

Accreted terranes

- Rock located at a plate boundary that is part of another plate
- Common: subduction zones, pieces of oceanic crust found on continent
- Alaska, western Canada, and western US

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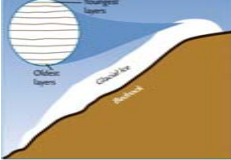
Determining past climates

- Changes in climate could mean:
 - Large-scale period of cooling or warming (i.e. global or occurring in a hemisphere)
 - Continents used to be located at a different latitude
- Common methods for determining climate change
 - Ice cores
 - Radiocarbon dating
 - Water sediments (ocean and lakes)
 - Tree rings

Era	Period		Epoch
	QUATERNARY	NEOGENE	
CENOZOIC	QUATERNARY	NEOGENE	HOLOCENE
			PLEISTOCENE (ICE AGE)
	TERTIARY	NEOGENE	PLIOCENE
			MIOCENE
			OLIGOCENE
			EOCENE
PALEOGENE	PALEOGENE	PALEOCENE	

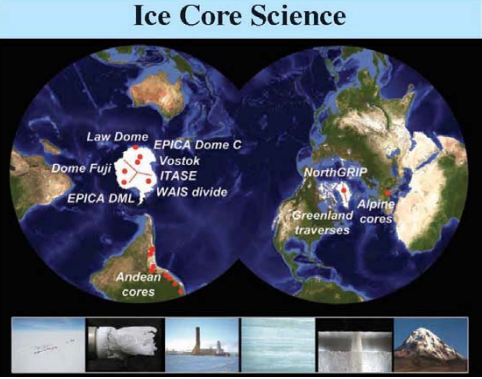
- **Ice age** – or the **Pleistocene**; between 1.8 mya to ~10,000-12,500 ya
- Considered a period of global periods of cooling and warming
- Still experiencing the effects of period
 - Landforms still adjusting

Ice Cores

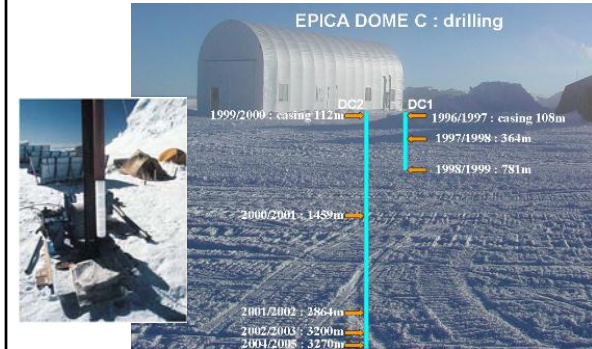


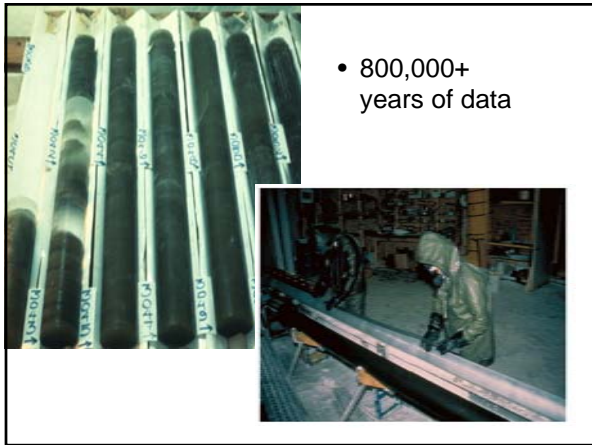
- Provides the longest record of climate with 800,000 + years of data
- Oxygen concentrations in the ice provides information to reconstruct the climate
- Ice cores also contain dust, charcoal, and volcanic ash
 - Can help reconstruct environmental events

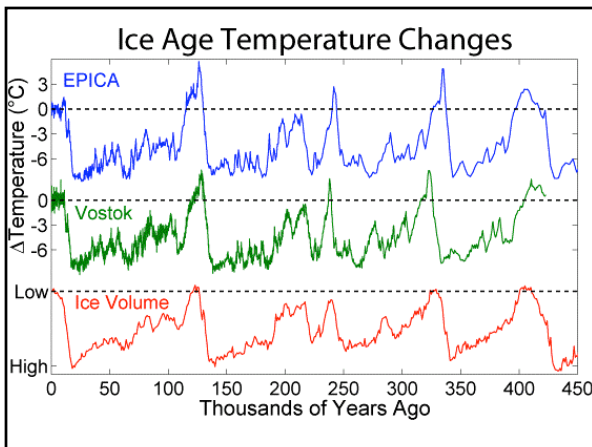
Ice Core Science



Ice cores – Greenland

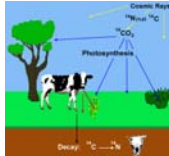






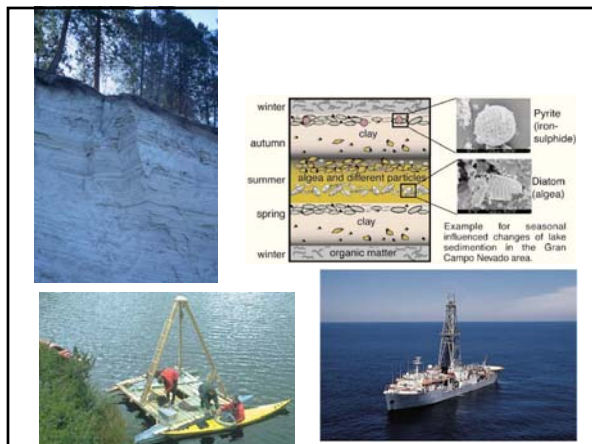
Radiocarbon dating

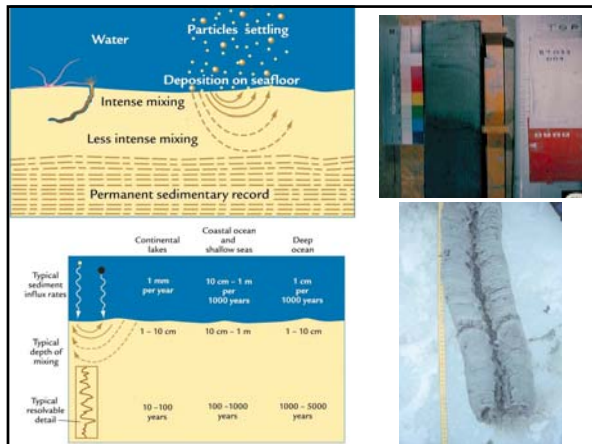
- Uses the amount of carbon remaining after the plant or animal has died to determine how long ago it lived
- Used to determine the climate of an area
 - Plants live in specific climates
- Reconstruct climates less than **50,000 years ago**



Water sediments (varves)

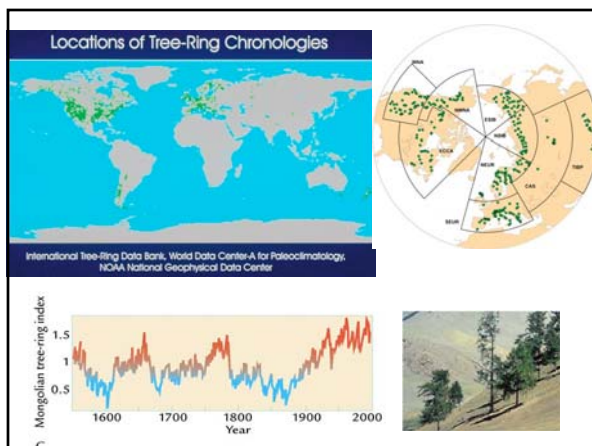
- Accumulations of sediment deposited in water
 - Lakes
 - Oceans
 - Ponds
- Determine the plants and animals that lived in area
- Amount of precipitation
- 1,000's of years of climate data





Tree-ring analysis


- Use the annual growth of tree rings to look at climate
- About 1,000 years BP
- Most useful outside of the tropics
- Also used to determine natural disasters
 - Volcanic eruptions
 - Mass movements
- Intro: (number 37)
<http://www.weather.com/multimedia/videoplayer.html?clip=6068&collection=100biggest>





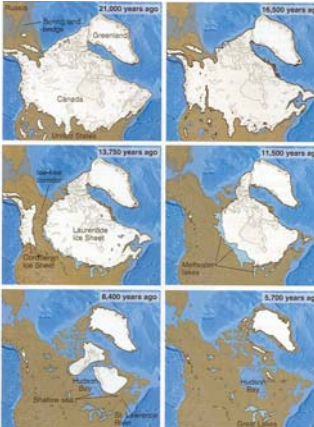
Pleistocene worldwide

- Height of last glaciation
 - 1/3 of earth's land mass covered
 - Only 3% in Southern Hemisphere
 - Ice thickness averaged 1-2 miles
 - Estimates of amount of rock stripped are over 375 feet (Bell and Laine 1985)



Pleistocene Glaciation

- 2 ice sheets:
 - Laurentide
 - Cordilleran
 - Sutured together (when they did join) at or east of the Rockies
- Upon retreat, left deposits (moraines, outwash plains, till, and kettles)

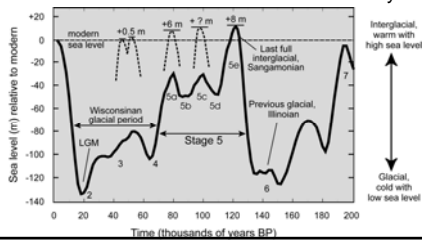


Glacial terms

- **Glacial stage:** glaciers are present
- **Interglacial:** time between ice ages, separates the glacial periods; each one lasted over 10,000 years
- **Stadials:** occurred during an interglacial and was a period of colder temperatures/brief glacial advance
 - Older Dryas – ~ 14,000 BP
 - Younger Dryas – ~ 12,900–11,500 BP
 - Little Ice Age – ~ 1400 to 1850

Interstadials

- A warmer period during an interglacial with no glacial advance or a period of glacial retreat and lasted less than 10,000 years
 - Higher sea levels (some higher than today)
 - Left evidence of coastlines above where they are today



Glacial Periods

- Time marked by colder temperatures and glacial advance
- Periods are named, general by country or continent
 - Periods may not have equal effect within the same hemisphere or continent so name is meaningful
- 17+ major glacial stages occurred in North America in last 1.8 my

Relevant glacial stages

Laurentide ice sheet

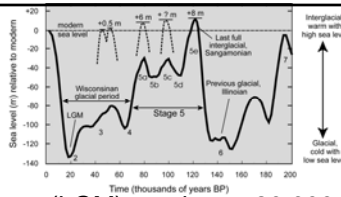
- Pre-Illinoian – ~ 2.5 to 500,000 ya
 - At least nine major glacial stages occur
 - New name for previously named stages (Kansan, Nebraskan, etc.)
- Illinoian - ~300,000 to 130,000
- Wisconsin Glaciation Period (110,000 to 12,500 years ago) – most recent advance of Laurentide ice sheet

Relevant glacial stages

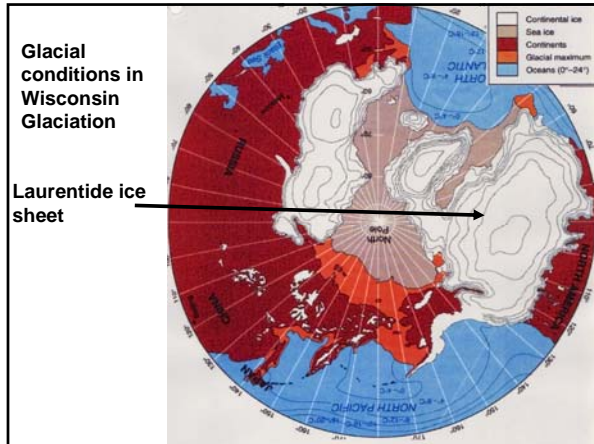
In Western US:

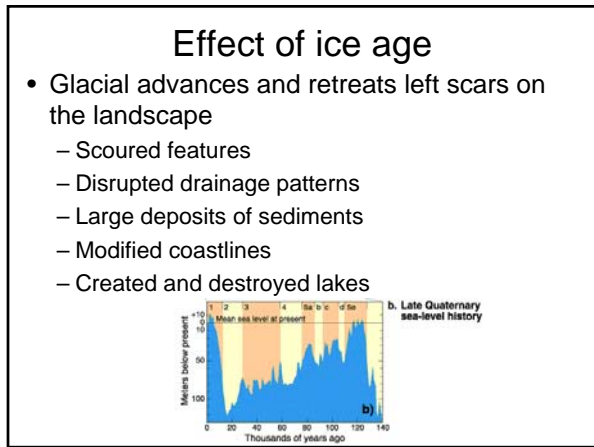
- Bull Lake Glaciation
 - Est. 125,000 to 50,000
- Pinedale or Fraser Period
 - Est. 29,000 to 7,600

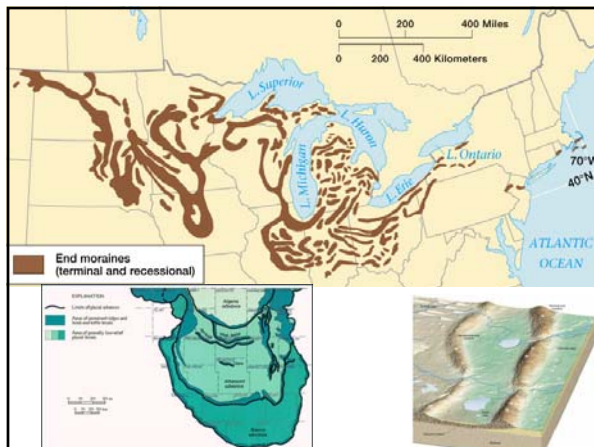
Glacial Period



- Last Glacial Maximum (LGM) – a time ~ 20,000 years ago with glaciers were at their full extent
 - Sea levels at lowest
 - In North America, LGM occurred during the Wisconsin Glaciation Period
 - May not have been the fullest extent of glaciation elsewhere

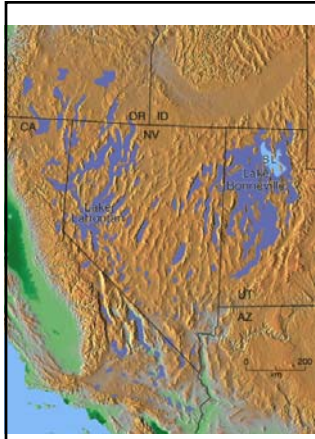






Glacial Lakes

- Those created during Pleistocene
 - Might not exist anymore but created landforms
- Created from several processes
 - Terminal moraines: Great Lakes
 - Ice: Glacial Lake Missoula (NW)
 - Natural ridges: Lake Bonneville (Utah) and Lake Lahontan (Nevada)
 - Glacier-scoured depressions: Great Lakes
 - Meltwater: Glacial Lake Agassiz (Canada)



- Lakes filled and drainage repeatedly
- Cooler temperatures meant less evaporation
- Large flat valleys seen today are a result of lakes

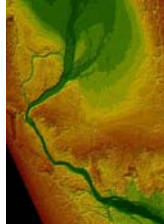
Glacial Lake Missoula

- Lake emptied multiple times
- Affected Montana, Idaho, Washington, and Oregon



Glacial Lake Agassiz

- 5 times size of North Dakota, held more water than all lakes in world today
- Filled and drainage many times
 - Left evidence of existence: shorelines, sediment, channels, smaller lakes



Isostasy

- Ice depressed the continents
- Since glacial retreat, continent has been rebounding
 - Called isostatic rebound
 - Ice over same continent had different thicknesses, retreat times, and duration
 - Result is different amounts of rebound
 - Hudson Bay most recently under ice – still has a lot of rebounding (current rate: 4.3 ft/100 yrs)
 - Great Lakes area still rebounding
- Rebound results in changes in elevation
 - Can result in drainage modification

