Shale Gas Wastes: Ohio Public Policy & Potential Impacts to Water Supplies

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2013 Focusing on Shale Gas Wastes

- **Ground Shale Rock:** hydrocarbons, heavy & radioactive metals, Ohio–NORM, **US EPA-TENORM**
- **Drilling Muds:** who knows what, **TENORM**
- **Fracking Fluids:** water, sand, who knows what, if recycled, are they **TENORM?**
- **Brine:** salts, hydrocarbons, heavy & radioactive metals, Ohio-NORM, **US EPA-TENORM**
- **Drilling Site Wastes & Accidental Releases:** who knows what is being released
- **Where are they coming from?**
- **Where are they going?**

Why the Current Concern?

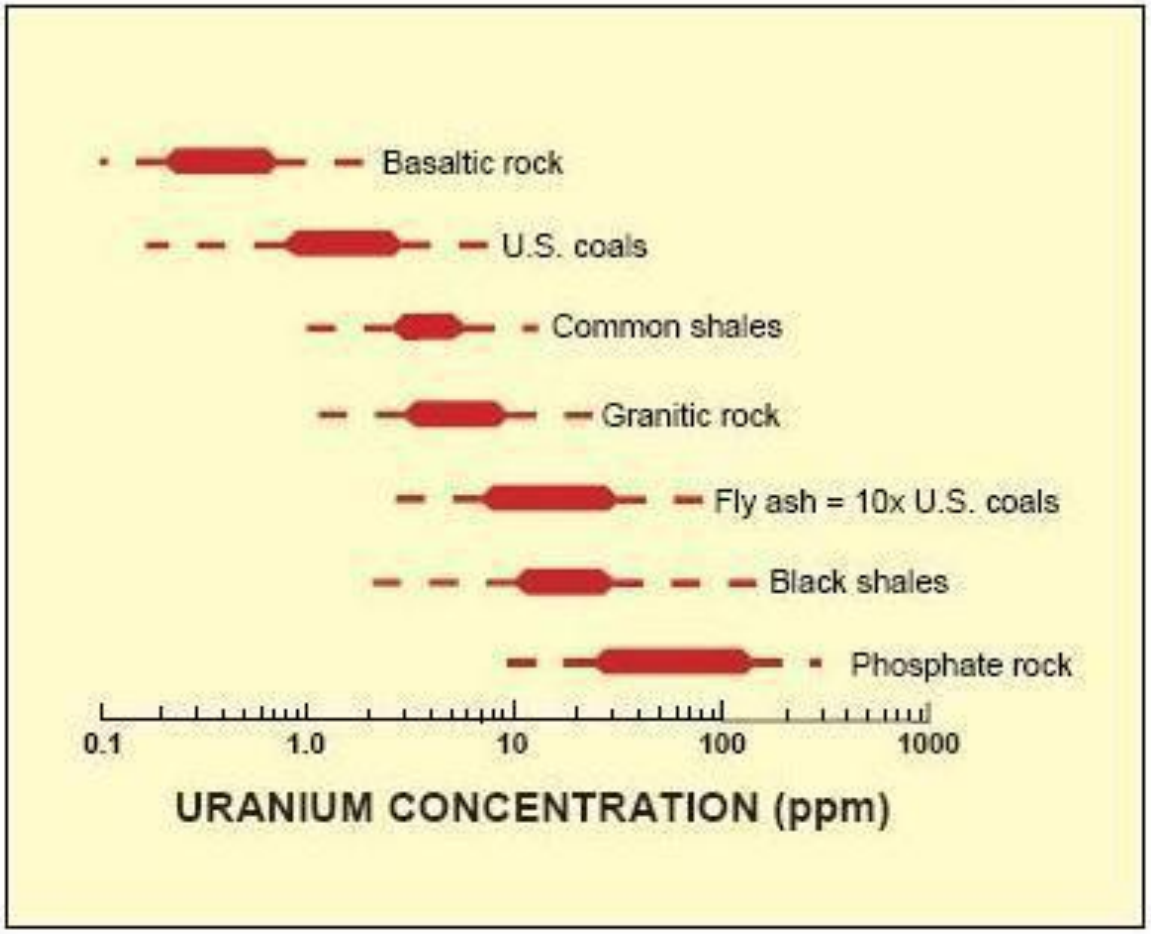
- **Ohio has paid for State & Local governments by taxing** (tipping fees, etc.) **out of state waste streams** (solid, C&DD, industrial, medical, O&G, etc.) **for last 20+ years**

- **Shale Gas drilling has created a big, new waste stream not addressed by surrounding states** - seen as a new & easily captured revenue source by Ohio's Administration

- **Ohio DOES NOT have magic GEOLOGY**
  - that can swallow all wastes without repercussions

Why the Current Concern Cont?

- **Blacks shales are early sources of Uranium ore for the "Atomic Age"** (Chattanooga Shale, TN; USGS, 1961)
- **Black shales like coal are full of heavy and radioactive metals:** ^{232}Th to ^{228}Ra & ^{238}U to ^{226}Ra are most common series
- ^{228}Ra, ^{238}U & ^{226}Ra water soluble, also in brines
- **US EPA limit on Uranium mill tailings, 5 pCi/g because of the Radium:** > LLRW Landfill, Utah or Washington State accept NORM
- **US EPA Drinking Water MCLs 5 pCi/l for Radium**



Typical range of uranium concentration in coal, fly ash, and a variety of common rocks.

Figure 1. Graph from Radioactive Elements in Coal and Fly Ash: Abundance, Forms, and Environmental Significance. U.S. Geological Survey Fact Sheet FS-163-97. October, 1997

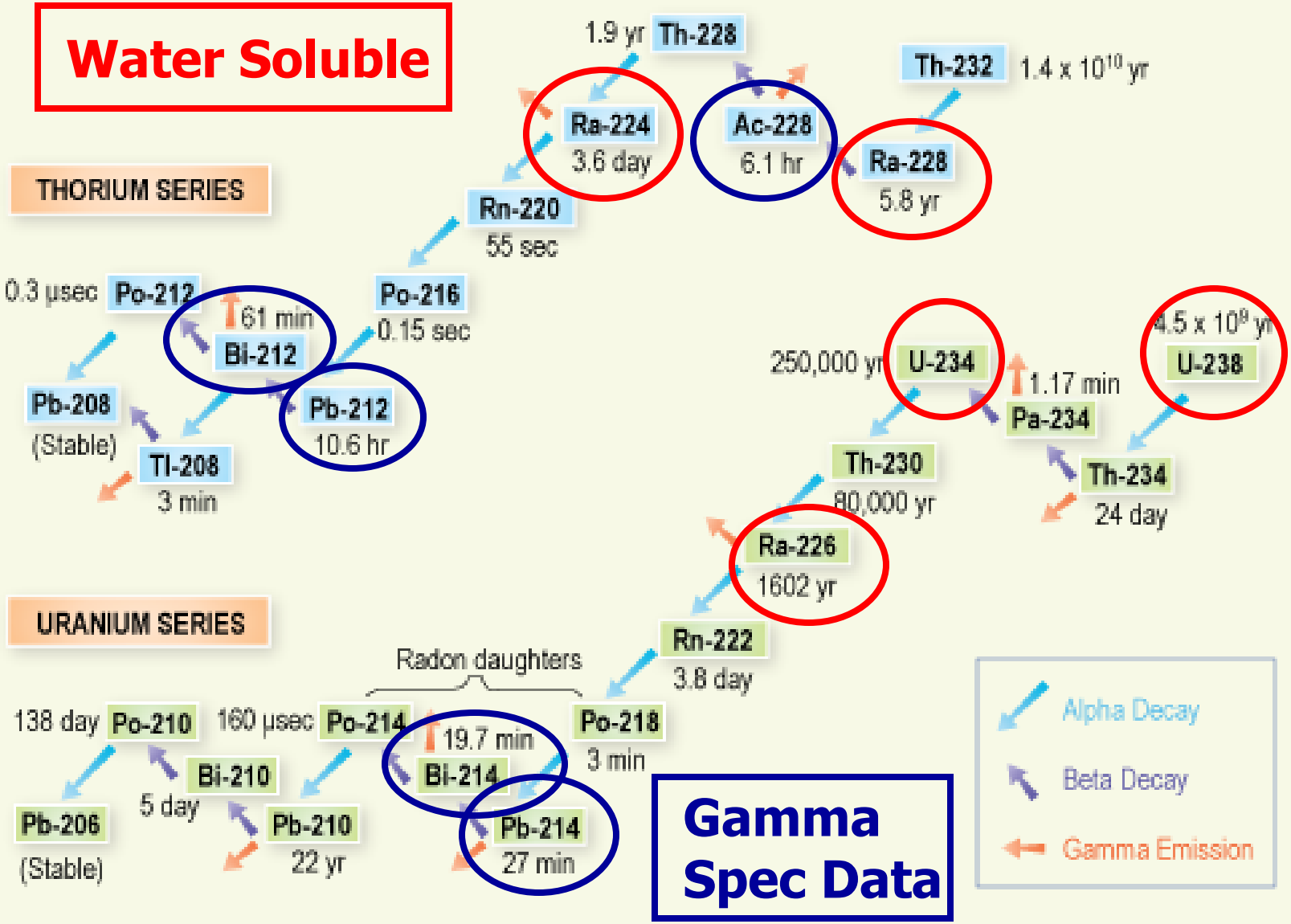
Why the Current Concern Cont?

- **Very limited chem data (gamma) for Utica shale, TENORM & brines:** 100's to 1,000's X 5 pCi/g or L
- **PA DEP Marcellus Shale U content:** 10-100 ppm
- **Uranium-238 content:** ~3.4 to 34 pCi/g
- **Radium-226 content:** ~ 3.4 to 34 pCi/g
- **Frac Water Ra-226:** 300 to 9,000 pCi/l
- **PA Marcellus brine chemistry up to 3,609 x MCLs for radioactivity:** 5 pCi/l US EPA
  - USGS reports median levels Ra >3x PA brines from conventional wells

Radioactive Decay in Thorium and Uranium Series

World Nuclear Association

Water Soluble



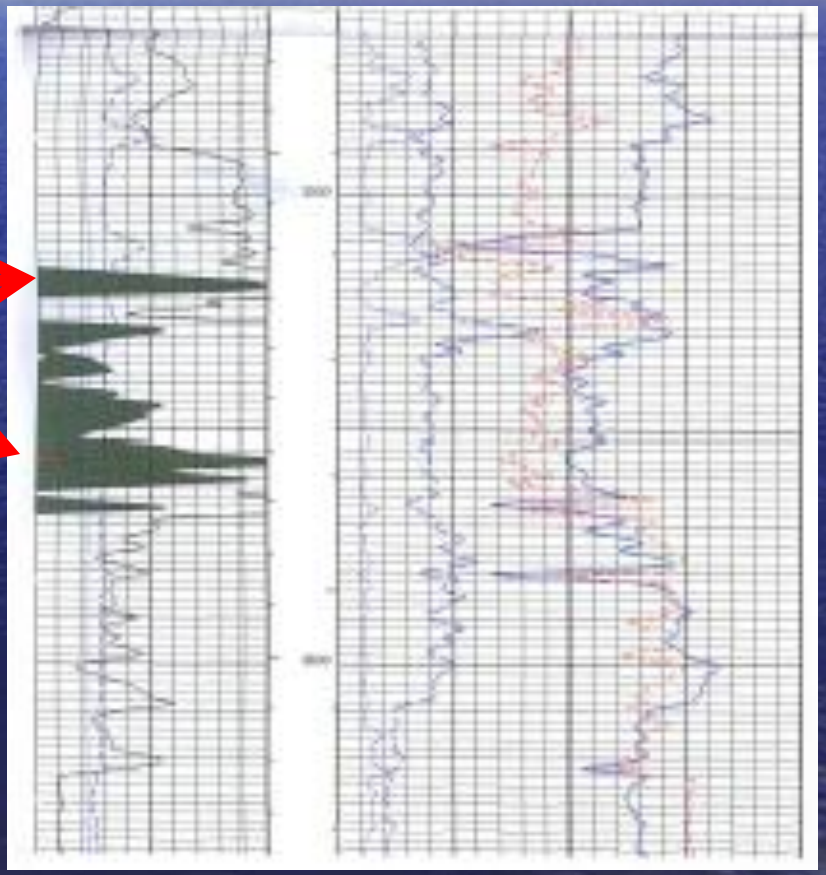
Gamma Spec Data

Why the Current Concern Cont?

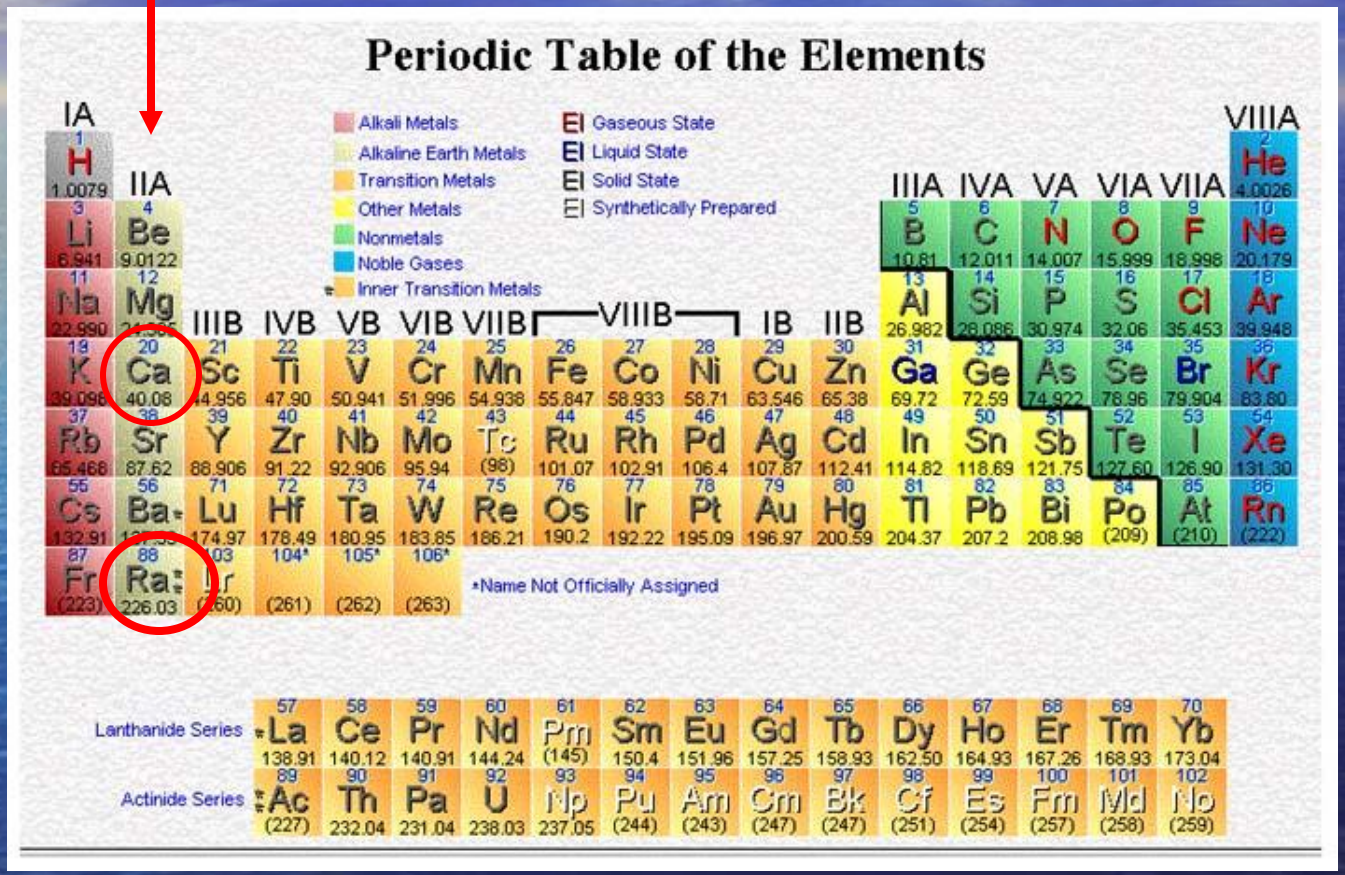
- **NY brine up to** 15,000 pCi/L ^{226}Ra
- **Hard scale in used drilling pipes up to** 6,000 pCi/g ^{226}Ra and up to 2,000 pCi/g ^{228}Ra
- **Ohio still contaminated from the Manhattan Project**
  - we know better now

Radioactivity = TOC = Gas

- Gamma Ray signature shows highest levels of radioactivity in the shale
- Horizontal laterals installed in hottest zones
- Shale cuttings are from hottest areas



5 pCi/l MCL: Why the Health Risk?



Because water-soluble Radium replaces Calcium in your bones if you drink it

Shale Gas Wastes: A Growth Industry for Ohio

- Wastes coming into Ohio by road, rails & soon by river barge, port Washington Co. in place
- Over 52% 2012 injections in Class II wells came from out of state, mostly PA & WV
- Dedicated out-of-state Class II wells being installed in SE Ohio (new one Athens Co.)
- No Public Hearings being held for anyone
- With NY still to be decided & barge ports for Ohio River/Gulf wastes coming on line
  - may be up to 80% out of state wastes in a few years

Shale Gas Wastes: A Growth Industry for Ohio cont.

- Ground Shale Rock with drilling muds to Solid Waste and C&DD Landfills; no records of how much or where, just listed as "solid wastes"; used as daily cover, not buried
- All Fracking Fluids & Brines to be injected in Class II wells except when spread on roads (brines), "solidified" and put in landfills or other management processes yet to be determined
- ODNR Div. Oil & Gas Resources calls the shots; OEPA and ODH are second

New ODNR OEPA ODH Regulation Chart

- **Waste Streams Generated During the Exploration and Production for Oil and Natural Gas**
- **Summary of Potential Regulatory Oversight, January 2013**
- www.epa.state.oh.us/portals/34/document/NewsPDFs/Oil-Gas Waste Matrix Jan20132.pdf
- **Check it out**

Class II Injection Wells

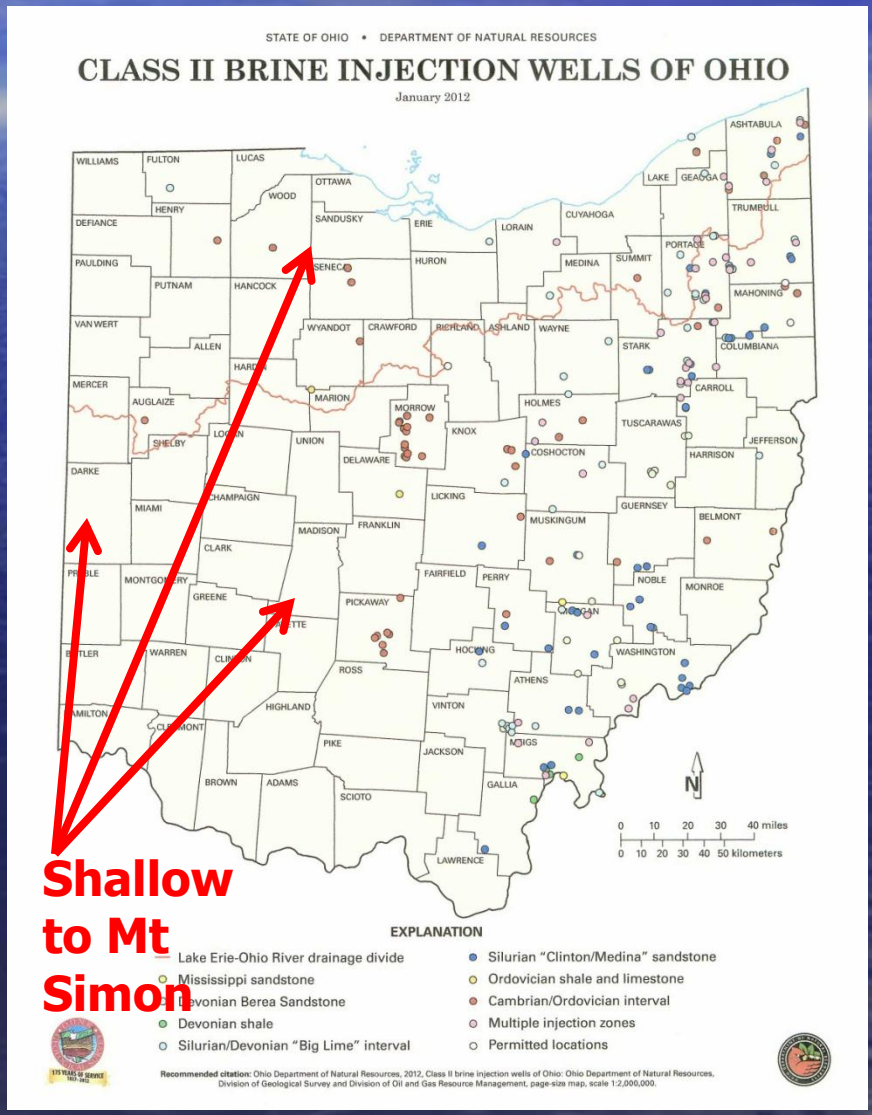
- **Class II Injection Wells Revisions**

  (above Pre-Cambrian basement rock now)

  Seismic rules added by emergency in 2012 to lift moratorium, 30+ waiting applications being processed & approved

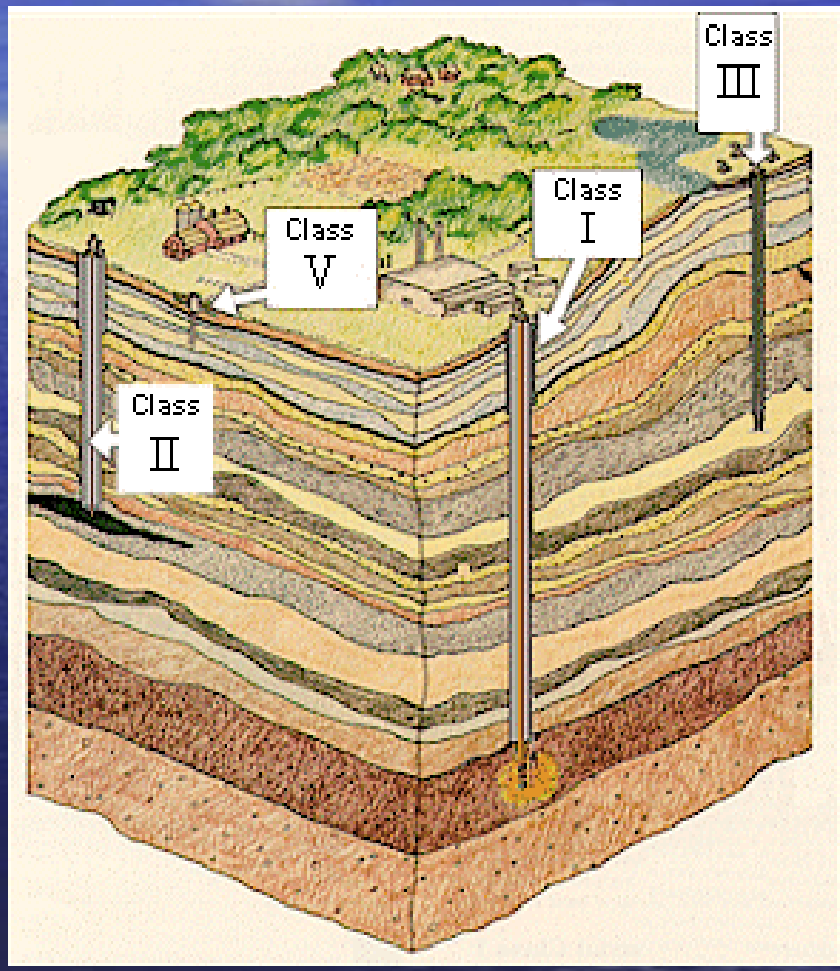
- **Check new web site often**

  www.oilandgas.ohiodnr.gov

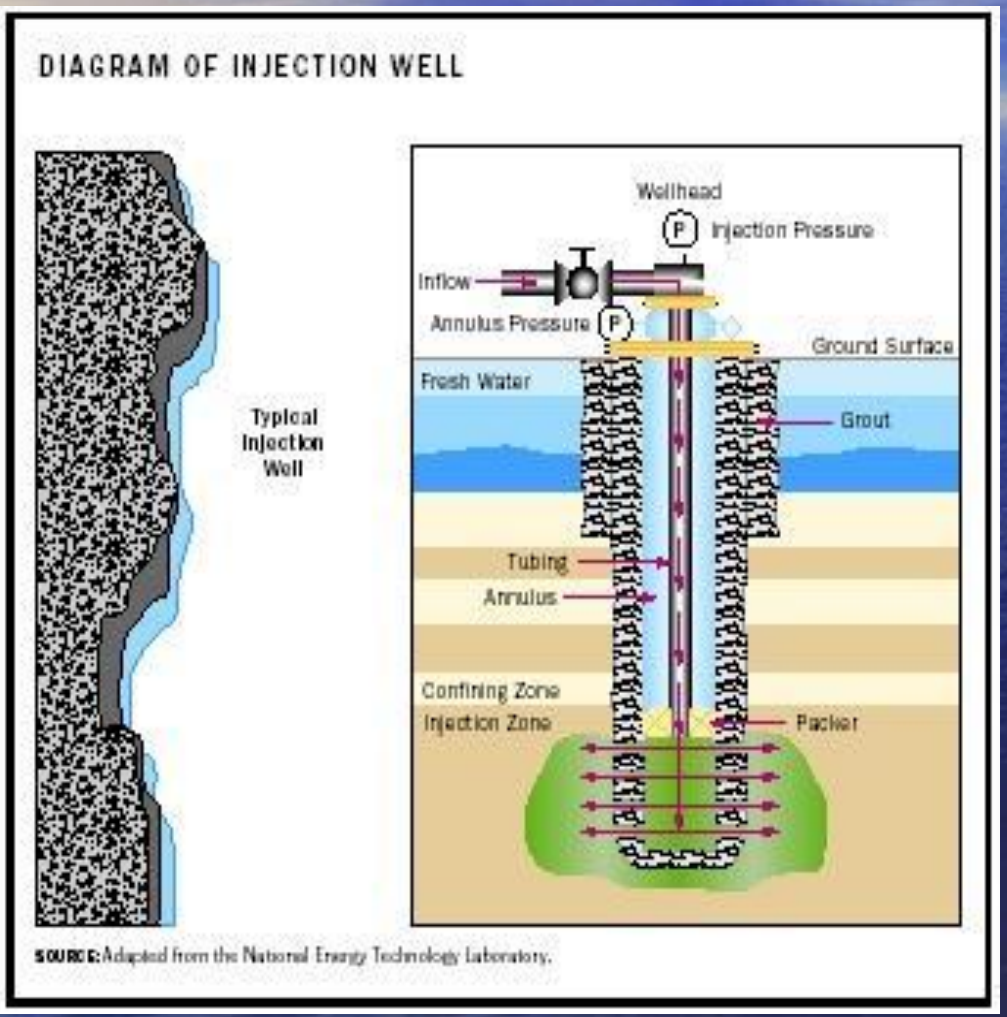


What are Class II Injection Wells?

- Class I – Hazardous Waste
- Class II – Oil & Gas Fluids
- Class III – Solution Mining of Minerals
- Class IV – now banned
- Class V – Stormwater, etc.
- Class IV – CO2 Sequestration



Why Do We Have Them in the First Place?



- Originally used to rehabilitate old O&G fields
- Converted production wells in field to be rehabbed
- Brine & other fluids injected back into field to force out remaining product
  - Called "Flooding"

How Do They Fail?

- **Limited Site Visits by Operators**
  - can be operated 24-7-365
- **Surface & Near Surface Spills**
  - from valves, lines & tanks
- **Compromised Spill Protection Systems**
- **Structural Failure Over Time**
  - Casings and Cement
- **Earthquakes, increases w/ increase in pressure**
  - (National Resources Council rept., www.nap.edu/catalog.php?record_id=13355)

Do We Even Need Them?

- **Important for SS & LS O&G well field rehabilitation**
  - **but not for shale gas production**
- **All other uses**
  - **long term, probably not**
- **Planning now for the short term & intermediate futures**

Landfilling the Wastes

Legal disposal for shale rock cuttings, drilling muds and associated wastes

Currently HB 59 requires downblending if Ra levels above MCLs for TENORM only

Press releases do not indicate that chemical binding of radioactive materials to dilution materials must occur

But are they LLRW Landfills?

- No solid waste and C&DD waste landfills in Ohio meet our siting & design criteria for LLRW disposal
- OSU Extension Research "Low-Level Radioactive Waste Fact Sheet Series" (RER-00) explains why

Cement vaults above ground, wastes drummed, overpacked and sealed

Ohioline.osu.edu/rer-fact/

Other Solutions for Brine Disposal Sure to Reach the Water

Dump it down a storm drain!

Ben Lupo, president D&L Energy/Hardrock Excavation admits to at least 250,000 gallons of brine & oil-based muds dumped into the Mahoning River, 2012-2013

Use for deicing on winter roads

still legal in parts of Ohio

No one told Beaver Falls, PA

Recycling of Fracking Fluids

- Chesapeake in Carroll County, Ohio
- Range Resources in PA
- Consol/Epiphany/PMC Biotech solar powered recycling pilot plant started in July 2012 in PA
- Number of others as well

Why? Because they need the water for the next well & savings on reclaimed chemicals

Potential Problems from Recycling

- Recycled fracking fluids need to be filtered
  - to remove sand, rock cuttings, etc. before being reused
- Filtered materials go to landfills
- Reusing the fluid increases the levels of Radium each time through, not removed
- Eventually TDS etc. so high that fluid must be disposed of in Class II wells anyway
- Ohio not collecting information on Recyclers
  - who/where they are, how they collect fluids, how dispose of wastes

Repurposing of O&G Brine

- Almost everything in O&G brine has an industrial application & a current market
- Already "mine" salts in Ohio for industrial applications
- DOE/GE working on process to remove Radium-228 and 226 from brine
- Technology already exists to break O&G brine down, working on economics
- Why dispose of resources we need & would have to make/extract in other ways for other costs?
- Ohio could still extract "tax" for out-of-state brine if reprocessed here, real jobs for Ohio

Contacts for this presentation & Ohio Journal of Science Papers

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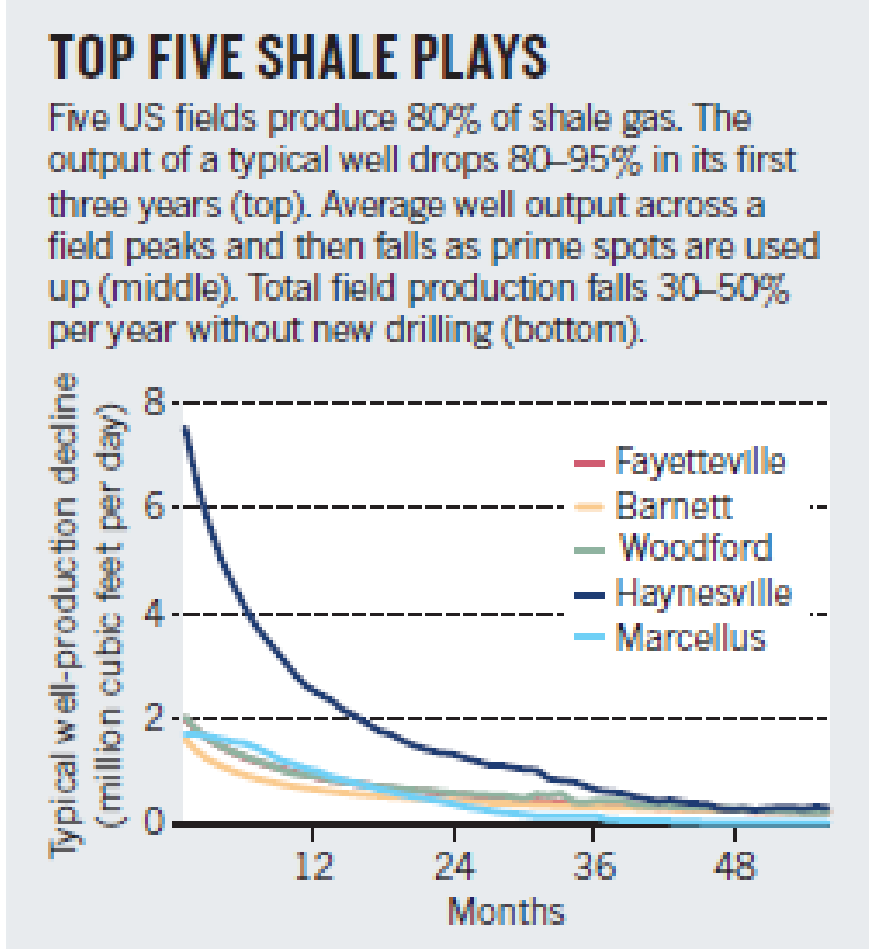
Ohio Journal of Science Web Link at OSU, https://kb.osu.edu/dspace/handle/1811/686

Ohio EPA Division of Drinking and Ground Waters Source Water Assessment and Protection Program, www.epa.ohio.gov/ddagw/swap_ssa.aspx

Keeping Ohio's Water Clean
Ohio Fracture Flow Working Group

Even Without Disposal Issues, Does it Make Current Economic Sense to Drill?



- **Drilling Costs >$42 Billion/yr to maintain production**
- **Dry Gas Sales ~$33 Billion/yr**
- **Some additional value from wet gases**

JD Hughes, 2013, Nature vol. 494

How long to Protect from human interaction if use Michigan's 50 pCi/g limit

- 50 pCi/g Radium-226 (1,609 yrs/1/2 life) to 5 pCi/g is 3+ half lives, ~5,000 yrs, beginning of Egypt's pyramids
- 50 pCi/g Uranium-238 (4.468 Billion yr/1/2 life, from almost the birth of the earth until now 1 ½ life) to 5 pCi/g, so 3+ half-lives, back to the beginning of the Universe
- 50 pCi/g Thorium-232 (14.05 Billion yr/1/2 life, longer than the age of the Universe until now 1 ½ life) to 5 pCi/g, ~45 Billion years, more than the diameter of the visible universe