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CLIMATE THROUGH TIME – 2

Temperature and Sea Level Changes; Ice Ages

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Introduction to this Issue

This issue focuses on the graph, or curve, on the left edge of the BGS *Climate through Time* poster and the Ice Age oval and map on the opposite side of the poster. The curve shows the fluctuating temperature and sea level over geological history, as well as highlighting the periods when the Earth was affected by major ice ages. Due to the close correlation between long periods of colder average temperatures, falls in sea-level and the ice ages, the activities in this issue are linked to both the graph and ice ages in general and will investigate the associated environments and the evidence for glaciation and ice cover.

Temperature and Sea Level Curve

One of the possible consequences of falling temperatures is glaciation and the accumulation of snow and ice in mountainous regions, at the North and South Poles and generally within the Arctic and Antarctic circles. When winter accumulation is greater than summer melting the ice caps and glaciers grow, covering larger areas and forming vast ice sheets. Water evaporated from the seas is transported around the globe by atmospheric circulation and weather systems and much of it falls as snow in these very northerly or southerly regions. In times when snow remains and accumulates on the polar ice caps, the water that has been evaporated or removed from the oceans and fallen there as snow is locked it up in the ice sheets, resulting in lower sea levels. It can be released later by the melting of the ice caps when the water can eventually be returned to the oceans and sea levels rise again.

With reference to the temperature and sea level curve, low temperatures and sea levels can be seen (tending to the left, or blue side) at the times of the indicated ice ages when polar ice caps existed, such as in the Ordovician Ice Age, when the large ancient land mass called Gondwana was near the South Pole and was heavily glaciated, and again in the early Permian, when there was a large ice sheet over Antarctica. Sea levels are low again today as there is extensive ice cover at both the North and South Poles as we come to the end of the Great Ice Age.

Make Your Own Iceberg

Sea ice is frozen seawater and is even present during the summer in some Antarctic bays and in the Arctic. In winter it expands to cover the whole of the Arctic and much of the sea around the Antarctic and has a typical thickness of about 2m. In contrast, ice bergs are much larger and thicker masses of ice broken from ice shelves (iceberg calving) which are then swept out to sea. The melting of sea ice or icebergs from ice shelves does not affect sea levels as such ice is already floating in the sea. This activity helps to demonstrate why this is so. Ice that forms from and floats on the sea will not alter sea-levels as it is not removed.

Method:

1. Fill a balloon with tap water and knot the end (this may need adult help)
2. Freeze the water-filled balloon
3. Place in a bucket and cut the balloon from the iceberg
4. Fill the bucket with cold water, enough for the iceberg to float

Observations:

1. Mark the water level on the side of the bucket
2. Note how much of the iceberg is above and how much is below the surface
3. Icebergs can be seen above the surface so why do you think they are a hazard to ships?
4. Let the iceberg melt naturally and observe any changes (checking every 20-30 minutes may help. Does is float higher or lower in the water as it melts?
5. When it has completely melted check the water level. Is it higher, lower or the same as when the iceberg was present and first observed?

What is Permafrost and why does it matter?

Permafrost is defined on the basis of temperature, as soil or rock that remains below 0°C for at least two years and forms when the ground cools sufficiently in winter to produce a frozen layer that persists throughout the following summer. Much of the current permafrost (e.g. in Alaska and Siberia) has remained since the previous glaciated period (the Great Ice Age) and the time of the Mammoths (about 18,000 - 40,000 years ago). Its thickness ranges from less than 1 meter to greater than 1,000 meters. Permafrost regions occupy approximately 24 percent of the exposed land surface of the Northern Hemisphere. The arctic snow-deserts and the Northern Tundra are examples of permafrost areas.

With global warming some of the permafrost is starting to melt. Where it is wet, liquid water is released and the ground becomes unstable.

Materials:

To observe some of these effects in school we need to freeze and thaw different soils. If possible, use at least one sample of peat or peat-rich soil. Make two substantial samples of each soil.

1. Dry sample (dry soil in an oven, under a light, or in the sun)
2. Wet sample (the same soil saturated by soaking in water but allowing excess water to drain away, such as through a cloth)

Method:

1. Take equal quantities of each sample. Measure by volume using a plastic bottle with the top half cut off. (The volume levels can be marked by pouring in measured amounts of water. If you are lucky you may be able to “borrow” plastic standard volume containers from the maths department.)
2. Put the soil sample into the cut off bottle. Weigh it and measure its depth.
3. When everything is recorded, freeze the samples for about twenty four hours.

Investigation:

1. Remove the samples from the freezer and measure and record again noting any changes. Use the investigation to record observations such as:
   - Has it changed weight since being frozen?
   - Has it changed volume since being frozen?
   - Is it harder or softer?
   - Does it feel wetter or drier?
2. If you put a small block onto the surface, what is the maximum weight it will support before the block sinks into the soil?
3. Optional extra: Make a range of samples with different amounts of water, from dry soil to sloppy mud. Weigh the frozen sample and tip it into a cloth to melt so that the water can drain away, then reweigh it and see how much is lost.

All these observations can be related to real life. For instance in Russia oil and gas pipelines are collapsing, the Trans Siberian railway needs constant repair, and coastlines are eroding, all because of melting permafrost.

As well as releasing a lot of water the soil releases a large amount of trapped methane which is a greater threat than carbon dioxide as a promoter of the greenhouse effect.

Another property of frozen soil is that it becomes impermeable and thus is often covered in a layer of liquid water even though its temperature below the surface is below freezing point. Try the permeability test from "Working with Soils" or PEST issue 3, but compare frozen and unfrozen soils of the same type.

Do It Yourself Glacier

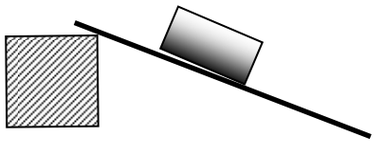
This activity helps pupils to investigate how glaciers scrape and reshape the surface of the land as they move down valleys, the way they transport debris and the evidence they leave behind once they have thawed. It would need setting up at least the day before due to the time needed to freeze the glacial blocks and prepare the slopes but could be organised well in advance.

Materials:

1. 3 old ice-cream tubs or similar (preferably 2 litre capacity)
2. Coarse Gravel, enough to cover a tub's bottom to about a third of its depth
3. Coarse sand or sand/gravel mix to fill another tub to about a third of its depth
4. Water
5. 3 short planks of wood (up to a metre), old trays or similar. Better results can be seen if the top sides are painted with emulsion, different coloured coats are effective
6. 3 bricks or blocks to allow planks to form slopes of the same gradient
7. Camera to take photographs at intervals

Method:

1. Place the gravel in one tub, the sand or sand/gravel mix in another and leave one tub for water only. Fill each tub with water (leaving 1-2 cm for expansion) and freeze.
2. Build three slopes with the blocks and planks
3. Remove tubs (glaciers) from the freezer and observe any changes (e.g. bulging tubs, domed top to ice etc) and discuss their possible effect on surrounding ground (e.g. opening up cracks in rocks etc).
4. Remove glaciers from the tubs and place each one on a prepared slope (grit side down) with sufficient gradient for each to slide down (they may need some encouragement).



Investigation: *It is a good idea to take a series of photographs during the activity to help with understanding and to provide display material, slide show or PowerPoint presentation.*

Compare the three glaciers:-

- Which moves the fastest? Which causes the most damage to the planks/paint? What kind of marks do they leave behind? Striations. Note how easily ice can transport relatively large pieces of rock long distances.
- Leave your glaciers to thaw on a tray and then observe what is left behind (e.g. glacial till or moraine, tillites, erratics etc). Is the remaining sediment well sorted into graded sizes, like river or beach sediments, or very jumbled up?
- Discuss the abrasive action of the ice on valley floors. Investigate the evidence of glaciation in highland areas of Britain (e.g. U-shaped valleys, hanging valleys, drumlins). Crummock Water, in the Lake District, and Glen Roy, in Scotland, are both classic examples of areas previously subjected to glaciation.
- Look up the key words [underlined in this section] in books or on the internet and research ice ages and glaciation in general, the effects on the land and the evidence left afterwards. The last ice age, the Great Ice Age, is usually given capitals.

Britain during the Great (last) Ice Age

Looking again at the BGS *Climate through Time* poster and the small map of Britain and Ireland just below the ice age oval, we can see the extent of the ice coverage during the last Ice Age, the Quaternary or Great Ice Age, which entered its final stages about 10,000 years ago.

Pupil Activity:

1. Look at the blue arrows showing the directions the ice moved. Why do you think it moved in those directions?
2. Locate the area where you live.
3. Was your location covered by ice over 10,000 years ago?
4. Could your location have been one affected by permafrost at this time?
5. Earlier ice sheets may have extended further south and land beyond the leading edge of a glacier or ice sheet would have been affected by permafrost. Was your location?
6. Can you find any evidence for ice coverage locally? (Polished scraped rocks and wide U-shaped valleys (Scotland, Wales and The Lakes), glacial till (East Anglia), erratic rocks (foreign to the area) dumped in field and on hillsides, glacial moraine (rounded mounds of poorly sorted sediment including fine sands and large boulders).

Investigating Ice Age Animals and Extinctions

This activity is ideal for older and more able pupils. It is cross-curricular and ideal to bring together some of the threads of their ice age investigations. Pupils should work in pairs or small groups and focus on one of the following areas of interest. Each group could giving a final presentation of their findings to the others.

- Investigate the kinds of animals that were living at the time of the Great Ice Age
- What characteristics of large animals made them well suited to survival in an extremely cold climate? For example look at the woolly mammoth, woolly rhinoceros, mastadon and glyptodon (an ancient armadillo)
- Were these animals herbivorous or carnivorous? What did they eat?
- Do these animals have descendants alive today? Highlight their similarities and differences
- Do a cave painting of one of the extinct animals on a flat piece of rock.
- Research the recent fossil finds of extinct animals from Siberia and the Russian Steppe.

The *Climate through Time* poster can be downloaded in low or high resolution formats from: www.bgs.ac.uk/education/climate_change/climate_through_time.html

Forthcoming Events. Full information is available from the respective web sites.
ESTA Primary Team Members will be providing practical workshops, resources and useful information at:-

Geographical Association Conference, Derby, 9th – 10th April 2010. www.geography.org.uk
Rivers and Coasts in Action. Hands on workshop on rivers and coasts, their formation, erosion and evolution. Participants build their own rivers or coasts and watch them evolve through time. Ideas will be provided to help transfer this to individual classroom situations, using unusual everyday items and how to acquire and adapt resources. Cross curricular work will be emphasised.

ESTA Conference Leicester, 17th – 19th September 2010. www.esta-uk.net Primary INSET Saturday 18th – practical workshops on minerals, rocks, soils, rivers and coasts with an emphasis on cross curricular themes.

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