Farnham Geological Society

[www.farnhamgeosoc.org.uk]

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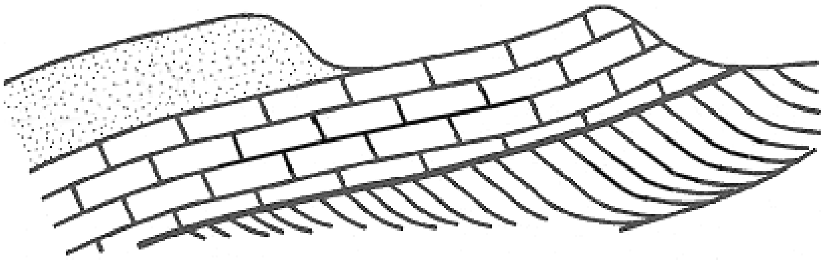


A local group within the GA

Vol. 6 No.3

Newsletter

October 2003

INSIDE THIS ISSUE

Thank you, readers, for all the favourable comments you have made about this year's Newsletters. The editorial committee tries to provide a mixture of items each time and this issue is a bumper one. Once again many thanks to all those members who have contributed articles, summaries of lectures or accounts of field trips. Please keep the copy flowing in for next year's publications.

The Society's committee has spent a lot of time recently discussing the provision of an up-to-date system for projection of information via a laptop computer and multimedia projector at our monthly lectures. Many of our speakers are from universities, where this form of projection is used more and more. John Gahan, the programme secretary, has purchased a projector for his personal use and has agreed that the Society can hire this when needed until we can resolve whether the cost of purchasing our own machine can be justified. At the Members' Evening in July, both John and Lyn used this system for projection.

The year 2003 has been an eventful year for the Society and at the annual reunion of the Geological Association at University College, London on Saturday 8th November, we intend to display the specimens from our mineral collection which were shown at the Members' Evening in July, together with photographs from our field trips.

Chairman (Acting):
Robert Gott
01483 - 235422

Treasurer:
Peter Luckham
01428 - 607229

Business Secretary:
Lyn Linse
01428 - 712350

Programme Secretary:
John Gahan
01252 - 735168

Field Secretary:
Dorcas Cresswell
01497 - 847262

Membership Secretary:
Michael Weaver
01252 - 614453

Newsletter Editor:
Peter Cotton
01428 - 712411

GA Representative:
Shirley Stephens
01252 - 680215

Proposed field trip - US & Canadian Rockies - 1st September 2004

The 17 day trip will be led by John Williams, a member of Farnham Geological Society and one of the Adult Education tutors of the Natural History Museum and Birkbeck College. The cost for all travel, entrance fees and bed and breakfast will be £1589 per person, 2 sharing - [Single supplement: £745]

To enable the maximum variety of exposures to be covered, the tour will involve long distance coach travel between some locations. However, the grandeur and variety of the geology and the scenery will well reward you. The tour will provide an opportunity to view the effects of the eruption of Mount St. Helens and allow a walk on Mount Rainier, before traversing the North Cascade range and entering Canada for the transit of the Southern Canadian Rockies. We then travel into the prairie lands of Alberta and visit the Royal Tyrell Dinosaur Museum at Drumheller. Finally, we travel, via Yellowstone Park, to our Southernmost location in the Rockies, the Grand Tetons.

Full details from the Leader, John Williams on 01276 - 26494

FGS monthly meetings - 2003

Oct 17	Society dinner
Nov 14	Dr Alan Jobbings: *A gemological journey from the Alps to Vesuvius*
Dec 12	Dr Tony Hall: *The granites of Cornwall*, followed by *Christmas party*

China clay and the rocks of the Algarve
Summaries of July's *'Members' evening'* talks given by John Gahan & Lyn Linse

At this year's members evening, talks on China Clay, given by John Gahan, and the FGS trip to the Algarve, given by Lyn Linse, were supplemented by a display of many of the Society's mineral collection which was put together by Peter Cotton.

China clay is found in many localities in Cornwall as a result of hydrothermal alterations to the granite masses which stretch westwards from Devon down to Land's End. This process is known as kaolinization and was particularly concentrated in the St Austell area of Cornwall. Kaolin or china clay is a clay mineral produced from the feldspars in the granite and is a soft white residual deposit used to produce porcelain and other types of ceramics.

The history of the development of the various types of ceramics goes back to China in the years BC, when it achieved supremacy in the potter's art and in particular in the manufacture of high quality porcelain. Europeans attempted to produce porcelain in the 15th and 16th centuries by copying Chinese techniques. In England William Cooksworthy discovered the Cornish china clay and took out a patent for manufacturing a hard-paste porcelain but this enterprise was not immediately successful. In the meanwhile the Royal Worcester Porcelain Company was successful in producing porcelain from a material imported from America called Unaker. Also Josiah Wedgewood had been using imported material prior to using the china clay from Cornwall. As a result of the enterprise of these people a large and growing ceramics industry began to develop in the Staffordshire Potteries where the original clay deposits were superseded by Cornish china clay whose quality was found to be excellent and, because it could be taken by sea and canal to Staffordshire, was an economic material.

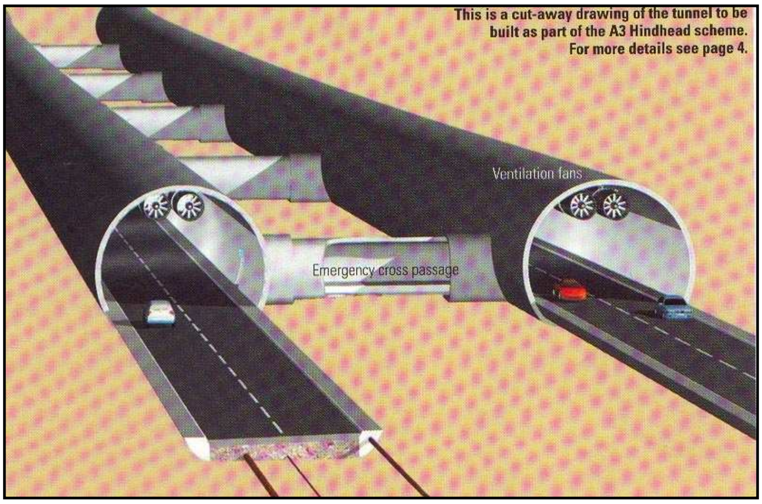
The process of extracting the china clay has improved over the centuries but the basic operations are open-cast quarrying using powerful water jets, repeated washing away of impurities, followed by drying out to produce a powder ready for delivery overland or by sea from nearby Cornish ports such as Fowey. The huge mountains of waste material in the St Austell area bear witness to the fact that for every 1 tonne of china clay there are up to 9 tonnes of waste. Cornwall enjoys a world-wide market for high quality clear white kaolin and demand continues to exceed supply. Over 80% of china clay is exported mostly to Western Europe and Scandinavia. Apart from its use in the pottery industry it is used as an inert filter in paint products, cosmetics and pharmaceuticals.

Lyn's presentation on the **Algarve** was visually outstanding in that she showed a stunning collection of photographs taken during the FGS trip to the region last Autumn; geographic and geological details of the trip are given in her reports which can be found in the February and June 2003 issues of the FGS Newsletter.

Peter Cotton

The Hindhead tunnel project on the A3

This project is now in the advanced preparatory stages, having received government approval for inclusion in the targeted programme of road improvements in March 2001. There have been, and will continue to be, major problems in the acceptance of this scheme by many interested parties such as the National Trust, the local councils whose residents will be affected by changed traffic flows, and by English Nature.

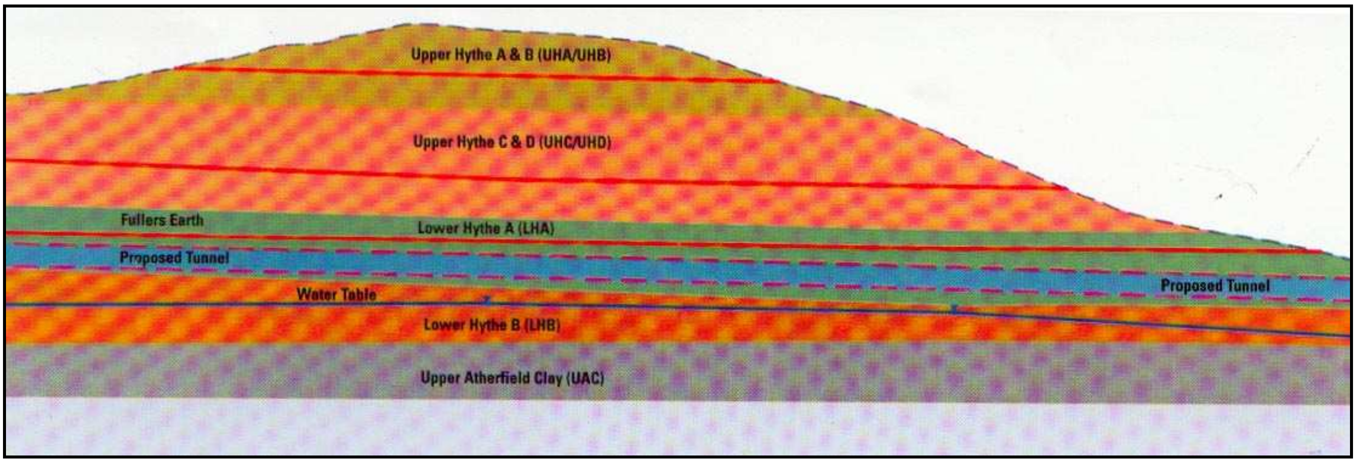


The Highways Agency is the co-ordinating body for the project and has selected Balfour-Beatty out of five competing companies for constructing the tunnel and all associated civil engineering and road-works. There are understandably major geological and hydrogeological aspects to be considered in constructing the tunnel and extensive investigation was carried out in the 1990s to help determine the best route for the tunnel. In the Spring 2003 issue of the A3 Hindhead Newsletter the following statement was made:

"*The A3 team is carrying out further investigations to gain a fuller understanding of the ground conditions. The investigations comprise the drilling of 27 boreholes up to 80m in depth, and 25 trial pits. These will allow the designers to fine tune the tunnel route alignment and will provide sufficient geotechnical and groundwater information for the design of the tunnel and its portals.*

Existing information suggests that the shape of the Devil's Punch Bowl, the largest spring sapped valley in Europe, is likely to be controlled by planes of weakness – faults – within the rocks. Up to now there has been very little exploratory work carried out within the Punch Bowl itself, so it is important to investigate there. Detailed discussions were held with the National Trust and English Nature to find the least damaging way of doing this, which was to use a large mobile crane parked on the A3 to lift a drilling rig in and out of position during night-time carriage-way closures.

The tunnel route generally runs within the Hythe Beds, which are mainly formed of layers of sands and sandstones which can be highly variable in their nature. Underlying the Hythe beds is the Atherfield clay. The top of the Atherfield clay is marked by a spring-line which can be seen in the Devil's Punch Bowl and within the Boundless Copse areas. Boreholes at the top of Hindhead Common will encounter the full thickness of the Hythe Beds while those within Boundless Copse will encounter the Atherfield clay near the surface."



As can be seen from the geological cross-section, the route of the tunnel steers a course just above the water table. The Hythe Beds are an important aquifer for the district and the upper surface of the saturated zone marks the water table which is, of course, subject to variations depending on the seasons. To the geologists advising on the route of the tunnel, the nearby example or "spring sapping" at the junction of the Hythe Beds with the Atherfield Clay – the Devil's Punch Bowl – must be a salutary reminder of the power of erosion!

Finally, for those of you who bothered to read the article in the June Newsletter about Fuller's Earth, will notice the layer of this material resting above the route of the tunnel.

Peter Cotton

Granite - "*The Place of Origin*" attraction

Tower Bridge, the Forth Railway Bridge and the new Scottish Parliament have all used granite from the Kemnay Quarry, near Aberdeen. The site has been worked for over 150 years. It is about 4 miles SE of Mt. Bennachie where we as a group stopped at a unique quarry site with Sue Hay three years ago. Remember? This was to see the brecciated granite there, surrounded by Macaulayite (due to an intrusion placed at the end of the Caledonian Orogeny and chemically altering minerals in the granite)

Three sculptors are working with the quarry owner Aggregate Industries to create "*The Place of Origin*" attraction which will officially be opened in autumn 2004, to celebrate Kemnay's history and the importance of granite to Scotland. The project began back in 1996 when the quarry, then owned by John Fyfe, was looking for a way to celebrate 150 years in business. On its takeover Aggregate Industries took on the idea, matching the lottery funding with help in kind in the form of the stone itself, machinery and labour.

Over 100,000t of waste material from the site has been carefully formed into a 25m high cairn-shaped summit named the "*Ziggurat*" by John Maine who was instigator of the Yorkshire Sculpture Park. It is 20 metres from Kemnay's southern rim, from where visitors can look down, right into the bowels of the quarry. On the way up through a newly planted woodland, there are dotted a series of special features of granite in its various forms – from glacial boulders to gravels and quarried blocks. *(From the New Civil Engineering Magazine – June 2003)*

Claire my daughter, and family who live a few miles away, enjoyed the climb to the top this summer and sent the photos.

On the way up, showing cairn

View of quarry below the summit

Shirley Stephens

Sequel to the five volcanoes field trip - Scilla

In August 2002, when all other colleagues on the FGS field trip to Italy were on their way to Sicily, I was flat out in the hospital at Scilla following being taken ill at the mainland port of Reggio di Calabria. Paul Olver had pointed out the rock that called men to their death, but I never thought it would have a go at calling me. I spent 6 days in bed – nursed most wonderfully even though my knowledge of the Italian language was sparse

After recovering, I spent time waiting to be escorted home and found on my walks that Scilla is a wonderful place, with its the castle, town square (with compass floor design in the middle), and the nearby fishing ports with their special swordfish boats. The rock itself is like an eagle, with the beaches left and right of the harbour its wings, the castle its head and the harbour wall its beak.

Reggio di Calabria was a short train journey away; this too is a wonderful town, well worth the effort of getting there. It has a huge museum; the geology displays were marvellous and the bronze figures found offshore were perfect after 2,000 years on the sea bed. They stand in the museum so tall and wonderful.

If anyone gets a chance to go to this beautiful place, please do. My sincere wish is to visit it again, because to me Scilla is a pure bit of heaven.

Sally Hurst

FGS trip to the Cyclades - May 2003

The purpose of the study tour, led by John Williams, was to compare the Cycladic islands formed from volcanic products (Milos and Santorini) with those that have been metamorphosed by the processes of tectonics (Naxos and Paros), and also to observe various effects of volcanism, view the products of an eruption and to see how they have weathered over time.

Sixteen members of Farnham Geological Society were thoroughly prepared for this Aegean trip by John's very comprehensive Study Tour Field Guide and the opportunity to attend a Day Course given by Alan Timms and John at the Natural History Museum. This explored the complex geology of the region and how it has dictated historical development and archaeology.

The first and last night were spent in Athens, four nights on Naxos with a day trip to Paros, six nights at Oia on Santorini then three nights at Adamas on Milos. Carole Hodge from Island Wandering was a very able right hand lady.

"One hundred and ninety million years ago the sun shone and the seas were warm, clear and blue. Surrounded on three sides by landmasses: Asia to the N.E., EuroAmerica to the N.W. and Africa to the S.W., life in the Tethys ocean was bliss. However, nothing lasts for ever. The supercontinent of Pangaea was breaking up and the Atlantic ocean far to the west was beginning to open. As a result, Africa rotated anticlockwise and was pushed northwards towards Eurasia.

At the Eurasian border the Tethys Ocean started to subduct ,pulling behind it a series of microcontinents, pieces of continental shelf that had once been attached to the African plate but had been separated from it by the formation of a new basin, the Mediterranean. The Tethys gradually shrank in size and by 60 Ma, when the most northerly of the microcontinents, Pelagonia, reached the subduction zone, the ocean closed. Pelagonia, being too buoyant to subduct, docked with the Eurasian continent folding and thickening because of being continually pushed from the SSW into the solid continent. One by one the other microcontinents docked behind it each adding to the pile-up and each increasing the deformation of the one in front. Eventually nappes formed with younger, unaltered folds thrust over earlier ones. The whole area became a mountain chain. The limestones and muds originating in the shelf seas metamorphosed with increasing pressures and temperatures to marbles and schists. Pelagonia where the most deformation took place became known as the Cyclades, and the mountain chain was the Hellinides, the Aegean portion of the Alpine orogeny."

The sun shone and the seas were clear and blue. We wore hats and carried bottles of water wherever we went. We travelled on coaches, local buses and taxis, took boat trips, walked, swam, went shopping, visited museums and archaeological sites, dined wonderfully at the local tavernas and rested at the local watering holes. There were those among us who got lost, tired, forgetful, embarrassed and brown. We all got hot. In fact a typical field trip.

We were introduced to the metamorphic rocks of Naxos and Paros. 20 Ma of erosion had exposed the roots of the mountains. Marbles formed barren ridges and schists the fertile valleys. Crops and olives were growing in small fields (*see above photo*) that had bamboo windbreaks and the occasional tethered cow. Many hillsides terraces were neglected as land had been divided up more and more between successive generations until the portions were too small and uneconomical to work so many had been abandoned.

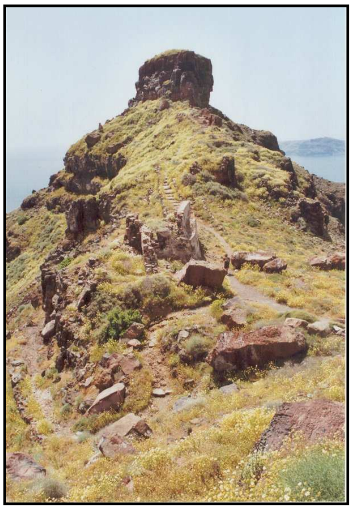
Marble quarries punctured the landscape. We visited a marble mine at Marathi on Paros that descended 2000 ft into the mountain. We walked through the adit and down a slope (*see photo*) away from the bright sunlight to the gloom of the first gallery and peered into passages that led into the depths. The steeply dipping bed had last been mined by the French in the early 18th Century who brought up the beautiful highly metamorphosed marble with such large crystals that the rock was translucent up to 3½ cms. We all applied our torches for confirmation. Ancient Greek civilisations had appreciated its beauty, and Venus de Milo had started life as a piece of Paroan mountainside. Sites on Naxos and Paros had Kouroi statues, considered by some to be idols that had been partly carved from the bedrock in 7th century BC and then abandoned. They lay there still. We were convinced (I think,) that a hillside at Melanes, covered with marble boulders was an apprentice's practise ground where they could develop their marble-carving techniques. Emery (Moh's scale 9) was used for carving and we visited an emery dump to identify the black mineral. Emery is a metamorphosed laterite deposit rich in Fe and Al (corundum) and named after Cape Emeri on Naxos. Emery is no longer mined as there is a synthetic substitute. We visited George's marble works on Naxos. (There are, apparently, several islanders called George), and saw how huge white blocks, some streaked with grey, brought from the quarries that dotted the mountainsides were roughly cut to manageable sizes (ie.large) then sliced, polished, cut to size and then stacked ready for shipping. Only the 20 kg airline luggage limit prevented us from walking away with some tempting off-cuts.

The intense high temperatures reached during nappe formation had in places further altered areas of schists to form augen gneisses and within these, further alteration had produced migmatites. The highest temperatures of all within the migmatites had actually melted the rocks to produce granites. We inspected samples of granite domes and their aureoles in a roadside exposure in the Koronis area of Naxos. Nearby was a very neat and tidy marble quarry that was removing the top of one of the mountains. At Naoussa in the north of Naxos we saw how quartz in the highly metamorphosed schists at the centre of the nappes had been mobilised to form pegmatites in the highly deformed rocks. We followed the exposure across the bay.

Naxos with its windmills, its mountainous interior and its busy capital was a good introduction to the Cyclades. We looked eastwards through Apollos Gate at the old Venetian fortified Castro guarding Naxos town and the busy port, and then westwards through the Gate out to sea at the setting sun, real Greek holiday stuff.

"When the Hellenides mountain building could no longer accommodate the push from the SSW it became an active margin and a new subduction zone formed as the Mediterranean oceanic lithosphere subducted northwards beneath it. A calc-alkaline volcanic arc erupted through the mountains about 100km above the descending slab.

The opening of the Red Sea affected the absolute motion of the Aegean Plate. In the north, southwesterly movement was slowed to 2.5 cm. per year, while in the south nearest the trench it was 2.9 cm. per year. Clearly the middle of the Aegean plate was under tension and being stretched. Old faults and sutures were reactivated as the crust thinned. The result was uplift and erosion of Horst blocks and sinking of Grabens as the Hellinides sank beneath the sea with only the tops of the mountains remaining visible. Extension has given the Hellenic chain its present arcuate shape."



Santorini and Milos became our stamping ground for the rest of the two weeks. It was a good time to visit them, right at the beginning of the tourist season. Brilliant blue and white paint was being applied to all suitable surfaces and everywhere else was fresh and green and completely covered with wild flowers. They had even painted flowers on the road in Milos for the Easter processions. On Santorini we came to grips with the calc alkaline volcanoes. In fact a little party of 'intrepids', inspired by our leader did just that and scaled a promontory (*see photo*) on Skaros. We discovered that it had been previously inhabited because it was covered with the remains of dwellings dating from the Venetian occupancy of the island. They must have had a good head for heights in those days, and sure feet!

"There are few exposures of the metasediments on Santorini. For 1.5 Ma volcanic activity associated with the subduction zone has gradually shaped the island. At least five large volcanoes have formed since then, Megalo Vouno, Therasia, Skaros, MicroProfitis Ilias and Thera. Eruptions have been of basalt, basaltic-andesite, andesite, dacite, rhyodacite and rhyolite with the longer gaps between eruptions producing the more acid magmas and pyroclastics. Some eruptions formed calderas.

The enormous eruption that shaped present day Santorini and formed the present caldera happened in 1600 BC. Known as the Minoan because it wiped out the Minoan civilisation it was also responsible for the legend of Atlantis.. The eruption was so violent that it emptied the magma chamber, and the sea rushing in enhanced the activity still further.20cu km of pumice and ashes that were ejected came from a magma chamber situated below the northern half of the present 16km wide caldera. Sections of the previous volcanoes are exposed in its impressive 300m high rim . This rim is broken in three places so Santorini comprises three islands. In the centre of *the caldera volcanic activity since 197 BC has produce the Kameni islands and their eruptions of dacite lavas are gradually filling in the caldera. Volcanic activity is centred on a crustal fault that strikes NE/SW beneath Santorini."*

If sailing into Santorini's caldera was breathtaking the drive away from the port up a road cut into the sheer walls of the caldera was even more so. We zigzagged up through the whole range of rocks that Santorini had to offer until on reaching the incredibly thick layer of ash and pumice we knew we were at the top (see photo). The best way to see Santorini's geological history was from our specially commissioned boat (owned by another George). We studied the rocks of the volcanic sections at close quarters and learnt to differentiate between the grey andesitic blocky lavas and lava flows, red pyroclastic scoria, pale dacitic ashfall and the creamy rhyodacite pumice. There were welded tuffs and unconsolidated pumice. The more resistant dark basic dykes stood proud of the weathered cliffs and were in places displaced by faults.

We landed on the Kameni islands and trekked across various lava fields to the crater (see photo) where current activity is progressing. Fumeroles were gently leaking hot sulphurous gases. We were in time to see their temperature being taken, a healthy 95°C-97°C just below the surface. The last eruption was in 1956. Sea temperatures and levels and Seismic monitoring also takes place regularly.

We were promised a swim at the islands, but nobody explained that the hot springs leached iron from the lavas, which combined with bacterial activity to form a thick red '*gunge*' that squelched through your toes when they landed on the seabed.

Back on land we examined hand specimens and looked at the products of the main Minoan event at Thera quarry. First the well-sorted pumice from the initial blast, followed by surge deposits, fine deposits that filled great channels scoured out by steam from when the magma chamber was breached by the sea. In the third stage a slurry of ash and pumice and blocks of volcano wall were incredibly violently ejected, followed lastly by the high temperature finer ignimbrite flow. The quarry was within a kilometre or so of the vent and here the various layers were thickest and the largest blocks had fallen. We included one in our group photo complete with its sag (see photo). The quarry was no longer being worked for pumice. It used to be tipped over the cliffs into the boats waiting to carry it away. The Suez canal had used hydraulic cement made from Thera pumice. The demands of tourism however required a pristine blue sea, and the fine dust was also a problem, so quarrying had to stop.

The third stage of the Minoan event dominates the island. It is easy to excavate and original dwellings in the cliff tops were man made caves. These have subsequently been improved and are very upmarket *des-res*. However their position on the caldera rim of an island often visited by earthquakes must make life exciting. 3,600 years of ash cover preserved the remains of the better situated fishing village of Acrotiri after the Minoan eruption. Archaeologists are still excavating the site and we had a glimpse of a life that basically differed little from our own.

Milos was our final port of call. It is far richer in minerals than Santorini because small high level magma chambers released gases and hydrothermal fluids through cracks and fissures into the overlying, mainly acid igneous rocks, altering and concentrating the minerals.

From the beginning this mineral wealth was traded. We visited the site near Filakopi where neolithic men worked and traded obsidian tools. The area was covered with obsidian flakes as well as pottery sherds.

The Romans exported sulphur, pumice, clay and alum from the old Dorian port of Klima as well as oil, wine and honey until the 6th century when it was abandoned after an earthquake.

At Paliochori on the south coast, groundwater moving up through the vent-agglomerates, ignimbrites and lahar deposits that formed the cliffs, leached out minerals such as copper, sulphur and iron and brought them to the surface. We saw where the rocks were coated with crusts of green chrysocholla, yellow sulphur and red oxides (*see photo*). There were hot springs bubbling through the sea here and steam rising through fissures in the rocks. The last sulphur mines on Milos closed in 1962.On the way to Plathiena we saw baryte crystals that had been brought to the surface by hydrothermal fluids rising through fissures in the rhyolite domes where the rocks were all stained red with iron or altered to white kaolin.

At Voudia we were in the industrial Milos and saw kaolin, formed from altered rhyolitic feldspars; perlite, a quickly cooled volcanic glass that contains water in its structure. (its density decreases as it expands on heating and it is used for thermal and acoustic insulation etc) and bentonite, an altered ash that increases its volume when water is added and is used as a sealant in landfill sites, as cat litter etc.

With trade came wealth, and we saw several archaeological sites including: the Bronze age site at Filakopi (where three ancient cities had stood), the Dorian site above Klima (~1000BC), and near Tripoti, the ancient Roman theatre and the Christian catacombs (2nd- 3rd century AD) which are the most extensive in Greece. Today Milos continues to trade and tourism is starting to be important. There are no eruptions pending, the sun shines, the warm seas are clear and blue….I've heard that before!

Many thanks John for an excellent, friendly, well organised, field trip.

Beryl Jarvis

Isle of Man – June 20th to 23rd, 2003

I joined 16 other GA members for four days of Isle of Man geology. Our leaders were oil geologists Dave Quirk, who knew the island well, and Dave Burnett whose Ph D was based on Isle of Man turbidites.

Manx geology is influenced by the closure of the Iapetus Ocean and the formation and erosion of the Caledonian mountains. The rocks have a NE/SW trend parallel to the Iapetus Suture. The oldest rocks, the Manx group, are Ordovician dated at about 485 Ma. They are found over most of the Isle of Man; they are finely laminated sandstones and mudstones that have been compressed, slightly metamorphosed and tilted by the closure of the Iapetus Ocean. They originated as turbidite flows off Avalonia, a small micro-continent off the NW edge of Gondwana (the SE edge of the Iapetus Ocean) We saw good examples of these rocks on the coast road south of Douglas where we looked for sedimentary structures, which would establish their "way up." There were six other localities where Manx group rocks were associated with younger rocks.

The Dalby group is of Silurian age, ~ 425 Ma. They are also turbidites, but originate from the SE margin of Laurentia (the NW edge of the Iapetus Ocean) and outcrop mainly in a small area in the west, near Peel.

At Niarbyl, south of Peel, we saw a fault that we convinced ourselves was the Iapetus Suture (*see photo: Manx group on right, Dalby group on left, quartz in suture*). Certainly it passes through the Isle of Man between the Solway Firth and Northern Island; the rocks to the south are Manx group and to the north are Dalby group; there is much shearing along the fault with intruded quartz veins. One problem, apparently, is the 60 Ma difference in ages of the rocks. I am afraid that the explanation got too complicated for me to follow!

After the Caledonian mountains had been eroded, the Isle of Man sat 20º S and sandstones similar to the marine Devonian rocks in South Devon were laid down. They are thought to be Devonian but have not been definitely dated because of lack of fossil evidence. We saw an excellent exposure at the end of the Peel promenade where we established that they were water lain, not Aeolian and were probably laid down from braided rivers over flood plains.

There is a small area of Carboniferous limestone in the south around Castletown. The area was faulted during the Variscan orogeny and the limestone was laid down in a half graben. We saw a magnificent unconformity at Langness Arch on the south coast, between tilted Manx group and horizontal Carboniferous conglomerate. At Poyllraaish on the shore were many reefs with the usual associated fossils – brachiopods, bryozoans, corals and crinoids. We then walked along the cliff path towards Scarlett, past horizontal beds of limestone and basaltic volcanic agglomerates and tuffs, including very good examples of pillow lavas which partly overlaid the limestone.

There are two main granite intrusions, at Dhoon and Foxdale. We examined the Foxdale granite in a disused quarry. It is dated at about 400 Ma and consists of quartz, feldspar and muscovite mica. There are many coarse pegmatite veins and all are very weathered. There is a vast amount of quartz debris from the pegmatite. Associated with the granites and faulted rocks are hydrothermal mineral veins from which lead, zinc, copper and some silver were mined in the past. We went to the famous Laxey Water Wheel, the Lady Isabella (*see photo*), that drew water from the lead mine, which went down to 500 metres below sea level.

The top third of the island, north of Ramsey, is covered with Pleistocene and recent glacial deposits from ice sheets from Scotland and the Lake District. They are probably about 100 metres thick. We went to the extreme northern tip, the Point of Ayre to look at the flattened rounded pebbles brought in by the Devensian ice sheet. Long shore drift along the northwest coast has brought pebbles from the bottom of the Irish Sea and others have come from Scotland. Riebeckite pebbles from Ailsa Craig are said to be abundant. The end of our trip was a three-mile walk along the beach on the northeast coast, past the Bride moraine. This was the result of the late Devensian re-advance acting like a snowplough pushing up earlier sediments to make a terminal moraine up to about 100 metres high.

Cath Clemesha

FGS field trip to Herefordshire and the Forest of Dean

On Friday evening the 30th May, 28 people from three societies met at the Three Counties Hotel in Hereford for the start of a two day trip lead by Paul Olver. There were 15 members from the Farnham Society, 9 from Horsham and 4 from Hereford including Paul and Sue Olver.

After dinner on Friday, Paul sketched out the palaeogeography of the Silurian outcrops in Herefordshire which occur in a large area to the west of Ludlow; and in a narrow belt to the north and south west of Ludlow embracing Wenlock Edge down to Aymestry – which gives its name to a division of the Silurian rocks of the Ludlow Series. In addition to these outcrops there are significant inliers of Silurian limestone in sites to the east of Hereford, and in particular, the Woolhope Inlier. Although this visit was concerned with Silurian rocks, it must of course be remembered that the largest area of the county is resting on the Old Red Sandstone which gives the soil its characteristic reddish-brown coloration.

On Saturday morning, by minibus and cars, we travelled east from Hereford with the intention of visiting a small quarry at Perton at the northern edge of the Woolhope Inlier. Unfortunately the owner wouldn’t allow us to enter the quarry because of safety reasons. The quarry is in the Aymestry Limestone whose rocks were deposited in a warm shallow sea near the eastern margin of the Iapetus Ocean. This area then lay at a latitude of about 15° South and a diverse brachiopod fauna dominated the seabed. Whilst the Silurian limestones were being laid down in the coral reefs bordering the Iapetus Ocean there was considerable volcanic activity in the area to the south-west and the ash fall led to the formation of bentonite clays.(Fuller's Earth) These clays are responsible for a series of landslips such as the dramatic Wonder Landslip at the eastern edge of the Woolhope Inliers. Further out into the ocean, subsiding basin areas were evolving and into these basins, turbiditic flows were taking place.

The present day scenery reflects the two distinct types of Silurian deposition: the deep ocean basinal deposits give rise to the bold rounded hills in the north of Herefordshire: and the limestones of the "shelf areas" give rise to conspicuous, well wooded scarp and dip slope features such as those at Wenlock Edge, Aymestry and Woolhope.

After the abortive visit to Perton Quarry there was an unscheduled visit to the Southern Malvern Hills to visit the well-known geological unconformity in Gullet Quarry (*see photo*) where the oldest series of Silurian rock, the Llandovery, rest unconformably against the Pre-Cambrian of the Malverns. For many people this was a re-visit to this location.

A long drive in glorious sunshine through the beautiful Herefordshire countryside took us to the main Silurian outcrops round Ludlow. This charming town is situated on the northeastern rim of a plunging anticline in the core of which lies the Vale of Wigmore. Wigmore Basin (*see photo*) during the Devensian Glaciation 20,000 years ago was filled with ice but as the glacial phase waned water poured into the basin but was blocked to the south by a continuing ice barrier near Aymestry. The meltwater rose until it catastrophically broke through a gorge at Downton and features of this can be seen in the present landscape. The course of the River Teme was completely changed which accounts for its sudden turn to the north before flowing through Ludlow and then south again.

Also in this area west of Ludlow is another much visited spot, the Mortimer Forest Geological Trail, managed by the Nature Conservancy Council. During Silurian times Ludlow lay at the edge of a shallow water marine shelf. As one follows the geological trail eastwards towards Ludlow the strata becomes progressively younger from the Wenlock Series to the Ludlow Series. At one of the stops on the trail there is an abundance of trilobite parts, the search for which occupied many people for half an hour or so. Another location provided an opportunity to examine the Aymestry Limestone which we didn't see at Perton quarry. Paul Davis produced a specimen of Fuller's Earth from this location, which had been the reason why the first quarry visited had been unsafe because of rock slippage on the bentonite clay.

On Sunday morning, all packed, we headed Southeast to the Forest of Dean and the Severn Estuary, and here was something completely different – much younger than Silurian. The Forest is almost entirely Carboniferous with considerable amounts of coal measures. During the course of the morning the group saw many reminders of the thriving coal-mining industry carried on by the "Free Foresters." Much, if not all of the coal winning was by drift mines which continued to operate well into the 20th century. As with the Mortimer Forest Trail, there is a walk called the Blakeney Walk that allows one to see the progression from the Devonian Old Red Sandstone through to the upper measures of the Carboniferous represented by the Pennant Sandstones. Continuing uplift in the area during the Upper Carboniferous led to folding – the Forest of Dean Syncline - and planing off of the Lower

Carboniferous rocks. During a relatively stable period in terms of earth movements and a climatic environment of warm and humid conditions, vegetation flourished in deltaic swamps, which eventually produced coal. The coal measures of the Forest are very thin because there was a steady influx of sediments and continuing subsidence, which formed the Coal Measures cyclothem.

After the Forest of Dean and a pub stop, the group headed to the Severn Estuary at Lydney Cliff to see the Old Red Sandstone cliffs at low tide – 27 feet lower than high tide in this estuary. The cliff face comprises a series of cyclothems starting at the base with estuarial deposition followed by fluviatile sandstone deposits. In the top layers, the deposits of siltstone are rich in limestone concretions known locally as "race." There is a most remarkable section of the cliff where a siphoning process has produced a column of rock which is surreal in appearance.

It was a most enjoyable weekend trip and nice to see the Olver and Cresswell families, the Society's "outliers" in the west.

Peter Cotton

Introduction to microfossils

Summary of the Society's May 2003 lecture given by Dr Adrian Rundle, Geological Society

Dr Rundle began the presentation by giving his definition of a microfossil, which is any "fossilised" living object found in a geological deposit of any age, provided the size of the object is less than 1.3mm and greater than 0.05mm; objects smaller than 0.05mm are classified as nanofossils. Many microfossils are not preserved as whole plants or animals, but as their component parts: eg, otoliths, scales, platelets, pollen. Microfossils are particularly useful in the classification of rock strata when for one reason or another, larger fossil types are not available.

Marine deposits like chalk and the Oxford and London clays prove to be very fruitful sources of microfossils. Microfossils generally fall into one of two categories, namely *mineral walled* or *organic walled*, and the methods used in the preparation of the two types of specimen are different.

Clay samples are first dried in an oven and then soaked in water in order to give a mud slurry; this is then sieved, dried and soaked again in order to ensure the solids are as clean as possible. The clean solids are then graded using sieves of decreasing aperture size in order to separate the different size fractions. A preliminary examination of the solid fractions under a microscope allows any microfossils to be separated and stuck onto a glass slide for detailed microscopical examination. If a clay does not break down using the *bake & soak* method, then dilute hydrogen peroxide can be used instead of water in order to accelerate the breakdown of the clay bonds. Another variant is to soak the dried clay in dilute turpentine substitute, followed by washing in boiling water.

Chalk samples are best treated using a hot solution of sodium sulphate (Glauber salts) for the initial soaking. The chalk solids are then subjected to up to 3 cycles of *deep freeze - heating in microwave - water soak* in order to cause sufficient breakdown of the chalk to allow efficient sizing to be undertaken. If fish teeth are being looked for specifically, then washing in acetic acid will dissolve any carbonate fossils/solids but leave teeth (calcium phosphate) unaffected.

If one is specifically interested in **organic walled** specimens (eg: pollen), which are often only a few microns in size, then these are best found after attempting to dissolve away any mineral walled fossils and other mineral debris. To do this, the deposit of interest is dried, treated in hydrochloric acid to dissolve carbonates, centrifuged to separate the remaining solids, treated with fuming hydrofluoric acid to dissolve silicates and finally treated with fuming nitric acid , which will oxidise most organics but not pollen. The tiny amount of residue left after this chain of events should contain any pollen microfossils.

All 3 biological Kingdoms, Protista, Plantae and Animalia provide examples of microfossils, together with the plant and animal remains found in faecal pellets. Dr Rundle presented detailed sketches of some of the many microfossils that can be found in the various Kingdoms: foramanifera, radiolaria and diatoms from the Protista Kingdom; calcareous green algae, stoneworts and flowering plants (seeds & pollen) from the Plantae Kingdom; and sponges, corals, brachiopods, worms, crustaceans, insects, sea-lilies, sea-urchins, starfish etc from the Animalia Kingdom. On the subject of faecal pellets, each species of small creature has its own size and shape!

To complete the presentation, Dr Rundle had brought with him examples of actual microfossils together with two microscopes through which they could be examined.

Michael Weaver

Meteorites - Their Origin and Significance

Summary of the Society's June 2003 lecture given by Kevin Attree MSc, Environmental Diagnostics

Kevin Attree is by profession a geologist who has always had a great interest in astronomy, and his lecture brought to light the relationship between geology and astronomy, tying in very well with the Society's January lecture on the sun and the creation of our solar system.

1. Meteoroids, Meteors and Meteorites? Space is dirty and full of particles and fragments of rock called **Meteoroids**, which range in size from a grain of dust on up to many tons in size.

Most of the fragments which enter the earth's atmosphere are no bigger than a grain of sand and are seen as a brief flash of light and they are gone, burned up by friction. These are called **Meteors**, or 'shooting stars'. Up to 200 thousand million enter the atmosphere each year. Fragments that do reach the surface of the Earth, meteoric dust, are found everywhere in oceans, deserts and ice caps.

Comets are composed of rock and ice and travel around the sun in elliptical orbits. As they get closer to the sun they start to vaporise, creating long tails of particles. When the Earth passes through this band of ejected material a "*Meteor shower"* occurs. This may be a yearly event, such as the Persieds and Leonids.

Meteorites on the other hand are sporadic, much larger than meteors, and most are fragments of asteroids. An example is Eros, a potato shaped rock, about 13 Km in length. "*Falls*" are when a meteorite is actually observed entering the atmosphere day or night; a "*Find*" is found later, well after landing.

2. Early Ideas Meteorites were originally thought to be an atmospheric phenomenon. Derived from the Greek known as 'things on high'. Fossils and stone axes were mistaken for meteorites. Falls were also attributed to volcanic concretions. They were finally accepted as extra-terrestrial during the 19th century. It was also noted that meteorites came from fireballs (exploding meteorites). Examples for reaching this conclusion emanated from observation of a meteor shower which occurred over Normandy in 1803. Meteor Crater in Arizona is a good example of an impact origin but at first was thought to be a volcano. In 1896 a team tried unsuccessfully to find an iron lump which could have been of commercial value. It was probably vaporised just before impact and the tremendous shock-wave preceding it created the crater.

3. Reaching the Earth Most meteorites originate in the asteroid belt. Predictions were for a planet between Mars and Jupiter but it never accreted.. The asteroid belt consists of fragments of varying size and it is thought the influence of Jupiter's gravity prevents a planet from forming. Fragments continuously escape from orbit and are hurled toward Earth. Meteorites can collide with Earth head on or nose to tail. Friction with Earth's atmosphere causes ablation. Gravity affects velocity and 90% of the objects are lost by ablation by the time they reach the ground. Temperatures can reach 2000°C.

4. Types of Meteorite

Meteorites can be broadly classified into two types, either Stony or Iron.

> **Stony:** Some stony meteorites contain chondrules which are small globular masses composed of olivine, pyroxene and glass. Other types of stony meteorites do not contain chondrules but have varying compositions depending on the influence their proximity to the sun.
>
> **Iron:** Iron meteorites are composed of iron-nickel alloys and are the result of very slow cooling. There are some special types which are representative of the core/mantle boundary of a planet.

5. Significance of meteorites

Meteorites offer up clues to the origin of the solar system, are a source of organic compounds and can cause considerable environmental damage when impacting the Earth. For example, the Yucatan impact which occurred ~65MA at the Jurasic-Cretaceous boundary. There are 135 recognised impact structures world-wide. Shock waves ahead of the meteorite heat the atmosphere and can cause it to shatter before hitting the earth. The air blast caused is highly destructive. It is estimated that an object 1 Km in diameter can cause a 20 Km deep hole some 200 Km in diameter, exploding with a force equal to 500 million Hiroshima bombs.

A large impact can occur every 1000-100,000 years, and one is overdue! It is not "*Will we be hit*"?, but more like "*When will we be hit*"!?

Lyn Linse