

Carbon Stabilization along a Reconstructed Prairie Chronosequence

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Introduction

- Over time, prairie reconstructions can be an effective tool for increasing nitrogen (N) and carbon (C) within the soil
- However, C stocks in reconstructions lag greatly behind remnant, uncultivated prairies
- Organic C and N can chemically bond with silt/clay in soil, promoting C and N stabilization & accumulation
- Polyvalent cations or certain iron oxides could also help bond organic C and N with silt/clay surfaces
- Another stabilization mechanism is physical occlusion, where particulate organic matter (POM) is physically protected from decomposition
- Protected pools of C from physical or chemical bonding are theoretically finite due to limited surface area on clay particles and could saturate over time
- Unprotected pools of POM have no such theoretical limit

Questions

- Is C from prairie going into unprotected or protected stocks?
- Do chemically or physically stable C pools change significantly over time?
- Is C stabilization on silt/clay enhanced by cation concentration or iron oxides?

Soil Fraction	Origin	Stabilization Mechanism	Mean Residence Time ^{1, 2, 3}
Silt/clay-Associated OM	Plant/Microbial	Chemical	100+ years
Microaggregate Occluded POM	Plant	Physical	100+ years
Unprotected POM	Plant	None	Less than 5 years

Implications

- Understanding C cycling in reconstructed prairies may help us understand why there is a large discrepancy between their remnant counterparts
- This may in turn help identify ways of management that would increase C storage in these reconstructions
- In addition, if prairies are placed back into cultivation, estimates of C lost can be very important to policymakers and ecosystem modelers

Data

Figure 1.1

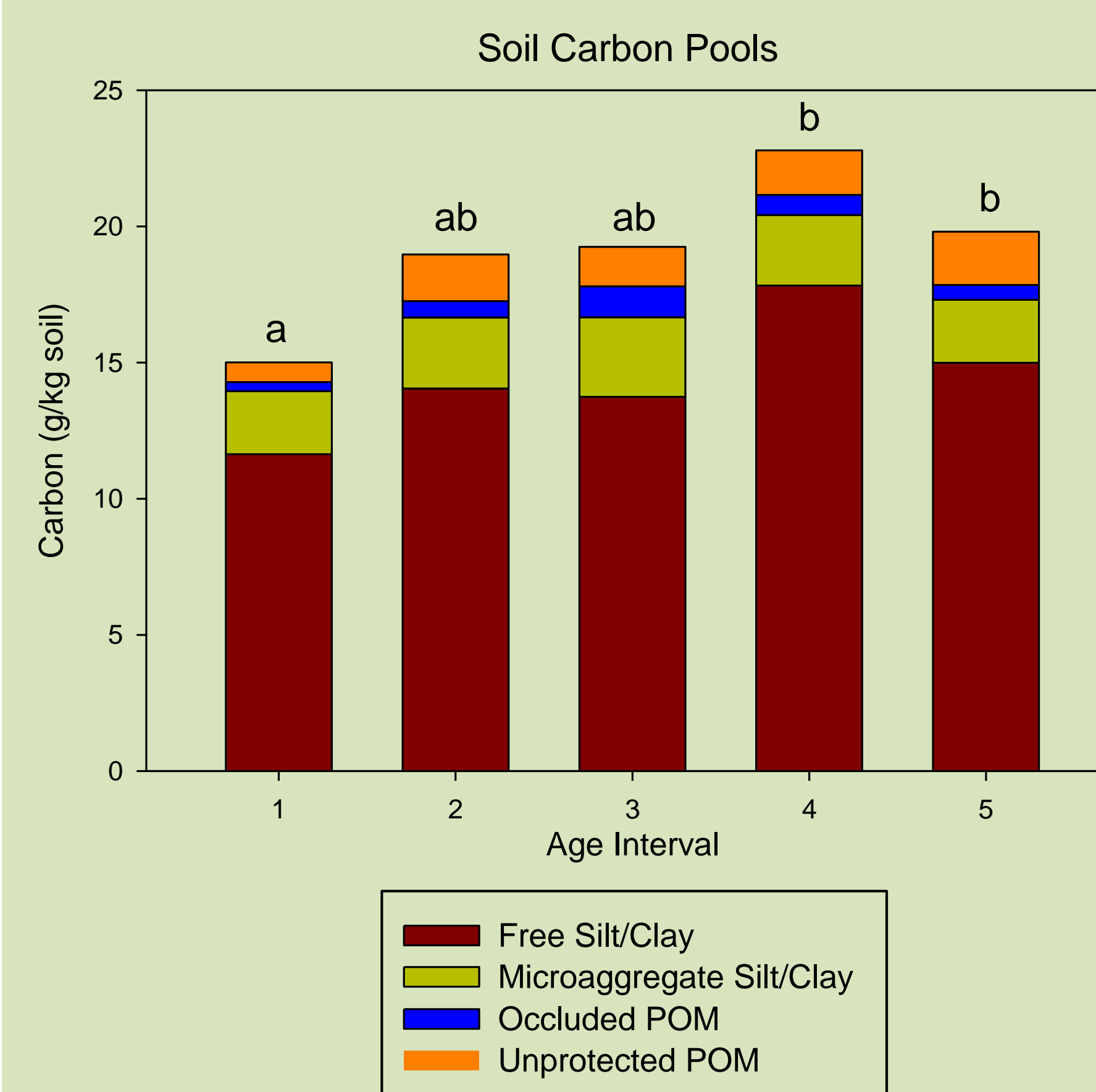


Table 1.1

Age Interval	# of Replicate Prairies	Prairie Age
1	3	1-3 years
2	4	6 years
3	4	11-12 years
4	4	17 years
5	4	21 years

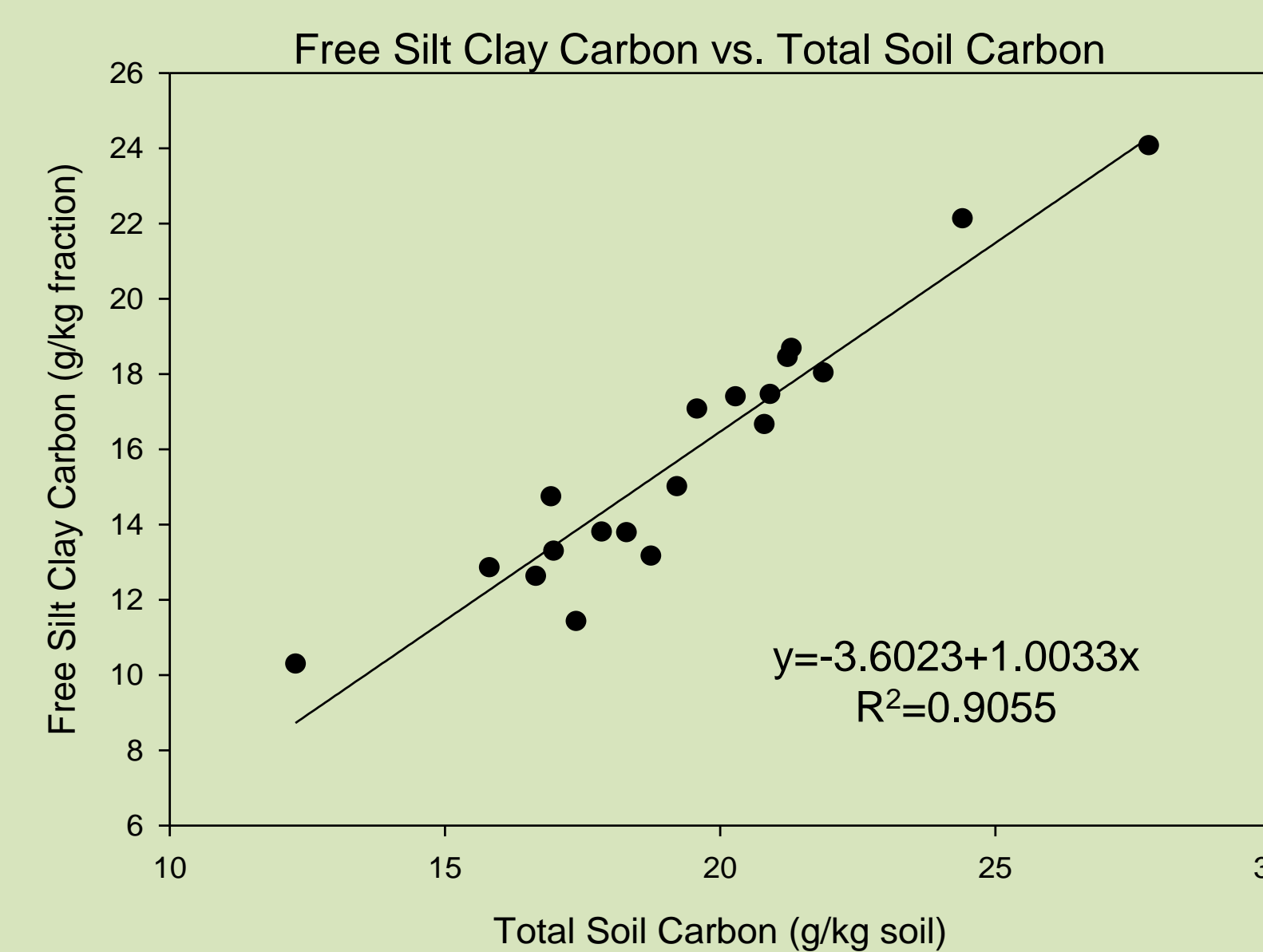


Figure 1.2

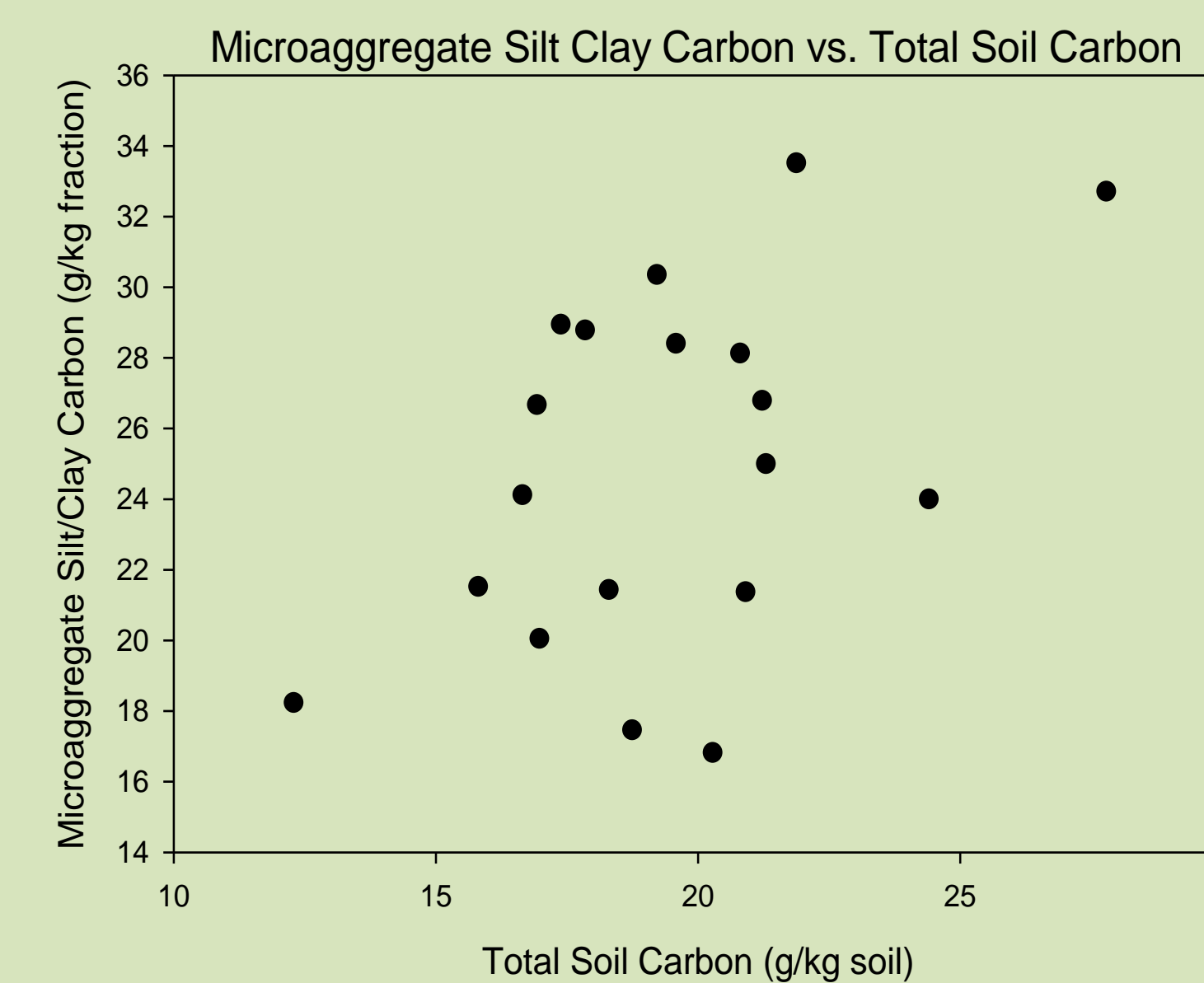


Figure 1.3

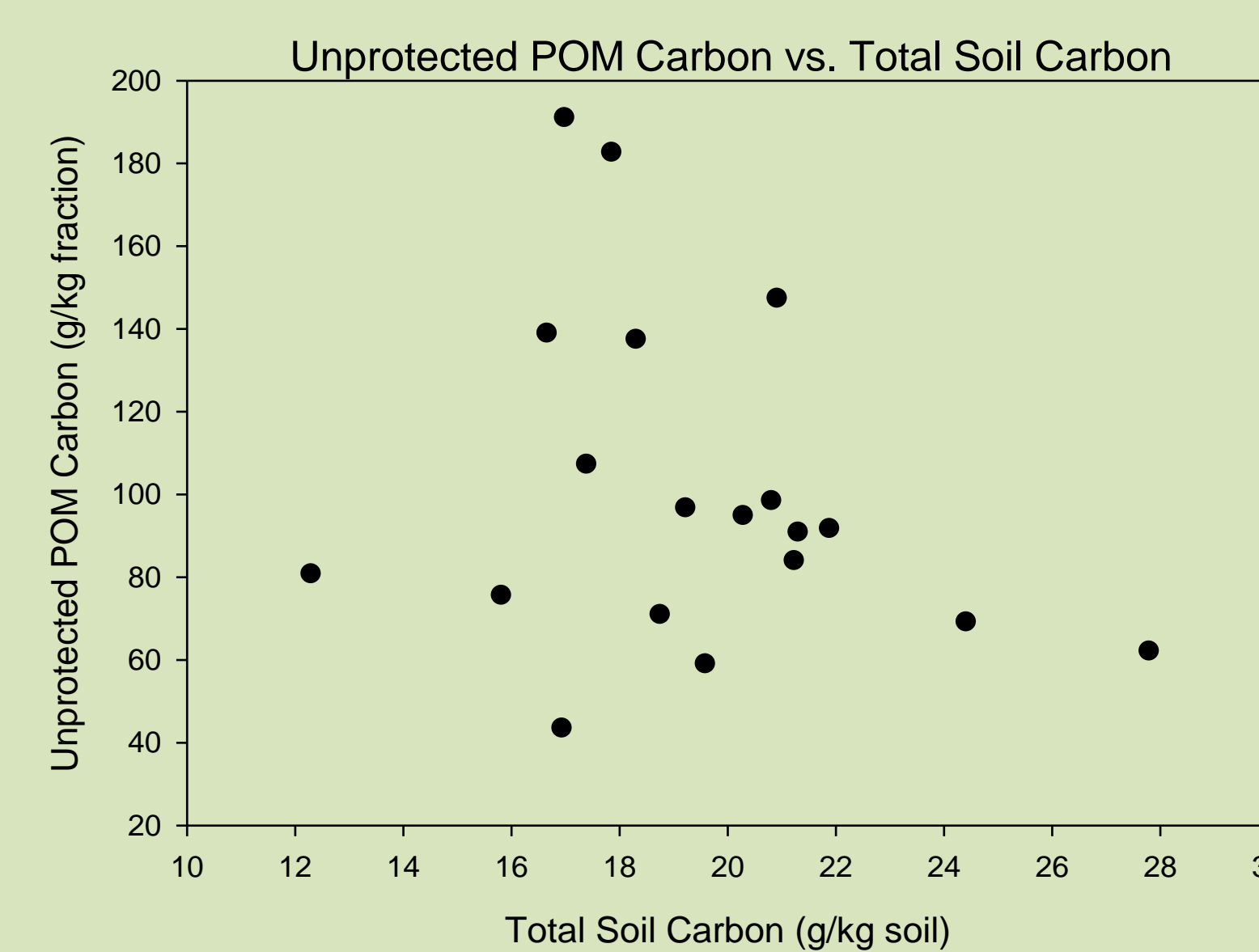


Figure 1.4

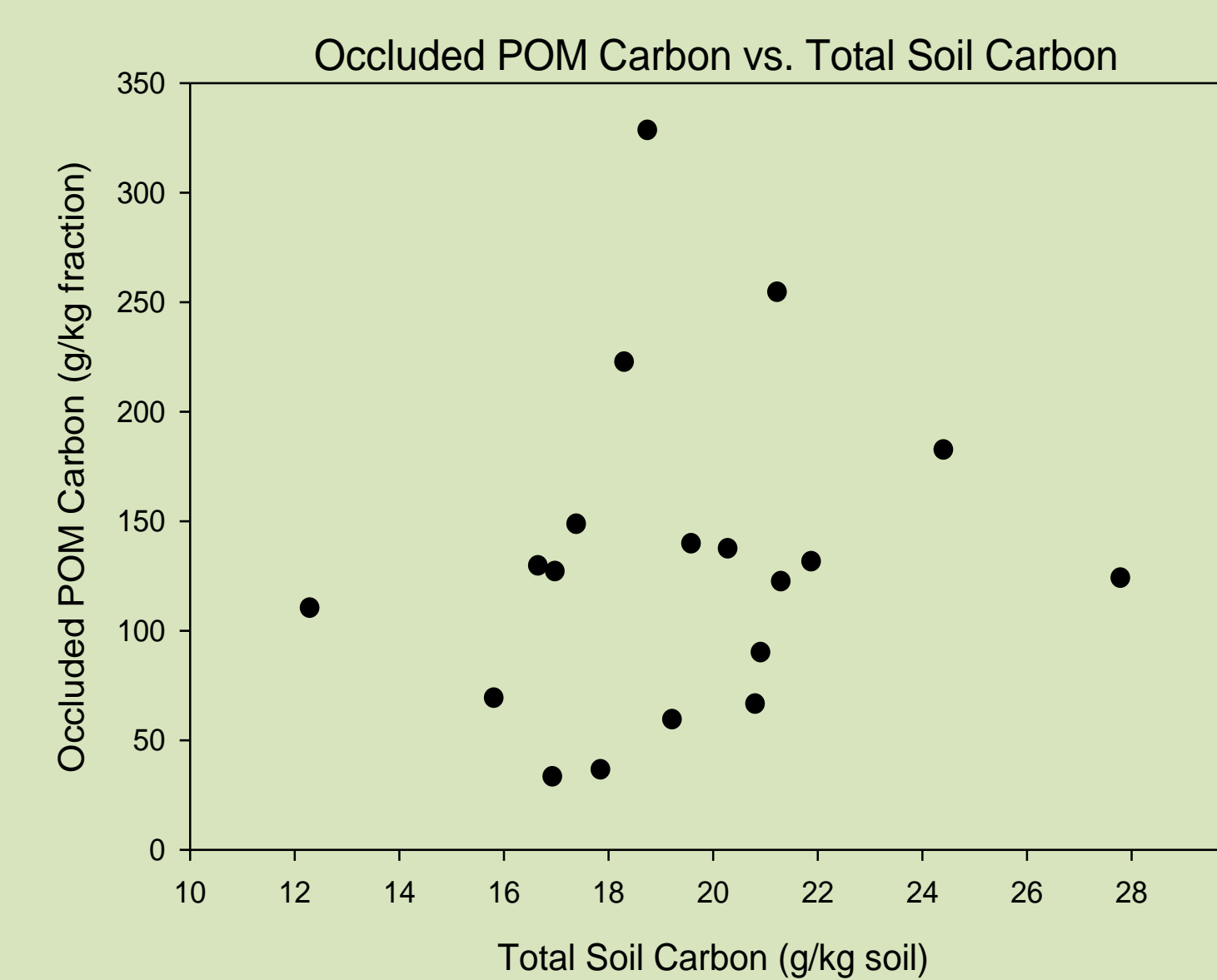


Figure 1.5

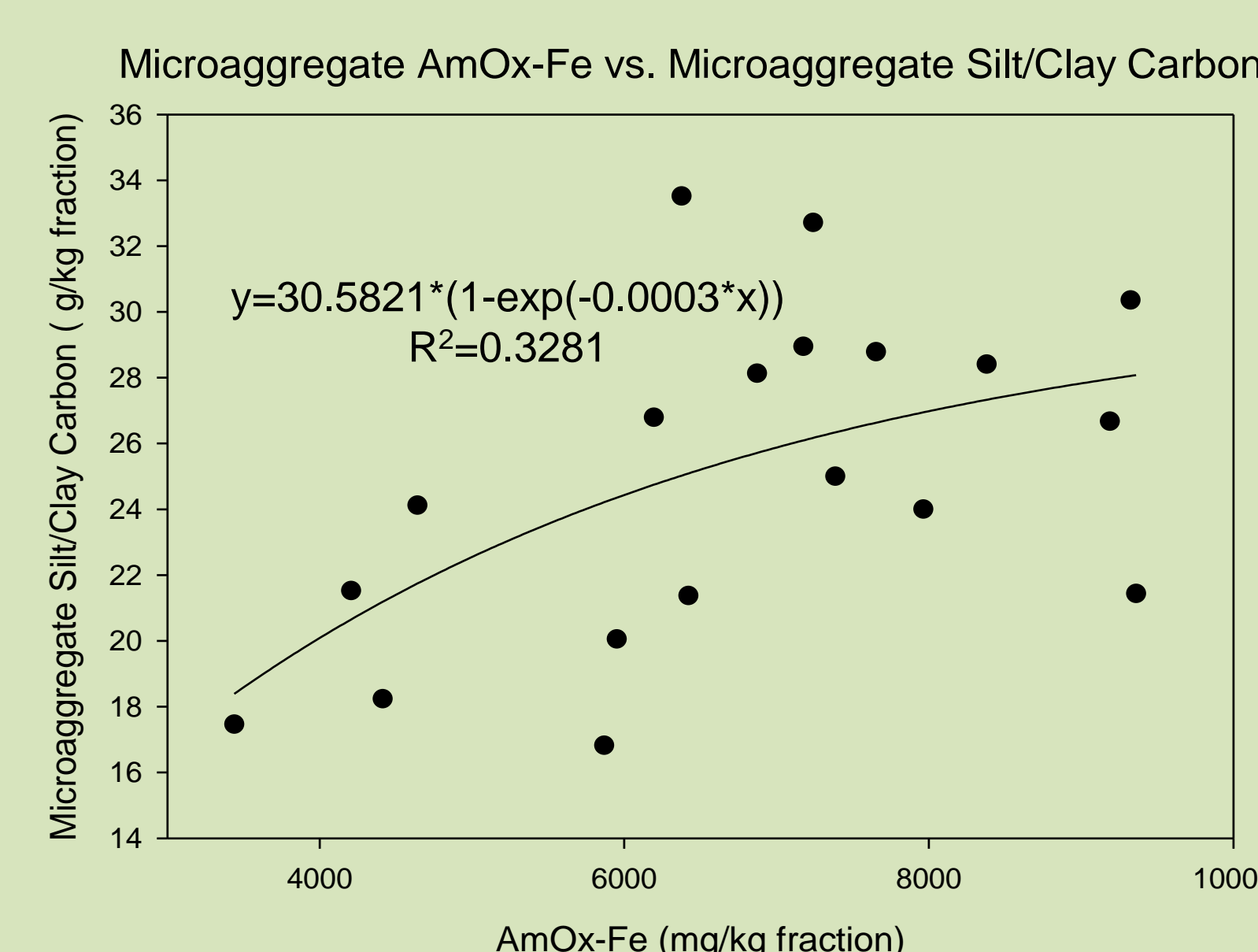


Figure 1.6

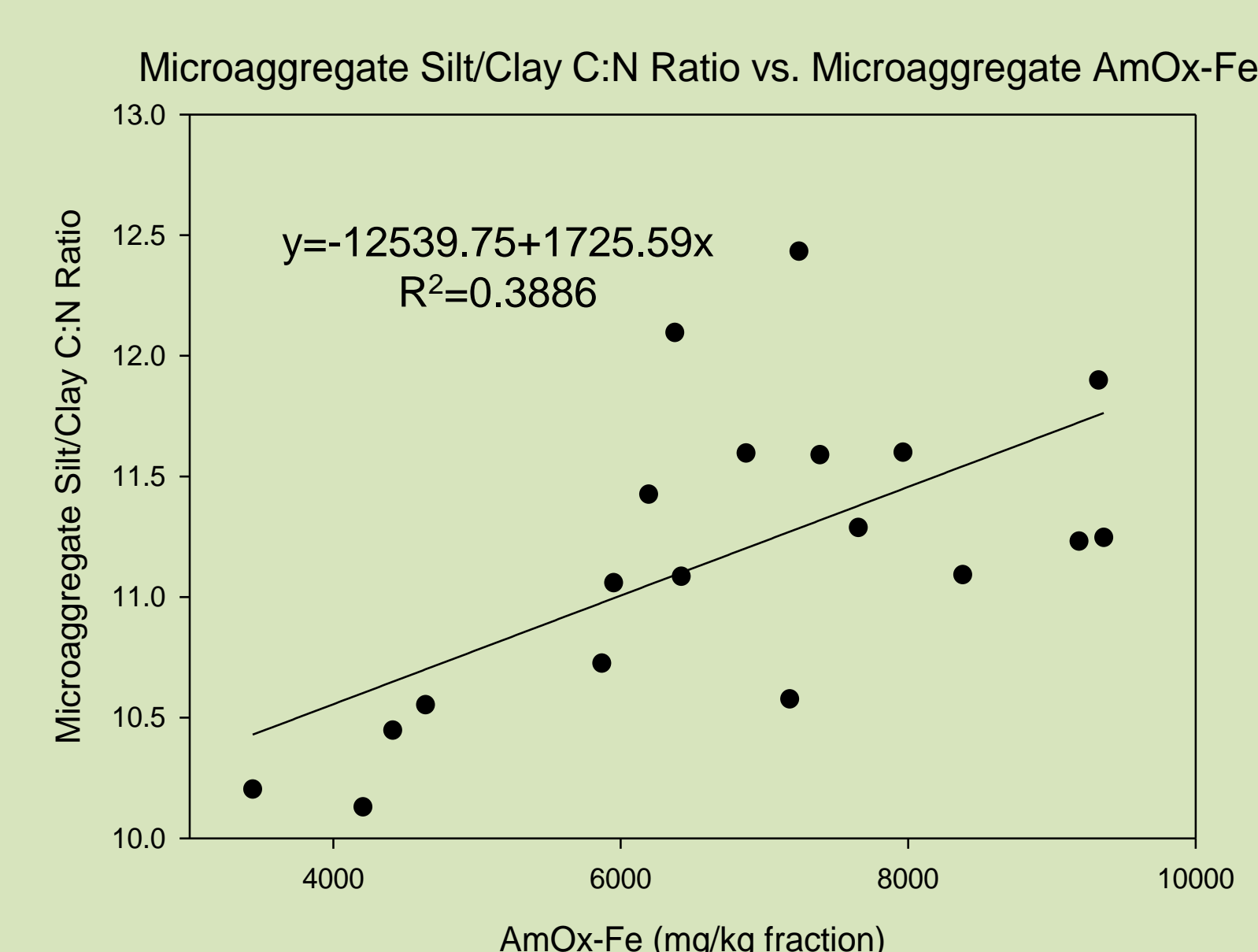


Figure 1.7

Method

- 19 prairie plots with similar clay content, landscape position, and drainage class were sampled at Neal Smith Wildlife Refuge in Prairie City, Iowa (Table 1.1)
- Soils were sampled to a 0-15 cm depth
- Stable and unprotected soil pools were separated with physical fractionation
- Total N and C were found via dry combustion
- Polyvalent cations were extracted via 1 M ammonium acetate solution while non-crystalline iron was estimated using 0.2 M ammonium oxalate

Discussion and Conclusion

- Total C increased non-linearly across the chronosequence but was variable (Figure 1.1)
- Silt/clay outside of microaggregates was responsible for most of the gains of C observed (Figure 1.2)
- Physically protected pools did not change significantly under 21 years of prairie nor were predictive of total C (Figures 1.1, 1.3, 1.5)
- Polyvalent cation concentration had no effect across chronosequence C with any soil fraction
- Although ammonium oxalate extractable iron (AmOx-Fe), did not change with time, there were C and C:N relationships with microaggregate silt/clay fractions (Figure 1.6, 1.7)

Future Work

- Are there biotic or abiotic disturbances taking place in prairie that prevent physically protected C from accumulating?
- AmOx-Fe's effects on physically protected pools are not well studied in Midwestern soils. While not showing major effects on total C, larger AmOx-Fe concentrations on microaggregate silt/clay could represent more plant influenced OM that is protected

Acknowledgements

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Works Cited

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