

Selenium Location and Mode of Occurrence in the Kanawha Formation Rocks in West Virginia

WEST VIRGINIA MINE DRAINAGE TASK FORCE SYMPOSIUM
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Outline

- Objectives & Purpose
- Project summary
- Total Se distribution
- Se mode of occurrence
- Next steps

Project Objectives

1. How do Se concentrations change in a single core?
 - Stratigraphy (depth), rock type, other chemical parameters
2. How is Se chemically bound to the rocks? (mode of occurrence)
 - Rock type

Purpose

- Better understand the chemistry of selenium in coals and related strata
- Help predict where selenium is most likely to be encountered

Samples Used

Summary

1 core from south-central WV



63 samples

- 11 Coal, 25 shale, 9 mudstone, 12 sandstone, 6 carbolith
- Kanawha Formation (Coalburg – Winifrede coal beds)

Sample prep by Research Environmental & Industrial Consultants (REIC)

- Lithology described
- Ground to <60 mesh by lithology
 - <0.5 feet: completely composited
 - >0.5 – 5 feet: ~1-inch interval from top, middle, & bottom of each 1-foot length. Ground to 1/16 inch, composited, then 500 g ground to <60 mesh

Stratigraphic Nomenclature

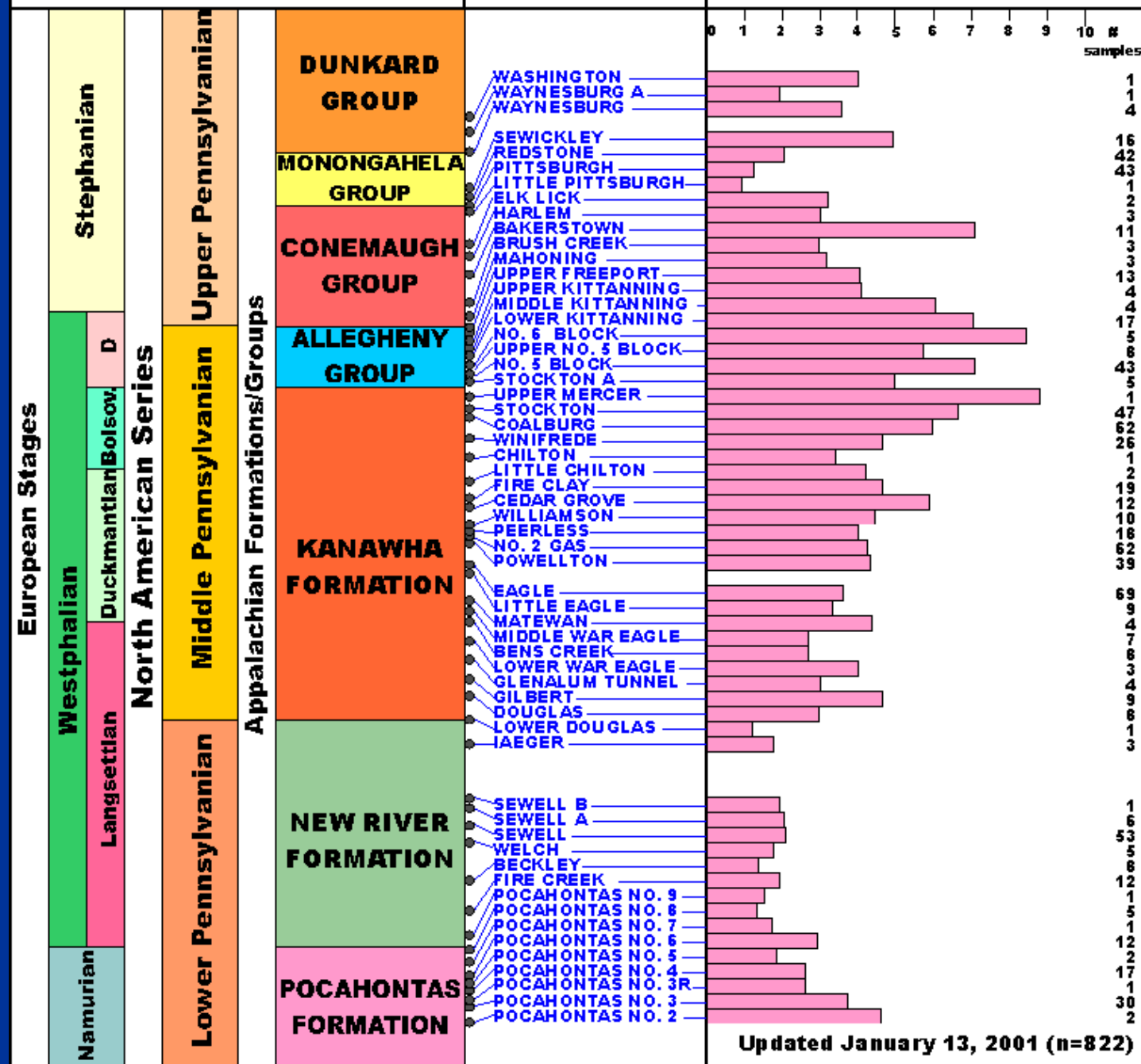
Coal Beds

Selenium (Se)

Parts-per-million (ppm) on a whole coal basis



WVGES,
2002
(coals only)



Updated January 13, 2001 (n=822)

Data provided by REIC

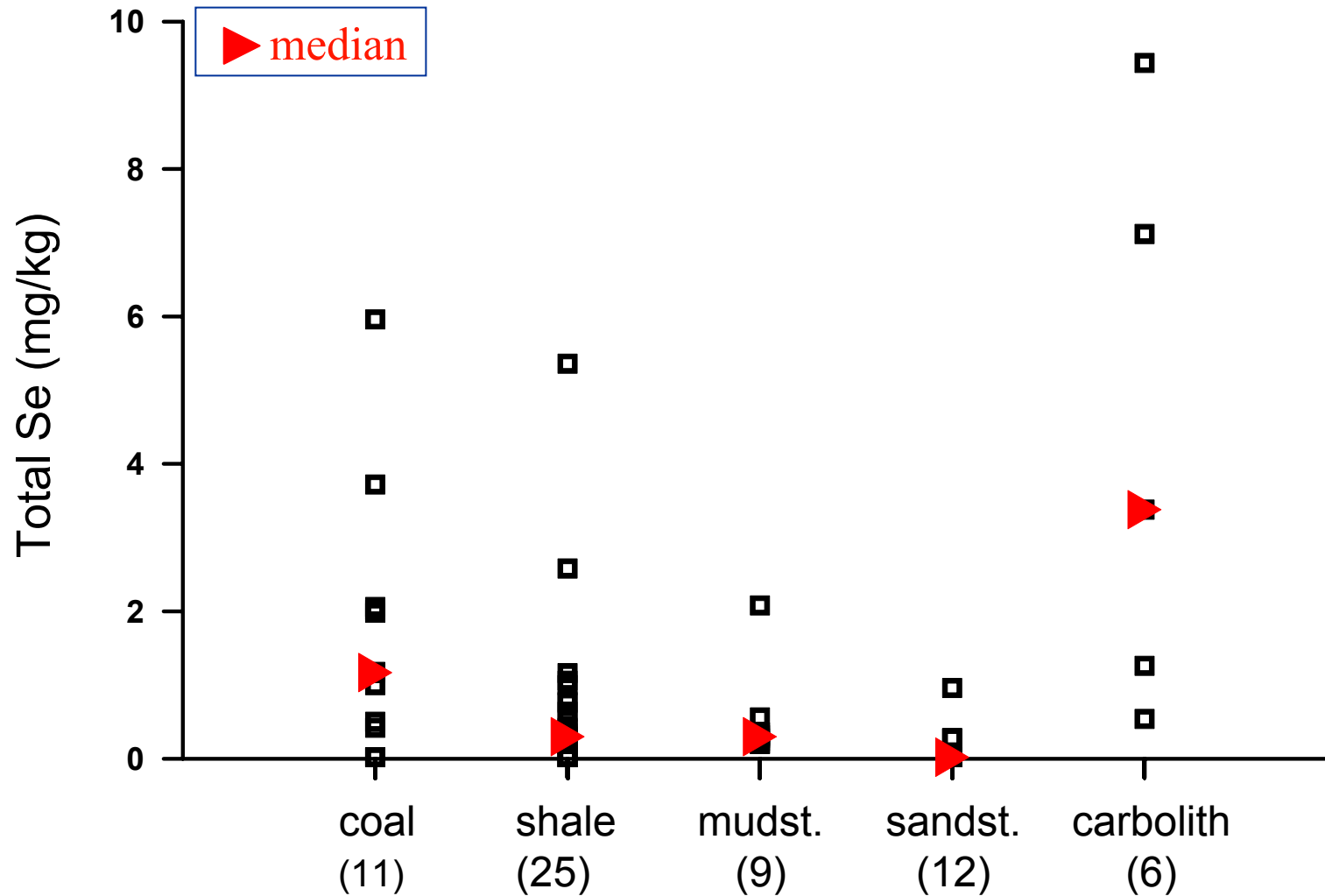
- Acid-base accounting
- Paste pH
- Total organic carbon (TOC)
- Total Se
- Sulfur

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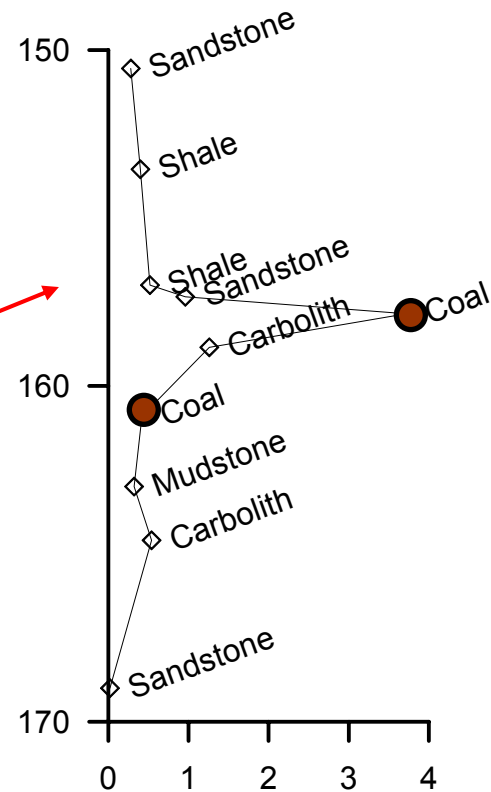
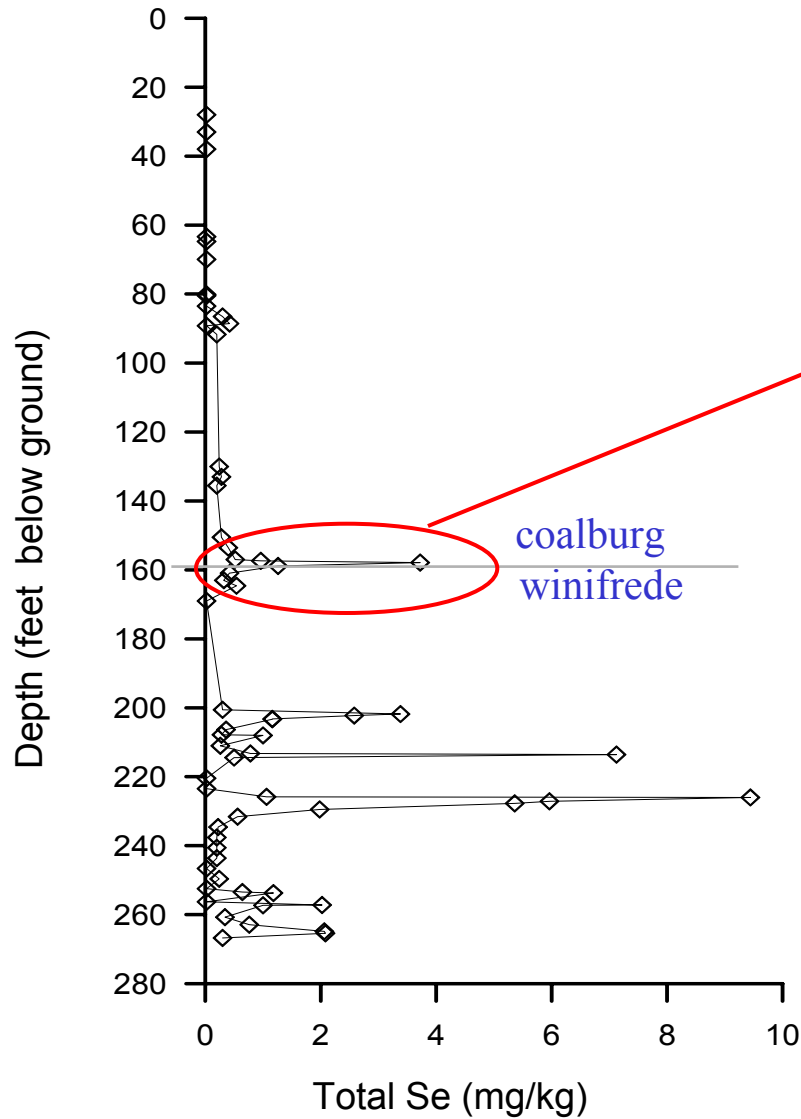
Se by rock type

Total Se Distribution



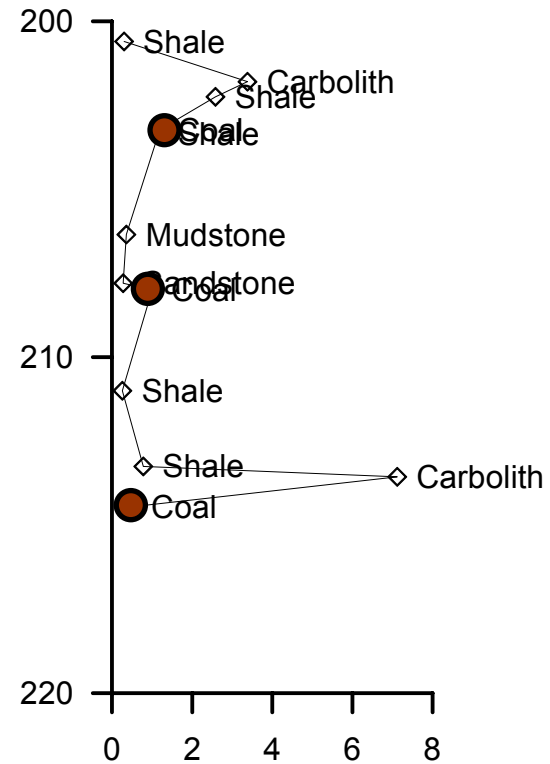
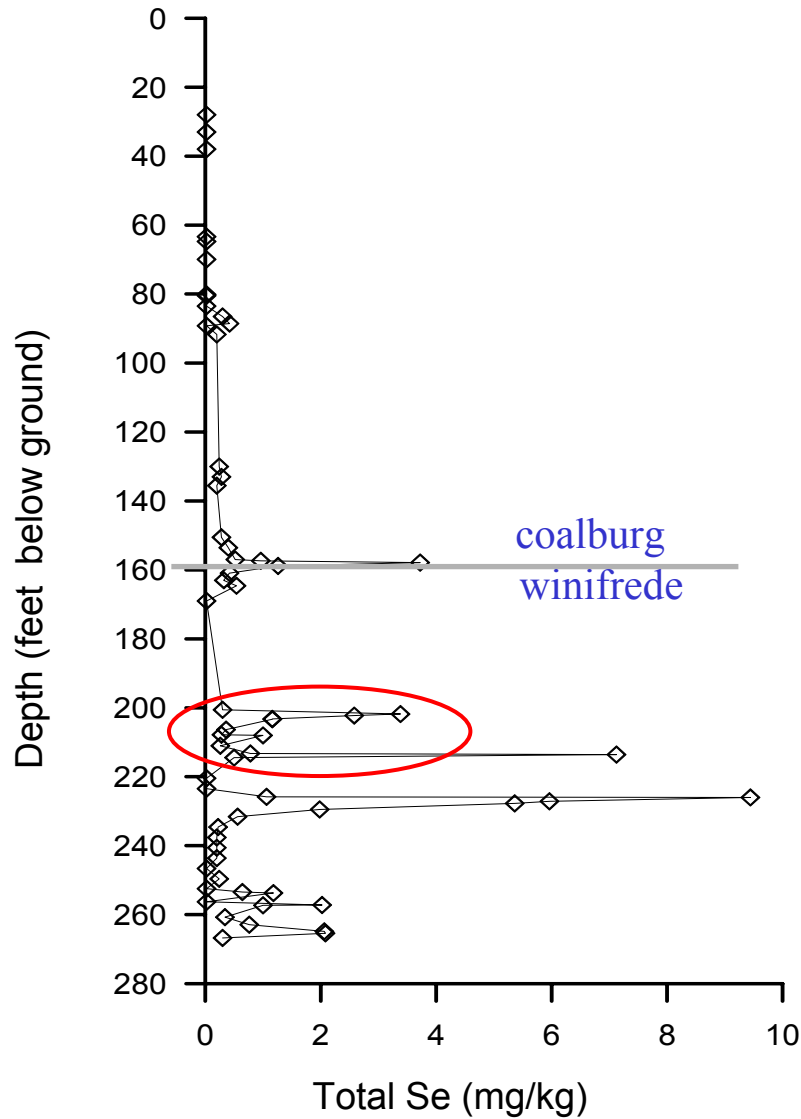
Se by depth

Total Se Distribution



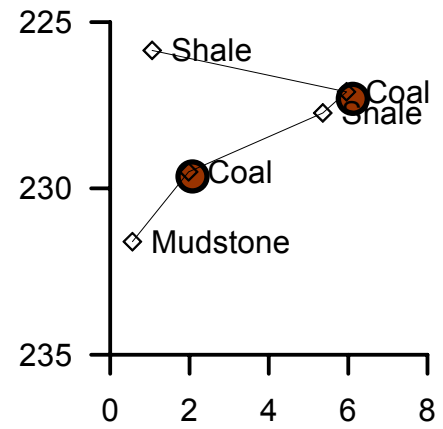
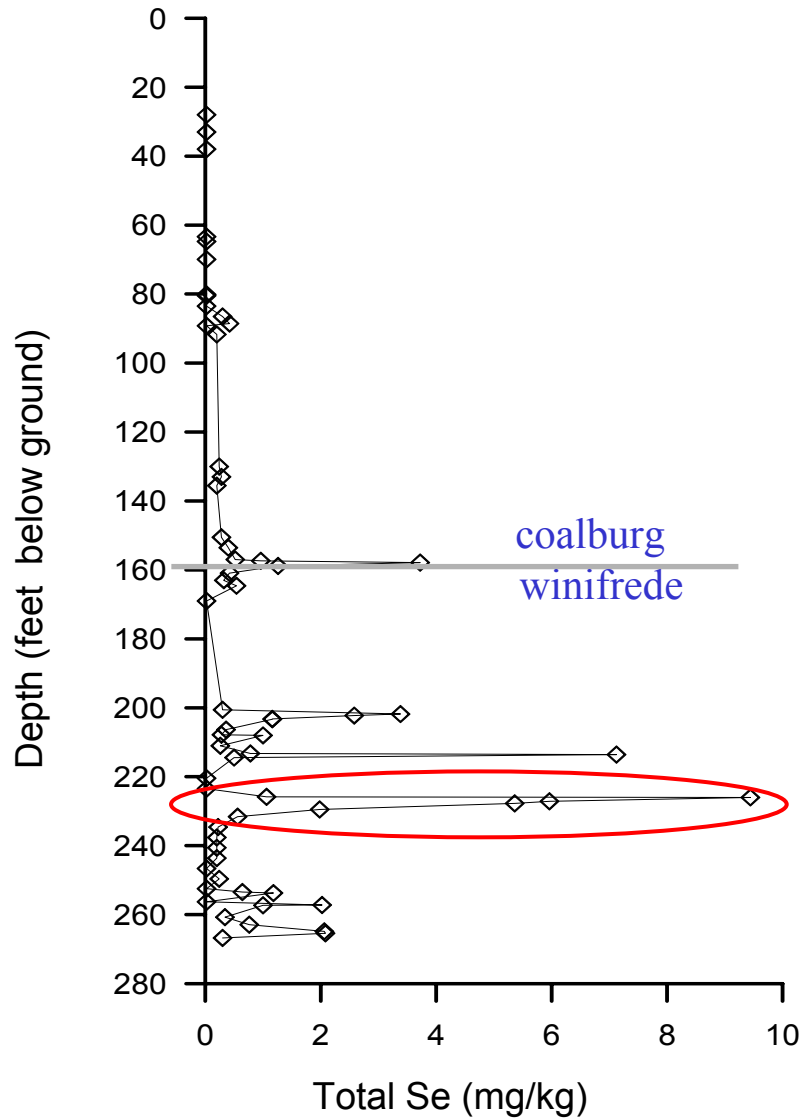
Se by depth

Total Se Distribution



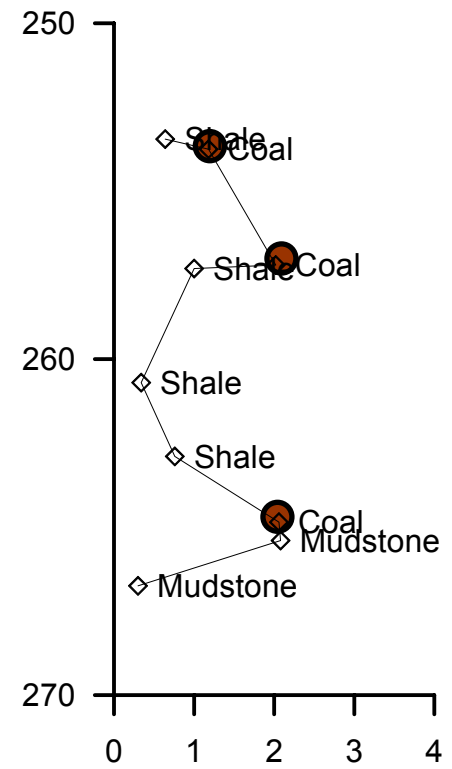
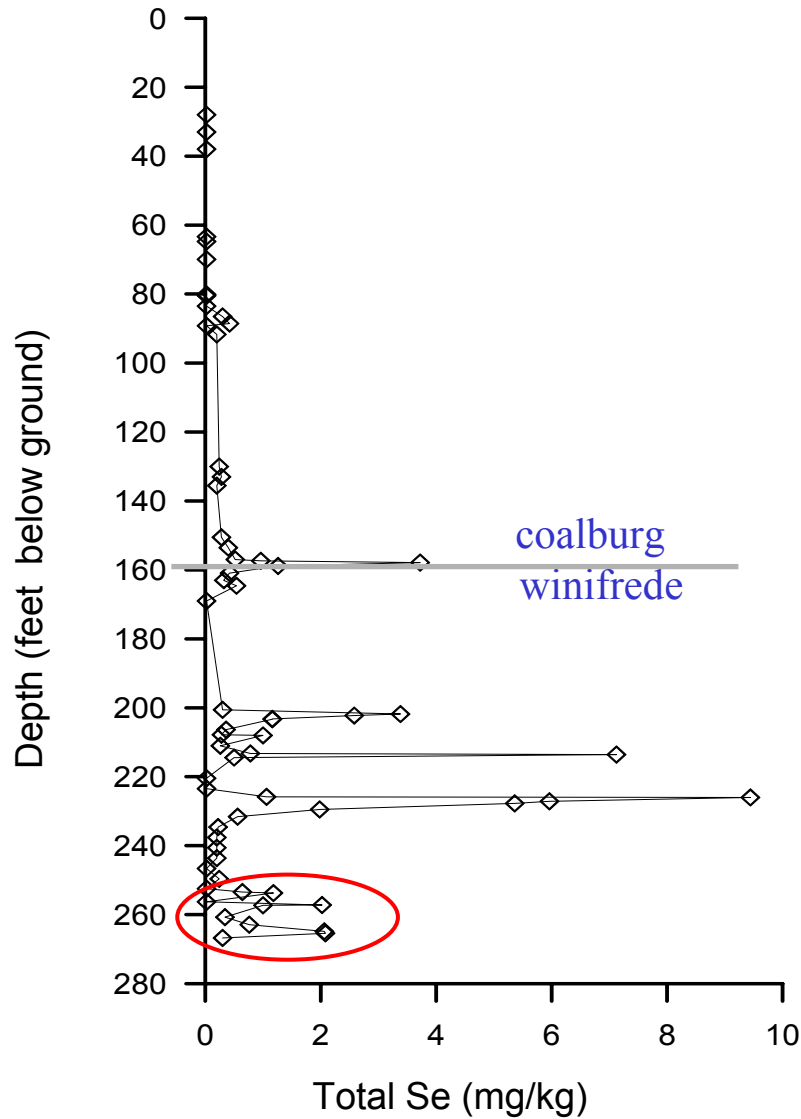
Se by depth

Total Se Distribution



Se by depth

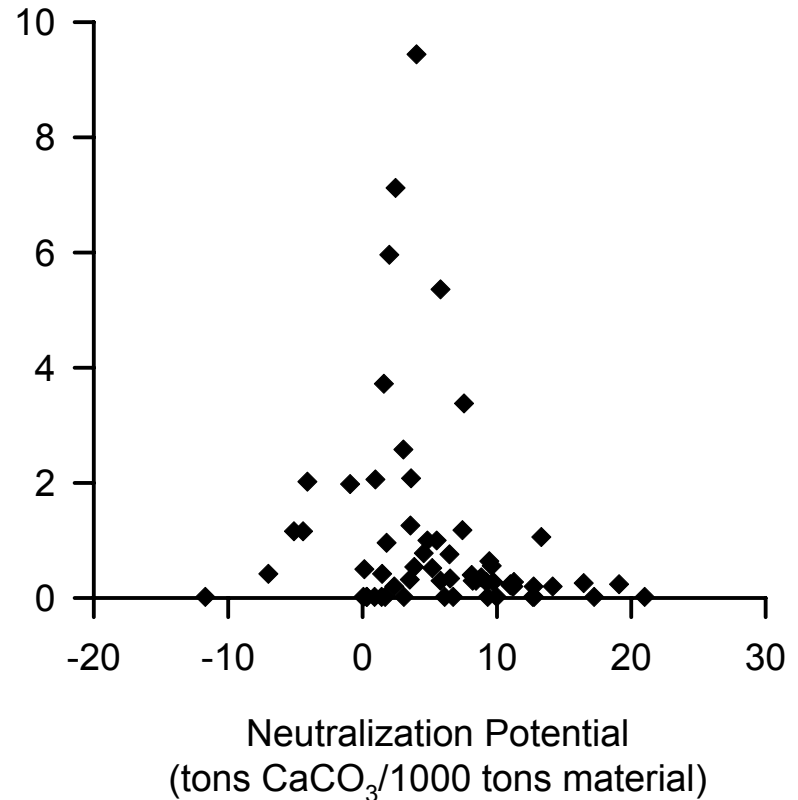
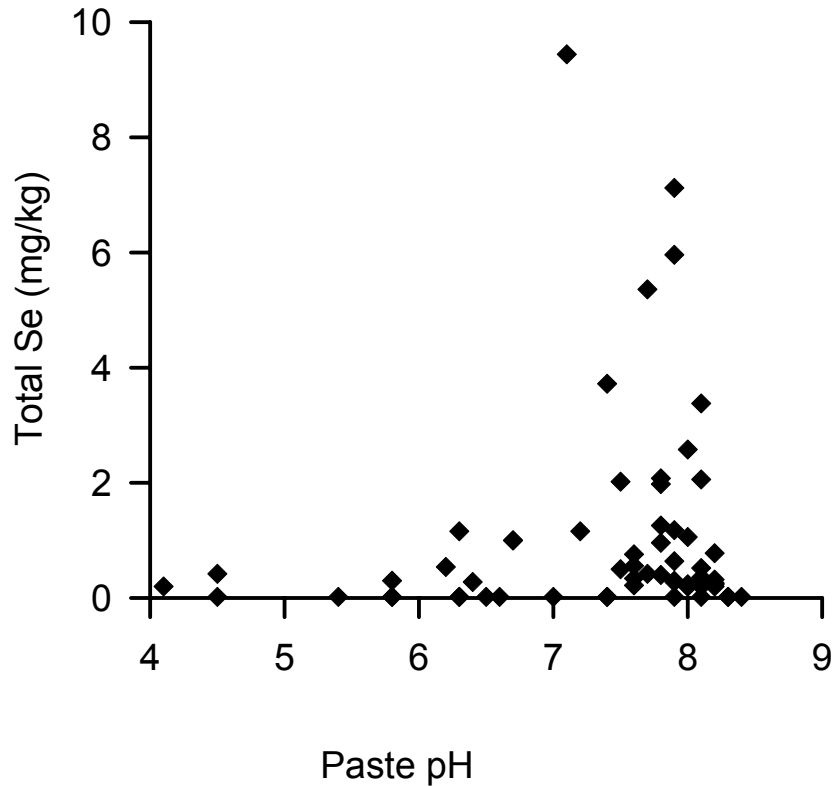
Total Se Distribution



Se vs. other parameters

Total Se Distribution

What seems to work?

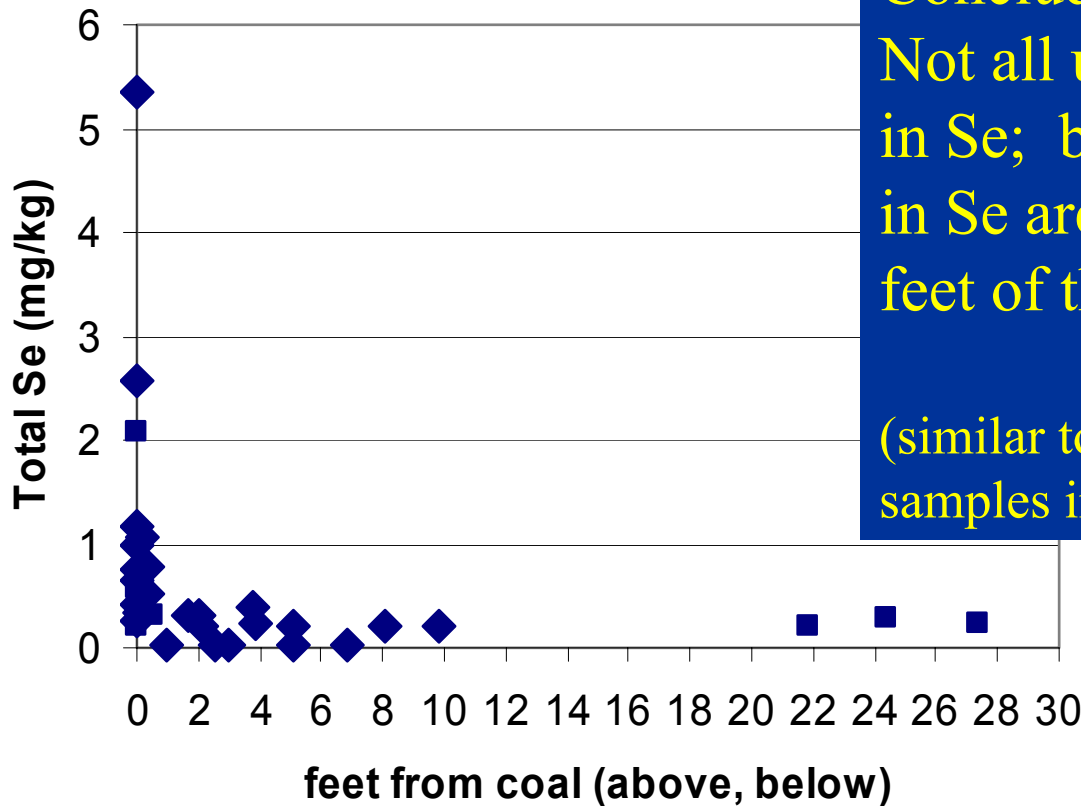


Higher Se conc. more likely to be found in rocks with “neutral characteristics”

Coal-proximate layers

Total Se Distribution

Same trends for shale and mudstones (34 total)



Conclude:

Not all units close to coal are high in Se; but the layers that are high in Se are typically found with two feet of the coals

(similar to Mullenex 2005 - >400 samples in Allegheny & Kanawha Fms)

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Modes & Methods

See mode of occurrence

Defined via a reaction with:

Residual

Sulfides

Organics

Ascorbic acid + peroxide

Na Pyrophosphate

Oxide coatings

Hydroxylamine hydrochloride

Exchangeable

Potassium Phosphate

Soluble

De-ionized Water

Modes & Methods

Se mode of occurrence

Residual

Sulfides

Organics

Oxide coatings

Exchangeable

Soluble

A few details

- 46 samples
- Duplicate & triplicate
- Process blanks fine
- % recovery good
- Analyzed for total Se (some S)

MEANING

Se mode of occurrence

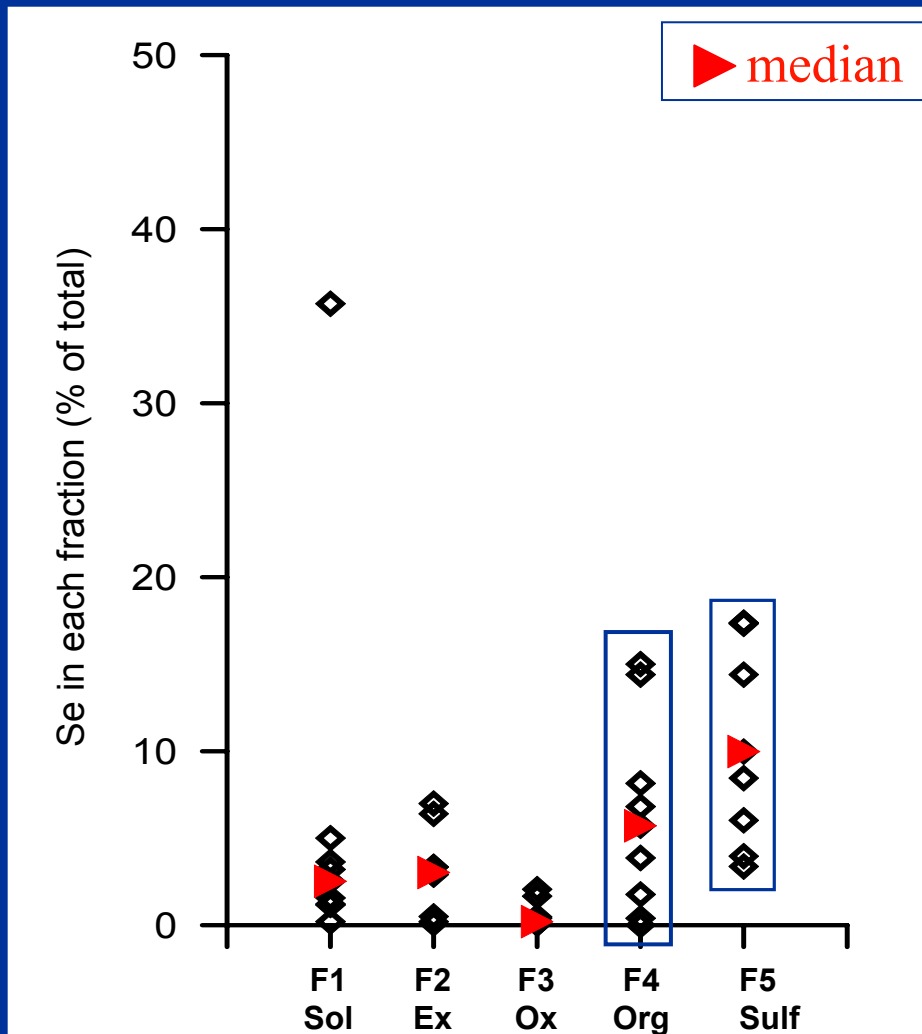
Methods designed to target specific chemical reactions – for determining modes of occurrence



Not designed to be a direct measure of what would leach in nature

Distribution in coal samples

Se mode of occurrence



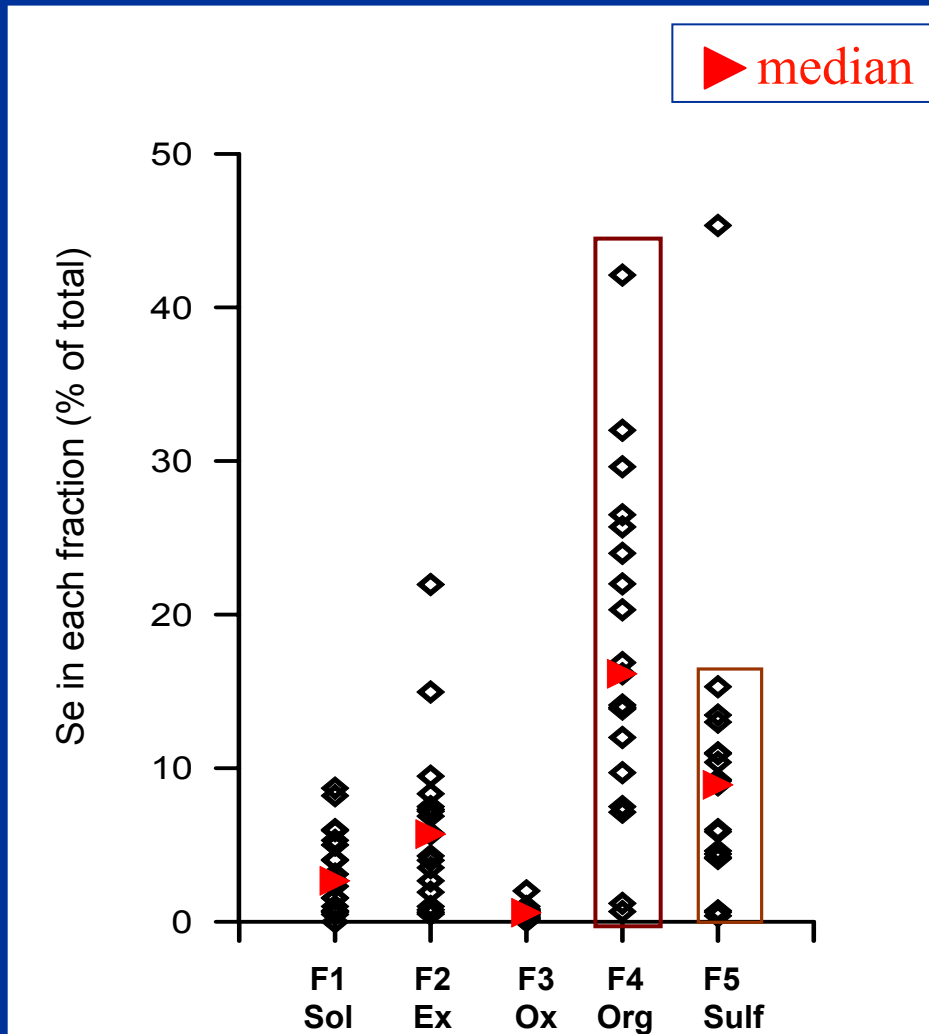
9 coal samples

Regions overlap, but in 8/9 samples there was as much or more Se found in the sulfide than in the organic fraction

Generally, more Se is detected in the sulfide fraction than the organic fraction

Distribution in mudst-shale

Se mode of occurrence



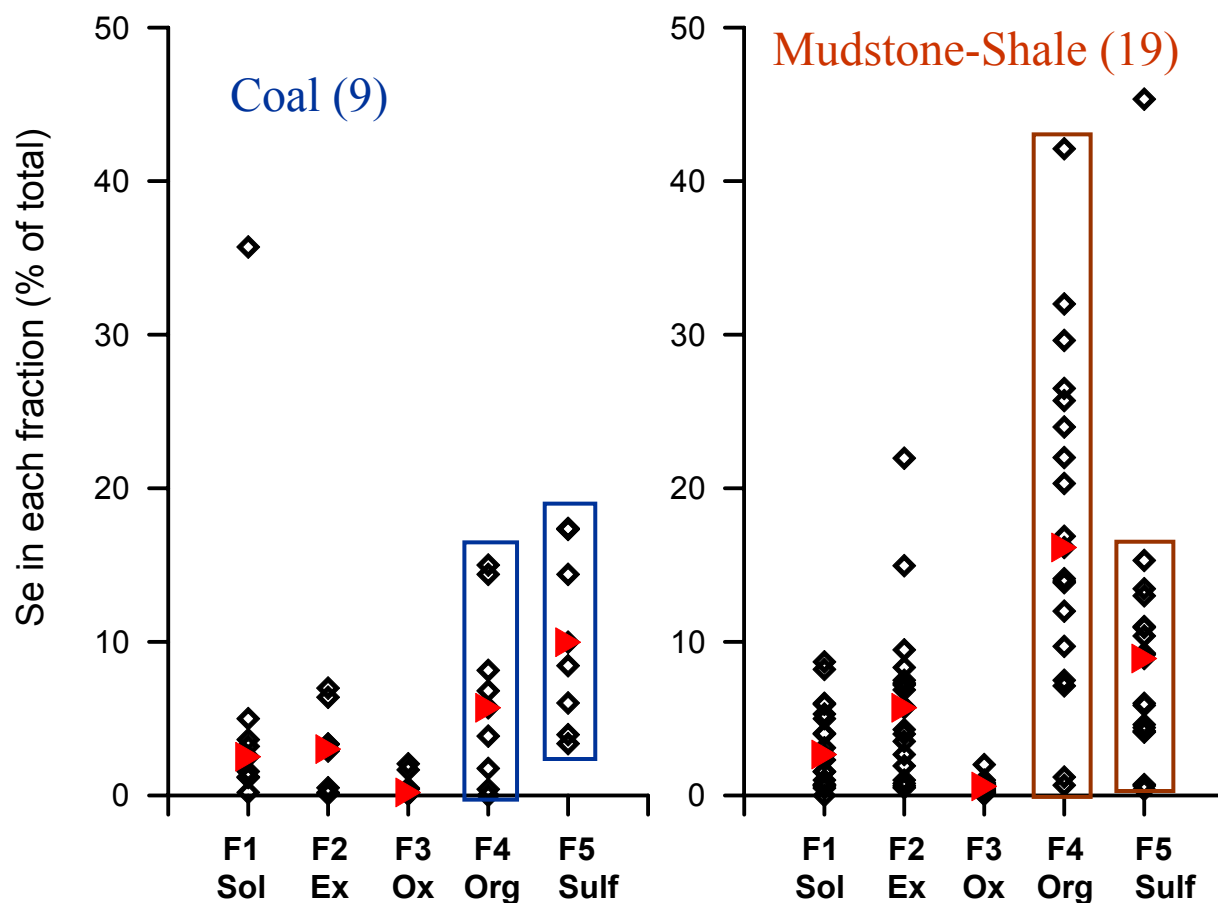
19 samples

Regions overlap, but in 15/19 samples there was as much or more Se found in the organic than in the sulfide fraction

Generally, more Se is detected in the organic fraction than the sulfide fraction

Comparing rock types

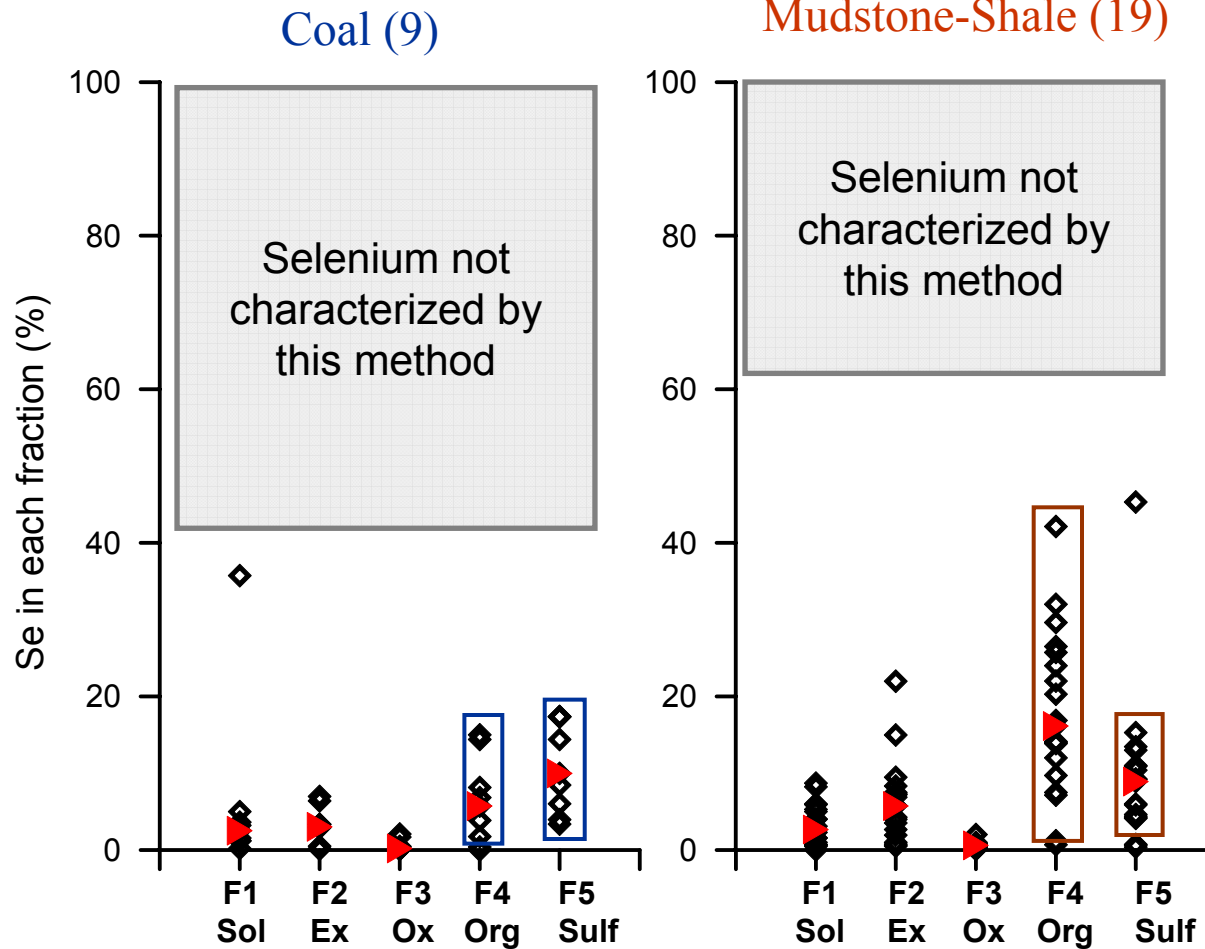
Se mode of occurrence



- Both rock types have Se bound in sulfide & organic fractions
- Usually... Sulfide-Se dominates for coal & organic-Se dominates for shales and mudstones

What's left behind?

Se mode of occurrence



Different y-axis

Is Se in residue generally unavailable? Or is this a function of the test used?

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Limitations

Next Steps

- Only a single core
- Extraction studies are NOT leaching studies
- Modes of occurrence operationally defined

Do the total-Se conclusions apply to a wider area? Compare to:

- Additional cores at site
- Other available data sets

How do mode-of-occurrence studies compare to leaching tests?

- Conduct both types of studies on the same samples
 - ADTI (Brady, Hornberger) samples
 - Leaching “round robin”

Acknowledgements

- U.S. Department of Interior Office of Surface Mining (OSM)
- West Virginia Water Research Institute
- REIC (Tim Keeney)



References

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