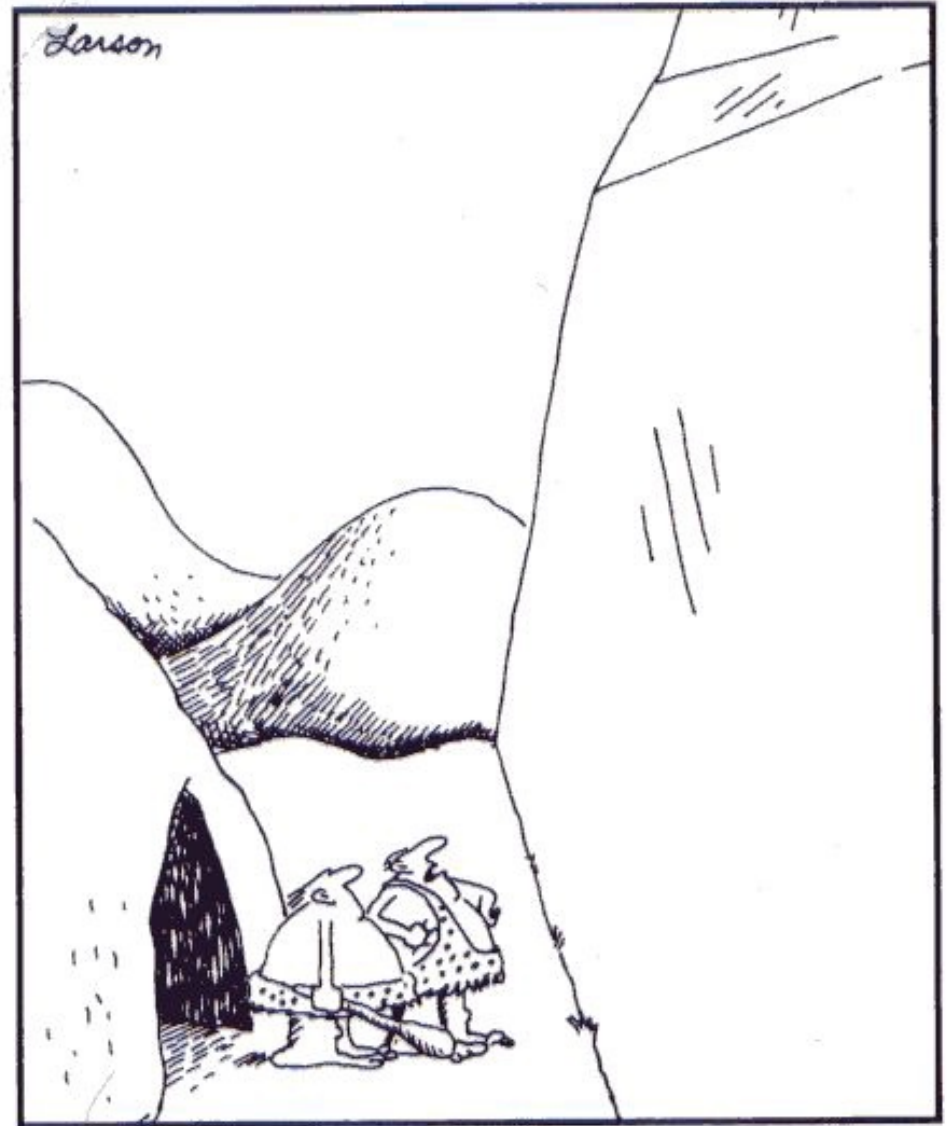


THE MIDDLESEX READVANCE IN THE WINOOSKI RIVER BASIN, NORTHERN VERMONT

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University of Vermont



"Say, Thag ... wall of ice closer today?"

cal. age
(kyr B.P.)
INTCAL-09

Middlesex Readvance

14.7-15.1 ?
PR ↓

44°

EXPLANATION:

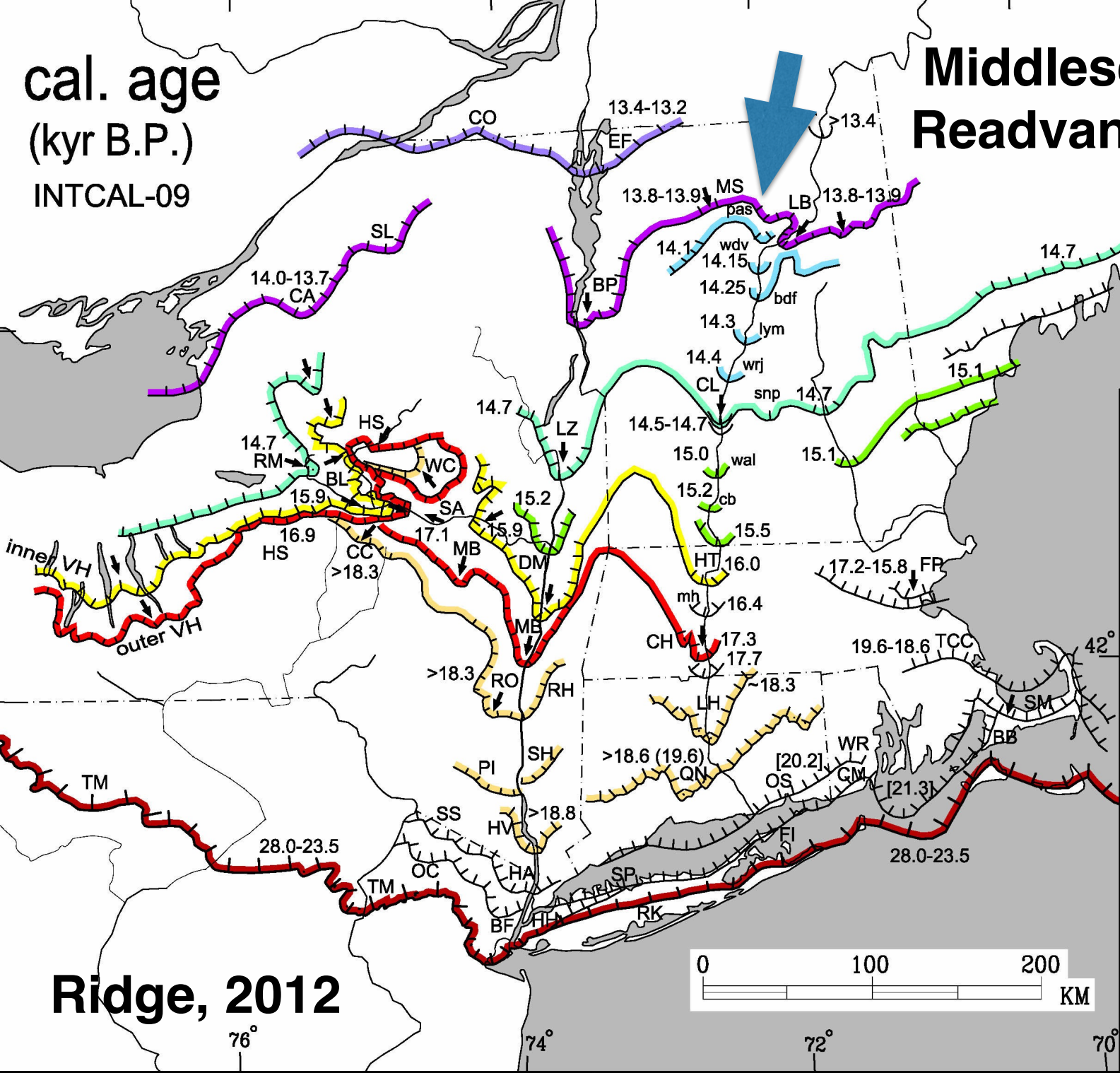
() - estimates from J. Stone and others (1998)

[] - based on proposed correlations with Greenland ice core ¹⁸O records (Boothroyd and others, 1998)

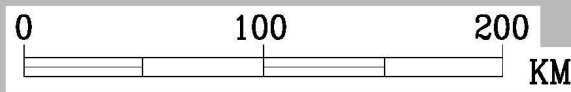
All other ages based on ¹⁴C ages and ¹⁴C-dated varve and paleomagnetic sequences, or are proposed corrections of lake-bottom, bulk-sediment, and marine ¹⁴C ages.

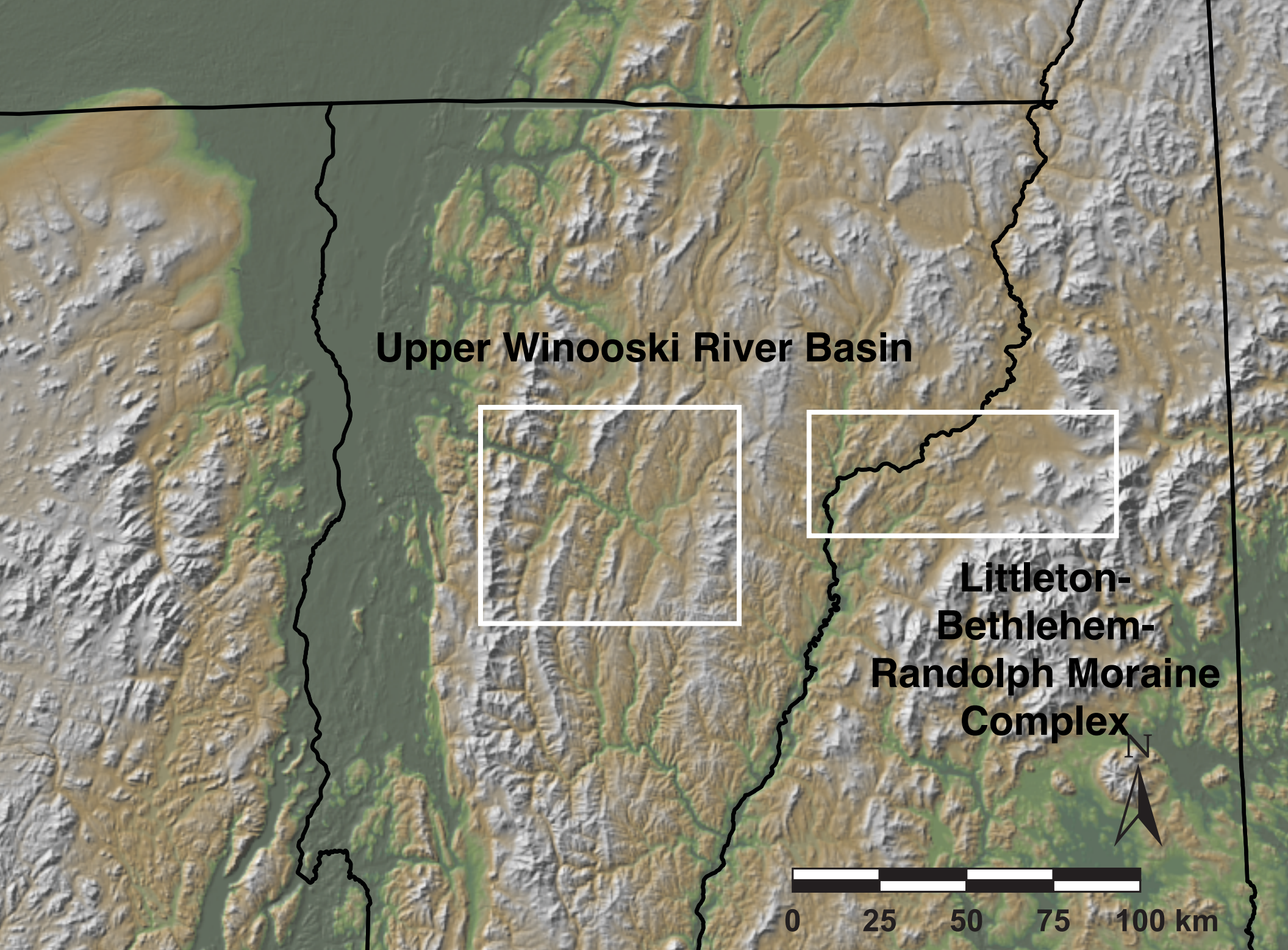
Capitalized ice margin abbreviations are named moraines, ice-front positions, readvances (arrows), and lakes. Small abbrev. in Connecticut Valley are local names.

Version: 6/2012



Ridge, 2012





Upper Winooski River Basin

**Littleton-
Bethlehem-
Randolph Moraine
Complex**



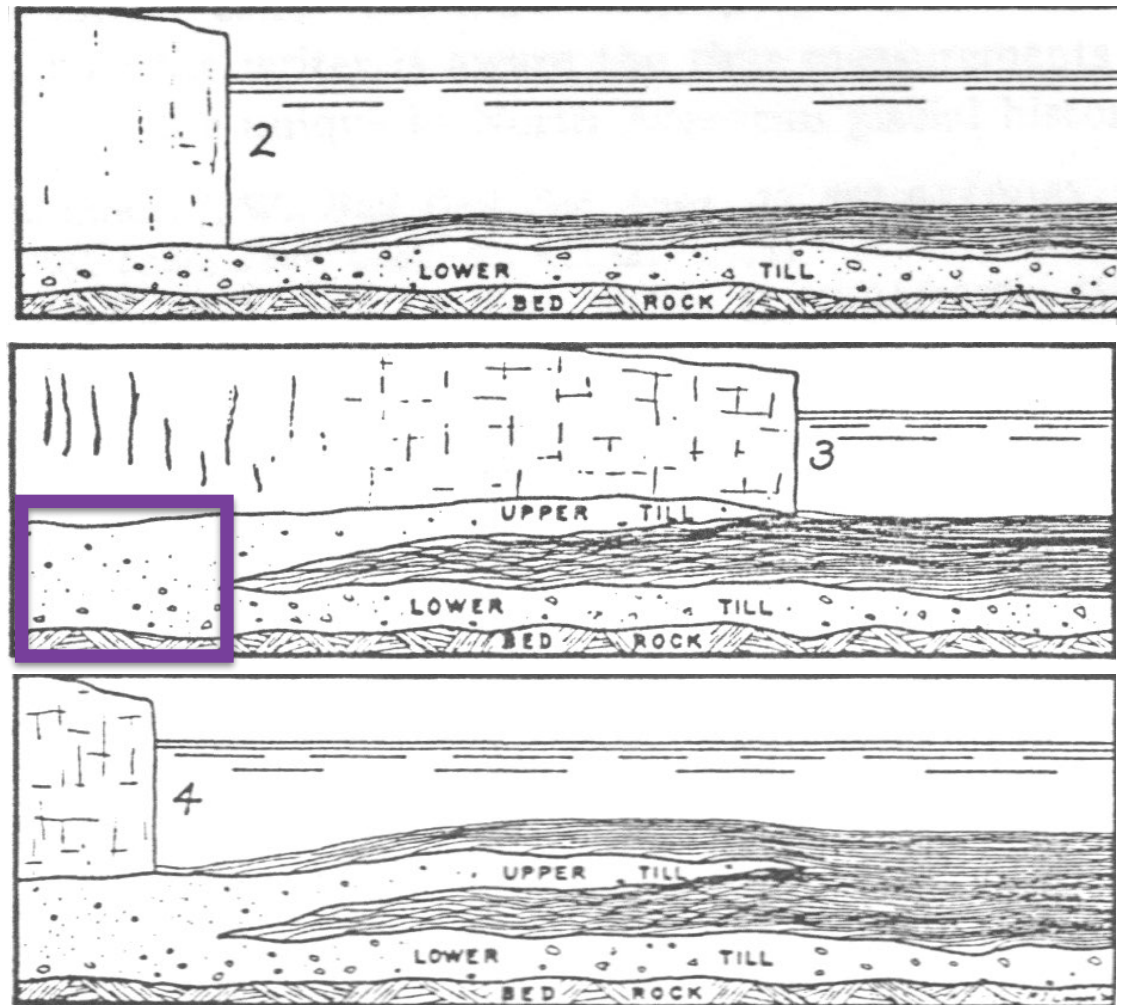
A photograph of a man, Fred Larsen, standing on a dark, layered geological outcrop. He is wearing a blue long-sleeved shirt, khaki pants, a cap, and a beard. He is holding a shovel vertically. The background shows a steep, rocky slope with scattered stones and debris. The text "Fred Larsen" is overlaid in white on the upper left side of the image.

Fred Larsen

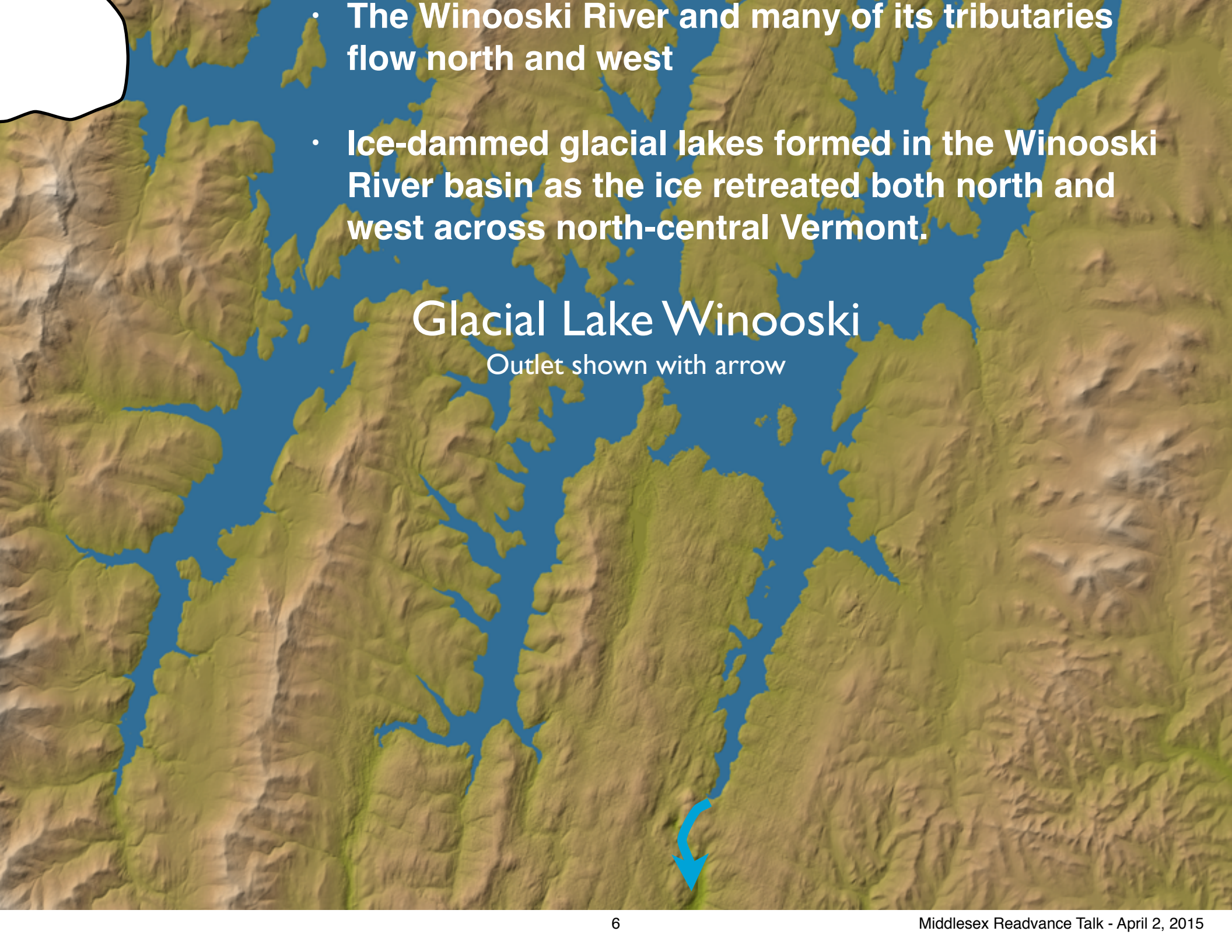
**Acknowledge:
George Springston
Rick Dunn**

Evidence for Ice Sheet Readvance

- When the ice sheet advanced into ice-marginal lakes, it deformed the sediments deposited in these lakes and deposited a layer of till.
- Thrust faults commonly form in the overridden sediments as opposed to normal faults
- Overturned folds
- Sediments are overcompacted from the weight of the overlying ice sheet.
- No recognized moraines



Figures from Lougee (1935) based on observations in the upper Connecticut River valley.

- 
- The Winooski River and many of its tributaries flow north and west
 - Ice-dammed glacial lakes formed in the Winooski River basin as the ice retreated both north and west across north-central Vermont.

Glacial Lake Winooski

Outlet shown with arrow

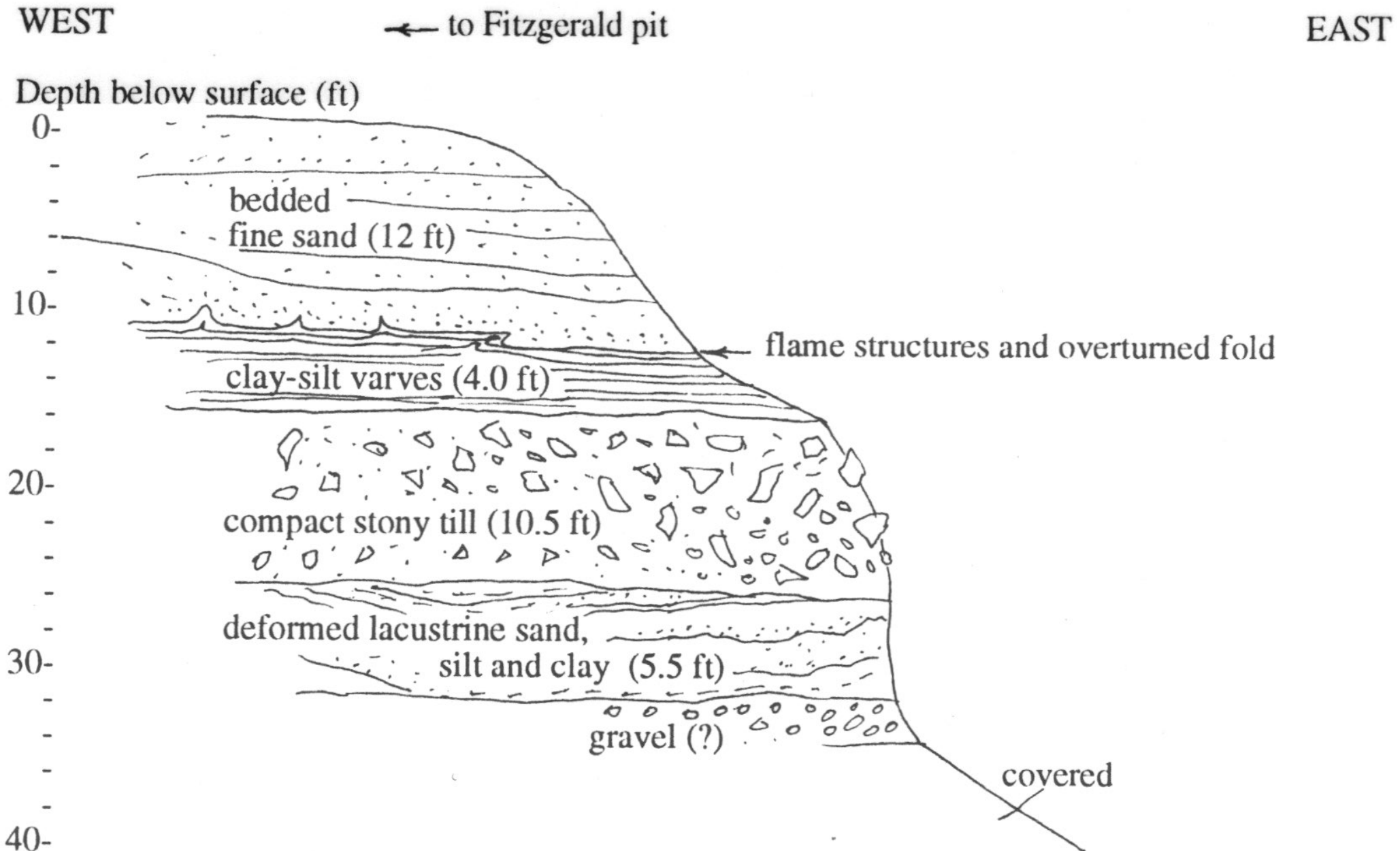
Thrust faulted & folded lacustrine sediments: Barre Montpelier Road

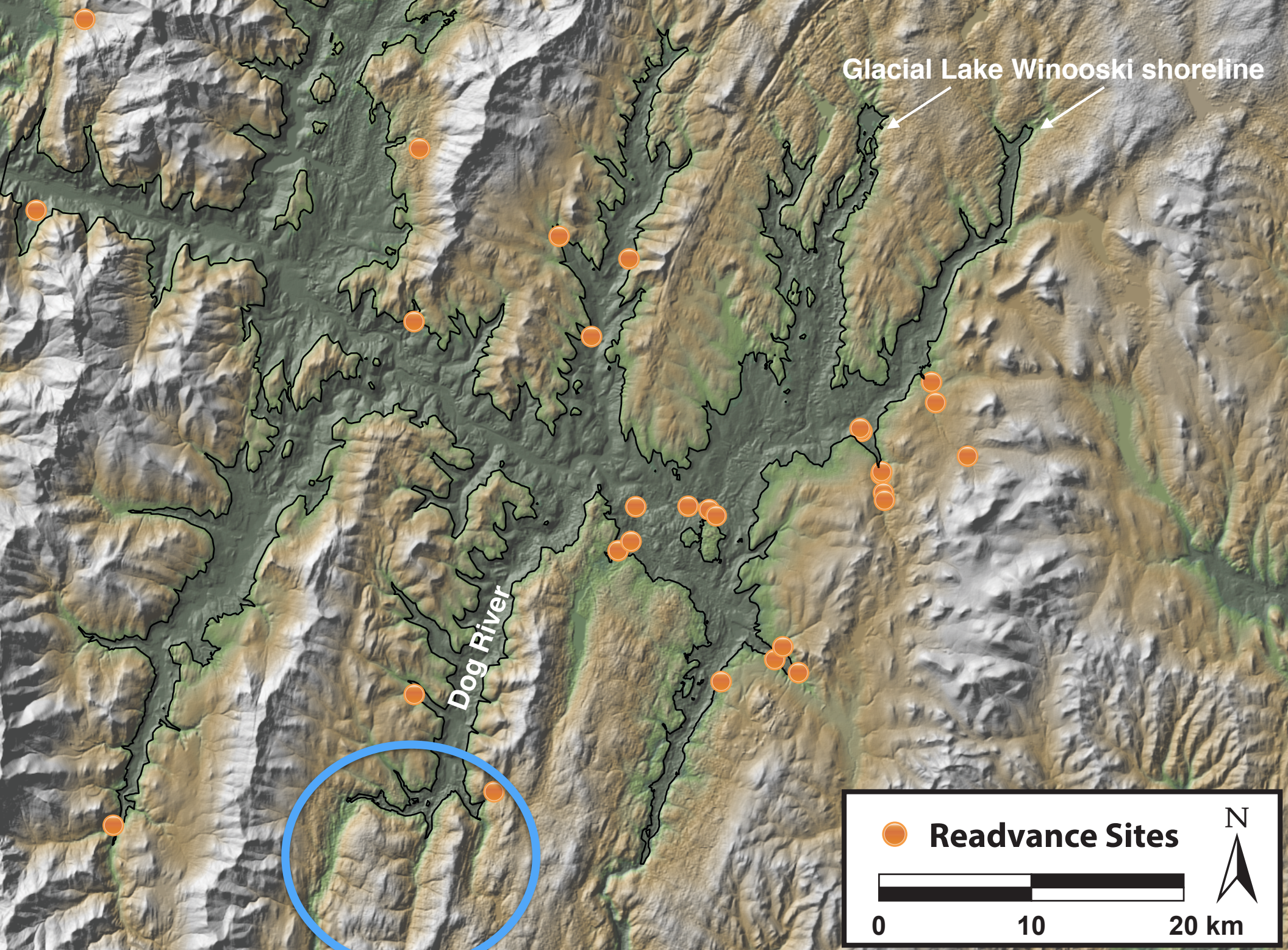


Overturned fold and thrust faults



Till over deformed lacustrine sediments Patterson Brook, North Branch of Winooski River Larsen, 1999





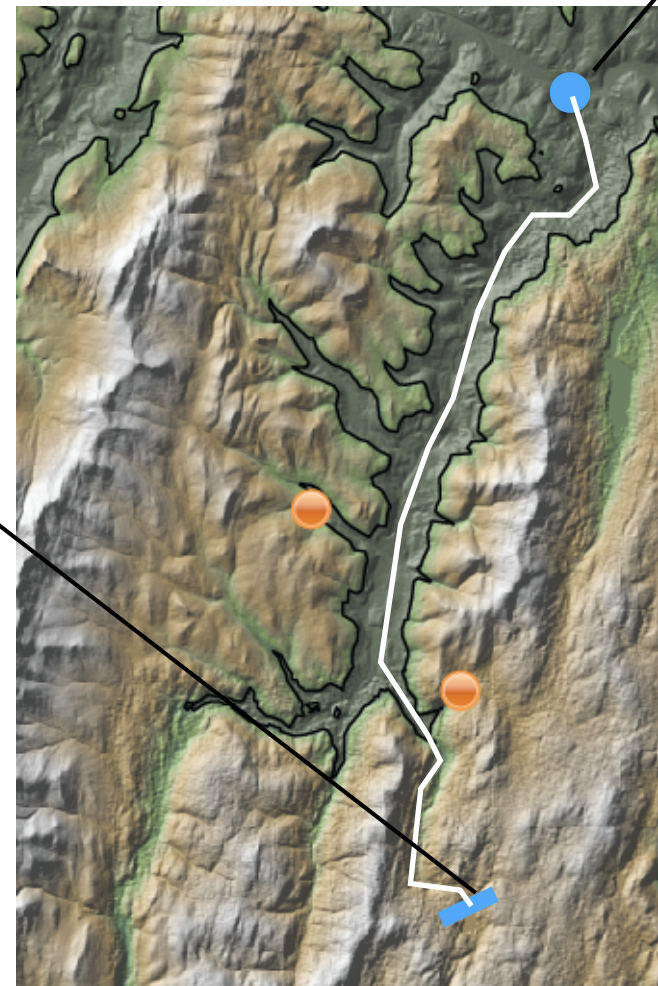
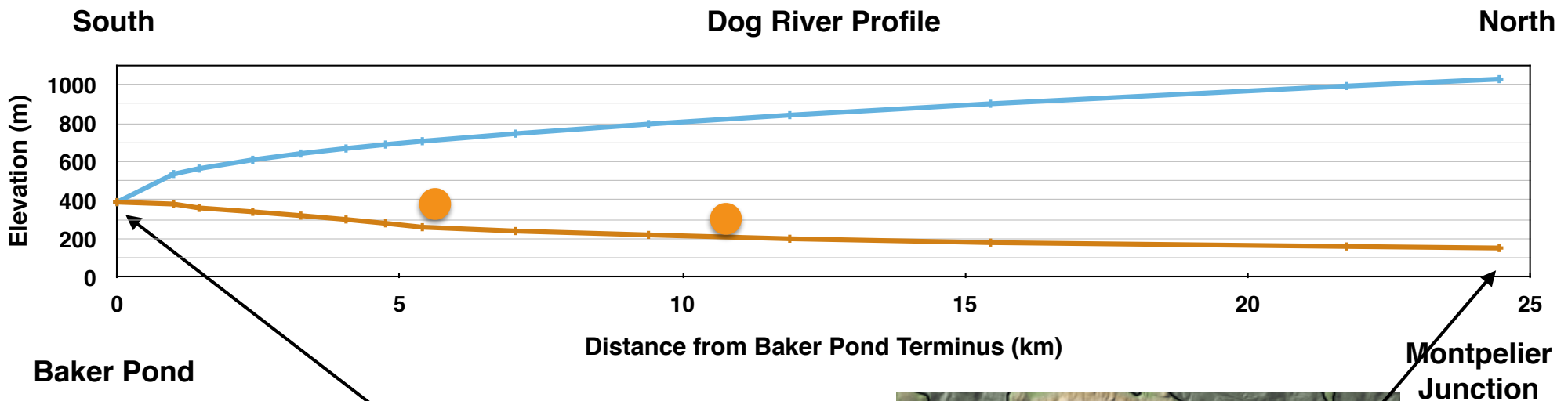
Glacial Lake Winooski shoreline

Dog River

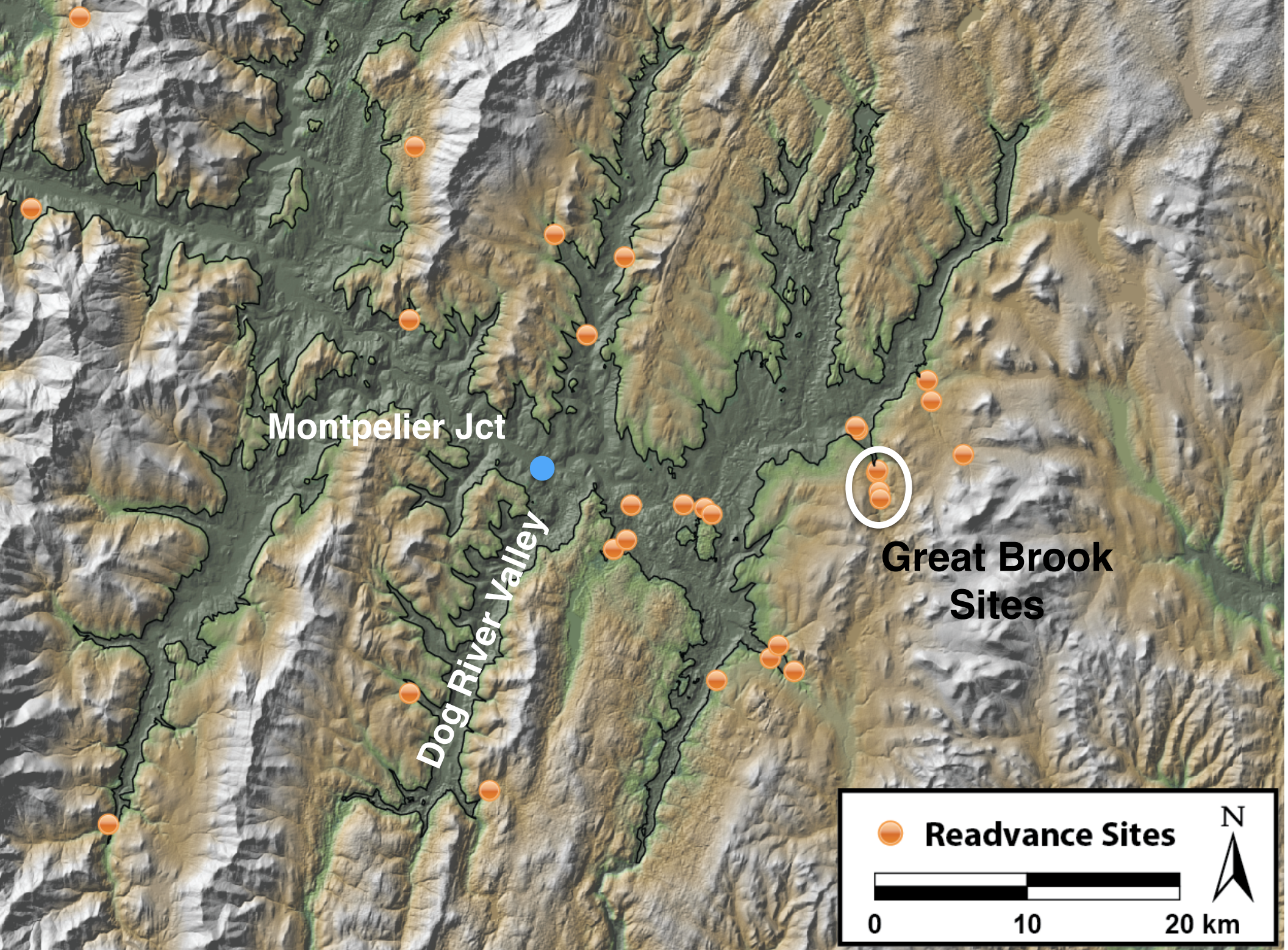
● Readvance Sites

0 10 20 km

N



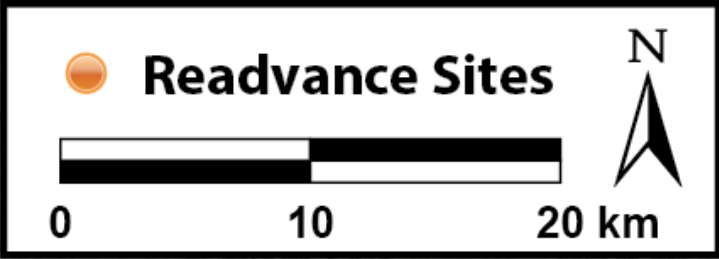
- Assumptions
 - Ice Density: 900 kg/m^3
 - Uniform Shear Strength: 100 kPa
 - No valley shape factor included
- Benn & Hulbert, 2010 Profiler Model

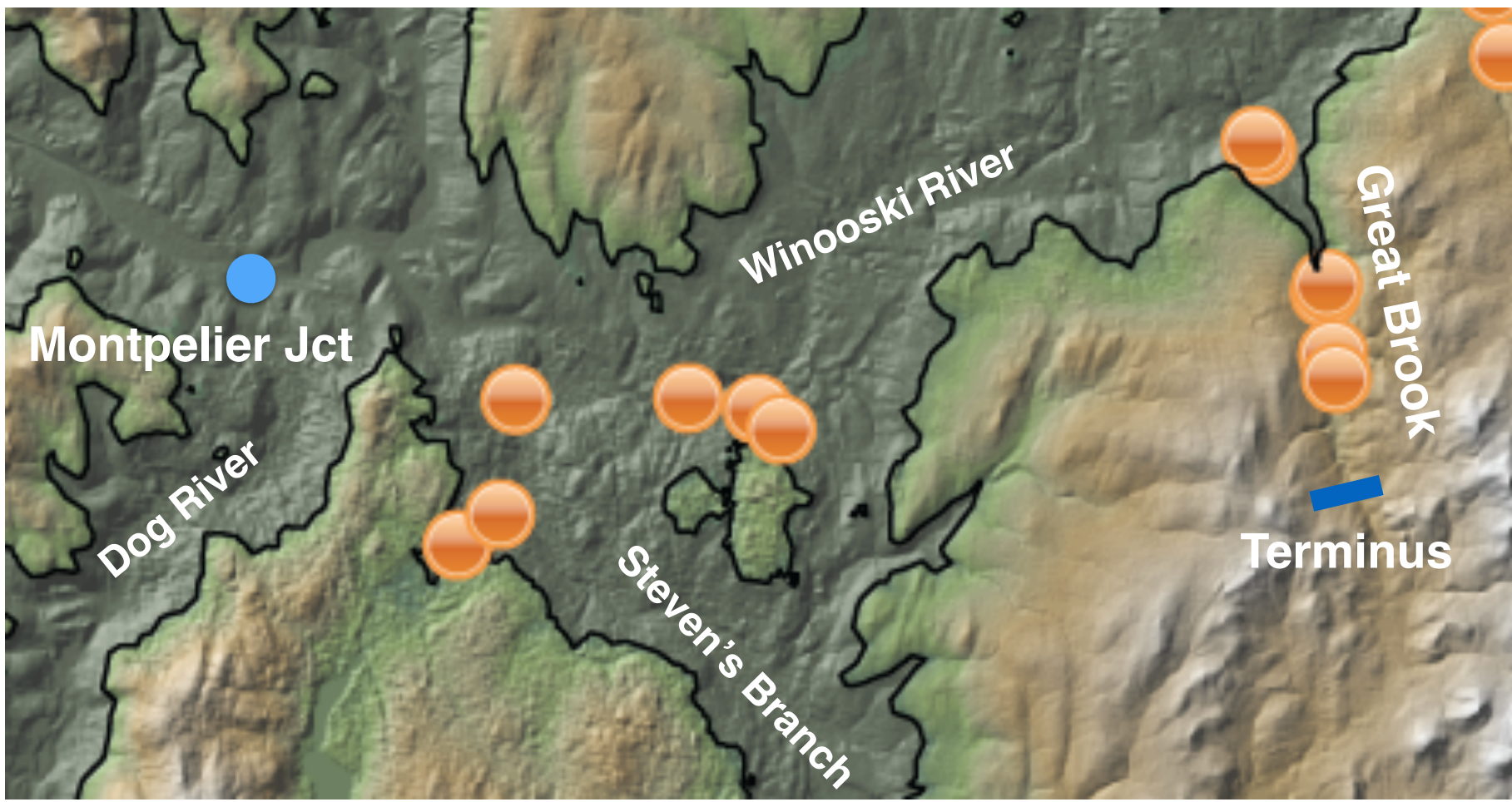
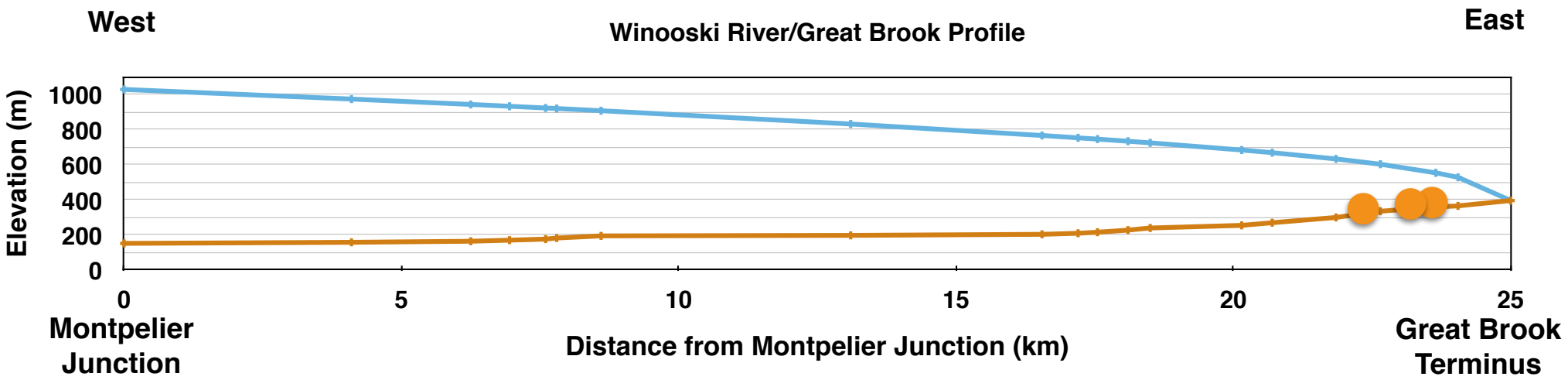


Montpelier Jct

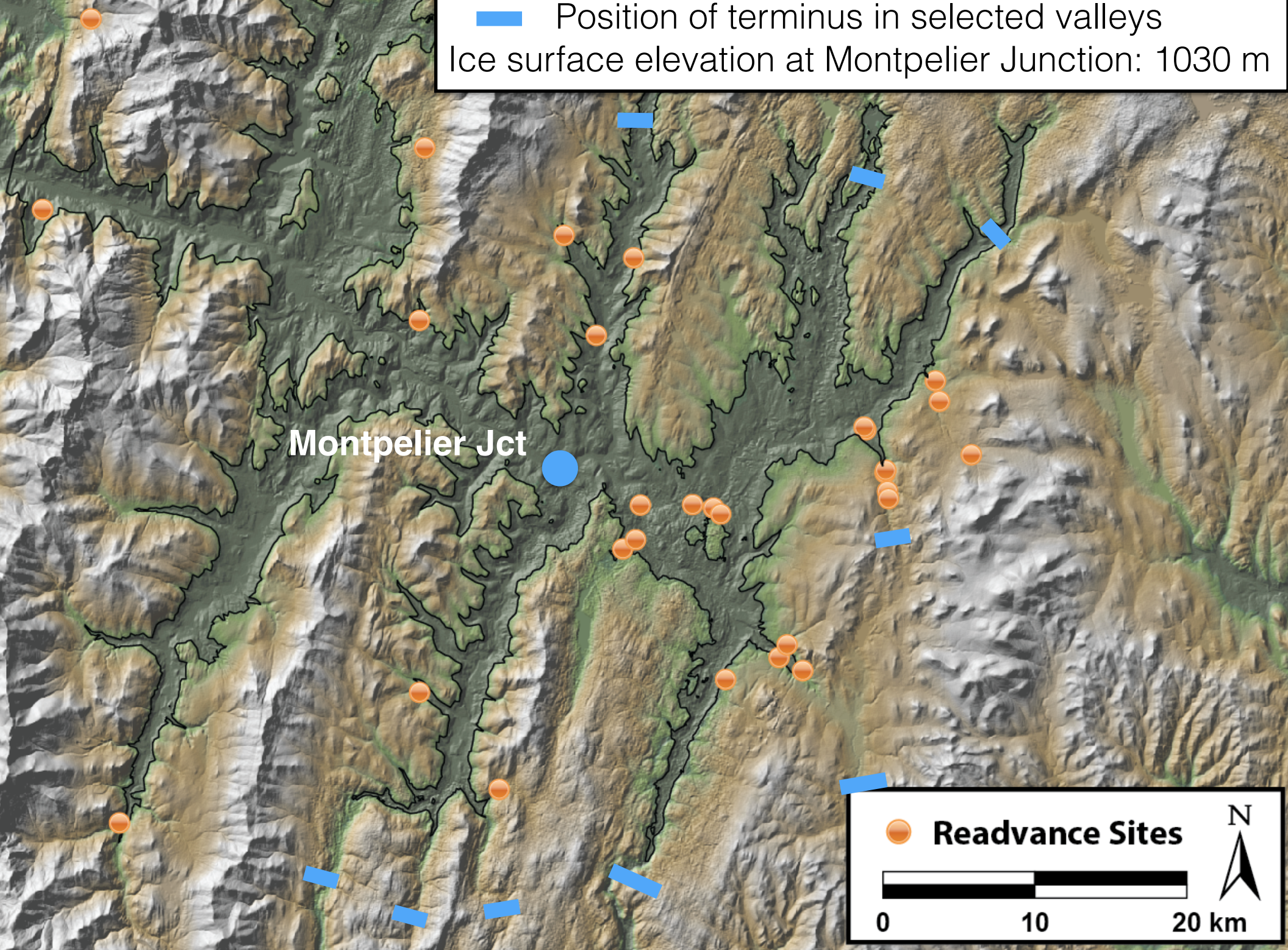
Dog River Valley

Great Brook Sites





— Position of terminus in selected valleys
Ice surface elevation at Montpelier Junction: 1030 m



Montpelier Jct

● Readvance Sites

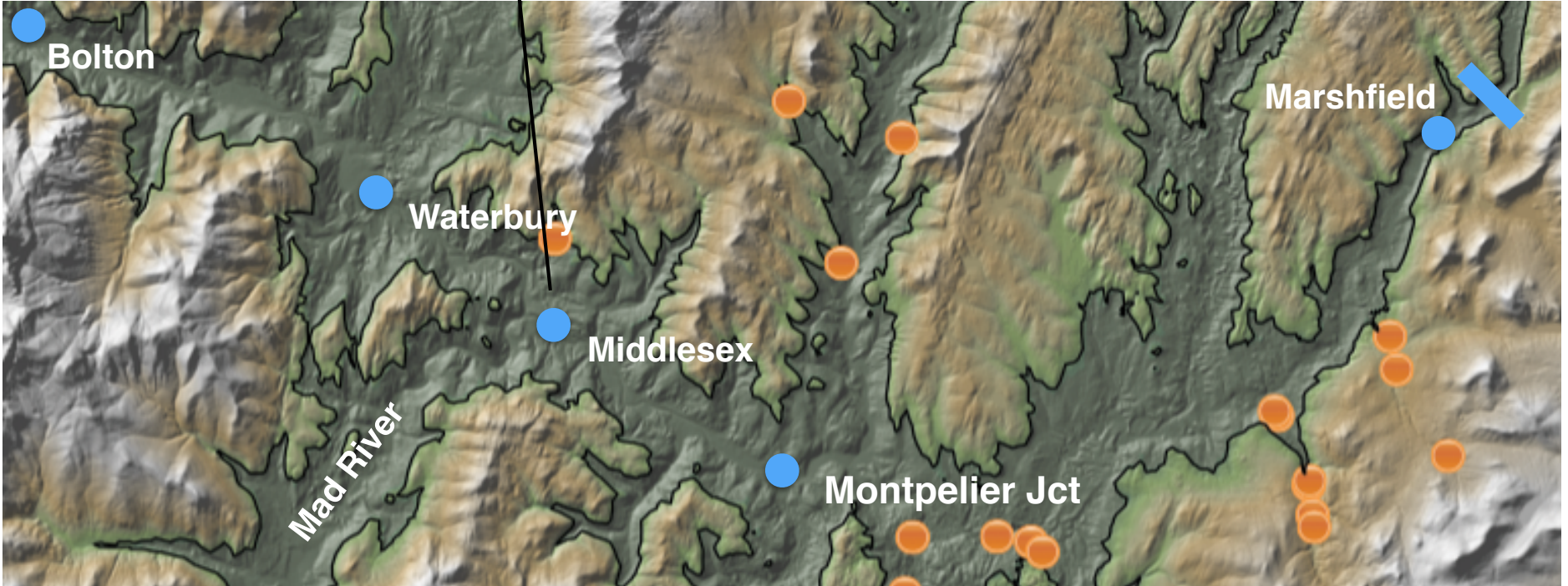
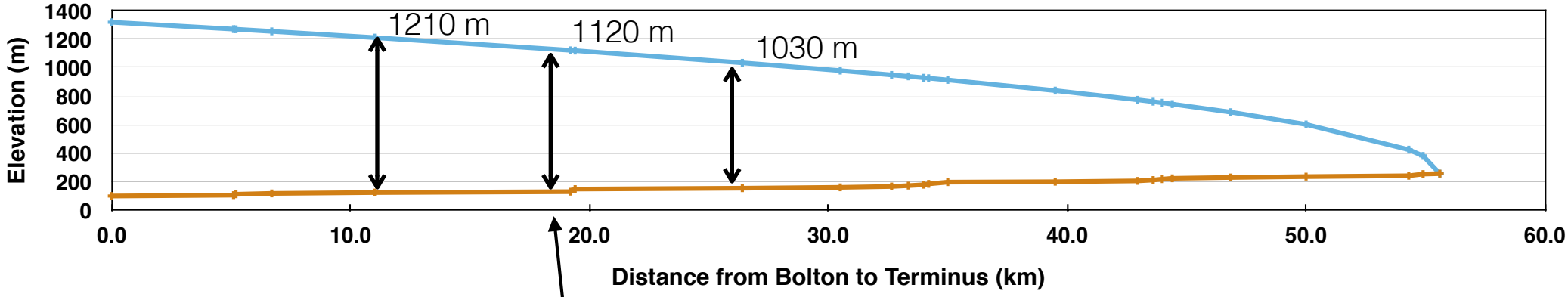
0 10 20 km

N

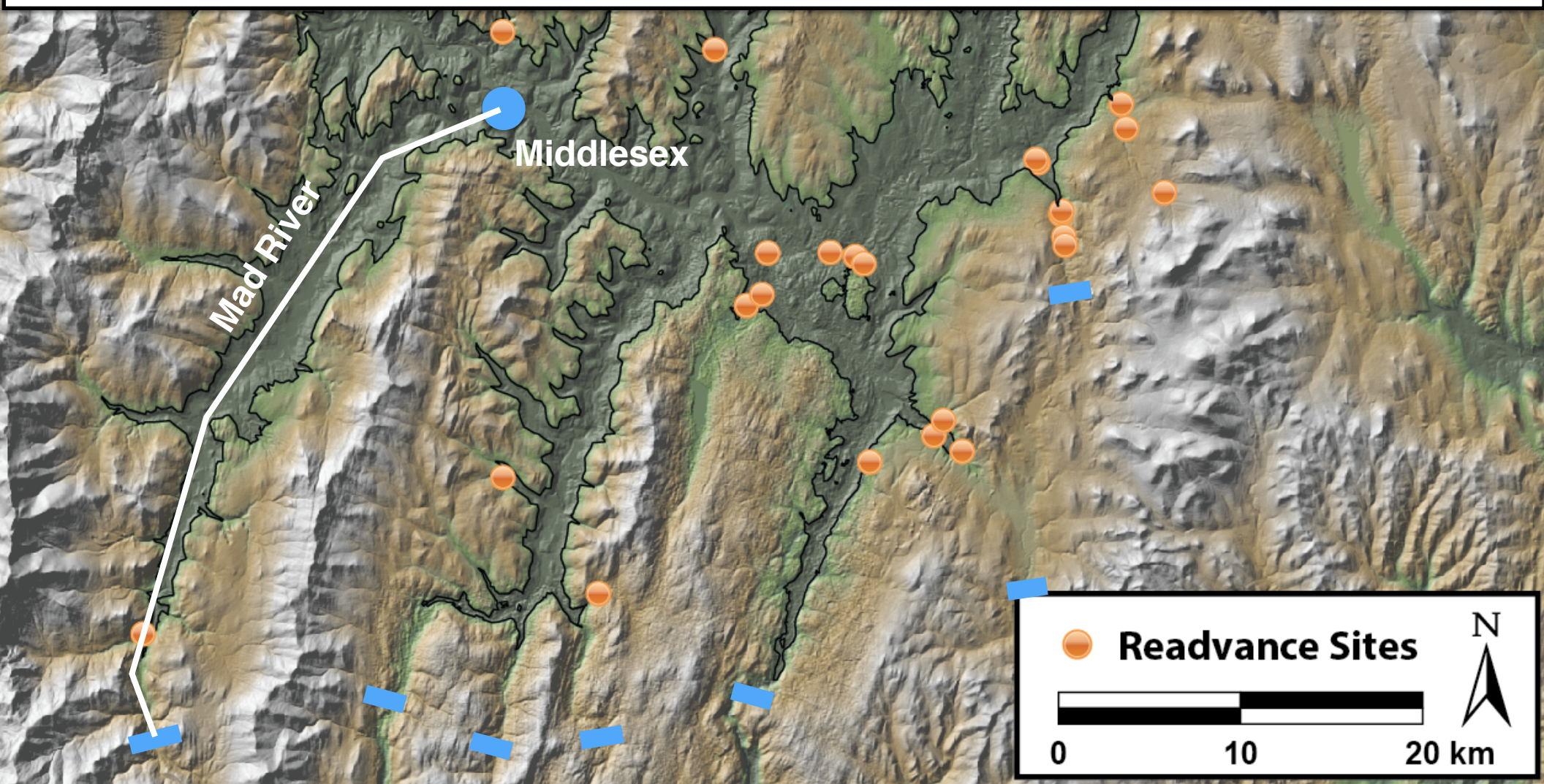
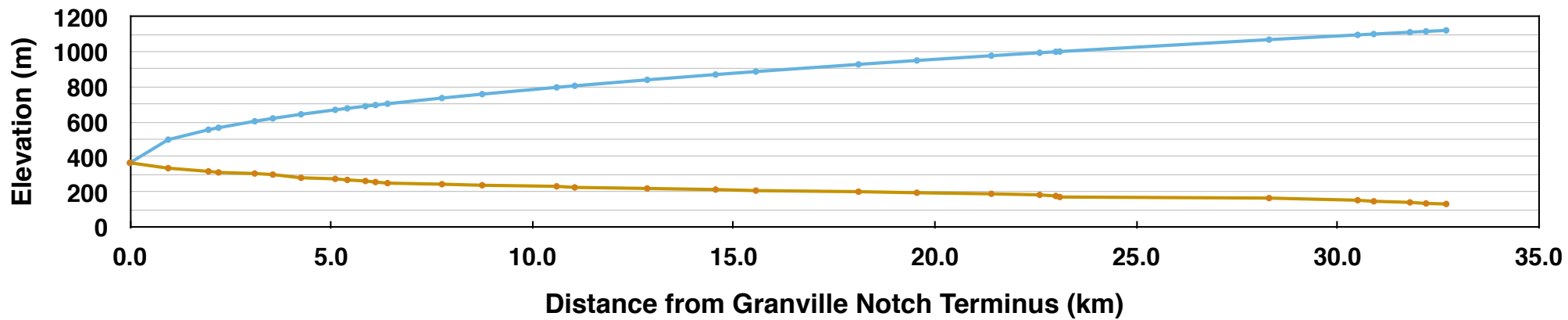
West

Winooski River Profile: Bolton to Marshfield

East



Mad River Profile

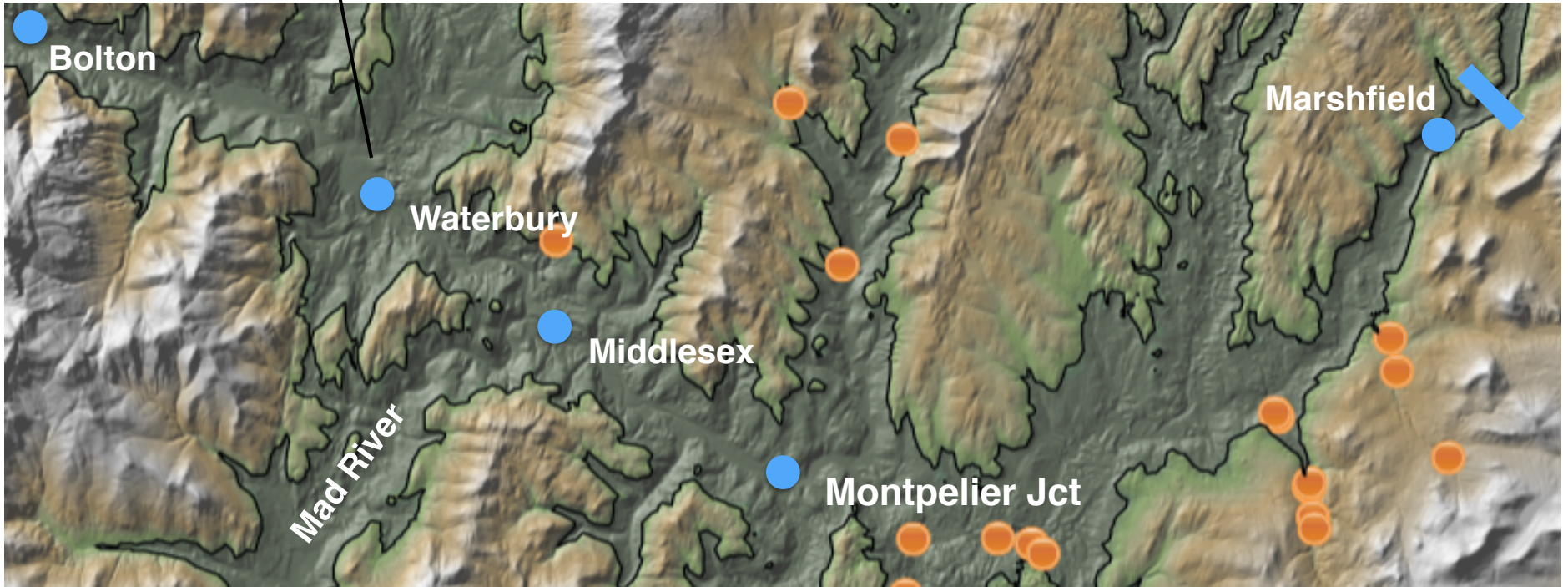
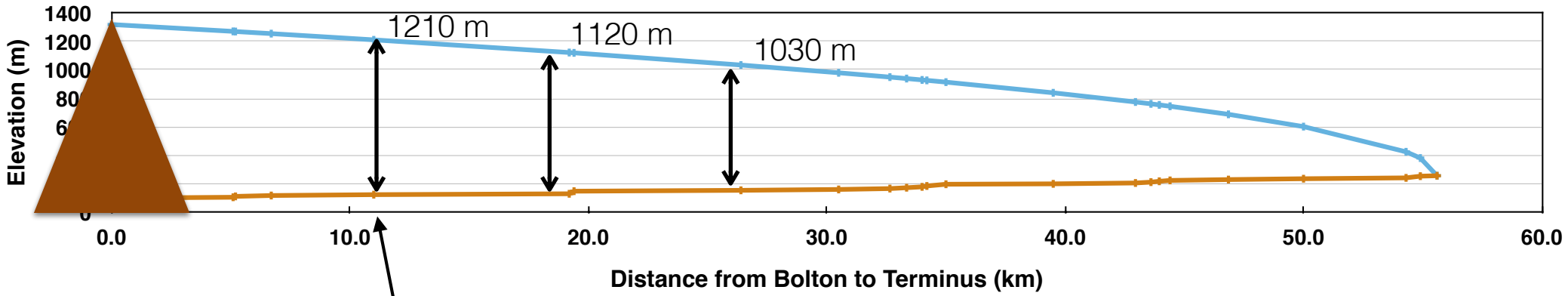


Mount Mansfield

West

Winooski River Profile: Bolton to Marshfield

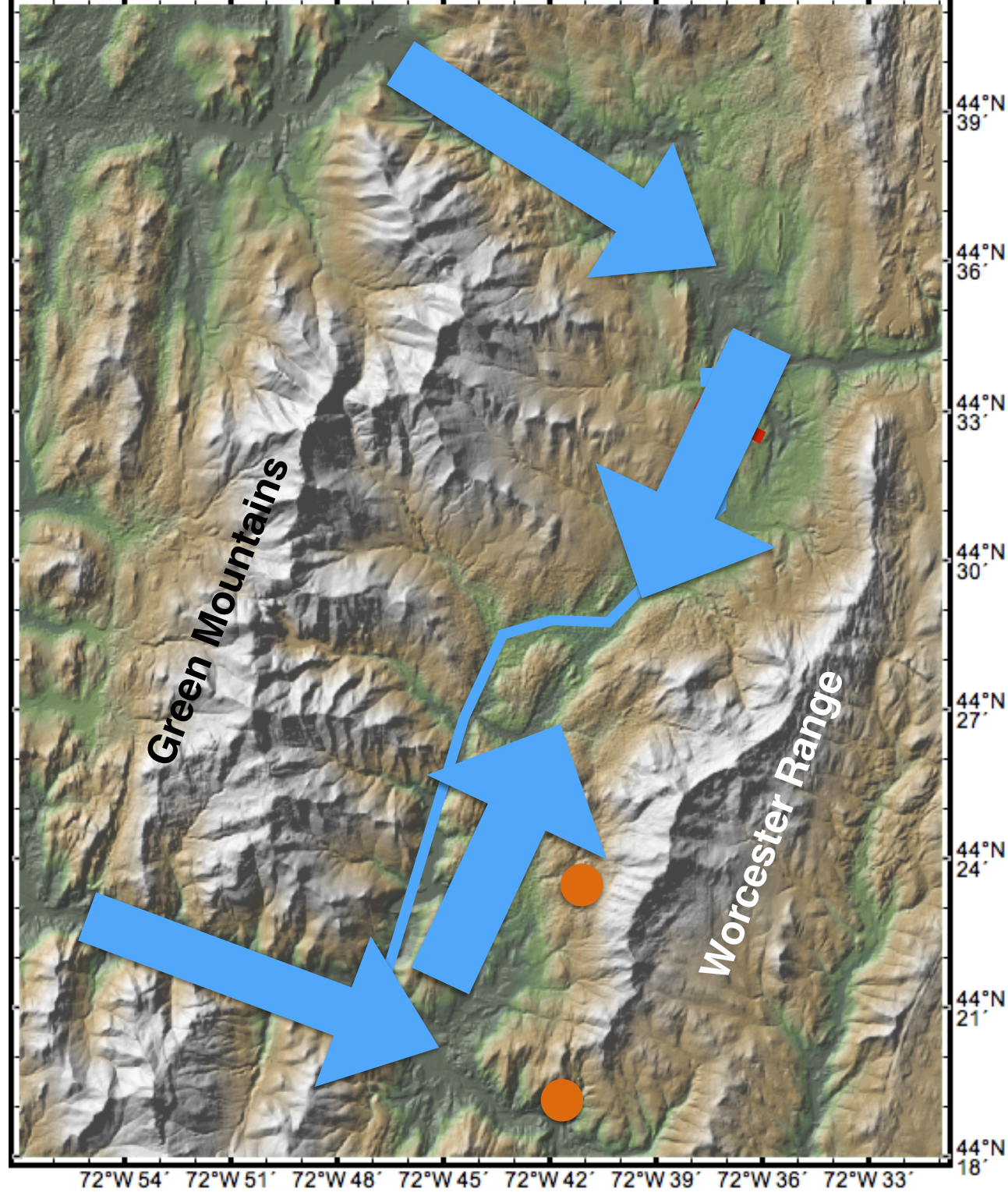
East



Ice flowing north, up the Little River valley would extend all the way to the Lamoille River valley.

Unrealistic: Ice was also advancing across the mountains through the Lamoille River valley

The valley between the Green Mountains and the Worcester Range must have been filled with ice during the readvance sourced from both the north and the south.



Timing of the Middlesex Readvance

Till over deformed lacustrine sediments Culver Brook, North Branch of Winooski River Larsen, 1999

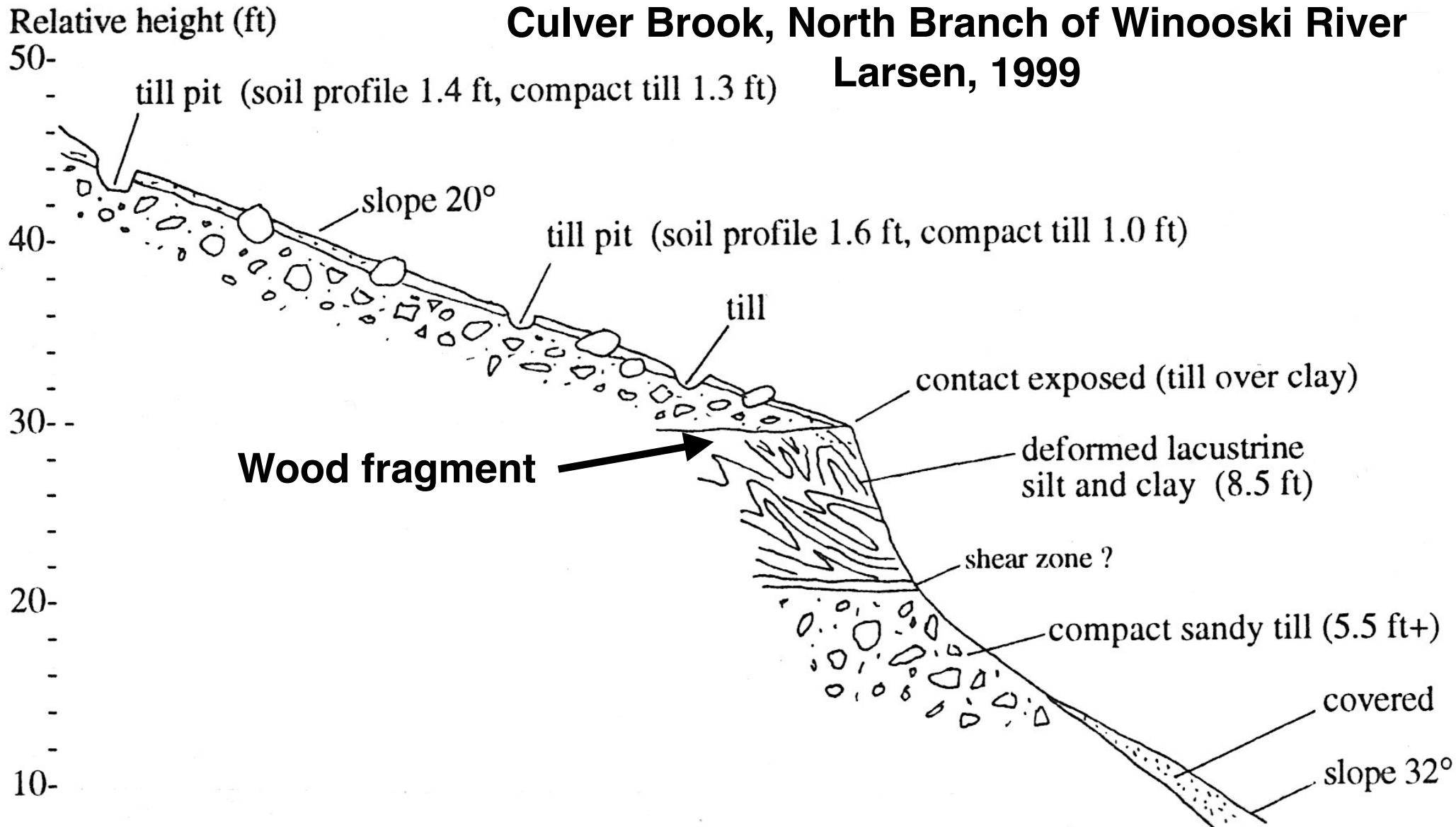
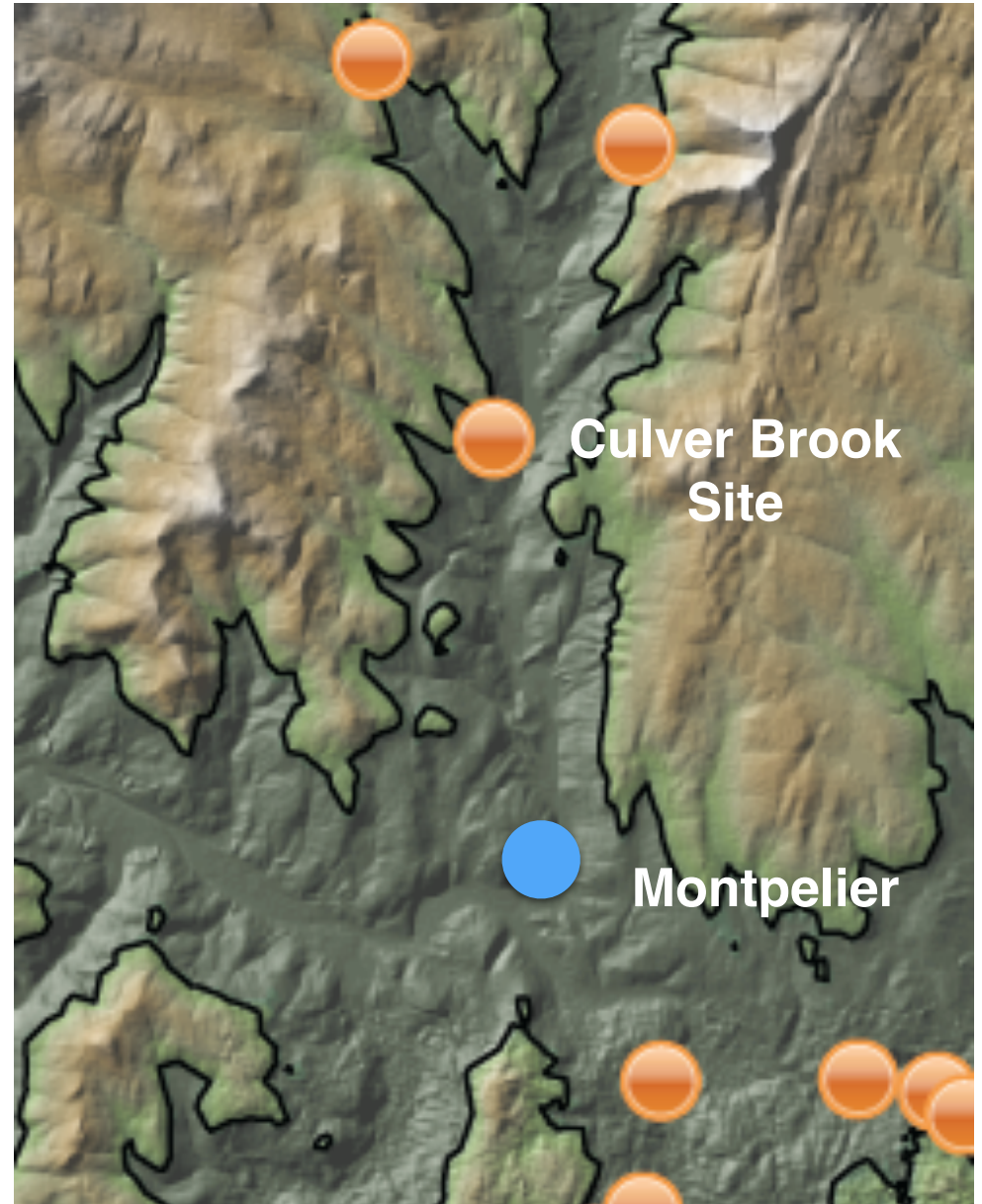


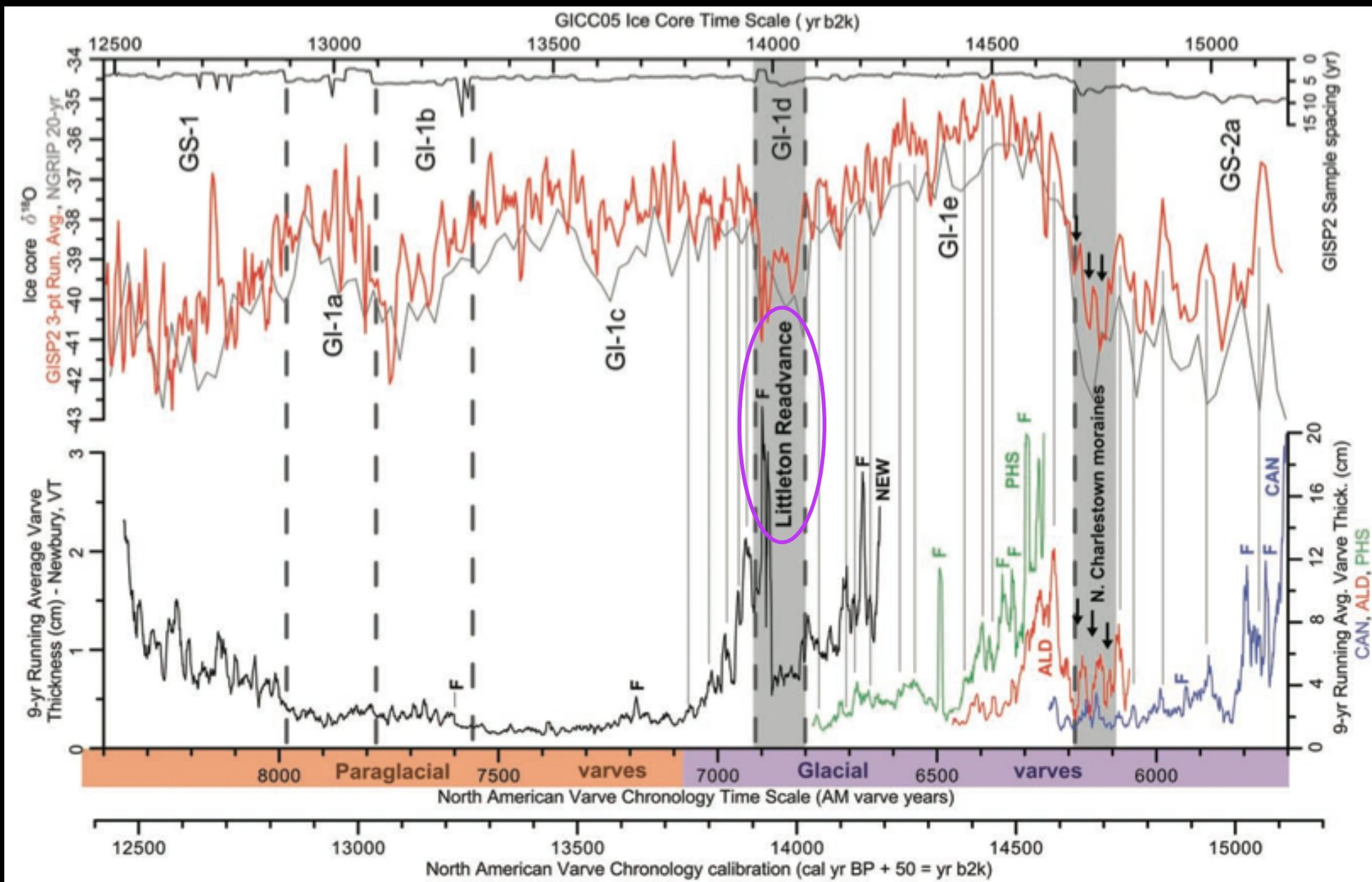
Figure 9. Stratigraphic section at STOP 5C, Culver Brook Section 2. View looking northwest.

Timing of the Middlesex Readvance

- Culver Brook Site
- Wood underlying the upper till:
- 11,900 +/- 50 Years BP
¹⁴C Age
- 13,750 Calibrated Age
- Larsen (2001)

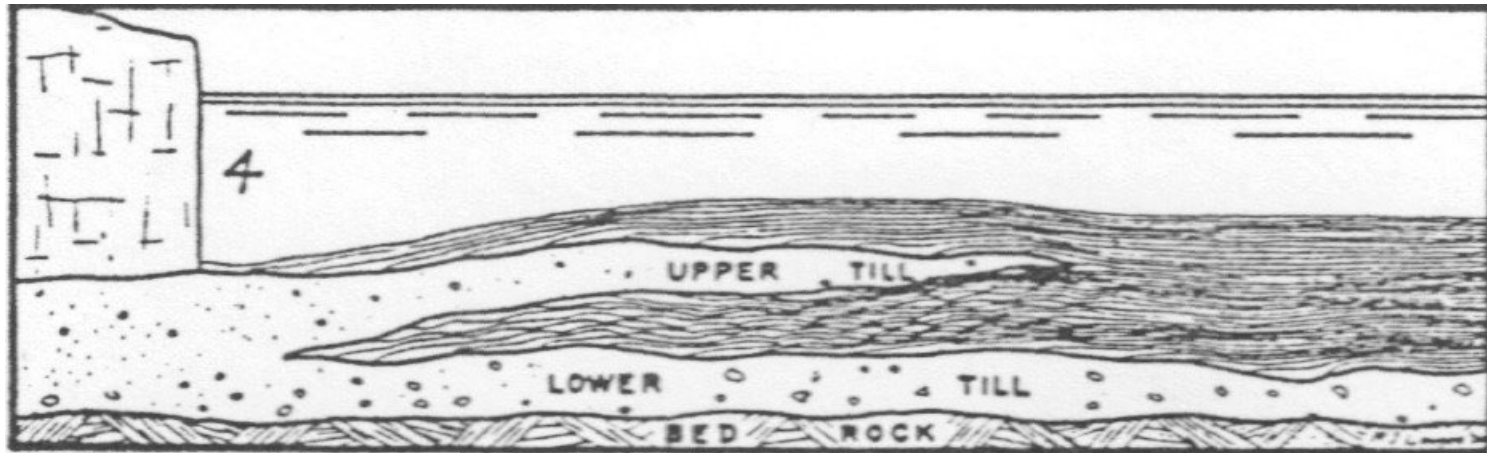


Duration of the Older Dryas GI-1d ~125 years



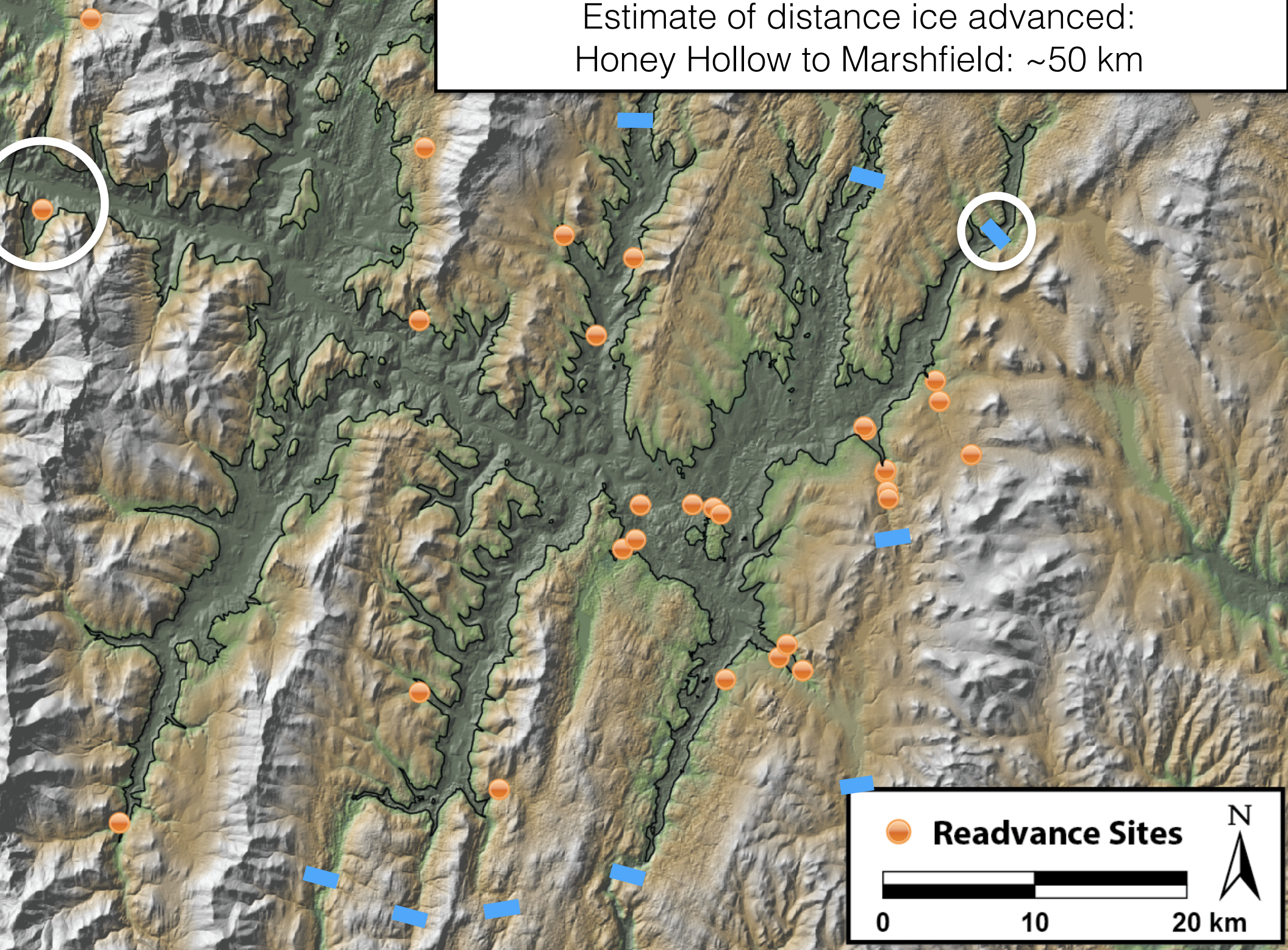
Ridge and others, 2012

Duration of the Middlesex Readvance



- Lougee (1935) calculated that the upper till at the Commerford Dam site in the Connecticut River valley formed during a time span of 151 years by counting the “missing varves” in the two till section vs the sections uninterrupted by the readvance till.
- Duration of the Older Dryas (Gl-1d) ~125 years

Estimate of distance ice advanced:
Honey Hollow to Marshfield: ~50 km



Estimate of the rate of ice advance

- Honey Hollow to Marshfield Terminus
 - $\sim 50 \text{ km} / 151 \text{ years} = \sim 330 \text{ m/year}$
 - $\sim 50 \text{ km} / 125 \text{ years} = \sim 400 \text{ m/year}$
 - Ice Stream Velocities!!
 - Honey Hollow readvance section may have been produced at a later time, i.e. the ice had not retreated this far down the valley (west) before the readvance initiated.
- Western margin the Greenland Ice sheet velocities: 75–125 m/year
 - $125 \text{ m/year} \times 151 \text{ years} = 19 \text{ km}$

19 km of ice advance from Montpelier would cover most of the readvance sites

