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Gamma-Ray Characterization of the U-Series Intermediate Daughters from Soil Samples at the Peña Blanca Natural Analog, Chihuahua, Mexico

Presented to:
GSA

Presented by:
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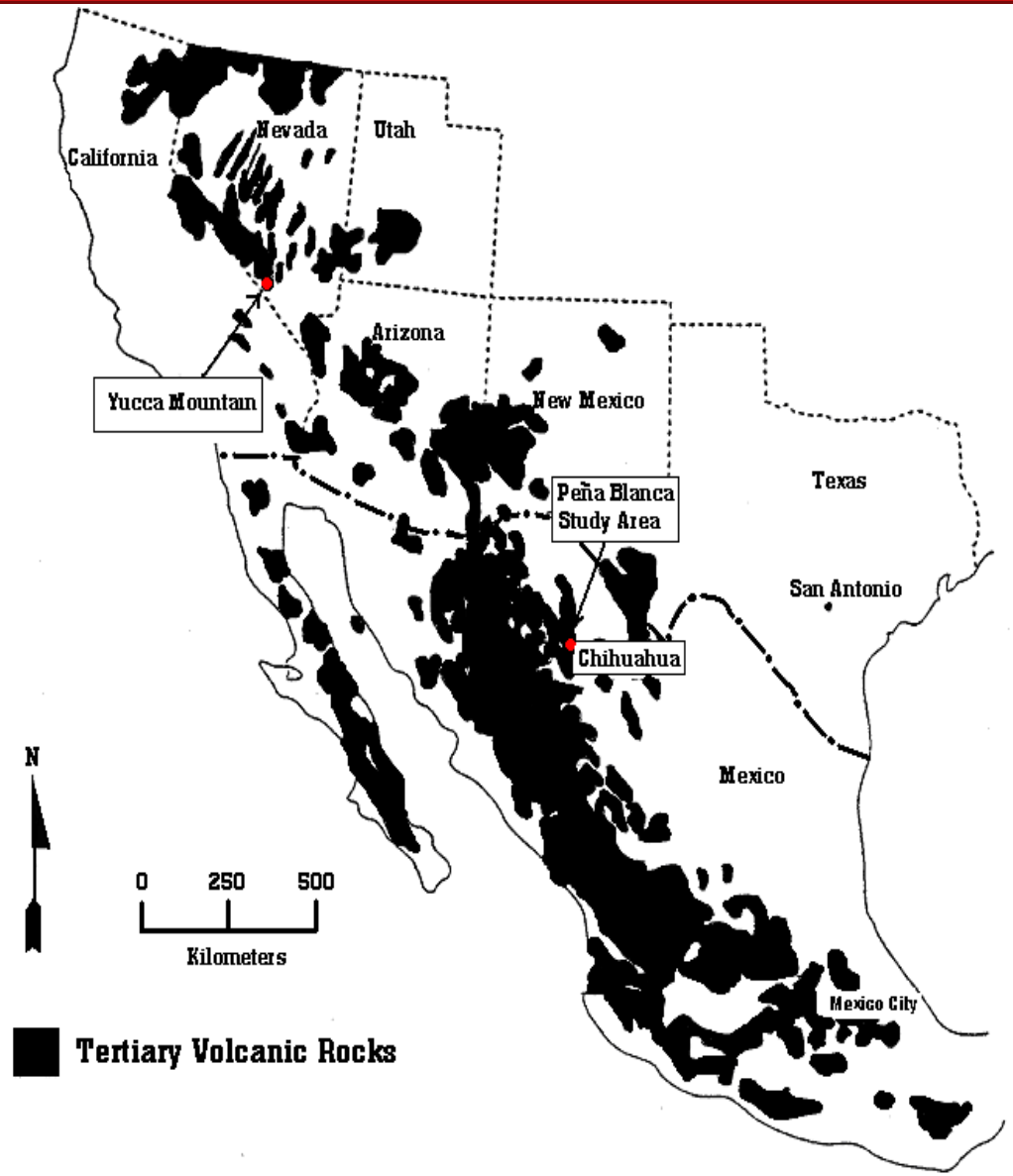
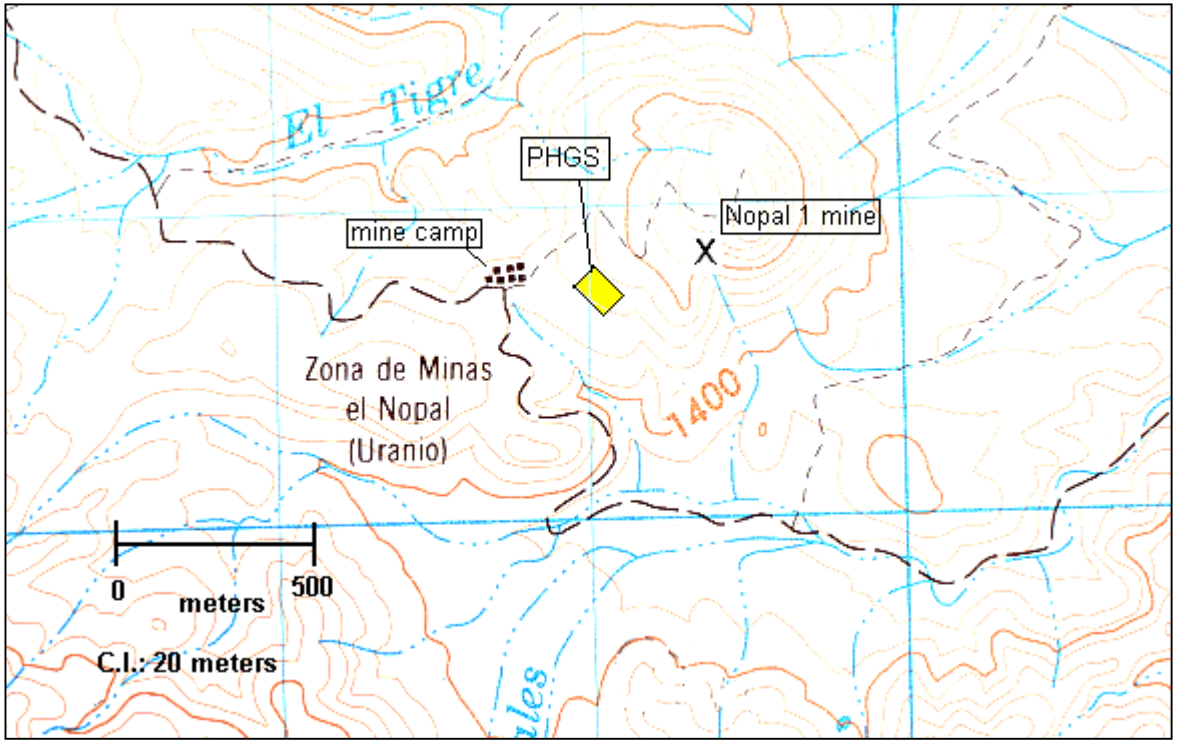
Location of Peña Blanca



(Pearcy et al., 1994)

Location of Prior High Grade Stockpile Relative to Nopal 1 Mine



- **Prior High Grade Stockpile (PHGS): ore transported to site during mining in the 1980's, then removed from site in 1990's. Some ore boulders rolled down slope from site. Maximum residence time for boulders studied: 25 years.**

Purpose of Study: Gamma-Ray Characterization at Prior High Grade Stockpile

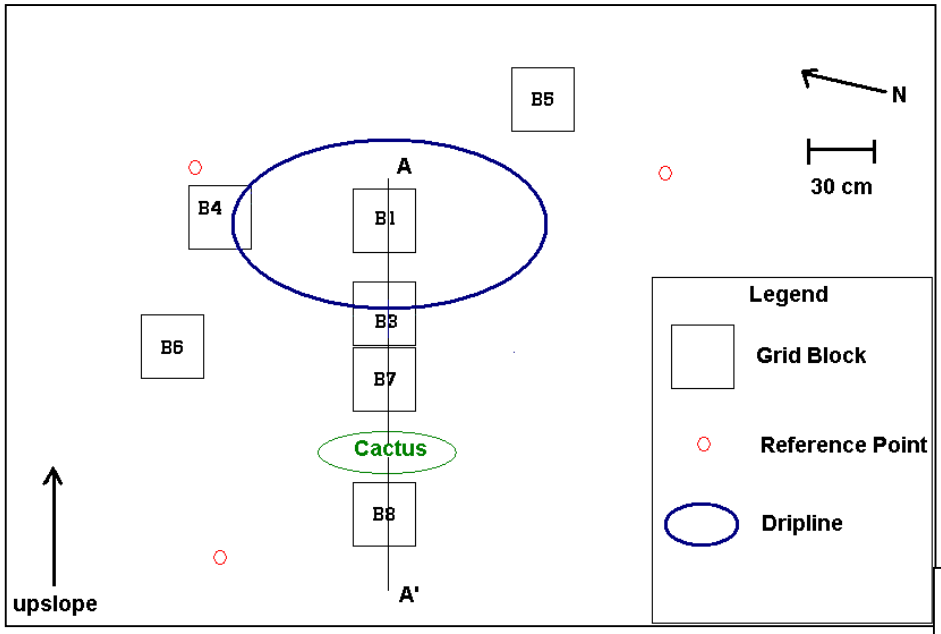
- The purpose of this study is to characterize intermediate daughters of the uranium decay chain in the soil below high-grade boulders.
- U-series disequilibria documents mobilization of uranium and other radionuclides.

Sample Area

- PST (Potential Scientific Target) #110
- The boulder is located just downslope from the Prior High Grade Stockpile site
- Samples were collected from the boulder itself, and from beneath and adjacent to the boulder

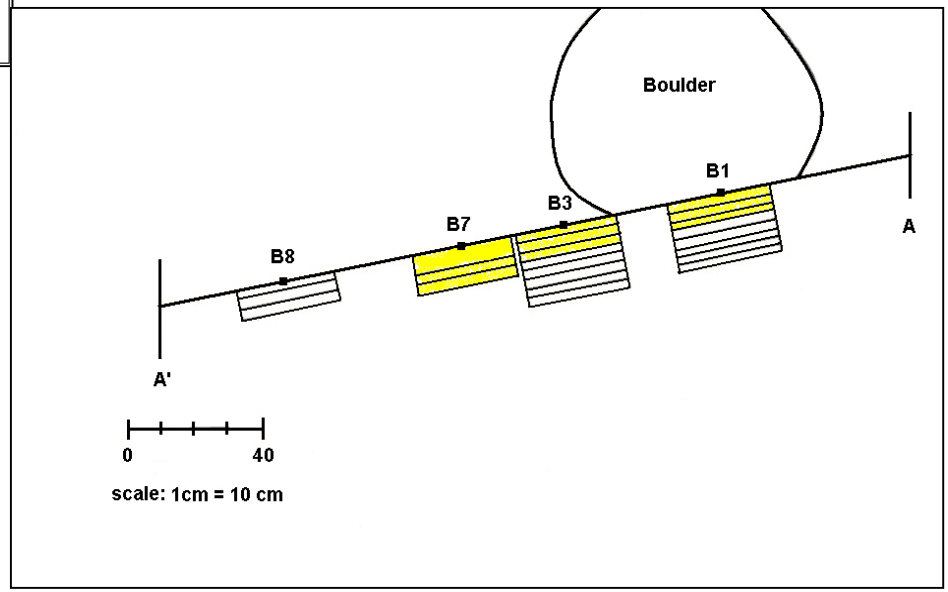
Sample Area After Boulder Moved

Sketch of Sample Locations



- Plan view of sample area
- Samples analyzed thus far: B1, B3, B7, and a boulder sample.
- B3 and B7 higher gamma-ray activities than B1: boulder shields B1; B3 and B7 active transport from boulder

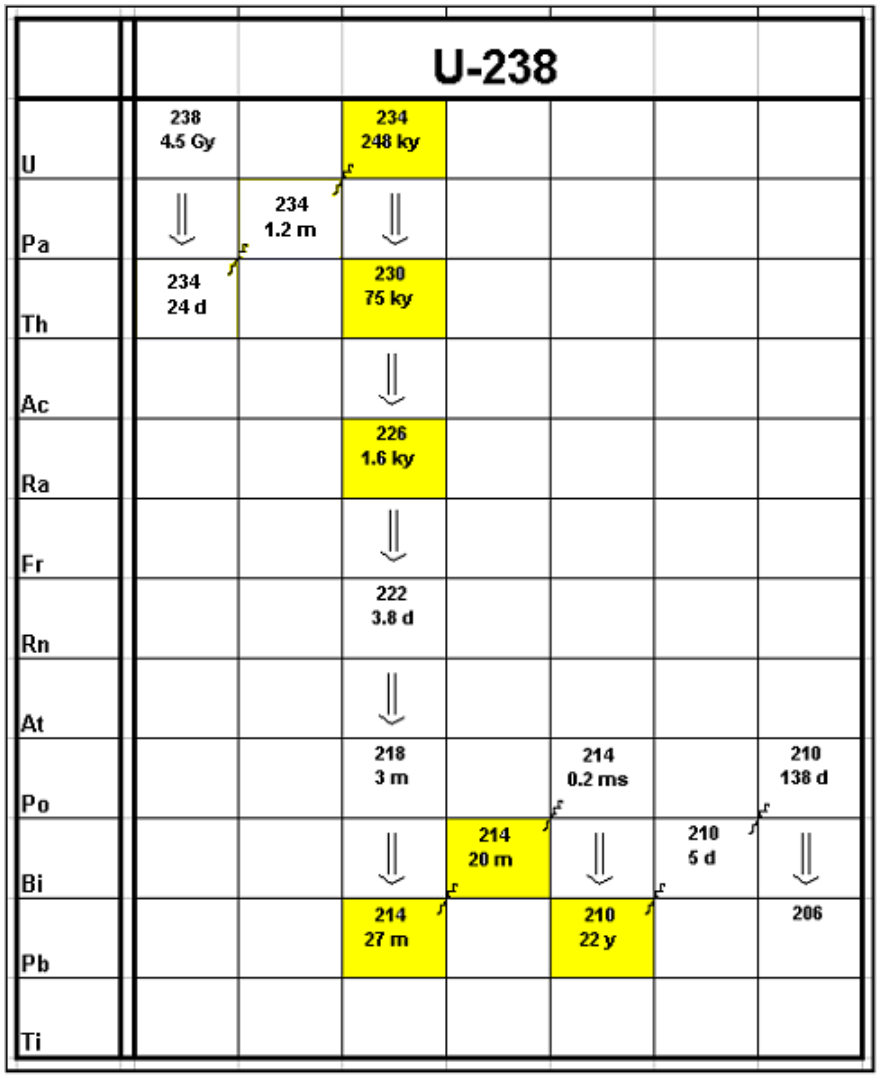
- Cross-section A-A' of sample area.
- Samples from levels 1, 2 and 3.



Samples

- Large samples necessary for analytical precision because activities are low.

Uranium Disequilibria

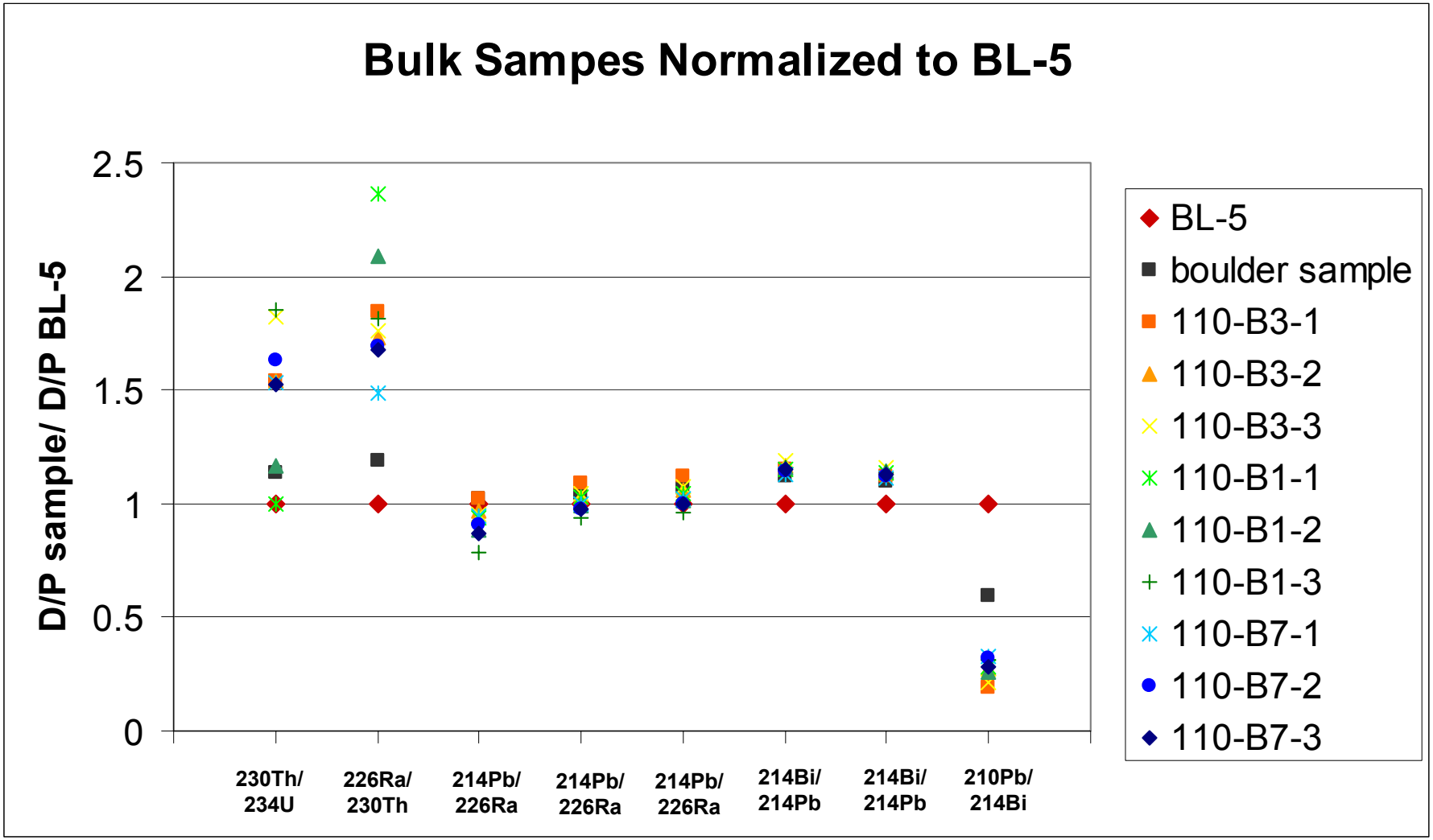


- Gamma ray spectra yield peaks of ^{210}Pb, ^{234}U, ^{234}Th, ^{230}Th, ^{226}Ra, ^{214}Pb, ^{214}Bi, and ^{234}Pa.
- Half-lives of upper part of chain many appropriate for documenting mobility on timescales important to Yucca Mountain performance assessment.
- ^{214}Pb, ^{214}Bi short half-lives, counted for quality control.
- ^{210}Pb half-life appropriate to residence time of boulders at Prior High Grade Stockpile.

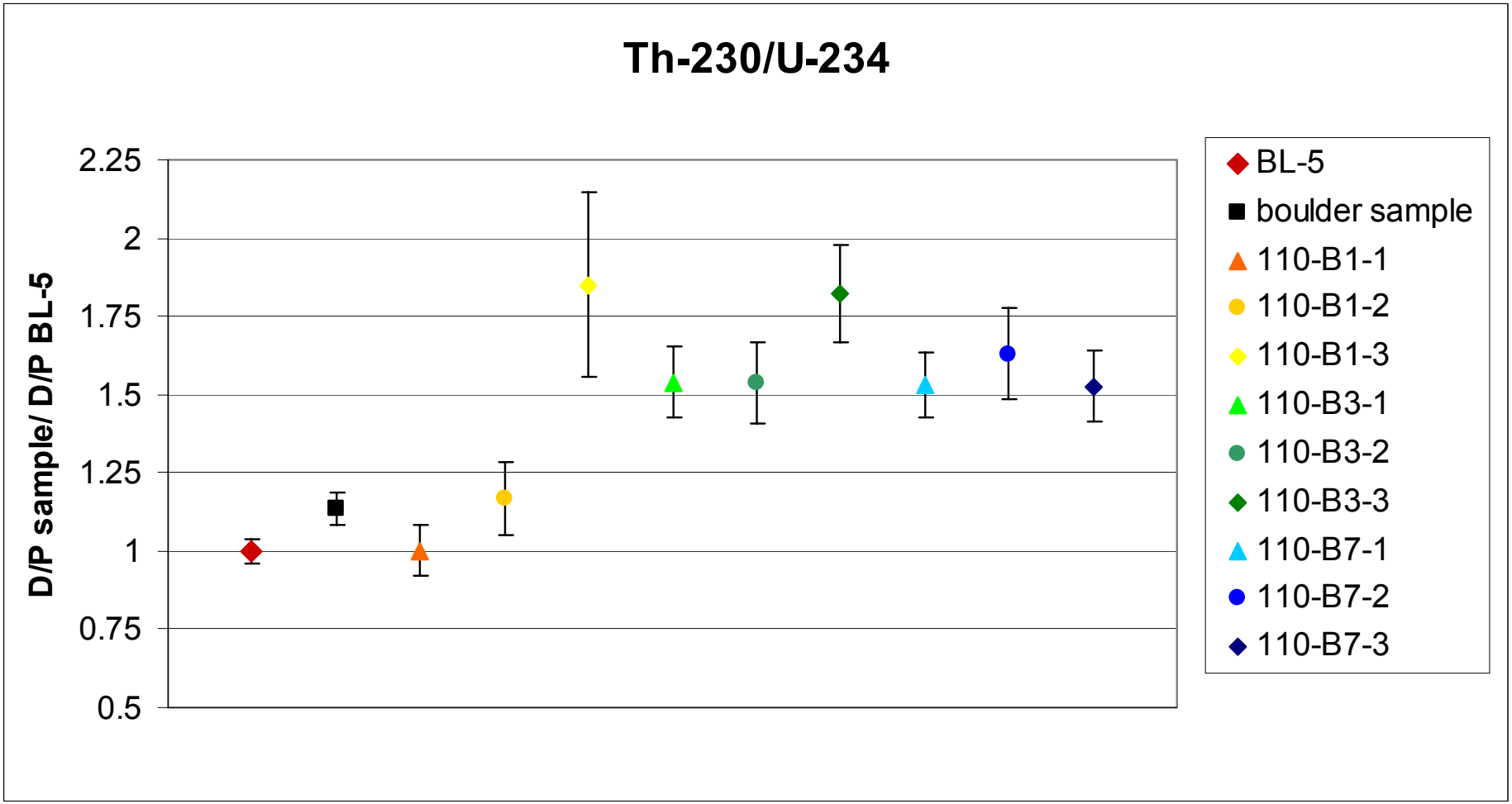
Analytical Procedure for Gamma-Ray Counting

- The standard used for this study is BL-5, uraninite from the Beaver Lodge deposit supplied by the Canada Centre for Mineral and Energy Technology.
- BL-5 is used for a standard because it is certified to be in secular equilibrium.
- BL-5 is cast in a resin disk and counted in the same fashion as the samples.
- Error analysis is done on each daughter/parent (D/P) pair using peak areas generated by Canberra GENIE 2000 software.
- Self-attenuation corrections are propagated for all D/P pairs.

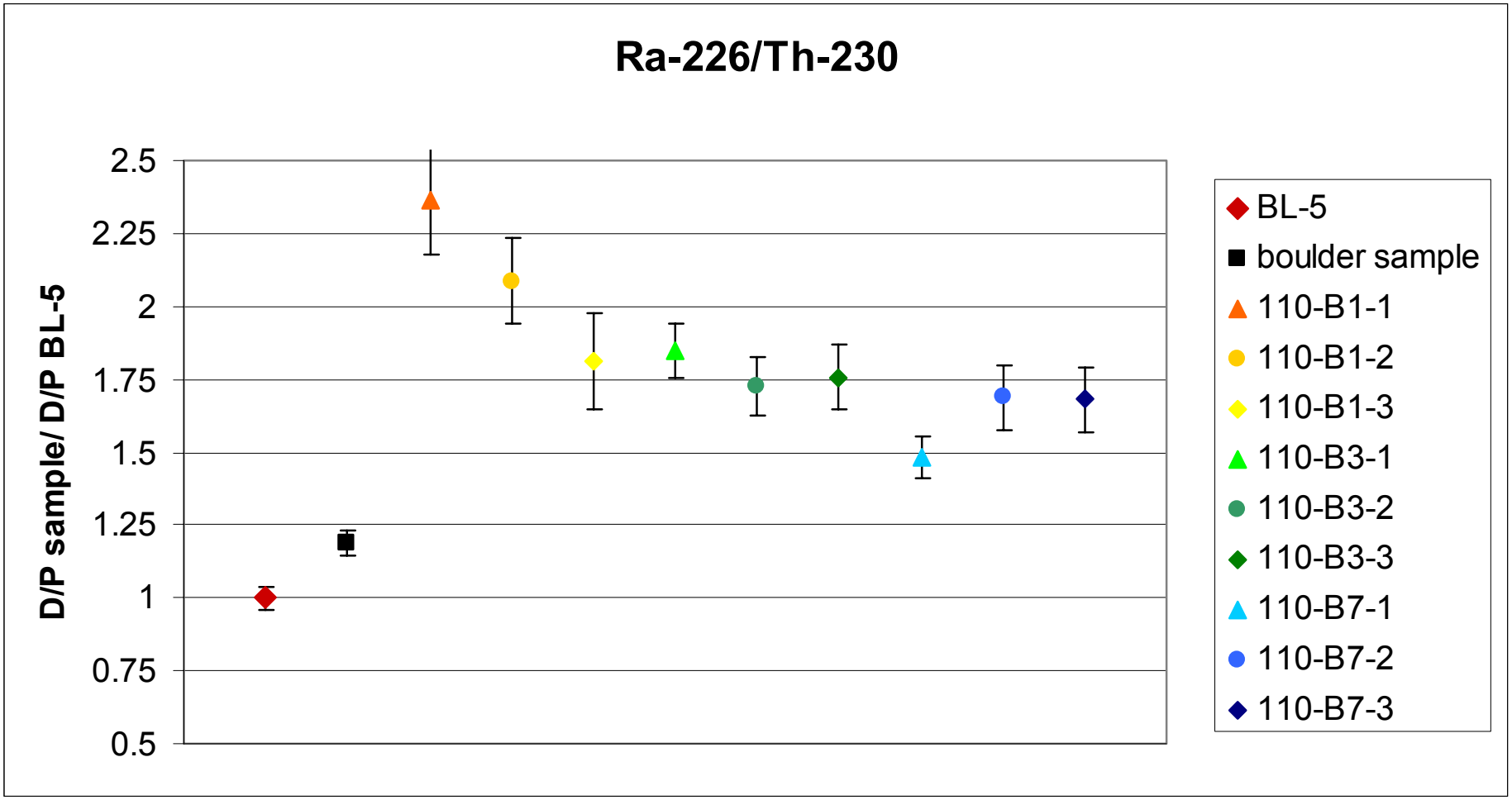
Results for Bulk Samples



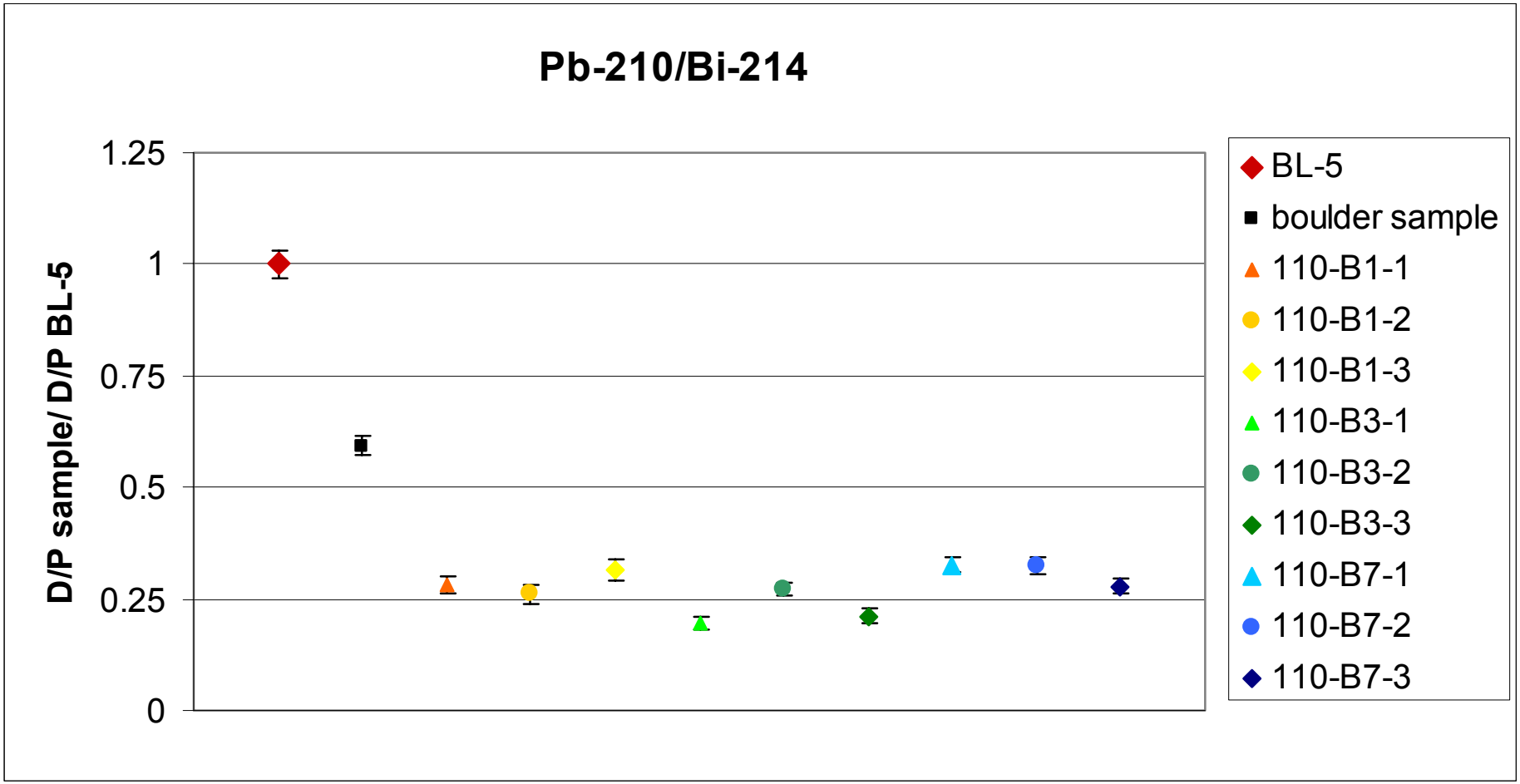
$^{230}Th/^{234}U$


Th-230/U-234
D/P sample/ D/P BL-5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
BL-5
boulder sample
110-B1-1
110-B1-2
110-B1-3
110-B3-1
110-B3-2
110-B3-3
110-B7-1
110-B7-2
110-B7-3

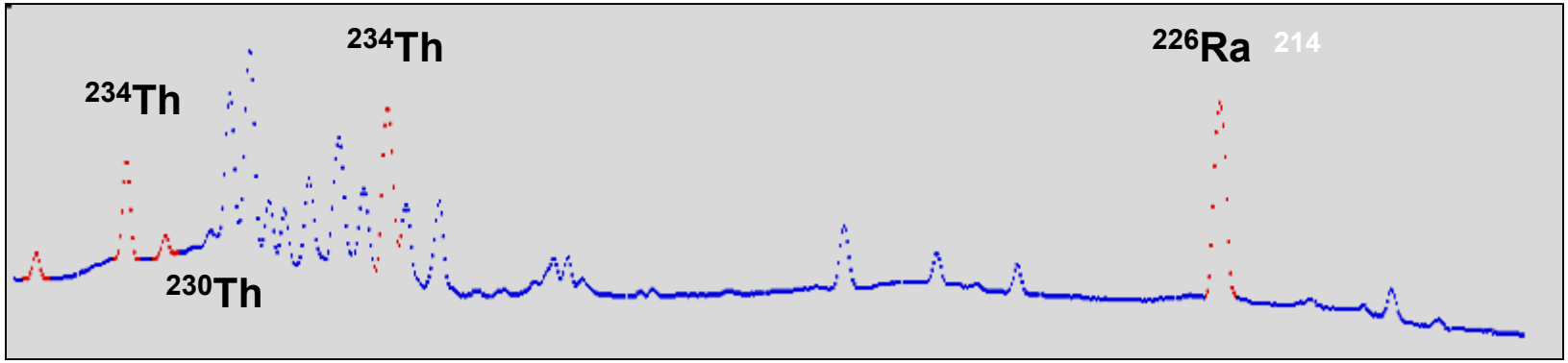
$^{226}Ra/^{230}Th$


Ra-226/Th-230
D/P sample/ D/P BL-5
2.5
2.25
2
1.75
1.5
1.25
1
0.75
0.5
BL-5
boulder sample
110-B1-1
110-B1-2
110-B1-3
110-B3-1
110-B3-2
110-B3-3
110-B7-1
110-B7-2
110-B7-3

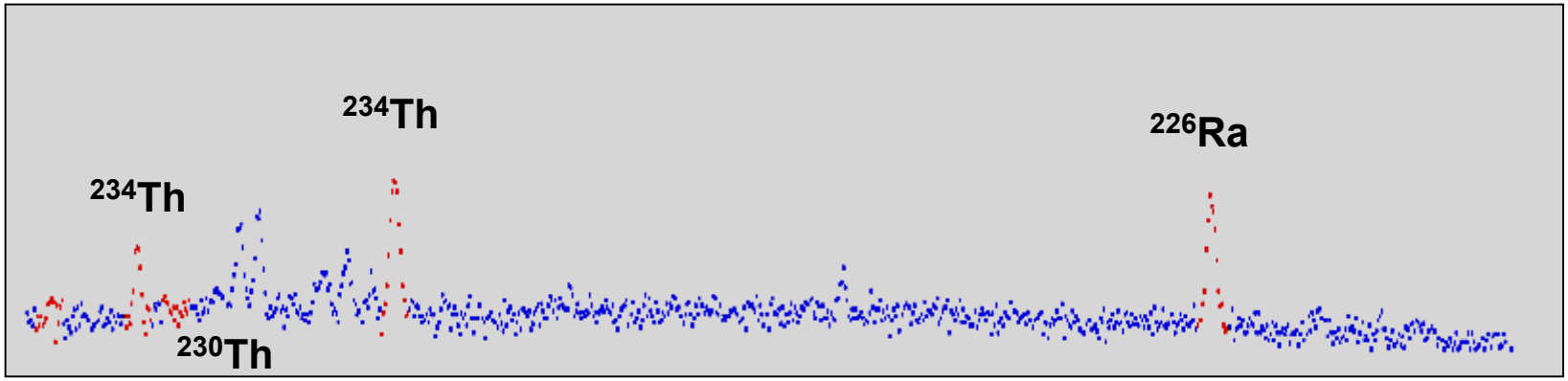
$^{210}Pb/^{214}Bi$


Pb-210/Bi-214
D/P sample/ D/P BL-5
1.25
1
0.75
0.5
0.25
0
BL-5
boulder sample
110-B1-1
110-B1-2
110-B1-3
110-B3-1
110-B3-2
110-B3-3
110-B7-1
110-B7-2
110-B7-3

Results for Organics



- Spectra produced with GENIE 2000 software – BL-5 (above) and organic sample (below)



Comparison of current results to those of previous studies

- Scientists at the Southwest Research Institute (SWRI) found mobilization of U, Th, and Ra within the last million years adjacent to the breccia pipe. This study documents mobilization in the last 20-30 years.
- Wong et al. in 1999 also found U, Th, and Ra disequilibria. The most pronounced mobility was in veins and fractures with oxidized alteration minerals, e.g. hematite.
- Murrell and others (2002) found deficiencies of ^{226}Ra using Thermal Ion Mass Spectroscopy (TIMS), similar to our study and the SWRI results. They did not find disequilibria for the other isotopes.
- Leslie et al. in 1999 documented that plants fix ^{226}Ra. We are also finding large ^{226}Ra excesses in organic material from PST 110.

Preliminary Conclusions

- Secular disequilibrium: $^{230}Th/^{234}U>1$ and $^{226}Ra/^{230}Th>1$.
- ^{226}Ra excess similar to that previously found in plants; ^{226}Ra is mobile and may be fixed into organic material.
- These patterns agree with previous work: $^{234}U/^{238}U>1$ outside the deposit is attributed to leaching by meteoric waters. $^{230}Th/^{234}U>1$ suggest Th mobility.
- This study and previous studies suggest multi-stage mobilization.
- Contribution of this study: short residence time of ore at the Prior High Grade Stockpile, time span for mobility decades rather than previous minimum estimate of thousands of years.

Acknowledgements

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Questions?