GCSE Geology 2.4: Global climate and sea level change

There is evidence for global climate change through geological time, with the Earth switching from icehouse to greenhouse conditions many times. Icehouse conditions occur when there is ice at the poles, the average global temperature is below 15°C, a lot of land area is exposed and sea levels are low. The Earth is currently experiencing icehouse conditions. Evidence for past icehouse conditions comes from the deposition of glacial deposits close to the equator.

Hothouse conditions occur when the poles are ice-free, average global temperature is above 20°C, less land is exposed and sea levels are higher. Evidence for past hothouse conditions is the deposition of limestone/chalk outside the tropics. Evidence for recent rises in sea level as the climate warms is drowned forests.

As the climate warms, continental ice sheets and glaciers melt and reduce in volume, leading to sea level rise. As the climate cools, more snowfall occurs and glaciers and ice sheets increase in volume, leading to a reduction of water flowing back to the sea in rivers and consequently a global fall in sea level.

Evidence for climate change in the British area caused by a change in its latitude

Age of rocks	Location of rocks	Type of rocks	Latitude at which rocks are formed
700 Ma	Scotland	Tillites/glacial breccias formed under glaciers/ice sheets	70° South, close to South Pole
380 Ma	Scotland	Desert sandstones and breccias with red haematite cement and large-scale cross bedding (dune bedding)	20° South – same latitude as the Great Australian Desert
359-299 Ma	Lancashire, Yorkshire	Limestones with corals and coal with tropical plant fossils	5° South - 5° North (or on Equator)
270-260 Ma	Devon	Desert sandstones and breccias with red haematite cement and large-scale cross bedding (dune bedding)	20° North – same latitude as the Sahara Desert
2 Ma - 11.7 Ka	Scotland, Lake District	Boulder clay/glacial till/glacial breccias formed under glaciers/ice sheets	51° - 55° North – present latitude

Indicates the British area drifted northwards from 70°South to its current latitude, passing through various climatic belts, with their characteristic rock types.

Greenhouse gases – most important is carbon dioxide, which is derived from volcanic gas emissions and from the burning of fossil fuels (coal, oil and gas). Until the start of the industrial revolution (circa 1784), all the carbon dioxide in the atmosphere was from volcanic sources. Since the start of the industrial revolution, 99% of all the carbon dioxide added to the atmosphere has been from the burning of fossil fuels.

There is evidence for changes in atmospheric carbon dioxide levels over geological time. Ice cores from Greenland and Antarctica allow carbon dioxide levels to be determined back to 800,000 years ago. Deep sea sediment cores involving the analysis of microscopic seashells provide records of changing carbon dioxide levels dating back to 70 million years ago.

There is both positive and negative feedback on the carbon dioxide content of the atmosphere. Positive feedback leads to increasing temperatures and rising sea levels, which results in a reduction of icecap albedo. (Less white ice = less solar energy reflected away from Earth.) Negative feedback leads to decreasing temperatures and falling sea levels, which results in carbon dioxide being dissolved in seawater and absorbed by organisms to form limestone. Other factors controlling carbon dioxide levels include subduction of carbonates, amount of volcanic emissions, chemical weathering of silicates and marine storage.

Carbon capture and storage or carbon sequestration is a geological strategy to reduce atmospheric carbon dioxide. It involves capturing carbon dioxide at its source from industrial processes, converting it into a liquid or solid state and then storing it in geological formations underground. Depleted oil and gas fields are ideal sites as the pipeline infrastructure is already in place and the wells can then be sealed once the carbon dioxide is in place.