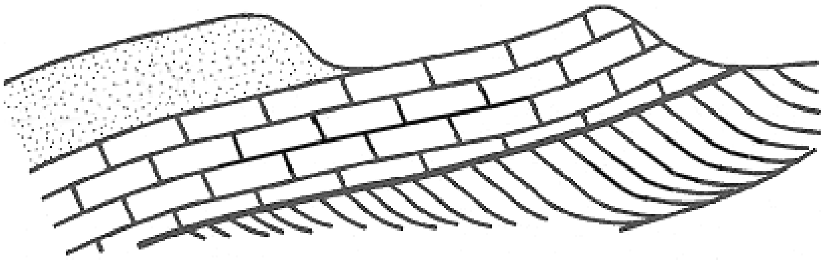
Farnham Geological Society

[**www.farnhamgeosoc.org.uk**]

Farnhamia farnhamensis



A local group within the GA

Vol. 8 No.2

Newsletter

June 2005

INSIDE THIS ISSUE

This edition has gone to press with few problems in filling the 12 pages, thanks to contributions from Judith Wilson on her Himalayan trip and from Jackie Young on a visit to Turkey. Additionally, our new committee member, Graham Williams, has written an article covering the first 4 billion years of our planet. This has been split into two parts: the first part, covering the Archean era, appears in this issue, and the second part, dealing with the Proterozoic era, will appear in the October newsletter.

An important step has been taken in widening the participation of members on field trips – hands-on geology – by the introduction of monthly day trips to places in Southern England. Graham Williams has put an immense amount of effort into planning these trips, which will cover the evolution of Southern England over the past 210 million years. The first trip on Sunday April 3rd was a tremendous success (helped by marvellous weather) during which Graham guided 25 of us from the chalk of the North Downs at Newlands Corner through the Wealden succession of Upper Greensand, Gault Clay and the various Lower Greensand beds finishing at the pub in Albury. Well done Graham! Further trips are programmed for the first Sunday of the month up to and including October. See page 2 for further details.

Finally, a party of 14 members visited the Isle of Arran at the end of April, and a report of this trip, with copious photographs, will appear in the October newsletter.

Peter Cotton

FGS monthly meetings and field trips - 2005

June 10	Dr Paul Craddock British Museum, London ***Early mining and extractive metallurgy***
July 8	***Members evening & presentations***
Aug 12	Summer break - no meeting
Sept 9	John Atkinson, Portsmouth Water Company ***Water supply with regard to Cretaceous strata'***
Oct 14	Dr Rex Taylor, School of Ocean & Earth Sciences, S'ton ***Volcanoes & volcanic processes along the Izu-Bonin arc***
Nov 4	**Society dinner at Farnham House Hotel**
Nov 11	Dr Christopher Green, Royal Holloway College ***Reconstructing Quaternary Rivers***
Dec 9	tba
Jan 13	Annual General Meeting 2006

Field Trips 2005

Various-First Sunday of month (April to October) 23-30 April: Isle of Arran 5 -9 September: Bideford

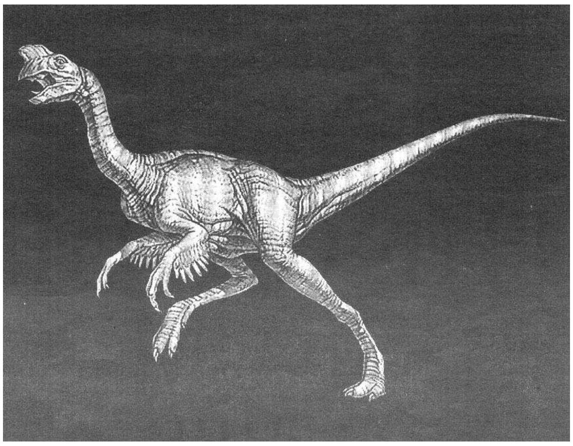
Note that due to lack of sufficient numbers, the proposed trip to Tunisia in September of this year has had to be cancelled. In its place, it is hoped to run a 4-night trip to study the geology of North Devon, staying at the Hallsannery Field Centre, near Bideford.

Graham Williams' one-day meetings on the first Sunday of the month, as mentioned in the Editorial, are as follows:

5 June:	Cotswolds	4 September:	Sussex
3 July:	Portland, Osmington and Kimeridge	2 October:	North Kent coast
7 August:	Hastings, Smokejacks		

Newspaper snippet - Do fossilised eggs prove this dinosaur cared for its young?

A fossilised dinosaur has been found in China with two pineapple-sized eggs, their shells intact, in its pelvic cavity. Scientists believe the discovery adds further weight to the theory that modern birds evolved from a group of feathered dinosaurs. The eggs are nearly 7ins in diameter and are of roughly equal size, suggesting they would probably have been laid at the same time unlike birds which lay single eggs at intervals. Finding a fossil with a pair of eggs ready for laying suggests that female reproduction in dinosaurs was at a stage somewhere between that of reptiles, such as crocodiles, which lay all their eggs at once, and birds. Tamaki Sato of the Canadian Museum of Nature in Ottawa, Ontario, and her colleagues describe the fossil in the journal *Science*. They say it sheds fresh light on the mystery of how dinosaurs reared their young.



Steve Connor, Science Editor, The Independent, Friday 15 April 2005

A trip to the Himalaya

On the arrival of the G.A. magazine in spring last year, a leaflet fell out entitled "*The Making of Mountains*," a geological trip in the Himalaya. I said to my non-geologist husband that I had found my summer holiday for this year expecting little response. His reaction was to tell me that I should go and when asked if he would come too, he said "*Yes*". The next day the form was in the post.

We set off on 1st August and arrived in Delhi with the monsoon which had been absent during July. Following one night in a very grand hotel we set off through the Delhi rush hour in traffic (see photo) like I have never seen before. There is an interesting article in the "*Lonely Planet*" travel guide which starts: "*Theoretically vehicles keep to the left….most vehicles keep to the middle….remember traffic coming from the left has priority, so does traffic from the right & also traffic in the middle.*"

Delhi is certainly a place I would not contemplate driving. The rain continued to deluge such that children were swimming in the puddles at the roadside. This continued overnight and we set off again in heavy rain to Kalka, for the toy train to take us to Shimla. This has an altitude of 2000m and is where the British Raj retreated to escape the heat of the plains in summer. As a result of the rain, the train journey took eight hours instead of five, though this was fortunate as we met some people who took the train the following day and had been stranded overnight for 15 hours. We also learned that one of the towns we had passed through on the way to the station had been totally cut off due to flooding shortly after we passed. There were some interesting sayings on the wall at some stations on the way: "*The Allah of Islam is the same as the God of Christians and the Iswar of Hindus*" and "*Tolerance to other faiths imparts to us a true understanding of our own*". Oh that more people could think like this.

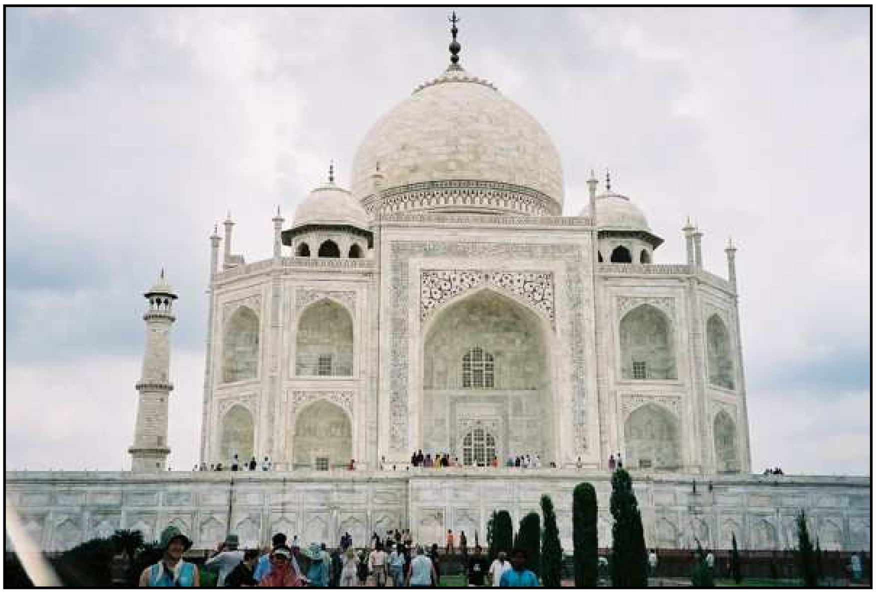
Another grand hotel in Shimla which the local monkey population had discovered. They were seen entering a window that one of the party had left open, to steal fruit left on a plate. Here, a visit to the Vice-Regal's palace had to be cancelled as a Bollywood movie was being filmed inside with India's top star. While in Shimla we heard that there had been a landslide caused by the rain, which was across the road which we were to take in a few days, making it impassable. The next part of our journey was through the foreland basin which is a feature produced due to the load of the mountain belt, depressing the crust in front of it. Sediments from the mountain belt are then deposited in the basin. Here, the sediments are known as the Siwaliks. Trace fossils were found and some debate ensued as to whether they were burrows or roots. The rocks were red in colour suggesting continental deposition. As the thrust sheet moved forward, these sediments were moved forward also.

From Shimla we travelled to Mandi and passed over the main boundary thrust into the lesser Himalaya. These are Indian crustal rocks containing no fossils and have proved difficult to date. The next stop was Naggar where we visited the Roerich museum and art gallery and in the afternoon travelled to Manali. The journey was through the Kullu valley where vast quantities of cannabis grows by the roadside, terraces were covered with peas, potatoes and apple orchards, a large box of which was bought for the coach costing very little.

On arrival in Manali, we heard that the landslide blocking the road to Keylong, which we assumed would be clear by the time we arrived, was not! This meant we would have to abandon our coach and climb over the landslide. Therefore, our Indian guide, who was worth his weight in gold, spent many hours, with little sleep, finding a replacement coach and also making contingency plans as some members of the group thought they may not be able to manage the climb. [see photos below] In the event, this turned into a team building exercise, the stronger walkers in the group taking time to help the less confident up the steep hill. Porters, walking in T-shirts and flip-flops, carried our luggage, wrapped in polythene to keep it dry. At the top, it was realised that both oxygen cylinders had leaked, which presented another problem for the guide as these were a necessity due to the high altitude to which we were travelling. Also at the top were queues of lorries, loaded with peas and halted by the landslide with many porters queuing to carry loads back down the hill. So many lorries were held up, which was in a way fortunate, as we met less on the narrow winding roads for the remaining journey. Our comfortable coach and friendly drivers were abandoned for a coach that was old, bumpy and smelled of exhaust fumes but was probably the only one available at short notice.

We were now in the higher Himalaya and travelled over the first high pass, stopping to take photos of the prayer flags and the long queues of lorries held up by the landslide and stretching for miles. The rocks here are metamorphic augen gneiss and garnet-mica schist. There were superb geomorphological features in abundance, roche-moutonee, retreating glaciers indicative of climate change, and incised alluvial planes evidence that the Himalaya is still rising. It was here I learned of a new dating technique—cosmogenic dating. High energy cosmic rays bombard elements exposed at the earth's surface. Their interaction with silicon and oxygen in quartz produce ^{14}Be and ^{26}Al. It is suggested that the quantity of these isotopes in a rock at the surface could be used to estimate the length of time these rocks had been at the surface. The dating technique could be used to date the rate a glacial outwash stream cuts down through the beds and can be used to estimate the rate of rise of the Himalayas. We arrived in Keylong for a two night stop to acclimatise to the altitude of 4,000m.

From Keylong we travelled to Sarchu which was to be the first night camping as there were no hotels at this height and it was here that some people showed the first signs of altitude sickness and were grateful that replacement oxygen had been obtained. The following day we were still within the higher Himalaya and it was noticeable that the lush green landscape had changed to an arid desert. The local rock is granite: one being 25Ma, a result of the Himalayan evolution and one of 50Ma, produced by the melting of the Indian plate.



The coach was replaced by 3 off 4x4 vehicles for the remainder of the journey, and the next day we passed over the South Tibetan Detachment Zone, which is a normal fault between the higher Himalaya and the Tibetan sedimentary series. These are rocks from Tethys before collision and Mesozoic ammonoids, molluscs and corals were found. Also to be seen were fantastic sedimentary structures known as fairy chimneys, a result of erosion. From there, on to the Indus suture zone which is the collision line between Asia and India. It is a line of weakness and thus is exploited by the modern Indus river.

The second nights' camp was at Tso Lar, at 4700m, and here a number of people had serious problems with the altitude. They therefore had to quickly reduce height which meant leaving the campsite, travelling over some rather bad roads [see photo above] and another pass in the dark to arrive at the next hotel at 2.00a.m. where they had considerable trouble gaining entry. Most roads had warning signs by the road, "*Someone is waiting for you, drive slow*," and "*Darling I want you but not so fast*." The remainder of the party joined them in Leh the following day. By now the Tibetan influence was evident with many prayer wheels, temples, monks and monasteries. From here we visited a number of Buddhist temples and monasteries and made a trip to the Kardang La pass, the highest motorable road in the world at 5,600m (allegedly). This road through the Trans Himalaya was through igneous plutons formed as a result of the subduction of Tethys. The rocks contained "blebs" which are apparently the result of the mixing of two magmas. We also visited a Tibetan refugee children's camp and a donation made form the trip's profits. The final geological site was the confluence of the Indus and Zanskar rivers where some well preserved sedimentary structures were seen.

We left Leh on an early morning flight, (no planes take off after 9.00a.m. due to the rarified atmosphere) after extensive checks and 3 body searches to return to Delhi and a drive round the city and a visit to Humayan's tomb. After a very early start on the final day, we made the trip to Agra to the Taj Mahal and also to Agra Fort.

The Taj Mahal [see photo above] was built by Shah Jehan, work starting in 1631 and taking 22 years. The Shah had 3 sons. The youngest killed his 2 elder brothers and wanted to kill his father also, so that he would inherit. In the event, he imprisoned his father for the reminder of his life in a castle a few miles away in a room from which he could see the Taj. After a final dinner we left Delhi at 2.00a.m. and on arrival at Heathrow discovered that a number of the party were quite unwell. Fortunately, both my husband and myself were unscathed by the various afflictions affecting many other people.

Judith Wilson

Planet Earth - First 4 billion years - Part 1: The Archean

We divide the history of the earth into two periods at about 540 million years. The earlier, Precambrian Eon covers the time from the formation of the planet (4600 my) until the mass appearance of hard shelled invertebrate animals. The succeeding period is the Phanerozoic Eon. The first 2100 my is referred to the Archean; the remainder of the Precambrian is called Proterozoic.

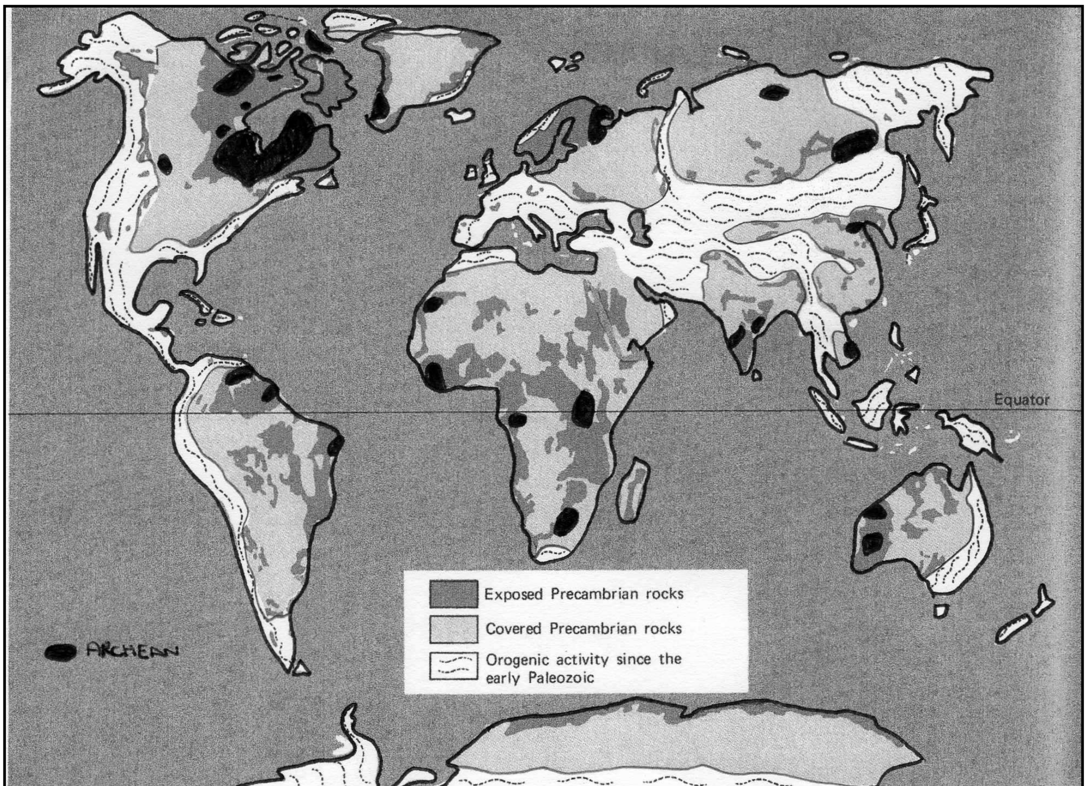


FIGURE 1 Distribution of Precambrian rocks in the modern world. Note that these rocks form or underlie most of the cratonic area of the modern world. (After A. M. Goodwin, in B. F. Windley [ed.], The Early Histor[y] of the Earth, John Wiley & Sons, Inc., New York, 1976.)

There is not much outcrop to examine (fig 1), and frequently it is severely deformed, metamorphosed or otherwise mistreated. Many of the best outcrops are in inhospitable areas which have been explored only in recent times such as Greenland, where Precambrian rocks are gradually being exposed by ice melt, the Australian outback and the remote, icy Canadian Arctic.

The Isua Supracrustal Group of SW Greenland includes the oldest dated rocks at about 3750 my. These severely metamorphosed sediments include carbonates; the measured date reflects the time of the metamorphism. This tells us three things, the original rocks, and therefore the planet, are older than 3750 **my,** their sedimentary nature suggests the presence of liquid water and the carbonate indicates carbon dioxide in the atmosphere.

Bits and pieces of evidence like this have enabled geologists to begin to understand the early evolution of the earth, the gradual development and accretion of tectonic plates, the formation of seas, the development of erosion and sedimentation, the origins of life, and the development and evolution of the atmosphere and the ozone shield which now protect us from solar radiation. Figure 2 summarises of some of these aspects.

So, how did the planet evolve? and what is the evidence? First, let's look at our.

Archean planet

Earth formed about 4600 my ago from a whirling cloud of dust, at the heart of which was the sun. How do we know the date? Stony and metallic meteorites from the solar system have been radiometrically dated by several decay systems (rubidium-strontium, potassium-argon, uranium-thorium). The results cluster around 4600 my.

Earth has a layered structure, from the core to the atmosphere, arranged according to density. This may mean that Earth accreted rapidly and consequently was molten; then, the heaviest material sank to the centre, and the lightest floated to the surface. Alternatively, Earth accreted solid components slowly, and upon reaching a certain size developed a molten interior; then gravitational collapse moved heavy elements to the earth's core; such contraction would release an enormous amount of energy, perhaps raising Earth's temperature by as much as 1 2000C. Under such conditions the mantle would liquify, and allow the layering we see to-day.

When Earth liquified, there was extensive degassing to the surface to form the primordial atmosphere. We see degassing to-day when volcanoes erupt - this gives us a clue as to the nature of the first atmosphere - mainly water vapour, hydrogen chloride, carbon monoxide, carbon dioxide and nitrogen = unpleasant! As the Earth cooled, the hot clouds of water vapour condensed to form rivers, lakes and oceans.

Earth was bombarded by meteorites during it's first 600 million years. Evidence for this comes from the Moon; no atmosphere means no weathering, therefore the oldest rocks are preserved. The large lunar craters have been dated from associated rocks, and they mostly fall within 4600 to 4000 my - and it seems that meteorite impacts were 1 000 times more frequent than now. Evidence on Earth has been destroyed by weathering, erosion, metamorphism and igneous activity.

As accretion decreased (ie, we were bombarded by fewer meteorites!) the surface cooled and solidified to form a thin crust. Heat flow from the molten core was greater than today, and as a consequence this thin crust was perturbed and fragmented into many small plates separated by numerous rifts and subduction zones. Constant subduction and remelting allowed further differentiation of the lightest minerals of the basaltic ("oceanic") crust and lithosphere to form granitic ("continental") crust.

The earliest granitic crust was present by about 4200 my. Evidence comes from zircon, which is extremely resistant to weathering and survives as grains in Archean sediments. It has been radiometrically dated as old as 4100 - 4200 my; it forms by metamorphism of felsic (granitic) rocks).

The earliest continents were small and thin. Seismic evidence demonstrates that surviving Archean cratons are thinner than Phanerozoic cratons. Most Archean sediments are deep water in nature; terrestrial and shallow marine sediments are rare; carbonates and evaporates are almost non-existent before the Proterozoic. All of this suggests there were no large continents during most of the Archean.

Surviving Archean terrains consist of pods of intensely metamorphosed "felsic" material (usually gneisses) separated by "greenstone" belts. The greenstone belts originated as ultramafic vacancies similar to those extruded to-day along volcanic arcs. Many have pillow lavas; this indicates underwater extrusion. There are also turbidite sediments. This association suggests a subduction zone.

Other Archean sediments include banded ironstones and conglomerates. Banded ironstones (alternating iron rich and chert layers) are widespread, but thin. Occasional coarse conglomerates have large rounded pebbles of felsic and greenstone origin; they lack any crossbedding structures, and appear to have been dumped by enormous turbidity flows.

To-day, typical Archean terrains consist of a number of small felsic protocontinents with numerous greenstone belts. Having originated along subduction zones, the greenstone belts were wedged between protocontinents that collided and became sutured. Given the small size of the protocontinents and the abundance of greenstone belts, subduction zones formed frequently and came to constitute a large proportion of Archean terrains.

Thus, by the end of the Archean, substantial continents had formed. The largest is in Swaziland (S Africa); basement is overlain by a widespread sedimentary sequence (about 3000 my) that appears to be of inter-tidal origin; this suggests a sizeable land mass. The overlying Witwatersrand sequence (2800-2500 my) covers 40,000 sq km, is 8km thick and consists of continental sediments indicative of braided streams which washed down huge quantities of sediments from the highlands across alluvial fans into lakes.

Was there life in the Archean?

Apatite containing carbonaceous material is present in the Isua banded iron formations of Greenland (pre 3750 my) - could this reflect a concentration of carbon by living organisms? The carbon is isotopically light (ratios 13C to 12C) the same as biological systems to-day.

In the Pilbara Shield of **NW** Australia (3500-3400 my) there are stromatolites - dome shaped mounds consisting of alternating layers of organic rich carbonate and pure carbonate. These mounds are formed by mats of thread like organisms called cyanobacteria (blue-green algae) at the margins of warm seas (as at Shark Bay, Western Australia, today) and may be metres in size. Stromatolites occur in several Archean cratons, but are not common; perhaps this reflects the rarity of Archean shallow marine environments.

Apart from stromatolites, at least six different types of filamentous cyanobacteria have been found preserved in cherts in Pilbara and Swaziland metasediments (3500-3400 my). Filaments identical with those of Pilbara and Swaziland exist today.

Bacteria and cyanobacteria (oxygen producing bacteria) are prokaryotic - primitive single celled organisms with no nucleus, and their DNA isn't clustered into discrete chromosomes. Eukaryotic cells characterised by nuclei and chromosomes (ie plants and animals) have not been found in the Archean.

Some prokaryotes derive energy from chemosynthesis: they convert sulphate compounds into sulphides by removing oxygen atoms, or they convert simple organic compounds, producing methane. Some prokaryotes (including purple and green bacteria) derive energy more efficiently via photosynthesis; this employs chlorophyll to transform sunlight into chemical energy to split water into hydrogen and oxygen; the hydrogen then combines with carbon dioxide to produce sugar, releasing oxygen as a waste product.

To-day, none of these bacteria can tolerate oxygen. Amino acids, the building blocks of Archean life, can't form in the presence of atmospheric oxygen; it prevents the growth of primitive living bacteria, including purple photosynthetic bacteria, and methane producing bacteria which live in stagnant ponds and swamps. The Archean bacteria could thrive because there was little oxygen in the Archean atmosphere.

Thus, by 3500 my substantial evolution had taken place, producing not only simple bacteria which fed directly upon the environment, but also advanced photosynthetic oxygen producing cyanobacteria which used sunlight energy to make food.

The evolution of the photosynthetic prokaryotes profoundly affected life on earth by liberating oxygen into the atmosphere (fig 2). Evidence from the Greenland Isua sediments suggests that the sunlight, water and carbon dioxide necessary for oxygenic photosynthesis were present before 3750 my; is this photosynthesis confirmed by the Isua banded iron formation?
How are banded iron formations deposited? They consist of alternating iron rich and chert layers. Submarine volcanic eruptions provided the iron and silica which dissolved in oceanic waters. The silica was precipitated as

chert. The iron rich layers are hematite - iron oxide. The hematite forms when iron dissolved in oceanic waters combines with molecular oxygen in the upper part of the water column; a rain of insoluble rusty particles fails to the ocean floor. The key point is - oxygen. Oxygen isn't released when rocks are heated, it didn't come from within the planet through volcanic degassing. The primary source of oxygen in the atmosphere is photosynthesis. Therefore, a banded iron formation suggests the presence of advanced photosynthetic cyanobacteria.

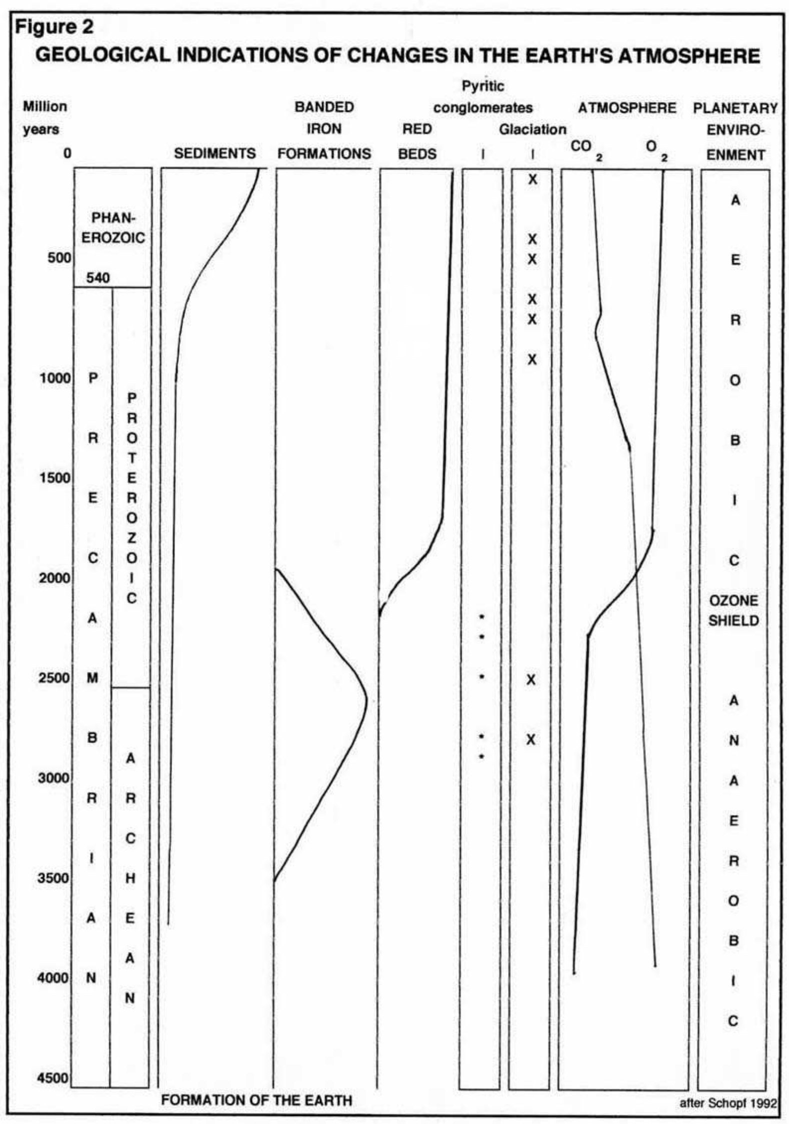


Figure 2
GEOLOGICAL INDICATIONS OF CHANGES IN THE EARTH'S ATMOSPHERE

The Isua banded iron formation is the oldest, deposited prior to 3750 my. There isn't much Isua ironstone, it is seriously metamorphosed, it is not considered conclusive evidence, but nevertheless - a tantalising thought!

After 3500 my, banded iron formations become extensive and thick reaching a peak about 2500 my before gradually disappearing about 2000 my in the early Proterozoic. They are found in Australia, China, India, Russia, N and S America. More ironstone requires more oxygen; it can be no coincidence that stromatolites become abundant through the same period, becoming particularly common around 3000 my.

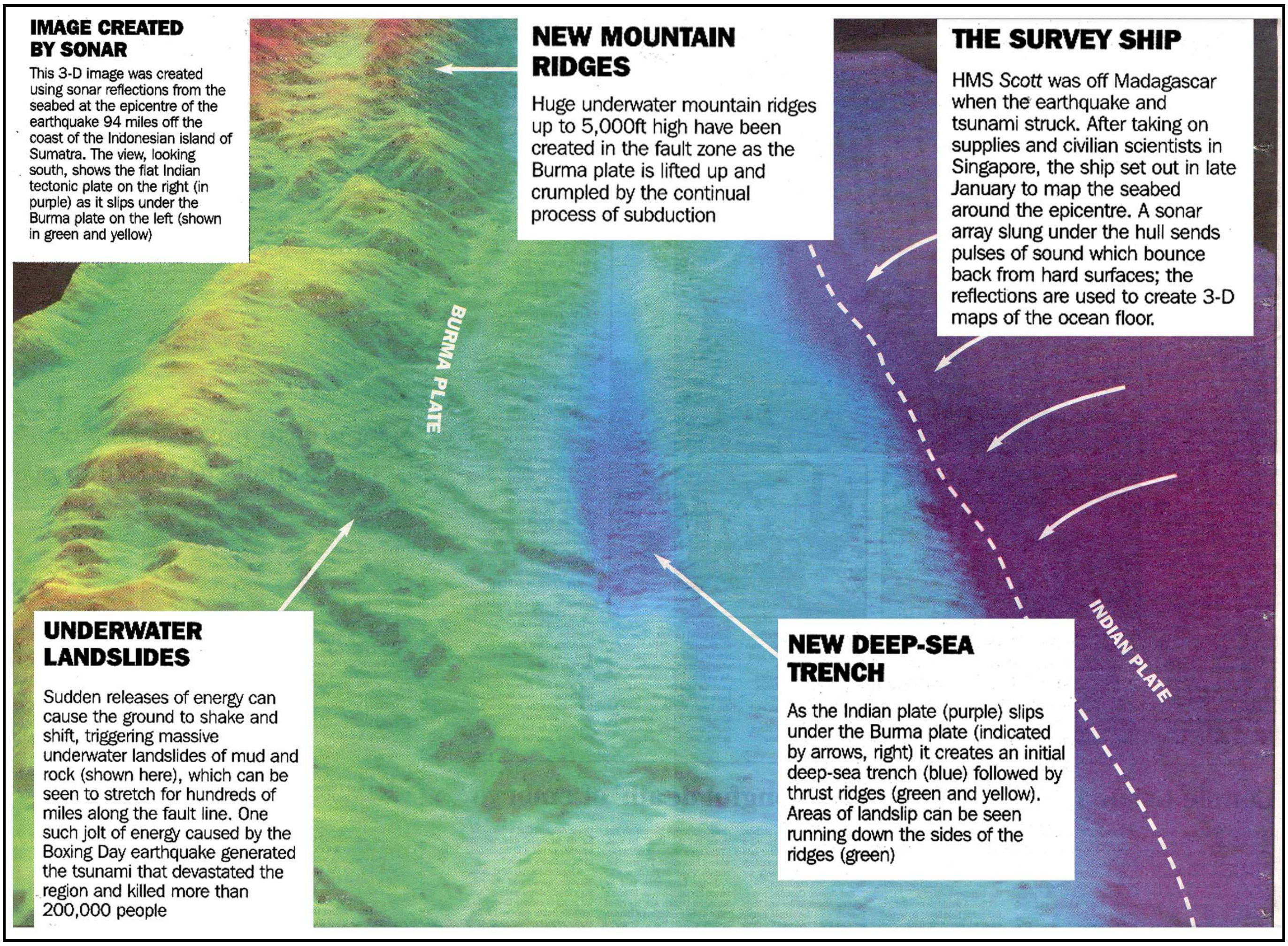
Did the planet's atmosphere suddenly change from anaerobic to aerobic, and able to support oxygen breathing life forms? Pyritic conglomerates provide a clue; they contain rounded grains of pyrite. Such deposits don't form any more. The pyrite comes from the weathering of granitic rocks, and is easily oxidised, dissolved and destroyed by reaction with molecular oxygen. The Archean pyritic conglomerates frequently include uraninite grains - a uranium rich mineral even more easily oxidised than pyrite. Therefore, the environment could not have contained large amounts of molecular oxygen when these rocks were deposited. After 2000 my these rock types no longer form - therefore, prior to 2000 my, the amount of oxygen in the earth's atmosphere must have been low.

Stromatolites plus banded iron formations versus pyritic conglomerates - the evidence seems contradictory! The cyanobacteria could provide oxygen to the water, which can be used up by the banded iron formations. As the stromatolites become increasingly abundant and widespread, so do the iron formations. Nevertheless some oxygen should leak to the atmosphere. Initially, much of this oxygen was lost through chemical reaction; oxygen plus hydrogen yields water, with methane and carbon monoxide yields carbon dioxide, and with hydrogen sulphide yields soluble sulphate. Some oxygen is scavenged by bacteria - a form of aerobic respiration. Volcanic gases still scavenge oxygen, and so do we, by breathing! However, by 2000 my virtually all of the iron dissolved in the oceans had been converted to banded iron formations, and this allowed oxygen to escape to the atmosphere in increasing volumes. At about the same time, red beds came into being. These are usually desert (not sub-aqueous) sediments; iron is only about 1% of the rock and occurs as iron oxide coatings on sediment particles. This indicates that, at last, substantial amounts of molecular oxygen were present in the atmosphere......... *To be continued*

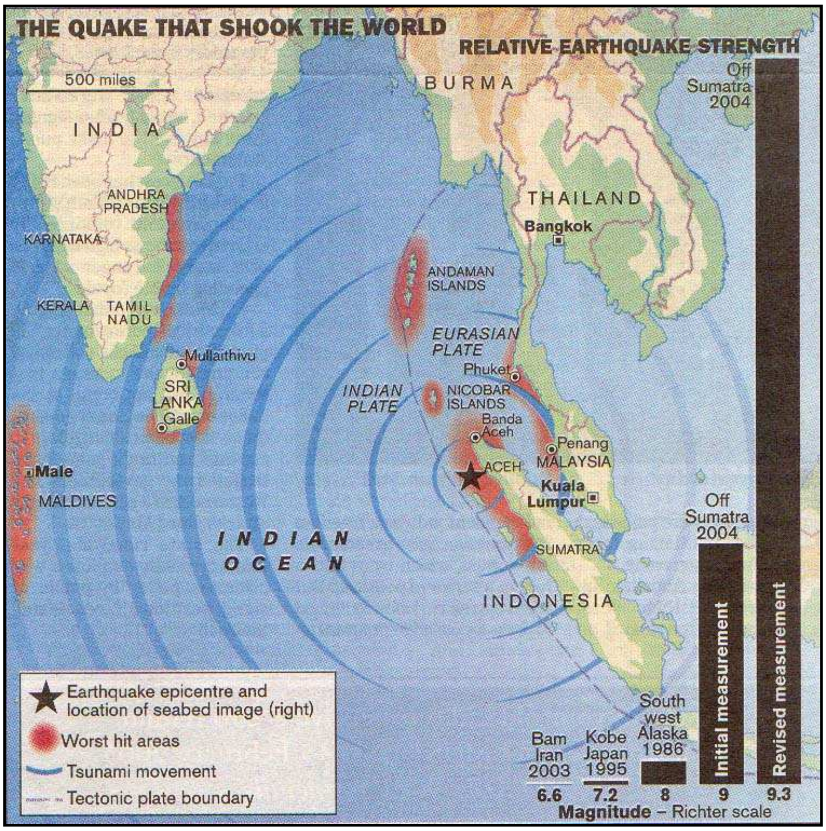
Graham Williams

Please note that Part 2 of Graham's article, describing the *Proterozoic*, will appear in the next edition of the Newsletter

Newspaper snippet: The undersea upheaval caused by the tsunami earthquake



The first underwater images of the seabed off Indonesia where an earthquake struck on Boxing Day show the colossal scale of the geological forces that sent a devastating tsunami across the Indian Ocean. Three-dimensional pictures taken by a sonar on the Royal Navy vessel *HMS Scott* reveal a ruptured sea floor of submarine canyons and mountains created by the movement of one tectonic plate beneath another at the rate of 2.4 inches a year. It was the sudden release of pressure built up over decades of tectonic movement that triggered the earthquake, which some geologists have re-evaluated as three times more powerful than previously thought.



Images released yesterday by the Navy show how the flat Indian tectonic plate (shown in purple) is slipping under or "sub- ducted" beneath the crumpled Burma plate (shown in green and yellow), which is being pushed up in the process. Steve Malcolm, commanding officer of *HMS Scott*, said the seabed at the earthquake epicentre looked like a "rumpled carpet" when viewed on the sonar screen. Data from the sonar is being analysed by the marine geologists Lisa McNeill and Tim Henstock of the Southampton Oceanography Centre. It is the first time the sea floor has been studied so intensely after such a large earthquake.

Dr Henstock said: "*There are features which we would think are something like the Grand Canyon would look. You can see huge piles of mud maybe a few hundred metres thick, there's a lot of evidence of activity at the subduction zone*." The scientists estimate some of the ridges are up to 5,000 ft high. Some of the ridges have collapsed to produce huge land- slides of mud and rock several miles long. Seismologists have calculated that the epicentre of the earthquake was some 25 miles below the sea floor. They initially registered it as 9.0 on the Richter scale. But, seismologists from Northwestern University in Evanston, Illinois have recalculated the earthquake as 9.3, which would make it three times larger - because the scale is logarithmic - and the second-largest recorded earthquake. Seth Stein, who reanalysed the seismograms, said: "*The rupture zone was much larger than previously thought. The initial calculations that it was a 9.0 earthquake did not take into account what we call slow slip, where the fault delineated by aftershocks, shifted more slowly. It was the forces generated by the quake that lifted huge volumes of water. The additional energy released by the slow slip along the 745- mile long fault played a key role in generating the tsunami*."

Dave Long of the British Geological Survey, said that an early-warning system in the Indian Ocean would give better protection against a tsunami caused by an earthquake. "*A tsunami warning system simply tells you the earthquake had happened and that a tsunami is going to come through later. The advantage of this sort of information is that we can model in advance, if we have a certain type of earth-quake, what might happen*."

Steve Connor, Science Editor, Independent, 10 February 2005

Geological trip to Lycia, Southern Turkey

In September 2004 we were delighted to fulfil our wish to visit Southern Turkey. We travelled with a Geo/History Group led by Dr Jill Eyers of the High Wycombe Geo Group. Having taken note of the advert on the FGS Board, well placed by Shirley Stephens, we contacted Jill and booked our places for the trip. Came the day of departure, we were pleased to meet up with Jill and 20 other members of the group at Gatwick Airport. After a smooth flight we landed at Dalaman and boarded the coach for the drive to our hotel in Olu Deniz in the Bay of Fethiye. From the moment of our arrival we realised we were in a veritable geologists paradise. Crossing the Dalaman Plain a great range of limestone mountains came into view. These mountains, called the Baba Dag Range, with Mount Cragus being the high point, run steeply down to the sea to one side of the bay in which our hotel was situated. The other side of the bay is enclosed by a rounder shape of red peridotite hills, which gives the area a feeling of being in a large cove and well protected from invasions in past centuries.

The next morning, our group found themselves picking their way across the blisteringly hot rocky beach, not to swim in the warm sea but to explore the 'Thrust' forming part of the Lycian nappe. A mantle of peridotite, formed at great depth beneath the crust, had been thrust up and over the limestone. Rock samples were collected. In the afternoon we did get our swim, in the lovely pool at the hotel which was situated very close to the cliff face.

The following day after an early start we set out for Fethiye, in the comfort of our air-conditioned coach, to visit the peridotite hills we had seen in the distance, with Mount Charles as the highest point. Here we were introduced to a chromite ore quarry, still actively mined. The gravel is crushed and graded into separate piles ready for transportation to the factory for exportation. Chromite is, of course, used in many manufacturing processes including paint and chromium plating. These high quality podiform deposits were formed in the magma chambers by crystallisation millions of years ago. After the heat of the quarry we were glad of a break for apple tea in the nearby village of Uzumlu. Here, we sat alongside the local menfolk playing draughts in the morning sunshine. Their wives were at home, weaving on ancient looms, to provide an income from the colourful shawls and tablecloths they sold to passing visitors. On our return journey we passed beautifully carved rock tombs high up in the rock face (see photo below). These were used for sarcophagus burials, dating from around 500 BC, for well-bred Lycian gentry.

The next day our tour took us to the Dalyan river delta for a fascinating cruise, on our privately hired local boat, through the reed beds to the thermal springs, discovered by the Romans. Refreshed by a soak in the hot mineral-water pool we climbed up to the ruins of Kaunos, originally a Hellenistic Greek settlement, later occupied by the Romans, with added amphitheatre and forum. Sailing deeper into the delta, we finally stopped to explore the vast sandbank, now the protected 'nesting' place for local turtles, which come in great numbers, in the season, to lay their eggs at night.

Perhaps our most exciting day was the visit to Pammukkale. Up and out on the coach before dawn for the long journey inland, with a stop for breakfast at a roadside café, we finally reached our destination and realised the beauty of this special terrain. The name of Pammukkale means 'Cotton castles'. The travertine cliffs gleamed white in the morning sun for miles in each direction (see photo below). Once again the Romans had established a city there, called Hierapolis, but even in Hellenistic time the Greeks also knew of the curative powers of the mineral deposits and created a settlement in 1850 BC. Since that time, even to the present day, the calcium, sodium-bicarbonate deposits mixed with sulphur have given rise to the spa baths for curing all manner of ailments. There is even a mention of these springs in the Bible. Known as the 'City of Hera', sacred at first, then a Holy City for pilgrims in Byzantine times, these travertine terraces held pools of minerals of differing hues according to their properties. Currently, the Tourists come to wander across the terraces and bathe in the man-made Spa Pool waters, surrounded by idyllic foliage displays and ancient Roman columns. A sight to be behold indeed!

The following day, back on the seashore, in rough surf, we boarded a well-furnished cruise boat to view the cliffs from the seaward side. The rose colour of the peridotite cliffs became more apparent when reflected in the clear, vivid blue copper-saturated sea, which was pleasantly warm for swimming. The mouth of an inland, fresh-water stream was suddenly discovered, by a shout from one of the group, and we experienced the icy cold water pouring out from a crevice in the cliff-side. Our boat eventually reached Nicholas Island, reputedly where the 4th Century Saint from Myra, a Byzantine community, had come ashore. We were able to climb the limestone crags to visit the small stone churches dedicated to this Saint. After much collecting of rock samples, to compare with others previously gathered, the day ended with a 'picnic' on board and a very 'wet' disembarkation on return to the beach of Olu Deniz.

Another exciting day was spent walking through the Saklikent Gorge in the Ak Daglari mountains, which rise up to 3000 metres high. Wading through the cold river along the rough floor of the limestone canyon, the 100 metre cliffs narrow to a boulder-strewn scramble. However, we were rewarded with finds of rudist fossils of 'Cornetto' shape bivalves.

Our last day was spent in Olu Deniz with the now familiar view of the limestone cliff-top of Baba Dag. Some of our group members took the ultimate adventure, to sky-dive from the top of the mountain. From the top could be seen the ‘Thrust’ formed by the collision of the African and Eurasian plates and the closure of the Tethys ocean, 58 ma. Thus was formed the Lycian Nappe of Southern Turkey. The skydiving geologists were well pleased with their view over the mountaintop and the whole group agreed the week-long adventure as rewarding in all aspects. We recommend this region of Lycia for further exploration.

Jackie and Harold Young

Landslides, landslide dams and dams for hydro-electricity in the Italian alps

Summary of the Society's January 2005 lecture given by Prof. Eddie Bromhead, Kingston University

Professor Bromhead spoke from a detailed personal knowledge of this area in the Italian Alps describing the villages, river systems and mountain-sides where major natural disasters as well as continuing problems with man-made structures have occurred. He distinguished between mud-slides, where flows of material from Dolomite cliffs on to the Triassic San Cassiano formation of red marls, created shallow mud-slides, and rock and debris flow down the rivers. These latter slides could produce dramatic effect on settlements close to the river. At some point in the valleys, dams would be created by the material flows and behind these dams lakes would form. Later landslides down the cliff-sides into these lakes raised the level of the water and created alternative channels for the overflow.

A lot of effort has been devoted by engineers to minimise the damage caused by landslides including setting up remote-controlled stations in armoured sheds to discover the source area of new landslides. Also, new channels have been built to take excessive flows and to make it easier for the debris to move downstream by water injection. A further factor in creating landslides is the continuing rise of the Alpine mountains and their subsequent erosion.

Many hydro-electric schemes have been built using dams on main river valleys as well as a series of dams on side tributaries. Many of these schemes have not been successful but the Italian engineers continue to see the economic advantages of hydro-electric generation as justifying the risks.

Peter Cotton

The RSPB Farnham Heath project

Summary of the Society's February 2005 lecture given by Mike Coates, Chief Warden, Farnham Heath

Mike Coates began his talk by reminding the audience that, although there had been a significant amount of opposition to the RSPB project of felling a large number of trees in the Lower Bourne-Tilford parishes, it had to be recognised that these were commercial plantations which would have been felled anyway at some time. It was the intention to leave areas unfelled and in particular deciduous trees would be left standing. He furthermore stressed the importance of leaving deadwood since this provided the habitat for many species of insects which in turn offered a food supply for birds and other animals.

Mike then went on to outline the main purpose of this RSPB project which was to re-create a greater area of lowland heath which had been decimated in Surrey and East Hampshire by the change from a peasant agricultural scene to one where their use of the heathlands for grazing, turf collection, thatching and broomsquire materials came to an end. In addition, of course, the growth of towns and villages used up considerable areas of lowland heath. The lowland heath countryside with its predominance of heather, both short and tall, was the favoured habitat for a variety of birds and lizards , snakes and butterflies. Slides were shown of three types of birds whose numbers had declined dramatically and which it was hoped would re-establish themselves in breeding communities; the Dartford Warbler, Woodlark, and Nightjar were the three species shown.

Referring to the soil of the heathland this was very acidic since it was essentially resting on Lower Greensand Folkestone Beds. However, there was a considerable quantity of air-borne nitrogen fertiliser which, unfortunately, helped in the growth of bracken which had to be kept under control. It was also noted that as part of the clearance programme much brash was produced which was most effectively dealt with by burning; this itself resulted in the creation of further nitrogen fallout. In creating conditions for the re-growth of heather it was noted that heather seed was extremely resilient and could lie dormant in the soil for up to 100 years.

Peter Cotton