Farnham Geological Society

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

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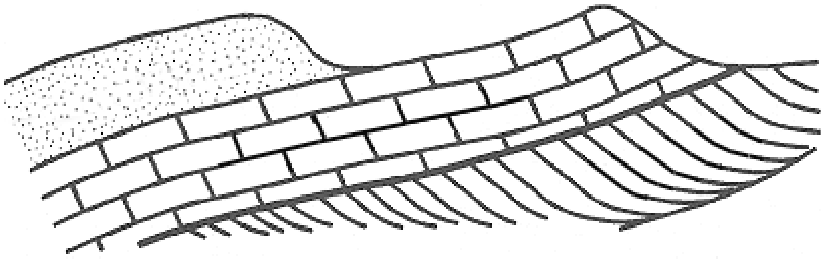

A local group within the GA

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Editorial

Having recorded the historic moment of Peter Luckham's 40th Anniversary with the FGS, and as Treasurer for almost all of that time, I thought it would be good to show him receiving his award from the Society, presented by Graham Williams at the AGM. An amazing record of service to the Society – very well done Peter and very many congratulations - again.

As always the newsletter focuses on reports of the Society, particularly of the meetings and field trips, but in this newsletter, several talkers failed to provide a summary and I have not received sufficient details from members on the Jersey Field Trip to allow publication in June. Consequently, I have included several items which members have provided on various topics of interest to them and which I hope will be of interest to most members. I have also included a summary of the meteor strike, which hit Russia and made the news this year and of details of three volcanic cones on Mars. I am consistently amazed at the clarity of the images, which come from the probes which are circling the planets of our solar system.

The October issue of the Newsletter will include details of the Jersey Field Trip in great detail.

An archaeological addendum to the field trip to Ivinghoe and Coombs – Sept 2012

We visited the Iron Age hillfort at Ivinghoe Beacon, and remarked that part of the ancient "Icknield Way" long distance trackway lay along the ridge. A parallel track also runs along the spring line at the foot of the chalk, and it may be that these were summer and winter routes. It is thought that this is the oldest known trackway in England. Barrows and mounds line the route in places. A Roman road, Icknield Street does not follow this track; it joins modern day Gloucester and York.

Around 1250 AD the Icknield Way was depicted on a map by Matthew Paris, extending from Salisbury to Bury St Edmunds, Suffolk. Later researchers found evidence of a route from Exeter to destinations on the east coast such as Icklingham, Suffolk and Hunstanton, Norfolk. En route the track passes not far from Stonehenge, and in places it meanders as one might expect, avoiding difficult topography, with some detours perhaps to known settlements. It also passes through the area of extensive Neolithic flint mines known as Grimes Graves in Norfolk. It seemed then that this ancient route ended at The Wash, where there may have been sea routes available.

However, another ancient trackway known as "High Street" has been traced from north of the Wash northwards across the country as far as the R. Humber. It is now known that in Neolithic times (from around 5th or 4th millennia BC in Atlantic Europe) sea levels were lower than today, and The Wash would have been fordable, so it seems possible that the Icknield Way may have originally continued right across the country from the south west at least to the R. Humber in the north east.

Using early records, the late Dr Ernest Rudge (1894-1984) walked a section at a time along what he judged to be an ancient trackway marked by conglomerate boulders. Many of these he identified as "pudding stone." This trackway meandered across the country also linking the two prehistoric sites of Stonehenge and Grimes Graves. The route was not as direct as the Icknield Way, and detours included a number of ancient village and church sites including St Albans, already an established settlement in the Iron Age, with origins possibly earlier. Itinerant traders might have travelled in an irregular pattern from settlement to settlement, trading and seeking food and shelter. Sadly many of the recorded boulders have now disappeared, or are buried beneath modern roads and housing estates. Dr. Rudge's work, The Lost Trackway was recorded in a publication produced by the Pudding Stone Study Group in 1994.

A number of modern roads follow sections of the Icknield Way, e.g. the A505 from Baldock to Royston, where it crosses the Roman road Ermine Street. There is also a great deal of evidence in other parts of Britain that people were using routes such as the Icknield Way thousands of years before the Conquest.

Joan Prosser

The British Geological Survey

The British Geological Survey's website provides very useful information for the amateur geologist. The *BGS Geology of Britain Viewer* is a particularly useful tool should you need a geological map for an area within the UK. It can be found on:

http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html

The web-site can be accessed either via your computer, tablet or your smart-phone, and enables you to explore the bedrock geology and superficial deposits for the whole of the UK. You can "pan and zoom" a geological map in order to find a particular area, and you can search for a specific location by place name or postcode.

The geological map is overlain on a base map, and there are various street map and satellite image options available, including the 1815 William Smith map. The street map option is particularly useful for the geology of built-up areas, as you can adjust the transparency of the overlay.

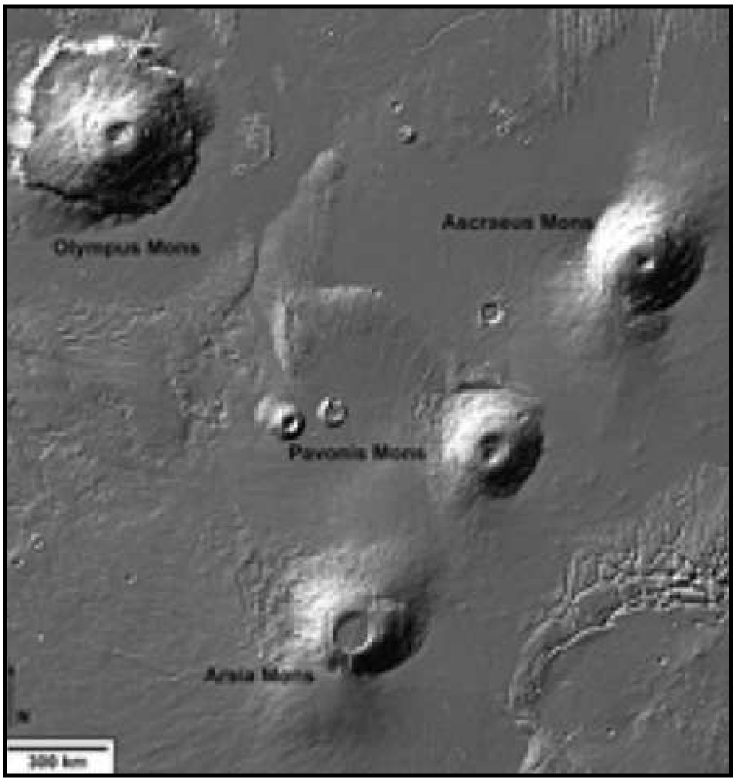
Click on a particular point on the map, and the underlying rock Formation with a brief description is revealed. You can even access a description of the superficial deposits above the bedrock geology. A "further details" link takes you to the relevant page of the BGS Lexicon of Named Rock Units. This lexicon provides details of all the Rock Formations in the British Isles, including Age, Lithological Description, definitions of the lower and upper boundary of the Formation, thickness, geographical limits, any previous names the Formation may have had, a list of type and reference sections for the Formation and a list of references where you can find out more.

Graham Williams

Mars – its volcanic history

A combination of data acquired from NASA's Mars Reconnaissance orbiter and gravity mapping by the Mars Express show that the lava in the Tharsis bulge has become denser with time and that the thickness of Mars's rigid outer layers varies across the Tharsis region. The bulge includes Mount Olympus (the tallest volcano in the Solar System - 21km high) and the Tharsis Montes (three evenly spaced smaller volcanoes, lying along a line). The image below of the Tharsis Montes trio and Olympus Mons is taken from the ESA webpage and included here to assist the reader understand the research and interpretations.

These volcanoes represent a long period of volcanic activity, which continued until 100-250 Ma. The three peaks are interpreted to vary in age with Arsia Mons being the oldest, Pavonis Mons. the next oldest and Ascraeus Mons being the youngest. Their sequential formation is thought to be due to a hot mantle plume or 'lava lamp' moving sideways beneath the surface, creating the row of peaks, and not, that the crust moved (as a plate) over a static lava plume.



The Tharsis Montes volcanoes

Variations in the density of the rocks were calculated from the deviations in the trajectory of the Mars Express as it passed across the region and the results have proved to be compatible with density measurements determined from Martian meteorites collected on Earth.

The data show that the lava density changed during the formation of the three Tharsis Montes volcanoes; initial andesitic lavas are overlain by heavier, basaltic, lavas which form the present crust. However, the density of the surface and youngest lavas in Ascraeus Mons, is interpreted have a lower density.

The outermost shell of the planet is interpreted to show lateral variations in density, particularly between Olympus Mons and the Tharsis Montes. The latter have a root of higher density rocks (possibly dense pockets of solidified lava or ancient magma chambers) than Olympus Mons. It is suggested that Olympus Mons developed on a rigid lithosphere, whilst the other volcanoes partially sank into a less rigid lithosphere, in turn suggesting that there were significant variations in the heat flux from the mantle whilst the volcanoes were forming.

The results are proving to be fundamental to interpreting the evolution of Mars and the European Space Agency (ESA) are keen to acquire simultaneous measurements of seismic activity from multiple small landers in order to increase their observations and understanding of the planet's formation.

Compiled from ESA reports of work by Mikael Beuthe and Veronique Dehant, both of the Royal Observatory of Belgium (authors of a paper published in the Journal of Geophysical Research) and Olivier Witasse of the ESA Mars Express Project.

For full article and further images, see: "*Density and lithospheric thickness of the Tharsis Province from MEX MaRS and MRO gravity data*," by M. Beuthe et al. is published in the Journal of Geophysical Research, vol. 117, E04002, doi:10.1029/2011JE003976.

http://www.esa.int/export/esaSC/SEM6HJNW91H_index_0.html

Mass grave in London reveals how volcano caused global catastrophe

Summary of article seen in the Guardian Sunday 5 August 2012

Archaeologists discovered thousands of medieval skeletons in a mass burial pit in east London in the 1990s and assumed they were 14th-century victims of the Black Death or the Great Famine of 1315-17. The search for the source of a disaster that wiped out almost a third of Londoners in 1258 has taken a different tack and there is now a more explosive explanation – their deaths were the result of a cataclysmic volcano that had erupted thousands of miles away in the tropics.

Scientific evidence, including radiocarbon dating of the bones (Radiocarbon dating gave dates of ca. 1250) and geological data from across the globe, shows for the first time that mass fatalities in the 13th century were caused by one of the largest volcanic eruptions of the past 10,000 years.

Such was the size of the eruption that its sulphurous gases would have released a stratospheric aerosol veil or dry fog that blocked out sunlight, altered atmospheric circulation patterns and cooled the Earth's surface. It caused crops to wither, bringing famine, pestilence and death.

The Icelandic volcano of 2010 (Eyjafjallajokull), which spewed out ash which disrupted flights for a few days, was miniscule in comparison.

Mass deaths are recorded in contemporary accounts. In 1258, a monk reported: *"The north wind prevailed for several months… scarcely a small rare flower or shooting germ appeared, whence the hope of harvest was uncertain... Innumerable multitudes of poor people died, and their bodies were found lying all about swollen from want… Nor did those who had homes dare to harbour the sick and dying, for fear of infection… The pestilence was immense – insufferable; it attacked the poor particularly. In London alone 15,000 of the poor perished; in England and elsewhere thousands died."*

The explanation at the time was probably assumed to be a punishment from God. London's population at the time was around 50,000, so the loss of 15,000 would have radically changed the city.

The volcano's exact location has yet to be established. Mexico, Ecuador and Indonesia are the most likely areas, according to volcanologists, who found evidence in ice cores from the northern hemisphere and Antarctic and within a thick layer of ash from Lake Malawi sediments. The ice core sulphate concentration shows that it was up to eight times higher than Indonesia's Krakatoa eruption of 1883, one of the most catastrophic in history.

Some 10,500 medieval skeletons were found at Spitalfields market, the site of the Augustinian priory and hospital of St Mary Spital, and the remains suggest there may have been as many as 18,000. The excavation between 1991 and 2007 by the Museum of London Archaeology (Mola) was the largest ever archaeological investigation in the capital. It was a member of that team, osteologist Don Walker, who discovered the link with a volcano. The findings will be revealed in Mola's report, to be published on Monday.

"That was a eureka moment," he told the Observer. *"These people living in medieval London would have had no idea that this global event – one of the largest volcanic eruptions of the Holocene, which is the last 10,000 years, and certainly the largest of the last millennium – was causing the problems."*

He now believes that mass burials in medieval pits across Britain and Europe might also have been caused by the same disaster. Documentary evidence in 1257-58 references *"heavy rains"* and *"a failure of the crops; …a famine ensued… many thousand persons perished"*. Specific diseases of malnutrition – scurvy and rickets – were also found among some skeletons, although malnutrition would not have been the sole cause of death during famine. Many would have suffered hunger-induced diseases, such as dysentery, and diseases which are more a product of social disruption caused by famine, such as typhoid fever.

He discovered that volcanologists had been trying to locate the site of this massive volcano. He said: *"What is new is linking the cause of the deaths of so many thousands to this volcano. No-one has linked it to archaeological evidence – and specifically to these mass burial pits. Documentary evidence is not necessarily reliable, whereas now we've got physical evidence."*

Volcanologist Bill McGuire (Professor of Geophysical and Climate Hazards at University College London) said: *"Volcanoes have a very long reach because they can impact climate…They don't just affect people nearby."* He cited an Icelandic eruption in 1783 which produced a sulphurous cloud that hung over Europe for nearly a year, affecting air quality and causing thousands of deaths.

The 13th-century eruption was far bigger, he said. *"This was the biggest eruption in historic times. It may have brought the temperatures down by 4°C, a huge amount. Because it was somewhere in the tropics it meant that the winds of both hemispheres were able to carry these gases right across the planet. If you have a volcanic eruption at high latitudes, then the gases will stay in the northern hemisphere. But if you have an equatorial or tropical eruption that's big enough, then the sulphur gases can spread into both hemispheres and really encircle the whole planet in a sulphurous veil."*

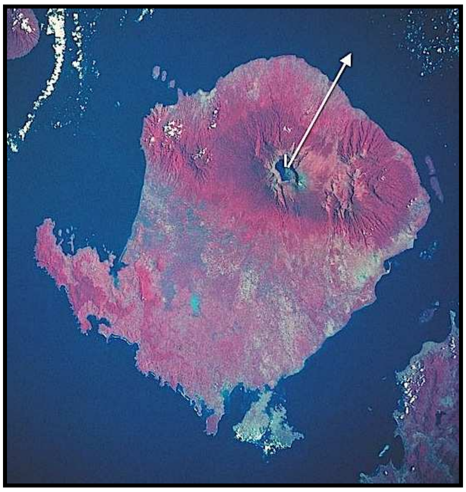
Asked whether another such volcanic eruption is due, McGuire said: *"It's been pretty quiet for a while. I'm looking forward to something big."* Only a volcanologist would take that view.

Barry Eade

Editor's comments:

Investigating for suitable eruptions, it appears that ice cores from Greenland and Antarctica from 13th Century contain huge amounts of sulphur, indicating that a 'significant' eruption had occurred and historical records and other evidence show that the planet cooled soon thereafter.

Franck Lavigne of Panthéon-Sorbonne University's Laboratory of Physical Geography in Meudon, France, showed data and close-up photographs of one volcano at an American Geophysical Union conference in 2012, saying "*We have new and solid evidence for the biggest volcanic eruption in 7,000 years*" and "*We think the eruption may have been in the late spring or summer of 1257*", but he would not name the volcano, until the work was published and I cannot find any published clarification.



Rinjani (arrow points ca N) cone ca 15 x 30 km and caldera ca. 3km; VE7; caldera created 1258.

Quilotoa cone ca 20km across and caldera ca 3km; VE 6; caldera created 1280

ElChichon cone ca 10km across and caldera ca 1km; VE 5 in 1982 v sulphurous eruption; also erupted 1340 +/- 150.

Delegates at the conference thought the pictures were from Indonesia and one volcanologist speculated that they might be the Rinjani volcano on the island of Lombok, which is known to have erupted in ca. 1258. The explosions were extremely large (VE 7), creating a massive caldera and gases and ash would have circled the earth and the tephra covered a large area.

Other possible volcanoes, responsible for the 1258 eruption, include El Chichón in Mexico (VE 5 in recent 1982 eruption), and Quilotoa in Ecuador (VE6 in 1280), however the chemistry of the deposits from these volcanoes do not match well with the sulphur from the 1258 ice cores, whereas the data supplied by Lavigne from his mystery volcano were very close.

All three volcanoes are shown above, Rinjani, El Chichón and Quilotoa - one of these is the probable source of the 13th Century disaster which effected London, amongst many other towns across the

Dinosaurs and art through the ages

Summary of December 2012 lecture given by Prof. Dick Moody, Kingston University

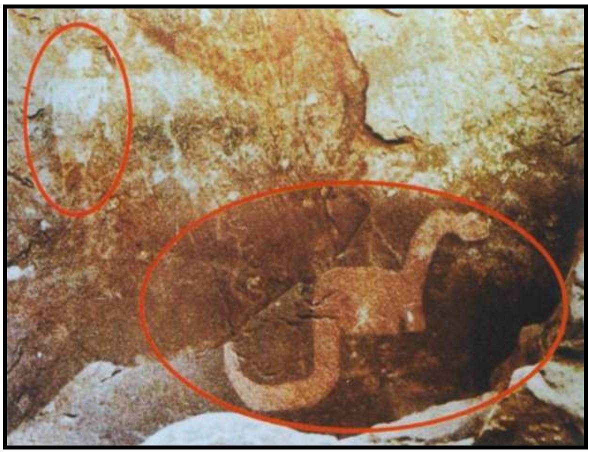
Provocatively the first slide of this presentation showed a dinosaur petroglyph painted on the wall of a cave occupied by the American Anasazi Indians who lived in Utah between 150BC to 1200AD: the message from the outset being that artists, including graphitists, can greatly influence the evolving world of vertebrate palaeontology.

The body of the talk spanned the relationship of art and dinosaurs from the classical sketches and lithographs by Henri De La Beche and a number of artists depicting lectures by Buckland and the discovery of Iguanodon in the Tilgate Forest. As the number of discoveries increased so did the various pieces of art - from scale drawings to reconstructions of gigantic reptile set in essentially hadian backgrounds.

Most of the creatures were drawn as huge, four-legged, heavily scaled creatures a far cry from the agile creatures painted today. Mantell’s first sketch was a ‘lizard with a very long tail’ with a horn on its nose. Interpretive works by Goodrich (1859), and Schubert (1886) began to show dinosaurs in their environments and the colourful work of Schubert must have contributed greatly to the fascination of the great beasts worldwide.

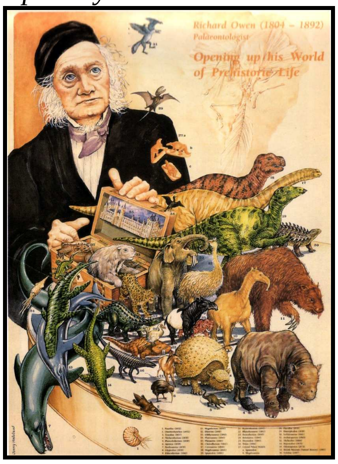
The trend towards more realistic artwork took place in the late 19th century with the beautiful paintings of Charles Knight reflecting the discovery of dozens of new species in the American outback.

The role of women in paleontology and art was also most evident in the early work of Mary Mantell (1795-18690 for her husband and of Cecilia Beaux (1855-1942) ‘America’s most famous’ portrait painter for Edward Drinker Cope and the Woodward sisters in London during the early part of the 20th Century.

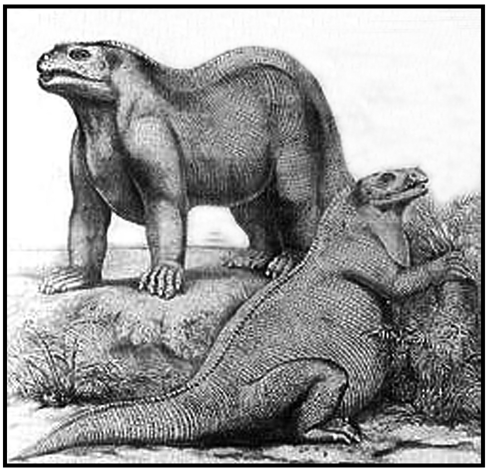


Petroglyph of a dinosaur painted on the wall of a cave occupied by American Anasazi Indians.

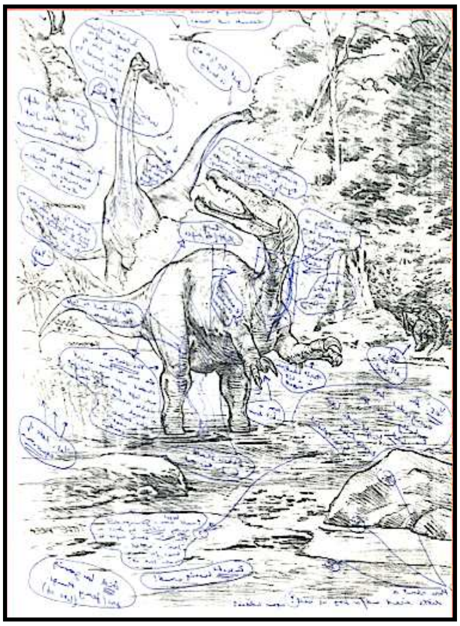
Statues of Iguanodon, by Benjamin Waterhouse Hawkins



Richard Owen, often remembered for using the word Dinosauria (Terrible Reptile or "Fearfully Great Reptile").



Reconstruction by Samuel Griswold Goodrich from Illustrated Natural History of the Animal Kingdom 1859



Baryonyx - finalised landscape image by John Sibbick

Great artists such as Burian and Neave Parker helped bring dinosaurs to life to the public at large and the age of dinosaur books was upon us. Dinosaurs also became part of life in the home and at school with the advent of the Brooke Bond Dinosaur Tea Cards in 1970.

By the middle of the 1900's dinosaur art had adopted the trend of detail and mannerism and the artwork literally moved across the page. The discovery of agile fast running creatures such as the raptors and feathered dinosaurs resulted in a revolution in terms of vertebrate palaeobiology and an avalanche of new wondrously skilled artists – who work within a holistic environment established in modern science.

The geology of East Greenland and Svalbard

Summary of April 2013 lecture given by James Cresswell, GeoWorld Travel – abridged by Liz Aston

East Greenland has rocks as old as 3Ga and an almost complete sedimentary record from 1.6Ga to the present. Many of the Earth history's most important stories can be told in the rocks here. From towering 1 km high stripy cliffs, to fossils that link fish to amphibians, with a complete succession of Jurassic ammonites, to dinosaurs and columnar basalt, East Greenland has much to offer.

Svalbard, while not as spectacular, is also somewhat of a Mecca for Geologists. It has rocks representing virtually every period from the Cambrian to the present and shares a similar geological history to the UK, however due to the sparseness of the vegetation; the exposures are very visible making the geology incredibly easy to see.

Greenland is a huge country and 80% is covered by ice, up to 3.4km thick, but the ice-free area is almost twice the size of the UK, is generally sparsely vegetated, leaving the rocks exposed. The area of East Greenland around Scoresby Sund, Kong Oscar and Kejser Franz Joseph Fjords is the largest ice-free area in Greenland. Its geology comprises basement rocks (3Ga), an almost complete sedimentary record over the last 1.6Ga and huge volumes of flood basalts from the splitting of the Atlantic.

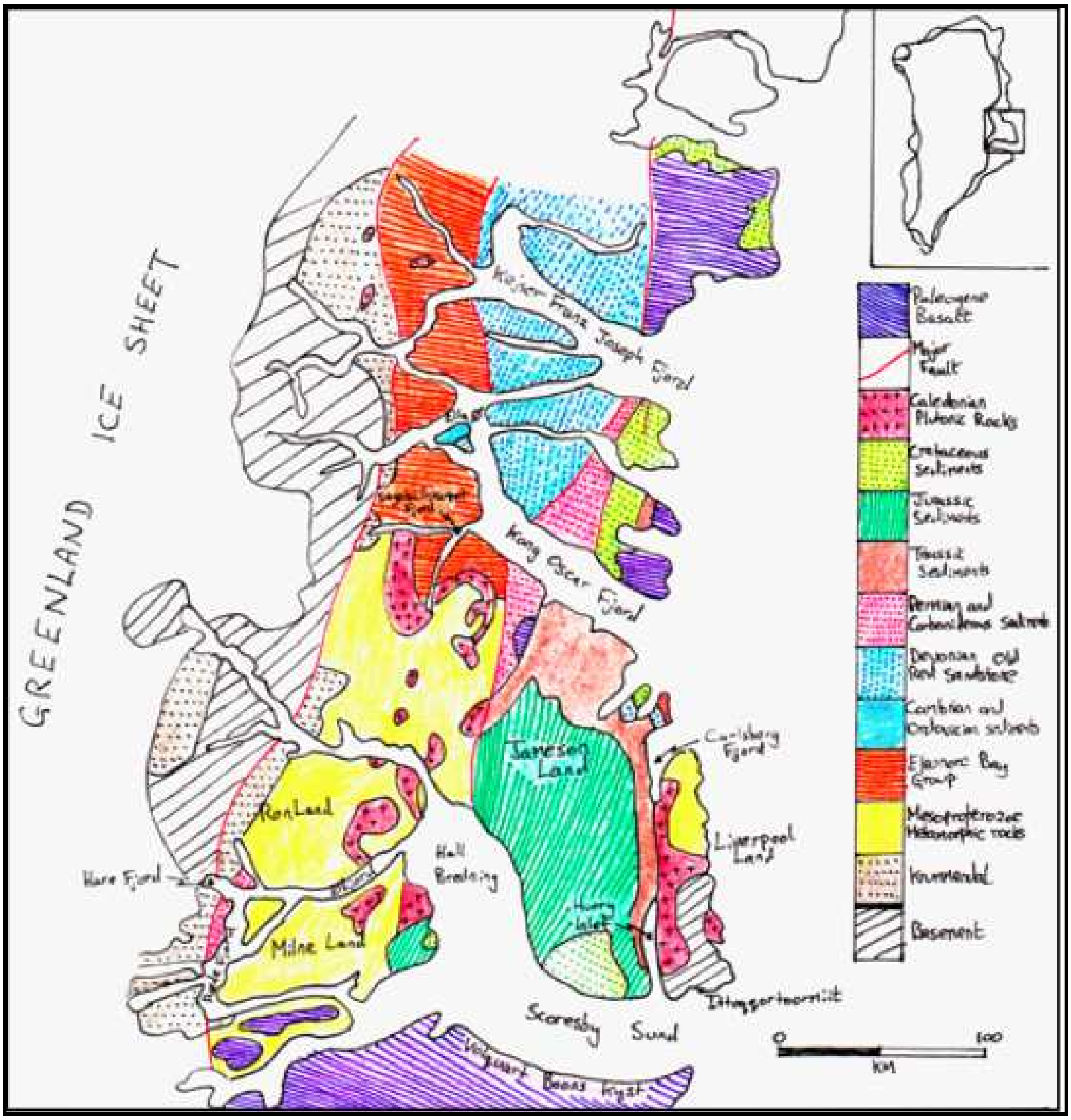


Fig 1: (Above) A simplified geological map of East Greenland

The oldest rocks are the 3.8Ga Isua Complex, situated in West Greenland, near the capital Nuuk; the Earth's oldest, most well-preserved sedimentary and volcanic rocks, with carbon particles that most likely originate from the oldest known life on the planet.

The basement complex comprises gneisses and associated rocks spanning 3.8 - 1.75Ga. By 2.7Ga, most of West, East and South Greenland had formed and were probably part of an ancient continent referred to as Kenorland, which split up at 2Ga and parts of West Greenland rifted apart, only to come back together 200Ma later. The final stages of basement building occurred from 1.8 - 1.725Ga, when Greenland was part of another supercontinent referred to as Columbia. These youngest basement rocks are seen in South Greenland.

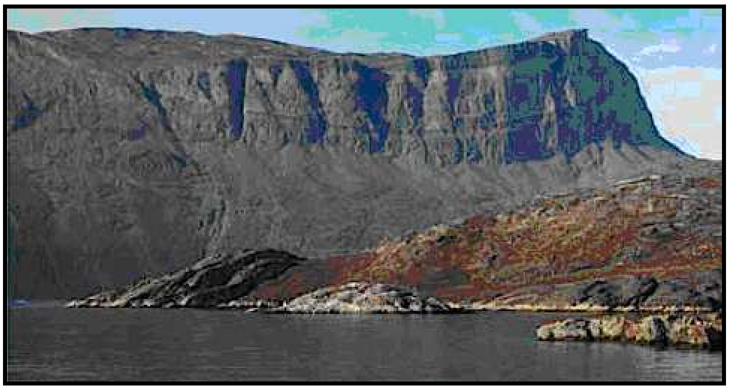


Fig. 2: Basement metamorphic rocks thrust over Krummedal Rocks in Hare Fjord

The basement rocks of East Greenland (approx 3 Ga) are covered by younger (1Ga) sedimentary rocks, the Krummedal supra crustal sequence, deposited within 50Ma, in a deep ocean environment after the breakup of Columbia. The sequence, up to 8.5km thick, forms a great thrust sheet that has travelled westwards over the basement rocks and is often heavily metamorphosed (Fig. 2). Further continental collisions gave rise to yet another supercontinent named Rodinia, which existed from 1.1Ga to 750Ma and igneous rocks (430 to 400Ma) have been intruded into the older rocks during the Caledonian mountain building phase (Fig. 3).

With the supercontinent of Rodinia established, sedimentation began on Greenland's eastern margin. The scale of this sedimentation was vast. A staggering 18.5km thick succession of sediments was continuously laid down from 900 to 450Ma. Tillites from the Vendian, ca 600 – 542Ma are from the period when there is thought to have been a global glaciation, a 'Snowball Earth'. It is thought this global glaciation was caused by the breakup of the super continent Rodinia. The tillites are overlain by Cambrian and Ordovician sediments, deposited within the Iapetus Ocean, which formed between East Greenland and Europe as Rodinia split apart, these rocks are very fossiliferous.

Fig. 3: Caledonian intrusion of hypersthene monzonite (within red line) into Krummedal Rocks, metamorphosed 900Ma in the building of Rodinia. The photograph was taken in Øfjord.

The next stage in the story of East Greenland is the final closing of the Iapetus Ocean, about 420Ma, which thrust up a mountain chain running from Svalbard, along the coasts of Norway and Greenland, through the UK and into Canada and the USA (all joined together at this time). The force of this collision caused older sediments of East Greenland to be folded and thrust up in great sheets over the basement. Erosion of these mountains allowed deposition of 10km continental sandstones of Devonian, Carboniferous and lower Permian age. The Devonian sandstone of East Greenland is very fossiliferous and over 10,000 fish fossils have been recovered, allowing the evolution of amphibians to be traced from fish, with some fossils having both fish and amphibian characteristics.

By the Carboniferous and Permian, the most recent supercontinent, Pangaea, had come into existence and rivers continued to deposit red sediments. These have been cut by dolerite dykes intruded during the rifting of the Atlantic; at this time, the Jameson Land graben developed, forming a basin, which later filled with sediments.

In the late Permian, East Greenland was covered by a shallow sea that eventually retreated, leaving semi-arid Triassic continents and one of the richest locations for Triassic plant fossils. Remains of the dinosaur Plateosaurus and early mammals have also been found.

During the Jurassic, Pangaea began to split and a shallow sea flooded East Greenland, resulting in a 55Ma continuous sequence of marine sediments full of ammonites. The whole of the Jurassic is preserved, and 60 distinct ammonite zones indentified together with marine reptiles, such as plesiosaurs and ichthyosaurs.

Marine sedimentation continued into the Cretaceous and, by ca 50Ma, Europe began rifting away from Greenland to form what is the present day Atlantic Ocean and huge volumes of lava erupted in East Greenland. The layers of lava are up to 10km thick in places and stretch for many thousands of square kilometres offshore.

The Geological Association and its Local Groups

What does being a Geologists' Association (GA) Local Group mean for Farnham GS members? The Geologists' Association (GA) is strongly committed to encouraging "Geology for All", and caters particularly for the amateur geologist. The GA has served the interests of both professional and amateur geologists, as well as making geology available to a wider public, since 1858. The GA is the national organization; it is based in London and is represented by Local Groups in 16 centres around the country, including Farnham; there are 73 other geologically related societies that are Affiliated Groups.

The objects of the GA are:-

- To promote the study of Geology and its allied sciences by holding Ordinary Meetings for the purpose of hearing lectures and encouraging discussion among Members, and by arranging Field Meetings.
- To extend knowledge of the science by publications, by the maintenance of a library, and by such other means as the Council may from time to time determine.
- To promote interest in Geology at all levels of knowledge.
- To promote awareness of our geological heritage.

All of these objectives are actively pursued. Monthly Meetings are held in London with talks from distinguished geologists, and an extensive programme of Field Meetings is maintained throughout the year in the UK and abroad. An Annual Festival and Reunion brings the GA together with Local Groups and Affiliates. An annual conference and other regional meetings are held around the country each year. Geological research is encouraged by the publication of a scientific journal, The Proceedings of the Geologists' Association, and supported financially, notably from the Curry Fund of the GA, which assists geological conservation projects and the dissemination of geological interest to the wider public. The interests of children are provided for through Rockwatch, the junior club of the GA. A series of excellent field trip guides enables the independent geologist to explore geology all over the UK.

As a GA Local Group, Farnham GS members can participate in all GA activities including lecture meetings and field trips. Also, Farnham GS can benefit from financial support in aid of geological investigations, publications, conservation activities, and to support regional meetings that involve other nearby groups (such as our 40th Anniversary meeting in 2010). GA publications are available to Farnham members at a discounted rate.

The GA provides Farnham with their newsletter (usually found on the desk at our evening meetings) which discusses interesting geological topics and lists the talks and field trips of the GA and of Local Groups and Affiliates around the country. Farnham members can participate in other Groups' and Affiliates' activities, but it is always polite to call the organisation in advance in case they have a restriction on numbers; after all, one's own members always come first.

Graham Williams is the Society's GA representative and "information hub" between Farnham and the GA. Graham has been on the GA Council for many years, served as Vice-President, and has been the GA's Treasurer since 2009.

The GA website is: www.geologistsassociation.org.uk . You can link to the GA via our own website.

Graham and Susan Williams

Dam and blast

Summary of January 2013 lecture given by Derek Jerram, Member FGS

The talk began with a description of the Vaiont Dam disaster. This is a double-arched dam, 262m high, situated in the Italian Dolomites about 100km north of Venice. In October 1963 a portion of the valley side, consisting of a block about 2km long by 1.6km wide by 150m thick, slid into the reservoir. This was due to the shear strength of the Lias clay, which, interbedded with the dolomitic limestone, was reduced by the penetration of the impounded water, and the dip being towards the reservoir. The resulting tidal wave was huge and overtopped the dam by more than 100m, causing five villages below the dam to be destroyed, with great loss of life. Miraculously the dam survived.

The speaker then described how he became involved in the promotion during the 1970s of Carsington Reservoir, a new water resource for the Severn Trent Water Authority, working for a consulting engineer appointed by STWA. This reservoir is in the middle of Derbyshire, close to the National Stone Centre visited by a FGS trip in

2011. It was required for the regulation of the River Derwent, from which supplies to Derby and Nottingham are abstracted. Water is pumped from the river through a tunnel for storage in the reservoir during times of high flow, and released from the reservoir through the tunnel to maintain the river flow during dry periods. The reservoir is sited on Carboniferous limestone, overlain by Millstone Grit, which in turn is succeeded by Triassic shales and mudstones with Boulder Clay at the surface.

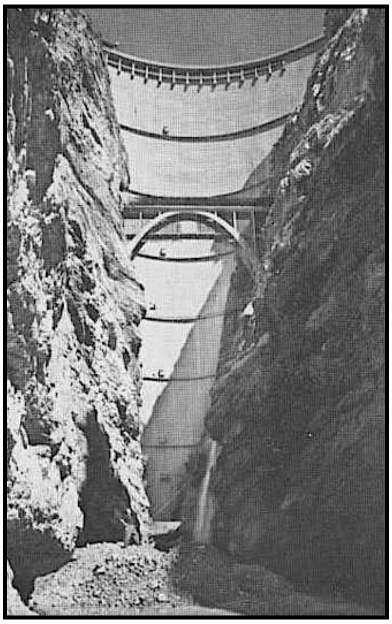
The first public inquiry was for the purpose of obtaining access for a site investigation. The second public inquiry was for the scheme itself, which was rejected by the inspector because of opposition from the Derbyshire County Council. The council did not oppose the scheme as such but the proposal to open up two disused quarries in the outcrop of the Millstone Grit, close to, but above, the new shoreline, on the grounds that they had enough quarries in Derbyshire and didn't want any more. The rock was to be used in the shoulders of the dam, which is of the earthfill kind. The third public inquiry was held into a revised proposal to quarry shale from the valley floor, to be used instead of rock. This revised scheme received ministerial approval.

The outline design of the dam was basically traditional, being a design that had been used successfully over many years. It had a central core of puddle clay, as employed by the canal builders, surrounded by fine shale and then the shoulders of compacted shale. Sand blankets in the shoulders were required in order to drain the shale fill to keep the piezometric pressures under control, so as to maintain the stability of the fill.

When the minister signed the order giving the scheme the go-ahead, the final design and supervision of construction were given to someone else and the speaker left the firm of consultants to work in Ethiopia. After returning, he learned from the national news that on 1st June 1984 the Carsington dam had collapsed. No-one fingered his collar, and it was by chance many years later that he learned of what had taken place from an engineering geologist who had been involved in the post mortem and the fourth public inquiry into the disaster. The original outline design prepared for the public inquiry had been altered, causing a slip circle to be formed in the section, which probably led to the failure. Also, instead of sand for the sand blankets, crushed limestone from a local quarry had been used, and its deterioration during construction could have impaired its drainage properties, which might have contributed to the failure. Although virtually complete, the dam had not reached the stage where water had been impounded, consequently there was no loss of life.

The instruments for the piezometers built into the fill to measure the water pressure were installed in chambers in the dam shoulders. These instruments had to be read on a regular basis during construction in order to ensure that the pressure was under control: on one occasion four men died in a chamber from suffocation by carbon dioxide given off from the crushed limestone.

Carsington Reservoir Today



Vajont Dam as constructed

The collapse of the Bilberry dam in 1852, and of Dale Dyke in 1864, both in the Yorkshire Pennines, were described. Both resulted in extensive loss of life and of property. The Bilberry failure was caused by the dam having been built over a spring. The reason why Dale Dyke collapsed was never determined because there was no inquiry, but almost certainly it was overtopped by the occurrence right on cue of a storm exactly as predicted by Admiral Fitzroy, captain of the Beagle on Darwin's voyage, and later the first weather forecaster. It was not however until 1930 that the Reservoir Safety Provisions Act came into force as a result of these disasters, which required all reservoirs above a certain capacity to be designed and supervised by an engineer belonging to a panel constituted under the act, which is why the STWA appointed the consultant for the Carsington scheme.

The talk concluded with reference to the most famous dam disaster of them all, during May 1942. This was Operation Chastise, otherwise known as The Dambusters.

By the vote of thanks the speaker believed he had been praised by faint dams.

Derek Jerram was a Chartered Engineer and a Chartered Arbitrator. He began work in 1950, was a water engineer for many years and then worked as a consultant representing clients in construction disputes in this country and abroad, mainly in the oil and gas industries. He has written many papers and articles on legal matters connected with dam construction

Sally & Charles - memories

The Society and its members are diminished by the losses published in the Obituaries of the February Newsletter. We were enhanced by their presence.

I am able to report that one field trip will live long in the memories of those who participated, mainly thanks to one couple, Sally and Charles. We set off for North Wales, with a leader I will not name as I do not want him to feel embarrassed, although I can mention that he was renowned for his imaginative choice of accommodation. First stop was Hereford, where we awoke to find the coach on fire. Then on to Barmouth, where the members were segregated in suitably Presbyterian fashion by the single females being placed in one hotel, the single males in another and the couples in a third, called Harley's. This was distinguished by having a motor-cycle theme. The parents ran the bar well into the night, otherwise the hotel (I use the word Hotel with hesitation) was under the supervision of an assortment of 12 year-old girls, whose duties included caring for the baby who joined us for breakfast. This meal was on a help yourself basis, if you could find it, or one of the girls could be persuaded to go to the local supermarket to provide for example a jar of marmalade. I cannot speak for what happened at supper, since we were not sufficiently adventurous to find out.

One morning we emerged for breakfast to find Sally downstairs, supported by several members of the group, helpless with laughter. She and Charles had a collapsible shower in their room, and the shower had collapsed with Charles inside it. Sally's description is unsuitable for publication in this rather staid Newsletter.. Charles too was a character, albeit rather quiet as an antidote to Sally. He flew over The Hump, in the war against the Japanese. Sally, Charles, Barmouth and Harley's are names that will be linked for ever.

Derek Jerram

Virtual fossils: soft bodied sensations from the Silurian

Summary of March 2013 lecture given by Prof. Derek Siveter, University of Oxford

My research in the last 15 or more years has focused on the faunas of the Herefordshire (Silurian; UK) and the Chengjiang (Cambrian; Yunnan Province, China) exceptional preservation horizons (Konservat-Lagerstätten), the first of these forming the subject of tonight's lecture. Lagerstätten are fossiliferous deposits showing exceptional preservation, often including soft tissues, and usually considered to be the result of burial in an anoxic environment which delays decomposition.

The Herefordshire Lagerstätte is a unique fossil deposit of Silurian age (about 425 Ma). The millimetre to centimetre scale fossils are preserved in a volcanic ash deposited in an outer shelf/upper slope position in the Anglo-Welsh Basin. They are remarkable in that not only biomineralized shells are preserved, but also soft-bodied invertebrates, spectacularly preserved in the round. Soft-bodied fossils belonging to the earlier Cambrian Period, from deposits such as the Burgess Shale in North America or the Chengjiang exceptional preservation horizon in Yunnan Province, China, have been highly significant for our understanding of the early evolution of animal life and the spectacular diversification of it known as the 'Cambrian Explosion' event. However, soft-bodied faunas from the Silurian are largely unknown, and the Herefordshire fauna provides us with a previously unavailable window onto a community from a time some 100 Ma after the 'Cambrian Explosion' event.

Soft-bodied fossils are usually compressed to two dimensions, and must be reconstructed artistically to an approximation of their original form. The unusual three-dimensional nature of the soft-bodied Herefordshire fossils, in contrast, has enabled an innovative and more direct approach. Digital images of the specimens are obtained, which are then combined by computer to reconstruct the animal in minute detail as a three-dimensional virtual model that can be examined interactively on screen. These models thus enable the fauna to be studied through 'virtual palaeontology', and the computer reconstruction can even be turned into a physical model through rapid prototyping technologies.

The oldest galaxy?

Scientist Garth Illingworth, professor of astronomy and astrophysics at the University of California, analyzing the Hubble telescope’s images, has recently discovered what he believes to be a small galaxy of blue stars, and which he believes to be the oldest object in the universe discovered to date - a galaxy dating back to 13.2 Ga, some 500Ma after the Big Bang. This ancient galaxy shows as an extremely faint, blue object with numerous stars being formed within it and is interpreted as a compact galaxy of blue stars, an object significantly smaller than the Milky Way.

He has also found some 50 galaxies which date back to 13.05 Ga; this increase in the number of galaxies represents a ten-fold increase in the rate of star birth during that 150Ma period, a short period in cosmic terms, and suggests that the birth of stars would continue to increase with increasing time after the Big Bang.

The Big Bang theory suggests that the universe was ‘born’ 13.7 Ga as a single violent event and that all galaxies have formed, from gaseous clouds, since then, the galaxies getting younger as the universe has expanded, presumably in all directions. Our galaxy, the Milky Way is just one of the many galaxies and the oldest starts within it date back to ca. 13.4Ga.

It is thought that astronomers will discover more ancient galaxies of approximately 13 Ga or older when the next generation of telescopes are developed and working. Details are published in the January issue of Nature.

Roy Mitchell – summarised by Liz Aston

What exploded over Russia?

When the Sun rose over Russia's Ural Mountains on Friday, Feb. 15, some of the residents of Chelyabinsk already knew that a space rock was coming: later that day, an asteroid named 2012 DA14 would pass by the Earth, only 17,200 miles above Indonesia. There was no danger of a collision, NASA assured the public. So when the morning sky lit up with a second Sun and a shock wave shattered windows in hundreds of buildings around Chelyabinsk, not many people recognized what had happened right away, it was not a crashing plane or a rocket attack, but a meteor strike, the most powerful since the Tunguska event of 1908. In a coincidence that still has NASA experts shaking their heads, a small asteroid completely unrelated to 2012 DA14 struck the Earth only hours before the publicized event. The impactor arrived from the direction of the Sun where no telescope could see it coming, and took everyone by surprise.

Researchers have since pieced together what happened. The most telling information came from a network of infrasound sensors operated by the Comprehensive Test Ban Treaty Organization (CTBTO). Their purpose is to monitor nuclear explosions. Infrasound is a type of very-low-frequency sound wave that only elephants and a few other animals can hear. Meteors entering the atmosphere create infrasound, and by analyzing records of it, it is possible to discover how long a meteor was in the air, in which direction it travelled, and how much energy it released. The Russian meteor's infrasound signal was the strongest ever detected by the CTBTO network. The furthest station to record it was 15,000 km away in Antarctica. Analysis has shown the asteroid to be about 17m in diameter and weighing approximately10,000 tons. It struck the atmosphere at about 20 km/s (40,000 mph) and broke apart at about 12 to 15 miles altitude. The energy of the resulting explosion exceeded 470 kilotons of TNT. For comparison, the first atomic bombs produced 'only' 15 to 20 kilotons.

The meteor's trajectory shows that it came from the asteroid belt, about 2.5 times farther from the Sun than the Earth is, but its orbit was nothing like that of 2012 DA14. The fact that the two came on the same day appears to be a complete coincidence. The infrasound records show that the meteor entered the atmosphere at a shallow angle of about 20° and lasted more than 30 seconds before it exploded.

The loud report, which was heard and felt for hundreds of miles, marked the beginning of a scientific scavenger hunt. Lots of fragments of the meteor must lie scattered across the Ural countryside, and a few have already been found. Preliminary reports suggest that the asteroid was made mostly of stone with a bit of iron.

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