Controls of soil organic matter degradability in thawing Holocene permafrost deposits in the Lena delta, Russia

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Methods

Objective

- Determine soil organic matter (SOM) degradability in permafrost deposit
- Identify controls of SOM degradability in Holocene deltaic permafrost
- Estimate soil organic carbon (SOC) loss from OM degradation during thaw

Background

- SOM degradation leads to greenhouse gas release - CH4, CO2, and N2O
- As Permafrost thaws, previously frozen SOM is available for microbial degradation
- Permafrost is thawing at an accelerated rate
- Additional gas release may "tip the scale" towards irreversible, severe climate change

Methods

- 4C signal of bulk SOC
- Elemental Analysis of Bulk SOM (C, N, S)
- Extractable SOM (C, N)
- Basal Respiration
  - 5 g fresh thawed soil, Duplicates
  - 20 °C, 5 Days, Oxygen atmosphere
- Total Neutral and Phospho- Lipid Fatty Acid Concentration (NLFAs or PLFAs)
- External Contract Lab: Microbial ID
- Modified Bligh-Dyer Extraction

Results

- Active zone: ↑ PLFA, ↓ Respiration Rate
- Frozen Soils: ↑ PLFA, ↑ Respiration Rate
- Where C:N Ratios and NLFA peak, we observe peaks in Respiration Rates
- Areas of higher C:N ratios – less degraded OM, but C:N of profile within average permafrost range
- Low extracted C:N ratios suggest mostly microbial origin

Whole Profile Correlations (Spearman’s R)

<table>
<thead>
<tr>
<th></th>
<th>% TOC</th>
<th>C:N</th>
<th>% WC</th>
<th>Resp.</th>
<th>PLFA</th>
<th>NLFA</th>
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<tbody>
<tr>
<td>C:N</td>
<td>0.80***</td>
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<tr>
<td>% WC</td>
<td>0.56**</td>
<td>0.59**</td>
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<tr>
<td>Resp.</td>
<td>0.63***</td>
<td>0.57**</td>
<td>0.94***</td>
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<td>PLFA</td>
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<td>0.33</td>
<td>0.04</td>
<td>0.16</td>
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<tr>
<td>NLFA</td>
<td>0.81***</td>
<td>0.58**</td>
<td>0.68***</td>
<td>0.77**</td>
<td>0.45</td>
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Significance: *** = p < 0.001; ** = p < 0.01; * = p < 0.05

Future Work

- Analysis of Fe and Mn along profile
- Pre-Post-Respiration NLFA/PLFA analysis
- Specific lipid analysis (alkanes, alcohols, phospholipid ether lipids)

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This work would not be possible without help from the technicians in the AG Rethemeyer and AG Bonkowski laboratories, thank you! Samples were collected in 2014 by Stephen John. A special thanks also to my co-authors for their guidance and time.

References
