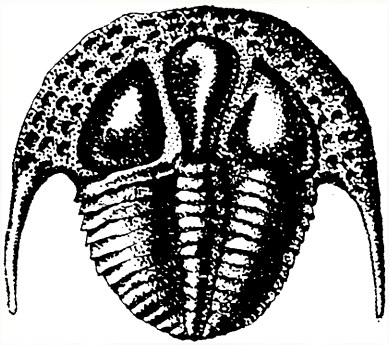
THE CUMBERLAND GEOLOGICAL SOCIETY



PROCEEDINGS

Volume 3 1973-74 Part 3

Price £1.00

The Cumberland Geological Society

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

PROCEEDINGS
1973—74

Volume 3 Part 3



Published by the Cumberland Geological Society. June 1975

General Secretary

T. Shipp, Esq., B.Sc., F.G.S.

Publications Secretary

S.H. Gate, Esq., M.Sc.,

Editor

F.J. Cockersole, Esq., F.R.C.O.G.,



RED HOUSE HOTEL

KESWICK

A country house hotel situated in 10 acres of landscaped gardens overlooking the beautiful Borrowdale valley and located on the slopes of Skiddaw, 2 miles outside Keswick.

Ideally situated for a holiday in the Lakes or as a centre for field excursions. Special terms will be quoted for geological or other educational parties for the off-season from October to the end of April.

Geological weekends are held regularly at the hotel during the autumn and offer the opportunity to enjoy two full days of field geology with evening lectures and discussions.

For the hotel brochure or details of geological weekends, please call or write to:

K. W. Bond, Red House Hotel, Keswick CA12 4QA
Tel. 72211

EDITOR'S NOTE

For the first time since the initial issue of the 'Proceedings' in 1962 there has been a change in the editorship. The Society owes a great deal to Mr. Tom Shipp, who has now become its General Secretary, for his consistent efforts over the years to improve the standard of the Society's publications.

The present editor will endeavour to continue on the same general lines to encourage the development of the academic quality of the contributions while always bearing in mind that the 'Proceedings' are for the benefit and interest of the members of what is primarily an amateur local geological society.

The Council hopes, however, that as the reputation of the Society and its publications extends, it will be possible for the 'Proceedings' to become the natural vehicle for at least a proportion of the scientific work done in the area. In this connection we particularly welcome Dr. Frank Moseley's important contribution, which should also serve to stimulate interest in local field work by members. Our President, always a generous contributor in the past continues his series of short biographical notes on Lake District geologists, while another of our members, Mr. John Moon provides some information about local collieries which is of considerable interest and historical value.

Perusal of these articles and the supporting excursion and lecture notes reveals some recurring themes. For the first time in our 'Proceedings' the theory of Plate Tectonics with its important impact on traditional geology is referred to several times. Linked to this one notes the renewal of interest in the Skiddaw Slate - B.V.S. relationship and the stratigraphical problems of the Carboniferous Limestones. On the educational side we note with pleasure the evidence of continued links with geological activity in our local schools and the development of a mutually rewarding relationship with the Open University.

Lastly readers will note some changes in type-face and lay-out. Traditional printing methods are becoming prohibitively expensive for small amateur societies with limited means. At present we are probably in a position of only being able to publish the 'Proceedings' in alternate years, and to do even this it is necessary to explore more economical methods of reproduction. This issue has been typed by Mr. Denys Hinde, one of our members, who is also responsible for much of the art-work. The completed pages of typescript and the diagrams have been photographically reduced and printed by the off-set litho process by Messrs. Bethwaites of Workington. The editor would like to express his thanks to Mr. Hinde and also to Mr. Wilkinson and Mr. Moss of Bethwaites for much helpful advice and finally to Mr. Tom Shipp for his continued help and encouragement.

C O N T E N T S

Page

ORIGINAL ARTICLES

Structural Relations between the Skiddaw Slates and the Borrowdale Volcanics - F.Moseley 127

J.F.N.Green...Amateur Geologist - E.H.Shackleton 147

Some Notes on the History of the Harrington Collieries and on the Locations of Old Pit Shafts at Workington - J.Moon 151

EXCURSION NOTES

Glacial Deposits in Ennerdale 159

Weekend Field Meeting in the Appleby Area 160

Cockermouth Lavas in the Blindcrake Area 162

Weekend Excursion to the Furness Peninsula 164

Intrusive Rocks in the Eskdale Area 168

Carboniferous Limestones of Humphrey Head 170

Haig Colliery, Whitehaven 171

LECTURE REPORTS

Revolution in the Earth Sciences 172

The Geology of Ethiopia 173

One Man's View of the Skiddaw Group 174

The History of Lead & Copper Mining in the Keswick Area 176

The Lower Carboniferous stratigraphical palaeontology of the Furness and Grange Area 178

OBITUARIES 179

ANNUAL DINNERS

15th March, 1974 181

14th March, 1975 182

ANNUAL GENERAL MEETINGS

The thirteenth Annual General Meeting 183

The fourteenth Annual General Meeting 188

STRUCTURAL RELATIONS BETWEEN THE SKIDDAW SLATES AND THE BORROWDALE VOLCANICS

F. MOSELEY

A B S T R A C T

The junction between the Skiddaw Slates and the Borrowdale Volcanics has been controversial for a century. It is partly faulted, and this is generally accepted, but elsewhere the questions at issue are:

(i) are the two groups separated by an unconformity of orogenic proportions, that is, were the Skiddaw Slates cleaved and subject to polyphase deformation prior to the deposition of the Borrowdale Volcanics?

(ii) is the unconformity a relatively mild one with angular discordance in some areas, but none in others, perhaps comparable to the unconformity between the Carboniferous and Permo-Trias in northern England?

(iii) is there a conformable passage across the junction with local discordances simply related to the violence associated with the onset of vulcanicity?

In this paper more than twenty exposures of the junction are recorded, and the conclusion presented that apart from the faulted contacts, the junction is an angular but non-orogenic unconformity over the greater part of the southern outcrop, but it is conformable in the northern outcrop (Binsey-Eycott).

(A) I N T R O D U C T I O N

Ever since Geologists began to make detailed maps of the Lake District there has been controversy about the relationship between the Skiddaw Slates and the Borrowdale Volcanics, whether it was a conformable one, unconformable or faulted. During recent years, following Simpson's (1967) paper, in which he claimed there was a major unconformity, the controversy intensified with contributions by Soper (1970), Helm (1970), Helm & Roberts (1971) and others, and whilst it is generally accepted that parts of the junction are marked by high angle faults, and others by 'décollement thrusts' resulting from differing competence of two groups, there has been no agreement on the unconformable-conformable issue. The differing points of view expressed up to the beginning of 1972 were summarised by Moseley (1972), but this was not the end, and further evidence and opinions on the nature of the junction and related problems were presented by Jeans (1972), Mitchell et al. (1972), Wadge (1972) and Downie & Soper (1972).

It has become increasingly apparent that this junction is an exceedingly difficult one to interpret, even when it is completely exposed. During the recent Geologists' Association excursion to the northern Lake District (Mitchell et al., 1972), the principal protagonists were assembled together in front of critical exposures and even after prolonged discussion during which every inch of rock was examined, there was still no general agreement on the structural relations. It will be understood, therefore, that this account, which includes descriptions of several previously unrecorded exposures of the junction, represents mostly the 'objective' views of the writer. Other people's 'objective' views may conceivably differ. Some details of a number of localities will now be examined, hopefully in such a way that readers can, if they wish, check the observations themselves.

(B) JUNCTION LOCALITIES

1. HIGH STILE, BUTTERMERE (17.15 to 18.14) Clark (1964), Simpson (1967) and unpublished Birmingham University reports by K. Smith (1972) and D.T.Aldiss (1974).

The junction between the Skiddaw Slates and Borrowdale Volcanics runs near to the foot of the steep crags which extend from Bleaberry Tarn to High Crag (Fig. 2), but it is generally concealed by aprons of volcanic scree and morainic mounds. There are, however, three localities where the junction can be inspected, as follows:-

1a High Stile (170 152). This is a mediocre exposure with no sharp dividing line between the Skiddaw Slates and Borrowdale Volcanics. Clark (op.cit.) suggested a fault since he thought 1000 feet of volcanic rocks were missing, but Aldiss believed it to be a minor unconformity.

1b High Stile (173 151). The junction here is marked by a thin conglomerate composed of volcanic pebbles which rest on cleaved 'mudstone'. The conglomerate is followed by andesitic lava with some tuff. The presence of volcanic pebbles indicates that the beginning of the volcanic episode must have been at an earlier time whilst the rapidly changing inclination of the junction led Smith to suggest that there was a valley in the Skiddaw Slates and that this governed the flow of the first lavas to cover the area.

1c High Crag (182 146). The junction is marked by a thin conglomerate of banded mudstone pebbles, in a well-cleaved matrix, which may or may not have been contemporaneous with 1b. There is amygdaloidal andesite above this horizon and normal Skiddaw Slates not far below it. Clark (1964) thought it was a tectonic conglomerate indicating a thrust plane, but Simpson (1967), whilst not referring to the conglomerate, suggested that there was a major unconformity

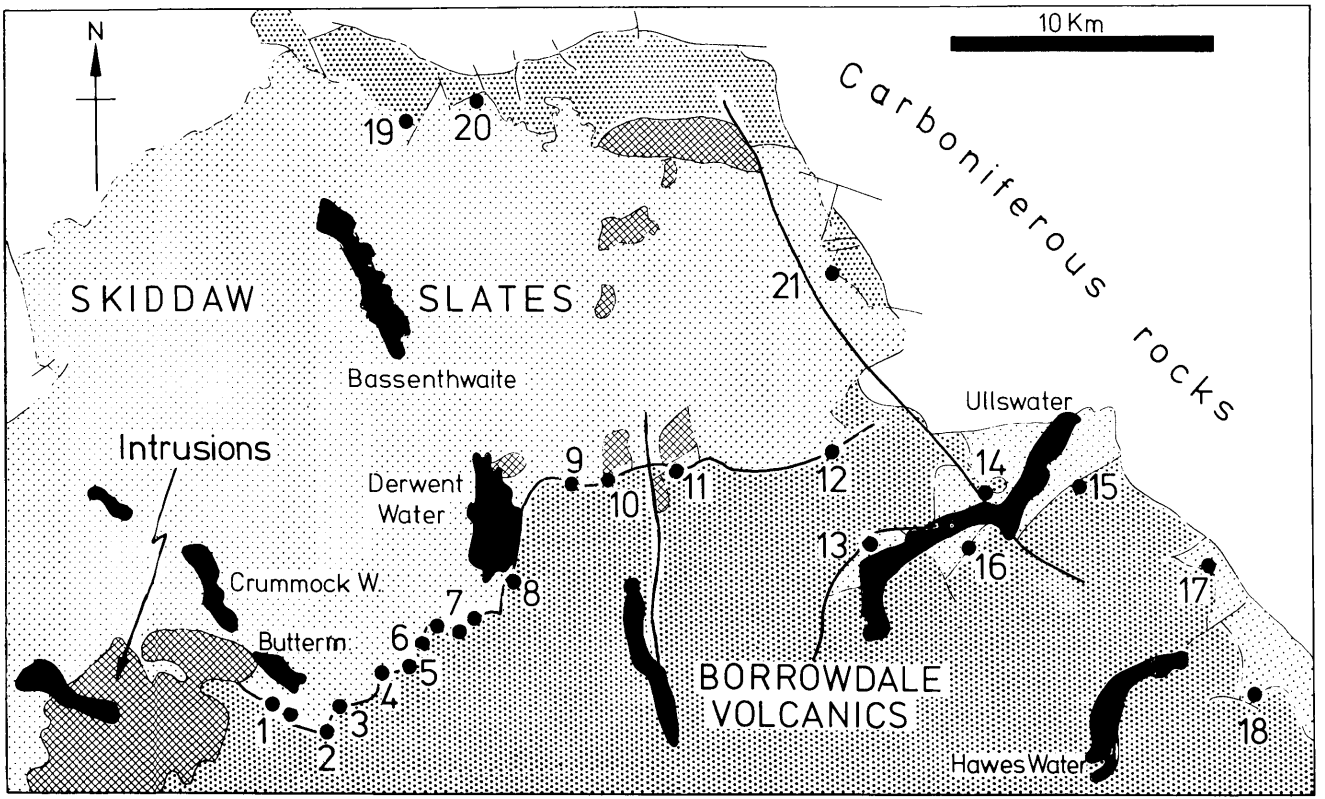


Fig. 1. Map of the northern Lake District to show the approximate positions of the localities described.

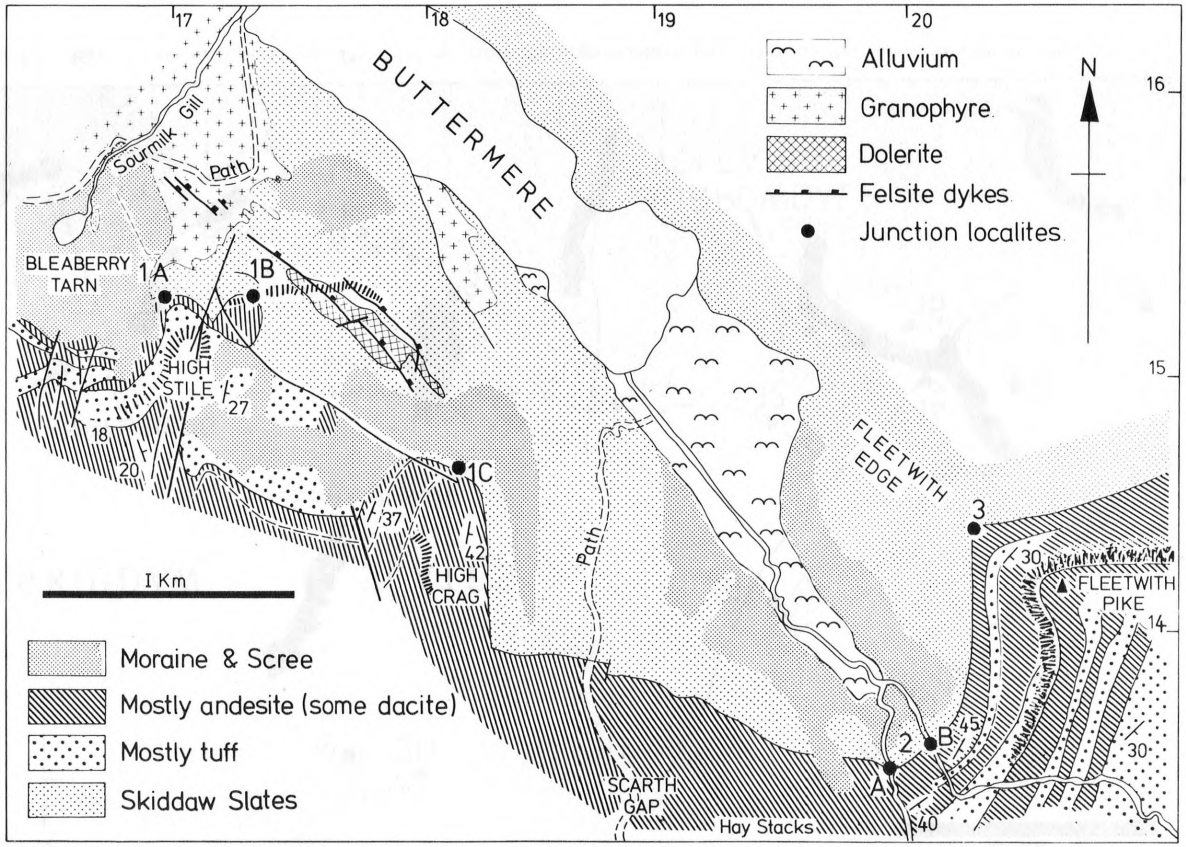


Fig. 2. Simplified geological map of the Buttermere area showing the positions of localities 1, 2 and 3.

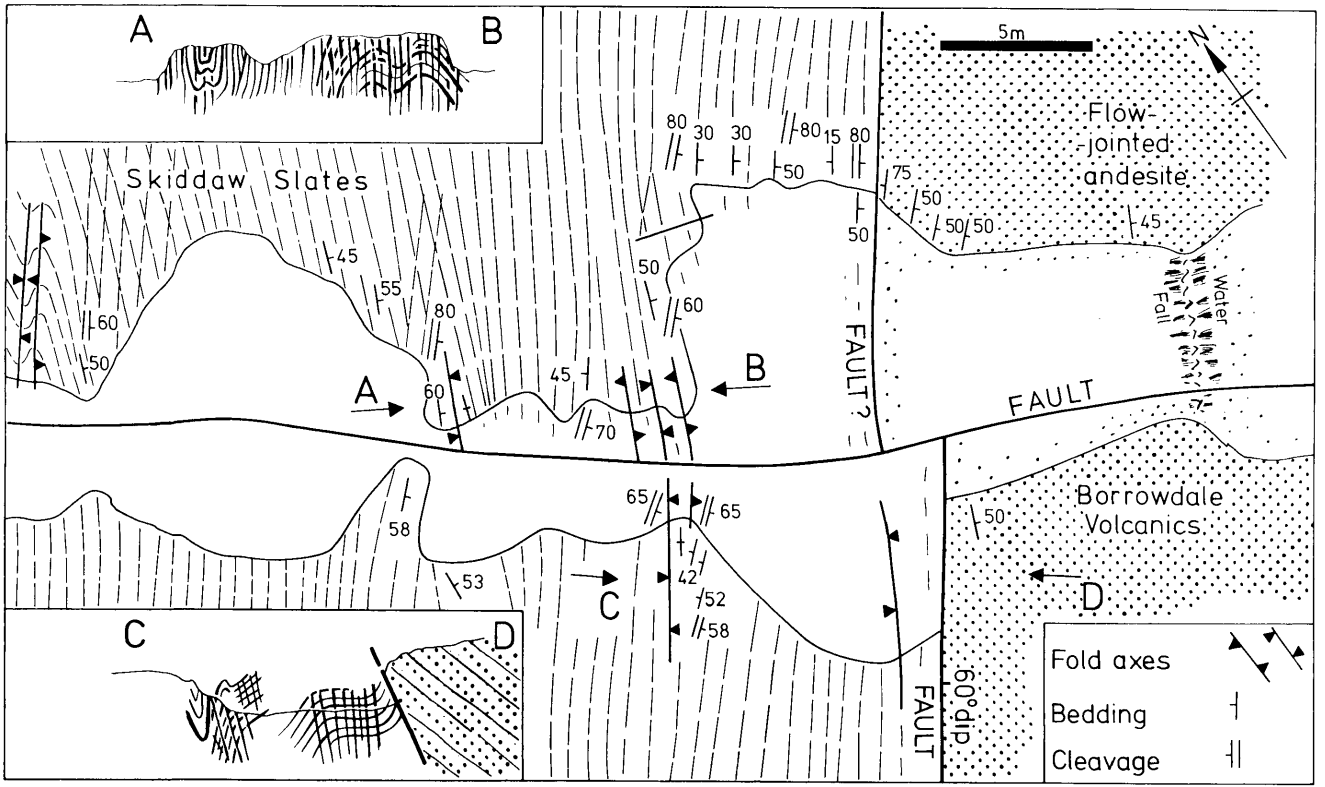


Fig. 3. Detailed map and sections of the Skiddaw Slate-Borrowdale Volcanic junction exposed in Wamscale Bottom (locality 2B).

The stream bottom, mostly boulder covered is left blank.

Anticlines, synclines, dip of bedding and cleavage shown by conventional symbols.

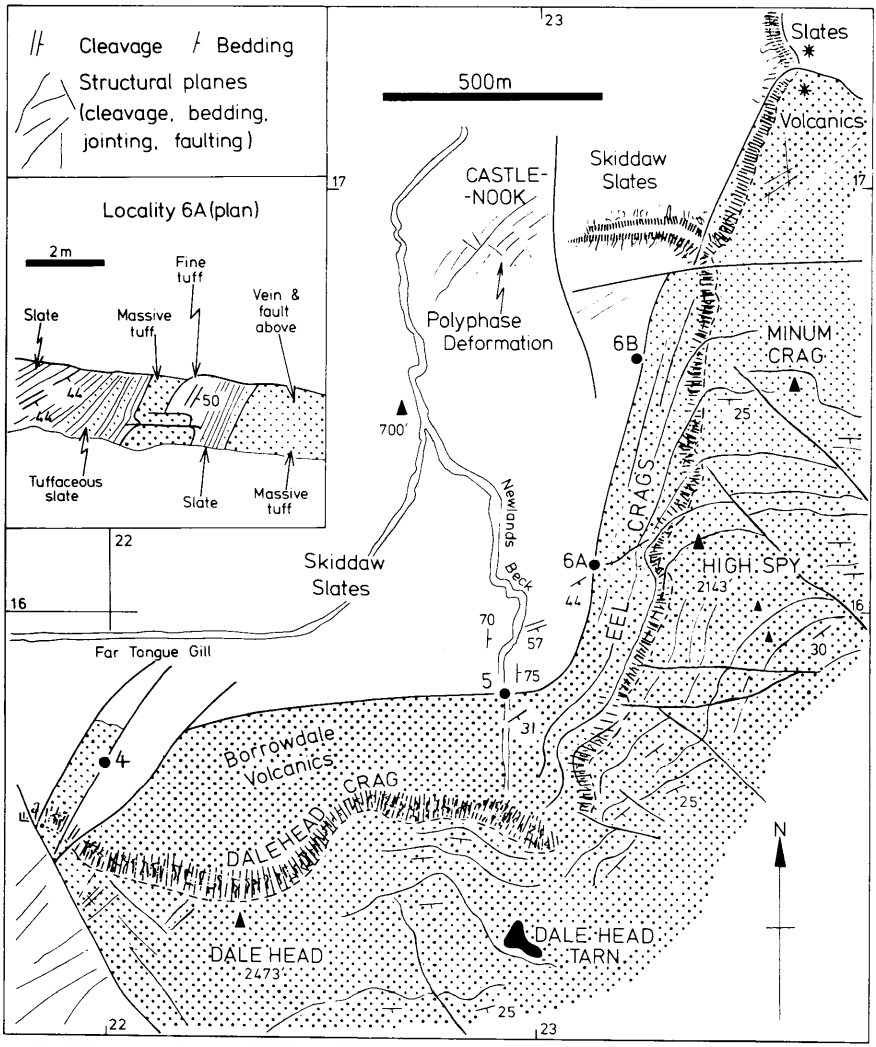


Fig. 4. Map of the upper part of the Newlands valley, showing localities 4 to 6.

here, with many thousands of feet of Skiddaw Slate cut out. Both Smith and Aldiss also suggested an unconformity, but noted that the cleavage in the Skiddaw Slates was sub-parallel to that of the volcanics, whilst there was no cleavage in the pebbles of striped mudstone in the conglomerate. This suggested a 'non-orogenic' unconformity, that is, there was no pre-volcanic cleavage or metamorphic effects.

2. WARNSCALE BOTTOM, BUTTERMERE (20.13) From the unpublished field maps & notes of F.Moseley and B.W.Bull (Birmingham University).

There are two adjacent exposures in this area illustrated by figures 2 and 3.

The Warnscale Beck locality (2B, 201 135) has been examined in detail by the author, and provides a continuous section across the junction. Starting downstream the Skiddaw Slates immediately pose a number of problems, particularly for those inexperienced in this type of geology. They are banded with pale silty layers in dark pelite. The cleavage is moderately strong, visibly axial planar to small folds, but often sub-parallel or parallel to the silty laminae. Along the stream bottom the slates are highly smoothed and the bedding is beautifully seen, but this type of erosion completely fails to reveal the cleavage. On the stream banks weathering has clearly picked out the cleavage, but the bedding is now almost completely concealed. This perplexing situation can only be resolved by careful study, and it is necessary to break small (oriented) cleavage fragments and examine them carefully using a hand lens. The silty laminae can then be seen. When the details are worked out it becomes quite clear that the Skiddaw Slates are tightly folded as far as the junction, and that these folds are abruptly truncated by a sharp 'joint' plane inclined 60°SE (Fig. 4). This exposure was first cleared by Barry Webb and must be regarded as a fault. Continuing upstream there is a massive flow jointed andesite which dips steadily to the SE and is completely unfolded.

Black Beck (2A, 199 135) shows a 20m exposure across the junction but the contact is not so clear. The bedding in the slate is discordant to the junction, which does not appear to be faulted (Bull, 1974). Bull also noticed that there were slate blocks near the base of the Borrowdale lavas, and that the cleavage in them was parallel to that in the underlying Skiddaw Slates (60°/120°), once again suggesting an unconformity, but not one of orogenic proportions.

3. FLEETWITH EDGE (202 144). Unpublished Birmingham University report by B.W.Bull (1974).

Immediately above the junction there is an andesitic flow breccia which contains uncleaved blocks of Skiddaw mudstone. The slates below the junction have steeper dips than the volcanics.

4. DALE HEAD (221 155). R.G.J.Strens, unpublished Ph.D. thesis, Nottingham University; E.B.Daniels, unpublished report, Birmingham

University, and field notes by F. Moseley.

To the north of Dale Head a wedge of Borrowdale Volcanics penetrates into the Skiddaw Slates (Fig. 4). The actual contact is only exposed on the SE side. where Skiddaw Slates rest on a planar surface of volcanics which dip 50° to 110°T. Although Strens suggested a normal fault, it seems more reasonable to interpret this outcrop as a thrust slice of volcanics emplaced during the Caledonian orogeny, when the difference in competence between the two groups resulted in vigorous disharmonic relations.

5. NEWLANDS BECK (230 158). Jeans (1972).

In the upper reaches of Newlands Beck, Borrowdale Volcanics, dipping 30° to the SE, rest on vertical Skiddaw Slates which strike north-south (Fig. 4). Although there is a one metre gap of no exposure at the actual junction there can be little doubt that there is an unconformable relationship at this point, and that north-south folding preceded the deposition of the volcanics. There is no cleavage associated with this folding, however, which, like some of the exposures already mentioned, suggests that the unconformity is not of orogenic proportions. The one cleavage in the area trends ENE and is common to both the slates and the volcanics. It is therefore to be regarded as an end-Silurian structure.

6. EEL CRAGS, NEWLANDS (23.16). From an unpublished Birmingham University report by J.M.Chaytor (1975) and notes by F. Moseley.

At the base of Eel Crags the junction between the Skiddaw Slates and Borrowdale Volcanics is marked by a long line of scree, but it is exposed at two points (Fig. 4 and Plate 1).

At the base of Eel Crags below High Spy (6A 231 162) there is an apparently conformable passage between slates and volcanics (Fig. 4, inset) rather like that of locality 7B (below). The exposures are along a prominent gully which rises up the steep crags to the east and is in fact the line of a mineral vein. Pelite alternates with tuffaceous pelite and tuff, whilst the cleavage and bedding in the pelite and in the overlying volcanics has the same orientation.

SE of Castlenook (6B 232 168) the junction is marked by a thin conglomerate similar to that of locality 1c. It contains mudstone pebbles with disoriented bedding but no cleavage.

7. HOLLOWS AND BLEA CRAG, BORROWDALE (24.17). Soper (1970), Helm and Roberts (1971), Mitchell et al. (1972) and unpublished Birmingham University report by P.J.F.Jeans (1970).

The Scarbrow Wood localities near Hollows Farm (7A, 248 170) have long been regarded as classic exposures of the Skiddaw Slate-



Plate 1. *Junction localities 5 and 6 below Eel Crags, Newlands, as seen from Hindscarth. The dip of the volcanics can be seen to be parallel to the junction and the fault is the same one as that referred to in locality 7B. (see plate 2)*

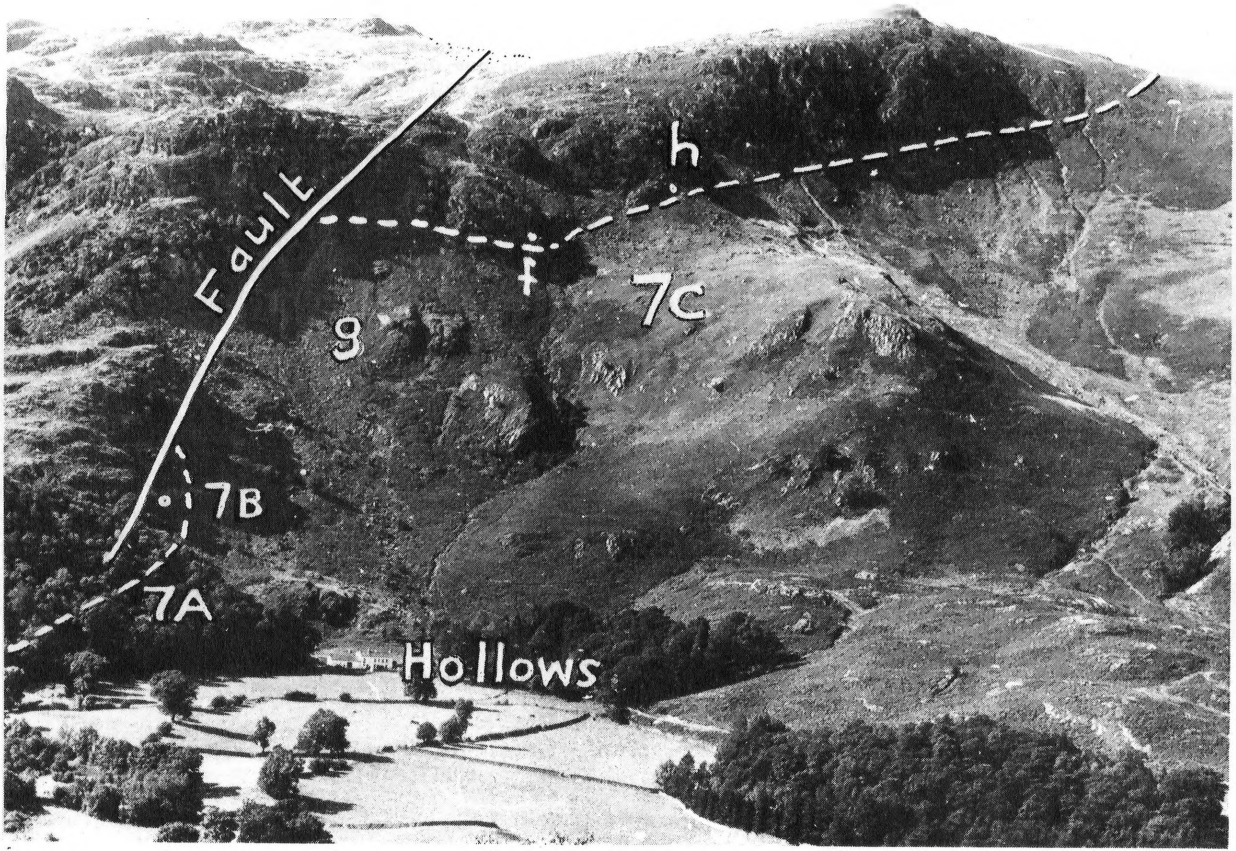


Plate 2. *The Skiddaw Slate-Borrowdale Volcanic junction between Hollows and Blea Crag, Borrowdale, localities 7A - C. Exposures of the junction are marked.*

Borrowdale Volcanic junction (Plate 2). The details have been recorded recently by Soper (1970), who considered the relationship to be conformable or near conformable. Soper's localities B, C and D (7A in this account) are in Scarbrow Wood, and show tuffs resting on an eroded surface of conglomerate containing both volcanic and mudstone pebbles, which in turn pass downwards into Skiddaw Slates. He demonstrated a single cleavage passing from the Skiddaw Slates into the volcanics. Helm and Roberts (1971), however, suggested that the transitional beds described by Soper were entirely within the Borrowdale Volcanic episode, which here started with a pelitic phase, and the true unconformity was at a lower level in unexposed ground. Further details can be consulted in Soper (1970), Helm and Roberts (1971) and in the Geologists Association excursion report and discussion (Mitchell et al., 1972).

Above Hollows Farm (7B, 246 170, Plate 2) there is another comparable exposure first cleared of its thick coating of moss by P.J.F.Jeans. The upper part of the outcrop is crossed by a vertical fault, which brings Skiddaw Slates against tuffs, but lower down there is clear transition from tuffs into tuffaceous pelite and pelite, all affected by the one end-Silurian cleavage. Although the details are more complex than this statement would imply, all who have seen the exposure have agreed with this interpretation. Helm and Roberts (1971), however, suggested that here also all belonged to the Borrowdale Volcanics, and the true unconformity was lower down in unexposed ground.

Much higher up the fellside below Blea Crag (7C) there are three relevant exposures referred to by Soper (1970) as f, g and h (plate 2) and the reader is advised to consult this paper for the exact locations and descriptions.

f (242 170), at the base of the steep crag of volcanic rocks consists of a conglomerate with mudstone fragments showing disoriented bedding, but only one cleavage, which has the same orientation as that affecting the volcanic rocks.

g (243 170) is lower, within the main Skiddaw Slate outcrop, and has thin tuffs interbedded with pelite. Soper suggests that these tuffs indicate an early phase of 'Borrowdale vulcanicity', but naturally it would be possible to argue that some unrelated vulcanicity accompanied the Skiddaw Slate deposition. It could be that it represents the feather edge of the Eycott Volcanics (see comment to localities 13 and 19).

h (240 172) is also at the base of the steep crag and resembles f.

8. TROUTDALE COTTAGES (261 177)

It is reputed that the junction is exposed at this locality,

but it has not been visited by the author, and there does not appear to be any modern report of it in print.

9. CAUSEWAY FOOT (290 220). Wadge (1972).

The exposure is a small one in the stream bed close to the main road and it was claimed by Wadge that there is a conglomerate resting unconformably on Skiddaw Slates. This interpretation may be correct, but the exposure is such a poor one that this author is hesitant in completely accepting it.

10. LOW RIGG (301 222). Wadge (1972).

This is a well known exposure of conglomerate, which occurs at the base of the High Rigg volcanic succession. It is principally composed of volcanic pebbles, with some mudstone pebbles showing no evidence of pre-volcanic cleavage. The actual junction with older rocks is not exposed, but there are outcrops of St.John's Microgranite and Skiddaw Slates within a few tens of metres. Detailed mapping seems (to this author) to leave no doubt that the junction is faulted at this locality, although Wadge suggests an unconformity (see Mitchell et al., 1972; Wadge, 1972; Moseley, 1972 (in discussion with Wadge), and Moseley, 1975).

11. WANTHWAITE CRAG (326 227). Unpublished notes by F.Moseley.

Andesites and subsidiary tuffs dip gently across the steep face of Wanthwaite Crag and even from a distance are clearly seen to be truncated by a fault, inclined about 40^{o} in a southerly direction (Plate 3). Closer inspection reveals that the fault plane is marked by a thin clay band and a zone of broken rock, whilst the area to the north is composed of Skiddaw Slates, and then of Threlkeld Microgranite, the former very much complicated by tectonics, and partly concealed by landslip and scree.

12. MATTERDALE BECK (388 234). Wadge (1972) and Mitchell et al. (1972).

There is a quite distinct unconformity at this locality, described by Wadge and discussed in Mitchell et al. Gently dipping conglomerate, with mudstone and volcanic pebbles, rests on steeply dipping, folded, Skiddaw Slates which contain fossils of the D. bifidus zone, a conclusion accepted by all of those on the recent Geologists' Association excursion (Mitchell et al., 1972). It was the explanation of detail which gave rise to controversy, with Helm and Roberts (op.cit) taking the view that there was a major orogenic unconformity, with at least one cleavage which failed to penetrate the conglomerate and the overlying volcanics, and Moseley and Soper claiming that the cleavage in the slates passed through into the volcanics and was therefore later than both, the implication in this latter case being that the

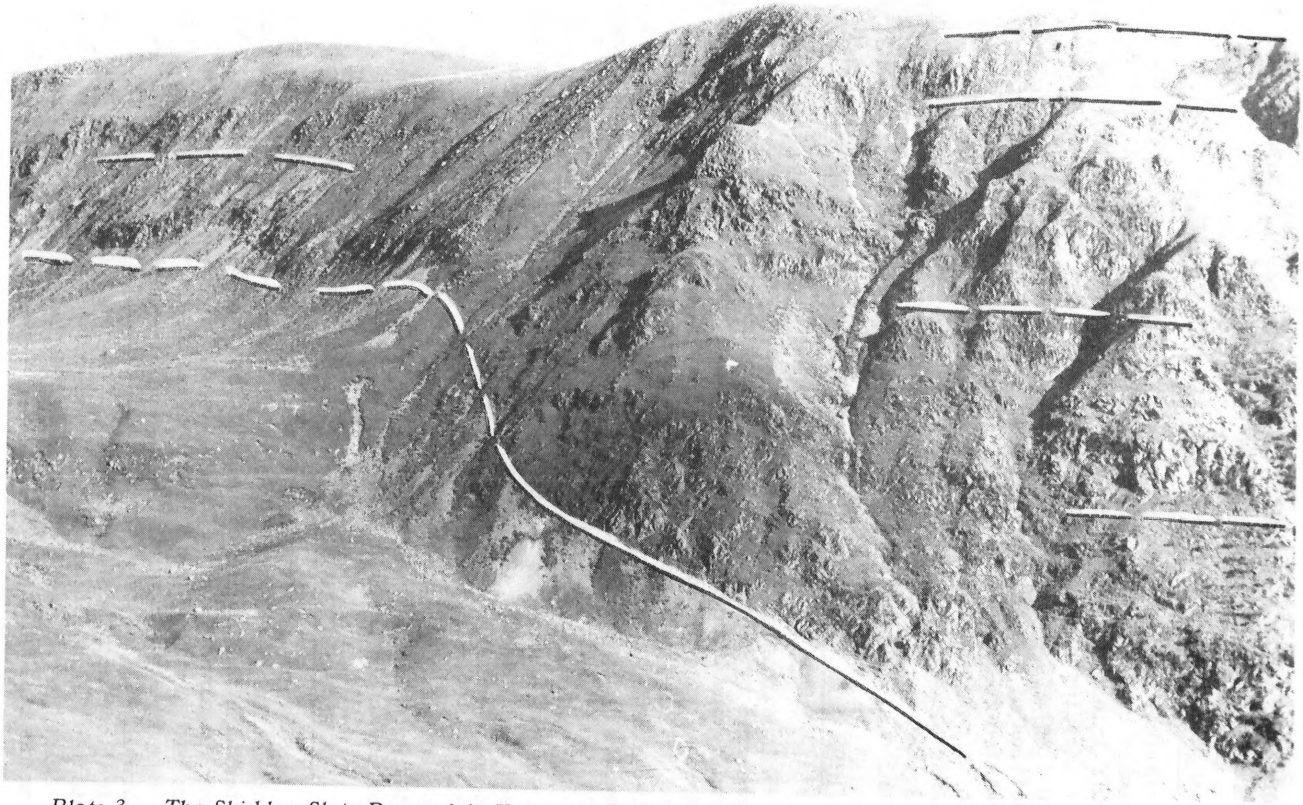


Plate 3. *The Skiddaw Slate-Borrowdale Volcanic junction on Wanthwaite Crag, locality 11. A complex tectonic belt of Skiddaw Slates is faulted against gently dipping volcanic rocks.*

unconformity was non-orogenic. The exposure is there for all to see and to form their own conclusions.

13. GLENCOYNE PARK (393.203 and 386.199). Moseley (1964).

In this region the Skiddaw Slates are separated from the volcanics by a large high angle fault. The interest lies in beds of tuff interbedded with the slates in exposures adjacent to the fault (Moseley op.cit., p.128 and plate 7). The tuff bands are up to 1 metre thick, and indicate a phase of vulcanicity during deposition of the Skiddaw Slates. It is possible that they could be related to the Eycott-Binsey vulcanicity (localities 19-21) which is now believed to be earlier than the main Borrowdale Volcanic episode (Downie and Soper, 1972), although it must be noted that these tuffs are rather acidic, whereas the Eycott volcanics are tholeiitic.

14. BIRK CRAG, ULLSWATER (432 217). Moseley (1964), Mitchell et al. (1972).

This exposure, which is in a small disused quarry, was interpreted by Moseley (op.cit) as a thrust junction between the volcanics and Skiddaw Slates. Coarse and medium tuffs, strongly cleaved, are to be seen above the thrust, and dip 30° to the north-east. Careful inspection is necessary to determine dip in these tuffs, and the occasional finer and medium grained interbeds have to be located since there are close spaced joints making an angle of 20 to 30° with the bedding which are easily confused with it. The junction is marked by a thin clay layer inclined 38° to 220°, and the upper metre of Skiddaw Slates is badly sheared and slickensided, with the slickensiding sub-parallel to the dip of the junction. Below this there are pencil slates in which tight folding was recorded by Helm and Roberts who claimed that the junction was an unconformity (in Mitchell et al., 1972). For further details the reader should consult the discussion in this paper under the heading of the Gowbarrow Excursion.

15. AIK BECK, ULLSWATER (473 220).Green (1915) and Moseley (1960).

J.F.N.Green recorded this section as a conformable one, in which coarse tuffs with Skiddaw Slate pebbles (his 'mottled tuffs') rested with no discordance on Skiddaw Slates. The actual junction is no longer exposed, although no doubt it could be excavated, but there are certainly complications not suspected by Green. A major north-easterly fault runs parallel to the junction effectively separating the slates from the volcanics, but leaving a thin 'slice' of 'mottled tuff' on the north-west side of the fault in contact with the slates. Not far below the junction the slates are folded and cleaved in a complex manner, these structures not being co-axial with the major structures in the volcanics (Moseley,

1972, fig. 2C), and it would not be surprising if there was an unconformity in this area.

16. SANDWICK (425 196). Moseley (1960).

The field relations to be seen in the stream at Sandwick are not unlike those of Aik Beck (locality 15). There is certainly a strong fault separating the main outcrop of slates and volcanics, but the actual junction is not exposed. The lowest exposures of the volcanics are coarse tuffs and lapilli tuffs with occasional Skiddaw Slate pebbles (the Mottled Tuff of Green, 1915).

17. HUNGERHILL, BAMPTON (513 174). Nutt (1966) and Mitchell et al. (1972).

The Skiddaw Slate-Borrowdale Volcanic junction in the Haweswater area is apparently faulted over much of the outcrop, although exposures are not good. In the Hungerhill area, however, Nutt has referred to a minor unconformity which he suggests was produced locally by vulcanicity with shifting centres. Thick conglomerates above the unconformity contain both volcanic and mudstone phenoclasts, the latter uncleaved, and are regarded as intra-volcanic and strongly diachronous (see discussion to Wadge, 1972).

18. SWINDALE (517 137). Nutt (1966).

Nutt observes that Skiddaw Slates here rest on andesites, and he interprets the outcrop in terms of a tectonic slice, perhaps not unlike that of locality 4.

19. WHITEFIELD COTTAGE (238 348). Eastwood et al. (1968), Downie and Soper (1972).

The junction between the Skiddaw Slates and the Binsey volcanics (Eycott Volcanic Group), forming part of the northern volcanic outcrop of the Lake District is exposed in small quarries north and east of Whitefield Cottage (Eastwood et al., p.66). There seems to be little doubt that hereabouts there are inter-bedded slates and volcanics in an exposed sequence more than 20m. thick, and the two groups must be regarded as conformable. Downie and Soper (1972) have examined the micro-fauna from the mudstone interbeds and concluded that the sequence is of Llanvirn age. They also suggest, however, that the Binsey-Eycott volcanics are not part of the Borrowdale Volcanic episode, but represent an earlier event, thus allowing for the possibility of a minor unconformity between the Skiddaw Slates and the main Borrowdale Volcanic sequence.

20. OVERWATER (259 355). Eastwood et al. (1968), Downie and Soper (1972).

Exposures in the reservoir spillway reveal a similar sequence (with similar explanations) to those near Whitefield Cottage (locality 19). There are undoubted volcanic/slate interbeds which have yielded a Llanvirn micro-fauna (Downie and Soper op. cit.), and again there seems little doubt that a conformable relationship exists here.

21. FAIRY KNOTT, EYCOTT HILL (383 305). Eastwood et al. (1968) and Gate (1971).

A small exposure in the stream south of Fairy Knott was described by Eastwood et al. It appears to show gradation from tuff to tuffaceous shale (with some sandstone) and to slate, and thus suggested a conformable relationship consistent with those determined for the other outcrops of the Eycott Volcanic Group (localities 19 and 20). However, it seems that the pelites are no longer exposed at this locality (Gate, 1971).

(C) C O N C L U S I O N S

It is possible to account for the junction between the Skiddaw Slates and the Borrowdale Volcanics by any one of four mechanisms:-

(i) A conformable relationship with transitional interbeds of slate (mudstone) and volcanics.

(ii) A major unconformity with the Skiddaw Slates subjected to a major orogeny, including polyphase deformation and strong cleavage formation, before the volcanic episode started.

(iii) Faulted contacts, which are high angle structures in some areas, and low angle decollement thrusts in others.

The diversity of opinion will be evident from the foregoing descriptions of localities, and it now remains to present a personal opinion on the interpretation of the evidence.

It is beyond question that the junction is marked by faults for considerable parts of its outcrop. Both high angle and low angle structures are represented, the latter most likely to be decollement structures related to the different competence of the two groups and forming when both were folded during the Caledonian Orogeny. Elsewhere the nature of the junction is controversial, but the following sequence of events is suggested:

(1) Skiddaw turbidites formed as trough deposits on the SE margin of the proto-Atlantic Ocean, with ocean floor spilitic pillow lavas, and ophiolites associated with a south dipping Benioff Zone further north in the Girvan-Ballantrae area of Ayrshire (Jeans, 1973).

(2) The Binsey-Eycott volcanics of tholeiitic affinities extruded towards the end of Skiddaw 'Slate' deposition during Llanvirn

times. They are conformable and interbedded with the slates (Fitton and Hughes, 1970; Downie and Soper, 1972). They and the succeeding Borrowdale Volcanics were erupted in an island arc environment.

(3) Minor earth movements resulted in folding along N-S axes. No cleavage was developed during these earth movements and the Skiddaw 'Slates' still remained as clays or mudstones.

(4) Subaerial erosion and almost contemporaneous initiation of the calc-alkaline Borrowdale Volcanics from several local centres. The volcanics locally came to rest on the Skiddaw 'Slates' (mudstones) with strong angular discordance (Matterdale, Newlands, etc.), but elsewhere there is no angular discordance and the two groups appear to be interbedded (Hollows, etc.). It is possible that folding developed locally, almost contemporaneously with the early phases of vulcanicity, and that pelite deposition continued throughout. Violence associated with early volcanic uplift may have been partly responsible.

(5) Periods of quiescence during the early vulcanicity gave opportunities for further erosion of the still exposed areas of Skiddaw 'Slate', and of the early formed volcanic rocks. This is likely to have happened many times. The debris from these erosion episodes accumulated in the valleys carved into the Skiddaw 'Slates' and the early volcanic rocks, and formed conglomerates composed of varying proportions of volcanic and mudstone pebbles (Nutt, 1966).

(6) Eventually the whole of the Skiddaw 'Slate' outcrop, and the diachronous early volcanics were covered by continued growth of the volcano.

(7) The bulk of the tectonic structures (including all development of cleavage) were imposed during successive phases of the end-Silurian earth movements. This was the main Caledonian episode in the Lake District.

- - -

(D) REFERENCES

CLARK, L., 1964, The Borrowdale Volcanic Series between Buttermere and Wasdale, Cumberland. Proc. Yorks. Geol. Soc., 34, 343-356

DOWNIE, C. and SOPER, N.J., 1972, Age of the Eycott Volcanic Group and its conformable relationship to the Skiddaw Slates in the English Lake District. Geol. Mag., 109, 259-268.

EASTWOOD, T., HOLLINGWORTH, S.E., ROSE, W.C.C. and TROTTER, F.M., 1968, Geology of the country around Cockermouth and Caldbeck. Mem. Geol. Surv., x plus 298 pp.

FITTON, J.G. and HUGHES, D.J., 1970, Volcanism and plate tectonics in the British Ordovician. Earth Planet. Sci. Letters., 8, 223-228.

GATE, S.H., 1971, Excursion to the Eycott lavas. Proc. Cumb. Geol. Soc., 3, 105-108.

GREEN, J.F.N., 1915, The structure of the eastern part of the Lake District. Proc. Geol. Assoc., 26, 195-223.

HELM, D.G., 1970, Stratigraphy and structure in the Black Combe Inlier, English Lake District. Proc. Yorks. Geol. Soc., 38, 105-148.

HELM, D.G. and ROBERTS, B., 1968, The Caledonian history of the north eastern Irish Sea Region (letter). Scot. J. Geol., 4, 375-376.

HELM, D.G. and ROBERTS, B., 1971, The relationship between the Skiddaw and Borrowdale Volcanic Groups in the English Lake District. Nature Phys. Sci., 232, 181-183.

JEANS, P.J.F., 1971, Relationship between the Skiddaw Slates and the Borrowdale Volcanics. Nature Phys. Sci., 234, 59.

JEANS, P.J.F., 1972, The junction between the Skiddaw Slates and Borrowdale Volcanics in Newlands Beck, Cumberland. Geol. Mag. 109, 25-28.

JEANS, P.J.F., 1973, Plate tectonic reconstruction of the southern Caledonides of Great Britain. Nature Phys. Sci. 245, 120-122.

MITCHELL, G.H., MOSELEY, F., FIRMAN, R.J., SOPER, N.J., ROBERTS, D.E., NUTT, M.J.C. and WADGE, A.J., 1972, Excursion to the Northern Lake District. Proc. Geol. Assoc., 83, 443-470.

MOSELEY, F., 1960, The succession and structure of the Borrowdale Volcanic Series, south-east of Ullswater. Quart. Journ. Geol. Soc., 116, 55-84

MOSELEY, F., 1964, The succession and structure of the Borrowdale Volcanic rocks north-west of Ullswater. Liverpool and Manchester Geol. Journ., 4, 127-142

MOSELEY, F., 1972, A tectonic history of North-West England. Journ. Geol. Soc., 128, 561-598.

NUTT, M.J.C.,1966, Field Meeting in the Haweswater area. Proc. Yorks. Geol. Soc., 35, 429-433.

NUTT, M.J.C.,1968, Borrowdale Volcanic Series and associated rocks around Haweswater, Westmorland. Proc. Geol. Soc. Lond., 1649, 112-113.

SIMPSON, A., 1967, The stratigraphy and tectonics of the Skiddaw Slates and the relationship of the overlying Borrowdale Volcanic Series in part of the Lake District. Geol.J., 5, 391-418.

SIMPSON A., 1968, The Caledonian history of the North-Eastern Irish Sea region, and its relation to surrounding areas, Scot. J. Geol., 4, 135-163.

SIMPSON, A., 1968a, The Caledonian history of the North-Eastern Irish Sea region (letter), Scot. J.Geol., 4, 380-385.

SOPER, N.J., 1970, Three critical localities on the junction of the Borrowdale Volcanic rocks with the Skiddaw Slates in the Lake District. Proc. Yorks. Geol. Soc., 37, 461-493.

SOPER, N.J. and BROWN, P.E., 1968, The Caledonian history of the North-Eastern Irish Sea region (letter). Scot. J. Geol., 4, 378-379.

SOPER, N.J. and ROBERTS, D.E., 1971, Age of cleavage in the Skiddaw Slates in relation to the Skiddaw aureole, Geol. Mag., 108, 293-302.

WADGE, A.J., 1972, Sections through the Skiddaw-Borrowdale unconformity in Eastern Lakeland. Proc. Yorks. Geol. Soc., 39, 179-198.

WADGE, A.J. and BURGESS, I.C., 1968, The Caledonian history of the North-Eastern Irish Sea region (letter), Scot. J. Geol., 4, 377.

WADGE, A.J., NUTT, M.J.C. and SKEVINGTON, D., 1972, Geology of the Tarn Moor Tunnel in the Lake District. Bull. Geol. Surv. Gt. Brit., 41, 55-73.

- -

J.F.N.GREEN.....AMATEUR GEOLOGIST.*

by

E. H. SHACKLETON, F.G.S.

At the time of the death of John Frederick Norman Green on 11th December, 1949 The Geological Society, in his obituary, said that it had lost one of its most distinguished amateur geologists, and we of Lakeland also suffered a great loss for 'J.F.N.' had, over many years stimulated a great deal of research into our ever fascinating rocks.

Green was born on the 26th June, 1873, and was educated at Bradfield College, Berkshire and at Emmanuel College, Cambridge, where he distinguished himself in both mathematics and Natural Science. He became a Secretary at the Colonial Office and in 1919 was a member of the British Delegation to the Paris Peace Conference. Throughout his official career he was greatly interested in the work and development of our Colonial Geological Surveys; an almost world wide task which, I am sorry to say, has gone little appreciated. He retired in 1933.

For over forty years Green devoted himself in his spare time to original work in geology, and whilst much of it is of great interest to us it would be altogether wrong to imply that all his work was on-Lakeland rocks. His first venture in fact was in Wales, where he tackled a problem of succession in the St. David's area and, in the opinion of Professor O. T. Jones made his greatest contribution to geological science. Here 'J.F.N.' ventured into an area which had long been a bitterly contested geological battle-ground between doughty opponents. Jones in his assessment says that if one listened to the conflicting interpretations of the sections around the St. David's peninsular one could only infer that there was no such thing as factual geology....all was a matter of opinion! Green realised that only detailed mapping on a six inch scale of the whole area, inland as well as along the coast, could reveal the true state of affairs. His resulting maps clearly justified his belief and demonstrated that the basal Cambrian adjoins different lithological horizons in the Pre-Cambrian rocks. His mapping also shed much light on the complicated relationships between the St. David's granite and the surrounding rocks and gave rise to his first published work in 1908.

But it was Green's next venture that is of greatest interest to us for from about 1912 to 1920 he turned his attention to the Lake

---

* This is the sixth article in the series about celebrated geologists whose names are connected with the Lake District.

District. To understand his contributions to the geology of our area one needs to appreciate some of the controversial issues that then held the field, and perhaps it will occasion little surprise that some of them have a slightly familiar ring. He first turned his attention to the junction between the Skiddaw Slates and the Borrowdale Volcanics and all these junctions at that time were mapped....no, not as unconformities, but as faults! Green's work of course kept him for much of his time in London, and so he turned his attention to the Geological Survey's six inch maps, and his study of these at the nearby Jermyn Street office, led him to doubt the interpretation that had been put upon them. His studies suggested that a very useful area might well be in the few miles stretching between Millom in the west and the Duddon in the east. Here the rocks seemed little disturbed by folding and were comparatively free from major intrusions. Also it was a district reasonably accessible from the south.

His first paper on this area, 'The Older Palaeozoics of the Duddon Estuary', was given to the Geological Society in 1912 and caused such a rumpus that publication was declined in the Society's Journal, so Green had it published privately. His work showed clearly that one could trace the succession without a break from the 'blue shale', as they called the Skiddaw Slates locally, into the volcanics without any sign of the great faults invariably shown on the older maps. Next he turned his attention to that equally debated junction between the Borrowdales and the overlying Coniston Limestone. Here he was directly challenging Professor Marr when he maintained that the junction was an unconformity and not, as the Cambridge school maintained, a fault or faults! 'J.F.N.' then applied the succession he had worked out in this area to the rest of Lakeland and what he was attempting to justify was his belief that the volcanic succession was not really as thick as many supposed. First in 'The Vulcanicity of the Lake District' (1919) and then in 'The Structure of the Lake District' (1920), which were Presidential Addresses to the Geologists' Association, he dealt with our rocks. In the first of these he suggested that much of our vulcanicity had been of a submarine kind, and that many of our rocks hitherto regarded as explosion breccias were in fact flow breccias. He also thought that there had been much subsequent overfolding and this had given rise to an exaggerated idea of the thickness of the series. Rhyolites, he believed, belonged almost exclusively to, and in fact clearly indicated, the upper part of the volcanics. It was in 1915 that he gave a paper on 'The Eastern Part of the Lake District' and in this he used as a basis the succession he had first worked out around the Duddon, using his 'Harrath Tuffs' as an easily distinguishable horizon.

If his interests were diverse his enthusiasm was immense. If his work on the age of the great intrusions of the area, and on the garnets and associated streaky rocks caused fierce debate, with him

such a debate was always conducted in a friendly manner, and he was ever ready to acknowledge the help he had received from the work of others. If in much of his work he tended to over-simplification, particularly in the fold structures, there can be no doubt that his work, over the years, stimulated a tremendous amount of patient mapping by many workers in and around the English Lake District.

It was always his intention that upon retirement he would return to us and continue his work, but the intervention of the second World War made this impossible and confined him to the south of England. This did not in any way reduce his enthusiasm and he did much good work on the local geology and was in fact a founder member of the Weald Research Committee.

It was in 1908 that Green was elected to the Geological Society and gave freely of his services on the Council (1918-1923 and 1930 -1938). In 1931 - 1934 he was Vice-President, and President from 1934 to 1936. Of this high honour he was justly proud, recalling that he was only the second amateur that had ever held the position. From J.F.N.Green I think we can all learn, first that there is, and always will be, room for the work of the dedicated amateur in our science, and second that however decided our views there is no need to give offence to those who find them unacceptable.

Finally I would like to pay my own small tribute, for much of Green's work appeared whilst I was myself a student and, belonging as I did to a school that firmly adhered to the 'go and see' belief, we spent many happy hours on Lakeland rocks, with 'J.F.N.'s papers in hand.

- - -

SOME NOTES ON THE HISTORY OF THE HARRINGTON COLLIERIES AND ON THE LOCATIONS OF OLD PIT SHAFTS AT WORKINGTON.

Contributed by

JOHN MOON

THE HARRINGTON COLLIERIES

The Harrington Royalty is divided into two areas north and south of the Micklam Fault. The Northern area was known as the Old Harrington Royalty in which, due to the influence of the fault, the highest seam worked to any great extent was the Six Quarters. All the coal was worked under the land in this area and the last pit working here is the Micklam Day Drift which works the Lower Three Quarters seam and its Fireclay floor.

In the Southern area all the coal is coastal or under the sea and was last worked from Harrington No. 10 pit. In this area the Six Quarters is the lowest seam to be extensively worked, although small areas of the Four Foot seam have been extracted close to the No. 10 shaft.

Coal was worked in the Old Harrington Royalty from a dozen or more pits between 1750 and 1790 and conveyed along wooden railways to Harrington harbour.

By 1804 the collieries consisted of UDALE, TARN, JANE, BELLA and HENRY pits, and 41,420 tons of coal were mined by 70 hewers in that year. During the same year HODSON pit was sunk to work the Four Foot seam from the John and Jane pit faults, southwards towards Lowca Beck. HODSON pit was important because from it a water level was driven through to the sea shore. This level followed a devious route through many of the neighbouring pits and drained all the workings in the area.

In 1825, Mr. Curwen, who owned the mineral rights, sank MICKLAM No. 5 pit to a depth of 540 feet on the upthrow side of the Micklam fault. Its purpose was to win some of the upper seams on the downthrow side of the fault and was to be the first breakthrough into the Southern half of the Harrington Royalty. However in 1830 a short drift contacted the Main Band seam through the fault, but liberated a feeder of water which stopped further working till 1865. Meanwhile in 1838 an explosion of firedamp in JOHN pit killed 40 men and boys.

JOHN and HODSON pits worked until 1864, when MICKLAM No. 5 was reopened to work some of the lower seams north of the Micklam fault. This continued until a decision was taken to try again

for the large area of coal south of the fault and in 1867 a pumping engine was installed.

About this time No. 3 pit was sunk north of No. 5 pit and worked the lower seams remaining between Mr. Curwen's old workings and high water mark. This pit was closed in 1879.

In 1871 No. 4 pit was sunk 294 feet to the Four Foot seam to work the remaining coal between the Hodson pit workings and Lowca Beck. This pit ceased working in 1879.

No. 6 pit was sunk in 1871 near Lowca Point to work the upper seams south of the Micklam Fault. Only small areas of the Bannock and Main Band seams were worked and operations were discontinued three years later.

No. 8 pit was also sunk in 1871 on the foreshore near the estuary of the Lowca Beck to work the Main Band at a depth of 66 feet. An influx of water closed the pit in 1874.

During this time No. 5 pit was working the Main Band south of the Micklam Fault with such good results that in 1874 No. 7 pit was sunk south of No. 5 to a depth of 650 feet to the Six Quarters seam. From this shaft the Main Band and the overlying Bannock Band were worked northwards towards the No. 5 workings.

No. 9 pit was sunk 645 feet to the Six Quarters seam in 1880 at a point close to the No. 7 shaft. The object was to work the Six Quarters seam underlying the Main Band which was already being worked from No. 5 and No. 7.

In 1900 the Harrington Collieries consisted of Nos. 5, 7 and 9 pits. The following year No. 7 pit was converted into a return air shaft for No. 9 and some time later Beam Pumps were installed in No. 7 to deal with water in the Main Band. This would be when the dams were made in No. 7 shaft below the Main Band to stop water going down into the Six Quarters seam which was now being worked from No. 9.

1910 saw the sinking of No. 10 pit very close to Nos. 7 and 9. It penetrated 647 feet to the Six Quarters seam. In 1911 the No. 7 shaft was filled with colliery refuse and the water it had been pumping from the Main Band was allowed to flood these workings. It would seem that the effect of this was soon felt in No. 9 shaft because in 1914 it was resunk and lined with concrete to stop a flow of water entering at Main Band level. At the same time a fan was installed and No. 9 became the return shaft for No. 10 pit. Also about this time in 1913 and 1914 No. 11 pit was sunk 210 feet to the Four Foot seam to work the remaining coal between the workings from No. 4 pit and Lowca Beck. Faulting in the No. 11 pit workings rendered accessible areas of Six Quarters, Main and even the Bannock Band which were worked until the pit closed in June, 1963.

JOHN and JANE pits ceased working between 1930 and 1936, but neither shaft was filled in. The modern aspect of the headgear at these shafts is rather puzzling. From the information at hand it would seem that the pits were both reorganized some time after 1900 because there is no mention of either pit in the list of Harrington Collieries working during that year. By the lay-out of the surface buildings JOHN pit appears to be the downcast and coal-drawing shaft and JANE pit the upcast shaft. A third building in close proximity suggests a screening plant at which the coal was cleaned after being brought up JOHN pit.

Harrington Collieries, with the exception of Micklam No. 5 pit were taken over from the United Steel Companies in January, 1947.

In 1951 the MICKLAM DAY DRIFT was brought into operation and No. 5 shaft was filled in. With the exception of this drift the mining in the Harrington Royalties came to an end in August, 1968, with the closing down of No. 9 and No. 10 pits which remained open only for a short time after that date to allow for salvage work to be carried out.

THE LOCATION OF OLD PITS IN THE WORKINGTON AREA

Workington rose to importance on the west coast of Cumberland chiefly because of the export of coal. Of all the pits in the territory to the south of the River Derwent and east of the coastal railway, only one really interesting site remains - that of JANE Pit (M.R. 995 277). This pit was sunk in 1843 by Henry Curwen and later became a ventilating shaft for BUDDLE Pit.

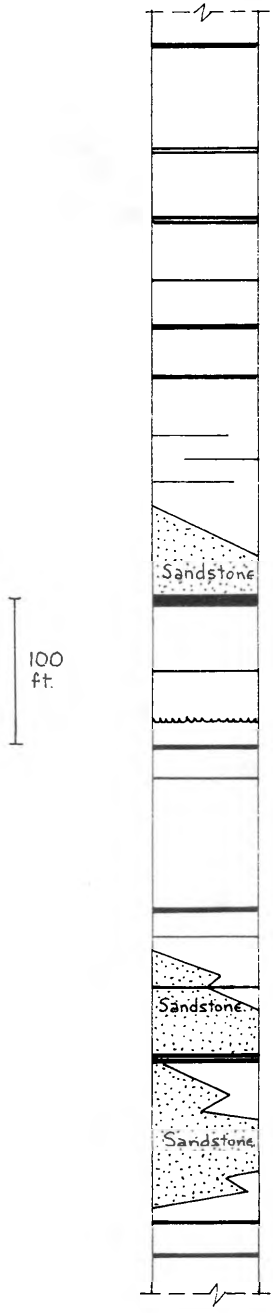
The other large pits, LADY Pit and CHAPEL BANK Pit lie under the United Steel Company's slag banks (986 288) while ISABELLA Pit is within the present steelworks area.

There is no trace of HOPE Pit where the first local Watt winding engine was set up by J.C.Curwen in 1783.

A list of the known pits in this area with their locations is given below:-

NAME OF PIT	DEPTH TO SEAM (FT.)	LOCATION
1. Curwen Pit	108' to coal (working in 1762)	Tannery
2. John Pit	360' to Moorbanks Band	Junction of John St. and Jane St.

COAL SEAMS, WORKINGTON



Brassey Band

Kennel Band

METAL BAND

Fiery Band

MOORBANKS BAND

LITTLE MAIN BAND

Main Band Rock

GREAT COAL or MAIN BAND

Cannel

Mussel Bed
Yard Coal

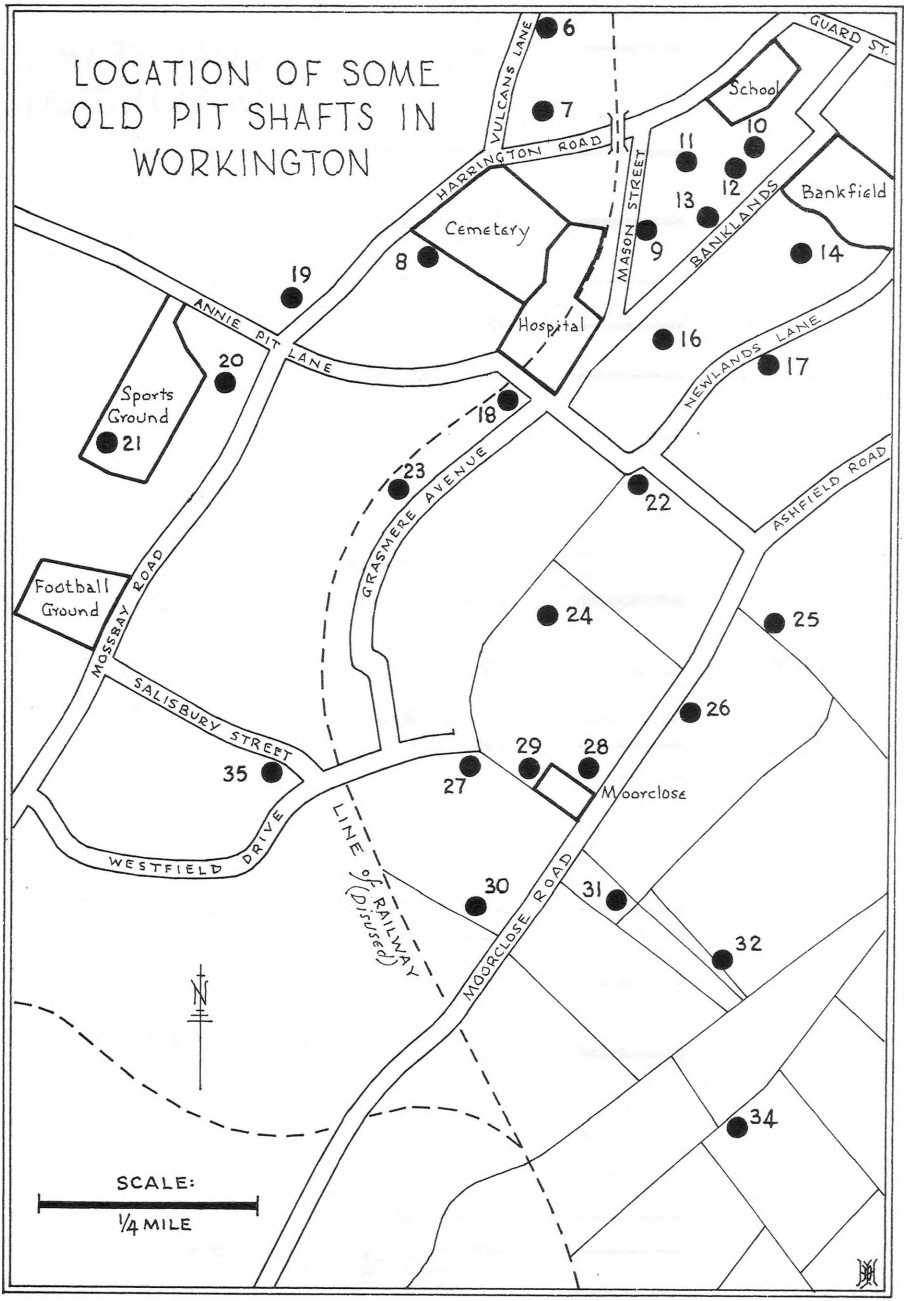
WORKINGTON YARD or LITTLE MAIN
Potash Seam

Lickband Seam

WORKINGTON 4FT OR HAMILTON
OR SIX QUARTERS

Upper 3/4 Coal

Workington Udale or Virgin
or Lower 3/4 Coal


LOCATION OF SOME OLD PIT SHAFTS IN WORKINGTON
VULCANS LANE
HARRINGTON ROAD
GUARD ST
School
Bankfield
Cemetery
Hospital
MASON STREET
BANKLANDS
ANNIE PIT LANE
NEWLANDS LANE
Sports Ground
Football Ground
GRASMERE AVENUE
ASHFIELD ROAD
MOSSBAY ROAD
SALISBURY STREET
Moorclose
WESTFIELD DRIVE
LINE OF (DISUSED) RAILWAY
MOORCLOSE ROAD
SCALE:
1/4 MILE
6
7
8
9
10
11
12
13
14
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
34
35

3.	Elizabeth Pit	414' to Moorbanks Band	S.E. of Technical College
4.	Church Pit	131' to Moorbanks Band	Junction of Hyde St. and Corporation Rd.
5.	Alexander Trial	-	Patterson Hill
6.	Hope Pit	589' to Main Band	Junction of Vulcans Lane & Hunter St.
7.	No name ?Lanty Pit		Half-way up Hartington St., Northside
8.	Charles Pit	133' to Main Band	Junction of Shaw St. and Canning St.
9.	Stephen Pit	552' to Main Band	Junction of Mason St. and Dalston Rd.
10.	Banklands Engine Pit	570' to Main Band	Banklands area
11.	Wilson Pit		Banklands area
12.	Robinson Pit		Banklands area
13.	Smithy Pit		Junction of Michael Rd. & Chilton St.
14.	No name ? Thompson Pit		S.E. of Smithy Pit
15.	No name		Schoose Cottages
16.	High Pit		Craig Bank
17.	Newlands Pit		North of Craig Rd. - Newlands Lane Junction
18.	Moorbanks Great Engine Pit	360' to Main Band 575' to Udale Band	Annie Pit Lane Railway Crossing
19.	Annie Pit (closed 1875)		Territorial Army Centre
20.	Jane Pit (sunk 1843)	74' to Main Band 402' to Six Quarters	Ellis Park
21.	Buddle Pit	165' to Six Quarters	Ellis Park
22.	Bella Pit	354' to Main Band	Junction of Annie Pit Lane & Newlands Lane

23. West Moorbank Engine Pit	162'	to Main Band	See sketch map
24. Henry Pit (or Fix Pit)	204' 402' 532'	to Main Band to Little Main or W'kton Yard Band to Six Quarters	See sketch map
25. Uldale Pit	243'	to Main Band	See sketch map
26. Crosthwaite Pit	210' 420' 522' 666'	to Main Band to Little Main or W'kton Yard Band to Six Quarters to W'kton Udale Band	See sketch map (220 yds. NE of No. 28)
27. Walker Pit	126'	to Main Band	See sketch map
28. Well or Bowness Pit	66' 276' 532'	to Main Band to Little Main or W'kton Yard Band to W'kton Udale	See sketch map (Moorclose Farm)
29. Drift (probably to above)			See sketch map (Moorclose Farm)
30. No name			See sketch map
31. Meadow Pit			See sketch map
32. Ellerbeck Pit	148'	to Main Band	See sketch map
33. No name			Castle Gardens
34. High Hope Pit (sunk 1854)	180'	to Little Main or W'kton Yard Band	See sketch map
35. Jackson Pit	137'	to Main Band	See sketch map (behind Westfield)
36. Wilson Pit	114'	to Main Band	See sketch map (160 yds. N of No.28)

CHAPEL BANK PITS:

Union Pit	Chapel Bank Farm
Isabella Pit	Nr. Lifeboat Station
Lady Pit	South of Isabella

These pits were inundated on 28th July, 1837.

EXCURSION NOTES

GLACIAL DEPOSITS IN ENNERDALE

Director: Mr.Mervyn Dodd,
assisted by Sixth Form students from
Whitehaven Grammar School.

1st April, 1973.

Twenty-five members attended this excursion on a chilly April afternoon punctuated by hail squalls. The party met at Whins Farm (098 167) and made their way on foot up to the level of the 650 ft. contour where they were standing on thick fluvio-glacial drift deposits. Miss Helen Quail, together with Messrs.Ian Wilson and Gordon Hadwin, all following 'A' Level Geography courses at Whitehaven Grammar School, demonstrated quantitative techniques of sedimentary analysis.

A gently sloping patch of apparently undisturbed land was chosen and after removing the turf a layer of brownish soil extending down to about twelve inches below the surface was investigated. First the soil was seived through wire meshes of progressively smaller size and the successive fractions weighed, using a spring balance, with the object later of plotting the size distribution of the particles graphically on a histogram. The patterns obtained can be characteristic of the type of sediment and the environment of its deposition. Unfortunately technical difficulties were encountered arising from the wet soil and hostile weather conditions, so that the investigation could not be properly completed in the field, but the members of the Society appreciated the practical demonstration of the method.

The next demonstration was the quantitative analysis of the orientation of fragments in the deposit. Using a compass, the alignment of the long axis of 55 undisturbed pebbles and rock fragments was determined. The sample was taken from two horizons, one near the surface and another at a depth of 12 inches. An initial study of the results showed two patterns; small fragments, especially near the surface, were aligned on bearings between 20° and 60° magnetic, while the larger stones showed a grouping between 300° and 10°. Members discussed the findings and it was suggested that the results might indicate the operation of different methods of transport. The smaller superficial fragments might have been influenced by solifluction down the slope, while the larger and deeper fragments might indicate the direction of ice movement in glacial times. The leaders emphasised that such judgements at this stage, though interesting, were subjective and speculative and that the demonstration was intended to emphasise the importance and value of objective observations backed by statistical analysis.

The members of the Society expressed their thanks for the insight they had been given into the techniques demonstrated which had made an interesting change from the more usual type of excursion, while for their part the leaders expressed appreciation of the patience and endurance of members in watching the procedures in such adverse weather.

AUTUMN WEEKEND FIELD MEETING IN THE APPLEBY AREA.

Director: I.C.Burgess B.Sc.

7th to 9th September, 1973.

There was a good attendance of members and friends for this weekend excursion and the weather was pleasantly warm and sunny. The director was Mr.I.C.Burgess, Principal Geologist at the Leeds Office of the Institute of Geological Sciences.

At 8.30 p.m. on Friday evening the 7th September an introductory meeting was held in the Courtfield Hotel at Appleby. Mr.Burgess explained that he had recently completed the re-mapping of the southern half of the Cross Fell Inlier+ for the Institute and had also written (with Mr.A.J.Wadge) a new Memoir* to accompany the map. The director gave a general talk on the geology of the area describing it as a large-scale fault breccia. He dealt in detail with the sequence of deposition from Ordovician to Triassic times and with the later glaciation.

On Saturday the 8th September the excursion began at 10.30 a.m. near Bow Hall Farm (374 251). After a brief geological description of the locality the party proceeded to Harthwaite Syke (378 248) to examine the acid tuffs and volcanic sands in the beck. In the overlying Dufton Shales of the Coniston Limestone Group in the bank, fossils of Lingula were to be found in the 'Corona beds'. Downstream in later beds many other fossils abound. Continuing up the lane to Peeping Hill a prominent glacial overflow channel was noted to the south. In the quarry on Dodd Hill the ash-flow tuffs of the Borrowdale Volcanic Group, derived from 'nuées ardentes', with their eutaxitic texture were examined. A hundred yards uphill beyond a fault, Skiddaw Slates of Arenig age were reached, and then the quartz pebble conglomerate that forms the base of the Carboniferous sequence which is marked by a strong spring line. After crossing the limestone succession the party sat down to lunch looking down on High Cup Gill (725 250). The columnar structure of the Whin Sill and the spring line at the bottom of the conglomerate were very noticeable.

After lunch an old quarry was visited lower down on the same side of the High Cup Gill valley. Here the Skiddaw Slates of Arenig age show tight folding and cleavages from two different periods and the pressure has been great enough to make the rocks somewhat schistose. About three hundred yards to the north-west an overflow channel had been eroded along the line of a major fault. On the slope a lenticle of Melmerby Scar limestone was examined. It is embedded in Skiddaw Slate having been collected as the land moved up on one fault and was brought down again by the next movement. Stud Gill was also found to be an overflow channel. Finally the famous Kiesley exposure of the Coniston limestone was reached (715 239). Trilobites and brachiopods were found in this fossiliferous reef knoll. In the Kiesley quarry below, the relationship of bedding to cleavage, which shows that the strata are the right way up, was discussed and finally graptolites were collected from the basal Silurian exposures in the lane leading to the quarry.

Soon after 10 a.m. on Sunday the 9th September members had parked near Appleby golf course and proceeded up the misfit stream in George Gill to examine the exposure of Permian dune-bedded desert Penrith sandstone. On the left bank of the stream the false bedding is clearly visible and on the right the rock is intersected by siliceous and calcareous veins due perhaps to slip planes developing soon after deposition. A short way downstream is a brockram deposit containing Whin Sill pebbles indicating that the material originated in the escarpment to the east.

The party then proceeded by car to Hilton Beck about $1\frac{1}{2}$ miles east of the main road. Starting at the west end of the wood, water-laid red millet-seed Penrith Sandstone and brockram were examined. 100 yards upstream the cream coloured Hilton Plant Beds of early upper Permian age were traced and many fragmental plant remains found. Still higher at the foobridge vugs are visible where anhydrite has dissolved from the sandstone indicating this as the edge of an evaporite basin.

After lunch the Belah Dolomite, with bands of algal limestone, and the overlying collapse breccia and solution residue of the D-bed Anhydrite, which is present at depth, but dissolved away at the surface, were viewed in the bank of the stream where it runs close to the road. At other exposures are a lens of millet-seed sandstone, brown mudstones, water and wind-laid beds, and finally typical St.Bees Sandstone in a quarry on the left of the road. Mr.Burgess explained how changes in climatic conditions are deduced in considerable detail from this sequence.

Finally the cars were driven to Hilton Village and the party made its last stop on the bank above Hilton Beck (735 208). St.Bees Sandstone is exposed, but just upstream is the Hilton Fault and beyond the rocks are Ordovician Dufton Shales, - and so the excursion had returned to its geological point of departure on the morning of the previous day.

Mr. Burgess was warmly thanked for a most enjoyable and informative excursion, and left behind him a group of geologists eager to expand their knowledge of the area by studying the new Memoir.

T. J. ROBERTS

REFERENCES:

+ Cross Fell Inlier. 1:25,000 Geological Special Sheet published 1972, price £1.10, available flat or folded.

* BURGESS,I.C. and WADGE,A.J., 1974. 'The Geology of the Cross Fell Area', H.M.S.O., London. vii & 92 pp. Price 75p.

EXCURSION TO THE COCKERMOUTH LAVAS IN THE BLINDCRAKE AREA

Director: Mr.Tom Shipp, B.Sc., F.G.S.

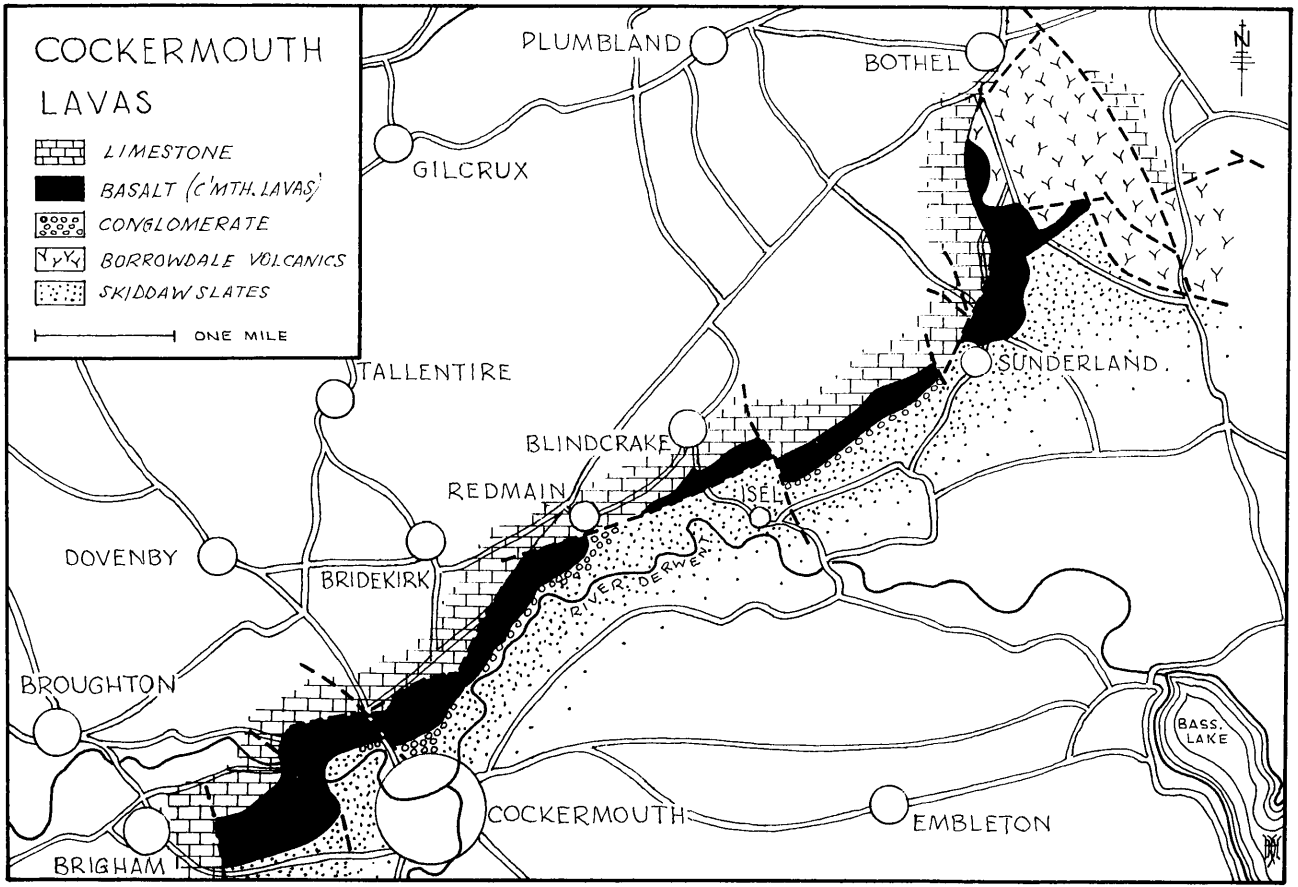
30th March, 1974.

Forty members and friends of the Society met at Blindcrake on a beautifully sunny afternoon for the first excursion of the summer programme to examine exposures of the Cockermouth Lavas. The excursion was led by Mr.Tom Shipp, the General Secretary of the Society.

Exposures of the lavas extend from near Brigham to Bothel Crags, a distance of some eight miles. They have a maximum thickness of 300 ft. so that it is evident that they were produced by a volcanic outburst of some considerable magnitude although the site of the vent is unknown. The leader, using a large scale coloured geological map of the locality, explained that when first surveyed these lavas, which abut against the older volcanic rocks of the Borrowdale series, were also though to be of Ordovician age. However, one perceptive Geological Survey Officer, Mr.Tom Eastwood, working in the area in the 1920's, noticed that these basaltic lavas of the Cockermouth region resemble the basalts of Lower Carboniferous age in the Scottish Coalfield and in Derbyshire. It is now agreed that the Cockermouth Lavas are in fact Lower Carboniferous in age and directly underlie the limestone.

The party then moved off to Wood Hall where by kind permission of Mr. and Mrs. Jackson sections of the rust-coloured basalt were examined in the grounds. After explaining some of the difficulties of making a geological field survey, Mr. Shipp invited members to attempt to fill in on a base map the geological information they observed at the various exposures during the course of the afternoon.

As the party moved towards Park Hill at Redmain it became clear from the mapping exercise that the base of the lava, resting on an older conglomerate, was not horizontal but was rising perceptably to the north. Great variations in the texture of the basalt were seen. In some places the freshly broken rock was dark blue-black and crystalline, in others it was fine-grained and splintery. A very noticeable feature was the vesicles - originally holes caused by gases excaping from the molten lava as it cooled. These vesicles, or amygdales as they are sometimes called, were filled with a variety of secondary minerals such as calcite, barite and quartz, the latter occurring in the form of clear or amethystine crystals, or as banded agate. At one point the leader led the party to a small mining level where in the past somebody had mistaken the green-stained vesicles for copper ore and made an abortive trial. A recent analysis had shown the green mineral to be calcite stained with glauconite. Mr. Morley Burton, the Society's Librarian, suggested that the glauconite, a hydrated potassium iron silicate, had formed after the lava had been submerged by the sub-tropical Carboniferous seas that deposited the overlying limestone.


COCKERMOUTH
LAVAS
LIMESTONE
BASALT (C'MTH. LAVAS)
CONGLOMERATE
BORROWDALE VOLCANICS
SKIDDAW SLATES
ONE MILE
PLUMBLAND
BOTHEL
GILCRUX
TALLENTIRE
SUNDERLAND
BLINDCRAKE
REDMAIN
SELL
DOVENBY
BRIDEKIRK
RIVER DERWENT
BROUGHTON
BASS. LAKE
COCKERMOUTH
EMBLETON
BRIGHAM

movement and erosion, consists of a series of shallow water calcareous sediments. They also include pebble beds and ashy mudstones in the Appletreeworth area. Fossil seekers in the party found Orthid brachiopods and 'Phacopid' trilobites in addition to corals and ostracods. Phacops mucronatus is found typically in beds above a characteristic 15' ash band.

The contact between the limy conglomeratic base of the Coniston Limestone, in which the pebbles are rhyolitic at this point, and the Borrowdale Volcanics below was seen in a small Foresty Commission quarry.

Before taking lunch in rapidly deteriorating weather, the shale tip beside an old adit alongside Appletreeworth Beck was examined. Mineralisation was noted along a fault in normal Skelgill beds. Haematite, calcite and pink-stained barytes were found. Not far from this spot the site of an old bloomery is marked by scattered pieces of possibly pre-Roman slag. The primitive iron-making process was to 'blow' a mixture of haematite and charcoal chips in a crucible-shaped kiln.

Appletreeworth Beck follows the line of weakness of the basal Silurian Skellgill Beds. They are in part bleached to a pale pink colour. Dark, dendritic manganese is a feature of this formation which also contains Monograptus. Following along the exposure 'normal' Skellgill Shales appear. Faulting and dark concentrations of carbon 'wads' were examined. Reverse faulting parallel to the strike repeats the outcrop of Coniston Limestone and basal breccia across the stream. A bend in the river is a feature probably caused by dip faulting as yet unidentified. South of the river a thrust fault breccia in the Brathay Flags was seen. Some curious pink-banded Skellgill sandstones were also noticed.

Those members trained as prop-forwards (or small enough to crawl between legs) were able to take some light refreshment at the Blacksmith's Arms, Broughton Mills, before proceeding downstream to an exposure of what has been described as a volcanic breccia. The field relations of this rock, which contains angular fragments of Coniston Limestone and Borrowdale Volcanics in a calcareous matrix, are uncertain but if it is contemporaneous with the Skellgill Shales it could account for the strange bleaching of these sediments referred to above by this late phase of vulcanicity. After a short walk a further expanse of breccia 30' thick with a clear contact on Coniston Limestone was seen. Sediments above the breccia may be Browgill material in which case the Skellgill Beds are not present here.

The return walk northwards from Hartley Ground was blessed in this idyllic setting with sunshine and blue skies. For those with the energy left, ripple marks and animal tracks on a bedding plane in B.V.S. tuff exposed by the stream presented an interesting diversion and made a relaxed ending to a splendid day.

The Sunday's excursion, under the leadership of Derek Leviston, was to the Greenscoe and Park quarries area. An initial meeting was held in Greenscoe quarry (219 764) after which members made their way to the top of a small hill just west of Green Haume. From this hill, formed of Lower Carboniferous Martin Limestone below, and Red Hill Oolite above, the whole panorama of the beautiful Duddon estuary can be seen.

Close by, to the right behind Greenscoe quarry, the three Coniston Limestone scarps formed by repeated Caledonian (i.e. Devonian) thrusting, could be clearly seen. Below us were the clay pits near Park Farm in Skiddaw Slates, and away in the distance iron pits, also in Skiddaw Slates, where it was suggested that perhaps iron-rich solutions had gravitated down through a previously existing cover of Carboniferous Limestone in faults and swallow-holes.

After surveying the view the excursion was resumed by making a traverse to the north-east following approximately the line of the Coniston Limestone scarps and so leaving the unconformable Carboniferous basement beds away to the east. Between the two most westerly of the three scarps the sediments consist of Skiddaw Slate with included lenses of andesite and tuff, whilst High Haume mudstone makes up the ground on both sides of the third scarp; this situation being caused by thrust faulting as previously described. In the normal succession Coniston Limestone post-dates the andesitic agglomerates and tuffs of the Greenscoe volcanic group, which are a late phase of the Borrowdale Volcanic Series. Although described as vent material, faulting has rendered the field relations of this feature somewhat inconclusive. Interbedded with the High Haume mudstone is a rhyolite. What connection this has, if any, with the Greenscoe Volcanic Group is not known. The high angle thrust contact between the Coniston Limestone and the Greenscoe Volcanics is marked by a strong feature line at the top of the high wall of the quarry and by slickensides and re-crystallised calcite when the ground is examined in detail. Within the quarry itself, volcanic bombs may indicate close proximity to the volcanic source which blasted its way through the Skiddaw Slates causing fragments of slaty mudstone to be included within the agglomerate. This interesting feature has not yet been fully explained and poses some very good problems for detailed field examination.

The weather having deteriorated somewhat, the shelter of the brickworks canteen was kindly made available to members at lunch-time and there was an opportunity to inspect some of the different processes in brick-making. The afternoon's programme began with a walk to the shale pits near the brickworks. Here the contact between the Skiddaw Slates and the andesite is seen in three small quarries adjacent to the pits. The bulk of the volcanic material is small and the Skiddaw Slates are not altered by the contact suggesting that these exposures represent small side vents of the main volcano at Greenscoe. Furthermore, an exposure on the north side facing the brickworks reveals six feet of agglomerate resting on Skiddaw Slate and overlain by Coniston Limestone. Since there is no sign of faulting or thrusting to reduce the thickness of agglomerate or complicate the succession, this again would suggest a side vent, providing always that erosion has not taken place before the deposition of the Coniston Limestone. It still has to be determined how much of the Greenscoe Volcanic Group is intrusive into the Skiddaw Slates, and how much is extrusive and represents lava flows and surface accumulation of material.

A final location in the side wall of the shale pits was found to reveal the contact of the basal Carboniferous on Skiddaw Slates. The Carboniferous rocks were pebbly and reddened with bands of brown ilmenite or limonite. The black Skiddaw Slates below were soft cleaved mud-

stones with a high carbon content. It is perhaps worth noting that this close juxtaposition of red or pink with dark grey sediments is a constantly recurring situation throughout Cumbria from the coal measures of Aspatria to the Skellgills of Appletreeworth, and here again at Greenscoe.

All told some 80 members of the combined Societies had attended the weekend's activities, and their sincere thanks were expressed to the organisers and leaders whose efforts had made the occasion so worthwhile and enjoyable.

I.R.Wilkinson

- - - - - -

USEFUL REFERENCES:

BRITISH REGIONAL GEOLOGY, NORTHERN ENGLAND. Fourth Edition, H.M.S.O., 1971.

GREEN, J.F.N., 1912, The older Paleozoic Succession of the Duddon Estuary. Hayman, Christy & Lilly Ltd., London (published privately).

HELM, D.G. and ROBERTS B., 1971, The Relationship between the Skiddaw and Borrowdale Volcanic Groups in the English Lake District. Nature: Physical Sciences, vol. 234, No. 46, pp 59-60.

MITCHELL, G.H., 1956, The Borrowdale Volcanic Series of the Dunnerdale Fells, Lancashire. Liverpool and Manchester Geol. Journal. vol.1, pt.V, pp 428-449

SOPER, N.J., 1970, Three Critical Localities on the junction of the Borrowdale Volcanic Rocks with the Skiddaw Slates in the Lake District. Proc. Yorks. Geol. Soc., vol 37, pt.4, pp 461-493.

- - - - - -

INTRUSIVE ROCKS IN THE ESKDALE AREA

Leader: Mr.M.F.Burton

Sunday, 19th May, 1974.

The Eskdale Granite occupies approximately 48 square miles of Western Cumbria and, according to the Survey Memoir, appears to be 'stock-like' in its emplacement. Simpson, however, in his paper refers to it as being laccolithic in structure and in support of this assertion points out the occurrence on the south side of Devoke Water of a 'window' carved out by Rigg Beck which reveals a porphyritic andesite, the surface of which dips at a low angle into the granite mass which also appears to dip with this plane. The granite here is in the nature of a small pocket apparently removed from the main mass by two NW-SE trending wrench faults. A contempoary of Simpson's was of the opinion that the andesite in Rigg Beck was a faulted wedge and saw no evidence for a low-angled junction - thrust or otherwise. Whether in fact the Eskdale Granite be a stock or a laccolith we see an intrusion which has considerable variations in its upper part but which could well be less modified at depth. In this respect it is generally held that the pink, green and grey varieties of the Granite are cognate intrusions and not products of a differentiated magma, the less acid granodiorite - the Grey Granite - being intruded first.

The party first visited Waberthwaite Quarry (112 943) towards the south of the intrusion. Here the rock is in the main greyish, with an abundance of ferromagnesian biotite and liberally traversed by aplite veins. This is the 'grey granite' of Simpson and with an average S.G. of 2.72 it is slightly heavier than the normal pink type of rock which has an S.G. of 2.619. Petrologically the increased weight of the 'grey granite' is accounted for by a marked increase in ferromagnesian minerals, mainly biotite, and is also characterised by a considerable increase in orthoclase and plagioclase with a corresponding loss in quartz and perthite. A rock sample analysis published by the Geological Survey shows plagioclase to be dominant to the extent of at least two-thirds of the total feldspars present and understandably this rock falls into the granodiorite class and is referred to as such in the Survey Memoir. Outcrops of rock encountered by the track on entering the quarry revealed specimens having a reddish groundmass and very heavily biotised, but which on closer examination could not be confused with the pink type of rock seen later further north. Another specimen taken nearby appeared very dark with a light relief from fair-sized pink feldspars exhibiting good crystal faces. These two specimens in no way resemble in colour the normal grey rock which comprises the main sections of the quarry face.

The examination of the face was limited to certain areas due to the dense undergrowth on the quarry floor. Aplite veins were abundant at one place and small reddish garnets were found in association with them, sometimes being nothing more than red spots or stains in the rock. They were rather disappointing as mineral specimens. One member produced

a small but rather attractive specimen of brownish black tourmaline showing characteristic ridges on the prism faces. Working round the quarry haematite staining was noticed in places and the leader found a spot where the rock was completely friable and corroded by iron, being of a dark red colour.

A number of specimens of the grey Waberthwaite Quarry rock had been submitted by the leader to X-ray powder diffraction tests in the hope of revealing any accessory minerals that might be present. Zirconium was indicated, but individual zircon crystals could not be detected.

Lunch was eventually taken in the warm sunshine on a knoll above the quarry facing the main road with Muncaster Fell in the middle distance.

After lunch the party proceeded to the Stanley Ghyll Hotel, Eskdale, where the cars were parked and the line of the "La'al Ratty" railway was followed to the Beckfoot Quarry (164 003). As at the previous locality variations in the 'normal' granite of the area were observed. Access to the side walls was made difficult by undergrowth, and the main back-wall was discovered to be in a shattered and dangerous condition from the last big quarry blast.

A lightish grey rock containing a fair amount of biotite and showing randomly scattered plates of white mica, which glistened metallically in the sunlight, was found on the eastern side of the quarry. This rock also contained patches of a very pale yellowish-green mineral which on later analysis turned out to be orthoclase. Crossing the face in a northerly direction the rock acquired a reddish hue with much haematisation and then graded into a more normal pink granite. Towards the centre of the face and extending nearly to the floor there was a brecciated granite, while further round to the west the rock became much finer-grained and finally assumed a micro-granitic texture. Brown to black tourmaline was abundant in rocks on the quarry floor in radiating aggregates, but not of any appreciable thickness. The Secretary produced a specimen containing a largish orthoclase crystal with Carlsbad twinning.

An interest had been shown by some members in the various adits to the iron ore bodies which were located on the fellside in close proximity to the quarry. It was decided to round off the excursion by a brief visit to one of these on the way back to the vehicles. An interesting discussion arose as to the age and mode of emplacement of the iron ore bodies in West Cumbria with emphasis being placed on the likelihood of the iron originating from the St. Bees Sandstone.

REFERENCES:

RASTALL,R.H., and WILCOCKSON,W.H., 1917, Accessory Minerals of the Granitic Rocks of the Lake District. Quart. Jour. Geol. Soc. Vol. lxxi Pt.4.

SIMPSON, B., 1934, The Petrology of the Eskdale (Cumberland) Granite. Proc. Geol. Assn. Vol xlv part 1.

TROTTER, F.M. et al., 1937, Geological Survey of Great Britain, Gosforth District. H.M.S.O.

EXCURSION TO THE CARBONIFEROUS LIMESTONES

OF

HUMPHREY HEAD

Leader: Dr.F.H.Day

15th June, 1974.

Some thirty members of the Cumberland Geological Society met at Flookborough for an excursion to the rocks of Humphrey Head (391 738) under the leadership of Dr.F.H.Day, President of the Westmorland Society.

In giving a general description of the geology of the area Dr.Day explained that strong north-south trending faults divided the territory into blocks. Deep cut valleys had formed in the thick Carboniferous beds along the fault lines and in some instances had cut down to the older Paleozoic basement. One of these major faults was responsible for the valley of the Lyth with Scout Scar a prominent feature. The Winster valley to the west was similarly formed and came out into Morecambe Bay just east of Holme Island with the crags of Whitbarrow Scar in a corresponding position.

These features were surveyed by the party from the summit of Humphrey Head after which a descent was made to examine various exposures where a variety of typical Carboniferous fossils were found. A discussion developed on the vexed question of the cross-correlation with the limestones of West Cumberland. Dr. Day explained that there was a long standing uncertainty on this point but further field work was being done at the present time which might elucidate the question. Dr. Day suggested that the key to the problem might be the rather elusive algal fossil species Girvanella. Thus stimulated the party did in fact succeed in finding some very fine specimens of this fossil.

At the conclusion of the expedition Dr. Day was warmly thanked by the members for making the occasion so rewarding and interesting.

T. S.

VISIT TO THE

HAIG COLLIERY, WHITEHAVEN

- -

20th March, 1975.

A small, specially arranged, party of ten members of the Cumberland Geological Society visited the Haig Colliery of the National Coal Board at Whitehaven.

The party was met by the Safety Engineer who first explained the lay-out of the workings and the safety measures employed. After a three mile underground journey by rail-motor, in conditions not unlike the London Tube system, the party still had a longish walk to the coal face which was reached 1700 feet below sea level. Great interest was shown in the rapid operation of the coal-cutting machines and also in the system of roof supports using jacks. At this depth the immense pressure of rock above requires careful and constant supervision and maintenance of the supports.

The seven foot thick Main Band seam, which was being worked, lies in the middle coal measures and is roofed in this locality by a whitish, flaggy siltstone with micaceous bands indicating the varying environments of deposition in the estuarine conditions that existed when the sediments were laid down. The coal itself is bituminous, consisting mainly of clarain - a type of coal with a rather bright, lustrous appearance - although at the top of the band there was a layer of durain, a harder type of coal with a dull appearance. Below the coal there is a grey, non-fossiliferous mudstone passing down into shale. There was little evidence of pyrites or of compressed siliceous material although a faint odour of sulphuretted hydrogen indicated that sulphides did exist. Methane gas passes into the porous sandstone strata above the coal from where it is drawn off. An appreciable dip of 20^{o} - 30^{o} was noted in the beds in this locality.

The visitors were impressed by the improvements that had been made in recent years in working conditions and safety underground and thanks were expressed to the General Manager and his Staff for an enlightening visit.

F. Jones.

LECTURE REPORTS

REVOLUTION IN THE EARTH SCIENCES AND THE TEACHING OF THE EARTH SCIENCES IN THE OPEN UNIVERSITY

by Mr. Eric Skipsey

Some 35 members and guests of the Society forgathered in the Derwent Centre, Cockermouth, on 6th March, 1974, to hear a talk by Mr.Eric Skipsey, B.Sc., F.G.S., the Staff Tutor in Science in the Northern Region of the Open University.

In the last two or three years close links between the Society and the Open University had been formed in the Region so that there was considerable interest in the subject chosen by the lecturer.

Mr. Skipsey first outlined the general structure, mode of operation and the teaching systems adopted by the Open University and then went on to explain how some of the problems of teaching geology at a distance had been tackled. With regard to the syllabus the policy adopted had been very much influenced by the revolution that had taken place in the Earth Sciences in recent years as a result of the development of plate tectonic theory.

In developing his theme Mr. Skipsey spent some time outlining the historical development of these newer concepts. Geology had progressed from the 'catastrophists' to the inescapable logic of stratigraphy to the point where Wegener advanced the idea of continental drift. This was fiercly argued for many years but in the 1960s rapid development occurred in oceanography and in geophysical methods, particularly in relation to residual rock magnetism, heat flow and radioactivity. The resulting explosion in geological knowledge owed much to the Polaris nuclear submarine and missile programme and to the sophistication of seismic recording required for the Atomic Test Ban Treaty.

Evidence pointing to the migration of the magnetic pole in geological time together with other evidence such as palaeoclimatic changes led to gradual acceptance of continental drift. The mapping of the ocean floor, with regard to topography and rock magnetism and the distribution of shallow focus earthquakes led to the concept of sea-floor spreading from mid-ocean ridges and this in turn led to the detection of compensatory consumption of crustal material at destructive plate margins. The identification of mobile crustal plates was accompanied by the discovery of evidence for a layered mantle and the development of convective theories to explain the crustal movement.

The time was now ripe for the re-interpretation of the great mass of detailed stratigraphical geological information accumulated over the years and this is still going on.

Returning to his original theme, the speaker explained that a deliberate decision had been taken to introduce geology to Open University science students, in their first year foundation course, on the

basis of plate tectonic theory - a topic that hitherto had only been introduced towards the end of orthodox academic geology courses. More formal geological teaching was embodied in specialised second level courses but with much emphasis on economic and environmental geology in relation to man's natural resources.

A lively discussion followed stimulated by both the scientific and educational aspects of the talk, and finally a warm vote of thanks was proposed to the speaker for a lecture of great interest and originality.

- - - -

THE GEOLOGY OF ETHIOPIA

Professor R. M. Shackleton.

The first meeting of the winter session was held at the Ullswater Centre, Penrith, on Wednesday 9th October, 1974. The guest lecturer, Professor R. M. Shackleton, F.R.S., of the University of Leeds, gave a talk to about forty members and guests on the Geology of Ethiopia. The speaker said that he had spent about six months in that part of Africa investigating various aspects of the geology.

According to the latest theory of plate tectonics, the earth's crust in the Arabia - East Africa region is being affected by a deep-mantle plume. This is regarded as an upwelling of hot plastic material from deep in the earth's mantle which is causing the crust to bulge upwards and split. The pattern of splitting can be seen on maps as a three-pronged system of rift valleys with the Ethiopean Rift extending south west into East Africa, the Red Sea Rift stretching northwards and the Gulf of Aden Rift reaching out into the mid-Indian Ocean.
The Professor drew parallels between the present geological activity in the Ethiopian region and the processes which, it is conjectured, led to the opening of the Atlantic Ocean between North and South America on the one hand and Europe and Africa on the other, beginning in the Mesozoic about 200 million years ago. Perhaps in 50 or 100 million years time the Red Sea will have become a new ocean.

With the aid of colour slides Professor Shackleton showed how the terrain of high plateaux and deep rift valleys makes for difficult communications within Ethiopia. Much of the geological exploration has been done by helicopter. Large areas of high plateaux are composed of thick layers of basaltic lava which has welled up from the base of the earth's crust through cracks formed by crustal stretching.
Faulting is very widespread in the rifts but almost entirely absent in the plateau blocks. Some superb aerial photographs were shown which revealed series of fault scarps partly over-ridden by basaltic lava flows. The slaggy, unstable surface of the basalt presents some of the most inhospitable terrain to be found anywhere in the world.

With all the faulting and volcanic activity earthquakes are very prevalent, and the few solid buildings in the region are particularly vulnerable. The very complex structures found at the meeting of the three rift systems - known as the Afar province - were illustrated with maps and with pictures showing volcanic activity. The lecturer said that comparisons could be made between the Ethiopian-Arabian region at the present day with its crustal tensions, arid climate, vulcanicity and evaporite formation and North-West Britain in Permian times, where the palaeogeology points to a similar type of environment.

In his talk Professor Shackleton not only presented a picture of the geology and climate of a little-known region, but he also showed how the scope of geology had been extended to indicate how world-wide movements of slabs of the earth's crust have altered, and continue to alter, the configurations of the continents and oceans. He also brought home vividly the fundamental geological principle that a study of present changes and processes is a key to the past.

A vote of thanks on behalf of the Society was proposed by Mr.Walter Annis.

- - - -

ONE MAN'S VIEW OF THE SKIDDAW GROUP

Dr. Dennis Jackson.

It was with great pleasure that members and friends of the Cumberland Geological Society welcomed Dr. Dennis Jackson of the Department of Earth Sciences of the Open University. Dr. Jackson is an old scholar of Cockermouth Grammar School and chose as his subject 'One Man's View of the Skiddaw Group' on which he is a leading authority. He claimed that it was the President of the Society, Mr.E.H.Shackleton, who first introduced him as a small boy on a family picnic to the subject which had become his major interest. He explained that having been brought up at Embleton he had the advantage of living and working for many years with the rocks of Skiddaw which became the subject of his researches. More recently he had been especially fortunate as an oil company geologist working in Canada in being able to investigate a succession of North American sedimentary rocks of comparable age. In his work of mapping and recording these rocks and their contained fossils he was able to call upon his earlier work in Cumbria and found that the sedimentary rocks of the Northern Lake District could be made the basis, on their fossil content, of a world-wide correlation of the Arenig and Llanvirn Stages of the Lower Ordovician System.

The fossils in these 500 million year old rocks are principally graptolites - tiny marine colonial organisms which became extinct 100 million years later. These fragile creatures lived and died floating in ancient seas, sank to the bottom and became entombed in the mud on the sea bed. As the muds became compressed into rocks the animals' remains became flattened, and now appear as black or brown pencil-like markings on bedding planes. Graptolites changed in size and shape during their

millions of years of existence and so are used by geologists to identify the rock layers in which they are found.

Dr.Jackson outlined the investigations that had been made into the Skiddaw Group of rocks from the early 1800's up to the present. Jonathan Otley first recognised the rocks calling them the Clay Slates, but it was Professor Adam Sedgwick in the 1820's who gave them the name by which they are more commonly known - the Skiddaw Slates, though they are neither exclusively slaty nor found only in the Skiddaw region. J.W.Salter in the 1860's first described the graptolites whilst J.Clifton Ward ten years later attempted to divide the Group into five major rock formations with an estimated thickness of over two miles. Professor J.E.Marr, J.F.N.Green, R.H.Rastall, and G.L.Elles attempted to correlate the Skiddaw Group with rocks of similar age and type found elsewhere. The speaker expressed the opinion that a great deal of this early work was perhaps less thorough than it should have been because the researchers did not live in the locality and relied partly on material collected for them by students, some of it from loose scree rather than from solid bedrock. The evolutionary trends in the graptolites suggested by Marr and Elles were, he felt, based more on pre-conceived notions than on geological field evidence, and Marr's three and Elles's six graptolitic zones should be used only with great reservation.

Having expressed doubts about apparently firmly established palaeontological views, Dr. Jackson went on to show how, by world-wide studies of Lower Ordovician sedimentary rocks, he had been led to the opinion that the earlier graptolites at least, had developed and evolved differently depending on whether they had formed in cold or warm seas. He thought that the rocks of the Skiddaw Group had been deposited in cold seas, while rocks of similar age in Scotland and Ireland, containing demonstrably different species of graptolites in much greater variety, had formed in warmer climes. Dr.Jackson believed that the close proximity of the two distinct faunal provinces of graptolitic rocks in Northern Britain could be accounted for on the basis of plate tectonic theory by the moving together of great slabs of the earth's crust which were originally widely separated in Ordovician times.

During his talk Dr. Jackson stressed the difficulties he had encountered in trying to elucidate this thick succession of Northern Lake District rocks. He maintained that despite technical difficulties, it was people living in the locality, who need not be experienced geologists, who had the best chance of investigating, recording, and turning up something new. There was at present a chance which should not be missed of investigating fresh exposures of the Skiddaw Group along the line of the A66 road works, and Dr. Jackson offered to examine any fossils that members might find.

- - - -

SOME ASPECTS OF THE HISTORY OF LEAD AND COPPER MINING IN THE KESWICK AREA

by Mr.J.D.J.Wildridge.

On 8th January, 1975, Mr. Denis Wildridge gave a talk at the Whitehaven Branch of the West Cumbria College of Science and Technology to some fifty members and friends of the Society. The speaker is an authority on the history of mining in Northern England and has devoted a lot of time to exploring old mines and going over documentary evidence in the County Archives. He concentrated in his talk on some aspects of lead and copper mining in the Keswick area.

First of all he traced the descent of the mineral rights from the Barony of Egremont in 1120, through the Dukes of Northumberland and Somerset, to the Leconfield and Egremont Estates in recent times. There was no evidence, documentary or archaeological, that the Romans ever worked the Lakeland mineral veins. The first written records of mining in the area are of 1264, about a lead mine in the Derwent Fells identified, probably wrongly, by later commentators as the Goldscope Mine in the Newlands Valley.

The Goldscope Mine is probably the most famous and certainly was the richest mine in the area, producing copper, lead and some silver.

The mine was opened in 1566 by a group of German miners, brought over by Queen Elizabeth I, and led by a man called Daniel Hochstetter. This group actually started operations in 1564 at Stoneycroft where there are still traces of mining and of a smelt mill at the water intake by Stoneycroft Beck. They eventually formed a company called The Mines Royal which was in operation from 1568 until the early 1600's.

There is no evidence of further working of the Goldscope Mine until 1757 when the workings were pumped clear of water by John Gilbert.

In 1848 three partners worked in along the copper vein, and by 1851 they had extracted 32 tons of ore and amassed £4,000 in debts. Two partners dropped out, but the persistent survivor, Mr. Clarke, broke into an area where the lead and copper veins crossed and hit a three feet wide rib of solid lead ore, making himself a personal fortune of £25,000 by 1855.

Mr.Wildridge commented on the present state of the old mine workings, saying that with few exceptions they were dangerous places which should only be explored in the company of experts who could recognise the danger signals. He mentioned that even when the Goldscope Mine was in production, part of the vein had fallen in underground leaving a chasm 160 feet deep and 50 feet wide; a warning note for would-be explorers.

Some of the tools used by miners before the advent of power drills and explosives were shown; a hand drill or jumper, stopes and feathers forsplitting the rock, and a curious mallet called a bucker for breaking up the ore. The ore and waste rock would have been hauled on sleds dragged by manpower or with the aid of a winding 'gin' powered by a water wheel or a horse. In the earliest days the mineral veins would have been worked at outcrop in the form of bell-pits, some of which survive in Newlands at the roadside by Uzzicar Farm. Later, tunnels called adits were driven to break into the ore-bearing veins which unlike coal seams are generally nearly vertical.

The copper veins in this area run approximately north-south and the lead veins east-west.

The life of the miners must have been very hard. They were usually smallholders combining mining with farming. They would travel long distances from home to live out at the mines, often in very remote bleak surroundings. Gangs of them would bargain for payment at a given price per fathom of tunnel driven. Payment would have been every six months, so that the miner's family was usually permanently in debt to local suppliers. Tools were leased to the miners, and deficiences due to wear and tear during the stint had to be paid for. The miner and his family often supplemented a meagre income by knitting, and it was no unusual sight to see gangs of miners knitting as they walked on the way to work, or during breaks from swinging a hammer or a pick.

Mr. Wildridge showed some typical samples or ores from the Lakeland mines; malachite (copper carbonate), copper pyrites, galena and also blackjack or zinc blende. Some photographs of documents, letters, bills, production records and mine prospectuses dating back to the 1630's were shown. These throw considerable light on past conditions and production and, though most of the original records have been destroyed down the years, enough is left to provide a most interesting link with the Lakeland of yesteryear.

A vote of thanks for a most absorbing talk was proposed by the Society's Librarian, Mr. Morley F. Burton.

- - -

THE LOWER CARBONIFEROUS STRATIGRAPHICAL PALAEONTOLOGY OF THE FURNESS AND GRANGE AREA

By Mr. Murray Mitchell.

The final lecture meeting of the 1974-75 programme was held at the Whitehaven Branch of the West Cumbria College of Science and Technology on Wednesday, 12th March, 1975. The speaker was Mr. Murray Mitchell, M.A., Principal Scientific Officer from the Leeds Office of the Institute of Geological Sciences.

The lecturer gave an interesting and informative talk on the limestones and associated rocks of the Lower Carboniferous in the Furness and Grange area. Similar rocks and strata are to be found, however, in the Egremont-Frizington region which is more easily accessible for the members living in West Cumbria.

One of the major problems in stratigraphy is the correlation of rocks of similar age from region to region. This is normally done by recognising groups of fossils, each group being characteristic of a particular time span and hence being found in particular strata or zones of rocks. Fossiliferous rocks are usually muddy, sandy or limy sediments laid down in strata, each of which would accumulate during relatively brief spans of time in geological terms.

The main type area for the correlation of the Carboniferous Limestone has hitherto been Avon Gorge near Bristol, where the sequence was worked out by Dr. Vaughan in the early 1900's. Early workers suggested that the sea in Carboniferous times 340-325 million years ago 'transgressed' to cover practically the whole of the area of England and Wales depositing layers of limestone as it spread. This was followed by uplifts of the sea bed and the formation of thick sandy deltas upon which Coal-Measures swamp-forests grew. In his talk Mr. Mitchell showed that the evidence from many areas of Britain and Belgium indicates that the Avon Gorge section is unsatisfactory due to gaps in the sequence there and that more complete sections can be found elsewhere. The Furness and Grange limestones in South Cumbria are particularly useful in this respect. Recent studies have shown that the Carboniferous seas advanced and retreated not once, but in six major cycles. This is not improbable in view of the huge span of time involved. The lecturer went on to show, by means of slides, the evidence for this assertion as indicated by the sequence of strata and the contained fossils, mainly brachiopod shells, coral skeletons and algae.

In thanking the lecturer the Society's Excursion Secretary, Miss Doreen Slater, said she thought that Mr. Mitchell had probably changed some of the long held views of many members about this important group of rocks. She hoped that as many members as possible would take the opportunity of joining Mr. Mitchell on a weekend of field work in the Furness area planned by the Society for June, 1975.

OBITUARIES

PROFESSOR FRANCIS JOHN MONKHOUSE, M.A.,D.Sc.,F.R.G.S.

The Officers of the Society were deeply shocked to learn of the sudden death early in March, 1975, of Frank Monkhouse, one of our most distinguished members.

At the age of sixty he was still at the height of his intellectual powers and, indeed, it had been planned that he should give the opening lecture of the Society's winter programme next October. Those who had heard him lecture on previous occasions were looking forward to an intellectual treat, for his style in lecturing, as in writing, was always clear, vigorous, well organised and excellently illustrated.

Frank Monkhouse was a native of Cumbria and was educated at Workington Grammar School. The writer can recollect that even as a schoolboy he showed that exceptional ability to marshal and organise geographical facts, which, coupled with an abounding enthusiasm for his chosen subject, was to last him for the rest of his life. It was then too that he developed a deep love for the fells and crags of his native Lake District and he became a devoted fell walker and rock climber.

From Workington he proceeded to Cambridge where he gained a good degree, and for some years taught geography at Wakefield Grammar School. During the second World War he worked for the Intelligence Division of the Naval Staff on the production of the now famous Admiralty Handbooks. In 1946 he was appointed a lecturer in the Department of Geography at the University of Liverpool, under Professor H.C.Darby, and he played an important part in organising new courses in the rapidly growing department, particularly in physical geography and cartography. Much of the material which he developed at this time formed the basis of two of his most important books: 'Maps and Diagrams' (in collaboration with H.R.Wilkinson) and 'Principles of Physical Geography'. Both of these have been standard university text books for over twenty years.

In 1954 he was appointed to the Chair of geography at the University of Southampton, and the breadth of his geographical interest is shown by the fact that he turned to a study of Europe in his monumental 'Regional Geography of Western Europe'. An earlier monograph on 'The Belgian Kempenland' remains a model of lucid geographical description, based firmly on the underlying physical and geological facts, and elucidating changes in landscape and settlement pattern in the light of past history and recent economic development.

In 1966 he retired from the Chair at Southampton partly to concentrate on his writing and partly to enjoy fell walking and rock climbing in his beloved Lake District while still comparatively young. He bought and modernised a farm house nestling beneath Angler's Crag and giving superb views up Ennerdale, and here he pursued his many interests. On a number of occasions he served as visiting professor at universities in the U.S.A. and his wide knowledge of that country was put to good use in further publications.

I quote from Professor H.R.Wilkinson's tribute in the 'Geographical Magazine': - 'Frank Monkhouse was a great enthusiast in all he did and an indefatigable exponent of his subject. He expounded it at home and abroad, in schools and in universities ... ...He made a major contribution to the advancement and extension of geographical studies and stimulated interest in geography everywhere'.

The Society has lost an outstanding member, and our sympathy goes out to Mrs. Monkhouse and to his family.

H.A.W.

- - - -

ALFRED H. HOLDEN, B.A.

Alfred Holden, who died on 15th April, 1975, at the age of 74, came to live in Keswick upon his retirement in 1961 from a career in teaching. He joined the Society in 1964 and until comparatively recently had been a regular attender at the Society's functions.

He received his education at the City of London School and at St. John Baptist College, Oxford, where he read classics. On leaving Oxford he taught for a few years at Liverpool Collegiate School before moving to Whitgift School, Croydon, where he remained for the rest of his working life, becoming Senior Classics Master and a Housemaster.

He was a man of wide interests and in addition to his geological activities he was a keen amateur meteorologist and became the official weather recorder for Keswick. His comments on the monthly weather statistics which were published in the 'Keswick Reminder' will be greatly missed.

He leaves a widow and a son and daughter to whom the members of the Society will wish to extend their sympathy.

THE ANNUAL DINNER 1974

The 1974 Annual Dinner of the Society was held at the Red House Hotel, Keswick, on Friday 15th March. Forty members and guests attended.

At the conclusion of an excellent meal the President Mr.E.H. Shackleton used the occasion to make a presentation to the retiring General Secretary, Mr. R.E.O.Pearson. The presentation consisted of an inscribed desk ornament in polished serpentine together with an antique print of St.Bees Priory. The President emphasised the Scoeity's indebtedness to Mr. Pearson for the long and excellent service he had given to the Society, having managed its affairs for some fifteen years. Mr. Pearson replied suitably.

The President then invited the Guest of Honour, Professor M.H.P. Bott, of the Department of Geophysics at Durham University, to give a short after-dinner talk to the company.

Professor Bott spoke about a gravimetric survey he had made in the Lake District some years ago. He amused the audience by recounting some of the remarks made to him by passing tourists as he peered into the gravimeter to take readings of gravity anomalies at different locations. He explained how the varying density of crustal rocks could give rise to very small gravity variations or anomalies. A mass of granite for example at depth would give rise to a 'gravity low' which could be plotted on a map after making somewhat complicated corrections for elevation above sea level and other variables.

The speaker illustrated his theme with excellent slides showing the results of his work. The maps produced showed very clearly areas of low gravity centred on the known Lake District granites (Shap, Skiddaw and Eskdale-Ennerdale) but extending beyond their known outcrops. Computor 'models' based on the experimental data suggest that the granite extends downwards for five or six miles into the crust. The results also indicate that the known outcrops are linked at no great depth below the surface - an idea previously deduced from field evidence found in the Skiddaw Slates at Blake Fell, Grasmoor and Causey Pike. The granites of the Lake District can be regarded as part of a batholith extending across Northern England as far as Durham.

Professor Bott commented in conclusion that since granite is a 'light' rock, it tends to float upwards in the earth's crust. In the Lake District the granite is prevented from doing this by the weight of the mountains, which he had calculated to be 1,500 million, million kilograms. It is perhaps reassuring to realise that as the Fells are eroded away they are constantly being buoyed up by the underlying granite batholith.

Professor Bott, who had evidently stirred the imagination of his audience, faced a barrage of questions with equanimity and was thanked for his talk by the Vice-President of the Society, Mr. M. B. Dodd.

THE ANNUAL DINNER 1975

The 1975 Annual Dinner of the Society was held at the Red House Hotel, Keswick, on Friday 14th March. Some forty members and guests attended and the Guests of Honour were Dr. and Mrs. Patrick Brenchley of the Liverpool Geological Society.

Following the meal Dr. Brenchley was presented with a polished specimen of local coral limestone by the President. Miss Judith Straughton presented a bouquet to Mrs. Brenchley, and each of the ladies present received a small heather spray by courtesy of Mr. Bob Bennett. The geological motif on the menu cards was designed by Mrs. Audrey Chandler.

A short after-dinner talk was given by Dr. Brenchley who, after thanking the Society for their hospitality, referred to the links that had been established between the Liverpool and the Cumberland Geological Societies. He then went on to talk about the rocks of the Skiddaw Group which had been one of his particular interests. He linked them with their counterparts in the Isle of Man and in South East Ireland and showed how the concepts of plate tectonics were altering our views on the origin and subsequent history of the Group. He also referred to recent ideas on the nature of the junction with the succeeding Borrowdale Volcanic Series.

The evening proved most enjoyable and interesting for all those present and the thanks of the Society are due to Mr. and Mrs. Bond of the Red House Hotel and their staff for making the members and their guests so welcome.

- - - -

13TH ANNUAL GENERAL MEETING

The thirteenth Annual General Meeting of the Society was held at Whitehaven Grammar School on the 6th February, 1974.

GENERAL SECRETARY'S REPORT

This will be my fifteenth Report as General Secretary of the Cumberland Geological Society. This is not strictly true in as much that for the first two or three years I was the Secretary - there being no other officers apart from the co-founders Mr.C. Edmonds and Mr. E. H. Shackleton. Due to the steady growth of the Society in the early 1960's, firstly a Treasurer was appointed (Mr. T. Shipp), followed by the other officers, the last one being a Librarian appointed to look after the Library formed from the personal collection of the late Mr. Tom Eastwood.

The reason for this brief reminiscence is to draw attention to the fact that the Society is built on a firm foundation, and in some way represents a renaissance of Geological Societies. They had been very much in the doldrums since the early 1930's. One has only to look at the steady increase in the number of amateur societies given publicity in the Geologists' Association circular to see that this is no idle statement. Only five or six years ago the Cumberland Geological Society was the only one - the latest circular lists ten.

As General Secretary I must once again, and, as it happens for the last time, sincerely thank the officers of the Society for the support they have given to me this past year. I feel I must mention separately the President and Treasurer, who have done far more to keep the Society running than the duties for which they were elected. Only by such efforts can an amateur society function.

The Lecture Programme for 1973-74 has been reasonably successful. The Soiree, held this year at Workington Grammar School was rather disappointing so far as attendance was concerned. This may have been due to the inclement weather and the somewhat isolated venue. The most disappointing part of the evening was the fact that so few members of the Society were able to see the very creditable display arranged for the Society by members of the VIth form of the Grammar School. The film, 'The Coal Gatherers' was of interest, the N.C.B. representative being somewhat taken aback by the presence of members of the Open-Cast Executive.

The prevailing economic situation has unfortunately caused the cancellation of the last two meetings because of the power cuts. It is hoped, however, that the proposed meeting at Penrith will take place later in the year. The Annual Dinner, held at the Chase Hotel, Whitehaven, was a great success. The occasion was enlightened in no small way by the presentation of the Charles Edmonds Memorial Prize to the President, Mr.E.H.Shackleton.

In closing this short report I would like to place on record that I cannot think of any member of the Society to whom I would rather hand over my post as General Secretary than Tom Shipp. Apart from being the first Treasurer, when I recall he took over a debit balance, he has, by his work as Editor, more than anyone else enhanced the reputation of the Society. I know that he will make a very good General Secretary who will build up the Society and bring to it the professionalism that in this day and age a Society such as ours needs.

R. E. O. PEARSON.

HONORARY TREASURER'S REPORT

We began the year with £198 in hand and ended it with £599 in the bank. However, members must not jump to the conclusion that the Society has suddenly become wealthy. The explanation is quite simple. We have not yet agreed on the final figure of our indebtedness to the printers of the 'Proceedings'. In the Statement of Assets and Liabilities you will see a sum of £280 is held in respect of the demands of 'Sundry Creditors'. Furthermore, an appeal which was made in the spring for interest-free loans to guarantee the cost of producing the 'Proceedings' met with a ready response. At the time the production of the 'Proceedings' was thought to be imminent, and we might not have been able to meet the expense in addition to our other obligations. In the event a total of £236 was contributed by some 34 members, and this prompt and generous reply to the Secretary's letter relieved your Council of any further anxiety on that score. We hope that sales of the last two parts of the 'Proceedings' to the general public will continue to grow, and will soon enable us to repay these loans. It will be seen that some £500 will be needed to meet our commitments under these two headings.

The largest single item under the heading 'Donations' consists as usual of the generous gift made annually by the Marchon Division of Messrs. Albright and Wilson, continuing the tradition first established by Sir Frank Schon several years ago. There have also been more donations that usual from members, some of them specifically to help with the cost of printing the 'Proceedings'.

The number of full members increased from 135 to 151, with 7 institutional members and 14 associates. There has been a further decline in the number of junior members, and as I commented last year, this continued decline is regrettable and surprising.

On the expenditure side it is not unexpected to find that costs of materials, postages and expenses of all kinds have risen when compared with the previous year, but our income from subscriptions alone is sufficient to cover these items, while our income from sales may be devoted to financing future publications.

The Charles Edmonds Memorial Fund deserves a brief reference. The Trustees made an award during the year to our President, and the fund now has £8.27 in hand.

In conclusion I think you will agree that the Society's financial position might be described as solvent though not affluent. An increase in the income from subscriptions and from sales of publications would be very welcome.

I must not close without expressing my sincere thanks to our Auditor, Mr. Mervyn Dodd, for his help and advice in disentangling the details of our accounts, and for the care with which he scrutinises them.

H. A. WHITE

The following Officers and Members of the Council were elected to serve for the year 1974:

President	E.H.Shackleton, F.G.S.
Vice-President	M.B.Dodd, M.A.
General Secretary	T.Shipp, B.Sc., F.G.S.
Treasurer	H.A.White, B.A.
Excursions Secretary	Miss D.Slater
Publications Secretary	S.H.Gate, M.Sc., A.R.I.C.
Editor	F.J.Cockersole, F.R.C.O.G.
Librarian	M.F.Burton
Members of the Council	G.S.Gowing, M.A., F.G.S.
	J.D.Hinde
	Mrs.E.Roberts, B.A.
	G.Wood

EXTRAORDINARY GENERAL MEETING

An Extraordinary General Meeting of the Society was held on 6th November, 1974, at the Derwent Centre, Cockermouth. 16 members were present. The business was to approve the new Subscription rates for 1975 as recommended by the Council and also to approve various alterations to the wording of the Rules of the Society necessitated by the new rates and by the recent change of the county title.

All the proposals were adopted unanimously.

CUMBERLAND GEOLOGICAL SOCIETY

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR 1973 ENDING 1 JANUARY 1974

EXPENDITURE

(1972) £		£
(12)	Stationery, materials, membership cards etc.	30.98
(30)	Postages	58.41
(1)	Subscriptions to other Societies: Lake District Naturalists' Trust Ltd.	1.05
(6)	Expenses of excursion leaders & lecturers	19.33
(4)	Hire of rooms for lectures & meetings	6.25
(-)	Cost of printing 'Proceedings'	-
(1)	Purchase of books for library	-
(5)	Hire of film	.50
(1)	Bank charges	-
(-)	Repayment of interest-free loan at member's request	10.00
(6)	Cash in hand on 1.1.74	-
(192)	Balance at Bank on 1.1.74	599.05
		£ 725.57

INCOME

(1972) £		£
(58)	Balance at Bank on 1.1.73	192.43
(19)	Cash, cheques etc. in hand on 1.1.73	5.92
(120)	Subscriptions:	
	Arrears: 11 Full members @ 75p £8.25	
	1 Associate .40	
	1973: 151 Full members	
	150 @ 75p £112.50	
	1 @ 50p .50	
	14 Associates @ 40p £5.60	
	6 Institutions @ 75p £4.50	
	1 Institution @ 76p .76	
	1974 & 1975 in advance	
	12 Full members @ 75p £9.00	141.51
(-)	Contributions towards additional postages for 'Reminders'	7.50
(11)	Donations	27.33
(47)	Sales of publications	98.88
(-)	Advertisements in 'Proceedings'	16.00
(-)	Interest-free loans by members to guarantee publication of the 'Proceedings'	236.00
		£ 725.57

CHARLES EDMONDS MEMORIAL FUND

Balance in Bank on 1.1.73	£19.12
Interest for one year on 3½% War Stock (nominal value £146.25)	5.10
Bank Interest on Deposit Account	1.05
	25.27
LESS Award made during the year	17.00
Balance at Bank on 10.1.74	8.27

STATEMENT OF ASSETS AND LIABILITIES AT 1 JANUARY 1974

LIABILITIES	£	ASSETS	
Subscriptions for 1974 & 1975, paid in advance	9.00	Balance at Bank on 1.1.74	599.05
Sundry creditors	280.00	Duplicator (cost price £50, less depreciation)	10.00
Interest-free loans by members to guarantee publication of the 'Proceedings'	226.00	Typewriter (cost price £15, less depreciation)	5.00
Balance, being excess of assets over liabilities	484.92	Estimated value of stock of publications, at 50% of nominal selling price	385.87
	£ 999.92		£ 999.92

- - - -

14TH ANNUAL GENERAL MEETING

The fourteenth Annual General Meeting of the Society was held at the West Cumbria College of Science and Technology, Workington, on the 12th February, 1975.

GENERAL SECRETARY'S REPORT

At the end of my first year as General Secretary of the Cumberland Geological Society I am happy to report that both I and the Society seem to have survived. In my first report I would like to deal with a number of aspects of the Society's activities:

MEMBERSHIP. An up-to-date membership list has been prepared showing that in December, 1974, there were 177 Ordinary Members, 14 Associate and 9 Institutional Members, making a total of 200. Of this number 49 have been members for more than 10 years, 63 have been members for between 5 and 10 years, and 88 for less than 5 years. 34 new members were admitted in 1974. At a meeting in November it was agreed to make a new category of Ordinary Membership, namely Joint Membership for husband and wife. It remains to be seen how unavoidable increases in subscriptions will affect the existing membership or future applications for membership. In order to ease the administrative strain on your voluntary officers it has been agreed by Council to persuade members to pay by Banker's Order. Further, in order to recover Income Tax already paid by members on their subscriptions, payment under Deed of Covenant has been promoted.

CONTACT WITH MEMBERS. Four circulars have been sent out during the year. The addressing of envelopes, a formidable task undertaken on many occasions by Mr. White, will in future be made easier by snipping up the new Membership lists to provide paste-on address stickers. At the present rate of 3½p postage per envelope, and even allowing for some to be delivered by hand, it costs in the region of £10 postage and stationery to send out one circular to all members. Proposed increases in postal rates can only be viewed with trepidation.

MEETINGS. There have been six indoor meetings during the year, with a varied programme of topics:

1. The thirteenth Annual General Meeting on 6th February, 1974, at Whitehaven Grammar School. This was followed by a videotape film on Plate Tectonics. 14 members attended.

2. A lecture on 'The Teaching of Earth Sciences in the Open University' by Mr.Eric Skipsey at the Derwent Centre, Cockermouth on 6th March. 25 members and 10 visitors attended.

3. A lecture on 'The Geology of Ethiopia' by Professor R.M. Shackleton, on 9th October at Ullswater Centre, Penrith. 13 members and 25 visitors attended.

4. A lecture on 'One Man's view of the Skiddaw Group' by Dr.Dennis Jackson, at the Derwent Centre, Cockermouth, on 6th November. 20 members and 11 visitors attended.

5. A film evening. 'Abu Dhabi 1969', 'The Birth of the French Alps' and 'The Living Mountains' were screened at Workington College on 4th December. 14 members and 10 visitors attended.

6. A lecture on 'Aspects of the History of Lead and Copper Mining in the Keswick Area' by Mr.Denis Wildridge, at the Whitehaven College on 8th January, 1975, was attended by 37 members and 12 visitors.

The Annual Dinner, organised by my predecessor, was a great success. We are indebted to Mr. Bond and his staff at the Red House Hotel for making us so welcome. The Guest of Honour, Professor M.H.P.Bott of Durham gave an interesting after-dinner talk on his geophysical investigations on the granite intrusions underlying the Lake District and the North Pennines.

There were six Outdoor Excursions ably organised by Miss Doreen Slater, the Excursions Secretary, including a Joint Weekend Meeting with the Liverpool Geological Society in the Furness Area.

The Council has met eight times, and the Society is indebted to Messrs. Cockersole, Dodd, White and Shipp for hospitality.

One Extraordinary General Meeting was held to change the rules relating to subscriptions.

PUBLICITY. Publicity for meetings and publications of the Society has been kindly accorded by Radio Carlisle, C.N.Print, Cumbria Library Services, Cumbria Education Authority and 'Cumbria' magazine. The Society reciprocates publicity and attendance (on request) at meetings of The Geological Society, The Geologists' Association, The Yorkshire Geological Society, The Liverpool Geological Society and The Westmorland Geological Society.

Two exhibitions were arranged, one at Seaton Branch Library, Workington, and the other at a 'Leisure in Copeland' exhibition at Whitehaven.

CORRESPONDENCE. During the year I have dealt with more than 150 letters and telephone calls. Replies to these, the arrangement of meetings, letters of thanks and other correspondence have necessitated over 200 letters and 100 or so telephone calls, quite apart from the 1000 circulars sent out during the year. When one considers the additional correspondence dealt with by the other Officers of the Society, it becomes evident that a great deal of work and expense is entailed in the promotion and maintenance of the Society's activities.

CONCLUSIONS. In spite of the rather facetious opening sentence, I am confident that the Society is moving from strength to strength. Although not academically based, its prestige is mounting. There is a goodly number of members, and the continued good attendance at meetings both in and out-of-doors is an indication that we are providing a palatable programme for them. Some of the more recently-joined members will, I hope, eventually take a part in the running of the Society.

Finally, I would like to place on record my thanks for the enthusiasm and support of the other Officers of the Society.

T. SHIPP.

HONORARY TREASURER'S REPORT

We began the year with a balance at the Bank of £599.05 and ended it with a total of £287.27, including cash in hand and a sum of £13.47 as Bank Interest on our deposit account. It must be remembered, however, that we owed £200 to the Liverpool Geological Society with respect to the loan they made to help to finance the printing of the second edition of the Bibliography.

This has been in many ways an exceptional year. The total sum due to the printers of the last issue of the 'Proceedings' had not been agreed at the end of the last financial year, and the balance of £599 made provision for that item, which eventually came to £273. It also allowed for repayment of the interest-free loans made by a number of members to guarantee the production of the 'Proceedings' and these were repaid during the current year, amounting to £226.

Also during 1974 we undertook the printing of a second edition of the 'Bibliography' at a total cost for 1000 copies of £450. To help to pay for this a sum of £190 was contributed as donations by several members and various interested bodies such as the Universities of Durham, Newcastle and Lancaster. Other generous donors include British Gypsum Ltd., and the Marchon Division of Albright and Wilson Ltd. Furthermore we are greatly indebted to the Liverpool Geological Society for the interest-free loan referred to above, which was repaid.

Our income from subscriptions has increased from £141 to £172. Although membership has increased, the growth in subscription income was mainly due to the increase in subscription rates agreed at the extra-ordinary general meeting in November, 1974. The income from sales of publications rose from £99 to £201, partly as a result of demand for the new 'Bibliography'.

On the expenditure side the three largest items have been mentioned already. The costs of such routine items as stationery and postages shows a rising tendency as one would expect in these days of inflation.

The trustees of the Charles Edmonds Memorial Fund have not made an award in 1974, and the balance stands at £15.

In my report last year I said that the Society's financial position could be described as solvent but not affluent. The same might be said of the situation at the end of 1974.

In conclusion I must express my grateful thanks to our Honorary Auditor, Mr. Gerald Winn, for his help and advice in disentangling the details of our accounts, and for the patience and care with which he verified their correctness.

H. A. WHITE.

The following Officers and Members of the Council were elected to serve for the year 1975:

President	E.H.Shackleton, F.G.S.
Vice-President	M.B.Dodd, M.A.
General Secretary	T.Shipp, B.Sc., F.G.S.
Treasurer	H.A.White, B.A.
Excursions Secretary	Miss D. Slater
Publications Secretary	S.H.Gate, M.Sc., A.R.I.C.
Editor	F.J.Cockersole, F.R.C.O.G.
Librarian	M.F.Burton
Members of the Council	Mrs.E.Roberts, B.A.
	E.L.Day, A.R.S.M., C.Eng., M.I.M.M.
	G.S.Gowing, M.A., F.G.S.
	G.Wood
	Miss G.Richardson (Associate Members' representative)
Auditors	J.D.Hinde
	G.C.Winn

STATEMENT OF ASSETS AND LIABILITIES AT 1 JANUARY 1975

LIABILITIES	£	ASSETS	£
Subsciptions for 1975 paid in advance	31.72	Cash in hand and balance at Bank on 1.1.75	288.99
Interest-free loan from Liverpool Geological Soc. to guarantee the printing costs of the 'Bibliography'	200.00	Duplicator (cost price £50 less depreciation)	10.00
		Typewriter (cost price £15 less depreciation)	5.00
Balance, being excess of assets over liabilities	852.27	Estimated value of stock of publications, at 50% of nominal selling price	780.00
	£1083.99		£1083.99

CHARLES EDMONDS MEMORIAL FUND

Balance in Bank on 10.1.74	£8.27
Interest for one year on 3½% War Stock (nominal value on purchase £146.25)	5.10
Bank Interest on Deposit Account	1.64
Balance at Bank on 1.1.75	15.01

CUMBERLAND GEOLOGICAL SOCIETY

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR 1974 ENDING 1 JANUARY 1975

EXPENDITURE

(1973) £		£
(31)	Stationery, materials, membership cards etc.	32.30
(-)	Telephone (Secretary)	6.20
(58)	Postages	65.85
(10)	Repayments of loans by members to guarantee 'Proceedings'	226.00
(1)	Subscriptions to other Societies: Cumbria Naturalists' Trust Ltd.	3.05
(-)	Printing:	
	(a)'Proceedings 1971-72' 1000 copies	273.00
	(b)'Bibliography' 1000 copies	450.00
	(c)Letters to advertise 'Bibliography' 2000 copies	10.56
(-)	Ordnance Survey - Royalty on map copying	1.10
(-)	Lake District Planning Board - discount due on sales of publications	3.30
(19)	Expenses of lecturers and leaders	5.00
(6)	Hire of hall for lecture	.30
(-)	Purchase of books for Library	1.65
(-)	Purchase of 'reprints' for Library	3.41
(-)	Film catalogue	.45
(-)	Set of files for Secretary	9.18
(-)	Net cost of Annual Dinner	36.65
(-)	Hire of film	3.50
(-)	Photographs	1.32
(-)	Overpaid subscription refunded	27½
	Cash in hand on 1.1.75	10.34½
(599)	Balance at Bank on 1.1.75 Current a/c 43.97 Deposit a/c (including £13.47 interest) 234.68	
		1422.09

INCOME

(1973) £		£
(198)	Balance at Bank on 1.1.74	599.05
(141)	Subscriptions:	
	Arrears: 10 Members @ 75p £7.50	
	1 Member @ 55p .55	
	1974: 160 Members @ 75p £120.00	
	1 Member @ 50p .50	
	15 Associates @ 40p 6.00	
	8 Institutions @ 75p 6.00	
	1975: (paid in advance) 8 Members @ 75p 6.00	
	2 'Dual Members' @ £2 2.00	
	18 Members @ £1.25 22.50	
	1 Member @ £1.22 1.22	172.27
(-)	Subscription overpaid	.25
(7)	Extra postages for 'Reminders' 20 @ 35p	7.00
(99)	Sales of publications	201.15
(16)	Advertisements for 'Proceedings'	-
(236)	Interest-free loans from members	-
(-)	Net receipts for Annual Dinner	36.65
(-)	Interest-free loan from Liverpool Geological Soc.	200.00
(27)	Donations, including those specifically to guarantee 'Bibliography'	191.25
(-)	Repayment of hire fee for room (cancelled lecture)	1.00
(-)	Bank Interest	13.47
		1422.09

PUBLICATIONS OF THE CUMBERLAND GEOLOGICAL SOCIETY

The Society publishes Proceedings which contain, amongst other articles, accounts of the Society's activities, in particular, excursions in the Lake District. Also published are a bibliography and a description of the limestone series in West Cumberland.

A complete price list, including postage, is given below.

PROCEEDINGS

VOL. 1 (8 parts)			VOL. 2 (4 parts)			VOL. 3 (3 parts to date, A 5 size)		
1962	part 1	32 pages	part 1	1966	58 pages	part 1	1970-71	56 pages
	" 2	24 "	" 2	1967	46 "	" 2	1971-72	68 "
1963	" 1	34 "	" 3	1968-69	38 "	" 3	1973-74	70 "
	" 2	36 "	" 4	1969-70	56 "			
1964	" 1	36 "						
	" 2	30 "						
1965	" 1	32 "						
	" 2	26 "						

PRICES

Volumes 1 & 2 each part £1.00p (parts that are out of print will be Xerox copied as required; in such cases please allow a little extra time for your order to be met)

Index to Volume 1 (5 pages) .20p
" " 2 (2 ") .10p

Volume 1 complete plus index £7.00p
" 2 " " " £3.50p

Volume 3 part 1 .70p (first copy to new members 40p)
" " 2 .90p (" " " 60p)
" " 3 £1.15p

SPECIAL PUBLICATIONS

THE LIMESTONE SERIES OF WEST CUMBERLAND £1.65p (to members £1.15p)
by E.H.Shackleton, F.G.S. (45 pages)

A BIBLIOGRAPHY OF THE GEOLOGY AND GEOMORPHOLOGY OF CUMBRIA (published June,1974) £1.10p
by R.A.Smith, M.A., Ph.D.

GEOLOGY/GEOGRAPHY EXCURSION GUIDES (1972) .30p each

POST CARDS (4 designs) 2p each (post-free if ordered with other publications)

All the above are available from:

Mr.S.H.Gate, M.Sc., A.R.I.C., Publications Secretary,
'Four Winds', 8 West Spur, Moor Row, Cumbria, CA24 3LG.

(Please make cheques etc. payable to
The Cumberland Geological Society.)

THE CUMBERLAND GEOLOGICAL SOCIETY LIBRARY

The Society's Library is housed in the Whitehaven Branch of the Cumbria County Library.

A comprehensive catalogue (price 25p) may be obtained from the Society's Librarian, Mr.M.F.Burton, 47 Whinlatter Road, Mirehouse, Whitehaven, Cumbria to whom all requests for the loan of books and periodicals should be addressed. The facilities of the library are available to members only. Postal charges must be met by borrowers.

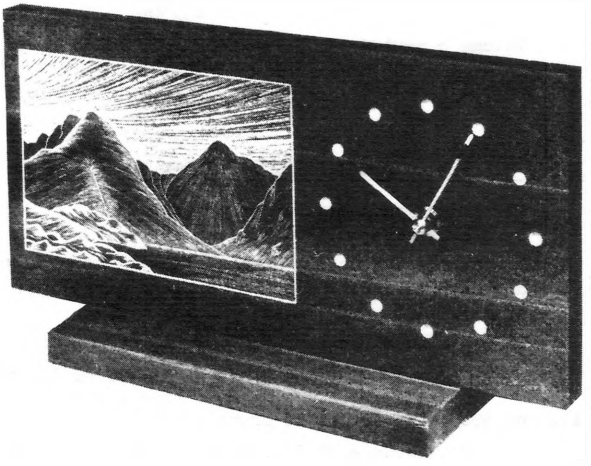
MATERIAL FOR PUBLICATION

Manuscripts should be addressed to the Editor. The material should be typed, with double spacing, on foolscap, quarto or A4 size paper, leaving wide margins, and should not normally exceed 10,000 words.

Line drawings should be submitted in Indian ink on good quality paper. Captions should be stencilled, and any photographs must be of excellent definition. Photographs and line drawings should be capable of reduction to the proportions of 12 cm by 18 cm. S.I. units should be used if possible, although for the present Imperial units may be inserted in addition where they may be thought necessary for clarity.

A request for our brochure would give you the opportunity to acquire something of natural beauty, such as this clock.

Created by craftsmen from the unique stone of the mountains of Lakeland.



Yewdale Lakeland Stonecrafts

Copper House, Mines Beck, CONISTON. Tel. 236

Trade inquiries welcome

Bethwaites Printers, Cleator Moor & Workington