Influence of Holocene thermokarst activities on mineral element content in Yedoma deposits

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Yedoma are ice-rich permafrost

Contain 1/3 of the global permafrost organic C stock

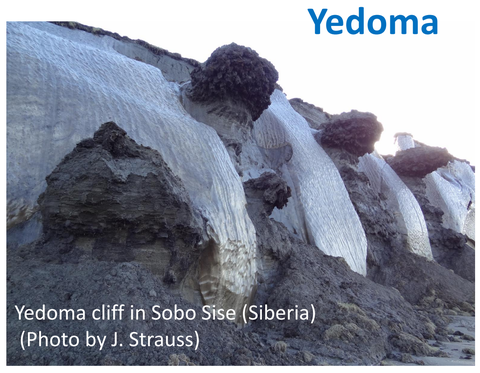
Are highly sensitive to thaw with warming climate

Expose deep organic matter (OM) and mineral constituents

Unlock interactions between OM and minerals

Mineral elements assessment is needed in Yedoma regions because of their influence on organic carbon dynamics

Yedoma



Yedoma cliff in Sobo Sise (Siberia)
(Photo by J. Strauss)

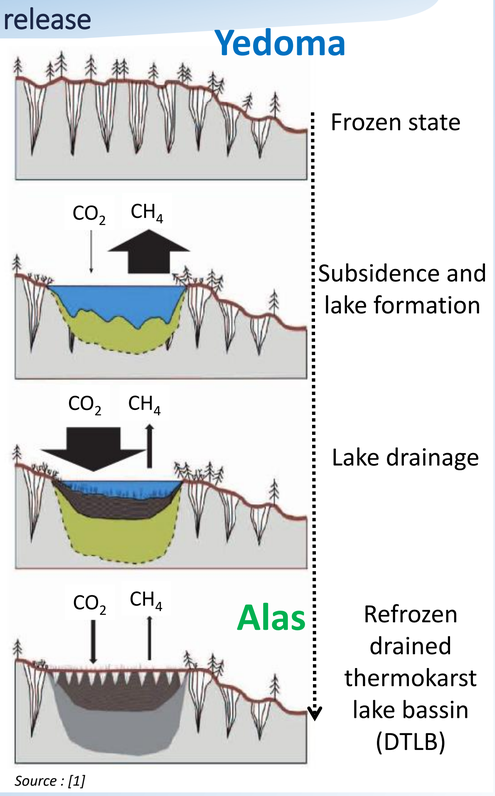
Thermokarst processes

Alas

=Drained thermokarst lake bassins

Alas exposure in Baldwin peninsula (Alaska)
(Photo by J. Strauss)

Thermokarst: a driver for elements release

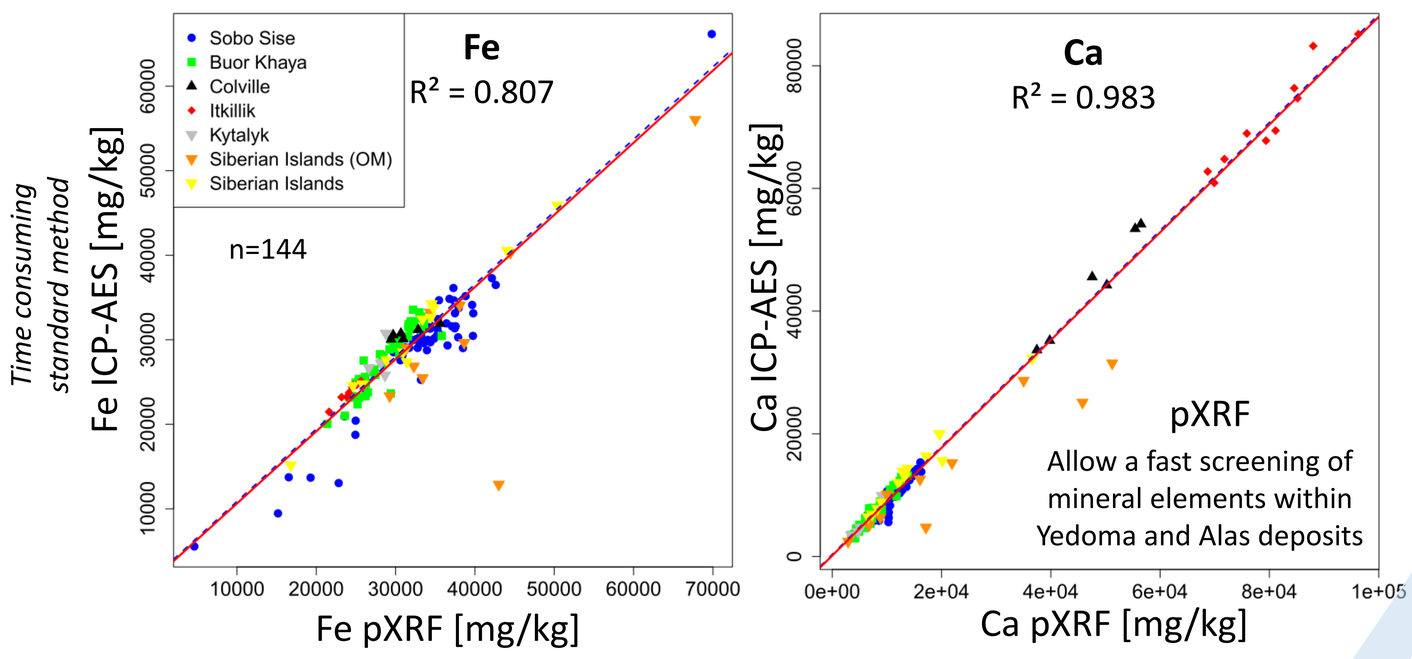


Source : [1]

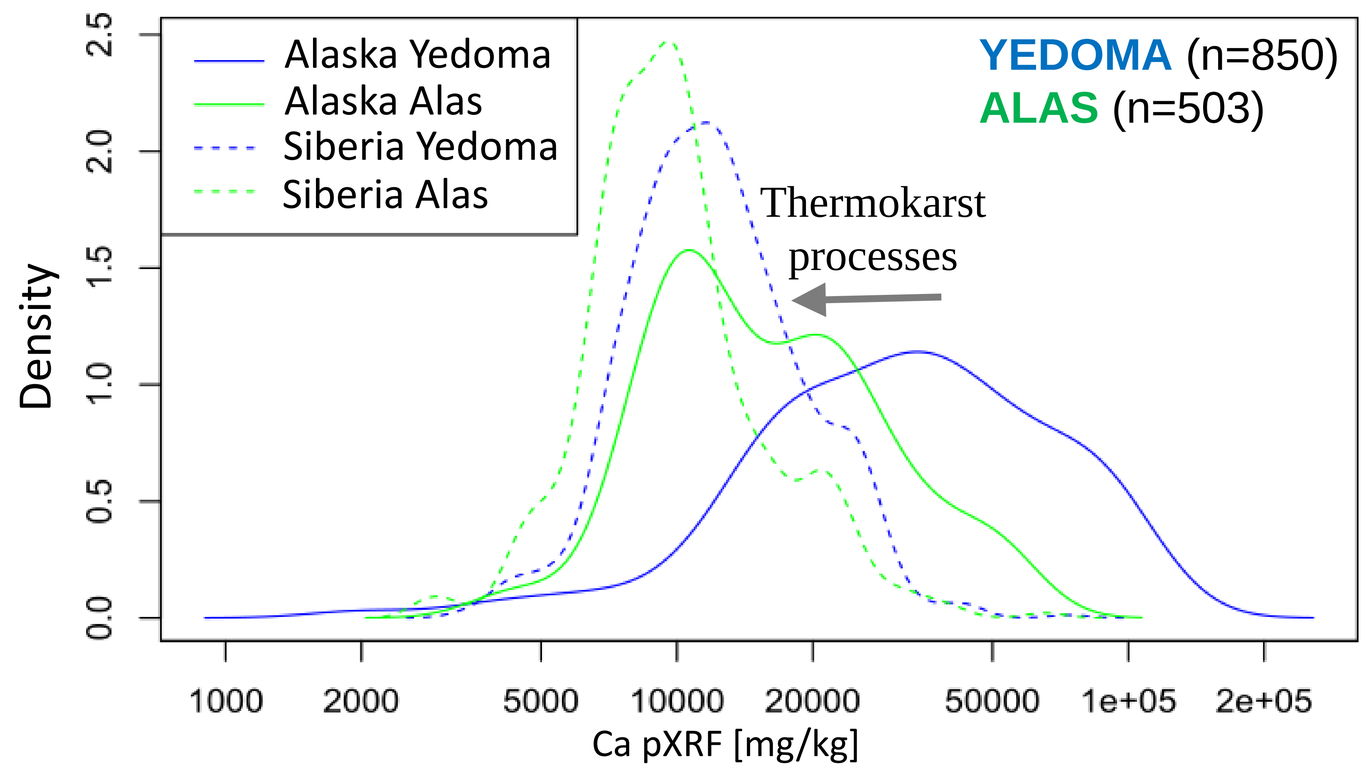
We are studying the Yedoma domain region

Assessing mineral element content on a global scale

- Portable X-Ray Fluorescence device (pXRF) : fast and cheap alternative method to assess mineral element content (R^2 > 0.6 for Fe, Ca, Si, K, Ti, Zn, Sr and Zr).



Decrease in soluble mineral elements such as Ca upon thermokarst processes



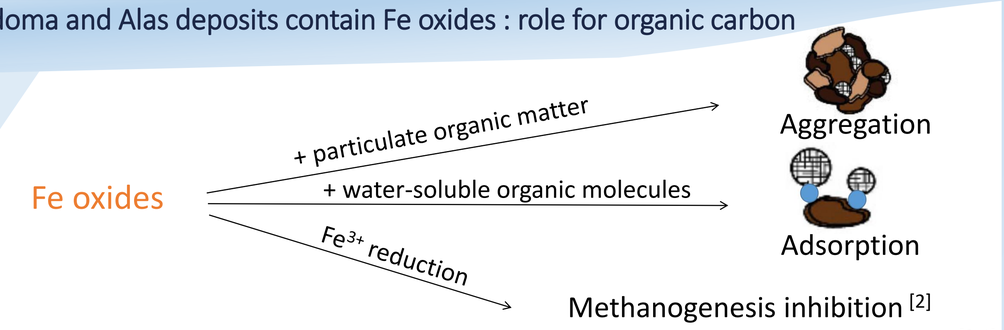
Take home messages

- Fast method (pXRF) to assess mineral element content in permafrost samples Fe, Ca, Si, K, Ti, Zn, Zr and Sr.
- Changes in total content in Ca, Al and Fe between Yedoma and Alas deposits.
- Thermokarst disturbances affect mineral element distribution and might affect the mineral elements availability to form associations with organic carbon.

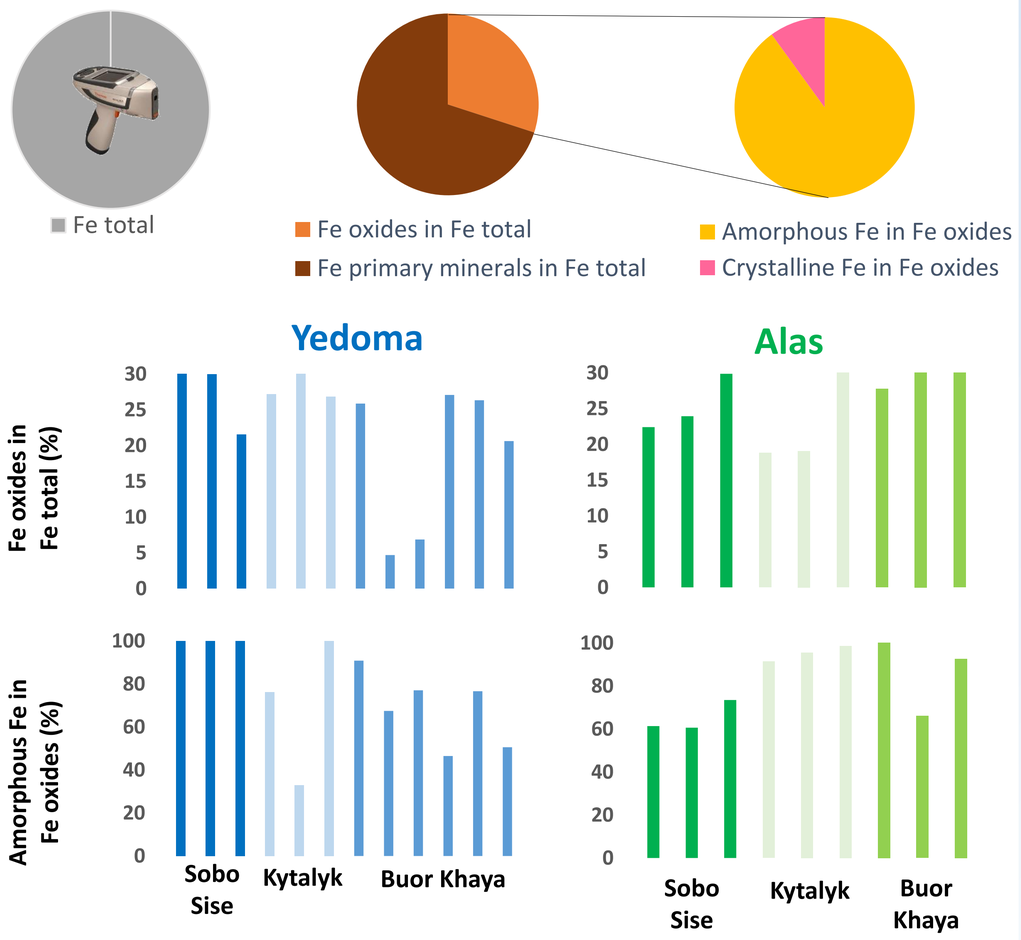
What is the potential impact of mineral elements release on organic carbon?

- Organic carbon stabilization (complex formation Fe^{3+}, Al^{3+}, Ca^{2+})
- Supply of limiting micronutrients for microbial growth (Fe, Mn,..)
- Possible inhibition effect on CO_2 and CH_4 emissions

Yedoma and Alas deposits contain Fe oxides : role for organic carbon



- What is the proportion of Fe oxides and amorphous Fe oxides in **Yedoma** and **Alas** deposits?



- Yedoma and Alas deposits contain 25% (average) of Fe oxides of which 81% are amorphous or readily dissociated.
- Distinction between Yedoma and Alas requires to compare more sites at comparable distances.

[1] modified from Walter Anthony et al., 2014, Nature.
[2] Lipson et al., 2012, Biogeosci., 9, 577–591.
[3] Baek et al., 2019, Ren. Sus. Energy Rev. 113, 109282.
[4] Schwertmann et al., 1977, Soil Sci. Soc. Am.

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