

Outline 10: The Ice Ages-Cenozoic Climatic History

Ice Ages in Earth History

- Late Cenozoic: last 5 MY
- Pennsylvanian and Permian: 300 MY ago
- Ordovician: 450 MY ago
- Late Proterozoic: 700 MY ago
- Early Proterozoic: 2200 MY ago

Definitions

- Ice Age or Ages: whenever there are glaciers at one or both poles during earth history.
- Glacial stage: when glaciers are very extensive during an ice age.
- Interglacial stage: when glaciers are less extensive during an ice age.

Cenozoic Climatic History

- Paleocene and Eocene: warm, tropical climate, no ice at the poles.
- Oligocene: ice starts to form on Antarctica as the Circum-Antarctic Current forms. This leads to Albedo changes causing more cooling.

Circum-Antarctic Current

- Flows clockwise around Antarctica; driven by westerly winds.
- Formed as South America, Africa, and Australia moved away from Antarctica.
- It's the fundamental cause of the Cenozoic ice ages.

Earth's Albedo

- Albedo refers to total reflectance of sunlight from the Earth.
- Ice: >90% reflectance
- Land: 30-70% reflectance
- Water: 20%

Cenozoic Climatic History

- Miocene: glaciers on Antarctica reach maximum size 5 MY ago. Sea level falls 150 ft. causing Mediterranean Sea to dry up. Deep oceans cool to near freezing causing cooling of Arctic waters. Earth's albedo continues to change.

Cenozoic Climatic History

- Pliocene: first glaciers in Arctic; earth's albedo continues to change.
- Pleistocene: maximum glaciation in Northern Hemisphere. About 20 cycles of glacial-interglacial stages. We are currently in an interglacial stage.

Ice Age Facts

- Ice Cover of Land
- 10% today
- 30% during last glacial stage
- Ice Thickness
- up to 9,000 ft. on Greenland
- up to 11,000 ft. on Antarctica

Ice Age Facts

- Sea Level Changes:
- If all modern ice melted, sea level would rise 200 ft. to pre-Ice Age levels.
- During maximum glaciation sea level was 400 ft. lower.
- Range of possible sea level changes = 600 ft.

Ice Age Facts

- Isostatic Depression and Rebound
- Currently, the center of Greenland is 1,000 ft. below sea level.
- Hudson Bay and Baltic Sea areas have rebounded 800 ft. since last ice age ended 10,000 years ago.

Ice Age Facts

- The Great Lakes were carved by glaciers.
- The ice sheets were larger in North America than in Eurasia. Size of sheets depends on amount of snowfall and rate of melting.

Causes of Glacial Cycles: The Milankovitch Theory

- Changes in the Earth's orbital parameters causes climate extremes of northern hemisphere summers.
- Cool northern hemisphere summers lead to glaciation as less winter ice melts.
- Cold winters by themselves don't cause glaciation.

Causes of Glacial Cycles: The Milankovitch Theory

- **Orbital Parameters:**
- eccentricity: the shape of the orbit
- tilt of Earth's axis: ranges from 22.1-24.5 degrees, currently 23.5
- perihelion: time when the Earth is closest to the sun

Deep Sea Record of Temperatures

- The ratio of O-18 to O-16 in deep water sea shells indicates cycles of temperature change.
- These cycles match the predicted Milankovich cycles.