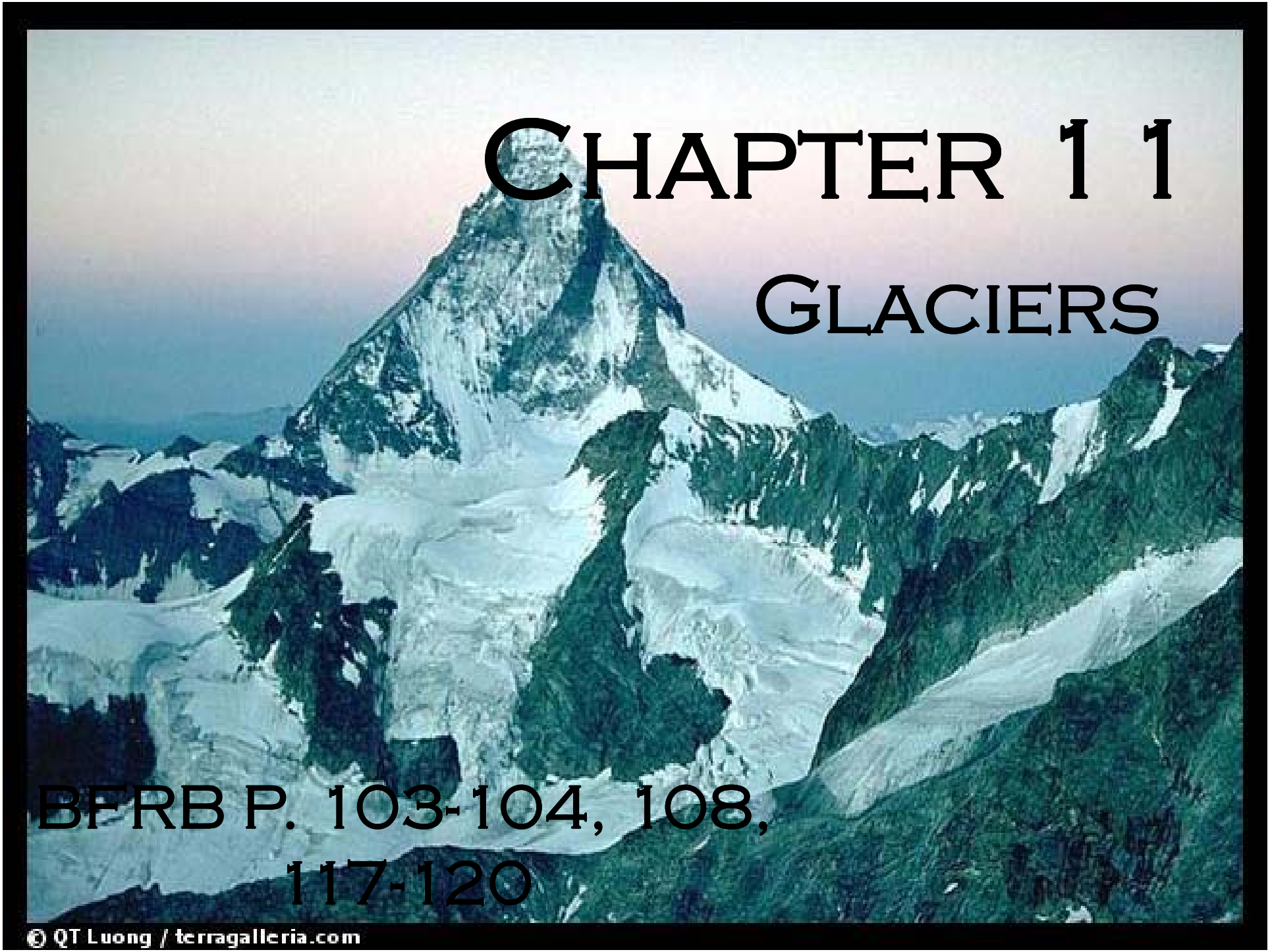
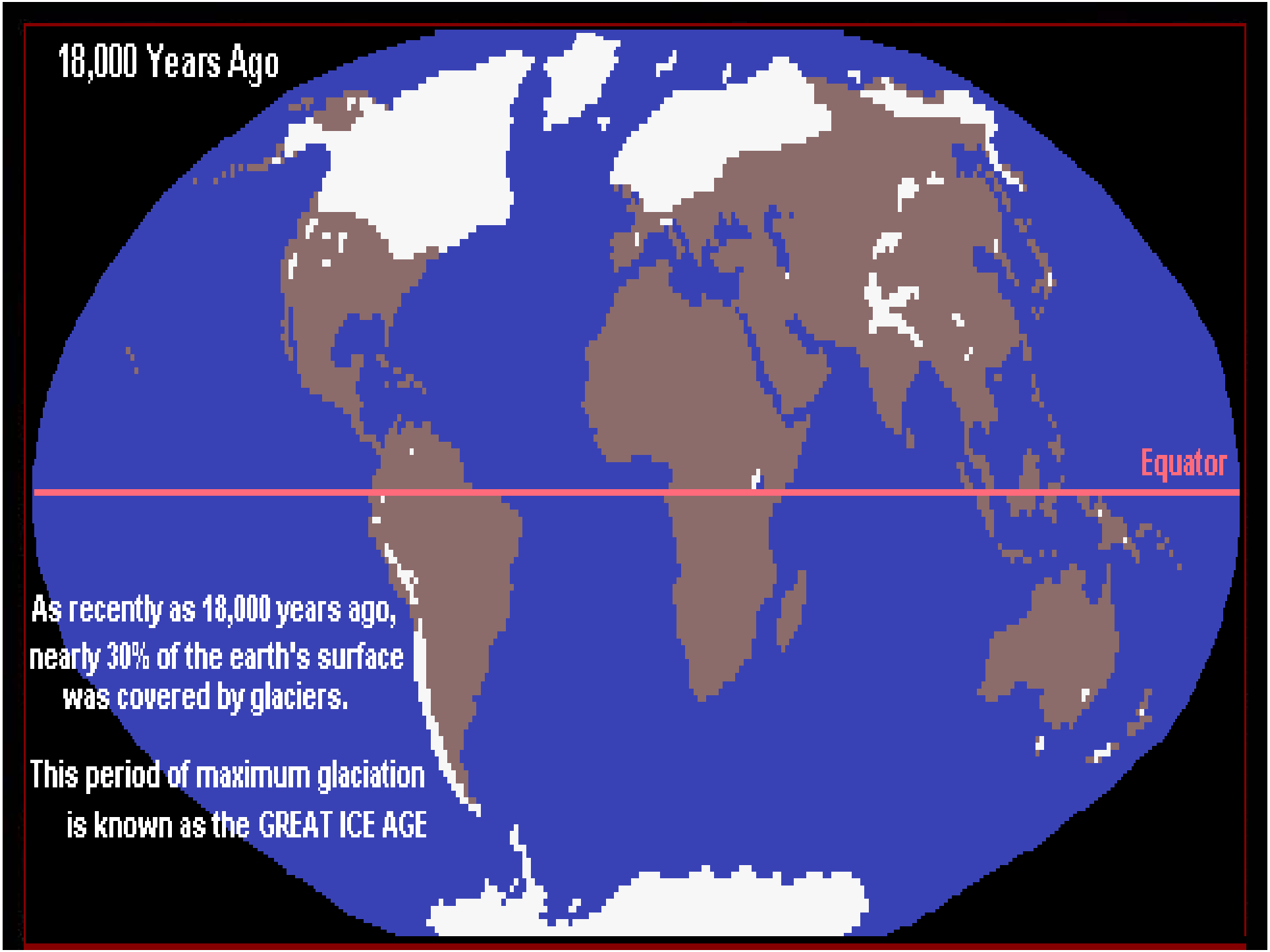


Chapter 11

Glaciers

BFRB p. 103-104, 108, 117-120


18,000 Years Ago
Equator
As recently as 18,000 years ago, nearly 30% of the earth's surface was covered by glaciers.
This period of maximum glaciation is known as the GREAT ICE AGE

Process of Glacier Formation

- Snow does NOT melt in summer
- Recrystallization of snow to form LARGE crystals of ice (rough and granular)
  - called **FIRN**: like packed snowballs
- Lower layers turn to **SOLID ICE** under the weight of overlying firn and snow.

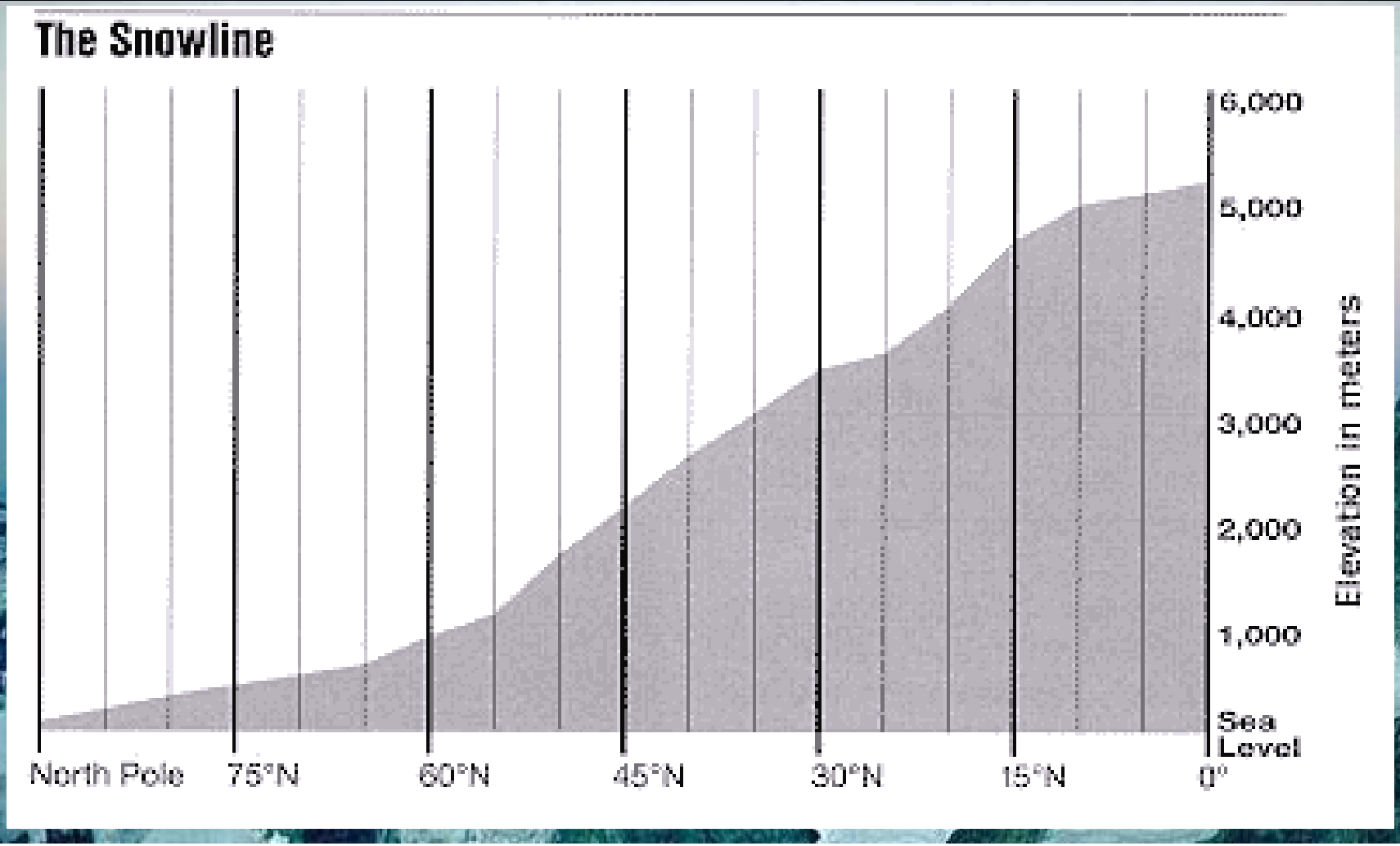
Snow becomes FIRN

What Are Glaciers?

- Def. - A glacier is a mass of snow covered ice that moves due to the force of gravity
- There are 2 main types of Glaciers:
  - Valley Glacier (Alpine)
  - Continental (Ice Sheet / Ice Cap)

Valley Glacier
aka Alpine Glacier

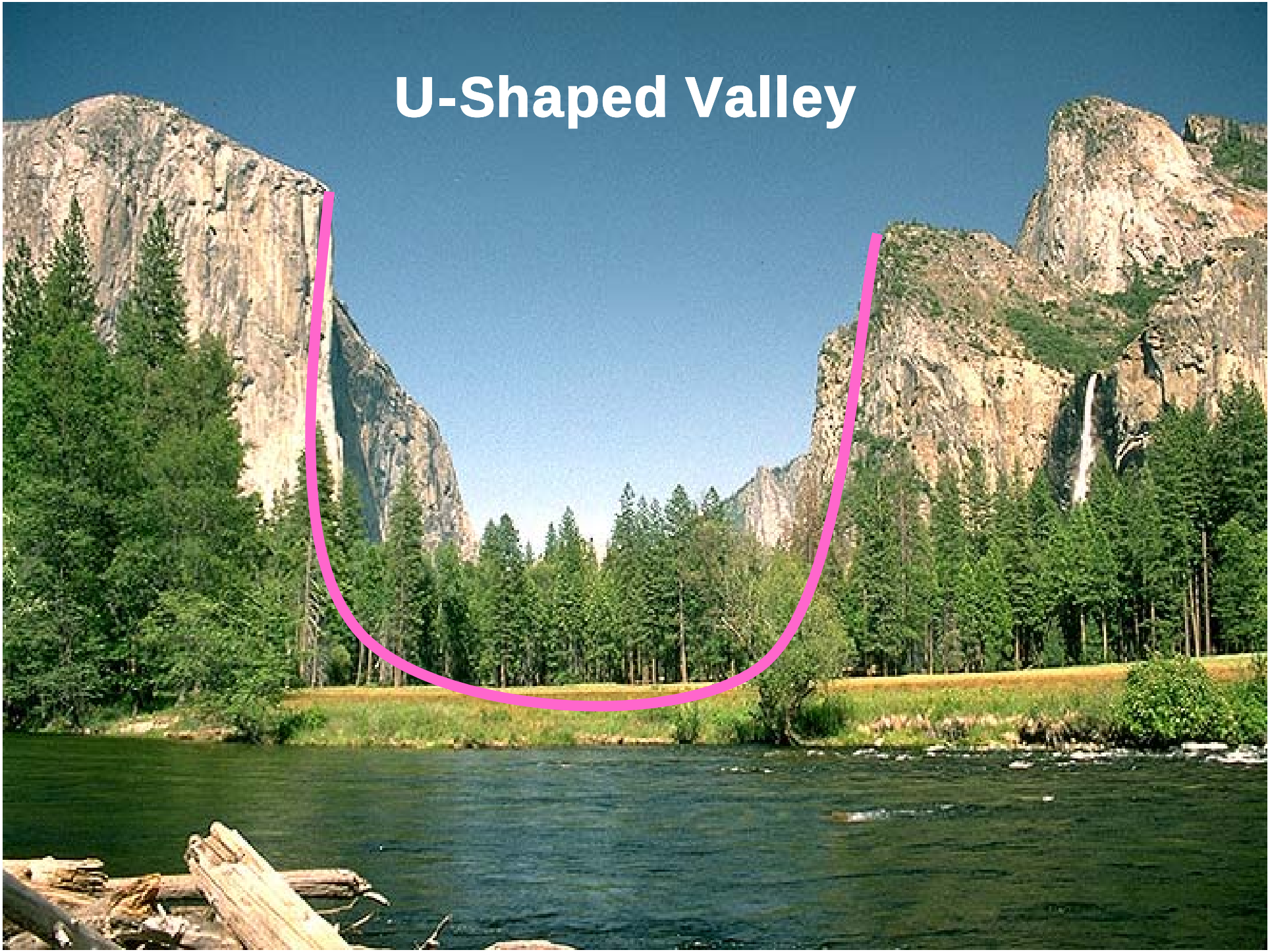
- Def. - long, narrow, slow moving wedge-shaped stream of ice that forms on the highest mountain peaks where the mountains stretch above the <u>snow line</u>
- The snow line is the lowest elevation that **permanent** snows reach in the summer (the snow line is highest in elevation near the equator, and lowest in elevation near the poles)



This diagram shows how the elevation of the snowline changes with latitude. The approximate elevation of the snowline is indicated on this diagram where the white and gray areas meet.

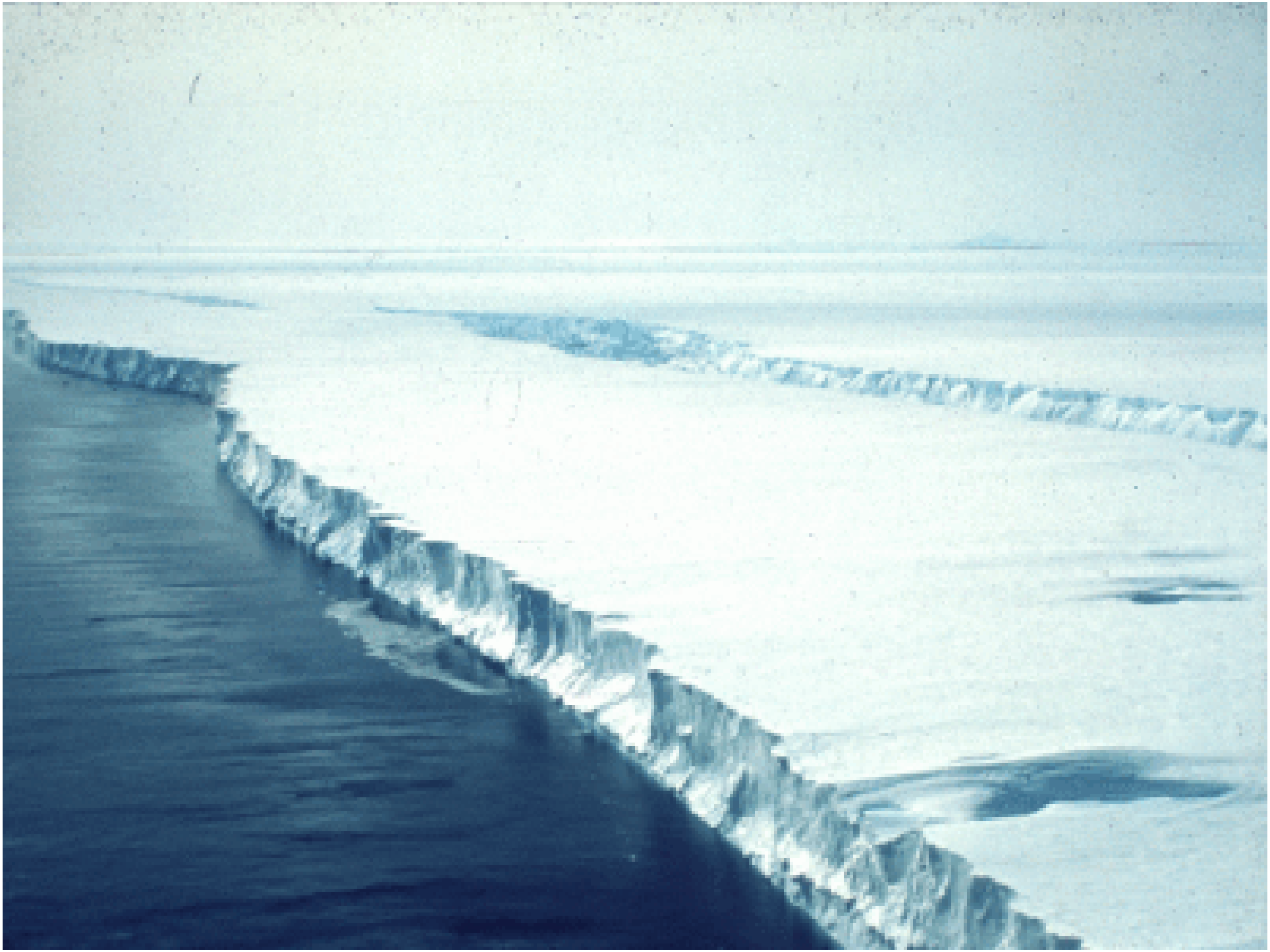
- Gravity then starts to slowly pull it downward and outward from the bottom layers
  - smallest = 1-2 km long, 100's m wide, 100's m deep
  - largest = Over 100km long X 100's m deep
- This type of glacier carves out "U"-shaped valleys from once "V" shaped valleys. **Remember, streams and rivers carve "V"-shaped valleys.
  - Ex. Glaciers of Alaska

U-Shaped Valley

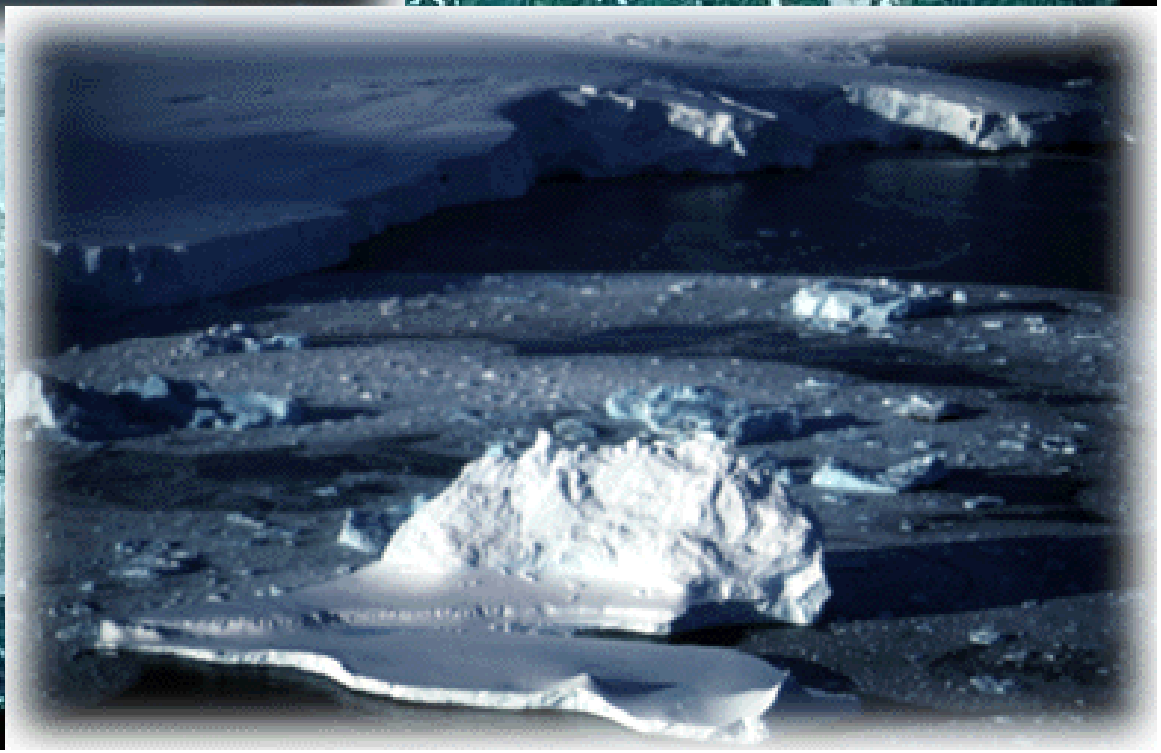


Continental Glacier aka Ice Sheets

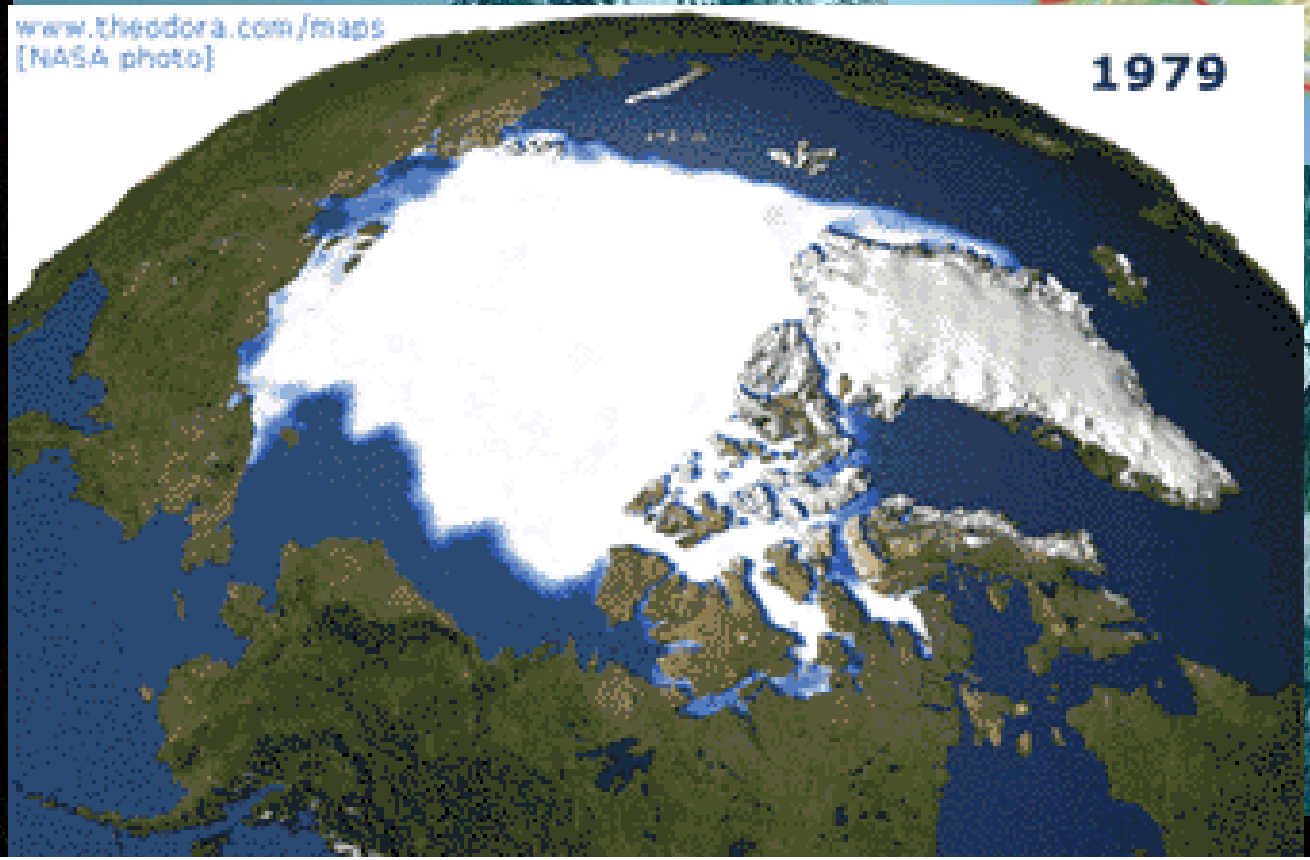
- Very old (1000's of years), thick (1000's of meters) mass of ice covering almost an entire land mass
  - GREENLAND: 1.7 Million SQ MI , 3 KM thick
  - ANTARCTICA: 12.5 Million SQ MI, 5 KM thick
- The snow line in these regions is close to sea level and these areas are very large (they may cover several thousand to several million square kilometers)



- The tremendous weight of these glaciers causes it to **slowly move outward from the center** (some only moving centimeters per year)
- When the glacier reaches the sea, chunks break off and become icebergs (this is called calving)
- *Smaller ice sheets are called *ice caps*
  - Iceland, Baffin Island, Spitsbergen (all in Arctic Ocean)
  - May be several thousand square kilometers in area.




ICELAND
Akureyri
Godafoss
Lake Myvatn
Hveravellir
Hofsjokull
Langjokull
Snafell
Vatnajokull
Reykjavik
Keflavik
Gullfoss & Geysir
Skaftafell
Hofn
Trekking


www.theodora.com/maps
[NASA photo]
1979

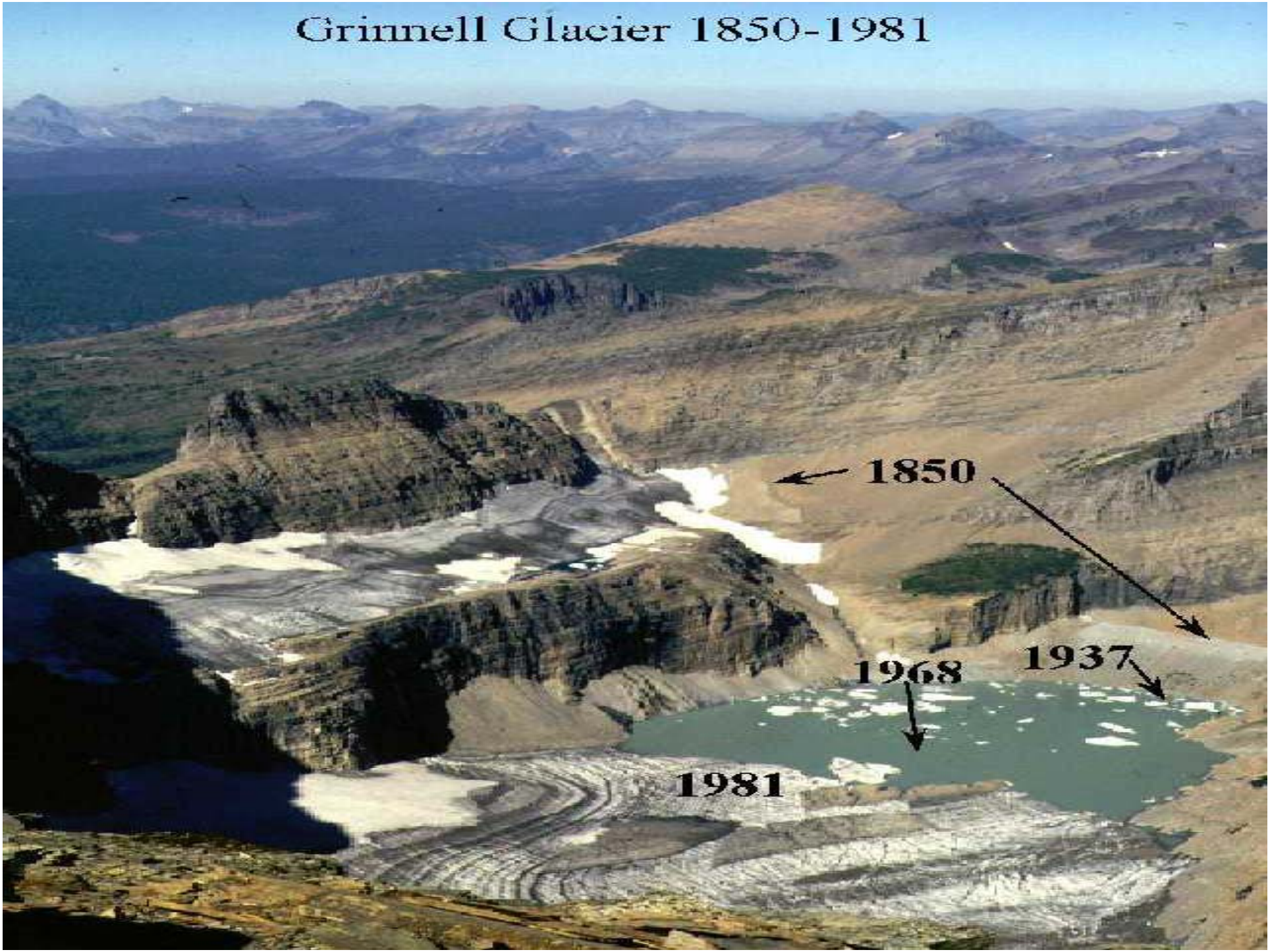
Glacier Movement

- The farthest a glacier has moved is the ice front
- A glacier is always moving forward (advancing) (although it may appear to move backwards at times, it cannot actually move backwards)
- During the winter, a glacier may advance farther than usual because the snow accumulates faster than it melts
- The opposite is true during the summer. Melting will take place at a much greater rate than accumulation, causing the glacier to recede (appear to move backward)
- A glacier will not move (stationary) when the rate of accumulation is equal to the rate of melting

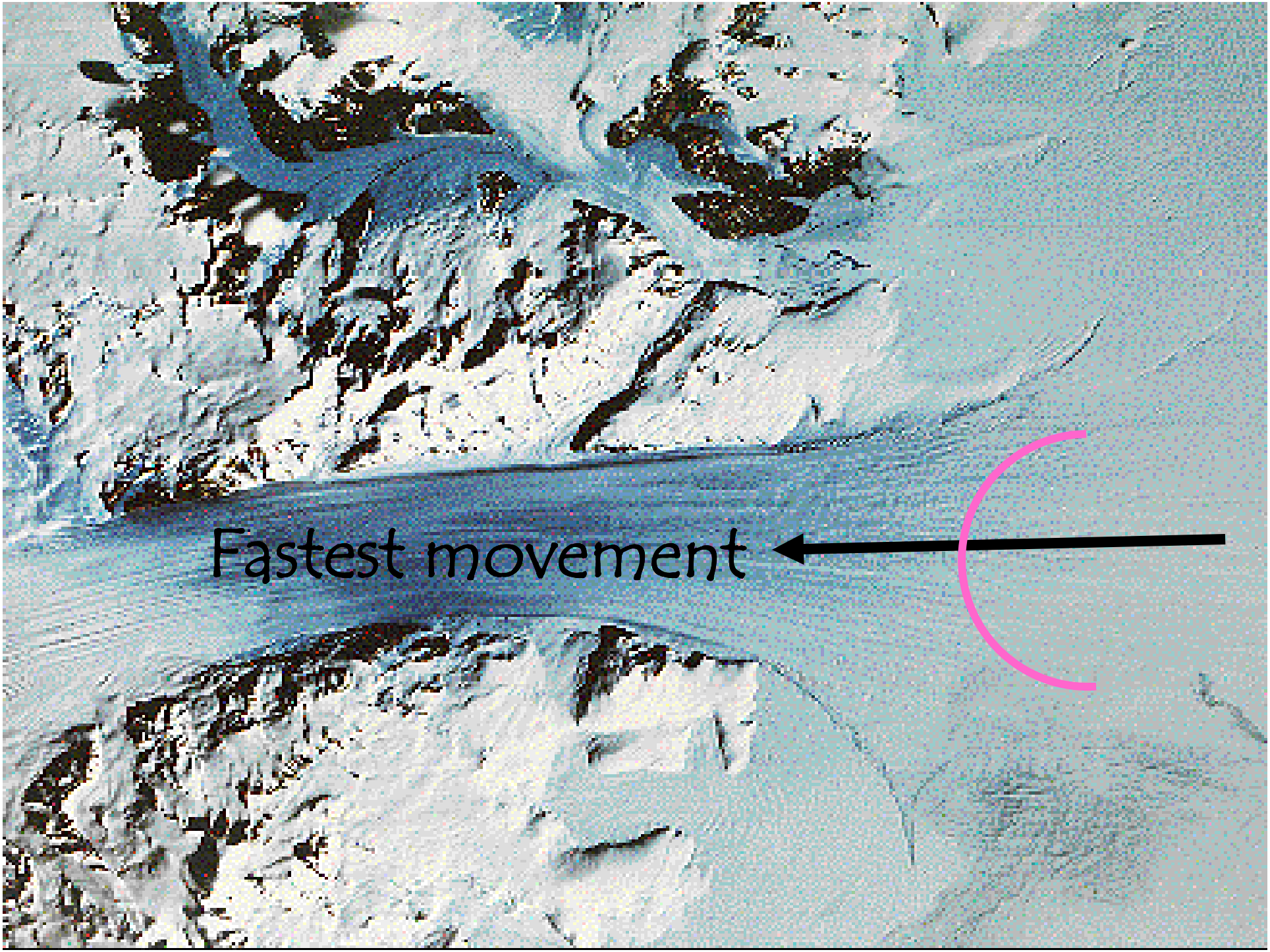
Grinnell Glacier and Grinnell Lake
Glacier National Park, 1910-1997

Photo by Kiser, GNP Archives, 1910

Photo by Fagre, 1997

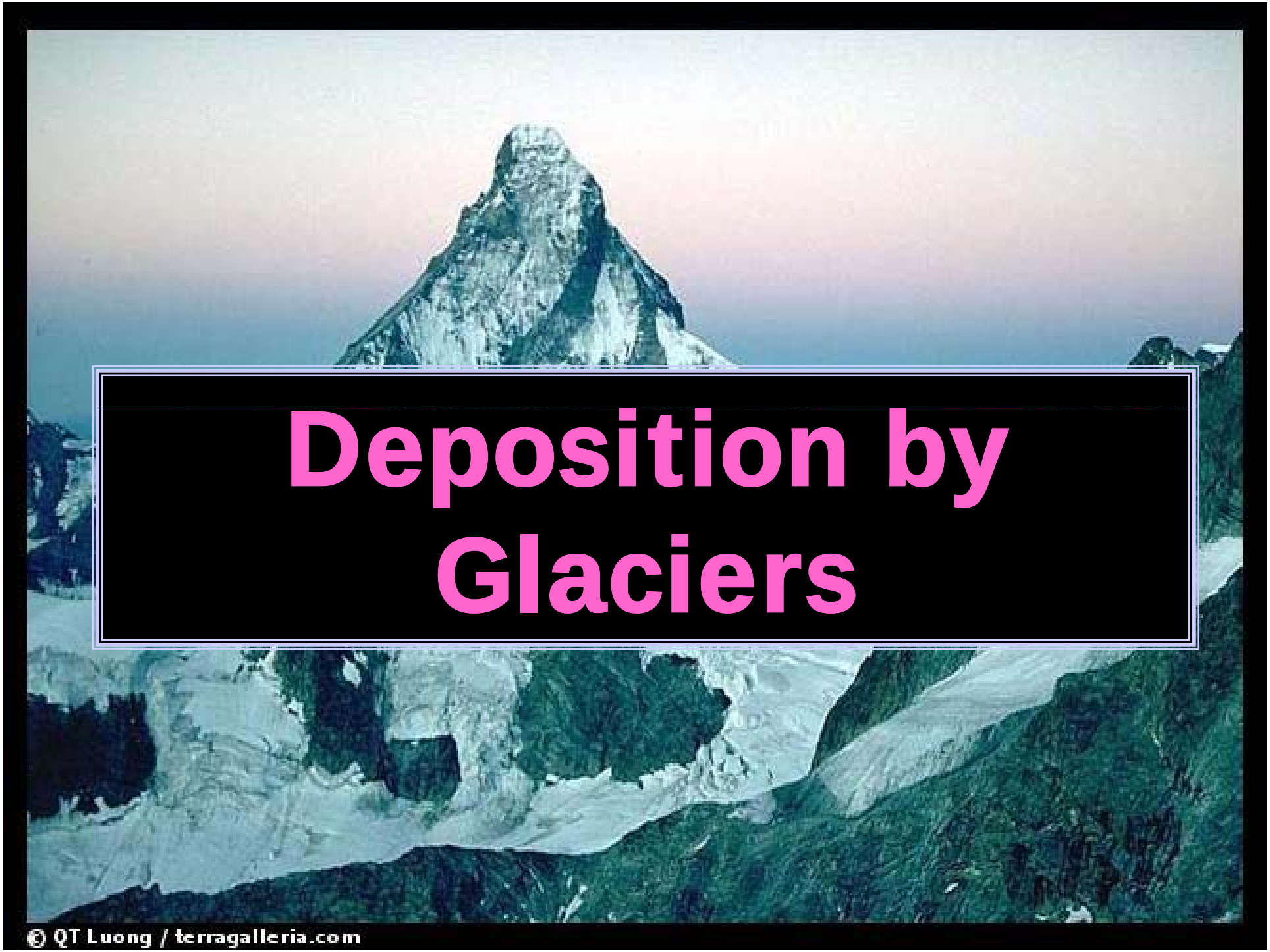

Grinnell Glacier 1850-1981
1850
1937
1968
1981

- The fastest part of a glacier's movement is in the center of the flow, away from the walls of the valley.
- This is because friction is lowest as you move away from the valley walls.


Fastest movement

- **As a glacier moves, rocks that are stuck in the ice are dragged across the exposed bedrock. This causes deep scratches and gouges in the bedrock called striations**
- **VIF*** *The direction of the striations shows the path of movement of the glacier****

Deposition by Glaciers

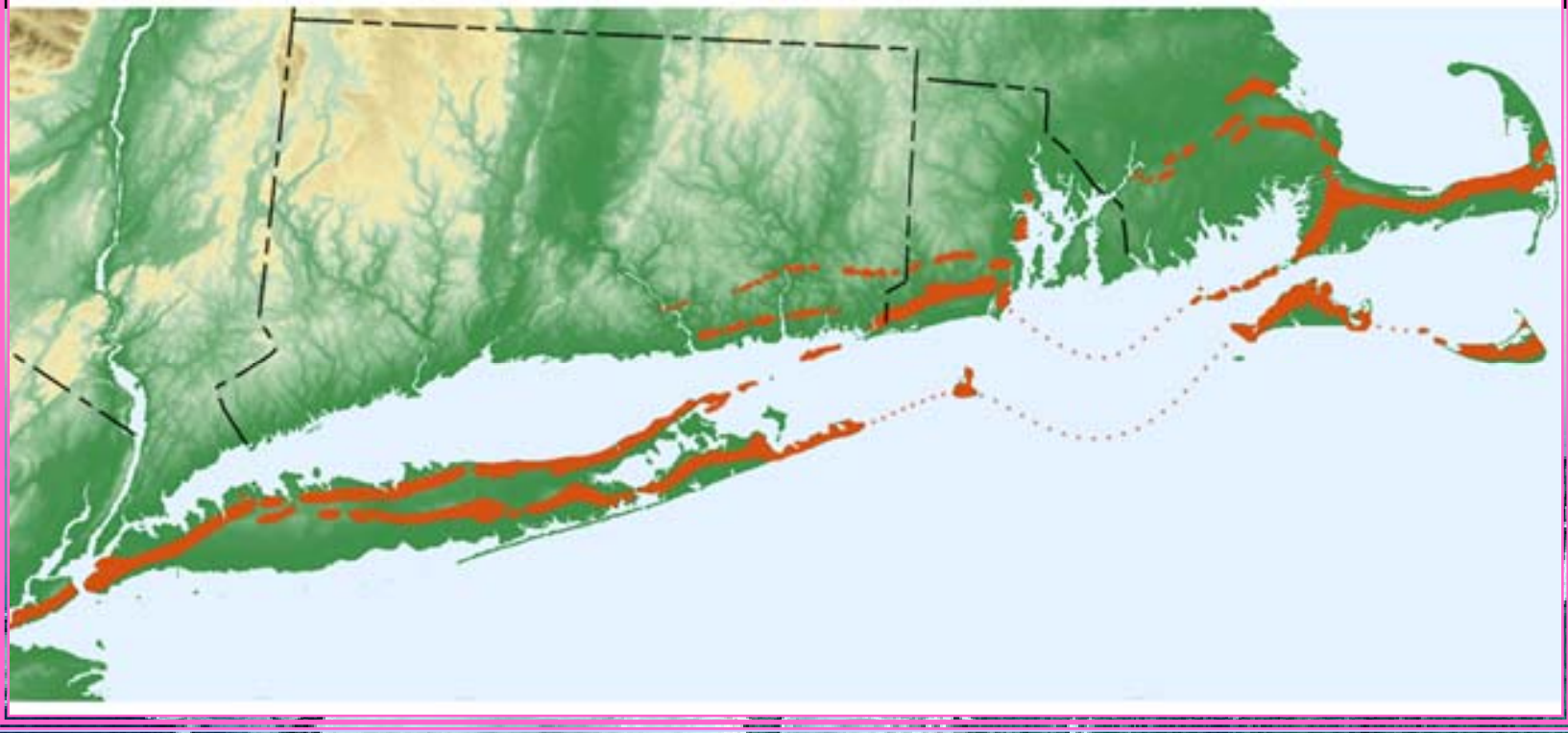


- Glaciers can carry sediment just as streams and rivers can (only glaciers can carry more and much larger sediment)
- VIF - Since a glacier acts like a bulldozer as it moves, the various sediment sizes become mixed together and are deposited unsorted
  - This is called glacial till – UNSORTED!!!!!!!
- If the sediment is deposited by the running melt water from the glacier, it will be sorted (just like from any stream)
  - This sorted material is called outwash and it is deposited on an outwash plain.


Glacial till - unsorted

Landforms Caused by Glacial Movement and Deposition

(you must memorize what these landscape features are! These are some of the very few things you must have set to memory for this class...)



Moraines- deposits of <u>unsorted</u> sediment along the edges and southern end of the glacier.

- The moraine that forms at the end of the glacier (showing its farthest advance) is called a *terminal moraine or AKA end moraine* (Ex: Long Island, Cape Cod)

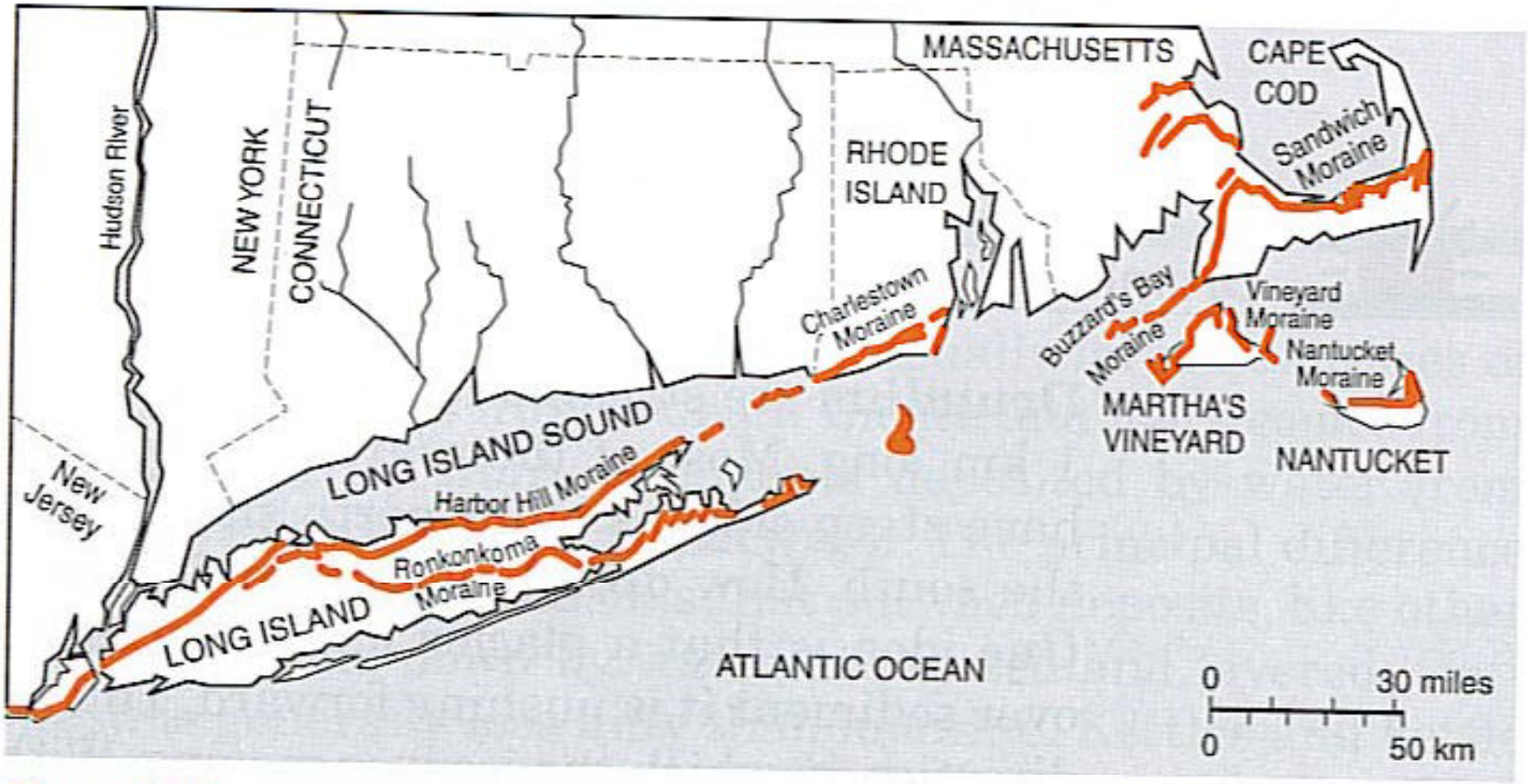
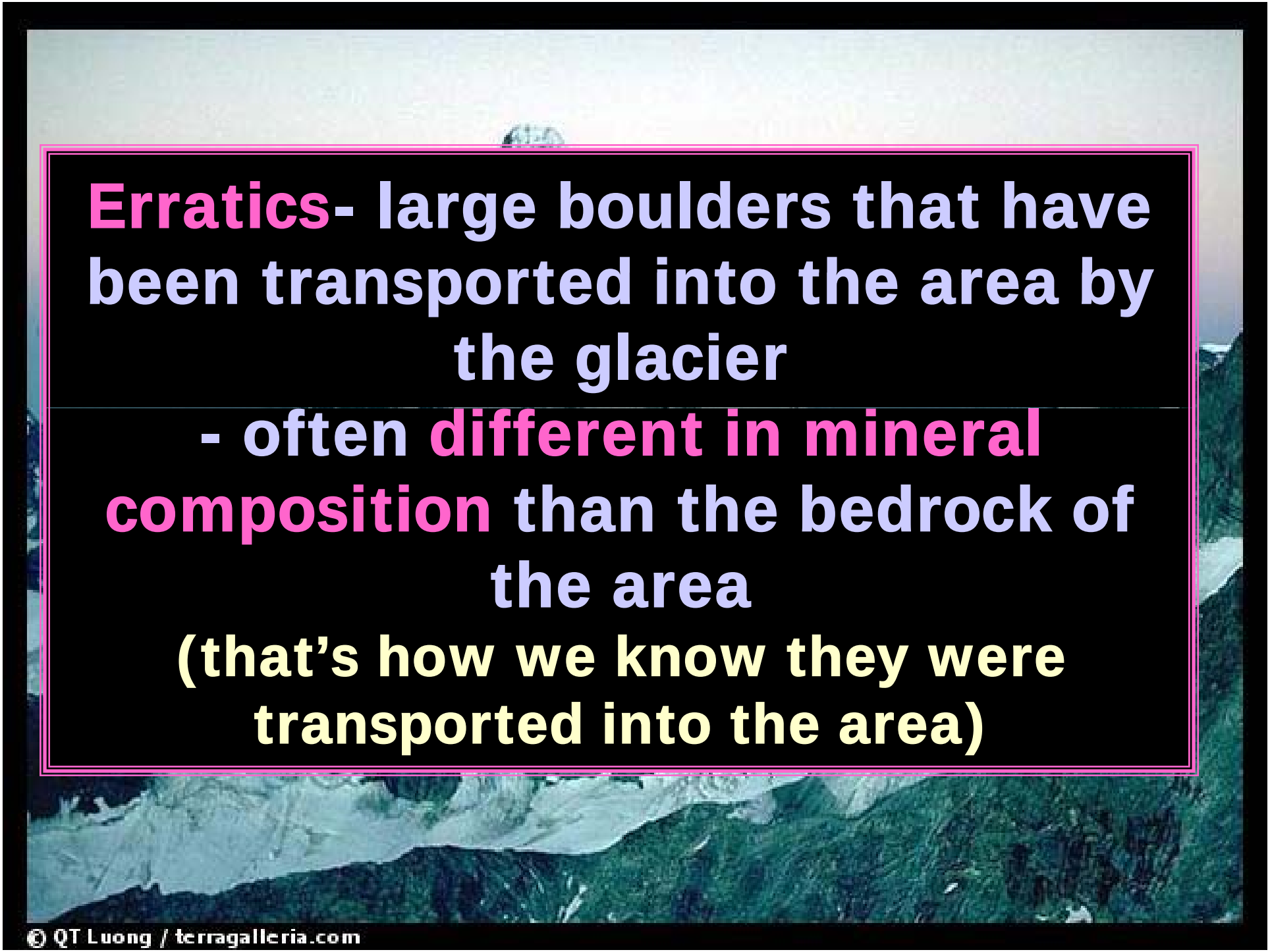


Figure 14-7 Long Island was built from sediment pushed into place by glaciers. Most rock-strewn, north shore beaches lie at the bottom of the high bluffs of the Harbor Hill Moraine. South shore beaches are composed of mostly fine sand washed from the moraines by glacial meltwater. These moraines extend into southern New England.



Erratics- large boulders that have been transported into the area by the glacier

- often different in mineral composition than the bedrock of the area

(that's how we know they were transported into the area)

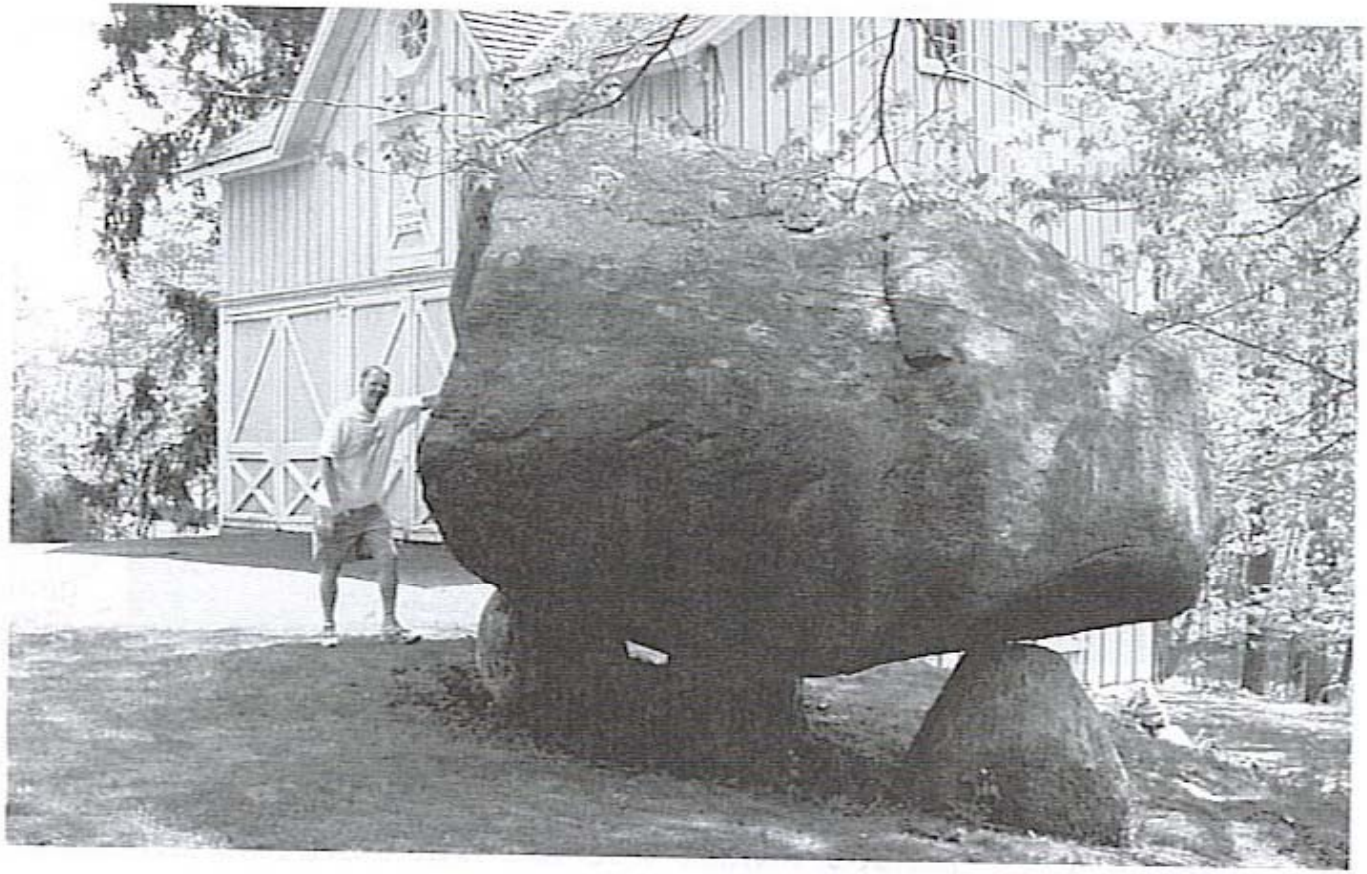


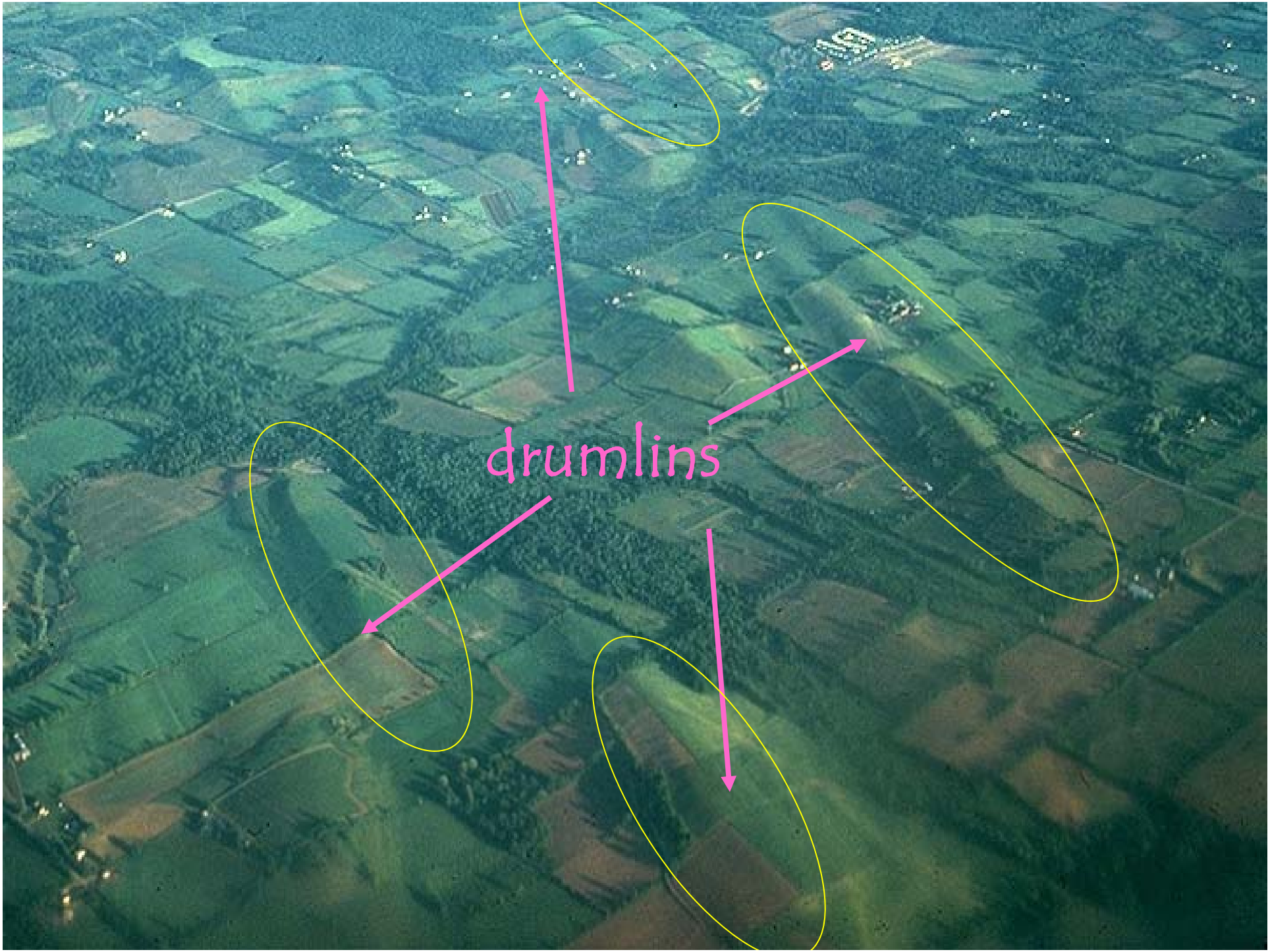
Figure 14-6 This large boulder, a perched erratic, was transported south by a glacier and deposited in till north of New York City. The smaller particles of till were washed away, leaving the large erratic balanced, or perched, on three smaller erratic boulders.


MT + MARIE
1989
88

Drumlins- long, smooth hills made of glacial till.

- formed when a glacier runs over a moraine made by a previous glacier, "smearing" it out.

- The drumlin points in the direction that the glacier was moving (advancing)


drumlins

Outwash Plains- melt water from the *bottom* of the glacier carries sorted sediment out in front of the glacier

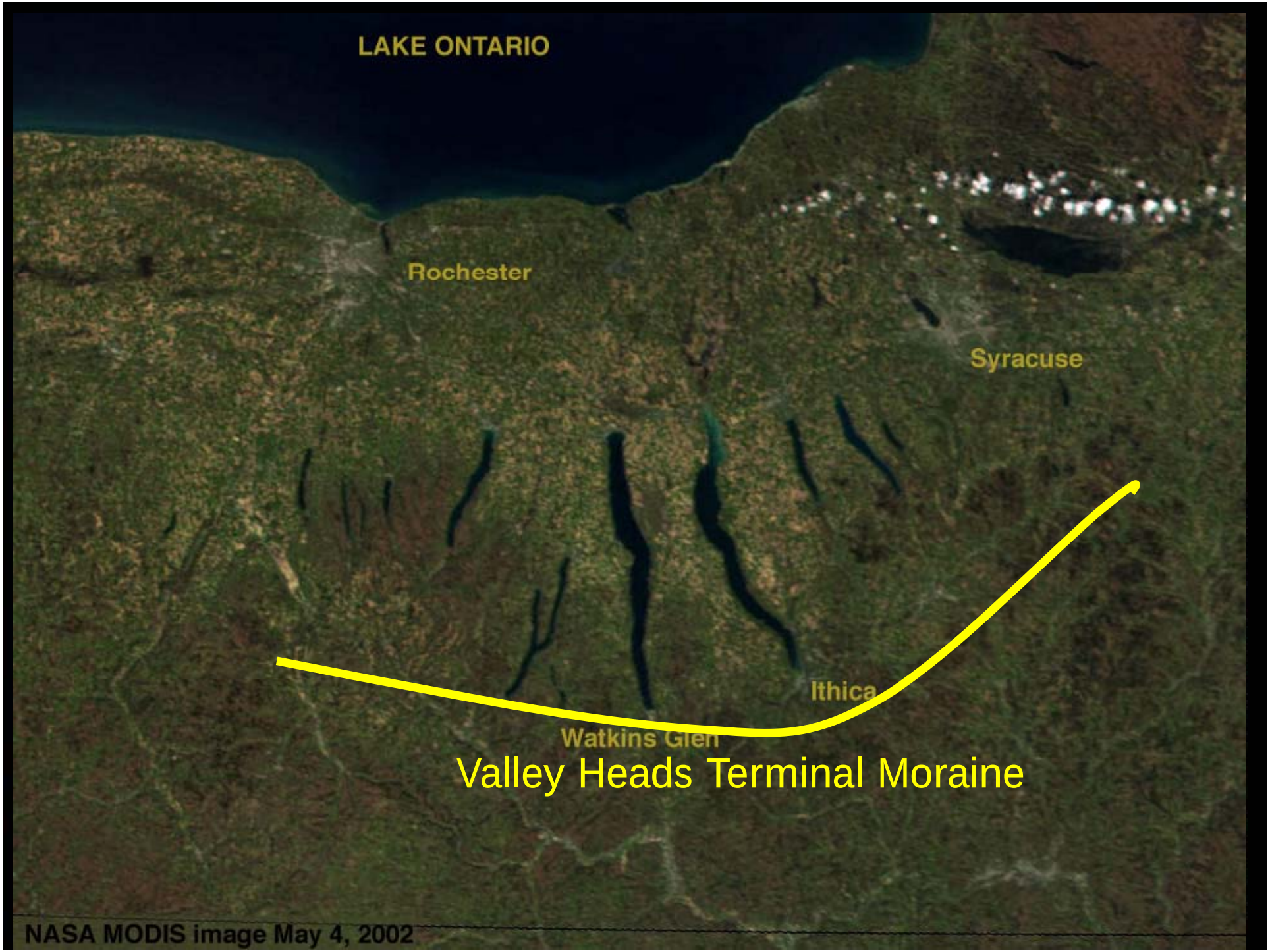

Outwash Plain

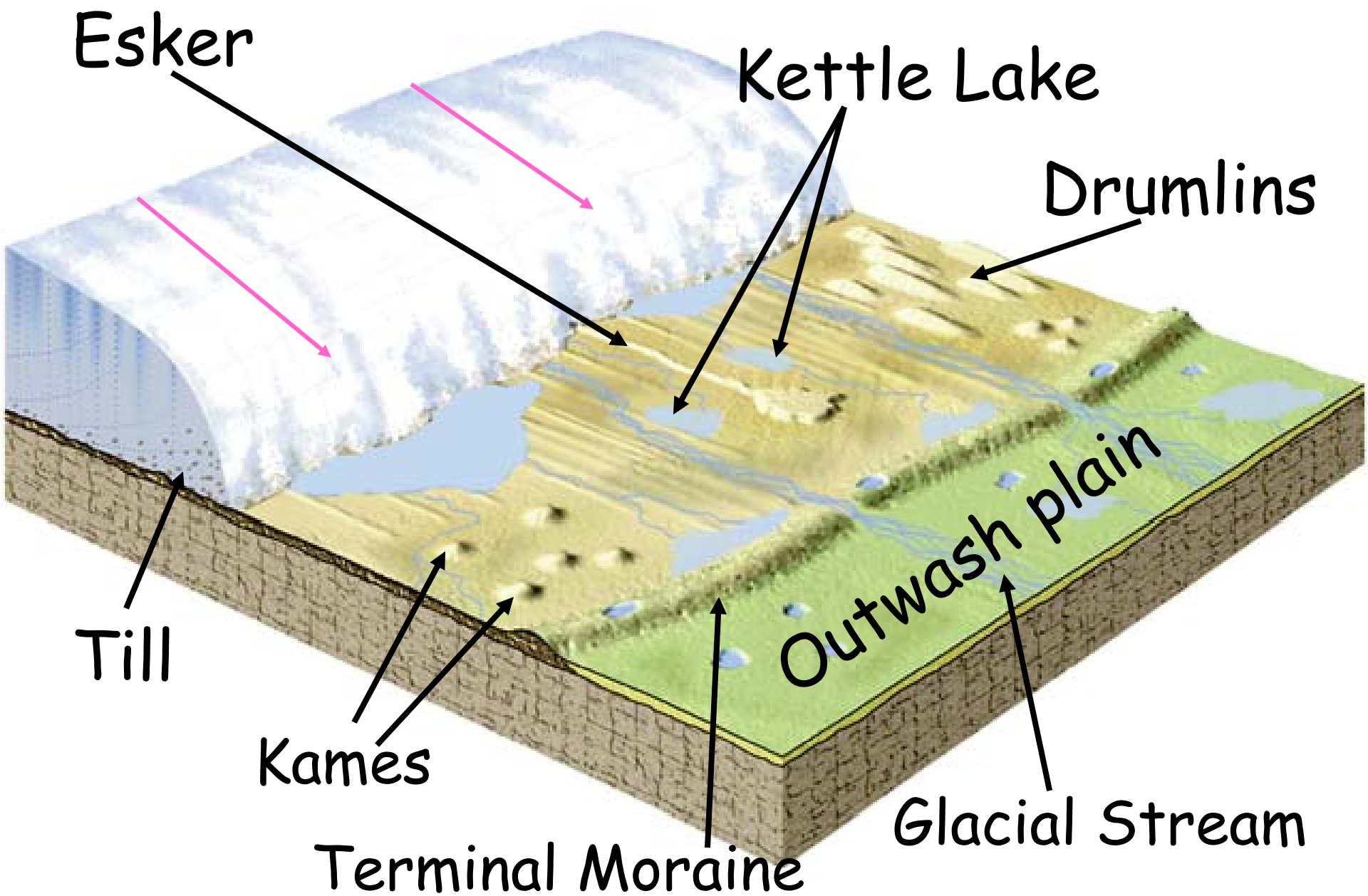
Kames- melt water from the *top* of the glacier deposits sediment when it flows down off the glacier and reaches the ground. The sediment is deposited as small hills of sorted sediment

Kettle Lakes - circular lakes. Chunks of ice often break off the glacier and are buried in the ground by sediment. As the buried ice melts, the sediment sinks into the hole and the water fills it up

Another type of lake, found in New York, is called a **moraine-dammed lake**. This is formed when a glacier scours (carves out) a river valley even deeper and then a glacial moraine blocks the river valley from draining. The river floods the valley and forms a long, narrow, deep lake.

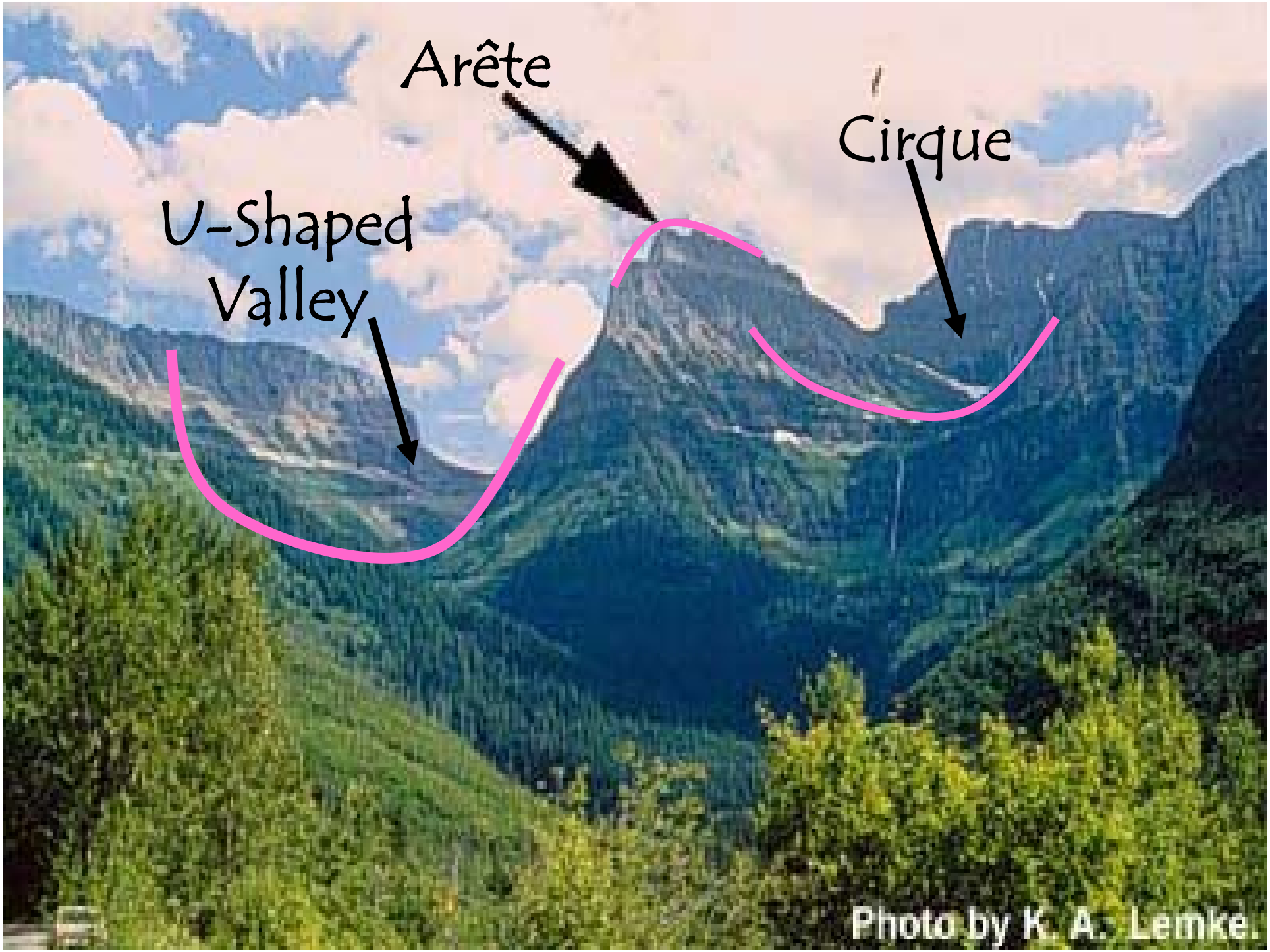
Ex. the **Finger Lakes** in upstate New York.

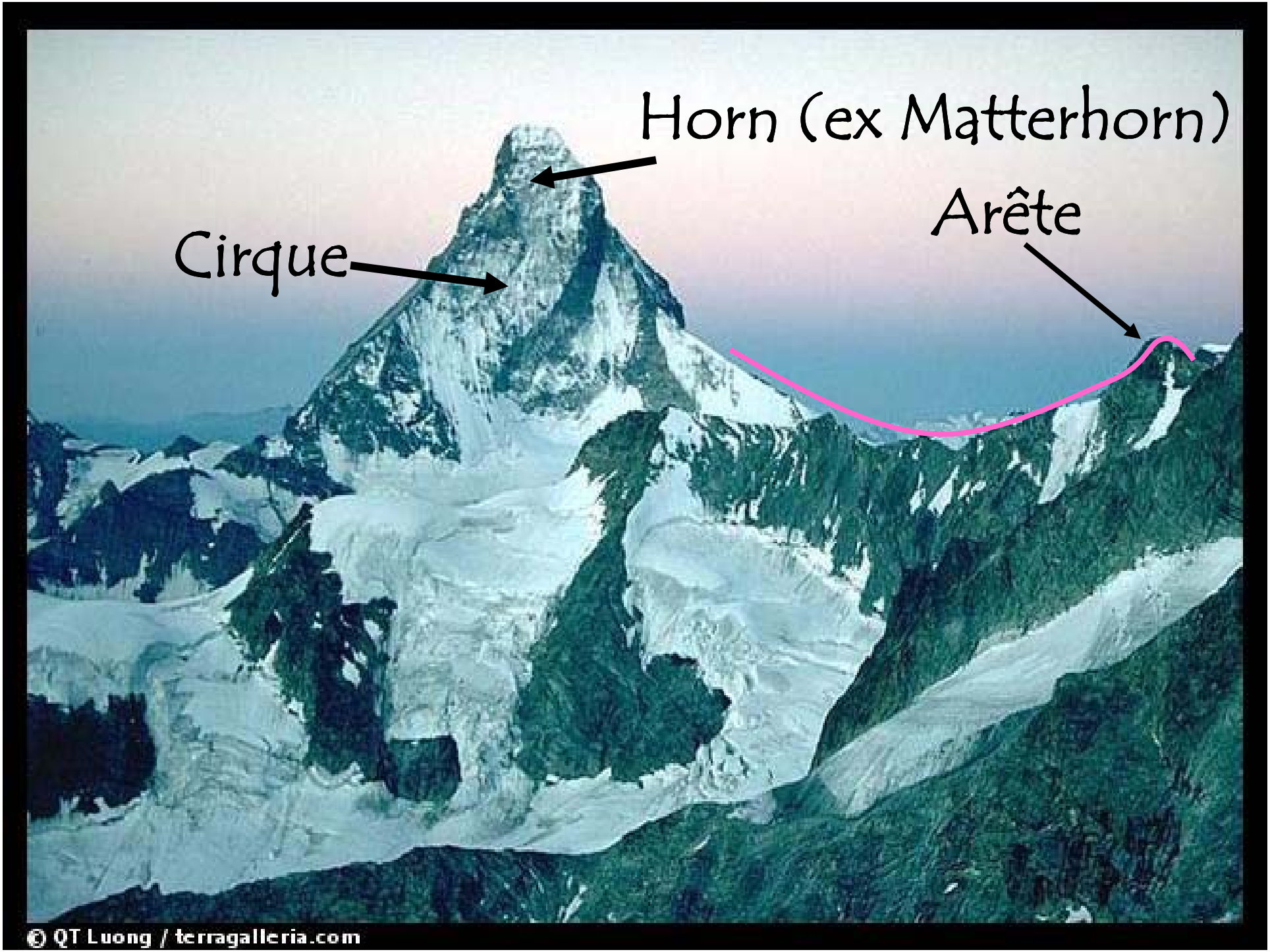

LAKE ONTARIO
Rochester
Syracuse
Ithica
Watkins Glen
Valley Heads Terminal Moraine
NASA MODIS image May 4, 2002



Landscape Features that Valley Glaciers carve out…(you don't have to memorize these..)

- **CIRQUES: semi-circular shaped bedrock feature created as a glacier scours back toward the mountain (1st place snow and ice accumulate)**
- **ARÊTES: steep-sided, sharp-edged bedrock ridge formed by two glaciers eroding away on opposite sides of a ridge**
- **HORNS: 3 or more cirques adjacent to one another**


Arête
Cirque
U-Shaped
Valley
Photo by K. A. Lemke.


Horn (ex Matterhorn)
Arête
Cirque
© QT Luong / terragalleria.com

And in keeping with tradition…
DEVIL's glacier