THE AYRES OF SWINISTER

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Introduction

The gravel beaches of the Ayres of Swinister ('ayre' is a local Shetland name for a spit or barrier) together form an exceptional example of a barrier complex, connecting the north-east mainland of Shetland to the small offshore island of Fora Ness (Figure6.25; see Figure 6.2 for general location). Of the three gravel barriers, only the South Ayre forms a complete connecting tombolo. The other two extend out from the mainland but do not reach Fora Ness. However, they are classic examples of bay-head and mid-bay barriers (Shepard, 1952). A tidal basin called 'The Houb', lies below mean low-water springs between the South Ayre and North Ayre and contains submerged peat deposits, the dates of which have provided important information concerning the Holocene sea-level history of the area (Birnie, 1981). This site is a classic example of a coastline undergoing submergence.

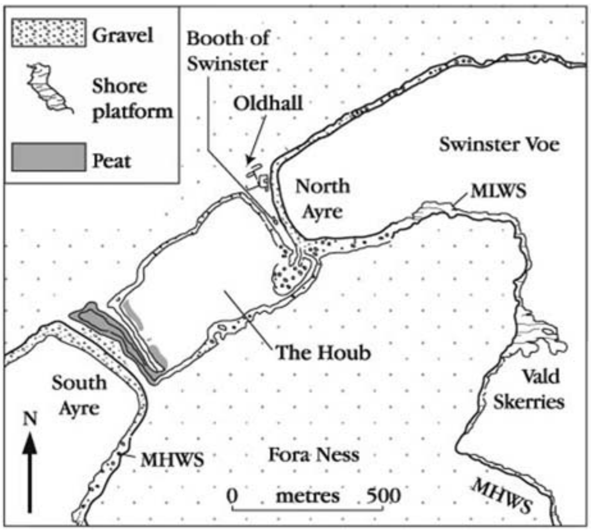

Figure 6.25: The Ayres of Swinister: a triple gravel barrier. Only the southern barrier is a true tombolo, the others are spits that enclose The Houb, a tidal basin. For general location, see Figure 6.2.

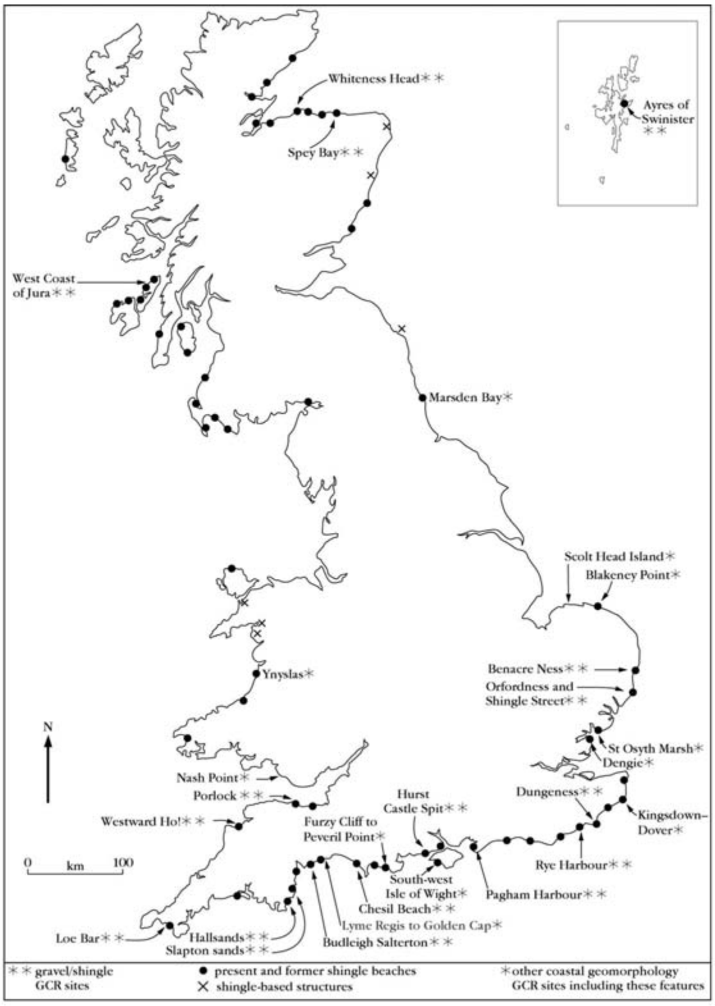

Figure 6.2: Coastal shingle and gravel structures around Britain, showing the location of the sites selected for the GCR specifically for gravel/shingle coast features, and some of the other larger gravel structures.

Tombolos, bay-head and mid-bay barriers are relatively common features of the inner coastline of the Shetland archipelago (Flinn, 1964). However the complexity of the gravel landform assemblage at the Ayres of Swinister, with three substantial features occurring within a small area containing submerged peat deposits and saltmarsh remnants is unique both nationally and internationally. In spite of these credentials and numerous descriptive accounts, the site has failed to attract detailed geomorphological research. Nevertheless, Birnie (1981) provides stratigraphical details of the submerged peat at the site as part of a wider study to determine past environmental changes in the Shetlands, and Bentley (1996a) speculated on the evolution of the ayres.

Description

In contrast to the west coast of Shetland, the east coast is less exposed to storm-wave activity from the west yet remains open to waves from the east and north-east. Since the most frequent strong winds and storm wave activity come mainly from the south-west (BGS and Scott Wilson Consultants, 1997a), the eastern voes of Shetland and the inner reaches of Dales Voe, where Fora Ness is located, are relatively sheltered and subject mainly to locally generated waves. On account of the shelter provided by Fora Ness, sea conditions adjacent to the North Ayre are benign enough for the safe mooring of floating pontoons associated with a fish farm (Figure 6.26). In spite of this, severe storm events from the north and east can affect the east coast of Shetland, especially the outer reaches of the eastern voes. Spring tidal range on the east coast of the Shetland Islands is limited to 1.5 m and maximum tidal streams on spring tides are generally between 0.25–0.5 m s^{-1} (BGS and Scott Wilson Consultants, 1997a) although these speeds may be exceeded where the voes narrow.

Figure 6.26: South Ayre and North Ayre at high tide looking north-east towards Swinister Voe, showing the very sheltered nature of the site. Fish farms can be seen at the North Ayre (upper left of the photograph) (Photo: J.D. Hansom.)

The relative sea-level history of Shetland is incompletely known (Firth and Smith, 1993), but the work of Birnie (1981) provides more local information than is available at other similar sites in Shetland. The general lack of emerged ('raised') marine sediment and landforms combined with classic drowned river valleys (the voes) and a local tradition of marine submergence in historical times, have long been accepted as evidence for continuously rising sea-level since the decay of the late Devensian ice-sheet (Mykura, 1976). This view is supported by observations of now submerged freshwater peats in many of the sheltered voes (Hoppe, 1965; Birnie, 1981).

The Ayres of Swinister consists of a tombolo (South Ayre) which connects the mainland to Fora Ness, a bay-head barrier (unnamed) and a mid-bay barrier to the north-east (North Ayre); all of which are mainly composed of angular and subangular gravel (Figures6.26 and 6.27). The bay-head barrier and mid-bay barrier are both hinged on the mainland side of the voe and enclose the shallow lagoonal area (The Houb), which lies below MLWS and does not dry out. A smaller lagoon is enclosed between South Ayre and the bay-head barrier, although this dries out at low tide.

Figure 6.27: Washover lobes of gravel on the tombolo of South Ayre (to the right), with Fora Ness in the distance. Intertidal peats, which extend subtidally, are exposed at low tide in the lagoon between South Ayre and the unnamed barrier to the north-east (on the left). (Photo: Lorne Gill/SNH.)

The gravel tombolo of South Ayre, which is 300 m long and *c*. 50 m wide connects the island of Fora Ness to the north-east mainland of Shetland (Figure 6.25). The outer (south-west) side of the tombolo is exposed to waves from the south-west and Dales Voe, and the gravel beach maintains a smoothly curving swash-aligned arc, whereas the inner (north-east) side is characterized by a grassy turf, which is affected by spray and waves from the south-west (Bentley, 1996a). The inner side is characterized by a series of well-defined washover lobes and, in places, the colonizing vegetation has been subsequently partly or wholly buried by gravel. It is not known whether the peat exposed in The Houb to the north-east of the South Ayre extends to any extent under the feature itself, since it is absent from the exposed intertidal foreshore on the south-west.

A narrow, *c*. 20 m-wide lagoon separates South Ayre from the unnamed bay-head barrier immediately to the north-east (Figure 6.27). Indeed, as a result of the proximity of these two gravel features, South Ayre has often been described as a double ayre (Smith, 1993). However, the bay-head barrier is breached by a narrow tidal channel at its recurved southern tip connecting the lagoon to The Houb. The north-east side of the barrier describes a series of small arcs in response to the low-energy waves and shallow waters within The Houb. This narrow lagoon has been described as an intertidal peat flat (Smith, 1993) on which drying cracks readily develop at low tide. The peat substrate, exposed beneath the intertidal muds of the lagoon, extends between the South Ayre and the bay-head barrier.

The North Ayre lies 500 m to the north-east of South Ayre and extends from the mainland towards the island of Fora Ness (Figure 6.26). A *c*. 40 m-wide tidal channel with a substantial flood-tide delta separates the gravel barrier from the island and connects the intertidal basin (The Houb) to Swinister Voe. North Ayre is recurved at its south-east end and a smaller, *c*. 30 m-long barrier extends towards it from Fora Ness. North Ayre appears to be relatively stable; a derelict crofthouse is located on the ayre and a grassy turf mat covers much of the ayre's surface. In places the turf is covered by lobes of gravel, which have been deposited by waves from both north-east and south-west directions.

On the eastern shore of The Houb, hill peat overlying till and weathered bedrock extends below the high-water mark and floors the intertidal basin. The submerged peat contains in-situ tree stumps complete with stems and roots (Smith, 1993). The dissected peat apron (parts of which have been subject to peat cutting operations in the past) has in places been transformed into pseudo-saltmarsh. Coring of one of the uncut peat areas in the lagoon showed approximately 3 m of organic material overlying a grey, gritty clay, and yielded a radiocarbon date on *Betula* (birch) fragments 1.6 m below the surface of 4586 ± 40 years BP (Birnie, 1981). The intertidal zone on the western shore of The Houb is characterized by a low-gradient slope of sands and gravels that extend south-eastwards from the flood-tidal delta at the North Ayre.

Interpretation

Individual tombolos, bay-head and mid-bay barriers are characteristic features of the submerging inner coastline of the Shetland archipelago (Flinn, 1964), however the Ayres of Swinister provide a unique assemblage of all three of these landforms in close association. It seems likely that given its angularity and match with local glacial tills, the sediment that comprises the North and South Ayres has been eroded from the flanks of Swinister Voe by waves refracting from the north-east and south-west. Waves approaching the North Ayre comprise both swell and storm waves generated in the larger Voe in the east and thus energy levels on the northern shore are likely to be relatively higher than on the south shore. As a result the Ayre is wider and higher on this side, and it tapers to the south where the tidal prism of The Houb has given rise to flows strong enough to keep open the tidal narrows. On the other hand, waves approaching the South Ayre are unidirectional having been generated wholly within Dales Voe and travelling north-east. As a result, energy levels are evenly distributed across beach and a uniformly wide barrier has been constructed, which joins the mainland and Fora Ness to form a tombolo.

Over a longer period of time the development of The Houb must have been linked to changes in sea level. The Holocene period in Shetland is generally considered to have been characterized by a rising relative sea level (Firth and Smith, 1993). Modelling of sea-level change seems to support this view of an early and rapid rise in sea level at Shetland sites, slowing towards about 6500 years BP, but at no time undergoing relative sea-level fall (Figure 6.28; Lambeck, 1993) . During the early phase of rapid Holocene relative sea-level rise, shoreline migration in Scotland was probably too rapid for significant shoreface modification (Hansom, 1999, 2001) and so it seems reasonable to suggest that these constructional features were not emplaced until after the rate of sea-level rise began to slow down at some time around 6500 years BP. A radiocarbon date of 4586 ± 40 years BP (Birnie, 1981) from the underlying peat in The Houb suggests that although subsequent sea-level rise flooded The Houb and arrested further peat development, it is possible that earlier rising sea levels drove pre-existing gravel barriers onshore over any pre-peat backshore wetland. Barrier growth before about 4600 years BP may have resulted in the water table alterations that led to peat growth.

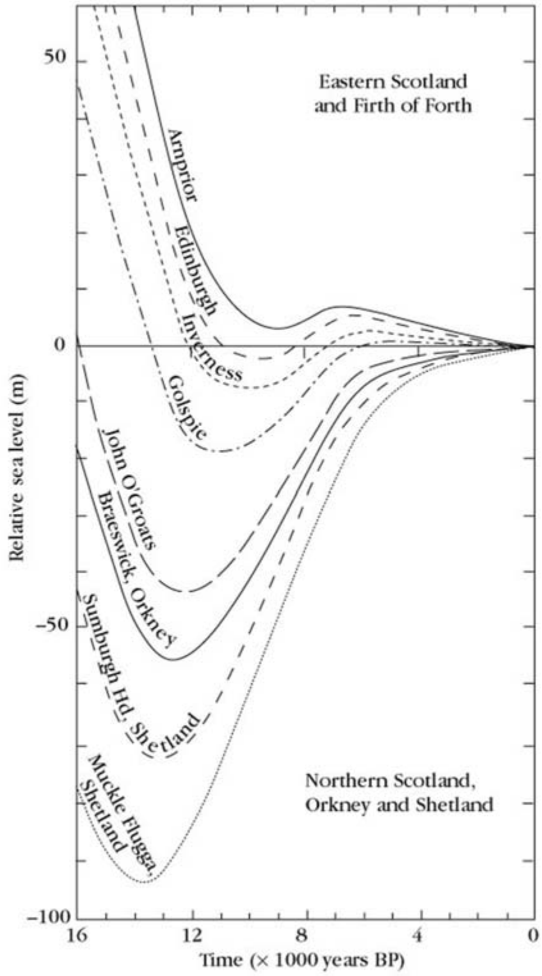

Figure 6.28: Graphs of modelled relative sea level against time over the last 16 000 years, along a south– north transect from Shetland to the Firth of Forth. (After Lambeck, 1993; Hansom, 2001.)

Unfortunately, the outcrops of intertidal peat that might be expected to be eroding out of the foreshores of both the North and South Ayres, are nowhere to be seen. However, the existence of peat between the South Ayre and the bay-head barrier (Smith, 1993) strongly suggests that it is continuous below the latter and that the bay-head barrier was constructed after the peat developed and thus it may post-date the development of both the South Ayre and North Ayre, although its relationship with the latter is less clear. This would suggest that the bay-head barrier may be the product of sediment eroded from the underlying glacial till and reworked alongshore. Further, the low-energy undulating planform of the feature suggests that it has never been subject to strong swash-aligned wave action from the north-east, although, if the Houb were open, this would be the direction of approach of storm waves. It may, however, be subject to waves of sufficient power to move sediment alongshore within The Houb to construct the bay-head barrier.

An alternative explanation is provided by Bentley (1996a) who has proposed the construction of the South Ayre and bay-head barrier at a high relative sea level, and the North Ayre at some time later as a result of sea-level fall. Sea-level rise then consolidated the North Ayre, flooded The Houb at some time after 4600 years BP and reworked all three features. A slowly rising sea level is suggested to have resulted initially in the development of a tombolo (South Ayre) either by normal tombolo constuction or by 'roll-over' as the gravel barrier mounted a peat-covered gap connecting Fora Ness to the mainland. A bay-head barrier then formed on the north-east side of the tombolo as a result of gravel moved from the north-east into the newly formed bay. Prior to *c*. 4600 years BP a suggested fall in sea level resulted in shoreline migration to the north-east and a new bay-head barrier (North Ayre) formed allowing peat to develop in the dry area (The Houb) between the two barriers. A later rise in sea level resulted in the breaching of the North Ayre, the flooding of The Houb, the submerging of the peat and gravel washover of the structures.

The above two evolutionary models of the Ayres of Swinister are speculative and raise several unanswered questions. For example, are the levels of longshore wave power and sediment supply of Model 1 sufficient to result in construction of the inner barrier? Model 2 requires a sea-level fall before 4580 years BP followed by a rise, for which there appears to be no other evidence in Shetland. Much scope remains for further research at this site and the triple assemblage of gravel landforms together with the associated peat beds rich in plant remains provide an excellent site for detailed research in evolutionary chronology and in stages of submergence of the Shetland coastline. Establishing these details would enhance the scientific interest of the site. Nevertheless, this triple assemblage of a gravel tombolo, bay-head barrier and mid-bay barrier, unique in Britain, forms a classic example of gravel construction on a submerging coastline.

Conclusions

Although individual barriers and tombolos occur around much of the Shetland Isles, the Ayres of Swinister is a rare example in Britain of a triple gravel tombolo-barrier complex where a tombolo, bay-head barrier and mid-bay barrier exist in close association. In addition, the site includes important peat deposits that record the sea-level history of the area and have already provided an important constraining date on sea-level rise in this part of Shetland. For these reasons, the site is justly regarded as a classic example of a submerging coastline and is of international geomorphological importance. The site is also important for its biological interest, including lagoonal flora and fauna (Thorpe, 1998).

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