Distribution of mineral constituents in Yedoma permafrost: implications for Yedoma formation and upon thawing

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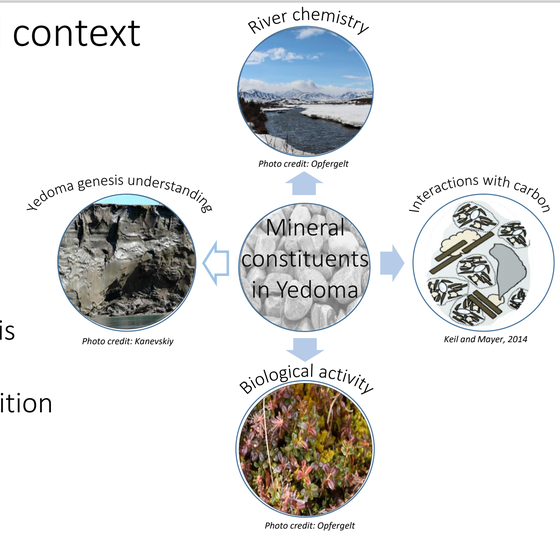
General context

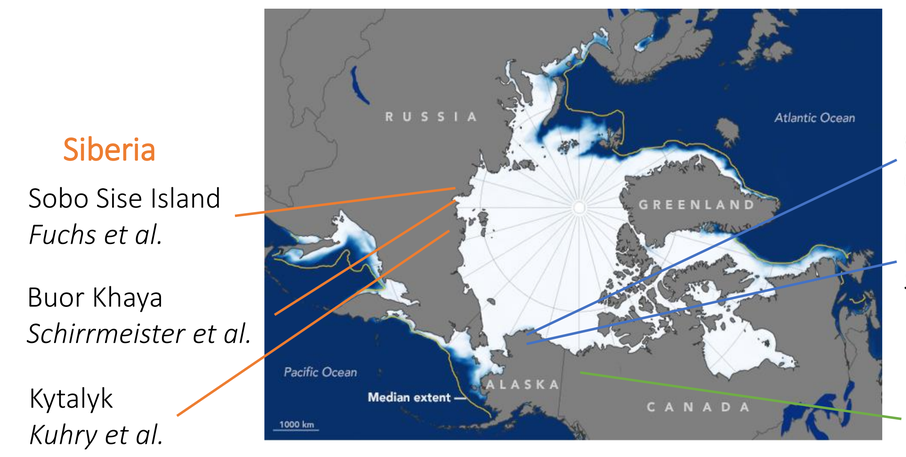
Yedoma deposits
- High sensitivity to thaw
- Deep remobilization of mineral material

Look at the mineral constituents reservoir
- Mineral distribution (complementary to previous carbon distribution studies)
- New information about the Yedoma genesis

Potential implications of such a mineral exposition
- River chemistry change
- Biological activity modifications
- Interactions with carbon



Study sites

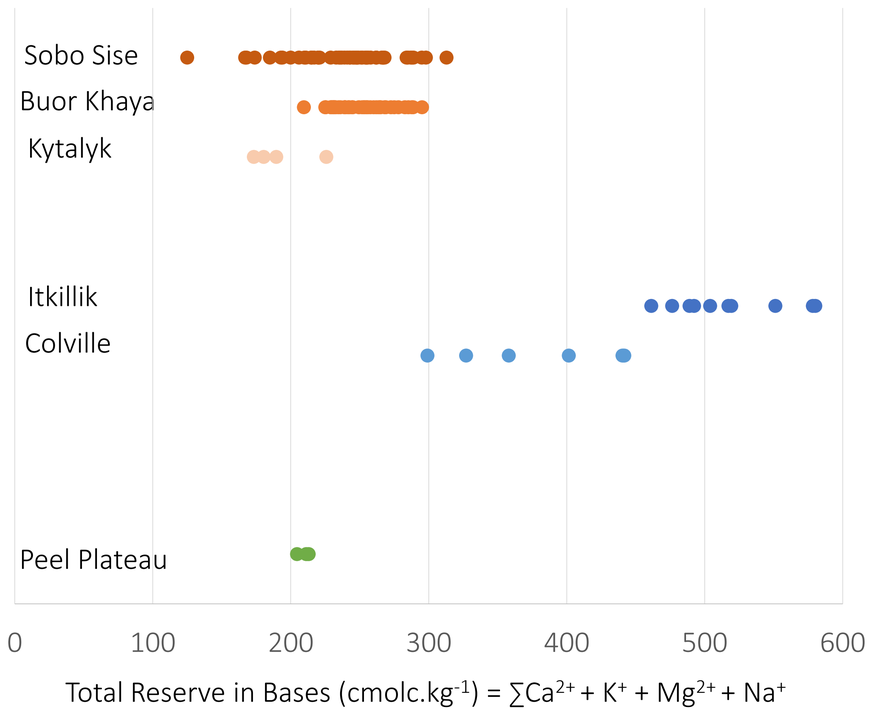


Siberia
Sobo Sise Island
Fuchs et al.
Buor Khaya
Schirrmeister et al.
Kytalyk
Kuhry et al.

Alaska
Colville river
Grosse et al.
Itkillik river
Strauss et al.

Canada
Peel Plateau
Vonk et al.

Chemical composition of Yedoma deposits



TRB range

Alaska TRB (*66% Ca; 21% Mg; 7% Mg; 6% Na*) > Siberia TRB (*30% Na; 26% Mg; 24% K; 20% Ca*)

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Specific mineral composition

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Specific parent material

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Local deposit sources

TRB variability

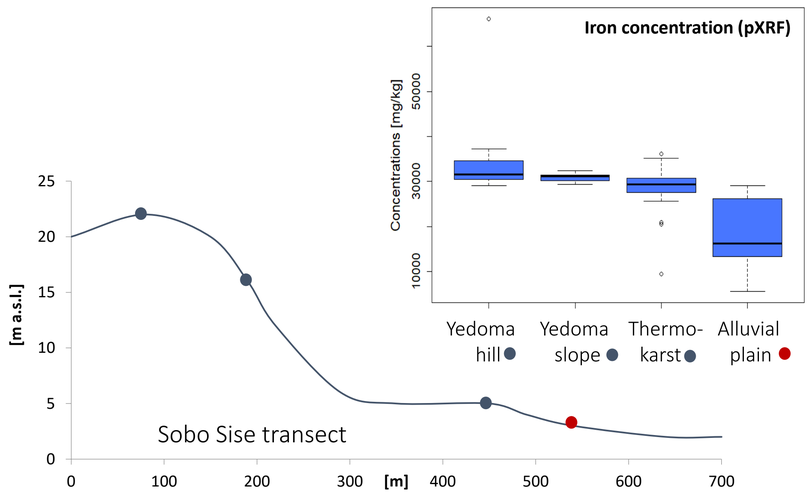
Higher variability in Alaska TRB

⇩

Hypothesis 1: Temporary changes in sources during deposition in Alaska

Hypothesis 2: Post deposition processes in Alaska

Along the « Yedoma transect » of Sobo Sise (Siberia), major changes in the alluvial plain ● :
- Chemical composition : Al, Mg, Fe ↘ (ICP-AES)
- Mineralogy : chlorite, illite, kaolinite ↘ (XRD analysis)
- Material redistribution : example with the lower and more heterogeneous iron concentration (pXRF)

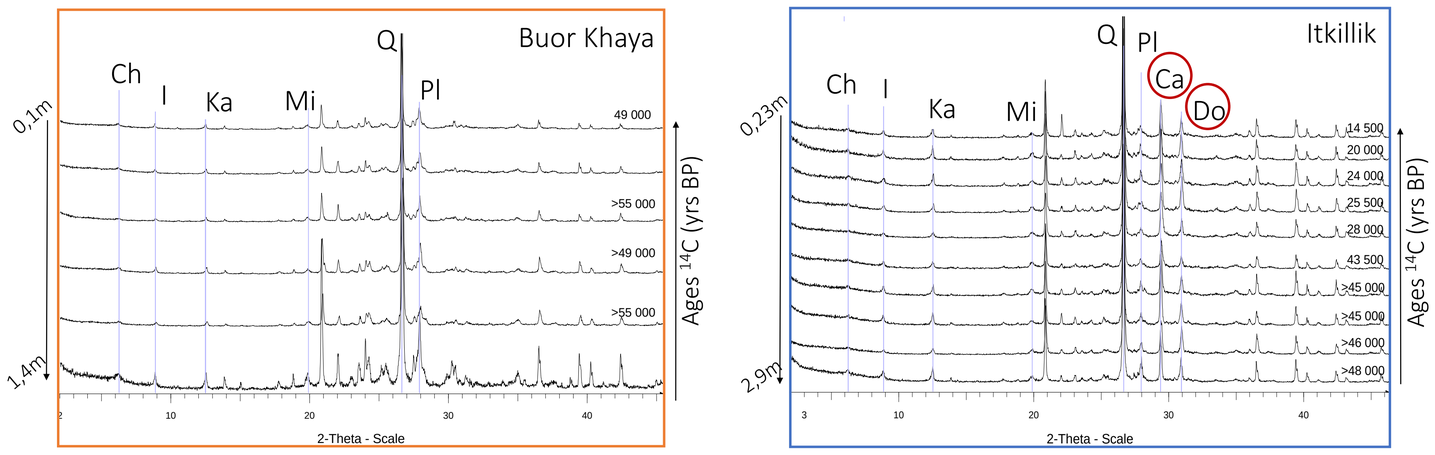


Mineralogy of Yedoma deposits

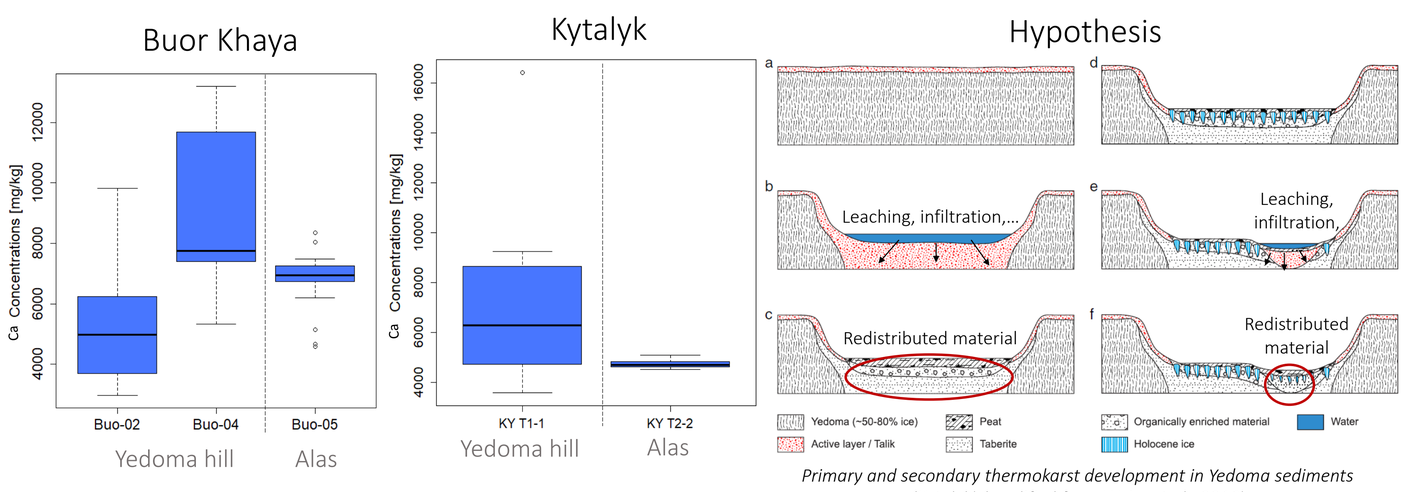
Minerals found in Yedoma deposits:
Chlorite (Ch), Illite (I), Kaolinite (Ka), Mica (Mi), Quartz (Q), Plagioclase (Pl), Calcite (Ca), Dolomite (Do)

Homogeneous mineral composition with depth, and hence with time
⇨ Local source of the fine-grained material in deposits

Presence of calcite and dolomite in Alaskan sites (linked to their high Ca contents)
⇨ Strong contribution of carbonates in Alaska, not in Siberia



Spatial redistribution of calcium during thermokarst process

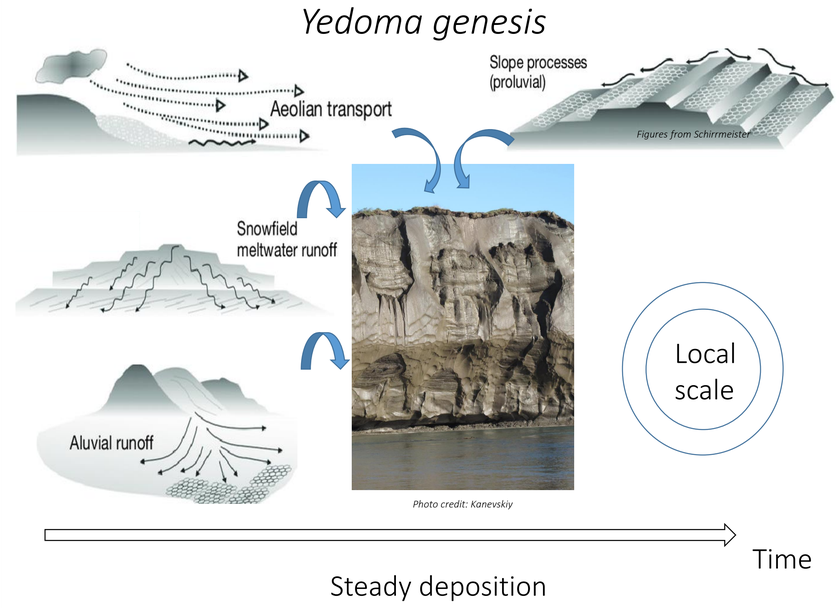


Primary and secondary thermokarst development in Yedoma sediments (Kytalyk) (modified from Weiss et al., 2016)

Observations
- Undisturbed Yedoma hill : heterogeneous calcium concentrations across Yedoma profiles
- Alas : calcium concentrations more homogeneous

⇨ Thermokarst mineral composition is not representative of the original Yedoma deposit

Conclusion



Acknowledgments

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References

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