Is It Likely That Fracking the Organic-Rich Utica Shale Beneath Bowling Green, OH Would Be Environmentally Safe ?

Dr. Robert K. Vincent
Prof. Emeritus, Dept. of Geology
Bowling Green State University

- How does fracking of organic shales differ from traditional oil and gas drilling methods.
- How and why fracking of organic shales is performed.
- How far above the organic shale fracking target
  - do stimulated hydraulic fractures extend upward and how far?
  - do natural hydraulic fractures that could be charged with fracking fluids extend upward?
  - what percentage probabilities exist for those two types of fractures?
- What organic shale exists beneath the city of Bowling Green, OH and at what depths?
- What effect do the old wells in and around the town have on fracking considerations?
- Is it likely that oil shale under Bowling Green, OH could be fracked in an environmentally safe way?

The Organization of This Talk

- Traditional drilling methods create vertical holes down to good reservoir rocks (rocks with good porosity, which creates high amounts of storage for oil and gas, and good permeability, which permits easy flow of oil and gas through the rock)
  - Includes sandstones, siltstones, and limestones
- Fracking methods create vertical holes to an organic shale (which has high porosity but low permeability and lots of oil and gas), a horizontal hole in the organic shale, and explosive plus high hydraulic pressure with fluids that contain chemicals and sand to open cracks that are kept open by the sand
  - Only in organic shales (rarer than other sedimentary rocks because they occur in deeper ocean waters, because they are at the end of a sea level regression series and beginning of a transgression series)

How Does Fracking of Organic Shales Differ from Traditional Oil/Gas Exploration?

- An April, 2012 refereed paper entitled "Hydraulic Fractures: How far can they go?" by Richard J. Davies et al, Marine and Petroleum Geology, an Elsivier web publication, briefly explains the fracking process of organic shales at the following URL: http://ac.els-cdn.com/S0264817212000852/1-s2.0-S0264817212000852-main.pdf?_tid=4be80f74-f2d0-11e2-b4ca-00000aab0f6b&acdnat=1374498901_f80495268b921462a1e2530364cea120
- The next three slides come from that paper

How Far Above the Organic Shale Toward the Surface Are Cracks Caused by the Fracking Process?

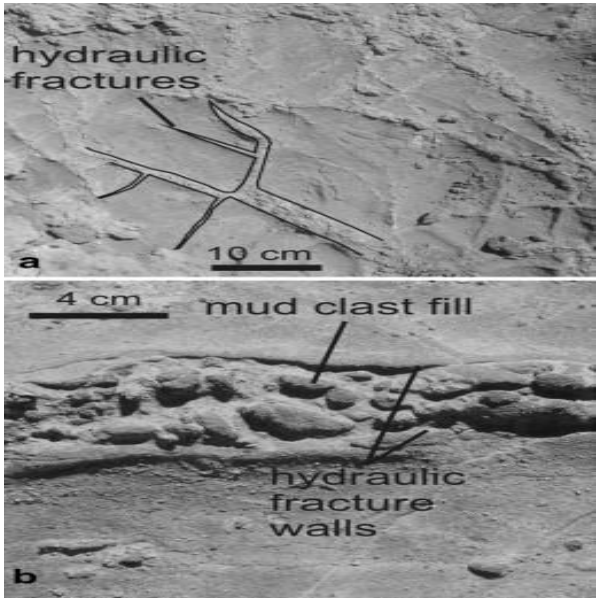

Figure 1 (a) Examples of natural hydraulic fractures in shale (b) close-up of a natural hydraulic fracture filled with shale clasts (both examples from onshore Azerbaijan).

Richard J. Davies , Simon A. Mathias , Jennifer Moss , Steinar Hustoft , Leo Newport

Hydraulic fractures: How far can they go?

Marine and Petroleum Geology Volume 37, Issue 1 2012 1 - 6

http://dx.doi.org/10.1016/j.marpetgeo.2012.04.001

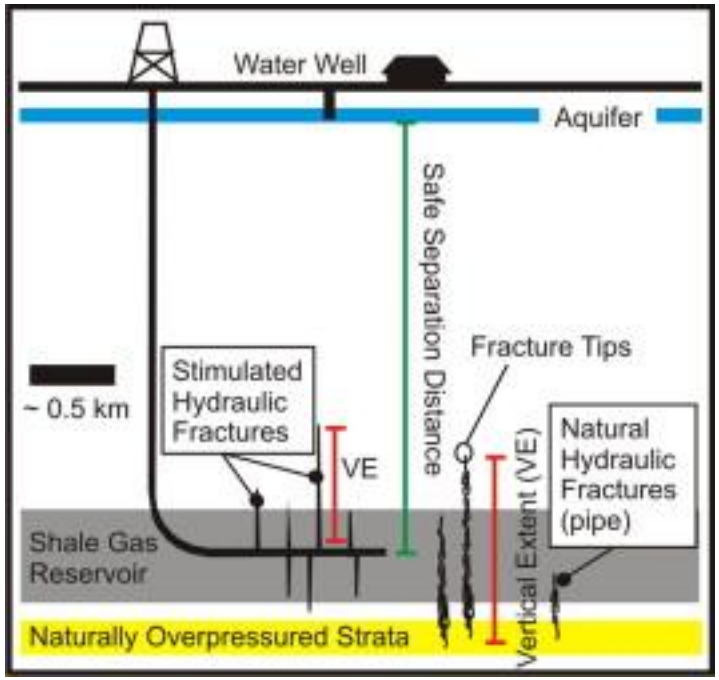

Figure 2 Schematic diagram showing stimulated hydraulic fractures within a shale gas reservoir, natural hydraulic fractures initiated at a naturally overpressured reservoir, the vertical extent (VE) of hydraulic fractures reported here and the safe separat...

Richard J. Davies , Simon A. Mathias , Jennifer Moss , Steinar Hustoft , Leo Newport

Hydraulic fractures: How far can they go?

Marine and Petroleum Geology Volume 37, Issue 1 2012 1 - 6

http://dx.doi.org/10.1016/j.marpetgeo.2012.04.001

- The maximum reported height of an upward propagating, stimulated hydraulic fracture from several thousand fracturing operations in the Marcellus, Barnett, Woodford, Eagle Ford and Niobrara shale (USA) is ~588 m (1,911 Ft).
  - The probability of stimulated fractures extending at least 350 m (1,138 ft.) upward from the fracked shale is ~ 1%.
- Of the 1170 natural hydraulic fracture pipes imaged with three-dimensional seismic data offshore of West Africa and mid-Norway, the maximum vertical distance of natural fractures extends ~1,106 m (3,595 ft).
  - The probability of natural fractures extending at least 350m (1,138 ft.) upward from the naturally hydrologically fractured shale is ~ 33%.

Conclusions About Stimulated and Natural Fracture Extension Above the Hydrological Fracturing Depth

- My conclusion of these results is that the least conservative distance between the fracking depth and the aquifer depth should be 1,138 ft., or the depth below surface of the fracking should be (1,138 + x) ft., where x is the depth in ft. of the aquifer supplying groundwater.
  - Implies that if aquifer depth is 100 ft., fracking depth from the surface by the least conservative estimate should be at least at 1,238 ft. depth or greater.
- A moderate conservative estimate of the distance between fracking depth and aquifer depth, based on this same paper, was made by The Gaurdian, U.K. publication in their April 25, 2012 issue is 600 m (slightly more than the longest stimulated crack of 588 m in the Davies et al paper from the same month), or 1,950 ft.
  - Implies that fracking depth should be at least 2,050 ft. depth or greater if the aquifer is 100 ft. below the surface'
- A fully conservative estimate can be made from Davies quote in that same press article as follows: "Based on our observations, we believe that it may be prudent to adopt a minimum vertical separation distance for stimulated fracturing in shale reservoirs. Such a distance should be set by regulators; our study shows that for new exploration areas where there is no existing data, it should be significantly in excess of 0.6km".

Conclusions That Could Be Made from That April, 2012 Paper

- The Marcellus Shale, which is younger than the Ordovician-Aged Utica Shale, does not exist below the city of Bowling Green, OH, which sits atop the Cincinnati Arch
  - Surrounded by the Illinois, Michigan, and Appalachian Basins on the W, N, and E.
- Based on my perusal of some old well logs, the top of the Utica Shale is about 1,000 ft-1,250 ft beneath the city, or about 900-1,150 ft. below a 100 ft. depth aquifer.

What Organic Shales Exist Below Bowling Green, OH, and At What Depths?

- The 900-1,150 ft. depth of the Utica Shale below an assumed 100 ft. deep aquifer would be 1000-1,250 ft. below surface of the city of Bowling Green, Ohio
  - Mostly fails the 1,238 ft. depth below surface of even the least conservative estimate for keeping a 100-ft. deep aquifer safe
  - Fails the moderately conservative 2,050 ft. minimum depth for the fracked shale for the same 100-ft.-depth aquifer based on the longest natural fracture found off-shore in the Davies et al study
  - Greatly fails (by a factor of more than 3) the fully conservative minimum depth for the fracked shale from Davies quote of "significantly in excess of" that moderately conservative 2,050 ft. minimum depth, which I would take to be about 3,600 ft below the surface for the fracked shale, to protect a 100 ft. deep aquifer from the fracking process.
- There are many unplugged old wells in and around Bowling Green city limits that extend from within 6 feet of the surface, through the the Utica Shale into the Trenton/Black River Formation that could bring fracking fluids to the surface almost anywhere those unplugged wells occur.

How Does That Compare With the Least, Moderately, and Fully Conservative Estimates?

- Fracking of the Utica Shale beneath the city of Bowling Green,OH would most likely result in environmental damage to aquifers beneath the city, and if the fully conservative estimate is correct, could be expected to leak fracking fluids to the surface.
- The greatest worry is likely to be escape of methane into the air, which could become an explosion hazard to buildings and would help accelerate global warming.
  - I don’t know of a single company with experience in fracking organic shales that would risk losing their product (natural gas) to the air and additionally be liable for environmental damage in the city limits of Bowling Green, OH; the business model fails.
- The answer to the question in the title is : “No.”
- However, traditional oil and gas drilling in our area should be encouraged because there is still a lot of oil that can be found along the Bowling Green Fault in Ohio and Michigan, judging from the past, particularly if new sections of the BG Fault are drilled where drilling has not yet been done.

Bottom Line Conclusions