Science 20 Unit C - Earth

Climate Change and Mass Extinctions

POS Checklist:

- explain, in general terms, how changes to Earth's climate and how mass extinctions could be caused by changes or variation in the following: Earth's orbit around the sun, the inclination of Earth's axis, solar energy output, Earth's geography due to crustal movement, volcanic activity, ocean currents, atmospheric composition or asteroid impact.
- describe, in general terms, the major characteristics and life forms of the four eras: Precambrian, Paleozoic, Mesozoic and Cenozoic
- explain how sedimentary rock layers along with fossils can provide evidence of chronology, paleoclimate, evolution and mass extinctions;

Climate Change

Climate change is one of the most important issues that faces our society today.

But it might surprize you to learn that we are not the first species to have this problem...but before we dig into that idea, recall from Science 10:

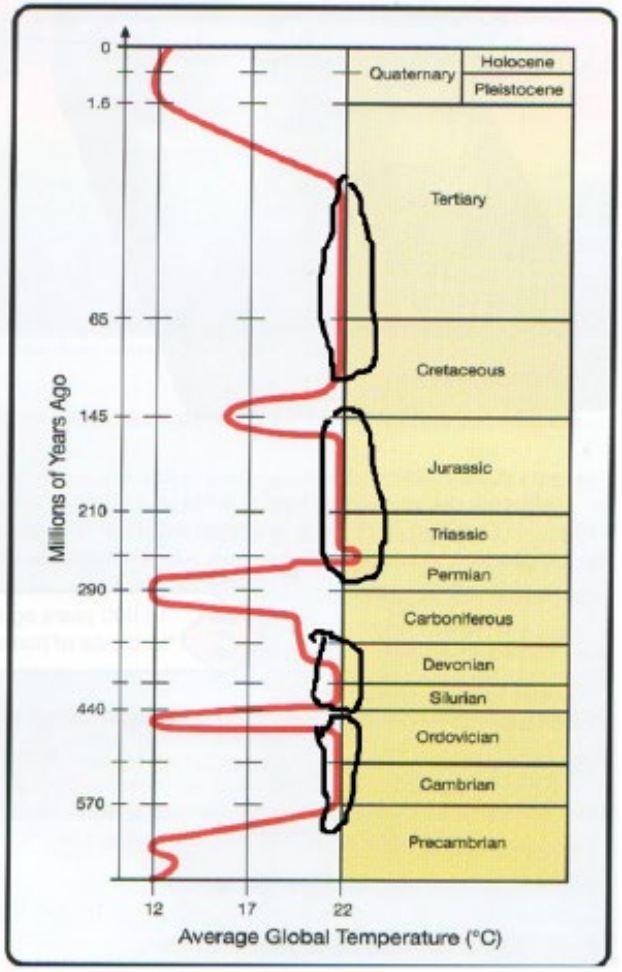
Weather: the state of the atmosphere in terms of variables such as temperature, cloud cover, precipitation and humidity for a particular place at a particular time.

Climate: the average of daily and seasonal weather events that occur in a region over a long period of time.

Weather changes vastly from day to day, but climate remains more or less the same (or changes slightly...).

You might think that a changing climate is a new problem on Earth, but really our planet`s climate has been changing greatly over geologic time.

Average Global Temperature



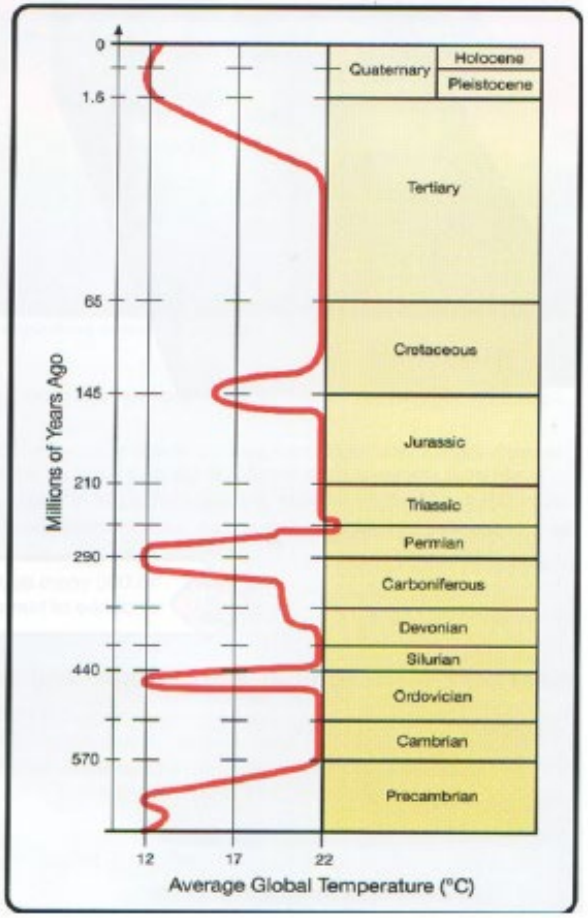
Evidence from rock strata (ex. tropical plant life indicates warm temperature, evergreen trees indicated cold temperatures) cause geologists to believe the global climate has changed over the history of the Earth.

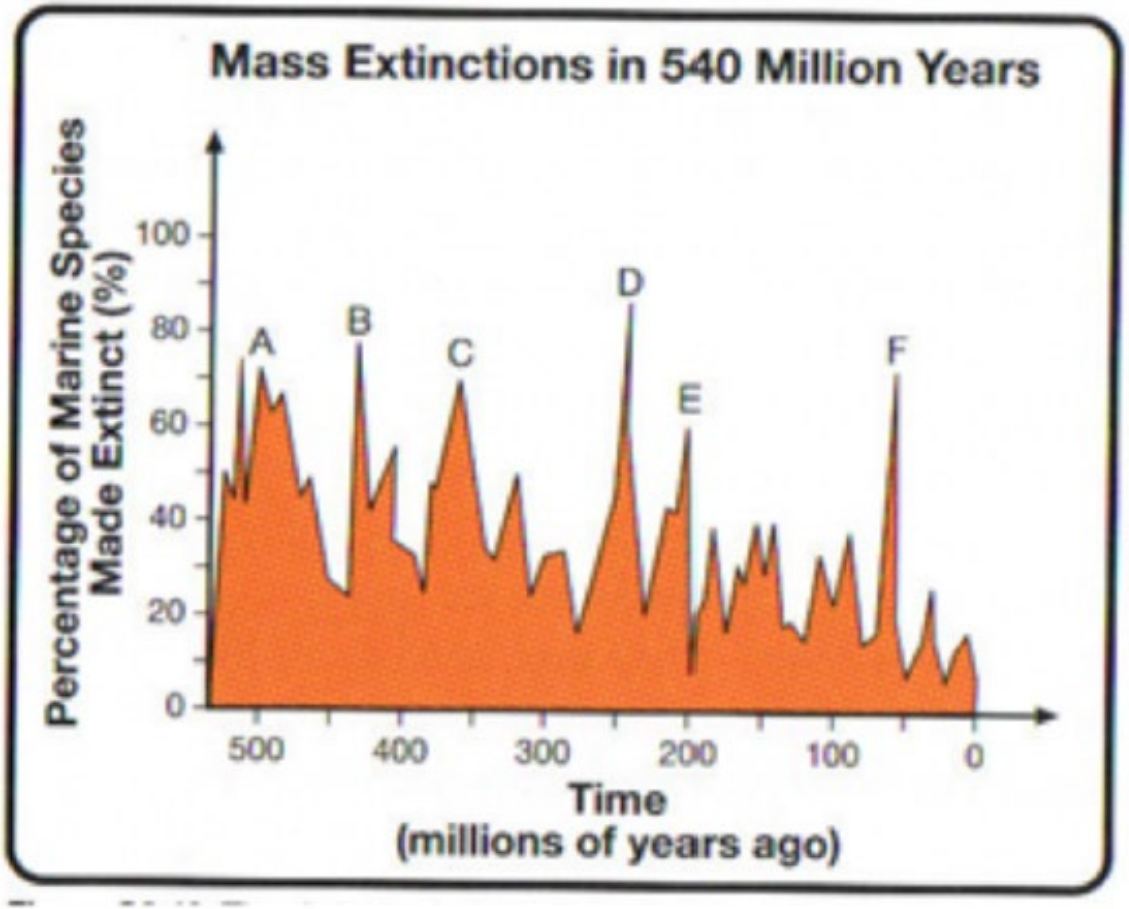
Note that this has not been a huge average different, and that things today are just slightly cooler than average.

A repeating pattern exists of a warming trend following a glaciation – Alberta should experience the next glaciation within the next 100 000 years.

This pattern has repeated all the way back to Snowball Earth in the Precambrian Era as shown by the global climate record.

This change in average global temperature is devistating to living things. Earth seems to have followed a cycle of life flourishing and extinctions that are tied to climate cycles.





Note the similarities in mass extinctions and climate fluctuations!

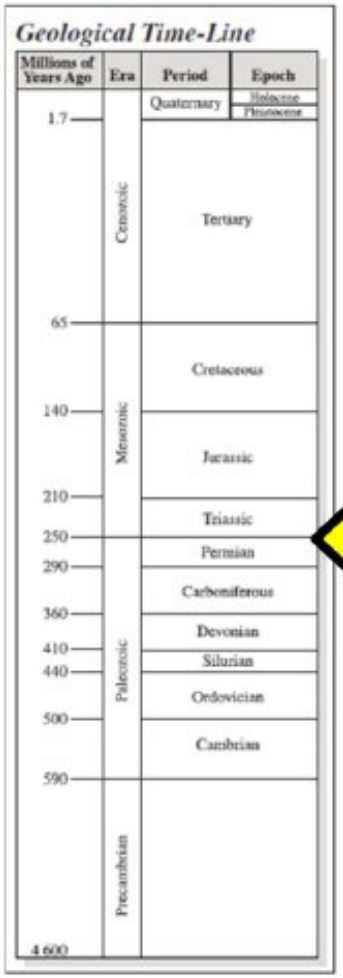
Mass extinction

Potentially caused by changes in...

	End - Ordovician	End - Devonian	End - Permian	End - Triassic	End - Cretaceous
Global cycles/ sea levels					
Ocean chemistry					
Atmospheric chemistry					
Climate					
Oceanic O_2 Levels					
Volcanic activity					
Asteroid impact		?	?		

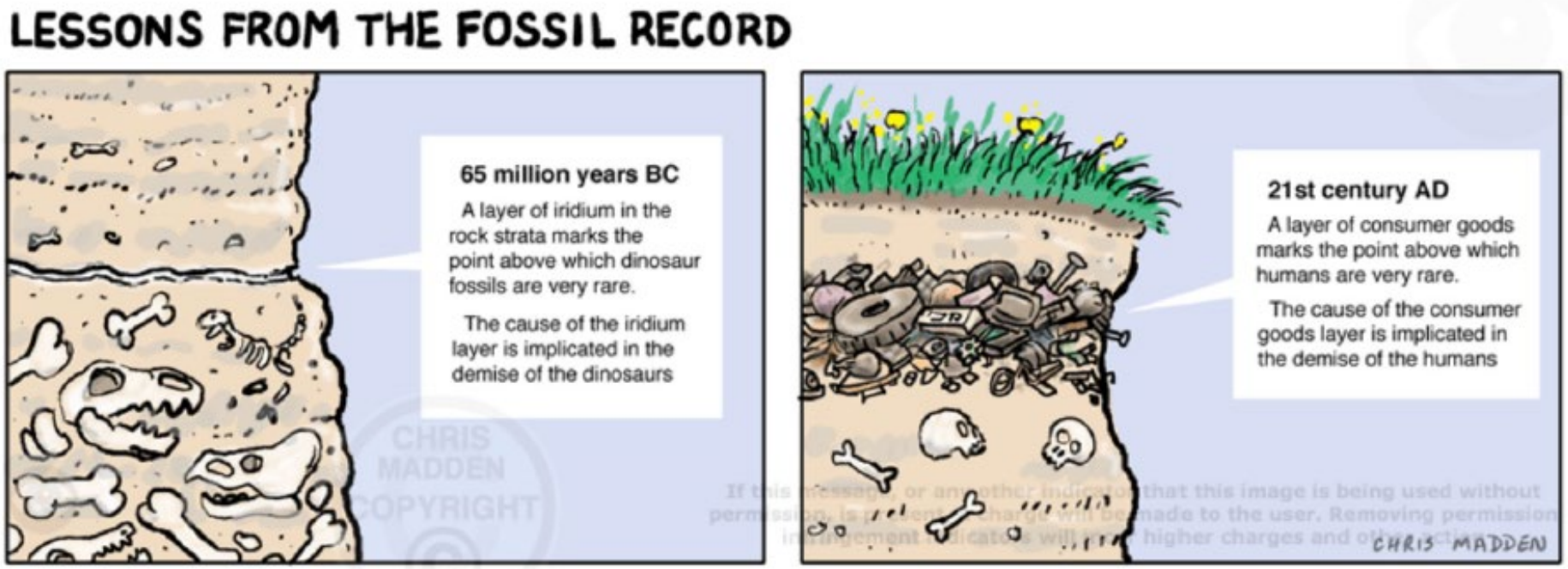
The Permian Extinction

One example of this is the Permian Extinction, occuring at the end of the Paleozoic Era.



70% of land animals and 90% of ocean life became extinct at this time!

We know of these mass extinctions because of index fossils in rock strata.



Extinction Causes and Types of Life:

The following activity will help you investigate how extinction could be caused by events that also impacted climate. You will also summarize some of the life forms that became extinct.

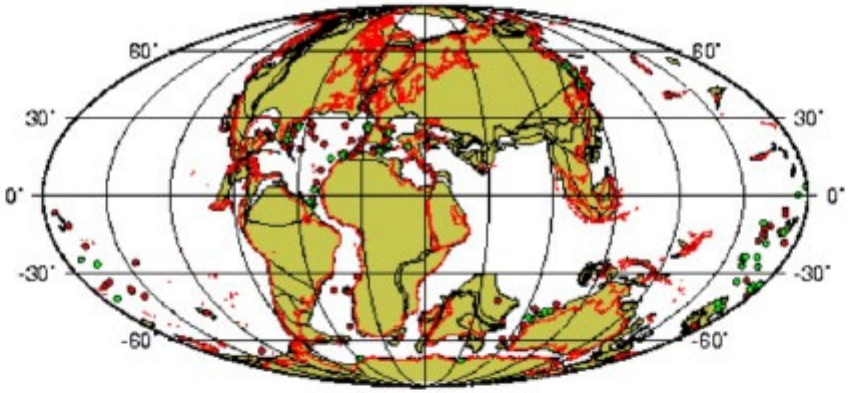
Question!

How do we know about the climate millions of years ago?

What causes Global Cooling?

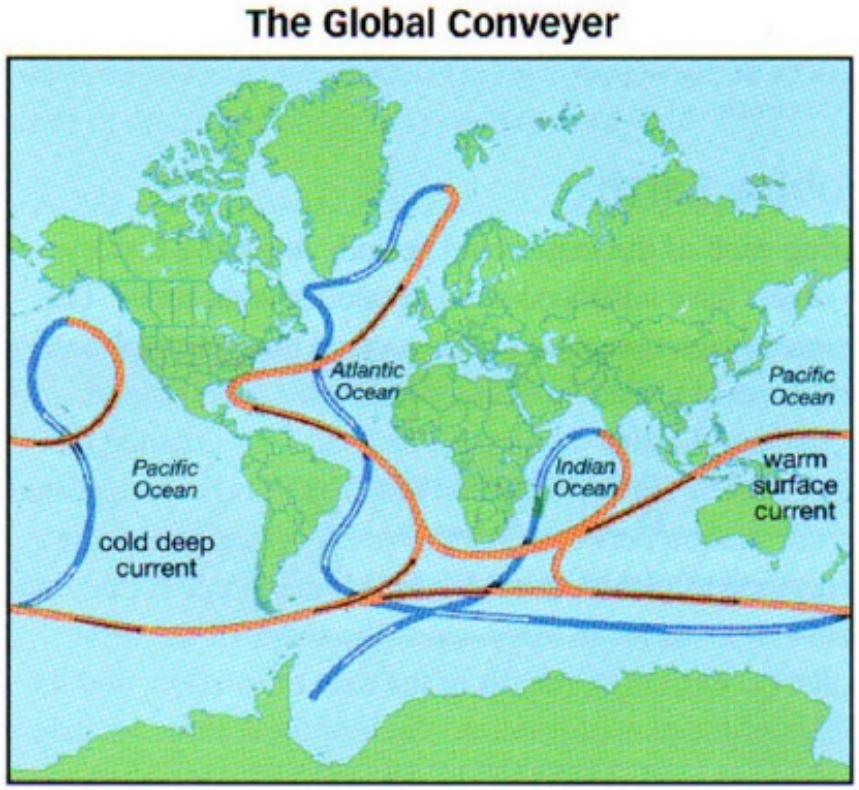
Most likely a combination of the following effects:

1. Continents moving north and south (plate tectonics)



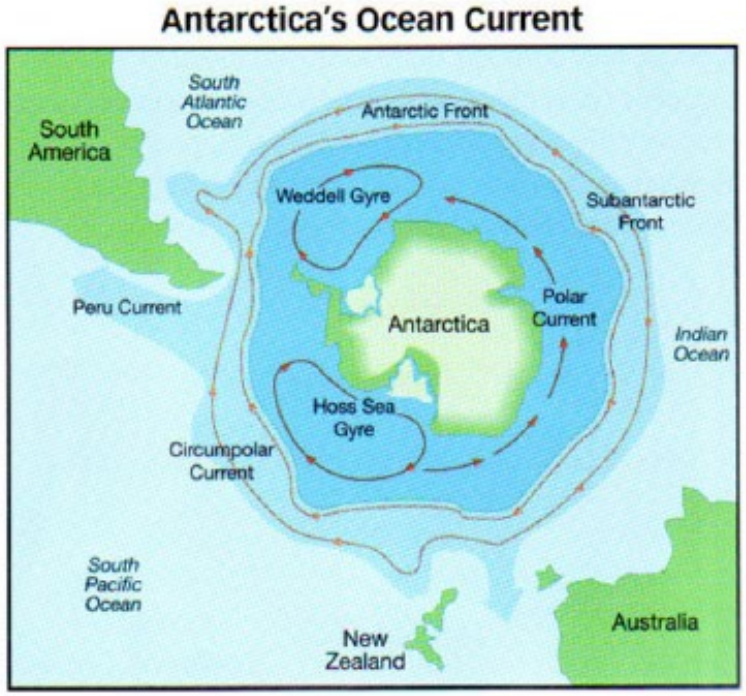
100 My Reconstruction

2. Ocean as a heat pump



Earth's oceans have giant convection currents that act as a <u>global conveyor.</u>

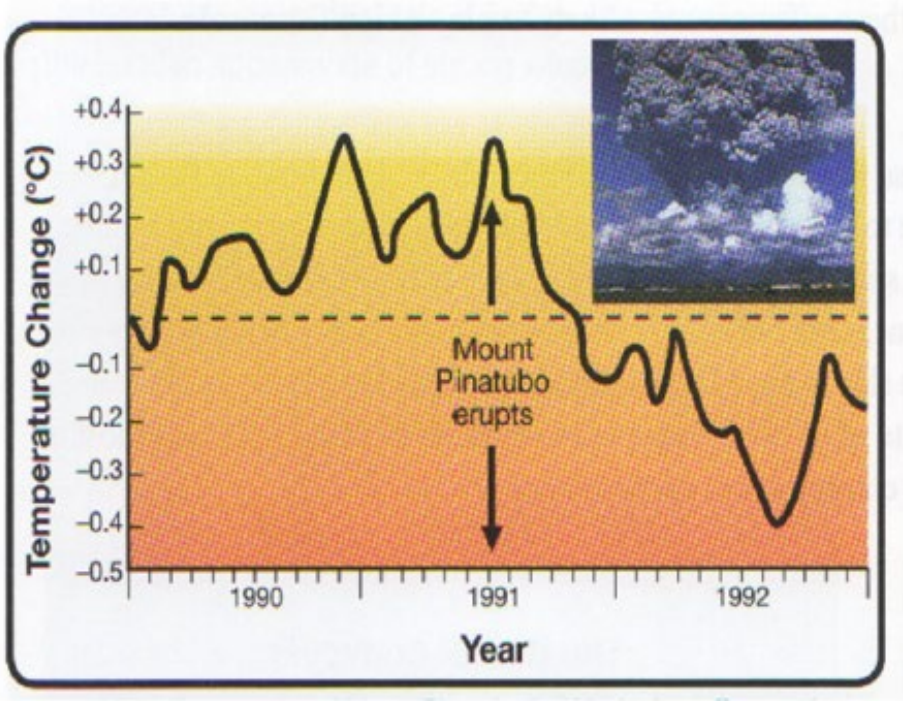
This circulates warm water away from the tropics and recirculates cold water of the polar regions.



- **This heats some areas and cools others.**
- **Heat from the tropics is brought up to the North Atlantic and released to Europe by winds (why Europe is warmer than Canada!)**

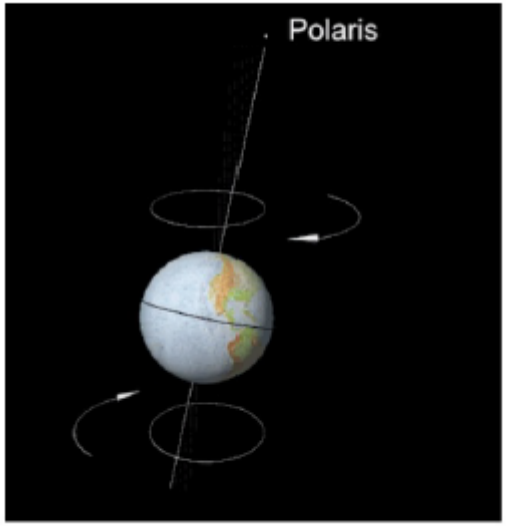
3. Volcanic Activity

Old volcanic activity may have contributed to long-term climate change.



Volcanoes were a major reason for the extinction of many species in the Permian Period, but they can also add to short-term fluctuations in climate.

4. Wobbly Earth



Repeated glaciations appear to match changes in Earth's orbit around the Sun and Earth's rotation on its axis.

This varies the amount of solar radiation that hits the Earth.

This is not believed to be the cause of the cold periods but instead control the timing of the glaciations.

5. Sunlight Variation

- The sun doesn't always shine so bright!

- **The changes in the intensity of solar radiation appear to follow a regular pattern determined by the frequency of sunspots.**
- **More sunspots: additional energy released by the Sun but minor impact on climate change (0.1 to 0.2% increase only)**
- **Less sunspots: Maunder Minimum (1645 – 1715) corresponds with an unusual cold period in the Little Ice Age in Europe**

6. Greenhouse Effect

In Earth's atmosphere, gases such as carbon dioxide and methane trap heat near Earth's surface – natural insulating effect (it's a good thing!).

CO_2 levels can fluctuate greatly due to:

- **Natural events – volcanic activity or weathering of carbonate rocks**
- **Correlates with changes in the average global temperature over the last 160 000 years**
- **CO_2 changes with other factors (Milankovitch Cycles, global ocean circulation) may have increased the effect on the atmosphere's temperature**

7. Enhanced Greenhouse Effect

- Not so natural changes to CO_2 levels also occur:
- Exponential increase since the Industrial Revolution
- Largest human-caused source of CO_2 is the burning of fossil fuels
- Scientists believe this increase is enhancing Earth's natural greenhouse effect leading to significant increases in the average global temperature during the last century
- In Alberta, we contribute more than the global/person average share of emissions (fossil fuel energy sources, low efficiency)