Erosional Glacial Features

Skaftafelljokull (glacier)

Part 0

Glacial Feature in Pics from Social Media

Glacial Valley

Arête

Moraine

Moraine Lake

Two Glacial Valleys

Arête

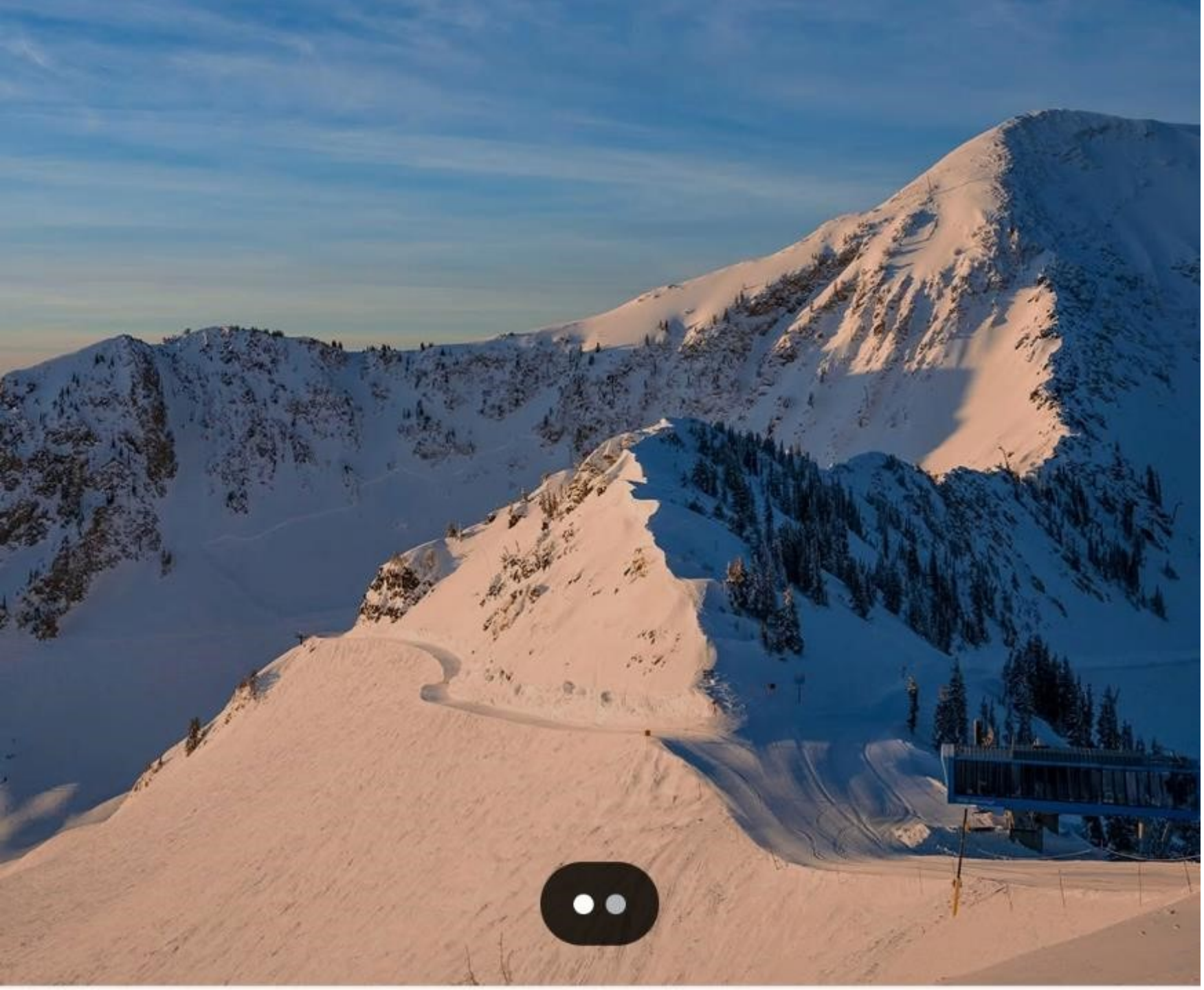
Horn

Watch It!

Crater

Crater Rim

Crater Lake



Cirque

Arête

Cirque

Moraine

Moraine Lake

Cirque

Arête

Part 1

Mapping what's beneath modern glaciers

"The Present is the Key to the Past"

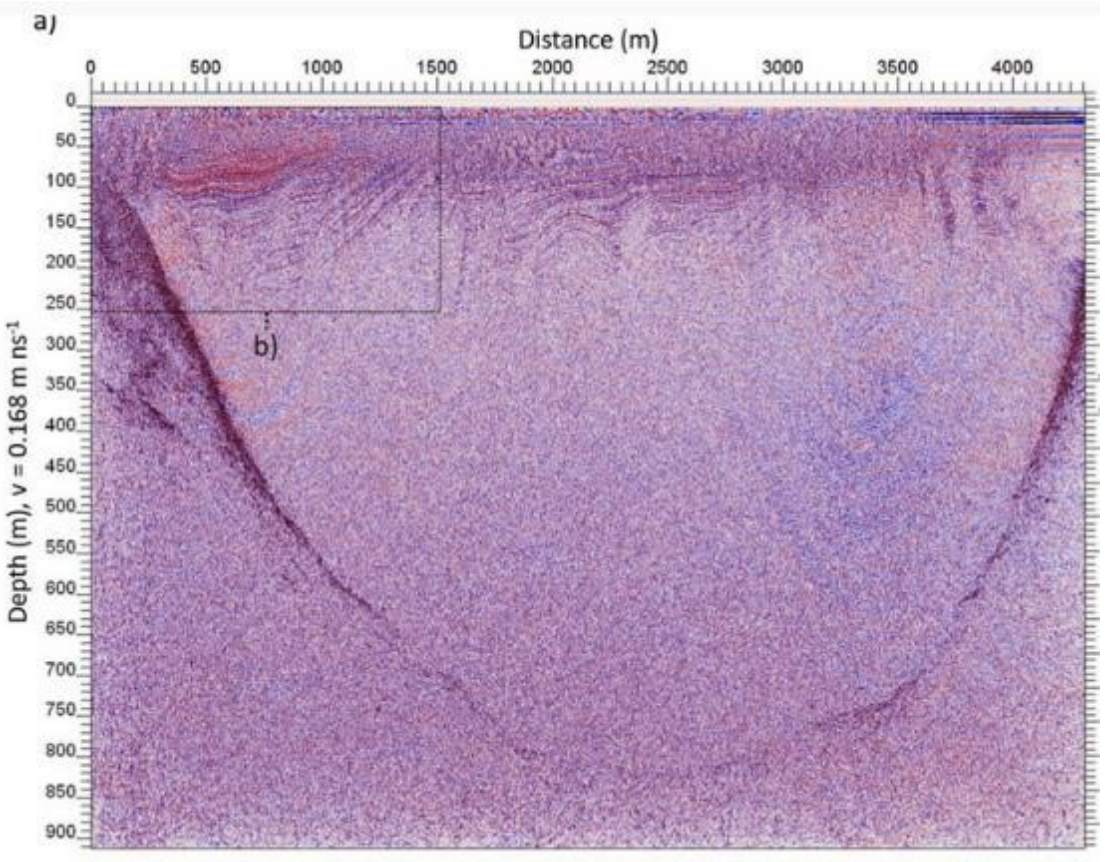

ANTARCTIC SURVEY

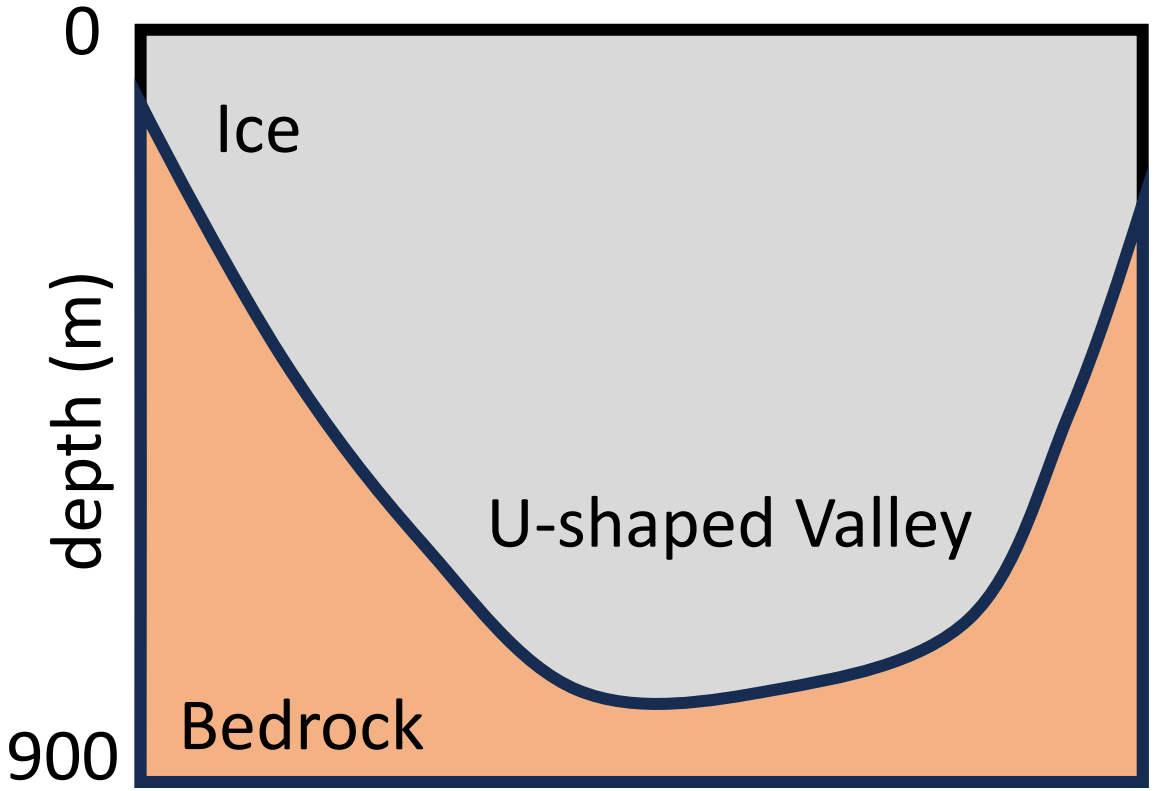
Radio Waves

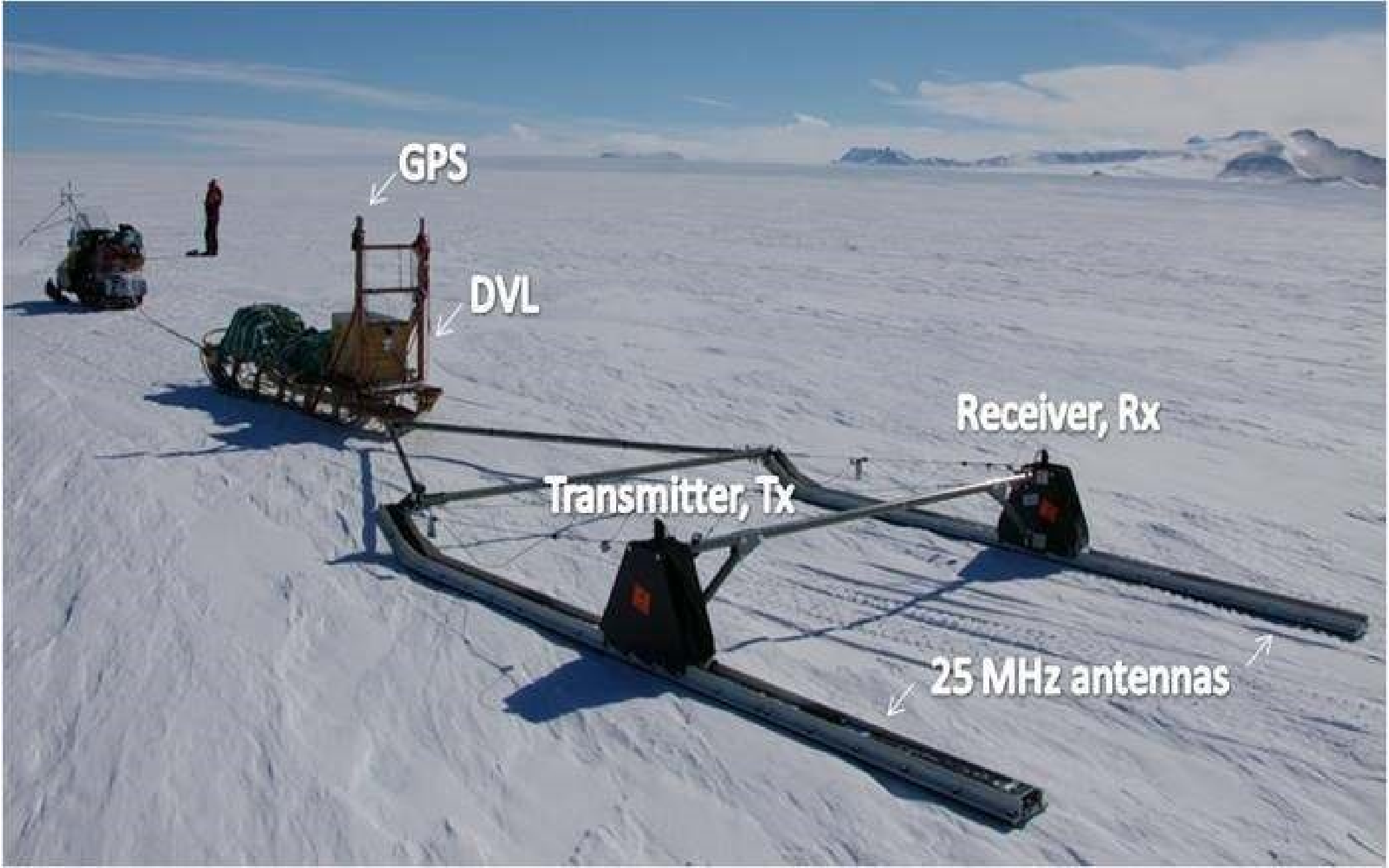
Radio Waves

Ice

Bedrock


a)
Distance (m)
0
500
1000
1500
2000
2500
3000
3500
4000
b)
Depth (m), v = 0.168 m ns-1
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900


0
Ice
depth (m)
U-shaped Valley
Bedrock
900

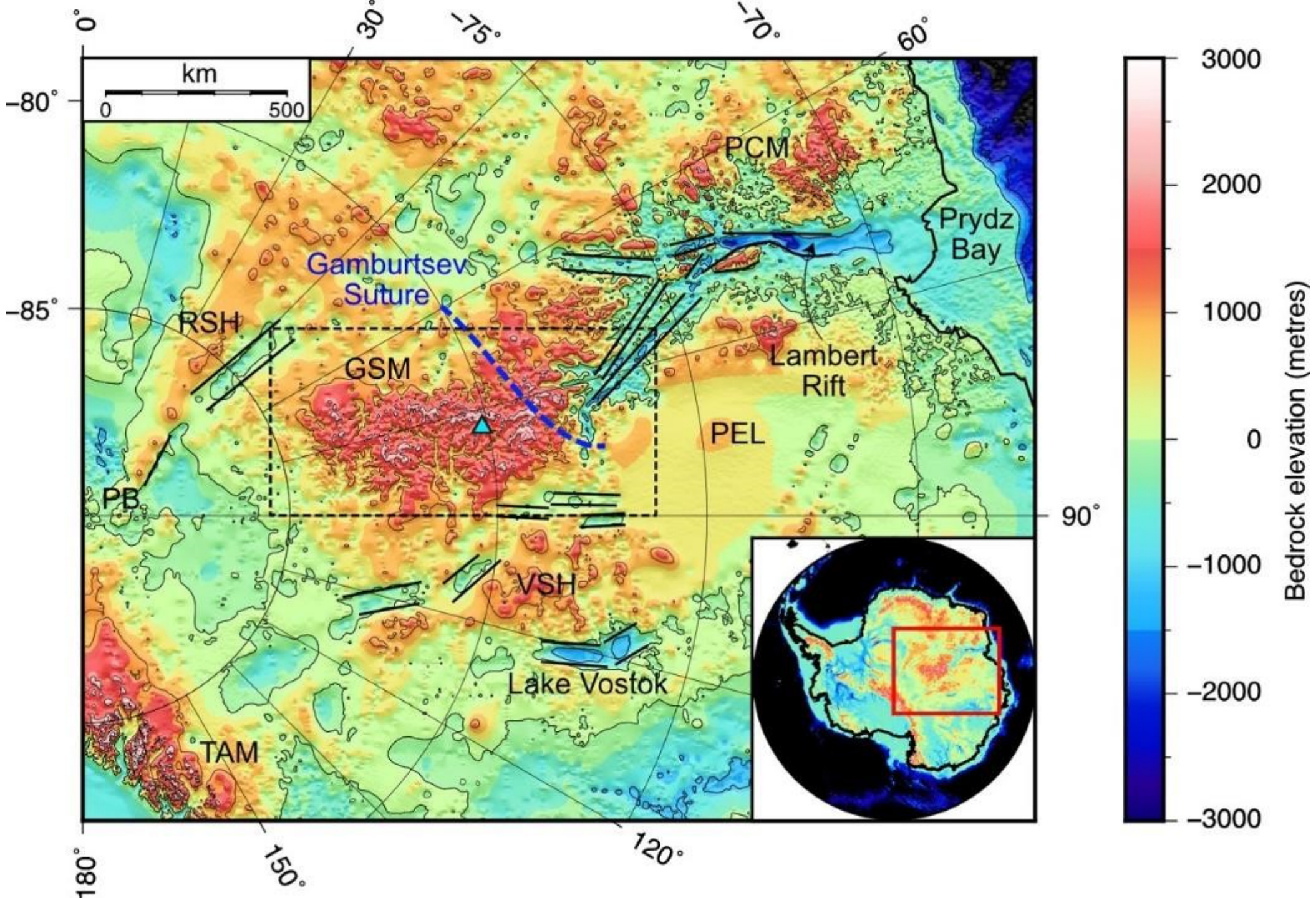

GPS
DVL
Receiver, Rx
Transmitter, Tx
25 MHz antennas

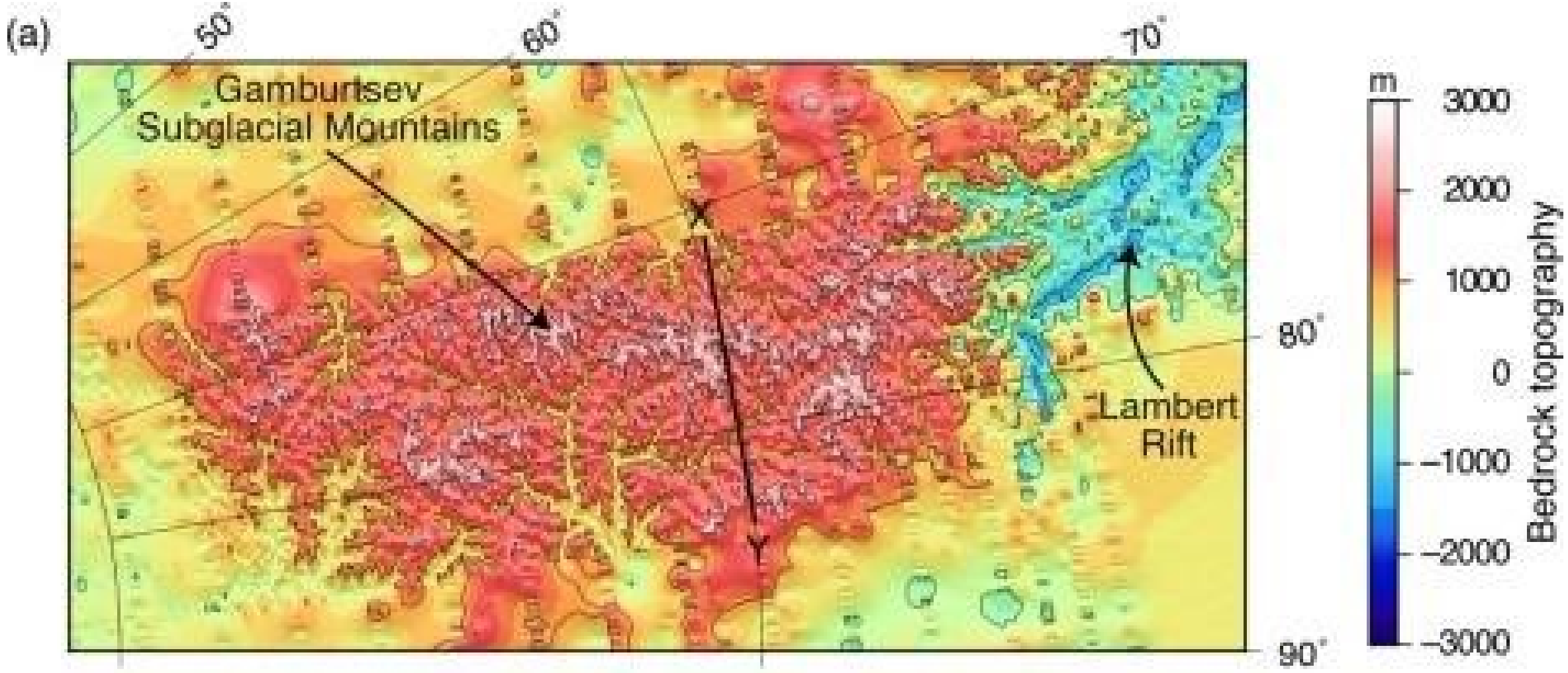
wavelength λ of radio waves

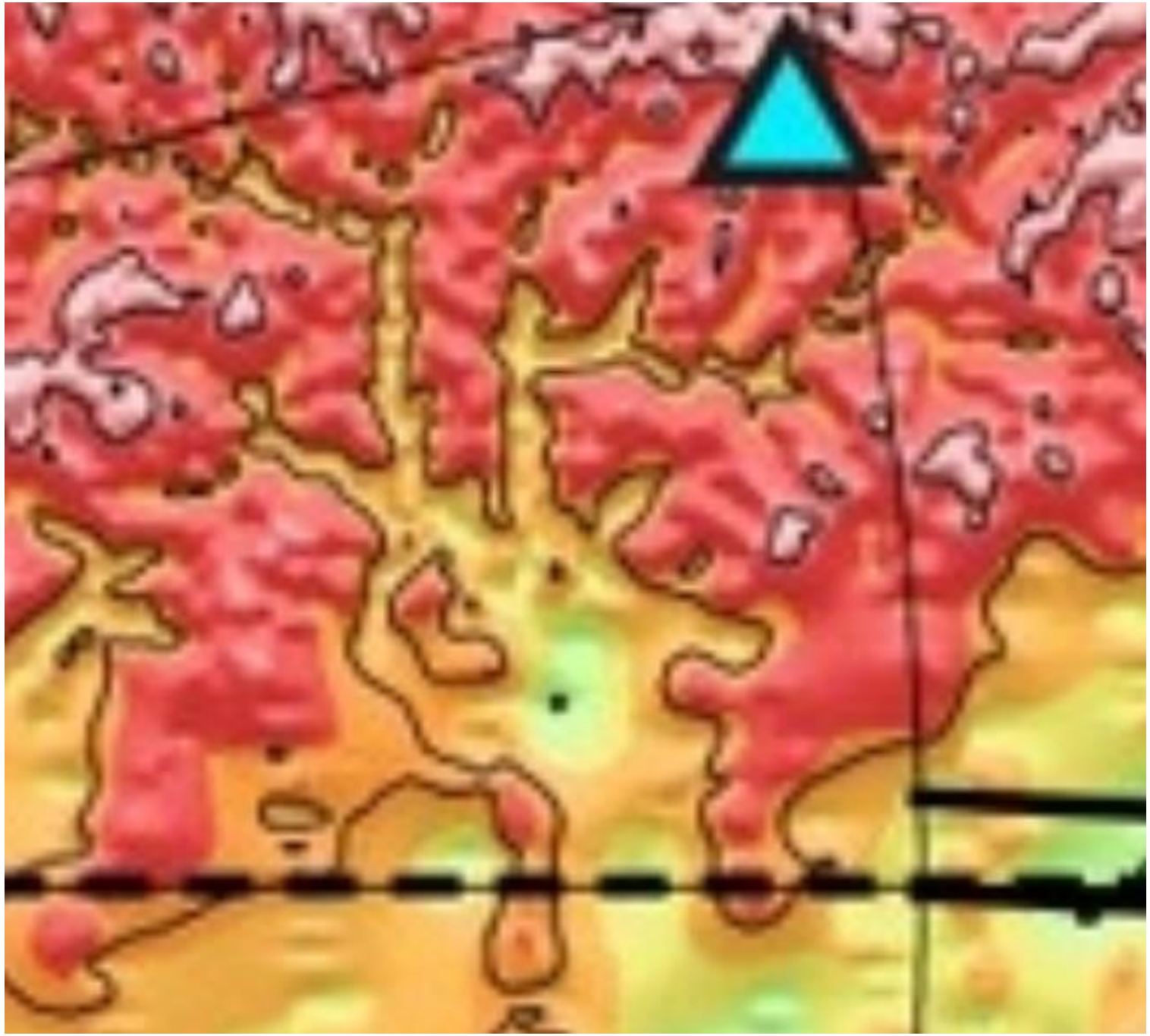
$$c = \lambda f$$

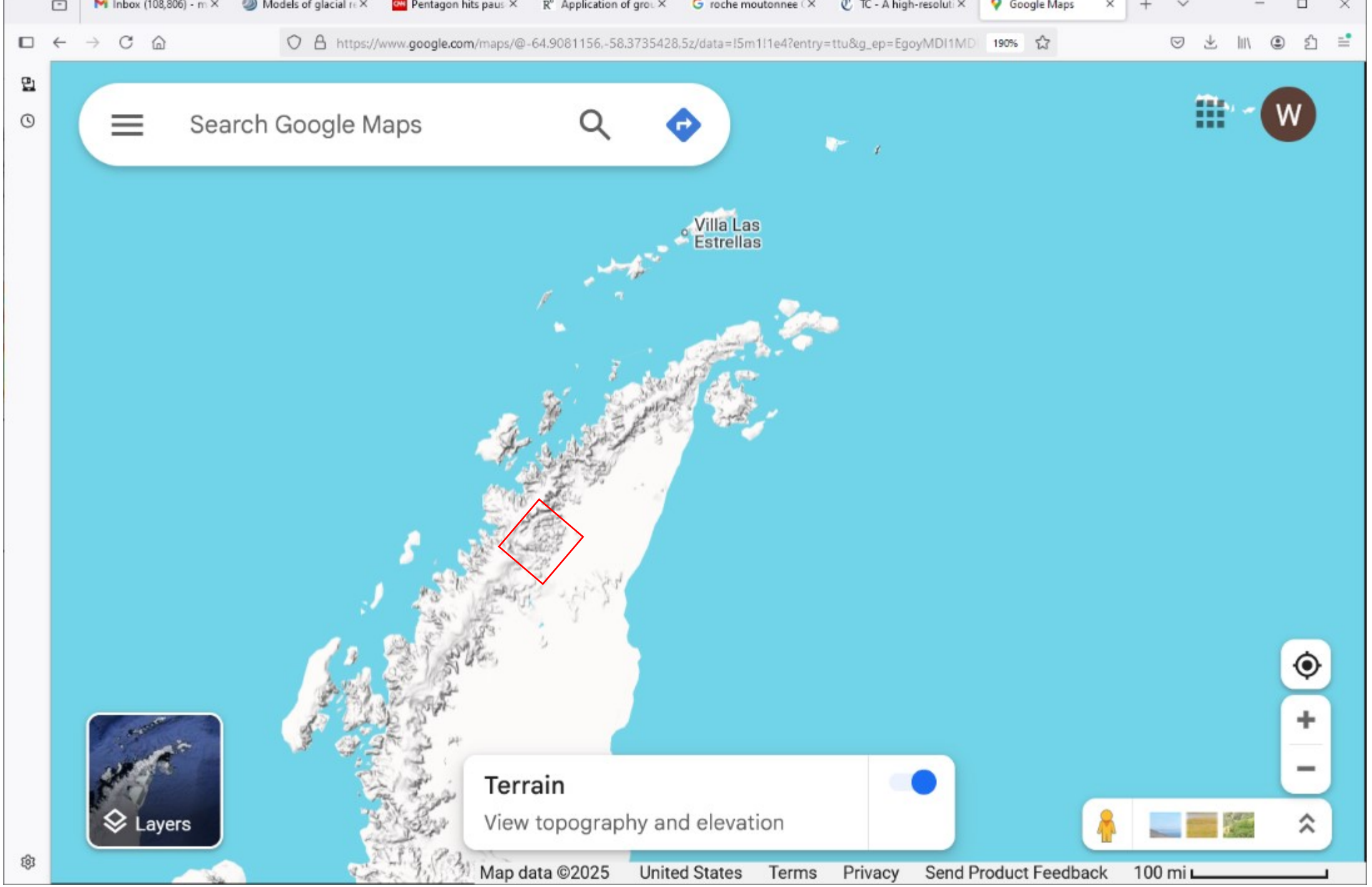
$$\lambda = \frac{c}{f} = \frac{3 \times 10^{8}\ \mathrm{ms}^{-1}}{25 \times 10^{6}\ \mathrm{s}^{-1}} = 1.2 \times 10^{-3}\mathrm{m}$$

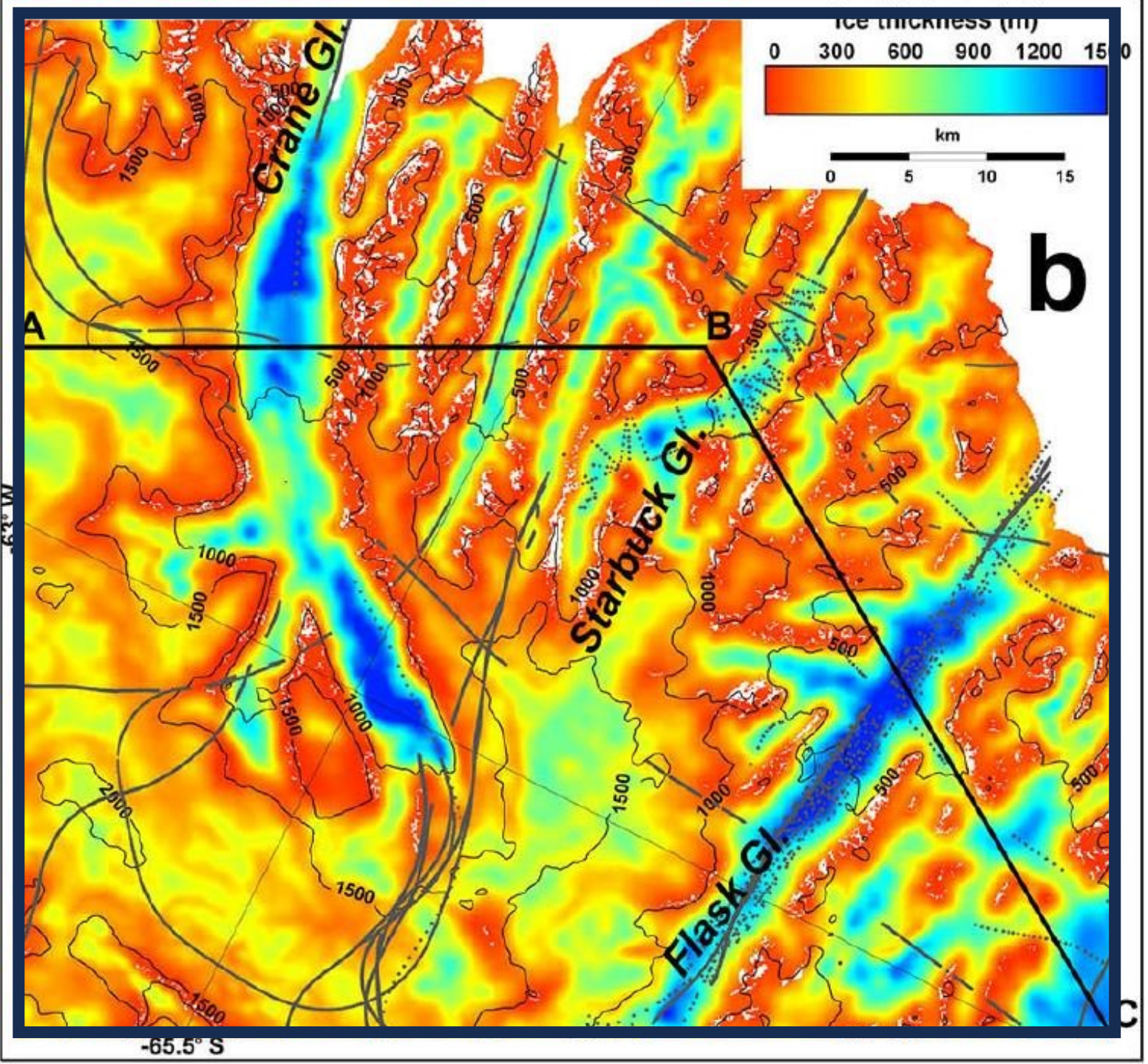
about a millimeter


km
0
500
0°
30°
−75°
−70°
60°
−80°
−85°
90°
150°
120°
180°
PCM
Prydz
Bay
Gamburtsev
Suture
RSH
GSM
Lambert
Rift
PEL
PB
VSH
Lake Vostok
TAM
3000
2000
1000
0
−1000
−2000
−3000
Bedrock elevation (metres)

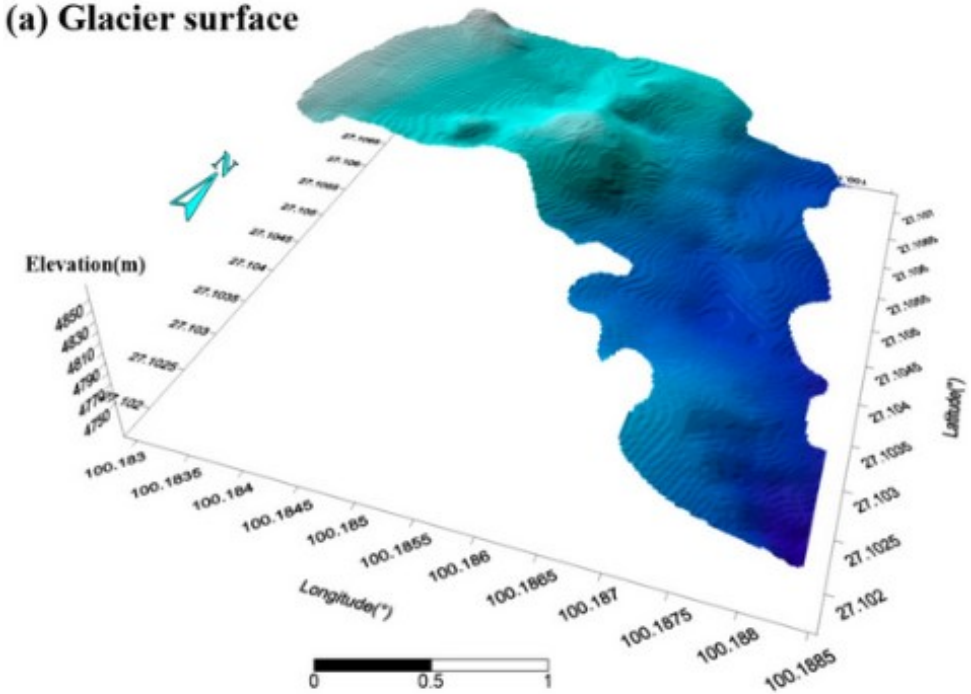

(a)
50°
60°
70°
80°
90°
Gamburtsev
Subglacial Mountains
Lambert
Rift
m
3000
2000
1000
0
−1000
−2000
−3000
Bedrock topography



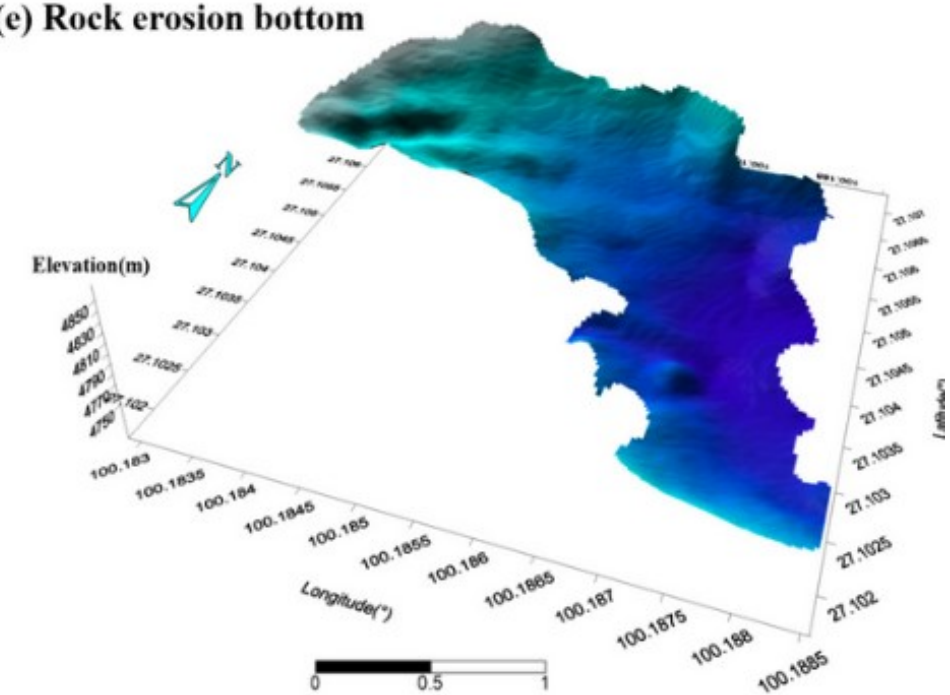

Search Google Maps
W
Villa Las Estrellas
Layers
Terrain
View topography and elevation
Map data ©2025
United States
Terms
Privacy
Send Product Feedback
100 mi


Ice thickness (m)
0 300 600 900 1200 1500
km
0 5 10 15
b
A
B
C
Crane Gl.
Starbuck Gl.
Flask Gl.
500
1000
1500
2000
-65.5° S

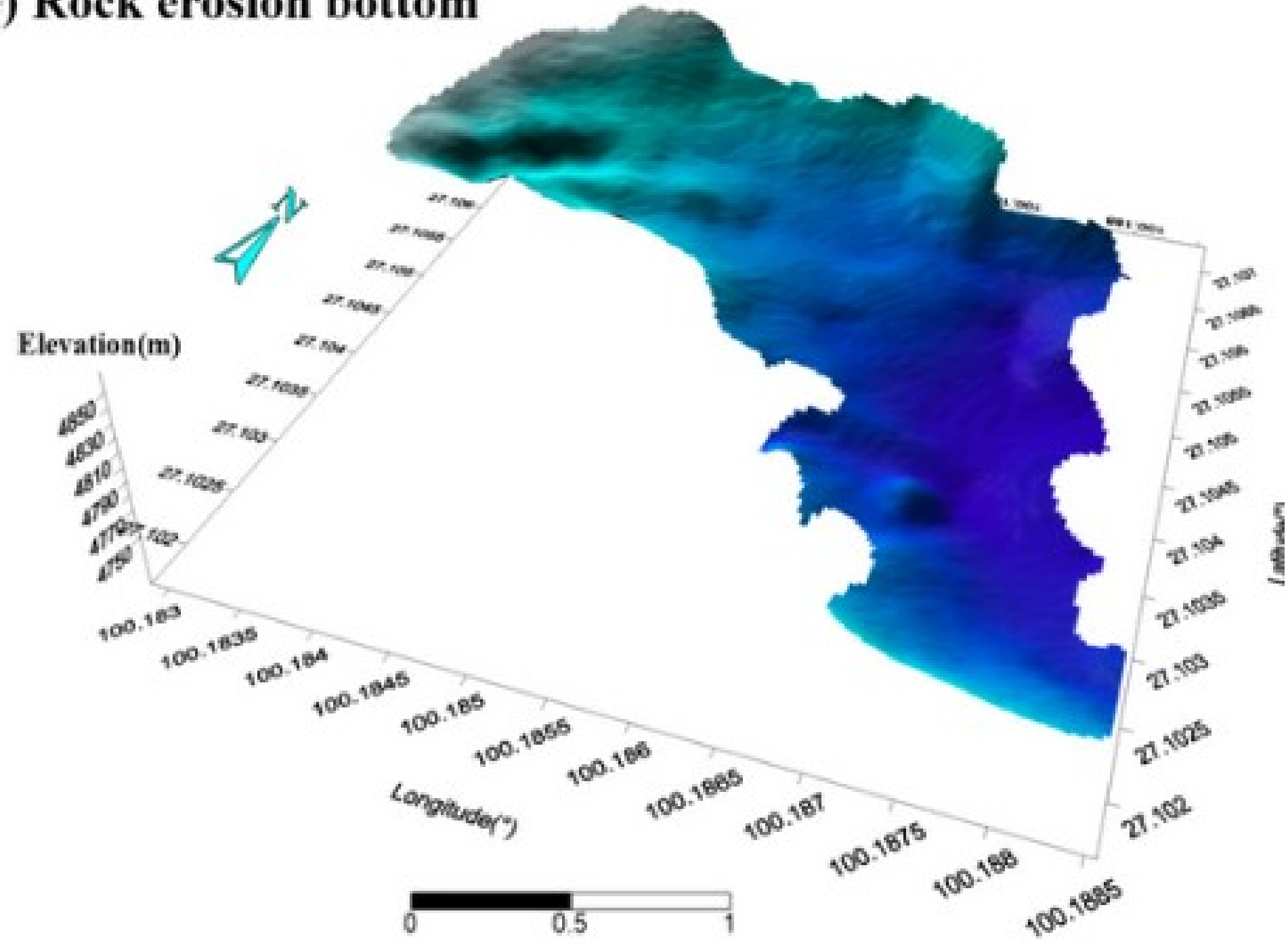
(a) Glacier surface



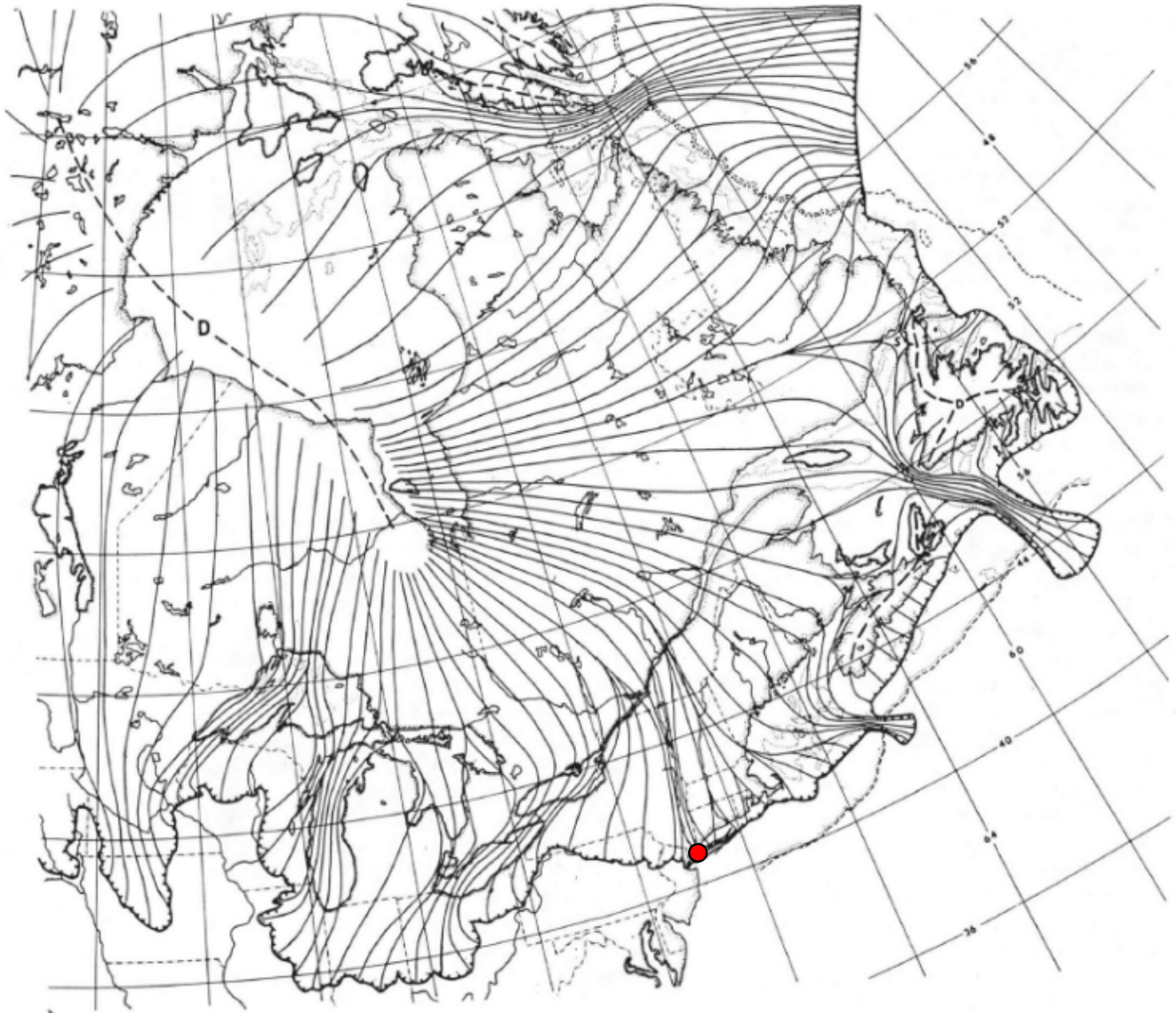
(e) Rock erosion bottom



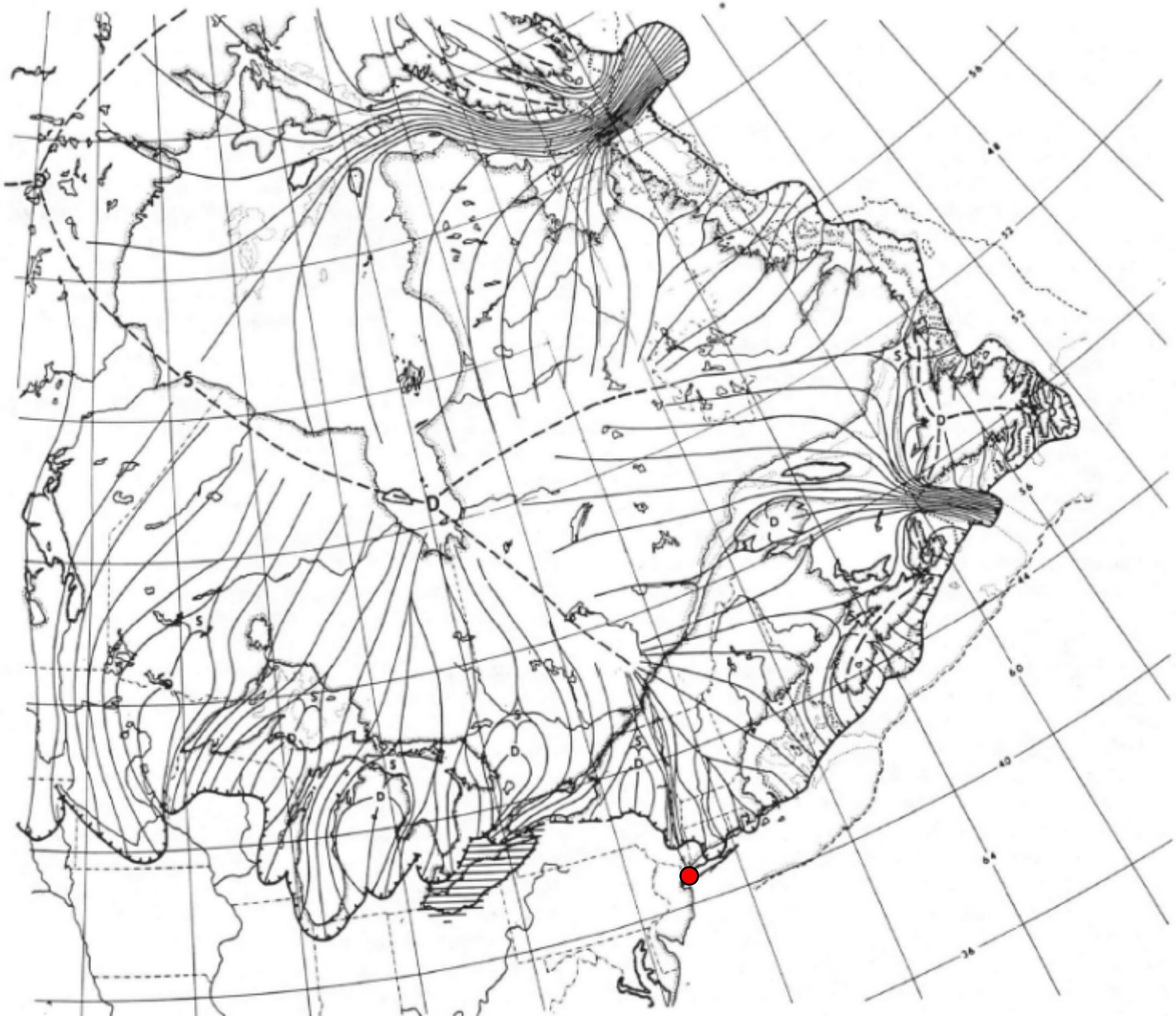
(e) Rock erosion bottom



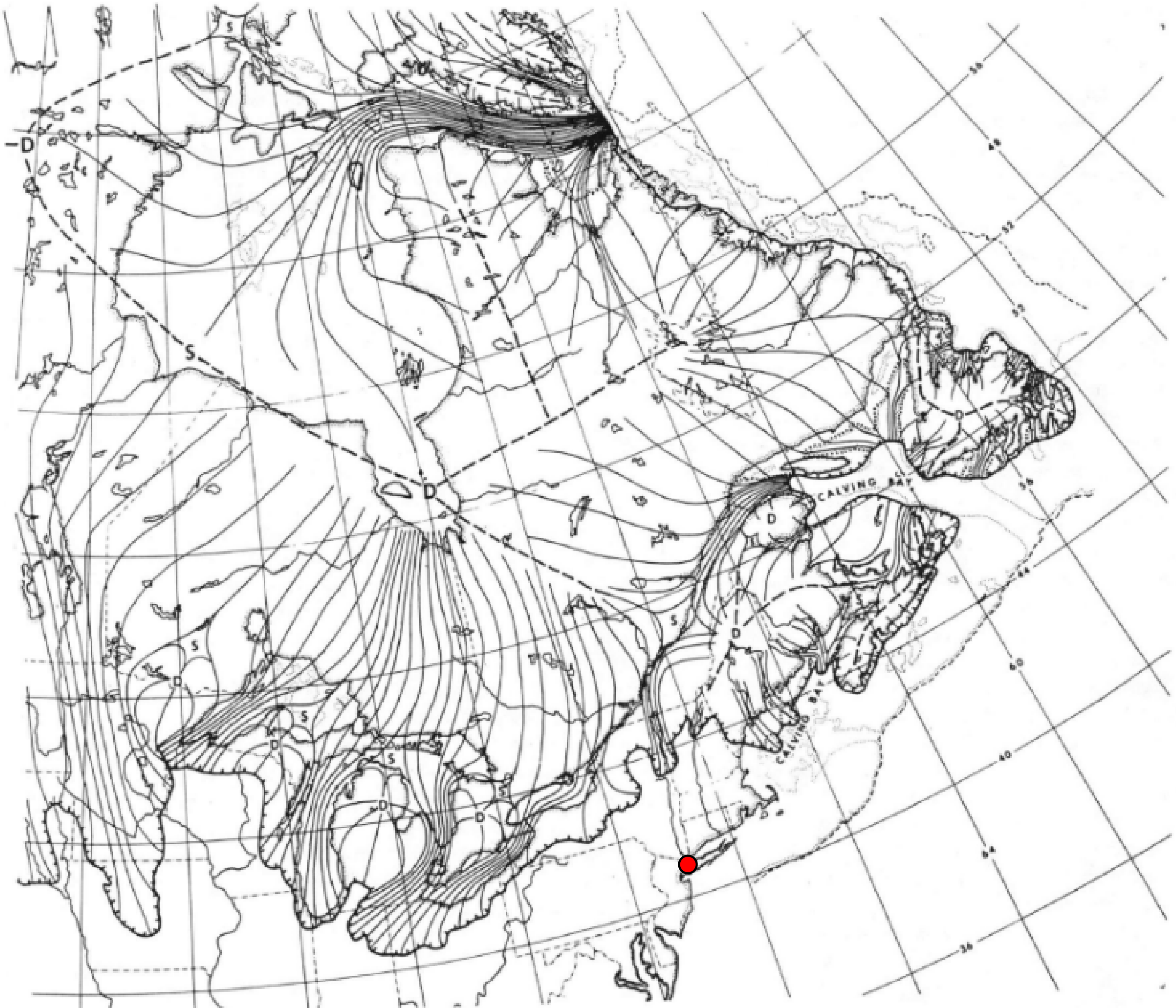
Part 2
Erosional Features Formed During Glacial Retreat



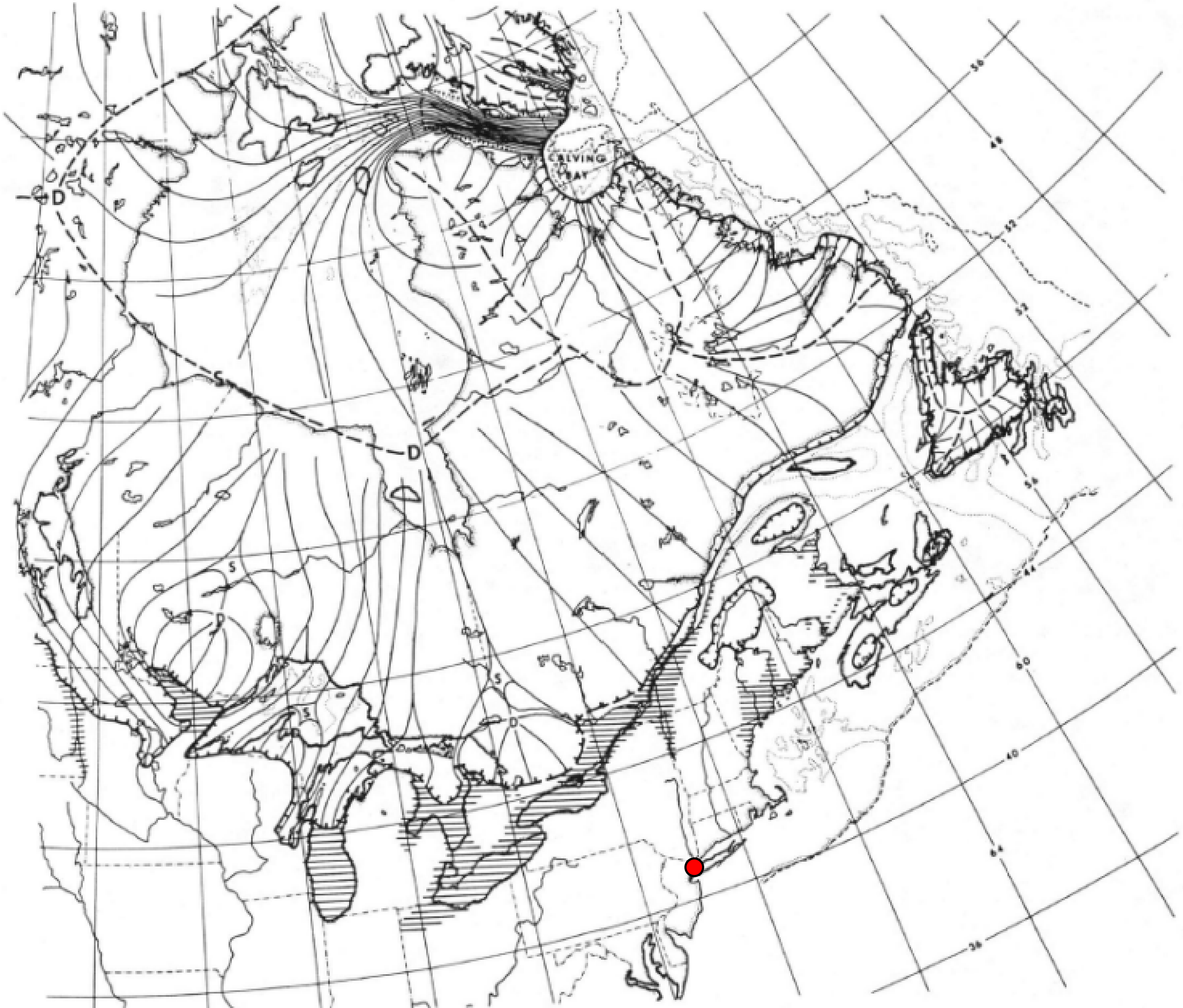
18,000 year ago



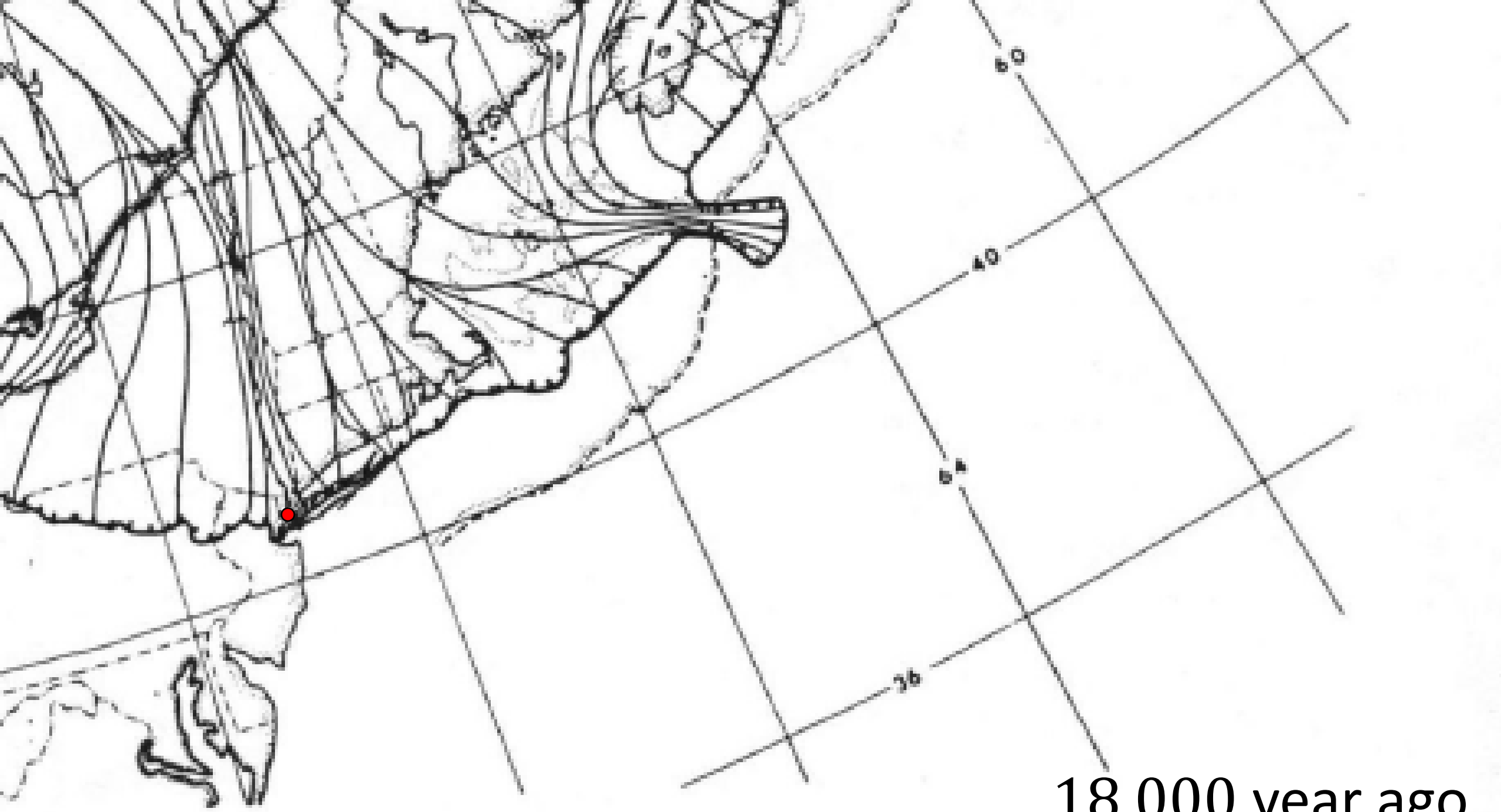
16,000 year ago



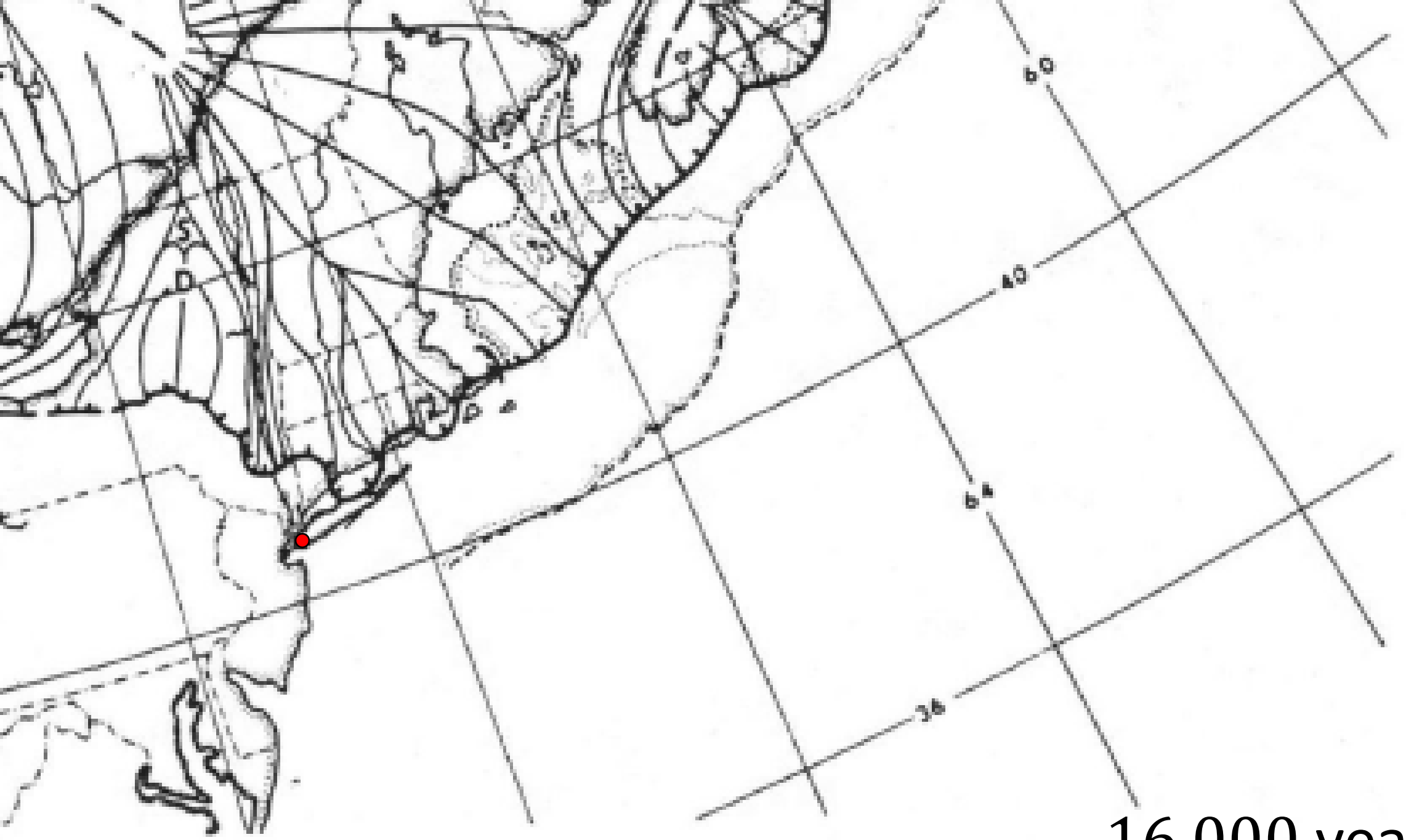
14,000 year ago



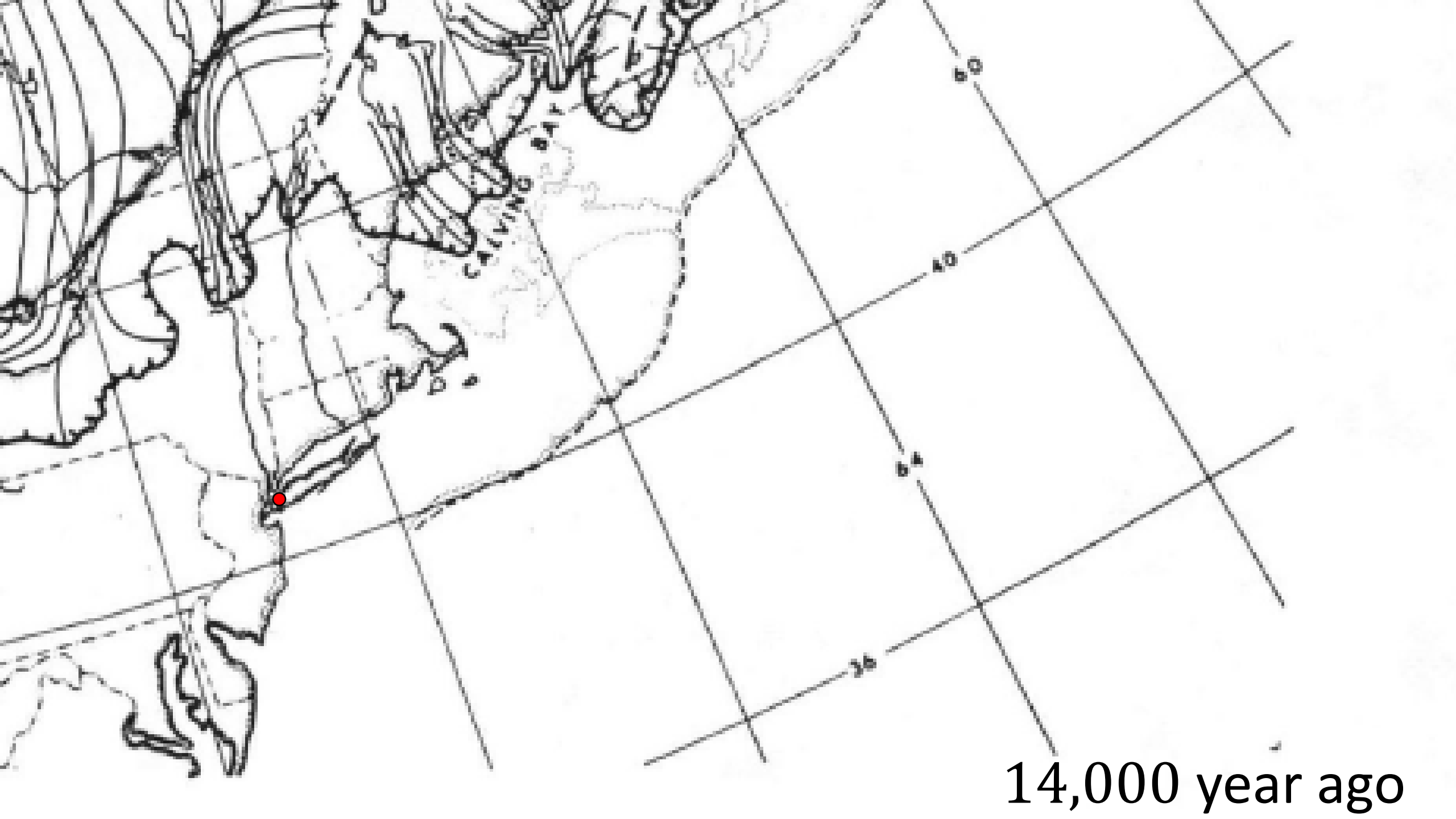
12,000 year ago



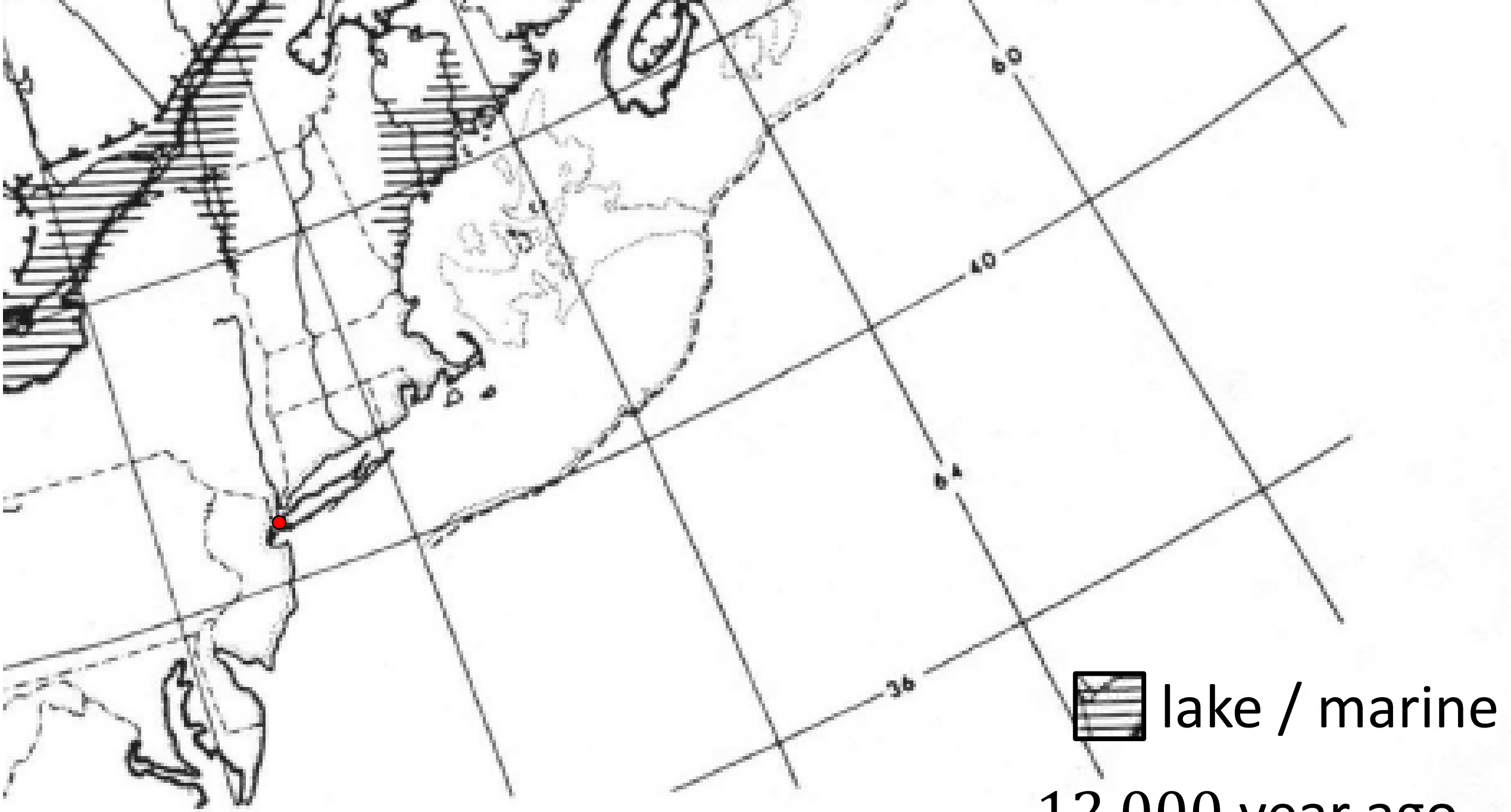
18,000 year ago



16,000 year ago



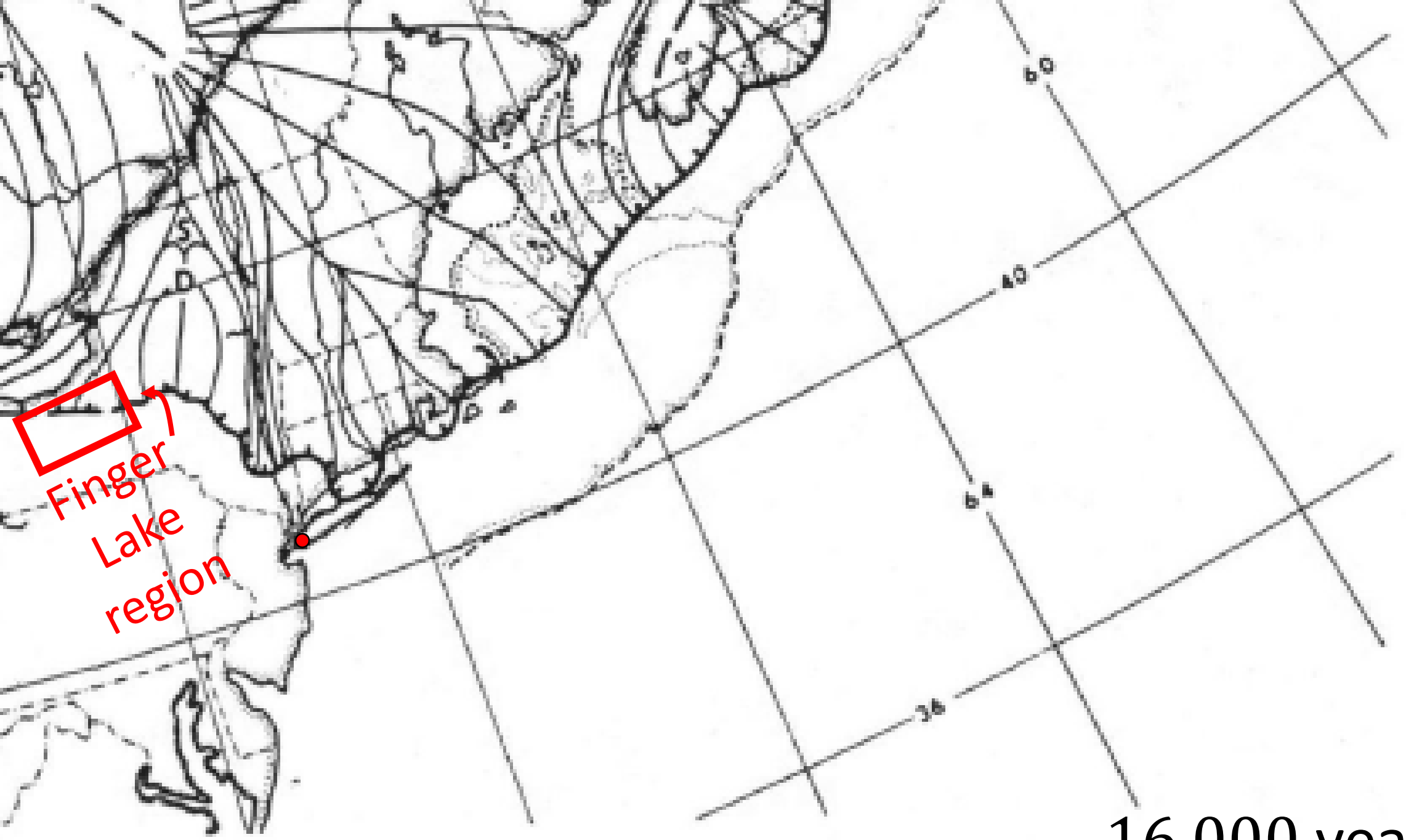
14,000 year ago


60
40
36
lake / marine
12,000 year ago

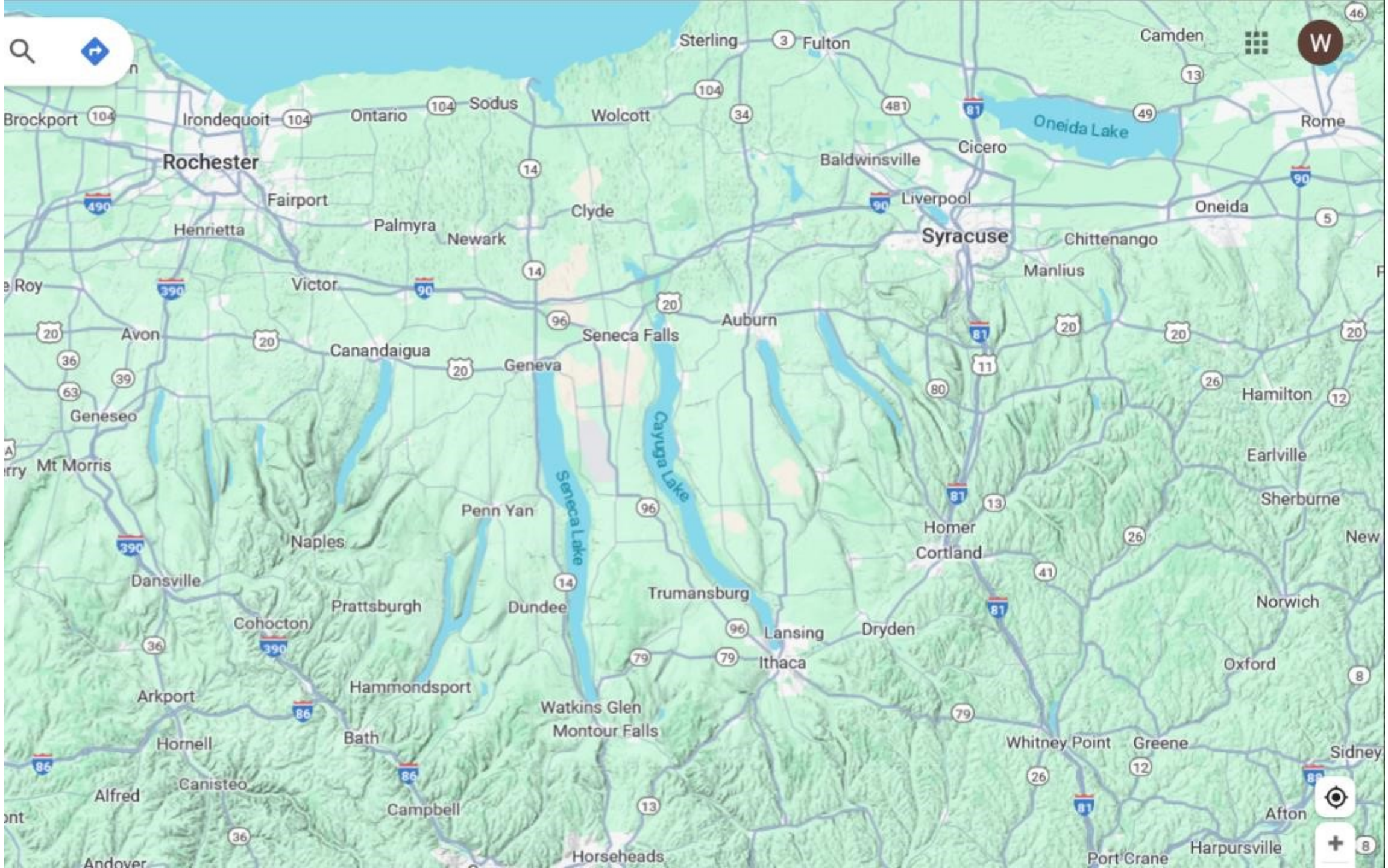
18,000 Ice Front at Ronkonkoma Moraine, Fast flow in Hudson Valley

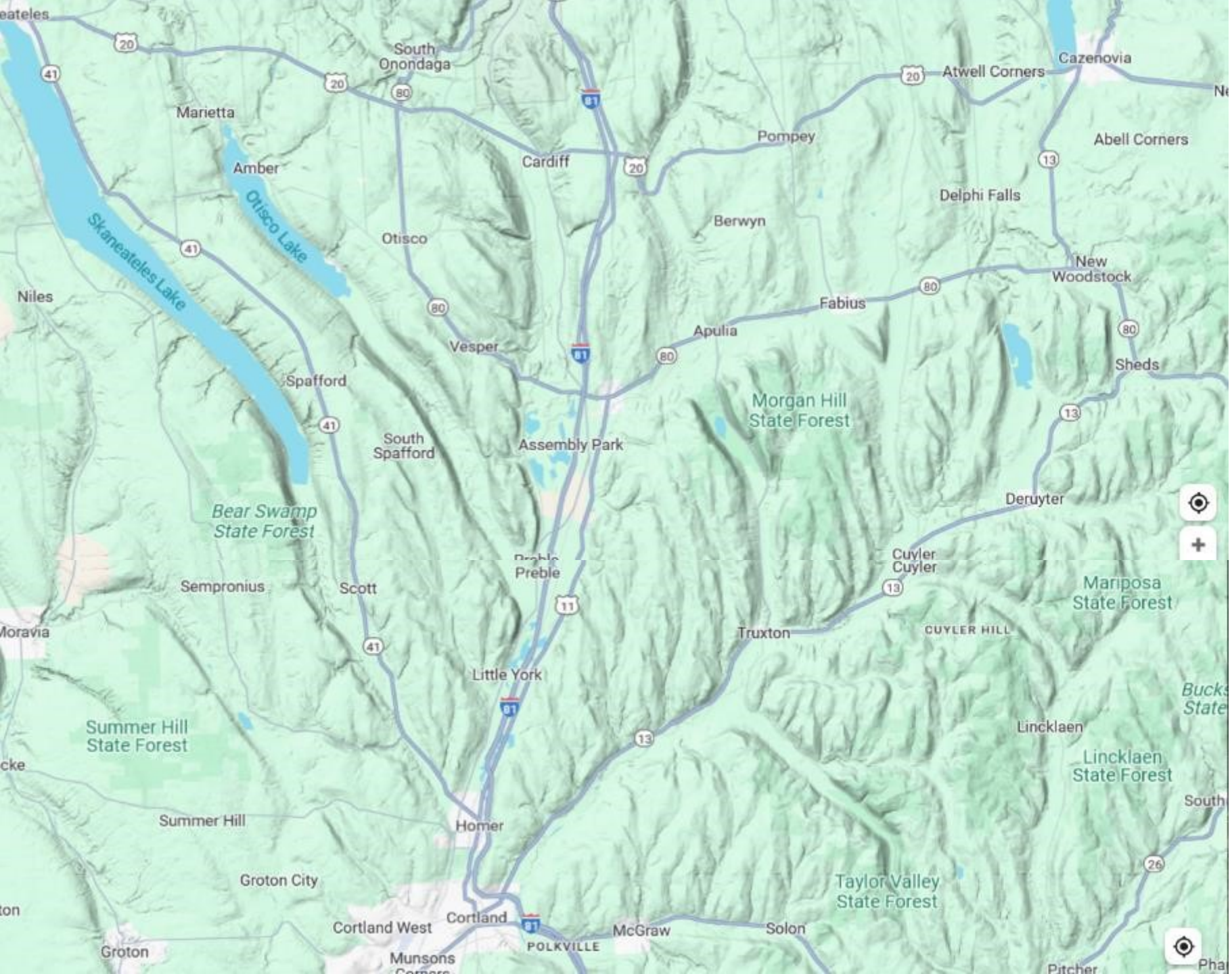
steady retreat

12,000 has melted back to St Laurence River, large flooded regions



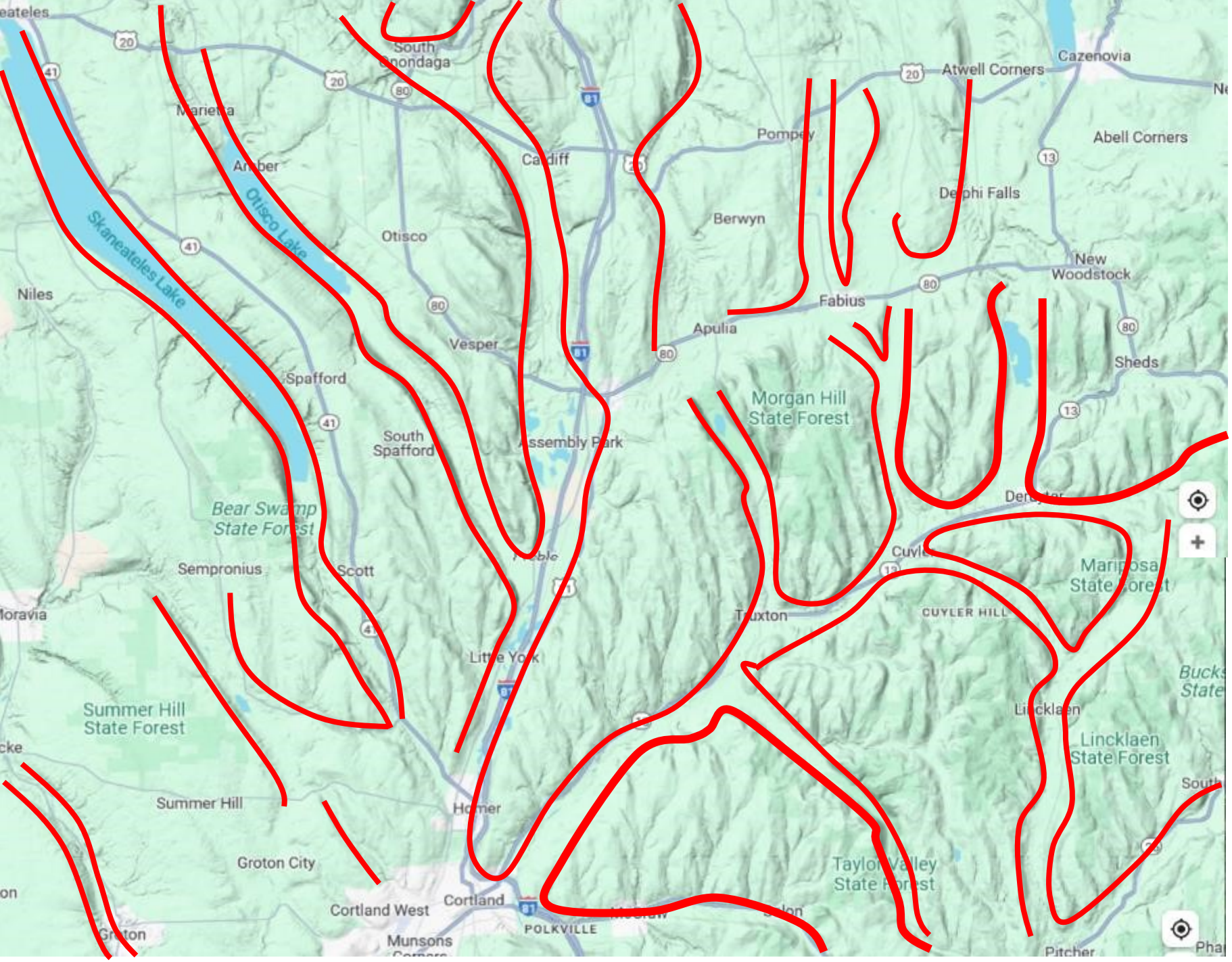
16,000 year ago


Sterling
Fulton
Camden
Brockport
Irondequoit
Ontario
Sodus
Wolcott
Oneida Lake
Rome
Rochester
Cicero
Baldwinsville
Fairport
Clyde
Liverpool
Oneida
Henrietta
Palmyra
Newark
Syracuse
Chittenango
Victor
Manlius
Auburn
Avon
Seneca Falls
Canandaigua
Geneva
Hamilton
Geneseo
Mt Morris
Earlville
Sherburne
Penn Yan
Seneca Lake
Cayuga Lake
Homer
Cortland
Naples
Dansville
Trumansburg
Norwich
Prattsburgh
Dundee
Lansing
Dryden
Cohocton
Ithaca
Oxford
Hammondsport
Arkport
Watkins Glen
Montour Falls
Hornell
Bath
Whitney Point
Greene
Sidney
Canisteo
Alfred
Campbell
Afton
Horseheads
Harpursville
Port Crane



valleys bigger than modern lakes

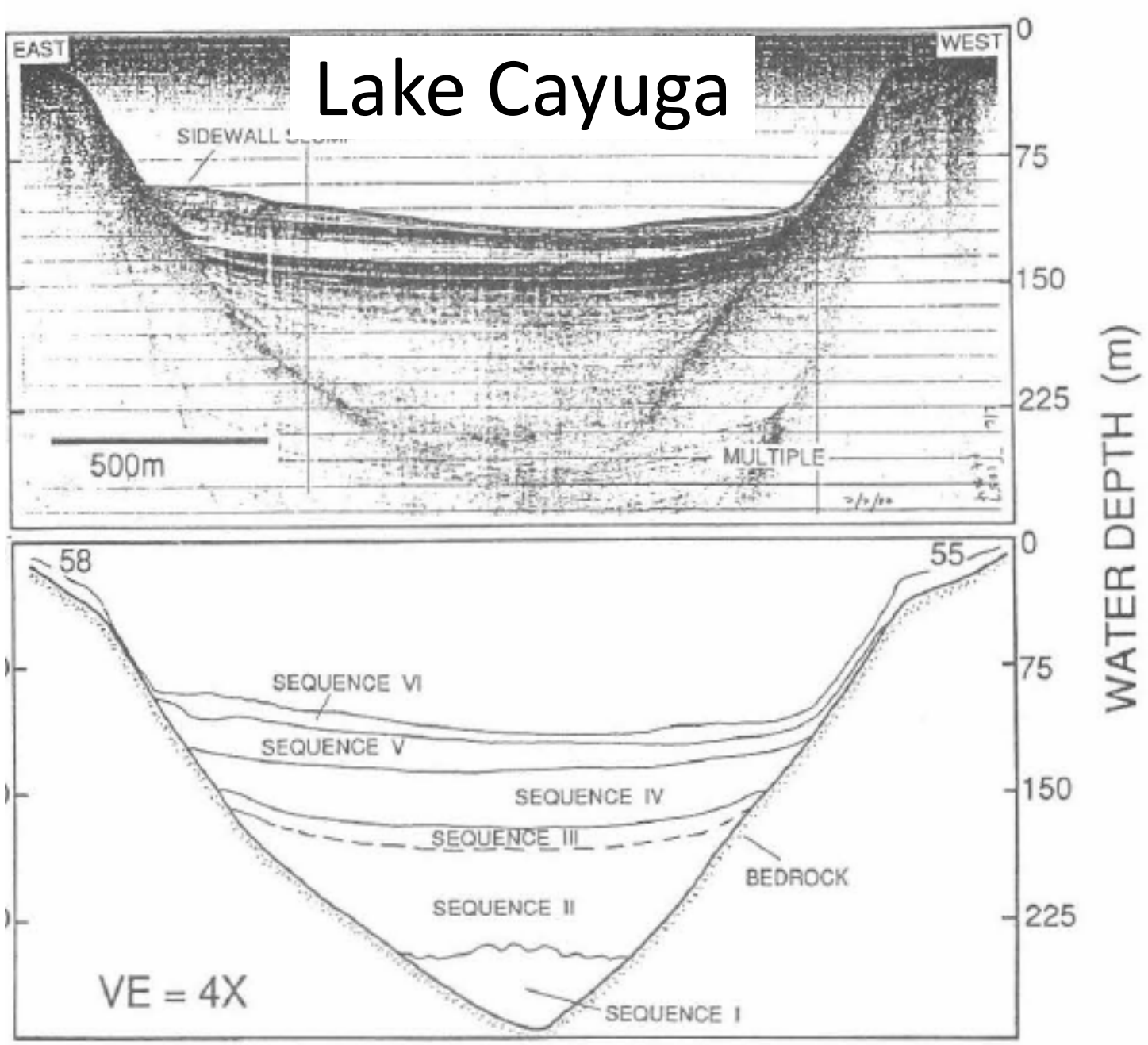
not all are north-south



most valleys have no lakes

valleys bigger than modern lakes

not all are north-south



seismic
echo sounding
indicates
valleys are
substantially
deeper than they
appear and are
filled with
sediments

Tunnel Valley

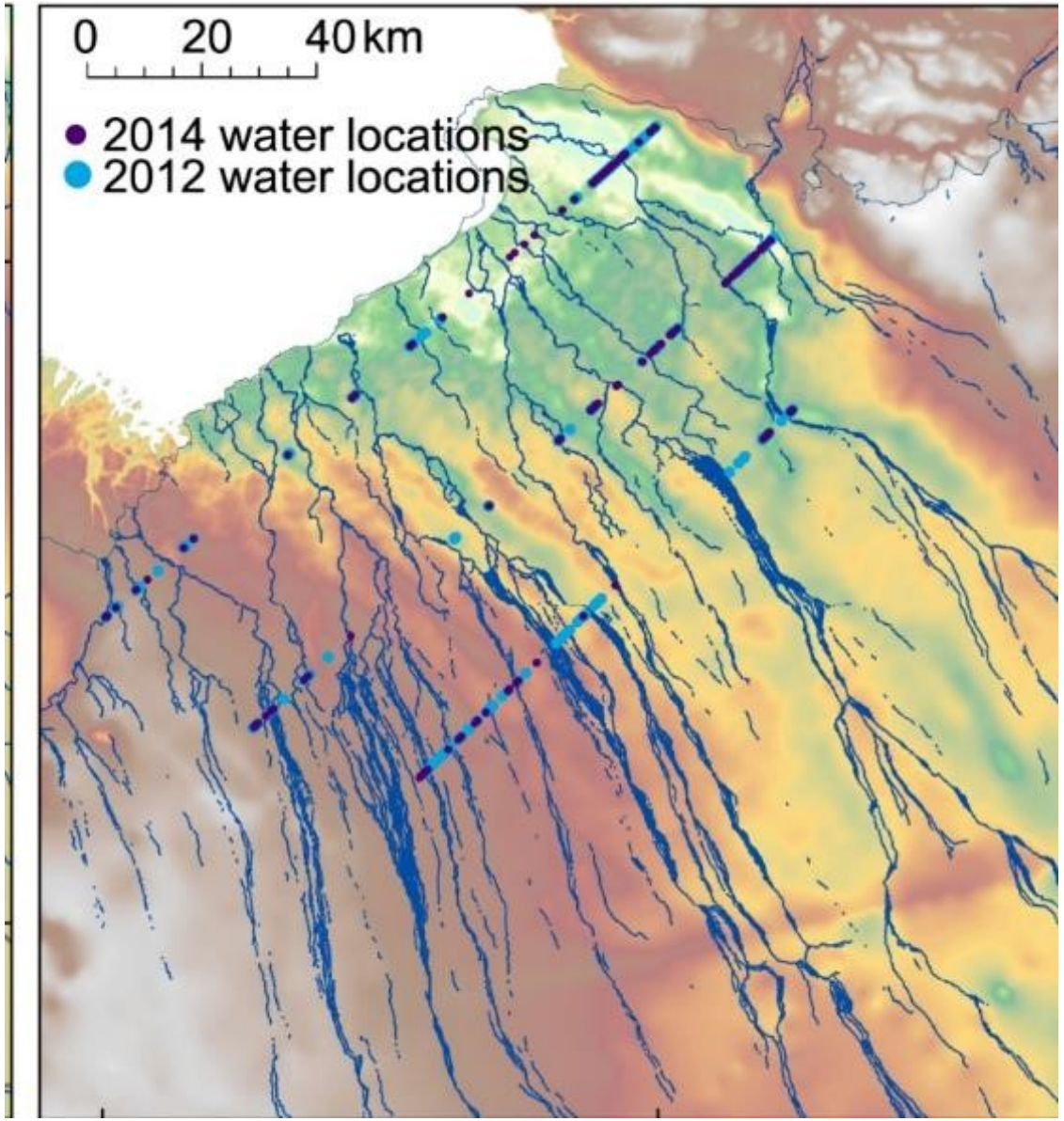
Valley formed under the ice sheet when it its rapidly melting back

very broad infiltration of ice from surface melts
(lots of moulins)

flow of water along glacial bed, concentrated in large tunnels

erosion of bedrock beneath glacier

not known if flow is steady or sudden floods



Modern tunnel valleys beneath Humbolt Glacier, Greenland


Extra Space Storage
Woodchuck Hill Rd
481
274
6
Lafayette Rd
Clark
Reservation
State Park
Jamesville
91
Gates Rd
Apulia Rd
Jamesville
Beach Park
Sentinel
Heights
1.6 km
Map data ©2025 Google
United States
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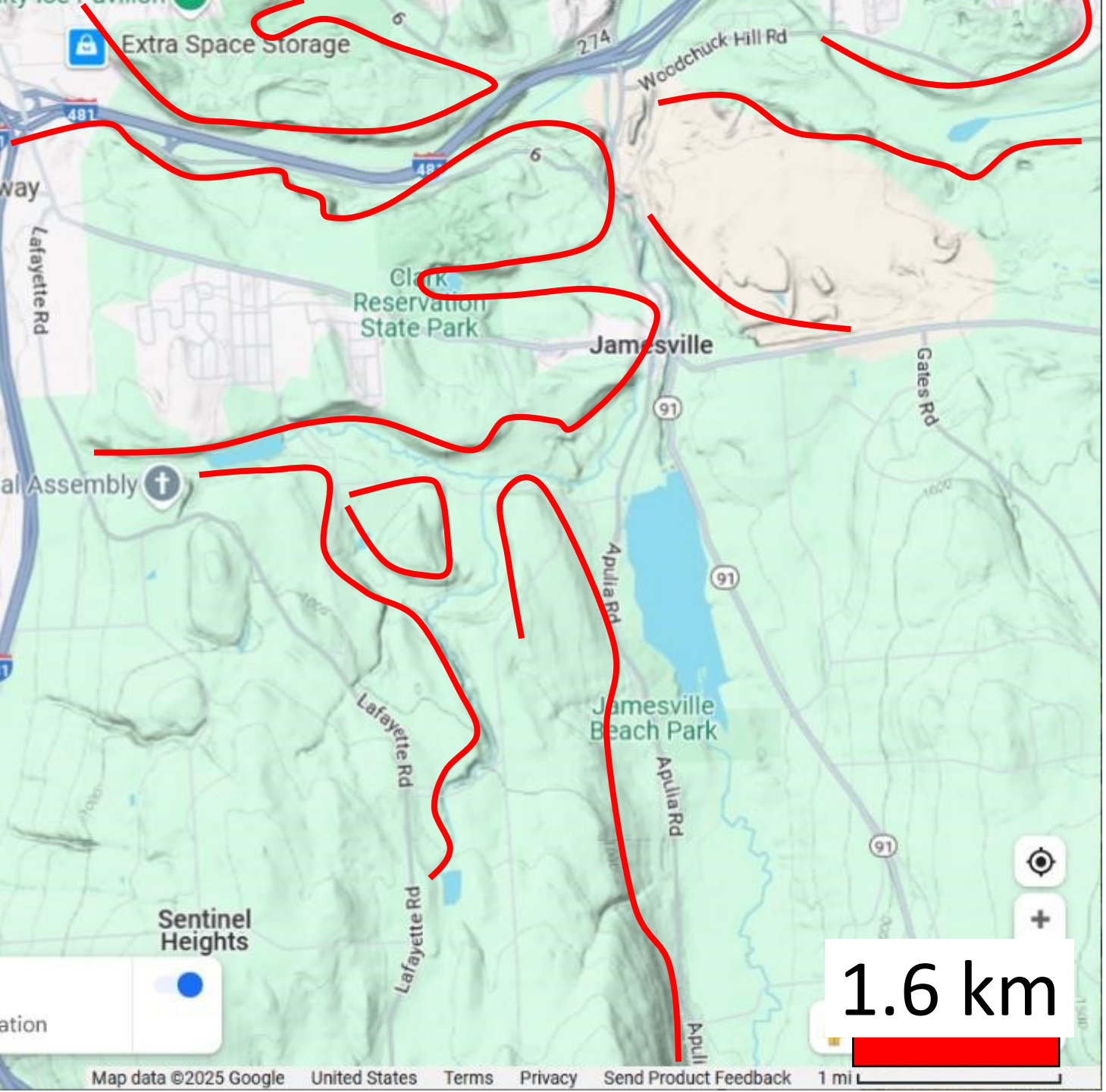
Privacy
Send Product Feedback
1 mi



are the channels
really subglacial
(below the glacier),
or might they be
proglacial
(in front of glacier)
?

Plunge Pool

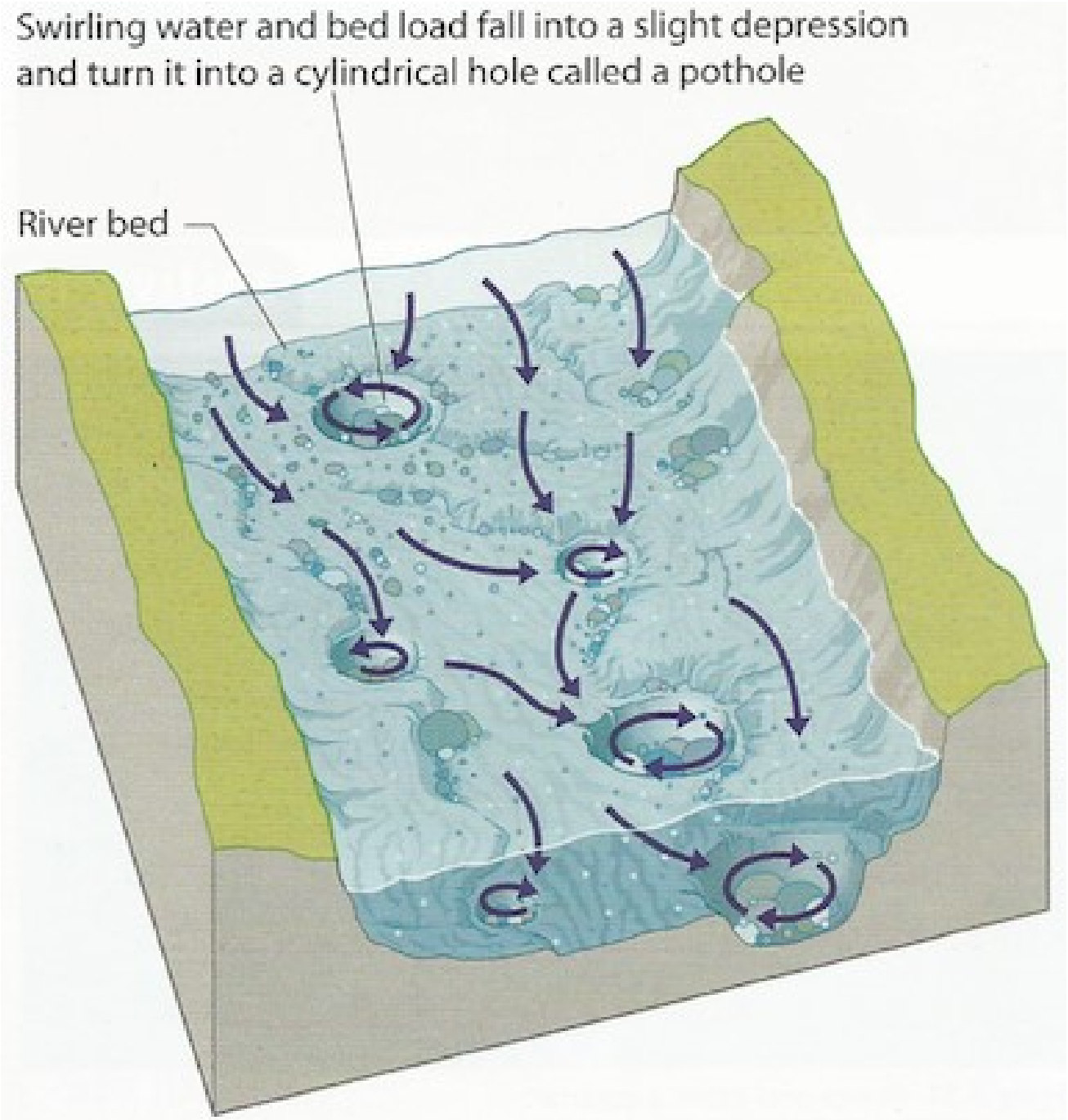
1.6 km

younger pool ?

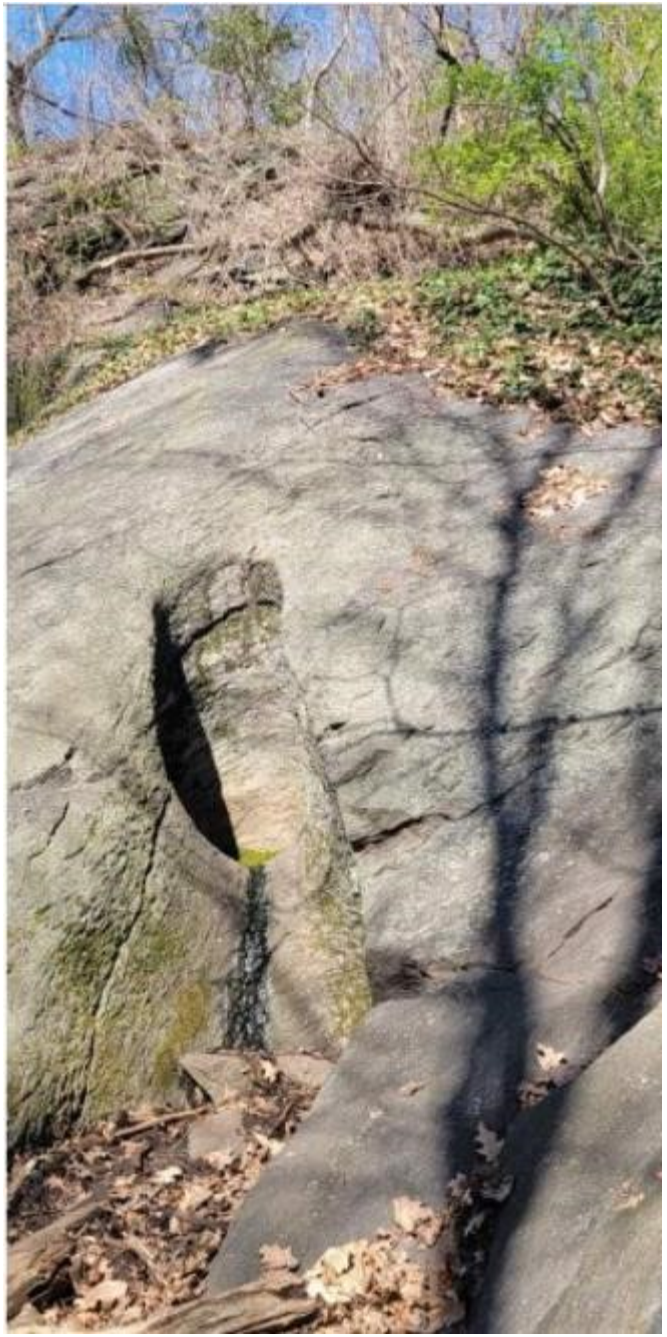
older pool ?

presence of two pools suggestive of change in pathway of subglacial water flow

waterfall off of ice shelf in Antarctica

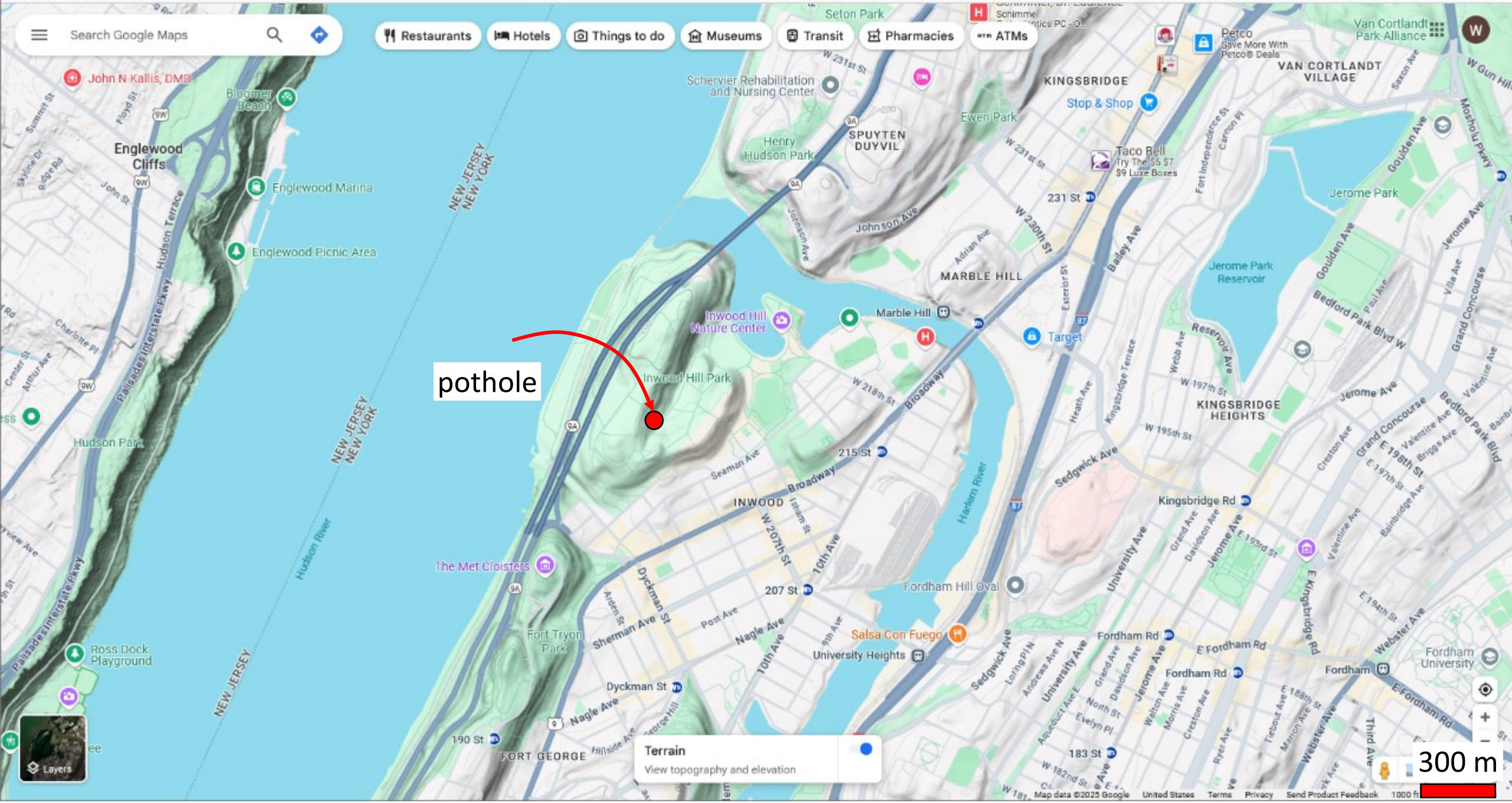


Pothole
swirling water causes stones to erode cylindrical holes in river bottom



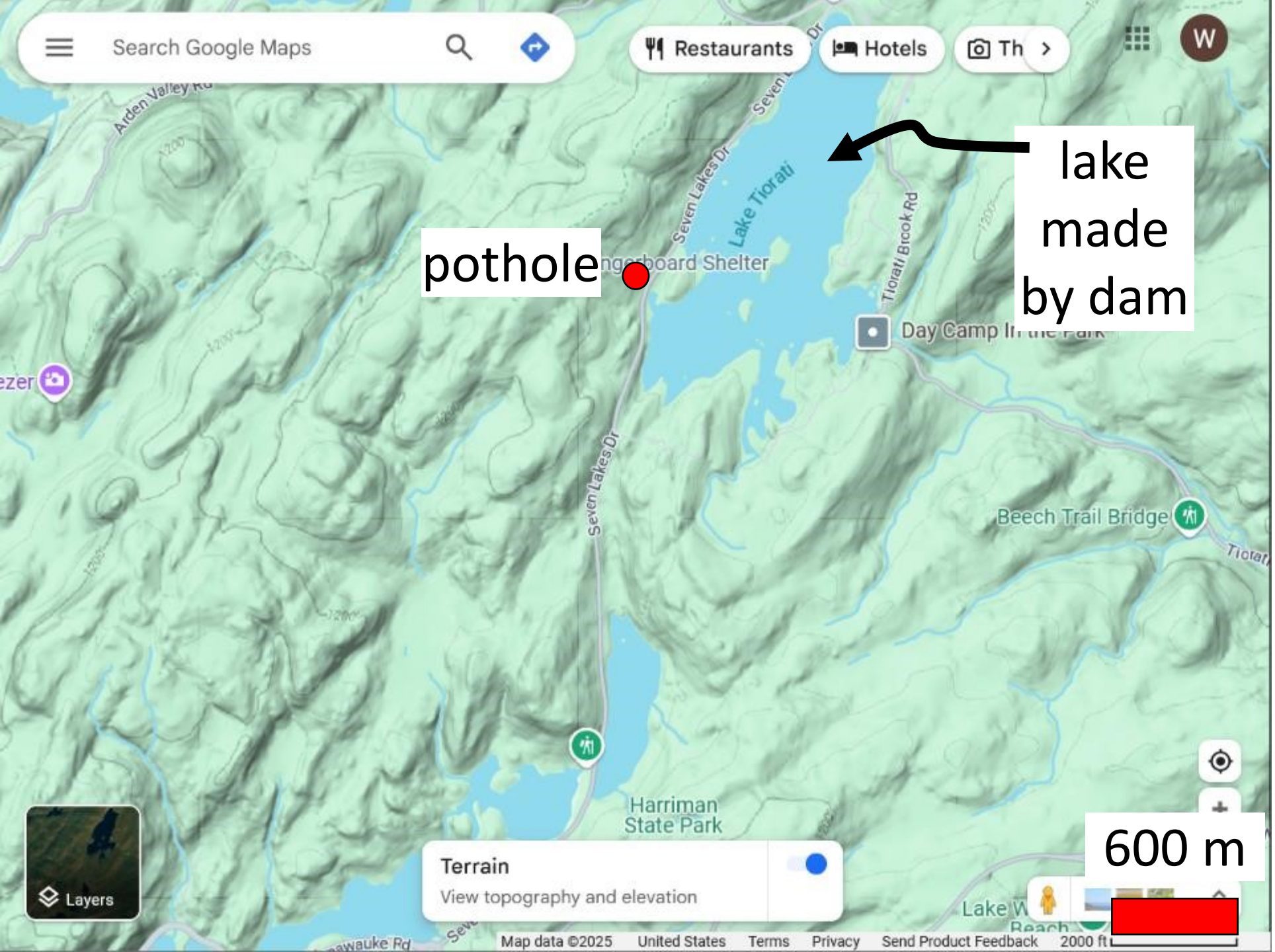
Glacial Pothole
(Inwood Park)

Pothole not near present-day river formed from Ice Age meltwater


pothole
Search Google Maps
Restaurants
Hotels
Things to do
Museums
Transit
Pharmacies
ATMs
Englewood Cliffs
Englewood Marina
Englewood Picnic Area
Bloomer Beach
Hudson Park
Ross Dock Playground
Fort Tryon Park
The Met Cloisters
Inwood Hill Park
Inwood Hill Nature Center
Marble Hill
MARBLE HILL
INWOOD
KINGSBRIDGE
KINGSBRIDGE HEIGHTS
VAN CORTLANDT VILLAGE
SPUYTEN DUYVIL
Jerome Park
Jerome Park Reservoir
Fordham Hill Oval
University Heights
Fordham
Fordham University
FORT GEORGE
Schervier Rehabilitation and Nursing Center
Henry Hudson Park
Ewen Park
Seton Park
Van Cortlandt Park Alliance
Petco
Stop & Shop
Taco Bell
Target
Salsa Con Fuego
NEW JERSEY
NEW YORK
Hudson River
Harlem River
Broadway
231 St
215 St
207 St
190 St
183 St
Dyckman St
Nagle Ave
Kingsbridge Rd
Fordham Rd
Terrain
View topography and elevation
Layers
300 m
Map data ©2025 Google
United States
Terms
Privacy
Send Product Feedback

Glacial Pothole

near
Hurst
Trailhead
Harriman
State
Park)


Search Google Maps
Restaurants
Hotels
Th
W
Arden Valley Rd
Seven Lakes Dr
Lake Tiorati
Tiorati Brook Rd
pothole
lake made by dam
Day Camp In the Park
Beech Trail Bridge
Harriman State Park
Terrain
View topography and elevation
Layers
600 m
Map data ©2025
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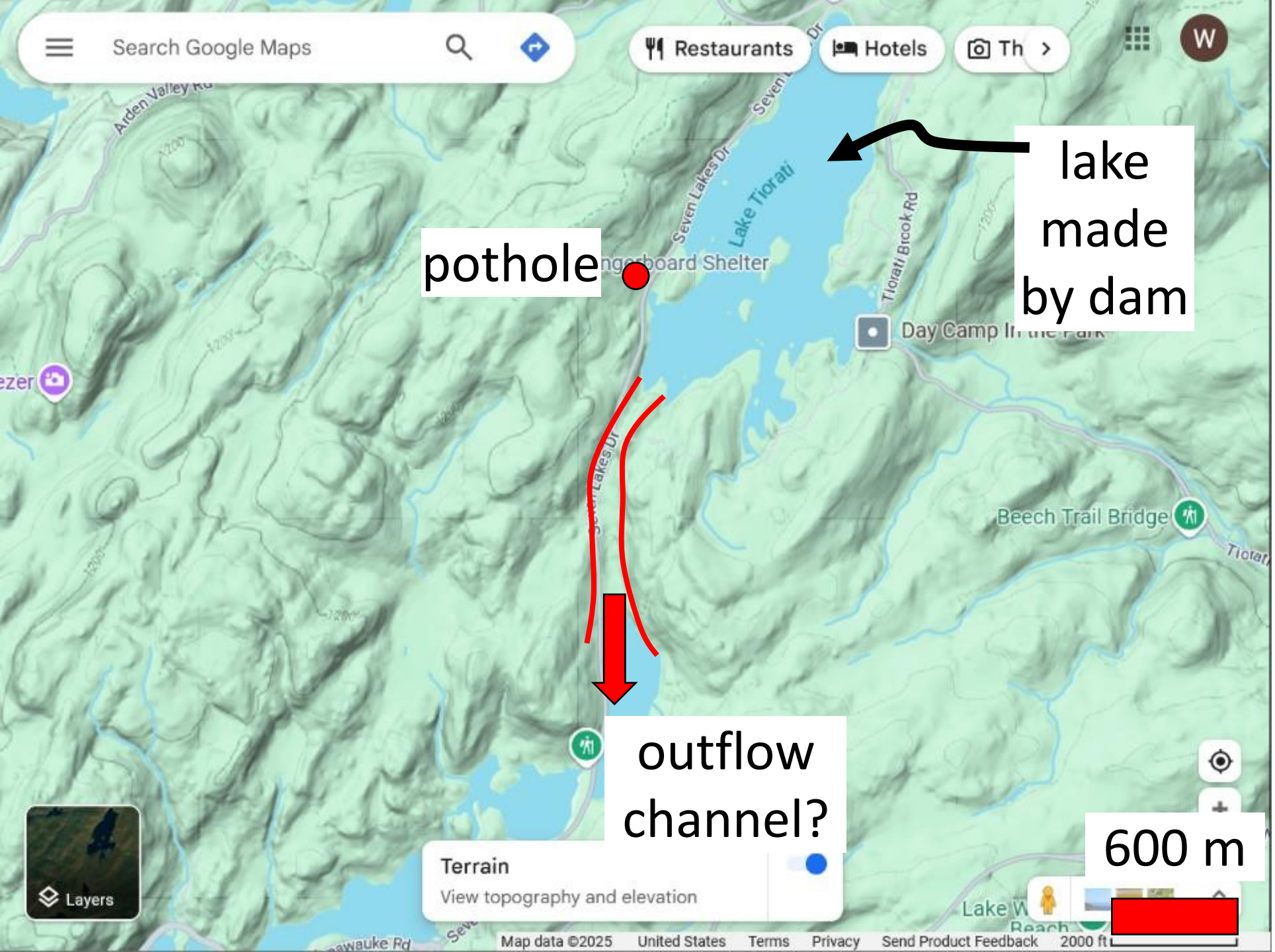
Send Product Feedback
2000 ft


Search Google Maps
Restaurants
Hotels
Th
Seven Lakes Dr
Lake Tiorati
Tiorati Brook Rd
Day Camp In the Park
Beech Trail Bridge
Layers
Terrain
View topography and elevation
Map data ©2025
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Privacy
Send Product Feedback
2000 ft
pothole
lake made by dam
outflow channel?
600 m

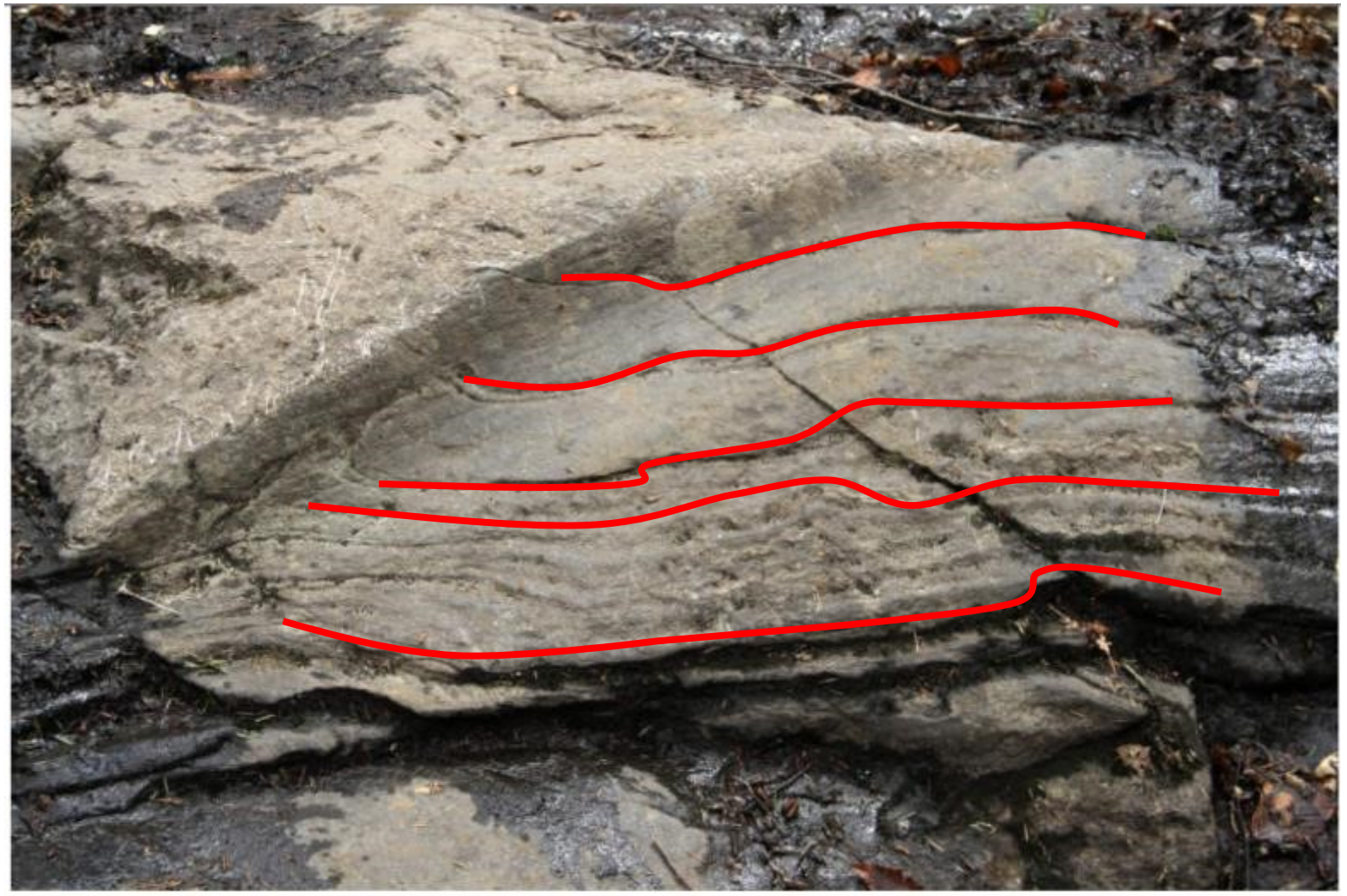
Glacial flute

Glacial Flute

Glacial flute

Glacial Flute

subglacial water may have played a role in its formation



Glacial flute

Glacial Flute

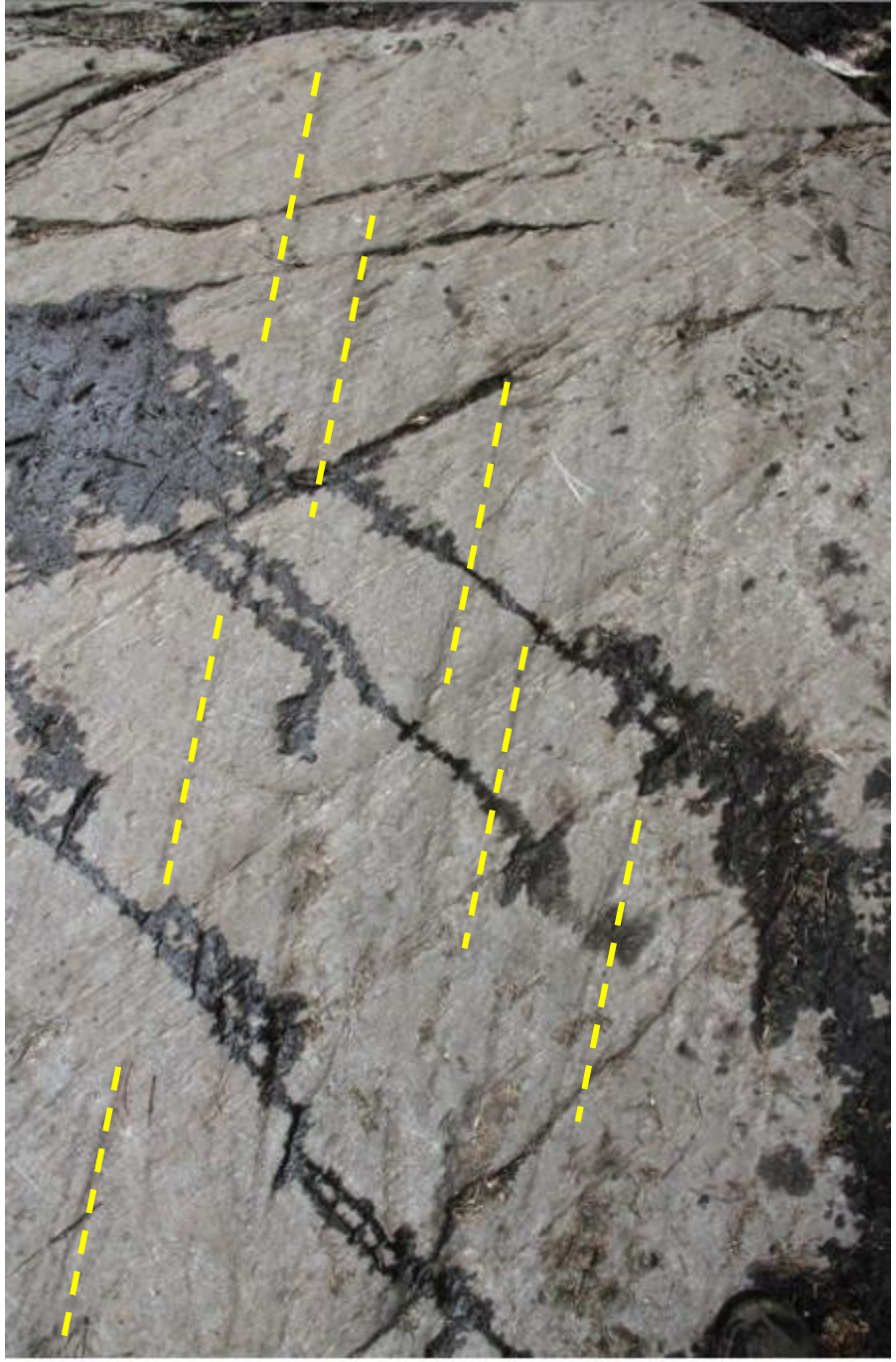
don’t confuse metamorphic banding with flutes

Part 3
Small-Scale Erosional Features

Glacial striae on a rock ledge

glacial scratches

“striae”



Glacial striae on a rock ledge

glacial scratches

“striae”

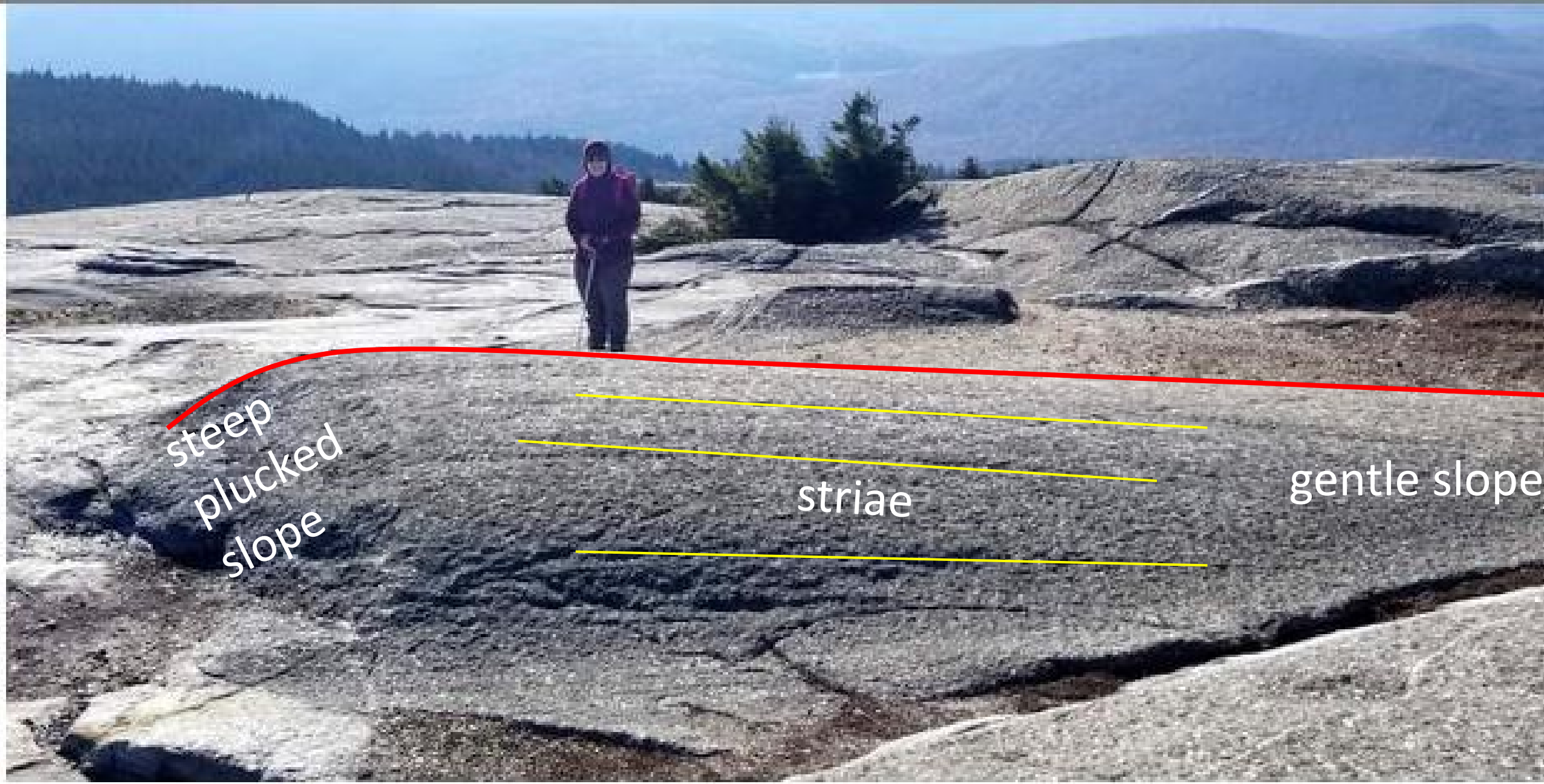
Glacial striae on a rock ledge

careful observation
needed to distinguish

striae
(on surface of rock)

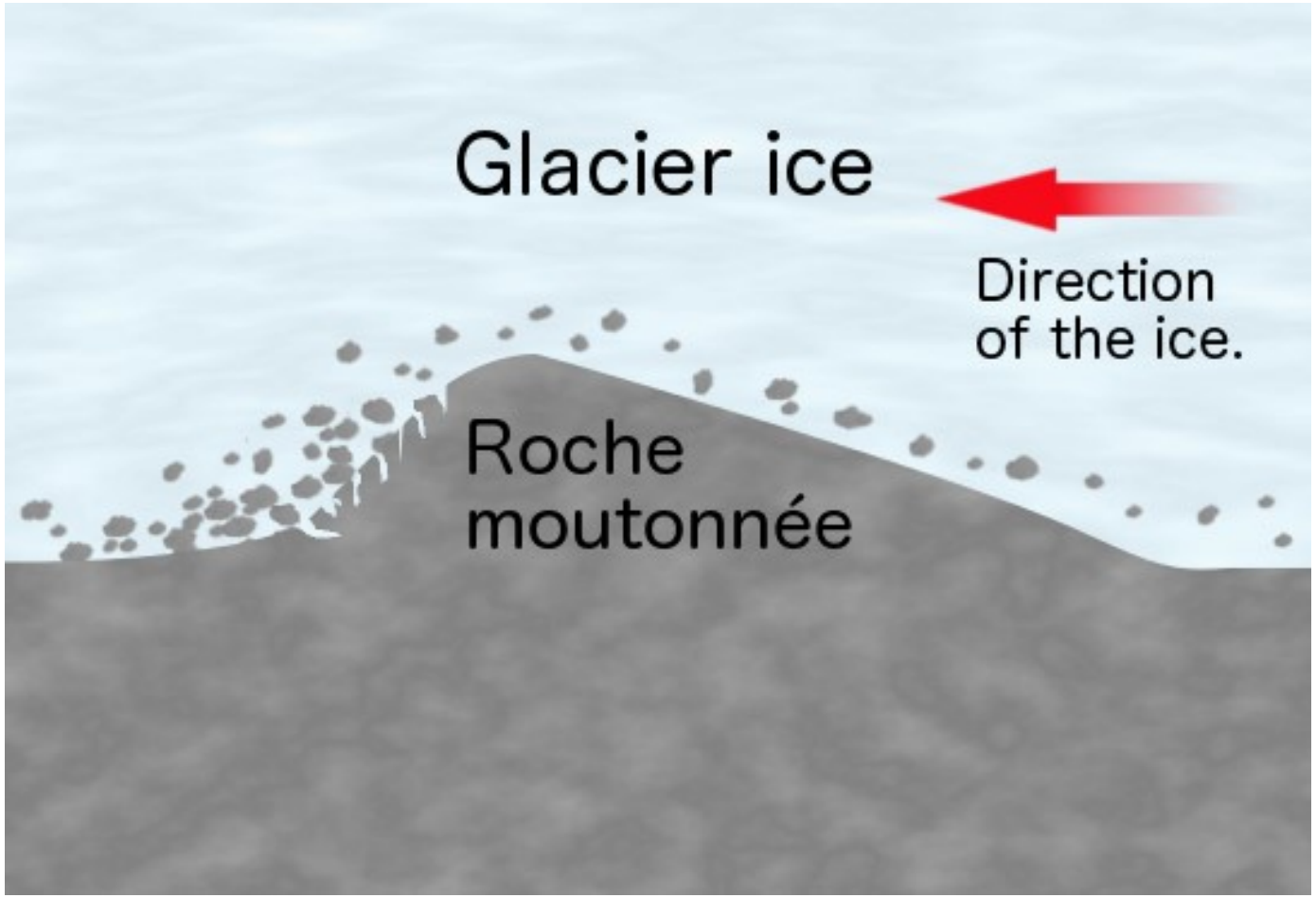
from sedimentary layering
or metamorphic banding
(internal to the rock)

roche moutonnée with striae



roche moutonnée with striae

“plucking” or “quarrying” implies ice is in a freezing – not melting - regeim



Roche Moutonnée

roche moutonnée with striae

roche moutonnée

“Roche”
Rock in French

“Moutonnée”
Sheepskin in French

18th Century French Wig “The Moutonnée”

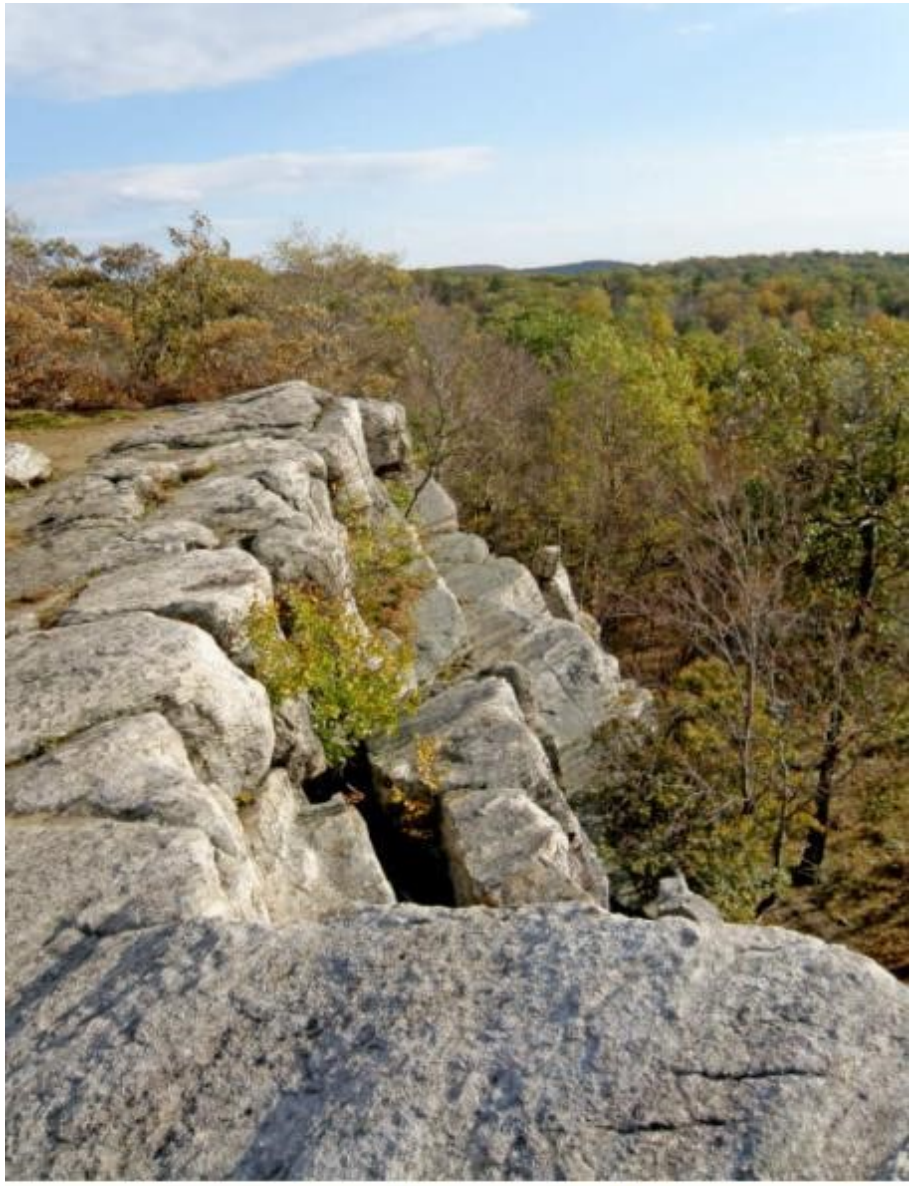
Dunning Trail near the Bowling Alley

Suffern Bear Mt Trail near Stone Memorial Shelter

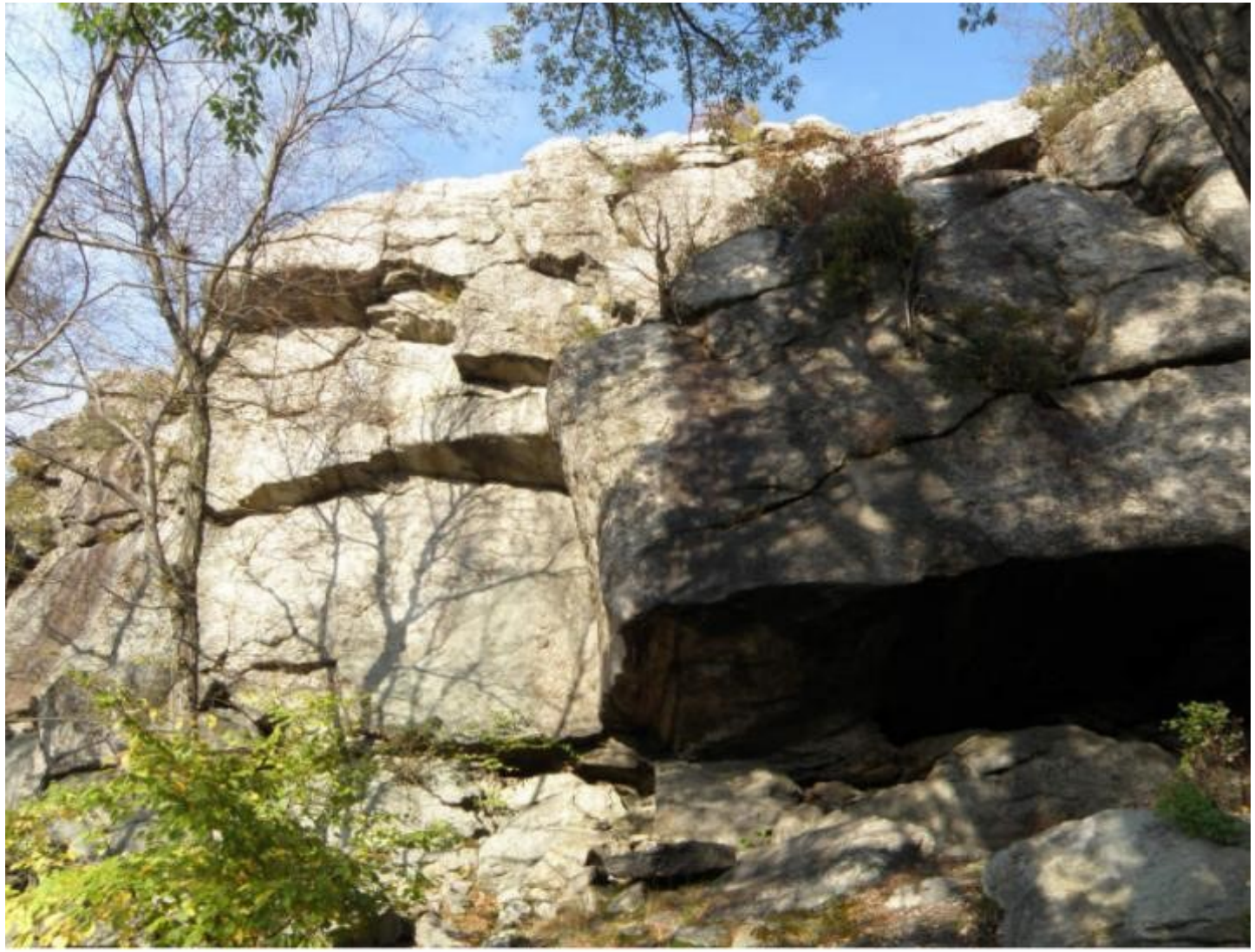
Ramapo Dunderburg Trail at the Bald Rocks

Woods road north of Little Long Pond

a lot of plucked material from this roche moutonnée was left nearby



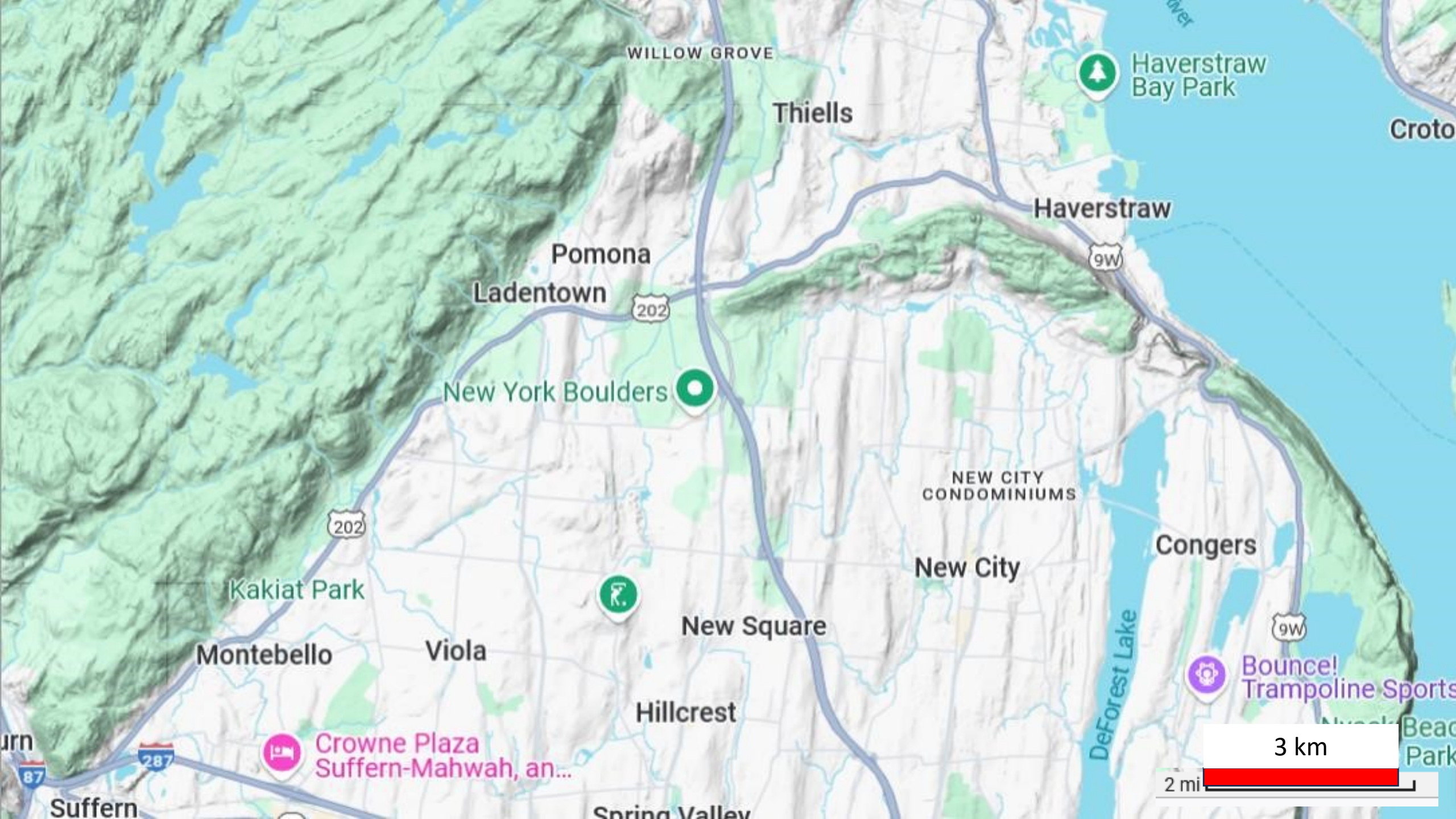
Cliff above Claudius Smith Den

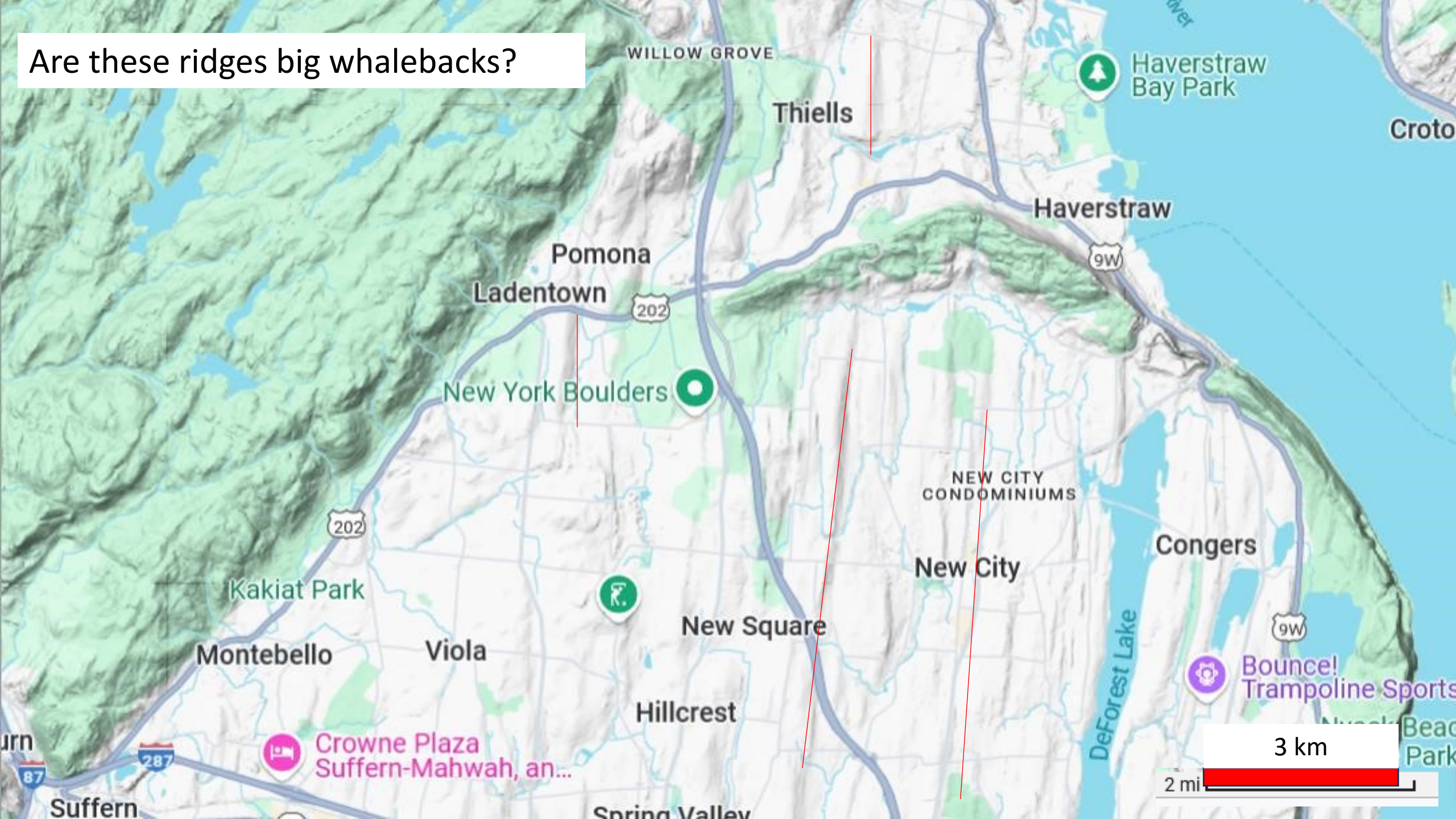


Overhanging cliff that makes the Den

giant roche moutonnées and glacially-plucked cliffs

An elongated, glacially-smoothed rock outcrop lacking plucking is called a “whaleback”


WILLOW GROVE
Thiells
Haverstraw Bay Park
Croto
Haverstraw
9W
Pomona
Ladentown
202
New York Boulders
NEW CITY CONDOMINIUMS
Congers
New City
Kakiat Park
New Square
Montebello
Viola
Hillcrest
DeForest Lake
Bounce! Trampoline Sports
Crowne Plaza Suffern-Mahwah, an...
Suffern
Spring Valley
287
87
3 km
2 mi

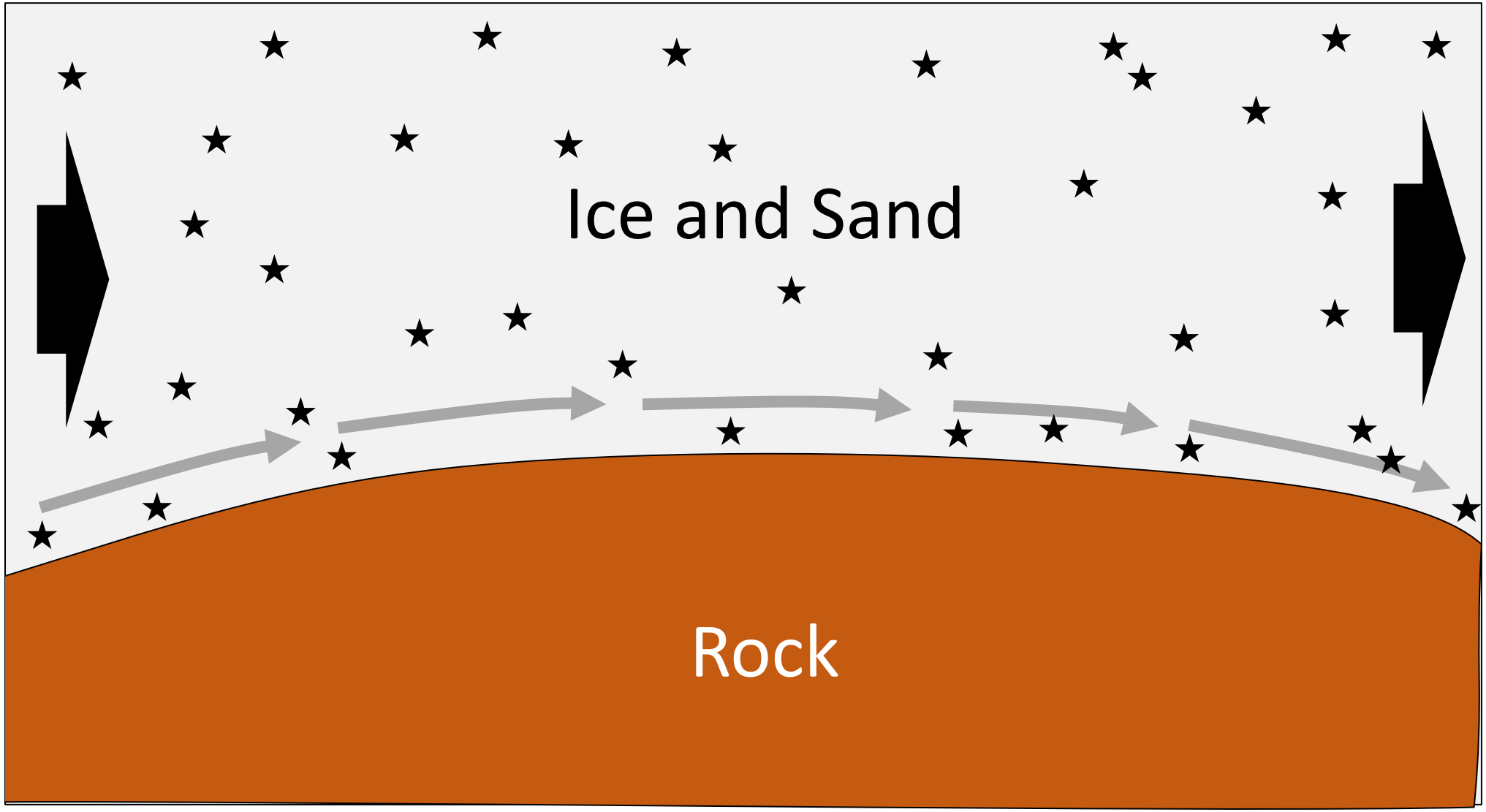

Are these ridges big whalebacks?
WILLOW GROVE
Thiells
Haverstraw Bay Park
Croto
Haverstraw
9W
Pomona
Ladentown
202
New York Boulders
NEW CITY CONDOMINIUMS
202
Kakiat Park
New City
Congers
New Square
Montebello
Viola
9W
Bounce! Trampoline Sports
DeForest Lake
Hillcrest
Crowne Plaza Suffern-Mahwah, an...
287
87
Suffern
Spring Valley
3 km
2 mi

Glacial Polish

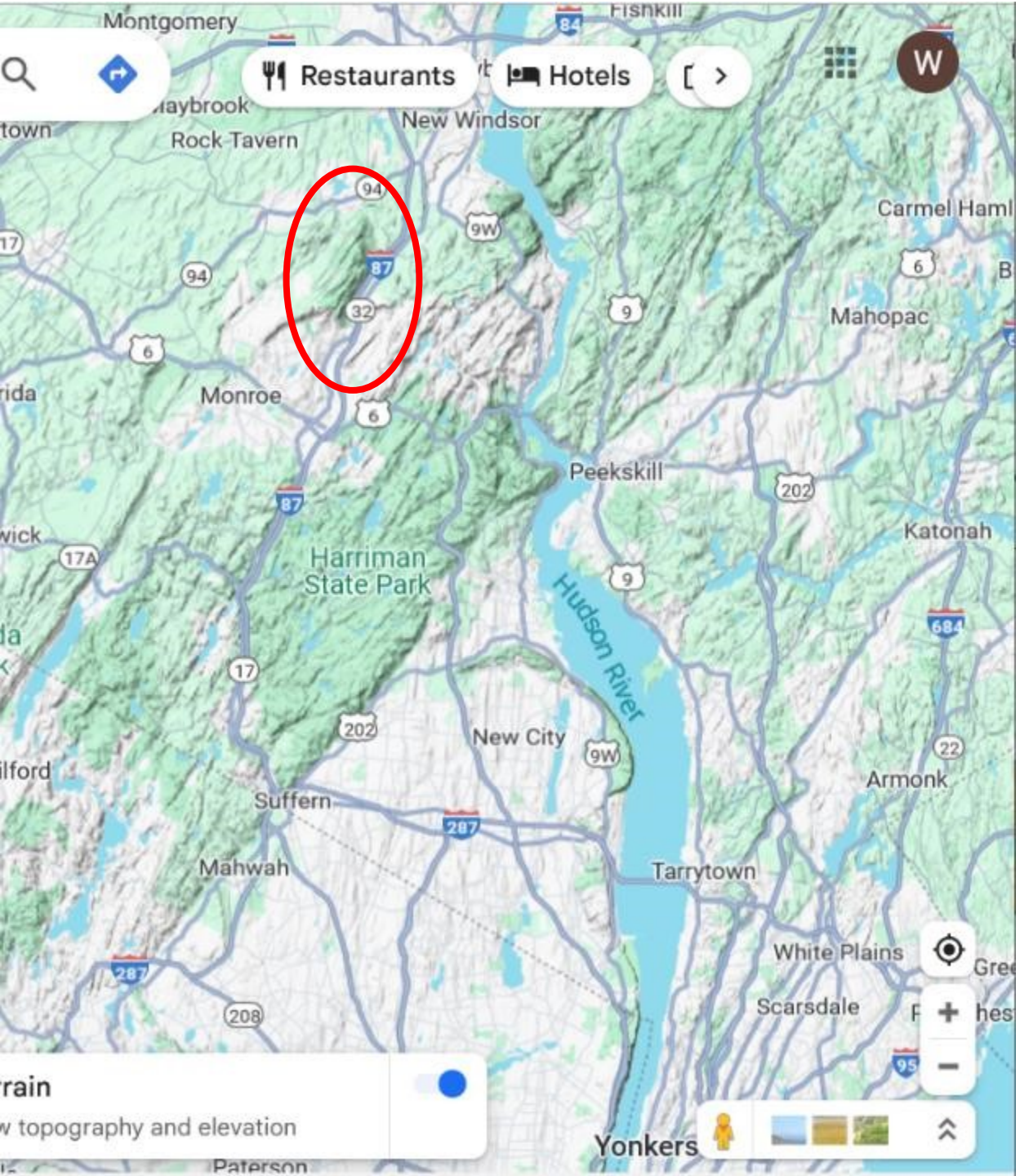
glacier buffed the rock to a shine


Glacial Pavement
rock surface smoothed by ice

Glacial movement “sandpapers” rock pavement



How Thick was the Ice near Manhattan?



Schunemunk Mountain

elevation
507 m

Schunemunk Conglomerate (puddingstone)

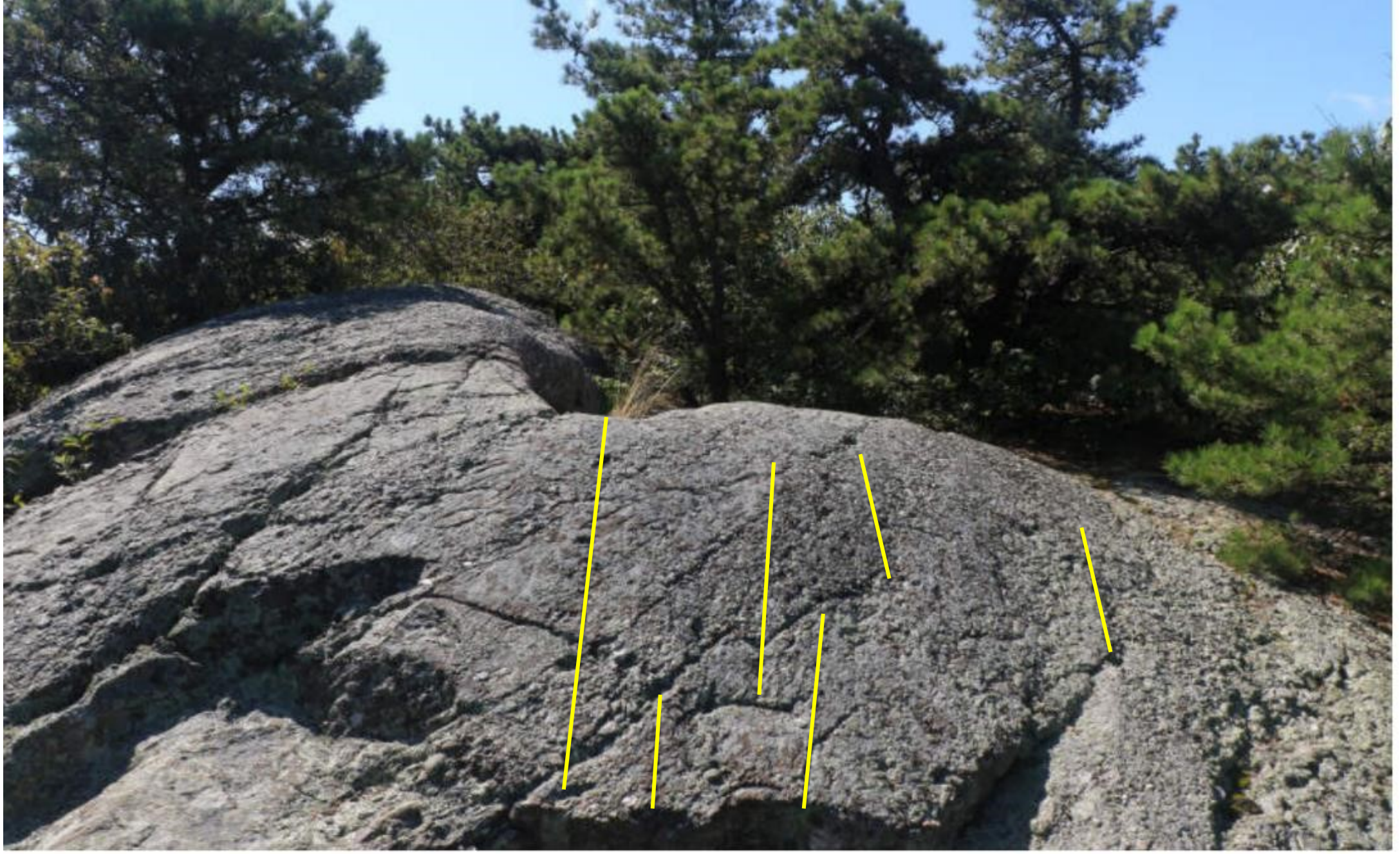
u/~menke/www_users_menke/slides/public/19/Schunemunk19/Schunemunk19_15.html

purple quartzite with white pebbles

“pudding-stone”

glacial pavement with faint striae

Glacial Straie on a puddingstone ledge

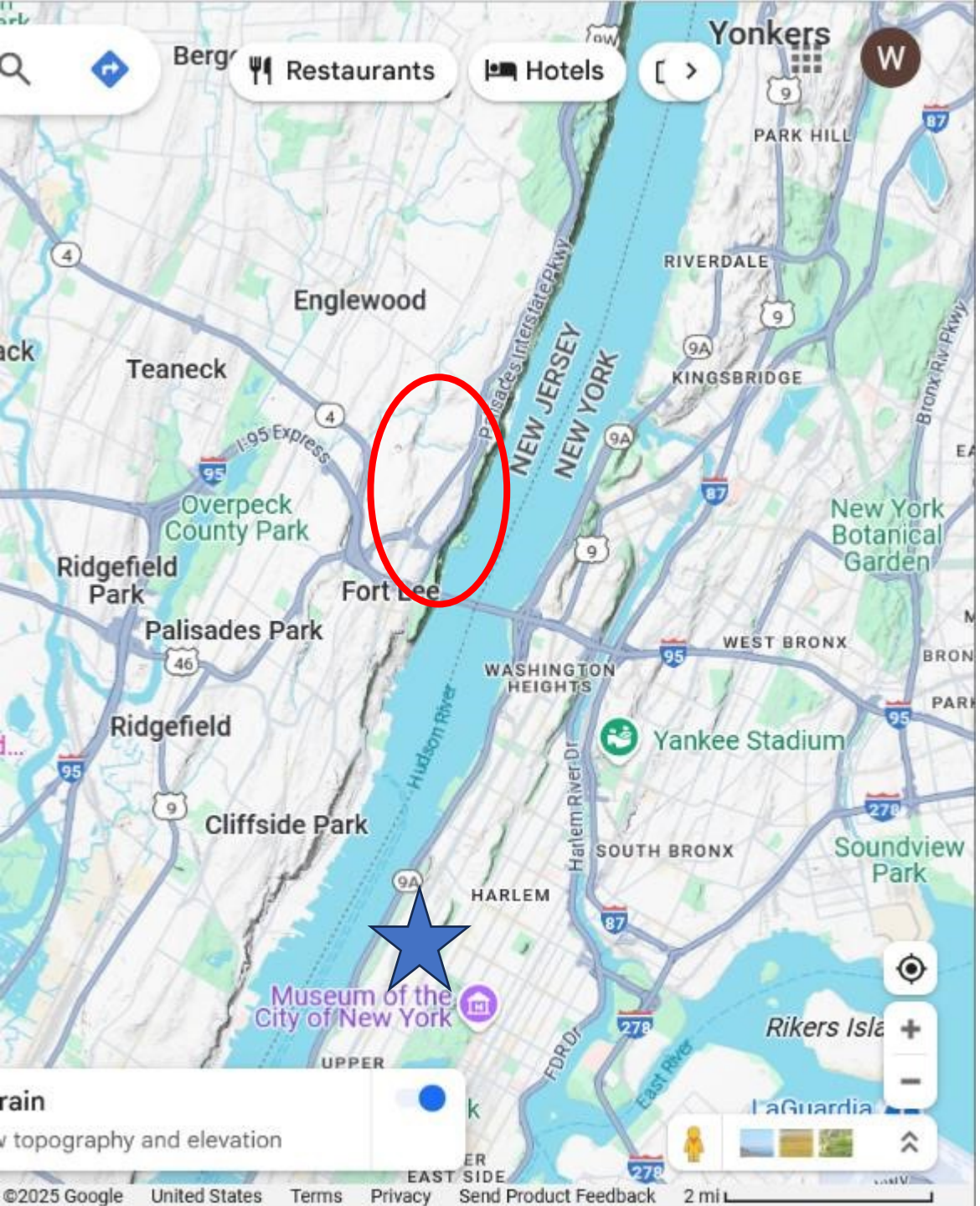


Glacial Straie on a puddingstone ledge

pebbles
all cut flat

by glacial
polishing

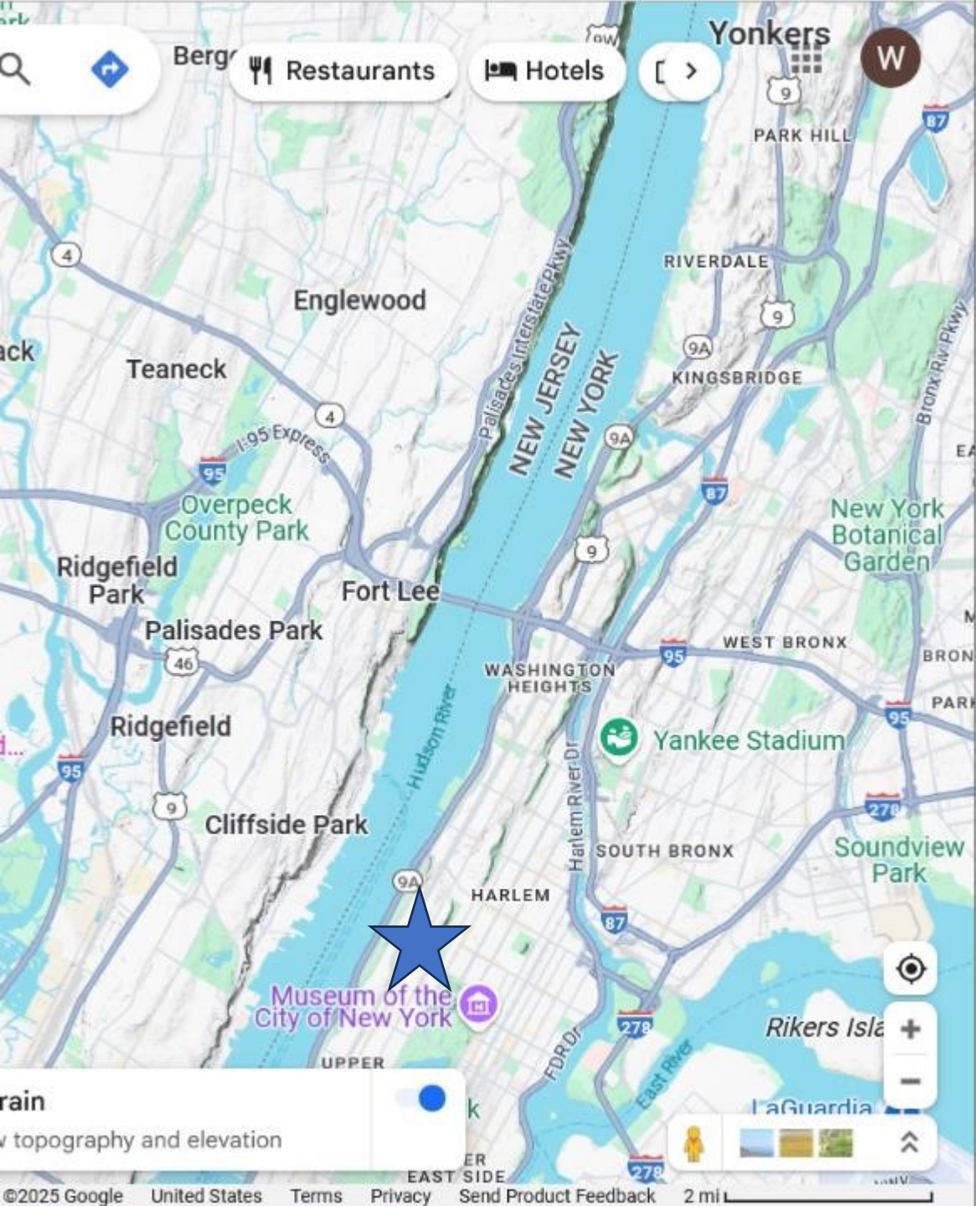
pebbles
all cut flat
by glacial
polishing



Englewoods Cliffs

elevation
102 m

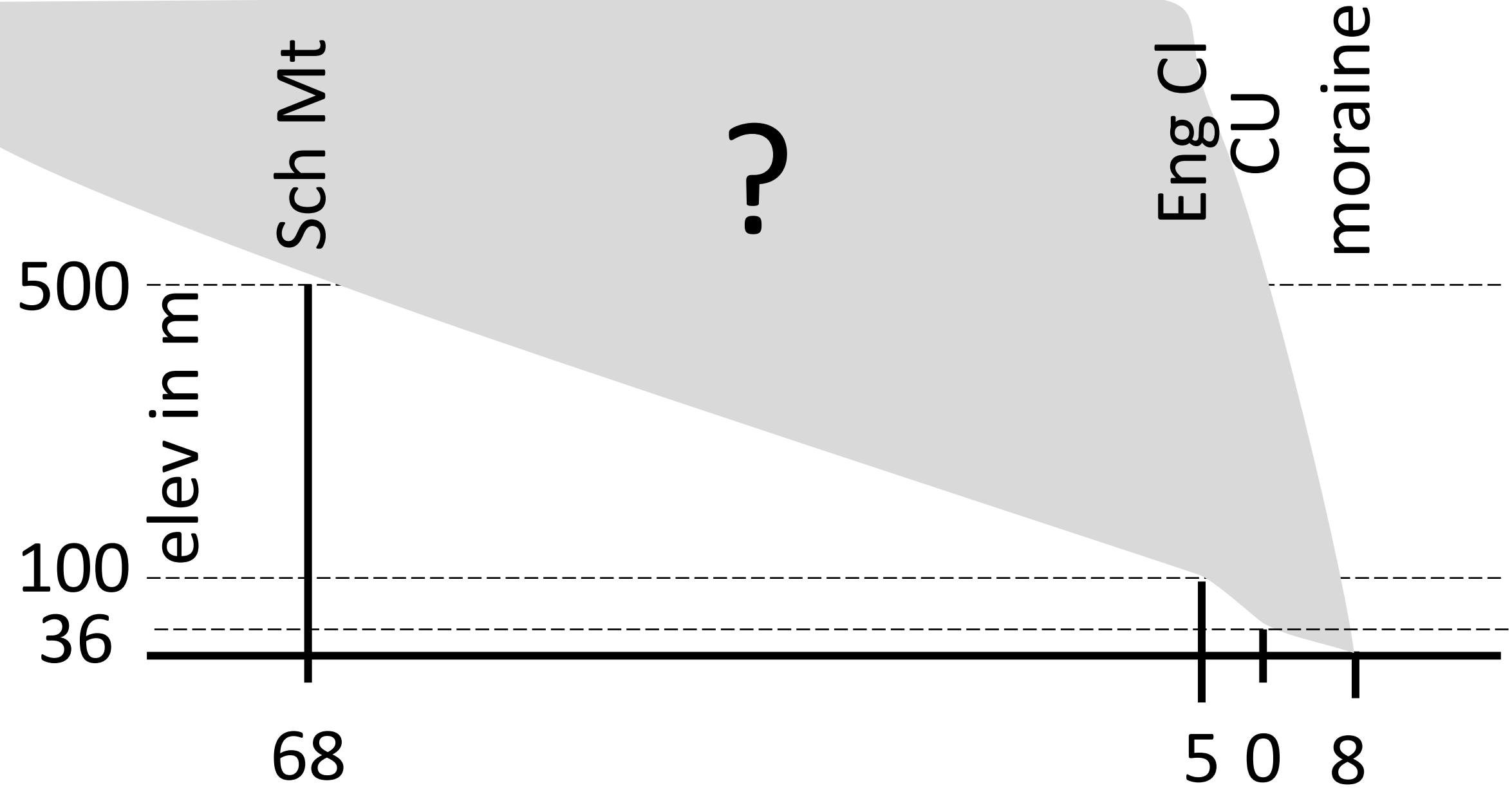
Glacial scratches on bedrock near the cliff edge

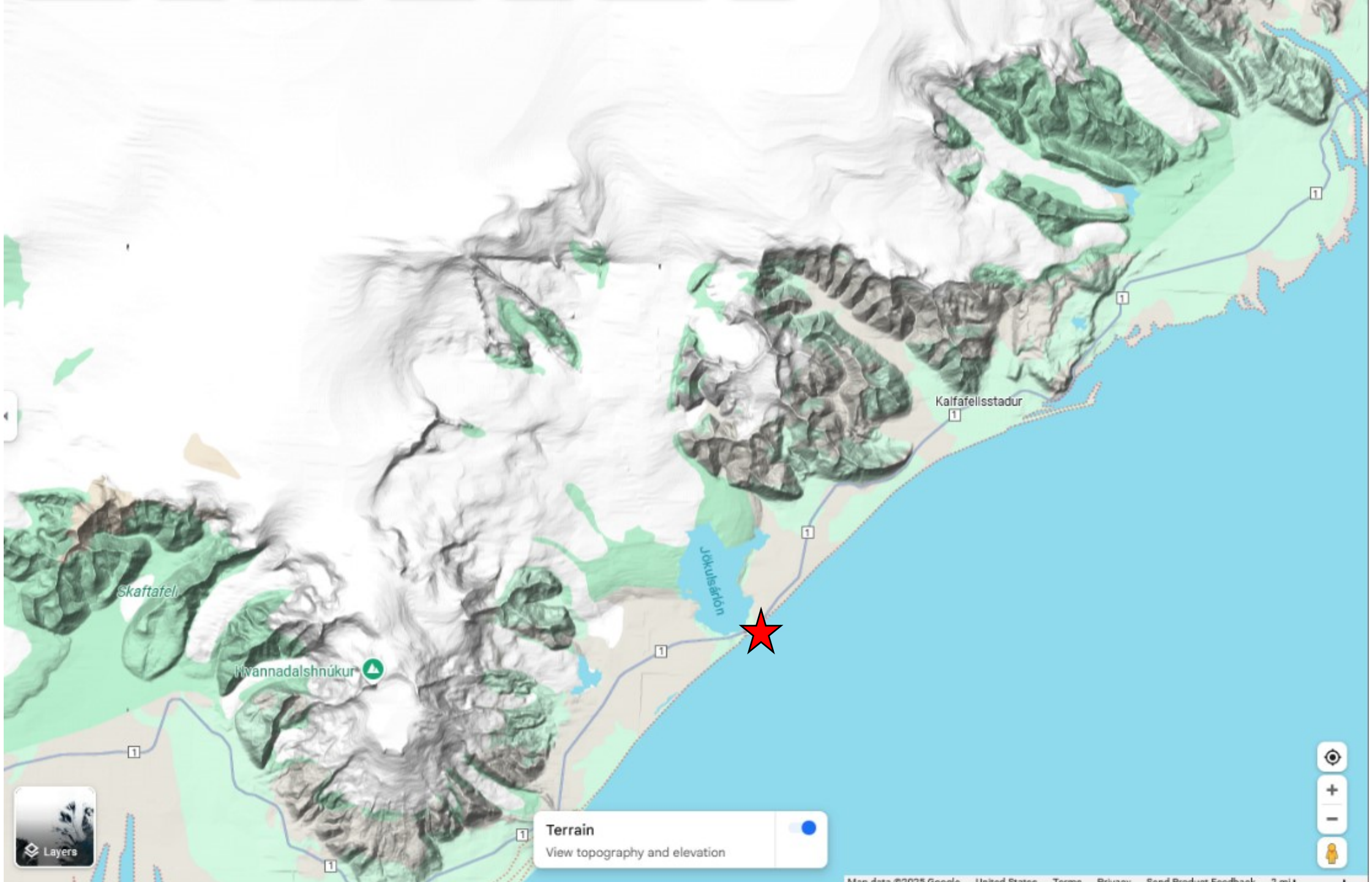


Glacial Features in Morningside Park, too

elevation
36 m

Morningside Park


Sch Mt
?
Eng Cl
CU
moraine
500
100
36
elev in m
68
5 0
8
distance from CU in km


Kalfafellsstadur
1
Jökulsárlón
Skaftafell
Hvannadalshnúkur
Layers
Terrain
View topography and elevation

Icebergs in Jokulsarlon