Late Cenozoic Orogeny & Polar Continental Configuration

Promote "Ice Ages" (Cold = Glaciers)

North American Glaciation: Miocene to Present
Antarctica: even Older

Cordilleran

Deflection of Jet Stream by Rockies **
Alberta Clippers (= Low P)
Polar Air Mass (= High P)

Great Ice Age = Pleistocene Epoch

Ice Sheets

Laurentide Ice Sheet
Antarctic Ice: Now & Then

http://www.glacier.rice.edu/misc/whatisglacier.html
modified from Denton et al., 1991

Ice Age Climate

Ice Age Climate

PresentDayIce
20,000
yearsago
Migration of Species

Oxygen Isotopes in Greenland Ice Cores Record Global Ice Volume

Ice-core record from the Greenland Ice Sheet Project

Greenland Ice Sheet Project: 160,000 years of Ice-Core Record


Simultaneity

http://www.grida.no/climate/ipcc_tar/wg1/073.htm#fig224

Isostacy

Restoring force due to buoyancy

Outward flow in asthenosphere

Return flow in asthenosphere
Hudson Bay: Emergent

vs.

Gulf of Maine: Submergent (Now, vs. > 100 M/1000 yr Emergence @ 13-12 ka)

Hudson Bay Sea-Level Curve

http://www.homepage.montana.edu/~geol445/hyperglac/isostasy1/
Tom Rothhamel and William W. Locke Montana State University

Aerial Oblique Photo of Emergent Hudson Bay Beaches

The Remote Sensing Tutorial

NASA
Isostatic Response to Glaciation & Deglaciation

Complex Reaction!

Ice Volume Varies So Rapidly That Late Cenozoic System Is Always Adjusting

How is Late Cenozoic unique?

EUSTACY

Movement of Water from Glaciers on Continents to Oceans

Bath Tub

http://www.homepage.montana.edu/~geol445/hyperglac/eustasy1/
EUSTACY

Yields Changes in "Base Level"

Triggering Deposition & Erosion Cycles

Climate Change and Sea Level

38 meters high
Warm climate
(Plissean, 4 million years ago)

100 meters deep
Cold climate
(Ice age)

Sea Level Changes Over Four Glacial Cycles
Ice-berg Rafting Pulses: Heinrich and D/O Events

http://www.ngdc.noaa.gov/paleo/ctl/clisci10kb.html
Data from several sediment cores from Dowdeswell et al. [1995].

Contractions appear related to H and D/O events.

Ice Streams Produce Lobes on Continental Margins, Calving Bays on Marine Margins.

Contractions appear related to H and D/O events.
Pacemaker of the Ice Ages:
Milankovic Orbital Cycles

Tim Killeen,
David Allan,
George Kling,
James Teeri,
Ben van der Pluijm
University of Michigan

http://www.sprl.umich.edu/GCL/Notes-1998-Fall/climate_rec.html

Oceanic Conveyor Today


Orogeny, Epeirogeny, Climate-Glaciers, Isostasy & Eustacy Favor Glacial Systems, Colluvial Systems, & Clastic Sediments

Ice-Age Systems = So Dynamic that Equilibria May Never Be Reached