Varves, Loess and Biostratigraphy

Lecture 11

Skaftafelljokull (glacier)

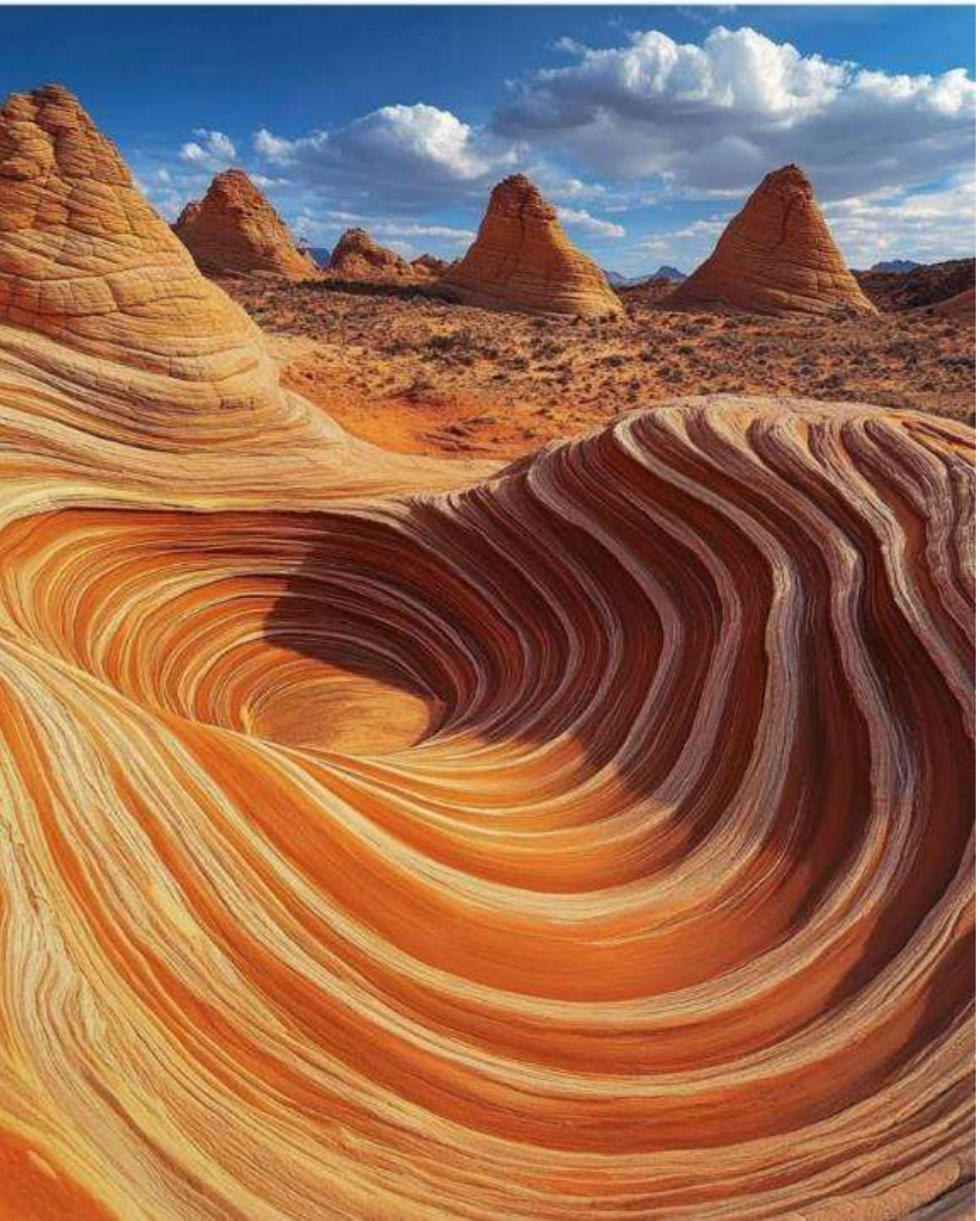
Part 0: Social Media

U shaped valley

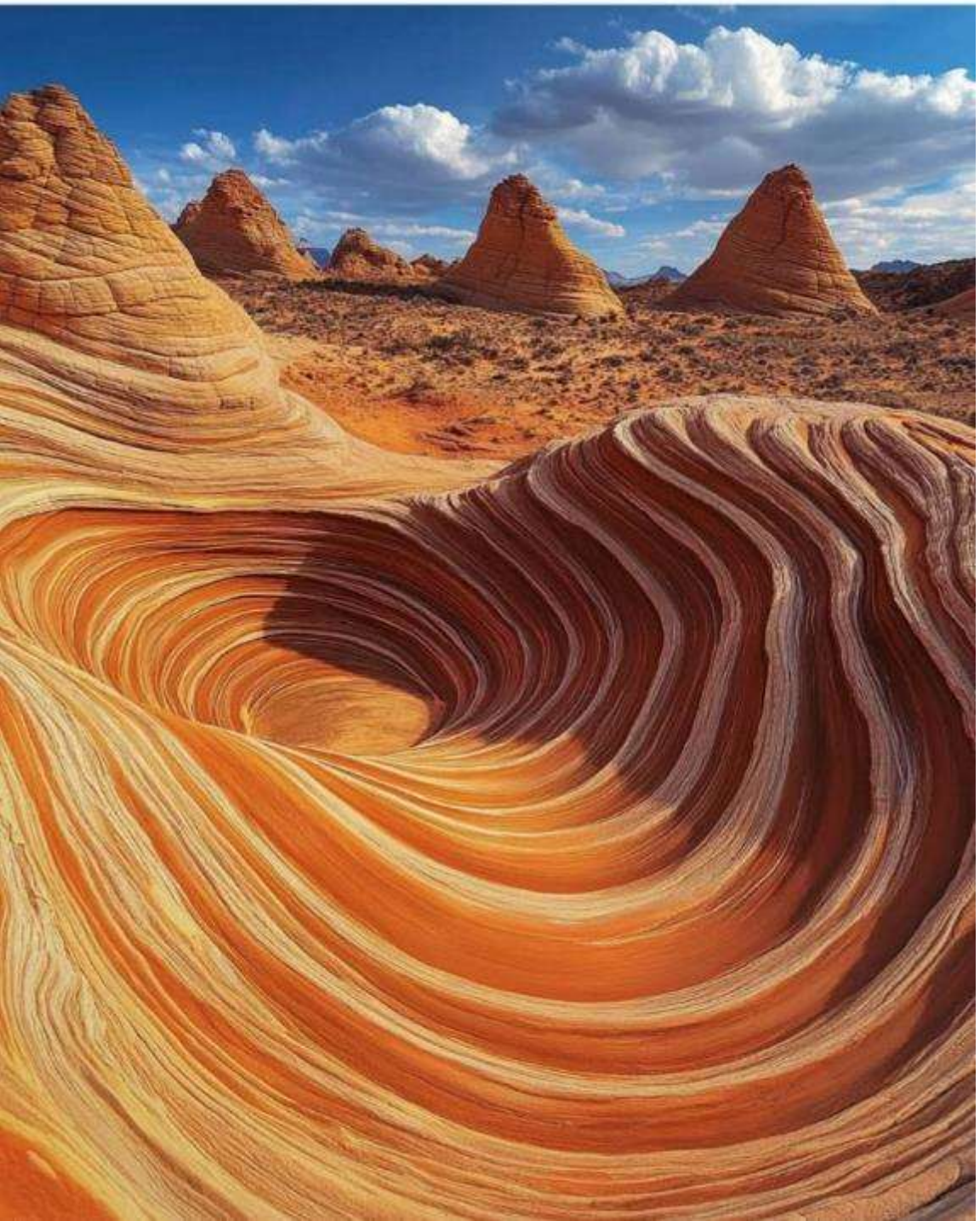
two levels of cirques

cirque lakes

This terrain is glacial



Could this be a cirque with horns in the distance?

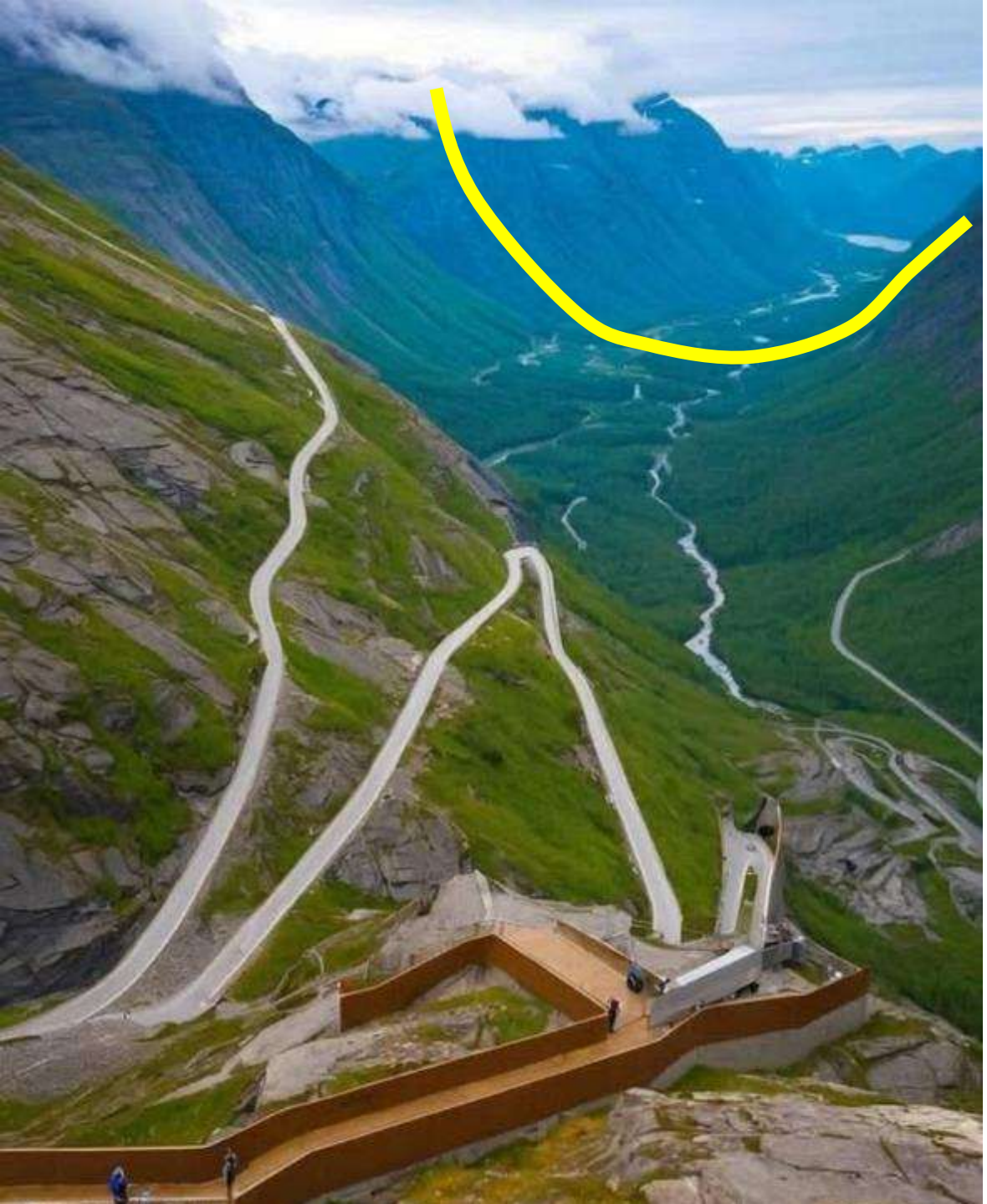


Not triangular enough for horns, and no cirques below them

This terrain is not glacial

large U-shaped valley
stream at its bottom
lake in the distance

cool roadway ascending side of valley



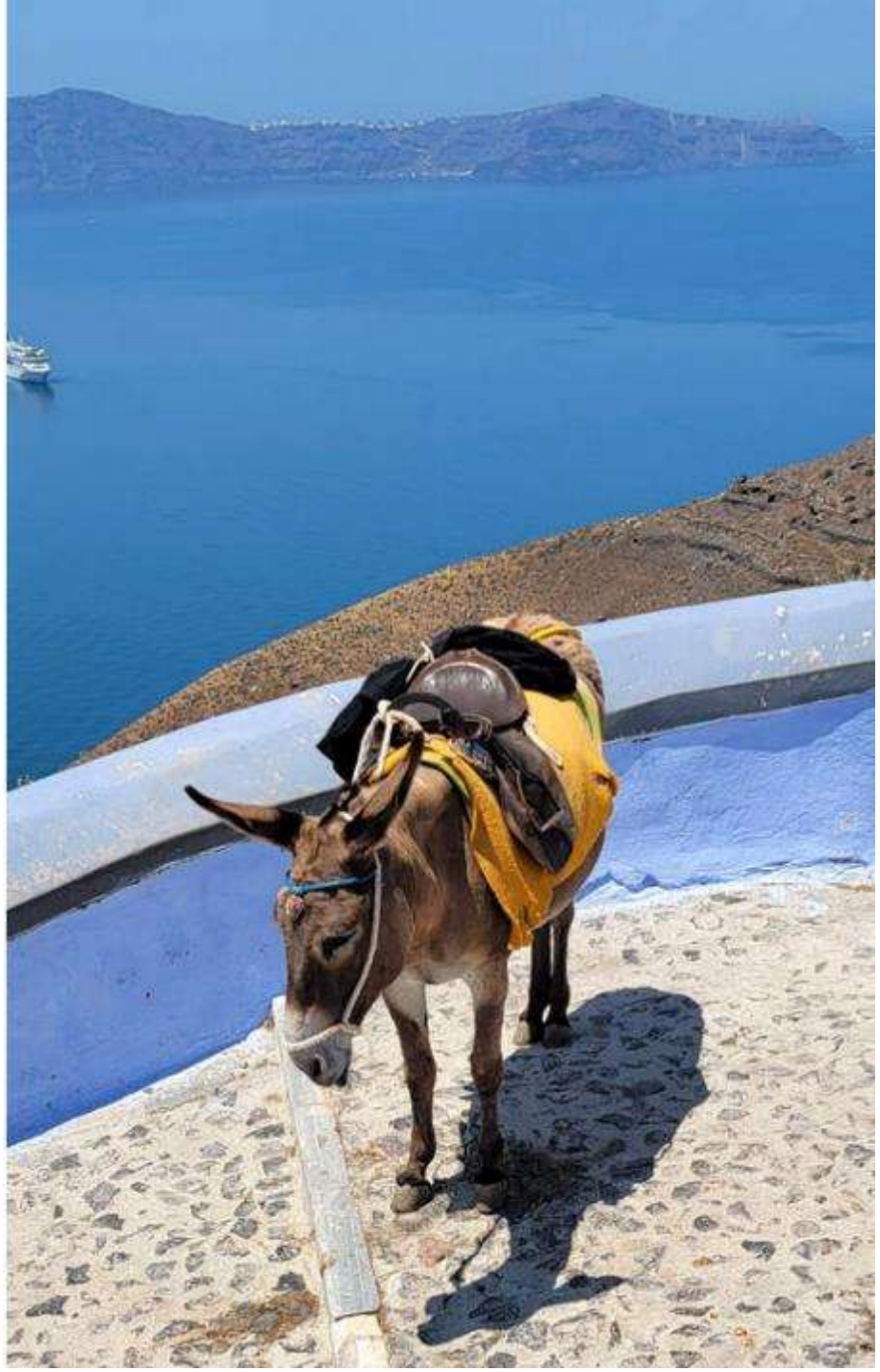
large U-shaped valley
stream at its bottom
lake in the distance

another steep cliff
cool roadway
water at the bottom

Lot’s of cliffs in the world
and not all of them glacial

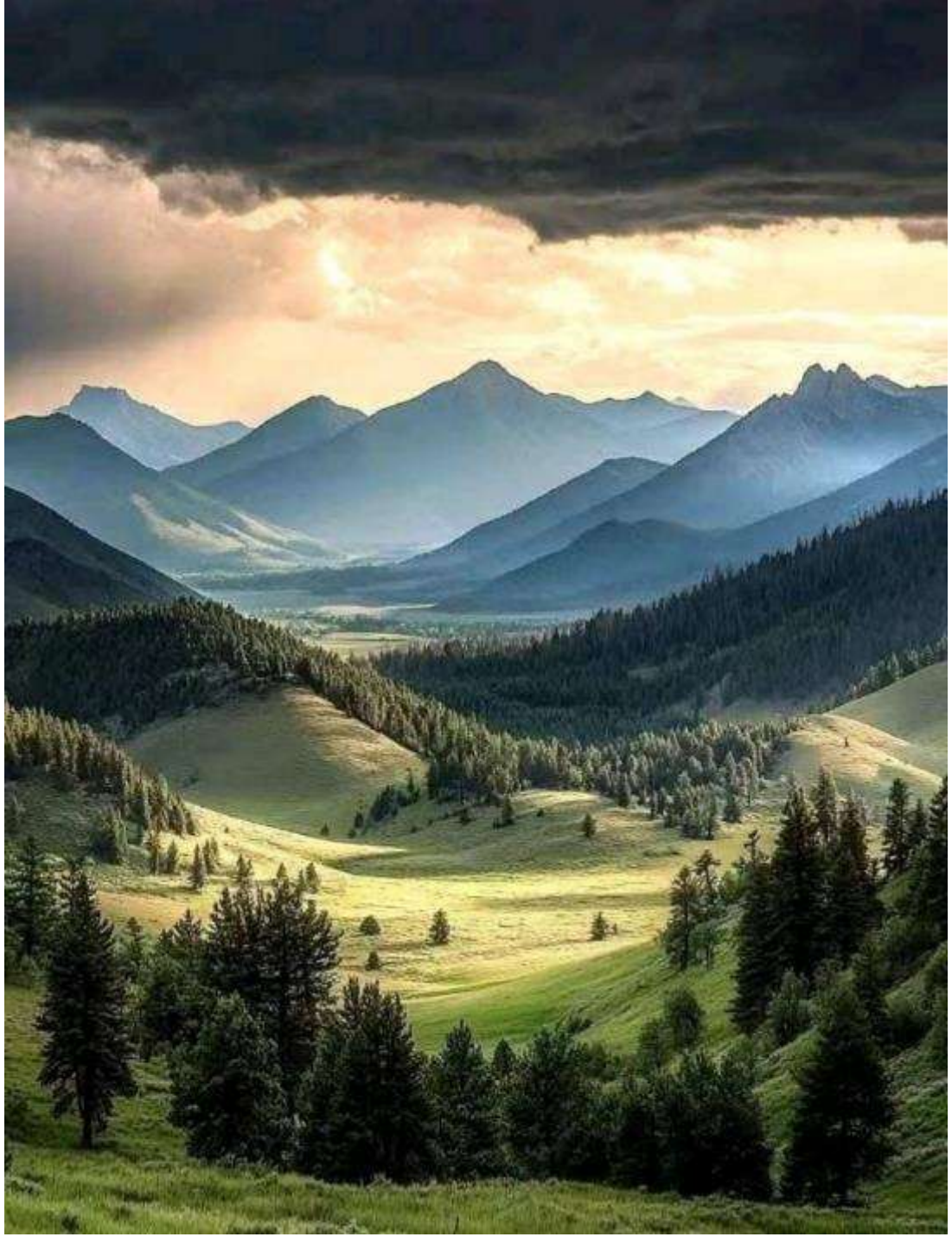
nothing in the picture that
is especially glacial

anyone recognize the spot?

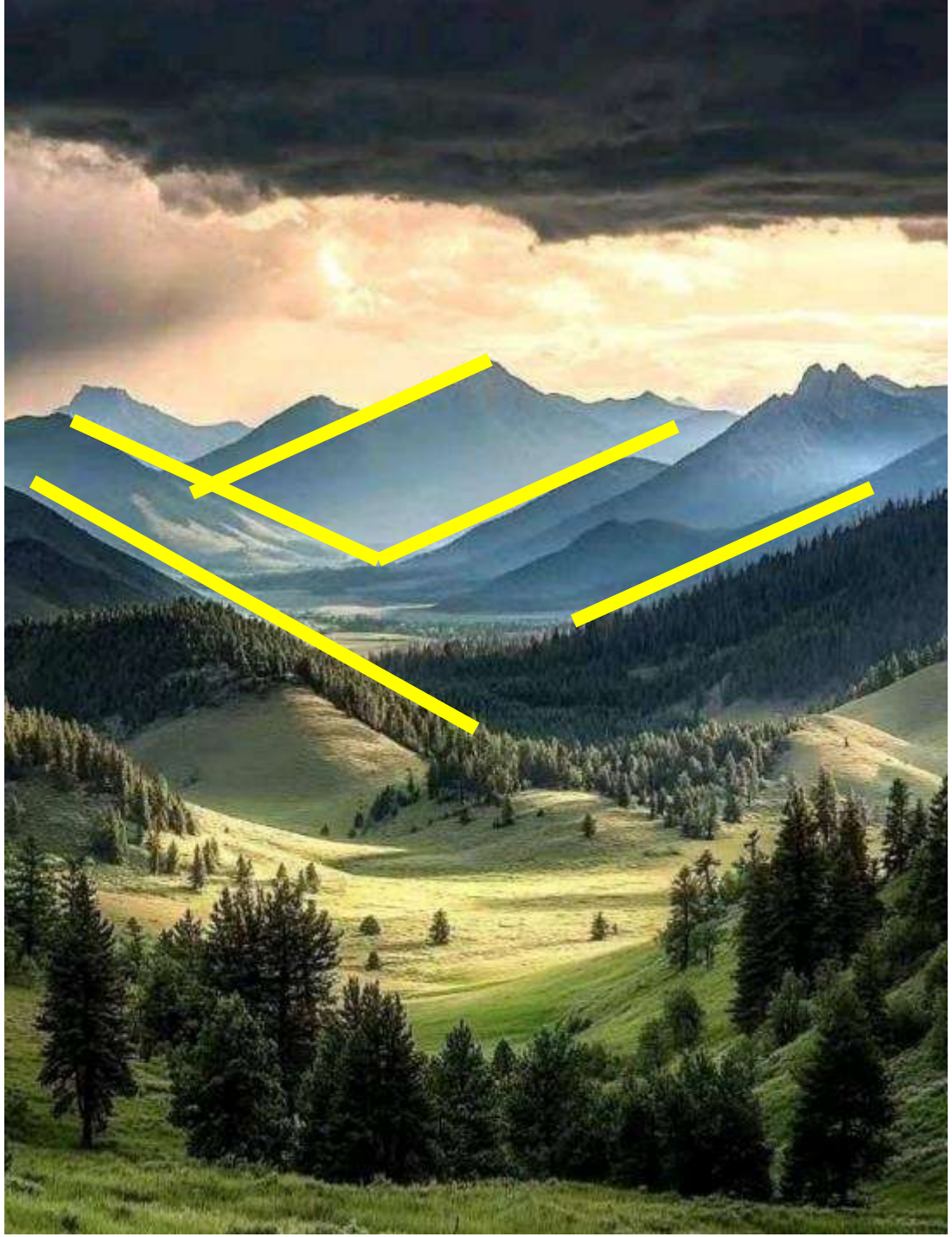


Santorini (Greece)

Volcanic Caldera
Not Glacial in origin



A big valley



Not especially U-shaped

Nothing strongly suggestive of a glacial origin

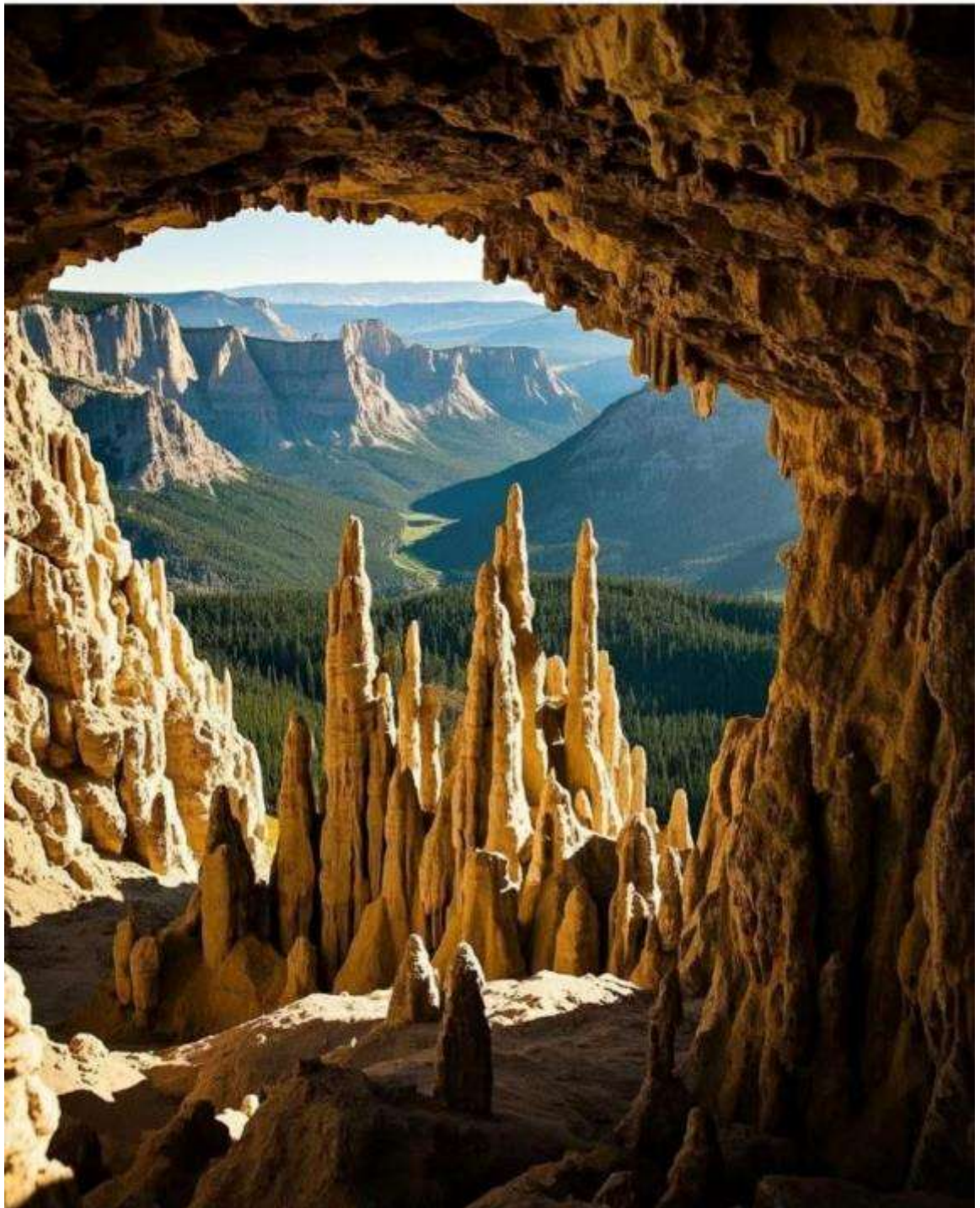
ponds in a hummocky area

with snowy mountain in distance

bowls could be cirques

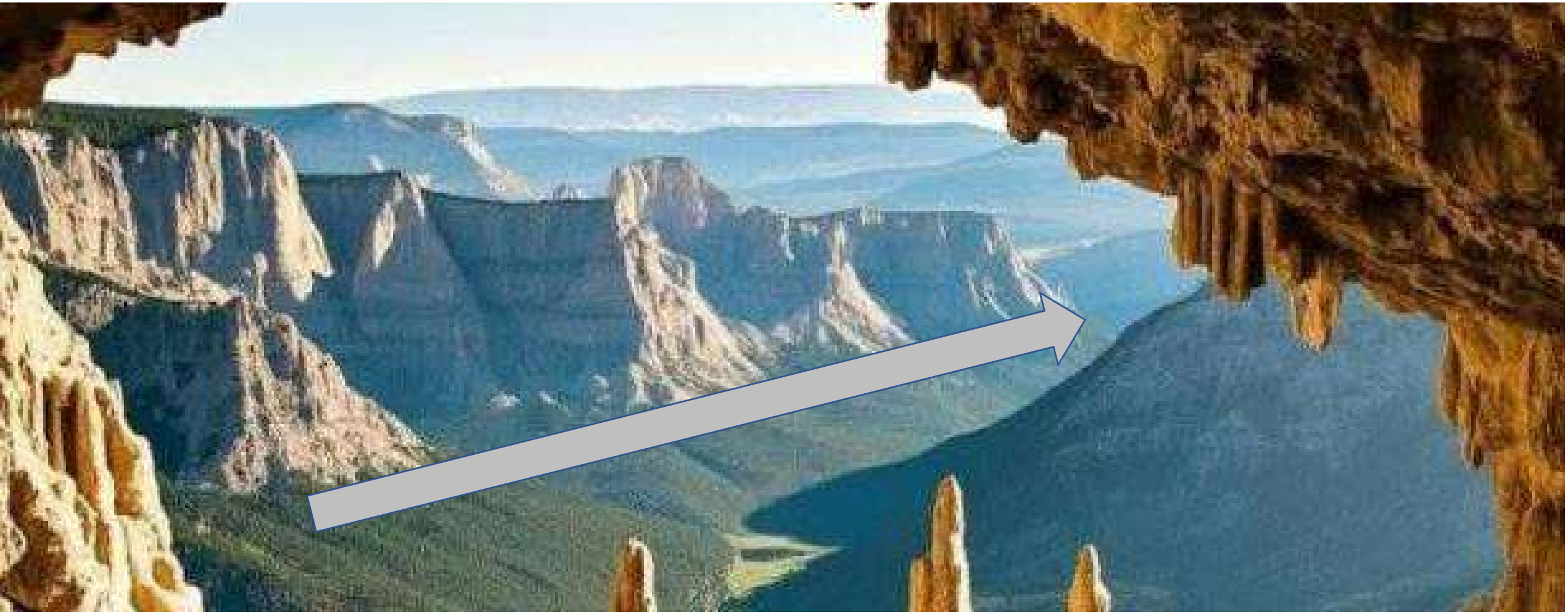
but distant mountain looks very much like a volcano

so these are more likely volcanic craters with lakes in them

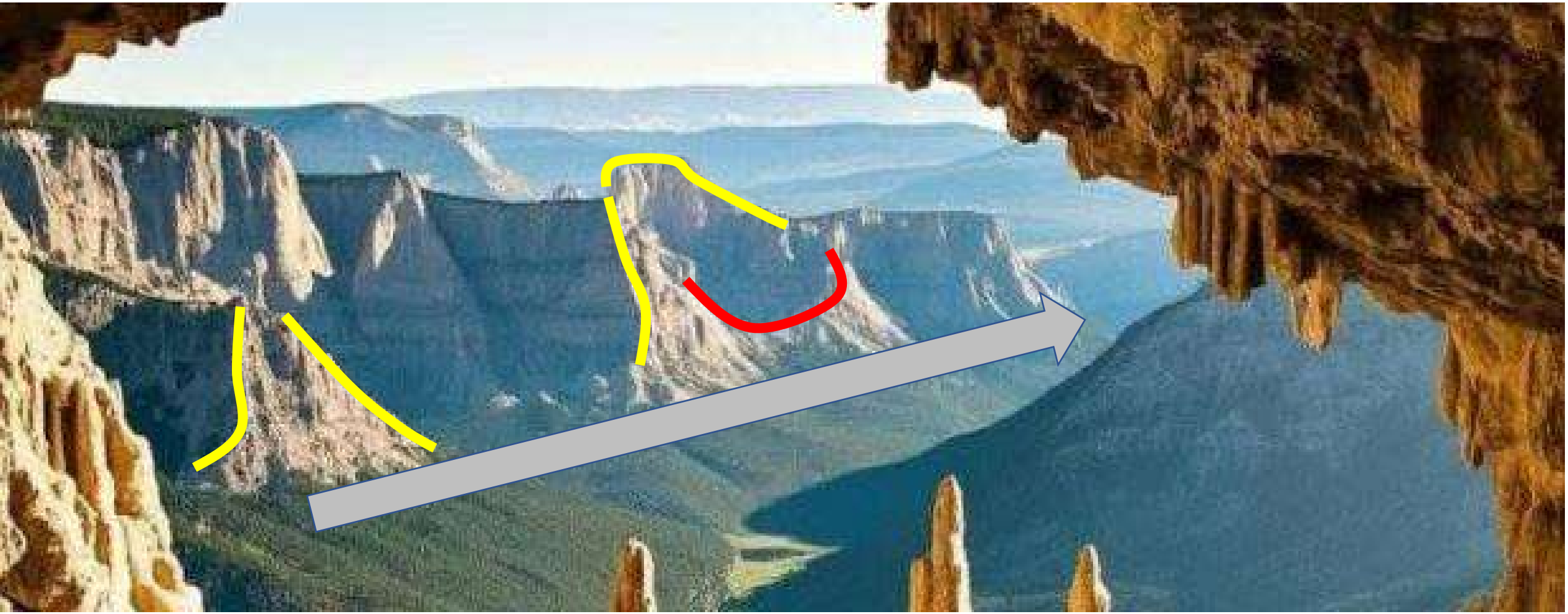


View looking our of a limestone cave with stalagmites

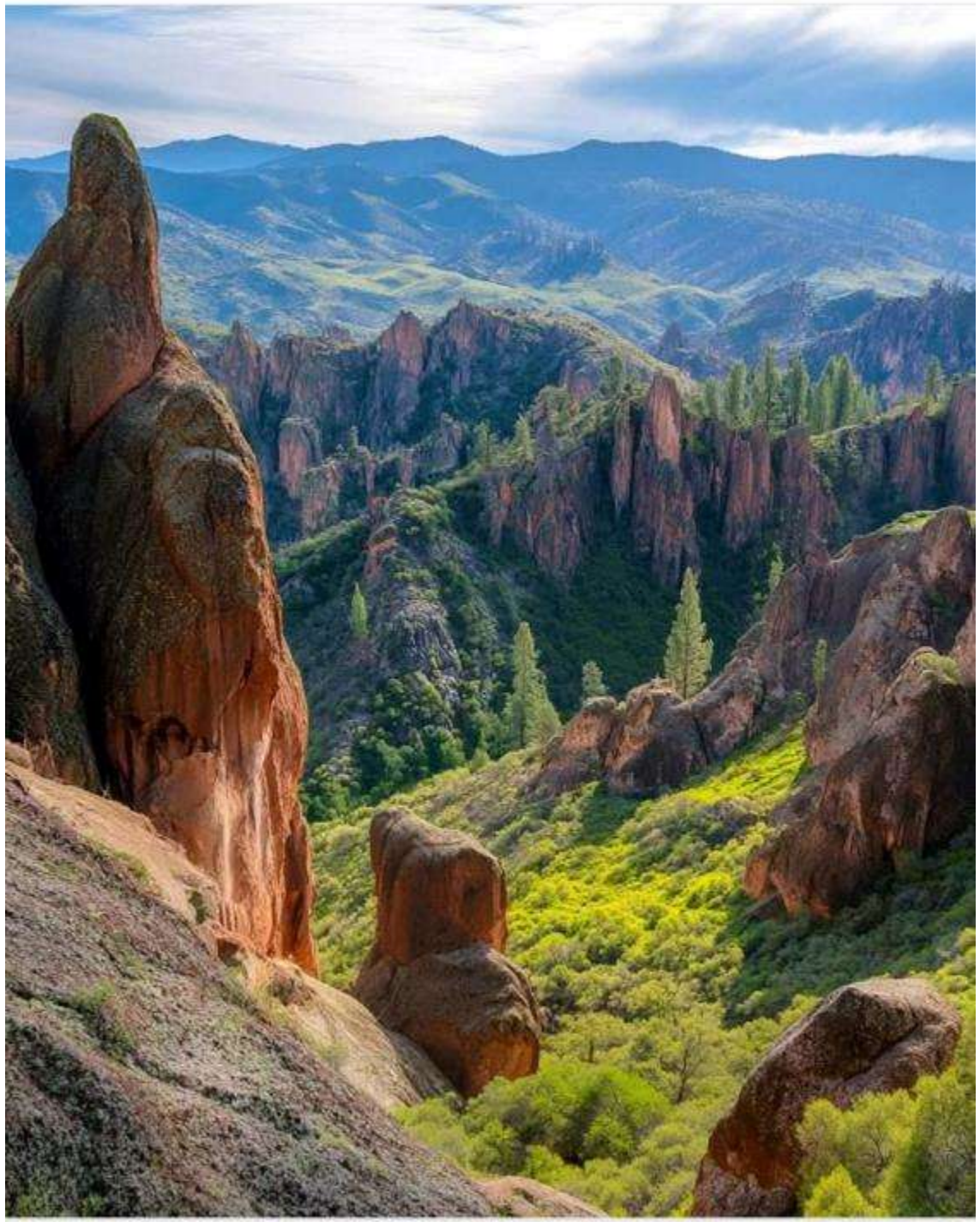
towards big valley in distance



Enlargement.



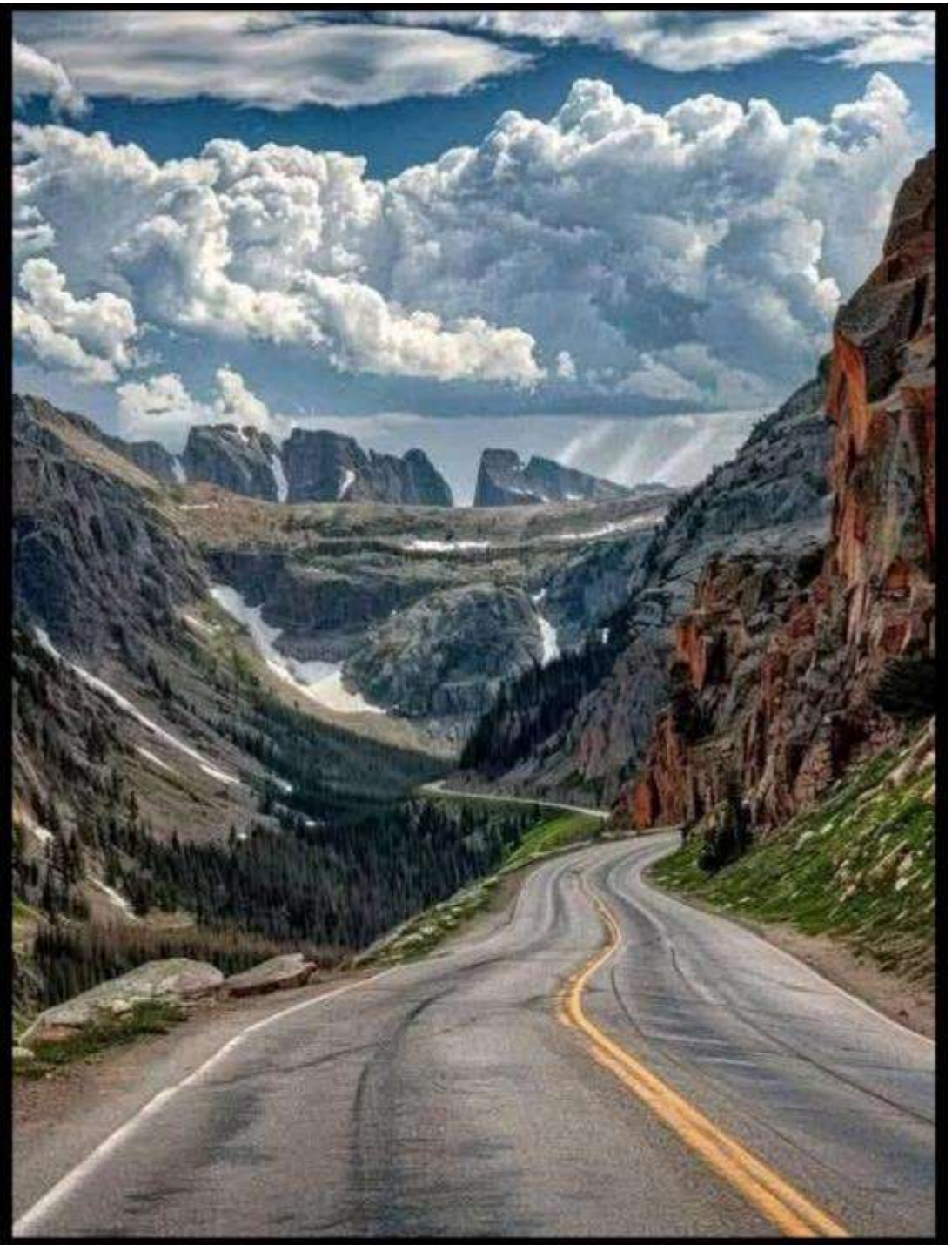
wall of valley seems to have lots of aretes (yellow) and at least one cirque (red), so this area probably glacial. Valley is straight (arrow) with lots of flat faces. So this is probably glacial.



Hilly area with lots of pinnacles

Pinnacles not consistent with glacial action, which would knock them over

so not a glacial terrain



Mountains with notches

white ridge (or cloud?) in distance

Enlargement

Arete and Cirques (red)

Likely glacial origin

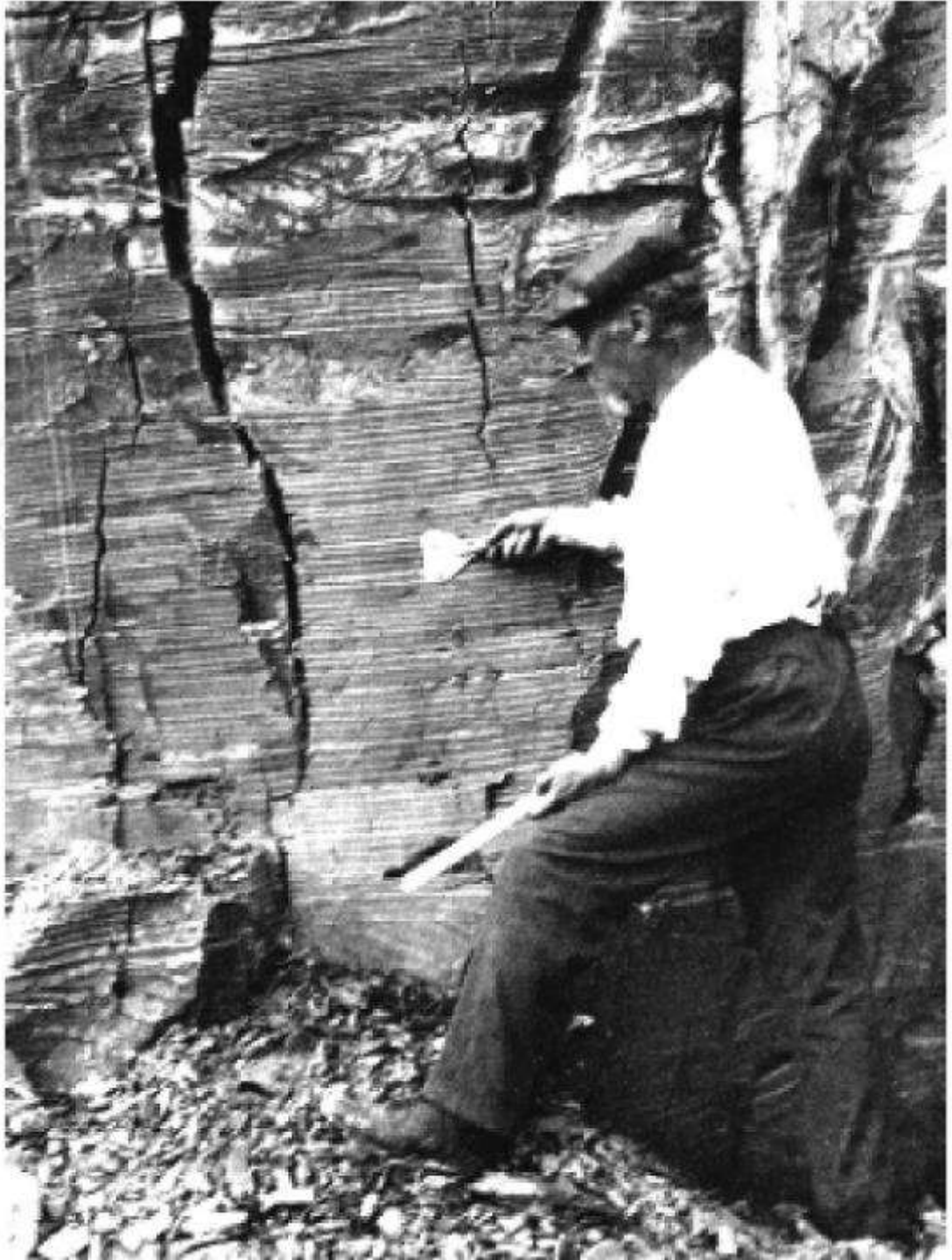
White ridge looks pillowy (arrow) so probably a cloud

Part 1: Varve chronology

dating pro-glacial lakes

and

sea along the ice margin



finely
layered (or “varved”)
silts and clays

varve derived from a
Swedish word for
“circle”, which is to
say, “cycle”

Annual cycles

1 yr

little biological activity to disturb layering

winter:

glacial melting suppressed

still water due to ice

sediment is dark colored

and fine grained

dark

summer:

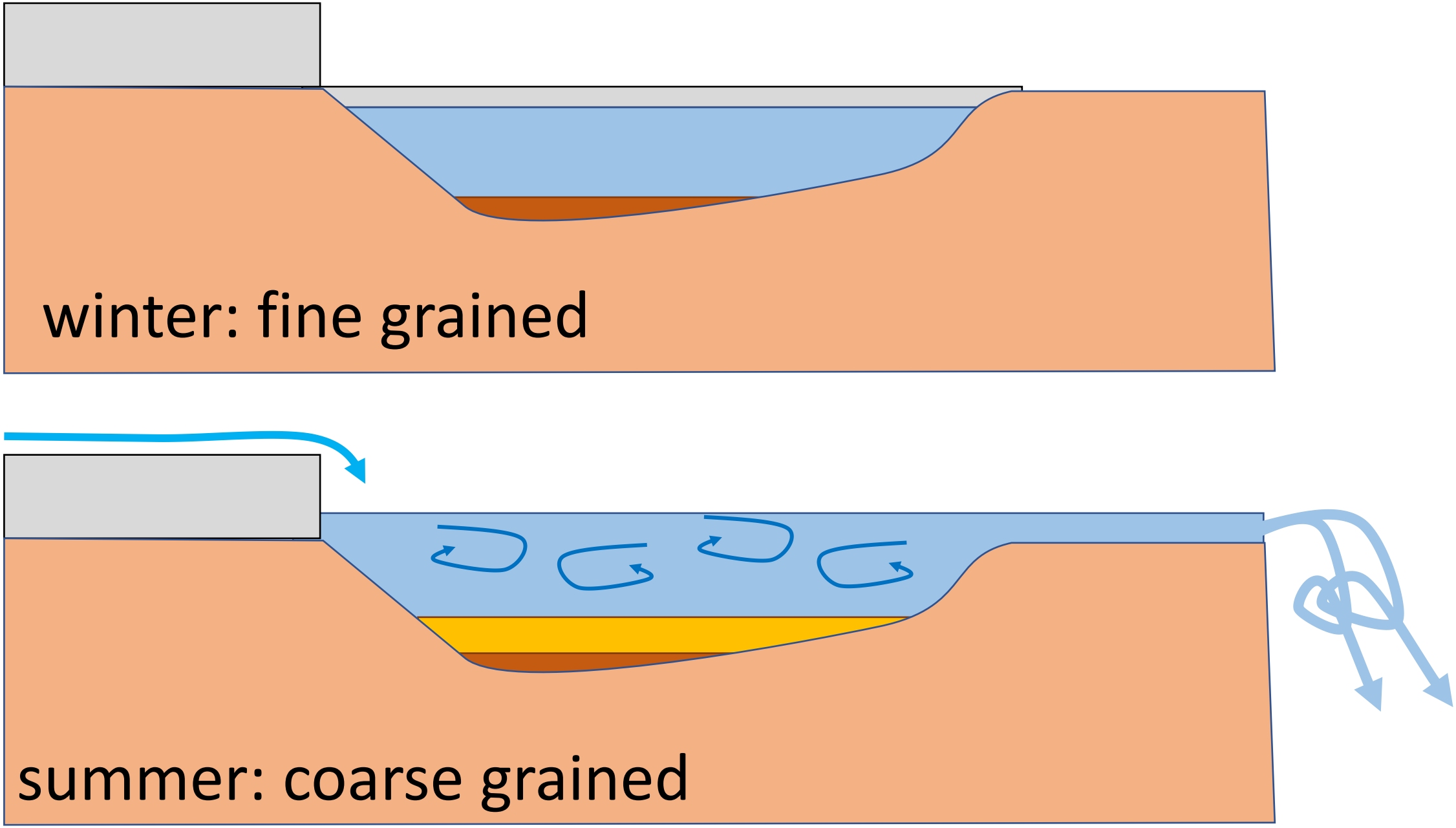
glacial melting accelerated

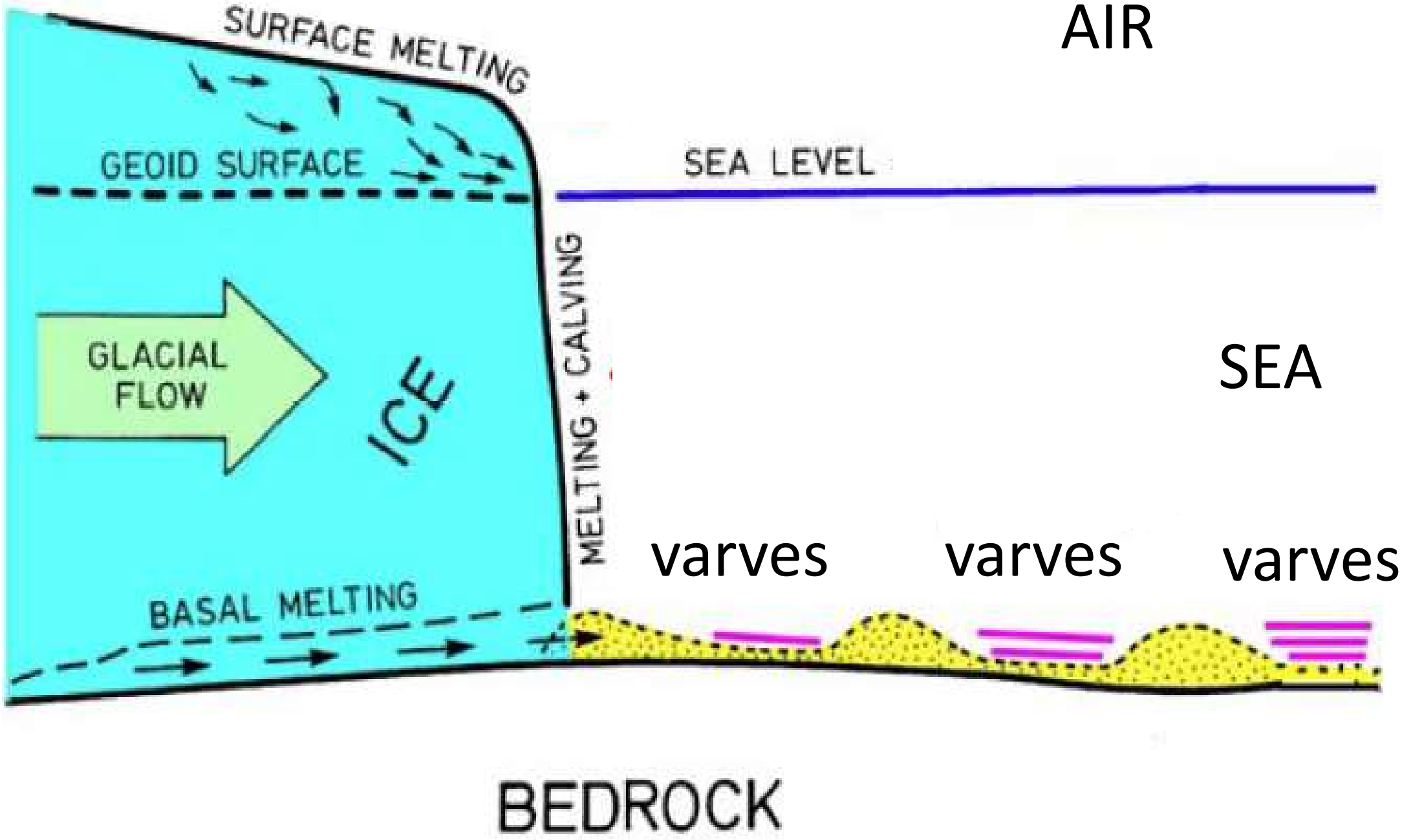
more turbulent water

sediment is light colored

and coarse grained

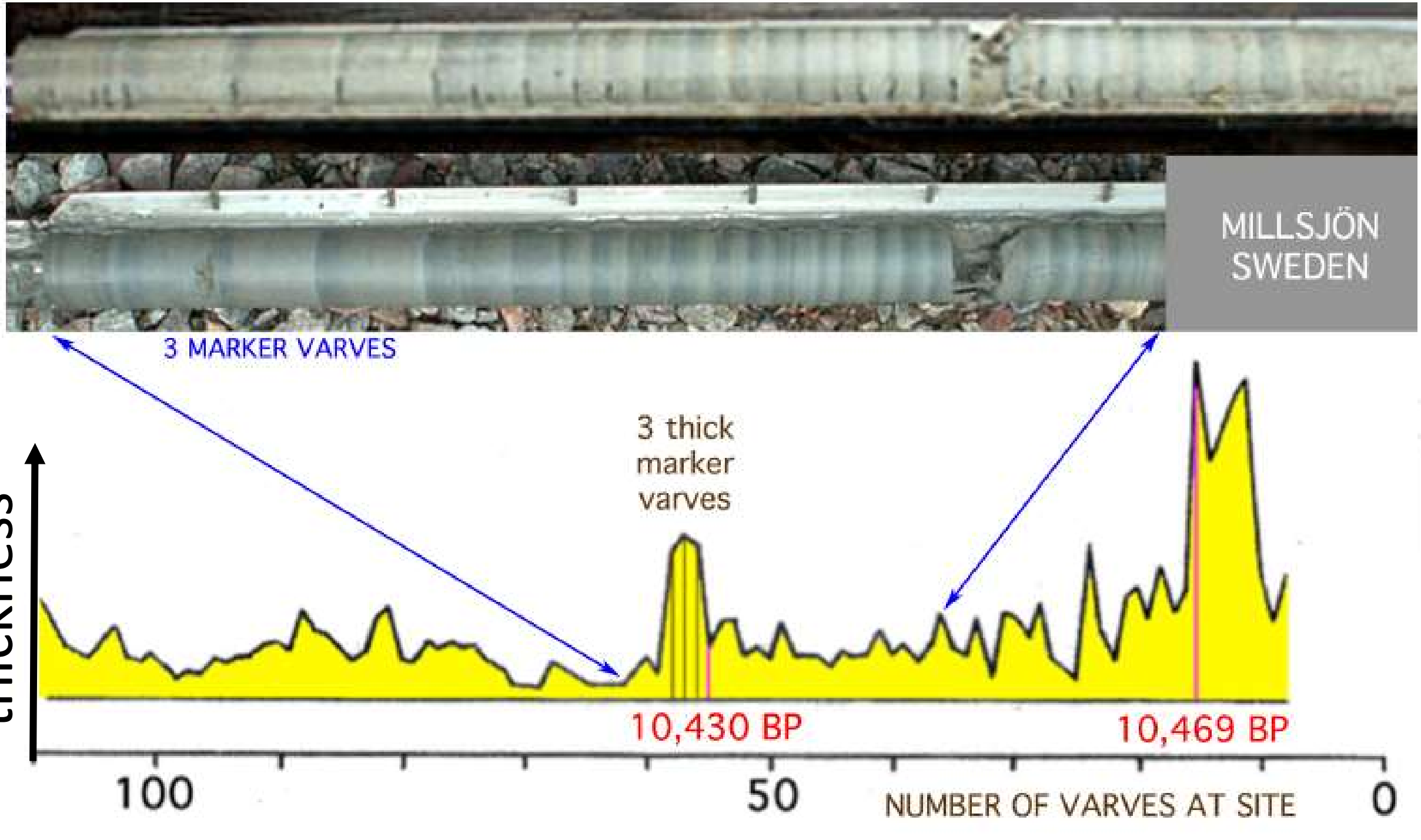
light


winter: fine grained
summer: coarse grained


AIR
SURFACE MELTING
GEOID SURFACE
SEA LEVEL
GLACIAL FLOW
ICE
MELTING + CALVING
SEA
varves
varves
varves
BASAL MELTING
BEDROCK

Varves can be counted like tree rings

thickness of rings provides a way of correlating varves between different sites


MILLSJÖN
SWEDEN
3 MARKER VARVES
3 thick
marker
varves
thickness
10,430 BP
10,469 BP
100
50
NUMBER OF VARVES AT SITE
0

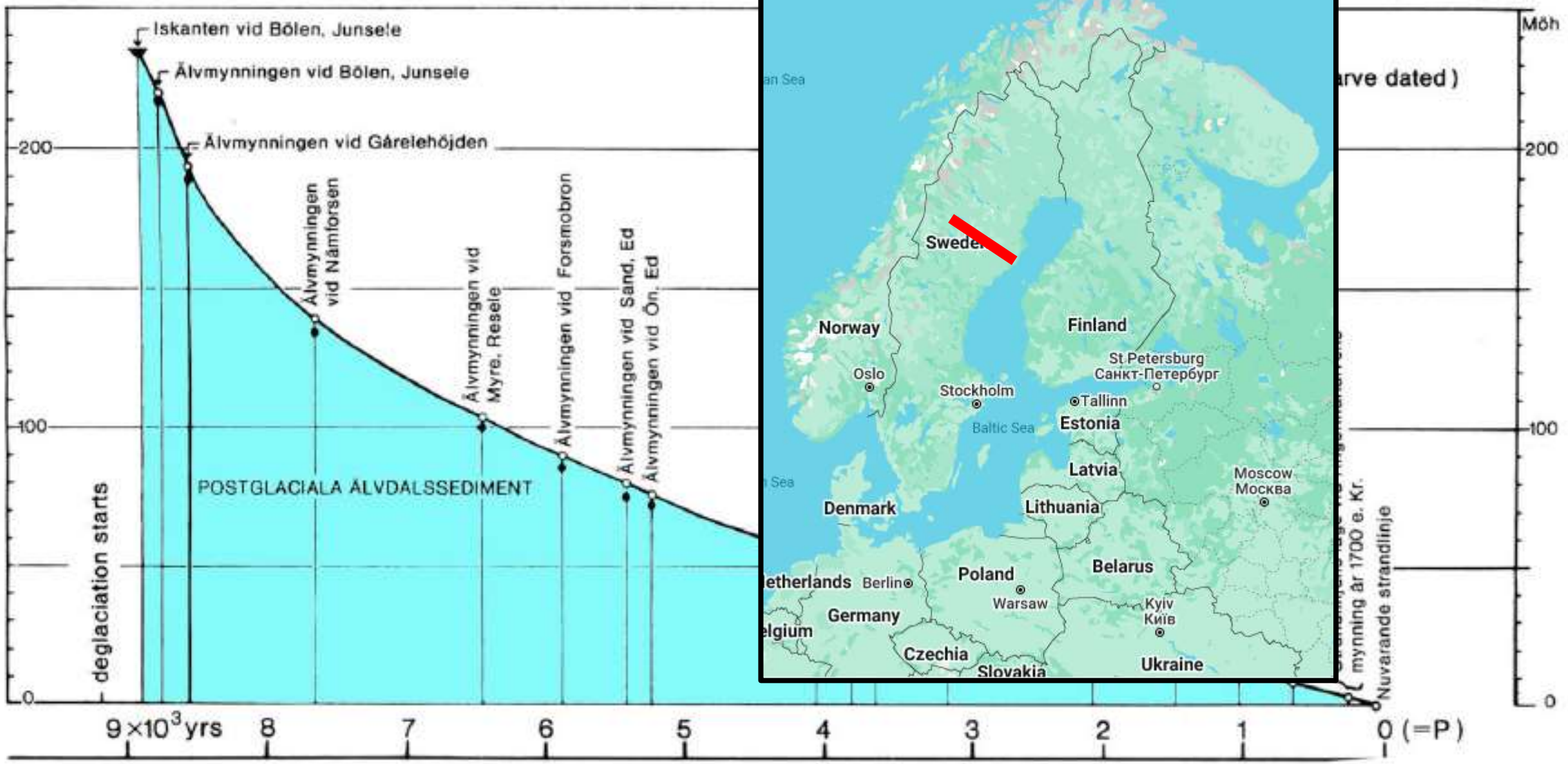
application 1.

The lowest varve at a site

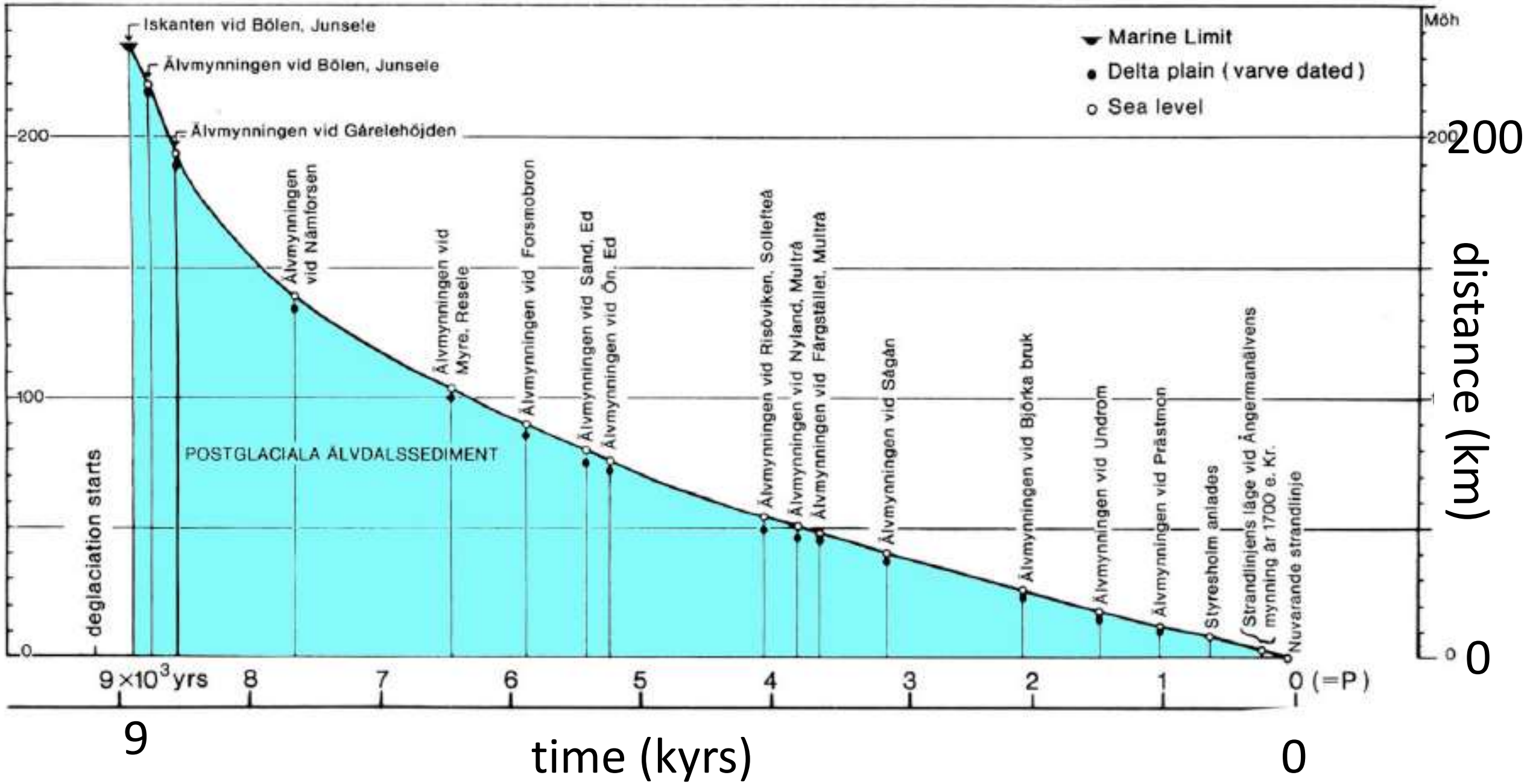
dates that part of the lake floor

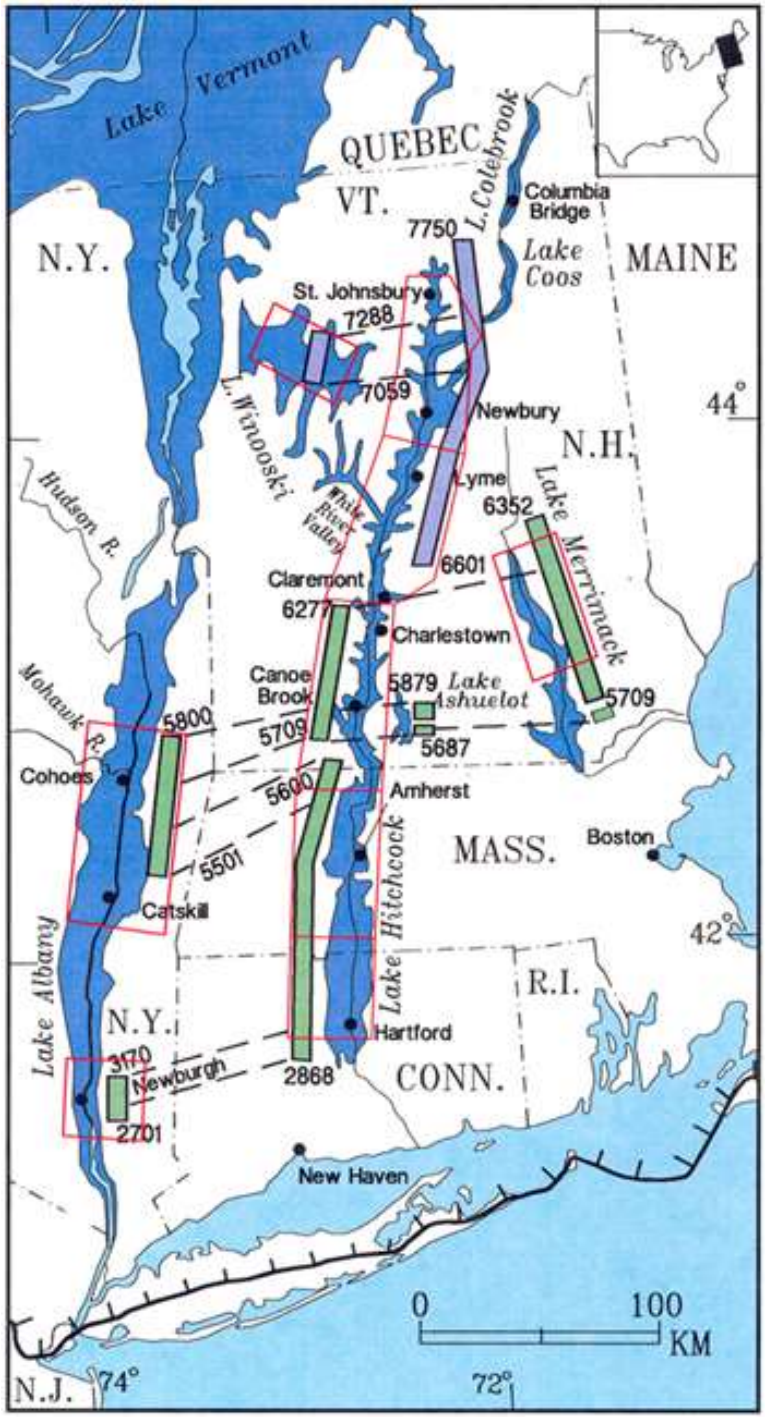
and is a proxy for the position of the glacier

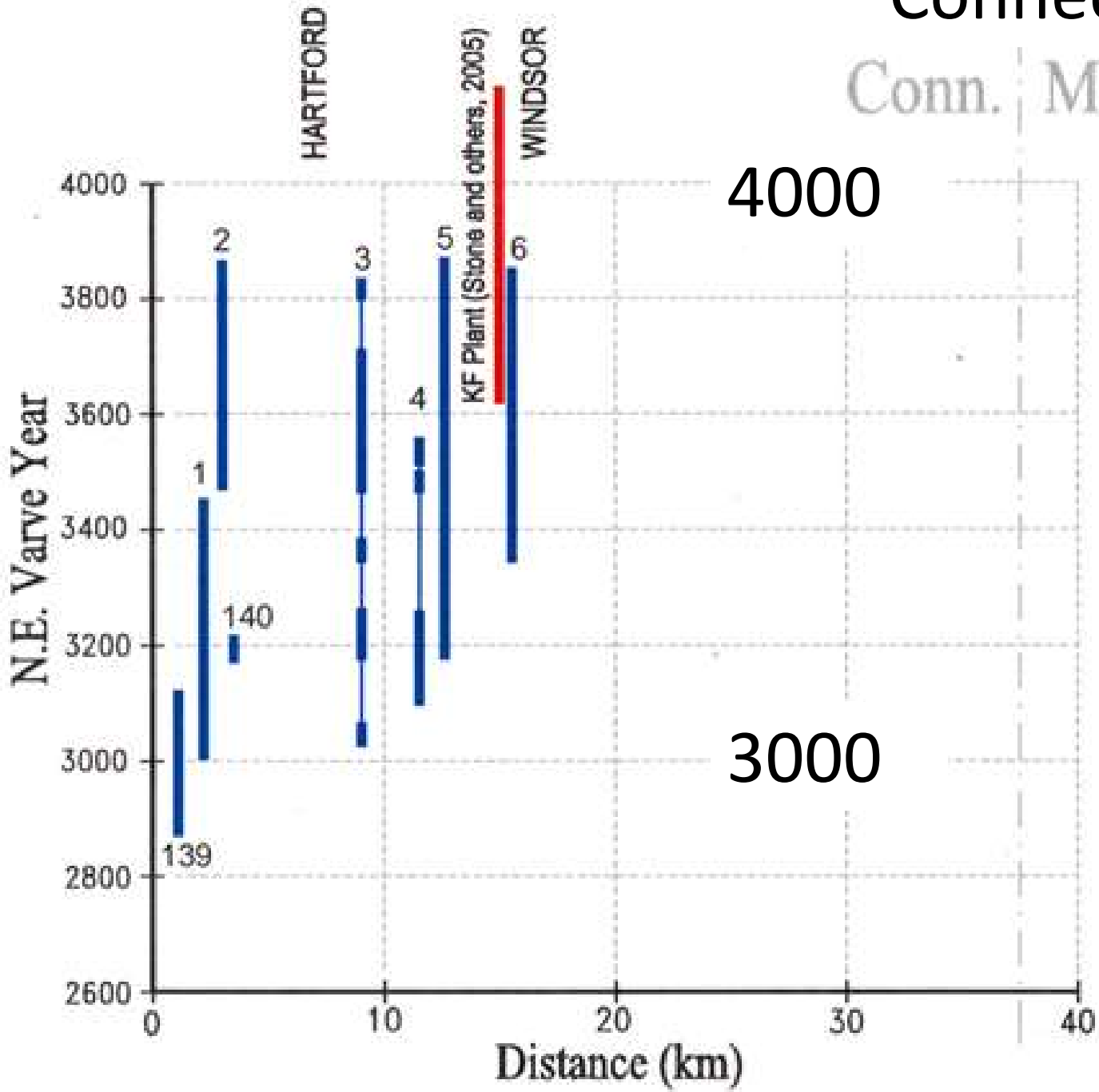
Baltic Sea shoreline of Sweeden

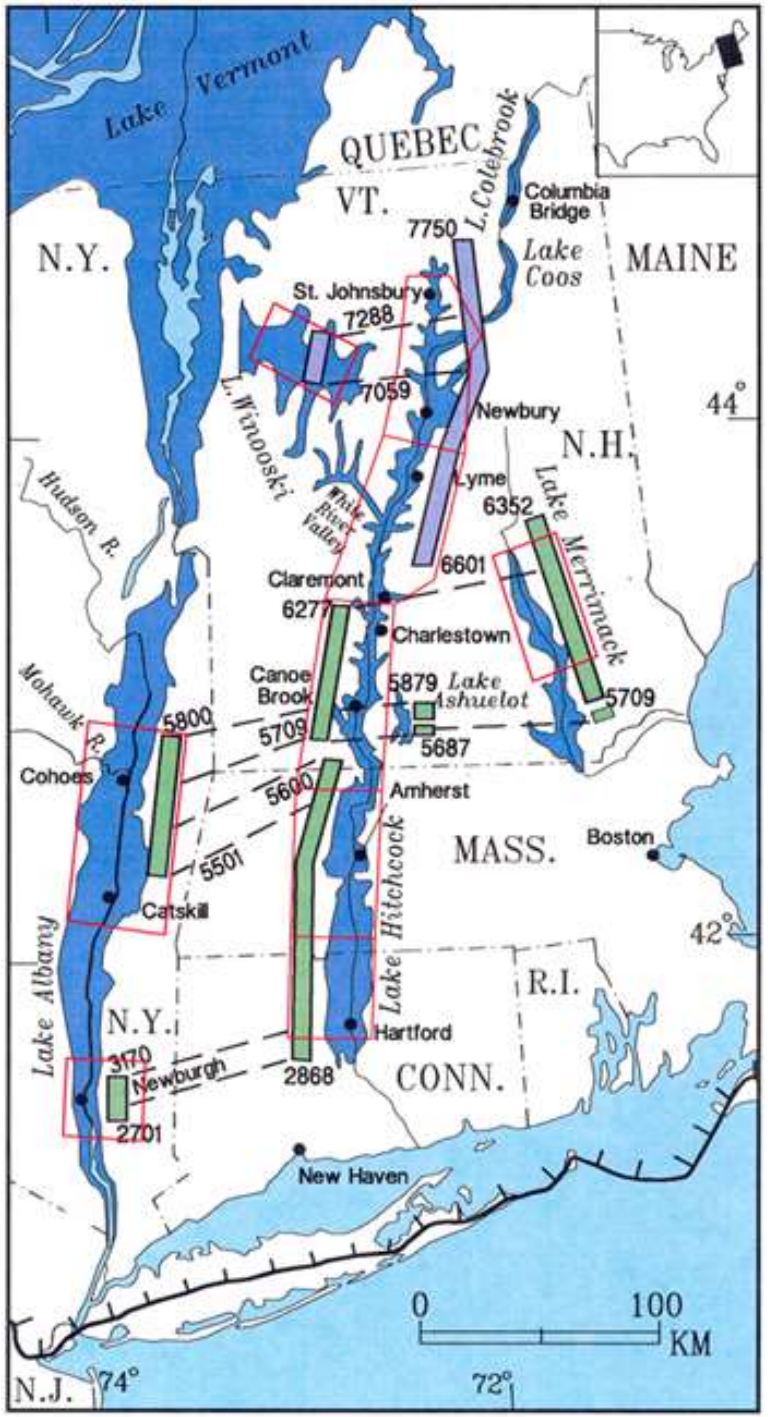


Baltic Sea shoreline



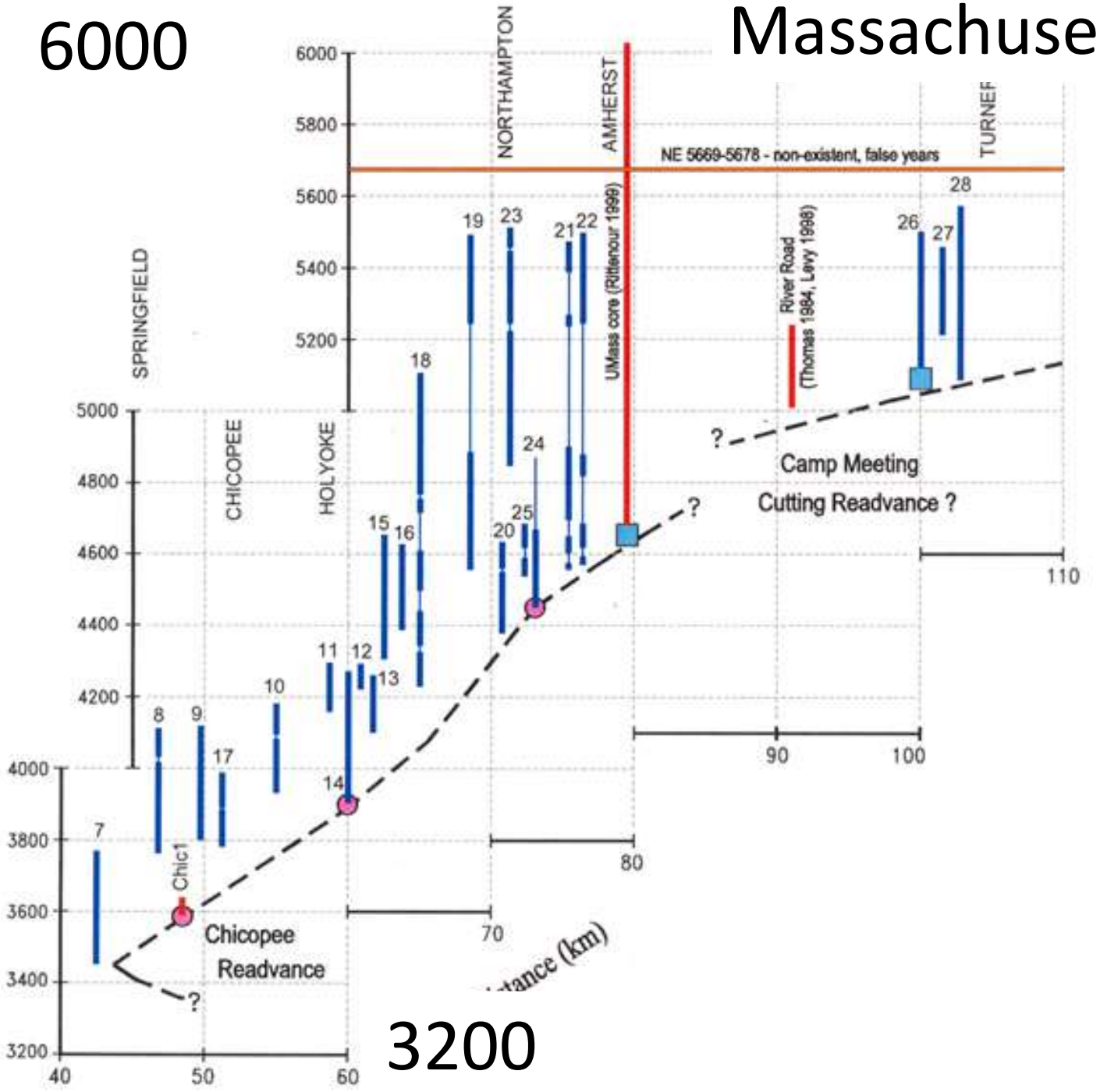

Lake Vermont
QUEBEC
VT.
L. Colebrook
Columbia Bridge
7750
Lake Coos
MAINE
N.Y.
St. Johnsbury
7288
7059
Newbury
44°
N.H.
L. Winooski
White River Valley
Lyme
6352
Lake Merrimack
Hudson R.
6601
Claremont
6277
Charlestown
Canoe Brook
5879
Lake Ashuelot
5709
5800
5709
5687
Mohawk R.
Cohoes
5600
Amherst
Boston
MASS.
5501
Catskill
42°
Lake Hitchcock
R.I.
Lake Albany
N.Y.
Hartford
3170
Newburgh
2868
CONN.
2701
New Haven
0
100
KM
N.J.
74°
72°


Connecticut
Conn.
Mass.
HARTFORD
KF Plant (Stone and others, 2005)
WINDSOR
4000
3000
N.E. Varve Year
4000
3800
3600
3400
3200
3000
2800
2600
1
2
3
4
5
6
139
140
0
10
20
30
40
Distance (km)



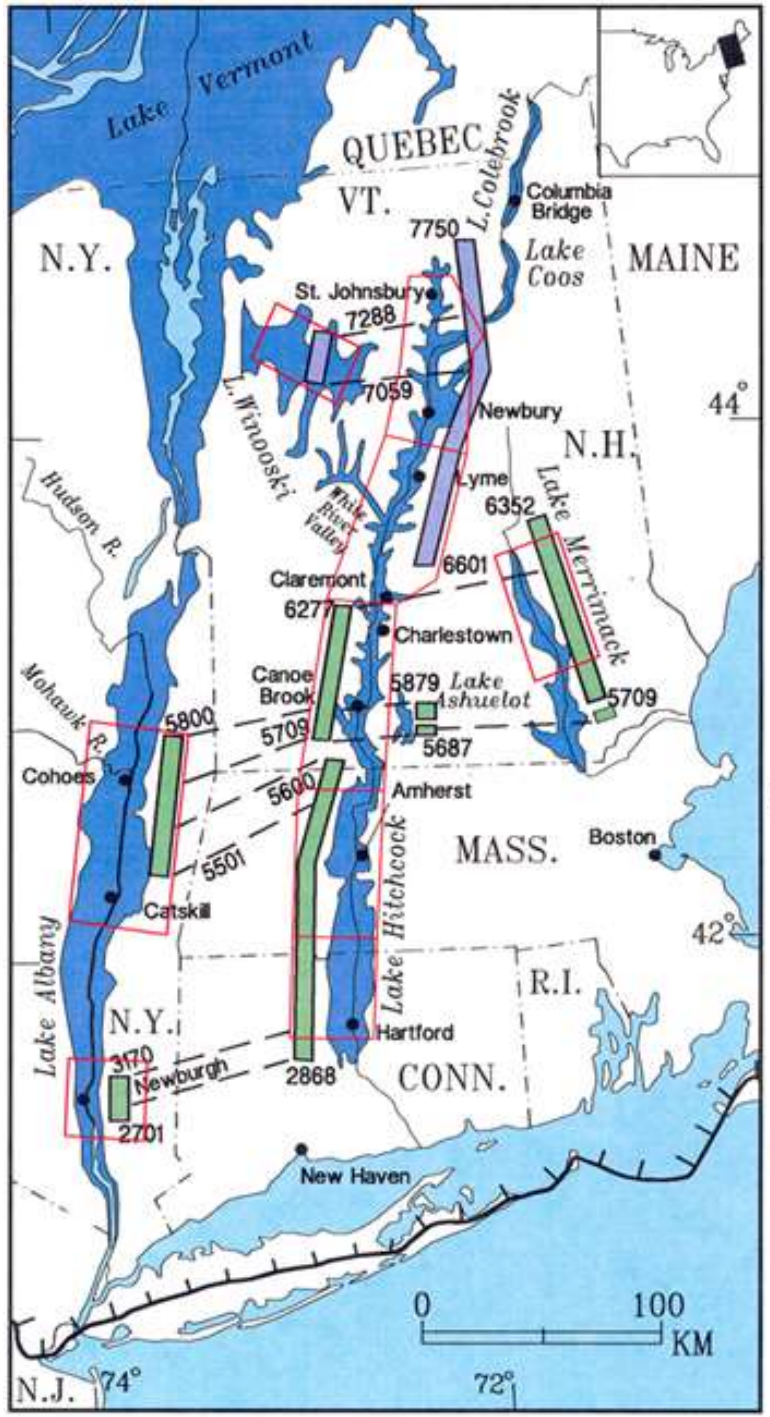
6000

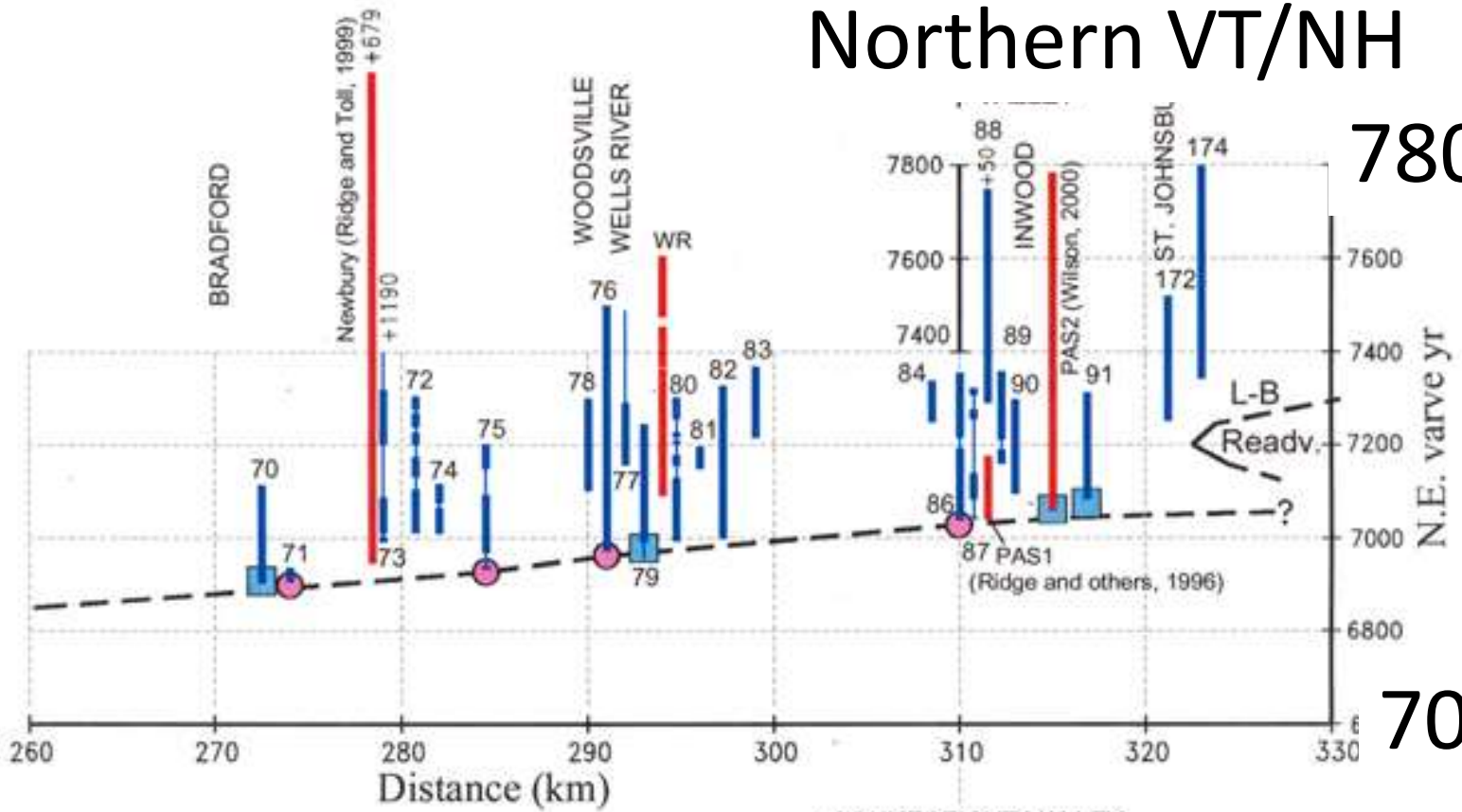
Massachusetts

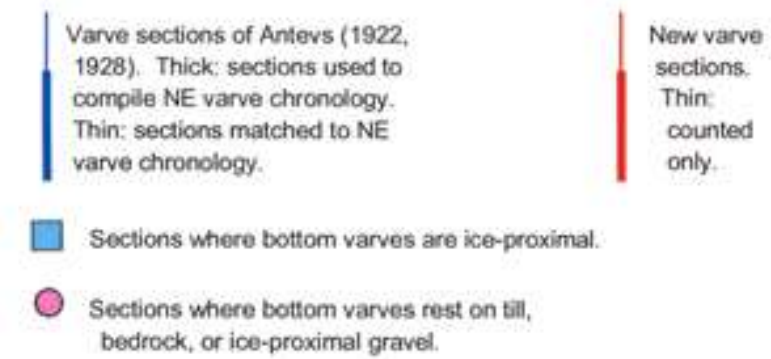


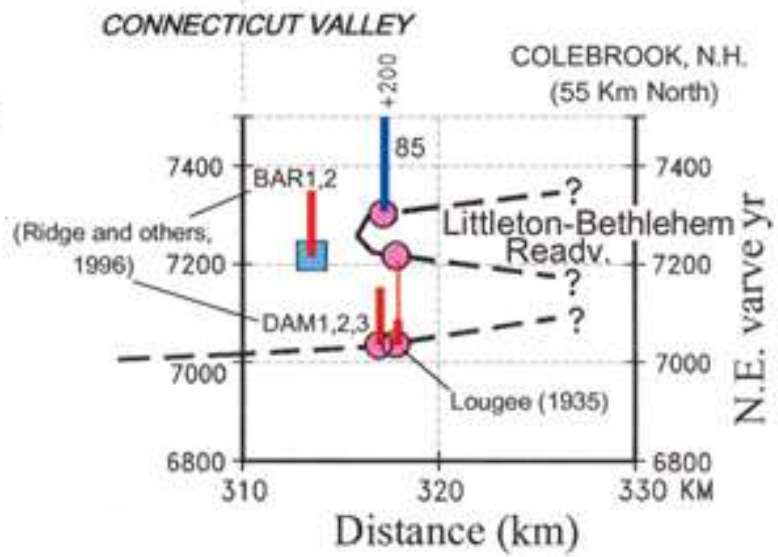
3200

Northern VT/NH





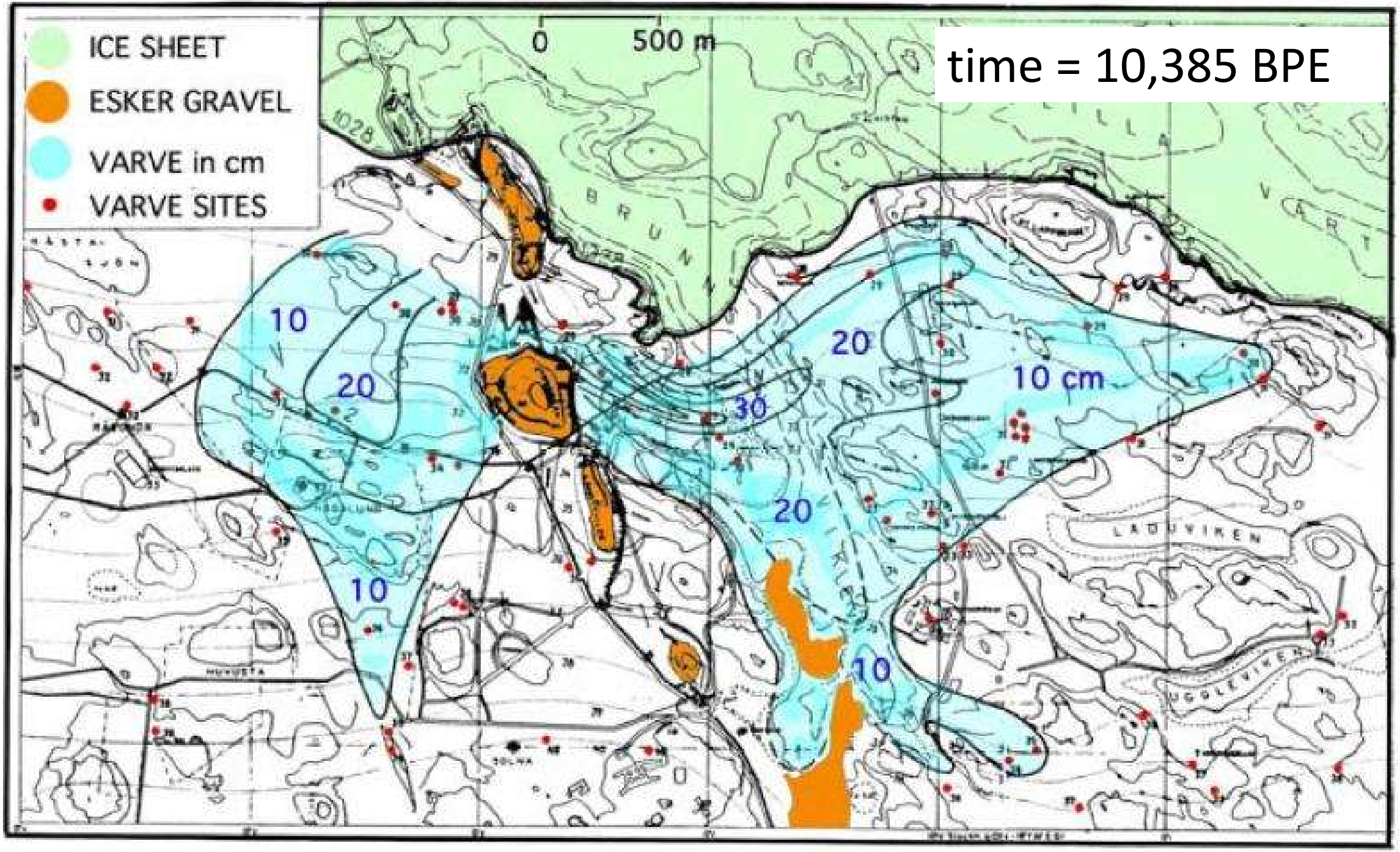




application 2.

Date advance/retreat of glacier

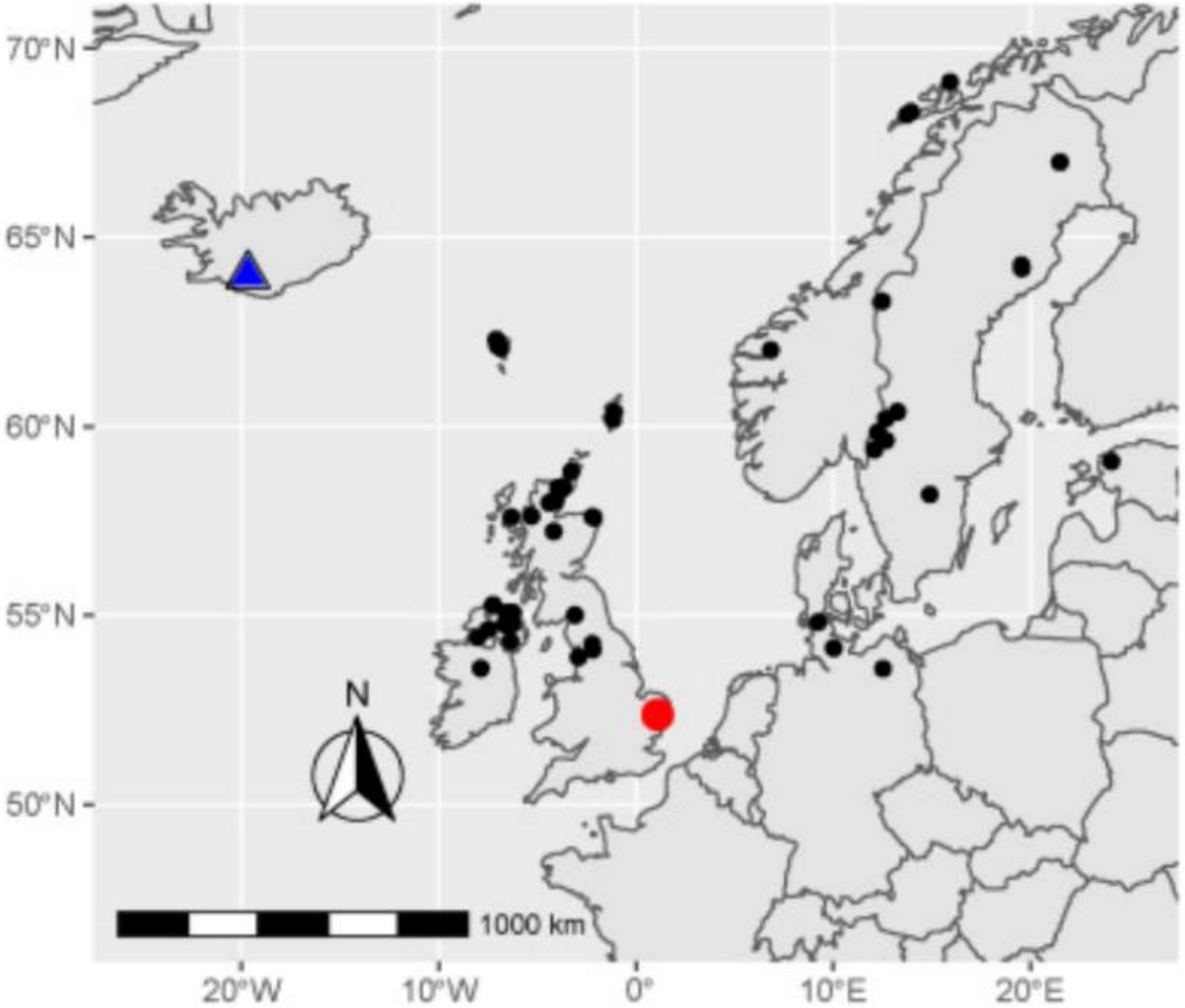
till (or esker gravel) lying on top of a varved sequence


ICE SHEET
ESKER GRAVEL
VARVE in cm
VARVE SITES
0
500 m
time = 10,385 BPE
10
20
30
20
10 cm
20
10
10

application 3.

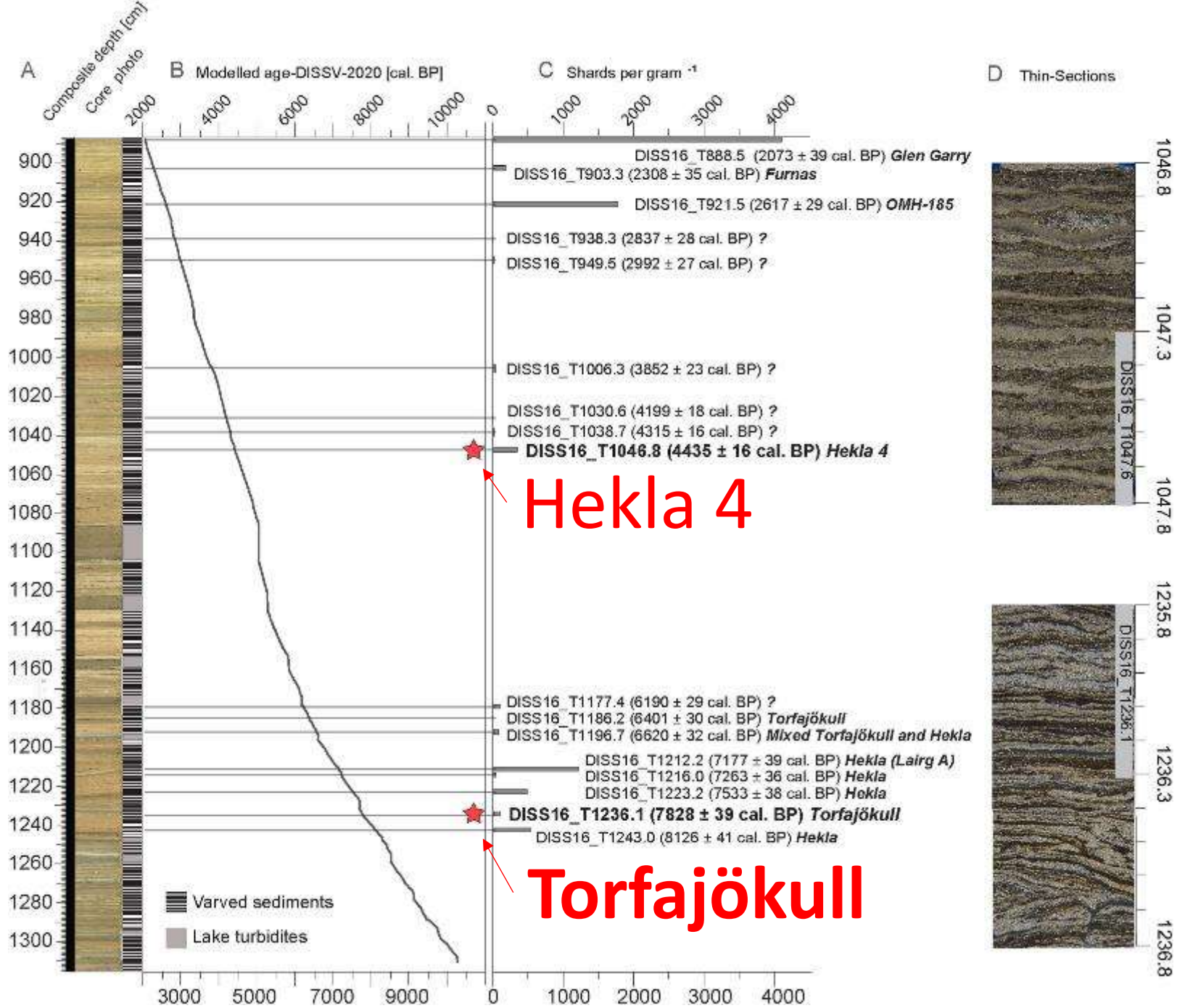
Date local events that left a record in the varved sediment

- volcanic eruptions (through tephra)
- very large earthquakes (through disturbed layers)
- lake drainage (through uncomformaties)
- marine/freshwater transition (through microfossils)



Iceland: triangle

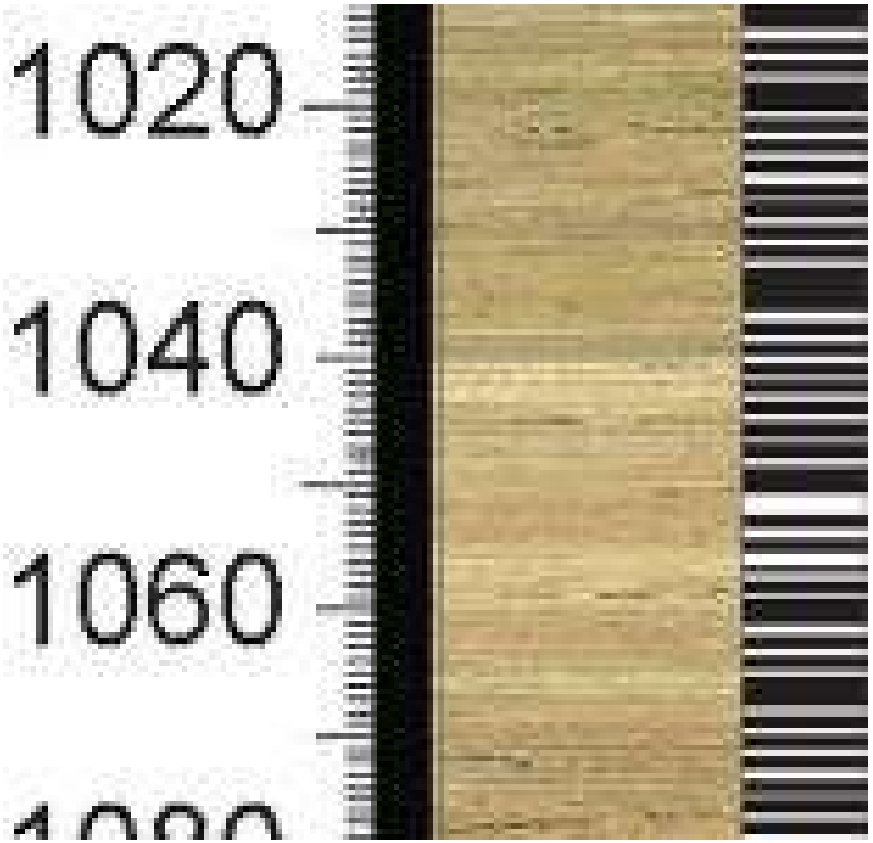
tephra layers: circles



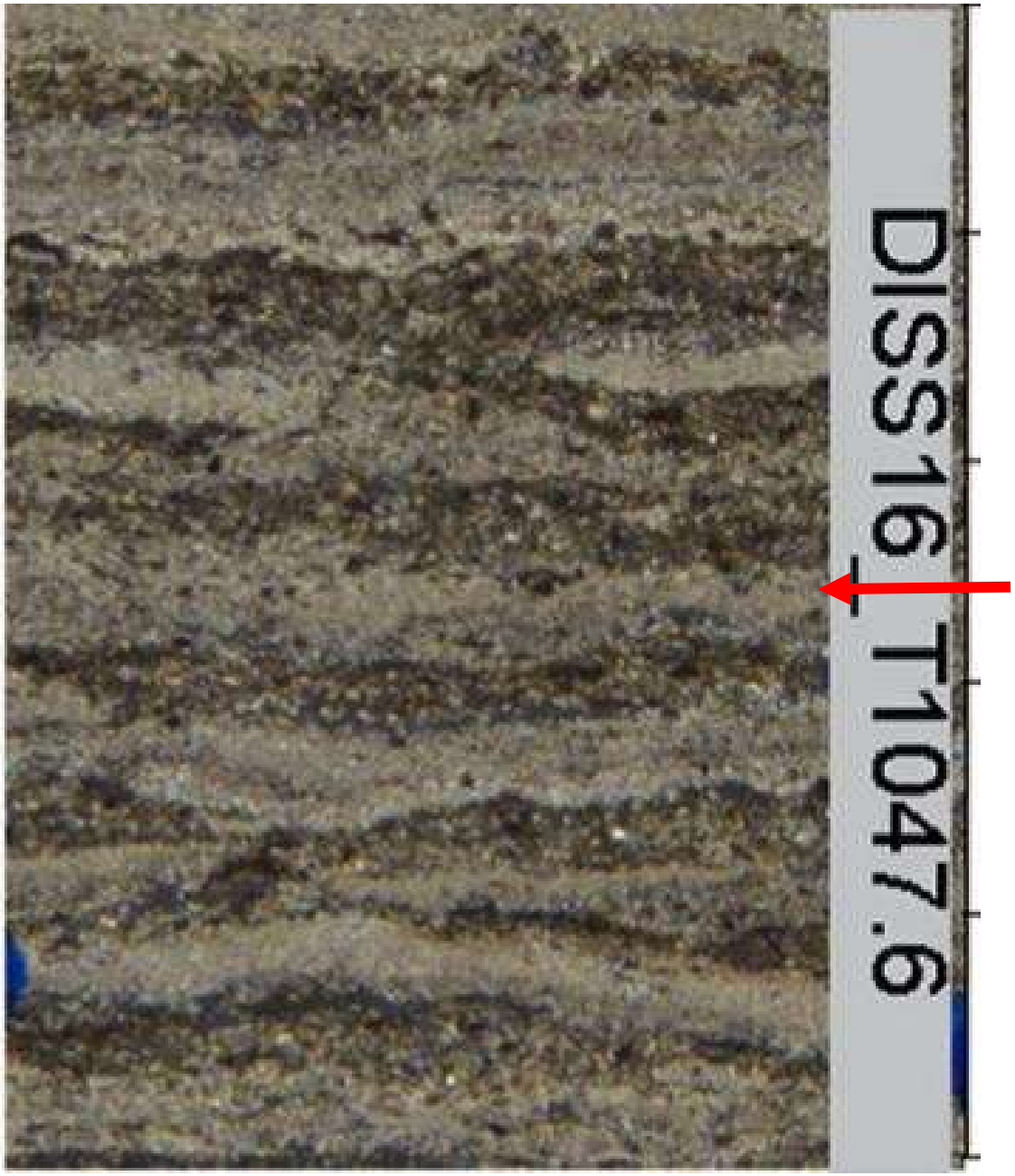
core in south Britain

(red circle in previous slide)

Hekla 4

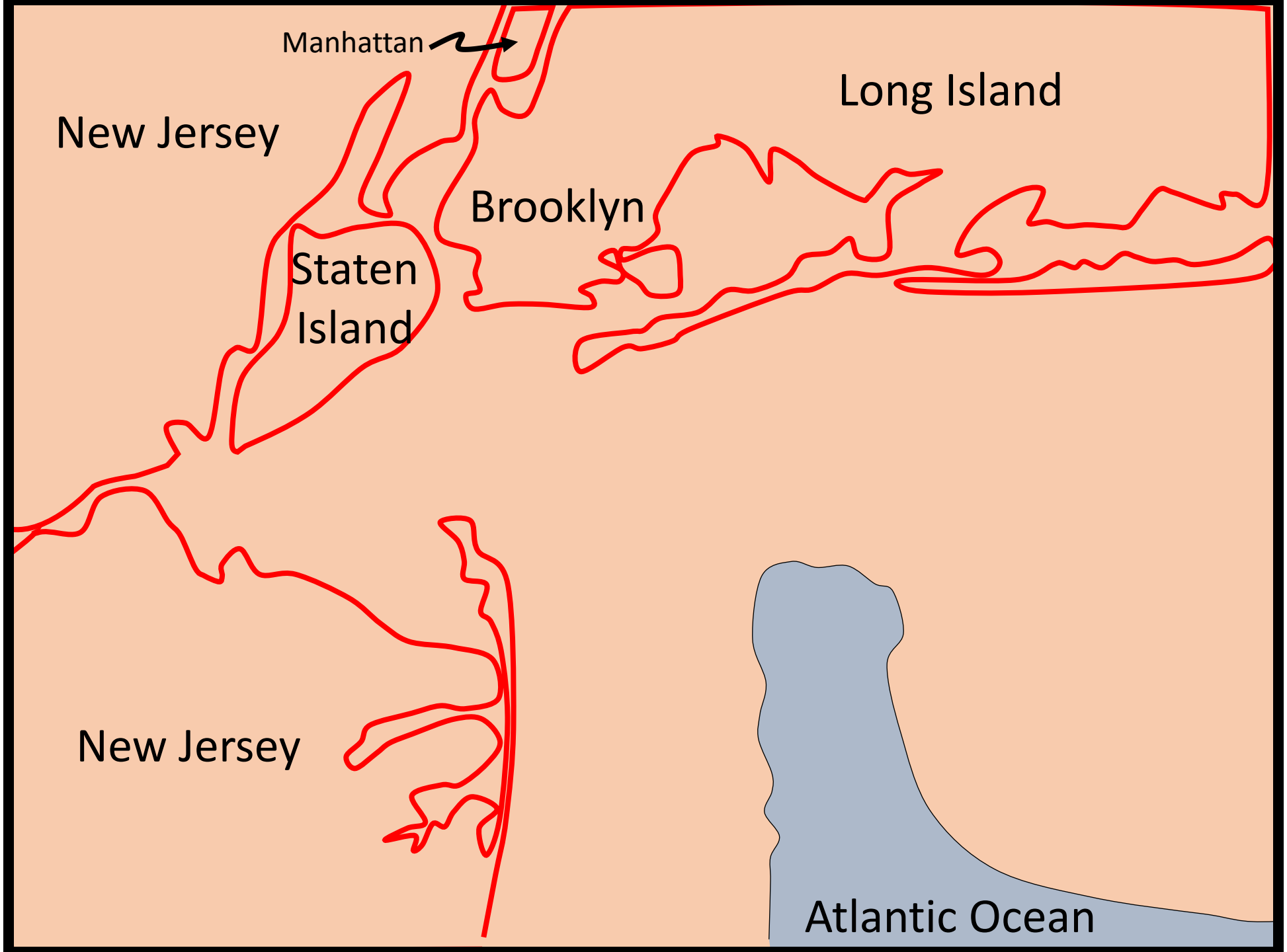


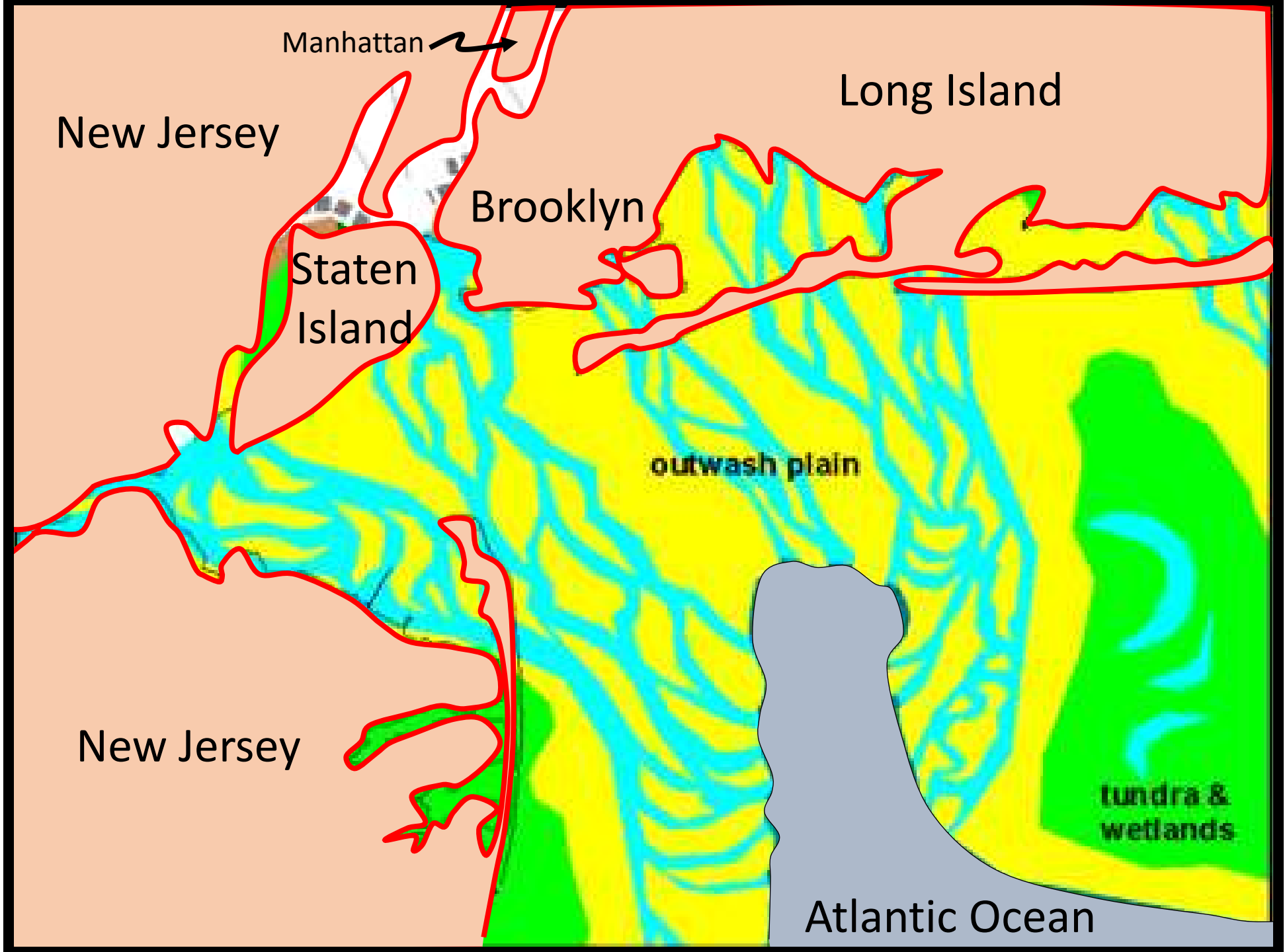
1047.6

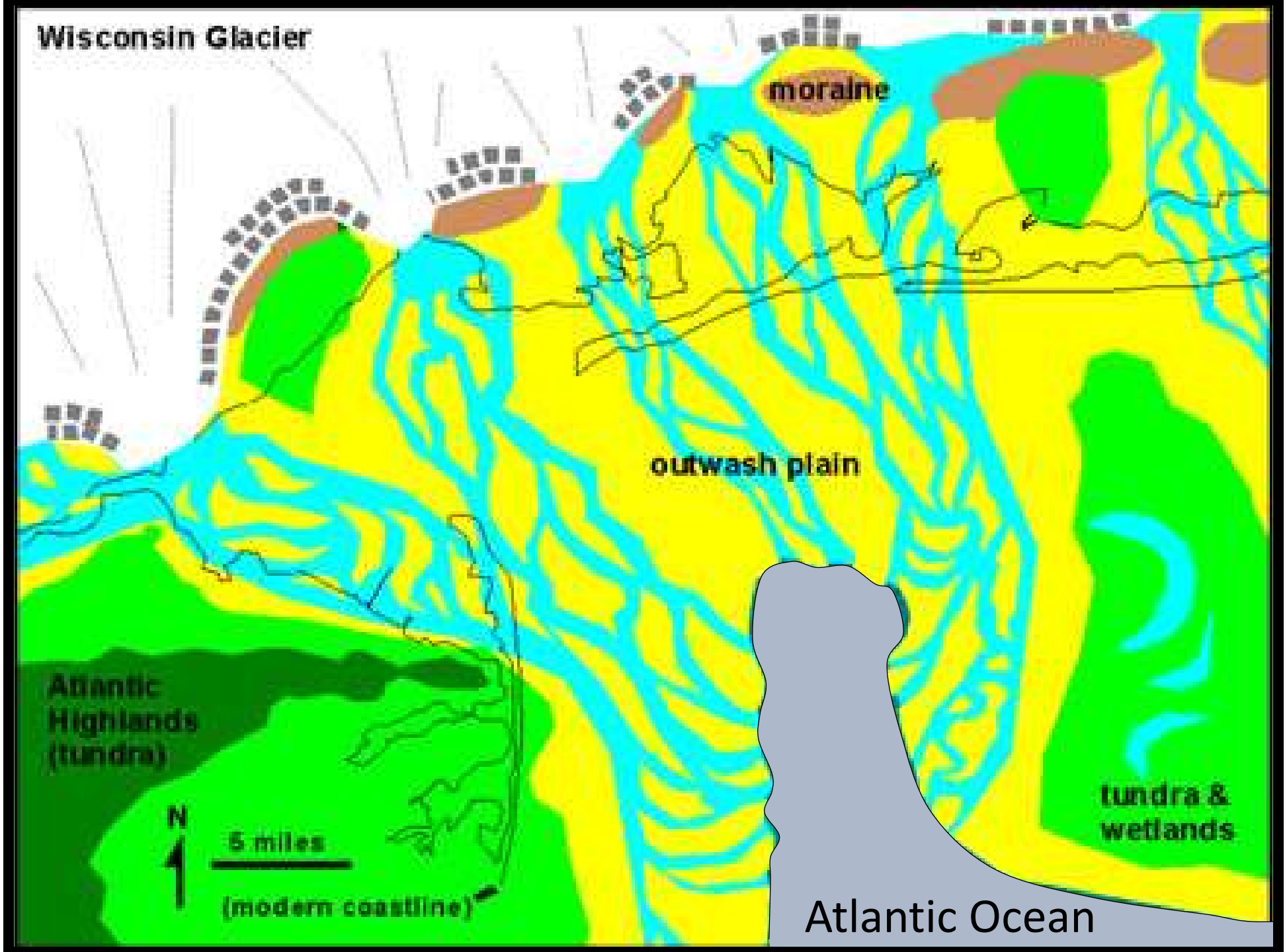


Part 2: North American Ice Margin and Biology


Manhattan
New Jersey
Long Island
Brooklyn
Staten Island
Atlantic Ocean
New Jersey

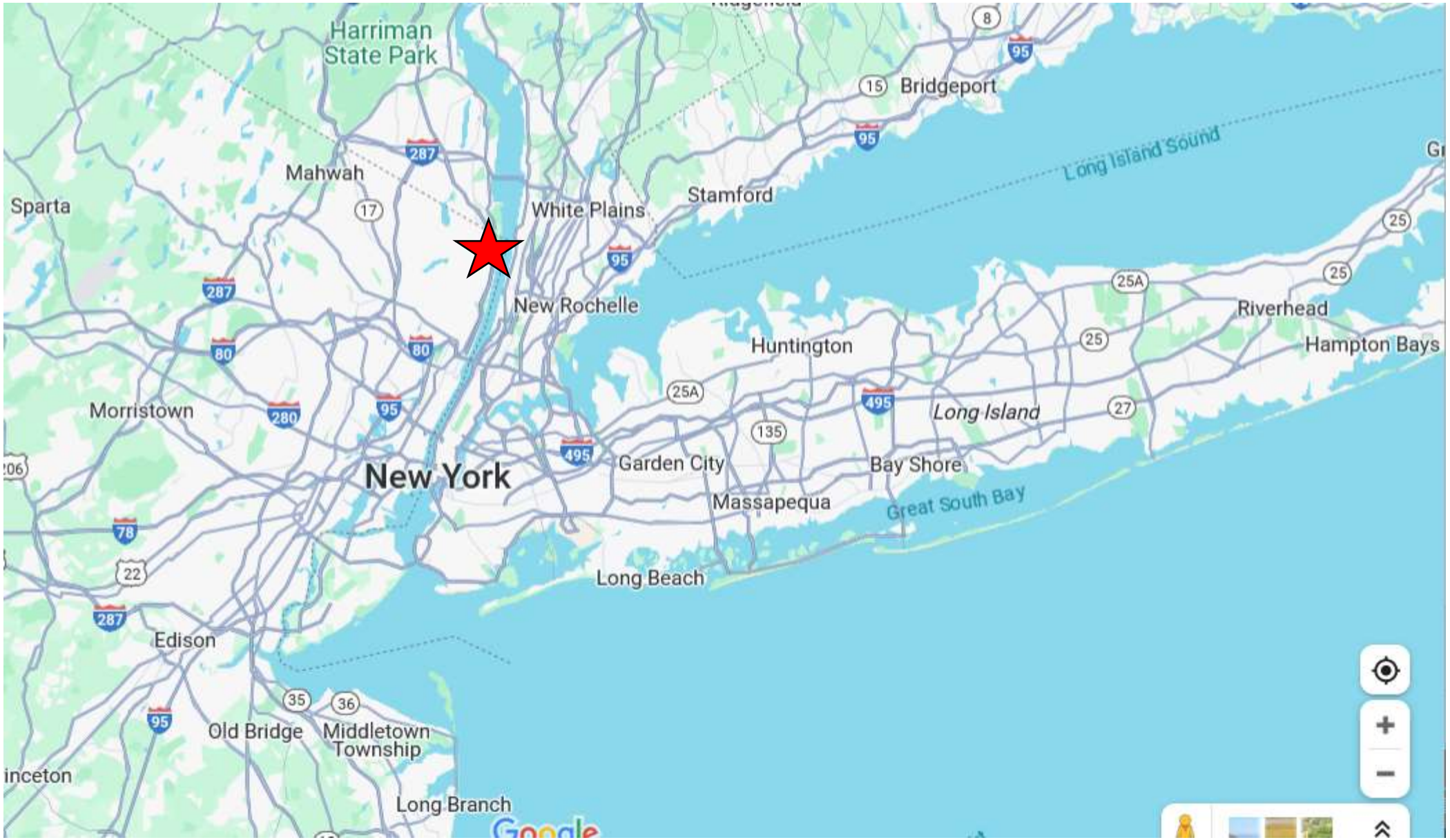

Manhattan
New Jersey
Long Island
Brooklyn
Staten Island
New Jersey
Atlantic Ocean


Manhattan
New Jersey
Long Island
Brooklyn
Staten Island
outwash plain
New Jersey
tundra & wetlands
Atlantic Ocean


Wisconsin Glacier
moraine
outwash plain
Atlantic Highlands (tundra)
N
5 miles
(modern coastline)
tundra & wetlands
Atlantic Ocean

Outwash plain, Iceland

Alpine Swamp

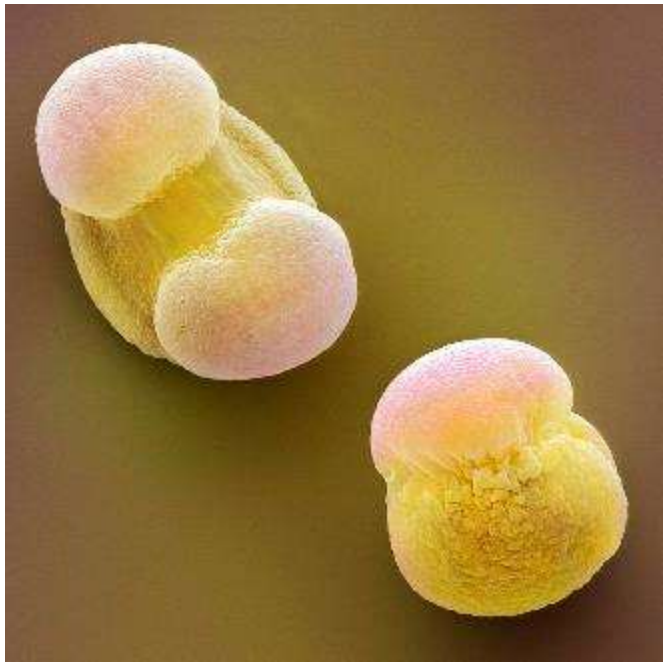


Dr Peteet

Alpine Swamp

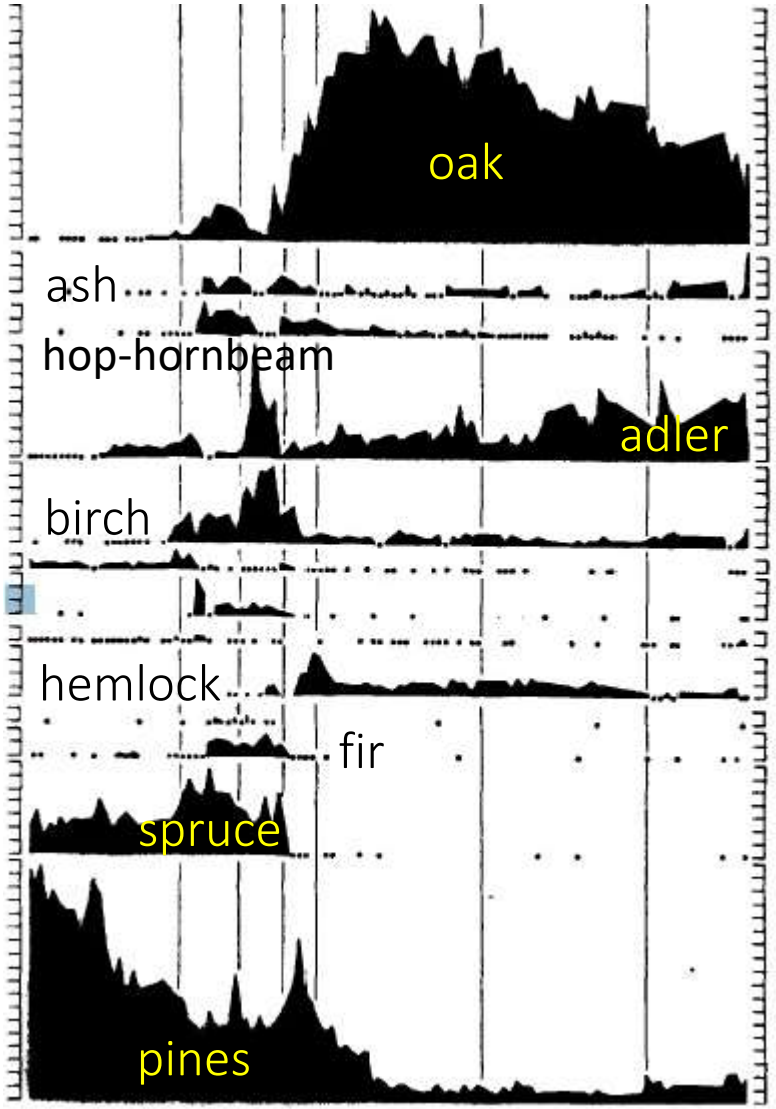
Pollen

Oak



Pine

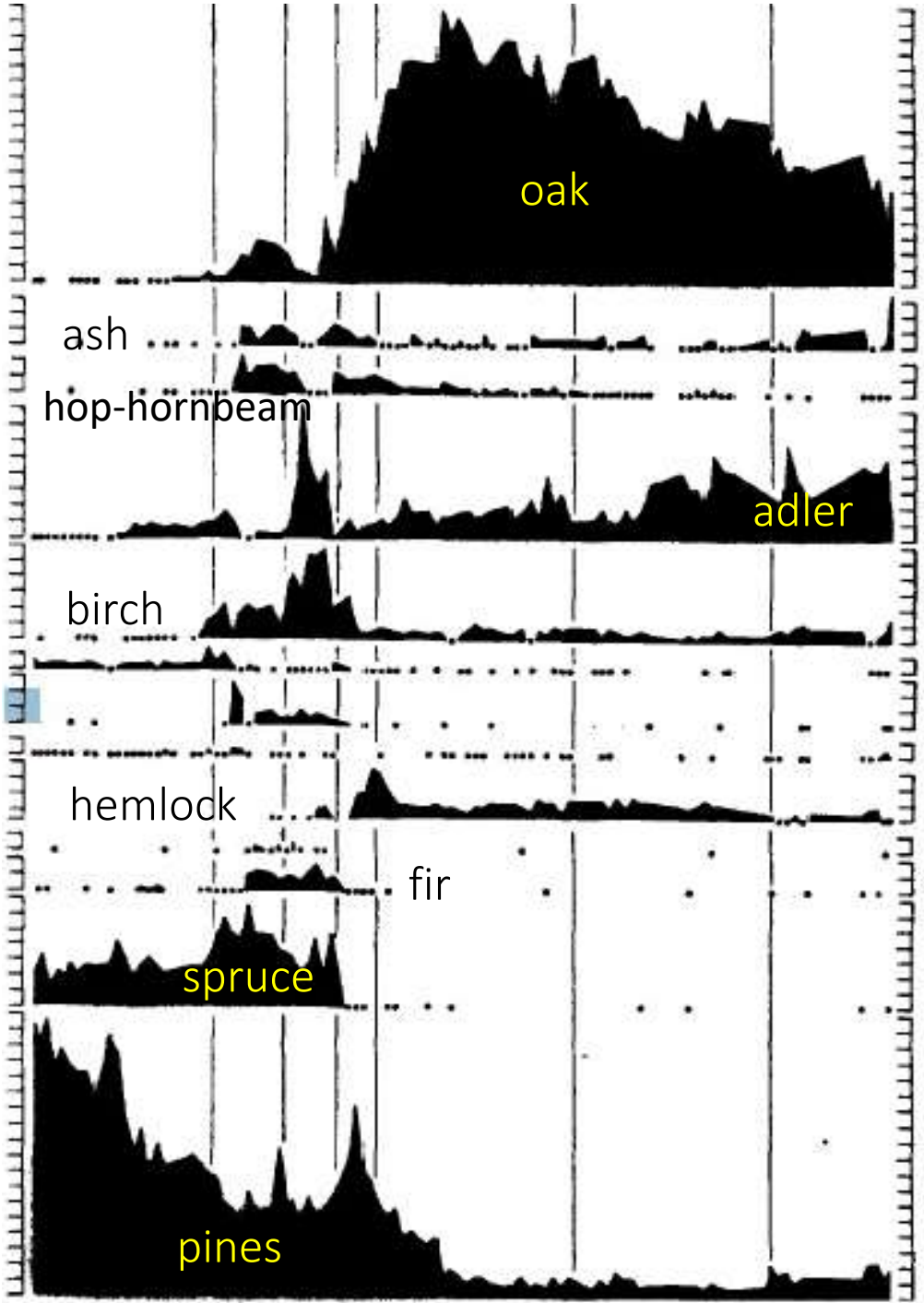
Birch

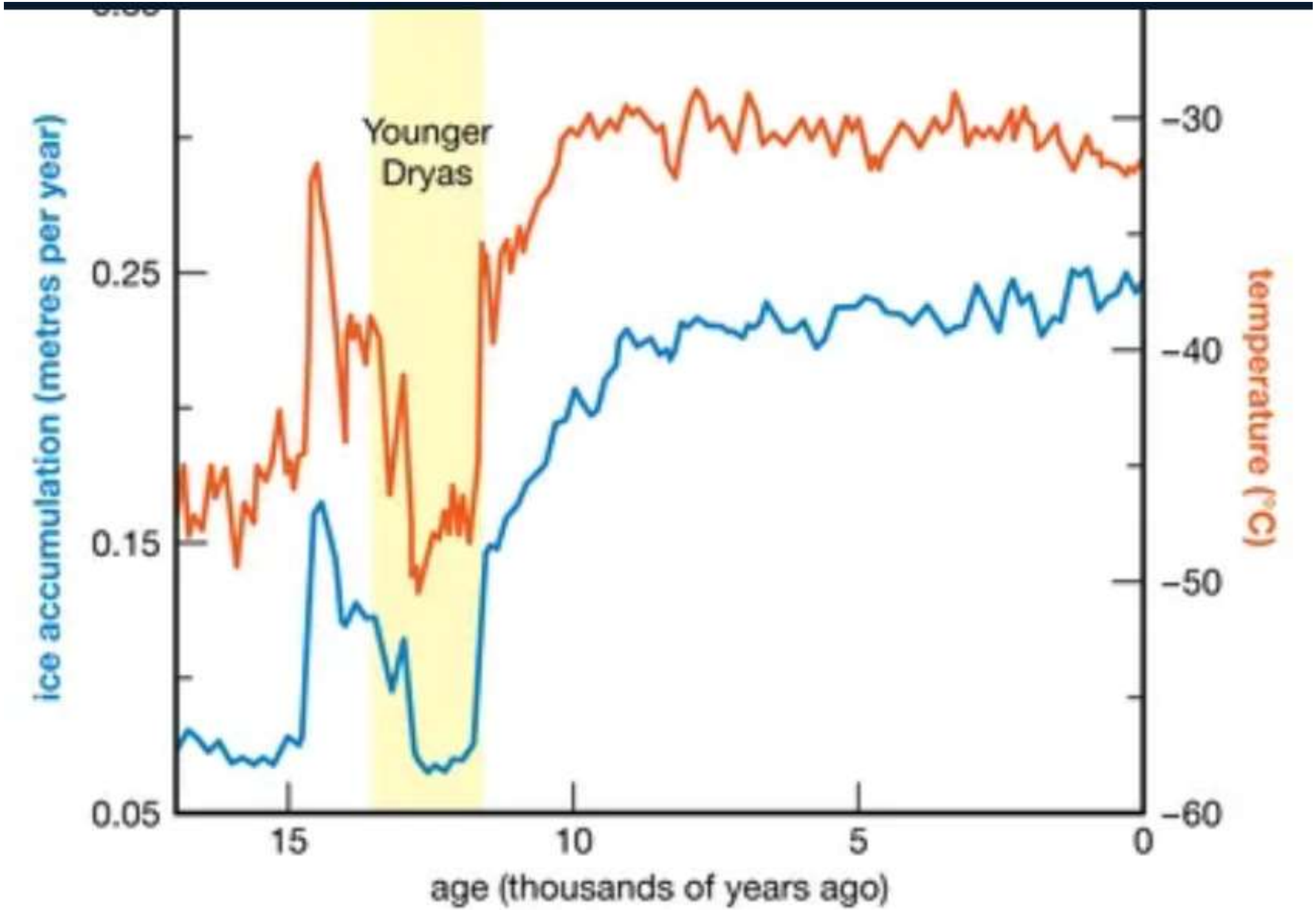


14000

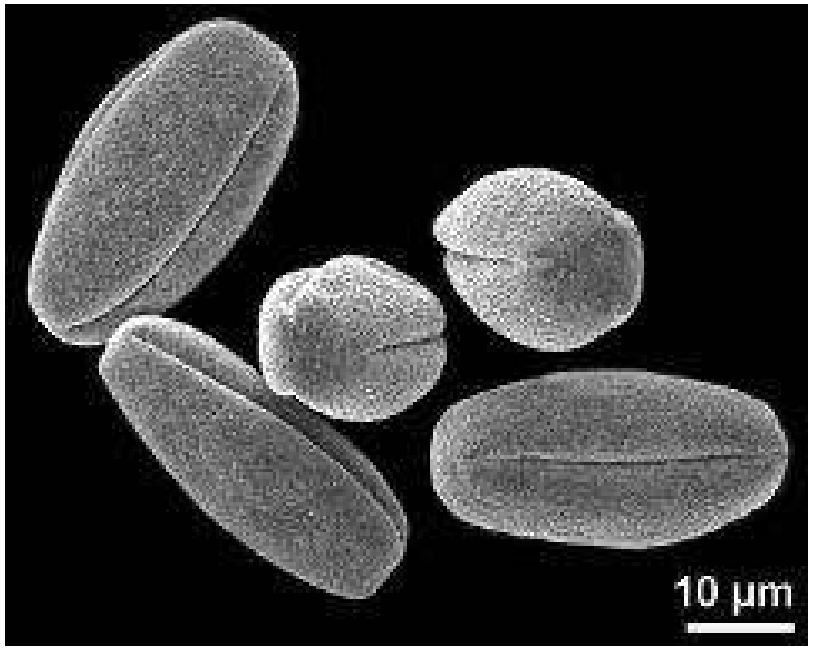
today

Dorothy Peteet

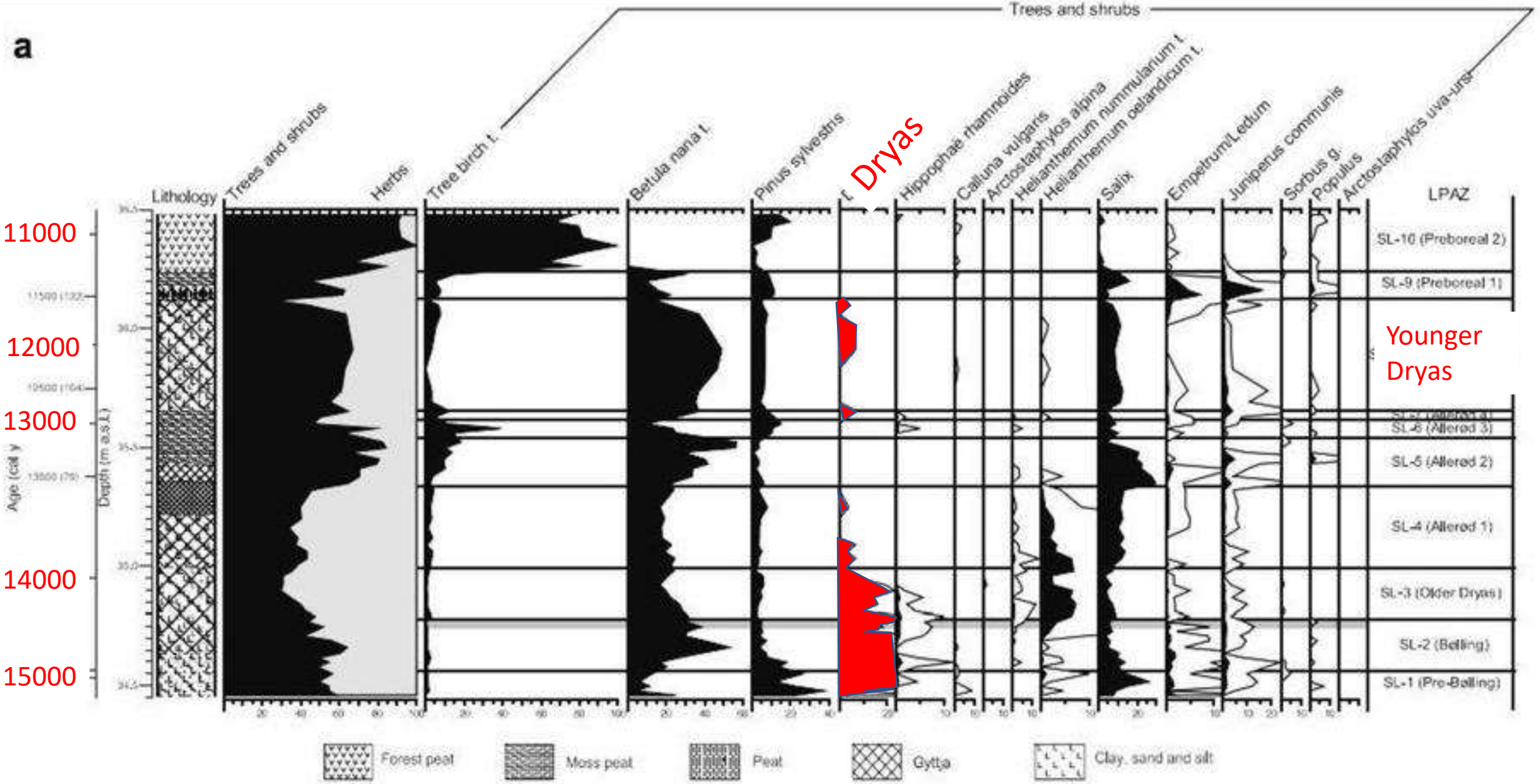

oak
ash
hop-hornbeam
adler
birch
hemlock
fir
spruce
pines


Younger
Dryas
ice accumulation (metres per year)
0.25
0.15
0.05
15
10
5
0
age (thousands of years ago)
−30
−40
−50
−60
temperature (°C)

Dryas flower

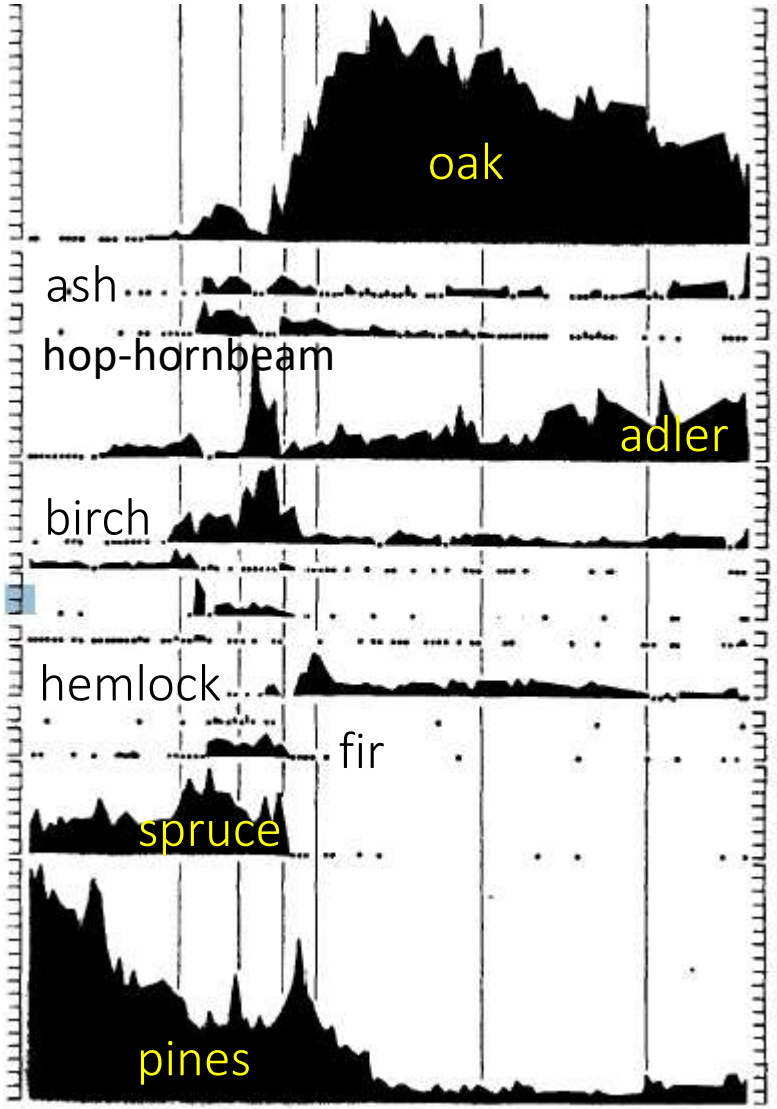


pollen



Site in Denmark

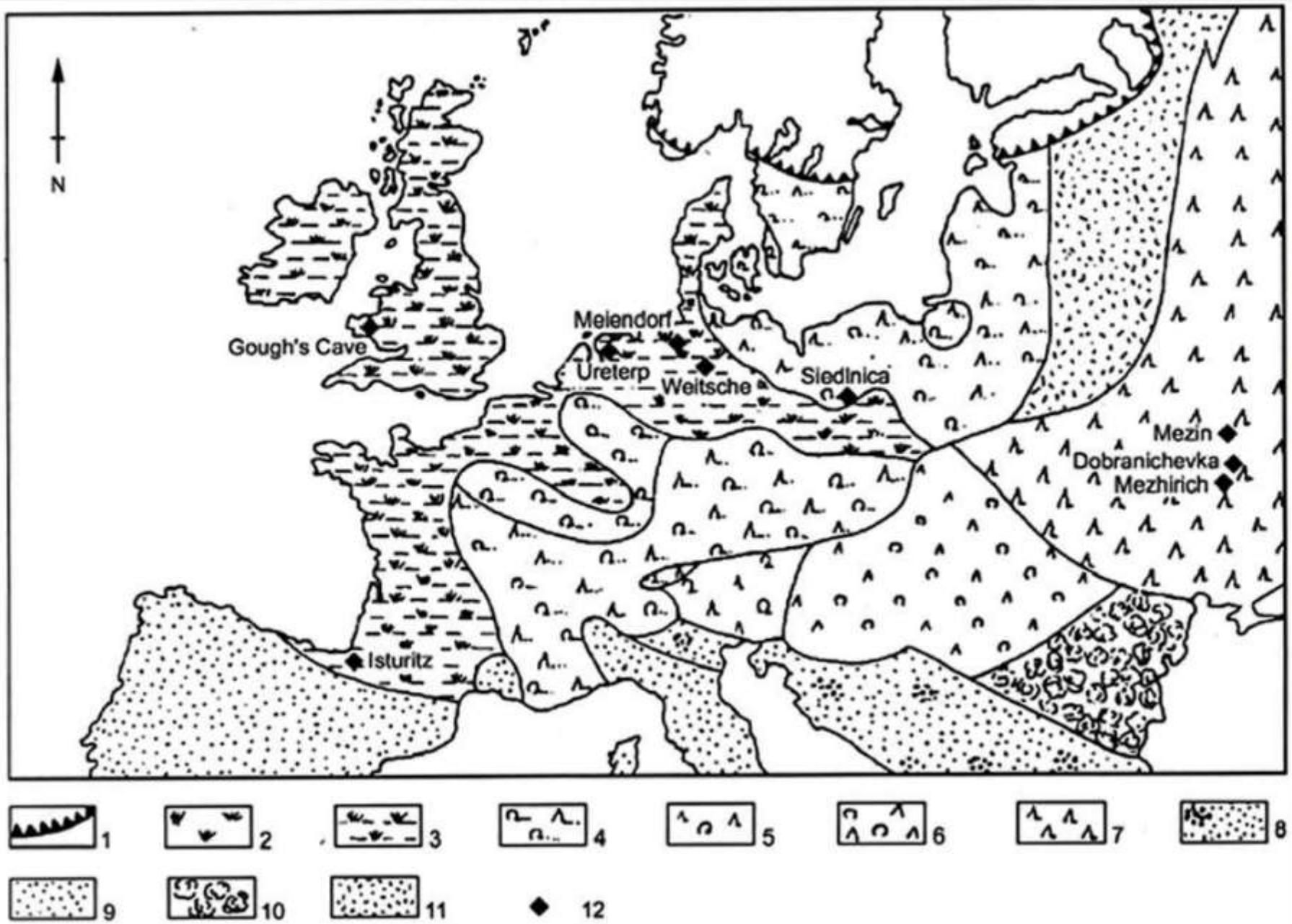
evolution of vegetation at Alpine Swamp



14000

today

Dorothy Peteet



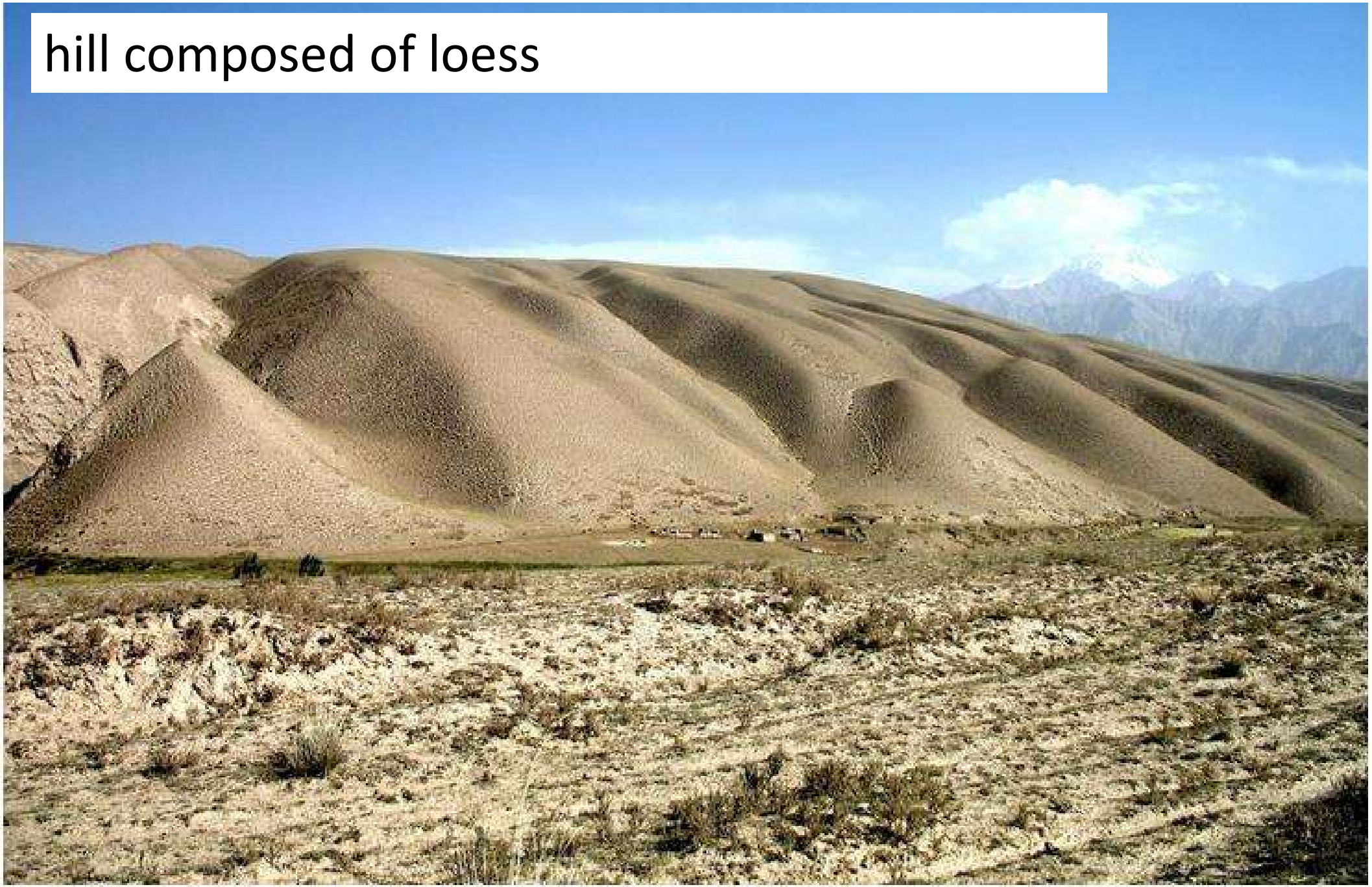
Map of the vegetation in Europe between 13 000 BP and 12 000 BP.

1 - Ice sheet
2 - Tundra
3 - Tundra 'xeric' variant (i.e. dry tundra)
4 - Birch-Pine forest
5 - Mixed forest
6 - Northern mixed conifer-deciduous forest
7 - Spruce dominated forest
8 - Steppe with Gramineae (now called Poaceae)
9 - Steppe (i.e. vast semi-arid grass-covered plain, as found in southeast Europe, Siberia, and central North America)
10 - Mixed-deciduous forest
11 - Mixed forest
12 - Sites with amber artefacts

Photo: Burdukeiwicz (1999)

Part 3: Loess deposits

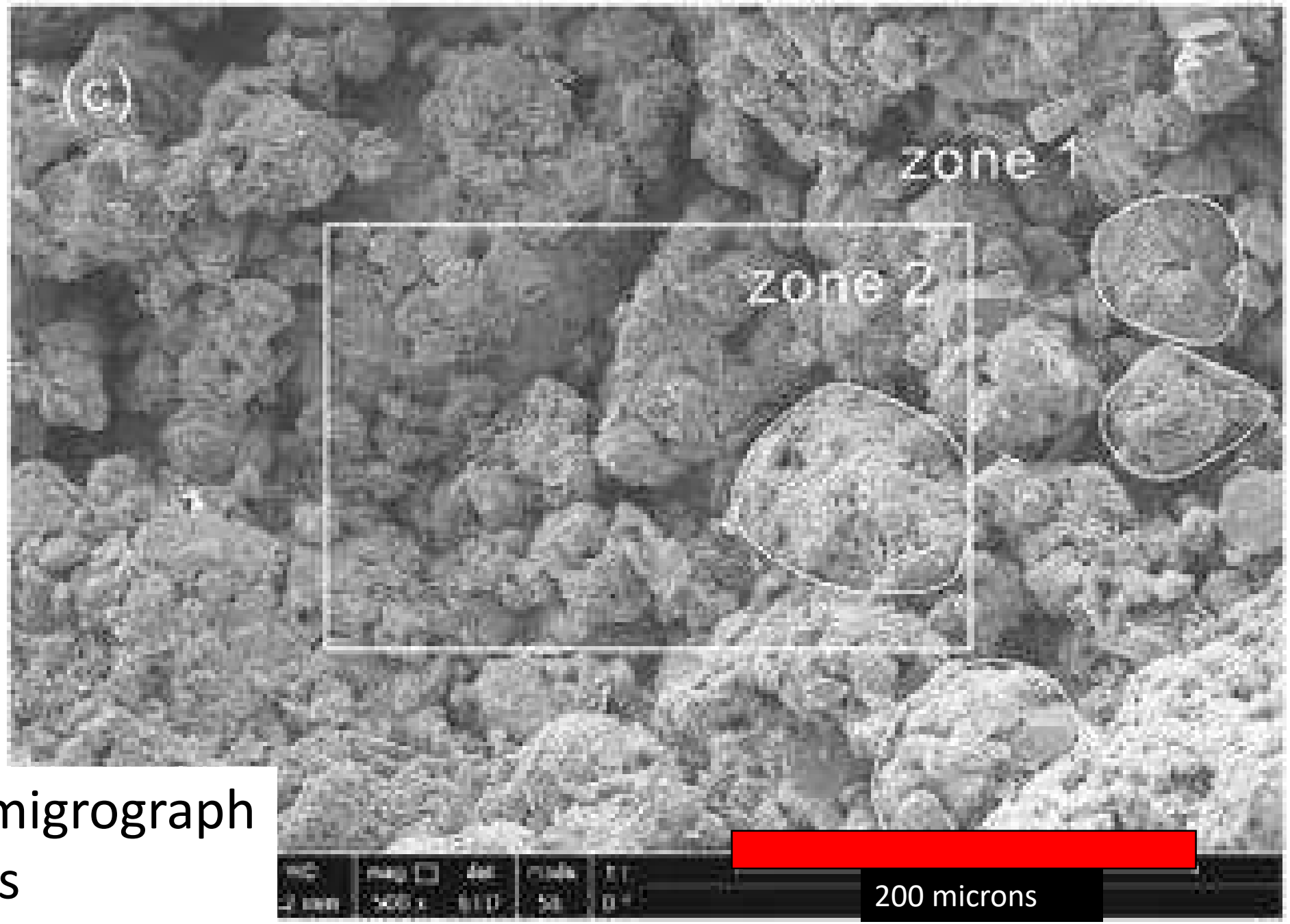
hill composed of loess



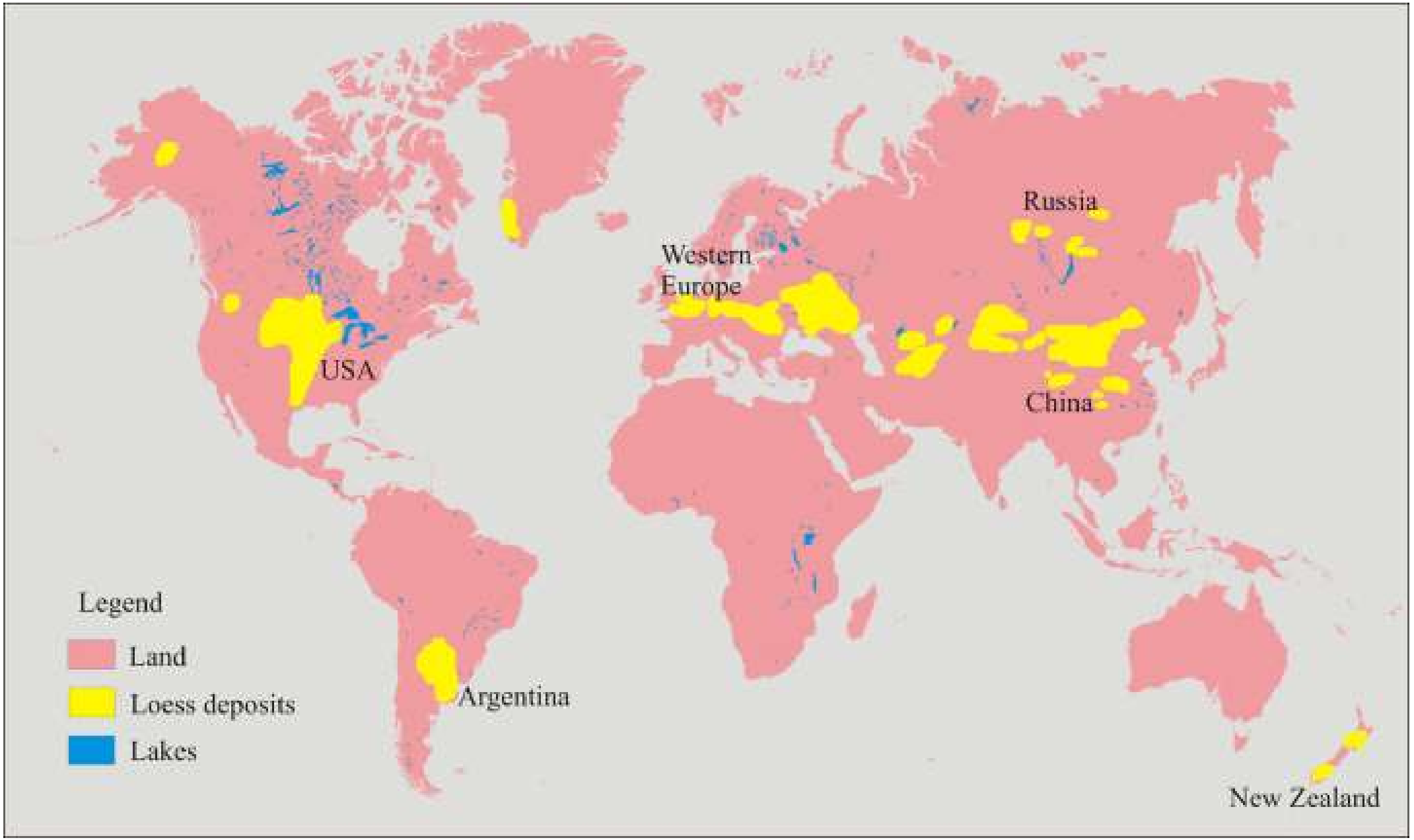
cross-stratified dune deposit

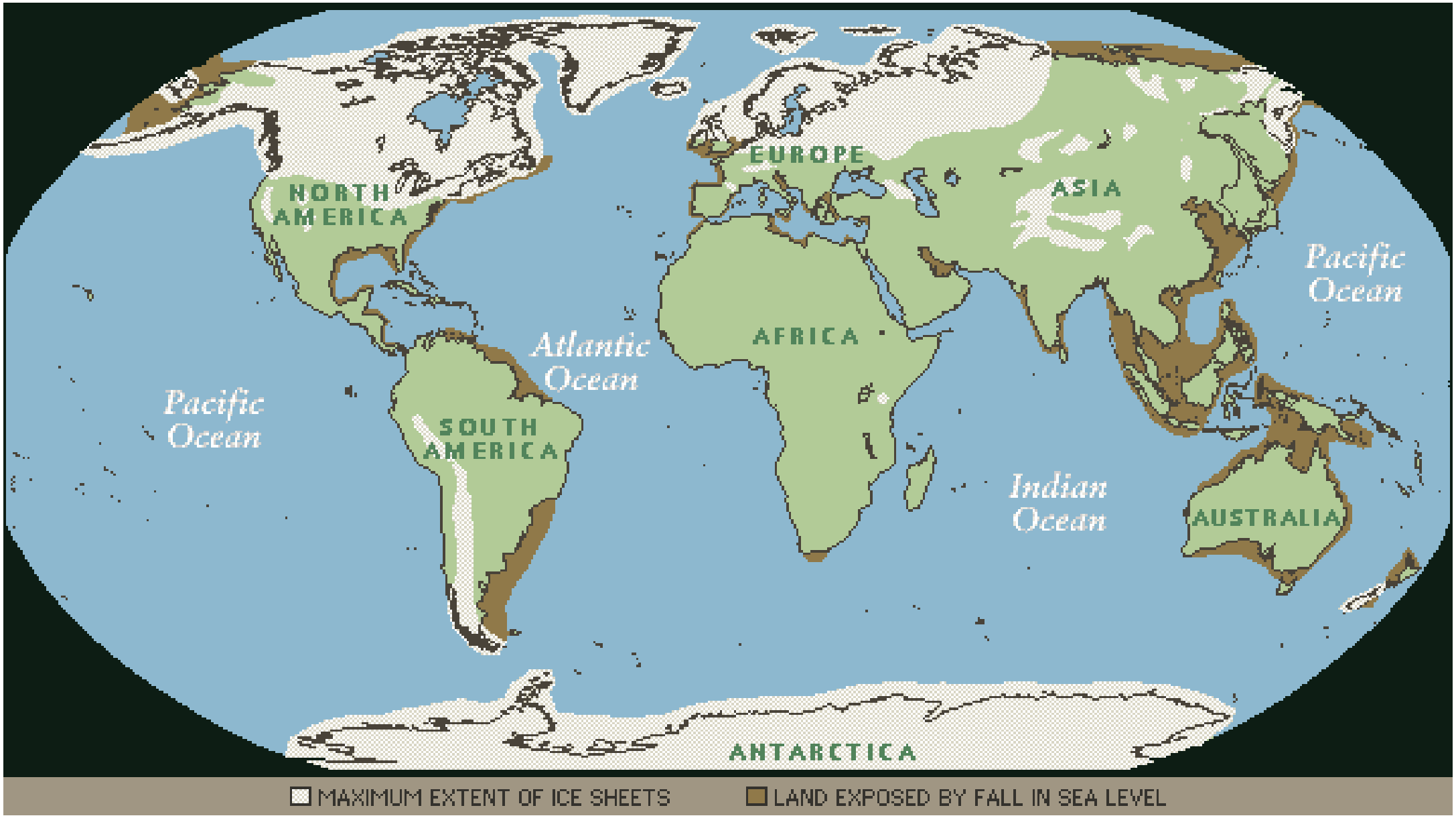
loess

Silt-sized wind-deposited sediment



photomigrograph of loess


Russia
Western
Europe
USA
China
Argentina
New Zealand
Legend
Land
Loess deposits
Lakes


EUROPE
ASIA
NORTH AMERICA
Pacific Ocean
Atlantic Ocean
AFRICA
Pacific Ocean
SOUTH AMERICA
Indian Ocean
AUSTRALIA
ANTARCTICA
MAXIMUM EXTENT OF ICE SHEETS
LAND EXPOSED BY FALL IN SEA LEVEL

Glacial Outwash Plain with braided river

Dust blowing from dry bed of glacial outwash river