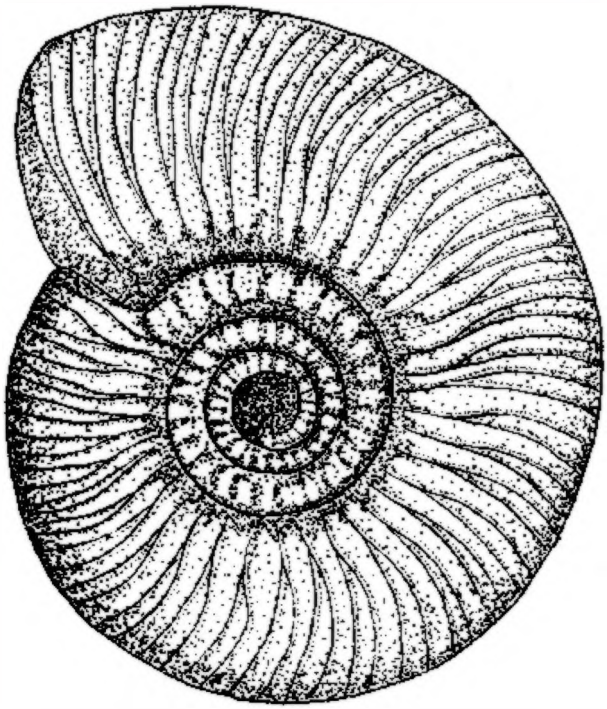
THE CUMBERLAND GEOLOGICAL SOCIETY



PROCEEDINGS

Volume 7 2008-2009 Part 4

THE CUMBERLAND GEOLOGICAL SOCIETY

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EDITORIAL

This edition of Proceedings (Volume 7, Part 4) completes our seventh volume and hopefully presents a record of two more successful years of the Society.

I hope members will feel that we have been able to maintain our record of providing a forum for the publication of original material on the geology of Cumbria, as well as keeping a record of what the Society has been doing. It is increasingly difficult to find authors willing to contribute original material and write papers on their research or findings in the region. We are not alone as a Society in this respect. I still believe however, that we have an important role to play in maintaining a record of local work. Cumbria is an important piece of our national geology and contains a landscape with an amazing array of different landforms. We are always looking for contributions, however small or profound. We would particularly like to hear from students, amateurs and anyone who has a love and interest in the Cumbrian landscape.

Can I thank all of you who have contributed to this volume. I know I have had to 'bend a few people's arms' and persuade them to put pen to paper or switch on their computers. (I don't mind which – we can still cope with long hand on paper). I hope you feel we have presented your contribution satisfactorily.

As the Society approaches its 50th birthday in 2012 we are planning a number of events and activities to celebrate this landmark. Our next volume (Vol. 8, part 1) will probably have a nostalgic look over geology in Cumbria since the 1960's.

How things have changed!

How our knowledge of the region has been transformed through our grasp of Plate Tectonics, climatic change and the enormous strides made in measuring techniques.

We will remain however a Society focussed on Cumbrian rocks and landscapes.

If you have any observations, ideas, reminiscences, or records please let us know.

Alan Smith (Editor).



RECORDS OF THE USE OF EGGLESTONE MARBLE IN CUMBRIA

Murray Mitchell

Polished marbles or marble-like stones have been extensively used as decorative and structural materials in cathedrals and churches throughout England, with Purbeck Marble from Dorset being perhaps the most famous. A number of polished crinoidal limestones of Carboniferous age were widely used throughout northern England from the late Middle Ages onwards, mainly for grave slabs and occasionally for fonts. However, the widespread use of Egglestone Marble from quarries near Barnard Castle has been largely unrecorded.

Documentary sources described the localities of the earliest Egglestone Marble quarries on both banks of the River Tees, 1.5 km south-east of Barnard Castle (Figure 1). John Leland, King Henry V111's antiquary, visited Egglestone Abbey during his north-eastern journey of c. 1541 – very shortly after the Abbey's suppression (Chandler, 1998). After crossing Thorsgill, he noted:

"Hard under the clif by Egleston is found on eche side of Tese very fair marble, wont be taken up booth by marbelers of Barnardes (Castelle) and of Egleston, and partely to have be wrought by them, and partely sold onwrought to other" (Toulmin Smith, 1907).

Four separate quarry sites have been identified and named by Blacker and Mitchell (1999, p. 119; see Figure 1); **Abbey Quarry** (NZ 064150) and **Mains House Quarry** (NZ 065150) are the two quarries noted by John Leland as being a quarter of a mile from Egglestone Abbey. **Westfield Quarry** (NZ 083144) and **Watersmeet Quarry** (NZ 085145) are about 2km east of Abbey Bridge, close to where the River Greta joins the River Tees. The quarry details are discussed below.

The fourteen examples of the monumental use of Egglestone Marble and four short flights of steps in Durham Cathedral were discussed by Blacker and Mitchell (1999), and parts of this paper are repeated here. The Cumbria records of the use of Egglestone Marble were made between 1997 and 1999 by Dr. J.G.Blacker and the author who made numerous visits through Northern England and the North Midlands, and identified more than 350 uses of this handsome stone (mainly for grave slabs) from localities as far north as Carlisle and south as Lincoln. The visits to Cumbria did not cover the whole of the county, but concentrated on the northern and eastern parts – sites close to the Roman Road over Stainmore to Carlisle. Any errors are the responsibility of the present author.

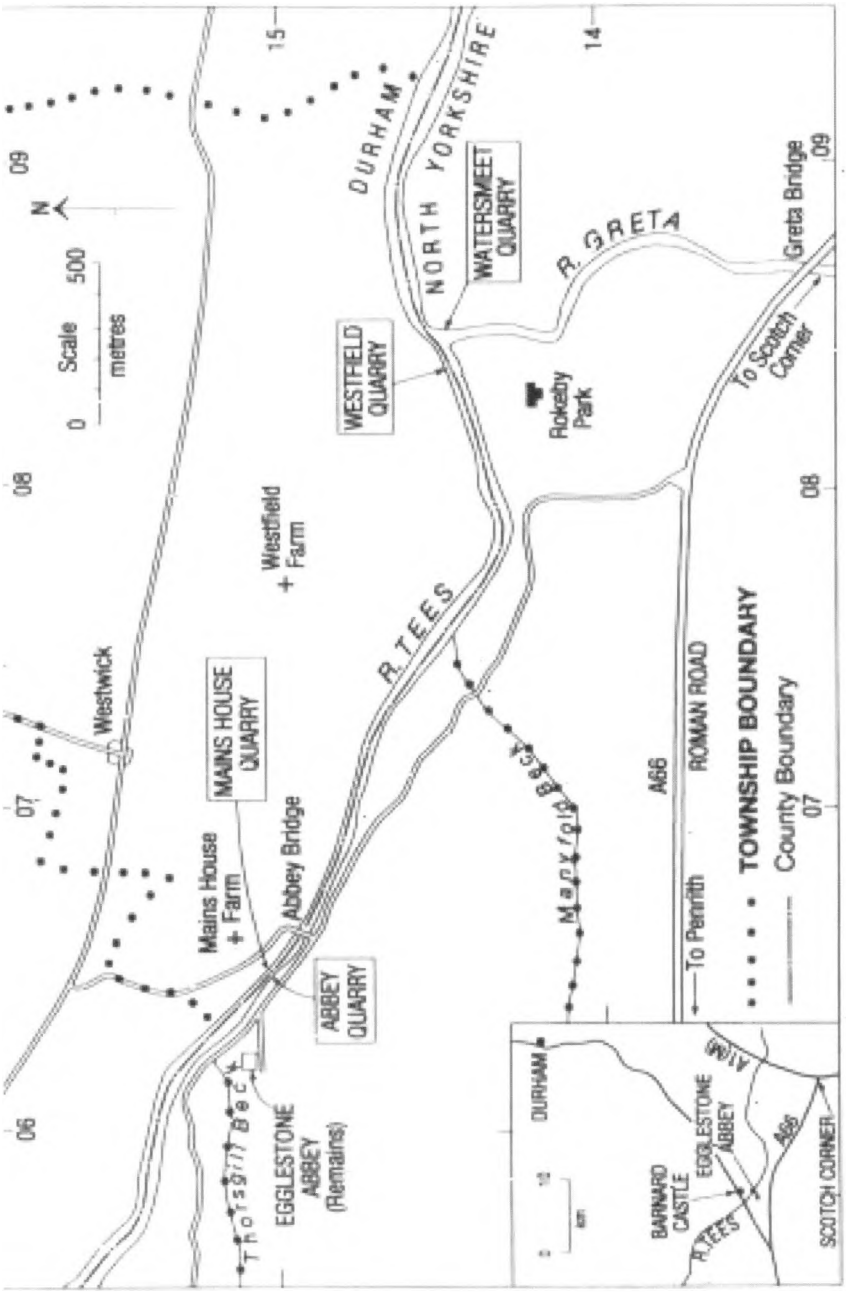


Figure 1. Location Map.

Crinoids and Crinoidal Limestones

Crinoidal limestones are notoriously variable, due to the form of crinoids and the way that beds of this kind of limestone were deposited. Sometimes known as sea lilies, crinoids belong to the animal Phylum Echinodermata, and are related to sea urchins and starfish. They are common as rock-forming fossils in the Palaeozoic Era, less common in the Mesozoic and rare in the Cenozoic. However, crinoids are still living today, with their maximum occurrence in warm-sea environments such as the Great Barrier Reef of Australia.

Crinoids consist of a more or less flexible stem up to a metre or more in length, usually rooted into the seabed, with a cup or calyx at the top, and movable arms growing free from the margin of the cup. They feed by filtering minute organisms from sea water. A living crinoid consists of a calcareous skeleton, bound together and surrounded by organic tissue. The stem of the skeleton consists of a number of disc-like segments or columnals, which have a central opening. The cup and arms are also formed by a series of plates. After death, the calcareous skeleton usually breaks into fragments. The shining cleavage faces of calcite crystals from which they are composed can often identify these pieces.

Many Lower Carboniferous limestones contain scattered broken fragments of crinoids, stem columnals being the commonest debris. However, under especially favourable conditions, for example near the edge of relatively shallow-water areas where nutrient-rich cold-water currents from deeper water occur, dense thickets of crinoids often grew. Under these conditions, the fragile crinoid skeletons were broken up and short lengths of stems and disarticulated fragments were sufficiently abundant to form richly crinoidal deposits. These beds either accumulated where the crinoids grew, or more commonly the fragments were carried away by strong currents, and laid down in banks elsewhere. The strength of the currents was a major factor in determining the extent to which the stems broke up, the size of the crinoid debris laid down, and the composition, nature and amount of matrix or cement in which the crinoid debris was deposited.

Being current-reworked bank deposits, richly crinoidal limestones are very variable in composition, vertical thickness and lateral extent. It is this variable character which makes it difficult to identify the source of specific crinoidal limestones with certainty. Many rocks rich in crinoids are dense enough to take a polish which accentuates the fossil content, and is retained when used in interior positions in buildings protected from natural weathering action. They are often referred to as "marbles". However they are sedimentary rocks and not in the geological sense true marbles, which are limestones metamorphosed by heat and pressure.

Geology of Egglestone Marble

Egglestone Marble is a crinoidal limestone from the Carboniferous (Yoredale Series) and takes its name from its proximity to Egglestone Abbey situated on the south bank of the River Tees about 1.5 km south-east of Barnard Castle (Figure 1).

The medieval quarries described by John Leland on both banks of the river were worked into the river cliffs east of Egglestone Abbey at the north-west end of a gorge cut into the Great Limestone (Namurian age). Mills and Hull (1976) recorded a section of the Great Limestone 22 m thick below Barnard Castle, downstream from Abbey Mill. The Great Limestone was noted as a fine to medium-grained, massively-bedded, bioclastic rock except for the top 4.5-6 m, which is commonly argillaceous and thin bedded. The beds that have been quarried lie in the massive bedded limestones, the top of which forms the highest of a series of small falls and rapids on the River Tees.

The following description is based on polished samples from Abbey Quarry. The rock is a fine-grained, medium grey-brown coloured bioclastic limestone. Crinoid debris occurs mostly in two size ranges with common, uniformly distributed, small crinoid columnals, ranging in diameter from 0.6 mm to 2.7 mm, and a few larger examples up to 5-6 mm. Rarely, columnals up to 10-11 mm have been noted. The small diameter columnals sometimes occur in lengths up to 10mm long. It is a compact fine-grained limestone that will take a polish, and can be carved in fine detail. The beds range from about 0.5 m up to 1.06 m thick. The limestone has been extensively bioturbated and this character can be recognised by the blotchy appearance of a polished surface with roughly circular areas being darker coloured than the rest of the rock. Bioturbation has completely destroyed any layering or bedding that might originally have been present in the limestone, and so removed some of the lines of weakness which would have affected its value as a monumental stone. As a result of this process, the rock is hard and has a wide-spaced jointing pattern, which allowed very large blocks and slabs to be extracted. Calcite filled tension cracks are also present.

The full thickness of the Great Limestone is exposed in Westfield Quarry on the north bank of the Tees, 2.5 km downstream from Egglestone Abbey, with the top beds at the east end of the section. The river cliffs for about 300 m west of where the River Greta joins the Tees have been extensively quarried. The characters of the limestone in this quarry are similar to those in Abbey Quarry, but the joints are in some cases even more widely spaced allowing significantly larger slabs to be extracted.

Another smaller area of quarrying (Watersmeet Quarry) occurs in the Great Limestone, at Watersmeet where the River Greta joins the Tees. Levels in the Great Limestone similar to those in Abbey Quarry have been quarried. Although the limestones at both localities have much in common (bedding, jointing, bioturbation, colour and distribution of crinoid debris) all the beds sampled at

Watersmeet contain dark-coloured shell fragments which are not present in the limestones of Egglestone.

Egglestone Marble is very different from Frosterley Marble, which is so well displayed in the columns of the Chapel of the Nine Altars in Durham Cathedral. Frosterley Marble, from the Great Limestone of Weardale, is characterised by containing the white skeletons of fossil corals and these make it easy to identify. However, the Frosterley corals occur in well-defined bands and the beds between these coral bands contain crinoid debris. A sample of non-coral bearing limestone from Harehope Quarry, Frosterley, the source of the Frosterley Marble in Durham Cathedral, was polished for comparion with Egglestone Marble. Frosterley Marble is darker in colour than Egglestone, and the small sized crinoidal columnals are more scattered, more broken and have corroded margins. No large diameter columnals were seen. These characters can be used to distinguish the Frosterley crinoidal limestone from Egglestone Marble.

RECORDS OF EGGLESTONE MARBLE IN CUMBRIA

CARLISLE CATHEDRAL

Seven tomb slabs of Egglestone Marble (EM) have been identified.

1. Southern slab of two below the West Window at the west end of Nave (laid north-south).
EM tomb slab; with indent of civilian; died (d.) c 1480; wife and three children; quatrefoils at corners.
2.66m x 1.21m.

2. Northern slab of two below the West Window at west end of Nave (laid north-south).
EM plain tomb slab; no details.
2.43m x 1.105m.

Note: Corals present including *Dibunophyllum sp.*

3. North Aisle in front of St. Wilfred's Chapel.
EM top slab of red sandstone chert; Simon Senhouse, Prior of Carlisle, 1500, 1505, 1507 and 1518; d. c. 1520.
2.415m x 1.135m and 0.145m thick.

Note: Top surface of slab is level and polished; base of slab is also level. Suggested that this slab may have been split with wedges from the middle of a block of stone, perhaps more than half a metre thick (See note with the Crosthwaite Church slab).

4. Eastern end of Choir.
EM major tomb slab; Bishop Bell, Bishop of Carlisle; d. 1496.
3.30m x 1.88m (edges repaired).

Note: This is one of the largest EM slabs in Cumbria. Transport from the Egglestone Quarries was presumably by wagon via the Roman Road over Stainmore which passes less than 1 mile to the south of the quarries near Egglestone Abbey.

5. Western of two slabs on north side of Chancel.
EM tomb slab; indent of Lady; quadrefoils; d. c. 1420.
2.62m x 1.39m.

6. Eastern of two slabs on north side of Chancel.
EM plain tomb slab; no details.
2.00m x 0.87m.

Note: One coral fragment identified as Aulophyllum sp.

7. Behind the altar and to south of East Window.
EM plain tomb slab; indent; no details.
2.43m x 1.24m.

Cathedral Notes: Floor of the Choir; laid with squares of limestone identified as Frosterley Marble from the Great Limestone of Weardale and Swaledale Fossil Marble from the Great Limestone quarries north of Scotch Corner.
Base of Altar; slabs of crinoidal limestone – some with large diameter crinoid columnals, identified as Derby Fossil: others are black limestones with small crinoid debris which is probably Ashford Bird's Eye Limestone from Ashford, N.W. of Bakewell in Derbyshire.

CROSTHWAITE KESWICK, ST. KENTIGERN'S CHURCH (NY 257243)

South side of the Altar.
EM slab with brass inset; mounted on sandstone pillars; Sir John Ratcliff; d. 1527; and wife.
2.355m x 1.085m and 0.145m thick.

Note: Cross-section shows that the bottom surface of the slab is an uneven natural bedding plane. The upper surface has been slit from a bed of stone with wedges, and then worked to the present smooth polished surface.

GREYSTOKE, ST. ANDREW'S CHURCH (NY 443307)

Five tomb slabs of EM have been identified.
1. Western slab of two in Choir.
EM tomb slab with brass plate and 4 corner shields; William le Bone, Baron of Greystoke; d. 1359.
2.76m x 1.36m.

2. Eastern slab of two in Choir.

EM tomb slab with brass plate; Thomas Eglisfelde and Walter Readman, Provosts of Greystoke; Walter d. 1509.
2.005m x 0.96m.

3. North side of Altar.
EM tomb slab with brass plate and shields: John Whelpdale priest; Master of Caldbeck College of Rectors; d. 1526.
2.05m x 0.95m.

4. South side of Altar.
EM plain tomb slab under carpet; no details.
2.24m x 1.19m.

5.West side of Altar.
EM plain tomb slab, badly worn; no details.
1.97m x 0.93m.

EDENHALL, ST. CUTHBERT'S CHURCH (NY 569320)

South side of Altar.
EM tomb slab with brass plate; Knight and Lady; William Stapilton, Lord of Edenhall; d. 1458; and wife, Margaret;
d. 1470.
2.25m x 1.15m.

Note: Field site away from village, overlooking River Eden flood plain.

GREAT ASBY, ST. PETER'S CHURCH (NY 681132).

EM tomb slab set in porch floor; indent of civilian; d. c.1480; and wife; no details.
2.39m x 1.27m.

Note: Font and Pulpit are identified to be " Red Barrow Marble" probably from Stainton Quarry in Furness, where the Urswick Limestone has been stained red with hematite.

GREAT MUSGRAVE, ST. THEOBOLD'S CHURCH (NY 767132)

South side of Altar.
EM tomb slab with brass of priest; Thomas Ouds, Rector;
d. 1502
1.72m x 0.85m.

BROUGH, ST. MICHAEL'S CHURCH (NY 793139)

East end of Nave.
Possible EM tomb slab with indent; too badly weathered to be certain.
2.13m x 1.23m.

KIRKBY STEPHEN, PARISH CHURCH OF ST. STEPHEN (NY 775088)

Chapel in South Chancel.
EM badly weathered top slab of tomb chest of sandstone slabs; Sir Richard Musgrave; d. 1464; and wife.
2.06m x 0.89m (seen) and 0.19m thick.

CARTMEL PRIORY (SD 380787)

Piper Choir floor.
EM tomb slab with brass indent; William Knipe of Broughton Hall; d. 1745.
2.225m x 1.03m.

KENDAL, HOLY TRINITY PARISH CHURCH (SD 517927)

The Font and five tomb slabs of EM have been identified.

Font

Fine example of octagonal font, carved from a single block of stone; late fifteenth century; same style as fonts in Barnard Castle Church (1485), Ripon Cathedral (late 15th century), South Kilvington Church (1461-83) and Startforth Church (1483-85).

Note: The beds near the top of the Great Limestone exposed in the River Tees east of Egglestone Abbey, and probably worked in Mains House Quarry (Figure 1), have a jointing pattern that allows blocks about 1m x 1m square and 1m thick to be extracted; ideal for carving of fonts in one piece.

Five EM tomb slabs in Old Sanctuary.

1. Large tomb in Parr Chapel.
EM top slab of chest tomb; tomb of Sir William Parr, Knight of the Garter; d. 1483.
1.95m x 1.05m x 0.20m thick.

2. Large tomb in the Strickland Chapel.
EM top slab of chest tomb; Sir Walter Strickland; d. 1528; and wife, Katherine Neville.
2.23m x 1.11m and 0.15m thick.

Note: There were strong links between the Stricklands of Sizergh Castle, south of Kendal, and the Nevilles of Raby Castle, Staindrop near Barnard Castle and the Egglestone Marble Quarries.

3. Large tomb in the Bellingham Chapel.
EM top slab of chest tomb; Sir Roger Bellingham; d. 1533; and wife Margaret (Aske).
1.94m x 1.04m and 0.08m thick.

4. Floor of Old Sanctuary.

EM tomb slab with brass plate; Father Robert Dawson, Bishop of Clonfert and Kilmacduogh (Ireland); d. 1643.
1.48m x 0.90m

5. Floor of Old Sanctuary.
EM tomb slab with brass plate; Raulph Tiror B.D., Vicar; d. 1627.
1.48m x 0.76m.

Discussion and Conclusions:

In the early 21st century it is difficult to understand the importance and significance late medieval society placed on funerary practices. Testators frequently made request for burial in a particular church, in a chosen position and with a stone of particular type to cover the grave. A "marbyll stone to cover my grave" was a common instruction but the source or type of stone was usually left to family and executors. Brass effigies and inscriptions were often inlaid to further embellish the monument.

Purbeck Marble was frequently selected in the 13th and 14th centuries, its texture, colour and appearance apparently meeting the requirements of the deceased and executors, even for Royal monuments. From the late 14th centuries other sources of stone with similar character was being sought and, in the northern part of England and into the Midlands, dark-coloured, crinoidal limestone seems to have met the requirements.

Of other varieties of crinoidal limestones available, the stone from Egglestone seems to have been favoured, perhaps because it could be extracted in very large slabs in addition to having all the other desirable features. From the early 15th century Egglestone Marble was in demand for monuments to persons of status and distinction. Usage had declined by the middle of the 16th century perhaps because of the lack of interest in exploiting the mineral rights by the Strelley family who acquired the Egglestone estate eight years after the Abbey's surrender in 1540. Disused slabs from monuments that had been defaced were also readily available.

Acknowledgements: Dr. Alan Smith is gratefully thanked for help with the preparation of this paper.

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Glossary:

ARGILLACEOUS Sediments composed mainly of fine-grained clay minerals.

BED Roughly horizontal layers of sedimentary rock. Individual beds are separated by bedding planes. The term is also used to denote the horizontal plane on which a block of stone formerly lay in the quarry.

BIOTURBATION Reworking of soft sediments by burrowing animals feeding on contained organic debris prior to rock formation.

BRASS A flat plate of latten (see belw) often with an engraved figure and/or inscription to a deceased person.

CARBONIFEROUS A period of geological time extending from 360 to 286 million years ago.

CRINOIDS Marine animals belonging to Phylum Echinodermata related to sea urchins and starfish.

INDENT The recess in a stone slab left after the removal of a brass.

JOINT A fracture in a rock usually at right angles to a bedding plane, between which there is no observable relative movement. Produced by tension.

LATTEN A metal alloy consisting mainly of copper and zinc used for brasses.

MARBLE Geologically, a limestone that has been recrystallised as a result of metamorphism. Commercially, a rock which is hard enough to be polished for decorative purposes.

POLISHING Some limestones can be rubbed with successively finer abrasives to produce a highly polished surface. Sometimes dilute acetic acid in the form of vinegar was also used.

AUTHOR'S NOTE.
Since this short paper was written, the author has become aware of the publication of the following book; BADHAM, S. and BLACKER, G. 2009. *"Northern Rock: The Use of Egglestone Marble for Monuments in Medieval England". BAR British Series 480,* Archaeopress Publishers, 147 pages, 69 plates.

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THE MANY USES OF SHAP GRANITE

Geoff Brambles

The lease for the opening up of the Shap quarries was granted by the Earl of Lonsdale in 1865, thus setting in train Shap pink granite's steady march to the front rank of polished decorative crystalline rocks. Its success derives from its distinctive appearance, but this was not all. An enthusiastic local newspaper report of 1869 pointed out that supply was 'inexhaustible'; that there was 'an absence of extraneous deposit', giving a 90% yield; and that blocks of 'immense size' could be obtained. It was further pointed out that 'save for minor deposits at Mountsorrel and Groby, Leicestershire' Shap was the only granite between Scotland and London, boding well for market penetration.

The venture was not, however, a local initiative, but an extension of existing Scottish interests. The lessee was 'Samuel Curteis of Stroquhan House near Dumfries North Britain Esq.', owner of the principal Dalbeattie granite quarries, hence the birth of the 'Shap and Dalbeattie Granite Company', the first of Shap's owners.

Exploitation of Shap granite, however, has a far more ancient history, thanks to the abundance of erratic boulders in the Shap area. A few of the larger of these are recorded by the O.S. as 'thunderstones', presumably a folk name, though inspection in the field suggests that in this case, as in general, the O.S. was guilty of a high degree of selectivity in its preservation of topographical names.

Like everything else in the natural environment, boulders are a potential resource, and the earliest surviving instances of their exploitation lie in the seven stone circles near Shap consisting wholly or mostly of Shap erratics. An eighth, Grey Yauds, about a mile west of Newbiggin, lies 25 miles north of the Shap granite outcrop. This was destroyed, its 88 'pretty large granite stones' falling victim to the 'necessities of agriculture' at the time of enclosure. Improvement here, as elsewhere, was no respecter of antiquities. A stone circle just south of Shap village was half destroyed by the building of the Lancaster and Carlisle Railway in 1846, and another, on Iron Hill, two miles east of Shap, had a drystone wall built right through it. The circles that survive are all modest affairs, but are testimony, nonetheless, to whatever cultural imperative it was that drove small populations to shift big stones.

Undoubtedly the greatest loss to posterity, however, was the Avebury-style stone avenue, generally known by the name Karl Lofts, that ran for over a mile in length between Skellaw Hill and the present southern end of Shap village. As early as 1777 it was being destroyed by blasting, the fragments

being carried away to be used in the foundations of buildings. The mutilated remains of once much larger erratics survive in the bases of contemporary drystone walls. One of the few intact survivors, about 6 foot square and 3 foot high, lies prostrate in a field just to the west of the village. (A similarly large erratic was re-erected nearby in 1978, and has the distinction of bearing a name – The Goggleby Stone – but, sadly for our story, it's a Borrowdale Volcanic 'agglomerate'.)

Shap erratic boulders and cobbles were not only of interest to the ancients. The 18th and 19th century enclosures created a huge demand for walling stone and field gate stoups. Most of the walls in the Shap area contain Shap erratics, though in greatly varying quantities. The wall by the entrance to the pink quarry is unusual in consisting entirely of Shap erratics. At the other extreme, the limestone walls around the village contain only sporadic granites; few motorists entering the spur to the M6 near the ever white-plumed Corus kilns, will have noticed that the wall to their left is rich in granite at the corner, the rounded erratics contrasting strongly with interleaved thin slabs of limestone.

The demand for gate stoups was partly met by splitting conveniently located erratics. This was done by the traditional 'plug and feather' method, in which a line of hand drilled holes were wedged and hammered so as to produce breakage along a more-or-less uniform plane. Further hammer trimming of the large resulting clasts produced crudely shaped, but fully functional, gate posts that still bear bisected drill holes. Such stoups are instantly distinguishable from their more expensive factory-shaped Shap pink brethren.

Shap erratics have also been used as stepping stones in small becks, and as ready made piers supporting footbridges over larger ones. A few years ago, Macdonalds bought erratics from around the quarry to place outside some of their restaurants. Some householders with flat-topped garden gate posts have placed smallish erratics thereupon as an adornment. The placing of erratics for visual effect was similarly practised by the builders of the M6, who lined up large specimens on the west side of the B6261 Orton road at the point where it meets the junction 39 access road.

The opening of Shap pink quarry introduced to the wider world (and to the narrower one around Shap) one of its most distinctive and decorative polished stones. A large processing plant was developed two miles north of the quarry, directly opposite the blue quarry, on a flat site adjacent to the west coast main line. The granite was carried to the factory on a company railway line and, from the opposite direction, a special works train carried workers the short distance to and from Shap village along the main line. Sidings accommodated trains for the loading of finished products and the workers' train. The blue

quarry was connected to the works by a short company railway that passed under the A6 through a tunnel. The proximity to limestone, combined with the granite and the blue 'hornfels' was an embarrassment of rocky riches that was fully exploited by the company and its successors over the next 140 years.

Shap pink is probably the most recognisable British ornamental granite and certainly one of the most widely distributed. Those polished feldspars twinkle their cleavage planes from a legion of shops, office blocks, hotels, banks, civic buildings, railway stations, churches, museums, fountains, plinths, bollards and memorials of all kinds across the UK and beyond.

A short list of some of the prestigious buildings partly adorned with Shap pink tells the story. Manchester Town Hall, St George's Hall in Liverpool, Glasgow University, the London Stock Exchange and Birmingham Art Gallery indicate the esteem in which the stone has been held. Two examples from Cumbria illustrate the opposite poles of usage to which polished Shap granite has been put. Penrith Post Office shows the common technique of cladding a corporate modern building with polished slabs. It is decorative, but undemonstrative. The Elisa Moore memorial in Wigton, by contrast, is a fancy confection standing at a prominent road junction, and conceived as an individual and public display of spousal regard.

For sheer exuberance, though, Leicester's Town Hall Square fountain is hard to beat. Here, as in many other places, Shap pink is used in combination with other decorative stones: in this case, Ross of Mull granite. This latter stone was quarried by the Shap company at one time, and this may be why it was used here.

In Scotland, home of many granites, Shap was nevertheless chosen to support Greyfriars Bobby, Scotland's most faithful dog, a testament to the stone's desirability. Despite their sobriety of purpose, war memorials may employ such a showy stone as Shap pink. In Cumbria, Carlisle, Shap, Penrith and Witherslack are all examples.

In their combination of geology, geometry and aesthetics, Shap columns are particularly appealing, and seem to have been something of a speciality. They can be admired in, for example: Hull Museum; St Pancras Station; Newcastle-upon-Tyne's Crown Court; St Mary's Cathedral, Edinburgh; the HSBC bank, Carlisle and the Irish Life Assurance Building, Manchester.

Perhaps the most numerous pieces of polished Shap are those that adorn burial grounds. Kendal cemetery has 120, Barrow's has 76 and, loyally, Shap's has over 190, as well as another 70 in the churchyard. (Further contributions, with dates, from readers will be gratefully received by the writer.)

Possibly unique, on the other hand, is the Bull's Head sculpture, by Shawn Williamson, that sits atop a rough quarried block of grey Silurian slate in the grounds of Lancaster University.

The result of a less ambitious shaping of Shap granite, into rather crudely formed decorative stone balls designed to be placed on top of gateposts, is to be found in Ravenstonedale. The writer has not yet seen examples elsewhere, but it seems certain that they are more widely distributed.

Not all Shap pink intended for public display is polished, or indeed, even smoothed. The geologically most piquant example is the large chunk placed in Dent as a memorial to Adam Sedgwick. One wonders what Sedgwick, a dalesman, would have thought about being commemorated with such an un-Pennine rock.

Millennium fever was responsible for the plucking from obscurity of a similarly angular and vaguely pyramidal 50 tonne piece of blast debris from Shap quarry. This is the Eden Millennium Monument, possibly the only bit of Shap pink to have been dedicated by a bishop. It stands near Mayburgh Henge, outside Penrith, adorned with incised alpha, omega, cross and 2000. Two other rough chunks of Shap stand at celebrated road locations, supporting commemorative plaques. The one on Shap Summit celebrates the travails of pre-motorway lorry drivers. The other, overlooking the M6 in the Lune gorge, records a Civic Trust award to the design of the M6 in this, its most difficult stretch. A less glamorous, but economically far more important use of Shap blast debris, is the rock armour protecting the gas terminal at Westfield Point, just south of Barrow.

The most dramatic recent use of Shap granite in a public space, however, is in Curwen Place, Workington. This extravaganza of stone includes a number of large granite seats whose sitting surfaces are polished mirror-smooth, but which are otherwise rough and unworked.

Away from the glamorous world of public display, the strength and durability of Shap granite, and its availability in large sized pieces, have made it a reliable stone for heavy duty civil engineering projects, particularly in docks, such as the King George V dry dock in Southampton, the QEII dock on the Manchester Ship Canal, Goole docks and Heysham harbour. It has also been used on the cills of reservoirs such as Selset and Balderhead in Yorkshire and, on a smaller scale, at Levers Water, Coniston. In Inverness it was used in the abutments of a new road bridge over the River Ness.

Underfoot, Shap pink is widely found as kerbstones, for example in Barrow,

Ambleside, Malton, Dumfries, Ripon and Portpatrick. In the latter place the kerbs also function as pavement-edge gutters, being specifically shaped for this purpose. From the grounds of Abbot's Hall, Kendal, to the streets of King's Lynn, stone setts denote yet another use of Shap pink as street furniture. Shap pink is also to be found underfoot in more prestigious settings, such as in the steps outside County Hall, Kendal.

Pink chippings, surprisingly, were once a product of some standing, as they were valued for use on carriage drives and country garden paths. A promotional leaflet of the time gives Lowther Castle; The Manor, Poulton-le-Fylde; Worsley Hall, near Manchester; Bridle Rectory, Chorley and Hipperstone Manor, Nottingham as satisfied customers.

Less recognisable as usages of Shap pink are the concrete products energetically developed as a major part of the business from as early as 1882. These use granite aggregates and granite sand, either in pre-cast concrete bollards, fence posts and bus shelters, or in hydraulically pressed flags and walling blocks. A moment's inspection reveals the fragments of pink feldspar in all these products. Concrete panels with exposed chippings up to about 3cm across were also made for use as external decorative cladding. A smoothed variety gave a terrazo finish for flooring. All these concrete products, whose heyday was the 60s and 70s, are unlovely to gaze upon, but widely distributed. Typical examples occur at Marske, near Saltburn, where walling blocks were used for a short terrace of shops and maisonettes; Lancaster, where blocks were used for new aqueduct abutments; and Annan's Greencroft Estate, which has pressed flags and kerbs.

It comes as a surprise, perhaps, to realise that despite its multifarious uses, Shap granite seems seldom to have been used as an 'ordinary' building stone. The only example seen by the writer is Tebay church, which is built of roughly squared blocks, though the dressings are all sandstone. Its rarity value is enhanced by the interior, which contains three polished Shap features. A small, conventional, rectangular war memorial plaque lies opposite the door, but to the left and right are an elaborate font and, perhaps uniquely, an equally elaborate pulpit.

And what of Shap village itself ? It is a limestone village, true to its native bedrock, but its proximity to the granite outcrop and 140 years of operation at the works are reflected in a wide range of granite features. These include: numerous gateposts of various designs; a striking polished font; a Celtic cross war memorial; a drinking fountain dedicated by a grieving father to the memory of his small daughter; the stone pillars at the entrance to Shap Memorial Park; a cylindrical roller for the bowling green; quoins and door and window surrounds on one short terrace of cottages; the top two steps of the mounting block beside the Greyhound pub; an 1879 datestone; a mysterious mutilated

datestone; and large fragments that may have come from Karl Lofts (the stone avenue), used as crude revetments by the roadside.

Despite its illustrious past, it is sad to report that, at the time of writing, Shap pink quarry is moribund. The Sheffield firm of Thomas Ward & Co. took over the business in the early 1960s, though they continued to trade under the name Shap Granite Company. This was the first of a succession of corporate owners and, although Thomas Ward continued to operate the business vigorously, its successors – RTZ, RMC and, presently, Cemex – being multinationals, had less commitment to the polished stone business. Foreign competition, the economic recession of the 1990s and the greater scope of the cement-based side of the business have proved a deadly brew. Let's hope this celebration of Shap pink turns out not to be also its epitaph.

G. Brambles



THE SEATHWAITE GRAPHITE MINE

Jeff Wilkinson

Over the years there have been many theories, hypotheses and scientific studies attempting to find the origins and mechanisms responsible for the rare graphite deposit within Borrowdale Volcanic Group Rocks at Seathwaite in Borrowdale, in the English Lake District. None have been able to give a definitive answer of where the source carbon originated, or how it was transported and then deposited. A recent collaboration between the British Geological Survey (B.G.S.) Edinburgh and the Department of Crystallography and Mineralogy, Complutense University, Madrid resulted in an extensive examination of the mine and laboratory analysis using the latest scientific techniques. The results have now been published in a series of technical papers (references at the end). This is a personal record of that visit to the graphite mine and the author's involvement as a mine explorer, with the logistics of accessing the abandoned workings. The paper also summarises the results of the research, written in layman's language, in the hope that this material can be brought to a wider audience.

The Project:

As far back as 2001 the idea had been muted to me that some Spanish scientists wanted to visit Seathwaite at some point. At the beginning of 2006 I got a call from Dave Millward of the B.G.S. in Edinburgh. He informed me that these eminent colleagues of his from the University of Madrid finally wanted to set a date to visit the Borrowdale mine. They also have a high grade graphite mine in southern Spain that lies within volcanic rocks; the only other known occurrence. Having written technical papers on the origins of Fluid Deposited Graphite from various locations around the world they were very enthusiastic about a "hands on" visit to the renowned Cumbrian mine.

I had known Dave Millward since 1993 and had worked with him during the productive examination of the Coniston Copper Mines; resulting in a link between active volcanism and copper mineralization being established. Knowing my background and long interest in the origins of the graphite deposit he asked if I would like to be involved in the project, advise on equipment, and look after the safety of the group.

My first job was to come up with a safe, reliable partner to help with these tasks. Although the graphite mine in relative terms is a pretty safe mine "we" would be responsible for the complete safety of these professional people. Any "incident" would have very serious consequences and repercussions indeed! The obvious choice for me was Dave Bridge. I have the greatest respect for him; he is safety conscious and just as important he has the same burning curiosity in the origins

of the graphite deposit as I have. A visit date was arranged for July 2006. Dave Millward had the unenviable task of obtaining the correct authorisations and paper work from all the relevant authorities and carrying out risk assessments which would include having to have a satellite phone to report in at various times. Some of the authorities who had to be contacted included: National Trust, The Lake District National Park, Natural England and the Secretary of State.

A couple of weeks before the said date, Dave and I visited the mine with a view to checking out the safety aspects and having a good look from a purely geological point of view. It's amazing how much more you notice in "geological mode" instead of the usual mining history mode! Right from the beginning of this project I felt it imperative that someone from the group should descend the Grand Pipe to the Old Men's Stage and inspect the lower workings. This would ensure that we had a good overall representation of the mine. It is highly unlikely that such eminent specialists have gained access to this area. This posed the tricky problem of how to get novices safely down and back up the 70 foot pipe. Dave produced a relic from "explorations past" in the form of an electron ladder; a rare sight and privilege indeed. I set up a belay passing a safety rope through a rock climbing stitch-plate on the harness, then up through an anchored pulley-wheel which gave a smooth controllable action. The plan was for them to use the ladder mainly as hand holds, while walking the feet down the angled wall rock of the pipe. All seemed to work reasonably well and we agreed that it was "possible" to get a few of them safely down to the lower workings and more importantly back up!



Figure 1. Traversing across the Grand Pipe to reach Fareys level.



Figure 2. Descending the Grand Pipe lit up in shaft of brilliant sunlight.



Figure 3. Looking 100 ft up the Grand Pipe from Old Men's Stage to the surface.



Figure 4. The classic 'hand-driven' coffin level in Old Men's Stage, circa 1625.

The Visit: (July 2006)

We all met up on the road beneath the mine at 10.00am and sorted out the equipment. There were two members from the B.G.S. and four from the University of Madrid. Also present on the first day was the National Trust's Archaeologist, Jamie Lund; the mine lies on land owned by them. I have to admit that I was a little concerned at the outset that an overzealous official might jeopardise a very important visit. Visions of someone with a clip board waving a stern finger in disapproval flashed across my mind. This concern turned out to be totally wrong. Jamie allowed the experts to take whatever samples they deemed necessary and he was a pleasure to work with. I know he really enjoyed the day and found it very informative. After a brief summary of the local geology by Dave Millward we weaved our way up the old miners track to the entrance of Gilberts Stage which intersects the Grand Pipe near its base. Unfortunately the visit took place during a major heat wave. The temperature was around 100°F (hotter than it was in Madrid), even the Spanish visitors used to such temperatures found it way too hot for walking up a steep fellside. We entered the cool draft of Gilberts Stage where it became immediately apparent that these people knew exactly what they were looking for. Half an hour was spent at the base of the Grand Pipe taking samples of rock, minerals and graphite. We then moved higher up the fell and entered the extensive Gill Stage level where a number of locations exhibiting interesting geology were pointed out. These showed the relationship between the graphite, mineralized veins and the altered volcanic rock. After much sampling and many photographs, we dropped down to Fareys Stage, traversed across the Grand Pipe and continued with the observations and sampling. Watching and listening to these people was extremely informative. Observing the overwhelming delight and enthusiasm of the Spanish visitors at finally being in this world famous Cumbrian mine was really quite infectious. Thankfully our initial fear that the mine may be worked out and devoid of useful, relevant geology was resigned to the dustbin.

We could not have been more wrong.

Day two was another very hot one. The plan on this day was for the two B.G.S. members and Jose of the Spanish contingent to descend the Grand Pipe, while the others collected samples from the dumps. We set up the electron ladder and ropes while the rest geared up outside and took in the sun. Everything was double checked at the edge of the Grand Pipe then Dave descended to receive the three visitors. Amusingly before each made the step across onto the wobbly electron ladder (all be it with a safety rope attached) there was a meaningful look in their eyes that said "I hope you know what you're doing!" On the way down Jose became quite animated, not about the descent, some features within the wall rock of the pipe seemed of great interest to him.

As always it was a great pleasure to re-visit the classic "hand-driven" coffin level in the Old Men's Stage, it never disappoints. We made our way below the Old Men's Stage where there was a very interesting stoped area which contained large amounts of in-situ graphite and exhibited interesting geology. We had identified this area on our earlier visit and we were pleased to let the experts see it. After a good look round we started the ascent of the Grand Pipe. This turned out to be a bit strenuous for our visitors, but they took their time and the task went more or less to plan and was completed without incident. The comprehensive study of this most fascinating mine by leading experts in their field was now complete. After a group photo we said our goodbyes.

Being a part of this project has been fantastic. Constantly hoping for a new, up-to-date mineralogical survey of the graphite mine was one thing, but being involved, that was something else.

Before the specialists returned home they collected samples of various Skiddaw Slate rocks for later analysis. This was deemed important because these older marine mudstones are the basement rocks that underlie the B.V.G. It was suggested that the biogenic material they contain may in some way be responsible for the original source of carbon that has later been deposited at Seathwaite as graphite. So that was the quick part of the operation completed. Now it was the long wait while all the technical lab work was completed and the papers penned. Long standing questions would finally be answered; or would the mysteries still remain?

Time would tell.

The Results:

Anyone who looks past the mining history aspects of this mine will inevitably end up asking probing questions about this rare graphite deposit. Some of the older papers written about the deposit did a good job at putting their theories and hypotheses across, but due to the knowledge and technology available to them at that time, they could not really scientifically prove their theories.

Some of the questions that often arise relating to the deposit are:

- **Where did the source carbon originate?**
- **How was the carbon mobilized?**
- **How did the graphite get deposited?**
- **Why only graphite at Seathwaite?**

Graphite at Seathwaite occurs as - large masses (often nodules) within mineralized pipe-like bodies, late graphite-chlorite veins and disseminations within the host rocks. It has the greatest variety of crystalline morphologies in a single deposit. The source carbon originated from the Skiddaw Slate rocks. These older marine mudstones are the basement rocks that underlie the Borrowdale Volcanic Group (B.V.G.) and have a thickness of at least 5000m. Preserved within these rocks is a small percentage of biogenic material. This took the form of algae, soft bodied graptolites (part of the marine plankton community) and other organic material.

Due to the proximity of intensely hot, andesitic magmas from the B.V.G. the Skiddaw Slate rocks were thermally altered. This released the carbon atoms, primarily as CO2 which became assimilated into a rich hydrothermal fluid.

The analytical method used to determine this result was - Stable Carbon Isotopic Analyses:

There are three possible sources of carbon in Fluid Deposited Graphite:

(1) Removal of volatiles from carbonaceous sediments

(2) Carbon derived from carbonate rocks.

(3) Carbon derived from the mantle.

Each carbon source has a distinct signature. The "light" isotopic signatures from various graphite morphologies tested are consistent with the carbon source being of a biogenic origin.

C-O-H rich hydrothermal fluids migrated up through fissures and fractures in the host volcanic rocks. Andesite and dioritic rocks next to the veins were intensely, hydrothermally altered to a propylitic assemblage containing chlorite, epidote, sericite and albite. The mineralizing fluids evolved from CO2-CH4-H2O to CH4-H2O mixtures. In all recorded fluid-derived graphite deposits worldwide, the temperature of the fluid has always been extremely high, however research has shown that the fluids responsible for graphite precipitation at Seathwaite were of moderate-temperatures in the region of 500°C. This is the first time such low temperatures have ever been recorded for a volumetrically large graphite occurrence.

Initial precipitation of carbon into graphite from the hydrothermal fluid was probably the result of its vigorous reaction with the host volcanic rocks and rapid cooling of the fluid. In particular, water was removed from the fluid due to hydration reactions of the primary minerals. This, in turn, caused relative carbon enrichment in the fluid that eventually became supersaturated with respect to graphite. As the main mineralizing phase along the pipe-like bodies continued the reaction was CO2 Æ C + O2. Data indicates that graphite first precipitated out as cryptocrystalline and spherulitic aggregates. As the fluid content/ temperature decreased the carbon became enriched and the graphite precipitated out as flaky crystals; the most common in the deposit. At this point, in addition

to the above reaction, graphite precipitation could also occur by CH4 + O2 Æ C + 2H2O. Such a reaction involving oxidation of methane was probably dominant during the formation of the late graphite-chlorite veins. Some of the crystal morphologies found at Seathwaite have not been recorded from any other deposit worldwide; another first for the mine. The scientific method used to study the crystallinity of the graphite was Raman Spectroscopy.

The evocative question of "why only graphite at Seathwaite and nowhere else?" is a very good one indeed. Skiddaw Group rocks underlie the whole of the B.V.G. yet we do not have any other fluid deposited graphite deposits whatsoever. There has to be something extremely rare and special about the Seathwaite mine. Although there is one other known occurrence of graphite within volcanic rocks in southern Spain, Seathwaite mine is unique in that it is the only deposit that has economic concentrations.
It has been known and reported for many years that within the mine there is a probable hypabyssal dioritic intrusion. This intrusion was in the vicinity of a deep-seated active fault system which allowed a pathway for the hot C-O-H fluids.

The suggested scenario is as follows:

Under normal circumstances of sub-aerial volcanism, carbon volatiles assimilated from the Skiddaw Group mudstones would be released to atmosphere during volcanic eruptions. At Seathwaite a section of the magma chamber started to crystallize out (dioritic intrusion) giving a totally different scenario.....effectively preventing the assimilated carbon volatiles from escaping. Crystallization of primary anhydrous minerals in this intrusion allowed the magma to become highly enriched in volatiles. This caused a large increase in vapour pressure ultimately leading to extensive hydraulic brecciation of the wall rock. Subsequent expansion of the volatiles within the magma allowed the upwards mobilization of andesitic/dioritic rock/melt, fragmented quartz and carbon-rich fluids leading to the formation of the breccia pipe bodies. Exposures viewed in the mine clearly show extensive hydraulic brecciation of the wall rock and fragmented pieces of quartz ripped from their original location and transported upwards.

Graphite mineralization at Seathwaite is described as a "catastrophic mineralization event." In the opinion of one of the Spanish authors the time scale may not only have been short in geological time, but also extremely short even at the human time scale! Although it can only be viewed as speculation the estimated speed of the magma ascent up through similar structures (pipe-like bodies) in diamondiferous kimberlites has been reported as much as 70 km/h; an astonishing speed.

Again this would tend to point to a very fast mineralization process.

It would be a reasonable assumption to regard the graphite deposit at Seathwaite as one of "nature's freaks" being that it is so unique. Having delved long and hard into the mysteries of this rare deposit I would like to suggest a more evocative and suitable alternative: "This mine is one of nature's greatest wonders.", "This mine is one of nature's greatest tricks."

Please note: The mine is a scheduled site under the Ancient Monuments and Archaeological Act 1979 and also a Geological Conservation Review site. Unauthorized damage or removal from the spoil heaps is illegal.

Acknowledgements:

This article could not have been produced without the kindness, encouragement and information provided by Javier Luque, senior lecturer at the University of Madrid.

Thanks also go to Dave Millward of the B.G.S. Edinburgh for involving me in the project from the beginning and his continued help and support.

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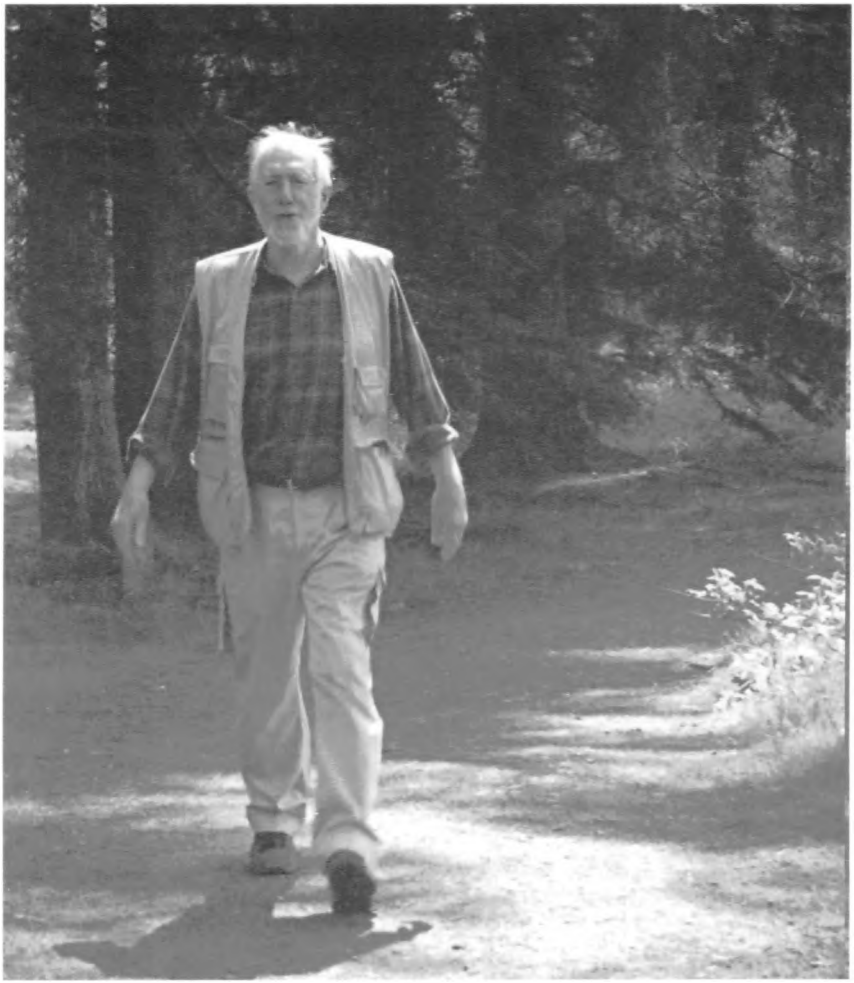
The original article with 16 colour photos can be accessed as PDF from a mining history website page. It includes photographs showing the relevant geology / mineralogy from within the mine.
http://www.aditnow.co.uk/mines/Borrowdale-Graphite-Mine /

Jeff Wilkinson
[redacted]

DR. RICHARD, PETER, KELVIN CLARK (1927-2009)
An Appreciation

Alan Smith

The death of Dick Clark on January 12th 2009 was a sad loss to his wife, family and friends, but it also marked the end of a full and influential life. The Society lost a valuable and inspirational member. This is the first opportunity we have had to look back on his life, his contribution to the Society, to Lakeland geology and geomorphology, and to evaluate the legacy of his writings and ideas.



Dick (as he was always known to both family and friends) was born in Huddersfield, the only child of Richard and Ethel Clark. His parents loved the countryside which they explored together as a family, and his father, a Post Office engineer and survivor of First World War gassing in the trenches, infected him with his own love of gardening. He attended schools in Newsome and later at High Storrs Grammar School in Sheffield. He went on to Sheffield University, graduating with a first-class honours degree in Geography just before his twentieth birthday.

Over the next few years he set about acquiring experience which would serve him well in a career in land management. His first employment was with the Forestry Commission planting up tracts of countryside on the slopes of the Pennines near Ladybower Reservoir. This was a tough, hands-on experience. To follow came periods of experience in farming, first in Wales, then in the uplands of Dumfrieshire, an area which he loved for the rest of his life. From Dumfries he moved to the small Scottish island of Shuna, near Oban. There were cattle to farm and part of his job was to swim them across to the mainland for sale.

He changed career in the 1950's becoming a Grammar School teacher in the Potteries, but not for long, as he was soon seconded to the British Antarctic Survey Team (then the Falkland Islands Dependencies). There followed an enormously exciting period, travelling south by ship, employed as a painter to pay for his passage, visiting the Falkland Islands and eventually reaching Deception Island which was to be his base for the next two years. Officially he was a meteorologist, part of a six man team which formed a very small British presence on that island. The Falkland Islands made a lasting impression on him and during his retirement he returned to them with Tom Shipp, Peter Wilson, Niel Simpson and Amyan MacFadyen to carry out more scientific research. The naming of an entirely new species of invertebrate was one of the outcomes of the expedition. He returned twice more and kept friendships with some Falkland Islanders alive for the rest of his life.

Ever searching for pastures new in 1959 he moved to the Ford Centre in Northumberland to a newly established residential field study centre, the first of any LEA. The aim was to offer all secondary age children, many who came from industrial and coal-mining areas, a week-long study course which took them into wild countryside, develop their knowledge of what the countryside was all about and foster their confidence in their own abilities. It was at Ford that Dick met his wife Liz. After marrying in 1963 they together took on wider responsibilities in Northumberland developing centres across the County. Dick then moved to the Northumberland College of Education in 1964 and in 1969 to the then newly established University of Ulster in

Coleraine. There he taught in the Education Centre, but also had very close links with those working in Environmental Science. It was there that he first met Peter Wilson, which led to their later collaboration on Lakeland geomorphological research. He continued to put himself and his family into challenging situations moving from the comfort of Portstewart to a rundown farm and woodland of 25 acres with half a mile of salmon river at Aghadaway. There it took 18 months to make the house habitable. Gardens were created, drains fixed and woodlands replanted.

By the time he took retirement in 1984 he had gained his D.Phil researching 'Landform Development in the Cheviot Hills and adjacent parts of North Northumberland'. He moved to Hartsop in the Ullswater valley in 1985 where he devoted his time to exploring and researching the Lake District landscape and creating, with his wife, their magnificent hillside garden (a nationally acclaimed example).

It was only from the mid 1980's that he turned his attention to the Lakeland landscape and became involved with the Society. He served on Council, led field excursions, delivered several lectures, helped with Editorial advice and contributed regularly to these Proceedings and to the Society Field Guides. In 1999 the Society formally recognised this contribution to Lakeland Geology and Geomorphology with the award of the Charles Edmonds Prize. Right through to his final days in January 2009 he remained a loyal supporter of the Society events. On a personal note I recall seeing him days before he died in his home at Hartsop still discussing Lakeland geomorphological problems and investigations that need pursuing. It is fitting that many of his books, maps and papers have been bequeathed to the Society Library. We are very grateful to Liz, his wife for passing them on to us. Early in his retirement he became an Honorary Research Associate of the University of Lancaster and a student on one of the University's diploma courses. The landscape history of Hartsop became a consuming interest. Sadly, his plan to publish a definitive history of his home village was never completed, but his research material hopefully one day may be made available to wider audience.

Since his death his wife Liz has compiled a list of his published papers and other writings. Dick himself knew this was approaching 100, a landmark figure he would have reached if a few of the things on his desk at his death had been finalised. Overall, 25 of his published papers were on the Lakeland landscape, 12 of these here in our own Proceedings. 10 of his Lakeland papers were in collaboration with Peter Wilson. His other writings range widely from work on the Falkland Islands, Northern Ireland, Northumberland and North Yorkshire, Archaeology in Matterdale, Weather Studies as well as numerous papers on Educational themes. A full list of his Lakeland papers is appended here.

Dick's first contact with geomorphology came through his undergraduate studies in Sheffield in the period immediately after the Second World War. Ideas in that period were dominated by the writings of the American Physiographer W. M. Davis and in Britain by the work of Wooldridge and Linton and the persistent search for regional denudational chronologies. Dick's approach to Lakeland reflected this upbringing. His generation had never had the advantage of modern analytical techniques to help with dating events and understanding geomorphological processes. His concern was with the 'macro' landscape, the search for an understanding of how Lakeland as a whole had evolved. His first paper to the Society in 1988 on 'Pattern and Order in the Lake District Landscape' reflected this. He came back to these themes in 1994 with 'The Skiddaw Massif Problem' and in 2004 with 'How Old is the Lake District Landscape ?'. In a lecture to the Society in September 1992 which he entitled 'The Challenge of the Lake District's Big Landforms' he presented his view of Lakeland in terms of distinctive morphological terrains. He saw the landscape in terms of tectonic units differentially uplifted and tilted. This was Dick at his best, challenging conventional ideas, questioning published interpretations and offering his own original thoughts.

He was clearly inspired by the work of Thomas Hay, a fellow resident of the Ullswater valley who had recorded his thoughts on Lakeland landforms in a series of published papers between 1926 and 1944. One of these 'Mountain Form in Lakeland' (Geogr. J 1944), in many ways encapsulated Dick's approach. He took on Hay's work and moved it forward, elaborating on Hay's observations on glaciated landforms, moraines, slope forms and the morphology of the Lake District mountains. Most of Dick's Lakeland work was done in retirement. He had to rely heavily on his own acute powers of observation as he walked the landscape asking the key questions as to how it came to be like it is. His later papers, as he increasingly worked with Peter Wilson, became more process orientated and heavily focussed on glacial landforms. Much of this reflected back to his Falkland Island and Antarctic experience where cold climate processes had dominated.

On a personal note I always found Dick quite a challenging person to work with. In the relatively few publications I was privileged to contribute with Dick collaboration was often a testing time. In discussion he was often several steps ahead in his thinking and needed to be pulled back to explain how he had reached a conclusion. It was always a demanding task to write with him. Our writing styles were so different. His insistence on absolute accuracy, lack of ambiguity and scrupulous attention to detail could be frustrating. His fondness and ability to produce long, complex, sentences (which were always grammatically correct) frequently led to long discourses. I enjoyed immensely our sessions together talking about the Lakeland landscape in

his cottage at Hartsop. He always had ideas in his mind, questions that couldn't be answered and original thoughts to mull over. In the field he could often be in his own world, quietly making notes, looking and thinking about the landscape. He was an avid and critical reader. This was borne out not only by the large number of books that surrounded him, but by a large collection of scientific journals he subscribed to. These he clearly read in great detail. Frequently he would present you with a journal article, heavily annotated, sections highlighted and marginal comments almost as extensive as the article itself.

My overriding memory is of a man who was always polite, calm and showing great courtesy for your personal welfare. A person with a mischievous sense of humour and great respect for his fellows. He has left us with much to think about in our Lakeland landscape.



Three Clark generations in the garden at Hartsop:
Dick, son and grandson.

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Alan Smith

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THE RAASAY IRON MINES

David W. Powell & Mervyn Dodd

In 1911 William Baird & Co. Ltd, ironmasters of Coatbridge and Gartsherrie Scotland purchased the island of Raasay situated between the east coast of Skye and the Applecross peninsula. The reason for this purchase was to exploit the recently proved ironstone field.
(William Baird &Co.Ltd. are the same company that owned the Kelton Fell and Knockmurton mines in west Cumbria. They also built the Rowrah and Kelton Fell (mineral) Railway that served these mines.)

A great deal of construction work would be required to develop this project and one of the first projects was to construct a suitable pier to handle all the incoming materials for the construction of the site and, when completed, the outgoing shipment of calcined ore from the island. (Fig. 1)



Figure 1. Raasay Ironstone pier with a steamer alongside. The covered conveyor and loading tower can be seen

To help in the construction work and later on to transport the ore from the mines a narrow gauge railway 2' - 0' gauge was built. The railway was constructed in a straight line from the pier to No. I mine with a branch off to No. 2 mine. (Fig. 2)

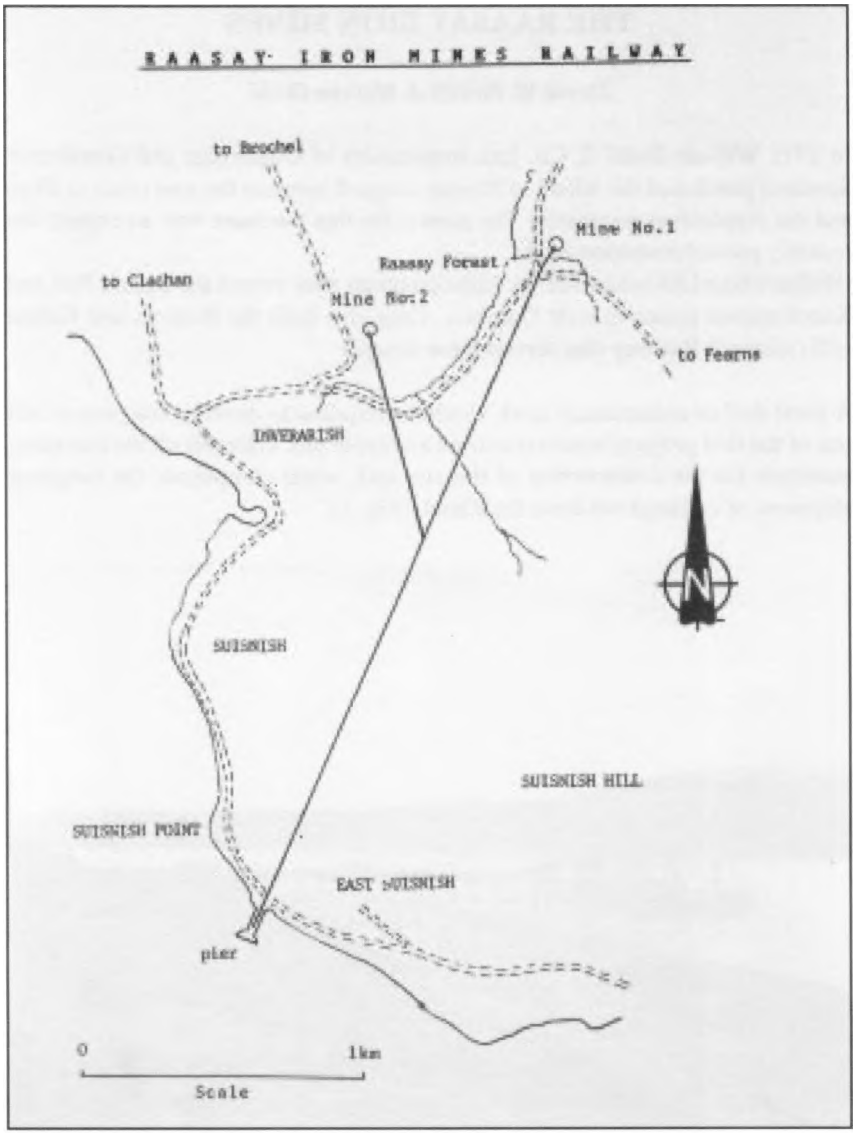


Figure 2. The Raasay Ironstone mine railway

This involved the building of two high viaducts. The railway was double tracked for most of its length and worked with electric haulage engines and appears to have been an endless haulage system using 7/8" wire rope. The Haulage engine at the top of the incline from the pier was for the pier incline only, which was single tracked. The haulage engine at No1 mine transported the ironstone from the mine to the crusher. At the branch off to No 2 mine there was another haulage used for this mine.

On the hill above the pier the processing plant was constructed. The installation consisted of a crusher, five calcining kilns and a large hopper for the storage of the calcined ironstone before loading on to ships at the pier. Also in this area were all the ancillary buildings containing the workshops and offices. The diesel driven electrical generating plant was also built here. (Fig. 3)



Figure 3. The Raasay Ironstone processing plant. The buildings seen are the five calcining kilns and domed hopper. At the top of the incline is the pier haulage house and to the right is the crusher and covered conveyor to the kilns. To the left are the generating house, office and workshops

The ironstone came from the mines directly to the top of the crusher mixed with the coal that had been hauled up from the pier after it had been unloaded from the ship. This mixture was then transported to the top of kilns by conveyor. After the calcining process was complete it was again transported by conveyor to the hopper with a 5,000ton capacity before being loaded on to the waiting ship by a conveyor. It has been said that when the kilns were working the sea between Raasay and Skye turned a rusty red and the area around the kilns was covered in fine ash.

William Baird & Co. opened two drift mines on Raasay on the borehole evidence. In the Inverarish area the southern part of the Upper Lias strata was about 6 meters in thickness. There was an average of about 2.5 meters of ironstone. The greatest thickness of ironstone was 5.2 meters and was subsequently mined.

At No. 1 mine they also worked an opencast site using a Bucyrus Steam Dragline and two Bucyrus steam shovels that had been shipped to Raasay from the USA. There was an extension of the railway and haulage up to the opencast site. (Fig 4)

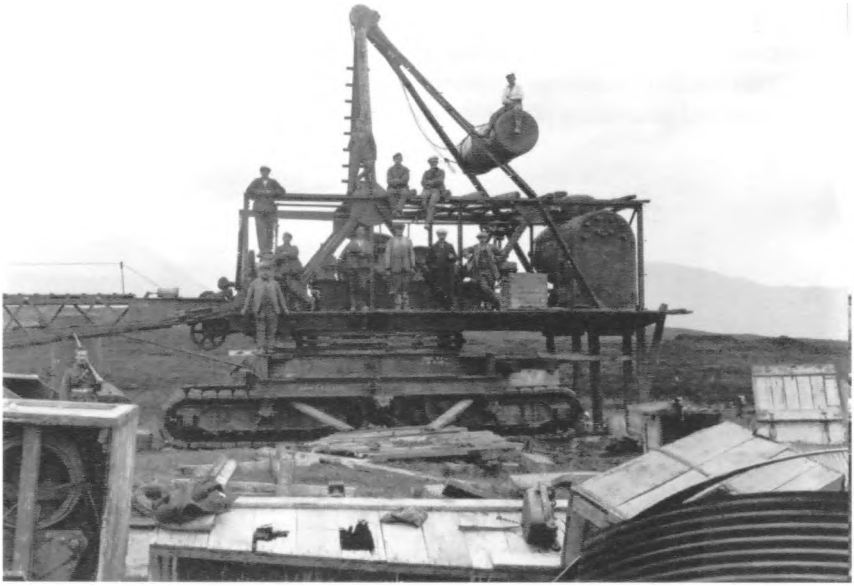


Figure 4. The Bucyrus Steam Dragline under construction above No.1 mine entrance. It was used to remove the burden from the opencast site.

The entrance to No 1 mine (Fig.5) was 2.6 kilometres from the pier and was driven into the Lower Jurassic (Upper Lias) Ironstone. It was driven for 300 meters in a north-easterly direction at a slope of 1 in 100. For safety reasons they left 0.3 meter in the roof of the workings due to the shale above the ironstone. The method of working the mine was by board and pillar and there were estimated underground workings of 8 kilometres. The main haulage road travels in to the mine for 300 meters and then the fan drift comes in from the left. The main road then continues on for another 470 meters where it comes to the surface. There may have been plans for the future here to continue with the opencast operation to take the opencast material through the mine. To ventilate the mine workings and to remove the fumes after blasting, there must have been some brick air crossings built in to the ventilation system. (An air crossing is the way to stop the air from short circuiting by building an overpass.) The fan house at No1 mine is visible on the hill above the mine entrance and the fan drift is still open but the mine entrance is now gated.

There was a three shift system in operation to work the mine - drilling and blasting on the afternoon and night shifts and filling and loading out on the morning shift. The ironstone was loaded on hutches to be transported to the processing plant at the pier. (Hutch - an old Scottish term for a small wheeled box-like truck used to transport the ore or coal from the face.)



Figure 5. No. 1 mine entrance. Note the Hutch at the mine entrance and the Fan house on the hillside above the mine entrance. The over bridge, with the incomplete railway in the foreground, is going to the opencast site.

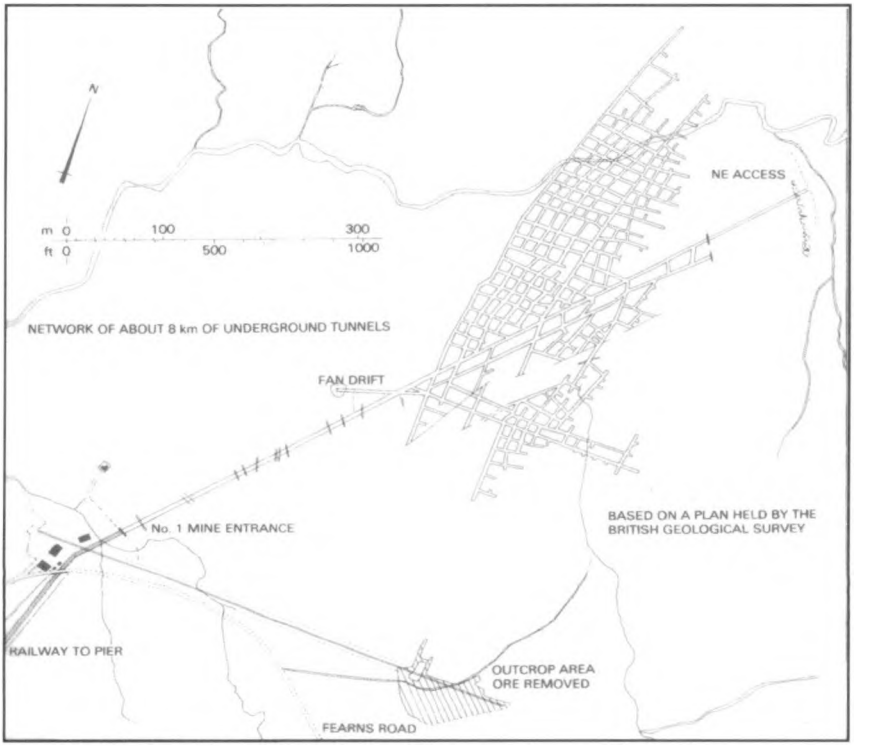


Figure 6. The underground workings of No. 1 Mine

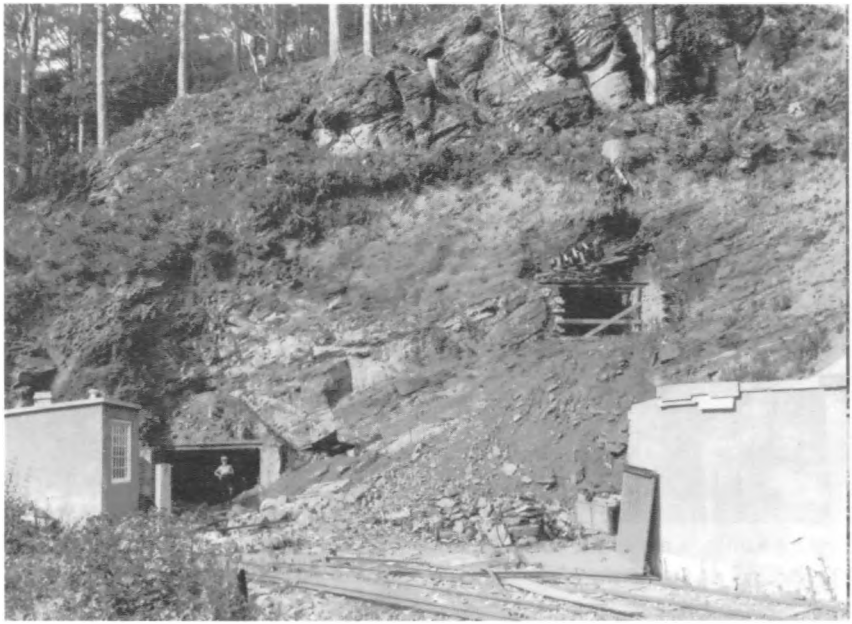


Figure 7. No.2 mine entrance - obviously not in use. This mine never went into production due to the severe geological faulting. The site was used as a sawmill supplying pit props, sleepers and power poles.

The other drift mine, No.2 appears to have experienced extreme geological problems and produced very little, if any, material. The area was used as a saw mill for the production of pit props, sleepers and power poles for the mine. (Fig 7)

The mine was ready to start production in 1914 just as the First World War started. This left a man power shortage as men on the island were called up. This put Bairds in a dilemma as the site was now idle. The possibility of using German prisoners of war to work the mines was considered. In 1916 it was agreed that the Government would take over the mines and Bairds would manage the mines on behalf of the Ministry of Munitions. The houses that Bairds had built for his workers were turned into a prison camp for German prisoners of war.

After the war the price of ore had dropped and by 1920 the mines were put into care and maintenance basis. The plant was dismantled for scrap during the Second World War and this may have been the most profitable time of the mines life.

THE SOCIETY TRIP TO RAASAY

August-September 2008

12 members of the Society enjoyed this week long field study course organised and led by Chris Darmon of 'Down to Earth'. Apart from two days on Skye, the localities visited were on Raasay itself, a 15km by 5km island east from Skye across the Sound of Raasay. Figure 1 is a simplified geological map of the island locating most of the places visited.

The Archaean Lewisian Gneiss with its characteristic rather subdued "knock and lochan" landscapes and glacially stripped rocks outcrops and now lacks permanent settlements north of Arnish. How far this is an old relict landscape and how far it has been glacially modified during the Pleistocene is not obvious. The Gneiss was of two main types. Pale, often pink, "acidic", granitic like rocks with many quartz veins are much more extensive than the dark, "basic rock type rich in biotite mica and hornblende. The pink acidic rock was probably ancient continental crust compressed and folded, the dark basic rock was probably ancient oceanic crust suggesting spreading mid ocean ridge provenance. Cross cutting dykes trending northwest to southeast were much less common than on the mainland. Plastic deformation had created fold like features with marked colour contrasts, very obvious along the path to Fladday from Torran and by the end of Calum's Road at Loch Arnish. The high ground above and south east of Fladday has glacial striae and several morainic ridges so it could have been an ice collecting area.

The Neoproteroic Torridonian Sandstone occupies the island of Fladday and the centre of the island as far south as the north east to south west trending Screapadal Fault. It is generally a well bedded, strongly jointed coarse arkose sandstone with markedly reddened quartz and feldspar crystals. Near Brochel Castle on the east coast are extraordinary cylindrical patches of conglomerate extending vertically over 100m but little more extensive horizontally. . These are unbedded and unsorted with Torridonian clasts, remarkably up to 2 to 3m across and have abrupt contacts with "normal" Torridonian sandstone below. North west to south east trending dykes are common with at least one near the roadside heavily eroded showing onion skin weathering of the basic rock. Deep gorge like valleys more or less parallel to the west coast were probably eroded by sub glacial or ice marginal streams.

The south of Raasay has more varied rock types. The sedimentary rocks are mainly Lower to Middle Jurassic in age with an ironstone outcrop. There is an extensive Palaeogene granophyric sill, its pale, impermeable surface forming a sterile damp plateau. This is well exposed along the dismantled railway line from Suisnish Pier to the First World War Ironstone mine. The

highest point on the island, Duncaan, at 444m, is a basaltic lava flow of Palaeogene age, probably associated with the opening of the Atlantic Ocean. The Screapadal Fault line scarp with its loch filled valley separates Duncaan from the granophyre to the west

Two excursions in the south of the island were particularly interesting. One was around the south east corner to Hallaig, a cleared crofter settlement approached along a track affected by land slides which still threaten. The second was to a most unexpected feature, the Jurassic ironstone mine worked during World War 1 with the remains of its infrastructure. (See the preceding article on the Raasay Iron Mine).

The very dark Broadford Limestone of Lower Jurassic age had pronounced solution features reminiscent of Fauld's Brow, Caldbeck. Its small outcrop above the old calcining kilns near the mine railway was highly fossiliferous with many gryphaea and some bialves

For the first excursion to the south of the island the party drove to North Fearns through the Allt Fearns valley deeply incised into thick till deposits, unusual for Raasay. The walk from North Fearns towards Hallaig follows a track well engineered by Hallaig crofters before their eviction in 1832 to allow sheep ranching. Landslides had occurred onto this path as resistant, massive, thick beds of permeable Bearreraig Sandstone, (Estuarine deposits of Middle Jurassic age), overlie softer, impermeable shales, both dipping seawards. The debris from one landslide had almost reached the seashore. Blocks of the sandstone which had slipped showed the characteristic back tilting of the beds. Large towers of the sandstone had become detached from the main outcrop and were ready to slide. The Hallaig crofters farmed a gently sloping bench on Lower Jurassic shales and sandstone further northeast Most of the party descended the steep slope to the promontory of Rubha Na' Leac where Triassic sediments outcropped. The basal beds were conglomerates with clasts of angular blocks of Lewisian Gneiss, Torridonian Sandstone and a limestone not exposed on Raasay. The matrix contained small gypsum veins, probably part of a calcrete, a tropical weathering product. Dykes of dolerite, showing honeycomb weathering, had intruded this conglomerate. Above this upward fining conglomerate was a Triassic, cross bedded, red, fluvial desert sandstone, not unlike St Bees Sandstone. The southwest to northeast trending Hallaig Fault line is northwest of a hill, Beinn Na' Leac. The fault line is followed by a narrow, shallow trough usually 1-2m or more deep and its accompanying bench for well over 1 km. In places this trough is marshy and elsewhere is filled with poorly organized material. The fault downthrows to the southeast and thus the succession is repeated. Landslides have disrupted the trough and bench in places as a resistant, permeable sandstone of Lower Jurassic age overlies an incompetent impermeable shale and ironstone.

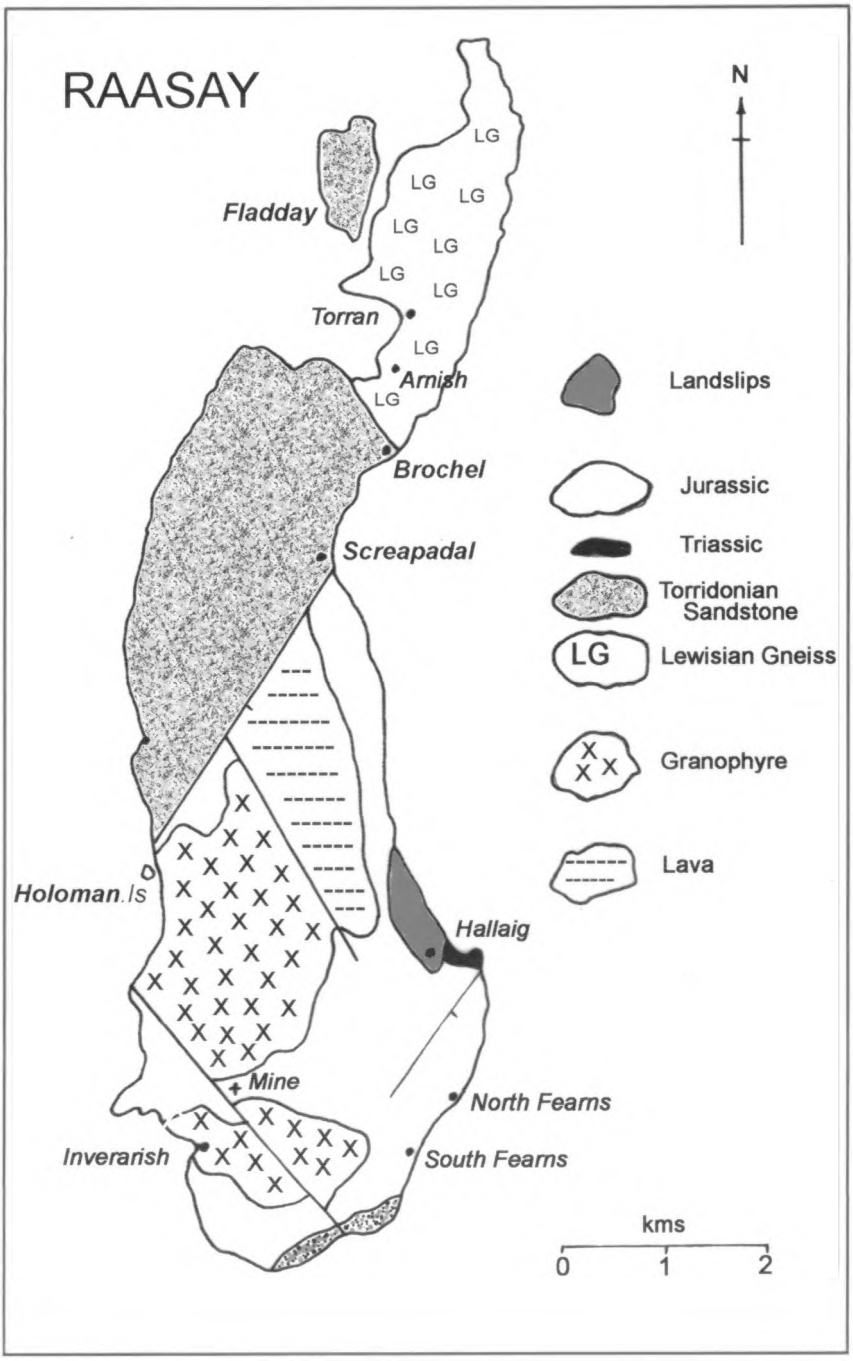


Figure 1. Raasay:simplified geology

Raised beaches occur along the south and west shores of Raasay with steep slopes, probably old sea cliffs, immediately inland. The photo, Figure 2, shows the raised beach and degraded cliff with sea caves cut into Triassic conglomerate near the Eyre Point Lighthouse. The steep slopes there are on the granophyric sill cut in places by a basalt/dolerite sill. At Oskaig and near Holoman, both on the west coast, the main cliffs are also in the granophyre with the lower gentler slopes on the raised beach at Oskaig have gabbro/dolerite dyke outcrops. At sea level below the old sea cliffs a wide variety of rocks are exposed including Torridonian Sandstone by the Ferry Road.



Figure 2. Eyre point at the south-east end of Raasay. A 20ft raised beach bounded by sea cliff of Triassic Conlomerate.

The day visit to South Skye began with an atrociously wet walk to a small exposure of the Moine Thrust in a river bank near the road to Armadale. The Lewisian Gneiss has been thrust over the younger Torridonian Sandstone at an angle of about 10-20 degrees. Samples of mylonite, the product of dynamic metamorphism, were plentiful beside the stream. We then followed the Broadford-Elgol road stopping to view an abandoned Skye Marble quarry and its accompanying ruined settlement on a hillside to the south where an impure Cambro-Ordovician limestone (known previously as the Durness

Limestone) was close to a granite. There was a limestone pavement with well developed grikes and a swallow hole below the granite. The limestone had been metamorphosed to marble and the edge of the pale granite had been altered to a much darker colour. Members of the party found samples of serpentine, wollastonite, chert and skarns in the small abandoned quarry. We continued to Elgol with its fabulously situated Primary School alongside the sea cliff which has Jurassic oil shales at its base overlain by sandstones deposited in estuarine conditions, now honeycombed by waves The view of the Black Cuillins above Loch Scavaig was magnificent.

The other sites we visited on the second day on Skye were mainly in the Trotternish Peninsula in the northeast of Skye. Our first stop was by the Falls of Liath, where the stream coming off a dolerite sill was cutting a deep gorge into underlying Jurassic sediments. At sea level there were remains of a small jetty. This had been a loading point for diatomite from a long abandoned mine on the marshy ground between the road and the dramatic basalt ridge with its impressive corries to the west. Our next stop was a little further north at an extensive shallow quarry no longer in use. This was in a layered gabbro sill. Its top surface was an amygdaloidal basalt, with rocks below about 1m thick showing separate layers of pyroxene and denser olivine overlying a leucogabbro with calcium plagioclase. The edges of the sill in contact with country rocks were dolerite rather than gabbro due to their more rapid cooling. This exposure showed the effects of the differences in temperature of crystallization and the densities of the minerals in the magma. Next was the Kelt Rock. Here a small stream plunges vertically over a dark coloured dolerite sill which transgresses the underlying softer, yellow Jurassic sandstones at varying levels.

We continued to Duntulm Castle, almost at the northern tip of the Trotternish Peninsula. This had a dyke of an ultrabasic type. There were at least 20 differentiated layers about 5-10 cm or more in thickness alternating between pyroxenes above and olivines below. The country rocks alongside were thinly bedded Jurassic shales dipping west or northwest. This was where one of the party managed to hammer himself! We then drove around the north of the peninsula to approach from the west the Quiraing, a landslip which has detached a lava tower. Part of the lavas had split off with the backtilting of detached blocks increasing as you move further away from the Quiraing. Incompetent Jurassic shales failed followed by the dolerite sill faulting. The cross-section, Figure 3, illustrates these features. Water getting behind the lava speeded up movement along rock debris beneath. About 200m depth of rock was affected by the landslides. The lavas were a succession of flows separated by periods of tropical weathering which produced the interbedded red soil horizons.

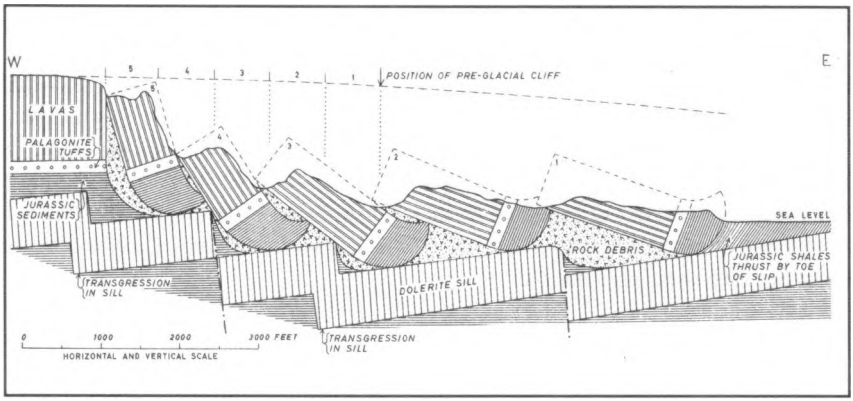


Figure 3. The Quirang Landslip.

The final site visited was near the Storrs hydro-electric plant above Bearreraig Bay. The dolerite sill had almost vertical cliffs with gentler slopes on the underlying very thick Bearreraig Sandstone Formation of Middle Jurassic age reflecting differences in rock hardness. On the path part way down to the beach almost unconsolidated, friable, poorly cemented siltstones of 22% porosity were exposed, which would have made good oil reservoir rocks. The beach itself had a wide range of fosssils, belemnites, gastropods, ammonites and a trace fossil of straight burrows. The shallow marine conditions of deposition were shown by the fossil ripple marks and cross bedding. Doggers (nodules) of limestone were being eroded by the sea and were also rotting from the inside. The slippery beach was responsible for another minor casualty!

EXCURSION REPORTS 2008

THE NEWLANDS VALLEY

Leader: Tony Rigby

Saturday 26th April, 2008.

On an extremely wet and windy day a small group of members braved the elements and ascended the Newlands valley as far as Far Tongue Gill to view the former mining locations.

The leader explained the importance of the valley as a major mining location since Elizabethan times. Relatively small, but high grade deposits of copper, lead-zinc and other minerals were exploited along two principal sets of fault veins. East-west trending copper rich veins, tending to dip southwards and believed to be Devonian in age dominate the valley. They contained copper sulphides as well as arsenic, bismuth and minor concentrations of lead-zinc. These E-W structures are cut and displaced in places by lead-zinc bearing veins with a strong north-south orientation. These are Carboniferous in age and contain important quantities of galena and sphalerite.

The famous Goldscope Mine was visited first. The surface tips are trivial as compared with the extent of the mine workings that extend great distances back into the hillside. Members spent a short time searching the mine tips for specimens. Recent shallow landslips triggered by the recent storms of 2005 were pointed out on the slopes of Barns Gill on the east side of the valley (NY 232184).

The Castle Nook Mining area (NY 237170) was examined and the leader pointed out the extent of the mine workings. Adits and tips are still visible. Galena was common on the tips here, with useful examples of sphalerite and chalcopyrite.

The latter part of the day was spent traversing the flooded old workings along Near and Far Tongue Gills. The steeply, southerly dipping, excavations along the E-W strike of the rocks provide prominent features across the valley. The methods of working and mining techniques were explained.

PARKEND QUARRY, CALDBECK

Leader; Susan Beale

Wednesday May 14th, 2008.

Access to this now disused quarry (NY 339409) in the Great Limestone and the overlying Hensingham Group had been acquired thanks to the previous owners, Hanson Aggregates. Much of the lower parts of the quarry workings have been infilled and stabilised prior to possible further development of the land for other uses. The main quarry face however, is still visible, but detailed examination of the rocks and structures was only possible along the western edges of the workings as the main faces are unstable and dangerous.

The base of the quarry exposes the well-bedded Great Limestone which was exploited mainly for road stone and aggregate. Above, the Hensingham Group shows excellent cyclothem sequences of sandstones, seat earths, thin coals and dark grey shales. Huge coarse sandstone slabs were extracted for sea defences and other uses. Limited amounts of coal were also taken out. The weak grey shales were largely useless overburden. Some superb zoophycos specimens exist on the faces of the sandstone blocks. A classic graben structure (Figure 1) dominates the main quarry face. A series of NW-SE trending faults cut through the Hensingham Group in this terrain, the western edge of the quarry being defined by the Hazelgill Fault.



Figure 1. The main face of the Parkend.Quarry. The Great Limestone forms the lower rock faces. Faults shown (F) in the Hensingham Group beds above.

(The Society has acquired an excellent electronic file of 66 images of this quarry from Hanson Aggregates. They show the quarry workings at various dates and illustrate some of the structures in good detail. It is available from the Society Library).

At the end of the evening a short visit was made to the nearby limestones exposed below Low Parkhead Farm (NY 337403). Here some clear cliffs of clean, well-bedded Four Fathom limestones are seen gently dipping to the N. They are broken by two sets of strong vertical joints, more or less at right angles to each other, resulting in a noticeably regularly jagged face to the cliffs (Figure 2). Many of the bedding planes have distinctly wavy surfaces. Haematite and calcite occurs along the joint planes. A few shale partings exist between the limestone beds.



Figure 2. Low Park Head Farm – limestone exposures.

SHAPFELL LIMESTONE QUARRY AND WORKS

Leader: Andrew Dunn (Corus)

Saturday June 7th, 2009.

The morning was devoted to a visit to the huge site quarry in the Knipe Scar limestone (NY 586138) and was followed in the afternoon by a detailed tour of

the works and to the lime kilns. We were greatly indebted to Andrew Dunn from Corus who explained everything in superb detail for us, provided us with hospitality on site and detailed pamphlets on the works and quarry activities. It was a perfect summer day when a large number of members were able to see at one of the districts main industrial sites and an interesting geological location.

The location of the plant has been determined by three main factors; the very pure quality of the limestone, a site alongside the main West Coast railway (most of the product goes out by rail) and nearness to the M6 motorway as certain products are moved by road.

Quarrying on the site goes back many years but the present extensive operations date from 1973-4. the Knipe Scar Limestone dips at 10° to the east and is extremely pure and consistent with a very low phosphorus and sulphur content. A continuous process of surface restoration work operates. Waste, mainly shale and poor limestone overburden and the smaller debris from the grading and crushing plants is backfilled into the western side of the excavations. Two areas of restored land, now grassed were visited. The main quarry face is being worked back eastwards but strict limits to protect adjacent farmland and the hamlet of Oddendale are in place.



Figure 1. The main working face of the Quarry. Very evenly bedded, Knipe Scar Limestones. The dip is into the quarry face at about 10°

The succession in the main quarry face (Figure 1), and the methods of working were explained. Beneath a thin soil, 15m of poor limestone, light coloured sandstones and shale beds is stripped off as overburden. Beneath the top part of the Knipe Scar Limestone (around 18m thick) is extracted. A 5m bed of dark shale beneath forms the current base of the workings, although limestones exist below. Time was spent examining the fossil content of the limestones with some large productids and colonial corals dominating. Much of the limestone is blotchy with conspicuous black and dark grey patches of seemingly organic material.

The main purpose of the works is the manufacture of lime to supply the steel industry. Four Maerz Kilns are on site producing calcined soft burnt lime in a continuous 24 hour process. The capacity of the works is 8,400 tonnes a week, representing around 60% of Corus UK's requirements. Most of the material is moved by rail via the extensive sidings on site adjacent to the main West Coast main line. On site the shot stone from the main quarry is moved by dump trucks to the Crushing Plant where Jaw Crushers and secondary Roller Crushers reduce the material to between 40 and 100mm. The material is then washed and fed by continuous processes into the gas-fired kilns at approximately 9.5 minute intervals.



Figure 2. The four huge Maerz Kilns.

KELTONFELL TOP, ENNERDALE

Leader: Mervyn Dodd

Wednesday July 2nd 2008.

A group of over 20 members, on a beautiful summers evening were led expertly through this interesting former iron mining area just east of Kirkland village. With magnificent views over into lower Ennerdale, the group were also able to appreciate some of the glacial and geomorphological features of the area.

The ores are largely in a thrust block of Loweswater Flags (Skiddaw Group) overlying younger Kirkstile Slates (Figures 1 and 2). To the south is the Buttermere Formation separated by the Causey Pike Fault. To the west of Keltonfell Top the Kirkstile Slates outcrop beyond a normal fault. Kirkland village lies on Carboniferous Limestone beyond yet another fault.
This area, along with nearby Knockmurton to the east is the only large haematite resource within the Lake District Palaeozoic core. It produced over 1 million tons of ore between 1874 and 1913. Closure was due to exhaustion of reserves and occasioned by drainage problems. The ore was 50-55% iron, but much less spectacular than ores in the limestones.

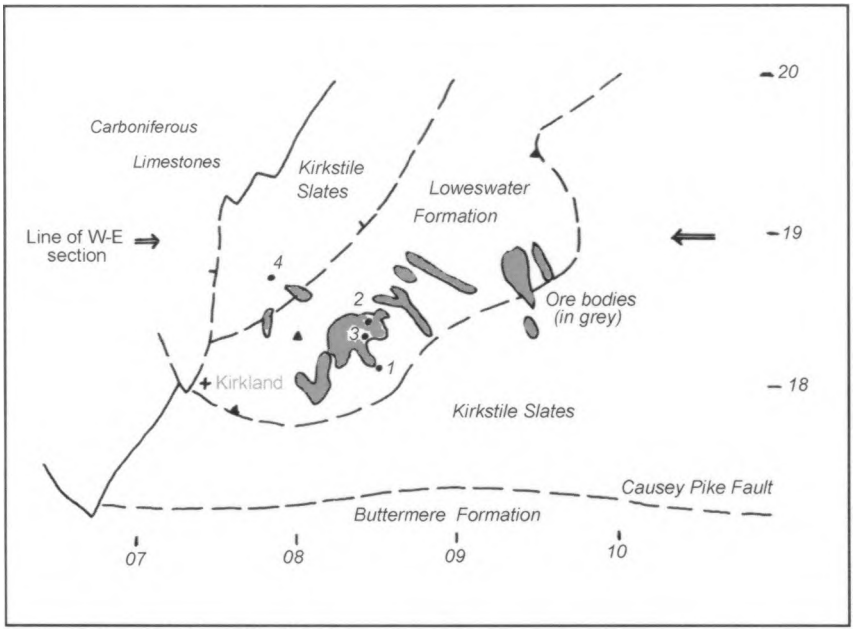


Figure 1. Kelton Fell Mines
(Based on British Geological Survey 1:50,000 sheet 28.

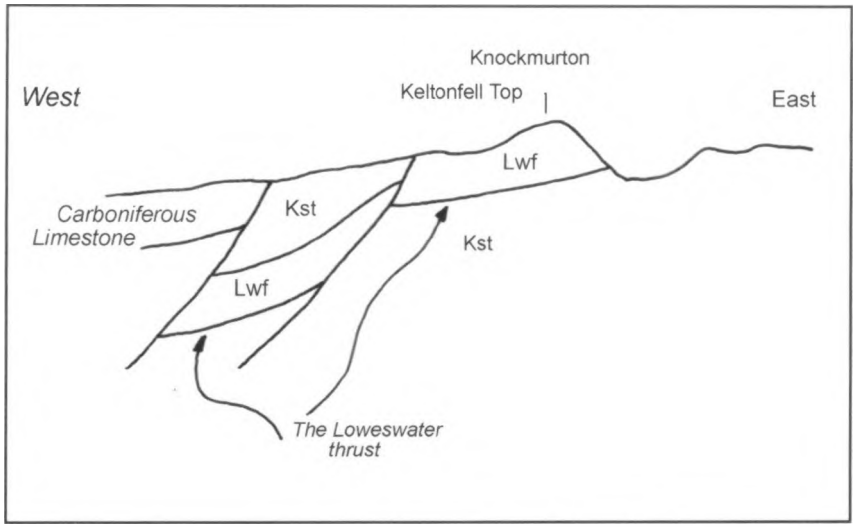


Figure 2. West-east section through Keltonfell Top along line of section in Figure 1.

A brief stop was made at the start of the excursion where the Kirkland-Ennerdale road crosses the Baird Line (the old Rowrah-Keltonfell railway). (NY 086182). Here a rather complex outcrop of the Loweswater Formation was discussed. The leader pointed out a range of features – the almost vertical dip direction, some way-up indications, the direction of strike, the alternation of thinly bedded shales and thicker beds of greywacke and some possible slump folds, small faults and discontinuities.

The group then descended southwards into the very large glacial meltwater channel which dissects this sloping ground in the direction of Ghyll Farm. Its sinuous course, complex gradient and depth (over 10m) suggest it may have a humped profile and hence may have been cut sub-glacially. The size of the feature surprised many of the group and intense discussion ensued. Distant views over the lower end of Ennerdale and across to Anglers Crag and Crag Fell prompted discussion of the glacial landscape (Figure 3).

The remainder of the evening was devoted to the mining area on the flanks of Keltonfell Top to the north of the road. Around Shaft No. 1 (Figure 1), the old tips provided numerous samples of the ore with manganese dioxide coatings, much quartz, small kidneys and less common specularite. Here the ore veins run north-south. Crossing one vein, now forming a more or less continuous hollow, suggesting almost complete digging out of the ore, two further veins were next crossed with quite different features. Here large collapses exist where larger ore masses of ore were found. In one of the

collapses a modest exposure of Bouma sequence rocks was exposed dipping steeply and striking southwest.



Figure 3. Ghyll Farm Channel.

Moving northwards up the fell the veins change in direction to run NW-SE. A series of collapses mark the former workings which were the most productive part of the field. The line of the veins can be picked out across the hillside by collapse features. Beyond the ridge top the steep slope parallels a NE trending normal fault where Loweswater Flags meet Kirkstile Slates. One collapse exposes the vein outcrop and the workings below are open but dangerous. Fault drag shows up very clearly in greywacke by the north wall of the vein. Slightly lower down, on Kirkstile Slates, is a collapsed adit with very pale, thinly bedded/laminated rocks dipping steeply. This together with the fenced off No 4 shaft were almost the last workings dating from early in the 20th Century.

On the walk back to the Lamplugh road a storage hut remains and the sites of Shafts 2 and 3 are visible, served by railway sidings, with huge barren tips beyond.

GLENRIDDING LANDFORMS AND LANDSCAPES

Leader (Alan Smith, deputising for Dr. Richard Clark)

September 21st 2008

This excursion basically followed Walk No. 4 in 'Exploring Lakeland Rocks and Landscapes'. This excursion was devised by Dr. Richard Clark who at the time was unable to lead on the day, but who supplied background notes for members to discuss.

A small group of members completed the 7.5km walk on a fine September day. Details of the excursion are well documented in the Society field guide.

An excursion to the Armathwaite Dyke, led by Professor Joe Cann took place on Saturday July 12th, 2008 but was not reported.

The planned excursion to the Maryport Foreshore had to be cancelled due to a clash with another event in Maryport that day.

EXCURSION REPORTS 2009

GHYLL SCAR QUARRY, MILLOM

Leaders: Thomas Clifford and David Kirk (Aggregate Industries).

Sunday April 26th, 2009.

A small group of members were led around the quarry by the leaders and the methods of quarry working were explained. Then a brief look around the crushing plant was followed by a visit to the area where 'The Millom Rock Park' was being created on an elevated site overlooking the main quarry.

The quarry is in the Millom Park Formation of the Borrowdale Volcanic Group and primarily produces high quality aggregates for roads. Currently it also has a major contract with the nuclear industry at Drigg, to which it is directly connected by rail.

The geological structure of the quarry is complex and was not revealed in any detail by the excursion. There is a regional dip in the beds of the quarry of around 30° to the SE. The rock is a sub-aerial grey/green tuff. Two intrusive masses (probably dykes) of lighter igneous material also occur, but are not regarded as peperites.

Thomas Clifford of Aggregate Industries has kindly supplied the following account of the quarrying activity:

Ghyll Scar Quarry, near Millom in south-western Cumbria is a high specification aggregate quarry operated by Aggregate Industries. The quarry, originally a borrow pit, was sited in the now worked out canyon formed by the Ghyll Scaur Fault. It probably first extracted the country rock, know locally as the tuff, when the local area became occupied by managed farming. The quarry became significantly active around the 1970's when the properties of the tuff as a road stone became apparent during technological advances in asphalt manufacturing. Presently it is the only viable location outside the boundary of the Lake District National Park to mine this deposit and so the quarry has a nationally important role in providing high specification road surfacing aggregate.

The quarry extends over approximately 30 hectares and ranges from c90m AOD to currently 20m AOD, with plans to take it down to 10m AOD, and so will make the excavation at its deepest c80m. Current annual production tonnage is around 0.3 to 0.4 million tonnes with the current estimated tonnage extracted from the quarry being in the order of 8 million tonnes. Aggregate Industries has planning permission to extract a further c4 million tonnes to 2020. To put the volumes into context it has been estimated that 8 million tonnes of Millom aggregate would be sufficient to surface a motorway from Millom to Naples, that's *one caldera volcano to another!*

Quarry and Product Design

PSV or 'polished stone value' is the British Standard technical test used to determine how grippy an aggregate is. This is how much friction exists between the aggregate/road and a car tyre. In basic production a very high quality road stone requires two physical properties; firstly roughness and secondly resistant to breaking down, so it's high PSV, strength and resistance to abrasion. What makes Millom so unique is that due to its geology it has very high values for the respective tests and so is the preferred choice for road stone. The stone does not polish; that is it does not become smooth due to eroding a flat surfaces. This is due to the granular nature of the ash, Fragments in the rock erode unevenly and so resists polishing in the longer term.

Due to the complex geology there are multiple geotechnical and operational difficulties working the site. First, the presence of discrete intrusions and clay/weathered contaminated faults which are poor in quality, requires the quarry to be developed in a manner that does not allow for such poor zones to be concentrated within the final product. As such, a decision between operational management and the geologist as to whether the poor quality mineral requires to be tipped, screened (separated off at the production plant), blended or left in place (sterilized) has to be weighed to ensure that the final product complies to the high specification standard and its effect on the quarry design (loss of reserve/development). The majority of the poorer quality mineral is screened off and sold as low quality general fill into the local market. In general the development of the quarry is engineered to minimize the potential for contamination and allow the quarry manager maximum flexibility to operate the poor quality mineral. This has been achieved by instead of working more traditional and simpler methods of working where the top level of the quarry is advanced back, followed by the next, down to a bottom face; the design is to work all the faces at the same time backwards. This maximizes the available face room, which gives the quarry manager the maximumlatitude to blend the variable rock mass, though it does put considerable pressure on designing the formation and removal of ramps for each face.

The geotechnical constraints on the development require that each face orientation has its own design. This is because there are several major joint sets in the rock as well as a cleavage. As such the eastern faces have been designed so that the final face is pre-split (using closely spaced single rows of high shock explosives) along a parallel joint plane dipping at 50 degrees into the quarry. The result is a very clean stable final face with minimal potential for rock fall; and so a narrower final rock catchment bench can be left. The southern face has a very complex interaction of three steeper discontinuities which can form toppling and wedge failures; as such this face is smooth blasted (closely spaced production blast design) at 65 degrees to reduce the potential for failure. However due to the closely spaced interaction of the joints the face does normally have a blocky nature which increases the risk of rock fall and so a wider final bench with a higher rock catchment bund has been designed. The western and northern faces are the most stable and so a relatively higher face angle can be used, though due to the sub-vertical cleavage being sub-parallel on the western faces, the risk of toppling is present and so 70 degrees is used as for the final face angle.

Further, due to the geotechnical constraints and risk to the face operator working under such faces with known failure mechanisms, the decision was made to reduce the face heights from 15m to 12m and change the face machine from a more common backhoe excavator to a face shovel (backhoe pulls

rock towards itself, shovel scopes it up). This meant that the face shovel could work from the quarry floor, excavate the blast pile whilst maintaining the face at a safe location and height.

The process of extraction starts with the geology and geotechnical properties of the rock mass. Once a design and development scheme has been produced the quarry manager can then work individual face sections to the design. First the face is profiled (surveyed) so a blast design can be drawn up. The face is then drilled to the design and charged (normally with emulsion explosives). The charge is then fired with each hole having an engineered delay time to maximize the efficiency of fracturing (fragmentation) and minimizes the maximum instantaneous charge (MIC) which results in the highest PPV (peak particle velocity) which is the induced ground vibration.

Once the face has been blasted (normally 10-18,000 tonnes at a time) the face shovel can then dig out the blast pile and load c35 tonnes onto a dump truck which will normally make 8-10 trips to the primary crusher in an hour. Once the rock arrives at the primary jaw crusher its two plates push together, crushing the rock into football sized lumps. The poor quality rock is screened off here and sold as quarry scalpings (general low quality fill). Conveyors then carry the good rock onto the secondary and tertiary cone crushers, which oscillate a cone inside a solid case to put enough stress on the rock to fracture it down to the required product size. Once through the crushers the aggregate is screened which is the separation of its sizes over several large vibrating metal sieve like meshes.

The material is sized or blended into its final product, which ranges from 5mm (dust), to 6, 10, 14 and 20mm asphalt aggregates, up to the larger general fills and various blends of the sizes to suit engineering specifications. The product can be hauled via dump trucks to the stocking area and tipped onto the stockpiles from where they can be loaded via the sites loading shovel onto large aggregate articulated lorries which are then weighed and ticketed at the weighbridge.

Location:

Ghyll Scar (Millom Quarry) is located just to the west of The Hill which is 2.5km north of Millom in southwest Cumbria. (SD 170830). The Rock Park is accessed via the School Ellis road on the northern side of the quarry and further information can be found on the website **www.millomrockpark.org.uk**

CLEATOR MOOR MINES

Leader; Mervyn Dodd

Wednesday May 20th 2009.

Cleator Moor Square:

The excursion started in the main square in Cleator Moor. The now much faded mural is a representation of the area at the height of the iron mining boom, when it also had an active iron works. Alongside is a Conrad Atkinson sculpture that has distinctly political overtones.

From the Square, walking behind the backs of the terraced houses it was pointed out that these had been spared demolition in the 1940's. Streets nearby however, along with two schools, had been cleared as they were unsafe as a result of 'robbery' workings beneath in the Crowgarth/Leconfield mine. These workings had 20m high cave like chambers within 30m of the surface. This mine was first worked in the 1750's and was finally abandoned late in the 1940's.

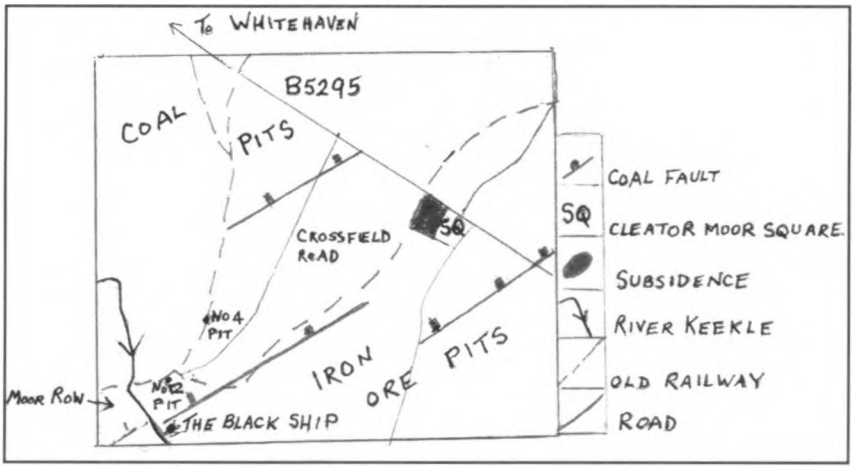


Figure 1. Sketch Map of the Cleator Moor Mines

Continuing along the main road (B 5295) to Crossfield Road (Sketch Map Figure 1) the route passed over the Cycleway, originally the Whitehaven, Cleator and Egremont railway. The site of the ironworks is on the north (right hand side) of this road.

Crossfield Road:

Past the Church, the present Cleator Moor Coop Superstore is on the site of the Sir John/Lord Leconfield pit, the pumping shaft for the Leconfield mine.

It was close to a fault, north of which the Coal Measures have been dropped down. South of the fault the Coal Measures have been eroded off and the Carboniferous Limestones which host the iron ore are nearer the surface. There are many abandoned iron ore pits here, almost all now landscaped. Further down Crossfield Road to the River Keekle Montreal Mine No.4 and No. 12 pits are reached. No. 12 was the pumping shaft for the mine. The River Keekle is in a 500m long concrete box from the railway bridge south. This was made to prevent its water flooding into the mine below.

Montreal Mine (Figure 2).

This was the biggest and most productive of the local mines. It raised hematite and some coal from its 20 pits, mainly near Moor Row. Between 1872 and 1882 it produced 2,250,000 tons of iron ore. Its No. 4 pit, 300m deep, mined both coal and hematite from the same shaft, which cuts through the main fault (Figure 2). The hematite occurred in a very large, irregular mass and was 50-60% iron by weight. On No. 4 site is a modern artefact, a giant rock crusher, with two large blocks ready for crushing. After abandonment in the 1940's this was a car scrap yard, so the mine remains are much disturbed. There were two shafts with a connecting mineral line.

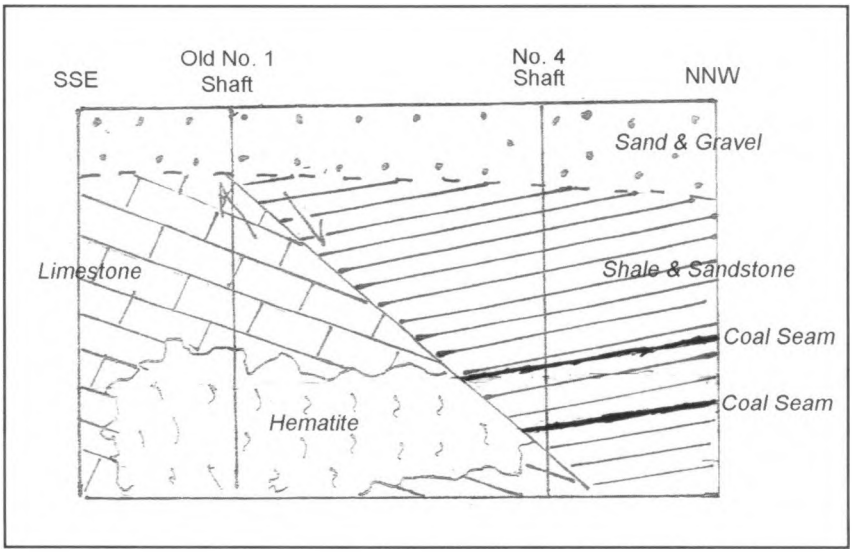


Figure 2. Section of Montreal Mine

The Cycleway.

Originally this was the track of the Whitehaven, Cleator and Egremont railway which had a virtual monopoly of the ore traffic and paid 10% dividends to its shareholders for many years.

A sandstone pillar along the route carved with a verse from a Norman Nicholson poem celebrates Montreal No. 4 pit. In the field to the west are the remains of Crossfield No. 5 pit, which collapsed in the 1990's. Farther on, but almost impossible to locate, is the site of a collapse in 1871 of the railway into a 30m deep hole close to Crossfield No. 2 pit. The Crossfield Mine was the least successful of the three major Cleator mines. The route passes several enclosed hollows, almost certainly the result of collapses into underground iron workings.

The final part of the excursion walked over the waste ground which was part of the Leconfield Mine, with tips of the James Pit to the north (left) and subsidised, ill drained ground where the York pit was.

THE GEOLOGY OF THE TILBERTHWAITE AREA

Leader: Geoff Brambles

Joint meeting with the Westmorland Geological Society.

Sunday 14th June 2009.

The excursion was introduced by the leader as a 'souped-up version of Walk 11 of the Society Field Guide 'Exploring Lakeland Rocks and Landscapes'. The aim of the day was to elaborate on that account and to place the geology in the broad context of the subject's historical development and the role therein of some of the pioneering geologists.

Before setting out members were given a coloured version of Figure 1. This summarises the geography and geology of the area and identifies the localities to be visited.

The solid geology is Ordovician, a patch of time-turf fought over by two of the early giants of geology and given its independence by a third. Murchison having claimed it for his Cambrian period and Sedgwick for his Silurian, it fell to Lapworth to set it free. Lapworth had used palaeontology and sedimentary rocks to establish the Ordovician, but in the Lake District the rocks of that period are overwhelmingly igneous in origin, being designated the Borrowdale Volcanic Group. In the Tilberthwaite area these belong to the later, explosive phase of the volcanism and largely comprise a series of ignimbrites and subaqueously deposited fine-grained volcaniclastic sediments, all dipping steeply to the south-east and cut by numerous strike faults. A number of mineral veins occur in the Paddy End Member (an ignimbrite), and it is these, and the finest grained components of the Seathwaite Fell Formation that have been exploited in the past, leaving a firm human imprint on the landscape. The natural landscape is a characteristic array of glacial landforms, modified by post glacial processes to some degree or other.

Any mention of glaciation should cause two names to spring to mind: Agassiz who was responsible for converting a sceptical audience to view that some present day

ice-free areas had previously been glaciated; and Milankovic, pioneer investigator of possible causes of glaciation.
The party walked the short distance to Locality 1, near the road bridge over Tilberthwaite Gill. Looking south-west this spectacular fault-guided, water eroded gorge, one could well imagine the force of the water when in spate. And yet, upon its emergence from the confining walls of the gorge, the river does a strange thing. Instead of continuing across the wide, level, open ground to the north-east – a direction that gives unimpeded access to Little Langdale – the river turns abruptly and flows through a short gorge. The party walked to the mouth of this gorge (Locality 2) and speculated on the reason for this interesting change of direction. The leader's suggestion that this feature represents a diversion caused by the overflow of a pro-glacial lake –let's call it Lake Tilberthwaite – ponded up by a tongue of ice was not universally embraced.

Nearby, the slate 'artfold' of Andy Goldsworthy beckoned, unheeded on this occasion. It is though a good example of the modern fashion for outdoor artworks.

The party then made their way to a roadside knoll overlooking the controversial gorge (Locality 3), a vantage point from which the eccentricity of the river's course is well displayed. From this point, a group of ruinous buildings and spoil heaps pointed the way to Locality 4. The buildings are the remains of Penny Rigg Crushing Mill where, for about 10 years (c.1866-75) copper ores from Tilberthwaite Mine were prepared for onward transport. These remains are important for two reasons. First, the fact that they survive at all, being the last of their kind in the Lake District. Despite this, they have no protection. Second, they betoken the presence of a remarkable subterranean excavation, the Horse Crag Level, (see figure 2) a 3240' long tunnel leading from here to the bottom workings of Tilberthwaite Mine. Its course is marked out as a line of dots on Figure 1. The ores crushed at Penny Rigg were trammed from that mine along this level. In addition it provided drainage and ventilation. It took ten years to make (1849-59), cost a fortune (£3000), and never paid for itself. Its instigator, John Barratt, owner of the Coniston Copper Mines in the mid Nineteenth Century, was one Cumbria's most successful and richest Victorian entrepreneurs.

Having examined the mill buildings, the waterwheel pit, the leat that fed the wheel, the entrance to Horse Crag Level and the brownish waste tips, the party moved on a short distance to a point overlooking the north-eastern end of Penny Rigg Quarry (Figure 3).

This long, narrow slate quarry is aligned with the cleavage, a product of low grade regional metamorphism resulting from the closure of the Iapetus Ocean, itself a reflection of plate tectonic motions driven by mantle convection. Upon descent to the quarry floor (Locality 5) we paused at the narrow entrance, whose slightly overhanging, fractured rock face, yellow stained and encrusted with tiny colourless crystals, echoed on the opposite face of the quarry by a prominent crack, suggested the presence of a fault. The small crystals encrusting the fault plane are gypsum,

crystallised from groundwater. The slates in Penny Rigg Quarry are pale greenish-grey and are part of the extensive Seathwaite Fell Formation. In nearby Hodge Close the bedding of the parent volcaniclastic sediments is much in evidence in the form of colour variation. Here, though, the unrelenting uniformity of colour and absence of sedimentary structures make the bedding well-nigh impossible to identify.

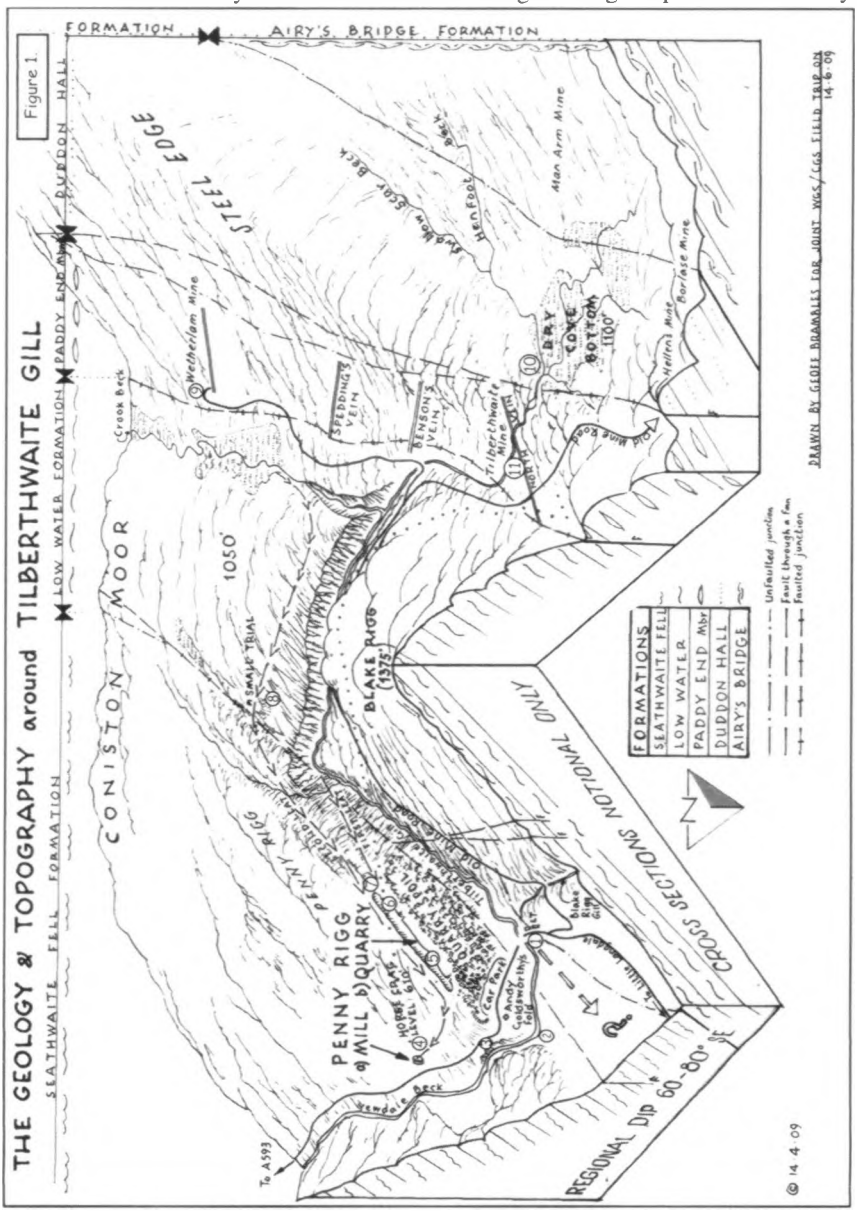


Figure 1. The geology and Topography around Tilberthwaite Gill



Figure 2. Entrance to Horse Crag Level.



Figure 3. Penny Rigg Quarry.

Ascent to the upper part of the quarry (Locality 6) was made by way of the main track. Here a possible sighting of the bedding was made. On the north wall of the quarry entrance, an irregular intrusive vein of milky quartz is associated with a plunging fold set that seems to reveal bedding.

After lunch, returning to the main track, the party contemplated the two divergent tracks. These are marked on Figure 1 as 'First Leat' and 'Second Leat' and, remarkable though it seems, they both started life as carefully engineered paths of water conduits designed to supply the waterwheel at Penny Rigg Mill. The first leat was later truncated by the southward expansion of Penny Rigg Quarry, so a second and much longer replacement had to be built. As the path was ascended members were invited to watch for the abrupt change from the cleaved Seathwaite fell Formation tuffs to the Low Water Formation ignimbrite. This faulted junction is picked out by a conspicuous wet gully. At this point the gradient levels off and a rest was taken at a small mine trial (Location 8). The spoil from this small exploration adit is devoid of metalliferous mineral, and the quartz stringers that tempted the miners proved in this instance to be a false trail. Weatherlam Mine was the next site visited (Locality 9). It lies on one of the mineral veins that occur in the Paddy End Member. These veins well illustrate the unpredictable variability of mineralisation, both within and between veins. The mine was a short lived venture (c 1901-1910) because the chalcopyrite bunch that gave it birth soon pinched out. Nevertheless it left two interesting features for explorers to examine, in addition to the spoil heaps that yield sulphide minerals. The timber posts are the supports for a corrugated iron mill building and, lying close to the ground, there is an iron horse gin, bearing its manufacturers name – Fell & Co. Wolverhampton.

Northwards towards Tilberthwaite Mine, the small workings on the other veins were examined. None had proved worth pursuing. Before examining Tilberthwaite Mine the party crossed the threshold of the cirque lying below Wetherlam (Locality 10). The bedrock here is the Paddy End member, a rhyolitic ignimbrite, pale grey-weathering and cut by a dense network of small interlocking joints. The cirque is the most northerly of a line of cirques lying along the eastern side of the Coniston Fells, one-sided arrangement referred to in America as 'biscuit board topography'. It reflects the orientation of the ridge which, lying athwart the prevailing westerlies, would have caused greater accumulation of snow on the sheltered leeward side, thus leading to the growth of cirque glaciers. The leader commented that examples of landforms illustrated in textbooks were usually the 'best' ones and so misleading the unwary, This one, for example, has no cirque lake, and its enfolding arêtes are not sharp crested. It may once have held a shallow lake that was later infilled with sediment and then developed a layer of peat, hence the present flat, waterlogged moss called, inaptly, Dry Cove Bottom. Standing on the cove threshold and looking back towards the south, it was clear the Crook Beck lay in a shallow basin that would have been occupied by a stagnant ice body towards the end of the last glacial. The leader referred to this, somewhat whimsically, as 'The Wetherlam Puddle' and suggested that its meltwaters would have contributed to the formation of the Tilberthwaite Gill gorge.

The final locality (11) was close at hand. Tilberthwaite Mine was worked sporadically between c. 1600 and 1930. It produced copper ore, principally chalcopyrite. This

small area was carefully studied by the late Eric Holland and his principal findings are shown in Figure 4. A line of elongated holes marked the earliest workings on the North Vein. The tips are rich in small malchite-green mineral fragments, though these seem to be oxidised surface coatings rather than pieces of malachite proper. It was to the lowermost workings on the North Vein that Horse Crag Level was directed, 540' beneath our feet.

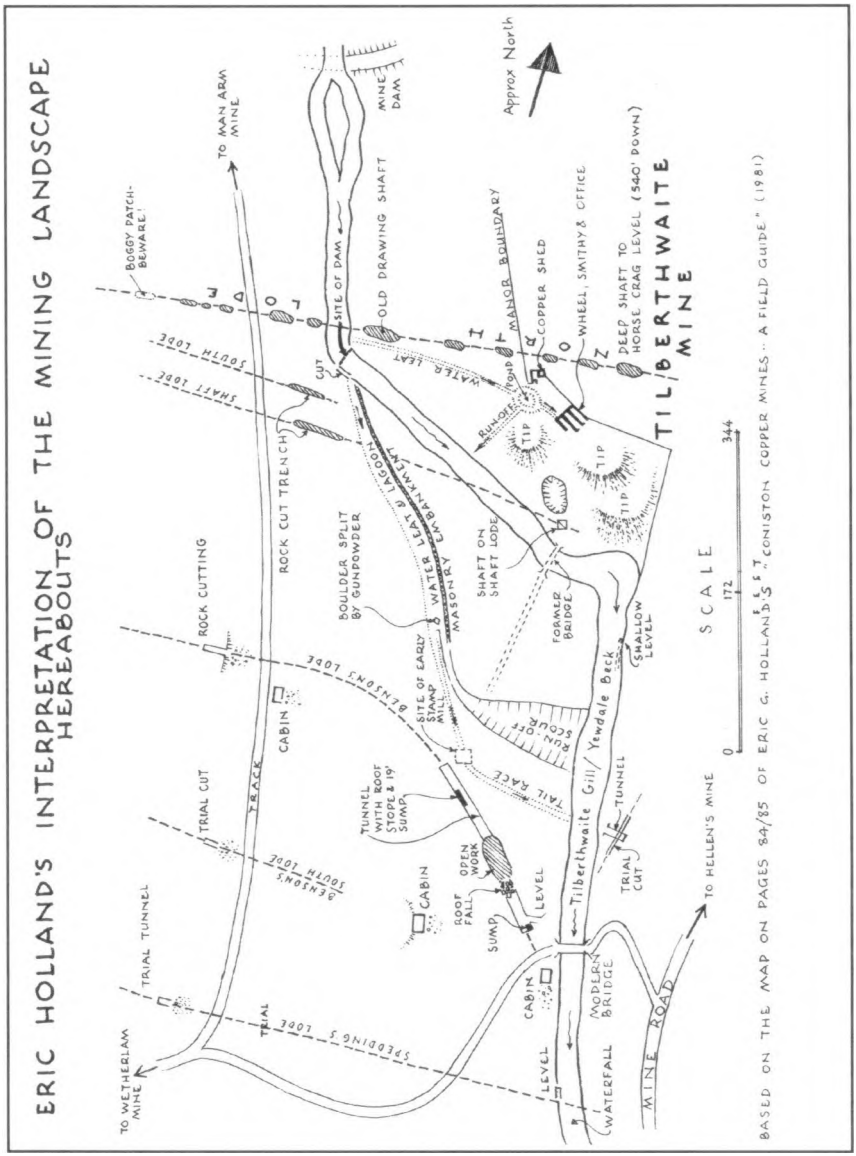


Figure 4. Eric Holland's interpretation of Tilberthwaite Mine.

CROSS FELL AND THE PENNINE ESCARPMENT

Leader; John Rodgers (CGS)

Saturday July 4th. 2009.

This was an excursion following much of the route described in the leaders excursion published in *'Exploring Lakeland Rocks and Landscapes'*. A large group of members met at Town Head Farm, at the foot of the Pennine Escarpment on an excellent day, warm and with good visibility.

After a brief introduction to the area (documented in the guide book) the group made for the disused quarry on the western face of Gregory (NY 711248). The rock exploited was a rhyolite ash flow tuff, a rock high in silica with a very flinty texture. Some possible crude stratification is seen, but the overriding impression is one of a very broken up rock with sharp angular pieces. It was used for hardcore for road and track maintenance. There is also a major landslip feature on the lower slopes of Gregory. Running south-north, to the west of Gregory is a magnificent glacial meltwater channel, one of several that form a complex network on the western flanks of the Pennine escarpment.

The main Pennine Way Path was reached at NY 711250 where there is a small barn. Bedrock is not exposed but the underlying material consists of a variety of pale coloured volcanic rocks. The walls nearby show the same material. These are ash flow tuffs and are probably from a small quarry in a field slightly further up the track (NY 713252).

Further along the track at NY 715252 dark-grey fine grained rocks appear quite abruptly in small outcrops in the track. They are mainly siltstones of the Murton Formation – deep sea sediments of the Skiddaw Group. In one outcrop approx 100m from the gate there are highly inclined partings either bedding of cleavage planes – an indication of strong folding.

Ascending the track to NY 723250 the change from the older rocks of the inlier to the overlying and unconformable Carboniferous beds occurs roughly halfway between the two gateways. Dark grey fragments in the track gradually give way to small outcrops of greenish sandstone with occasional thin band of conglomerate. These are the Basement Beds, but the unconformity itself is not exposed. From this point there are excellent views of the escarpment and the isolated resistant hills of Dufton Pike and Knock Pike.

Through the gateway and the walled enclosure is an area with abundant outcrops of the pale grey Melmerby Limestone (NY 723250).This is the first of a series of limestones which form prominent and usually horizontal bands (Scars) in the Pennine landscape. A short time was spent here searching for corals and

brachiopods. From this viewpoint the effects of the Murton Pike Fault were very clear in the landscape across the valley.

The next locality (NY 727253) exhibited an extensive stretch of blockfield of pale quartz sandstones with abundant 'rusty' spots. Cross-bedding in some of the blocks and the linear form of the outcrop suggests this was a channel sand deposit.

Over the next stretch of ground the magnificent panorama to High Cup Nick came into view. The leader pointed out a number of significant features in the landscape. A definite spring line occurs on the opposite hillside below Middle Tongue, which marks the unconformable junction between the Carboniferous and older rocks below. There is clear evidence of landslipping on the opposite valley side. The prominent line of the vertical crags of the Whin Sill dominate the landscape.

A short stop was made at Strands Beck (NY 736259) where above a deeply weathered limestone there is a sequence of crumbly black shales containing numerous hard nodules of ironstone up to several cm long. The outcrop of the Whin Sill was examined. At the top of the sill it is a fine-grained, black basalt, with small metallic spots of pyrite. The grain size increases in the main part of the intrusion becoming a dark green dolerite.

The walk was then extended to look at Maize Beck (NY 749270). Here in the gorge section the polished and dimpled eroded surfaces of the black limestone are very striking. Sometime was spent exploring the lower parts of the gorge where recent bankfalls had caused some small diversions of the stream bed.

At the end of a splendid day in the field, the group retraced the path back to Town Head Farm where Ron Barker (a CGS member) and his wife showed the group around their Winery (High Cup Nick Wines) and various bottles were sampled by the group.

The planned excursion to Crosthwaite Church, Keswick on Wednesday May 6th was cancelled due to a clash with an event in the Church. Excursions were also held to Faulds Brow and Potts Gill, Caldbeck on May 30th and to the Maryport Foreshore on June 27th but were not reported.

A successful joint weekend excursion programme was mounted for a small group Geologist's Association members on August 8/9th. A full day visit was made to the Glenderaterra valley (Excursion 2 in *'Lakeland Rocks and Landscapes'* and a half day to the Shores of Derwentwater (Excursion 1 in the same guide).Thanks are due to the members who turned out and led our visitors on those days.

OBITUARY

FRANK MOSELEY (1922-2009)

Frank Moseley, who died on September 23rd 2009, was closely associated with the Society for many years through the 1970's and 1980's. His enduring contribution was to Lake District geology through his scientific papers, books, excursion guides, lectures and detailed knowledge of rocks in the field. All these activities touched the Society.

Frank was born in Bradford and after war service read geology at Sheffield University, gaining first class honours in 1949. Work in several universities eventually led to his 30 year association with Birmingham, from where he retired as Reader in Geology in 1989. Throughout his time in Birmingham he worked on Lake District geology, particularly on the Borrowdale Volcanic rocks and the regional structure. Regular field classes based in Keswick and Coniston inspired a generation of students and led to an outpouring of writings on the district, much of it designed for the beginner, student and the amateur.

He was a member of the Society for many years and we were fortunate in being able to persuade him to lecture to us and lead on field excursions on several occasions. Long, detailed, hands-on visits to Buttermere, the Newlands valley, High Rigg and the Langdales were times when members learnt a great deal of the intricacies of the Borrowdale Volcanics and the complexities of the structures from a consummate field geologist.

Many were introduced to Lakeland geology through his writings and many members must have at least one of his volumes on their shelves. In 1978 he edited the Yorkshire Geological Society Occasional Publication No. 3 *'The Geology of the Lake District'*, which was the first significant overview of the geology of the district since Marr's Geology of the Lake District published in 1916. It brought together the current thinking on the district by all the acclaimed geologists of the day and was skilfully drawn together by Frank's own contributions. In 1981 his *'Methods in Field Geology'* gave an insight into how he approached work in the field, much of it illustrated with Lakeland material. This was an invaluable tool for students and highlighted the use of aerial photography in field mapping. There followed two field guides; *'The Volcanic Rocks of the Lake District'* in 1983 and *'Geology and Scenery in the Lake District* in 1986 – both lavishly illustrated with his own field sketches. The latter volume was particularly useful to the student and non-specialist. This was followed in 1991 by his editorship of 'The Geology of the Lake District', the detailed Geologists' Association field excursion guide.

He also contributed three papers to these Proceedings. In 1973 he wrote on *'The Structural Relations between the Skiddaw Group and the Borrowdale Volcanic Group'* (Vol. 3, pt 3). Then in 1975 on *'The Explosion Breccias on High Rigg'* (Vol. 3, pt. 4) and in 1984 on *'The Use of Aerial Photography in Field Mapping'* (Vol. 4, pt 4).

He was guest speaker at the Society Annual Dinner in April 1979 and on that occasion the Society was pleased to mark his considerable contribution to Lakeland Geology by the award of the Charles Edmonds Prize. For many of us in the Society Frank's contribution has been a lasting legacy to our understanding and enjoyment of our own patch of British geology.

Alan Smith

LECTURE MEETINGS
2008-9

September 11th. 2008
Newton Rigg Campus, University of Cumbria, Penrith.

The Glaciation of the Vale of York – how 3D datasets are used to understand the geology.

Dr. Anthony Cooper (British Geological Survey).

October 22nd 2008.
The Friends' Meeting House, Cockermouth.

Some British Building Stones – a brief trip through the Geological Column.

Geoff Brambles (Westmorland Geological Society).

November 19th 2008
The Friends' Meeting House, Keswick

Faulting in Magma

Dr Hugh Tuffen (University of Lancaster).

December 10th. 208
Friends' Meeting House, Keswick.

Members Evening.

January 14th. 2009
The Sandgate Room, The Methodist Church, Wordsworth Street, Penrith.

Watching the Earth split apart, the oceans from Cyprus to Oman.

Professor Joe Cann (University of Leeds)

February 18th. 2009
Tullie House Museum and Art Gallery, Carlisle.

Conserving and celebrating Geology, Landscape and Wildlife in the North Pennines AONB and the UNESCO European Geopark.

Chris Woodley-Stewart, AONB Officer and Geopark Manager.

March 11th 2009
The Friends' Meeting House, Cockermouth

Annual General Meeting and Presentation by Members on the Society trip to Raasay.

LECTURE MEETINGS
2009-10

16th September, 2009
Caldbeck Room, Newton Rigg Campus, University of Cumbria, Penrith.

Life of the Rocks

Prof. Stuart Munro (British Geological Survey and Dynamic Earth, Edinburgh).

21st October, 2009
Friends Meeting House, Cockermouth.

The long-lived, ongoing eruption of the Soufrière Hills Volcano, Montserrat - what have we learned.

Dr Sue Loughlin, (British Geological Survey, Edinburgh)

18th November, 2009.
Friends Meeting House, Cockermouth.

Managing adverse effects of climate change: glacial hazards in high mountain environments.

Prof. John Reynolds (RGSL)

9th December, 2009.
Friends Meeting House, Keswick.

Members Evening

20th January 2010
Tullie House Museum and Art Gallery, Carlisle. (Joint meeting with Carlisle Natural History Society)

Quaternary landscape changes in the Falkland Islands.

Dr. Peter Wilson (University of Ulster)

24th February 2010
The Sandgate Room, Methodist Church, Penrith.

Solving the Bassenthwaite mystery: magnetic fingerprinting of fine sediment sources.

Prof. Barbara Meyer (University of Lancaster).

Replaced at short notice by *Mr. Toby White, Leeds University (Energy and Resources Research Institute, School of Process, Environmental and Materials Engineering)* on **Smart Materials.**

10th March 2010.
Friends Meeting House, Cockermouth.

Annual General Meeting and Presidential Address: John Rodgers 'Between heaven and hell: A tale of two valleys'.

ANNUAL GENERAL MEETINGS

THE 48 TH. ANNUAL GENERAL MEETING of the Society was held at The Friends Meeting House, Cockermouth on Wednesday, 11th March, 2009. The President David Kelly was in the chair. Reports from Officers and the balance sheet of the Society Accounts were presented and approved. The list of Officers for 2009-10 proposed by the Council was accepted unanimously.

The main item of business was the proposal to raise subscription rates for the next year. The Treasurer explained that rates had not increased since 2004 and that a small increase was necessary in order to continue Society activities. The meeting approved the new rates of £7 for students, £15 for individuals, £23 for joint membership and £25 for institutions.

At the end of the formal business a presentation was made by members on the recent Society trip to Raasay.

THE 49TH. ANNUAL GENERAL MEETING of the Society was held at The Friends Meeting House, Cockermouth on Wednesday 10th, March 2010. The Vice-Chairman took the chair. Reports from Officers and the Society Accounts were accepted and approved by the meeting. New Officers and Council members were elected.

There were no items of other business.

Following the formal business the Vice-Chairman delivered the Presidential Address 'Heaven to Hell – a tale of two valleys'

ANNUAL DINNERS

2009

Over 40 members and guests once again enjoyed an evening of food and fellowship in the Greta Suite of the Skiddaw Hotel in Keswick on Saturday March 28th, 2009.

The Speaker was Dr. Alan Smith whose title 'Down Under' was an obvious hint that the content involved some reminisces of some geological sites seen on recent visit to Australia.

2010

Again in 2010 the Society met for its Annual Dinner on Saturday March 27th in the Greta Suite of the Skiddaw Hotel in Keswick.

Another gathering of over 40 had a good evening of friendship followed by an excellent illustrated talk by the guest speaker Professor Joe Cann. His topic was 'Black Smokers and the Origin of Life'.

This was a splendid and lucidly presented talk about some of his work on the geology of the ocean floors, together with his thoughts about the possibility that this kind of environment may hold the clues to the origins of life on earth.

OFFICERS AND COUNCIL

Officers and Council members for 2009 and 2010 are listed below.

	2009	2010
President	David Kelly	John Rodgers
Senior Vice-President	-	David Kelly
Junior Vice-President	John Rodgers	Jim Samson
Treasurer	Margaret Bennett	Margaret Bennett
General Secretary	-	-
Lecture Secretary	Susan Beale	Susan Beale
Council Secretary	Rosemary Vidler	Rosemary Vidler
Excursion Secretary	Alan Smith	Alan Smith
Membership Sec.	Chris Thompson	Chris Thompson
Editor	Alan Smith	Alan Smith
Publicity Officer	Anne Freeland	Anne Freeland
Librarian	David Powell	David Powell
RIGS Rep	Jim Samson	Jim Samson
Auditor	Tony Rigby	Tony Rigby
Council Members	David Steele	David Steele
	Judy Suddaby	Fiona Harwood

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