by the location of the structure on the western flank of a series of gravity and magnetic positives. High resolution seismic reflection profiles, gravity, and magnetic-intensity data indicate the structure continues under Lake Ontario into Canada. The geophysical anomalies also suggest the fault has a northwest branch near Attica, NY, which may account for the moderate seismicity between Attica and Buffalo. The mafic intrusions associated with the fault probably indicate fracture zones in the Precambrian basement. The potential of these fracture zones for generating earthquakes in the area is of major concern in nuclear power plant site location.

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Computer Enhancement of Old Well Logs Suggests New Plays in New York State

There has been oil and gas exploration in New York State since the 1860s, and geophysical well logs have been recorded and deposited in state well information repositories since the 1930s. These logs contain a wealth of information that has largely been overlooked in the recently intensified search for new petroleum and natural gas reserves. The majority of old wells were drilled by small companies using numerous logging contractors. There were a wide variety of logging tools and an astonishing number of both vertical and horizontal scales employed. Often log interpretation was minimal. Regional exploration has been very difficult because of this general lack of well-to-well uniformity, as displayed by the various logs.

The Department of Geology at Syracuse University has compiled a data base of digitized computer processable well logs for a large part of central New York State. These logs have been standardized to a uniform lithology response and uniform scales for optimum correlation, porosity computation, and lithology evaluation. Evaluation of these corrected logs suggests that reservoirs which were either overlooked or considered uneconomic when the wells were drilled could, under today's economic conditions, provide extensive new and potentially profitable gas reserves.

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Newburg Porous Carbonate Zone of Lockport Group (Middle Silurian), Northeastern Ohio

The Ohio driller's "Newburg sand" or Newburg zone lies in a stratigraphic position approximately equivalent to part of the Guelph Formation of the Lockport Group (i.e., at the top of the Lockport and just below the Salina A Unit of the Cayugan). The Newburg is characterized by a higher overall porosity than the rest of the Lockport. The porous dolomite extends downward as much as 80 to 100 ft (25 to 30 m) below the top of the Lockport. More than one interval may be porous. Stratigraphically, the base of the Newburg zone parallels the top of the Lockport regardless of whether the Lockport is thick or thin. The thickening of the Lockport occurs locally, especially where there has been a thickening of the lower unit of that group, the Gasport Formation. The thick Newburg zone in the upper Lockport tends to overlie thick Gasport and may reflect reef or reefoid buildup in the Guelph Formation. Mapping of the Lockport surface shows that local structure is caused by the thickening. The small local structures can be detected several hundred feet up-section because of the draping effect of overlying beds on the more rigid Lockport dolomites. Structural mapping of the top of the Lockport or of the top of the Devonian "Big Lime" (Columbus Limestone) may reveal areas of potentially productive thickening of the Newburg zone.

The Newburg usually contains salt water. Accumulation of commercial gas is controlled both by local structural features and by changes in the relative percent porosity in the Newburg and consequent change in the total porosity feet. Examination of production records from four Newburg gas pools in Summit County, Ohio, shows that the largest and longest yields come from wells located high on structure.

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Depositional Environments of Silurian Whirlpool Sandstone (Medina) in Western New York

The Whirlpool Sandstone (Medina Group), quartzose, white, clean, well-rounded, and well-sorted, is the basal Silurian unit in western New York. Its source was the Queenston delta some distance to the southeast. Sedimentary structures indicate that deposition occurred in a beach-shore face environment. Fragmented phosphatic marine fossils are found throughout the sandstone.

Erosion of Upper Ordovician sediments in western New York was minimal and involved only the uppermost green (reduced) portion of the Queenston Shale, which supplied lags of flat, green shale pebbles to the Whirlpool Sandstone. Soft sediment deformation and burrowing in the Queenston substrate (the transitional contact between the red Queenston Shale and red Grimsby Sandstone [Silurian] in Rochester, New York, immediately to the east of the area of Whirlpool deposition) suggest a short period of nondeposition or possibly mild erosion following the deposition of the Queenston Shale. Thus, the Ordovician-Silurian boundary in western New York is essentially conformable and signified only by an abrupt influx of clean quartz sand.

Petrographic analysis shows that the Whirlpool is a second or multicycle sandstone composed primarily of quartz grains originally derived from igneous and metamorphic terranes with only a minor sedimentary component. Because the sandstone is cemented by quartz overgrowths, usually in an advanced stage of development, primary porosity is reduced and the overall porosity of the Whirlpool Sandstone is low (less than 5%). Higher porosities are attributed to the development of secondary moldic porosity caused by dissolution of detrital quartz grains and their original calcite cement. These zones of higher porosity are the most prolific natural gas producing areas in the Whirlpool Sandstone when hydraulic fracturing is used.

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Computer Mapping of Quality Data for Coals in West Virginia—An Aid in Matching a Specific Coal Grade to a Specific End Use

In 1907, the first studies of the state's coal reserves were initiated as part of the West Virginia Geological and Economic Survey's statewide geological mapping program. Since then, extensive work has been conducted to map and characterize the state's 62 minable seams. This effort has shown that the coals exhibit a wide diversity of quality, and this diversity provides the coal user a choice of grades to meet specifications for varied applications. Approximately 6,000 coal samples have been analyzed and a computer data base of coal-quality information is now maintained and continues to grow. An extensive coal-quality mapping project makes this information convenient to use.

The objective of coal-quality mapping is to produce a series of contour maps showing the variations in coal quality for the most important seams. Parameters being mapped include sulfur, ash, Btu, fuel ratio, Hardgrove grindability, volatile matter, fixed carbon, and kilocalories per kilogram. This type of information is extremely valuable for someone interested in buying, selling, evaluating, or developing West Virginia coal.

The maps are computer-generated at a scale of 1:500,000 and show the trends of coal-quality parameters for individual seams. The maps are supplemented by a computer program that searches the data base and generates a printout of geographical areas within the state where coal has been sampled that meets the desired specifications. These computer techniques go a long way in helping the user to find target areas within the state to match the right coal to the desired end use.

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Depositional Patterns of a Silurian Shelf Sand in Central Appalachians

The Keefer Sandstone in the subsurface of West Virginia and Kentucky, where it produces small volumes of natural gas, was deposited on the western shelf of the Appalachian basin. The formation is a dolomitic quartzarenite and quartzwacke and ranges from 13 to 50 ft (4 to 15 m) thick. As interpreted from four cores and isopach and lithofacies maps, the sand was transported by longshore currents from a southeastern source area and laid down in a variety of environments. In Kentucky, Keefer deposition was on a wave-dominated coast. The rocks are characterized by physical sedimentary structures and textures which developed under high-energy conditions, and the formation is divided into shoreface and foreshore facies. In adjacent West Virginia, however, Keefer deposition occurred offshore in water near the depth of wave base, swept out onto the shelf by storm-generated currents. Sedimentary structures and textures indicate a lower energy environment, bioturbation is more common, and the formation contains a greater amount of shale. The isopach map shows two linear tracts of thick sand in this offshore facies that may represent a coalescence of subtidal bars on the shelf. Between major sand bodies, the Keefer becomes appreciably thinner and is interbedded with fossiliferous dolomite. In the basin center of West Virginia, sandstone is replaced by shale. Thus, the geographical distribution of lithofacies shows a transition of shelf environments within a blanket sandstone. In all cores, regardless of depositional facies, the sandstone displays evidence of aggrading sedimentation; sedimentation exceeded subsidence, and the sand body built upward into shallower water.

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A Potential Method for Predicting Coal-Mine Floor Heave

Floor heave or deformation of the mine floor into the mine opening is a problem which has plagued coal mines in this country and others. This paper describes the problem as it was manifested in two coal mines located in eastern Illinois, and reports the results of a U.S. Bureau of Mines-sponsored study conducted by the University of Missouri-Rolla. The ultimate objective of the study was to develop a procedure that could be used to define a potential floor heave problem during the exploration phase of mine design—before initiation of production mining.

Floor heave within the mines did not occur with uniform intensity throughout each mine or even within mine panels. Floor deformation was often deep-seated and involved two subfloor lithologies. A wide variation in measured strength for each of the subcoal lithologies was recorded during laboratory testing; underclay triaxial compressive strength best correlated with underclay natural water content. The severely heaved areas were not located in the deepest or shallowest portions of the mines. Severe floor heave occurred in areas of thicker (greater than 6 ft, 2 m) underclay. Severe floor heave occurred at those sites where the natural water contents of the underclay and claystone were highest. The presence of swelling montmorillonite clay did not seem to be a major cause of floor heave. Triaxial compressive strengths measured from underclay samples from severely heaved sites were not the lowest values measured. A bearing capacity model developed by Vesic was modified so that a "heave factor" could be calculated using only that information obtainable from exploration core borings; use of the "heave factor" would have predicted floor heave at the study sites where severe heave occurred.

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Porosity Pods in Whirlpool Sandstone (Lower Silurian), Chautauqua County, New York

The Lower Silurian Whirlpool Sandstone is an important natural gas producing formation in western New York State. The Whirlpool outcrops in Niagara County, and is present in the subsurface in portions of Erie and Chautauqua Counties as well as adjacent areas in Pennsylvania.

In gas-productive areas of Chautauqua County, the Whirlpool usually ranges in thickness from 5 to 20 ft (2 to 6 m). Porosity as measured by the compensated formation density logging tool is typically 4 to 8%. Gas saturation is normally in the 20 to 65% range. The permeability of the rock is limited. Occasional localized areas of sharply greater porosity, permeability, and hydrocarbon saturation ("porosity pods") occur within the larger volume of tight, low permeability Whirlpool. The producing characteristics of the porosity pods are such that gas recovery may increase by a factor of 3 to 5 as compared with an average well. The economic benefits of drilling into these features are therefore substantial.

The presence of a porosity pod is sometimes indicated by an unusually large natural flow of gas from a well prior to stimulation. It can also be detected by certain characteristic indications on the density, resistivity, and neutron logs. Whirlpool porosity pods appear to be mappable and may be sufficiently large to provide 4 or 5 well locations. Recognition of their characteristics can be a significant aid to natural gas exploration in Chautauqua County, New York, and possibly elsewhere in western New York and northwestern Pennsylvania.

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Fracture Analysis of Eastern Ohio

Selected shale characterization exploration parameters defined from Eastern Gas Shales Project investigations to identify highly potential Devonian shale exploration areas were used by Tetra Tech, Inc., to select drilling sites in the Appalachian, Michigan, and Illinois basins. The characterization parameters used for site selection were: (1) thickness of the shales, (2) type of organic matter, (3) percent of organic carbon, (4) thermal maturation, and (5) the presence of secondary natural-fracture porosity. The fracture analysis investigation over eastern Ohio using remote sensing techniques describes a method which should prove useful for locating secondary natural-fracture porosity reservoirs in regions of horizontal or slightly dipping strata.

Detailed field checks over a pilot area in Hocking County, Ohio, indicated that approximately 50% of mapped photo linears were not fracture related. A hypothetical interpretive technique developed to identify only the fracture-related photo linears was used in interpreting and mapping fractures over the entire area of eastern Ohio.

Statistical analysis of this data was necessary due to the large volume of data. A computer program was developed that analytically distinguished the regional and local components of the data. Computer-generated first and second-degree and corresponding residual maps showed areas of eastern Ohio where fracture density exceeded or was less than the regional norm.