Evaluation of P Sorbing Materials for use in Edge-of-Field P Filters

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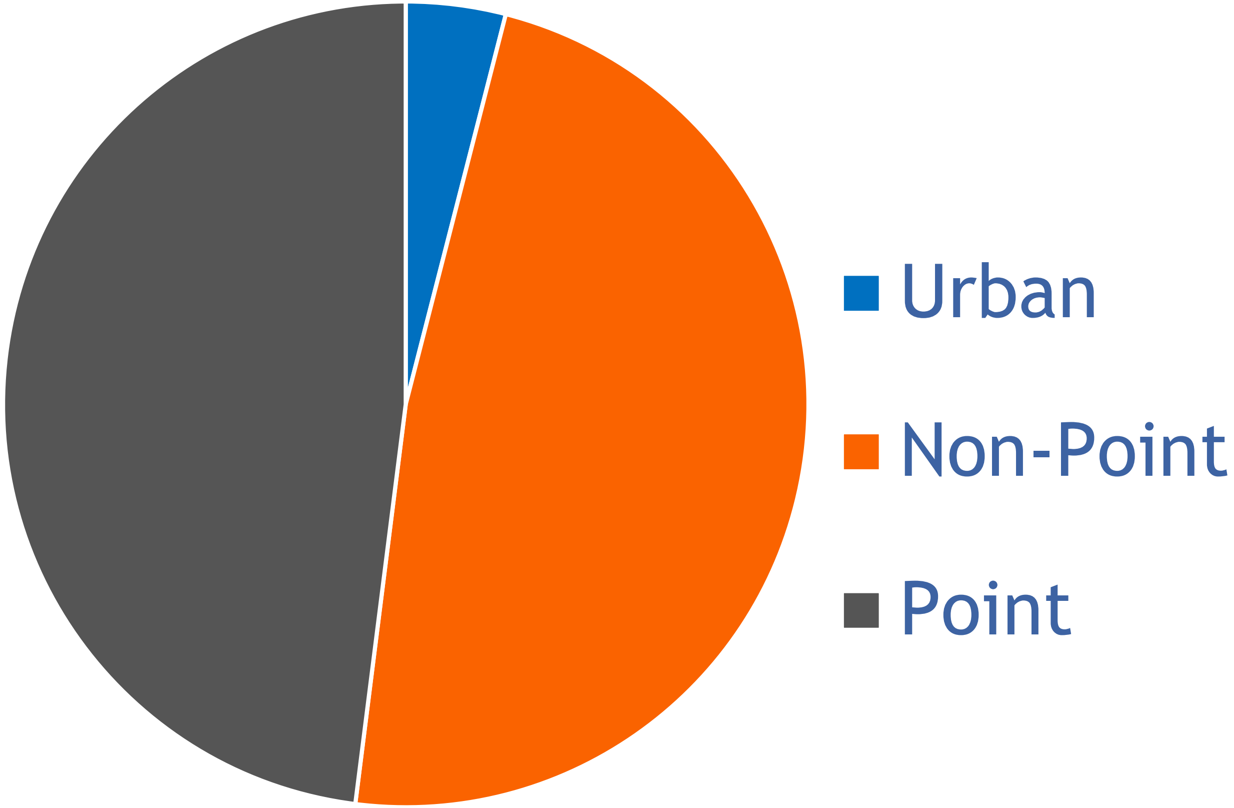
Total P Loads in IL



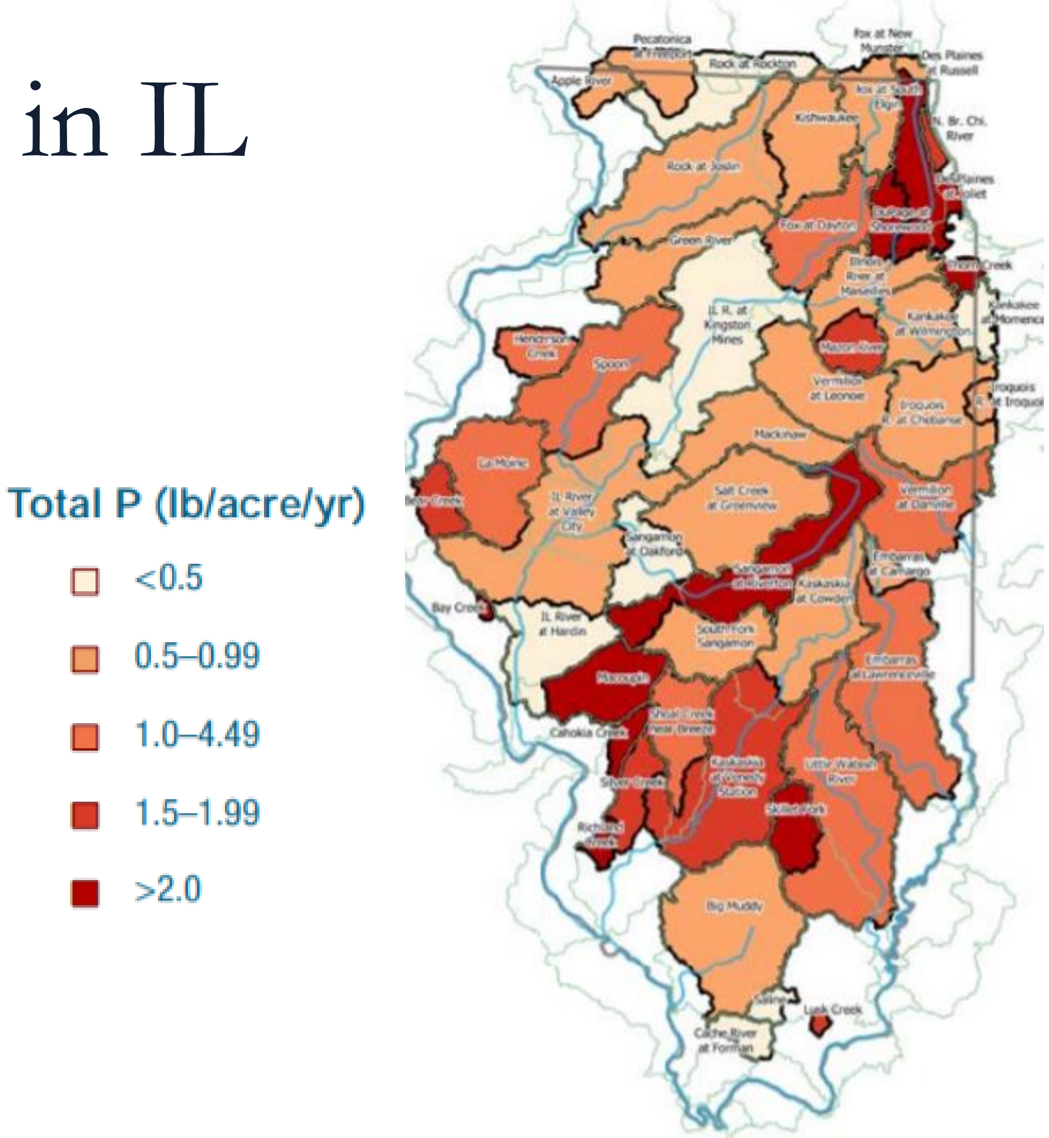


Figure 3.5. *Annual average 2012–17 estimated incremental TP yield at monitoring locations.*

Non-Point P Loads in IL

- Current Loads: 18 mil lbs P/yr (2011)
- Focus in Southern IL
  - More erosional loss due to hills

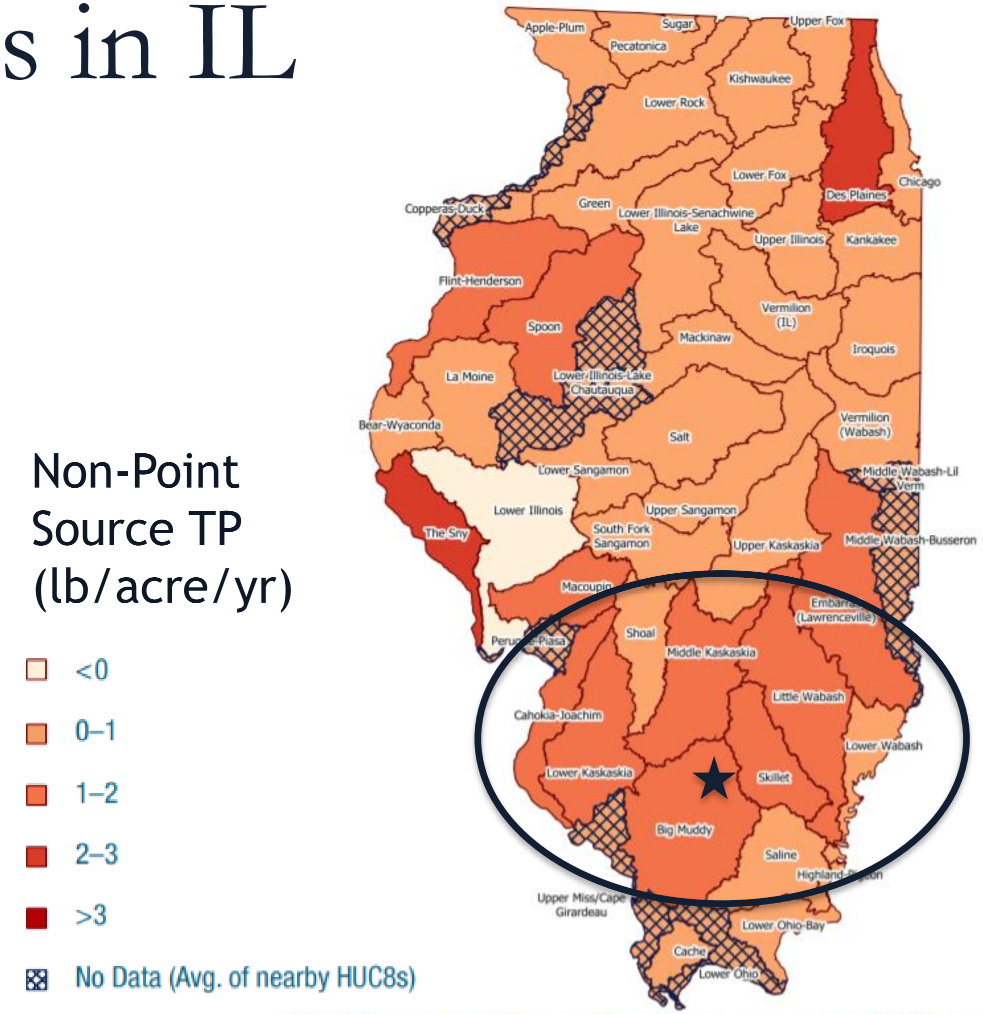


Figure 3.7. *Estimated annual average 2012–17 non-point source TP loads for HUC8s using point source locations relative to monitoring locations.*

Current Best Management Practices (BMPs)

- Cover Crops
- Conservation tillage/No-till

Cereal rye cover crop in spring

Current BMPs

- Cover Crops
- Conservation tillage/No-till

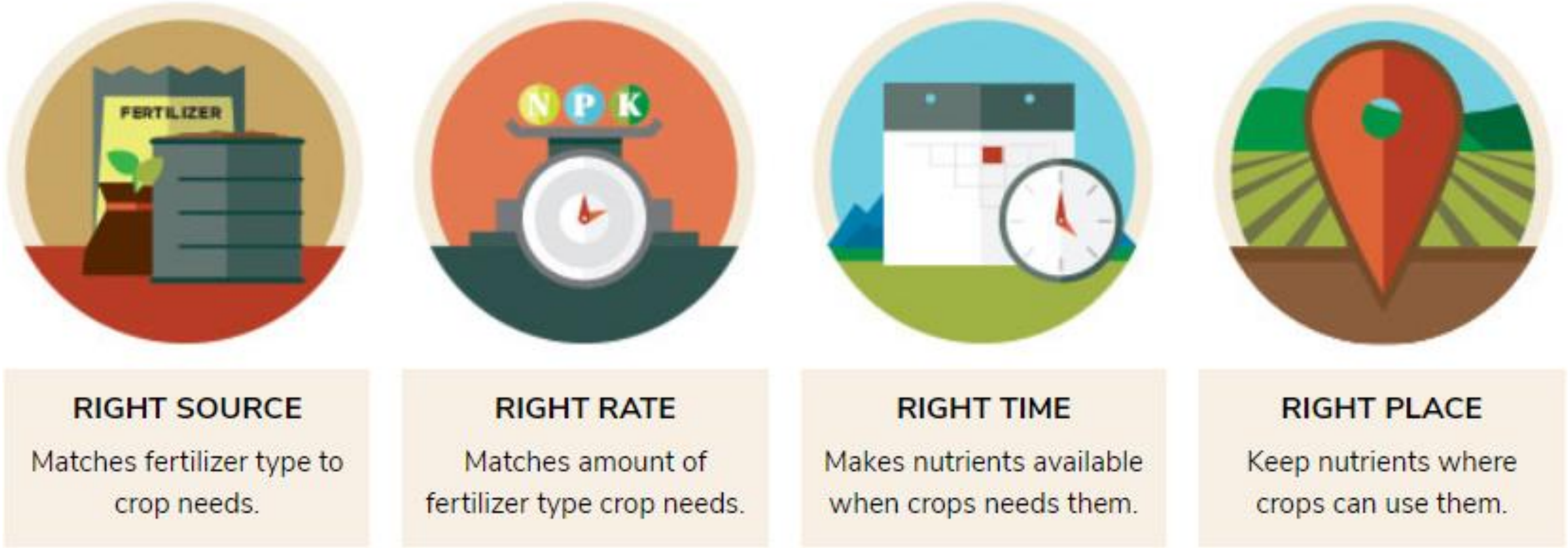
Focus on particulate P via erosion mitigation

Cereal rye cover crop in spring

Current BMPs

- Cover Crops
- Conservation tillage/No-till
- 4 R's

} Require management changes



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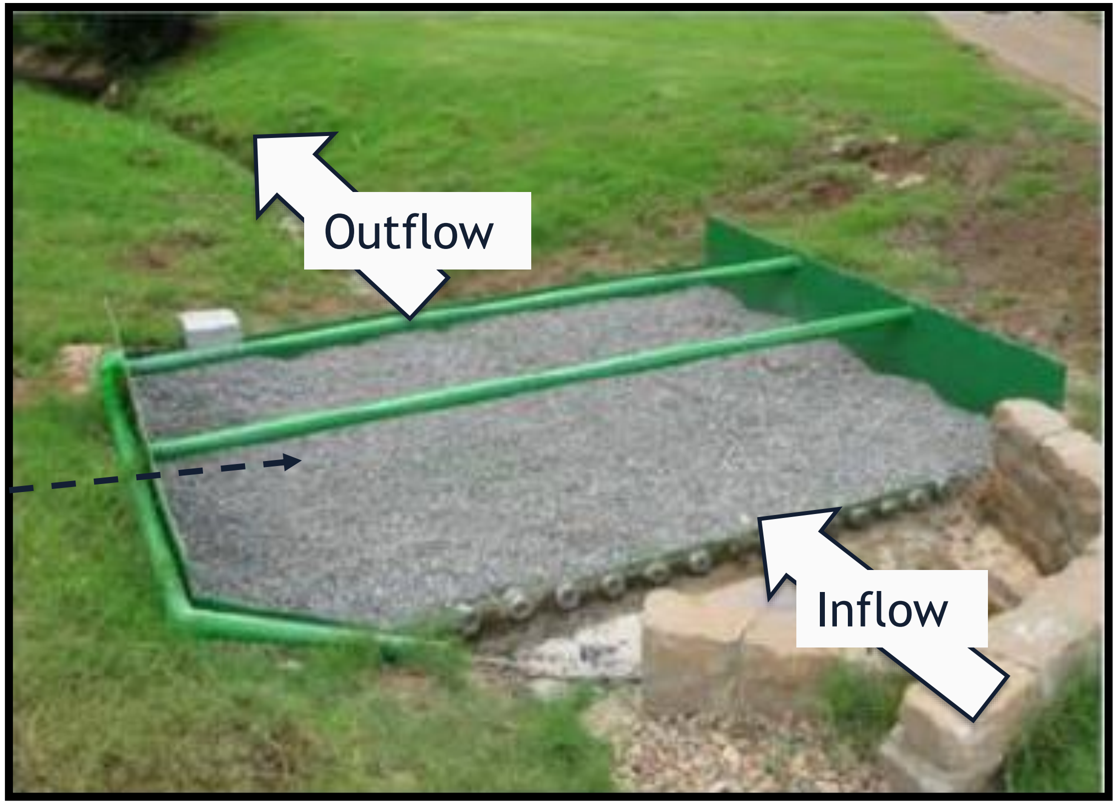
Edge-of-field P filters

- Placed in area of diverted surface runoff
  - Does not require extra management
  - Small physical footprint
- Uses industrial waste by-product as P sorbing media (PSM)

- PSM
  - Steel Slag
    - Source 1
    - Source 2
  - Acid Mine Drainage Residuals
    - Source 1
    - Source 2



Source: Penn et al., 2012. Trapping Phosphorus in Runoff with a Phosphorus Removal Structure. *J. Environ. Qual.* 41:672-679.

P Sorbing Media (PSM)

Steel Slag (SS1)

Source 1

Source 2

Acid Mine Drainage Residuals (AMDR)

Source 1

Source 2

PSM Physical Characterizations

- Research gap
  - Evaluating the trade-off between material characteristics
- Objective 1a
  - Evaluate the relationship between particle size, P removal, and hydraulic conductivity (K_{sat})
- Objective 1b
  - Identify optimum particle size that maximizes K_{sat} and P sorption

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Approach
Batch Isotherms
Hydraulic Conductivity

PSM Chemical Characterizations

- Research Gap
  - Assessment of elemental composition with particle size changes
- Objective 2
  - Determine what P is binding to

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- Research Gap
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<u>Approach</u>

Total elemental analysis

Water Soluble Ca and Mg

Ammonium oxalate extractable Fe and Al

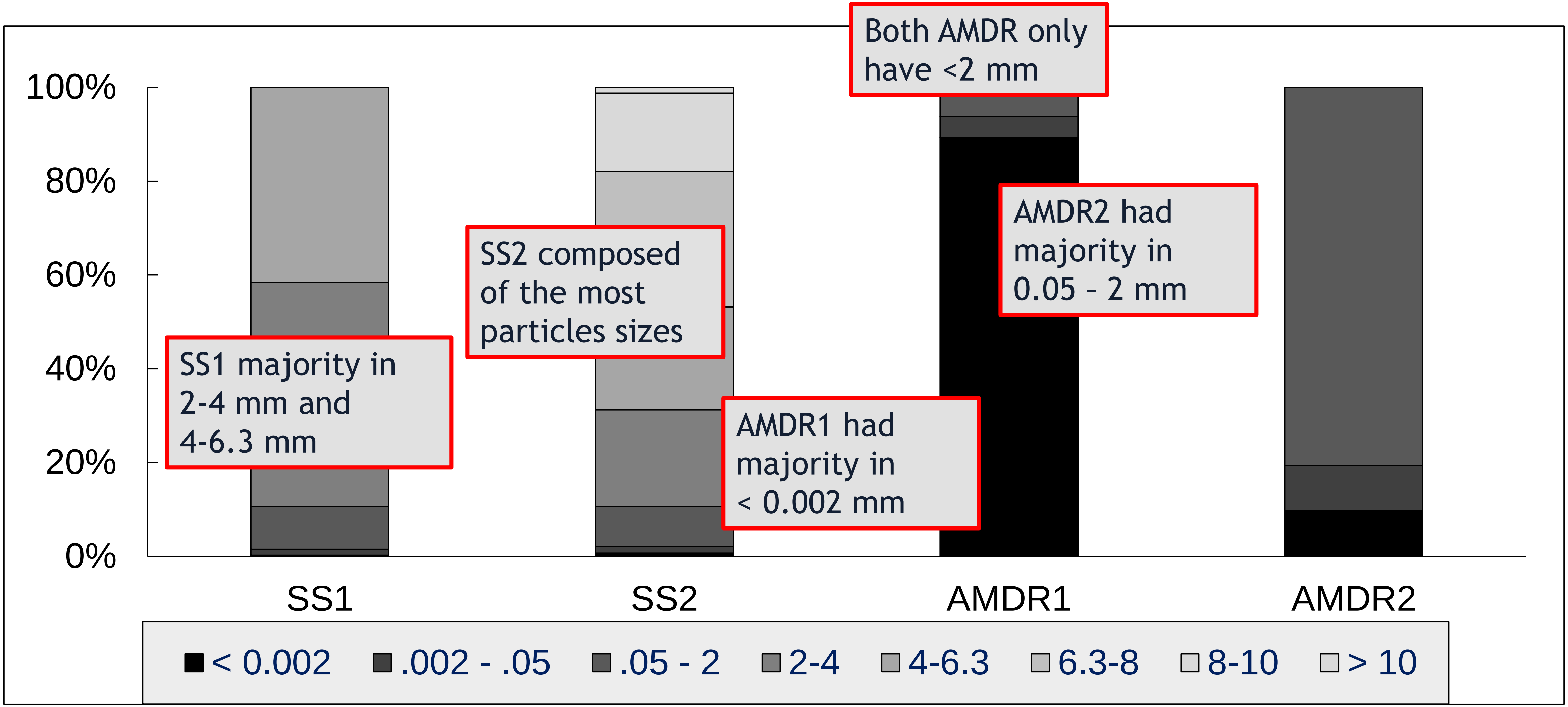
Dithionate extractable Fe and Al

Chang fracti

FTIR

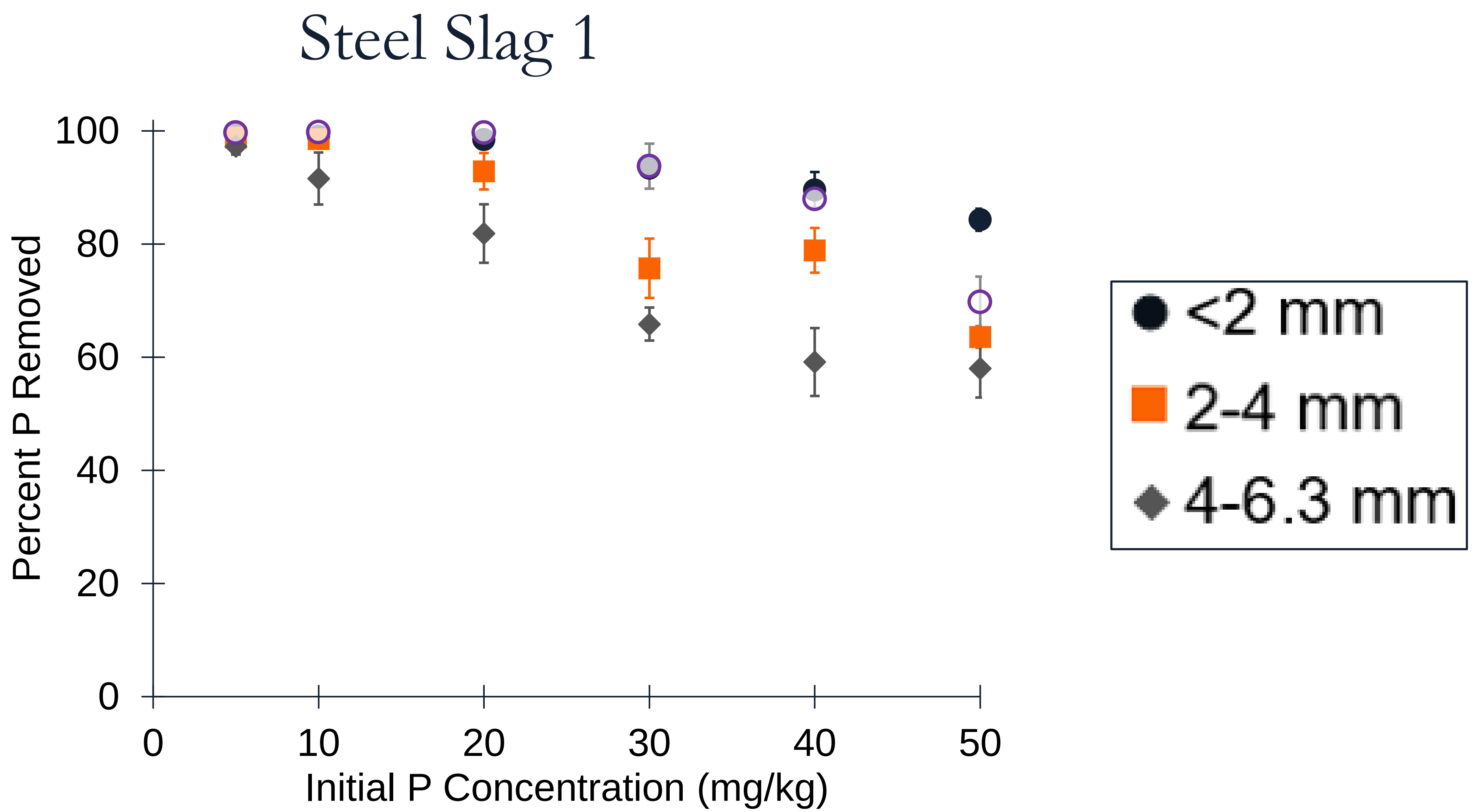
Will you have a verbal explanation of what this gets at? Yes

Particle Size Varies with Type & Source



Varies most by type

P removal decreases with particle size



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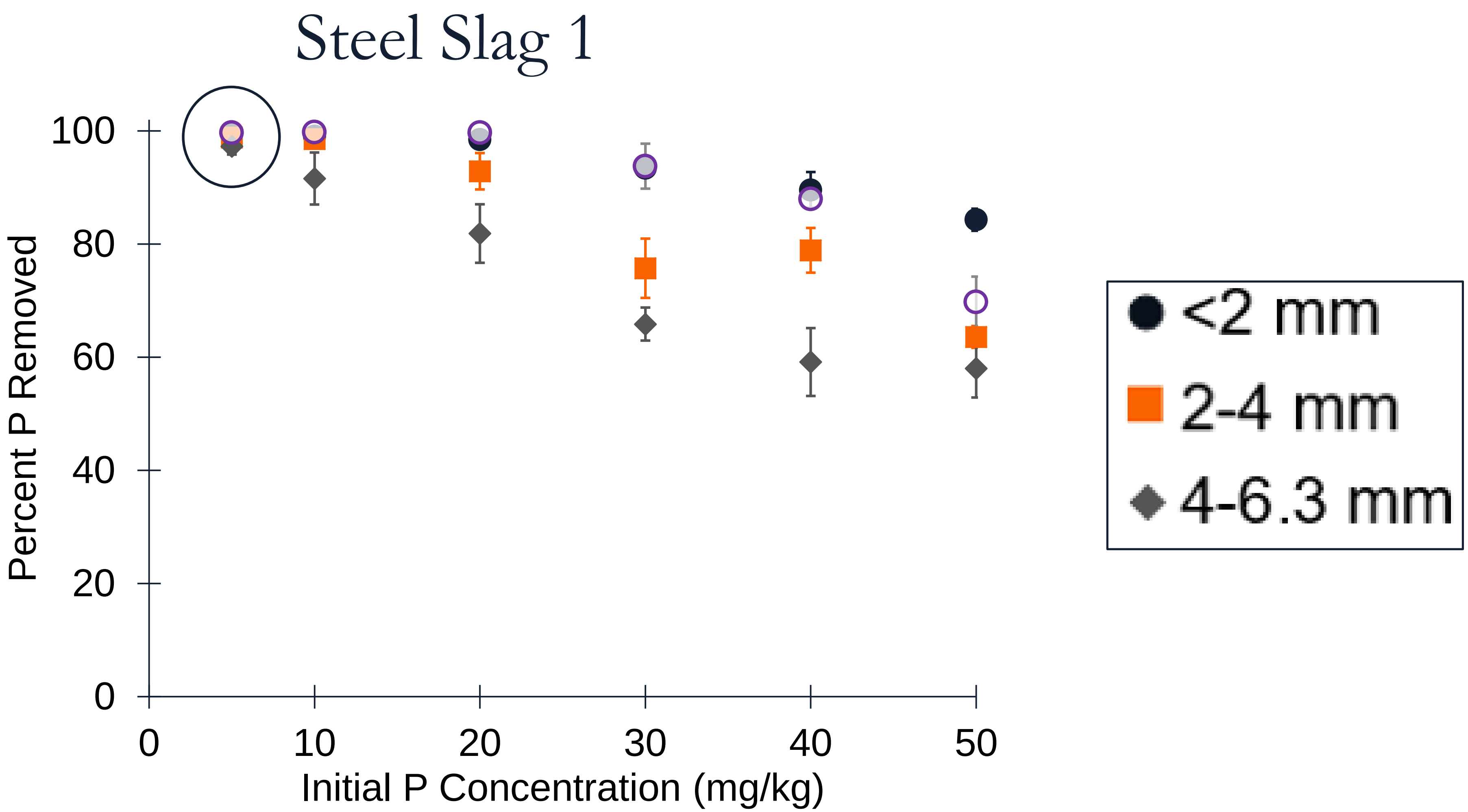

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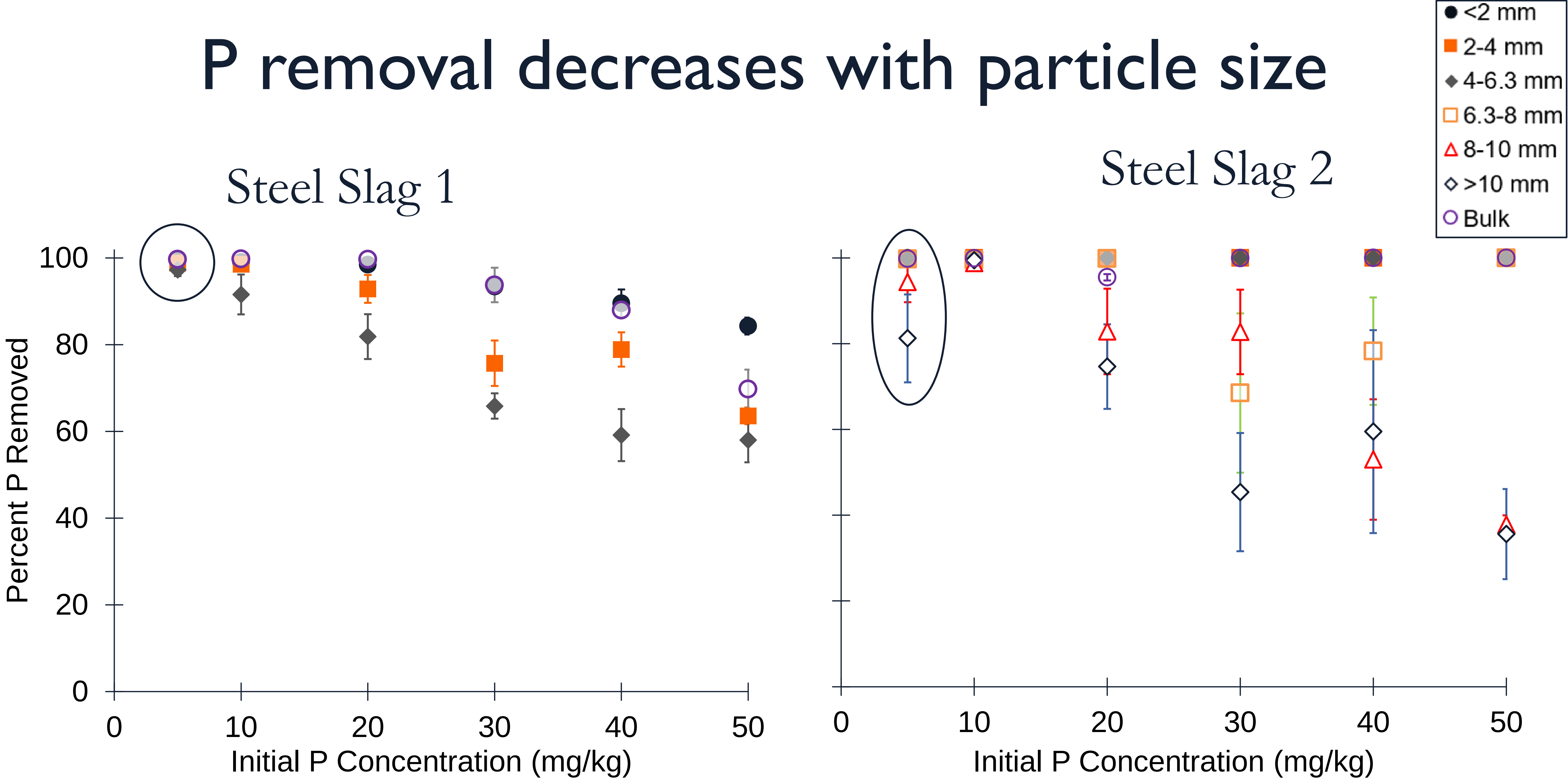

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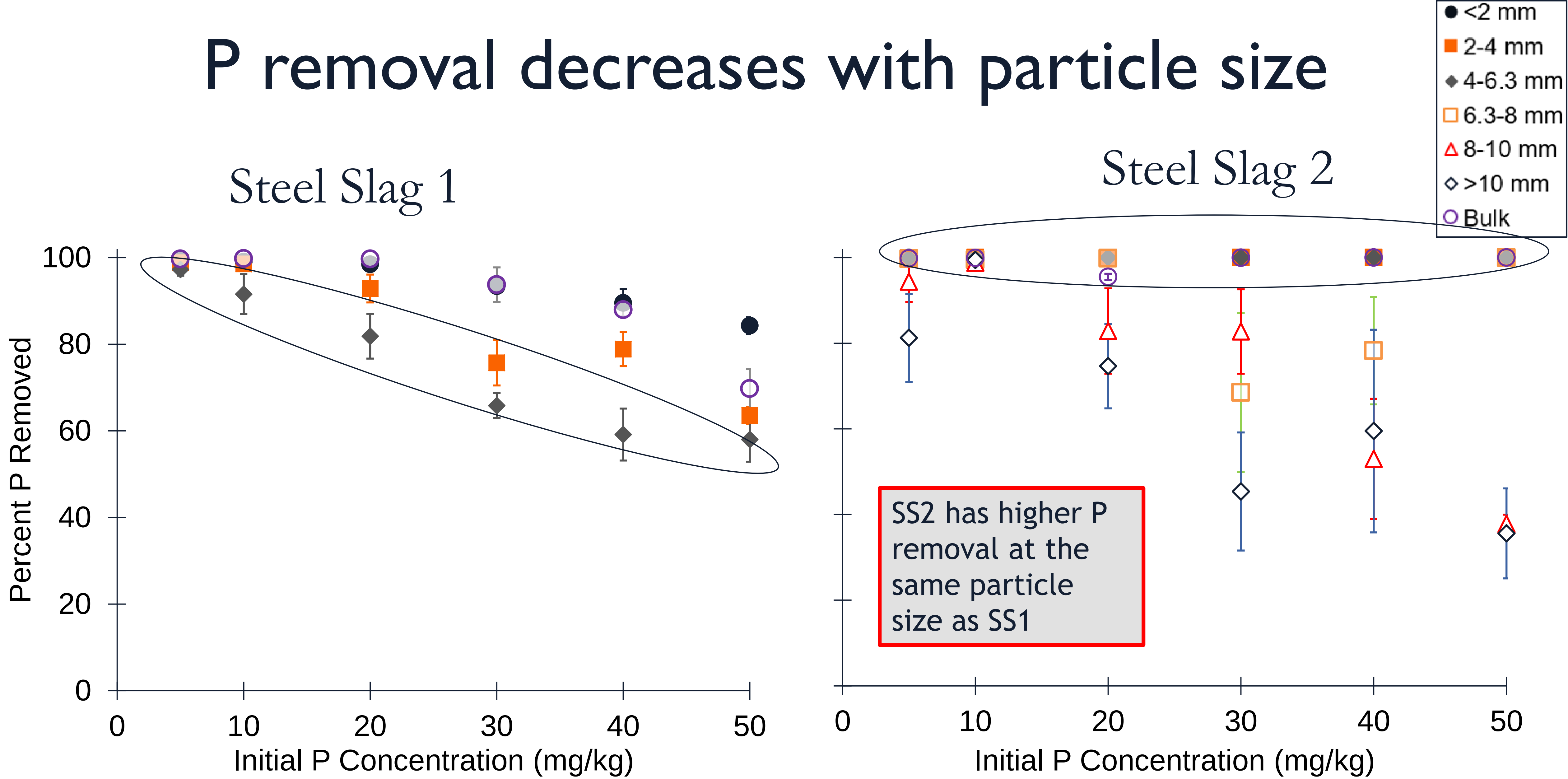
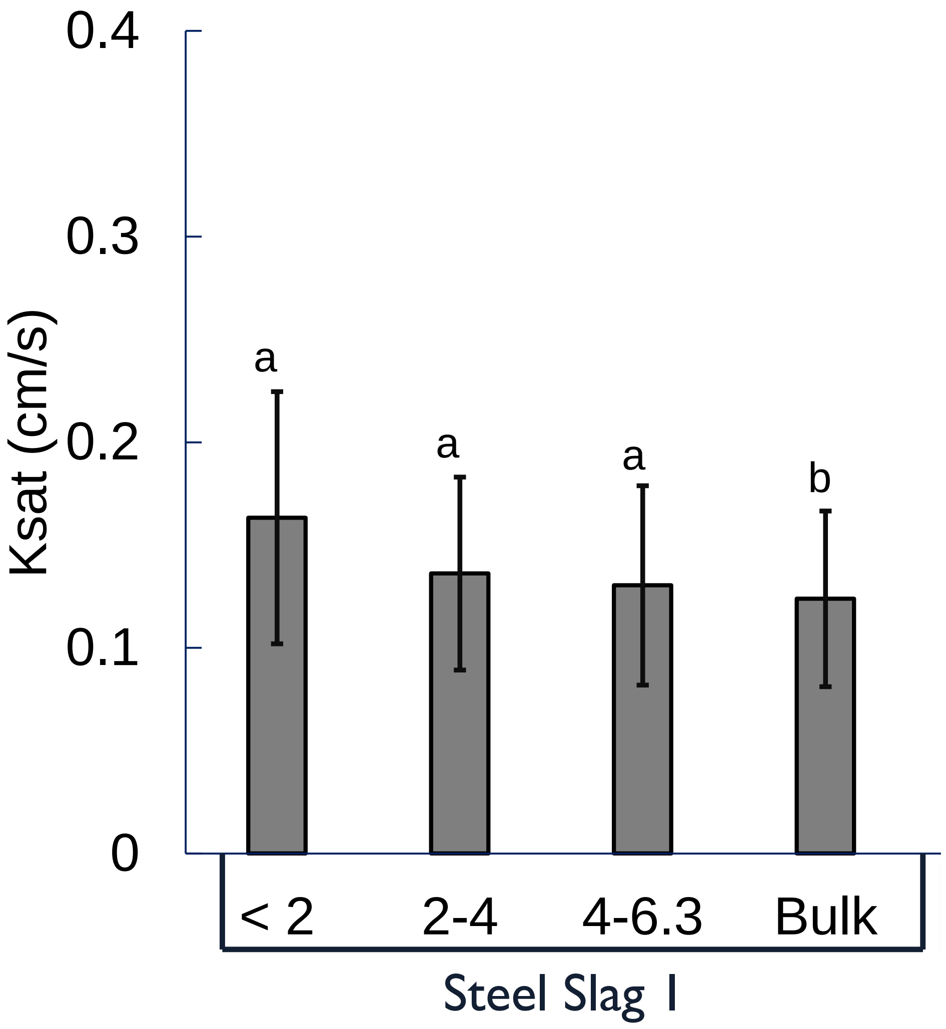
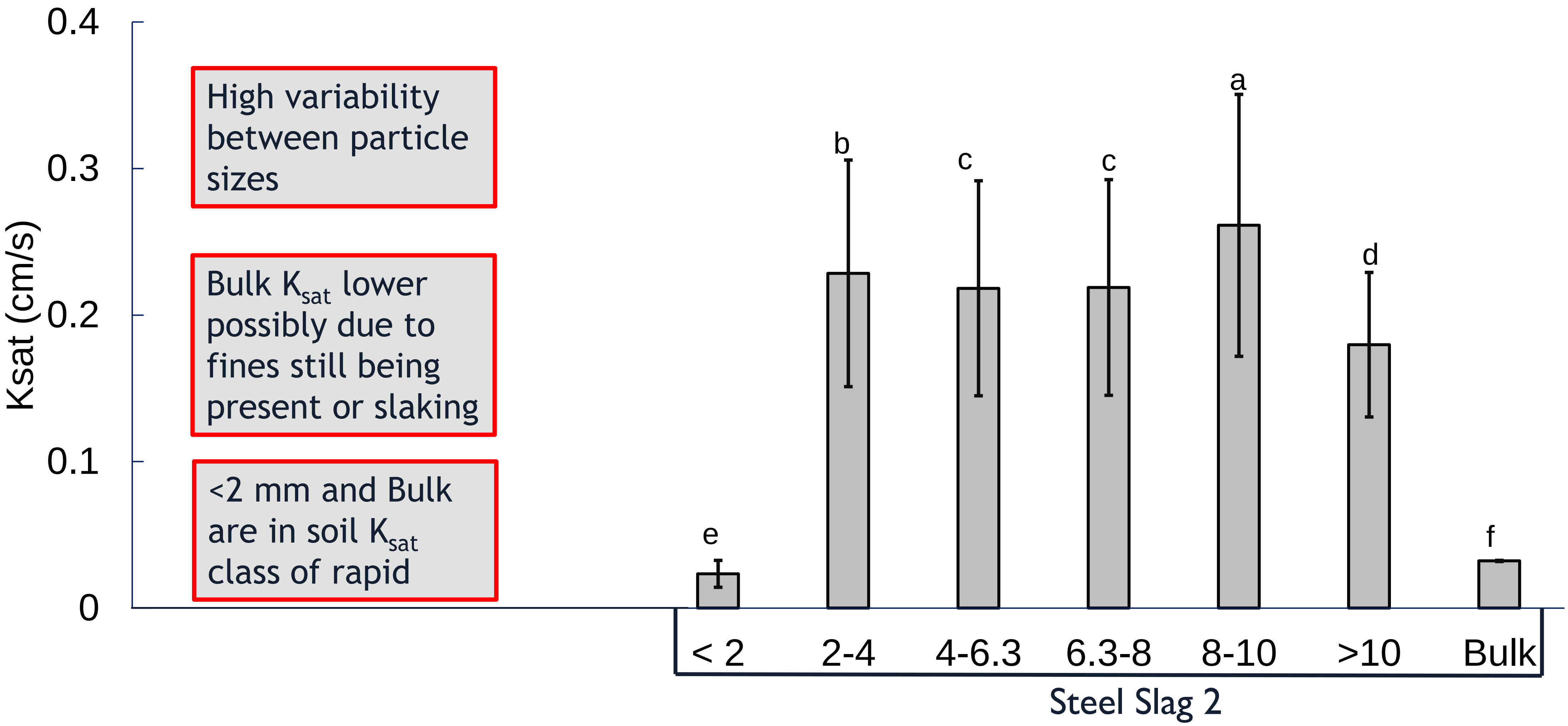


K_{sat} similar between particle sizes

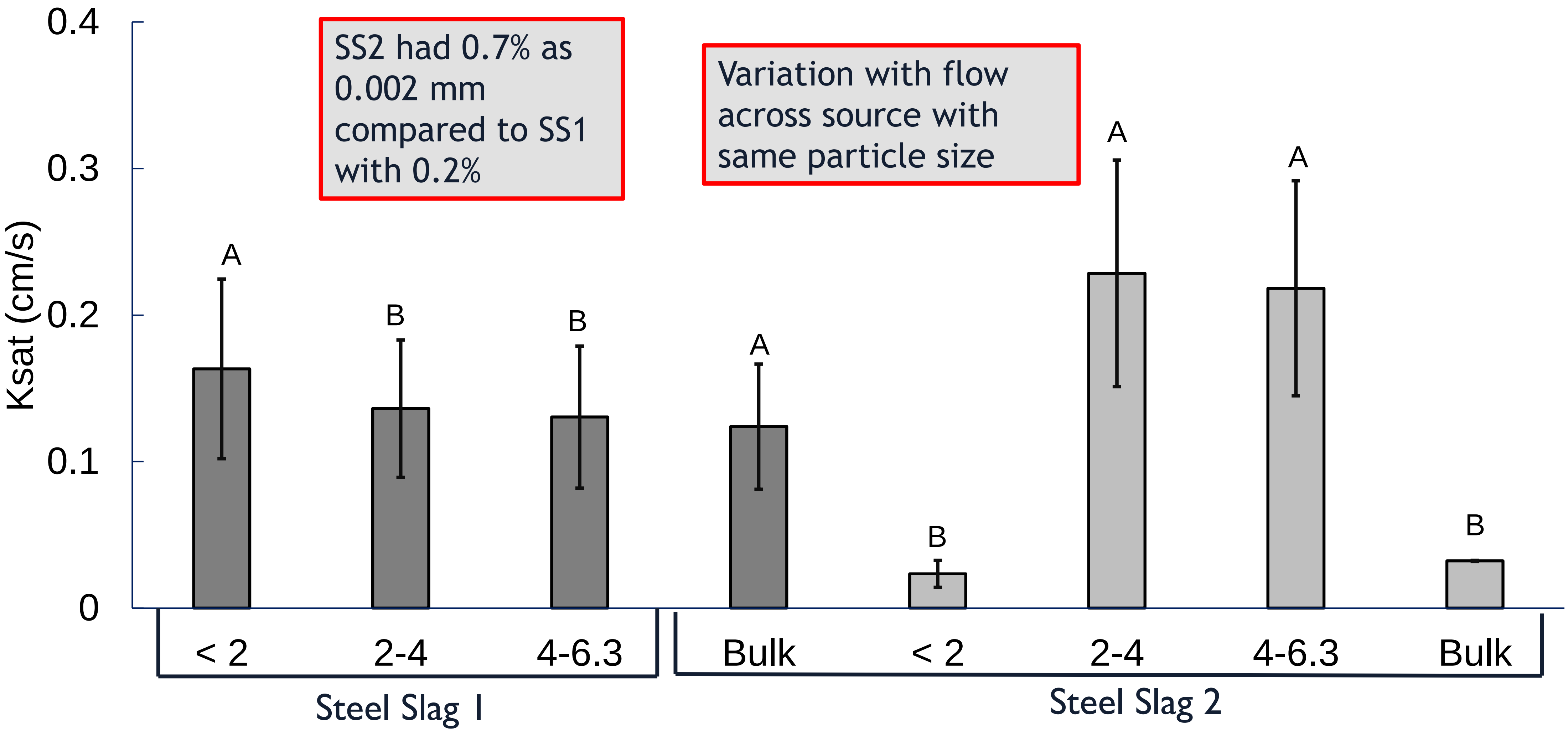


All fall under soil K_{sat} class of “very rapid”

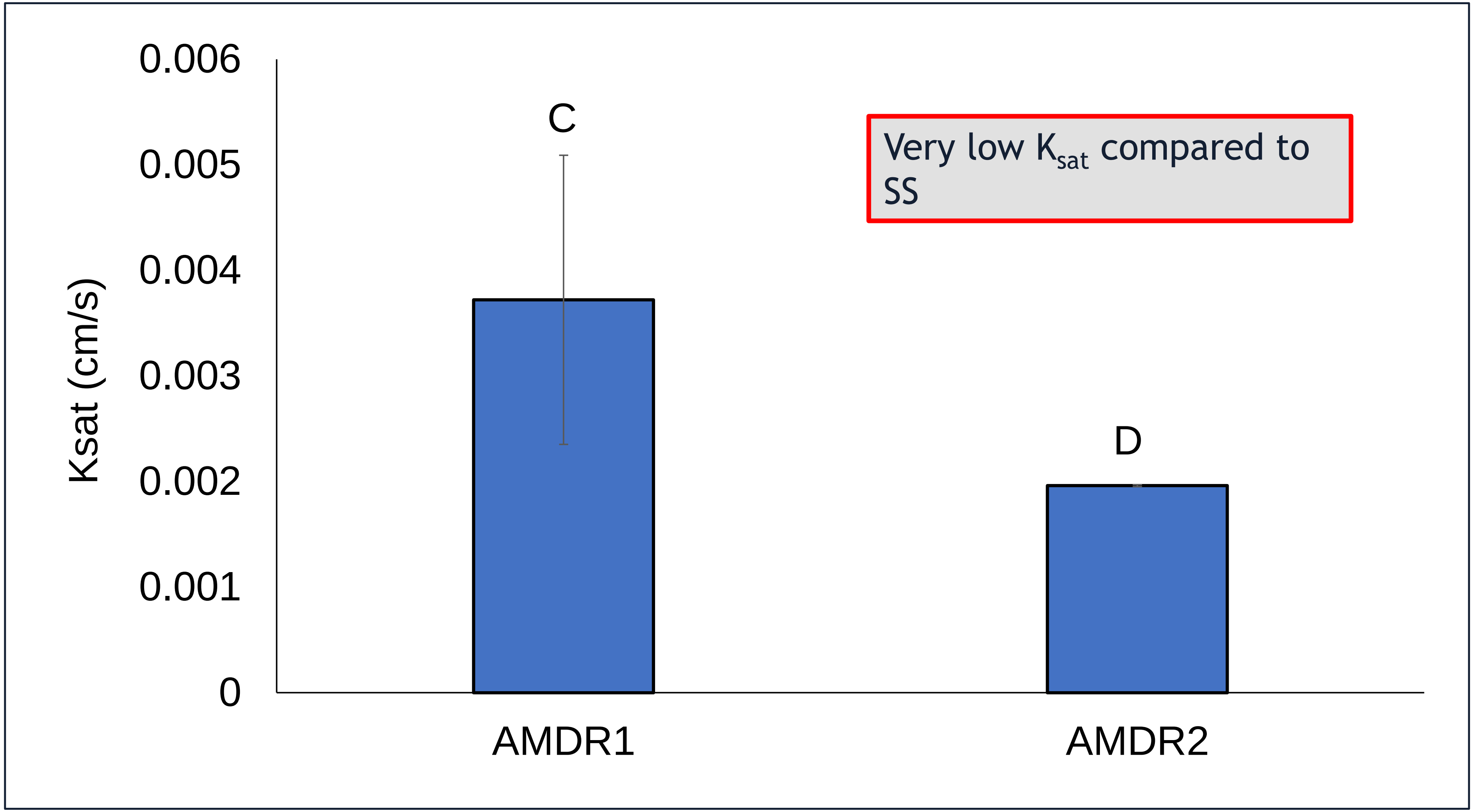
K_{sat} varies by particle size



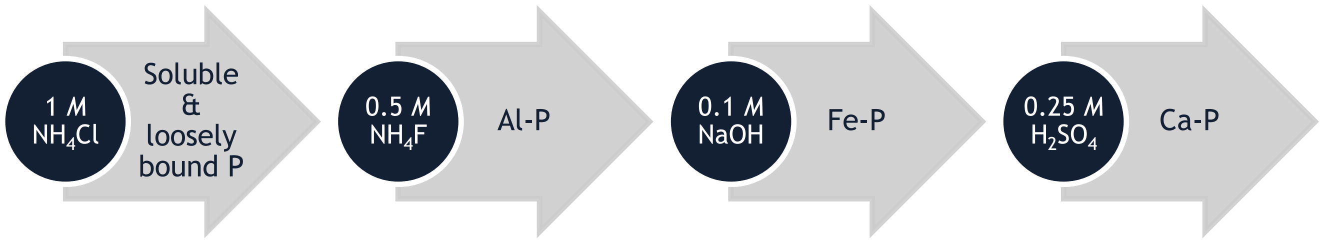
K_{sat} varies by Source



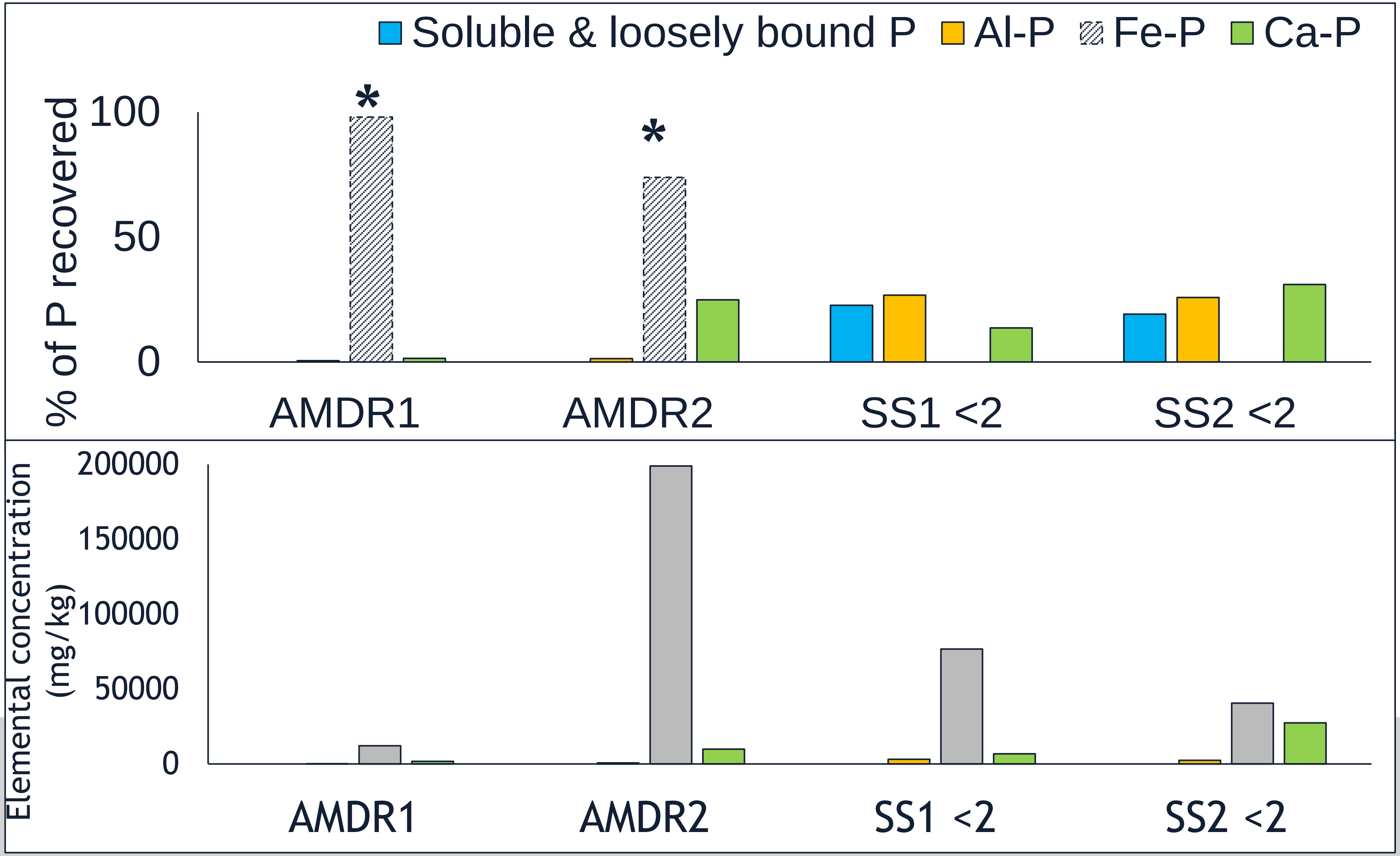
AMDR K_{sat} one order of magnitude lower than SS



Sequential Fractionation

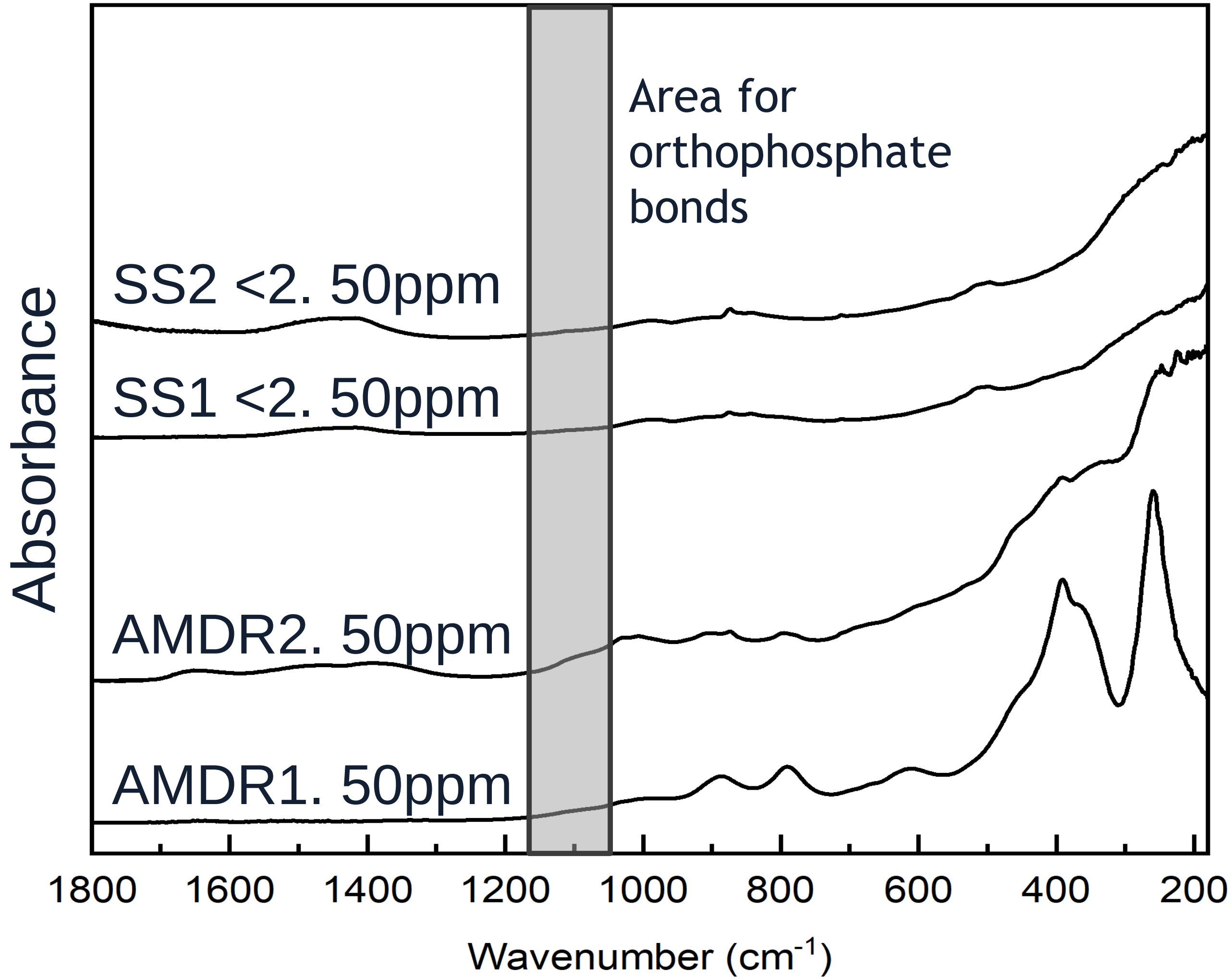


* Not determined due to iron interference but determined by mathematical difference.



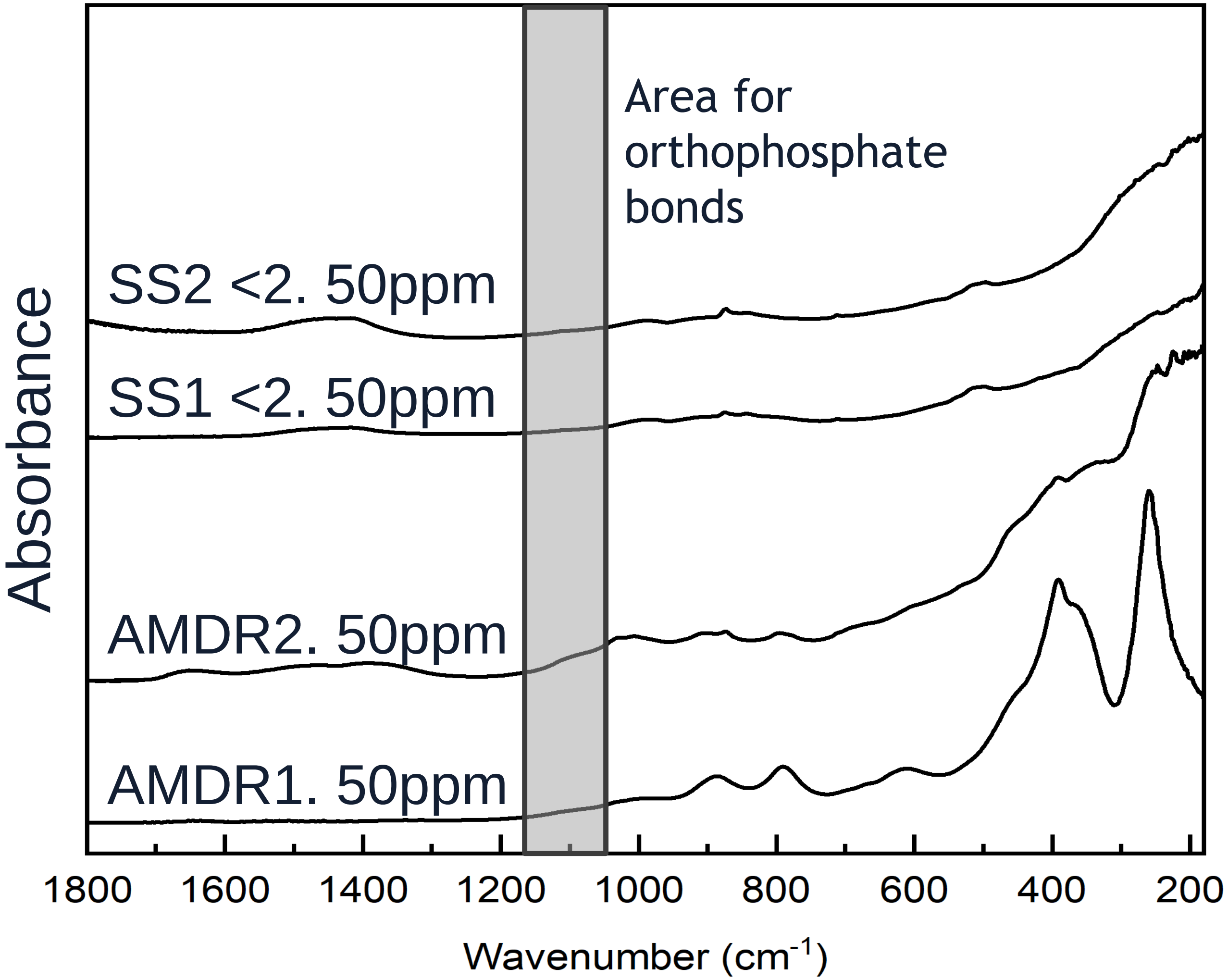
Generally, the elemental composition of the PSM indicates which fraction will have the highest percent of P recovered, although there are some discrepancies.

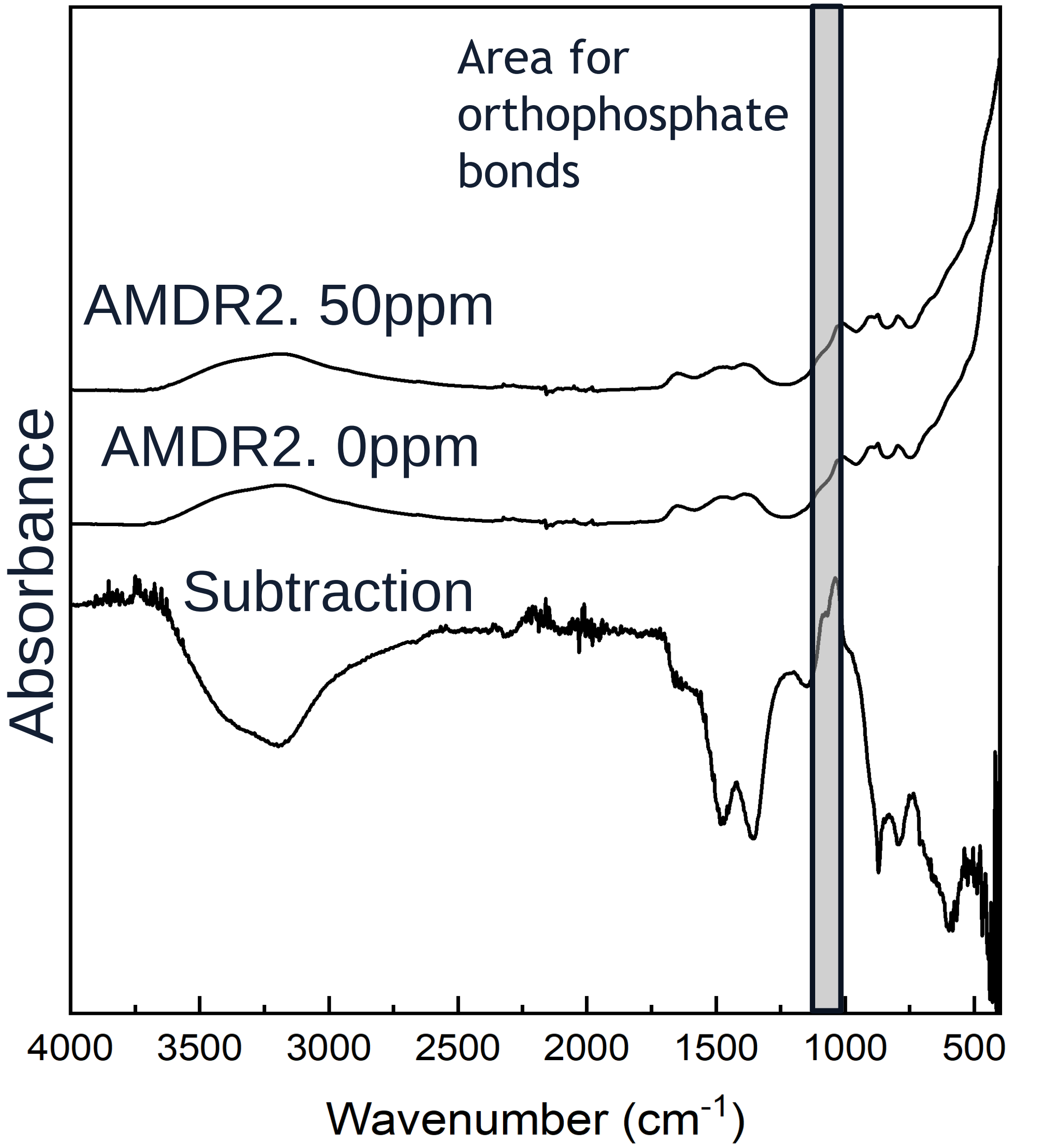
FTIR spectroscopy



Raw spectrum of PSM loaded with 50 PSM

FTIR spectroscopy



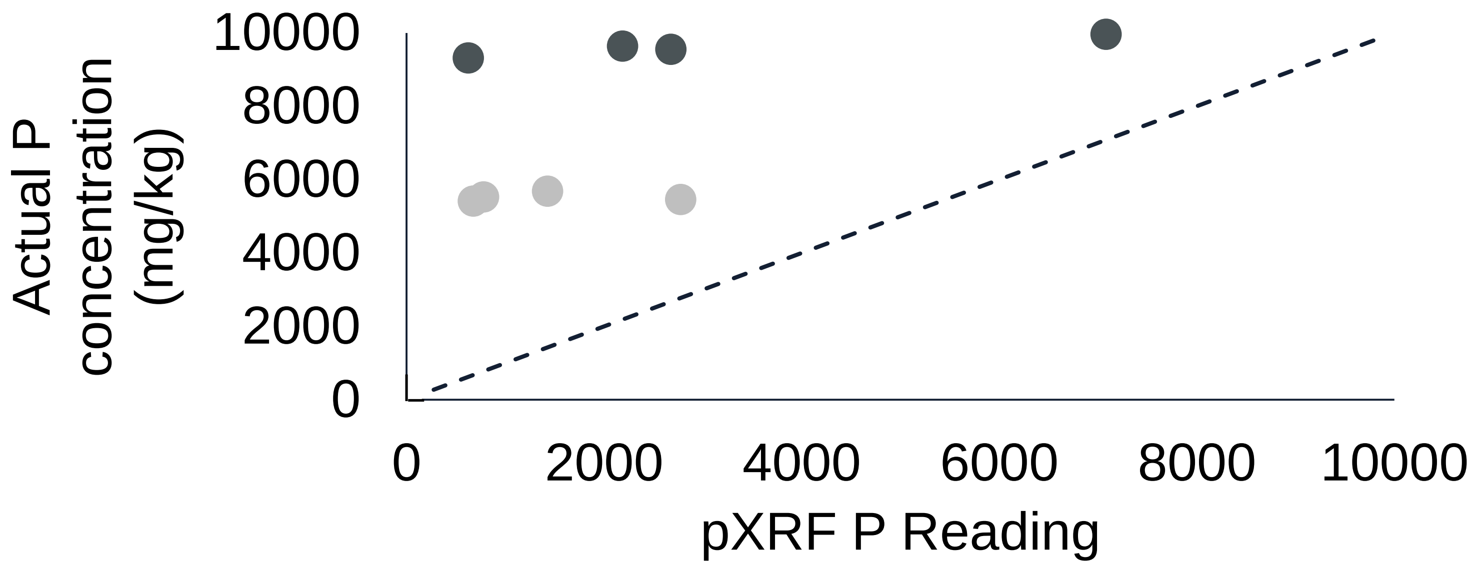


Raw spectrum of PSM loaded with 50 PSM

Subtraction spectra reveals the orthophosphate bonds

Portable X-Ray Fluorescence (pXRF)

- Traditionally used for geosciences: rocks
- Research Value:
  - In-situ as a way to analyze sorption capacity left for material



pXRF has the potential to detect P saturation

Need to develop a calibration for the PSM

Findings

- P removal by PSM decreases as particle size increases while K_{sat} increases
- PSM Source matters more than particle size for P removal
- Type of material matters for choice of PSM – driven by K_{sat}
- Optimum PSM & particle size: SS2 4-6.3 mm
- Iron binds P in AMDR
- Calcium and Aluminum bind P with SS

What does this mean moving forward

- Field application this year in Ewing

- Dream a little
  - Drainage ditch systems
  - Small streams
  - Lakes (think floating buoy)

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Thank you!