U.S. DEPARTMENT OF ENERGY | Legacy Management

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Can Pb-210 be used to indicate long-term Rn-222 transport in Radon Barriers?

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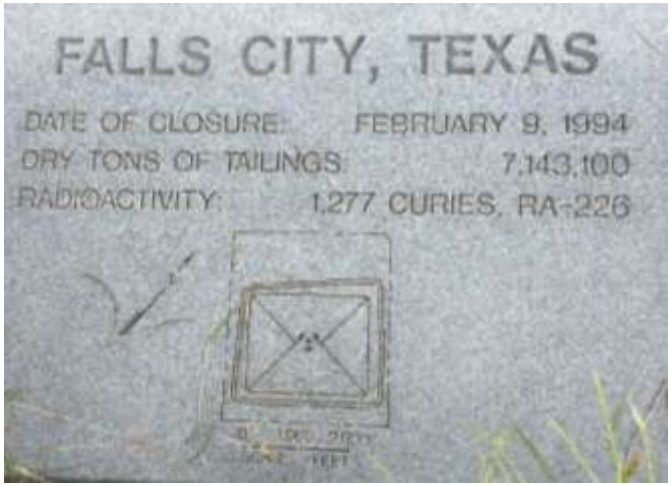
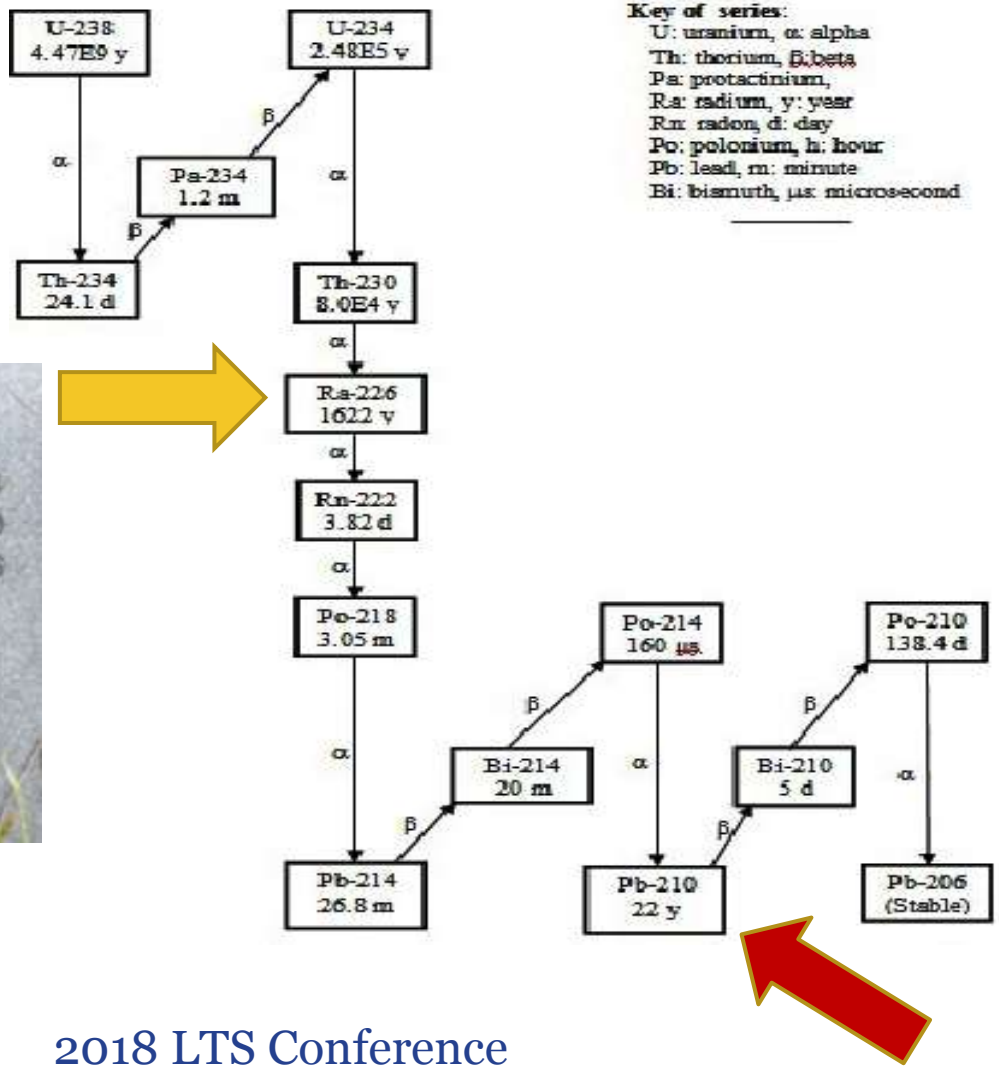
Hydraulic conductivity measurements

Radon Flux Measurements at top of Rn barrier

U-238 Decay Chain





Hypothesis; Pb-210 distributions/profiles can be used to evaluate long-term Rn transport in radon barriers.

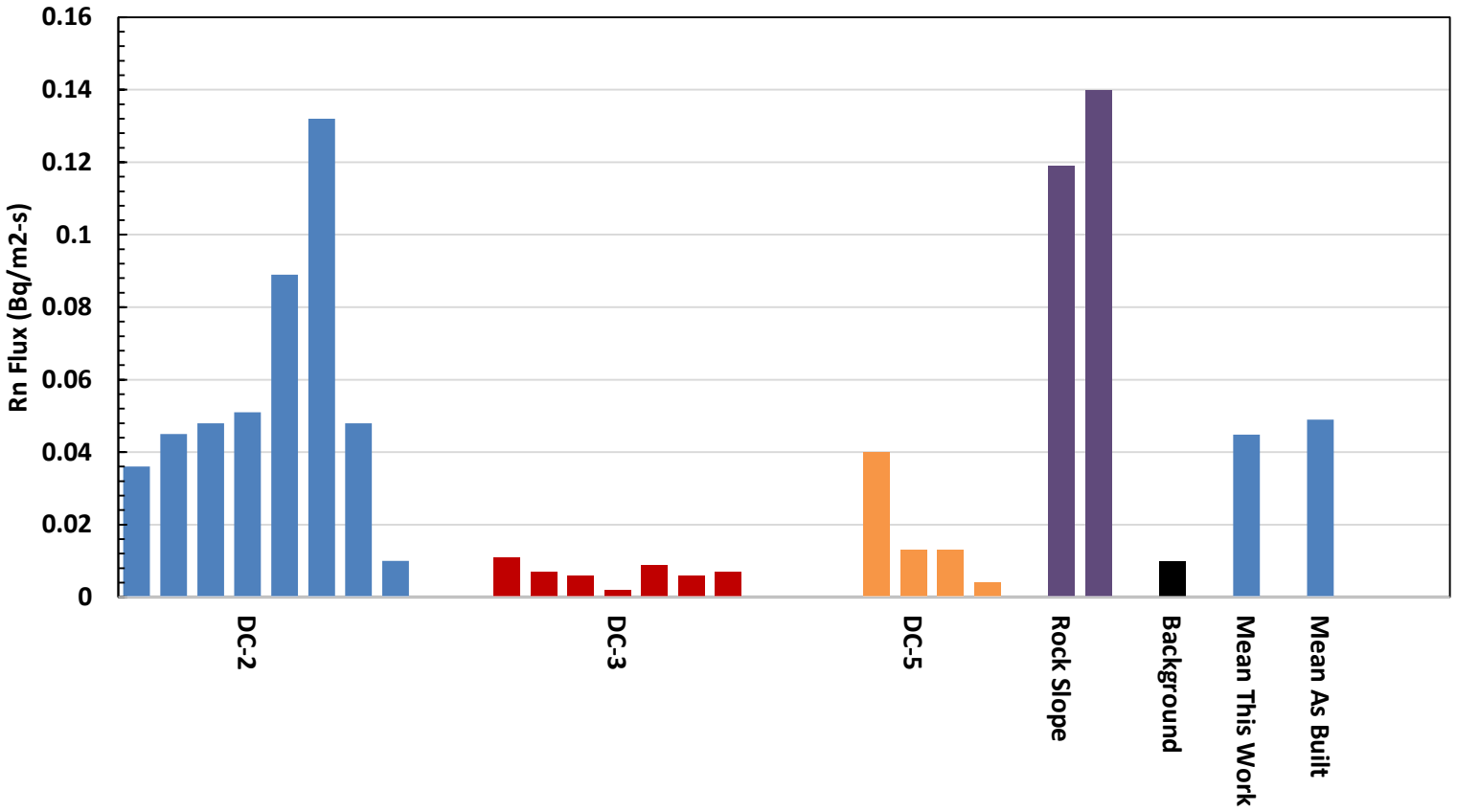
Can we detect Pb-210 in radon barrier material?

Can we observe Pb-210 profiles in radon barriers that are the result of Rn-222 migration from the tailings?

Do the results make any sense?

Can we relate measured Pb-210 to Rn-222 generated by the tailings? Can we model Rn distribution and compare that to Pb-210 profiles?

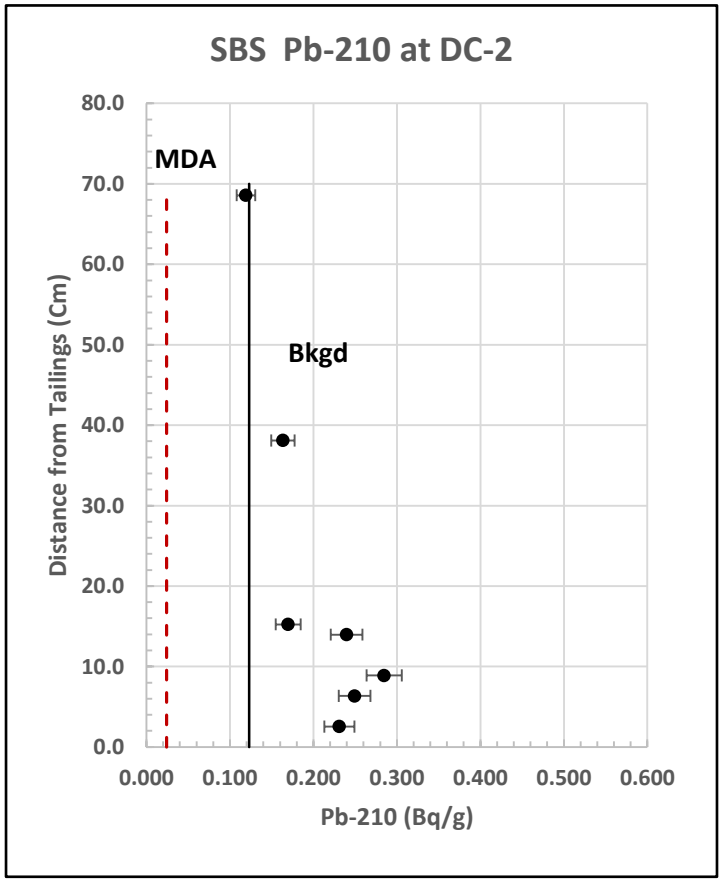
Shirley Basin South Rn Fluxes at Barrier Surfaces in Cells Where Pb-210 was Measured



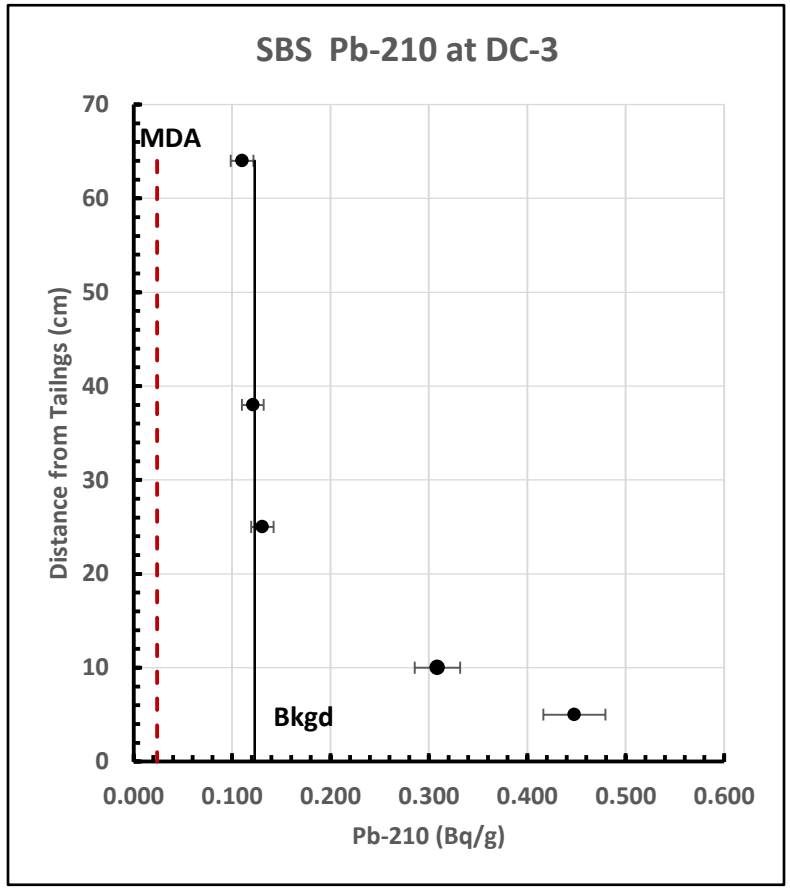
Rn fluxes measured at experiment pits at Shirley Basin South vary substantially. Note the background flux on the right. Can Pb-210 profiles within the barrier material tell us about long-term transport of Rn?

Measured Pb-210 in the Shirley Basin South Barrier Material

2-Sigma Error Bars, MDA, and Background



Bottom Flux = 8.39 Bq/m2.s
Mean Top Flux = 0.057
Attenuation Factor = 147

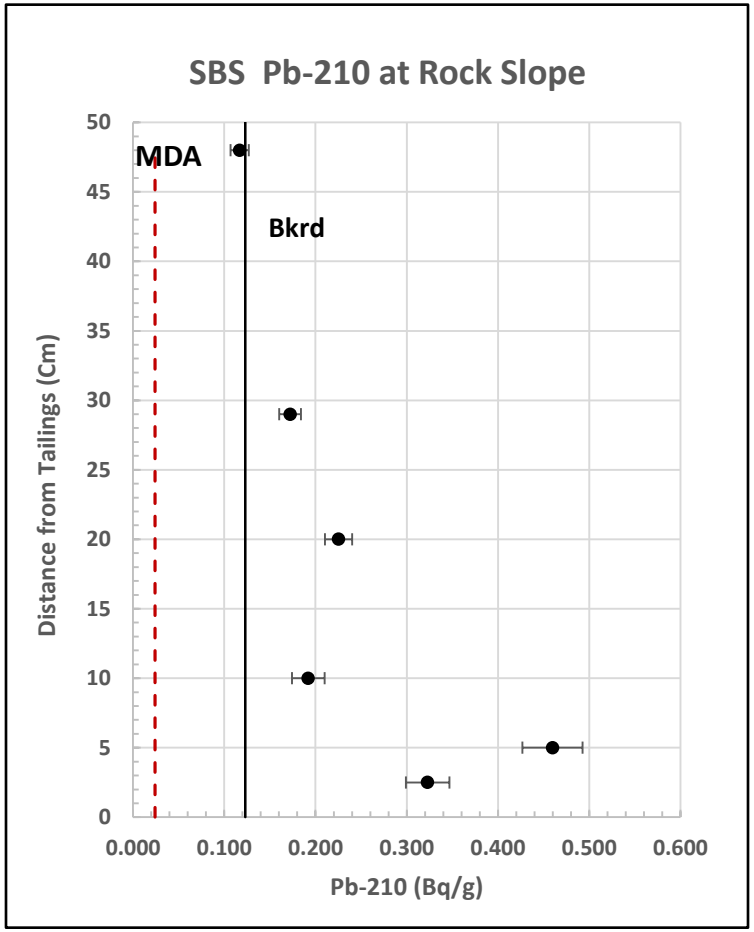


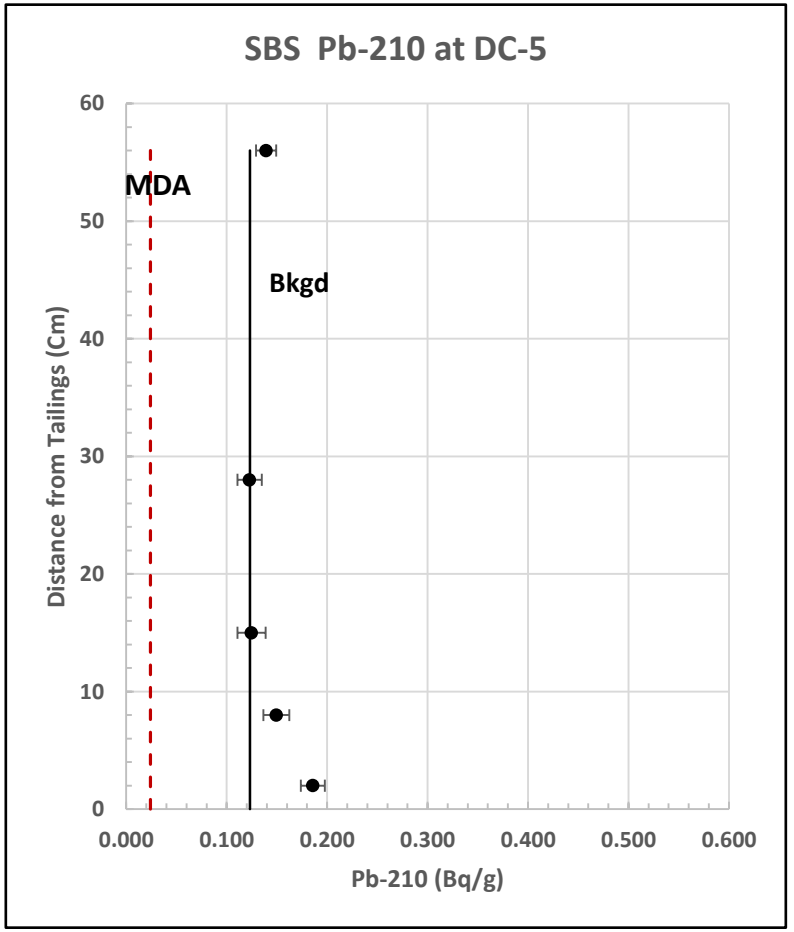
Mean Bottom Flux = 370 Bq/m2.s
Mean Top Flux = 0.006
Attenuation Factor = 6170

Background was determine two ways; modeled Ra-226 content of material and Pb-210 measured in stockpiled barrier material away from tailings.

Measured Pb-210 in the Shirley Basin South Barrier Material

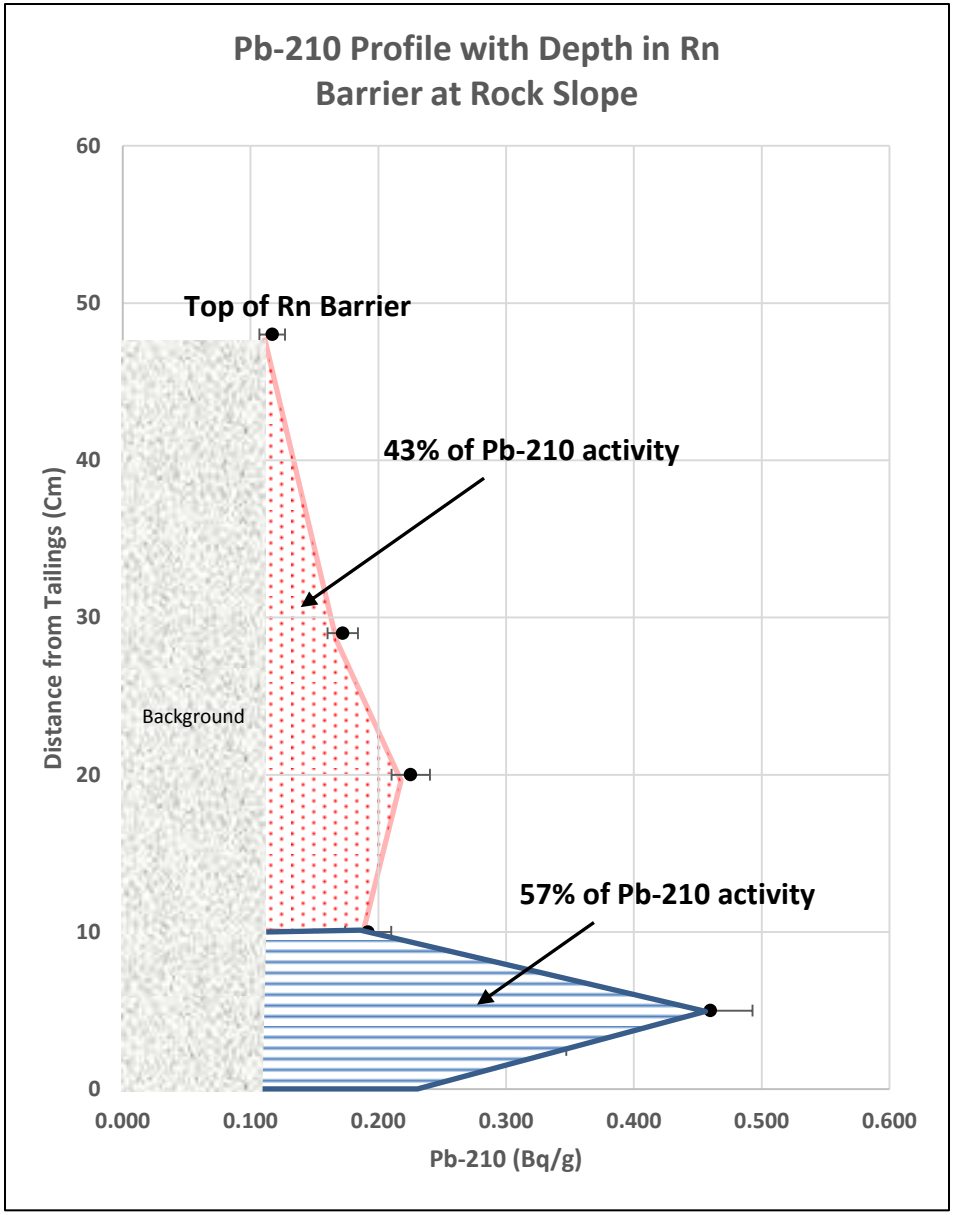
2-Sigma Error Bars, MDA, and Background





Bottom Flux = 69.9 Bq.m2.s
Mean Top Flux = 0.13
Attenuation Factor = 538

Bottom Flux = 0.244
Mean Top Flux = 0.018
Attenuation Factor = 14

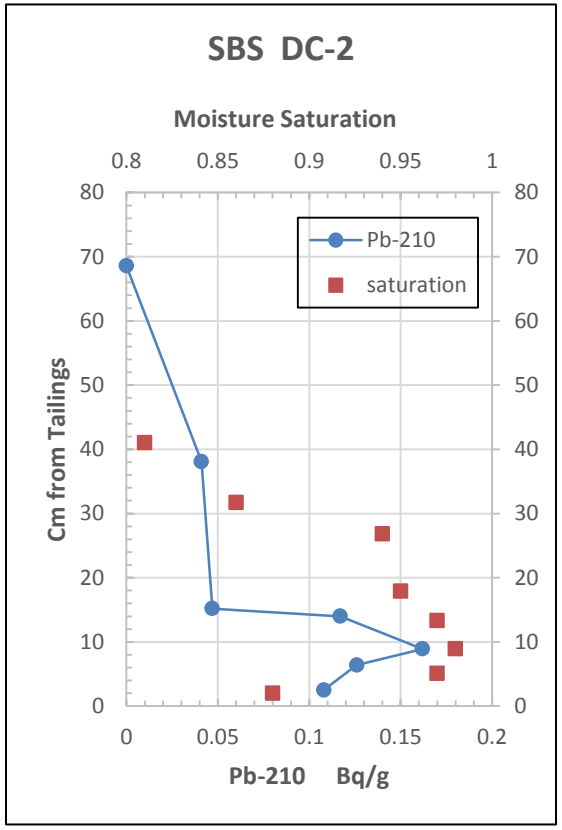


There is measurable Pb-210 background in the barrier material.

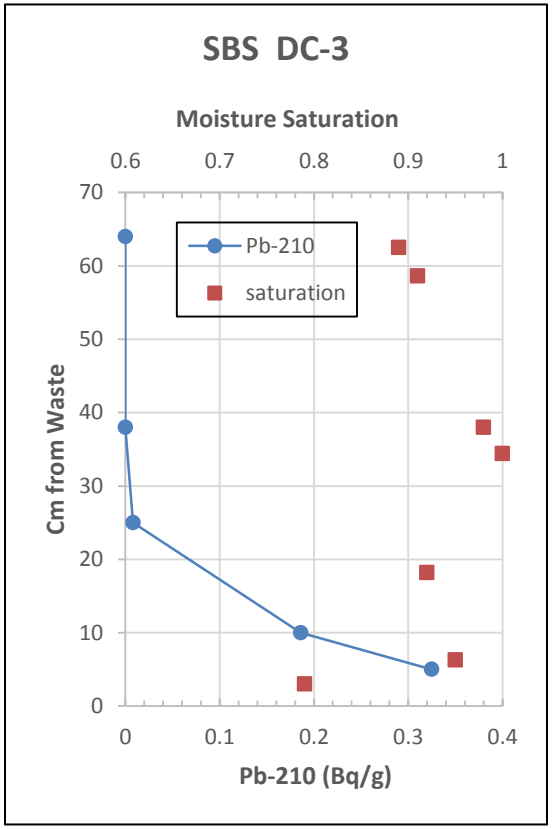
As indicated by Pb-210, most Rn decays before reaching the surface of the Rn barrier.

Where the Pb-210 profile approaches the surface we observe elevated Rn fluxes.

Impact of Moisture Saturation on Pb-210 Distribution



Bottom Flux = 8.39 Bq/m2.s
Mean Top Flux = 0.057 > Bkrd



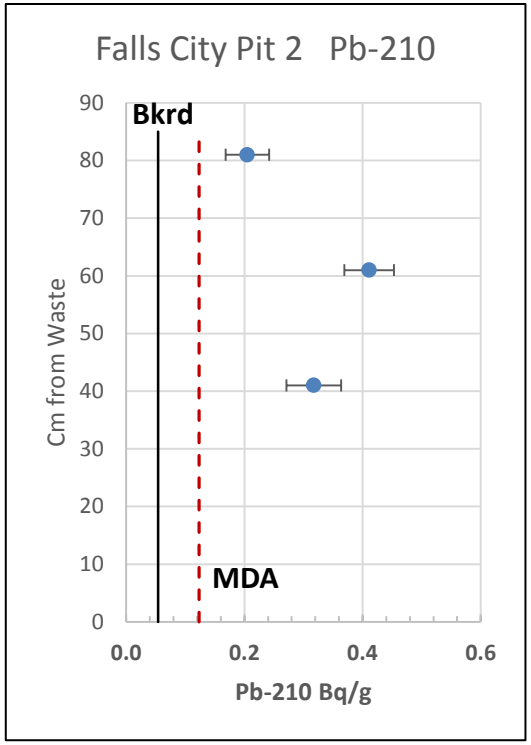
Bottom Flux = 370 Bq/m2.s
Mean Top Flux = 0.006 = Bkrd

Pb-210 is background subtracted

Measured Pb-210 in the Falls City Barrier Material

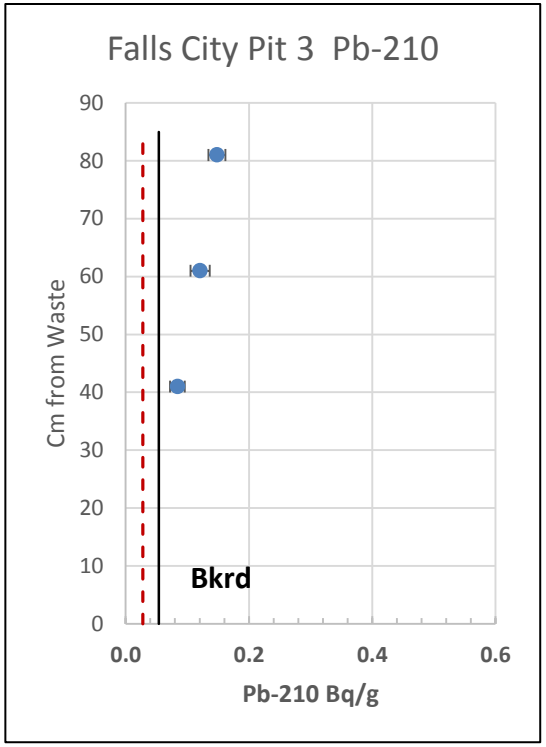
2-Sigma Error Bars, MDA, and Background

Top Rn Flux was elevated



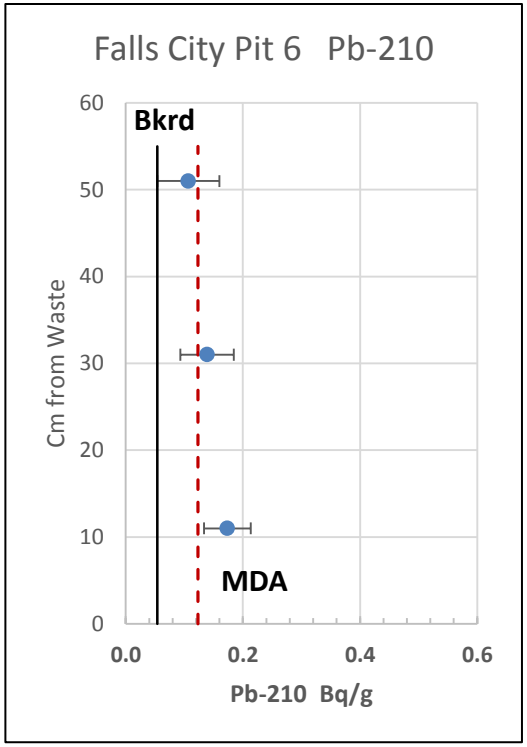
Bottom Flux = 2.06 Bq/m2.s
Mean Top Flux = 0.30
Attenuation Factor = 6.9

Top Rn Flux was elevated



Bottom Flux = 5.15 Bq/m2.s
Mean Top Flux = 0.60
Attenuation Factor = 8.6

Top Rn Flux was background



Bottom Flux = 42.5 Bq/m2.s
Mean Top Flux = 0.013
Attenuation Factor = 3270

Red dashed line is the Minimum Detected Activity and the black line is background Pb-210.
All samples are from Shelby tubes and only from the upper portion of the barrier.
Pb-210 in pits 2 and 3 is substantially above MDA and background, indicating Rn movement through the barrier. For Pit 6 Pb-210 is at MDA and suggests little or no radon moving through the barrier.

***Note Pb-210 MDA for Pits 2 and 6 are higher than Pit 3 because a different method was used*.**

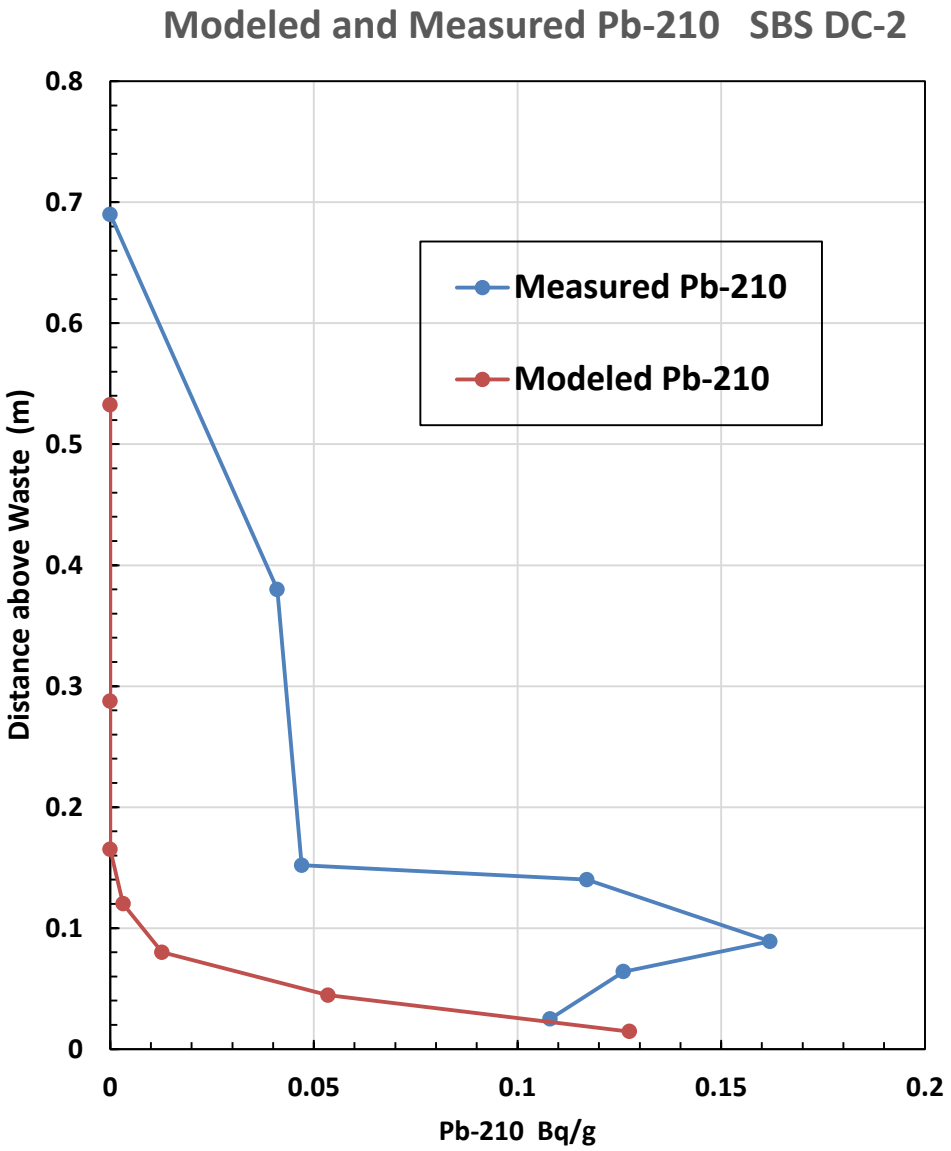
Can we compare measured Pb-210 profiles in barrier material to modeled Pb-210 based on Rn-222 generated by tailings?

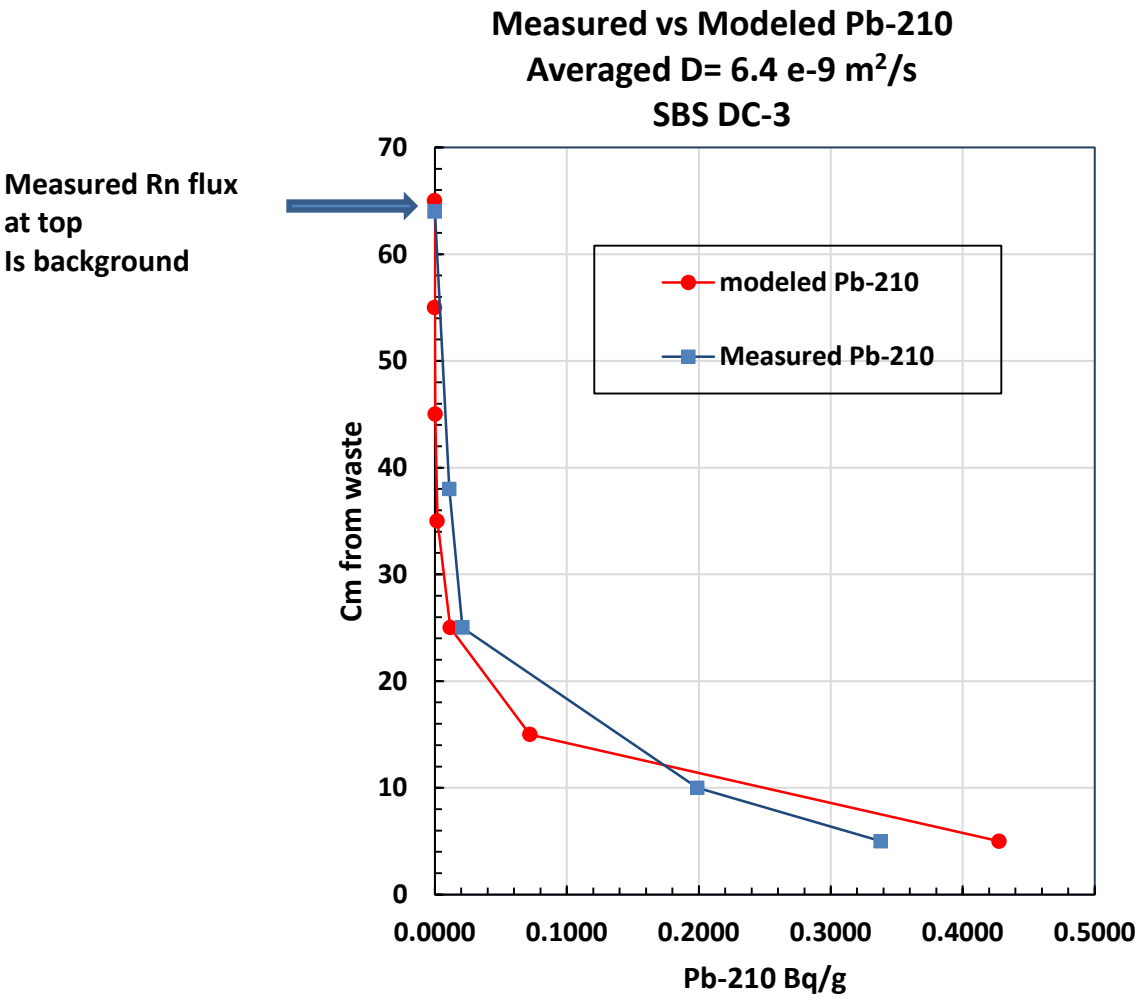
- **Modeled Pb-210 Methods**
  - **Measure top and bottom Rn-222 fluxes and maximum Rn-222 concentrations with Flux Chambers and Rad-7.**
  - **Measure moisture, density, porosity profiles**
  - **Ra-226 and Pb-210 of barrier material for background.**
  - **Using RAECOM and 2-flux method calculate Rn Diffusion Coefficient.**
  - **RAECOM calculates steady state concentrations and fluxes of Rn for layers within barrier profile.**
  - **Convert Rn concentrations to Pb-210 and allow for in-growth time (age of the barrier).**

Model results used D calculated for layers based on measured moisture and porosity of each layer.

Really poor fit for oddly shaped Pb-210 Profiles.

But we are working on the model to adjust fluxes; allowing model to generate the complex shape.





Measured top flux was background (average 0.006 Bq/m^3) and Pb-210 measurement agreed.

Conclusions

- **Pb-210 concentrations can be measured and they show structure within the thickness of the barrier.**
- **Pb-210 is substantially elevated near waste and decreases toward the barrier surface.**
- **In some locations Pb-210 indicates all Rn decays away before reaching the surface. At these locations measured Rn flux at the surface is background.**
- **At other locations Pb-210 indicates a small fraction of Rn reaches the surface. At these locations measured Rn fluxes are elevated at surface. Preferential pathways?**
- **Comparison of Pb-210 distributions with moisture saturation profiles suggest strong small-scale control of Rn transport within barriers.**

Possibilities

- **Transport Mechanisms.**
  - **Develop Models and Data to Use Pb-210 as Indicator of Long-Term Rn-222 Transport Process Within the Barrier.**
- **Monitoring of Long-Term Rn Surface Fluxes.**
  - **Geoprobe sampling of top of barrier**
  - **Elevated Pb-210 in upper barrier is associated with elevated fluxes at the top of the barrier.**