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a short history of planet earth

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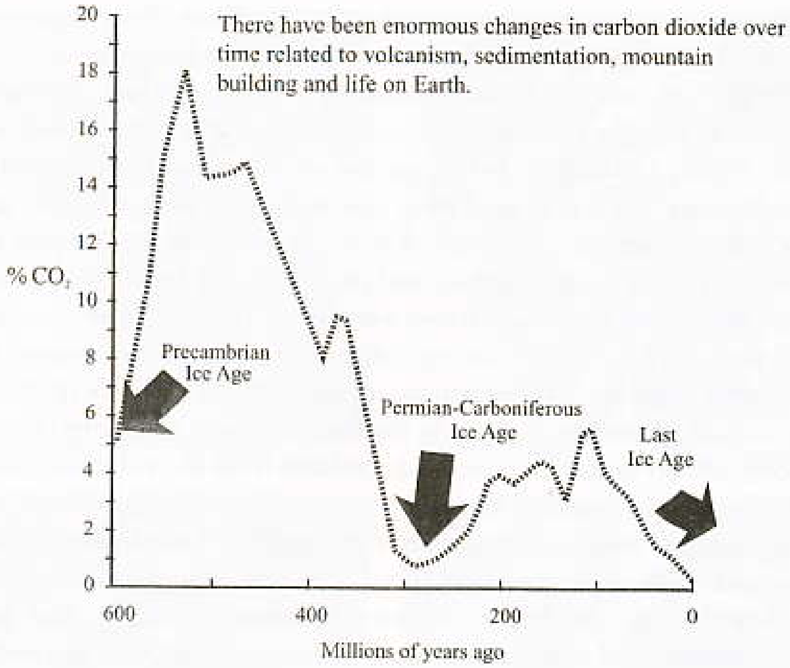
was joined to Antarctica and was close to the South Pole, warm high rainfall conditions existed and conifers, cycads and ferns thrived.

Atmospheric carbon dioxide was about 1 per cent when the world's major coal deposits formed in the period 320 to 250 million years ago. From 300 to 120 million years ago, the global carbon dioxide content varied greatly, increased over time and reached a peak of 6 per cent 120 million years ago. The peak of 6 per cent carbon dioxide was at a time of a protracted greenhouse and maximum sea level. At this time, mean annual surface temperatures were 10 to 15 °C warmer than now. This peak carbon dioxide content also coincides with accelerated sea floor spreading and continental fragmentation. Rifting (sea floor spreading, continental fragmentation) always involves a massive degassing of water vapour, carbon dioxide, helium and methane from the mantle.

During these greenhouse times, some 150 million years ago, the oxygen content rose again to a peak of 26 per cent. Some insects became giant and flighted vertebrates such as birds, bats and dinosaurs evolved to capitalise on the denser oxygen-rich atmosphere. The first bird, *Archaeopteryx*, and pterosaurs appeared during these times of elevated oxygen. As soon as the oxygen content of the atmosphere decreased, the giant insects became extinct as earlier giant insects had done once before, and birds modified their anatomy in order to keep flying. At the peak of these greenhouse times 150 million years ago, flowering plants appeared and filled a warm wet carbon dioxide- and insect-rich terrestrial ecosystems.

This was a time when the carbon dioxide content of the atmosphere rapidly decreased from 5 per cent to 3 per cent before bouncing back to a peak of 6 per cent. Planet Earth then experienced 100 million years with an atmosphere warmer and richer in oxygen and carbon dioxide than at the present time. Carbon dioxide was again extracted from the atmosphere into limey sediments and carbon-rich materials. Since the high atmospheric carbon dioxide levels of 120 million years ago, the carbon dioxide content has decreased from 6 per cent to almost 0.0365 per cent now. This long greenhouse came to an abrupt end with the onset of another icehouse 2 million years ago.

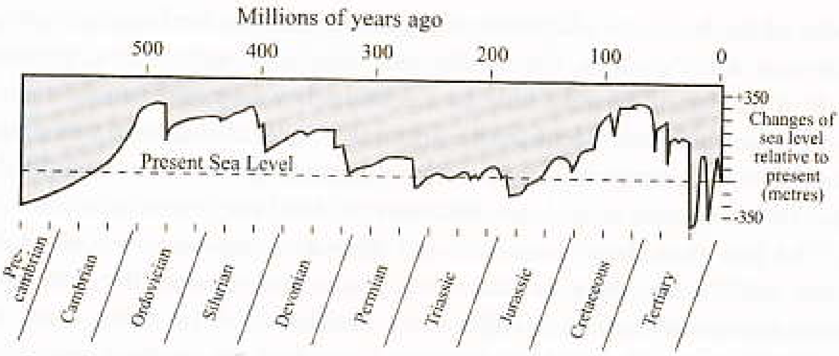
Some 143 million years ago, a minor mass extinction occurred and 42 per cent of all multicellular species disappeared. Again, this mass extinction is probably related to extraterrestrial visitors. A 340-kilometre-wide crater at Morokweng, Kalahari Desert, may be the smoking gun for this mass extinction. This is a huge crater and other smaller craters



There have been enormous changes in carbon dioxide over time related to volcanism, sedimentation, mountain building and life on Earth.

at this time suggest that Earth was again hit by a cluster of comets or meteorites. The 40-kilometre-wide Mjolnir crater in Russia, formed about 142 million years ago. There are also two impacts in Australia from this time. The 24-kilometre-wide crater at Gosses Bluff, Northern Territory, formed 142.5 million years ago and the 3-kilometre-wide Liverpool Crater in Arnhem Land, Northern Territory, has broken and shocked rock of a similar age. Gosses Bluff has a crater, broken rock, ejected rock, shocked minerals and glass formed from impact melting and is probably one of the best-preserved ancient impact sites in the world. Impacting by a swarm of meteorites or comets may have initiated the break up of continental Africa and the outpouring over a very short period of time of masses of lava in the Sudan.

A later impact occurred, this time in Queensland at Tookoonooka in the Eromanga Basin. A 55-kilometre-wide crater was blasted out 128 million years ago. Although the crater is now covered by a thick sequence of rocks, tell-tale signs of shattered and broken rock and of glass formed from the melting during impact. Elsewhere in the Eromanga Basin at Talundilly, a 30-kilometre-wide subsurface structure of the same age was detected during oil exploration and identified as an impact crater.



Over time, there have been huge changes in sea level related to continental movement, supercontinents, uplift, subsidence and glaciation.

As greenhouse conditions intensified, sea level rose to a maximum 115 to 110 million years ago. Australia, while still near the South Pole, was covered in a warm shallow inland sea and all that remained of the continental land mass was four low-lying islands. Tropical climates extended above the Arctic and Antarctic Circles. Extinct groups of shellfish, the ammonites and belemnites, lived in profusion in the shallow warm north-south sea throughout central Australia.

During the period of maximum sea level, much of the continent was covered with a blanket of shallow marine sediment, mainly mud, with rare layers of sand and silt. The muds are the opal dirt at Coober Pedy, White Cliffs and Lightning Ridge and they give us a good picture of what Australia was like at that time. At White Cliffs, the opal dirt contains shallow marine fossils of crinoids, lamellibrachs, brachiopods, foraminifera and cephalopods. These fossils are commonly opalised. Fossilised and opalised plesiosaurs and coniferous wood suggest a marine environment close to the shore. Ice-rafted boulders of quartzite occur in the opal dirt and derive from areas which outcrop to the west of White Cliffs. White Cliffs 115 million years ago was at a high latitude adjacent to quartzite mountains within which there were glaciers.

In parts of southern Victoria, the 122- to 113-million-year-old rocks show sedimentary structures which have derived from seasonally frozen ground similar to that which we see today in Siberia. Vegetation was ferny with rare flowering plants. At that time, southern Australia was at a high latitude, probably at 78° South, and the temperature calculated from isotope measurements indicates that the warmest month in southern Victoria was 15.6 to 21.4 °C and the coldest month was −32.3 to −23.9 °C. Dinosaur fossils in the same rock sequence have large optic