

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

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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

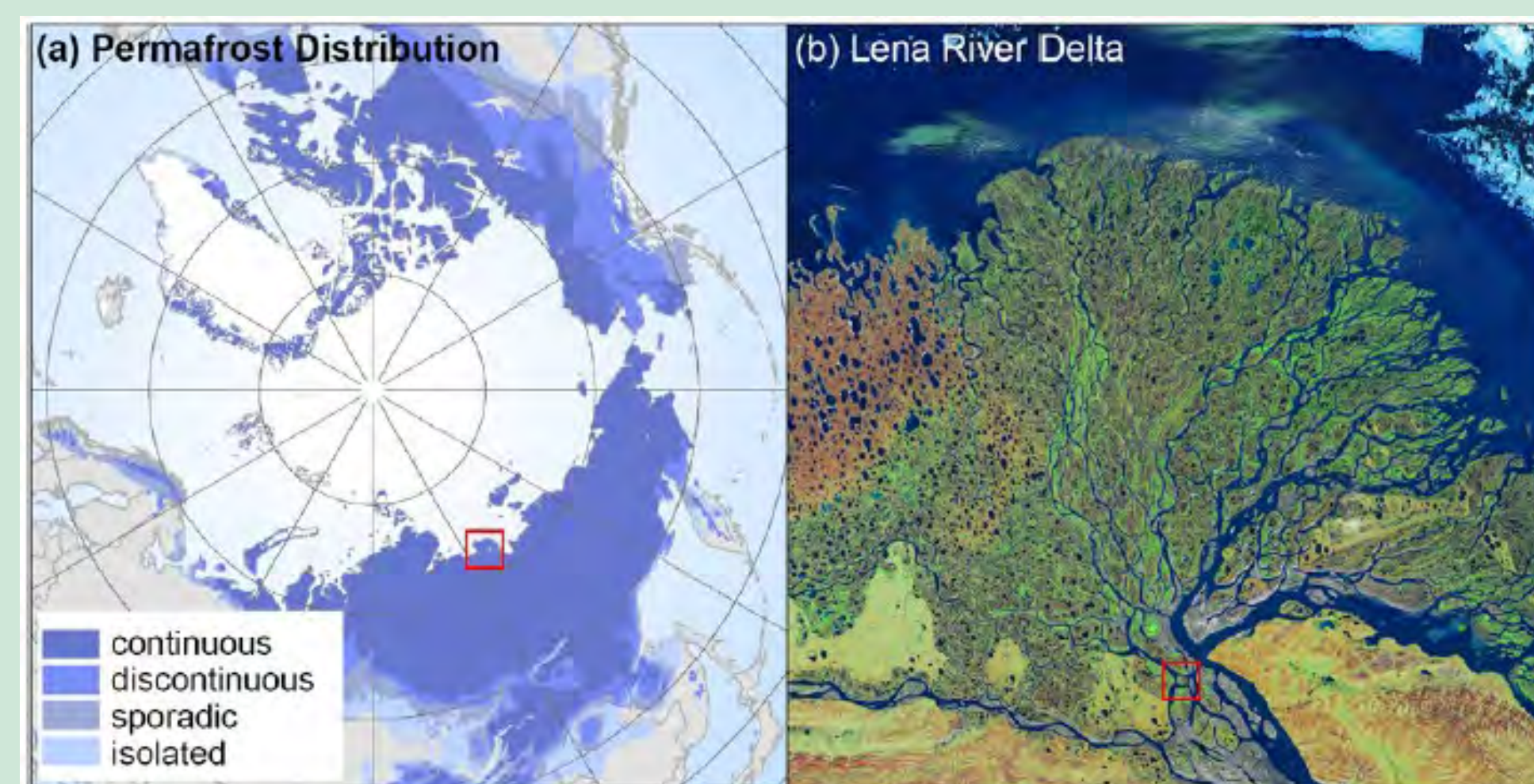


Image from Boike et al (2013), showing distribution of arctic permafrost and the Lena River Delta. The red squares indicate the location of Samoylov Island

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

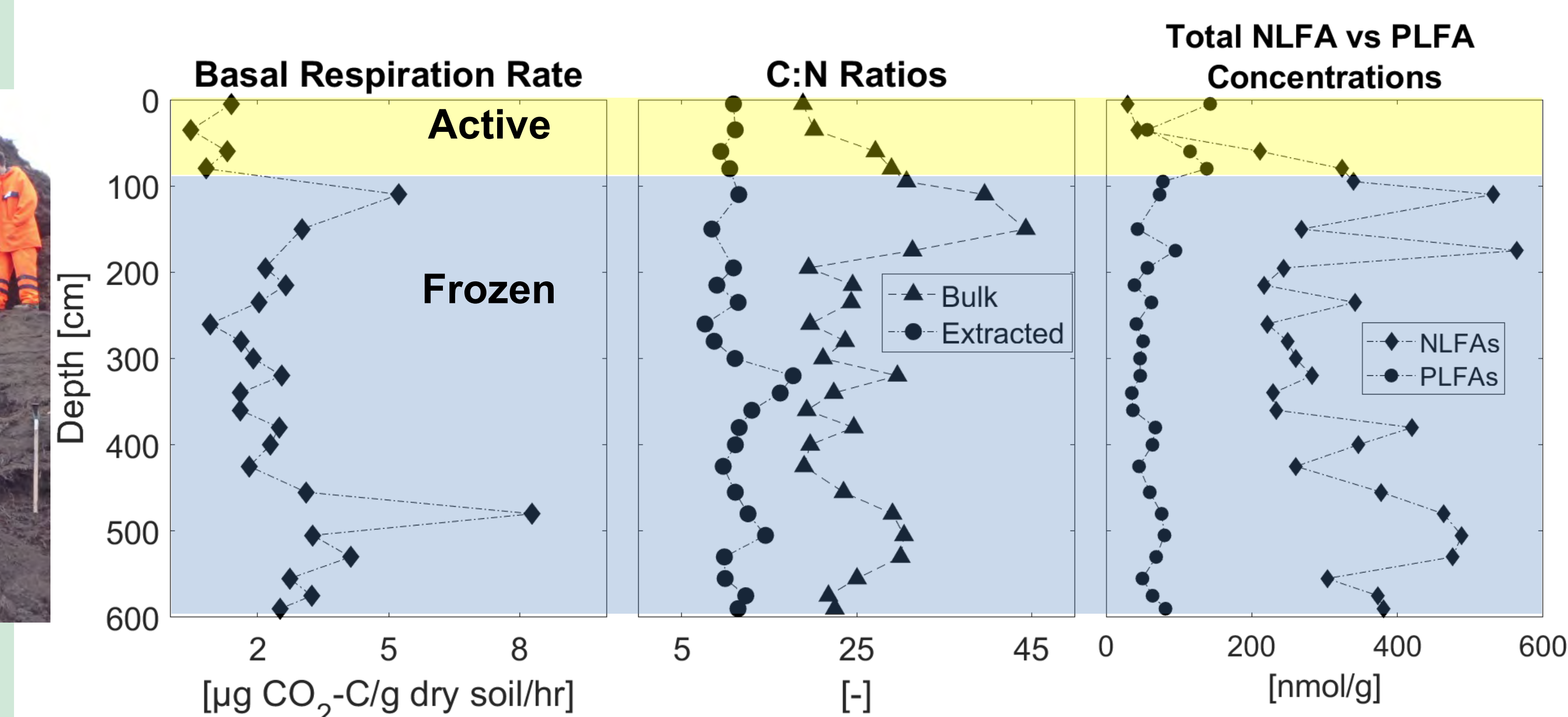
- ¹⁴C signal of bulk SOC
- Elemental Analysis of Bulk SOM (C, N, S)
- Extractable SOM (C, N)
- Basal Respiration
 - 5 g fresh thawed soil, Duplicates
 - 20 °C, 5 Days, Oxygen atmosphere
- Total Neutral and Phospho- Lipid Fatty Acid Concentration (NLFAs or PLFAs)
 - External Contract Lab: Microbial ID
 - Modified Bligh-Dyer Extraction

Methods Continued

- PLFAs: a proxy for viable microbial biomass
- NLFAs consist of Eukaryotic storage lipids and partially degraded microbial biomass
- C:N Ratio: Proxy for state of degradation
 - (8 = fully degraded, 90 = Undegraded leaf litter, range most permafrost = 10 - 50)

Results

- Active zone: ↑ PLFA, ↓ Respiration Rate
- Frozen Soils: ↓ PLFA, ↑ NLFA, ↑ 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



- **Respiration very strong correlation with %WC.**
- **NLFA strong correlation with Respiration and % TOC**
- **NLFA and PLFA moderately correlated**
- Suggests that initial respiration not dependent on extent of total viable microbial community

Whole Profile Correlations (Spearman's R)						
	% TOC	C:N	% WC	Resp.	PLFA	NLFA
C:N	0.80***					
% WC	0.56**	0.59**				
Resp.	0.63***	0.57**	0.94***			
PLFA	0.63***	0.33	0.04	0.16		
NLFA	0.81***	0.58**	0.68***	0.77***	0.45*	

Significance: *** = p < 0,001; ** = p < 0,01; * = p < 0.05

Summary

Average SOM degradation state (via C:N) is in range of other arctic permafrost deposits

- Schädel et al (2014) found that a majority of permafrost soils had C:N ratios of 10 - 50

Regions of lower degradation (higher C:N) support higher respiration rates upon thaw

Basal respiration not correlated to total viable microbial community (via PLFAs)

- Suggests that conditions at time of deposition more important (NLFAs, C:N, %WC)

Basal respiration strongly correlated to % WC and total NLFAs

- Suggests Eukaryotic storage lipids and partially degraded microbial lipids are easily digestible for viable microbial community upon thaw

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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