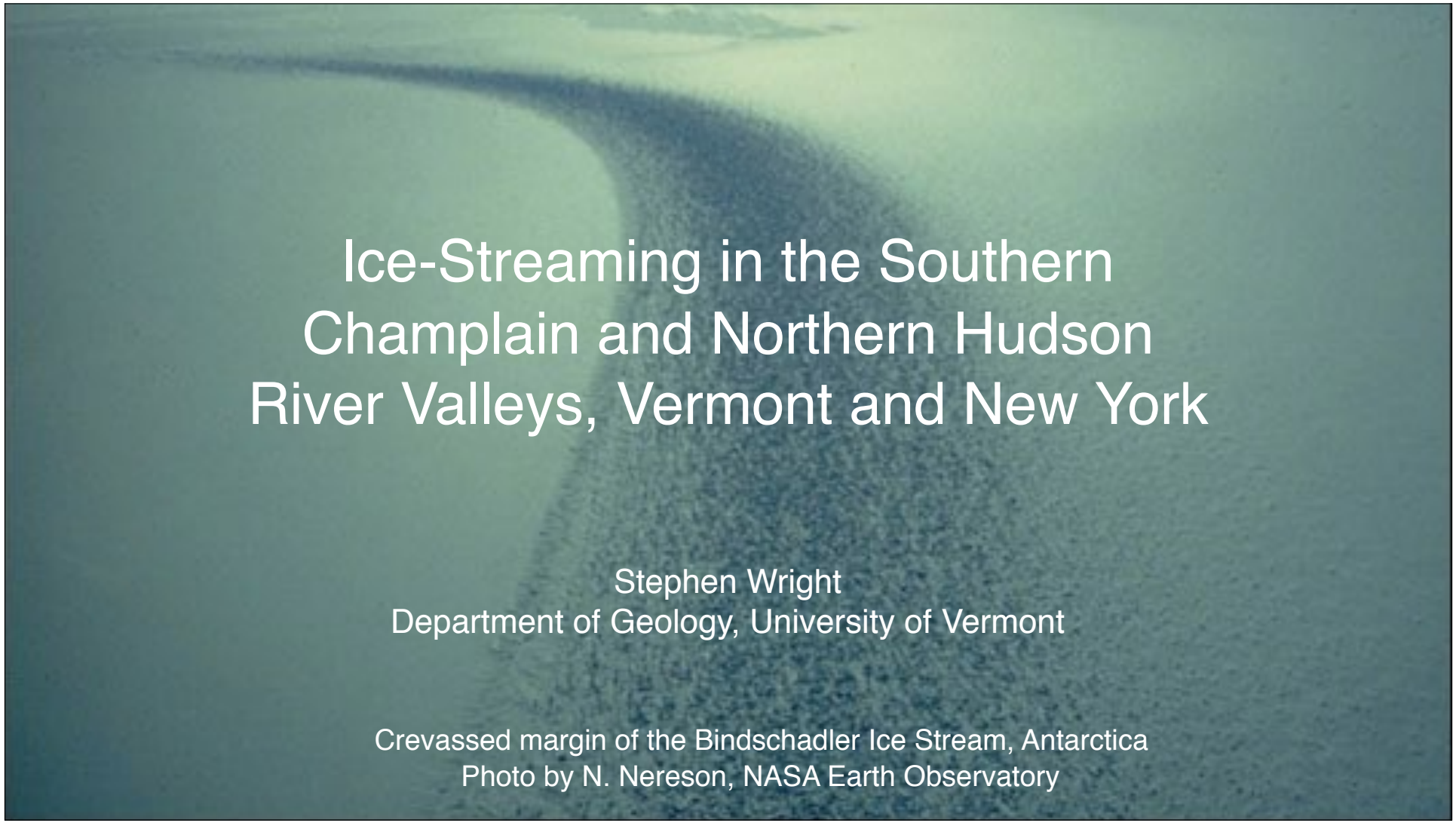
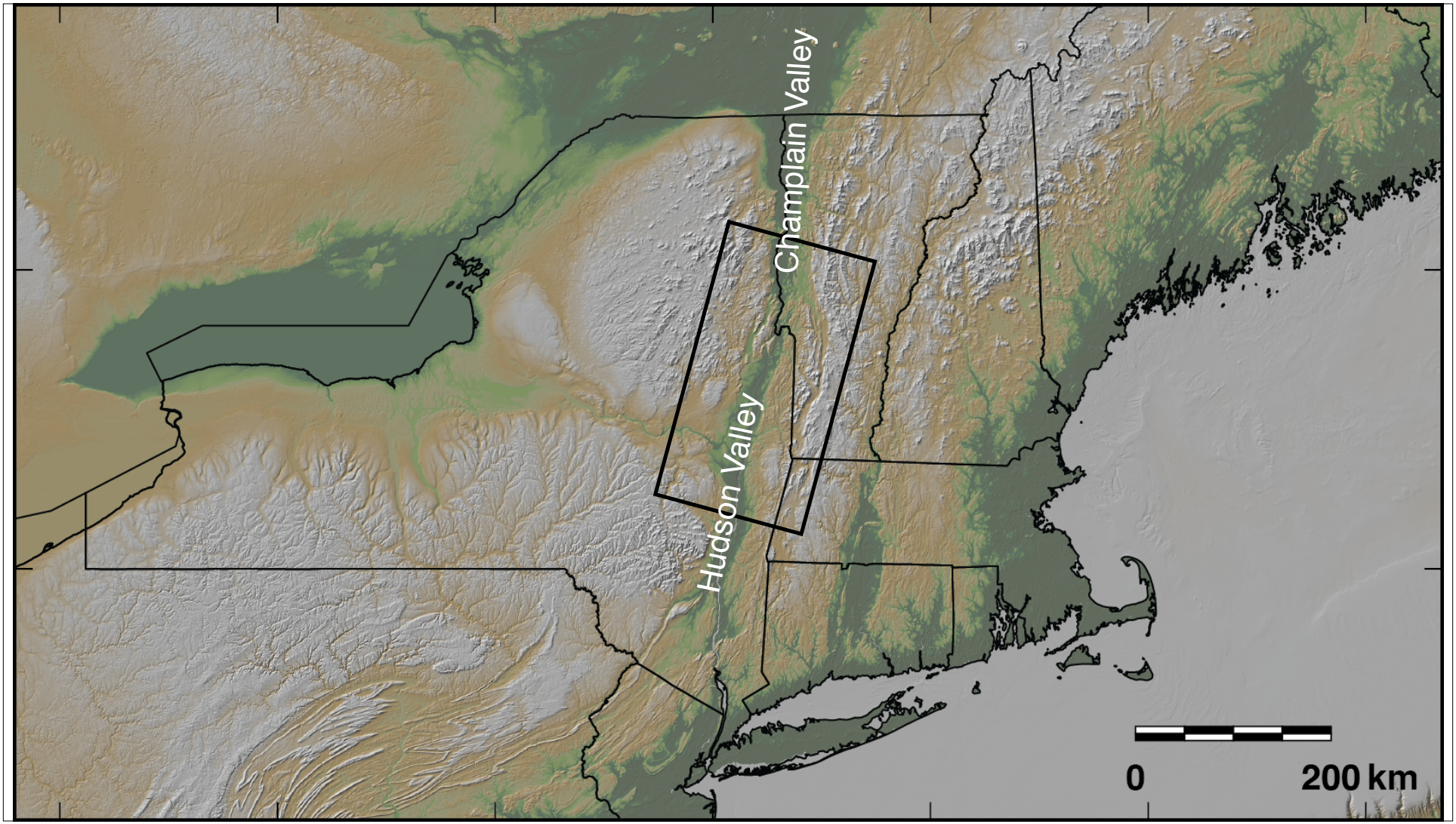
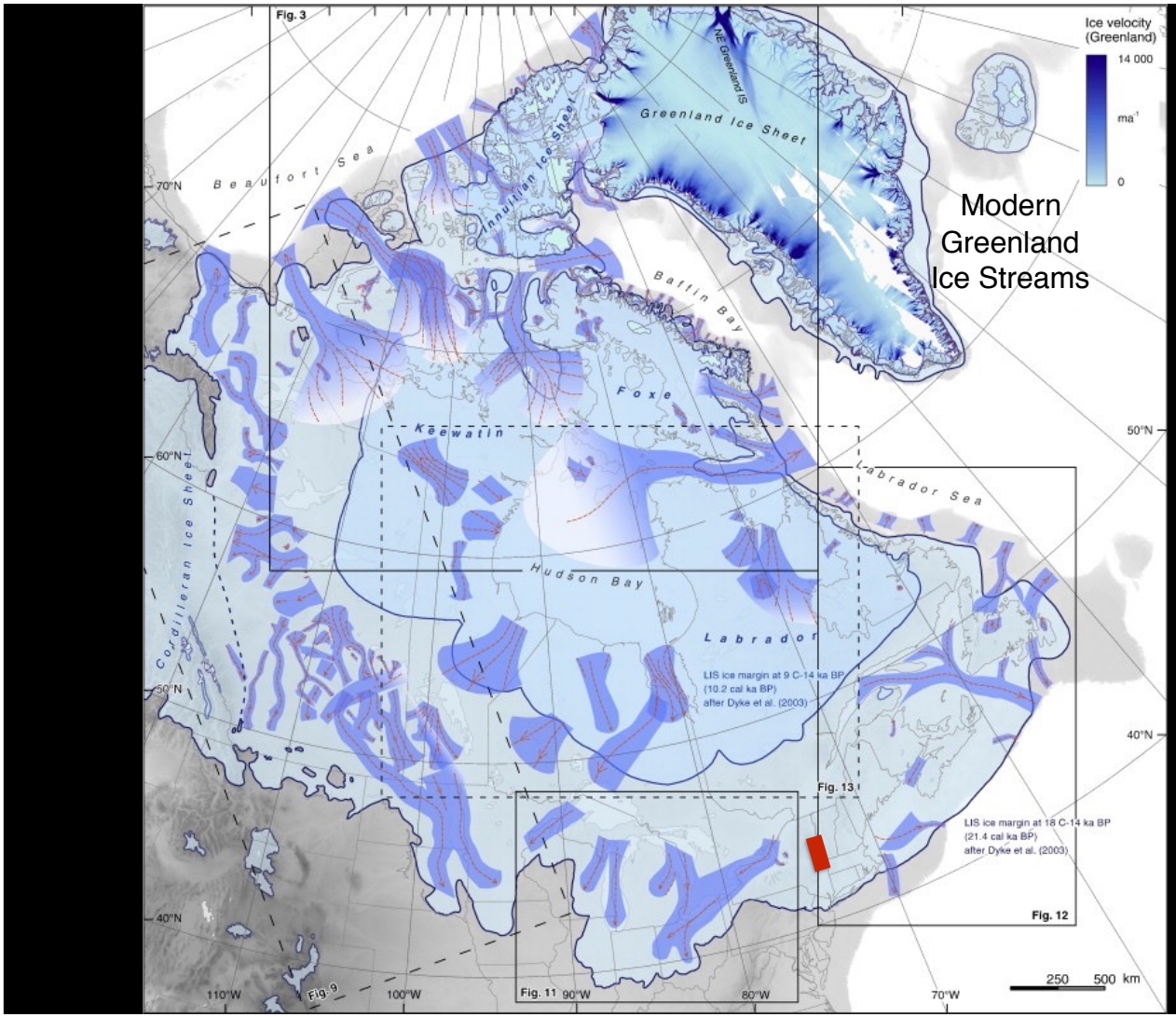


Ice-Streaming in the Southern Champlain and Northern Hudson River Valleys, Vermont and New York

Stephen Wright
Department of Geology, University of Vermont

Crevassed margin of the Bindschadler Ice Stream, Antarctica
Photo by N. Nereson, NASA Earth Observatory


Champlain Valley
Hudson Valley
0
200 km



Modern Greenland Ice Streams

Recent inventory of **paleo-ice streams** around the perimeter(s) of the Laurentide Ice sheet

(Margold et al., 2015)

How have these paleo-ice streams been identified?

1. Characteristic Shape and Dimensions

   Convergent ice flow from the surrounding ice sheet into the ice stream.

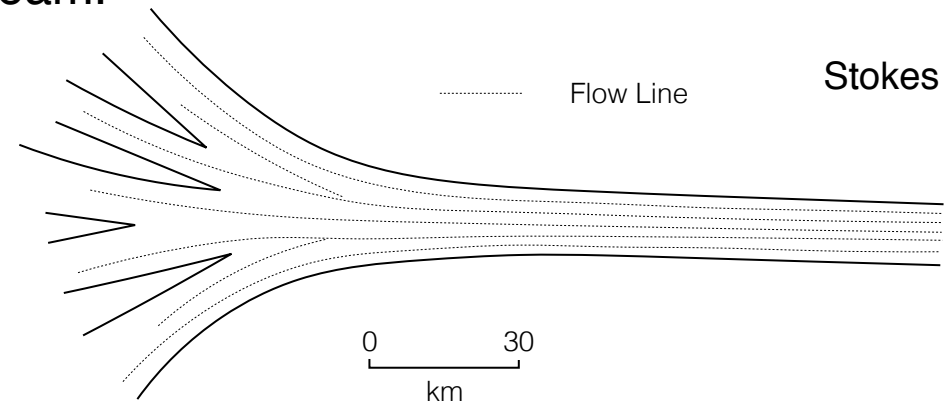
2. Topographic Ice Streams located in large-scale troughs

3. Underlain by “Soft Beds:” Low-strength rocks/surficial materials

4. Highly elongate, streamlined bed-forms: Mega-scale glacial lineations

(1) Characteristic Shape and Dimensions

- Convergent flow lines in the onset zone feeding the ice stream.



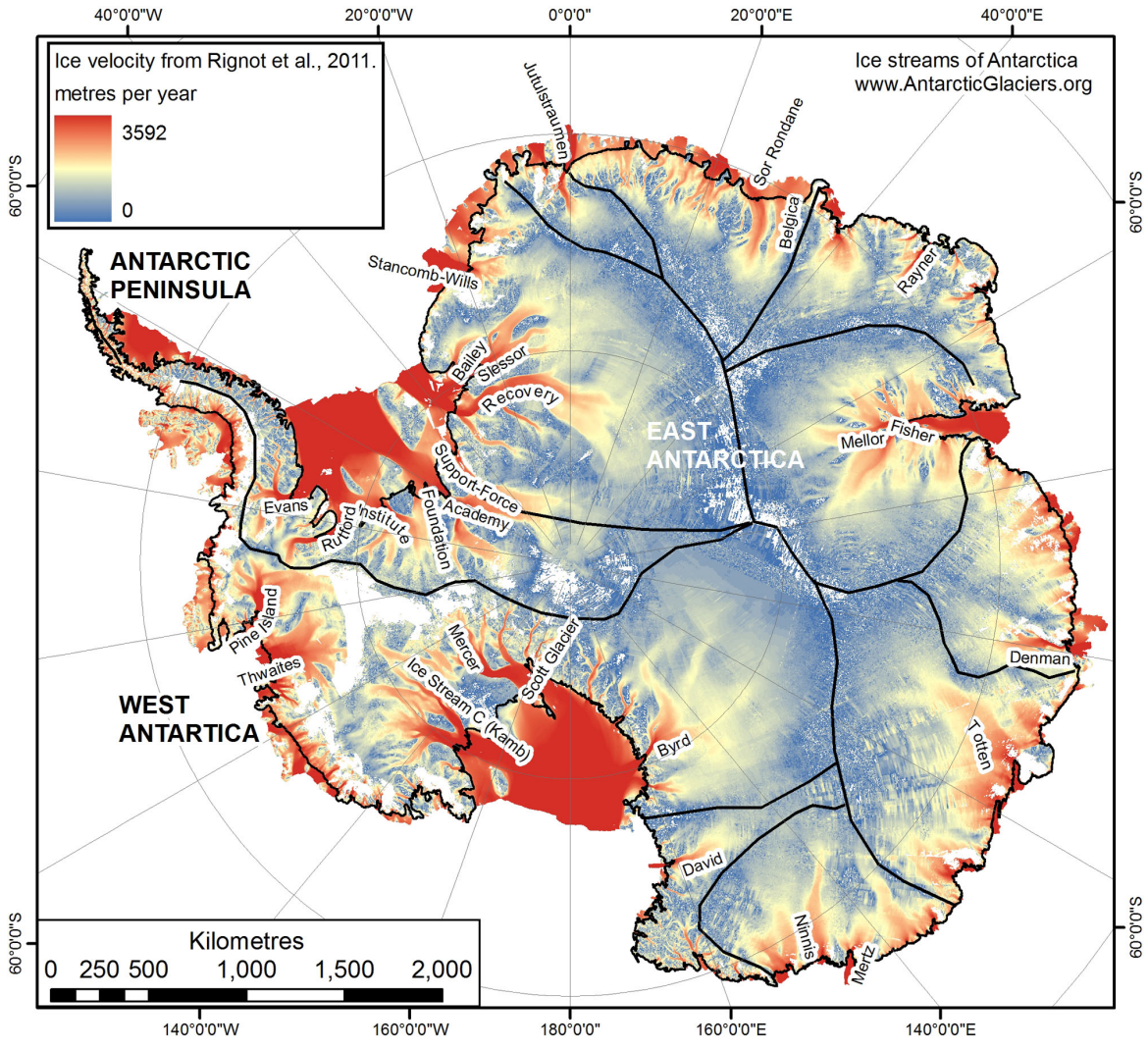
Stokes and Clark, 1999

- Dimensions are generally >20 km width, >150 km length.

Antarctic Ice Streams

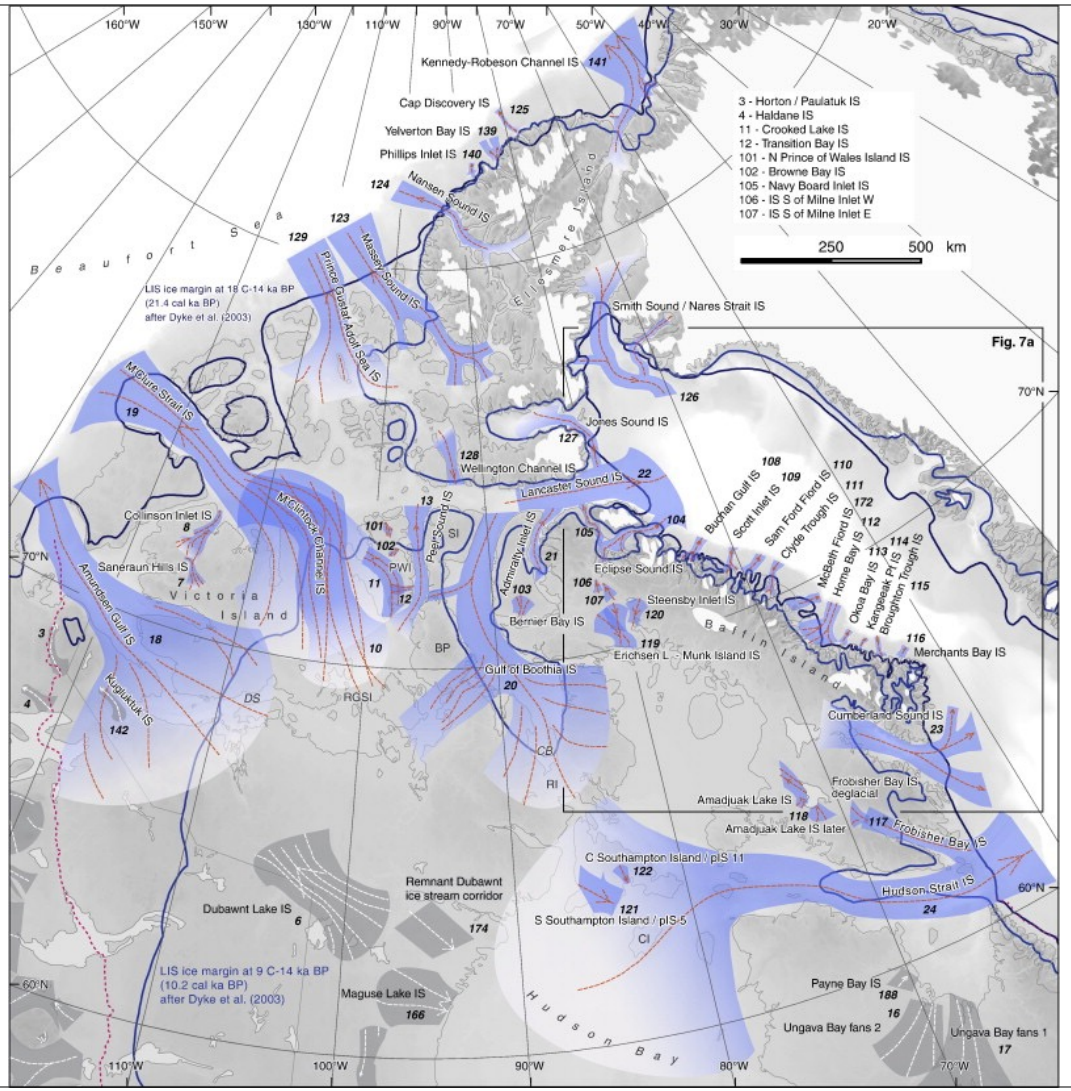
Large ice stream discharges are sustained by converging ice flow from the surrounding ice sheet.

Rignot et al., 2011

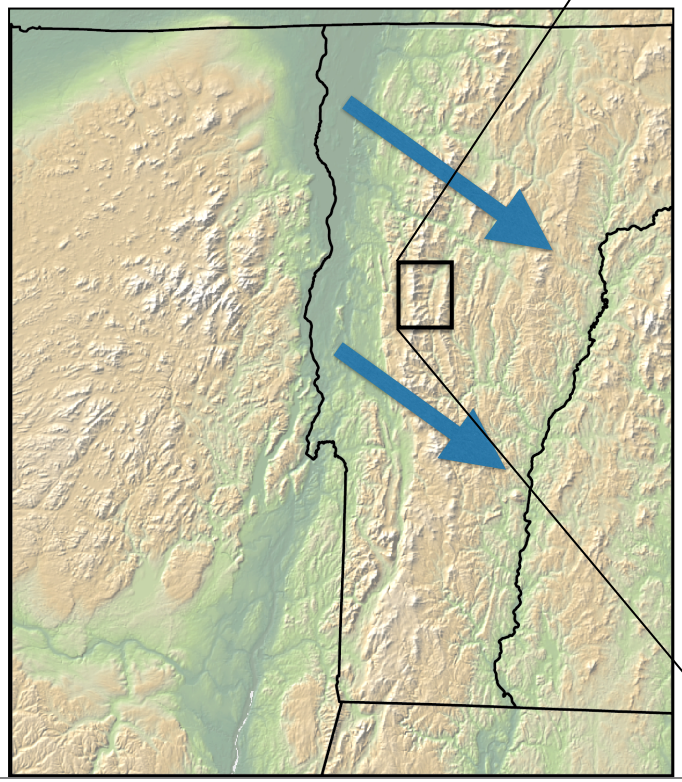


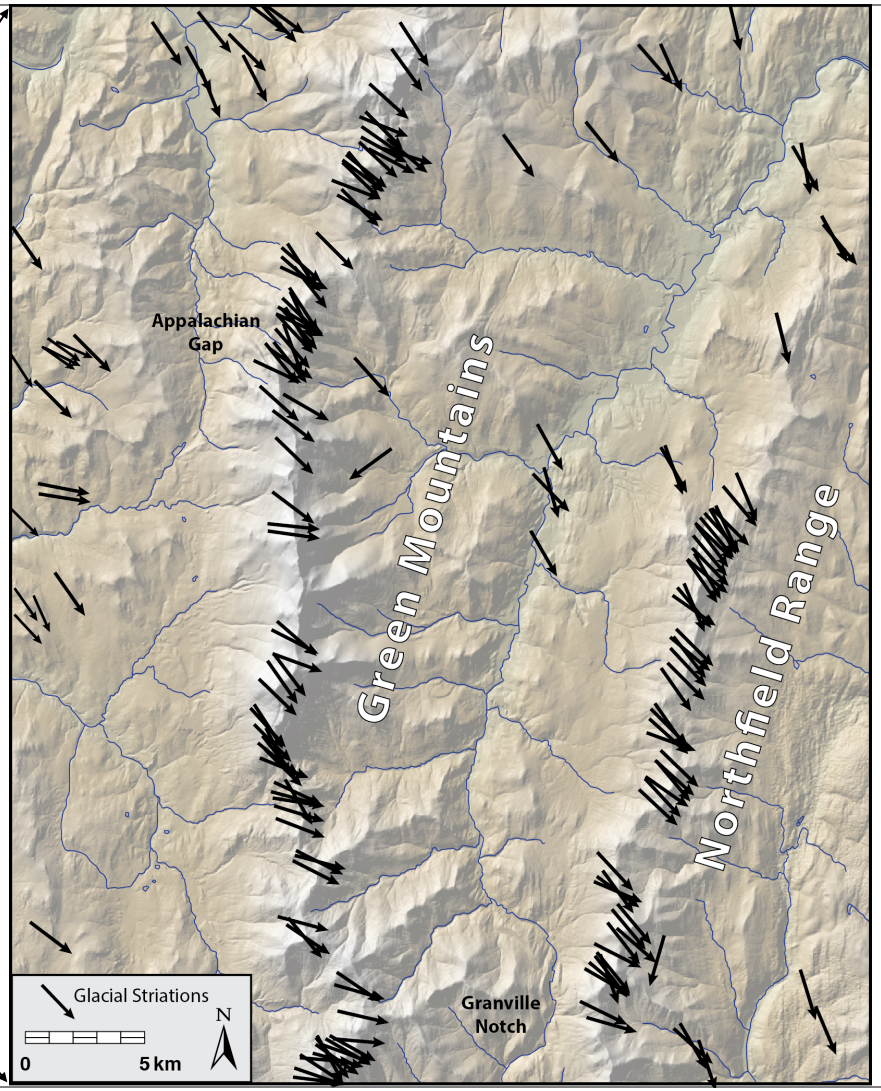
Convergent ice flow into paleo-ice streams, northern Laurentide Ice Sheet

(Margold et al., 2015)



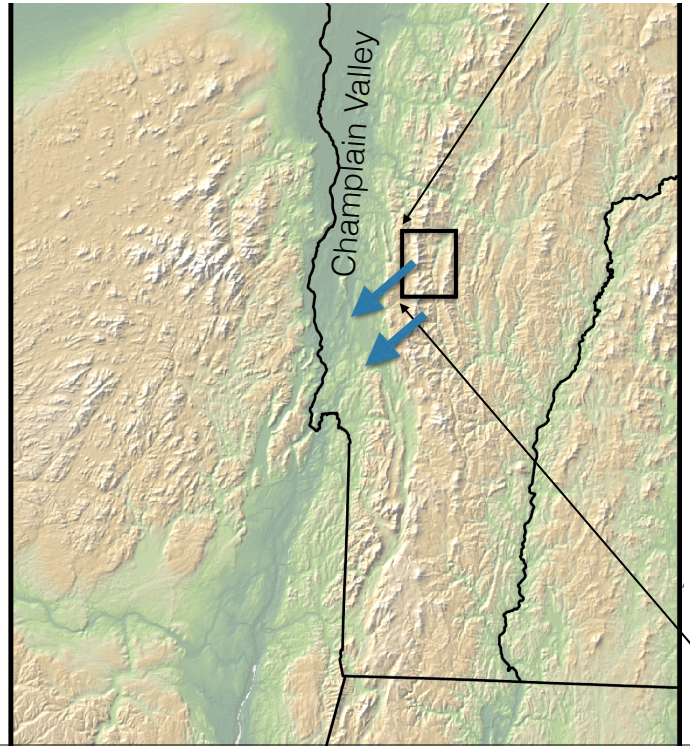
Regional ice sheet flow across Vermont and adjacent parts of New England was from **Northwest** to **Southeast**.

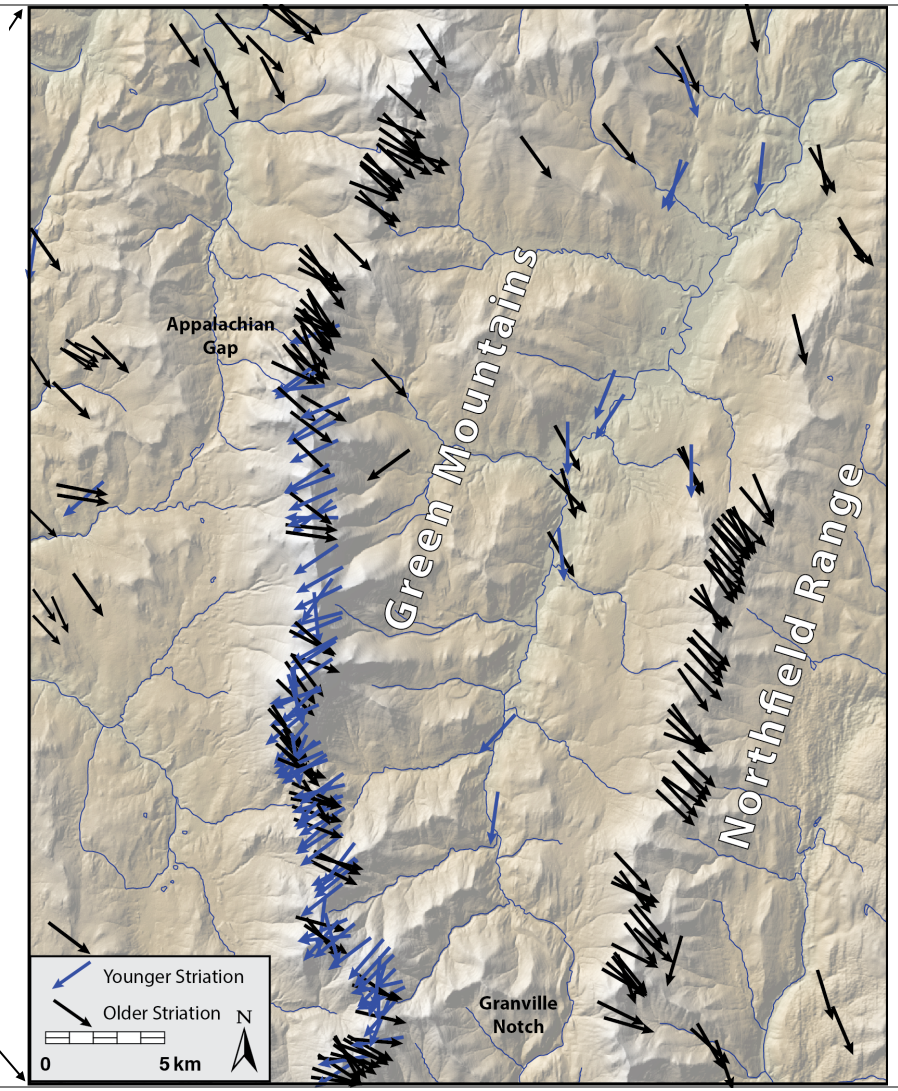




Converging Ice Flow into the Champlain Valley

A younger set of striations indicate that ice flow shifted to the southwest, into the Champlain Valley implying a drawdown of the ice surface elevation in the valley.

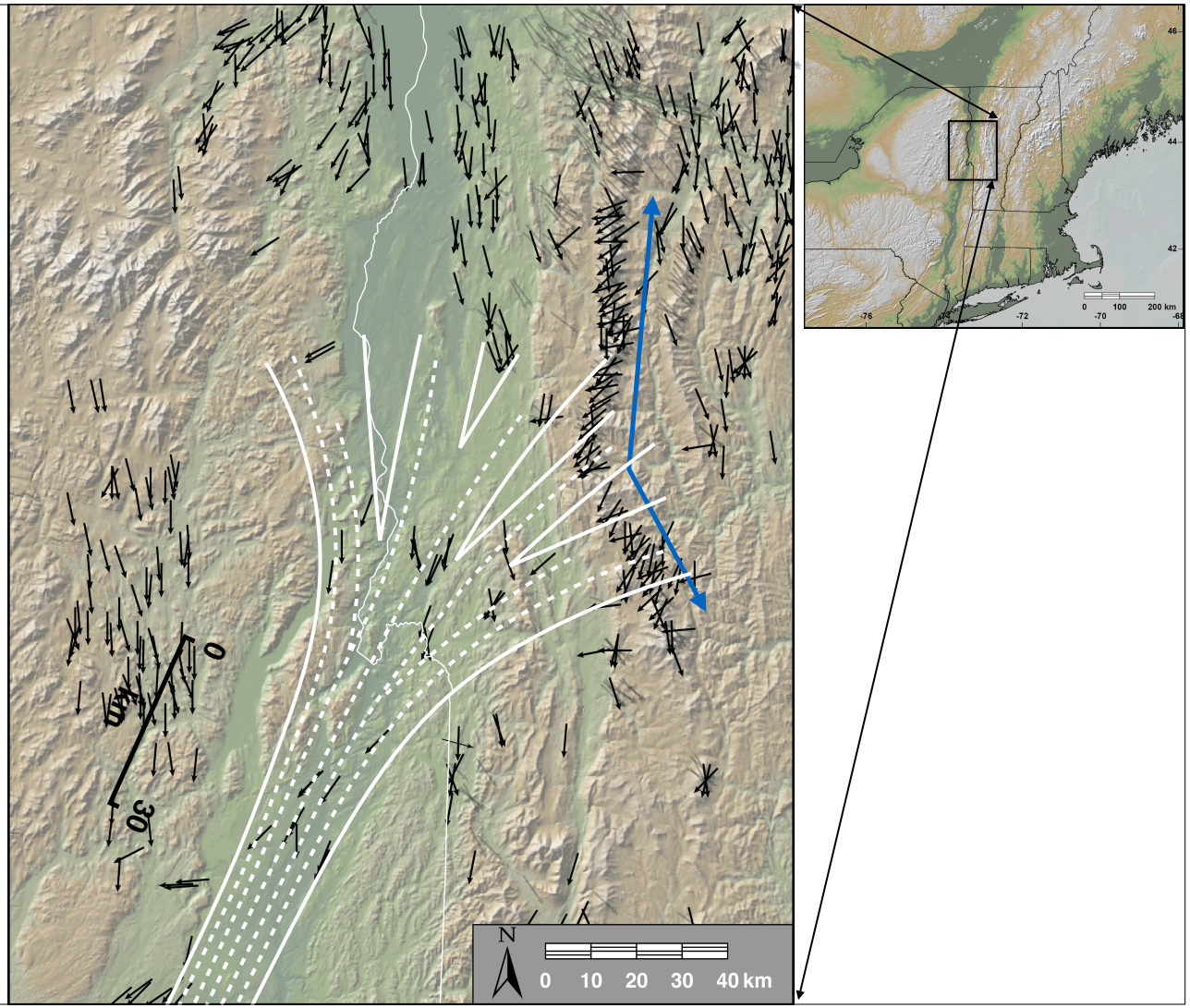




Compilation of glacial striations from areas surrounding the southern Champlain valley and the northern Hudson River valley.

Extent of SW-directed striations in the Green Mountains

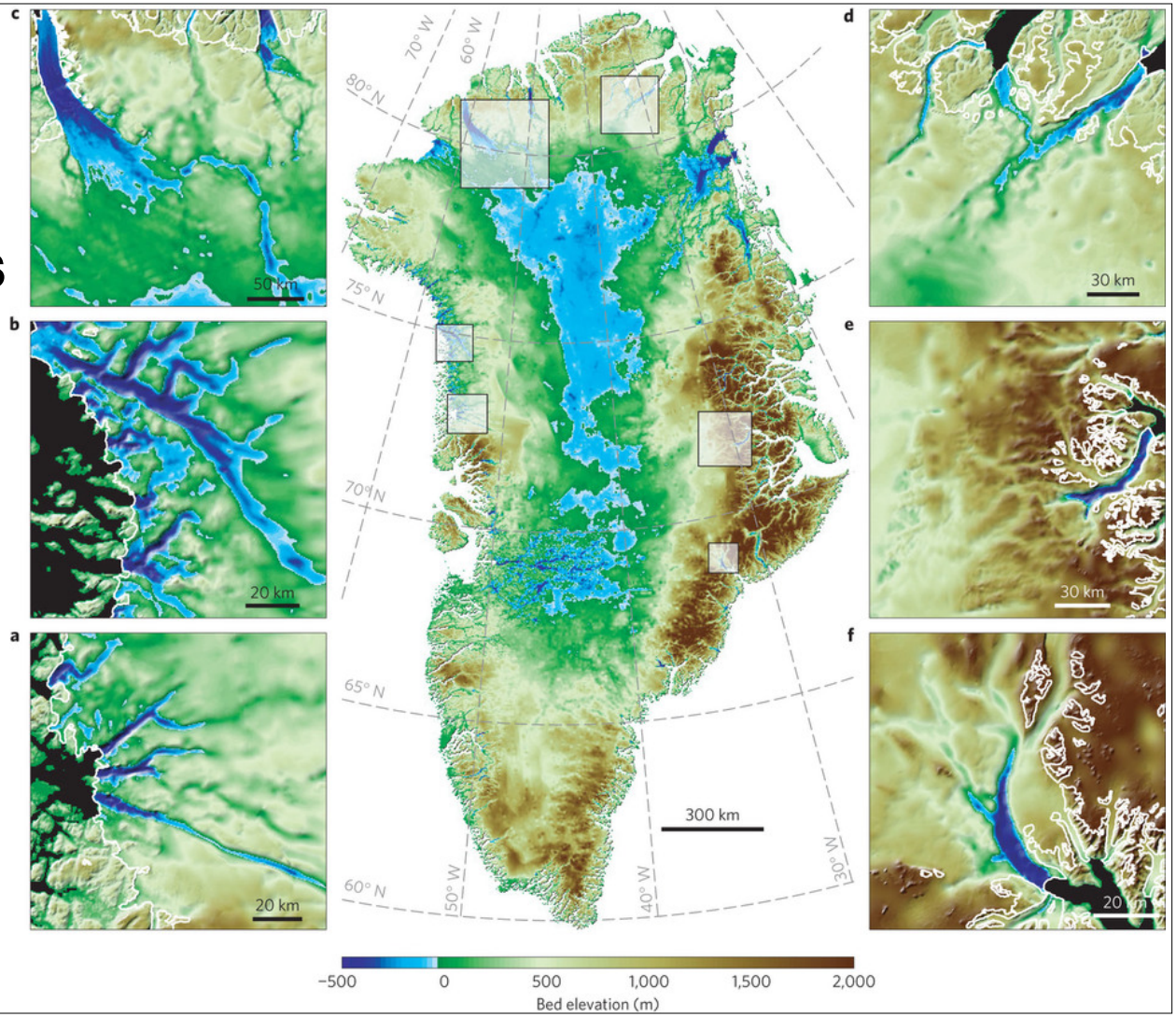
"Typical" shape of an ice stream with convergent onset zone superimposed over the lower Champlain and upper Hudson River valleys.
Note similar scale.



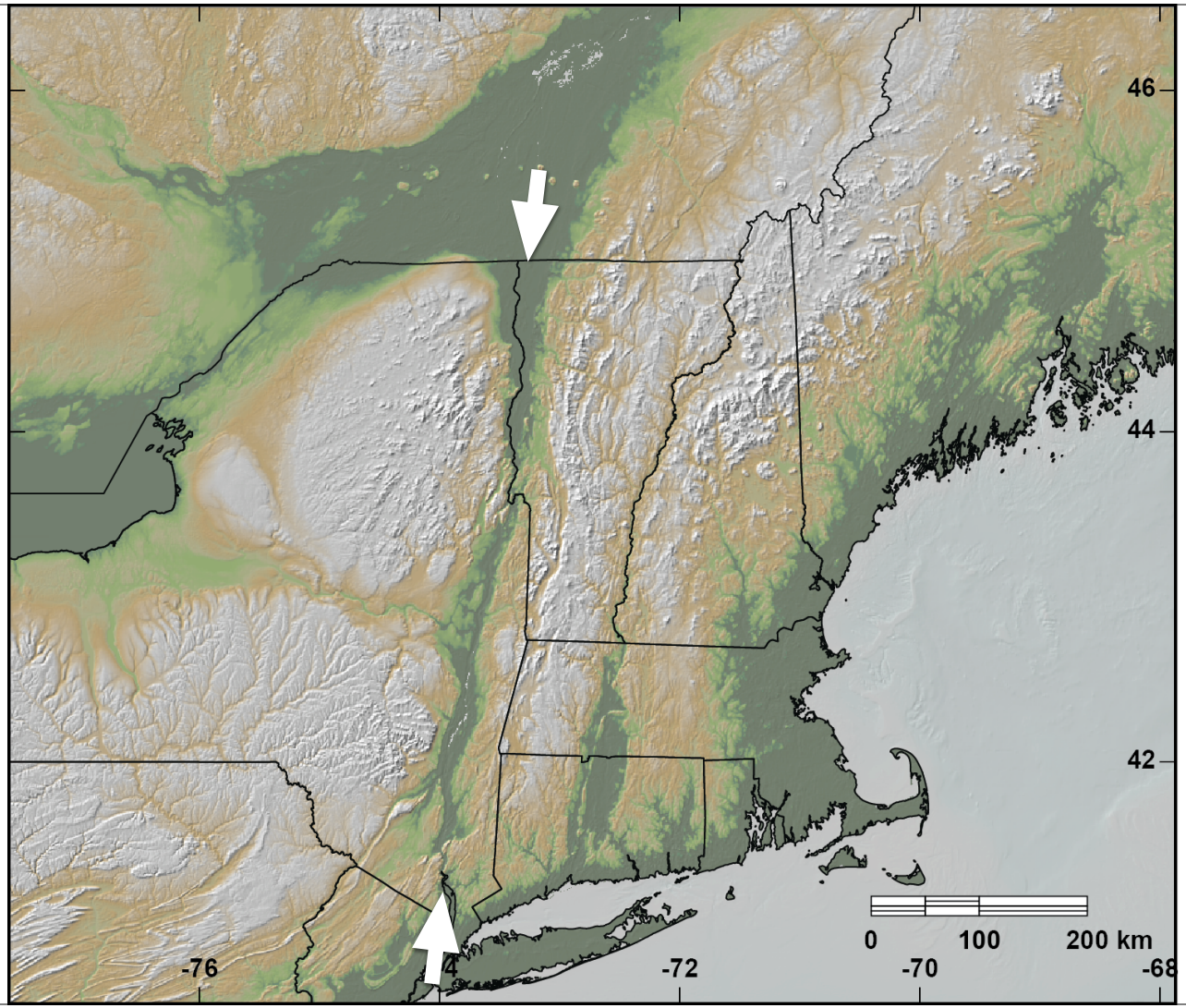
(2) Bedrock Troughs

Topographic ice streams are localized in substantial bedrock troughs.

Morlighem et al., 2014



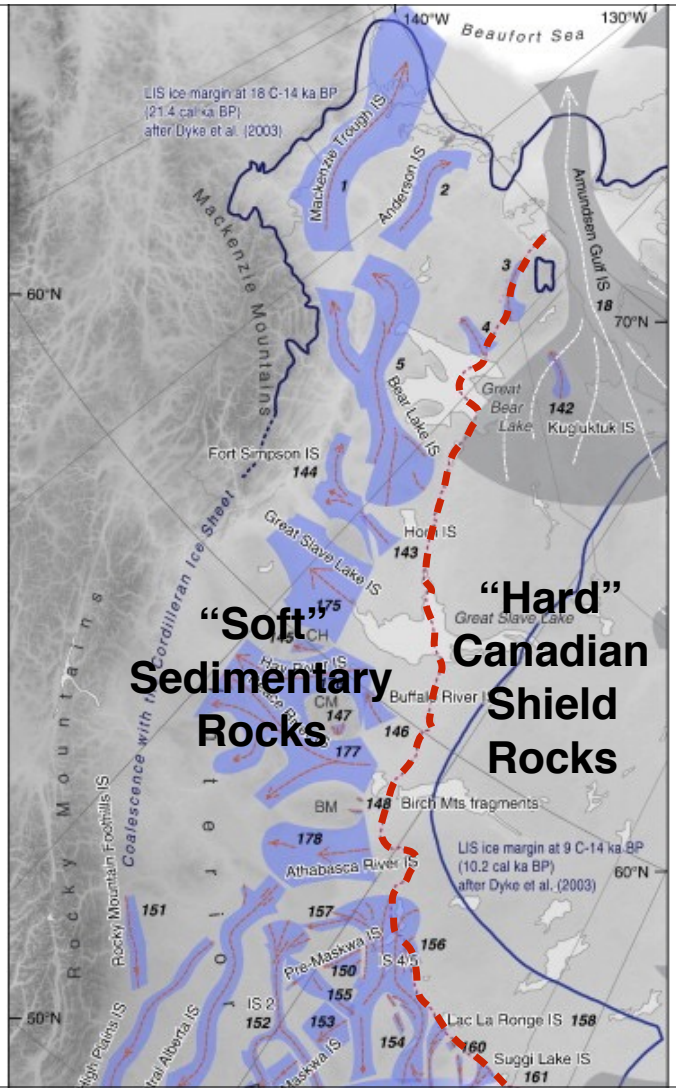
The Hudson/ Champlain Valley is the only through-going bedrock trough across the New York/New England mountains.



(3) “Soft Beds”

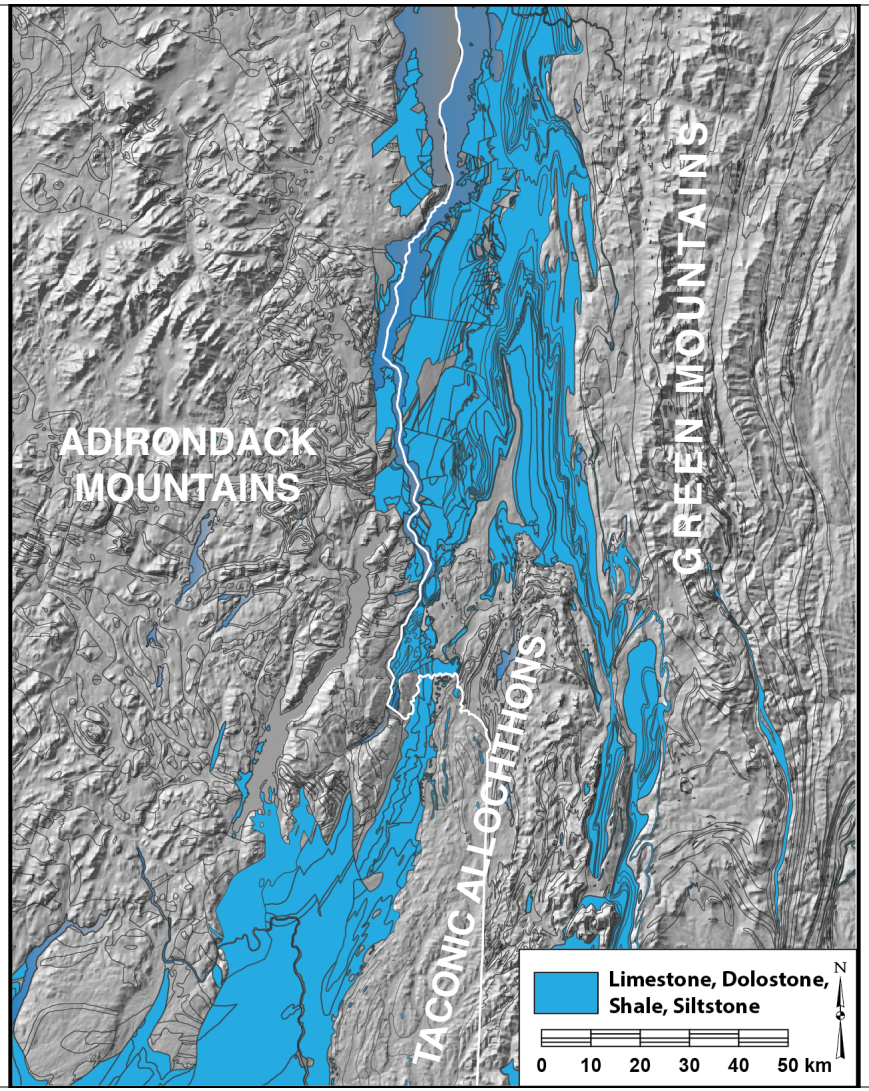
Ice Streams are commonly underlain by weak clay/calcite-rich rocks that source weak tills.

Paleo-ice streams in the western interior (shown in blue) preferentially developed on “soft” sedimentary vs “hard” Canadian shield rocks. Margold et al., 2015



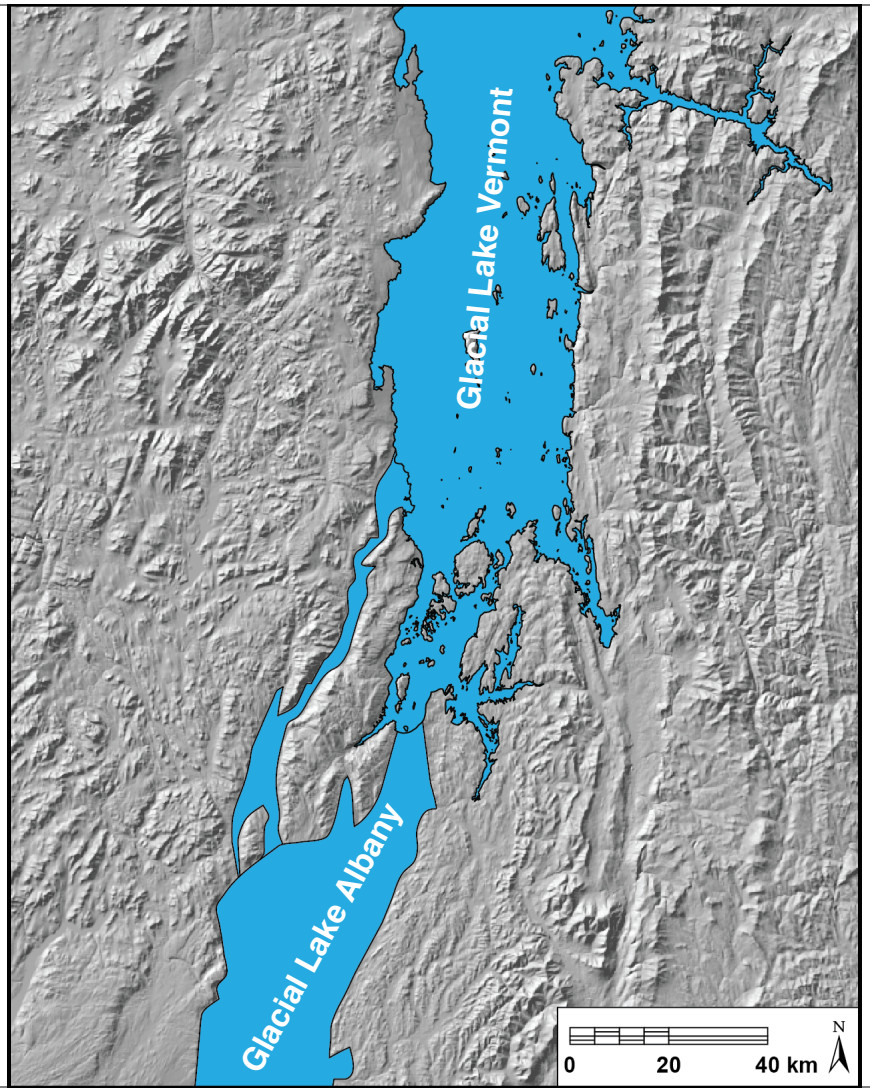
“Soft Beds”

The Champlain and Hudson River valleys are bordered by metamorphic rocks, but are underlain by weak sedimentary rocks largely composed of carbonate and clay minerals.



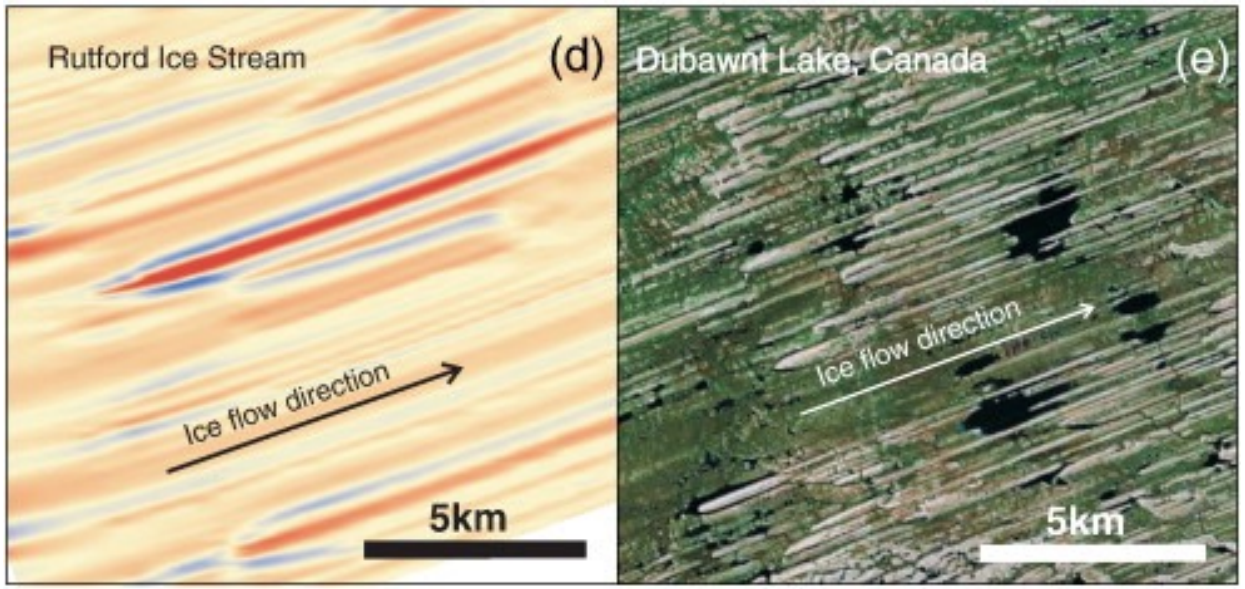
“Soft Beds”

- At the end of the previous glacial period the Champlain and Hudson valleys were likely occupied by glacial lakes, Paleo-Glacial Lakes Albany and Vermont.
- Similar to today, these valleys were mantled with lacustrine sediments largely derived from the underlying limestones, dolostone, siltstones, and shales.
- These weak, fine-grained lacustrine sediments were incorporated into the till.



(4) Streamlined Bed-forms

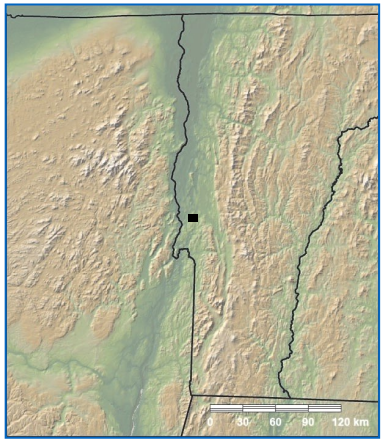
- “Mega-scale glacial lineations”
- Drumlins, flutes, etc. with Length/Width Ratios > 10:1

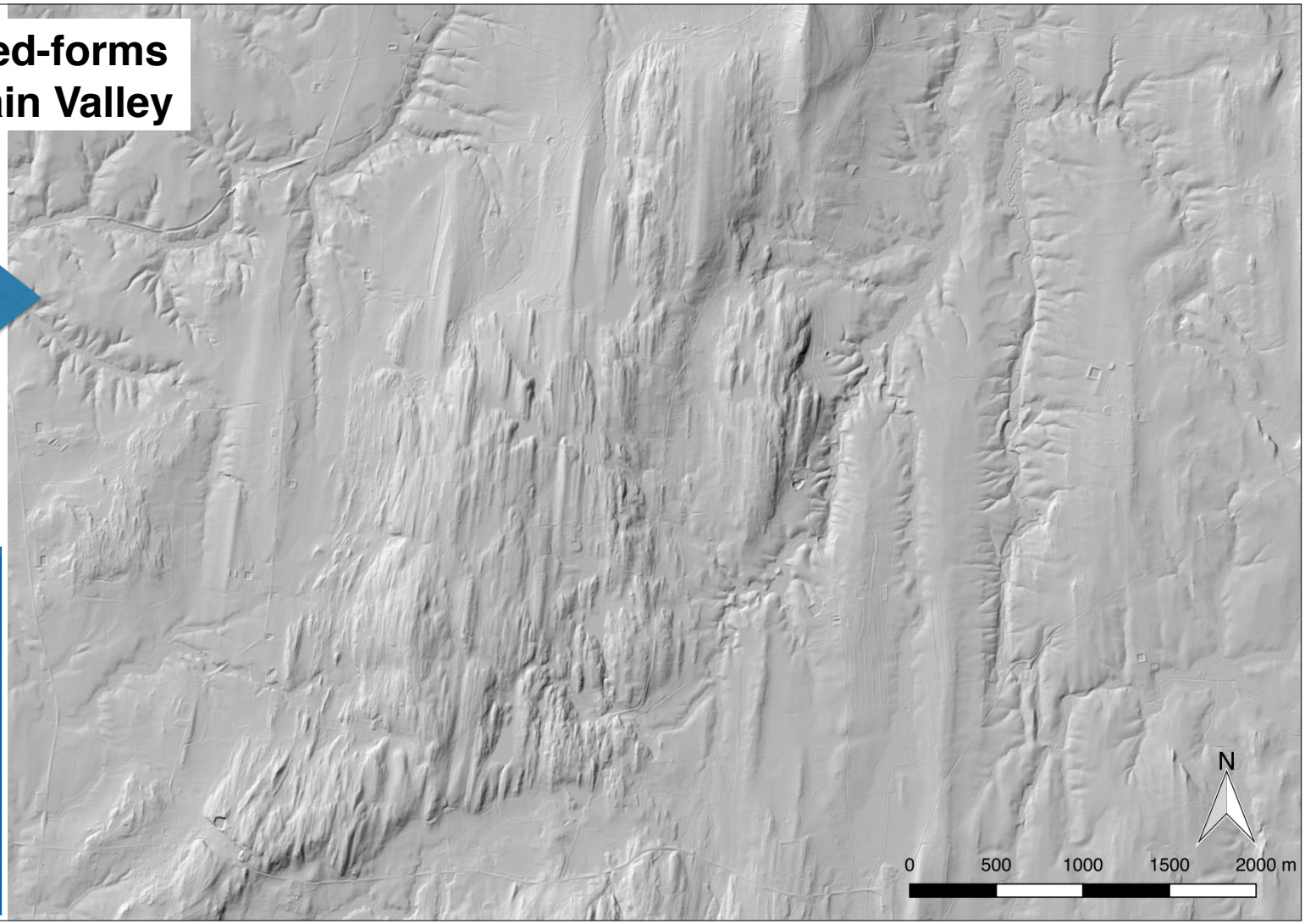


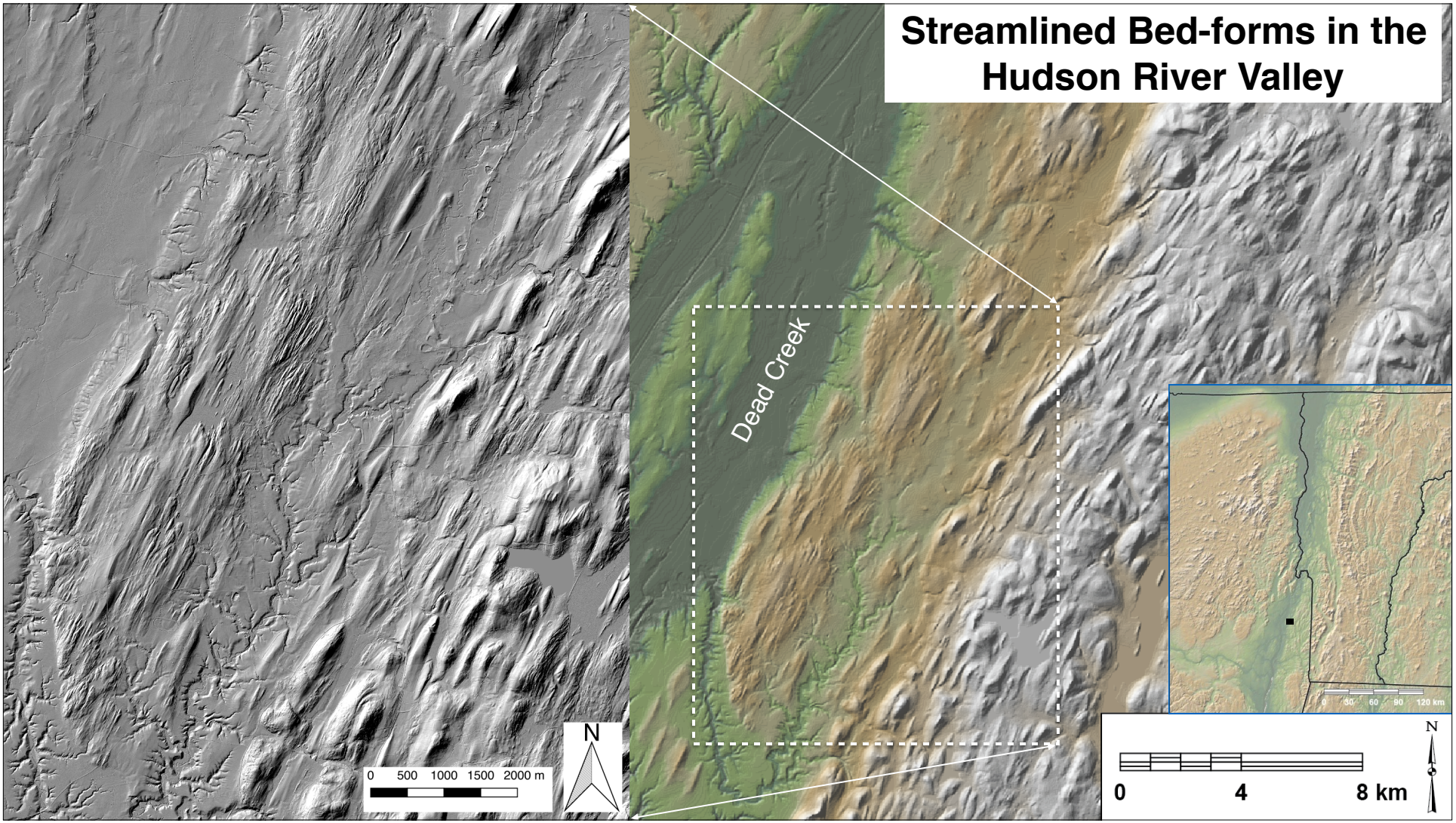
Marigold et al., 2015

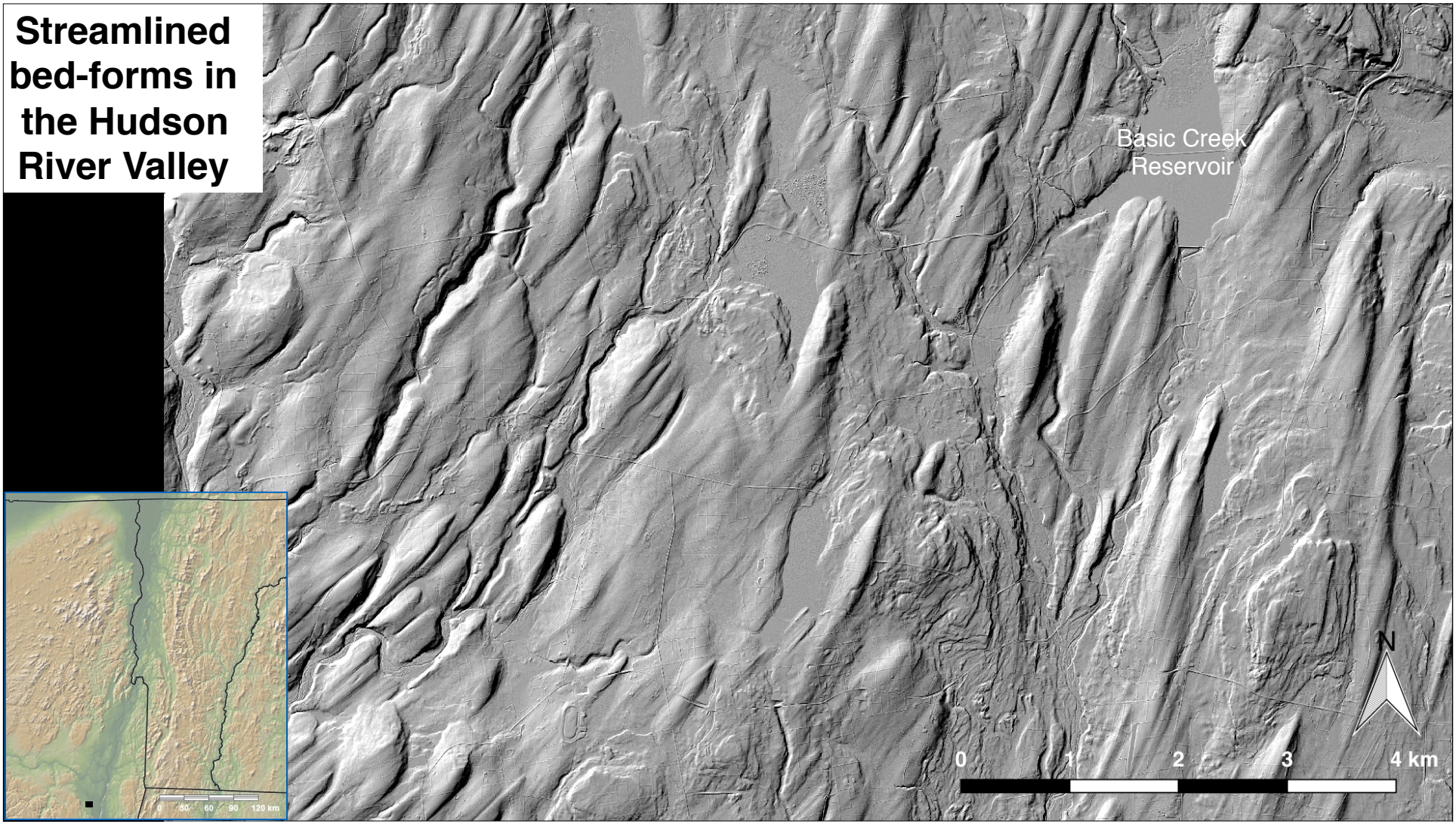
Streamlined bed-forms in the Champlain Valley

In the Champlain and Hudson River valleys many subglacial landforms are mantled by thick sequences of lacustrine and marine sediments.

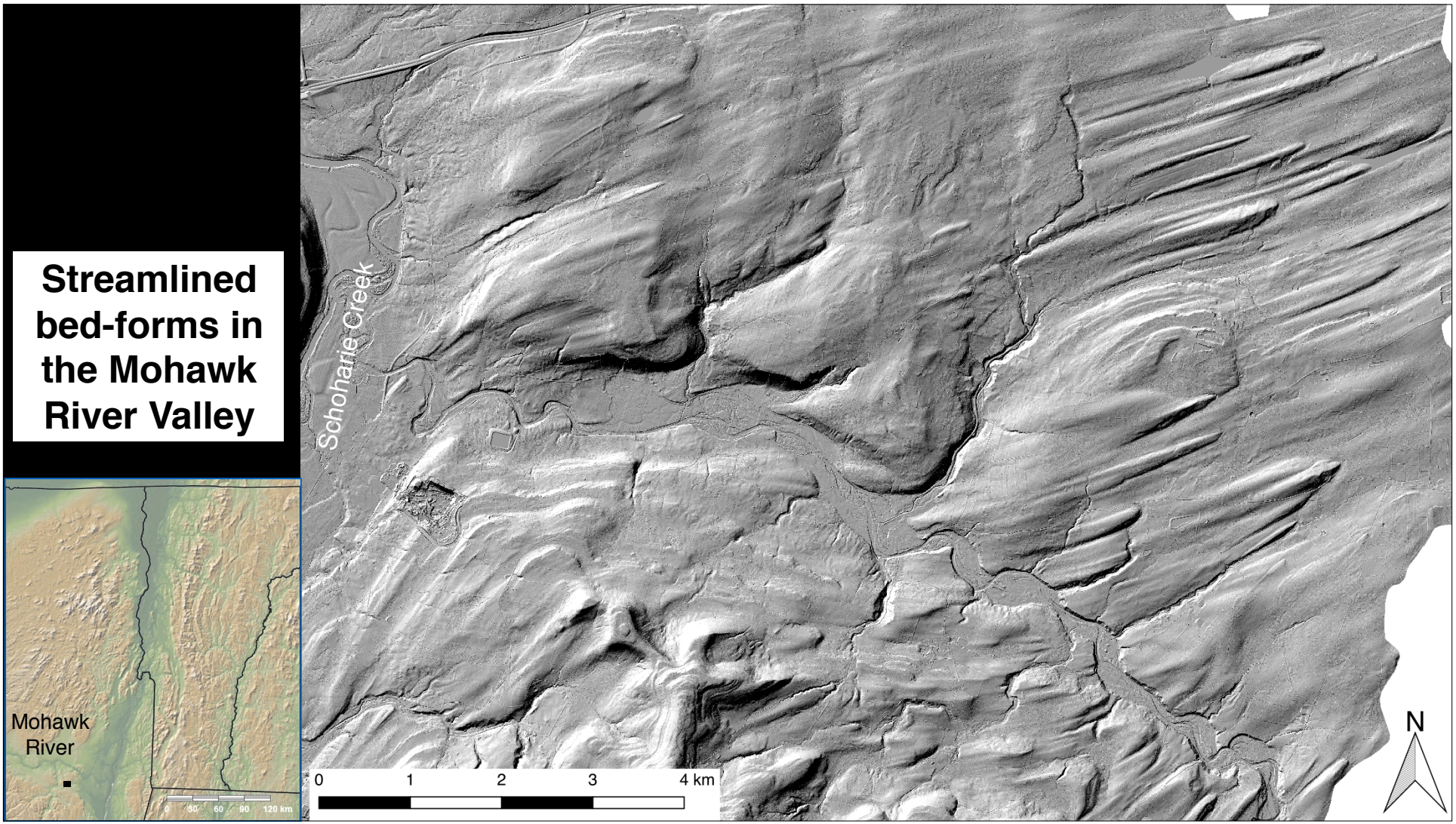




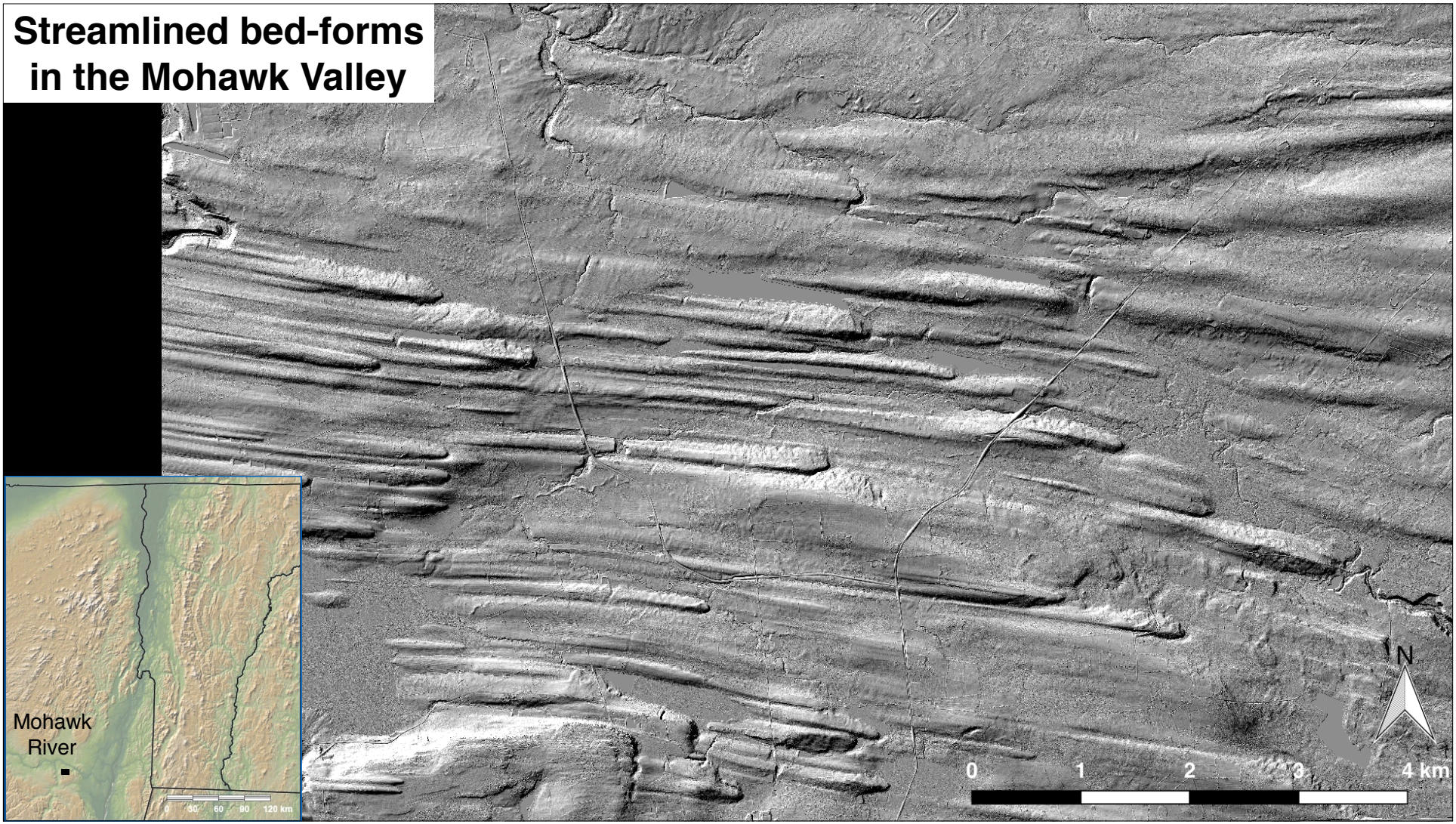

Streamlined Bed-forms in the Hudson River Valley
Dead Creek
0 500 1000 1500 2000 m
N
0 4 8 km
N
0 30 60 90 120 km


Streamlined bed-forms in the Hudson River Valley
Basic Creek Reservoir
0
1
2
3
4 km
N
0
30
60
90
120 km

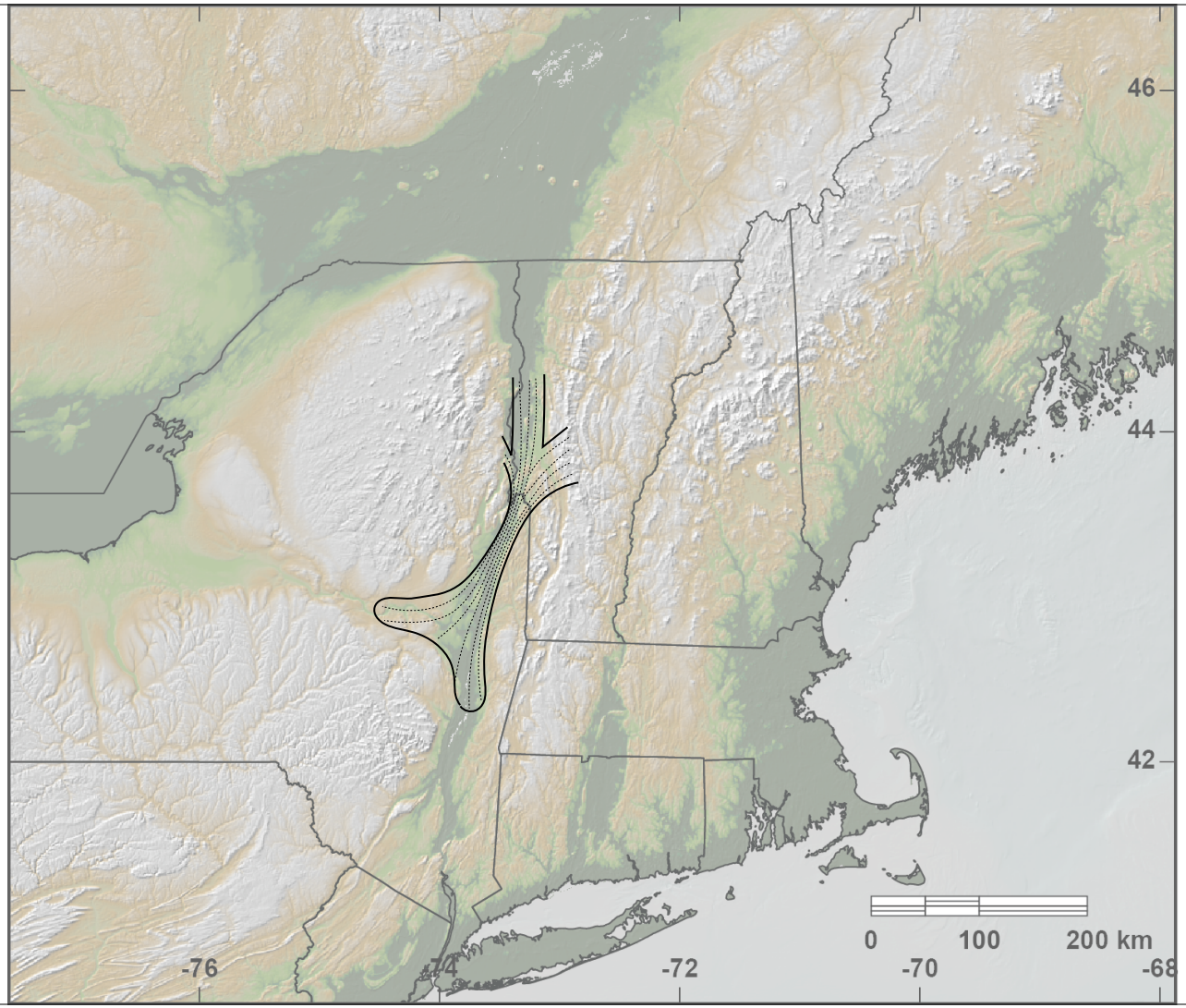
Streamlined bed-forms in the Mohawk River Valley



Streamlined bed-forms in the Mohawk Valley

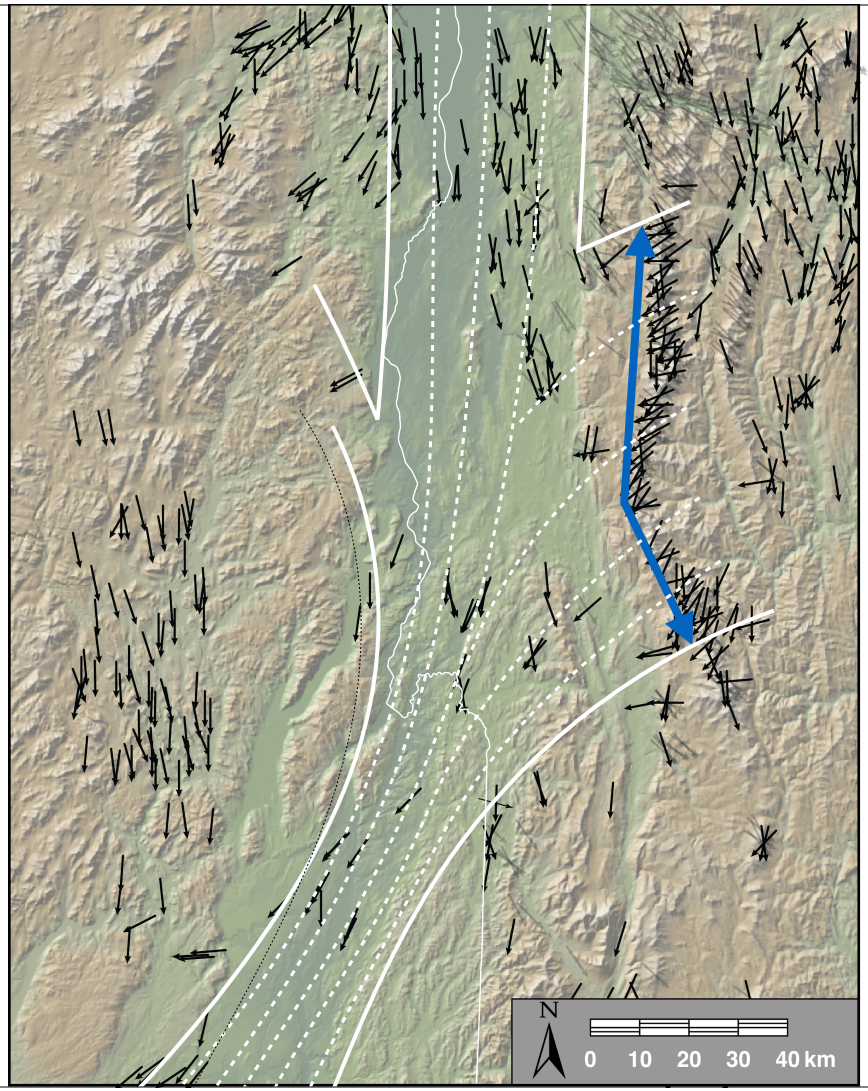


Proposed extent of the Ice Stream in the Lower Champlain and Upper Hudson River Valleys



Ephemeral Ice Stream

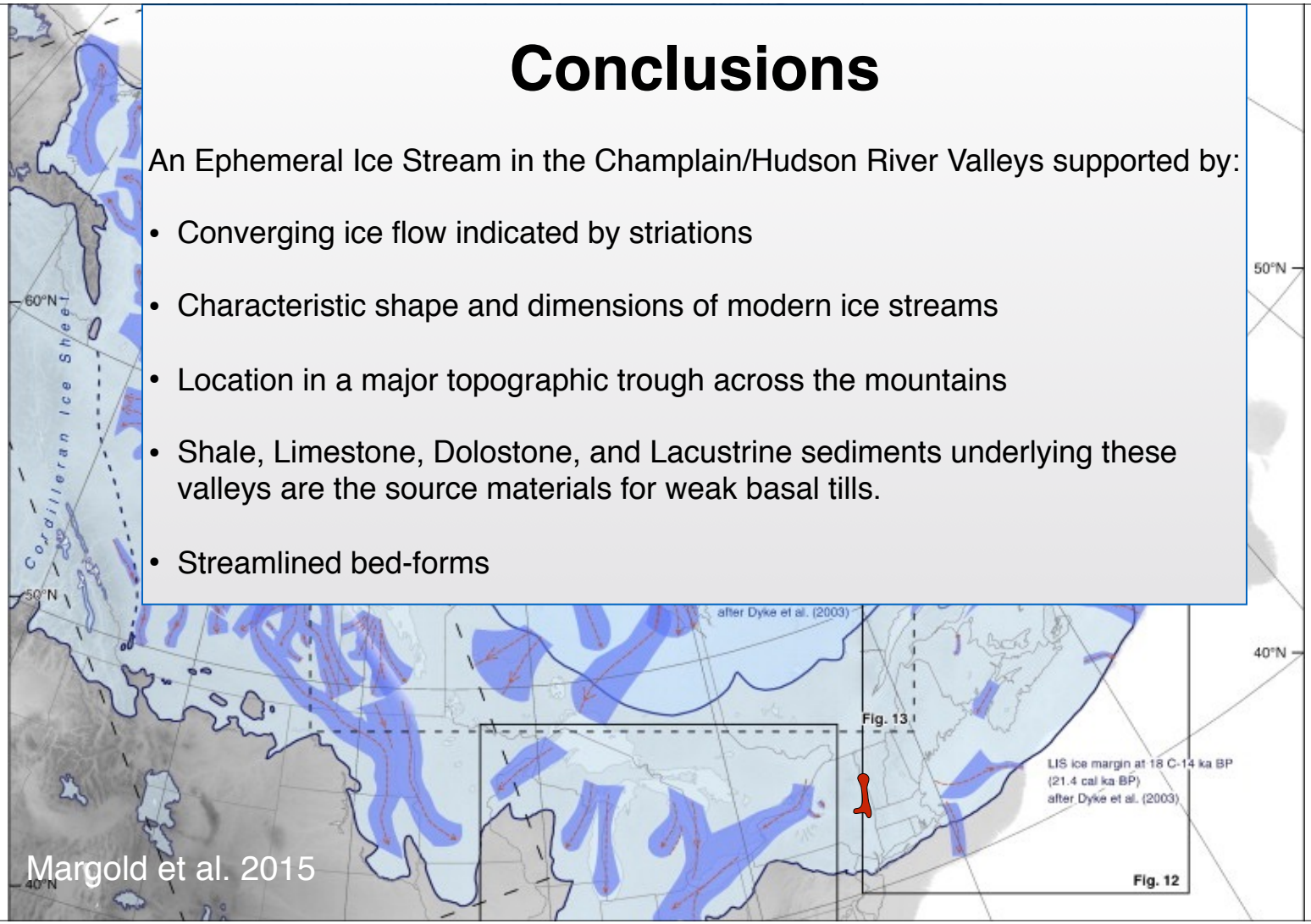
- "Ephemeral" implies that this postulated ice stream was relatively short-lived, only active for 10's to several 100's of years.
- Extent of SW-directed striations across the Green Mountains is limited.
- SW-directed striations aren't overprinted by any younger striations implying that this part of the Green Mountain range emerged from the ice shortly after SW-flow ceased.
- This period of fast ice flow occurred while the ice sheet was retreating.



Conclusions

An Ephemeral Ice Stream in the Champlain/Hudson River Valleys supported by:

- Converging ice flow indicated by striations
- Characteristic shape and dimensions of modern ice streams
- Location in a major topographic trough across the mountains
- Shale, Limestone, Dolostone, and Lacustrine sediments underlying these valleys are the source materials for weak basal tills.
- Streamlined bed-forms



Margold et al. 2015