THE LEADER IN ENVIRONMENTAL TESTING

Radiochemical Analytical Challenges with Hydrofrac Fluids

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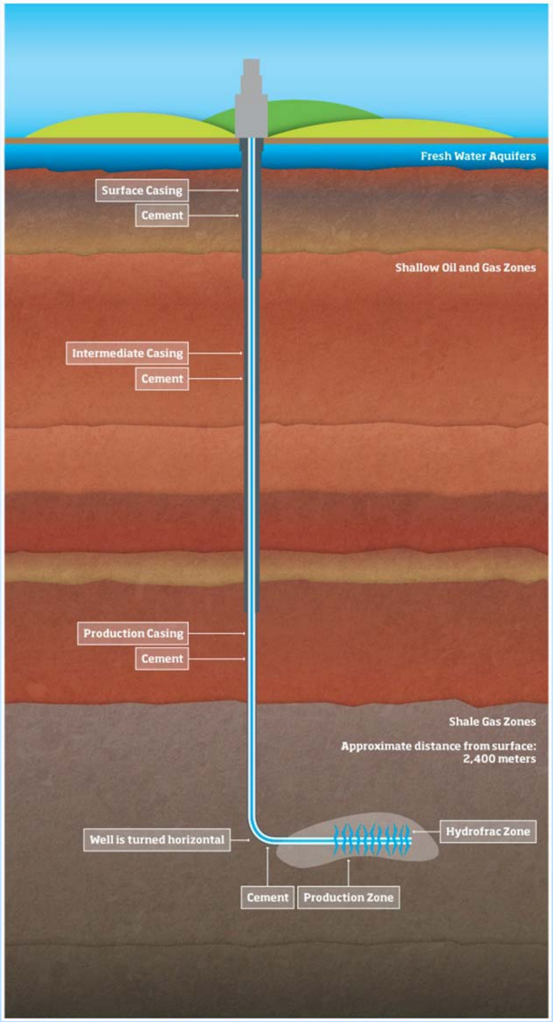
Flowback Composition

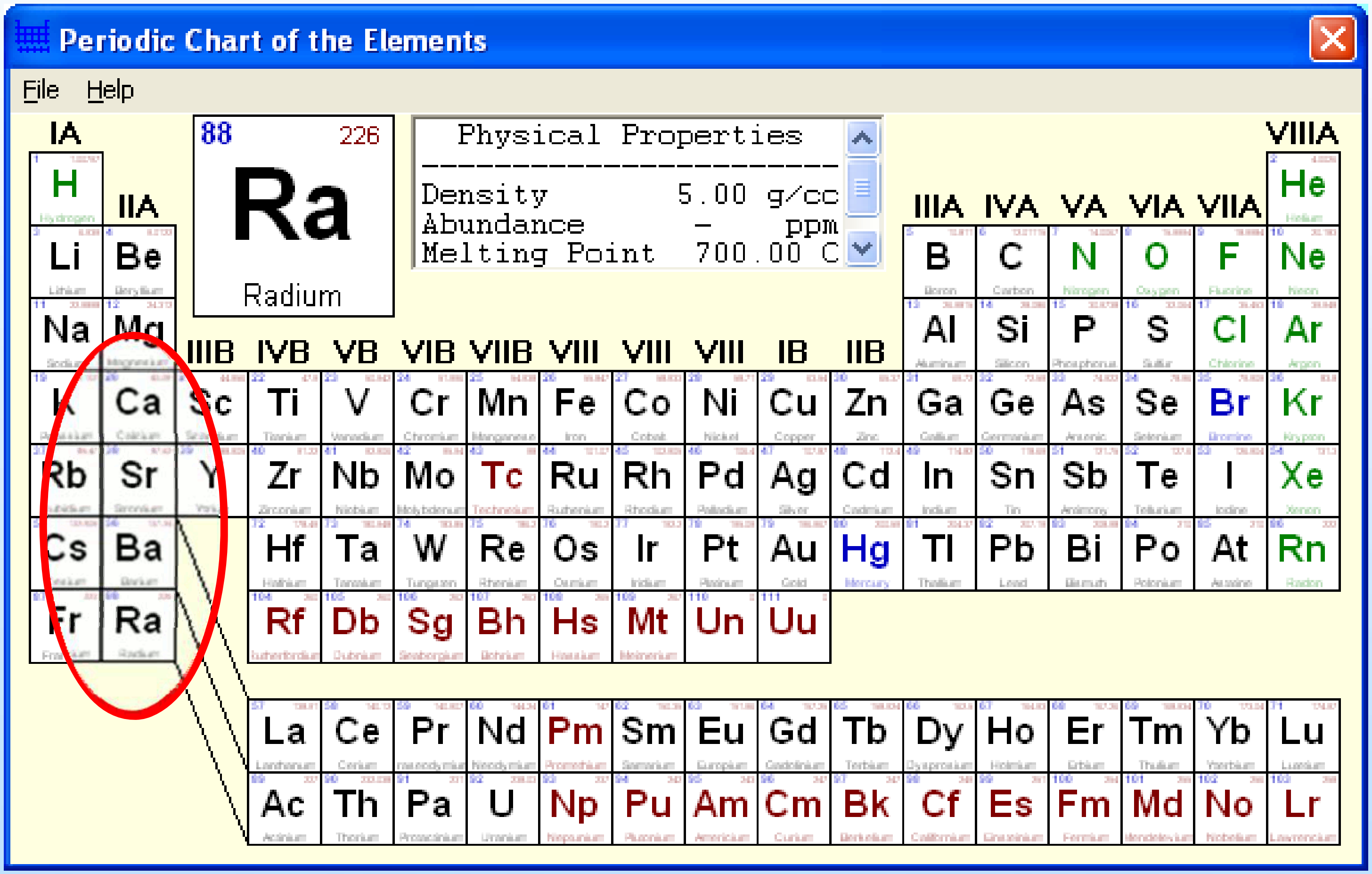
- **Relatively High TDS** (some >250,000 mg/L)
  - ~ Barium (>4,000 mg/L)
  - ~ Calcium (>31,000 mg/L)
  - ~ Strontium (>2,000 mg/L)
  - ~ Iron (>100 mg/L)

Gross Alpha/Beta

- **Gross Alpha/Beta** (EPA 900.0/SW846 9310)
  - ~ "Rough" screening
  - ~ Mass on planchet limited to 100 mg for alpha
  - ~ High solids leads to reduced aliquot and counting efficiency
  - ~ EPA 900.1/SM 7110C can help, but …

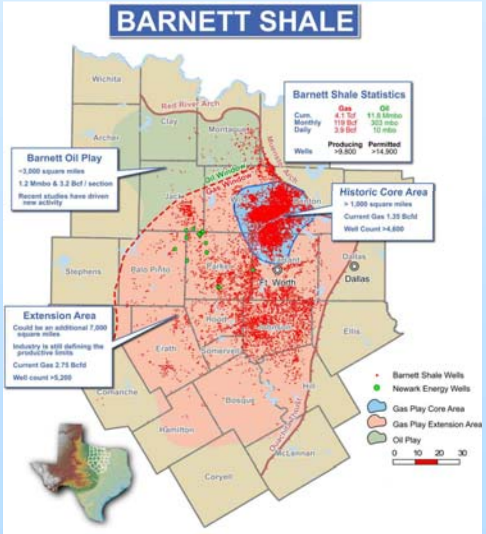


Radium


Periodic Chart of the Elements
File Help
88
226
Ra
Radium
Physical Properties
Density 5.00 g/cc
Abundance – ppm
Melting Point 700.00 C

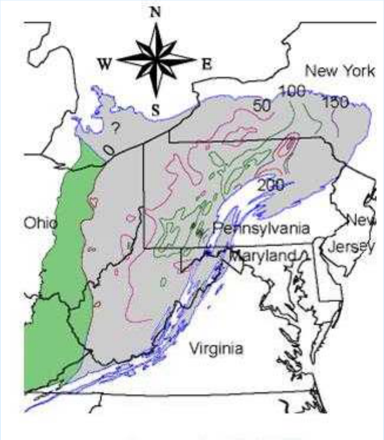
Ra-226/228 Analytical

- **Radium Co-precipitation**
  - ~ Most “traditional” precipitation chemistry methods employ sulfate co-precipitation
  - ~ Various Pb/Sr/Ba concentrations added
  - ~ EDTA cleanup
  - ~ Eventually barium sulfate
    - ◦ carrier for chemical recovery calculation
    - ◦ ~30 mg barium



Ra-226/228 Analytical

- **Interferences**
  - ~ TDS and Ba/Ca/Sr all cause problems
    - ◦ General competition in chemistry
    - ◦ Large qty of barium sulfate precipitate
      - – Spoils gravimetric chemical recovery
      - – For GFPC creates flaking issue
      - – For GFPC increases self-absorption



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Ra-226/228 Analytical

- **Possible Solutions**
  - ~ Reduce aliquot (increases MDC)
  - ~ Ba-133 as tracer for chemical yield
    - ◦ Still have large qty of precipitate
  - ~ Use “non-traditional” method
    - ◦ Gamma Spectroscopy (direct count)
    - ◦ Gamma Spectroscopy (Ga. Tech method)

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Gamma Ra-226

- Ra-226 has one weak gamma emission
  - ~ 3% abundance at 186 keV
- U-235 has several gamma emissions
  - ~ 11% at 144 keV
  - ~ 54% at 186 keV

U-235 is large interference for Ra-226!!

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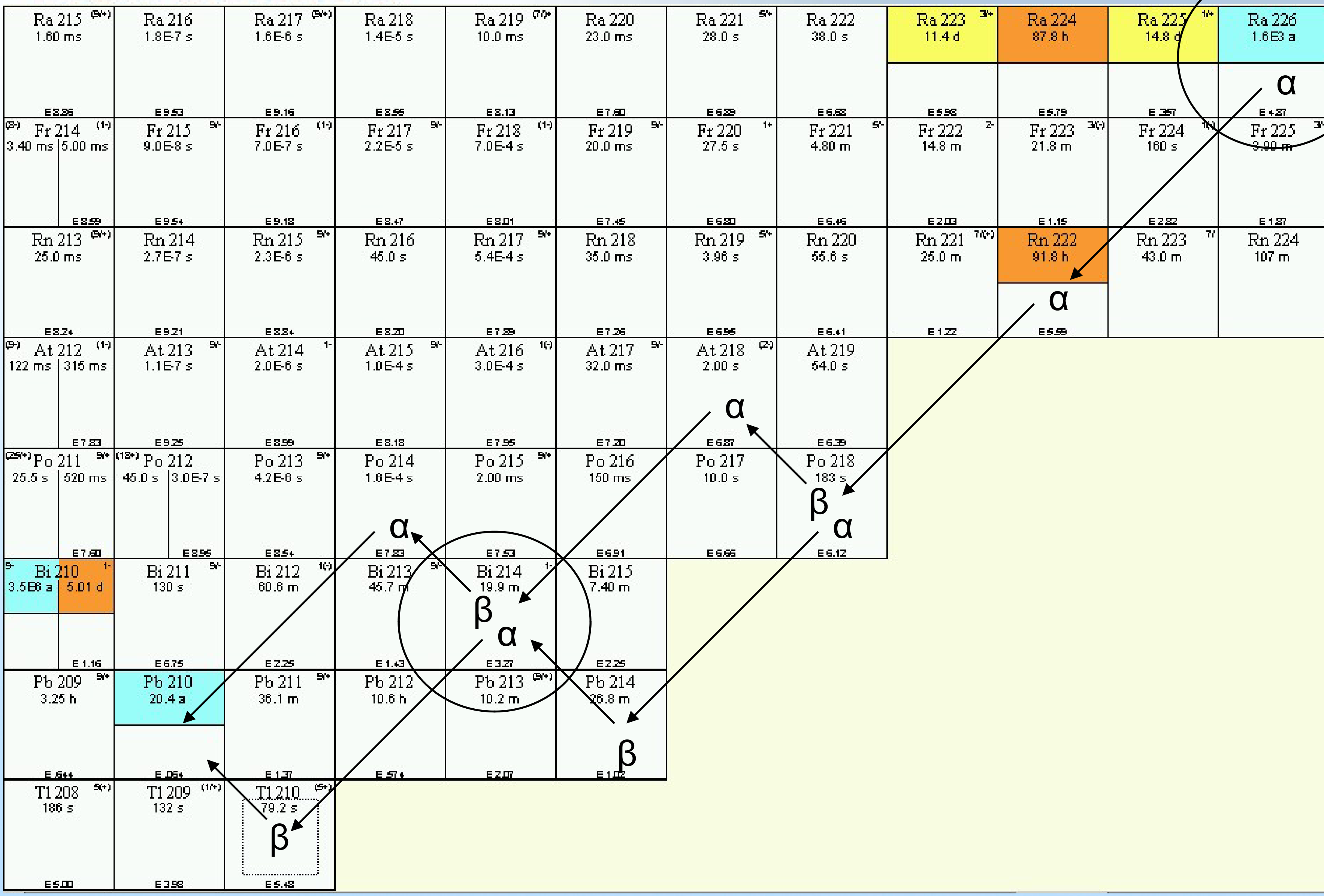
Ra-226 Decay Chain



Gamma Ra-226

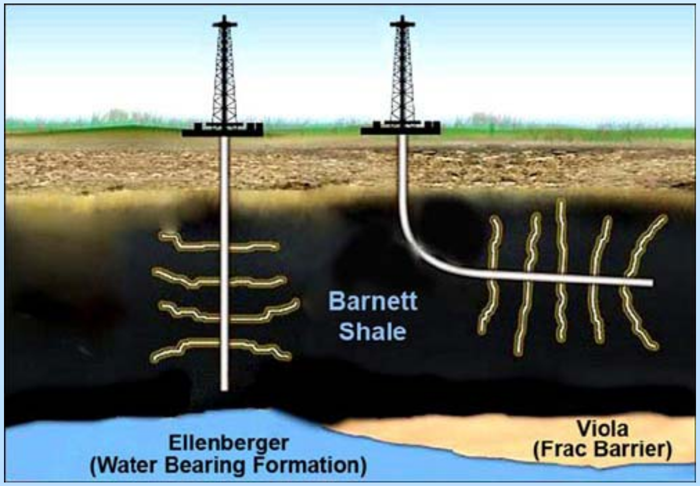
- First progeny of Ra-226, Rn-222 (gas), can escape matrix.
- Seal in a geometry, then allow for decay chain to <u>ingrow</u>
- Measure Bi-214 (46% gamma at 609 keV)

Ra-226 to Rn-222 Ingrowth

- **Secular equilibrium**
  - Half-life of Ra-226 (1600 years) is much greater than of Rn-222 (91.8 hrs)
  - Rest of decay chain down to Pb-210 has short half-life (<30 min.)
    - 7 days = 72% ingrowth
    - 14 days = 92% ingrowth
    - 21 days = 98% ingrowth

Direct Count

- **Direct Count (No Preparation)**
  - ~ Place sample (e.g. 1L) in geometry
  - ~ Count after ingrowth
  - ~ MDC of 30-50 pCi/L
  - ~ Ra-226/228 concentration:
    - Flowback duration
    - Ba content



Ga Tech Method

- Georgia Tech Research Institute (Bernd Kahn, Robert Rosson)
  - ~ Coprecipitate Radium with barium sulfate
  - ~ Modify by adding Ba-133 as tracer
  - ~ Allow ingrowth (can use any time)
  - ~ Ra-226, Ra-228, and Ba-133 recovery from single analysis
  - ~ Should allow for lower MDC (<5 pCi)

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Other Considerations

- **What is actual sample matrix?**
- **What is ultimate goal of analysis?**
- **What are regulatory requirements?**
- **?????**

Questions/Contact Info

Questions?

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