ART. I – *The distribution of some archaeological sites in relation to features of Holocene coastal change.*
By T. CLARE

THERE is now general acceptance that the present trend of rising sea levels will have adverse impacts in some areas, including the potential to 'drown' data of archaeological interest currently available at low tide. However, it is also apparent from the palaeo-environmental record that sea levels have fluctuated relative to the land throughout the Holocene (Tooley and Shennan, 1987) and that such changes have been accompanied by related if independent processes of sedimentation and erosion (Zong, 1993). In this context one might expect former coastal changes to have caused differential preservation of archaeological data, for example by burying or eroding sites, and some surviving sites to represent a human response to those changes. The purpose of this paper is, therefore, to explore how sea level changes provide a context in which to interpret and question the present archaeological record. As such it should be seen as extending the general survey of England's Coastal Heritage (Fulford *et al.,* 1997).

The general pattern of Holocene sea levels and some archaeological sites

The pattern of past sea level changes in north-west England have been extensively studied (e.g. Tooley, 1974 and 1978; Zong, 1993 and 1996) and the record shows that since the last ice age (during the Holocene) sea levels have risen by more than 15 m. One result of this rise was the drowning of some areas of limestone pavement (Plate 1) providing, thereby, areas where, by comparison with terrestrial surfaces, the extent of Holocene weathering can be studied. Another result of sea level change has, however, been the accumulation of deposits leading to the growth of land in some areas, most noticeably along the Solway Coast north of Dubmill Point (Fig. 1a).

However, the general post glacial sea level rise has not been continuous as the land has itself adjusted isostatically to removal of the weight of ice. One important result of this adjustment is the fact that, for most of Scotland, the land has risen faster than sea levels so that prehistoric land surfaces are now above rather than beneath the estuaries and current marine areas, whilst further south sea levels have overtaken the rise in land, so that prehistoric land surfaces will tend to be buried (Fig. 1b). In this context it is possible to suggest that the distribution of the earliest archaeological sites may have been distorted: that south of the Solway they may have been buried by subsequent sea level rises. It may, therefore, be significant that two *putative* maglemose points found in Cumbria came from the southern side of the Solway estuary where they were found on top of shrunken peat 'evidently part of an ancient estuary' (Hodgson, 1895).

It is also possible that key sites for understanding the mesolithic-neolithic transition may be buried. For example at Silverdale Moss, Oldfield encountered charcoal which he thought might be from a settlement below the marine layer

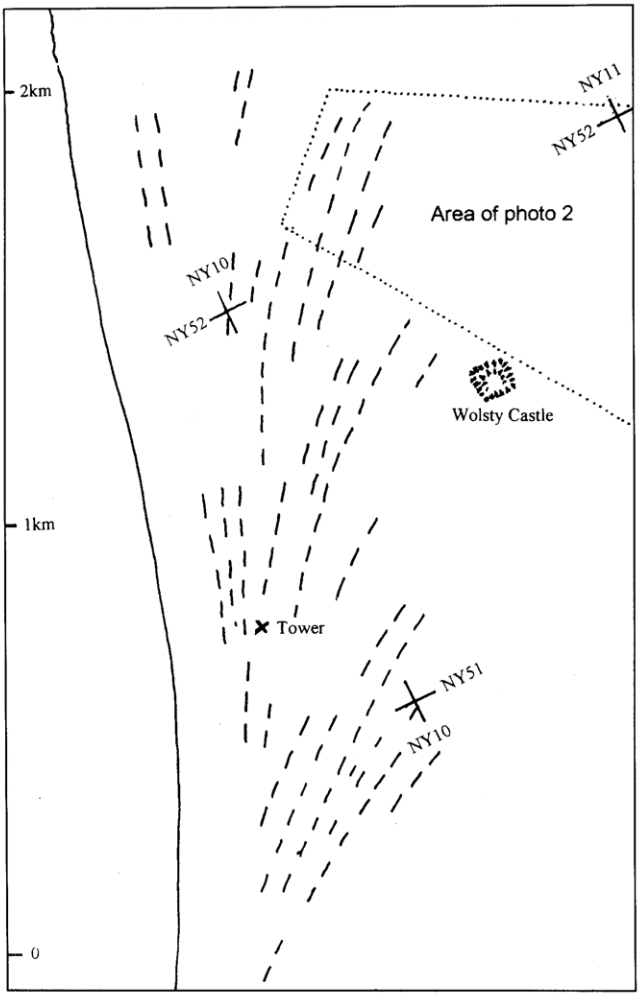

FIG. 1a. Ridge lines within raised beach deposits show how the land north of Dubmill Point grew in the early Holocene and how they provide a context in which to view archaeological sites. *Based on NRSC air photo 42 97 306.*

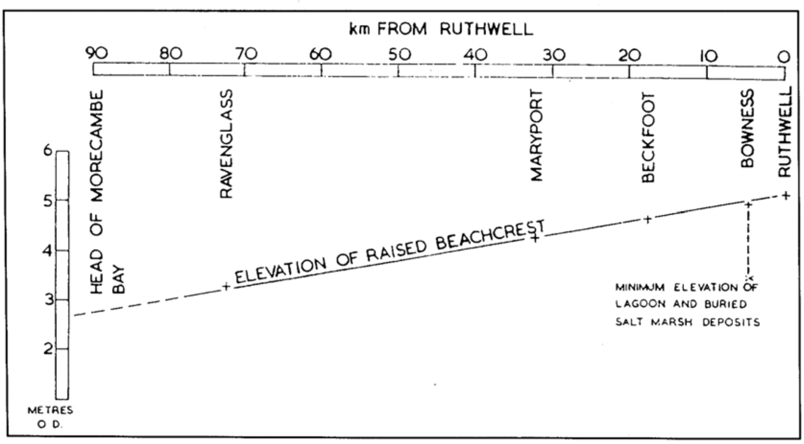

FIG. 1b. The difference in the height of the land relative to sea level along the Cumbrian coast. *Based on Walker 1966, Fig. 30.*

(Oldfield *pers. comm*) which appeared to divide pollen zone Vlla (Oldfield, 1960). Although later attempts to obtain radio carbon dates for this transgression proved problematic (Oldfield, 1965) it is probably the same as that recorded on Merseyside with dates of 5900-5615BP (Tooley, 1978). However, it is also apparent that this transgressive phase had ended a little before the elm decline at Ellerside Moss in the Leven estuary (Godwin and Willis, 1961), in the Lyth valley (Smith, 1959) and at High Hyton, Bootle, where peat formation had begun by 5480±70BP (Beta 134769).

Features associated with late glacial and early Holocene changes as a context for understanding sites

Raised beaches

In the area north of Dubmill Point (Fig. 1a) the ridges of the raised beaches associated with early Holocene seas provide a topographical context for later sites such as Wolsty Castle and the 'native settlement' at Wolsty Hall (Blake, 1959). Like many such settlements in the Solway area (Higham, 1986; Bewley, 1994), the latter settlement appears to have been placed to utilise the properties of one ridge (well drained, warm ground less prone to flooding than the surrounding areas) but the fact that its field systems cross the troughs between the shingle ridges (Plate 2) means that there is a potential to recover palaeo-environmental area for the contemporary landscapes.

Valley sediments

One effect of land-sea level adjustments can be seen at Furness Abbey where the medieval builders had to construct their walls on timber piles (Kendall, 1880). The reason for this was that the valley floor consists of sediment; the product of the rapidly rising sea infilling the lowest parts of the fluvio-glacial channel. Once this adjustment had been made a period of relative stability ensued with local sedimentary sequences, including peat and colluvium, occurring. It is these deposits which provide the context for the buildings discovered north of the Abbey (Kendall, 1880) and the metalled causeway at Thwaite Flat (Brady, 1971) and, slightly further afield at Pennington, the stone axes found 'twelve feet down' (Barber, 1869, 30). However, in addition to providing contexts for archaeological artefacts such deposits also form a stratigraphic record of environmental change, which might include the local effects of human impact.

At St. Bees the priory is built at the side of a similar channel and there too one might expect a complex localised sequence of deposits (Walker, 1956 and 1966 for one such deposit of the early Holocene). It is, therefore, possible to envisage the mesolithic sites here (Cherry and Cherry, 1983) as being located above and adjacent to a valley floor characterised by areas of mire and pools. What may also have made this particular area attractive to settlement was, however, the ridge of drier ground, which almost closes off the western end of the valley, effectively separating the sedimentary sequence of the latter from the submerged forest with a date of 7790±160BP (British Nuclear Fuels plc *pers. comm.*).

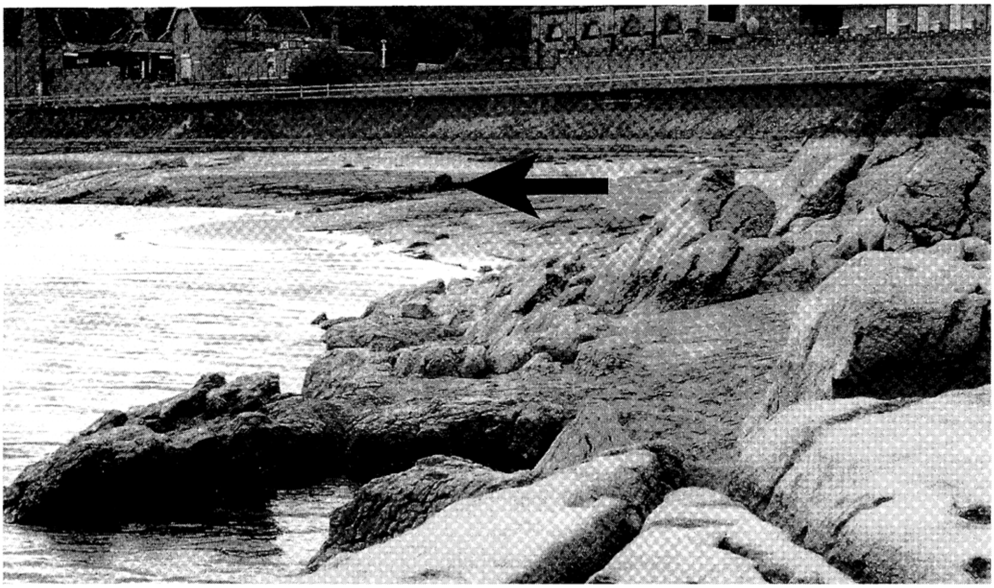

PLATE 1. Below Morecambe Bay: limestone pavement and a tree stump (arrowed) briefly exposed by channel shift near Grange Railway Station.

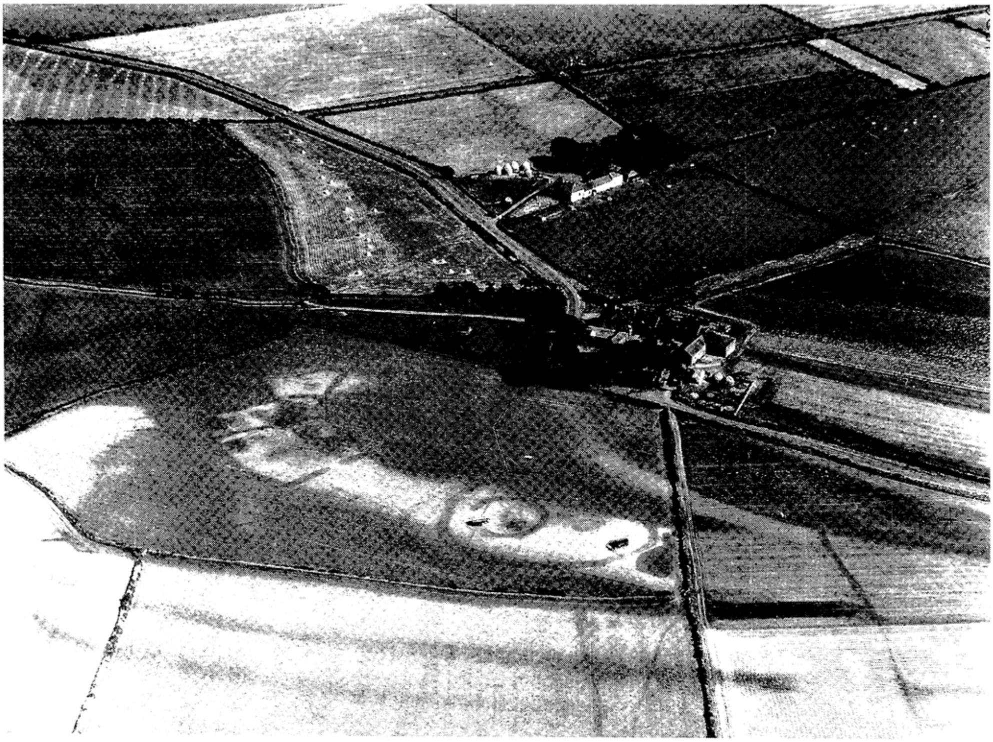

PLATE 2. The field system of the native farm at Wolsty Hall in relation to the ridges of the raised beach. Note the accumulation of material – appearing as dark lines – between the ridges.
Source: St. Joseph Air Photographic Collection, Cambridge.

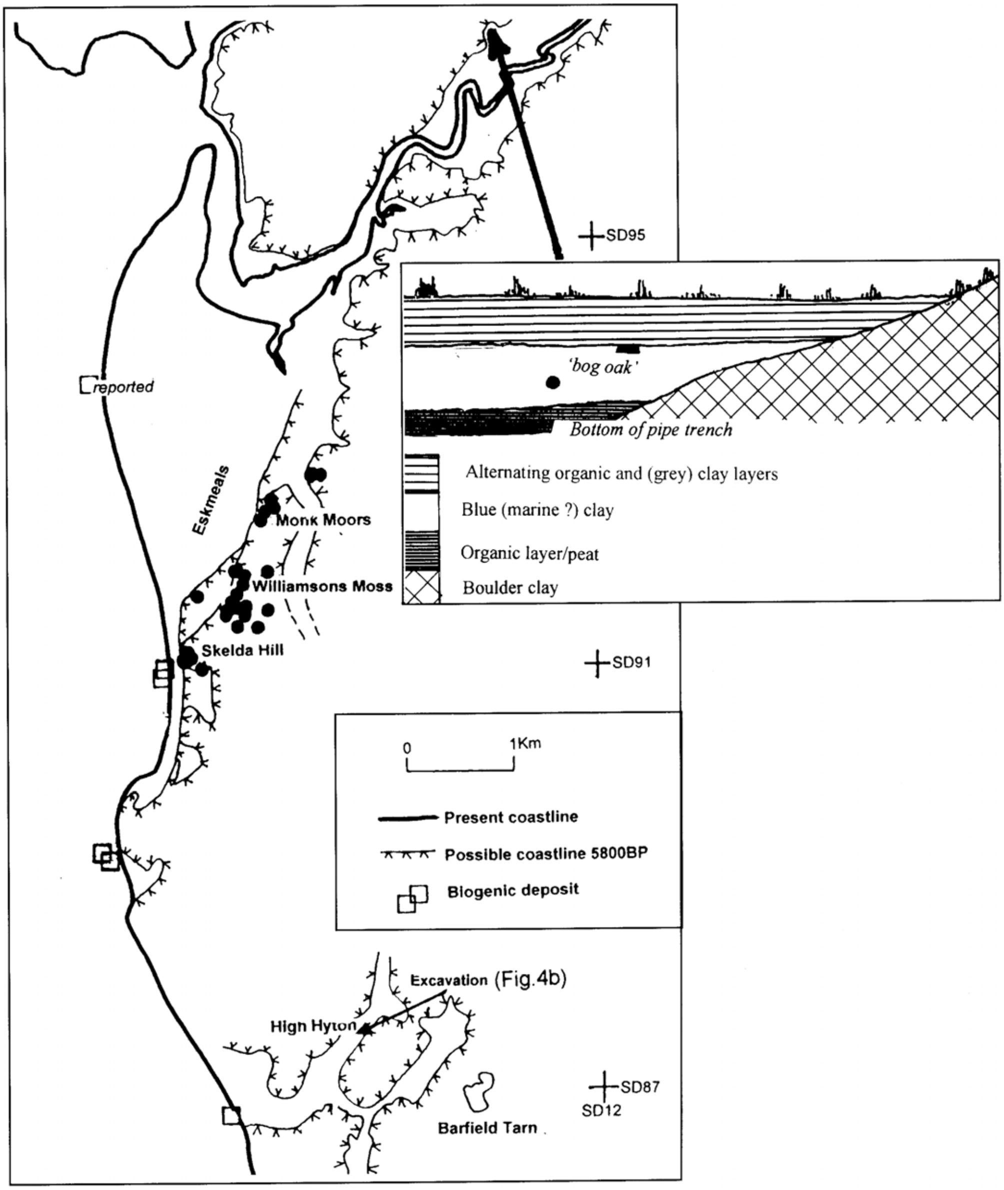

FIG. 2a. The present coastline south of Ravenglass in relation to the distribution of mesolithic and neolithic flints sites, biogenic deposits on the foreshore and the coastline *c.* 5800BP.
Based on Bonsall et al 1985.

FIG. 2b (INSERT). Schematic section of the stratigraphy north-east of Muncaster Castle briefly revealed during pipeline construction.

Biogenic deposits including 'submerged forests'

These represent one type of buried land surface and have long been known. West, for example, described the journey from Hawcoat round the coast of Furness as 'dangerous and disagreeable' on account of the pits dug through the sands to obtain the peat beneath (Close, 1818, 20). The significance of such deposits is, however, that apart from providing localised information about relative sea levels they also provide a unique opportunity to study the macrofossil remains of ancient habitats not available through palynology. Most importantly, they allow the spatial distribution of particular species and the age and size of individual trees to be recorded and, therefore, provide an opportunity to study the extent to which fossil pollen recovered from a single core allows reconstruction of past landscapes (Clapham, Clare and Wilkinson, 1997).

In the vicinity of Morecambe Bay 'submerged forests' were first described, in detail, by Gaythorpe (1896), Kendall (1900) and Reade (1902) and subsequent coring suggests that in the main part of the Bay they lie on fossil interfluves between palaeo-channels of the Leven, Kent and Keer (Tooley, 1974, Fig. 5). Indicative dates obtained by Tooley (1978) are 5435±105BP, 7995±80BP, 8740±65BP and 9720±200BP, and the latter date might also be compared with the marine sediments on the foreshore at Glasson (on Solway) assigned by Walker to pollen zone 3 (Walker, 1966, 135-139). The fact that early Holocene deposits are exposed on the beach at Glasson and buried in Morecambe Bay is consistent with the effect of isostatic adjustment noted above (Fig. 1b).

However, it is also apparent that biogenic deposits and submerged forest remains can belong to other phases of land-sea adjustment. At Eskmeals (Plate 3) and at nearby Annaside, for example, such remains (Fig. 2) date to *c.*7300BP and *c.*6600BP respectively; dates which appear to correlate with two brief periods of marine transgression recorded in the Leven estuary by Zong (1993 & 1998 and Fig. 3 here) and dated to 7750BP and 6680BP. The earlier of these dates is also similar to the date for St. Bees (7790±160BP) noted above and the date from Allonby of 7620±70BP (below), whilst the later date compares with the 'second emergence of the basin above marine influence' recorded at Bowness Common by Walker (1966, 133).

Fossil tidal creeks

These represent another former surface; essentially that of salt marsh. Today, these areas can be seen as earthworks, as in the area to the south of Conishead Priory, or as cropmarks (Plate 4). For archaeologists their principal interest is that they are indicators of a once tidal area; that they represent a specific type of intertidal environment which may well have been attractive to grazing animals; and that they may contain artefacts or other objects of interest. For example, the red deer discovered at Bardsea appears to have been in one channel and as such may have been washed or dragged in from another locality (Middleton, 1992, 27).

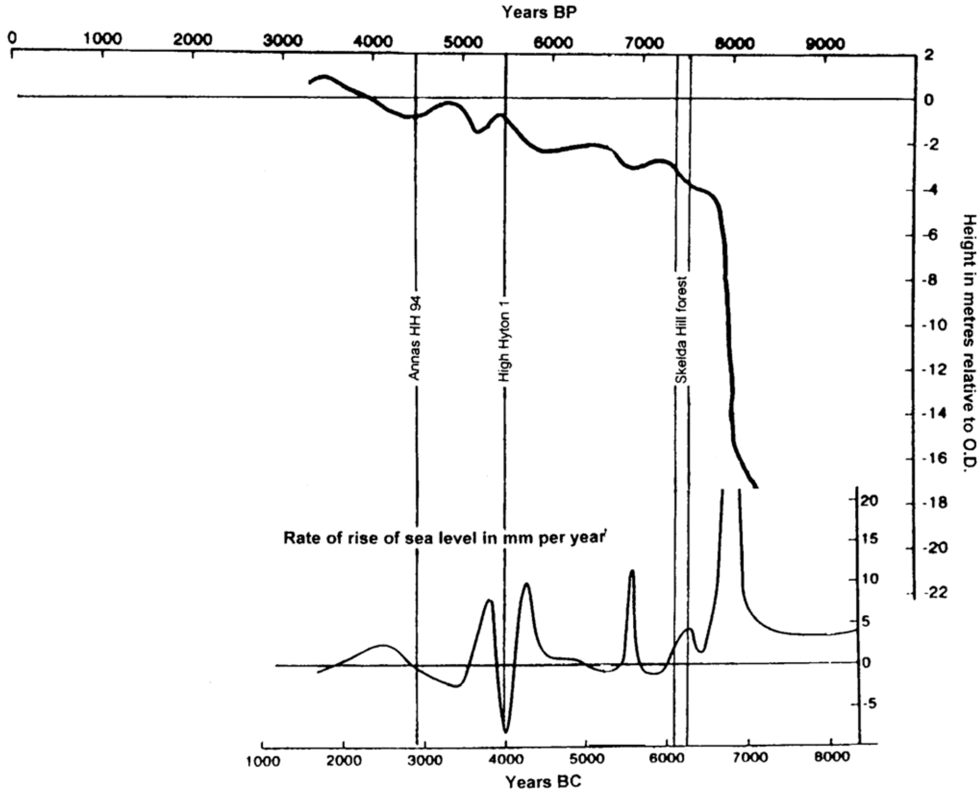

FIG. 3. A comparison of the sea-level curve for Morecambe Bay and the dates of stratigraphic changes in the Ravenglass-Bootle area. *Based on Zong 1996, Fig. 7.*

Other buried surfaces.

In some cases trees from 'submerged forests' have been washed into other deposits. 'Bog oaks', for example, were recovered from marine clays north-east of Muncaster Castle during construction of the gas pipeline in 1992 (Fig. 2b). Similarly, the fossil tree visible on the beach near Goadsbarrow, south-east of Barrow, is said to have been discovered when the promenade was constructed, and to have been within the raised beach, which in turn overlies an area of marine sediments associated with quieter conditions and the fossil tidal creeks recorded in Plate 4.

Localised processes and sequences

The sequence at Goadsbarrow demonstrates that one marine deposit indicative of a particular process and time can overlie another (Fig. 4a for this situation in general). It is, therefore, necessary to recognise that localised conditions and processes may have buried some surfaces, including some of those mentioned above. At Bowness, for example, Walker (1966) considered the sequence to reflect the breaching of a beach barrier or channel shift, and similar explanations might also apply to the later transgressions noted around around Morecambe Bay by Smith (1959, 120), where one such episode in Arnside Moss was dated to 1545±35BP (Tooley, 1978).

PLATE 3. The biogenic deposit at Skelda Hill looking southwards.

PLATE 4. Cropmarks of fossil tidal creeks near Goadsbarrow. *Source: T. Clare/Cumbria SMR.*

Walney Island and Barrow

It is also possible that some dune systems, from which artefacts have been recovered, may have advanced across areas which were once open, or across the surface of old dune systems which had been 'blown out', burying quite different land surfaces which were the original context of the artefacts. On Walney Island, for example, it is possible to suggest some of the flint scatters found in dune slacks (e.g. Barnes, 1970) represent exploitation of land originally to the leeward of dunes: a possibility suggested by the existence of peat deposits on Walney Island (Kendall, 1900; Oldfield, 1971). Indeed West stated the island 'lies upon a bed of moss, and all round the island, moss is found by digging through a layer of sand and clay which covers it' (Close, 1818, 18). In future, therefore, it will be necessary to seek to identify the existence and nature of any buried land surface and to establish and date the stratigraphy of the adjacent dunes.

It would, however, be a mistake to assume that the present surface of the Island and adjacent mainland has developed over a single surface representative of a single

TABLE 1: The context of stone axes in the Barrow and Walney Areas (The Furness peninsula west of northing 80) in relation to buried or marine surfaces

SMR No.	NGR	Artefact	Context
2201	SD200760	stone celt'	shore
2300	SD227746	axe hammer'	unknown
2302	SD228742	perf. Axe'	unknown
2304	SD214704	stone axe'	unknown
2593	SD207694	frag. Polished axe	less than 4ft down
2710	SD195726	2 axes	ancient tarn'
2717	SD193701	polished axe	3ft down in boulder clay
2718	SD180740	polished axe	shingle
2719	SD180740	polished axe	scar above channel
2725	SD183694	axehammer with tar coat	5ft down
2729	SD185683	Macehead	Clay 4ft down
2730	SD186681	axe hammer	surface
2731	SD176677	polished axe	shore
2740	SD190660	axehammer	in a wall
3970	SD185685	frag. Polished axe	digging a grave
4383	SD219739	unfinished	unknown
5598	SD170725	polished axe	surface
5600	SD216701	polished axe	garden
5601	SD180670	polished axe	unknown
6394	SD227743	axehammer	surface
17931	SD195717	roughout	in 2ft of clay

environment, for Oldfield (1965, 250-251 & 1971) demonstrated that the peats on the foreshore of Walney Island included both lacustrine and lagoonal deposits. The significance of the latter is that the flint scatters either side of the Barrow Channel may have related to exploitation of a lagoon or estuary rather than the coast as previously assumed.

It is also apparent that, without new analysis, it is not possible to assume that the peats recorded by Kendall (1900) on Old Barrow Island are those of a 'submerged forest' rather than a freshwater lagoon. Two clues to the context for the deposition of the lowest peats are, however, provided by the recorded thickness of the peat and the reported macro-fossil remains. Of these, the depth (30ft+ in the deepest part) suggests that they formed in a basin mire isolated from the sea as Kendall inferred. However, it is unlikely this had grown 'uninterruptedly without break of any kind from the end of the glacial period up to the present time' as 'alders' were amongst the tree species found in the 'lowest layers', and alder would not have colonised the area until sometime after 8500BP (Chambers and Price, 1985 for early dates along the coast and Chambers and Elliott, 1989 for early dates in general).

Within the area other artefacts than flints can also be seen in the context of these biogenic deposits and/or lower sea levels/buried surfaces. Table 1, for example, records the depth at which stone axes in the area have been found, whilst Kendall (1900, 60) noted the discovery of a broken antler of 'Irish Elk' 17 ft below the surface and, near Rooseholme, 'the horns and perfect skeleton of a red deer' (Kendall, 1880, 58 and 60). The particular context of the latter is said to have been a 'curious bank of gravel and sand' and it may have been a fossil creek or a deposit similar to that excavated at High Hyton (Clare, 1994 and Fig. 4b here), for Kendall also notes that, 'interstratified with the sand and gravel were thin beds of black earth, almost like the remains of leaf beds'.

Ravenglass-Bootle

In this area the earliest visible 'submerged forest' remains (Plate 3 and Huddart and Tooley, 1972, 68-69) indicate the early Mesolithic coastline lay somewhere to the west of (and below) the present one. About 7000BP this coastal lowland was inundated and a broad shallow embayment created north of Skelda Hill and at the mouth of the Esk and it was this new environment which provided the context for the earliest recorded settlement in the area.

It is also apparent that, from at least 7000BP onwards, the coast south of Skelda Hill (Fig. 2a) has had a very different history from that to the north. In particular, whilst the area to the north had accumulation in the form of shingle ridges and sand dunes, that to the south was subject to periodic submergence and inundation with, presumably, some (local) erosion. This difference provides a further context in which to review the distribution of later mesolithic sites (Fig. 2a) discussed by Bonsall *et al.* (1985) and Cherry and Cherry (1996) but it is unlikely that coastal changes alone are the reasons for the absence of sites south of Skelda Hill, for later archaeological data is also missing, even when the macrofossil record indicates the proximity of settlement as at High Hyton (Clapham *pers. comm.*). Nevertheless it is evident that interpretation of the distribution of artefacts and sites needs to take into

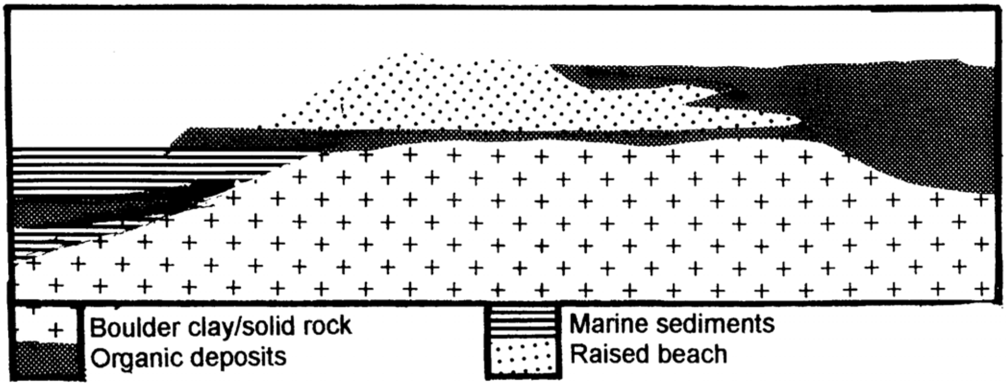

FIG. 4a. The potential stratigraphic relationship of various coastal deposits. Note how some peats to the rear of the raised beach may have continued to develop throughout the Holocene.

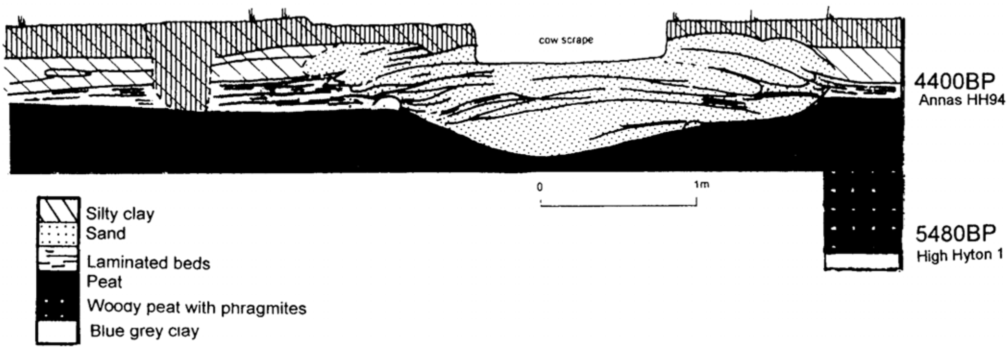

FIG. 4b. The stratigraphy of the valley floor at High Hyton based on Clare 1994, Fig. 2.

account possible burial by later marine deposits or colluvium whilst other, contemporary sites, originally located to overlook estuaries, might now appear in a terrestrial context.

At High Hyton, however, the stratigraphy of the valley floor (Fig. 4b) provides further evidence for sea level changes, for there the formation of the peat, which began 5480±70BP, represents colonisation of a marine surface (the clay) which belonged to a late mesolithic transgression. Interestingly, therefore, the date of the earliest 'platform' at Williamsons Moss (5500±70BP, Bonsall *et al.* 1985 Table 1) dates to the end of this transgression and the subsequent colonisation of some lagoons and estuaries by phragmites.

Prehistoric settlement raised mires and lagoons

In the lower Lyth valley the extant areas of peat show that a raised mire developed on a marine surface at a time probably contemporary with those at High Hyton. However, subsequent peat cutting has removed all but the lowest few centimetres of the resulting biogenic deposits so that the record is now far from complete. Nevertheless, finds such as the bronze dagger (Clough, 1969, Fig. 5), which may have been a ritual deposit like that of the Salta Moss rapier, and the 'corduroy trackway' reported by Barnes in 1904, show that the area was being exploited in prehistoric times and that prehistoric settlement may lie nearby.

Quite what that exploitation was is not clear and Barnes may have been correct in assuming that the trackway was built simply to facilitate communication across the valley floor. This implies, however, that there was a substantial population in the area and in this context it is necessary to re-evaluate known sites. In particular, attention is drawn to the settlement site on Sizergh Fell (RCHM, 1936, 157). Whilst this appears to have been built over an earlier burial – itself of late prehistoric date – it is adjacent to what might be an earlier hut circle and a possible cairnfield. However, there is no reason why the cairnfield should be Bronze Age in date for at Barnscar a similar site appears to be associated with a settlement presumed to be of Roman-post Roman date (Pennington, 1970, 72). Nevertheless, the finding of 'a stone axe and several flints' nearby (SMR 4315) and in nearby Levens Park (Sturdy, 1972; Robinson, 1982; Cherry and Cherry, 2000) are indicative of prehistoric settlement being located near to the former estuary and its tributaries, and their associated habitats.

Certainly it is likely that the prehistoric population would have regarded the mire as an area to be exploited rather than (simply) a barrier to communication. For example, once established, the area would have offered the opportunity to fowl, and the surface, itself a mosaic of habitats, would have been available for grazing when the water table permitted. Something of that variety of habitats, not recognisable in the palynological record, is provided by macrofossil analysis of High Hyton, where there was birch carr and areas of shallow standing pools or slow moving water and, nearer to the edge of the valley, yellow flag iris, water mint, sedges and rushes as well as bramble and stinging nettle (Clapham *pers. comm.*).

Here, however, particular attention is drawn to the fact that the 'reed swamp' (characterised by *phragmites),* which developed on the former marine sediments at the end of the late mesolithic transgression (Smith, 1959 for this sequence in the Lyth valley; Walker, 1966 for Bowness-on-Solway; Tipping, 1994 for Eskmeals), would have provided an environment attractive to ungulates such as red deer and aurochs. In Denmark, for example, 'it would seem that the narrow lacustrine zone between the forest edge and open water would have represented the optimum ungulate resource zone' in the mesolithic, and in the neolithic 'unimproved swamp grazing' of the type still prized in parts of Europe (Bay-Petersen, 1978).

That such a situation, inferred for Danish areas, actually existed in north-west England is demonstrated by the work of Roberts at Formby, where late mesolithic-neolithic hoof-prints of auroch, red deer, pig and other animals have been preserved adjacent to what was probably a lagoon (Roberts, *et al.* 1996). There can, therefore, be little doubt that the areas of former marine incursions would have proved attractive to both mesolithic and neolithic farmers and it is in this context that we must review settlement evidence in Cumbria including that around the raised mires and basin mires of the Solway. In particular the above view supports the finding of Bewley that part of the resource territory of individual farms included wetland areas (Bewley, 1994, Fig. 5) whilst former lagoons have been noted above at Eskmeals, on Walney Island and at Bowness-on-Solway.

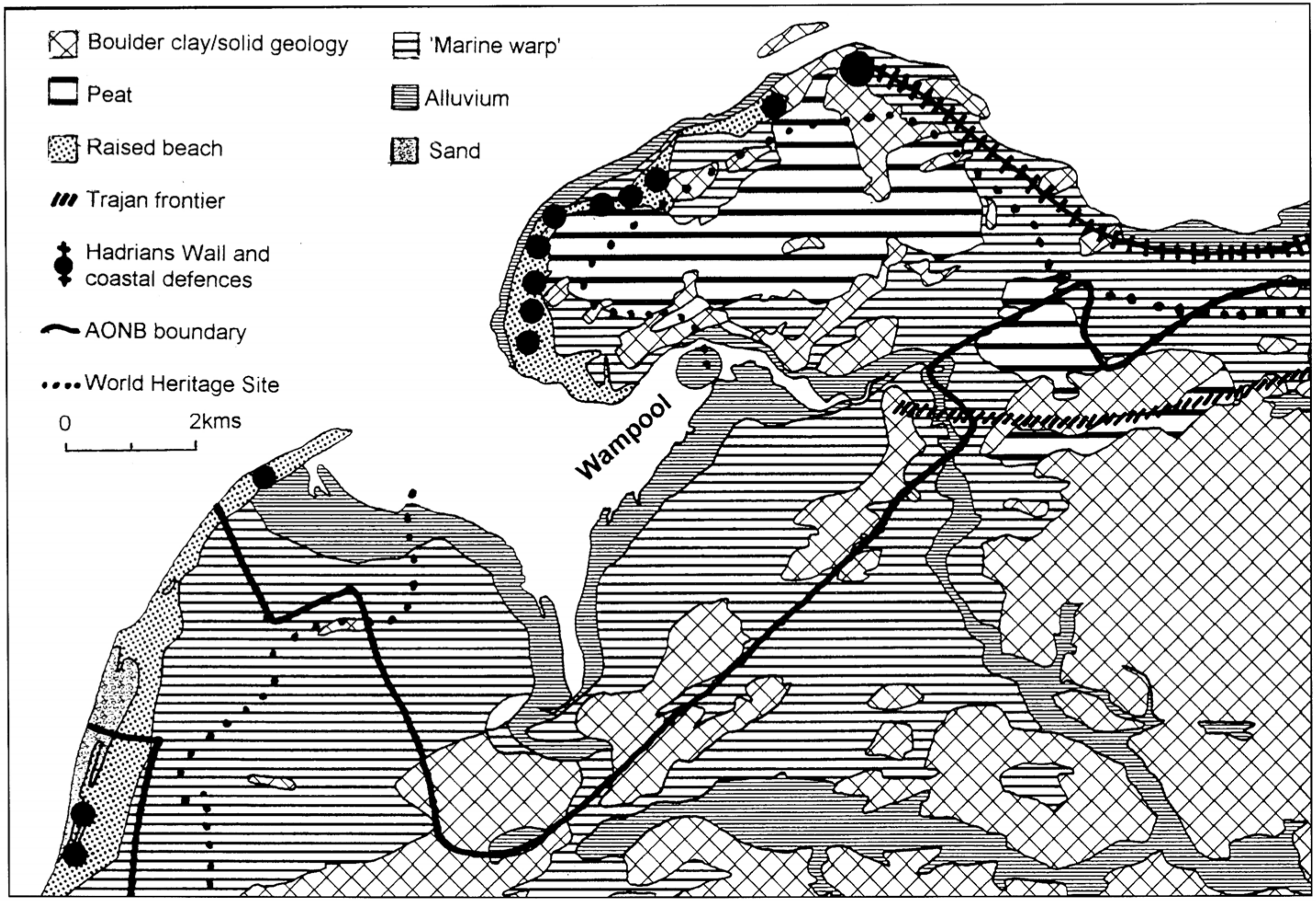

FIG. 5. Hadrian's Wall and the Stanegate in relation to drift geology and designated areas.

Hadrian's Wall and the Stanegate

The raised mires and other topographical features resulting from Holocene coastal processes in the Solway area also provide a context in which to evaluate the strategic thinking behind the Roman frontier (Fig.5). In particular, attention is drawn to the fact that the Stanegate frontier runs along the northern edge of that area which does not have marine or biogenic deposits, whilst the effect of constructing the Hadrianic frontier to the north was to include land which was predominantly raised mire and raised beaches. Note, however, that the Wall proper ended on the last boulder clay headland.

This difference in the location of the two frontiers may simply reflect the fact that the Stanegate frontier was based on an existing road to an existing fort, which was also on a navigable inlet (Kirkbride), but it may also be more significant and reflect the conceptual thinking behind the Wall as a 'frontier'. In particular, it is consistent with the idea that the Stanegate was a practical, operational frontier and that the Wall was more 'symbolic'. In this interpretation, symbolism required the Romans to include bog within the empire rather than be seen to exclude any land.

At first sight such an interpretation is at variance with the fact that, immediately east of Bowness-on-Solway, (Fig. 6a), the line of the Wall was inland, effectively excluding an area of boulder clay. The reason for this has been discussed elsewhere (Clare *submitted)* and all that need be noted here is that the area to the east of Bowness-on-Solway, was prone to flooding and that at times tides may well have washed right up to the Wall (Fig. 6b).

Whatever interpretation is put on Fig. 6a it is evident that there is a need to evaluate or establish the coastal environment east of Bowness-on-Solway, at the time when the Wall was built. East of Drumburgh, for example, its line has been lost to erosion, a situation which may have led Kendall to date his upper peat beds to the post Roman period (Kendall, 1880, 60). As noted above, however, we know now that Kendall's peats were pre-Roman although a localised marine incursion is recorded at Arnside Moss in post Roman times (above). Nevertheless, whilst a marine transgression might have removed part of the Wall, and the north wall of Bowness fort (Birley, 1931, 142), it is also possible erosion was caused by a shift in the channel of the Eden within the estuary. Such an explanation may also apply to the Wall length lost east of Drumburgh but the possibility that the erosion there occurred in Roman times should be considered.

Other localised changes and the Roman coastal defences

As indicated above, the coastal defences west of Bowness-on-Solway were constructed primarily on raised beaches although in some areas, such as that immediately south of Silloth, the sites are now within a dune system (Bellhouse, 1966). The Roman use of the existing coastal features is, however, probably best appreciated immediately west of Bowness and between Maryport and Allonby, where they utilised the early Holocene cliff line and/or raised beaches, and where there appears to have been little change in the coastline during the last two thousand years. However, between Allonby and Dubmill Point, substantial erosion has been postulated in order to accommodate a regularly spaced sequence of towers and milefortlets (Bellhouse, 1986 and 1989, Fig. 11).

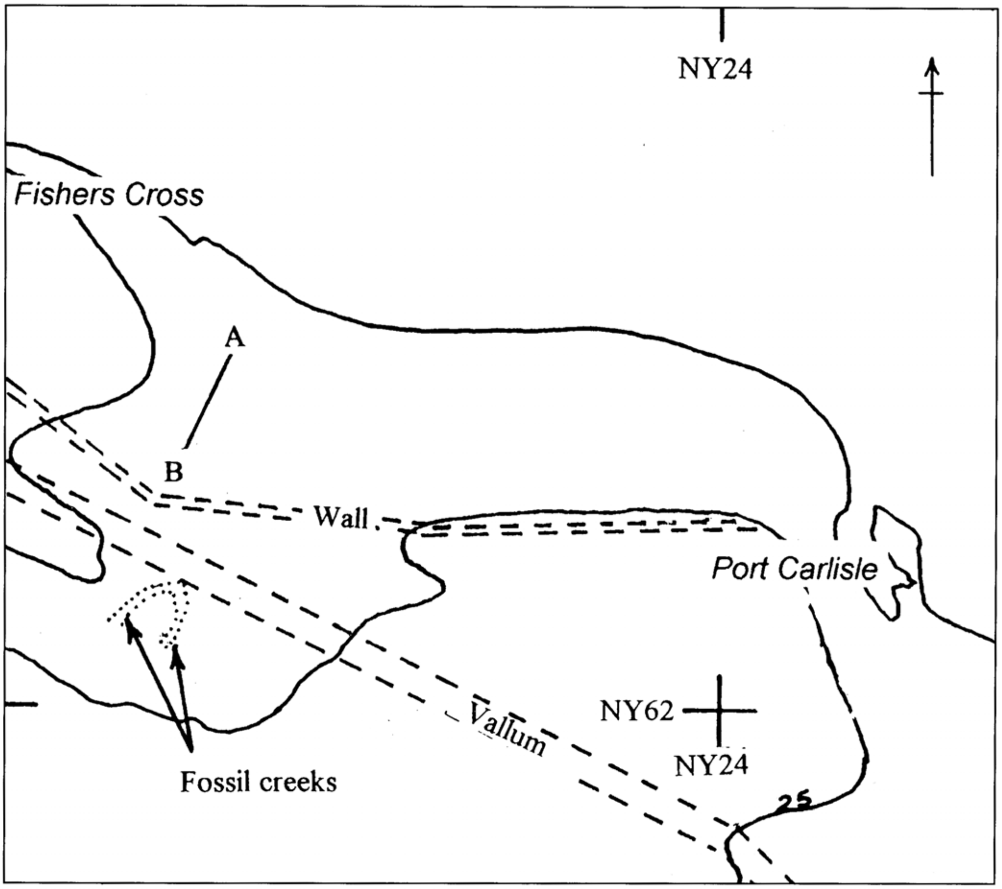

FIG. 6a. Fossil tidal creeks and the line of Hadrian's Wall between Bowness-on-Solway and Port Carlisle. Note the creeks do not extend north of the Vallum and that the Wall did not take the shortest distance between high ground.

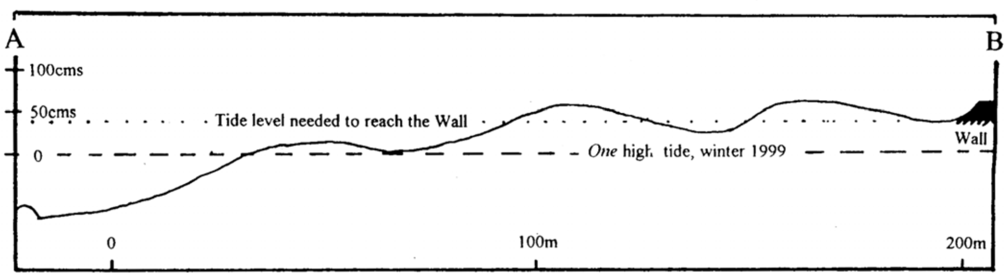

FIG. 6b. The present extent of high tides and the earthworks of the Wall between Bowness and Port Carlisle suggesting the Wall system may have limited tidal incursions.

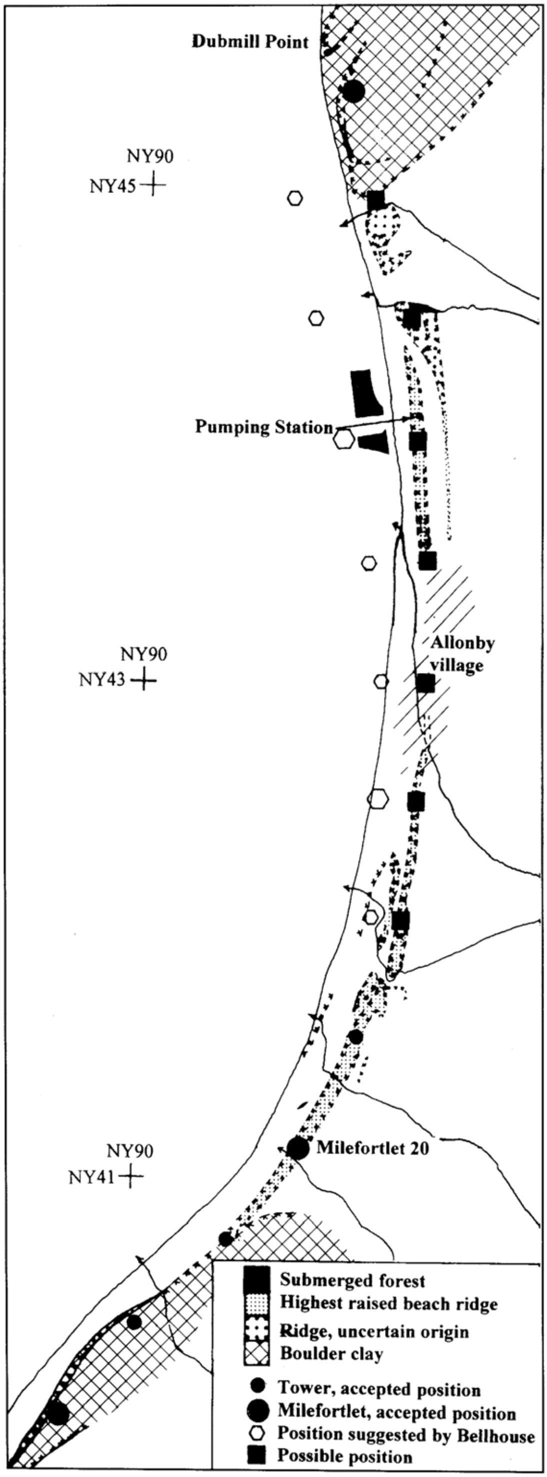

FIG. 7. The distribution of Roman sites and features of Holocene coastal change in Allonby Bay.

However: the existence of biogenic deposits on the beach north of Allonby (Huddart and Tooley, 1972, 64) requires the nature of this postulated erosion to be questioned. The remains, briefly revealed in 1993 and dated to 7620±70 BP (Beta 129611) are clearly those of a land surface which developed in front of earlier Holocene raised beach deposits. Borehole data obtained for construction of a nearby pumping station shows these raised beach deposits extend to a depth of at least 12 m and that, therefore, they effectively provided a barrier behind which the basin mire of Black Dub developed: a situation similar to that observed for Bowness Common by Walker (1966, Fig. 25: see also Fig. 4 here). In short, the observed stratigraphy in Allonby Bay shows that the submerged forest developed on a marine surface in front of the early Holocene coastline represented by the extant raised beach, whilst Bellhouse's theory requires that forest to have been buried by deposits which were subsequently eroded back to the early Holocene coastline.

Although the latter sequence is not impossible it is not necessary to postulate substantial erosion in the Bay, for all of the missing Roman sites can be accommodated down the centre of the highest extant ridge: a ridge on which Tower 19B and Milefortlet 20 are located (Fig. 7). As argued elsewhere (Clare *submitted)* this arrangement suggests that the coastal defences were laid out not from the fort at Maryport but from Dubmill Point, which on the evidence of Fig. 1a appears to have been in existence throughout the Holocene. The advantage of this interpretation is that it does not require any 'dislocation' of the system south of Maryport but allows for the latter to run beneath the fort down to Risehow, as suggested by Daniels (1990, 401).

Recent air photographs of Skinburness Grune also suggest that erosion since Roman times may have been over estimated elsewhere. These show the former beach or accretion lines and their alignment (Fig. 8) are flatter than that projected by Bellhouse. On the other hand the loss of fort walls at Bowness (above) and Burrow Walls (Bellhouse, 1955) and the exposure of Roman burials at Beckfoot (Bellhouse, 1958; Hogg, 1962) does demonstrate that some localised erosion was considerable. At Burrow Walls, however, Brian Blake (in Bellhouse, 1955) suggested that the agent of erosion was river swing rather than coastal erosion *per se* and this might also have been the agency at Bowness (above). Whilst the explanation at Burrow Walls would require the river to have been deflected northwards by a spit and then to have broken through this spit (possibly as a result of a storm surge), such a sequence would not be impossible. The point to be made here is, therefore, that the wetland area in front of Burrow Walls, which is protected as a nature reserve, should be regarded as a site of palaeo-environmental interest to archaeology.

That sand dunes may have existed to the seaward of the coastal defences north of Dubmill Point is suggested by the sequence exposed at Beckfoot, where sand dunes overlie an old surface which is probably that reported as containing Roman burials. Whilst this situation is consistent with the idea of sand dunes blowing out and/or migrating landwards, the sediment supply for the post Roman sand hills may simply have been the beach. Certainly beach sediment was the source of the sand dunes which have formed in the last century in front of Allonby (Mike Faulkner, *pers. comm.*).

The possible configuration of the Roman coastline at Maryport has been discussed by Bellhouse (1984, 54-58) where attention was drawn to Stukeley's

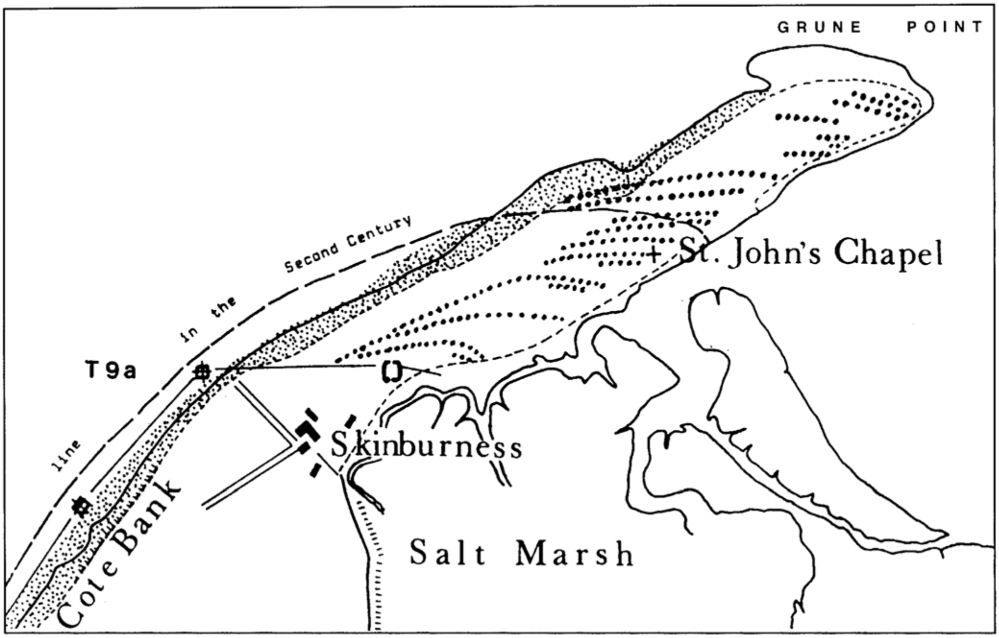

FIG. 8. The alignment of the ridges in Skinburness Grune showing how the feature has grown. Based on Bellhouse, 1989 and NRSC air photos 42 97 306 and 42 97 316.

reference to the old river channel being visible beneath the cliffs. In discussing this, and the suggestion that the river had been deflected north as far as the fort by an extension of that sand bar or by a raised beach on the seaward side, Bellhouse considered that Stukeley saw an elbow or triangle of ground below Castle How which was no longer visible. Quite why this conclusion was drawn is, however, not clear, for such a triangle is visible both on the ground and from the air (Plate 5) and it is associated with an old river channel/loop. It is, therefore, possible that in Roman times the river Ellen entered the sea either in its present position or further south: an interpretation in accord with observations made by the author during building work in the harbour, which showed that the spit now occupied by the docks is principally sand.

That this spit is medieval or later in date is indicated by an OSL date obtained for a beach deposit against the low cliff which forms the western edge of the triangle of land recorded in Plate 5. The beach dated to 910±40 BP (OXL – 1043) implies that in the eleventh century this part of the present river was open coastline, a situation which provides a context in which to view the location of the motte. However, it is also possible that the 'low cliff' was cut into the low lying ground shown on Plate 5, after the Roman period by a rising/eroding sea: a process which could have removed any evidence for the Roman coastline (including, if one wants, a Roman harbour to the seaward of the present cliffs).

Medieval and post medieval sites.

Tradition and historical records suggest that a number of settlements have been lost to marine and coastal changes and that two different types of process have been involved. The first type of process is that sometimes described as a storm surge and the best example of this was the loss, in a single night, of the port of Skinburness: an event which led to the founding of Newton Arlosh. The second type of process is that which might be best described as (long term) coastal erosion and this is best represented in Furness where, for example, West noted that a '. . . great part of the parish of Aldingham has been swept away within these few centuries. There is a tradition . . . that the church of Aldingham stood in the centre of the parish . . . It is said, that not long ago, some part of the ruins of a village called Low Scales was visible on the sands . . . (Close, 1818, 21). West also referred to the loss of half of the motte at Aldingham and to this example it is possible to add Piel Castle and the adjacent earthwork enclosure (Plate 6).

During the same period, however, humans have also 'reclaimed' land from the sea. For example eighteenth and early nineteenth century 'improvements' in the lower Lyth and Winster valleys and the building of the Furness railway led to significant land gain in the Castlehead-Grange area. Similarly, between Arnside and Carr Bank the railway embankment was built in front of an older dyke with sluices, which in turn was built in front of the site of the former salt pans.

However, it is not always possible to determine whether dykes, like those on Walney Island said to have been built by the monks, were originally constructed to 'reclaim' tidal areas (i.e. a winning of new land) or as defensive measures (ie. protection of existing land). Similarly, the dykes built along the southern side of the Morecambe estuary (Fletcher and Miller, 1997) appear to have been originally constructed to win land but became essential for coastal defence. Whatever the reason for construction, it is these areas – perhaps not surprisingly – which are most at risk from rising sea levels.

Two post medieval features which may make little sense once sea levels have risen and covered the sand bars in the Solway are the concrete arrows in the dunes at Mawbray (Scottish Natural Heritage air photo CU 071). Constructed in 1940-41 as 'bombing range direction markers' they indicated which sand-banks were available for target practice. Originally there were three sets, the others being at Allonby and Burgh by Sands. The large arrow was painted white to indicate smoke bombing only whilst the smaller one was painted red for live ordnance and the 'circles and bars were canvass covered, these covers being removed to indicate which range was available' (Mike Faulkner *pers. comm.*).

Conclusion: the need for a considered response of survey and monitoring

The above review shows that archaeological sites may have been buried by Holocene deposits and that present geomorphological features, such as sand dune systems, may not represent the environment contemporary with the use or deposition of archaeological artefacts. Similarly shifts in coastline indicate the need to collect data regarding the environment contemporary with a site. At the same time, however, it is evident that archaeological data can contribute to understanding of earth science processes, sediment sources and basin dynamics over long periods of time and thus contribute to modelling of future changes.

There is, therefore, a need for archaeological research and conservation strategies to reflect these mutual interests. For example, interpretation of the coastal defences

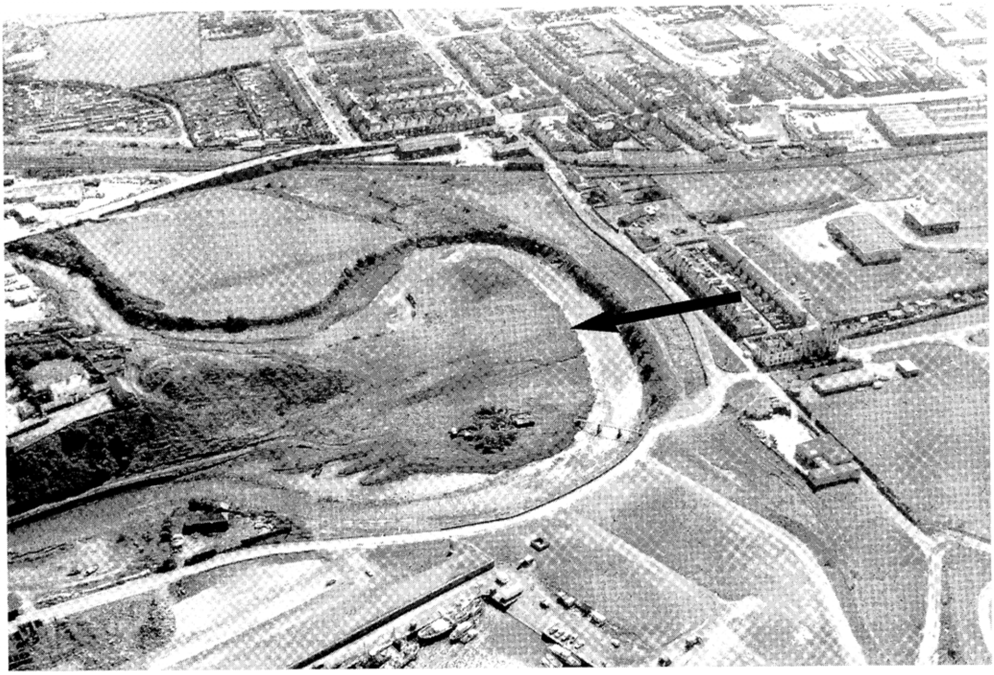

PLATE 5. The river Ellen at Maryport, note the old meander loop and how it formed a triangle of land and the old cliff line in front of which is a fossil beach (arrowed).
Source: T. Clare/Cumbria SMR.

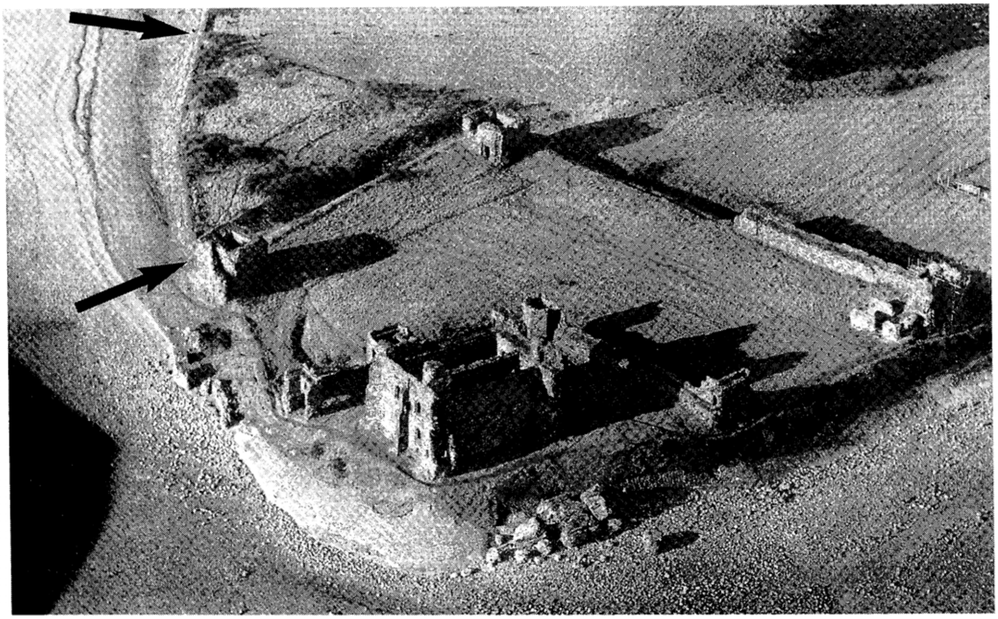

PLATE 6. Piel Castle and the remains of an adjacent enclosure (arrowed).
Source: T. Clare/Cumbria SMR.

of Hadrians Wall requires reference to raised beaches and early Holocene cliff lines and the preservation of these must form part of the strategy of the World Heritage Site (Fig. 5). At the same time, however, there is a need, e.g. in the Muncaster and Barrow areas, for archaeologists monitoring planning applications and other development proposals to be aware of the potential scientific data likely to be provided by a proposal, regardless of whether tangible archaeology is present. As Kendall observed, when reporting the peat deposits in Barrow Harbour just over one hundred years ago, there is 'no distinct line of demarcation between the geological and historical, or between the historical and pre-historical'.

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