[PS]Is It Time to Revisit the Eastern Overthrust Belt of New York and New England?*

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Abstract

In the early 1980s, Columbia Gas Company began a significant exploration of the Eastern Overthrust Belt in eastern New York and western New England. The result of this effort were two test wells, one in New York and one in Vermont. No further work occurred. Explora-tion in nearby Quebec, in pursuit of both carbonates (St. Flavien field) and shale gas (Utica/Lorraine), has identified quality reservoirs in the para-autochthonous zone of the Taconic overthrust. The existence of reservoir rocks to the north begs the question: is it time to revisit the Eastern Overthrust Belt in New York and New England?

The Taconic overthrust belt is defined by a significant continental-scale thrust (Logan's Line) and a number of regional thrusts. This suture sepa-rates the highly deformed sediments of the Taconic Sequence with the normal Tippecanoe and Sauk sequences so prevalent in the AppalachianBasin. Evidence provided by Gerald Friedman and others suggests that the rocks of the Taconic sequence are thermally overmature, but the rocks below the thrust are likely similar to those identified in Quebec and further west in New York. Potential reservoir rocks include the Ordovician Utica Shale, the Trenton and Black River carbonates and erosional remnants in the Sauk Sequence. Even with limited data, several compelling play concepts can be developed.

Though the risk is high, the pursuit may be lucrative. This area is within the eastern gas market and producers can expect a sales price premium over NYMEX.

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Is it Time to Revisit the Eastern Overthrust Belt of New York and New England?

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ABSTRACT: In the early 1980s, Columbia Gas Company began a significant exploration of the Eastern Overthrust Belt in eastern New York and western New England. The result of this effort were two test wells, one in New York and one in Vermont. No further work occurred. Exploration in nearby Quebec, in pursuit of both carbonates (St. Flavien field) and shale gas (Utica/Lorraine), has identified quality reservoirs in the para -autochthonous zone of the Taconic overthrust. The existence of reservoir rocks to the north begs the question: is it time to revisit the Eastern Overthrust Belt in New York and New England?

The Taconic overthrust belt is defined by a significant continental-scale thrust (Logan's Line) and a number of regional thrusts. This suture separates the highly deformed sediments of the Taconic Sequence with the normal Tippecanoe and Sauk sequences so prevalent in the Appalachian Basin. Evidence provided by Gerald Friedman and others suggests that the rocks of the Taconic sequence are thermally overmature, but the rocks below the thrust are likely similar to those identified in Quebec and further west in New York. Potential reservoir rocks include the Ordovician Utica Shale, the Trenton and Black River carbonates and erosional remnants in the Sauk Sequence. Even with limited data, several compelling play concepts can be developed.

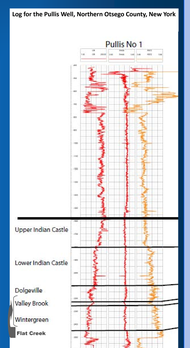
Though the risk is high, the pursuit may be lucrative. This area is within the eastern gas market and producers can expect a sales price premium over NYMEX.

BACKGROUND: The Taconic region of New York and New England is a complex geologic puzzle that has confounded geologists since the early days of the profession. The great James Hall-Ebenezer Emmons controversy surrounded each man's interpretation of the rocks of the Taconic region. Emmons proposed the name "Taconic system" to represent older rocks that had been pushed above the younger rocks of the Ordovician.

RESERVOIR ROCKS:

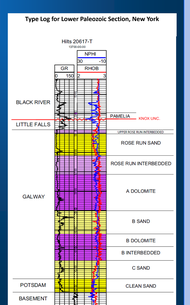
Utica Shale. One of the oldest and most widespread black shales is the Ordovician-age Utica Shale. It was deposited very broadly across the Appalachian Basin and into Ontario and covers thousands of square miles. In New York the Utica is found in outcrop along the west and southsoutheast sides of the Adirondack Mountains and is well exposed in several locals along the northern margin of the Allegany Plateau. The Utica is a massive, fossiliferous, organic-rich, thermally mature, black to gray-black shale deposited in a subsiding trough that generally trended north-south. Source rock for the organic-rich black shale was supplied from the eroding Taconic highlands to the east. As the deep marine trough was filled in, the deposition of the lower members of the group onlapped westward over the carbonate platform. The westward migration was periodic, as well effected in the presence of multiple facies intervals, which are bounded by unconformities or condensed beds (Lehmann 1995). Each unit represents a pulse of subsidence and subsequent sedimentation in the basin, and all have several similarities. Each interval onlaps argillaceous limestone, condensed interval, and each appears to record a localized deepening event. The overlying unit has shifted westward with respect to the underlying unit. The Flat Creek Member is the basal unit of the Utica and sits unconformably on the Trenton Formation. It is a transgressive deep basinal calcareous shale that represents the first mud flux from the erosion of the Taconian Island Arc to the east (current orientation). The middle member of the Utica is the Dolgeville, a ribbon layered carbonate/shale unit. The uppermost member of the Utica is the Indian Castle, a transgressive, fissile shale with some calcareous interbeds. The upper units are more monotonous and fissile while the lower units are more blocky with impure limestone beds (Martin et al., 2008). The Utica is thermally-mature with conodont alteration indices approaching 5 in Eastern New York. The nearest well, N.L. Industries 75-NY-2 near Saratoga Springs, NY (see map to right), thermal maturity measurements have a VRo equivalent of 4 and TOC as high as 2%.

In the Finnegan well, the rock resembles the upper member (Indian Castle) rather than the expected lowermost Flat Creek. TOC's are relatively low (less than 1.4%) which again resembles the upper Indian Castle. The blocky limestone has been identified as the Steuben (Nyahay, 2010). This resembles logs in central New York rather than those in eastern New York.



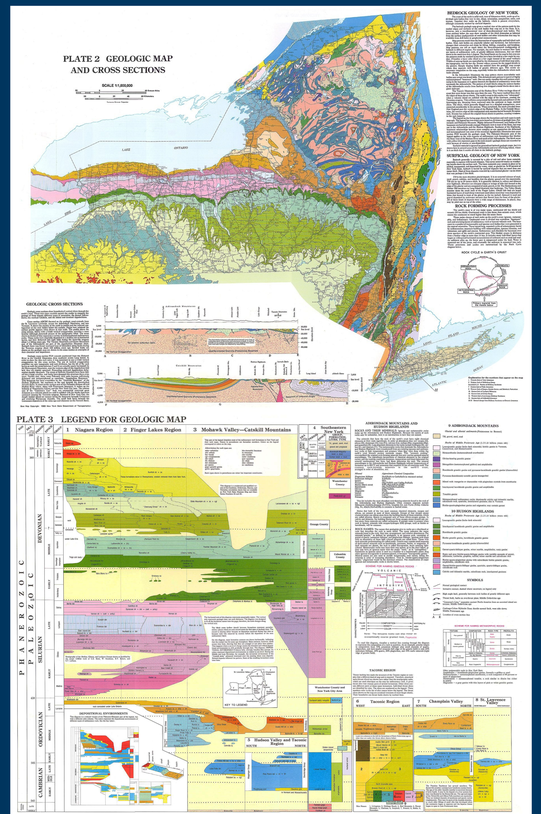
Little Falls Formation. According to work done by the New York State Museum, the Little Falls is primarily composed of dolomite, but has several sandstone or dolomitic sandstone beds near the base. These represent a transition into the underlying Galway Formation.

In the Finnegan well, it is the basal sandy carbonate that offers the best reservoir potential (Billman, 2010). "The interbedded interval at the top marks a transition from the sandstone of the underlying Rose Run and the dolomite of the overlying Little Falls Formation" (Slater, 2010). "This interval can be porous" and can be considered the basal Little Falls Formation but just as easily included as the uppermost part of the Galway Formation (Slater, 2010).



Galway Formation. The Upper Cambrian Galway was deposited in a shallow marine shelf environment. In western New York, the New York State Museum Reservoir Characterization Group has divided the Galway Formation into seven members based on the abundance of sand and dolomite in each. "The upper Galway consists of the Rose Run Upper Interbedded, Rose Run Clean Sandstone, and Rose Run Lower Interbedded. These units consist primarily of pure sandstone beds with some sandy dolomite. The lower Galway has been divided into the A Dolomite, B Sand, B Dolomite, B Interbedded and C Sand. These units contain more dolomite and dolomitic sandstone. There are few beds that do not contain any dolomite; therefore units are called sands where they are predominantly sandstone, and dolomites where they are predominantly dolomite." (Smith et al., 2010), In New York, the productive unit is at the top of the Galway (called the Theresa Sandstone in western New York).
In the Finnegan well, the Galway is also a mix of sands and sandy dolomite. There is not enough well control in this area to do direct correlation with the western part of the state. Billman (2010) identifies possible reservoir-quality rock at approximately 6,900'. This is not located near the unconformity, as is the "Rose Run" of western New York but it does resemble a "Rose Run" sand.

CONCLUSION: Though the Finnegan well creates more questions than answers, the existence of reservoir rock offers promise. Future work includes correlating the Finnegan well with wells in New York, Vermont, and Quebec to develop a depositional model in the Taconic area.



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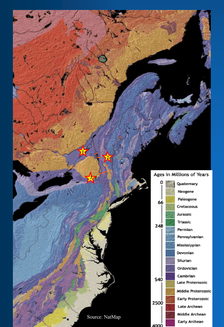
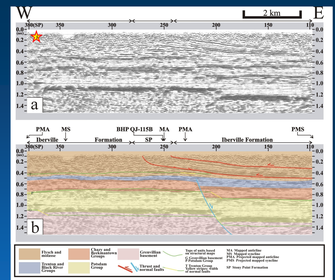
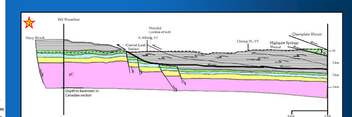
Some Interpretative Examples of the Structure of the Taconic Region New York, Vermont, and Quebec

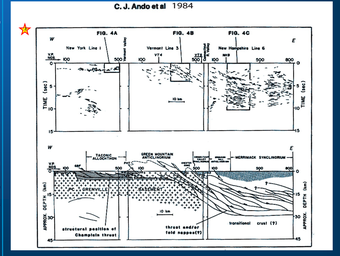




East-West Seismic Profile Across Lac Mississiquoi, the Northern Extension of Lake Champlain in Quebec. (a) Uninterpreted; (b) Interpreted. Note in (b) the presence of overthrust sheets (curving red lines) overlying and truncating the normal fault (curving blue line). (Interpretation by Stephan Séjourné from Wallach, 2004)

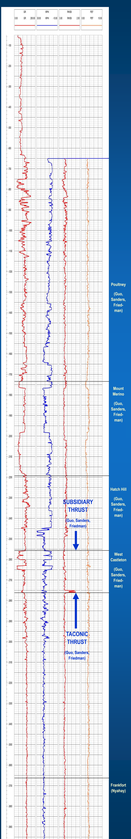


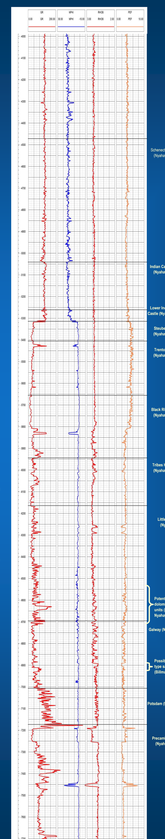
This cross section was developed by the Vermont Geological Survey. The autochthonous domain is shown on the west side of x section while the west shows the Taconic Allochthon. Normal faults west of S. Alburg, VT dropped down basement to ~ 1820 meters (~6000'). Thickest repeated shales east side of x section are approximately 1.8 km. The westernmost thrust is lowest in sequence of west directed thrusts in the shales (Becker, 2009)



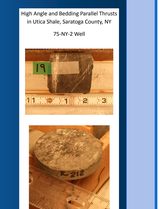
This is an interpretation of three lines collected during the COCORP program. The ruled pattern represents mostly lower Paleozoic shelf carbonates, clastics, and synorogenic flysch. (Ando et al., 1984)

Data from the Finnegan Well (SHORT API 18370-00)





New York Utica Shale Test, September 2009



High Angle and Bedding Parallel Thrusts in Utica Shale, Saratoga County, NY

75-NY-2 Well

(Hanson, et al., 2010)

Thin Sections From the Bethlehem Steel Well, Erie County, New York

Porosity changes rapidly in "Rose Run" type rocks.

4088.5' - 1.5x

4162.5' - 1.5x

(Smith et al., 2010)

Total Organic Content vs. Depth (samples taken from cuttings)