Leeds Geological Association

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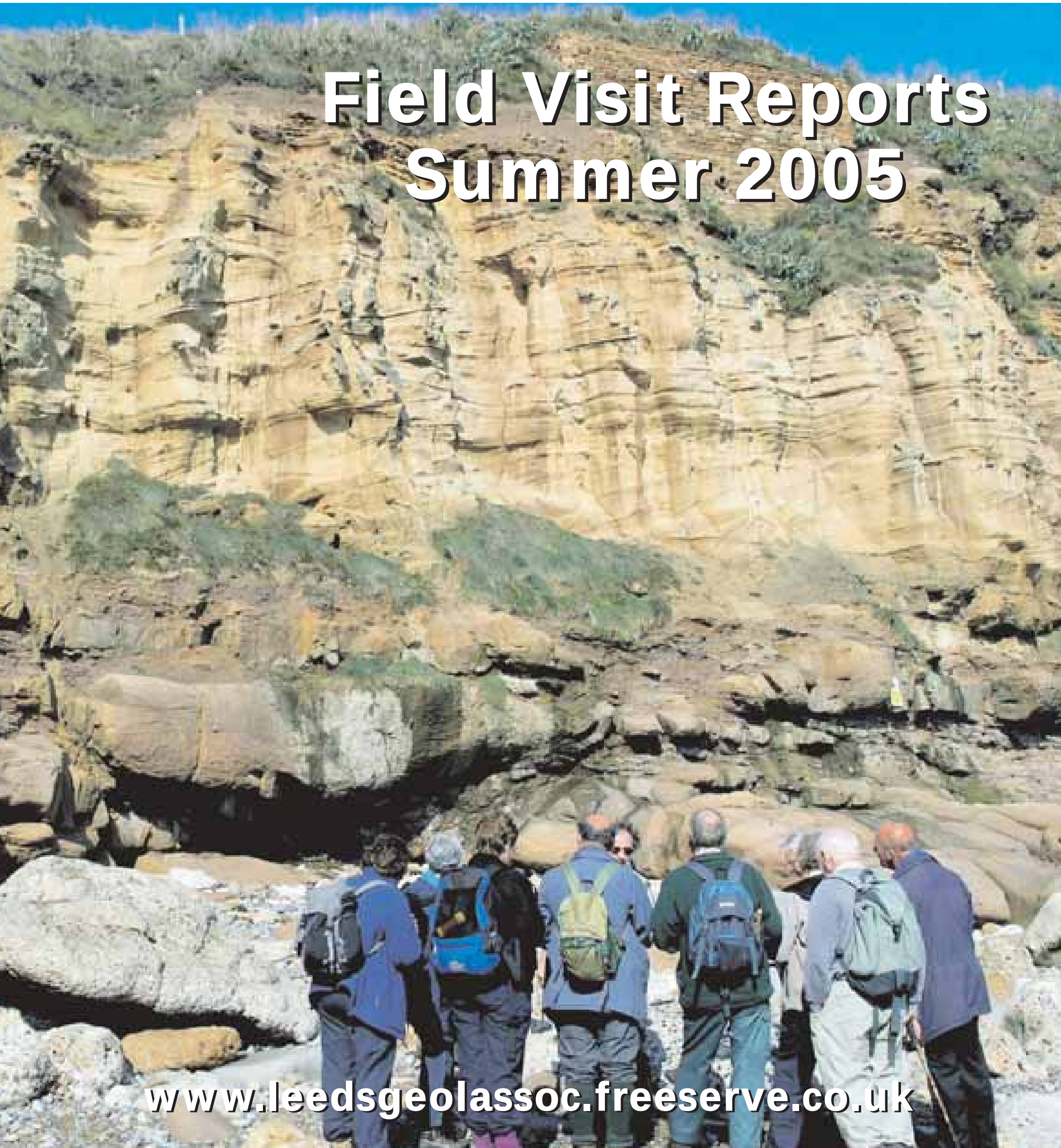

Field Visit Reports Summer 2005

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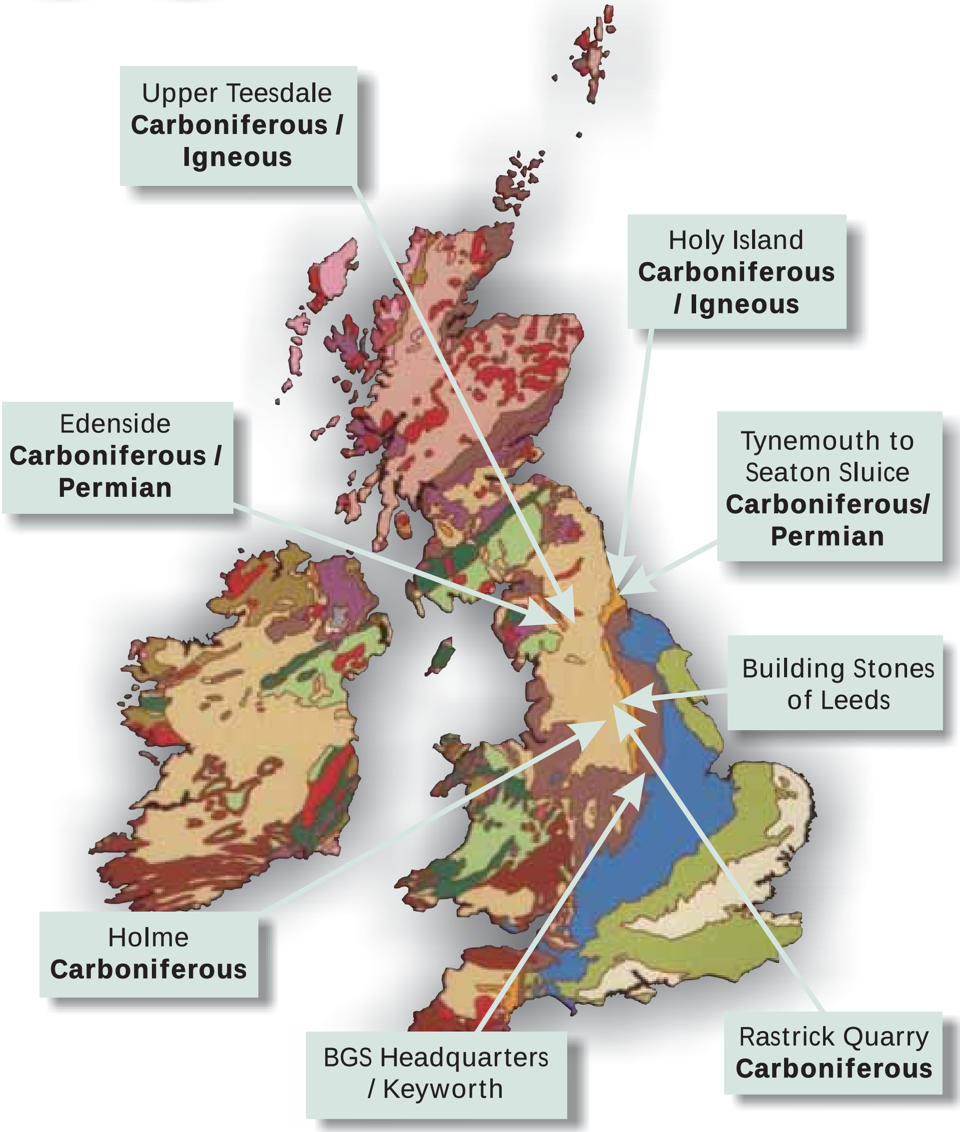
05 Where did we go?



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2005 Field Visit Locations

Thanks to contributors of field visit reports and images used in this compilation: Neil Aitkenhead, Tony Benfield, Anthea Brigstocke, Howard Dunnill, Jeremy Freeman, Bob Gibson, David Holmes and David Peatfield.

Cover picture: Leader Brian Turner explains the unconformable relationship between basal Permian dune bedded Yellow Sandstone Formation and underlying upper carboniferous Westphalian B Sandstones in the cliffs below Tynemouth Castle.

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Mineralisation in Upper Teesdale
Sunday 5th June

Leader : Dr Brian Young
13 Members present

The group met at Bowlees as a convenient starting point to visit Pike Law, an old centre of lead mining on Newbiggin Common, in the morning, and travel up the dale to Lady's Rake Mine in the Harwood Valley after lunch.

Pike Law is an area of intense mineralisation, mainly in veins along NE-SW trending fault lines (see diagram below) all of which were worked from the surface from middle 18thC to early 19thC. Mineral veins would have been apparent on the surface. In this area most of the mineralisation is in the Great Limestone. The whole mineralised area has evidence of intensive mining activity, with traces of hush dams/workings still evident. Hushing, surges of stored water over the workings from strategically located dams, was probably used to clear debris and to expose new deposits (a sort of prospecting tool).

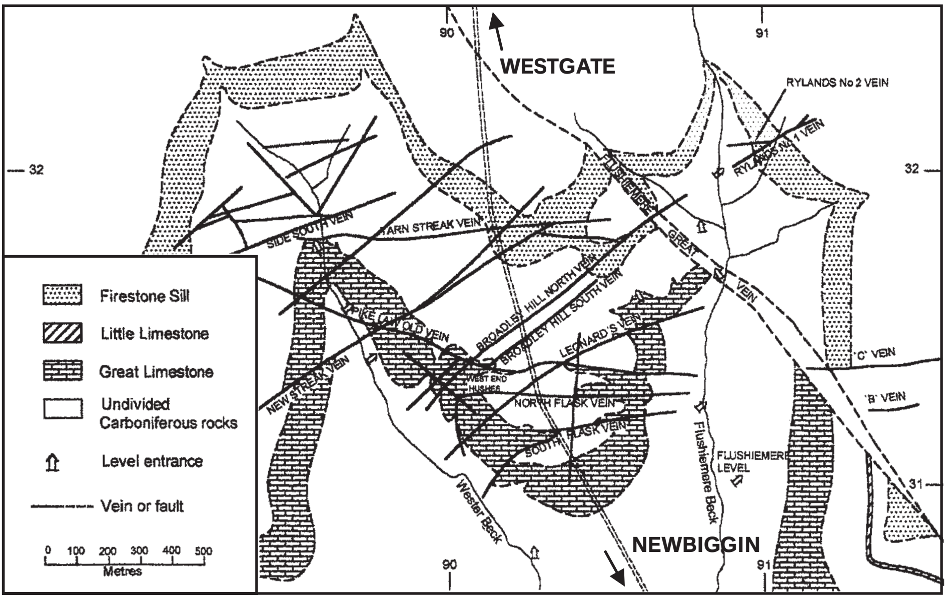
The concentration of veins in this locality is probably because it was close to an 'emanative centre' of fluid flow above a high spot on the underlying Weardale Granite. It is probable that the granite batholith in this area is closer to the surface than the 390m depth proved in the famous borehole at Rookhope a few miles to the north. There is evidence that mineralisation is more intense when the main limestone members are closest to the source; it may be therefore that mineral deposits below the workings at Pike Law could be rich and, as only 1700 tonnes of ore concentrate were extracted from this site over its working life, they may one day be again commercially interesting.

There is evidence of voids close to the line of veins viewed. These result from limestone adjacent to the fault being altered by mineralising fluids to form ankerite, $Ca(Mg,Fe)(CO_3)_2$ dolomite with iron replacing some magnesium, the most abundant mineral in the area. This change results in a loss of volume leading to voids (vugs) or in some areas mineralised limestone breccias. It is in these 'vugs' that large mineral specimen samples are formed, crystals 'growing into space'.

Unfortunately threatening weather forced our picnic lunch from the splendid viewpoint above Newbiggin back to the Bowlees car park, and our afternoon visit was conducted in very poor conditions.

Harwood Valley, in which the old workings of Lady's Rake Mine are located, would be a charming location on a beautiful spring day, but our spring afternoon deteriorated into a deluge. It was, however, very much enlightened by our leader Brian Young's fascinating geological detective story the 'mystery of the magnetite'. The following notes cannot do it justice and the work is fully reported in the reference below.

A chance find of an unusual mineral sample in the Harwood Valley proved to be niccolite, (or nickeline, NiAs-nickel arsenide), not unknown in the Northern Pennines but a rarity. Further samples were found on the spoil heaps of Lady's Rake Mine, proving the sample to be of local origin. Further examination, however, showed the sample to be slightly magnetic, and the main component to be magnetite, with much more magnetite on the mine spoil heaps. This poses a major problem as temperatures of 600 deg C are needed to form magnetite, whilst the maximum temperatures experienced in solution mineralisation are little more than 200 deg C. Examination of Lady's Rake Mine records showed that an adit had been driven to the south to locate the nearby Teesdale Fault and check it for mineralisation. The fault was located and recorded as a 15 feet thick 'whin dyke'. As conditions to form a dolerite intrusion could also form magnetite and create niccolite and other minerals, thin section samples of the original sample were examined to check its relation to Whin Sill dolerite. These showed the sample not to be have any igneous origin, but to be an altered limestone.



It may be possible that the 'dyke' material found by the miners was not dolerite but magnetite; much magnetite has been found on the heaps, but no dolerite. This leads to the hypothesis that mineralisation with a contemporary experience of high temperature may be associated with the Whin Sill, implanted at 295Ma. The Whin Sill is very close below the mine and cooling would have taken place over many years; solution mineralisation was happening at a similar time in the late Carboniferous. This may not be the end of the magnetite story, however, as deposits are now known to be widespread in parts of the Northern Pennines, and a full understanding of the mechanism of formation concurrent with solution mineralisation is still evolving from today's studies.

Sadly, our examination of Lady's Rake spoil heaps yielded neither samples of magnetite or niccolite, and a thoroughly soggy party concluded the visit by examining the (covered) mine shaft. (see photo below). The mine was, incidentally, not a highly productive unit, but notable as the last Northern Pennine mine of the famous London Lead Company to close in 1908.

Reference : Young, B., Styles,M.T. and Berridge,N.G. 1985 Niccolite-magnetite mineralisation from Upper Teesdale, North Pennines. Mineralogical Magazine, Vol. 45, pp 555-559.

Inspection of the shaft at Lady’s Rake Mine

Rand and Asquith Quarry, Rastrick
Thursday evening 9th June

Rand and Asquith Representative : Richard Bolland

The quarry is situated between Rastrick and Elland [SE 124 213] on a north facing slope above the prominent escarpment of the Lower Coal Measures, trending roughly N-S but near Elland diverted to roughly E-W by local faulting. The succession, dipping gently eastward, extending from the Rough Rock to the Elland Flags, comprises mudstones, containing many marine bands, with thin sandstone beds. Of the many quarries formerly active on the escarpment (including Elland Brick Pit; LGA visits 1962 and 1970) only one other, Calder Pit (Hansons Bricks) is still worked.

On a dry but overcast evening, 12 members and a visitor were met at the quarry entrance by Mr Richard Bolland, deputising for Mr Rand, and were conducted southwards along the western edge of the quarry, then down into the workings, some 45m deep, cut into the Elland Flags capping the hill. The quarry had earlier been abandoned and filled in, and had only recently reopened. The main rock face runs roughly E-W, and at its foot, the lowest beds have been worked down to the junction with the underlying mudstone. The lower part of the approx. 30m rock face comprised predominantly massive sandstones at the base, giving place to thinner beds higher up the succession. About half way up, the section was cut by an old mine level backfilled with spoil. This had produced some subsidence of the overlying fairly flaggy beds (see photo page 11). The old levels were said to have been worked from the south and not, as might have been expected, southwards from drifts cut into the scarp face. Water collecting in the quarry where the lowest beds had been extracted was pumped to ground level and discharged where it could join the natural water cycle.

The undulating contact surface with the underlying mudstones was seen on a large quarried block. The fairly fine-grained sandstone from this block was extremely uniform and almost a freestone. Thin bedding planes, more abundant at higher horizons, were silty with conspicuous mica flakes (up to 2mm) and frequently with carbonaceous plant material. Occasionally, the massive rock contained plant fragments, up to 3 cm across but with no visible structure preserved, scattered in an otherwise uniform sandstone.

Individual beds were seen to thin slowly to the east. The bedding was very flat, though some cross stratification was seen in a restricted region above the old workings. Examining fragments on the quarry floor, some examples were found showing ripple marks with wavelengths of a few centimetres. In one part of the quarry, several slabs contained well preserved bivalve escape structures. Some weathered surfaces showed more or less well-developed liesegang rings, (see photo below) Large split blocks, instead of being pale yellowish-brown, were 'blue-hearted', i.e. greyish, where insufficient oxygenated groundwater had penetrated to convert iron compounds from ferrous to ferric. There was some speculation as to the conditions of deposition of such uniform sandstone beds, led by Messrs Benfield and Wilson.

Mr Bolland explained how the rock was quarried, using a slow explosive or the traditional plug and feather. Blocks, usually 12 to 14 tonnes but sometimes up to 18 tonnes were cut for high value civil engineering applications. 5 tonne blocks went for walling, roofing, etc. Stone had been supplied for a number of prestigious projects in the area; one substantial user was the Bingley Bypass Project (LGA visit 2002). He demonstrated the use of the scrippling maul, a large hammer with a square section head, about 5cm square and 20cm long, handle about 60cm, used to check the bedding orientation of massive blocks by smiting off the corner with the edge of the maul. He also drew attention to a problematic feature, the occasional ironstone ball or concretion, up to 30cm across. Besides being of no value, these had the peculiarity of never seeming to dry out.

Our thanks are due to Mr Rand, the proprietor, for permission to visit the quarry and to Mr Bolland for his good humour and patience while taking us round and explaining the working of the quarry.

Liesegang rings in Elland Flags at Rand and Asquith's Quarry, Rastrick.

Early Permian Environment in Edenside
Saturday 25th June

Leader : Dr Colin Rowley
13 Members present

After meeting in Appleby our group moved 3km SW to the hamlet of Hoff, to spend most of the day examining exposures of Carboniferous strata and the immediately overlying Permian (New Red Sandstone) exposures at the locality known as Rowley Wood between Hoff and Burrells.

The Carboniferous surface had experienced a long period of weathering and erosion before being overlain by the first Permian deposits at 285Ma. From our examination of these exposures we were trying to understand the events happening over a few million years around the time of the Carboniferous Permian boundary, and to form a view about the nature of the topography and climate at that time.

The solid geology is displayed towards Burrells in two parallel escarpments trending NW-SE. The lower escarpment has a series of small quarries in the highest of the thick Yoredale facies limestones (the Great Limestone) where it is seen to be resting on a massive sandstone (the Tuft). Above these outcrops a gentle dip slope runs back to a higher feature, which is the basal NRS conglomerate (the Lower Brockram).

The Carboniferous exposures were examined in a series of old quarries. In the first, small outcrops showed a buff coloured granular rock with small vugs lined with rhombic crystals; the rock does not react with HCl but the shape and interlocking nature of the grains indicate not a sandstone but a dolomite. Traces of crinoids remain to show that this was a normal calcitic limestone which has undergone extensive dolomitisation after lithification.

In the second exposure the dolomitised limestone is underlain by a medium/fine sandstone, darkening towards its upper surface, with a maroon coloured layer at the dolomite base. This dark layer results from marine transgression, the sandstone passing upwards into limestone via a very thin soft siltstone and a bed of calcareous sandstone containing traces of crinoid fragments. This bed and the limestone above have a deep maroon colour due to the presence of finely divided haematite, which is unlike normal Yoredale limestones and indicates a further local change in addition to dolomitisation. It only occurs in areas close to the basal Permian unconformity.

The main quarry has several metres of dolomitised limestone with fine black dendrites of pyrolusite (MnO_2) prominent. Below, several metres of the Tuft Sandstone are exposed and show a remarkable alternation of red and white bedding-parallel layers. (Photo page 11) The layers have irregular margins and patches of deeper maroon, often with purple cores. The nature of the boundaries suggests that this is not a depositional feature. The phenomenon only exists in Tuft Sandstone close to Permian sediments; normally it is buff or almost white. There was discussion on the source of the haematite, whether it had percolated down from Permian sediments. The leader is convinced however that its origin is in mudstones immediately below the Tuft, being transformed from a hydrous ferric oxide colloid to the carbonate or sulphide and diffusing/migrating into the more porous sandstones. Oxidation to the coloured bands and dispersion by ground water would have taken place after later uplift. The banding may also indicate lengthy periods during which the water table was immobile below the late Carboniferous/early Permian land surface.

To examine the overlying Permian exposures in the higher outcrop, the party walked 200m down the NE dipping slope from the top of the eroded Carboniferous surface.

The contact surface is not exposed, but the basal bed is New Red Sandstone conglomerate (brockram), a breccioconglomerate containing poorly sorted clasts, both angular and rounded by wear and/or dissolution, the clasts becoming smaller and more rounded upwards (see photo page 12). Almost all are Carboniferous limestone, often with evidence of crinoids and corals, and with some cherts. Some clasts show reddening from iron content gained in their previous depositional environment, and are derived from the oldest NRS in the area.

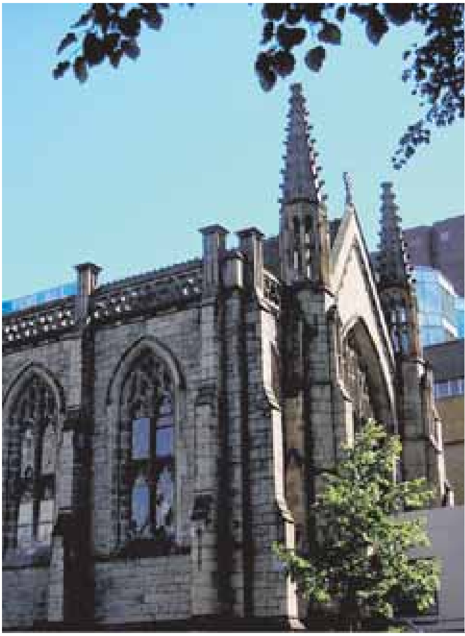
There are examples of stratification and cross-stratification, and also cross-bedding and channelling. Clast deposition also shows much evidence of an imbricated structure, with their longer axes lying more or less parallel to one another and 'leaning' in the direction of flow of the depositing current.

Together with other evidence from brockrams in the area, it is clear that these were wadi deposits and alluvial fans swept down from high ground to the south.

View of the main quarry face at Rastrick Quarry.
Note old back-filled workings from earlier stone mining.

Leader Colin Rowley explains the source of "reddened bands" in Tuft Sandstone exposures at Hoff.

Party inspecting exposures of the Lower Brockram at Hoff.



Contrasting architecture in City Square, Leeds.
Mill Hill Chapel and No 1 Park Row.

Inspecting brockram containing clasts of hollow, dolomitised limestone at Whirly Lum, Appleby.

A visit to a second brockram exposure close to the River Eden at Whirly Lum, immediately NW of Appleby, showed very different clasts incorporated. Most are hollow and clearly heavily dolomitised. (see photo). The reason for this could be that the deposit rests on impervious mudstone/sandstone which may have increased exposure to dolomitising solutions. An explanation for the contrast between clasts here and at Hoff (where there are no hollow dolomitised clasts) may be that these deposits were laid down earlier and dolomitised concurrently with the late Carboniferous Yoredale limestones seen earlier at Hoff.

To conclude the afternoon a visit was made to see impressive large scale aeolian dune cross-bedding in the Penrith Sandstone at Bondgate Scar next to the river terrace in Appleby.

The Building Stones of City Square, Leeds.
Thursday evening, 7th July 2005

Leader: Murray Mitchell.

On a balmy summer evening, 24 members and friends congregated in the centre of City Square, with its statues of 4 famous men, an overpoweringly mounted prince, and some torch bearing maidens, to listen to Murray talking about some important buildings around this site. Traffic noise problems are to blame for errors and omissions in this report of recollections of the evening and readers are advised to refer to Murray's book on “The Building Stone Heritage of Leeds” for more reliable information. (A second edition now in preparation will include some buildings we saw which are not dealt with in the existing edition).

With one small but significant exception, (the single remaining gatepost of the demolished 1771 Infirmary), the oldest building in the area is the Presbyterian, now Unitarian, Mill Hill Chapel of 1848 (see photo page 12). This is a traditionally built structure, mainly of coarse-grained Rough Rock from the very local Meanwood Quarries, and is thought to be one of the last buildings in Central Leeds to have used small hand-worked blocks of sandstone having the characteristic Meanwood zigzag or herring-bone decoration on the outer surface, and sometimes laid with irregular coursing.

No.1 Park Row (see photo page 12) is a post war building which follows the modern trend of being clad with thin panels of machined decorative stone imported from many parts of the world. In this case, for the lower courses a red granite from Finland is used, some panels being polished and some not, with some red Permo-Triassic St. Bees sandstone to provide a subdued checkerboard appearance. The upper part however is clad with our own Crosland Moor light coloured, fine grained, uncharacteristic Rough Rock slabs.

The 1899 Observatory is the elaborate building at the top of New Station Street, built for the Yorkshire Banking Company. The upper region and balustrade with its urns and statue is of Bolton Woods Coal Measures sandstone, and displays seven richly carved coats of arms, presumably of local towns associated with that Bank. The arms of Leeds are carved significantly above the entrance doorway, but the only others that could be recognised were those of Bradford and (probably) Ripon. Ten massive fluted columns and the door surrounds are of red Ross of Mull granite and the column bases and much of the lower construction is of massive pieces of blue-grey Rubislaw granite from Aberdeen, once polished but now spoiled by the etching action of fluids inexpertly used in cleaning the upper sandstone features.

In keeping with the pre-war popularity in Leeds of “self-cleaning” buildings, the 1937-8 reconstruction of the 1869 Leeds New Station included the Queens Hotel/ Railway Offices structure dominating the south side of City Square. This is of white Upper Jurassic Portland stone from Dorset, but has Crosland Hill sandstone pavings. On the Eastern side of the hotel are carved some rather subdued coats of arms of other towns which also had LMS Hotels, - perhaps echoing the coats of arms on the Yorkshire Banking Company opposite. Those with very good eyesight or binoculars may find that although the hotel is called The Queen's the London, Midland and Scottish Railway company decided to have their own initials discretely carved high up on the eastern side of the frontage, and their initials, coat of arms, and the date MCMXXXV11 slightly more prominently displayed on its western side.

Inside the lofty pre-war station concourse Murray described the development stages of Leeds City Station and its eventual link with the earlier Marsh Lane terminus of the old Leeds and Selby Railway. Following the closure of the Leeds New section of City station after the war and its temporary use as a car park, the concourse lost most of its dark Derbyshire limestone panelling and its coloured quartzite tiles from Tuscany, but it still remains a very elegant part of the station complex.

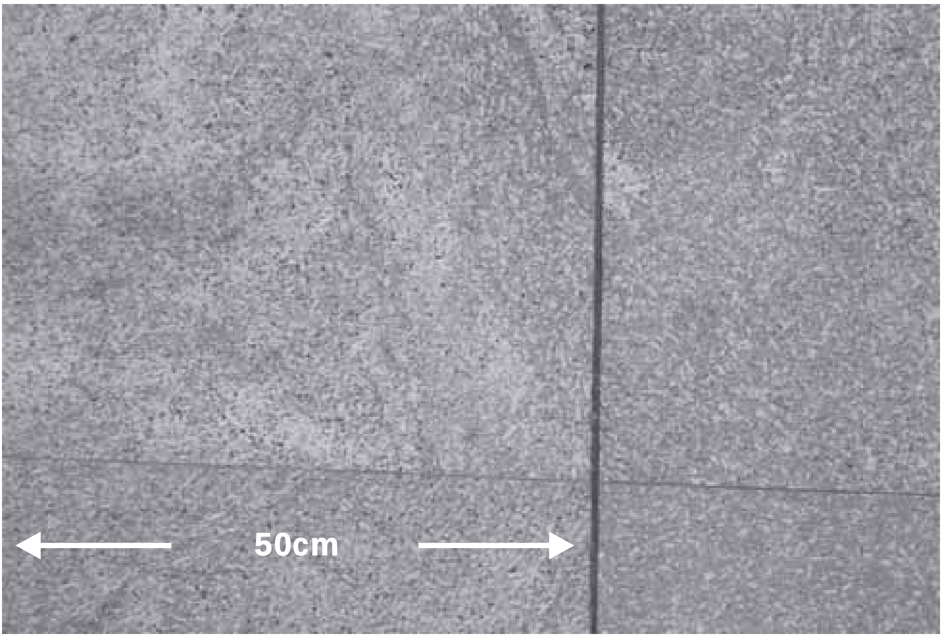
On the occasion of this field trip, scaffolding prevented the 1896 Post Office, made of Haworth Sandstone and Aberdeen and Shap granites, being examined from City Square.

In the limited time available we examined two buildings in Infirmary Street, both of which make use of the same Thornhill Rock sandstone from Morley. The upper section of older Yorkshire Penny Bank of 1894 is now a pale buff colour, the original colour when quarried, but the nearby Cloth Hall Court, built on the site of the original coloured Cloth Hall, and clad with the same sandstones, has turned a rich buff brown colour since its erection in 1980, the colour changes characteristic of this Thornhill rock probably being due to some iron content in the material.

The striking Eagle Star Insurance (now Zurich) building at No.1 East Parade is faced with red brick, with horizontal bands of buff and blue bricks, and has dressings of two different local medium to coarse sandstones, a floor of South African gabbro, an entrance hall of Italian Marble, and a roof of North Wales purple and Brazilian light grey slates! This mix of stones from many parts of the world for exterior cladding can be seen in many other buildings in this area, for example the 1990 Royal Bank of Scotland tower at the bottom of East Parade uses granites from Sardinia and Finland, some plastic sheeting, and some Carrara marble in its East Parade entrance.

Finally, in Quebec Street the Cornish granite cladding of the New Bank of England, which was first taken up as far as Aberdeen for machining operations, shows the interesting flow banding structure developed in a cooling magma still in motion after the first minerals, feldspars, have already crystalised out (see photo below). Interesting, but not improving the look of the building, is part of the attached but unused elevated pedestrian walkway of concrete proposed for this part of Leeds in the 1970's.

With approaching dusk the party thanked Murray for his descriptions and his fund of relevant anecdotes which he delivered with great patience under sometimes very noisy traffic conditions.



Flow banding in Cornish granite, New Bank of England building, Leeds.

Surface Expression of the Holme Fault
Sunday 31st July

Leader : Dr Ian Chisholm
12 Members attended

The group met at New Mill car park for our leader Ian Chisholm to explain and show us the results of his survey work for the BGS to examine the surface expression of the Holme Fault. The diagrams in his handouts illustrated graphically the underlying structures and faults and the wider context: the failed rift structure causing the series of E-W faults over northern England resulted from extensional movement and pulling apart during Devonian to Lower Carboniferous periods. Later compressional movement followed. The Holme Fault can be traced for about 20 Km. in an E-W direction from High Hoyland via Denby Dale, New Mill and Holmfirth to the crest of the Pennines near West Nab. The fault is a deep structure affecting the basement and overlying Carboniferous succession. It has a downthrow of up to 100 metres toward the north. It was first inferred from gravity surveys by Lee in 1988 and shows on seismic profiles (Kirby et al. 2000).

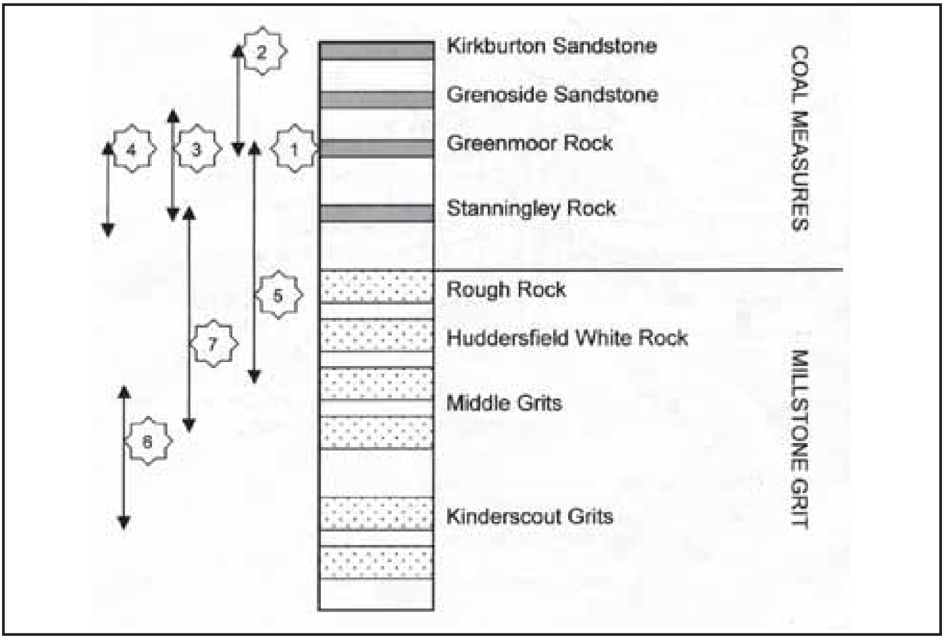
It is one of a series of faults that moved during the deposition of Carboniferous sediment (Lee 1988). In these circumstances more sediment accumulates on the downthrow side of a fault than on the upthrow side. The fault plane flattens off downwards and the strata on the downthrow side bend over towards it the resulting geometry resembles that of a rotational landslip, though on a much bigger scale. The structure on the downthrow side is called a 'rollover', and in the case of the Holme Fault it turned into a proper anticline during compression movements at the end of the Carboniferous, when the throw on the fault reversed direction.

This 'hanging wall anticline' produces 'reverse drag' in the strata close to the fault, and this is the key to finding the surface position of the fault. A parallel syncline (or in some places just a monocline) is present to the north of the anticline, and this has a big influence on the scenery, the most obvious example being the 'saddle' of Rough Rock on the skyline at West Nab.

At location 2 [SE 1760 0790] we stopped at an old quarry at High Brow to appreciate an overall view of the area. Here we were in the middle Coal Measures standing on Greenmoor Rock (see stratigraphy diagram) where we had an excellent viewpoint. We were above Horn Hill Quarry with the Holme Fault lying beneath us along the valley. We were shown where the hanging-wall anticline lies to the north of Horn Hill Quarry with the Meltham Syncline forming the skyline to the west at West Nab where the Coal measures have eroded and the underlying Carboniferous Millstone Grits are exposed. The monocline formed during later movement was seen to the north of the fault.

At Location 3 [SE 1934 0904] at Cross Lane we stopped at a working quarry in Greenmore Rock on the upthrow side of the fault. This is a flagstone quarry in the Kirkburton Sandstone where we could see the 4 degree dip toward the east with jointing dipping toward the Fault. We walked west down the road, crossing the Fault, to see the south-dipping Grenoside sandstone exposed within the hanging wall of the Holme Fault [SE 1934 0904]. Here we found the evidence that we had crossed the fault in strata above us on the main road: southerly-dipping sandstone with flow structures clearly visible. A 90 metre fault is needed to get the Grenoside Sandstone from Shepley at the bottom of the hill, (220 m OD) up to the skyline at the top of Marshalls Appleton quarry (310 m. OD). The exposure within a wall showed the strata dipping in the opposite direction from the Greenmore sandstones now we were above the Grenoside Sandstone on an anticlinal axis showing later reverse drag. We identified joints parallel to the fault and concentric patterns of slumping with concretions and clear evidence of ripple laminated sand.

Horn Hill Quarry [SE 173 086] was a scenic if exposed viewpoint for lunch (see photo page 21). Here we found Greenmoor Rock dipping south into the Holme Fault and since it is present also on the skyline to the south we could appreciate the throw of the fault and the extent of the hanging-wall anticline. This is derived from a westerly source. We found ripple laminations indicating a river delta system running in a west to east direction.



Locality Numbers & Stratigraphy

During the Lower Carboniferous when the fault was active it affected the depth of the sea. South of the fault the sea was persistently shallow over the Holme High, allowing a build-up of limestone to form, similar to that in the White Peak area of Derbyshire. To the north in the Huddersfield Basin the sea was deeper and mudstones were formed. From the different heavy mineral signatures we can now distinguish sandstones coming from Caledonian/Scandinavian sources (the Grenoside) from those from the south west (the Greenmore).

We got in our fleet of cars again and drove west, back through the valley, past Holmfirth and to the other side of the Fault to Flush House for Location 5: Carr Green [SE 1180 0750]. Here, standing on the middle grits, we had a viewpoint from the north, showing dip slopes both nearby toward the Holme Fault and at Wooldale Cliff above Holmfirth. Here we were standing on the Middle Grits.

From Location 6 at Digley [SE 1120 0740] we could look back toward our starting point at Horn Hill and see the Middle Grits around Austonley dipping toward the Holme Fault and all the way back to Horn Hill. We estimated the position of the Fault between the Kinderscout Grit and finer Middle Grits and noted the positioning of the reservoirs along the line of the Fault.

At Wessendale Head [SE 0775 0760] we had amazing views of West Nab and across to the north-east. We traced where the Meltham Syncline ends, mysteriously petering out into landscape unaffected by the Fault.

We concluded above Snape Reservoir [SE 1142 0870] with a walk along the dip slope in the Huddersfield White Rock to appeciate the extent of the Meltham Syncline from West Nab to Honley and then walked east to view the anticline axis forming the lower ground between Thurstonland and High Brow. We saw the Fault running behind the outlier, obliquely up the escarpment and down to the Holme Valley, covering the synclinal axis of the Fault right back to our starting point at High Brow.

This was a fascinating exercise in a lovely area, much enhanced by the local knowledge of our leader and the masterly explanations of a complex geological area.

Background Reading:

Aitkenhead, N. Barclay W. Brandon A. W. Chadwick R. Chisholm J. Cooper A. and Johnson E. British Regional Geology: the Pennines and adjacent areas (4th edition) BGS Nottingham

Huddersfield Geology Group: Guide to the Rocks and landscapes of Huddersfield. 1998 (ISBN 0 9532828 0 5)

Residential Weekend based at Alnmouth, Northumberland

Saturday 10th and Sunday 11th September - 18 attended

Holy Island, 10th September
Leader: Dr Brian Turner, University of Durham

After arriving in heavy rain on the Friday evening at the 'Famous Schooner Inn', Alnmouth, we were encouraged by an improvement to only low cloud and slight drizzle for the start of the excursion to Holy Island on the Saturday. Travelling by shared cars, we followed the receding tide across the 5 kilometre Lindisfarne Causeway and assembled at the west end of Heugh Hill. Here we heard Dr Turner briefly tell us how the local geology fitted into the general development and stratigraphy of the Northumberland Basin. This had formed in early Carboniferous times by subsidence caused by crustal extension related to tectonic plate movement and subduction south of Britain. The Holy Island succession mainly comprises two successive cyclothemic sequences (or parasequences), one based on the Acre Limestone and the other on the overlying Sandbanks Limestone, high in the Middle

Inspection of Holy Island Dyke protruding from wave cut platform of Acre Limestone.

Greenmoor Rock exposures dipping into Holme Fault at Horn Hill Quarry.

Remnants of Acre Limestone preserved smeared against the Holy Island Dyke.

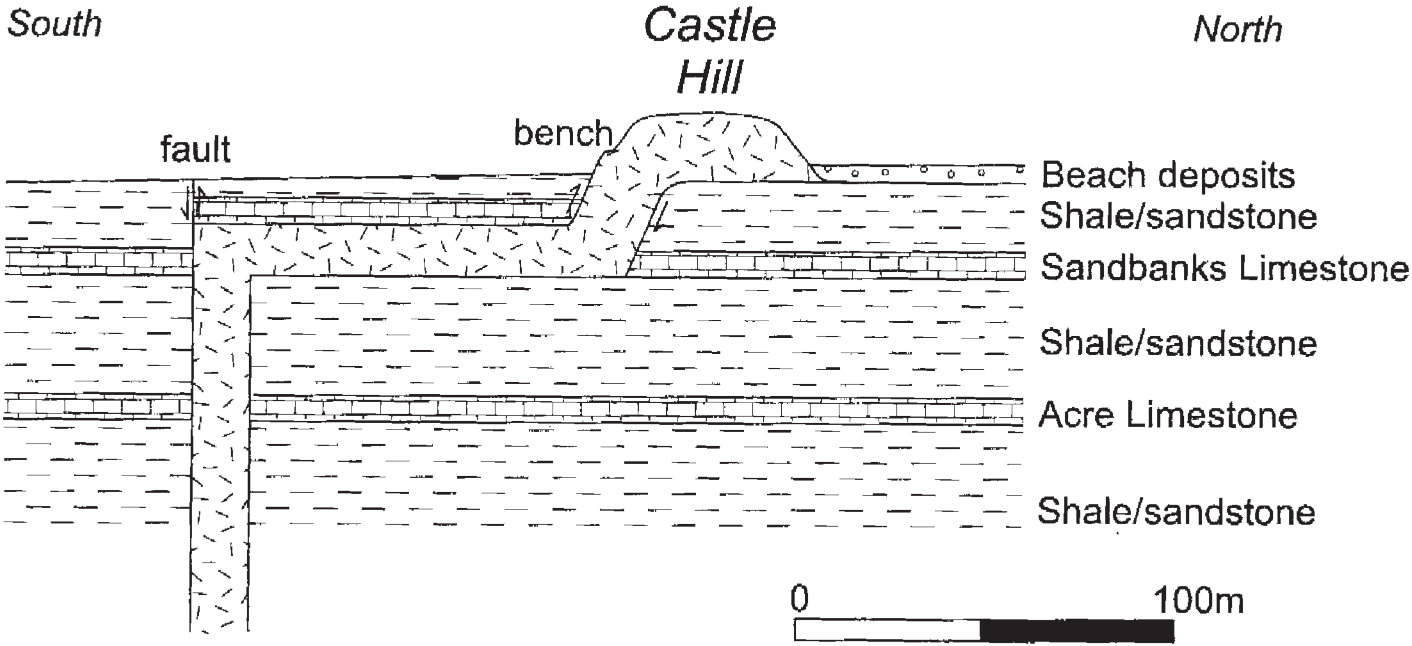
Example of ‘ropey texture’ below the surface of the dyke on St Cuthbert’s Island.

Cemented fractures in Yellow Sandstone at Cullercoat’s Bay.

Limestone Group of Brigantian age. These rocks therefore correlate with part of the Yoredale succession of the Yorkshire Dales. However, the main interest here was the Holy Island dyke, an intrusion of tholeitic quartz dolerite of identical composition to the Whin Sill that crops out extensively in North-east England. Indeed this, plus three other similar suites of dykes or 'dyke echelons', are generally accepted to be feeders to the Whin Sill. Along the south coast, the dyke forms the main topographic high points of the island including Heugh Hill overlooking the Priory, and the much photographed and painted Castle Hill surmounted by Lindisfarne Castle.

We first examined the south face of Heugh Hill formed by the vertical chilled margin of the dyke in contact with the fossiliferous Acre Limestone forming a wave-cut platform at its foot (see photos page 20/21). Small brachiopods were the most obvious fossils to be seen but soon we were distinguishing various others such as orthocone naultiloids and crinoid ossicles. In places, bits of the pale brown limestone were still smeared against the dark grey-brown of the dyke rock. The tide had now receded far enough to enable us to walk across to St. Cuthbert's Island where the dyke had a sill-like form with dominant subhorizontal joints. Just below the chilled upper surface is a prominent zone of oval shaped vesicles whose long axes have resulted from plastic deformation in the direction of magma flow. This flow process may also account for the most remarkable and unexpected structure we saw on the excursion, namely ropey texture, (see photo page 22). Most, if not all of us, were familiar with these concentric wrinkles in recent pahoehoe lava flows, but to see them in an intrusive rock caused considerable wonderment and discussion. The likely explanation is that in the upper part of this sill-like dyke, a reduction in pressure caused gas cavities or vesicles to form and amalgamate to a diameter of 10 to 20 centimetres. The roofs of the vesicles, being closer to the chilled upper margin of the dyke, would have started to solidify while flow was still proceeding on the floors of the cavities producing the ropey texture. Further examples of this texture were seen at exposures at Steel End flanking the entrance to the harbour.

Our last close view of the Holy Island Dyke was obtained as we walked round under the north face of Castle Hill where it seems to take the form of a monocline steeply dipping on the south face and near horizontal on the north face; a form due not to tectonic folding but to the way magma has forced its way along the path of least resistance through the sedimentary rock strata. A magnetic survey has helped to suggest the likely shape of the intrusion (see diagram on page 24).



A sketch N-S section at true scale through the centre of Castle Hill. *(Reproduced from GOULTY, N. R. et al. 2000. Magnetic survey of the Holy Island Dyke on Holy Island, Northumberland. Proceedings of the Yorkshire Geological Society, Vol. 53, Pt 2, p.118, Fig.14, by kind permission of the Editor)*

A summary of the morning's observations might read: 'when is a dyke not a dyke when it turns into a sill'!

After marvelling at the well preserved six-pot limekiln complex at the eastern end of Castle Hill, we enjoyed a bracing 2 km walk along the coast to Nessend where we saw the remains of a quarry in the Sandbanks Limestone that had provided feedstock for the kilns. This limestone forms prominent cliffs and the underlying coarsening-upwards mudstone to sandstone sequence is well exposed around the headland. The coarsening-upwards succession is interpreted as a prograding deltaic sequence and we found Stigmaria on the topmost bedding surface that suggested delta abandonment. A dark shaly limestone immediately overlying this represents the marine flooding event over the delta top; it is succeeded by the Sandbanks Limestone.

Approaching Snipe Point, the next headland, we walked over extensive bedding planes in the Acre Limestone that had been moderately deformed into low-amplitude folds. We were told that such folds occur all along the Northumbrian coast and represent the effects of Variscan compression of the ductile sedimentary succession against the more resistant Cheviot Granite block. This was to be the last geological locality of a most interesting and enjoyable day.

The Permian and Carboniferous Rocks between Tynemouth and Seaton Sluice

Sunday, 11 September 2005

Leader: Dr Brian Turner, University of Durham

Members and guests left Alnmouth on a bright sunny morning and drove south across the gently undulating drift-covered ground of the Carboniferous to rendezvous at the headland carpark facing out over the river at Tynemouth.

Our leader led us to the exposures in the cliffs immediately to the north of the North Pier protecting the entrance to the Tyne. After descending some rather steep steps to the shore, the majority of the party examined the red-stained medium-grained channel sandstones of the Priory Sandstone of Westphalian B age in the Productive Coal Measures. These were unconformably overlain by dune bedded aeolian sandstones of the late Early Permian Yellow Sandstone Formation and Dr Turner explained that some 400m. of Upper Carboniferous strata had been removed during uplift and erosion following the Variscan Orogeny (see photo on front cover). Finally, Dr Turner drew our attention to the outcrop of an early Tertiary (c. 58ma) east-west trending basic dyke almost hidden by the stonework at the base of the Pier. Some 1.5 meters of porphyritic basalt grading into a marginal development of "white trap" or altered dyke rock was seen to be intruded into the Carboniferous strata.

Walking back to the carpark, we followed the poorly exposed outcrop of the dyke before stopping briefly at an old quarry below Tynemouth Castle to examine a further exposure of the Coal Measures sandstones heavily ironstained during the early Permian.

The party then drove north to Cullercoats Bay enjoying extensive views of the sunlit North Sea. Here we walked down into the bay to firstly examine an exposure of the Yellow Sandstone Formation where our Leader drew our attention to the prominent system of fractures which had been cemented with both calcite and barite, (see photo page 22). Nearby, less well cemented sandstone had been differentially eroded by the sea to form caves. Dr Turner had hoped to have shown us the local representative of the overlying Upper Permian Marl Slate Formation, famous for its fish fauna, but sadly, the tide had not yet fallen sufficiently. Seaward, the Marl Slate is overlain by limestones and dolomites of the Raisby Formation, and the presence of Permian rocks at this locality results from the northwards downthrow on the Ninety Fathom Fault, part of the regionally important fault system bounding the southern margin of the Devonian-early Carboniferous Northumberland Trough, which was re-activated in post-Permian times. We walked southwards out of Cullercoats Bay, noting en route the obvious northwards dip of the Yellow Sandstone Formation and the minor folding of the Upper Carboniferous strata on the footwall of the fault, to Longsands Beach to examine a spectacular exposure of the fault itself.The fault plane dipped at about 35 to the north and its 150m. downthrow had brought the Permian sequence in contact with Productive Coal Measures strata including the Hutton Coal and an overlying freshwater mussel band, (see photo below).

After returning to the cars, we headed north again passing through a very busy Whitley Bay to Hartley where lunch was taken, by some outside the pub, and by others down on the beach. Our excursion continued here with an examination of the Westphalian B strata at the horizon of the Northumberland Low Main Coal, here some 1.7m. thick and well exposed in the cliffs, whilst evidence of the Mussel Band which overlies it, was provided by loose blocks of this unit. The overlying sequence comprises a series of coarsening upwards cycles which Dr Turner ascribed to crevasse splay

The 90 Fathom Fault exposed at Longsands Beach.

channels building out deltas into the shallow lakes of a broad equatorial alluvial plain.

One feature of particular interest was the development of a widespread horizon of penecontemporaneous deformation in the basal beds of the sandstone member of the cycle immediately above the Low Main Coal. The continuity of this horizon suggested to Dr Turner and other members of the party that seismic activity, probably on the Ninety Fathom Fault system, might well have been responsible. After inspecting evidence of old coal mining shafts of early nineteenth century date, now exposed on the wave-washed rock platform and emphasising the rapid rate of coastal erosion hereabouts, the party returned to their cars and drove to the final locality of the day at Seaton Sluice.

Seaton Sluice is named from the artificial channel excavated by the local mine owner in the nineteenth century to increase the capacity of the port to ship out coal from the many mines in the area. Fortuitously, the Sluice provides excellent exposures of two very different sandstones within the Westphalian B sequence, though some members were deterred by the precipitous nature of the access route! The Lower Crag Point Sandstone is fine-grained and trough cross-stratified. Dr Turner reported that palaeocurrent measurements from this unit showed that deposition was from currents flowing to the south east. The upper coarse-grained sandstone (the Upper Crag Point Sandstone) could be seen to rest on a marked erosion surface above which small pebbles and a concentration of plant stems occurred, (see photo page 31). Dr Turner said that this erosive phase had cut out a regionally important Coal Seam. Sedimentological studies by Dr Turner and Dr O'Mara have shown that this upper sandstone contains elevated proportions of both microcline and orthoclase feldspar and that deposition was from currents flowing from the east. Bedding characteristics indicated deposition in a braided river system, which Dr Turner ascribed to base level changes following fault-controlled uplift of the Farne Granite, some 80 km to the east.

Finally, the party gathered together above the Sluice and our President, Dr Neil Aitkenhead, proposed a warm vote of thanks to Dr Turner for an excellent week-end's geology, with which all present concurred, and after which some of the party repaired to a convenient cafe for most welcome refreshments before returning home to Yorkshire.

Hand-out Reference

Leeds Geological Association Field Excursion to Northumberland, September 10th 11th, 2005 by Brian Turner, Department of Earth Sciences, Durham University.

Visit to British Geological Survey Headquarters at Keyworth
Thursday 13th October

A party of 22, including 2 visitors, travelled to Keyworth mainly by coach to spend the day being introduced to some of the key departments of the BGS, a programme kindly arranged for us by David Bailey.

The array of Survey products for sale in the reception area shop was a major attraction/distraction but once the party had signed in, the morning was spent hearing about mapping. This included the undoubted highlight of our visit, an opportunity to experience the new 3-dimensional facility which was only completed and officially opened this year, the culmination of the 5 year Digital Geoscience Spatial Model Project. This astonishing technology, demonstrated by Bruce Napier and explained by Tony Cooper, enables a computer generated image presented on a large screen to be experienced in 3 dimensions by a room full of viewers wearing special glasses so effectively that to those at the rear of the auditorium, people in the front two rows appear to be inside the image! The geology of the British Isles down to the MoHo, created by input of huge amounts of data, can be turned for viewing from all angles and manipulated (e.g. by changing the vertical scale exaggeration) to give an unprecedented view of UK geological structure in 3 dimensions for the first time.

We had presentations on mapping, in particular progress on digital mapping, from Jerry Hodgson and Rob Armstrong, notably on the rapid progress being made in creating the Digital Geological Map of Great Britain (DiGMapGB), a national database of digital geological data at scales of 1:625,000, 1:250,000, 1:50,000 and 1:10,000. Maps from this source will become available showing solid, drift, artificial ground and mass movement deposits and will be more readily accessible than current maps.

A description of the library facility by Rachel Mackenzie, apart from revealing the impressive statistics about the extent of the Survey's literature store, emphasised how accessible the library is to interested outside parties, either to consult from a distance to obtain information or copies of documents etc., but also to visit and use the facility for reference for a project or to satisfy a particular interest.

We were given a potted history of the internationally important National Geological Materials Collection by Dr Mike Howe, the Chief Curator, who recounted the growth of the collection and its movement through several sites in London from its first approval in 1837, ending at the Geological

Museum in South Kensington in 1935. More recently there was a period when some parts of the collection were dispersed to field offices (Carboniferous samples residing for a time in Leeds when the BGS had its northern office here) with the collection finally moving to Keyworth during the 10 years following after purchase of the site in 1976. Murray Mitchell, then working for the Survey, was involved in the installation of the Palaeontological Collection at Keyworth and was present to give an account of his own contribution at that time. A very brief examination of some of the 2 million specimens put on show for our visit were just a taste of this enormous and important collection.

Rod Bowie gave us a brief description of the National Geological Records Centre, an important and unique archive containing over 3 million items dating back over 200 years. These include nearly 900,000 records of boreholes, shafts and wells ranging from 1 metre to several thousand metres in depth, the majority containing written descriptions of the ground encountered. Also 30,000 Geologists field maps and notebooks are recorded, and more than 30,000 geological maps dating from the 1860s. The existing Records buildings at Keyworth and Edinburgh are about to be extended and improved, which will enable BGS to house the geological data currently held by the Coal Authority and other donations, plus the inflow of new material (including details on a further 50,000 boreholes) every year.

Finally Chris Wheatley showed us another enormous collection, this time hard evidence, in the core store housed in 2 very large buildings with 1 metre long sections of cores from over 20,000 boreholes stored in 80,000 palletised trays racked to 15 metres high. The store has in total over 200km of core samples.

Neil Aitkenhead had arranged for extraction and display for our examination of core samples from earlier work which he had done on a borehole at Hag Farm, 3km SE of the Cow and Calf Rocks. The samples were from 2 successions including the rock sequence exposed at the entrance to the quarry at the Cow and Calf. The laminated fine-grained ripple marked sandstones in the succession are thought to be tidal in origin based on evidence of a cyclicity in measured thickness of the laminations. As a memento of our visit the group was photographed (opposite) after examining the core samples.

A wealth of information about all of the departments referred to above can be accessed and explored on the BGS website **www.bgs.ac.uk**

Brian Turner and Tony Benfield discussing the erosion surface
at the base of Upper Gray Point Sandstone.

Our party in the Core Store at BGS Keyworth.

Lunch party below the castle on Holy Island.