Fremington Quay

S. Campbell and D.G. Croot

Highlights

Exposures at Fremington Quay show a complex and controversial sequence of stony clay, gravel, sand and silt which has long figured in reconstructions of regional Pleistocene history. Some authorities claim that the site shows raised beach deposits overlain by glacigenic sediments, others that the sequence comprises soliflucted and fluvially sorted materials. Recent evidence shows that the site may demonstrate glacially dislocated and thrusted 'rafts' of bedrock overlain by glaciofluvial materials.

Introduction

Exposures at Fremington Quay have figured prominently in interpretations of the Pleistocene history of the Barnstaple Bay area, particularly in establishing the crucial relationship between the raised beaches and possible glacial deposits. A sequence of gravels and stony clays has been interpreted as a Hoxnian raised beach deposit overlain by Wolstonian till (e.g. Stephens, 1966a). An alternative view, however, is that the raised beach deposits date from the Ipswichian and that the overlying stony clays are head deposits (including reworked till) emplaced during the Devensian. The site was referred to in early studies by Maw (1864), Ussher (1878) and Dewey (1913), and in regional Pleistocene syntheses by Zeuner (1959), Mitchell (1960, 1972) and Everard *et al.* (1964). More detailed interpretations of the site were provided by Stephens (1966a, 1974), Kidson (1971), Edmonds (1972) and Kidson and Wood (1974). The site was also referred to by Wood (1970, 1974), Stephens (1973) and Kidson and Heyworth (1977), and is the subject of current reinterpretation (Croot *et al.,* in prep.).

Description

The Fremington Quay exposures run for 0.5 km in a low coastal cliff on the south edge of the Taw Estuary, between [SS 514 332] and [SS 509 331]. Despite having featured in numerous Pleistocene stratigraphic correlations, the exposures and sediments have not been described in great detail.

Edmonds (1972) stressed the sedimentary variability of the Quaternary deposits around Fremington Quay, and referred to them as the 'pebbly drifts of the estuary'. At [SS 511 331] he recorded that the pebbly clay, sand and silt enclosed a large clay lens (5 m x 1 m), and that at other locations stratification was evident. Seams and lenses of clay, silt and gravelly sand are a common feature of the beds (Edmonds, 1972). He recorded that the pebbly drift rises to 18 m OD, and that it underlies much of Fremington Camp.

On the east side of the Pill, these sediments extend to form the promontory of Penhill Point.

At the eastern end of the Fremington Quay exposures, at Fremington Pill, about 4 m of Quaternary sediment overlies a small cliff some 4–5 m high cut in steeply dipping shale bedrock. Although this rock surface is uneven, it has been described as a 'wave-cut' platform (Stephens, 1966a). It falls in height westwards and the western end of the GCR site comprises a low, 1–2 m-high, cliff of Quaternary sediment disrupted by vertical 'pipes' or cracks which are infilled with lighter-coloured silt and clay (Figure 7.5). Stephens (1966a) records a generalized sequence of:

4. Weathered, pebbly sandy clay with striated stones and erratics

3. Gravels and sands

2. Silts with pebbles

1. Shale, distorted and brecciated

Croot *et al.* (in prep.) records the following section at the eastern end of the Fremington Quay outcrop (SS 513 332; (Figure 7.6)) (maximum bed thicknesses in parentheses):

4. Sandy gravels, partly cross-laminated (2.0 m)

3. Poorly sorted silt with some sand (0.2 m)

2. Laminated sandy silts with inclusions of grey-blue silt. The whole unit is contorted and reverse-faulted, with planes dipping northwest (1.4 m)

1. Broken bedrock: large cobble- to small gravel-sized blocks of bedrock dislocated south-eastwards from source by up to 0.5 m (1.5 m)

Interpretation

Raised beach deposits were first described in the Fremington area by De la Beche (1839), and a gravel bed was recorded at Fremington Quay by Maw (1864). Maw traced this shingle bed inland, via open-sections in the railway cutting west of Fremington Pill, through Bickington and Lake to Combrew, where he believed it underlay a considerable depth of clay — the Fremington Clay (Figure 7.2). Although he regarded the shingle as a raised beach deposit, he noted the possibility that the bed could also be related to the overlying clays which he regarded as glacial in origin. Maw's paper raises a critical issue which has been central to most subsequent studies of Pleistocene sediments in the area; namely, do the sands and gravels at Fremington Quay form a raised beach and can they be correlated with the gravels underlying the Fremington Clay (e.g. at Brannam's Clay Pit)?

Ussher (1878) believed that the gravels in the Fremington area were estuarine deposits of the Taw. Dewey (1913) regarded the gravels as marine and described them as overlain by head and stony clay. The latter contained deeply striated clasts and led Dewey to correlate the stony clay at Fremington Quay with the Fremington Clay (and till) inland.

Mitchell (1960) proposed a stratigraphical model for the Pleistocene history of the Irish Sea using sections from the Barnstaple Bay area, including Fremington Quay and Brannam's Clay Pit, as critical evidence for his arguments. He suggested that the erratic-bearing raised beach gravels at Fremington Quay overlay a raised shore platform and that the gravels could be traced inland where they underlay the Fremington Clay (Figure 7.2). He argued that Maw's (1864) section … shows clearly and correctly that there is no justification for pretending that the beaches at Fremington and at Saunton are stratigraphically above the Fremington boulder clay … and if the boulder clay is of Gipping age, the Fremington and Saunton beaches cannot lie in the last interglacial period' (Mitchell, 1960; p. 319).

Mitchell envisaged that the shore platform had been cut probably in Cromerian times and that the overlying raised beach gravels could be ascribed to the Hoxnian. The Fremington Clay or Till was regarded as a glacial deposit of Gipping/Wolstonian (Saalian) age.

Stephens (1961a, 1966a, 1966b) examined the sections at Fremington Quay and at Brannam's Clay Pit in more detail, and independently came to the same conclusions as Mitchell (1960). However, his analysis showed that, unlike the Fremington Clay at Brannam's Clay Pit, the stony clay at Fremington Quay contained no shells and was non-calcareous; a glacial origin was nonetheless favoured. He proposed that the beds were subsequently weathered during the Ipswichian and then deeply cryoturbated in the Devensian when, he believed, glacier ice did not reach north Devon (Stephens, 1966a, 1966b).

Subsequent workers, however, have tended to follow Zeuner's (1959) interpretation of regional Pleistocene stratigraphy. Zeuner argued that there was no evidence for a raised beach anywhere in the region having been overridden by ice. He concluded that the glacial deposits of the Barnstaple Bay area pre-dated the local raised beaches; the latter he therefore regarded as having formed during the Ipswichian Stage.

This view has been reiterated by others including Bowen (1969), Kidson (1971), Edmonds (1972) and Kidson and Wood (1974). Edmonds did not differentiate between raised beach and other deposits at Fremington Quay and referred to the beds simply as the 'pebbly drifts'. He argued that this gravelly drift could be traced a short distance inland, but certainly not to the point of demonstrating the bed's equivalence with the gravelly material spasmodically exposed in the bottom of Brannam's Clay Pit. The 'pebbly drift' rested on a shore platform at Fremington Quay and had been derived, at least in part, from till, some sorting having occurred as the glacial material was soliflucted downslope and reworked by fluvial and, finally, estuarine processes. The 'pebbly drift' was therefore regarded as reworked (Saalian) till, soliflucted and fluvially sorted, and emplaced on to the shore platform in an estuarine environment during the Ipswichian (Edmonds, 1972). He argued that this pebbly sediment graded inland into a river terrace (Terrace 1 in his classification), and that this terrace, the pebbly drift and the local raised beaches (at Saunton and Croyde) were all Ipswichian in age.

Wood (1970, 1974), Kidson (1971) and Kidson and Wood (1974) in part followed earlier interpretations of the sequence, recognizing a raised beach deposit overlain by more poorly sorted sediments. However, they disputed Mitchell's and Stephens' chronostratigraphic interpretations and argued that the raised beach had formed during the Ipswichian and that the overlying sediments were head deposits, soliflucted into their present position during cold conditions in the Devensian. They emphasized the importance of the stratigraphic relationship of the coastal Pleistocene sediments with those inland, particularly at Brannam's Clay Pit; a detailed analysis of gravel samples from both sites was undertaken (Wood, 1970). At Brannam's Clay Pit the gravels were composed predominantly of Cu1m grits and sandstones. No erratics were recovered, and the deposit was both more poorly sorted and contained more angular clasts than the gravel exposed at the coast (Wood, 1970; Kidson and Wood, 1974). This, they suggested, discounted Mitchell's and Stephens' assertion that the raised beach was traceable inland where it could be seen to underlie the Fremington Clay. They also discounted Stephens' correlation of the stony clay at Fremington Quay with the Fremington Clay at Brannam's Clay Pit. Instead, the stony clay at Fremington Quay was interpreted as a solifluction deposit. The upturned beach materials, which Stephens (1966a) argued had been disrupted by Woistonian glacier ice, were believed to have resulted from periglacial activity. 'They are inadequate testimony to the powerful machinery of an advancing ice-front' (Kidson and Wood, 1974; p. 233). No glacial deposits in *situ* were recognized above raised beach material in the region, and the raised beach deposits were therefore demonstrably younger and accordingly ascribed to the Ipswichian.

However, recent studies have shown that the exposures at Fremington Quay may in fact show evidence for glacial activity (Campbell and Scourse, 1996; Croot *et al.,* in prep.). During the 1996 Annual Field Meeting of the Quaternary Research Association, members were shown dislocated, possibly thrusted, blocks of bedrock at the base of the Pleistocene succession (Figure 7.7). Croot *et al.* (in prep.) argue that the distinctive reverse-faulting of bed 2 at the eastern end of Fremington Quay, related to the localized transport of bedrock blocks, is characteristic of small-scale glaciotectonism associated with a thin-ice margin. He suggests that bed 2 is therefore a basal/subglacial unit. Although he does not record any erratics in bed 2, and finds no evidence of overconsolidation, other authors have recorded striated erratics at this locality (Dewey, 1913; Stephens, 1966a). The more widely developed overlying unit (bed 4) is interpreted by Croot *et al.* as glaciofluvial material deposited in an outwash fan.

There is some degree of equivalence, therefore, between Croot *et al.*'s record of Fremington Quay (east) and Stephens' record for Penhill. However, there is clear evidence that the gravels exposed at Penhill and Fremington Quay are quite different from the basal gravels at Brannam's Clay Pit. There is, therefore, no basis for establishing a common lithostratigraphy for these sites. However, the proposed glacial event responsible for the glaciotectonic structures at Fremington Quay may also have caused the overconsolidation of the Brannam's Clay Pit sequence. This event remains imprecisely dated (see Brannam's Clay Pit).

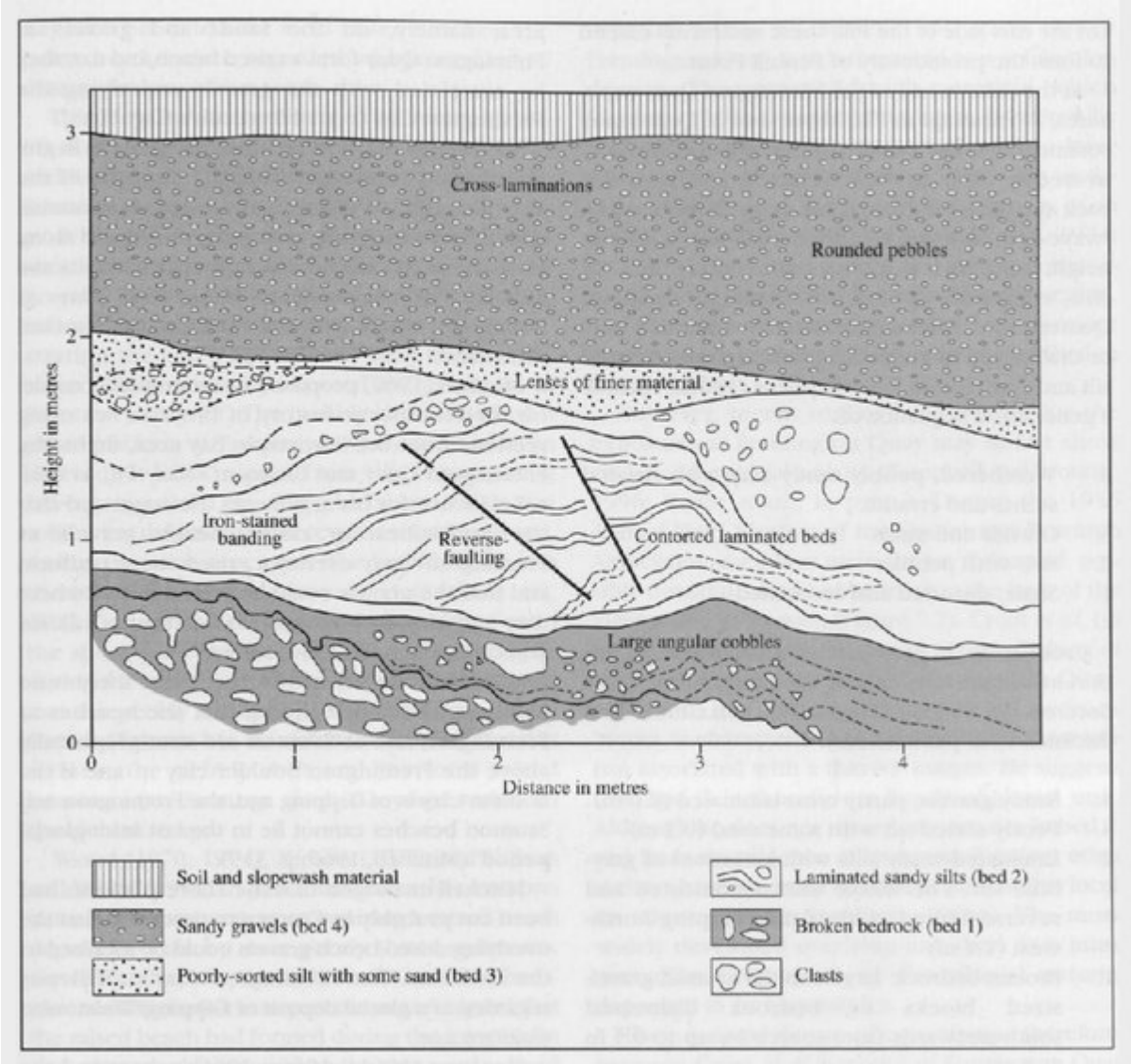
Conclusion

Fremington Quay is an important site for interpreting Pleistocene stratigraphy in South-West England. The origin of the sediments here has caused considerable debate and has led to widely disparate opinions as to the sequence and timing of Pleistocene events in the region. Fremington Quay is an essential reference site for resolving two principal and crucial stratigraphic questions: firstly, whether the clay overlying the postulated raised beach deposits is an *in situ* till as claimed by Stephens (1966a); and whether the shingly gravel extends inland to underlie the Fremington Clay. Some workers

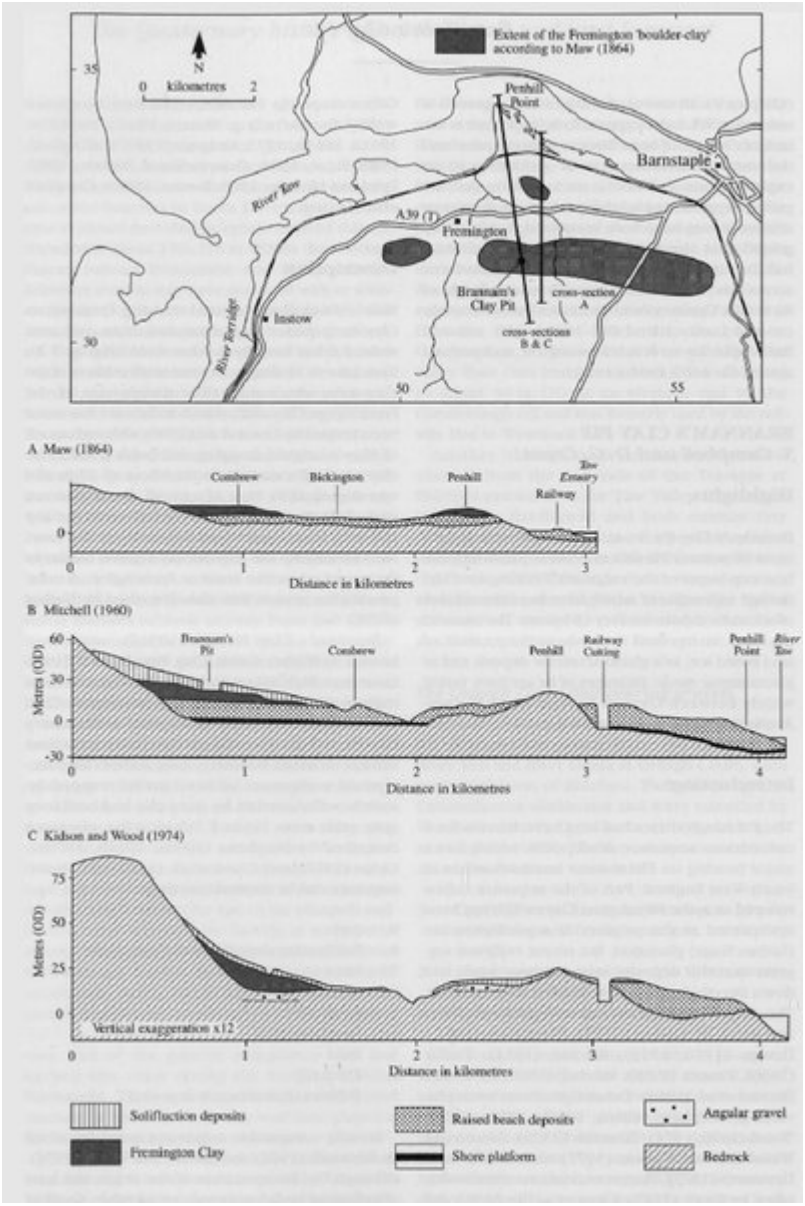
have maintained that the sequence at Fremington Quay shows a Hoxnian raised beach deposit overlain by a Saalian-age till. Others have argued that the raised beach deposit is Ipswichian in age and that the overlying stony clay is a Devensian solifluction deposit. A recent proposal is that the site shows evidence of glacially thrusted (tectonized) bedrock, formed at a thin-ice margin, overlain by glaciofluvial sediments. However, there is still no firm agreement as to the age or origin of these controversial sediments. The interpretation of Pleistocene stratigraphy, and therefore of events and conditions in the Barnstaple Bay area, relies very heavily on exposed sequences at Brannam's Clay Pit and Fremington Quay. Together with exposures at Croyde and Saunton and at Westward Ho!, these stratigraphic reference sites are central to any reinterpretation of Pleistocene events in the region.

References

(Figure 7.5) The Pleistocene sequence towards the western end of the Fremington Quay exposure. The vertical 'pipe' structures are infilled with lighter-coloured silt and clay, and penetrate beyond the base of the exposure: they may be frost or desiccation cracks (Wood, 1970). (Photo: S. Campbell.)



(Figure 7.6) The Quaternary sequence at the eastern end of the Fremington Quay exposure. (After Croot et al., in prep.)



(Figure 7.2) The extent of the Fremington 'boulder-clay' according to Maw (1864), and proposed stratigraphical relationships in the Fremington area. (After Maw, 1864, Mitchell, 1960 and Kidson and Wood, 1974.)

(Figure 7.7) Members of the Quaternary Research Association discuss possible evidence for glaciotectonism at the base of the Pleistocene succession towards the eastern end of the Fremington Quay exposures. (Photo: S. Campbell.)