When did the LIS begin shrinking?

- Hundreds of core-bottom cores (C3) and in situ cosmogenic 10Be ages in northeastern US suggest that LIS margins began retreating from Last Glacial Maximum extent (Fig. 1 inset).
- Problem? Ages between methodologies (Fig. 2) differ by thousands of years near LGM terminal moraines (Fig 1a, b, c and d). Especially true for macrofossil (C3) and 10Be ages and exposure ages.

Problem? Ages agree well when ice margin was >150 km from LGM terminal moraines (Fig 1d).

What is the deglacial chronology of this LIS margin, why do deglacial chronometers disagree in some places but not others, and what are the implications for deglacial chronologies elsewhere?

- PROBLEM? Ages agree well when ice margin was >150 km from LGM terminal moraines (Fig 1d).

In situ cosmogenic 10Be ages in bedrock suggest that they are reliable

* Older varve chronology calibrated with bulk sediment and concretions. The calibration samples within area and age of 14C/10Be agreement

* Calibrated using 14C dating on arctic plant macrofossils in varves

* Varve chronologies are calibrated using 14C ages in varves, can we use varves in situ cosmogenic 10Be ages in bedrock and boulders below 2 kyr, >11 m of erosion needed to reduce 10Be inheritance

- Perhaps, but two arguments in favor of using varve chronologies as controls:

1. Varve chronologies are calibrated using 14C ages in varves.
2. Younger varve chronology is calibrated with macrofossil C3 ages, but ages where macrofossil ages are in good agreement with exposure ages, suggesting that they are reliable

Is there inheritance to be blame?

- We modeled the pre-LGM accumulation of 10Be in bedrock in the northeastern US for different exposure durations (Fig. 3).
- Most likely pre-LGM exposure duration near terminal moraines is ~110 kyr (red line).

- ~6 m of erosion needed to reduce "be inheritance below 2 kyr. 11 m needed to get below 1 kyr"

- "Inheritance decreases rapidly with distance away from terminal moraines, minimal ~90 km away"

Four in northeastern US (use yellow lines in Fig. 1 for location for locations):

- Terminal moraines to southern NY (24 - 22.5 kya)
- Southern CT to northern NH and VT (18 - 13.4 kya)
- Calibrated using "C3" dating on concordant bulk sediment and varves
- All calibration samples within area and age of 14C/10Be agreement

- "Be" age vs "C" age on strict place macrofossils in varves

Chronologies are not connected, gap of ~3.5-4 kyr

Problem of Circularity?

- Varve chronologies are calibrated using "C3" ages in varves, can we use varves as controls and compare deglacial chronologies based on "C3" ages

- Perhaps, but two arguments in favor of using varve chronologies as "controls":

1. Older varve chronology calibrated with macrofossil C3 ages, but at locations where macrofossil ages are in good agreement with exposure ages, suggesting that they are reliable

Cold North Atlantic conditions from LGM to ~11 kya, caused partly by weak AMOC, likely prevented extensive vegetation growth in northeastern US, delaying macrofossil deposition in bays.

References


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INACCURACIES IN DEGLACIAL CHRONOMETERS RECORDING LAURENTIDE ICE SHEET (LIS) RETREAT IN THE NORTHEASTERN UNITED STATES: PRESENCE, Magnitude, and Controls

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Figure 1: (Inset) Deglacial chronology constraints in the northeastern US. Numbers and arrows indicate when LIS margins was at different distances according to varve chronology. Number black lines are ice margin positions corresponding to the panels in the main Fig. 1. Juxtaposition of the LIS advance and retreat chronologies (C) constrained by LGM ice cover and thus shallow erosion.

Figure 2: Two in northeastern US (use yellow lines in Fig. 1 for location). A) Terminal moraines to southern NY (24 - 22.5 kya). B) Southern CT to northern NH and VT (18 - 13.4 kya). C) Varve chronologies are calibrated using "C3" dating on strict place macrofossils in varves. D) All calibration samples within area and age of 14C/10Be agreement.

Figure 3: Ice retreat chronometer data from LIS advance (B) and retreat (A) as informed by LIS advance chronologies (C). The Greenland temperature reconstruction from the NGRIP ice core (D) and Greenland temperature reconstruction from the GRIP ice core (E). The GRIP ice core temperature data from the compilation SD + Olden-Dryas, BA + Belling-Aldrich = Olden-Dryas + H. Nohrde.

Figure 4: (A) Ice retreat chronometer data from samples located near and far from the LIS terminal moraines at different global glacial events. Inheritance is calculated by solving ~10 Be/LIS ext 10 Be/LIS ext chronology of LIS margin. This work was supported by NSF EAR-1602280, 1603175, and 1735676