KENSWORTH CHALK PIT

OS Grid Reference: TL015197

Introduction

Kensworth Chalk Pit (TL 015 197) is a large working quarry located 1 km south of Dunstable, adjacent to Whipsnade Zoo, in the Dunstable Downs, northern Chiltern Hills (Figure4.20). The pit exposes a continuous, 40 m section through the higher part of the New Pit Chalk Formation and the Lewes Nodular Chalk Formation up to the Beachy Head Zoophycos Beds. This corresponds to a stratigraphical range from the Middle Turonian*Collignoniceras woollgari* Zone to the Lower Coniacian *Micraster cortestudinarium* Zone. It thus provides a unique standard section for the Transitional Province. It is best known for the Chalk Rock, which, in some parts of the quarry, is extremely fossiliferous, and it is one of the three most important extant sources of Chalk Rock ammonites, including figured material. The marl seams beneath the Chalk Rock at this locality provide the key to the interpretation of the relationship between the basinal chalk facies and the marginal, condensed Chalk Rock hardground facies. The interval between the Chalk Rock and the Top Rock is more condensed than elswhere, and contains several unnamed hardgrounds. This hardground succession, together with the Top Rock, is termed the 'Kensworth Nodular Chalk Member' by the British Geological Survey, with the Kensworth section being taken as the stratotype. The Top Rock is particularly well exposed and, compared with other localities, relatively fossiliferous, yielding basal Coniacian inoceramid bivalves critical to long-range correlation.

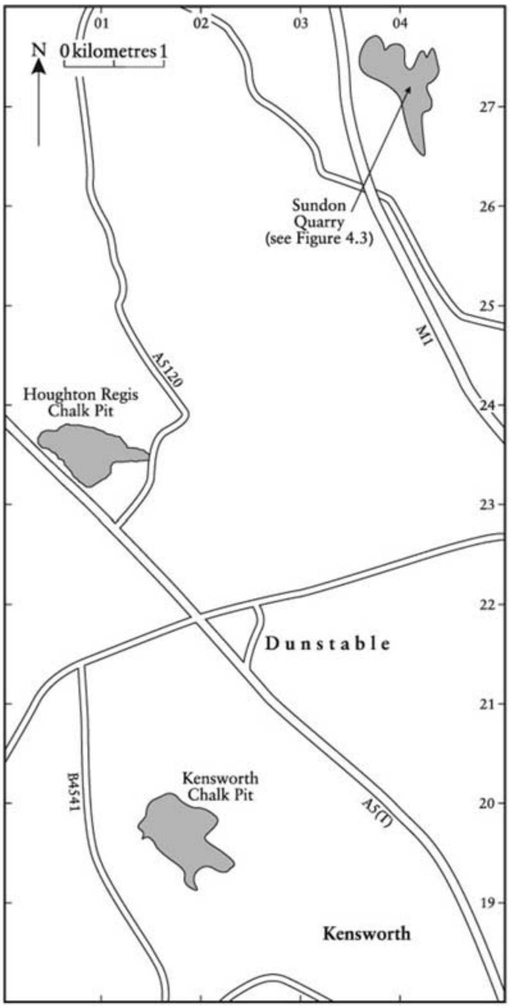

Figure 4.20: Location of Kensworth Chalk Pit, Bedfordshire, and adjacent sections.

Description

The Kensworth Chalk Pit section (Figure 4.21) extends from a level 30 m below the Chalk Rock to some 5 m above the Top Rock. The strata dip at *c*. 3° to the south-east. Faulting is minimal, and there are few faults with displacements in excess of 1 m. The chalk is worked in several faces, separated by wide benches. In the near future it is intended to extend quarrying to an even greater depth than at present. A recently opened section, 3 m high, exposing the Chalk Rock in about the middle of the face, and some distance from the present worked faces, will be retained as a GCR site after the remainder of the quarry has been restored by landscaping.

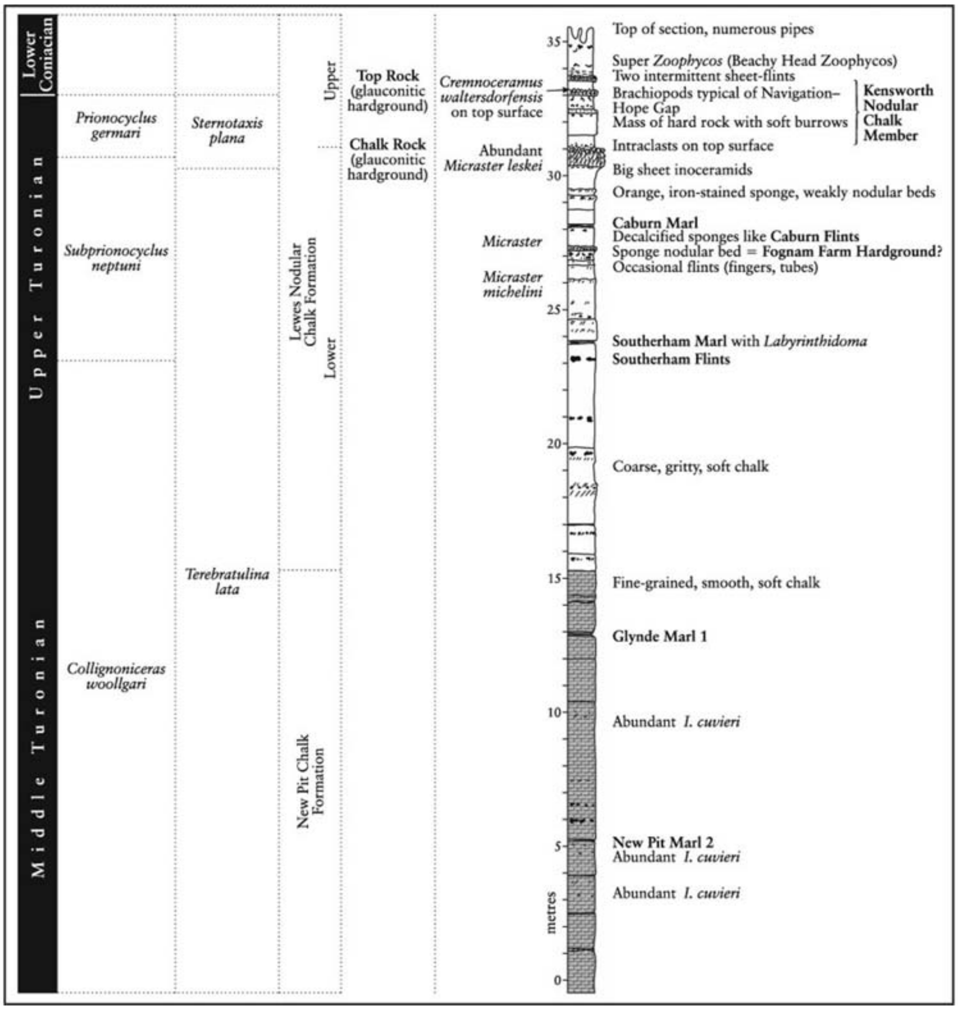

Figure 4.21: The Chalk succession at Kensworth Chalk Pit, where the inter-basinal Turonian marker marl seams are present and the northward change in development of the Chalk Rock and Top Rock is illustrated.

Various parts of the Kensworth section, notably the Chalk Rock and the underlying marl seams, have been discussed in the literature (Bromley and Gale, 1982; Mortimore and Wood, 1986; Wray and Gale, 1993; Hopson *et al*., 1996; Gale, 1996), and the entire section has been described and illustrated in detail by the British Geological Survey (Shephard-Thorn *et al*., 1994). Chalk Rock ammonites from here were illustrated by Wright (1979) and by Kaplan *et al*. (1987).

Lithostratigraphy

The succession (Figure 4.21) below the Chalk Rock comprises relatively soft, coarse, gritty chalks with several minor flint bands, as well as some weakly indurated horizons preserving sponges emphasized by pale orange-yellow limonite. This succession also includes several conspicuous, widely spaced marl seams up to 0.10 m in thickness. The uppermost two marl seams, 6 m and 2 m below the base of the Chalk Rock, equate with the Southerham Marl 1 and Caburn Marl of the Southern Province basinal succession respectively (Mortimore and Wood, 1986). One or more of the underlying marls are tentatively correlated with elements of the Glynde Marls group.

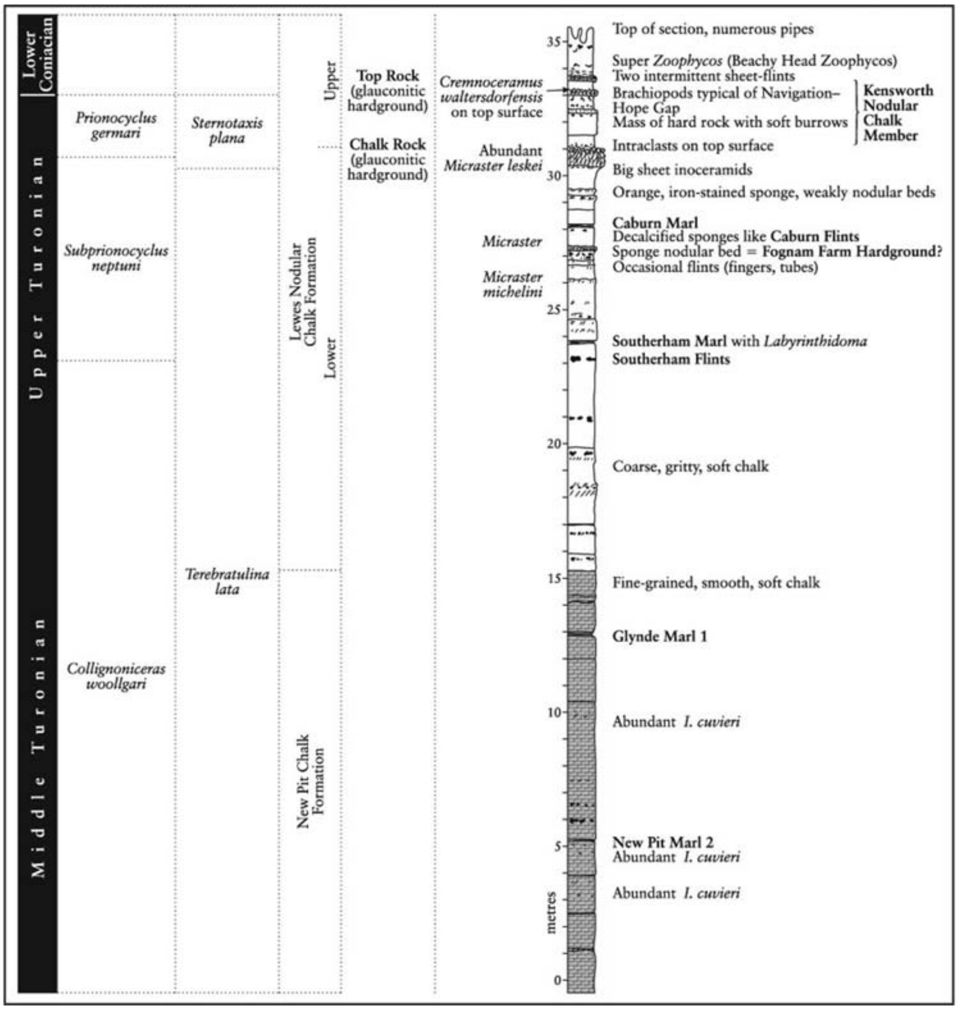

Figure 4.21: The Chalk succession at Kensworth Chalk Pit, where the inter-basinal Turonian marker marl seams are present and the northward change in development of the Chalk Rock and Top Rock is illustrated.

The Chalk Rock is represented by a prominent chalkstone unit 0.7 m thick, which comprises only the top suite of the standard succession. Although apparently a single, massive, homogeneous bed, it is in fact composite and contains two minor phosphatized surfaces (cf. Bromley and Gale, 1982, fig. 13). The chalkstone is penetrated by an extensive *Thalassinoides* burrow system, mostly filled either by friable, granular chalk or else empty of sediment. The Chalk Rock chalkstone terminates in the convolute Hitch Wood Hardground, which here is heavily glauconitized and phosphatized; its associated pebble bed is locally highly fossiliferous (see below). This is a typical development of the so-called 'Hitch Wood facies' (Hopson *et al*., 1996), in which the terminal (Hitch Wood) hardground has not yet split into the succession of mineralized hardgrounds and nodular chalks (Reed facies) that characterize successions in eastern Hertfordshire and areas to the east.

The interval between the Chalk Rock and the base of the Top Rock is thinner here (*c*. 2 m), than in any other known section in the Chiltern Hills–north Hertfordshire area. This interval includes a chalkstone with a glauconitized and phosphatized hardground overlain by glauconitized pebbles, which is followed by three weakly glauconitized and poorly lithified hardgrounds. The chalk above the highest of these hardgrounds contains small *Zoophycos* flints. The hardground succession above the Chalk Rock up to the top of the Top Rock forms the stratotype of the Kensworth Nodular Chalk Member of the British Geological Survey (Hopson *et al*., 1996, fig. 17). The Top Rock is double, comprising two hardgrounds welded together. The main component is a massive, slightly pink-coloured chalkstone with a terminal convolute, dark-green glauconitized hardground, overlain by large glauconitized pebbles, several centimetres across, which include rolled hexactinellid sponges and echinoids. This is followed by a second, less strongly lithified and unmineralized hardground. The chalk above the higher of these hardgrounds contains conspicuous *Zoophycos* traces and small *Zoophycos* flints at the beginning of the Beachy Head Zoophycos Beds.

The succession below and including the Glynde Marls group is the upper part of the New Pit Chalk Formation. The succession from above the Glynde Marls group, through the soft, gritty chalks up to and including the Chalk Rock, corresponds to the lower Lewes Nodular Chalk Formation. The interval from the top surface of the Chalk Rock up to the Quaternary erosion surface at the top of the section, including the Top Rock, equates with the upper Lewes Nodular Chalk Formation (Figure 4.21).

Biostratigraphy

The succession below the Chalk Rock belongs to the *Terebratulina lata* Zone. At some levels it is relatively rich in fossils, including the diminutive zonal index brachiopod and *Inoceramus cuvieri* J. Sowerby (for details see Shephard-Thorn *et al*., 1994). The echinoids *Micraster corbovis* Forbes of *lata* Zone type and *Sternotaxis plana* (Mantell) are found at the level of the flints beneath Southerham Marl 1. Of particular note are the occurrences of well-preserved limonitized sponges in the weakly nodular horizons above Southerham Marl 1, and of the small echinoid *Micraster michelini* (Agassiz) together with common specimens of the bivalve *Spondylus spinosus* (J. Sowerby) between the Caburn Marl and the base of the Chalk Rock.

The highest part of the *lata* zone, together with the basal part of the overlying *Sternotaxis plana* Zone, is condensed into the chalkstone of the Chalk Rock. In addition to sponges, corals, and a high-diversity *reussianum* fauna of originally aragonite-shelled molluscs, the pebble bed of the Hitch Wood Hardground contains small *Micraster leskei* Desmoulins, brachiopods including *Cretirhynchia cuneiformis* Pettitt and *Gibbithyris subrotunda* (J. Sowerby), the inoceramid bivalves *Inoceramus perplexus* Whitfield, *Mytiloides costellatus* (Woods) and *M. incertus* (Jimbo), together with a rich Upper Turonian *Subprionocyclus neptuni* ammonite fauna. This assemblage enables correlation with the *plana* Zone Kingston Nodular Beds of the lower Lewes Nodular Chalk Formation of the standard Southern Province basinal succession.

The unnamed hardgrounds of the Kensworth Nodular Chalk Member have so far not yielded any diagnostic fauna, but they can be attributed on general stratigraphical grounds to the higher part of the *plana* Zone. The occurrence of *Zoophycos* in the chalks immediately above these hardgrounds points to a correlation with the terminal *plana* Zone Cuilfail Zoophycos Beds of basinal successions. The Top Rock contains common small uniplicate terebratulid brachiopods (*Concinnithyris*?) and recent collecting (1998) has yielded the topmost Upper Turonian–basal Lower Coniacian inoceramid bivalve *Cremnoceramus waltersdorfensis* (Andert). The glauconitized, pebble-preservation fossils resting on the lower hardground of the composite Top Rock include rolled hexactinellid sponges and echinoids, such as *Micraster cortestudinarium* (Goldfuss). The white, flinty chalks above the Kensworth Nodular Chalk Member contain common *Zoophycos* flints and larger, thick-shelled *Cremnoceramus* sp. typical of the Beachy Head Zoophycos Beds of the Southern Province.

Interpretation

The lower part of the succession at Kensworth Chalk Pit remains poorly understood, but it can be used to establish a tentative correlation (Mortimore and Wood, 1986, fig. 2.4), by means of marl seams and flint horizons, via the section in the Royston road cutting (TL 372 410) (Hopson *et al*., 1996, fig. 16), to the successions in East Anglia.

Kensworth Chalk Pit is of particular importance because of the extensive 30 m succession, including marl seams, exposed beneath the Chalk Rock, which form part of the marl/tephro-event stratigraphy for north-west Europe (see Chapter 1). The two highest sub-Chalk Rock marl seams were originally named the ‘Latimer Marl' and ‘Reed Marl' by Bromley and Gale (1982) after a section near Latimer in the southern Chiltern Hills (TQ 005 993) and the Reed Chalk Pit (TL 359 371) in north Hertfordshire respectively. Of these two names, the Latimer

Marl is unsatisfactory, because the type locality does not expose the relationship between the marl and the Chalk Rock. The Reed Marl, on the other hand, is well established as the marl seam that occurs below the Reed facies of the Chalk Rock. Mortimore and Wood (1986) showed that the 0.1 m ‘Latimer Marl' at Kensworth Chalk Pit was closely comparable with the Southerham Marl 1 of the basinal succession and was, like that marl, full of the large foraminifer *Labyrinthidoma southerhamensis* Hart (formerly *Coskinophragma*, see Hart (1993)) and underlain by the same distinctive vertical ‘finger', tubular and nodular Southerham Flints. A similar development is found at the Great Chesterford Chalk Pit (Cambridgeshire), but there the marl in question is correlated with the Mount Ephraim Marl of the Norfolk succession (Ward *et al*., 1968). Mortimore and Wood (1986) also suggested that the 0.05 m thick marl seam below the Chalk Rock was the equivalent of the Caburn Marl, and that certain of the marl seams beneath the Mount Ephraim/‘Latimer'/ Southerham Marl 1 could be correlated with marl seams belonging to the Glynde complex. These correlations were substantiated by Wray and Gale (1993), on the basis of trace-element characterization studies of the clay minerals of the individual marl seams in the two areas.

Additional support for the Reed Marl–Caburn Marl correlation is provided by the macrofossils. The echinoid *Micraster michelini*, which is not uncommon here above the Reed/Caburn Marl (cf. the specimen figured by Stokes (1977, figs 4–6)), characterizes the interval between the Caburn Marl and the Bridgewick Marls of the basinal succession (Mortimore, 1986a). The record (Gale, 1996) of the zonal index ammonite *Romaniceras deverianum* (d'Orbigny) from a nodular horizon just above the same marl in a section near Luton railway cutting, agrees with finds of this species close to the Caburn Marl in Sussex.

Kensworth Chalk Pit is the sole locality where the relationship between the top hardground suite of the Chalk Rock and the marl seams of the standard basinal succession can be unequivocally demonstrated. On the basis of this correlation, the Bridgewick Marls and associated large nodular flints – the so-called ‘Basal Complex' or ‘High Turonian flint maximum' (Mortimore and Wood, 1986, fig. 2.2.) – must be condensed within the complex Chalk Rock chalkstone. An intermediate stage in this condensation is seen at Reed Chalk Pit (TL 359 371) in north-east Hertfordshire, where the relicts of the flints belonging to the Basal Complex are still preserved (Gale, 1996, fig. 7; Hopson *et al*., 1996, fig. 17).

The relationship between the Chalk Rock succession at Kensworth Chalk Pit, which involves only the top hardground suite and the underlying marl seams, and the succession at the **Aston Rowant Cutting** GCR site, where the Chalk Rock comprises both the top and middle hardground suites and is underlain by a marl seam inferred to correlate with the Fognam Marl of the standard succession, is unclear. All of the attempts to satisfactorily interpret the correlation between these two key sections (cf. Bromley and Gale, 1982; Wray and Gale, 1993; Gale, 1996) are bedevilled by the absence of comparably extensive sections in the intervening ground. In any case, even the identity of the sub-Chalk Rock ‘Fognam' Marl (Glynde or Southerham Marl 1?) in the **Aston Rowant Cutting** section (see GCR site report) is uncertain. In the present state of knowledge, it is impossible to state how the named hardgrounds (Fognam Farm, Blounts Farm) of the latter section are to be correlated with the incipiently nodular developments in the lower Lewes Nodular Chalk Formation at Kensworth.

The Hitch Wood Hardground pebble bed in the present working face is thin, and contains mostly relatively small fossils belonging to the *reussianum* fauna. Former Chalk Rock sections, much closer to the entrance to the quarry, yielded abundant fossils, notably ammonites, including large specimens of *Puzosia muelleri* de Grossouvre (*Austiniceras curvatisulcatum* Chatwin and Withers in the older literature). The recently cut preserved face is in this latter area and appears to expose Chalk Rock of this type. It is possible that these former sections intersected minor channels or depressions in the hardground surface, within which the larger material accumulated and was protected from erosion, and that the pebble bed elsewhere in the quarry was located on areas of high sea-floor relief, and consequently more exposed to erosion.

Kensworth Chalk Pit is particularly well known for the large number and taxonomic diversity of well-preserved ammonites belonging to the Upper Turonian *Subprionocyclus neptuni* ammonite Zone (Figures 2.9 and 2.11, Chapter 2) that have been collected from the Chalk Rock. Most of the 25 recorded species have been found here, and large collections, including specimens figured by Wright (1979) and by Kaplan *et al*. (1987), are preserved at the British Geological Survey, Keyworth. The only other Chalk Rock sections that have yielded comparably diverse ammonite faunas are the Hitch Wood (Hill End) and Reed chalk pits. The occurrence at Kensworth of the ammonites *Baculites undulatus* d'Orbigny, *Puzosia muelleri* and *Subprionocyclus normalis* (Anderson), associated with the inoceramid bivalve *Mytiloides incertus*, indicates that the Chalk Rock fauna here also incorporates elements from the highest of the three ammonite assemblages in the coeval Scaphiten-Schichten in Germany (Kaplan and Kennedy, 1996; Wiese and Kröger, 1998).

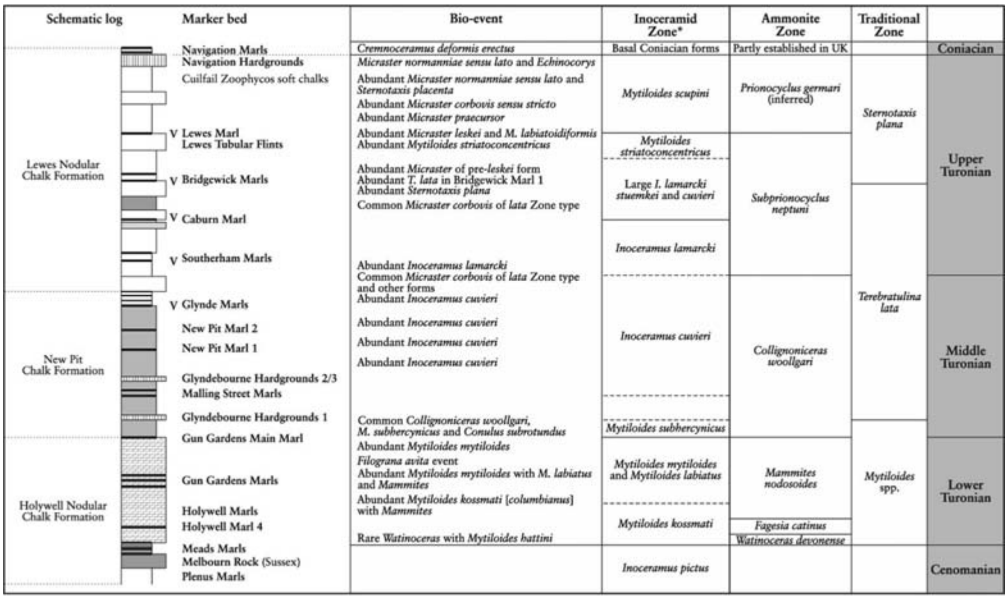

Figure 2.9: Turonian stratigraphy for the onshore UK based on Lewes Pits and Beachy Head, Southern Province. V = marl derived from volcanic ash. (= The inoceramid zones used are transferred from the current scheme used in Northern Europe and are under review.)*

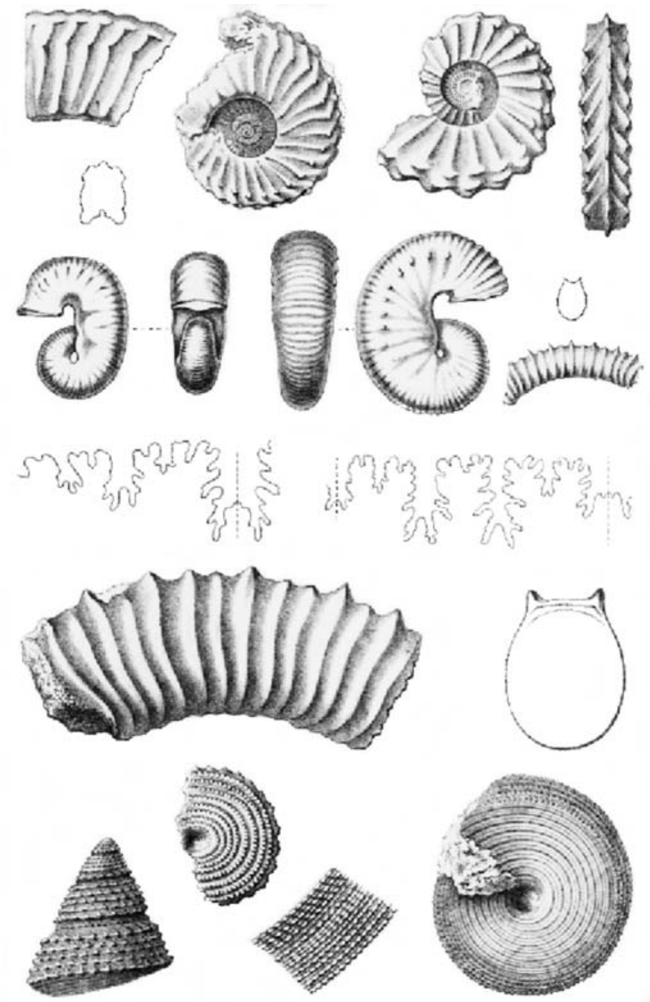

Figure 2.11: Upper Turonian mollusca of the Chalk Rock (from Woods, 1896; see also Wright, 1979). (A, B, D) Subprionocyclus neptuni. (C) Subprionocyclus branneri. (E, F, G) Scaphites geinitzii. (H, I, J) Allocrioceras angustum. (K, L) Turcica? schlueteri. (M, N) Bathrotomaria perspectiva. (O, P) Metaptychoceras smithi. (Q, R, S) Hyphantoceras reussianum. (T, U, V) Eubostrychoceras saxonicum. (W, X) Sciponoceras bohemicum.

The main (lower) chalkstone of the Top Rock yields common small, uniplicate terebratulid brachiopods, as well as sporadic specimens of the topmost Turonian–basal Lower Coniacian inoceramid bivalve *Cremnoceramus waltersdorfensis*, which enable correlation with the standard European inoceramid zonal scheme (cf. Kauffman *et al*., 1996; Walaszczyk and Wood, 1999b). Recent observations suggest that the intensely hard Top Rock at Kensworth, which hitherto has been considered to be relatively poorly fossiliferous, is probably broadly comparable with that exposed, in a weathered state, in a shallow trench at the Redbournbury Quarry RIGS site (TL 123 103), 14 km to the south-east. In addition to *C. waltersdorfensis*, the latter has yielded numerous specifically Lower Coniacian inoceramids, including *C. deformis erectus* (Meek) and *C. waltersdorfensis hannovrensis* (Heinz) (British Geological Survey collections). These inoceramids are found, in basinal successions, in the interval between the Navigation Hardground and Hope Gap Hardground, and are critical in establishing the stratigraphical equivalence of the Top Rock. Similar – but much more diverse – assemblages, including moulds of gastropods and the brachiopod *Cretirhynchia subplicata* (Mantell), occur in the Top Rock in various localities near Bury St Edmunds in East Anglia (Wood and Bristow, 1990). The fauna of the gritty chalk above this interval, containing abundant *Zoophycos* and examples of the large, thick-shelled inoceramid bivalve *Cremnoceramus crassus crassus* (Petrascheck) and the echinoids *Echinocorys gravesi* (Desor) and *Micraster* sp., is typical of the Beachy Head Zoophycos Beds.

Conclusions

Kensworth Chalk Pit is unique in the Transitional Province in providing a continuous section through the upper part of the New Pit Chalk Formation up to a horizon close to the top of the equivalent of the Lewes Nodular Chalk Formation. This is the only site where the identity of the marl seams beneath the Chalk Rock can be unequivocally established and it is, therefore, critical in interpreting the tephro-event stratigraphy and the stratigraphy of the Chalk Rock. The great diversity and richness of well-preserved Upper Turonian ammonites and other fossils from the Chalk Rock is also unique in the UK. The site provides the stratotype of the Kensworth Nodular Chalk Member of the British Geological Survey. Both the Chalk Rock and the Top Rock yield fossils that enable long-range correlation with successions and zonal schemes in northern Europe.

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