BARRINGTON CHALK PIT

OS Grid Reference: TL399511

Introduction

Barrington Chalk Pit is located south-west of Cambridge (TL 399 511) and consists of an enormous working quarry belonging to Rugby plc, which is cut into the hillside above the village of Barrington. The pit exposes a section from Gault mudstones below the Cambridge Greensand Member at the base of the West Melbury Marly Chalk Formation, to a level in the Zig Zag Chalk Formation, several metres above the Totternhoe Stone. It is thus the most extensive section of the lower part of the Grey Chalk Subgroup in the Transitional Province. It is also the better of the only two extant sections in the Cambridge Greensand Member, albeit not particularly fossiliferous compared with other former sections near Cambridge. It is important for showing a succession of the lower part of the West Melbury Marly Chalk Formation that is transitional between those of the Chiltern Hills and the condensed successions of the Northern Province Ferriby Chalk Formation. The base of the Totternhoe Stone is demonstrably erosive. The immediately overlying beds yield important inoceramid bivalve faunas that are older than the succeeding *Inoceramus atlanticus* assemblage of the *Acanthoceras jukesbrownei* Zone and which can be better collected here than elsewhere.

Description

The section at Barrington Chalk Pit has been considerably extended in recent years. At present, there are three main working faces, separated by benches, with the lowest beds under water. There is, surprisingly, no published log of this much-visited section, but considerable stratigraphical information, based on cored boreholes, is held by Rugby plc in a consultant's report. Because of the difficulty of logging the relatively inaccesible faces, the site (Figure 4.22) is illustrated by a panoramic photograph (Figure 4.23). A fault, or group of faults, affecting the Totternhoe Stone, can be seen in the centre of the main (second) working face.

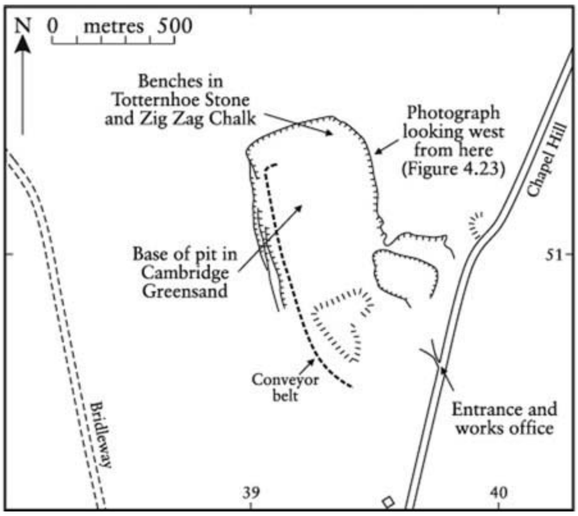

Figure 4.22: Barrington Chalk Pit, Cambridgeshire.

Figure 4.23: Barrington Chalk Pit, Cambridgeshire: a classic locality for the Cambridge Greensand and Totternhoe Stone. Photomosaic: R.N. Mortimore.)

Lithostratigraphy

The exposed Chalk Group succession extends from the Cambridge Greensand Member, at the base of the Grey Chalk Subgroup, through the relatively incomplete West Melbury Marly Chalk Formation preserved beneath the Totternhoe Stone, up to a level, several metres above the Totternhoe Stone, in the lower part of the Zig Zag Chalk Formation. The higher part of the Zig Zag Chalk Formation is not exposed in the present working faces.

The Cambridge Greensand Member is exposed at the top of flooded excavations at the base of the quarry; and can be examined in the dumps of excavated material on the quarry floor. Detailed lithological descriptions, based on localities outside the Cambridge area, were given by White (1932) and Hopson *et al*. (1996). It consists of a silty, glauconitic, micaceous marl, rich in well-preserved coccoliths, with a basal concentration of phosphatized pebbles (‘nodules') ranging in size from a few millimetres up to 0.15 m. The glauconite and phosphate content imparts a distinctive overall green colour, which contrasts with the paler grey of the Gault beneath. The pebbles, which were originally known as ‘coprolites' (fossil faeces) and were exploited for agricultural phosphate, are typically bored, encrusted by small oysters and other bivalves (*Atreta nilssoni* (von Hagenow)), and exhibit various degrees of rolling and phosphatization. The extent of phosphatization can be seen from their colour, the most strongly mineralized being black, while the less mineralized are brown. Many of them are recognizable as reworked, variably abraded internal moulds of fossils; in some cases, notably the bivalve *Aucellina* and the larger terebratulid brachiopods, the shells are relatively well preserved and only the internal mould is partially or wholly phosphatized. The Cambridge Greensand also contains rare, rounded, angular and subangular erratic components, up to cobble size, of igneous and metamorphic rocks, such as granite, schist and gneiss, in addition to sedimentary rocks, which include greyish and greenish grits and greywackes, as well as red and purple sandstones of Old Red Sandstone and Lower Carboniferous aspect (Sollas and Jukes-Browne, 1873; White, 1932; Hawkes, 1943; Worssam and Taylor, 1969).

The overlying dark, poorly differentiated, marly beds are exposed in relatively inaccessible steep faces. They are rich in fragmented inoceramid bivalve shell debris. The interval from the Cambridge Greensand up to the base of the Totternhoe Stone was recorded as 90 ft (27 m) by Burnaby (1962), but this is known to be variable depending upon the extent of downcutting prior to the deposition of the Totternhoe Stone.

Biostratigraphy

The Cambridge Greensand contains one of the most diverse, albeit derived, Cretaceous faunas in the UK. Penning and Jukes-Browne (1881), summarized by White (1932), noted that the fauna comprised 200 species of invertebrates, including sponges, corals, serpulids, brachiopods, bivalves, gastropods, ammonites, crustaceans (crabs and lobsters) and echinoderms (regular echinoids and crinoids). Of even greater interest is the vertebrate fauna, which includes fish (mainly teeth of sharks), reptiles (ichthyosaurs, pterosaurs, turtles, crocodiles) and even birds (Seeley, 1869). Small phosphatized turtle skulls, up to 0.04 m long, are one of the more remarkable components (see illustrations and references in Collins, 1970). The macrofossil and microfossil biostratigraphy of the Cambridge Greensand is described in several key papers (Morter and Wood, 1983; Wilkinson and Morter, 1981; Wilkinson, 1988). Details of the derived Upper Albian ammonite faunas and their biostratigraphical significance were given by Casey (1965) and Spath (1943).

Interpretation

The Cambridge Greensand first appears in the northern Chiltern Hills, where it relatively abruptly replaces the thin Glauconitic Marl Member at the base to the Chalk (seen in the British Geological Survey Sundon Borehole, Figure 4.3), in the vicinity of a fault or monoclinal structure known as the 'Lilley Bottom structure', which is inferred to follow the north-east edge of the buried Midlands Microcraton (Shephard-Thorn *et al.*, 1994; Hopson *et al.*, 1996). From the Cambridge area, it can be traced eastwards in East Anglia as far as the British Geological Survey Stowlangtoft Borehole, east of Bury St Edmunds (Bristow, 1990) and northwards to the British Geological Survey Marham Borehole, SSE of Kings Lynn. Farther to the north, where the Gault mudstones pass into the Red Chalk Formation, the basement bed of the Chalk becomes the 'Paradoxica Bed' of Northern Province successions (see Hunstanton Cliffs GCR site report, this volume).

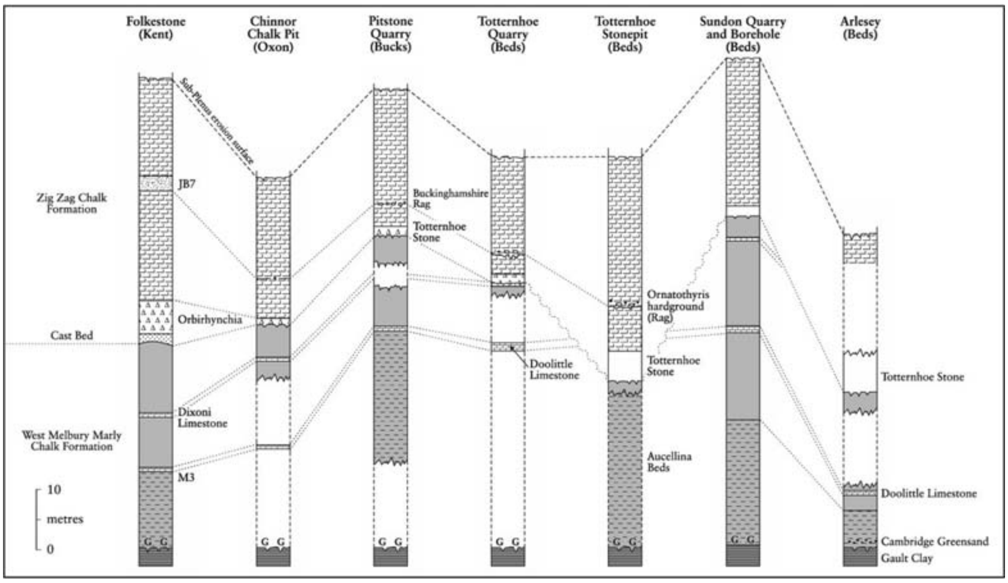

Figure 4.3: Correlation of the Cenomanian Grey Chalk Subgroup from Chinnor Chalk Pit to other sites in the Transitional Province and a comparison with the Folkestone standard section. (G = Glauconitic Marl; JB7 = Jukes-Browne Bed 7; M3 = marker horizon 3 of Gale, 1989.)

The Cambridge Greensand is essentially a Chalk basement bed like the Glauconitic Marl Member of the Southern Province. However, it differs from the Glauconitic Marl Member in that the greater part of the phosphatized pebbles and fossils that it contains are not of Cenomanian age, but have been derived from the progressive erosion, repeated reworking and further mineralization of several, stratigraphically separated, 'phosphate nodule beds' in the underlying high Upper Albian Gault mudstones. In the past, opinion was divided regarding the age of the sediment itself, rather than that of the reworked fossils, but it is now accepted to be of Cenomanian age (for discussion see Morter and Wood, 1983; Wilkinson, 1988 and references therein). In fact, the Cambridge Greensand is composite (Morter and Wood, 1983), consisting of a lower phosphate and glauconite-rich part, and a higher part of greenish marls without phosphates containing an indigenous macrofauna dominated by small brachiopods and the thin-shelled bivalve *Aucellina.* In Ely-Ouse (Mildenhall) Borehole No. 6 (TL 6928 7307) this bipartite succession is actually underlain by a thin (Upper Albian) unit containing oysters and the belemnite *Neohibolites praeultimus* Spaeth (Morter and Wood, 1983). Ostracod evidence (Wilkinson, 1988) indicates that this lowest unit belongs to the *Mortoniceras rostratum* Subzone of the Upper Albian *Stoliczkaia dispar* ammonite Zone and that the remainder of the Cambridge Greensand is Lower Cenomanian in age, belonging to the *Neostlingoceras carcitanense* Subzone of the *Mantelliceras mantelli* Zone. Hart (1973), on the basis of foraminiferal evidence, suggests that there is a major non-sequence at the erosion surface that generally marks the base of the Cambridge Greensand, involving not only the highest part of the *dispar* Zone, but also the basal Cenomanian benthic foraminiferal Zone 7, which is co-extensive with the thin Glauconitic Marl Member in boreholes near Folkestone (see **Folkestone to Kingsdown** GCR site report, this volume).

The Cambridge Greensand is the type horizon for the biostratigraphically important bivalve *Aucellina gryphaeoides* (J. de. C. Sowerby *non* Sedgwick). Although the microsculpture of the shell of the neotype suggests that it comes from the lower (Cenomanian) part of the Cambridge Greensand (Morter and Wood, 1983), the age of this specimen and all other non-indigeneous *Aucellina* from this member cannot be determined. In conjunction with the belemnite *Neohibolites ultimus* (d'Orbigny), this bivalve gives its name to the *Neohibolites ultimus/Aucellina gryphaeoides* event and transgression of European event stratigraphy (Ernst *et al*., 1983, 1996). In the UK this event finds its expression at the base of the 'Paradoxica Bed' of Northern Province successions, for example **Hunstanton Cliffs**, and in the Rye Hill Sands in the area to the north of **Dead Maid Quarry**, Mere.

The Cambridge Greensand has long been famous for its fossils. The large numbers of these fossils, particularly ammonites, housed in museum collections – most importantly the Sedgwick Museum, Cambridge and the British Geological Survey, Keyworth – give a completely misleading impression of their relative abundance. In fact, most of the fossils were collected from piles of excavated sediment left to dry in the sun on the edges of the flooded coprolite pits. The proportion of collectable macrofossils to shapeless phosphatic nodules is actually extremely low, this being particularly the case both at Barrington Chalk Pit and also at the other extant exposure at Arlesey Pit, north of Hitchin (TL 1879 3476) (see Hopson *et al*., 1996, pp. 34–35 and fig. 9; and Figure 4.1). Ammonites have always been extremely rare here, but there is evidence from museum collections that other sites nearer Cambridge were more fossiliferous.

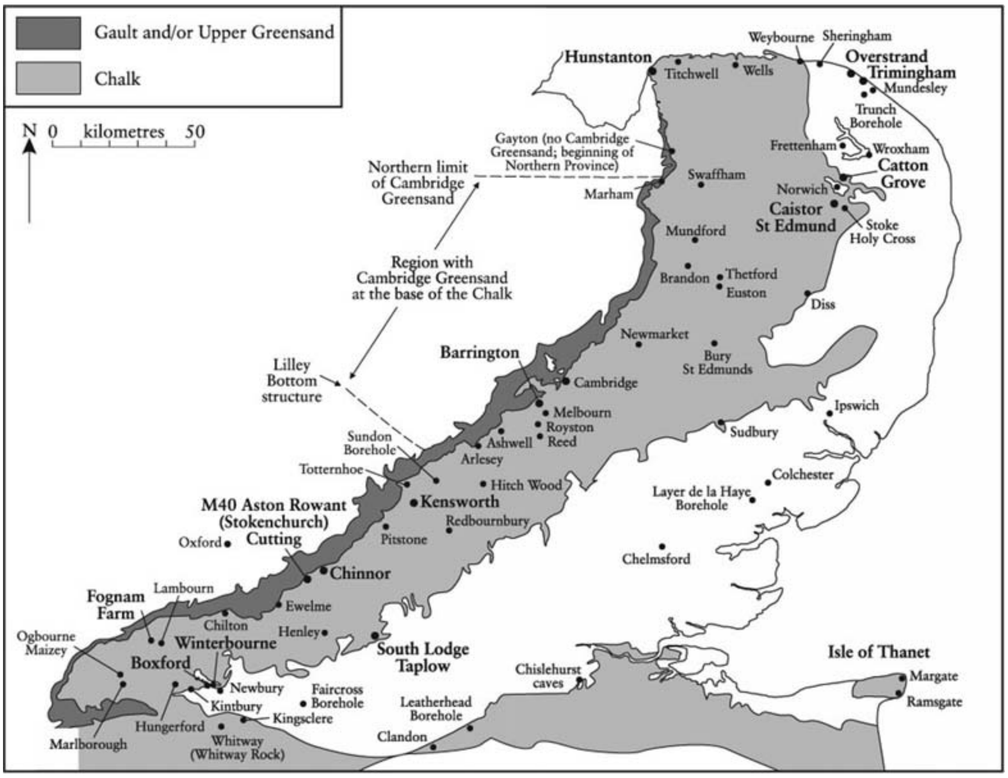

Figure 4.1: Location of GCR sites (bold type), and other sites also mentioned in the text, in the Transitional Chalk Province of England.

The overlying silty marls rich in fragmented inoceramid bivalve shell debris represent an expanded version of the two Inoceramus Beds of the condensed successions in the northern part of the Transitional Province and in the Northern Province. As at the Arlesey Pit (see Hopson *et al*., 1996, fig. 9), there is no evidence here for the existence of the poorly fossiliferous and pale-coloured 'Porcellaneous Beds', which, in East Anglia, are intercalated between the Cambridge Greensand and the Inoceramus Beds (Morter and Wood, 1983). There is also no evidence that the two inoceramid-rich units can be differentiated at Barrington Chalk Pit but, by extrapolation from the lower part of the Grey Chalk Subgroup at Abbot's Cliff, Folkestone, the lowest shell-detrital chalks can probably be assigned to the *Sharpeiceras schlueteri* Subzone. Microfaunal evidence (summarized by Wilkinson, 1988) places the basal beds of the West Melbury Marly Chalk Formation, above the Cambridge Greensand Member, in the *N. carcitanense* Subzone, which supports the above interpretation.

The stratigraphy of the West Melbury Marly Chalk at Barrington Chalk Pit is difficult to see in the working faces. The cored boreholes prove that pre-Totternhoe Stone erosion cut down here to approximately the same level as in the Chiltern Hills, i.e. a short distance above the lowest *Orbirhynchia mantelliana* Band (the *mantelliana* band in the middle of the Lower Cenomanian *Mantelliceras dixoni* Zone), but that locally it cut down to below this marker horizon.

In contrast to the sections in the Chiltern Hills (e.g. **Chinnor Chalk Pit**, Totternhoe, Houghton Regis), in which the *Orbirhynchia* of the third *Orbirhynchia mantelliana* Band (i.e. the band in the Middle Cenomanian *Turrilites costatus* Subzone) occur throughout the thickness of the Totternhoe Stone, the *Orbirhynchia* at Barrington Chalk Pit occur in a bed of chalky limestone containing large, glauconitized ammonites, which overlies the brownish arenaceous sediment of the Totternhoe Stone. The Totternhoe Stone here, and at all localities to the east, equates with the Cast Bed of the basinal successions of the Southern Province (e.g. **Folkestone to Kingsdown**, **Southerham Grey Pit**, **Compton Bay**) and the overlying bed corresponds to the group of marl–limestone couplets that comprises the third *Orbirhynchia mantelliana* Band. This type of succession is found throughout East Anglia, and also characterizes the Northern Province (e.g. **Hunstanton Cliffs**, Middlegate Quarry, South Ferriby, **Melton Bottom Chalk Pit**). The present site is of particular interest in that the bed above the Totternhoe Stone, and the immediately overlying beds, yield a distinctive inoceramid bivalve assemblage, including *Inoceramus tenuistriatus sensu* Keller (1982), which precedes the *Inoceramus atlanticus* assemblage of the lower part of the *Acanthoceras jukesbrownei* Zone.

Conclusions

Barrington Chalk Pit is of crucial importance to British Cretaceous stratigraphy in that it is one of only two extant sites exposing the Cambridge Greensand at the base of the Chalk. This greensand has long been famous for its derived phosphatized fossils, including, in addition to invertebrates (particularly ammonites), skeletal material of fish, turtles, flying reptiles and birds. The provenance and mode of transport of the exotic cobbles at the base of this bed remain highly controversial topics. The Grey Chalk Subgroup here shows transitional features to the successions in the Northern Province. The beds above the Totternhoe Stone contain an inoceramid bivalve fauna that cannot be readily collected elsewhere in England but is useful in long-range correlation to sections in northern Europe.

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