EMRG Meeting Reports 2002

Sea Level Rise - Cause and Effect at the Coast

The media feast daily on matters that worry the Island Race. Of a published list of over sixty subjects which occasion significant public concern, rising sea level is listed as seventeenth.

On 23rd January Dr. Peter Balson, our first speaker for 2002, began his lecture by quoting this fact. While citizens appear to have numerous other things to worry them, we were left in no doubt of the seriousness of the problem and we gathered that there is considerably greater scope for the public to be made more aware of sea level rise. As it is, dog fouling, in at the number 16 slot, is only one place down in the worry index.

Sea level is not merely a simple figure. While British maps use a datum, the earthly manifestation of which can be seen cast in bronze on the seaward side of Newlyn's western breakwater, this zero level is an average of the highest and lowest tides derived from many observations.

Strong winds and atmospheric pressure affect sea level locally, so tides are monitored around the coast, mostly near sea ports. Mechanical methods such as a float in a sheltered water column are still commonly used; but now satellites measure sea levels as a topographic study on a global scale. Tidal changes, which can be thought of as a two waves, 180 degrees apart, passing over the Earth, vary radically with place because of the effect of land masses. A range of only 6m. may apply in shallow waters near continents but 15m. can be observed in narrow tidal estuaries. Although some tidal records in Europe were started much earlier, those in the UK date only from 1970 and this makes the prediction of long term trends difficult.

Eustatic movement, or long term change, is the large-scale rise or fall of sea level determined by the total volume of water in the oceans, the relative volume of ice, the shape of ocean basins and so on. Total sea volume depends upon input and output (evaporation, freezing and temperature). Steric (molecular size) changes relate to water expansion with temperature.

The shape of ocean basins is determined by the area and thickness of the Earth's crust, the volume of spreading ridges, subsidence, uplift and sedimentation. Owing to the shape of the Cretacean ocean basin, the sea was at a much higher level than today when the Chalk was laid down.

As examples of the estimated speed and range of these changes, the formation of land ice could cause a change of 150m. at 10mm. per year, sub-ocean ridges could cause 300m. change at 10 mm per 1000 years, sediment accumulation could cause a 10mm. per year change; and dessication could cause variation of 15m. at 10mm. per year.

Changes occurring at present are not all the same way: relative sea level is determined by eustatic sea level, vertical land movements, isostasy, sedimentation and consolidation. In the Gulf of Mexico sea levels are rising but in Alaska they are falling, as they are in Norway. Globally however, by 2100 a sea level rise of about half a metre is anticipated.

In the UK sea level is generally rising, but because of pressure release following the melting of the ice cap, the reverse is happening in Scotland. In London the danger of flooding is increased by a fall in land level, the cause of some concern. Land drainage and water abstraction can have marked effect upon coastal flooding. At Galveston, Texas, abstraction has caused land to sink below flood levels.

So what changes can we expect in the UK which suffers a stormy climate? The disastrous East Coast floods changed Government policy overnight and was the trigger for the Thames Barrier. These 1953 floods were a storm surge effect from the Humber to the Thames caused by low atmospheric pressure over the North Sea coupled with strong northerly winds at a time of spring tides.

Typical low slope coastlines, for example at Salthouse in Norfolk, are the ones at risk. Sea encroachment can be up to 2000 times the sea level rise. Present areas at risk of permanent flooding include large parts of the Fens, parts of the Humber hinterland and certain coastal areas of Lancashire, Cumbria, Suffolk and Essex.

In 1992 Pilkey & Thieler said, "There is no erosion problem until someone builds something close enough to the shoreline to be affected by erosion." This leaves a considerable number of properties at risk. Marine flooding threatens 976,000 residential and 70,000 commercial properties while coastal erosion threatens 69,000 homes and a lower figure of commercial ownerships. It is not yet clear whether or not sea level change is due to eustatic factors. Rises and falls are both happening but the trend is probably more towards rise.

What can be done? Action must be weighed against cost. The options are:

- Coastal defence: to "hold the line" (The action taken near towns)
- Managed retreat
- Manipulation of the hydrological cycle
- No action

A speech of thanks was given by Martin Culshaw.

Geoffrey Jago

Dinosaurs and the History of their Discovery
Report by Geoffrey Jago

Convened by Katherine Royse, Martin Culshaw and Naomi Wing, our meeting of Monday 18th February 2002 was held at Derby University, jointly with the Derby Student's Geological Society. Our speaker was Dr. Hugh Torrens, Professor of the History of Science and Technology at Keele University.

In his introduction, Professor Culshaw described the work of the Geological Society and stressed the significance of Continuing Professional Development leading to Chartered status which is becoming internationally mandatory for professional employment.
Professor Torrens' talk included a number of quotations and curious facts pertinent to his subject. An American claimed that "Dinosaurs are the most American animals that have ever lived, enjoying a free market economy and taking no flack from anyone. Another American made the first use of the word "dinosaur" to mean old fashioned and of limited use. He was describing the Republican Party.

As we know, the big lizards occupied the Earth for many times the three or so million year time span of humans and their ancestors. Yet a survey of US high-school students showed that 14% of them believed that man and dinosaurs co-existed, and they were biology students at that. In a study of the internet, a group of students were invited to write a treatise where half were asked to seek their information using only books while the others were asked to use only the internet. The latter got 30% fewer marks. Could it be that the digital world contains an awful lot of rubbish? [Hey! This is on the web.]

Who invented dinosaurs? One of the first to study vertebrate fossils was the French naturalist Baron Georges Cuvier, 1769 - 1832, who classified the bone structures of living and fossil animals, reconstructed fossil skeletons and devised today's comparative anatomy. Although he was a creationist, believing that species arrived ready-made, he also proposed the possibility of extinctions following disasters, and his findings later supported the theory of evolution. Incidentally Cuvier was less than complimentary when speaking about Britain, claiming it had no science, that everything in our islands was devoted to making money and that everything revolved around money. Over the last two centuries, at least our science has seen great changes.

In the 18th century British anatomists were rare and the French were way ahead, but from the 1820s it was in Britain that the study of the big fossil lizards began. At Lyme Regis, Mary Anning found the first ichthyosaur in 1811 and in 1821 the first plesiosaur. Mary Anning's contribution to paleontology was appreciated during her lifetime and Professor Torrens displayed a contemporary drawing of land and water-living giant lizards made to be sold to provide funds for her work. She wrote to the founding geologist Dean William Buckland at Oxford describing the plesiosaur. Buckland, 1784 - 1856, together with George Humphreys, collected bones from roof slates being quarried near Oxford but were hampered by the problem that these were large unrelated fragments. Buckland observed the similarity with modern lizards and he noted especially, in the case of an individual which he named a megalosaurus, that its sacral vertebrae (at base of spine) were fused together to make a very rigid supporting structure. In Sussex in the lower Cretaceous, Gideon A. Mantell, a Sussex surgeon, fossil collector and a vice president of the Geological Society made the crucial discovery of a femur which could only have belonged to a large animal, but determining the stratigraphic level was difficult in the Wealden rocks. Mantell took fossils to the Royal College of Surgeons where a member from the West Indies noted that the teeth were much like those of modern iguanas and Mantell coined the name "iguanadon". Progress was not helped at that time by the competitive atmosphere between the Royal Society and the Geological Society. When Georges Cuvier died in 1832 there was a struggle to take over the reins between the creationist Sir Richard Owen and Robert Grant, a Scot who influenced Charles Darwin. The Geological Society awarded a £100 grant to the Swiss Louis Ingasie for research work in 1835-7. Not to be outdone, in 1837 the British Association upped the ante with £200 for Owen.

Later shown to be in error, Owen considered there were two distinct groups by the crucial feature of a fused sacrum. From this it is clear that Owen was not the original one to formulate the concept of the dinosaur. Owen originally claimed that no gradation took place, believing each lizard had been suddenly created individually. However, he then changed his mind and decided that dinosaurs were a completely new race of animals. Could this have been because the industrious Mantell had published two papers in 1842? Owen completely revised his paper and sent it to the printers in 1842; but mysteriously the date of 1841 appeared. Dinosaur mania started at the 1851 Crystal Palace Exhibition when all the known dinosaurs were modelled in concrete by the gravely ill and pain-stricken Mantell. In 1852 following an overdose of the pain-killer of the day, laudanum, Mantell died and the large models, some of which survive, were completed by Owen. The American physician and anatomist Joseph Leidy, 1823 - 1891, made the first description of North American dinosaurs in 1856 . At Haddonfield, New Jersey, bones were unearthed of dinosaurs with large hind limbs and small fore limbs.

Pioneering work in the USA in vertebrate paleontology was also carried out by Charles Marsh, 1831 - 1899, professor of the subject at Yale. In 1867 to 1889 another American paleontologist and prolific author with a refreshingly curious middle name, Edward Drinker Cope, 1840 - 1897, made valuable contributions to the science. He favoured the theory of Lamarck that parents could acquire characteristics capable of being passed on to progeny. A change of interpretation in 1859 saw another puzzling case of date change, Marsh craftily keeping two copies of a Cope paper with differing dates. Despite foreign claims to the contrary, it can be seen that the early study of dinosaurs began in Britain in the first years of the nineteenth century. As an interesting tailpiece Professor Torrens told us of the way Sir Arthur Conan Doyle gained the idea for his 1911 book 'The Lost World'. Fossil footprints of a large lizard had been were found on his land in Sussex. This engaging talk saw a welcome good attendance of young geologists. They were given a useful tip, while not directly connected to dinosaurs, during the ensuing question time: the teaching of hydrogeology is not strong in the UK but this expertise will soon become more valuable with the increasing criticality of water resources. China has a water crisis, so hydrogeology is an important subject there. For a promising career, concentrate on hydrogeology!

Naomi Wing of Derby Students Geological Society thanked Professor Torrens for his very interesting lecture.

All You Need is Cool - or how you should learn to stop worrying and love the media
East Midlands Regional Group Meeting at British Geological Survey, Notts, on 19th March 2002.
Speaker: Dr. Ted Nield, FGS NUJ

Report by Geoffrey Jago

Scientists are a rare breed. There are only 1,865,000 qualified scientists in the UK, a pocket-sized tally when one reads, for instance, that the registered members of a Badminton Racquets Club number five million. Then, of scientists, most are chemists or physicists with geologists forming less than a quarter percent of the working population.

These facts were contained in the opening part of our March talk on the presentation of geology to the media by the Society's guru on the subject.

Dr. Ted Nield told us that an important aspect of his job is to communicate scientific ideas to a popular audience and to get the message across to the population of the importance of geological work. This is more difficult than it appears.

When some sciences are presented, they can occasion a glazing of the eyes in the Great British Public, at least in the perception of sub-editors. However, despite the small number of its practitioners, geology as a discipline punches above its weight in the publicity tournaments because events like earthquakes, dinosaurs, volcanoes and tsunamis gain public attention through sensationalist media articles. In fact there are very few areas of geology that offer no hope of popular coverage. Metamorphic petrology is perhaps an exception, our speaker conceded, deadpan.

Hence, when interacting with any media publicist, a scientific understanding of the public mind is most important for any professional body, not least for our Society. Moreover, one has to know exactly how the media works, what the public understands and how the Society can best present itself.

The method of communication, indeed the purpose, of newspapers and other mass-media is quite different from the world of academe. Scientists wish to put on record the precise facts, finding patterns of truth by systematising their findings, whereas journalists are there to sell papers and gladden those who fund their adverts by entertaining readers. In this respect journalists and scientists may be opposite to one another.

So how are scientists to woo the media and present their message?

Firstly, what is news?
People volunteer to hear news - it is not compulsory. News is principally entertaining - people read to be entertained, not educated. So if education, in the form of geological knowledge, is to be disseminated and understood, a measure of stealth is required.

And what are the media?
They are part of the entertainment industry, with a business is to sell, delivering advertisements and fostering business. News is not equivalent to education but many intellectuals are deluded that it is. They equate "interviews" with "lectures"; "journalists" with "students"; "stories" with "essays". Public Relations Officers are not in the education business either. PR is not teaching - its aim is to make people like you. This is the main mistake of the whole Public Understanding of Science movement whose aim is: "Teach people science and convert them". Almost nobody wants to be educated, but everybody will like you if you entertain.

What do the newspapers' customers, their readers, want?

Readers like stories with pictures that cause smiles, that relate to what is already known, that confirm their prejudices and are easily grasped. While this is true of broadsheets, it is especially so of the tabloids. The "redtops" are the most popular papers but present a difficult market, heavily illustrated and focusing on entertainment. Science here is always very secondary to the story and when one wishes to see it in print, science has to be "smuggled in".

Kinds of Story
In the general realm of "science", Mike Hanlon of the aily Mail has listed his personal six categories of newspaper stories.

1. STAR TREK
This can be any subject that can be illustrated by Starship Enterprise or pictures of the crew.

2. XFILES
These stories feature the paranormal - crystals, crop circles, new age mysteries. They are not science but if told in such a way that they can be debunked, they can convey science because quirkiness allows a scientist to smuggle a story in.

3. DOLLY THE SHEEP
These articles spotlight any form of reproductive biology.

4. FRANKENSTEIN
A subdivision of Dolly articles: genetic engineering, especially where science can be drawn into speculation.

5. MEDICAL MIRACLES.
One-off stories - some one (usually a child) saved by medicine. Possibility of genetic theory.

6. OTHER STUFF (anything else)

Geology can often feature, with fearsome ancient lizards always popular.

Treatment of News Items
There is a significant distinction between the broadsheets and tabloids in the treatment of news items. The tabloids, very nationalistic, like to stress or conjure up any significance to Britain. Coverage of the phenomenon of ancient tsunamis affecting the coast of Scotland caused by undersea slumps off Norway gave rise, in the less europhobe press, to headlines like "Tsunami Turned Britain into an Island Overnight", "How Britain Waved Goodbye to the Continent", "The Tidal Wave that Took Us Out of Europe" while the more staid element stuck to "Giant Wave Hit Ancient Scotland". Here the press sought information from the experts who grasped the opportunity to smuggle in a scientific element.

In another instance the publication via email of a conference paper on a possible relationship between sightings of the Loch Ness Monster and water surface disturbances caused by movements in the Great Glen fault was followed by 48 hours of international mayhem as phone calls came in from 26 countries.

What are the problems in presenting science?

Dr. Nield rounded off his presentation with a plea for scientists to learn to gain respect by embracing lightheartedness at times, and to avoid the tendency for their utterances to be perpetually solemn. Institutional or personal self-importance, reluctance to to be seen as quirky, a need to justify their existence, fear of ridicule from their stuffier peers are all factors that militate against a desirable leavening of papers that can be all too stodgy. The injunction of one tabloid editor to his vassals to "make the reader gasp" is perhaps too radical, but a judicious leavening of a serious paper is to be applauded as a Good Thing. Seriousness Is not the same as solemnity and scientists must be seen to have self confidence or *COOL*.

Professor Culshaw gave a speech of thanks for this fascinating and thought-stimulating evening.

Dry Out the Mediterranean- climate, tectonics and lots of 6 Million Year Old Salt

Those whose distractions include immersion in the Mediterranean should be grateful that this inland sea enjoys a connection to the world's oceans at its western end. It was not always so and future disconnection is not ruled out. But take heart, members, you have no need to cancel holidays or even sell your villas in the south of France, for we are talking timescales of millions of years. From 12 Ma to the present in fact.

On Thursday 16 May 2002 at East Midlands Regional Group's customary meeting place, British Geological Survey near Nottingham, Dr. Rob Butler of the University of Leeds described a study of paleoclimate and tectonics of the Mediterranean which he and eight colleagues had undertaken. Rocks of Messinian age in Sicily were the target for much of the study. These are underlain by Tortonian mudstones and overlain by marine Pliocene rocks. Following the discovery of evaporites in the bed of the Mediterranean it was realised that at some stages drying out took place while the area was cut off from the world's oceans.

By 10 Ma the western end of the Mediterranean became gradually narrower until the Gibraltar Straits closed. Evidence lies in the many evaporites which have been found - gypsum, halite and some potassium salts - drying out in an extensive basin which was deep in relation to the world's oceans but which contained areas of shallow water. At certain times some areas were replenished by limited amounts of water cascading in from the Atlantic. For evaporites to form, a basin does not need to dry out completely because crystallisation can occur under a deep water column. Evaporation down to one fifth will see gypsum starting to form on the bottom. How did this deep basin come about? Mother Earth is prone to fidget in the Mediterranean area and responsibility lies with her movement at depth.

Vertical sections across Sicily showed us a series of overthrusts, ahead of each of which lay synclines, giving rise to depressions where evaporites form. This thrusting is ongoing - it predated the evaporites and still continues. Carbonate rocks are an important part of the picture. A typical postulated sequence points to evaporites forming in basins gradually isolated by the formation of carbonate dams, followed by flooding and then higher carbonate build-up to allow more evaporites to form. Dating of the rocks is difficult because few organisms live in very saline water, so foraminifera offered no help, but magnetism provided a key. The Earth's magnetic field reverses every 24,000 years or so, a time span known as a chron. At present compass needles point north, awaiting the end of the current chron when they will point south until the next reversal.

The polarity of magnetism induced into rocks as they are laid down, and then frozen as they harden, provides a fossil "barcode", and from this the magneto-ferrographic group of scientists were able to determine a timescale and to correlate it with a number of beds. In all, this most interesting lecture exemplified a commendable piece of detective team work.

A speech of thanks was made by Martin Culshaw.

Report by Geoffrey Jago

The Geology of the East Midlands, with particular reference to Nottingham

This was the title of a very successful weekend programme covering Friday 26th and Saturday 27th May, 2002 organised jointly by the Geologists' Association, the East Midlands Geological Society and our Geological Society East Midlands Regional Group under the coordination of Professor Mike Rosenbaum of Nottingham Trent University and Alan Filmer of EMGS.

Following refreshments at Nottingham Trent University on Friday evening we listened with interest to two lectures by acknowledged experts on their subjects, John Carney of the British Geological Survey and Tony Waltham of Nottingham Trent University.Saturday morning and afternoon were taken up by field excursions covering a wide area of the city firstly within the centre of Nottingham and then around the campus of Nottingham University to the west, following which strenuous activity refreshments at the University were gratefully welcomed.

The evening saw us entertained by our third lecturer, Ian Smalley of Nottingham Trent University before enjoying a buffet supper.The Field Programme leaders were Tony Waltham, Albert Horton (formerly of British Geological Survey and now working from time to time at Nottingham University), Andy Howard of BGS and Graham Lott, also of BGS.The initial lecture on Friday was entitled 'The Geology, Mineral Resources and the Environment of the East Midlands' by John Carney who provided the following synopsis:

"The geological succession of the East Midlands encompasses over 600 million years of the Earths history. The region is one of the few in England to expose basement (pre-Carboniferous) rocks, and these date back to the latest Precambrian at Charnwood Forest. If we have interpreted the Charnwood rocks correctly, they reveal a time of great volcanic and tectonic activity along a convergent plate margin lying off Gondwana's margin, along which spectacular, Montserrat style volcanic eruptions took place. There is little surface record of geological events over the subsequent 250 million years, but there is a wealth of subsurface information to suggest that in Ordovician times subduction once more prevailed in eastern England, generating magmas that now constitute granodiorites of the type seen at Mountsorrel and Croft. By early Carboniferous times sedimentation was resumed, characterised by limestone reef systems that fringed deep, fault-bounded, asymmetric rift valleys. The faults presently seen at the surface a reminders of this tectonism, and on occasion they are reactivated at depth, giving rise to some of the larger earthquakes experienced in the UK. The subsequent infilling of the rift basins, combined with gentle regional subsidence, produced a subdued landscape dominated by delta plains in which the Coal Measures were laid down.

As a further reminder of continuing tectonism, substantial basaltic shield volcanoes were built up, interrupting sedimentation during Lower Coal Measures times. The Permo-Triassic strata of the region were laid down nearly 300 million years ago, after the end of the Carboniferous - Variscan uplifts, across a landscape that was in places spectacularly rugged. By the end of the Triassic, however, these highlands were largely buried by sediment and an arid plain existed across which the Rhaetian marine transgression took place. This submergence was only terminated in Tertiary times, with renewed uplift and dissection. The Quaternary glaciations destroyed the major Tertiary drainage systems, although some gravels remain preserved in valleys, but the modern landscape of the East Midlands was not initiated until Anglian ice had retreated, about 400 000 years ago. The geology of the region explains why it is well supplied with mineral resources such as hard-rock aggregate, coal, gypsum, sand and gravel, and even oil. However, we must also consider the environmental effects that the natural geology, and mankind's exploitation of it, have had on the region in which we live."

The second lecture on Friday was entitled 'Caves in the Nottingham Sandstone' by Tony Waltham, author of 'Sandstone Caves of Nottingham', who provided the following synopsis: "Nottingham contains scores of caves and cellars in its underlying sandstone. All were cut into the rock by man; none is natural. They were largely excavated to provide extra space in a very crowded urban area. Few caves were lived in, but they were ideal for storage because temperatures are naturally almost constant underground. Three groups of caves were mines, excavated to produce sand. Though some older caves do exist, the great majority of the caves date from the period 1600-1900. The inner city of Nottingham lies on the outcrops of two rock units. The older and lower is the Sherwood Sandstone, consisting of coarse, buff coloured sandstones up to 90 metres thick; it was formed as flash flood sediments in desert basins during Triassic times. Above the sandstone, the thick Mercia Mudstone includes various marls and siltstones. Its outcrop lies to the east and south of the sandstone, as the rocks now dip at about 10 to the southeast.

The low ground south of the city centre is covered with the alluvium of the Trent and Leen valleys, which is mostly sandy clay and is less than ten metres thick. This was deposited on the glacial meltwater floodplains before the river flows reduced to their present levels, as well as recent canalisation created by artificial levees and embankments. The city of Nottingham originated on, and then spread over, the sandstone to high ground immediately north of the Trent floodplain; essentially this is the very gently dipping escarpment of the Sherwood Sandstone. Southward, fault line scarps which originally truncated the sandstone escarpment have been cut back by lateral expansion of the Trent valley; this has left steep slopes and cliffs along the floodplain margin. Castle Rock reaches to 40 metres above the Trent floodplain.

The Sherwood Sandstone consists largely of medium to coarse grains of quartz sand; a small iron oxide content gives the rock an overall buff colour. There are many scattered pebbles of tough quartzite and also numerous flakes of red mudstone; both the pebbles and the flakes are locally concentrated into thin beds of conglomerate. It can only be described as a weak, friable rock, because its unconfined compressive strength is generally around 10 MPa. Its strength is low largely because it relies on a weak clay cement as a binder between the quartz grains. Sherwood Sandstone from deep boreholes in the south of England has widespread cementation comprising calcite, dolomite and anhydrite, but all these minerals are leached from the shallow zones of rock close to the outcrop. The clay cement also accounts for the substantial reduction in strength when the sandstone is saturated; this has major implications on the rock's durability and the caves' stability. Though the sandstone is potentially weak, it is also distinguishable by its notable lack of fractures. Much of the rock has some degree of cross bedding, although bedding planes are generally not conspicuous.

Joint spacing, as revealed on the cliff exposures, is generally in excess of ten metres; very few joints are encountered within the 'caves'. Along with the scarcity of major bedding planes, this lack of structural weakness ensures the stability of the cave roof spans. Such a soft, unfractured rock is ideal for excavation of an underground opening. Natural weathering has caused the Nottingham Castle Sandstone to disintegrate ultimately to a loose, granular sand, which is naturally found in the first few metres beneath the ground surface. Partial weathering also produces a steady decline in the rock strength in the last ten metres towards the surface. Conditions can vary locally, but across much of the city centre, sound rock is encountered at depths of two to five metres, unless there is an unusually large thickness of artificially placed sand or rubble fill."

FIELD WORK

Saturday's field excursion began with an examination of the Victorian gothic architecture of Nottingham Trent's historic Arkwright Building decorated by the eminently carvable Jurassic Ancaster freestone. Incidentally a freestone can be cut in any direction but will flake with weathering if laid on end. Traversing ripple-marked Carboniferous 'York' sandstone pavers we examined walls of the attractive and widely used reddish-brown local Bulwell stone, a Permian dolomitised limestone. On one building, St Andrew's church, faced with Bulwell stone, grey courses had been added of Barnstone Rock from the base of the Lias.

On the new cinema complex, some artificial stone had been used in restoration work which is difficult to distinguish from natural limestone. Almost everywhere Millstone Grit is found for wall capping. Passing Nottingham Trent's tall 'modern' Bauhaus style Newton Building, faced with white Portland stone and with walls capped with Portland Rag, we walked down to Nottingham's Market Square, appropriately known locally as Slab Square, with its curbs of pinkish Mountsorrel granodiorite and steps of various Cornish granites, overlooked by its impressively classical Council House of Portland stone with its portico floor of black fossiliferous Carboniferous limestone. The surrounding buildings displayed many different and beautiful facing stones: grey

Aberdeen and red Peterhead granites, schists, gneiss, serpentinites from Brazil, grey white-veined limestone from Devon and the many-coloured feldspars of pale and dark Larvikites (syenite).

Heading north we passed the Theatre Royal with its pillars and portico of Ancaster limestone hiding shyly under a coating of cream paint and followed briskly the mile or so taken, in past centuries, by unfortunates to Gallows Hill and its adjacent Church Rock Cemetery with its exposures of Lower Triassic Sherwood Sandstone. The road northward from the City towards Mansfield now crosses ground that, before its development in the 19th century, was a common. This road roughly divides it into an area to the west on the Sherwood Sandstone from land to the northeast where, helped by the downthrow of faults, lies the clay soils above the Upper Triassic Mercia Mudstone.

Of the two sections of former common land, known as the Sandfield and the Clayfield, the Church Rock Cemetery now occupies part of the former common. Until the early years of the 19th century sandstone exposures on the scarp slope provided a free, easily mined, source of sand which was used mostly as floor covering after wood shavings became scarce and before carpets became affordable. The sand was removed both by quarrying and tunnelling until in 1806, when a roof fall caused a fatality, the City fathers blasted down the mine roof, leaving part of the current depression from which still lead the remains of the tunnelling and, of a later date, an unused catacomb complex. Both sets of tunnels are now secured from entry by steel gates. After examining these exposures we retraced our steps to the entrance to the most extetensive of Nottingham's caves - an old sand mine which extends for 700 metres under the buildings of Peel Street and Mansfield Road.

Equipped with torches and hard hats we were led by Tony Waltham through a maze of tunnels where the sand had been mined commercially by a Mr. James Rouse for at least 30 years at the end of the 18th century. The employees removed about 10,000 tons of the fairly easily hewn sand, leaving pillars which to this day maintain the roof without need of additional support. This provided us with another opportunity to examine the structure and composition of this fascinating sandstone which, although weak enough to be removed with a trowel, is still strong enough to sustain the weight of overlying buildings.

Tony also explained his work in assessing the strength of foundations and their positioning in relation to voids, as building work continues across the City. With the opportunity to examine more of the sandstone, after lunch the group reassembled in Brewhouse Yard at the foot of the cliff which is topped by Nottingham Castle. From here tunnels extend into Castle Rock up to the Castle grounds. Part of the nearby famous 'Trippe to Jerusalem' inn lies within the rock, providing year-round access not only to clear sandstone exposures but to excellent food and ales as well.

The afternoon's walk took us in to the Park Tunnel, again in the Sherwood Sandstone, containing an 8-metre-high excavation 75 metres long, built by the Duke of Newcastle to allow a coach and four to drive in and out of the new Park Estate. Used now just for foot access, it remains in good condition with no signs of bed or block failures. Here we paid particular attention to the mode of deposition of the sandstones, identifying foresets from the nature of the cross-bedding as well as differences in the velocity of depositional flood waters from the fining upwards sequences. Using cars and public transport, the group relocated to Nottingham University for a tour of the campus.

As we gazed at a tall, deep red exposure of the Upper Permian Lenton Sandstone formation, Andy Howard took us in imagination to the southwestern shore of the Zechstein Sea where rapid sea level rise followed by gradual drying out led to the formation of the Lenton beds in desert sand dune conditions. A little slower by now, a circuit of Nottingham University's picturesque lake took in another aspect of the Nottingham Castle sandstone and a glimpse of the dark brown clays of the Mercia Mudstone.

Regenerated by tea, coffee and cakes in the University Life Sciences Building, we all settled at 6 p.m. to hear Ian Smalley speak on 'Wagga Wagga a model for Nottingham in the Permian?'

By means of graphs and photomicrographs Professor Smalley drew attention to the similarities in particle size, voids and packing density between loess beds formed in the Australian Quaternary and the English Mercia Mudstone. He showed us a map of the global distribution between loessic deposits, covering most of the USA, through northern France and Italy across to China, together with South America (south of Brazil), and contrasted these deposits with global diluvium covering Eurasia, north of the loess, and Canada. New studies of the extremely fine grained loess are taking place in view of its tendency, with 15% compaction, to sudden subsidence. One such study of loess has examined the subsidence of a major dam in Libya, Russia experienced the subsidence beneath the huge Atom-mash factory, and even in the UK there is an increasing awareness of the possible damage to new housing developments from the eccentric behaviour of these potentially loose soils. A major paper in the forthcoming Mercian Geologist will be taking the debate still further.

A vote of thanks was given by the EMGS president, Tony Morris, concluding the formal proceedings before we completed the day with an excellent buffet supper and a further chance for long, cheerful discussion.*Report compiled by Geoffrey Jago and Mike Rosenbaum.*

DOLOMITE - A MAJOR GEOLOGICAL ENIGMA

At our meeting on Tuesday 11th June, 2002 at British Geological Survey, Keyworth, Notts, Dr. David Wright of the University of Leicester spoke on the above subject of which he is a leading expert. Many theories of the formation of dolomite have been put forward over the years, most of them unsustainable, so Dr. Wright's exposition of his work to demonstrate a true genesis of this important rock was of great interest.
We can do no better than repeat his excellent synopsis:-

"The genesis of dolomite in the natural environment has been one of the outstanding enigmas of geology, despite some two centuries of intensive research and debate. The mineral occurs in a range of scales, from micromillimetric laminae in limestones or some clastic rocks, to thick monomineralic sequences. Surprisingly, dolomite has not been synthesized in physico-chemical laboratory experiments at normal temperatures and pressures, so that the chemical controls on dolomite precipitation remain undefined. Conventional hydrologically-driven models of dolomite formation, though popular, often lack empirical support, and encounter fundamental chemical problems related to kinetic impediments in saline solutions: these include the high hydration energy of the magnesium ion, the extremely low activity of the carbonate ion, and the presence of even very low concentrations of sulphate.

The lack of a convincing hydrological model has redirected the search for a solution. An appropriate approach is to consider under what conditions the kinetic constraints on sedimentary dolomite formation might be overcome in natural aqueous saline environments, and whether those conditions could plausibly have resulted in the thick platformal dolostones abundant in the Precambrian. Most modern dolomite is found in intertidal to supratidal environments (including alkaline lakes), whereas most Precambrian dolomite was deposited in shallow subtidal marine settings. However, a common factor linking both modern and ancient dolomites is their frequently observed association with benthic microbial communities, typically as stromatolites and cyanobacterial mats. There is increasing evidence that microbial degradation of organic matter, particularly the activities of sulphate reducing bacteria in anoxic layers beneath cyanobacterial growth surfaces, can play a critical role in the biochemical modification of ambient waters creating the conditions necessary for widespread dolomite formation.

Laboratory experiments simulating the anoxic bio-depositional environment of dolomitic lakes of the Coorong, South Australia, have successfully precipitated dolomite, and an organogenic model may have significant implications for understanding dolomite formation throughout the geological record.
Microfacies studies of representative platformal microbial carbonates, comprising cyanobacterial mat, stromatolites and giant ooids, from the Late Archaean Ghaap Group of South Africa have provided compelling evidence for an intimate relationship between taphonomic evolution, fabric development and mineralogy in rocks of the Gamohaan and Boomplaas formations. Carbonate cements, both in fold hinges and between the limbs of slump-folded and contorted partially-degraded, pyritiferous stromatolitic laminae, were precipitated after deformation of organic fabrics, but before or during their compaction, indicating that cementation took place at the same time as anoxic organic degradation involving bacterial sulphate reduction. Petrographic analysis and biogeochemical modelling support a genetic link between bacterial sulphate reduction and (1) calcite precipitation in the contorted laminae, and (2) replacement dolomitisation of the calcitic matrix in the stromatolites and ooids.
The evidence indicates that anoxic organic diagenesis was an essential and major process in controlling carbonate precipitation and mineralogy in a depositional environment analogous to other Archaean, Proterozoic and, during periods of biotic stress, some Phanerozoic carbonate platforms."

A speech of thanks for this very significant talk was given by Tony Cooper.

Field Excursion to Harborough Rocks and Bees Nest Pit, Derbyshire

Report by Geoffrey Jago with grateful thanks to Dr. Aitkenhead for his comments, as well as to 'The Mercian Geologist'.

Nestling beneath the southern side of a steep hill lies the comely village of Carsington where East Midlands Regional Group began its Derbyshire field meeting on the evening of 3rd July. In pleasurable anticipation of later refreshment, we parked by the Miners Arms at 6 pm whence we were guided by our leader Dr. Neil Aitkenhead up the very steep south-facing slope formed by the top beds of the Carboniferous limestone. Carsington lies on the junction between the limestone and the overlying Edale Shales and once housed miners seeking local vein minerals. Less than a kilometre to the east the village of Hopton was built over a volcanic neck. Vein mining hereabouts, mostly for lead and later for barite and fluorite, began with the Romans but was revived in the 18th century to continue until as late as 1953 with the closure of the Golconda Mine, two kilometres to the north.

With a local resident joining the party, a small ginger and white cat, we climbed to our first stop, halfway up the slope, where there are outcrops of the Bee Low Limestone which has been interpreted variously as shelf or apron reef facies. These outcrops are on the line of old lead workings, on the Yokecliffe Rake, the southernmost of many such veins. Dr. Aitkenhead explained that the ores are thought to have been derived from late Dinantian to early Namurian shales that were deposited in basins such as the Widmerpool Gulf. By late Westphalian times, pore fluids in these shales, buried to depths of up to 3 kilometres, would have become hot brines dissolving lead, barium, zinc and fluorine now typically found in orebodies in the limestone. Seismic pumping took place at times during the Variscan orogeny. This process moved the brines into cracks and cavities in the limestone where the ores crystallised, awaiting the miners. (For more information on Peak District mining, see also our Group's September 2001 report of the lecture given by Professor Trevor Ford.)

As we began to scramble up the rest of the slope the cat decided that altitudes of over 300 metres called for too great an exertion, and loitered to examine the minerals thrown from a rabbit hole. The hill top, a limestone plateau with a covering of loessic glacial drift, overlooks a gorgeous landscape from which the downpour which immediately preceded our tour could be seen scudding away, to be replaced by dry skies. Shoals of white-sailed dinghies on the wide acres of Carsington reservoir enhanced the view. Plunging beneath this landscape below the shales, the more southerly Carb Lime contains turbidites where the slow advance of the delta muddied the idyllic tropical seas.

Attaining the crest of the slope we examined a small dolomite tor known as the King's Chair which resembles two roughly shaped standing stones. By this level much of the limestone has become dolomistised, a process of replacement of calcium with magnesium which was described very recently by Dr. David Wright in our Group's lecture on 11th June (see above). In this southern part of the Peak District, dolomitisation has been applied to the main limestone outcrops downwards via percolating brines from overlying strata, some of which may have come from salty long-eroded Trias.

We walked north into a shallow dry valley to look at a group of grassed-over pits, thought to be from searches for silica sand. As with many areas in the Peak, restoration work was formerly considered an unnecessary expense but at least these remnants afford interest to the industrial archaeologist. Re-excavation in places by animals showed sandy glacial deposits with abundant well rounded pebbles. Once mapped as boulder clay but now reclassified as head, it is believed to have been moved down into the depression during periglacial conditions, with an addition of wind-blown silt.

Pressing briskly further northwards we crossed the Wirksworth to Brassington road and then turned west to follow the track of the disused High Peak Railway for a kilometre until turning north again to Harborough Rocks. This picturesque craggy escarpment of dolomitised limestone has been heavily timeworn with many small wind and weather eroded cavities. Another scramble to the top of the Rocks furnished views across the Derbyshire Carbonate Platform, with its many manifestations of current and former quarrying and mining, to the distant hills of Axe Edge and Kinderscout

Our final site, the disused Bees Nest Pit, which provided silica sand for refractories, lay nearly a kilometre to the south. This is a Pocket Deposit of over 45 m. depth in a blind solution hollow (doline) dated from spores in the youngest member as late Miocene to early Pliocene. The sand from the lowest bed, the Kirkham Member, provided the economic mineral. Mixed with well rounded pebbles, it is deduced to have been deposited as alluvium from the southwards retreating escarpment of Triassic Sherwood Sandstone.

The two-kilometre descent back to Carsington nurtured a wholesome thirst satisfactorily quenched at the atmospheric Miners Arms as, amid an agreeable and well-informed discourse typical of our Group, we extended our thanks to Dr. Aitkenhead for a most interesting evening.

Geological and Other Aspects of Flooding

19 September 2002

The prospect of especially high tides due in the next month made the subject for East Midlands Regional Group¹s September meeting an especially topical one. Flooding is a matter of increasing concern for many of the Island Race. With carbon dioxide levels having climbed demonstrably, local climate is changing and flooding is on the increase. Oceans are predicted to rise as the world warms up, and we can expect hotter drier summers with winters 20% to 30% wetter. Following the rigours of their summer holidays, a generous portion of members and friends reassembled at British Geological Survey, Nottinghamshire to listen to Dr. John Carney¹s talk with the above title. After achieving his doctorate in the study of volcanics,

Dr.Carney has worked for British Geological Survey for a number of years, specialising in metamorphics, drift and the geology of the Midlands. His talk began by describing the main types of UK flooding. These are: coastal inundation, inland flooding on flood plains, ground water flooding in narrow valleys, flash flooding and urban flooding. The risk of coastal inundation extends to considerable areas of the UK, particularly in low lying parts of England that border the North Sea from Yorkshire south. A map emphasised the extent of the areas that are at risk. Still clearly in the minds of the responsible authorities are the widespread east coast floods of fifty years ago.

These, however, were caused by a rare coincidence of high tides with a deep atmospheric depression which sucked the North Sea to cataclysmic levels; and coastal reinforcements were carried out in subsequent years. Inland, development on flood plains has been escalating rapidly since 1997 so that already about 5 million UK citizens live on flood plains. Moreover, as the pressure for new building increases, such areas are now considered to be prime sites. While flat valleys are visibly at risk, flash flooding can happen anywhere where development has been allowed along a narrow valley. Lynmouth is the first name that comes to mind but this disaster was preceded by another severe example of flash flooding at Louth, Lincolnshire, on 29 May 1920 where five inches of rain fell in a short time to the west, causing 23 deaths. As a local more recent example, in 2001 the Sheepwash Brook flooded part of Keyworth and East Leake when a culvert became blocked.Ground water flooding can occur, for example, in chalk areas in southeast England when normally dry valleys become rapidly filled with water. Special studies of flooding in the Trent valley were described, firstly in the Long Eaton / Sawley area and secondly ten miles or so downstream between Stoke Bardolph and Gunthorpe. Impressive scrolling aerial panoramas taken during floods were displayed. In both locations the experience of the centuries ordained that older buildings accumulated on areas of river terraces which remain above flood level; but more modern development including that alongside the M1 in the Long Eaton district, for example, was not so fortunate.

In the Midlands in September 1920 there was a sudden increase in rainfall which continued until December. In November, over a period of only nine hours, most of the Trent floodplain lay under water from Stoke Bardolph downstream to Gunthorpe Bridge with only river terraces, such as the one on which Gunthorpe village stands, remaining relatively dry-shod. This was classed as a 65-year event. The Gunthorpe Flood Action Group took some trouble to chart the directions and volumes of flows as flooding rose and receded and Dr. Carney was able to show us these maps. We were also shown the three-dimensional diagrams of floodplain, aerial photos and maps produced by Bruce Napier. Research, which to be useful must have the end-use of flood damage limitation, is ongoing. Empowered responsible authorities include the Environment Agency, Internal Drainage Boards and local authorities, with the Department for Environment, Food and Rural Affairs (DEFRA) providing guidance.

The determination of accurate land levels is one important factor and modern airborne techniques include Synthetic Aperture Radar surveys which gives topographic accuracy of 0.3 to 0.5 metre and LIDAAR (Light Ranging and Detection) which is a laser scanning system. LIDAAR, although considerably more accurate, is also more expensive with its flights covering narrower corridors. However it allows subtle delineation of floodplain levels, showing the development of the meanders of the main channel and old abandoned river channels like ox-bows.

Dr.Carney described the publicly available documentation on the subject of flood risk which include useful guides such as an indicative map. In making probabilistic assessments and calculating flood event limits, the Flood Estimation Handbook enables an estimate of the time-year peak flow. It was pointed out, however, that any single source does not encompass the whole subject and interested parties are well advised to undertake thorough research. The formal definition of a floodplain has yet to be written but it must be scientifically founded, historically based, easy to understand and incorporate a visual representation. A fact that arose during question time is that British Waterways still own data in which 42 flooding events in the mid-Trent valley since 1795 are listed. This may indicate that a major event could be expected on average every five years or so.

A speech of thanks for this very informative talk was given by John H. Powell of BGS. *Report by Geoffrey Jago*

EMRG Meeting Reports 2002 (continued)

Forensic Geology (Geoforensics)
17 October 2002
Report by Geoffrey Jago, with acknowledgement and thanks to Dr. Donnelly

The longer the experience of geology, the greater is the appreciation of the enormous breadth of studies covered by the science. The September meeting of East Midlands Regional Group at British Geological Survey, Keyworth illustrated a new perspective on how geology can contribute to society. Forensic work is defined as that relating to courts of law, so geoforensics describes the part that geology can play; and that is a very significant one.

From his wide experience of the subject, our speaker, Dr Laurance Donnelly, a geologist with International Mining Consultants and a Research Fellow of the British Geological Survey, left us in little doubt.

Geoforensics is about helping the police. The first notion that springs to mind is the identification of the sources of mud and minerals on the shoes or clothes of a suspect. Detective writers Sir Arthur Conan Doyle and R Austin Freeman both used this idea. Dr. Watson noted how Holmes could recognise different soils on clothing, and identify where in London an individual had been walking, while FreemanÂ¹s pathologist character Dr. Thorndyke traced a body at Gravesend from loam containing foraminifera. As long ago as the nineteenth century it was discovered that the myriad minerals and micro-fossils in traces of mud could yield such abundance of information that murderers who lacked the foresight to burn their shoes before the police sequestered them were left with scant choice but to own up.

The search for graves of murder victims takes up overwhelming amounts of police time. Here the skills of a geologist with the expert eye to landscape provided by mapping training can be brought into play and Dr. Donnelly has devoted much time alongside the police with some very useful conclusions. A disturbance of surface structure of a rough moorland scene is often invisible to the eye of the layman but to a geologist who knows the characteristics of the ground, evidence of recent digging can be obvious. Coupled with an understanding of the various modern techniques of geophysics, immeasurable help can be provided by the geoscientist towards diminishing the difficult tasks of the constabulary. Surveys using electrical conductivity, magnetism, gravity and ground penetrating radar (GPR) have all been used effectively. This applies equally to geological maps which have been used in police investigations to identify potential burial sites and topographic features mentioned in witness or suspect statements. Again, geological maps can be used to eliminate areas of ground which are less likely to conceal buried objects, thereby enabling the more cost-effective use of resources and reducing the time spent on unsuccessful searches. Similarly, aerial photographs when interpreted by an experienced geologist can provide much information, including the highlighting of areas of ground deformation. In mining circles especial care has to be observed when ore samples are assayed. A few years ago the shares of a company rose rapidly following news of enormous gold reserves in Indonesia. Imagine the disillusionment

of shareholders when geoscientists were able to point out that the shape of gold particles in rock core samples betrayed their river bed origin.
Geologists are not always such spoilsports.

Photographs of rock structures can help a lot. In 2001 the famous videotape from Afghanistan which was displayed universally on television enabled the search for the subject to be narrowed dramatically. Rock exposures were recognised by a field geologist with extensive local field mapping experience. These particular rocks, which occur only in the Katawaz Basin in the southeastern part of Afghanistan, are soft, coarse, shallow-water Pliocene sandstones and limestones. These have the tendency to form natural caves and support man-made tunnels and chambers.

A lighter note concerns the owner of a Canadian store who was disappointed to discover, in boxes purporting to contain bottles of whisky, material of a less intoxicating nature in the form of an equivalent number of lumps of limestone. Where, over its long journey from the UK, could such a deceit have been effected? Our science was able to define with certainty that the stone could only have come from a particular quarry in England whence the suspect had been seen carrying home rock samples.

Dr. Donnelly concluded by drawing attention to the requirement, as yet unfulfilled, for training courses both for investigating officers and geologists so that their separate skills can be understood and shared.

A speech of thanks was given by Professor Martin Culshaw.

From Sandcastles to Snowballs - Exploring the Physical Properties of Rocks
6 November, 2002
Report by Geoffrey Jago

The speaker at our meeting of 6th November 2002 at British Geological Survey, Keyworth was Michael Lovell, Professor of Petrophysics in the Department of Geology at Leicester University. The sandcastle section of his talk dealt with the petrophysical properties of rocks while snowballs referred to methane hydrates, those enigmatic sub-oceanic gas reserves which must one day be tapped when homo sapiens finds that oil is becoming a luxury.

In the meantime, an increasing proportion of our gas and oil comes from marginal deposits and their efficient recovery depends upon the best understanding of how liquids move through rocks.

The four main attributes in the study of how liquids behave in porous rocks are porosity, permeability, water saturation and capillary pressure. There is no simple law to relate porosity and permeability. If all grains were perfect spheres of equal size calculation would be easy but since nature does not provide such integrity, permeability depends upon the sizes, shapes and interconnections of the spaces between particles. Porosity is reduced if a rock undergoes cementation, whereby the grains are coated and stuck together.
From his work on the flow of water through sand, Henry Darcy (1803 -1858) defined permeability as the measure of the ease of flow through a medium under pressure, his name being perpetuated as the standard unit of permeability. Gravels have values of 1 to 3 darcy, plutonic rocks are low, volcanics are variable while sediments, from sands to clays, can differ by a factor of a million. G.E. Archie found that there is a linear relationship (Archies "law") between electrical resistivity and porosity which depends upon the shape of the grains.

Water saturation is the proportion of water to air in the spaces between sand grains.Capillary pressure adds to the complexity because liquids defy gravity in small spaces, a characteristic of which use is made when sponging beer from the kitchen floor to obviate discovery by oneÂ¹s spouse. Wetability, another factor, depends upon the nature of the liquid. Mercury does not wet a surface but water does. Water fills part of an unsaturated void by sticking to the sides, and the narrower the spaces the greater the water attraction. Rocks with many different particle sizes make for high wetability and greater capillary pressure.

Professor Lovell then went on to the second part of his talk. The snowflakes he referred to are gas hydrates of which methane hydrates, existing at depth in certain areas, mostly below the sea, may well represent a greater energy source than all other sources combined. Water molecules can entrap gas molecules in cage-like spheres, rather like the lattice domes of the Eden Project except the crystal patterns differ - gas hydrates crystallise in the cubic system. This is a physical rather than a chemical phenomenon, and the volume of gas comprises about 200 times the volume of its imprisoning water. Methane hydrate forms in cold high pressure zones at depths between 100 m. and 1200 m. Below this zone lies non-hydrated methane gas, because with increasing temperature the hydrates disassociate.

These hydrates can be brought to the open air in drill cores where they occur typically in very thin frozen layers, white or brown in colour. On surface they do not last long. Their potential as an energy source would be attractive but for the cost of extraction; but research continues, particularly in Japan where hydrates exist and where lack of indigenous oil is a strong incentive. Commercial exploitation may be seen within five years.
The report on these pages of our GroupÂ¹s meeting of April 1999, when Dr. David Long of BGS Edinburgh spoke on gas hydrates, is also relevant.

Professor Lovell rounded off his interesting talk with illustrated advice, of clear value to parents, on the best water content to make a stable sandcastle on the beach.

A speech of thanks was given by Professor Martin Culshaw.

Geochemistry at the Global Scale 12th December 2002.
Report by Geoffrey Jago

The last meeting of East Midland Regional Group in 2002 was devoted to a talk by Professor Jane Plant, Director of British Geological Survey, Keyworth and President of IMMM. Her illustrated talk on *Geochemistry at the Global Scale* was devoted to the work which BGS, in association with a number of other organisations worldwide, undertakes to study the global and local effects of chemicals in the ground upon the environment and the health of human populations. Predictions for the growth of world population show a steep rise for the next half century, almost wholly accounted for by people outside the industrialised countries.

In combating illness, an initial step is to seek and define the cause; and here BGS and its associates continue to contribute valuable information internationally. Much of this work concerns the heavy metals and other harmful elements. Amongst those listed were beryllium, radon, thorium, uranium, arsenic, cadmium, mercury, antimony, titanium, lead, tin and ruthenium. However, there are many other elements and compounds that have to be taken into account. To appreciate the extent of the task that geochemical study incurs, one had only to read a BGS work, provided as an example, Regional Geochemistry of Northeast England in which detailed information on nearly forty elements has been obtained and mapped.

A large number, but not all, diseases arise from ingestion, directly or indirectly, from soils. In the study of how the human body can absorb chemicals directly, tests have been devised to emulate the digestion of food passing through the human digestive tract, with its radical change of acidity over a day or so. When a pollutant has been found, it is necessary to seek its source and the pathways it takes prior to accumulating within the human body. Persistent organic pollutants (POPs) and their relative mobility in oxidising and reducing environments is another area of work under investigation.

Some disorders result from a deficiency rather than an excess of certain elements. For example, soils in large areas of China, where the diseases Keshan and Kashin-Beck occur, have low selenium.

Aside from these elements, China has health problem with domestic coal combustion, one coal-related disease being fluorosis which causes deformed bones.

The incidence of cancers of various sorts in males and females has been studied by populations. Radon gas has been proved to cause lung cancer and in certain cases in the Middle East is estimated to result in harm equivalent to smoking 60 cigarettes a day.

Professor Plant devoted part of the evening to specific instances. Of these, one referred to uranium which has been found to occur in many individual deposits all situated around the Mediterranean. Nearer home, other maps showed areas around Manchester and Liverpool where elevated copper, lead and tin values have been found, consistent with fenland infilled with foundry waste.

A Stoke on Trent survey revealed pockets of variable acidity where lead is present. Nitrate and sulphates in surface waters show a much higher occurrence along the Welsh border, against low values in central Wales.

In replying to questions following this interesting and important lecture, Professor Plant made the points that a major hope for the future of the human race lies with education and that women should be allowed to play a larger part in society.

A speech of thanks by given by Professor Martin Culshaw.

Landfill & Legislation- Where Are We Now?

15 January, 2003

Report by Geoffrey Jago

Humans of the wealthier nations throw away ever-increasing volumes of crud. As suitable places to put it all, such as completed quarries, are used up ever more rapidly this burgeoning problem was the subject of our first speaker for 2003. Ms. Leslie Heasman is an environmental chemist, Technical Development Director of Marion Carter Associates and a leading specialist in landfill management. No better introduction to her valuable presentation can be provided than from her own synopsis:- [3]The legislation controlling the landfilling of waste recently has been subject to unprecedented levels of change.

The UK approach to landfill has to change fundamentally following the implementation of the Landfill Directive. As the Directive is a poorly drafted and ambiguous text which is not based on easily identifiable logic, in order to implement the legislation we are reliant on interpretation by Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency (EA) of the meaning of the legislation.[2] Because of the very complicated written definitions of waste, which differ in each country, the final word is normally left with the national or European courts. There is a move towards simplification and a necessary broadening of wording. For example, the farming industry, whose lobbyists ask many questions, generates a huge amount of waste; and further legislation is needed in respect of the mining industry.

LANDFILL

On the main topic of her talk, Ms. Heasman maintained that the Landfill Directive (LD) has an immediate requirement to be made clearer and its ambiguities resolved. Implemented through the Landfill (England and Wales) Regulations 2002 in tandem with the Pollution Prevention and Control (PPC) Regulations, the clarity of its objective has faded with its growth. The final document is prescriptive regarding construction but not so regarding environmental impact. Far from offering generalisations, Ms. Heasman went on to make specific and constructive suggestions as to what are the main requirements, under nine headings.

1. Site location
2. Permitting sites
3. Finance costs
4. Definition of landfill
5. Banned wastes
6. Reduction of landfill of municipal.wastes
7. Site types
8. Site engineering
9. Acceptance criteria.

1. **Site location:** Already covered in part by existing planning legislation, more general requirements are necessary for landfills, taking into account distances from housing, water / flooding regimes and cultural heritage and so on.
2. **Permitting sites**: Permissions are already covered by PPC legislation for new sites and all must have permits by 2007. Some directives go into unnecessary detail.
3. **Financial Position**: Sites must ensure that charges are adequate to cover all operations over the whole life of the operation, including thirty years of aftercare, until the permit is surrendered.
4. **Definition of landfill**: A waste disposal site is one lasting more than a year, and includes in-house waste disposal. There are exemptions, for example where recovery operations are carried out, for fertiliser spreading, for the deposit of inert wastes in permitted development and water-course dredging. Here, clarification of interpretation is awaited.
5. **Banned wastes**: These include certain liquid wastes plus explosive, oxidising, corrosive, and infectious materials. In respect of rubber tyres, however, where some categories are fine and the rest are not, Ms. Heasman invited her audience to read the rules and weep.
6. **Reduction in landfilling of biodegradable municipal waste**: Implemented through the Waste Strategy, this reduction requirement will affect everyone before too long and can be expected to be costly Targets for reduction have been set in three stages down to 35% of 1995 levels by 2016 (or 2020). Incineration, very unpopular, may be the only answer. Apart from a little paper, none of the stuff can be sold or reused. Whereas third world countries recycle much of their waste, in the UK totting is not allowed under Health and Safety Regulations. Local Authorities would like to encourage householders to minimise but at present there are no incentives. Perhaps one may see the council issuing smaller bins!
7. **Site types:** Sites are categorised as inert (a narrow range), non-hazardous (broadly stable and non-reactive wastes without biodegradable material) and hazardous.
8. **Site engineering**: All sites must have a geological barrier, of specified thickness according to site type, combined with a top and bottom liner.
9. **Acceptance criteria**: Ms. Heasman provided considerable detail on this subject for which space here is insufficient.

Implementation: We were given a series of dates by which implemention of the various types of landfill must be in place.

Ms. Heasman ended her very comprehensive presentation firstly by advising a regular check on Environment Agency¹s website and secondly by displaying the banner headline:

INTERESTING TIMES AHEAD.

A speech of thanks was given by Professor Martin Culshaw.