Read at the Annual Conference of the Ussher Society, January 1990

The Upper Greensand in East Devon: new data but old problems

M.B. HART and C.L. WILLIAMS

Hart, M.B. and Williams, C.L. 1990. The Upper Greensand in East Devon: new data but old problems. *Proceedings of the Ussher Society, 7,* 273-278.

Boreholes drilled as part of the site investigation for the A303 Honiton-Marsh Trunk road in East Devon have recovered over 30m of Upper Greensand. The sections have been logged and the successions correlated with other Upper Greensand successions in the area. No new micropalaeontological data have been obtained despite exhaustive studies. Using what limited data are available an attempt at graphic correlation is presented using the Upper Greensand successions of East Devon and the Albian succession of the Glyndebourne Borehole. This confirms the dating of the Chert Beds as Late Albian *dispar* Zone and indicates the timing of the onset of Albian sedimentation in the area.

M.B. Hart and C.L. Williams, Department of Geological Sciences, Polytechnic South West, Drake Circus, Plymouth PL4 8AA.

Introduction

Despite one hundred years of geological research, our knowledge of the stratigraphic position of the Upper Greensand has hardly advanced from the work of de la Beche (1839). Much of this early work was summarized by Jukes-Browne and Hill (1900) in their Geological Survey Memoir, and that volume remains the starting point for most modern research. Although the term Selbornian was proposed at that time to accommodate the Gault Clay and Upper Greensand, the majority of workers then, and now, regard this facies pair as representing the Middle and Upper Albian. The Upper Greensand in Devon is generally accepted as being of mid-Late Albian age (Hancock 1969; Hamblin and Wood 1976; Rawson *et al.* 1978). This conclusion has been challenged by Carter and Hart (1977) on the basis of the microfauna but unequivocal evidence is still elusive. Recent work by Schroeder *et al.* (1986) on *Orbitolina* has provided important new data but even this is not conclusive. *Orbitolina (O.) sefini* Henson has a known range of latest Albian to earliest Cenomanian, and while the occurrences in SW England are unlikely to be at the lower end of this range (allowing for northward migration of a benthonic foraminiferid) the dating is not particularly precise. This does indicate, however, that it is unlikely that much, if any, of the Upper Greensand is of Early Cenomanian age.

Work on the Devonshire Upper Greensand has always concentrated on three areas; the Haldon Hills, the Blackdown Hills and the SE Devon coastline (Sidmouth-Axmouth). Areas away from the chalk outcrop are invariably decalcified producing the so-called "Blackdown Facies" (Tresise 1960, 1961). The only exceptions to this are the isolated occurrences around Newton Abbot, of glauconitic limestone rich in *Orbitolina* (Hamblin and Wood 1976; Carter and Hart 1977; Hart *et al.* 1979; Schroeder *et al.* 1986). These isolated exposures were found by Edwards (1969, 1970) and Hamblin and Wood (1976) during the re-mapping of BGS Sheet 339 (Newton Abbot.)

Little new stratigraphic data on the Blackdown Hills have appeared since the work of Downes (1882) during the last century, although the palaeontological data from that time have been used extensively (Tresise 1960, 1961; Hancock 1969; Rawson *et al.* 1978). It was therefore with some anticipation that new material was recovered, by drilling, during the summer of 1989 along the route of the new A303 Honiton-Marsh road.

Borehole data from the A303 site investigation

Borehole data, made available by Rendel Geotechnics, from the area north-east of Honiton (Fig. 1) have provided a near-complete succession of the Upper Greensand. The site in question (Fig. 2) is almost mid-way between the Wilmington area (from which the authors have data) and the Blackdown Hills (north of the area shown on Fig. 1), and provides information from an almost unknown area. The nearest reference sections are those recorded from the railway tunnel near Wilmington. These are of particular interest as Jukes-Browne and Hill (1900, p.213 and fig. 65) recorded the geological successions of shafts which included what was reported to be the western-most development of the Gault Clay. During the present study, two boreholes (21A and 29) have been investigated. These are closely spaced on the side of a hill just east of the present A30 (A303) road. The two borehole successions are easily amalgamated (Fig. 2) to provide a succession that can be favourably compared with the successions in the railway tunnel, one of which has been reproduced in Fig. 3.

Borehole 29 recovered a succession of Upper Greensand resting on red siltstones of the Mercia Mudstone Group and overlain by just over one metre of chert gravel and clay. In places the core was extremely disturbed and/or collapsed because of drilling disturbance or high water content. There was little evidence of carbonate-rich sediment and this, coupled with a lack of calcareous foraminifera, suggests that this is a part of the "Blackdown Facies". No cherts were recovered *in situ*. There is evidence of bioturbation, especially in the

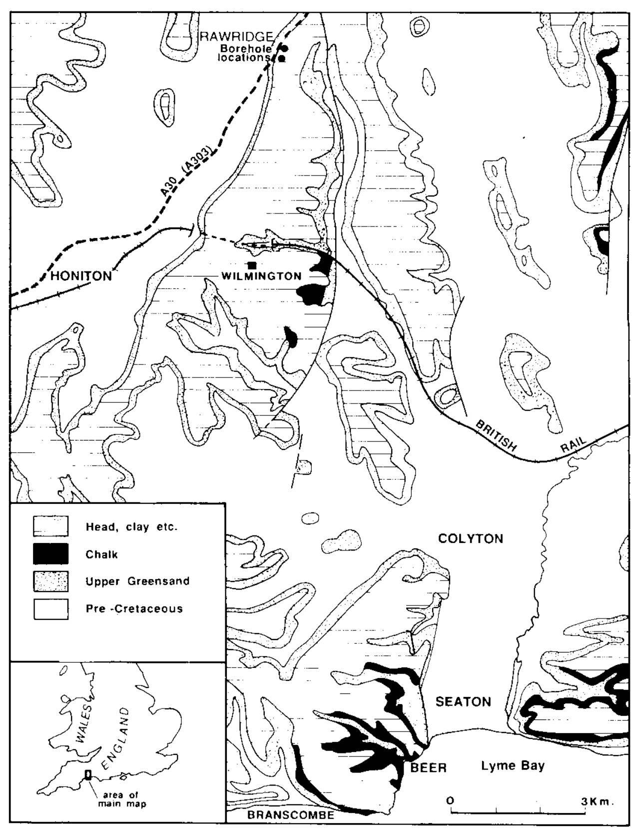

Figure 1. Outline geological map of SE Devon. The present A30 (A303) NE of Honiton passes close to the site of the two boreholes discussed in the text. The railway tunnel, the geology of which was reported by Jukes-Browne and Hill (1900) is shown immediately east of Honiton and north of Wilmington.

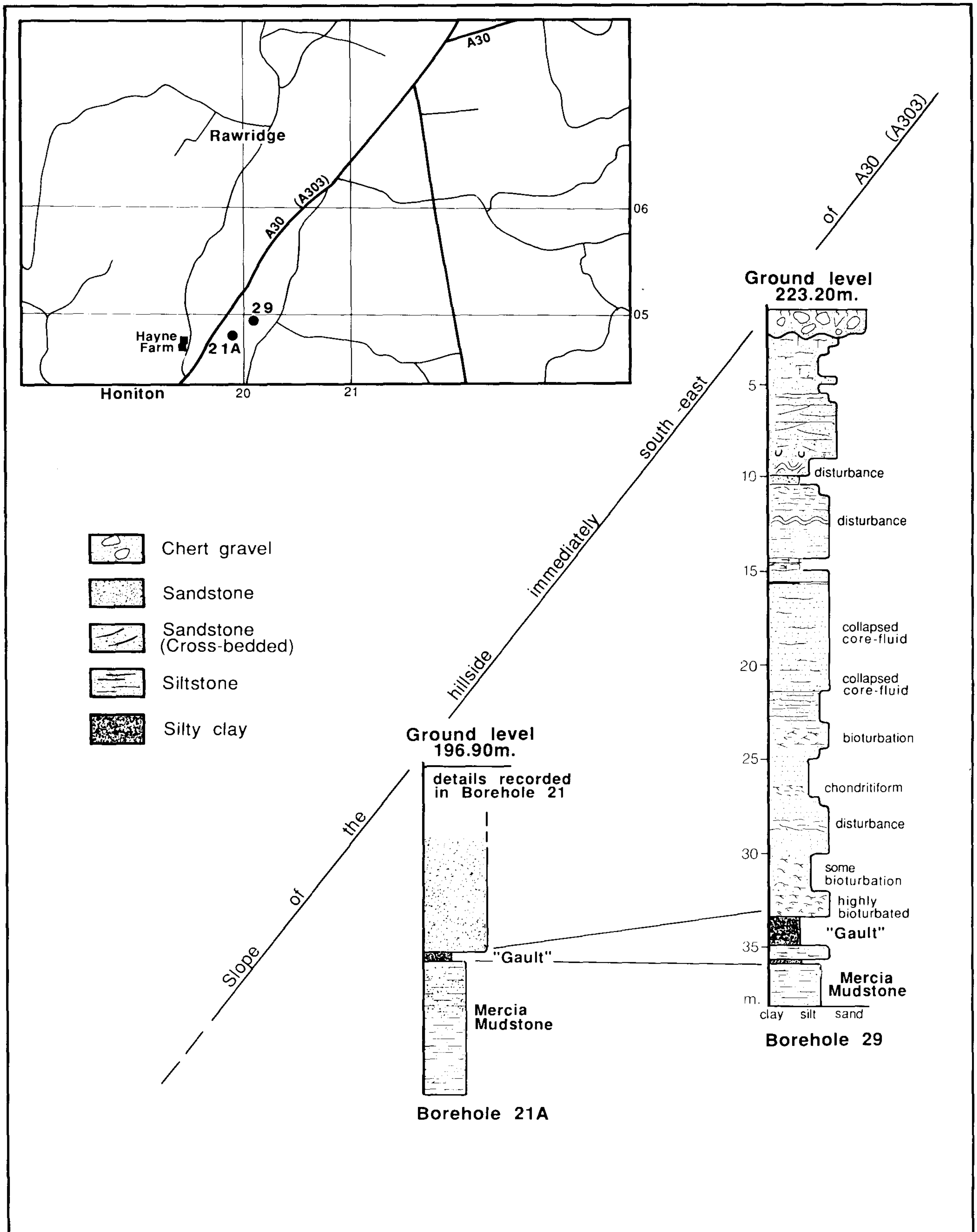

Figure 2. Location of boreholes 21 A and 29; part of the site investigation for the A30 (A303) Honiton-Marsh road. The site details and topographical data were kindly provided by Rendel Geotechnics. Borehole 29 was logged and sampled by MBH but only spot samples were available from borehole 29, the log being provided by the consultants.

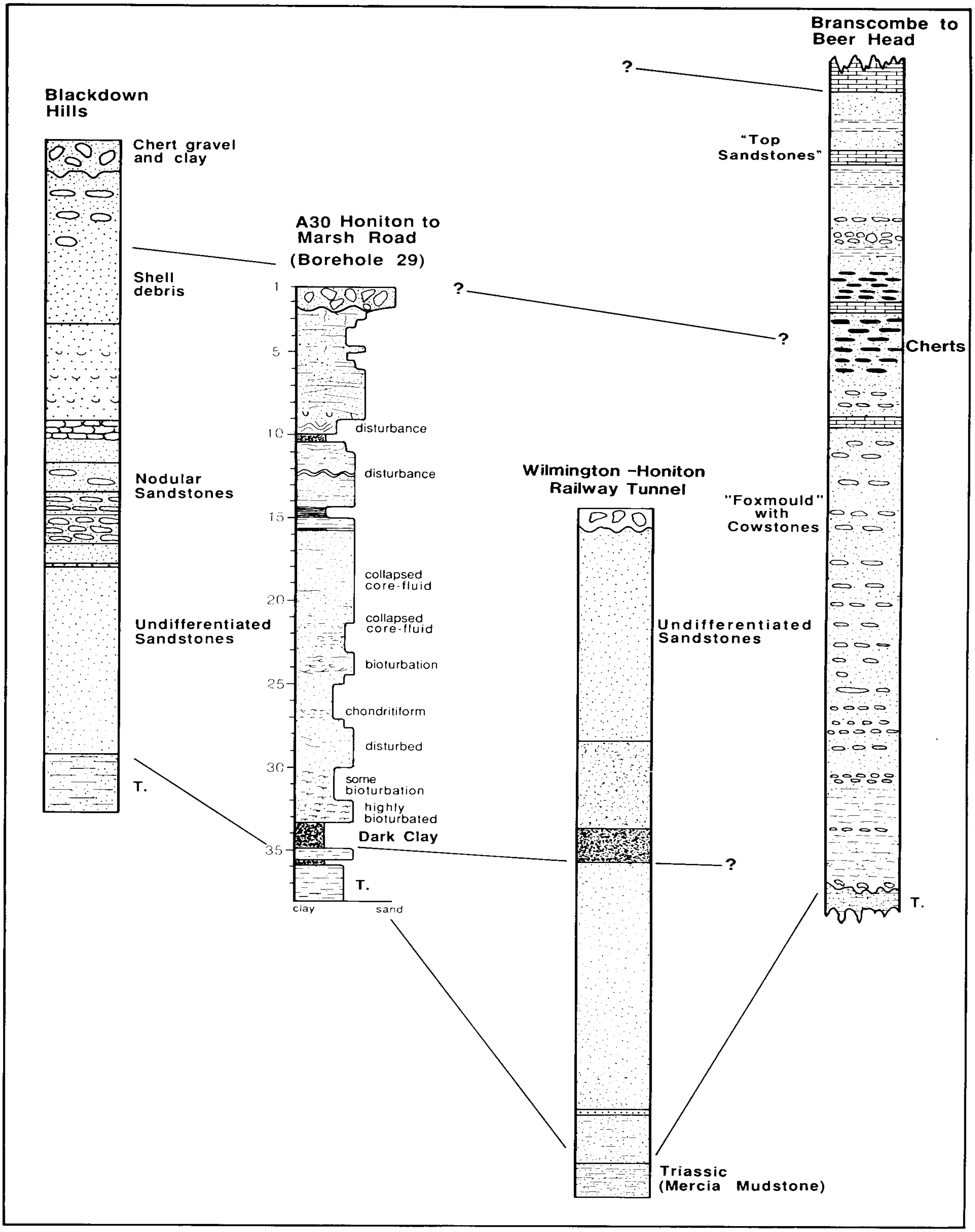

Figure 3. Tentative lithological correlation of Upper Greensand successions in the Blackdown Hills, the A30 (A303) site investigation boreholes, the HonitonWilmington railway tunnel and the Beer Head coastal section. In the railway tunnel succession, the 53ft (16. 10m) of black sand, white sand and sandy clay between the "dark clay" and the red marls of the Mercia Mudstone Group, were described by Jukes-Browne and Hill (1900) and have not been seen by the authors. This thickening of the succession is in a direct N-S line with the thickness increases seen in the Cenomanian sands (White Hart Sandpit, Wilmington, and the Bovey Lane Sandpit, Beer; Carter and Hart (1977)) and the structures reported from the coastal sections (see Carter and Hart, 1977 and references therein).

lower part of the succession and this probably equates with the equally bioturbated facies of the Foxmould seen in the coastal succession. Between 33.80 and 35.80m is a very dark green-blue-grey silty clay, also recorded in Borehole 21A. The well-known record of Gault Clay in the Honiton-Wilmington railway tunnel also seems to equate to that recorded in Borehole 29. Jukes-Browne and Hill (1900, p.213) listed the geological successions recorded in five "shafts" as well as showing the geological profile of the final tunnel. While the overall thickness of Greensand in these shafts varied between 251ft (76m) and 95ft (28.75m) all recorded 'Gait Clay' (blue and brown) that was in a bed 6-7ft (1.82-2.12m) thick. This bed of clay could be followed easily between the shafts and in the eventual tunnel. It is in the same position in all the logs and would also seem to be the correlative of that in boreholes 21A and 29 (Fig. 3). In this tentative correlation the dark clay can be seen just above the contact with the Mercia Mudstone Group in borehole 29. The Honiton-Wilmington railway tunnel log (Shaft 4) is placed in position by the knowledge that, at Wilmington Quarry (Carter and Hart 1977; Hart 1983) beds of chert are present in the calcarenites that typify the upper levels of the Upper Greensand succession. This would indicate that none of the Chert Beds are present in the tunnel, or indeed in borehole 29. Beds of brown-yellow cherty sandstone are known from the upper levels of the Blackdown Hills succession. There are no faunal markers known to the authors that will facilitate any more accurate correlation.

Samples from boreholes 21 A and 29 have been washed for foraminifera with little success. The fine-grained sediments have also been investigated for calcareous nannofossils and while a flora has been recorded all are exceptionally long-ranging taxa. None of the palaeontological data from these sections, or the proposed correlation with the Blackdown Hills and the coastal sections actually advances our knowledge of the stratigraphical position of the Upper Greensand. It is doubtful if any, fresher, less decalcified, material will be obtained even when the construction work beings.

Graphic correlation

Recent work by one of us (MBH) on material from the Glyndebourne (Sussex) Borehole (Lake *et al.* 1987), coupled with the foraminiferal data of Harris (1982), has led to the generation of a standard UK Middle-Upper Albian succession for graphic correlation. This has been constructed using data from the borehole together with data from the Copt Point (Folkestone) succession (Hart 1973; Carter and Hart 1977; Price 1977). Using the available ammonite data (Owen 1976; Lake *et al.* 1987) the microfaunal correlations can be confirmed and the methodology justified. Using the Glyndebourne standard it has been possible to attempt a correlation with the marginal facies of SE Devon. There are very little data for such a correlation (Fig. 4) and it is clear that the distribution of the smaller foraminifera are too facies controlled. The only two data points usable from the authors' work are the occurrence of the ammonite *Prohystoceras (Goodhallites) delabechei* Spath and the larger foraminiferid *Orbitolina (Orbitolina) sefini* Henson. Two points are totally inadequate for such work and any conclusions so derived must be suspect. The ammonite data point is plotted (Fig. 4) as accurately as possible against the Glyndebourne log, as is the *range* of O.(O.) *sefini*. Normal practice is not to use ranges in such correlations but in this case it is impossible to know the precise level of occurrence. This range necessitates the construction of an "error triangle" and this creates an error factor in any correlations generated by the data. Normally one uses only data points, thereby creating a line of correlation, against which quite accurate correlations can be generated.

The line of correlation tentatively suggests that the base of the Foxmould Sands should be at the base of the *varicosum* Subzone or perhaps just into the *orbignyi* Subzone. In West Dorset the base of the Gault Clay is recorded (Hancock, 1969) as being of *intermedius* Subzone age while the base of the Foxmould Sands is reportedly *inflatum* Zone age (probably *varicosum* Subzone). The Blackdown Sands may begin in the *varicosum* or *orbignyi* Subzones. The result from the graphic correlation, while hardly of great significance, actually confirms that the methodology used here might be applicable to the problem in hand. The base of the *auritus* Subzone correlates with the middle of the Foxmould Sands, again agreeing with Hancock's (1969) assertion that these sands span the *varicosum* and *auritus* Subzones. The base of the *dispar* Zone, using the graphic correlation method, plots out on either the base of the Chert Beds or the base of the Top Sandstones. Data from Devonshire are scarce, although Hamblin and Wood (1976) recorded a phosphatised *dispar* Zone assemblage at the top of the Chert Beds in the Shapwick Grange Quarry. Hancock (1969) drew attention to this lack of equivocal data, while acknowledging the rare records of *dispar* Zone ammonites in SW England. It is interesting here to consider the coastal sections of Purbeck (Arkell 1947; Carter and Hart 1977, fig. 45). In the successions of Lulworth Cove and Durdle Door there is a well-known ammonite bed present in the Upper Greensand just below the Chert Beds. This contains a phosphatised, reworked (?), *dispar* Zone fauna - inspiring Wright (in Arkell 1947) to equate the fauna with that of the Cambridge Greensand. This ammonite fauna is located just above an *Exogyra*-rich glauconitic sandstone which is reportedly of *aeguatorialis* Subzone age. This set of correlations would imply that the lower of the two alternative correlation lines is the more accurate and this would confirm the *dispar* Zone age for the Chert Beds. The Top Sandstones would then be placed in the very latest Albian or the earliest Cenomanian (as indicated by Kennedy (1970) and Carter and Hart (1977)).

Summary

The new stratigraphic data provided by the A303 Honiton-Marsh road site investigation have not yielded any new information about the age of the Upper Greensand, although work on the samples continues. It does however confirm the presence of a thin development of dark-coloured silty clay, comparable to the "Gault Clay" previously recorded in the area. The application of graphic correlation to the succession, whilst giving sensible results, does not change, or even unequivocally confirm, previously held views. It does however provide an interesting line of approach and when current work using this method on sections in Sussex, the Isle of Wight and Dorset is completed, it may be possible to produce a more effective, staged, correlation to the marginal facies of SW England.

Acknowledgements. Mr John Abraham is thanked for his efforts in producing the figures. Dr Richard Scrivener is thanked for alerting the authors to the material and Rendel Geotechnics are thanked for their willingness to share their data and borehole records.

References

Arkell, W.J. 1947. The geology of the country around Weymouth, Swanage, Corfe and Lulworth. *Memoir of the Geological Survey of Great Britain*.

Beche, H.T. de la 1839. Report on the geology of Cornwall, Devon and West Somerset. *Memoir of the Geological Surrey of Great Britain*.

Carter, D.J. and Hart, M.B. 1977. Aspects of mid-Cretaceous stratigraphical micropalaeontology. *Bulletin of the British Museum, Natural History (Geology), London, 29,* 1-135.

Downes, W. 1882. The zones of the Blackdown Beds, and their correlation with those at Haldon, with a list of fossils. *Quarterly Journal of the Geological Society, London, 38,* 75-94.

Edwards, R.A. 1969. Preliminary results of the mapping of the Bovey Basin. *Proceedings of the Ussher Society, 2,* 85.

Edwards, R.A. 1970. Aspects of the Upper Greensand of the Bovey Basin. *Proceedings of the Ussher Society, 2,* 178-179.

Hamblin, R.J.O. and Wood, C.J. 1976. The Cretaceous (Albian - Cenomanian) stratigraphy of the Haldon Hills, south Devon, England. *Newsletters in Stratigraphy, 4,* 135-149.

Hancock, J.M. 1969. Transgression of the Cretaceous sea in south-west England. *Proceedings of the Ussher Society, 2,* 61-83.

Harris, C.S. 1982. *Albian microbiostratigraphy (Foraminifera and Ostra-coda) of SE England and adjacent areas*. Unpublished PhD thesis, CNAA/ Plymouth Polytechnic.

Hart, M.B. 1973. A correlation of the macrofaunal and microfaunal zonations of the Gault Clay in south-east England. *In:* Casey, R. and Rawson, P.F. (eds) The Boreal Lower Cretaceous, *Geological Journal, Special Issue,*

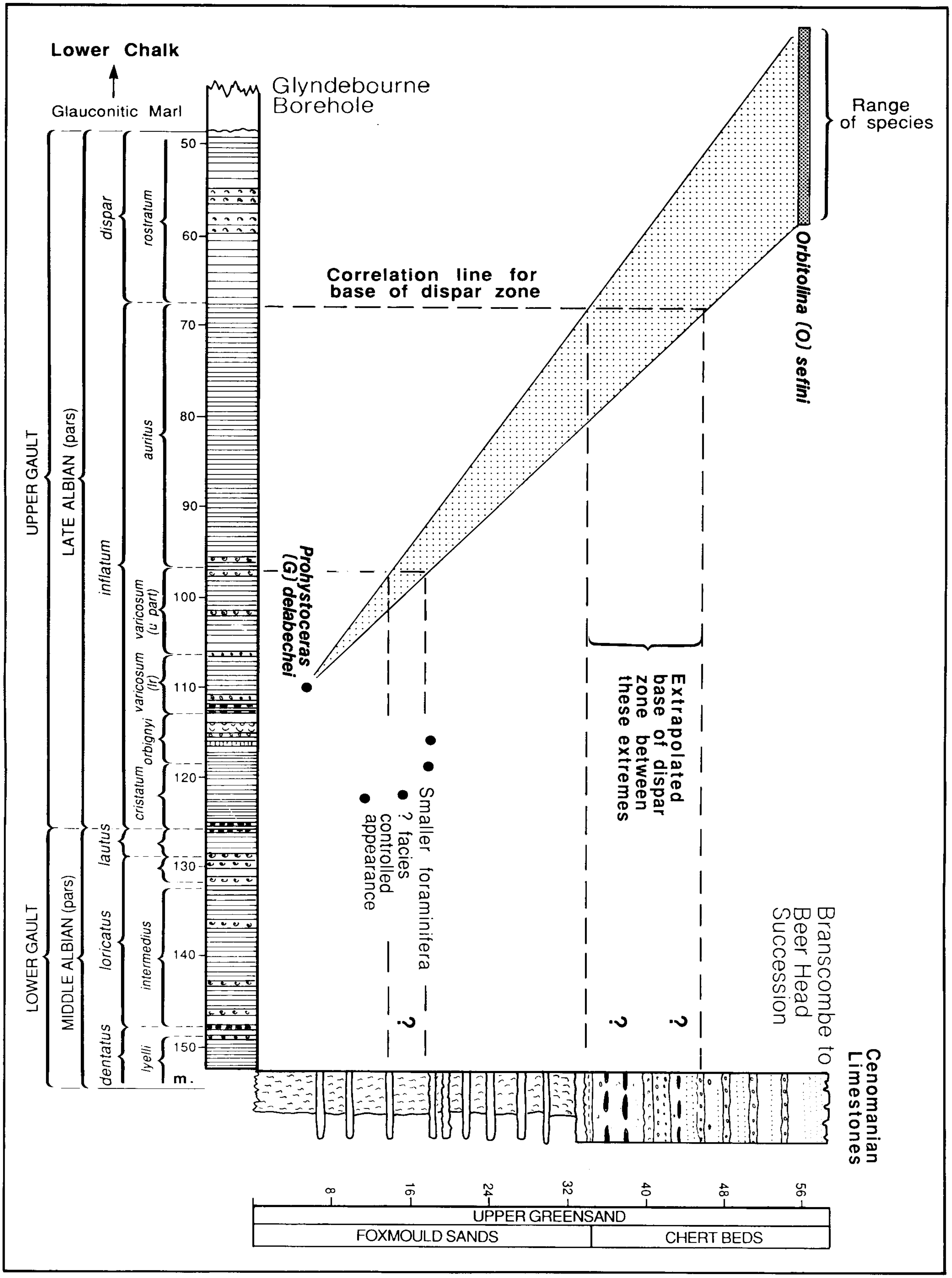

Figure 4. Graphic correlation of the SF Devon coastal succession of the Upper Greensand with the Glyndebourne borehole. For discussion see text.

5, 267-288.

Hart, M.B. 1983. Planktonic foraminifera from the Cenomanian of the Wilmington quarries (SE Devon). *Proceedings of the Ussher Society, 5,* 406-410.

Hart, M.B., Manley, E.C. and Weaver, P.P.E. 1979. A biometric analysis of an *Orbitolina* fauna from the Cretaceous succession at Woolborough, S Devon. *Proceedings of the Ussher Society, 4, 317-326.*

Jukes-Browne, A.J. and Hill, W. *1900.* The Cretaceous Rocks of Brtain. 1, Gault and Upper Greensand. *Memoir of the Geological Survey of Great Britain.*

Kennedy, W.J. *1970.* A correlation of the Uppermost Albian and the Cenomanian of south-west England. *Proceedings of the Geologists' Association, 81, 613-667.*

Lake, R.D., Young, B., Wood, C.J. and Mortimore, R.N. *1987.* Geology of the country around Lewes. *Memoir of the British Geological Survey.*

Owen, H.G. *1976.* The stratigraphy of the Gault and Upper Greensand of the Weald. *Proceedings of the Geologists' Association, 86, 475-498.*

Price, R.J. *1977.* The stratigraphical zonation of the Albian sediments of north-west Europe, as based on foraminifera. *Proceedings of the Geologists' Association, 88, 65-92.*

Rawson, P.F., Curry, D., Dilley, F.C., Hancock, J.M., Kennedy, W.J., Neale, J.W., Wood, C.J. and Worssam, B.C. *1978.* Cretaceous. *Geological Society Special Report, 9.*

Schroeder, R., Simmons, M.D., Hart, M.B. and Williams, C.L. *1986.* A note on the occurrence of *Orbitolina (orbitolina) sefini* Henson, *1948* (Foraminiferida) in the Upper Greensand of SW England. *Cretaceous Research, 7, 381-387.*

Tresise, G.R. *1960.* Aspects of the lithology of the Wessex Upper Greensand. *Proceedings of the Geologists" Association, 71, 316-339.*

Tresise, G.R. *1961.* The nature and origin of chert in the Upper Greensand of Wessex. *Proceedings of the Geologists' Association, 72, 333-356.*