

Metal and organic matter dynamics in permafrost environments

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Metal and organic matter dynamics in permafrost environments

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ARCTIC WEEK 2019

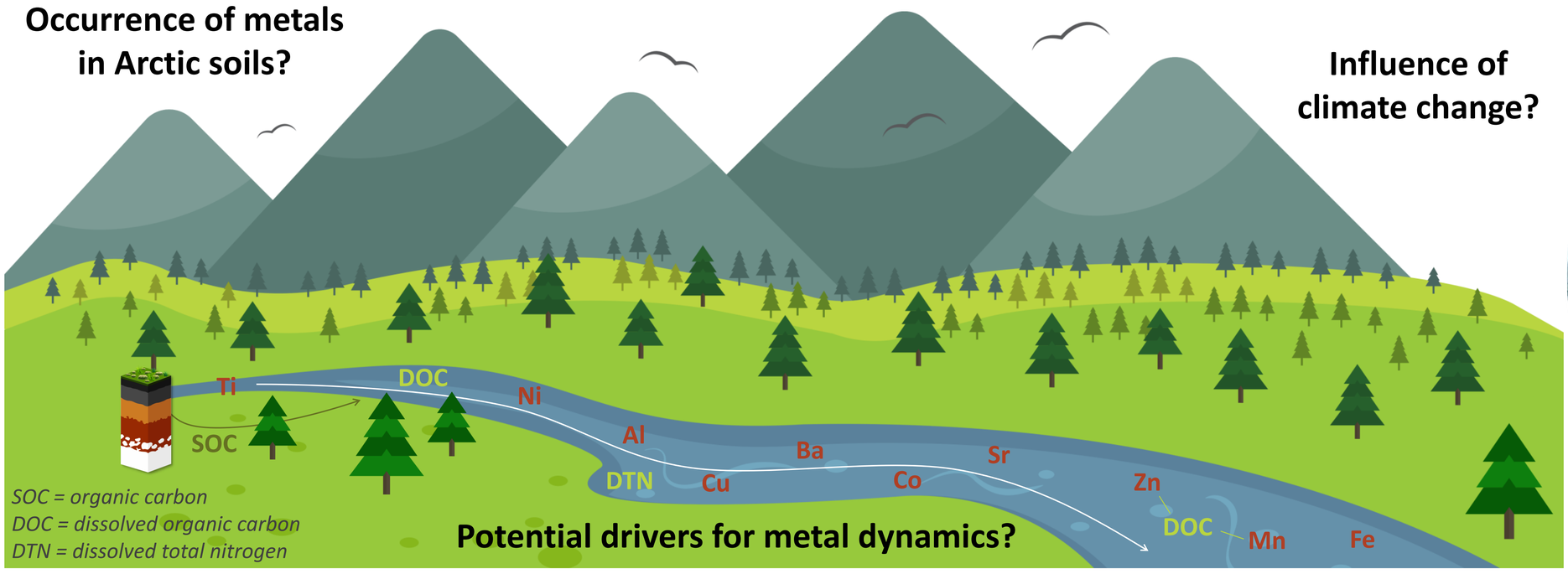
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CONTEXT

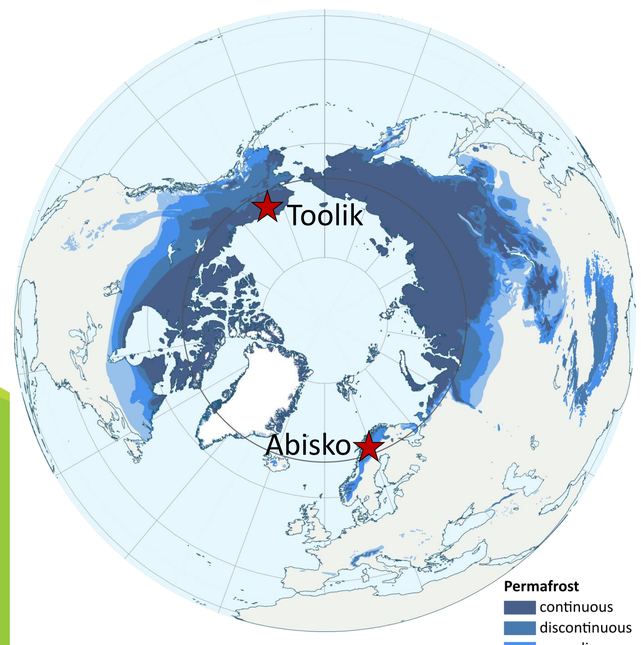
Occurrence of metals in Arctic soils?

Influence of climate change?



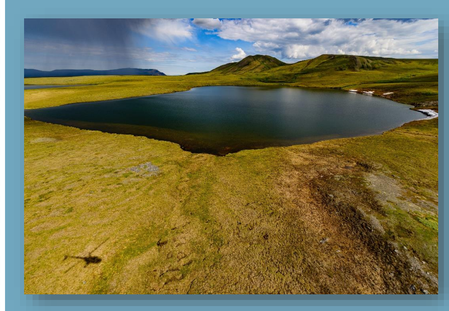
SOC = organic carbon
DOC = dissolved organic carbon
DTN = dissolved total nitrogen

Potential drivers for metal dynamics?

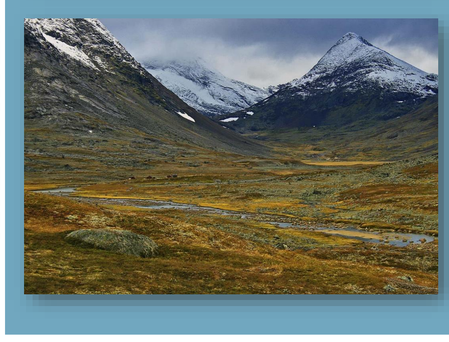


MATERIALS & METHODS

Comparison of two study areas

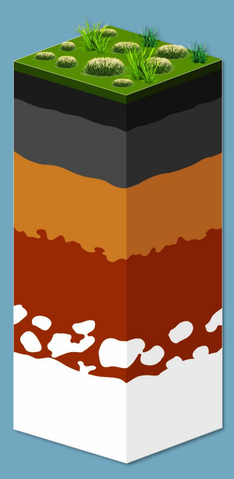


Toolik (AK, USA)
–8 °C
tundra ecosystem
continuous permafrost



Abisko (Sweden)
–0.8 °C
tundra and taiga ecosystems
discontinuous permafrost

Sampling and sample preparation



BULK FRACTION

extraction 0.25 mM $CaCl_2$

EXCTRACTABLE FRACTION

Chemical analysis

→ **Metals**
XRF / ICP–OES / ICP–MS

→ **Organic matter**
EA (C and N)
^{13}C NMR

→ **Metals**
ICP–OES / ICP–MS

→ **Organic matter (DOC and DTN)**
DOC analyzer

→ **pH_{CaCl2}**

RESULTS & DISCUSSIONS

BULK FRACTION

- Mineral soil horizons show higher metal concentrations than organic ones. Differences between Abisko and Toolik in mineral soil horizons result from distinct lithologies (*Fig. 1*).
- Concentrations do not show the same patterns between the two study areas in both horizons, indicating various inputs and dynamics of metals.

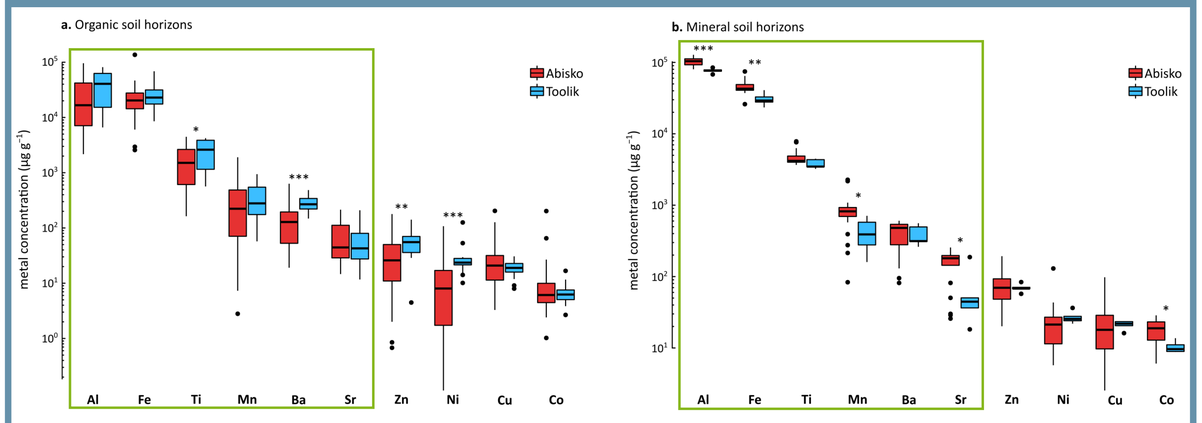


Fig. 1. *Metal concentrations in organic (**a**) and mineral (**b**) soil horizons.*
**p < 0.05, **p < 0.01, ***p < 0.001.*

EXCTRACTABLE FRACTION

- Extractability of metals ranged from <0.01 to >10‰ of soil total metal concentrations according to the considered soil horizon and metal (*Fig. 2*): extractability is higher in the organic soil horizons.
- Differences between Abisko and Toolik appeared for aluminum, titanium, and barium, indicating different transfer processes involved.

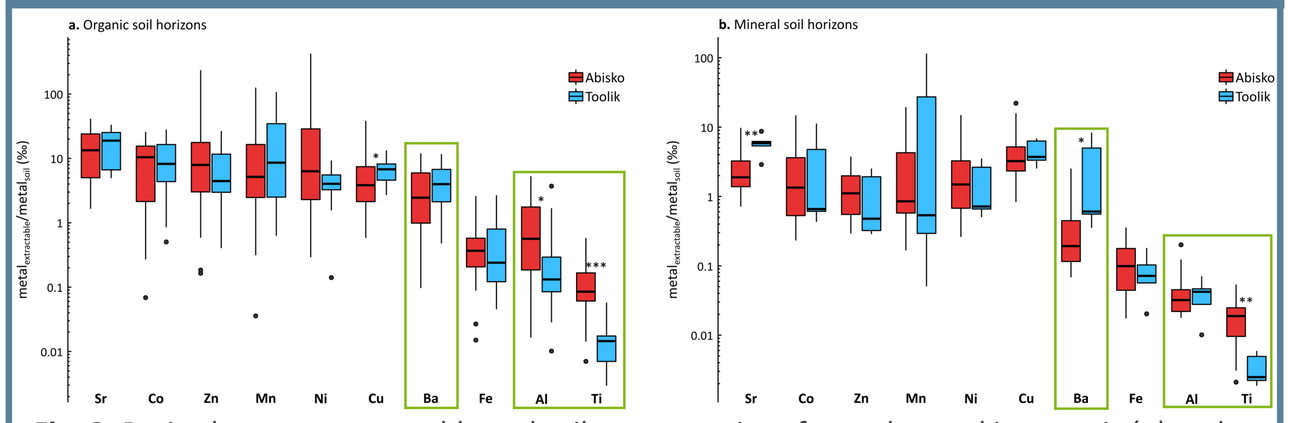


Fig. 2. *Ratios between extractable and soil concentrations for each metal in organic (**a**) and mineral (**b**) soil horizons.* **p < 0.05, **p < 0.01, ***p < 0.001*

ENVIRONMENTAL CONTROL

- DOC production is related to SOC quality based on distinct decomposition degrees (*Fig. 3a*) and likely on different decomposition processes (*Fig. 3b*).
- As illustrated for aluminum and titanium, metal extractability is directly related to SOC extractability (*Fig. 4*).
- Metal extractability is also related to either soil pH (aluminum) or study area characteristics (titanium) such as climate or permafrost conditions.

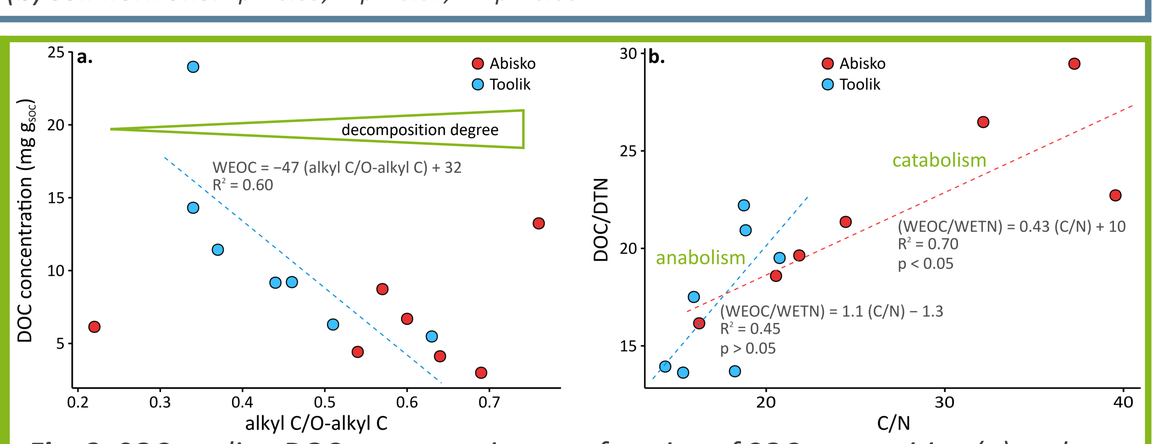


Fig. 3. *SOC quality: DOC concentration as a function of SOC composition (**a**) and DOC/DTN as a function of C/N (**b**).*

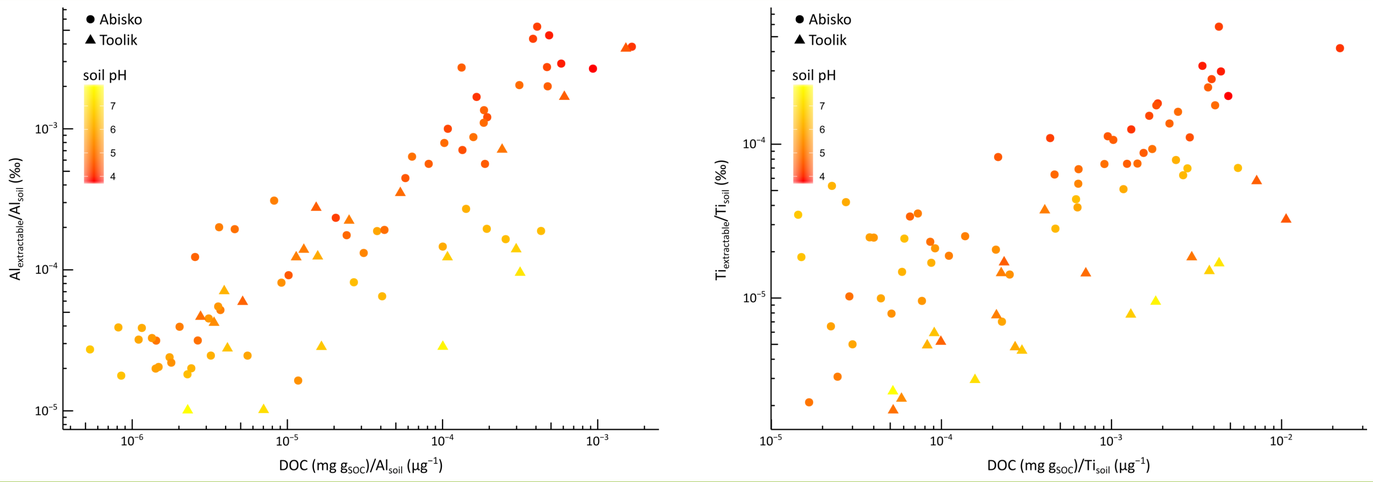


Fig. 4. *Aluminum and titanium extractability as a function of DOC quantity according to soil pH_{CaCl2} (color scale) and study area (shapes).*

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