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

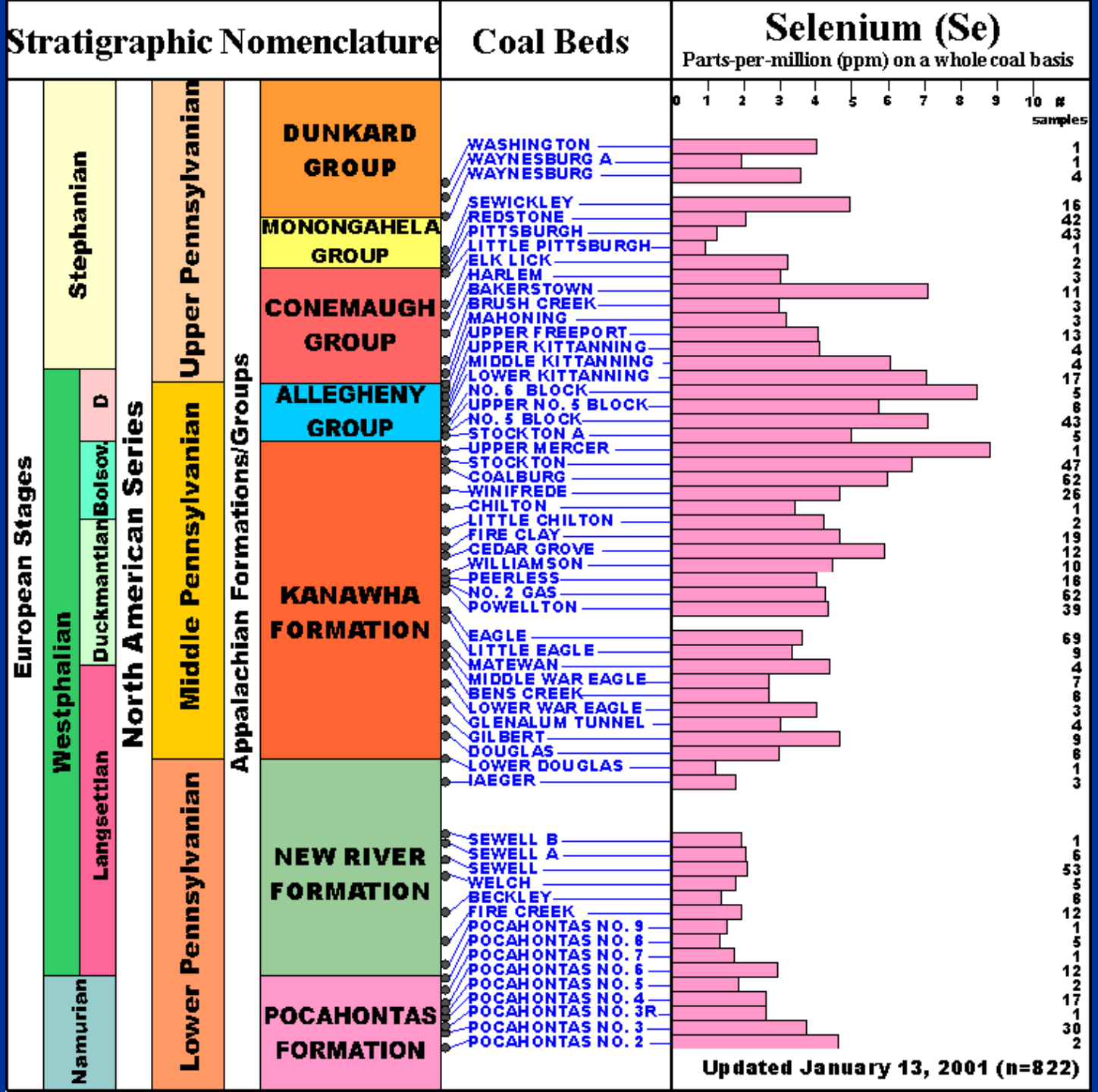
1 core from south-central WV

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



WVGES, 2002

(coals only)

Bulk Analyses

Summary

Data provided by REIC

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

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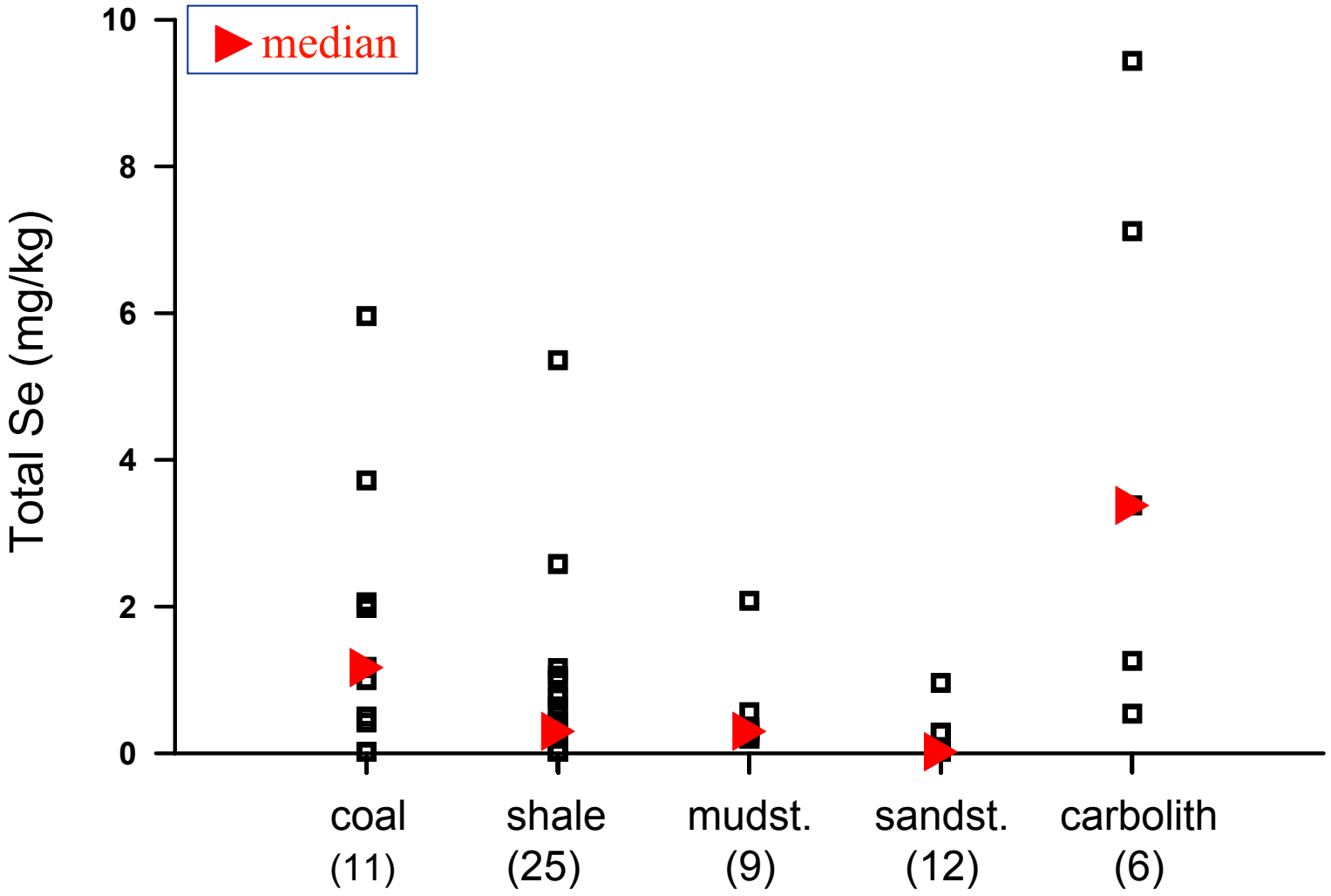
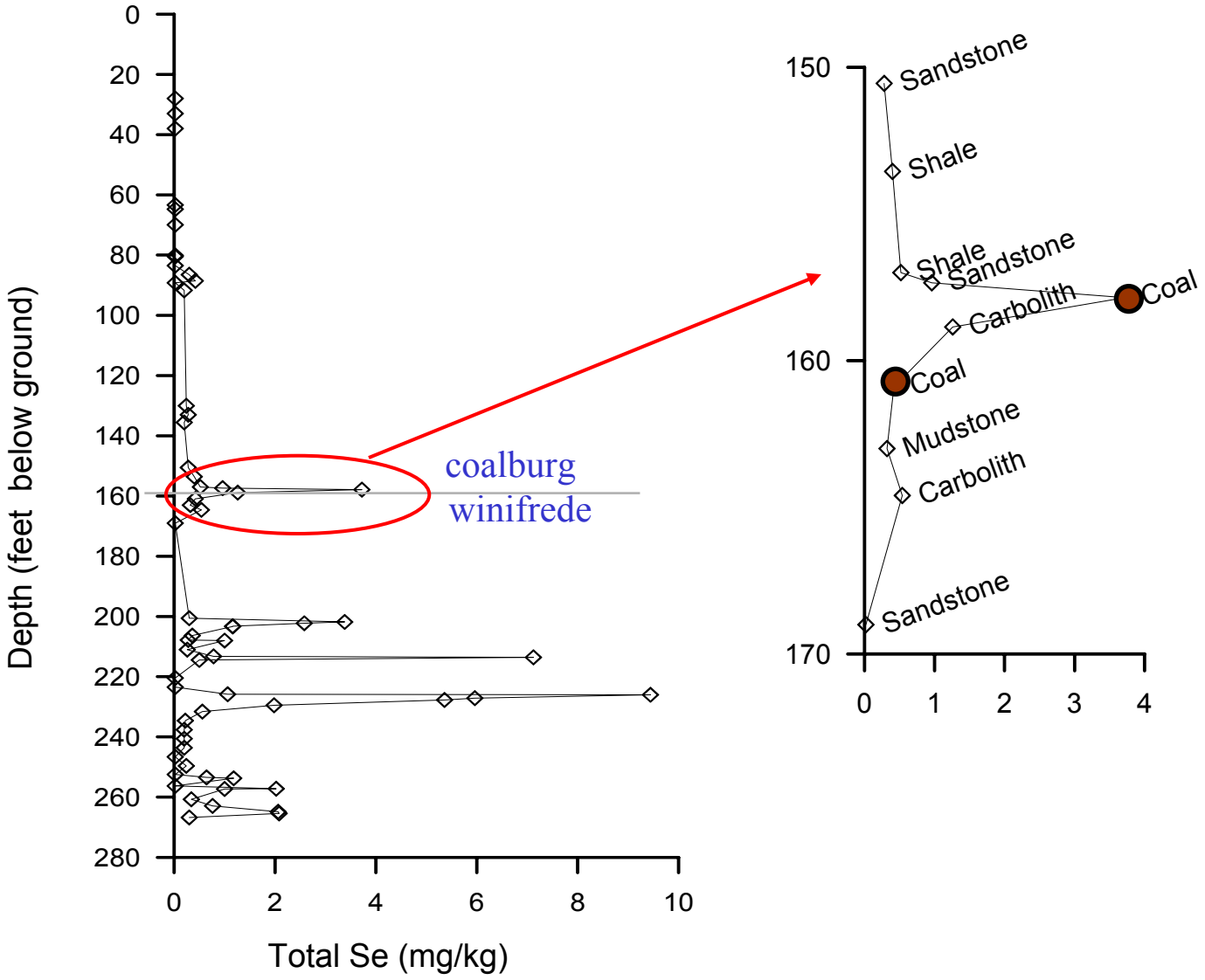
Se by rock type

Total Se Distribution



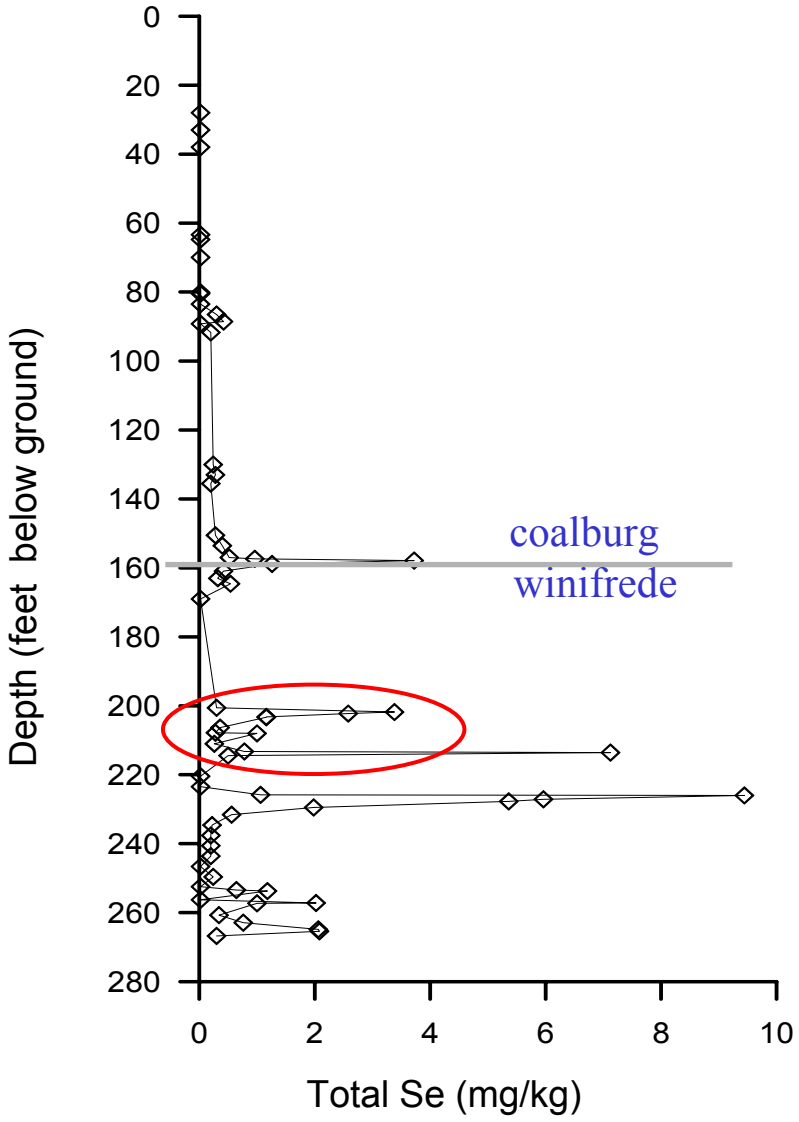
Se by depth

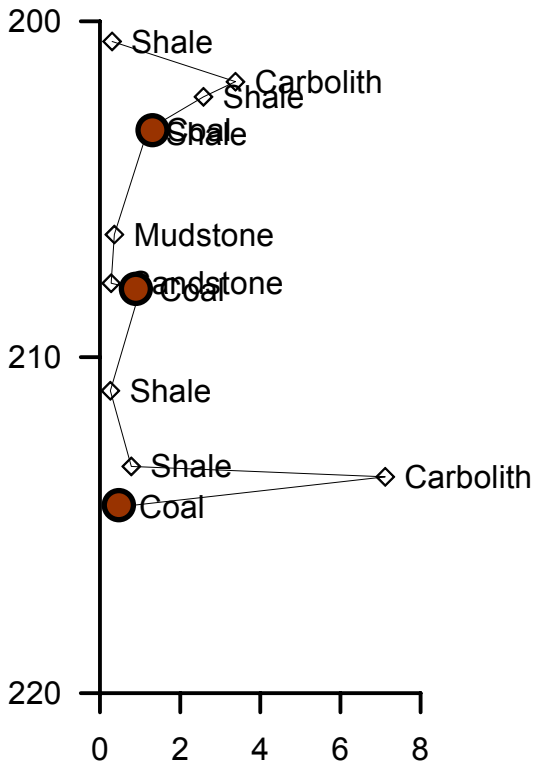
Total Se Distribution



Se by depth

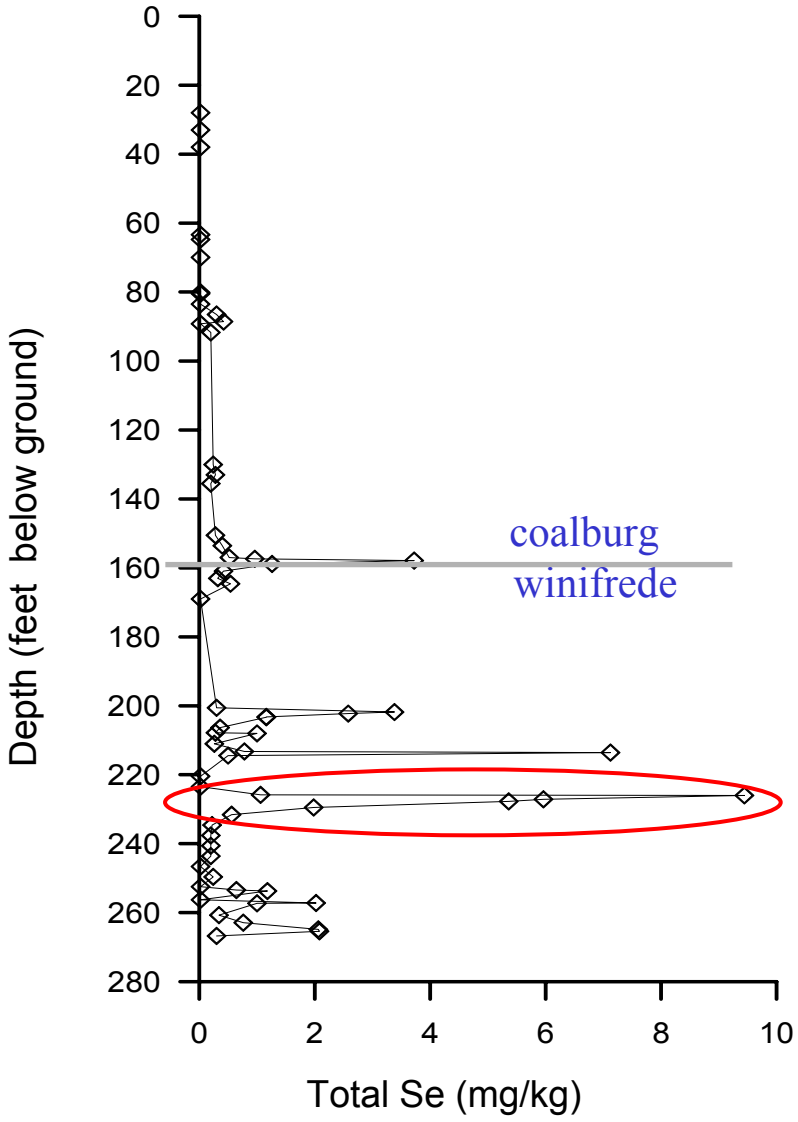
Total Se Distribution

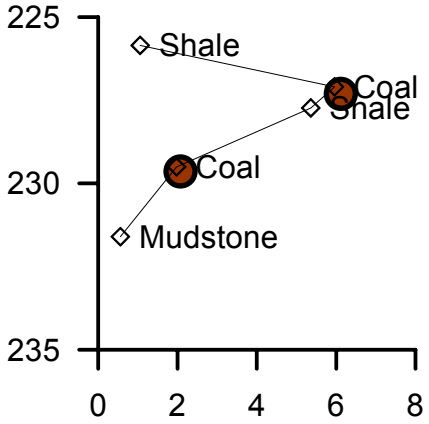




Se by depth

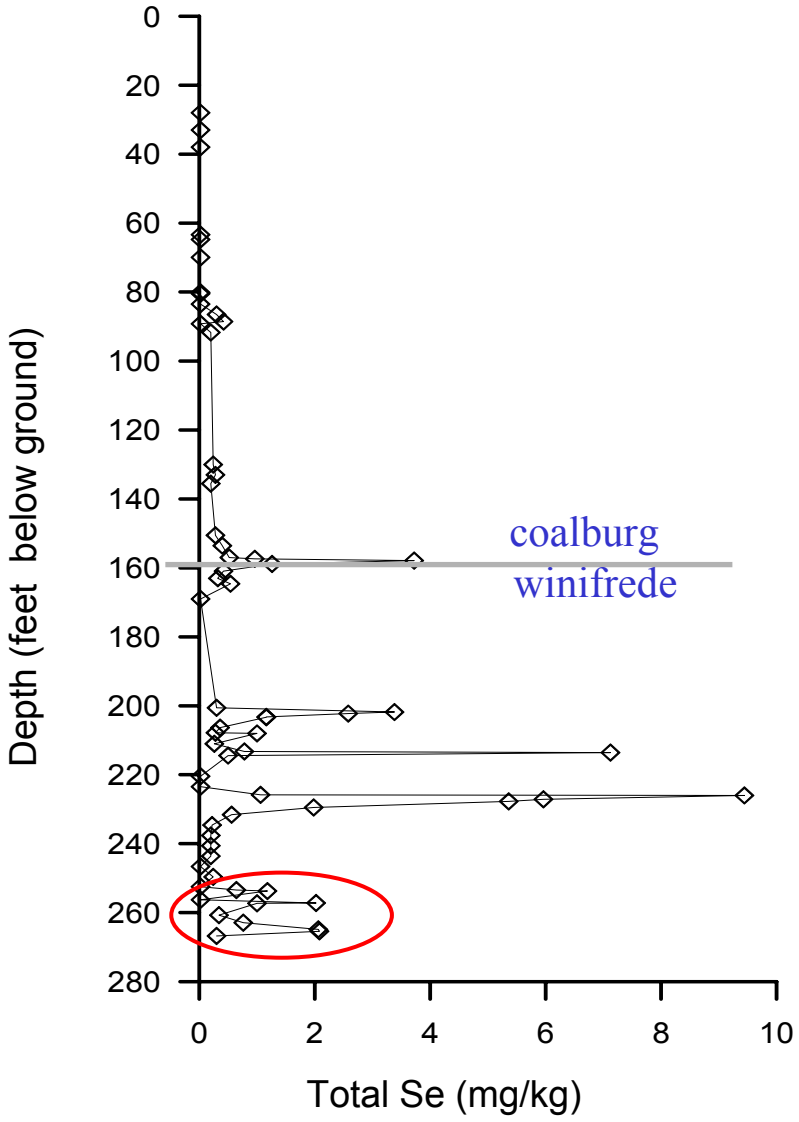
Total Se Distribution

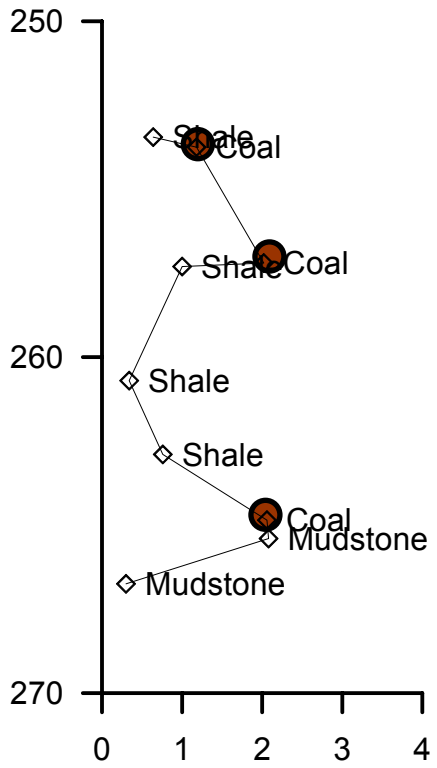




Se by depth

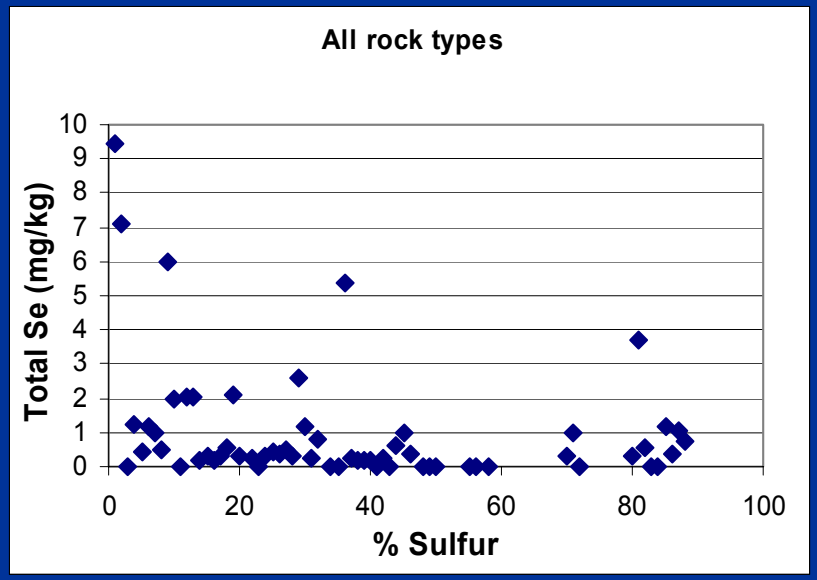
Total Se Distribution

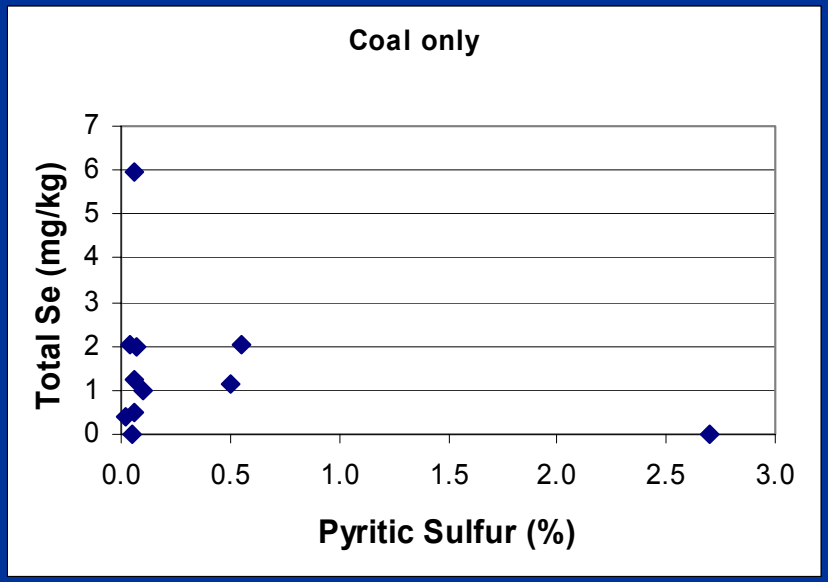




Se vs. other parameters

Does sulfur predict Se concentrations?





Sulfur is not a good predictor

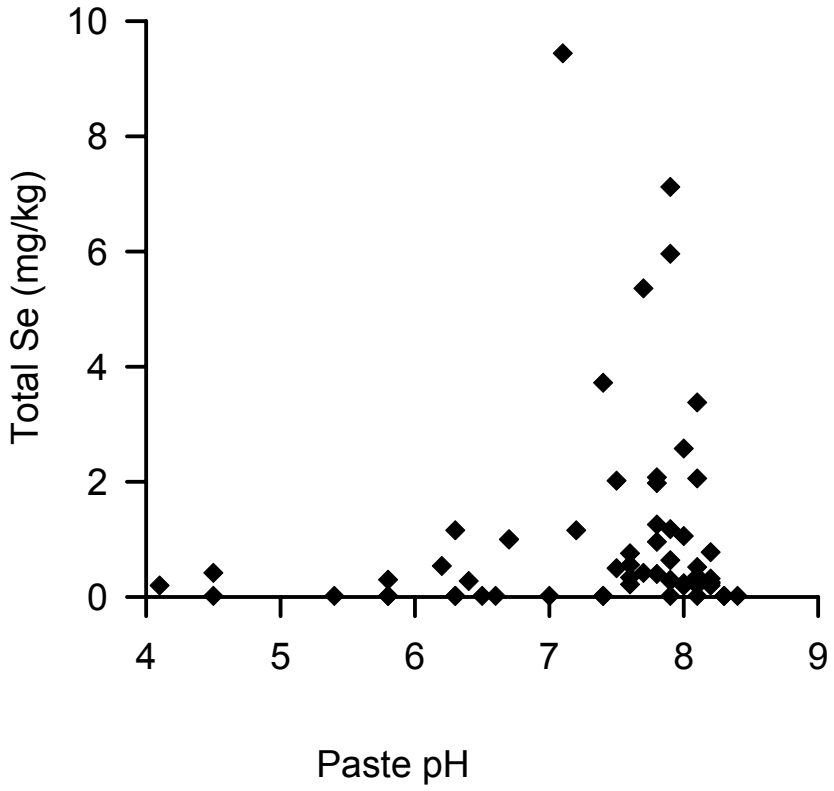
- Coleman et al. (1993) – Eastern coals
- Neuzil et al. (2005) – Appalachian Plateau coals
- Mullennex (2005) – Southern WV strata

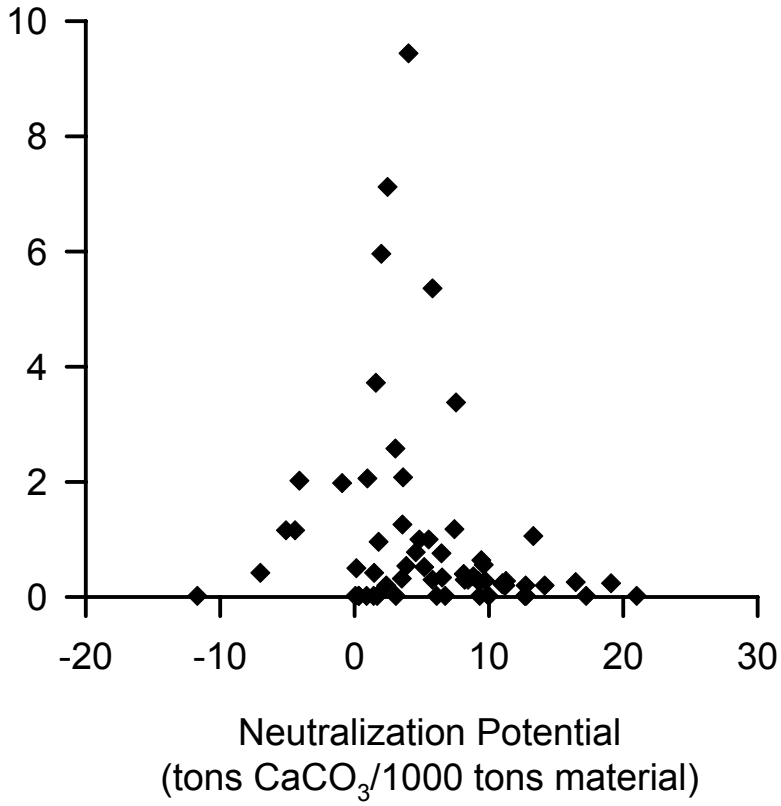
Suggests that not all Se in bound in a sulfide minerals

Se vs. other parameters

Total Se Distribution

What seems to work?





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

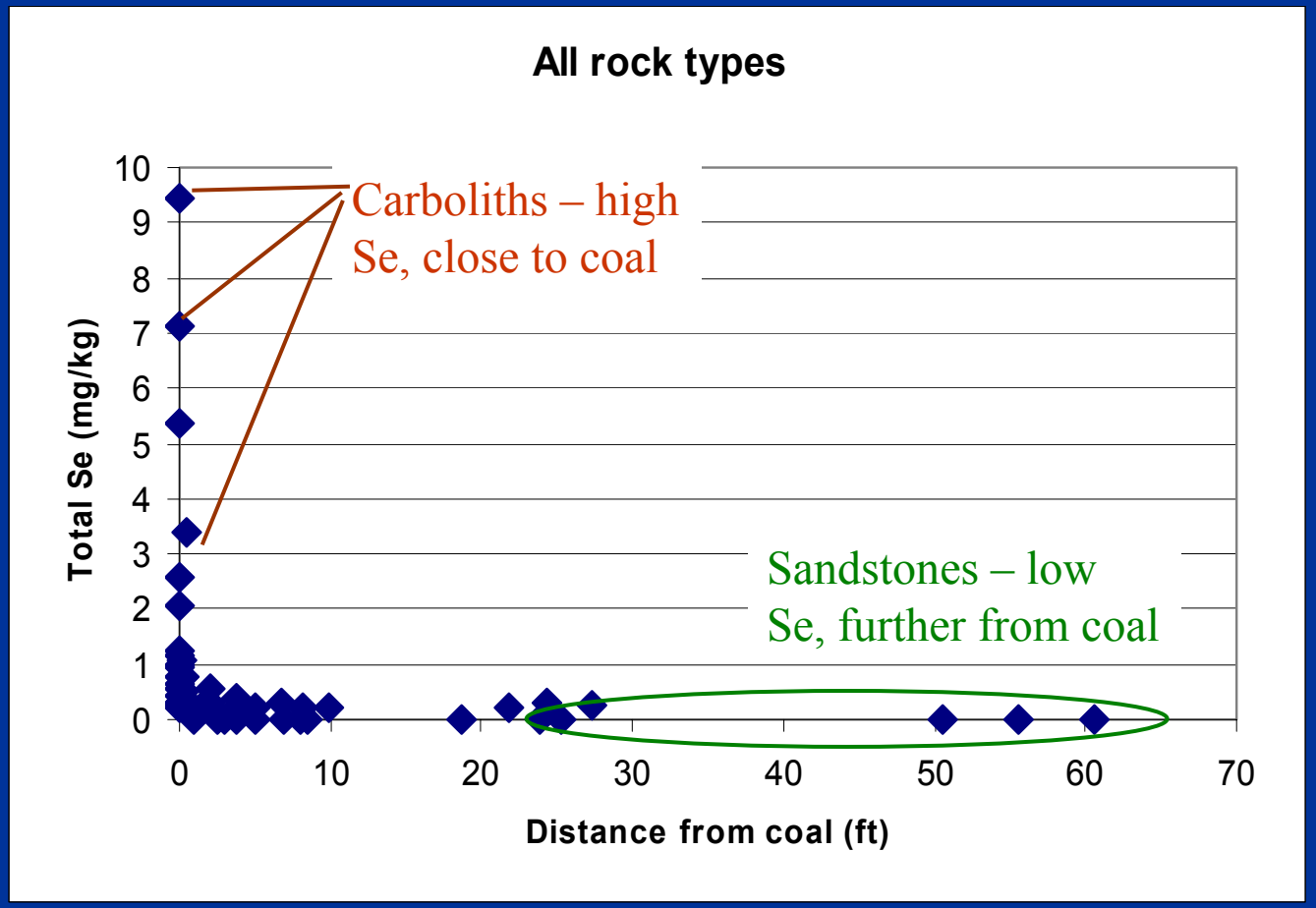
Coal-proximate layers

Total Se Distribution

Layers closer to coal – typically have higher Se

But is there a bias by rock type?

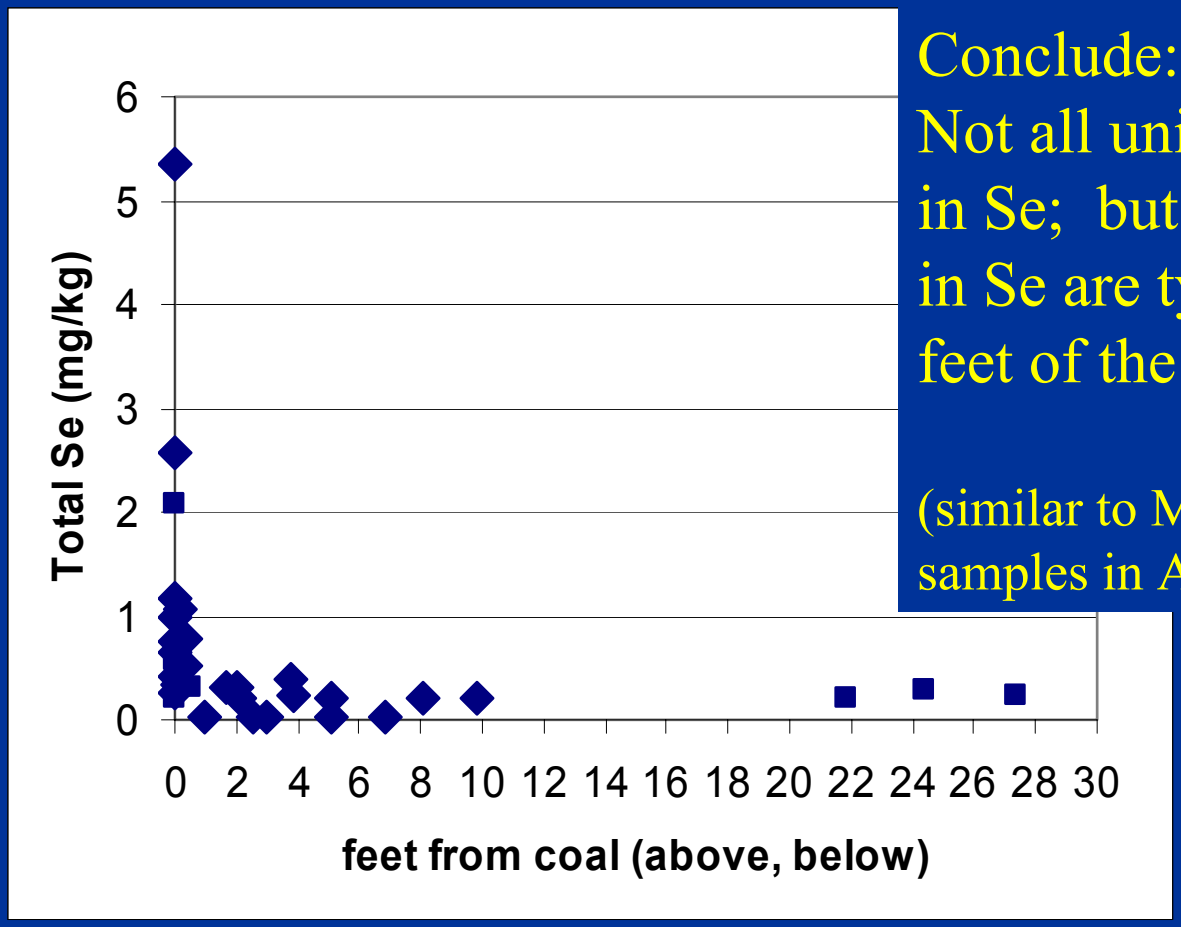
Consider a lithology found both close and far from coals



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 Mullennex 2005 - >400 samples in Allegheny & Kanawha Fms)

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- Se mode of occurrence (objective 2)
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Modes & Methods

Se mode of occurrence

	Defined via a reaction with:
Residual	
Sulfides	Ascorbic acid + peroxide
Organics	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

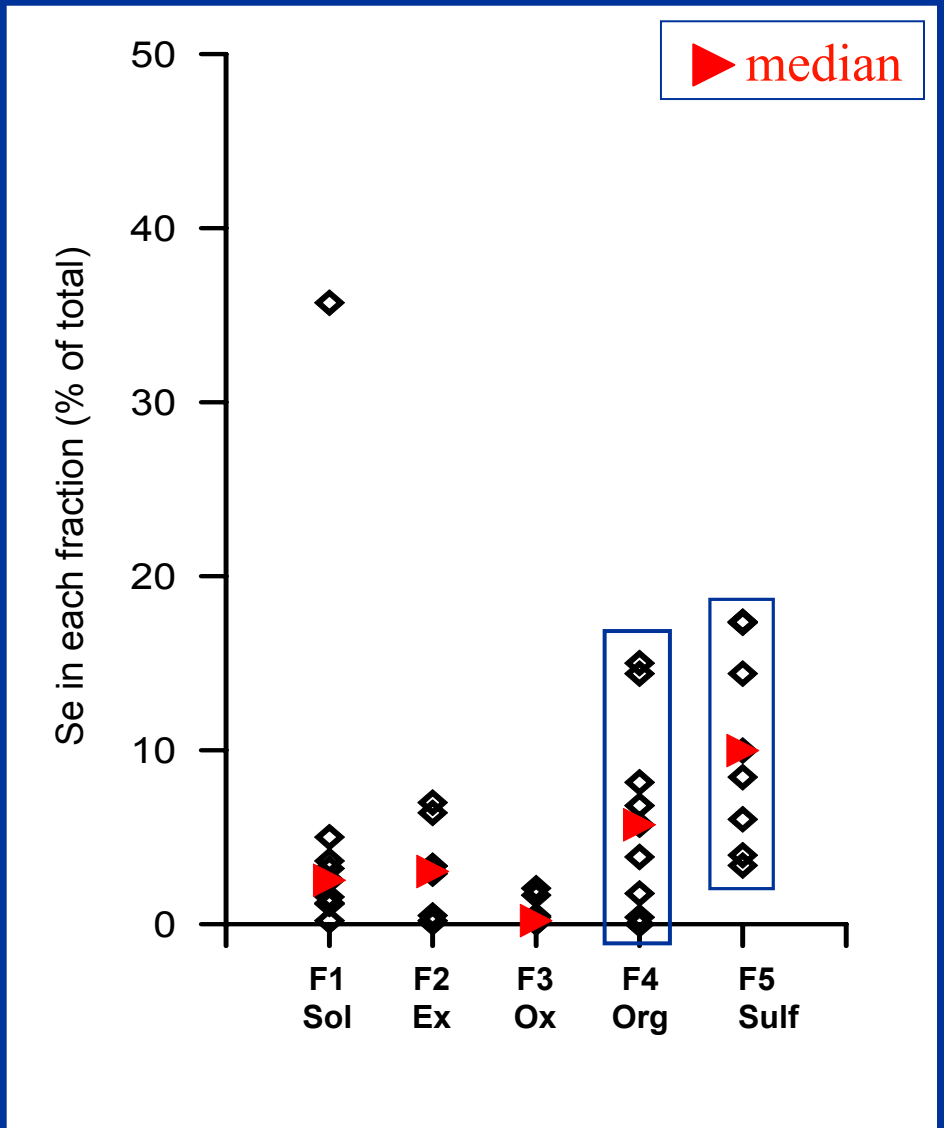
Se mode of occurrence

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



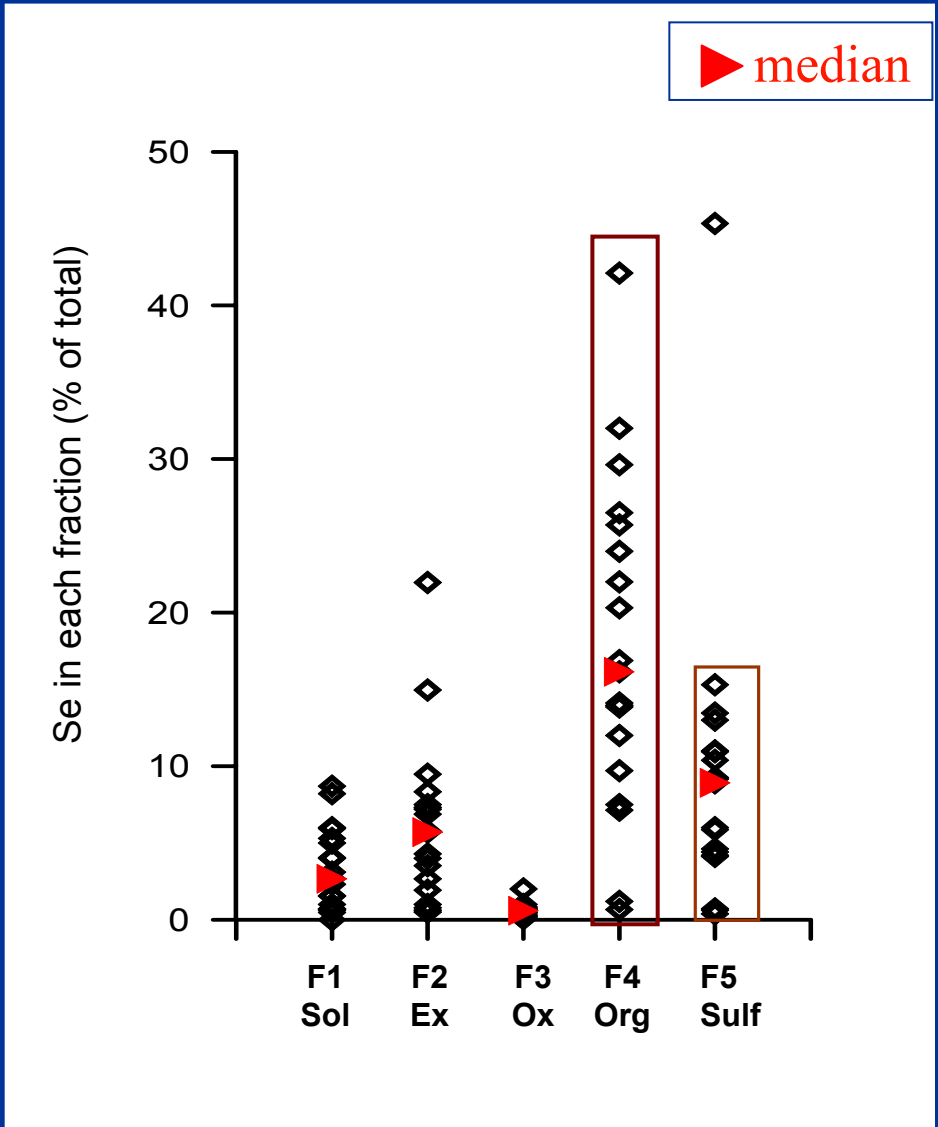
9 coal samples

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



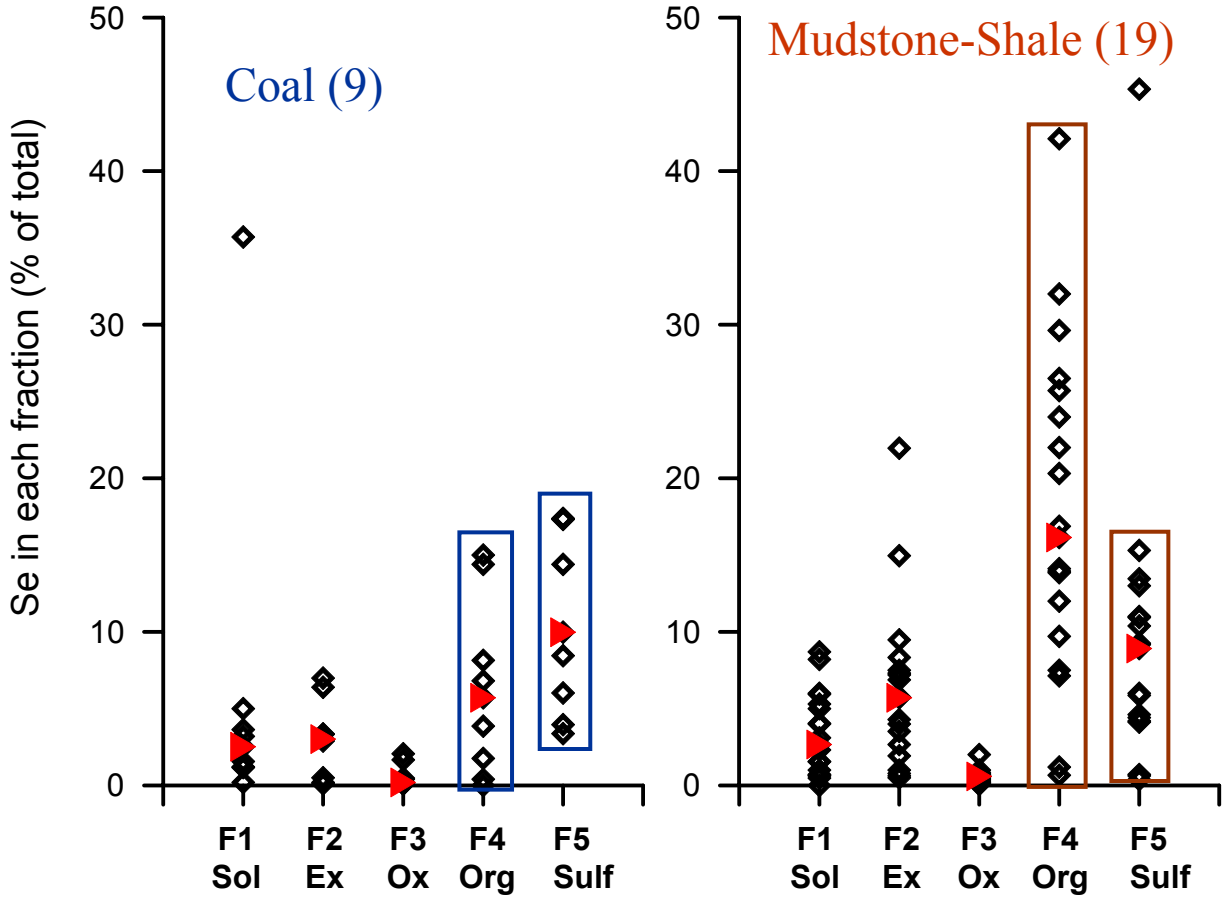
19 samples

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

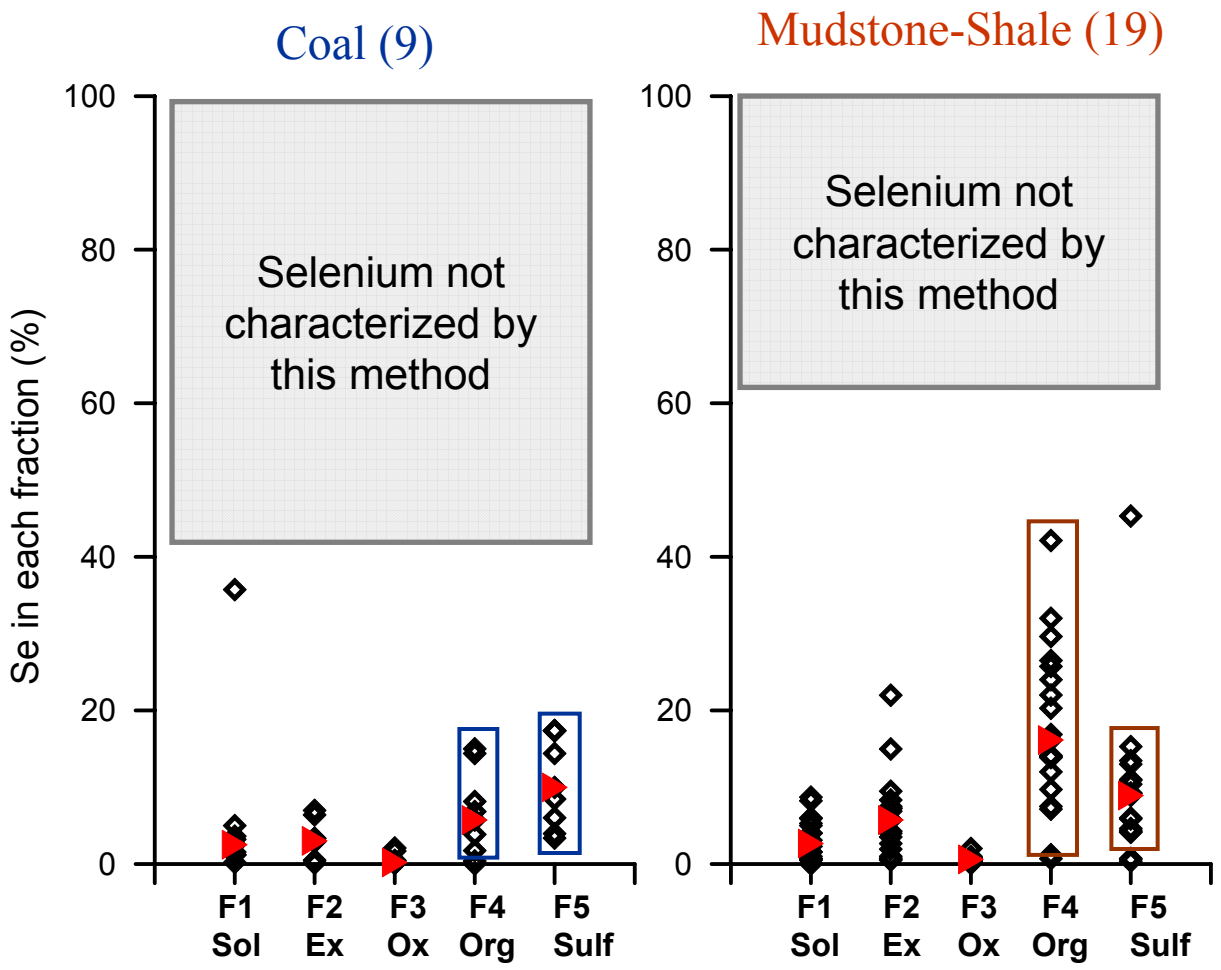
Se mode of occurrence



- 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

Total Se

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

- Additional cores at site
- Other available data sets

Extract vs. Leach

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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