Soil C Dynamics in Unprotected and Protected Pools
Task 4a. Process/mechanistic-based fractionations

Results (to date) for Year 0 samples
Mineral Soil; 0 – 15 cm depth

Julie Jastrow
Sarah O'Brien
Jeff Ullian
Brent Van Til
Argonne National Laboratory
Chris Swanston
Lawrence Livermore National Laboratory

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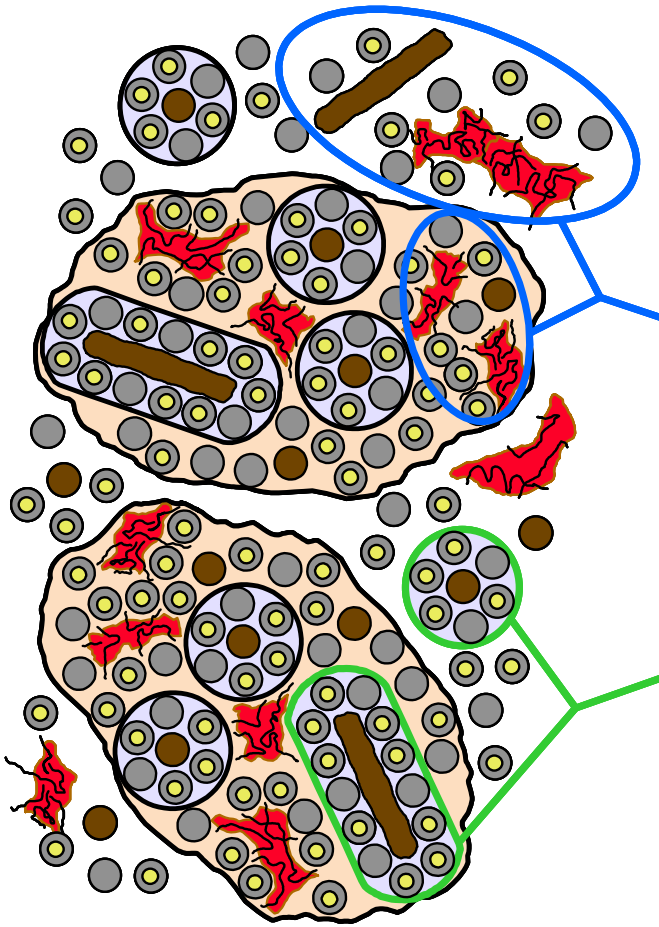
EBIS Fractionation of Soil Organic Matter

(Investigating the protective function of microaggregates)



Physical fractionation

Chemical fractionation

Non-Microaggregated

Microaggregate isolator
⇒ POM, silt & clay

Acid hydrolysis
silt & clay

Microaggregated

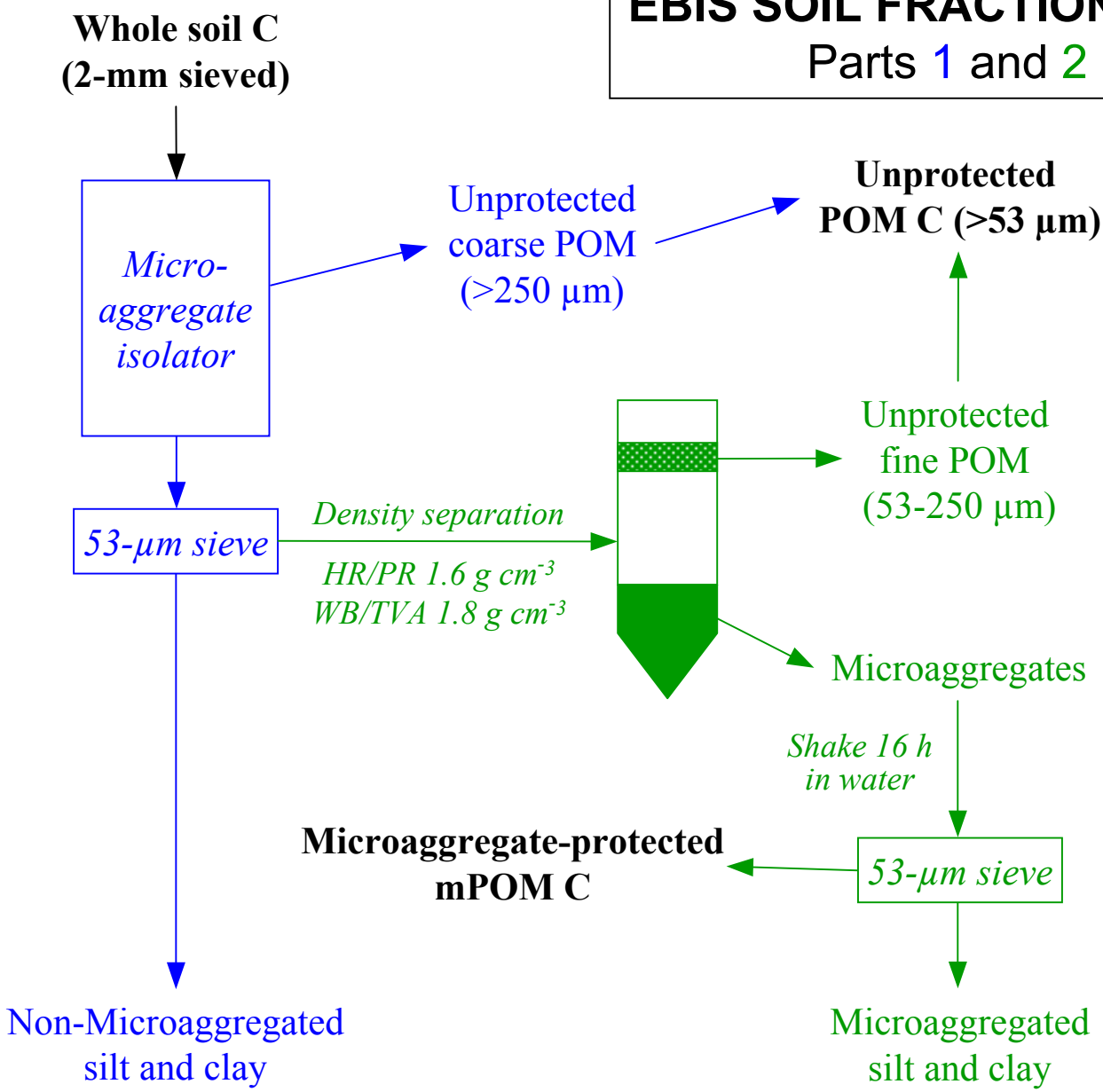
Dispersion
⇒ POM, silt & clay

Acid hydrolysis
silt & clay

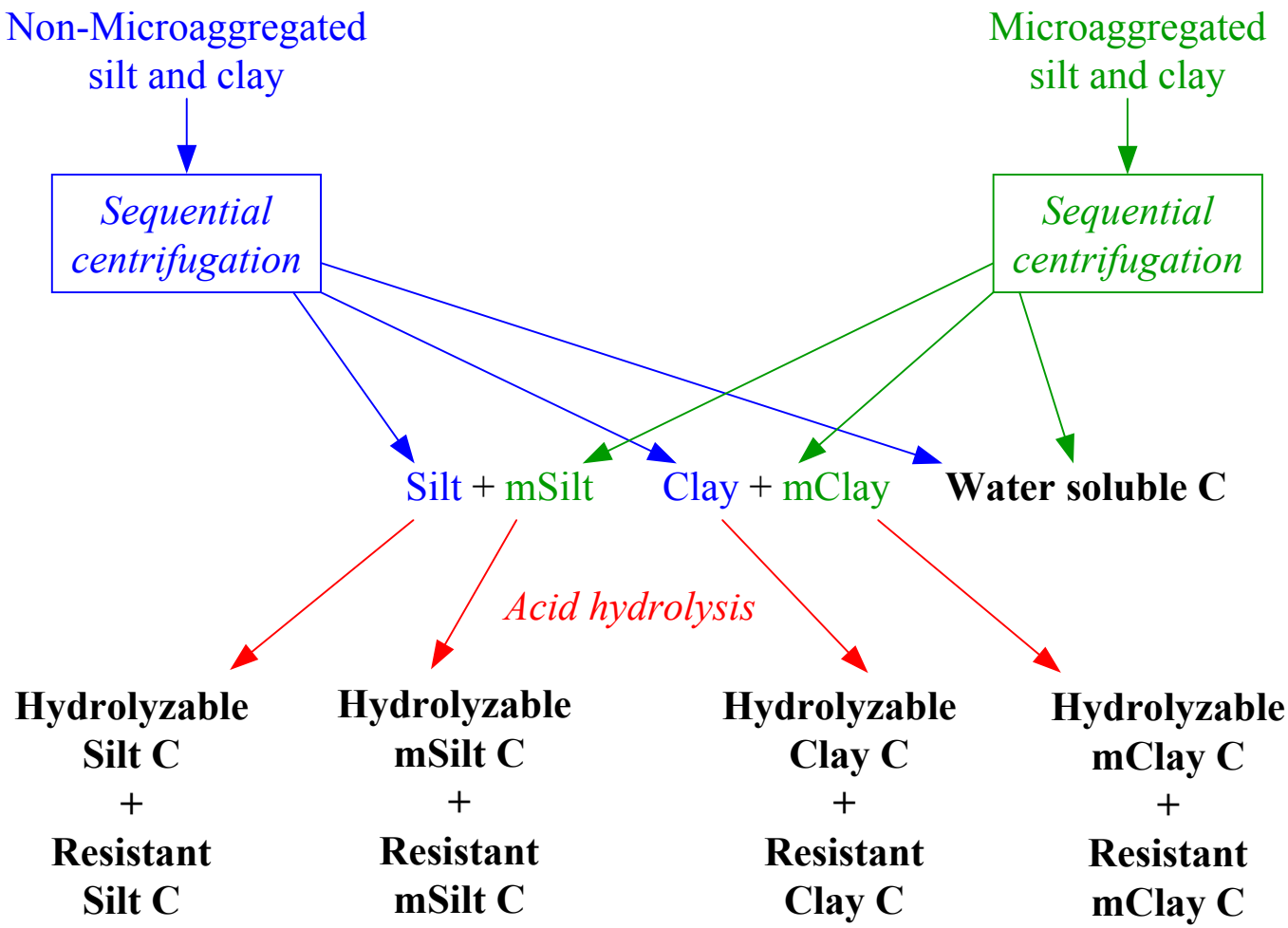
Based on increasing disruptive energies

Yields resistant and more labile fractions

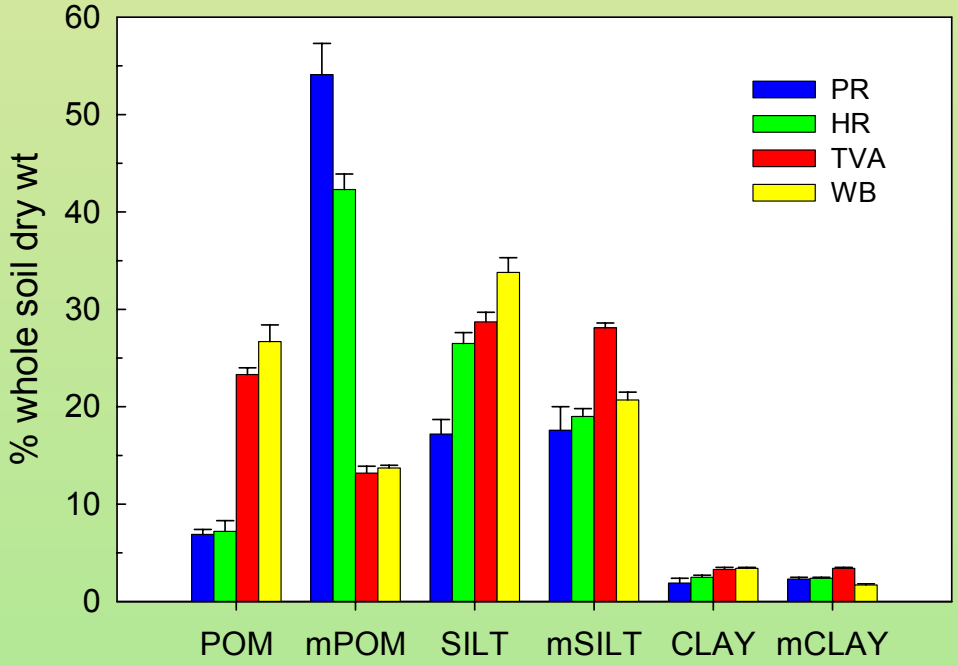
EBIS SOIL FRACTIONATION
Parts 1 and 2



EBIS SOIL FRACTIONATION
(continued)
Parts 1, 2, and 3



Distribution of Fraction Weights (% of Whole Soil)
0 – 15 cm depth

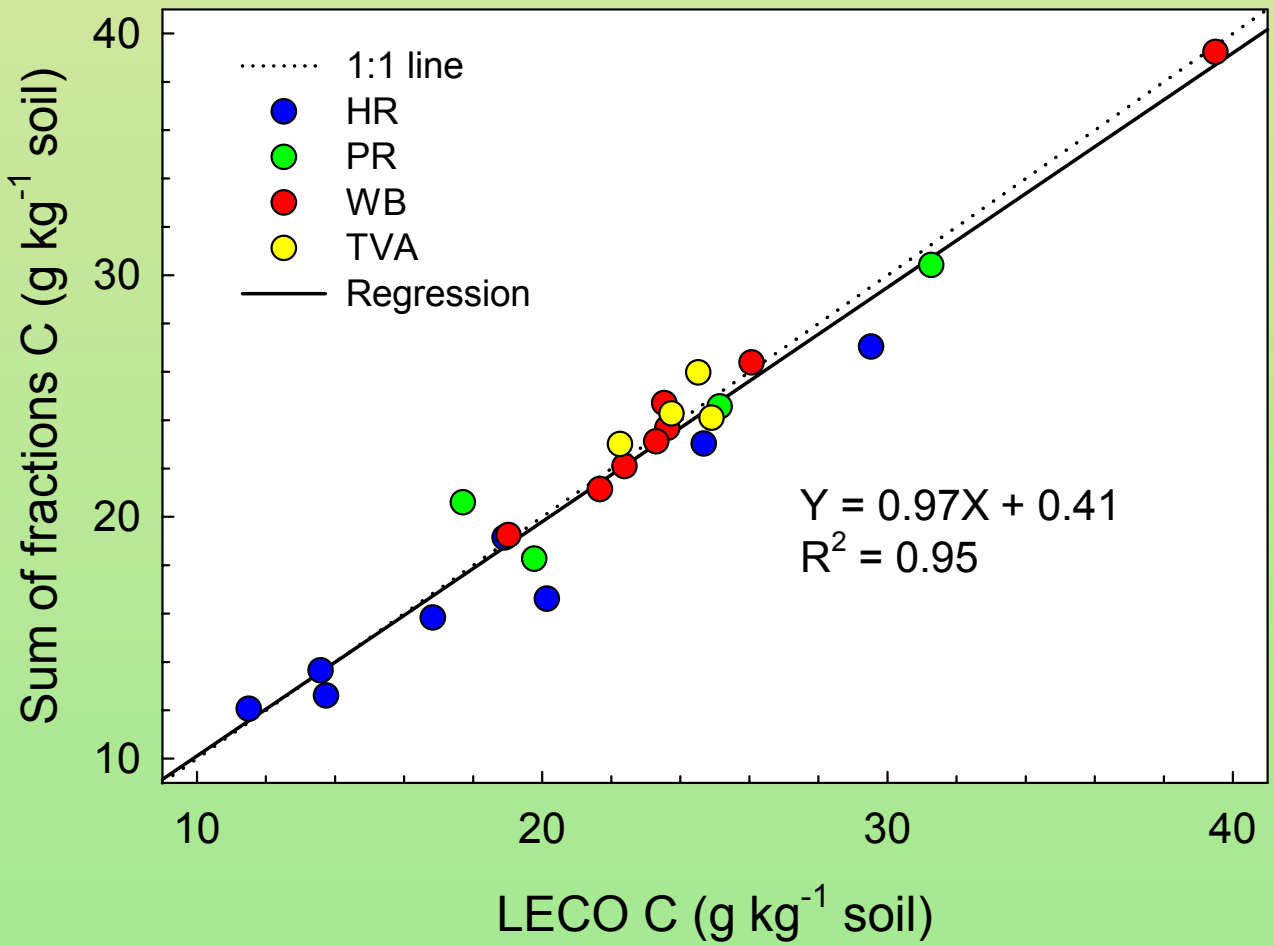


Fractionation recovery efficiencies
Part 1 = 98.3 ± 0.2 %
Part 2 = 99.3 ± 0.2 %
Overall = 97.6 ± 0.2 %

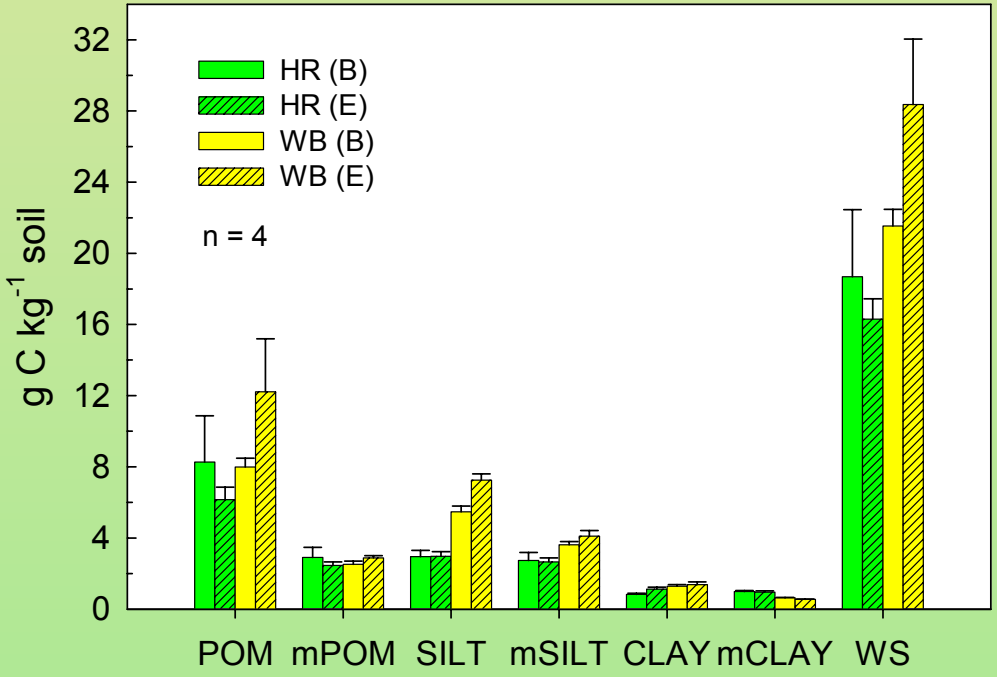
- POM fractions are sand-sized:
  - POM is mostly >250 µm
  - mPOM is 50-250 µm
- POM vs. mPOM distribution switches between HR/PR and WB/TVA soils
- PR and HR distributions differ between mPOM and SILT
- TVA and WB distributions differ between SILT and mSILT
- Silt may include some aggregated clay particles

Sum of Fractions C* vs. LECO Measured Whole Soil C

*CAMS-estimated C corrected to Carlo Erba-measured C

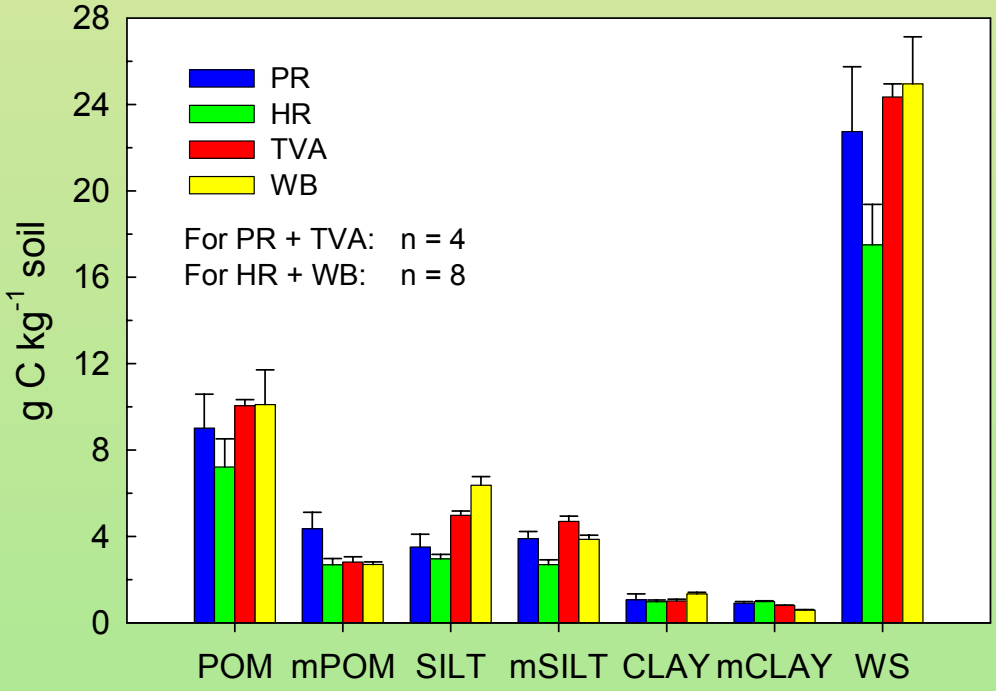


Fractionated C Concentrations of Background (B) and Enriched (E) Litter Plots on Background Soils (HR and WB) at Year 0



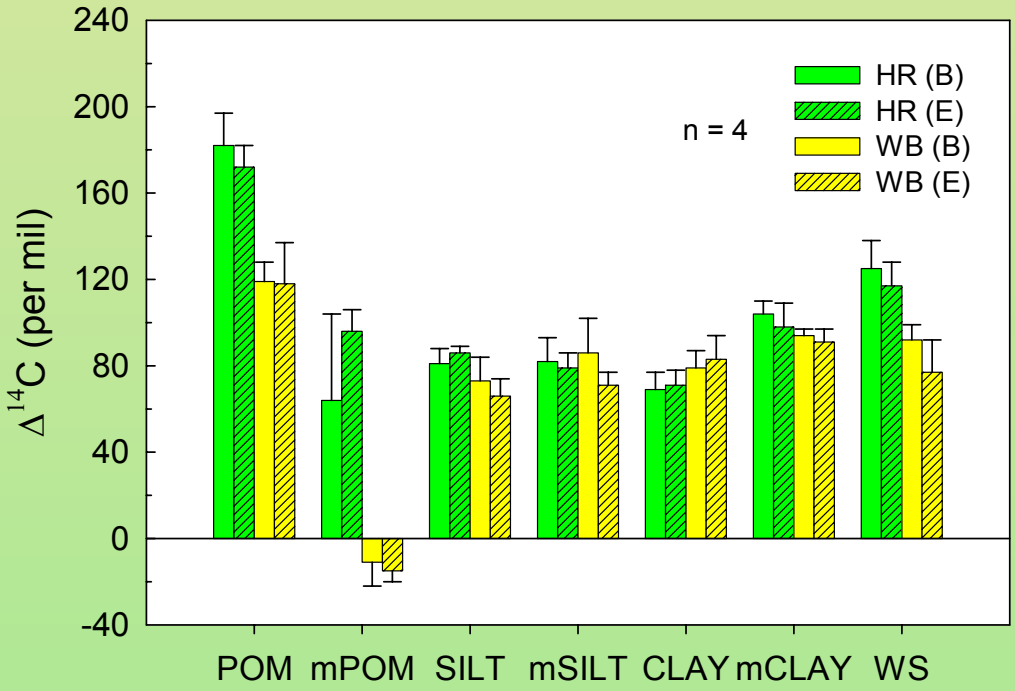
- Generally comparable within soil type
- WB Plot 7 has higher SOC including > 2 times the POM C of other WB plots
- HR variability is more distributed

Fractionated C Concentrations of Enriched (PR + TVA) and Background (HR + WB) Soils (Year 0)



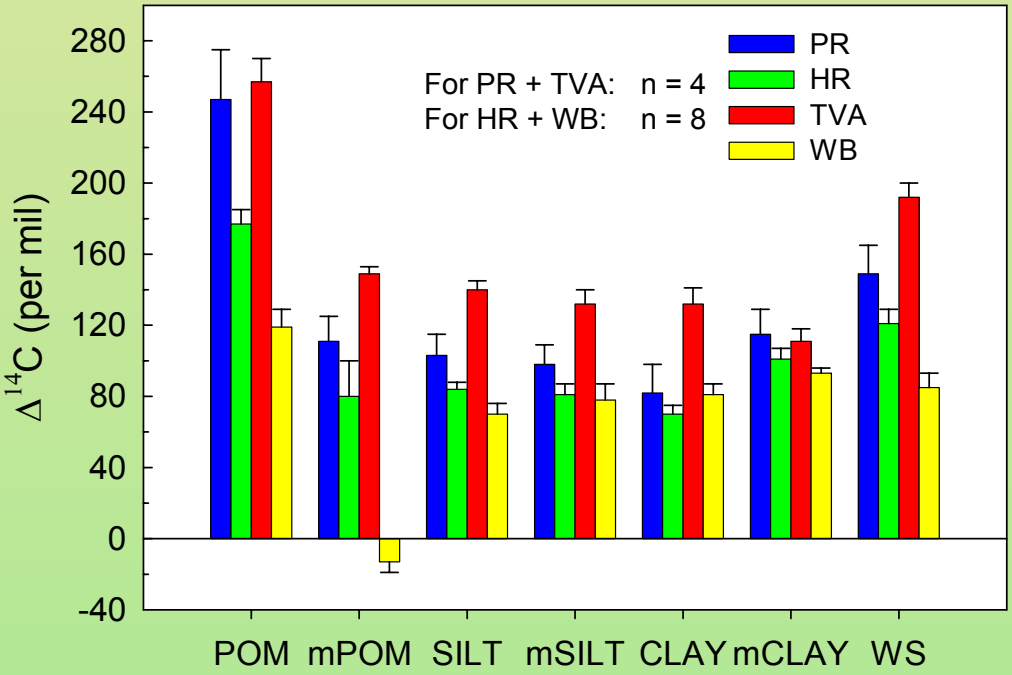
- 50-60% of SOC in POM fractions
- 30-40% of SOC in silt and ~10% in clay fractions
- PR and HR differences are mostly in POM and to some extent silt fractions
- Greatest differences between WB and TVA are in SILT and mSILT and due to weights not C concentrations

Fraction $\Delta^{14}C$ of Background (B) and Enriched (E) Litter Plots on Background Soils (HR and WB) at Year 0



- No differences within soil types (as expected)
- Negative $\Delta^{14}C$ for WB mPOM due to charcoal? (probably some in POM too)
- Negative $\Delta^{14}C$ for HR-5 mPOM decreases average and increases error
- Similar silt and clay $\Delta^{14}C$ suggest WS differences between HR and WB are due to POM/mPOM differences and may be related to charcoal

Fraction $\Delta^{14}C$ of Enriched (PR + TVA) and Background (HR + WB) Soils (Year 0)



- Significant enrichment mostly in unprotected POM for PR; some enrichment in all fractions (not significant)
- TVA has significant enrichment in all fractions
- Enrichment in mineral fractions likely to be hydrolyzable (not completed)

TVA vs. PR differences

- Affected by inputs?
- Porosity and transport of DOC?
- Protective capacity and respiratory loss?

How much new C has already reached soil fractions at "Year 0" (i.e., from inputs during 1999 and 2000 growing seasons)?

Estimate with a mass balance approach using ^{14}C signatures:

$$S_E = f\,(I_E) + (1 - f)\,S_B$$

or

$$f = (S_E - S_B)/(I_E - S_B)$$

f = proportion new

S_E = enriched soil (PR or TVA)

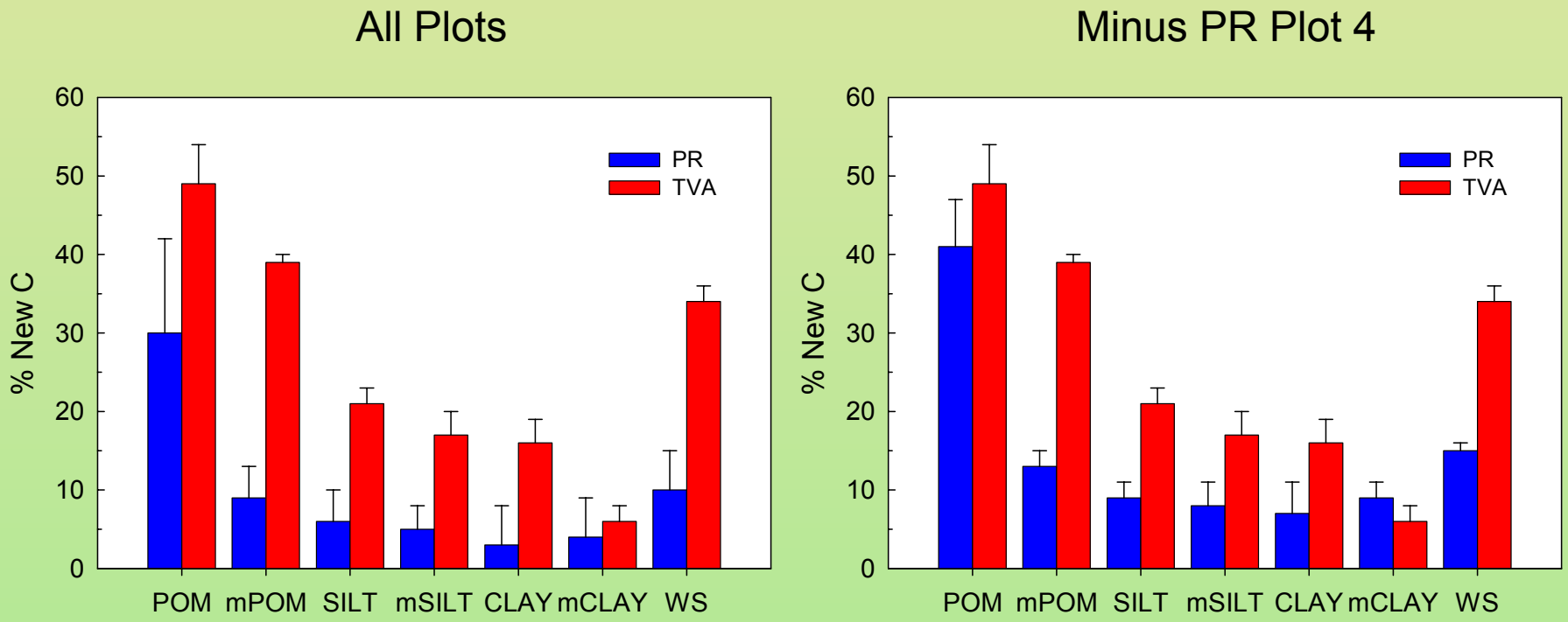
S_B = background soil (HR or WB)

I_E = dead roots (<2 mm) from PR or TVA

How valid is I_E?

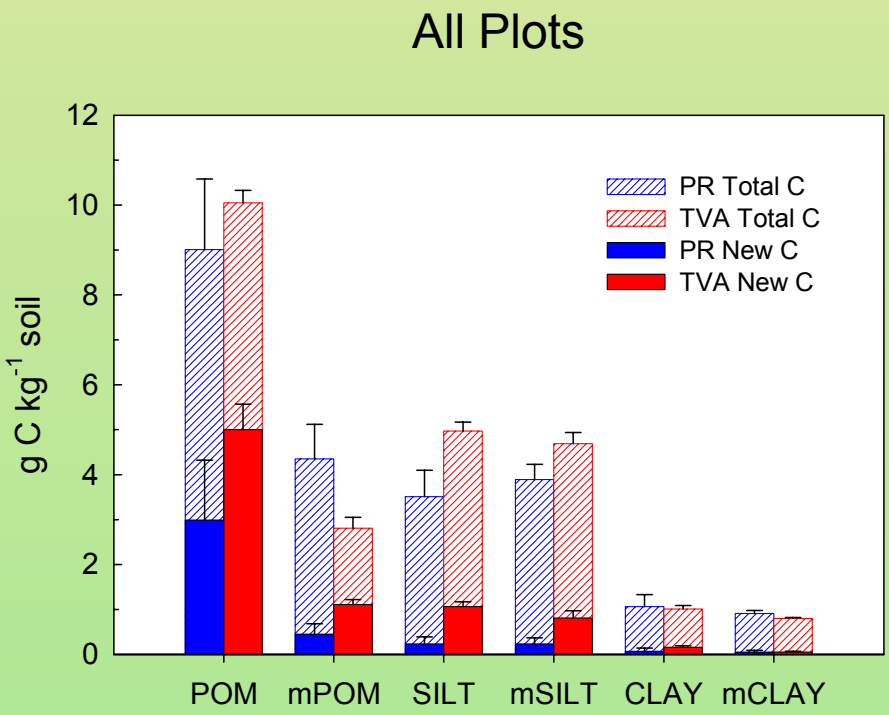
- What were PR or TVA root signatures in 1999? Before?
- What is the signature of root exudates?
- Need to account for root turnover (standing crop signatures may not reflect signatures of actual root inputs to SOM).
- Could I_E be modeled? Does f need to be modeled?

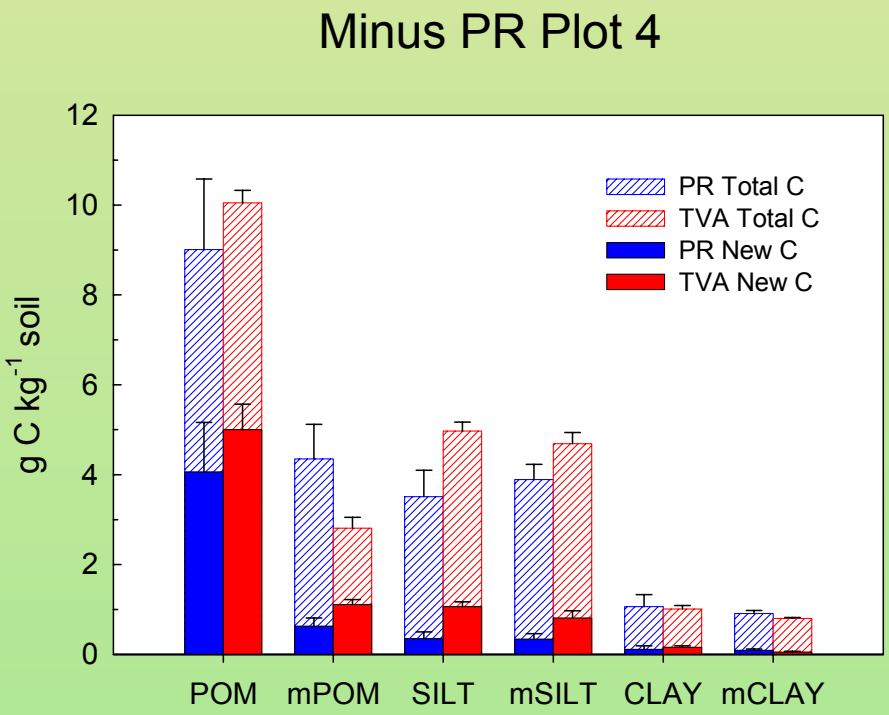
Estimated % New C in PR and TVA (Enriched) Soils



PR Plot 4 signatures lower than average HR signatures for all fractions and whole soil suggesting this plot may be an outlier (low root inputs?)

Estimated New C Concentrations in PR and TVA (Enriched) Soils Relative to Total SOC



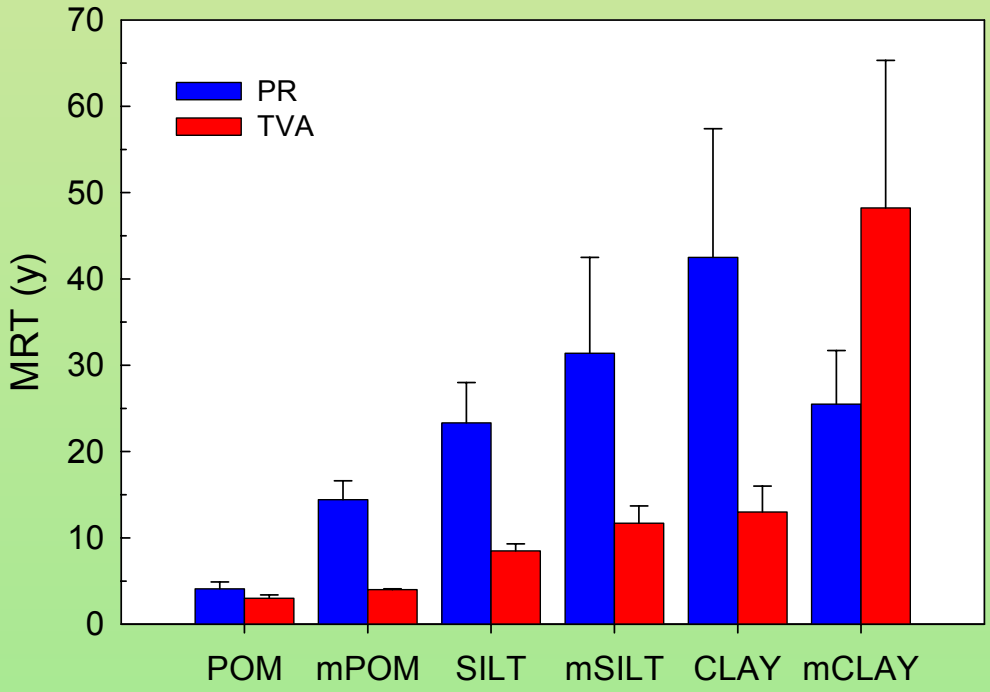


- What is effect of long-term labeling at lower levels vs. the pulse?
- How much of labeling is related to exudates and microbial action rather than root tissue inputs to SOM?

Just for Fun…

Estimated MRTs in Enriched (PR + TVA) Soils (0 Year) Assuming a 2-yr Label (1999 and 2000)

(Minus PR Plot 4)



- MRTs = 1/*k* where *k* = -ln(old C/total C)/t and t = 2 years
- MRT values affected by assumptions regarding I_E in calculation of % new C and period of ^{14}C labeling
- Absolute values tentative due to assumptions but relative comparisons between fractions and soils are more reliable

WHAT'S NEXT?

- Year 1 samples are currently being processed through Part 2 of fractionation
- Acid hydrolysis of mineral fractions (Part 3 of fractionation) for Year 0 and selected Year 1 samples to verify no change in resistant fractions over time
- Analyze fractions for C and N concentrations with LECO elemental analyzer; analyze fractions for ^{13}C (for ^{14}C correction)
- Analyze Year 1 samples and hydrolyzed fractions at CAMS

LONG TERM GOALS

- Fractionation and analysis of Year 2 and Year 3 samples (plus later years?)
- Follow dynamics of ^{14}C signatures in fractions over time
- Modeling