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Preliminary report on the stratigraphy of Cretaceous strata exposed in the Aston Clinton Bypass (A 41) excavations

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Preliminary report on the stratigraphy of Cretaceous strata exposed in the Aston Clinton Bypass (A 41) excavations

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Key words

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Foreword

This report provides preliminary details of the stratigraphy of the Gault, Upper Greensand and Chalk exposed in August 2002 during construction work for the Aston Clinton Bypass (A 41). A future report will provide more detailed stratigraphical interpretations based on the identification macrofossils collected from the site.

Acknowledgements

Paul Axon and Lindsay Barnard (Ove Arup & Partners) generously allowed access to the A41 construction site, and provided details of site plans and digital photographs that have greatly assisted with the production of this report.

Contents

Summary

This report gives a preliminary account of the stratigraphy of the Chalk Group of the Aston Clinton Bypass (A41) visible during construction work in August 2002. Exposures of the topmost Gault and Upper Greensand are also briefly described. The vertical thickness of the Chalk Group exposed along the length of the excavation is difficult to determine because of poor exposure of individual beds, variable dip, and likely repetition of strata by faulting. However, preliminary interpretations for the Grey Chalk Subgroup suggest that it may be similar in thickness and stratigraphical development to the succession recorded at Pitstone Quarry [SP 946 147] (Mortimore et al., 2001), c. 6 km to the north-east of the construction site.

1 Introduction

In August 2002, excavations for the Aston Clinton Bypass (A41) had cut through topmost Gault, Upper Greensand and Chalk Group north and eastwards of Aston Clinton, between SP 89228 12831 and SP 90423 11342.

At the time of field work, many of the cuttings had been graded, precluding detailed bed measurements and preventing an accurate assessment of formational thicknesses. Tentative thicknesses for the Grey Chalk Subgroup, which forms the bulk of the exposed succession, are based on crude estimates of dip, and make no allowance for possible repetition of strata through faulting (apparent at several points along the course of the excavations; see Fig. 2). Dip appears to be greater in the south-eastern part of the excavation (c. 4° or 5° to the south-east between SP 90042 11712 and SP 90423 11342) than in the north-western part (c. 2° to 2.5° to the south-east between SP 89276 12760 and SP 90042 11712). Faulting at the south-eastern end of the exposure (Fig. 2) may in part be responsible for the increased dip thereabouts. The alignment of the road excavation is approximately perpendicular to local strike, and so the above estimates are for true dip rather than apparent dip.

The stratigraphy of the bypass excavations is summarised in figs 1 and 2 and described below. Author citations for fossil species are given in Appendix 1.

2 Stratigraphy

2.1 GAULT FORMATION

The top of the Gault Formation is exposed at SP 89228 12831 (Locality 12 of Fig. 2). It comprises soft, sandy and micaceous clay. The junction with the overlying Upper Greensand is transitional over about 0.3 m.

2.2 UPPER GREENSAND FORMATION

The base of the Upper Greensand is seen at SP 89228 12831 (Locality 12 of Fig. 2), and the top occurs at SP 89276 12760 (Locality 11 of Fig. 2). The lithology is pale grey weathering micaceous clayey sandstone, burrowed intensively throughout, with lenses of hard sandstone, characteristically bluish grey when freshly broken. The Upper Greensand is estimated to be about 3 m thick. Elsewhere in the Aylesbury district the Upper Greensand is up to 5 m thick (Woods, 1998), and thins progressively north-eastwards from Chinnor [SP 755 008] (c. 9-10 m) until it disappears near Dunstable (Owen et al., in Sumbler, 1996). The fauna includes common large specimens of the bivalve *Aucellina*, the ammonite *Lepthoplites* spp. and a heteromorph ammonite (possibly *Idiohamites*). The fauna is almost certainly indicative of the Upper Albian *S. dispar* Zone.

2.3 CHALK GROUP

2.3.1 West Melbury Marly Chalk Formation

The base of the formation is coincident with the base of the Glauconitic Marl Member, seen at SP 89276 12760 (Locality 11 of Fig. 2) where a concentration of black and buff coloured phosphatic nodules marks the contact with the underlying Upper Greensand. The Glauconitic Marl is estimated to be about 3 m thick, and it is locally cut by a fault of unknown displacement just to the south-east of where the B 489 crosses the bypass excavation (Fig. 2).

Above the Glauconitic Marl, the lower part of the West Melbury Marly Chalk Member is dark greyish marl, with a striking superficial similarity to the Gault. South-eastwards along the bypass excavation, between localities 7 and 6, hard, spongiferous limestones are increasingly incorporated in the middle and higher parts of the West Melbury Chalk succession. At Locality 6 [SP 89892 11939] (Fig. 2) the succession becomes very fossiliferous with abundant specimens of the bivalve *Inoceramus crippsi* and the ammonite *Schloenbachia varians*. This fauna is indicative of the *S. schlueteri* Subzone, in the middle part of the *M. mantelli* Zone. The top of this subzone is marked by a hard, splintery limestone seen in the excavations for the diverted Wendover Canal [c. SP 899 117] (localities 3-5 of Fig. 2). The limestone contains an acme of *Schloenbachia varians* and large *Inoceramus crippsi*, and equates with the 'M3' limestone marker of Gale (1989) in the Folkestone succession, and the Doolittle Limestone of Shephard-Thorn et al. (1994) in the Leighton Buzzard district.

Above the 'M3' limestone, the succession in the Wendover Canal excavations includes a sandy bed that was originally thought to be the Totternhoe Stone. Like the latter, its fauna includes common specimens of the bivalve *Entolium orbiculare*, but none of the characteristic brachiopods that are distinctive of the Totternhoe Stone. Above this bed, there are occasional records of the inoceramid bivalve *Inoceramus virgatus*, indicative of the *M. dixoni* Zone.

2.3.2 Zig Zag Chalk Formation

The base of the Zig Zag Chalk Formation is marked by the Totternhoe Stone, seen at SP 90176 11603 (Locality 8 of Fig. 2). It is a sandy bed with common greenish black, glauconitised phosphatic nodules. The fauna is characteristic, comprising numerous dark shelled specimens of the coarsely-ribbed brachiopod *Orbirhynchia mantelliana*, with subsidiary *Kingena concinna*. *Entolium orbiculare* is unusually rare, and no specimens of *Oxytoma seminudum* were seen (typically common in the Totternhoe Stone). The base of the Totternhoe Stone is an erosion surface, and the dark-shelled *Orbirhynchia mantelliana* are almost certainly reworked from the top of the West Melbury Marly Chalk Formation (*C. inerme* Zone). The Totternhoe Stone itself belongs to the *A. rhotomagense* Zone, and judging by the frequency of the brachiopod *Concinnithyris subundata* in the immediately overlying succession (characteristically common in the upper *A. rhotomagense* Zone, *T. acutus* Subzone), it probably equates with the greater part of the lower *A. rhotomagense* Zone (*T. costatus* Subzone). The proximity of the Totternhoe Stone to Jukes-Browne Bed 7 (see below) also suggests that the Totternhoe Stone is likely to condense much of the *T. costatus* Subzone (Fig. 1).

Above the Totternhoe Stone, the interbedded limestone / marl lithology continues south-eastwards along the bypass excavation to SP 90243 11541 (Locality 2 of Fig. 2). Here occurs a marl seam with abundant specimens of the oyster *Pycnodonte vesiculare*, together with the bivalves *Inoceramus atlanticus* and *Inoceramus pictus*. The fauna indicates a correlation with the base of Jukes-Browne Bed 7 (Kennedy, 1969) of the standard Dover-Folkestone Grey Chalk Subgroup succession. This marker-bed, belonging to the *A. jukesbrownei* Zone, can be traced through into northern England, where it equates with the base of the Nettleton Stone (Gaunt et al., 1992). A large fragment of the zonal ammonite (*A. jukesbrownei*) was found just above the marl. In Buckinghamshire, Jukes-Browne Bed 7 has been referred to as the Buckinghamshire Rag in some previous accounts (Mortimore et al., 2001).

Above Jukes-Browne Bed 7, the succession seen south-eastwards of Locality 8 increasingly comprises massive bedded creamey-grey chalk, with less frequent and generally thinner marl seams. The top of the Zig Zag Chalk is seen at SP 90423 11342 (Locality 1), where its contact with the overlying White Chalk Subgroup is marked by a burrowed erosion surface immediately below the Plenus Marls Member (= Sub Plenus Erosion Surface; Fig. 1). A strong colour contrast from grey chalk to pale, whitish chalk, offset by faults, is approximately coincident with the contact of the Zig Zag Chalk and overlying Holywell Nodular Chalk (but see below) (Fig. 2).

2.3.3 Holywell Nodular Chalk Formation

The highest stratigraphical interval of the Chalk Group that is visible in the Aston Clinton bypass excavations is the Holywell Nodular Chalk Formation. It was seen between SP 90423 11342 (Locality 1 of Fig. 2) and SP 90756 11041 (Locality 13 of Fig. 2), either side of the Tring Hill Interchange. The basal succession, including the Plenus Marls, was logged in detail at Locality 1 (Fig. 1). Here, the Plenus Marls are c. 1.6 m thick, and can be seen to comprise at least three gross lithostratigraphical divisions: a basal marly interval (c. 0.8 m thick), massive, creamy-grey chalk (c. 0.5 m thick), and an upper grey-green and iron-stained marl-rich interval (c. 0.31 m thick). The base of the Plenus Marls is an erosion surface (Sub-Plenus Erosion surface), below which burrowing has carried greenish-grey marl into the top of the underlying Zig Zag Chalk Formation. The distinctive colour change seen in the section between the Grey Chalk Subgroup and White Chalk Subgroup (Fig. 2) actually occurs just above the marl-rich basal part of the Plenus Marls. By comparisson with the standard Plenus Marls succession described by Jefferies (1963), the central bed of creamy-grey chalk can probably be equated with that author's Bed 3, in which case, the lower marl-rich unit represents Jefferies' beds 1 and 2, and the upper marl-rich unit equates with beds 4 to 8. It is in Jefferies' beds 4-6 that *Praeactinocamax plenus* (the belemnite from which the marls take their name) occurs, although none were seen in the course of this work.

Immediately above the Plenus Marls is a 0.7 m thick interval of intensely hard, nodular chalk, overlain by a further 0.5 m of slightly less hard, nodular chalk (Fig. 1). Most of this succession probably equates with the Melbourn Rock. Thin, grey plexus marls occur in the inferred Melbourn Rock, but 0.9 m higher in the succession are a pair of thick plexus marls (up to 0.28 m thick), that might represent the lowest of the three pairs of Meads Marls of Mortimore and Pomerol (1996). The Cenomanian / Turonian boundary occurs between Meads Marls 4 and 5 (Gale, 1996), which are probably above the top of the exposed succession at Locality 1.

Between Tring Hill Interchange and Locality 13, the Holywell Nodular Chalk becomes shell-rich with the fragmentary remains of the bivalve *Mytiloides*. Seams of nodular, burrow-form flints occur in the excavations below Tring Hill Interchange, associated with *Mytiloides*-rich chalk. Flints are not typical of the Holywell Nodular Chalk, but their occurrence has been recorded elsewhere in the Chilterns (e.g. Hitchin district; Hopson et al., 1996). Borehole resistivity logs from the district suggest that the Holywell Nodular Chalk is up to 20 m thick.

3 Correlation

Depending on the value of assumed dip, two markedly different thicknesses of Grey Chalk Subgroup can be calculated. Using the higher estimates of dip shown on Fig. 1 produces a total Grey Chalk Subgroup thickness of 103 m, and using the lower estimate of dip produces a thickness of 82 m. The nearest available succession for comparison is Pitstone Quarry [SP 946 147], where Mortimore et al. (2001) showed that the Grey Chalk Subgroup was c. 77 m thick.

All of these thicknesses exceed the c. 55 m estimated by Jukes-Browne & Hill (1903) and Sherlock (1922), although these authors' calculations may have been based on successions where there was more pronounced sub-Totternhoe Stone down-cutting.

Using a thickness of 82 m for the Aston Clinton bypass succession produces a fairly close correlation with Pitstone (Fig. 3). However, the higher estimate of thickness for the bypass succession is not without significance, since although it might not be an accurate guide to the true vertical thickness of the Grey Chalk Subgroup, it may indicate that there is considerable repetition of strata by faulting, which is not allowed for in the thickness estimates.

Appendix 1

Acanthoceras jukesbrownei (Spath, 1926)
Concinnithyris subundata (J Sowerby, 1813)
Entolium orbiculare (J Sowerby, 1817)
Inoceramus atlanticus (Heinz, 1936)
Inoceramus crippsi Mantell, 1822
Inoceramus virgatus Schlüter, 1877
Inoceramus pictus J de C Sowerby, 1829
Kingena concinna Owen, 1970
Orbirhynchia mantelliana (J de C Sowerby, 1826)
Oxytoma seminudum (Dames, 1874)
Pycnodonte (*Phygraea*) *vesiculare* (Lamarck, 1806)
Praeactinocamax plenus (Blainville, 1825)

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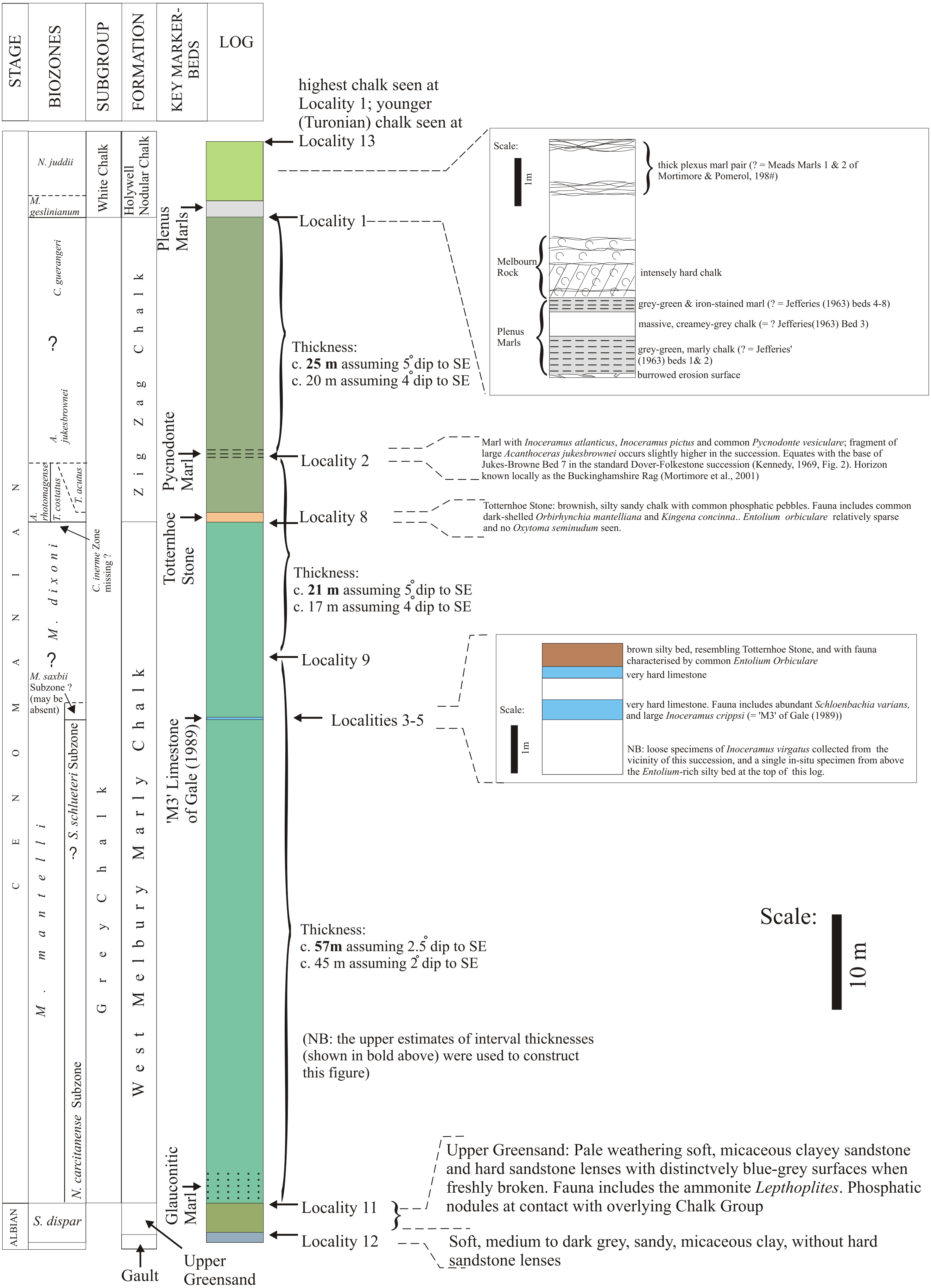
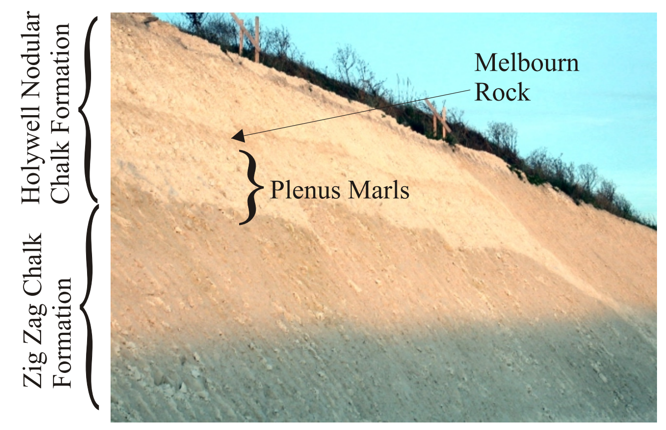
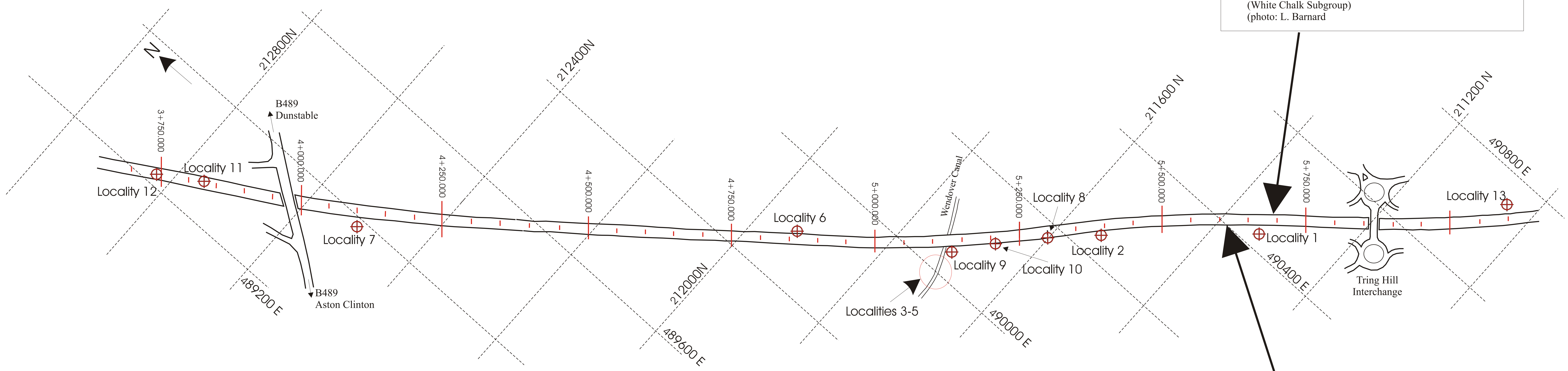


FIGURE 1. Summary stratigraphy of part of the Aston Clinton Bypass Excavation (as seen August 2002). For details of Locality positions see Fig. 2. Thickness estimates do not take account of possible repetition of strata due to faulting.



Faulting visible at the contact of the Zig Zag Chalk (Grey Chalk Subgroup) and Holywell Nodular Chalk Formation (White Chalk Subgroup)
(photo: L. Barnard)



The contact of the Zig Zag Chalk Formation (Grey Chalk Subgroup) and Holywell Nodular Chalk Formation (White Chalk Subgroup)
(photo: L. Barnard)

Key:

Locality referred to in text and on figures

5+250.000 Chainage along bypass excavation

490000 E British National Grid intercepts

Geological Summary of localities:

Locality 1: Contact of Grey Chalk Subgroup and White Chalk Subgroup. Locality exposes top of Zig Zag Chalk and basal Holywell Nodular Chalk formations.
Locality 2: Grey Chalk Subgroup, Zig Zag Chalk Formation. Oyster (*Pycnodonte*)- rich marl, representing the basal part of Jukes-Browne Bed 7. In Buckinghamshire, Jukes-Browne Bed 7 has been referred to as the Buckinghamshire Rag in some older literature (Mortimore et al., 2001)
Localities 3-5: Grey Chalk Subgroup, upper West Melbury Marly Chalk Formation. Succession includes a hard, splintery limestone with abundant specimens of the ammonite *Schloenbachia varians* and large specimens of the inoceramid bivalve *Inoceramus crippsi*. This limestone almost certainly equates with 'M3' of Gale (1989) at Folkestone, and the Doolittle Limestone of Shephard-Thorn et al. (1994).
Locality 6: Grey Chalk Subgroup, upper West Melbury Marly Chalk. Interbedded limestones and marls with a rich fauna of *Schloenbachia varians* and abundant *Inoceramus crippsi*, representing the middle *M. mantelli* Zone, *Sharpeiceras sclueteri* Subzone.
Locality 7: Grey Chalk Subgroup, basal West Melbury Marly Chalk Formation. Top of Glauconitic Marl Member exposed.
Locality 8: Grey Chalk Subgroup, junction of West Melbury Marly Chalk and Zig Zag Chalk formations. Exposure of Totternhoe Stone in drainage ditch adjacent to excavated road surface.
Locality 9: Grey Chalk Subgroup, upper West Melbury Marly Chalk Formation. Probable *M. dixoni* Zone present in middle and higher part of cutting for diverted Wendover Canal.
Locality 10: Grey Chalk Subgroup, topmost West Melbury Marly Chalk. Probable *M. dixoni* Zone exposed in drainage ditch adjacent to excavated road surface.
Locality 11: Junction of Upper Greensand and Chalk Group. Exposed base of Glauconitic Marl Member has concentration of buff or black phosphatic nodules, immediately above contact with Upper Greensand.
Locality 12: Junction of Gault and Upper Greensand formations.
Locality 13: White Chalk Subgroup, upper Holywell Nodular Chalk Formation. Nodular chalk with abundant shell fragments of *Mytiloides* spp. Nodular flints present lower down in succession in cuttings beneath Tring Hill Interchange

FIGURE 2. Positions of key localities referred to in the text and summary of main points of geological interest.
(based on plans supplied by Ove Arup and Partners)

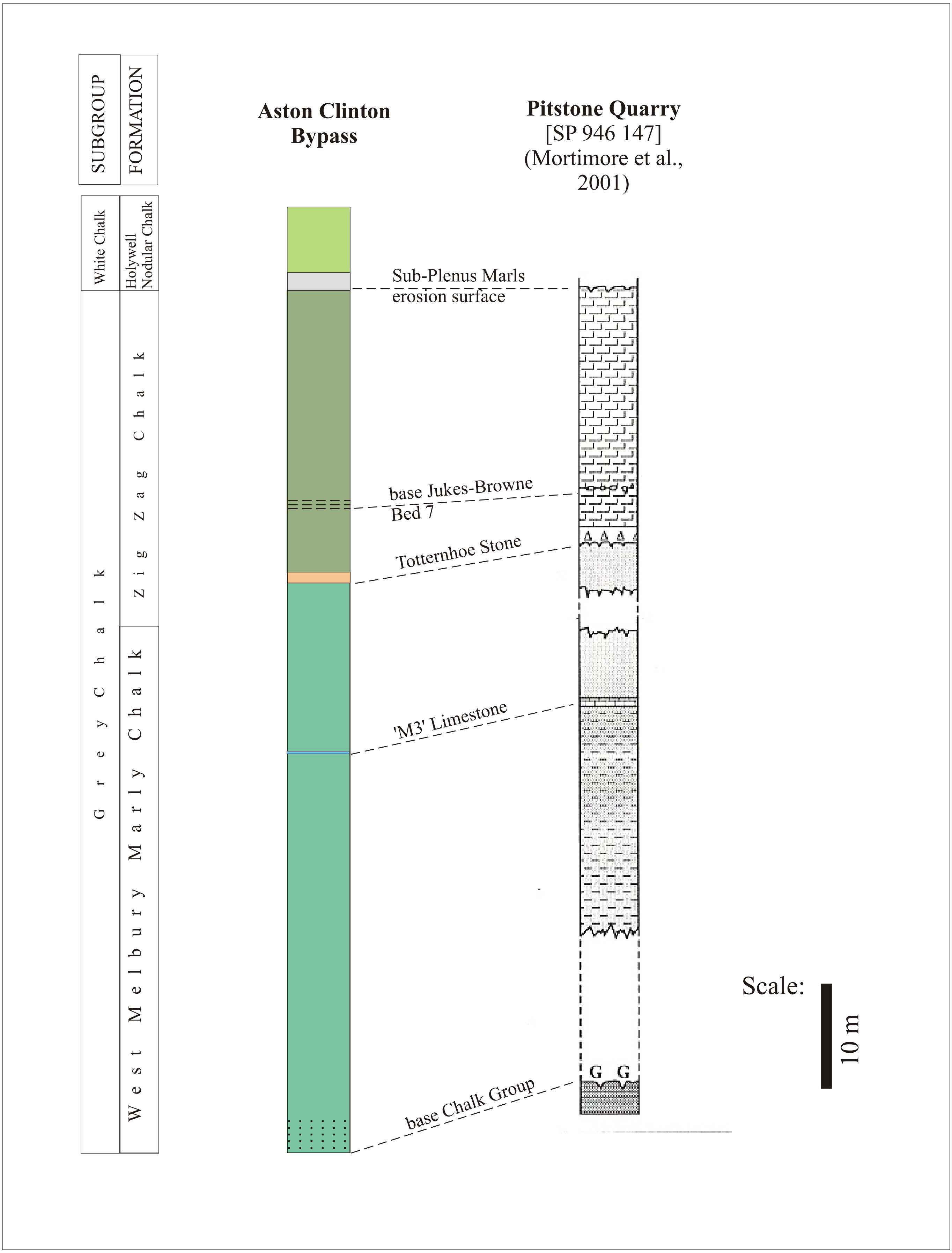


FIGURE 3. Correlation of the Aston Clinton Bypass and Pitstone Quarry Chalk Group successions. Correlation is based on the lower estimates of interval thicknesses for the Aston Clinton Bypass succession given on Fig. 1. Thickness estimates do not take account of possible repetition of strata due to faulting.