A Section of the Oxford Clay and Pleistocene Gravel in North Oxford

By L. W. Grensted

THE area which gives its name to the Oxford Clay is now devoid of permanent exposures, as the various brickpits have long been closed. Although the pits once yielded many fossils, these were frequently collected from loose clay and were not recorded stratigraphically so that the precise level of their occurrence is unknown. There is, therefore, sometimes doubt as to the zones present at the various pits. More precise modern methods of zoning demand careful collecting over narrow limits of depth of strata, in order that accurate correlations may be made over wider areas and a fuller picture of rates of deposition in the ' Oxford Clay ' sea may be obtained.

The examination of shallow localized sites has the advantage of restricting the width of band over which the fossils are collected so that there is no possibility of mixing the fossils at one level with those at another. By building up a vertical column of thickness of strata with accurate fossil marker-indices at successive levels we can estimate the thickness of the Oxford Clay in various parts of the Oxford area, and this may be of vital interest to engineers. Thus the recording of all such sites helps materially in the attempt to complete the picture.

The laying of a deep drain running the whole length of Charlbury Road, Oxford, an operation which occupied almost the whole of 1952, gave an invaluable opportunity of examining a section of the Oxford Clay nearly a quarter of a mile in length and all within a very narrow horizon. The north end of Charlbury Road, at its junction with Belbroughton Road, lies exactly a mile almost due north of the site of the New Bodleian, the geology of which was described in detail by Dr. W. J. Arkell in *Oxoniensia*, III (1938), 1-6. From that point it runs, almost in a straight line, about seven degrees east of south, for approximately 400 yards to Bardwell Road and the Dragon School. The two ends of the road are at the same level, 190 ft. O.D., but at about 160 yds. from its north end it rises to 199 ft. O.D. at its crossing with Linton Road. Linton Road, in fact, runs from Banbury Road down a slight but very definite ridge, the reason for the existence of which has been sufficiently explained by the recent excavation.

The trench which was cut was 13 ft. deep at the south end of the road, and, sloping very slightly (2 ft. in all), 19 ft. deep at Linton Road. Of this the lowest 3 ft. was in hitherto undisturbed Oxford Clay, and at Linton Road, allowing for some disturbance due to previous drainage work, some 10 ft. of the clay was exposed. There was a very clearly marked rise in the level of the clay in the 80 yds. south of the Linton Road junction. On the other side of Linton Road the clay, though still at a much higher level than at Bardwell Road, sloped steadily down to the north. The Linton Road ridge was thus fully explained as a ridge in the Oxford Clay itself, a ridge which the overlying gravel of the Summertown Terrace has not wholly obscured.

As the Oxford Clay has a general maximum dip of 60 ft. to the mile, S.S.E. in direction, the Charlbury Road exposure represents a single horizon of not more than 15 ft. in depositional thickness of strata, the lowest levels being at the north end. The whole section thus lies approximately 45 ft. below the Oxford Clay of the New Bodleian site, which was clearly marked as of the *lamberti* zone. In Charlbury Road we have thus had the opportunity of examining a long section, equally clearly defined and uncontaminated from above, of part of the underlying *athleta* zone, the lower section of the Middle Oxford Clay, indicated, as at Wolvercote brickpit, by the very high percentage of species of *Kosmoceras*.

The overlying river gravel was much more disturbed by previous roadwork, but at some points interesting sections were opened up, and deserve a separate note to themselves.

The fossils from the clay were collected partly in Charlbury Road itself and partly from the dumps in Aristotle Lane by Mr. J. H. Callomon and myself. As I then lived in Charlbury Road I was able to keep a continuous watch on the work and to make friends with the workmen, to whom I am indebted for some of the most interesting finds. The Pleistocene fossils from the river gravel occurred in one small patch and are of my own collecting.

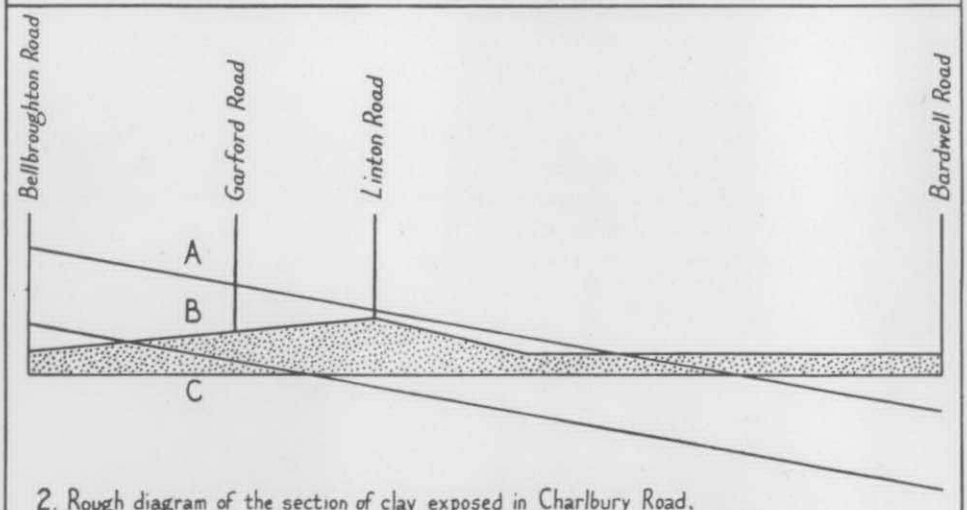
I. THE OXFORD CLAY

There was nothing special to note about the general character of the clay, which was as usual blue-grey in colour, fine in texture, and drying almost to the hardness of rock. The fossils were scattered, and much of the clay was barren, but taken over the whole length a large number were collected. Many were more or less completely pyritized, especially the small species of *Nucula* and the smaller ammonites. But the process is curiously selective. Small valves of *Astarte* were very common, and were never pyritized. The numerous large specimens of *Gryphaea* only showed pyritization in two cases, both remark-

A c. 4½ feet exposed	Kosmoceras species abundant (K. spinosum, tidmoorense, duncani, proniae); Horioceras baugieri, Perisphinctes sp.
B c. 7½ feet exposed	Few fossils except Hibolites and Lamellibranchs, common to all three levels. Near the base one specimen of Kosmoceras rowlstonense, with Rhynchonella socialis and bones of Plesiosaurus.
C c. 3 feet exposed	Hecticoceras species abundant; A few Kosmoceras (K. spinosum and duncani, mostly nuclei).

Feet: 0 1 2 3

1. Section of Oxford Clay, *athleta* zone, exposed in Charlbury Road, Summertown, Oxford.



2. Rough diagram of the section of clay exposed in Charlbury Road, showing how it cuts the three levels of Oxford Clay indicated in diagram 1. Depth at Bardwell Road 3 ft.; at Linton Road 10 ft. Length 400 yards.

FIG. 1

SECTION OF THE OXFORD CLAY IN NORTH OXFORD

able for the distortion of the shells, which had grown in cramped situations. The belemnites, even more numerous, were never pyritized. With one large and striking exception, *Kosmoceras rowlstonense*, the more fully grown ammonites were but little pyritized, and had often left no more than casts in the clay. As the pyrites has apparently been formed by the action of the sulphur in the soft tissues of the various organisms it should be possible to draw a certain number of inferences from this evidence. Thus the species of *Arca* and *Nucula* doubtless lived in the mud, with *Gryphaea*, of which, in one very interesting specimen, the embryonic shells were found in some number attached to a broken *Kosmoceras*, where they had just started to deposit the first flat layer upon which the growth of the adult shell would be based.[1] The ammonites presumably dropped down from the surface as they died, and the pyritization of the smaller specimens probably means that the innermost, embryonic, septa still contained their organic content. The guards of the belemnites, on the other hand, though probably very porous and light, brought down no sulphur with them.

But why the process was not set up in the big specimens of *Gryphaea* remains obscure. When, in the geological history of the clay, this chemical action took place is not clear. But the sulphur found traces of zinc, as well as iron, and some of the pyritized fossils contained clusters of small crystals of blende. This was a likely find enough, as fossils from adjacent geological levels show similar crystals. But blende has not, I believe, been recorded from the Oxford Clay, at least of this district, before.

The list of fossils which follows represents collecting from the whole length of the road, since, owing to the speed of the work, the dumping, and the use of the grab, it was not easy to keep fully accurate records. But it was quite clear that the 15 ft. exposed could be divided into three levels. The uppermost, at the south end, was marked by a great numerical preponderance of *Kosmoceras*. The middle section had few fossils. The bottom section, first exposed about 80 yds. north of Linton Road, showed a sudden profusion of *Hecticoceras*, which now greatly outnumbered *Kosmoceras*, though this was still fairly common. No *Hecticoceras* were found in the two upper levels, and it may fairly be inferred that the ammonites of this genus are characteristic of about the lowest 3 ft. of the total 15 ft. exposure.

I owe the identification of the ammonites to Mr. J. H. Callomon, and of the other Oxford Clay fossils to Mr. J. M. Edmonds.

[1] These prodissoconchs closely resemble those figured by J. Weigelt, 'Die Bedeutung der Jungenformen Karbonischer Posidonomyen für ihre Systematik', *Palaeontographica*, LXIV (1922), 74, as the supposed fry of *Posidonia* from the Oxford Clay of Weymouth. These may well also belong to *Gryphaea*, since there can be no doubt about the species of the Charlbury Road specimens. See also G. Ranson, 'Note sur la classification des Ostréidés', *Bull. Soc. Geol. France*, 1942, pp. 161-4.

Phylum MOLLUSCA

Class CEPHALOPODA

Horioceras baugieri (d'Orbigny).
Hecticoceras cf. glyptum (Buckman). (abundant).
Hecticoceras sp. indet. cf. punctatum (Stahl).
Kosmoceras spinosum (J. de C. Sowerby).
Kosmoceras tidmoorense (Arkell).
Kosmoceras (Lobokosmokeras) duncani (J. Sowerby).
Kosmoceras (Lobokosmokeras) spinosum—duncani (nuclei abundant).
Kosmoceras (Lobokosmokeras) proniae (Teisseyre).
Kosmoceras cf. proniae.
Kosmoceras (Zugokosmokeras) rowlstonense (Young & Bird).
Perisphinctes ?latilinguatus Noetling.
?Grossouvria sp.
Peltoceras sp.

Hibolites hastatus (Blainville). (abundant).
Belemnopsis sulcata (Miller).

Class LAMELLIBRANCHIA

Nucula cf. ornata Quenstedt.
Nucula pollux d'Orbigny.
Parallelodon gnoma (d'Orbigny).
Arca (Barbatia) sp.
Oxytoma expansa (Phillips).
Pinna lanceolata (J. Sowerby).
Chlamys (Radulopecten) scarburgensis (Young & Bird). (abundant).
Chlamys (Radulopecten) fibrosa (J. Sowerby).
Liostrea sp. undescribed.[2]
Liostrea (Catinula) cf. alimena (d'Orbigny).
Gryphaea lituola (Lamarck). (abundant).
Trigonia cf. meriani Agassiz.
Astarte murchisoniana d'Orbigny.
Astarte cf. mosae (d'Orbigny).
Astarte sp. ?undescribed. (small). (abundant).
Corbula mosae (d'Orbigny).

Class GASTROPODA

Fragmentary unidentifiable casts.

Phylum BRACHIOPODA

Class ARTICULATA

Rhynchonella socialis (Phillips).

Phylum PROTOZOA

Class SARCODINA

Bullopora rostrata Quenstedt (on Hibolites hastatus & Ostrea)

Phylum ECHINODERMA

Class ECHINOIDEA

Collyrites sp., crushed test, unidentifiable.

[2] Cf. *Ostrea* sp. figured by W. J. Arkell, *Oxoniensia*, III (1938), pl. IA, figs. 1a, 1b, p. 5.

Class CRINOIDEA

Pentacrinus sp. (stem columnals).

Phylum ARTHROPODA

Class CRUSTACEA

Crustacean fragments, cf. Mecochirus sp.

Also five bone fragments including phalange and rib bone of Plesiosaurus sp., fragments of Lignite, and Serpula sp.

II. THE PLEISTOCENE GRAVEL

The gravels were of the usual kind found in the river terraces, and, so far as they could be studied, fully confirmed the interpretation established by Dr. K. S. Sandford, to whom our knowledge of this period is almost entirely due.[3] It was quite obvious that the upper surface of the Oxford Clay had been eroded irregularly. The marked rise at Linton Road probably represents the separation of the Thames and Cherwell courses during some episode in the history of the Summertown gravels. At this higher point there were two or three sections, unfortunately exposed and covered by the excavators' grab almost too quickly to be studied, which showed marked turbulent bedding, and there was one patch of a closer whitish material, almost a clay, which had been washed down from some unknown source. This turbulent bedding is explained by Sandford as probably due to Pleistocene 'freeze & thaw', rather than quick river-flow. It has been noted in several local gravel-pits.

The most interesting find was a small fossiliferous patch in which, by long and rather slow collecting, the following list of species was found. For the identification of these, which was quite straightforward, I am responsible.

Phyllum MOLLUSCA

Class LAMELLIBRANCHIA

Corbicula fluminalis (Müller).
Sphaerium corneum (Linné).
Pisidium amnicum (Müller).
P. cinereum Alder.
P. cinereum var. ponderosa Stelfox.
P. subtruncatum Malm.
P. supinum Schmidt.
P. henslowanum Sheppard.
P. nitidum Jenyns.

Class GASTROPODA

Bithynia tentaculata (Linné).
Valvata piscinalis (Müller).
Limnaea truncatula (Müller).

[3] K. S. Sandford, 'The River-Gravels of the Oxford District,' *Quart. Journ. Geol. Soc.*, LXXX (1924) 113-179.

Class GASTROPODA—*continued*
Limnaea palustris (Müller).
Limnaea pereger (Müller).
Planorbis spirorbis (Linné).
Succinea pfeifferi Rossm.
Trichia hispida (Linné).
Pupilla muscorum (Linné).

This list represents just what we might expect to find in flood refuse, after a fairly large river had overflowed the flat watermeadows along its banks. This corresponds exactly to the picture given by Sandford in his reconstruction of the considerable Pleistocene river, some 30 feet deep, which flowed past Oxford during the warmer intermissions of the Ice Age. The presence of *Corbicula* (now living in the Nile) indicates a warmer climate. The numerous specimens of *Trichia hispida*, still one of our commonest snails, and the fragments of *Pupilla* clearly come from the river banks, while *Succinea pfeifferi* and *L. truncatula* are typical of the flat water-meadows. Most interesting of all are the Pisidia, since the list is exactly that to be expected in a considerable, slow-moving river, with a muddy bottom. All are species now found in the Thames. *P. supinum* and *P. cinereum* var. *ponderosa* (regarded by some as a good species) are striking additions to the list given by Kennard and Woodward,[4] since these are forms with heavy, thickened shells, especially characteristic of such rivers.

It is curious that only one specimen of *Bithynia tentaculata*, normally almost the commonest shell in such deposits, was found. Nor was there any sign of its characteristic opercula, which are usually quite as abundant as the shell itself. Its usual companion, *Valvata piscinalis*, occurred in plenty. With these holocene shells a very interesting find occurred, in a complete specimen of *Oxytoma inequivalvis* Sow., with the valves still attached, washed clean, and empty of matrix. This is a common enough Middle Lias fossil, and would in itself be sufficient evidence that the river which left this particular deposit as it swept round the ridge at Linton Road, was an earlier version of the Cherwell, and had picked up this curiously well-preserved stray from the Lias deposits towards Banbury. Liassic material is distinctive in the Cherwell gravels, and forms a notable percentage of those of the 100 foot level at Kirtlington.

A striking confirmation of this occurred during the excavations in Charlbury Road. Dr. John Badenoch, digging in his garden in Bardwell Road, about 100 yds. to the west of the south end of Charlbury Road, turned up in the gravel a large fragment of a Lias ammonite, *Pleuroceras* sp., a good deal waterworn, and clearly indicating, like the *Oxytoma*, a source much further north.

[4] In K. S. Sandford, *op. cit.*, 170-5.