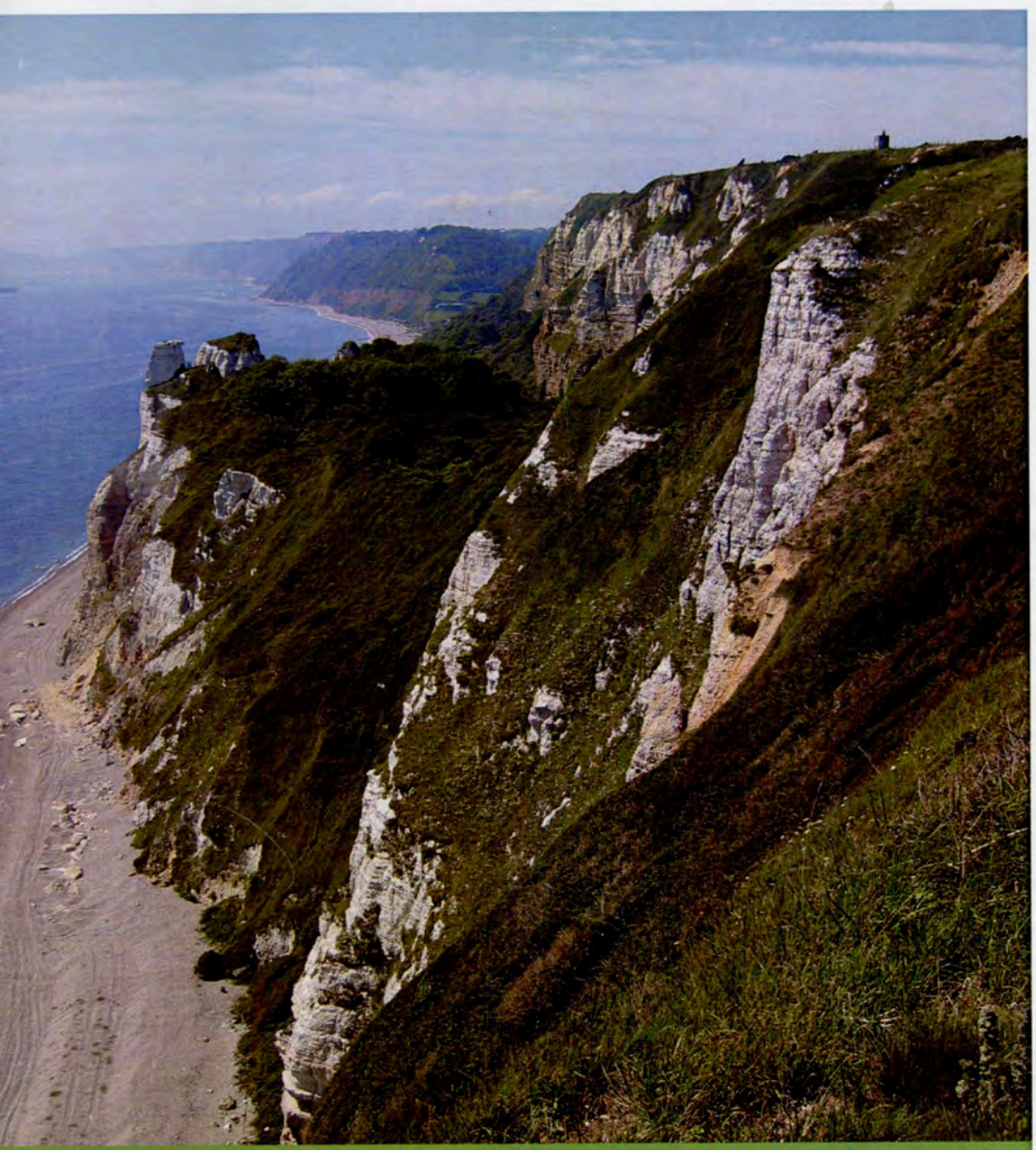
Plymouth University
6th - 12th September 09

8th International Symposium on the Cretaceous System

Convenors: Malcolm B. Hart and Gregory D. Price



Field Excursion to Beer, South-East Devon

Leaders: Ramues Gallois & Malcolm Hart

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Field Excursion to Beer, South-East Devon [Jurassic Coast World Heritage Site]

Leaders: Ramues Gallois & Malcolm Hart

In 2001 the Dorset and East Devon Coast was inscribed on the World Heritage List as a place of outstanding universal value on the basis of its geological succession, coastal processes and landforms and its place in the history of the development of geology (especially stratigraphy and palaeontology). Extending from Orcombe Point in the west to Studland in the east, this World Heritage Site's 85 miles of coastline contains a record of 185 million years of Earth history.

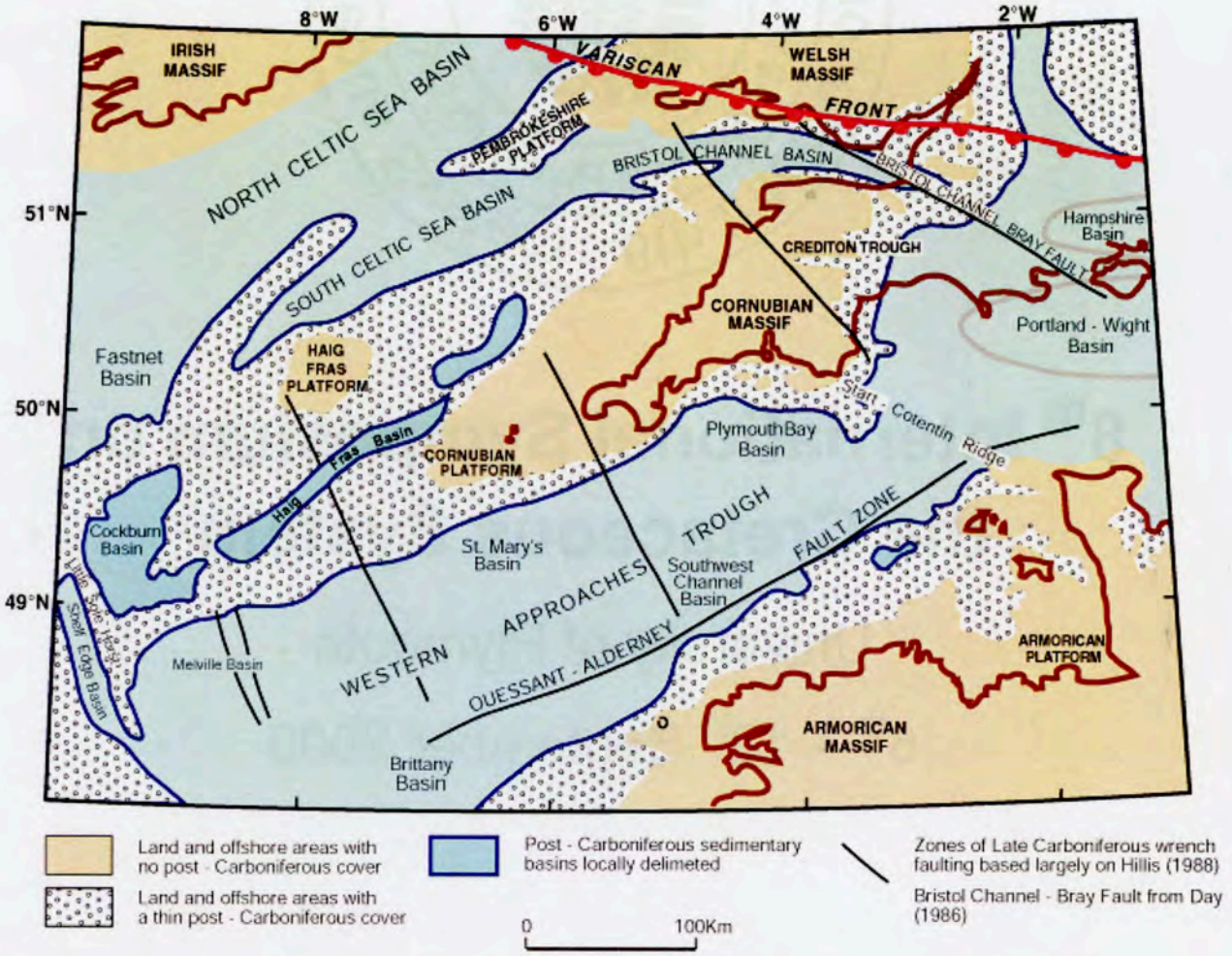


Figure 1. Major structural elements of South West England (after Hart, 1998).

The Dorset and East Devon Coast sits on the western edge of the Portland-Wight Basin which is often referred to as the Wessex Basin. During much of the Mesozoic, even at times of high sea level, the basement massifs (Cornubian, Armorican, Welsh and Irish massifs) were often land, providing sediment for the subsiding parts of the basin. At times there was open marine connection through to the developing Atlantic Ocean by way of the Western Approaches Trough, although the connection was often reduced in importance by the Start-Cotentin Ridge.

During the Cretaceous Period, at a time of much elevated sea level, many of these basement massifs were submerged and the sediment supply reduced or even

removed. This can be detected by the presence/absence of minerals such as tourmaline that are supplied by the granites of the Cornubian Massif. The various transgressions and regressions of the Jurassic and Cretaceous can be detected against this variable shoreline. The most dramatic change occurred during the Cretaceous when the mid-Cretaceous transgression extended right across the

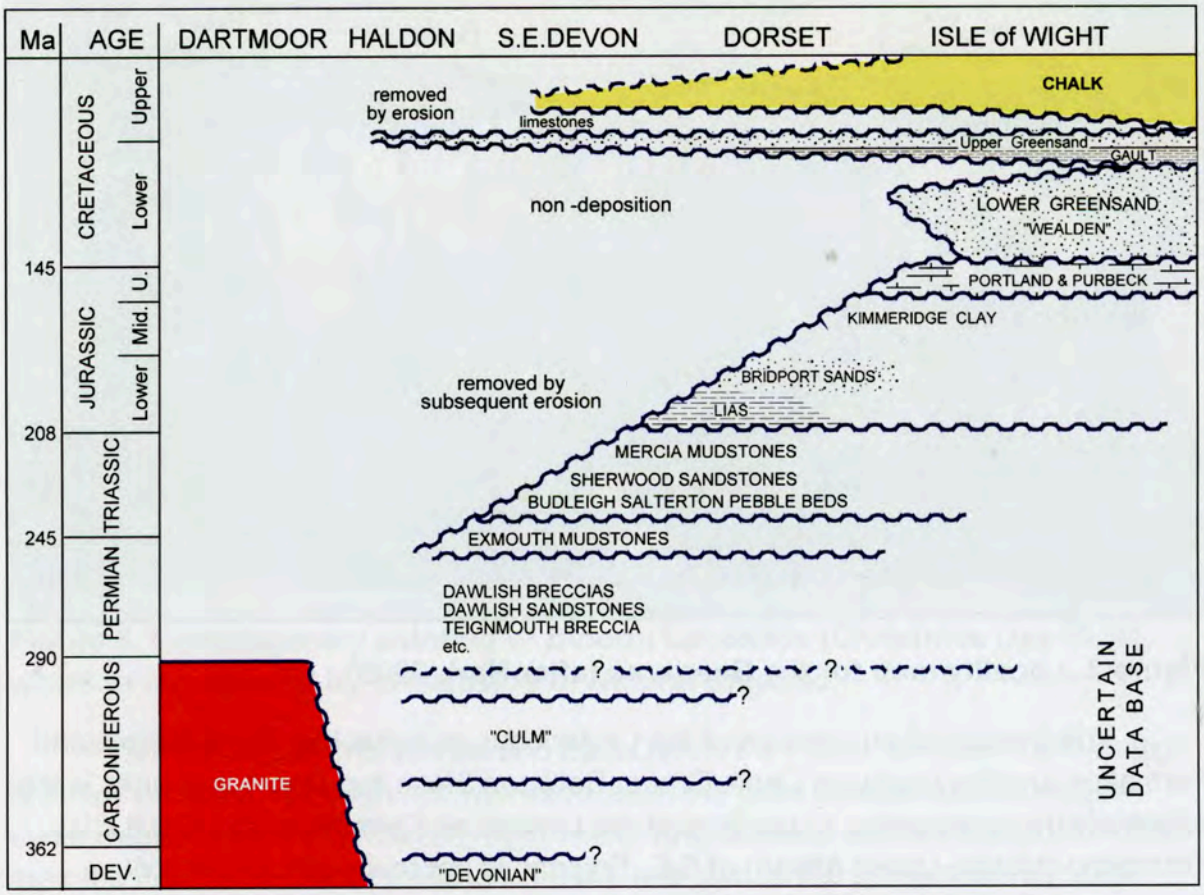


Figure 2. Chronostratigraphic chart for South West England (after Hart, 2009).

County of Devon and the chalk area of deposition submerged the Dartmoor granite during the Turonian (but have subsequently been removed by erosion). In the area we are to visit (in S.E. Devon) the Upper Greensand and Chalk rest on the Mercia Mudstone Formation, while further to the east strata of Jurassic age intervene.

During the excursion we will visit a number of locations in Seaton, Axmouth, Beer and Beer Head (weather permitting). This will allow access to the Upper Greensand Formation, The Beer Head Limestone Formation and the Chalk Group (mainly Middle Chalk). From the boat it is hoped that you will be able to appreciate the overstep of the Cretaceous strata westwards onto the Upper Triassic sediments and the impact this has on coastal stability and the formation of landslips such as the Axmouth – Lyme Regis Undercliff and the landslides below Hooken Cliff. If time permits we will walk to beer Head to get an overview of the geology of the area.

If we take the boat cruise we will visit the area to the east of Seaton and then head west towards Beer Head and the dramatic cliffs to the west of Beer.

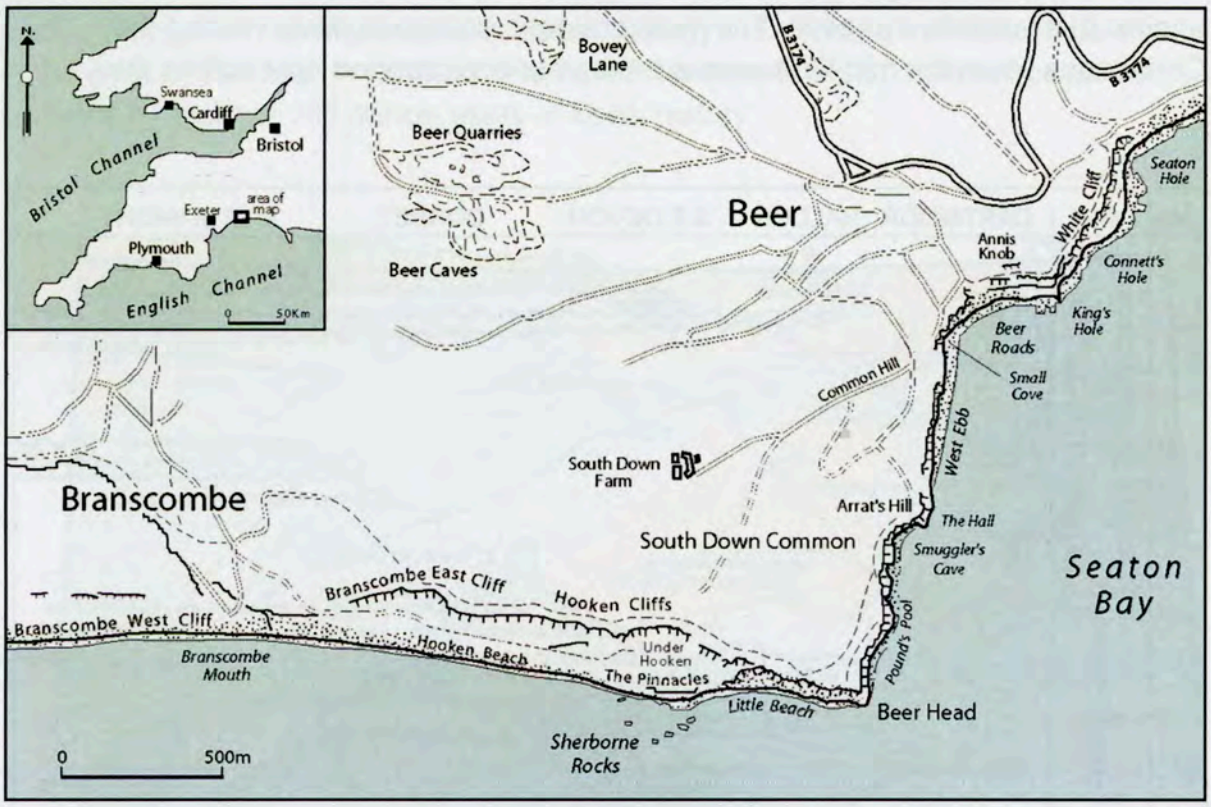


Figure 3. Locality map for the Beer area (after Hart, 2009).

The geological succession of the Cretaceous includes the Upper Greensand Formation and the overlying Chalk Group. Between these two lithological units is the extremely thin succession of the Beer Head Limestone Formation. The Gault Clay Formation (Middle-Upper Albian) of S.E. England is not really present in S.W. England, as the glauconitic, clay-rich sands in the base of the Upper Greensand Formation are not really the same lithology as the fossiliferous clays further east. The transition from the Gault Clay facies into the Upper Greensand facies begins in Surrey/Sussex, and becomes more marked in Hampshire and the Isle of Wight. Across Dorset the Upper Greensand Formation almost replaces the whole of the Gault Clay Formation. The age of the basal Gault Clay Formation also becomes younger towards the margins of the Wessex Basin. In West Dorset and East Devon the 'Gault Clay Formation' cannot really be used as a lithostratigraphical term. In this area the surface water passing through the Chalk and the Upper Greensand Formation stops abruptly at the boundary with the underlying Charmouth Mudstone Group, creating the massive landslides of Stonebarrow [SY 376930], Black Ven [SY 356933] and the Axmouth-Lyme Regis Undercliff [SY 270896 – SY 331914]; the Mercia Mudstone Group which lies below the Upper Greensand Formation at the western end of the Undercliff also acts to expel groundwater, as it does below Hooken Cliff [SY 220880].

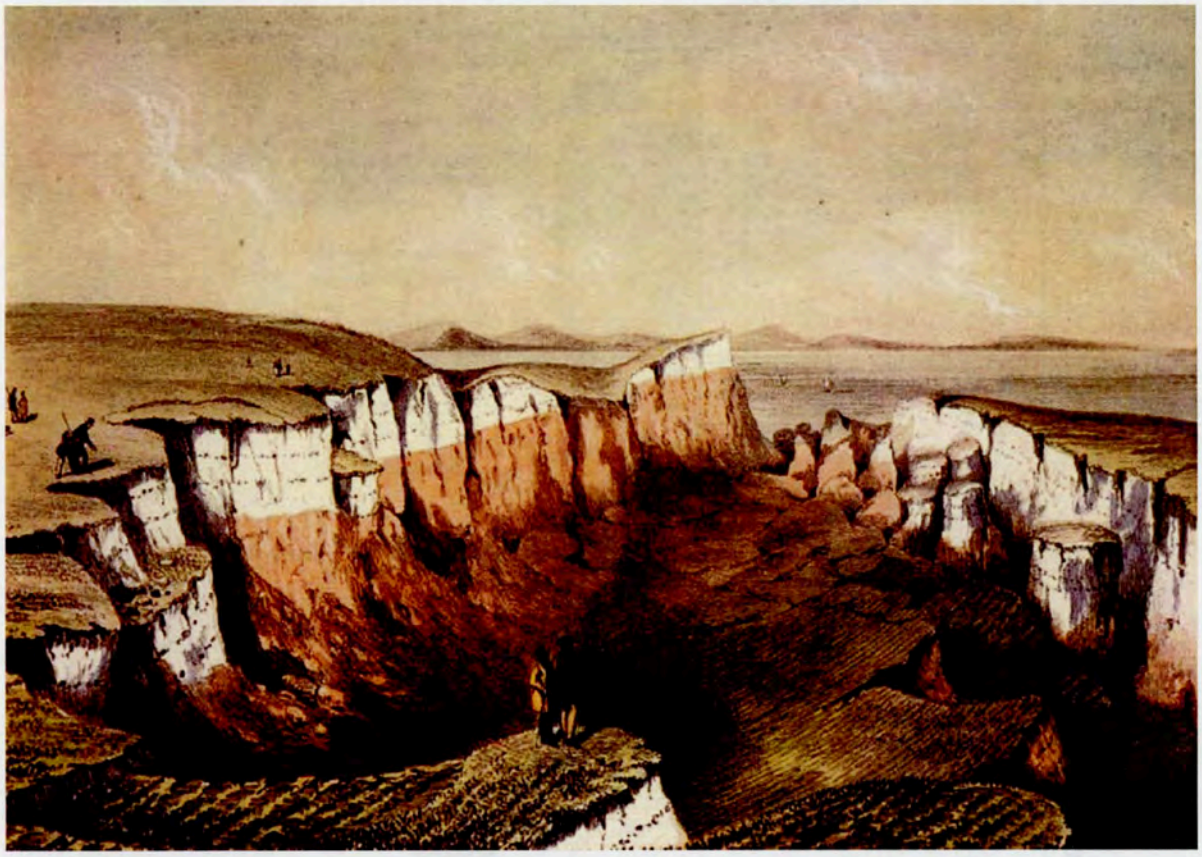


Figure 4. Contemporary painting of Bindon Landslide (Christmas Day 1839), which is reproduced by permission of Natural England.

Throughout much of Dorset and East Devon the Upper Greensand Formation is poorly exposed, although it is well exposed in the cliffs between the Axmouth-Lyme Regis Undercliff, Whitecliff, Beer Head, Branscombe and Dunscombe. In this area the Foxmould Member (Gallois, 2004), soft glauconitic sands with rounded concretions and beds of sandy limestone crowded with serpulid worm tubes, appears to be the lateral equivalent of the Cann Sand and the Shaftesbury Sandstone of North Dorset. The overlying Whitecliff Chert Member contains lines of massive brown chert which is often crowded with sand grains, fossils and other signs of the original sedimentation. The Whitecliff Chert Member is thickest at Whitecliff [SY 235894], with quite massive tabular and nodular chert horizons present in the succession. The uppermost levels of the Upper Greensand Formation (Bindon Sandstone member) are also intensely disturbed, forming a distinctly blocky appearance. This is best, and most easily seen at the southern end of Beer Beach and along the cliffs beyond the end of the beach. Some of these features are de-watering and soft-sediment slump structures. This sandstone can be quite hard (almost calcarenite) and massive and was used, in the past, for the construction of part of Exeter Cathedral.

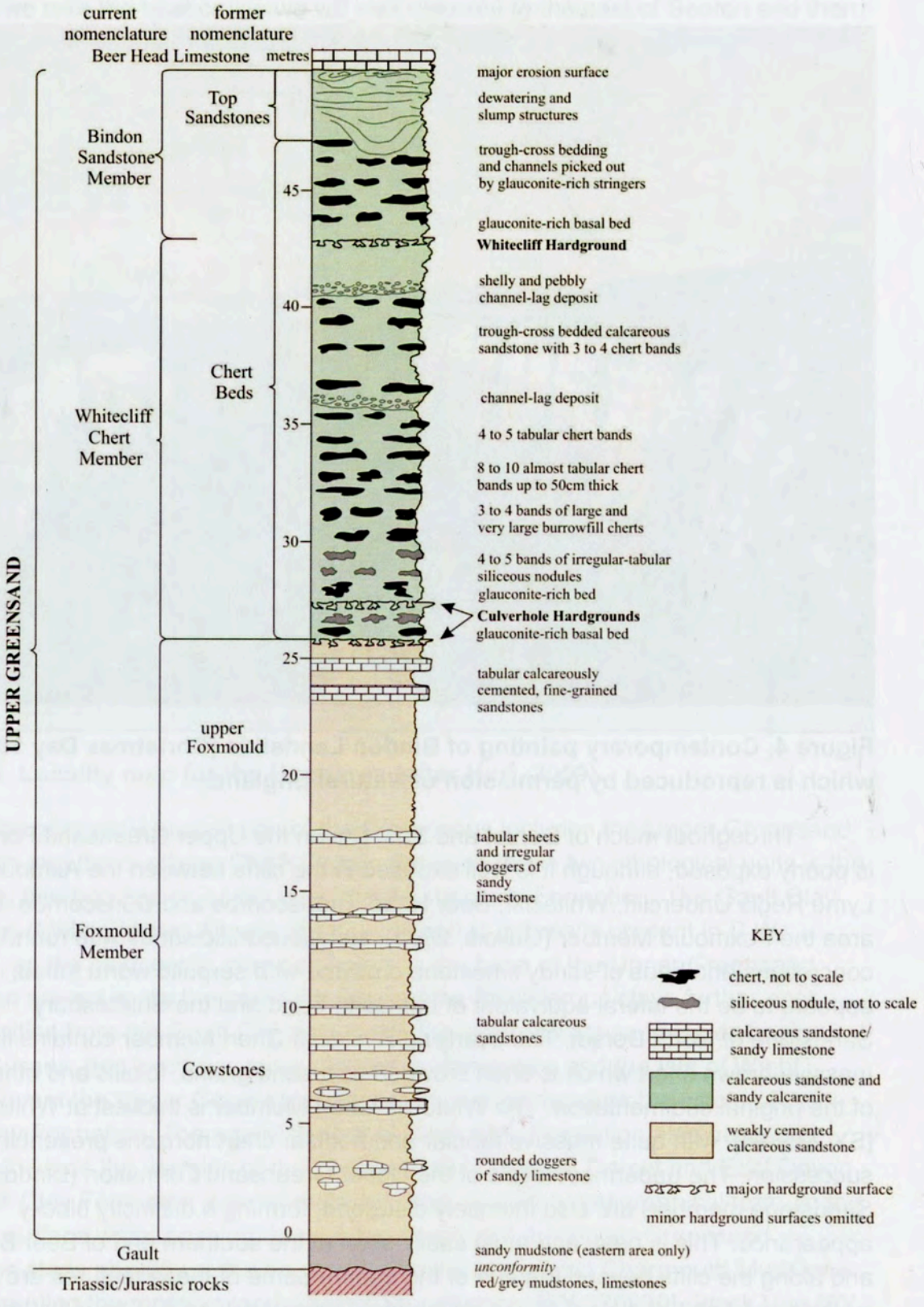


Figure 5. Generalised lithostratigraphy of the Upper Greensand Formation based on coastal exposures between Beer and Lyme Regis (after Gallois, 2004).

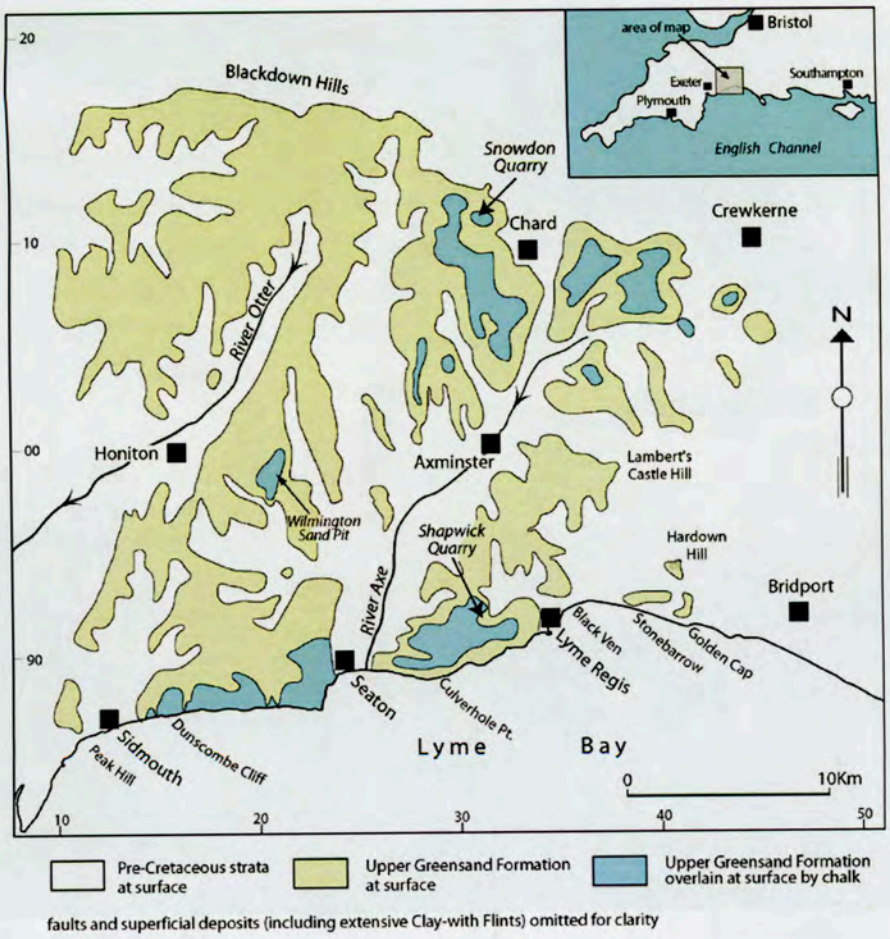


Figure 6. Map of the Upper Greensand and chalk outcrop in West Dorset and East Devon (after Hart, 2009).

Other inland exposures of the Upper Greensand are badly degraded, especially in areas beyond the edge of the chalk outcrop where the sands are largely decalcified into what is known locally as the "Blackdown Facies".

The overlying **Chalk Group** comprises one of the most characteristic lithostratigraphical units within the UK (and European) Cretaceous succession. In S.E. Devon, however, the succession is atypical despite having many features in common with successions further to the east. The most significant difference is in the Cenomanian, where the 85 m of Chalk Marl and Grey Chalk seen at Folkestone and Dover is replaced by, in places, less than 1 m of indurated sandy limestone. The Beer Head Limestone Formation was first described in the nineteenth century and identified as consisting of 4 beds (A1, A2, B and C) separated by complex phosphatised horizons. In places the limestones are conglomeratic, with the included pebbles impregnated with both glauconite and phosphate. The limestones are extremely fossiliferous, although extracting microfossils can be a challenge. The thickest development of the Beer Head Limestone Formation is located under Hooken Cliff, in what is known as the Hooken-Wilmington Trough. In this area

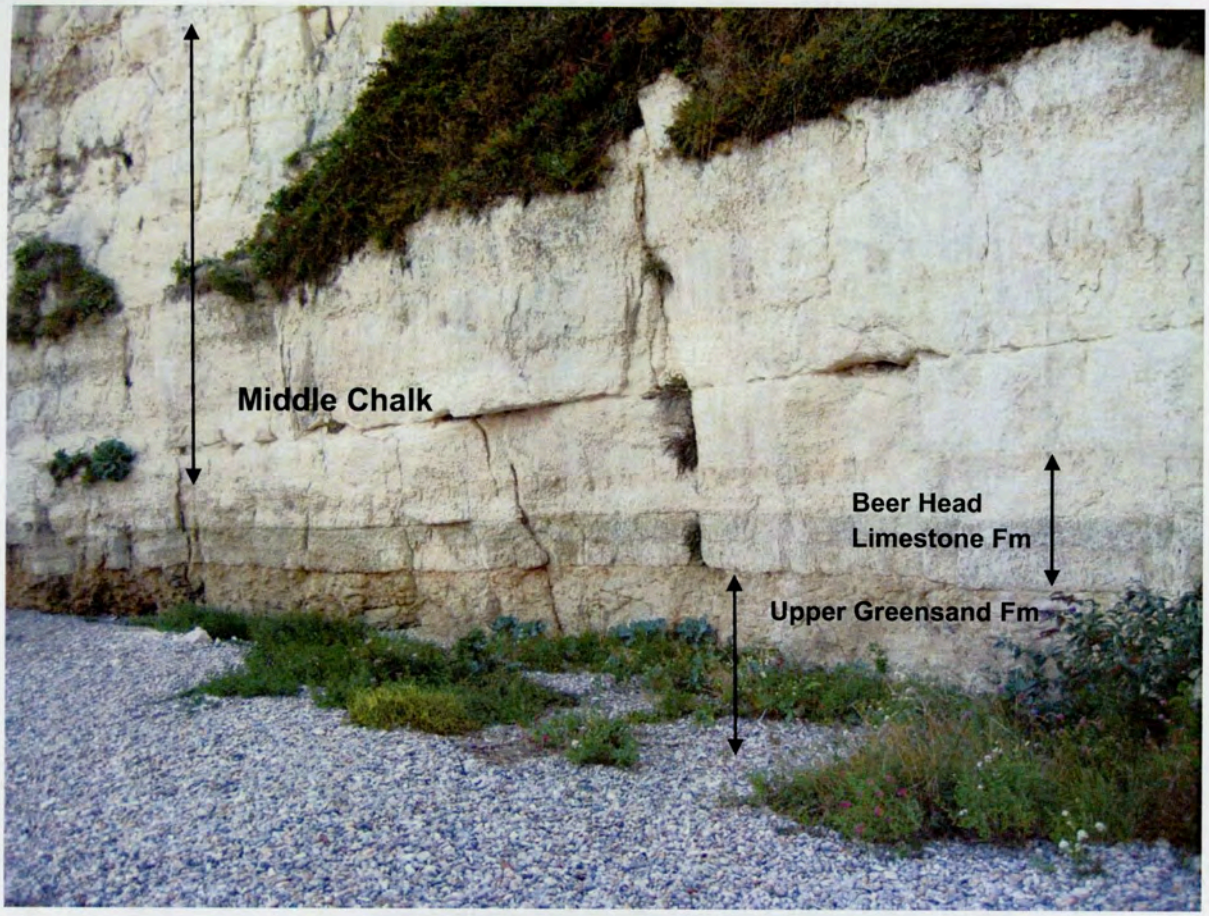


Figure 7. The top of the Upper Greensand Formation, Beer Head Limestone Formation and the lower part of the Middle Chalk in Beer Roads.

the lowermost bed of the Beer Head Limestone Formation (Hooken Member) is much thicker and contains numerous quite large examples of "*Ceriopora ramulosa*". This was formerly though to have been a large bryozoans but it is now classified as a calcareous sponge.

Figure 8. "*Ceriopora ramulosa*" from the Hooken Member of the Beer Head Limestone Formation, collected from the foot of the cliffs at Beer Head.

The foraminifera of the Beer Head Limestone Formation can be seen in thin section, though identification of most species is impossible. Using acid reduction it has been possible to extend the faunal list and, by combining thin section, normally processed and other information together a zonation has been established. Of particular interest is the presence, within the Pinnacles Member, of the *Rotalipora cushmani* and *R. greenhornensis* (now placed in the genus *Thalmanninella*) extinctions. This places the CTBE within this succession quite accurately, with the first appearance of *Helvetoglobotrunacana helvetica* in the overlying chalk (see below).

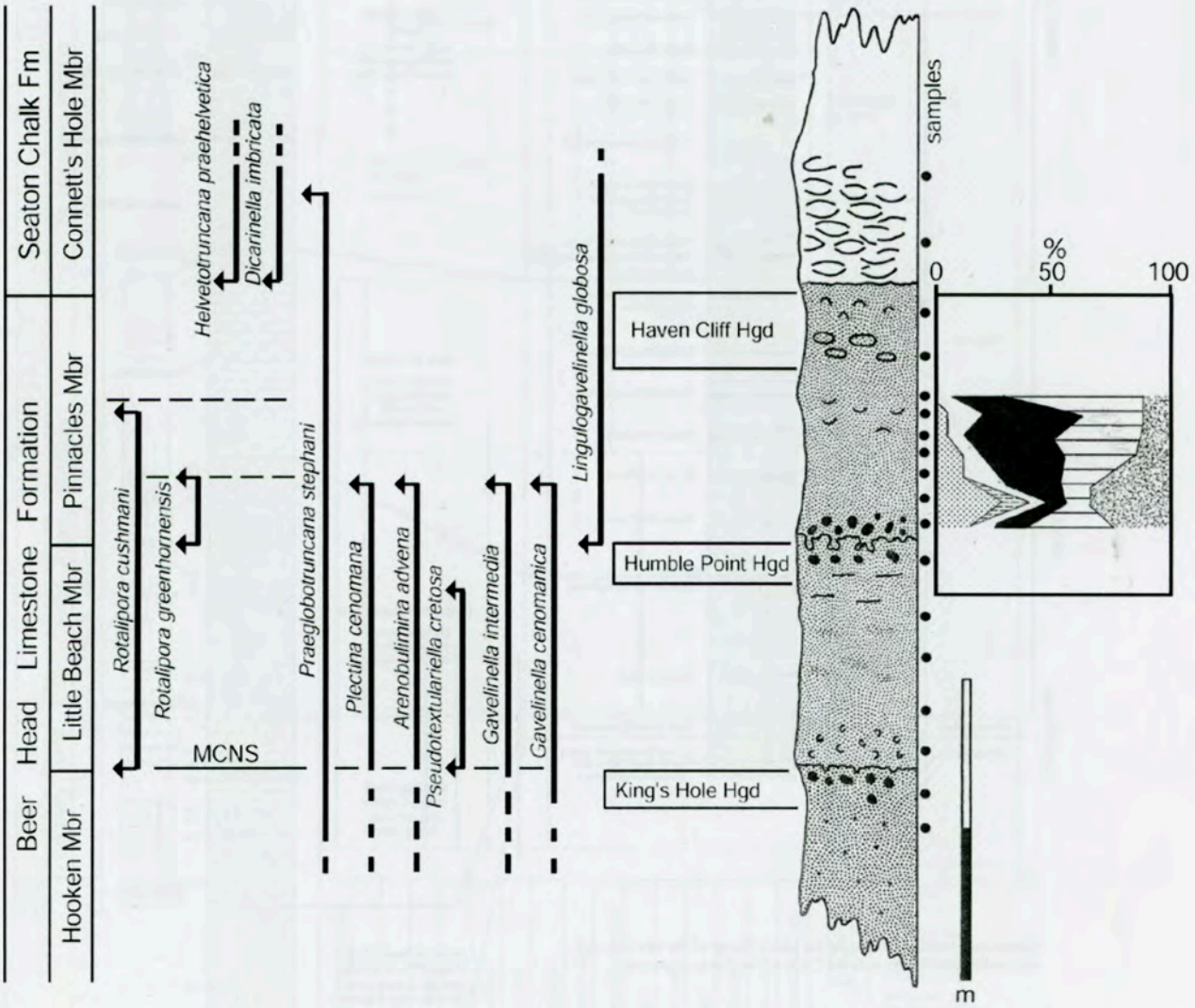
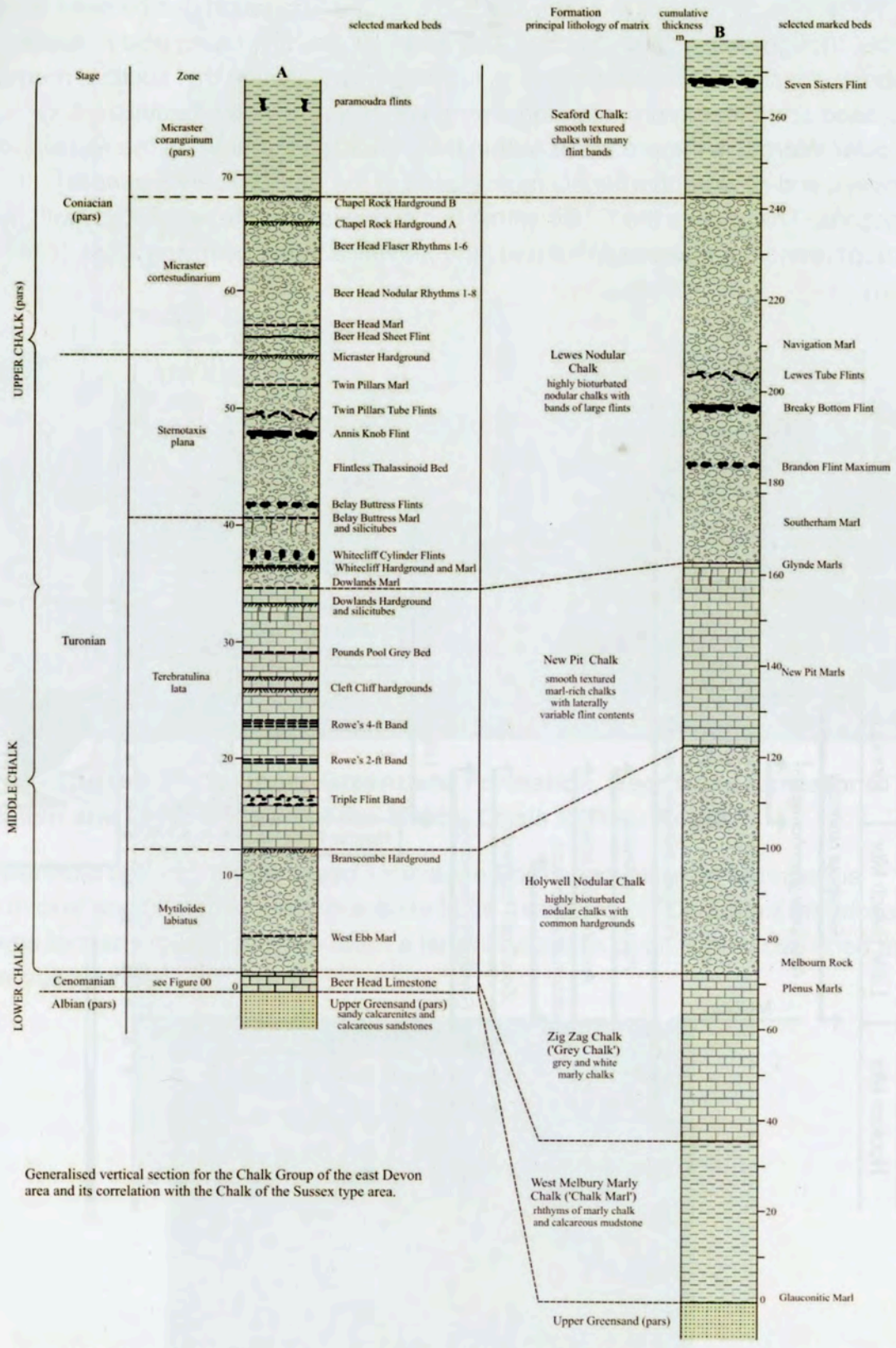


Figure 9. The Beer Head Limestone Formation, sampled in a fallen block below Hooken Cliff. In graph dots = *R. cushmani*, dash = *R. greenhornensis*, white = *Hedbergella* spp., black = *Praeglobotruncana/Dicarinella* spp., lines = calcareous benthic forms and irregular ornament = agglutinated taxa. (after Hart, 2004).



Generalised vertical section for the Chalk Group of the east Devon area and its correlation with the Chalk of the Sussex type area.

Figure 10. Generalised vertical section for the Chalk Group in S.E. Devon and a correlation with the Chalk of the Sussex area (based on work of Gallois and Mortimore *et al.*, 2001).

The lowermost Middle Chalk in the Beer area contains a number of limonitic and phosphatic hardgrounds. The most distinctive features in the cliff are the two flint-free chalk marl horizons known as Rowe's 2ft and Rowe's 4ft Bands. Up to, and including, the Dowlands Marl, the succession can be tied to the Sussex succession quite accurately, and the foraminifera used for biostratigraphy. The planktic foraminifera here are abundant and quite diverse, with many warm-water taxa present.

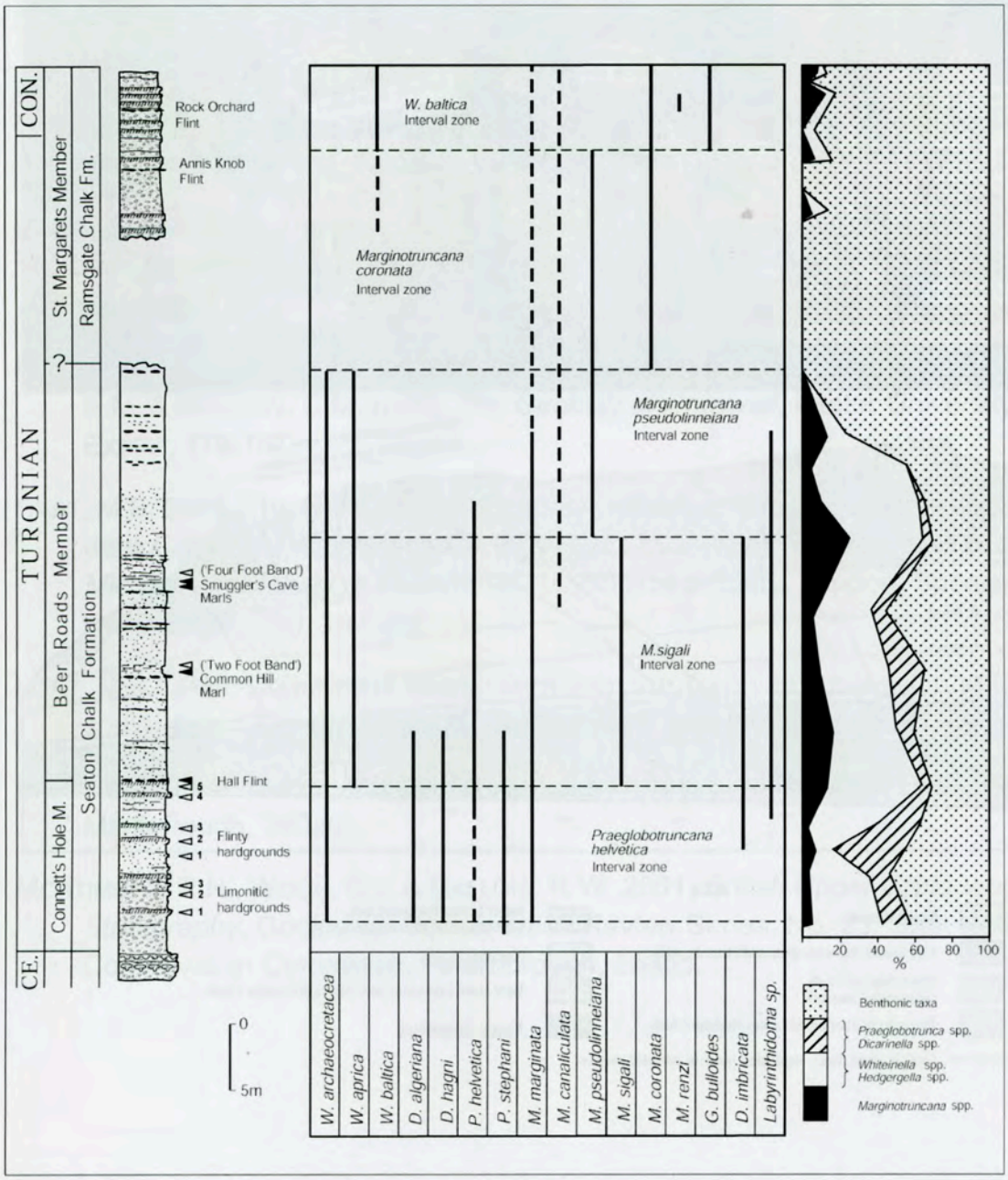


Figure 11. Distribution of foraminifera in the Middle Chalk of the Beer Succession (after Hart, 2008).

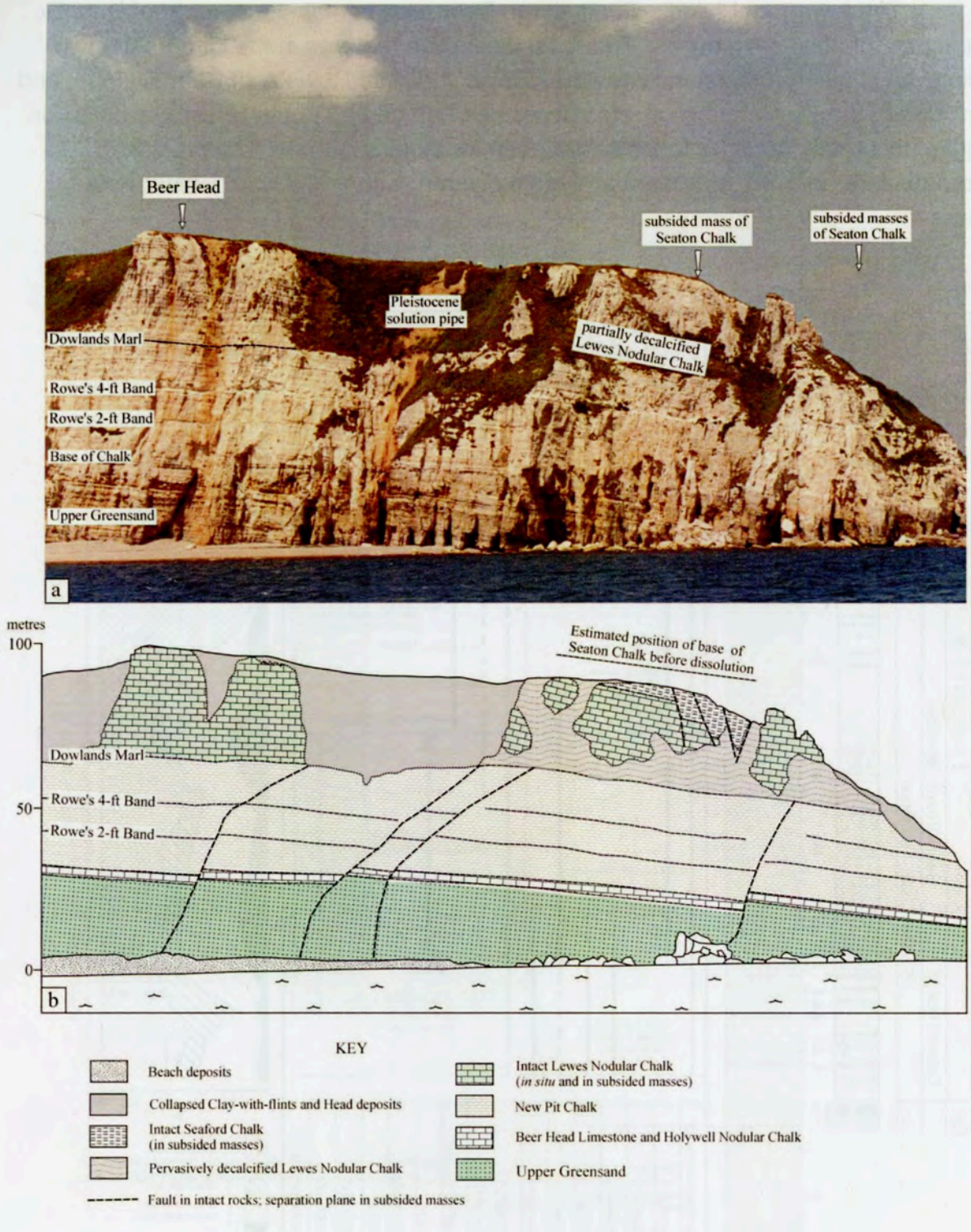


Figure 12. View of Beer Head showing how the Lewes Nodular Chalk can be in-situ or is isolated blocks within decalcified chalk (after Gallois, 2005).

The upper part of the succession, on a "block" known as Anis' Knob (Bailey, 1975), is almost certainly out of place, either slightly slipped or settled down through decalcified chalk. The near-continuous Annis' Knob Flint is a reliable marker within this part of the succession. The general decalcification of the chalk appears to have occurred in the early Tertiary (Gallois, 2005), although the timing of this is difficult. It is clear that many of the cliff falls in the area, including the most recent (in 2001) are caused by the lack of engineering strength caused by this decalcification.

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