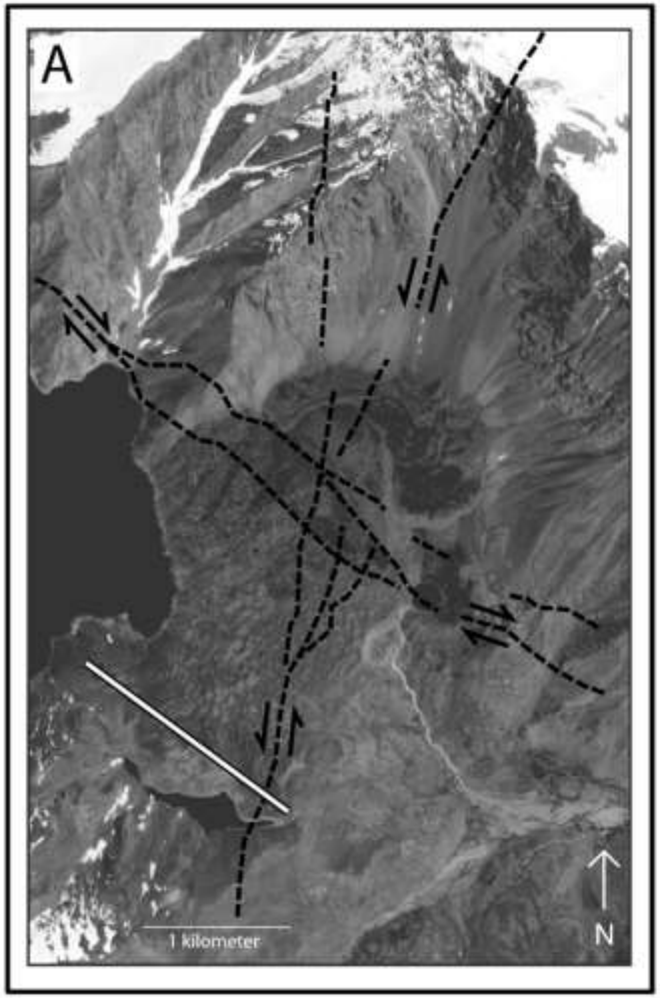
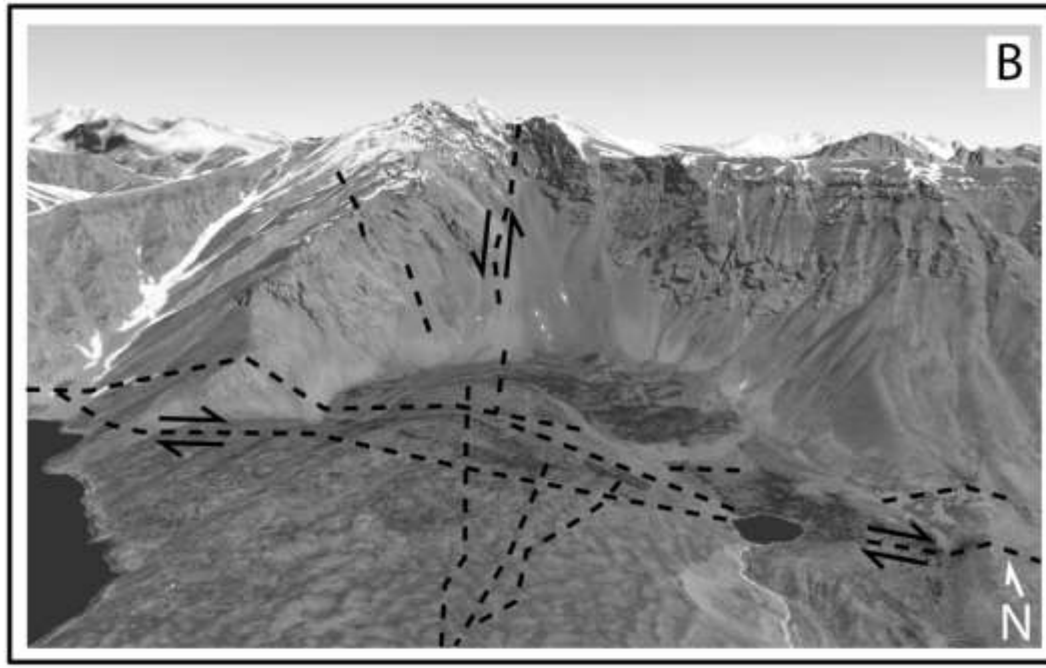
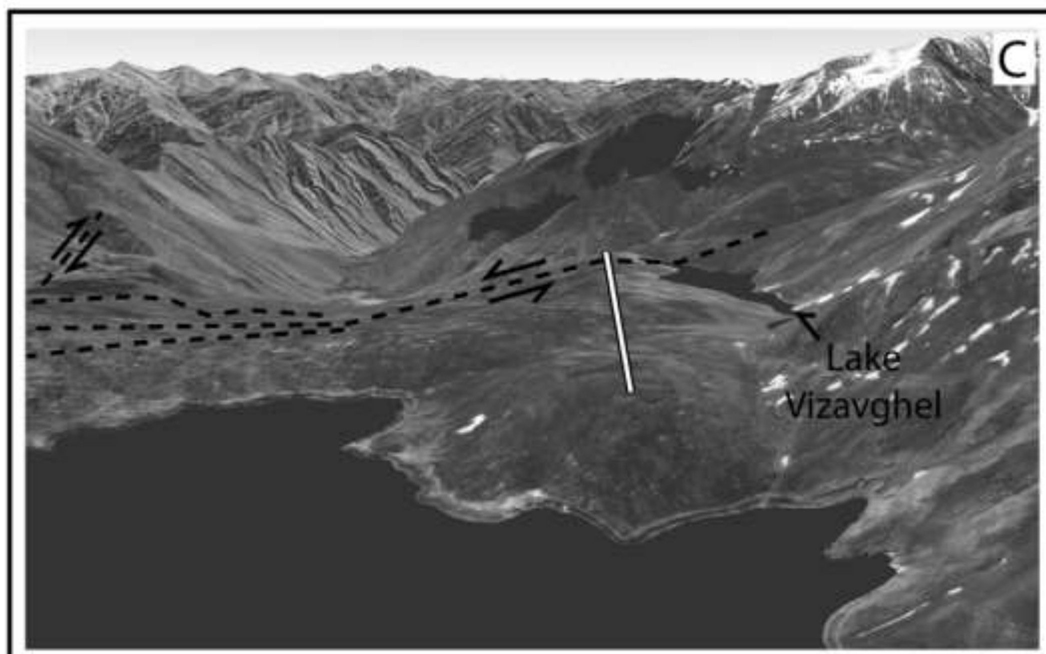
Alluvial Fans & Debris Flow Furrows

Photo by J. Shroder







Lake Shiva, Afghanistan

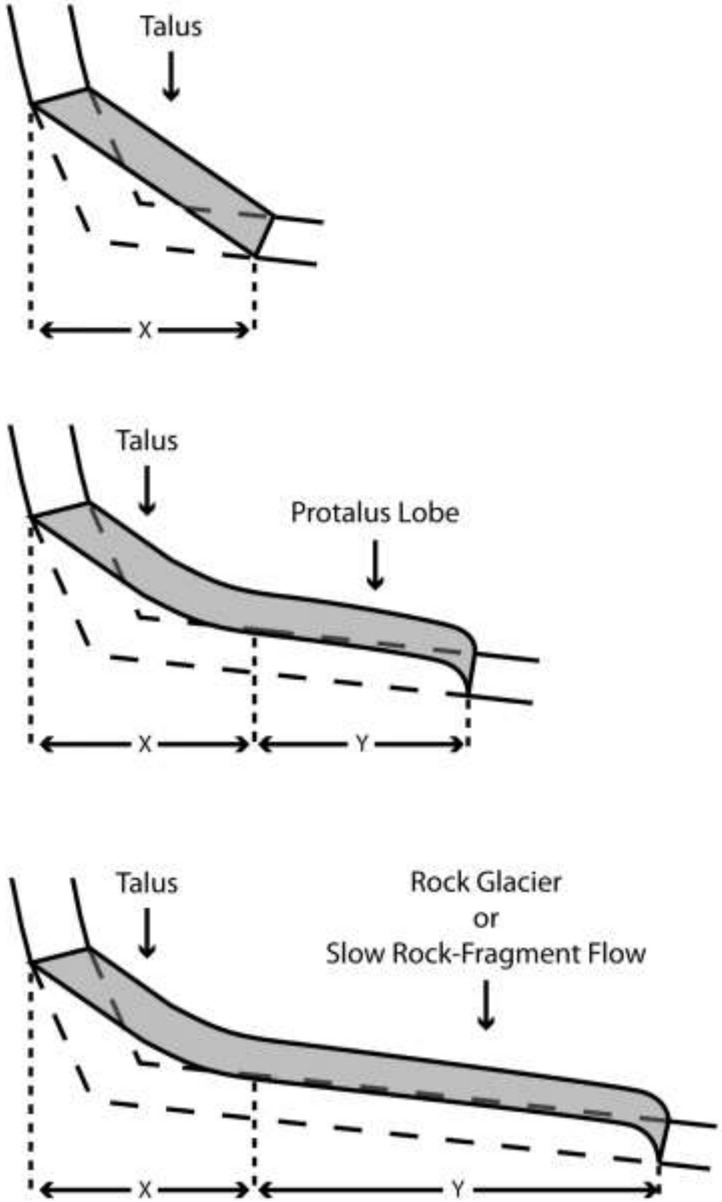
- - - - Strike-Slip Faulting

═══ Hauptanlage

Sturzstrom – rock avalanche = largest rock falls possible

Lake Shiva Sturzstrom Dam

- A large portion of the mountainside detached and fell (yes fell) and tumbled into the valley, creating the mass movement dam and eventually creating the lake (Shiva) behind it.
- Mass movement-dammed streams are very dangerous because they can collapse at any moment
  - Natural dams are weak because the rocks are unorganized and unpacked/unconsolidated material.
- If this dam fails, millions of people are directly downstream and will be impacted.
  - We have asked for this dam to be monitored in our published research about it (see in Canvas).
  - It has been showing signs of water movement through it and slumping on the front where water escapes and flows.
    - Dams shouldn't have too much seepage, or they will fail because the water erodes even the strongest dams. See slides about the concrete/steel/etc. dam in SE Missouri (Johnson Shut-ins State Park area) that failed because the water flowed over it too long…



Talus Slope to Protalus Lobes to Rock Glacier Evolution

Figure 9. Generalized graphic of talus slopes, protalus lobes, and rock glaciers or slow rock-fragment flows.

Rock Glacier

Photo by J. Shroder

Rock Glaciers

Photo by J. Shroder

Glacier regimes & mass balance

- Positive accumulation factors
  - Snowfall
  - Avalanches (both snow & ice)
  - Rime formation (water vapor to ice crystals)
  - Sleet (freezing rain)
  - Regelation (refreezing from below)

Negative wastage factors

- Ablation
  - Melting
  - Evaporation of runoff
  - Sublimation
  - Wind erosion

- Calving of icebergs

Net balance of a glacier

1. Direct measurement method
2. Photogrammetric (satellite imagery) methods
3. Hydrological methods
4. Reconnaissance methods

Direct measurements

- Study site on glacier – best is 20/km2
  - In actuality 1/10 cubed km squared is more common
  - Snow pits above & ablation stakes below

- Energy balance
  - Heat balance count of calories incoming & outgoing

Thermal flux measures

- Radiative heat flux
- Sensible heat flux
- Latent heat flux from condensation evaporation
- Heat content of precipitation
- Heat from water freezing
- Change of heat content in snow & ice

Photogrammetric methods – satellite imagery

- Accurate contour maps
- Accurate digital elevation models (DEMs) [also known as DTMs]
- X, Y, Z measures have to be robust (Z is commonly problematic)
- Compare maps over time to determine glacier mass changes

Hyrdological methods

- Measurements are made over whole basin
- $Bn = P – R – E$
  - Where:
  - Bn = balance
  - P = precipitation
  - R = runoff
  - E = evaporation & sublimation from all sources

Reconnaissance methods

- Assessment of snowline at end of sumer from air photos, satellite imagery, or ground visit.

- Calculate accumulation ratio
  - (accumulation area/area of whole glacier)
  - 0.85 – 0.35 possible range of values

Glacier movement

- Internal deformation of the ice
- Basal sliding
- Bed deformation
- Kinematic waves

Internal deformation of ice

- Folding
- Thrusting (especially at terminus)
- Creep
  - Crystal orientation (original)
  - Longitudinal compression
  - Deformation history (to line up crystals)
  - Debris content (to allow crystals to reorient)

Temperature controls creep

- < – 8 degrees C – basal gliding between crystal latices
- – 8 degrees – 1 degree C – liquid phase at grain boundaries
- At ~0 degrees C – pressure melting & regelation (refreezing)

Basal sliding & regelation – roche motonnée

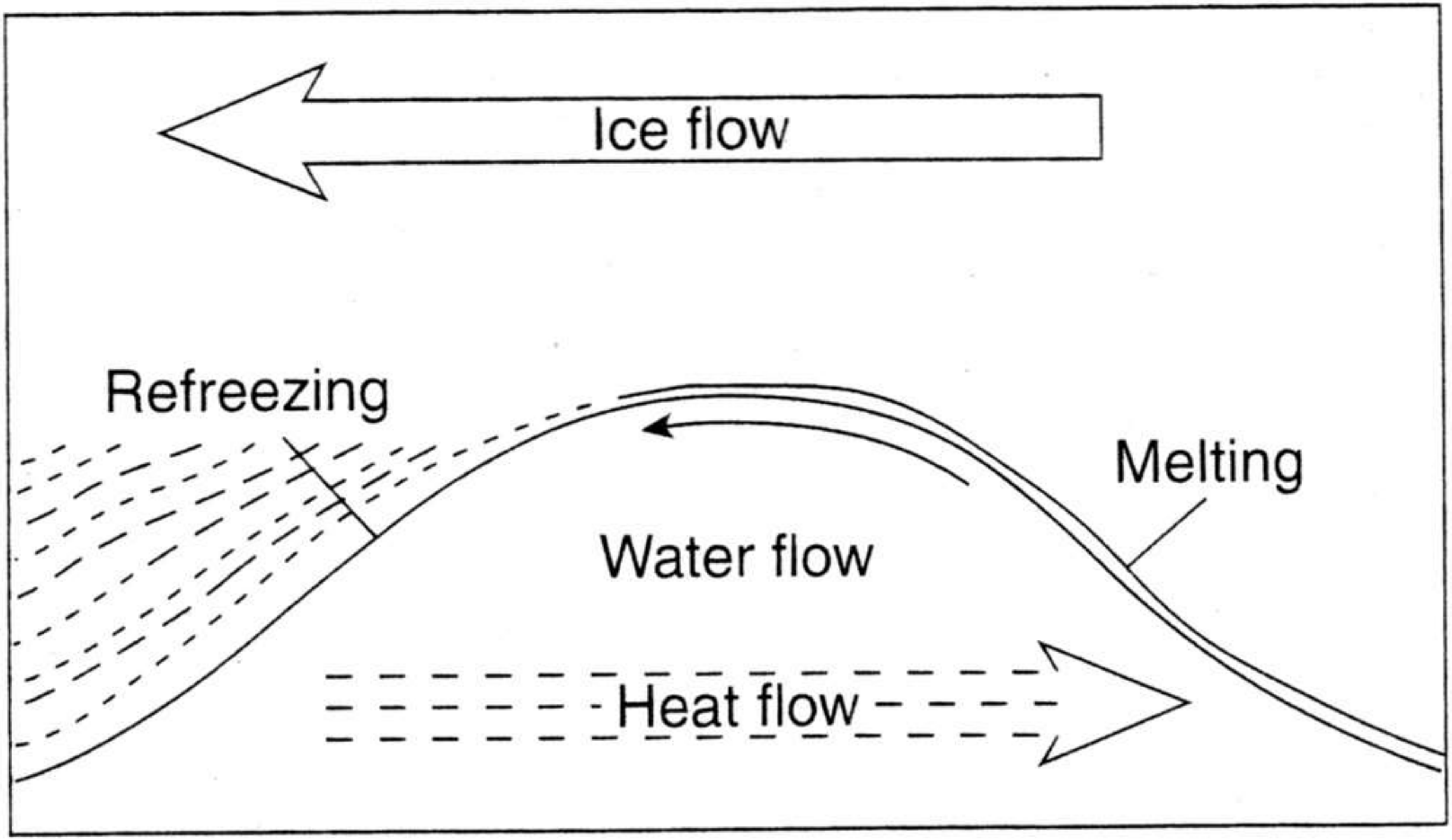
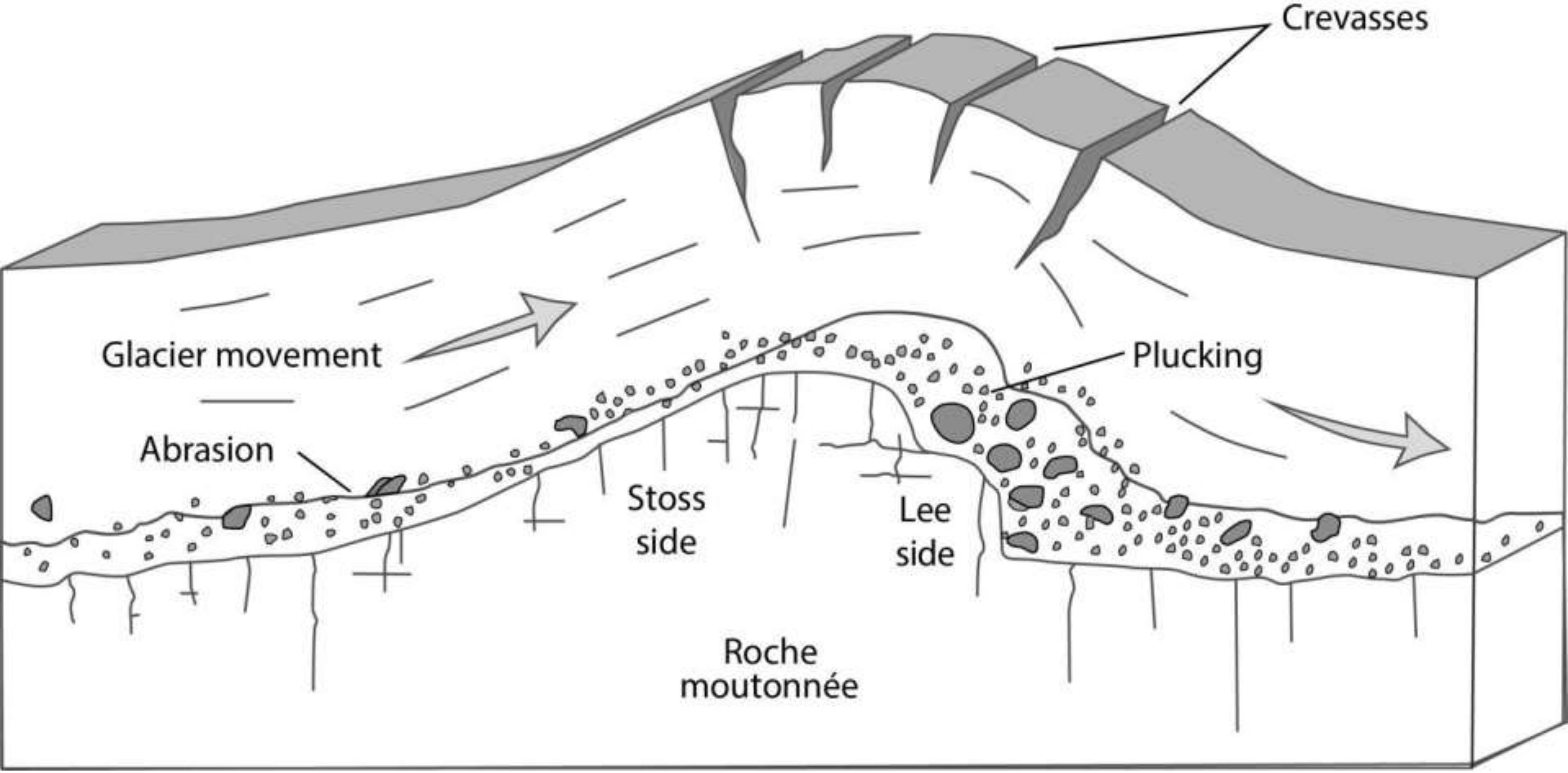


Fig. 4.16 Regelation sliding mechanism

Roche Motonnée



https://gq.mines.gouv.qc.ca/lexique-stratigraphique/quaternaire/roche-moutonnee_en/

Bed deformation

- Water saturated till
- Till squishy & squeezed out

Kinematic waves

- Analogous to river flood peaks & traffic flow
- Can move 4 times that of ice flow velocity

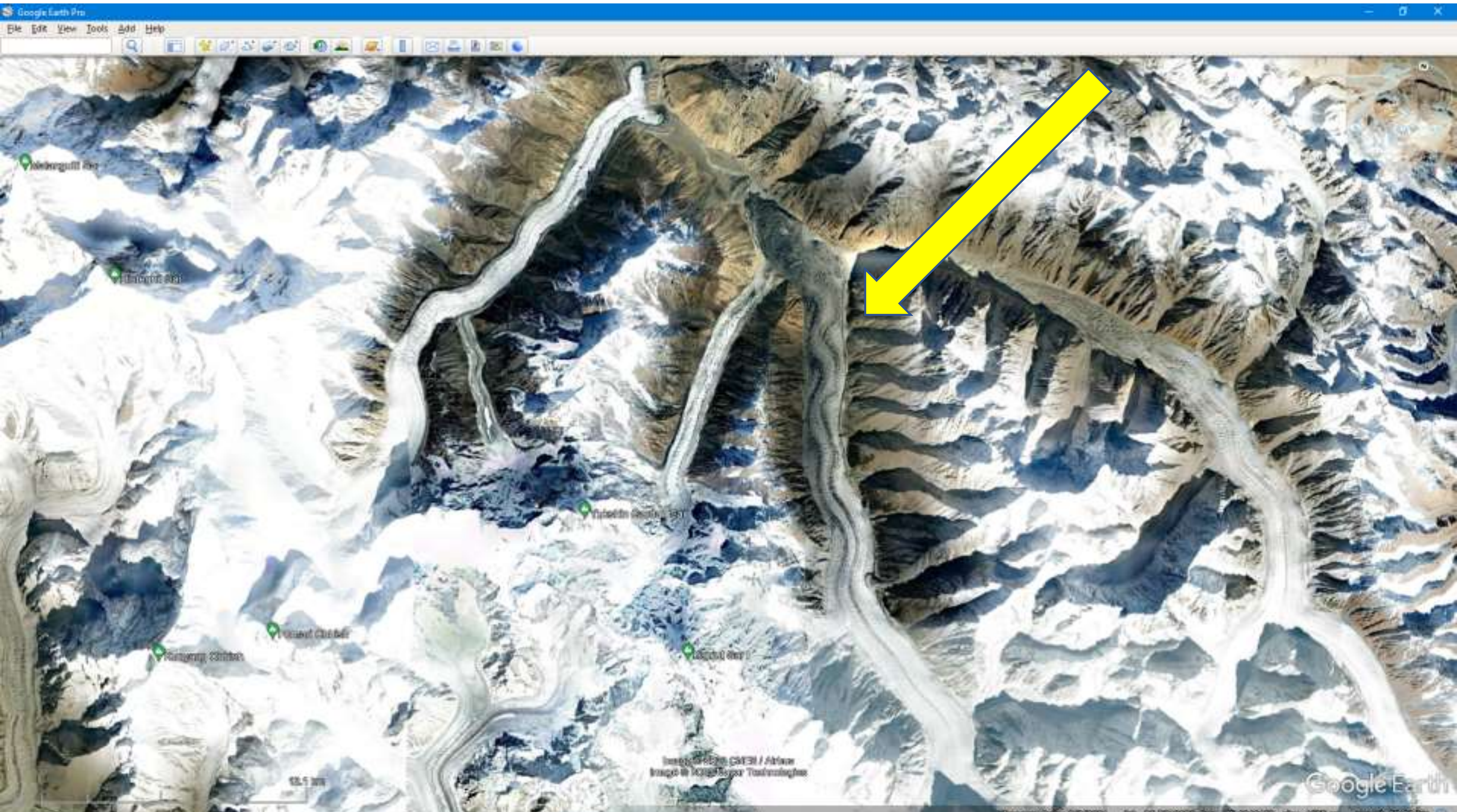
- Mass balance fluctuations

- Surge type

Surge triggers

- Some are periodic (Kamb's (1985) guess on Varigated Glacier in Alaska)
- Collapse of subglacial water tunnels & 'floating' of ice on basal water layer
- Increased meltwater buildups?
- Earthquakes?
- Landslides or avalanching sometimes?

Shimshal Valley – Surging Khurdopin Glacier

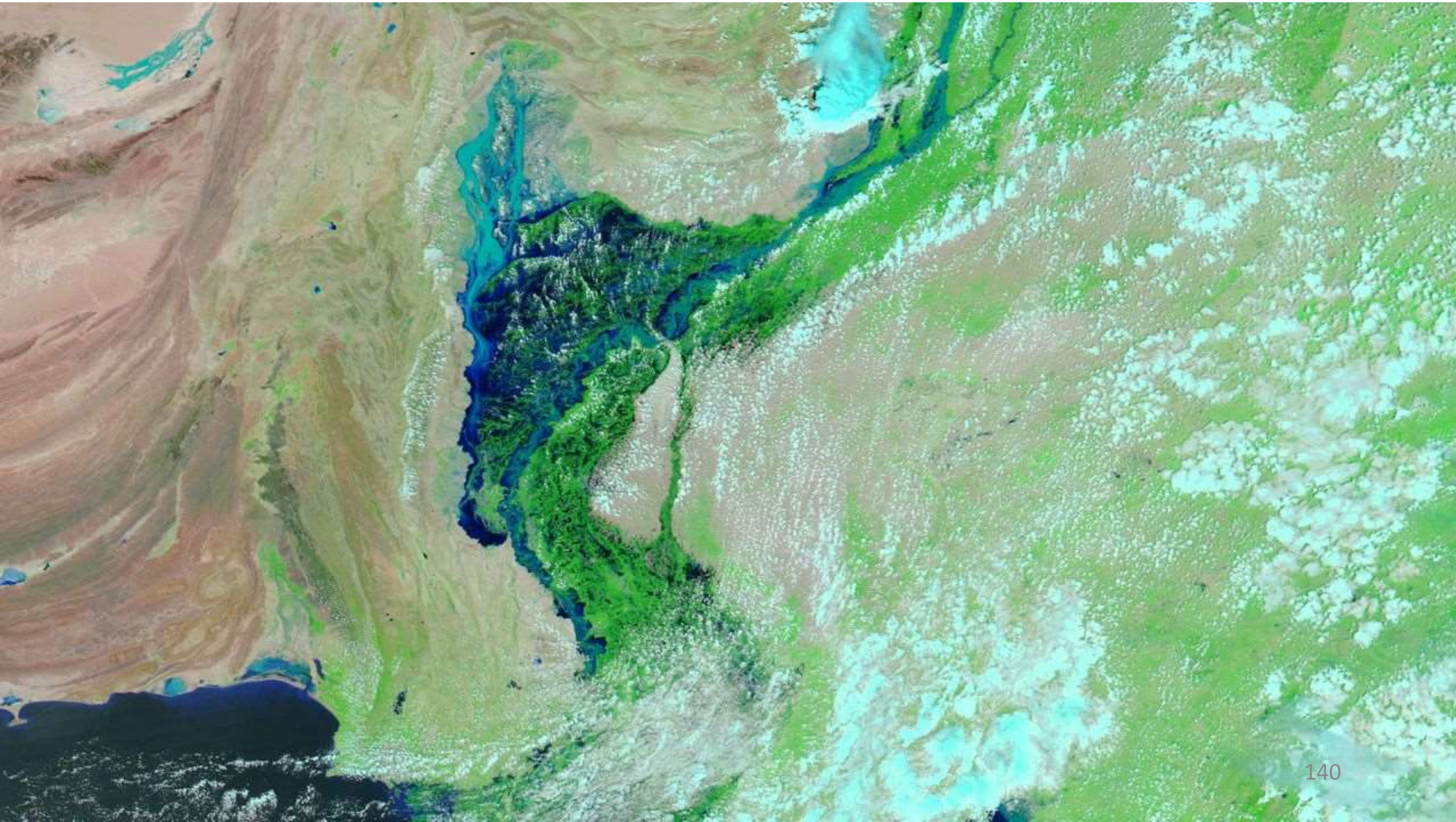


Hazards and Climate Change

- River Incision
- Glacial Debuttressing
- Flooding
  - Coastal
  - Riverine
- Droughts
  - Wildfires
- Mass Movement
  - Flows
    - Debris
    - Ice
    - Lahars
- Weather Related
  - Hurricanes
  - Tornadoes
  - “Atmospheric Rivers”

An image of Sindh province, taken on August 28, 2020 from NASA's MODIS satellite sensor

https://www.cnn.com/2022/08/31/asia/pakistan-floods-forms-inland-lake-satellite-intl-hnk/index.html



Spring 2019 Missouri River Flooding

Saddle Creek Road in Omaha

- Built over Saddle Creek many years ago
  - It’s a low point and a drainage.
  - They (the city) just filled it in and put a road over it. Not good!
  - The storm sewers get overwhelmed and it floods the entire road with a large rain every once in a while.
  - This is the result of poor planning…
    - Never build in a flood zone. **NEVER EVER EVER!!!!**
    - Check out the next pictures from June, 2008…
    - If you live on Saddle Creek road near here, you might consider a safer place to live, seriously.
    - UNMC built at the top of the hill for this reason… Smart choice!
    - There are new plans on the books to further develop this area… lets hope they add some fill to elevate this new construction…

Saddle Creek, Omaha – June 27, 2008