

## Basic Geology Information

Contributed by Dave Hutchison  
Monday, 15 September 2008

Dave H gives us some background on what's under our feet!

I have a PhD in geology and taught several aspects of geology at Hartwick College for 32 years. Probably I understand geology more than folks who have chosen other areas of study. When I see comments that do not make good geologic sense, I "stick my nose into the comments" and try to correct them- as most teachers would do. There are several other geologists in the area who can help answer questions. Hartwick College, State University College Oneonta, State University at Binghamton, Cornell University, Syracuse University, Hamilton College, Colgate University and others have a Department of Geology, or Department of Environmental and Geological Sciences, or Departments of Earth Sciences, etc.

I am happy to help people better understand the geology of the area and the current gas drilling situation as I understand it. That is easy. However, there are so many unknowns at this time it is difficult to be specific. Like almost every one else, I just "got on board" the issue this past June. In the past 90 days I have attended four or five sessions and have read as much as I could about the issue. It has been very interesting and I am glad so many people have become interested in the issue. First some "basics" on the local geology follow. (Sorry, what do you expect from a teacher?)

### Basic Geology Information

Bedrock is the "stuff" that extends from the surface of the earth for many miles (the depth varies from place to place) to the mantle below, however, it does exclude the zone of weathered material which we called soil, river deposits called alluvium and glacial debris which may be a few feet thick or several hundreds of feet thick.

You can see outcrops of bedrock for several hundred feet on the road between Oneonta and Franklin, NY near the Otsego - Delaware County line at the top of Franklin Mountain (they are reddish in color here), and at several localities along I-88 (both toward Albany and Binghamton) where road construction has cut into the bedrock exposing it along the highway (generally the bedrock is grey or black in color here). In all these outcrops of bedrock you are seeing sediment that was deposited approximately 375 million years ago. The grains of clay, silt and sand have been compacted and cemented together (with calcite, silica and iron oxide) to make them "strong enough" so that you can take pieces out of the outcrop and use them for paving stone, walls, or break them with a hammer. (It is illegal and dangerous to stop and collect on Highways). If you do choose to break the law be careful and watch for falling rocks and make sure your car is off the highway.

In these outcrops you can see the horizontal planes of sediment deposition formed in Devonian time (called bedding planes) in these outcrops (some may be inches thick and other appear to be feet thick). Also you can see channels of erosion (eroded in Devonian time and refilled in Devonian time). You might also see ripples in the rock (a few inches wide and an inch or two high) formed in Devonian time.

You can also see fractures (usually vertical planes of breakage) in these outcrops of bedrock. In our area the fractures were produced when the continent of "Africa" collided with (what we now call) North America. This took place over millions of years. (Africa and Europe are now moving away and forming the Atlantic Ocean). Late in this "collision" or in a more recent collision, rocks of the entire east coast were folded (to form the Appalachian Mountains) and rocks in our area were gently uplifted several thousand feet above sea level. This occurred over millions of years. As you know, when rocks are uplifted above sea level rivers erode them and form deep valleys. Uplift and erosion in this area formed the Catskill Mountains and in the valleys of the Appalachian Plateaus in the "Southern Tier". The fractures you see in the rocks most likely formed at the time of the uplifting of the rocks. These fractures (or the potential to fracture) continue at depth. Faulting (or movement along fractures) is minimal in this area.

The Marcellus shale and the Utica shale are part of this stack of beds (or bedrock) which is several thousand feet thick in the southern tier.

Just recently (in the past million years) glaciers moved into the area and melted away four times. Melt water from the glaciers deposited sand and gravels in our area and is responsible for the many gravel deposits. For the moment we are not really interested in the glacial deposits.

### Information about the Local Gas Deposits

As you know gas (and oil too) and water are found in the pore spaces and fractures of (mainly) sedimentary rocks. Fractures in igneous and metamorphic rocks may contain water (and rarely petroleum) - generally speaking these two rock types are unimportant for petroleum. Let's forget about them now.

The Marcellus "play" is all about the slightly dipping (one or two degree dip to the SW) of the Devonian age ( 360 -408 million years ago) sedimentary rocks. As the formation called the Marcellus shale is older than the rocks in the Oneonta area (and because the rocks are slightly dipping SW) the rocks of the Marcellus shale are several thousand feet below us. There is also another even older and deeper formation of rocks called the Utica shale (Ordovician in age 438 - 505 million years old).

Both if these formations have a high Total Organic Content (TOC) and have been buried deep enough so that they have experience temperatures high enough for the TOC to mature (forming gas or oil). Consequently, the product the gas drillers want is there. As shale has very low permeability (the ability for fluid to pass through) it needs to be fractured to permit the gas to "flow". You know the rest of the story about the need for horizontal drilling, propitiatory fluids to assist hydrofracking, the one to three million gallons of water needed to hydrofrack the wells and the millions of gallons of "produced" as it returns to the surface, etc.

#### A few Concerns and Suggestions

1. Although gas drilling companies are required to case the upper (500' to 1,000' ??) of the wells to protect the fresh waster aquifer while drilling, who is going to provide the funds to monitor and repair the casing in the next decades? NY State should set up an ongoing fund (financed by the gas companies now) for use in the future.
2. How often will the wells (which may have a duration of 20 or 30 years) need to be hydrofracked? Some wells may need to be refracked many times. How will this effect the land owner? Does the land owner understand this? NY State should have limits on this.
3. NY State should limit the number of wells drilled per year in a give drilling unit (or in a larger area). The Susquehanna River Basin Commission may impose a limitation on the amount of water withdrawal permitted, but NY State should look at this from the land owners (and neighbors) point of view.
4. NY State DEC must acquire the necessary funding to hire and train adequate technical and legal personnel immediately. Expenses for this should be passed on to the gas companies.
5. NY State must insist on knowing and making public all chemicals used (and their known health and safety hazards) in the drilling, fracking and transportation of gas in NY State.
6. Produced water must be closely controlled and monitored by NY State and records made public.
7. NY State should make every possible attempt to require "closed drilling systems" to contain drilling mud and fracking water in closed tanks rather than in open pits.
8. NY State should closely monitor weight of tanker trucks and trucks moving equipment. A fund should be established (financed by the gas companies) to repair roads, bridges, etc. This should extend for several decades as the wells will be serviced and refracked many times (after the initial drilling and hydrofracking) requiring continued use by trucks.
9. In populated area noise abatement of drilling areas should be required by local governments (with help from the State of NY State).