Sources and age of terrigenous organic matter exported from the Lena River watershed, NE Siberia

Maria Winterfeld\textsuperscript{1,2}, Miguel Goñi\textsuperscript{3}, Janna Just\textsuperscript{4}, Jens Hefter\textsuperscript{2}, Shuwen Sun\textsuperscript{2}, Pai Han\textsuperscript{2} & Gesine Mollenhauer\textsuperscript{1,2}

\textsuperscript{1}Alfred Wegener Institute, Germany; \textsuperscript{2}University of Bremen, Germany; \textsuperscript{3}Oregon State University, USA; \textsuperscript{4}MARUM, Germany
Motivation

Composition of modern exported POM?
Can it serve as baseline for future changes in the catchment?
Lena River catchment

catchment: $\sim 2.5 \times 10^6$ km$^2$
discharge: 588 km$^3$ (1999-2008)

- strong seasonality of discharge
- $\rightarrow$ spring freshet end of May/early June with $\sim 50\%$ of annual sediment, DOC, and POC export

sources: www.arcticgreatrivers.org; Holmes et a. 2002, 2012; Roshydromet
Sources of POM – Approach

1. Lignin phenols

2. POM $^{14}$C

- Holocene (recent to $10^3$ yrs)
- Late Pleistocene ($10-40*10^3$ yrs)
Sources of POM – Approach

1. Lignin phenols
2. POM $^{14}$C

How big is the contribution from taiga & tundra in exported POM?

How old is soil-derived POM from the Lena catchment?
Sampling locations

- Holocene soil profiles
- Pleistocene soil profile
- suspended matter 2009-2011
- surface sediments
Lignin phenols – sources of POM

Syringyl/Vanillyl

Cinnamyl/Vanillyl

woody angiosperm

non-woody angiosperm
(e.g. grasses, leaves)

non-woody gymnosperm
(e.g. needles)

Holocene soil profiles
Pleistocene soil profile
suspended matter 2009-2011
surface sediments
unpublished

Tesi et al., 2014

Winterfeld et al., 2015a
Lignin phenols – sources of POM

~50% contribution from taiga and tundra

Winterfeld et al., 2015a
Lignin phenols – sources of POM

- Woody angiosperm
- Non-woody angiosperm (e.g. grasses, leaves)
- Non-woody gymnosperm (e.g. needles)

Holocene soil profiles:
- <63μm
- 63μm - 2mm
- >2mm

unpublished data
Lignin phenols – sources of POM

- Woody angiosperm
- Non-woody angiosperm (e.g. grasses, leaves)
- Woody gymnosperm

Syringyl/Vanillyl vs. Cinnamyl/Vanillyl

Holocene soil profiles:
- <63μm
- 63μm - 2mm
- >2mm

unpublished data
Lignin phenols – degradation

[Graph showing data points for Acid/Aldehyde ratio]

- More degraded samples are plotted higher on the graph.
- Fresh tissue is plotted lower on the graph.

Legend:
- Holocene soil profiles
- Pleistocene soil profile
- Suspended matter 2009-2011
- Surface sediments
- Unpublished surface sediments
- Tesi et al., 2014

Acid/Aldehyde ratio:
- Ad/Al:Vanillyl
- Ad/Al:Syringyl

Note: The graph depicts the degradation of lignin phenols with the x-axis representing Acid/Aldehyde ratio and the y-axis representing another Acid/Aldehyde ratio.
Lignin phenols – degradation

Acid/Aldehyde<sub>Syringy</sub>

Acid/Aldehyd

Holocene soil profiles
- <63μm
- 63μm - 2mm
- >2mm

Pleistocene soil profile

suspended matter

2009-2011

surface sediments

more degraded

fresh tissue

more degraded

fresh tissue
Lignin phenols – degradation

Acid/Aldehyde

more degraded

Acid/Aldehyde

more degraded

Holocene soil profiles
- <63μm
- 63μm - 2mm
- >2mm

Pleistocene soil profile

suspended matter

2009-2011

surface sediments

fresh tissue

fine

coarse

fresh tissue
$^{14}C$ age of POM

**surface water**
- particulate organic matter

**surface sediment**
- particulate organic matter

<table>
<thead>
<tr>
<th>$\Delta^{14}C$ [‰]</th>
<th>$^{14}C$ age [years BP]</th>
</tr>
</thead>
<tbody>
<tr>
<td>-150</td>
<td>1,250 yrs BP</td>
</tr>
<tr>
<td>-100</td>
<td>1,730 yrs BP</td>
</tr>
<tr>
<td>-500</td>
<td>2,800 yrs BP</td>
</tr>
<tr>
<td>-400</td>
<td>4,050 yrs BP</td>
</tr>
<tr>
<td>-300</td>
<td>5,500 yrs BP</td>
</tr>
</tbody>
</table>

Winterfeld et al., 2015b
$^{14}$C age of POM

![Graph showing $\Delta^{14}$C and $\delta^{13}$C values.](image)

- Holocene soils
- Suspended matter 2009-2010
- Surface sediments

**Key Time Periods:**
- 1950 AD
- ~1,730 yrs BP
- ~4,050 yrs BP
- ~7,300 yrs BP
- ~12,930 yrs BP
- ~18,420 yrs BP

$\Delta^{14}$C [‰]

$\delta^{13}$C [%o]
Take home messages

1. Lignin phenols
   - ~50% contribution from taiga and tundra based on bulk data
   - POM sources (Holocene vs. Pleistocene) and/or particle size/density influence lignin composition

2. POM $^{14}$C
   - estimated $\Delta^{14}$C of soil derived POM reflects heterogeneity of permafrost soils in the catchment