CUMBERLAND GEOLOGICAL SOCIETY

DIORAMA—LAKELAND SCENERY

Lake Derwentwater, from Castle Head, near Keswick. The hills left (east) of the lake are formed of lavas and tuffs of the Borrowdale Volcanic Series; these rest on Skiddaw Slates, occupying the low ground and the nearer hills to the right. Castle Head in the foreground is a mass of igneous rock (dolerite), smoothed and striated in the Ice Age.

PROCEEDINGS

No. 2 1962

Two Shillings and Sixpence

DIORAMA LAKELAND SCENERY - R.T. Roussell
B. Matthews (Photo Printers) Bradford
DIAGRAMATIC SECTION S.of ENNERDALE
SECTION ACROSS ENNERDALE
Above. Reproduced by permission
H.M. Stationery Office
SECTION IN SKELGILL, printed by permission
The Syndics - University Press Cambridge

CUMBERLAND GEOLOGICAL SOCIETY

Session 1962.

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PROCEEDINGS OF THE SOCIETY, SUMMER AND AUTUMN 1962.

List of Contents:

List of members of the Society, 1962.

[redacted]

[redacted]

Institutional member:

TULLIE HOUSE (Library & Museum), Carlisle, Cumberland.

* denotes Associate Membership.

June 3rd., 1962.

VISITS TO (i) THE LIAS AT THORNBY, NEAR WIGTON,

(ii) THE DRYGILL SHALES AT THE HEAD OF CARROCK BECK.

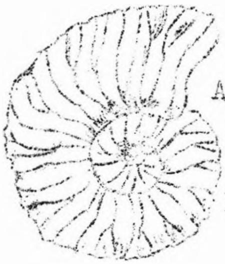
Having assembled at Market Hill, Wigton, the party proceeded under the leadership of Dr. F.H. Day and Mr. N. Thomson, B.Sc., both of Carlisle College. From Micklethwaite, the party drove along the Thornby road for about half a mile, to where the road bridges Thornby Beck, a tributary of the Wampool.

This fairly flat area is covered by glacial drift, which overlies New Red Sandstone in the Carlisle-Thursby-Wigton area. At the Thornby locality, however, there are Liassic (Lower Jurassic) shales beneath a general cover of six feet or more of glacial clay. In this particular place the stream has eroded through the cover, and the Lias is exposed along the banks of the stream.

During Jurassic times, a warm shallow sea, supporting abundant life lay over most of England producing highly fossiliferous shales and thin limestones noted for the many and rapid mutations in ammonites, which are therefore used as zone fossils. In the cliffs of the Whitby area of the Yorkshire Coast, these strata are seen to perfection. The areas to the west have generally had these deposits eroded away, and so we are fortunate in having even traces of them within easy reach.

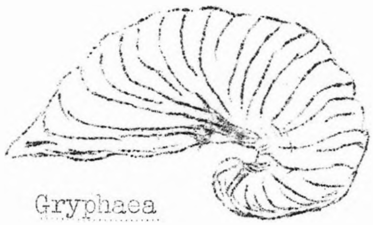
In bright sunshine, the members examined the bed and sides of the stream. Several limestone fragments containing ammonites, brachiopods and lamellibranchs were found. One enterprising syndicate systematically dismantled the stream bed, removing and examining the larger fragments first, then finally sifting the sand. Some good specimens were obtained in this way. The shales themselves are somewhat difficult to examine as they weather rapidly to a very crumbly mass. They were found, however, to be crowded in places with the lamellibranch Corbula, and one apical disc of a small echinoderm (sea urchin) together with a few detached spines.

TYPICAL LIASSIC FOSSILS



Ammonite (Plane spiral, NOT helical)

Corbula

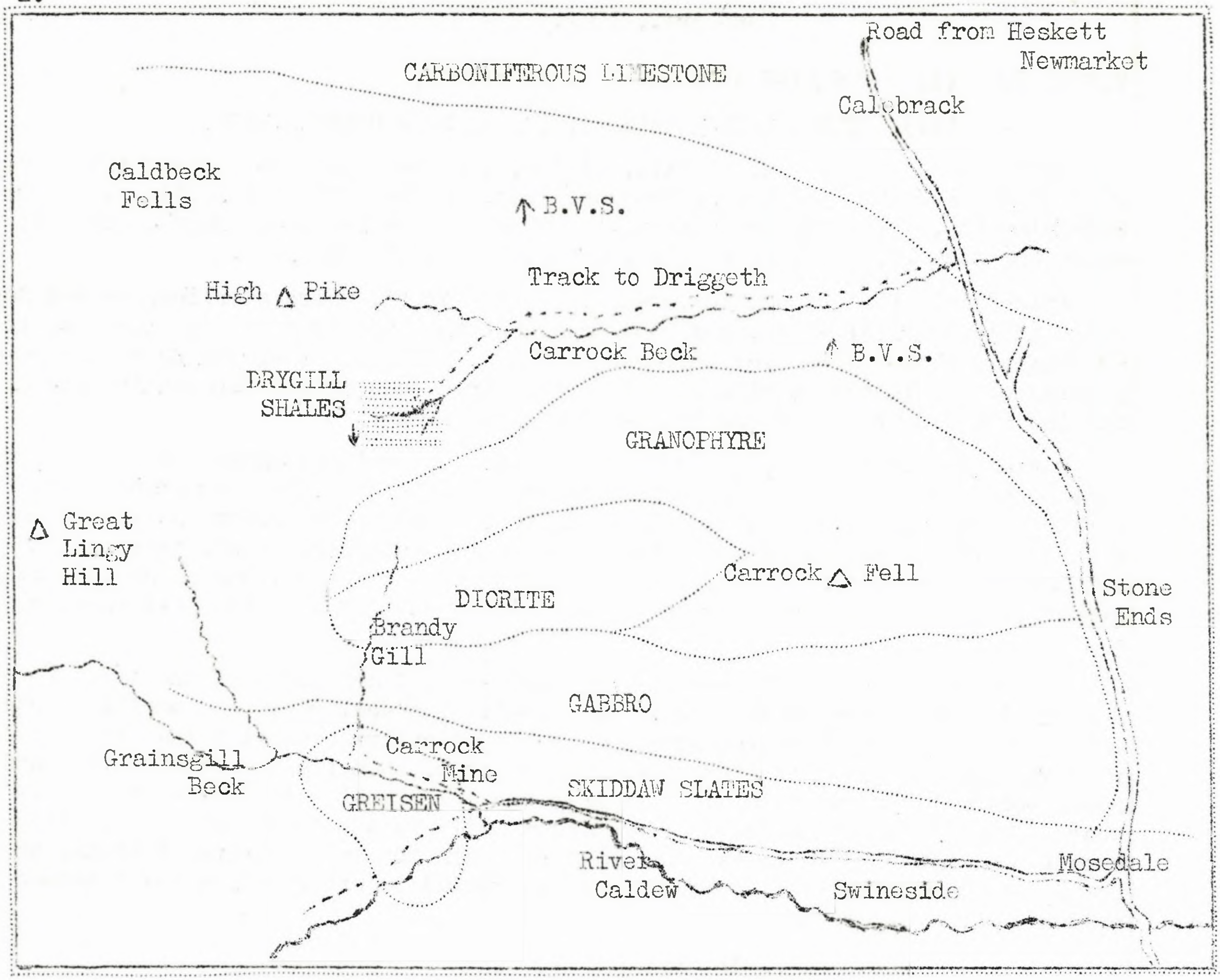


Gryphaea

The party, having thanked the leaders, proceeded across Red Dial for a roadside lunch at Waverhead, overlooking Caldbeck.

It was intended to reach Dry Gill from the north east, but the Calebrack mine road had itself undergone considerable erosion, therefore the party followed the metalled road to Mosedale and thence to Swineside and Grainsgill (visited before on April 1st.). After ascending Brandy Gill, in quartz hornfels and diorite, the party crossed the flat saddle between High Pike and Carrock Fell and descended into Dry Gill, the rise of Carrock Beck.

The Dry Gill shales, of Ordovician age, weather white but are blue when fresh. Here the most abundant fossils were Trinucleus concentricus and Orthis testudinaria, and nearly everyone obtained specimens. On working downstream, the extensive quartz vein containing manganite was seen, and yellow-brown barrel-shaped crystals of campylite (lead phospho arsenate) were found. This vein runs roughly east-west in the shales, and below it, the shales contain Orthids.



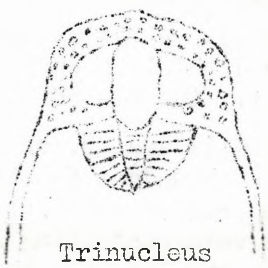
SKETCH MAP OF THE CARROCK AREA.

Further down Carrock Beck, the Eycott Lavas (B.V.S.) are exposed, dipping north. The Drygill Shales present a problem in field relationships. The fossils are mostly Caradocian (i.e., Coniston Limestone level), with a few from the higher Ashgillian horizon. The Skiddaw Slates and Borrowdale Volcanics are thus both older than the Drygill Shales which dip south. The problem, briefly, is to reconcile the difference in dip. Marr, in his "Geology of the Lake District" invokes a thrust plane, while J.F.N. Green in his "Structure of the Lake District" prefers a deep infold.

After looking round Dry Gill, time was running short, and not everybody went down to look at the Eycott Lavas, preferring to return to the cars at Carrock Mine.

TYPICAL ORDOVICIAN FOSSILS

Orthis



Trinucleus

S.H. Gate, B.Sc.,

THE BUTTERMERE AND ENNERDALE GRANOPHYRE

This is the second largest igneous intrusion in the Lake District, and it extends as a wide band about three miles south westwards from the southern shore of Buttermere to the south western tip of Wastwater.

It is generally accepted that the intrusion has a stock-like form, and this is especially noticeable in the Ennerdale valley where deep dissection has exposed the vertical nature of the junction, as seen in the section visited. Here the juction rises vertically from the edge of the lake to the top of Bowness Knott and is displaced by a slight tear fault in the depression between Bowness and Brown How before continuing vertically up the side of Herdus.

Part of the original roof is also preserved along the Buttermere and Ennerdale watershed. The junctions are almost horizontal, or at a low angle - indication again of the stock-like form of the intrusion.

The whole intrusion dips at a low angle to the south so that exposures on Iron Crag and Caw Fell are not much below the limit of the granophyre.

An interesting feature of the intrusion is the evidence for the existence of a "raft" of basic material in the centre of the intrusion. There are exposures of a dioritic rock type on the east shoulder of Bowness Knott, opposite at about 1,000 ft. on the high crags of Crag Fell and eastwards. Exposures of acicular or contaminated rock are found east of Bowness along the Scaw, and on Latter-barrow, suggesting that there is some considerable extent to the basic material.

In the area there are also a number of dyke rocks, described by the Survey as Spherulitic Rhyolites. They occur in the granophyre itself and are well developed along the side of Great Bourne, but similar rocks occur in the Skiddaw Slates in Rake Beck, in Borrowdale Volcanics on White Pike, and are reported by Rastall & Walker in Burtness Combe. It is possible that they represent a late stage in the differentiation of magma, but whether from the basic, or from the acid granophyre magma it is difficult to say at the moment.

The normal granophyre is a pink, fine-textured rock with ill-defined greenish specks and blotches of chloritised ferromagnesian minerals. Felspar and quartz in micrographic intergrowth make up the bulk of the rock, the amount of ferromagnesian minerals being very small.

The felspar is commonly albite-oligoclase, but albite and andesine also occur.

Quartz may occasionally form idiomorphic crystals.

The granophyric structure is best developed near the centre of the intrusion whilst the margins are usually fine grained rocks of the same composition but without the granophyric structure, or develop into felsitic types as those which occur near the margins on Bowness Knotts, Crag Fell and Herdus.

The basic rocks are essentially dark grey doleritic types, but rocks resulting from the interaction between the basic and the acid granophyre magma range from patchy pink and grey ill-mixed rocks to the acicular or "needle" rock typical of a basified acid rock.

It is suggested by Dr. Rastall that the basic magma was intruded before the granophyre and that the amount of interaction between the two suggests that the latter was still hot, though in part consolidated, since there exposures, as on Bowness Knott, where the normal granophyre lies close by basic rock and where junctions are abrupt and unmerged as if granophyre has apparently invaded along the joint planes of the basic rock.

Two specimens of the dyke rocks have been cut into slides by Mr. Dickson and were examined by Dr. Davy. They appear to be devitrified and devitrifying rhyolites.

************ ************

On Sunday, July 1st., members of the Cumberland Geological Society met at Ennerdale Bridge and proceeded by cars to Bowness Knotts, where Miss Slater who was to lead the excursion outlined the geological features of the area.

The general indications of junctions and contacts were pointed out, notably the difference in weathering between the granophyre which produced rounded outlines, smoothly rounded boulders and vertically jointed planes on precipitous slopes, and the Skiddaw Slates - especially those within the metamorphic belt - which showed contrasting shattered craggy outlines.

Further down the valley, the junction between granophyre and Borrowdale Volcanics was noted, especially Steeple ridge, sharp and craggy where capped by Borrowdale Volcanics, broadening into a wide shoulder below on the granophyre.

The party then divided into two groups, one led by Mr. Shackleton to look for exposures of the junction and a second party to examine exposures on Bowness Knotts.

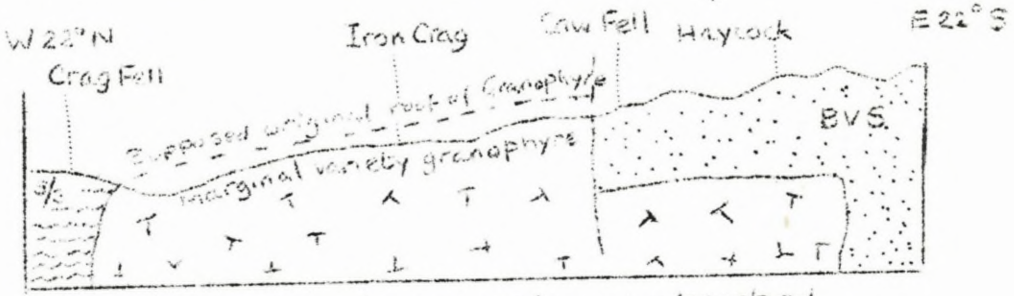
This group followed up the main gully on the west face of Bowness Knotts, noting a vertical dyke of doleritic rock on its left hand side, probably connected with the basic magma. Thay also noticed here evidence of metasomatism where the Skiddaw Slates had been invaded by magmatic liquids producing either pinkish blotchy spotting along lines of flow or pink and green chloritic material along joints and bedding planes.

At the top of Bowness Knotts, thermal metamorphism was in evidence, the Blakefell Mudstones having been altered almost to quartzites.

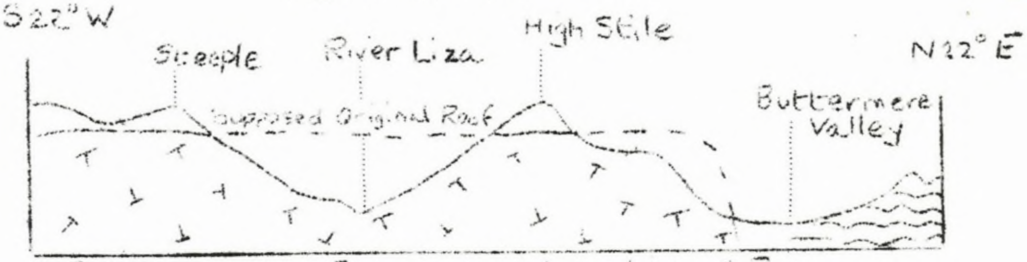
On the eastern shoulder, exposures of the basic doleritic rock were found. It was noticed that in places the normal granophyre was in contact with basic rock, with little interaction along the edge, apart from a growth in the size of quartz and felspar crystals in the granophyre. Elsewhere, specimens of intermingled and acicular rock were found.

The group next moved on to Brown How, and the vertical junction between the Skiddaw Slates and the granophyre up the side of Herdus was seen. Here most of the group followed down Rake Beck to look for the small swarms of Camptonite dykes a little above the 900 ft. contour and exposed in the beck. A little below this is a dyke with small greenish spherules, flow banded parallel to the margins, similar to one to be found on the Scaw, or another near Gamlin End. Here, at Rake Beck, they met Mr. Shackleton's group who had been unable to find an exposed junction along the lake shore but had noticed the change of rock type on Bowness Screes and the hardening of the slates in proximity to the junction. A small group continued up the side of Herdus, following the junction, then along the top of Great Bourne on granophyre boulders, the roof of the intrusion not being preserved here, to the shattered region of the Red Gill fault. Faulting here and on the far side of Starling Dodd has dropped the original roof of Skiddaw Slate and thus preserved it.

Along the line of the fault the rock is barely recognisable as it is heavily haematised and shattered. Sections were found where shattered slates merged imperceptiby into the granophyre, suggesting both metasomatism and magmatic stoping.



Diagrammatic Section along watershed South of Ennerdale.



Section across Ennerdale along line AB.

Lower down in Clews Gill an exposure of a banded rock was noted, apparently a banded jasper, but appearing as a vertical E-W dyke and completely surrounded by normal granophyre. The river cuts it cleanly, and it appears to continue for some 20 yards on the western bank before being lost in a further shatter belt.

A little lower down a striking dyke of marked rhyolitic appearance with large pink spherules arranged in lines of flow, again almost vertical, and running in an E-W direction, was noted. This dyke has since been traced for some 50 yards along the fellside. It is very similar to another mentioned by the Survey, but lying in a direction E5°W.

MAKING PETROLOGICAL MICROSCOPE SLIDES

The Cumberland Geological Society is very grateful to Mr. T. Dickson, B.Sc. for the lecture and demonstration given by him at Whitehaven College of Further Education on Tuesday 29th. May, 1962. This report is a brief description of the process and techniques involved.

Selecting the specimen.

It was stressed that when taking a piece of rock from strata or geological position, it was necessary first to note the relative attitude of it to other strata in such a manner that the information would not get lost. Next it was necessary to mark the rock with a N-S arrow (a microscope slide diamond engraver is a useful tool) and also a mark to indicate the vertical direction as found. The specimen can then be cut or broken off, and subsequently any drift, rotation or inversion is known or can be measured. (Figure 1.)

Removing a specimen plate for slide making.

The piece which is going to be the plate is now marked with a N-S arrow or vertical arrow to correspond with the marks on the specimen and the section being taken. It is then cut off the specimen with a carborundum wheel or hack-saw, and the cut face is ground and polished. The grinding is first done with 320 mesh carborundum and water until flat and free from flaws, and then by hand with a circular motion on plate glass with finer grades of of wet carborundum down to 600 mesh. The grades of carborundum must not be mixed, and the plate should be washed before transfer to a finer grade. The surface is then examined dry and must have no scratches. (Figure 2.)

Mounting on slide for grinding.

A clean microscope slide and the specimen cut to correct size are heated on a thermostatically controlled hotplate, set accurately at 110°C. The heating serves two purposes:

i. It removes air from the specimen by expansion.
ii. It gets the specimen and slide hot enough for the application of Lake-side 70 cement.

The specimen and the slide are both covered liberally with Lakeside 70 cement and the specimen watched closely until bubbling ceases. The specimen is then tipped smartly over on to the glass slide so that the two layers of hot bubble-free cement meet. The slide and specimen are put on a paper pad, and by a pressing and rubbing motion, air is slid out sideways. Once the assembly is bubble-free it is allowed to cool.

N.B. It is very important at this stage that the assembly is bubble-free, for if a bubble is present it will rub into a hole as you grind down to the correct thickness. This is because the air trapped in the bubble is at a higher pressure than atmospheric and will raise the specimen (Figure 3.). It will thus be rubbed into a hole by the time the rest of the specimen is the correct thickness.

Grinding to thickness: 30μ

Before grinding, any directional arrows must be marked on the slide with a glass cutter, because the arrows on the upper surface of the specimen plate will be ground away. The specimen is now ground down to thickness first on the wheel and finally on plate glass, taking care to grind it evenly and thus avoid making a wedge. This technique is partly achieved by turning the specimen constantly, and is partly an acquired skill. As soon as light begins to show through the specimen, it is examined periodically in the microscope using the polariser. It is an advantage to examine it wet. Certain minerals in the specimen act as indicators of thickness at this stage. With crossed Nicols, felspar and quartz show the following colours:-

Just seen through at 100/u
Blue/green at 50 - 60/u
Red at 40/u
Grey to yellow at 30/u

(1/u = 0·001 millimetre)

Calcite shows red at 30/u except in microcrystalline structures. Olivine gives long crystals which are red and yellow with traces of purple at 30/u. Chlorite is green at 30/u.

The grinding on the wheel is done with 320 mesh carborundum and water, carried out with a light circular motion and examined periodically until the light shows through. Next the specimen is ground on the glass plate with a circular motion using carborundum 320 and water, and examined microscopically until its thickness is 30/u, i.e., 0·03mm. At this stage, felspars will be grey, and olivine will be red, yellow and purple. The surface is now finished with about ten light circular strokes on plate glass using 600 or 700 mesh carborundum and water. At this stage, if you are not careful, the specimen can be rubbed away completely. The object of getting all sections down to 30/u in thickness is that this thickness gives a good contrast after dyeing. Also, uniformity of thickness minimises the amount of refocussing of the microscope which is necessary.

Dyeing or staining.

The staining of the specimen is done with various reagents and dyes which invariably either chemically combine with the surface or are adsorbed on it. In either case, the stain does not penetrate, and thus a protective film has to be used to protect the delicate colouration from damage. Mr. Dickson showed some of his own staining techniques, but since he will be including some in his Thesis, I have omitted them from this report.

Transferring the specimen.

Make sure you know the N-S or Top-bottom before transferring the specimen to an unmarked slide. A new microscope slide, cover slip, and specimen still on the original microscope slide are put on the 110°C. hot plate and allowed to heat up. They are all liberally covered with Canada balsam. The specimen is now turned over on to the new slide, and the old slide slid off - considerable skill is needed at this point. A drop of Canada balsam is put on the specimen to displace the Lakeside 70 cement. The cover glass is dropped on the specimen and pressed down gently. If this is done carefully, bubbles will not be trapped under the cover glass. The whole assembly is now removed from the hot plate and allowed to cool, after which the surplus Canada balsam is scraped off or dissolved in methylated spirit.

Marking the slide.

The slide is now complete, and it is best marked, using a diamond microscope slide engraving tool, or a sticky label can be applied. It can be marked with a catalogue number, and also a N-S arrow or Top-bottom arrow related to the rock from which it was removed.

Porous rock, friable material and small grains can be difficult to mount free from bubbles. A good technique which may work here would be to use a small vacuum/pressure impregnator, and a heated specimen covered with Lakeside 70 cement.

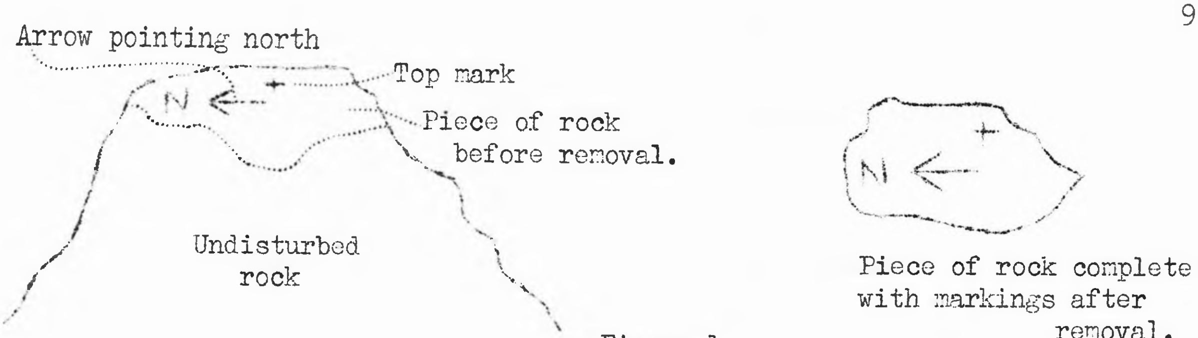


Figure 1

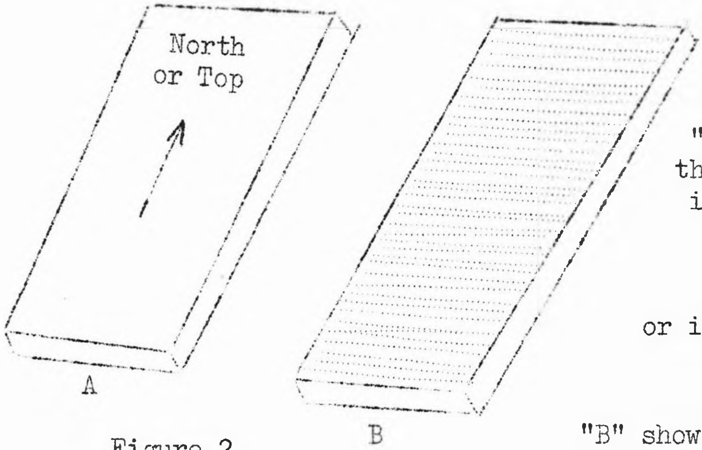


Figure 2

"A" showing the face with the arrow showing either:

i. north as found, and parallel to the bedding if the slide is to be transverse.

or ii. top as found, if cut at right angles to the bedding.

"B" showing polished face on opposite side, i.e., "B" is "A" inverted.

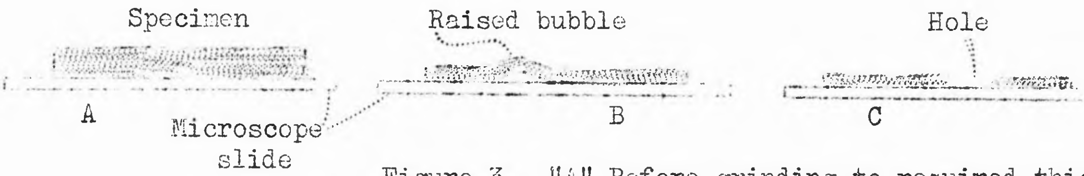


Figure 3

"A" Before grinding to required thickness.

"B" Bubble forming as required thickness is approached.

"C" Hole formed at site of bubble when down to required thickness.

Peels.

Another good technique which will readily show mineral structure is the making of peels. This consists of grinding and polishing the specimen to 700 mesh on one face. The surface is then etched with an appropriate solution. For limestone and calcite the solution is 2%v/v hydrochloric acid for 30 seconds, then wash and allow to dry. Do not wipe or touch the etched surface. Acetone is now poured on to the etched surface and quickly drained. A piece of celluloid or cellulose acetate which is thin and has a good surface is now smoothed on to the etched surface and left for 20 minutes. It is then peeled off and has a perfect profile of the etched surface. It will, for instance, show every detail of the grain boundaries and cleavage planes in calcite. The peels are best mounted in lantern slides and projected.

R. H. Hewitt

Weekend excursion to Ambleside, 15th & 16th September, 1962

SECTION IN SKELGILL.

After Marr & Nicholson. Q.J.G.S., 1888.

TYPE FOSSILS

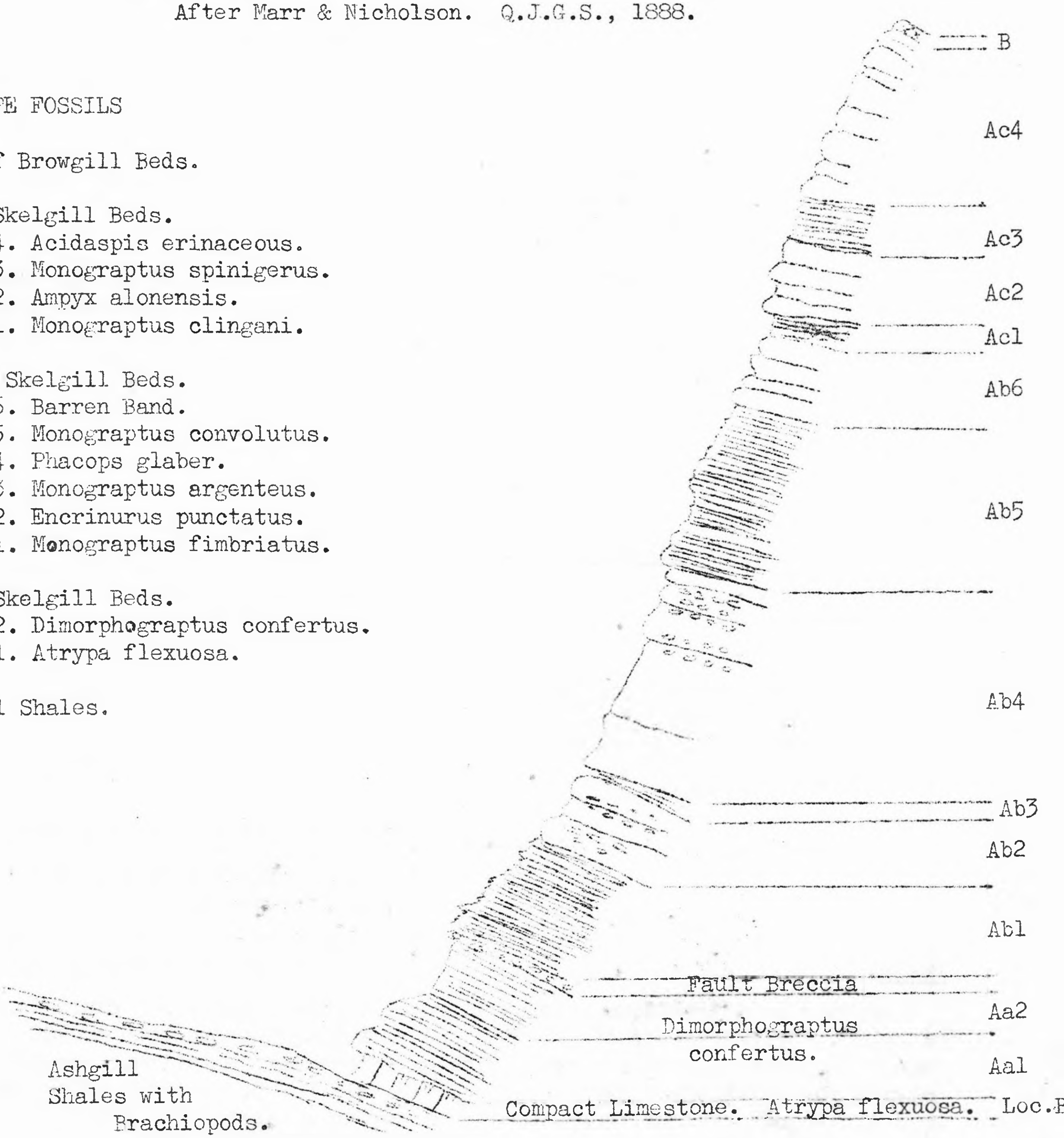
B. Base of Browgill Beds.

Ac. Upper Skelgill Beds.
- Ac4. Acidaspis erinaceous.
- Ac3. Monograptus spinigerus.
- Ac2. Ampyx alonensis.
- Ac1. Monograptus clingani.

Ab. Middle Skelgill Beds.
- Ab6. Barren Band.
- Ab5. Monograptus convolutus.
- Ab4. Phacops glaber.
- Ab3. Monograptus argenteus.
- Ab2. Encrinurus punctatus.
- Ab1. Monograptus fimbriatus.

Aa. Lower Skelgill Beds.
- Aa2. Dimorphograptus confertus.
- Aa1. Atrypa flexuosa.

Ashgill Shales.



E.H. Shackleton, F.G.S.

Weekend Excursion to Ambleside and Coniston

14th. to 16th. September, 1962.

The object of the excursion was to explore the Lower Silurian rocks of the area. These Lower Silurian rocks are exposed in a comparitively narrow band that runs across the country from Millom to Shap, crossing the head of Lake Windermere. In places there are fossiliferous bands containing Graptolites in a good state of preservation, whilst Trilobites have also been found.

On the evening of Friday, 14th. September nine members of the Society met in the White Lion Hotel, Ambleside. After settling in to a good dinner, Mr. Shackleton who was acting as director outlined the aims of the excursion. He explained the succession from the Borrowdale Volcanic Series, up through the Coniston Limestone and Ashgillian to the top of the Silurian, but pointed out that during the weekend it was only intended to deal with the Ashgillian and Lower Silurian.

In order that the members should be familiar with some of the fossils it was hoped would be found, a sheet of drawings was provided (see next page), and this was supplemented by a selection of actual specimens from the director's personal collection.

On Saturday 15th., the party, augmented to thirteen by members coming for the day, left for Skelgill. After leaving the cars by Troutbeck Road, they followed the old Hundreds Road over the shoulder of the fell with magnificent views of Lake Windermere and the fells beyond. Before taking the footpath that leads to Skelgill the director pointed out the many small quarries in the fields. These are in the Braythay Flags (or Lower Coniston Flags) and whilst on the whole poorly fossiliferous, there are one or two bands which swarm with Trilobites. Across the Lake the little bay of Pull Wyke was pointed out, eroded from the shales of the Skelgill Beds. To the notth these are underlain by the Ashgillian and Coniston Limestone and this is underlain, usually unconformably, by the Borrowdale Volcanic Series, so well seen in Loughrigg Fell.

At Skelgill, the section made famous by Marr and Nicholson (see opposite) was seen by the old bridge and explained by the leader. Because it was so well known and had been so much worked, Mr. Shackleton was not too optimistic as to what could be found. In the gill below the bridge the Ashgill Beds are exposed at water level and at the base of a ten foot cliff they are overlain by a tough grey mottled limestone. The junction between the two is almost invariably a strike fault, and Skelgill itself is eroded along this line of weakness. The Flexuosa Limestone, as it is called, was examined, but few recognisable fossils extracted. The black shales above comprise the Dimorphograptus confertus zone, but the difficulty is to get at them. The leader was able to point out one or two minor slips in these beds and also the peculiar "green streak" which occurs some three feet from the base. This green streak has been found all round the southern part of the Lake District, and even as far away as North Wales. In all probability, said the leader, it represented a volcanic eruption of the Krakatoa type, which scattered fine dust over a wide area. The fault breccia at the top of the zone was pointed out, and then Messrs. Hewitt, James, Mayson and Shipp fell to work on this difficult exposure in an endeavour to find type fossils. As the same shales are exposed in the right bank opposite, the ladies of the party were given the job of examining them as they were more accessible. Meanwhile, Mr. Clive Nicholas, of Queen Mary's College, who was acting as co-director, fell to work with the assistance of other members on the beds above the bridge. At first sight this abrupt cliff seemed an impossible proposition, and even in the 1880's Marr remarked that the Monograptus argenteus zone was no longer accessible. Nevertheless, the band was located, and specimen fossils extracted. This band, which is only about 8 inch thick, was located about three feet above the stream bed, between two faults. The lower part is grey, passing up into tough black shale. Then there is a thin "green streak" similar to the one in the lowest zone. The top three inches is again black shale with fossils in high relief, and pyritised.

In spite of a lot of detailed searching, the lowest zone was not located. Fossils were found in both banks of the stream, but not Dimorphograptus confertus. After lunch the party moved to other locations nearby and were rewarded with some interesting finds. Meanwhile, others had visited the higher reaches of the stream in search of the nodules that are recorded as having Trilobites preserved in them. Once again it proved a disappointment; not a single Trilobite was recorded. Messrs. Hobbs and Mayson spent some time above the bridge, at the head of the stream, where the Ashgill Shales outcrop. Good specimens of the fossils Harknessella (Orthis) vespertillio, Orthis calligramma, Dalmanella and Leptaena were found.

If the directors were hard pressed making identifications and giving explanations, one of Mr. Shackleton's worries disappeared. He had worried in case the Skelgill locality would not fully occupy the party for a full day. As it was, the party left only just in time to arrive back in Ambleside for dinner. It was generally agreed that the area could profitably be visited for a week. Among the interesting finds were Graptolites showing the sicula and nema, as well as specimens of:

Monograptus crispus (1)
M. fimbriatus (4)
M. cyphus (1)
M. gregarius (1)
M. leptotheca (3)
M. lobiferus (2)
M. argenteus (2)
M. triangulatus (2)
M. revolutus (1)
M. tenuis (2)
Climacograptus sp. (4)
Petalograptus (4)
Rastrites (1)

Saturday had favoured the party with blue skies and bright warm sun, but the following day reverted to "English Summer". It was cold and wet when the cars assembled to set off for the day. Once again, the weekend party was augmented by members and visitors over for the day.

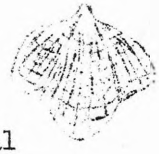
After travelling to Torver by way of the "Drunken Duck" and Tarn Hows, the party made their way on foot up to Ashgill. The moorland was wet and soggy, and from time to time, sharp cold rain showers made the going unpleasant. Lunch was taken beside a waterfall in the old quarry, and even during this spartan meal, some members could not but help splitting rocks, and finding fossils, with the result that quite a large number of parts of Trilobites were recorded. After lunch, Mr. Shackleton led the party over the section, pointing out the Calymene Beds (the upper part of the Coniston Limestone), the succeeding Phillipsinella Bed, the so-called White Limestone, and the volcanic ash above the falls. At the falls, the Mucronatus Beds were pointed out, and then the party split up to collect from the type exposures. For the most part, the specimens found were Brachiopods, Bryozoans, Crinoid columnals, etc. Only in the Mucronatus Beds were Trilobites found, and whilst no complete specimens turned up, both heads and tails of the type fossil Dalmanites (Phacops) mucronatus were collected. The bitterly cold wind made collecting on the exposed upland most unpleasant, and a retreat was made to the more sheltered Ashgill Quarry.

Here the Dimorphograpus confertus Beds were pointed out, but again with no luck for the type fossil. Also in the quarry, the Ashgill Shales provided some brisk fossil collecting, and many specimens were obtained including the type fossil, O. vespertillio. In belated sunshine, the party crossed the moor to Torver Beck to see a magnificent gorge cut in the Borrowdale Volcanic Series. The overlying Skelgill Beds were located, and at least some fossil evidence extracted from a very poor exposure. The Beck was followed down, and exposures of the Browgill Beds noted, but

SOME FOSSILS FROM THE SKELGILL BEDS.


Aa2
Dimorphograptus confertus (Nich.)


Aa2
Monograptus revolutus (Kurck.)


Aal
Atrypa flexuosa


Abl
Monograptus fimbriatus (Nich.)


Abl
Monograptus triangulatus (Hark.)


Abl
Monograptus cyphus (Lapw.)


Abl
Rastrites peregrinus (Barrande)


Abl
Climacograptus sp.


Ab2
Encrinurus punctatus (Salter)


Ab2
Acidaspis sp.


Ab3
Monograptus argenteus (Nich.)


Ab3
Ab5
Monograptus convolutus (Hist.)


Ab4
Phacops glaber (Marr & Nich.)


Ab4
Cheirurus bimucronatus (Murchison)


Ab4
Calymeme blumenbachi (Brongniart)


Acl
Favosites sp.


Ac3
Ampyx sp.


Ac3
Monograptus lobiferus (M'Coy)


M. turriculatus (barrande) Browgill Beds.

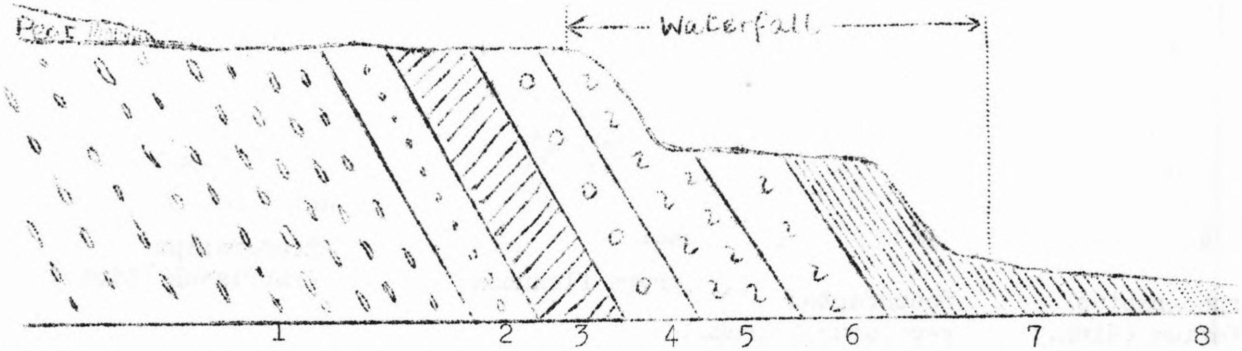

Monograptus crispus (Lapworth)


Monograptus griestonensis (Nich.)

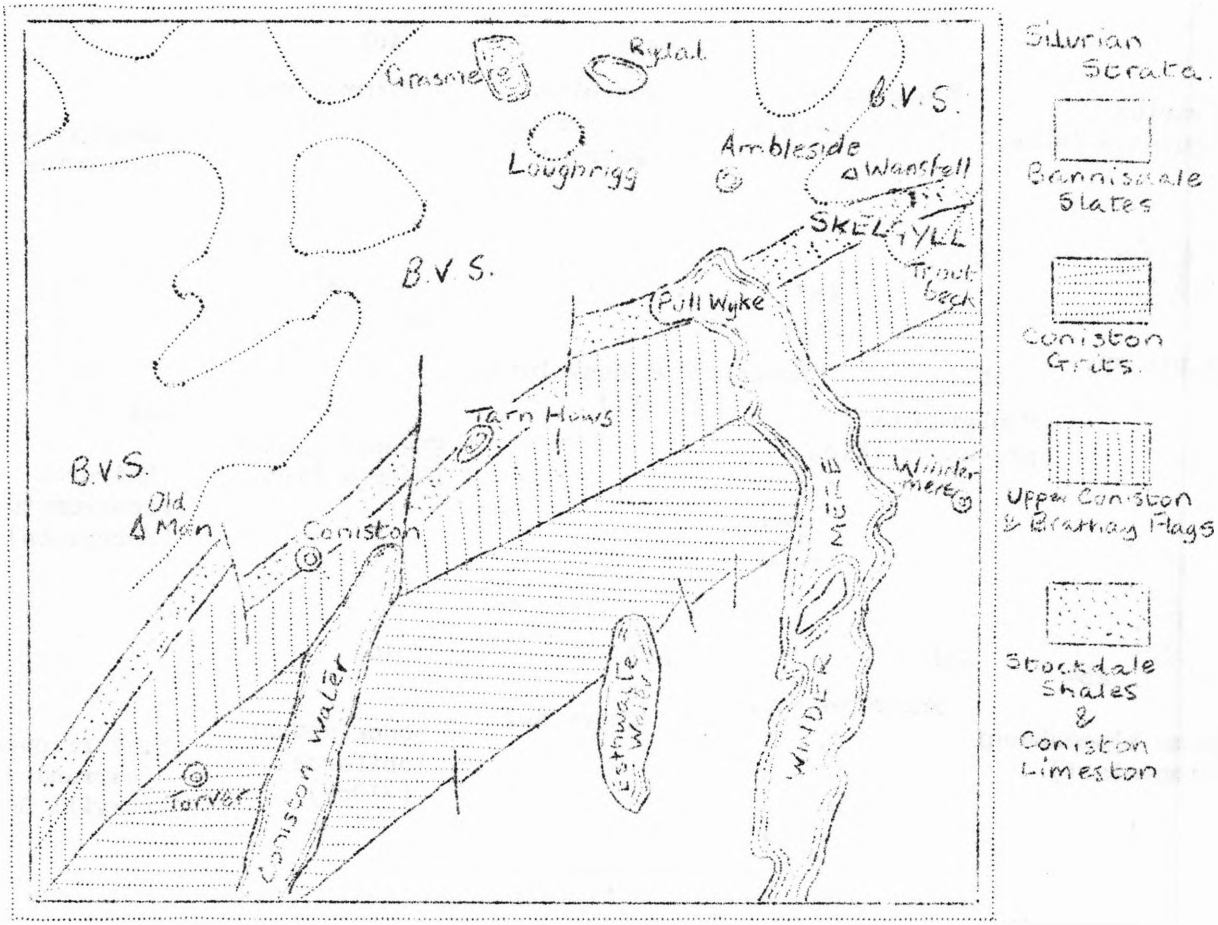

Monograptus gregarious (Lapw.)


Monograptus crenulatus (Lapw.)

Section along Ashgill Beck Scale 1" ≡ 60 ft.



1. Calymene Beds.
2. Phillipsinella Beds.
3. White Limestone.
4. Volcanic Ash.
5,6. Mucronatus Beds.
7. Ashgill Shales.
8. Stockdale Shales.



Simplified Geological Map of the Ambleside-Coniston Area.

but time did not allow the party to locate the fossil bands.

Back at Torver, all agreed that an excellent and profitable weekend had been spent, and it is to be hoped that future excursions could be arranged to what had proved to be a most interesting area. The thanks of the party were extended to the directors for their planning and leadership, whilst the excursion secretary was thanked for the accommodation arrangements, and his outsize, but welcome coffee pot.

E. H. Shackleton, F.G.S.

MINERALOGY

The report of a lecture given by Mr. R. H. Hewitt on 27th. September 1962 at Workington Technical College.

The lecturer commenced with a description of the constitution of matter, and the manner in which atoms are arranged in space in the SOLID, LIQUID and GASEOUS states. The actual volume and the VAN DER WAALS' volume of an atom was described and their relationship to expansion, contraction, hardness, thermal diffusion, absolute zero and superconductivity, all in the solid state, was explained.

The structure of atoms and the idea of a NUCLEUS surrounded by ORBITAL PARTICLES was illustrated. From this picture, protons, neutrons and electrons were described and the way they "combined" with a certain volume of "empty" space to form atoms of the various elements. A mechanical model was used at this point to illustrate a three dimensional atom complete with spinning nucleus. The idea of electrons being "smeared" around electronic shells was next described, and the structure of the so-called Inert Gases listed:-

	Electronic Shells					
	K	L	M	N	O	P
HELIUM......He......	2					
NEON........Ne......	2	8				
ARGON.......A.......	2	8	8			
KRYPTON.....Kr......	2	8	18	8		
XENON.......Xe......	2	8	18	18	8	
RADON.......Rn......	2	8	18	32	18	8

these elements being monatomic gases.

The laws of chemical combination of atoms of metallic and non-metallic elements to form molecules of compounds of various types were explained. The formation of ionic compounds in the solid state was demonstrated with the help of magnetic floats which, floating in a tank of water, formed themselves into a two-dimensional model of a cubic lattice.

The lecturer now dealt at greater length on the different types of chemical bonding.

1. The IONIC or POLAR bond which involves the giving of electrons by the metallic atom from its outer orbit, and the accepting of them by the non-metallic atom so that each of the atoms achieves the electronic structure of an inert gas. The resulting IONS, positively and negatively charged, are held together by electrostatic attraction.
2. The COVALENT or HOMOPOLAR bond, the mutual sharing of electrons between atoms or groups of atoms so that they are bound together within a common electronic shell, and each have achieved an inert gas structure.
3. The METALLIC bond in which the atoms are neatly arranged and stacked, like eggs in cases layer on layer, and the residual extra orbital electrons swarming around them in the electronic cloud. This is actually a random electric current.
4. The RESIDUAL or VAN DER WAALS bond. When some of the above bonds are holding atoms together, there is often a residual partial charge which is not evenly distributed. The combination of atoms thus has a polarity, and this, together with gravitational effects, causes groups of atoms to attract other atoms or groups of atoms, giving rise to a weak linkage. When the groups also fit each other geometrically, this type of bond becomes stronger.

By reference to atomic tables, relationships of periodicity, valency, chemical properties and reactivity of the various elements were established. By reference to various elements and mineral compounds, explanations were given of:-

rock. The volatile materials crystallise last, and often migrate upwards and outwards into overlying sedimentary rocks, giving interesting concentrations of minerals, e.g., iron pyrites, bismuthinite, etc.

The final de-gassing of a body of nearly solid magma gives boroh-containing minerals such as tourmaline. In the body of solidified magma, pegmatite veins are formed containing large crystals of quartz, felspars, and occasionally beryl and other rare minerals. Very high temperature solutions, under great pressure, force themselves into cracks in the overlying rocks and form veins of minerals such as quartz, wolfram, molybdenite, iron and copper pyrites, and fluorspar.

Where these mineral veins are open to attack by atmospheric agents, secondary minerals are formed, for example in our own district:

Molybdenite is changed to wulfenite (lead molybdate).
Galena " " " cerussite (lead carbonate).
Silica + copper minerals are changed to chrysocolla (copper silicate).
" + zinc " " " " hemimorphite (zinc silicate).
Lead minerals + phosphates give pyromorphite (lead phosphate),
and campylite (lead phospho arsenate).
Silica may recrystallise to give such minerals as chalcedony, opal, agate, onyx, etc.

Metamorphism, the effect of heat and pressure, results in the formation of many secondary minerals such as garnet, chiastolite and epidote, whilst cavities in igneous rocks often become filled with zeolites.

Igneous rocks are formed by the cooling of magma, often under considerable pressure. The silicate mixtures of which these rocks are formed are metastable, and readily break down mechanically and chemically under atmospheric influences. The end products of this weathering are mainly clays and sands, though running water may give localised deposits of minerals resistant to weathering, e.g., gold placers.

Chemical precipitation may give deposits of useful minerals, such as sedimentary iron and manganese ores. Ferrous bicarbonate dissolved in river water precipitates hydrated ferric oxide when it meets the sea, whilst in deeper water, deposits of manganese oxide, psilomelane and pyrolusite, may be formed in a similar manner.

The most extensive biochemical reaction on Earth is photosynthesis, whereby green plants remove atmospheric carbon dioxide and replace it by oxygen. In this manner they build up their stems and leaves of carbonaceous material, some of which may eventually form peat and coal.

An interesting example of bacterial action was quoted; certain bacteria live on solutions of iron salts, and form iron oxide as a waste product, giving deposits of bog iron ore.

With these and other biochemical reactions giving useful geological deposits, Dr. Day brought his lecture to an end. After answering many questions put by an interested audience, he was thanked by the chairman, Mr. Hewitt, who declared the meeting closed.

T. Shipp.

VISIT TO WHITEHAVEN BRICKWORKS QUARRY 25th. November 1962,

followed by

VISIT TO HAIG COLLIERY 26th. November.

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The visit to Whitehaven Brickworks Quarry (Low Road, Whitehaven) was arranged at an impromptu Council Meeting at the Whitehaven College of Further Education during one of the weekly Tuesday sessions. It was thought that a visit to the quarry would be useful in view of the visit to Haig Colliery on the evening of the following day.

There are five distinct seams exposed in the quarry face, and they are numbered upwards from the lowest one. The Survey records a total of nine seams in the immediate area, exposed upwards from No. 1 in the quarry. They are all of the Preston Isle Seam, worked at one time in the Duke Colliery on Prospect.

The seams of coal and their associated deposits can be seen very clearly in the quarry, and the rhythmic deposition, a characteristic of the Coal Measures can be clearly studied. It must be understood that these conditions of deposition obtained over a vast area and a very large number of years.

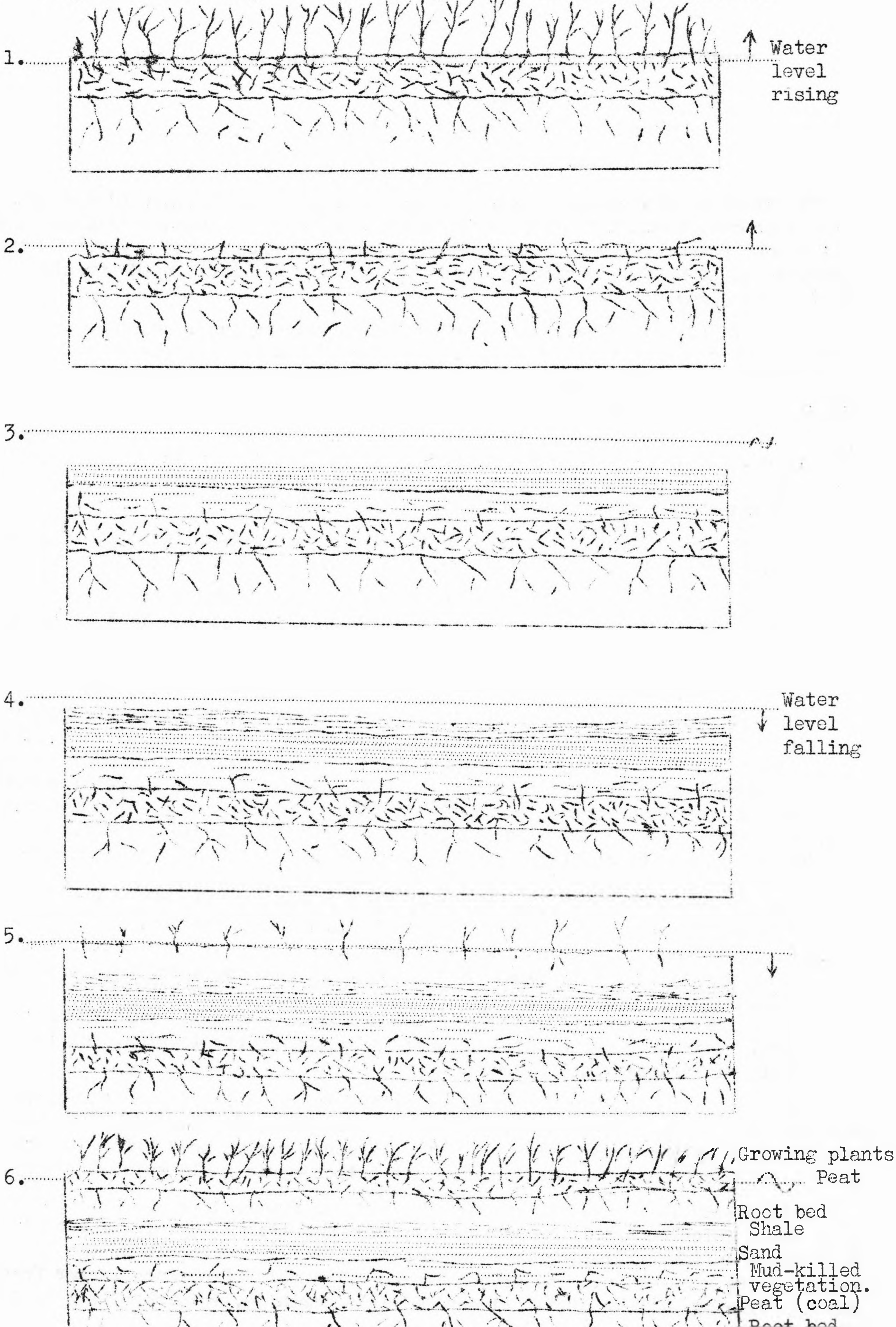
The following notes, together with the diagrams overleaf, attempt to show and explain the rhythmic deposition associated with coal deposits:

1. Peaty material is deposited on the low-lying swampy floor of a forest. At a rough estimate, 1 foot of coal has been formed from a 15 feet thick accumulation of peat.
2. The land surface subsides, a feature of the Carboniferous era, to below water level. The subsidence is gentle and the water overflows the land slowly. Water moving this slowly can only carry the lightest of grains in suspension, and therefore fine mud is brought in and deposited. This encloses dead trees and vegetation which has fallen into the muddy water. The resultant rock will therefore be a fine mudstone rich in plant remains, leaf impressions, branches and tree trunks (Sigillaria and Lepidodendron).
3. The rate of subsidence increases, and the resultant basin deepens. The waters flow more swiftly, bringing coarser gritty material to form sandstone.
4. The rate of deposition overtakes that of subsidence, and the depth of water lessens, resulting in the deposition of finer mud particles.
5. The subsidence stops, and the muddy deposits rise just above water level, allowing vegetation to regain a roothold, and the trees to establist themselves again.
6. The detritus of the forest once again collects on the floor in the form of peat. This will again build up until the land starts to sink, and the whole cycle will repeat itself again.

There are of course many variations of the theme, depending on the prevailing conditions. If the subsidence is rapid to start with, for instance, the primary deposit will be a coarser material. If subsidence recommenced before the mudbank could give purchase to vegetation, the deposition cycle would naturally vary.

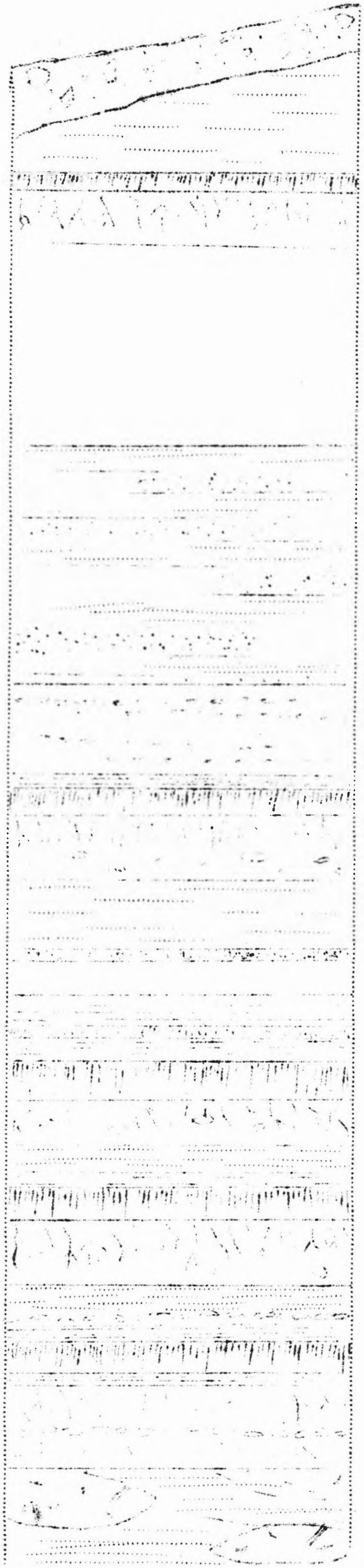
This quarry is remarkable in the area for its fossil impressions. The light blue shale which occurs in bands has a wealth of fossil material. I consider this to be an inwash area, rather than an area where, as described, the mud has engulfed the vegetation. The preponderance of pinnules from much larger fronds, and the paucity of both Sigillaria and Lepidodendron do, I think, point to this.

20. Diagram illustrating the rhythmic deposition in the Coal Measures.



SECTION IN THE NORTH WEST CORNER OF HOWGILL QUARRY, WHITEHAVEN.

Approximately 110 ft.
Not to scale.



	Glacial drift.
	Silt.
	COAL No. 5.
5 ft.	Seat earth.
20 ft.	Massive, fine-grained sandstone.
20 ft.	Alternation of thin bands of hard silt and sandstone.
8 ft.	Finely laminated shale with strings of siliceous nodules.
6 in.	Carbonaceous shale.
9 in.	Poor quality COAL No.4.
4 ft.	Brown shale with ironstone nodules passing into seat earth with rootlets.
6 ft.	Silt.
6 in.	Purple sandstone.
3 ft.	Mudstone
2 ft.	Dark grey laminated shale.
3 in.	COAL
6 in.	Dirt parting.
1 ft. 6 in.	COAL No.3.
6 ft.	Seat earth (nodular).
1 ft. 3 in.	Tough, dark grey silt
3 in.	Dirt band.
1 ft. 6 in.	COAL No.2.
5 ft.	Brown seat earth with roots & flinty nodules.
2 ft.	Grey silt.
1 ft.	Laminated shale
1 ft.	COAL No. 1.
1½in.	Black shale.
2 ft. 6 in.	Ironstone nodules.
	White mudstone with root traces.
20 ft.	Large, lenticular concretions of sandstone with many fragmentary plant impressions & crossed by irregular thin calcite & dolomite veins with occasional pyrites crystals.

Traces of terrestrial or airborne animated life have yet to be found here. I feel that from the obviously muddy nature of the deposits, marine forms of life can be ruled out, though categorical statements of this type are usually proved incorrect !

Specimens of the following plant fossils were obtained during the visit:

Alethopteris lonchitica	Cyclopteris sp.
Neuropteris gigantea	Cordaites sp.
Neuropteris tenuifolia	Sigillaria sp.
Linopteris munsteri	Sphenopteris sp.
Dactylotheca plumosa	Sphenophyllum sp.
Myriophyllites graciis artis (root of calamites)	Calamites sp.

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The visit to Haig Colliery, Whitehaven, was limited to twelve members only. Some two hours were spent travelling slowly along the return airway, a very dusty journey as the Safety Department follows the practice of heavily coating everything in finely-powdered limestone to lessen the fire risk.

The shale in the rock sides of the tunnel is extremely hard and singularly unfossiliferous. The shale above the coal seam, which could be followed all the time along the walls of the drift, bore plenty of impressions. All were formless shapes of pitch since the tremendous pressure exerted on the rock has destroyed any traces of structure. The shale also was very much broken up, and showed little trace of bedding. The party crossed into the main return drift via some cuttings showing excellent examples of slickensiding, some "pots" in the roof being polished to a mirror brightness all the way round.

After two hours walking, the party were pleased to return to the shaft bottom via the regular "ride". Complete with its stations with waiting rooms and "Mind the Trains" signs, it was somewhat reminiscent of the London Underground.

R. E. O. Pearson.

SOME FOSSILS FROM THE WHITEHAVEN BRICKWORKS QUARRY.