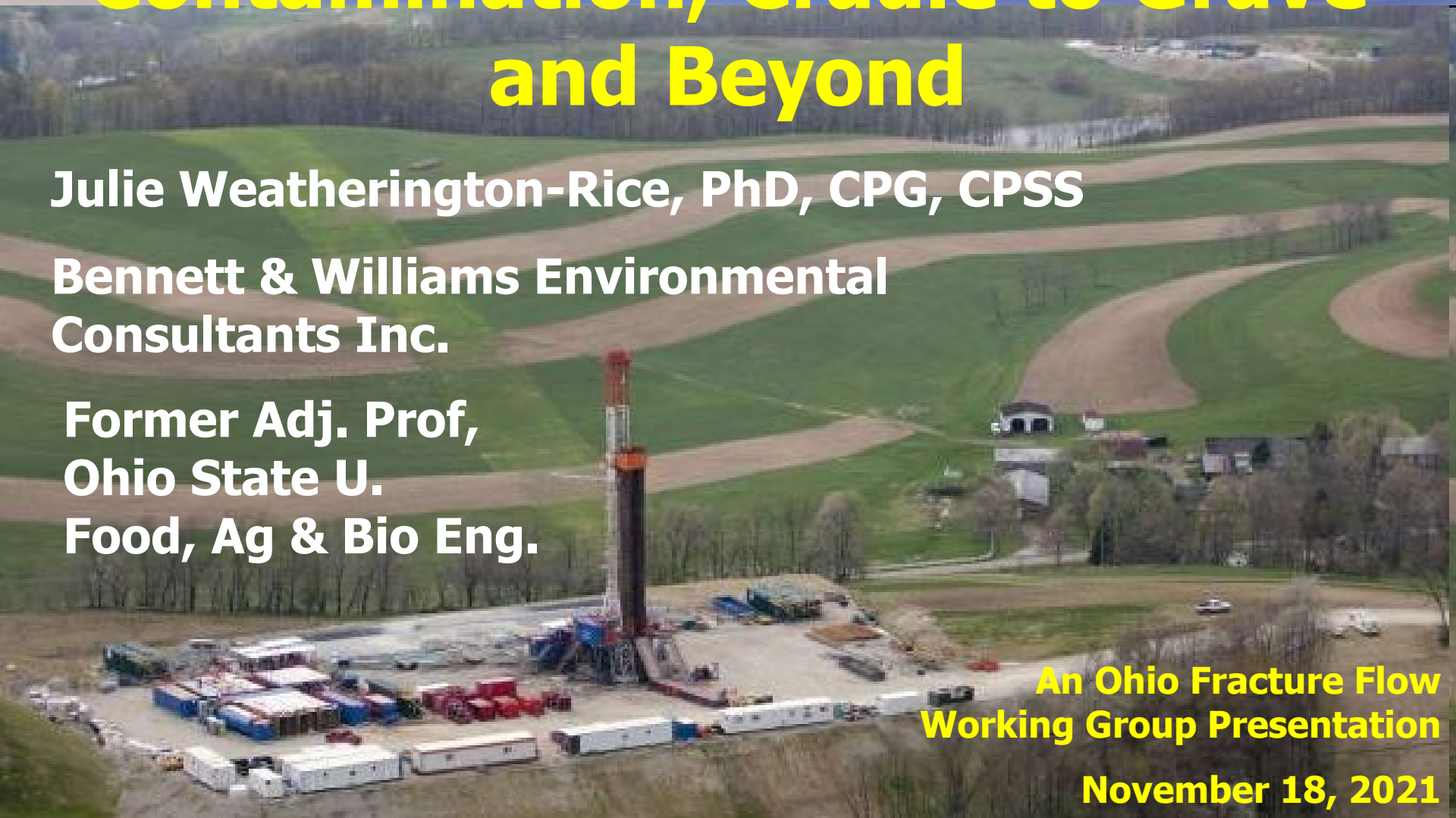
The Science Behind the Major Issues: Ohio's Gas & Oil Contamination, Cradle to Grave and Beyond



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An Ohio Fracture Flow Working Group Presentation

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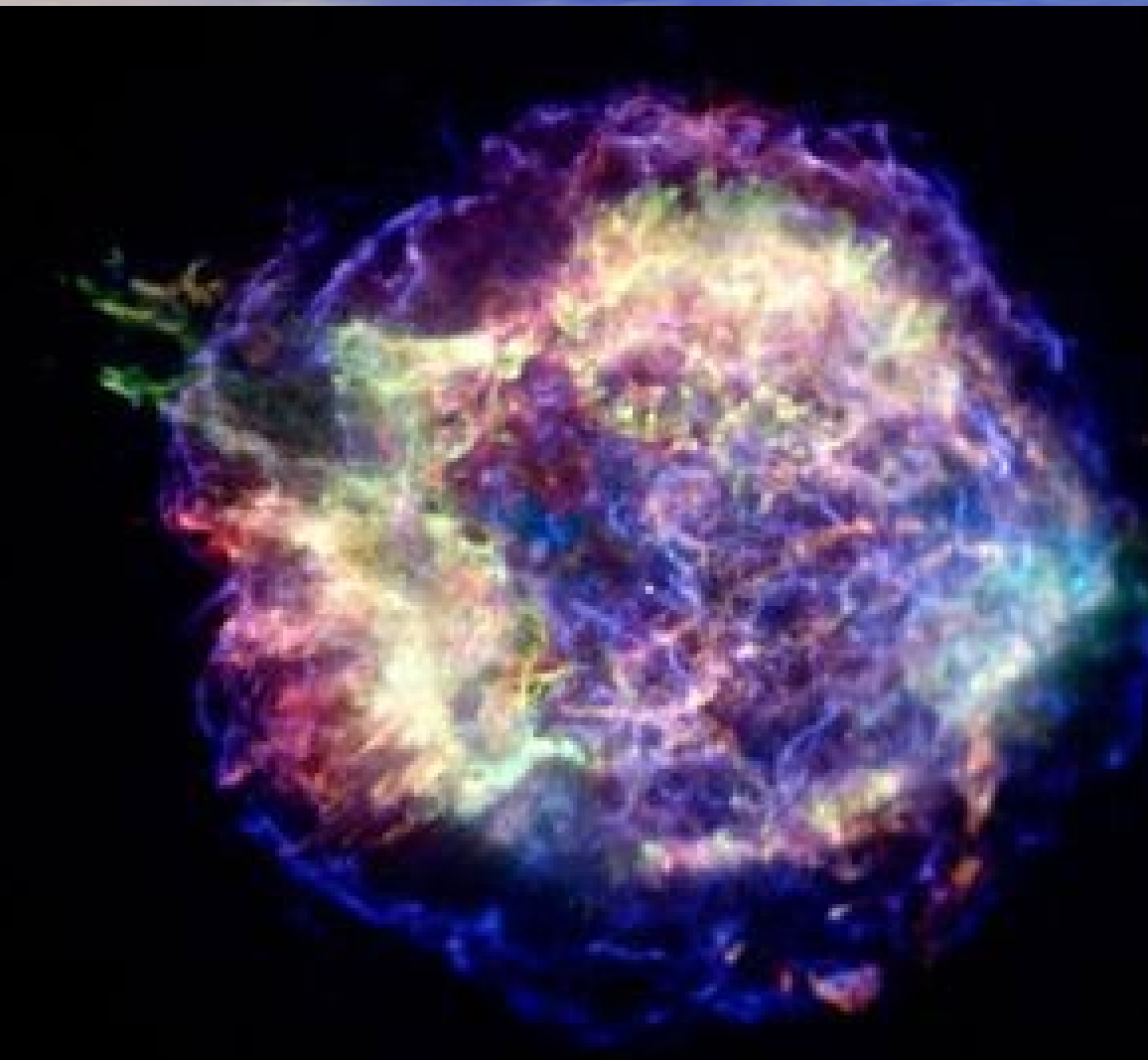
Natural Law Rules the Universe

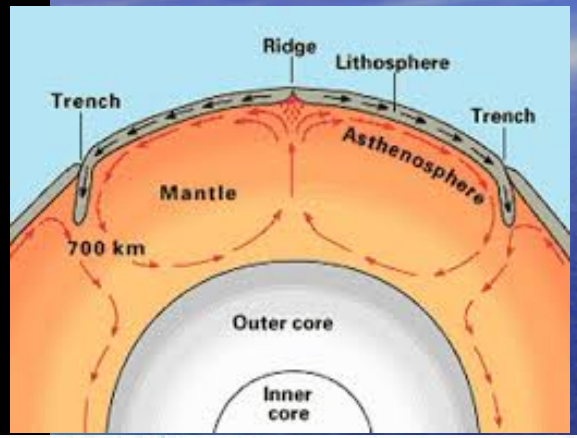


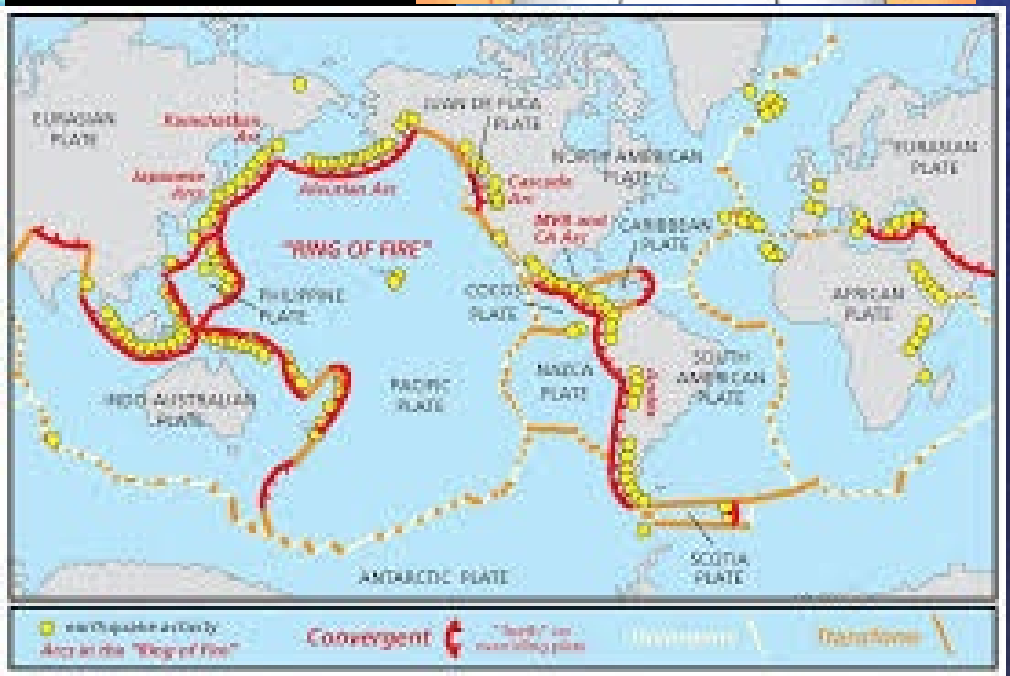
All the elements that are found in our earth, in our solar system and in us came from stars that went supernova and exploded. In that explosion, all elements were formed &/or released

Space Clouds of Dust/Gas and Meteors came together to form our Earth/all its elements >4.5 Billion Years (BY) ago

This includes all the original amounts of Thorium and Uranium

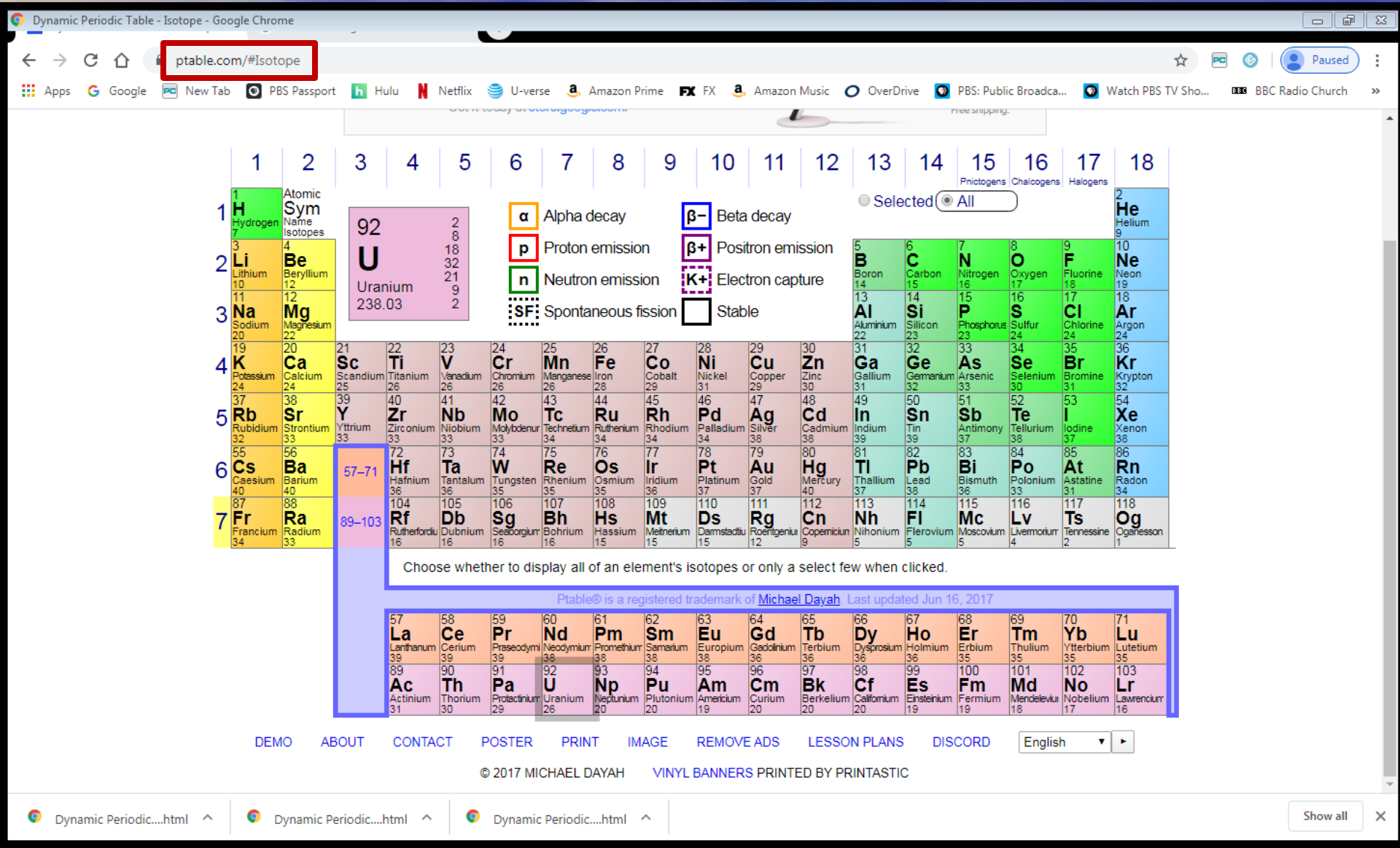
Earth's Furnace – Radioactive Decay





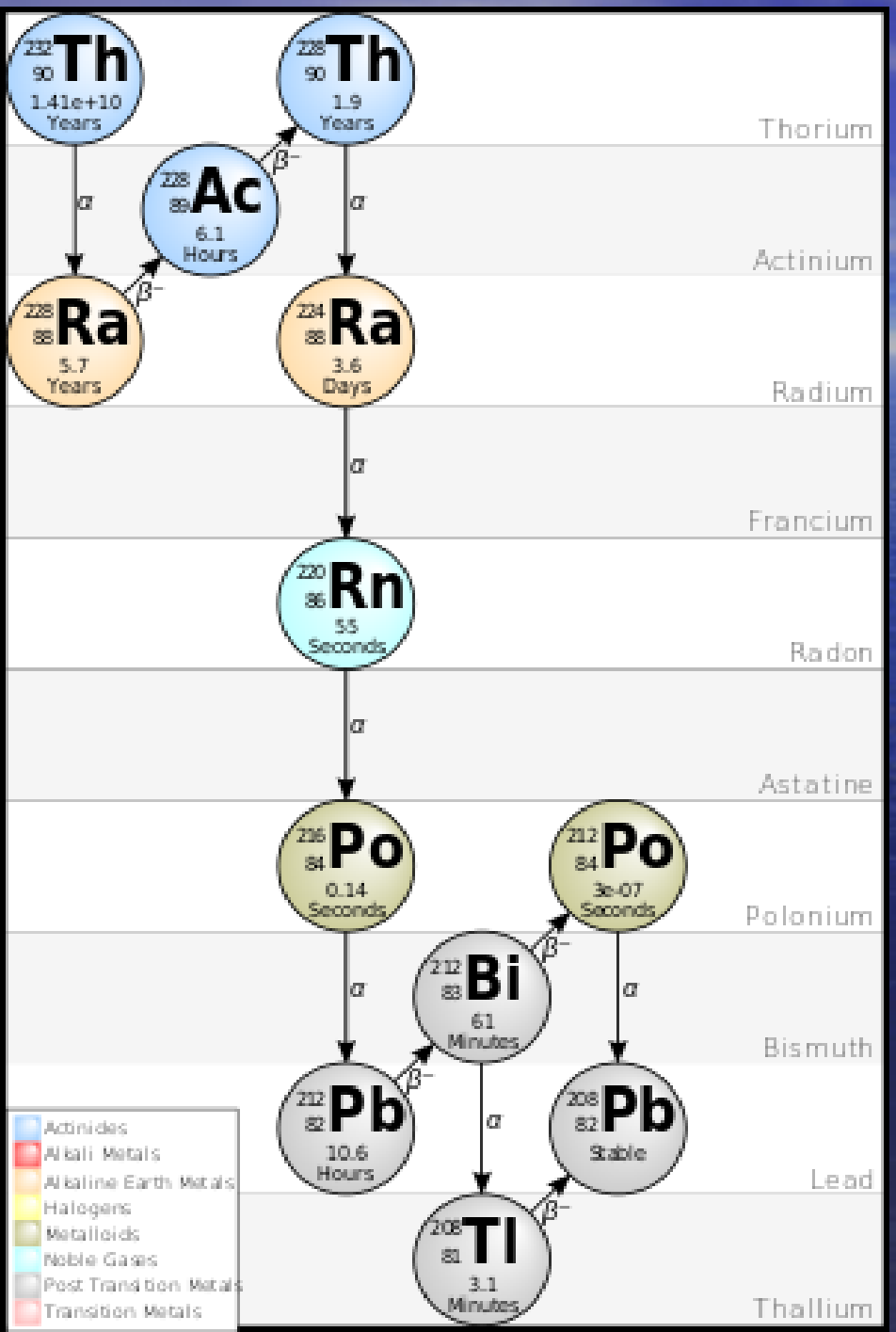
Volcanos & earthquakes are driven by the heat of radioactive decay.
We just don't want it happening in our back yards, on our roads, in our landfills, in our soil, air and water.

Thorium & Uranium are the Parent Radioactive Elements



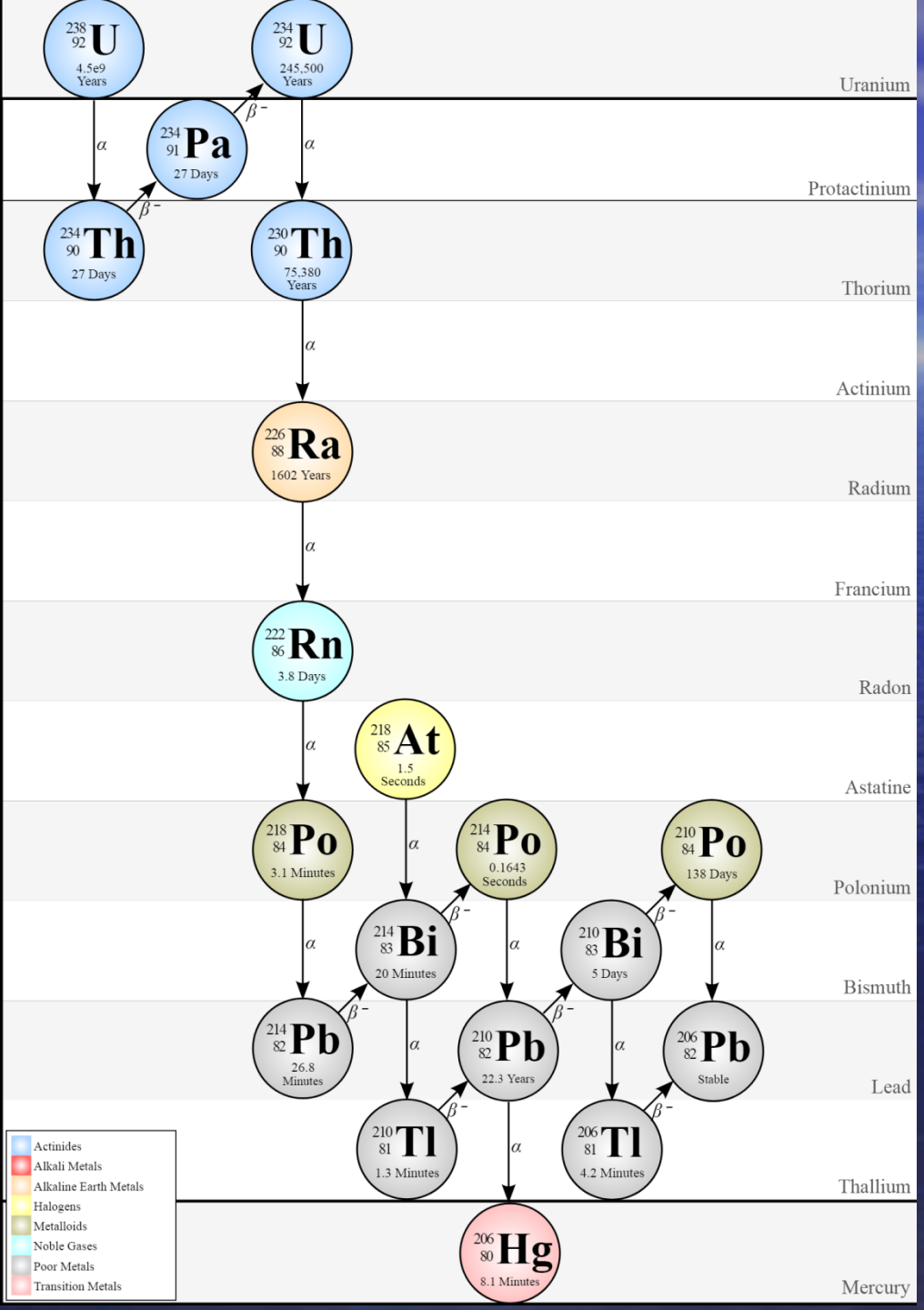
Thorium-232 14 BY ½ life
Uranium-238 4.47 BY ½ life

This means that we have ~ 5/6 of all the Thorium-232 and just under ½ of all the Uranium-238 that was originally incorporated into Earth when it was formed. The rest has decayed away.



Thorium-232 decay chain

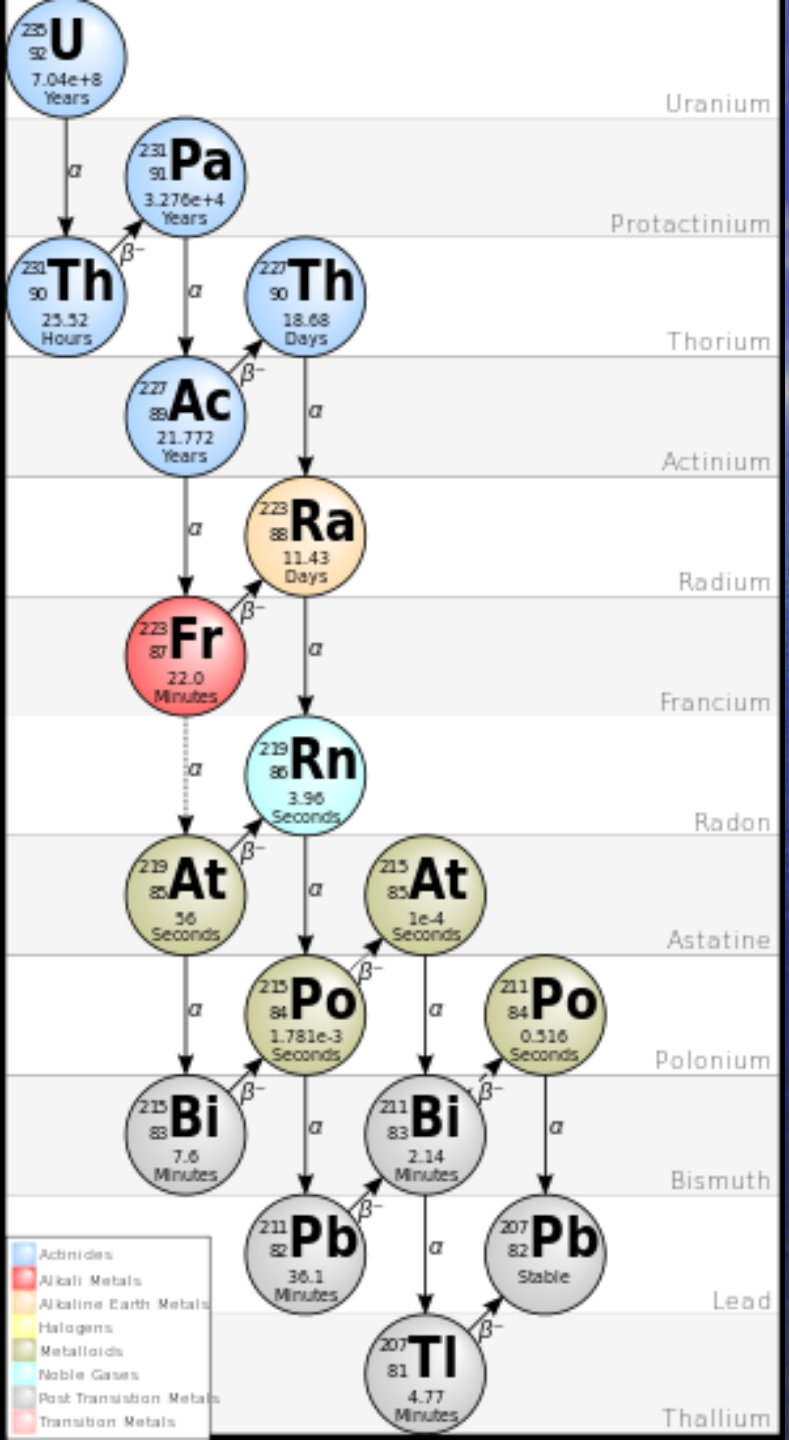
Thorium-232 to Radium-228 (5.7 years ½ life) to Radium-224 (3.6 days ½ life) to Radon gas down to Lead-212



Uranium-238 decay chain

Uranium-238 to Radium-226 (~1602 years ½ life) to Radon gas down to Lead -214 This is the most common chain and also the most dangerous because Ra lasts so long

Actinium Series Uranium-235 decay chain



Uranium-235 (atomic bomb series) to Radium-223 (11.43 days ½ life) to Radon gas to Lead-211

Exists in nature but is rare, this is the Uranium that is enriched for atomic weapons, separated from the more common U-238

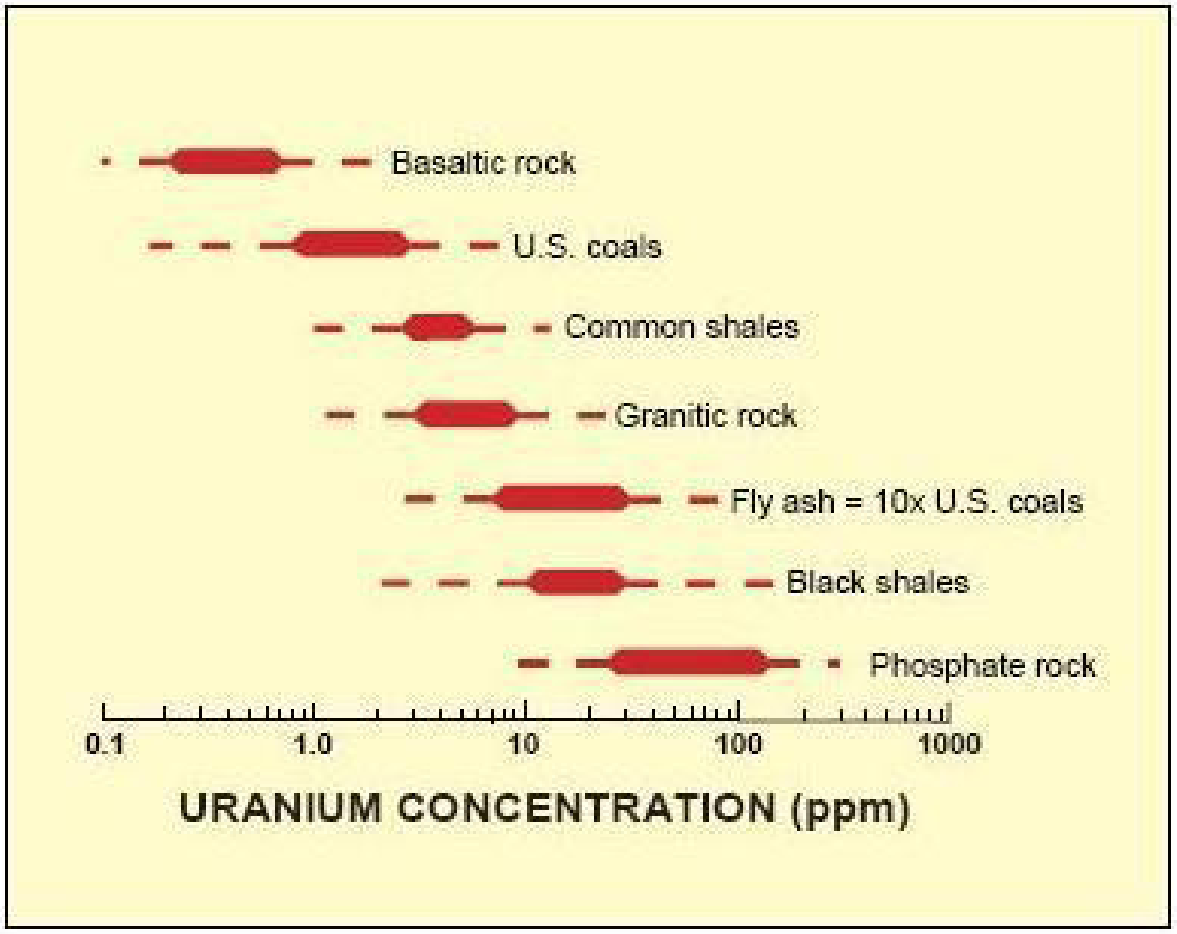
Because Radium & Radon are so Dangerous, Maximum Exposure Levels for Human Health & Safety

- **Combined Radium-226 & -228 Safe Drinking Water MCL's 5 pCi/Liter of water**
- **Combined Radium-226 & -228 Superfund Clean-up standards 5 pCi/gram of soil**
- **Total Radon Indoor Air standard 4 pCi/Liter of air** (above that, remediation is required)
- **Ohio discharge limits to environment Radium-226 60 pCi/Liter & Radium-228 60 pCi/Liter each** (OAC 3701:1-38-12, Appendix C Table II)

Black Shales are Radioactive two ways

- From their parent source rocks
- Devonian Marcellus – Appalachian uplifts
- Silurian Utica – earlier mountain building & Canadian Shield

- From Bioaccumulation
- Black shales and coals are big, dirty, old activated carbon filters
- As surface & ground water carrying soluble heavy & radioactive metal cations move through the shales, the organic carbon, a very strong negative magnet, releases small & light cations and binds bigger & heavier cations
- The older the rock & higher the carbon content, the more the radiation, sources being equal
- The higher the sources, the more the radiation



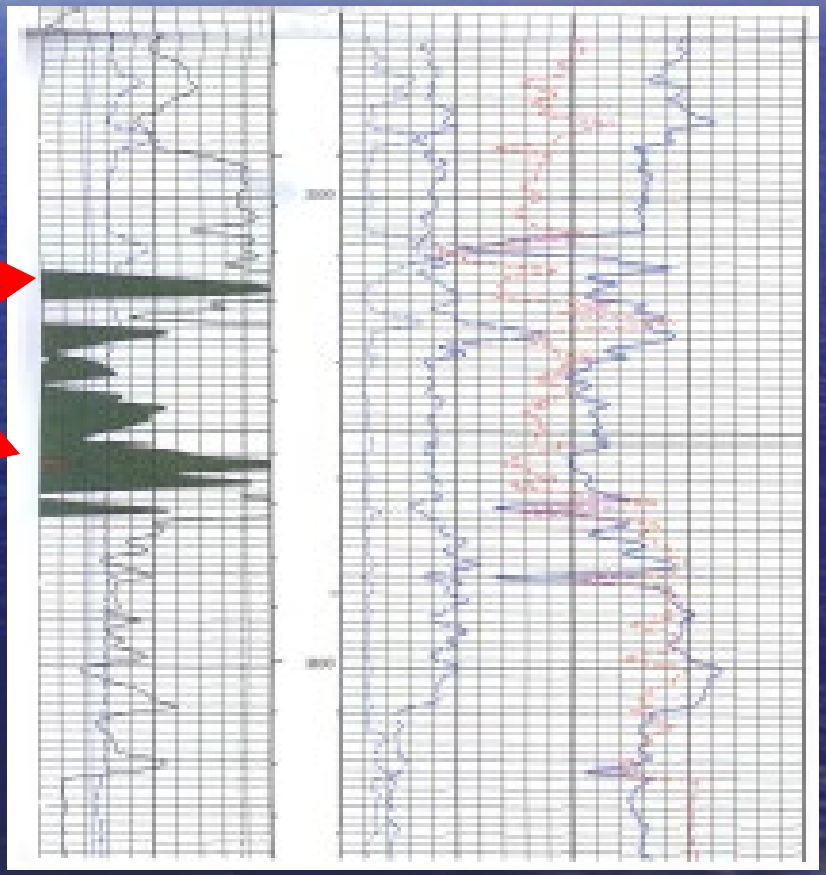
Typical range of uranium concentration in coal, fly ash, and a variety of common rocks.

100 ppm Uranium is considered a low level uranium ore suitable for mining. The Marcellus & Utica shales would qualify

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

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



ODNR O&G Tested Conventional Brine permitted for Road Spreading 2017-

- 151 production brine samples reported so far
- Testing for Ra-226 & -228 pCi/L
- Most data from Ohio
- Most from Vertical Wells permitted for road spreading

- From High to Low
- Ra-226 Ra-228 Total
- 9294 308 9602
- Clinton fm Portage Co.
- 679 368 1047
- Clinton fm Perry Co.
- 60 6 66
- Trenton fm Morrow Co.

How Long Before Safe to Spread?
Goal is Ra-226 & -228 60 pCi/L each

Ra-226, ~1600 ½ life	Ra-228, ~5.7 ½ life	Total
9294	308	9602
4647	154	
2324	77	
1162	38.5	
581	17.1 years	
291		
146		
73		
36.5		
12,800 years		

Hottest sample

How Long Before Safe to Spread?
Goal is Ra-226 & -228 60 pCi/L each

Ra-226, ~1600 ½ life	Ra-228, ~5.7 ½ life	Total
679	368	1047
340	184	
170	92	
85	46	
42.5	17.1 years	
6,400 years		

Midpoint Sample

How Long Before Safe to Spread? Goal is Ra-226 & -228 60 pCi/L each

- Ra-226, ~1600 ½ life Ra-228, ~5.7 ½ life Total

  60 6 66

Only Sample safe to spread now, all others would have to wait

It Gets Worse

- Dave Mansbury's people introduced another set of bills in Ohio House and Senate exempting his AquaSalina from ODNR reporting making it a commercial product with no oversight.
- At least the third? time he has tried to get these bills passed.
- SB171/HB282 both still in committee

If passed as written, legal limits in Ohio will skyrocket

- (a) Arsenic 5.0 mg/l; 0.010 mg/L MCL
- (b) Cadmium 0.2 mg/l;0.005 mg/L MCL
- (c) Chromium 1.0 mg/l; 0.1 mg/L MCL
- (d) Copper 1.0 mg/l; Action Level=1.3 mg/L, 1.3 mg/L PHG
- Safe Drinking Water Limits
- Public Health Goals

If passed as written, legal limits in Ohio will skyrocket

- (e) Lead 1.0 mg/l; Action Level=0.015 mg/L , zero PHG
- (e) Mercury 0.05 mg/l;0.002 mg/L MCL
- (f) Selenium 5.0 mg/l; 0.05 mg/L MCL
- (g) Zinc 10 mg/l; 5 mg/L 2ndMCL
- (h) Barium 50 mg/l; 2.0 mg/L MCL
- (i) Benzene 0.31 mg/l;0.005 mg/L MCL
- Safe Drinking Water Limits
- Public Health Goals

If passed as written, legal limits in Ohio will skyrocket

- (j) Toluene 17.5 mg/l; 1 mg/L MCL
- (k) Ethylbenzene 29 mg/l; 0.7 mg/L MCL
- (l) Xylenes 10 mg/l; 10 mg/L MCL
- (m) Radium-226 20,000 picocuries/l;
- (n) Radium-228 2,500 picocuries/l.
- 5 pCi/L combined MCL, zero PHG
- Safe Drinking Water Limits
- Public Health Goals

How long would it take to be safe to spread? (60/60 pCi/L)

- Ra-226, ~1600 ½ life Ra-228, ~5.7 ½ life Total

Ra-226, ~1600 ½ life	Ra-228, ~5.7 ½ life	Total
20,000	2,500	22,500
10,000	1,250	
5,000	625	
2,500	312.5	
1,250	156.25	
625	78.125	
312.5	39.0625	
156.25	~34.2 years	
78.125		
39.0625		

~ 14,400 years

How could anyone propose these bills with a straight face?

- Ohio Senate Agriculture & Natural Resources Committee
- Senator Tim Schaffer, Chair
- Ohio Senate Bill 171
- Ohio House Energy & Natural Resources Committee
- Rep. Jason Stephens, Chair
- Ohio House Bill 282
- Please contact them & your Rep/Senator and ask them to "Kill the Bill"

We are Creating Permanent Sacrifice Zones in Ohio

- Landfills with Shale cuttings become low-level nuclear reactors as U and Th in cuttings decay
- Spills, brine spreading and other accidental releases put heavy/radioactive metals, gases and hydrocarbons + fracking fluids into the environment
- The heavy/radioactive metals will be a problem until the sun burns out, ~5 BY

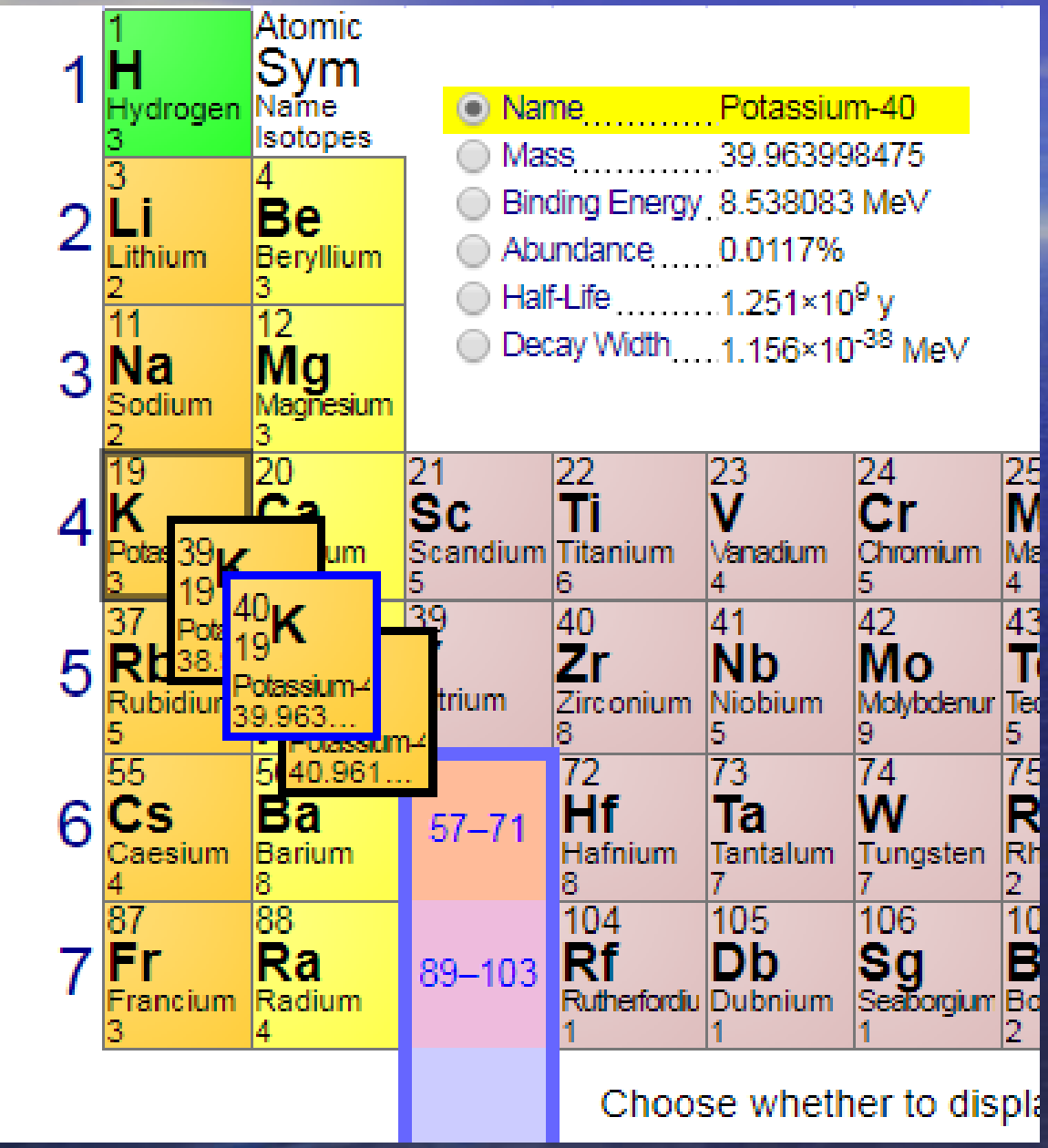
Impacts to Human Health & the Environment

- Depends how often, what level of exposures: The more often, the higher the levels, the worst for you
- Skin, inhale, ingest: Inhaling and ingesting are the most damaging
- Which radioactive elements/ heavy metals: the heavy metals, even the salts can kill
- Workers & near neighbors at highest risk

Contacts for this Presentation

- Buckeye Environmental Network, info@benohio.org
- OFFWG, Dr. Julie Weatherington-Rice, B&W, former OSU FABE, jweatherington.rice@gmail.com
- 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



Because the claim will be made that Bananas are radioactive

K-40 ½ life 1.251 Billion years
Other K isotopes are stable

Naturally occurring potassium is composed of three isotopes, of which ^{40}K is radioactive. Traces of ^{40}K are found in all potassium, and it is the most common radioisotope in the human body.

Potassium ions are vital for the functioning of all living cells. The transfer of potassium ions across nerve cell membranes is necessary for normal nerve transmission; potassium deficiency and excess can each result in numerous signs and symptoms, including an abnormal heart rhythm and various electrocardiographic abnormalities. Fresh fruits and vegetables are good dietary sources of potassium

All isotopes of radium are highly radioactive, with the most stable isotope being radium-226, which has a half-life of 1600 years and decays into radon gas (specifically the isotope radon-222). When radium decays, ionizing radiation is a product, which can excite fluorescent chemicals and cause radioluminescence.

Radium, in the form of radium chloride,

In nature, radium is found in uranium and (to a lesser extent) thorium ores in trace amounts as small as a seventh of a gram per ton of uraninite. Radium is not necessary for living organisms, and adverse health effects are likely when it is incorporated into biochemical processes because of its radioactivity and chemical reactivity. Currently, other than its use in nuclear medicine, radium has no commercial applications; formerly, it was used as a radioactive source for radioluminescent devices and also in radioactive quackery for its supposed curative powers. Today, these former applications are no longer in vogue because radium's toxicity has become known, and less dangerous isotopes are used instead in radioluminescent devices.