LGA

Leeds Geological Association

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Field Visit Reports Summer 2011

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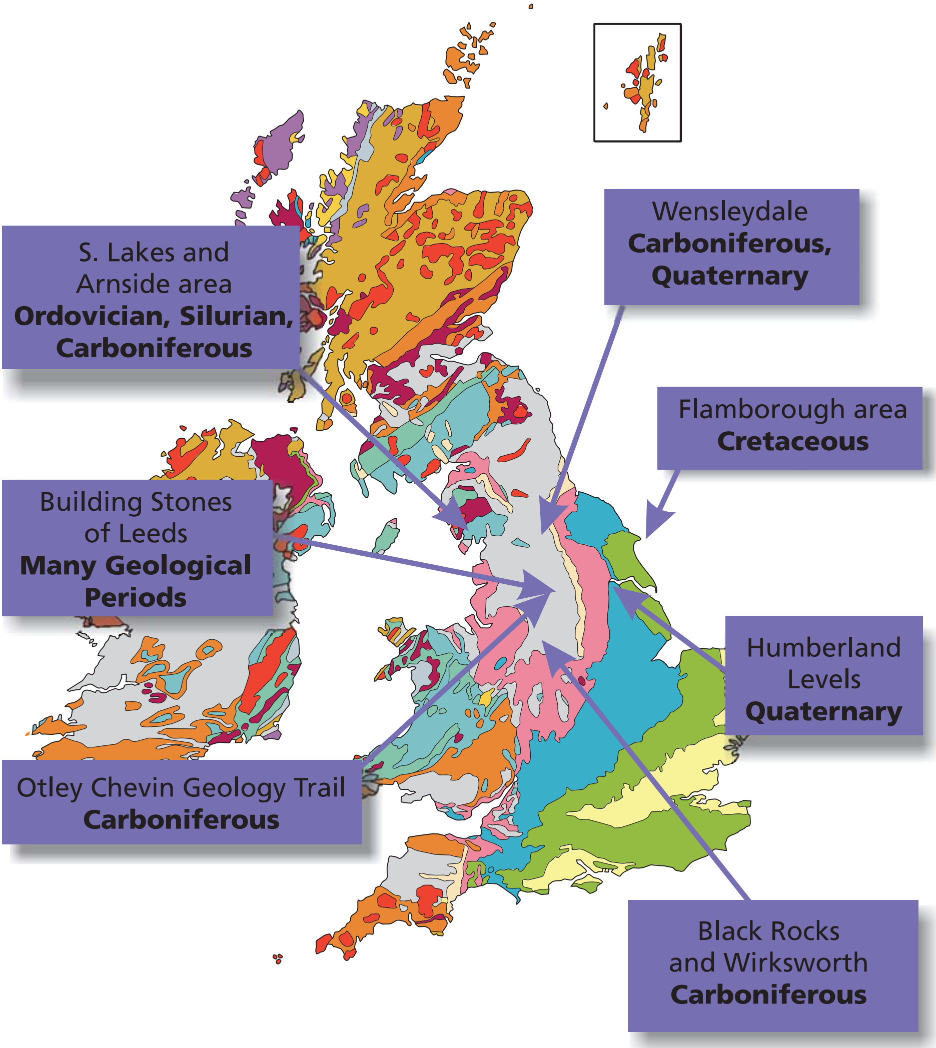
11 Where did we go?



Contents

2011 Field Visit Locations

Thanks to the authors of the field visit reports who also produced the images: Neil Aitkenhead, Tony Benfield, Howard Dunnill, Bill Fraser, Jeremy Freeman, Shirley Leach, David Leather, Judith Whalley. Extra images provided by Tom Halstead and Kevin Read.

Cover Picture: Examining the Flamborough Formation at South Landing for echinoids *(Hagenowia blackmorei)*.

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Whitfield Gill, Askrigg, Wensleydale
Saturday 14th May

Leader: Dr. John Varker
12 Members and 2 visitors present

The group met on a bright and breezy spring morning at 10.30am by Askrigg church for a full day on foot in nearby Mill Gill and Whitfield Gill. The aim was to examine three or four sedimentary cycles of the Wensleydale Group (Late Dinantian) of which there was a fairly continuous succession, and to attempt some stratigraphic logging.

We soon found ourselves on a paved path in a flowery meadow as we paused near an old water mill where John gave an introduction to the sedimentary cycles or cyclothems, putting them in the wider perspective of nearby ancient delta, shallow equatorial seas, Askrigg block with underlying granite, and how the number of cycles increased from 4 to the south to 10 in Wensleydale, and 17 further north. He reminded us that the new geological name of 'Wensleydale Group' has changed from 'Yoredales', rather like the name of the dale, that changed to Wensleydale from Uredale, and earlier still, Yoredale.

On the other side of the water mill, in the stream bed of Mill Gill, we discovered that the massively bedded Gayle Limestone, the second above the Great Scar Limestone, contained the tiny tear-shaped outlines of Saccammina, a large primitive form of Foraminifera. This limestone was referred to by Kendal and Wroot as the 'Saccammina Limestone', of which there are very few exposures.

Higher up the flowery wooded ravine, the next limestone was the Hardraw Scar Limestone which cropped out at the top of Mill Gill's high and impressive waterfall and below which there was a wonderful succession of darker, thickly bedded sandstones, then more thinly bedded fine sandstones and beneath those, siltstones and black shales, representing a large part of that cycle. (see photo opposite).

Out came clip boards, squared paper, coloured pencils and mapping pens. We decided on a scale up the left hand side and, along the bottom, the distance each stratum jutted out was determined by its grain size. We added shorthand for all the rock types and other possibilities such as coal, and symbols to indicate such things as foraminifera, brachiopods, corals, crinoid stems or rootlets. The results were rather varied, especially as we were

Mill Gill Waterfall formed by the Hardraw Scar limestone and underlying sandstones.

estimating thicknesses (and even rock types!) as we gazed at the layers in the waterfall; John's example certainly looked very neat and professional. We had our picnic lunch looking down into the ravine where bluebells, red campion and wild garlic added colour to the scene.

Entering the gill higher up, where it takes the name of Whitfield Gill, we found on the side of the path a substantial gannister about 2m thick that had small rootlets, pale in colour with a black carbon covering. The finer roots showed downward branching and in strongly folded strata these can be used to show way-up of the beds. Above the footbridge the Simonstone Limestone indicated the top of the next cycle. During his research John Varker had found a large proportion of microscopic authigenic quartz crystals in this limestone. In higher limestones a similar presence of silica had precipitated as chert. Four symmetrical dimples in a shale fragment were interpreted as the rare impression of a small jelly fish with its fourfold symmetry. There followed a discussion on the origin of the cyclothems and, as there are only ten cycles in this dale, representing about ten million years, it may have been the shifting position of the delta that gave rise to the repeated strata.

We crossed the footbridge and climbed steeply up out of the ravine and, with the farmer's permission, crossed his land to enter the beck higher upstream. Here were lots of the huge shells of *Gigantoproductus giganteus* in the Middle Limestone. (see photo below). We learned that in the phylum Brachiopoda these are in a primitive group known as Strophomenids. They have a concavo-convex shell with little space for the animal inside.

Returning to the top of the track to Askrigg we met the farmer who was most interested to see what we had found. Visibility was excellent as we examined the view across Wensleydale and the amazing collection of glacial depositional features. Just to the right was the village of Bainbridge where the short River Bain joins the Ure from Semerwater, once ponded up much deeper by the lateral moraine we could see on the other side of the valley. Along the valley floor was the elongated ridge of a perfect esker, on top of which was the Roman Fort, and in the foreground were the green mounds of two or three drumlins.

We thanked John for leading the field day. Those present certainly appreciated his clear descriptions, and the enormous amount of interesting information he gave us, with everything put into context, so that we all felt it had been a very rewarding day. And the rain showers never reached us.

'The biggest *Gigantoproductus giganteus* I have seen'
micropalaeontologist John Varker in Whitfield Gill.

Otley Chevin Geology Trail
Thursday evening 9th June

Leader: Alison Tymon
13 Members and 2 visitors present

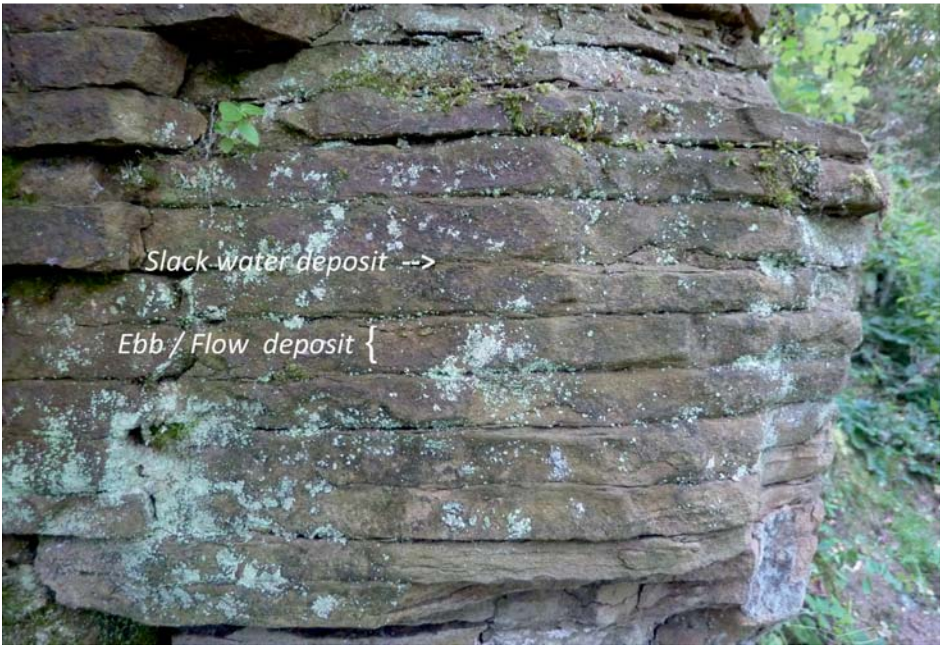
Otley Chevin has been the location for several visits by the LGA and associated groups over the years. On this visit we were privileged to be led by Alison Tymon who, in her role as Chair of the West Yorkshire Geology Trust, was the prime mover in developing the Geology Trail, the excellent leaflet which describes it, and the new display board at Surprise View. The party met Alison in East Chevin car park on a perfect summer's evening when she told us that, as she was on her way to Scotland, we had to be back in 2 hours so we were not to dawdle at the back! Those who have followed the Trail, and/or read the leaflet describing it, will know that as well as the locations being numbered, they are also marked by sculptures produced by a local artist. On this walk not only did we get the geology explained but, as an added bonus, Alison was able to explain the significance of the carvings.

Otley Chevin is underlain by rocks of the Millstone Grit Series. While the majority of outcrops are gritstone there are glimpses of some of the intervening mudrocks and their presence can be interpreted from the landforms. On the steep north facing scarp slope, mass movement has relocated some very large boulders and rock masses, and as the whole area has been heavily quarried over a long period, the ground has seen a lot of disturbance. While the mass movement processes were most active in late and post–glacial times they are still going on today. Some people may remember the extensive programme of works that took place around 20 years ago to stabilise the A660 down the Chevin.

The first 'hard rock' site is an unusual one. Close to the top of the Addingham Edge Grit, a vertical face reveals approximately 1.5m of horizontal laminites; well bedded, pale, fine grained sand/siltstones 0.5 – 2cm thick, separated by thin (1-2mm) layers of dark silt or mudstone. (see photo overleaf). These were explained by Neil Aikenhead (who had described them in core samples from nearby Hag Farm while resurveying the Bradford 1:50.000 sheet 69 in the mid 90's) as being tidal in origin. This had been deduced by plotting the thickness of laminae which showed a cyclicity that matched the effect that the moon today has on tides. The thicker, coarser layers represent the stronger currents of the flowing and ebbing tide; the thinner, finer layers, the slack water interval at high /low water when the tide is turning. The difference in thickness of the coarser layers was caused by the neap and spring tide cycles.

Having examined faces of more 'typical' Addingham Edge Grit (coarse grained sandstones with large scale current bedding) the party came to the site of the Great Dib Landslip. Here the Long Ridge Sandstone and the (now underlying) Addingham Edge Grit have slipped several hundred metres down slope when the mudrocks that lie beneath each unit failed. This most likely occurred in late glacial times when periglacial conditions existed. The slip has left a large amphitheatre approx 50m across with an almost vertical back wall. Although not part of the trail, close to this location are outcrops of the Otley Shell Bed, a few metres of fossiliferous mudstones that were formed during a brief marine incursion into the mainly fluviatile environment of the Namurian delta. The Otley Shell Bed is a SSSI for the occurrence of some of the last British trilobites before they became globally extinct in the early Permian.

The remaining exposures seen were all in the Doubler Stone Sandstone which forms the highest points of the Chevin. Excellent examples of soft sediment deformation and dewatering structures and a jumbled mass of fossil tree branches were seen in these massive, cross-bedded sandstones. One large block created discussion as to its 'way up'. Cross-bedding was inconclusive as adjacent units on the same face appeared to suggest the block being both the right and wrong way up! Graded bedding seemed to be more reliable and pointed to the block being the right way up.



Tidal Laminites on Otley Chevin.

Ascending the summit ridge of the Chevin the route passed more outcrops of the Doubler Stone Sandstone that showed how varied the rock is. At the top of Yorkgate Quarry it is of fine - medium grain size with some quite obvious pink feldspars. The bedding planes here are 'lumpy' and carry impressions of Stigmaria (tree roots). Lying on top of the sandstone is a bed of grey clay that contains a thin coal seam – the Morton Banks Coal. The clay is a fireclay, a fossilised clay rich soil that formed the seatearth on which a forest must have grown. Tree roots penetrated the soil leaving their impressions in the underlying sands and their trunks, branches and leaves, along with other vegetation, formed the coal seam. This point, and in the quarry faces, are good places to see the tectonic structure of the Chevin. All the beds dip south at around 20° as they are part of the E-W trending fold structures of the region created during the latter part of the Variscan Orogeny. Yorkgate Quarry was a large operation which was closed on environmental grounds in the early 60's when further take would have resulted in the Otley skyline being breached.

Approaching the display board at Surprise View, the Doubler Stone Sandstone becomes increasingly pebbly. Pebbles of white vein quartz up to 4cm in diameter show how strong the currents that deposited these sediments must have been. Cross bedding directions in all of the Chevin sandstones along with analysis of their accessory mineral content indicate a direction of deposition from the NE.

The visit ended at the display board. On such a clear evening is was easy to interpret the geology of the full 360° of vision taking in the glacial features of the Wharfe valley and extending as far as the White Horse on Sutton Bank to the north and Holme Moss to the south. Alison then outlined the changes that had been made to the original display board which was placed here 13 years ago before being thanked for an excellent visit and dashing off to make her journey north – we had only delayed her by 45 minutes!

Quaternary Deposits in the Humberhead Levels and North Lincolnshire
Sunday 19th June

Leaders: Professor Mark Bateman, University of Sheffield, and Dr Paul Buckland
13 Members and 3 visitors present

The group met the leaders at the Service Station by the M18/M180 Junction north east of Doncaster on a cloudy morning following overnight rain, before driving to our first locality at Tudworth Hall Farm, south of Thorne. Here we viewed and then ascended a low ridge which Prof. Bateman explained was a segment of a discontinuous, slightly sinuous feature, running just east of south for some 14km from Thorne through Tudworth Hall then Lindholme Hall to Wroot. The ridge comprises sands and gravels, although unfortunately they are no longer exposed at this locality. Dr Buckland explained that cores across the ridge had proved up to 1m of sands and gravels with a high proportion of Permian pebbles, indicating a westward or northward derivation, resting on Sherwood Sandstone; this sequence had also been observed in the M18 excavations. Prof. Bateman referred to the work of Dr Gaunt (formerly of the Geological Survey), who had linked them to similar gravels occurring at High Barham on the Isle of Axholme and concluded that this gravel ridge had been laid down at the far south west margin of the Late Devensian Vale of York icelobe, perhaps following a short-lived surge. More recently, other Geological Survey workers, including Dr Cooper and colleagues, had disputed this conclusion, and proposed the Escrick Moraine as the southern limit of this icesheet.

The party returned to the cars and drove to our second locality, Lindholme Hall, now a Buddhist Retreat Centre, situated on a slightly elevated 'island' in the centre of the peatlands of Hatfield Moors. We then walked to an open area which had been the site of an abortive sand and gravel extraction enterprise in the Thorne-Wroot ridge. Three shallow excavations were available for inspection, and Prof. Bateman explained that they had been studied in some detail by Robert Friend for a Joint Edinburgh/Sheffield MSc.

The first pit revealed a section of 1.5m of gravel, mainly well-bedded, resting with a sharp contact on about 1.5m of orange brown, fine to medium sand, with scattered pebbles, some of which were only visible as “ghosts” of decalcified limestone. (see photo on back cover). The lower unit exhibited deformation structures and Prof. Bateman suggested that it represented cryoturbated Sherwood Sandstone, here forming a bedrock high. He added that he had obtained Optically Stimulated Luminescence (OSL) dates from sands within the upper gravels which, despite problems of replication, yielded a maximum age of 82 Ka (ie Early Devensian). These gravels differed both in age and lithology from the Older River Gravels, probably dating from 250 Ka to 125 Ka, recognised elsewhere in the region. The strong colour and presence of iron deposits in the Sherwood Sandstone suggested that a humic soil had developed on the bedrock which had been removed by subsequent erosion.

In the second pit an approximately 2.5m thick sequence of level bedded sediments, said to rest on Sherwood Sandstone was exposed. The lowest unit visible comprised fine-grained, well sorted sand representing aeolian deposition, overlain by rippled sands and silts with a dark brown clay layer, barren of microfauna, probably deposited in an Arctic lake. A succeeding 10cm thick layer of diamict, of indeterminate origin, was followed by fine grained sands, gradually coarsening upwards, representing more shallow water deposition. Prof. Bateman said he had obtained OSL dates of less than 74 Ka from this level. The highest gravels showed evidence of cryoturbation.

Dr Buckland commented that a flint implement picked up from the floor of this pit, but thought to be in situ, was clearly from the Upper Palaeolithic, and probably dated to between 30 Ka and 11 Ka, ie within the Late Devensian, thus supporting Dr Gaunt's hypothesis. However, as Prof. Bateman pointed out, there were other problems at Lindholme. Although ground levels are only around 5m AOD, there is no evidence of deposits of either the High Level (c. 30m AOD) or the Low Level (c. 7 AOD) glacial Lake Humber, although deposits of the latter occur close by. One possible explanation favoured by Robert Friend invoked isostatic uplift ahead of an advancing icesheet. Prof. Bateman added that a shallow glacial lake might freeze completely, permitting the Vale of York icesheet to surge southwards on a frozen substrate.

Finally, the third pit revealed an apparent succession, some 4m thick, comprising gravels, fine grained sands, thin clays, and diamicts dipping at around 25 degrees. (see photo overleaf). Prof. Bateman said the gravels included Millstone Grit, Coal Measures and Magnesian Limestone lithologies indicating, together with the possible origin of the diamicts as flow tills, the proximity of Pennine ice. Sands within the sequence had yielded OSL dates of 34 Ka and 32 Ka. Moreover, it was possible that the sequence visible in fact comprised four slices thrust over each other by glacial action. Another explanation could involve the rotation of blocks of frozen sediment. It was clear that the Lindholme exposures had posed more questions than answers, and that further work is required before a final solution can emerge.
Before moving back to the Hall for a picnic lunch, we paused at the southern edge of the Lindholme 'island' to view the hectares of black and bare soil left

Lindholme Pit 3 - layers of sand, gravel and diamict dipping at up to 25 degrees.

after the overlying peat, formed in a period of rising water tables some four to three thousand years ago, had been stripped for horticultural purposes.

Thereafter the group drove some 40km eastwards via the Ml80 to our next locality at Twigmoor Woods, 8km SE of Scunthorpe. Prof. Bateman led us through wooded, undulating ground, in which the topography was partly the result of eastwards sand-dune migration in a period of cold aridity that occurred during the Loch Lomond Stadial between 12,500 and 11,400 calendar years ago. Sand accumulation was influenced by the presence of north-south trending, west-facing scarp slopes in the underlying Jurassic bedrock. However, ground-penetrating radar studies had revealed complicated internal structures suggesting later modification, both by wind, resulting in inter-dune sedimentation, and by rain, resulting in over-steepened slopes.

The group then headed northwards for some 20km to Alkborough where at Julian's Bower, a medieval maze site, we had a spectacular overview of the Humberhead Levels extending westwards over the alluvial plain, around the confluence of the Trent and the Ouse. Dr Buckland explained that much of the agricultural land surface had benefitted from the practice of warping, whereby sediment-laden water was allowed to settle out on to the fields, thus raising their levels. However, just below our viewpoint was a good example of where this process has recently been reversed, and former agricultural land has been allowed to revert to wetland within a programme of managed retreat in the face of rising sea levels.

We then drove some 10km due east to our final locality on the south bank of the Humber, 3km west of South Ferriby. Prof. Bateman explained that here we were standing just inside the limit of the Late Devensian ice-lobe which had extended westwards through the Humber Gap. Deposits of Skipsey Till and outwash sands and gravels were present at Eastfield Farm, only 2km further west and similar till occurred at Horkstow, 3km due south. Looking north eastwards, a ridge of the same till could be made out at Redcliff on the north bank of the estuary. Closing the excursion, Judith Dawson thanked our two leaders most warmly for a very interesting and informative day.

The Building Stones of Central Leeds
Sunday 3rd July

Leader: Murray Mitchell (formerly of BGS)
11 Members and 1 visitor present

On a sunny Sunday morning we met outside the Corn Exchange, a mid-Victorian monument with a strikingly domed roof, built by Cuthbert Broderick between 1861 and 1863 for the corn traders of Leeds. Construction was delayed on this building when excavations for the foundations uncovered 40 old ironstone bell-pits. Coarse-grained, grey-weathered, cross-bedded sandstone with conspicuous quartz pebbles was used throughout, typical of the classic Rough Rock (Millstone Grit). The paving of the lower ground floor is a fine example of the use of Yorkshire Flagstones – the classic Elland Flags, Coal Measures.

The third White Cloth Hall (1776) peeped out at the rear of the Corn Exchange as we moved on to Kirkgate market, one of the finest market buildings in England, built of fine sandstone from Radfield Quarry, Eccleshill, supplemented when necessary from the Idle Moor stone of Eccleshill.

Larvikite was used at the doorway to the County and Cross Arcades (1900), now known as the Victoria Quarter. Red brick and butterscotch-coloured Burmantofts Faience was used for the exterior walls above ground floor level. Mid-grey Larvikite shop window surrounds were replaced with Blue Pearl Larvikite, during refurbishment in 1989 because of the difficulties in matching the stone. This illustrates the variation that occurs in the igneous mass. The flooring is polished pale-grey granite from the Bodmin granite mass in Cornwall edged with Peterhead granite and South African Bon Accord, an olivine gabbro. (see photo opposite). The old Mecca ballroom has red marble pillars from Italy, showing Ammonites near the top. The three floor mosaics are composed dominantly of marble, and were re-laid in 1989 by Andrews of Meanwood.

Thorntons Arcade, sited across Briggate from the Victoria Quarter, was the first Leeds arcade. Constructed along the line of the Old Talbot Inn Yard, one of the long narrow burgage plots, which ran at right angles to Briggate, it helps to preserve the distinctive layout of medieval Leeds. Some of the original 1878 shop fronts of grey Rubislaw granite from Aberdeen have survived.

On the Albion Street/Commercial Street corner, is Moorlands House which has a sandstone base of Bramley Fall Stone, Rough Rock. The ground floor

Victoria Quarter interior showing brightly-coloured Burmantofts Faience above the shops and marble pillars between them.

(Venetian window) has stone from the Pool Bank Quarry and the two upper floors used the Lower Follifoot Grit from Rawdon Hill Quarry, Harewood. Berry's Jeweller further up Albion Street had three different Serpentinites now sadly replaced by a washed out pinky-beige coloured Brazilian granite. Albion House at the corner of Albion Street and The Headrow is built of white Portland stone and brick to conform to the Headrow development. A variety of green serpentinites known as Verde d'Alpe from St Pauls Quarry, Basses-Alpes in France, is used in the entrance. The door surrounds are of a pale-grey, pink tinged granite which is probably Sardinian.

After lunch in St. Johns Centre cafe, we continued to St. Anne's Roman Catholic Cathedral built at the corner of Great George Street and Cookridge Street between 1902 and 1904. This has a main wall of a local Yorkshire grit stone (Horsforth Stone), which is a coarse-grained, cross-bedded sandstone with conspicuous quartz pebbles. The doorway, window surrounds, and string courses are of Ketton Stone from the middle Jurassic outcrops west of Stamford, Lincolnshire. It is a beautiful buff-coloured oolitic limestone regarded as one of the finest examples of this kind of Jurassic stone, completely composed of small spheres of concentrically deposited calcium carbonate. Although the mixed use of limestone with sandstone is not normally recommended, no evidence of damage is yet apparent, so

Abtech House with carved frieze.

presumably the Rough Rock from Horsforth is a good quality stone. Cathedral Chambers (formerly Masonic Hall) is faced with red brick and red Corncockle Stone, which comes from Lochmaben near Lockerbie (Dumfries and Galloway), and is basal Permian in age. The foundation stone for the Masonic Hall is a block of Shap granite.

The Light (completed in 2001) at the corner of Cookridge Street and The Headrow, (formerly Permanent House), is built of Portland Stone, originally selected by the City Fathers in 1924 to present a cleaner face to the new development of The Headrow. The Courtyard of this building has a floor of polished slabs of buff-coloured Bavarian Marble, a fossiliferous metamorphosed limestone in which cross sections of shells and ammonites can be seen.

Park Row is late Victorian, once dominated by banks and now by coffee bars! St. Andrews Chambers, (next to Cafe Nero), is built of Yorkshire sandstones by George Corson. The roof of the entrance porch is supported by 4 Peterhead granite pillars, remarkable examples of monoliths (stones turned in one piece). The left hand one contains fine dark-coloured xenoliths. Opposite, the Bank of England, built in 1862, has a Rough Rock base, walls of sandstone from Ringby Quarry north of Halifax, and Peterhead granite around the door. Abtech House shows a ground floor of blocks of dark Larvikite (variety known as Emerald Pearl) and deep, rich-red Swedish granite, with a purplish opalescent colour to the quartz crystals. The front elevation is made of Huddersfield Stone, a medium grained variety of Rough Rock. Above the ground floor is a splendid frieze, stretching the width of the building. Carved in good quality sandstone, it depicts scenes highlighting a wide range of commercial activities. (see photo opposite).

Finishing in South Parade, we looked at Pearl Chambers (built in1911) with its upper floor of richly carved Portland stone and Aberdeen granite below. Next to it the Legal and General building (from 1930-31) shows the change between the work of pre-war skilled craftsmen and post war modern building techniques.

We then thanked our leader for sharing his extensive knowledge with us and giving us the opportunity to examine buildings that we frequently rush past without a second glance.

'The Building Stone Heritage of Leeds'. Francis G. Dimes and Murray Mitchell. Second Edition. ISBN 1-870737-10-5

Delta Slumps in the Millstone Grit around Wirksworth, Derbyshire
Sunday 17th July

Leader: Ian Chisholm (formerly of BGS)
12 Members and 2 visitors present

After assembling at 10.30 am at the National Stone Centre Car Park, we drove to a roadside viewpoint near Kirk Ireton. Here, looking east, Mr Chisholm pointed out the large-scale topographic expression of a set of slumped masses below the skyline at Alport Height. Fortunately, the visibility was excellent and we were even able to see the Charnwood Hills some 44 km away to the south-east.

We then drove to the village of Middleton and walked via field paths for about 600m to look down at Dene Quarry exposing the highest beds of the Carboniferous Limestone succession, (Monsal Dale Limestone Formation and overlying Eyam Limestone Formation), currently being worked here. These beds lie on the eastern flank of the regional structure known as the Derbyshire Dome. Significant shale beds are absent here and this was said to be typical of the 'Derbyshire Shelf' that formed in a shallow sea area flanked on the south, west, and north sides by steeply sloping 'reef' limestones.

Our next stop was a car park near our main objective, Black Rocks, where we ate our packed lunches. Black Rocks comprise crags about 10m high of coarse-grained , thick-bedded, massive and laminated non-pebbly sandstones, unusually thick for this facies. (see photo opposite). These appear to have been displaced to a relatively low level compared with the nearby quarried sandstone equivalents. Though it couldn't be proved, this displacement was thought to be due to subaqueous slumping on the Carboniferous delta front similar to that described by Mr Chisholm at Birchover (Chisholm, 1977) rather than Quaternary or recent landslipping. Cross-bedding in the sandstones was said to be complex and variable and these complications had not yet been resolved. Higher up the slope is the escarpment known as Barrel Edge where we saw a few thin fine-grained silty sandstone and micaceous siltstone beds showing a 15 to 20 degree dip to the north-east. These clearly overlie the Black Rocks sandstones and can be interpreted as a set of large foresets deposited after the slumps had finished moving.

Adjacent to Black Rocks there is evidence of disused mineshafts and we clambered up a large spoil tip containing limestone debris and scattered mineral fragments including calcite ($CaCO_3$), barite ($BaSO_4$), galena (PbS) and sphalerite (ZnS). Fluorite (CaF_2) has also been reported from the area.

Coarse-grained, thick-bedded sandstone of Black Rocks.

Our final visit was to the National Stone Centre at Wirksworth where the excursion finished and the party dispersed at about 4.30 pm after an enthusiastically supported vote of thanks to the leader by Judith Dawson.

Reference

Chisholm, J.I. 1977. 'Growth faulting and sandstone deposition in the Namurian of the Stanton Syncline, Derbyshire'.
Proceedings of the Yorkshire Geological Society 41, 305-323.

Flamborough area - North Landing, Thornwick Bay, and South Landing
Saturday 17th September

Leader: Mike Horne, Hull Geological Society (HGS)
Joint Meeting with HGS
11 LGA and 3 HGS Members present

Purpose: to examine the Cretaceous: Turonian to Santonian.

On a fine, dry day members assembled in the car park at North Landing, Flamborough, and walked down to the NE corner of the bay for the leader's introductory talk. Mike explained that earlier work on the Yorkshire Chalk had concentrated on coastal sections and biostratigraphy. For its centenary in 1988, HGS had decided to study the lithostratigraphy and had measured sections at about 20 mainly inland sites, producing a nearly complete composite section of some 430m of exposed chalk. Correlation was possible using the more prominent of the many marl bands, mostly detrital, but a few were produced by volcanic ash falls. Correlation in the flint-bearing Middle Chalk was possible using the more persistent nodular or tabular flint bands. The cliffs at North Landing exposed part of the Turonian Burnham Chalk Formation. This was previously seen by the LGA in N.Lincs (27.6.09), near the

Chalk block with flint-lined burrows, Welton Chalk Formation, Great Thornwick Bay.

Mike Horne and paramoudra, Burnham Chalk Formation at North Landing.

'flint maximum'. The exact mode of flint formation remains obscure but it seemed reasonably certain that some flints had built up around horizontal burrows or worm tubes (see photo opposite). The large, roughly spherical or cylindrical flint masses known as paramoudras seemed to have formed round vertical burrows and had not been found close to, or transgressing, marl bands.

Mike stated that more work was needed on Chalk biozones, which at present were not very scientifically defined. Importing zones from Southern England was not satisfactory as the fossils in Northern England were different and generally rare. Ammonites were scarce and poorly preserved as the original aragonite shells had dissolved in the calcitic chalk. Also, although it was difficult to see, most Chalk was highly bioturbated.

Nearby features included a deep groove of volcanic origin in the cliff at the horizon of the Ulceby Marl, and close by at a slightly lower horizon, Mike drew attention to a roughly spherical paramoudra, standing out from the cliff face and showing at its top vestiges of a vertical burrow. (see photo above).

The leader invited members to search for fossils. Some moved seawards, down the succession almost to the Triple Tabular Flints and sighted two more paramoudras beyond reach in the cliff face. The only fossil discovered was a fairly worn *Echinocorys* loose at the foot of the cliff. Others moved up the beach and located fallen blocks with an oyster and some small bivalves, perhaps from the Ulceby Oyster Bed. Interest was shown in some irregular solution pipes with infill of dark silt, some of it fairly firmly cemented.

The party then walked back to the cars and drove the short distance to Great Thornwick Bay, (see photo below), where a picnic lunch was taken on the beach in the SE corner, and from where several faults of small throw could be seen. The sequence here is lower than at North Landing, the Triple Tabular Flints being near the cliff top and the Deepdale Flint, in the Welton Chalk Formation, near the base. Mike drew attention to the fairly widespread occurrence of *Inoceramus* shells and fragments. Specimens up to 0.9 m long had been found. Fragments could be recognised easily from their structure, being made up of small calcite prisms perpendicular to the shell surface. Several fragments were quickly found in the cliff and a fine specimen in a fallen block. (see photo opposite).

The party then drove across the Flamborough headland to South Landing, descending to the beach by the path along the side of a deeply incised drainage channel, thought to be fault controlled. Passing the lifeboat station, the party set off across the seaweed-strewn sand, pausing to look at lines of boulders marking the remains of the medieval harbour. Reaching the

Members arriving on the beach at Great Thornwick Bay.
(Welton Chalk Formation with till above).

***Inoceramus* in fallen chalk block, Great Thornwick Bay.**

cliffs of East Nook, in Chalk of the Santonian Flamborough Formation, South Landing Member, a section through a vertical swallow hole was seen. At this horizon the Chalk has no flints and few marl bands. *Micraster coranguinum* is rarely found in Yorkshire, hence the local but ill-defined *Hagenowia rostrata* zone. A search was made for *H. blackmorei*, (see photo front cover), and some specimens were seen in cross section. Several belemnites were seen, some in cross-section and one, in a fallen block, in longitudinal section; also a fragment of pinkish sponge. Veins and blebs of calcite in the Chalk were attributed to faulting nearby.

Walking back, Mike pointed out that the Chalk cliffs are overlain with till at either side of the bay, but the centre is occupied by beds of Chalk boulders or of Chalk pebbles, poor in erratics, with sandy beds above, overlain by till. Roger Connell (HGS) indicated that in some places, particularly to the W of the lifeboat station, the pebbles had been frost-shattered and subsequently calcreted. The relation of these beds to the famous 'buried cliff' section at Sewerby, a little further west, and to the overlying till is a matter of active research by members of HGS.

The party returned to the car park, where Judith Dawson, on behalf of the LGA, thanked Mike Horne and the other members of Hull Geological Society for a fine and interesting day at exposures not visited by the LGA within living memory.

Residential Weekend to the Southern Lake District
Friday 30th September to Sunday 2nd October

Leaders: Saturday, Dr Christine Arkwright, Open University
Sunday, Colin Patrick, Westmoreland Geological Society
17 Members and spouses present

Our weekend comprised two formally led field visits. Saturday included a traverse across exposures in the Borrowdale Volcanic Group and Windermere Super Group of the Lower Palaeozoic rocks around Coniston, as well as an examination of industrial archaeological sites at Low Tilberthwaite. On Sunday we visited locations around Arnside and Silverdale to examine features of the Silverdale Disturbance and limestone members associated with it.

Prior to these visits, on Friday most party members met at Longstone Common, near Sedbergh, to explore the Adam Sedgwick Geology Trail, and later in the day members of the group climbed Hampsfell to give the weekend a flying start.

Friday morning 30th September
Adam Sedgwick Geological Trail

The Trail explains the geology surrounding the Dent Fault and is well documented by a Yorkshire Dales National Park leaflet, very well written for participants with a wide range of geological knowledge, and is well marked. We enjoyed the visit, and found the Carboniferous exposures approaching the fault zone to be very well presented. Around the fault zone itself, however, the geological features described were very difficult to see, probably because vegetation has encroached over the years, and we reached the conclusion that some work is needed to enable visitors better to interpret this part of the trail.

Friday afternoon 30th September
Hampsfell

In the late afternoon, our party enjoyed a walk from our hostelry up on to Hampsfell. From the Hospice on the summit, although our view of Lake District peaks was not as clear as we had hoped, we were able to see local limestone exposures and to appreciate at close range the characteristics of Urswick Limestone which caps the hill (as well as Whitbarrow nearby) as a prelude to the Sunday field work. We appreciated a fine sunset before descending with good appetites for a well-earned dinner.

Saturday 1st October
Coniston Area with Christine Arkwright

We met Christine in a roadside quarry layby just north of Outgate. To start with she gave us a general overview of the geology of the Lake District, which is a glacially eroded asymmetrical syncline, with a ENE-WSW axis. She explained that we would be concentrating on the Borrowdale Volcanic Group (BVG) and younger Windermere Super Group (WSG) in the Coniston area, which are separated by an unconformity. The Borrowdale volcanic rocks we would see belong to the later explosive phase of Ordovician volcanicity, deposited on land and in shallow seas, whereas the Silurian WSG sediments were deposited in a deeper sea and were subjected to turbidity currents and basin infill, with the characteristic, cyclic graded bedding of turbidites.

We visited 4 locations.

Outgate Roadside Quarry [NY 356003]

The group examined the exposed Wray Castle Formation, (the youngest Silurian rocks we would see), in the rock face at the back of the layby. The rocks were dipping gently to the SE and at first seemed to be uniformly fine grained mudstones in beds about 1m thick. On further inspection there were several thick and thin pale bands of coarser material within the beds and some small-scale cross-bedding. The structures indicated distal turbidites deposited at the edge of a deep-sea submarine fan.

High Cross Plantation Quarry [SD 328985]

A short drive brought us to the High Cross Forestry car park and then after a short walk we entered the disused High Cross Plantation Quarry. Here the Brathay Formation and overlying Birk Riggs Formation, (lower in the succession than the Wray Castle Formation), are exposed although the boundary between the two is not clearly defined and one may merge into the other. Slabs of the Brathay Formation in the NW of the quarry contain dark mudstones, buff siltstone laminae with small-scale ripples, and carbonate concretions. These latter may be a secondary feature which crystallised out during cementation and may indicate a shallower sea level. There was very obvious cleavage in the rock, (occurring at the end of the Silurian), which was observed to be slightly deflected in one area, possibly reflecting the changes in the grain size of the material.

Walking clockwise round the bottom of the face, the beds became paler, indicating that we had reached the Birk Riggs Formation (NE of quarry). (see photo below). Here were paler-coloured greywackes, siltstones and mudstones, with more small scale sedimentary features than the Brathay, including graded bedding. There was obvious cleavage in the mudstone at the top of the beds, but not in the coarser siltstone at the base. (see photo opposite). A discussion took place about features visible in the base of one bed which gave a rippled effect. These had characteristics common to both flute casts (formed during deposition of turbidites) and load casts (a later compactional process), pehaps a combination of both (see photo opposite).

The conclusion was that the rocks in this quarry were turbidites which were deposited in a more active environment than those at the Outgate Quarry, indicating an increasing proximity (Brathay to Birk Riggs) towards the centre of a submarine fan.

High Cross Plantation Quarry showing Brathay Formation rocks on the left and paler Birk Riggs Formation on the right.

Birk Riggs Formation turbidite showing paler coarse bands at the base and fine mudstone with obvious cleavage higher up, (to the right of the hammer).

Ripple-like structures in base of bed in Birk Riggs Formation, which after discussion were thought to be formed by a combination of turbidite deposition and later compactional loading.

Tarn Hows [SD 330997]

We then proceeded to Tarn Hows where we sat on rocks by the lake in warm sunshine eating our packed lunches and enjoying the view. Afterwards, we resumed our discussion of the geology. There are a number of mostly N-S faults crossing the area, including a fault down the length of Tarn Hows. The unconformity between the upper BVG and the Dent Group, of the lower WSG, outcrops down the eastern edge of Tarn Hows, displaced locally by smaller faults trending E-W. Walking round the tarn we would see the change in the rocks from igneous to sedimentary.

The BVG rocks to the west and north of the Tarn were formed from explosive material, mainly airfall tuffs, and some were deposited in shallow sea water and show laminations. The rock we had been sitting on at lunchtime was fairly coarse and showed different size clasts from ash to lapilli-size, but no laminations. Further along the lakeside footpath we came to another coarser BVG rock outcrop which had weathered to a pinkish colour and had quartz veins running through it in some areas. There was evidence of hot explosive material in darkish patches, welded pumice lapilli, which had been squashed during compaction and were lying parallel to the bedding. In this ignimbrite there were also dark lines of flattened pumice or glass.

We passed a large smoothed, but glacially striated block of BVG, a typical roche moutonnée, with a plucked rough surface on the down-current side.

Climbing away from the Tarn to the SE, it was clear that the unconformity crossed between BVG and WSG when a thick succession of sediments forming outcrops of cliffs and benches of the WSG were exposed. Erosion material from the BVG produced conglomerates and sandstones, and formed the lower beds of the Dent Group. They are overlain by many interbedded mudstones and limestones, some with weathered out carbonate concretions. All these rocks show cleavage striking ENE. (see photo opposite).

Low Tilberthwaite [NY 307009]

Our last location of the day was an examination of the remains of the mining and quarrying in the BVG rocks at Low Tilberthwaite. Initially there was copper mining (chalcopyrite) but when supplies dwindled slate was extracted.

Again these rocks belong to the later explosive phase of Ordivician volcanicity and are composed of fine-grained ash which was folded, faulted, and vertically cleaved into slate. Mineralisation may be related to the intrusion of the Eskdale and Ennerdale granites.

Tony Benfield sitting next to rocks of the Dent Group which show ENE cleavage.

We climbed a steep rocky path and passed through the narrow entrance of the Penny Rigg Quarry into a dramatic elongated space with vertical walls and a pile of slate waste at the far end leading up into a higher level quarry. There was little sign of bedding and scant mineralisation at the lower level. At the entrance to the higher level, an interesting plunging fold was exposed with disrupted bedding and a large quartz vein in the centre of the anticline. From here, there was a magnificent view of the landscape through the lower quarry. (see photo overleaf).

We then proceeded round the shoulder of hillside to the Penny Rigg Mill with the industrial ruins and waste from copper mining including the wheel pit, which had had a 10m waterwheel used to drive the machinery for crushing and separating the ore. The wheel was powered by water from a leat higher up. We walked along a cutting to admire the impressive entrance of Horse Crag Level, over 900m long, and constructed as a drain, but also used for transport of ore, and for ventilation.

At this point Howard gave Christine a well earned vote of thanks for an extremely interesting and varied day, and the party returned to our hotel in Grange over Sands.

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View from upper quarry at Penny Rigg, Low Tilberthwaite, into lower quarry and the Langdale Fells beyond.

Sunday 2nd October
Arnside – Silverdale area with Colin Patrick

Our visit initially examined exposures and landscape features of the three principal limestones underlying the area, which are, in decreasing age, the Dalton Beds, the Park Limestone and the Urswick Limestones (Lower and Upper) deposited in the Lower Carboniferous, Visean, (340-320 Ma). (see figure1 below). We then visited exposures of the Silverdale Disturbance, an east facing monocline involving these limestones which runs in a curving outcrop for about 6 km from Leighton Moss to Sandside

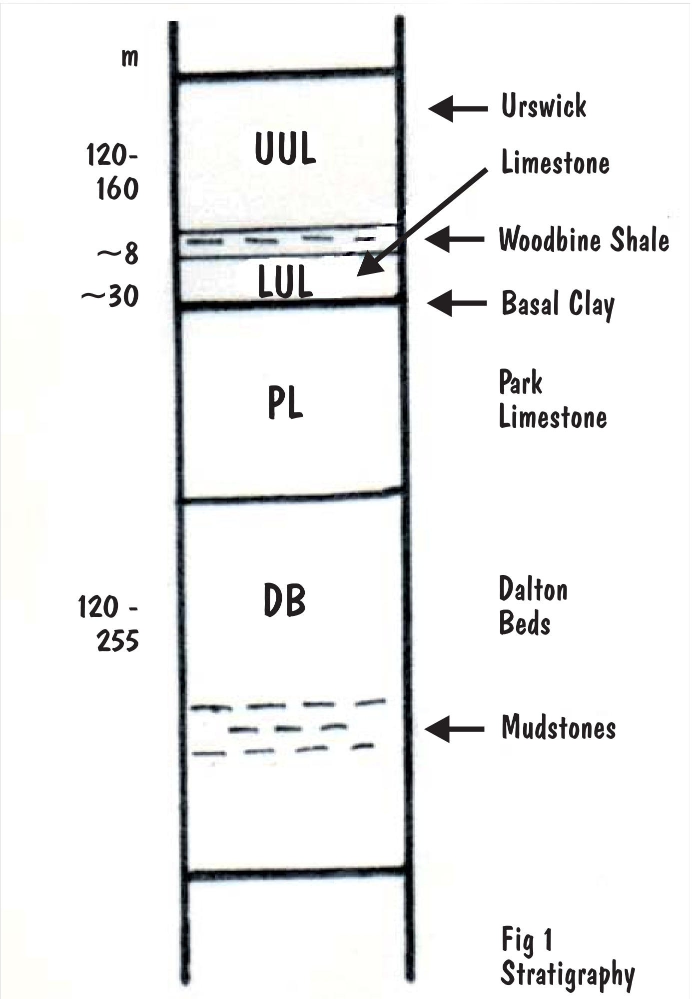

Fig 1 - Stratigraphy in the Arnside area.

The three limestone beds exhibit different lithologies and appearance: the Dalton Beds are interbedded limestones and mudrocks; the Park Limestone is very thickly bedded (bedding planes at 8m or so separation); the Urswick Limestone is thinner bedded (approx.1 – 4 m). Within the sequence there are recurrent beds of mudstones and shales, the most extensive being the Woodbine Shale which is close to the boundary of the Upper and Lower Urswick Limestones.

Regional faulting within the limestone has split the local area into a series of steep sided upland blocks, such as Arnside Knott, that are separated by low lying basins.

Fronting the estuary at Arnside [SD 451784] exposures of the Dalton Beds (DB) were well-bedded with thin bedded mudstones. The interface between the two is not sharp but gradational as pulses of deposition took place from a source to the north as a result of climatic or tectonic activity, into water of a depth up to 100 metres. Seen inland at Arnside Moss [SD 470781] the gently dipping beds of DB form a terraced topography, a series of rock ribs with troughs between where mudstones had preferentially weathered, assisted by the fact that the area was intertidal post the last glaciation. The DB are dipping to the east at about 30 degrees as they approach the Silverdale Disturbance (qv). Also from this location topographical characteristics of the Park Limestone (PL) could be seen on Arnside Knott to the west; its poor cementation and exposure to permafrost has led to break-up and formation of a scree at outcrop, the characteristic slope of which can be seen in the profile of the feature. This stone has been used for building, but with poor results due to its weak cementation. Urswick Limestone (UL), in contrast, is very well cemented, a hard rock resistant to weathering, which is seen as the pavement at the top of Whitbarrow and Hampsfell.

We visited Middlebarrow Quarry, worked by Hanson until 10 years ago. The lower 20 metres of the approximately 30m back face is PL below 10m of Lower Urswick Limestone(LUL). The top surface would have been covered by the Woodbine Shale (WBS) but this had been stripped by erosion and, more recently, glaciation. The only part of the PL which seems to be well bedded is the top part with several ?dolomitic layers, otherwise it is very difficult to see any bedding. Boreholes have shown extensive cavities along the bedding planes. A palaeosol exists on its upper surface as a result of exposure during a period of sea level regression at the end of PL deposition.

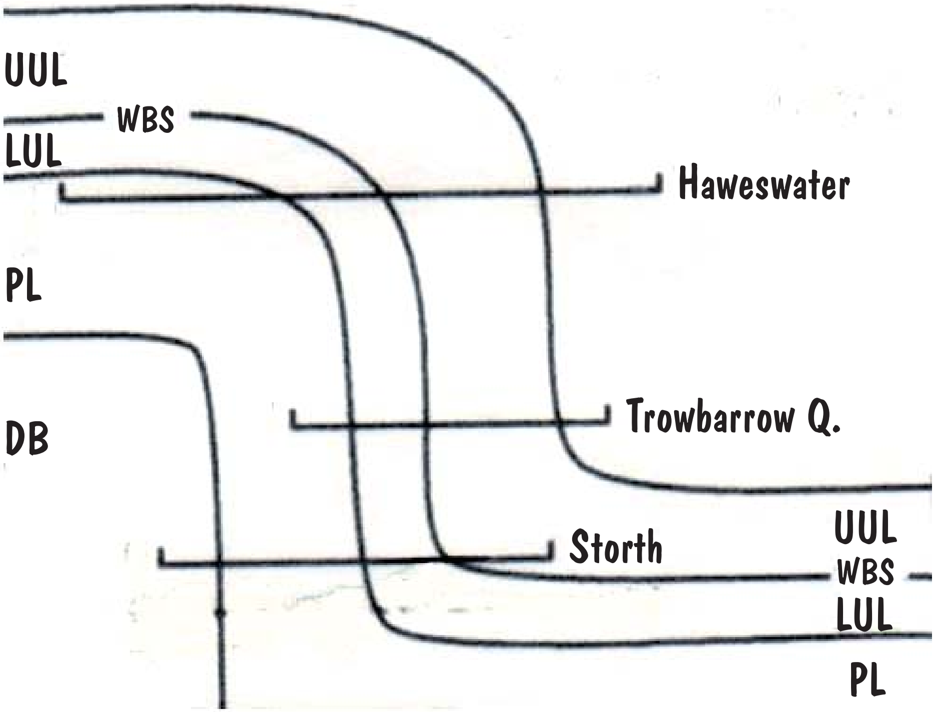

Fig 2 - Composite section through the Silverdale Disturbance showing position of traverses described.

The Silverdale Disturbance

This feature is a belt of rocks 0.25 to 0.75km wide involving vertical to slightly overturned Carboniferous limestones and associated mudstones which runs over about 6km in a gently curving outcrop from Leighton Moss to Sandside. It represents the outcrop of the vertical limb of an east-facing monocline involving the Dalton Beds and the Park and Urswick Limestones. Beds to the east and west of the feature are horizontal or only gently dipping. (see fig.2 above). The Upper and Lower Urswick Limestones are normally separated by the Woodbine Shale.

The form of the monocline can be interpreted from traverses at different locations, today's eroded ground surface exposing the fold at different heights and showing how the rock units determine the local topography.

Today's ground surface at Trowbarrow Quarry cuts through the middle of the fold. (see fig 2 above). We entered by a footpath up the Trough [SD480754], a remarkable feature with vertical outcrops on each side which are the LUL and

UUL to west and east respectively, the Trough being eroded out, softer, Woodbine Shale (see photo opposite). Looking westwards from the LUL over the neighbouring golf course, the undulating near ground is the topography of the vertical PL in the fold, with more level ground beyond 200m from our position reflecting horizontal PL to the west of the fold. In the main quarry all beds are vertical or slightly overturned UL. There are locations where a section of the WBS between UL members and the contact between PL and LUL can be seen.

In the section at Haweswater [SD475766], the local ground level is towards the top of the fold. (see fig.2 previous page) The track into the National Nature Reserve traverses the monocline. Rubbly PL is exposed alongside the track, which is eventually overlaid by UL, and is therefore horizontal. About 100m before the vertical wall of the White Scar feature is reached a gentle hollow with no rock outcrops is passed. This sequence represents the 'turning over' of the monocline; the vertical wall is UUL and the outcrop free hollow is eroded WBS in the upper curve of the fold, which must be very abrupt. The topography of this feature contrasts with the Trough at Trowbarrow due to the lower dip angle of the shale.

The final location of the day was at Storth [SD478802] just inland from Sandside. Throughs Lane descends between vertical outcrops, until a point is reached where a major outcrop to the west is seen in the act of' 'turning under' the road, its dip changing from near vertical to about 50 degrees over a few feet. Although time did not allow us to see other local exposures in Sandside, vertical beds in the DB and PL are exposed to the west; the vertical beds in Throughs Lane are LUL and UUL, and the ground level in Storth is low in the monocline. (see fig.2 previous page) The lane itself is again in a trough weathered from WBS, and it is clear that the fold is turning very sharply. The trough disappears to the north as a result of the WBS being folded 'under' the UUL to the east.

We had a most enjoyable and informative day in which the wealth of geology in the area became increasingly apparent, and we thanked our leader, Colin Patrick wholeheartedly for his lucid and very interesting exposee of his investigations in the area.

Diagrams reproduced by kind permission of Colin Patrick.

'The Trough' between vertical outcrops of Lower and Upper Urswick Limestone at Trowbarrow Quarry.

Lindholme Pit 1 - sands and gravels resting on cryoturbated Sherwood Sandstone. Members for scale.