Radioactivity and Shale Gas: Some Like It Hot?

Tags: Energy Environmental Policy Natural Gas Nuclear Power radioactivity shale gas uranium

8 comments Posted December 1, 2010 by David Lewis

The shale deposits that have the US gas industry so excited were studied after WWII by the Atomic Energy Commission and declared to be the largest uranium resource in the US.

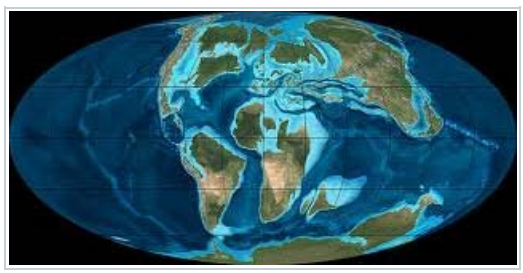
Because the gas industry is now going after gas by drilling into a uranium resource their new gas is contaminated with many times the radiation their former product contained.

According to Dr. V.E.Swanson, author of: ***Oil Yield and Uranium Content of Black Shales***: "the amount of uranium in these shales is extremely large reckoned in billions of tons of metallic uranium."

Why aren't companies mining for uranium? There is a catch. Richer deposits were discovered.

Supposedly, when uranium becomes scarce they're going to mine it from sea water. But first, they'll go for what is in these shales. Sea water contains about 3 parts per billion uranium. The US shales that have all the new gas average out between 16 - 20 parts per million uranium, which is a concentration 5,000 times higher.

The richest gas and uranium bearing shales are former shallow ocean bottoms. Hence the immense extent. A large area of the US happens to be former ocean bottom. Here is a world map showing the oceans as they looked in Cretaceous times:



Geologists call some deposits that were formerly the bottoms of these oceans "marine black shales". Bits of dead carbon based lifeforms and their wastes constantly rain down on ocean floors all over the world and accumulate along with clay and bits of rock as sediment. The organic matter preferentially absorbs, i.e. concentrates, some of the dissolved uranium that exists as parts per billion in all ocean water. Over millions of

years a thick layer builds up. As conditions change layers of different composition build up on top which compress and heat the deposit. The organic matter is cooked into hydrocarbons: i.e. the gas and oil. The concentrated uranium sits there mixed in with it.

Hundreds of tons of uranium were refined from a shale deposit very similar to the US shales that contain gas, in Sweden from 1950s to the 1980s. (See page 22 in this paper.) The Alum Shale there, compared to all known shales here, is a bit higher grade if evaluated as a uranium deposit. It is now uneconomic to produce uranium from deposits of this type. Ore deposits that become uneconomic get reclassified from "reserve" status and are then called part of the "resource". As the world runs out of richer deposits, or if prices rise and/or new technology is discovered, parts of the "resource" are reclassified into parts of the "reserve" and mining begins again.

Whatever the classification scheme, all those billions of tons of uranium are in the US shales, intimately mixed in with all the new gas.

Shale gas was once a lowly "resource" like this. The DOE mapped it out just after the energy crisis in the early 1970s. The resource was found then to be colossal, but no one knew how to extract it economically. Higher prices and new technology ("fracking") turned the "resource" into a "reserve".

Uranium in shale tends to be most concentrated precisely where the greatest amount of gas in shale is. Perhaps you can see now where this article is headed. Studies were done on the same US shale formations from two very different perspectives, i.e. by those looking for uranium and by those looking for gas. I looked at both.

I was wondering how much radioactivity is in the new shale gas.

A bit-o-background: all natural gas is contaminated with some radioactive radon gas. Radon is produced constantly as the uranium in all rocks undergoes radioactive decay. Natural gas extracted from a uranium deposit contains more radon than natural gas extracted from ordinary rocks. Radon decays rapidly which means it is highly radioactive. It lasts long enough to reach places where the natural gas is consumed, like your home. Burning it mixed with natural gas in, say, in a cookstove doesn't change it at all. It survives the flames and enters the room air where you can breathe it. If it decays in your lungs, the cells nearby are blasted with ionizing radiation at close range. This is one way cancer is known to be initiated.

There isn't a lot there. If you cook and heat with gas, you get exposed to a dose of radioactivity a mere 15 times what you'd be exposed to if you lived right next door to a nuclear reactor and you used nuclear electricity to cook and heat with instead of gas. Because reactors emit so little radiation, 15 times as much as what living next to a reactor exposes you to isn't dangerous.

The authorities I got the 15 times figure from put it online to show people who worry about nuclear reactors how safe they are. They weren't trying to pin a label of radioactive danger on natural gas. But how will people feel if the new gas exposes them to hundreds of times more radioactivity than a reactor?

Turning to the DOE study: Review of Rn^{222} In Natural Gas Produced From Unconventional Sources:

"If one were to assume that the US average concentration of 37 pCi/l of Rn^{222} in natural gas were due to approximately 3 ppm U^{238} in the reservoir rock, the 151 pCi/l of Rn^{222} observed in the gas from Devonian shale wells is roughly in proportion to the overall average 16 ppm U^{238} observed in Devonian shale."

This gibberish can be turned into useful information. What that paragraph says is if we know how much radioactive uranium is in the "host" formation they are extracting any gas from, we can have a good idea how much radon will be in the gas, and hence, how much of a radiation dose we will get as we use that gas. The radon/uranium ratio was observed to stay relatively constant even as the uranium content varied fairly radically.

That study was intended for the gas industry. It is in the interest of the gas industry and those scouring the

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US for new places for them to drill to ignore or minimize the existence of uranium. And, the focus was on a shale gas industry when it was still a gleam in some gas driller's eye. It assumed the average Devonian shale to be only 5 times as radioactive as the average host formations are that the good old regular gas comes from, and ignored radical deviations. Devonian shale is one major type the gas industry is looking at when they talk about the massive new reserves. Devonian is a subcategory of gas bearing shale: geologists refer to "marine black shales" as generally rich in gas.

But let's go back to Swanson, the Atomic Energy Commission study guy. He said this about marine black shales: "most contain less than .01% U^{238}" That's 100 p.p.m. That's 33 times as much radioactivity as the host formations for regular gas.

Swanson described "hundreds of square miles" of Tennessee where there is a 15 foot thick layer of marine black shale bearing U^{238} at 60 ppm. That's 20 times as much as an average host formation they extract regular gas from.

Returning to the DOE study. It couldn't look at shale gas in much detail. The industry did not exist compared to today: the study was written in 1980. As it says: "it has not been possible in every case to directly obtain information... ...that could be considered typical of future production."

The Atomic Energy Commission study guy, Swanson, published another paper He examined an extremely high grade (for a marine black shale) sample containing uranium in Arkansas in 1962. This was a sample that contained 0.55% U^{238}. He described a report on another sample in the area he didn't see personally which was 0.71% U. Incidentally, that's 5,500 and 7,100 ppm U^{238}, respectively. These are not typical.

At that time he summed up the US shale situation this way: "marine black shales... have an average uranium content of about .002% and a general range of about .0008 to 025%.

That's 20 ppm average, a bit higher than the DOE found later. But note the high end of the range. 250 ppm.

Consider how they explore for gas.

I found an online edition of *Pennsylvania Geology* which contained an article by one of the geologists who originally mapped out the Eastern Gas Shales for the DOE. He had some advice for companies who want to prospect for shale gas. I quote:

"RADIOACTIVITY = ORGANIC RICHNESS = GAS... [my note: the gas industry prospects for shale gas with a type of geiger counter] Organic-rich shales have higher radioactivity responses than typical shales because the organic matter tends to concentrate uranium ions that otherwise would be scattered throughout the sediment.... ...higher-than normal gamma-ray response also equates to gas-production potential. The correlation might not be 100 percent, but it is very high. This is a very important concept for those looking to produce shale gas. Many companies would look for places where the entire formation is thick, but they should actually be looking for where it is most rich in organic matter."

In other words, companies are being advised to look for shale that is the most radioactive if they want to find shale with the most gas.

The shale formations they want to find gas in can have as much as 250 ppm U^{238}. If they have that much they are 80 times as radioactive as "normal average", good old red blooded American conventional gas.

80 times the radioactivity of normal average gas is going to expose consumers to 1,200 times the radiation dose they'd get if they lived right next door to an operating nuclear reactor.

I'll certainly be sleeping a lot more soundly tonight now that I know this.

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About David Lewis

David Lewis made pottery in rural Canada for a number of years starting in the early 1970s. He felt a call to become an activist over ozone depletion after the Antarctic ozone hole was discovered. He became a voice for conservation of the planet in Canada, especially on climate, after he attended the Toronto Changing atmosphere conference in 1988 as a delegate and discovered that eminent scientists shared his concerns. He staked his prospects for success as a politician beginning in 1988 on whether voters would support stabilization of the composition of the atmosphere. Obviously, voters have yet to do this. David is somewhat disturbed to find himself a member of a dying civilization. He lives near Seattle these days with his wife and two dogs.

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John from PA said:

David,

Really Outstanding!

My specific interest is gas drilling here in PA and the Delaware River Basin (my general interest extends far beyond and seems to be in sync with yours).

James Northrup of Otsego2000 in NY first brought this long neglected problem to my attention in an interview some months ago. I hope it quickly takes its place among the other severe consequences of the growing natural gas madness. Fracking has gone global & your voice is important..

TURN IT UP

Thanks

reply 0 points Sun, 2010-12-12 08:34 — John from PA

David Lewis said:

Thanks for the reference to Northrup. He has written an article "Radioactive Waste from Horizontal Hydrofracting" on the radioactivity that contaminates the fracking water when they drill into the Marcellus Shale.

In his references to that article is this Scientific American article: "Natural Gas Drilling Produces Radioactive Wastewater" , which was written by the ProPublica author Abraham Lustgarten with help from Sabrina Shankman and is probably the same thing as what Rod Adams reposted on TEC not long ago.

The writer refers to this radioactivity as some mysterious NORM i.e. "naturally occuring radioactive material", without twigging on to the fact because the gas is being "fracked" from a uranium deposit, the source of the radioactivity isn't mysterious or an isolated case. It isn't "natural" in the sense this is like conventional gas operations that have gone on in the past, where some small percentage of the gas was extracted out of rocks as highly radioactive as these shales. All the gas shales as a group, because they are marine black shales are far more radioactive than normal rocks gas is extracted out of.

reply 0 points Sun, 2010-12-12 18:41 — David Lewis

Meredith Angwin said:

Terrific post! I was in a debate a few days ago with the local VPIRG (Vermont PIRG) energy person. He said that we didn't need Vermont Yankee: "It's an old plant leaking tritium." He was pleased to explain that abundant shale gas will be available and keep electricity prices low. I wish I had known some of these numbers before debating him.

reply 0 points Sun, 2010-12-05 07:38 — Meredith Angwin

David Lewis said:

VPIRG's "Repowering Vermont" plan carefully avoids all mention of shale gas.

If they are going to talk shale gas, you can bring up climate implications as well as its radioactivity.

Hit them with Dr. Robert Howarth's research. He's got a paper in the process of peer review. I was able to get some info out of him which I summarized here. He makes a case that previous use of gas up to now, globally, has had a worse impact on global warming than the use of coal. The industry found it economic to leak a lot of methane which is a far more potent greenhouse gas than CO2. E.g.: they power a lot of gas field equipment in remote areas where gas is, when they don't have access to the electric grid by using gas as if it was compressed air.

One gas tout waved around a recent General Accounting Office "study" of the US gas industry saying it supports a case that the US industry is squeaky clean on this front. That study actually confirms Howarth. The touts have never had to look into how to defend their industry on this point before. Gas has been getting a free ride from types like VPIRG, as they crucify nuclear for no good reason, and its time for it all to stop.

reply 0 points Sun, 2010-12-05 10:43 — David Lewis

RodAdams said:

@David - thank you for your excellent research.

For the record, I am still not terribly concerned about the health effects of radiation exposures that are 15-1,000 times what you get from living next door to a nuclear reactor. Much above that level, however, starts to get into a region where I would at least like to measure the levels so I can know when to start worrying. As many people are beginning to understand, the health effects of low level radiation can actually be positive. That is only reassuring to me when I have a way of knowing that what level I am getting. I felt pretty darned good when I was on a nuclear submarine, wearing a TLD constantly and getting that device read monthly.

There is no doubt in my mind that the oil&gas industry will work very hard to suppress the information in your post. I am already getting comments on Atomic Insights from never before heard commenters telling me not to worry about NORM. Funny how those comments never seem to come when ignorant people like the new Vermont governor make a big deal about picocuries (1 x 10^-12 curies or 1 x 10^-16 grams) of tritium.

reply 0 points Sat, 2010-12-04 06:24 — RodAdams

David Lewis said:

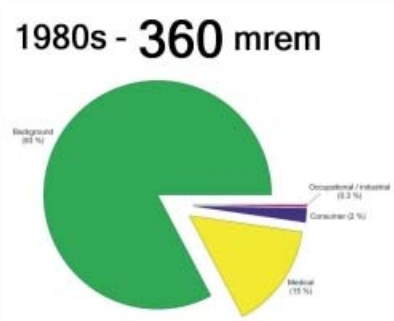
If any gas tests this high its 720 mrem.

I agree with your view that radiation is not as harmful as people have been led to believe.

When it comes to radiation, you have to test for it. But in this case I just made some assumptions and calculated. Idaho State says using ordinary natural gas in the home exposes you to 9 mrem. Shale gas extracted from a uranium resource at the high end of the normal range cited by Swanson would be 80 times more radioactive than 9 mrem, or 720 mrem.

The NRC allows nuclear workers, who understand the risks and who are well paid for taking them, to receive 5,000 mrem. Authorities have stated children should not be exposed to more than 500 mrem. Most would agree with limiting unnecessary doses for children. Who needs natural gas in the home so badly they'd tack on 720 mrem to what they and their kids are getting already?

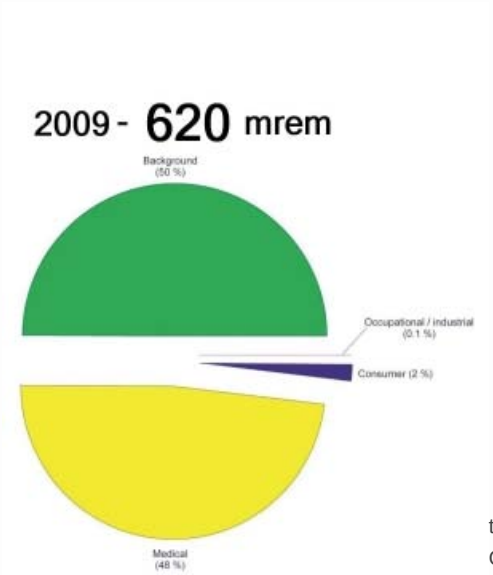
The National Council on Radiation Protection reports that we're all being subjected to a steadily increasing dose greater on average than any previous human beings, because we go to doctors demanding medical imaging tests. The doctors add in extra medically unnecessary testing to defend themselves against our lawyers. I worked out a graphic interpretation of how things have changed since the early 1980s.



In the early 1980s the same background radiation that has bathed all life on Earth since life first existed still dominated the picture. That big green pie slice on this chart is all normal background radiation sources lumped together. This chart was published in report 93 by the NCRP in 1987. Radiation entering the planetary system from space, what emanates from the ground we stand on, what radioactivity we've ingested with our food that remains inside us, the radon gas we've inhaled, etc., its all in that green slice. What we were doing to ourselves in workplaces, with medical imaging, and consumer products are the rest of the slices.

Compare that 360 mrem total radiation dose to my calculation for using hot shale gas at 720 mrem. But this picture from the 1980s has changed drastically. I note here that a lot of online sources are using the old data NCRP published in 1987. Verify the source data before thinking I'm wrong here. Here's what the NCRP update, its report 160 published in 2009 , said:

> This chart is to the same scale. What was in the green slice in the 1980s is still about the same amount, but because medical imaging has increased to equal the total of natural sources, the entire pie chart has grown in size to 620 mrem. The average American is now exposed to much more radiation than was the case only decades ago.
>
> All medical imaging is added up



together. It is the yellow slice. Occupational radiation and whatever is in smoke alarms and other consumer products is the other tiny slice.

This level of radiation is not regarded as dangerous. But the fact that it is increasing so radically is a cause for concern. Authorities would like to see the total stop increasing. The data for this chart is from 2006. The NCRP announced that medical imaging is now greater than 50%.

So sources that don't matter to an individual should be eliminated. We all want to receive the best medical care. If we were less trigger happy with our doctors and stopped suing them we could cut out 1/3 of the increased medical right there.

Do we need to use contaminated gas because fossil fuel interests want to continue on with their activites no matter what the cost to future generations is, even if that cost is the viability of the planet to support life? Should we buy into what environmentalists say as they tell us gas is "green", even though it is clear that the history of gas use with its attendant leakage means the net climate impact of global gas use may well have been as bad or worse than coal? The environmentalist position that nuclear power is too dangerous to use evolved before they realized that climate change was real. The Sierra Club once promoted nuclear power as a better alternative than big hydro dams, because the dams flood so much good land. The exposure the average American gets from the entire nuclear industry doesn't even show up on a chart like this. The dose is too small.

I'm moving to right next door to a nuclear reactor where its safe. I'll only get a 0.6 mrem - 1 mrem additional dose there.

I originally became interested in how much radiation the use of natural gas causes people to be exposed to because it was obviously so much more than what nuclear reactors cause. I saw that some of the people who promote natural gas and ignore its radiation hazard are the same ones who want the nuclear industry shut down over any tiny speck of radiation that can be pinned on it.

reply 0 points Sat, 2010-12-04 17:36 — David Lewis

CharlesBarton said:

Excellent post!

reply 0 points Fri, 2010-12-03 10:38 — CharlesBarton

willem Post said:

Charles,

I agree with your "excellent post" comment. News travels fast. Will it affect future shale gas production and use? Will fracking become a ground water problem?

How do I add my vote to the article?

reply 0 points Fri, 2010-12-03 18:01 — willem Post

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