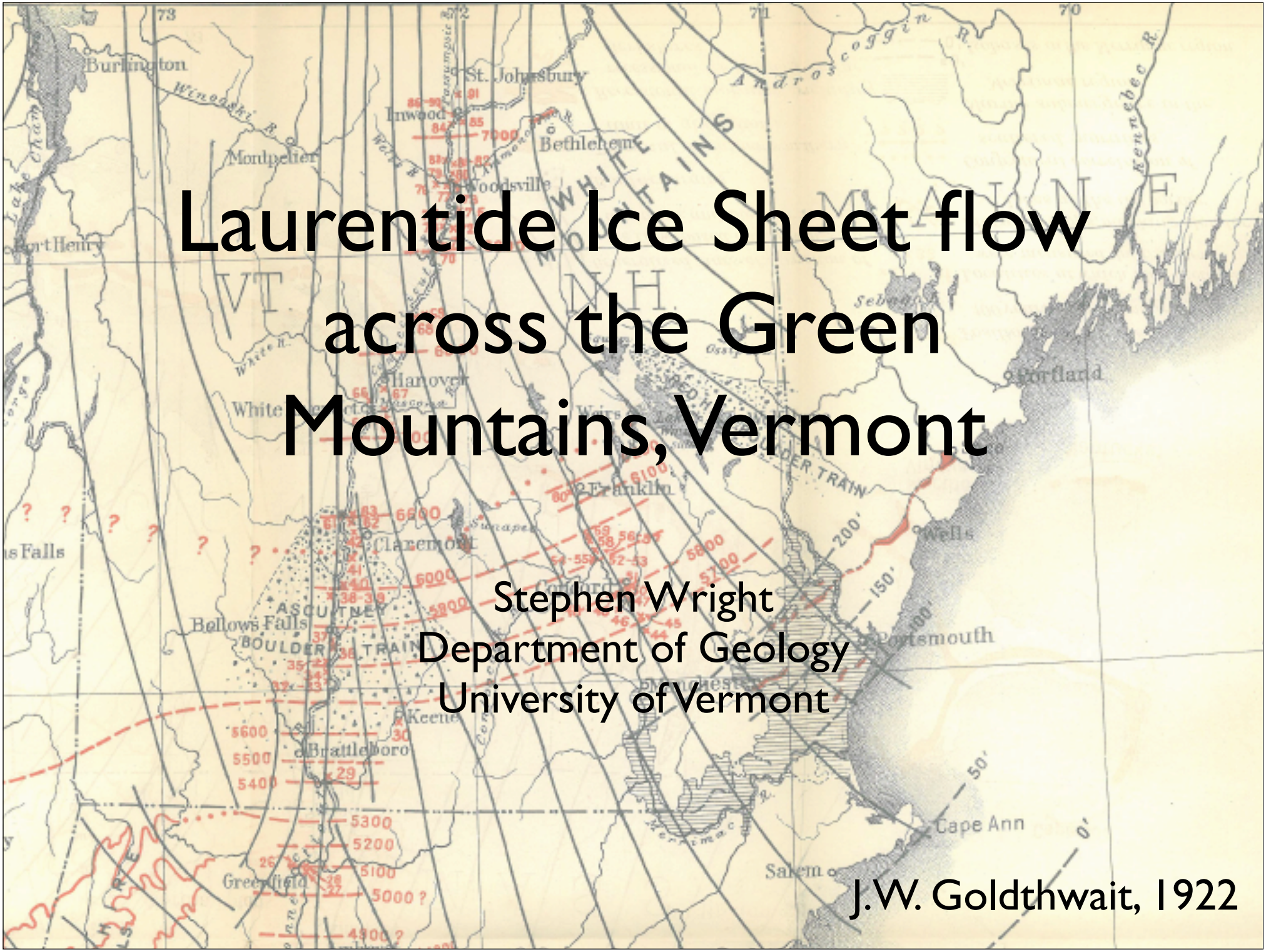
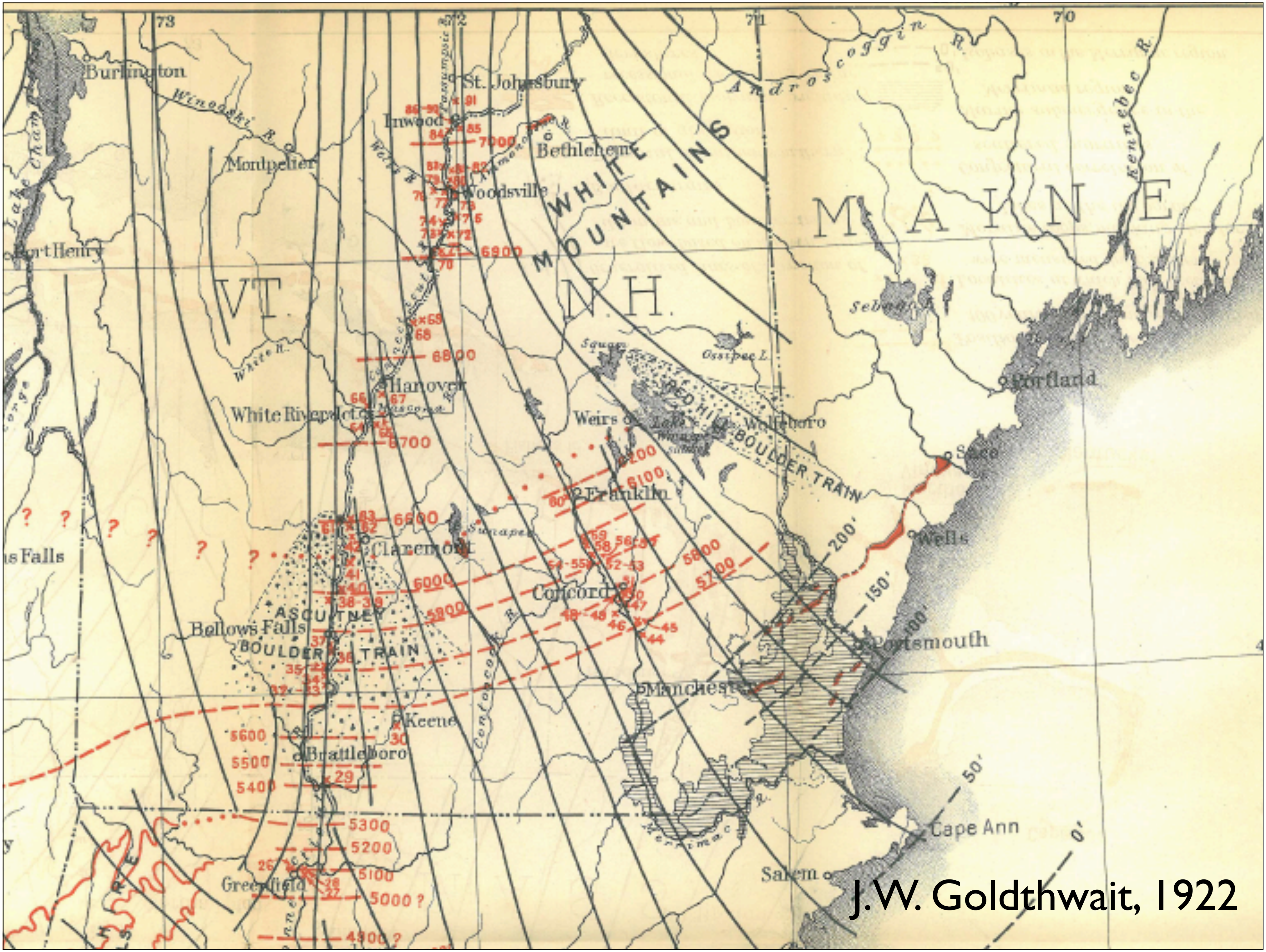

Laurentide Ice Sheet flow across the Green Mountains, Vermont
Stephen Wright
Department of Geology
University of Vermont
J.W. Goldthwait, 1922
Burlington
St. Johnsbury
Montpelier
Bethlehem
Woodsville
Hanover
Franklin
Claremont
Bellows Falls
Keene
Brattleboro
Greenfield
Portland
Wells
Portsmouth
Cape Ann
Salem
VT
NH
MAINE
BOULDER TRAIN
ASCUTNEY
WHITE MOUNTAINS
Androscoggin R.
Kennebec R.
White R.
Winooski R.
Lake Champlain
200'
150'
100'
50'
0'
5600
5500
5400
5300
5200
5100
5000 ?
4900 ?
6600
6100
6000
5800
5700



J.W. Goldthwait, 1922

SSE Indicator Fans sourcing from the Barre and Braintree Granite Stocks (Larsen, 1972) and Grenville plutons in Québec (Larsen and Donahue, 2003)

Barre Granite

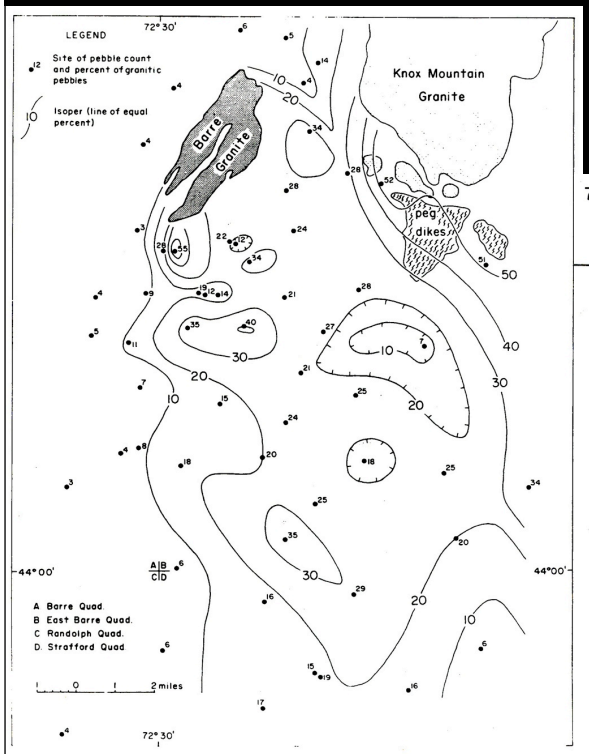


Figure 3. Indicator fan of pebbles from the Barre Granite (location of bedrock exposures from Murthy, 1957).

Braintree Granite

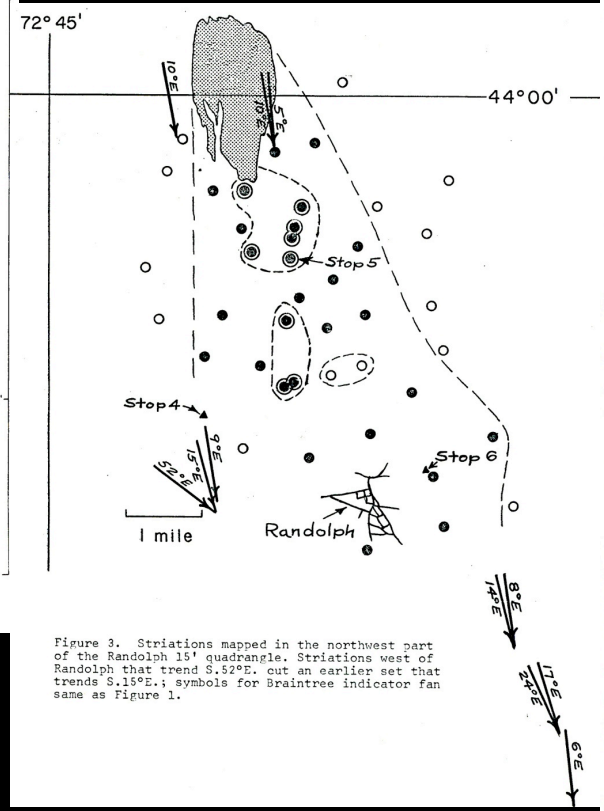
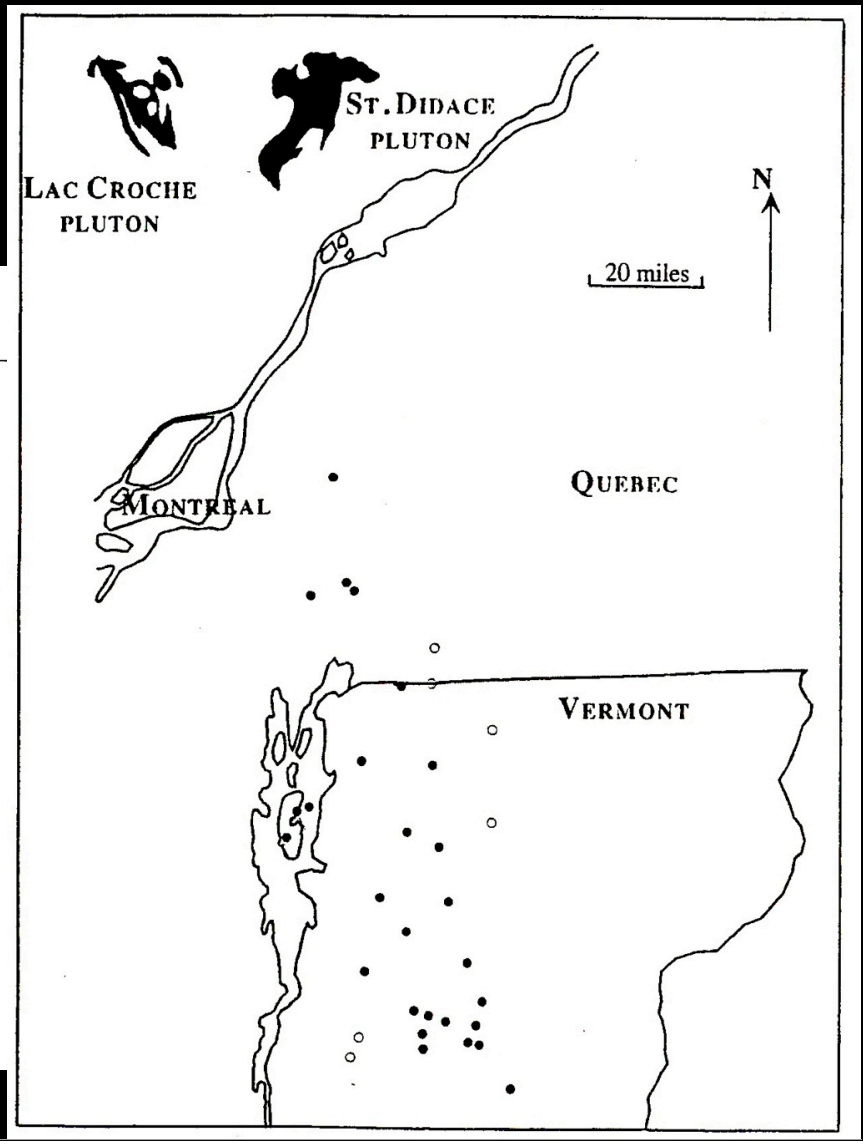
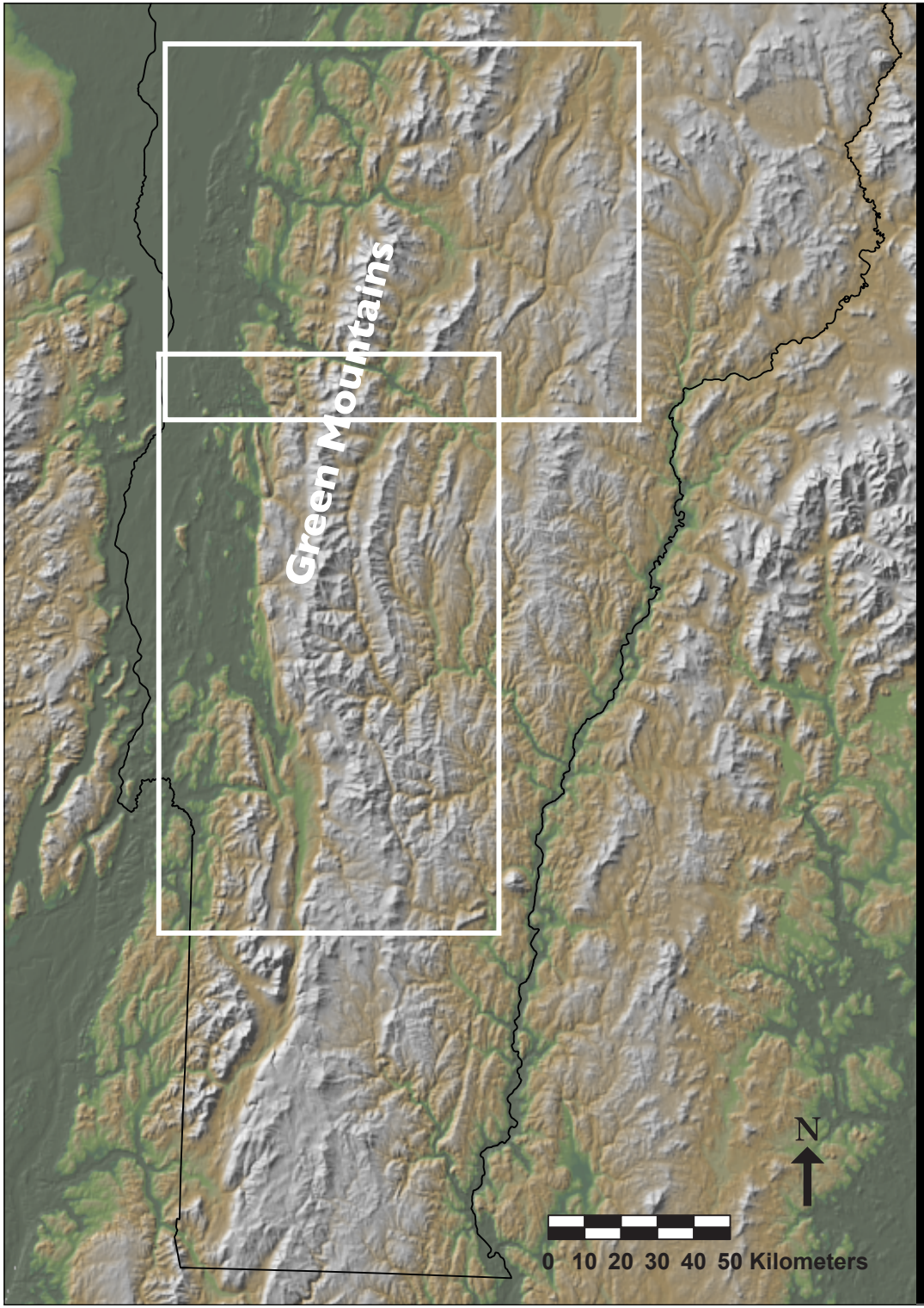


Figure 3. Striations mapped in the northwest part of the Randolph 15' quadrangle. Striations west of Randolph that trend S.52°E. cut an earlier set that trends S.15°E.; symbols for Braintree indicator fan same as Figure 1.

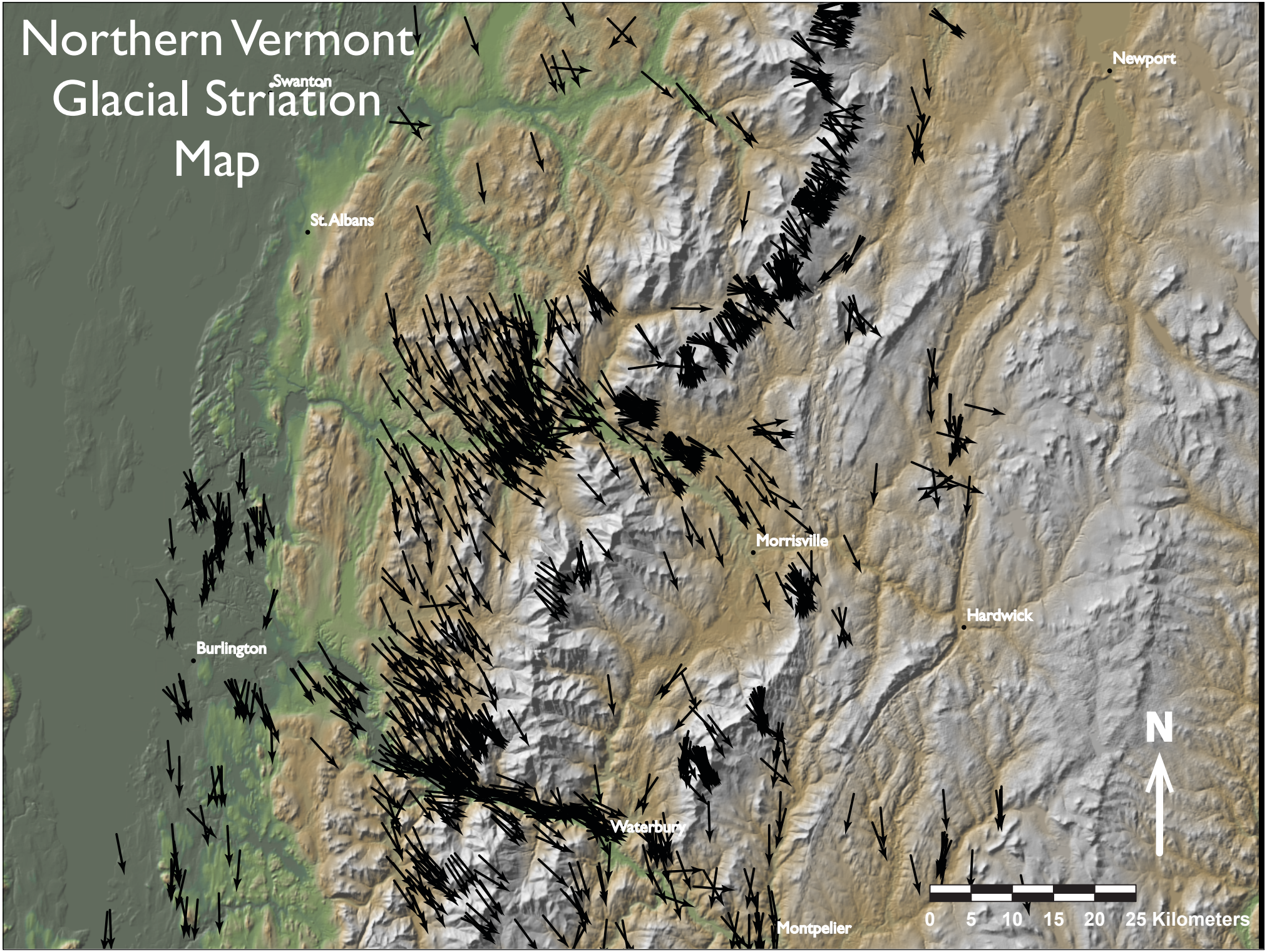




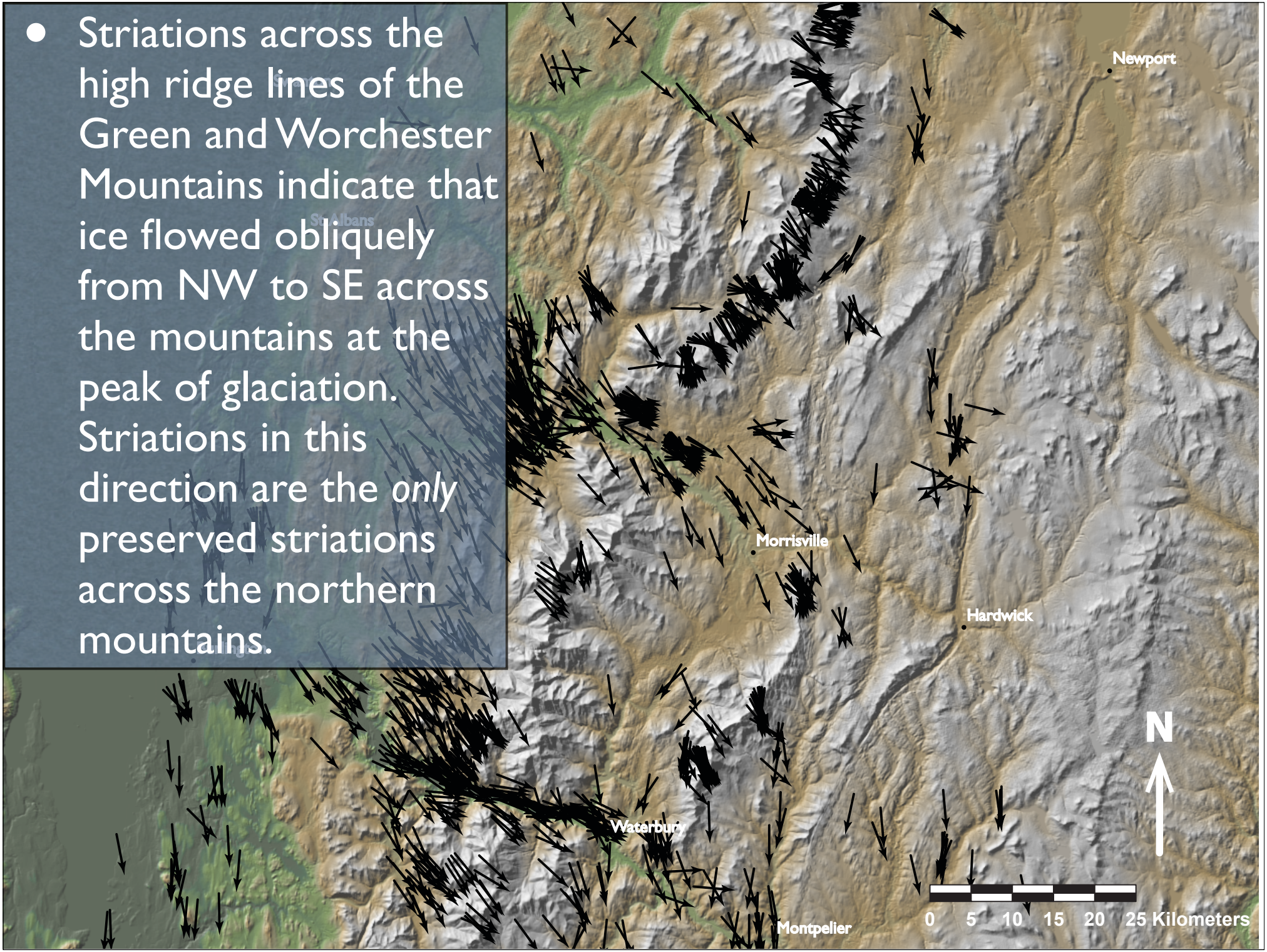
Glacial Striation Measurements

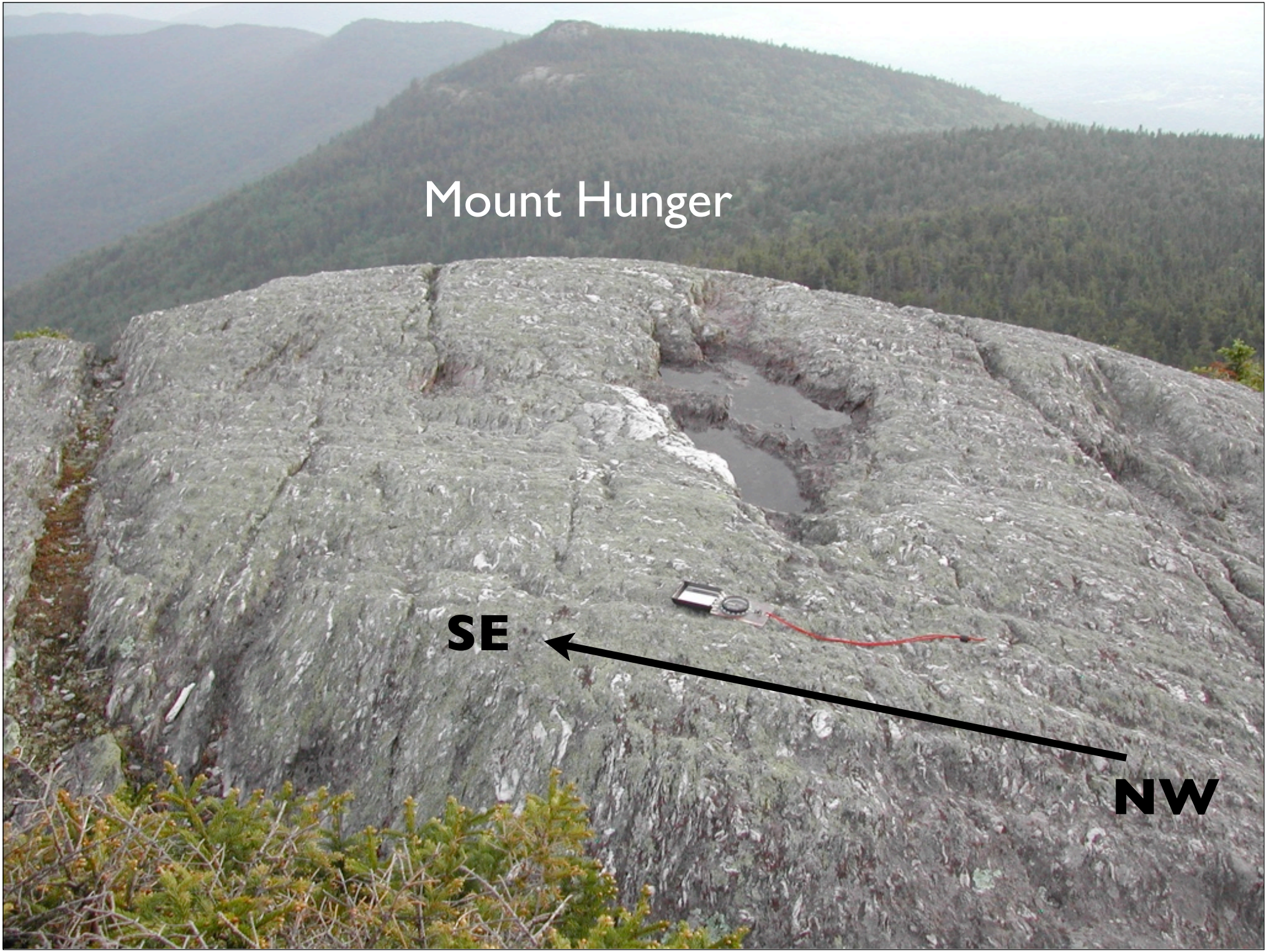
Additional Sources of Striation Data

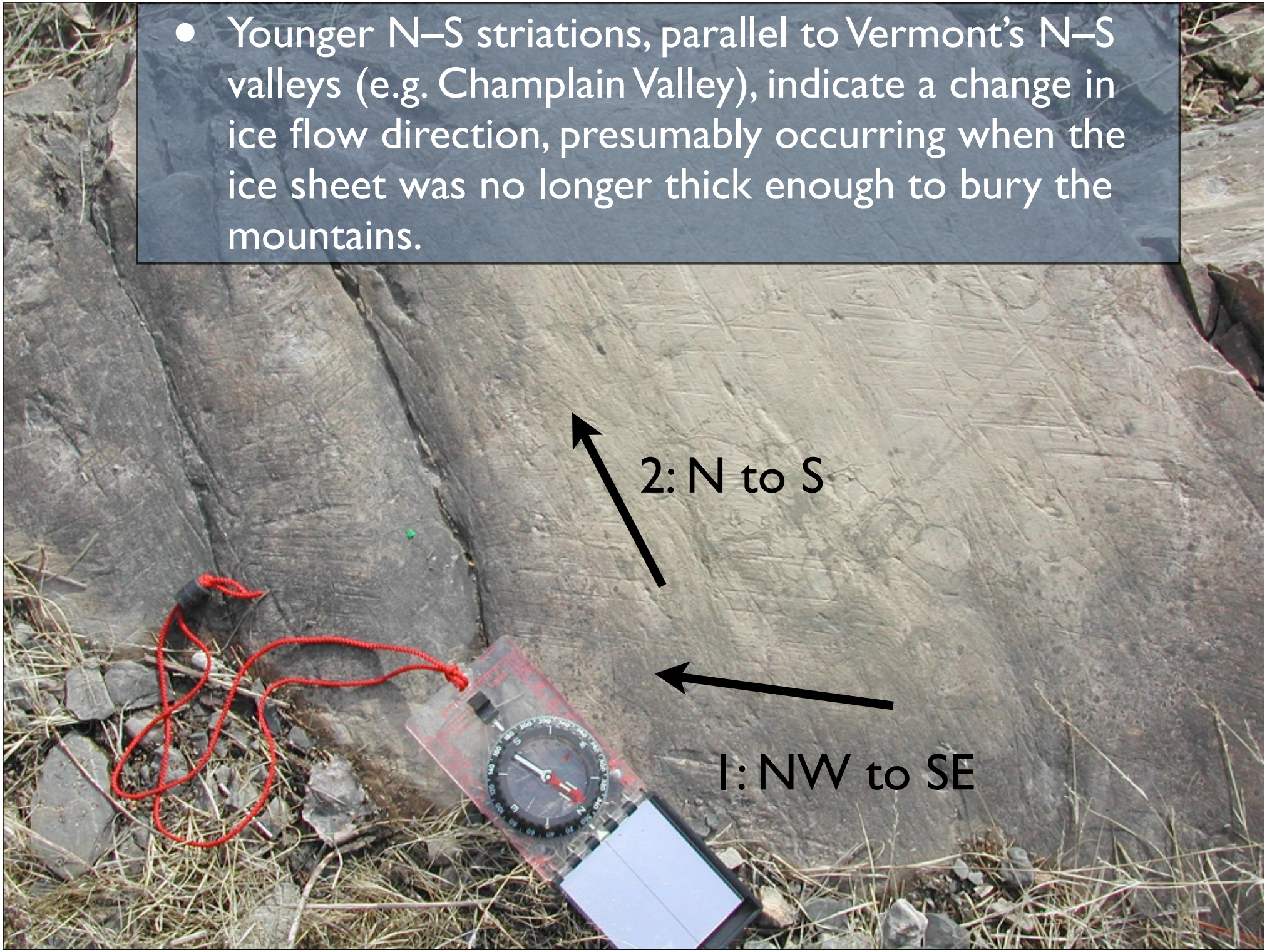
- G. Springston & R. Dunn
- F. Larsen
- UVM Students: D. Brennan, M. McGee, A. Bosley, S. Fuller, S. Jones
- S. Clark
- J. Van Hoesen
- R. Christman
- G. Connally
- P. MacClintock
- P. Calkin
- W. Cannon
- D. Stewart


Northern Vermont
Glacial Striation
Map
Swanton
St. Albans
Newport
Morrisville
Hardwick
Burlington
Waterbury
Montpelier
N
0 5 10 15 20 25 Kilometers

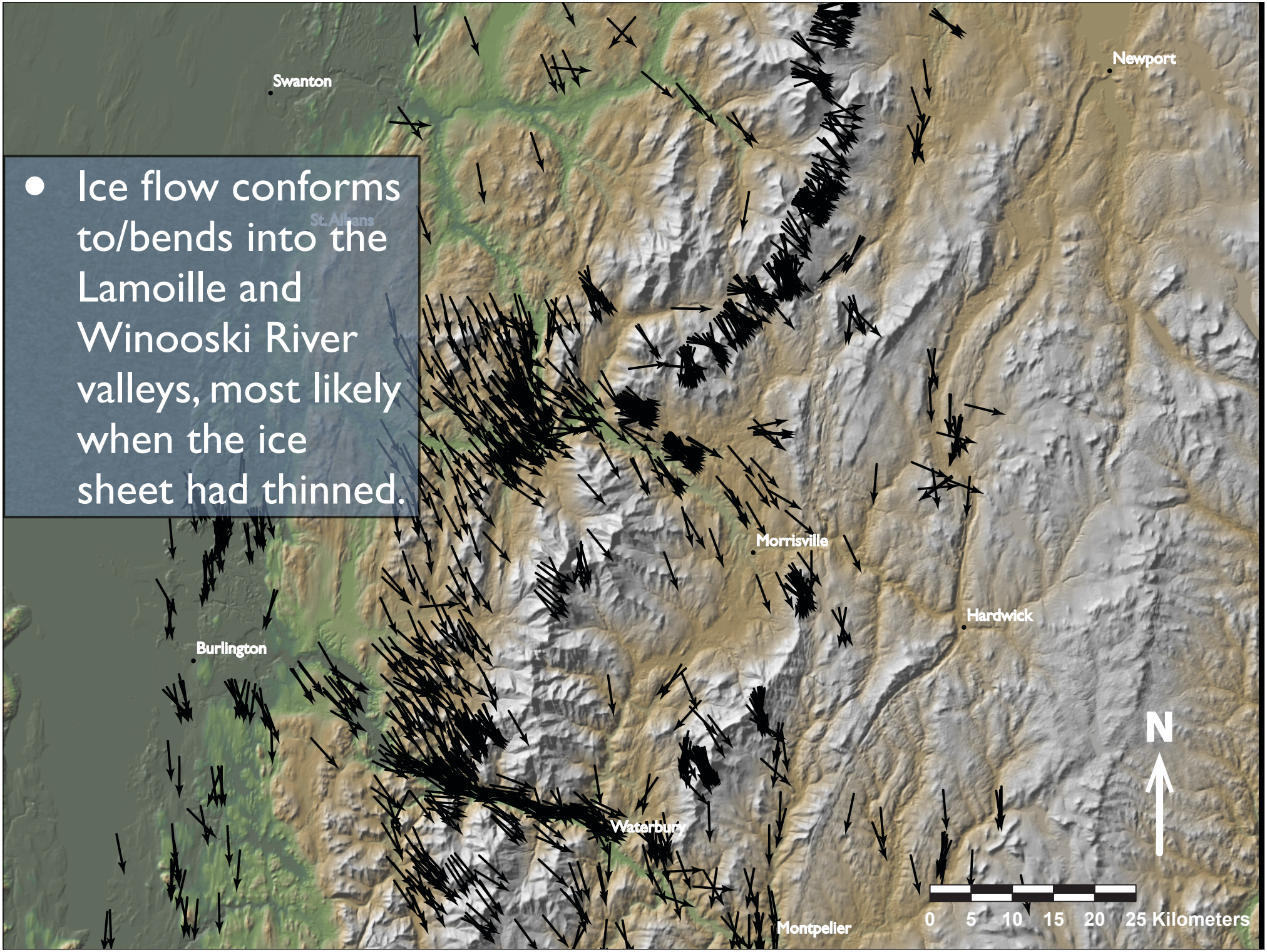
- Striations across the high ridge lines of the Green and Worchester Mountains indicate that ice flowed obliquely from NW to SE across the mountains at the peak of glaciation. Striations in this direction are the *only* preserved striations across the northern mountains.



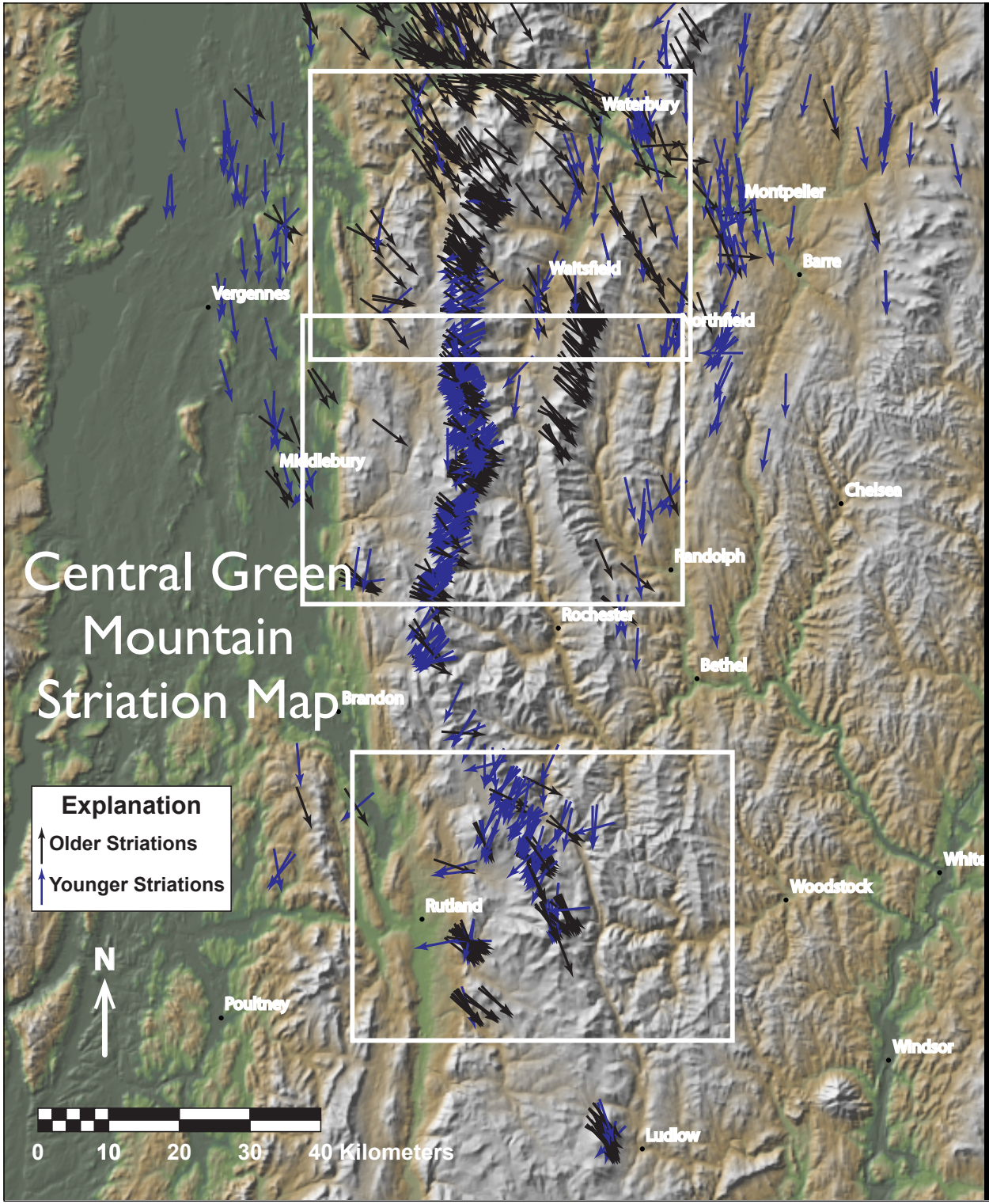

Mount Hunger
SE
NW



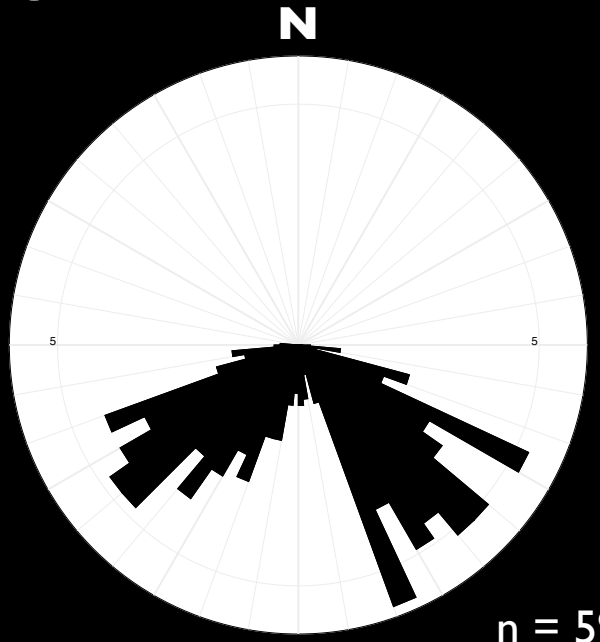
- Younger N–S striations, parallel to Vermont's N–S valleys (e.g. Champlain Valley), indicate a change in ice flow direction, presumably occurring when the ice sheet was no longer thick enough to bury the mountains.



- Ice flow conforms to/bends into the Lamoille and Winooski River valleys, most likely when the ice sheet had thinned.

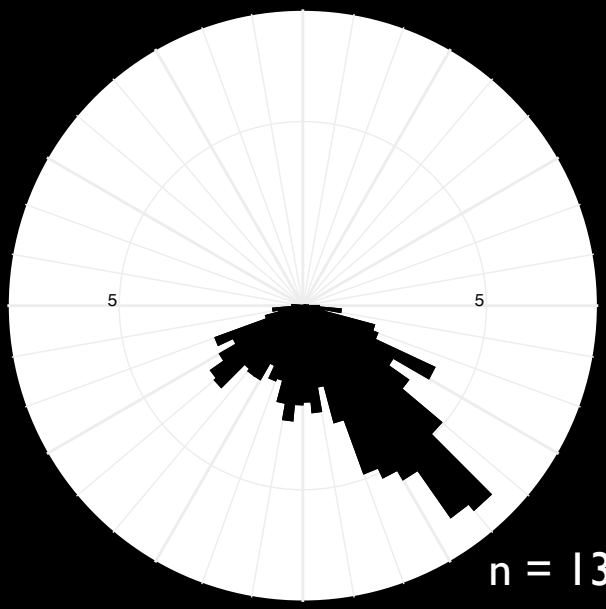


High-Elevation Striations

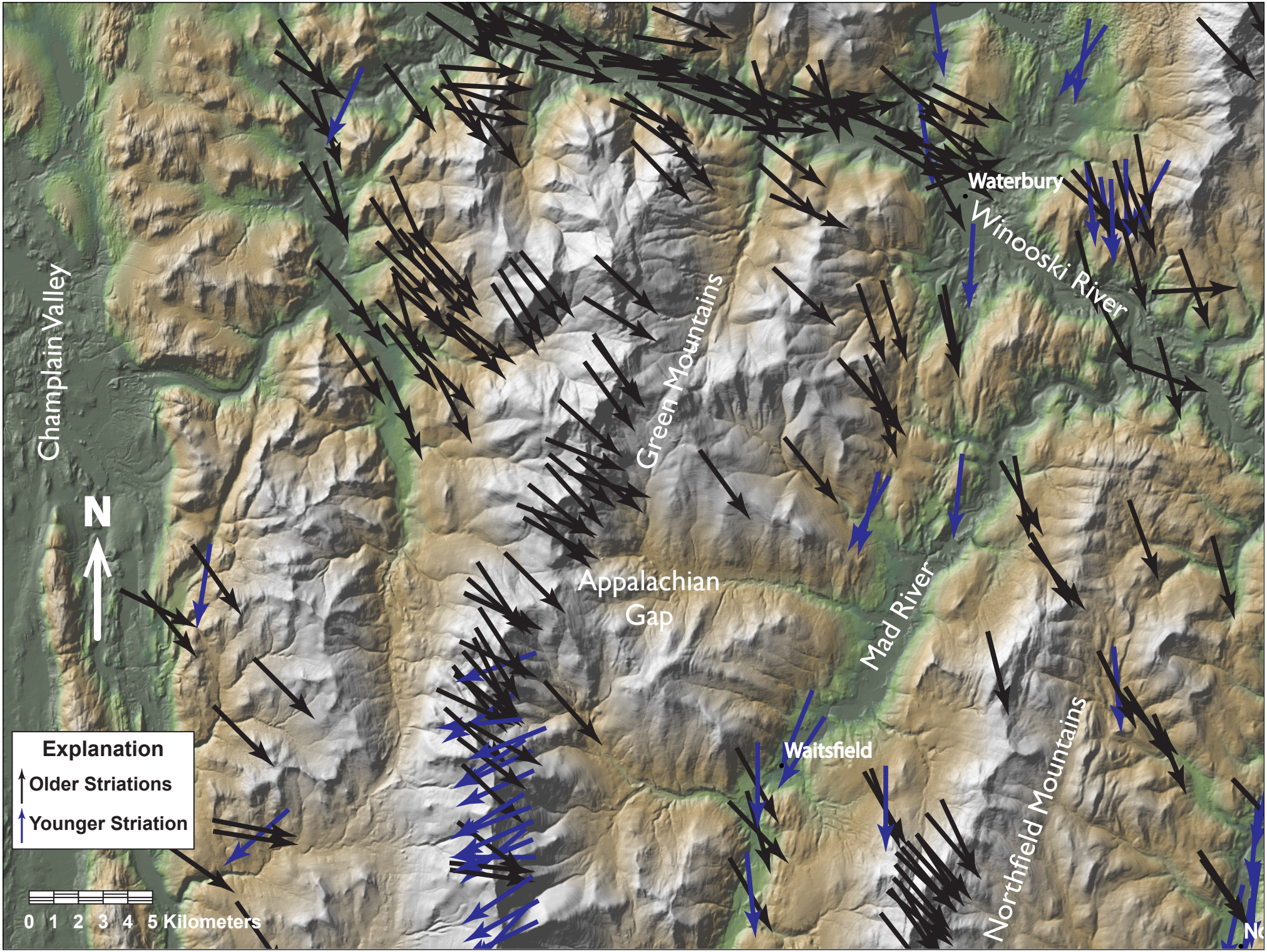


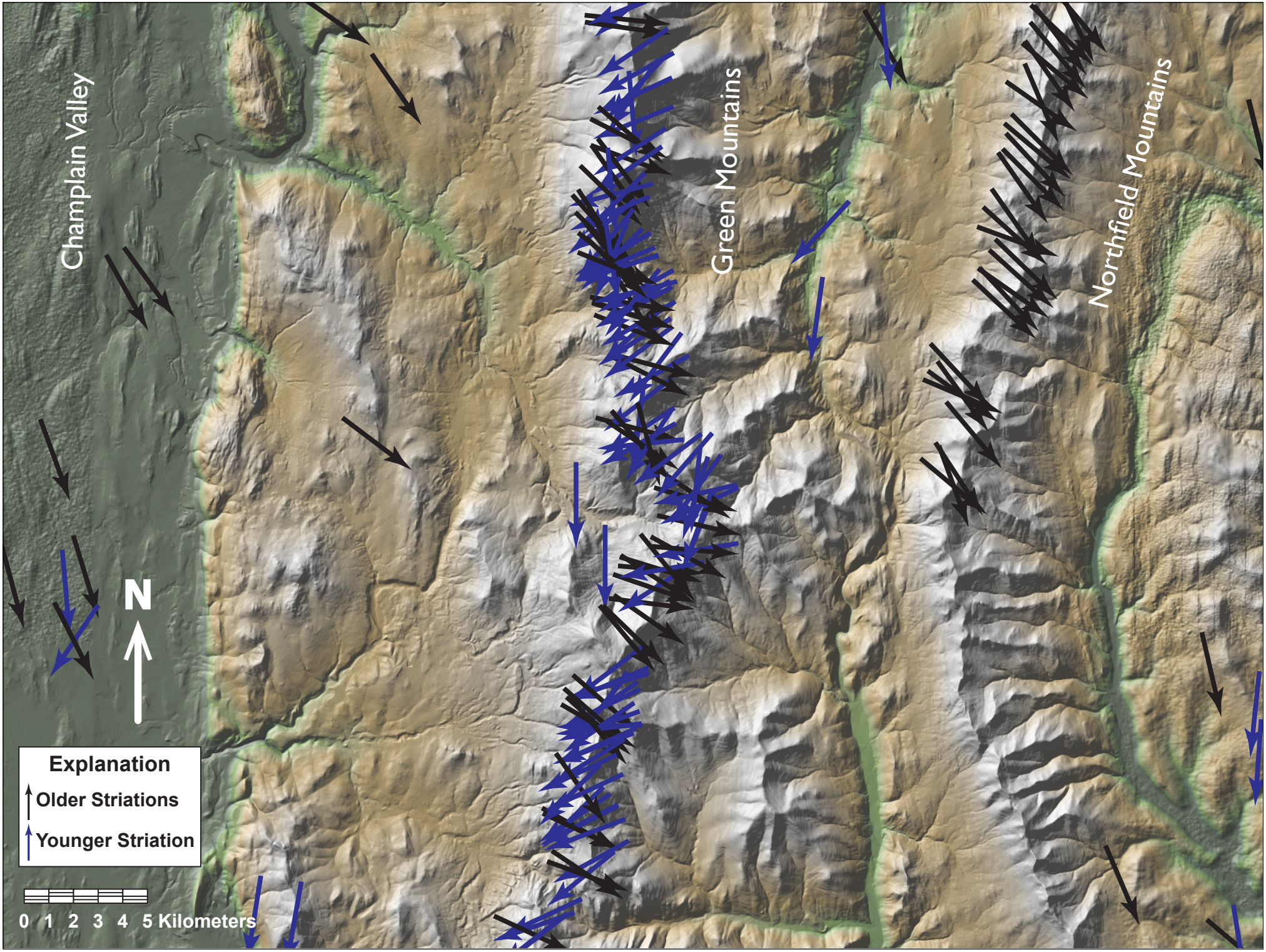
n = 598

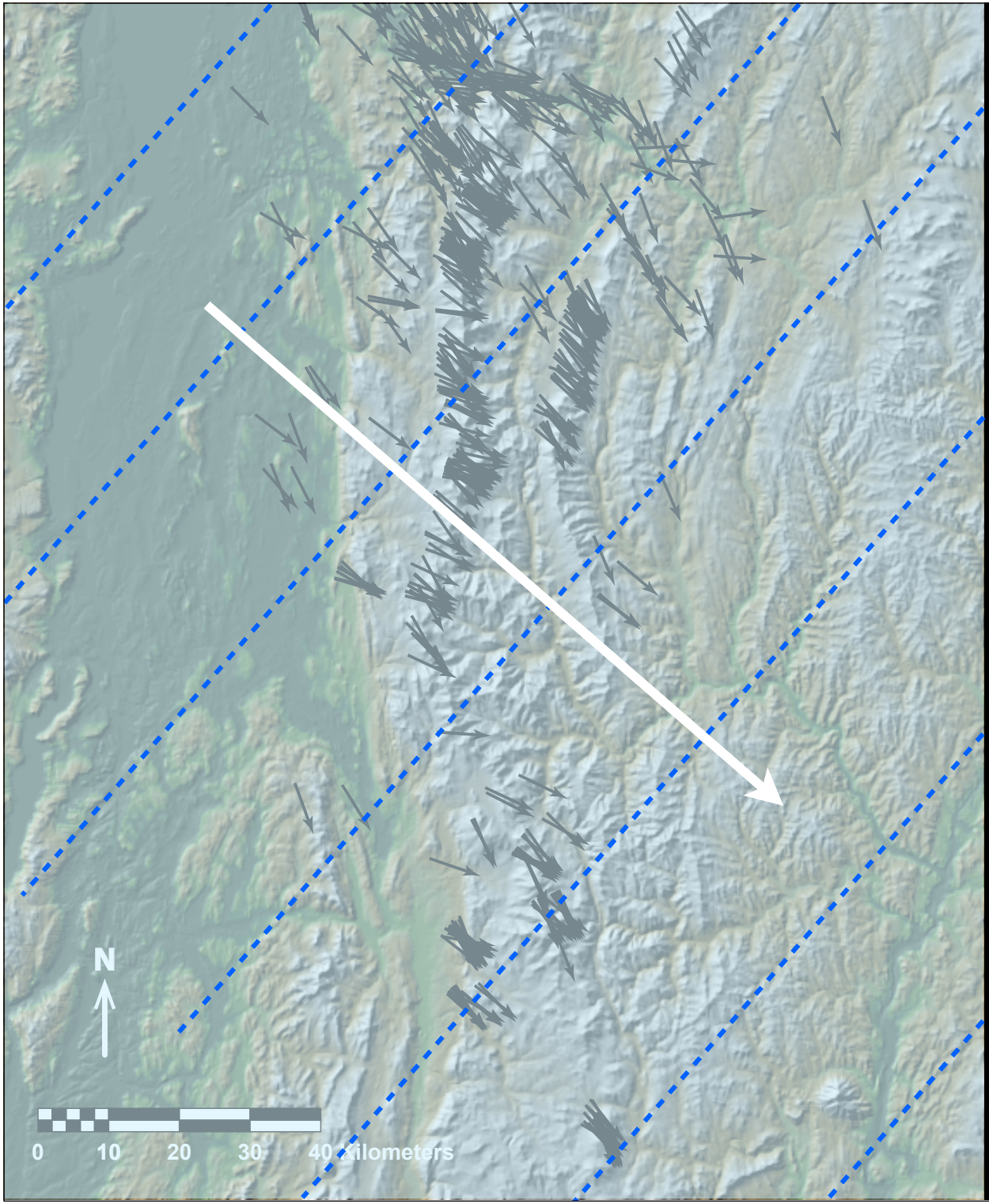
All Striations



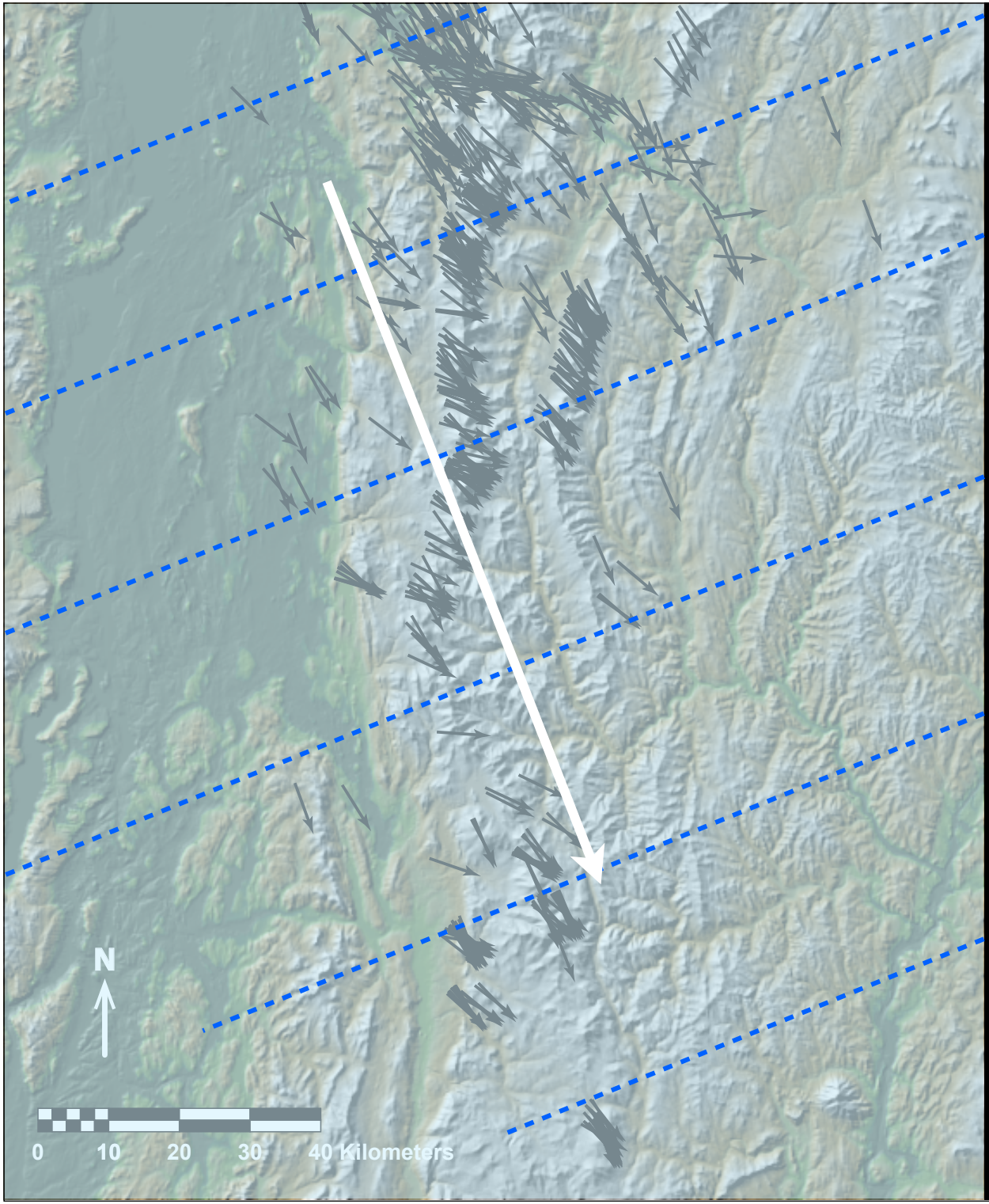
n = 1346


Champlain Valley
N
Green Mountains
Appalachian Gap
Mad River
Waterbury
Winooski River
Waitsfield
Northfield Mountains
Explanation
Older Striations
Younger Striation
0 1 2 3 4 5 Kilometers


Champlain Valley
Green Mountains
Northfield Mountains
N
Explanation
Older Striations
Younger Striation
0 1 2 3 4 5 Kilometers

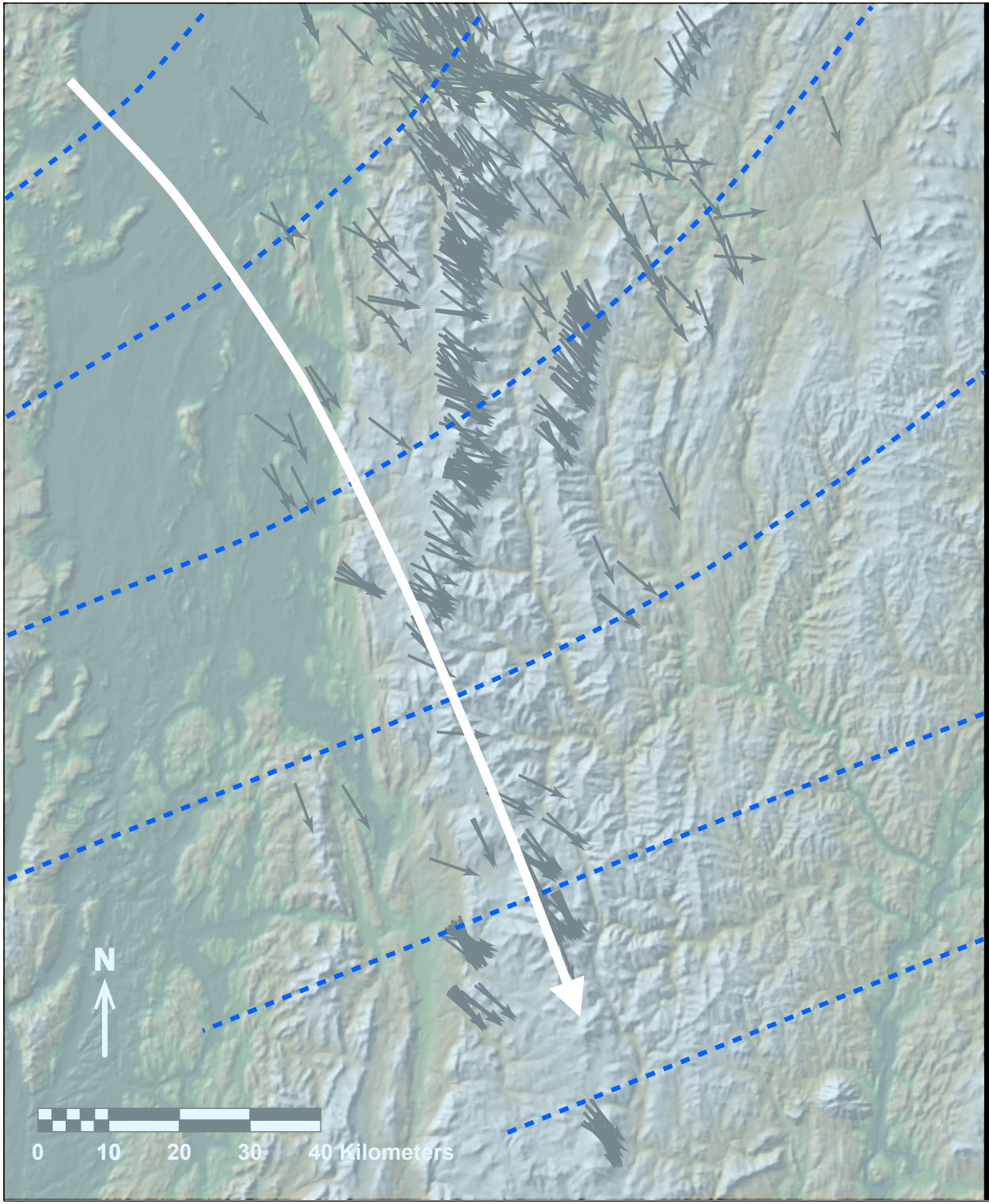


"Early" ice flow to the SE across the Green Mountains

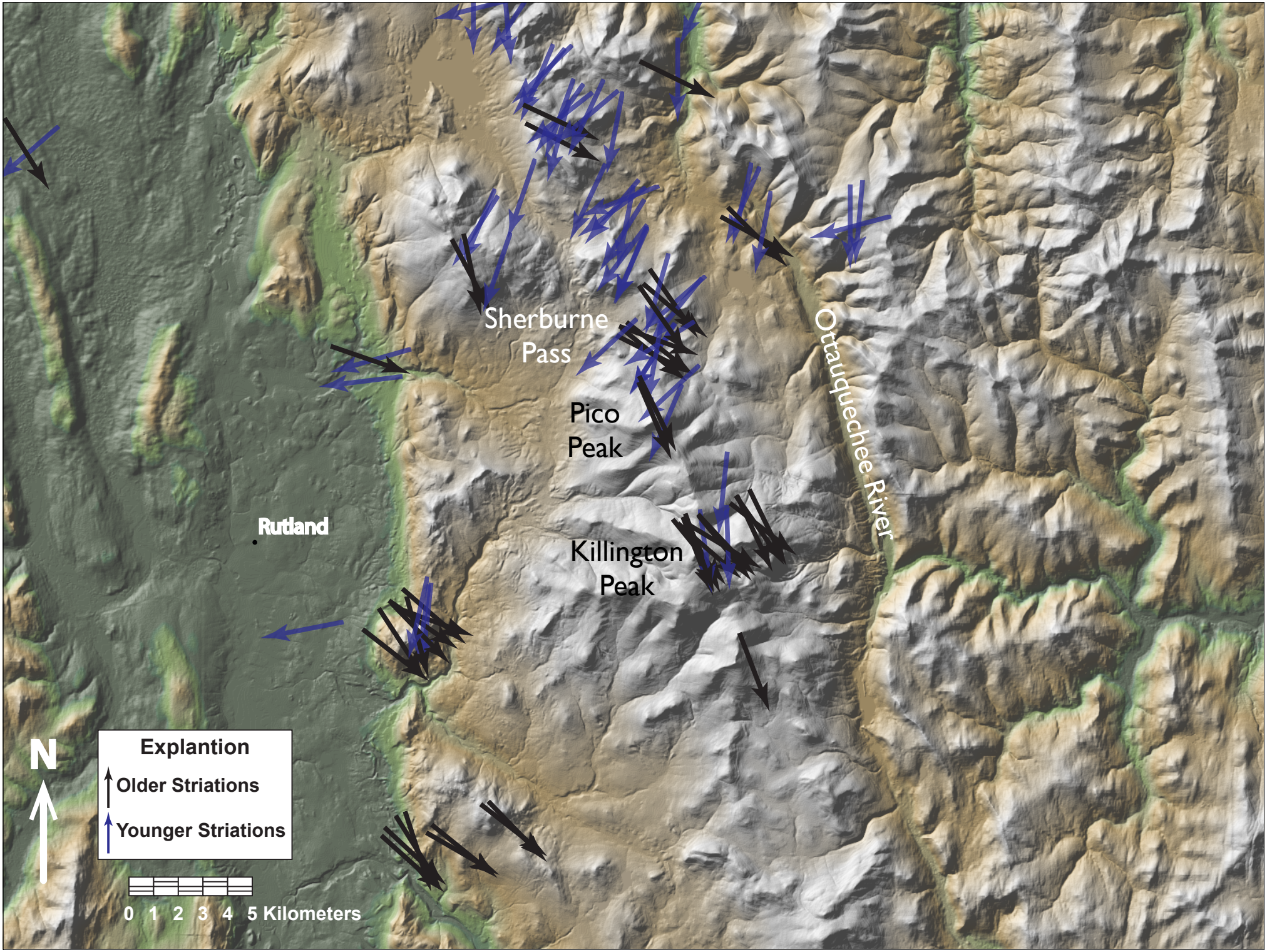


Shift in ice flow to SSE

High-elevation striations record this shift, so the ice was still thick enough to cover the mountains when this shift occurred.



At any particular point in time ice flow shifted smoothly from SE to SSE.


Sherburne
Pass
Pico
Peak
Killington
Peak
Ottauquechee River
Rutland
N
Explantion
Older Striations
Younger Striations
0 1 2 3 4 5 Kilometers

How to drive ice into the Champlain Valley?

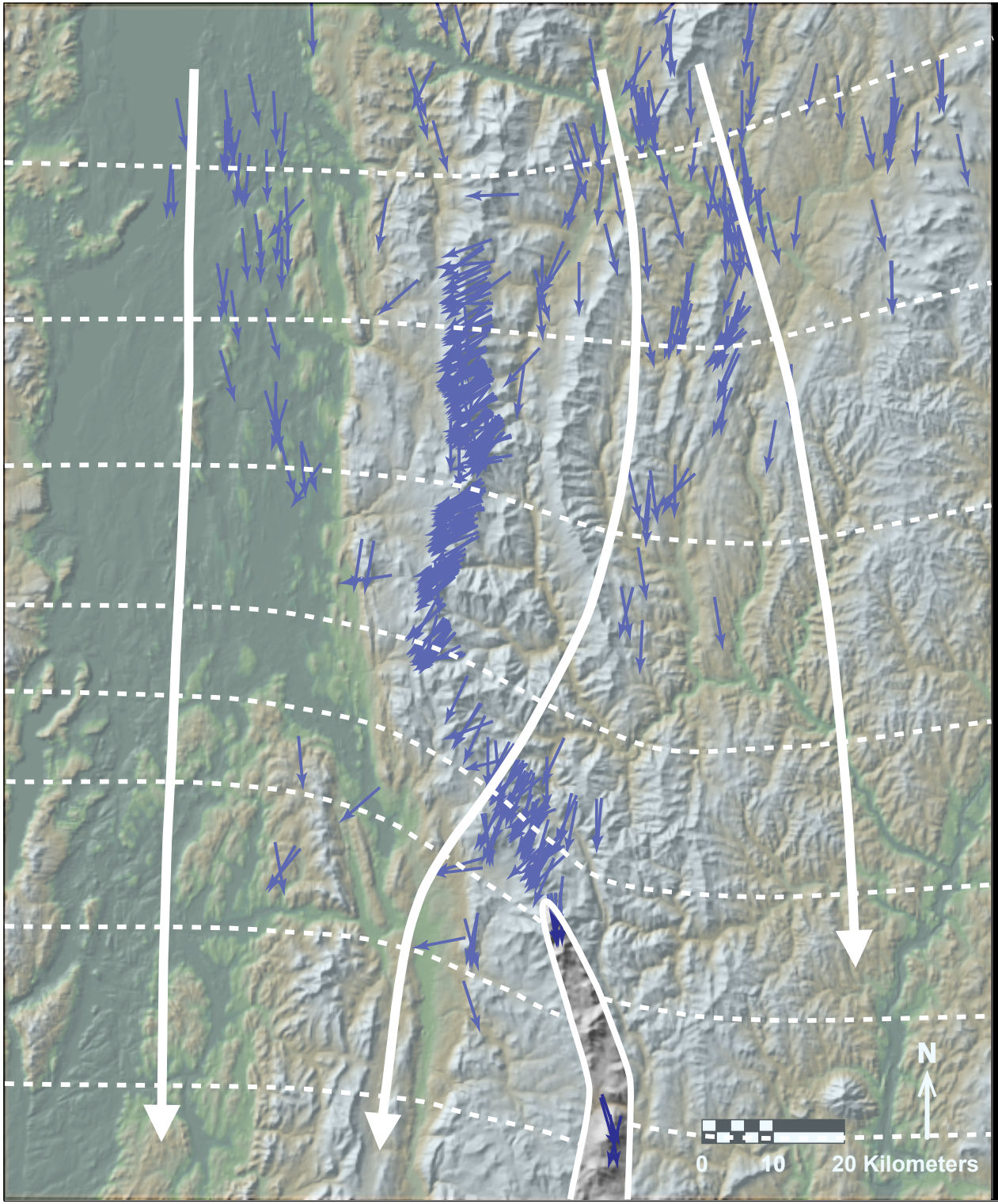
1. Elevation of the ice surface east of the Green Mountains had to increase relative to the ice surface in the Champlain Valley
    - Difficult to imagine a process that would funnel ice into the mountains and not into the Champlain valley
    - That ice bulge and change in striation direction would propagate from north to south. There's no evidence of SW-directed ice flow north of Appalachian Gap.

How to drive ice into the Champlain Valley?

2. OR Elevation of the ice surface in the Champlain Valley had to decrease relative to the ice surface east of the Green Mountains

    a) If driven by rapid retreat and thinning, lowering of the ice surface in the Champlain Valley would have propagated from south to north.

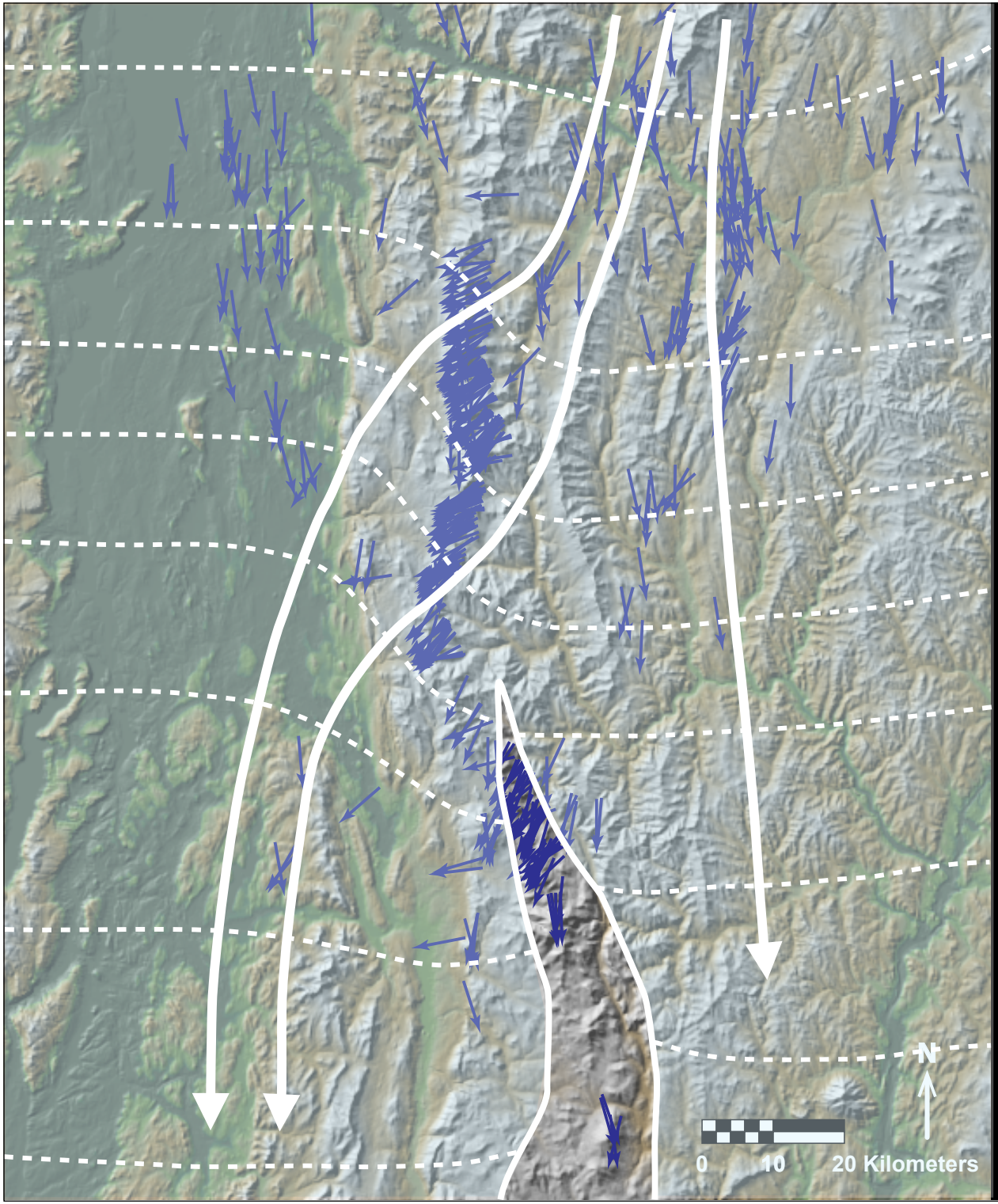
    b) If driven by a surge, lowering of the ice surface in the Champlain Valley could have initiated north of the ice margin (at the latitude where ice reversals have been documented in the Green Mountains) and propagated either or both north and south, respectfully up or down glacier.



Contour lines model a drawdown of the ice surface in the Champlain Valley: Rapid retreat; A Surge???

Ice Surface Contours

Flow Lines

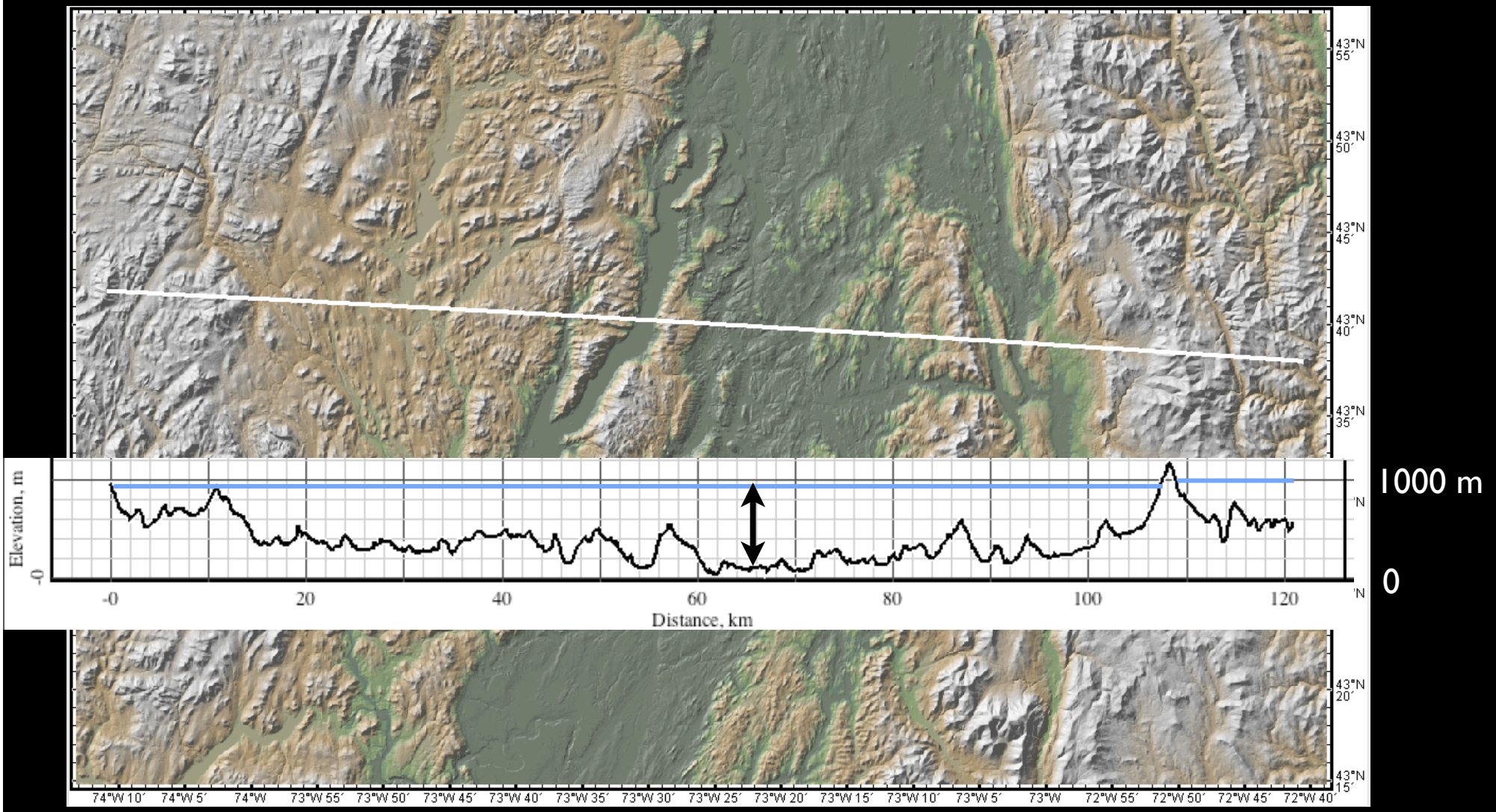


Steep inflection of ice surface contours (drawdown of ice in the Champlain Valley) propagates up-glacier, but stops near the latitude of Appalachian Gap: Is the ice sheet frozen to its base here?

Ice Surface Contours

Flow Lines

Ice surface elevation ~930 m
Land surface elevation ~100 m
Ice Sheet thickness ~830 m

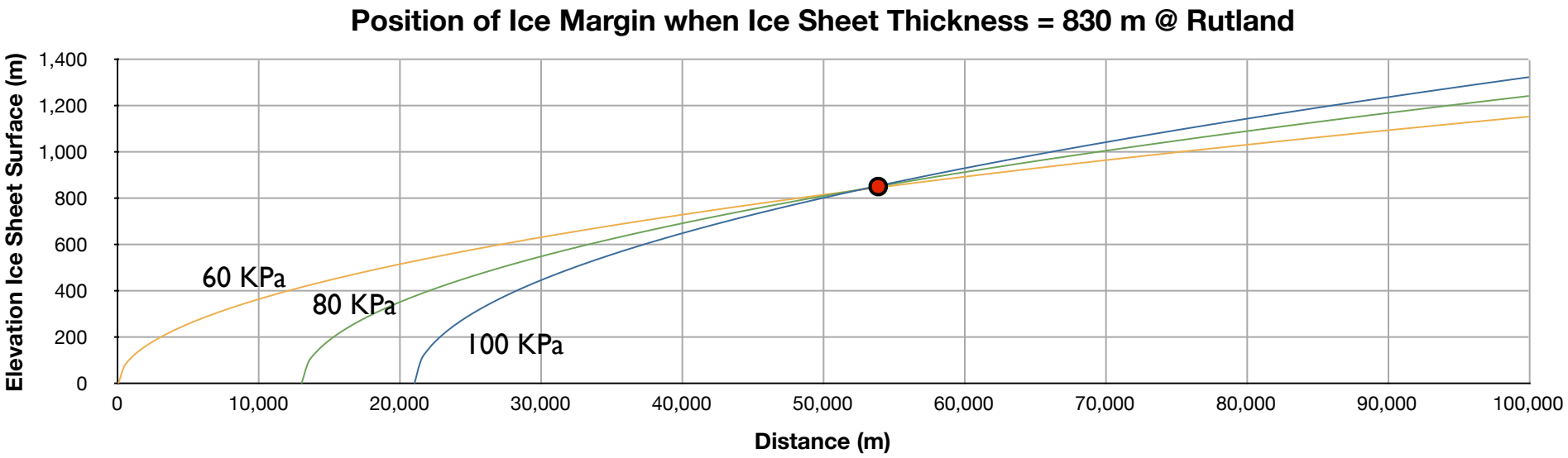


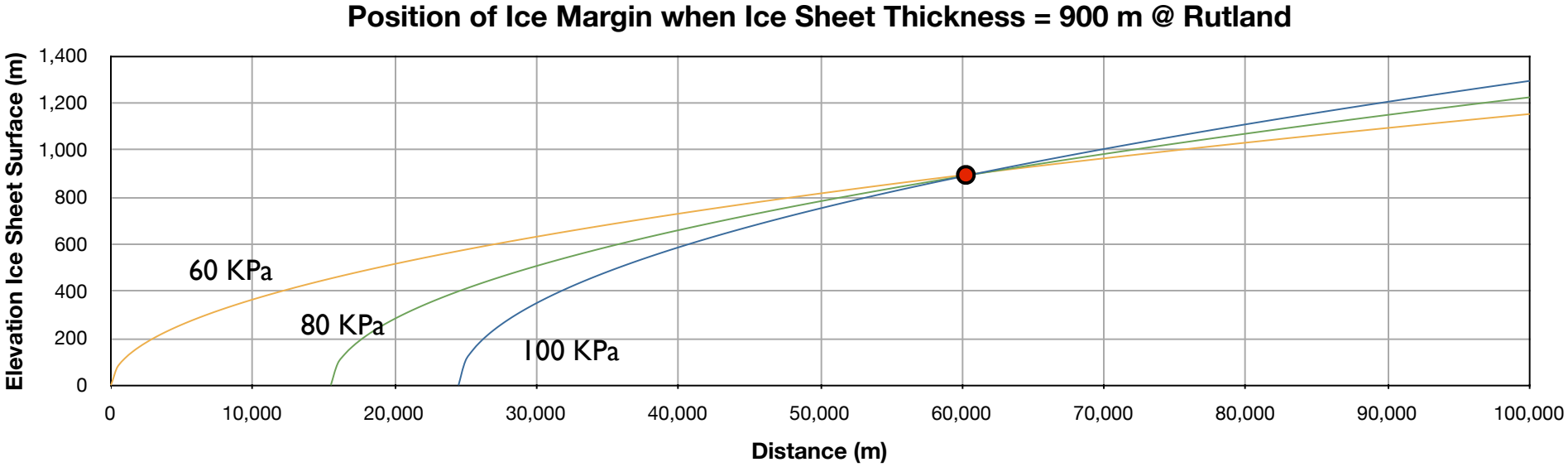
1000 m

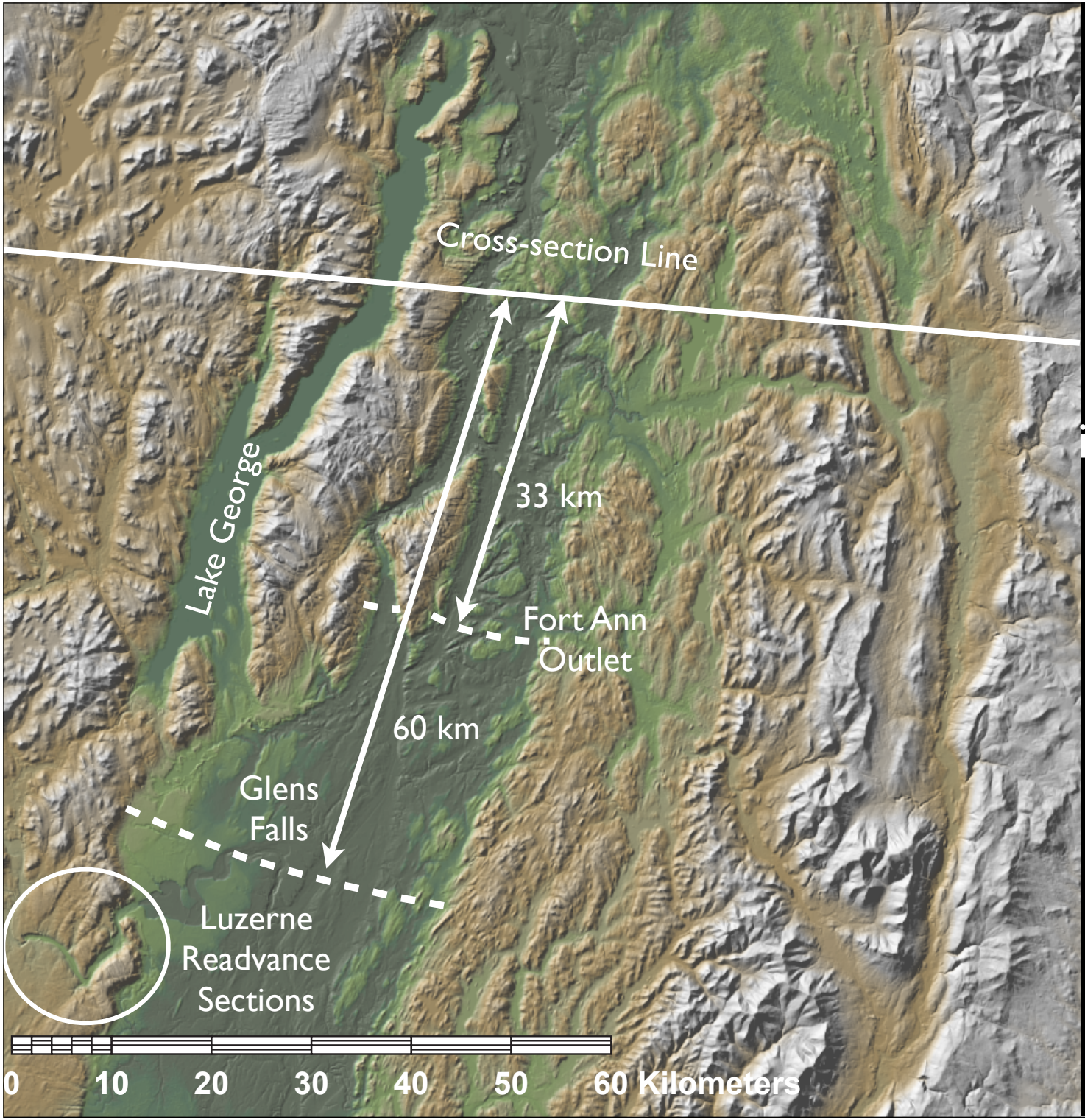
0

10x Vertical Exaggeration

Ice sheet profiles

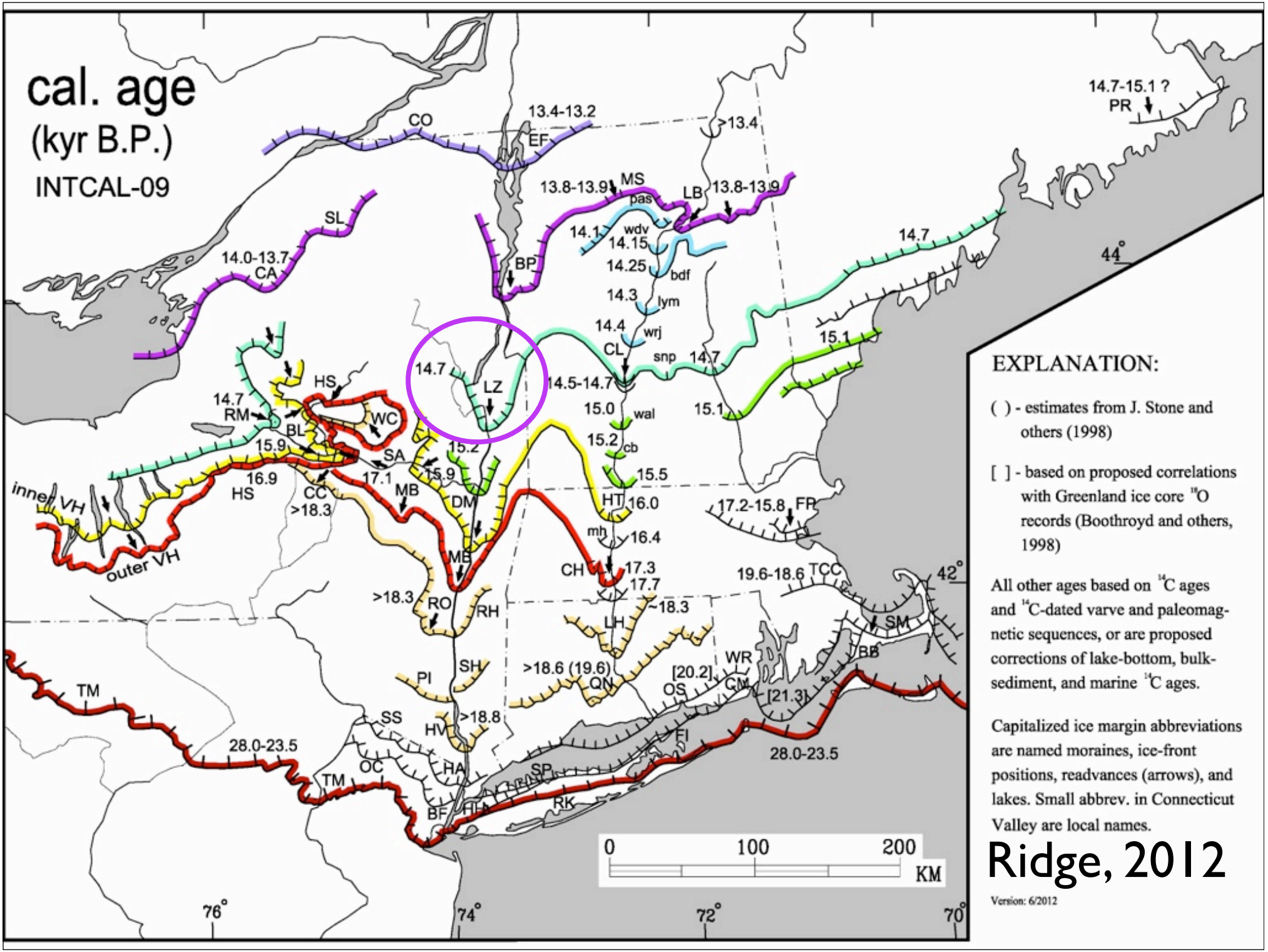




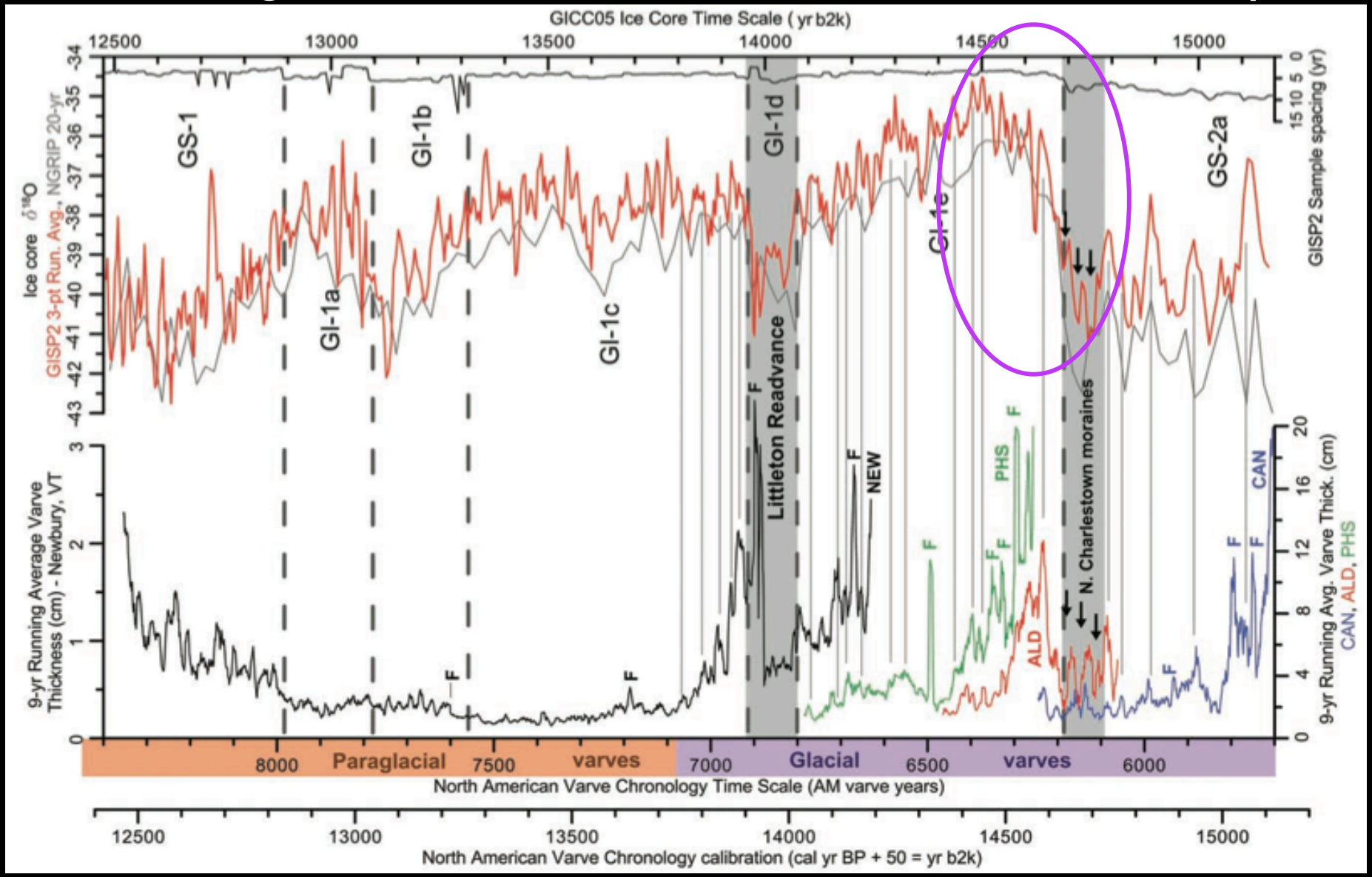


Estimated ice margin positions (33–60 km from Cross-section Line) at the time ice began flowing into the Champlain Valley.

Ice margin positions are north of sections showing evidence of the Luzerne readvance (Connally & Sirkin, 1971).


cal. age
(kyr B.P.)
INTCAL-09
CO
13.4-13.2
EF
>13.4
14.7-15.1 ?
PR
13.8-13.9
MS
pas
LB
13.8-13.9
SL
14.1
wdv
14.15
14.0-13.7
CA
BP
14.25
bdf
14.3
lym
14.4
wrj
CL
snp
14.7
15.1
44°
14.7
LZ
14.5-14.7
HS
14.7
RM
WC
BL
15.9
SA
15.2
15.0
wal
15.2
cb
15.5
16.9
HS
CC
>18.3
17.1
MB
15.9
DM
HT
16.0
17.2-15.8
FR
inner VH
outer VH
mh
16.4
MB
CH
17.3
17.7
19.6-18.6
TCC
42°
>18.3
RO
RH
~18.3
LH
SM
BB
WR
PI
SH
>18.6 (19.6)
QN
[20.2]
OS
CM
[21.3]
TM
SS
>18.8
HV
28.0-23.5
FI
28.0-23.5
OC
HA
SP
TM
BF
HF
RK
0
100
200
KM
76°
74°
72°
70°
EXPLANATION:
( ) - estimates from J. Stone and others (1998)
[ ] - based on proposed correlations with Greenland ice core ^{18}O records (Boothroyd and others, 1998)
All other ages based on ^{14}C ages and ^{14}C-dated varve and paleomagnetic sequences, or are proposed corrections of lake-bottom, bulk-sediment, and marine ^{14}C ages.
Capitalized ice margin abbreviations are named moraines, ice-front positions, readvances (arrows), and lakes. Small abbrev. in Connecticut Valley are local names.
Ridge, 2012
Version: 6/2012

Ice flow into the Champlain Valley occurred during a period of rapid warming and ice retreat in the Connecticut River Valley



Ridge and others, 2012