

and yellows originated. Attention was directed to a number of secondary structures which simulate the organic; some may be termed globular, others tapioca-structures. Others have no parallel in nature.

The Director called attention to the manner in which the cliffs spontaneously fissured and fell. Where clay is present the beds fissure vertically. These fissures may occur only a few inches apart, but in addition there are large cylindrical fissures, irregular segments of circles, ten to a hundred yards long, and often in a few weeks or months the fissure opens and mass falls. Instead of forming a screen the fallen mass may be swept away by a tide as has occurred recently. It is estimated that an average of three feet a year are lost in this manner, but where the current runs in, the destruction may be five or even ten times as great as this.

Perhaps the feature of greatest interest was the foot-prints of dinosaurs. Over thirty of the casts of these were then to be seen, despite the large number that had been recently taken away. When these huge Wealden creatures made a foot-print on the sand, its preservation depended upon its being filled with finer silt, thus the mould and the cast became differentiated, and the cast being the tougher becomes easily detached when the blocks of sandstone fall from the cliffs. It has been the custom to speak of all these large foot-prints as those of the iguanodon, but when one sees a number of them together the differences are so great as to suggest that several distinct genera were concerned in their making.

After the field work a very large exhibit of specimens to illustrate the various points raised was seen at the house of the Director.

## EVIDENCE FOR FOLDING IN THE TERTIARY AND CRETACEOUS ROCKS NEAR SOUTH MIMMS AND RIDGE HILL.

WITH REPORT OF EXCURSION, MAY 28TH, 1920.

BY S. W. WOOLDRIDGE, *Director of the Excursion.*

FROM Potter's Bar Station the party walked westward over the Tertiary beds towards the valley of Mimms Hall Brook. A halt was made near Mimms Hall (A on the map), and the Director briefly alluded to the physical features and the geology of the district.\* The party then visited a chalk pit (B) on the other side of the valley—which showed some pipes lined with re-arranged Reading Sand and filled in the centre with drift. At

\* Geology of London, *Mem. Geol. Surv.*, vol. i., 1889, pp. 77, 79, 200-204, 255, 306-7.

South Mimms the Director outlined from a suitable view point (C) the structure of the area as described below. After tea at the Waggon and Horses Inn, Ridgehill, the party proceeded eastward along the London Clay escarpment, obtaining a magnificent view from the point (D) across the Colne Valley to the distant Chiltern Hills. Small exposures in the 400 feet Pliocene (?) gravel were seen near by, and a good junction of Chalk and Reading Beds was inspected near Cob's Ash (E). The party returned eastward across North Mimms Park and a brief examination of the well-known Mimms Swallow-holes\* was made.

#### THE STRUCTURE OF THE DISTRICT.

The investigation of the geology of this area was undertaken primarily with a view to determining the structure. The old 1-inch map shows that the Mimms Valley closely resembles that to the west at Radlett, in respect to the outcrop of the Chalk, which forms the floor of the main valley for some distance and then is exposed along the valley of a tributary stream from the west. We have found no printed reference to this obvious similarity of form.

It seemed likely at the outset that the features owed their existence to a slight anticlinal fold N.E.—S.W. parallel to the strike and just within the Tertiary outcrop. The crucial area has been re-mapped on the 6-in. scale and a series of levels of points at the base of the London Clay and of the Reading Beds has been taken. The base of the London Clay has obvious advantages as a datum line; it marks a definite marine invasion and originally it probably approximated to a plane. The levels of the base of the Reading Beds are of more doubtful application owing to the sub-Tertiary unconformity and the possibility of subsequent solution along the junction. It does not appear, however, from the results, that much discrepancy has arisen from the latter cause, although the Reading Beds vary greatly in thickness. Moreover it became abundantly clear in the course of the mapping that although the base of the London Clay was, theoretically, an excellent datum line, its use as such often presented practical difficulties. Frequently it is difficult to locate with accuracy, and hence it is better to combine both series of levels in interpreting the structure.

Turning now to the levels as shown on the map, we note:—

1. A general easterly drop of the London Clay base and that of the Reading Beds away from an area in the neighbourhood of the main St. Albans road. On the eastern side of the map, however, the beds appear to lie nearly flat.
2. The Reading Beds figures indicate also a westerly

\* Hopkinson, *Geology in the Field*, 1910, pp. 11 & 13. Whitaker, *Proc. Geol. Assoc.*, vol. xxvii., 1916, p. 59.

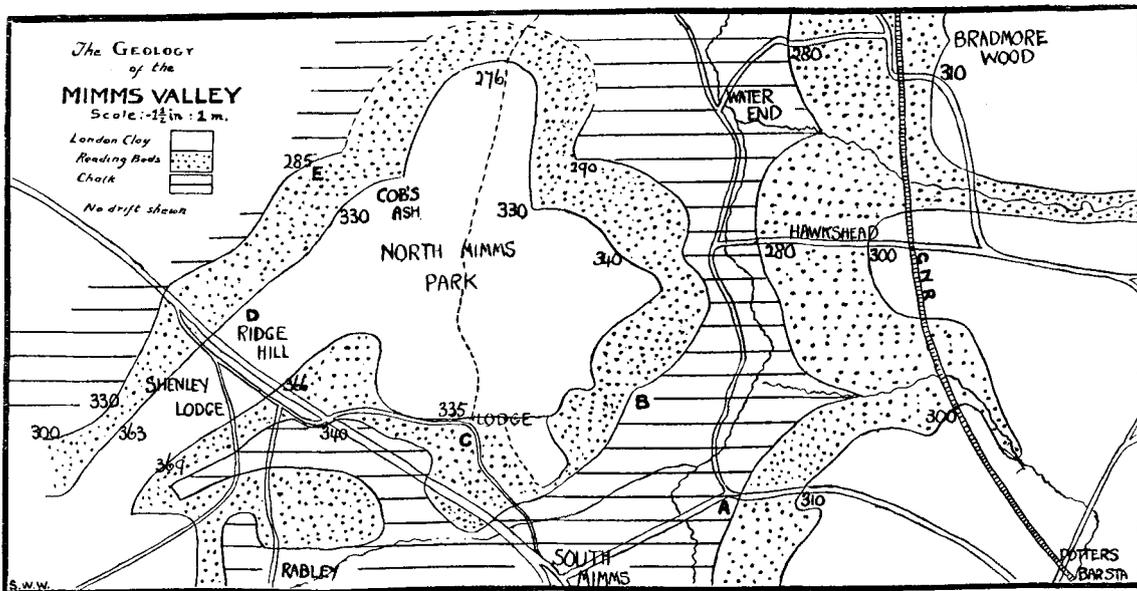


FIG. 26.—GEOLOGICAL MAP OF THE MIMMS VALLEY.

drop (near Shenley Lodge) and the London Clay base is believed to drop to about 340 feet beyond the western borders of the map.

3. The levels indicate a slight northerly or north-westerly dip; e.g. over the North Mimms Park area.
4. Apart from the general dip to the south, three definite dips have been observed and the arrows are shown on the map. At Rabley the dip is to the south-west (as first noted by Trench); in the pit near Cobs Ash visited by the Association there is a marked north-easterly dip, and a similar dip can be seen in a neighbouring pit.

Wells in the area to the north-east of our district indicate that the drop of the London Clay base continues in that direction. At Essendon Place the base is about 160 ft. O.D., and at Little Berkhamstead 211ft., and at Ponsbourne Park 170ft.\*

The inferences from the facts briefly stated above are :—

1. That an anticlinal axis of Charnian trend (N.W.—S.E. approximately) traverses the district, the beds dipping both to the north-east and south-west from an area about the St. Albans Road.
2. That in all probability a north-east—south-west anticlinal axis cuts the above approximately at right-angles. The evidence for this fold is not quite so clear, and no definite dips supporting its existence have been observed in sections. We may note, however, that the three wells mentioned above at Essendon Place, Little Berkhamstead, and Ponsbourne Park, lie on a N.W.—S.E. line, and the levels of the London Clay base seem to indicate a slight N.E.—S.W. fold, which agrees in axial alignment with that postulated in the Mimms area.

Folding of the character indicated is known to occur in the north of London. The distribution of inliers and outliers has been explained as due to folding parallel to the strike;† Charnian lines have also been found both in the London District‡ and elsewhere§. L. J. Wills' map of the sub-Tertiary Chalk contours|| reveals two similar sets of folds crossing each other at right angles. The N.W.—S.E. axis whose existence we have demonstrated may possibly be a continuation of that shown cutting across the Hampstead syncline near Hornsey and Finsbury Park.

\* Whitaker, Water Supply of Herts & Bucks, *Mem. Geol. Surv.*, 1921, pp. 188, 211, 219.

† Cf. A. E. Salter, *Proc. Geol. Assoc.*, vol. xix., 1905, p. 26.

‡ Hopkinson, *Geology in the Field*, 1910, pp. 24-25.

§ Prestwich, *Waterbearing strata round London*, p. 49.

|| Whitaker, "Geology of London, *Mem. Geol. Surv.*", vol. I, 1889, pp. 483, 404.

H. B. Woodward, "Geology of London District," *Mem. Geol. Surv.*, pp. 47, 61.

‡ H. A. Baker, *Geol. Mag.*, 1918, p. 299.

§ P. G. H. Boswell, *Geol. Mag.*, 1915, p. 168, H. A. Baker, *Geol. Mag.*, 1917, p. 398.

|| "Records of London Wells," *Mem. Geol. Surv.*, 1913.

Two interesting final points may be mentioned. It has generally been assumed that the Tertiaries rest on the zone of *Micraster cor-anguinum* in this area. They certainly do so to the south-west at Watford and Harefield, and to the north-east at Hertford. At the pit near Cobs Ash (E) however, two *Micrasters* have been obtained within two feet of the Reading Beds. They appear to be *M. praecursor*, indicating a horizon in the *cor-testudinarium* zone or, at the highest, in the lowest part of the *cor-anguinum* zone. The lithology of the Chalk is also suggestive of the *cor-testudinarium* zone. One is tempted to speculate as to the possibility that a pre-Eocene fold of Charnian trend existed in approximately the same position as the fold which affects the Eocene beds.

It is also interesting to note that the Reading Beds become more sandy as the axis is approached. Upper mottled clays appear to be absent or very poorly developed on the eastern side of the district. At the old Hatfield Park kiln the Reading Beds consisted entirely of sand, but to the south-west and north-east mottled clays come on again in force. These facts suggest movement during Eocene times; the phenomena are precisely similar to those described by Prof. Boswell in Suffolk.\*

## EXCURSION TO WALTON HEATH AND HEADLEY,

WITH SPECIAL REFERENCE TO THE SUPPOSED PLIOCENE DEPOSITS\*

SATURDAY, JUNE 11TH, 1921.

REPORT BY GEORGE W. YOUNG, F.G.S., AND ERNEST ARTHUR TURNER, F.G.S., *Directors of the Excursion.*

At the east end of Hogden Bottom a small chalk pit (No. 194 of G. W. Young's "Chalk Area of N.E. Surrey") was inspected. It is situated on the flank of the valley and the chalk has only a thin covering of gravelly soil, from which Pleistocene fossils have been obtained. It shows several pipes and some horizontal clayey layers along the bedding planes, evidently washed in from above, and many of the joint faces are iron-stained. Most of the common fossils of the *Micraster cor-anguinum* zone have been obtained, but they are not very plentiful.

The party inspected some new sections in the gravel, not many yards west of the chalk-pit and on the same side of the valley, at 500 feet O.D. Here large flint nodules occur, both worn and fresh, and also pebbles of all sizes (chiefly flint). The matrix is a brown or reddish sandy clay, which also contains some rubbly chalk in detached masses near the surface. The

\* Boswell, *op. cit.* p. 202.