Roslyn Hole

[TL 555 808]

Potential GCR site

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Introduction

Roslyn (or Roswell) Hole at Ely, Cambridgeshire, is a large pit complex that has been worked almost continuously since early Victorian times to provide embanking materials for the River Great Ouse drainage system. It provides the most famous section in the Kimmeridge Clay of East Anglia (Gallois, 1988). Many field parties from Cambridge and London visited the pits in the latter part of the 19th century, not only to see the highly fossiliferous Kimmeridge Clay but also to observe the unusually large erratic raft of mainly Cretaceous rocks, first described by Sedgwick (1846), which was exposed in the Quaternary Anglian till (Boulder Clay) there. The controversy and discussion about the relationship of these differently aged strata one to another, and the general interest in the geology of the pit, led to an extensive literature (Seeley, 1865a, b, 1868; Fisher, 1868; Bonney, 1872a, b, 1875; Blake, 1875; Skertchly, 1877; Whitaker, 1883; McKenny Hughes, 1884, 1894; Whitaker *et al.,* 1891; Roberts, 1892; Rastall, 1909). The pits referred to by the 19th century authors, notably Blake (1875), Whitaker *et al.* (1891) and Roberts (1892) all of whom described extensive faunas from the Kimmeridge Clay here, lay on either side of the railway and are now flooded. A new pit was opened by the local river authority in the 1930s immediately south-west of the old pits on the north side of the railway. Gallois (1988) reported that this still exposed a Kimmeridge Clay section (see below) similar to that described by Roberts (1892) (probably at [TL 555 810]) and a shorter section (probably at [TL 555 806]) recorded by Skertchly (in Whitaker *et al.,* 1891).

Independent of any stratigraphical significance, the site has been confirmed as a GCR site for its fossil reptiles, in particular, the remains of sauropod dinosaurs and pliosaurs. An account of the reptilian fauna can be found in a companion GCR volume (Benton and Spencer, 1995).

Description

The following description is based on the section [TL 552 807] in the west face of the modern pit, recorded in 1979 by R.W. Gallois and the present author during the geological survey of the Ely district (Gallois, 1988); for ease of reference in the present account, bed numbers (1–27) have been added to their section (Figure 3.9).

	Thickness (m)
Kimmeridge Clay Formation	
27. Oil shale and pale-grey, calcareous mudstone interbedded in 50–100 mm thick units; very shelly in parts with '*Lucina*', *Protocardia,* abundant *Amoeboceras* (*Nannocardioceras*) *, Aulacostephanus, Pseudorbytidopilus, Dicroloma,* fish debris and shell dust	2.45
26. Mudstone, pale and medium grey, moderately shelly with fauna as Bed 27; serpulids locally common; *Lingula* and coalified wood fragments common; 80 mm-thick oil shale in middle part of bed	1.33
25. Oil shale, very shelly; fauna as Bed 26 but with *Aulacostephanus* and faecal pellets especially common	0.06

24. Mudstone, pale and very pale grey with bioturbation at several levels picked out by darker infills; sparsely shelly in upper part but with abundant serpulids, *Nanogyra virgula* (Defrance) and other small oysters in lower part	1.40
23. Mudstone, calcareous, with prominent, closely spaced (1.0–1.2 m apart), flattened, spheroidal and ellipsoidal cementstone nodules, mostly 0.35–0.40 m (up to 0.47 m) thick and 1.0–1.2 m in diameter; septarian cracks in cores partially infilled by sparry calcite; 0.150.20 m thick band of soft limestone occurs between nodules at level of their horizontal axis; sparsely shelly but with relatively common *N. virgula* and other oysters, and rare *Crussoliceras*	0.40
22. Mudstone, pale and medium grey; sparsely shelly	0.36
21. Lumachelle composed almost entirely of *N. virgula*	0.07
20. Mudstone, dark grey, sparsely shelly to shelly with *Amoeboceras* (*Amoebites*), serpulids and rotted bivalves and ammonites; abundant *N. virgula* at base	0.40
19. Mudstone, thinly interbedded, pale, medium and dark grey; sparsely shelly but with some more shelly bands; fauna as Bed 20	1.75
18. Mudstone, dark grey with thin seams of muddy oil shale; poorly exposed; passing down into Bed 17	1.10
17. Mudstone, medium grey, silty, sparsely shelly, passing down into Bed 16	0.15
16. Siltstone, medium grey, weakly calcite-cemented with widely spaced cementstone nodules (10–15 m apart) of similar size to those in Bed 23; shelly with *Aulacostephanus* ex gr. *eudoxus* (*d'Orbigny*) *, Aspidoceras, Laevaptychus,* poorly preserved bivalves and fish debris; inter-burrowed junction with Bed 15	0.17
15. Mudstone, pale grey becoming darker with depth; shelly in lower part; interburrowed junction with Bed 14	0.40
14. Oil shale, brownish grey, muddy, deeply weathered	0.10
13. Siltstone, medium to pale grey, with widely spaced (more than 30 m) cementstone nodules; locally shelly in lower part with common *Aspidoceras* and *Laevaptychus;* interburrowed junction with Bed 12	0.12
12. Mudstone, pale grey, sparsely shelly	0.20
11. Mudstone, dark grey, very shelly with *Aspidoceras, Laevaptychus* and *N. virgula*	0.09
10. Mudstone, pale and medium grey, sparsely shelly	0.65
9. Mudstone, dark grey, shelly with bivalves and ammonites rotted by weathering but *Laevaptychus* occurring in loose spoil	0.45
8. Mudstone, mostly medium and pale grey; sparsely shelly but with some rotted shelly bands *c.*	1.5
7. Mudstone, pale grey, moderately shelly with bivalves and ammonites, including *Aspidoceras,* in rotted pyrite	0.30
6. Mudstone, medium grey, fissile, shelly; some pyritic bivalves and ammonites; possible phosphatized burrowfills	0.15
5. Mudstone, pale grey, sparsely shelly, becoming darker in lower part and passing down into Bed 4	0.55

4. Siltstone, medium grey, pyritic but weathered to form a prominent yellow band with natrojarosite?-coated surfaces; very shelly with fauna concentrated in lower part; *Aspidoceras* and *Aulacostephanus eulepidus* (Schneid) common, *Neocrassina supracorallina* (d'Orbigny), oysters and fish debris also present	0.15
3. Mudstone, medium grey, sparsely shelly	0.50
2. Mudstone, faintly brownish grey, fissile; very shelly with abundant *A. eulepidus; ?A. mutabilis* (J. Sowerby), *N supracorallina* and faecal pellets	0.15
1. Mudstone, medium and pale grey, sparsely shelly with concentrations of large, smooth body-chambered ammonites (*?A. mutabilis*) at several levels seen	0.90

Gallois (1988) reported that part of the sequence described above was also seen below the boathouse in the north-western corner of the old flooded pit [TL 554 810] where the two siltstones (beds 13 and 16) were exposed, the upper one containing cementstone doggers at 2–4 m spacings. The lowest horizon exposed in the modern pit is a pale grey, deeply weathered mudstone that occurs 1–2 m below the lowest beds of the main section. The Kimmeridge Clay is overlain here by the Lower Cretaceous Woburn Sand (Lower Greensand Group), the basal bed of which consists of very pebbly, ferruginous sand that rests on an irregular surface cut into the Kimmeridge Clay. The pebbles include phosphatic casts of Kimmeridge Clay fossils. Inevitably, as the pit is worked, the succession of strata exposed may vary somewhat, and a few metres of Kimmeridge Clay, representing higher levels than that recorded herein, have been exposed beneath the Woburn Sand from time to time. The Woburn Sand is itself overlain by Anglian till.

Fauna and flora in old museum collections, additional to that recorded above, includes bivalves (including *Deltoideum delta* (Wm Smith)), belemnites, brachiopods (including *Torquirhynchia inconstans* (J. Sowerby)), echinoid spines, fish (including a well-preserved specimen attributed by Woodward (1890) to *Eurycormus*), plant debris and reptilian remains comprising a mix of terrestrial and marine Kimmeridgian forms including turtles, crocodilians, dinosaurs, plesiosaurs and ichthyosaurs (Tarlo, 1959; Wells, 1964; Benton and Spencer, 1995). As 'Roswell Pits, Ely', the site is included in the companion GCR volume on fossil reptiles; sauropod dinosaurs and pliosaurs are of particular significance here.

Interpretation

The ammonite faunas recorded in the above section indicate that it exposes the Lower Kimmeridgian Mutabilis and Eudoxus zones within which representatives of KC18 to KC32 of the standard bed-numbered Kimmeridge Clay sequence (Gallois and Cox, 1976) can be recognized (Figure 3.9). All the ammonites labelled 'Roslyn', 'Roswell' or simply 'Ely', amongst the large faunal collections in the BGS and Sedgwick Museum, Cambridge, could have come from this stratigraphical interval. Gallois (1988) thought this was surprising because the depth (up to 12 m) and large areal extent of the workings, combined with the low westerly dip, suggested rather that the whole of the Lower Kimmeridge Clay might formerly have been exposed. The non-ammonite fauna in the old collections, with the notable exceptions of *Torquirhynchia inconstans* (J. Sowerby) and *Deltoideum delta* (Wm Smith), could also have come from KC18–KC32. The presence of *T inconstans,* index of the basal Kimmeridgian Inconstans Bed, at Roslyn Hole was noted by Bonney (1875), Roberts (1892) and McKenny Hughes (1894) but there is no record of it ever having been collected *in situ* apart from McKenny Hughes' (1894) description of an excavation made below water level and 'not available at the time of Roberts' measurements' from which 'amongst other finds there were some remarkably large *R. inconstans*'*.* The section was not described and it seems likely, in the absence of an accompanying ammonite fauna, that these *Torquirhynchia* and the *D. delta* came either from the Jurassic-rich till or from an erratic mass of Kimmeridge Clay within it (Gallois, 1988).

The formation in the Ely area is thin in comparison with that of adjacent parts of Fenland due to attenuation within the formation, as it approaches the stable high of the London Platform, and pre-Aptian (Early Cretaceous) erosion. Although the lithological and faunal sequences can be matched with those of more northerly parts of Fenland, there are small differences at Ely that reflect the proximity of land in Early Kimmeridgian times. For instance, at Roslyn Hole there is a minor erosion surface at the base of the Eudoxus Zone, such that KC24 rests unconformably on KC21 and the widespread marker known as the Supracorallina Bed (KC22) is missing (Figure 3.9). Also, there are additional thin siltstone horizons notably in KC29, here represented by beds 8–18 (Gallois, 1988). Two well-established marker beds of the Eudoxus Zone can be recognized. Bed 21, composed almost entirely of *N. virgula* shells, represents the Virgula Limestone, and the ammonite *Crussoliceras* in Bed 23 indicates the Crussoliceras Band (= the *Propectinatites*-rich band of Cox and Gallois, 1981). The cementstone nodules that occur with this marker (in KC30) form the most striking feature in the degraded pit face (Figure 3.8).

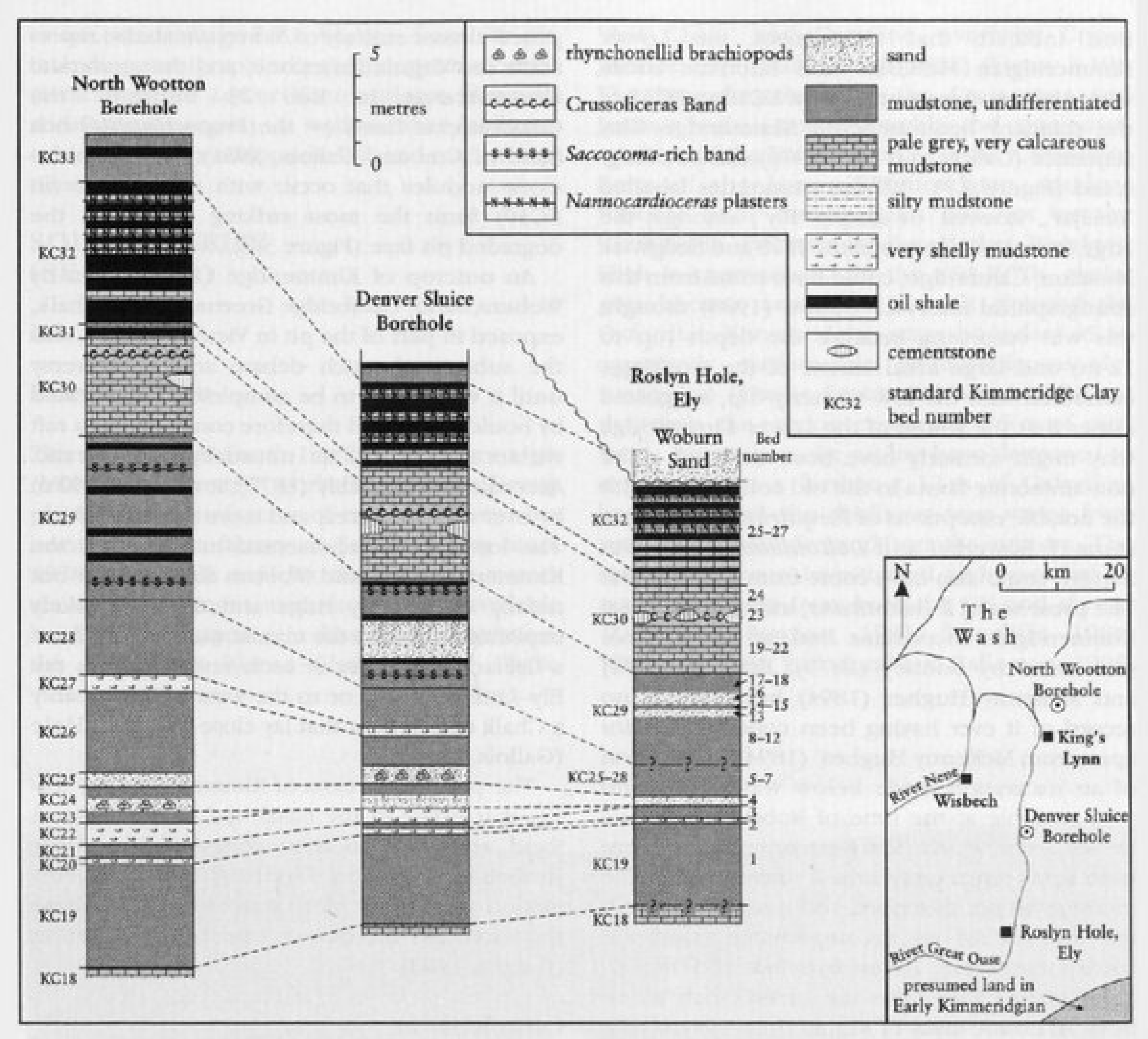
An outcrop of Kimmeridge Clay overlain by Woburn Sand, Cambridge Greensand and Chalk, exposed in part of the pit in Victorian times, was the subject of much debate and controversy until it was found to be completely surrounded by boulder clay and therefore confirmed as a raft within the till, i.e. an unusually large erratic. According to Skertchly (1877), it was about 50 m by over 400 m in area, and more than 5 m thick. The lower beds represented in the raft — the Kimmeridge Clay and Woburn Sand — crop out nearby on the Ely ridge and the most likely explanation is that the erratic was derived from a Cretaceous outlier or escarpment lying in the Ely–Littleport area or to the west of it, probably a Chalk escarpment that lay close to Roslyn Hole (Gallois, 1988).

The phosphatic casts of Kimmeridge Clay fossils that occur in the basal bed of the Woburn Sand are likely to have come via the older Jurassic–Cretaceous Sandringham Sand Formation as they are more water-worn than those that occur in the base of the latter formation (Gallois, 1988).

Conclusions

The large pit complex at Roslyn Hole has provided an exposure of Kimmeridge Clay since early Victorian times and has had a long history of geological investigation. It provides the only significant exposure of Kimmeridgian strata in East Anglia, where they are otherwise known mainly from cored boreholes. The sections are degraded at the time of writing, but they show fossiliferous shales, mudstones and calcareous mudstones in which a line of cementstone doggers forms a prominent marker. In the late 19th century, the locality became the scene of geological controversy concerning the origin of a large mass of Kimmeridgian and Cretaceous rocks that proved to be a large erratic raft in the Anglian till. This was first described by Professor Adam Sedgwick of Cambridge University in 1846, and the pit has had a long association with this seat of learning. The Sedgwick Museum there houses an extensive faunal collection from the pit, including stratigraphically diagnostic ammonites (indicating the Lower Kimmeridgian Mutabilis and Eudoxus zones), as well as other molluscs, echinoderms, brachiopods, fish and marine reptiles.

References



(Figure 3.9) Graphic section of the Kimmeridge Clay at Roslyn Hole and borehole sections in Norfolk showing the southwards attenuation towards Ely (after Gallois,1988, fig. 14).

(Figure 3.8) View of a degraded section of Lower Kimmeridge Clay at Roslyn Hole showing the prominent marker band (arrowed) formed by a line of cementstone nodules in Bed 23 (KC30). Ely Cathedral is seen in the background. (Photo: A13722, reproduced by kind permission of the Director, British Geological Survey © NERC.)