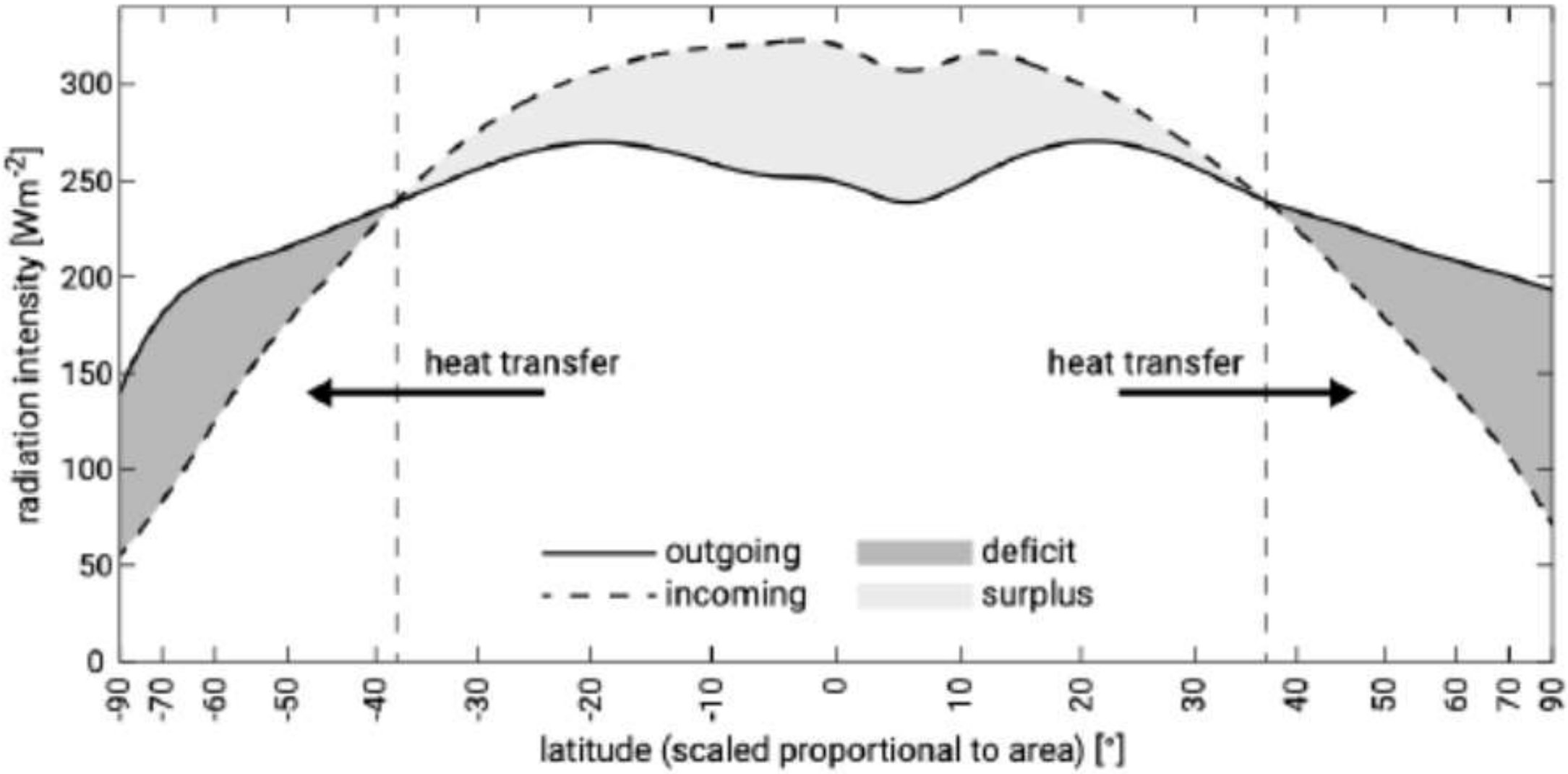
glacial hydrology

Skaftafelljokull (glacier)

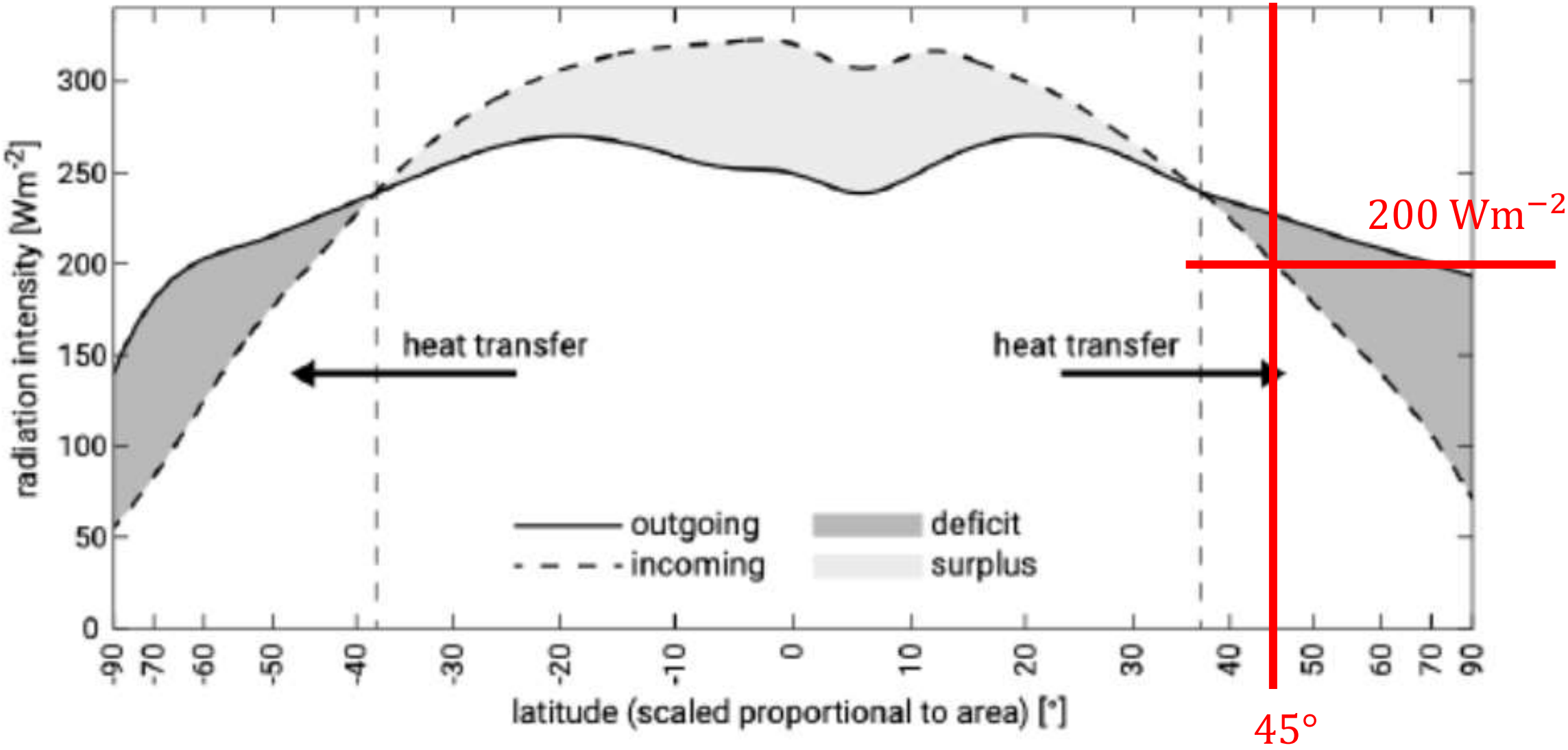
heat from sunlight is the main reason a glacier melts

Solar “constant” $1370\ \mathrm{Wm}^{-2}$

Incoming and outgoing solar radiation as a function of latitude

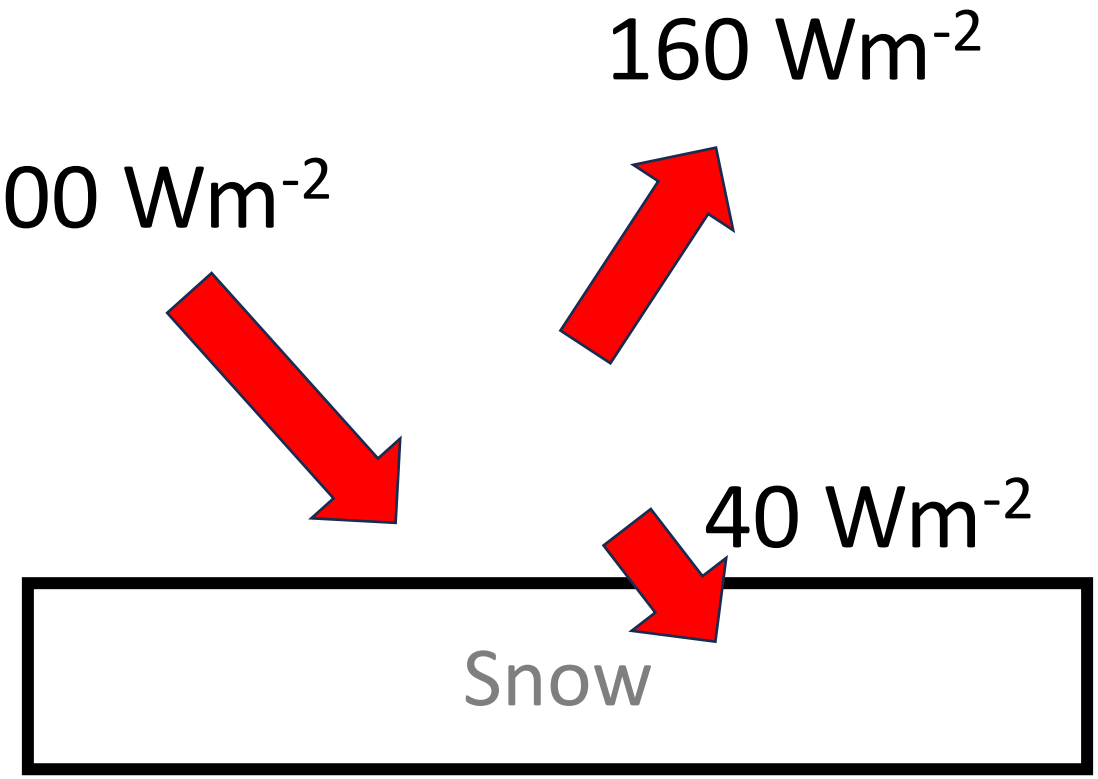


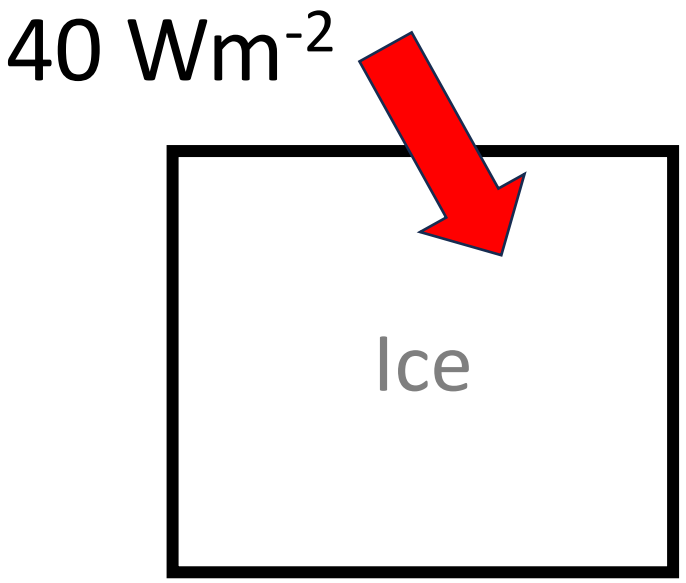
Incoming and outgoing solar radiation as a function of latitude



Albedo 0.8

fraction of
light reflected





heat of fusion 334,000 J/kg

mass 917 kg/m^3

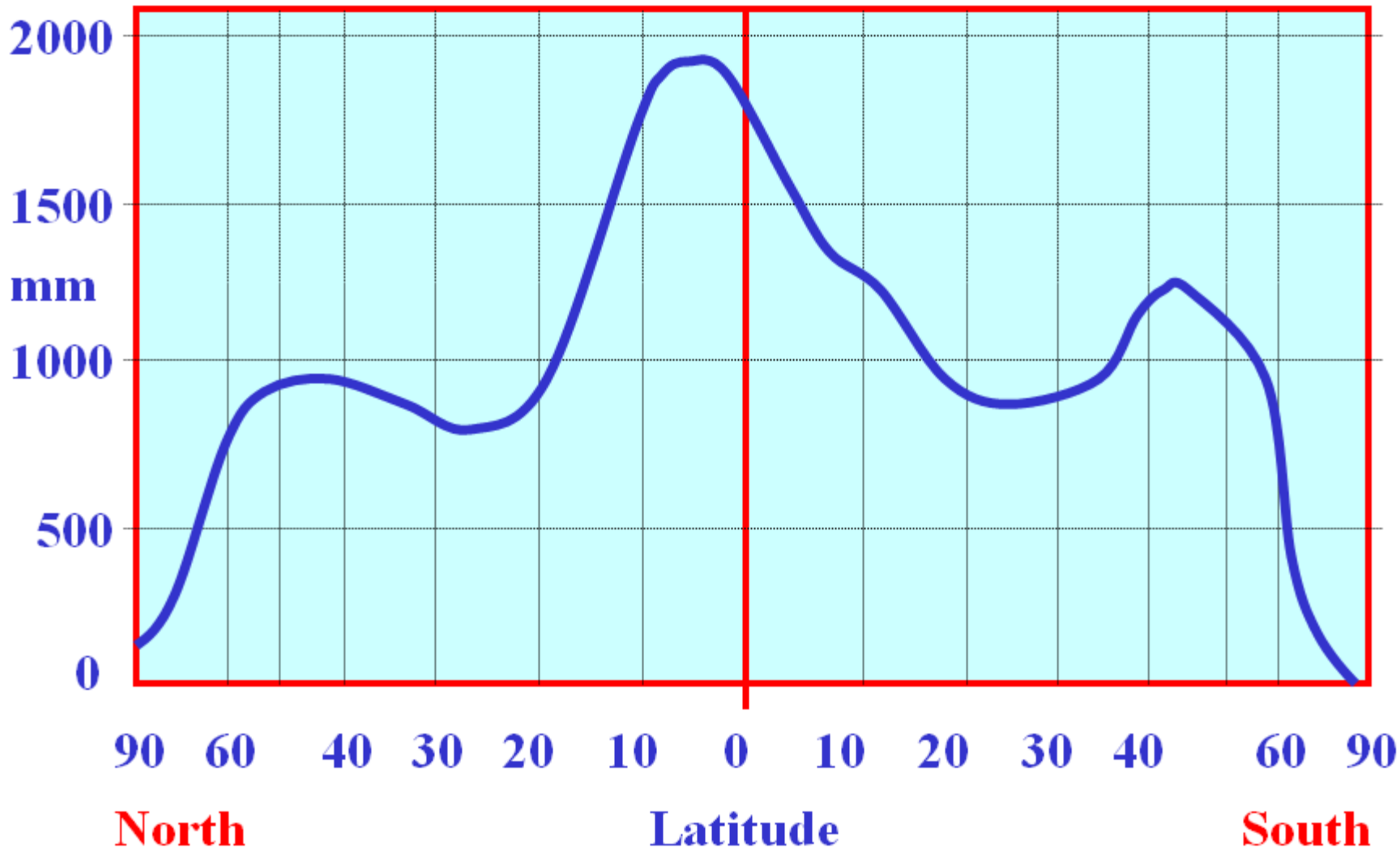
heat to melt
334,000 x 917 = 314,500,000 J/m^3

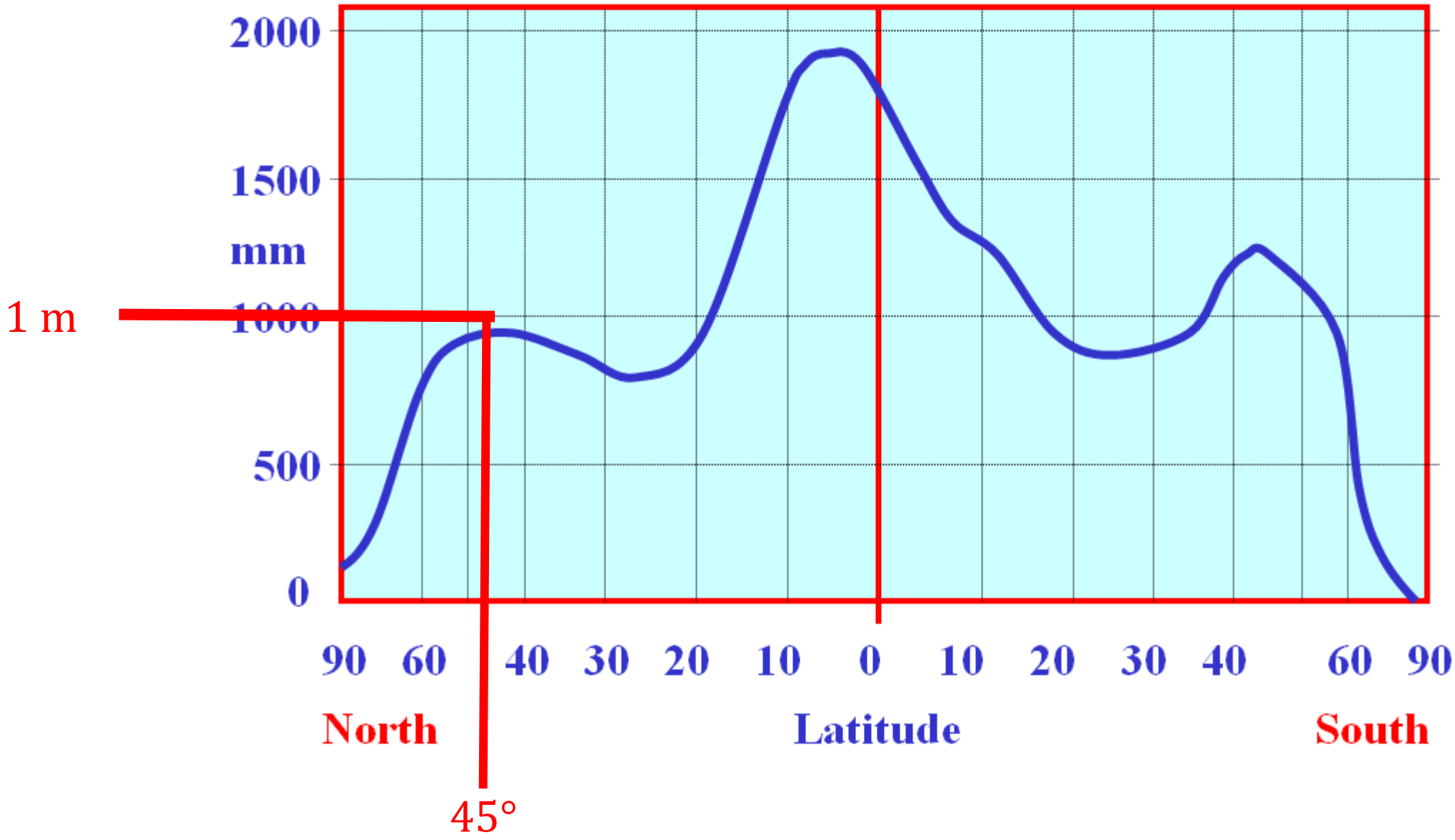
heat supplied 40 J/sm^{-2}

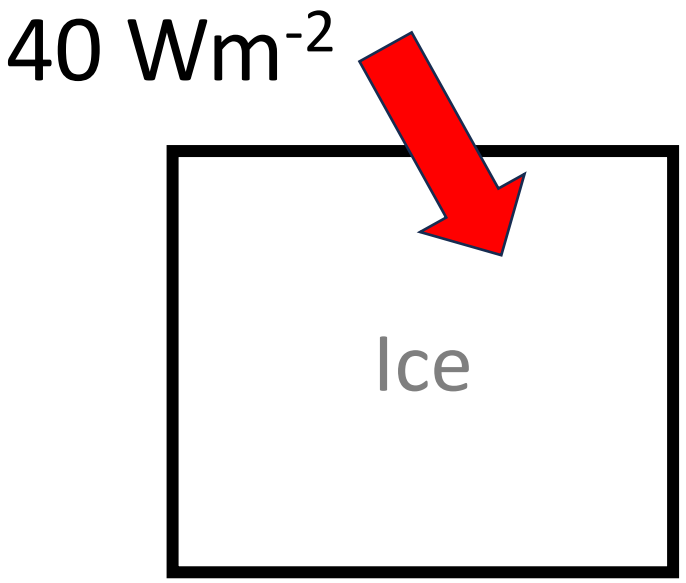
time to melt =
314,500,000 /40=7,886,200 s/m

91 days to melt 1 meter of ice

What’s a typical amount of precipitation per year?


2000
1500
mm
1000
500
0
90 60 40 30 20 10 0 10 20 30 40 60 90
North
Latitude
South


2000
1500
mm
1000
500
0
1 m
90 60 40 30 20 10 0 10 20 30 40 60 90
North
Latitude
South
45°



heat of fusion 334,000 J/kg

mass 917 kg/m^3

heat to melt 314,500,000 J/m^3

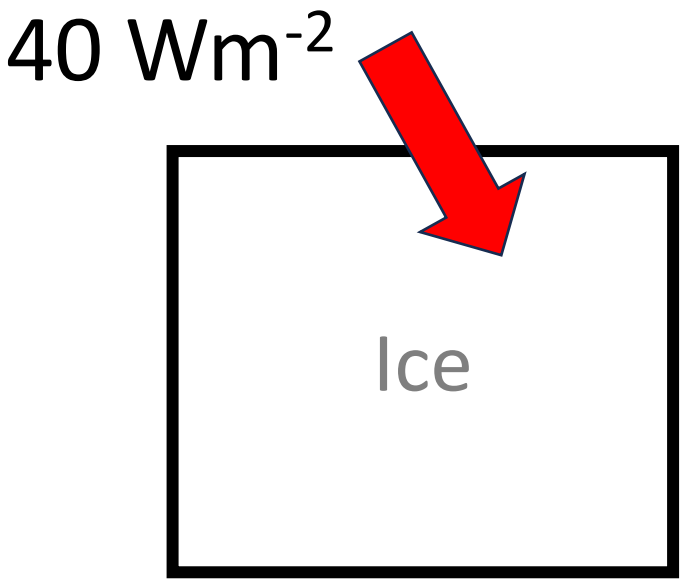
heat supplied 40 J/sm^{-2}

time to melt 7,886,200 s/m

91 days to melt 1 meter of ice

about the summer

about a year of ice



heat of fusion 334,000 J/kg

mass 917 kg/m^3

heat to melt 314,500,000 J/m^3

heat supplied 40 J/sm^{-2}

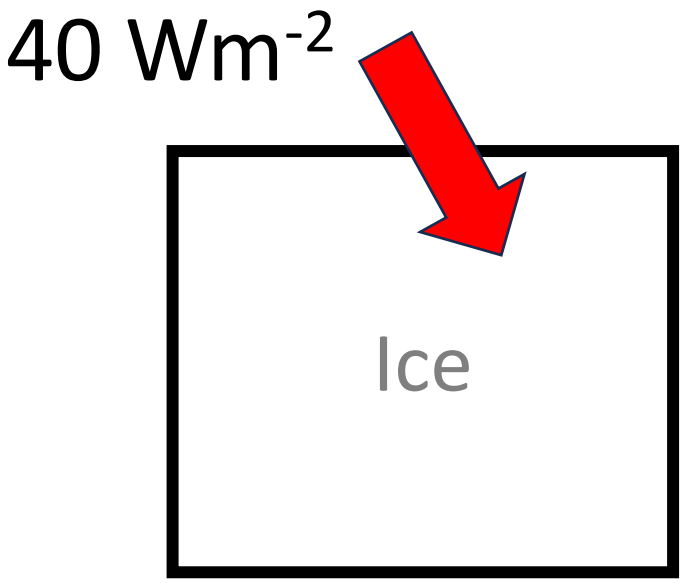
time to melt 7,886,200 s/m

91 days to melt 1 meter of ice

about the summer

about a year of ice

if more than a year's worth of ice melts in the summer, then the glacier melts away …



heat of fusion 334,000 J/kg

mass 917 kg/m^3

heat to melt 314,500,000 J/m^3

heat supplied 40 J/sm^{-2}

time to melt 7,886,200 s/m

91 days to melt 1 meter of ice

may take longer, because some energy needed
to warm cold ice, some heat lost to cold air

Toe of Fjallsjokull (glacier)

Why isn’t this glacier snowy white?

Toe of Fjallsjokull (glacier)

Claire holding glacial ice

Glacial ice

Stream on the surface of the glacier

supraglacial stream

stream on top of the glacier

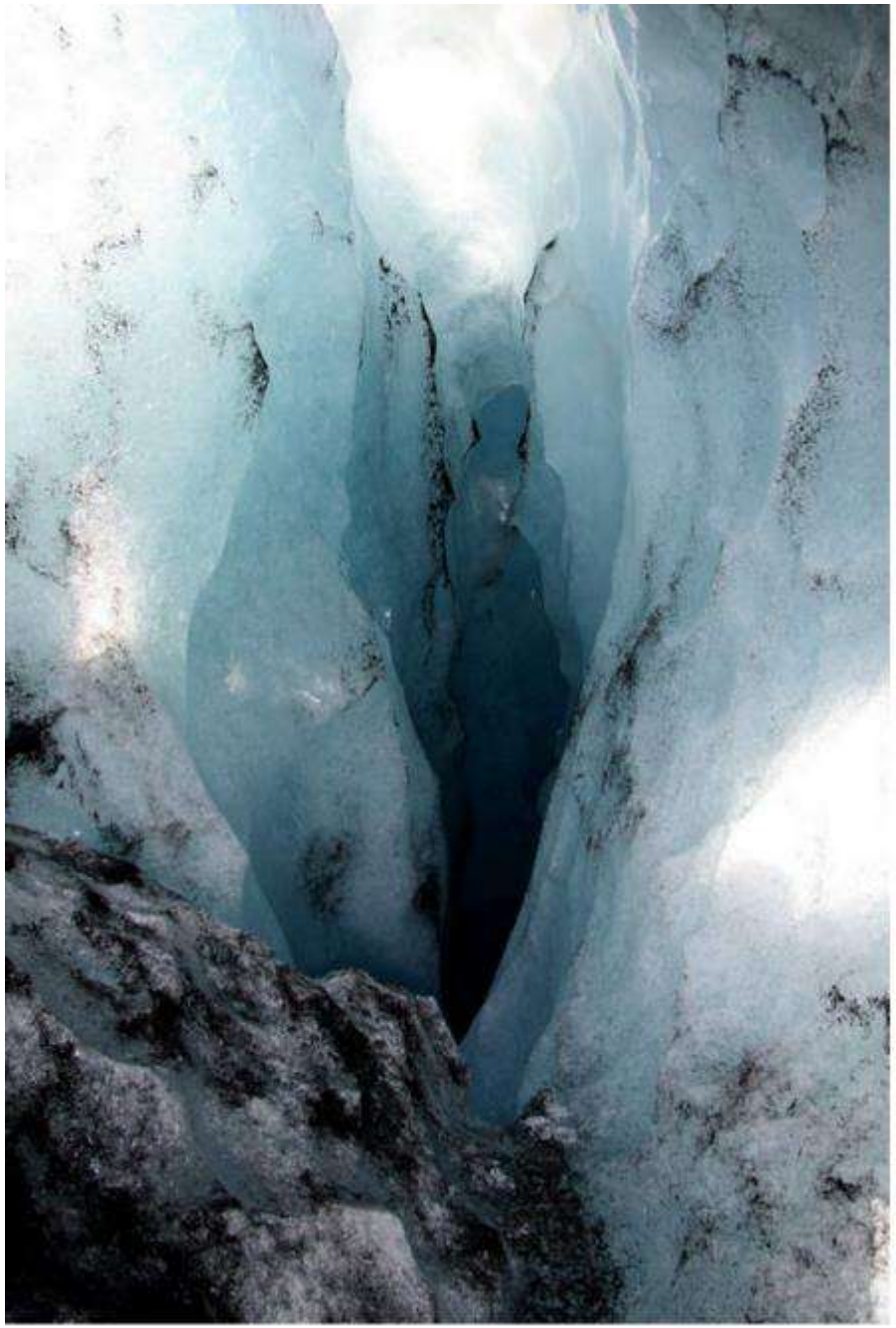
Stream on the surfacce of the glacier

supraglacial stream

supraglacial stream draining into moulin

moulin (or glacier mill)
hole in ice into which water drains

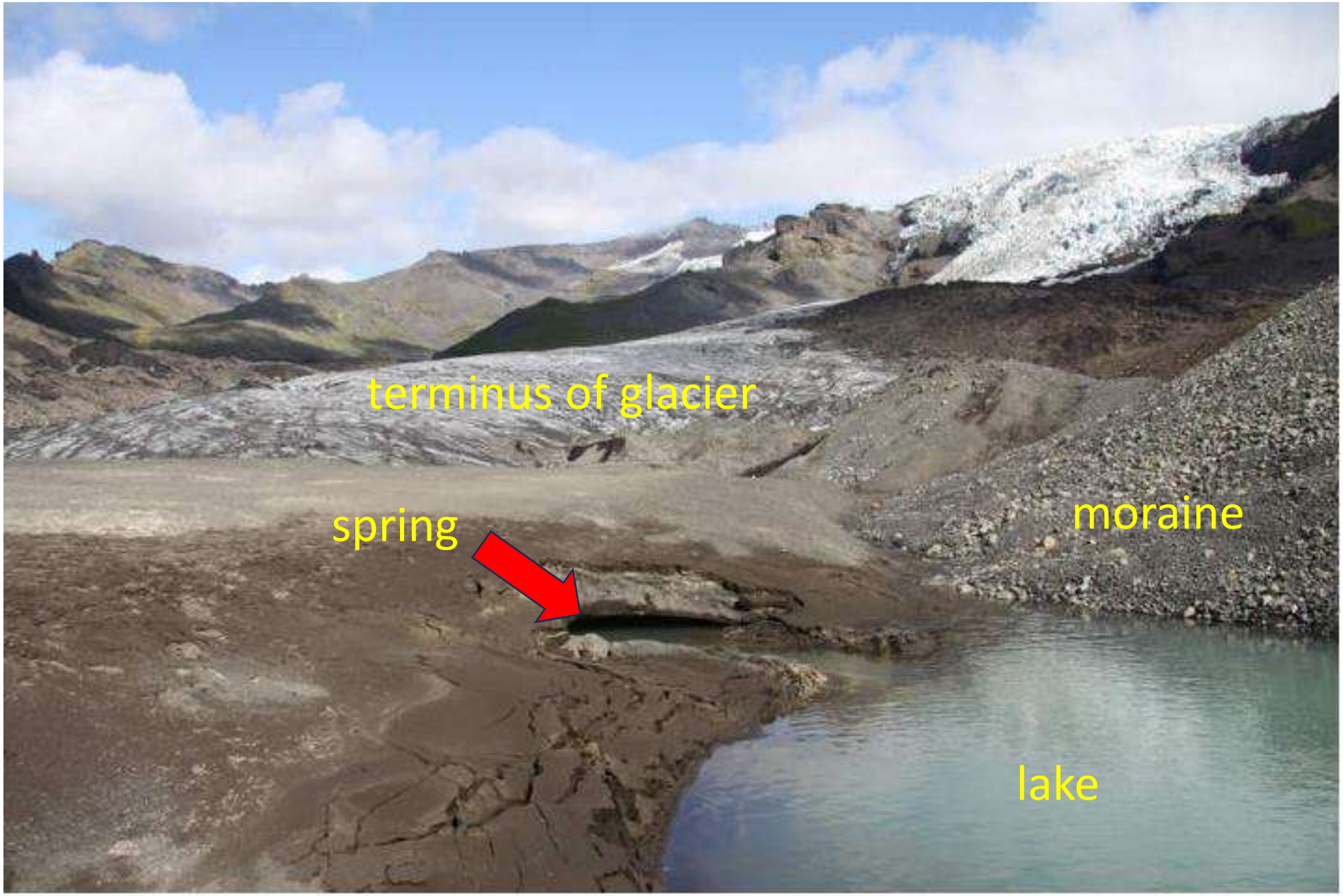
French word for “mill”



supraglacial stream
draining into
moulin

supraglacial stream
draining into
moulin

Fjallsjokull (glacier)



Fjallsjokull (glacier)

moraine

heap of gravel and rock
left when glacier melts

typically unsorted

types

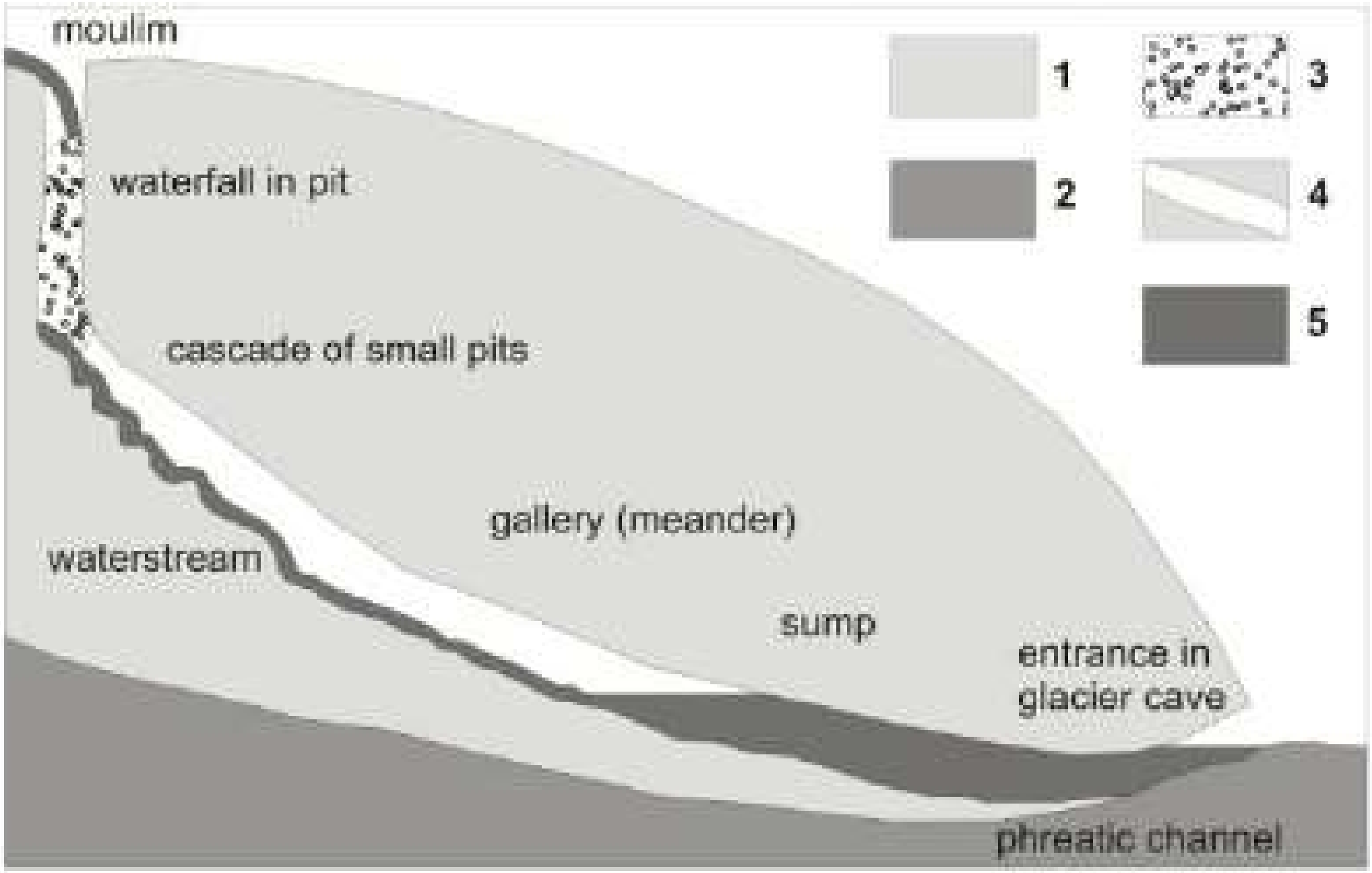
- lateral
- medial
- terminal

r)

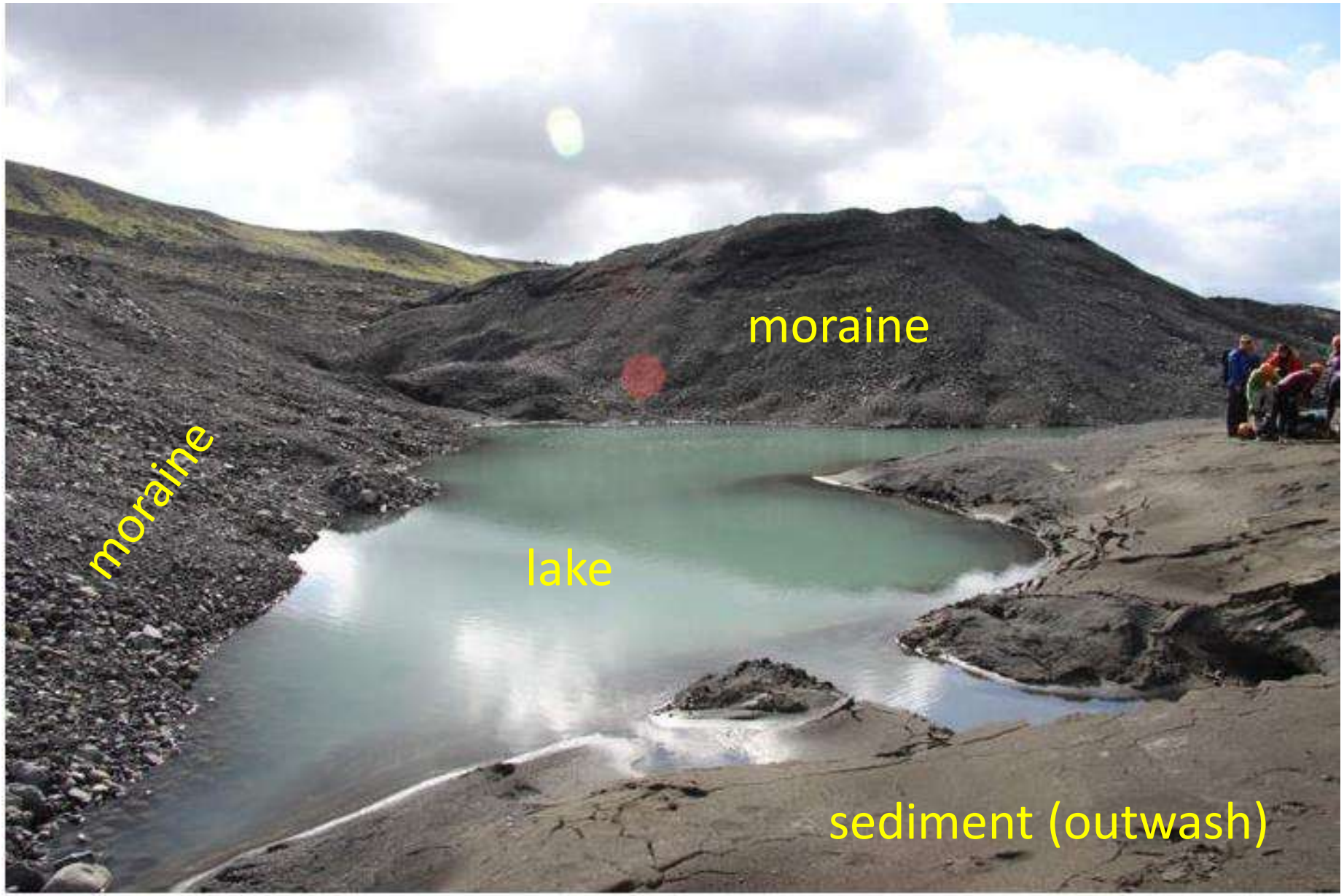
Stream exiting ice cave

People by an ice cave near Kverkfjoll

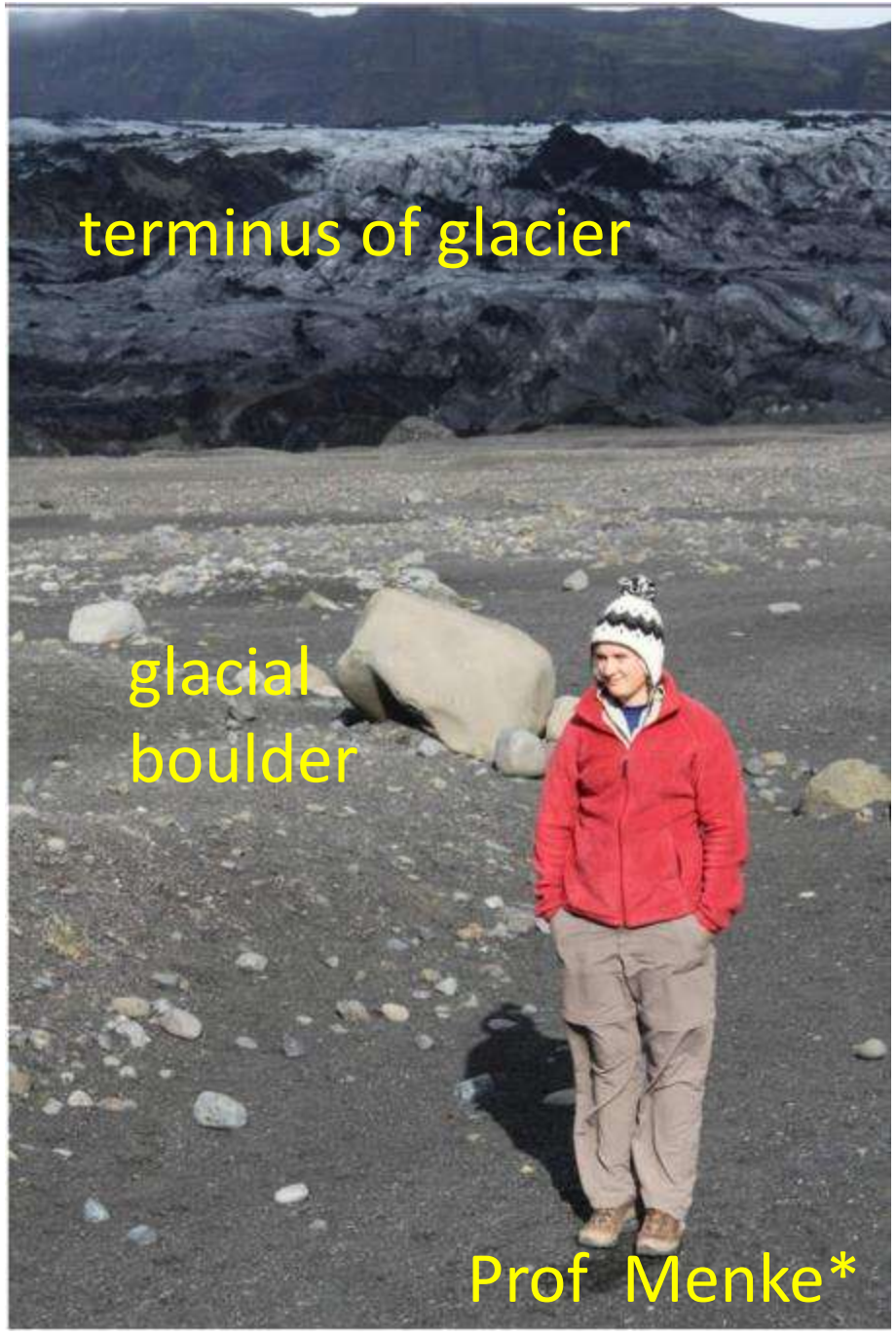
Josh (left) and Adryana Perez in an ice cave at Kverkfjoll


moulim
waterfall in pit
cascade of small pits
gallery (meander)
waterstream
sump
entrance in
glacier cave
phreatic channel
1
2
3
4
5

Pond among moraines



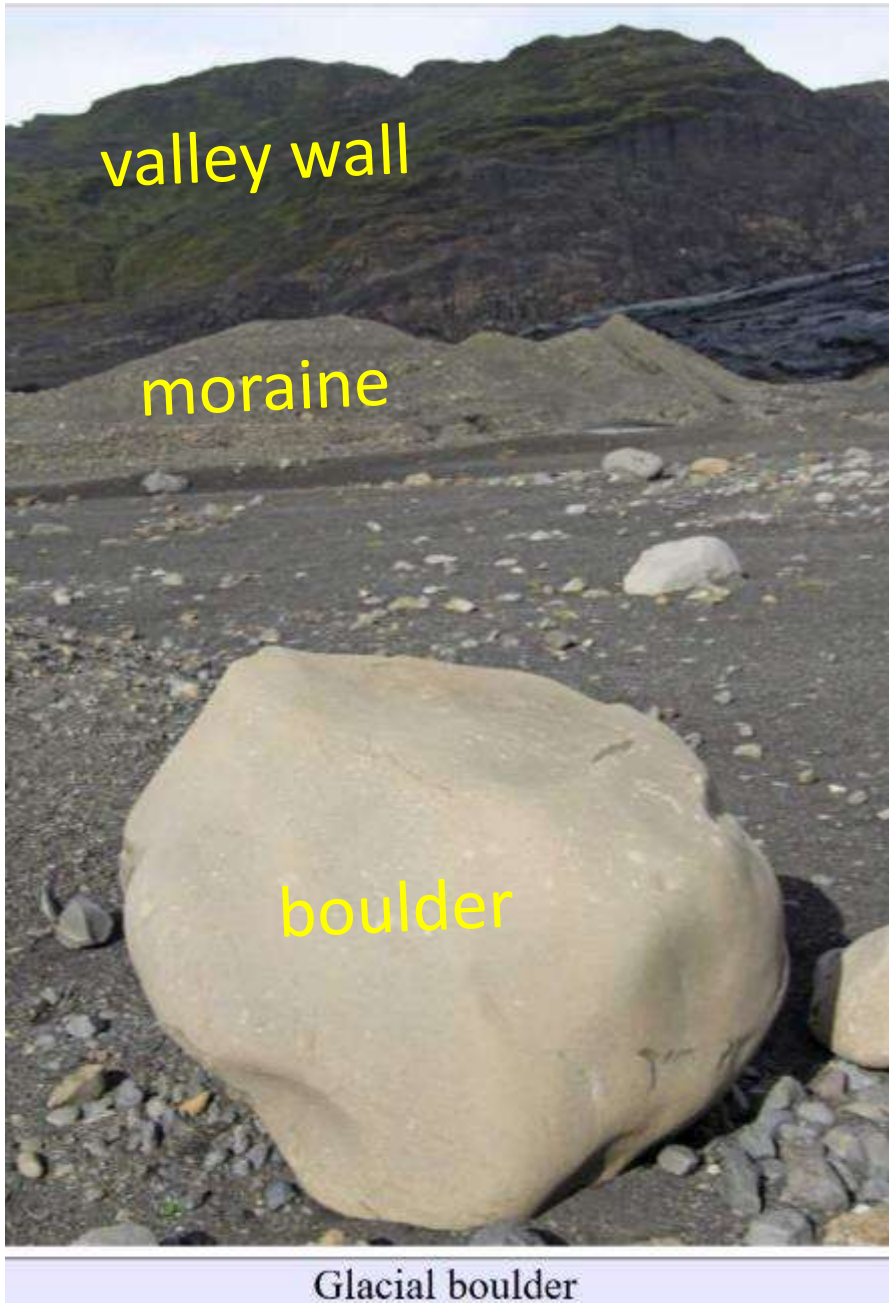
Pond among moraines



Glacial boulder
boulder transported by a glacier

Glacial erratic boulder
boulder of one rock type
transported by glacier
and left atop rock pavement
of a different rock type

* the other one

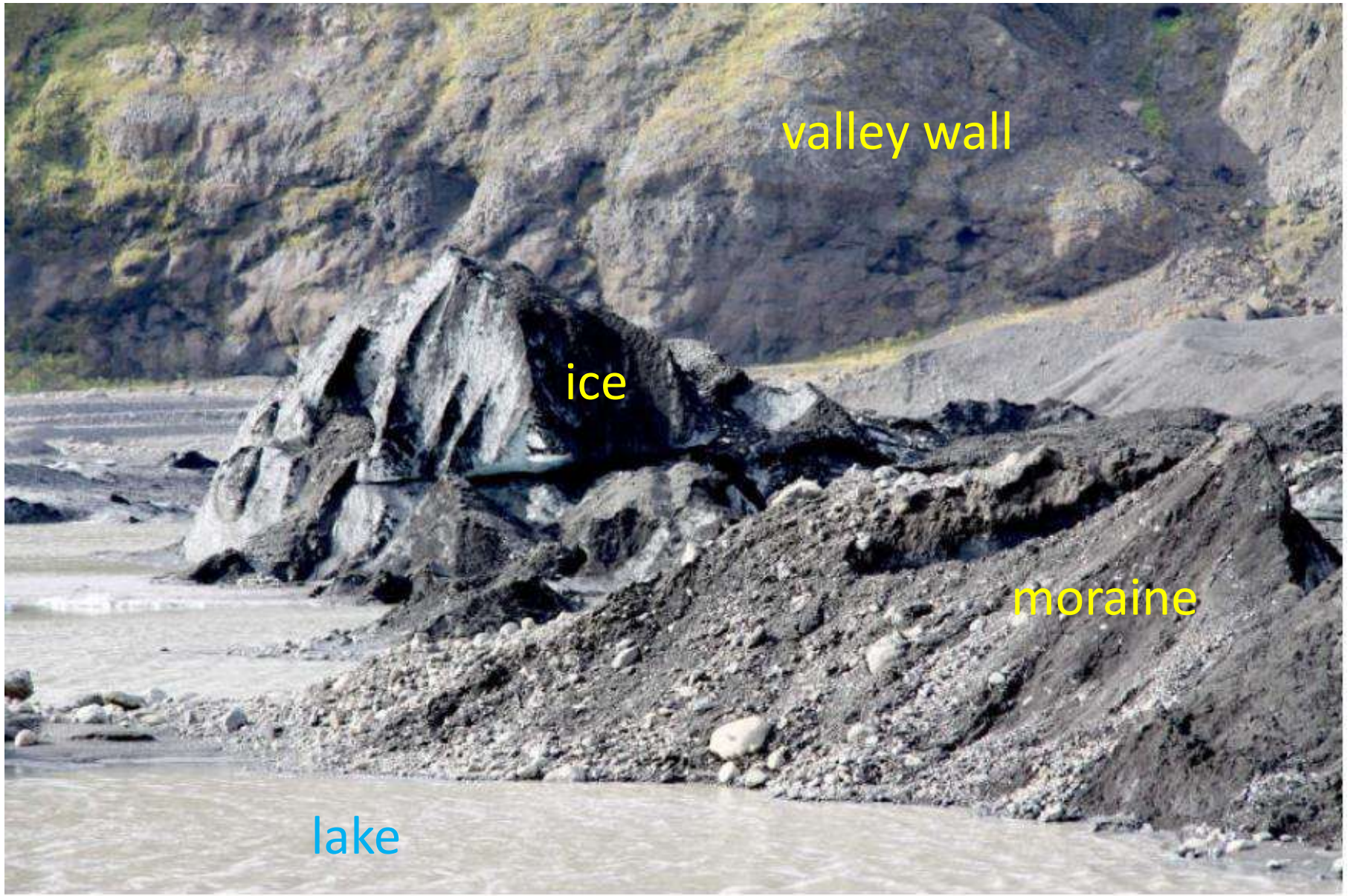


Glacial boulder

Glacial boulder

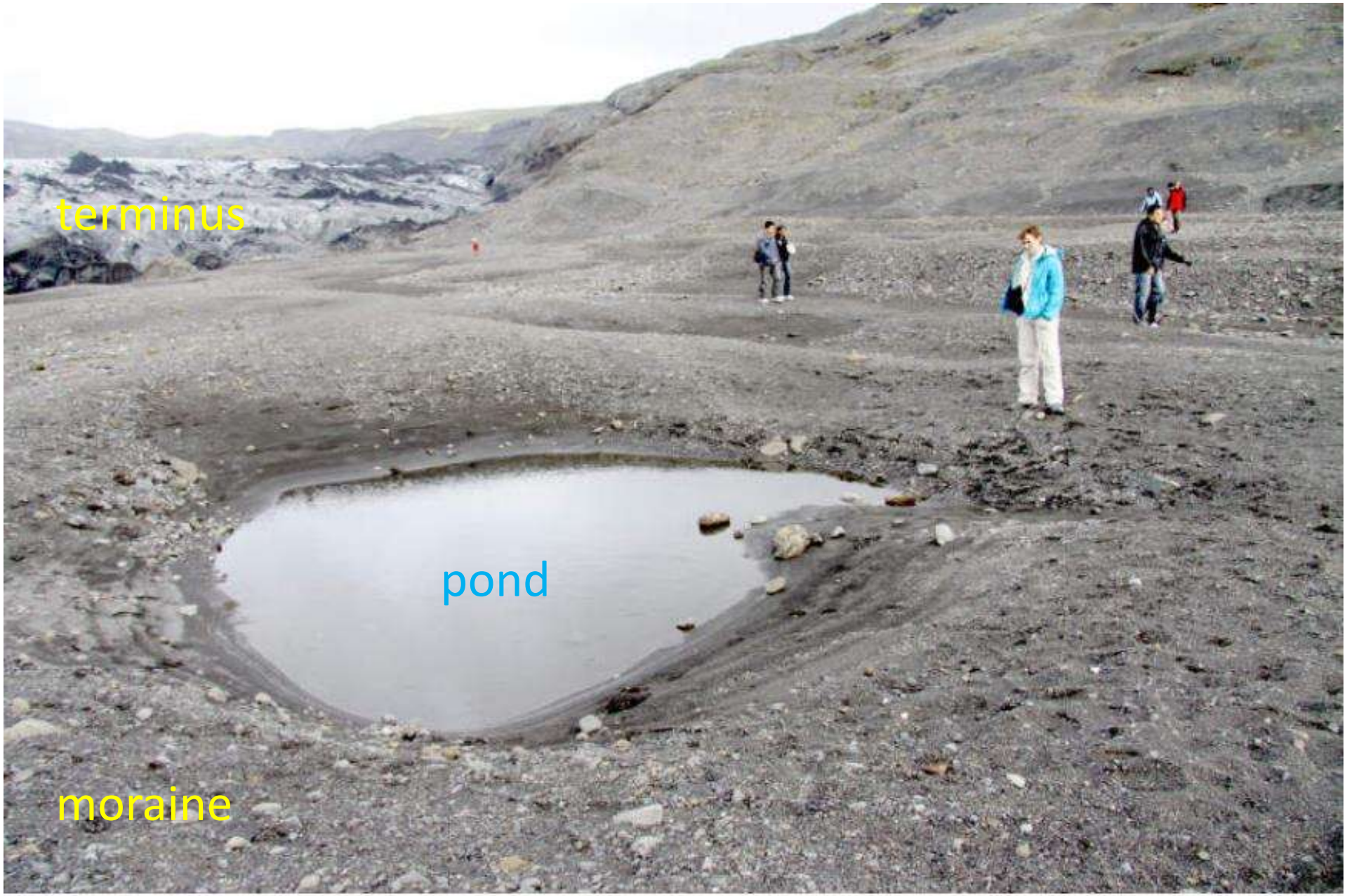
Glacial boulder sometimes have a faceted shape

Stranded ice near toe of glacier



Stranded ice near toe of glacier

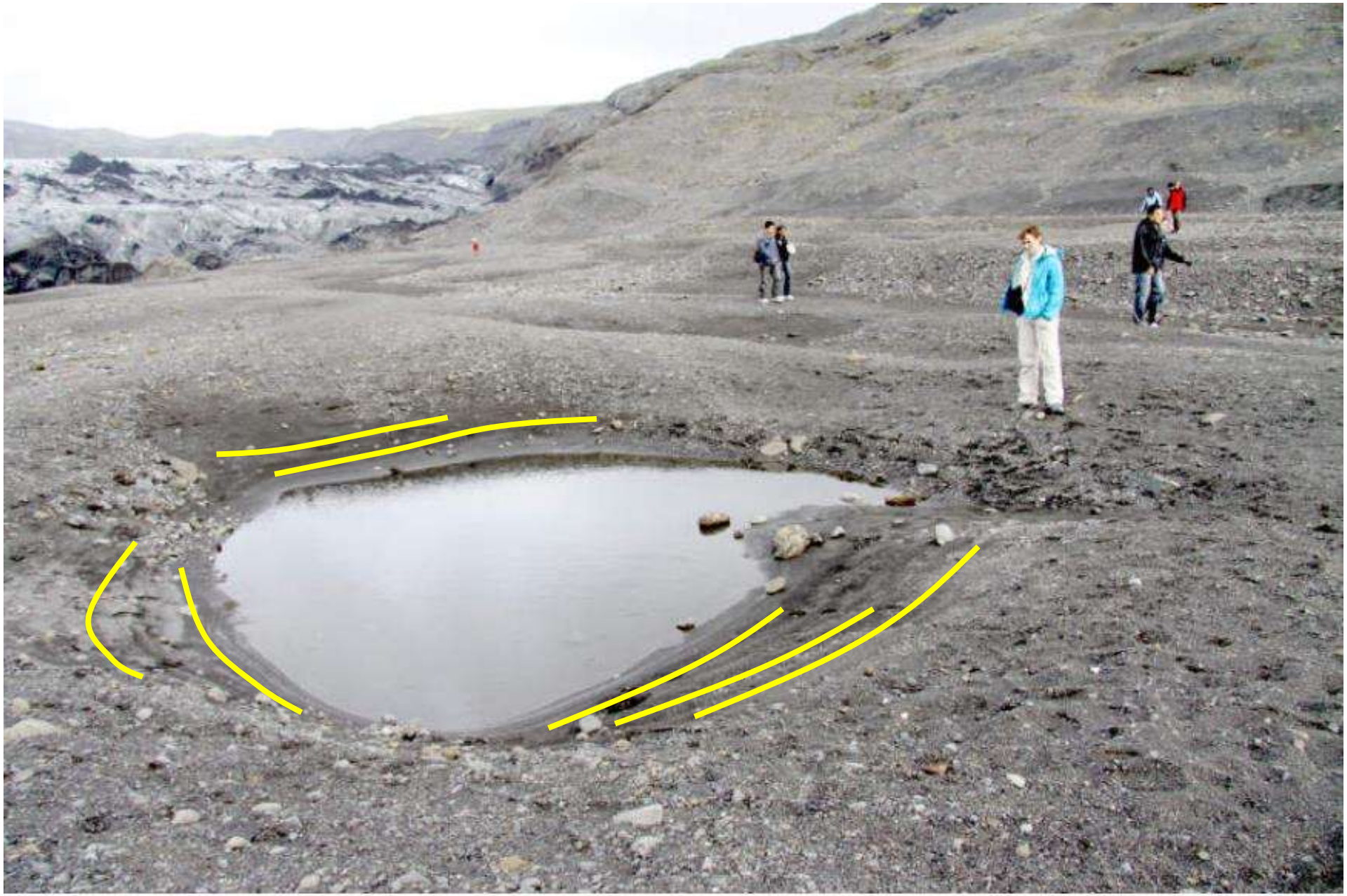
Kettle



Kettle

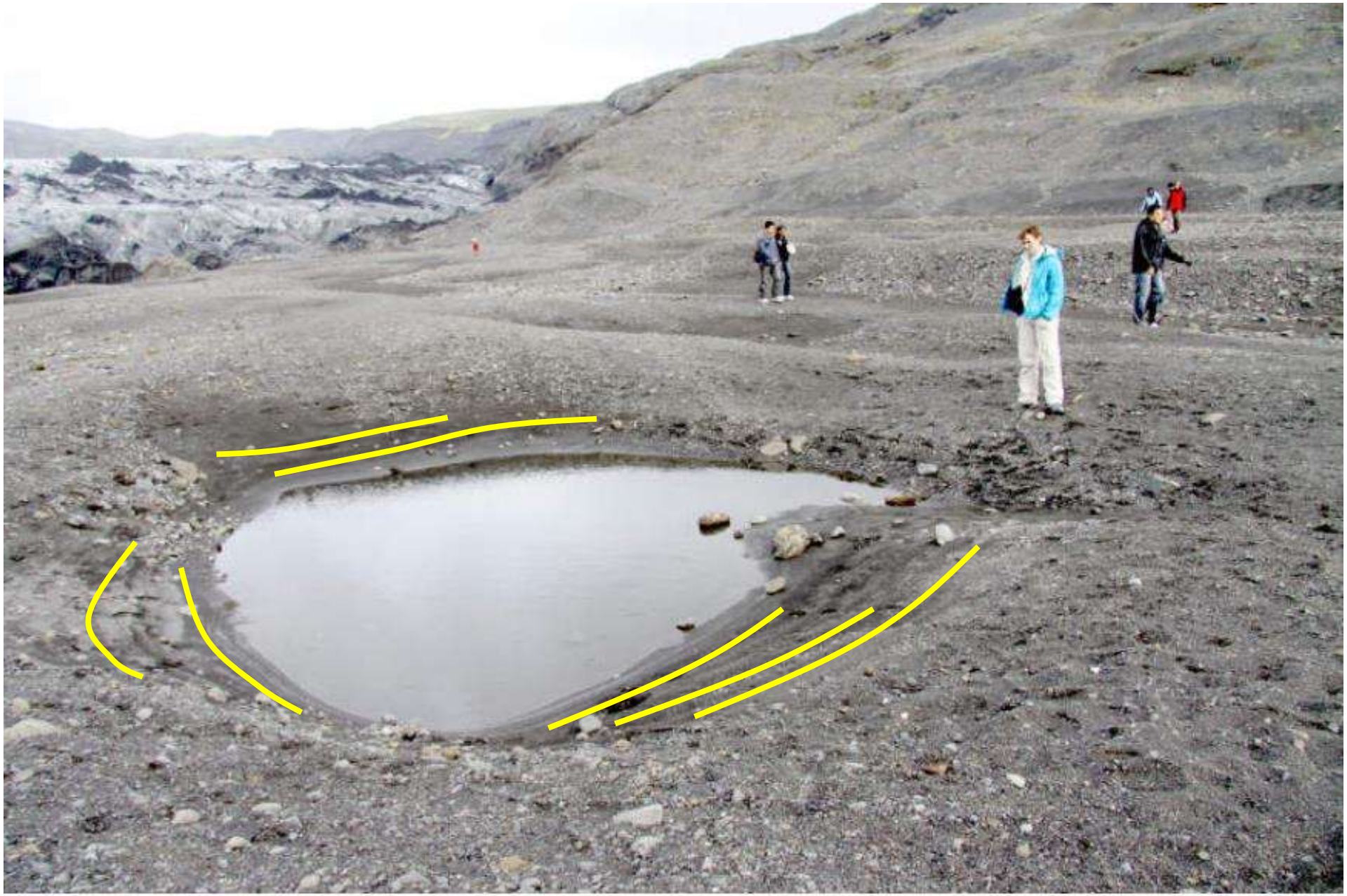
Kettle

pond formed when stranded ice melts and leaves a hole



Kettle

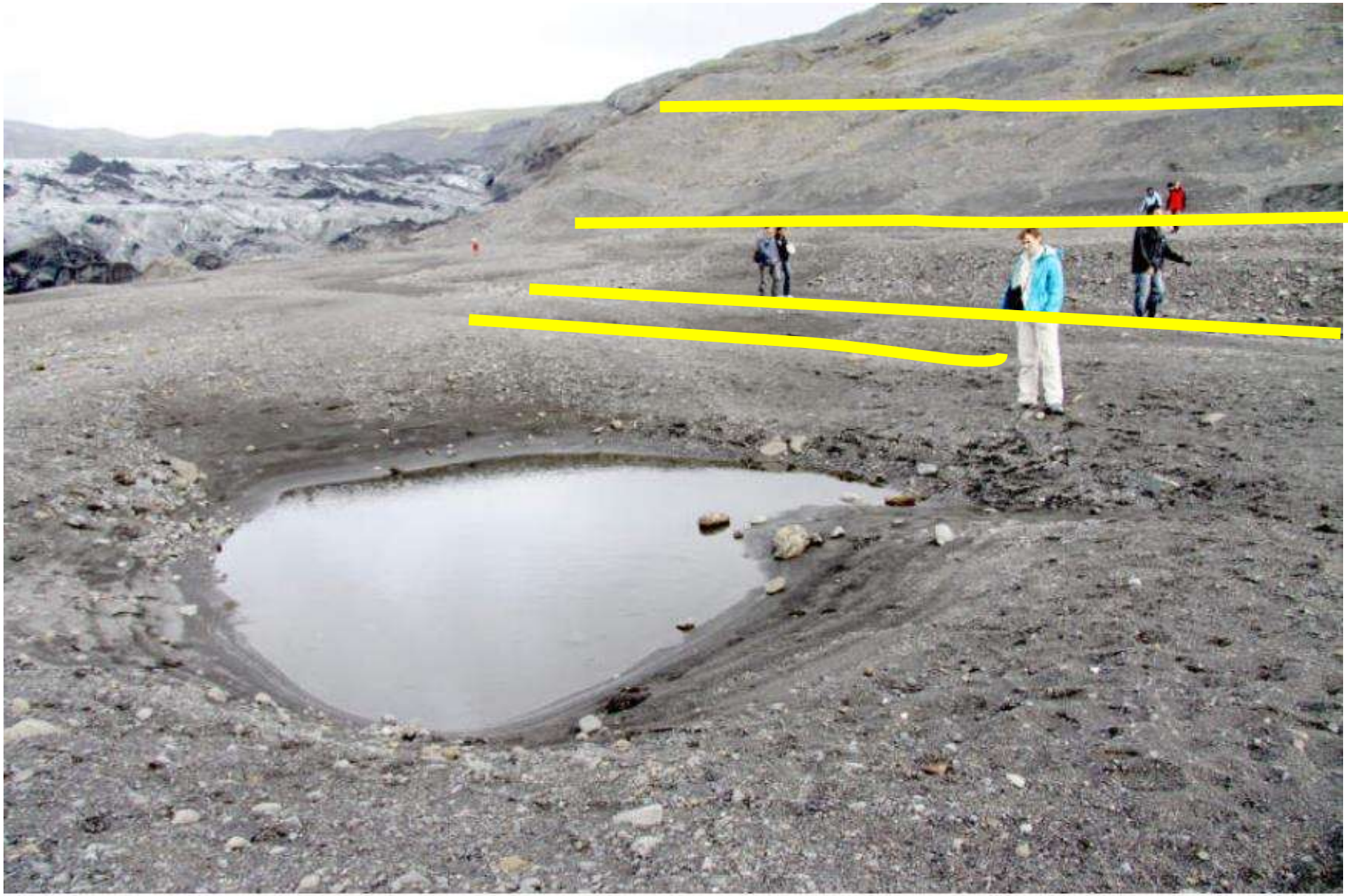
what made these lines?



Kettle

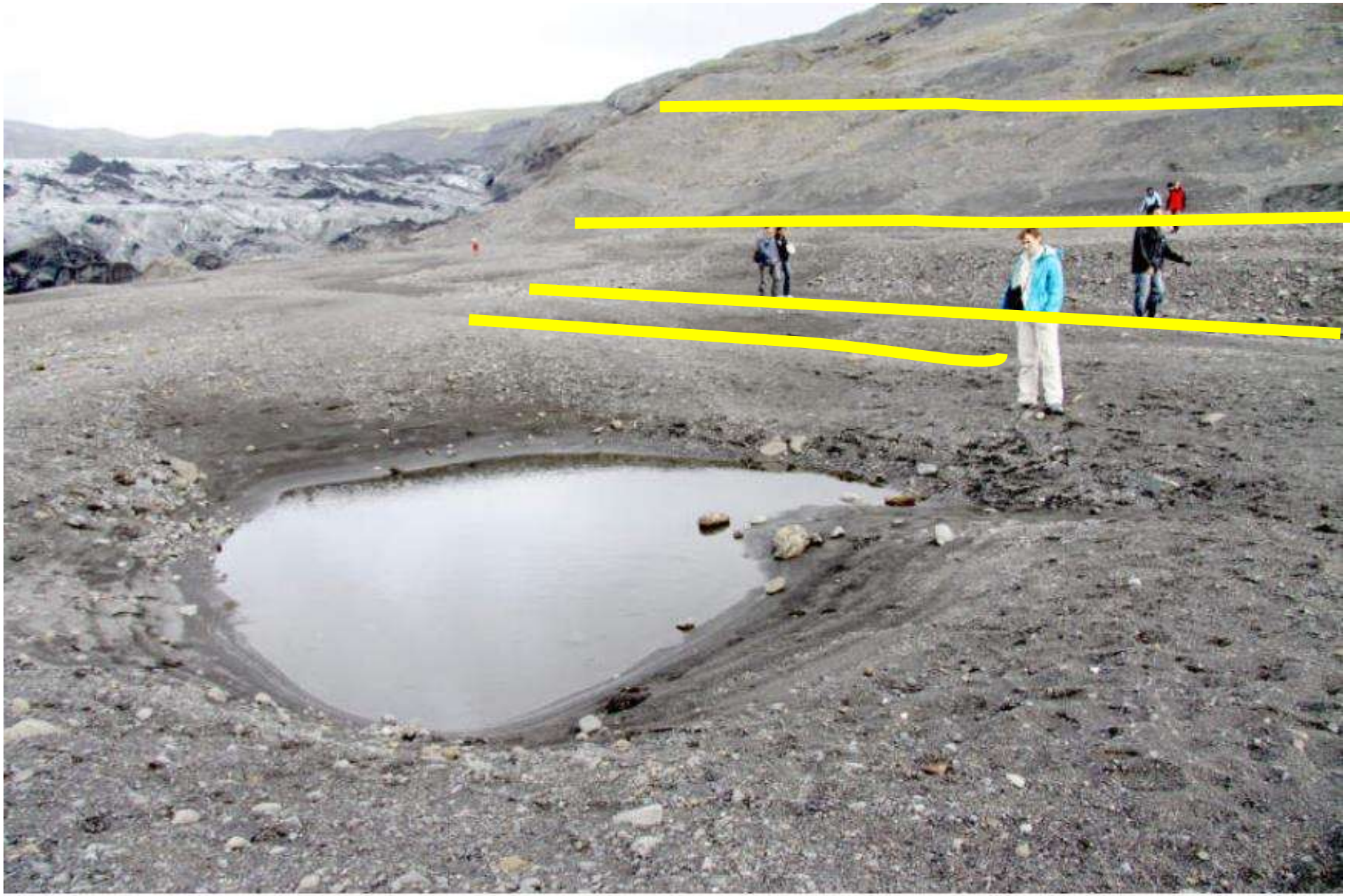
terraces

beaches
when
water
level in pond
was higher



Kettle

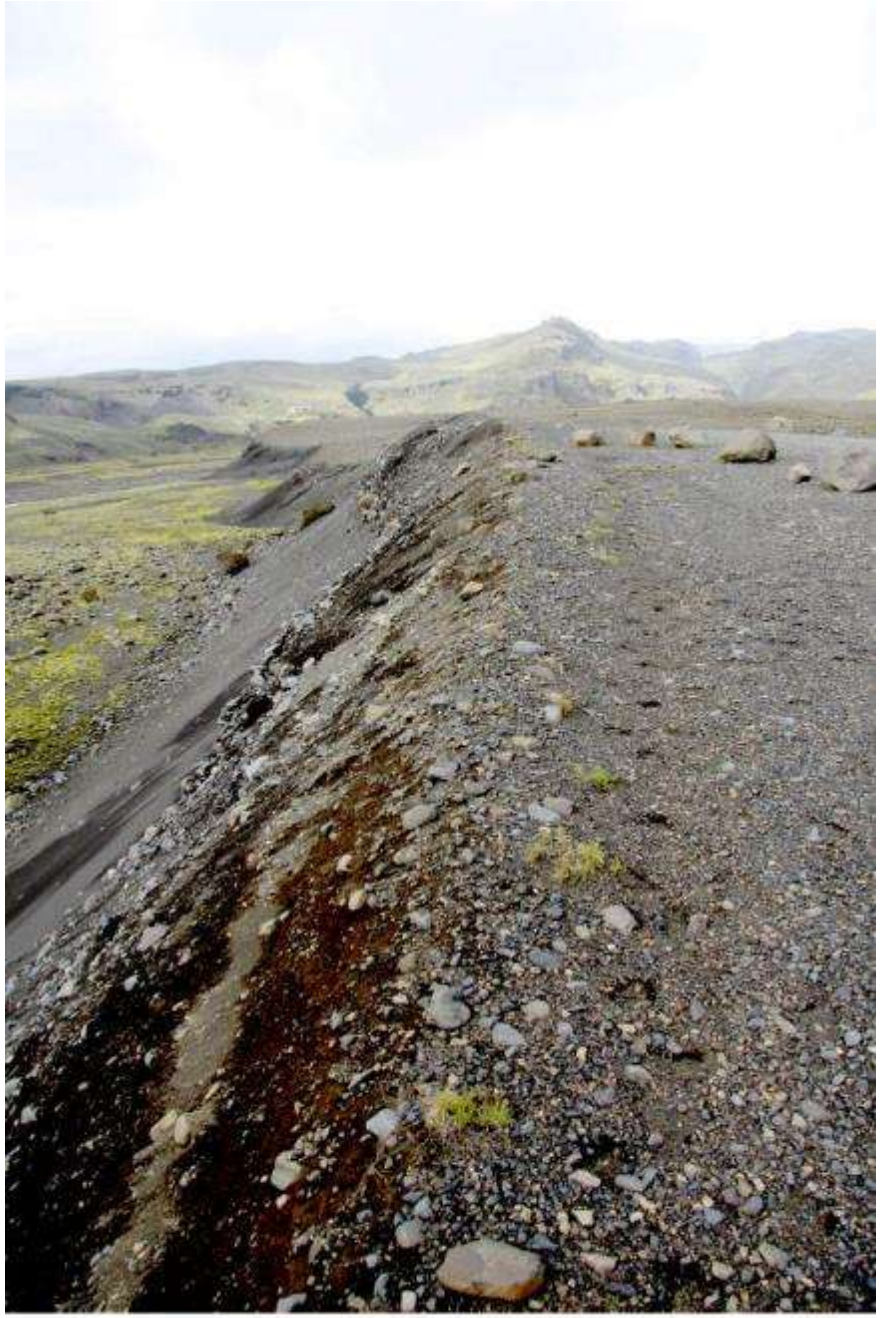
what made these lines?



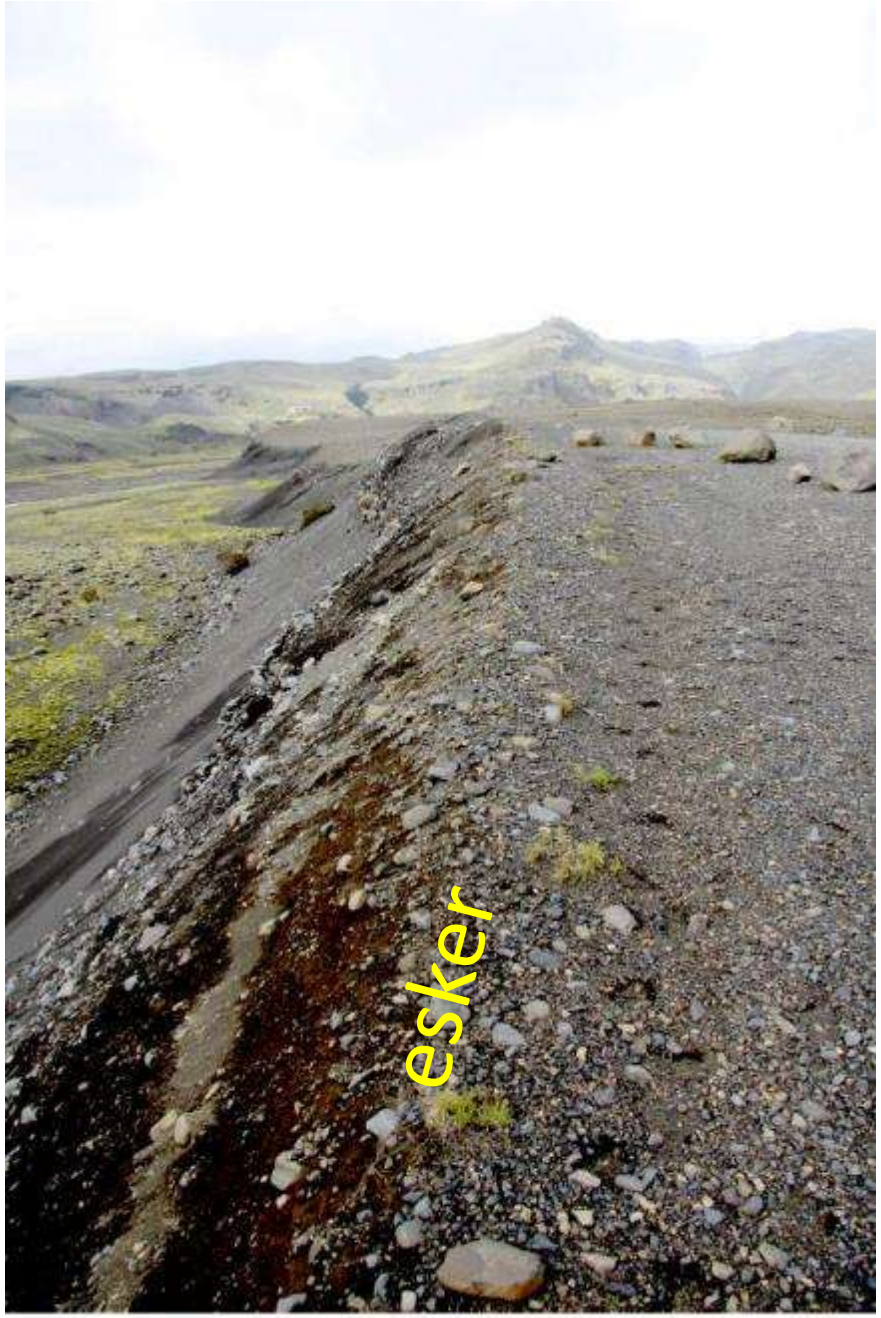
Kettle

they're terraces too

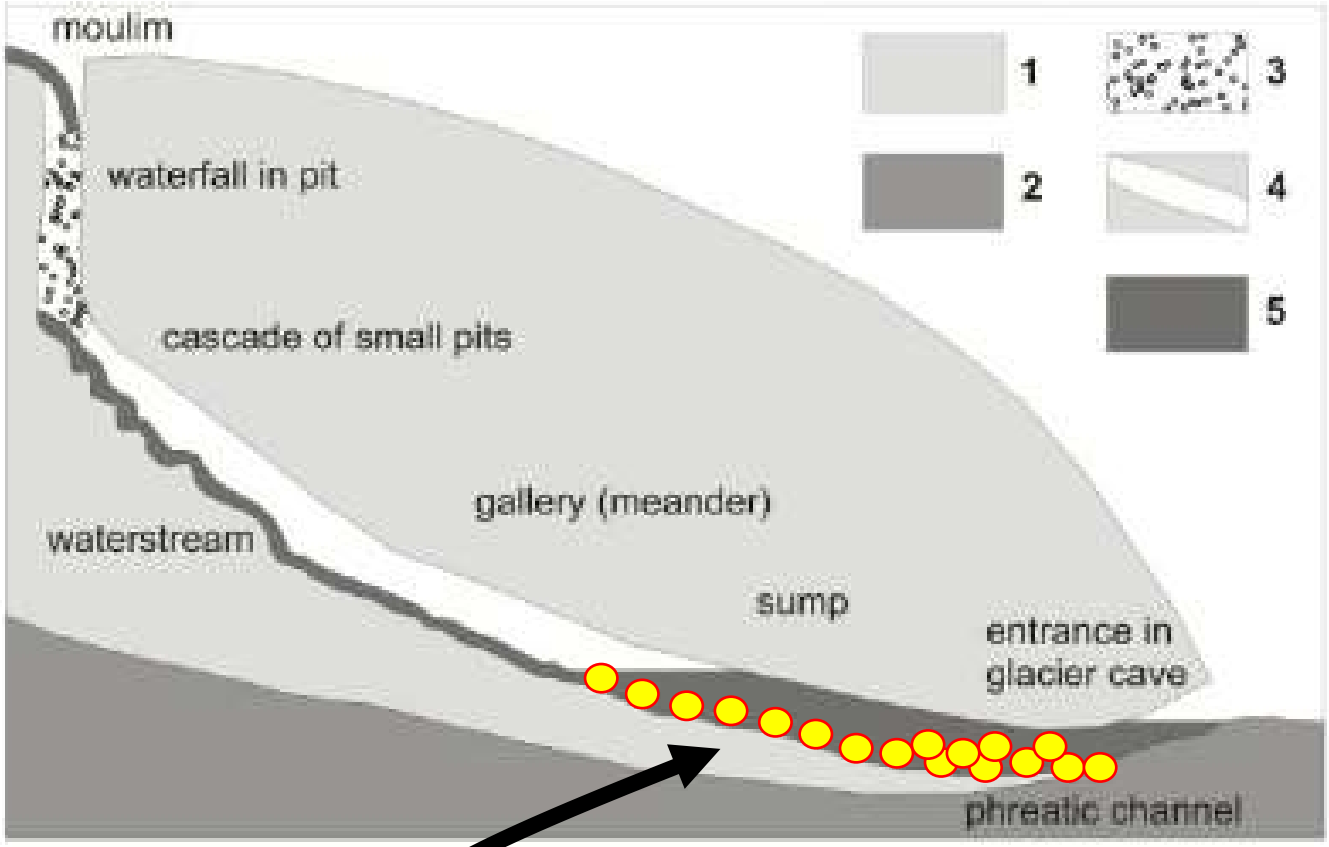
shoreline of a now-defunct lake



Bank of esker or lateral moraine



Bank of esker or lateral moraine



sediment at bed of subglacial stream

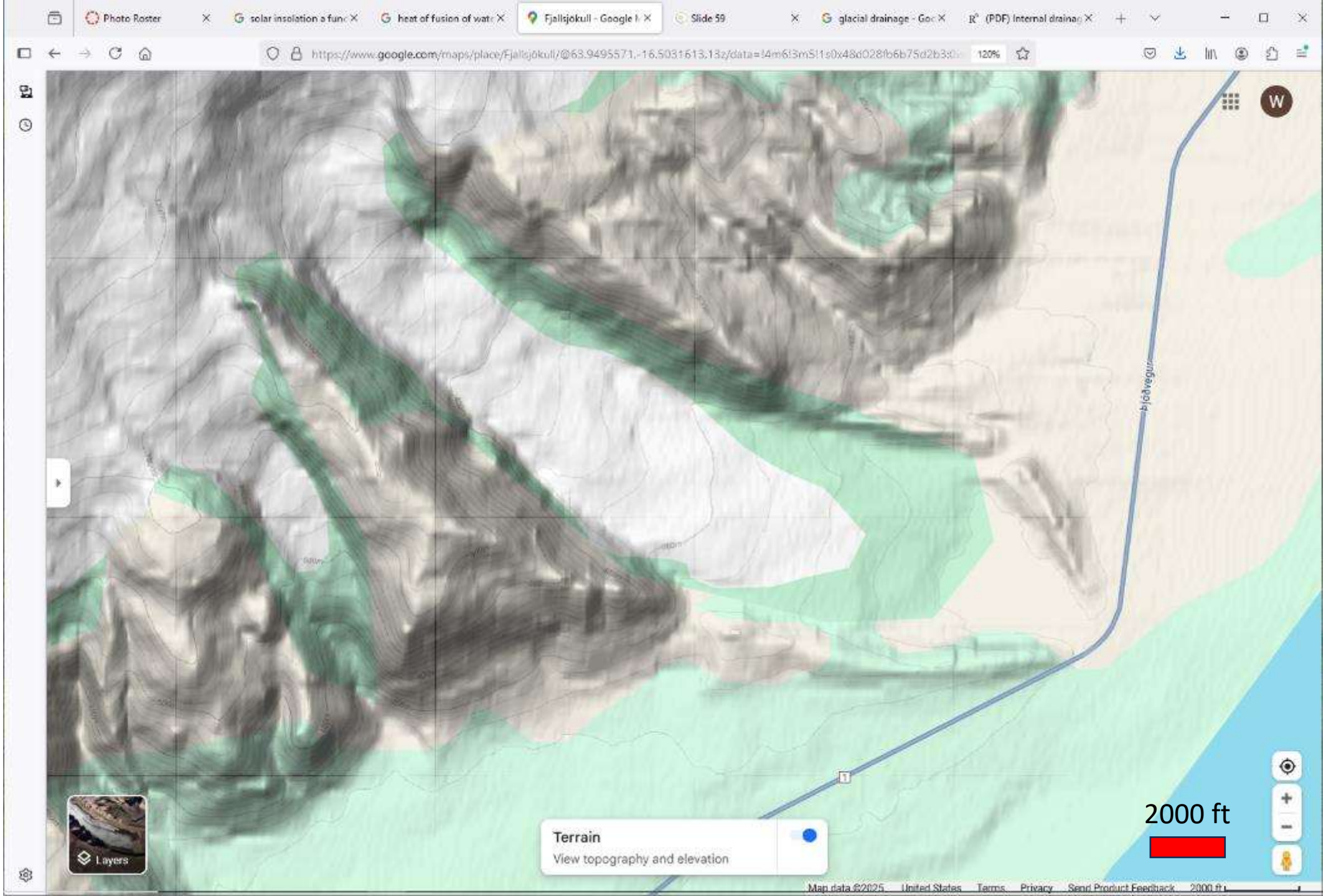
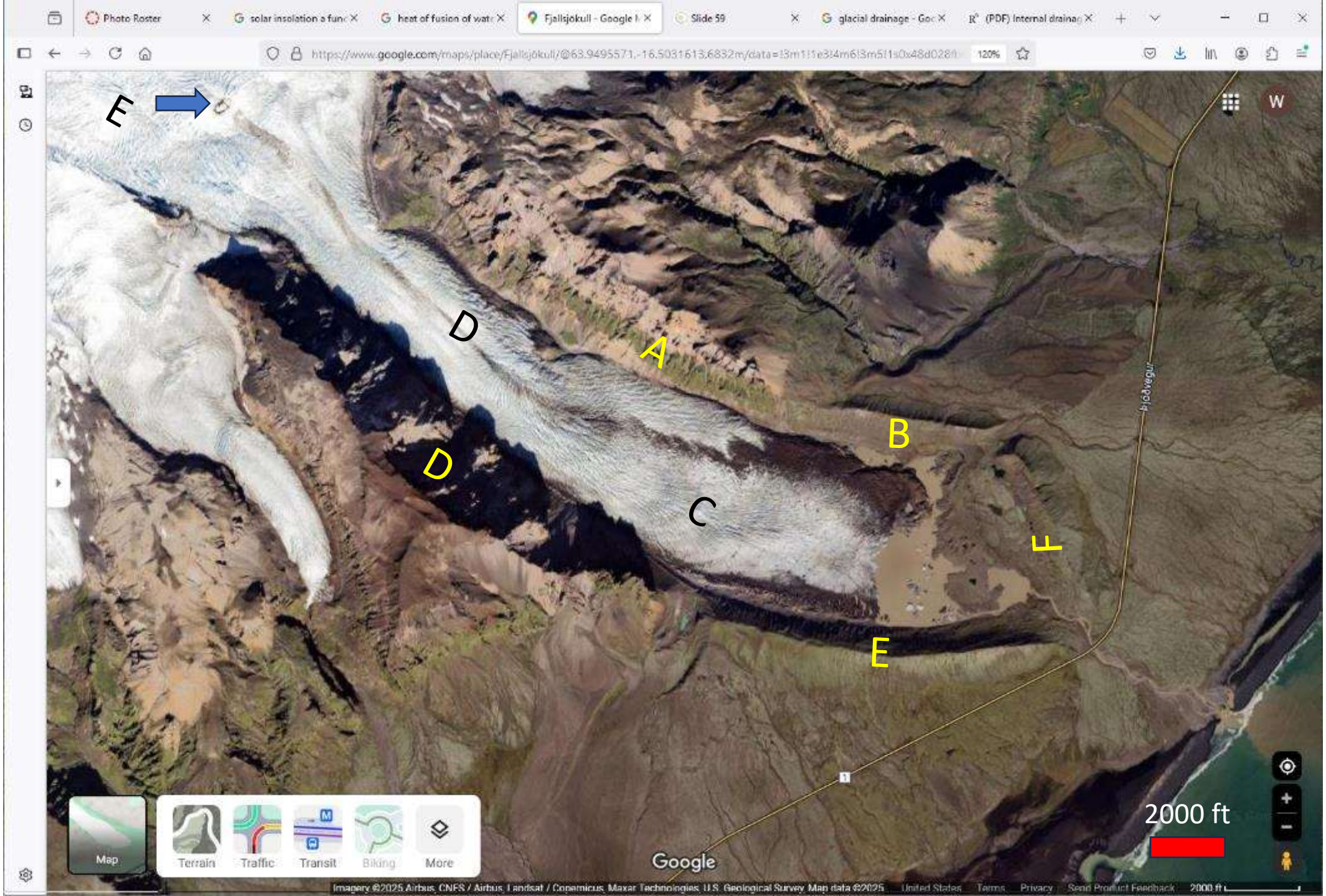
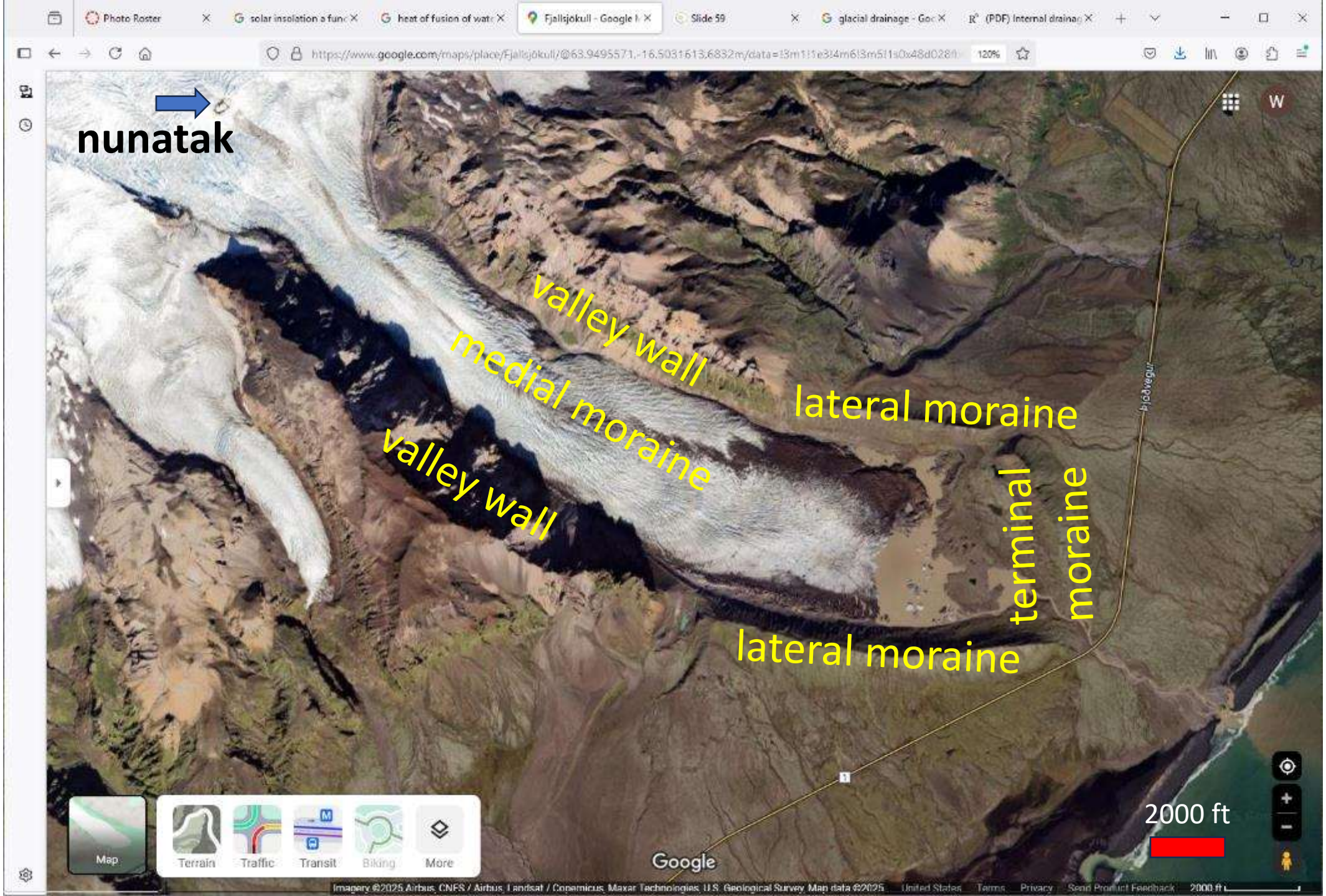


Photo Roster
solar insolation a func
heat of fusion of wate
Fjallsjökull - Google M
Slide 59
glacial drainage - Goo
(PDF) Internal drainag
https://www.google.com/maps/place/Fjallsjökull/@63.9495571,-16.5031613,13z/data=!4m6!3m5!1s0x48d028fb6b75d2b3:0
120%
W
Bjórvegur
1
Layers
Terrain
View topography and elevation
2000 ft
Map data ©2025
United States
Terms
Privacy
Send Product Feedback
2000 ft


Photo Roster
solar insolation a func
heat of fusion of wate
Fjallsjökull - Google M
Slide 59
glacial drainage - Goo
(PDF) Internal drainag
https://www.google.com/maps/place/Fjallsjökull/@63.9495571,-16.5031613,6832m/data=!3m1!1e3!4m6!3m5!1s0x48d028f
120%
W
Þjóðvegur
Map
Terrain
Traffic
Transit
Biking
More
2000 ft
Google
Imagery ©2025 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies, U.S. Geological Survey, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
2000 ft


E
D
A
B
D
C
F
E
Bjódvegur
2000 ft
Google
Map
Terrain
Traffic
Transit
Biking
More


nunatak
valley wall
medial moraine
valley wall
lateral moraine
terminal moraine
lateral moraine
2000 ft
Google

nunatak

mountain peak protruding from glacier

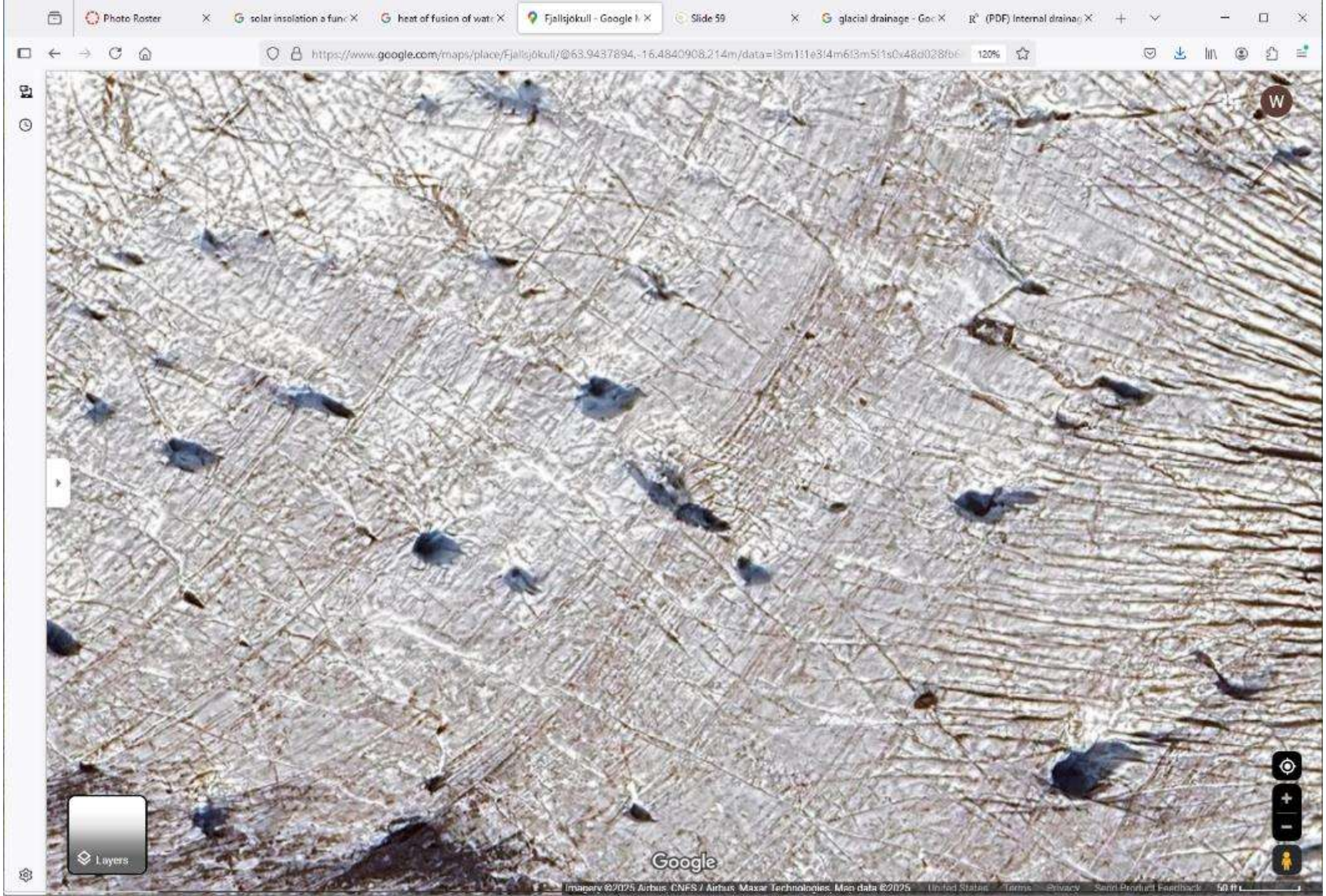
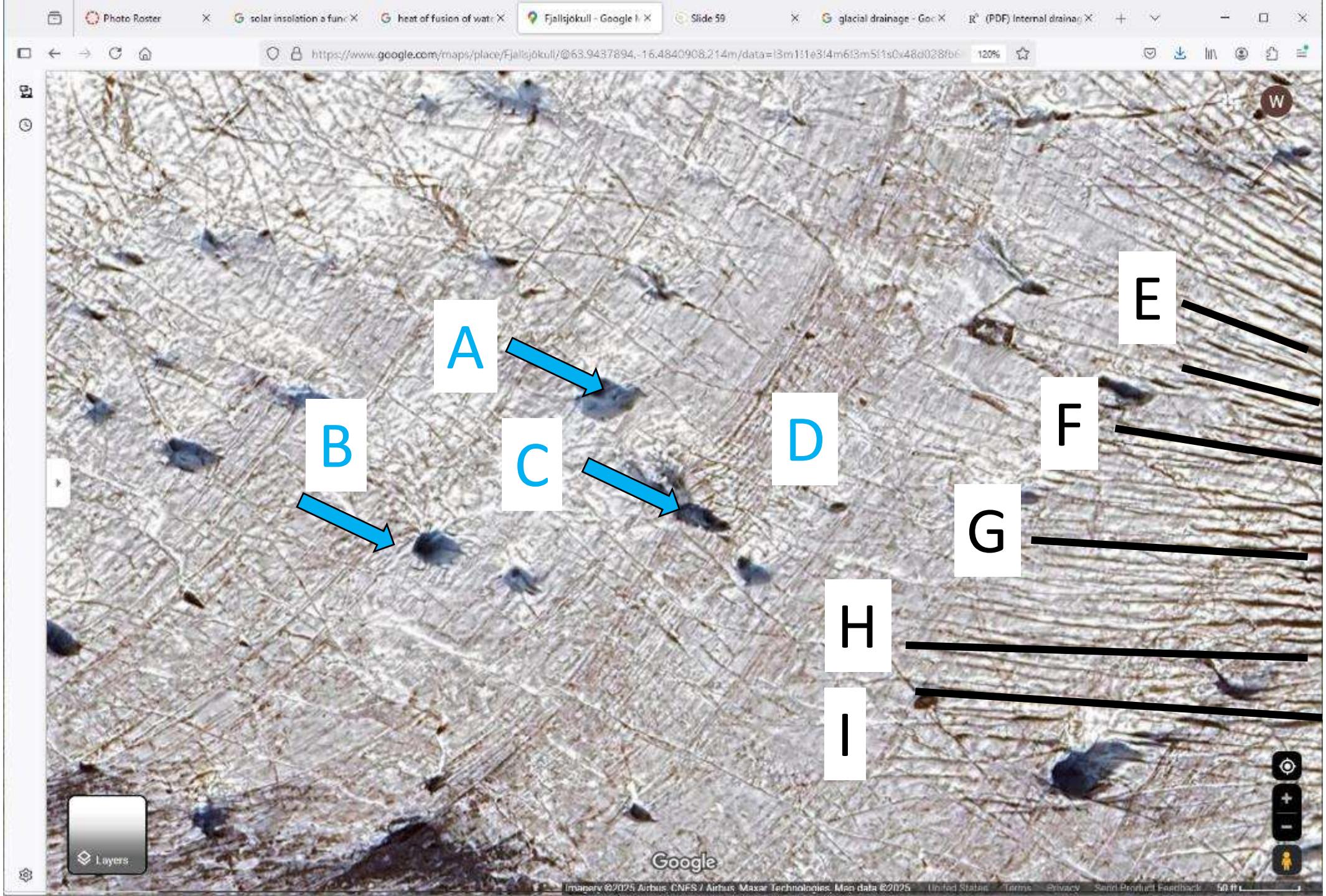


Photo Roster
solar insolation a func
heat of fusion of wate
Fjallsjökull - Google M
Slide 59
glacial drainage - Goo
(PDF) Internal drainag
https://www.google.com/maps/place/Fjallsjökull/@63.9437894,-16.4840908,214m/data=!3m1!1e3!4m6!3m5!1s0x48d028fb6
120%
W
Layers
Google
Imagery ©2025 Airbus, CNES / Airbus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
50 ft


A
B
C
D
E
F
G
H
I
Layers
Google


moulins
crevasses
Layers
Google

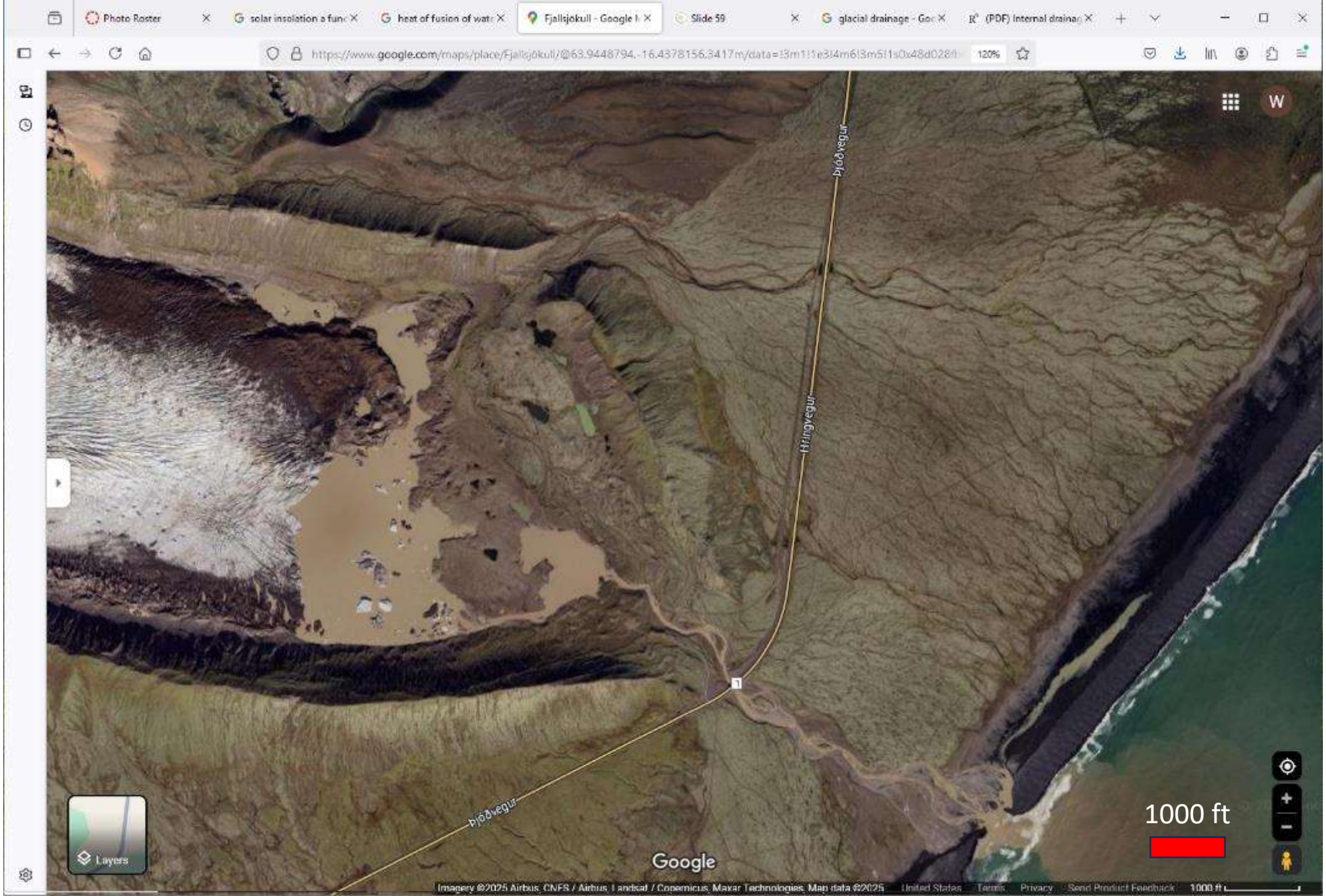
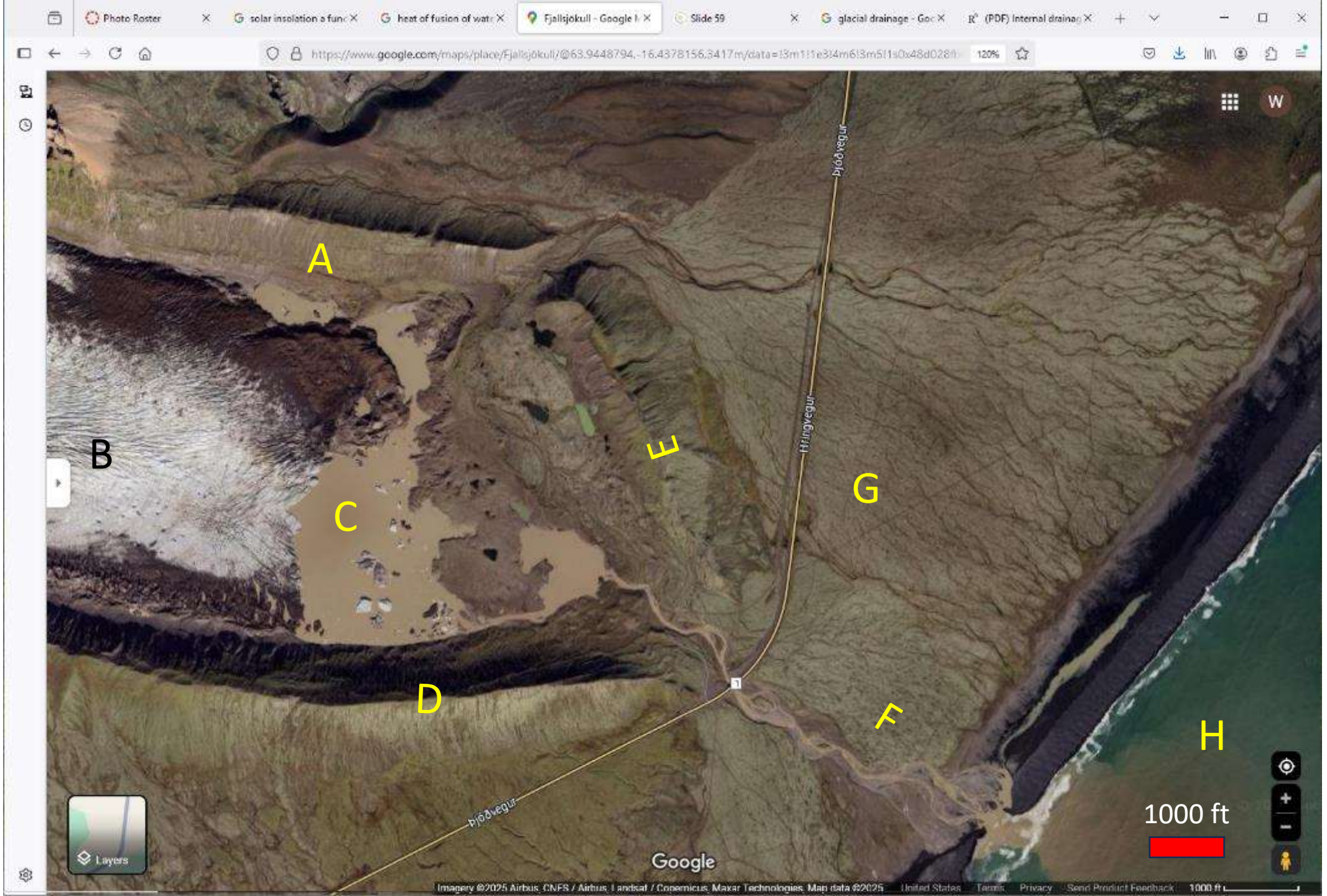
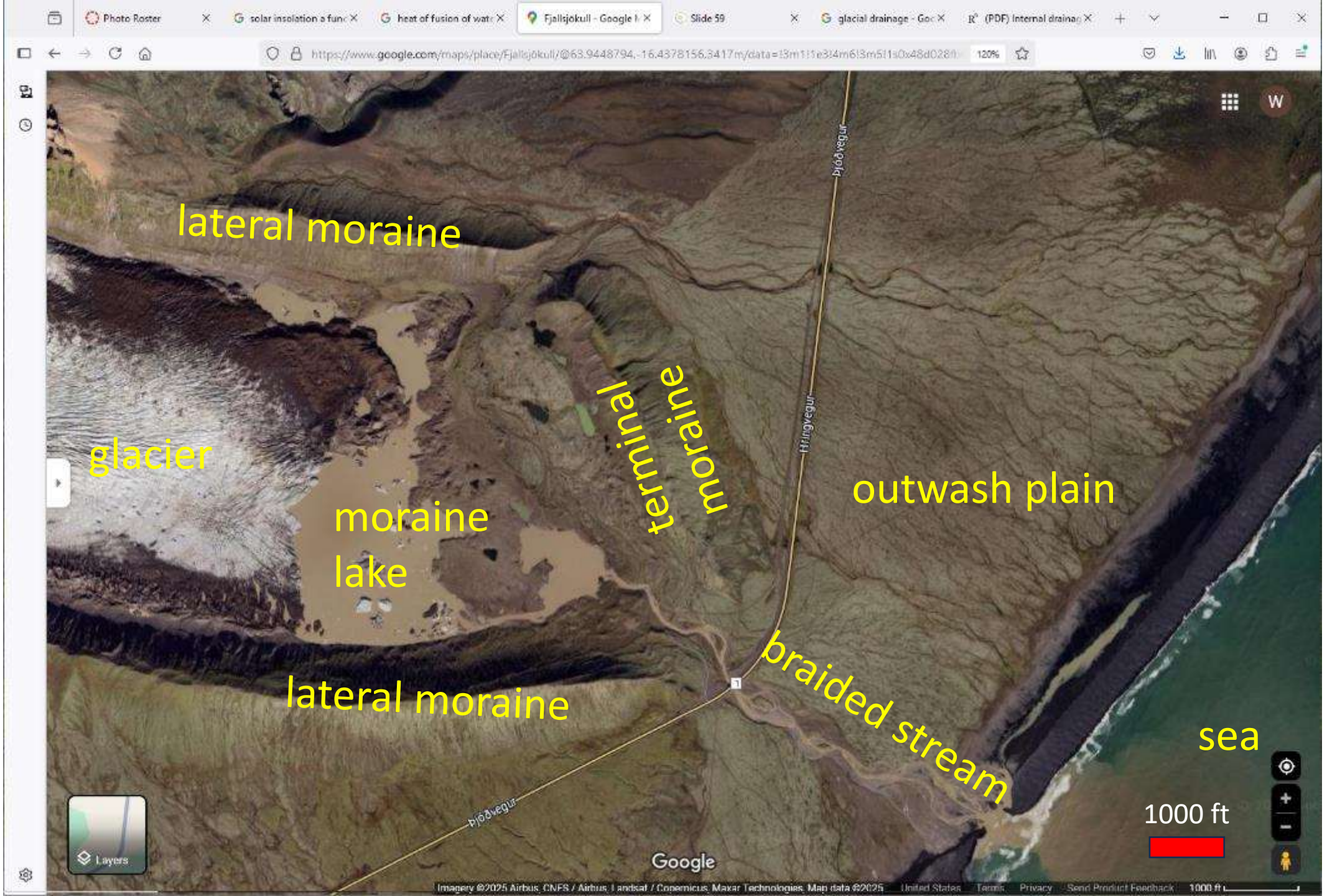


Photo Roster
solar insolation a func
heat of fusion of wate
Fjallsjökull - Google M
Slide 59
glacial drainage - Goo
(PDF) Internal drainag
https://www.google.com/maps/place/Fjallsjökull/@63.9448794,-16.4378156,3417m/data=!3m1!1e3!4m6!3m5!1s0x48d028f
120%
Þjóðvegur
Hringvegur
Þjóðvegur
Layers
Google
1000 ft
Imagery ©2025 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
1000 ft


A
B
C
D
E
F
G
H
Þjóðvegur
Hringvegur
Þjóðvegur
1000 ft
Layers
Google


lateral moraine
glacier
moraine lake
terminal moraine
outwash plain
lateral moraine
braided stream
sea
1000 ft
Þjóðvegur
Hringvegur
Google

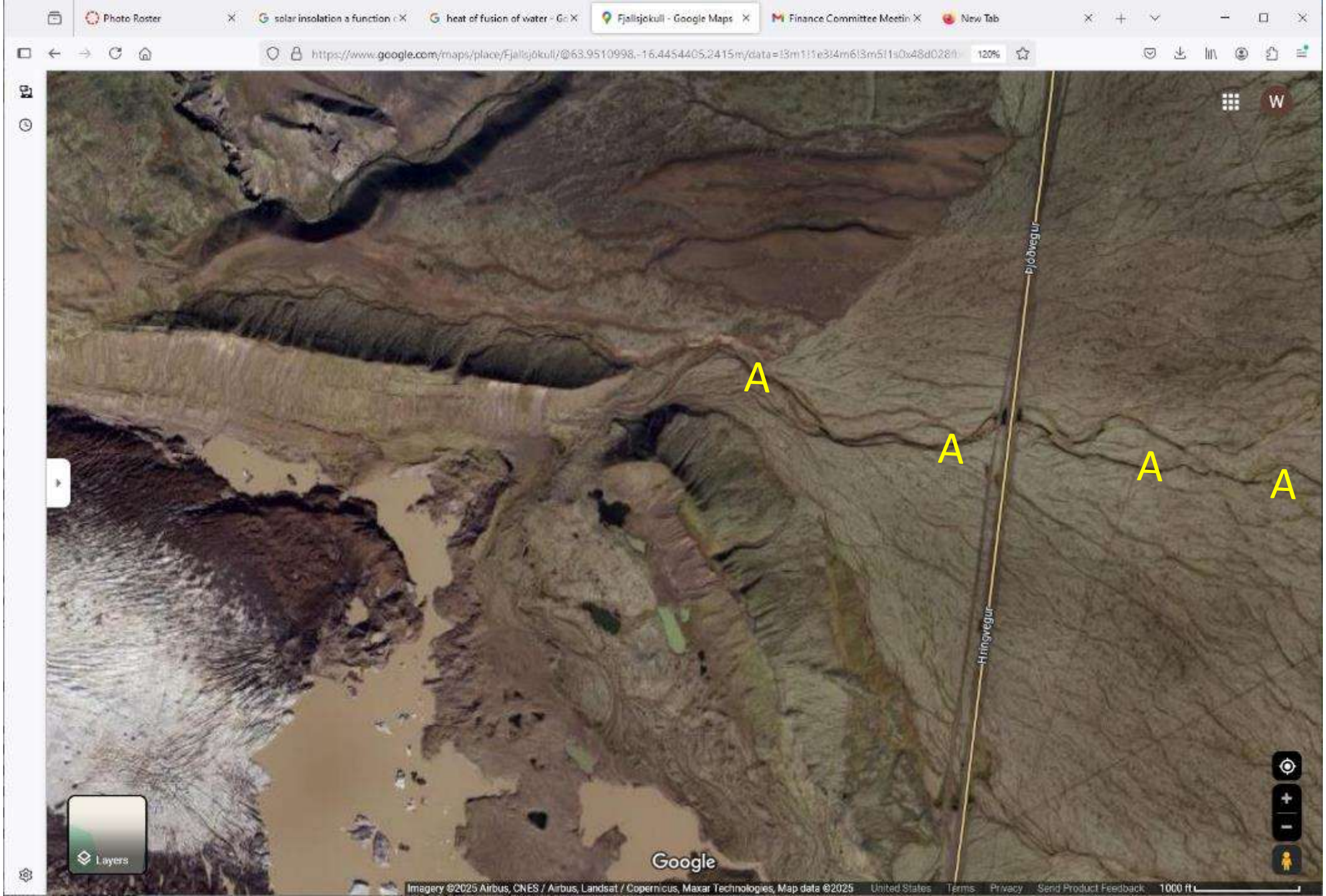


Photo Roster
solar insolation a function
heat of fusion of water - Go
Fjallsjokull - Google Maps
Finance Committee Meetin
New Tab
https://www.google.com/maps/place/Fjallsjökull/@63.9510998,-16.4454405,2415m/data=!3m1!1e3!4m6!3m5!1s0x48d028f
120%
Þjóðvegur
Hringvegur
A
A
A
A
Layers
Google
Imagery ©2025 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
1000 ft

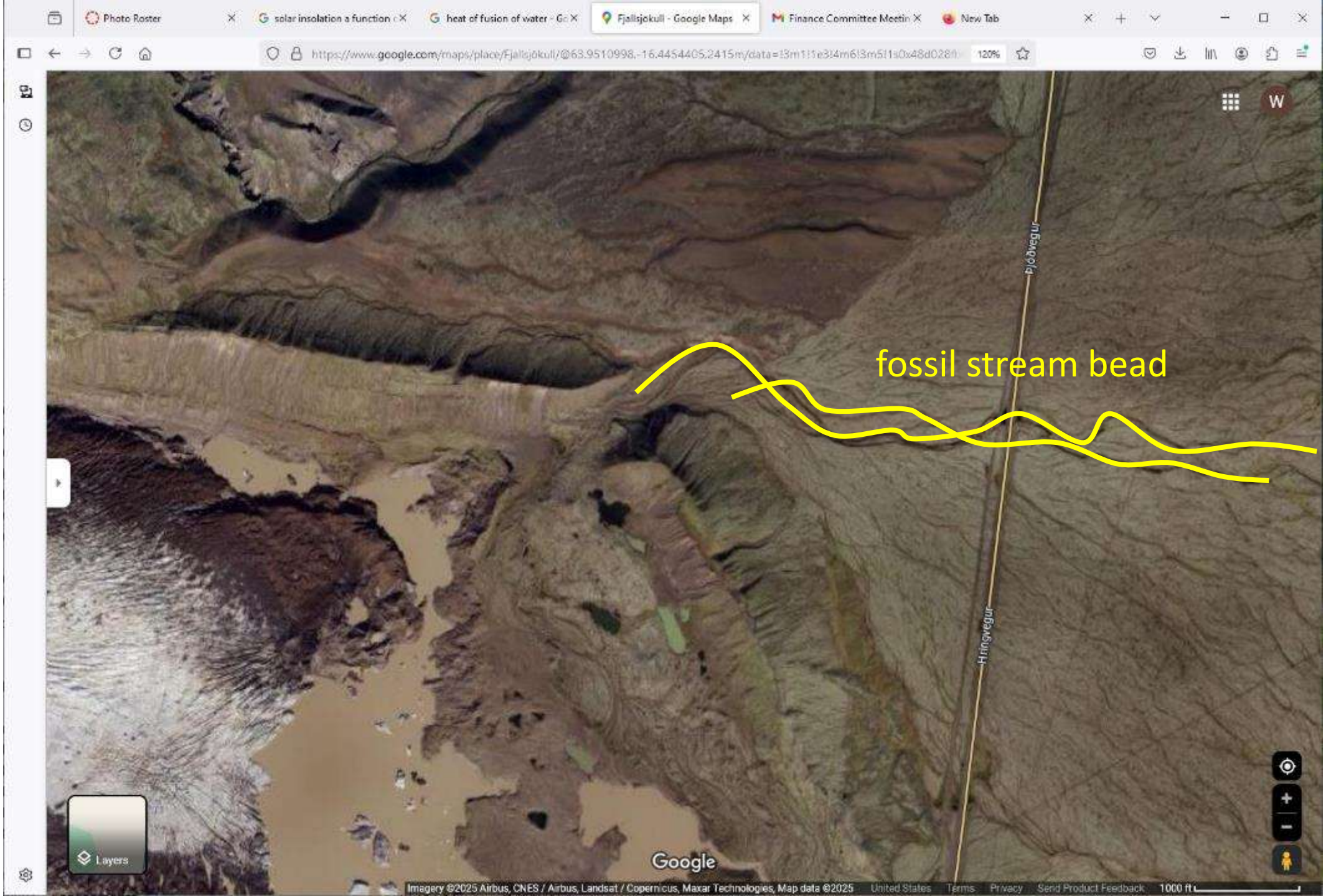


Photo Roster
solar insolation a function
heat of fusion of water - Go
Fjallsjokull - Google Maps
Finance Committee Meetin
New Tab
fossil stream bead
Þjóðvegur
Hringvegur
Layers
Google
Imagery ©2025 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
1000 ft

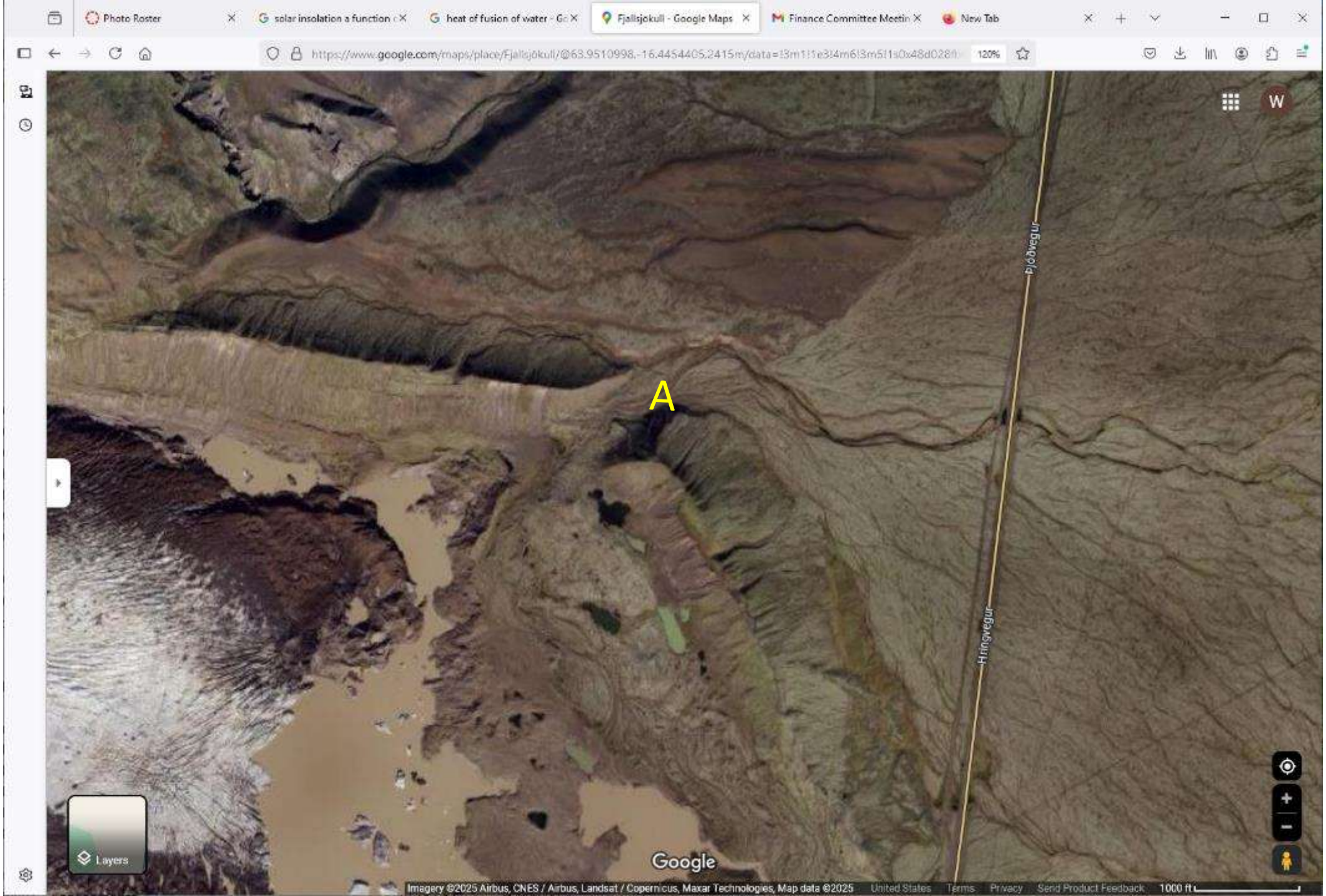
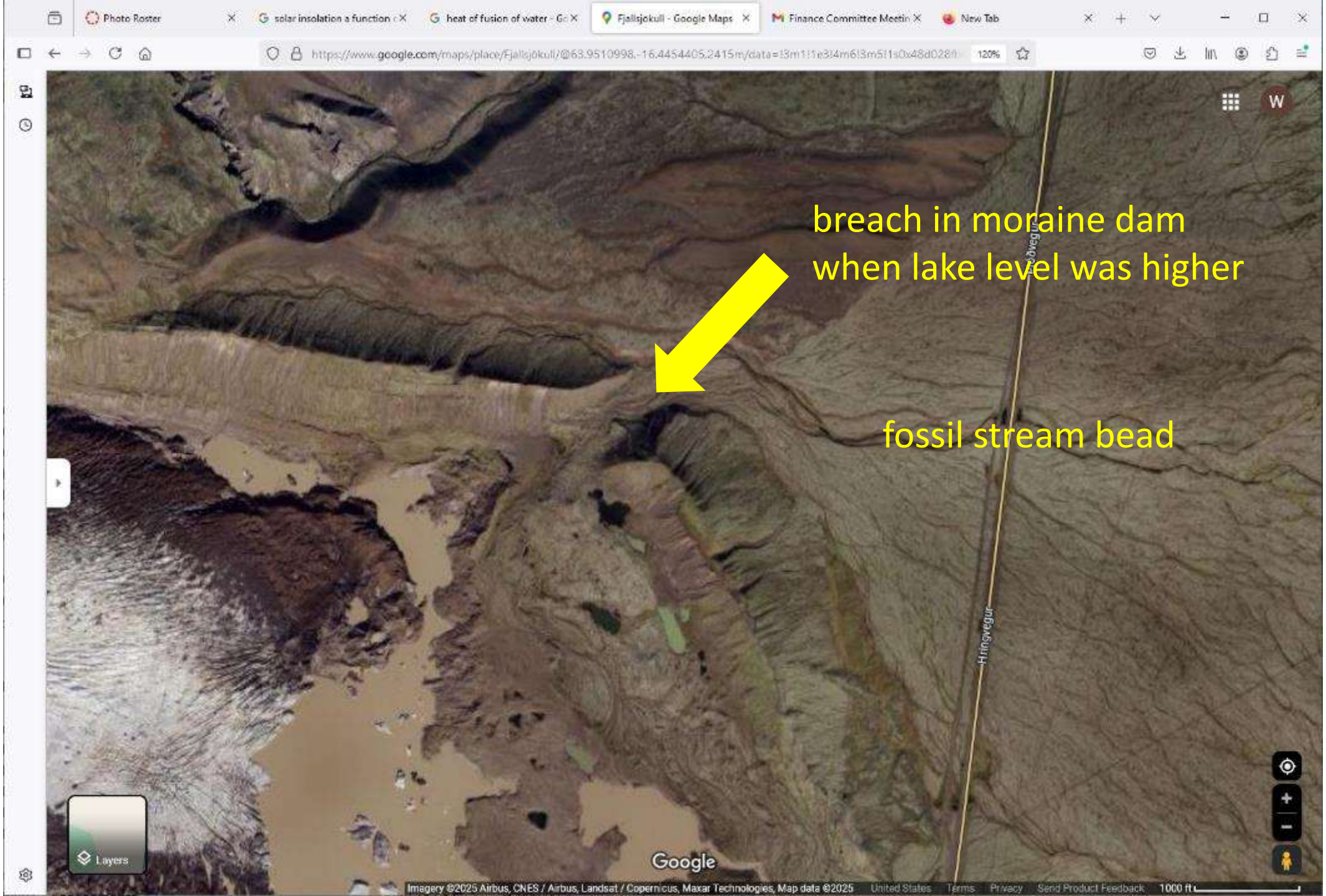
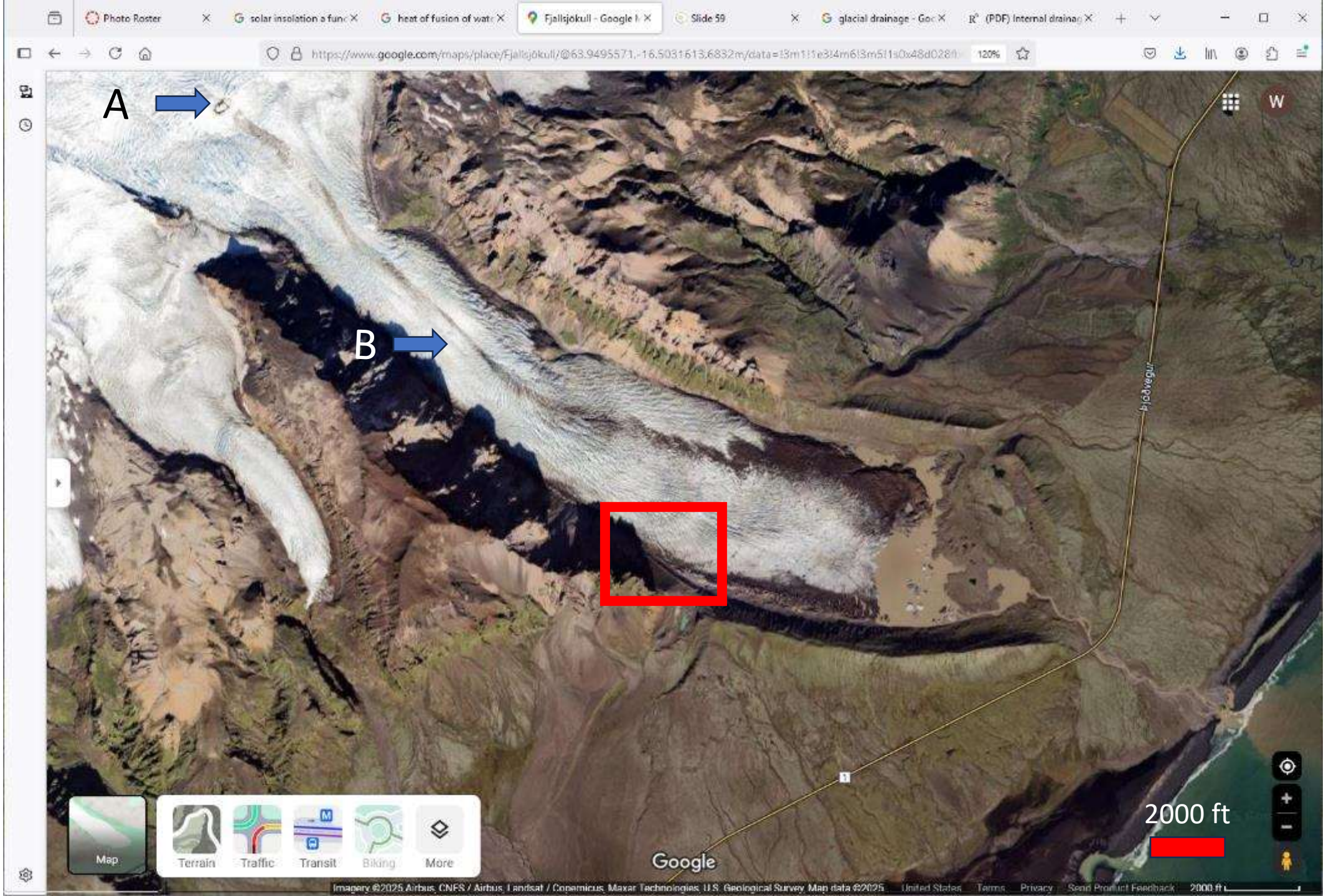


Photo Roster
solar insolation a function
heat of fusion of water - Go
Fjallsjokull - Google Maps
Finance Committee Meetin
New Tab
https://www.google.com/maps/place/Fjallsjökull/@63.9510998,-16.4454405,2415m/data=!3m1!1e3!4m6!3m5!1s0x48d028f
120%
A
Þjóðvegur
Hringvegur
Layers
Google
Imagery ©2025 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
1000 ft


breach in moraine dam
when lake level was higher
fossil stream bead
Hringvegur
Layers
Google
Imagery ©2025 Airbus, CNES / Airbus, Landsat / Copernicus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
1000 ft


A
B
2000 ft
Google

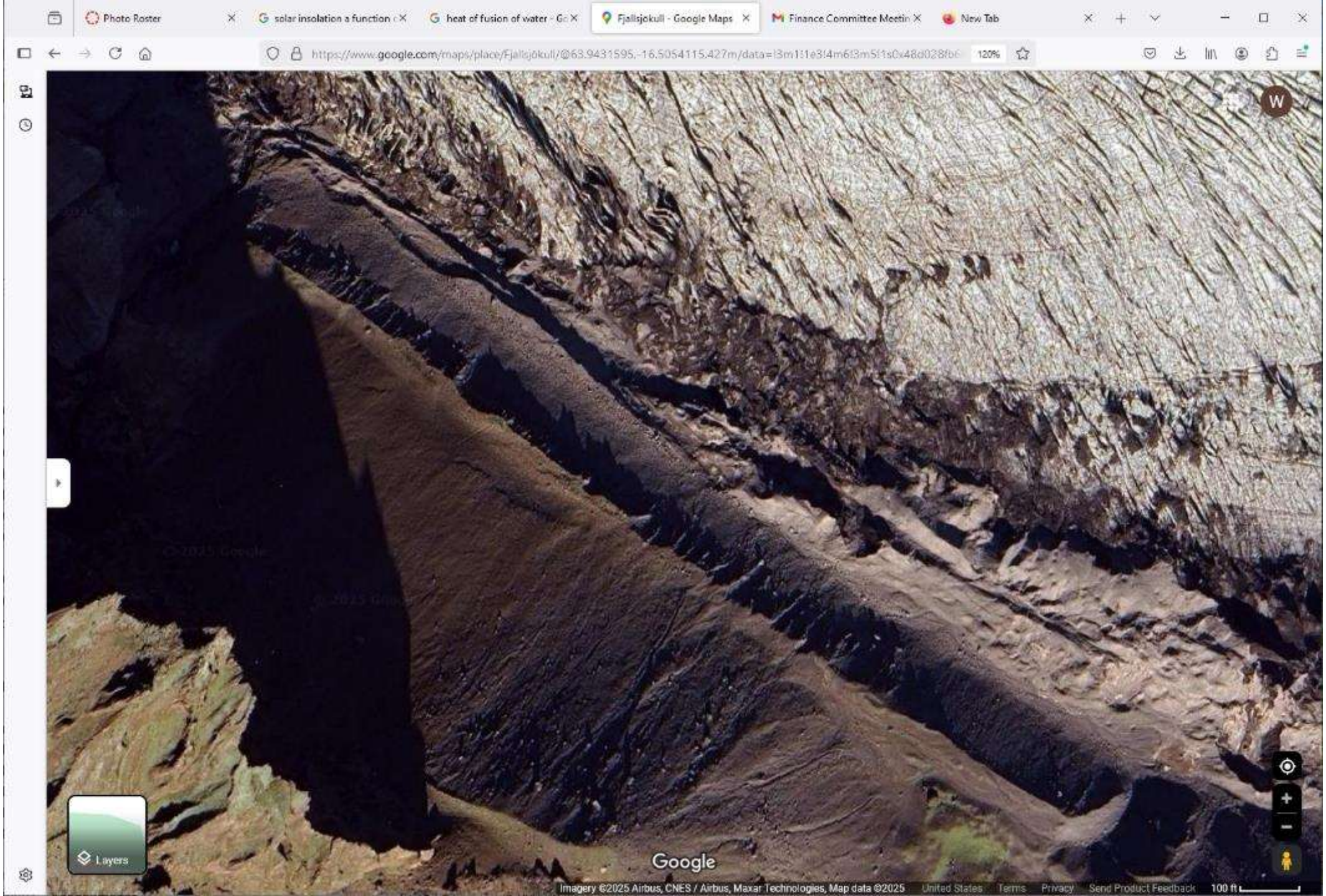
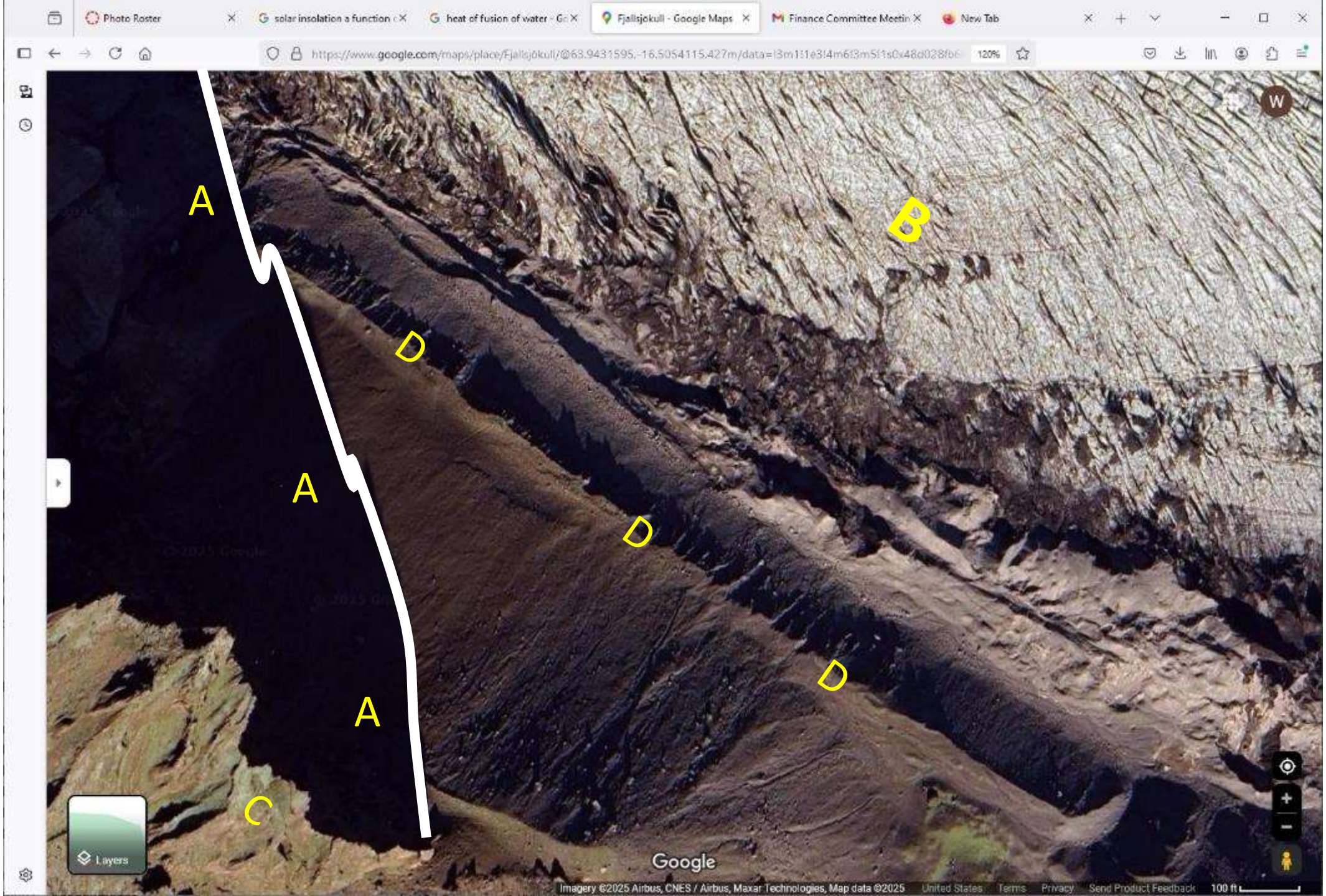
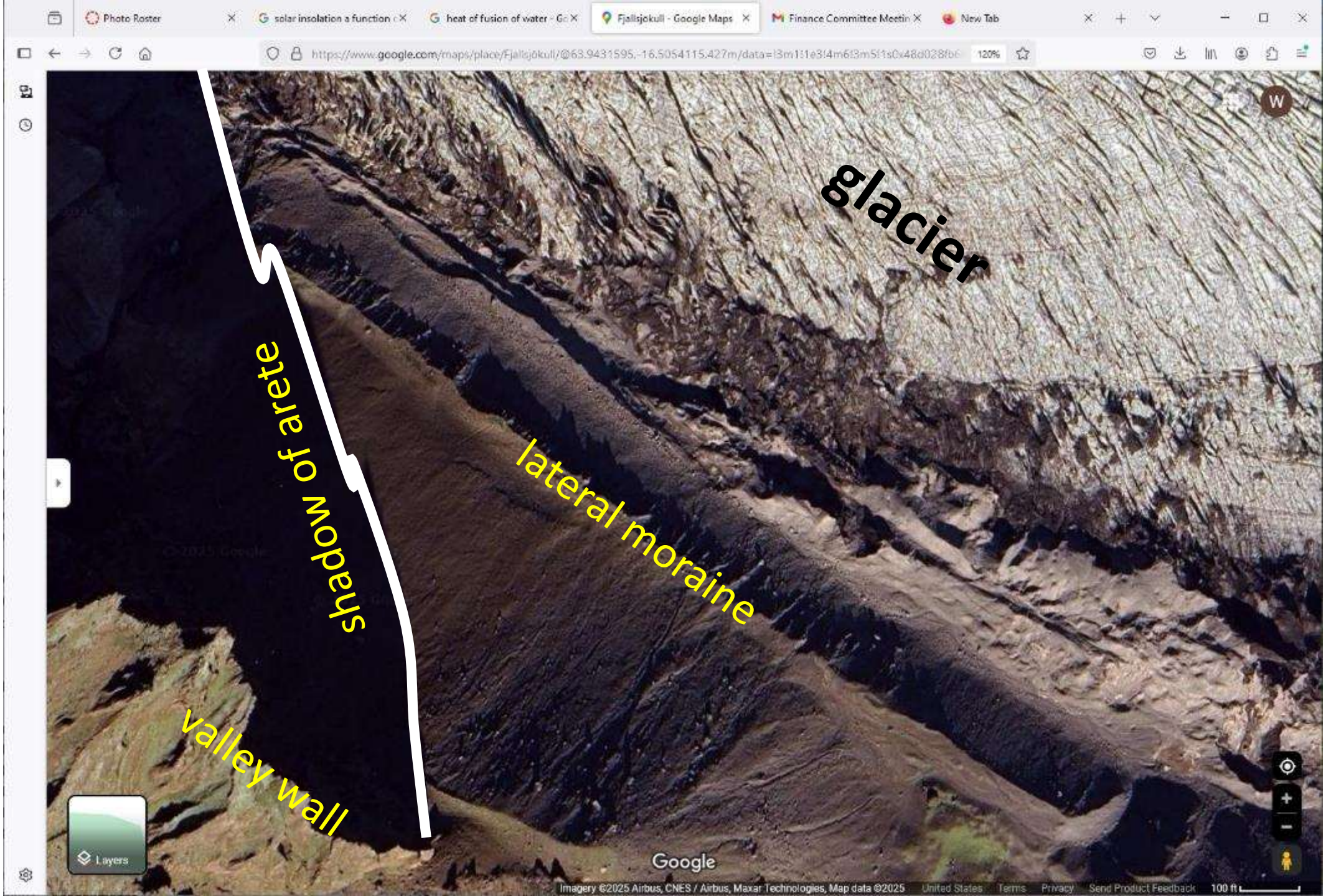


Photo Roster
solar insolation a function
heat of fusion of water - Go
Fjallsjokull - Google Maps
Finance Committee Meetin
New Tab
https://www.google.com/maps/place/Fjallsjökull/@63.9431595,-16.5054115,427m/data=!3m1!1e3!4m6!3m5!1s0x48d028fb6
120%
W
Layers
Google
Imagery ©2025 Airbus, CNES / Airbus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
100 ft


A
A
A
B
D
D
D
C
Layers
Google
Imagery ©2025 Airbus, CNES / Airbus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
100 ft


glacier
lateral moraine
shadow of arete
valley wall
Google
Imagery ©2025 Airbus, CNES / Airbus, Maxar Technologies, Map data ©2025
Layers

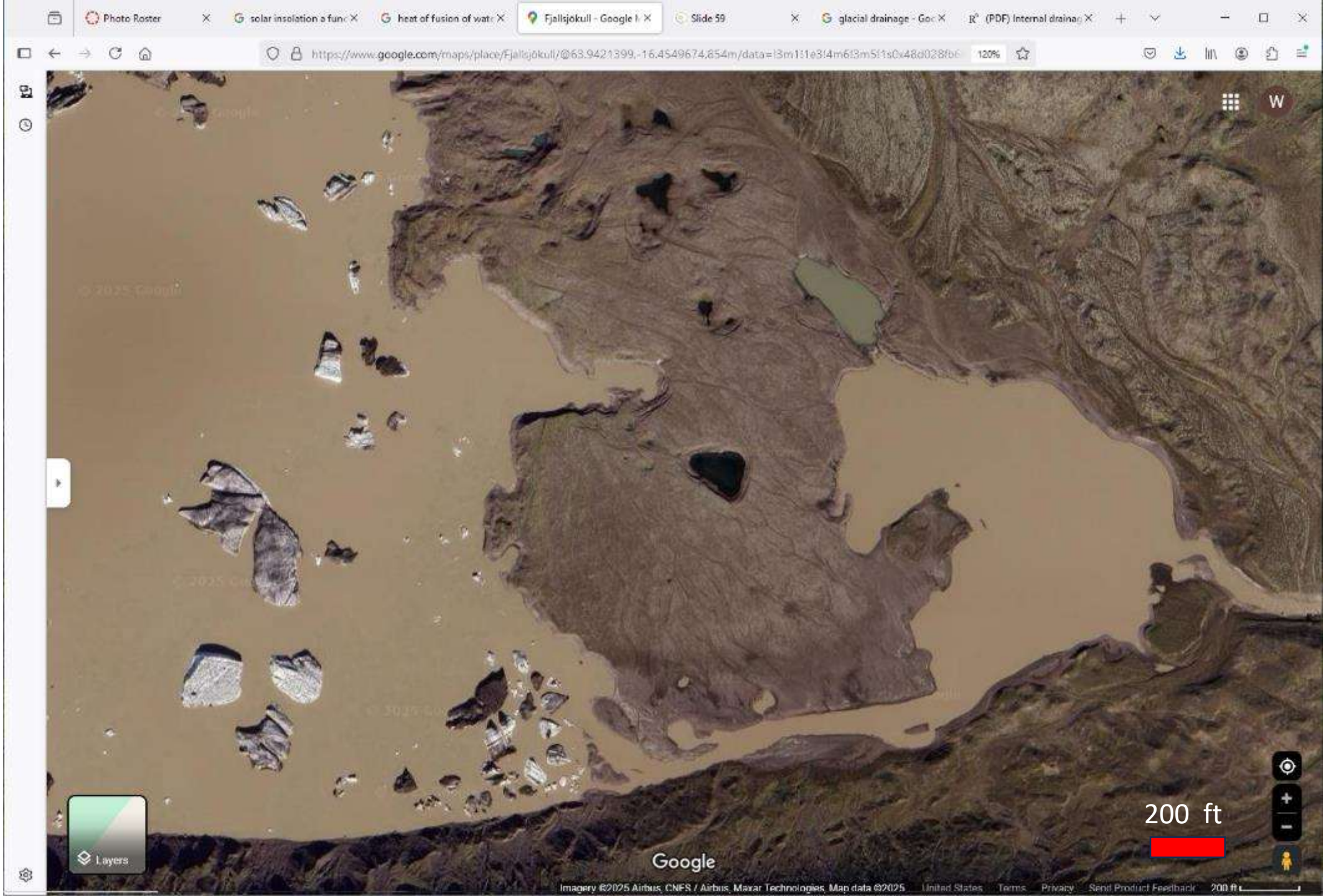
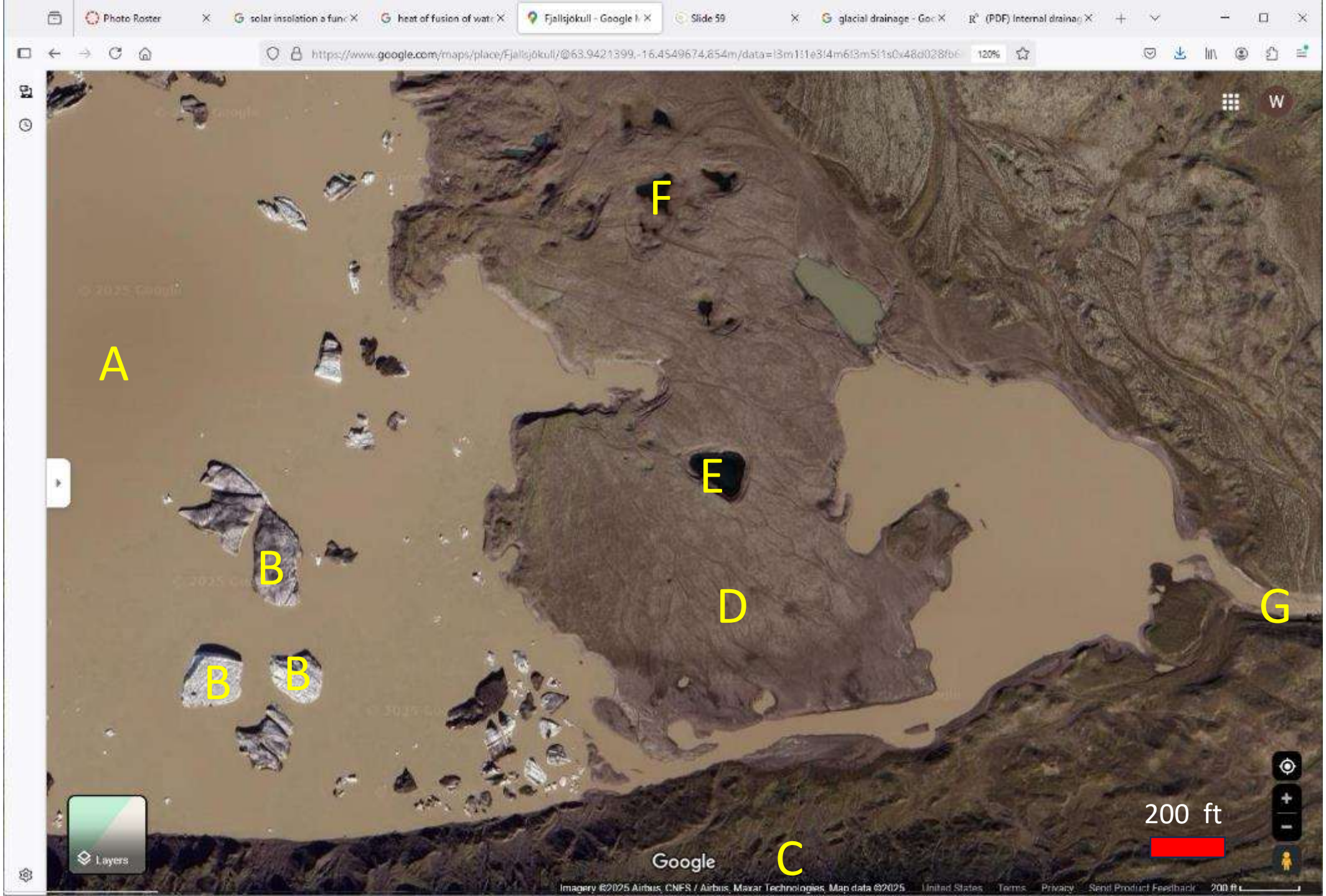


Photo Roster
solar insolation a func
heat of fusion of wate
Fjallsjökull - Google I
Slide 59
glacial drainage - Goc
(PDF) Internal drainag
https://www.google.com/maps/place/Fjallsjökull/@63.9421399,-16.4549674,654m/data=!3m1!1e3!4m6!3m5!1s0x48d028fb6
120%
W
200 ft
Layers
Google
Imagery ©2025 Airbus, CNES / Airbus, Maxar Technologies, Map data ©2025
United States
Terms
Privacy
Send Product Feedback
200 ft


A
B
B
B
C
D
E
F
G
200 ft
Google
Layers


kettles
lake
kettle
outlet
stream
icebergs
outwash
moraine
200 ft
Layers
Google