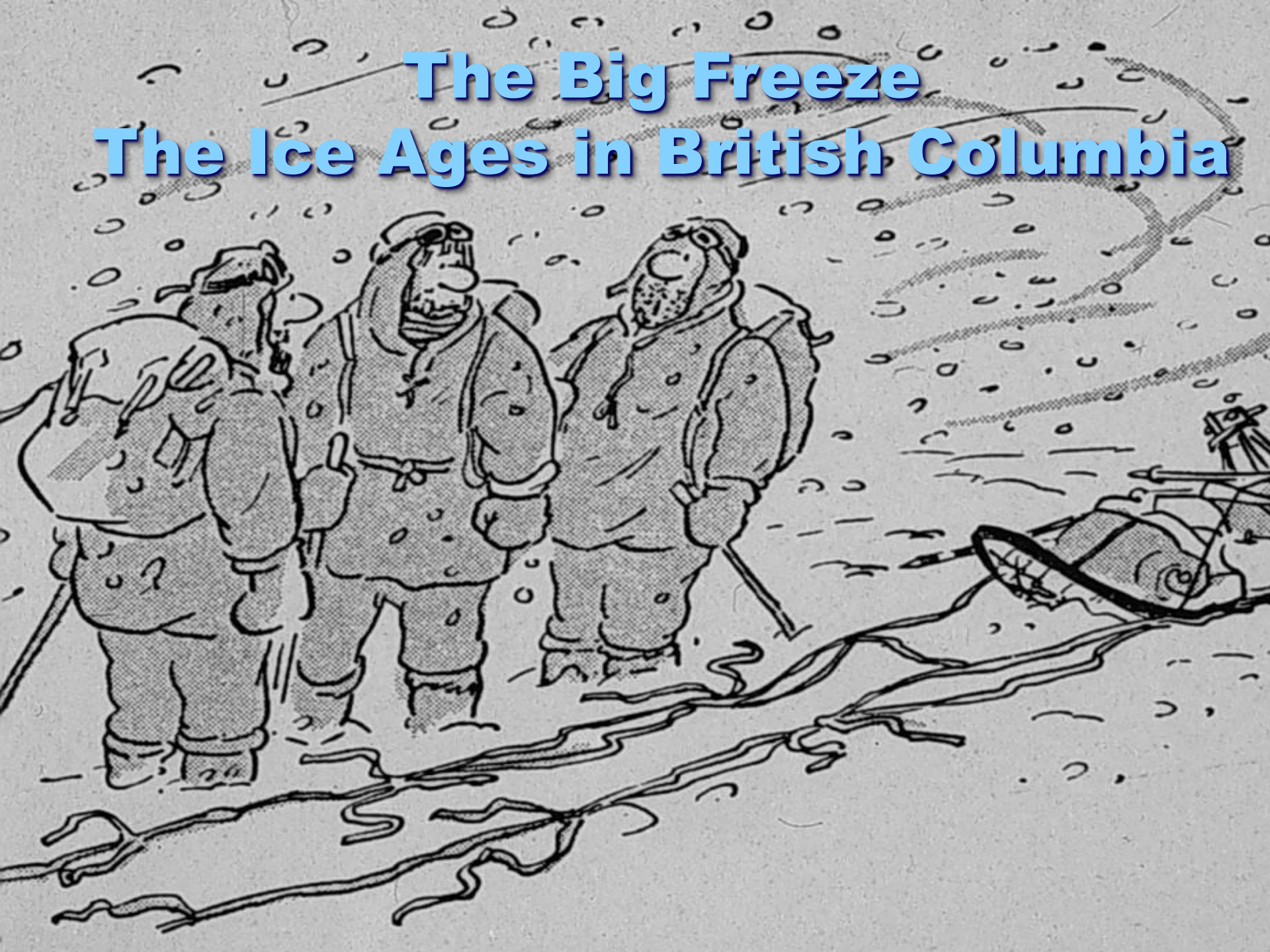
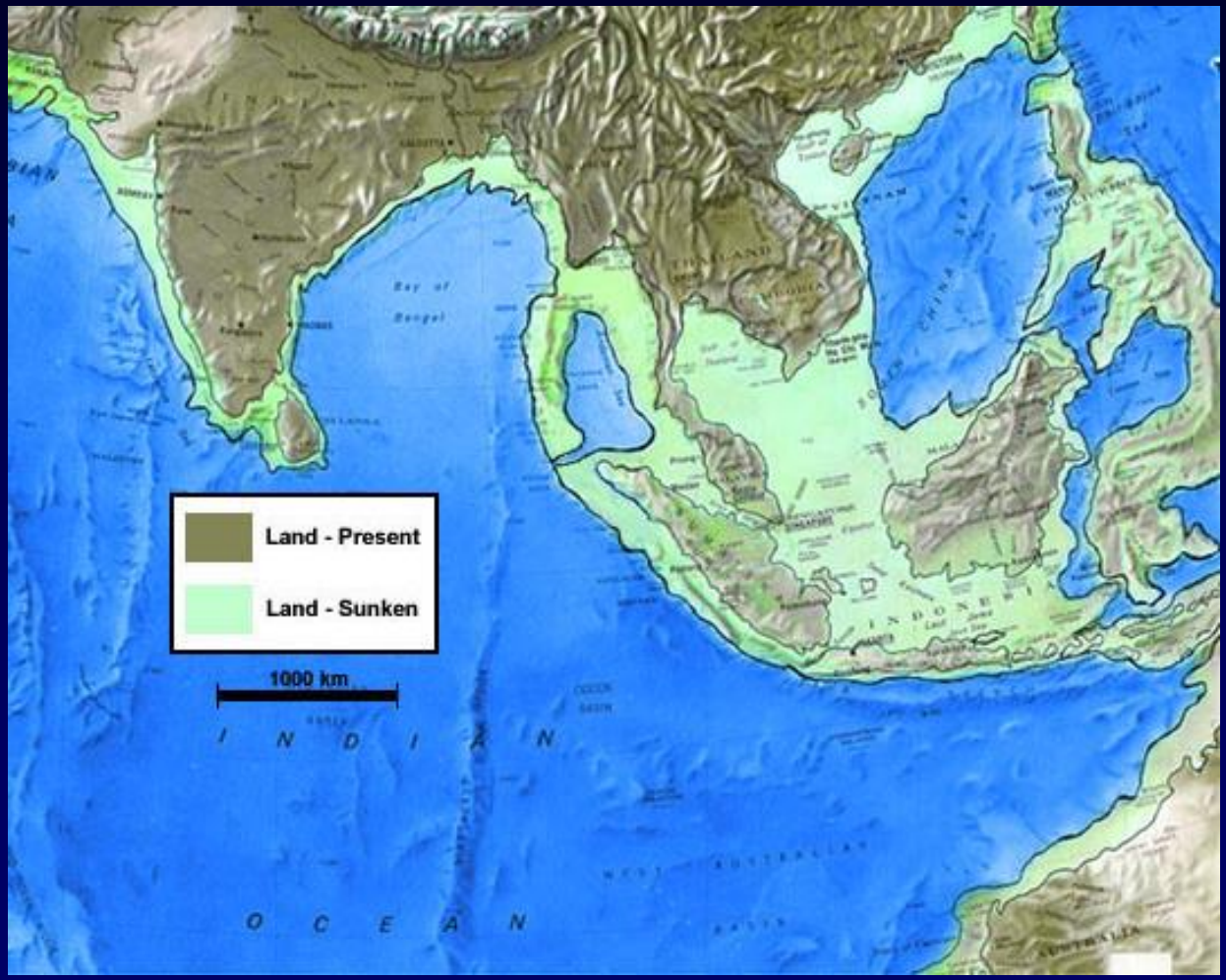
The Big Freeze
The Ice Ages in British Columbia



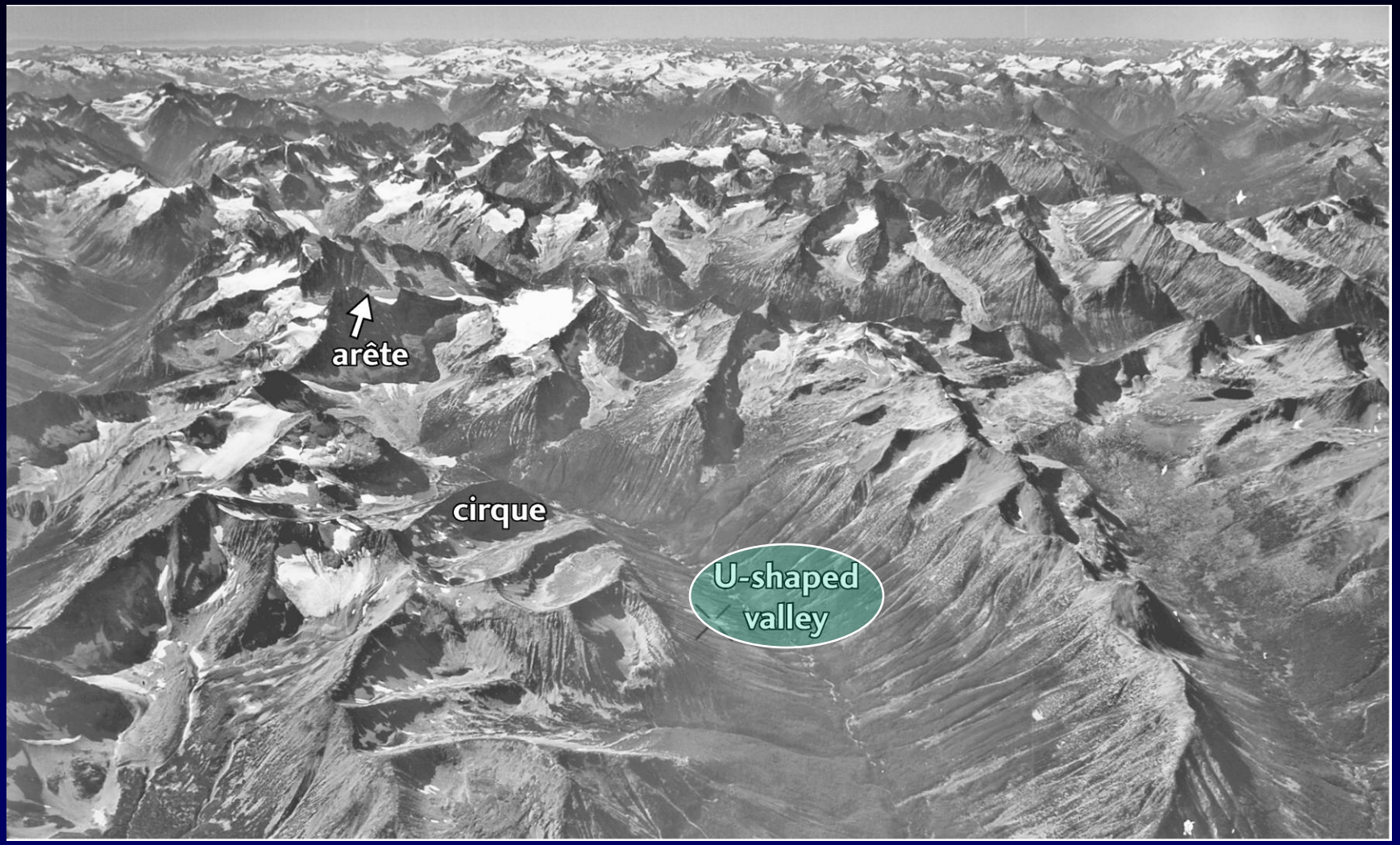

Clague and Turner, 2003
Arctic Ocean
Innuitian ice sheet
Greenland ice sheet
unglaciated
Cordilleran ice sheet
Laurentide ice sheet
Pacific Ocean
unglaciated
Atlantic Ocean

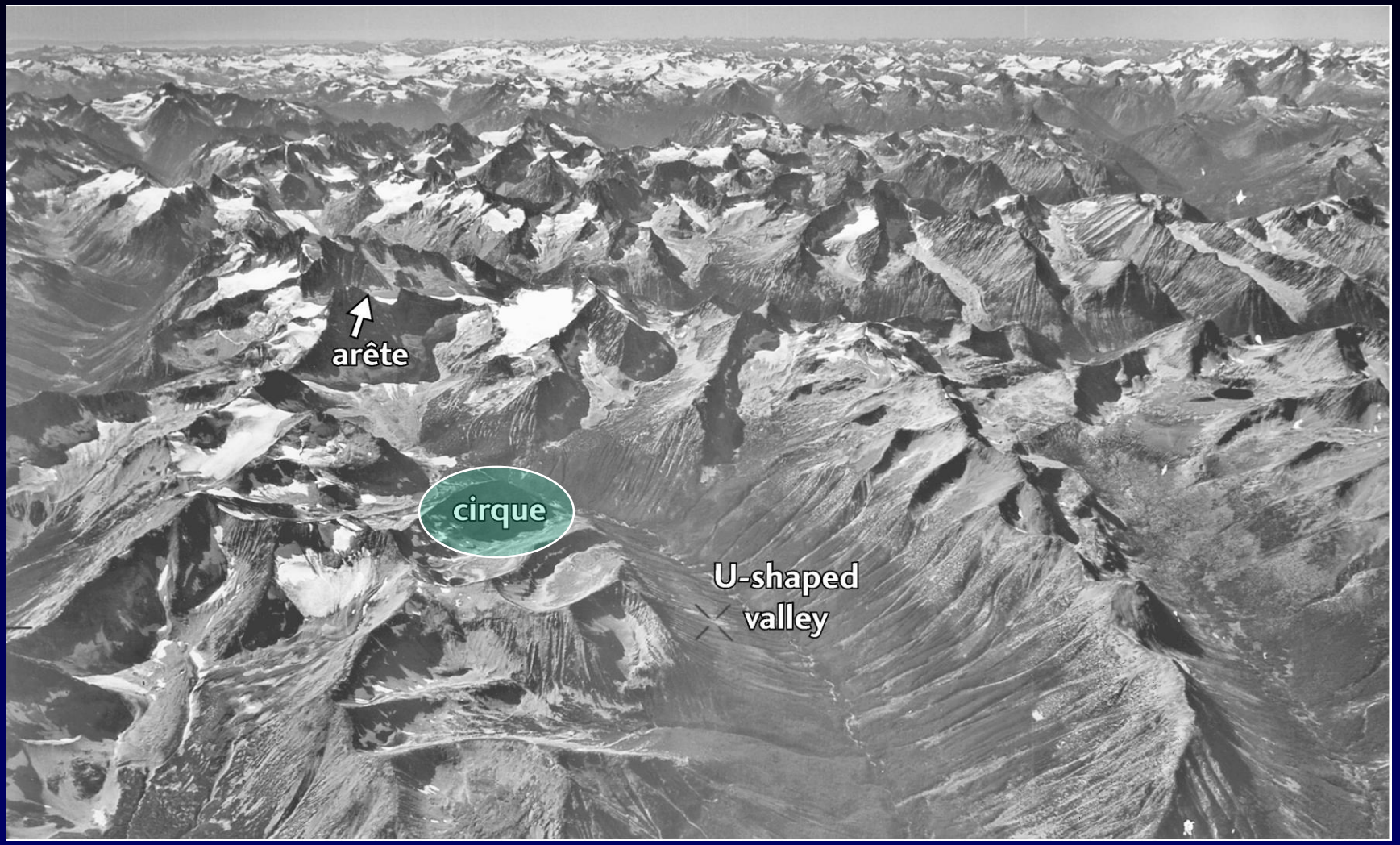
Consequences of sea level lowering include linking of:

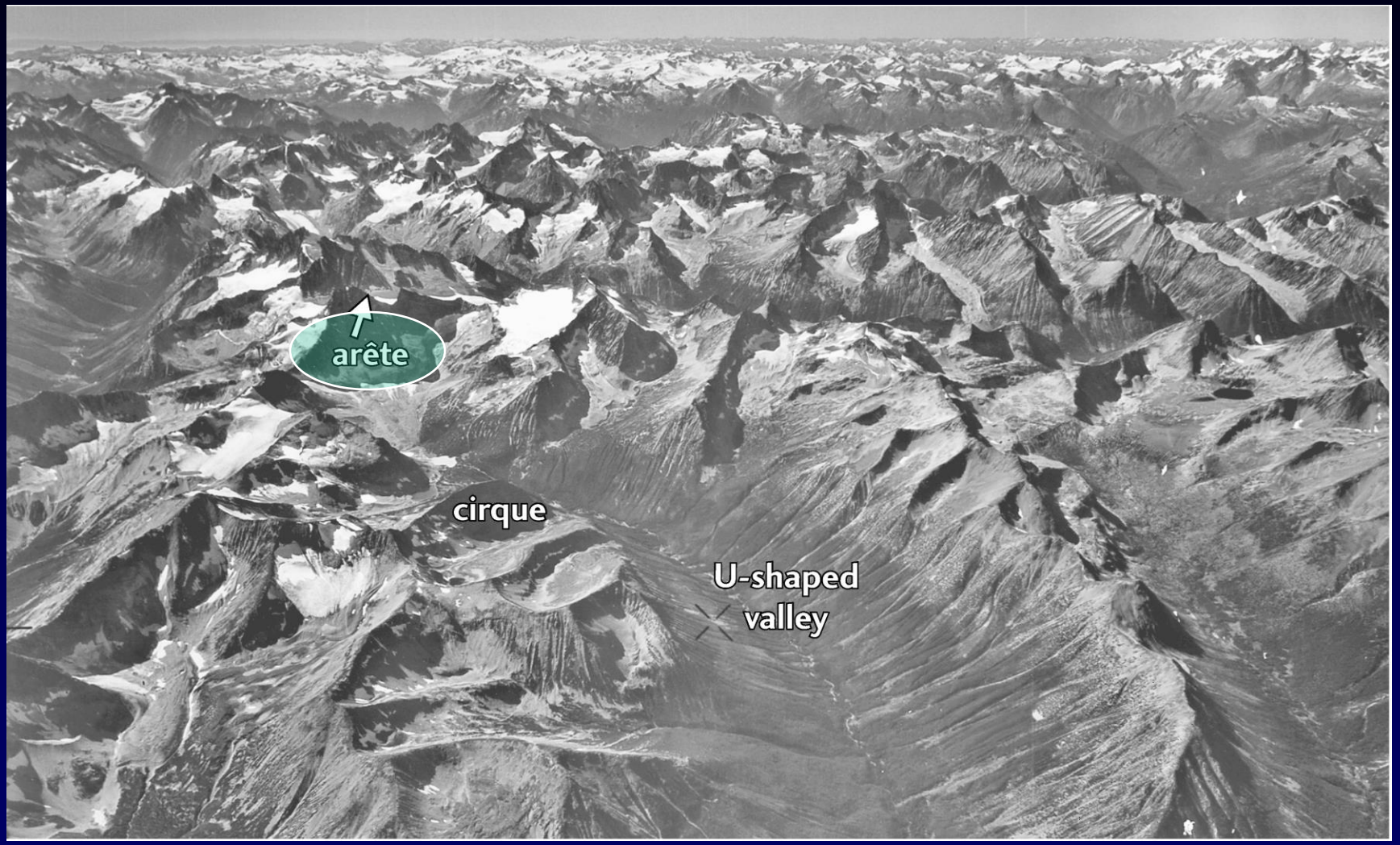
- Britain to continental Europe
- Ireland to Britain
- Australia to New Guinea
- Japan to China
- Siberia to Alaska



The ice sheet's 'footprint'


arête
cirque
U-shaped valley

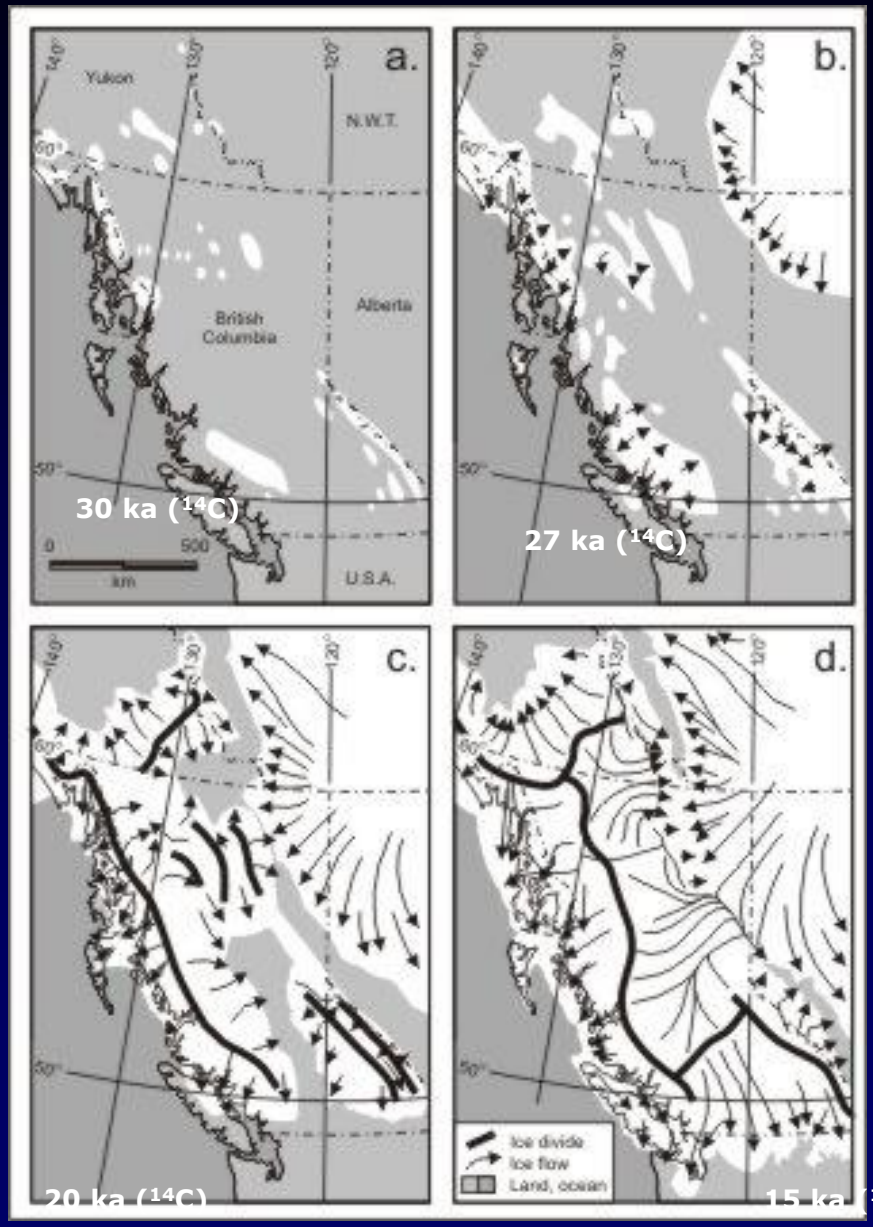

arête
cirque
U-shaped
valley

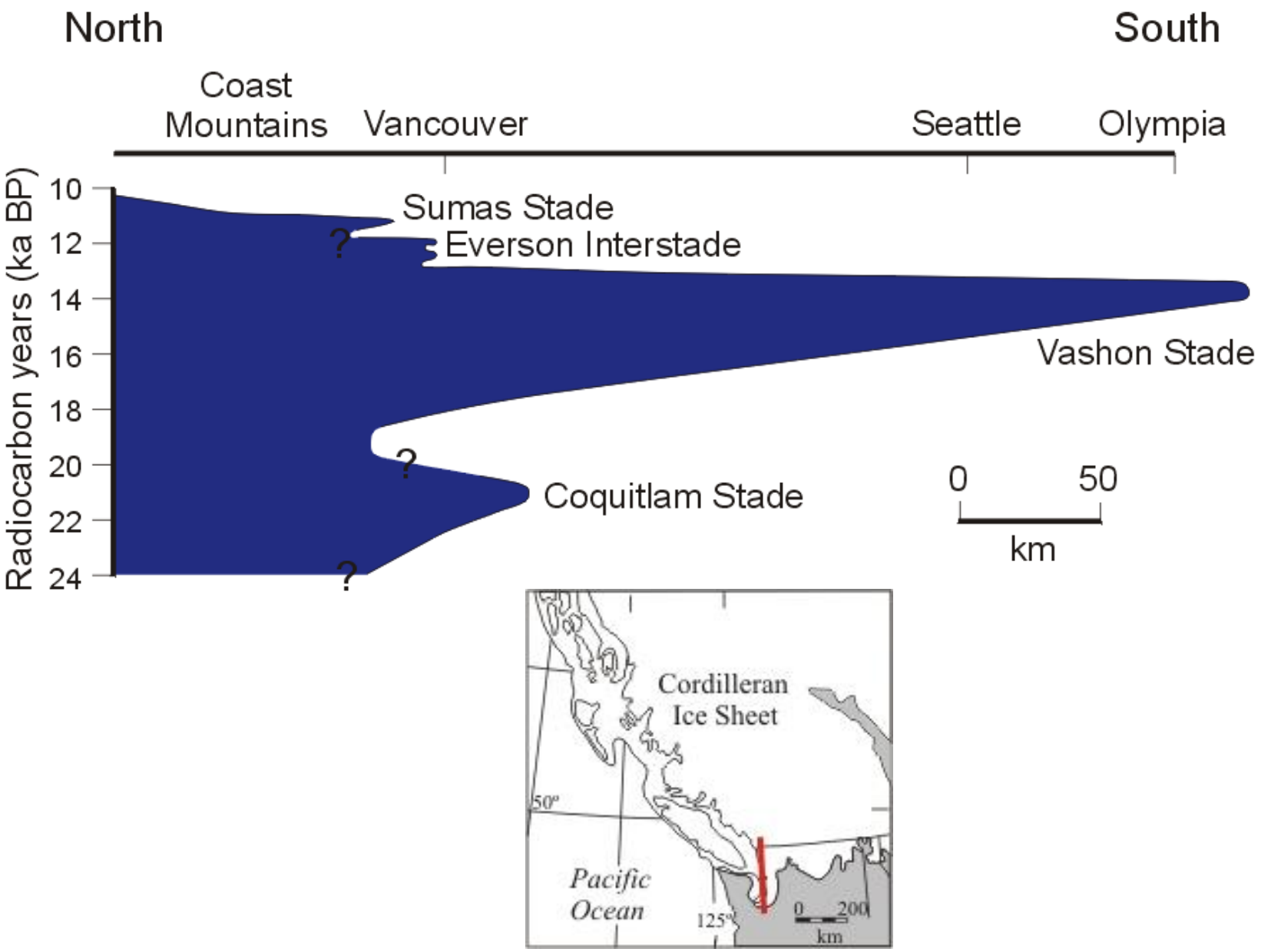

arête
cirque
U-shaped
valley

Glacier erosion

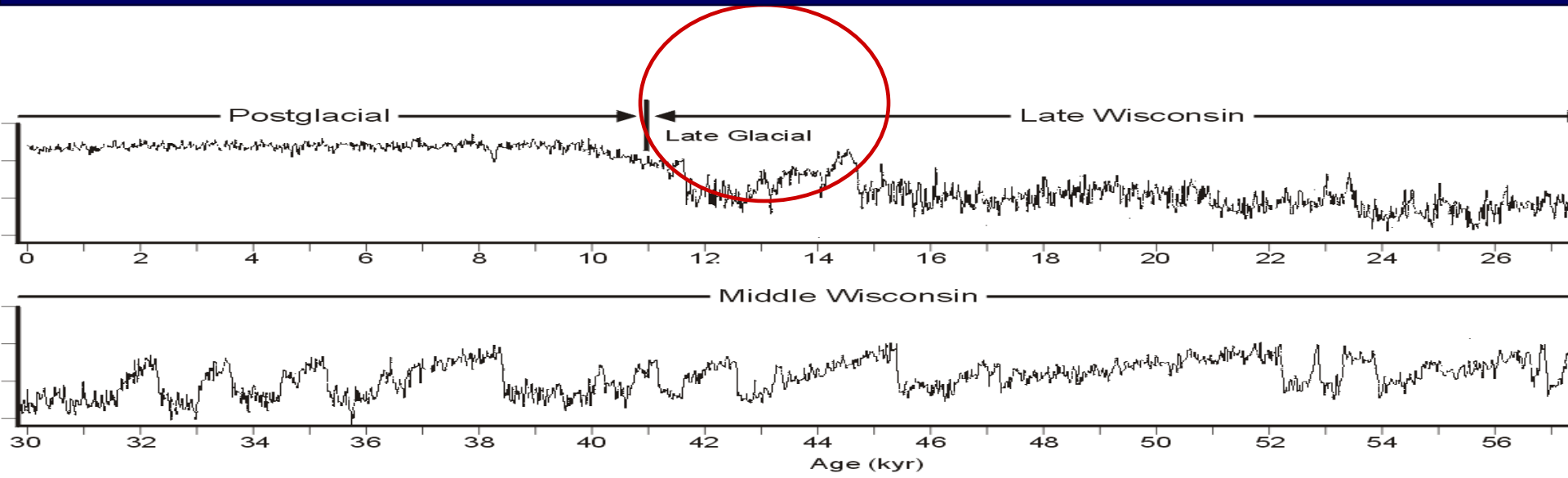
Sediments

The ‘glory years’ -
Growth of the Cordilleran ice sheet



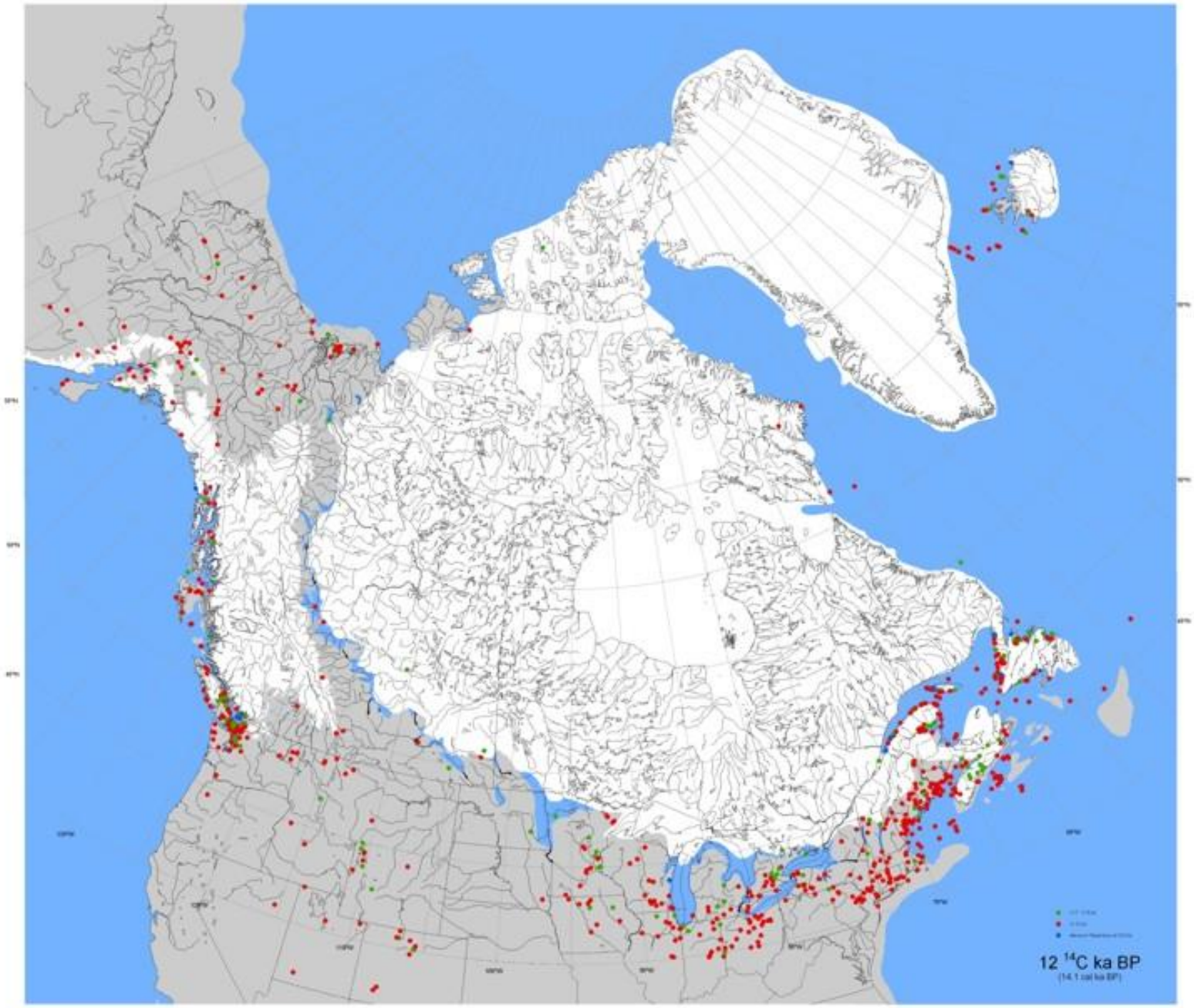

North
South
Coast Mountains
Vancouver
Seattle
Olympia
Radiocarbon years (ka BP)
10
12
14
16
18
20
22
24
Sumas Stade
?
Everson Interstade
Vashon Stade
?
Coquitlam Stade
?
0
50
km
Cordilleran Ice Sheet
50°
Pacific Ocean
125°
0
200
km

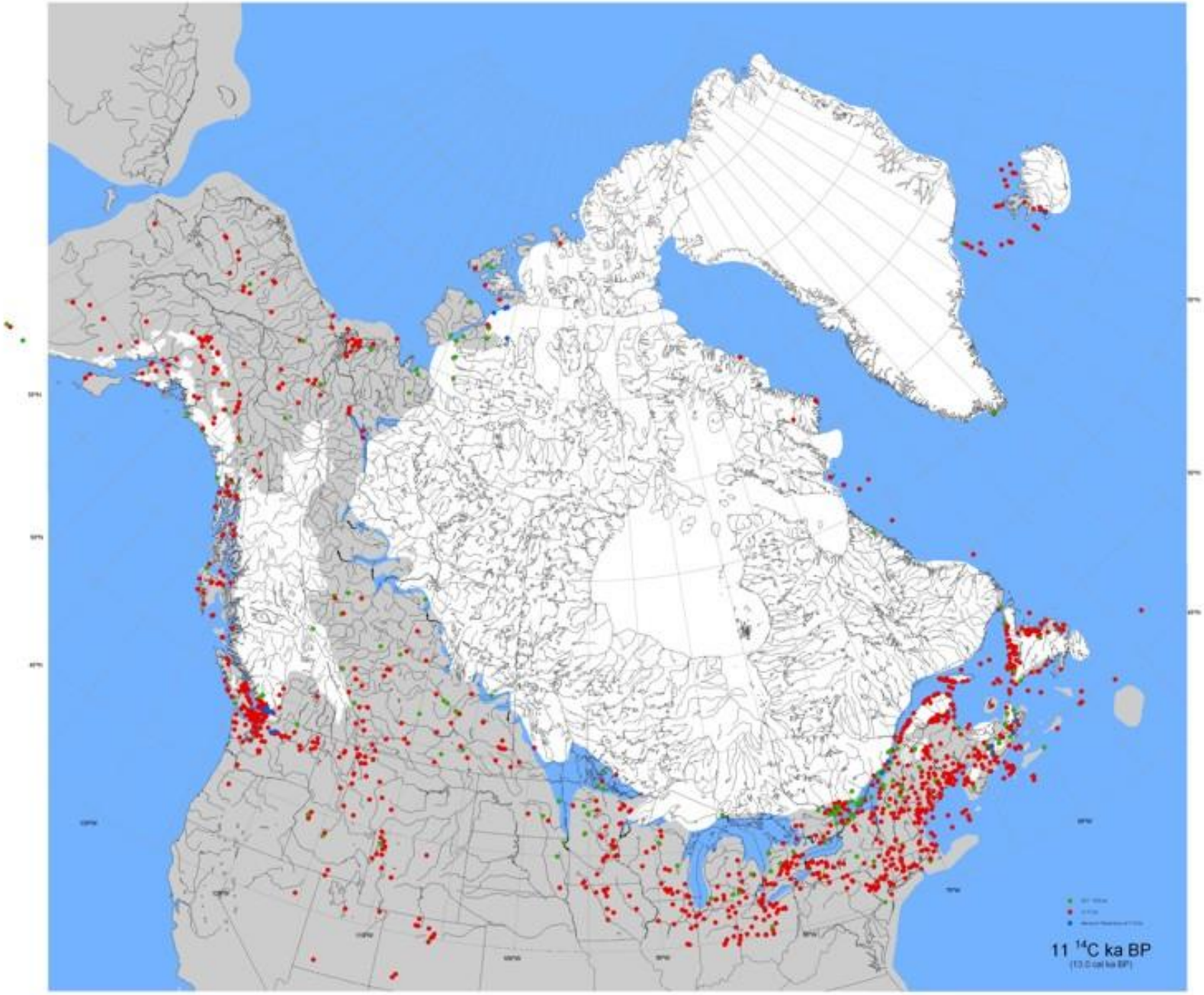
Ice sheet ‘senility’

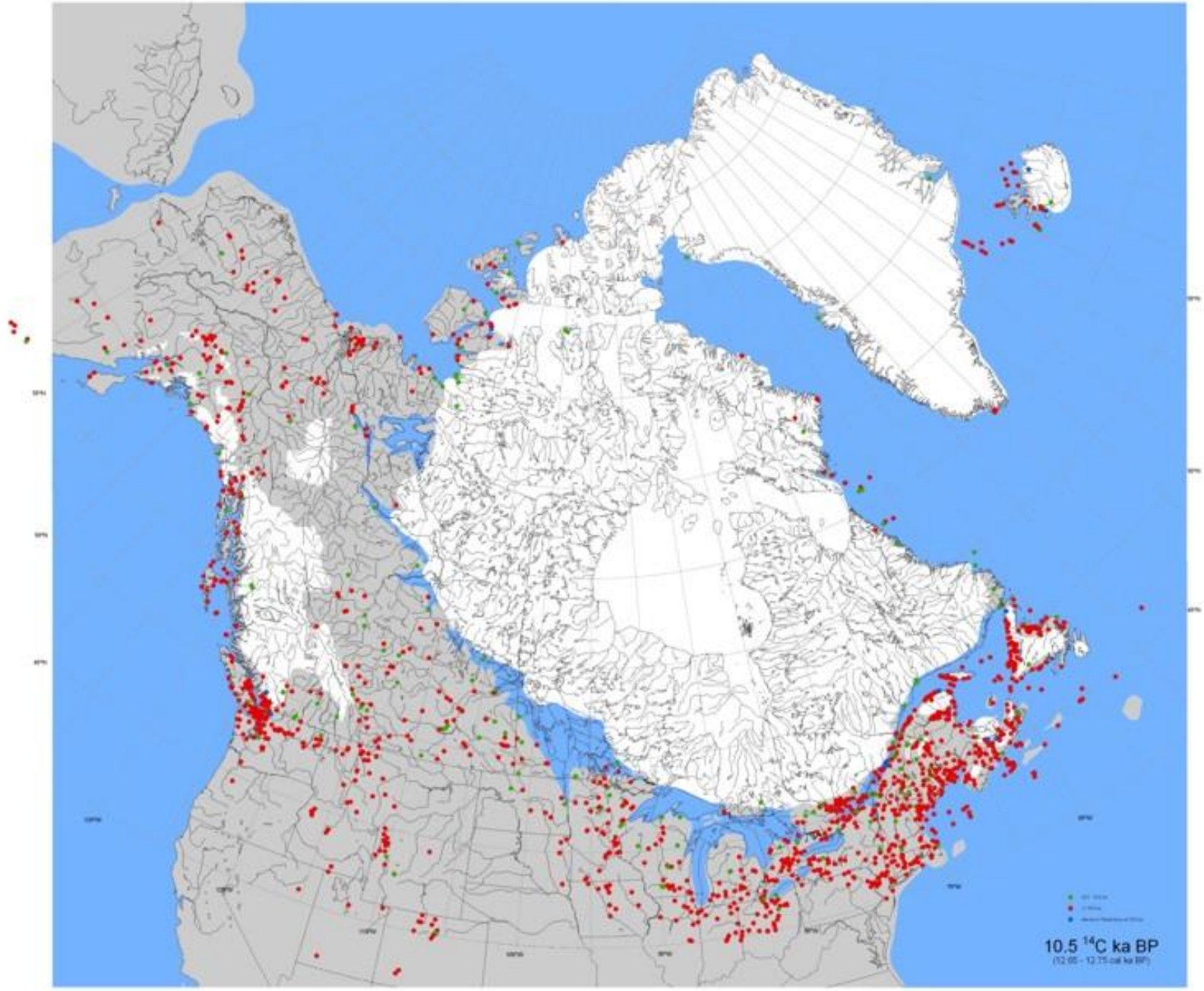


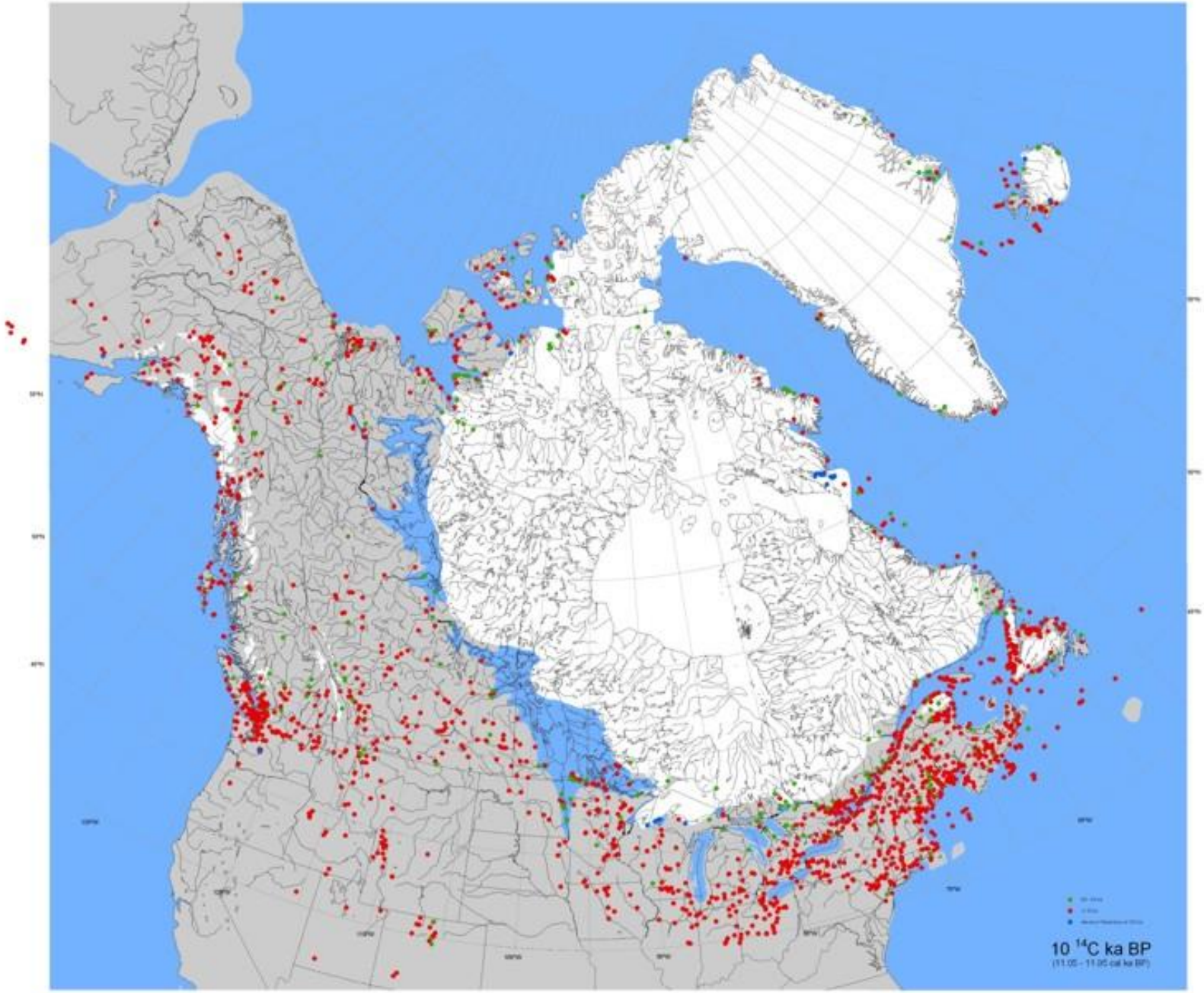
Stuiver et al.

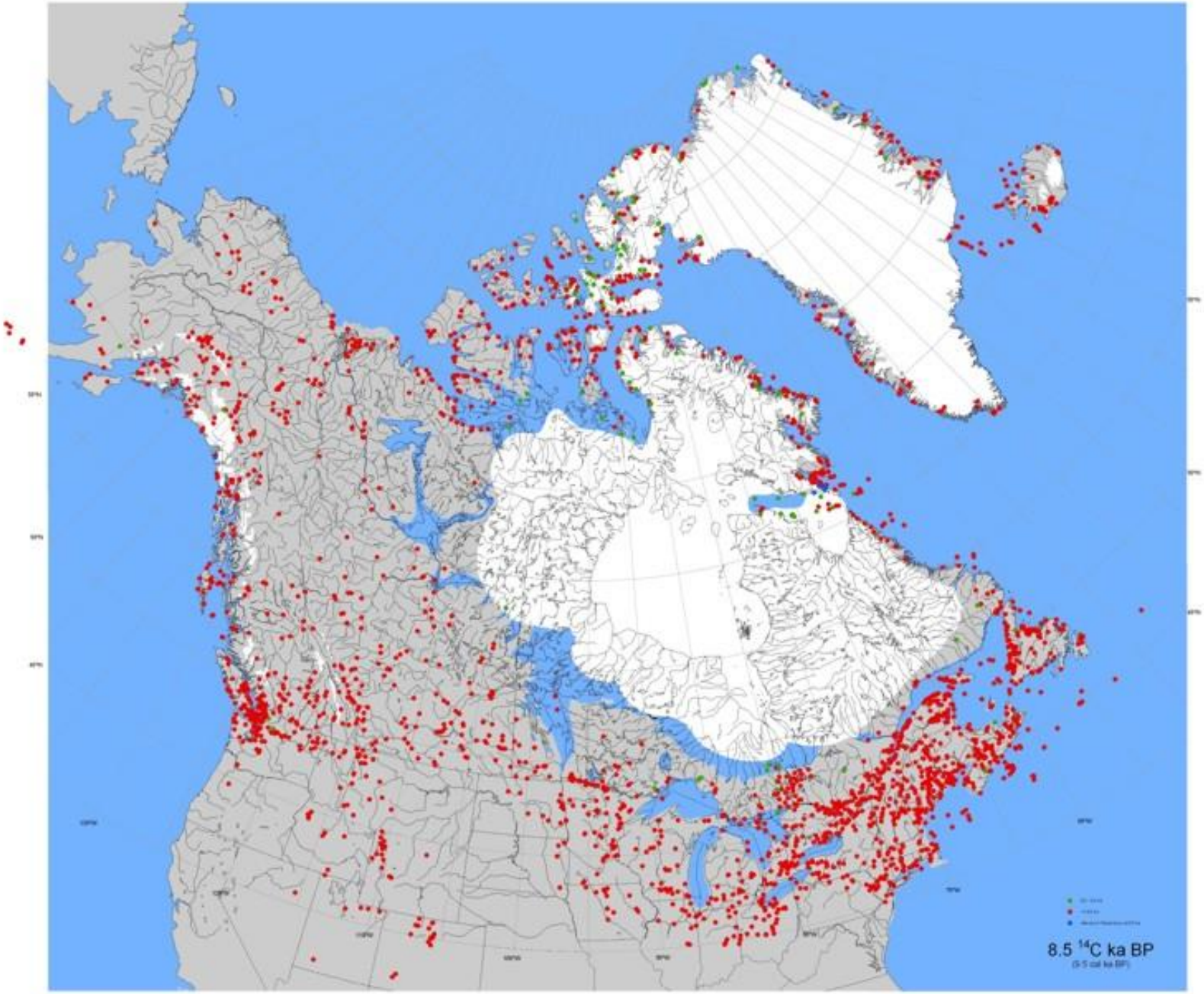
Dyke and Prest

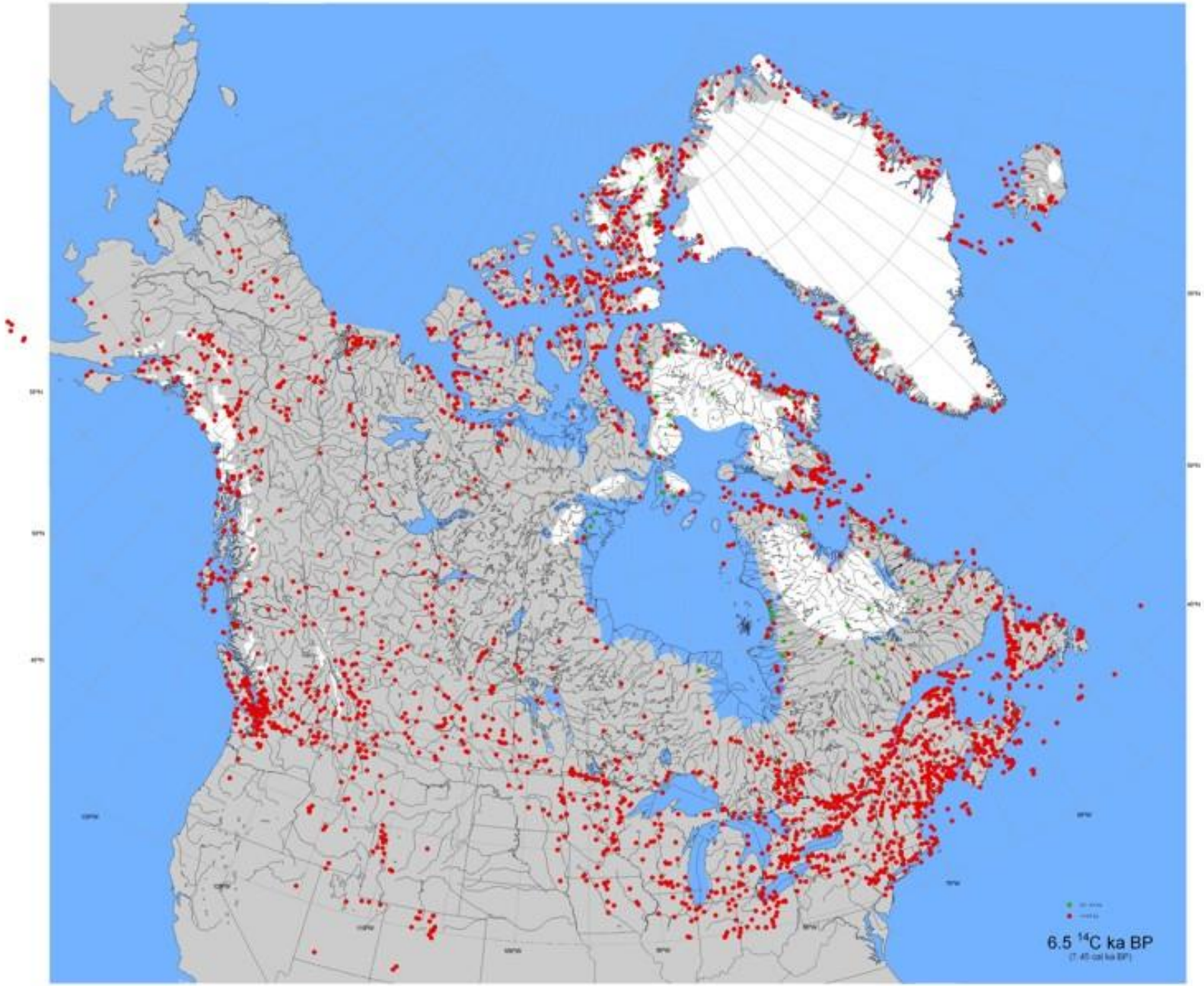

12 ^{14}C ka BP
(14.1 cal ka BP)

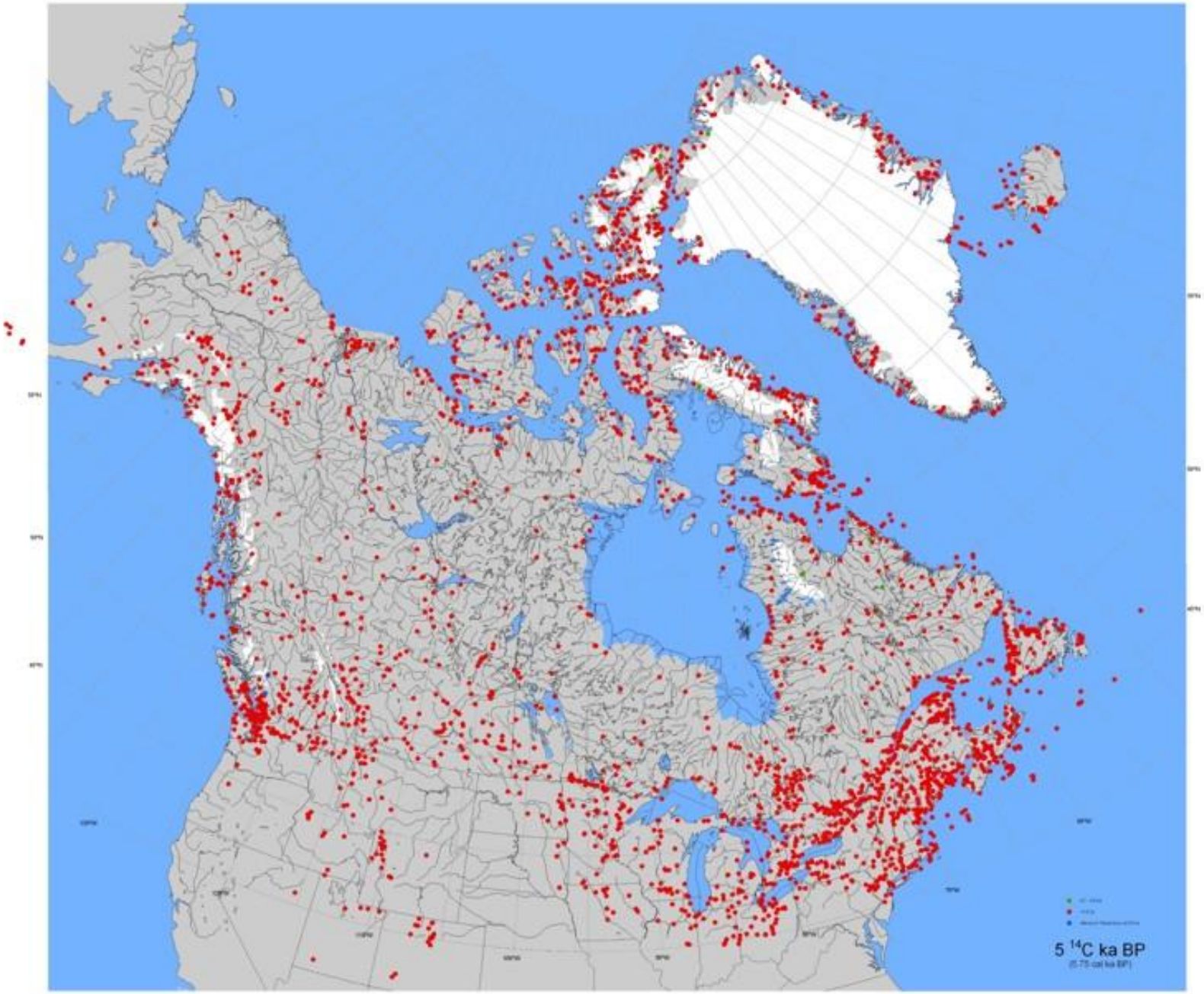

11 ^{14}C ka BP

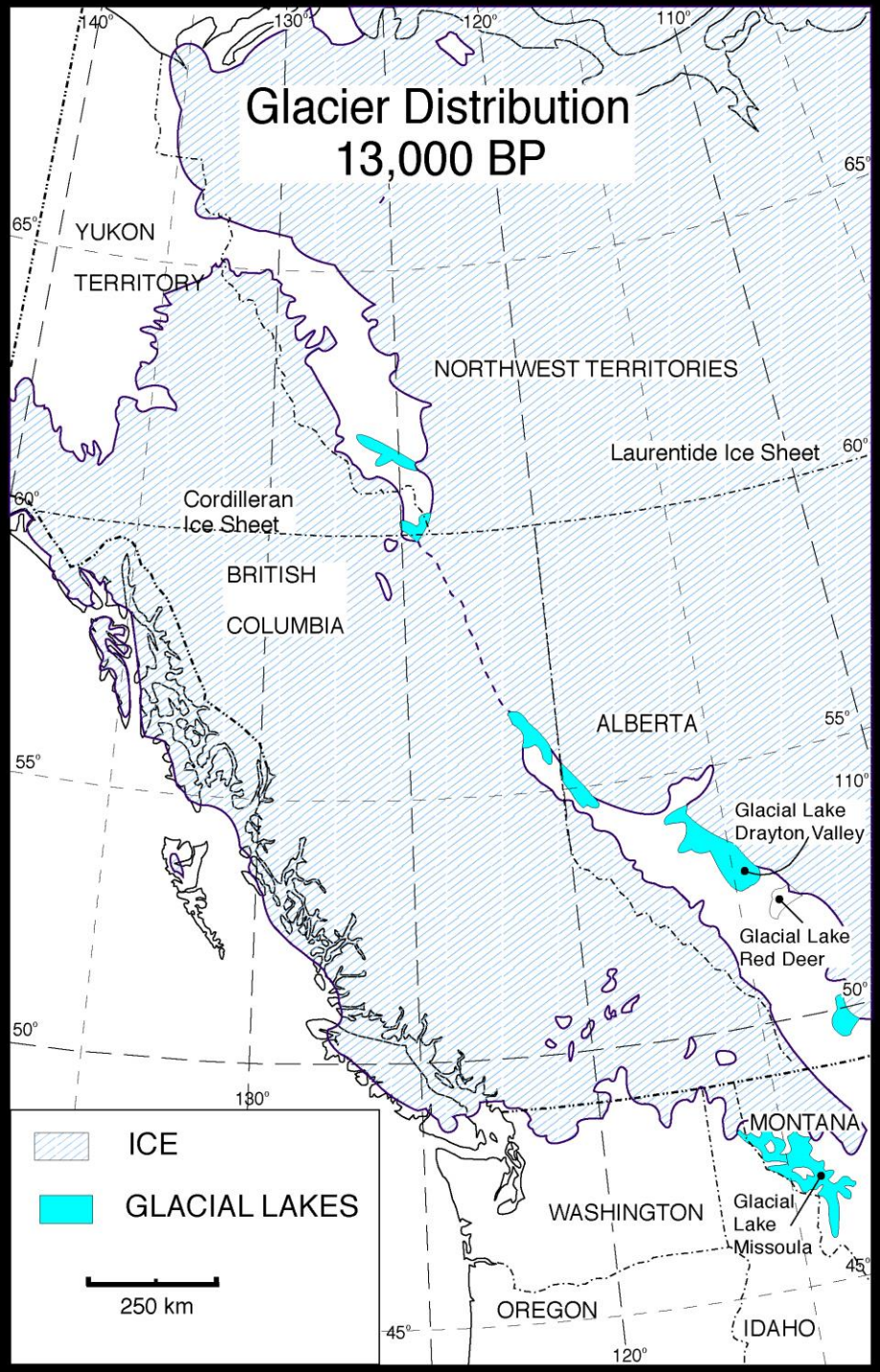

10.5 ^{14}C ka BP
(12.05 - 12.75 cal ka BP)

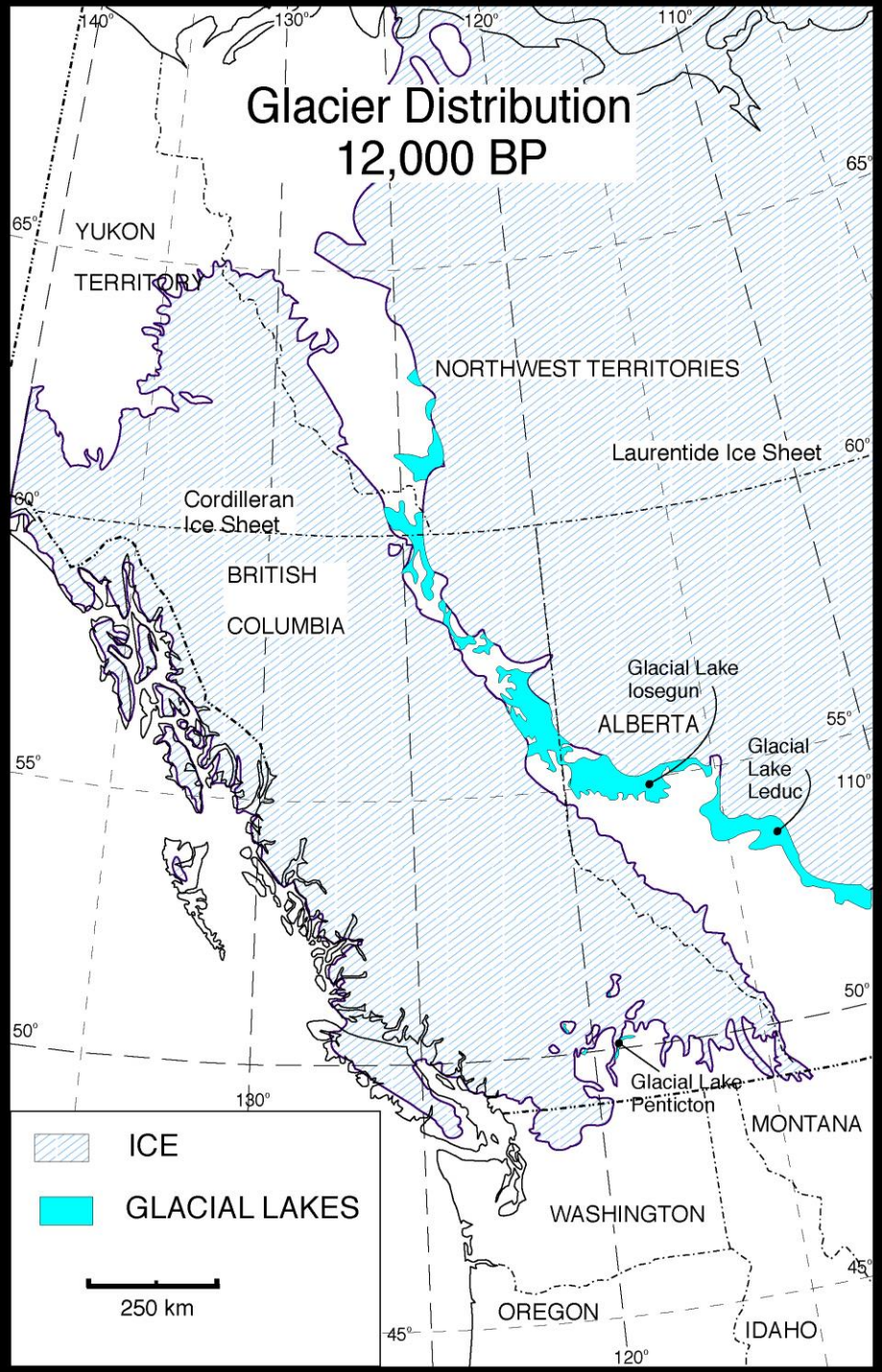

10 ^{14}C ka BP
(11.05 - 11.05 cal ka BP)

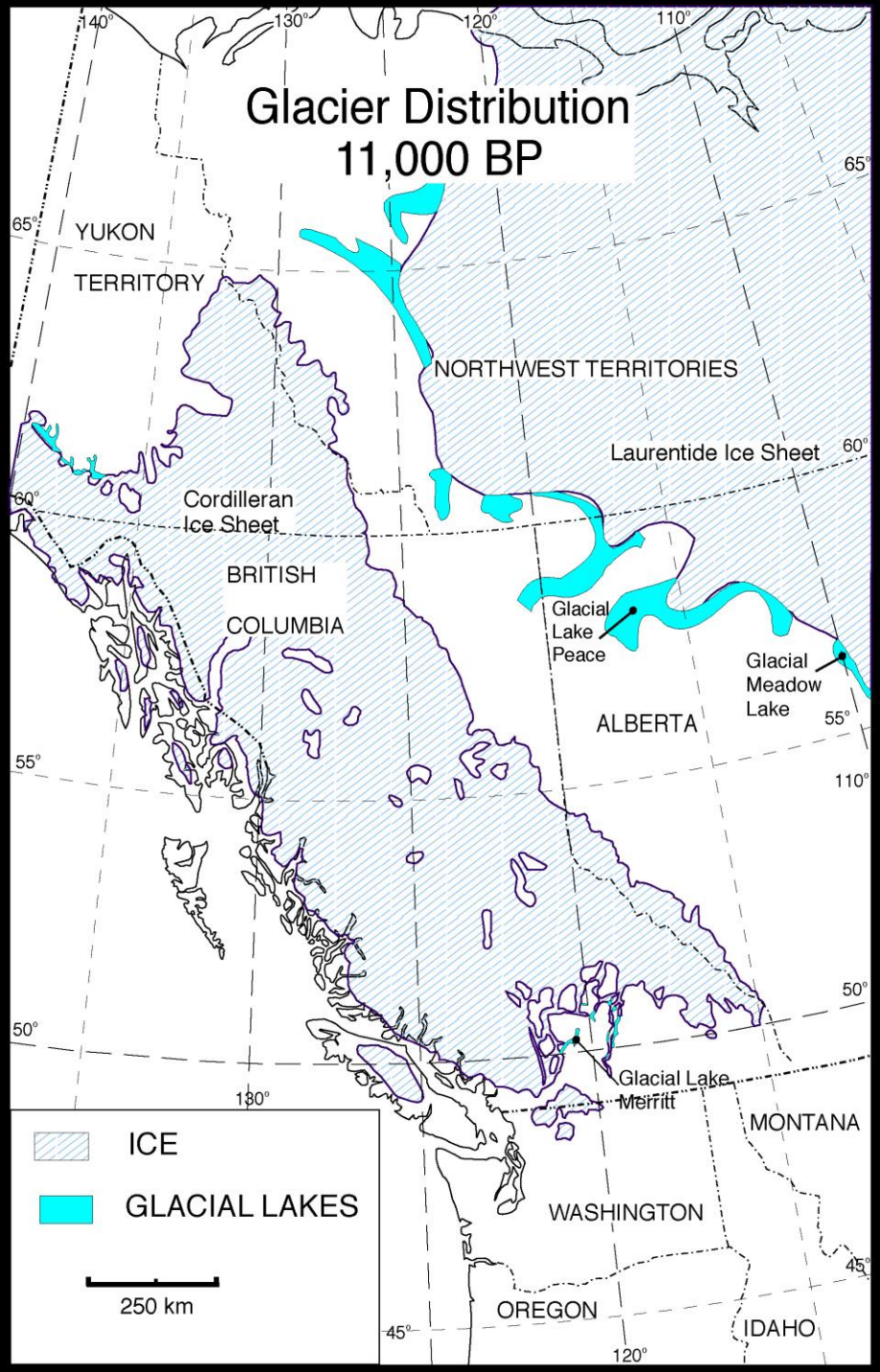

8.5 ^{14}C ka BP

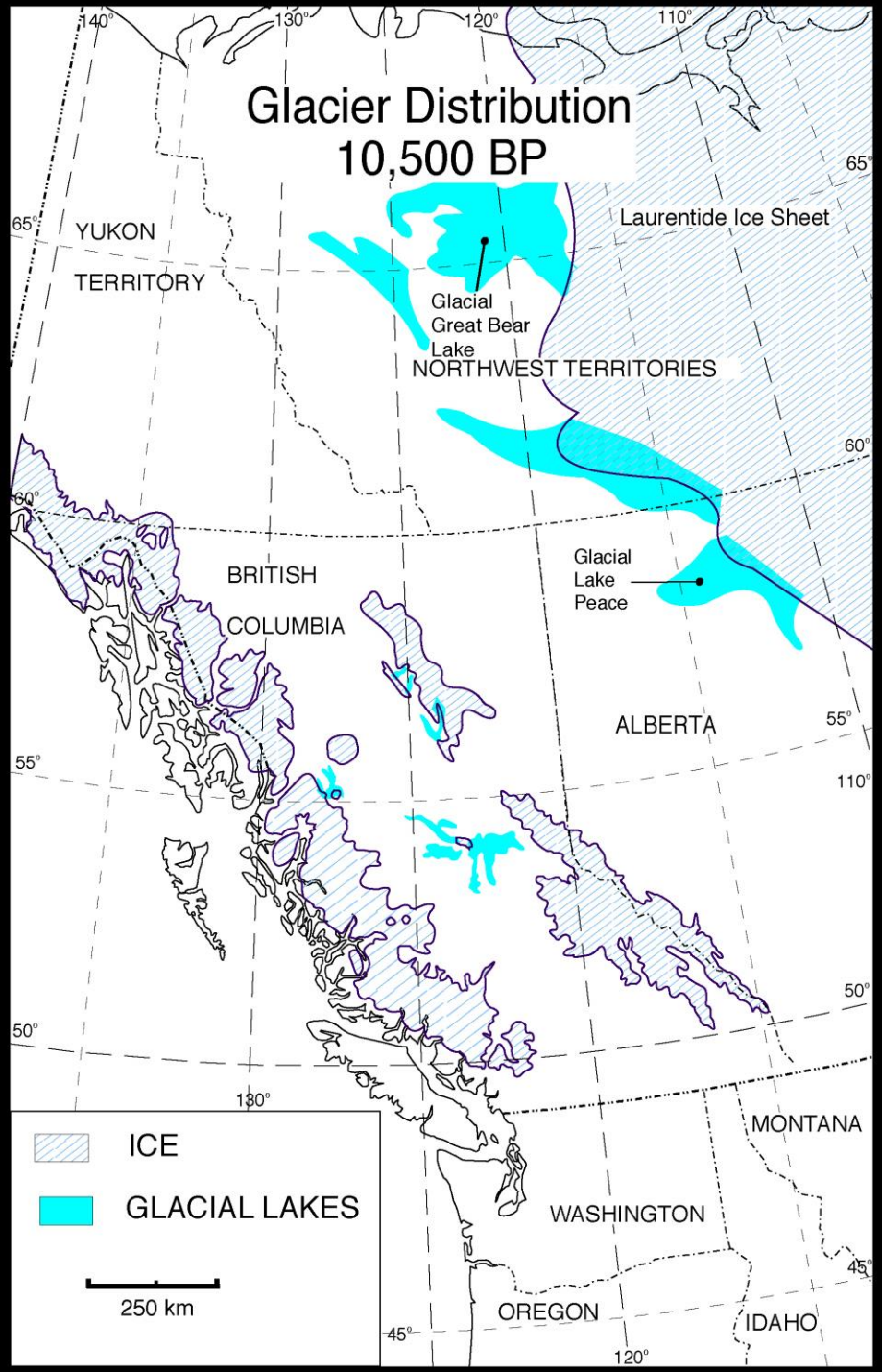

6.5 ^{14}C ka BP

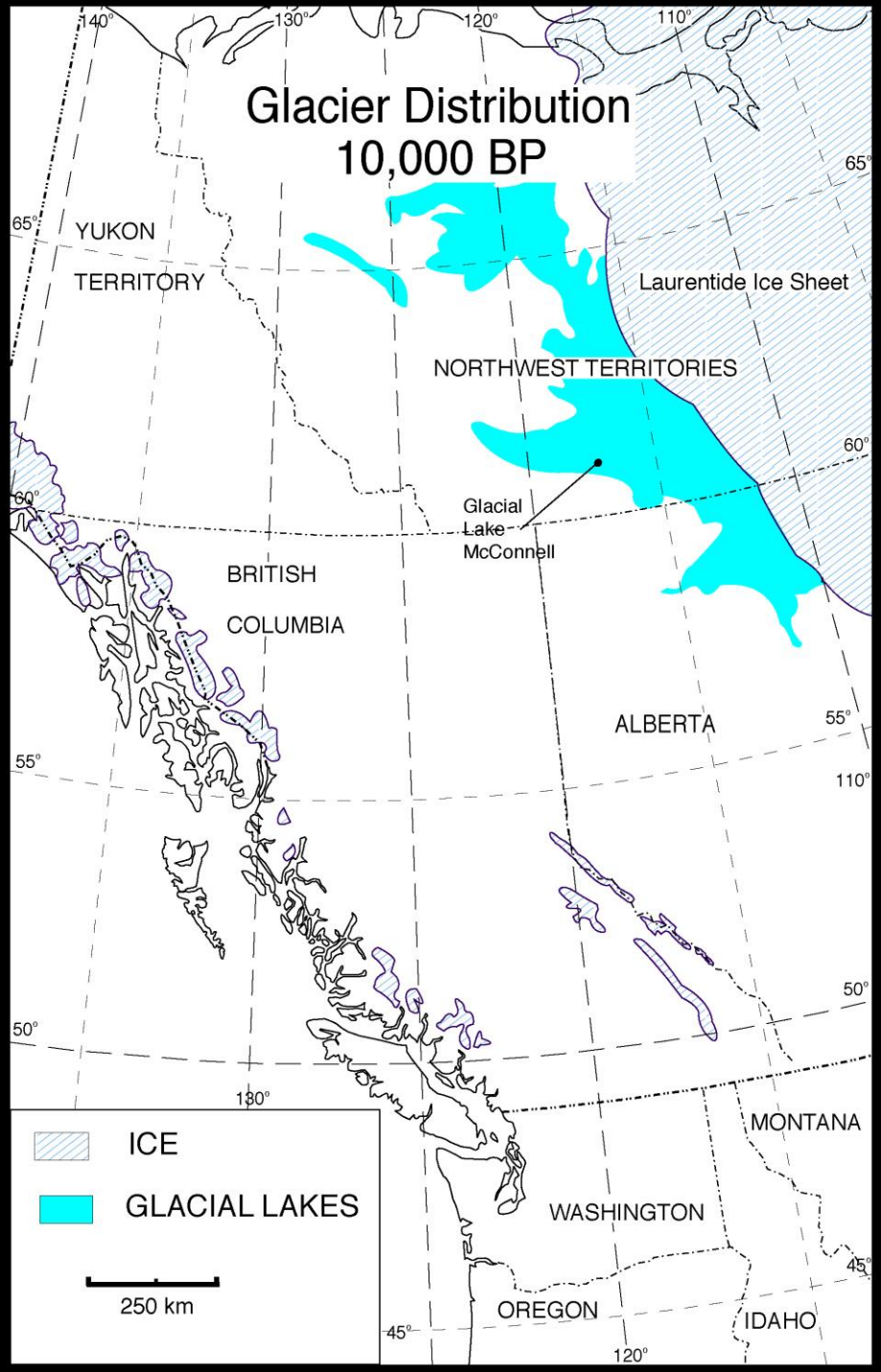

5 ^{14}C ka BP


Glacier Distribution
13,000 BP
YUKON
TERRITORY
NORTHWEST TERRITORIES
Laurentide Ice Sheet
Cordilleran
Ice Sheet
BRITISH
COLUMBIA
ALBERTA
Glacial Lake
Drayton Valley
Glacial Lake
Red Deer
MONTANA
WASHINGTON
Glacial
Lake
Missoula
OREGON
IDAHO
ICE
GLACIAL LAKES
250 km
140°
130°
120°
110°
65°
60°
55°
50°
45°

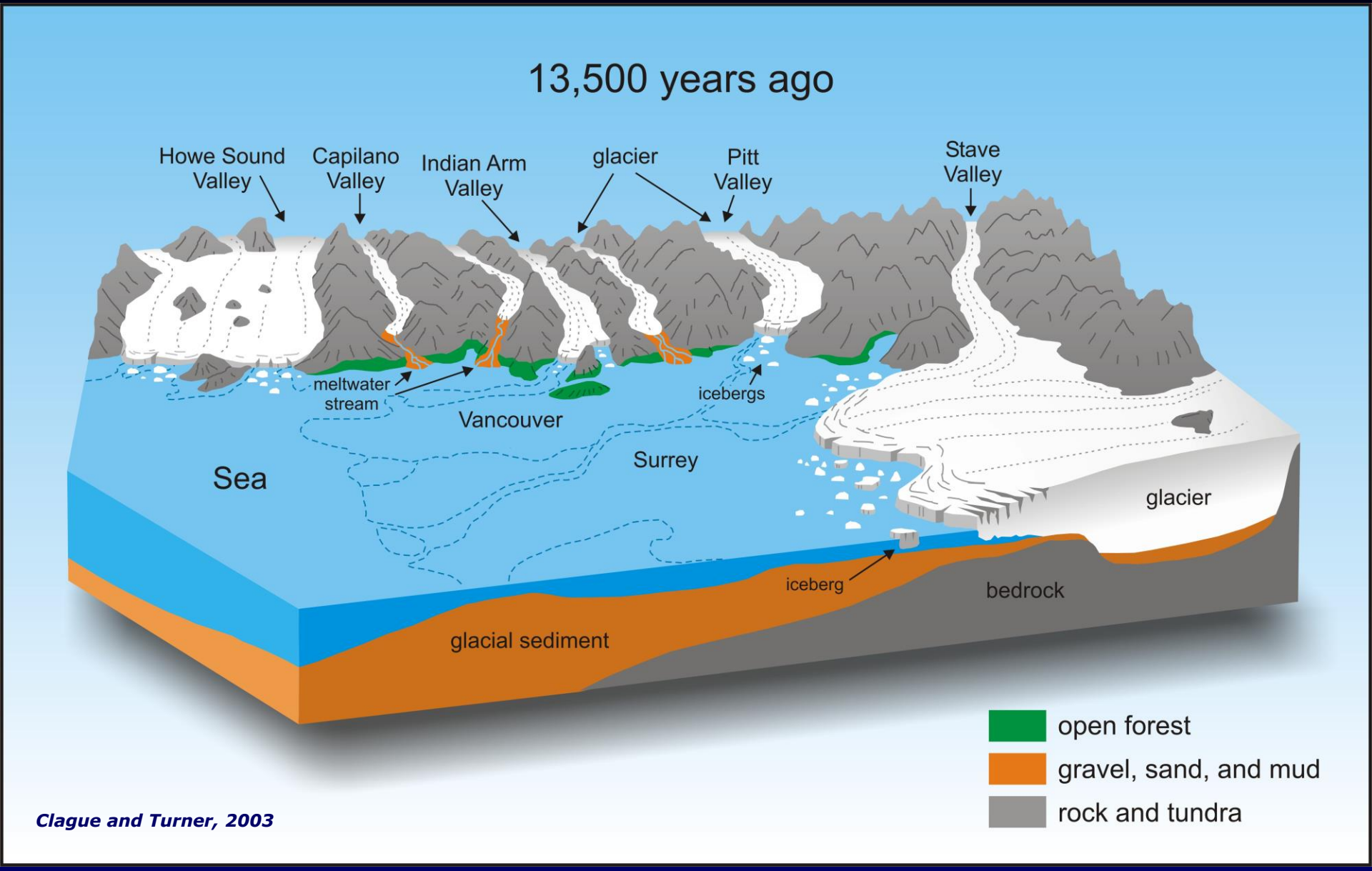

Glacier Distribution
12,000 BP
YUKON
TERRITORY
NORTHWEST TERRITORIES
Laurentide Ice Sheet
Cordilleran
Ice Sheet
BRITISH
COLUMBIA
Glacial Lake
Iosegun
ALBERTA
Glacial
Lake
Leduc
Glacial Lake
Penticton
MONTANA
WASHINGTON
OREGON
IDAHO
ICE
GLACIAL LAKES
250 km
140°
130°
120°
110°
65°
60°
55°
50°
45°


Glacier Distribution
11,000 BP
YUKON
TERRITORY
NORTHWEST TERRITORIES
Laurentide Ice Sheet
Cordilleran
Ice Sheet
BRITISH
COLUMBIA
Glacial
Lake
Peace
Glacial
Meadow
Lake
ALBERTA
Glacial Lake
Merritt
MONTANA
WASHINGTON
OREGON
IDAHO
ICE
GLACIAL LAKES
250 km
140°
130°
120°
110°
65°
60°
55°
50°
45°


Glacier Distribution
10,500 BP
Laurentide Ice Sheet
YUKON
TERRITORY
Glacial
Great Bear
Lake
NORTHWEST TERRITORIES
BRITISH
COLUMBIA
Glacial
Lake
Peace
ALBERTA
MONTANA
WASHINGTON
OREGON
IDAHO
ICE
GLACIAL LAKES
250 km
140°
130°
120°
110°
65°
60°
55°
50°
45°


Glacier Distribution
10,000 BP
YUKON
TERRITORY
Laurentide Ice Sheet
NORTHWEST TERRITORIES
Glacial
Lake
McConnell
BRITISH
COLUMBIA
ALBERTA
MONTANA
WASHINGTON
OREGON
IDAHO
ICE
GLACIAL LAKES
250 km
140°
130°
120°
110°
65°
60°
55°
50°
45°

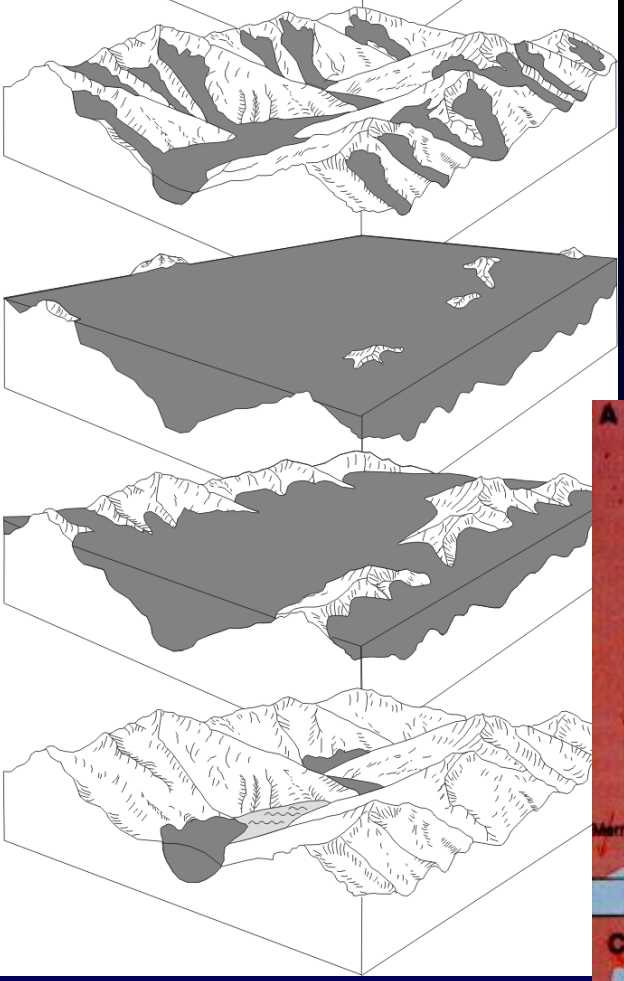
Retreat at the western front

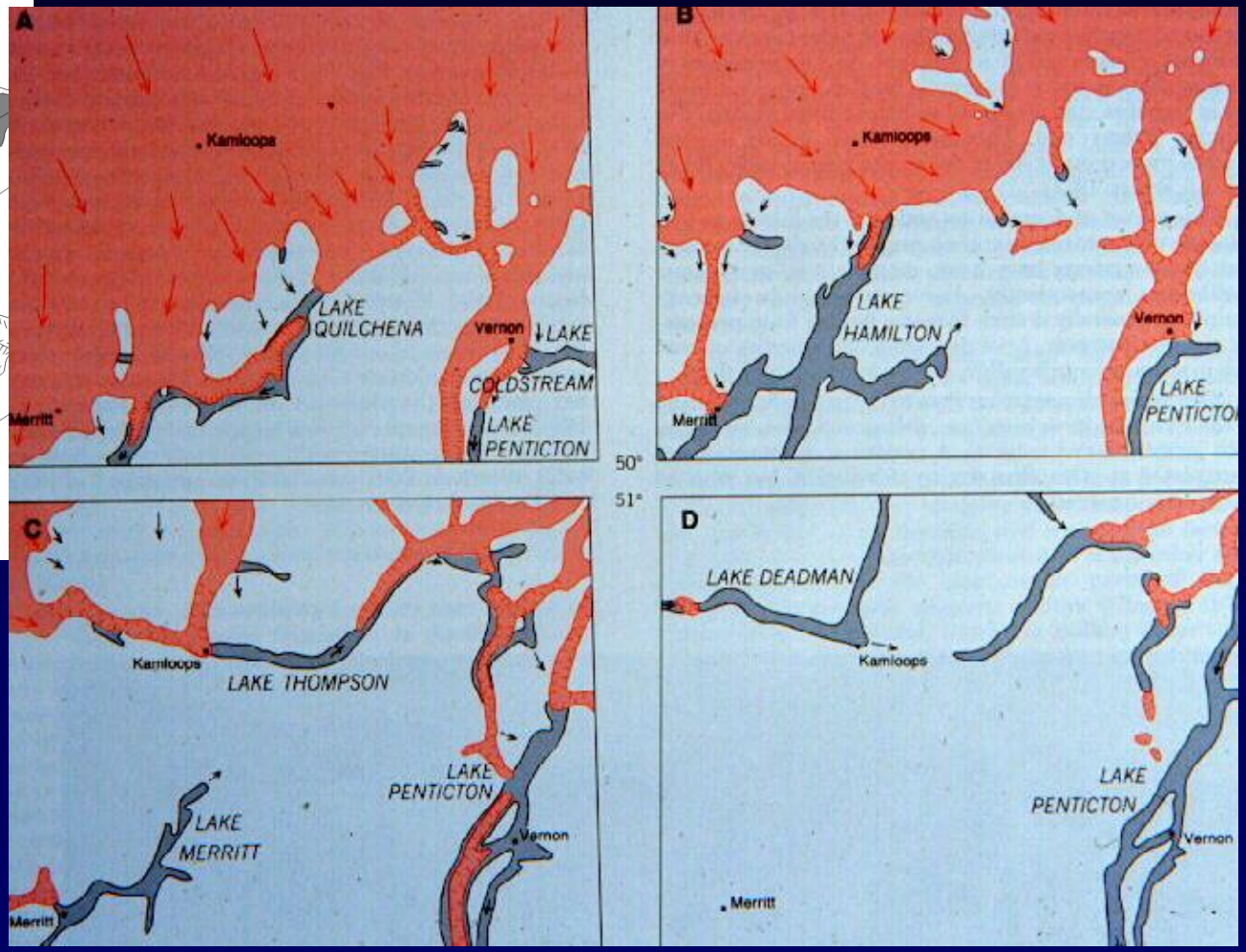


Clague and Turner, 2003

Hubbard Glacier, Alaska

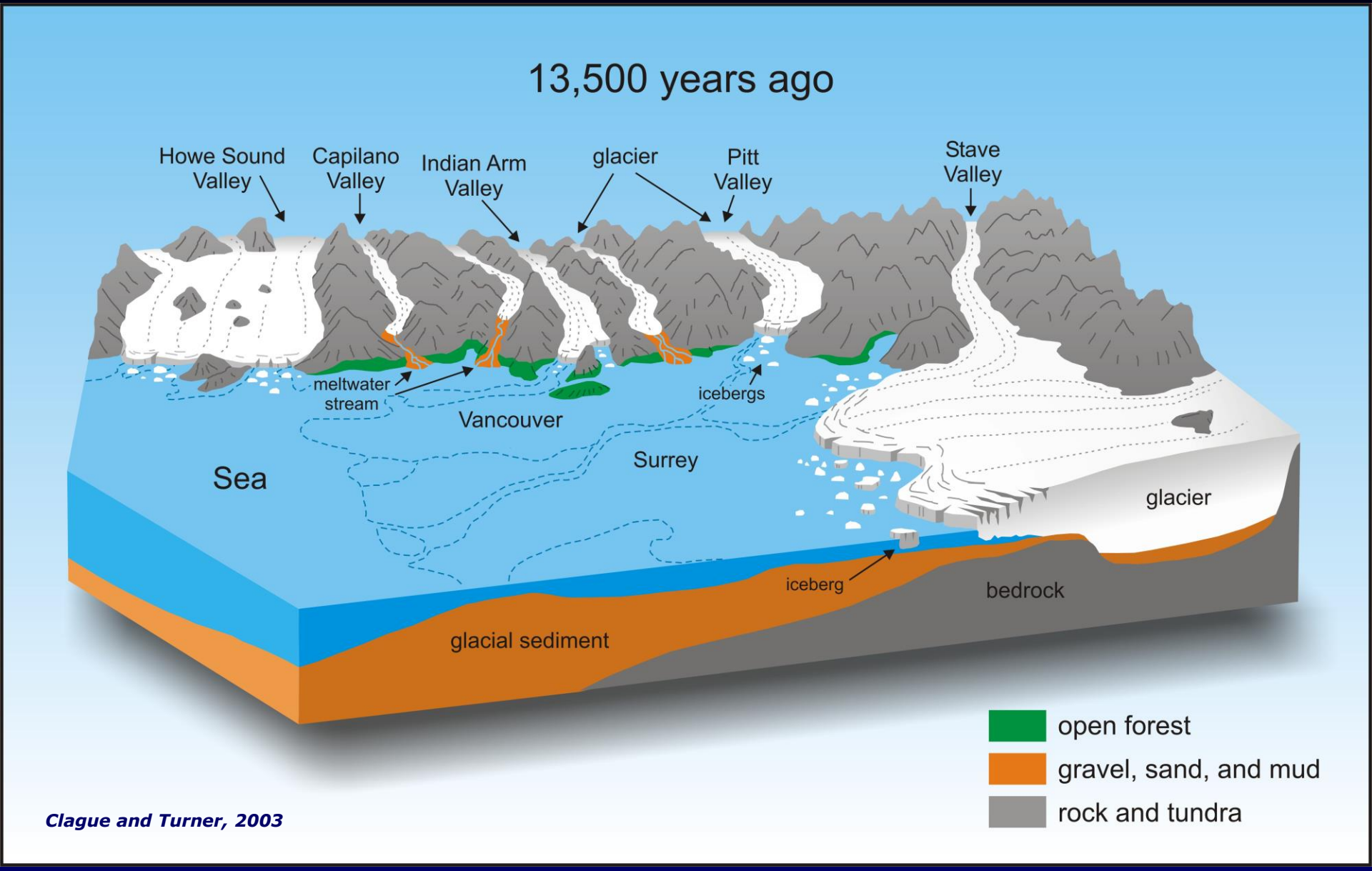
Retreat near the centre



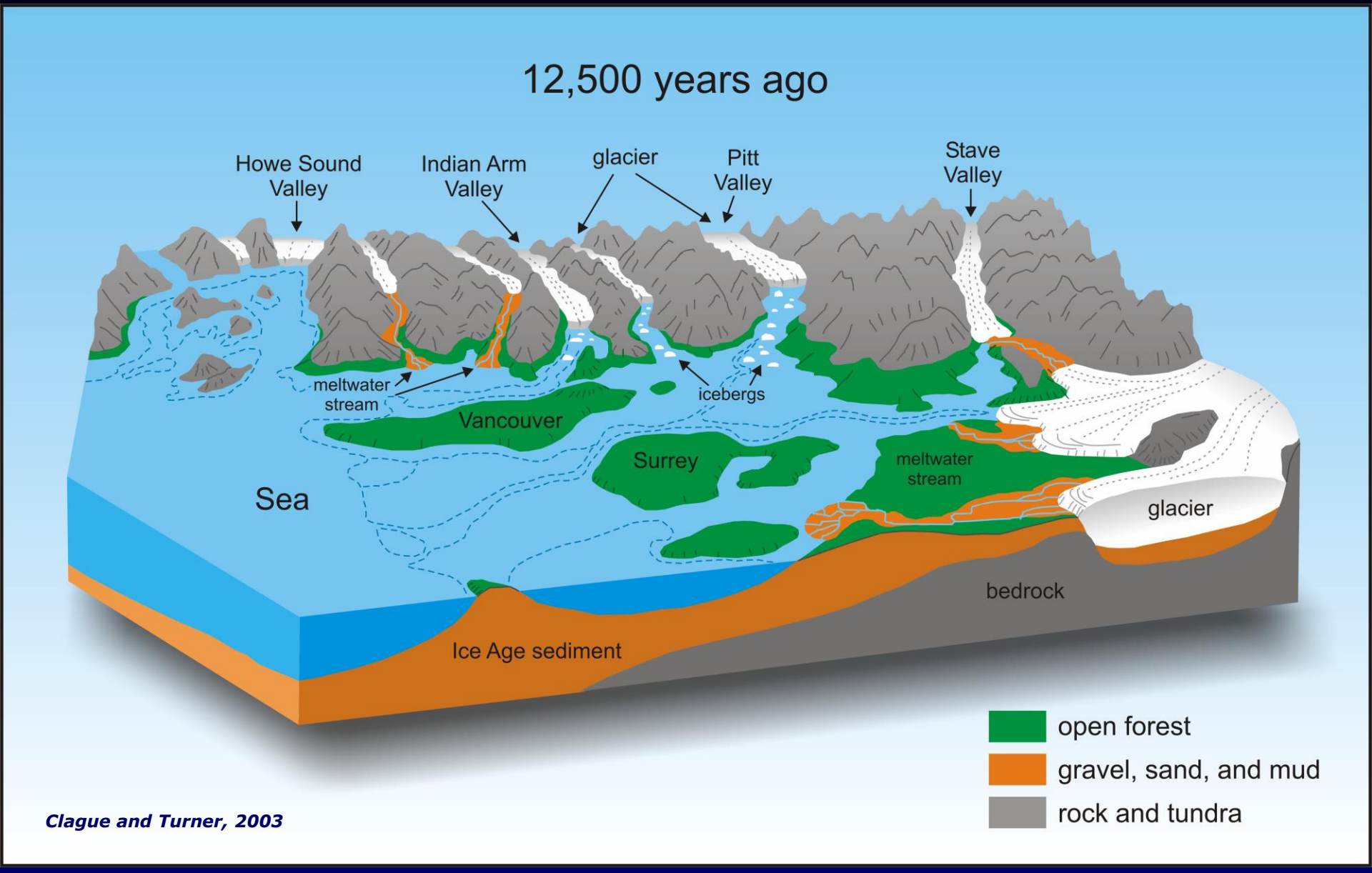


Glacial Lake Melbern, BC

Relieved of its burden, the land rises



Clague and Turner, 2003



Clague and Turner, 2003

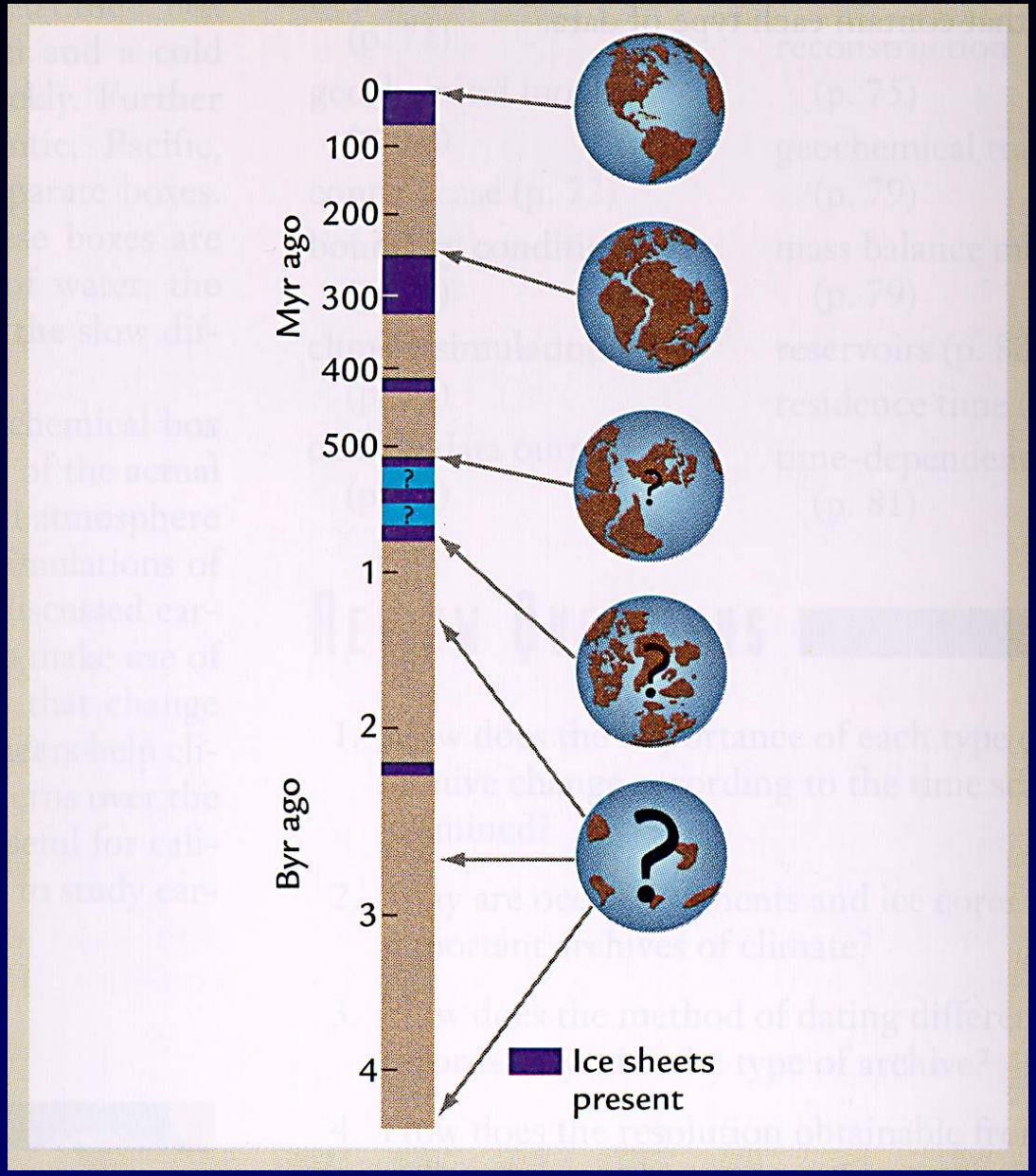
So what causes ice sheets to grow?

So what causes ice sheets to grow?

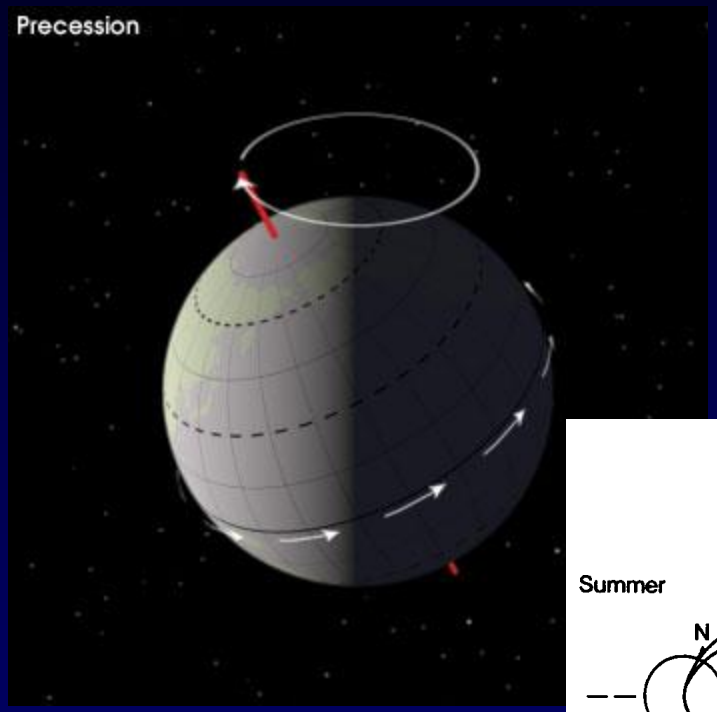
Or put in another way,

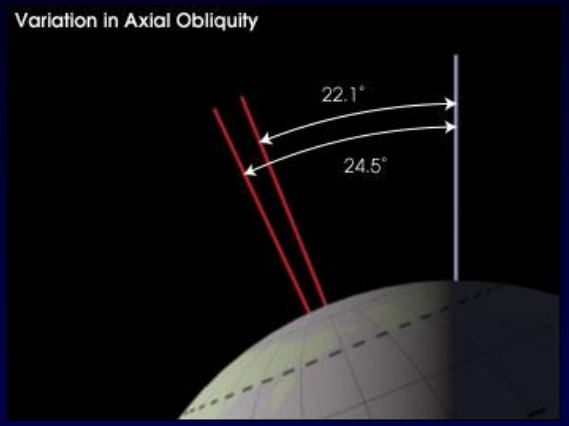
What causes climate to change so radically?

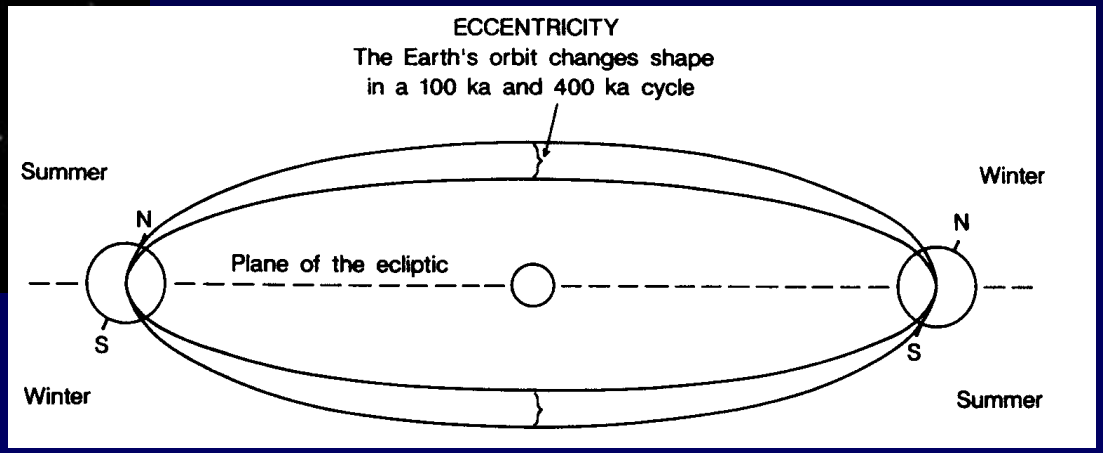
Position of continents on Earth's surface

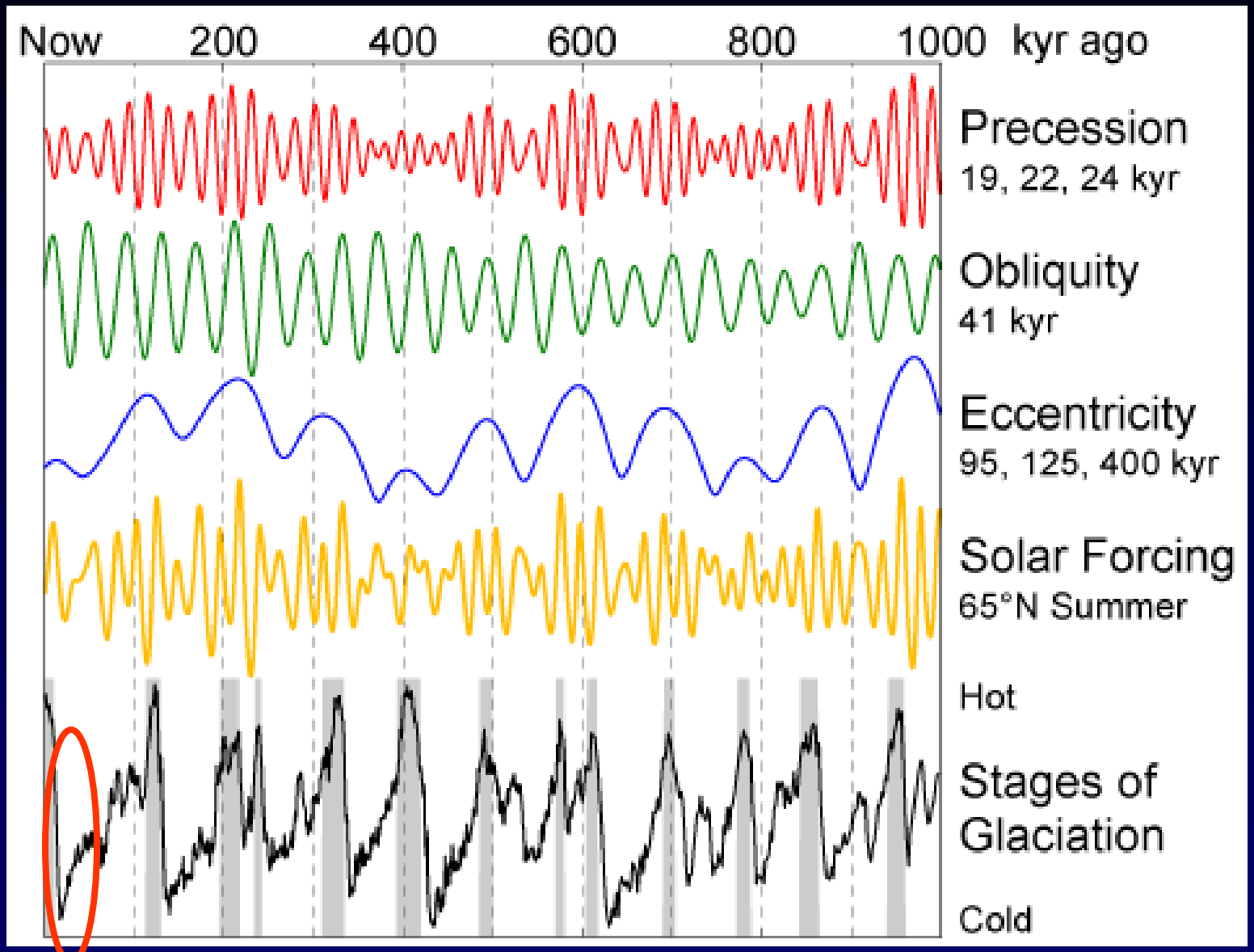


Milankovitch cycles – The long-term climate 'metronome'



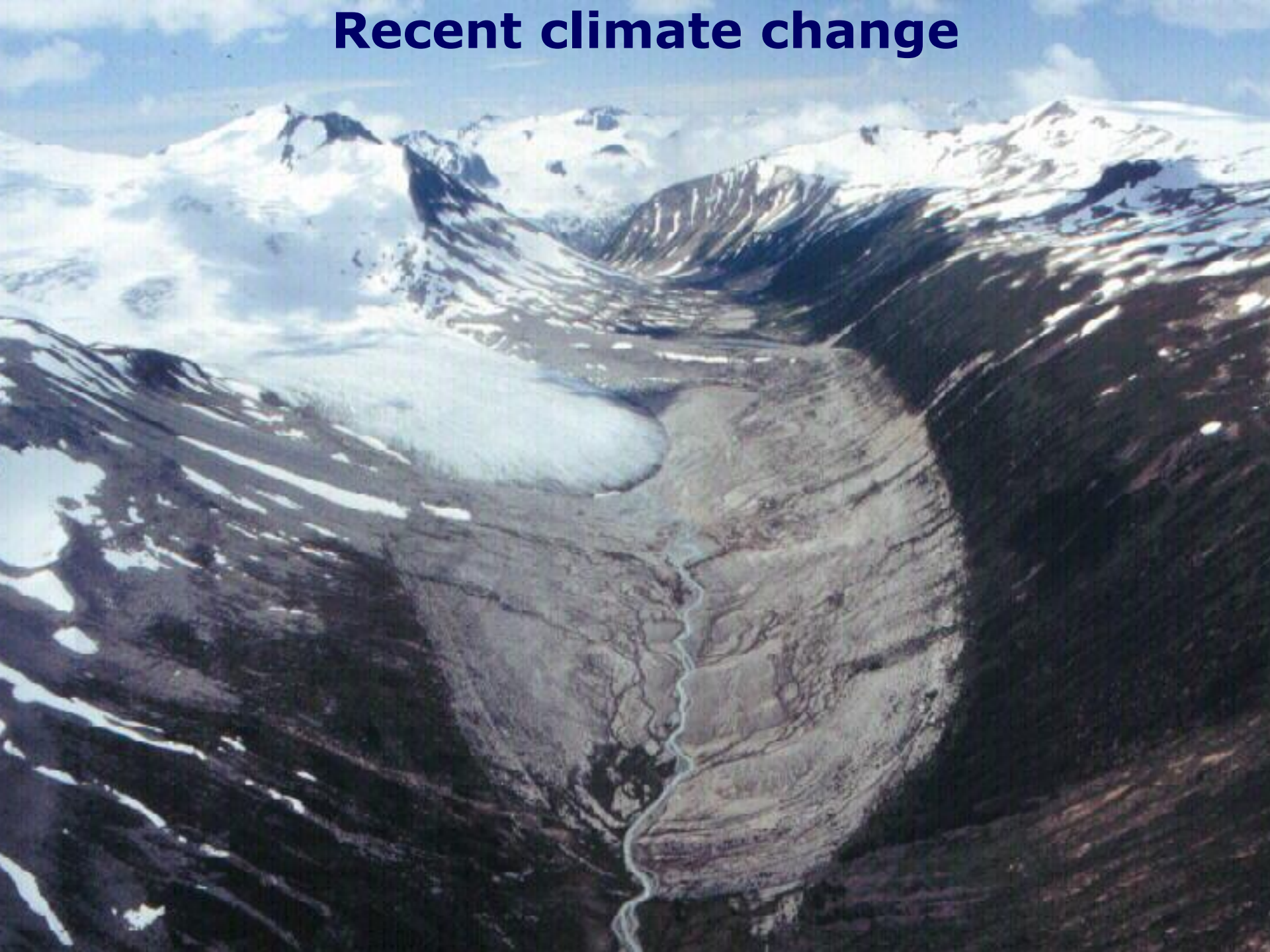





Now
200
400
600
800
1000
kyr ago
Precession
19, 22, 24 kyr
Obliquity
41 kyr
Eccentricity
95, 125, 400 kyr
Solar Forcing
65°N Summer
Hot
Stages of Glaciation
Cold

Glaciers are proxy atmospheric thermometers

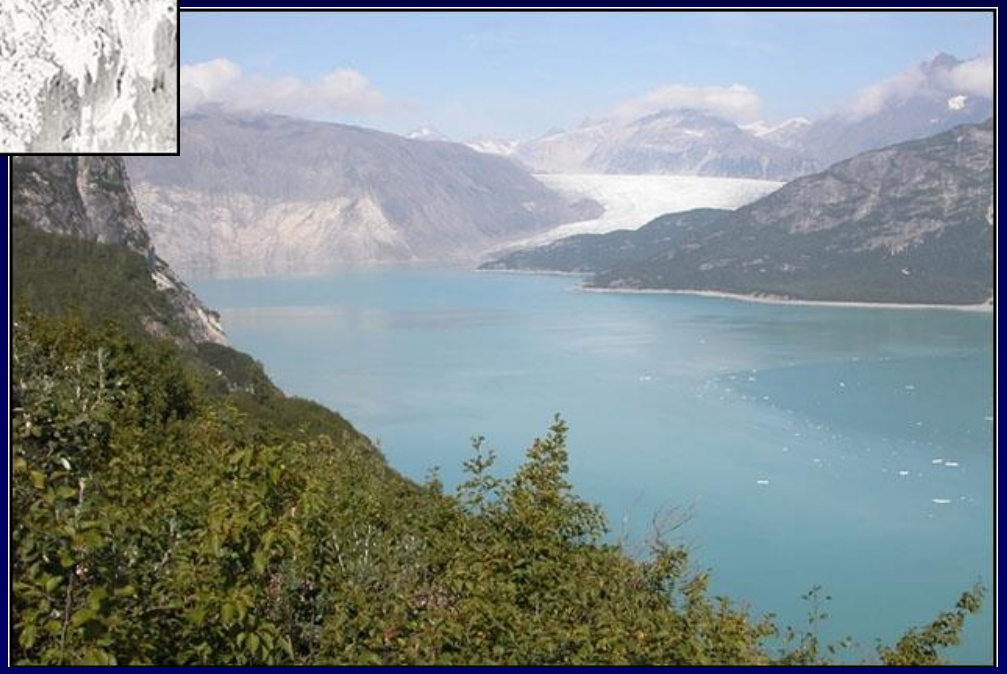
Recent climate change



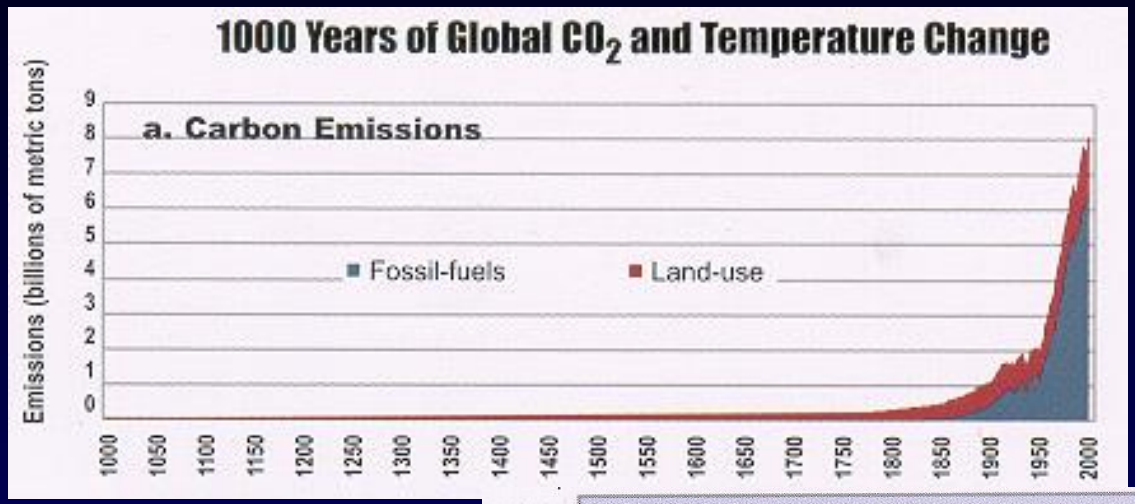
Muir Glacier, Alaska

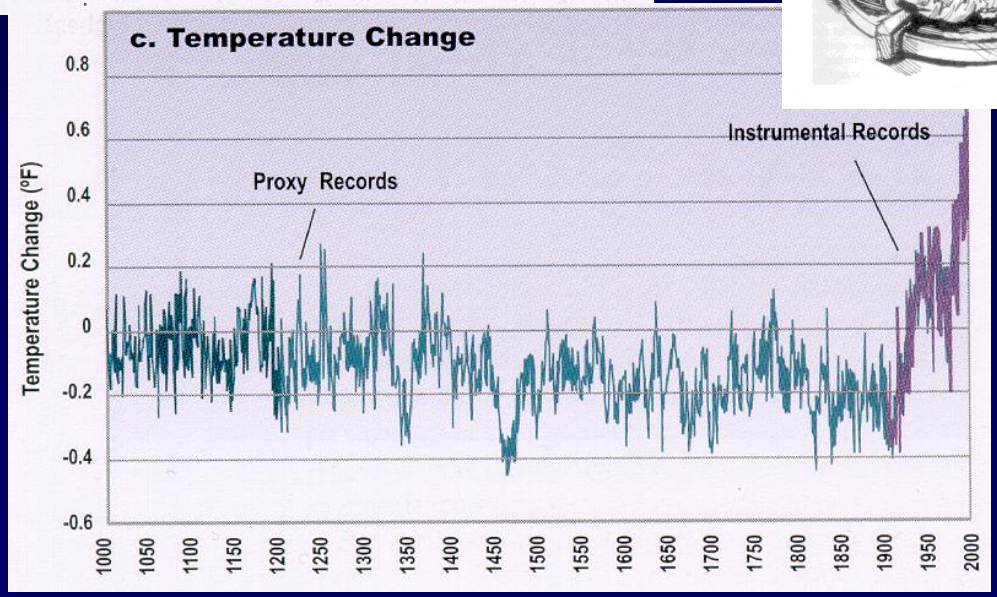
1941

2004



Humans are modifying Earth's climate






The End