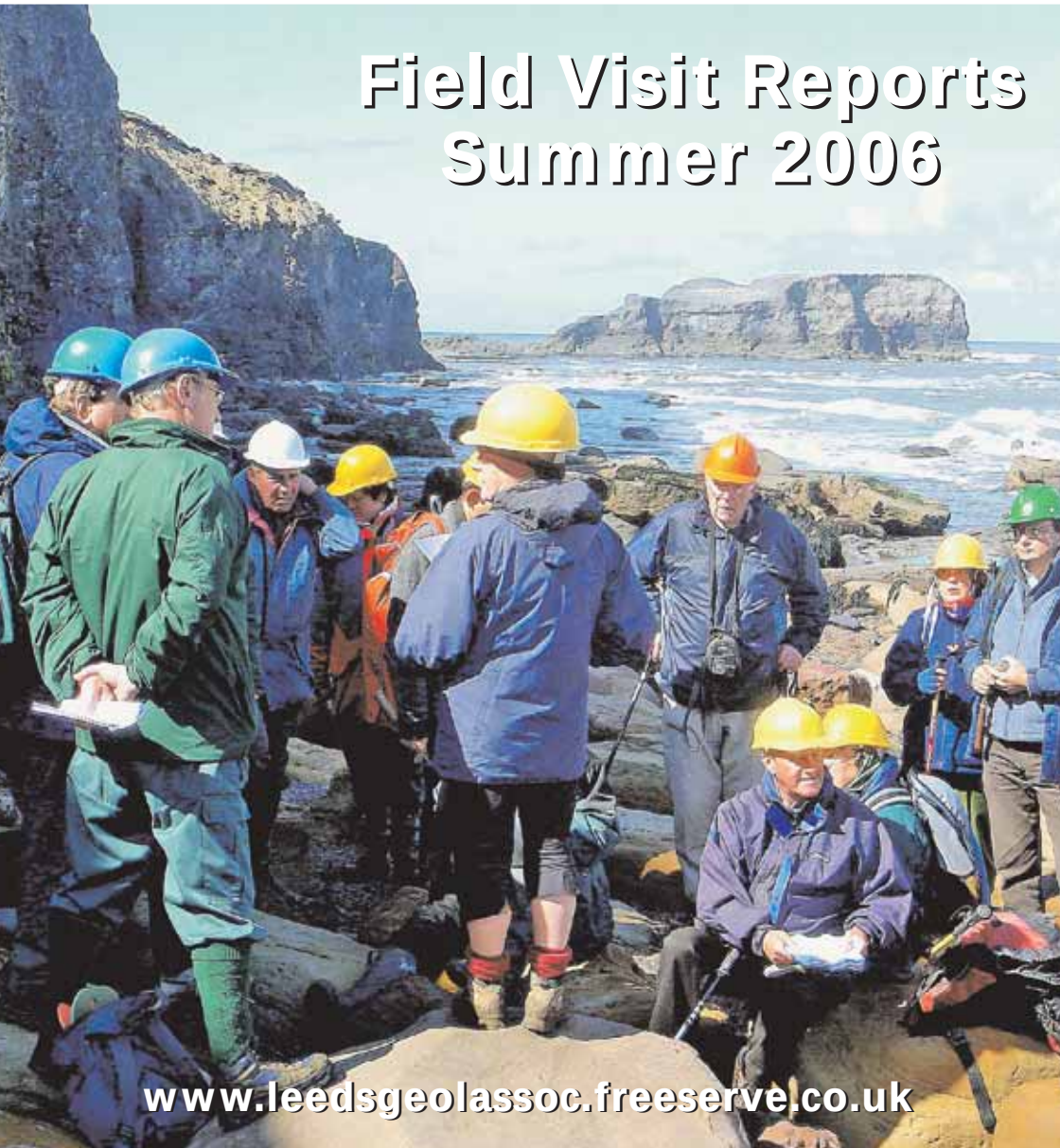
# Leeds Geological Association

Founded 1874 - Registered Charity No. 1016696

## Field Visit Reports Summer 2006



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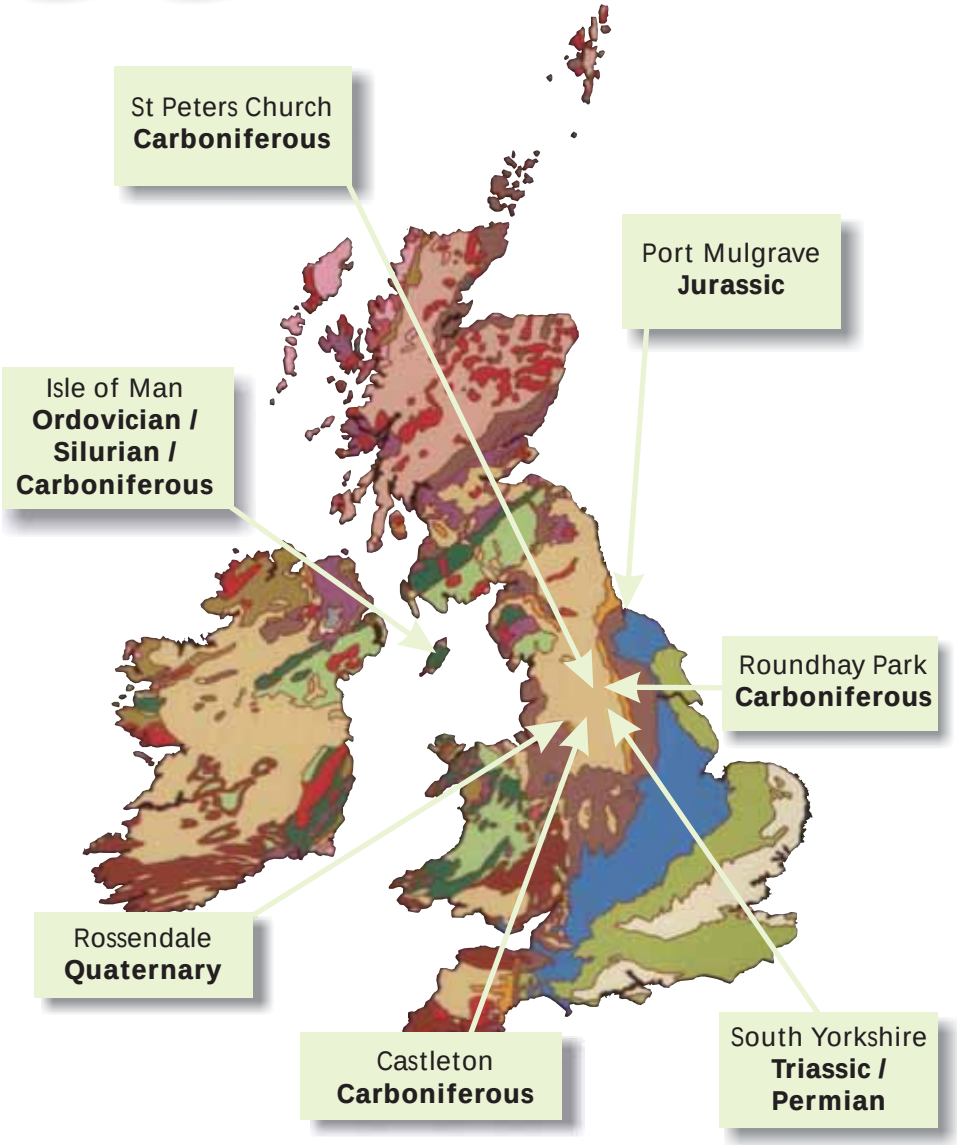
# 06 Where did we go?



# Contents
# 2006 Field Visit Locations




Thanks to contributors of field visit reports and images used in this compilation: Neil Aitkenhead, Tony Benfield, Anthea Brigstocke, Howard Dunnill, Bob Gibson, David Leather, Jane Michael (Manchester GA),David Peatfield.


*Cover picture: Leader Angela Coe discusses fossil samples collected on the beach at Saltwick Bay (See visit report page 4).*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## Toarcian Exposures on the North Yorkshire Coast - at Port Mulgrave and Saltwick Bay
## Saturday April 29th

### Leader : Dr Angela Coe
### 17 Members present

From the cliff top at Port Mulgrave the sea looked calm and the tide was out. However when we got to the beach we were surprised by the first drops of rain, though this did not dampen the enthusiasm of our leader Angela Coe of the Open University, assisted by Bryony Caswell. Port Mulgrave was once an industrial port exporting iron ore, and the ironstone was transported via a tunnel, the entrance of which can still be seen. During WW2 the jetty was destroyed and the 1953 storms damaged the piers, and the 'port' now has a drab and abandoned look. Only a few fishermen and jet collectors use the place regularly.

Looking at the cliffs to the south we observed a contrast of the grey muds of the Lower Jurassic with the brown sands above of the Middle Jurassic, there being a 3 million year gap between the two. The Lower Jurassic sediments were laid down in the Cleveland Basin which thins south to the Market Weighton high. In Yorkshire, the Toarcian (equal to Upper Lias) includes the Grey Shale, Mulgrave Shale and Alum Shale of the Whitby Mudstone Formation.

All seventeen LGA members present had attended Thursday's lecture on "Detecting Global Environmental Change from the Jurassic of England" by Angela Coe. The detective story had been told and the theory was laid. Interest began about 10 years before when dating of the Jet Rock showed a massive increase in Osmium isotope ratios over a short time span. An explanation for this increase could be a huge increase in continental chemical weathering and erosion. Research continued and the theory goes on to say that an increase in global temperature, triggered by the warmest part of the Milankovitch Cycle (a roughly 100,000 year cycle), allowed the escape of massive amounts of methane from methane hydrate (frozen in seafloor sediments), to become the greenhouse gas of the Jet Rock age. The methane rapidly oxidised to $CO_2$ producing at the same time a sudden increase in organic carbon ($^{13}C$) and high levels of atmospheric carbon dioxide. In addition, the oceans were deprived of oxygen and seawater may have been 10°C higher and global atmospheric temperatures 3 or 4°C higher. This event, about 180 million years ago, lasted only for about 500 years, and is associated with marine extinction events. It is suggested that the earth took another 150,000 years to recover.

With this massive global warming crisis in mind, we inspected the deposits at Port Mulgrave. North of the ruined pier we saw the top part of the Jet Rock, overlain here by the yellow Fox Cliff Sandstone. During the day we worked our way down the succession, about 50m of organic-rich mudrocks (Angela's

favourite!). The grey shales of the Jet Rock are marked by several lines of nodules. Named ones include cannon ball nodules, whalestones and curling stones. On the shore were the cannon ball nodules, many washed out or taken by fossil collectors. Whitby jet collectors had made small excavations into the dangerous cliffs, and we were able to examine a 20 cm seam of jet – about 2½cm thick – at the back of a small cave. The jet is uniquely formed from branches of Araucaria wood, the monkey puzzle tree of the present day.

On the wave-cut platform we examined a bedding plane crowded with ammonites of Harpoceras type, a photograph of which appeared on the cover of the fieldguide. Bryony Caswell, bivalve enthusiast, (blow the ammonites) showed us another surface matted with the pyritised mussels of *Bositra radiata*. Bryony pointed out the importance of bivalves in reflecting the environment of the muddy seafloor where, for a period, hydrogen sulphide replaced oxygen for living things, and of the diverse bivalve population only *Bositra radiata* and *Pseudomytiloides (=Inoceramus) dubius* survived.

South of the old pier the curling stone level comes out onto the shore and the dogger that forms the top of the Jet Rock is only a metre and a half up the cliff and here there was a greater diversity and abundance of fauna with belemnites, ammonites and pieces of fossil wood. The Whalestones further down the shore mark the highest organic carbon content – from an average 2ppm to over 16ppm. Freshly broken fragments of shale smelled of oil.

Lunch was taken in the sunshine at Sandsend before proceeding to Saltwick Bay (immediately south of Whitby) for a bright afternoon. High on the cliff face, the Saltwick sandstone showed successive sand banks of channel infill, the slipoff slopes of former river meanders. We walked along to Saltwick Nab, making use of the low tide which was visibly creeping in. On the Nab the middle of the cliff face changed from dark to pale grey at bed 44 almost to the top where at bed 46, a siderite bed of iron carbonate, was prominent. On the coastal cliff a big hollow indicated the former quarrying of alum shales with a heap of burnt red shale standing out. The shales on the shore had a conchoidal fracture in contrast to the fine laminated shales in the Jet Rock, possibly indicating more oxygen or lime in the muds. We found many interesting fossils including a group of pyritised bivalves encrusted in the shape of a large 30cm ammonite, and examples of *Dacryomya ovum, Pseudomytiloides dubius* (pictured overleaf), squashed Harpoceratids and one or two brightly pyritised fragments of a huge ammonite. A nodular band at the base of the Alum Shale has a complex make up, with worked carbonate pebbles that have been rolled around and siderite below. There were examples of cone-in-cone structure here and many of the nodules were of septarian type. On an upturned fallen block were two beautiful dinosaur footprints (see photo overleaf). Finally our leader, Angela Coe, reminded us of the main features of the day and entertained us as she explained some of them by using the beach sand to make sketches and three dimensional models.

**Cast of Dinosaur footprint on upturned block in Saltwick Bay**

**Fossil of Pseudomytiloides dubius on the beach at Saltwick Bay**

## Roundhay Park Geological Trail
## Wednesday evening 17th May

### Leader : Bill Fraser

This visit to the proposed Geological Trail in Roundhay Park was timely as work to make it a reality is about to get under way, but it was marred by a downpour of almost biblical proportions, as a result of which the leader and a soggy group of only 4 hardy souls completed a circuit of the 11 locations which comprise the Trail.

As many members will be familiar with the geology involved, a summary only follows. The Trail is a circular route taking about 1 ½ hours to walk commencing at the Waterloo (lower) Lake dam and following the far shore past exposures of Elland Flags. The presence of Coal Measures strata at this lowest point of the Trail below an older Millstone Grit sequence is due to the Roundhay Park Fault, with a downthrow of about 200 metres, which crosses the valley at the head of the lake. Upstream a sequence of dark shales capped by harder wearing sandstone has seen the shales more easily eroded to form the well known narrower gorge structure. The Trail progresses up the gorge to visit a series of exposures in the Millstone Grit. These include:

- a small disused quarry in the Rough Rock, showing all the classic features of this member, deposited in a fast flowing river environment; coarse angular grains and pebble inclusions, cross-bedding which indicates the direction of the depositing current.

- Rough Rock Flags, a fine-grained sandstone below the Rough Rock, deposited in a slower moving current. Also springs at the base of the flags which lie on impermeable shales.

- dark shales, deposited in very slow moving water and having a very high organic content.

- a location where compression forces have folded the shale to form an anticline and syncline, visible at both sides of the stream.

- bands of sandstone deposited within the shale showing periods of higher energy river flow, possibly a flood, which are harder wearing and form the small waterfalls in today's stream.

Plans to create the Trail have been worked on for a number of years and earlier this year, following a presentation to the Friends of Roundhay Park group by Bill Fraser, the Friends decided to support the project and it is now progressing with a target opening in 2007.

Our Association will be formally involved in the project, both in helping the Friends to prepare the exposures (which has already commenced – see photo below), and in contributing to the design and content of a proposed "Interpretative Centre" which will be located in the Mansion House. The Project has received a Heritage Lottery Award to fund the work, which includes provision of the Centre.

During the next few months as the project progresses, your Council will from time to time ask members for their voluntary help towards our input to bringing this project to fruition.


**LGA and Friends of Roundhay Park members clearing debris to show exposures in Rough Rock quarry on the Geology Trail.**

## Glacial Geology of the Rossendale Forest and North Manchester
## Saturday 10th June : Joint Meeting with Manchester Geological Association

### Leader : Dick Crofts
### 10 Members present

Although this was a joint meeting with Manchester GA, in the event attendance was disappointing with 10 in the group, including 3 from Manchester. We enjoyed a fascinating day looking at features of the Quaternary geology at locations surrounding the Rossendale Anticline in the light of recent BGS survey work on the Manchester and Rochdale sheets, starting in the Cliviger Valley and ending on the Tandle Hill Moraine outside Oldham. Our leader, Dick Crofts of BGS Keyworth, had prepared a comprehensive handout describing the long history of evolving views of the geology of the Lancashire Pennines and Cheshire Plain following survey work through the 20th century and new conclusions following recent work, especially at the locations visited. This summary can only cover key points of today's view and anyone interested in the detail can borrow a copy of the handout from Howard Dunnill.

We first visited Shedden Hushings [900305], a location close to the wind farm to the north of Cliviger, an area of about 0.5 sq.km. This site, along with Hapton Park and Hurstwood Hushings locally, worked the Ribblesdale Till for limestone boulders between the 15th and early 19th centuries, as a convenient source of raw limestone without the need to quarry. The till, rich in limestone along with sandstone and other erratics, set in a distinctive blue-grey matrix, was brought from the Clitheroe area by a southerly / south westerly Ribblesdale ice flow in Devensian times. This is between 10 and 20 metres thick in the area of the hushings, but a thinner deposit elsewhere in the area, where it is overlaid by classic Lake District Till containing Lake District erratics. This was the other, south-easterly, flow of glacial ice to the Lancashire Pennine area.

In the hushings, dams and channels were built to store and transport water and "hush" (scour) boulders from the till. Kilns were built locally (up to 50 recognised at Shedden alone) and kept burning 24 hours a day, with coal (or charcoal) and raw limestone added at the top and lime raked out of the fire hole, to be carried away by pack horse to the Halifax area. The charcoal industry destroyed much of the Rossendale Forest. An estimated 4 million cu.

metres of ground was turned over during the lifetime of the workings (and even more at the other sites). The opening of the Leeds – Liverpool Canal in the late 18th century made large quantities of limestone readily available from the Skipton area with low transport costs, and work at the hushings finally ceased in the early 19th century. The area today has preserved remains of the kilns and hushing channels, and extensive piles of discarded sandstones from the till.

There is evidence that Devensian ice covered the Rossendale Anticline and we saw a substantial channel on top of Worsthorne Moor, above Shedden Hushings (see photo below), once thought to be a spillway between glacial lakes in neighbouring valleys, or to have been cut by water moving powerfully in channels under the ice; it is now believed to result from both mechanisms. There are several such channels on the high ground above Cliviger.

**Examining a glacial channel on Worsthorne Moor above Cliviger Gorge**

Descending again into Cliviger Gorge above Cornholme the party took in an overview of the valley (see photo page 11). The gorge runs NW / SE, is about 7km long, and carries the headwaters of the Yorkshire Calder. At Todmorden, the Calder valley turns east, travelling along its well known route to join the Aire at Knottingley. From Lydgate to the Aire, a distance of about 70km, the valley is underlaid by sand and gravel, a deposit that continues as a valley sandur along its entire length.

**Leader Dick Crofts describes glacial features from a vantage point above Cliviger Gorge**

**The group at Odin Vein, old lead workings below the Blue John Mine**

The rest of our day then focussed on glaciolacustrine sedimentation, ice-dammed lakes and moraines at locations around the Rossendale Anticline. The recent BGS survey work has enabled much finer detail of the complex Devensian history to be added to the general glacial history developed between 1965 and 1985. Much of this new understanding has resulted from computer assimilation of data from 30,000 boreholes and trial pits in the area. New Sheet Explanations and maps of the Manchester and Rochdale Districts are currently in preparation. Until about 1960 glacial deposits around the Rossendale Anticline were given explanations ranging from a series of ice-dammed lakes with overflow channels to a major glacially impounded lake from Wigan to Market Drayton. There followed a period when the many meltwater channels were explained solely by subglacial erosion. The recent studies incorporating the wealth of borehole data support the concept of localised, and possibly long-lasting, ice dammed marginal lakes during Devensian glaciation. (Some detail of this evidence and of specific lakes is covered in the handout mentioned above).

The party finally ascended to the top of Tandle Hill Park overlooking Oldham and Manchester, a 50m high, approx 3.5km long x 1km wide ridge with a very steep south facing slope, which the recent survey work identifies as one of three moraines marking a major halt in the recession southwards of the Devensian ice sheet. This moraine is part of a larger complex with the nearby Rainscough – Chadderton Heights Moraine (40m high x 10km long x 1.5km wide); the smaller Pilsworth Moraine (20m high x 7km long x 1.5km wide), near to Heywood, has more gentle slopes and marks a major oscillation in the recession southward of the waning Devensian ice sheet from the Rossendale Plateau.

Our thanks went to Dick Crofts for a stimulating and rewarding day in the field.

## A geological ramble in the Castleton area. Sunday 2nd July

### Leader : Paul Hildreth
### 10 Members present

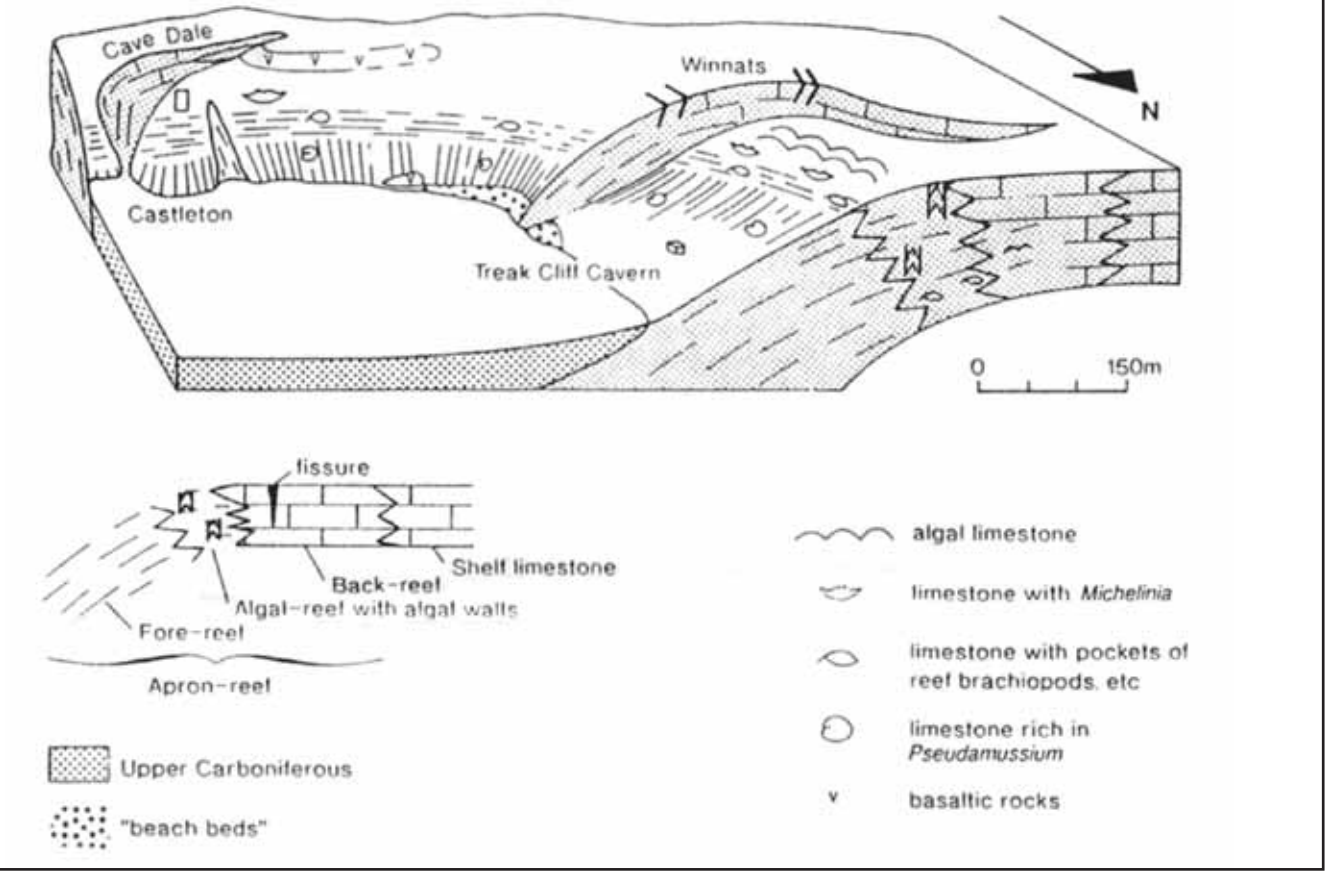
Our route was a circular ramble from close to Treak Cliff Caverns, over the landslip of Millstone Grit beds from Mam Tor, round and up the remains of the old road to the Blue John Mine; then to Windy Knoll and along the reef top past New Rake and finally down the Cave Dale defile to Castleton with lovely views of Peveril Castle above; a gentle walk of about 6km.

Walking up the old road above Treak Cliff and admiring the splendid view across Hope Valley, we examined limestone outcrops which lie unconformably beneath the Millstone Grit series. These were originally reefs of Visean age (350 Ma), forereef deposits which dip to the north at two distinct angles of 25 and 35 degrees, explained as occurring naturally on the sloping sea floor, the steeper forereef being nearest to the adjacent deep basin to the north (see diagram page 14). We found crinoids and brachiopods. The reefs were later buried to a depth of 2km by sequences of delta sands and muds from rivers flowing from NE to SW.

The next feature was the rake of Odin Vein, a mineralised fault mined for galena since pre-Roman times, but very intensively along its length in the mid 19th century (see photo page 11). There is much evidence of slickensides from the faulting activity and traces of mineralisation, calcite, fluorite and of blue fluospar, the Blue John stone famously mined in the caverns above.

Up the road, as Mam Tor came into view, we were onto the major landslip with Namurian rocks exposed in its back scar in the cliff above. These comprise a 140m thick sequence of alternating shales and sandstones deposited by turbidity currents underlain by siltstones and mudstones deposited in quiet deep waters. The cap of porous sandstones overlying impervious shales is a classic landslip situation and the history of movement goes back at least 3,600 years. In recent times, substantial work to rebuild the A625 had to be undertaken in 1947 with ongoing efforts to maintain the surface, but a movement of 1 metre in 1977 after a wet winter finally caused the road to be closed. The slippage rate has subsequently increased.

On the reef edge in front of the Blue John Mine we looked at an outcrop of the algal reef, looking for fossils of the coral *Lithostrotion* and shelly fauna,




**Diagrammatic representation of the reef area covered by our ramble**

but with limited success.

In the quarry at Windy Knoll we were now on the backreef where we would find younger crinoidal Mam Tor shelf limestones which formed in the extensive shallow lagoon environment. The limestone exhibits a classic fossil landscape of clints and grykes, the latter filled with debris of Millstone Grit age (known as Neptunian Dykes). They are very fossiliferous containing *Gigantoproductus*, brachiopods and corals. In the upper part of the quarry the fissures are filled with a dark, rubbery, bituminous substance, elaterite, the residue of a former oil reservoir, discovered and used by the Romans.

We then walked along the limestone reef past New Rake, another mineralised fault mined historically for galena, and descended into Cave Dale. An outcrop of a dark blue-grey basalt lava flow at the top of the dale is evidence of small volcanoes active in the lagoon in Carboniferous times.
(Evidence of a vent exists close to Speedwell Cavern, but was not visited on this trip).

The walk down Cave Dale was very impressive with butresses of algal limestone, considered to be a channel through the fringing reef during the life of the atoll and similar to Winnats Pass to the west.
Both were enlarged and deepened by glacial melt water at the end of the ice age 10-12,000 years ago.

Finally, we passed beneath the striking remains of Peveril Castle and arrived in Castleton in search of sustenance after a hot but very enjoyable day.

**Ann Clerk, archivist at St Peter's tells the story of the Anglian Crosses**

**Murray Mitchell details the stones used in the font and its plinth**

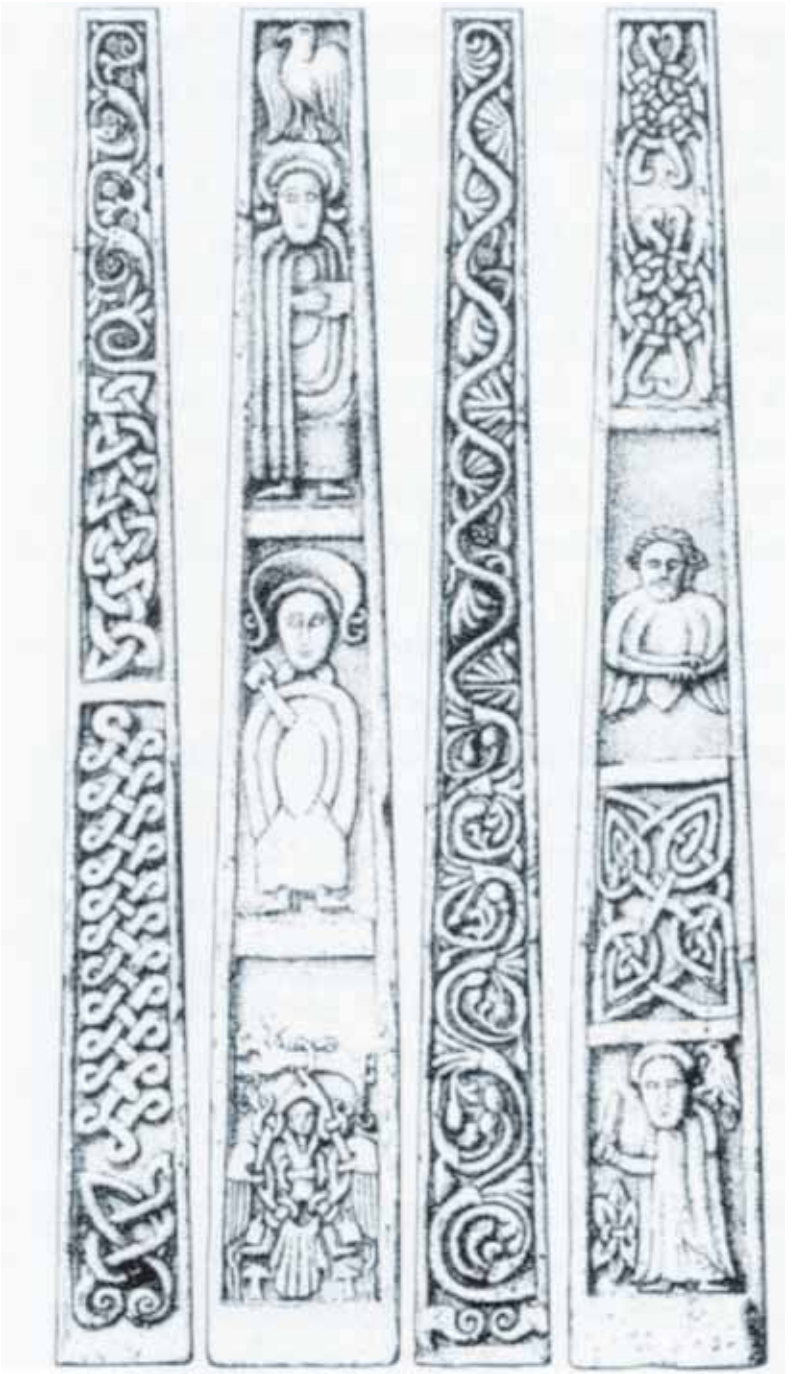
## Building and Decorative Stones of St Peter's Church, Leeds Saturday 8th July

### Leaders: Murray Mitchell and Ann Clark (St Peter's Archivist) 15 Members present

Our visit to St Peter's Church was somewhat overdue as Murray had volunteered in 2005. The morning lived up to all expectations with Murray as usual a mine of information, assisted by Ann Clark who gave a talk on the Anglian Crosses. The following notes cannot do justice to the visit and you are recommended (if you do not already own a copy) to buy Murray's 2nd edition book – details below.

The present church was built between 1838 and 1841 when it was realised that planned renovation and enlargement of the existing building (built partly in the 14th and partly in the 16th centuries) was not feasible due to its poor state. The 1841 church is the last of a series of church buildings constructed on the site since the 7th century; it contains virtually no stone from the earlier building and the exterior is large blocks of Rough Rock (Millstone Grit), from the Bramley Fall / Horsford area, with its classic quartz pebbles and cross-bedding features. Freestones for interior columns are fine-grained sandstones from local sources, including the Elland Flags (Coal Measures) from Gipton Quarry, and from Weardly, near Harewood, where Rawdon Hill Quarry worked the Lower Follifoot Grit. Welsh roof slates were replaced with similar slates from Penrhyn in 1996, but some old original Lake District blue slates from Wray Castle Formation (Silurian), Burlington Quarries in Cumbria still remain.

Ann Clark told us the story of the Anglian Crosses, the oldest building stone relics in the City. Remains from at least 5 crosses exist in St Peter's and the City Museum, the most complete being the Church Cross, positioned near the altar (see photo opposite). The stones are dated from the 10th century and are Anglian with Scandinavian influences. Originally the crosses were preaching centres, but later, when churches became established, used for burial stones of people of substance. The component stones themselves have a complicated history, having been for part of their existence incorporated into the mediaeval church tower, but fortunately recognised during its demolition in 1838 by the sharp-eyed architect who saved many of them. During the church reconstruction, all the stone involved was owned by the builder who constructed one cross from the remnants – the wheelhead at the top of the shaft is thought to belong to a different cross – and erected it in his garden in Sussex, later selling it to the Vicar of Leeds.



**Reconstruction drawing of the Church Cross by P. Brears**

All the stones are coarse-grained Millstone Grit (but not Rough Rock) and probably from a single source near Otley where this is the common rock type. Addingham Edge Grit has commonly been used for this sort of carving. The decoration of the crosses has links to other remains in Wharfedale, the Collingham, Otley and Ilkley crosses. The Leeds crosses have Celtic motifs in the Anglo-Scandinavian style; there are pagan elements, but thought to use Scandinavian heroes to tell a Christian story.

Although the Church Cross has been more sheltered from erosion in its recent past, the motifs are very weathered, but have been reconstructed in their original finery in the drawing reproduced opposite from his book by kind permission of Murray Mitchell.

Murray showed us several examples of Egglestone Marble tomb slabs used as memorial stones between the 14th and 18th centuries. This is a hard crinoidal limestone which polishes to a very dark finish, and has been the subject of a separate investigation by Geoff Blacker and Murray. There are about 360 slabs of this material known in the north of England, all with the same stone characteristics and from 4 quarries close to Barnard Castle. Some of the slabs are very large, and the logistics of how they were worked and then transported to their final installations by the transport of the day really stretches the imagination.

The font is a stunning installation (see photo page 16), largely constructed of different Devonian marbles – from Devon, with other stones as contrast and detail. The white crosses are onyx with small centres of green malachite. The 3 steps leading up to the font are Red Campan Rouge from France, a black limestone (probably from Belgium) and Carrara Marble.

One of at least 4 Bar Stones, which marked the boundary between the manorial borough of Leeds and Leeds Main Riding (the surrounding countryside), can be found in the perimeter wall of St. Peter's. This is the East Bar (or York Bar). It is coarse-grained grey-buff sandstone with quartz pebbles, probably Rough Rock. As this rock would not have been readily available in Leeds in mediaeval times, today's stone is probably a replacement for the original at the time of building the present church.

**Reference:** Dimes, Francis G. and Mitchell, M. 2006. The Building Stone Heritage of Leeds. Second Edition. Published by The Leeds Literary and Philosophical Society. ISBN 1 870737 10 5.
Copies can be purchased, price £8.95 (including post and packing) from the printers – Oblong Creative Ltd., 416B,Thorp Arch Trading Estate, Wetherby, LS23 7BJ.

# Quarry Exposures in the Sherwood Sandstone, South of Selby
# Saturday 2nd September 2006

## Leader : Dr. Steve Truss

In dismal driving conditions, and with an even more dismal but accurate weather forecast, an understandably small party of seven members travelled to the village of Pollington (SE 608206), roughly eight miles south of Selby, to examine an old sand extraction quarry in a section of the Sherwood Sandstone Group of rocks.

This group of arenaceous rocks extends, in spite of its Nottingham name, from Devon and the S.W. up to Yorkshire and County Durham, and before 1980 it was assigned to the Bunter and the lower part of Keuper in the British geological column. Our leader, who had worked for his PhD in this area, explained that it was deposited in the early Triassic, possibly with its base at the very top of the Permian, c.250Ma.

The formation at Pollington is now of graded beds of medium to fine sandstone deposited by a low velocity braided river, probably from some higher land (Variscan mountains?) to the south.

It is thought that there has been considerable reworking since the original deposition, leaving little of the original material in situ, but leaving clear evidence of channels and sub-aqueous dunes in the sections now exposed in the quarry face (see photo opposite).

The position and direction of some of these remaining channels had been mapped by our leader, using an interesting but less familiar radar technique analogous to the more usual acoustic methods applied for determining structures at greater depth.

The whole quarry consists of a number of interconnected flat-bottomed pits some five to seven metres deep, with almost vertical walls heavily iron-stained, clearly showing the depositional structures of channels and dunes together with occasional marl lenses. There were many sand martin holes excavated in the softer upper beds.

Economically the pits have been worked for building sand, originally by individual companies, and in one area the sand, being cohesive and sufficiently uniform in grain size, could be used as moulding sand in iron foundries.

**Braided river channel cut in early Triassic Sherwood Sandstone near Pollington, South Yorkshire**

**A general view of the marine Permian patch reef (SSSI) near South Elmsall**

**Detail of the dolomitised remains of the bryozoan reef overlaid by a stromatolite reef.**

Most of the quarry floors were totally obscured by vegetation, even though they had been worked up to twenty years ago. In one case though some of the floor was a bare flat sandstone, possibly lithified due to calcite cementation by descending ground water. As to be expected with the amount of reworking we had seen there were no records of fossils being found at this location.

By lunchtime, in increasingly heavy rain, the visit was terminated with the thanks of members to Dr. Truss; the party, sadly depleted by two of the wetter and weaker members, retired to a local hostelry to dry out, take on sustenance and plan their afternoon activities.

With a marked improvement in the weather after lunch, a short visit was made by the remainder of the group to a SSSI close to South Emsall. This is a disused and landscaped quarry wall with exposures of a magnificent example of a Marine Permian patch reef. The 80m long wall is very accessible and comprises a complete cross-section through one of the larger patch reefs, about 6 – 10m above the base of the Magnesian Limestone. The reef has 2 main parts, a bryozoan reef forming a raised foundation for a larger stromatolite reef (see detail photo above and general view of the face on page 21).

This site is just off the A638 Wakefield – Doncaster road with a convenient layby alongside and is well worth a visit. An information board explaining the section is still reasonably legible despite the usual vandal damage.

## Residential Weekend based at Douglas, Isle of Man Saturday 7th to Monday 9th October - 19 attended

### Leader: John Barker of the Manx Geological Survey Group

After a rather rough crossing by ferry from Heysham to Douglas on Friday 6th October, we were pleased to settle into the Glen Mona Hotel where John Barker kindly gave us a handout and a verbal briefing on the island's varied geology in preparation for the field trips that were to follow.

**Saturday 7th November**

A sombre note was struck on arriving at Marine Drive on the coast south of Douglas, our first stop on the Saturday morning, when a policeman asked us to keep a lookout for a young man who had expressed thoughts of suicide over the sea cliffs whose geology we were about to examine. Fortunately, no such person was seen and we were soon concentrating on studying excellent roadside exposures in the Manx Group comprising vertical thinly bedded, delicately laminated fine sandstones of the Lower Ordovician (early Arenig) Santon Member of the Lonan Formation (see photo page 24). A distal turbidite facies was indicated by the sharp based graded beds with directional sole structures that broadly indicate turbidity currents flowing down a submarine slope flanking the ancient microcontinent of Avalonia to the east. Trace fossils ("worm tracks") on the soles of some beds indicated that there was life on the ancient sea bed. The vertical beds were also deformed by a strong S1 cleavage and by a few tight parasitic folds and minor faults. Another curious structural feature was the presence of three joint directions that, in places, had caused the sandstone to break into pieces with the shape of equilateral triangles.

Our next stop was in the Foxdale mining area in the central part of the island where we visited the sites of the former Cross Vein or Snuff the Wind and Beckwith's mines said to have been worked between 1832 and 1881. These worked various hydrothermal veins, principally an east-west vein lying just north of the Foxdale Granite outcrop, the host rock being the slaty Barrule Formation in the Manx Group. A search of the spoil heaps yielded samples that included galena, sphalerite and a bright golden yellow mineral, probably chalcopyrite. Barite and quartz were the principle gangue minerals. Some of the fragments of host rock in the spoil showed strong cleavage as well as signs of contact metamorphism, presumably in the granite aureole.

**Examining parasitic folds and faults in Lower Ordovician turbidites of the Manx Group on Marine Drive, Douglas**

**Impressive syncline structure seen in the Niarbyl Formation, of mid-Silurian age, at Traie Dullish Quarry, south of Peel**

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**Highly deformed structures in the Ordovician Manx Group close to the Niarbyl Fault**

**Sandstones of the Dalby Group overtie much deformed Manx Group mudstones at Niarbyl. (Laurentia meets Gondwana!)**

A sombre note was struck on arriving at Marine Drive on the coast south of Douglas, our first stop on the Saturday morning, when a policeman asked us to keep a lookout for a young man who had expressed thoughts of suicide over the sea cliffs whose geology we were about to examine. Fortunately, no such person was seen and we were soon concentrating on studying excellent roadside exposures in the Manx Group comprising vertical thinly bedded, delicately laminated fine sandstones of the Lower Ordovician (early Arenig) Santon Member of the Lonan Formation (see photo page 24). A distal turbidite facies was indicated by the sharp based graded beds with directional sole structures that broadly indicate turbidity currents flowing down a submarine slope flanking the ancient microcontinent of Avalonia to the east. Trace fossils ("worm tracks") on the soles of some beds indicated that there was life on the ancient sea bed. The vertical beds were also deformed by a strong S1 cleavage and by a few tight parasitic folds and minor faults. Another curious structural feature was the presence of three joint directions that, in places, had caused the sandstone to break into pieces with the shape of equilateral triangles.

**Fossil of Orthocone Nautiloid in greywacke sandstones at Traie Dullish Quarry**

Our next stop was in the Foxdale mining area in the central part of the island where we visited the sites of the former Cross Vein or Snuff the Wind and Beckwith's mines said to have been worked between 1832 and 1881. These worked various hydrothermal veins, principally an east-west vein lying just north of the Foxdale Granite outcrop, the host rock being the slaty Barrule Formation in the Manx Group. A search of the spoil heaps yielded samples that included galena, sphalerite and a bright golden yellow mineral, probably chalcopyrite. Barite and quartz were the principle gangue minerals. Some of the fragments of host rock in the spoil showed strong cleavage as well as signs of contact metamorphism, presumably in the granite aureole.

Our picnic lunch was eaten on the island's west coast at Niarbyl. Here too on the foreshore, we found the Manx Group turbidites to be highly deformed in an extensive crush zone beneath the Niarbyl Fault or Slide represented by a prominent inclined vein of quartz and breccia in the cliff (see photos below and overleaf). The relatively undeformed beds above the fault belong to the Silurian Niarbyl Formation of the Dalby Group. Palaeocurrent and

**Sunday, 8 October 2006**

The morning dawned cloudy but bright, and very breezy. We drove south west from Douglas, skirting Ronaldsway Airport, to Derbyhaven and then south east to the Langness Peninsula. After a short walk, we scrambled down to the western shore where low cliffs, breached by marine erosion to form the Arches, exposed the spectacular unconformity between almost vertical beds of the Lonan Formation of the Manx Group and the overlying Lower Carboniferous (Tournaisian) Langness Conglomerate Formation (see photo on the back cover). The Manx Group rocks were stained purple and in the conglomerates, the poor sorting and angularity of the clasts, together with the presence of lenses of sandstone and red mud-flake breccia suggested deposition from periodic sheet floods on an alluvial fan in a possibly seasonally arid environment.

The succession was cut by a Tertiary dolerite dyke, which despite a rising tide, could be seen to change dip direction when passing from the Lower to the Upper Palaeozoic rocks. Finally, just before leaving, we examined a trial adit for copper in the Manx Group. This had proved unsuccessful, but our car park area was adjacent to the former Langness Copper Mine.

The party then drove to Scarlett, just south west of the historic town of Castletown, to begin the traverse of a three-mile-long shore-section in rocks of Lower Carboniferous age. Our first locality was immediately below the car park where some members braved a, by now, very rapidly rising tide and rough seas to examine giant specimens of the solitary rugose coral Siphonophyllia in the Castletown Formation of Holkerian age (see photo opposite). Luckily it was possible, in some cases with a helping hand, to climb the low cliff as the tide had now cut off retreat along the beach! Further along the outcrop of the Castletown Formation, at the base of an old lime kiln, a large (Carboniferous!) nautiloid was seen by some members just before it too disappeared beneath the waves!

Fortunately the higher limestones of the formation were exposed above high water mark and revealed a wealth of fossils including abundant crinoids and small brachiopods, sporadic corals, together with some goniatites and small bryozoa within interbedded dark mudstones. Another large nautiloid was spotted, whilst other bedding planes were covered with the trace fossil *Zoophycus* (formerly known as "caudi-galli"). The beds were folded into medium scale, asymmetric anticlines and synclines plunging to the south, one of which was cut by a Tertiary dyke trending in a north-north-west direction.

**Fossils of the giant solitary coral Siphonophyllia in the Castletown Limestone**

Crossing a fault, the downthrown Brigantian to early Namurian age Scarlett Volcanic Formation lay before us. Extensive agglomerates were cut by a spectacular wall of vesicular and amygdaloidal basalt lava, probably representing the site of a fissure eruption (see photo opposite). Out to sea, the Stack with its radial columnar jointing was a possible vent location. A breezy picnic lunch was taken overlooking the site of this ancient volcano.

A post-prandial ramble along the grass-covered cliff top took us to our next locality where very coarse agglomerate composed entirely of vesicular basalt clasts in an almost interlocking texture suggested an explosion event - probably steam generated. Further to the north west, a complex succession of volcanic sands and tuffs, thin conglomerates with both basalt and limestone clasts, and limestone beds clearly broken up by lateral movement, indicated submarine sliding, probably related to volcano-seismicity.
Our next locality provided further evidence of the proximity of the Lower Carboniferous sea with its spectacular development of several metres of classic pillow lavas (see photo opposite). Finally, just below a small Iron Age fort, the cliff at Close-ny-Chollagh Point showed complex interbedding of shiny black cherty limestones and agglomerates in which clasts of the former could be distinguished.

Continuing northwards and descending the succession, we passed the Black Marble Quarry in early Brigantian limestones to which, unfortunately, we had no access. However, further along we were able to examine the highly fossiliferous beds of the underlying Asbian age Poyllvaaish Formation. Orthicone nautiloids, goniatites in three-dimensional preservation, brachiopods and crinoids were all observed and collections made from the adjacent beach gravels. Our final locality, the cliffs below Salt Spring Cottage, exposed thin bedded black limestones containing small build-ups with colonial corals including *Lithostrotion* at the base of the same formation.

Members then walked to the main road at Strandhall where, before the drivers were ferried back to their vehicles, our President proposed a very warm vote of thanks to our leader, John Barker, for what had been two really excellent days in the field.

**Basalt lava flow at Poyllvaaish**

**Pillow lavas formed in the Lower Carboniferous sea**

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The famous unconformity at Langness; Ordovician Manx Group sandstones overlaid by coarse Carboniferous conglomerate