THE STRATIGRAPHY AND STRUCTURE OF THE INFERIOR OOLITE ROCKS OF THE COTSWOLDS

Leader:- Dr. P. L. Hancock

Saturday and Sunday 3rd - 4th July, 1965

Twenty-one members and friends, including two members of the Geological Association of London, attended the first weekend field excursion of the Society. The main purpose of the trip was to examine the stratigraphy of the Inferior Oolite and in particular the nature of the Upper Bajocian unconformity. Some attention was also given to joints and superficial structures.

Twelve localities were visited, from Bourton-on-the-Water to just south of Stroud. Locality positions on a section showing the "folding" beneath the Upper Bajocian unconformity are shown on text-fig. 1, and the route followed on text-fig. 2.

The party left Shakespeare Street, Nottingham at 9.40 a.m., and travelled to Bourton-on-the-Water via Loughborough, the Motorway and Southam.

Locality A. Quarry near Coldpark Farm, Bourton-on-the-Water (SP 157197)

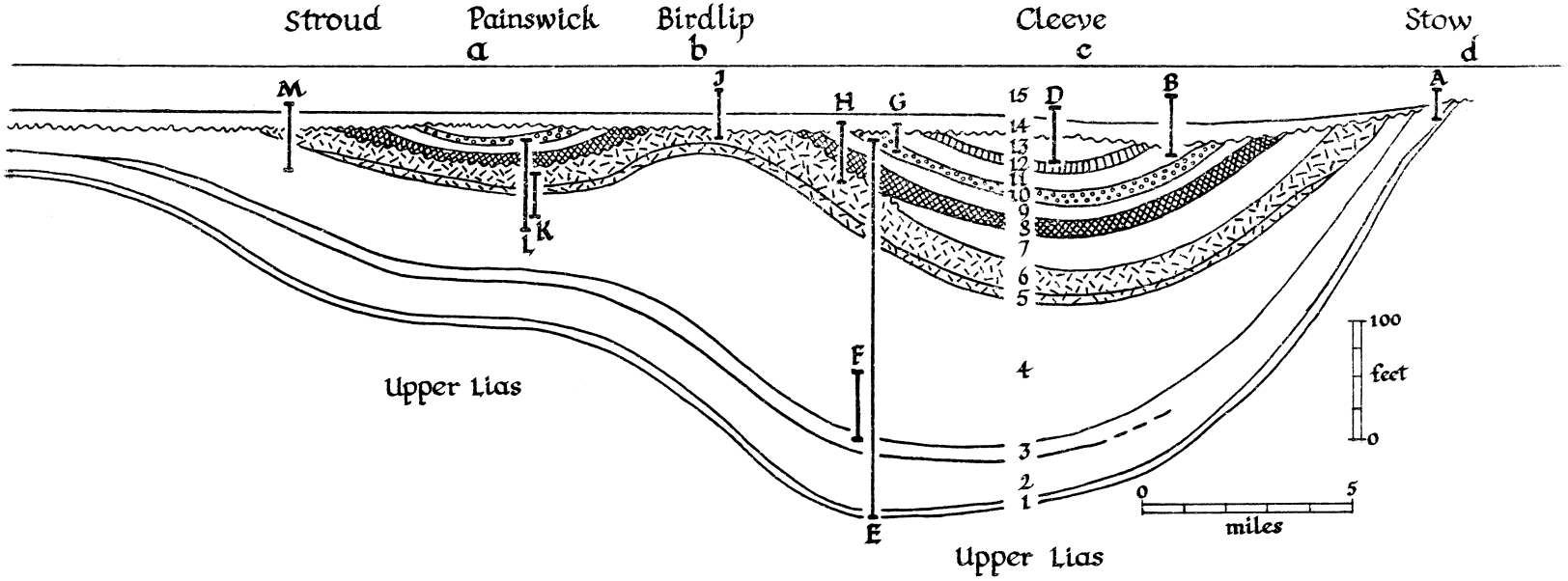
Since this locality lies nearly on the line of the Moreton anticline, the Upper Inferior Oolite rests on a low member of the Lower Inferior Oolite. In its present state the quarry shows only the "Yellow Stone", a local equivalent of the Pea Grit. At one time Clypeus Grit was exposed overlying the Yellow Stone (Richardson 1933, p. 31). The party found several specimens of the echinoderm Clypeus ploti loose on the floor of the quarry, although the Grit was not seen in situ. The Yellow Stone, which is a freestone, is unusual in two respects. Firstly, it is richly fossiliferous, and secondly, most of the 20 to 30 feet exposed is permeated by brown pipes; similar structures elsewhere, produced by the boring of annelids and bivalves, are restricted to the few inches immediately beneath the unconformity. The Upper Trigonia Grit is absent here, having been overlapped by the Clypeus Grit.

Locality B. First railway cutting west of Notgrove Station (SP 086199)

The following succession is now exposed:-

Upper Inferior Oolite	(Clypeus Grit	40' 6"
	(Upper Trigonia Grit	4' 6"
Middle Inferior Oolite	Notgrove Freestone	12' 8"

This locality is closer to the core of the Cleeve Hill syncline than the previous one; therefore the Upper Inferior Oolite rests on an upper member of the Middle Inferior Oolite. Further, the Upper Trigonia Grit, the usual basal member of the Upper Inferior Oolite, is present here. In one block of Upper Trigonia Grit, casts of both Trigonia costata and T. duplicata were found. The latter fossil is indicative of the Upper rather than Lower Trigonia Grit age of the formation. The ammonite Parkinsonia was also found in the Upper Trigonia Grit; ammonites are rare in the Cotswolds. The top few inches of bored Notgrove Freestone were located.



Text-Fig. 1. The relations between members of the Inferior Oolite in the Cotswolds

Folds:- (a) Painswick syncline (b) Birdlip anticline (c) Cleeve Hill syncline (d) Moreton anticline

Succession:- UPPER INFERIOR OOLITE (15) Clypeus Grit (14) Upper Trigonia Grit
(Upper Bajocian Unconformity)
MIDDLE INFERIOR OOLITE (13) Phillipsiana and Bourguetia Beds (12) Witchellia Grit (11) Notgrove Freestone (10) Gryphite Grit (9) Buckmani Grit (8) Lower Trigonia Grit
(Middle Bajocian Unconformity)
LOWER INFERIOR OOLITE (7) Tilestones, Snowshill Clay and Harford Sands (6) Upper Freestone (3) Pea Grit (2) Lower Limestone (1) Scissum Beds

Localities:- A to M

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Locality C. Old Slate Quarry, Salperton Downs (SP 079213)

Although the rocks in this quarry belong to the Stonesfield Slate division of the Great Oolite and are thus outside the stratigraphical scope of the excursion, the locality was visited to see the joint pattern. Throughout the Cotswolds four major joint sets are developed. They are usually orientated normal to bedding surfaces (the kathetal condition, cf. Hancock 1964); two of the sets frequently bear nearly horizontal slickensides. At many outcrops only two or three of the sets are well exposed, but here all four can be seen juxtaposed in the north-eastern corner of the quarry. Two of the sets show conspicuous slickensides in vein calcite, and the relationship between them and the unslickensided sets is also well displayed. (The author is preparing a separate account of jointing in the Cotswolds which he hopes to present shortly).

From the Old Slate Quarry the party drove eastwards into the core of the Cleeve Hill syncline.

Locality D. Rolling Bank Quarry, Cleeve Cloud (SO 988268)

At this classic locality the following succession is exposed:-

Upper Inferior Oolite	(Clypeus Grit	about 12'
	(Upper Trigonia Grit	9' 0"
Middle Inferior Oolite	(Phillipsiana Beds	10' 1"
	(Bourguetia Beds	about 10'

The Bourguetia and Phillipsiana Beds are the youngest Middle Inferior Oolite rocks preserved in the Cotswolds. Fossil collecting from these horizons is now difficult owing to the large number of parties which visit the exposure. The rocks dip W. N. W. at 12 degrees. This unusually high dip for the Cotswolds is due to the past outflow of the underlying Liassic clay into the Vale of Severn, and the consequent lowering of the limestones on the scarp edge. A small normal fault, also a result of the clay outflow, cuts the cambered sheet of limestone. These phenomena were the first superficial structures (cf. Hollingworth, Taylor and Kellaway 1944) the party had seen in the Cotswolds.

From the Rolling Bank Quarry the party returned to Cheltenham for the evening.

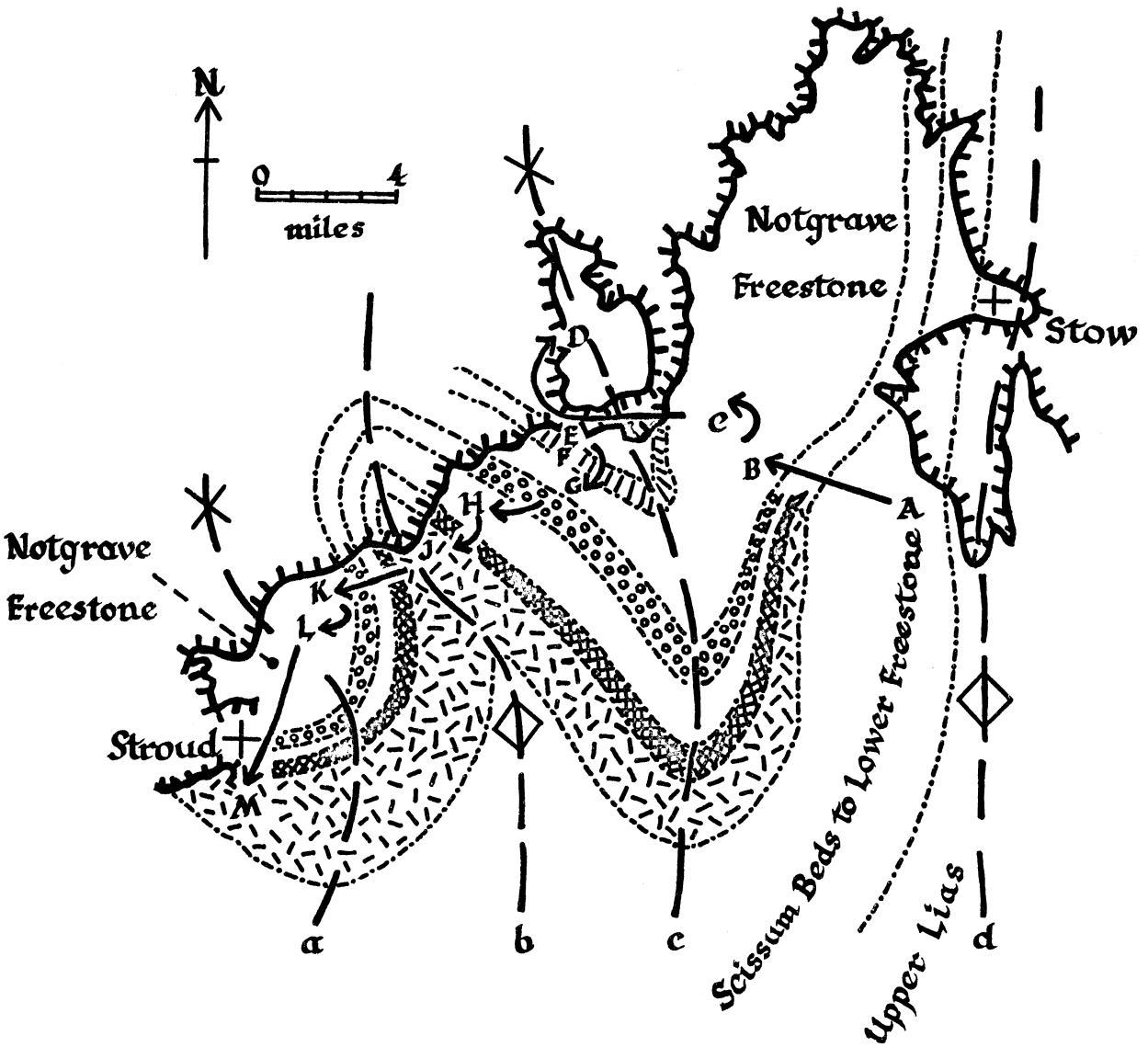
After dinner the party visited the Geological Department of St. Paul's College of Education at the kind invitation of Mr. W. Dreghorn, Senior Lecturer in Geology. He demonstrated a number of models illustrating the geology of the Cotswolds, and explained his techniques for instructing teachers in methods of presenting rock studies to children.

Locality F. Salterley Grange Sanatorium Quarry, Cheltenham (SO 946177)

In this quarry the top bed of the Pea Grit is overlain by at least 40 feet of cross-bedded Lower Freestone. The main interest of the quarry, however, lies in the structural details it shows.

The western face displays what appears to be a small moderately-dipping fault, striking at right angles to the exposure, which according to Ager (1964 p. 10) is a reversed fault. Close inspection reveals that it is a vertical fault, striking parallel to the quarry face and downthrowing about 3 feet east-north-east. Its apparently reversed nature is an effect produced by the rocks on the downthrow side standing a few feet east of the main face, and being separated from that face by a gently sloping track.

Two master sets of vertical kathetal-joints at right angles to each other are present. The N.E.-S.W. trending set bears gently plunging slickensides. Joints of the N. W.-S.E. set frequently



Text-Fig. 2. The route followed and the localities visited, shown on a map of the floor beneath the Upper Bajocian Unconformity.

The generalised base of the Middle Jurassic is shown by a continuous line hachured on one side. The approximate route followed is shown by the arrows and the locality positions by their index letters. Fold axes are shown using the conventional symbols. The lower case index letters accompanying then are used as on Text-Fig. 1. The ornamentation of the beds is also the same as that used on Text-Fig. 1.

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gape for a few inches. This incipient "gulling" was attributed by Dury (1959, Plate 75) to frost action. An alternative explanation is that because the outflow of the underlying Liassic clay towards the Vale of Severn was in a direction nearly normal to the set, it caused the gaping. The generally more closed nature of the joints of the N.E.-S.W. set is also accounted for by this explanation, since they strike sub-parallel to the postulated flow direction. Widening by frost action should be non-selective with respect to joint trend.

Locality H. Leckhampton Hill Top Quarry, Cheltenham (SO 951180)

Leckhampton Hill is situated south of the Cleeve Hill syncline axis. The Upper Trigonia Grit rests upon about 2 feet of Notgrove Freestone, itself overlying Gryphite Grit. The bored and oyster covered non-sequence is well displayed on the north face of the uncultivated part of the quarry. The oyster pavement in the Gryphite Grit is now poorly exposed owing to a thin rubble cover on the quarry floor. Abundant specimens of the bivalve Trigonia costata and the brachiopod Acanthothyris spinosa were obtained from the Upper Trigonia Grit. The Gryphite Grit yielded some imperfect specimens of Gryphaea sublobata.

Locality I Tuffley's Quarry near the Air Balloon (SO 933158)

The succession, which is well preserved seventy years after it was first described by Buckman (1895, p. 408), shows:-

Upper Inferior Oolite	Upper Trigonia Grit	about 4'
Middle Inferior Oolite	(Buckmani Grit	6' 4"
	(Lower Trigonia Grit	3' 10"
Lower Inferior Oolite	Upper Freestone	about 10'

The Notgrove Freestone, which was present at the last locality, is absent here because Tuffley's quarry lies 2 miles closer to the Birdlip anticline axis.

On the other side of a small valley in the escarpment from the quarry, Lower Freestone is exposed in another quarry at the same topographic level. The northerly downthrowing Shab Hill fault follows the valley.

After collecting in the quarry, the party visited the Air Balloon for lunch.

Locality J. Road cut below the Royal George Hotel, Birdlip (SO 926145)

Situated on the Birdlip anticline axis, this exposure shows the Clypeus and Upper Trigonia Grits resting directly on Upper Freestone. The non-sequence surface is bored and oyster encrusted. The lower part of the section also displays the Oolite Marl and Lower Freestone.

From Birdlip the party drove to Painswick Beacon and climbed the hill for the splendid panorama it affords of the Cotswolds, Vale of Severn, Malvern Hills and Forest of Dean. Whilst descending the hill due west from the Trig. point to the upper lip of the next quarry, it was possible to see the cambered nature of the limestones forming the hill. In the quarry immediately below the vantage point (Locality K) limestones dipping west at 30 degrees are visible, while nearly half a mile to the north, on the eastern side of the narrow steep-sided hill, another quarry (Locality L), containing limestones dipping 30 degrees east, can be seen. This apparently anticlinal structure is due to the limestones having been tilted valleywards during cambering.

Locality K. Painswick Beacon Quarry (SO 867121)

The party went down into the quarry for a closer view of the cambered limestones of the Freestone Group. A small normal strike fault downthrowing 3 feet east disrupts the limestones of the southern face.

Locality L. Catsbrain Quarry, Painswick (SO 867114)

Mr. H.W. Bingham, the manager for Portcrete Limited, kindly gave permission for the party to visit the quarry, which contains much of both stratigraphical and structural interest and which is unrecorded in Cotswold geological literature.

The succession is:-

Middle Inferior Oolite	(Gryphite Grit (Buckmani Grit (Lower Trigonia Grit
Lower Inferior Oolite	(Upper Freestone (Oolite Marl (Lower Freestone

The Oolite Marl, Buckmani Grit and Gryphite Grit are very fossiliferous. The sand bed in the Buckmani Grit is thick and conspicuous. Bottom structures in the limestone overlying it are well developed. The Lower Trigonia Grit is soft and in-weathering. The three Middle Inferior Oolite members are preserved here because the locality lies near the Painswick syncline axis.

The moderate easterly dip of the rocks due to cambering has been referred to already. Three normal strike faults downthrowing west, one displaying a maximum slip of about 15 feet, make up, with the cambered limestone, a "dip and fault" structure like those described by Hollingworth et al.(1944) from the Northampton Ironstone Field. In the Lower Trigonia Grit, at the western end of the south quarry wall, there is a conjugate system of small normal faults with displacements of up to 6 inches. Tilted calcite ribs of travertine-coated joint surfaces of all sets demonstrate that the cambering occurred after the joints were formed. The ribs were deposited at the successive surfaces of evaporation of underground water which partly filled the joints before cambering. Four kathetal-joint sets are developed, and can be seen together in the Lower Freestone at the southern end of the quarry. A conjugate pair of moderately dipping joints, at about 60 degrees to the bedding, cuts the Freestones of the southern quarry wall. The joints strike east to west sub-parallel to the principal normal fault system in the Cotswolds. Master joints of this attitude are restricted to the neighbourhood of Painswick.

Locality M. Leigh's Quarry, Selsey Hill, Strough (SO 826026)

The final locality visited lies four miles south of the Painswick syncline axis. As at Birdlip, the Clypeus and Trigonia Grits rest on the Upper Freestone. Middle Inferior Oolite rocks are no longer preserved this far south. In the quarry the Upper Freestone is underlain by the Oolite Marl and the Lower Freestone. The Oolite Marl is unusual; it consists of three beds of hard limestone containing marl partings, rather than being a soft chalky freestone as in the mid- and north-Cotswolds.

The party returned to Nottingham via Moreton-in-Marsh, the Fosse Way and the Motorway. A vote of thanks to the leader was proposed by Mr. R.E. Elliott.

P. L. H.

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