Holy Island

[NU 136 418]

A. Plater

Introduction

Holy Island, Northumberland is noted not only for outstanding coastal geomorphology but also for its morphological and sedimentary evidence of late Quaternary sea-level trends. The coast around this mantled outcrop of Whin Sill dykes and adjacent tidal flats is almost devoid of development, allowing virtually unabated development of dunes, blow-outs, barrier beaches and cliff exposures. Relict coastal features also are present in the form of emerged ('raised') beaches that can be traced on Holy Island itself and on the mainland at Beal Point, Whitelee Letch, and west of Ross Links (Gunn, 1900; Hogg, 1972; Plater and Shennan, 1992). The raised shoreline on Holy Island is a cliffline cut into glacial diamicton associated with a series of gravel spits and bars, often truncated, and locally intertidal lagoonal deposits. Recent work has revealed additional sedimentary evidence of Holocene sea-level trends in the region of Elwick immediately to the south of Fenham Flats (Plater and Shennan, 1992), and at Bridge Mill to the northwest of Beal Point (Horton *et al.,* 1999a). At these sites, intercalated sequences of minerogenic and organic sediments reveal the nature and extent of coastal change. Hence, the region of Holy Island preserves morphological evidence of a high post-glacial shoreline and a stratigraphical record of mid-Holocene sea-level trends.

Description

Although raised post-glacial shorelines are well developed in south-eastern Scotland (Sissons, 1983), they are relatively rare in eastern England. Examples such as the Easington raised beach in County Durham now appear to date from Oxygen Isotope Stage 7 (Bowen *et al.,* 1991), although it was first thought to be Late- glacial or post-glacial in origin (Woolacott, 1922). This absence is clearly a spatial function of relative rates of isostatic crustal rebound and sea-level rise (Lambeck, 1991, 1995). The coast of Northumberland is perhaps unique in this context as the low-raised beach features identified in the vicinity of Holy Island by Gunn (1900) appear to be Holocene in age.

Facets of raised beach features are preserved at Beal Point, Whitelee Letch and west of Ross Links. Gunn (1900) records a low-altitude raised beach of considerable extent at Whitelee Letch, approximately 2 m above the high water mark. This was said to be composed of silt and grey clay with traces of marine shells and having a border of shelly sand along the coast. Hogg (1972) carried out a detailed survey of this feature, the base of which was levelled at +7.01 m OD and noted as being best developed in the region of [NU 1183 3775] (Figure 8.83). The cliff-line slope was observed at 38° with the beach profile at 2–5°. Shells from a newly cut drainage ditch revealed a molluscan fauna indicative of a sandy or muddy foreshore, with *Mya* sp., *Lutraria* sp., *Scrobicularia plana* and *Lacuna crassior* the most abundant. By far the best example of the raised shoreline is found on Holy Island. Two raised beaches are located in the northern part of the island: a narrow beach partly covered by blown sand is located west of Caves Haven, and a gravel beach located 2.5–3 m above the high water mark on the east side of the island opposite Sheldrake Pool. The examples along the southern shore are broader and larger, and east of the castle there are two distinct levels of gravel (Gunn, 1900). Narrow strips of raised beach features also are found on the west of the island, and patches occur at two levels in The Snook, with the highest being made up of gravel. Gunn (1900) also notes that in 1854, Johnston (1873) recorded shells of *Mytilus edulis* with *Littorina littorea, Patella vulgata, Cardium edule* and a few broken valves of oyster from a beach on St Cuthbert's Isle not less than *c.* 3.5 m above the level of the sea. According to Tooley (1978a), at the foot of the cliff on Lindisfarne (renamed 'Holy Island' in the 11th century), north-west of the castle in the region of [NU 1320 4190] to [NU 1350 4175], the mean altitude of the raised beach is +5.89 m OD. From the sandy raised beach between the foot of the cliff and the present shore at an altitude of +4.67 m OD a rich molluscan fauna, dominated by *Littorina littorea, Patella vulgata* and *Litorella littoralis,* proved to be indicative of nearby rocky conditions.

The raised beach in the vicinity of the castle is cut into glacial diamicton and is clearly identified from a series of truncated gravel ridges and bars that run transverse to the present coastline (Figure 8.84). Isolated lagoonal sediments also are noted, but no details appear to have been published on these. Gravel ridges also are present to the east of the castle. These occur at three different levels and, like those to the west, are truncated by the present shoreline.

In addition to the morphological evidence of post-glacial sea-level trends, stratigraphical records are present along the shores adjacent to Holy Island. Gunn (1900) recorded the presence of marine alluvium, mainly silt and sand, in the region of Fenham Flats, Brockmill, and south of Ross Links, although other examples may be covered by blown sand. Plater and Shennan (1992) note that each of these alluvial tracts of estuarine sediment were only a metre or so above the present high water mark of spring tides and were separated from the shoreline by hills of blown sand. At Brockmill, a fining-upward minerogenic sequence overlies a purple-brown diamicton, reflecting progressive sedimentation in an intertidal environment of decreasing energy. Similarly, the Holocene sedimentary record overlying the pre-Holocene surface at Ross Low proved to be almost entirely minerogenic with only a few organic lenses.

The Holocene stratigraphy at Elwick, in the vicinity of Whitelee Letch, also was investigated by Plater and Shennan (1992). Here, a sloping surface of weathered diamicton is overlain by a severely oxidized, fining-upward sequence of grey-brown and orange silty sand and clayey silt. Incised into the diamicton surface is a narrow sinuous channel that preserves a complex Holocene stratigraphy (Figure 8.85). The lowermost unit is a blue-grey and grey-brown clastic unit of variable grain-size with dispersed organic material. The diatoms present within this are predominantly brackish and fresh–brackish (Figure 8.86)a. The lower clastic unit is overlain by an equally variable peat with gravel, sand, silt and clay. The altitude of the contact between the peat and the underlying clastic facies rises landward from approximately +0.30 to +2.00 m OD. The pollen in the peat shows a predominance of *Quercus* and *Corylus* types with subordinate *Betula, Pinus, Ulmus, Alnus* and *Salix,* with a significant rise in Gramineae and Cyperaceae towards the top accompanied by Compositae tub. and Chenopodiaceae (Figure 8.86)b. This indicates a trend towards a more open coastal marsh environment, although brackish diatoms are present throughout the peat (Figure 8.86)a. The peat is overlain by an organic blue-grey silty clay between +0.73 and +2.00 m OD, with a landward increase in contact altitude. This overlying minerogenic facies appears to have been deposited in a sand- and silt-dominated open tidal flat, as illustrated by the observed increase in the proportion of the diatom *Paralia sulcata.* From radiocarbon dating, it would appear that the peat started to accumulate approximately 7200 ^{14}C years BP in response to a reduced rate of sea-level rise. Frequent tidal inundation of the peat-forming communities eventually resulted in the return to an intertidal mudflat approximately 6900 ^{14}C years BP.

Horton *et al.* (1999a) also have recorded the presence of an intercalated Holocene stratigraphy to the north-west of Beal Point at Bridge Mill. A basal organic unit that includes saltmarsh indicators is overlain by a clastic marine sequence that includes one main intercalated peat bed and minor organic lenses. The micropalaeontological data obtained for this stratigraphical record (Figure 8.87) reveal that the basal peat and overlying silty clay contain saltmarsh Foraminifera and poly- and mesohalobous diatoms. Forams are absent in the upper organic unit but there are halophobous diatoms and saltmarsh pollen indicators, including Chenopodiaceae and *Plantago maritima.* Hence, the sedimentary succession in this location can be used to provide four sea-level index points for the reconstruction of Holocene sea-level trends.

Interpretation

Although the morphological evidence of former relative sea-level is expressed clearly on Holy Island, the chronology is less certain. The age of the raised beaches in the region of Holy Island has been inferred from pollen evidence from the Inner Fame Islands (Hogg, 1972; Tooley, 1978a). South-east of Middle Pond on the Inner Fame, Hogg (1972) described an intercalated peat sequence underlain by a coarse sandy clay. An upper monocotyledenous peat overlies a sandy peat with grey clay lenses, which, in turn, overlies brown peat with grey sand. Detailed pollen analysis of the peat revealed an Atlantic VIIa age for the base, becoming sub-Boreal towards the top. At Long Bog, a similar Holocene sequence of intercalated sands and peats is underlain by a coarse gravelly sand and several metres of peat grading downward into a gravel with clay. Although peat accumulation on the Inner Fame commenced approximately 7000 years BP two periods of marine transgression, to which the raised beaches are attributed, are evident from the pollen and lithostratigraphy (Tooley, 1978a). The first of these is proposed to have taken place towards the end of Flandrian II (approximately 5200 years BP) and the second early in Flandrian III (approximately 4000 years BP).

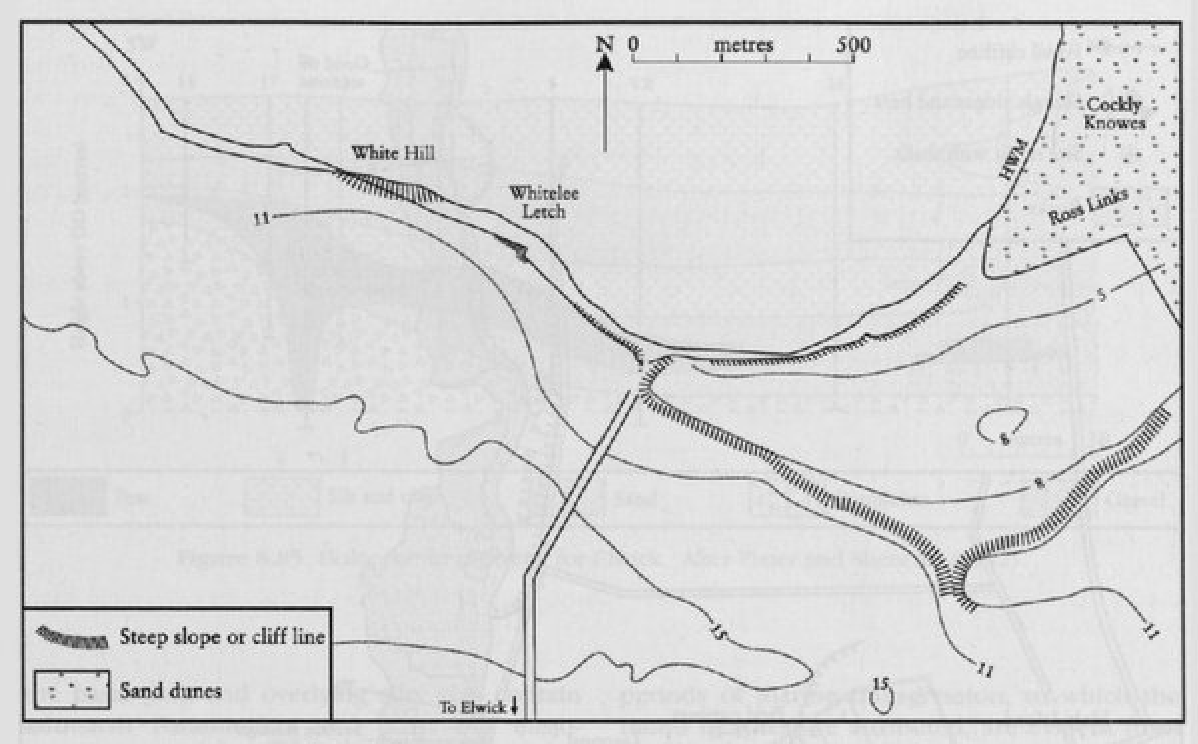
The data from Elwick and other sites on the Northumberland coast (Plater and Shennan, 1992) suggest that sea-level has changed by only approximately 2.6 m during the last 8000 years or so. As a result, site-specific factors, such as coastal morphology and sediment supply, have played an important role in shaping the coast. However, a plot of the validated sea-level index points for the coast of Northumberland (Horton *et al.,* 1999a) shows a record of relative sea-level from more than 5 m below present at approximately 9000 years BP to about 2.5 m above at *c.* 2500 years BP. If data points are considered geographically, there is a clear trend of increasing altitude with distance northward for sea-level index points of any given age (Plater and Sherman., 1992; Shennan *et al.,* 2000b; Horton *et al.,* 1999a), which is consistent with geodynamic model predictions of greater uplift towards the north (Lambeck, 1991, 1995; Shennan, 1992). The overall trend is, therefore, one of rising relative sea-level during the Holocene Epoch, with a fall during the past 3000 years or so. However, the expression of this trend is modified by site-specific factors that include changes in the tidal regime, sediment compaction, and the impacts of land drainage. If relict beach features are preserved around the former altitude of mean high water, then the observed trend of relative mean sea-level for the Northumberland coast is consistent with the raised beaches on Holy Island being mid- to late Holocene in age. Indeed, Shennan *et al.* (2000b) observe that the summary relative sea-level curve for north Northumberland indicates a mid- to late-Holocene maximum around 2.5 m above present. It certainly seems less likely that the raised beaches originate from the high relative sea-levels predicted for the region between *c.* 15 000 and 13 000 years BP from geodynamic modelling (Lambeck, 1991).

Conclusions

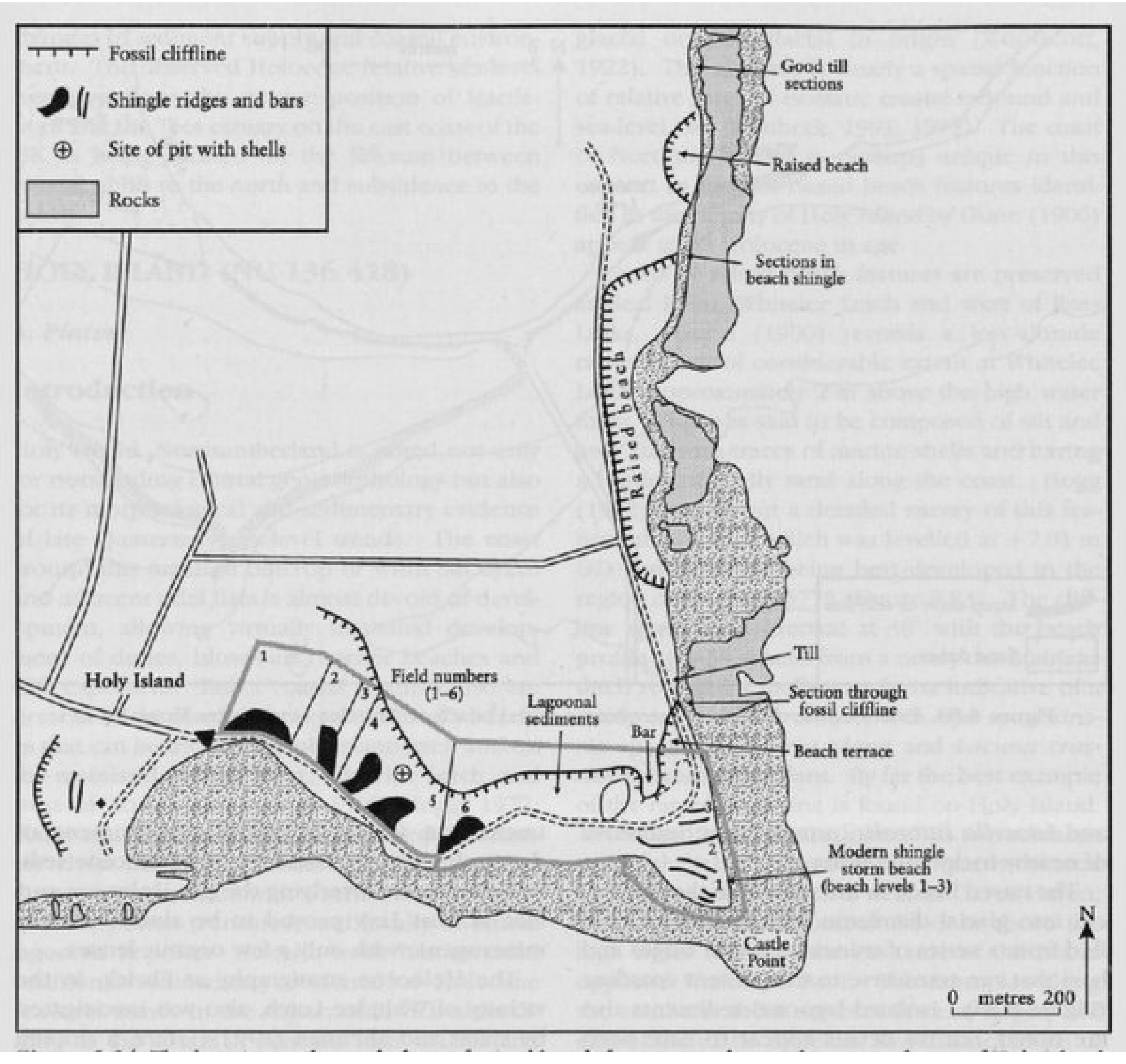
Holy Island and the shore of the adjacent coast possess records of Holocene sea-level trends and coastal change in the form of raised beaches and lowland stratigraphical records. The raised beaches are best developed in the region of the castle on Holy Island, where a beach cut into glacial diamicton and truncated gravel ridges can be found at an altitude of *c. +5.89* m OD.

The stratigraphical records from Elwick and Bridge Mill have been used to reconstruct the record of relative sea level from *c.* 9000 to 2500 years BP, which shows a rise from –5 m to +2.5 m OD and an increasing glacio-hydro-isostatic component towards the north. Some of this relative sea-level trend results from site-specific factors, such as changing tidal regime and sediment compaction. The observed sea-level highstand in the mid- to late Holocene corroborates the inferred chronology for the raised beaches obtained previously from stratigraphical evidence from the Inner Fame Islands.

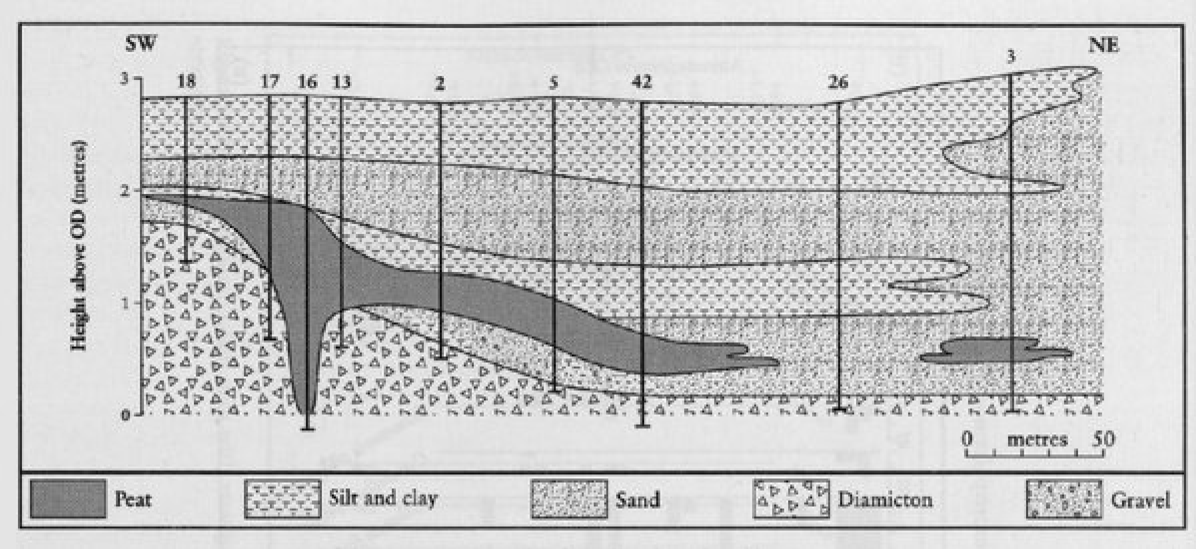
References



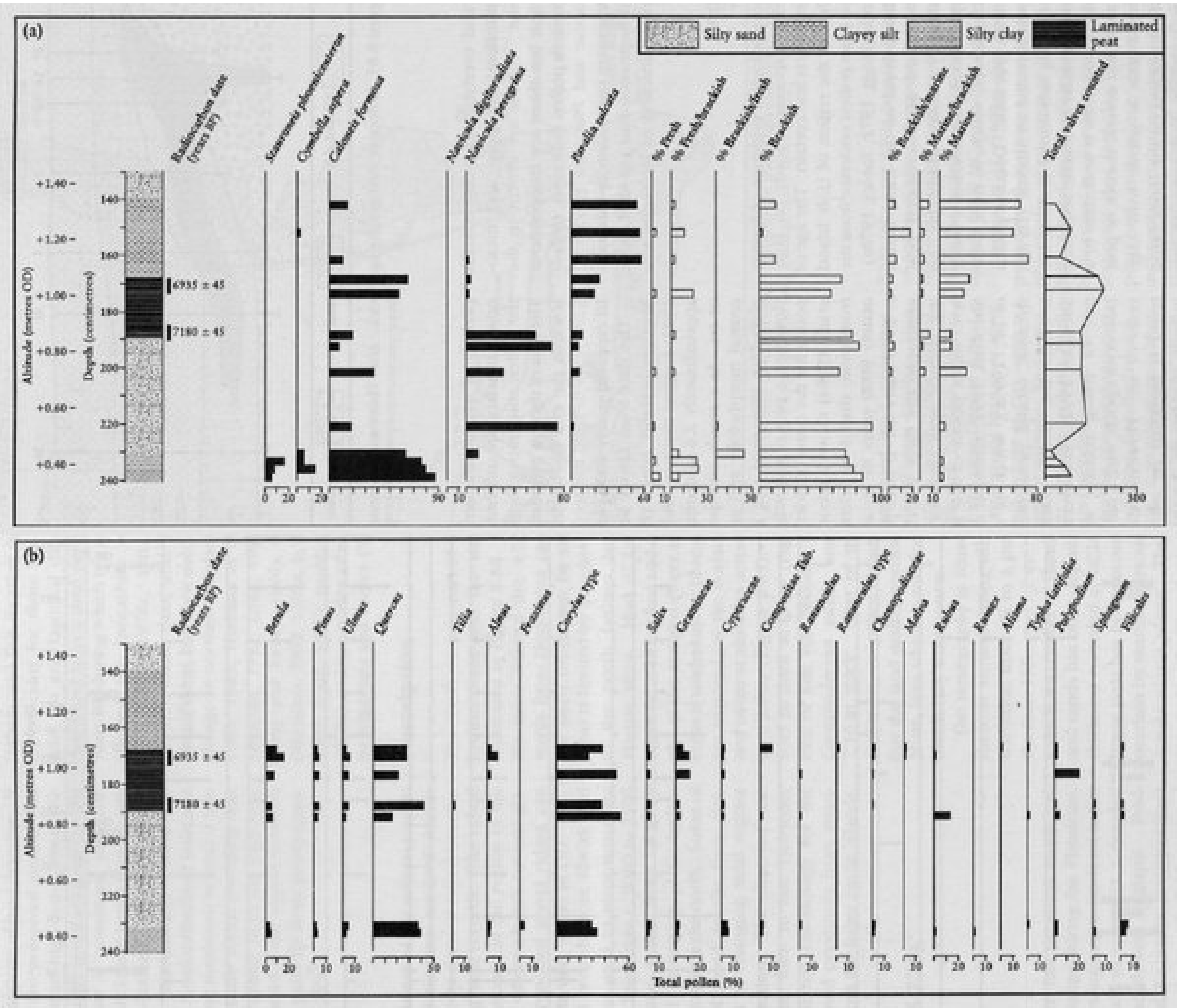
(Figure 8.83) Extent of the cliff-line demarcating a raised beach at Whitelee Letch (after Hogg 1972).



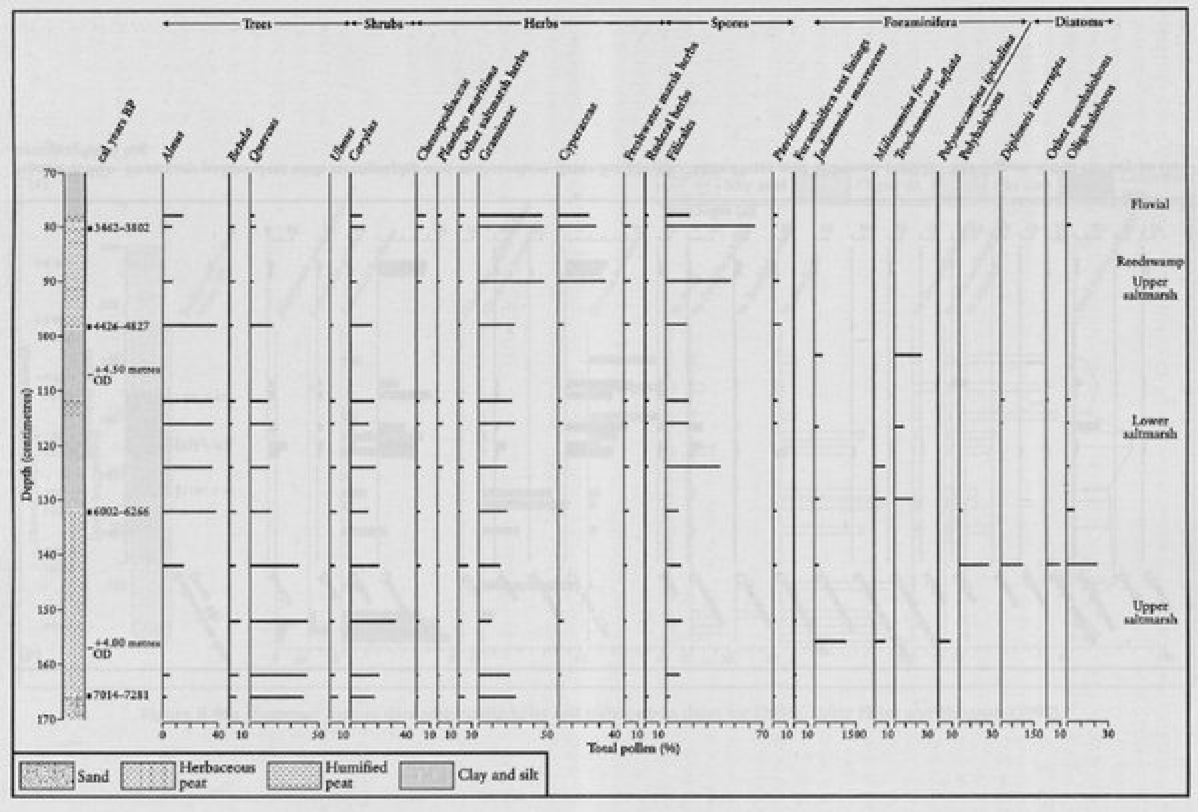
(Figure 8.84) The location and morphology of raised beach features on the south-eastern shores of Holy Island. From unpublished English Nature site documentation and management brief (1992).



(Figure 8.85) Holocene stratigraphy for Elwick. After Plater and Shennan (1992).



(Figure 8.86)a Summary diatom data with stratigraphy and radiocarbon dates for Elwick. After Plater and Shennan (1992). b. Summary pollen data with stratigraphy and radiocarbon dates for Elwick. After Plater and Shennan (1992). See (Figure 8.86)a for key to the stratigraphical log.



(Figure 8.87) Summary stratigraphy, pollen, Foraminifera and radiocarbon data for Bridge Mill. After Horton et al. (1999a).