Central Sanday, Orkney

[HY 6739 4242]

J.D. Hansom

Introduction

The south coast of the Island of Sanday, northeast of the Orkney Mainland (see (Figure 8.2) for general location), contains a unique assemblage of coastal depositional features, including tombolos, spits, sandflats, dunes and machair, most of which are relatively undisturbed by human activity (Figure 8.27). The most spectacular component of the assemblage of coastal landforms is the 2 km-long ayre, a gravel-cored sandy tombola that connects the island of Tres Ness to the shore and encloses a large area of intertidal sandflats (Cata Sand), backed by the Plain of Fidge, a broad machair plain. Farther west, a second tombola, Quoy Ayre, links the island of Els Ness to the mainland. While individually these features are of great geomorphological interest, collectively the complex and dynamic inter-relationships between the land-forms of Central Sanday are unique in Scotland and are of national importance (Nature Conservancy Council, 1978). Although, this importance has been recognized for some time and the research potential of the site repeatedly emphasized (Steers, 1973; Mather *et al.,* 1974; Nature Conservancy Council, 1978; Keast, 1994), it has failed to attract any detailed geomorphological study and interpretations of the complex evolution of this magnificent site remain speculative. However, research is now underway to establish the Late-Holocene shoreline response of the site in relation to changes in sea level and sediment supply (Rennie and Hansom, 2001).

Description

The extensive GCR site of Central Sanday, covering an area of *c.* 660 ha, consists of a complex series of depositional features. Two former islands (Tres Ness and Els Ness) are connected to the main island by dune-capped sand tombolos that partially enclose two embayments containing wide tidal sandflats (Little Sea and Cata Sand) (Figure 8.27) and (Figure 8.28). Short gravel-spits extend across the mouths of the embayments. Extensive areas of machair have formed landwards of the beaches.

The eastern part of this extensive site, the Bay of Newark is the largest and most complex beach unit in Orkney (Mather *et al.,* 1974; Nature Conservancy Council, 1978). The physiography is complex, consisting of sandflats, a dune-capped tombolo and the remnants of gravel ridges that underlie the site marking several stages in coastal evolution. The eastern end of the bay close to the Plain of Fidge consists of a complex of geomorphologically inactive sand dunes and parabolic blowthroughs. These steep, 7–10 m-high, longitudinal sand dune ridges trend almost at right-angles to the present-day coastline and although a few moribund stands of marram *Ammophila arenaria* survive, the Plain of Fidge contains the largest area of machair outwith the Western Isles (Mather *et al.,* 1974; Nature Conservancy Council, 1978). Two separate levels separated by an erosional scarp occur, the lower of these representing a deflation surface dose to the water table. In places the scarp is undergoing erosion with a distinctive series of finger-like blowthroughs at the scarp edge. In the western part of the bay a 2 km-long dune-capped tombolo connects the island of Tres Ness to mainland Sanday, enclosing the tidal sandflat of Cata Sand (Figure 8.28). In plan, the tombolo is long, straight and narrows towards its southern end to only 30 m wide. The present-day beach consists almost exclusively of shell-rich, medium-grained sand D_{50} = 0.29 mm) although gravel occurs at the extreme southern end of the tombolo where it hinges onto a low sandstone platform. The tombolo is capped by a single linear dune ridge, rising to *c.* 13 m in height, composed mainly of fixed dunes with local areas of mobile dunes (Keast, 1994). The most dynamic section of the dune ridge is at the narrow southern end of the tombolo, where unfixed dunes have been dissected by several blowthroughs, the largest of which is up to 40 m in wide. Mather *et al.* (1974) report no gravel at the base of these blowthroughs, however Keast (1994) found gravel at the base of the dunes, and substantial amounts were recorded during biannual field visits made by the author between 2000 and 2002. Unconfirmed reports suggest that the tombolo was breached at its southern end during storm conditions in the 1980s.

A system of gravel ridges underlie the machair of the Plain of Fidge at the mainland root of the sand tombolo and are also visible on Cata Sand where north-westerly relict gravel ridges diverge from the northward-trending dune-capped tombolo (Figure 8.28). The low gravel ridges form broad arcs, trending north and north-west from the outlet of Cata Sand. The linear dunes capping the tombolo rest on these gravel ridges, many of which are exposed at low tide (Nature Conservancy Council, 1978; Keast, 1994). The differences, both in composition and orientation, between these relict gravel features and contemporary sand landforms suggest a very different depositional environment in the past.

Farther west, a second dune-capped tombolo links the former island of Els Ness to the mainland of Sanday, enclosing the wide tidal sandflat of Little Sea. The tombolo (Quoy Ayre) forms the western part of the wide south-facing embay-ment of Sty Wick and is symmetrical in plan (Figure 8.27). The linear dune ridge capping the tombolo reaches a maximum height of 9 m towards the centre of the tombolo and consists almost entirely of highly stable and well-vegetated fixed dunes. Gravel is well-exposed at Quoy Ayre and appears to underlie the dune ridge.

The two sandflats (Little Sea and Cata Sand) are completely closed on their south and south eastern sides by the dune-capped tombolos. Their outlets are towards the south-west, both of which are partly enclosed by spits. Short gravel spits project outwards from each flank of the outlet of Little Sea, but appear to be relatively inactive features in spite of lacking a cap of blown sand. Cata Sand is partly enclosed by a low, dune-capped, rounded spit, which extends 0.5 km eastwards across the outlet. This spit is underlain by low belts of gravel that are a southwest continuation of the relict ridge system visible in Cata Sand. Much of this short stubby spit is capped by stable sand dunes grading landwards into machair, although the tip of the spit supports low embryo dunes that are still developing. Comparison with aerial photographs and field evidence suggest that the spit tip is highly dynamic, alternating between short periods of erosion and accretion (Mather *et al.,* 1974; Keast, 1994). A smaller gravel spit projects northwards from Tres Ness on the other side of the outlet.

Interpretation

In spite of the wealth of the landform assemblage at Central Sanday, until recently there has been limited detailed geomorphological research carried out (Rennie and Hansom, 2001). Although the interpretation of the Central Sanday site is necessarily speculative, the inter-relationships of the landform assemblage within this dynamic system are of national importance (Steers, 1973; Mather *et al.,* 1974; Nature Conservancy Council, 1978; Keast, 1994), particularly as there has been almost no anthropogenic modification to the natural system. The two sand-capped tombolos are spectacular landforms yet the underlying gravel ridge orientations are at odds with the present-day coastal trend. The site is a key area for the study of constructive shoreline processes in an area of relative subsidence and so has great research potential.

Throughout much of the Holocene Epoch, the coastline of Orkney has undergone approximately similar amounts of submergence to Shetland (Lambeck, 1993) (see (Figure 6.28)). As a result, emerged shoreline features are absent in Orkney and are replaced by features of submergence so that the low gradient coast of Sanday has undergone significant alteration in planform and as bays became flooded, peninsulas became islands and beaches changed orientation in response. On Sanday, the pattern of sea-level rise flooding embayments and isolated islands has been in part reversed by a healthy sediment supply that has connected or reconnected islands to the mainland. Historical map evidence exists in support of these changes. On John Thomson's map of 1832 (Figure 8.29), the low-lying former islands of Tres Ness and Els Ness that lie to the south of the mainland of Sanday, together with the offshore island of Start Point to the north, are depicted as long narrow peninsulas. The nature of these peninsulas is not known, but the form of Els Ness and Tres Ness suggests that they were, at least in part, complexes of gravel ridges, substantially wider than those at present, enclosing low-lying or flooded areas behind. The same map shows the area of Little Sea as a freshwater loch and the area that is now Cata Sand as a low area, possibly of seasonally-flooded machair or 'winter loch'. However, a map of 1847 shows both the loch at Little Sea and the low land at Cata Sand to be arms of the sea as they are today and, if both maps are accurate, marine inundation may have occurred between 1822 and 1847 (Black, 1847).

Central Sanday is a good example of a feature common to the sandy and dune-backed beaches of Scotland where a backbone of gravel provides the base on which wave-deposited or blown sand later accumulates (Mather *et al.,* 1974).

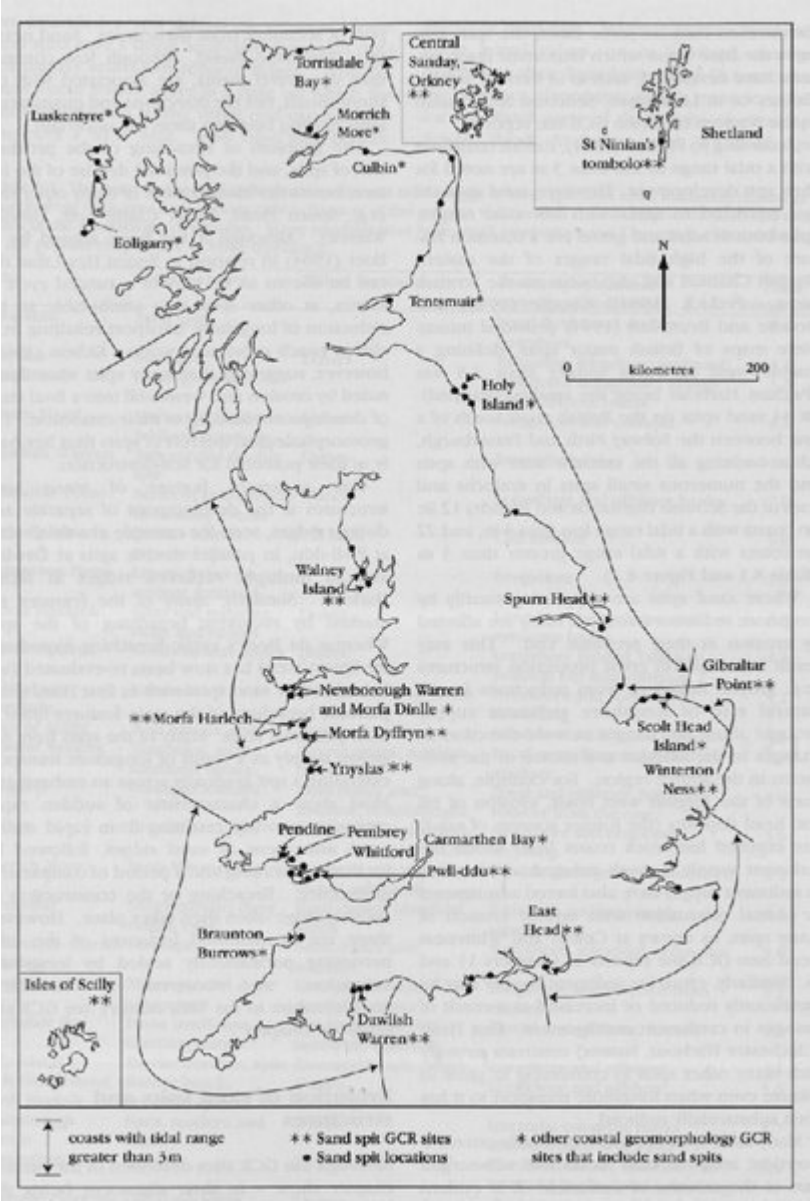
The gravels then play an important shaping role in the evolution of what are now mainly sandy beach complexes. For example, the gravel ridges that originally began the process of enclosure of the Cata Sand basin are visible under the machair of the Plain of Fidge (Mather *et al.,* 1974), but their mainly north-west orientations differ from the contemporary north-trending dune-capped tombolo of the present-day coast. This suggests that at some time in the past the embayment was partly enclosed by gravel ridges deposited at different orientations to the contemporary constructional sand features. In addition, at some period prior to the tying of Tres Ness to the mainland of Sanday, gravel was a relatively more important beach material than at present, highlighting a change in sediment supply over time, and possible relationships to an altered offshore sediment supply.

The orientation of the gravel ridges led Mather *et al.,* 1974 to suggest that they were hinged on a point under the Plain of Fidge and so had extended southwards as a result of longshore drift from the north. Recent detailed mapping and Ground Penetrating Radar survey shows that the ridges recurve and splay northwards, suggesting drift from the south. However, not all the ridges recurve to the north, particularly those dose to the outlet of Cata Sand (Rennie and Hansom, 2001). Although these relationships are not yet fully established it seems likely that gravel spit extension from the south resulted in partial closure of a wide and open bay at Cata Sand. Such spit extension requires a plentiful supply of coarse sediment, and the sequential drowning of areas of low-lying till-covered bedrock at Tres Ness, along with sediment driven onshore from glacial gravel banks offshore, may well be the source of much of the spit gravel. As sea level rose to its present-day level over the Holocene Epoch, the gravel was driven onshore from its source areas on the shallow Sanday shelf by storm conditions. Such a scenario requires an ongoing supply of gravel to allow the moving spits and barriers to keep pace with sea-level rise and extend along the coast. If the supply was insufficient then erosion of the updrift gravels would have fuelled distal extension (Hansom, 1999): Such reductions in gravel supply occur elsewhere in Scotland and coincide with the increasing importance of sand as a beach material about 6500 years BP (Carter, 1988).

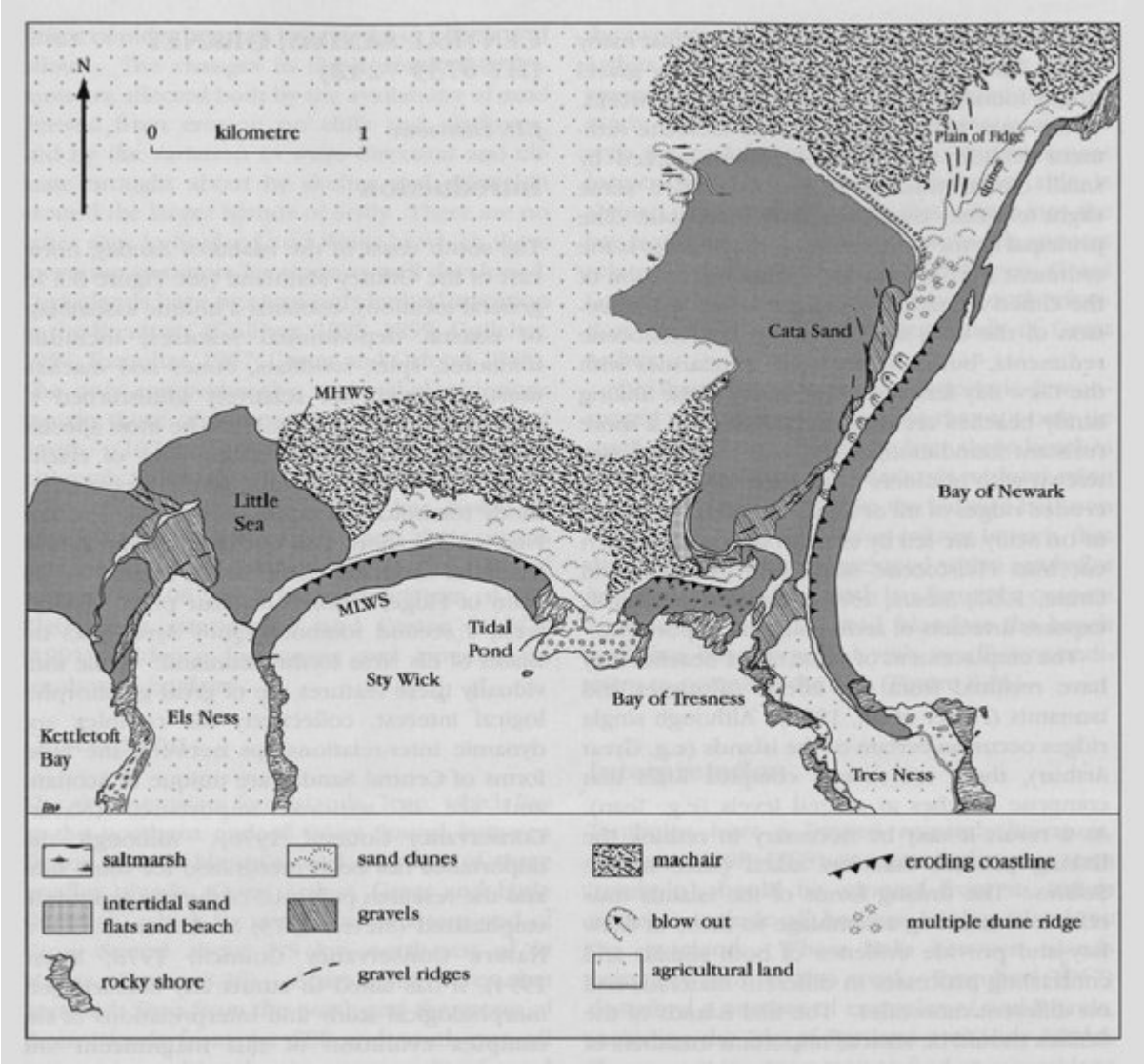
The variety of dune types, morphologies and processes at Central Sanday are unusual and are of interest in their own right, forming the most complex and complete beach–dune–machair system outside of the Western Isles (Nature Conservancy Council, 1978). The relationship of the dunes and machair with the tombolos, spits and relict gravel ridges on which they rest, adds to their scientific interest. Of particular interest arc the north-west-trending longitudinal dune ridges near the south end of the Plain of Fidge. The orientations of this suite of dune ridges, which trend at a high angle to the present-day coastal edge, suggest that they are related to a period prior to the tying of Tres Ness and the mainland of Sanday. No dates exist for the onset of sand deposition in the Plain of Fidge or Sty Wick but, since the sand has a high shell content, it is likely to be sourced from offshore and thus may date to the period after 6500 years BP when coastal sand became a more important sediment source for beaches.

Conclusions

Central Sanday contains a wealth of undisturbed coastal landforms on a scale unique in Britain. The diversity and complexity of the assemblage of tombolos, spits, sandflats, dunes and machair is unsurpassed in the UK. Gravel underlies important elements of the now sand-dominated geomorphology, indicating a complex evolutionary history of the site that has yet to be fully investigated. The most spectacular components of the assemblage of coastal landforms are the two dune-capped tombolos, which connect the formcr islands of Tres Ness and Els Ness to the mainland. The tombolo connecting Tres Ness is over 2 km long, enclosing the tidal sandflat of Cata Sand, while the shorter, but no less spectacular, tombolo, Quoy Ayre, encloses the embayment of Little Sea. Dunes are well-developed on both tombolos, grading into machair on their landward sides. The variety and diversity of the dune and machair of Central Sanday, the largest area of machair outwith the Western Isles, is of great geomorphological interest in its own right. Collectively, the complex and dynamic inter-relationships between both the windblown and wave-constructed landforms of Central Sanday are of national importance (Nature Conservancy Council, 1978). Central Sanday is a rare example of where a healthy sediment supply has led to island tying and tombo-lo building even though relative sea level is rising. It provides an excellent comparison with the Isles of Scilly (see GCR site report in the present volume) where sediment supply reduction may now preclude island tying as sea level rises. There is great research potential at this site and it is a key area for the study of coastal evolution and development in an area of relative sea-level rise.

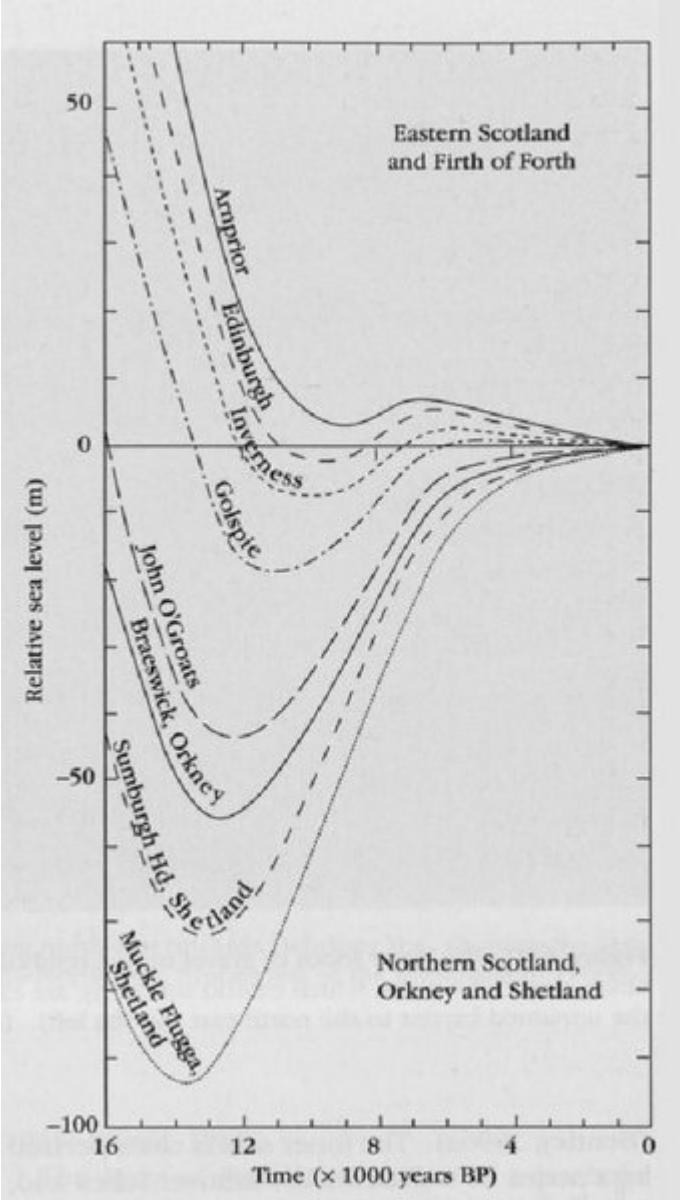


(Figure 8.2) The location of sand spits in Great Britain, also indicating other coastal geomorphology GCR sites that contain sand spits in the assemblage. (Modified after Pethick, 1984).

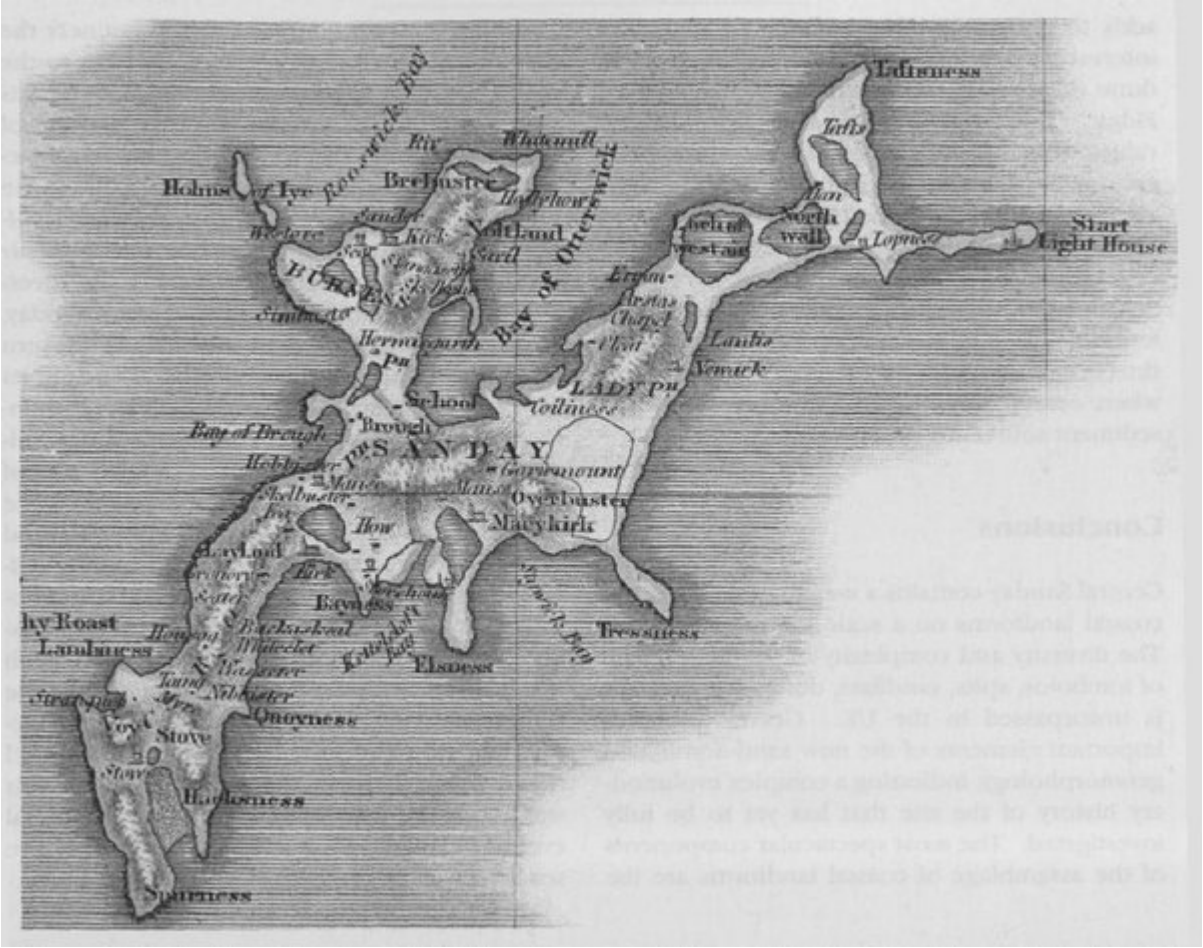


(Figure 8.27) Geomorphological map of central Sanday showing the two tombolos that enclose Cata Sand and Little Sea. Note the orientation of the gravel ridges in Cata Sand. MHWS: Mean High-Water Springs; MLWS: Mean Low-Water Springs. (After Rennie and Hansom, 2001.)

(Figure 8.28) Looking north-east along the dune-capped tombolo in the Bay of Newark. Older intertidal gravel ridges can be seen extending inland towards the north in Cata Sand. (Photo: J.D. Hansom.)



(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.)



(Figure 8.29) Coastline of Sanday in 1822 (from Thomson, 1832). Note the modem marine inlet at Cata Sand is mapped as a low area of land, possibly machair; the modem marine inlet of Little Sea is mapped as a freshwater lake and Start Island is mapped as a promontory with a lighthouse at the end.