Farnham Geological Society

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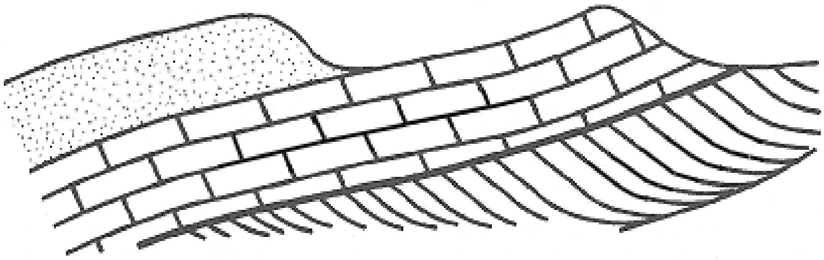

A local group within the GA

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Editorial

There have been four talks and an important field trip since the last newsletter, all of which I should have liked to report in this newsletter, but I have not received all of the talk summaries, and have only received half of the Brittany field trip comments. So these will have to go in the next newsletter.

However, there have been two significant earthquakes since the last newsletter came out and so I have included some information about both. The first one presents details of two people's personal experiences of the actual earthquake and aftermath from the Christchurch, New Zealand, earthquake - for those of us who have never experienced an earthquake, they give an idea of it's effect on one's life. The second article gives some observations on the Japanese earthquake.

I have many people to thank – first the many members of the Society are now providing good photographs and summaries of the field trips, which Graham Williams has continued to organise so expertly. Secondly to Janet, who has continued to organise the monthly talks and to coerce the speakers into providing us with summaries. I personally regret not being able to attend many of the lectures or fieldtrips, as they are all extremely interesting and varied. Also, my thanks go to John Stanley who is preparing a comprehensive index of the articles in all the Newsletters ever published and whom I am hoping to coerce into providing a similar library of all the photographs submitted by members to the FGS from field trips.

The layout for this newsletter is an experiment. We had a request to try a two-column format, so here it is. The Committee seeks your comments regarding appearance, ease of reading, understanding, etc. We will then review the comments and if necessary change to this format, or revert to the former layout, for following newsletters.

Another experiment is to provide information on websites - many members comment on both websites and articles which they have found on the 'net' and which are then forwarded to members who are on email. This leaves the non-email members in the dark, so I have included a short section noting the subjects and links that can be accessed for those members. Apologies to any member if you are not credited or if I have inadvertently omitted the information or link which you provided. Again please let me know if this is helpful and if you would like me to continue this in the future with other links.

Erratum: John Pearce, who gave the talk *30 Years Mineral Collecting* (October 2010), has contacted FGS to congratulate us on the photographic quality of our newsletter but noted that the last line of the summary of his talk should read "*Thanks to John Hall for allowing us to reproduce his photos*". I can only apologise for this omission.

Liz Aston

The Paphos Landslide Study, Cyprus

Summary of April 2011 lecture given by Dr Andrew Hart, URS/Scott-Wilson Ltd.

The Paphos District of Cyprus is characterised by a sequence of weak to very weak rocks, comprising bentonitic clays, mudstones, and tuffaceous sandstones, and a clay-rich melange with interbeds, derived by the erosion of the underlying rocks as a series of submarine debris flows. The uppermost units, forming high level plateaux, are a range of chalks and limestones. Where these formations outcrop in the highlands of the region, the relatively steep slopes, intense winter rainfall, and periodic earthquakes have combined to form one of the most landslide-prone areas of Cyprus, with landslides frequently impacting villages and roads (Photos 1 and 2). A recent project providing assistance to the Cypriot authorities has assessed the levels of landslide susceptibility across a project area within the district.

The project has catalogued 1,844 landslides within a GIS-based (GIS – Geographic Information System) landslide inventory, with landslides covering approximately 24 % of the 546 km^2 study area (Figure 1). A statistical analysis of the landslide inventory allowed the landslide activity of the project area to be characterized and some interesting relationships identified. For example, the landslide inventory records a number of landslide types that are strongly related to local stratigraphy and topography.

The results from this analysis of the landslide inventory were then combined with the results from a GIS-based factor analysis and a terrain classification developed by the project, to develop 1:50,000-scale maps of landslide susceptibility for the project area (Figure 2). In particular, the GIS-based factor analysis identified a number of combinations of terrain unit, geology and slope angle that are highly susceptible to landslide activity.

The presentation outlined how the landslide inventory and terrain classification were developed, some of the results from the statistical analysis of the landslide inventory and the GIS-based factor analysis and then how these results were used to develop the landslide susceptibility mapping. The presentation also described how this landslide susceptibility mapping can be used by the Cypriot authorities for planning purposes.

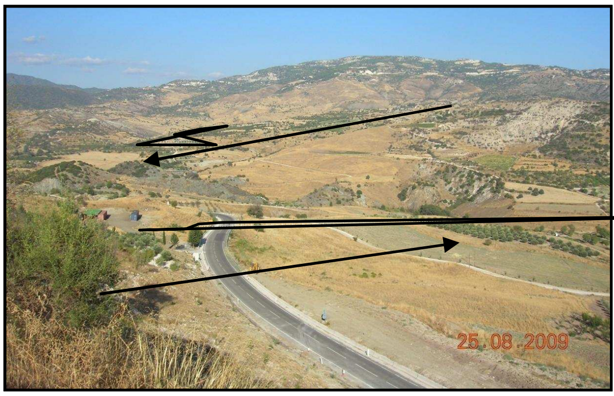
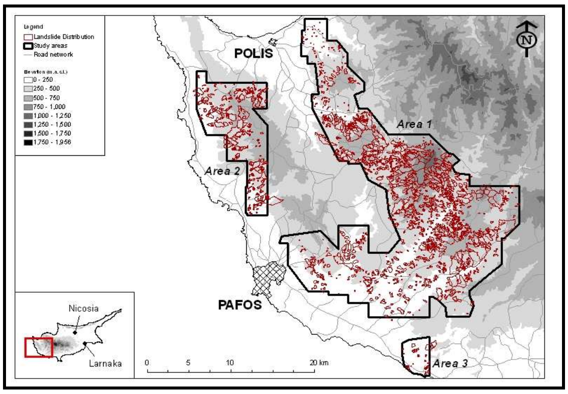
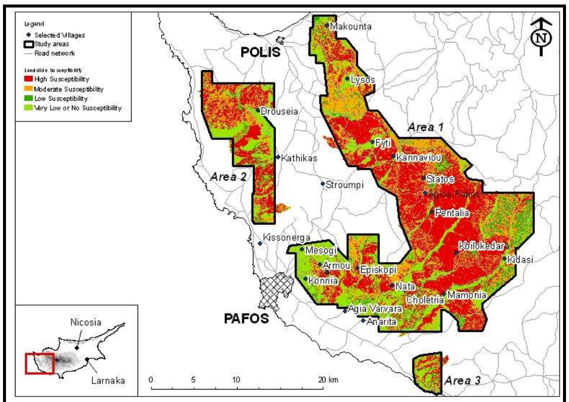


Photo 1 – Large landslides affecting roads and farmland.

Photo 2 – Landslide affecting new road.





1,844 landslides (ca. 24% of area covered); 3.4 landslides per sq. km

Fig 1 (above) : Study area location and landslide distribution

Fig 2 (above R): Landslide Susceptibility mapping for the study areas

Landslides Susceptibility	% Area	% Slides
High	41.8	83.4
Moderate	23.6	15.0
Low	7.5	1.5
Very Low	27.1	0

Andrew Hart

Spitzer Space Telescope Discovers Olivine Rain in Proto-star
From May, 2011 press release by NASA

Spitzer Space Telescope Discovers Olivine Rain in Proto-star
From May, 2011 press release by NASA

NASA's Spitzer Space Telescope has discovered tiny green crystals of olivine which are falling like rain in the gas clouds around a newly-forming star in the constellation Orion.

This is the first time such crystals have been observed and astronomers are still debating how they got there. It is considered that the forsterite crystalises near the surface of the forming star but are then carried up by jets of gas into the surrounding cloud where temperatures are cold (-170 ° C) and fall back down towards the surface.

NASA's Stardust and Deep Impact missions have detected olivine crystals in comets and in the gaseous disks that surround young stars. The discovery of the crystals in the cold outer cloud of a proto-star was previously unknown but could explain why comets contain olivine crystals. A similar situation may have existed with our solar system, with olivine crystals in the gas surrounding our early sun raining onto the outer regions of our gaseous solar system and eventually becoming frozen into comets.

Websites/information highlighted by FGS members

1. **Snowball Earth**: http://www.scientificamerican.com/article.cfm?id=when-earth-was-a-snowball&sc=emailfriend
2. **Astronomy – video of sun flares**: http://www.youtube.com/watch?v=IJViaJ_kgZ0
3. **A 160-million-year-old Chinese fossil of a flying reptile** preserved with an egg allows scientists to sex pterosaurs for the first time: http://www.bbc.co.uk/go/em/fr/-/news/science-environment-12242596
4. **Ammonite diet revealed in X-rays**: http://www.bbc.co.uk/go/em/fr/-/news/science-environment-12127790
5. **A new type of dinosaur** dating from the late Triassic period, around 230 Ma: http://www.bbc.co.uk/go/em/fr/-/news/science-environment-12175263
6. **Drillers propose deep-Earth quest:** Scientists hope this decade to be able to start drilling for rock samples lying several km below the Earth's surface in its mantle layer**.** http://www.bbc.co.uk/go/em/fr/-/news/science-environment-12841150
7. **Archaeologists unearth thousands of stone tools in North America they say predate the technology widely assumed to have been carried by the first settlers**. http://www.bbc.co.uk/go/em/fr/-/news/science-environment-12851772
8. **Image unlocks fossil skin secrets:** For the first time, an image maps organic compounds still surviving in a prehistoric reptile skin sample, offering an insight into how it was preserved. http://www.bbc.co.uk/go/em/fr/-/news/science-environment-12816862
9. **Some Useful BGS Links:** For those with an iPhone, iPad and Android, this shows how you can get the App and what you can do with it. http://www.bgs.ac.uk/iGeology/home.html?src=sfb
10. **Google Earth images**: Up-to-the-minute information on earthquakes from USGS. The website is updated every 5 minutes with the latest earthquakes worldwide and portrays the last 7-days' quakes. 1) Download the latest free edition of Google Earth - http://earth.google.com/intl/en/download-earth.html; then, 2) download the USGS real-time earthquake file (automatically added to your Google Earth application under 'my places' section); go to: http://earth.google.com/intl/en/outreach/showcase.html#kml=Real-time_Earthquakes.
11.

Addendum to Field Trip to Pinhay, Beer & Seaton, Devon – October 2010

NB. This article is a continuation of the report presented in the January 2011 newsletter.

Following our day at Lyme Regis, on Sunday we travelled to Seaton Hole and via the cliff path, walked to Beer Harbour where we lunched sitting in the sunshine.

After lunch we continued walking westward still on Chalk and gradually rising toward Beer Head, which was just about the western most point of Chalk on the south coast. As we crossed the South Down Common, we caught glimpses of Hooken Cliff Landslip. Half way up the slope to Beer Head we were able to get our first good look at the Landslip from a point level with the top of it.

Closer to Beer Head we went, in small groups, down a path to the left of the main one and looked directly onto the Landslip and its original location. Richard Bull, our leader, pointed out that the former cliff had dropped about 250 ft one night in 1790. This caused a rise in the land surface, a little off shore, of some 20 ft.

This part of the coast was an outlier of the Cenomanian Limestone deposited in a depression between two uplifted N/S axes. There is a 30-ft Greensand base at Beer Head overlain by Middle and Upper Chalk. Within the Chalk we could discern two bands of flint-free chalk marl, known as Rowe's 2ft. and Rowe's 4ft Bands. Above, there is Downland's Marl, up to which point a direct comparison can be made to the Sussex succession. (Gallois & Hart, 8th International Symposium on the Cretaceous System, September 2009)

So, unusually, we were able to see, in the cliff face left by the Landslip, a chalk succession a few feet away and similar to where we were standing. As we were quite close to Branscombe, some party members continued walking to the hotel, via Beer Head, while others walked back to Seaton Hole and their cars and thence to the hotel. We had a very nice afternoon blessed with continued good weather

Note: - Other information gratefully noted from Pinhay, Beer and Seaton, Richard Bull and Graham Williams, October 2010.

Colin Brash

Memorable Earthquakes of Spring 2011

From GNS Institute NZ - "*The hidden fault that caused the February 2011 Christchurch earthquake*

In September 2010, Christchurch was shaken by the Mw 7.1 Darfield earthquake, caused by movement along faults west of the city on the Canterbury Plains. This earthquake produced a visible rent across the landscape that allowed scientists to directly measure the movement of the longest fault segment, the Greendale Fault (approx 30 km of surface rupture on an E-W trending right-lateral strike-slip fault. Maximum displacement was nearly 5m; accommodated across a broad zone, often exceeding several tens of metres in width. Lateral spreading was pervasive along major rivers and streams throughout the region).

However, the violent Mw 6.3 earthquake that devastated Christchurch on 22 February 2011 was caused by movement along a fault that does not appear to have broken the surface. Scientists have thus had to rely on measurements using a variety of techniques and instruments to determine its location and the nature of its movement.

Based on data from GPS stations, satellite radar images, seismographs and strong-motion recorders, the fault that caused the 22 February earthquake lies within about 6 km of the city centre, along the southern edge of the city. The fault rupture (Fig. 1) was about 14 km long, and extends ENE from Cashmere to the Avon-Heathcote estuary area. The fault plane extends a few kilometres offshore, but not much fault movement occurred beneath the ocean."

Bizarrely Dr Clark Fenton gave a talk on the 'Geotechnical Aspects of the **4th September 2010** earthquake (Mw 7.1)' on 22nd February 2011! He described it thus: "*The Mw 7.1 Canterbury earthquake occurred at 4.35 am local time … Extensive damage occurred … although no buildings suffered total collapse. The … timing of the earthquake, coupled with successful seismic design, meant that there were no earthquake-related fatalities, despite the proximity of the epicentre to a major city. … Differential subsidence, fissuring, and sand volcanoes were widespread along the coast to the north of Christchurch.* ".

Then, on 22/02/2011, possibly as he was speaking, came the aftershock "*… on a buried fault oriented roughly E-W. There is no obvious structure directly connecting the faults that ruptured in the September's Mw 7.1 earthquake with the fault that generated the magnitude 6.3 event. On the contrary, precise aftershock relocations suggest that* *at least two NE-SW trending faults lie between the two and that there is no evidence from the earthquake data of an extension of the Greendale Fault."*

This second quake, the aftershock, was experienced personally as described below.

Escape From Christchurch: 22/02/2011 – a personal experience – Lyn Linse

I was at the airport, about to go through security when there was a loud BANG and what sounded like a jet engine starting up. Everything started shaking violently. Metal girders were shrieking and things were falling off shelves in shops. It was difficult to keep one's footing. I crouched down and held my handbag over my head and hoped my rucksack would protect my back from objects falling from the ceiling. People were panicking and running hither and thither but no one was really hurt. Over a thousand passengers were hustled outside. After the initial shock there were a series of after shocks, some of them pretty strong. Lots of people were upset.

After an hour in cold drizzle we headed to an evacuation centre at a nearby hotel. There was shelter, but no rooms were available. They could only give us blankets and pillows, a hot meal and drinks. After a rather uncomfortable night in the crowded hotel lobby a hearty breakfast was provided. Few telephones and 2 computers were working and in great demand. Even mobile phones weren't working. We found out that the quake had caused terrible damage in the city and also cut phone lines, electricity and water supplies. At least we had water and electric as we were about 5 miles out of the city. Two friends turned up after walking most of the way from the city. They saw the church spire come down. The police told everyone to get out of town. They weren't allowed back into the hotel to retrieve their luggage.

Another personal email account from a friend of mine:

Power came on last night and water is back on though sporadic. Biggest problem is lack of sewage facilities; we have built a 'portaloo' in the back shed. It won't win any design awards but it works.

The most awful thing about the quake was the noise; the incredible roar of the earth shaking, things crashing down around and then the seemingly endless wail of sirens. This coupled, with a feeling of complete helplessness. The damage inside the house - books over the floor, broken jars and ornaments everywhere. The ties we had on cupboard doors after the earlier shake paid dividends.

This 'aftershock' was much worse. We have had no power or newspapers, so have relied on the radio but it cannot convey the enormity of the event. We are asked to stay home unless our journey is really necessary so haven't seen much first hand. You will know better than we just what has happened.

The phone systems were not working - they were overloaded by the volume of traffic and also backups were damaged. Vodafone brought in generators only to have them stolen by some very low life. A trip home that should have taken 10 mins, took well over 1½ hrs.

Among neighbours, one old lady couldn't open her (twisted) back door and couldn't get to the front door (furniture had fallen across it). Another elderly neighbour was sitting in his chair, looking grey, with books, broken crockery, pictures and light fittings etc all down around him. He is deaf and almost blind, when I got there he didn't want to let go my hand - it was heart breaking. In many rest homes, the elderly were thrown to the floor and suffered broken limbs.

We left our cars on the forecourt - just as well, with the next big belt, the shelving system, which had been anchored to the wall, tore free and projected tools, sets of screws etc right across the garage. The drive has large 'cracks' in it and several 'volcanoes' where the liquefaction has bubbled up, along the drive, garden and path. This sediment is a problem as it sets like concrete once dry and is very heavy to shift when wet. The gutter is full of this horrid grey 'gunk'. The road has also risen and fallen, a bit like a switchback, and the footpath has lifted. But, it is nothing compared to other streets where there are massive rents in the ground and sink holes to trap the unwary.

Liquefaction on the corner of the house has broken the sewer line. It can leave a void from which the 'dissolved ground' has 'gone'. So other things fall in and break or are so stretched they break. Large cracks have appeared in the concrete paths, doorsteps, lawn and the side of the house is torn away from the main pad.

The cat spent last night on our bed, and each time he hopped off I thought 'wait for it' and then there came yet another good 'shake' - the novelty is wearing off!!

Our son had the power board wrenched away from the house. Power was disconnected and will be reconnected. When? Who knows but again nothing compared to what some poor souls are experiencing.

Some homes have been split in two, others have disintegrated. The suburbs aren't as bad as the city centre, but far too many instances of this still means complete disruption to life. And the fact that we continue to get fairly regular, large shakes isn't helping the nerves.

Now we can only mourn the poor souls who have lost their lives and offer support and prayers for the families hit so badly. Christchurch (and New Zealand) is a very small place so we all know someone who has been badly affected. We cracked a bottle of bubbles last night to celebrate having the power back on. How we take things such as electricity and water for granted.

Japan's Earthquake **Liz Aston**

Watching the progress of the Pacific plate as it attempts to subduct below Japan has been interesting. The BBC and others have covered the details of the tsunami, personal traumas and devastation from this huge Mw 9.0 quake, but I should like to provide a few geological comments. First, to summarise the facts:

- **The earthquake occurred 150 km off the eastern coast northern Honshu Island;**
  - The quake occurred when a discrete segment of oceanic crust (ca. 750 x 500 km with faulted boundaries to N and S), part of the huge Pacific Plate, which had become 'stuck' finally fractured and begin its subduction below the continental crust of the Japanese island arc (Fig. 1).
- **It was the largest quake ever recorded (Mw 9.0) in Japan and one of the biggest ever felt;**
  - The quake was 900 times stronger than the San Francisco quake of 1989 and 8,000 times stronger than the Christchurch quake; shaking was felt as far away as China; see Fig. 2;
  - There was a foreshock of Mw 7.2 two days previously, approx 40 km from the epicentre, with three aftershocks > Mw 6 on the same day (see Fig. 3).
  - Numerous (>300) aftershocks measuring > Mw 5.0 and several > Mw 7.0 have occurred since. Approximately 99% of these are confined to this specific section of the plate (Fig. 4), occurring where the stress regime has changed following the quake and define the limit of the rupture zone.
  - The earthquake and most of the aftershocks have been shallow (Fig 5) - one or two deeper ones appearing after a few weeks.
  - The rupture zone appears to be larger than most of the historical quakes (Fig 6).

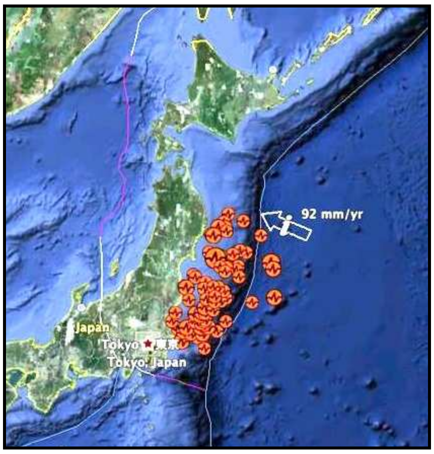


Fig. 1: Japan Quake and shallow aftershocks (11/03/11).

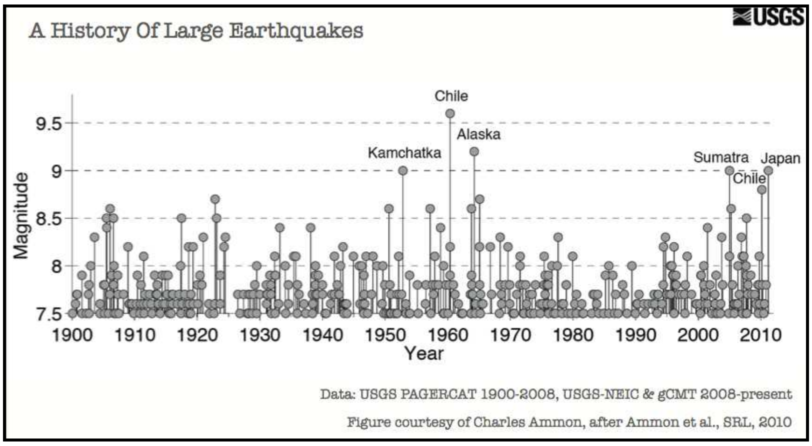


Fig 2: Comparison of Japanese Earthquake to other huge quakes USGS Eductionl Information

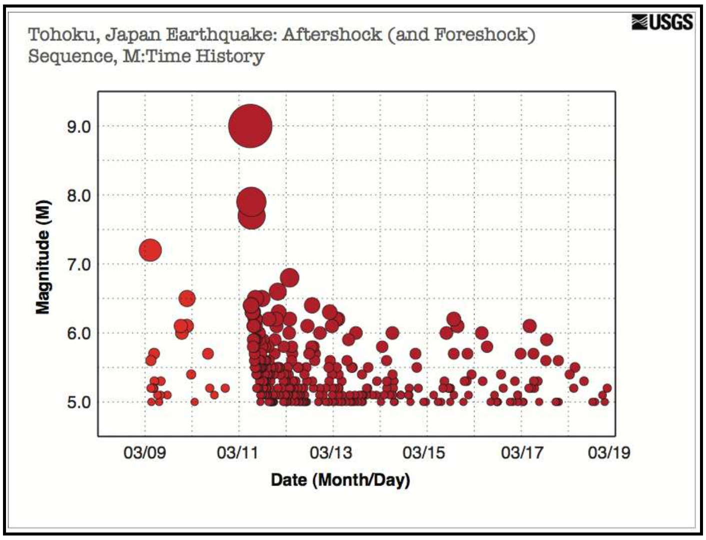


Fig 3: Large foreshock occurs 2 days before the main shock, then multiple aftershocks occur.

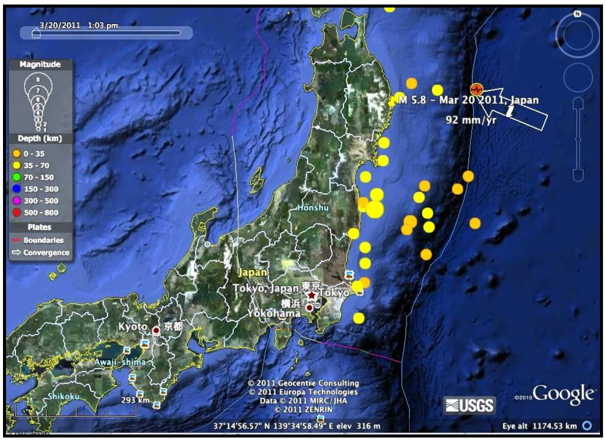


Fig. 4: Aftershocks still present, 10 weeks later (19/05/11)
As Fig 1, USGS data plots on 'google earth'.

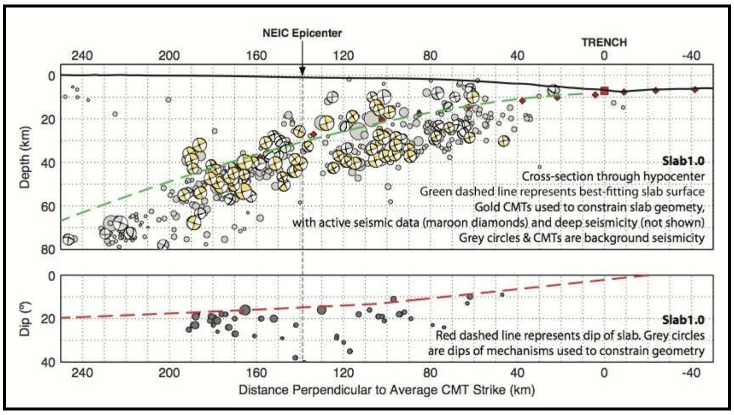
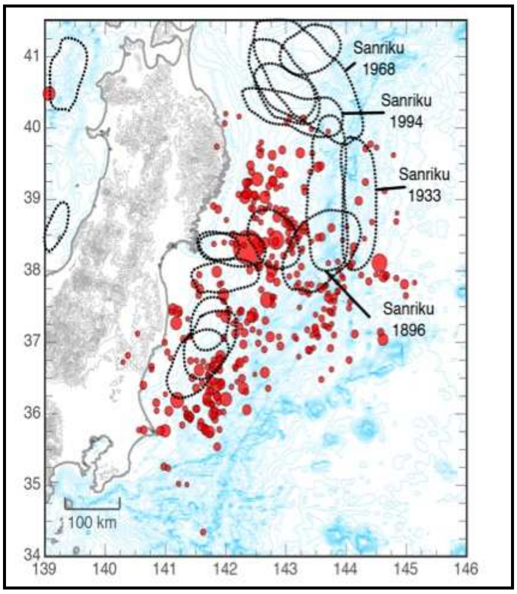


Fig 5: (above) Cross section through the area showing gently dipping fault. USGS educatonal information.

Fig 6: (R) The distribution of shocks from the March 2011 earthquake compared to estimates of historic ruptures. (Image: CJ. Ammon, Penn State; rupture: Hiroo Kanamori, Caltech, data: USGS). http://eqseis.geosc.psu.edu/~cammon/Japan/2011EQ



- **Japan's coast moved 2.4 m;**
  - The Japan Coast Guard maintains a network of underwater geodetic equipment along the fault area with one sitting almost on top of the epicentre. The equipment recorded a lateral movement of 5 – 24 m to SE and an upwards movement of 3 m (Figures 7 and 8).
  - The instruments were set up 10 years ago and a post-quake reading occurred at the end of March, beginning of April.
  - "*Although the seafloor may have been seen to shift horizontally by this astonishing figure, the distance the opposing slabs of rock at the site of the rupture slipped past each other under the seabed would have been even greater - perhaps 50-60 m by some estimates.*"

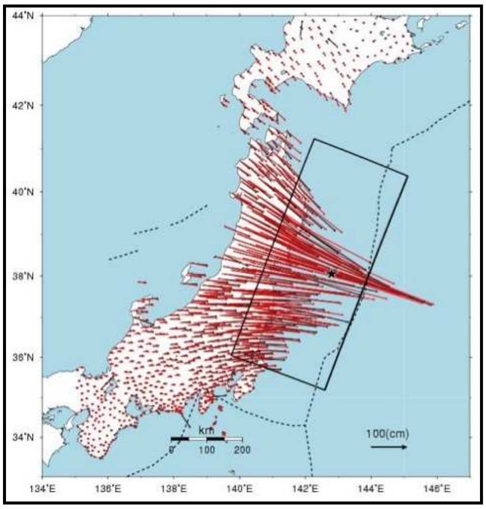


Fig 7: Horizontal slippage calculated (red) from modelling and observed (black)

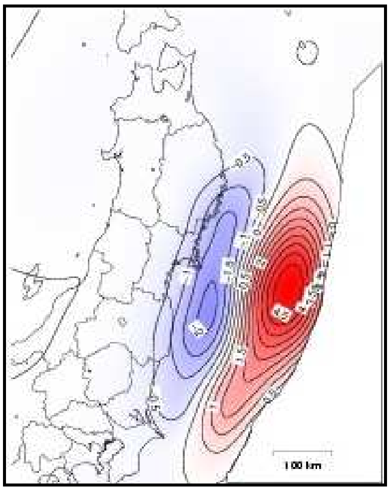


Fig 8: Vertical displacement calculated from modelling

- **The quake caused the Earth's axis to move and the speed of rotation to slow;**
  - Measurements in St. Louis, Missouri showed a displacement of 2.5 cm;
  - Richard Gross, NASA, calculated that the earthquake should have caused the Earth to rotate faster, shortening the day by ~1.8 µsec and should have moved the position of Earth's figure axis (the axis about which Earth's mass is balanced and offset from the N-S axis by ~10 m) by ~17 cm, towards 133° E. Natural changes during the year exceed these values. Any changes depend on the magnitude, location and fault slippage. Both values are expected to change as data are refined.
- **It was accompanied by a huge >10m tsunami wave;**
  - Dr. Masanobu Shishikura, working at the Active Fault and Earthquake Research Center in Tsukuba, had predicted that such a giant tsunami was likely and would eventually happen.
  - He showed that every 450 - 800 years over

the last 3,500 years, tsunami had devastated areas in Miyagi and Fukushima Prefectures; the soil profile comprises layers of sand and pebbles deposited by tsunamis. The embayments along this section of coastline cause amplification of the tsunamis.

- There was evidence of a tsunami associated with the 869 Jogan quake (which killed 1,000 people) and of a later tsunami (between 1300 and 1600) in the same region.
- In 2010 he noted: "It appears to be almost completely unknown among the general public that in the past great tsunamis have inundated areas as far as 3-4 km inland as the result of earthquakes exceeding magnitude 8."
- He was due to present his research to officials in Fukushima on March 23rd 2011 but when the tsunami occurred, " The thought that came to mind, he says, was "yappari," or "Sure enough, it happened." "It was the phenomenon just as I had envisioned it."
- There have been nine quakes ≥ Mw 7 in the Japan Trench since 1973, and three large offshore quakes over the last 300 years, which have produced huge tsunami waves (up to 38m high and killing up to 27,000).

Tectonic Summary

Modeling indicates that the quake resulted from thrust faulting on the subduction zone plate boundary between the Pacific and North America plates (the Pacific plate is moving ca. 83 mm/yr westwards beneath Japan at the Japan Trench). Further, it demonstrates that the fault moved >30 - 40 m, and slipped over an area approximately 300 km long (along-strike) by 150 km wide (in the down-dip direction). The fault is calculated to strike at 201° with a dip of 14° / 291°. The rupture zone is roughly centered on the earthquake epicenter along strike, while peak slips were up-dip, towards the Japan Trench axis. Figure 5 shows the amounts of movement, identified from the modeling, associated with this quake.

Japan is situated in a complicated Pacific plate boundary region where three subduction zones meet. To S, the Philippine plate subducts below the Eurasian plate, to N, the Pacific Plate subducts below the North American plate.

This particular section of the Pacific Plate (Miyagi segment) is old (probably ca 140 Ma) and probably some 100 - 150 km thick. It is very dense and indurated and extremely difficult to fracture or allow ductile deformation. The plate segment seems to have 'stuck' possibly due to some positive feature, such as a seamount, on the descending plate surface. Hence it took a huge amount of pressure to actually move it and to allow it to begin subducting.

Final Remarks

It is sad that very few commentators have commented on the successes of the Japanese government, namely that the earthquake defences – particularly their building standards – have been spectacularly successful, very little building damage has occurred and the motorway bridges withstood the amazing forces of the tsunami with little damage, even the nuclear power plants survived. They were very unlucky that the quake caused the coastline to sink some 1-2 m, effectively reducing the height of the tsunami barriers.

References:

Chris Rowan, Scientific American and from http://all-geo.org/highlyallochthonous/

Japanese government bodies: http://www.gsi.go.jp/cais/topic110315-index-e.html

Science correspondent, BBC News: Jonathan.Amos-INTERNET@bbc.co.uk

United States Geological Service (USGS) educational information.

University of Chicago: http://geosci.uchicago.edu/~rowley/Rowley/Extrapolating_Ages.html#2

Wall Street Journal: Peter Landers - peter.landers@wsj.com

Diversity in Stone: Links with Local Geology

Summary of December 2010 lecture given by Dr Lesley Dunlop, University of Northumbria

One of the interesting aspects of the UK is the rich and varied geology. This has contributed much to the range of landscape features seen, and, also to the character of towns and villages which use local material for their construction. Although this contribution may be lost in larger towns and modern developments, smaller centres retain much evidence of local materials and the style and character derives from this.

Oxfordshire has recently carried out a building stone survey as part of work with English Heritage and there have been projects within the North Wessex Downs to raise the profile of links to building styles and geology. As expected there is a strong correlation between materials used for older buildings and the bedrock material. In the north of Oxfordshire iron rich marlstone characterises the buildings giving a pleasant warm colour to the villages built from this stone. The stone can be used for all parts of the building - for example, walls, quoins and window frames. Not far to the south, however, the main bedrock is a Middle Jurassic limestone, the White Limestone, this is a much more rubbly and irregular material to work with and so close to the boundary with the ironstone the latter is still used for quoins and window frames. The talk illustrated other examples of the county.

Moving further south into Berkshire, the bedrock is mainly Upper Cretaceous Chalk and Palaeogene sands and clays. The variation can be clearly seen from the building materials used. In the north and west of the county, there are many examples of chalk being used, particularly as chalk block, where hard horizons are found (e.g. Melbourn rock). In the Lambourn Valley, chalk is used alongside sarsens stones in the north but moving further downstream and into younger Chalk, flint is seen increasingly as the additional stone.

The sands and clays of the Palaeogene led to extensive brick and tile works, especially from Newbury to Reading giving a characteristic red brick. In places the red brickwork is decorated by addition of grey or blue bricks made by firing at a higher temperature and with the use of a glaze.

Where the Lower Greensand is found, further to the south, many other styles of stonework can be found such as the use of the very characteristic ‘carstone’, either as main walling material or decoratively as galetting and pattern work. Upper Greensand, where used as a building material is nearly always an inferior type of stone, requiring other material for more structurally important aspects.

In conclusion it is relatively easy to track local geological changes and even pick up small unusual variations such as tufa and iron-cemented gravels by examining wall material from traditional buildings. By doing this, a useful atlas of the county can be produced and this can be used to guide and inform local planners and those involved with conservation areas. It has also been found that this is a good way to introduce and involve local people to the subject.

Lesley Dunlop

An illustrated account of the GA visit to Oman: 17 – 29 January 2006

Summary of January 2011 lecture given by Michael Cuming

Michael Cuming, a member of Harrow and Hillingdon Geological Society gave a talk about the GA visit to Oman in 2006, a visit which had been attended by at least 3 members of Farnham GS. He pointed out that this had been a rather special fraternal visit and therefore the Geological Society of Oman had arranged for different days of the trip to be led by specialists in their field, a real privilege.

Michael set the scene by summarising the geological history of Oman, a country which was passed by along its eastern coast and affected by India’s movement to its current position. He also pointed out that it is currently part of a continent-continent collision with Iran to the north. He outlined how the world famous ophiolite had been emplaced on the carbonate platform and had subsequently been arched up into an anticline giving an entry into the past by means of deeply cut wadis.

Rather than giving a ‘Cooks Tour’ of the visit, the speaker broke the talk up into four themes. In the first, he talked about the huge Pleistocene dune system south of Muscat. Steve Fryberger had shared with the group his understanding of the structure of the Wahiba Sands, giant dunes laid down during previous Pleistocene ice ages and now being reworked by the current prevailing winds. Understanding their complex structure is vital for exploiting oil reserves as ancient dune systems frequently provide excellent oil resevoirs.

In the next phase of the talk, the vital importance of the carbonate platform as a resevoir rock for oil was stressed, and we were told how Henk Droste had given the group a detailed analysis of the carbonate platform and its prodigious development during the Cretaceous, showing us how the progradation of the strata can be detected from seismic studies, and how simultaneous existence of different facies can complicate the analysis and give the oil men a headache. The need to carry a water spray when examining carbonate rocks was illustrated. Deep inside the eroded anticline, the group had been able to study Precambrian tillite dating back to the time of snowball earth.

A dramatic unconformity (Fig 1) spanning about 300 Ma was shown with Permian rocks overlying Precambrian rocks containing stromatolites. The unconformity provided a broad platform allowing the group to examine it in detail close up.

A highlight of the talk was a discussion of large-scale structures pointed out by the leading French expert Jean-Paul Breton. And what structures there were! All clearly visible with no vegetation to obscure the view, and on a gigantic, mountainous scale (Fig 2)! We were shown a stupendous duplex with 5 or so slabs superimposed, and a folded ramp (Fig 3), both of these on a massive scale. We also were shown some stunning examples of structural geology in the Wadi Mayh, including recumbant and ductile folds (Fig 4), and face to face hinges (Fig 5).

The last part of the talk covered a close examination of exposed parts of the ophiolite including examples of banded gabbro and the group’s search for the elusive moho.

Clockwise: Fig 1 (Above L) Unconformity with basal conglomerate. Fig 2 (Above) Large scale sigma fold in distance. Fig 3 (Far R) Folded Ramp. Fig 4 (below R) Foliation, Strain-slip Cleavage and Folds. Fig 5 (below L) Face to face hinges

FGS Field Trip to Pagham Harbour and Bracklesham 15th May 2011

A pictorial report on the FGS Field trip to Pagham by Janet Philips

FGS members fossil hunting.

The 4,000 year old tree trunk, above, marks the east bank of a Holocene river. Animal bones are also found.

Turritella & Nummulites laevigatus (left) & Cardita (centre) at Wittering and Colonial coral, Goniopora (above) on flint.

Beach strewn with pebbles, the effect of wave action – the finer sediments have been removed, leaving the pebbles behind.

Shingle bank with sea to right and harbour on left. The ridges are formed by storm actions.

View of lagoon from East side of Pagham harbour.

FGS Field Trip to Western Brittany, France, 3-10 April 2011 : Part 1 - Archeology

Another excellent trip was organised by Graham Williams, which is reported here and will form the FGS display at the GA Festival of Geology in November.

Graham identified four elements of the trip in particular for this report, namely:

- Lower Ordovician grès Armoricain
- Devonian miniature reef at L'Armorique.
- Ordovician volcanics
- Carnac archaeological remains

Unfortunately I do not have most of the geological reports, so rather than split the geology, I am keeping those for the September issue and providing just the archeological report here.

Carnac: On Saturday 9 April we studied rocks from quite a different point of view when we travelled to the Carnac region to see some of the monuments built by people of the New Stone, or Neolithic Age.

We visited Menec, one of the four major Carnac stone alignments. The lines extend almost to 1200m in length and there are 12 rows, with a total of about 1100 granite standing stones (Fig. 6). The stones were quarried locally, and spheroidal weathering in the granite shows where stone from exposed surfaces was used.

Fig. 6: Lines of stones at Carnac

Fig. 7: A “cromlech” or stone circle

Fig. 9: Carved black stone

A “cromlech” (which in Brittany means a stone circle) stands at each end of the rows, and the standing stones increase in size as the land rises uphill towards the cromlechs. The whole landscape is an enigma, and there are many theories as to its origins. The stones in these egg-shaped cromlechs are unusual in that they are closely set; some appear to have been specially shaped to fit together shoulder to shoulder, but many are missing. Evidence confirms that they pre-date the alignments. Lyn's photo shows part of the south west arc (Fig 7).

We travelled on past the other vast alignments to Kercado dolmen, a rare example of a complete passage grave of its kind. The carved capstone is supported by a corbelled roof. This is one of the oldest monuments in Europe, and was placed on high ground in sight of the great St. Michel tumulus near Carnac town.

We had little time, but we managed a brief "taster" visit to 3 of the many sites on the amazing Locmariaquer peninsula:

1. The site of the enormous "Er Grah" tumulus, the extent of which is marked today by a great cairn of cobbles and boulders. Romans mined the stone here, narrowly missing the vault covered by its enormous capstone of quartzite. Below the tumulus, excavations uncovered a thick fossil soil and bovine remains which confirmed that these animals had already been domesticated at 5400 to 5100 BC, and were bred from wild aurochs.

2.The 'Grand Menhir Brise' (Fig 8). This enormous block of orthogneiss over 20m long, and weighing, it is estimated 280 to 300 tons, was shaped, smoothed and transported over a distance as much as 10 km. It now lies in 4 pieces, and there is some doubt as to whether it was ever erected. Lyn's photo shows two of the colossal pieces. The row of stones along the path indicates the site of a line of deep holes for the erection of menhirs, now missing.

Fig. 8: (Above) 'Grand Menhir Brise'

Fig. 10: (Right) Carving of axe

3. La Table des Marchands. A memorable feature of this cairn with passage grave is the beautifully carved and shaped back stone, made from sandstone (Fig 9). Carved differently on each side, it stood as a menhir, possibly associated with the Grand Menhir, before the dolmen was built around it. The underside of the re-used capstone has a splendid carving of a hafted and thonged axe (Fig. 10), and a broken crook. (*Photos courtesy of: Lyn Linse*.)

Margaret Bourgoing, Lyn Linse, Joan Prosser and Mike Rubra

Remaining FGS monthly lecture programme for 2011

DATE	LECTURE	SPEAKER
June-10	Horsham stone and Sussex marble	Dr Roger Birch, Collyers College, Horsham
July-8	NZ earthquake and Madeira DVD	Dr John Gahan, Farnham Geosoc
Sept-9	Evolution of the Exe Valley	Dr Jenny Bennett, Open University
Oct - 21	How Britain became an island	Dr Sanjeev Gupta – Imperial College
Oct – 30	**FGS lunch @ Frensham Pond Hotel**	**Details at forthcoming meetings**
Nov-11	Gemstones	Prof Andrew Rankin – Kingston University
Dec-9	Geology of the London Basin	Dr Michael de Freitas – Imperial College

Remaining FGS field trips 2011

June 24	Evening Geowalk in Surrey countryside
July 1 - 4	Derbyshire Peak District
September 4 - 10	Inverness to Caithness
October 1 -2	Isle of Thanet