BORROWDALE, CARROCK FELL AND MANCHESTER CORPORATION WATER WORKS

Leader: Dr. R.J. Firman — Saturday & Sunday, 4th - 5th October, 1968

Thirty-five members and friends attended this excursion and were blessed with fine weather, following the torrential downpours of the earlier part of the week.

Saturday, 4th October. — The Borrowdale Volcanics of Borrowdale

The party left the Lingmell Hotel at about 9.45 a.m. by private cars, with the primary objective of studying the volcanic rocks exposed on the southern limb of Scafell syncline. In view of the promising weather the programme was modified to allow the party to gain height whilst the weather stayed fair.

The outward route was virtually the same as that taken by Oliver on a Geologists' Association excursion; and the following account is intended to supplement the report in the "Proceedings of the Geologists' Association" (Wells, 1954). Garnetiferous andesites of the Grey Knotts Group (Oliver, 1954, 1961) were examined near Stonethwaite (257137). The leader pointed out that there was now fresh evidence to support Oliver's contention that the garnets were pre-metamorphic: there is no new evidence supporting a hydrothermal or metamorphic origin. Since Oliver (1956a) discussed garnets in the Borrowdale Volcanics, it has become apparent that the garnets are chemically similar to those described from Upper Greenschist and Amphibolite Facies (e.g. Sturt, 1962). No garnets chemically similar to the Lake District almandines have yet been described from low grade rocks. Since the Lake District garnetiferous lavas and tuffs are Lower Greenschist Facies, on chemical grounds, all work subsequent to Oliver (1956) tends to support his view. New petrographic evidence has been provided by Nutt (1966), who has described a Borrowdale conglomerate from the Eastern Lake District whose heavy mineral suite appears to "consist almost solely of rolled and eroded garnets, mineralogically identical with those in higher Borrowdale rocks". Thus the proposition that the garnets were in the lavas and tuffs before they were metamorphosed or mineralised seems more strongly supported than it was fourteen years ago. The further suggestion (Oliver, 1956a, 1956b) that the garnets crystallised from the Borrowdale magma seems no better established and the writer's suggestion (Firman, 1956) that the garnets are xenocrysts still seems a valid alternative, although the suggested association with ignimbrites is less certain, now that more is known about the distribution of both garnets and ignimbrites within the Lake District.

The leader's discussion of the origin of garnets provoked much animated debate: it also allowed those who were not participating to get their breath back, in preparation for the steep climb to the top of Bessie Boot (259125).

En route, field techniques for studying Borrowdale Volcanic rocks were demonstrated with particular reference to the study of weathered surfaces; flow breccias were distinguished from agglomerates and flow banding in lavas contrasted with the "streaky ignimbrites". Problems of the initial dip of the lavas and possible sources were also discussed. Fine examples of contorted structures in lavas and in fine bedded tuffs were examined. The suggestion that these were due to flow and slumping respectively provoked much discussion. Ignimbrites almost identical with those illustrated by Oliver (1954) were examined near Bessie Boot. Many of these ignimbrites had previously been mapped as lavas and Oliver's identification had thus led to a reassessment of

the palaeogeography. The presence of ignimbrites, both welded and unwelded, implied a nuée ardente type of eruption and sub-aerial deposition. In contrast, structures seen in the overlying tuffs indicated sub-aqueous deposition.

Owing to low cloud the ascent of Glaramara was abandoned, members preferring a steep descent into Coomb Gill (251114) where, in the valley bottom, they were treated to a practical demonstration of the variability of drainage in morainic materials.

Although the main objective had been to study the Borrowdale Volcanics, the leader took the opportunity to point out the major geomorphological features, including evidence of pre-glacial and post-glacial landscapes.

Following tea at Seatoller, the more active members investigated the upper mine dumps at Seathwaite (232135), where good samples of graphite can still be collected. This locality is unique as an example of low temperature replacements of igneous rocks by graphite. According to Strens (1962), the most likely reaction, on thermodynamic evidence, involves the reduction of carbon monoxide under the catalytic influence of haematite, pyrite and decomposed ferro-magnesium minerals :-

$$2CO \longrightarrow C + CO_2$$

Samples of nodular graphite replacing highly altered diabase and volcanics were collected by several members; and the association with haematite was noted.

On the return journey, slate quarries and underground workings in Borrowdale (253172) were visited. These slates are part of the Honister Slate belt, one of the two major slate belts in the Lake District, within which most rocks are cleaved and chloritised. The rocks in the Borrowdale quarries are mostly coarse tuffs; members had the opportunity of comparing these intensively cleaved rocks with the uncleaved representatives they had seen earlier. The intensity of chloritisation, the development of white mica in veinlets and calcite mineralisation in wide horizontal tension gaps were all noteworthy features. In contrast to the exposures of uncleaved tuffs, bedding was difficult to locate.

Sunday, 11th October — Carrock Fell and Manchester Corporation Waterworks

This excursion was planned in two parts. Firstly a visit to the classical localities of Carrock Fell, Dry Gill, Brandy Gill and Grainsgill: and secondly (for those who did not have to hurry back to the Midlands), a look at the more recent of the Manchester Corporation Waterworks projects.

The Carrock Fell area must be one of the most frequently visited of the Lake District localities. It has been well described by Hollingworth (1938) and Wells (1954) and nothing substantial can be added to these accounts. On this particular excursion, attention was paid to folding in the Skiddaw Slates adjacent to the Carrock Fell Gabbro; some of the implications of Simpson's study (1968) were discussed and a search was made for refolded folds. Mr. D. Roberts, a research student from Birmingham, is making a detailed study of the Skiddaw Slates in this area; it may be anticipated that, when his study is published, the influence of the Carrock Fell Complex on the adjoining structures can be evaluated.

The vertical contact between ilmenite gabbro and the Skiddaw Slate was easily located and the bleached contact rock, produced by soda metasomatism, was examined. No contact garnets were found here, although they have been recorded: a garnet was, however, found in a

"screen" of Skiddaw Slate laying within the gabbro mass (355325). Examples of the various types of gabbro, contacts within the gabbro between Skiddaw Slates or Borrowdale Volcanics and gabbro, hybrid rocks near the granophyre-gabbro junction, the granophyre and the diabase were all examined.

In the afternoon the party split up, the keen palaeontologists collecting deformed Carodocian trinucleids and orthids from the Dry Gill Shales (325345) and the mineralogists collecting campylite from a nearby dump (324349). The mineralisation of Brandy Gill was then investigated, good samples of pyrolusite being collected at the head of the stream (323340); copper - lead arsenates, such as duftite, a few hundred yards downstream and wolfram, apatite and molybdenite near the junction with Grainsgill (322330). The Grainsgill greisen (326338) was also briefly examined.

After tea, at about 5.30 p.m., a smaller party made their way to Ullswater and the Pooley Bridge exposure of the Mell Fell Conglomerate (466243). At this exposure a fortnight earlier, Dr. J.A.D. Dickson (Nottingham University) had discovered two monograptid graptolites from Silurian sandstone boulders within the conglomerate. In spite of a most diligent search no more fossils were found; it must be admitted that by this time the light was beginning to fade.

From this viewpoint on the shore of Ullswater, the leader described the geology of the Southern side of the lake. In spite of the lateness of the hour, the dip of the Borrowdales on Barton Fell (4621) and the position of the Ullswater Thrust (Moseley, 1960) were clearly visible. Likewise the site of the pumping station and the portal of the Manchester Corporation Waterworks tunnel could be seen. When complete, water will be pumped from Ullswater up about 370 feet into the tunnel, from whence it will gravitate to Heltondale and to the Haweswater reservoir.

Eight stalwart members then proceeded to the Heltondale end of the Manchester Corporation Tunnel (495207), where, thanks to the courtesy of Thyssen Ltd. and Manchester Corporation, they continued work by the light of floodlights and the full moon until 7.30 p.m. Fine samples of conglomerates and agglomerates, some containing fragments of Skiddaw Slate, were collected from the spoil heaps. These seemed to be correlatable with the conglomerate described by Nutt (1968) from Bampton to the south.

The party was too large to examine exposures inside the tunnel, but the leader explained that these conglomeratic rocks occur below a prominent low angle plane at about chainage 6,400 feet. The Ullswater Thrust had not been identified in the tunnel and the junction between Borrowdale Volcanics and the Skiddaw Slates appeared to a steep angled fault plane. Perhaps Moseley (1960) was wrong in interpreting this junction as a thrust; the final analysis of the structure must await the completion of the detailed logging by M.J.C. Nutt and A.J. Wadge (Institute of Geological Sciences). This tunnel, in addition to affording considerable academic interest, had revealed hitherto unsuspected engineering geology problems. The principal surprise had been the amount of water issuing from calcite veins. Between 100 and 150 gallons per minute had been recorded from fissures in corroded calcite veins more than 300 feet below ground, although the Borrowdale Volcanic rocks only a few feet away were dry.

At 7.30 p.m. the party left to motor south and to sample the doubtful pleasures of long delays on the M6 Motorway.

R.J.F.

REFERENCES

FIRMAN, R.J. 1956. Garnets in the Borrowdale Volcanic Series. Geol. Mag., Vol. 93, pp. 435-36.

HOLLINGWORTH, S.E. 1938. Carrock Fell and adjoining areas. Proc. Yorks. Geol. Soc., Vol. 23, (for 1937), pp. 108-118.

MOSELEY, F. 1960. The succession and structure of the Borrowdale volcanic rocks south-east of Ullswater. Quart. J. Geol. Soc. Lond., Vol. 106, pp. 55-84.

NUTT, M.J.C. 1966. Field Meeting; Haweswater. Proc. Yorks. Geol. Soc., Vol. 35, pp. 429-433.

1968. Borrowdale volcanic series and associated rocks around Haweswater, Westmorland. Proc. Geol. Soc. Lond., no. 1649, pp. 112-3.

OLIVER, R.L. 1954. Note on the succession in the region around the head of Borrowdale. Proc. Geol. Assoc., Vol. 65, pp. 407-411.

1956a. The origin of garnets in the Borrowdale Volcanic Series and associated rocks, English Lake District. Geol. Mag., Vol. 93, pp. 123-139.

1956b. The origin of garnets in the Borrowdale Volcanic Series. Geol. Mag., Vol. 93, pp. 516 - 517.

1961. The Borrowdale Volcanic and Associated rocks of the Scafell area, English Lake District. Quart. J. Geol. Soc., Lond., Vol. 107, pp. 377-417.

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., Vol. 5 pt. 2, pp. 391-418.

STRENS, R.G.J. 1962. The Geology of the Borrowdale-Honister district (Cumberland), with special reference to the mineralisation. Ph.D. Thesis, University of Nottingham.

WELLS, M.K. 1954. Summer Field Meeting in the Lake District. Proc. Geol. Assoc., Vol. 65 pt. 4, pp. 415-425.