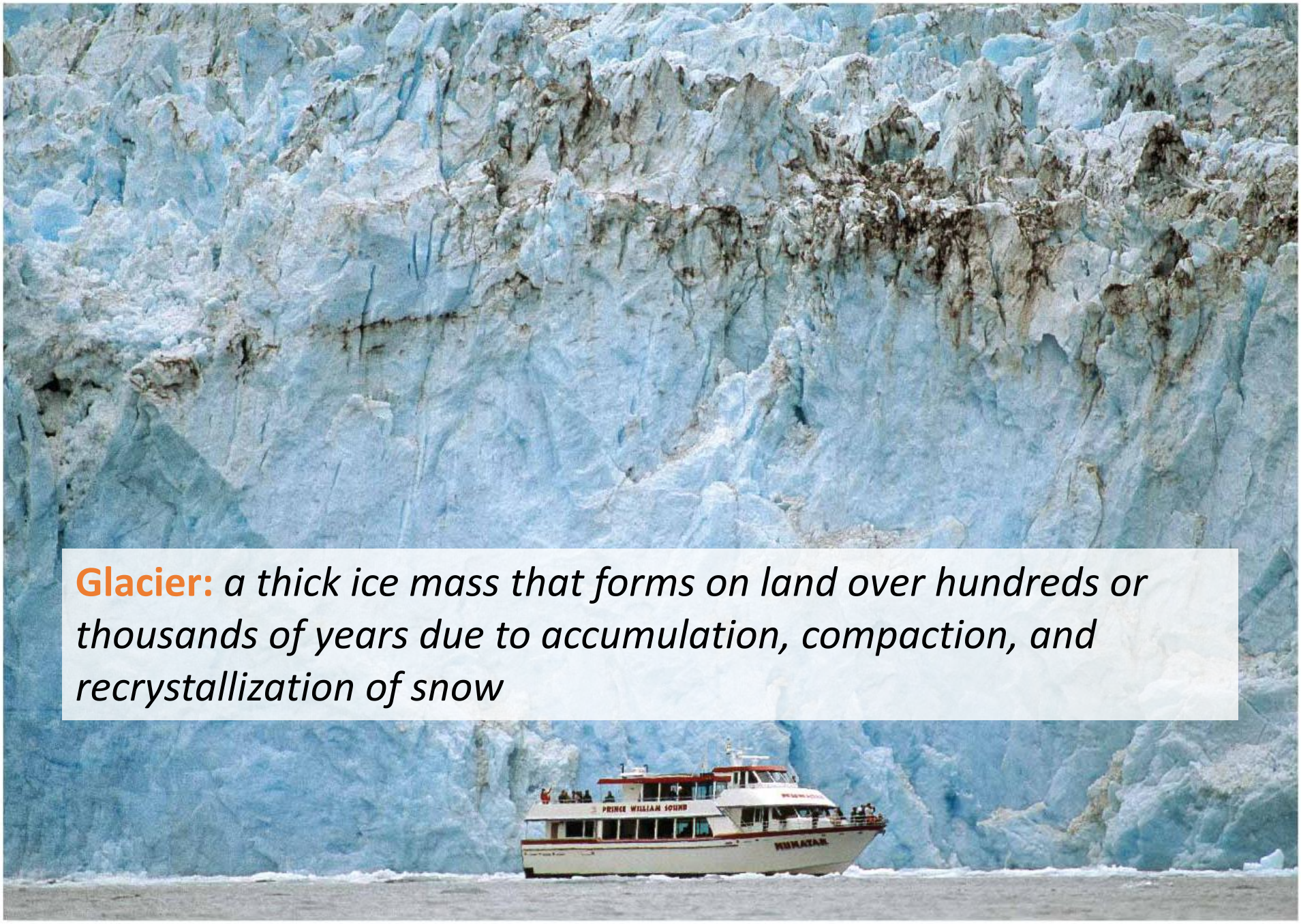
Glaciers & Glaciation



Glacier: *a thick ice mass that forms on land over hundreds or thousands of years due to accumulation, compaction, and recrystallization of snow*

Types of Glaciers

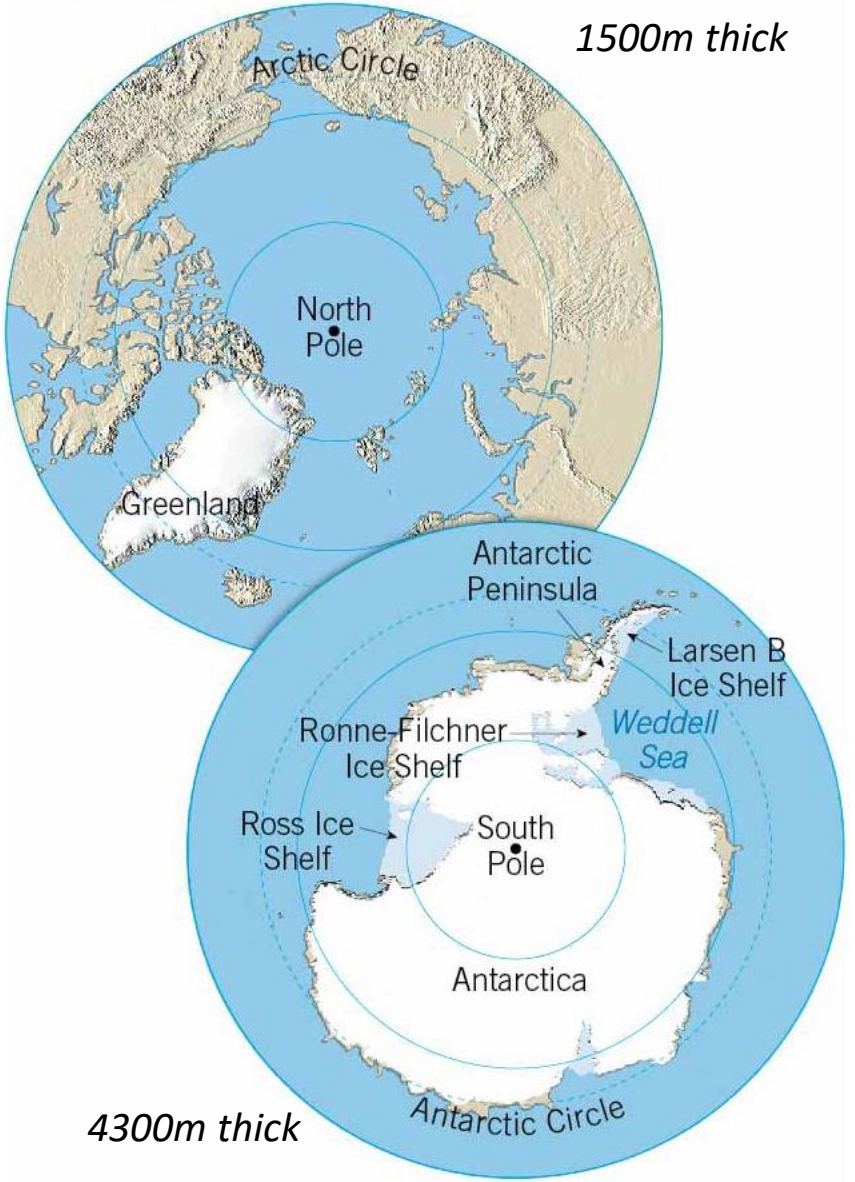
Valley (Alpine): *glaciers in high altitude valleys that were originally occupied by streams*

Ice Sheets: *massive (continent-scale) accumulations of ice*

Ice Shelves: *portions of the coast along Antarctica where ice flows onto the adjacent ocean (ice sheet over ocean)*

Greenland's ice sheet occupies 1.7 million square kilometers (663,000 square miles), about 80 percent of the island.

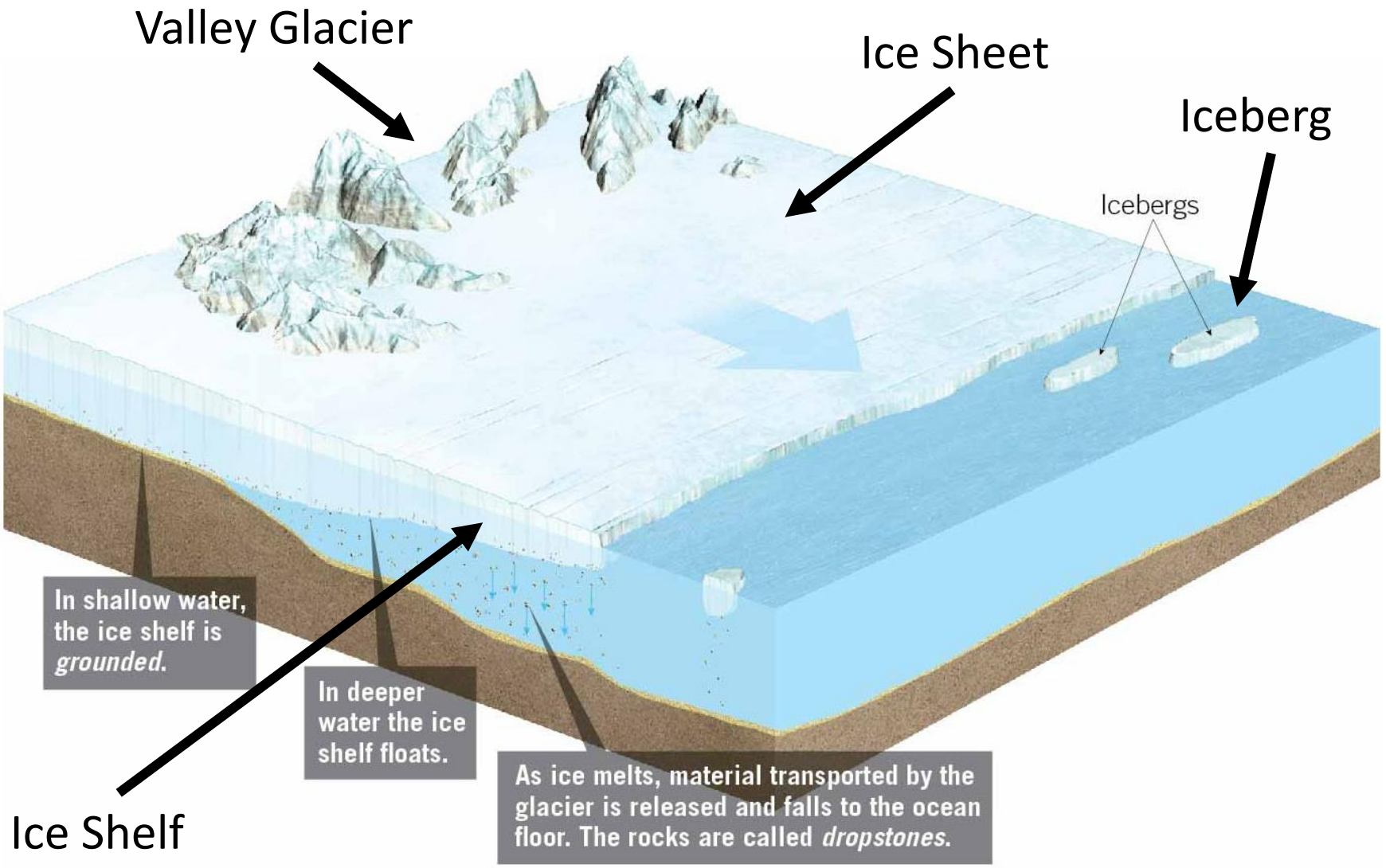
1500m thick



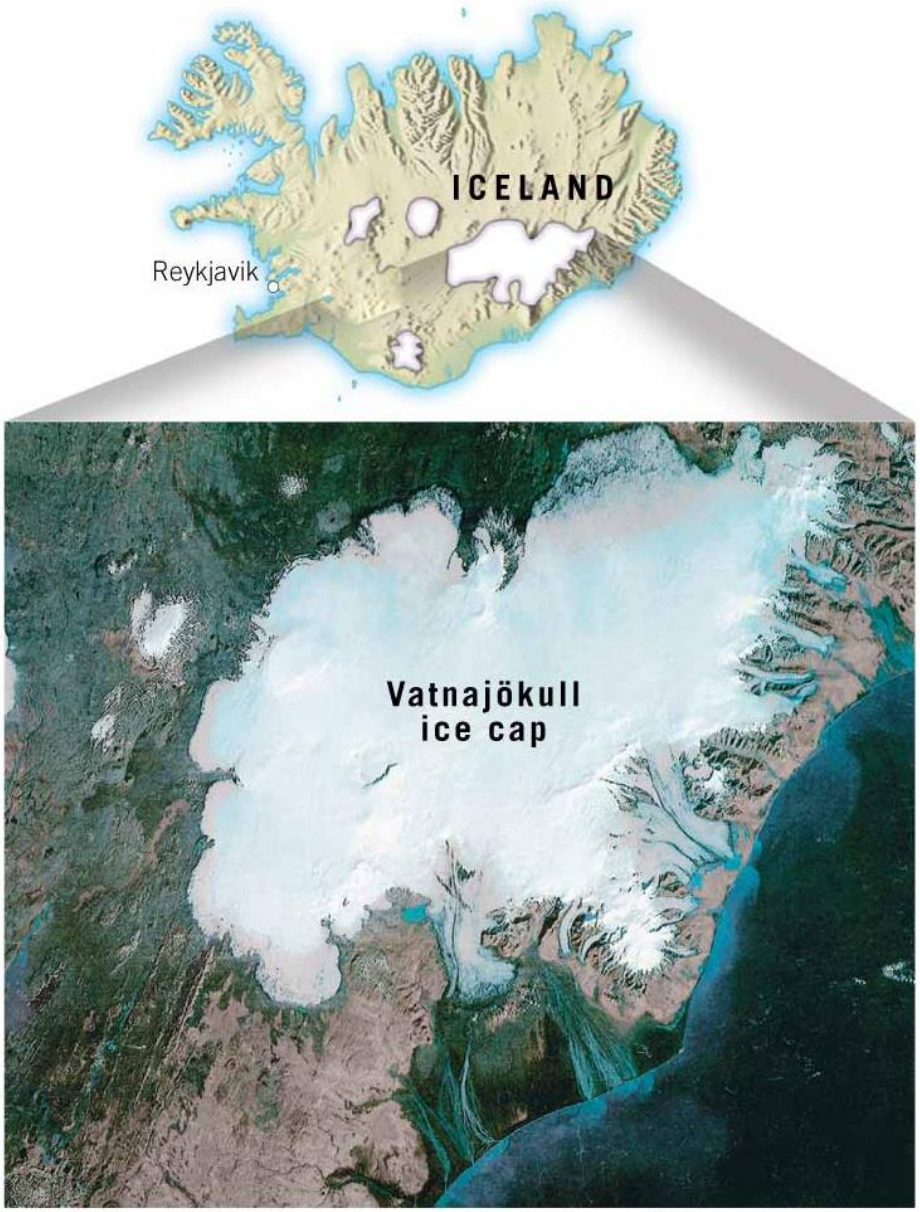
4300m thick

The area of the Antarctic Ice Sheet is almost 14 million square kilometers (5,460,000 square miles). Ice shelves occupy an additional 1.4 million square kilometers (546,000 square miles).

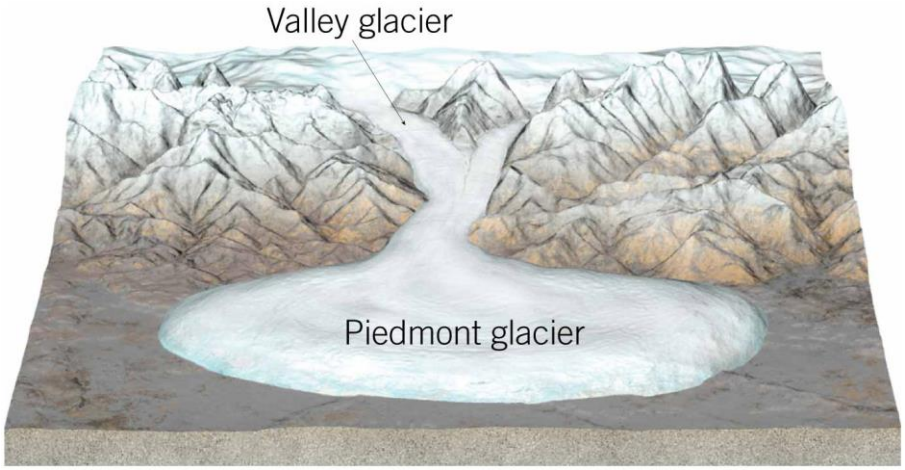
Types of Glaciers



Types of Glaciers

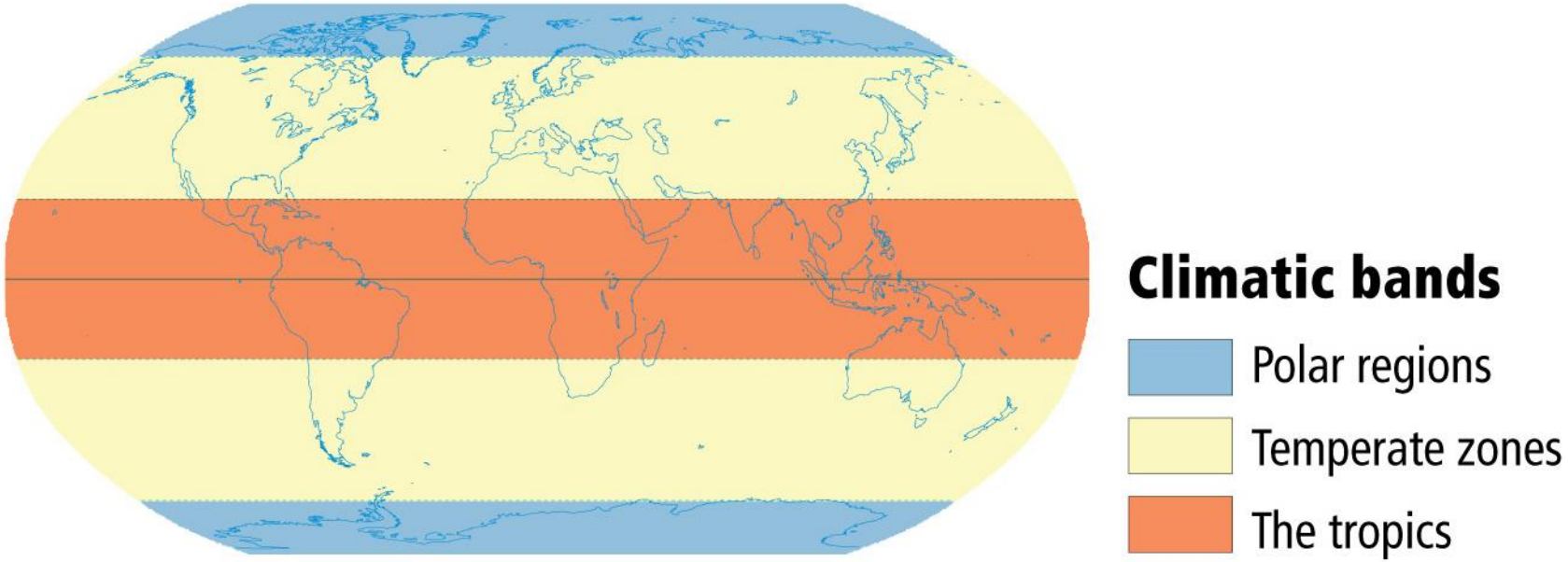


Ice caps completely bury the underlying terrain but are much smaller than ice sheets.



When a valley glacier is no longer confined, it spreads out to become a piedmont glacier.

Formation & Movement of Glacial Ice



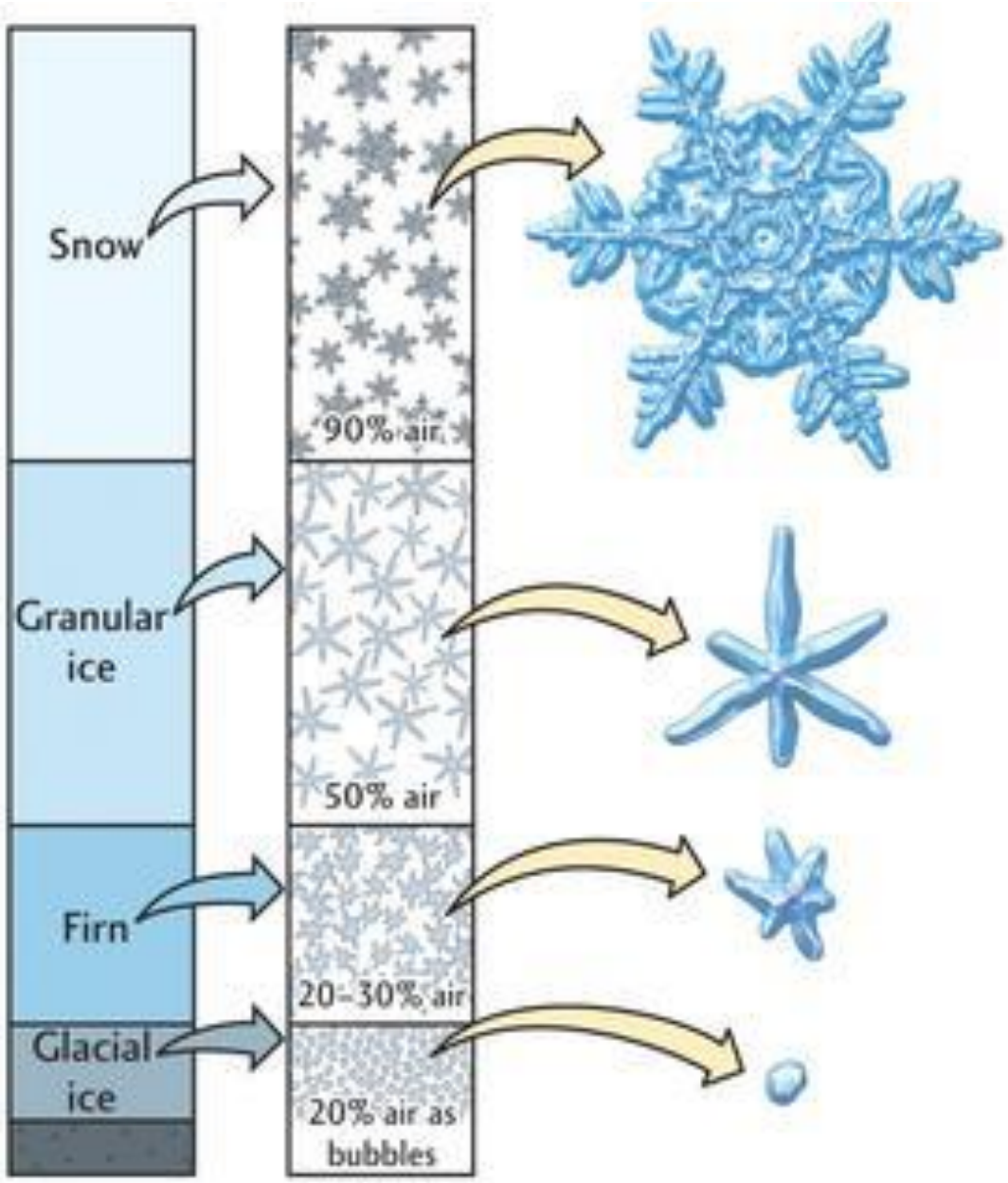
Glaciers form in the high-latitude **polar regions** *because temperatures remain low throughout the year so any snow that falls will not easily melt*

Formation & Movement of Glacial Ice

Glaciers can form in **high altitudes**, *at the top of mountains, at any latitude because temperatures remain low throughout the year*

Form above the **snowline**

Formation & Movement of Glacial Ice



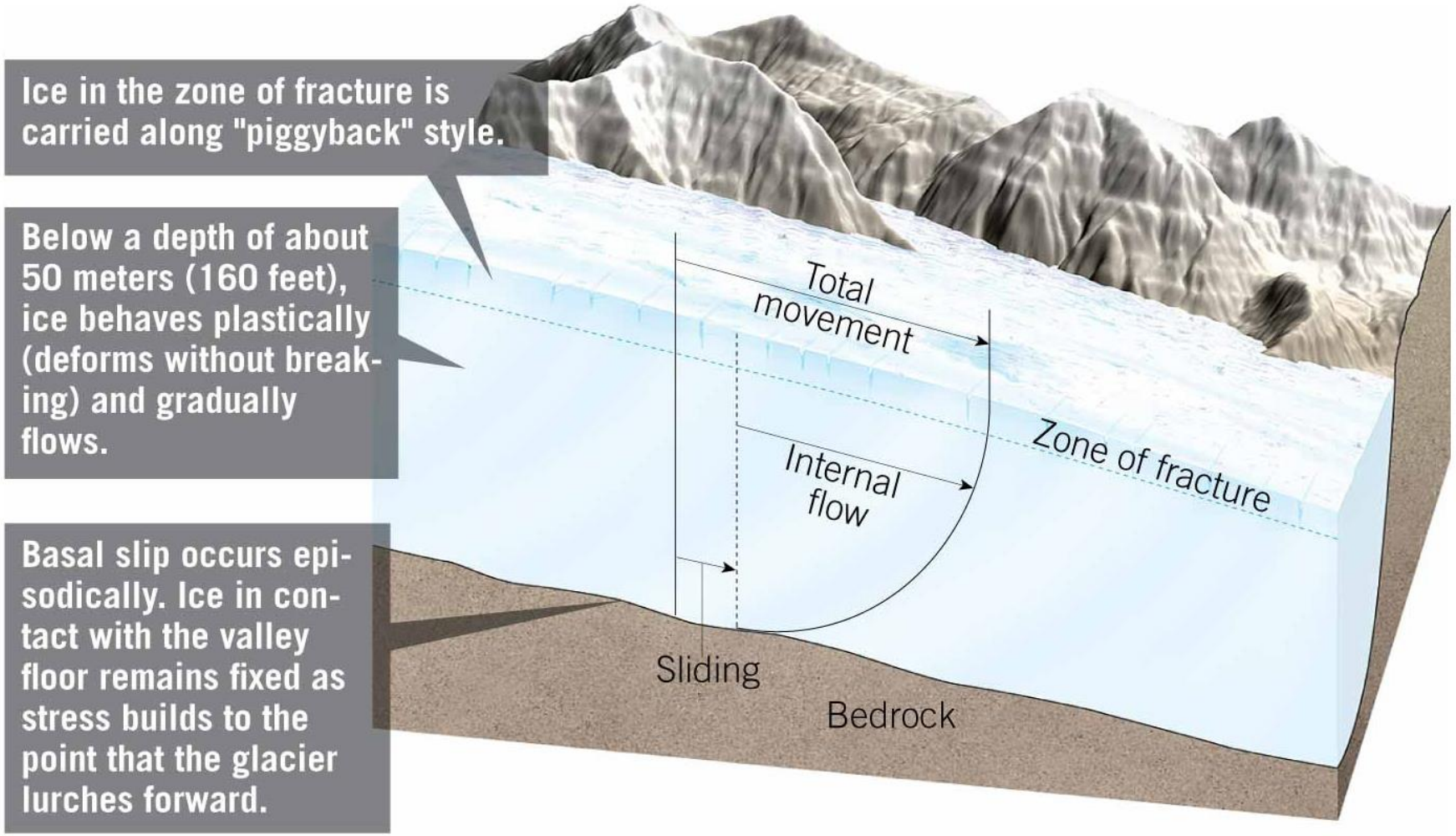
Glacial ice forms due to extreme **compaction** *(due to gravity) of snow*

Compaction causes recrystallization and reduction of air

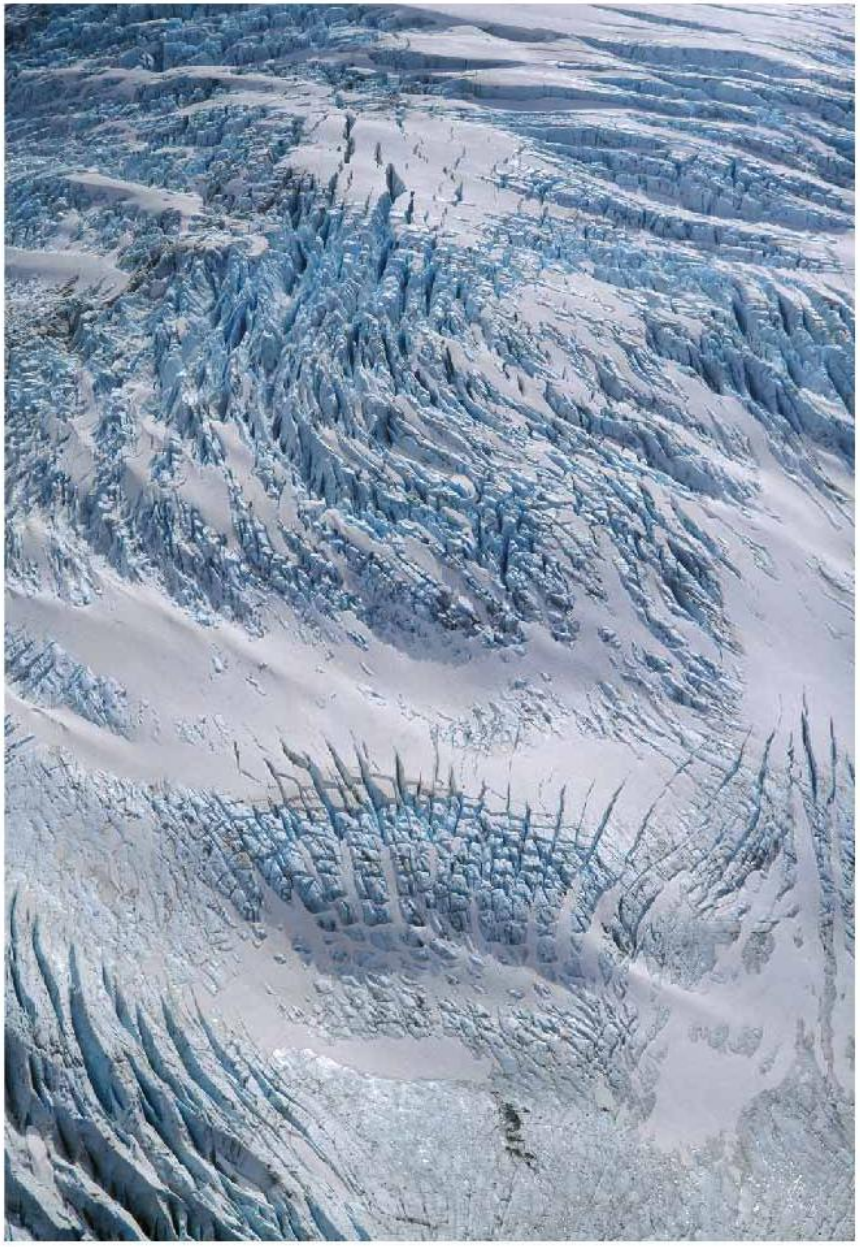
Formation & Movement of Glacial Ice

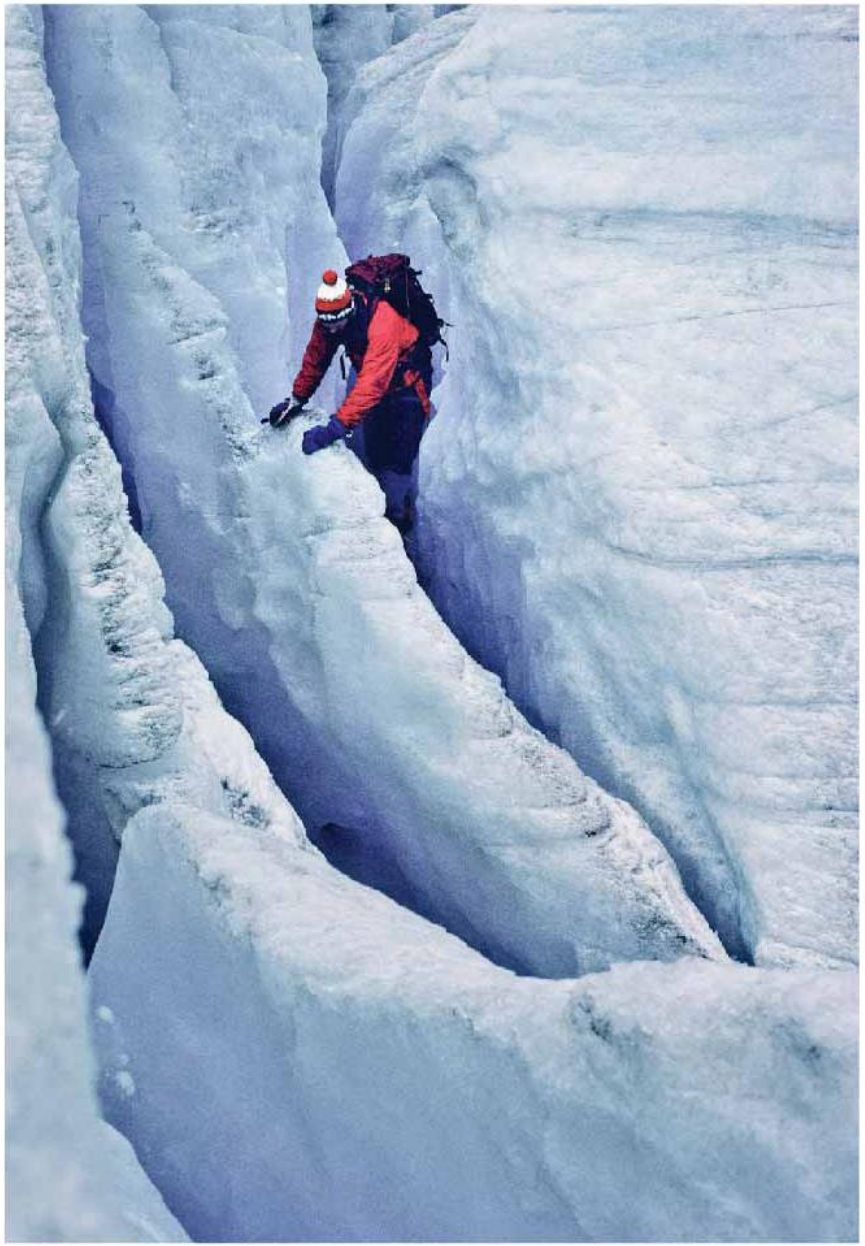
Glacial movement is called **flow**

Portions of a glacier flow differently

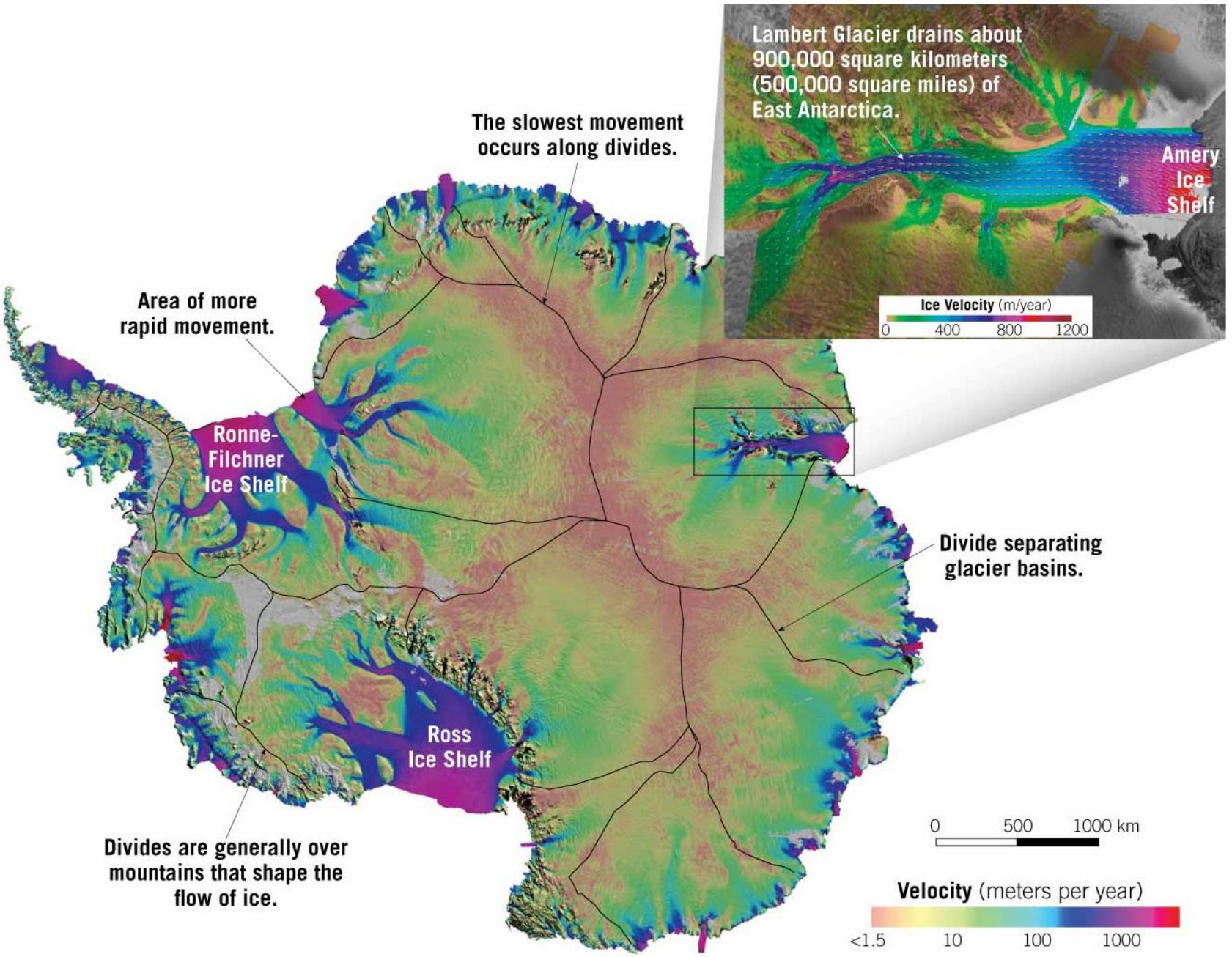


Formation & Movement of Glacial Ice

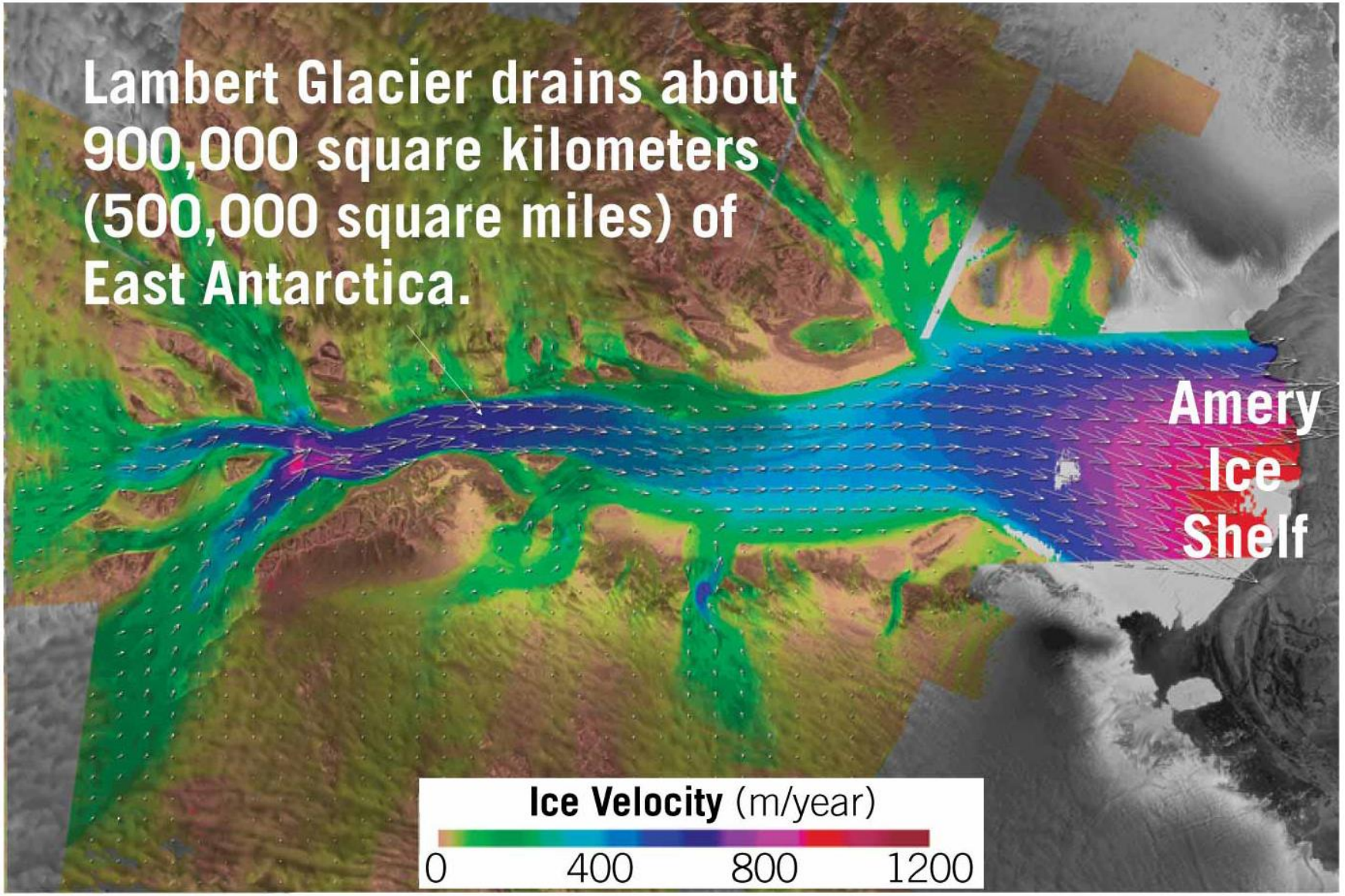




Formation & Movement of Glacial Ice



Formation & Movement of Glacial Ice

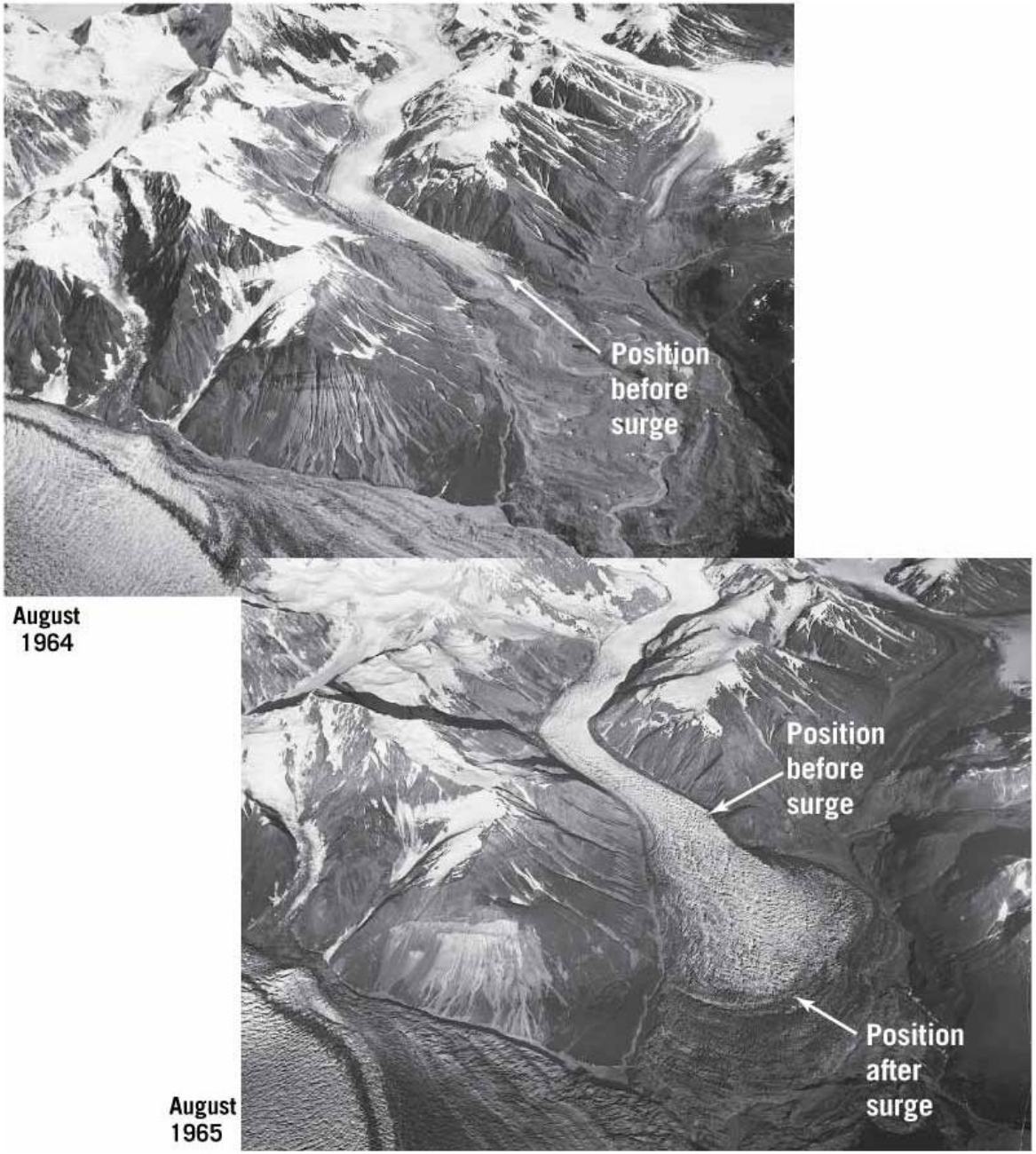


Formation & Movement of Glacial Ice

Periods of rapid glacial movement are called **surges**

Flow rate during a surge can be up to 100 times faster than normal

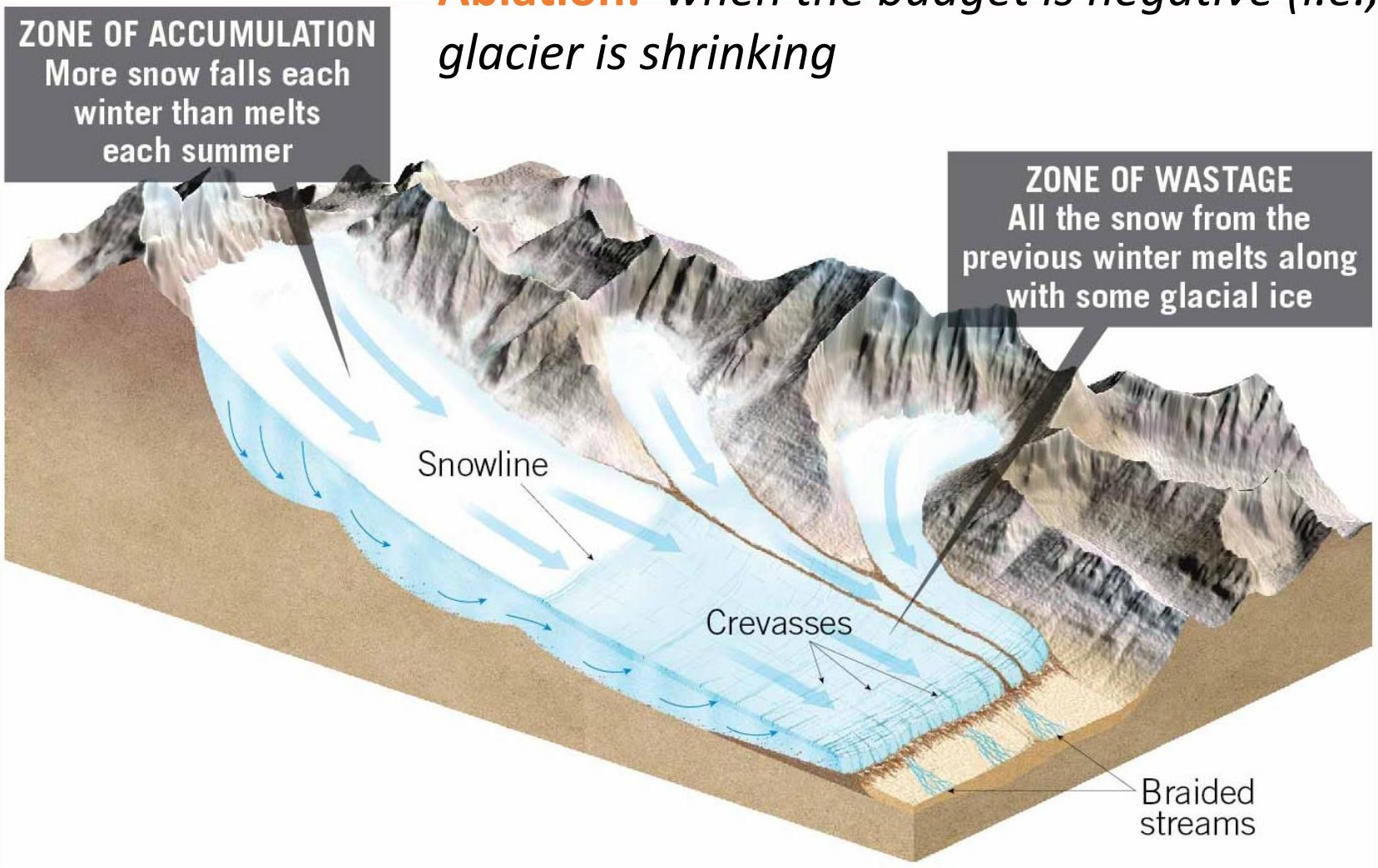
Likely due to increased basal sliding



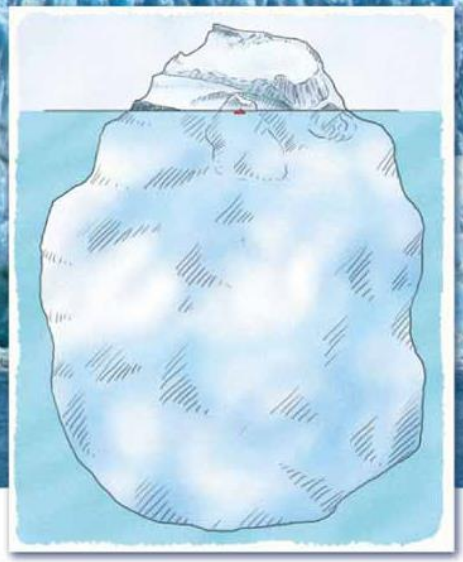
Formation & Movement of Glacial Ice

Glacial Budget: *the balance between accumulation at the upper end and loss at the lower end*

Ablation: *when the budget is negative (i.e., the glacier is shrinking*



Formation & Movement of Glacial Ice

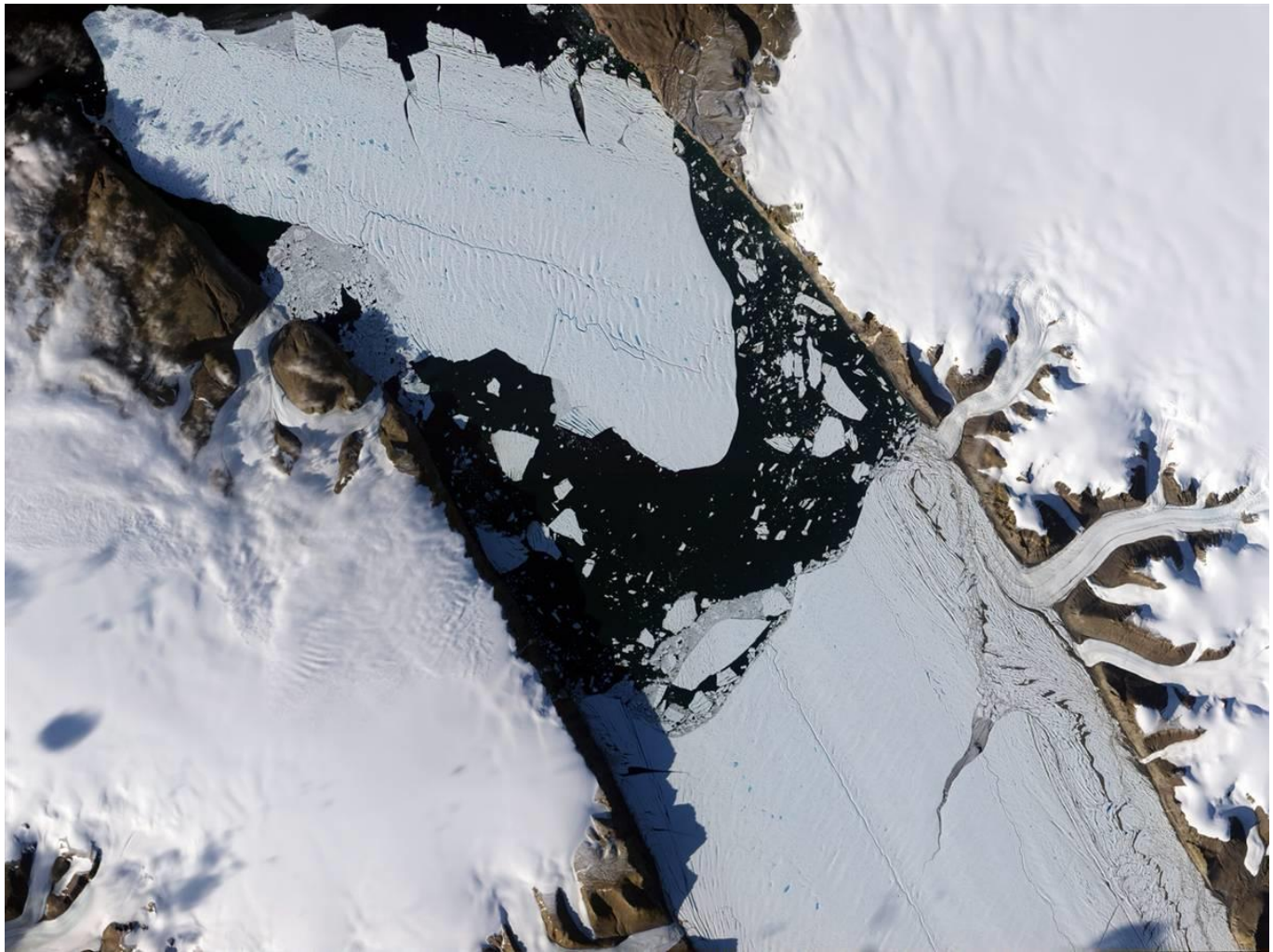


Only about 20 percent or less of an iceberg protrudes above the waterline.

Icebergs form when large masses calve from the front of a glacier after it reaches a water body.

Ice tongue calving

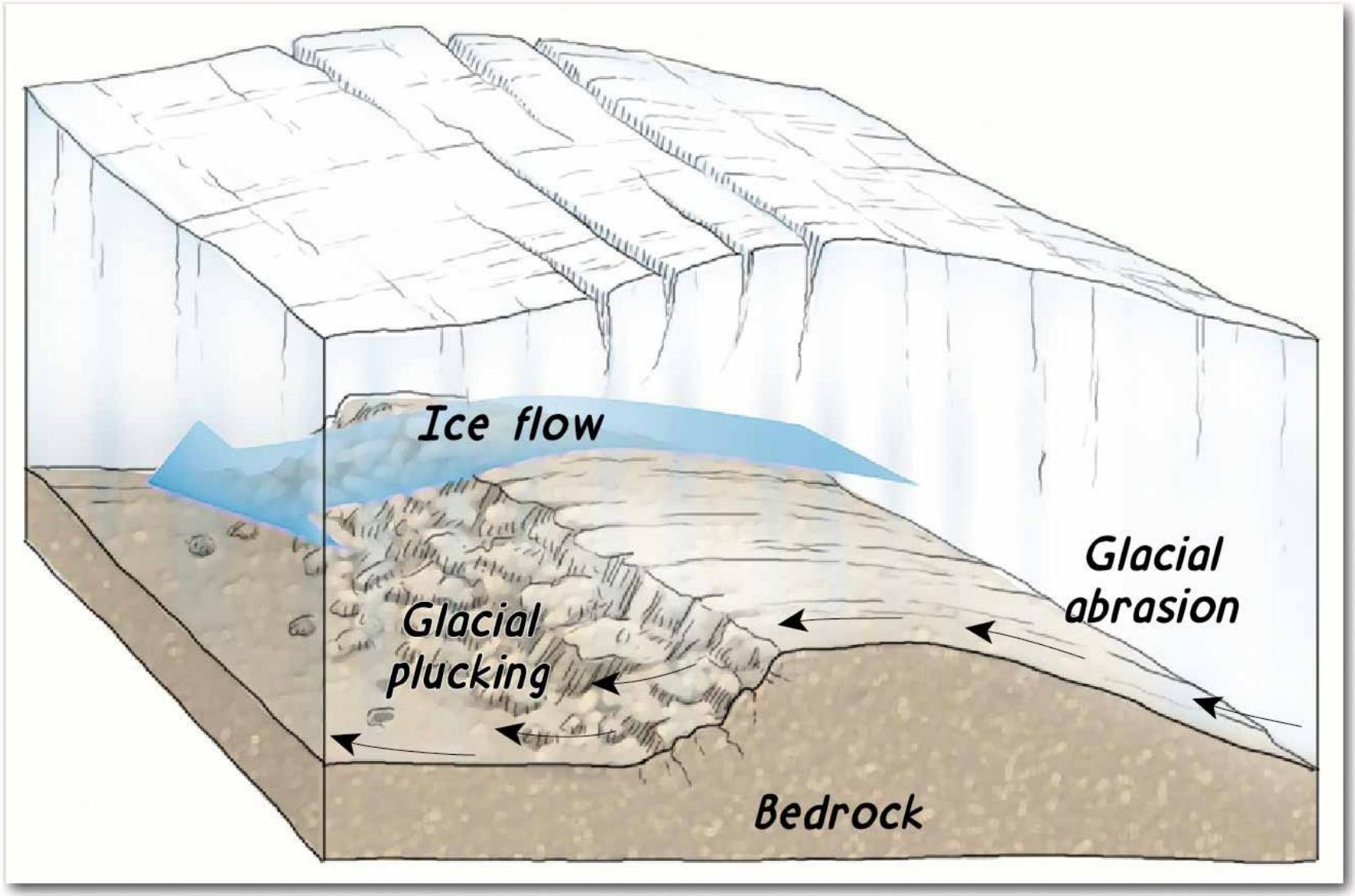
Petermann Glacier, Greenland



Iceberg off the coast

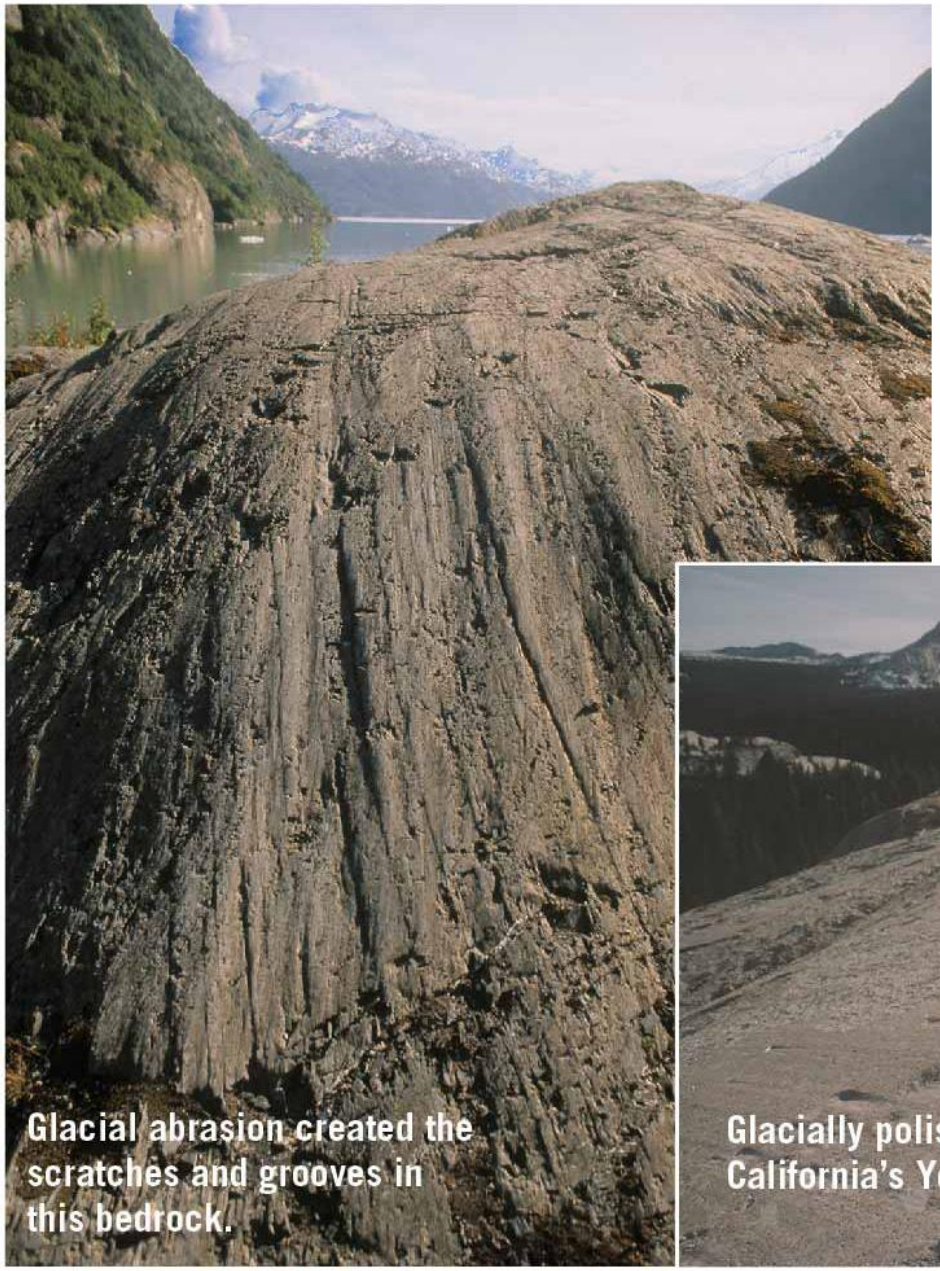
Glacial Erosion

Glacial Erosion



Geologist's Sketch

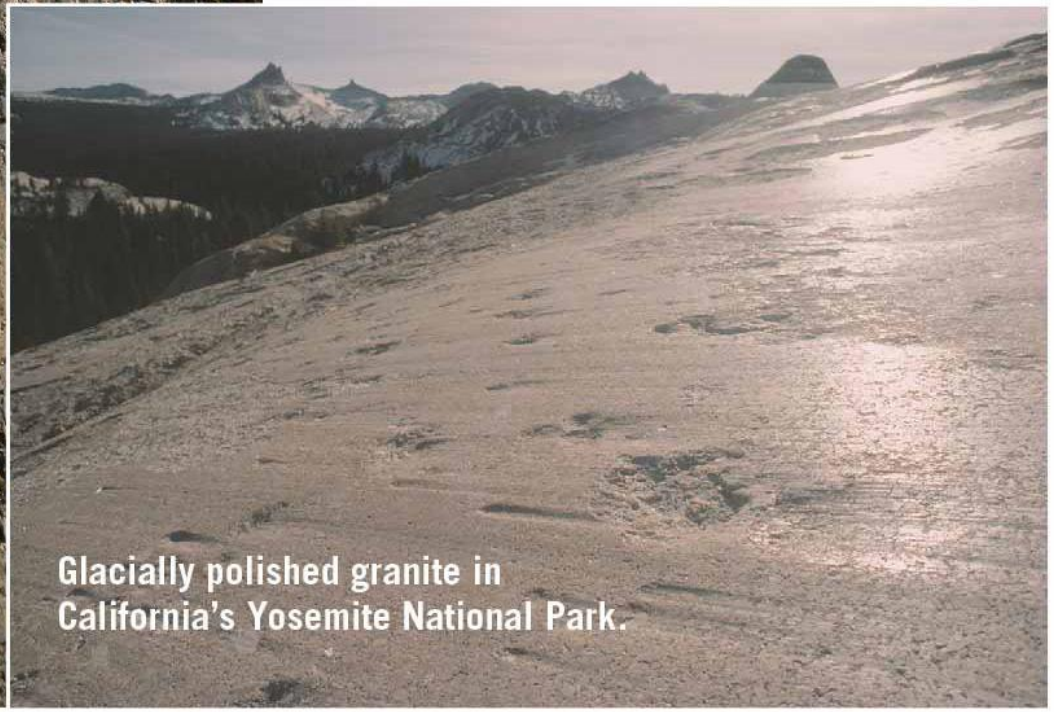
Glacial Erosion



Glacial abrasion created the scratches and grooves in this bedrock.

A.

Striations: *long scratches and grooves cut by rock fragments dragged by the base of the glacier (**abrasion**)*

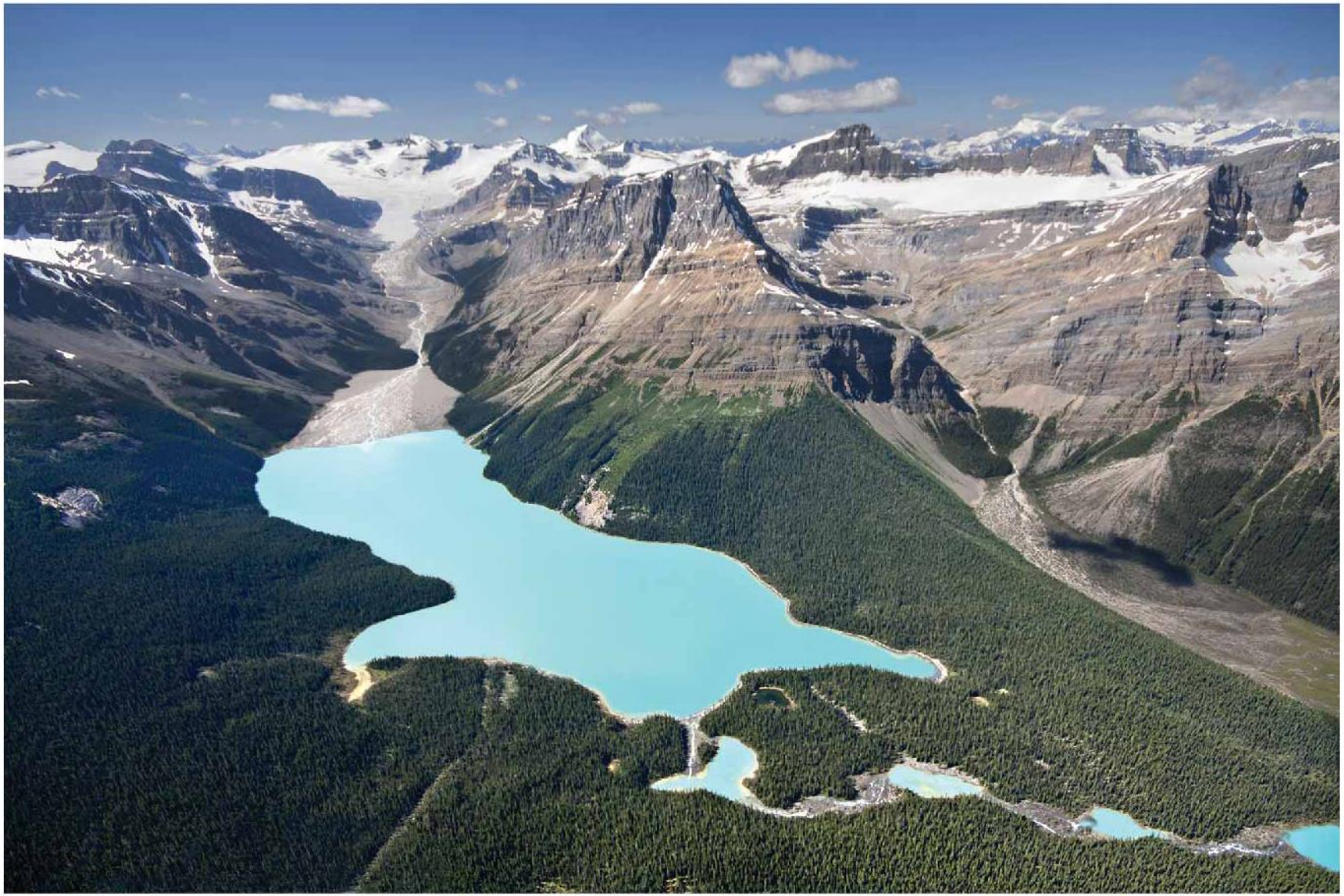


Glacially polished granite in California's Yosemite National Park.

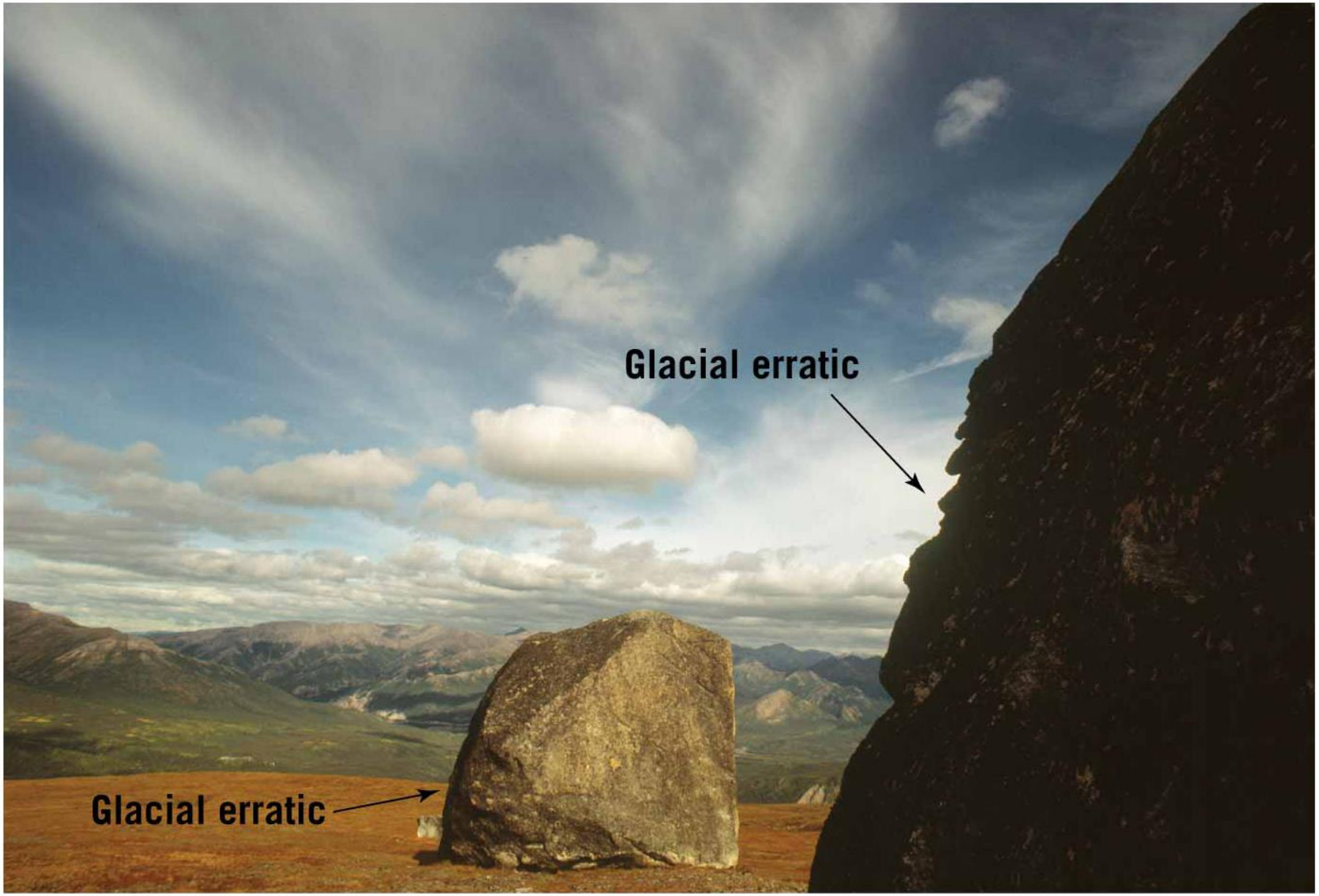
B.

Glacial Erosion

Rock Flour: *pulverized rock visible in the streams and lakes at the toe of glaciers*

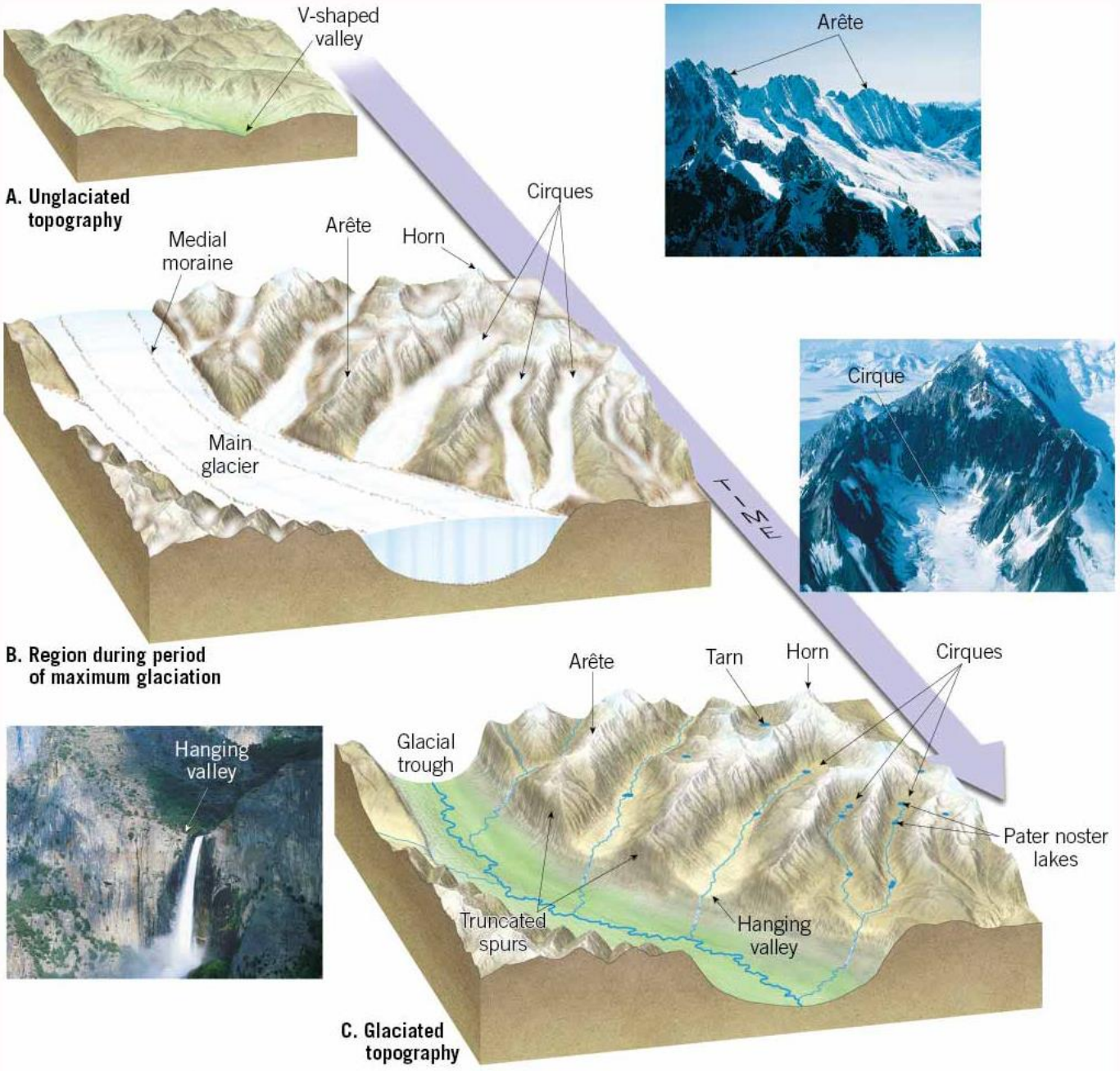


Glacial Erosion



Landforms Created by Glacial Erosion

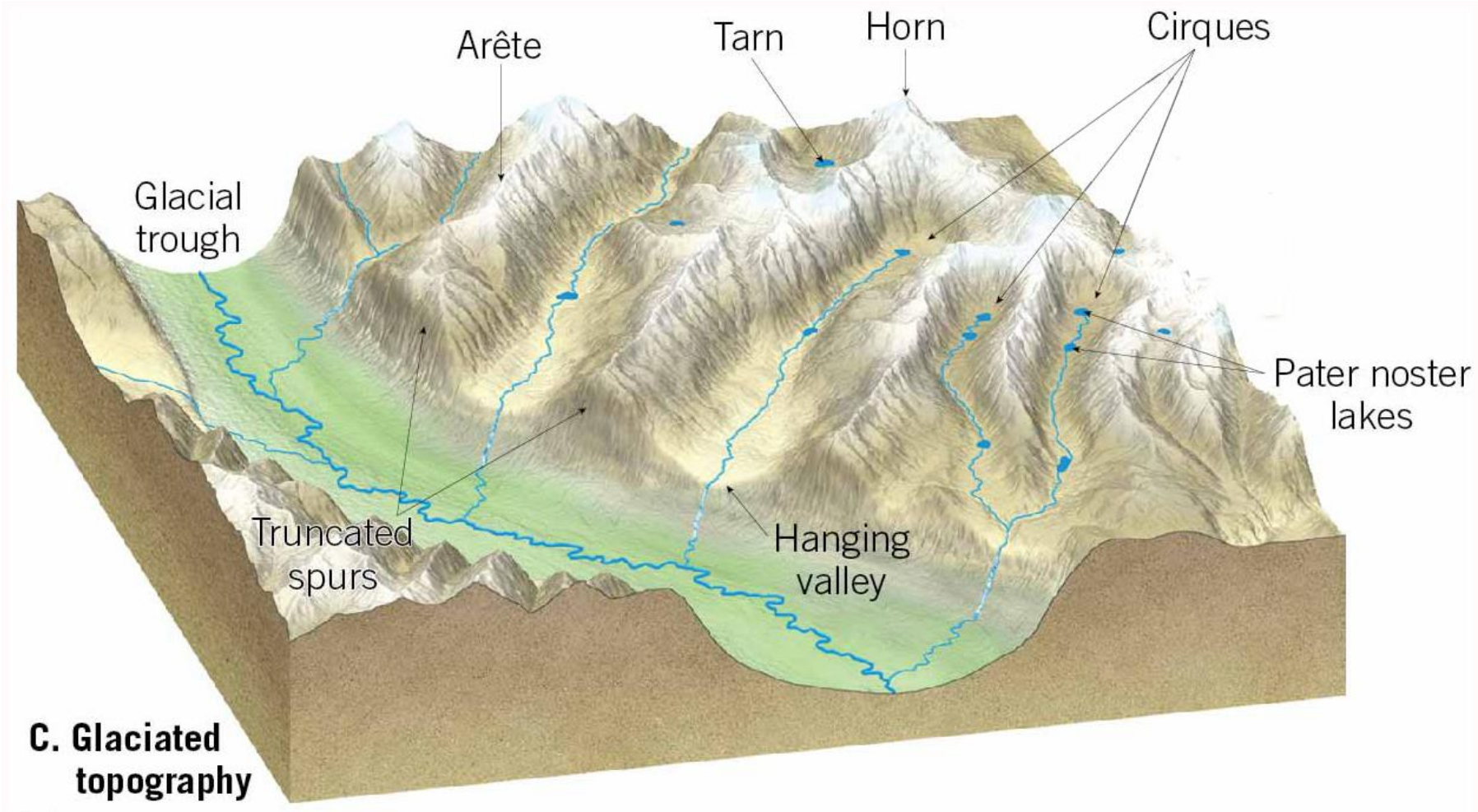
- *Moraine*
- *Medial moraine*
- *Arête*
- *Horn*
- *Cirque*
- *Tarn*
- *Glacial trough*
- *Truncated Spur*
- *Hanging valley*
- *Pater noster lake*



Tarn

Landforms Created by Glacial Erosion

A. Unglaciated topography

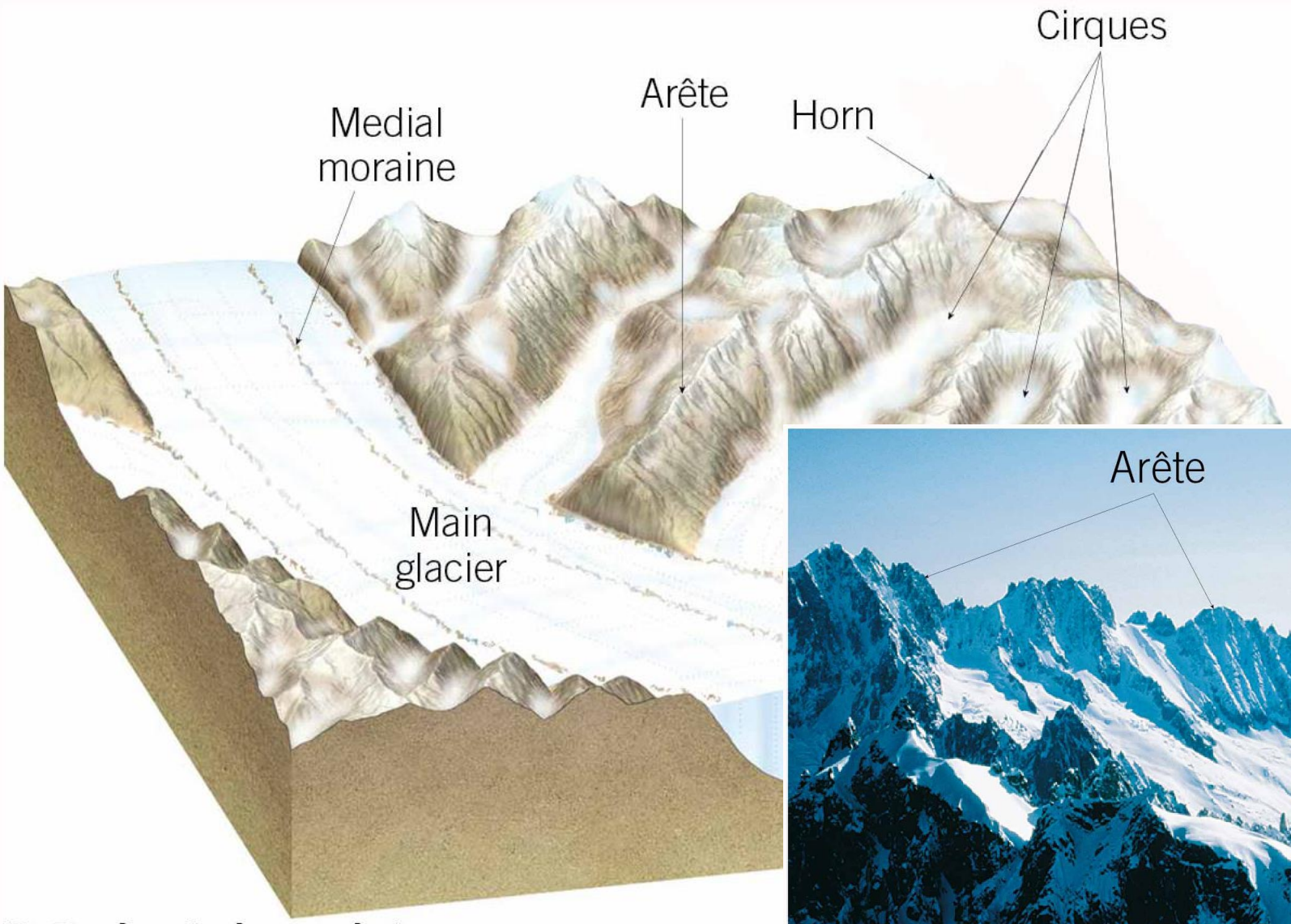


C. Glaciated topography

Erosional Features
U-Shaped Valleys

Yosemite, CA (below)

Landforms Created by Glacial Erosion

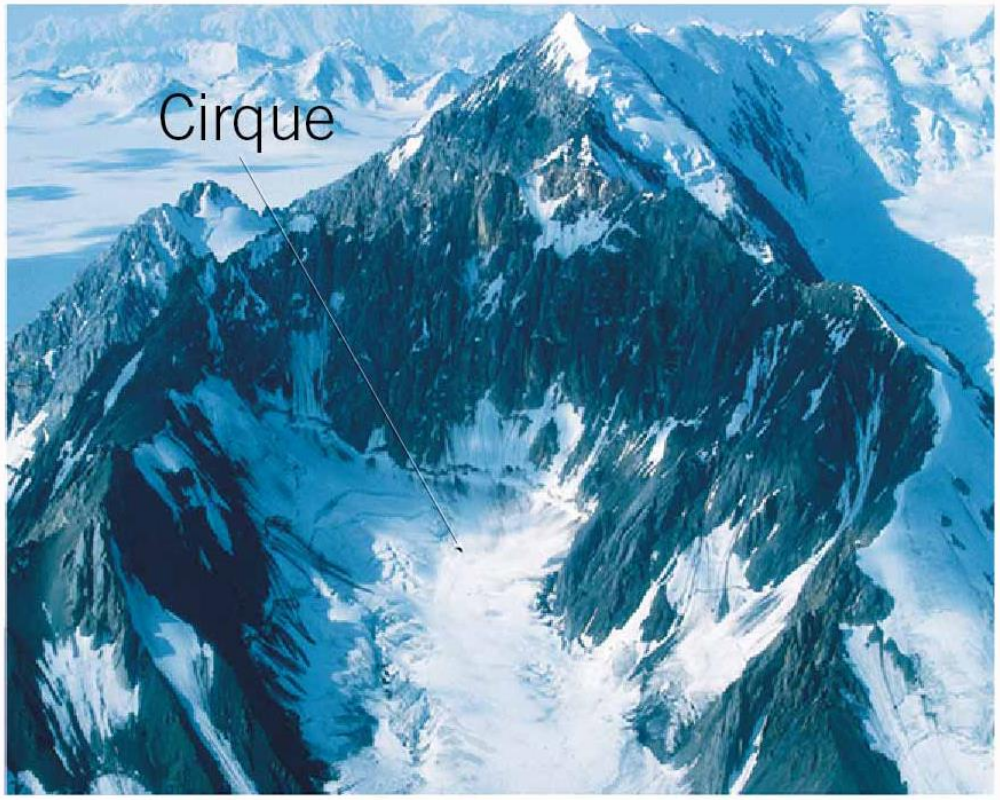


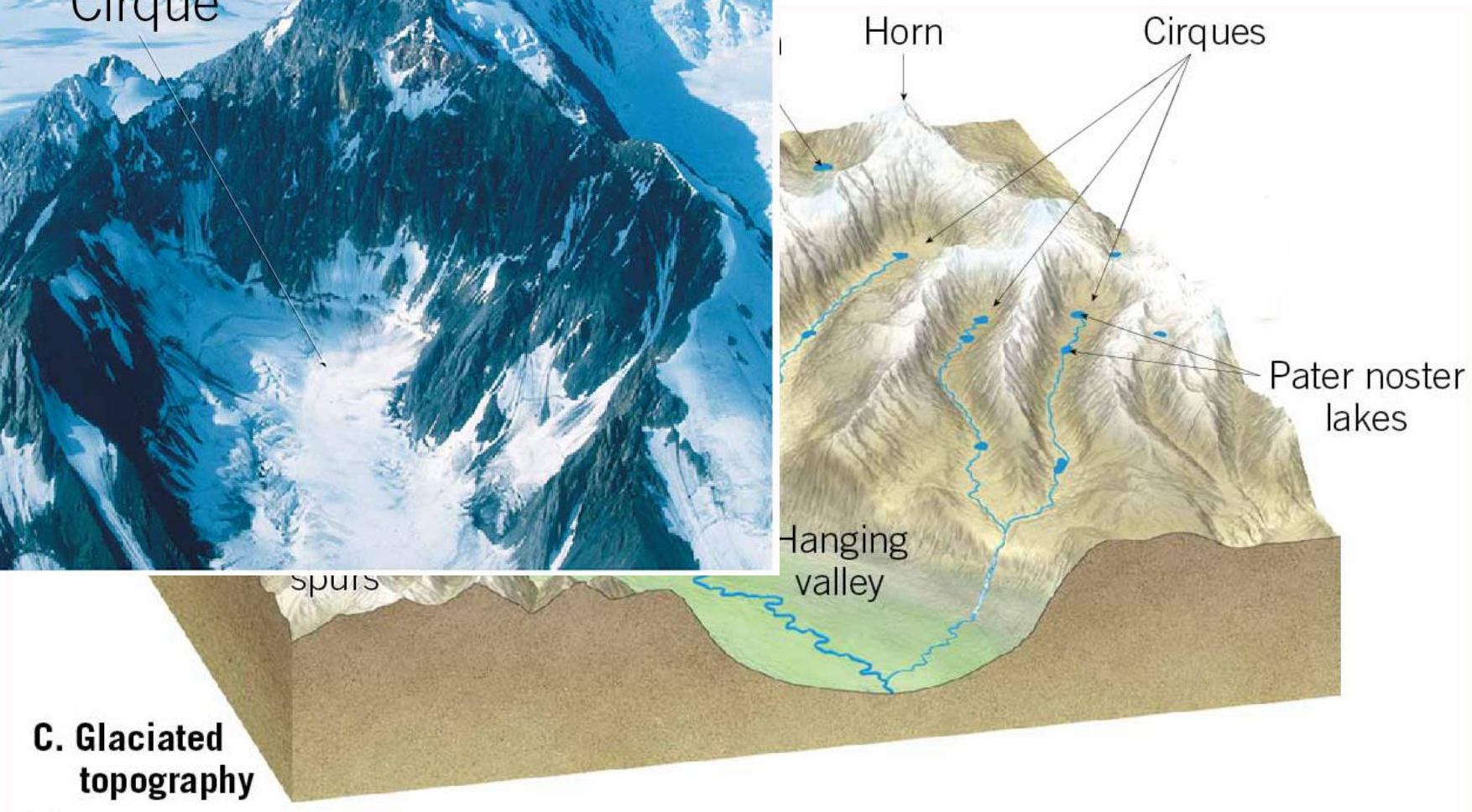
B. Region during period of maximum glaciation

Erosional Features
Hanging Valleys
Bridal Veil Falls, Yosemite Nat'l Park, California

Photo: J.A. Thomas. 1987. USGS Photographic Library, photo post00008. < http://libraryphoto.cr.usgs.gov/> Accessed July 2010.

Landforms Created by Glacial Erosion



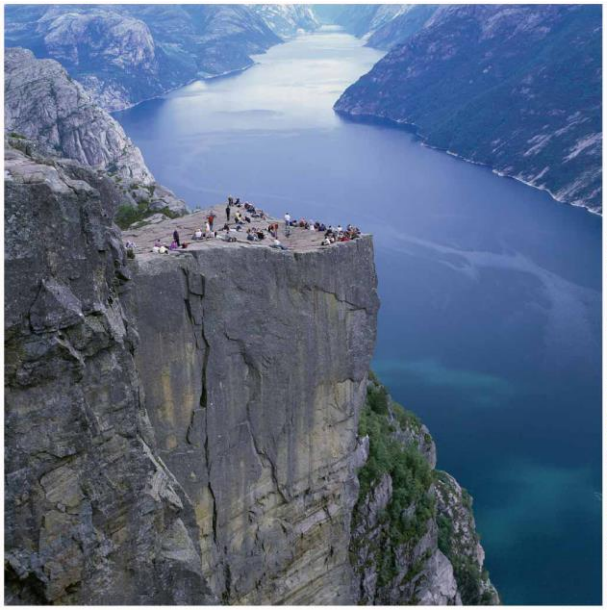


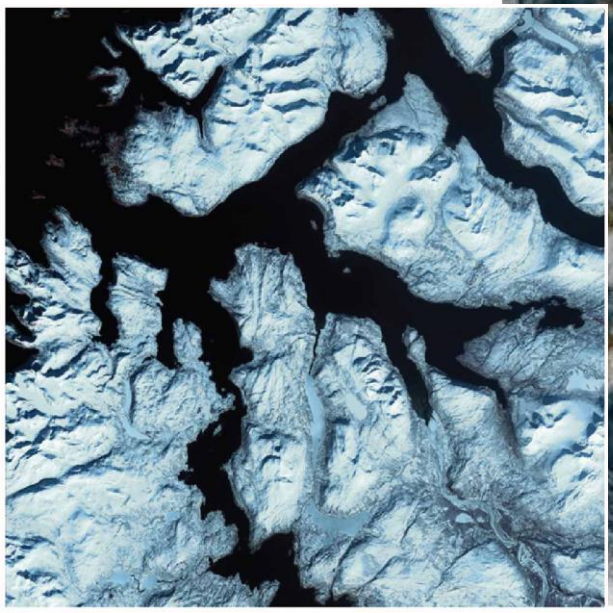
The Matterhorn in the Swiss Alps

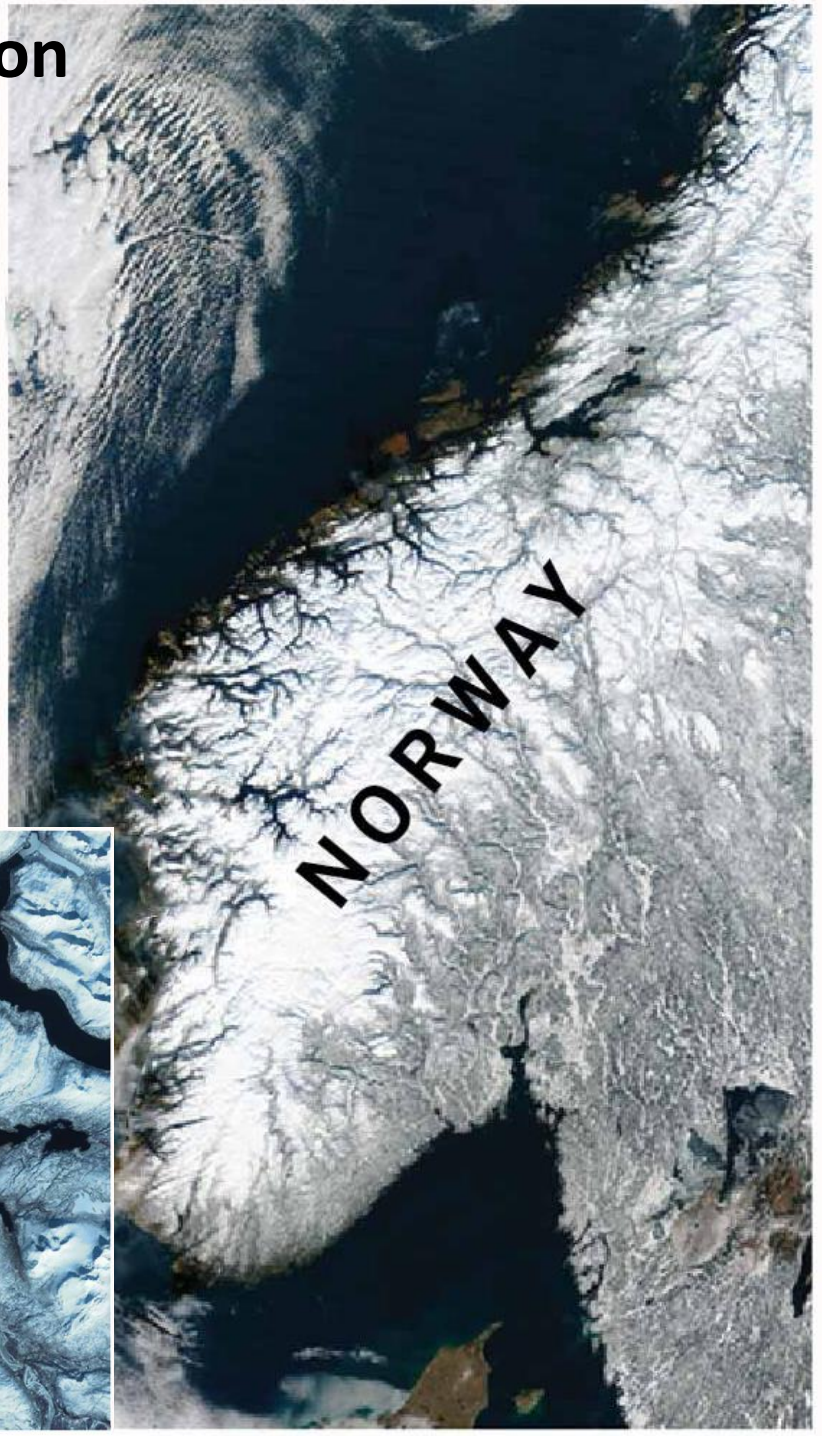
Landforms Created by Glacial Erosion

Fjords: *deep, steep-sided ocean inlets that are drowned glacial troughs*

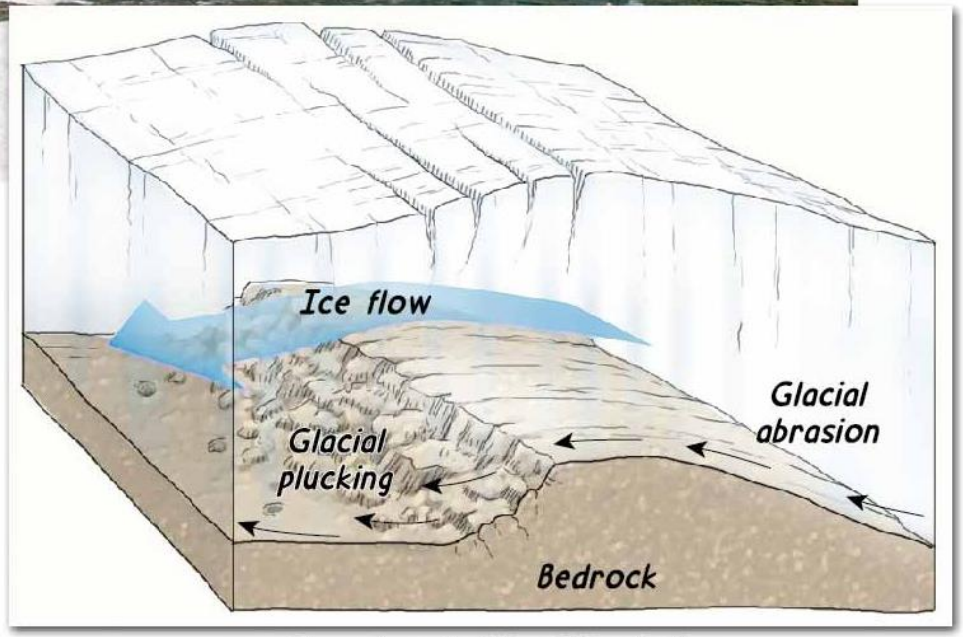
Form from a combination of sea level rise and **glacial rebound**







Landforms Created by Glacial Erosion



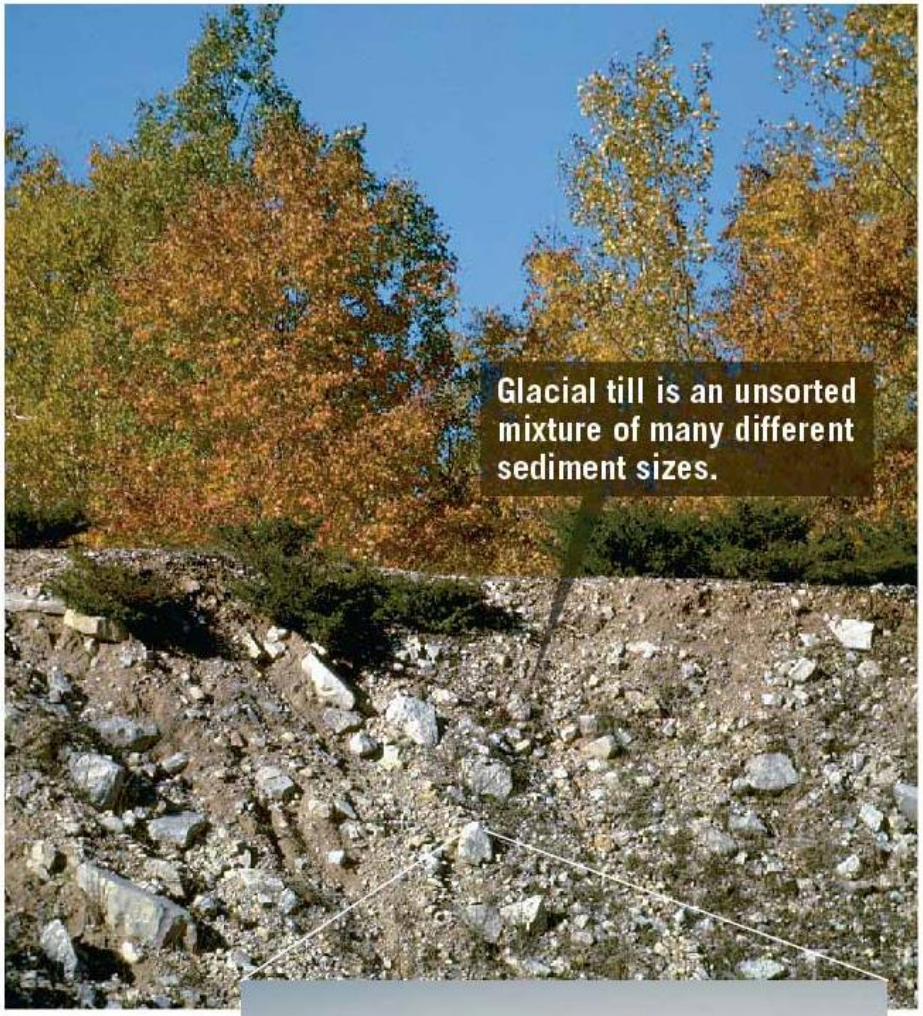
Geologist's Sketch

Roche Moutonnée:

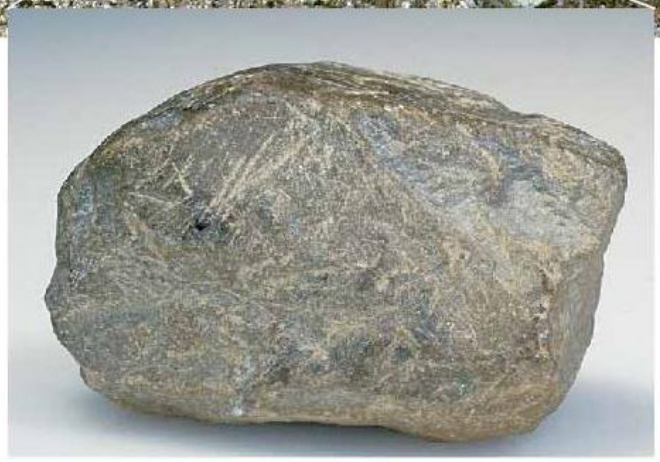
asymmetrical knob of bedrock formed by glacial abrasion and plucking

Glacial Deposits

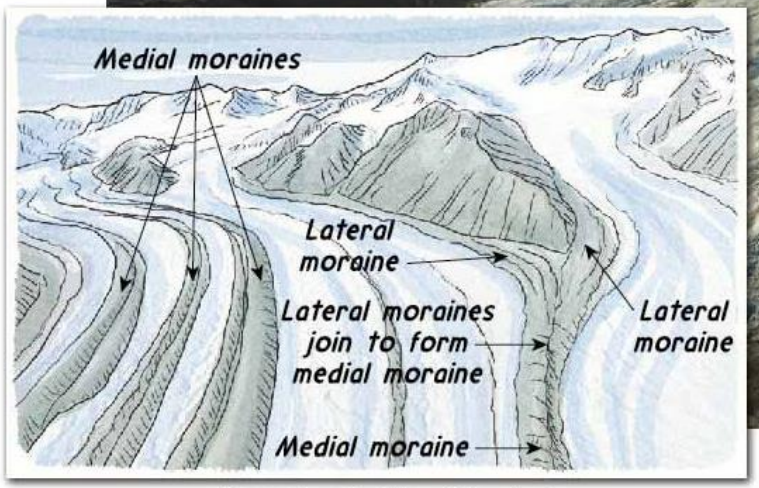
Glaciers can transport a vast amount of debris because ice has a much higher carrying capacity than water



A close examination of glacial till often reveals cobbles that have been scratched as they were dragged along by the ice.

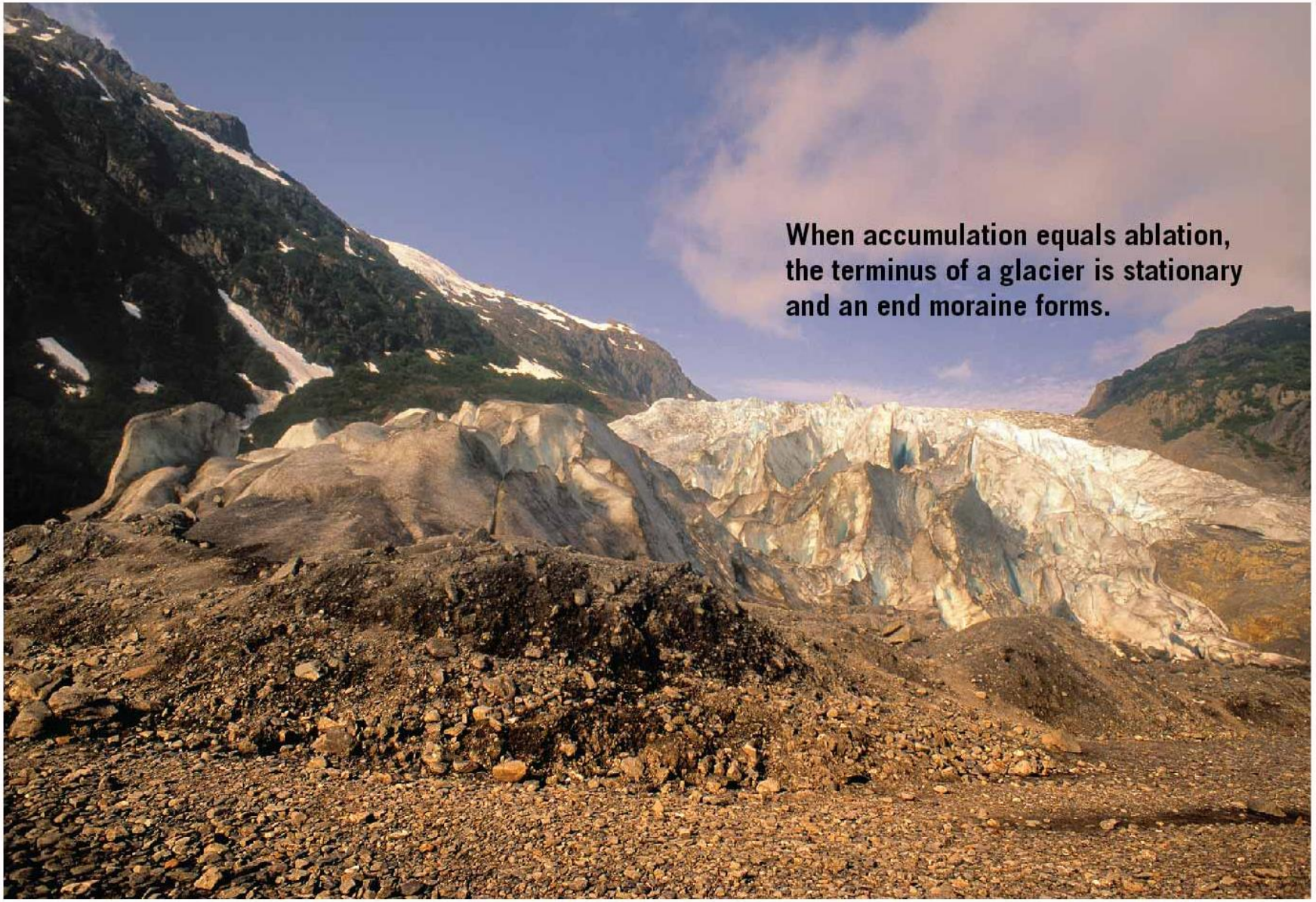


Landforms Made of Till – *lateral & medial moraines*

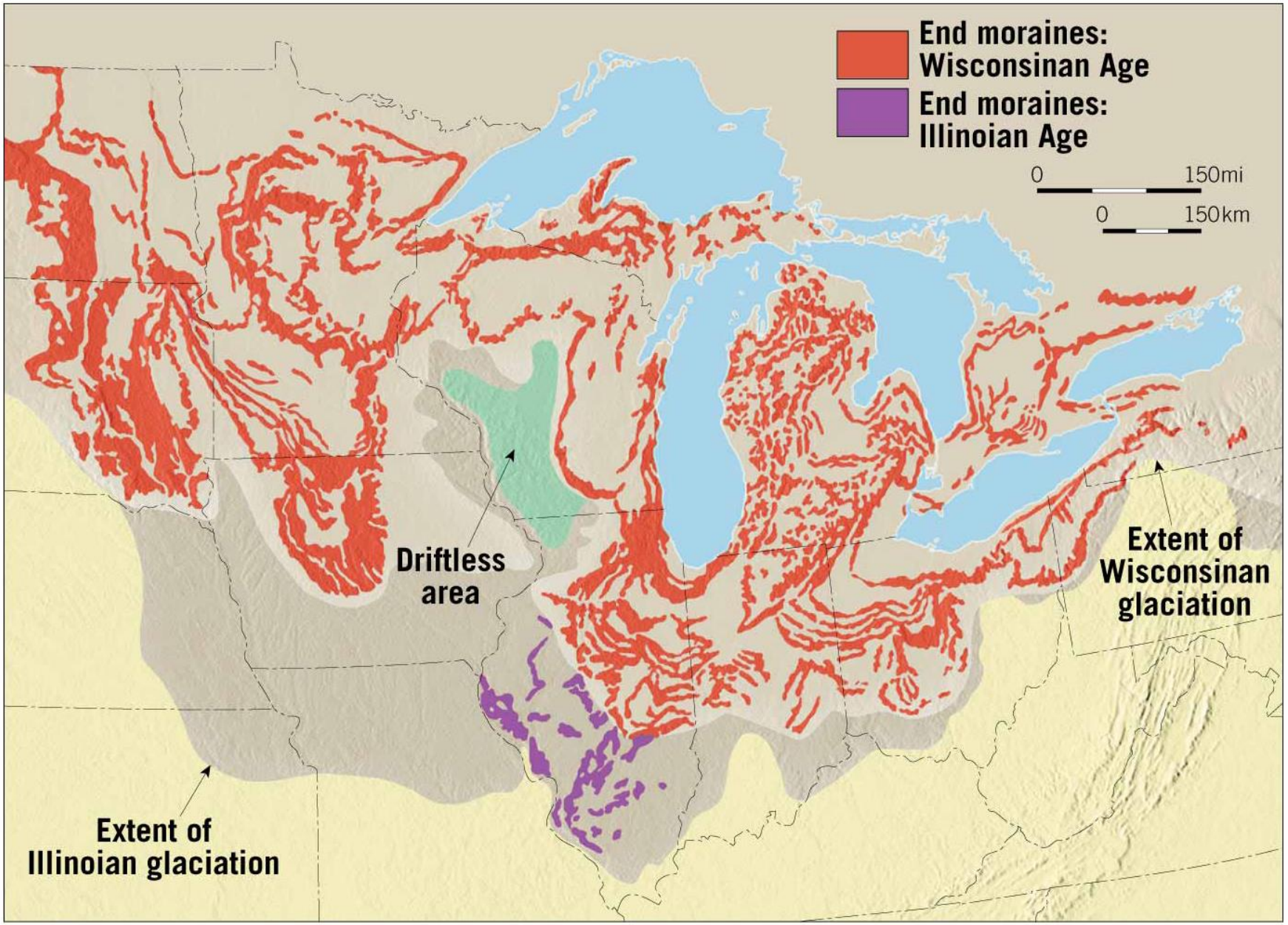


Geologist's Sketch

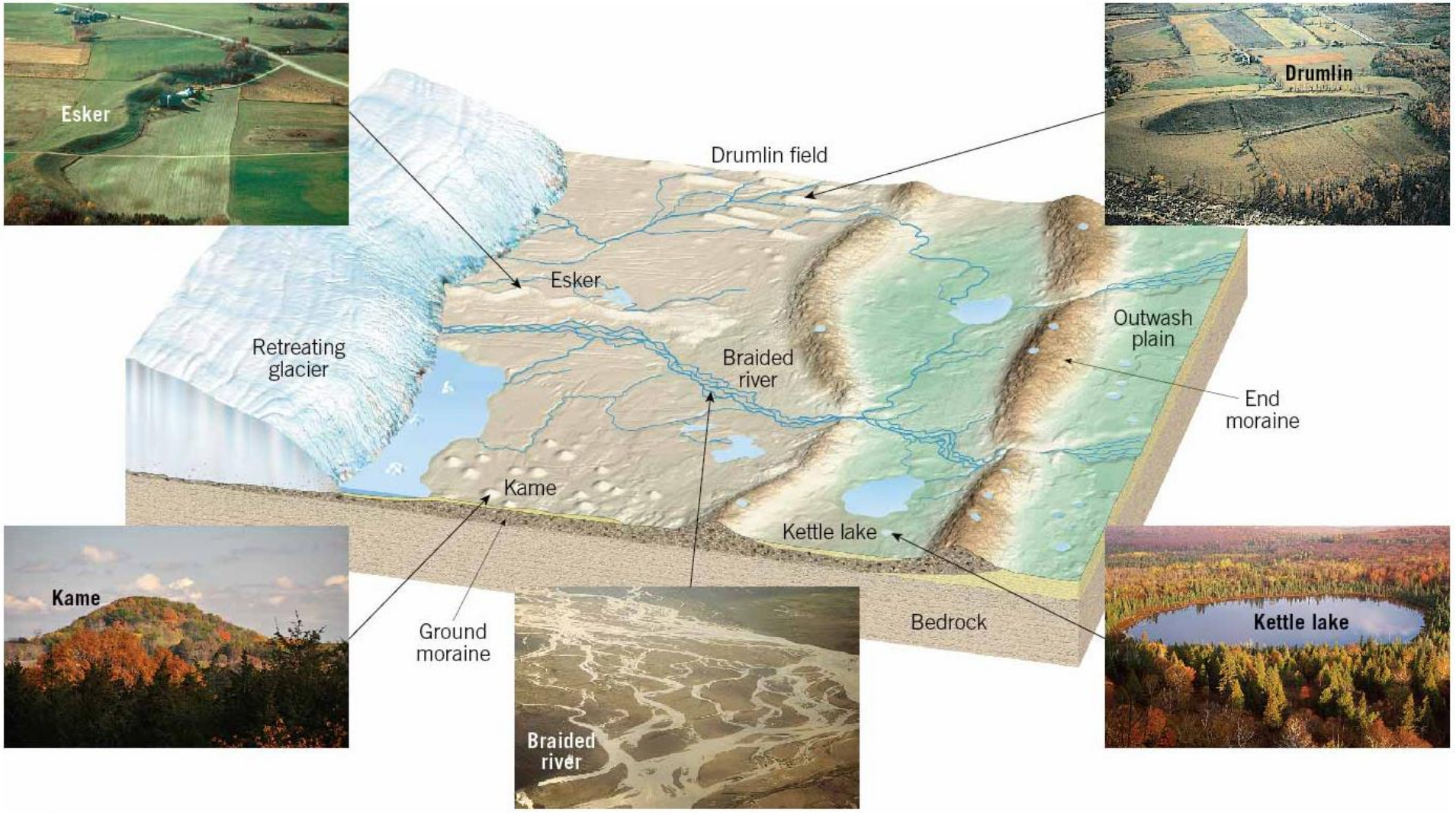
Landforms Made of Till – *end moraines*



Landforms Made of Till – *terminal and recessional moraines*

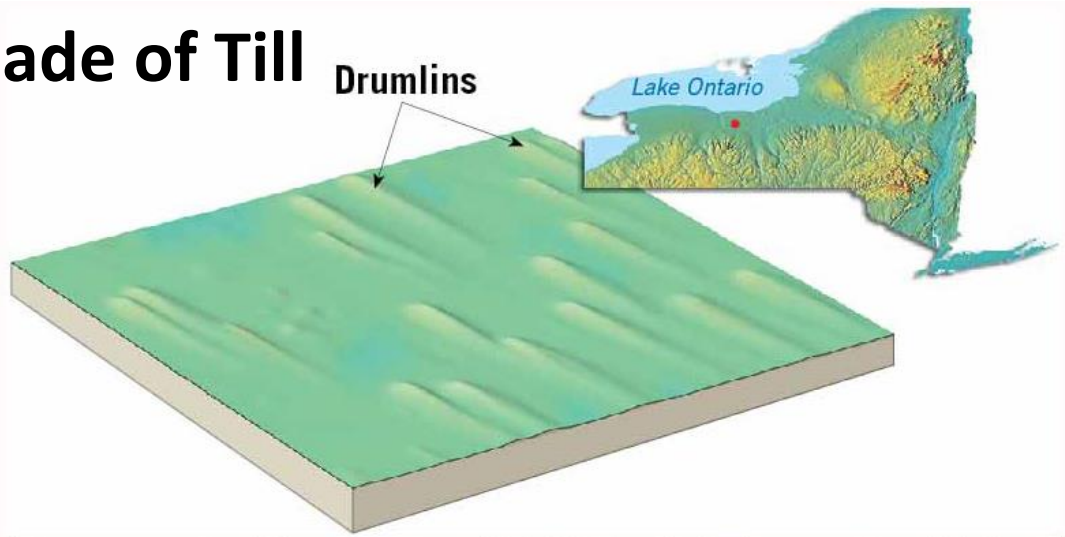


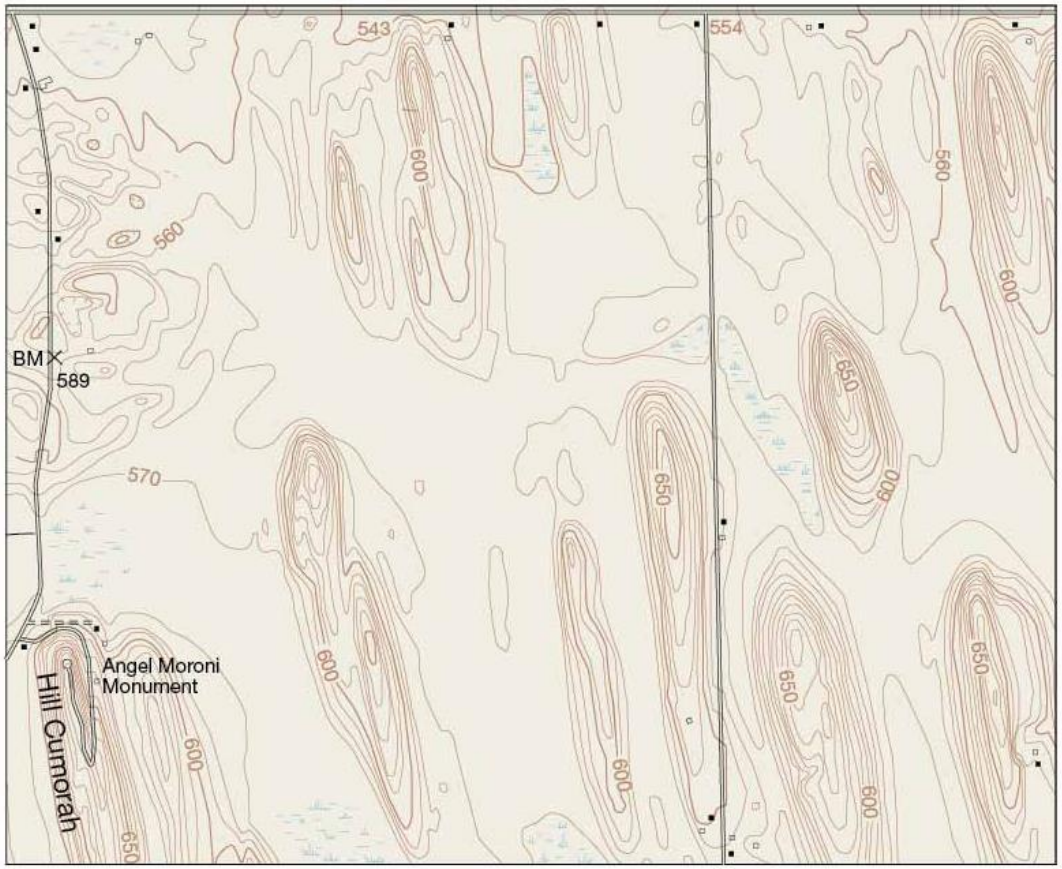
Landforms Made of Till – *other landforms*



Landforms Made of Till

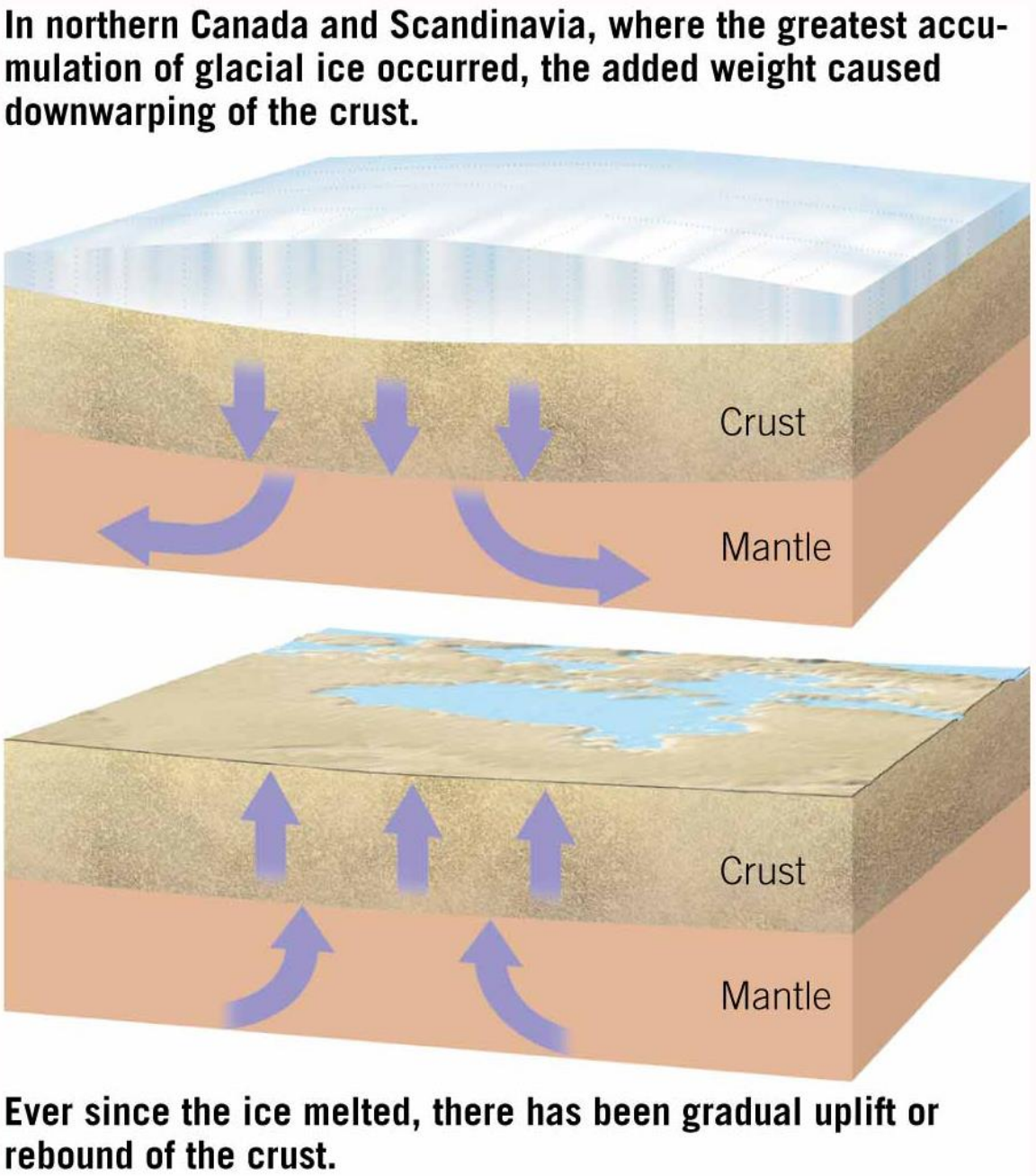
Drumlins





Other Effects of Ice Age Glaciers

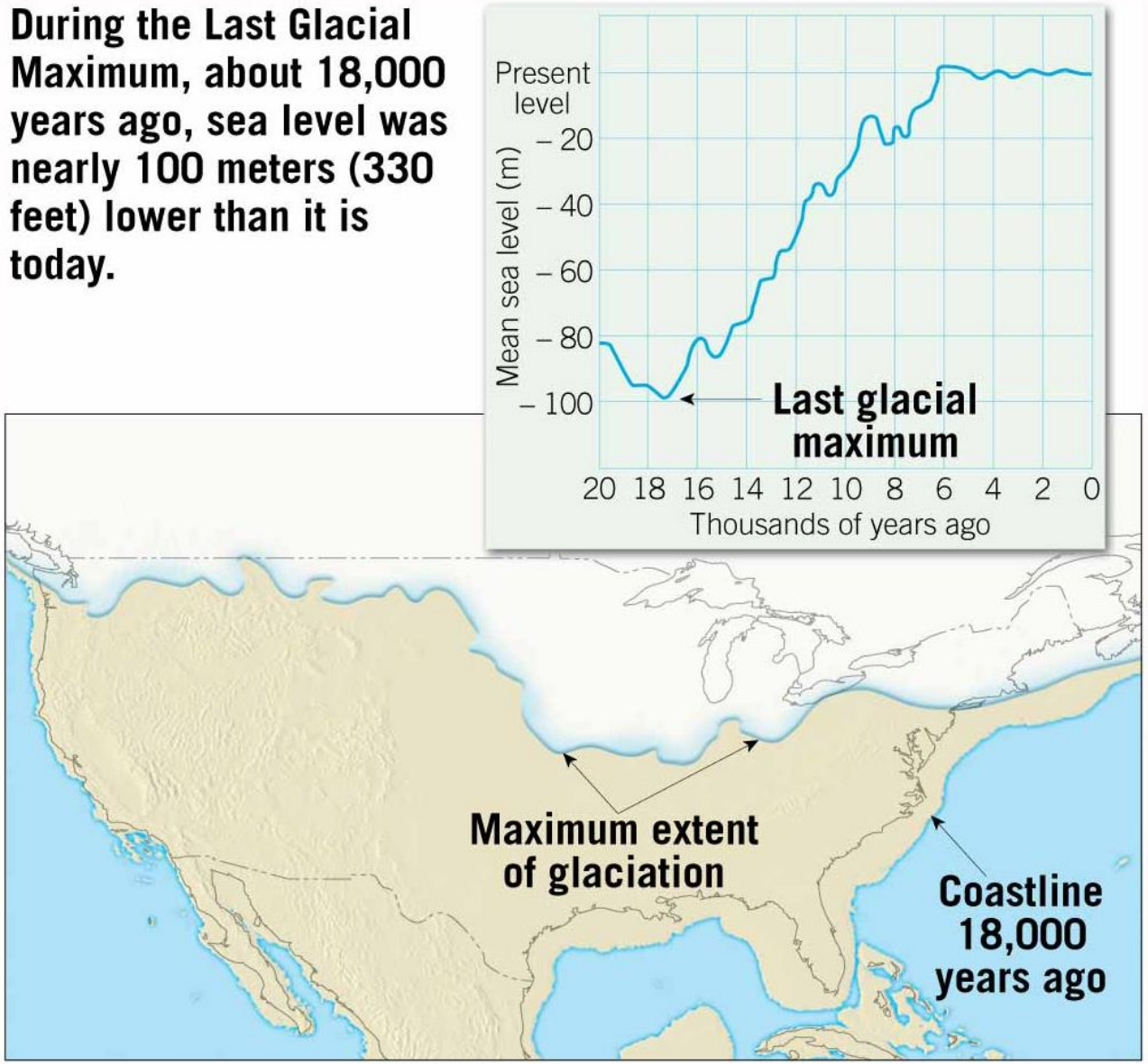
Crustal subsidence & rebound



Other Effects of Ice Age Glaciers

Sea Level Rise

During the Last Glacial Maximum, about 18,000 years ago, sea level was nearly 100 meters (330 feet) lower than it is today.



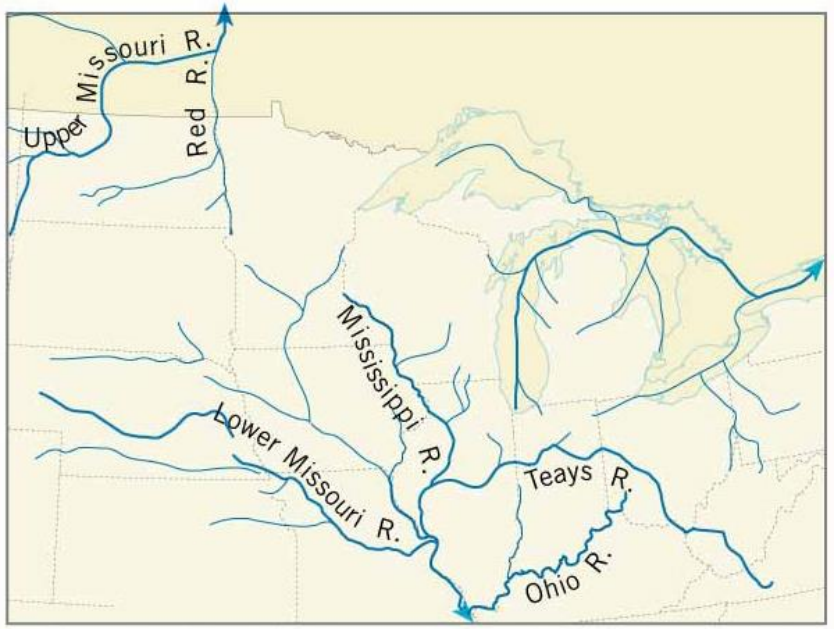
During the Last Glacial Maximum, the shoreline extended out onto the present day continental shelf.

Other Effects of Ice Age Glaciers

Changes to River Systems:

A major glaciation can shift the direction rivers flow

A. This map shows the Great Lakes and the familiar present-day pattern of rivers. Quaternary ice sheets played a major role in creating this pattern

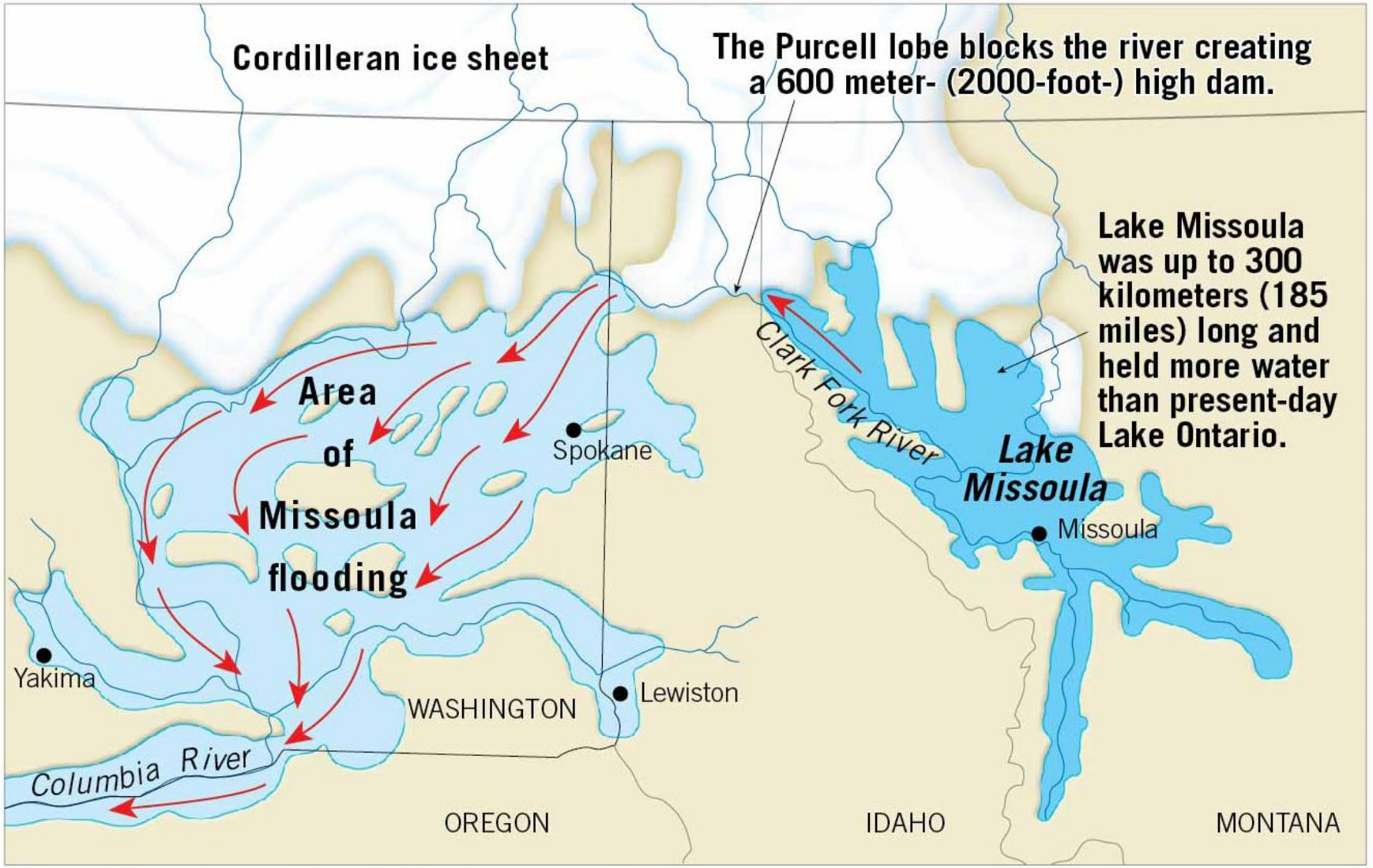


B. Reconstruction of drainage systems prior to the Ice Age. The pattern was very different from today, and the Great Lakes did not exist.

Other Effects of Ice Age Glaciers

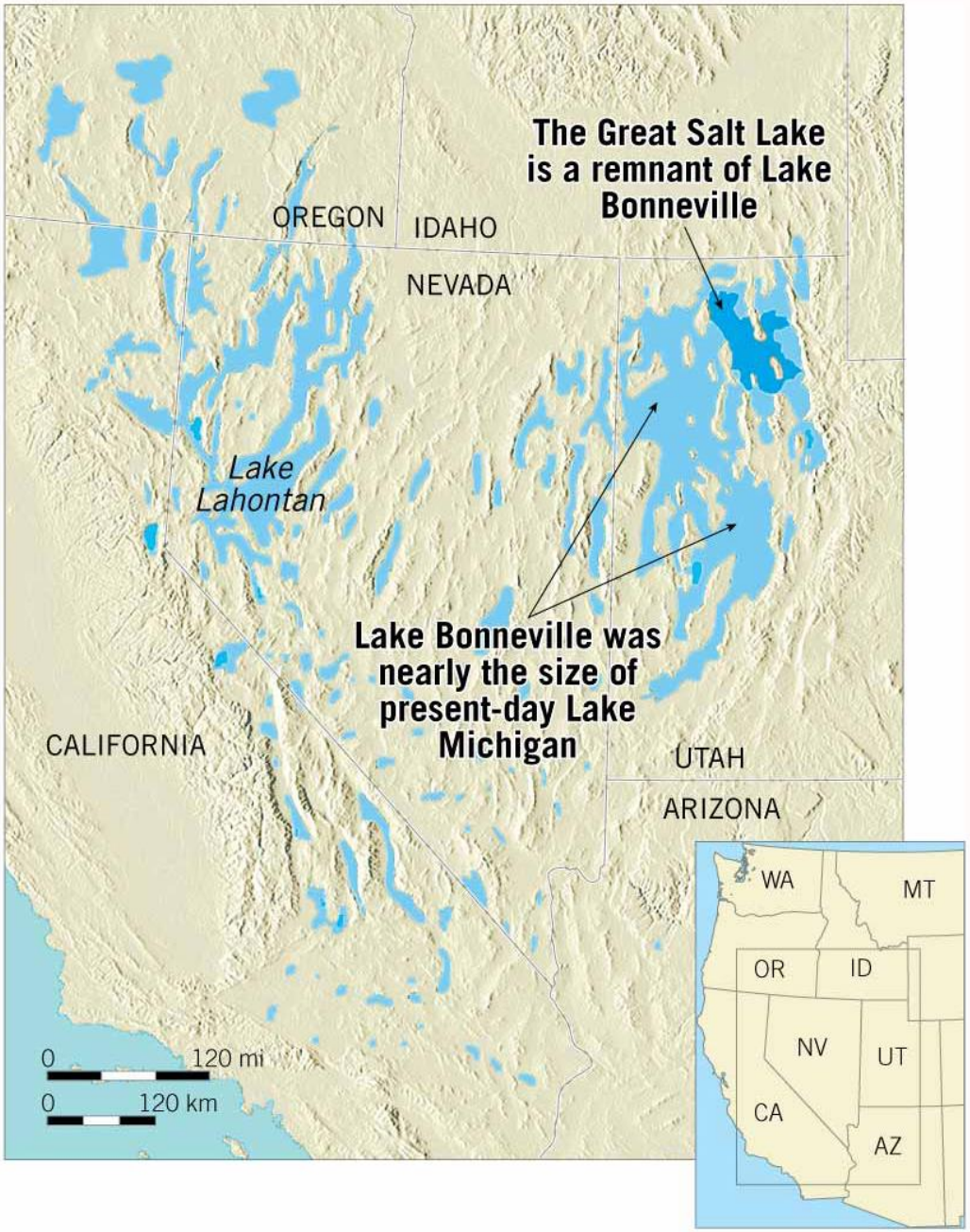
Proglacial Lakes:

Major lakes or bodies of water that form during a glaciation



This prehistoric proglacial lake in western Montana periodically broke through the ice dam that created it. This resulted in huge floods (megafloods) that shaped the landscape of eastern Washington State.

The towering mass of rushing water from each megaflood stripped away layers of sediment and soil and cut deep canyons (coulees) into the underlying layers of basalt to create the Channeled Scablands.


The Great Salt Lake is a remnant of Lake Bonneville
OREGON
IDAHO
NEVADA
Lake Lahontan
Lake Bonneville was nearly the size of present-day Lake Michigan
CALIFORNIA
UTAH
ARIZONA
0 120 mi
0 120 km
WA
MT
OR
ID
NV
UT
CA
AZ