THE GEOLOGY OF CALDECOTTE BALANCING LAKE, MILTON KEYNES, BUCKINGHAMSHIRE

J.D. RADLEY & R.J. SUTHREN, M.A., Ph.D., F.G.S.

During the summer of 1982, excavations for the Caldecotte Balancing Lake, Milton Keynes, Buckinghamshire, provided extensive exposures of Lower Oxford Clay, overlain unconformably by superficial deposits. The Lower Oxford Clay belongs to the Erymnoceras coronatum *and* Peltoceras athleta *zones and proved highly fossiliferous. Superficial deposits were clearly divisible into two units. The lowest comprises coarse river terrace deposits containing a variety of clast-types, all of local provenance. The higher unit consists of predominantly fine-grained alluvium of the River Ouzel, and locally yielded molluscan and vertebrate faunas.*

During the summer of 1982, excavations for the Caldecotte Balancing Lake (Figure 1) Milton Keynes, Buckinghamshire, provided extensive exposures of the Lower Oxford Clay and overlying superficial deposits. This report describes the results of the geological fieldwork and data collection undertaken in the excavations during 1982. The fieldwork was supplemented by the preparation, curation and documentation of rock and fossil specimens. Localities referred to in the text are shown in Figure 1.

The oldest rocks on the site of the Caldecotte Balancing Lake belong to the Lower Oxford Clay, which forms the local bedrock. The Lower Oxford Clay is assigned to the Callovian Stage of the Jurassic System. No younger Mesozoic rocks occur on the site, and the lower Oxford Clay is overlain unconformably by river terrace deposits of Pleistocene age. These, in turn, are succeeded by fine-grained alluvium of the River Ouzel. The stratigraphical succession is shown in Figure 2.

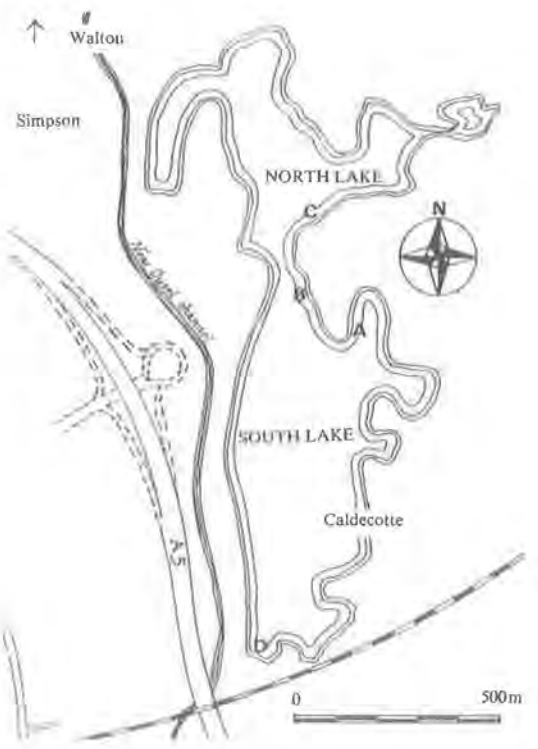

Fig. 1. Caldecotte Balancing Lake, showing the sites discussed.

THE LOWER OXFORD CLAY

The Lower Oxford Clay at Caldecotte comprises dark grey shelly mudstones. Massive clays predominate, but in places, well-laminated fissile shales are developed. Thin

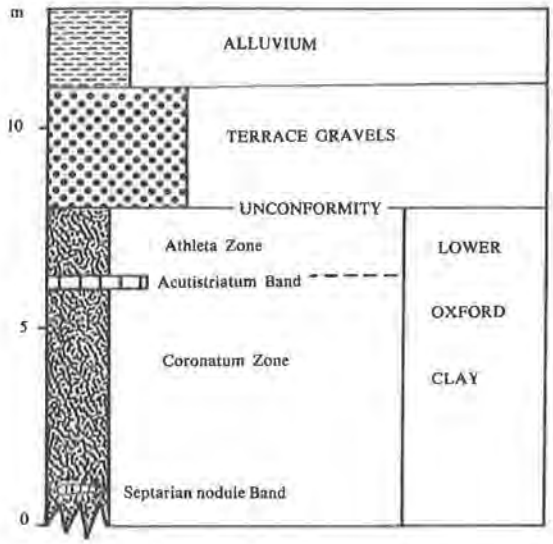

Fig. 2. The stratigraphical succession at Caldecotte Balancing Lake.

beds rich in pyritized shells occur occasionally, and large septarian nodules show the characteristic shrinkage cracks, infilled with sparry calcite.

The maximum exposed thickness of Lower Oxford Clay is about 8 metres, and the sequence closely matches part of that exposed at the London Brick Company's Newton Longville Pit at Bletchley (Horton *et. al.*, 1974). Most of the exposed interval belongs to the *Erymnoceras coronatum* Zone, although older strata may have been exposed in the deepest parts of the excavations. Towards the top of the sequence, a 20-30 cm thick, indurated lenticular muddy limestone, the Acutistriatum Band, outcrops in both the North and South Lakes. The base of the limestone is rich in shelly bioclastic material. The succeeding clays belong to the overlying *Peltoceras athleta* Zone (Figure 2).

Fauna and flora: Most elements of a typical Lower Oxford Clay fauna are present at the Caldecotte site. Fossils are abundant throughout the clays, except where intense weathering has locally taken place beneath, or prior to, the drift cover.

Preservation: except where extensive pyritization has occurred in thin, condensed shell beds, much of the fauna is found in a compressed state, as friable white aragonite, the original shell material. This occasionally bears small patches of dull pyrite, and sometimes exhibits a marked irridescence when fresh. Exceptions to this include belemnite guards, preserved uncrushed in original calcite, sometimes with a thin pyrite skin, and vertebrate remains, which are partly preserved in their original bone.

The fauna is dominated by molluscs. The bivalves include small deposit feeders such as *Palaeonucula* and *Mesosaccella*, which are abundant, whilst *Meleagrinella*, *Bositra* and *Thracia* are locally common. Oysters are rare, although *Liostrea*, *Nanogyra* and *Gryphaea* have been found.

Of the gastropods, *Procerithium* is abundant, and at one point forms a pyritized shell bed crowded with well-preserved individuals. Poorly preserved *Dicroloma* is also occasionally seen.

The cephalopods are represented by extremely abundant ammonites covering a large range of sizes. The genera most commonly encountered are *Erymnoceras*, *Kosmoceras* and *Binatisphinctes*. Belemnites are also common, the large *Cylindroteuthis* predominating, with *Hibolites* occurring infrequently.

Other conspicuous elements of the fossil assemblage include the serpulid worm *Genicularia vertebralis*, whose calcium carbonate tubes are abundant in the clays. Rare vertebrate remains have been recorded, including a fragmented reptilian limb bone recovered from a pyrite shell bed in the Coronatum Zone at locality A, and an ichthyosaur vertebra. However, the most spectacular vertebrate find was made by the contractors late in summer 1982, when they uncovered the greater part of the skeleton of a large ichthyosaur, *Opthalmosaurus*. The skeleton is undergoing preparation at Leicester University. Plant remains are confined to flattened logs of crumbly lignite up to 1

metre long, and these are occasionally pyritized.

Mr. A.T. Kearsley (Oxford Polytechnic) has separated the coarse fraction from samples of the Lower Oxford Clay from Caldecotte, and has found them to be rich in foraminifera, all of which are assigned to the order Rotaliina. The species identified include *Epistomina stellicostata*, *Epistomina* cf. *tenuicosta* and *Lenticulina* cf. *ectypa*.

SUPERFICIAL DEPOSITS

These are clearly divisible into two units (Figure 2): a lower unit of relatively coarse sands and gravels (terrace deposits) which are usually 2 to 3 metres in thickness, and an upper unit of clayey alluvium, up to 2 metres thick.

Terrace deposits

The terrace deposits lie unconformably on the Lower Oxford Clay. On a broad scale the unconformity appears planar, but in detail it is often rather irregular. The junction with the underlying strata is frequently marked by piping, brecciation or small antiformal structures in the top of the Lower Oxford Clay. These structures are attributed to cryoturbation (frost heave) during the Pleistocene following the deposition of at least the lower part of the terrace deposits. Locally, a breccia of clay fragments is present, and this includes many Oxford Clay fossils. Weathering at the junction is often intense, and in a section near locality A, a pyritized shell bed in the Lower Oxford Clay has been reduced to a crumbly ferruginous clay. This weathering took place prior to the deposition of the terrace gravels. At some localities, the unconformity is obscured by mixing of the clays and overlying gravels, resulting in a zone of matrix-supported pebbly mudstone up to 50 cm thick. Locally, as at locality B, rafts of peat up to 50 cm or so long are concentrated along the unconformity, and these were presumably derived by local erosion and fluvial transport. Selenite is occasionally present at the top of the Lower Oxford Clay in the North Lake area, whilst in other parts of the excavations, as at locality B, the contact is marked by intense iron-staining, and the development of an 'iron-pan' layer.

Although the terrace gravels are 2 to 3 metres thick over most of the Caldecotte site, at locality A they are seen to wedge out laterally, so that the overlying alluvium comes to rest directly on the Lower Oxford Clay. Close to this locality, the terrace gravels pass laterally into a thin silt unit with rootlets.

The terrace deposits show an alternation of sand-rich and pebble-rich layers, as well as finer grained silt and clay units. A typical section through these deposits in the South Lake area is given below:

overlying alluvium

0.6m	clayey sand, pebbly at base
0.5m	pebbly sand, with ferruginous cement at base
0.3-0.5m	grey sandy pebbly clay
0.2-0.4m	sandy gravel, with local sand lenses
0.2m	pebbly sand

---

underlying Lower Oxford Clay

The clasts in the gravels range from angular to well rounded, and are predominantly of pebble size. It is thought that most of the clasts are of local provenance, either derived directly from Jurassic and Cretaceous sedimentary strata, or from earlier superficial deposits such as boulder clay. The coarser units yielded the following identifiable clast types and derived fossils:

1. Ironstone clasts, probably from the Woburn Sands which outcrop nearby.
2. Flints, often large and subangular.
3. Worn and broken *Gryphaea* (an oyster) from the local Oxford Clay.
4. Fragmentary casts of the ammonite *Pavlovia*, derived from the basal nodule bed of the Woburn Sands.
5. Serpulid-encrusted *Nanogyra* (an oyster), often with some shelly matrix, probably

from the local Ampthill Clay or Cornbrash.
6. blocks of shelly Oxford Clay.
7. clasts of unfossiliferous quartzitic sandstone.
8. a variety of igneous and metamorphic rocks, probably derived from a former widespread cover of boulder clay.

Sedimentary structures: in some sand and pebbly sand layers, thin (up to 10 cm) cross-bedded sets were seen, picked out by slightly coarser or darker laminations.

Fauna: apart from the derived fossils mentioned above, an incomplete mammoth tooth was recovered from the terrace gravels at locality A.

Alluvium

The alluvium usually rests abruptly on terrace gravels with a shelly, locally peaty lithology developed at the base. In exposures between localities A and C, this lithology yielded the modern gastropods *Limnaea*, *Planorbis*, *Theodoxus* and a possible *Bithynia*. The modern bivalves *Pisidium* and *Unio* are locally abundant, as are large masses of wood, and the bones of modern species of cow and horse.

The predominant lithology of the alluvium is a brown, blocky weathering silty clay, with scattered clasts of flint and ironstone, probably derived from the underlying terrace deposits. Near locality B, a concentration of a powdery blue mineral is present in the clay. This has been identified as vivianite (a hydrated phosphate of iron), and occurs in association with bones.

The most extensive spreads of alluvium occur in the South Lake area, although patches are also present in the North Lake area, where the lithology appears coarser. Mention should also be made of some 4 metres of silty clays, often pebbly, carbonaceous or with rootlets, which are present around locality D in the South Lake. They appeared to occupy a channel eroded in terrace gravels, and traces of possible chalky boulder clay were observed below them. However, their exact field relationships remain uncertain.

BIBLIOGRAPHY

Callomon, J.H. 1968. 'The Kellaways Beds and the Oxford Clay'. *In*: Sylvester-Bradley, P.C. & Ford, T.D. (eds.). *The Geology of the East Midlands*. Leicester University Press, Leicester, pp. 264-290.

Chatwin, C.P. 1961. East Anglia and adjoining areas. *British Regional Geology*. H.M.S.O., London.

Horton, A., Shephard-Thorn, E.R. & Thurrell, R.G. 1974. 'The geology of the new town of Milton Keynes'. *Inst. Geol. Sci. Report* no. 74/16.

Radley, J.D. & Suthren, R.J. 1982. 'Investigations into the geology of Caldecotte Balancing Lake near Bletchley, Milton Keynes, Buckinghamshire'. Unpublished report for Milton Keynes Development Corporation.

APPENDIX I

Preparation and curation of specimens

Following the fieldwork in summer 1982, treatment, classification and documentation of specimens was undertaken. This work was concluded in April 1983.

Some specimens have proved fragile and difficult to conserve. In particular, molluscs preserved in their original aragonite are prone to flaking and disintegration of the thin shell material. Pyrite decay has also been a problem in some specimens.

The conservation and curation work was partly undertaken at the Buckinghamshire County Museum at Aylesbury, where the specimens are at present lodged.

APPENDIX II

Catalogue of curated material

Accession number	*Description*	*Group*	*Horizon*
1001.1982/1	*Binatisphinctes sp.*	Ammonite	Athleta Zone, LOC (Lower Oxford Clay)
/2	*Kosmoceras obductum*	Ammonite	Coronatum Zone, LOC
/3	*Erymnoceras sp.*	Ammonite	Coronatum Zone, LOC
/4	*Kosmoceras sp.*	Ammonite	Coronatum Zone, LOC
/5	*Binatisphinctes sp.*	Ammonite	Athleta Zone, LOC
/6	*Kosmoceras obductum*	Ammonite	Coronatum Zone, LOC
/7	*Cylindroteuthis puzosiana*	Belemnite	Coronatum Zone, LOC
/8	*Palaeonucula*	Bivalve	Coronatum Zone, LOC
/9	*Mesosacella*	Bivalve	Coronatum Zone
/10	*Procerithium*	Gastropod	Coronatum Zone
/11	*Meleagrinella*	Bivalve	Unknown zone, LOC
/12	*Gryphaea*	Bivalve	Unknown zone
/13	*Nanogyra*	Bivalve	Coronatum zone, LOC
/14	*Liostrea*	Bivalve	Coronatum Zone, LOC
/15	Shelly pyritic siltstone		Unknown zone
/16	Septarian mudstone		Coronatum Zone, LOC
/17	*Kosmoceras*	Ammonite	Athleta Zone, LOC
/18	*Thracia*	Bivalve	Coronatum Zone, LOC
/19	*Gryphaea*	Bivalve	Unknown zone, LOC
/20	*Procerithium*	Gastropod	Athleta Zone, LOC
/21	Centrum of ichthyosaur vertebra	Reptile	Unknown zone, LOC
/22	*Hibolites*	Belemnite	Athleta Zone, LOC
/23	*Cylindroteuthis* with serpulids	Belemnite/ annelid	Coronatum Zone, LOC
/24	Mammoth tooth	Mammal	Terrace Gravel
/25	*Kosmoceras*	Ammonite	Coronatum Zone, LOC
/26	Pyritized *Kosmoceras*	Ammonite	Coronatum Zone, LOC
/27	*Kosmoceras*	Ammonite	Coronatum Zone, LOC
/28	Ammonite-bearing pyrite nodule		Coronatum Zone, LOC
/29	*Kosmoceras*	Ammonite	Athleta Zone, LOC
/30	*Kosmoceras*	Ammonite	Athleta Zone, LOC
/31	Ammonite		Coronatum Zone, LOC
/32	Shelly concretionary mudstone with ammonite		Athleta Zone, LOC
/33	Limb bone	Reptile	Coronatum Zone, LOC

Notes : there are duplicates of many specimens, and these have been recorded under the same accession number. 1001.1982/12 (with duplicates) and 1001.1982/15 were collected from a dump of grey siltstone fragments in the South Lake. The parent bed was not seen *in situ*, and it is presumed that these specimens came from the basal Lower Oxford Clay, or from the underlying Kellaways Rock, probably exposed in deep excavations before the geological investigations commenced.