**A QUICK LOOK AT NEW YORK'S UNCONVENTIONAL GAS SHALES: SUMMARY AND ROAD LOG**

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The purpose of this trip is to take a look at the organic rich shales that are driving unconventional shale exploration in New York. These shales are the Devonian Marcellus and the Ordovician Utica. Over the last fifteen years Ver Straeten has worked on the Marcellus Formation and Brett, Baird, Mitchell, Jacobi, and Joy have worked on the Utica Group to determine new and improved correlations. These shales have joined the list of names such as the Barnett, Antrim, and Fayetteville to rejuvenate interest in organic rich shales for natural gas exploration

Technology has been able to make these highly impermeable shales that have long been considered nuisance gas in the past highly profitable. This then begs the question why are these shales highly productive? In order to answer this shales are being studied intensely across the nation. Of all the shales being studied the Barnett shale is the one everyone looks to use as the model. The Barnett shale exploration was inspired by the Eastern Gas Shale Project in the Appalachian Basin that took place during the late seventies and early nineteen eighties (Steward 2007).

The Utica Group is been divided into three formations, the Upper and Lower Indian Castle, the Dolgeville and the Flat Creek. The Dolgeville is coeval with the Rust and Steuben of the lower Trenton Group. The Flat Creek is coeval with the Denley of the Lower Trenton Group.

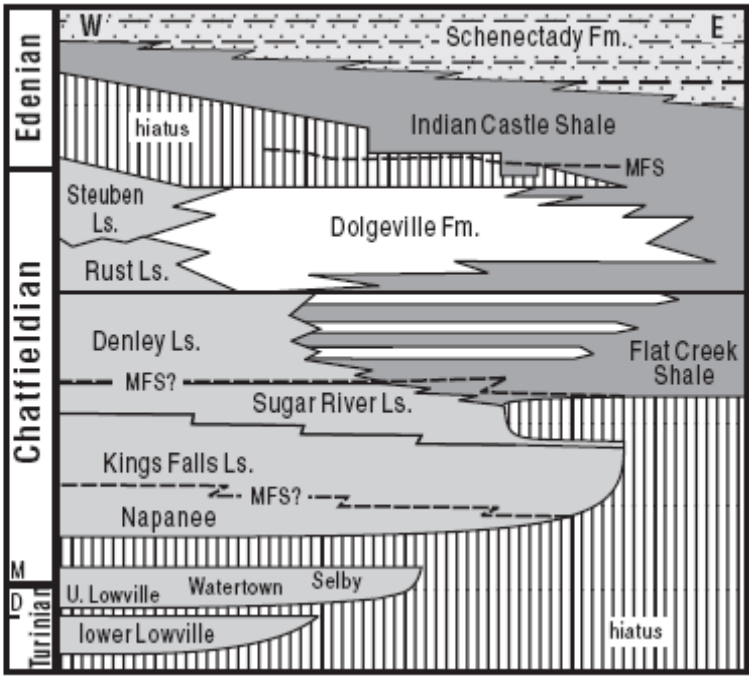


**Figure 1. Utica Chronostratigraphy (Joy, et al. 2000)**

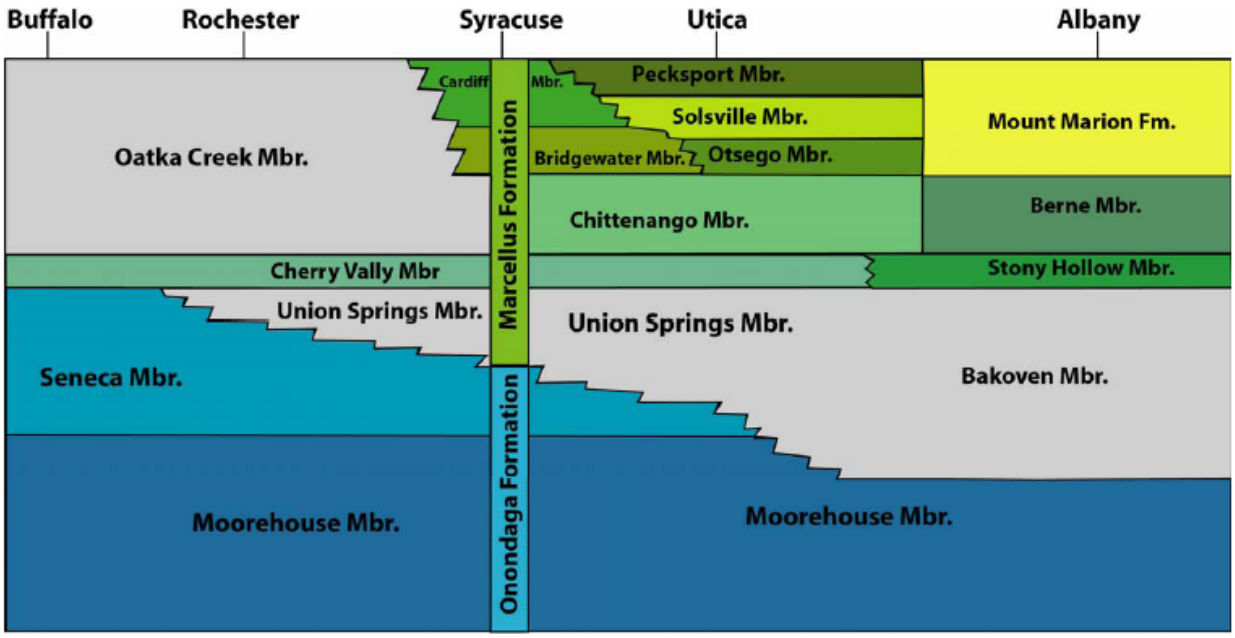


**Figure 2. Marcellus Stratigraphy (Rickard 1975)**

The Marcellus members we are interested in are the Chittenango, the Cherry Valley, and the Union Springs. Interestingly enough, the patterns of the Barnett, Lower Marcellus and Utica are similar. In the Barnett, the upper and lower shale units are separated by the Forestburgh Limestone. In the Lower Marcellus, the Chittenango, and the Union Springs are separated by the Cherry Valley Limestone. In the Utica Group, the Indian Castle and Flat Creek are separated by the ribbon limestones of the Dolgeville.

The deepening upward sequence that is evident within the Trenton Group and the overlying Utica Group was interpreted as a product of lithospheric flexure caused by the loading of the Laureantian margin during the Taconic Orogeny (Jacobi and Mitchell 2002). Numerous normal faults occur in the region and many underwent significant displacement during the deposition of the Trenton and Utica Groups as a consequence of the attempted subduction of the Laurentian margin (Jacobi and Mitchell 2002). Differential rates of subsidence across the region produced accommodation rates that increased by an order of magnitude from west to east. High rates of siliciclastic sediment supply and even higher subsidence rates resulted in thick deeper water succession to the eastern part of the study region (Joy, et al. 2000). The coeval Trenton Group succession in the west formed under conditions of moderate sediment supply and lower subsidence rates resulting in net shallowing in the upper succession (Joy, et al. 2000).

Baird and Brett (2002) noticed that both the Ordovician Indian Castle and Devonian Marcellus developed as onlap disconformities in a similar western cratonward side of a synorogenic foreland basin. These units record the transgressive drowning of a carbonate shelf with the ensuing establishment of a stratified dysoxic to anoxic bottom conditions.

The Dolgeville Formation formed as a short duration pulse of calciturbidites (Merthens 1988). The Dolgeville formation records a turbidite deposition on a subtidal slope well below fair weather base (Baird and Brett, 2002). The presumed source of the turbiditic carbonate was from the carbonate shelf to the north and west, storm energy as well as seismic activity disturbed sediments in the in the upper slope triggering gradient current and density flows( Baird and Brett 2002).

The Flat Creek Formation was formed as the basin deepened to the east, suggesting that differential tectonic subsidence was the dominant mechanism creating accommodation space (Joy, et al. 2000).

The Indian Castle Formation is divided into two units, the lower Indian Castle and the Upper Indian Castle separated by the Honey Hill disconformity (Baird & Brett 2002). It is overlain by the Schenectady and Frankfort formations and underlain by the carbonates of the Trenton to the west and the Dolgeville Formation to the east. The lower Indian Castle corresponds to the Climacograptus (Diplacanthograptus) spiniferous assemblage zone of graptolites and possibly to the lowermost Geniculograptus Pygmaeus Zone. The lower Indian Castle is hard blocky to sheety black shale with bundles of tabular impure limestone (Baird & Brett 2002). The upper Indian Castle corresponds to the Geniculograptus Pygmaeus Zone and is composed of fissile to platy shale that lack limestone beds (Baird and Brett 2002).

The Dolgeville Formation is distinctive unit that is composed of closely spaced rhythmic dark gray shale and calcisiltic ribbon limestones. The Dolgeville is overlain by the Thruway unconformity that bevel the soft sediment slumps and fault scars of the Dolgeville and is overlain further to the west by the onlapping upper Indian Castile and is underlain by the Flat Creek to the east of the Little Falls fault and lower Trenton Group carbonates west of the fault. The Dolgeville corresponds to the time range of Orthograptus ruedemmani assemblage zone of graptolites with only a very narrow segment of the basal Climacograptus (Diplacanthograptus) spiniferous assemblage near its top (Goldman, et al. 1994). Baird and Brett have traced the Dolgeville as far east as the Hoffman's Fault. Goldman, et al. 1994 describe the Dolgeville as a thin to medium bedded tabular silty black micrite and interbedded black shales. In subsurface cores at the NYSGS core repository the Dolgeville will show a white weathering color that distinguishes them from the Flat Creek below and Indian Castle above.

The Flat Creek Formation rest disconformably over the Sugar River of the Trenton Group (Joy, et al. 2000) and is gradationally overlain by the Dolgeville Formation (Goldman et al. 1994). The Flat Creek corresponds to the the Corynoides Americanus graptolite Zone assemblage to 8 meters below the base of the Dolegville where is corresponds to the Orthograptus ruedemmani assemblage zone (Goldman et al. 1994). The Flat Creek is a calcareous, laminated black shale with interbedded calcilutites.

The Chittenango is a jet black, very fissile shale, with no limestone beds as in the Union Springs. It is noncalcareous until the basal section near the top of the Cherry Valley.

The Cherry Valley is a black to brown argillaceous limestone that gives a petroleum odor when broken. It is divisible into two massive parts separated by a shaley limestone or shale containing limestone nodules, and pyrite.

The Union Springs is the basal Marcellus which is a black, pyritiferous, fissile, calcareous shale with concretions, and thin limestone layers.

## ROAD LOG

| Cummulative mi. | Miles from last Point. | |
|---|---|---|
| 0.0 | 0.0 | Start at Exit 27 of NYS Thruway |
| 0.1 | 0.1 | Take right and proceed to NYS RT 5S. |
| 1.0 | 0.9 | At the light take a left onto RT 5S and proceed to Stop1 |

**Stop 1. South Chuctanunda Creek and Rt. 5S Roadcut**

This outcrop features the Flat Creek Formation. This shale can be further subdivided into a black fissile shale overlying a dark gray calcareous mudstone with black shale interbeds. A north trending vein displays a nearly

vertical fault that might show possible lateral slip, with horizontal slickensides next to a clastic dike (Neptunian?) that strikes north. Could this be evidence of seismic activity that triggered the turbiditic flows of the Dolgeville? Vertical calcite veins cut the roadcut and strike nearly E-W. The roadcut as seen from the east shows a synclinal structure. Bentonite beds are can be easily picked out by their rusty colored weathering. The creek shows these E-W vertical calcite veins that show extensional horsetail features, breccias and possible small pull aparts. In the black fissile shale there is evidence of thrust faulting. Before Baird and Brett (2002), this outcrop could have been interpreted as Utica Shale undivided, but with the Dolgeville extended as far east as Hoffman's fault, this make this shale a good candidate to be the Flat Creek shale. Collections of graptolites would confirm this more correctly.

| Cummulative mi. | Miles from last Point. | |
|---|---|---|
| 2.0 | 1.0 | Turn right on to Rt. 5s going east to Rt. 30. Bear right on to Rt. 30 south then quickly turn left on to the New York State Thruway (90) entrance ramp. Proceed west on Thruway to Exit 29A Little Falls |
| 35.3 | 33.3 | Dolgeville outcrop on both sides of the NYS Thruway (90) |
| 39.3 | 4.0 | Exit 29A, proceed to toll both. Black Canyon outcrop of Indian Castile to the south on ramps going east. |
| 39.8 | 0.5 | Turn left on road leading to Rt. 5S |
| 40.1 | 0.3 | Turn right on Rt. 5S and go west to Paradise Road. |
| 42.8 | 2.7 | Turn left on to Paradise Road and proceed south. |
| 43.3 | 0.5 | Turn left and park by gated fence. |

**Stop 2. Paradise Road NYS Thruway Road Cut**

This roadcut displays Lower Indian Castile Formation overlying the Dolgeville Formation separated by the Thruway unconformity. To the eastern end we see a normal fault, a splay of the Little Falls fault. Weathered bentonite beds outline the dark gray Lower Indian Castile showing the blocky limestone beds and indurated shales overlying the alternating tabular beds of dark gray to black limestone and shale with fold trains that have a west vergence. Following the weathered bentonite beds small sags can be seen in the Lower Indian Castile. A fault at the eastern end displays the Upper Indian Castile down dropped to the east against the Lower Indian Castile and Dolgeville formations. Notice the lack of weathered bentonite beds in the Upper Indian Castile. The Upper Indian Castile is a dark gray fissile shale. These laminations can be seen from the perch of the farm field we are standing on.

| Cummulative mi. | Miles from last Point. | |
|---|---|---|
| | | Turn around and proceed north to Rt 5 |
| 43.8 | 0.5 | Turn right on to Rt. 5S and go east to Rt. 80 in Fort Plain |
| 58.6 | 14.8 | At the light turn right onto Rt. 80 going south. |
| 59.6 | 1.0 | Turn right into the parking area for the Town of Minden court and road maintenance. |

**Stop 3. Otsquago Creek Outcrop**

This creek cut shows the contact between the Dolgeville tabular alternating beds of limestone and shale overlying the Flat Creek black fissile shale . Calcite filled veins cut both the Flat Creek and Dolgeville Formations. The veins trend N 110° - 130° E and N 20 E forming a brick work pattern. The density of veins decreases away either side suggesting some type of fault activity. Beds dipping toward each other suggest a synclinal feature just around the bend of the creek.

| Cummulative mi. | Miles from last Point. | |
|---|---|---|
| 59.6 | 0.0 | Leave the Town of Minden Court an d Town garage and turn right on to Rt. 80 going south |
| 62.6 | 3.0 | Stop at first outcrop just below the crest of the hill |

**Stop 4. Hallsville Road Outcrop**

At this out crop we will examine the well laminated fissile gray to dark gray Upper Indian Castile. This lamination might be considered papery. This outcrop shows one tabular limestone bed that has a rusty weathering color outlining it. Walking further up the section we see just Upper Indian Castile with no tabular limestone beds.

| Cummulative mi. | Miles from last Point. | |
|---|---|---|
| 62.6 | 0.0 | Continue south on Rt. 80 to the junction of Rt. 20 |
| 64.6 | 2.0 | More Upper Indian Castile, fissile gray shale |
| 75.1 | 10.5 | Turn left onto Rt. 20 going east |
| 81.2 | 6.1 | Cherry Valley Limestone on the north side of Rt. 20 |
| 84.7 | 3.5 | Turn right on to Otsego County Rt. 54 and park next to outcrop. |

**Stop 5. Otsego County Rt. 54 or old Chestnut street outcrop**

At this classic outcrop we will see the lower part of the Chittenango now renamed to the Oakta creek (VerStraten, et al. 1994). Underlying the Oakta Creek is the Cherry Valley Limestone, and the uppermost section of Union Springs. Talus covers intensely deformed sections with the Union springs that exhibit a small thrust fault that ramps up through the Cherry Valley (Bosworth, 1984). The Union Springs member is the richest organic shale in New York, TOC range can be as high as sixteen percent.

**REFERENCES CITED**

Baird, G.C., and Brett, C.E., 2002, Indian Castile: late synorogenic siliciclastic succession in an evoloving Middle to Late Ordovician foreland basin, eastern New York State. Physics and Chemistry of the Earth v. 27, p. 203-230.

Bosworth, W., 1984, Foreland deformation in the Appalachian Plateau, Central New York: the role of small-scale detachment structures in regional overthrusting. Journal of Structural Geology, v.6, p. 73-81

Fisher, D.W., 1979, Folding in the Foreland, Middle Ordovician Dolgeville Facies, Mohawk Valley. Geology, v.7, p. 455-459.

Goldman, D., Mitchell, C.E, Bergstrom, S,M, Delano, J.W., and Tice, S., 1994, K-Bentonite and graptolite biostratigaraphy in the Middle Ordovician of New York State and Quebec: A new chronstratigraphic model. Palaios, v. 9, p. 124-143.

Jacobi, R.D., and Mitchell, C.E., 2002, Geodynamical Interpretation of a major unconformity in the Taconic Foredeep: Slide scar or onlap unconformity. Physics and Chemistry of the Earth, v. 27, Joy, M.P., Mitchell, C.E., and Adhya, S., 2000, Evidence of a tectonically driven sequence succession in the Middle Ordovician Taconic Foredeep. Geology, v. 28, p.727-730.

Joy, M.P., 1996, Evolution of the Facies Mosaic in the Taconic Foredeep Basin, Central Mohawk Valley, NY: A Graphic Correlation Approach. unpublished MA thesis, SUNY Buffalo, Buffalo, NY, 101 pp.

Mehrtens, C.J., 1988, Bioclastic turbidites in the Trenton Limestone: Significance and criteria for recognition. In: Keith, B.D., (Ed.), The Trenton Group (Upper Ordovician Series) of eastern North America; deposition, diagenesis, and petroleum. American Association of Petroleum Geologists Studies in Geology, 29, p. 87-112

Rickard, L.V., and Zenger,D.H., 1964, Stratigraphy and Paleontology of the Richfield Springs and Cooperstown Quadrangles, New York. New York State Museum Bulletin 396, 101 pp.,map

Steward, D.B., 2007, The Barnett Shale Play: Phoneix of the Fort Worth Basin a History. The Fort Worth Geological Society and The North Texas Geological Society, 202 pp.

Ver Straten, C.A, Griffing, D.H., and Brett, C.E., 1994, The lower part of the Middle Devonian Marcellus Shale, Central to Western New York State: Stratigraphy and depositional History. New York State Geological Association Guidebook. pp. 271-321.