

CUMBERLAND GEOLOGICAL SOCIETY

PROCEEDINGS 1963 No 2

Forty Pence

THE CUMBERLAND GEOLOGICAL SOCIETY

President:

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

.....

Honorary Life President:

C. Edmonds, M.Sc., F.G.S., J.P.

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LIST OF MEMBERS OF THE SOCIETY, 1963.

[redacted]

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[redacted]

[redacted]

Institutional Member.

TULLIE HOUSE (Library & Museum), Carlisle.

* Denotes Associate Membership.

EDITORIAL

Once again we are entering the season which inspires reverence and wonder in some, and gaiety and generosity in most. For the Cumberland Geological Society, it marks the approach of the most pleasant social function of the year, the Annual Dinner, and this year the Society welcomes as its guests Dr. and Mrs. G.H. Mitchell of the Scottish Geological Survey.

All members will have received with these Proceedings a copy of the provisional Constitution of the Society. This has been drafted by a sub-committee and approved by the Council of the Society. Read it carefully, and bring your views along to the A.G.M. on January 14th. when its adoption (or amendment) will be one of the main items to be dealt with.

In the November circular to all members, the General Secretary mentioned that one of his pet schemes had come to fruition. The Council of the Society authorised the purchase of a duplicator - these "Proceedings" are the first effort from it. The possession of our own means of mass-producing publications has cleared quite a few wrinkles from the brows of the Secretary and myself, and although the cash resources of the Society have been overstretched the debt is not so large that it cannot be cleared in a very short time, given a bit of help by members through donations, sale of publications, etc.

The production of these Proceedings involves late night working for a couple of months before they are actually sent out, and here I must thank contributors for the promptness with which they submitted their articles. This time I have introduced a number of new features. Firstly, the text has been tidied up, and I have tried to improve the presentation of maps and diagrams. The opening article is the first of a series of "potted biographies" of geologists associated with the Lake District, whilst at the end you will find reviews of two books whose authors are members of the Society. I also envisage a "correspondence column" in future issues.

I don't think I shall be stealing too much thunder from the Secretary's Annual Report on January 14th., in saying that this year has been a most pleasant and rewarding one for the Society. Membership is up, and although attendances at lectures have been a little disappointing, the excursions have been excellently supported, often in spite of very unpromising weather conditions.

With 1963 on its way out, and a full programme of events planned for the first half of 1964, I look forward with pleasure and confidence to the future of the Cumberland Geological Society.

T. Shipp.

This article is the first of a series of short biographies of men who were interested in and intent upon elucidating the complex geological features exhibited in the rocks of the Lake District.

JONATHAN OTLEY

If William Smith was the father of British geology, Jonathan Otley was undoubtedly the father of Lakeland geology. This was plainly stated by Professor Adam Sedgwick. But who was Jonathan Otley, when and where did he live, and what did he do to earn the acclaim of so exalted a leader of the science of geology ?

The Otleys were Grasmere folk and had been for a very long time, indeed when the first parish register was started there it soon contained the name Otley - 1575. The family lived at Nook House, Loughrigg, a house that was later to become known as Scroggs, and there they earned their living as wooden sieve and basket makers. In 1762 a Jonathan Otley married Jane Satterthwaite, a widow, and they had a first son, Edward, a second son Jonathan (our Jonathan, born October 19th., 1766), and lastly a daughter, Jane.

For all their humble estate the Otleys were well educated people, and Jonathan senior encouraged his sons both in Latin and Mathematics. Young Jonathan went to school, first in Langdale where he was taught by the Rev. R. Steel, and then in Ambleside.

From his schooldays until his twenty fifth year Jonathan dwelt with his father and worked with him at the making of baskets. He also cleaned and repaired all the clocks and watches of the district, becoming very skilful at it. In addition, he became proficient in the art of engraving.

In 1791, Jonathan Otley moved to Keswick to set up in business for himself as a watch and clockmaker. For five and a half years he lived at Brow Top before moving into town where his little shop soon became known as "Jonathan Otley's - up t'steps", and it was here that he established such a reputation for local knowledge that he became friend and correspondent to such people as John Dalton, Adam Sedgwick, Professor Phillips, and Sir Geo. Airey, the Astronomer Royal.

The following assessment of Otley's character we owe to Mr. Crosthwaite who was his fellow-worker and friend:

"Jonathan was by nature shy, quiet and reserved. A reader, a thinker, an observer and a listener rather than a talker, but at the conclusion of a conversation he was used to give his opinion in such a manner as to leave no doubt that he had grasped the matter. Mr. Otley was, however, quite fond of society, and especially of some of the ladies of his acquaintance. He would go to a picnic with a large party of friends, and gaily bring the hostess on his arm into the ring where the cloth was spread upon the green. Each year he would visit his native place and stay for two or three weeks. Not much of a holiday, as he once remarked, for all the clocks from far and near came in for attention!"

In 1812 we find Jonathan writing to John Dalton, that other celebrated Cumbrian, with whom he had been climbing Great Gavel to take temperatures, barometric pressures and samples of air. The heights and outlines of the different mountains interested Jonathan very much, but in his letter to Dalton he was discussing a peculiar rock cistern he had observed near the summit of Gavel, filled with cool fresh water. I wonder if it is still in situ. I hope so, for when Jonathan was an old man, the Survey team built a cairn right on top of it. Jonathan protested, and the Director compelled his minions to shift the cairn.

In Jonathan Otley's younger days Lakeland was largely unsurveyed, and the heights of the mountains, which we take for granted, were still hotly disputed. In view of this, he made his own map which he engraved himself in 1817 and first published in 1818. Five years later he added a Guide to the Lakes to his map, as well as several essays which had been read before the Manchester Literary and Philosophical Society. One of these essays concerned the Floating Island in Derwentwater, and another the celebrated Black Lead or Plumbago Mine at Seathwaite in Borrowdale. It was in 1823 that Otley introduced Adam Sedgwick to Lakeland geology, and their first excursion took them up the Caldew to see the Skiddaw Granite and the remarkable mineral veins thereabouts.

This was the beginning of a long and treasured friendship between the two men whose walks in life were so very very different. On the one hand the humble watchmaker, keenly observing and delighting in the then little-known countryside of Lakeland. On the other, the learned professor, lecturing at Cambridge in the first Chair of Geology to be established in a British University. Never did the professor prove his greatness more than by his open and generous acknowledgement of his debt to the watchmaker of Keswick.

Leaving aside Jonathan's many-sided participation in what was then termed Natural Philosophy, what did he do in the realm of geology to make him the friend and confidant of such men as Phillips and Sedgwick ? What did he do ? I could put this in a few words, but these, I fear, would convey little of his magnificent achievement, for it is so very difficult for us to realise what it is like to begin at the beginning. Even we at this late stage, if we are honest, are forced to admit to many things that puzzle in the geology of so old and complex an area as the English Lake District. And yet, consciously or unconsciously, we are heirs to all the patient work of our forbears. Never let us forget that the many things which today seem simple only do so because we are metaphorically standing on the shoulders of those who went before.

With this very necessary proviso in mind let us take a look at Jonathan Otley's Geology of the Lakes. I like his opening remarks:- "At the time this essay was first published, the structure of the mountainous district of Cumberland, Westmorland and Lancashire was but little understood; scientific travellers had contented themselves with procuring specimens of the different rocks, without taking time to become acquainted with their relative positions." * No wonder that a man so shrewd was able off his own

* 1830 Edition. Underlining mine, E.H.S.

hammer, so to speak, for none had gone before, to subdivide the rocks of Lakeland into three great groups which he called the Clay-slates, the Green Slates and Porphyries, and the Greywacke. The names may sound strange to our ears but we must remember that this was in the childhood of our science when men were groping their way towards principles, and an accepted nomenclature was yet to be resolved. Strange terms, perhaps, but turn the pages of his "Concise Description" *, and on reading, little doubt can remain as to the meaning of his 'Clay-slates':-

"....the lowest division of the series forms Skiddaw, Saddleback, Grassmoor and Grisdale Pike with the mountains of Thornthwaite and Newlands; it extends across Crummock Lake and by the foot of Ennerdale as far as Dent Fell; and after being lost for several miles, it is elevated at Black Coomb."

It is not very difficult to supply the present-day name, is it ? But try and divest yourself of hindsight for a moment, and remember that all this was long before the days of railways and motor cars. If Jonathan used anything other than his two feet to get about, it must have been a horse.

Again, from the same source:- "If we regard the granite of Skiddaw as a nucleus upon which these rocks are deposited in mantle-shaped strata, that which reposes immediately upon it is a gneiss; but it is rather more slaty and much less granular than the gneiss of some other countries. More distant from the granite, the quantity of mica in slate decreases, and it is marked by dark-coloured spots; it is then provincially called 'whintin' and is quarried for flooring flags. This again is succeeded by a slate of softer kind, in which crystals of chiastolite are plentifully embedded, these crystals gradually disappear and the rock becomes a more homogeneous clay-slate...."

How much could you add to that, one hundred and forty years later ? But he then goes on to discuss whether or not his clay-slates are truly bedded and comes up with a very precise and first ever description of cleavage, both as it is observed in the field and its relation to bedding, and includes some shrewd suggestions as to its origin. Professor Phillips in his exhaustive report on "Cleavage and Foliation in Rocks" ‡ mentions Otley's work thus:- "The earliest notice of a real and firm distinction between cleavage and stratification, derived from English examples, which I have met with is in Otley's 'Concise Description of the English Lakes' ". Had Jonathan done no more, his name would deserve to be cherished by all who wield a hammer. But he did more, much more. After describing his second rock division Green Slates and Porphyries, delineating their outcrop and remarking on the grandeur of the scenery to which they give rise he goes on to mention the quartz, calcareous spar, chlorite and epidote of Walla Crag, as well as the garnets, agates, etc. He also describes the bytownite porphyrite of Eycott Hill and points out that the same rock also occurs on Binsey.

"The Third Division - forming only inferior elevations - commences with a bed of dark blue or blackish transition limestone, containing here and

* "Concise Description of the English Lakes", J. Otley, Keswick, 1823.
‡ British Association Report, 1856, page 369.

there a few shells and madrepores, and alternating with a slaty rock of the same colour; the different layers of each being in some places several feet and in others only a few inches in thickness. This limestone crosses the River Duddon near Broughton; passing Broughton Mills it runs in a N.E. direction through Torver, by the foot of the Old Man mountain, and appears near Low Yewdale. Here it makes a considerable slip to the eastward, after which it ranges past the Tarns upon the hills above Borwick Ground, and stretching through Skelwith, it crosses the head of Windermere near Low Wood. Then passing above Dove's Nest and Skelgill, it traverses the vales of Troutbeck, Kentmere and Longsleddale; ...." There are no prizes offered for the present name of this limestone. He continues:-

"....crossing the intervening mountains in the direction of the roads that lead over them; so that no relation can be discovered between the direction of the valleys and that of the stratification. It dips to the SE. while the cleavage of the slate with which it is associated frequently inclines in an opposite direction."

This Third Division is now known as the Silurian, but at that time Sedgwick and Murchison were busy building up (and quarrelling about the limits of) the two systems. Cambrian and Silurian. Singularly enough, Jonathan Otley knew little about fossils, and whilst he was always ready to listen to his friend Sedgwick enlarging upon his fossil finds and their usefulness, he himself never seems to have been greatly interested. Be that as it may, I think I have said enough to show that, with or without the benefit of fossils, he had a sound grasp of the sedimentary succession and structure. How about the ingeous rocks of the Lake District ?

After carefully and correctly describing the Skiddaw Granite, its outcrops in the Caldew and between Skiddaw and Saddleback, and its associated minerals, he goes on to delineate the Eskdale and Shap Granites with considerable accuracy, though he fails to differentiate between the Eskdale Granite proper and the Ennerdale Granophyre. His remarks on Carrock Fell, whilst noting the hypersthene and magnetite, were not so felicitous, but then, do we not even today talk about the "Carrock Fell Complex" ?

Otley mentions the porphyritic rock on both sides of St. John's Vale and the Armboth Fell Dyke, concluding by doubting whether the sedimentary rocks were deposited on the granites, preferring the supposition that the granites protruded through them. His chapter on the geology of the Lakes runs to less than fifteen pages, but after reading and re-reading it one is bound to admire his grasp of the subject.

Jonathan Otley lived to the ripe old age of ninety one years, and just before he died in 1856 he was visited by his old friend Professor Adam Sedgwick. A stroke had paralysed the old man and bereft him of speech, but not consciousness. Sedgwick, renowned as one of our most learned geologists was still a simple man at heart. Grasping the hand of the man who for over thirty years he had always called friend, he said, with tears in his eyes "Jonathan, I'll pray for thee". Thus passed the last meeting between the two pioneer geologists, men who each in their own spheres contributed largely to our science, men we can truly speak of as being great.

E. H. Shackleton F.G.S.

DISCOVERY AND DEVELOPMENT OF THE OLD MINES OF THE LAKE DISTRICT

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The writer of this article and his associates have been engaged for some considerable time in exploring and mapping the old mines of the Keswick, Carrock and Alston areas. The article gives us some insight into the problems facing the "Old Men" those who mined before the days when detailed mining records were kept, in searching for mineral lodes and opening them up for exploitation using only the most primitive mechanical aids.

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The discovery of a mineral deposit depended on the ability of the prospector to detect the presence of mineralisation by one of the following visible means:-

1. The finding of pieces of ore on the ground.
2. The discovery of mineral waters, for example, the presence of copper salts in solution is easily detected by immersing in it a piece of polished iron which will instantly take on a copper colour. The method adopted by the "Old Men" was to put into the water a candle or a piece of tallow which in a short time became tinged a green colour.
3. The finding of the actual outcrop of the vein.
4. The finding of associated metalliferous sands or gravels.
5. Sometimes a discolouration of the vegetation is noticeable.

Any of these signs would have encouraged the finders to make a more detailed search of the area. Should none of the signs be present in an area where minerals were known to occur, then the miner would have to rely on his own knowledge (usually gained from experience), or, by observation he could sink his shaft or drive his level to where he thought the vein ought to have been. This same method can be used to locate old working sites at the present day.

When the miner had decided on the run of the veins, he would drive a short adit from the lowest ground to cut across the bearings of the veins; by thus doing, he was sure of cutting all the veins in the area. Sometimes other veins were discovered in the cutting of lower levels to de-water an existing mine.

After a vein had been discovered it had then to be considered whether it could be worked at a profit. In order to determine this, consideration had to be given to the nature and location of the site chosen on which to commence mining. Such things as water, timber, carriage, health and possible contamination of water supply, together with the cost of digging, crushing and smelting the ore would have to be balanced against the resultant thickness and extent of the vein, and its ore content.

The situation of the mine was of great importance, as an adit in the fellside is much easier and cheaper to de-water than a shaft sunk in the valley floor, up which water has to be pumped to the surface. Also, the raising of the ore to the surface is easier by incline than if it has to be hauled up a shaft by hand or by a winch. With these considerations in mind it is easy to see why most of the old mines consisted of easily drained adits driven into the veins, which were then stoped out as far as was practicable.

The main problem which faced the workmen in the dressing and separating of the ores was the provision of plentiful water, hence crushing plants and smelt mills had to be sited near a convenient water supply, otherwise the cost of building and cutting leats (water channels) sometimes for miles across the fellside from water supply to workings could put up the cost of metal production quite considerably. This method was adopted at Goldscope, Barrow and Driggith Mines, and their leats can still be traced along the fellsides near these mines, the longest being at Goldscope. The leats at Barrow and Driggith carried water to the smelt mills and crushers, whilst that at the Goldscope was used inside the mine for pumping water and hoisting the ore.

It will thus be seen that the type of mineral deposit easiest to work is that located as a vein or seam outcropping at the surface of a hillside, and there are many of these old "Outcrop Workings" scattered throughout the Lake District Mining Field, representing the first working mines of the "Old Men" of the mining industry.

J. Moon, F.G.S.

EXCURSION TO THE QUARTZ FELSITE DYKE OF THE ESKDALE GRANITE

Sunday, June 16th., 1963. Leader: M.F. Burton.

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FOREWORD

The dyke, which appears to be the only major one emanating from the Eskdale Granite with which it agrees petrologically, is of a reddish-coloured quartz porphyry. It is a holocrystalline rock with large, well-developed porphyritic felspar (orthoclase, showing zoning) and quartz crystals in a groundmass which has a microgranitic texture.

This single large dyke emanates from the Eskdale Granite at Great Bank in Miterdale and runs into the Borrowdale Volcanic Series along the south east of Illgill Head and the Wastwater Screes. Here its outcrop is irregular due to cross faulting. It comes down the fellside into Wasdale Head, crossing the Burnmoor track just behind Wasdale Head Hall. From there its outcrop crosses Lingmell Gill and the north west slope of Lingmell and appears to run into the small exposure of granite at Wasdale Head. From this granite in the vicinity of Burnthwaite and Gable Beck it can be traced up the side of Wasdale Fell and across the summit of Kirk Fell to Bayscar Slack to the east of Kirkfell Crags.

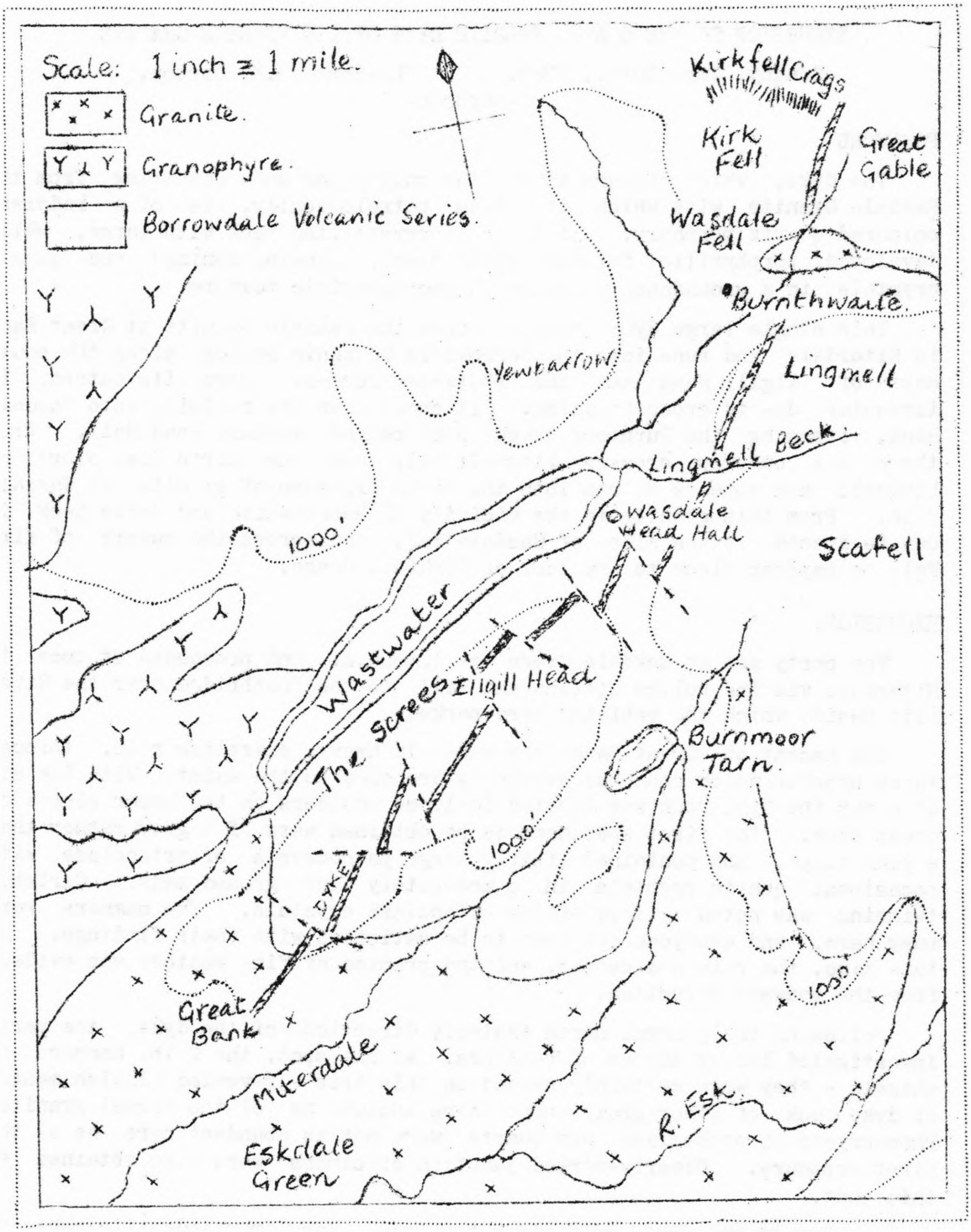
EXCURSION.

The party met at Eskdale Green at 10.30a.m. and proceeded at once to Miterdale via the Police Station and Mill to the footbridge over the River Mite beside which the vehicles were parked.

The ascent of Great Bank was made in heavy, drizzling rain, through thick bracken which soon had everybody drenched to the waist. With the aid of a map the dyke rock was located in loose boulders on the upper slopes of Great Bank. The first specimens to be obtained were of a grey rather than a pink tinge, and contained fairly large phenocrysts of orthoclase with occasional quartz crystals in a moderately fine ground mass. Carlsbad twinning was noted in some of the orthoclase crystals. The hammers were busy here, and everyone appeared to be satisfied with their findings. By this time, the rain had ceases, and the promise of fine weather was evident from the seaward direction.

Following the general north easterly direction of the dyke, the party investigated larger masses of boulders. At one spot, the 2 lb. hammers and chisels - they were certainly needed on this trip - revealed pinkish masses of dyke rock of finer grain containing inclusions of the normal granite. Phenocrysts of orthoclase and quartz were not as abundant here as at the first exposure. Clearly-marked junction specimens were also obtained at this spot.

Further to the north east along the dyke, dark grey andesitic ashes of the Borrowdale Volcanic Series dominated the landscape, rising at Illgill Head to a height of nearly two thousand feet. Before getting so high, the party returned to Miterdale down the side of a beck containing in its bed a variety of rocks from the neighbouring granitic and andesitic masses. Once



SKETCH MAP SHOWING THE POSITION OF THE QUARTZ FELSITE DYKE.

in the valley bottom, they followed the course of the Mite back to the footbridge and the cars, where lunch was taken.

After lunch, during which period socks were hung up to dry, and light entertainment provided by a young bull playing hide and seek with his harem round the parked cars, the party left for Wasdale Head to complete the second part of the excursion. As it would have been rather a strenuous task in the time available to follow the dyke along its entire course, the plan was to investigate its source in the granite on Great Bank in the morning, and motor round to Wasdale Head in the afternoon to locate it again in the volcanic rocks above Wasdale Head Hall.

At Wasdale Head, the party walked up the track leading to Burnmoor Tarn and Eskdale. Several outcrops were investigated, and one yielded good junction specimens of very compact-textured red dyke rock, which on closer examination appears to contain a high proportion of free silica. The complementary rock of these junction specimens is a grey andesite, coarser-grained at the boundary, and containing numerous patches of quartz. These specimens, besides showing the contact, contain veins of dyke material in the grey ash. Further up the track the actual dyke was observed crossing the path almost immediately above the Hall. Here a specimen containing a huge, shiny orthoclase phenocryst, together with smaller quartz crystals, and biotite in a pinkish-grey ground-mass was chiselled out of the solid rock.

The excursion was completed about 5.30p.m. when the majority of the twenty or so members who attended made for Burnthwaite where tea had been ordered.

CONCLUSION.

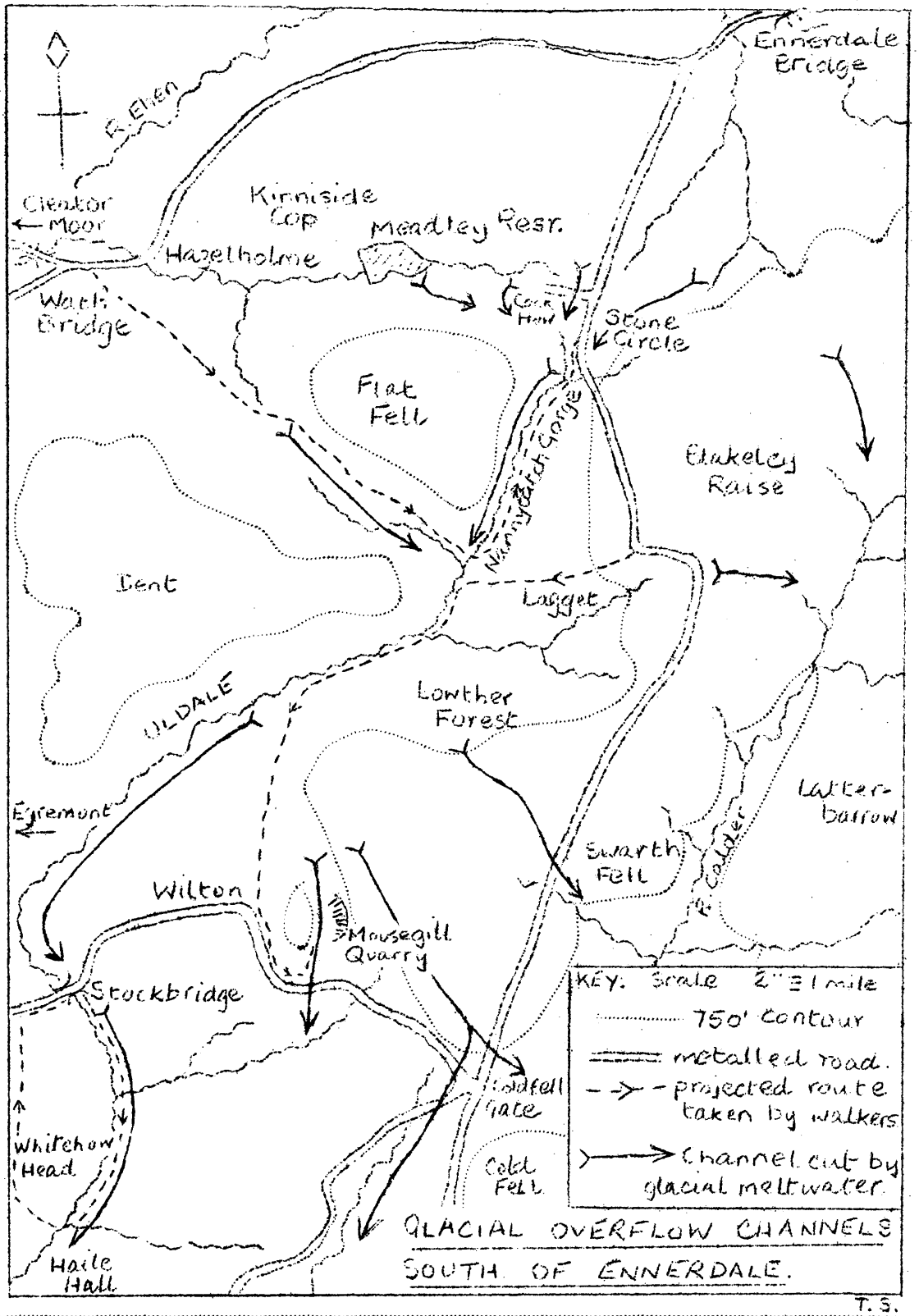
The Eskdale and Wasdale Granites and their associated dyke are much more acid than the surrounding rocks which include the many dykes of the Yewbarrow, Kirkfell Crags, Allen Crags and Piers Gill areas. They show very little alteration, with the exception of that due to weathering on the surface and along cracks and joints. It has been propounded that they are intrusive into the Borrowdale Series, and pre-Triassic in origin. No clear exposure of the junction with the Trias has been found, but the similarity of the relation which the Triassic outcrop bears to the Granite and the Borrowdale Series is strong evidence of the existence of the Granite before the Triassic Period. It seems probable that this intrusion belongs to the Devonian Period, as does the granite of Shap, with which it is not dissimilar in some of its varieties, apart from the large orthoclase phenocrysts of the Shap Granite.

The quartz felsite dyke must therefore be younger than the Eskdale Granite, but probably still Devonian in age.

M.F.B.

REFERENCE.

A.R. Dwerryhouse. Quarterly Journal of the Geological Society. 1909.



GLACIAL OVERFLOW CHANNELS SOUTH OF ENNERDALE.

T. S.

EXCURSION TO THE NANNYCATCH - STOCKDALE - HAILE GLACIAL OVERFLOW SYSTEM SOUTH OF ENNERDALE.

Sunday, July 14th., 1963. Leader: T. Shipp, B.Sc.

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INTRODUCTORY NOTE

During the final glacial period, two opposing forces were in evidence in the West Cumberland area, namely glaciers from the western valleys of the Lake District pushing their way westwards, and a great ice sheet from Southern Scotland moving south across the area of the Irish Sea and the coastal belt of Cumberland. Although the ice has now melted, topographical features imposed by it are easily seen in the area covered by the excursion - these features including moraines, outwash deltas and channels cut by escaping meltwater.

As the climate became less severe, perhaps 30,000 years ago, the ice began to melt back, and as one would expect, the more southerly mass of ice namely that centred on the Lake District, tended to shrink back towards the Fells of which successively lower peaks began to break through as nunataks. This "weakening" of the Lake District ice led to the inland encroachment of the Scottish ice which ground its way as far inland as the mouth of Ennerdale, and, rounding Dent Fell, choked the entrance of Uldale.

In the first stages of the retreat of the Lake District ice the peaks of the ridge running from Pillar to Blakeley Raise began to break through, and the ice to the south of this ridge retreated rapidly as its source in Ennerdale was cut off. This exposed open country, now drained by the River Calder, into which the meltwaters from Ennerdale, still choked with ice held back by Scottish ice at its mouth, could escape at successively lower levels across the cols along the ridge. Eventually, mid-Ennerdale became a vast lake which stood at a much higher level (up to 700ft) than it does at present. Shore lines of this lake at several levels can be traced by outwash deltas (where streams once entered it), and patches of gravel on the fellsides.

The water from the melting ice all escaped to the south over gaps in the ridge. As even the Scottish ice began to retreat from the mouth of Ennerdale, Lake Ennerdale as it has been called found outlets at lower and lower levels, its torrential overspill cutting great gashes across the countryside to the south. It was the most spectacular of these that was visited during the excursion.

The accompanying map shows the positions of the main overflow channels investigated during the excursion, together with projected routes for walkers.

Reference:
Memoir of the Geological Survey of England and Wales, Whitehaven and Workington District. Chapter XV, especially pp.235-240.

PROGRAMME

The party of fifteen members met at Wath Bridge, Cleator Moor, at 10.45 a.m., and in spite of the appalling weather, it was decided to proceed with the original excursion programme, as far as possible.

It was near Wath Bridge that the Lake Ennerdale of late glacial times eventually drained away southwards at its lowest level along what is now the course of the River Ehen. At that time the Scottish icefront probably stood along Wath Brow, to the west towards Cleator Moor. It is likely that the pre-glacial River Ehen drained westwards through Moor Row towards the sea at St. Bees. In the Ehen Valley are spreads of sand and gravel over boulder clay, i.e., material deposited by meltwaters over that left in situ by melting ice.

At this point, the party divided. Those going by car took the road towards Ennerdale Bridge, stopping to look at the River Terrace at Hazelholme ($\frac{1}{2}$ mile on right) with the old lead mine at Kinniside Cop further up the hillside. At Long Moor, half a mile before Ennerdale Bridge, the road to the right was followed up the hill to the Stone Circle near Cock How. The walkers took the first track on the right after leaving Wath Bridge, and walked up past the reservoir (not the one marked on the sketch map) to the rather boggy area between Flat Fell and Dent. A fierce following wind with driving rain made conditions far from pleasant. From this point onwards the path led into a magnificent gorge cut by water escaping from Lake Ennerdale in its later stages. At the point where this ravine enters the Nannycatch Gorge, a bedraggled set of motorists appeared, having walked down the Gorge from the Stone Circle.

The combined party followed the main gorge into Uldale, stopping where Lagget Beck joins Kirk Beck. This part of the overflow system was to have been visited after lunch by the walkers coming down from the Fell Road past Lagget, but in view of the unpleasant weather, it was decided to cover as much of the ground as possible by car. In Uldale there was a temporary lake formed between the Scottish ice choking the entrance to the west and Ennerdale ice choking the head of the valley to the north; this occurring, of course, before Ennerdale itself became free from ice and the meltwater channels had been cut. Excess water from this smaller Lagget Lake escaped eastwards, first to the north of, and then to the south of Swarth Fell, and into the Calder Valley. On the northern side of Uldale small outwash deltas were noted along the flanks of Dent.

As the two lobes of ice retreated from Uldale, the northern one quickly and the western one more slowly, more and more meltwater rushed down into Uldale to escape by the lowest exit possible. Two such overflows were seen later in the day near Wilton.

After the leader had pointed out and explained the features to be seen in Uldale, the party retraced their steps up the valley, past Nannycatch Gate, and into the upper reaches of Nannycatch Gorge. This was cut by water escaping through a series of "header channels" over Blakely Moss, Cock How, and Meadley Reservoir, from Lake Ennerdale at a higher level, and hence an

earlier stage than that at which the channel between Dent and Flat Fell was cut. On reaching the road, lunch was consumed in the shelter of the cars, with a certain amount of speculation as to whether it could get much wetter and windier.

After lunch, the party drove to Mousegill Quarry lane end via Cold Fell Gate, crossing three overflow channels en route, but seeing little of them through the mist. Mousegill Quarry is interesting on two counts. Firstly, it is an inlier, a patch of Carboniferous (7th) Limestone faulted down into andesites of the Ordovician Borrowdale Volcanics. Secondly, meltwater from the glacial Uldale Lake has excavated a trench along one line of faulting; this trench is now occupied by Limekiln Lane. Looking to the south west it is possible to follow the path taken by the meltwater down towards Stockbridge.

The next stop was further down the same road, at Stockbridge, by Kirk Beck. This is a most interesting aspect of a misfit drainage system. By looking at a map of the area, one would naturally assume Kirk Beck, coming south west from Uldale, to make for a junction with the Ehen at Egremont. This is not so. The lobe of persistent Scottish ice damming the entrance of Uldale forced the meltwater to cut south through the flank of the fell towards Haile. This happened to such good effect that even now the Kirk Beck forsakes the open valley bottom to plunge into the most unlikely-looking Stockbridge - Haile Gorge.

The last part of the excursion, namely the walk down the Gorge to Haile and back via Whitehow Head and Grange, was abandoned. Instead, the direct road to Egremont was taken, flanking the open end of Uldale at Moss Dalts. The ill-defined drainage here is due to material deposited by the melting ice having interfered with the pre-existing system. On the left of the road by Ullcoats Mine (Haematite), a man-made geological feature was evident - subsidence.

At 2.30p.m., rather earlier than had been anticipated, a rather damp party dispersed - just as the weather began to show signs of improving. The Vice President, Mr. G. S. Gowing, thanked the leader for his guidance under very trying conditions.

T.S.

CAMPING WEEKEND IN THE CALDEW VALLEY

26th. to 28th. July, 1963.

On the 26th. July early in the morning, we looked anxiously at the sky, the previous three weeks having been consistently wet. The sky was, to our astonishment, clear, so we said "It cannot last - it will be raining by tonight". With a resigned air, the camping equipment was packed, a truly varied mixture reminiscent of a glacial deposit. When the car had been securely and firmly loaded we discovered that to prevent isostatic forces from sinking the wheels axle-deep in the boulder clay foundations of the Seascale roads, it was necessary to keep the car moving.

Having picked up Mr. Pearson, Miss Slater's camping equipment, and Master Eadington, we proceeded as fast as possible to the camp site. This had been chosen a month previously, in drizzling rain, when the water table was high and we could see the dry "islands".

Once arrived, the main idea was to erect tents and get the equipment inside before the rain came. To our astonishment the day became hotter and drier as time passed. Mr. Gowing kindly came over from Keswick for a few hours to help us erect the tents, and the Society flag was duly hoisted (if that is the correct expression) at 6-30 p.m.

Mr. Dockwray, comfortably installed by the stream and above the bridge, came to see what was afoot, and we were relieved to know that at least one other member had arrived. By dusk, we noted four important facts:

i. sixteen people had arrived,
ii. nine tents had been erected,
iii. it had not rained,
and iv. Miss Slater had not yet turned up.

Mr. Dockwray and I went out by car to look for item iv., and having travelled some five miles, discovered her walking with great determination towards the camp site. We stopped, called out, and Miss Slater warily (or wearily ?) approached. I assume she thought we were strangers, and not upright members of the C. G. S.

Back at the camp, everybody except Mr. Pearson, who was cold and found the ground hard, slept soundly. The next day dawned hotter and drier than before. Fortunately nobody suffered from sunstroke during the weekend, and the water (which had been analysed) was pure. The cooking arrangements were modern calor and alcohol installations in the centre of a quasi-Neolithic dolmen-like structure arranged by Mr. Pearson and Master Walmsley from greisen and granite boulders.

The President arrived on Saturday in time for the afternoon excursion, and we were joined by ten visitors each day, making a grand total of forty people attending for all or part of the weekend.

Apart from camping and geological activities, there was one other exercise which caused a good deal of amusement, namely the "burgling" of a member's car-the key had been inadvertently locked inside the luggage boot.

This camping venture, the first of its kind by the Society, was voted an unqualified social and geological success by those who attended, the only enemy being time.

The geological programme was as follows:-

Saturday July 27th. 9 a.m. to 12-30p.m. Leader: Mr. T. Shipp, B.Sc.	The outcrop of the Skiddaw Granite and its contact with altered Skiddaw Slates was traced along the bed of the River Caldew. The Greisen was examined over Combe Height, and Poddy Gill was visited in a search for tourmalinisation. Specimens of granite and metamorphosed slate were collected.
2 p.m. to 6 p.m. Leader: Mr. E.H.Shackleton, F.G.S.	Mineral veins and old mine workings of the Brandy Gill area were visited. Good specimens of mispickel, molybdenite, wolfram, chalcopyrite and pyrite were obtained.
Saturday evening.	A very interesting and animated discussion on hereditary characteristics in and education of lower forms of life was stimulated, in part, by intoxicating beverages at the Mill Inn, Mungrisedale. The younger members roasted potatoes in a camp fire.
Sunday, July 28th. 10-30a.m. to 1 p.m. Leader: Mr. F. E. Dockwray, B.Sc. (See below)	The more energetic members walked over the shoulder of Carrock Fell above Mosedale to see the altered Skiddaw Slates and study the petrology of the edge of the Carrock Fell Complex. The second party, led by the President, who explained the features to be seen at the base of the Fell, was joined for lunch at Further Gill Syke.
2-30p.m. to 6 p.m. Leader: Mr. E.H.Shackleton, F.G.S.	The whole party motored and walked to Driggeth Mine where good specimens of pyromorphite, barytes, copper pyrites and bayldonite were found. More time would have been an advantage at Driggeth.

Back at the campsite at 7 p.m., we regretfully packed the equipment, and in bright, warm sunshine, started homewards.

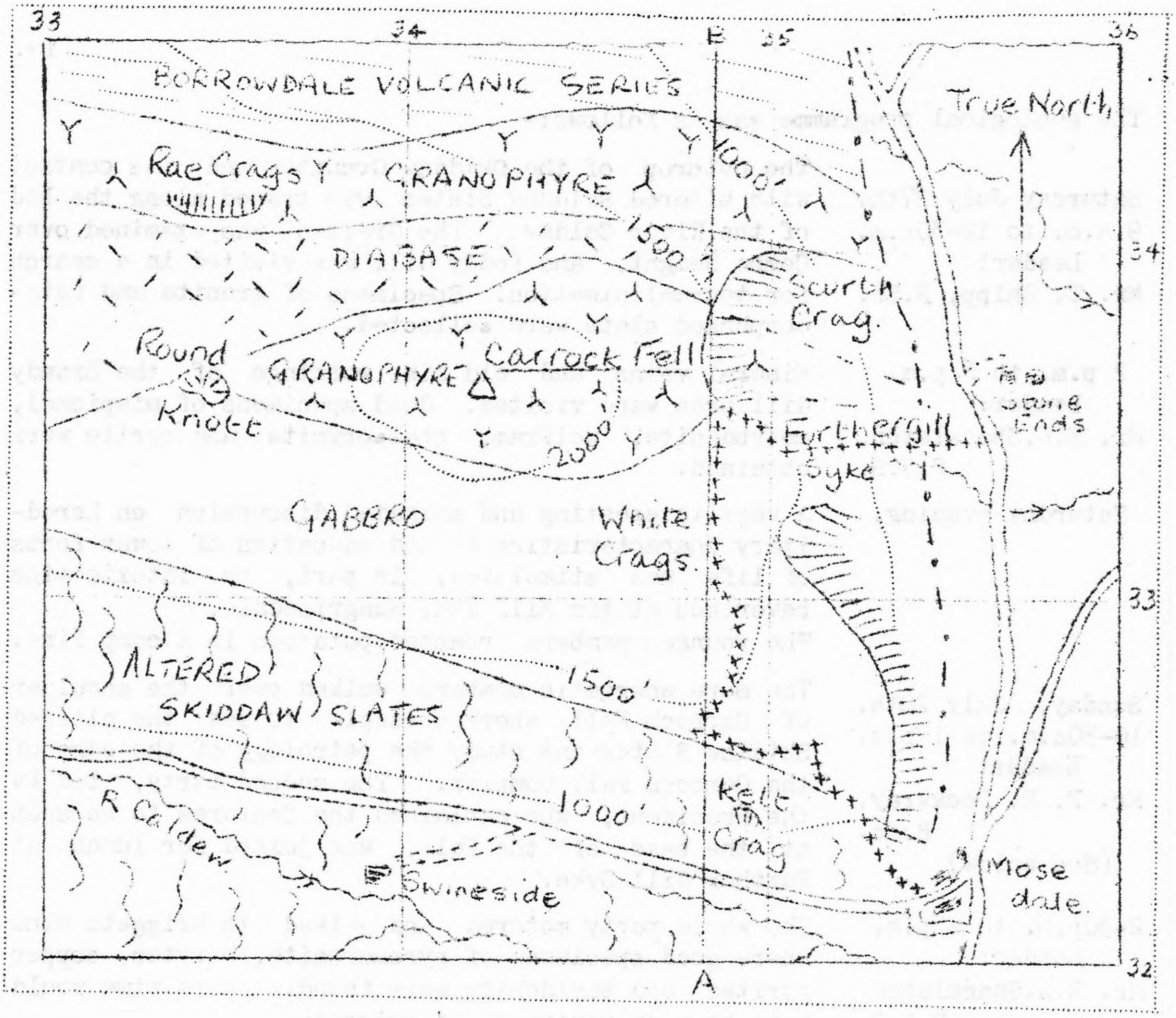
R. H. Hewitt.

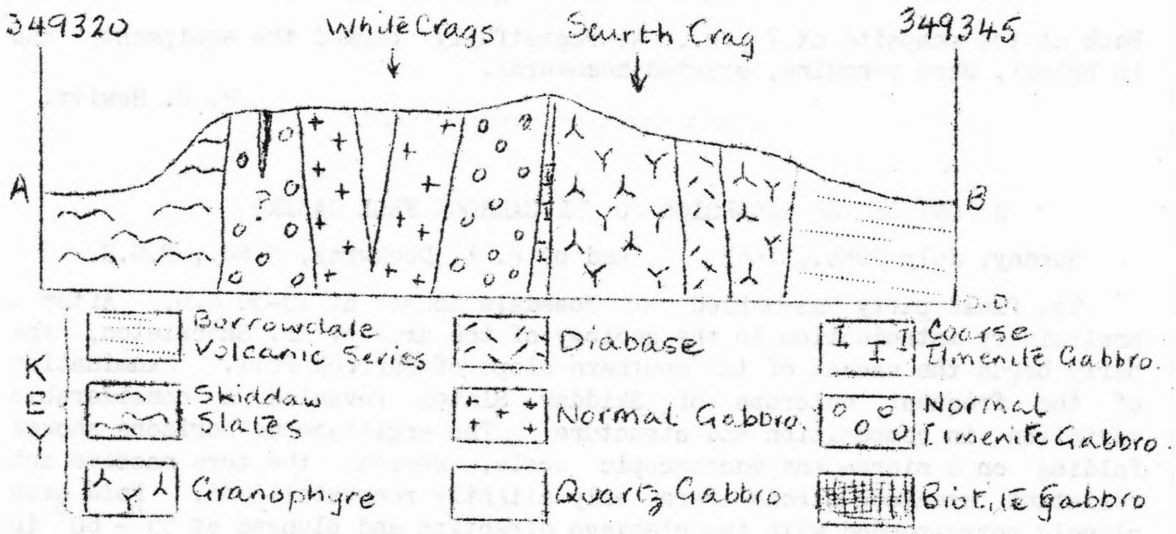
REPORT OF THE EXCURSION TO THE CARROCK FELL GABBRO

Sunday, July 28th., 1963 Led by F. E. Dockwray, B.Sc., F.G.S.

The field party assembled at Mosedale House at 10-30 a.m. After a preliminary introduction to the geology of the area by Mr. Shackleton, the party began the ascent of the southern slope of Carrock Fell. Examination of the frequent outcrops of Skiddaw Slates revealed a considerable variation in composition and structure. The argillaceous horizons showed folding on a micro- and macroscopic scale, whereas the more massive and resistant arenaceous beds were only slightly recrystallised. Fold axes closely corresponded with the cleavage direction and plunged at 55° - 60° in the direction W.20°.S.

The contact between the Skiddaw Slates and ilmenite gabbro is only visible in the area immediately north of Kelt Crag (see map). Elsewhere the boundary is deduced from relative percentages of slate/gabbro boulders.





Scale: Horizontal, 3 inches to 1 mile.
Vertical, 1/16th inch to 100 ft.

GENERALISED SKETCH MAP AND SECTION

ACROSS THE CARROCK FELL COMPLEX. CUMBERLAND.

In the immediate vicinity of the slate/gabbro contact, red garnets have developed. The contact zone is about three yards wide; the arenaceous slates have recrystallised into a dark, bluish-grey, flinty rock whilst cleavage and bedding planes have become secondarily folded and contorted. This contact is marked by a change in both the topography and vegetation. Heather, characteristic of the slates, gives way to coarse moorland grass, and the steep smooth slope of the slates is followed by a marshy depression giving way to the irregular topography associated with the gabbro. The strike of the contact in the area that the party visited was W.20°.N. to E.20°.S.

Examination of the rock types comprising the intrusion was made by taking a northerly traverse to Further Gill Syke via White Crags (see map and section). The Carrock Fell gabbro occupies the area between the Skiddaw Slates and the granophyre. Essentially the gabbro is a series of vertical (or nearly so) belts intruded on an east-west axis. There are two belts of ilmenite gabbro separated by a normal and a quartz gabbro.

The ilmenite gabbro is a dark greenish-black, medium-grained rock containing euhedral crystals of augite and ilmenite, together with biotite, set in a finely granular base of plagioclase and quartz. This ilmenite decreases as the percentage of free quartz increases. The two main features of this belt are:-

a. east-west trending xenoliths,
b. lens-shaped masses of biotitic and felsic gabbro.

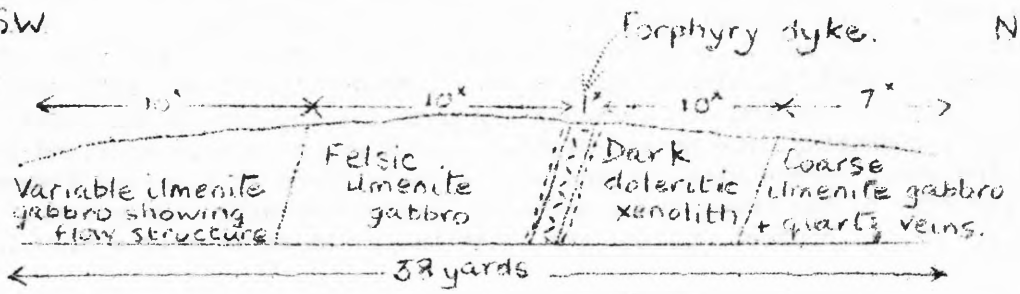
Xenoliths are very common and seem to be found throughout the whole of the ilmenite gabbro on the south side of the intrusion. The larger xenolithic masses may be roof pendants of Borrowdale Volcanics. One of these xenoliths that the party visited contained a distinctive porphyry dyke, closely resembling a veriety found in the Borrowdale Volcanics (see section). The lenses of biotite and felsic gabbro I regard as local segregations of the ilmenite gabbro, as they grade gradually into the parent type. Such a felsic lens can be seen in the sheep fold (Ref. 350.327).

The normal gabbro, of medium grain, changes to a quartz gabbro across a narrow transition zone, but the change to ilmenite gabbro is gradual.

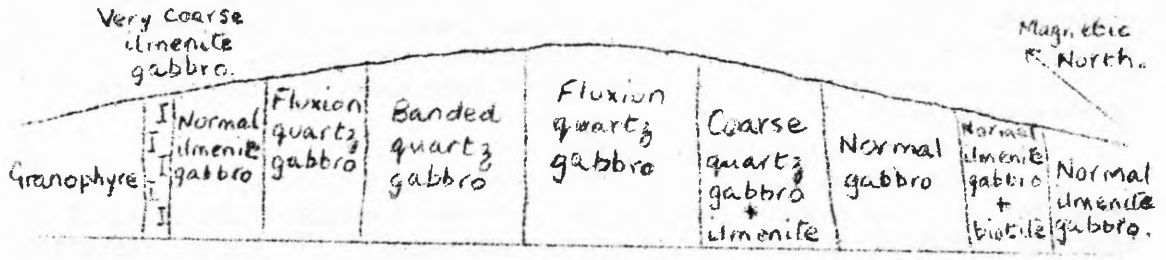
The quartz gabbro runs in an east-west belt through White Crags. This rock type shows distinct banding and flow alignment of crystals (see section). In the fluxion quartz gabbro, the pyroxenes and felspars show a linear trend parallel to the strike. The boundary between the fluxion and banded quartz gabbro is streaky, a gradual merging of the two types being apparent. The banded quartz gabbro is most striking, the width of bands being about one inch.

The party then descended to the head of Further Gill Syke where there is an excellent example of a hybrid zone developed between the gabbro and granophyre. Of special interest was the high concentration of ilmenite on the north side of the gully, which graded in thirty feet to a most distinctive, coarsely crystalline rock consisting of an interlocking crystalline base of pink felspar and quartz in which are set porphyritic hornblende crystals. This immediately stimulated a most involved discussion on the petrogenesis of the rock types, resulting in a compromise, involving "acid fronts" and "basic behinds".

As time was pressing, the party made a quick descent of the gully to the road where a belated lunch was taken.



Sketch Section across a Xenolith in the Ilmenite Gabbro at the S.E. of White Crags, Carrock Fell.



Diagrammatic Section through White Crags, Carrock Fell.



dark, fine-grained xenolith of Skiddaw Sl.

biotite developing at boundary between the slate and gabbro.

epidotic material - probably alteration of pyroxene.

crystalline quartz and felspar.

augite phenocryst of normal ilmenite gabbro.

ilmenite.

biotite developed in xenolith.

Diagram of hand specimen to show the contact relationship between gabbro and xenolith - Natural size.

F. E. D.

EXCURSION TO THE FURNESS DISTRICT OF LANCASHIRE

Sunday, 15th. September, 1963.

Report by the Director, Mr. Clive Nicholas, B.Sc.,
of Queen Mary College, University of London.

A large party of members assembled at the meeting place beneath the Coniston Limestone scarp, on the road from Askam-in-Furness to Dalton-in-Furness. A brief examination was made of the Ordovician Coniston Limestone in the fields east of the road, and the President commented on the purity of the limestone in contrast to the shaly nature at Coniston and in North-West Yorkshire.

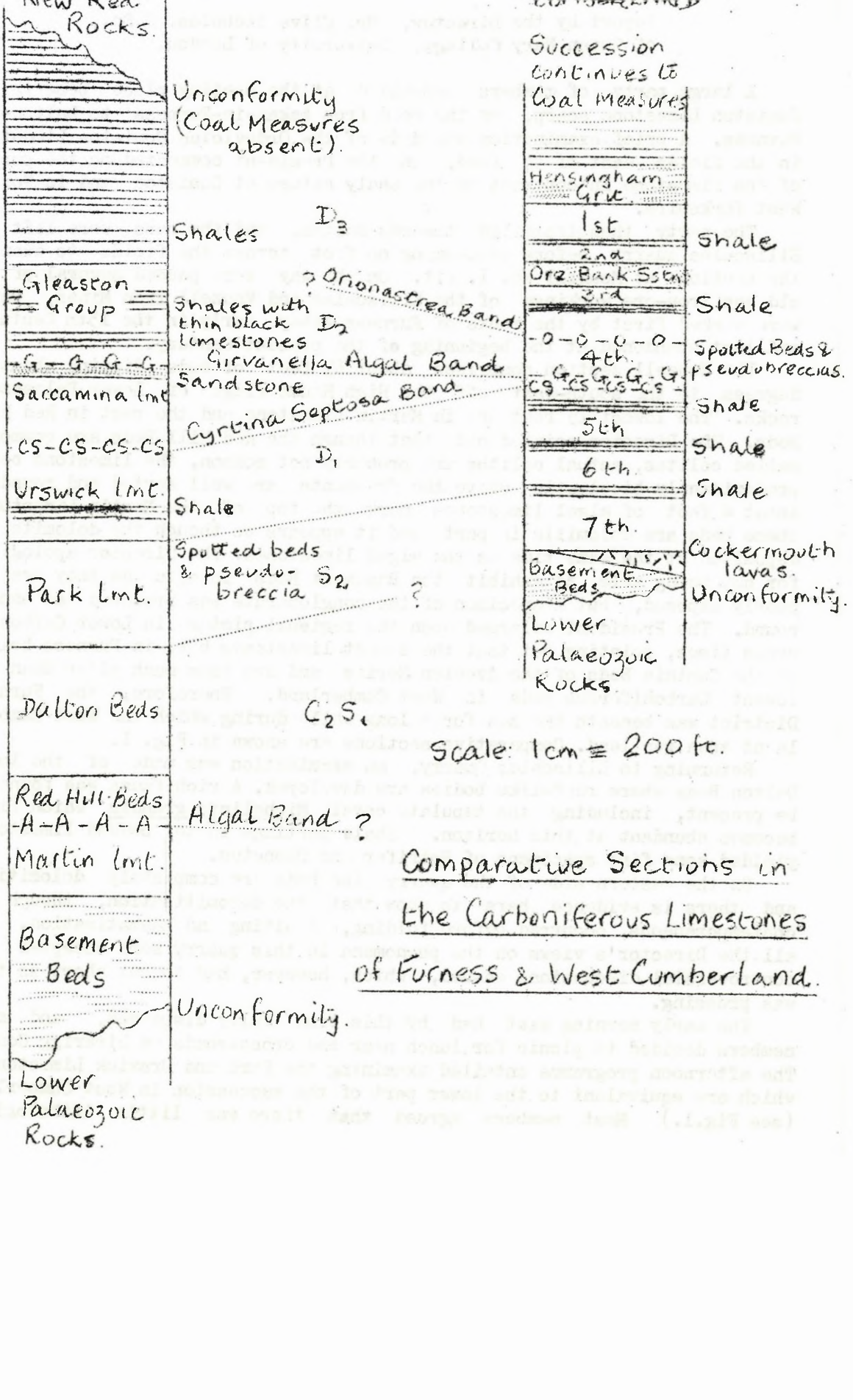
The party then travelled towards Dalton, and the cars were left in Elliscales quarry before proceeding on foot across the fields to examine the section at Mouzell No. 1. Pit. On the way were passed several of the old sop iron-ore workings of the Elliscales and Mouzell Iron Mines, which were worked first by the monks of Furness Abbey early in the 13th Century, and last abandoned at the beginning of the present Century.

The Mouzell section comprises about 65 feet of beds dipping about 15 degrees to the south-east off the High Haume ridge of Lower Palaeozoic rocks. The lowest 15 feet are in Martin Limestone and the rest in Red Hill Beds. The Director pointed out that though the Red Hill Beds are commonly called oolites, actual ooliths are probably not common, the limestone being predominantly bioclastic where the fragments are well sorted and rounded. About 4 feet of algal limestones mark the top of the Martin Limestone: these beds are dolomitic in part and it appears as though the dolomite was deposited at the same time as the algal limestones. The Director apologised for not being able to exhibit the Basement Beds in situ as they are but poorly exposed, but a specimen of the conglomerate was produced and handed round. The President enlarged upon the regional picture in Lower Carboniferous times, pointing out that the lowest limestones here in Furness belong to the Caninia Beds of the Avonian Series and are thus much older than the lowest Carboniferous Beds in West Cumberland. Therefore, the Furness District was beneath the sea for a long while during which the West Cumberla nd area was land. Comparative sections are shown in Fig. 1.

Returning to Elliscales Quarry, an examination was made of the lower Dalton Beds where reef-like bodies are developed. A rich fauna was found to be present, including the tabulate coral Michelinia grandis which first becomes abundant at this horizon. Shale partings in the bedded limestones yielded some fine specimens of Spirifer and Chonetes.

On the eastern side of the quarry the beds are completely dolomitised and there is evidence here to show that the dolomitisation, though not contemporaneous, occurred before folding, faulting and haematisation. Not all the Director's views on the phenomena in this quarry were accepted and controversial discussions ensued, which, however, had to cut short as time was pressing.

The early morning mist had by this time fully dispersed, and most members decided to picnic for lunch near the cross-roads on Birkrigg Common The afternoon programme entailed examining the Park and Urswick Limestones, which are equivalent to the lower part of the succession in West Cumberland (see Fig.1.) Most members agreed that there was little lithological



Scale: 1cm ≡ 200 ft.

Comparative Sections in the Carboniferous Limestones of Furness & West Cumberland.

similarity between the deposits in the two areas, though this is hardly surprising in view of the distance between. However, the fauna of the two areas are very similar. The Director assured members that the coral Nematophyllum minus, characteristic of the S_2 horizon and common in the Seventh Limestone of West Cumberland, did occur in the quarries on Birkrigg Common, but unfortunately it could not be found on this day. Linoproductids however were unearthed in profusion and these two characterise the S_2 horizon though they are not confined to it.

Crikes of the Urswick Limestone cap the summit of Birkrigg Common, and also form the dip slope towards Morecambe Bay in the east. Several large specimens of Dibunophyllum yielded to the hammer, proving that the succession had been ascended to the D beds. But the geology underfoot was of secondary importance to the magnificent view which was unfurled to the party as they proceeded to the summit. The fells of the Lake District, in particular the Coniston trio, were emerging from the low-lying haze, which lent a fairy tale atmosphere to the scene. Across Morecambe Bay, it was just possible to see the beginnings of Industrial Lancashire, whilst to the south, the giant cranes of the Barrow shipyards were reminiscent of a flock of flamingoes as they stood motionless and regimented, poised in readiness awaiting their next task. The famed view of the Snowdon Range in North Wales was invisible through the haze but the charm of the scene was such that most members were loath to leave.

On the way down the dip slope to Sea Wood, Mr. G. Jackson of Barrow took some of the party to see a Neolithic Stone Circle whilst the rest continued to the coast where they were rejoined later by the break-away group. At Sea Wood the Davidsonia (Cyrtina) septosa band is exposed on the shore. This band, characterised by the fossil after which it is named, can be traced throughout the North West of England and into Derbyshire on approximately the same horizon - i.e. near the top of the D_1 beds. A search was made for the fossil, which is a coarsely ribbed brachiopod easily recognised in cross section, when it appears like the broad arrow of the government bench mark. The limestones here have been perfectly weathered by the sea, and with a lens it can be seen that foraminifera are very abundant. Corals and Productids too are very abundany but difficult to extract.

The Gleaston Group could not be seen in situ but at Sea Wood, many pebbles of the black limestone from near the base of the Group occur on the beach. Fossils are very abundant in these black limestones and many specimens were collected, in particular the large, thin-shelled, coarse-ribbed Productids. The Director exhibited a cut and polished specimen of the Girvanella algal Band, which also occurs on approximately the same horizon in the limestones throughout North West England.

This concluded the field-meeting and before the party dispersed, the President expressed the thanks of the Society to the Director both for the demonstrations in the field, and for the preparation beforehand of the maps and succession sheets which had been distributed to members present. The Director in turn thanked the Society for the excellent turn-out, and expressed the hope that he would be able to lead a further excursion, as a sequel to this one, to the Cartmel District the following year.

Lithological Details of the Carboniferous Limestone of Furness.

NEW RED SANDSTONE

- - - - -Unconformity- - - - -

7.	Gleaston Group	Black shales predominate with thin sandstones and black limestones. Crinoidal limestones common in the lower beds.	1,200 ft.
		Girvanella band.	3 ft.
		Crinoidal limestones.	c. 200 ft.
6.	Urswick Limestone	Well bedded white bioclastic foraminiferal limestone, with some spotted beds and pseudo-breccias. Some shale partings. Forms grikes.	400 ft.
5.	Park Limestone	Poorly bedded, pale grey blocky-jointed limestone. No shale partings. Never forms grikes.	400 ft.
4.	Dalton Beds	Dark grey well bedded limestones. shaly beds numerous in the middle part. Reef-like bodies in the lower part near Dalton.	380 - 850 ft,
3.	Red Hill Beds	Medium-grey limestones, generally massive.	200 ft.
		Algal band.	1 - 4 ft.
2.	Martin Limestone	Calcite mudstone and tough grey limestone with thin shale partings. Thinly bedded.	150 - 450 ft.
1.	Basement Beds	Shale, sandstone and conglomerate with limestone becoming more common in upper beds.	0 - 300 ft. approx.

- - - - -Unconformity- - - - -

LOWER PALAEOZOIC ROCKS

Succession in the Carboniferous Limestones of Furness

	Garwood 1912 (faunal).			Dunham and Rose 1940. (lithological)
D	Dibunophyllum Zone	(Upper	= 7	Gleaston Group
		(Lower	= 6	Urswick Limestone
C	Productus corrugato-hemisphericus Zone	(Nematophyllum minus Sub-zone)		
		(Cyrtina-carbonaria Sub-zone)	= 5	Park Limestone
		(Gastropod beds)		
B	Michelinia Zone	(Chonetes carinata Sub-zone)	= 4	Dalton Beds
		(Camarophoria isorhyncha Sub-zone)	= 3	Red Hill Oolite
A	Athyris glabistria Zone	Seminula gregaria Sub-zone	= 2	Martin Limestone
		Unfossiliferous	1	Basement Beds

C and D with Lithostrotion.

A and B without " .

C. N.

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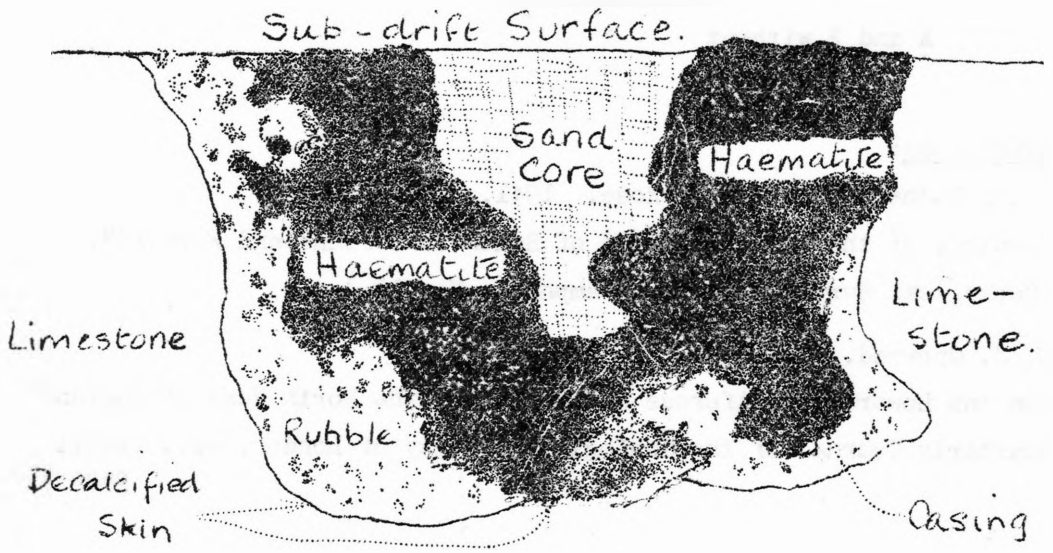
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THE IRON ORE SOPS OF FURNESS

C. Nicholas B.Sc.

Sops are bodies of haematite iron ore, circular to oval in plan, and narrowing downwards like deep basins, but the boundary walls are usually irregular. They are confined to the Furness ore-field but the area where they occur is restricted to the limestone outcrop north of a line from Dalton to Lindal: south of this line the ore bodies re more of irregular vein-like habit similar to the deposits in West Cumberland. Veins accompany the sops occasionally.

The greater part of the haematite in the sops is soft and can be dug with a pick in contrast to the vein ores which are hard and have to be blasted. Peculiar to the sops is the fact that in many places, irregular pipes, or masses of clay and sand, evidently originating from the New Red Sandstone, occur interspersed with the ore. It is the occurrence of this sand, together with the fact that the iron bearing solutions came from above, which gave rise to the theory that downward percolation of water through the New Red Sandstone carried haematite from the latter into the limestone (Trotter 1945). This theory has now been discarded as the ores in the veins can not be explained by it and it is hardly possible that the two so similar types of ore-body could have had totally different origins.



Vertical Section through a Sop:
(Showing the layers)

Dunham and Rose (1949) discuss the relation of the New Red Sandstone to the sops. The limestone walls of the sops, they say, are obviously water-worn with a white "decalcified" skin and immediately inside this is usually a cave-breccia of large rounded limestone boulders also with white skins and set in a brown clay matrix. Thus the sop ore has evidently been emplaced in a pre-existing cavity in the limestone, in contrast to the vein ore which has without doubt replaced limestone in the majority of cases (this latter fact is shown by fossils entirely replaced by haematite and the "bridging" of vein ore bodies by thin shales, which obviously could not have bridged a cavity - Kendall 1893 p.111,112)

Dunham and Rose go on to say that the rubble is not comparable to the Brockram. A "casing" of red clay up to 10ft. thick separates breccia from ore and this layer is markedly slickensided vertically. The ore is invariably broken into fragments in a matrix of powdery material of the same composition. Then in the centre comes the core of sandstone blocks.

It is suggested on the evidence by Dunham and Rose that before ore emplacement, the New Red Sandstone rested directly on Carboniferous Limestone with little or no intervening Zechstein or Yoredale Shales: swallow holes were formed at the top of the limestone by waters circulating from the sandstone onto the limestone. The rubble is a cave breccia. The iron was then introduced into the swallow holes by solutions from the sandstone, these solutions evidently having a hydrothermal origin. continued solution of the sop walls by percolating water caused brecciation of the haematite and the introduction of the sand and sandstone-block core.

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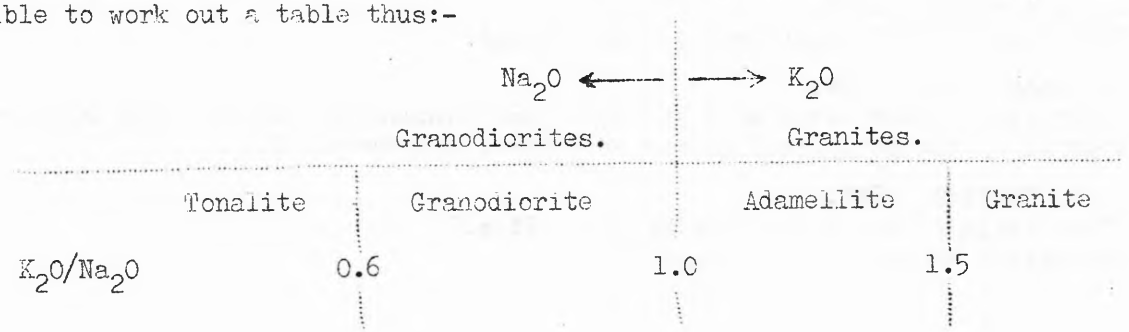
GRANITES AND OROGENY

On the 24th. September, in the Workington College of Further Education, the opening lecture of the winter session was given by J.R.Harpum, B.Sc., Ph. D., F.G.S., of Penrith, to a large and appreciative audience.

Dr. Harpum was formerly on the staff of the Geological Survey of Tanganyika, and whilst serving there was called upon by his director to make a survey of the granites of the territory. As there are some 80,000 square miles of Tanganyika's mountainous country occupied by rocks to which the term "granite" might apply, this was obviously no mean commission! The lecturer then illustrated his talk by a large number of very lovely colour slides, shewing some of the characteristics both of Tanganyika territory and the "granite" country.

At the outset, Dr. Harpum said, he was confronted by the problem, "What is a granite?" The more he tried to apply the ordinarily accepted criteria the more he got into difficulties. The text books describe granite as a rock essentially made up of orthoclase felspar, mica and quartz, with a silica content ranging from 63% to 76%. This is all very well in the laboratory, but in the field where does one place the wide variety of rocks associated, most of us would agree, with granites? The lecturer stressed that it was as well to put in the proviso, "most of us", for he soon found by experience that even his colleagues were not always agreed as to what should be accepted as a "granite".

In a learned, but at the same time very humorous way, Dr. Harpum unfolded the story of how, through many trials, false starts and tribulations he at last formulated a system which would satisfactorily classify the granitic rocks. The basis of this classification was chemical, and depended upon the relationship between the K_2O/Na_2O content. The clue to this came from the fact that as one moves from the granites towards the granodiorites the percentage of orthoclase (potassium) felspars falls and the percentage of plagioclase (sodium) felspars rises. Using this as a basis it was possible to work out a table thus:-



By very carefully choosing his samples, and making sure the material was fresh and representative, Dr. Harpum said he was able, over a period of many years, to reduce to some sort of order what had at first seemed a hopelessly heterogeneous collection of rocks.

As his experience in the subject grew, and he examined more and more of Tanganyika's wild and beautiful terrain, it became clear that there was a time relationship between the granites and the mountain-building movements, or orogeny. In fact there were types of granitic rocks referable to different periods of orogeny. The lecturer produced striking abbreviations to cover these relationships.

At the height of any great mountain-building period enormous masses of deep seated granite are formed. To the type of granite (used in its widest sense) formed in this way he gave the name SOG - meaning synorogenic. To a second class formed at a late stage in a mountain-building period he gave the name LOG - late orogenic. But there was a class of granite, a class which came nearest to our old conception of a "granite intrusion", and this class he had found to be emplaced when the orogeny had ended. This last division he named POG - post orogenic granite.

Now it turned out that there appeared to be a close connection between LOG and mineralisation. This was fortunate because all Surveys like to shew some economic justification for their researches. It amounted to this: that anyone skilled in the lecturer's methods could, by examining a granitic mass, say at once whether mineral wealth was likely to be found. He was even prepared to suggest that gold was more likely in a Tonalite mass, whilst tin was more usually associated with granite.

Dr. Harpum shewed that his SOG, LOG and POG could be related to earlier classifications. In doing this he neatly brought together H.H.Read's classification according to movement of magna, whether the granites were intruded (allochthonous) or formed in situ (autochthonous), and Buddington's work on the depth of formation of granites, very deep (katazone) or at no great depth (epizone).

In conclusion, he stated that now he was an amateur geologist, i.e. a geologist who did what he liked to do, as against a professional who did what he was paid to do, he was actively engaged on trying out his theory on the Shap Granite, and would in time like to extend his researches to cover the granitic masses of Lakeland as a whole. In this, perhaps, members of the Society would help by collecting material.

A lively discussion followed, during which the number and calibre of the questions asked, clearly shewed the interest the speaker had aroused. In conclusion the President thanked Dr. Harpum on behalf of the Society's members for what he described as a lively, amusing and highly informative address, which the members of the C.G.S. had been greatly privileged to hear.

E. H. S.

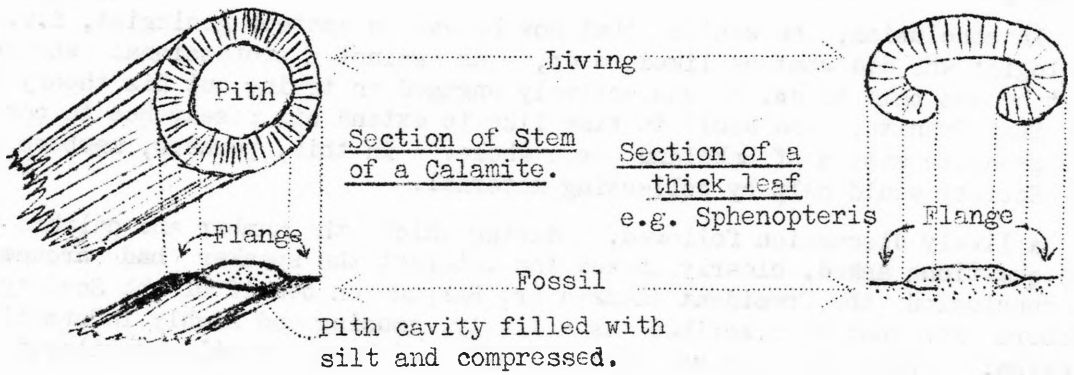
INVESTIGATING FOSSIL PLANTS

On October 25th. 1963 in Whitehaven College of Further Education, the second lecture of the Winter Session was given by D.L. Smith,B.Sc.,Ph.D., of Manchester University.

Attendance at this meeting left much to be desired, but those who did attend were rewarded by a most interesting talk, well illustrated both by slides and demonstrations of technique.

Dr. Smith pointed out that easily recognisable fossil plants came in only during Devonian times but by the Carboniferous there was a flourishing land flora. The very prolific plant fossils of this period brought about many problems of classification which were not solved for many years. Plant growth provides roots, stems, branches, leaves and fruits or spores. All of these plant members are capable of ready fossilisation; the difficulty is to recognise which of these diverse parts are from the same plant. Only if one found a complete plant was this formerly possible, and such an event was very rare.

This problem led to a study of <u>how</u> plants came to be fossilised. In reviewing the processes of partial decay, covering by silt, and petrifaction, it was realised that many features of fossil plants which had previously been regarded as actual plant structures, were in fact due to changes brought about during fossilisation. An instance was given of the "flanges" of carbonised material to be found on the edges of some fossil leaves and stems. This at one time was thought to be indicative of a peculiar type of ribbing on certain plants until it was realised that the flanges were due to compression of the plant material as shown in the diagrams below. The width of flange shows the original thickness of leaf or stem wall.



If some of the macro-structures of fossilised plants had hitherto proved unreliable, present day investigations were showing that micro-structures, where these could be worked out, were proving more helpful. The lecturer then gave some interesting demonstrations showing how the micro-structures of plant fossil material could be brought out and studied.

One method successfully demonstrated was that of making "peels" from coal balls. Coal balls are concretions of calcium carbonate containing carbonised plant material which has undergone very little crushing. The method of cutting and polishing, followed by "development" in hydrochloric acid, and the taking of an impression of the developed surface on cellulose acetate film, differs little from the method hitherto used by some of our members on fossil corals**.

Another technique described was the preservation of very delicate plant material by transference on to a film of cellulose ester. The method is as follows. The fossil is painted with cellulose ester which is allowed to harden. The siliceous rock material is dissolved away in hydrofluoric acid leaving the fossil stuck to a flexible, transparent base, and is an eminently suitable way of preparing material for microscopic or infra red photographic studies.

Dr. Smith then went on to talk about maceration techniques in which the plant material is deliberately destroyed to gain an impression of the outer waxy skin or cuticle which is characteristic to each type of plant. This led to a discussion of the value of spores - each type of spore being characteristic of a particular plant, and the lecturer dealt with the separation of spores from coal and from other rocks. One method involved the treatment of a powdered sample with hydrofluoric acid, followed by zinc bromide solution, from which the spores could be separated by centrifuge from the rock residuum. Spore assemblages are of special interest to the Coal Board and Oil Companies for identification and correlation of coal seams and other strata over a wide area.

After questions, discussion and further demonstration of techniques, a vote of thanks was put by Mr. T. Shipp, bringing to an end an evening thoroughly enjoyed by those present.

T. S.

** "Proceedings of the Cumberland Geological Society" No.2, 1962. Page 9.

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The November lecture, "Alpine Snow and Ice", to have been given by Mr. Richard Gowing, was postponed. In its place, Mr. E.E. Shackleton, the President of the Society, at very short notice delivered a lecture entitled "Mountains - their nature and origin". The Society is indebted to Mr. Shackleton for a most polished exposition of theories of orogenesis, well illustrated by slides.

B O O K R E V I E W S

"PORTRAIT OF THE LAKES" Norman Nicholson.

(Robert Hale Eighteen Shillings.)

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This is an admirable book, which fully bears out the promise of its title. While it incorporates some material already published in the same author's "Cumberland and Westmorland" in the County Books Series (and reproduces some of the same photographs), it is not a mere rehash of that well known book, but has many excellences of its own.

It is very satisfactory to find that Norman Nicholson does not interpret "The Lakes" too narrowly or too literally. He fully realises the close links, geological as well as human, which bind the Lakeland of the tourist and holidaymaker with the less visited industrial and farming country along the coast. Indeed, one of the most pleasing features of the book is its insistence on the essential geographical unity of the whole area lying between Morecambe Bay on the south and the Solway Plain on the north, and between the West Coast and the A6 road from Kendal over Shap to Penrith and Carlisle.

The first three chapters give an excellent general account of the lay-out and geology of the area. The trained geologist will not expect any startling discoveries to be revealed in a book of this kind, but it is most refreshing to see again the familiar landscapes through the penetrating eye of a poet who is also well and accurately informed on the nature of the rocks and on the long and complex geological history of our area. He uses geological structure and the processes of erosion to explain the landscape, but by many an unexpected turn of phrase or vivid analogy he throws fresh light on his subject. And again he pays full attention to the coastal strip, too often neglected by writers on the Lake Counties.

The remainder of the book takes us through the long story of Man's activities in our corner of England, from prehistoric times to the present day, but it is no mere recital of historical incidents. The author always stresses the vital interaction between the physical environment and human endeavour, not only in the ways that Man has chosen to wrest a living from his somewhat difficult surroundings, but also in the imprint which his activities have made on the living and ever-changing landscape. Norman Nicholson is equally interested in slag heaps and stone circles, in market towns and modern chemical works.

This book expresses admirably the unique personality of the Lake Counties, the result partly of its physical geography and partly of its many-sided human story. It is a book which every lover of Lakeland will wish to possess.

H.A.W.

"THE CHEMICAL ELEMENTS IN NATURE" Dr. F. H. Day.

(Harrap Forty Shillings)

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The more one reads of scientific achievements, the greater becomes the awareness of the breakdown of the old classification into physics, biology, chemistry, etc., resulting in larger and larger numbers of increasingly specialised topics. My own view of this, in spite of the apparent and increasing diversion of scientific work, is that there is a tendency toward the intermingling of the old disciplines exemplified by such terms as bio-geochemistry. This view has been crystallised (if you will pardon the pun; the book under review deals largely with minerals) in reading Dr. Day's book. He has demonstrated the interdependence of the various branches of astronomy, chemistry, physics, biology, geology and geography in explaining the formation, segregation, discovery and exploitation of the ninety or so elements of which the Earth is composed. The book is a digest of ideas and facts, many of which in the ordinary course of events would be very difficult to collect and collate. Dr. Day's wish to help chemistry students to learn where their materials have come from is, I feel, one that will be shared by many lecturers and teachers who regard chemistry not as an end in itself, but as an aid to the awareness of the processes of nature, and the impact of man's activities upon them.

The opening chapters of "The Chemical Elements in Nature" deal with 'Chemical Natural History', and as one who has had the privilege of hearing Dr. Day lecture on this very subject, I am impressed by his treatment of aspects of cosmochemistry, geochemistry, geology and biochemistry which have led to the formation of the elements and segregation of groups of them as mineral compounds. This is followed by a brief account of methods of locating mineral deposits. All this - in five chapters - means that a considerable amount of detail has been omitted, and, as a warning to the reader, I would quote from T. H. Huxley's Collected Essays: "Irrationally held truths may be more harmful than reasoned errors." The 'truths' in these chapters are a collection of very valuable summaries germane to the fuller treatment given to individual elements and groups of elements in the later chapters. These are merely the ideas, the theories, and it must be realised that many of them will be revised as man's knowledge and insight expands. Dr. Day has here written nothing to justify these ideas - he has simply stated them in order to fill the background of his elemental canvas, arousing the reader's curiosity, and inviting him to delve deeper into the source literature in order to satisfy that curiosity.

The remaining chapters of the book, no doubt based on Herbert Spencer's assertion that science is organised knowledge, deals with the elements both singly and in groups. The approach is a chemical one, and the order is that of the Periodic Table of the Elements, commencing with hydrogen, and ending with the actinides, a scheme used in most advanced textbooks of inorganic chemistry.

For each group in the Periodic Classification the author has compared the terrestrial and cosmic abundance of the individual elements, plotted on a logarithmic scale. Here I would have welcomed a complete chart embracing all the elements, instead of a number of dissected pieces that have to be searched for. The table of relative abundances on pp. 21 ff., although exhaustive, is also exhausting - I feel that a graph, as a folded insert to the book, would have conveyed the same information much more clearly.

In general, the author discusses for each element its probable mode of formation in the cosmos, its terrestrial abundance standardised in grams per ton, its distribution throughout the Earth, a representative list of minerals containing it, the relevant geochemistry and biogeochemistry, and, where it is economically important, the main uses are stated together with a table of the chief producing countries and a graph of world production.

Although the book is couched in chemical terms, and is mainly intended for chemists, it contains a great deal of material to interest geologists, geographers and economists. The purpose of the book is clearly stated by the author in his preface, and he has kept steadily to that purpose. The sketches and graphs are generally clear, whilst the diagrammatic "natural cycles" of certain elements are particularly noteworthy.

This book is recommended as an invaluable addition to the library of anyone who is interested in the occurrence and distribution of natural resources.

T.S.

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Space does not permit the inclusion of full reports of two functions held this Session. The first, a visit to the Ore Stocking Ground and Sinter Plant of the Workington Iron and Steel Company on November 30th., was organised and led by Mr Shackleton with the kind permission of the Company. The second was a programme of films, held in Whitehaven College on December 20th., 1963.

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The next Proceedings are due at the end of June, 1964, and the Editor requests contributors to submit their articles as soon as possible, and in any case, before April 30th., 1964.