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Shale Reservoirs, do they work, will they spread?

Andy May / November 13, 2018

By Andy May

Popular accounts of shale oil and gas reservoirs are often riddled with errors and, even when technically correct, often misleading. As a shale petrophysicist, retired from Devon Energy, I thought I would try and explain, in a non-technical way, how these reservoirs work and why they have been so successful.

We often hear the assertion that shale reservoirs deplete so fast that they cannot be economically viable over the long term and that shale development is a losing “house-of-cards” proposition that will ultimately fail. This [slide presentation](#) by Jeremy Leggett is just one example of many. Proponents of solar, wind and other alternative energy sources love to spread such stories, see [here](#) for an example. Be careful, not everything in these links is true and they are quite selective in their “facts.” Generally, these nay-sayers rely heavily

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The environmental claims

Many of the environmental claims about shale gas and oil are about methane leaks, because methane is a strong greenhouse gas. However, methane degrades quickly in the environment to CO₂ and water by way of a couple of intermediate reactions. According to the [EPA](#), total industry emissions of methane in the U.S. are only 31% of the total in 2016, and they are [declining](#) rapidly as technology improves. The largest source of methane emissions are natural wetlands, bacteria in shallow coal seams and termites according to the same EPA source.

We often hear the claim that ground water is contaminated by hydraulic fracturing, yet no verified claims of this have been found in numerous studies. Ground water can be contaminated if a well's steel casing and cement fails or fluids are spilled on the surface, but these problems are uncommon, local and can be fixed ([EPA](#)). Millions of wells have been drilled in the United States and mechanical failures, affecting the ground water, have occurred in very few wells. The rate of mechanical failures in hydraulically fractured wells in the Denver-Julesburg (DJ) Basin of Colorado, has been estimated at 0.06% to 0.15% and none were due to the fracking process itself (Sherwood, et al. 2016). For a discussion of why this is so rare see this [post](#) by Barry Stevens. By far, the most common source of methane in ground water is biogenic gas created by bacteria in shallow coal or the soil and in the ground water itself ([EPA](#)). Sherwood, et al. note that water wells drilled in the DJ basin in the 1880s produced flammable gas at 400 meters. At that time there were no oil and gas developments in the area.

The business viability claims

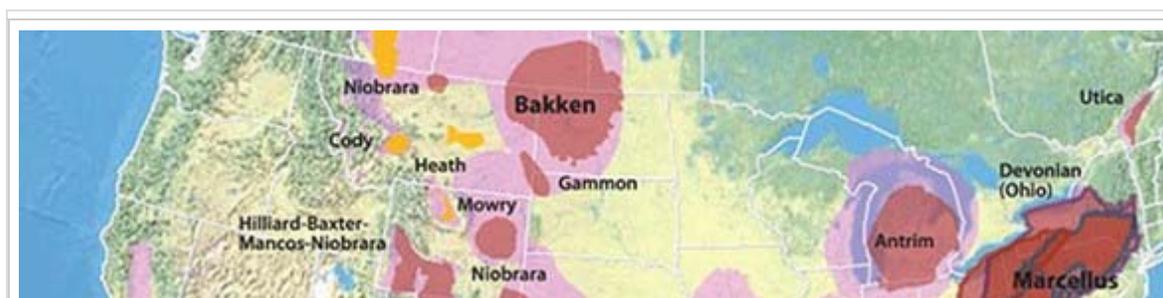
Pardon my bluntness, but claims that shale gas and oil production is not economically viable are obvious nonsense. Forty-four percent of [Devon Energy](#)'s reserves, at the end of 2017, were in the Barnett Shale alone. Devon Energy is my old employer and, full disclosure, I still own stock in the company. Thirty-two percent of Devon's production is from the Barnett and Eagle Ford shales. They have drilled over 5,000 wells into the Barnett Shale since 2002, yet their operating cash flow is up 61% in 2017 and they have raised their quarterly dividend, even though they have been in a tough price environment.

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many companies are created and only a few of the best thrive. How many people remember [Apollo Computers](#) or [Digital Equipment Corporation](#)? Judging the microcomputer industry based on these companies, or an average of all microcomputer companies in the 1980s, one could easily conclude that microcomputers have no future, but they would be wrong.

Shale is attractive because it is relatively low-risk from an exploration standpoint, but tough because each reservoir is different and the learning curve to make a development profitable is steep and very expensive. The Barnett Shale (see Figure 1 for location) play took years and millions of dollars to figure out. [George Mitchell](#) and Mitchell Energy began to work the Barnett Shale problem in [1981](#) and it did not bear fruit until the early 2000s. [Continental Resources](#) drilled many unsuccessful wells into the Bakken in North Dakota before they figured out how to drill a profitable one, and the Bakken is now one of the largest onshore oil fields in the United States, with more than [40 billion barrels](#) of oil-in-place. The [USGS estimates](#) that there are over 7 billion barrels of technically recoverable oil in the field. Continental Resources is a very successful company and 60% of its production is from the Bakken Shale.

Overall the shale oil and gas business, at least in the United States, is successful. The USGS estimates that the production of natural gas from shale increased [nineteen times](#) in the ten years between 2001 and 2011, in spite of the recession in 2008. Shale production is the main reason the United States is now exporting both natural gas and oil and currently is the largest oil producing country in the world according to [David Middleton](#) and the [U.S. EIA](#). It is also one of the principal reasons why oil and gas prices fell after 2008. But this post is not about the economic viability of shale gas and oil, it is about the rocks and how we get oil and gas out of them.



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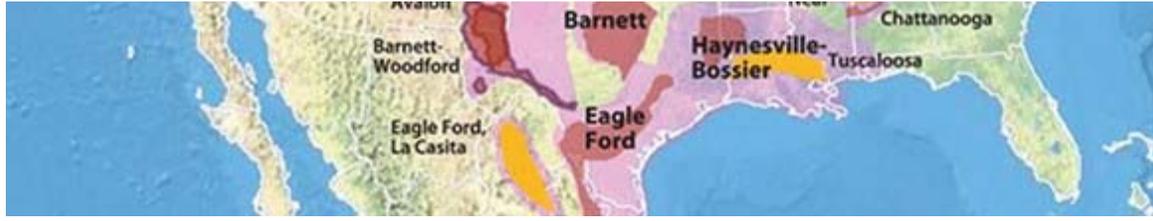
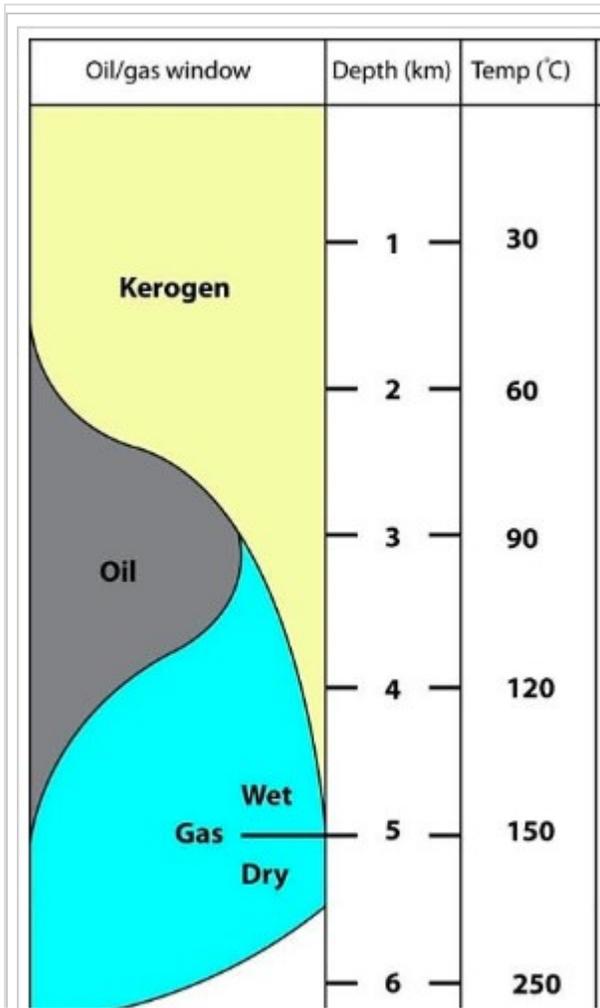


Figure 1. Major shale oil and gas plays in the United States. Source [EIA](#).

The basics of a shale gas and oil reservoir

A successful shale reservoir is composed of a rich oil or gas source rock, with an adjacent brittle unit that can be hydraulically fractured (“fracked”). The horizontal completion wells will be placed in or very near the brittle rock which is the conduit through which the oil and gas will be produced.



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David Middleton in WUWT, [here](#).

A shale's defining characteristic is that it is very thinly bedded and fissile, it can also be defined as a fine-grained detrital sedimentary rock. When we say shale in the context of shale oil and gas reservoirs, a more proper term might be mudstone, which is any rock composed mostly of grains smaller than silt size (smaller than four microns across). Here we will use the term shale, but we are referring to rocks with very small grain sizes. We expect, but do not require, that many of the grains will be clay minerals, like illite, kaolinite or chlorite. Typically, oil or gas source rocks are shales or fine-grained carbonates that contain more than 1% organic matter. Once the organic matter is heated to an appropriate temperature and placed under enough pressure it begins to turn into oil or natural gas, depending upon the type of organic matter and the temperature and pressure (see Figure 2).

The generated oil and gas both have a lower density than the organic matter, often called kerogen, that produced it, so once formed it cracks the rock holding it and leaves void space in the kerogen. Shales and fine-grained carbonate source rocks are almost completely impermeable to fluids until this happens (see Figure 3). The native intergranular permeability, from core analysis (Luffel and Guidry 1992) (Luffel, Hopkins and Schettler, SPE 26633 1993), in these reservoirs is around 300 nanoDarcys (10^{-9}), conventional reservoirs have permeabilities of over 10^{-4} Darcys. Once the escaping hydrocarbons and other geological forces crack (or naturally fracture) the shale the overall permeability goes up one to two orders of magnitude, from around 0.0003 milliDarcys to 0.009 to 0.02 milliDarcys according to [perforation inflow test analyses](#) (Rahman, Pooladi-Darvish and Mattar 2005). The level of natural fracturing is an important controlling factor in hydrocarbon producibility (Curtis 2002).

The whole rock unit will not contain organic matter, so one of two things happens once the oil and gas are generated.



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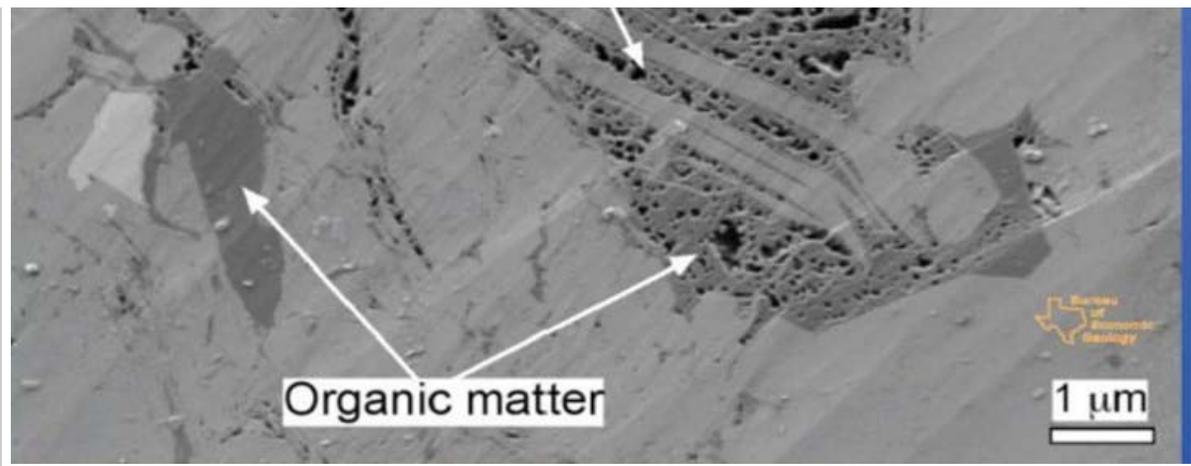


Figure 3. SEM photo of a source rock/shale reservoir. Microfractures also exist in this rock but cannot be seen in in this photo. The kerogen has numerous small pores. The kerogen is hydrophobic (repels water) so the pores are filled almost exclusively with hydrocarbons. Photo credit: Kitty Milliken and Robert Reed, Texas BEG (Bureau of Economic Geology).

If the source rock is adjacent to a permeable water-filled rock layer, such as a sandstone, the oil and gas will migrate into the permeable bed and, since it is less dense than the water in the permeable bed it will migrate up, until it is either trapped in a conventional reservoir or escapes to the surface where it is eaten by bacteria that have evolved to consume oil and gas. The second process, if no adjacent permeable bed is reachable, is to continue cracking the source rock. This causes a buildup of pressure in the rock and it becomes “over-pressured.” Strictly speaking, an over-pressured rock has a pore pressure that exceeds the hydrostatic pressure at the same depth, that is the pressure exerted by a column of water as high as the depth of the rock from the surface. A column of fresh water produces 0.433 psi/foot, so at 8000 feet the “normal” pressure would be 3,464 psi. Any pressure above that is considered over-pressure. Most good shale reservoirs are over-pressured.

Thus, some oil and gas is stored in the source rock as “free” oil and gas in small natural cracks and in larger pores. A second way that shale reservoirs store hydrocarbons, is as adsorbed gas and oil attached to the oil- and gas-wet particles, that is, the organic matter in the rocks (Spears and Jackson 2009). Some reservoirs, such as the Barnett, contain a lot of adsorbed gas and oil (Ambrose, et al. 2010). Adsorbed gas and oil is proportional to the amount of organic matter in the rock (Lewis et al 2004). This is because the other

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from the rock, some of the adsorbed fluids will be released, this increases well production. Figure 4 illustrates the accessible reservoir volume for a shale gas reservoir.

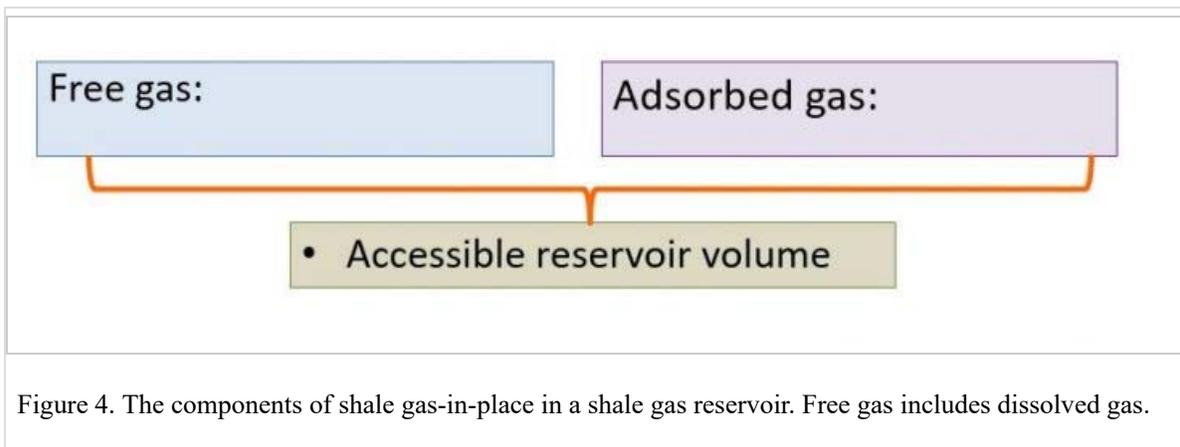


Figure 4. The components of shale gas-in-place in a shale gas reservoir. Free gas includes dissolved gas.

The structure of a shale reservoir

Shale reservoirs are all different, which means that completion designs are always customized for each reservoir (Rickman, et al. 2008). Most shale reservoirs have very plastic (flexible) rocks with a lot of organic matter (kerogen) and brittle rocks with less kerogen and more carbonate or silica. Generally, the operator will want to drill the horizontal well in the brittle rock, but close to the plastic rock which contains most of the oil and gas. The more brittle rock will drill faster, and it fractures (fracks) well (Jacobi, et al. 2008). Further, the proppant will hold the fractures open better in the harder more brittle rock. In the plastic rock the rock can collapse the fractures by deforming around the proppant.

In Figure 5, the Upper Barnett and the Lower Barnett are more plastic (lower [Young's Modulus](#)) and the central Forestburg and lower Chappel Limestones are brittle (or stiffer, higher Young's Modulus). These are often good places to put a horizontal well. There are similar "hard" or "brittle" zones in, over or under the Eagle Ford, Haynesville Shale, Bakken Shale and Marcellus Shale.



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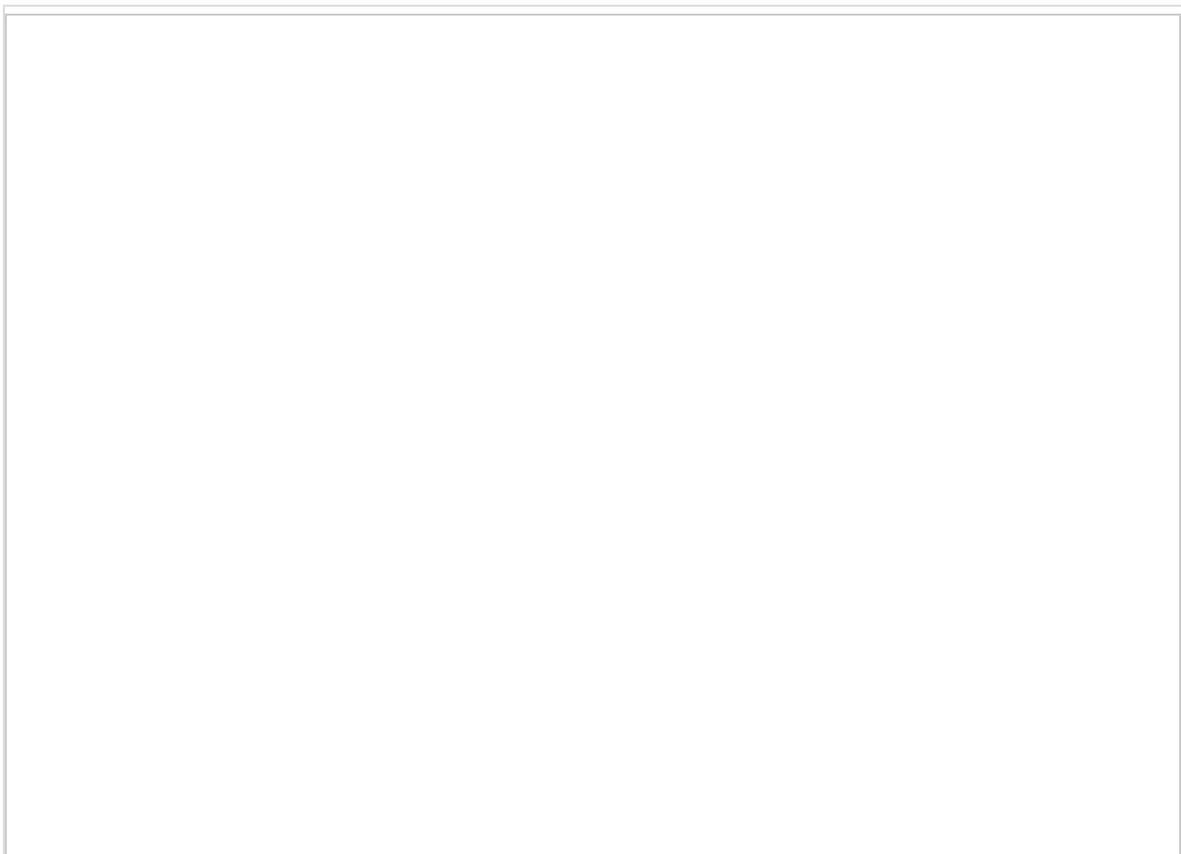
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Figure 5. Diagrammatic cross section of the Barnett Formation. It shows that the Forestburg Limestone divides the organic rich Barnett into two units and that the Barnett is underlain by the Chappel Limestone. The Barnett Shale is more plastic and less brittle than the limestone units.

Source USGS.

Figure 6 shows that the Bakken and Three Forks shale reservoirs have a similar structure.



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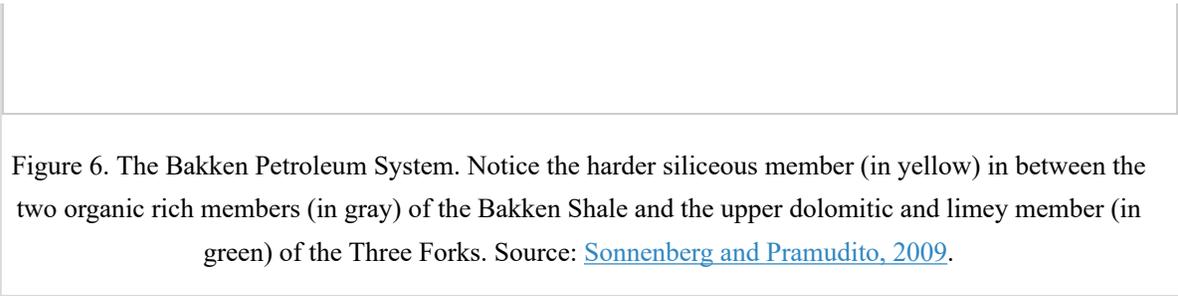
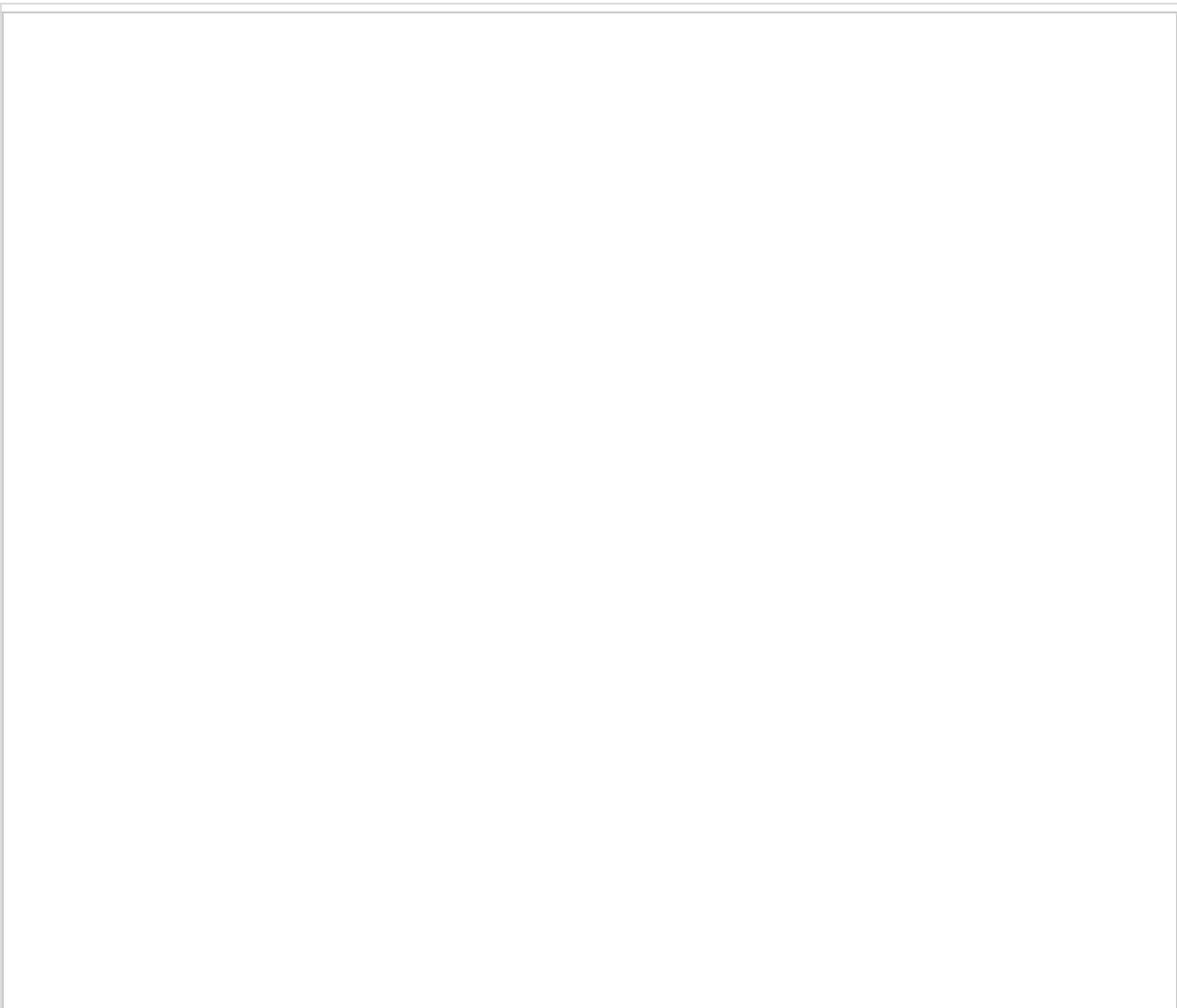


Figure 6. The Bakken Petroleum System. Notice the harder siliceous member (in yellow) in between the two organic rich members (in gray) of the Bakken Shale and the upper dolomitic and limey member (in green) of the Three Forks. Source: [Sonnenberg and Pramudito, 2009](#).

Hydraulic fracturing (“Fracking”)

While micro-fractures exist naturally in shale reservoirs, they do not interconnect enough to form an economic hydrocarbon flow network. For this reason, operators will hydraulically fracture their wells, usually in stages over a three to five-day period. This is illustrated in Figure 7.



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Figure 7. The hydraulic fracturing processes. Source [ConocoPhillips](#).

Besides fracturing the rock around the wellbore, proppant, which can be sand or ceramic pellets, needs to be placed in each fracture so the fractures don't close when the well is produced. We also hope the rock is "stiff" enough not to bend and close off the fracture around the proppant. This is illustrated in Figure 8.

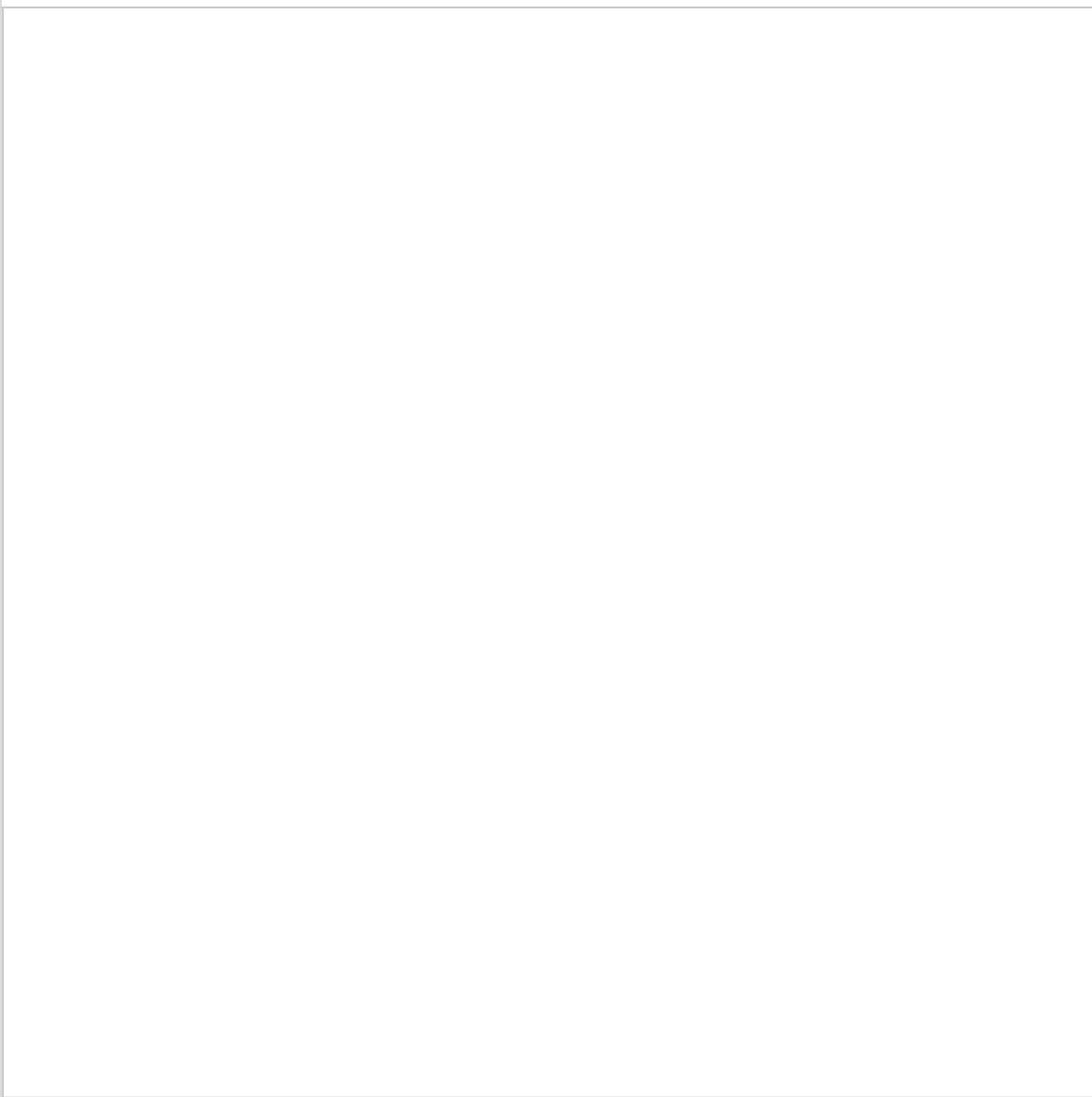


Figure 8. Pumping proppant into the fractures. Source: [Council on Foreign Relations](#).

The design of an economical well completion procedure for a shale play is the most

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Today most operators in the successful shale fields use “[slick water](#)” fracks in their wells. Slick water fracks use 98%+ water, 1-1.9% proppant, with a small amount of a friction reducing chemical (usually polyacrylamide), a chemical to lower the water viscosity, minor surfactant (detergent), a small amount of biocide, and additives to reduce corrosion. The advantages of a slick water frack included:

1. Lower cost
2. Can be pumped at higher pressures, creating more complex hydraulic fractures.
3. The water in the frack enters the rock more easily, attaching itself to the water-wet particles and forces the hydrocarbons out.

The details of the slick-water frack are varied for each well, depending upon the characteristics of the rocks. Not only is every shale reservoir different, but each well is also different. This is a learn-as-you-go process and expensive.

As shown in Figure 8, the idea is that the fracture near the wellbore perforation be wide and propped open with abundant proppant. This rock should be reasonably stiff (relatively high [Young's Modulus](#)) and brittle (Jacobi, et al. 2008). Then the fracture will hit the high organic-content and less stiff (low Young's Modulus) source rock that contains the oil. This will cause the fracturing fluid to slow down, pressure to build, and the fracture will naturally branch out. This puts the water into contact with more rock volume.

Nearly all shale reservoirs contain relatively salty water, the more saline the water the more compact the clay minerals in the shale. The slick water frack is composed of low salinity water, normally lower than the formation salinity. This has two effects on the rock, first it causes the clays to swell slightly, this has the effect of pushing the hydrocarbons into the fractures. Second, the water-wet grains (mostly clays and silica particles) will adsorb the fracturing water, pushing more hydrocarbons into the fractures. These processes, two parts of the same process, account for much of the initial production surge in shale wells.

Every shale is different, some shales, like the Haynesville Shale, have a lot of free gas and are very over-pressured. In these wells, only a small amount of the fracturing water is recovered, and the initial production surge is huge. The water replaces the void space of

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However, the Barnett is a more competent rock and the fractures prop open better. The amount of adsorbed gas is larger than in the Haynesville shale and the release of the adsorbed gas due to the production-caused pressure drop is longer lived and the wells have a longer life. The initial production surge is composed of the free and dissolved gas and oil. The production in the later portion of a shale well's life is from the release of adsorbed gas. [Coal-bed methane](#) production, as another example, is often nearly all adsorbed gas.

The economics of each well is affected by the time it takes to recover the investment in the well and the minerals lease. For this reason, the volume recovered in the initial production surge makes a huge difference. Good Haynesville Shale wells can pay-out in a few weeks, Barnett Shale wells take much longer. All shale plays have sweet spots that are very profitable and areas where the wells struggle to pay for themselves, so mapping the critical petrophysical properties for a good producer is very important. Good operators will use these maps to avoid the sub-economic and marginal parts of shale plays.

Why hasn't the shale technology spread more quickly?

The shale revolution has taken off in the United States, Argentina and Western Canada. Here we discuss shale oil and gas and exclude oil shales, which have been mined for over one-hundred years in China, Spain, Estonia and some other places for kerogen. Kerogen is not oil or gas but can be converted into them. We are only talking about true oil and gas already formed but trapped in shale.

In the United States and Canada, the plays are being developed on private land where the land owners own the minerals and receive royalties on the production. In most countries, a land owner only owns the upper six feet or so of his land, the minerals and water below that depth are owned by the government. In these countries, the land owner has no incentive to develop the minerals on his land, and every incentive to try and block the development. Leases on government land are rare due to landowner opposition, the strong environmental lobby and for other political reasons.

Shale developments require more wells, roads and construction than conventional oil and

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Argentina, the mineral rights are owned by the government, but they are pushing the development of their rich Vaca Muerta shale reservoir, which may contain 27 billion barrels of recoverable oil. The Neuquén Basin has very poor infrastructure which makes development expensive and difficult. Further, the government oil company ([YPF](#)) lacks the required expertise. So they have invited foreign companies to develop the field and have subsidized unconventional oil and gas prices (source [oilprice.com](#)) to entice them to come. The government wants them to build an experienced labor pool and the necessary roads and infrastructure.

Thus, we see the problem. The U.S. and Canada have the technical expertise and an experienced labor pool. They also avoid the political/environmental movement nonsense since landowners own the mineral rights and profit from the shale development. Finally, the U.S. and Canada have the high-quality oil and gas infrastructure and service companies required to do the shale evaluations, engineering, drilling, completions and transportation required. Most other countries have none of this.

Conventional oil and gas expertise is cheap and readily available. Production costs for most conventional onshore oil and gas fields are also cheap, so oil and gas companies can afford to build the infrastructure and develop the fields gratis, just to get the leases. Shale exploration is cheaper than conventional exploration, but the development and production of shale gas and oil is much more expensive. So, for a country to get their shale assets developed they are probably going to have to do what Argentina has done and pay some sort of subsidy or guarantee to the operator. This is not going to be politically popular and may be politically impossible for the time being for most governments. The good news? Like all new technologies, shale will get cheaper in the future and the expertise will spread with time. At some point shale oil and gas development will mature and spread around the world. When it does, it will change the world, just like it has changed the United States.

Selected bibliography

The post is based mostly on my years of experience as a shale petrophysicist and it is intended to be a non-technical layman's overview of the science. The following

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Works Cited

Ambrose, R., R. Hartman, M. Campos, I. Akkutlu, and C. Sondergeld. 2010. "New Pore-scale Considerations for Shale Gas-in-Place Calculations." *SPE Unconventional Gas Conference*. Pittsburgh. <https://www.onepetro.org/conference-paper/SPE-131772-MS>.

Curtis, John. 2002. "Fractured Shale-Gas Systems." *AAPG 86* (11). <https://pubs.geoscienceworld.org/aapgbull/article-abstract/86/11/1921/39953/fractured-shale-gas-systems?redirectedFrom=fulltext>.

Jacobi, D., M. Gladkikh, B. LeCompte, G. Hursan, F. Mendez, J. Longo, S. Ong, M. Bratovich, G. Patton, and P. Shoemaker. 2008. "Integrated Petrophysical Evaluation of Shale Gas Reservoirs." *CIPC/SPE Gas Technology Symposium*. Calgary. <https://www.onepetro.org/conference-paper/SPE-114925-MS>.

Lewis, Rick, David Ingraham, Marc Percy, Jeron Williamson, Walt Sawyer, and Joe Frantz. 2004. "New Evaluation Techniques for Gas Shale Reservoirs." *Schlumberger Reservoir Symposium 2004*. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.455.2453&rep=rep1&type=pdf>.

Luffel, D., and F. K. Guidry. 1992. "New Core Analysis Methods for Measuring Reservoir Rock Properties of Devonian Shale." *JPT (SPE)* 1184-1191. <https://www.onepetro.org/journal-paper/SPE-20571-PA>.

Luffel, D., C. Hopkins, and P. Schettler. 1993. "Matrix Permeability Measurement of Gas Productive Shales." *SPE Conference*. Houston. <https://www.onepetro.org/conference-paper/SPE-26633-MS>.

Rahman, N., M. Pooladi-Darvish, and L. Mattar. 2005. "Perforation Inflow Test Analysis." *Canadian International Petroleum Conference*. Calgary: Canadian Institute of Mining, Metallurgy and Petroleum. https://ihsmarkit.com/pdf/pita-paper_228014110913049832.pdf.

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Conference. Denver: SPE. <https://www.onepetro.org/conference-paper/SPE-115258-MS>.

Sherwood, Owen, Jessica Rogers, Greg Lackey, Troy Burke, Stephen Osborn, and Joseph Ryan. 2016. "Groundwater methane in relation to oil and gas development and shallow coal seams in the Denver-Julesburg Basin of Colorado." *PNAS* 113 (30): 8391-8396. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4968736/>.

Spears, Russel, and Lance Jackson. 2009. "Development of a Predictive Tool for Estimating Well Performance in Horizontal Shale Gas Wells in the Barnett Shale." *Petrophysics*. <https://www.onepetro.org/journal-paper/SPWLA-2009-v50n1a1>.

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148 thoughts on "Shale Reservoirs, do they work, will they spread?"

Bob Ernest November 13, 2018 at 6:33 am

This is one of and maybe the best article I have read at WUWT.
Thank you.

Andy May November 13, 2018 at 6:49 am

You are very welcome.

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Andy:

Figure 7 describes “cement”. Isn’t this a misnomer for CONCRETE. As a matter of clarity what is the strength of the mix between the cement, the aggregate (pea granite) and water. I’m assuming the concrete is pumped under pressure. Normal pumping concrete has a 4000 psi compressive strength or is it higher in this application?

David Middleton November 13, 2018 at 12:13 pm

Cement is the proper term... https://www.rigzone.com/training/insight.asp?insight_id=317

tommy graham November 13, 2018 at 6:53 pm

Oilwell cement slurries are not mixed with aggregate. If the slurry had aggregate in it it could not be pumped through the casing and the special cementing equipment. The cement slurry is composed of water, additives for retarding the cement set-up/thickening time (to allow it to be pumped into place without setting up prematurely), fluid loss additives (to prevent the slurry from de-watering and setting up prematurely), and a special grade/grind of portland cement.

Fernando L. November 14, 2018 at 4:37 am

Oil wells are cemented with special cement. The only “solid” aggregate I have seen used is ash, tiny glass spheres, etc to adapt it to special conditions. The cement is pumped down the inside of the casing (or

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we try to avoid high pressures on bottom because this can fracture the rock and some or all the cement ends up in the wrong place.

DeeDub November 14, 2018 at 6:28 am

Fernando, what do you mean by “special cement,” and what kind of ash are you talking about, coal ash? Also, you didn’t answer Carbon Bigfoot’s question about compressive strength, so I’m wondering if someone else on the thread can and am also curious about the quantities of this concrete (it can’t just be cement, which must have something to bind to). I imagine that the quantities are enormous and am therefore curious about the costs of it (per ton or cubic yard) as well.

Lastly, I’m curious about the “excess salts” mentioned here:

<https://www.riverkeeper.org/campaigns/safeguard/fracking-waste-in-new-york/what-is-fracking-waste>

Fernando L. November 14, 2018 at 9:26 am

Dee, as far as I know its just cement. The ash is pozzolan. The cement is curculated into a very narrow annular space so i can’t imagine why anybody would add sand or gravel to it (plus we have to keep the weight and ability to handle pressures). The additives have to do with setting time, fluid loss, and other parameters. We usually take the cement mix from the sacks we plan to use, put it in cans, and test it for compression in the lab. I used to do well completions 40 years ago. and I always carried a hunch of cans and

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The “extra salt” is probably anything from calcium chloride to exotic salts we see in tiny amounts in deep aquifers. We also get shale, which happens to be slightly more radioactive than sand. This item is used by the antifracking crowd to scare the heck out of civilians. The water that comes up from an oil well cant be consumed, period. What we usually do is clean it up, and pump it down a disposal well. Offshore platforms usually dump the clean water down a sump. My experience is that sumps have to be placed low and flushed with seawater, then chlorinated. This has to be done carefully to make sure the groupers we catch are edible.

DeeDub November 14, 2018 at 9:37 am

Thanks, Fernando, very interesting.

My company is pioneering the conversion of coal ash (properly, coal-combustion residuals, or CCRs) into flowable fill (CLSM) and concrete, and I’m curious as to whether you think this might be of use to the fracking industry.

Shawn Marshall November 14, 2018 at 5:25 am

Great explication – I agree it is one of the sterling things I have ever read at WUWT.
The technology is, frankly, amazing and highlights the vigor of private enterprise IMHO.

Joseph Campbell November 14, 2018 at 10:10 am

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R Shearer November 13, 2018 at 8:25 am

Yes, very interesting and enlightening. Thank you!

Leo Smith November 13, 2018 at 10:29 am

+1001 – should have been a book!

john November 13, 2018 at 10:30 am

Agreed! I live in Western Canada and grew up in oil country but fracking is a new thing since my day and this was an education. Thank you Andy! Concise but full and informative.

Tom Abbott November 15, 2018 at 5:01 am

“and this was an education”

Yes, it was. A very good article. I learned a lot.

I think it is safe to say this oil recovery method is just getting started on a world-wide scale. They are going to have to move that “Peak Oil” date farther into the future.

Fernando L. November 14, 2018 at 1:44 am

The article is really good. The only thing I would add is how the

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I started my career in the US, but later spent my time “overseas”, so I’m very familiar with those environments. The industry does have some problems dealing with the land ownership issue, but if the area is agricultural land that’s manageable. My perception is that companies bring managers who aren’t used to dealing with landowners and local interests and lack the diplomatic touch (a touch I learned a bit from my field foreman dealing with rich landowners in South Louisiana).

What we do see is a large cost difference in some cases. These are caused by logistics, lack of contractor competition, unionized work force, and weather. Argentina is really bad in these areas after the Kirchner years, but I’m not seeing enough movement to make it really competitive. I should add that exactly 40 years ago I almost died in Neuquen while looking for fresh water sources to use for a drilling operation. Im not sure what the fresh water supply will be like if they start using 100 rigs to develop the Vaca Muerta.

Another issue I’ve found is the surface. For example, Western Siberia ought to have decent shale targets, but it’s going to be difficult to move away from the developed areas because it’s so swampy and wet in the summer and winters are inhuman. And I’m wondering if the Bazhenov may not be oversold. Offshore shale development will also be quite difficult until oil prices reach \$120 to \$150 per barrel. And that may not happen for a while. So while the potential is there I don’t think that shale production of oil will be able to replace conventional oil. The US sure seems to be the Saudi Arabia of shale reservoirs, and the Permian Basin in particular is really exceptional for light crude. Shale gas reservoirs are a different matter, the methane molecule adsorbs and deadsorbs, FLOWS much better, and has much more compressibility, so I expect nations which do go after it (like Argentina) to do very well.

Andy May November 14, 2018 at 4:04 am

Thanks Fernando, good points. Neuquén Basin production has doubled since 2015 according to Wood-Mackenzie and

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Rud Istvan November 13, 2018 at 6:49 am

Great overview, one of the best I have read—and I have read a lot about shale. See, for example, essay Matryoshka Reserves in ebook *Blowing Smoke* for a layman level geophysical analysis of Russia’s Bahzenov shale, the largest in the world and the source rock for much of western Siberia including the supergiant Samotlor conventional oil field.

Andy May November 13, 2018 at 6:51 am

Thanks Rud

Tom Halla November 13, 2018 at 6:49 am

Good article, sort of Fracking for Dummies. Mr May clearly knows the field well enough to teach it to non-experts.

MARCUS November 13, 2018 at 6:50 am

Andy ..

“So, for a country to get their shale assets developed they are probably going to have to (do?) what Argentina has done and pay some sort of subsidy or guarantee to the operator. ”

Great essay, very technical stuff, but now my head hurts...lol

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David Middleton November 13, 2018 at 10:01 am

Marcus is a great proof-reader... 😊

Marcus November 13, 2018 at 7:48 pm

Tanx Dave ! ... LOL

Jeff Alberts November 13, 2018 at 6:39 pm

I saw a few things, mostly missing or improperly used commas. But people seem to dislike such corrections.

Retired_Engineer_Jim November 13, 2018 at 11:38 pm

My bride is a Welsh lass who was born and raised in England. I also read a fair amount of aviation, ship and railway books from the UK. I find that native English speakers put commas in the darnedest places, in comparison with us Amerikun speakers. And, of course, they can't spell at all.

Mardler November 14, 2018 at 1:47 am

I can spell a tall

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WILLIAM ABBOTT November 13, 2018 at 6:58 am

Wow. Thanks. That is information I have been wondering about for ten years. You filled in a lot of blanks for me. Much appreciated. One question: Are the shale formation maps static? How much unexplored potential exists? My father told me fifty years ago there was more oil in shale under Wyoming's Sweetwater county than there was in all the Middle East. Problem was nobody knew how to get it out of the ground. How much oil is in what your map calls the Hillard Baxter Mancos Niobrara foundation? I have heard that area called the Utica shale and the Green River Shale formation. Most of the land there is federal, BLM and Forest Service. Has it even been thoroughly explored? BTW you could light the gas that came out of my aunt's water faucets at her ranch near Douglas, Wyoming. There were no oil wells. Not back then.

Andy May November 13, 2018 at 7:16 am

William, The shale resource maps are revised regularly by the USGS and oil and gas companies have their own estimates which they usually keep proprietary. To see the resource estimates for various shale plays by the USGS, go to this link and find the play you are interested in: <https://energy.usgs.gov/GeneralInfo/EnergyNewsroomAll/TabId/770/PgrID/3941/PageID/2/PID/3941/evl/0/CategoryID/9/CategoryName/Regional-Studies/Default.aspx>

Most of the Green River shale resource is "oil shale" which is actually a kerogen resource and not part of what I discuss in this post. "Oil shale" kerogen is very abundant in the world. Probably almost all potential oil shale and shale oil and gas resources in the world have been identified, if not mapped. But, only a few are under development. As I say in the post, it is figuring out how to develop them economically that is the problem.

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As an old geologist, I have to laugh. I recall in class being told that shale could never be economically developed, but if it did, it would change the world. Up until 2007 or so I had geology friends e-mailing me articles laughing “look at those fools, those Ponzi schemers!” Not so much laughing now.

What is fascinating is that this illustrates something I have always said – the wealth or lack thereof of a country has nothing to do with resources, or with the people that live there. It has to do with good or bad economic policy. In other words, there are no “poor” countries, there are just poor governments and laws.

In the U.S. we have non-confiscatory laws about minerals, and hence the infrastructure to develop them economically, and the incentive to do so. There is nothing unique about our shale, yet no one can do what North America has done, not even Mexico, China, or Europe.

Greg in Houston November 13, 2018 at 3:42 pm

As far as I know, we are the only country that allows surface owners to own mineral rights. But this was told to me long ago by a econ professor, but if we aren't the only country, we are one of the very few. We can thank Thomas Jefferson for that.

David Middleton November 14, 2018 at 3:09 am

As a young geo working the Gulf of Mexico, back in the 80's, I remember being told that the deepwater was uneconomic and that reservoir rocks older than the Miocene didn't exist much beyond State waters.

Guess where the largest Gulf of Mexico discoveries

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Fernando L. November 14, 2018 at 5:00 am

The Permian Basin is abnormally good for oil production of all types. Some basins have the source rock too deep, too hot, have a really high pressure non source shale on top which drives well costs too high, are too faulted to allow long horizontal well drilling, the “shale” target is too thin (like the Eagle Ford towards Mexico), or it lacks brittleness. One example of a basin with poor shale prospectivity for crude oil is Lake Maracaibo, where the source is buried really deep, and has so much carbonate it looks like a dirty radioactive lime.

Ron Long November 13, 2018 at 6:59 am

Excellent post, Andy. As a Geologist that has walked many kilometers through the Vaca Muerta of Argentina I can say for sure that the shale was deposited in a more complex basin that originally thought. For instance there are many zones of patch reefs, with abundant *Trigonia brachiopods* with well-preserved ornamentation, ie insitu in a patch reef. Of course there are spectacular ammonites up to three feet across, usually sporting an impressive collection of barnacles, and sometimes a pleisosaur. But it is the patch reefs that are telling about the complexity of the basin geometry. The Neuquen Basin was heated up by the Andes volcanism and locally is cooked, but for sure the Baca Muerta will produce a lot of oil and gas once they get better at more exacting targeting parameters. What was a mining geologist doing walking through the Vaca Muerta? Looking for flood gravels, Quebrada Del Sapo fm., which is often mineralized with copper-cobalt-vanadium in the style of the Congo. OK, sometimes I was just admiring the fossils.

Don K November 13, 2018 at 7:00 am

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in permeable formations, requires relatively flat strata, probably not a good idea in areas (e.g. coastal California) with very numerous faults. But overall — just terrific.

David Middleton November 13, 2018 at 7:20 am

The toxicity of the frac fluids isn't an issue. The toxicity of produced water is. Frac fluid is only a small percentage of the wastewater that has to be disposed of. Most of it is connate/formation water that was produced along with the oil & gas. This water tends to be highly saline with a lot of heavy metals and hydrocarbon compounds.

Waste disposal wells have to be carefully sited and monitored to minimize the risk of induced seismicity.

Gerard O'Dowd, M.D. November 13, 2018 at 11:44 pm

I live in Central OK, North OKC to be more precise; and "induced seismicity" was a problem due to local disposal wells (? Number, ? Operator, ?distance) causing numerous earth quakes, tremblors, on the order of 2.0-3.5 on the Richter Scale, each lasting a few seconds, over a period of 2-3 years, 2015-2017, causing minimal property damage to my home's stone facade. Other houses in the news were reported with more severe damage. The disposal wells were moved to an alternative location after public and government pressure. Maps of the area's underlying geology reveals a very complex fault pattern. End result has been an almost complete absence of earthquakes in 2018 since the disposal wells were moved.

Questions: Andy and David, how is the well bore pipe perforated? Has the distance or spacing between perforations changed with time? Is the spacing of perforations another idiosyncratic feature of a particular

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Andy May November 14, 2018 at 4:11 am

Gerard, the pipe is normally perforated with explosive charges, see link below. Perforation spacing variation is often important in tight sandstone or carbonates, but in shales it isn't varied much from the norm in my experience.

<https://petrowiki.org/Perforating>

Andy May November 13, 2018 at 7:25 am

Don, I agree with David. Nearly all frac fluids are safe to swim in, some are safe to drink. But, the produced water needs treatment and/or proper disposal. Getting too aggressive in disposal wells can cause earthquakes. But, disposal was not the point of the post.

David Middleton November 13, 2018 at 7:40 am

If I had \$1 for every time an earthquake related to an injection well was blamed on frac'ing... I wouldn't have to find oil & gas for a living... 😊

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Don K November 13, 2018 at 8:59 am

“Don, I agree with David.”

So do I actually.

I do think that using/requiring non-toxic fracking fluids if that is technically feasible and not overly costly, would defuse some of the opposition to fracking. The few descriptions I’ve seen of fracking fluid contents make it sound like sandy Gatorade (yechh).

David Middleton November 13, 2018 at 10:00 am

Frac fluid 98-99.5% water with a few additives (biocides to suppress microorganisms that can foul fractures, acids to control scaling, friction reducers)...

<https://geology.com/energy/hydraulic-fracturing-fluids/>

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David Middleton November 13, 2018 at 7:16 am

“We often hear the assertion that shale reservoirs deplete so fast that they cannot be economically viable over the long term and that shale development is a losing “house-of-cards” proposition that will ultimately fail. This slide presentation by Jeremy Leggett is just one example of many. Proponents of solar, wind and other alternative energy sources love to spread such stories, see here for an example. Be careful, not everything in these links is true and they are quite selective in their “facts.” Generally, these nay-sayers rely heavily on industry averages of cash flow or profit and unsubstantiated, controversial and sweeping environment claims to make their point, quite dangerous in a new technology business.

Yep... Shale may not be a panacea or a cure for the Hubbert equation... But it's extremely viable. Like most other sectors of this business, it's usually a low-margin game. For every home-run we hit, there are hundreds of infield singles and more than a few strikeouts.

Andy May November 13, 2018 at 7:21 am

David, How true. I remember reading somewhere that if all airline costs and revenues since airlines began were summed, the airline business was a net loss. Look at how many airlines still exist! Obviously, analyzing any business with averages and totals is absurd.

davidgmillsatty November 13, 2018 at 9:28 am

Not necessarily true. The corporate entity, which is in essence the vehicle by which the capitalist business model today operates, is an entity whose sole reason for existence is to pass on responsibility to others and essentially the

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very successful, then my \$10,000 could be worth a \$1,000,000. The opposite is not true. If the corporation is a bust and causes a huge loss my loss is only \$10,000, not \$1,000,000. Society picks up that loss not me.

So it could be very well true that the airline industry has never made a profit.

GREG in Houston November 13, 2018 at 10:04 am

The loss is not picked up by “society,” but by the other stockholders. You seem to be quite cynical about corporate entities.... who sole reason for existence is to make a profit, not pass on responsibility to society as a hole. But.... discussing this with an “atty” is most likely a fool’s errand.

davidgmillsatty November 13, 2018 at 4:45 pm

They are not picked up by other stockholders that is the point. Maybe you should go to law school and take Corporations 101.

If my share of a corporate loss would be apportioned to me at \$1,000,000 and I have only invested \$10,000, and my loss is limited to that and the same thing happens for every other shareholder, who picks up the tab? Society, in the form of customers, taxpayers, creditors, etc. etc.

You obviously don’t have the even the basest understanding of limited liability. Why do you think the basis of corporate law is called limited liability?

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David, we in this blog are generally not attorneys, but engineers, science wonks, etc. Do not patronize us by scoffing that we don't have a clue about the definition of limited liability. Of course we don't. You have this one-sided view of a corporation, that seems to indicate that if I lose my small investment, "society" picks up the rest. Pure BS. The other stockholder lose their investment, and no one else. Customers go somewhere else for the product. Taxpayers get what the tax laws they should get. Creditors lose out to the extent that they did not protect themselves. In other words, the limited liability seems to mean that my liability is limited to \$10,000, in your example. And by the way, exactly what is your point?? And no, I don't know all your legal definitions – but what exactly then is the point of limited liability law?

D. J. Hawkins November 13, 2018 at 10:09 am

Society rarely picks up those losses. They are usually absorbed by other corporations.

GREG in Houston November 13, 2018 at 5:48 pm

Your legal knowledge and liberal bent are combining to making it impossible to understand your own biases. You are "poo poing" people who believe you don't think your poop stinks. "Ahem, well, I am a certified attorney. What do the hoi polloi know?"

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Capitalists deliver products and services that willing customers pay for, if the capitalists are successful, at least. What the customer pays is not a “loss” but is either an expense or an investment (depending upon circumstances and the product or service) that the customer believes delivers a justified value. Do some customers waste their money on bad purchase, or get cheated some times? Of course. Do some customers try to cheat the capitalists, or to steal from them? Of course. But that is neither here nor there. It takes two to complete a transaction.

And if you lose your \$10,000 investment in the capitalist company, again, that is a choice that you freely entered into, being aware that there are no guarantees of a return on any investment unless it is so stated.

davidgmillsatty November 13, 2018 at 4:49 pm

What do the words limited liability mean?
Apparently people here have not the slightest clue.

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Marcus November 13, 2018 at 7:58 pm

“Limited liability in general means that the liability of a business owner is limited to the amount that the owner has invested in the company. Common misunderstanding assumes that limited liability means that business owners are not liable for anything that happens in the business, but this is not true. “Limited liability” does not mean “no liability,” and business owners can be held liable in some circumstances.”

<https://www.thebalancesmb.com/what-does-limited-liability-mean-to-a-business-owner-398317>

So what is your point davidgmillsatty ?

davidgmillsatty November 14, 2018 at 5:31 pm

@ Marcus. Can you understand what just wrote? I never said it meant no liability; that is the definition of immunity. What I said was that an owner does not pick up all the costs. He may pick up most of them or only a small portion of them. It all depends, and the costs that are not borne by the business owner are then shifted to the rest of society.

It is not a difficult concept. Take your average bankruptcy. Who gets stuck with the tab when the debtor has paid all he can pay?

john November 13, 2018 at 10:39 am

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businesses is far surpassed by the economic good they leave behind. If that were not the case, society would have choked on residual costs and pollution long ago. In reality, even with the gross interference in the economy by governments, society continues to (slowly) get richer and cleaner.

bit chilly November 13, 2018 at 3:03 pm

some very naive replies to davidmills. i agree that free market capitalism is the way forward.for anyone that believes we have free market capitalism in the west i have a bridge you may be interested in.

davidgmillsatty November 13, 2018 at 5:25 pm

A sole proprietor is not entitled to have “limited liability” which means he is responsible for all his debts and obligations to his last penny and any in the future he may acquire to pay these debts and obligations.

How many billionaires are sole proprietors? None. It would be impossible to do.

So the corporation is the vehicle by which we create billionaires and more and more of us are falling out of the middle class and into poverty. And the fact that more and more people are falling into poverty means that segment of society is paying for the hidden losses that most of us never see when limited liability is now the basis of capitalism.

True capitalism does not embrace the concept of

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Fernando L. November 14, 2018 at 11:17 am

This comment is an excellent sample of what many students are taught in US universities, which explains why it's important to fix the problem before they turn the US into the USSR.

davidgmillsatty November 14, 2018 at 7:13 pm

Seems to me we have a lot of admirers here of the Jeff Bezos' model of capitalism. And of course they would probably immediately disavow any such admiration.

But the point I wish to make is that Jeff Bezos would not be what he is without the corporate entity, an entity, by the way that got its charter from the state, and is a creature of the state. And the state grants those who successfully use the corporate entity a means to acquire vast amounts of wealth that other individuals do not have.

Corporations have created the new ruling class.

And people need to think about that.

I did not intend to derail the thread. But the OP made a flippant comment that was not likely to be true.

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Steve R November 13, 2018 at 2:57 pm

Mr. May:

I am perplexed by the relatively high water cuts in the Bakken (for instance). Early on, my expectation was for these wells to produce for a long time (at low rates) with very low water. Is it possible that the fractures themselves penetrate all the way thru to underlying connate water? Am I right in assuming every bbl of water causes about the same drop in pressure as a bbl of oil?

David Middleton November 13, 2018 at 3:32 pm

It's definitely possible to frac into the water leg. A pressure depletion drive sees a barrel of oil the same way it sees a barrel of water.

Gerard O'Dowd November 14, 2018 at 12:30 am

M. King Hubbert is rolling over in his grave right now knowing a new AUC will have to be calculated in a few years to estimate the volume of US oil reserves for the 21st C because of fracking and horizontal drilling, deep off shore well, etc. This second production peak won't have his name attached, nor will I be alive when it happens. Perhaps Ken Deffeyes will write a new book as a follow up to his first three entitled "When Oil (Didn't Really) Peak" or "Beyond Oil (and Back Again)." He is a good writer and as a layman, I learned a lot reading his books.

David Middleton November 14, 2018 at 3:22 am

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CDP (CMP) 2d seismic didn't come into wide use until the late 50's to early 60's. Even as recently as the early 1980's seismic acquisition and processing methods were very primitive relative to today. Old fields in the Gulf of Mexico are routinely rejuvenated because improvements in seismic processing enable us to identify reservoir segments that were not imaged by earlier processing iterations.

Steven C Lohr November 13, 2018 at 7:21 am

So, after looking at the map of shale production areas, it seems the bans on "fracking" in the states of Washington and Oregon are exercises in fire-for-effect virtue signaling, with no real consequences at all. Did I miss something?

Andy May November 13, 2018 at 7:26 am

Steven, No you didn't miss anything. Fracking bans simply prevent the landowners from developing their minerals, taking away their rights to their property.

Phil R November 13, 2018 at 9:51 am

Andy May,

I know your post was about the general description of the fracking process and shale reservoirs, but since fracking bans came up (I didn't want to be OT), do you have any insight or thoughts regarding the (obviously political) fracking ban in New York, and if it will ever be lifted?

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landowner lawsuit will reach the Supreme Court which will hopefully overturn the ban. Lawsuits so far have been unsuccessful, because states have immunity from being sued for money. (11th Amendment) However, the 5th amendment prohibits uncompensated “taking.”

<https://www.democratandchronicle.com/story/news/politics/albany/2018/06/21/new-york-fracking-ban-lawsuit/719711002/>

SCOTUS will have to decide, I guess, which amendment takes precedence – the 11th or the 5th.

Phil R November 13, 2018 at 10:25 am

Greg,

Thanks for the response and info. We ain't no Clampetts, but my two brothers, my sister and I have mineral rights to about 140 acres (split between us) in Chemung County, NY, which is in the Marcellus. We would never get to retire on that, but I'd like to be able to buy some extra Christmas presents before we get too old.

Also, things that go to SCOTUS can take a long time.

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Kamikazedave November 13, 2018 at 10:14 am

I worked on the New York portion of the Eastern Gas Shales Project in the 70's, and it's sad to see that the Marcellus and Utica shales are off limits to exploitation.

Unfortunately, the fracking ban won't be lifted until NY voters elect politicians without their heads up their arses. Not likely given the extreme left tilt of a majority of NY citizens.

Andy May November 13, 2018 at 11:37 am

Hi Phil R., I don't have much to add to what Greg said. But, I think there are a lot of wells just across the border from you in Pennsylvania. Aren't there a lot of wells in the Marcellus around Mansfield, Pa.? If so, you could look up their production at the web site below and see how well they are doing. If NY lifted their ban you would get the dollar equivalent of 8% of the gross revenue, or more, after the well pays out. That would give you an idea of what you are missing. In my total non-lawyer, non-expert opinion, you land owners in NY are getting screwed by the NY city billionaire enviro-wackos. Maybe you could do a class action with a lot of other land owners? Here is the web site:

<https://www.dep.pa.gov/dataandtools/reports/oil%20and%20gas%20reports/pages/default.aspx>

GeONC November 13, 2018 at 12:02 pm

Phil R. Chemung County is pretty shallow for the

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Oil and Gas regulation in Albany and contributed to the draft Generic EIS which found no significant impacts from horizontal drilling and fracking. It was overruled by the director of the DEC on orders from Cuomo the Lesser. Strictly politics. I wish you luck in getting anything positive from the politicians in that state.

iurockhead November 13, 2018 at 2:17 pm

8% sounds a bit low, unless Marcellus/Utica leases are much more favorable to the operators than other areas. Royalties in my stomping grounds (Permian Basin) on newer leases are pretty standard at 25%, with the exception of Federal leases, which are still low.

Phil R November 14, 2018 at 6:33 am

Andy May,

Thanks for your response. I actually have relatives that live in the Mansfield area, though I don't think they own any land (other than their residences) and aren't involved in any gas wells. I also had relatives (grandmother and aunt) who lived in Sayre, PA (east of Mansfield). If you look on Google Earth, you can see a bunch of wells just south of the NY state border and none to the north.

It has been my contention that most of the state, with the exception of NYC and the other urban areas, are strongly conservative and Cuomo and the democrats want to keep upstate NY relatively rural and poor. and don't want a lot of newlv

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Phil R November 14, 2018 at 6:41 am

GeoNC,

...and thanks for your response too. We've signed leases for our mineral rights a couple times, but they've lapsed because of the ban.

They (and you too, I guess) were preparing the draft generic EIS the first time we signed a lease. I had hoped (like many) that when the EIS was issued the moratorium would be lifted. But noooooo.....!

I agree it's all politics. Don't want any of the poor, rural hicks (who coincidentally tend to be conservative) to make any money that could be used to challenge Cuomo and the liberal thugs.

Fernando L. November 14, 2018 at 11:29 am

The way I figure it, eventually gas prices will go above \$7 per MMBTU in the area, and that's a good time to sign up acreage. Land owners can then ask for 1/8th plus a signing bonus, and sell the royalty stream (will have to look out for taxes). New Yorkers will give the go ahead when they can stick a \$1 excise tax to sell it to the public.

Ric Haldane November 13, 2018 at 7:36 am

Thanks Andy. My son is a frac engineer in Texas. He is young (32) and brilliant. I believe there is no such thing as too much information. I have sent him a link.

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Gary from Chicagoland November 13, 2018 at 7:40 am

Great article, thanks for answering the details of how fracking works. I find fracking an amazing process filled with complex problems that have been solved with high level creative cognitive solutions. I am also interested in the big picture of how much recoverable oil and gas is there in both USA and worldwide due to fracking? Does fracking postpone Peak Oil by decades or more? Can USA double our oil and gas production in our lifetime so we can become the worlds new "Middle East" of oil? How much money does a landowner receive as royalties if their property is used to extract oil and gas? Did fracking cause the earthquakes in Oklahoma? Can fracking be used on fault lines to cause a control mini-earthquake to avoid a big quake?

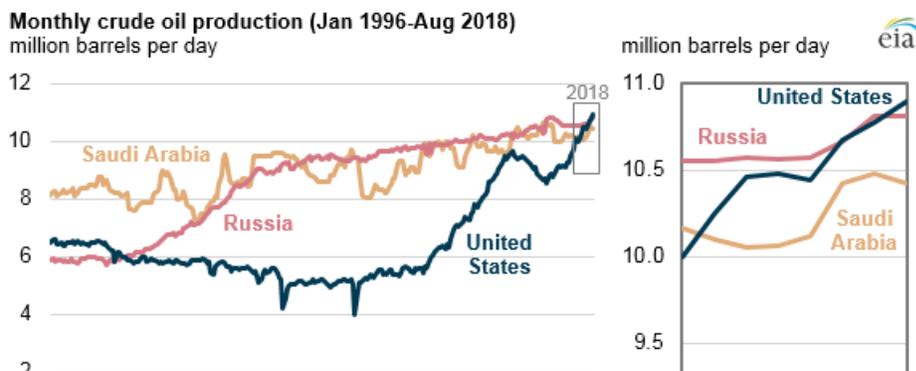
David Middleton November 13, 2018 at 7:55 am

"Does fracking postpone Peak Oil by decades or more?"

It already has.

"Can USA double our oil and gas production in our lifetime so we can become the worlds new "Middle East" of oil?"

US petroleum liquids production already has doubled...



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“How much money does a landowner receive as royalties if their property is used to extract oil and gas?”

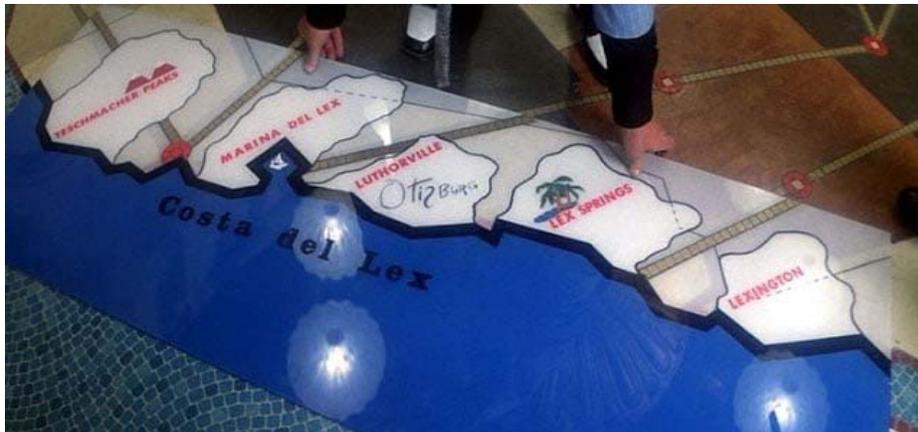
It can vary widely. The minerals owner is generally offered a cash bonus per acre and a percentage of any production established (often 1/8 to 1/6). The land owner isn't always the minerals owner, this can cause headaches.

“Did fracking cause the earthquakes in Oklahoma?”

Frac'ing might have been the proximal cause for one non-palpable earthquake in Oklahoma a few years ago, otherwise... No. Frac'ing did not cause any Oklahoma earthquakes.

“Can fracking be used on fault lines to cause a control mini-earthquake to avoid a big quake?”

Only [Lex Luthor](#) can do this.



//SARC

doug November 13, 2018 at 8:11 am

Fracking did not cause Oklahoma earthquakes. They have indeed, however, been caused by the Oil biz, by injecting wastewater from various wells (mostly wells which were never

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(producing at times 95% water, 5% oil), they have tainted the fracking process in the eyes of the public and press, who don't have the expertise to differentiate. The development of multi-stage horizontal fracking is a national treasure and we need to make sure it is understood, properly regulated, and protected from false claims.

Robert W Turner November 13, 2018 at 8:48 am

I bothered to go read the papers that claimed the earthquakes were due to injection of water and I found them unconvincing. They were based on circumstantial evidence alone, failed to mention that the Arbuckle is underpressured, ignored areas of high water injection without earthquakes, continually moved the goal posts for their claims, ignored the laws of thermodynamics, ignored that water injection volumes were actually higher in the 60s-70s, ignored the fact that the earthquake swarm didn't even begin in the area of the Mississippian dewatering play, ignore that the number and general intensity of earthquakes have increased 25-30% globally over the past 100 years theoretically due to natural rotational cycles, ignore other sudden swarms in areas that were generally quiet since we've been monitoring earthquakes, and the lack of measurable earthquakes in areas where we know they've happened in the past.

Stan Robertson November 13, 2018 at 9:24 am

It is pretty clear that injection of waste water into the Arbuckle is the problem. There are places where injection has significantly raised the pressure in the Arbuckle. When injection rates were lowered pressures decreased and numbers and magnitudes of seismic disturbances decreased. It is also significant that the

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john November 13, 2018 at 12:16 pm

I've always assumed that earthquakes occur in formations that are under stress. If water injection "causes" these quakes I would think that it merely facilitated a minor quake where one was set to occur anyway. If that is the case then it is quite likely that the stresses would have continued to build until an even larger quake was released. So small quakes initiated by water injection may be better than fewer big ones. Have any of these induced quakes caused any significant damage?

MPassey November 13, 2018 at 7:51 am

Very informative. I had been wondering about the old legacy fields around the Caspian, for example, and if or when they might start employing advanced recovery techniques.

Andy May November 13, 2018 at 11:43 am

MPassey, that is very fertile ground for tertiary methods, especially CO2 flooding. Someone will get very rich there one day. But, I worked in Russia back in 2007, and it is a mess. Totally corrupt, ancient technology, they are a long way from being able to do anything that advanced. And, while they have great shale resources, they won't be able to develop them with the technology they use today.

john November 13, 2018 at 12:30 pm

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GREG in Houston November 13, 2018 at 7:59 am

Andy, great article! I do have a question: You said that, “Shale developments require more wells, roads and construction than conventional oil and gas developments ...”

I thought that many wells were usually drilled/produced from a single pad, so would road requirements necessarily be greater in a shale play, as opposed to a conventional play? Also, what permanent construction, other than pipelines, is there – that is in excess of what one might normally see? I would think that since there would be many wells from one pad, the pipeline/field tank requirement would be lessened?

Finally, where did you go to school? A&M, UT, Mines, Penn State?

Andy May November 13, 2018 at 8:45 am

Greg, I graduated from the University of Kansas. Shale plays take a lot more wells over a larger area than conventional plays. You are right that they are developed from pads, but it takes a lot of pads, more roads than normal, more large truck traffic and lots of tanks, buildings, etc. Once the pad is finished and all of the wells are drilled and completed, a lot of the infrastructure is removed and the rest of the surface equipment is either underground or hidden. The pads are not noticeable at that point, unless you are right on top of them. I remember trying to find a pad once with my wife, I had the exact latitude and longitude but couldn't find it. But, when they are drilling and completing wells they are very noticeable.

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Stan Robertson November 13, 2018 at 3:50 pm

To the contrary, conventional oil plays developed with vertical wells were usually developed with more wells per square mile than is the case with horizontal wells.

doug November 13, 2018 at 8:12 am

Fracking did not cause Oklahoma earthquakes. They have indeed, however, been caused by the Oil biz, by injecting wastewater from various wells (mostly wells which were never fracked) into regional fault zones.

The magnitude of the stupidity and negligence of those companies and the regulators should not be underestimated. To save a few dollars disposing of waste water from marginal wells (producing at times 95% water, 5% oil), they have tainted the fracking process in the eyes of the public and press, who don't have the expertise to differentiate. The development of multi-stage horizontal fracking is a national treasure and we need to make sure it is understood, properly regulated, and protected from false claims.

ResourceGuy November 13, 2018 at 10:14 am

Correct. The regulators were too lazy to look back at the earthquake swarms historically at the sites they giving the okay to.

Robert W Turner November 13, 2018 at 8:15 am

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ResourceGuy November 13, 2018 at 8:45 am

I've got a question. Is the drawing of the fissures in Figure 8 stylized as vertical fissures for the viewer to envision or does the industry actually shoot the well that way in defiance of the logical pattern of horizontal shot through the lateral formation?

I'm asking because environmental detractors of the industry also use this same graphical depiction while suggesting to targeted nontechnical readers that this somehow causes contamination vertically through those fissures. (We do not need to aid and abet advocacy propaganda with potentially flawed depictions.) Which is it? And why would anyone shoot the well up through the limited dimension compared to the lateral extent of the formation?

Andy May November 13, 2018 at 8:51 am

The hydraulic fractures extend in every direction from the wellbore. They can be mapped as they are forming with a technique called microseismic. They go farther in the horizontal direction than in the vertical direction normally, but not always. Hydraulic fractures rarely go more than 100-200 feet in any direction. According to Durham university there has been a fracture 600 meters observed before, but there is less than a 1% chance of one going beyond 350 meters.

<http://www.refine.org.uk/media/sites/researchwebsites/1refine/hydraulicfracturesrb/Hydraulic%20Fractures%20RB%202.0.pdf>

ResourceGuy November 13, 2018 at 9:55 am

Okay, now how much energy is lost by “wasting” part of the shot in the (limited) vertical dimension of the formation?

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doug November 13, 2018 at 10:37 am

There is very little vertical fracturing. I tell people to take thick book and a butter knife and stab it between the pages—easy. Then try to stab it through pages-impossible. Shale permeability is much higher along bedding planes (horizontal) than vertical, and the fractures have very limited vertical propagation.

ResourceGuy November 13, 2018 at 8:56 am

Where are all the bad predictions of fossil fuel exhaustion today from industry, USGS, IEA, and academia? Sometimes error checking is useful.

DeeDub November 13, 2018 at 9:12 am

“By far, the most common source of methane in ground water is biogenic gas created by bacteria in shallow coal or the soil and in the ground water itself.”

Can anyone explain to me how Saturn’s moon Titan, which has a surface area of around of 12th that of Earth, can contain hundreds of time the oil and gas that Earth does, including methane, when life as we know it cannot possibly exist on it? —

https://www.nasa.gov/mission_pages/cassini/media/cassini-20080213.html

David Middleton November 13, 2018 at 9:53 am

Methane isn’t oil.

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DeeDub November 13, 2018 at 10:14 am

Russians & NASA Discredit 'Fossil Fuel' Theory: Demise Of Junk CO2 Science

<https://principia-scientific.org/russians-nasa-discredit-fossil-fuel-theory-demise-of-junk-co2-science>

In the 1980's distinguished British scientist, Sir Fred Hoyle FRS was one who tried and failed to expose the chicanery of proponents of the fossil fuel theory and diminishing world oil reserves. Hoyle, without the benefit of the worldwide web tried repeatedly to expose this flimflam: "The suggestion that petroleum might have arisen from some transformation of squashed fish or biological detritus is surely the silliest notion to have been entertained by substantial numbers of persons over an extended period of time."

Makes sense to me, in which case Earth's hydrocarbons are a renewable — i.e., inexhaustible — resource.

David Middleton November 13, 2018 at 10:34 am

100% abject nonsense.

doug November 13, 2018 at 10:43 am

They come out every time, don't they, Dave. Every Russian geologist I have worked with agrees with Dave Middleton. The shale is one more proof of biological origin. We have to frac to get it out of there, so how did it ever get in there if is supposedly seeped up from the mantle? Fracking shale works where abundant biological organic matter was deposited with the clays at the

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DeeDub November 13, 2018 at 11:00 am

With all due respect, I was hoping for a reasonable rebuttal, not abject dismissiveness, having found Thomas Gold's "The Deep Hot Biosphere: The Myth of Fossil Fuels" quite compelling, which Titan and any number of other celestial bodies would only seem to corroborate.

Why doesn't it make more sense for hydrocarbons to form continuously from the molten cores and/or atmospheres of these bodies — life or no life — than to have to make a single exception in the case of our particular celestial body?

David Middleton November 13, 2018 at 11:58 am

Methane on Titan is 100% irrelevant to hydrocarbon formation on Earth. Abiotic/abiogenic/inorganically-sourced methane is common throughout our Solar System and beyond, as are traces of other heavier simple hydrocarbons.

There is no evidence at all of any significant volumes of complex hydrocarbons on Earth that were not sourced from organic material (traces are not significant volumes). Petroleum is a mixture of complex hydrocarbons (paraffins, naphthenes, aromatics and asphaltics) and the vast majority of natural gas production comes from the same total petroleum systems as crude oil and other liquid hydrocarbons. It's possible that oil forms in the mantle all the time. The chemical equations can be balanced; so it's not impossible. There's just no evidence for it.

Biogenic vs abiogenic is really a poor way to

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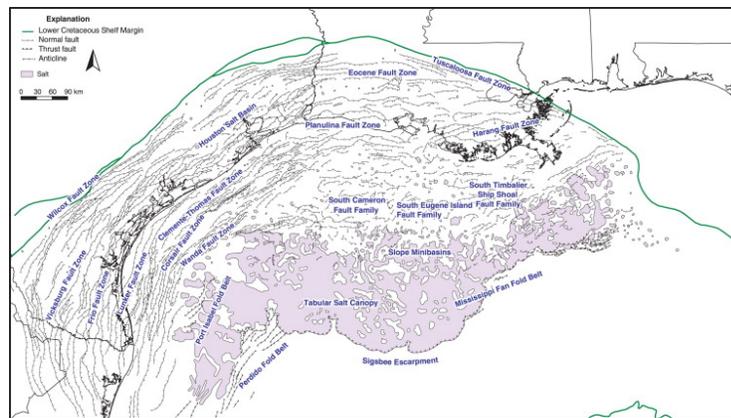
this.

<https://wattsupwiththat.com/2017/02/18/oil-where-did-it-come-from/>

These arguments, supposedly from Thomas Gold's book, demonstrate a total ignorance of the conventional theory of hydrocarbon formation and accumulation...

“(8) Petroleum and methane are found frequently in geographic patterns of long lines or arcs, which are related more to deep-seated large-scale structural features of the crust, than to the smaller scale patchwork of the sedimentary deposits.

Oil is generally trapped by structural features, commonly fault systems. Structural trends tend to follow linear and arc-like patterns...



“(9) Hydrocarbon-rich areas tend to be hydrocarbon-rich at many different levels, corresponding to quite different geological epochs, and extending down to the crystalline basement that underlies the sediment. An invasion of an area by hydrocarbon fluids from below could better account for this than the chance of successive deposition.

This is just plain ignorance. The conventional theory of oil formation and accumulation doesn't state that oil forms in situ. It forms in deeper sedimentary rocks and migrates upwards to

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regions, even where there is a minimum of sediments; and there are massive amounts of methane hydrates (methane-water ice combinations) in permafrost and ocean deposits, where it is doubtful that an adequate quantity and distribution of biological source material is present.

The methane straw man. No one has argued against inorganically sourced methane. Furthermore, the vast majority of natural gas production is not biogenic methane. It's thermogenic methane. The original source material was largely organic, however the process is not the simple decay of plant material.

“(12) The hydrocarbon deposits of a large area often show common chemical or isotopic features, quite independent of the varied composition or the geological ages of the formations in which they are found. Such chemical signatures may be seen in the abundance ratios of some minor constituents such as traces of certain metals that are carried in petroleum; or a common tendency may be seen in the ratio of isotopes of some elements, or in the abundance ratio of some of the different molecules that make up petroleum. Thus a chemical analysis of a sample of petroleum could often allow the general area of its origin to be identified, even though quite different formations in that area may be producing petroleum. For example a crude oil from anywhere in the Middle East can be distinguished from an oil originating in any part of South America, or from the oils of West Africa; almost any of the oils from California can be distinguished from that of other regions by the carbon isotope ratio.

This is because the source rocks are “independent of the varied composition or the geological ages of the formations in which” the oil has been tapped. The source rocks are structurally deeper and usually older than the reservoir rocks.

This argument from Kenny et al., 2002 fundamentally misstates the conventional theory of hydrocarbon formation, migration and

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thermodynamic-stability theory. The constraints imposed on chemical evolution by the second law of thermodynamics are briefly reviewed, and the effective prohibition of transformation, in the regime of temperatures and pressures characteristic of the near-surface crust of the Earth, of biological molecules into hydrocarbon molecules heavier than methane is recognized.

<http://www.pnas.org/content/99/17/10976.long>

The conventional theory of hydrocarbon does not bear any resemblance to a “spontaneous genesis of hydrocarbons” and the sources of energy are heat, pressure and chemical reactions resulting from heat and pressure.

Here’s a very simple example:

“ In Pescadero Basin, however, hydrothermal-vent fluids pass through thick layers of seafloor mud. As the hot hydrothermal fluid flows through this mud, it “cooks” organic material, forming methane (natural gas) and oil-like hydrocarbons. The Pescadero Basin vents contain very little sulfide, and the superheated fluids produce giant, light-colored, carbonate chimneys streaked with dark, oily hydrocarbons.

[MBARI](#)

The “oil-like hydrocarbons” were associated with hydrothermal-vent fluids which “pass through thick layers of seafloor mud” in the Pescadero Basin.

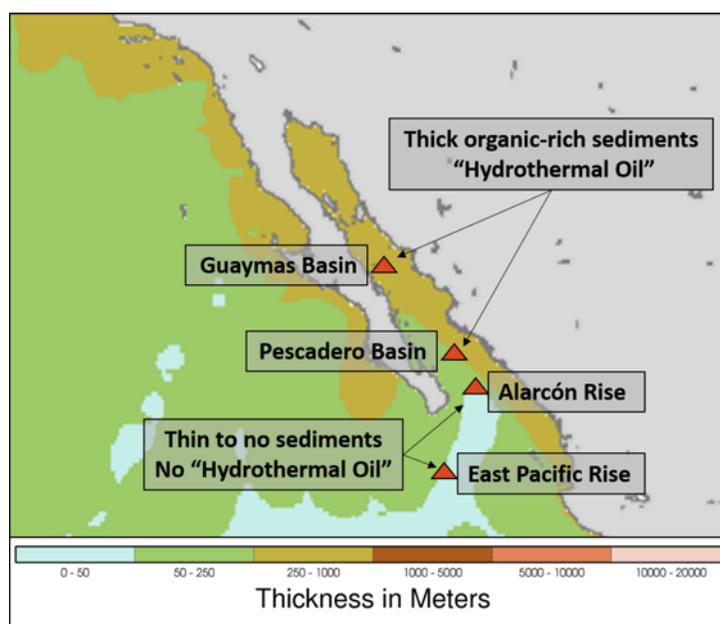
“ The Pescadero Basin is only the second place in the world where carbonate chimneys (instead of ones made primarily of sulfides) have been found in the deep sea. The other known location is the “Lost City” vent field in the middle of the Atlantic Ocean, at a spot on the Mid-Atlantic Ridge. The geologists also noticed that their rock samples smelled like diesel. They hypothesize that hot hydrothermal fluids migrating upward through the thick sediments of the Pescadero Basin “cook” organic matter in the sediment,

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Just 75 km to the south, the seafloor of the [Alarcón Rise](#) is covered with layers of relatively fresh lava flows and very little sediment. The Alarcón Rise hydrothermal vents are run of the mill black smokers, with no evidence of “hydrothermal oil.”



Petroleum-like substances have been associated with hydrothermal vents in basins with thick organic-rich sediments. However nearby hydrothermal vents with little to no sediment cover (rises) do not exhibit evidence of “hydrothermal oil.”

If petroleum was being formed in the mantle, the petroleum-like substances wouldn't be limited to hydrothermal vents in basins with thick organic-rich sediments.

Furthermore, the “hydrothermal oil” of the Guaymas Basin is extremely young and relatively rich in ^{14}C ...

“*Nature* 342, 65 – 69 (02 November 1989);
doi:10.1038/342065a0

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PETROLEUM-LIKE hydrocarbons have been detected in thermally altered Recent sediments of Guaymas Basin 1–5 and petroleum-like hydrocarbon impregnations were found in hydrothermal mounds on the sea floor and associated with hydrothermal vent emissions 5–9. Here we report the evaluation of such a hydrothermal oil, which we find to be similar to conventionally exploited crude oils. Its young geological age (< 5,000 yr, ¹⁴C) ¹⁰ indicates that a significant fraction of the organic carbon in the oil has completed the transformation from biomass to migrating oil in less than 5,000 years, thus limiting the oil generation, expulsion and migration processes to a geologically short timescale. We estimate the generation potential of such hydrothermal oil and discuss its implications to our understanding of the petroleum generation, expulsion and migration mechanisms.

<https://www.nature.com/nature/journal/v342/n6245/abs/342065a0.html>

The Lost City hydrothermal vent on the Mid-Atlantic Ridge and the Pescadero Basin are the only two known places where carbonate (rather than sulfide) chimneys have been found. While there are similarities between the Pescadero Basin and Lost City, there's a big difference...

“ Deep-ocean vents are a source of oil and gas

Hydrocarbons bubble up from the mid-Atlantic's Lost City.

Rachel Courtland

Undersea thermal vents can yield unexpected bounty: natural gas and the building blocks of oil products. In a new analysis of Lost City, a hydrothermal field in the mid-Atlantic, researchers have found that these organic molecules are being created through inorganic processes, rather than the more typical decomposition of once-living material.

Most of the planet's oil and natural gas deposits were created when decomposing biological matter is 'cooked' in high temperatures underground. But non-biological hydrocarbons have also been found deep inside the Earth, where chemical processes create the molecules from inorganic sources such as rock.

[...]

Among other measurements, the team analysed the

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process called the Fischer-Tropsch process is at work in Lost City, creating bigger and bigger hydrocarbons in the hydrogen-rich environment. Although the concentrations were too low to detect without a filter, small amounts of larger hydrocarbons such as kerosene and octane may also be produced.

The team also found that the methane in Lost City contained no carbon-14, suggesting the carbon source for the hydrocarbons comes from within the mantle, far away from organisms that might have had contact with the global carbon cycle at the surface.

[...]

Nature

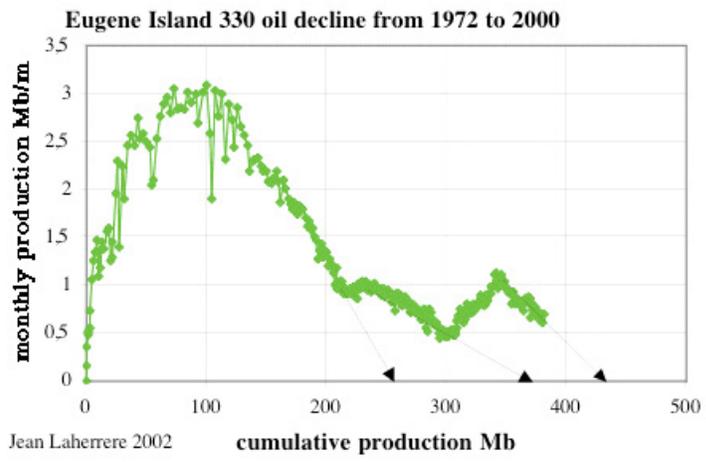
Setting aside the fact that “the building blocks of oil products” are not the same thing as oil (in much the same manner that a 2×4 is not the same thing as a house)... The carbon in the Lost City hydrocarbons is either so old that carbon-14 is undetectable or it has never “had contact with the global carbon cycle at the surface.” So, the methane and the traces of heavier hydrocarbons at Lost City were almost certainly sourced from inorganic substances. While the traces of “hydrothermal oil” in the Pescadero and Guaymas Basins were almost certainly sourced from organic substances.

If “Earth’s hydrocarbons are a renewable — i.e., inexhaustible — resource,” then no oil reservoir would ever exhibit a decline curve and every reservoir that has ever been produced has eventually exhibited a decline curve. Oil and gas are continuously formed in the Earth’s crust and continuously migrate into reservoir rocks. This process has possibly been documented with a 4d seismic survey in Eugene Island 330 Filed, the largest Gulf of Mexico oil field, not in deepwater. However, even EI 330 exhibits a decline curve...

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It's still producing and it will continue to produce until the production rate not longer justifies the operating expenses. We simply produce oil & gas at a rate many orders of magnitude faster than the Earth makes it, even if it was forming in the mantle.

Ultimately, it doesn't matter how hydrocarbons form. They have to be produced from economically viable accumulations... which only occur in or adjacent to sedimentary basins.

All that said, we have probably only consumed about 16% of the recoverable petroleum on Earth. From a human perspective, it might as well be infinite.

MarkW November 13, 2018 at 2:59 pm

Fossil fuels are found in those places where biogenic origin predicts they will be found. Fossil fuels are not found anywhere else.

David Middleton November 13, 2018 at 3:00 pm

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producible volumes.

DeeDub November 13, 2018 at 3:38 pm

Is there another kind? 😊

David Middleton November 13, 2018 at 3:53 pm



GeONC November 13, 2018 at 11:52 am

Thomas Gold may have been a competent chemist but

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hydrocarbons recovered from granitic reservoirs, they are demonstrably tied to organic source rocks.

David Middleton November 13, 2018 at 12:09 pm

There was a “sniff”...

“Asphaltene-Like Material in Siljan Ring Well Suggests Mineralized Altered Drilling Fluid (includes associated papers 20322 and 20395)

The chemical characterization showed that this material contains small amounts of hydrocarbons maximizing in the diesel range. No heavy hydrocarbons were identified, except for trace amounts of polycyclic aliphatics. From the chemical and stable isotopic characterizations, we concluded that the black gelatinous material is derived predominantly from the alteration of biodegradable nontoxic lubricant (BNTL) additives by caustic soda, admixed with diesel oil and trace amounts of polycyclic hydrocarbons from recirculating local lake water. No evidence for an indigenous or deep source for the hydrocarbons could be justified.

<https://www.onepetro.org/journal-paper/SPE-19898-PA>

The “asphaltenic-type material” was most likely derived from the drilling fluid used in the well.

Andy May November 13, 2018 at 11:54 am

DeeDub, abiotic methane and even ethane are relatively common in the solar system. It would not surprise me if some propane and butane (C3 and C4) were found at some point. But, abiotic C5 and higher would be tough to make abiotically.

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There may even be traces of octane at Lost City.

DeeDub November 13, 2018 at 2:56 pm

Thank you David, Andy, and GeoNC, much appreciated.

Even though I run a technology startup (industrial wastes to building products), I am neither a scientist nor an engineer, nor do I have a dog in this fight, other than to say just as I once went along with the crowd about Global Warming (back when it was called that), only to change my mind on closer examination, I have come to wonder about the “fossil” nature of Earth’s hydrocarbons.

Granted, Earth’s hydrocarbons might be sufficiently plentiful either way — regardless, they are or will be economically recoverable to meet humanity’s needs until such time as other forms of energy out-compete them — but I must admit that the idea of coal, oil, and gas being renewables is a particularly attractive one in that it would be a lovely finger in the eye of today’s CO2-obsessed “Green” movement (no matter, as even NASA admits — <https://www.nasa.gov/feature/goddard/2016/carbon-dioxide-fertilization-greening-earth> — that manmade CO2 emissions have greened the Earth the equivalent of more than twice the size of the continental United States).

“You want renewables, you fancy-pants watermelons? Here, try THESE on for size.”

So, for what it’s worth:

http://www.gasresources.net/energy_resources.htm

<https://en.reseauinternational.net/needless-wars-over-oil>

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David Middleton November 13, 2018 at 3:22 pm

I apologize for my initial “gruff” reply... I’m just a grumpy old geologist.

MarkW November 13, 2018 at 2:55 pm

Methane only, no oils.

When carbon and hydrogen get together in the absence of oxygen, methane results. Nothing mysterious about it, considering how common carbon and hydrogen are in the universe.

The earth has had an oxygen atmosphere for billions of years. Long enough to break down all of the methane that it received during it’s formation. (Assuming any of the methane managed to survive the heat of formation.)

Steve R November 13, 2018 at 3:12 pm

Lack of oxygen. Hydrocarbons remain in their reduced state indefinitely.

Martin557 November 13, 2018 at 9:15 am

Not exactly off topic, however, shouldn’t we be working with the greens and let them know about the geo-thermal energy that is still there when the well is done? The way I look at things, there is massive potential for energy that we could use. And it’s renewable.

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IIRC, geothermal wells are much shallower than what we're talking about here, and effective ones are in the range of 350°C. That suggests magmatic intrusion that would thoroughly cook off any oil or gas down around the 6 km mark.

Martin557 November 13, 2018 at 10:40 am

Yes, I understand that part. But the length of the heating surface, could offset the needed temp. These Oil companies are actually energy companies and there is energy there. We just need to figure out how to use it. IMO

James Allen November 13, 2018 at 9:48 am

What a superbly written overview. Thanks very much for sharing this.

J Mac November 13, 2018 at 9:58 am

Andy May,
Excellent overview!

F. ROSS November 13, 2018 at 10:20 am

Very interesting... thank you.

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production will require a lot of capital and change in the risk reward environment there. I don't think one or two large energy giants can do alone in a concession approach. Seizing the asset after its partly developed (e.g Shell Oil) will also not work well in the drilling intensive approach of shale basins.

john November 13, 2018 at 12:37 pm

Russia is now a Kleptocracy where the biggest crooks run everything, including the oil industry. More oil production will only strengthen the crooks hand.

Duane November 13, 2018 at 10:25 am

Excellent technical review .. more than I wanted to know, LOL, but still enjoyable for this gray-haired civil engineer.

For those who would claim that shale oil or fracking are illusory production models, it is worthwhile to consider that 40 years ago, in 1978, a few years after the first Middle Eastern oil cartel embargo, gas was selling in the US for about seventy cents a gallon at the pump ... using a CPI calculator for inflation since then, that implies a gas price today of \$2.71 a gallon. Right now, I am paying about 30 cents a gallon less than that here in south Florida.

So after all the talk about peak oil, and after the industry has been made to comply with tremendous amounts of environmental and land use regulation all of which pose a significant cost (not just on oil production, but also on transportation and refining costs as well), the end result is today gas is still significantly cheaper than 40 years ago.

So some of this new production stuff has to be working pretty well. The market says so.

Oh, and the other thing is, the US this month surpassed both Russia

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Steve R November 13, 2018 at 3:28 pm

I kinda wish the US never adopted the term “Gasoline”. It is far to tempting to shorten it using the slang term “gas”.

David Middleton November 13, 2018 at 3:35 pm

I often wonder how many people think that the Oil & Gas industry is the Oil & Gasoline industry and that Natural Gas is a separate industry.

Steve R November 15, 2018 at 3:18 pm

Natural gas is so much better for the environment than the synthetic type.

Paul Chernoch November 13, 2018 at 11:37 am

Thank you for the informative article. I work for one of the majors, but I am a computer programmer, not a petrophysicist, so bite-sized articles about how it all works are useful. Saves me having to read the drilling operator manuals.

Toto November 13, 2018 at 12:08 pm

“In the United States and Canada, the plays are being developed on private land where the land owners own the minerals and receive

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it is not that simple. In Canada, common law originally gave land owners mineral rights, but that progressively changed. Now the provinces are the major holders of mineral rights.

<https://www.pipelinenews.ca/opinion/columnists/mineral-rights-in-canada-1.2102451>

Andy May November 13, 2018 at 2:05 pm

Thanks, I didn't realize that so much of it was crown acreage.

Ken November 13, 2018 at 12:28 pm

Almost all of the oil and gas resource in Canada is owned by the 'Crown', that is, the provincial governments. The various governments make a lot of money 'leasing' the resource to upstream operators. The operators only have to deal with land owners to get surface access. The leases are for a fixed time and operators have a required amount of activity to hold the lease, typically seismic, drilling and production. The oil business has thrived in Canada because the governments have been relatively honest in their dealings with operators. In recent years 'green' advocates, often financed from the USA, have become more active and have convinced governments to make the oil business in Canada more risky and the major world players are leaving. The Canadian governments seem to think Venezuela is a good model.

bit chilly November 13, 2018 at 3:38 pm

fantastic article ,a really informative read. great comment stream as well, particularly that of david middleton in reply to the abiotic oil query. many thanks to both andy and david.

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Methane in groundwater is a very natural phenomenon. Where I live in the West of the Netherlands we live some meters below sea level. The peaty soils that were produced in the Holocene during times of rising sea level later became covered by clay from the sea when the sea overflowed the peat. In the peaty soils methane was produced by the rotting of the plant material the peat is consisting of. The impermeable clay that covered the peat kept the methane below. A pipe through the clay is enough to get the clean groundwater with the gas upwards. You can use the water for drinking and cooking.

Having had some years an office in an old farmhouse in the nineties I myself was using that kind of gas for some cooking and for heating my office during winter. Old farmhouses also used the gas for lightning. This video (unfortunately in Dutch) shows the gas wells and the way some 4500 farms were using the gas that came up from some meters below the surface to (depending on the location) from 60 meters below ground level. A pipe through the clay was enough to get the water with the gas upwards and in the well the gas was separated from the groundwater, after which the methane became stored in a floating tank.

<https://youtu.be/rGxrON73JKk>

In summer time you can see a lot of bubbles in our canals and lakes: methane from rotting plants on the bottom or from the peaty bottoms themselves. Sometimes in the lakes several square meters of peat from the bottom become floating because of the abundant gas that is formed during a period with warmer weather. When you put a stick in the mud on the bottom of the canals you can see the methane bubbles coming up. The next video is about a farmer who shows how he fills a bucket with natural bottom gas (just by stirring in the bottom of a small canal) and after that he is igniting that natural methane.

<https://youtu.be/-Kl67IopatU?t=172>

Methane in ground water: it is very natural. I have never seen something else in my life. When we were fishing in the canals we saw the activity of fishes at the bottom where methane bubbles were rising. Then we knew: a good place to fish.

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GREG in Houston November 13, 2018 at 5:51 pm

No, it wa correct as written.

Curious George November 13, 2018 at 7:13 pm

Off Topic – do we have a theory of origin of methane clathrate deposits?

Andy May November 14, 2018 at 4:37 am

Great story Wim! Thanks.

GREG in Houston November 13, 2018 at 5:52 pm

PS: could be methane in groundwater

Farmer Ch E retired November 13, 2018 at 6:38 pm

Andy – great article – thank you for increasing our understanding and perspective.

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Lil Fella from OZ November 13, 2018 at 8:14 pm

Very informative, thank you.

Paul November 13, 2018 at 8:15 pm

Andy, as someone who worked in the Permian as a production engineer back in 1968 I wonder when they will go back in all the productive formations, non shale, with horizontal drilling and fracing long intervals. Back then you fraced a ten foot thick formation with 10 perfs and pumped until the formation broke down and produced for 5 years then refraced. Cost was about \$3000 and you got about \$2.50 a barrel.

Andy May November 14, 2018 at 4:42 am

Paul, Already being done. Most of the old fields, like SACROC and Yates, are now being developed horizontally.

David Middleton November 14, 2018 at 4:52 am

And Gwahar too. SACROC is really cool!

Dario from Turin November 14, 2018 at 1:38 am

THANKS for a really GREAT article!!!

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Oatley November 14, 2018 at 5:07 am

This is the best site on the internet for pure learning. The comments are rich with information tempered with experience. Thank you all.

Renee November 14, 2018 at 5:55 am

Andy,

Thanks for a well written and factual post. The technologies utilized to economically produce shale hydrocarbon resources are a tribute to unconventional ideas. Funny how so many oil companies initially missed out based on conventional thinking.

Bill Rocks November 14, 2018 at 8:00 am

Andy and David,

Excellent. Very useful and skillful overview document and responses to questions. You demonstrate why you have had successful careers as scientists. Ya got the right stuff!

I appreciate your good work to communicate.

Richard George November 14, 2018 at 5:52 pm

Andy:

Excellent and informative post. Thank you for the hat tip to that gruff Texas oilman George Mitchell who stubbornly kept trying to

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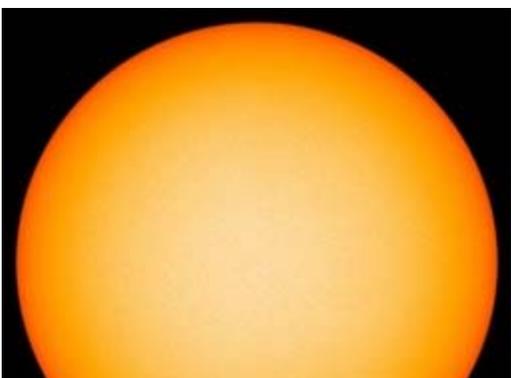
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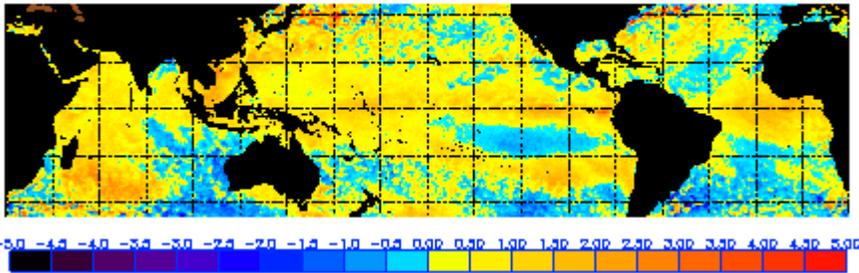
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