## GEOBROWSER

## Global climate change - a puzzle solved

The controversies over global climate change have generally revolved around two important aspects: a) is the Earth really warming up? and b) if so, what is causing it? Those in denial about the first question have so far been able to cite the fact that temperature readings taken from weather balloons and satellites have, according to most analysts, shown little if any signs of progressive warming when compared to surface measurements. If these weather balloon temperatures are truly representative of the situation, then most models that predicted global warming are wrong. This paradox has now been resolved by measuring changes in winds, which are tied to fluctuations in temperatures and would be a more accurate gauge of true atmospheric warming than the thermometers (*Nature Geoscience, May 2008*). Measurements on thermal winds, based on the motion of weather balloons at different altitudes in the atmosphere, show that temperatures at heights of 10 km in the Tropics have risen by about 0.65ºC per decade since 1970. This is probably the fastest rate of warming anywhere in the Earth's atmosphere, and is in line with other predictions of global warming models.

## Problems with methane

The possibility that (geologically) sudden releases of methane, a powerful greenhouse gas, could help to 'tip' the Earth's climate towards unbridled warming has been mooted for some years (e.g. *Geobrowser 2004, and talk by John Rees in November, 2005*). Such an event would be devastating, but its onset is difficult to predict; possibly for that reason, many non-geologists prefer to largely ignore it, and instead base their models on smoothly-curving extrapolations of recent global temperature increases. It is therefore up to geologists specialising in palaeoclimate changes to point out the danger. They can do this by going back into 'deep time', reversing Hutton's principle of uniformitarianism by suggesting that the past may be the key to what is happening in the present.

### In very deep-time….

With increasingly sophisticated methods of isotopic and geochemical analysis, we can now go back a long way and suggest that an abrupt release of methane may have occurred in latest Precambrian times, about 635 million years ago (*Nature, May 29, 2008*). This could have contributed to the chain of events that ended what was possibly the last "snowball" ice age, the Marinoan glaciation (see also *Geobrowser, 2005*). The mechanism involved is suggested to be the abundant release of methane from clathrates - masses of methane that form and stabilize within lattices of water molecules frozen in sea floor sediments beneath ice sheets under specific temperatures and pressures. When the Precambrian ice sheets became unstable and collapsed, they released pressure on the clathrates, which began to degas. The finding could explain many things, including the abruptness of the glacial termination, changes in ancient ocean-chemistry, and unusual chemical deposits in the oceans that occurred during the snowball Earth ice age. The researchers warn that we are currently witnessing an unprecedented rate of warming, with little or no knowledge of potential instabilities that lurk in the climate system and how they can influence life on Earth. But much the same experiment had already been conducted 635 million years ago, the outcome is preserved in the geologic record and this shows the planet's potential to undergo an abrupt and catastrophic change from a very cold, seemingly stable climatic state to a very warm and stable climate, with no pause in between.

### And the terrestrial dimension?

Methane out-gassing from terrestrial sources is another of the mechanisms suggested to advance the process of climate change towards the 'tipping point'. We only need to go back to between 11,000 and 12,000 years ago, to the end of the last glaciation, to establish the potency of this phenomenon. American and Russian scientists have found that from 8000 to 12,000 years ago, the vast area covered by northern hemisphere peatlands increased dramatically, and methane levels -resulting from the decomposition of organic material and its release upon thawing - rose to 750 parts per billion by volume, a level they would not be reached again until the Industrial Revolution. Temperatures over Greenland likewise jumped an additional 7ºF, reflecting a period of warming, which in turn thawed more ice, particularly in North America, and freed up more land for bog formation. Today, with global warming proceeding apace, methane is once again being rapidly released from the northern tundra and in the near future will boost the present level of atmospheric carbon, possibly by several billion tonnes (*New Scientist, August 2005*).

Further evidence corroborating the importance of terrestrial out-gassing has come from studies of core samples from the Greenland Ice Sheet Project II. These ice cores, from the last 40,000 years of Earth history, show a rapid increase in methane, and while some researchers believe that clathrates were responsible, others believe that the methane was generated in wetlands. (*Science Daily, February 2006*). By studying the ratio of the heavier isotope of hydrogen, deuterium, to the normal hydrogen it was found that a contribution from clathrates could be ruled out, leaving only two realistic candidates - changes in wetland systematics and/or increased natural gas emissions during the glacial period. The former of these explanations is thought to be the most likely, since it is compatible with models predicting that, as climates warmed, and the area occupied by wetlands expanded, methane emissions increase.

The study of terrestrial carbon out-gassing is relatively new, but is now being applied to much earlier geological records, as recent analysis of British Tertiary peat bog material has shown. These fossil wetland deposits, belonging to the 55 million years old Cobham Lignite, were intersected during the construction of the Channel Tunnel. Their geochemical composition (*Science Daily, September 2007*) shows that carbon isotope values of hopanoids - compounds made by bacteria - suddenly decrease in a manner that can only be explained by switching to a diet of methane. This indicates that methane emissions must have increased, suggesting that 55 million years ago there was a massive release of carbon into the atmosphere that coincided with, and probably enhanced, global warming. In *Geobrowser* (2003), this event was attributed to a combination of out-gassing by volcanism and methane hydrates, but the new study suggests that there was a knock-on effect, causing environmental changes in wetlands. It is perhaps the earliest example of how terrestrial ecosystems millions of years ago were affected by rapid warming-induced changes in climate, and is therefore a further salutary lesson on how they could respond to warming in the future.

## Good news for Nottinghamshire coal

Amid much fanfare it was revealed in April this year that UK Coal is considering re-opening Haworth colliery, in the village of Bircotes, 15 km south of Doncaster. This mine was mothballed 20 months previously, with 'geological problems' being cited as the cause, but even care and maintenance is expensive and last year it was marked for closure. All that changed with the doubling of world coal prices in the past year. The planned opening will not happen until seismic surveys and boreholes are completed, the company cautioned, but this could lead to an investment decision to re-open the mine. The last new mine to open was at Asfordby in Leicestershire 20 years ago, when the coal industry was still nationalised - and that pit was already being closed down (*Merciant, 1998*) by the time UK Coal bought the English coalfields in the 1994 privatisation. It is also reported that record coal prices have already encouraged UK Coal to invest £55m at Thoresby in Nottinghamshire and Kellingley in Yorkshire, extending the lives of those deep mines by a decade.

The company remains Britain's biggest producer of coal, despite falling output, but it supplies just 15% of the coal burned in Britain - while Russia, South Africa, Colombia and Indonesia account for most of the rest (*UK Government: figures for steam coal imports in 2006*). The concern for the security of supply is obviously very significant for government and consumers. One problem to further investment is that the three big customers - the electricity generators - signed fixed-price contracts with UK Coal, and are still buying cheaply. The company's average price last year was little more than half the market level and there are still 13M tonnes - 18 months' output - to supply under those contracts (*various reports, including the Daily Telegraph*).

## The Humber Stone - a misapprehension

Media reports (*Leicester Mercury and* BBC'*s East Midlands Today*) during April heralded the placement of an information board at the site of this large boulder, which is located near to the traffic island at the intersection of Thurmaston Lane and Sandhills Avenue (SK62410709), north Leicester. These reports correctly identified the stone as being a glacial erratic of Mountsorrel granodiorite, but fell into the trap of assuming that the stone was transported to its present site as a result of ice movement during the last glaciation, which ended only about 12,000 years ago. In fact, no ice reached here during this Last Ice Age - it stopped well short, in Derbyshire, Staffordshire and along the Norfolk coast. Instead, the erratic owed its journey to a much earlier and more widespread glaciation, which occurred about 420-440,000 years ago during the Anglian Stage of the Quaternary. Very good corroborating evidence for this is provided by the newly published BGS map of Leicester (Sheet 156, with Sheet Explanation). This shows that the Humber Stone lies squarely within an outcrop of Thrussington Till, a boulder clay deposited by an Anglian ice sheet that, originating as it did in the Pennines region, would have travelled across Mountsorrel, picking up the stone and dropping it in its present location about 10 km to the southeast.

*The Humber Stone. The trench surrounding this stone was constructed about the year 1900 - perhaps an early example of geological conservation in the East Midlands.*

## Another first for Charnwood Forest?

In this issue of *Mercian*, as in many others, deserved prominence has been given to the internationally important Precambrian fossils found in Charnwood Forest. The story behind their first recognition, by the then-schoolboy Roger Mason in 1957, has been recounted many times (Mercian 2007, p.280 for example). It was an event of tremendous importance globally, because it constituted the first find of large fossils in rocks that were conclusively of Precambrian age – in other parts of the world it had always been assumed that 'old' but undated rocks with fossils must be of Cambrian or Ordovician age.

If we examine the literature prior to Roger's discovery, we find that disc-like impressions in Charnwood Forest were occasionally mentioned, but were dismissed as being of inorganic origin. Recently, however, a very early reference, and the first to assign an organic origin to the discs, has been unearthed by Frank Ince, who brought it to the attention of Mike Howe, Chief Curator at the BGS. In 1868, a lecture on Charnwood Forest by R. A. Eskrigge (reported as an article in Transactions of the Manchester Geological Society, 7(5), 51-57) carried additional comments by a 'Mr J Plant'.

Plant stated that in April 1848, he and a colleague had 'discovered' on the rocks ring-like impressions, 6 to 12 inches [15-30 cm] in diameter, and had communicated this find to Professor A C Ramsay. The latter's opinion, as relayed by Plant, was that these circles originated where 'large seaweeds had been rooted, and probably by the action of the seaweed bending round by the force of the water, scooping out the mud in concentric circles'. Today this remains a most prescient conclusion, remarkably comparable to certain more recent suggestions. Although parts of the interpretation can be questioned, there seems little doubt that both Ramsay and Plant were convinced that these were the impressions of large, rooted organisms (modern seaweeds comprise several groups of multicellular algae, but also organisms of the kingdom Protista). Plant went on to say that no impressions of this type have been found in the 'Cambrians of North Wales', and here he may have been taking a sideways swipe at those who thought that the Charnian rocks were younger than Precambrian in age.

Unfortunately, we do not know the date of Ramsay's pronouncement, and it was presumably communicated in a letter or verbally, rather than being immediately published, but it probably occurred very shortly after 1848 and so could pre-date the accounts by Salter (1856) of organic impressions in Precambrian strata of the Long Mynd. If so, the Manchester article may document the earliest recognition of fossils in England's oldest rocks. In the communication, 'J Plant', stated that he had conducted '....many years careful exploration (in Charnwood Forest) before I came to Manchester'. This biographical note makes it fairly certain that the discoverer was John Plant rather than his brother, James, who also contributed on the geology of Charnwood Forest around that time.