☒ **Talk** ☐ **Poster**

Using X-ray computed tomography to examine the recovery in soil aggregate pore structure during prairie restoration

James B. O'Sullivan[1] Kenneth Kemner[2], Max Boyanov[2,3], Sarah O'Brien[4], Kelly Sturner[2], Julie D. Jastrow[2]

[1]*X-ray Science Division, Argonne National Laboratory, Lemont IL*
[2]*Environmental Science Division, Argonne National Laboratory, Lemont IL*
[3]*Biosciences Division, Argonne National Laboratory, Lemont IL*
[4]*Institue of Chemical Engineering, Bulgarian Academy of Sciences, Sofia 1113*
[5] *Office of the Vice Chancellor for Research, University of Illinois Chicago, Chicago IL*
[6]*Department of Biological Sciences, University of Illinois at Chicago, Chicago IL*

Author Email: osullivanj@anl.gov

The physical structure of soil aggregates regulates many soil processes, including organic matter protection. Micron-scale pores within water-stable aggregates can physically occlude organic matter, potentially slowing decomposition rates. However, agricultural practices disrupt these pore networks, and their recovery during ecosystem restoration is not well understood. Here, we used high-resolution X-ray computed tomography to examine the internal pore architecture and particulate organic matter content of 1-2 mm aggregates from three systems: remnant tallgrass prairie, conventional agriculture, and prairie restored for 30 years. Soils from the Drummer series (fine-silty, mixed, superactive, mesic Typic Endoaquolls) were sampled from a prairie restoration chronosequence at Fermilab in Batavia Illinois [1]: a cultivated soybean field (annually rotated with corn), a 30-year-old restored prairie on formerly agricultural land, and a never-tilled remnant prairie. Soil samples were collected from 0-5 cm depth, homogenized by passing through an 8-mm sieve, and dried at 65°C. Water-stable aggregates 1-2 mm were isolated and subjected to X-ray computed tomography at 1.5 μm resolution at the Advanced Photon Source. Pores and particulate organic matter were segmented using a random forest classifier. Visible porosity >3 μm, pore size distribution, and gamma factor (pore connectivity indicator) were determined. We found that soil carbon in the restored prairie increased by 56% compared to conventional agriculture, though it would need to increase another 84% to reach remnant prairie levels. Interestingly, 1-2 mm aggregates showed no significant differences in visible porosity or pore connectivity between remnant and restored prairies, suggesting pore characteristics had stabilized with prairie establishment [2]. The agricultural field showed both lower porosity (5%) and reduced pore connectivity (20%) relative to the remnant prairie, with 15% greater proportion of 3–6 μm pores. Particulate organic matter occupied 4.6% of aggregate volume in remnant prairie, but only 2.9% in restored prairie and 2.3% in conventional agriculture, indicating POM recovery lagged behind pore structure recovery. These findings suggest through the use of X-ray computed tomography, that while internal pore architecture recovers relatively quickly during prairie restoration, likely facilitated by fungal hyphae and root-derived inputs [3], particulate and mineral-associated organic matter accumulation requires longer timescales. Future work could utilize additional imaging techniques such as dual-energy X-ray computed with contrast agents or X-ray scattering tomography to attempt to identify where in the aggregates organic-rich regions accumulate.

References

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