Lesson 3: Geological time lines worksheet

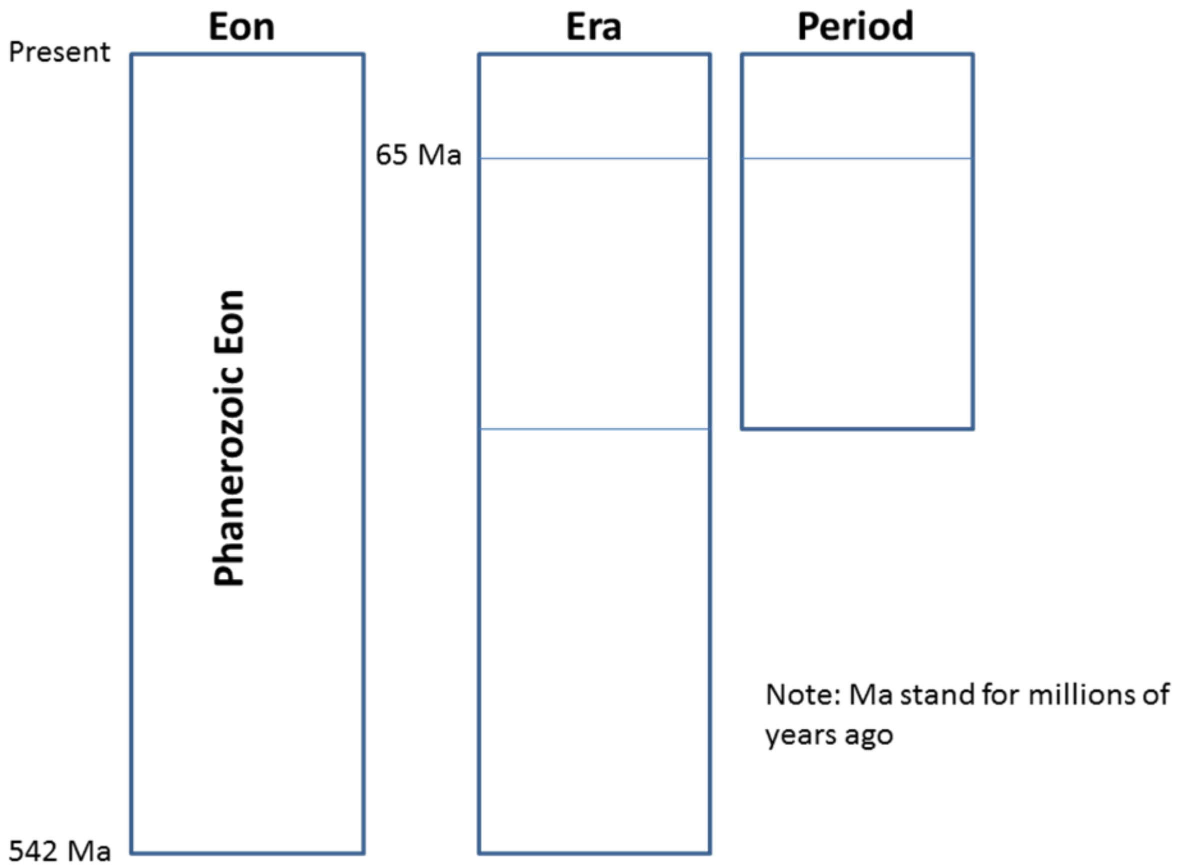
The Earth is about 4,600 million years old (or 4.6 billion years old). Dramatic changes in environment and climate have occurred throughout Earth's long history; but we know more about changes that have occurred in more recent geological time than those that occurred in the more distant past. This is because geological processes eventually erase evidence of earlier events: through the 'rock cycle', older rocks eventually get destroyed and replaced with new sediments and rock formations.

To study different times in Earth's history and the changes that occurred, scientists must have a common framework for talking about geological time – a **geochronology**. This involves slicing up Earth's geological history into a hierarchy of geochronological time intervals. The longest of these are Eons, and these are separated into different Eras. Eras are subdivided into Periods, which in turn are subdivided into Epochs. Visit the following British Geological Survey webpages on geological time to help you complete the diagram below and answer the following questions.

http://www.bgs.ac.uk/discoveringGeology/time/timechart/phanerozoic/home.html

http://www.bgs.ac.uk/discoveringGeology/time/timechart/phanerozoic/cenozoic.html

1. Using the web links above, add as much extra information as you can to this diagram.



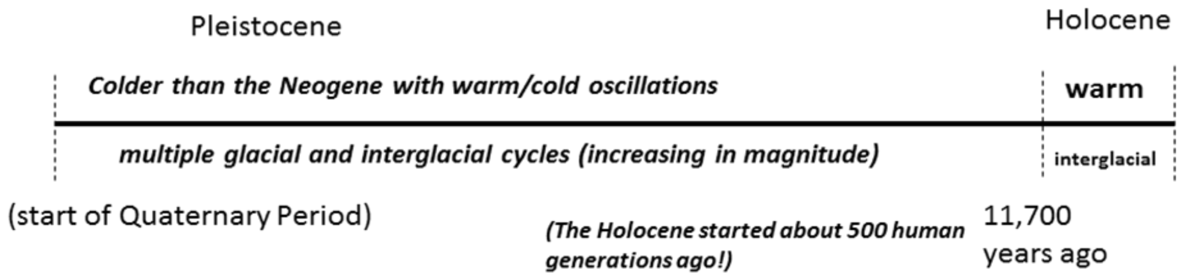
2. When did the Quaternary Period begin?

3. What two Epochs of geological time are contained in the Quaternary Period?

The Quaternary Period is the geological period in which we live. What makes it different from most other periods of geological time is that it has been a time of relatively cold climate with major ice sheets existing on the Earth. Today the major ice sheets are the Antarctic Ice Sheet and the Greenland Ice Sheet. However, during the Last Glacial Maximum (LGM) (see Lesson 1) ice sheets covered a far greater area than they do today.

Another distinguishing feature of the Quaternary Period is that it has been a time when Earth's climate has been highly variable. In other words, climate *has oscillated* many times between colder and warmer.

This diagram is not to scale, but summarises how climate has changed through the Quaternary. Although the Holocene is only the most recent interglacial, similar to many that occurred during the Pleistocene, it's given special status as the warm time frame when agriculture and civilisation arose.



The graph on the next page shows the glacial and interglacial cycles reconstructed by the European Project for Ice Coring in Antarctica (EPICA) Dome C ice core.

The ratio of hydrogen isotopes (deuterium to hydrogen) preserved in layers of ice tells us how the air temperature over the coring site has changed through time. Glaciologists have created a timescale by estimating the ages of layers of ice at different depths through the Antarctic Ice Sheet. Times when there is relatively more 'heavy hydrogen' (^{2}H) (known as deuterium) to ordinary hydrogen (^{1}H) were warmer times. For example, as shown in the graph, the less negative ratio of -400 indicates a much warmer climate (about 15^{o}C warmer over Antarctica) than the more negative ratio (even less deuterium to hydrogen) of -450.

To learn more about the EPICA research you can visit their website:
http://www.esf.org/index.php?id=855

To learn more about the theory and methods behind reconstructing past climate from ice cores, visit the British Antarctic Survey's webpage on ice cores:
http://www.antarctica.ac.uk//bas_research/science/climate/icecore/page1.php

Complete the following tasks using the graph on the next page:

4. Use a ruler to draw a straight vertical line from the temperature today (at about -400 deuterium/hydrogen ratio) to the bottom of the graph.

5. Add an arrow to the time axis to mark the transition from the Pleistocene to the Holocene (our present interglacial).

6. Looking at your vertical line, at what times was the temperature close to today's level? (These are interglacial times.)

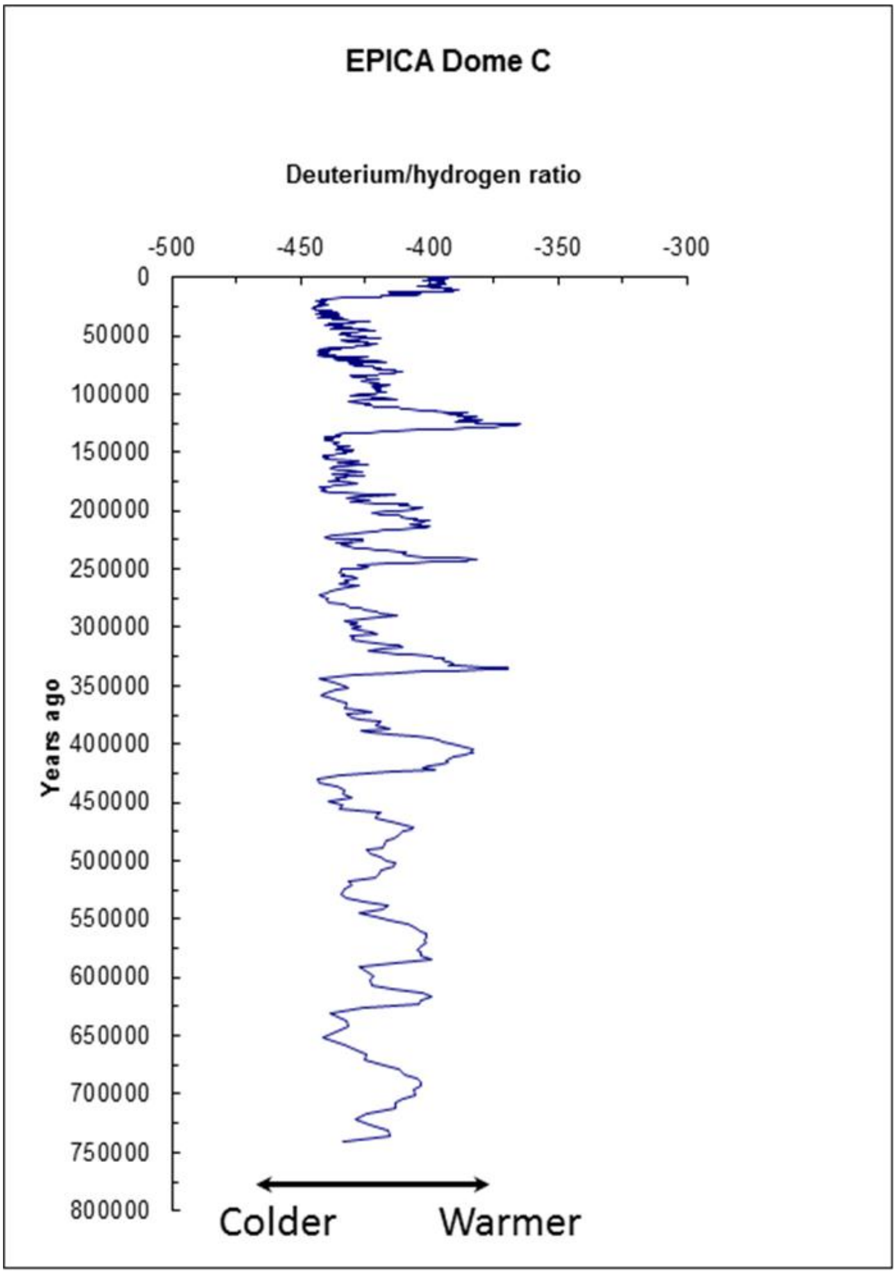
7. How many interglacials during the Pleistocene reached temperatures even warmer than today?

8. What do you notice about the climate cycles from about 450,000 years ago towards the present?

9. The most recent glacial phase started about 115,000 years ago. Add an arrow to mark the point at which the temperature reached its lowest level. Label this the Last Glacial Maximum (LGM).

10. Looking at the graph, and referring back to your notes from Lesson 1, write down the time span of the LGM.

Note that although this reconstruction is for temperature changes over Antarctica, these represent global changes in climate, for which evidence has been found in many parts of the world.



The EPICA ice core was drilled at 'Dome C' on the East Antarctic Ice Sheet with the ice surface at an altitude of 3,233m above sea level! The drilling reached near bedrock (a depth of 3,270m down through the ice) in 2004.

The average annual surface temperature at Dome C today is -55°C. During the coldest phases, the temperature would have been near -70°C!

To learn more about the causes for climate change on different timescales visit: http://www.ncdc.noaa.gov/paleo/ctl/

Source: NOAA Paleoclimatology Programme, data from EPICA Community Members (2004)