Leeds Geological Association

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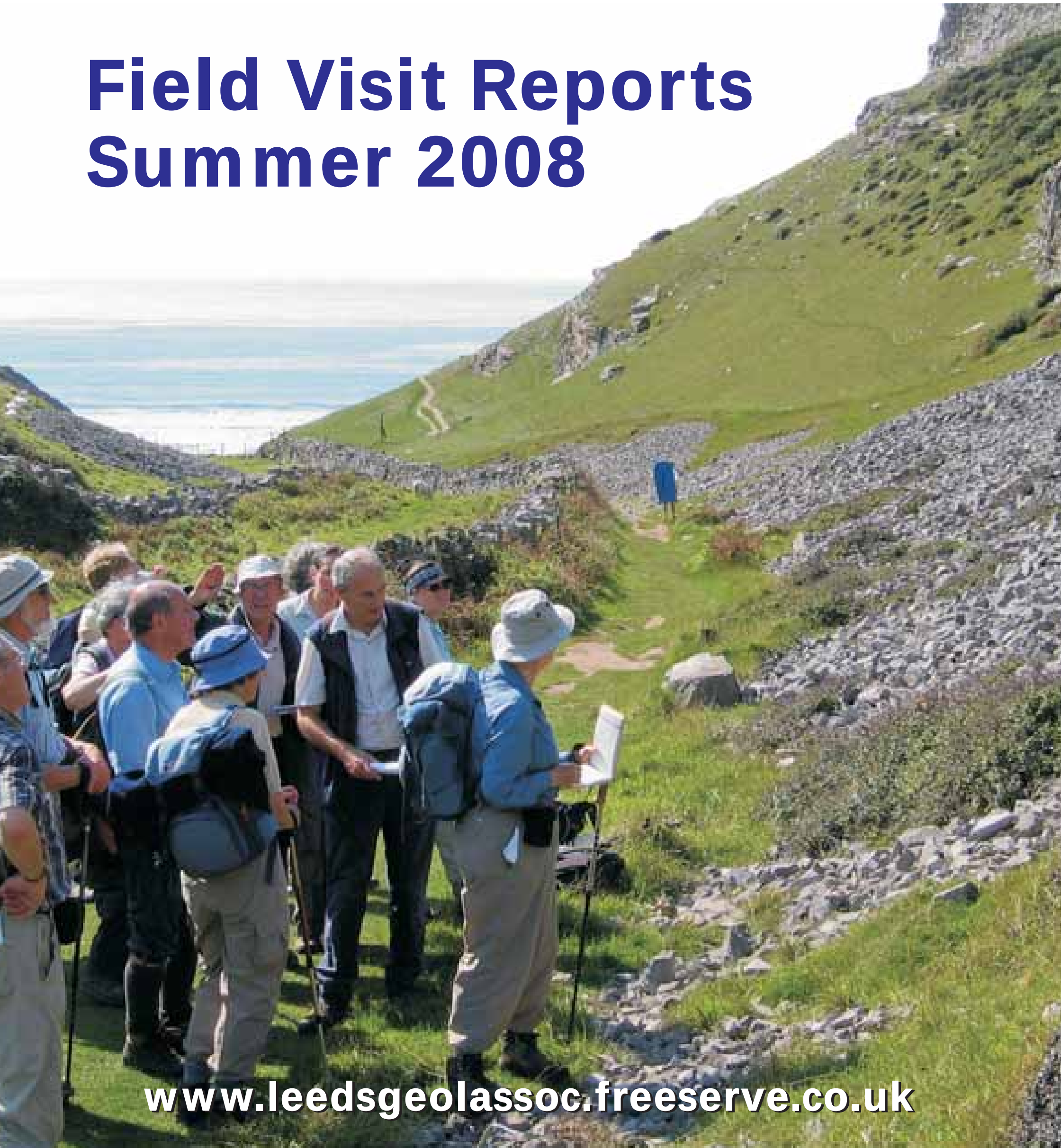
Field Visit Reports Summer 2008



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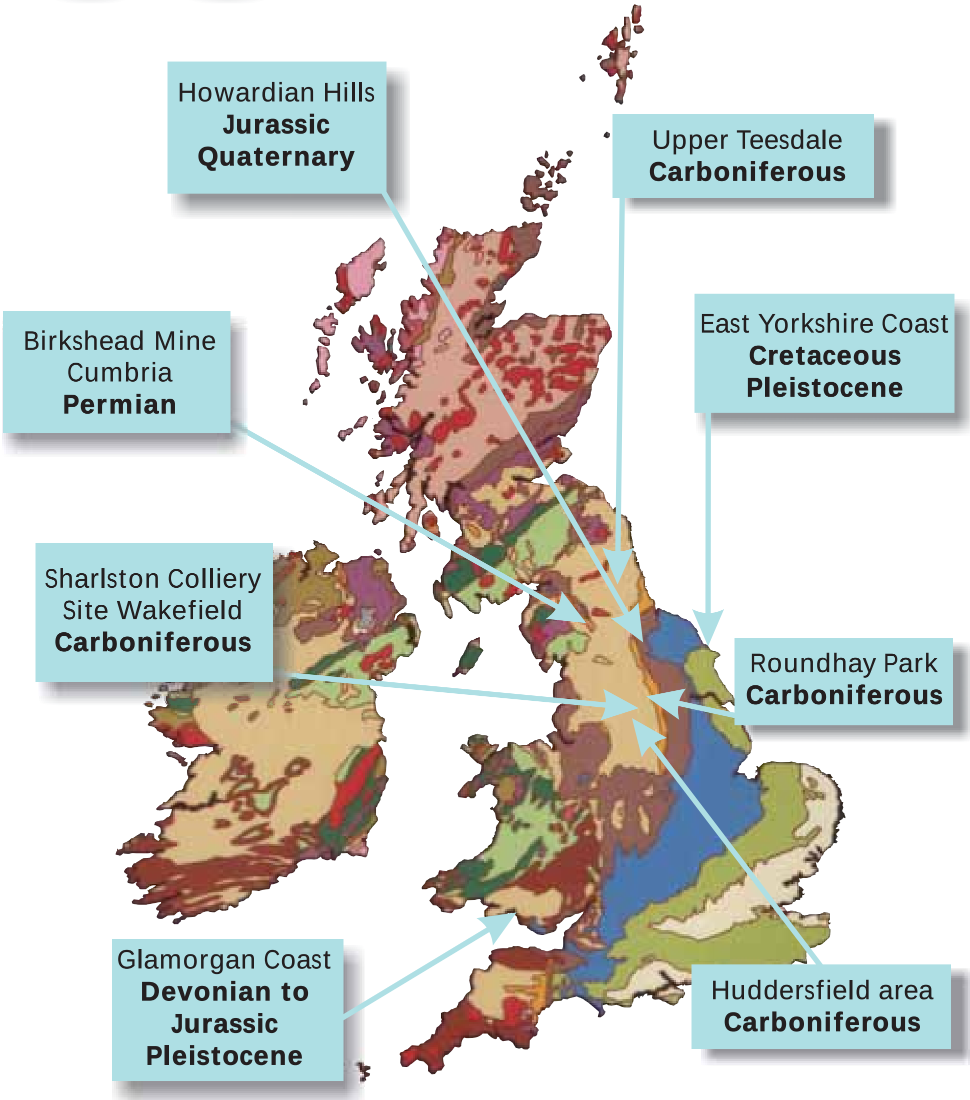
08 Where did we go?



Contents

2008 Field Visit Locations

The LGA acknowledges with gratitude the generous donation from Peter Smith in memory of his late father Dr Denys Smith. This is to help with production costs of this year's Field Visit Booklet. Having seen last year's booklet, Peter was reminded of the pleasure his father obtained from leading field visits.
Denys Smith was an expert in the Permian in the UK, and his work in this field was widely published. He was President of the LGA in 1975, and of the Yorkshire Geological Society from 1985-86.

Thanks to the authors of the field visit reports who also produced the images: Neil Aitkenhead, Tony Benfield, Jon Brotchie, Judith Dawson, Howard Dunnill, Bill Fraser, Jeremy Freeman, Ann Roberts, Phil Robinson, Judith Whalley.

Cover Picture: Mewslade Valley, Gower Peninsula. Probable Late Devensian cemented scree deposit derived from Lower Carboniferous Pembroke Limestone Group - outcrops visible in background (see visit report page 23)

Booklet designed and printed by Trendsetter Marketing Limited ☎ 01274 611222
www.trendsetteruk.co.uk

UK Coal: Sharlston Colliery Reclamation Site
Thursday evening 5th June

Leader: Graham Hindmarsh Site Manager
13 Members present

Members assembled at 5.45pm at the entrance to the site, to the south of the A655 Normanton by-pass, running roughly E-W and bounded to the south by the High Street, Sharlston. At 6pm the party was welcomed by Mr Hindmarsh, who summarised the history of the site and explained the present operation. Members were then taken by two landrovers to the opencast workings.

The former Sharlston Colliery stood on the outcrop of the upper division of the Middle Coal Measures, on a site cut by 3 major faults. In consequence the beds dip roughly northwest at around 10°, as against a slight southward regional dip. The Sharlston coal seams were formerly exposed in Coalpit Field, on the south side of High Street, from where they had been worked down the dip by pillar and stall drift mines probably in the late 18th century. Later, a 35m shaft was sunk towards the north of the present site, followed in the early 1900s by a 600m shaft slightly further south. The western end of the site was occupied by the usual pithead and coal handling gear, gasworks, coking plant (abandoned after 18 months as the coal was unsuitable), tar pits, etc. The abandoned mine had been pumped till 1975 and the site bulldozed in 1990 as a prelude to decontamination and reclamation. This was to be financed by a housing development (75 houses) on the southwest corner.

The eastern half of the site had been covered with mining spoil, much of it burnt out and reddened after spontaneous combustion. This area, divided into 3 sections, was to be reclaimed and landscaped after opencasting the high quality coal from the Sharlston seams, working to a depth of 54m. Clean coal was sold directly but dirty coal, coal-bearing spoil, carbonaceous shale and "anything black" was sent to the washer for a highly efficient separation of coal (down to about 1mm) by flotation, using a liquid phase of S.G. 1.4. Some coal went to Ferrybridge Power Station, the bulk to Kellingley for blending with the lower quality deep mined coal. Some fireclay was also recovered and sent to Nostell Priory.

At the time of the visit, a section towards the southeastern end of the site was being worked, with coal washing and handling facilities (not seen on our visit) to the northwest of the original colliery site. The seams to be opencast were:- Sharlston Top Rider (cannel coal), 0.23m; Sharlston Top, 0.99m.; Sharlston Muck, 0.79m; Sharlston Base or Lower, 1.35m. Some 10% of the coal (or 20%

from the Top seam) had been extracted by earlier mining; however, the Muck had not been mined on account of the two shale bands splitting it into three thin leaves.

Arriving in the workings, members saw a large excavator removing spoil from above the Top seam. To the south and west, this seam had already been recovered and a second excavator was seen working the 7m overburden above the Muck (see photo below), to be followed by another 7.5m to the Lower. It was intended to work these eastwards as far as a fault, here trending roughly NNW-SSE, downthrown 6-9m to the east, close to the eastern site boundary. These two German (O & K) excavators emptied their 25m^3 buckets into Caterpillar dumper trucks. Nearby, a 100m borehole discharged artesian water which appeared clear and free from iron compounds. Walking on the steep dip slope of the grey seatearth below the removed Top seam, members saw numerous small rootlets, typically 5mm thick, and some much larger roots, up to 3cm thick; also small rounded concretions. In the near vertical face, topped by reddened spoil, the Top Rider seam and several dark shale bands could be seen in predominantly silty sandstone. The N-S face at the eastern end also exposed a massive sandstone lens, perhaps up to 2.5m thick.

Excavation below Sharlston Top Coal: background shows red burnt shale, three markedly carbonaceous shale bands, Sharlston Top Rider Coal, Sharlston Top Coal (level with top of excavator).

Pillar and stall workings in Sharlston Top Coal.

After work stopped, at 7pm, members were able to move around more freely and inspect one of the excavators (see photo back cover). Moving up the dip slope, a spectacular section through collapsed pillar and stall workings in the Top seam was examined. Next to the southern face, more of the same workings had been cleared of overburden, enabling members to enter galleries cut perhaps 200 years ago (see photo above). The pillars (here elongated into walls) were 0.75-1m thick, the galleries about 2.5 m wide.

Shortly before 8pm, the party returned to the entrance by landrover and thanks were expressed to Mr Hindmarsh and to UK Coal for this very interesting visit.

Permian Evaporites of the Eden Valley: A visit to Birkshead Mine and Newbiggin Quarry
Wednesday 11th June

Leaders: Dr Noel Worley, BPB and Jim Davies, Mine Manager
8 Members present

We were warmly welcomed to Birkshead Mine on behalf of British Plaster Board by Noel Worley and Jim Davies. After refreshments Noel gave us a very comprehensive review of the broader background to world evaporite deposition, the geology of the area and evolution through the sequence from original deposition to today's sulphate deposits in their various crystalline forms. We then visited the mine to see locations demonstrating the various structures, features and formations in the A Bed evaporite. After lunch, by contrast, a visit to the remaining exposures of B and C Beds in Newbiggin Quarry completed a most interesting day.

Sulphate evaporites are present in this area and 4 developments occur called, A,B,C and D; the A Bed being the oldest and thickest. Extraction started in the district with quarrying of B and C Beds that are 3 – 6m and about 1m thick respectively, and then by pillar and stall mining. Boreholes beneath these workings discovered the A Bed during the 1930s and subsequent extensive borehole drilling has established its presence, 30 – 40m thick, over a strike length of 10km and occupying an area of approximately 20 sq. km. Current workings are now more than 300m below ground level, making Birkshead probably the deepest gypsum mine in the world.

The evaporites formed in a Permo-Triassic sedimentary basin developed within a half-graben structure in continental margin and interdune lacustrine environments at four different times which are represented by the A, B, C and D Beds. The basin was controlled by the footwall of the half-graben and was subsequently folded to form an asymmetric syncline which dips to the NNE towards the Pennine Fault Complex. The evaporites have developed within this part of the syncline, within the lower part of the Upper Permian Eden Shale Formation (Cumbrian Coast Group).

The A Bed is a sulphate supported shale/dolomite/siltstone evaporite comprising a sequence of alternating beds of bedded gypsum and anhydrite. The seam is separated from the underlying Penrith Sandstone by a Basal Mudstone Bed, which is interpreted as a palaeosol.

The lower 10-15m section of the seam, the Lower Sulphate Beds, contains the highest proportion of sulphate within thin beds of grey/red shale separating thicker layers of coalesced nodular sulphate, representing a sequence of sabkha cycles some 25-30cm thick. These beds contain the highest proportion of primary sabkha sulphate, which often remains unconverted because of its lower permeability. Partial slow hydration has occurred in some places by water contained in the underlying Penrith Sandstone and has produced selenitic spherules known locally as 'daisy beds' (see photo below).

The Upper Sulphate Beds (15-20m thick) contain a higher proportion of secondary gypsum in the form of satin spars, selenite. The Upper Beds represent the most uniform quality and are the part of the A Bed generally extracted (see photo opposite). The satin spars are a characteristic feature of the A Bed and the most abundant form of gypsum; the spars are thick (15-20cm) in this section of the seam, can comprise up to 30% of the seam thickness, and are mainly responsible for raising the gypsum purity to commercially attractive levels.

All of the material extracted from working a face of about 8m from the relevant part of the Upper Sulphate Bed is crushed and fed on to a conveyor at the face, and then forwarded to a secondary crushing station in the mine where it is more finely crushed, before belt transfer to the BPB processing and board mill plant at Kirby Thore about 3 km away.

Lower Sulphate Bed with a band of selenitic spherules known as a 'daisy bed': Birkshead Mine. © Noel Worley.

A general view of workings in Upper Sulphate Beds of A Bed evaporite : Birkshead Mine. © Noel Worley.

The B and C Beds were both quarried and later mined at Newbiggin from the 1960s until the mine closed in 2005. Restoration is in progress and will soon be complete, but the B Beds (3-6m thick) are still exposed on the south side of the remaining excavated area, with small exposures of the C Bed (about 1 m thick) on the north side; these are now the only exposures of these beds in Cumbria.

The B Bed is divided into 2 parts. The Lower Post comprises porphyroblastic selenite in an alabaster matrix that has a well developed layer structure. This is separated by a thin black shale layer from the Upper Post of alabastrine gypsum. Both B and C Beds have a high sulphate content and are therefore highly impermeable, with the result that conversion to gypsum does not normally progress to more than 30-40m below ground level.

N.B. Our party members were presented with a well illustrated hand-out on the geological formation of the area, deposition and development of the sulphate deposits and a detailed description of features seen at all the locations visited in the mine and at Newbiggin Quarry. This is required reading for those interested in more detail of the subject. Copies are held by those who attended and a spare copy is available to borrow from the Field Visit Secretary.

East Yorkshire Cretaceous Coast
Saturday 28th June

Leader: Dr. James Lawrence: University of Leeds SEE
9 Members present

Purpose: An investigation of the Northern Province Chalk geology including the applied aspects of the rock.

We began at Reighton [TA140763] where on a windy hill we were perfectly placed to view a 6km stretch of coastline looking toward the hard chalk headland of Bempton Cliffs. In the foreground we saw the oldest rocks of the day, the brown coloured ammonitic and coprolitic Speeton Clays deposited throughout the Lower Cretaceous 140-100 Ma in a low energy marine environment. Today the landslipped clays form a dangerous steep sided terrain, the legacy of coastal erosion, natural oversteepening and mass movement. Although absent from this exposure the overlying Hunstanton Red Chalk Fm (Albian) forms the top of the Lower Cretaceous and an important stratigraphical marker useful during offshore drilling to pick out the base of the chalk sequence.

Succeeding Chalks were laid down during the Upper Cretaceous from 100-80 Ma (Cenomanian to Early Campanian) and achieved a thickness of around 400m in Yorkshire. Whilst we would be looking at exposures from the youngest of the sequence (Flamborough Fm), it is possible that even younger chalks were deposited but subsequently eroded.

At Flamborough Head [TA254708] we descended into an arcuate cove surrounded on the landward side by 7m high white cliffs. The wave cut platform suggested a gentle eastward dip of strata into the North Sea. At first glance the chalk appears well-bedded and uniform in colour and texture. However on closer inspection, beds are highly fractured, sometimes contorted, contain stylolites and are periodically interbedded with thin marl bands. Some marl bands are sufficiently thick and continuous to allow correlation across Europe and chemical analysis proves that some have a volcanogenic origin, reminding us that the Cretaceous world was at times far removed from the placid environment generally associated with chalk deposition. Major tectonic activity throughout the whole Period was breaking up Pangaea, opening up the South and North Atlantic and extruding the Deccan Traps. In the Upper Cretaceous, widespread shallow shelf seas supported algal blooms and coccolith accumulation. They were created by eustatic sea level rise due to fast spreading constructive plate margins.

Also at this locality, the effects of the Alpine Orogeny, (Mid Tertiary 30-25Ma), have overprinted multiple deformational structures in the chalk. The degree of deformation is controlled by fracturing styles. These are closely spaced vertical fractures (Seaford style), large inclined faults with strong conjugate fracture sets (Newhaven style), a thrust fault, and brecciated chalk adjacent to horizontal beds. These features make Flamborough Head quite unique and suggest it was probably close to the front of a localised thrust zone which follows subsurface structures (see photo opposite).

Lab testing of recovered cores from the same stratigraphical sequence further

Gorgeous geologist inspects sub-vertical beds of chalk beneath a low angle thrust at Flamborough Head. The beds above the fault plane are ramped as displacement has been taken up.

inland reveal that a strong salt water weakening effect occurs when salt crystallises from especially saliferous pore waters. SEM imagery shows these crystals growing within the primary fabric, forcing individual grains apart, and in turn reducing rock mass strength. Further effects of glacial, periglacial and coastal weathering induce a weathering scheme where regolith thickness can achieve 25m before rockhead.

Firmly with our engineering geology heads on we continued to Dykes End [TA216692]. This coastal exposure is the southern termination of Danes Dyke, a 4km long N-S trending man-made defensive ditch. We reviewed the CIRIA guidelines for simple chalk logging. Assessments are made through actual measurements, such as width and spacing of fractures. Others are open to interpretation, such as breakability of hand specimens between finger and thumb, and penetration depth of a 150mm nail struck from shoulder height using a geological hammer. Many of these simple components link together to produce a geotechnical chalk grade.

Here, as with most of the Northern Province chalks (apart from those of Turonian and Coniacian age - mid Upper Cretaceous) there are no flints. However, when present, tabular flints are found parallel to bedding, and sheet flints shoot up fractures making the latter unsuitable for correlation. The unconfined compressive strength of the flints (1000 MPa) is ten times that of the enclosing chalks. When encountered during drilling and tunnelling they can significantly hinder progress.

This Dykes End exposure is the *Marsupites* (echinoderm) section but despite much searching we did not turn up any of the polygonal plates which make up the calyx. We did collect a selection of macrofossils such as belemnites, sponges and a death assemblage of bivalves, along with ichnofossils, such as bivalve borings and *Thalassinoides.*

The final stop of the day was to view the raised beach deposits and buried cliff at Sewerby (TA196684). This section is important as it demonstrates deposition in two separate glacial episodes with an interglacial in between (see photo below). The Yorkshire Coast trended inland between 128,000 and 116,000 years ago and this exposure is where the palaeocliff line cuts the present coastline. An interglacial shingle beach is seen about 1m above the current beach and rests on a planed surface of Basement Till (probably Wolstonian 140,000 years age). Vertebrate fauna date the raised beach to the last (Ipswichian) interglacial. Banked against the cliff is rainwash (chalky colluvium), and over this is aeolian sand accumulated during the Devensian, when falling temperatures and increased glaciation caused a drop in sea level, allowing accumulation at the foot of the palaeocliff. As ice covered the cliff it deposited the overlying Skipsea Till, itself overlain by the Sewerby Gravels of glaciofluvial origin.

The day closed with our sincere thanks offered to James for his tremendous insight into the chalk geology. Far from being a white homogenous mass, the rock contains all the usual sedimentary structures, although they are difficult to see. Lithostratigraphical mapping and an understanding of the terrestrial geology over the last 30 years by a dedicated few, has without doubt, led to success in the oil, gas, water and civil engineering industries.

Raised beach deposits and buried cliff at Sewerby. At lower right, interglacial (Ipswichian) shingle beach deposit approx 1m above the current beach. Succeeding unit, bottom left to middle upper right, aeolian sand (Devensian) and finally Skipsea Till with overlying Sewerby Gravels at the top.

Roundhay Park: A Walk Back in Time
Wednesday 2nd July

Introduction by Secretary of Friends of Roundhay Park: David Binns
Geological introduction: Dr. W. John Varker
Introduction to the Trail: Bill Fraser
Trail leaders: Bill Fraser and Margaret Cliff
Refreshments (including rock buns): Noreen Reid

Completion of The Roundhay Park Geological Trail has been accomplished with an excellent guide to accompany it.

On Wednesday 2nd July approximately 40 people assembled in the Education Centre at the Mansion House in Roundhay Park for the formal opening of the Roundhay Park Trail and its accompanying booklet (see photo below). Guests had the opportunity to look at displays of photographs, rocks and fossils collected from the trail, and to fortify themselves with tea and rock buns before joining a guided walk round the trail (see photos overleaf).

Copies of the booklet are available from the Visitors' Centre in the Mansion House or by post from Bill Fraser, 27 Marshall Terrace, Leeds. LS15 8EA with cheque (made to FoRP) £1.50

The LGA wishes to thank all who have helped in the project, either by lending manpower on the working days, factual help or constructive criticisms on the content of the booklet.

Bill Fraser addresses the assembled group for the opening of the geological trail.

Examination of the cross stratification in the Rough Rock at Scouts Quarry.

Margaret Cliff describing features of Scouts Quarry on the trail.

Cow Green and Cauldron Snout: Upper Teesdale
Sunday 13th July

Leader: Dr Doug Holliday
11 Members present and 3 visitors

On a cool grey July day our group met at Cow Green car park and admired the view of the surrounding peaks including Cross Fell, and Great and Little Dun Fell. Our leader, Dr. Doug Holliday, explained that we would be following the Cow Green Geological Trail round the edge of the reservoir, down the side of Cauldron Snout, and along part of the Pennine Way beside the River Tees. He gave us an introduction to the geological history of the region.

Like the Askrigg Block, the Alston Block has a core of Lower Palaeozoic rocks overlain by shallow Carboniferous sediments. At Cow Green, the Great Scar Limestone (here called Melmerby Scar Limestone) is succeeded by rocks of Yoredale facies but the limestone beds are thinner and the sandstones thicker than on the Askrigg Block. They are topped by the local equivalents of the Millstone Grit. It is probable that Coal Measures and some Permo-Triassic and Mesozoic rocks were also formerly present, but after several episodes of uplift and erosion these have been removed. The last major event was the ice age which created the rounded outline of surrounding hills. Devensian ice came down Teesdale from Cross Fell and left behind boulder clay with local erratics.

There were two major intrusions of igneous rocks into the Alston Block. The first was the Weardale Granite which intruded into the Lower Palaeozoic rocks in early Devonian time. The second, the Whin Sill, a huge sheet of dolerite, at 1100°C and up to 70m thick in places, intruded into Carboniferous rocks about 295Ma. The sill changes position via faults and joints and is at a low stratigraphical level in Teesdale. The old miners recognised the igneous origin of the rock and gave it its name – 'Whin' meaning hard rock and 'Sill', big thick bed. Consequently, 'sill' became the geological term we use today Both the sill and the country rock are cut by numerous mineral veins, locally mainly barite, which was mined hereabouts until the 1950s. The remains of these workings are visible along the trail.

Construction on The Cow Green Reservoir was started in 1968 to supply water for the steel industries in the Middlesbrough area amid much controversy because of the rare alpine flora, including Spring Gentian, on the adjacent fells. Fortunately these lovely blue flowers still flourish in spring on the limestone soils.

We walked towards Cow Green Dam along the narrow road. The scarp edges of the hard Yoredale limestones stood out as low lines of grey crags in the hillside, the highest being the dark Smiddy Limestone (due to mud and

Cow Green dam wall showing the two parts: the concrete wall and the earth bank.

organic material in it). We identified the pale Peghorn and then Robinson Limestones as we descended the sequence. The latter showed signs of thermal metamorphism as we approached the Whin Sill. It has been observed that the presence of organic matter inhibits recrystallisation in the dark limestones.

Further on and closer to the Whin Sill we noted small outcrops of Melmerby Scar Limestone which had undergone thermal metamorphosis changing the original bioclastic nature of the limestone to a coarse grained marble. It weathers to a crumbly texture ('sugar limestone'). Nearby, at Red Syke, the dark jointed dip slope of the Whin Sill was exposed. Examination showed it to be fine grained (chilled margin). Two further samples were examined as we walked towards the dam wall and crystal size increased the further away we were from the cooling effect of the limestone.

At Cow Green Dam, Doug explained that the dam wall is in two parts (see photo above). The concrete wall has its foundations in hard Whin Sill. The other part is an earth bank constructed on thick glacial deposits which had filled a deep narrow valley cut in the Whin Sill (the old course of the river Tees). The existence of this valley was unknown until investigations were carried out for construction of the dam. With hindsight there were surface features which indicated its presence.

Our lunch break was at the top of Cauldron Snout where the River Tees flows over a dramatic series of waterfalls cut in the Whin Sill. Descending the side of Cauldron Snout (a hanging valley) required some care. At the bottom, we could see the site of the old river channel on the western bank where there was a smooth grassy bank and an absence of in situ rocks. It ran parallel and a few metres to the west of the present channel. From here the river follows its old course.

Walking by the now calm River Tees in its steep sided valley, our next stop was below Falcon Clints where the base of the Whin Sill intruded at an angle to the bedding of the Melmerby Scar Limestone (now marble). A bedding surface in the limestone showed evidence of penecontemporaneous palaeokarstic weathering and later mud infill prior to renewed limestone deposition. The sill shows columnar jointing (see photo below).
After negotiating our way over rough boulders, our final stop was to examine early Carboniferous conglomerates, containing slates and pebbles of the Borrowdale Volcanic Group. We were not able to find any older, Lower Palaeozoic, rocks beneath these.

We made our way back to Cow Green Reservoir where we thanked our leader for an excellent day in such magnificent scenery.

The base of the Whin Sill, being indicated by the leader, resting on Melmerby Scar Limestone.

The Depositional Environments of the Huddersfield White Rock in the area between Golcar and Meltham Saturday 30th August

Leader: Tony Benfield, LGA
17 Members present including the leader

Purpose: To examine two different facies of the Huddersfield White Rock and to consider their depositional environments.

The group met at the Pennine Manor Hotel, overlooking the M62. Unfortunately the weather was overcast and we could not see the surrounding hills clearly. However, Tony gave a brief resumé of the geology of the area, and reminded members that during the Namurian, a river of Mississipian proportions brought sediment from the north and northeast to be laid down as a series of deltaic deposits which characterise the Millstone Grit. In the Central Pennines, the upper part of the Millstone Grit comprised a number of cyclic sequences which coarsen upwards from a marine shale, through silty and sandy mudstone into a sandstone, often capped by a rootlet bed and a thin coal below the shale of the next cycle. Thus, within each cycle, conditions changed from marine, to shallowing non-marine, to emergence, then back to marine. These cycles were caused primarily by eustatic changes in sea level related to fluctuating ice sheets over Gondwanaland, but delta switching may also have played a part.

Tony explained that the Huddersfield White Rock (HWR) was the name given to the sandstone member of the highest cycle within the Marsdenian sub-stage of the Namurian, and between Holmfirth and Halifax, was primarily laid down in a north-westwards prograding delta lobe. With the aid of the diagrams included in his handout, Tony described some of the facies that made up the HWR and related them to their deltaic depositional environments. He explained that we would be mainly looking at just two: deposits laid down within the proximal part of a distributary mouth bar and fluvial channel-fill deposits. He commented that many quarry faces were now overgrown, but had been much clearer 40 years ago when he first looked at them! Sharing cars, we then set off.

Location 1 - Clough Head Quarries, Bolster Moor [SE 082 157]
Viewed from the road this was a 20m high face of cross-bedded sandstone, with sets 1m thick dipping at 27° to the NW. The sandstone was fine to medium-grained, cemented with iron oxides, and with no fossils - trace or other.

We then moved round into a small quarry to examine a face at right angles to the one we had just seen (see photo overleaf). Here the cross-strata formed a series of intersecting troughs indicating that they had been formed by the migration of trains of linguoid mega-ripples. The trough axes plunged to the NW indicating a palaeo-flow in this direction. These beds had been allocated

Trough cross bedding in a face at right angles to the palaeocurrent direction, Facies D, Location 1

to Facies D of the HWR which Tony considered to have been deposited within inner distributary mouth bar channels. He also pointed out that at the top of the face, 3m of poorly bedded medium-grained sandstone containing shale-flakes and plant material represented a major flood event.

Location 2 - Field Cottage Quarry, Bolster Moor [SE 086 151]

This exposed trough cross stratified fine to medium-grained sandstone with sets 1m thick. This was Facies D again, but here the strata were deformed in places, some beds being over-steepened with balled up structures. These features were pre-cementation de-watering structures, probably a consequence of excess pore waters being forced upwards as sea level fell.

Location 3 - Scar Lane Quarry, Golcar [SE 103 158]

Located on a dog walkers' path below the Royal British Legion Club, this has a fine view across the Colne valley. Facies D could again be recognised in the lower 6m of the face. Cutting down into it was a 6m thick, massively bedded unit with a sharp erosive contact varying in level by up to 1m. This unit was coarse to very coarse-grained sandstone with black carbonaceous material and weathered (oatmeal) feldspar, cemented with silica which, when freshly quarried, would have looked strikingly white - hence the name given to this sandstone. Casts of tree debris were visible. The unit was named Facies J by Tony and represented a river channel deposit.

Location 4 - Manchester Road Quarry, Linthwaite [SE 109 155]
Behind some terraced houses, Facies J could again be seen to overlie Facies D (see photo below). The disparity in grain size could be readily felt. Facies D was more thinly bedded than at previous locations with trough axes plunging at 12° to the NW. Facies J contained casts of plant stems and large lenticular clasts of silty mudstone, some up to 1m in size. It appeared to be trough cross-bedded but Tony pointed out that the dips were only around 15° and in varying directions (mainly to the SE). Such low angles are not usual in cross-bedding: what we were probably seeing was lateral accretion on a point bar within a south-westerly flowing, braided river.

At this stage, location 5 - a local pub - made a welcome late lunch spot.

Location 6 - Wild Brow Quarry, Blackmoorfoot [SE 095 132]
Although used as a rubbish dump, low angle lateral accretion dips were visible in very coarse-grained sandstones - Facies J: a channel-fill deposit of the south-westerly flowing, incised river.

Location 7 - Old railway cutting, Meltham [SE 106 111]
We closed by taking another look at Facies D with its fine to medium-grained sandstone, trough cross-bedding (about 1.5m thick beds here) and de-watering structures: a distributary channel deposit on the inside of its mouthbar.

A vote of thanks was given to Tony for an excellent day and his usual comprehensive handout and explanations.

Contact between Facies D and overlying Facies J, Location 4.

Residential Weekend to locations on the Glamorgan Coast based at Swansea University
Friday 12th to Sunday 14th September

Leader: Dr Stephen Howe, National Museum of Wales Cardiff
20 Members and spouses present

The weekend's activities were based on geological walks described in the book 'Walking the Rocks' of which our leader is a co-author. (See below for details).

As a prelude to the visit most members of the party attended an illustrated talk in the SEE at Leeds very kindly given by Murray Mitchell based on the work that he and his BGS team had done in the 1970s to elucidate the limestone stratigraphy of the Gower coast and consequently the basin structure across the Severn estuary into the Mendip Hills.

The weekend field work started on Friday afternoon with a brief visit to Caswell Bay, west of Mumbles, using Murray's description / stratigraphical data and the above text. Most of the party made this assignment, although later arrivals met an incoming tide which left limited time for close inspection of the section. We were able to examine the northwards dipping strata in a descending sequence towards the Langland Anticline, from fossiliferous High Tor Limestone through Caswell Bay Mudstone and Caswell Bay Oolite into Langland Dolomite, and recognise High Tor Limestone overlaid by the older Langland Dolomite as a result of the Caswell Thrust. The sequence is then repeated into the Anticline. Evidence of erosion into deep pits on the exposed surface of the Caswell Bay Oolite, visible as a result of faster erosion of the softer overlying mudstone, shows that the surface was exposed as a result of sea level fall, and eroded before being resubmerged and the mudstone deposited in lagoonal conditions.

The party then withdrew from the incoming tide and, using the cliff top walk just above the cliff outcrops, were able to follow the whole section over 1km through the Langland Anticline, returning to (now south dipping) High Tor Limestone before Whiteshell Point and the first of several fine headland views of the weekend.

We then returned to our base at Swansea University for a well earned dinner.

('Walking The Rocks' Six walks discovering scenery and geology along the Glamorgan coast by Stephen Howe, Geraint Owen, Tom Sharpe. Geologists' Association - South Wales Group. 2004 ISBN 0 903222 01-9)

Saturday 13 September

Western Gower

Happily, Saturday was a day of blue skies and warm sunshine and our 16 miles (27 kms) drive from Swansea University to Rhossili at the far SW corner of the Gower Peninsula was enlivened by brief glimpses of a blue sea. We met our leader, Dr Stephen Howe of the National Museum of Wales, in the car park where he gave us a brief introduction to the Devonian and Carboniferous geology of Gower, and explained that our route had taken us across an erosional surface referred to as the 200 ft (60m) Platform. Traditionally this had been ascribed to marine erosion in late Tertiary or Pleistocene times, but was now thought to possibly represent an exhumed pre-Triassic erosion surface as evidenced by one relict deposit of Triassic age at Port Eynon, 4 miles (7 km) south-east of Rhossili, and by the presence of fissure fills of red Triassic sediments within the Lower Carboniferous limestones.

We then walked a few yards to view the magnificent stretch of Rhossili Bay backed by the 632ft (193m) high Rhossili Down with its anticlinal core of Old Red Sandstone and its fringing Late Devensian solifluction terrace (see photo below).

Rhossili Bay and Down: Old Red Sandstone cored anticline, with fringing Late Devensian solification terrace.

Old Red Sandstone quartz conglomerates and sandstones in disused quarry north of Rhossili.

Passing through the village, we reached a small disused quarry on the west flank of Rhossili Down. This exposed almost vertical beds of silty mudstone with thin limestones within the basal Carboniferous Avon Group. The steepness of the dip reflected proximity to a N-S trending normal fault on the western limb of the Rhossili Down Anticline.

Some 50m to the north, another small quarry exposed quartz conglomerates and red, coarse-grained sandstones of the Old Red Sandstone which had been laid down in late Devonian times within an alluvial fan shed from the Caledonian mountain front to the north. The strata were almost vertical and graded bedding indicated that they were in fact overturned to the north (see photo above).

The majority of the party then ascended the steep path to the summit of Rhossili Down where Old Red Sandstone conglomerates were again exposed. Dr Howe explained that during the Variscan Orogeny, extensive folding, thrusting and tear-faulting of the Devonian and Carboniferous rocks had occurred and that looking eastwards across the Gower Peninsula, all the prominent hills were made up of the more resistant Old Red Sandstone cropping out in the cores of a series of mainly NW - SE trending anticlines.

Jumping forward to the Pleistocene, Dr Howe said that during the late Devensian, the ice sheet that had covered most of Wales extended to the northern edge of Rhossili Down, but over the hill itself, periglacial conditions had produced extensive solifluction deposits of head, which now made up the extensive terrace to the west which we had observed earlier (see photo page 23). Unfortunately a heat haze obscured much of the panoramic view to the west, so the party descended to the SE, observing en route a section through the head which contained angular blocks of Old Red Sandstone.

Our route then took us across the main road and south to a small disused quarry in fossiliferous limestones of the Lower Carboniferous High Tor Limestone Formation which dipped steeply to the south into the SE plunging axis of the Port Eynon Syncline. Slickensided surfaces represented fault planes, whilst a striking feature was the development of small caves, with assorted flowstones, into one of which an especially agile member promptly disappeared (see photo below).

We then descended into the steep-sided Mewslade valley eroded out along a N-S trending normal fault, probably by glacial meltwater during a period of permafrost. Noting the change in dip across the synclinal axis and the cemented screes on the valley side (see front cover photo), we climbed down through a narrow gully where thick veins of calcite marked the position of

Cave development in Lower Carboniferous High Tor Limestone Formation (speliologist for scale!)

the controlling fault, to reach Mewslade Bay where we enjoyed a picnic lunch and one member had a swim!

At Mewslade, as elsewhere on the south Gower coast, there is evidence of a raised beach at about 30ft (10m) above present sea level which dates from the Last (Ipswichian) Inter-glacial. Dr Howe told us that animal remains such as hippopotamus dating from this period, together with those of bear, frog, owl and hedgehog of probable younger age, had been discovered in caves in Gower which had served as hyena dens.

We then climbed back up the valley side to regain the 200ft Platform before walking westwards along the cliff top to a vantage point overlooking Fall Bay where perfect weather provided magnificent coastal views of the spectacular limestone cliffs that extend south-eastwards along the strike (see photo opposite). We then descended to the foreshore near to Tears Point where bedding planes of fossiliferous bioturbated limestones of the Black Rock Limestone Group dipped seawards. Broken solitary corals and crinoid debris suggested deposition in shallow water above storm wave-base. Examples of fissures filled with red siltstone of probable Triassic age were observed. Above the rock outcrops, we examined a section through Pleistocene deposits which included the “Patella” beach of Ipswichian age comprising calcite-cemented pebbles and shelly sand with obvious limpet shells. This was overlain by a red clayey silt, periglacial head and a thin loess deposit, emphasising the way in which the climate had changed from interglacial warmth to glacial cold.

Climbing back once more to the 200ft Platform, we were rewarded with views to the Worm's Head which demonstrated the periclinal nature of the folding thereabouts. Further westward we descended to the shore line for the last time to examine another section through the Ipswichian “Patella” beach, here some 10m above the present-day shoreline, and overlain by the same sequence of red silty clay surmounted by Late Devensian head. We ascended to the 200ft Platform (yet again!) and walking back to our starting point, enjoyed magnificent views across Carmarthen Bay to Lundy Island and Pembrokeshire, bringing to a close what had been a most enjoyable, geologically varied and scenically spectacular day, enhanced by perfect weather.

South Gower coastal scenery from Falls Bay towards Paviland.

Sunday 14th September

Ogmore-by-Sea

The group met on Sunday morning at Ogmore with a good weather forecast for the day.

Our leader explained that during the Triassic the Vale of Glamorgan was a low-lying desert cut by a chain of E-W trending hills formed by Carboniferous limestone, now eroded to form the local topography. A hot and arid climate with occasional violent storms helped create wadi systems that deposited upland material onto the desert floor.

In the late Triassic, marine transgression isolated the limestone hills as a chain of islands which were submerged in the Lower Jurassic. In the shallowest water the Sutton Stone, a white conglomeratic limestone was deposited. With increasing depth, the limestones and shales of the Southerndown Beds were formed. These were followed by the intercalated muddy limestones and shales of the Blue Lias Formation. The Lower Lias deposits are the youngest rocks that can be seen in the area until the Pleistocene.

In the Devensian, the vale of Glamorgan was periglacial, situated to the south of the ice front. The melting ice created wide valleys of which Ogmore valley to the north-west of the start point is an example. The Ogmore River, which is much smaller than the preceeding Devensian river, is referred to as a misfit river.

Wadi deposits with a large rounded boulder.

Fossil coral bent to a right angle by a probable storm.

From the car park which is on Gully Oolite, the group headed along the beach to the south east. Here the oolite has coarse rounded gravels on top, deposited from meltwater in a large river. The limestone has two joint systems eroded into the rock.

Overlying the Gully Oolite, the first of three Triassic wadi alluvial fan deposits is a breccio-conglomerate containing various sized angular, sub-rounded and rounded pebbles and boulders of mainly grey Carboniferous limestones, set in a red silty and sandy matrix. Patches of sand suggest ponding. This end phase of a wadi system shows upwards fining with angular clasts. Interesting features were a large rounded boulder~3m x 1.7 in a limestone matrix and nearby a thinly laminated sandstone (see photo opposite).

The second wadi is the largest in the area and extends 0.8km. It has a grey matrix and angular clasts, possibly from a proximal source. The timing is thought to be near to the Triassic-Jurassic boundary when the climate had changed from hot and arid to wet. Post-Jurassic mineralization of barytes, calcite and galena could be seen. Nearby, extensive *Zoophycos* was seen in the limestone. Jointing, in two dominant directions, was filled by Triassic sediments of red mudstone. The fossiliferous High Tor limestone contains solitary and colonial corals and brachiopods. Some corals were bent suggesting a clear water environment with occasional storms that knocked the corals over and caused them to bend as they grew towards the light (see photo above).

The third and smallest Triassic alluvial deposit is draped over the High Tor Limestone and has varied clast sizes and large rounded limestone boulders up to 2m diameter with no obvious wadi-cut channel.

Further to the south-east at Black Rocks the Caswell Bay Mudstone was seen overlying the Gully Oolite. Gastropods and burrows were plentiful in the Oolite and excellent examples of tension gashes were associated with a fault in the cliff face (see photo opposite). Eroded fissures in the limestone clearly pick out the jointing.

Continuing south-east, at the mouth of Pant y Slade, a dry valley, the unconformity between the Carboniferous High Tor Limestone and the Jurassic Sutton Stone is clear. Burrows in the limestone are cut by the Triassic wave-cut platform. The Sutton Stone is an ammonite-free conglomerate limestone beach deposit in which clast size and content vary laterally. The variability is confirmed by a nearby lens of finer grained rock containing stylolites. Also nearby is an outcrop of Sutton Stone with corals at its base overlain by a gritty limestone with shale partings - interpreted as the edge of a palaeo-island. Looking to the south east, a series of caves in the cliffs could be seen in the Sutton Stone at the level of the unconformity. These were opened and controlled by the jointing, and enlarged by later roof-fall.

We had lunch in Pant y Slade, a former meltwater channel, where exposures of deep water, thinly bedded Southerndown beds, overlie the Sutton Stone.

We walked on to Dunraven Bay where excellent Lower Jurassic exposures are found (see photo opposite). On the north side of the bay, the lower platforms are fine conglomeratic limestone and thin sandy shales of the Southerndown beds, which contain clasts of Carboniferous limestone, chert and fossil wood fragments. Upwards, the sequence passes into the rhythmic muddy limestones and shales of the Blue Lias, a part of the Porthkerry Member. The Seamouth Limestone, a local marker horizon, stood out to at the top of the cliff.

To the south of the bay, Trwyn y Witch is a promontory in which Sutton Stone and the Southerndown beds drape over folded Carboniferous limestone. These rocks form an E-W trending anticline. The Dunraven fault is seen at Fault Corner at the junction of the promontory and the main cliff face. The fault has brought Sutton Stone in contact with the Blue Lias. Evidence of incremental movement of the fault is seen by the small displacement in the Lias. A smaller fault with a 2.5 metre displacement was seen to the north.

Nearby rocks at beach level are part of the Seamouth Limestone in which fossils of the bivalve *Pinna* are abundant in life position. Many other fossils such as *Gryphaea, Plagiostama* and *Pentacrinites* were seen in the bedding planes of the Blue Lias.

This location marked the end of the trip and we made our way back to the cars, where Howard Dunnill thanked Dr Howe for an excellent weekend introducing us to the spectacular geology of the Glamorgan Coast.
Finally, see photo inside back cover!

Tension gashes in the Gully Oolite.

Cliffs to the north of Ogmore-by-Sea!

The Jurassic of the Howardian Hills
Saturday 4th October

Leaders: Jon Ford and Simon Price: BGS Keyworth
14 Members present

In their introduction to this excursion, the leaders told us that though the York Geological Sheet 71 had recently been published on the 1:50 000 scale, further field revision is still taking place on the York Geological Sheet 63 and should be finished during the present field season. The revised sheet will then show the modern Jurassic and Quaternary stratigraphy so that it is compatible with other recently revised sheets in the region.

The main aim of this excursion was to examine some of the exposed rocks of the Jurassic succession in the Howardian Hills and to consider possible structural controls on their deposition. According to the handout kindly given to the participants, the area lies at the transition from the Cleveland Basin to the north and the East Midlands Shelf to the south. The boundary between the two is marked by a structurally complex east-west trending fault system termed the Flamborough Head Fault Zone. This marks the northern edge of a deep seated basement structure, the Market Weighton High, which has affected sedimentation during the Jurassic and has resulted in a significantly thinned succession.

The first locality, Birkdale Farm, Mowthorpe [SE 6870 6901] lay in a picturesque embayment at the foot of the main Howardian Hills escarpment. This escarpment is formed mainly by formations in the Lias Group, with the Redcar Mudstone at the base, succeeded by the Staithes Sandstone, Cleveland Ironstone and the Whitby Mudstone formations. There were signs of landslips in the Whitby Mudstone. The escarpment is capped by the Dogger Formation and after a trudge through a wood we came upon crags of ferruginous sandy limestone and sandstone belonging to this formation (see photo opposite). On the way up, the leaders drew attention to the distant ruins of the twelfth century castle at Sheriff Hutton built of this stone. They also said that a flat area in the middle foreground marked the former presence of a marginal glacial lake that had formed from meltwater trapped between the York-Eskrick Moraine and the escarpment. The Whitby Mudstone, we were told, had been somewhat eroded before the deposition of the Dogger which marks the base of the Middle Jurassic Ravenscar Group. Careful examination by members yielded evidence of this in the form of ironstone pebbles derived from the underlying formation. Fossils were also found including echinoid spines, ribbed bivalve fragments and bryozoans.

Jon Ford explaining the geology of the location before the group examined the crags of the Dogger Formation behind him.

The next locality was a caravan park [SE 7340 6702] south-west of Crambeck village where an old deeply weathered quarry face exposed the Lebberston Member of the Cloughton Formation, part of the Ravenscar Group. In general, the succession comprises an alternation of marine and non-marine facies marked by three leaves of limestone separated by sandstones. The exposure showed limestone at the base passing up into very soft, crumbly, trough cross-bedded sandstone overlain by the next limestone. We ate our picnic lunch at this site.

A short drive then took us to the car park at Kirkham Priory [SE 7350 6580]. The leaders explained that the fine deeply incised valley of the River Derwent here was mainly eroded by catastrophic outbursts of glacial meltwater from the ice-dammed Lake Pickering flowing to Lake Humber, also ice-dammed, that occupied much of the Vale of York. They went on to explain the use of the latest technology for geological mapping purposes, namely the Digital Terrain Model (DTM) on a portable laptop computer, which has now replaced the traditional six-inch map in its stiff leather mapcase.

The next locality was the large and spectacular working quarry at Settrington [SE 8288 7001] where oolitic limestone from the Malton Oolite Member of the Coralline Oolite Formation is extracted. The limestone forms flat lying,

Horizontal beds of the Malton Oolite Member in Settrington Quarry.

very regular even beds about a metre thick with a few clayey partings (see photo above). The oolitic character was instantly visible in hand specimens.

At the final locality, close to North Grimston [SE 8370 6836], we briefly studied the topography where the Howardian Hills meet the chalk Wolds. We were told that the broad dry valleys in the Jurassic limestones are floored by a spread of flinty gravels derived from the adjacent chalk. These valleys are thought to have been mainly formed in periglacial conditions during the Quaternary glaciations when permafrost prevented the subsurface drainage that is normally present in limestone terrains.

We thanked our leaders for an excellent day in which they shared the results of their research in an area where the Jurassic deposition was poorly understood and little studied.

Fossils of the future at Ogmore-by-Sea!

For more information visit us at:
www.leedsgeolassoc.freeserve.co.uk

Members in excavator $25m^3$ bucket.