The Croyde–Saunton Coast

S. Campbell and A. Gilbert

Highlights

One of South-West England's most famous Pleistocene localities, the Croyde–Saunton Coast exhibits one of the finest compound shore platforms in Britain, a series of spectacular, possibly ice-rafted, erratics and a thick sequence of raised beach, blown sand and head deposits. Although the sections have been studied for over 150 years, the deposits still present major problems of interpretation. Optically Stimulated Luminescence (OSL) dates indicate an Early Devensian age (Stage 4) for the aeolian 'sandrock'.

Introduction

The extensive exposures of Pleistocene sediments between Saunton [SS 445 378] and Baggy Point [SS 419 406], here referred to as the Croyde–Saunton Coast, are some of the best-studied in Britain, and they demonstrate significant evidence for interpreting Pleistocene events in South-West England. The raised beach deposits and erratics at the site first stimulated scientific interest in the early nineteenth century, and discussions have continued until the present day (e.g. Williams, 1837; De la Beche, 1839; Sedgwick and Murchison, 1840; Maw, 1864; Bate, 1866; Pengelly, 1867, 1873a; Ussher, 1878; Hughes, 1887; Dewey, 1910, 1913; Evans, 1912; Baden-Powell, 1927, 1955). Detailed descriptions of the erratics were later given by Taylor (1956, 1958), Madgett and Inglis (1987) and Sims (1996). Flint artefacts found in the Croyde Bay and Baggy Point areas were described by Whitley (1866). The site has been set in a wider context by Zeuner (1945, 1959), Mitchell (1960, 1972) and Cullingford (1982). Detailed accounts of the Pleistocene sediments were provided by Stephens (1966a, 1966b, 1970a, 1974), Wood (1970), Greenwood (1972), Kidson and Wood (1974) and Kidson (1977). Amino-acid ratios were presented and discussed by Andrews *et* al. (1979), Davies (1983) and Bowen *et* al. (1985). The site has also been widely referred to elsewhere (e.g. Green, 1943; Arkell, 1945; M. Arber, 1960; Stephens, 1961a, 1961b, 1973; Linton and Waters, 1966; Waters, 1966b; Macfadyen, 1970; Edmonds, 1972; Kidson, 1974; Kidson and Heyworth, 1977; Edmonds *et al.,* 1979, 1985; Keene and Cornford, 1995). Studies on 'pipe' structures (palaeokarst) in the 'sandrock' were carried out by West (1973) and Morawiecka (1993, 1994). The most comprehensive analysis of the sequence is that of Gilbert (1996, in prep.), who provides sedimentological evidence and OSL dates.

Description

Sections through Pleistocene sediments occur around Saunton Down, in parts of Croyde Bay, and from Middleborough to Morte Bay and Putsborough Sand. Two main areas of Pleistocene interest can be identified: sections around Saunton Down from Saunton Sands Hotel [SS 445 378] to just beyond Cock Rock [SS 436 392]; and sections from Middleborough House [SS 432 396] to just beyond Pencil Rock [SS 423 402]. Possible weathered till deposits east of Middleborough Hotel were described by Stephens (1970a, 1974) but are now obscured by a sea wall. Extensive, but thinly developed, head is exposed around the remainder of the Baggy Point promontory. The principal Quaternary features of this coastline are shown in (Figure 7.8). Schematic sections through the Pleistocene sediments at Pencil Rock and Croyde Bay are shown in (Figure 7.9) and selected cross-sections of the marine-cut platforms, which occur widely between Saunton and Baggy Point, are shown in (Figure 7.10). The generalized sequence for this part of the north Devon coast can be summarized thus:

5. Head

4. Cemented sand

3. Raised beach conglomerate

2. Erratic boulders

1. Shore platform(s)

However, considerable lateral and vertical variations occur, and the site's features are best described under the following headings (Stephens, 1970a, 1974):

Raised shore platforms

Three raised shore platforms have been recognized between Saunton and Baggy Point (Stephens, 1970a, 1974), all having been exhumed from beneath Pleistocene sediments by Holocene marine erosion (Figure 7.10). These platforms range in height from 0–6 m OD, through 5.5–7.6 m OD to 10.7–15.0 m OD (Stephens, 1970a, 1974). Although the lowest of these passes are below present HWM, at Bloody Basin [SS 438 378] and Middleborough the thick sequence of Pleistocene deposits cemented to the platform, and currently being eroded by the sea, attests to the considerable age of even the lowest platform (Stephens, 1974). The higher platforms are best seen between Middleborough and Pencil Rock and at Freshwater Gut [SS 427 400] where a 50 ton block of granulite gneiss is located near to the upper limit of the middle platform at a point where it notches the upper platform (Figure 7.8) and (Figure 7.10); Stephens, 1974).

Erratics

Large erratic boulders have long been known from the site (e.g. Williams, 1837; Maw, 1864; Bate, 1866; Pengelly, 1867, 1873a; Hall, 1879b; Hughes, 1887; Prestwich, 1892; Dewey, 1910, 1913; Hamling and Rogers, 1910; Evans, 1912), and the distribution of the principal examples is shown in (Figure 7.8) (Taylor, 1956, 1958; Stephens, 1966a, 1966b). These include the famous 'pink granite' erratic weighing some 10–12 tons (Taylor, 1956) at Bloody Basin near Saunton, and the granulite gneiss (weighing an estimated 50 tons) at Freshwater Gut; the former is firmly trapped between the shore platform and the raised beach deposits (Figure 7.11). Some of these erratics compare in size with the Giant's Rock at Porthleven (Chapter 6) in southern Cornwall (Flett and Hill, 1912; Stephens and Synge, 1966; Stephens, 1970a, 1974) and with others elsewhere around the Devon and Cornwall coast (Prestwich, 1892; Worth, 1898; Ussher, 1904; Reid and Scrivenor, 1906; Reid, 1907).

Raised beach deposits

At this site, the raised beach sequence has frequently been described as consisting of two elements; a lower raised beach conglomerate and an overlying cemented shelly sand. The latter has been shown to be of marine origin in its lowest layers, but aeolian towards the top of the beds (Greenwood, 1972; Gilbert, 1996). This sandstone ('sandrock' or 'aeolianite' as it is commonly described) reaches up to 9 m in thickness and sometimes overlies the raised beach conglomerate (2 m maximum thickness), but frequently overlies the raised shore platform(s) and giant erratics directly. It is almost completely cemented and, near Saunton, the horizontal bedding in the lower 1.8–3 m of the deposit is striking (see (Figure 7.11)). This bedding, however, gradually changes upwards to sloping beds of sand with small dispersed slate fragments. The high shell content of the upper sand beds (Hughes, 1887) and the bedding structures suggest that it is a wind-blown deposit, probably a series of fossil dunes (Greenwood, 1972; Stephens, 1974; Gilbert, 1996, in prep.). Layers and lenses of head are found in the sandrock at all levels.

The raised beach shingle is composed of well-rounded pebbles and cobbles with occasional larger boulders and erratic blocks. The matrix is of coarse sand with shale slivers, small pebbles, shells and shell fragments (Stephens, 1970a, 1974). Prestwich listed 26 species of marine mollusc from the shingle, all indicating temperate conditions. In some places, for example at Pencil Rock, the shingle is mixed with more angular head material, including a number of large blocks (Figure 7.9). The raised beach conglomerate is frequently interbedded with sand.

Head deposits and till

Along much of the coast, the sandrock is succeeded by considerable thicknesses of head (up to 21 m) which forms a large terrace or apron at the foot of the coastal slope. This head is thickest in the east, being particularly well exposed near Saunton Sands Hotel. To the west, the cliff of Pleistocene sediments becomes progressively dominated by the sandrock. The relationship of the head terrace to the shore platforms is shown in (Figure 7.10). Kidson (1974) saw little reason to subdivide the head deposits, but Stephens (1970a, 1974) recognized a thick 'Lower' or 'Main' Head and a thin 'Upper' Head of finer material, including slopewash sediments. Stephens noted that the Main Head was well weathered and cryoturbated, with frost-wedges extending into the deposit from the top of the bed some 1.5–1.8 m, and being sealed at their tops by the thin Upper Head. The latter was also disturbed by frost structures but was less weathered than the underlying deposits. The Upper Head can be seen in roadside cuts near Saunton Sands Hotel where angular shattered bedrock overlies *in situ* strata.

Stephens described a number of localities within this large coastal site where he believed till deposits to occur (Figure 7.8). These included sections near the old lime kiln east of Middleborough House, and temporary sections farther east. A low cliff at the head of Croyde Bay, at the junction with the Croyde Brook, was also thought to show till. The stratigraphic relationship of this deposit to others exposed in the coastal cliffs, however, is difficult to determine (Stephens, 1974). Soil horizons and slopewash deposits over the head contain many small flint flakes (some Mesolithic microliths?), indicating human activity during the Holocene (Stephens, pers. comm.).

Interpretation

Interest in the Croyde–Saunton Coast was stimulated, in particular, by the large erratics which lie on the shore platforms and which are sometimes overlain by raised beach, sand and head deposits (Figure 7.11). Williams (1837) was the first to mention the large granite erratic at Saunton and, by the turn of the century, this, and other erratics strewn along the coast, had attracted considerable comment and debate (e.g. Bate, 1866; Pengelly, 1867, 1873a; Hall, 1879b; Hughes, 1887; Prestwich, 1892). Some of these early studies discussed possible sources for the boulders and mechanisms for their transport and emplacement. Dewey's detailed petrological work established that some of the large erratics were foreign to the region, a number having probable sources in north-west Scotland. This, and additional work (Hamling and Rogers, 1910; Evans, 1912), established something of a consensus that the erratics had probably been emplaced on ice floes, a mechanism also to find favour with later workers (e.g. Stephens, 1966a, 1966b, 1970a, 1974).

However, whether these large erratics were moved into their present position by a regional ice sheet (Mitchell, 1960; Kidson, 1971, 1977) or by floating icebergs in the Early Pleistocene (Stephens, 1966a, 1974) has not been satisfactorily resolved. Stephens (1974) nonetheless suggested that the widespread occurrence of such large erratics throughout the Bristol Channel coastlands and even as far south as the northern French coast, supported the latter hypothesis (Mitchell, 1965; Stephens, 1966b), particularly since very large erratics like the pink granite at Saunton and the Giant's Rock at Porthleven are confined to very narrow zones along the coast, below 9 m OD and within the reach of present-day storm waves. Had they been emplaced by a regional ice sheet, their expected distribution might be much less selective (Stephens, 1974). Madgett and Madgett (1974) refuted this argument, citing the occurrence of a large erratic of epidiorite (apparently of Scottish origin) on Baggy Point at some 80 m OD. It is possible, however, that this boulder was dragged up from Croyde Bay to act as a boundary marker. Comprehensive reviews of erratics in the Barnstaple Bay area are given by Taylor (1956), Madgett and Inglis (1987) and Sims (1996).

Early studies by Williams (1837), De la Beche (1839), Sedgwick and Murchison (1840) and Bate (1866), among others, established that the shingle and sand beds in section around the Croyde–Saunton Coast were similar to those found around the present shore. They interpreted the beds as ancient beach deposits and explained their present position by changes in the relative level of the land and sea. Hughes (1887), however, disputed this and maintained that although the beds comprised marine sediments overlain by blown sand and capped by talus, the marine material lay well within the reach of present-day waves; and thus that the deposits in section did not necessarily reflect a former higher sea level.

Prestwich (1892) summarized much of the earlier work and provided a comprehensive stratigraphic analysis of the sections, comparing them with others in southern England and Wales. He argued that three main types of deposit overlay the shore platform:

3. The 'usual local angular rubble', composed of large and small fragments of slaty Devonian rocks in a brown earth without apparent bedding (3–15 m) — 'head'.

2. Blown sands (1.5–9 m), horizontally bedded with frequent oblique laminations and partly or wholly concreted. The sands include large numbers of land snails with occasional weathered valves of *Mytilus* and '*Cardium*'. He interpreted these beds as old dunes and correlated them with the Fremington Clay — a deposit he regarded not as till, but as a lake clay.

1. Raised beach deposits consisting of 'hard grey and micaceous sandstones, chalk flints, and pebbles of white quartz and reddish quartzite in a matrix of sand, with a large proportion of comminuted shells' and frequently cemented. He noted 26 species of marine mollusc from these beds, all of a 'temperate' character and indicating 'interglacial' conditions.

This simple stratigraphy has formed the basis for subsequent interpretations of the sequence; the origin of the beds as raised beach conglomerate and associated marine sand, blown sand, head and hillwash, is not generally disputed. Two very different schools of thought, however, have pertained regarding a chronology of events at the site, based principally on assumptions of the age of the raised beach deposits.

Workers including Mitchell (1960, 1972) and Stephens (1966a, 1966b, 1970a, 1974) have argued that the raised beach sediments accumulated in the Hoxnian, and that the overlying beds can be subdivided to represent the main remaining stages of Pleistocene time. Alternatively, Zeuner (1945, 1959), Edmonds (1972), Kidson (1974, 1977), Kidson and Wood (1974), Kidson and Heyworth (1977) and Edmonds *et al.* (1979), among others, have ascribed the raised beach deposits to the Ipswichian Stage, and invoked a different sequence of events.

Mitchell (1960) attempted to correlate the drifts of South-West England with those in Ireland. He suggested that the rock platform at Croyde and Saunton (Figure 7.12) had been cut in the Early Pleistocene, probably in the Cromerian, and he believed that the large erratics had been placed directly on to the platform by an ice sheet of Anglian age. He later revised this view on the extent of the Anglian ice sheet (Mitchell, 1972) and acknowledged that the erratics could have arrived on ice floes, becoming incorporated and buried by raised beach sediments during high sea levels in the Hoxnian.

Stephens (1966a, 1966b, 1970a, 1974) re-examined the sections around Barnstaple Bay including those along the Croyde–Saunton Coast. Like Mitchell, he concluded that the raised beach conglomerate and associated marine sands had been deposited during temperate, high sea-level condi tions in the Hoxnian. He argued that where the raised beach sediments were mixed with more angular material, a reworking of an ancient head deposit had taken place, this head perhaps having formed in the same cold period in which the giant erratics were emplaced by ice floes (?Anglian). Alternatively, and more simply, he suggested that the head may have accumulated contemporaneously as cliff fall material during the period of raised beach formation. As sea level fell towards the end of the Hoxnian, substantial areas of sea floor were exposed and sand was blown inland and banked up against the old cliffline. Thin layers of head found interbedded with the sandrock 'at all levels probably attest to intermittent falls of cliff material. However, as environmental conditions deteriorated into the Saalian, periglacial conditions pertained and head formation became the dominant process, and a massive terrace of head was formed seawards of the old cliffline (Stephens, 1974).

The dating of this thick (Lower or Main) head as 'Wolstonian' (Saalian) by Stephens rests very largely on analogies with head sequences (and thicknesses) in Ireland. There, he argued, no great thickness of solifluction deposits was associated with deposits of the last glaciation (Devensian).

This was in contrast to the thick head associated, stratigraphically, with the pre-Devensian (suggested Saalian Stage) Ballycronneen Till. To reinforce this dating, Stephens argued that the head at Croyde and Saunton showed evidence for a considerable length of weathering (in the ensuing Ipswichian). He noted that the head was also disturbed by cryoturbation, fossil ice-wedge casts and festoon structures, and he interpreted this as indicating that head material had ceased downslope movement by the time renewed periglacial activity had churned and disturbed the upper layers of the deposit. This phase of freeze-thaw activity could have taken place in either of the Saalian or Weichselian (Devensian) cold stages (Stephens, 1974). During the Devensian, less severe periglacial conditions returned and a further, but thinner (Upper), head accumulated together with hillwash sediments.

The sections showing possible till deposits in Croyde Bay and near Middleborough (Stephens, 1974) are difficult to interpret, and are not easily related to the coastal stratigraphy elsewhere within the site. Stephens (1974) nonetheless was convinced of the presence of till in Croyde Bay, since the deposit contained erratics and striated clasts. It is not clear, however, if this weathered deposit rests *in situ.* It may, for example, be mixed with head and, near the base of the bed, even with beach shingle (Stephens, 1974). In the absence of absolute dates and detailed sedimentological data, little more can be gleaned from these limited exposures which lie away from the main and extensive coastal sections.

The second main school of thought regarding a chronology of events at this site stemmed from Zeuner's claim that there was no evidence in the region for glacier ice having overridden any of the raised beaches; the latter could thus be assigned to the last (Ipswichian) high sea-level event. Following this premise, Kidson (1971, 1974), Kidson and Wood (1974) and Kidson and Heyworth (1977), among others, proposed the following scheme of Pleistocene events. A shore platform, being the oldest of the Pleistocene features, was likely to be composite in age, formed during high sea levels probably in the Hoxnian and earlier 'interglacial' events. The large erratics lying on the surface of this composite platform were believed to have been emplaced in the same (Wolstonian/Saalian) glacial event which deposited the nearby Fremington Clay (also containing some large erratics from comparable sources). The raised beach conglomerate and sands (including the sand-rock) which directly overlie some of the erratics were believed to be of Ipswichian (not Hoxnian) age. It followed that the succeeding head deposits which, according to Kidson (1974), showed little sign of differentiation, were periglacial deposits formed during the following Devensian Stage. Such a chronological interpretation was also followed by Edmonds (1972) and Edmonds *et al*. (1979), although these workers favoured that the large erratics had been emplaced during the Anglian rather than the Saalian.

More recently, fossil marine molluscs from the site have been subjected to analysis by both radiocarbon and amino-acid dating techniques. An infinite radiocarbon age determination on *Balanus balanoides* (Linné), taken from the surface of a shore platform, and a clearly unrealistic date of 33 200 + 2800/– 1800 BP (I-2981) (Kidson, 1974) from shells in the raised beach conglomerate, failed to determine the age of the raised beach sequence.

On the other hand, amino-acid ratios obtained from shells in the raised beach conglomerate and overlying sand (Andrews *et al.,* 1979; Davies, 1983; Bowen *et al.,* 1985) have provided significant results. Andrews *et al.* (1979) showed that most of the shells subjected to the technique gave ratios that were higher than the two principal groups of ratios obtained from shells at other raised beach sites in South-West England and Wales. The latter were believed to have lived and then been deposited during Oxygen Isotope Stage 5e (Ipswichian); such ratios were calibrated by Uranium-series dating to a high sea-level event at *c.* 125 ka BP (Keen *et al.,* 1981). The significantly higher amino-acid ratios from Saunton were interpreted as indicating a greater age (or significantly different temperature history) for the raised beach there (Andrews *et al.,* 1979). However, a single shell yielding a typical Stage 5e ratio introduced the possibility that the raised beach could be the product of two distinct (but similar in height) sea-level (interglacial) events. Davies (1983) provided additional amino-acid ratios from Saunton which were also significantly higher than most of those derived from sites elsewhere. This led to the correlation of the Saunton raised beach with the Inner Beach at Minchin Hole Cave, Gower: both were tentatively ascribed to Oxygen Isotope Stage 7 (*c.* 210 ka BP) (Davies, 1983).

Bowen *et al.* (1985) published amino-acid ratios on shells taken from the raised beach sequence both at Pencil Rock (near Baggy Point) and at Saunton. Shell samples were taken from both the raised beach conglomerate and overlying sands at these sites. This work confirmed the earlier ascription of the beds (Davies, 1983) to Stage 7. However, younger shells were also present in the samples. It was suggested that these had been banked up against the older Stage 7 beach deposits during a high sea-level event in Stage 5e (Ipswichian) (Bowen *et al.,* 1985). In addition, some ratios from the overlying sandrock were grouped with those from the 'unnamed' D/L stage at Minchin Hole Cave, but these were also ascribed to some part of Stage 7 (Bowen *et al.,* 1985), although other possible correlations were discussed.

These data have significant repercussions for interpreting the succession at Croyde and Saunton. An Oxygen Isotope Stage 7 age for the raised beach and associated sands allows the possibility that the overlying head deposits date from a variety of Pleistocene cold phases as Stephens (1974) originally suggested.

Gilbert (1996, in prep.) argues that previous interpretations of the raised beach-sandrock sequence (Figure 7.13) have been over-simplified. Instead, he proposes that five facies, widespread along the coast here, can be recognized in the deposits. These show the progression from: an initial marine transgression (facies 1 — the well-cemented raised beach conglomerate described by numerous previous workers); to a foreshore environment dominated by nearshore intertidal activity (facies 2); to a deeper-water environment on the flank of a wave-/tide-dominated river-fed embayment (facies 3); to a backshore environment with palaeosol development (facies 4); finally to a backshore dune environment (facies 5). He presents OSL dates which place the lowest marine deposits in Stage 5e (Ipswichian) and the aeolian sediments in Stage 4 (Early Devensian; *c.* 70 ka BP). These data conflict with previously published amino-acid ratios (Andrews *et al.,* 1979; Davies, 1983; Bowen *et al.,* 1985) which would point to a Stage 7 age for Gilbert's facies 1 and 2 (Campbell and Scourse, 1996).

Conclusion

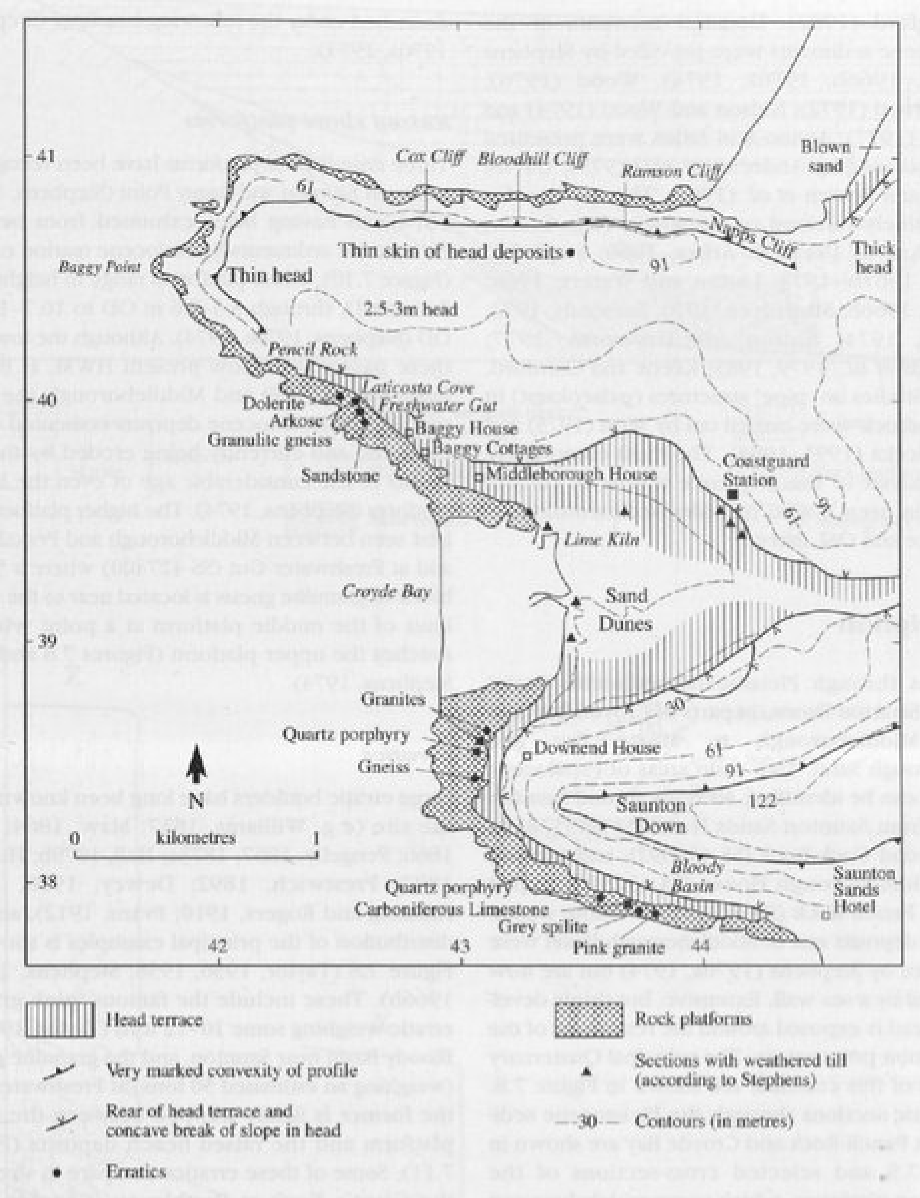
The exposures at Croyde and Saunton provide a key stratigraphic record and exhibit a number of features crucial to the reconstruction of Pleistocene history in South-West England. First, the shore platform between Croyde and Saunton is one of the finest examples anywhere in Britain; the extensive development at this site graphically demonstrates its compound nature and age, with at least three main platform surfaces (of unknown age) having been recognized.

Second, the site is also particularly important for the profusion of large erratics which are found overlying the shore platforms and below raised beach, blown sand and head deposits. Although sporadic examples (such as the Giant's Rock in Cornwall) occur elsewhere, those between Croyde and Saunton have proved especially important in reconstructions of earlier Pleistocene conditions in the region. Their lithological diversity, confined coastal location and limited altitudinal range, and their stratigraphic context have stimulated debate concerning their origins and mode(s) of emplacement. Whether these large erratics were introduced to this coast by a regional ice sheet or on ice floes (ice-rafted) has not been satisfactorily established; these examples will undoubtedly play an important role in the resolution of this debate.

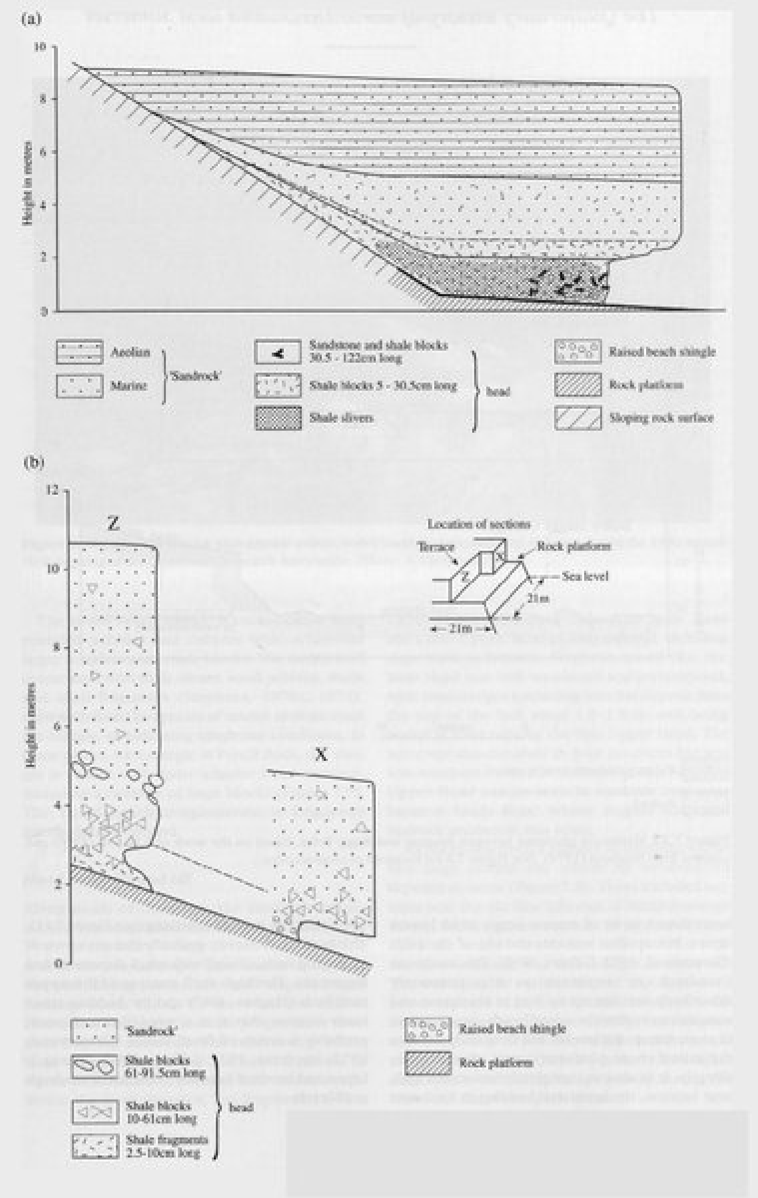
Third, the raised beach sequence at the site shows a transition from fully marine conditions (raised beach conglomerate and marine sand) to terrestrial conditions (blown sand and fossil dunes). Amino-acid ratios reveal a complex age for the raised beach sequence (probably reflecting high sea-level conditions in both warm Oxygen Isotope Stages 7 and 5e). The overlying beds of blown sand are some of the best and most extensive examples in Britain, preserving a rare and detailed record of terrestrial conditions. Recent OSL dates have shown that most of the blown sand accumulated during the Early Devensian (Stage 4; *c.* 70 ka BP).

Finally, the stratigraphic importance of the Croyde–Saunton Coast cannot be seen in isolation. Although providing a crucial record of Pleistocene conditions including evidence for glacial, interglacial and periglacial climatic cycles, the true value of the sections lies in their relationship to others in the Barnstaple Bay area, particularly critical exposures at Brannam's Clay Pit, Fremington Quay and Westward Ho! These form a core of stratigraphic sites indispensable to any reconstruction of Pleistocene history in the region.

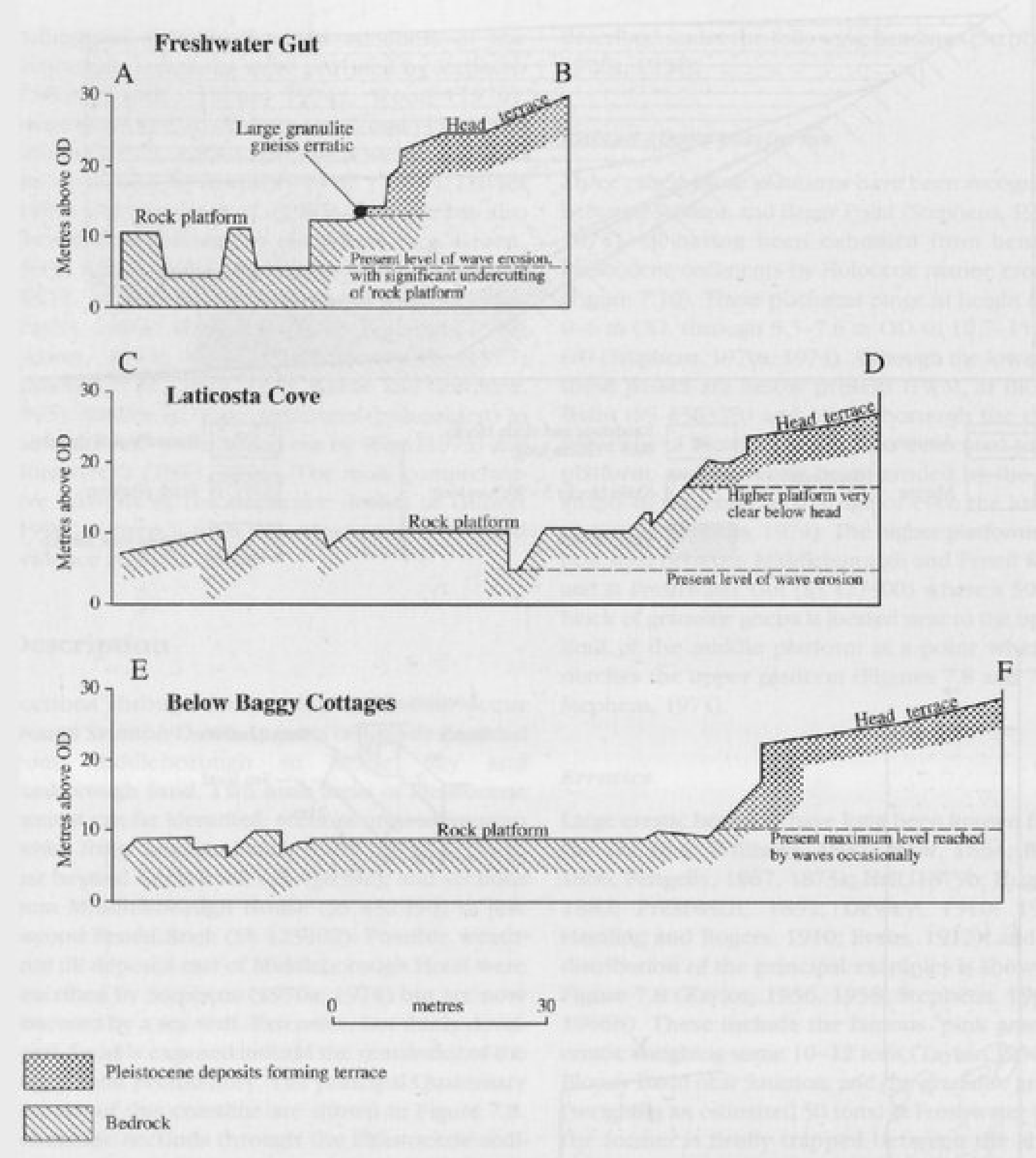
[References]



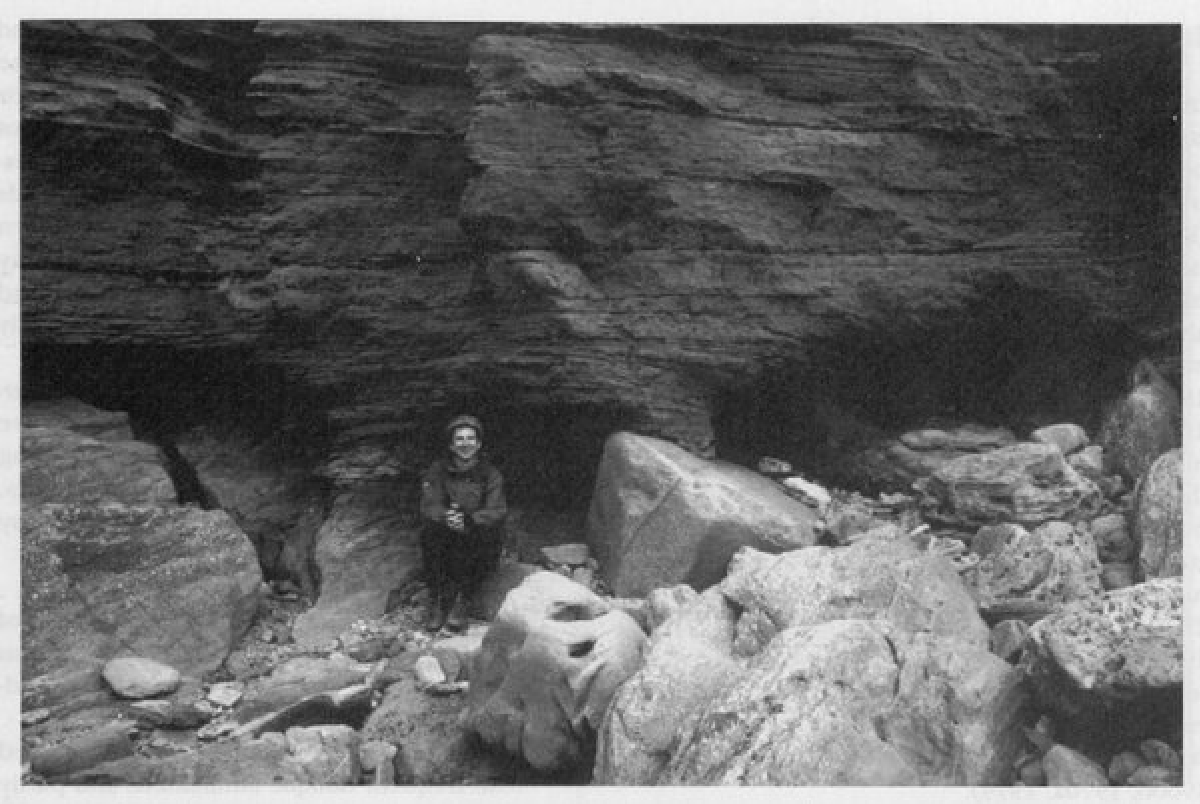
(Figure 7.8) The Quaternary deposits and coastal morphology of the Croyde–Saunton Coast. (Adapted from Stephens, 1970a.)



(Figure 7.9) The Quaternary succession at: (a) Pencil Rock; (b) East of Pencil Rock, based on the work of R.M. Eve (1970) and adapted from Stephens (1974).



(Figure 7.10) Marine-cut platforms between Saunton and Baggy Point, based on the work of R.M. Eve (1970) and adapted from Stephens (1974). (See (Figure 7.8) for locations of cross-sections.)



(Figure 7.11) Saunton's famous 'pink granite' erratic, sealed beneath cemented sand and seen during the 1996 Annual Field Meeting of the Quaternary Research Association. (Photo: S. Campbell.)

(Figure 7.12) Extensively developed rock platforms at the western end of Saunton Down, looking north across Croyde Bay. (Photo: S. Campbell.)

(Figure 7.13) Thick cemented sand (marine and aeolian) and overlying head deposits near Saunton Sands Hotel. (Photo: S. Campbell.)