellent estimate of the volume of recoverable oil in a reservoir in a very short time and with the least amount of physical and financial resources.

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Deposition in Anoxic Taconic Foreland Basin, Late Middle Ordovician, New York

The Taconic foreland basin resulted from a collision between the North American craton and the Ammonoosuc arc. The basin is positioned between a broad carbonate shelf on the west and the clastic arc terrane. In the downslope direction, basin deposits changed from distal shelf carbonates (Trenton Limestone), to coeval interbedded hemipelagic black shales and calcilutites on the slope (Dolgeville Formation and Utica Shale), to