


Key definitions

cryosphere

snow cover

glacier

ice sheet




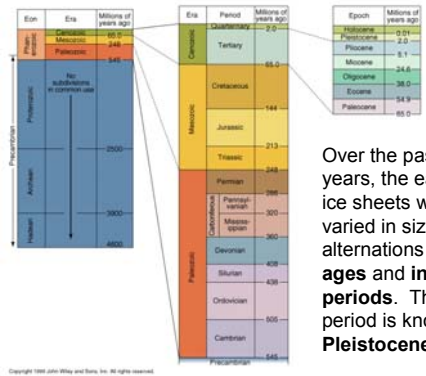
Where are the ice sheets in the present-day climate?

In the northern hemisphere, Greenland is covered by an enormous ice sheet which is a few kilometers thick and more than five times larger than the state of California in area. If this ice sheet were to melt, global sea level would rise by about 7 meters.

This is all that remains of the huge ice sheets that covered North America and Eurasia during the last glacial maximum, about 20,000 years ago.

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In the southern hemisphere, the Antarctic continent is covered with an even larger ice sheet. The Antarctic continent is about 25% larger than the United States. If this ice sheet were to melt entirely, global sea level would rise by about 70 meters. About 80% of the planet's freshwater is locked up in this ice sheet. The Greenland ice sheet contains about 9% of the planet's freshwater, with the remainder being contained mostly in lakes and mountain glaciers.

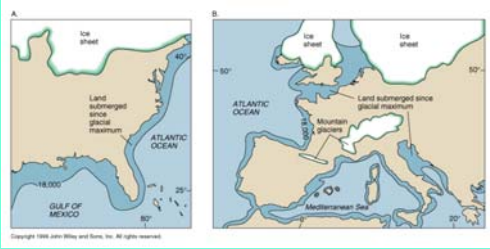
Era	Period	Millions of years ago
Cenozoic	Quaternary	0.0 - 2.6
	Tertiary	65.0 - 2.6
Mesozoic	Cretaceous	144 - 65.0
	Jurassic	199 - 144
	Triassic	252 - 199
	Permian	252 - 299
Paleozoic	Carboniferous	359 - 252
	Mississippian	359 - 359
	Devonian	419 - 359
	Silurian	438 - 419
	Ordovician	505 - 438
Precambrian	Cambrian	541 - 505
	Proterozoic	541 - 848

Over the past 2 million years, the earth has had ice sheets which have varied in size, causing alternations between **ice ages** and **interglacial periods**. This entire time period is known as the **Pleistocene**.

The extent of the northern hemisphere ice sheets at the last glacial maximum. The expansion of these ice sheets resulted in a sea level approximately 130 meters lower than today's.

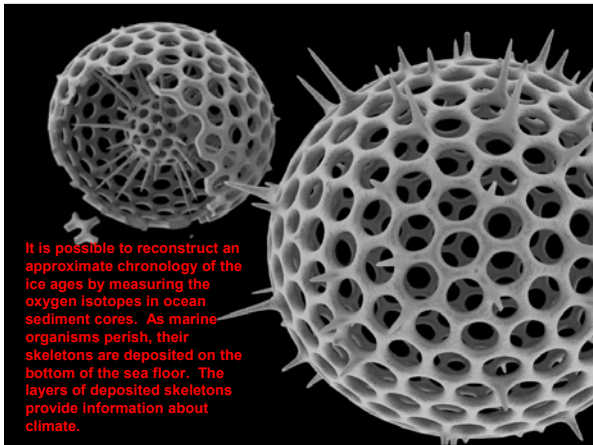
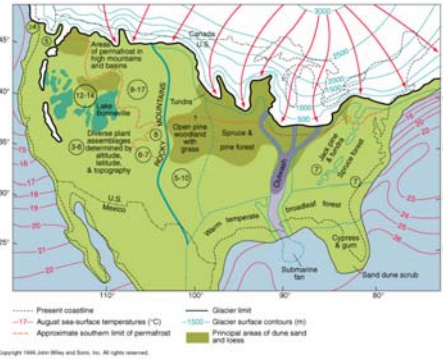



Deformation of the land surface, such as **glacial moraines**, are evidence of ice sheet extent



Because of the lowered sea level, the coastlines during the last ice age differed significantly from today's. North America was connected to Eurasia by a land bridge where the Bering strait is today, and the Mediterranean basin was cut off from the Atlantic.

The climate in North America was significantly different...



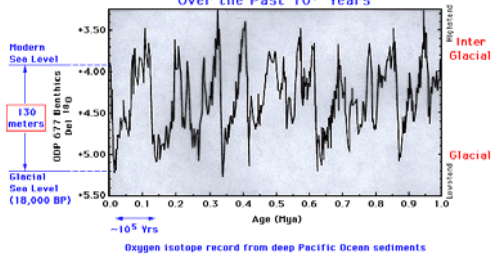
It is possible to reconstruct an approximate chronology of the ice ages by measuring the oxygen isotopes in ocean sediment cores. As marine organisms perish, their skeletons are deposited on the bottom of the sea floor. The layers of deposited skeletons provide information about climate.

(1) When temperatures are colder, the organisms incorporate more of the heavier isotope of oxygen into their skeletons. Measuring the ratio of the heavier to the lighter oxygen isotope in the skeletons therefore indicates how warm the water was when the organism was alive.

(2) The ratio of the heavier to the lighter oxygen isotope also varies in the ambient seawater because of the variations in total ice volume. The water molecules containing the heavier isotope are less likely to evaporate and be incorporated into the ice sheet. So as total ice volume increases, the ocean becomes increasingly enriched in the heavier isotope of oxygen.

So when ocean temperatures are cold and ice volume is large, the skeletons should be enriched in the heavier isotope. Presumably temperature and ice volume are tightly correlated, so an examination of the oxygen isotope record gives us a clear picture of when the ice ages occurred.

Record of Volume of Continental Glaciers Over the Past 10⁶ Years



The ice ages occurred approximately once every 100,000 years.