A scenic landscape photograph of a mountain valley. In the foreground, there is a dirt road or clearing with some sparse vegetation. The middle ground features a dense forest of evergreen trees. In the background, a large blue lake is visible, surrounded by rolling green hills and distant mountain ranges under a clear sky.

Application of Synthetic Precipitation Leaching Procedure (SPLP) to Waste Rock Characterization

Southeast Idaho Phosphorite Mining Operations

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Denver, Fall 2010

Major Points

- Conventional column data is better interpreted on an eluted-mass basis, rather than concentrations
- SPLP testing (E.P.A method 1312) can anticipate the results of column elution testing as currently used in EIS studies
- SPLP testing is more flexible, efficient and cost-effective
- SPLP testing allows more comprehensive and statistically-defensible sampling programs

Background of EIS Studies in Southeastern Idaho

An Evolutionary Process

Evolution of EIS Programs for Mine Permitting

- **Primary driver: Potential Selenium contamination of groundwater**
- **Early SPLP characterization replaced by column experiment**
- **Column testing now the standard basis for prediction of groundwater impacts**
- **Mono-lithologic columns currently preferred**

SPLP = Synthetic Precipitation Leaching Procedure

WR = Whole Rock Assays

SP = Saturated Paste Extractions

Project	Date	SPLP Extractions	Other Extractions	Monolithic Columns	Run-of-Mine Composite Columns
Dry Valley	1999	55	30 WR 85 SP	4	2
Smoky Canyon B&C	2001	138	6 WR	8	1
N Rasmussen Ridge	2001	0	13 WR 13 SP	15	0
Smoky Canyon F&G	2006	0	11 WR 11 SP	21	6
Blackfoot Bridge	2007	27	27 WR	0	11

Historic Column Testing Programs

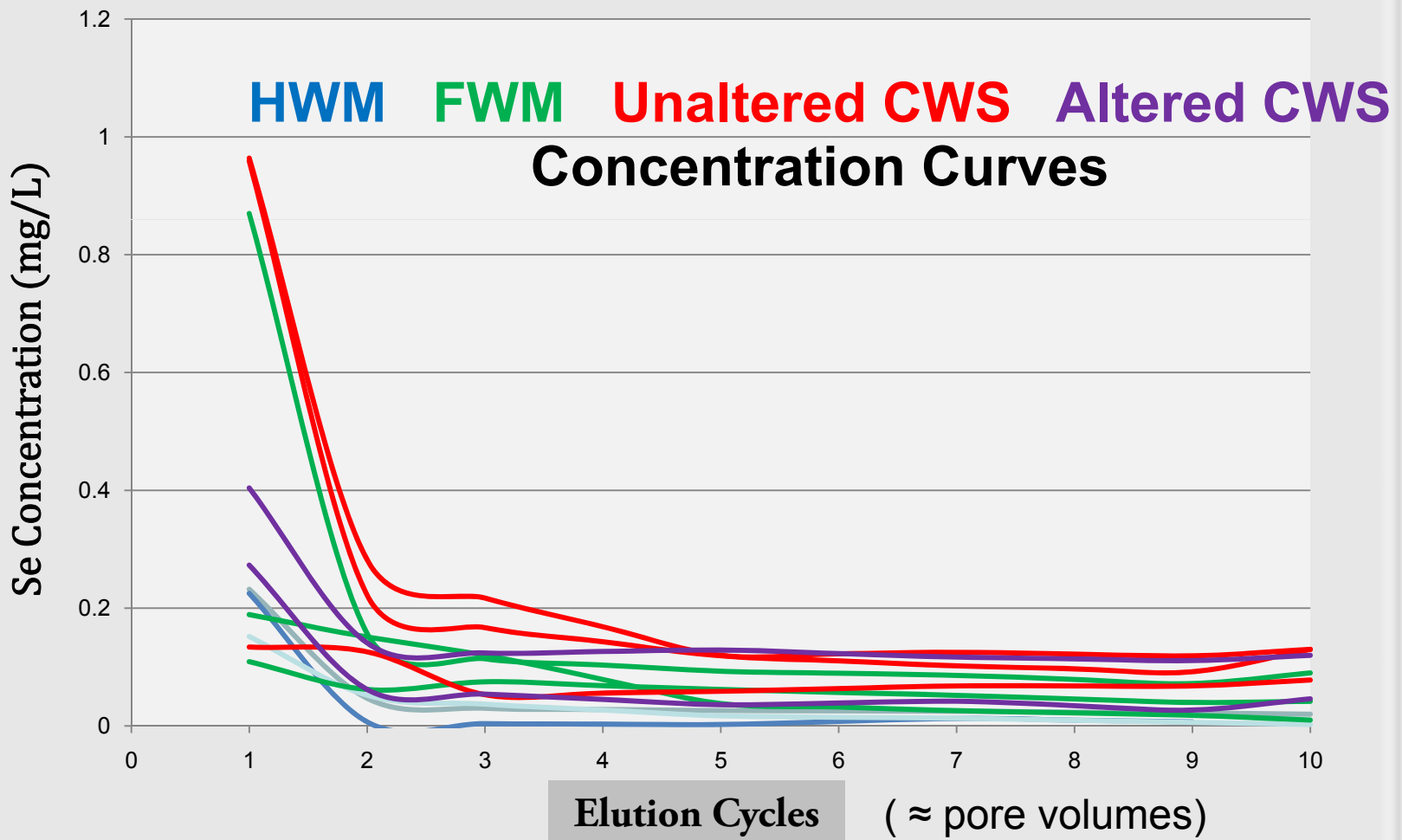
- Limited number of composite samples (<20) prepared from drill cuttings or core
- Columns represent:
 - 5 or 6 “mono-lithologic” waste units
 - Strike length 3 – 5 miles
 - 1 column per 10E6 cubic yards of waste rock
- Operated as “unsaturated”, saturated, w or w/o bacterial inoculation
- Inadequate statistical basis for sampling

Experimental Column Elution Data

*A tradition of concentration-based
interpretation*

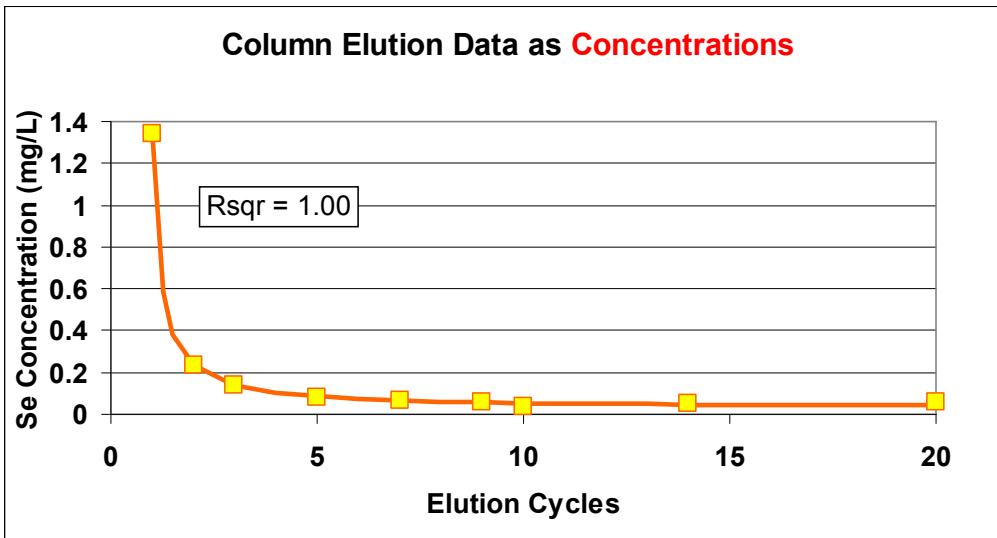
Cumulative mass is more versatile

Selected Elution Curves Illustrating Similarity in Form for all Columns



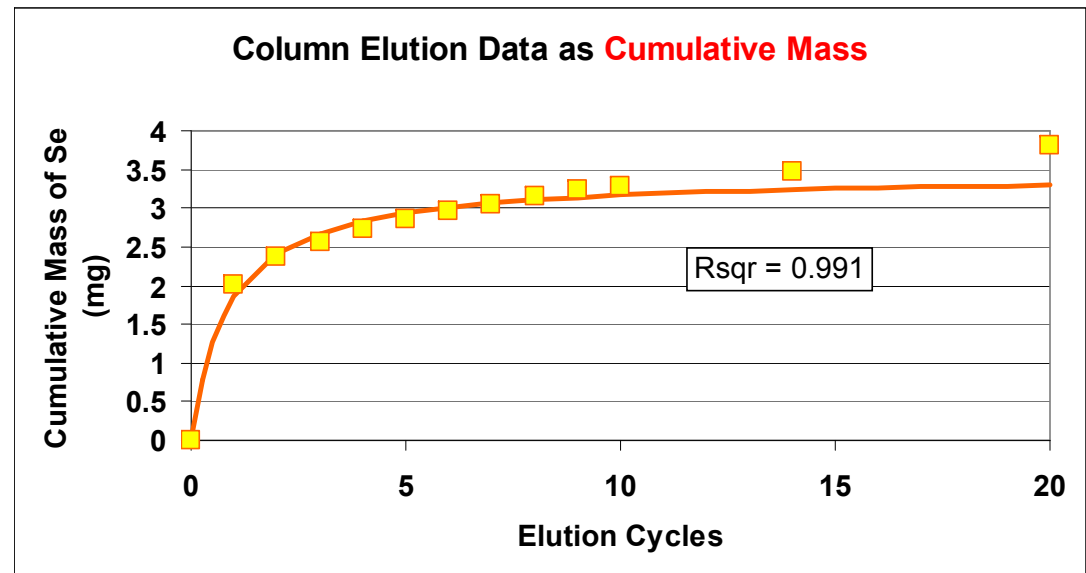
Fitting Experimental Data to Curve Forms

Column DSFG-10, Smoky Canyon Panel G

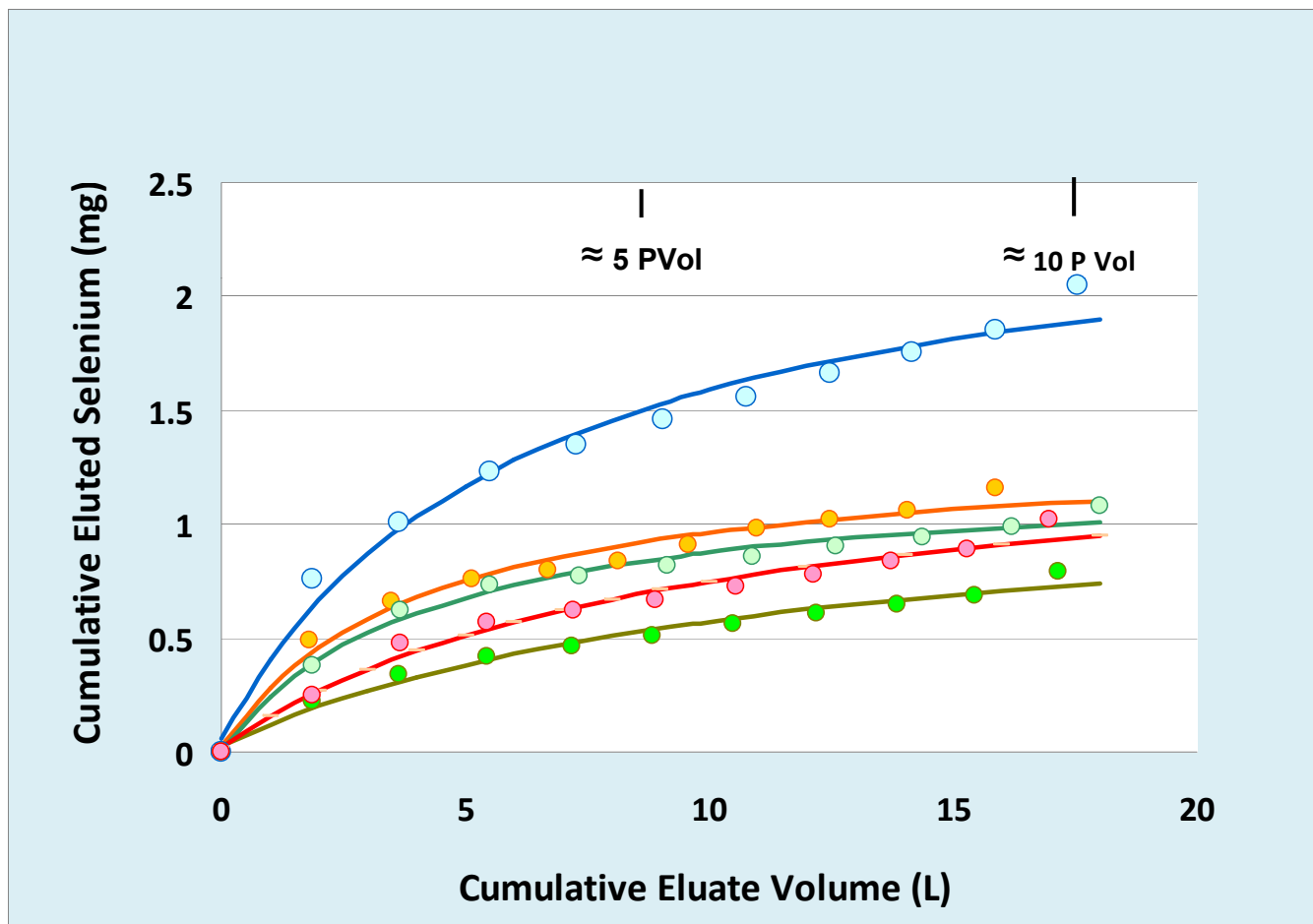


$$y = (a + bx) / (c+x)$$

$$y = (1 + ax) / (b + cx)$$

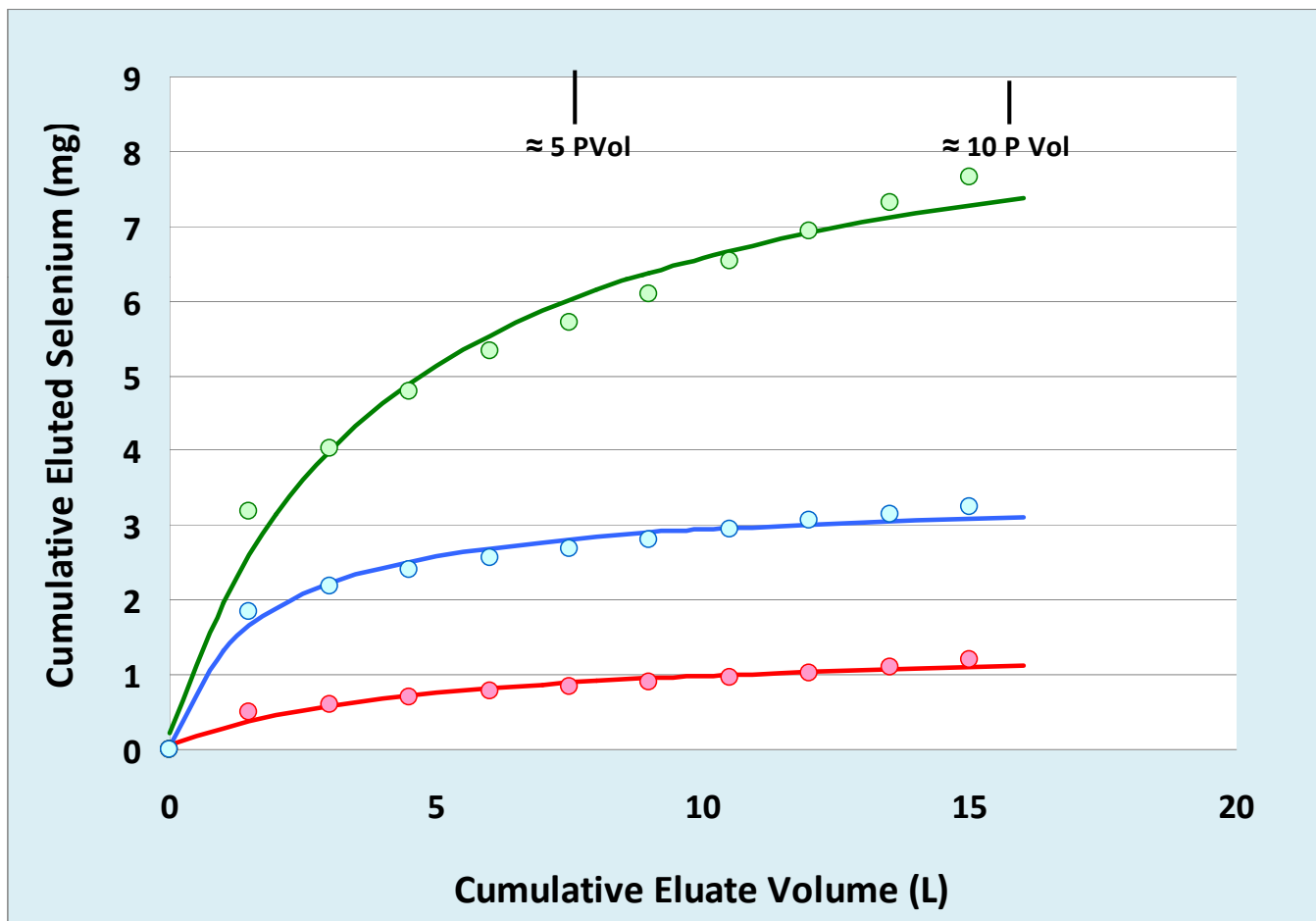


Cumulative Eluate Se Mass Center Waste Shale – Smoky Canyon B & C



Cumulative Eluate Se Mass

Center Waste Shale - Smoky Canyon F & G

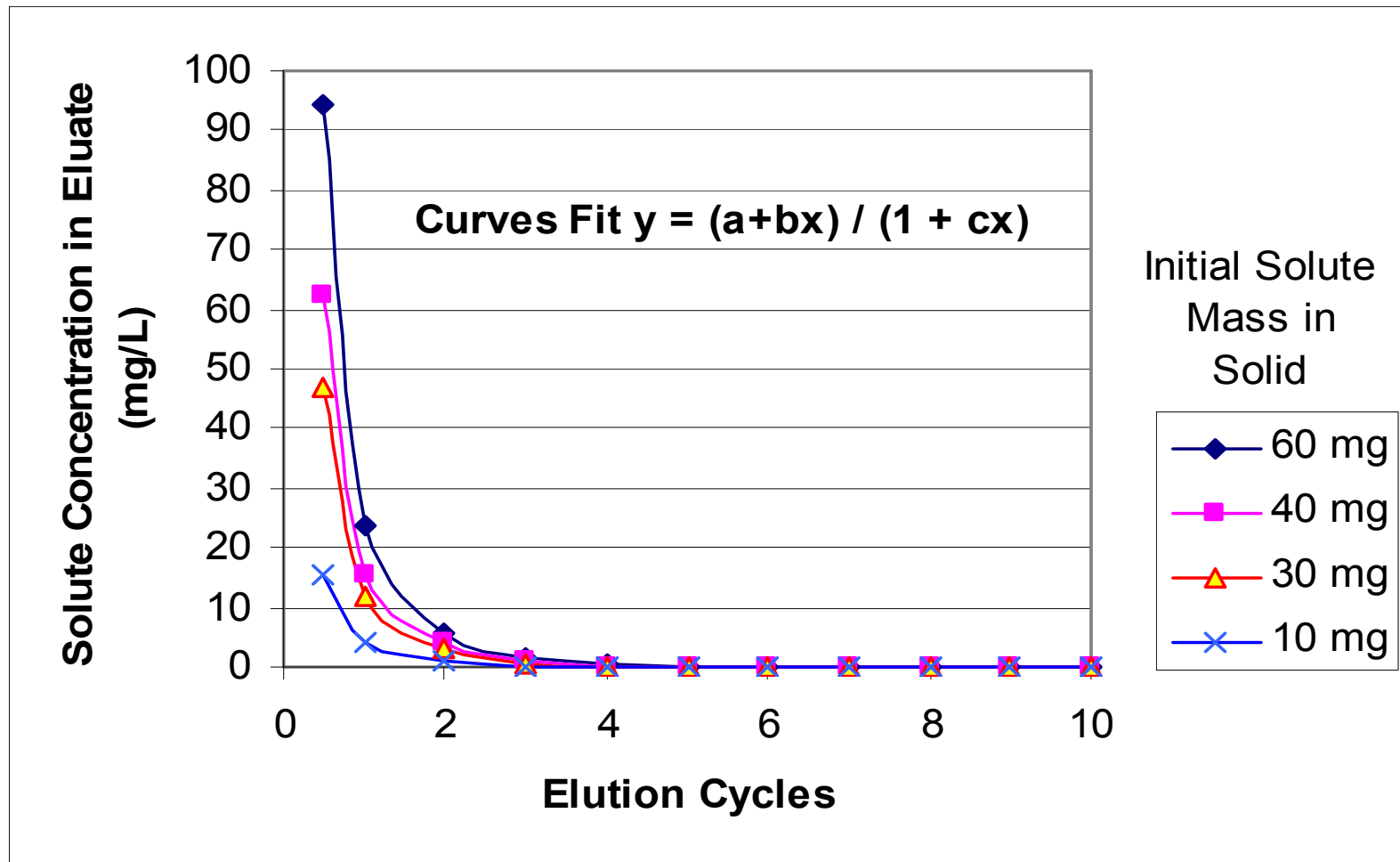


Mechanism of Se Elution

*Interpretation of Column Elution Data
as Simple Flushing Mechanism*

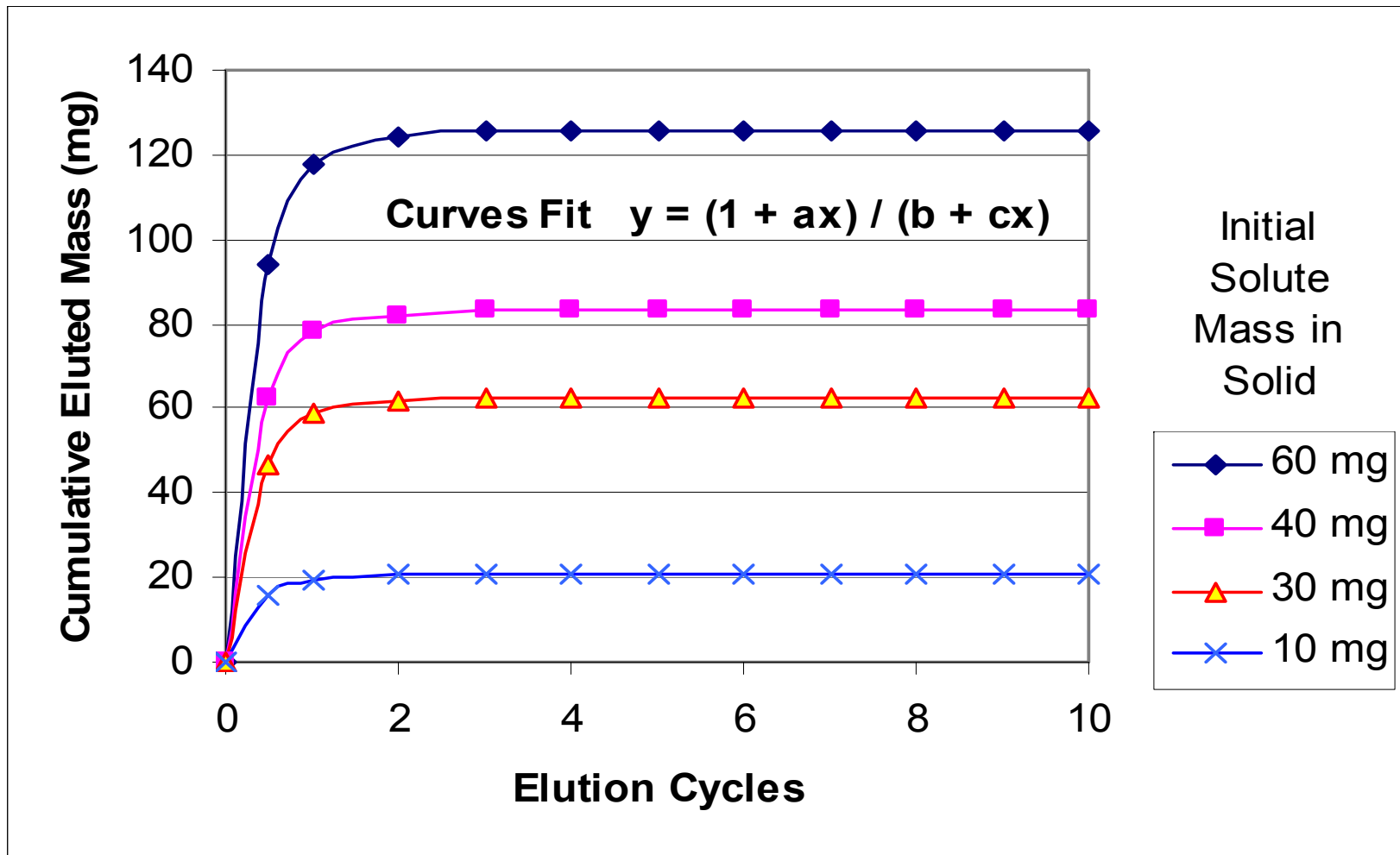
Simple Column Elution Model

Dependent on Initial Solute Mass



Simple Column Elution Model

Dependent on Initial Solute Mass



Column Elution vs. SPLP

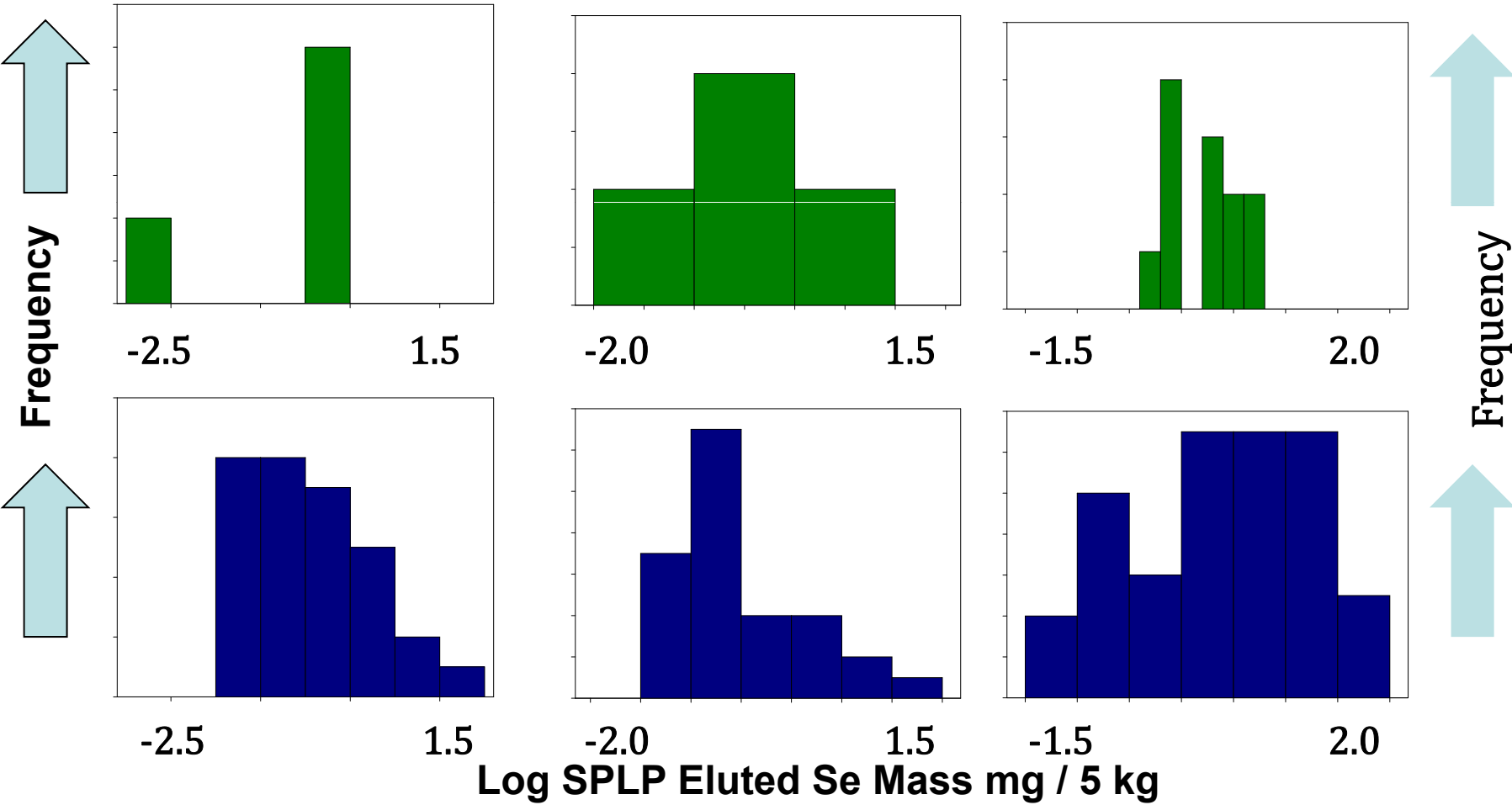
Same release mechanism
Results are comparable

Fraction of Total Se Removed by Columns and SPLP

Lithology	Average Eluted by Columns	Average Liberated by SPLP
Chert	0.8 %	≈ 1%
HWMS	0.44 %	1.34 %
CWS	1.04 – 1.91%	3.09 %
FWM	0.38%	1.22 %

Comparison of Cumulative Column Elution and SPLP-Eluted Masses

Log Cumulative Column Elution Data mg / 5 kg



HWM

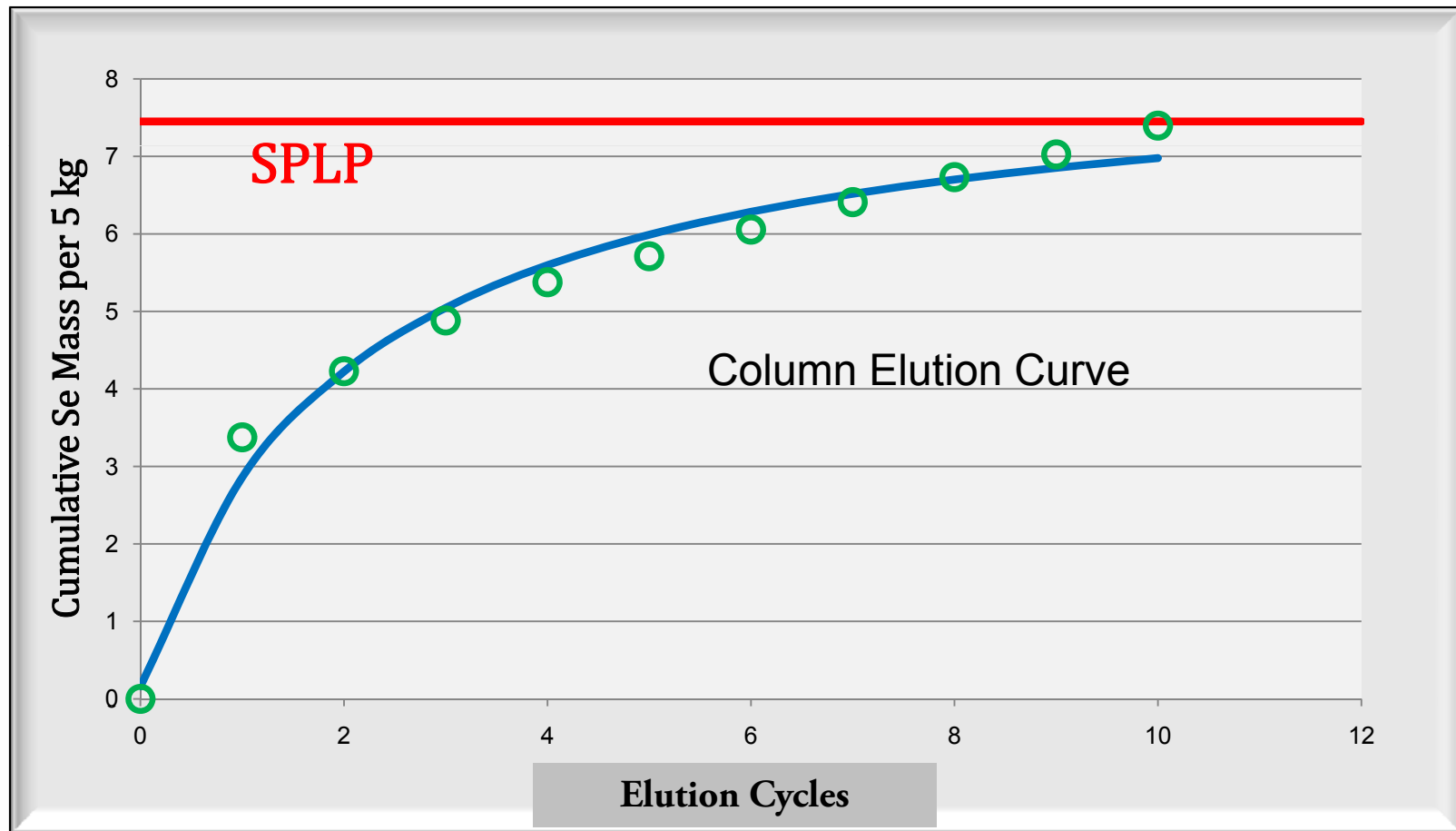
FWM

CWS

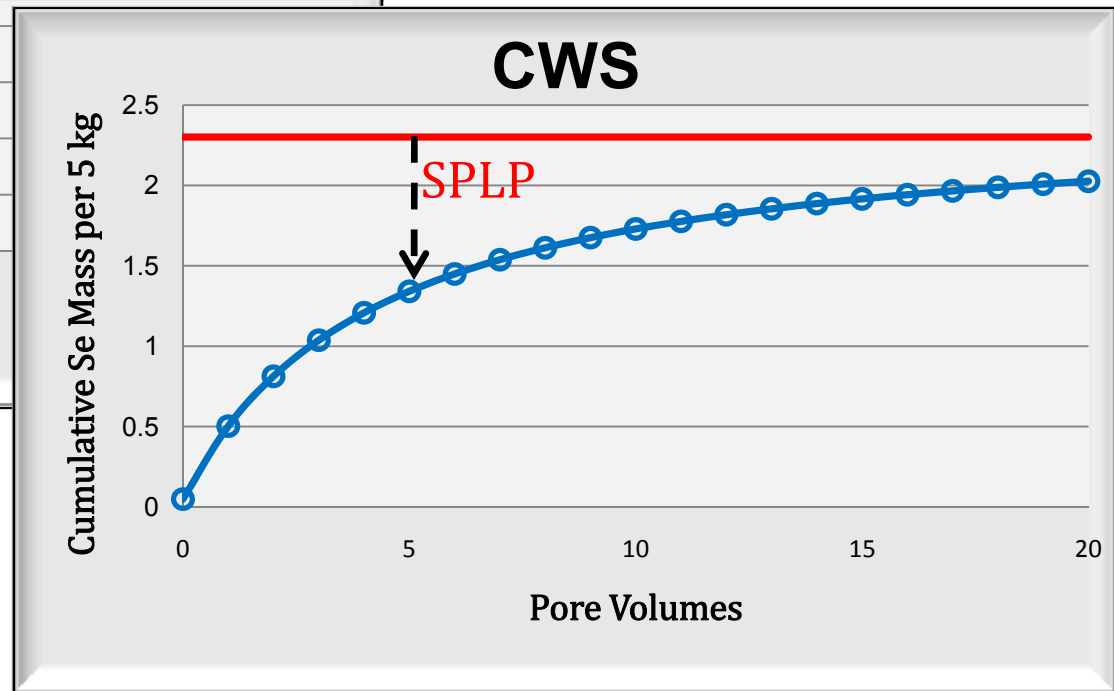
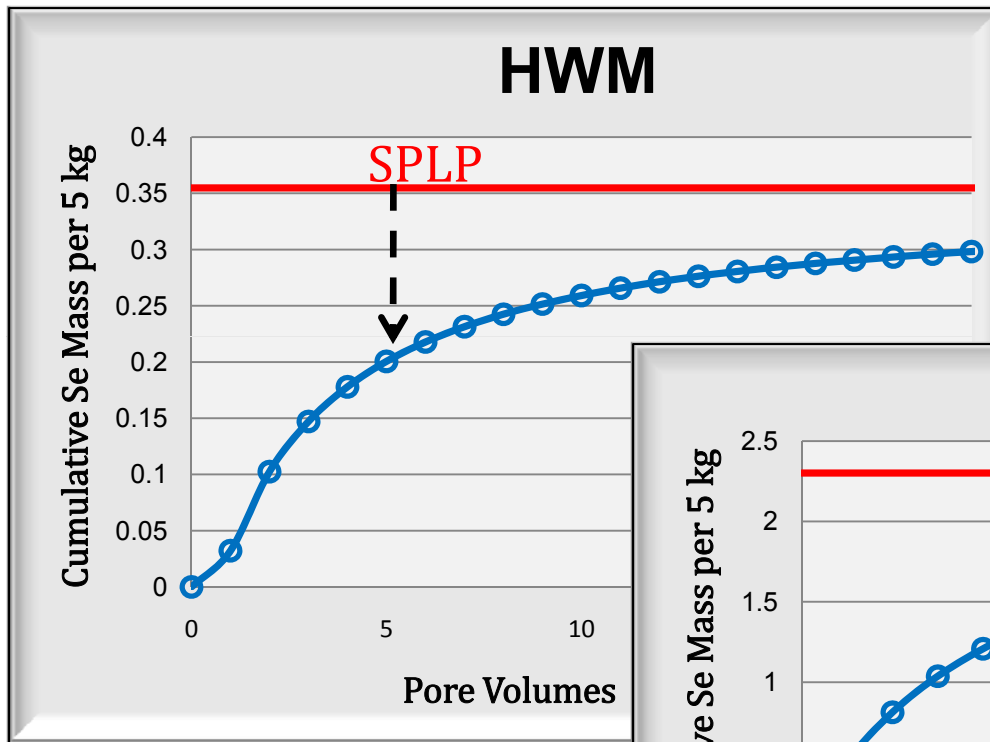
Typical SPLP Se and Cumulative Se Mass Column Result

SPLP : 00-54764-038 Smoky Canyon

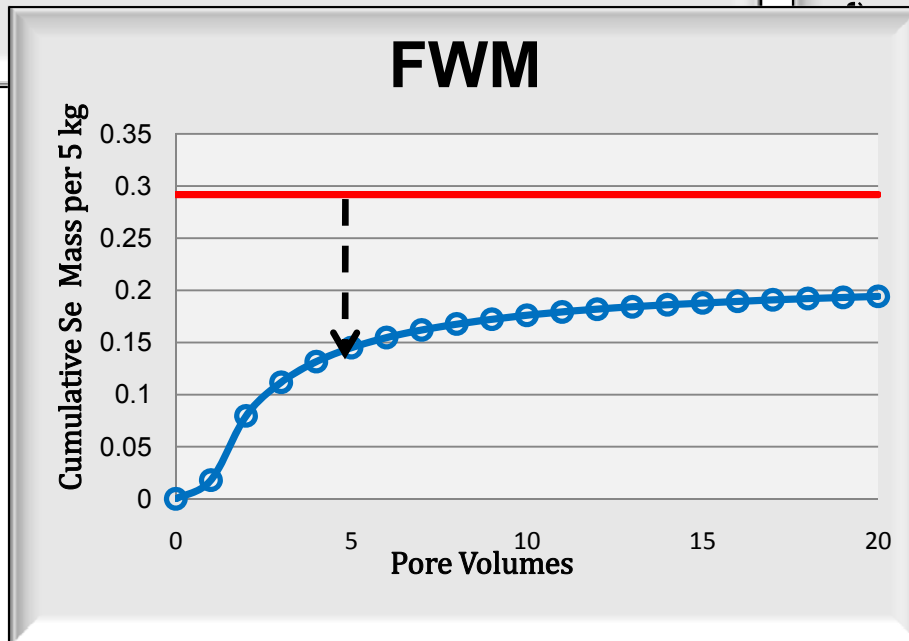
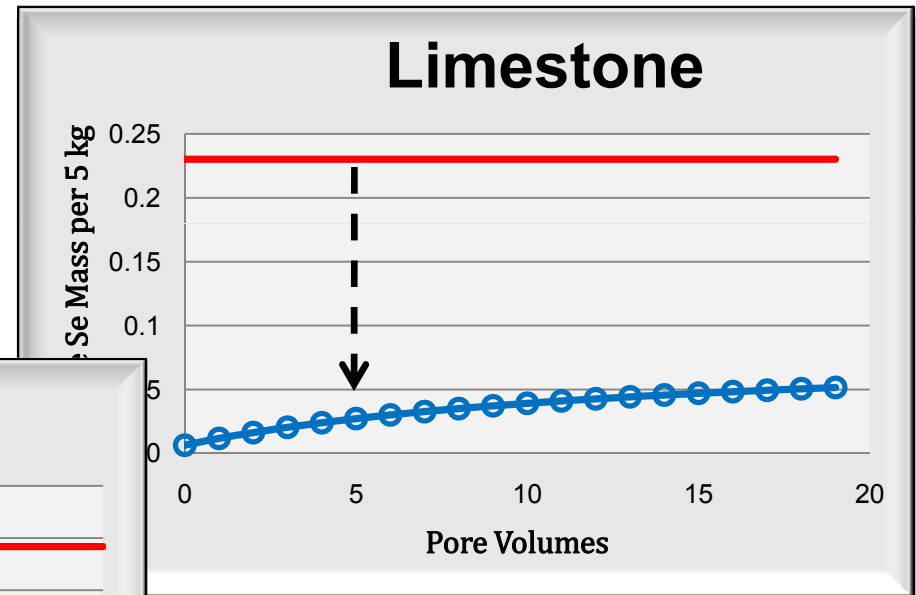
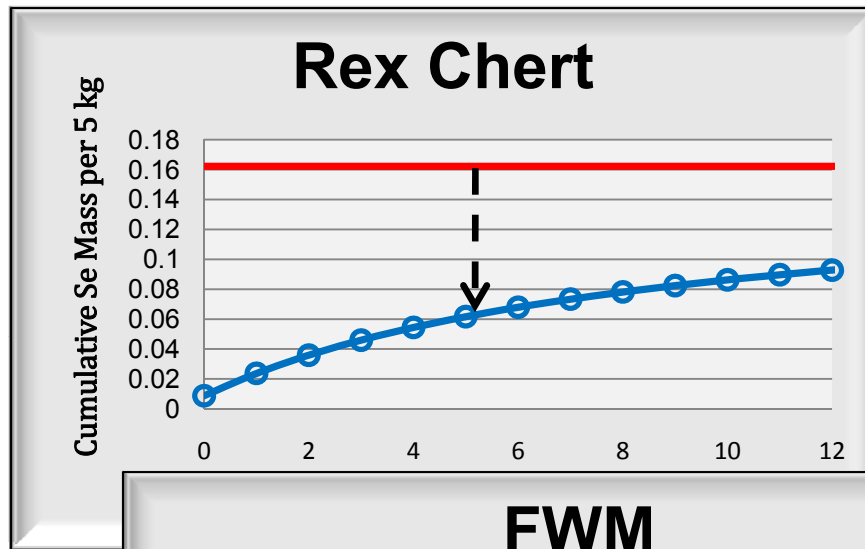
Column : MSFG -6 Smoky Canyon



Mean Column-Eluted Se and Mean SPLP-Eluted Se



SPLP Looks Beyond the Natural Buffering Capacity of Carbonate and Siliceous Rocks



Conclusions and Recommendations

- Mass-based data is more straightforward
- SPLP and column elution tests reflect the same chemical mechanisms – simple rinsing of highly soluble compounds
- Both methods liberate less than a few percent of total selenium
- SPLP and Column Elution Results may be Quantitatively Compared

Conclusions and Recommendations, con't

- SPLP allows much more comprehensive and statistically-defensible sampling
- Direct comparisons between SPLP and columns are needed

Acknowledgements

- J.R. Simplot
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