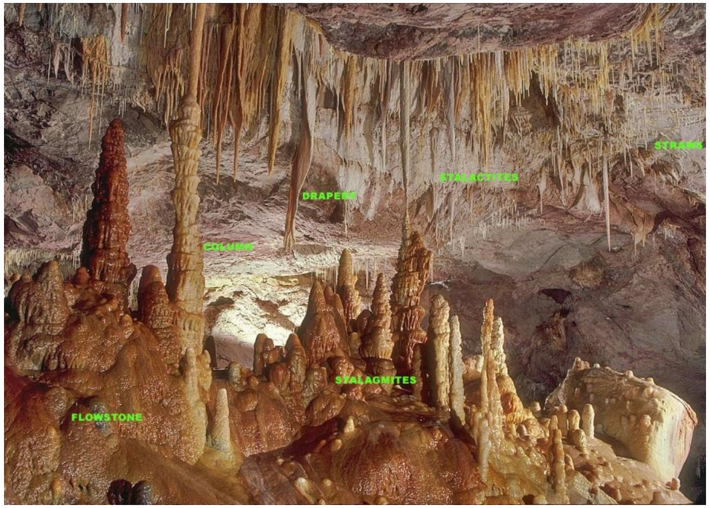
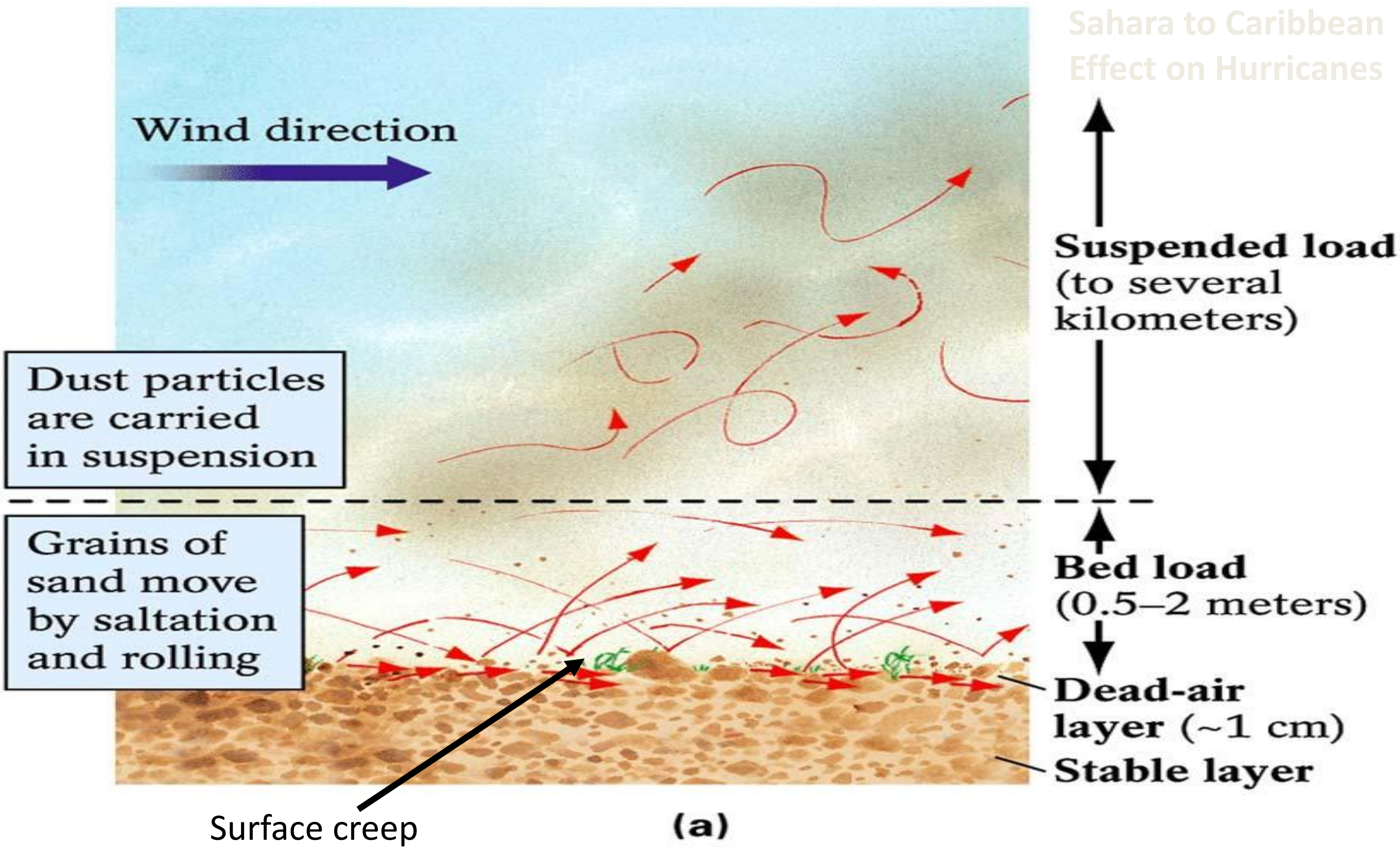
IDC 203: INTRODUCTION TO EARTH SCIENCES



Deserts and wind action

Wind-Borne Sediment causes deflation and abrasion



Deposition Landforms of Eolian Sands

- Reduced wind velocity results in sediments deposition
- Dunes are hills of loose wind-born sand
- Size, shape, and orientation of dunes are determined by available sand, vegetation, and wind

Formation of loess deposits

Pre-glacial weathering

Glacial Erosion

Production of unsorted sediments

Transport by streams or debris

Transport by glaciers

Further particle size reduction

Deposition of mixed sediment size

Removal of fine silt and clay by winds

Aeolian abrasion and particle size reduction

Medium to coarse silt transported
for short distances in suspension

Fine silt and clay transported
for long distances in suspension

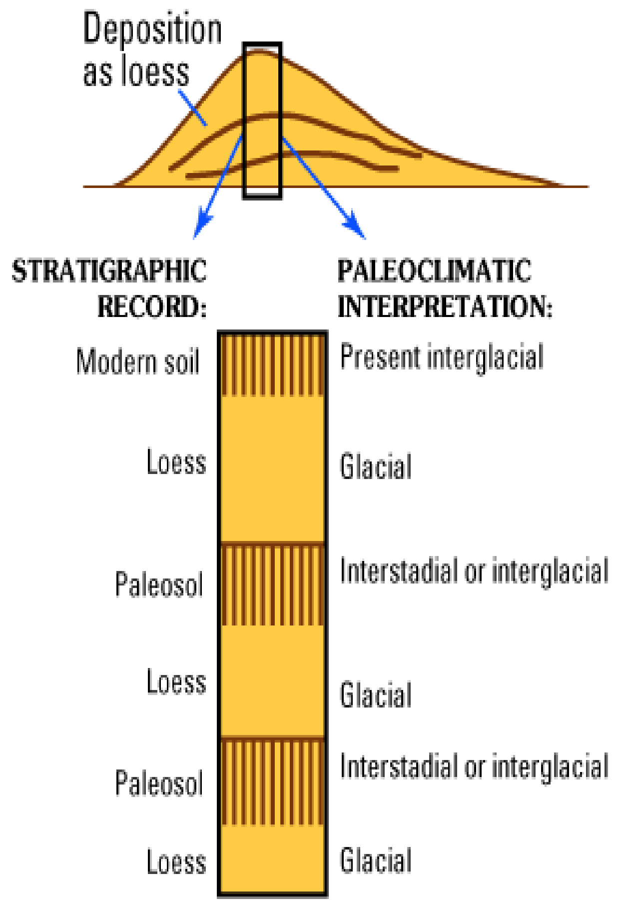
LOESS deposits

Widely dispersed dust

After Wright, 2001

Paleoclimate implications of Aeolian Sediments

Diagram showing the nature of the loess stratigraphic record. In most regions, including much of North America, Europe, and China, loess was deposited during glacial periods and soils were formed during interglacial periods. Soils that become buried by younger loess are called "paleosols."



IDC 203: INTRODUCTION TO EARTH SCIENCES

Outline

1. Glacial: the work of ice

Glaciers: the Work of Ice

Glacier

- Body of ice, snow, firn, and meltwater lying wholly or mostly on land showing evidence of present or former motion.

- Glaciers form where more snow accumulates in winter than melts in summer.

Types of Glaciers

- Based on their formation
- Geophysical classification
- Morphological classification

Types of Glaciers

- Based on their formation
  - Alpine: restricted to mountainous systems
    - Himalaya, Alps
  - Continental: covers extremely large areas
    - Antarctica: 12,500,000 km2 up to 3 km   thick, 80% of the ice on earth, 65% of the fresh water
    - Greenland: 1,700,000 km2 3.2 km thick

Types of Glaciers

- Geophysical classification
  - Warm base - water at the bottom
    - Alps
  - Cold base - ice at the bottom
    - Antarctic and Greenland ice sheet

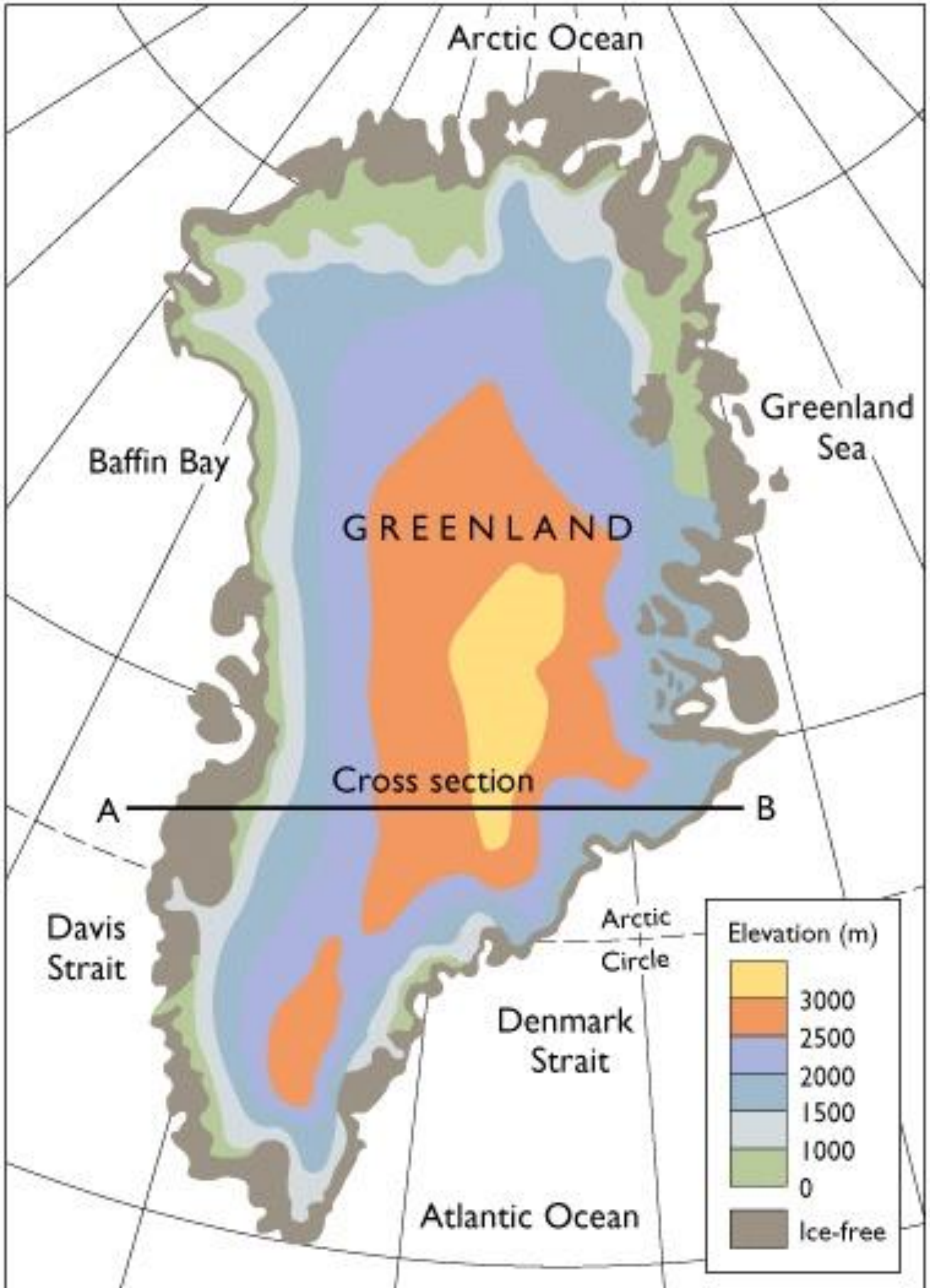
Types of Glaciers

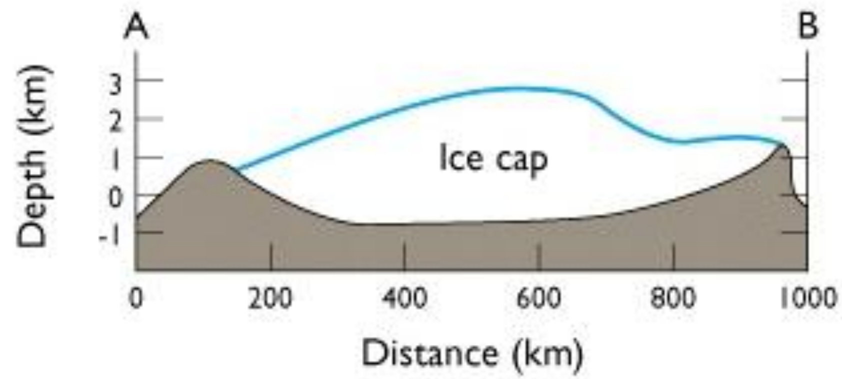
- Morphological classification
  - Valley glacier
    - Valley glaciers are streams of flowing ice that are confined within steep walled valley
  - Ice cap glacier
  - Ice shelf glacier

Types of Glaciers

- Morphological classification
  - Valley glacier
  - Ice cap glacier
    - Ice caps are miniature ice sheets, covering less than 50,000 square kilometers (19,305 square miles) thin steep walled valley
  - Ice shelf glacier

Greenland Ice Cap



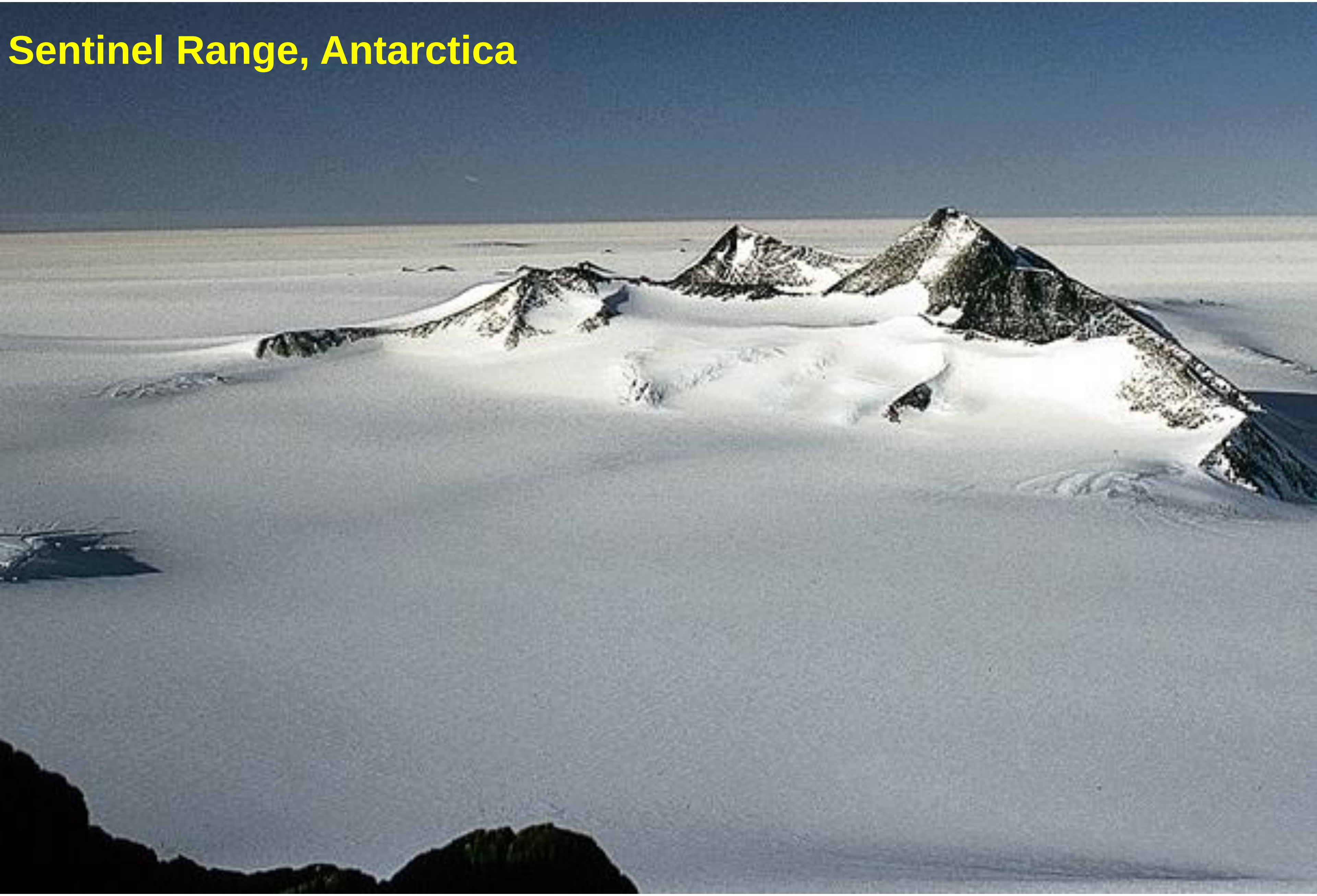


Types of Glaciers

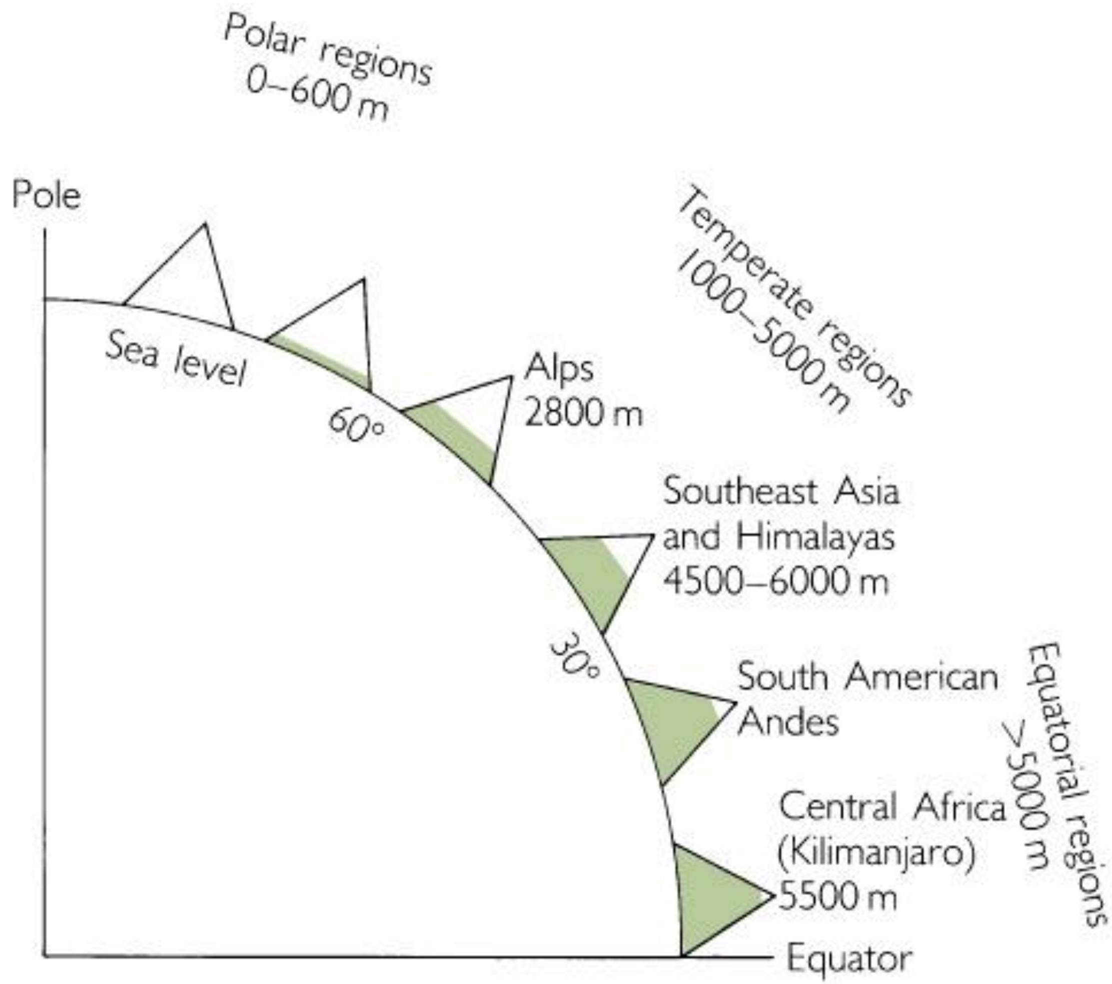
- Morphological classification
  - Valley glacier
  - Ice cap glacier

  - Ice shelf glacier
    - An ice sheet is a chunk of glacier ice that covers the land surrounding it and is greater than 50,000 kilometers (20,000 miles) wide.

Sentinel Range, Antarctica

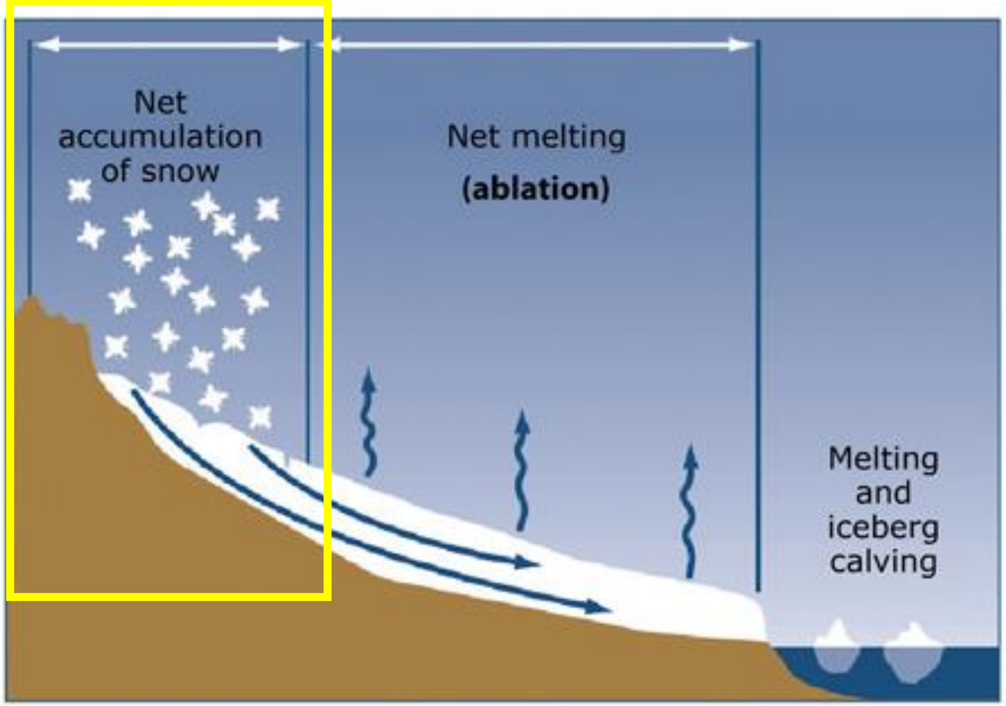


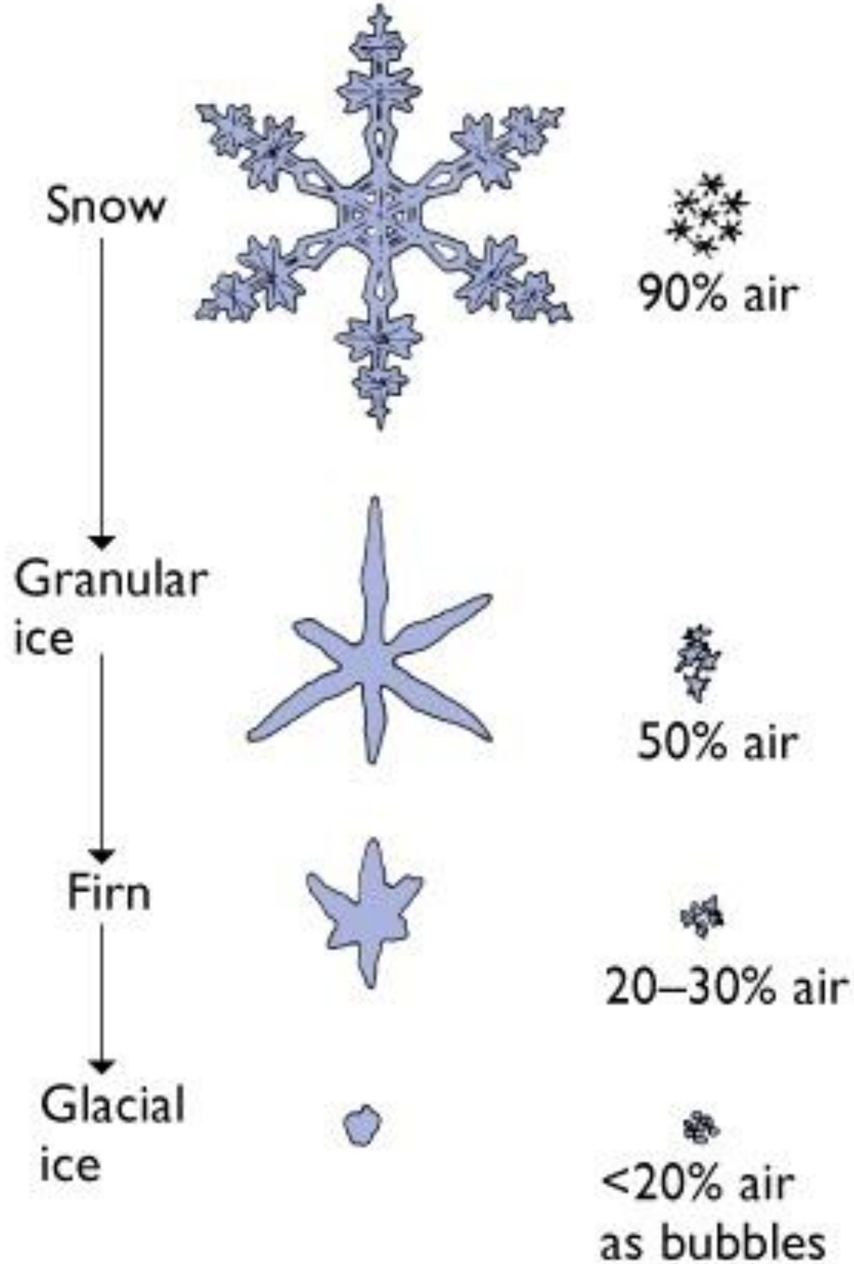
Variations in the Present Height of the Snow Line



Glacial growth: Accumulation

- Transformation of snow into ice
  - *Snow* may be thought of as sediment,
  - *Firn* as sedimentary rock, and
  - *Glacier ice* as metamorphic rock.

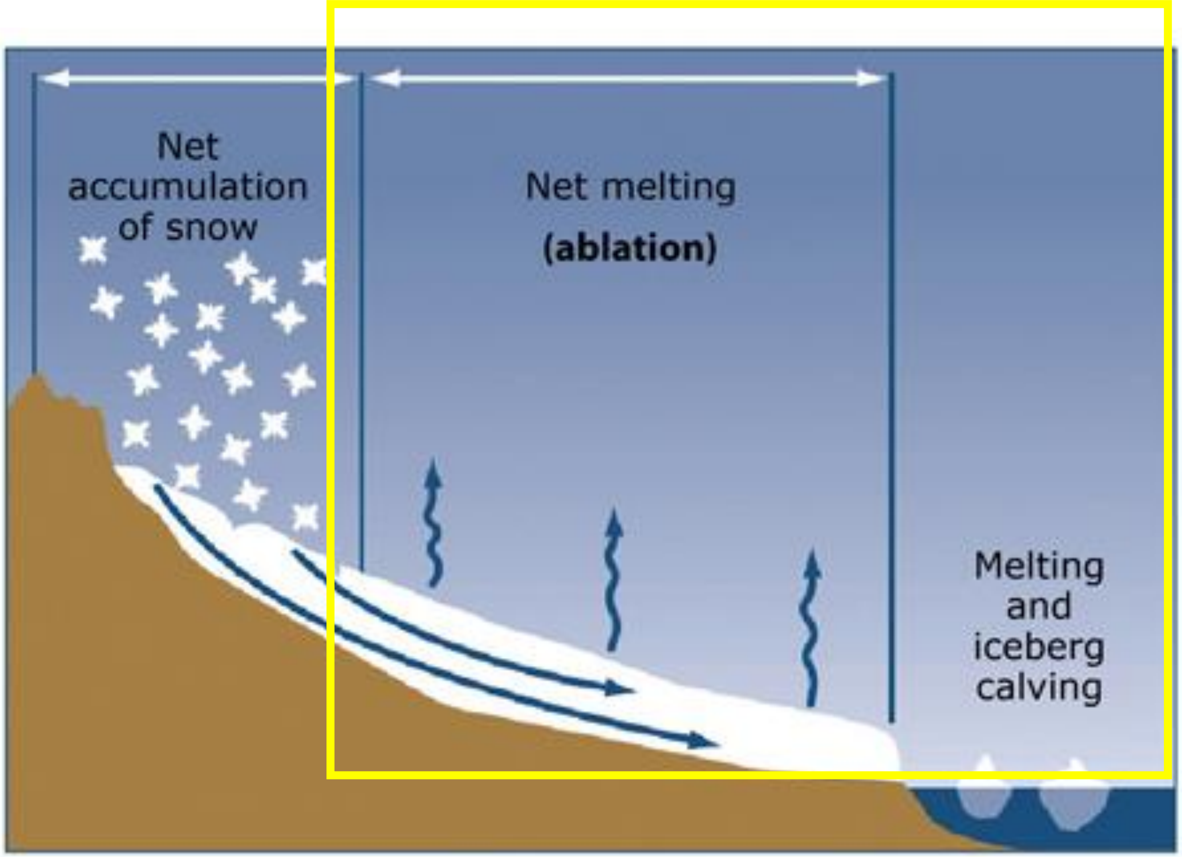




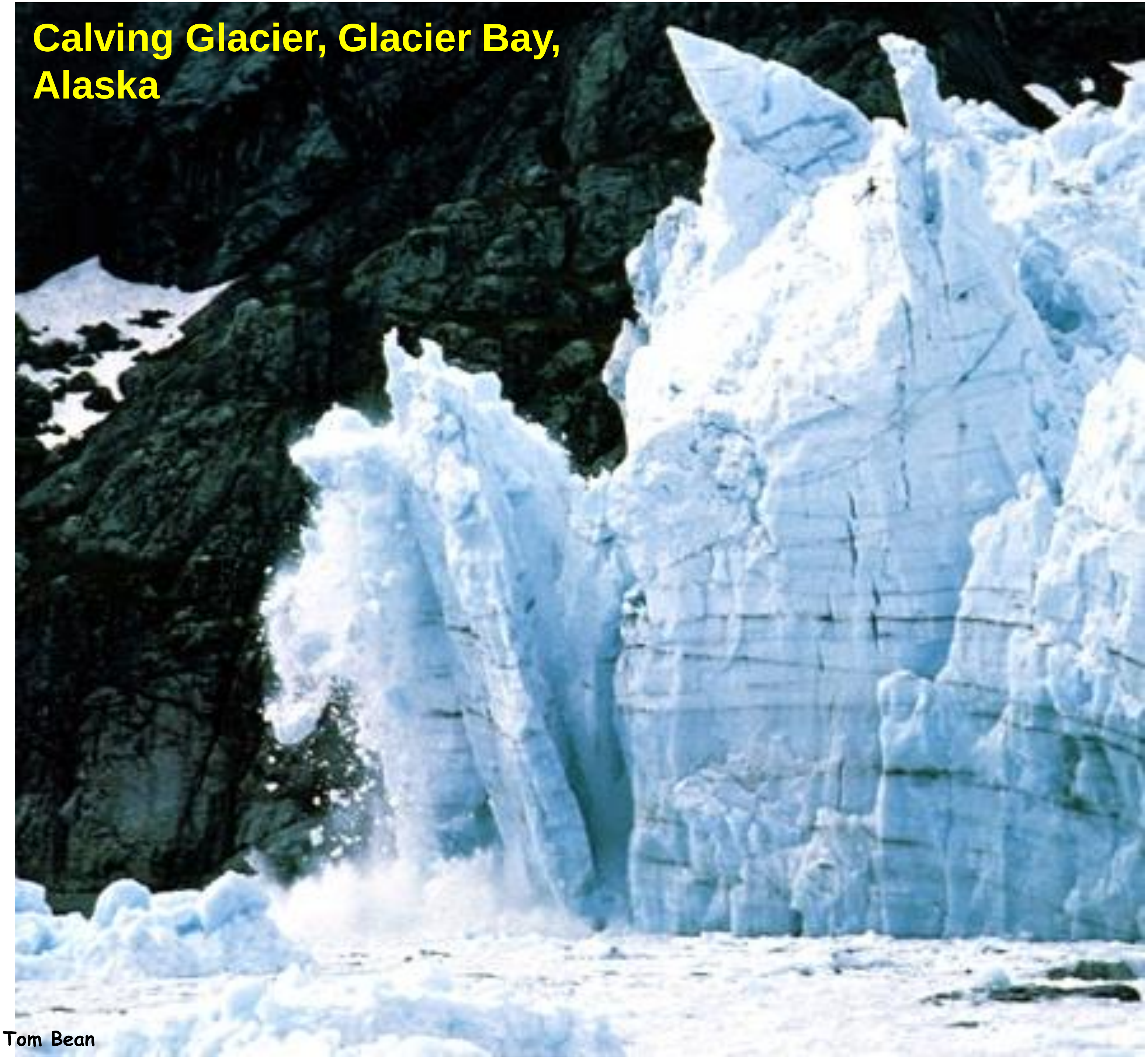
Transformation of Snow to Glacial Ice

Glacial shrinkage: Ablation

- Melting
- Iceberg calving: breaking off of chunks of ice at the edge of a glacier
- Sublimation

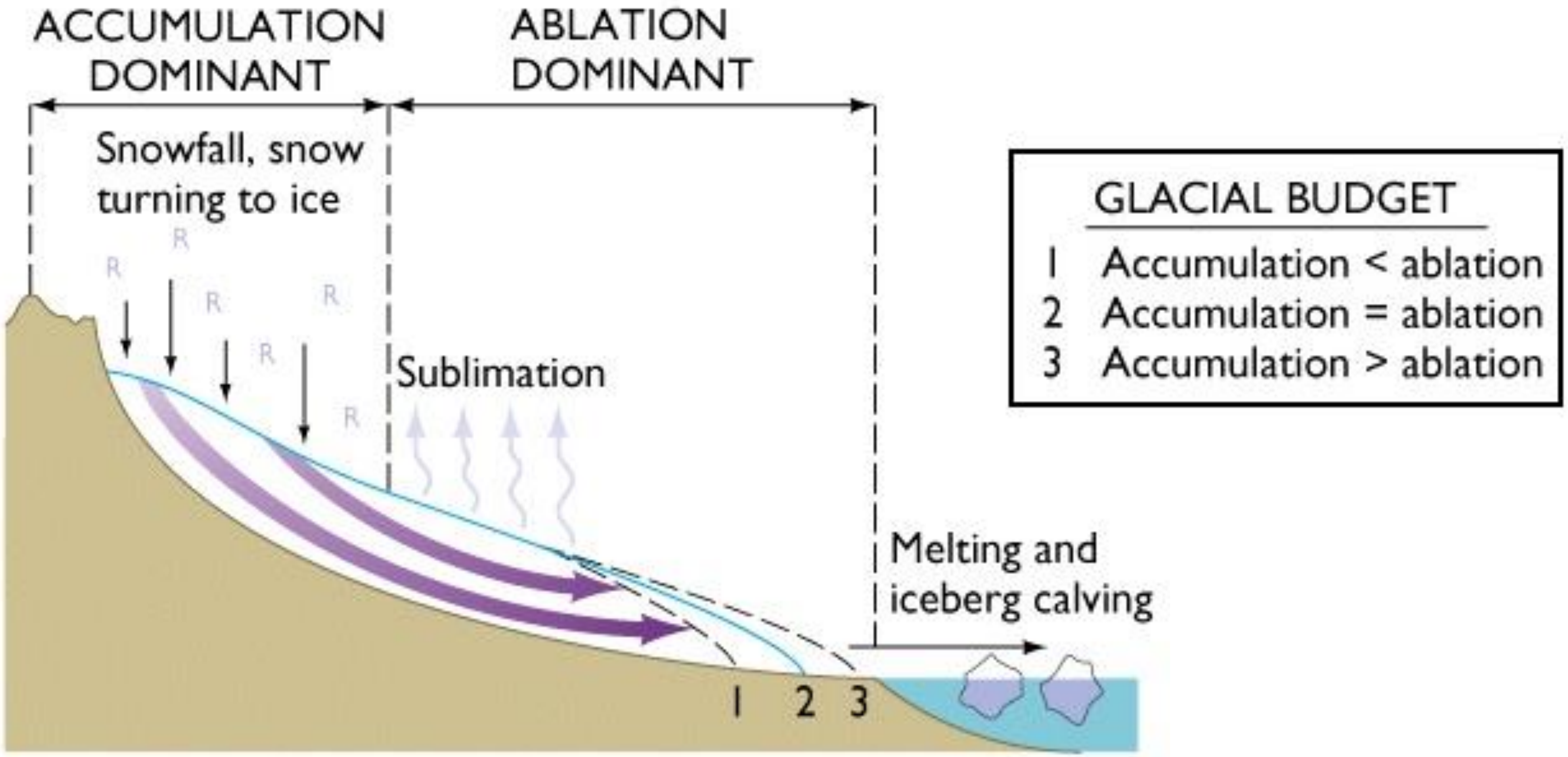


Calving Glacier, Glacier Bay, Alaska



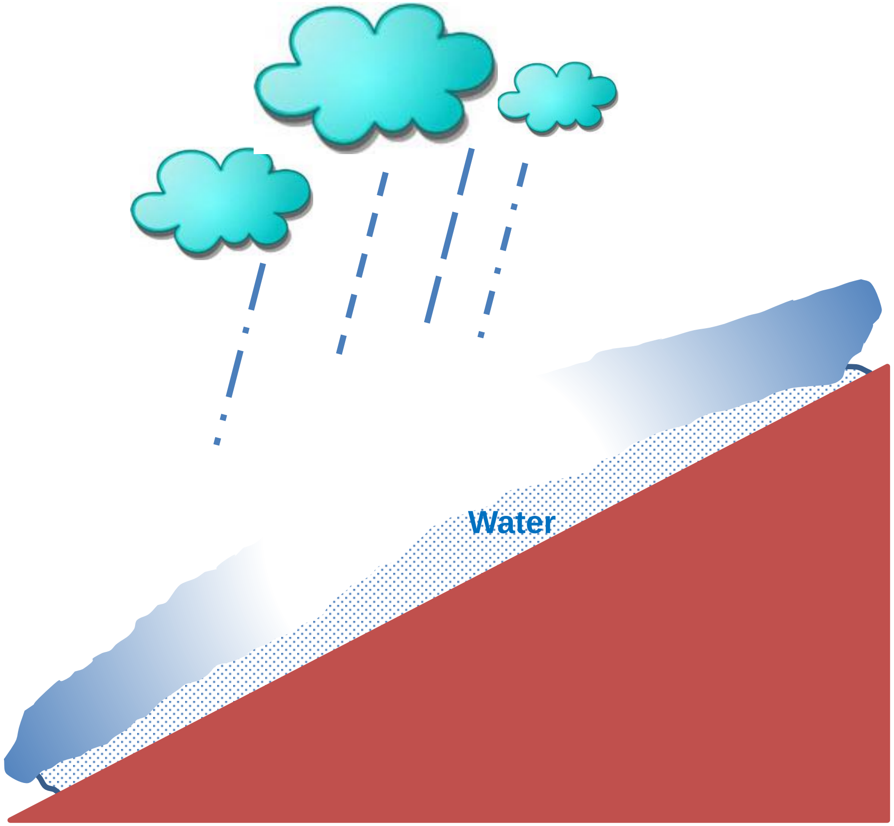
Tom Bean

Glacial Budget



Mechanisms of motion in glaciers

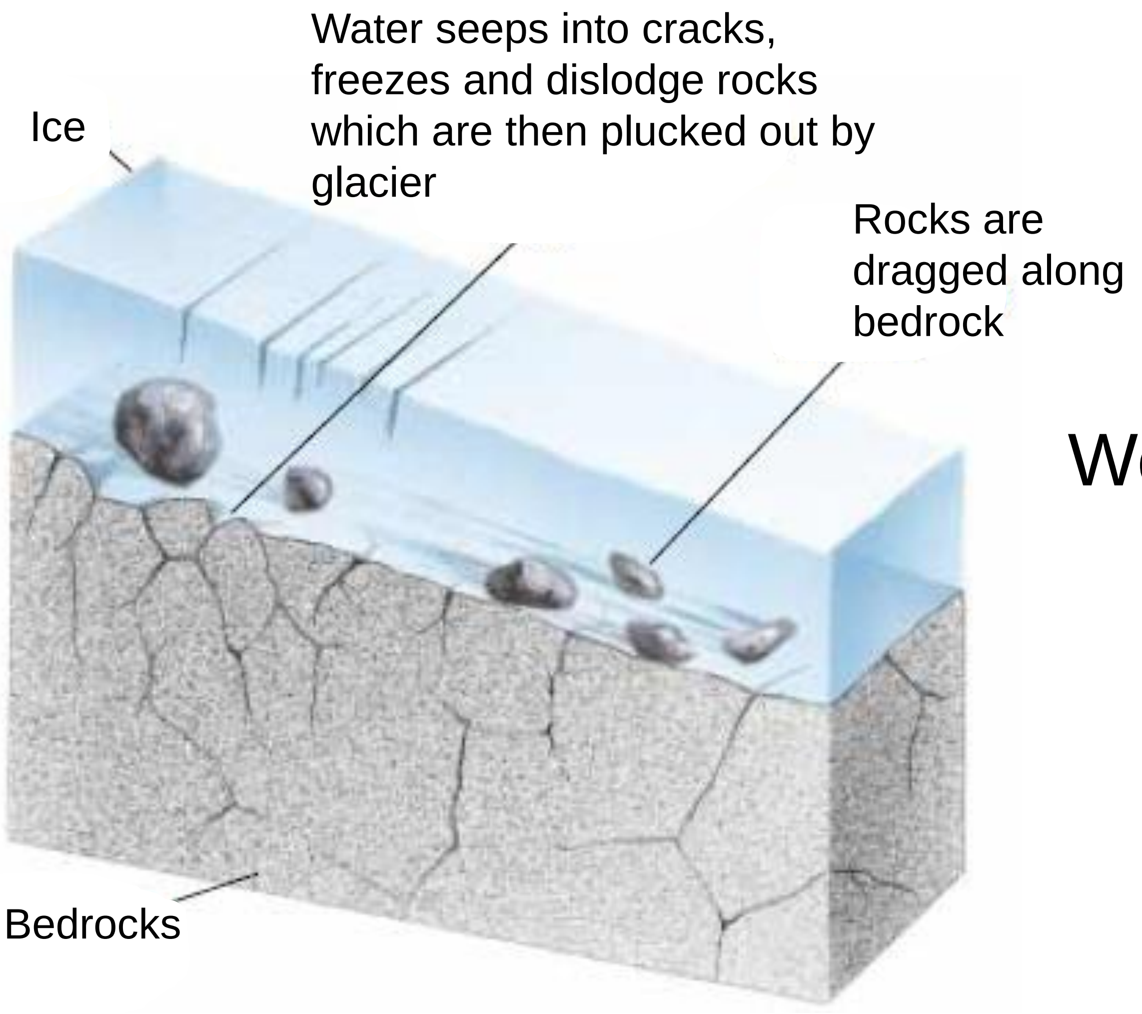
- Rates of glacial movement depends
  - Slope steepness
  - Precipitation
  - Air temperature



Rates of motion

- Extremely variable from one glacier to another
- Millimeters to meters per day
- Some glaciers move in surges: periods of rapid movement following periods of quiescence.
- During surge, rates may be 50 m/day.
- Rates vary with position in the glacier.

Glacial erosion



Weathering processes

- Temperature change
- pressure release fracture

Glacial erosion

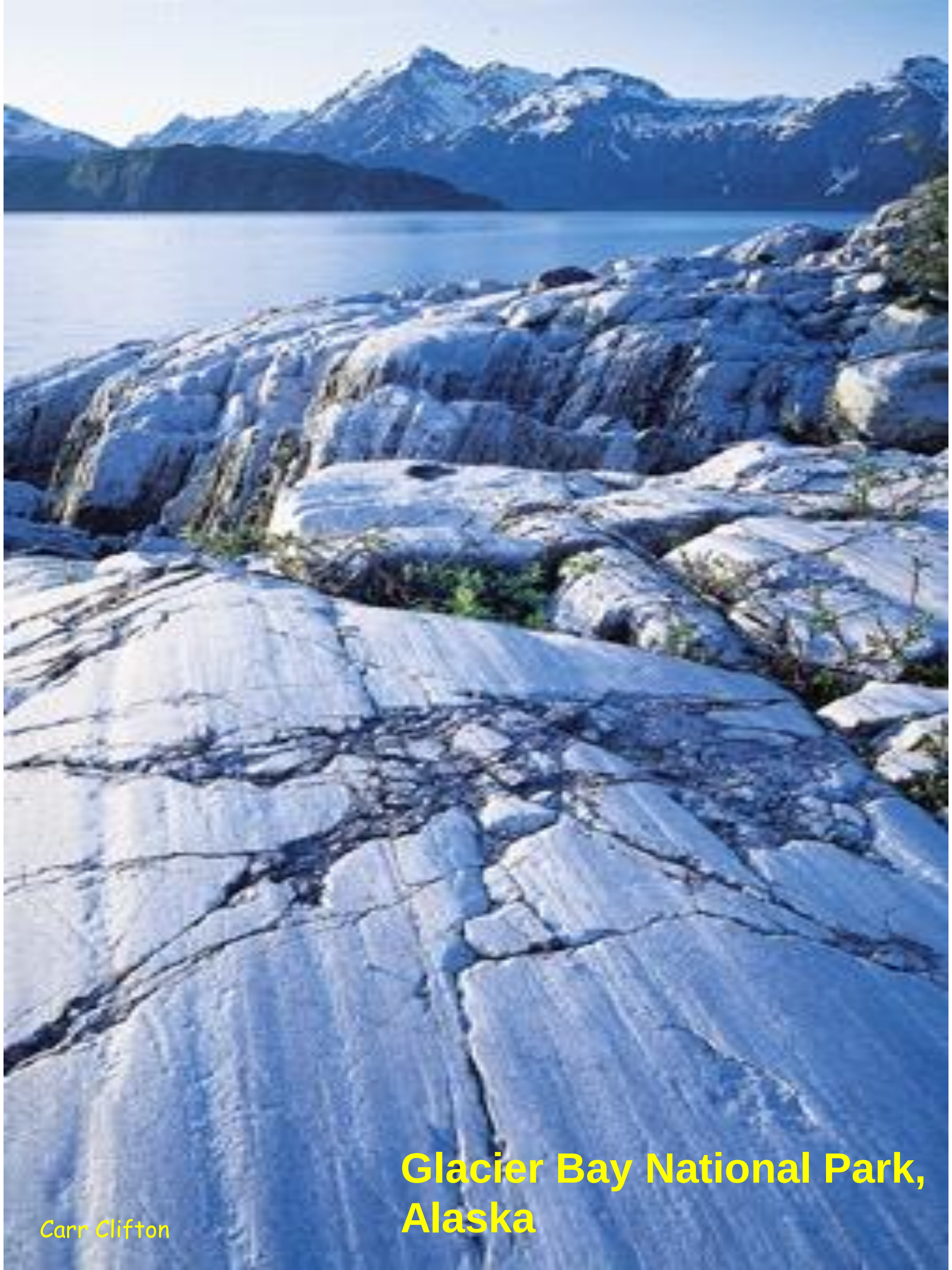
- Glacial erosional features
  - **Plucking**
    - rocks and stones become frozen to the base or sides of the glacier and are plucked from the ground or rock face as the glacier moves

Glacial erosion

- Glacial erosional features
  - **Glacial striations**
    - scratches or gouges cut into bedrock by glacial abrasion

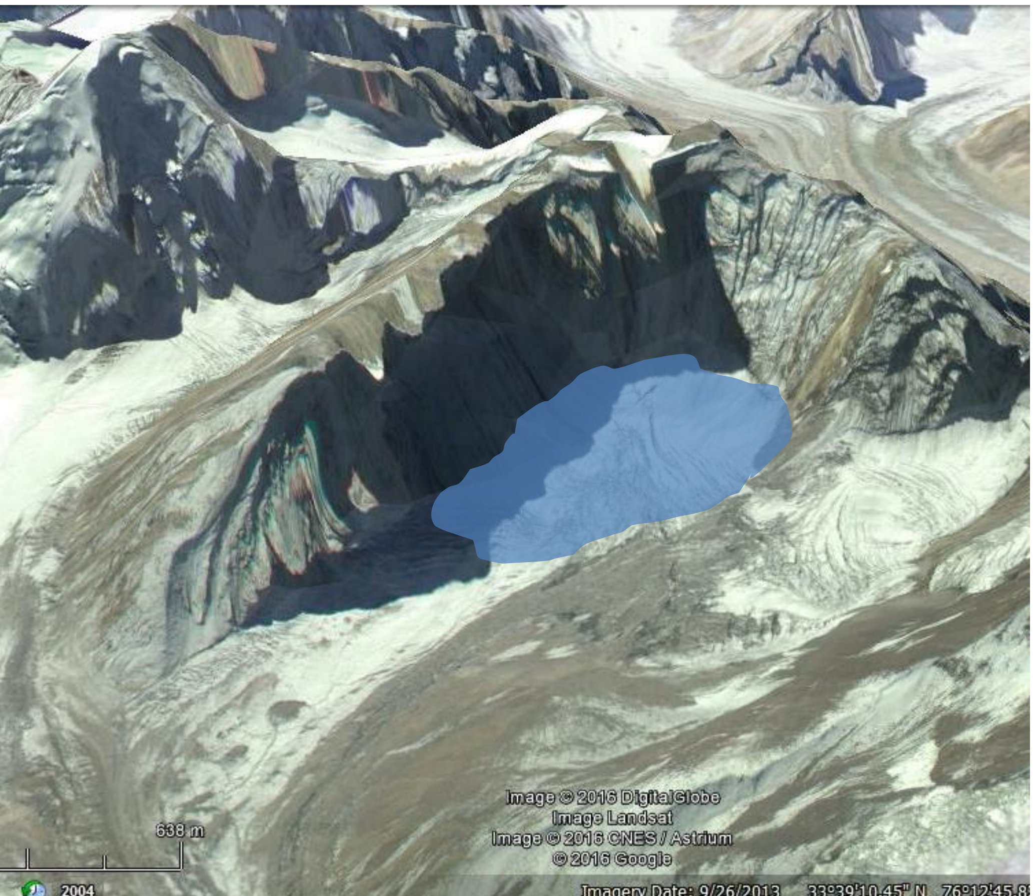
Glacial erosion

- **Rock flour**
  - fine-grained, silt-sized particles of rock, generated by mechanical grinding of bedrock by glacial erosion


Carr Clifton
Glacier Bay National Park,
Alaska

Glacial Landforms

1. Cirque

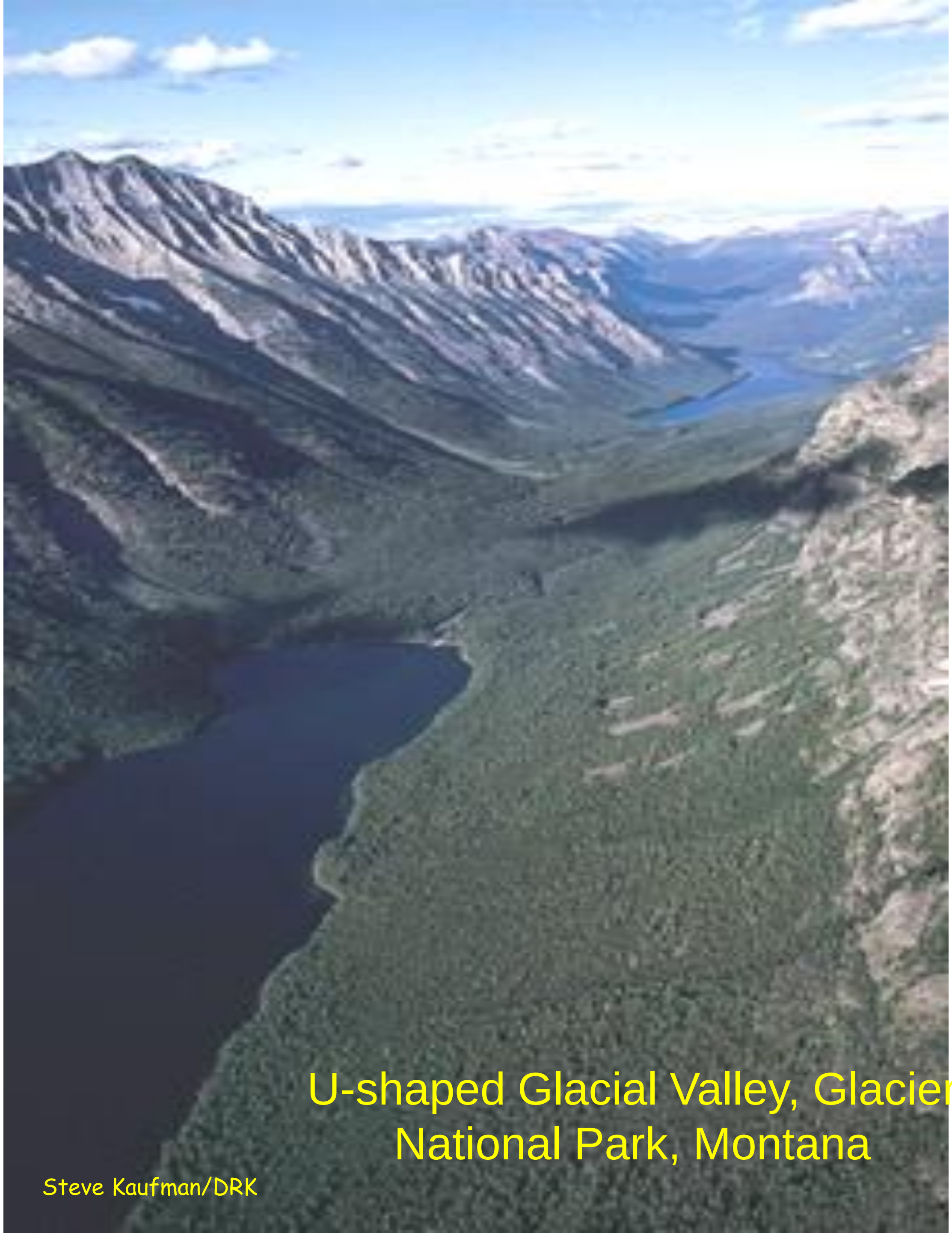


- Amphitheatre shaped
- Characterised by
  - Steep sided slope (3 sides)
  - Open end (one side)
  - Flat bottom
- May also develop into tarn lakes

Glacial Landforms

2. "U" shaped valley

- Uniform erosional activity
- Horizontal and vertical
- Steep sided and flat bottom



U-shaped Glacial Valley, Glacier National Park, Montana

Fig. 15.20

Glacial Landforms

5. Fjord

- A fjord is formed when a glacier retreats, after carving its typical U-shaped valley, and the sea fills the resulting valley floor.
- Narrow, steep sided inlet (sometimes deeper than 1300 metres) connected to the sea

6. Fjord

Glacial Deposits

- Erratics
- Glacial drift
  - Till
  - Stratified drift

Glacial Deposits

- **Erratics**
  - Large boulder size rock type
  - Transported by glaciers

Glacial Deposits

Glacial drift

- Averages 6 m thick over the rocky hills
- Two types
  - Till:
    - deposited directly by glacial ice
    - Highly variable
    - Variable grain sizes
    - Sharp edged or irregular shaped pebbles and cobbles
  - Stratified drift:
    - carried by streams and deposited by streams
    - Distinct horizontal bands
    - Rounded

Glacial Deposits

Till

Stratified drift

Martin Miller

Landforms by Glacial Deposits

Moraine

- Accumulation of till deposited
- Based on the locations, characterised by several types.

  - End moraine

  - lateral moraine

  -medial moraine


Lateral
Moraines
Stephen J. Krasemann/DRK Photo

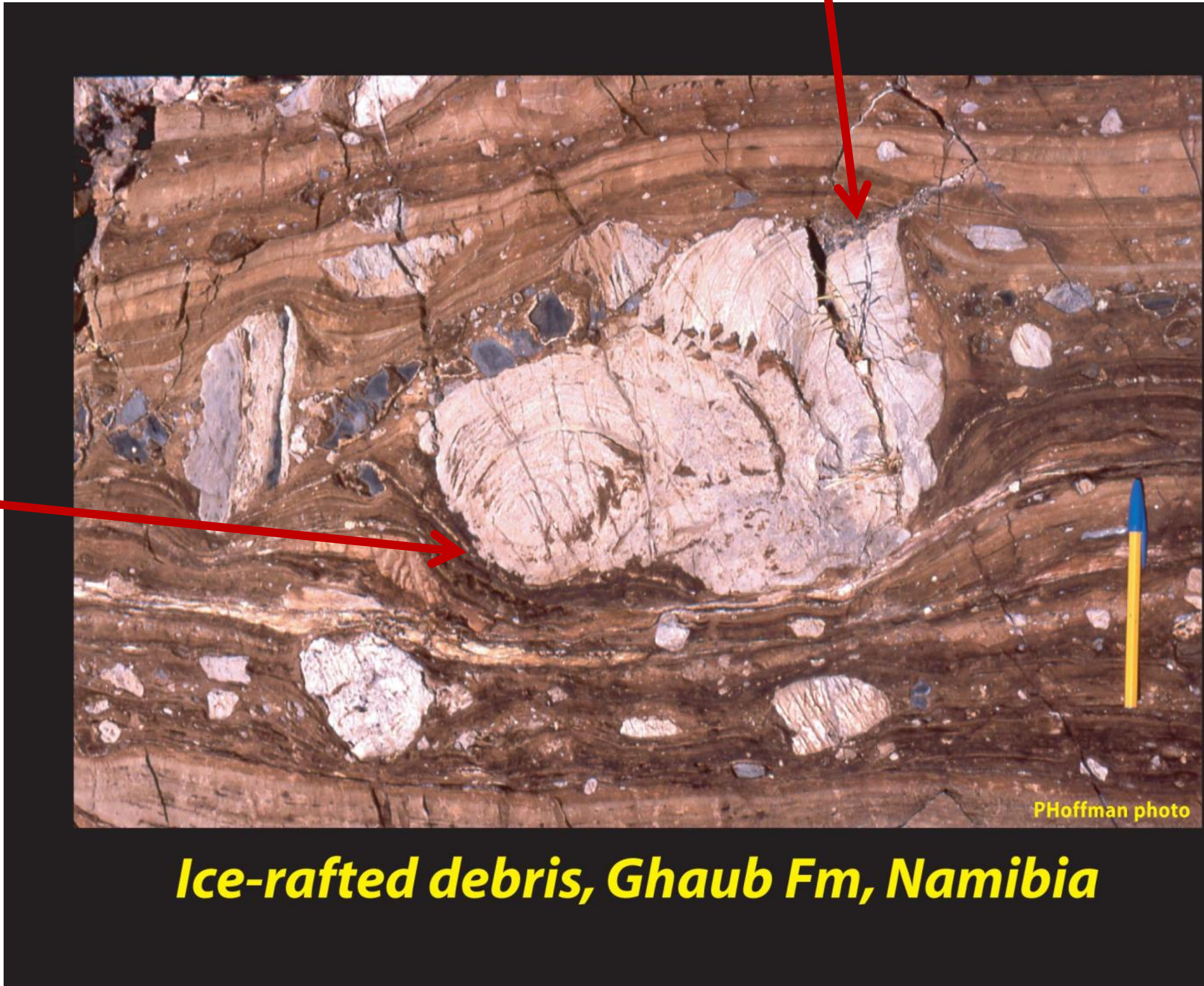
Indicator Facies

- **Dropstones:** Good indicator of glacial lacustrine/-marine environments where ice rafted debris was deposited as dropstones.

How we know it’s a dropstone:

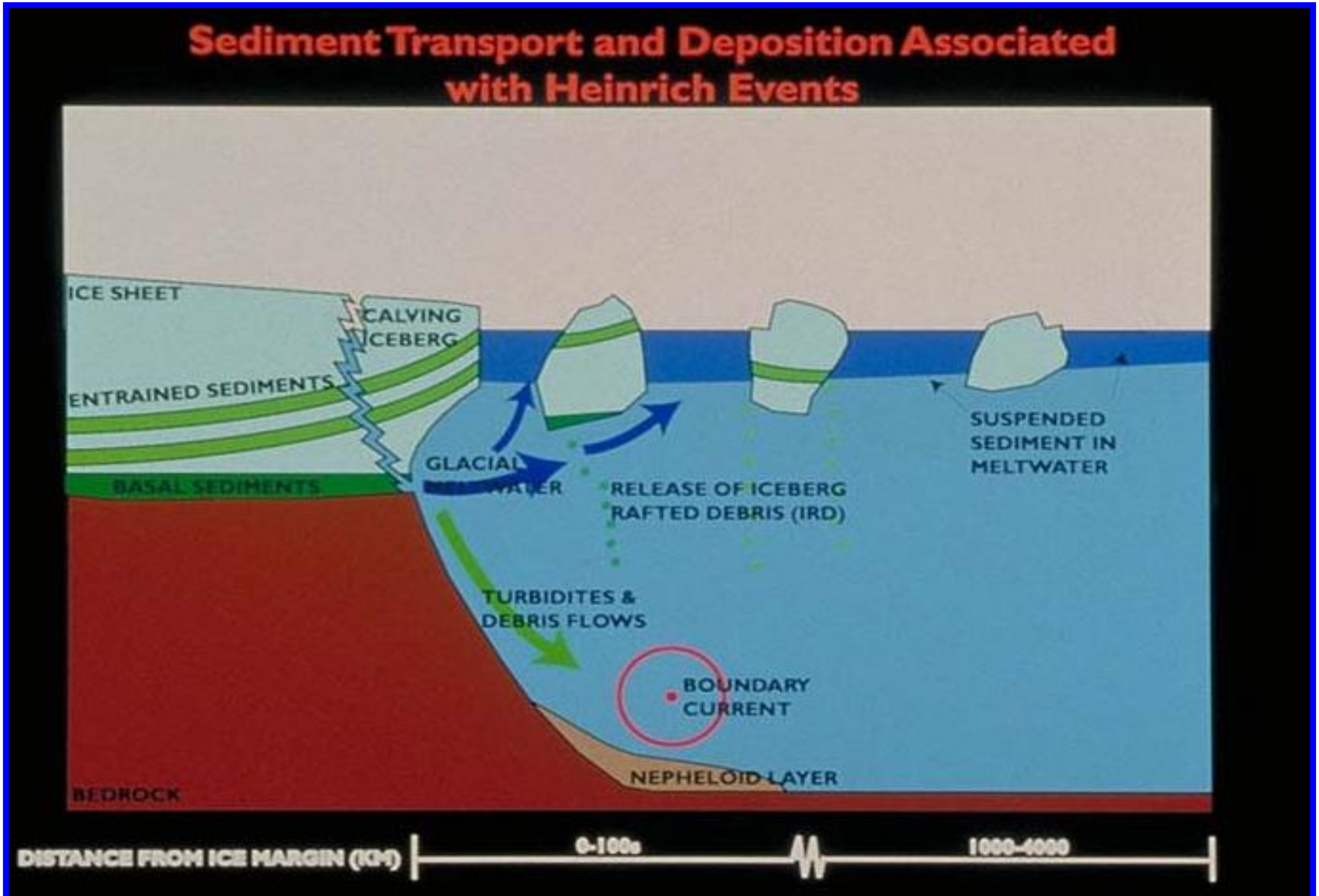
“On-lap” of sediment at top contact

Deformation/penetration of laminated sediment at bottom contact.



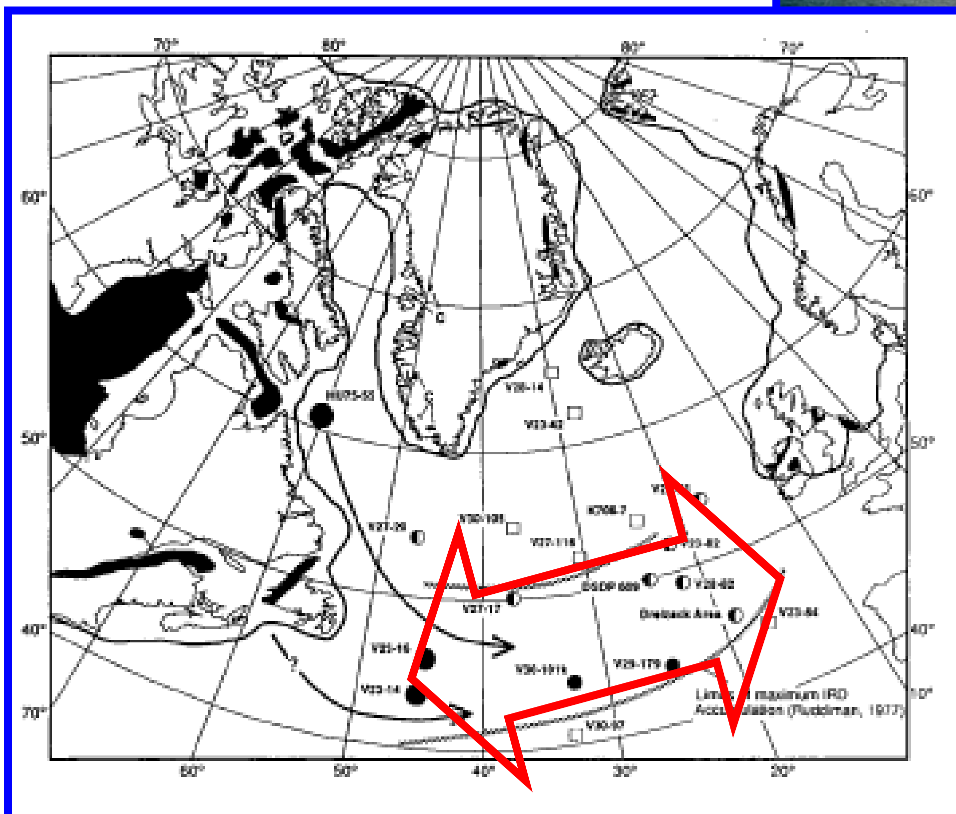
…. IN MARINE SEDIMENT ARCHIVES

Transport of ice-rafted debris (IRD)



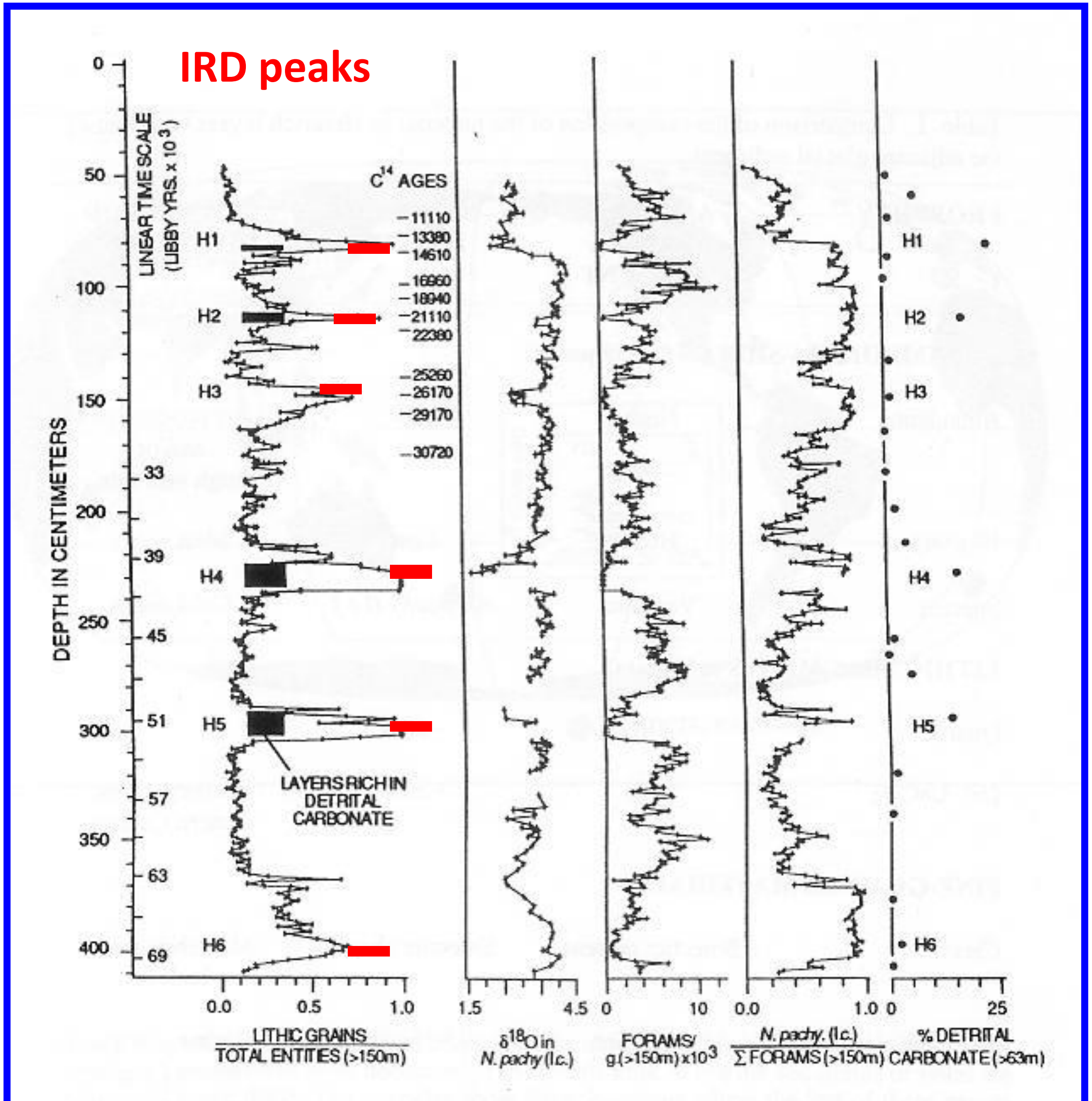
● Site with ice-rafted debris

□ Site without ice-rafted debris



"IRD Belt" - based on network of N. Atlantic marine sediment records

HEINRICH EVENT CHRONOLOGY



Bond et al. (1992)

Ice Cores

- Very important paleoclimatic archives.
- Records of past atmospheric conditions.
  - Temperature
  - Snow accumulation
  - Atmospheric composition
  - Volcanic activity

Ice Cores

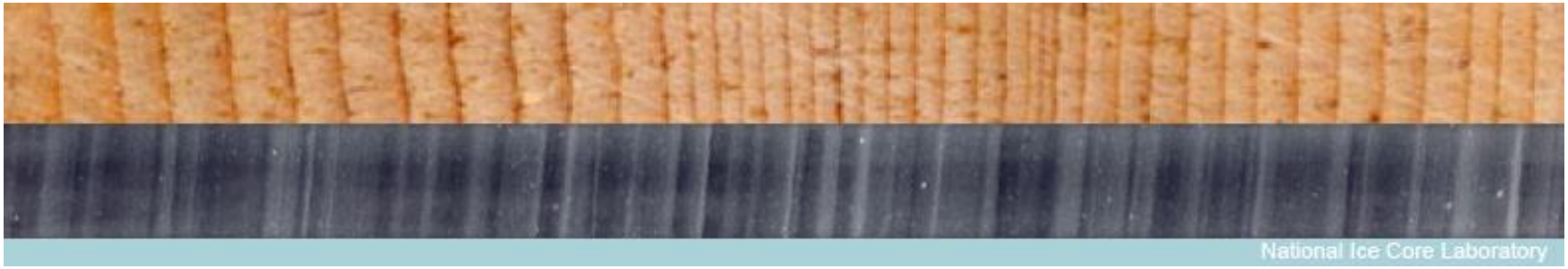
- Drilling into glacial ice allows us to see back in time.

- Each winter new snow fall packs on top of previous snow. This creates a new band each year.

The Vostok Ice Core

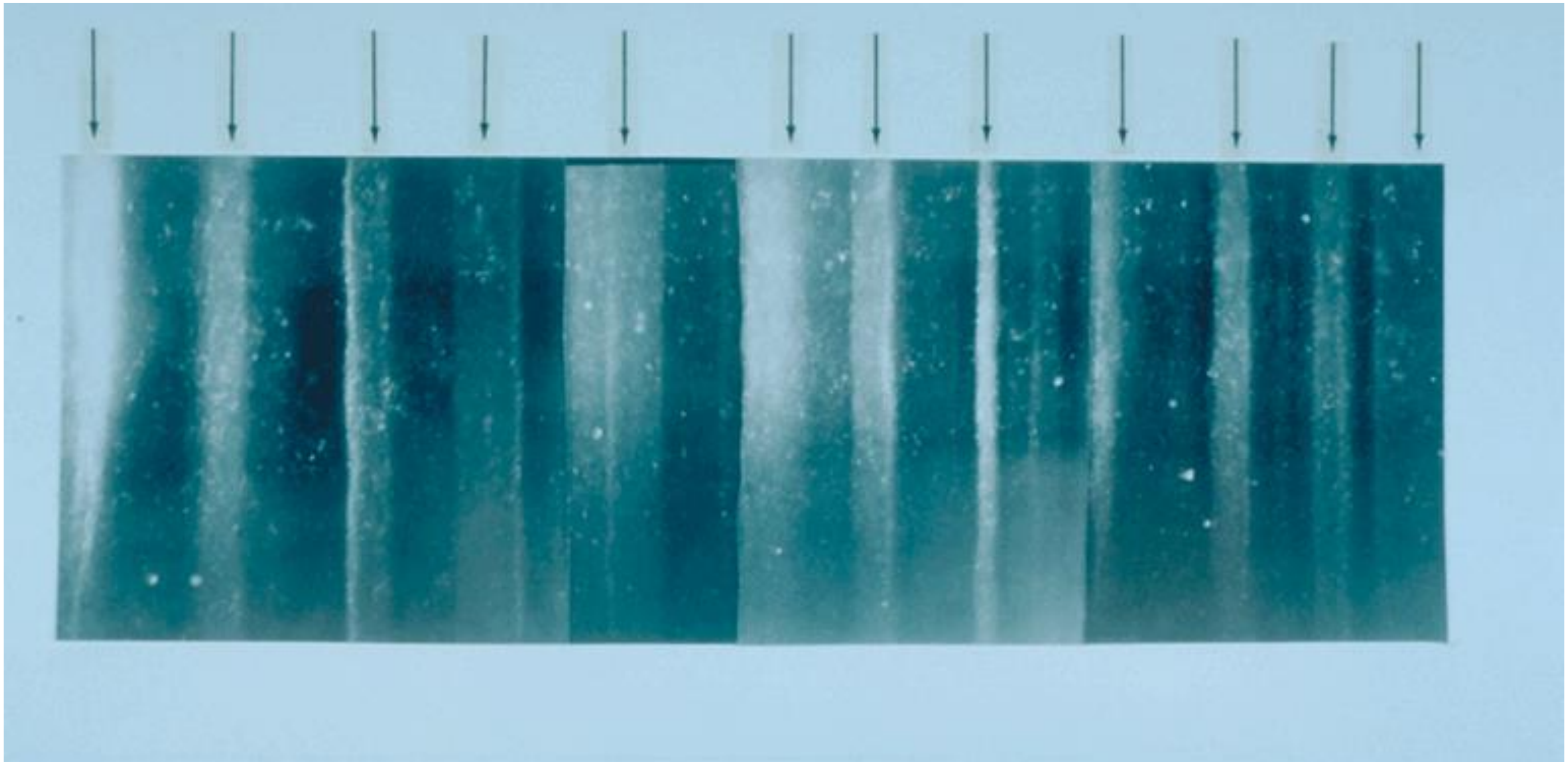
- The Vostok Ice Core is a Russian Station near the South Pole.
- Their ice cores have produced climate data for the past 420,000 years!

Dating Ice Cores



- Ice cores are like tree rings
- Summer ice appears light
- Winter ice appears dark
- How many years do you see?

Dating Ice Cores

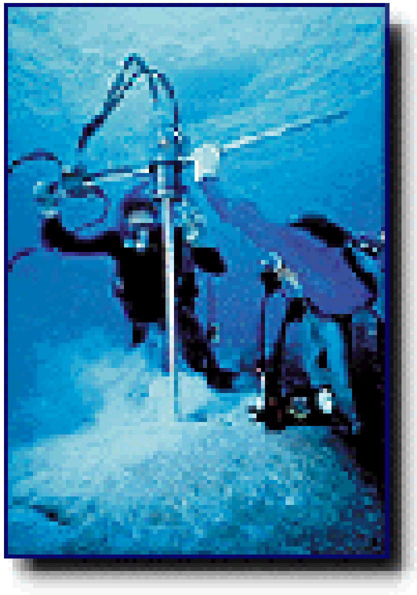


This ice core shows 12 years

1. Coral Reefs

- Corals are composed of calcium carbonate.

- This carbonate contains isotopes of oxygen that can be used to determine the water temperature when and where the corals grew.



2. Ice Cores

- As snow and ice accumulate in polar glaciers a paleoclimate record accumulates of the environmental conditions of the time of formation

- Ice cores can analyzed using stable isotope approaches for water or air bubbles within the ice as a record of past atmospheric gas concentrations.

3. Tree Rings

- Tree growth is influenced by climate. These patterns can be seen in tree ring width and isotopic composition.

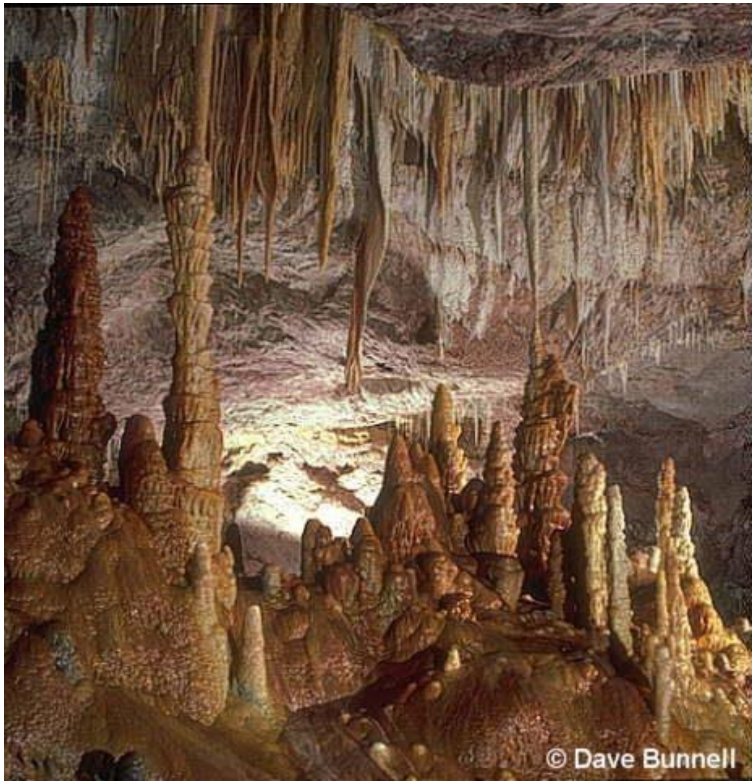
- Trees generally produce one ring each year.

- Trees ring records can extend back to the last 1000 years.

4.Stalagmites

Form from the bottom of the cave

They comprises of calcium carbonate

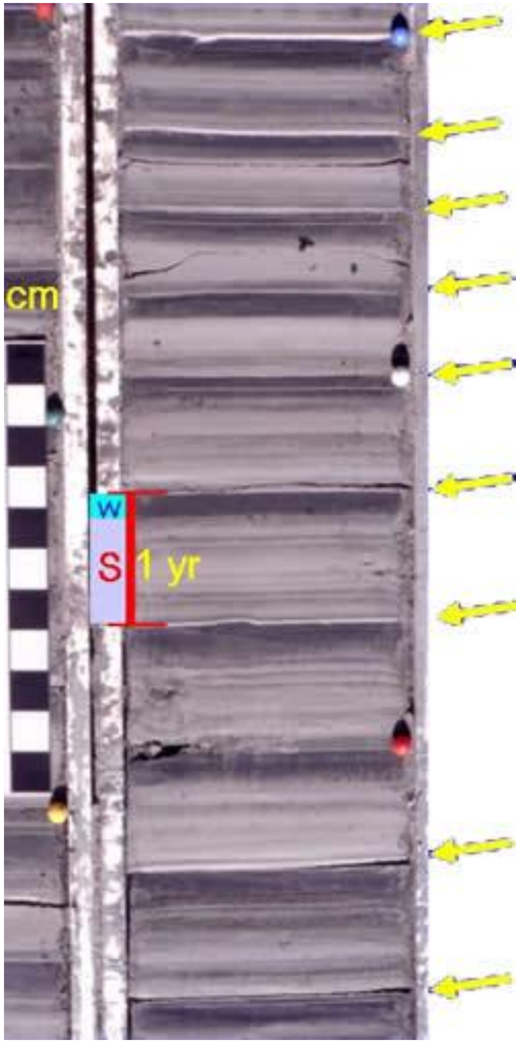


5. Sediment Cores

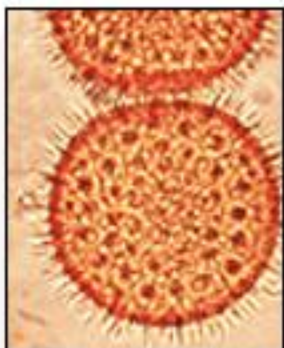
- Sediment cores can be taken from lakes, the shallow ocean, or the deep ocean.

- In some cases the thickness of these layers can be used to infer past climate.

- In other cases, these layers are composed of organic material that can be analyzed for other climate proxies.



Pollen



- Pollen grains are well preserved in lake and ocean sediment.
- The analysis of each of these sediment layers provides information on the vegetation present at that time.
- Scientists can infer past climates (warm or cold) based on the distribution and changes in plant species.

7. Moraines and fluvial systems