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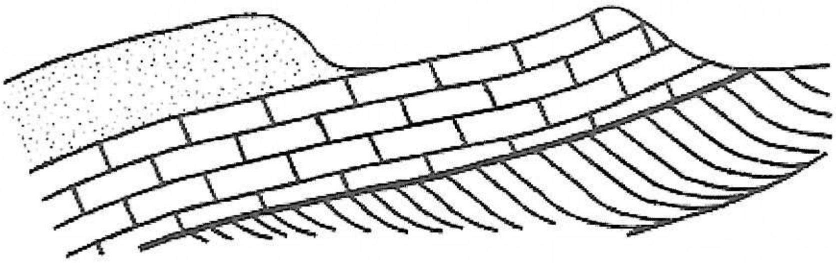

A local group within the GA

Vol. 15 No.2 **Newsletter** June 2012

Issue No: 81

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Editorial

First let me apologise that June's newsletter is rather late but a mixture of a number of editorial snags, together with new eyes (mine), new knees (husband Harry's) and the imminent arrival of a new granddaughter have kept me otherwise occupied. This issue has allowed me to catch up with most lecture and field trip reports and add a smattering of items of interest which members have brought to my attention and which other members might be interested in. So we have a mixture this time of academic lecture reports and of articles which have personal interest to our members. I hope it proves to be of interest to you too.

Liz Aston

The hair-raising truth about the Cornish tsunami

"This week, parts of the Cornish coastline were hit by what appears to have been a mini-tsunami. The wave was of no great height, but it was still substantial enough to suck the sea out for 150ft or more, before surging back in to drench the causeway linking St Michael's Mount to the mainland near Penzance, and giving tourists a soaking. The wave rolled up the estuaries and rivers from Mounts Bay in the W to Plymouth in the E, sending small boats rolling on their keels. If that isn't strange enough, witnesses said it was preceded by a surge of static electricity. 'People's hair stood on end,' said a National Trust guide on the Mount. Others reported the air going unnaturally still, with a dense, warm clamminess settling over land and sea before the wave struck.

Of course, the Cornish tsunami on Monday morning was tiny compared to the one that devastated Japan earlier this year. But the reports raise a tantalising question; might we have found one of the great holy grails of seismology - a reliable way of predicting earthquakes which could save thousands of lives? Experts suggest that the Cornish tsunami was caused by either a small earthquake or an undersea landslide off the Irish coast 250 miles away. One theory is that the resulting rock vibrations could generate a powerful electrical charge, strong enough to travel all the way along the seabed to land, up the beach, and reach the top of a tourist's head.

'It's called the Piezoelectric Effect,' says Chris Shepherd of the Institute of Physics, explaining that quartz crystals, present in the ancient rocks in and around Cornwall, could generate a high voltage if squeezed. 'It's the same effect used in gas lighters on your cooker.' Intriguingly, something similar but far more dramatic seems to have taken place several days before the Japanese earthquake. After studying data sent by satellites over the Pacific

Ocean, NASA scientists at the Goddard Space Flight Centre in Maryland have discovered that there was a sudden and dramatic pulse of heat high in the atmosphere over the epicentre of the quake 72 hours before it struck. The heat pulse was associated with an equally dramatic increase in electrical charge in the air. Similar effects were reported, retrospectively, before the Haiti earthquake in 2007.

Just what was happening is something of a mystery. A persistent conspiracy theory doing the rounds on the internet links recent big earthquakes and secret radio experiments allegedly being carried out by the Pentagon. Far more likely, however, is a little-understood phenomenon called the 'Lithosphere-Atmosphere-Ionosphere Coupling mechanism'. The theory is that in the days before an earthquake, the great stresses that have built up cause the release of large amounts of radioactive radon gas from deep in the Earth. The radioactivity from this gas ionises the air on a large scale, electrifying it and heating it up. So could something like this, on a smaller scale, have explained the weird phenomena seen in Cornwall this week? Perhaps what we saw was a combination of the piezoelectric effect and the release of radon gas - large quantities of which are present in Cornish rocks.

It is still very much a mystery. Dr Simon Boxall, an oceanographer who was out at sea on a small boat off the coast of Falmouth when the tsunami struck, thinks the wave had nothing to do with an earthquake at all, but instead was something called a 'seiche'. 'I'm 99% certain,' he says, pointing out that seismographs of the British Geological Survey did not seem to have detected any earth-shaking at all before the wave struck. A seiche is a freak wave which can be caused by an area of very low or high pressure crossing an area of water. If the speed at which the weather system is moving is just right, the sea underneath can 'resonate' like a wine glass ringing when you rub the rim in the right way, and a single big wave can come seemingly from nowhere. 'The static had nothing directly to do with the wave, but it did have a lot to do with the low-pressure system,' Dr Boxall insists, adding that S England was hit by a number of powerful thunderstorms later that day. 'The air would have been charged with static.'

Whatever the explanation, we may be getting tantalisingly close to finding a way to predict earthquakes - something dismissed as a pseudoscience until very recently. For centuries there have been reports of lightning, static and even fireballs in the sky associated with earthquakes together with, of course, persistent reports that animals are able to sense that something is about to happen and flee to higher ground. These reports are now being taken more seriously.

More than a third of a million people perished in the Indian Ocean tsunami, and 25,000 more in Japan this year. If satellites - or even the hairs on the back of your neck - could be used to predict disasters like these hours or even days ahead, millions of lives could be saved in years to come.

http://www.dailymail.co.uk/sciencetech/article-2010108/The-hair-raising-truth-Cornish-tsunami-triggered-sea-earthquake.html

Michael Hanlon. Daily Mail, 1 July 2011

Bluestones glacier theory is now frozen out

The long-running debate about the origin of the Stonehenge "bluestones" and how they got to Salisbury Plain some four millennia ago has taken another turn: a precise quarry source for much of the Stonehenge rock has been pinned down to a few square metres in southwestern Wales. This supports the notion that the bluestones were taken by human agency all the way from Pembrokeshire to Wiltshire, rather than helped along their way in the Ice Age by glacier transport. .

"The glacial theory is frozen out by this new evidence," Dr Rob Ixer of Leicester University told *The Times*. If the stones had been transported east of the Bristol Channel by glacial action, a much wider range of sources would be expected. The pinpoint sourcing that has now been done argues strongly for human quarrying and transport of the bluestones, whatever the motivation and precise route employed.

Stonehenge's "bluestones" are not the enormous sarsen trilithons which form the bulk of the visible monument, but relatively short, slender, single shafts which were used in an earlier version of the stone circle and then repositioned within the final layout.

Three major rock types and two minor ones can be identified within the "bluestone" range using both the entire stones and waste chips known as debitage which result from trimming the slabs on-site at Stonehenge. The three major groups, originally thought to be from different geographical sources, can now be shown to be from the same locale.

The area of the new find lies at Pont Saeson on the northern flank of the Preseli Mountains, long known as the general source of the bluestones, some 6.5 kilometres (four miles) from Newport in north Pembrokeshire. The discovery follows the use of zircons included in the rocks to identify an area near Pont Saeson as one likely source of Stonehenge material by Dr Ixer and his colleague Dr Richard Bevins of the National Museum of Wales.

"Almost all - 99.9 per cent - of the Stonehenge rhyolitic 'debitage' can be petrographically matched to rhyolitic rocks found within a few hundred square metres at Pont Saeson and especially to those found at Craig Rhosyfelin. However, it is possible in a few cases, where the petrography of these Welsh in situ rocks is so distinctive, to suggest an even finer provenance to within square metres, namely to individual outcrops," Ixer and Bevins report in *Archaeology in Wales, Vol 50 pp 21-31.*

They have pinned down the source of rhyolite rock fragments, found at Stonehenge more than 60 years ago and stored in a shoebox for decades, to a specific outcrop at Craig Rhosyfelin, part of the Pont Saeson outcropping. "These very distinctive rhyolitic rocks can be traced for no more than 150 metres from the northeastern most end of Craig Rhosyfelin," they say.

The outcrop itself is some 70 metres long and has many tall, narrow slabs up to two metres (6.5ft) high as the dominant feature, splitting off from the parent rock and reminiscent of the Stonehenge bluestones. One of the Stonehenge shafts, known as SH32e, can be matched very closely to this outcrop, and must have been quarried there, not transported by a glacier.

"I have always wanted to tell this story under the tabloid heading 'Old shoebox held key to Stonehenge mystery," Ixer said. "The work stems from an old box in the Salisbury Museum holding stones collected in 1947".

"The overwhelming majority of the Stonehenge rhyolitic 'debitage' can be sourced from the Pont Saeson area and perhaps entirely from Craig Rhosyfelin, but from more than one site on the crags," Ixer and Bevins conclude. The dispute over natural versus human transportation for these elements of an early and important phase of Stonehenge now seems to be settled; as Ixer says, "The glacial theory is out cold".

Norman Hammond, Archaeology Correspondent, The Times, Saturday 12 December 2011

Tectonic Archaeology in Japan: Volcanoes and Earthquakes in the Archaeological Record - Summary of April 2012 lecture given by Gina Barnes, SOAS, University of London

Japan's position at the juncture of four tectonic plates gives rise to much tectonic activity in the form of volcanoes and earthquakes. Both these hazards have affected occupants of the archipelago throughout history. Evidence of earthquake occurrence and volcanic activity is being garnered at archaeological sites through excavation, while the new field of 'disaster archaeology' assesses human responses to these hazards.

'Earthquake archaeology', as it is called in Japan, is very different from archaeoseismology in the Mediterranean. The latter focuses on earthquake damage to buildings and other features built of stone; Japan's archaeology contains little stone, instead being characterized as 'posthole archaeology' because most superstructures were organic and have decayed. Thus earthquake evidence in Japanese archaeological sites takes the form of sediment deformation itself: strata riven by fissures, intruded by sand boils due to liquefaction, eroded by landslips, displaced by fault action, and affected by soft sediment deformation.

SANGAWA Akira, of the Geological Survey of Japan and AIST (*Japan's National Institute of Advanced Industrial Science & Technology*), is the moving force behind Earthquake Archaeology; he noted that the dikes of the >200m-long 5th-century Kondayama Tomb in Osaka were offset by faulting during the survey for Active Faults in the 1980s. His efforts in establishing Earthquake Archaeology in Japan slightly preceded the development of Archaeoseismology at the Athens conference in 1991. In 1996, a compilation of earthquake evidence at 378 sites in Japan was published, with 75% being the result of liquefaction – such as the extraordinary case of a 35cm standing stone erected at the head of a spout of cobbles brought up by liquefaction from below (Fig. 1). Japanese researchers are now leading the field in soft-sediment deformation studies by taking radiographs of vertical sediment sections to assess the extent and kind of damage.

The main consumers of Earthquake Archaeology are palaeoseismologists who are working to discover the cycles of earthquake occurrence through history in order to refine predictions. There are two kinds of earthquakes whose effects need separating in the archaeological record: those caused by subduction, where a large earthquake occurs every 100 years or so (Fig. 2), and those caused by Active Faults (a result of compression of the archipelago between the Eurasian plate moving eastwards and the oceanic plates moving westwards) which occur about once in 1000 years on any particular fault.

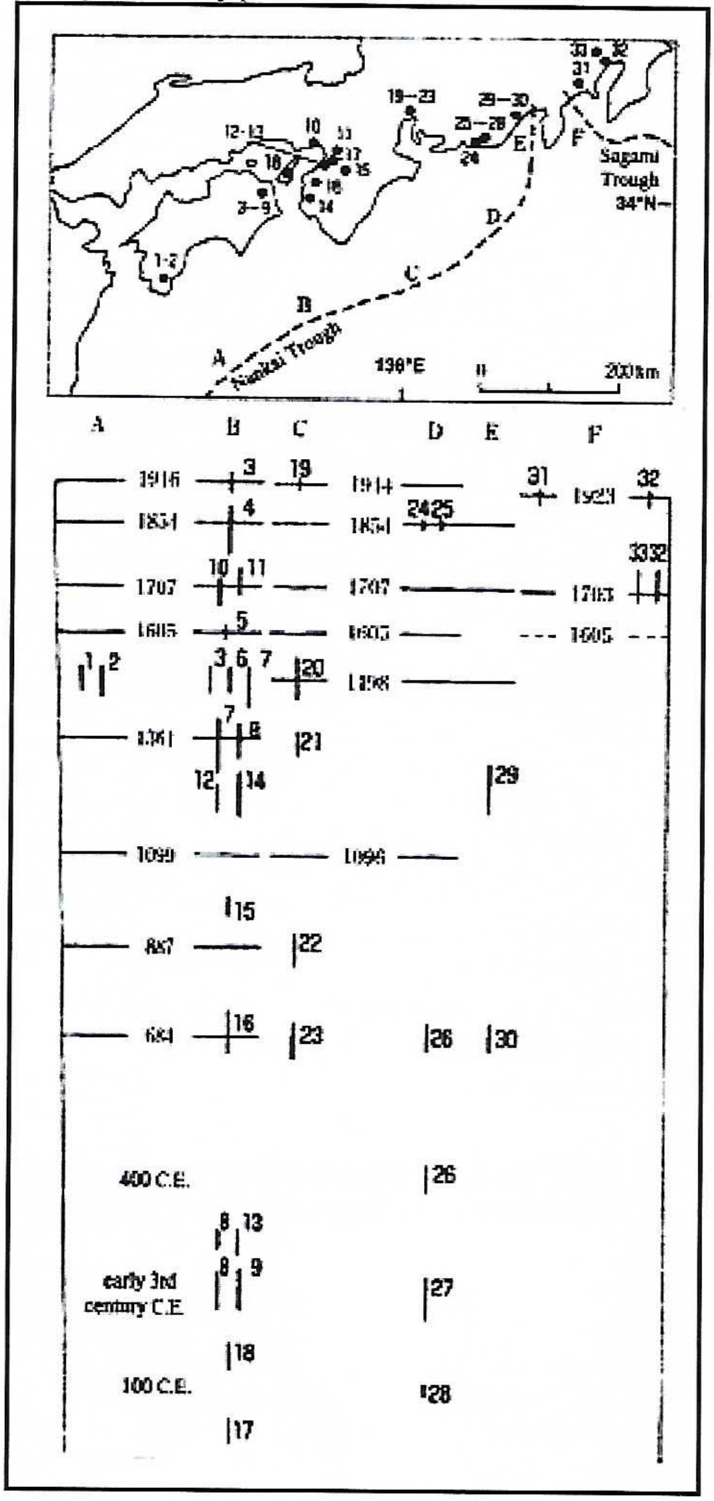


Fig. 2: Subduction earthquakes evidence in southwestern Japan from the historical and archaeological records (after Sangawa, 2001)

Fig. 1: The Late Yayoi period Izumida site, ca. AD 100, in Fukui prefecture, where a human-placed standing stone marks the eruption of cobbles during a liquefaction event

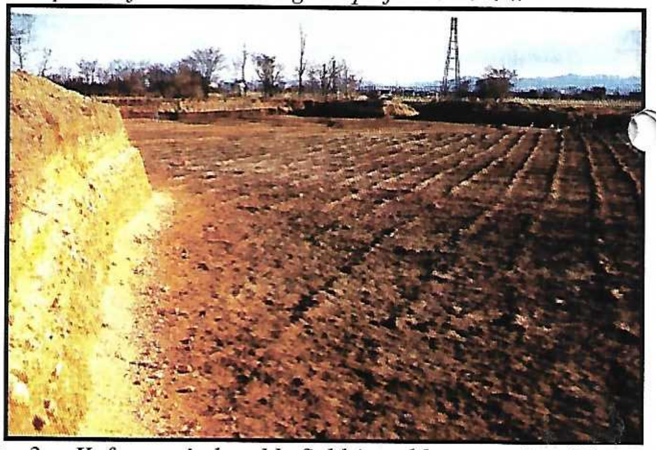


Fig. 3: Kofun-period paddy field (ca. 6th century) at Ofuro, covered by FPF-1 pumice, Takasaki City, Gunma prefecture

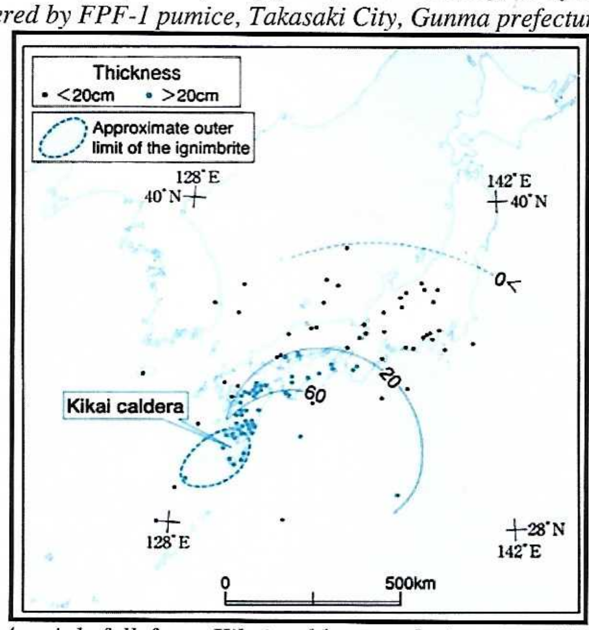


Fig. 4: Ash fall from Kikai caldera explosion, ca. 7,300 ca BP, devastating western Japan in the Jomon period (revised from Machida & Arai 1978)

Correlating archaeological evidence of earthquake damage is an inexact science. An important aspect is the regional scope of damage that can be identified as being within reach of the breaking fault or hypocenter – a subjective judgment, and the relative dating of archaeological remains does not give exact dates – namely date, time, and second – of earthquake occurrence as on a seismograph. Nevertheless, to ignore the archaeological record would be to ignore much general data that can exhibit patterns over a long time span.

The positive aspects of Earthquake Archaeology are that:

1) evidence of damage occurring at archaeological sites can be dated by relative material culture chronologies, unlike evidence found in the great out-of-doors;
2) training in recognition of earthquake damage can mitigate against mistaken cultural interpretations (liquefaction dikes as ditches, for example);
3) human behaviour in disaster situations can be monitored through time.

The negatives, however, are that:

1) one cannot assume damage evidence is caused by earthquakes until proven beyond doubt;
2) individual sites cannot be assessed without recourse to regional patterns; and
3) there is little discussion of the methodology among archaeologists.

'Volcanic Ash archaeology' is also a new discipline in Japan, following earlier development of the field in places like Italy and Mexico.

Quaternary volcanism began in Japan around 700,000 years ago, and there are 108 volcanoes active in the Holocene, with earlier Late Miocene and Pliocene volcanoes supplying humans with stone sources in prehistoric times and caldera lakes for modern leisure activities.

Although volcanoes are a small proportion of the mostly folded mountains in Japan, volcanic ash has reached every square inch of Japanese soil at some time or other; but the areas affected by thick tephra cover are the Kantō region around Tokyo and the island of Kyushu. Ash and pumice can be hundreds of metres thick and have affected the way that agricultural land is used in these areas: oranges being a good crop to grow in Kyushu pumice and buckwheat, or root crops like giant radishes, in the ash-laden areas west of Tokyo.

Archaeologists in Kagoshima prefecture, at the southern tip of Kyushu, and Gunma prefecture in the Kantō region practice disaster archaeology – recovering prehistoric and early historic sites that have either been destroyed by tephra, or temporarily disabled, but revived for further use. Paddy fields have been recovered in stratigraphic succession under various tephra falls (Fig. 3), giving us an idea about field structure and irrigation facilities that are different from modern solutions. House remains have been found collapsed by tephra fall, with some directly correlated with historic documents.

Two caldera explosions in Kyushu have adversely affected prehistoric Japan to a great degree: the eruption of Aira around 24,000 years ago, and the eruption of Kikai at 7,300 years ago (Fig. 4). Tephra fall buried much of Japan under 20 cm of ash, which would have devastated the environment for hundreds of years. Archaeology notes the extinction of regional cultures at these times, and their replacement by different material cultures after a long hiatus in each case.

Despite the risk of volcanic eruptions, there is little public information, other than crater avoidance, available to inhabitants near active volcanoes – unlike public prescriptions of what to do when earthquakes strike.

By comparison, British citizens should feel extremely safe in their home environments!

Gina Barnes

Geology of China

Summary of January 2012 lecture given by Roger Lloyd, Member FGS

My younger son took a job with a rock climbing company in Yangshuo, China (~25°N, ~110°E) so I went to visit him in January 2010. Yangshuo has a population of ~ 300,000 and has become a tourist destination for rock climbers.

The scenery around Yangshuo is fantastic. The shape of the town and the meandering river Lijiang are constrained by Karst towers. The area has a monsoon-influenced humid subtropical climate, with mild winters and long, hot, and humid summers. The monsoon lasts from March to August, and a pronounced dry season occurs in fall and winter; the total annual rainfall is 1,920mm. Mean temperatures range from 8.5 °C in January to 28.7 °C in July. Snowfall is rare but possible in winter.

My flight stopped in Muscat en-route to Bangkok. From the air, the ubiquitous sand dunes of the Saudi Peninsula gave way to a typical mountain desert landscape. The high ground was cut by steep canyon-like wadis and subject to flash floods. The country looked savage and really difficult to move across (see Fig. 1).

I left Bangkok on a China Southern Airlines Boeing. This was my first experience of a Chinese airline and I wondered what would be in store. Like much in China, the terminal building at Guangzhou was built to impress, it appeared to have a capacity that was far higher than needed for the numbers of people currently using it. On landing, I had to collect my bag and then check it in for the next flight to Guillin; baggage arrangements seemed rudimentary with a hand listing of all through bags coming from abroad.

My son met me and soon we were sitting in the Lizard Lounge at Yangshuo drinking free beers by courtesy of China Climb, my son's employer. Wholesale beer is so cheap that the company found that free beer for the employees was well worth the goodwill generated. China Climb's business is to teach rock climbing to all those who wished to climb the numerous and spectacular rock faces. Yangshuo is relatively westernised and quite a few of the locals have a smattering of English.

Bus travel is comfortable, quick and about 1/4 of the cost of air travel; the ease of booking and the relatively short times between destinations, makes it a good choice for most destinations. Rail was another good option and much cheaper than air travel.

Low Mountain where clients practise rock climbing techniques was my first encounter with Karst rock faces (Fig. 2). The near vertical rock faces have varying degrees of difficulty and frequent caves. The limestone is massively bedded (possibly due to Milankovitch cycles) with a gentle dip ~5°. Frequent hollows formed in the rock face as the river system cut into the Karst, providing numerous foot and handholds for climbers. Limestone is generally an excellent climbing rock; it does not crumble easily and few stones are dislodged during a climb. Going inside the cave on Low Maintain provided an opportunity to examine the limestone. The white and red streaks (probably calcite and iron deposits) probably developed during post depositional uplift.

There is not much traffic in Yangshuo, so the pace of life is pleasantly slower. In January the water in the River Lijiang was cold; it warms from April, reaching the high 20's C by September. Everyone swims in the river while it is hot and boat/raft tours occur all year; the local boatmen are convinced that your only reason to visit is to take their boat tour.

There is a lot of so-called 'marble' in the local buildings. In close up, uneven mud layers, mud drapes and irregular limestone units are apparent. I felt this 'marble' had a shallow water origin; discussions later identified it as an evaporitic sequence - the black drapings representing algal mats lying over fine limestone muds and anhydrite beds, now appearing as nodules. Many of the roads in Yangshuo have also been paved with other equally lovely limestone slabs (Fig. 4).

Fig. 1: The surface delineated at the lower edge of the light coloured rock layer could be a possible unconformity.

Fig.2: The limestone bedding and joints in the karst rock provide hand and foot holds.

Fig. 3: The local 'marble' really a shallow water evaporitic limestone sequence.

Fig. 4: Paving stones of another shallow water limestone showing bioturbation and possible stylolites and cementation features.

In Europe karst is classified by the shape of the outcrop, e.g. columns would be termed tower karst. However the Chinese classify karst not by the shape of the outcrops but by the presence (or not) of a karst plain between the karst hills. This produces two main types of karst: 1) Fengcong (pronounced fungtsung and translating as peak cluster) has roughly conical hills and separated by deep closed depressions, all standing on a common bedrock base so that it forms a continuous surface of steep slopes and notable relief; Fengcong is equivalent to Cone Karst in Western parlance. 2) Fenglin (pronounced Funglin and translating as peak forest) has isolated hills rising from a plain which is normally formed of limestone, capped with a thin cover of alluvium. There are numerous excellent examples of Fenglin karst between Yangshuo and Fuli.

The karst hills frequently have steep sided towers rising from a flat plain. Often these towers rise to more than 100m and are more striking when they lack talus aprons around their base. There is considerable variation in steepness and individual profiles but vertical cliffs do not occur in Fengcong karst. The Karst of Southern China is very extensive and extends across SE Asia to parts of Vietnam, Myanmar and Thailand.

The Karst is very thick; near Guilin the Devonian is thousands of metres thick. The Karst was laid down almost continuously from the Devonian through the Carboniferous and Permian into the Triassic; the outcrop is cut by large faults which extend over long distances. The Fengcong Karst extends from Three Gorges, China, in the NE to Vietnam in the SW. The Fenglin Karst is less extensive

The development of the Fengcong and Fengling Karst starts with an extensive unbroken sheet of thick limestone. Dolines (a general term for a closed depression in an area of karst topography which is formed either by solution of the surficial limestone or by collapse of underlying caves) start to form. In the tropics, beneath a cover of soil, limestone is dissolved rapidly to form deep dolines or cockpits; in porous limestone, not protected by soil, the solutions do not have time to drain from the rock before they are evaporated and calcium carbonate is reprecipitated nearby forming an indurated capping, very resistant to erosion. These effects of solution and induration are largely dependent on soil cover and on purity of the limestone to produce a rugged landscape.

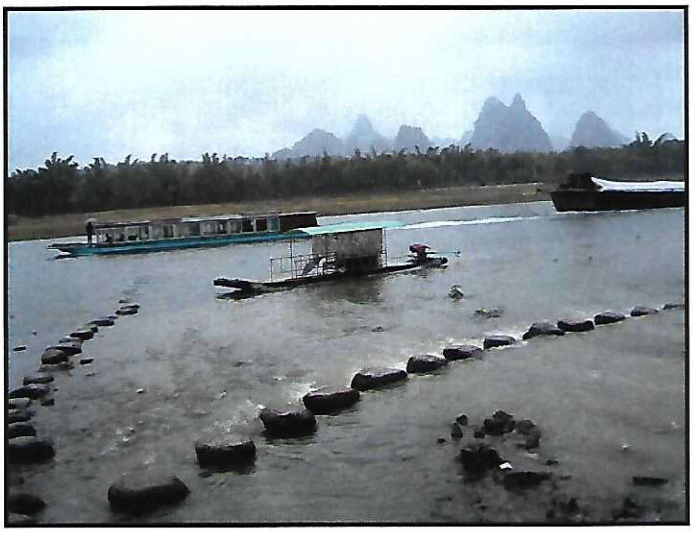


Fig. 5: River Li at Yangshuo - river trips are very popular with tourists and the stepping stones have been carefully placed. If you look carefully you can see the cement layers.

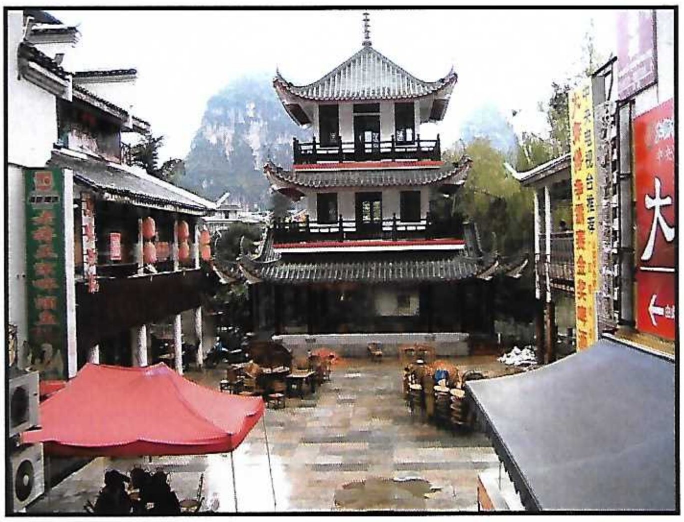


Fig. 6: A traditional Building in Yangshuo Some traditional buildings have been constructed recently.

Houses vary from modern to traditional (Fig. 6) and those perched precariously on the banks of the River Li are sufficiently high above the water line to avoid being inundated during flood conditions.

Driving back to Guilin, to begin my journey home, I was scheduled to catch an Air China Southern Flight to Guanzhou and then onwards to Bangkok before returning to the UK. However, there were thrills to come as a routine minicab journey proved to be rather alarming. All lanes are game for the Chinese and I was horrified to find that the inside lane was occupied by traders selling goods while cavalier drivers were hurtling down the inside lane.

This was a memorable holiday indeed. China is a wonderful country in which there is the full range of geological wonders to be seen. They do things differently but I can thoroughly recommend a visit. Perhaps the FGS might consider a visit there.

Roger Lloyd

FGS field trip to the Hertfordshire Puddingstone – 5 May 2011

On Saturday Graham Williams led about two dozen of us on a fieldtrip to Hertfordshire and (part of) Essex to show us, and to perhaps solve the mystery of, the Hertfordshire Puddingstone (hereafter HPS).

HPS is a conglomerate of well rounded smooth black pebbles in fine sand, strongly cemented by silica that has a hardness closely matching the (siliceous) flint pebbles, so that if fractured, it breaks as a coherent unit across both pebbles and cement. Individual pebbles have black rims, their centres stained yellow, brown, orange or red in an attractive pattern of colour (Fig. 1). For these reasons, the stones are collectable, popular in lapidary and polished pieces are made into pendants and other jewellery.

Larger blocks were used in Roman walls and in medieval buildings, particularly churches, and examples are found of its use as pre-historic and Roman quern stones (a quern stone is the lower stone, part of a pair of stones used for grinding).

Folklore has given HPS a mystique and power, typical comments being: "it grows in fields", "keeps away evil", "breeds new stones" and "the stones move".

We looked at HPS in the walls of two medieval churches, at St. Giles in Great Hollingbury and at St. Andrews at Much Hadham (St. Andrews also has some Henry Moore sculptures of heads). In both churches, the builders had placed HPS blocks in the rubble / cement flint-faced walls, always fairly low, some at ground level and often by doorways (Fig. 2). Were these placed near to doors to protect the entrance?

Near the church at Standon, a large monolith of HPS from an earlier church's wall had been erected. Perhaps, it was suggested, from a much earlier ritual site, upon which the church was built (see comments with Fig. 3). In Hertford museum there were other examples.

At Sutes Farm, a fine medieval house near Standon Green End, the owner showed us a dozen or so great blocks of HPS acquired from an A10 road improvement scheme, apparently excavated in a cutting across a small hill near the farm "from above the chalk". This was perhaps the nearest to an exposure anywhere!

So what could FGS make of all this? We were sure the pebbles were deposited in a high-energy beach environment; the flints are smooth, well rounded, generally well sorted, poorly parallel bedded with chatter-marks; the pebbles are in contact, thus self supporting with a matrix of sand. The flints probably originated from the White Chalk.

But where was the HPS from and how was it cemented? Although glacial origins were suggested locally, we could find no evidence on the stones for this and no sensible source came to mind. Could the pebbles have become cemented offshore? Sufficient silica could hardly be available in shallow waters and the pebbles could not be from the deep ocean. Why were there (apparently) no outcrops, no exposures, and why was it always in discrete lumps? Maybe the rock was *in*, or, was nearly, *in situ*, just below the present surface. So where did the Tertiary silica come from? We had Tertiary temperature data and the local geology, but were confused and needed help.

Graham summarised and gave the rock another name, *silcrete*, and the penny started to drop. We had seen it before on the Marlborough Downs as sarsens, at Stonehenge and at Avebury (more sarsens) and on some Surrey Heaths, including a puddingstone on Croham Hurst in South Croydon/Selsdon. It was a semi-continuous deposit, a late or post-Cretaceous beach, broken up by glacial/periglacial earth movements after it had become cemented in a much warmer climate and when Britain was some ten degrees south of its position today.

Severe periodic loss of water from later deposits overlying this beach deposit, together with evaporation exceeding precipitation, encouraged ground water to rise through the pebble bed to replace the losses of water above. Dissolved silica, concentrated in the ground water, precipitated out and slowly cemented the pebbles, as it rose and permeated through the pebble. Climate data show two phases of high temperatures, early Eocene and Miocene (ca. 55.8-50.0Ma and 23.0-5.3Ma) suggesting that the diagenesis and cementation had probably occurred at those times.

Good building stone is relatively rare in Hertfordshire, HPS was a "different" stone and could be used as an alternative to flint, and, as in medieval Surrey, where in folklore Carstone was used to protect buildings against evil and witches, so HPS was used in Hertfordshire.

It "grew in the fields" as flint does in "clay-with-flints" on the Chalk downs, and, as with flint, this implies it is plentiful below the surface in broken blocks and pieces that become exposed by weathering and ploughing. It "moves", but farmers since Neolithic times, working their fields build up lynchets (low banks), the soil and stones moving down-slope; these days, modern deep ploughing to break up any hard "pan" does the same.

The A10 road cutting at Sutes Farm hinted that HPS capped the local hills "above the Chalk" and is quite extensive, but such comprehensive cementation must have occurred millions of years before the Pleistocene.

Puddingstones (sarsens, silcretes) are not unique to Hertfordshire and occur widely but without question the Hertfordshire Puddingstone is one of the best.

Very many thanks to Graham from us all for an interesting and thought-provoking day.

Fig. 1: Close-up of the HPS. Typical view of the HPS pebbles showing the black coating of the pebbles and the fracturing across the silica cement and siliceous pebbles as a coherent mass when broken.
Scale: The large pebble is ca.6cm long.

Fig. 2 (above): This shows the HPS in the lower part of a wall with Roman tiles and flints.

Fig. 3 (above right): The Standon Village Monolith of Puddingstone ... called a "breeding stone". It was formerly incorporated in the wall of the churchyard. It is thought possible that the stone might have marked a prehistoric tribal, religious, meeting place and that the early Christians therefore chose the same site on which to build their church." Scale: ca. 60cm diameter.

Mike Rubra

Megaflood in the English Channel makes 'island' Britain

Summary of October 2011 lecture given by Dr Sanjeev Gupta, Imperial College

How did Britain become an island? Surprisingly the answer to this question has remained unresolved until recently. Yet Britain's island status has governed its palaeogeography in relation to western Europe, its archaeology, and ultimately its historical development. In my talk I show new geophysical data from the floor of the English Channel that reveals morphological evidence pointing to a huge megaflood event(s) being the causative mechanism.

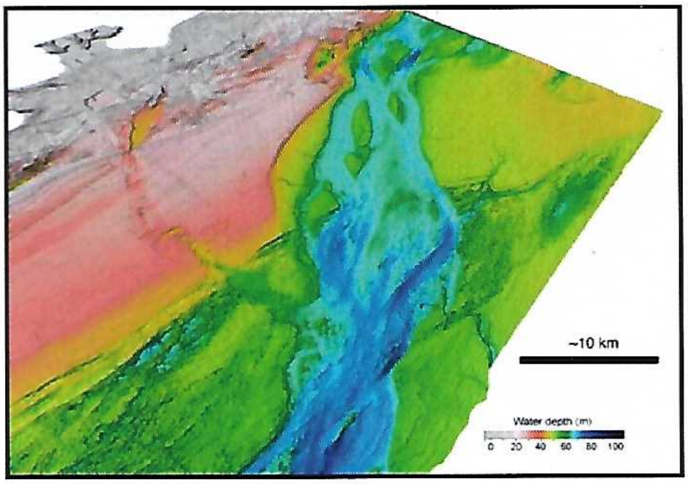


Fig 1: The lake that fed the mega-flood (blue), ice sheets (white), the red line indicates the position of the land bridge. The black arrows show rivers, and the exposed land between England and France is shown in brown.

Fig. 2: Three-dimensional perspective view of flood-eroded Northern Palaeovalley in English Channel looking NE. View is a coloured and shaded relief bathymetry image. Vertical exaggeration is ~6x. Water depth indicated by colour bar.

Twenty-thousand years ago, at the peak of the last glaciation, if you had stood at the present coastline of southern England and looked across the Channel, you would not have seen sea, but, instead, dry land extending all the way to France (Fig. 1). In the centre of the Channel a massive river, formed from the combined Rhine and Thames rivers, would have flowed westward to the Atlantic ocean. The Channel would have been dry land because during the glaciations, seawater gets locked in the ice sheets as these grow and expand and sea-levels fall. In the past 2-3 million years, Earth's climate has fluctuated between cold glaciations and warmer interglacials and as a result sea-levels have changed dramatically. In particular, in the past 500,000 years, sea-levels have fallen up to 120m below present on five occasions. As a result the shallow shelf areas around Britain have become exposed to subaerial conditions. Once climate warmed and the ice sheets melted, shallow seas once more covered the English Channel and North Sea.

However, these two seas, which now join each other at the Strait of Dover, would not have been connected until the narrow gap at the strait was created. Prior to formation of this gap, an extensive rock ridge made of Chalk (that forms the famous White Cliffs of Dover) would have extended from southern England into France – this ridge is called the Weald-Artois anticline. The presence of this rock ridge meant that even during times of high sea-level, the English Channel and North Sea were always disconnected. Breaching of the rock ridge to form the Dover Strait is thus the prerequisite condition for Britain to become an island during sea-level highstands.

How did this rock ridge get breached? Up to now, it was generally thought that slow erosion over hundreds of thousands of years progressively cut this ridge back. However, a number of alternative mechanisms have been proposed. In the 1970s marine geologists from France and Britain discovered that the floor of the English Channel was carved by a series of large valley systems eroded into bedrock. These valley systems were proposed to have been eroded either by rivers during sea-level lowering, or erosion by advancing glaciers. The latter mechanism has been shown to be false as there is clear evidence that glaciers did not reach the English Channel. Prof. Alec Smith proposed an 'outrageous hypothesis' in 1985; suggesting that the valleys had been carved by a catastrophic outflow of water from a huge lake in the Southern North Sea. This lake, he suggested, had been formed by the icesheets blocking the North Sea area to the north and the rock ridge at Dover forming a southern barrier. However, he lacked the detailed evidence to convince others of this mechanism, and thus the hypothesis has remained untested.

We have used a new regional compilation of sonar data that reveals the bathymetry of the English Channel floor for the first time. This remarkable dataset has been collected over a period of 30 years by the Maritime and Coastguard Agency and the UK Hydrographic Office for civil safety at sea. Now it has found a scientific application. When we analysed the morphology of the landscape now under the sea, we discovered clear geomorphic evidence to support Smith's hypothesis (Fig. 2).

Fig. 3: Close-up from image in Fig. 2 above. The dark (purple) areas are deep scours and grooves in the valley floor, where the rock is softer.

The data reveal a huge valley, some 10-15km wide and up to 50m deep carved into the bedrock floor of the Channel, this must have been caused by a huge torrential flood, a megaflood. Within the valley we see a whole host of geomorphic features that taken together are characteristic of erosion by catastrophic megafloods. Features observed include giant scours (Fig. 3), longitudinal striations, and streamlined islands where channels in the valley have bifurcated.

Such landforms are prominent in the Channeled Scabland in eastern Washington State (USA), where drainage of a huge ice-dammed lake – Glacial Lake Missoula – caused erosion of large channels some 15,000 years ago. The scale of the landforms observed in the English Channel are similar to those observed in the Scabland, and other regions that have experienced megafloods, and thus strongly suggest that a megflood origin for the English Channel valley systems is correct. Moreover it is quite clear that the landforms we observe could not be carved by normal river processes eroding into bedrock.

Overall our observations support the megaflood model, in which breaching of a rock dam at the Dover Strait instigated catastrophic drainage of a large pro-glacial lake in the Southern North Sea basin. This event created a gap in the rock ridge that previously straddled the Strait from England to France, thus allowing the English Channel and North Sea to connect during interglacial high sea-level stands. The flood thus explains how Britain became an island.

Our discovery also provides an explanation for large-scale reorganisation of palaeodrainage in NW Europe and patterns of early human colonisation of Britain. The flood event(s) caused the diversion of the combined Rhine-Thames river systems to flow through the Dover Strait and through the centre of the English Channel forming the mega-Channel river.

Archaeologists are also excited about our discovery. One of the great mysteries of the record of early human occupation in Britain is that early humans are missing from about 180,000 years ago to 60,000 years ago.

We propose that the megaflood event may have changed the landscape so significantly that it became difficult for early humans to migrate from France to southern Britain. In addition once sea-levels rose during interglacial periods and connected the English Channel with the North Sea, the former landbridge formed by the Weald-Artois anticline would no longer have existed. Thus early humans would have been confronted by a seaway at the Dover Strait, making it exceptionally difficult to cross. The absence of evidence for early humans during the last interglacial may thus be a consequence of the megaflood event(s) we have described.

Sanjeev Gupta

Lustrous Stone and Fatigue Cracking in Anthracite

My two publications: '*Lustrous Stone*' and '*Fatigue Cracking in Anthracite*', may seem to relate to disparate subject matter, but both are linked to earth movements that occurred in the past. Thus have caused both frictional change and what is generally described in an engineering context as fatigue, a well researched cracking phenomenon brought about by many repeated loads.

It has long been known that sliding rock interfaces may become polished, not just the commonly observed smoothing, but in some cases the achievement of a 'mirror-like' finish. Even as long ago as 1865, Sir Charles Lyell described this phenomenon in his 'Treatise on Geology', where he made the astute observation that the sliding movement involved must have been, to use his own word, reiterative.

The (*second*) note in 'Materials World' is a summary of a more extensive investigation of earth movements in other materials. Although it started as a study of the polished surfaces that characterise anthracite, it was no particular surprise, in view of what has been stated above, to find this evidence of fatigue cracking in a non-crystalline material such as vitrain.

In engineering circles use can sometimes be made of the spacing and numbers of the characteristic striations that appear on fatigue fractures to estimate the rate of crack growth, and hence predict the onset of catastrophic failure, but this is only feasible where a lot is known about the load history of the part. Clearly, no such analysis is possible in the case of anthracite. This cracking may, therefore, remain only as a scientific curiosity, but these fatigue cracks, and they are present in great numbers, explains why this material is so friable. This investigation has also shown that the other feature, the bright facets, are not, as the text books state, fractures, but are the result of mechanical polishing by earth movements.

If you are interested in this work, please email: rupal.mehta@iom3.org who will pass on your details to Peter.

Peter Forsyth, Member FGS

Lustrous Stone

Reprinted from British Archaeology, November/December 2007, p27

"While walking along a woodland path in the Farnham district, it was noticed that pebbles rather unnaturally glistened in the sunlight. One specimen was convex in shape, 50mm by 30mm, its surface almost totally covered by cones of percussion.

Closer examination revealed that the polish was generally limited to the raised areas on one side. The local cones of percussion had been cut through with the removal of a considerable amount of material (at least in microscopic terms) to produce an alignment of furrows (Fig. 1). The only defects in the high quality of this finish are the sectioned conical cracks and other associated pits (Fig. 2). At magnifications as high as x1500, no scores were visible, unusual even for a faceted gemstone.

The most plausible explanation would seem to be that, as railway ballast, this pebble had been wedged beneath a wooden sleeper that had been repeatedly loaded by the passage of rolling stock. This could well amount to many millions of load applications – the same loading environment that leads to fatigue cracking of tracks

Thus the wood, containing minute silica particles, acted as a natural lap. Extremely minute particles of flint debris would have augmented the abrasive material. One is reminded of the classic case of the polishing of flint sickles that arises from cutting straw, which also contains silica particles. However, in those situations any flint debris would more likely be freed.

Although the precise mechanism whereby brittle materials such as glass or gemstones can be polished has long been a subject of conjecture, it is generally agreed that the rate of material removal is much enhanced by chemical action. In the case in question the environment would be wet and most probably acidic.

It is sometimes worth exploring other branches of science and engineering beyond the purely archeological path."

Fatigue Cracking in Anthracite

Reprinted from Materials World (International Mining & Minerals) 2011, Journal of the Institute of Materials, Minerals and Mining

"A number of pieces of anthracite, including some from a spoil heap near Newgate, South Pembrokeshire, have been microscopically examined by Peter Forsyth FIMMM. When broken by bending with respect to its bedding plane, many fatigue fracture origins were exposed in the vitrain, the hard compact constituent of coal.

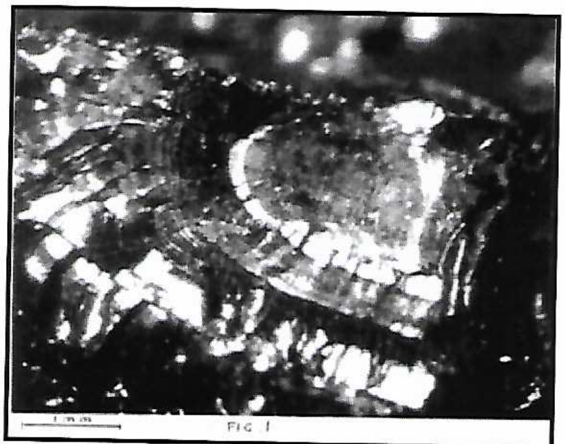
Fig. 1 shows a typical example which exhibits all of the characteristics of fatigue fracture associated with various amplitude loaded high strength metallic materials. Variations in the rate of crack growth, as revealed by striation spacing, changes in fracture roughness and occasional crack jumps that resulted in an increase of the crack front length are all features, observed on metal fatigue fractures. One feature, less likely to be found on fatigue fractures of metal components, was occasional abrupt tilts of the fracture surface. This is indicative of sudden changes in the principal tensile stress direction as might be expected from chaotic earth movements.

Apart from the crack growth rate changes there was evidence of extensive rubbing and polishing, particularly on the steeper fracture faces. – a common experience with metals where there has been crack closure. The considerable earth movements over geological time, particularly in the South Pembrokeshire region would have exerted variable amplitude loads on the anthracite seams, causing the observed fractures.

Every piece of anthracite that has been examined has exhibited some evidence of fatigue and such internal fissuring would account for its friable nature. Vitrain has been described as a hardened colloidal carbonaceous jelly resulting from the complete decomposition of plant materials. Its tensile fracture is sometimes conchoidal, but not necessarily lustrous. The highly polished appearance so characteristic of this substance [Fig. 2 above] is the result of extensive rubbing of sheared surfaces.

Highly polished surfaces have also been observed at the points of contact of pebbles and even long buried flint artefacts. These arise from the rubbing and rocking action imparted by earth or water movement, and it was a study of this phenomenon that prompted the examination of anthracite.

Similar fatigue fractures have been observed on opal - both are a hardened gel. Some cracks were found to have penetrated the surrounding parent rock, still exhibiting evidence of intermittent growth."



These Figs 1 and 2 relate to both reprinted articles and to Peter's original comments

FGS monthly meetings - 2012

Date	Speaker	Title
13 July	John Stanley & Edward Finch FGS	tba
14 September	Dr Paul Taylor Natural History Museum	The animals that David Attenborough forgot: the natural history of fossil and living Bryozoa'
12 October	Dr Douglas Robinson Bristol University	Geology of Naxos
9 November	Dr Mick Frogley, University of Sussex	Mud, Mites and the Incan Empire: Quaternary palaeoenvironments in the Andean Highlands
14 December	Dr R Moody, Consultant	History of Dinosaurs and art