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Seismic and Stratigraphic Models in Exploration for Devonian Oriskany Sandstone Structural Targets, Eastern Overthrust Belt

Seismic and stratigraphic models resulted from a successful 5-yr seismic and exploration drilling program focusing on the Devonian Oriskany Sandstone in north-central West Virginia. Disciplines applied to the geologic evaluation of the area include analyses of Landsat, synthetic-aperture radar imagery, outcrop, seismic, geophysical well logs, engineering, and reservoir fluid data.

Prospectiveness of the Oriskany, a key producer of natural gas in the northern Appalachian basin, is dependent on three basic factors: (1) the stratigraphic delineation of trends of matrix porosity lenses developed within the main body of the sandstone, (2) seismic definition of anticlinal and related fault closures, and (3) drilling of fracture-prone structural positions to achieve fracture-enhanced reservoirs.

Stratigraphically, the Oriskany Sandstone (Ulsterian Series) is a tight, regionally extensive, transgressive, marine sandstone. The unit ranges in thickness from zero at its pinchout edges on the north, south, and west, to a maximum thickness of 250 ft (76 m) within the study area. Depths vary structurally from 7,000 to 10,000 ft (2,100 to 3,050 m).

Structurally, the area of interest falls between the intraplateau structural front and the Allegheny Front, wherein seismic structural targets are predominantly thrusted cores of concentric folds and imbricately thrusted blocks. Listric faults originate from decollement zones below the Oriskany. Major shear zones are most effectively identified by satellite imagery.

Local recoverable gas reserves from the Oriskany range from 1.5 to 5 bcf per well, with an attained average of 2.25 bcf per well. Wells penetrating fracture-enhanced Oriskany exhibit high rates of natural flow. Reservoir engineering data are effective in defining the extent of fracture envelopes. Tighter sections require acidizing and hydraulic fracturing.

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Structural Influences on Facies Distribution in Silurian Medina Group of Northwestern New York

The gas-bearing sandstones of the Medina Group in western New York are the basal Whirlpool Sandstone and the Grimsby Sandstone. Toward the west, these are separated by the Cabot Head Shale and the Manitoulin Limestone. Farther east, the Grimsby overlies and interfingers with the Whirlpool. The reservoir is underlain by the Ordovician Queenston Shale and is capped by shales of the Silurian Clinton Group. The depositional sequence of the Medina Group may be summarized as a marine transgression toward the east that yielded the Whirlpool, Cabot Head, and Manitoulin formations, followed by westward progradation of the deltaic Grimsby formation.

Aspects of internal stratigraphy noted in subsurface studies may be correlated with anomalies in units much higher in the Silurian section and with disturbances on the Silurian-Devonian unconformity. Repetitive adjustments of large-scale structural features are inferred. These changes mark the transition from the westward-facing depositional front of the Ordovician to development of the isolated basins that dominated the Silurian Period.

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Elliptical "Morphotectonic" Features on Landsat Imagery in Southwestern New York, Northwestern Pennsylvania, and Northeastern Ohio

Circular to elliptical patterns are expressed in many diverse ways and scales on earth's surface. Some are clearly of endogenic origin, whereas others are proved to be astroblemes. Many are still of indeterminate origin, but hypotheses have been offered to explain some of them. The three features discussed here are manifested by morphologic and tonal features on Landsat imagery. Other anomalous areas on the same images are more subtle and some may be artifacts of the viewer's perception.

The Lake Chautauqua-Kinzua composite feature in New York and Pennsylvania is expressed by an inner ring of 29 km (18 mi) (long axis) and fragmented concentric bands extending up to 48 km (30 mi) from its center to include a curved part of the Allegheny River in the Kinzua reservoir area (Pennsylvania). It is bisected by the northeast-southwest Chautauqua anticline and fault zone (decollement), locus of the Bass Islands-Akron dolomite oil and gas play.

The Pymatuning reservoir, inverted teardrop feature of 34 km (21 mi) north-south length in Pennsylvania, is defined by impounded water and drainage courses bounding a topographically positive area. A slight anticlinal flexure is coaxial with the ellipse. A deep well found gas in the upper Gatesburg Formation.

A nearly circular ring of 9.75 km (6 mi) diameter near New Lyme, Ashtabula County, Ohio, is seen as a tonal design on a specially enhanced composite false-color Landsat image. Drilling is currently active in the vicinity of the anomaly.

Elliptical patterns may reflect deep deformation, differential compaction over buried basement hills, salt tectonics, filled negative areas, impact phenomena, or various other conditions that cause differences in surface configurations, surficial material, and moisture content. Also, the possibility exists that random cultural or natural effects are visually organized by the viewer. Some drainage patterns, which catch the eye, may be given more importance than is warranted. Investigation of such features, especially by seismic surveys and basement drill tests, is suggested for oil and gas exploration in this area.

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Trenton Strata in Western Illinois Basin, Brown and Schuyler Counties, Illinois

Trenton strata in the western Illinois basin are very good prospects for oil exploration. Much drilling has been done in the area but, as yet, no producing wells have been completed. Oil stains and some tars have been found in some samples from most wells.

The Trenton in the area of Brown and Schuyler Counties is a fine-grained limestone that underlies the Maquoketa Shale at an average depth of 800 ft (244 m). Because of its position near the edge of the Illinois basin, the stratigraphy varies considerably and inconsistencies are present in most samples viewed.

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Lateral Ramps, Basement Block Faults, and Igneous Intrusions in Central Appalachian Valley and Ridge Province

Radar images of the central Appalachian Valley and Ridge province show abrupt changes in wavelengths of folds along strike. These abrupt cross-structure terminations probably reflect lateral ramps that connect decollements at different depths. Field studies and seismic reflection surveys appear to support the radar observations. The locations of large lateral ramps may be controlled by cross-strike basement block faulting. Four large lateral ramps were identified; three of these show the shallower block to be to the southwest, bringing the master decollements closer to the present ground surface in that direction. The southernmost of the lateral ramps in the central Appalachians occurs at the Roanoke reentrant where several major decollements intersect the surface.

Several smaller lateral ramps complicate the larger picture because not all of them climb section to the southwest. For example, a smaller lateral ramp just north of Mathias, West Virginia, whose westward extension may truncate the Petersburg lineament, climbs section to the northeast. Extensions of this ramp both eastward and westward from Mathias appear on the radar data as lineaments and fold discontinuities.

A large lateral ramp that climbs section toward the north is present in Highland County, Virginia. This ramp and large ramps along the Susquehanna River in Pennsylvania and at the Pennsylvania-Maryland-West Virginia border coincide with belts of igneous intrusions. Cross-strike basement block faults and lateral ramps may have represented conduits for magmas to reach the surface.