Ardivachar to Stoneybridge, South Uist, Western Isles

[NF 740 464]–[NF 730 333]

Introduction

The 30 km-long stretch of South Uist coastline between Ardivachar Point in the north to Stoneybridge in the south (see (Figure 9.1) for general location) includes excellent examples of almost every type of beach, dune and machair surface in the Western Isles. These landforms have developed in the context of a high-energy and open Atlantic coastline that is subject to ongoing submergence (Figure 9.9). In the north, the island of Gualan represents a remnant dune and machair system and in the south, the machair is replaced by a gravel beach backed by marsh and loch. Between these lies a beach–dune–machair system that demonstrates a close inter-relationship between water table and landform with well-developed, low, wet surfaces and a prominent high machair terrace fronted by a conspicuous escarpment that is actively subject to wind-blow. The extensive and well-developed nature of the system and the range and variety of erosional and depositional landforms is of outstanding geomorphological importance. Most of the research so far conducted on machair development has focused on this area, its scientific interest being further enhanced by the presence of numerous archaeological sites that provide not only a cultural context for the development of the landforms but also a dating control. It is a type area for machair development and geomorphology.

Description

The beach that extends between two outcrops of highly resistant Lewisian gneiss at Ardivachar and at Stoneybridge is effectively a single system broken only by the rocky outcrops of Sgeir Dremisdale and by the exit of the Howmore River (Figure 9.9). The river exit is characterized by several sand-bars and by localized backshore accretion with embryo dune formation. North of this point, the low-angled beach as far as Drimore is up to 160 m wide and composed of sand with a calcium carbonate content of 42%, although the dunes and machair behind can reach up to 84% (Ritchie, 1971). Seepage of ground water from the landward surfaces seasonally affects the beach so that the higher water-tables of winter intersect the gravels of the backshore storm ridge. Such impounding of the winter water table has profound geomorphological and ecological consequences, since the low-lying parts of the machair and dunes landward remain flooded to depths of up to 0.5 m for up to five months of the year (Ritchie, 1971). The backshore ridge is affected by storm wave activity and wave-transported gravels are found up to 50 m inland flooring the erosion and deflation hollows in the dunes behind.

Two areas of the beach depart from the above pattern of sand beach, gravel ridge and backing suites of dunes and machair. To the south, near Stoneybridge, the backing dune and machair zone disappears and is replaced by a superb broad-crested coarse gravel ridge that reaches up to 10 m above mean sea level and up to 50 m wide (Ritchie, 1971). Under storm conditions the ridge is subject to roll-over of the constituent gravels that encroach into the area of marsh and lochs on the landward side. South of Ardivacher Point, at West Gerinish, about 200 m of beach is now backed by a sloping gabion wall built to protect military installations. To the north of Ardivachar Point, the island of Gualan is an arcuate but narrow ridge of low dunes that is over-washed by gravels from the upper beach over all except the northernmost part of its 2.2 km length (Figure 9.10). The lower beach on the seaward side is sandy, low-angled and only a few hundred metres wide at low tide. At the northern end of Gualan, and to a lesser extent in the south, the intertidal sands widen to about 1 km, behind which occur embryo dunes backed by well-developed dunes of up to 4 m high (Keast, 1994). The eastern beach of Gualan represents the westernmost limit of the intertidal sands of the narrows that separate South Uist from Benbecula (the South Ford). Much of the western coastal edge of Gualan is subject to erosion and this is manifest either in low cliffs cut into the underlying machair or by gravel washover in small lobes that extend eastwards considerable distances down the dune and machair backslope.

Elsewhere, the coastal edge is highly variable in elevation and morphology, although in general there is a tendency for erosion and retreat. In most places there is a steep seaward dune face, capped by a sharp crest at between 4 and 12 m

OD. More complex areas of dunes occur where higher transverse ridges intersect the coast but in general the profile is relatively constant with a gentle concave backslope leading landwards to a low-lying and generally wet machair (a representative section of the northern part of the coast is shown as (Figure 9.11)). In some areas, for example at Drimore and Eochar, there are excellent examples of linear blowthroughs some of which have developed into fully formed deflation corridors and peripheral re-depositional hummocks.

Immediately inland of the coastal edge the machair surfaces are generally low features and rarely reach over a few metres above mean sea level. Where low ridges occur they can be shown to be composed of machair draped on top of underlying glaciogenic ridges (Ritchie, 1971). Nevertheless two distinctive machair landforms occur within the otherwise subdued topography of this zone. Extensive fields of hummocky dunes exist superimposed on top of the low flat machair plains. Between 1 and 3 m high and up to 8 m across, these hummocky dunes extend for considerable distances inland from the main coastal dune ridge. Dominated by marram *Ammophila* vegetation, they have the appearance of recently deposited features formed from sand recycled from frontal or blowthrough erosion. Inland, the most prominent of the machair landforms is a curved seaward-facing escarpment that stretches almost the entire length of the coastline. Well-developed at West Gerinish, Dremisdale and Drimore, the 16–20° scarp slope varies in height from 1 to 7 m. Several sections are under active wind erosion that has revealed a stratigraphy that includes several buried palaeosols. The upper and landward slope of the escarpment has a more gentle dip and shows signs of ongoing sand accretion on its surface. The upper surface slopes landwards to the margin of blown sand deposition, a boundary usually marked by either a coast–parallel series of shallow lochans and marshes (such as Loch Bee (Figure 9.9) and (Figure 9.10)), themselves subject to inundation of windblown sand, or by the rising surface of the hill land beyond.

Interpretation

The Ardivachar to Stoneybridge beach and machair system likely responded to Holocene sea level and sediment supply constraints in the same way as other machair systems in the Western Isles and were first developed sometime in the early to mid-Holocene before about 6500 years BP (Hansom and Angus, 2001). The relative sea-level curve for the Outer Hebrides has a form broadly similar to that of Orkney (see (Figure 6.28)) and is characterized by a slowing, or inflexion, In the rate of rapid rise in sea level at about 6500 years BP This argument is supported by the existence of numerous sites in the Outer Hebrides where Holocene freshwater peat is now found in the intertidal or subtidal zones. In the Uists, submergence of up to 5 m is thought to have occurred since 8800 years BP (Ritchie, 1985). Such a rate of sea-level rise, across a pre-existing sediment covered shelf, is likely to be the main driver behind the existence of large areas of beach, dune and machair. However, at the local level, such as between Ardivachar and Stoneybridge, the main controls on the dune and machair geomorphology are the degree of local exposure to wind and wave, the availability of suitably sized sand for aeolian transport and, crucially for the timing of sand incursion, the local coastal configuration. The coast of the Uists and Benbecula is essentially composed of a series of low but varying altitude rock basins (Figure 9.9), the flooding of each of which was asynchronous. For example, at Peninerine on South Uist and at nearby Borve on Benbecula the first sand inundation occurred at about 6600 radiocarbon years BE indicating the proximity of the shore (Ritchie *et al.,* 2001). On the other hand, on Pabbay to the north, intertidal peat at three locations suggests that whereas one part of the island was first affected by a major sandblow event *c.* 7700 radiocarbon years BP, another part was first affected *c.* 4300 radiocarbon years BP (Ritchie and Whittington, 1994). It appears most likely that progressive inundation by sand occurred as the coastline, forced by a rising relative sea level over much of the Holocene Epoch, moved eastwards. The result was the development of beach, dune and machair complexes which themselves became subject to erosion or flooding as the coastline progressed eastwards.

For example, between South Uist and Benbecula, the low basin that now contains the South Ford became flooded during the mid-Holocene and most of the central low-lying machair cover was lost. The narrow dune ridge of Gualan, north of Ardivachar, and small lateral fragments to the north and south of the South Ford, are probably all that remains of this formerly extensive machair. Tidal access to the Gualan machair was probably first gained as the dune cordon was breached in both the north and south ends. The breaches remain, but the process has advanced to the extent that the Gualan dune cordon is now thin and low with a coastal edge that is being eroded (Figure 9.10). Almost everywhere it is threatened by washover of gravels in storm conditions that will eventually lead to loss of the remaining dune and machair and further migration eastwards into the narrows.

Ongoing relative sea-level rise coupled with reductions in the offshore sand supply has subsequently resulted in erosion of many Hebridean beaches and the frontal undercutting of the sand dune and machair systems that they support (Figure 9.3); Hansom and Angus, 2001). The mainly sandy linear beach between Ardivachar and Stoneybridge reflects this and is mostly characterized by landward retreat of the coastal edge. Nevertheless, the sloping gabions at West Gerinish appear to be stable, with limited sign of either undercutting or outflanking. It may be that the sediment supply along this part of the coast has been locally healthy in recent years. Frontal erosion of the foot of the prominent, bare dune-slope by waves and deflation of the face by wind, has resulted in progressive landward migration of the seaward escarpment into the dune cordon and machair behind. Such progressive coast-parallel frontal removal of the dune cordon and the development of bare sand slopes exposed to the west, also provides conditions conducive to the development of linear blowthroughs and deflation corridors at right angles to the coastline. Good examples of this occur at Drimore and Eochar, together with the re-depositional dune landforms that form downwind of the erosional sites. Much of the remaining area landward of the seaward dune cordon is characterized either by low-lying and wet machair surfaces or high landward-sloping machair surfaces separated from the low-lying ground seawards by a steep, wind-eroded escarpment.

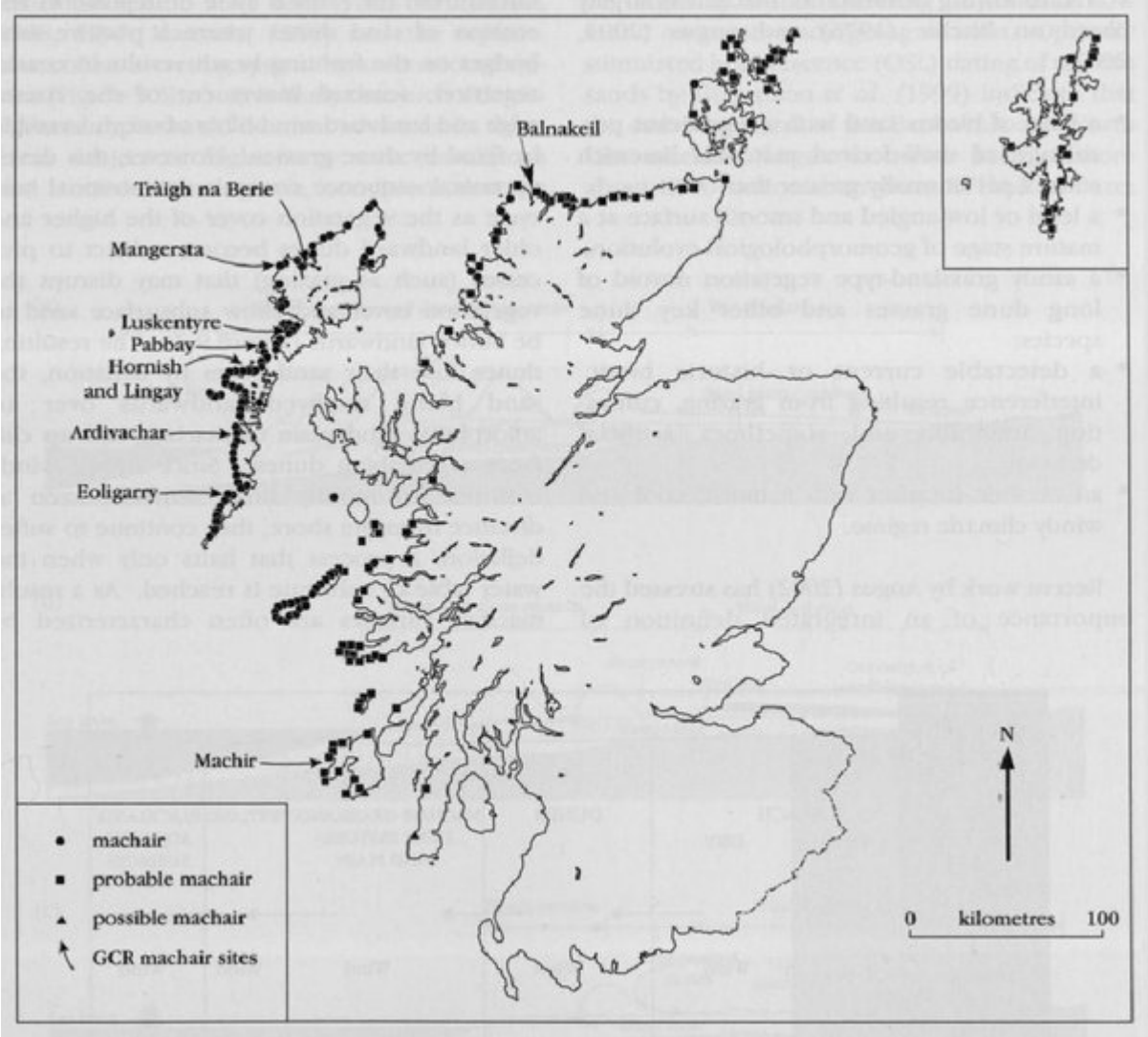
The low-lying machair demonstrates a sensitive inter-relationship between landform and water table. Although the higher and drier parts both to seaward and landward of the low-lying machair are subject to deflation for most of the year, the lower and wetter surfaces do not deflate when wet yet continue to accept deposition of windblown sand. The resultant land-forms are thus virtually flat and with a gentle landward gradient away from the main sand source. No detailed studies exist of the geomorphological processes involved in this windblown re-depositional system, but it seems likely that ongoing deposition onto the usually wet and gently sloping surfaces results in their progressive elevation, particularly at the seaward margin. Low-lying, flat and wet ground may be progressively replaced by higher sloping sand surfaces.

Similar processes are likely to have been responsible in the past for the initial development of the escarpment that often lies landwards of the low-lying machair, a feature prominent at West Gerinish, Dremisdale and Drimore. It is well-known that the landward slope of the high machair and wetland behind is continually elevated by the receipt of substantial quantities of blown sand deflated from both the beach and dune cordon as well as directly blown from the front of the escarpment itself. Accretion of the top surfaces of high machair appears to be both episodic and of long standing since palaeosols and archaeological remains ranging in age from the Neolithic to recent historic are exposed at several places in the deflated edges of the high machair. For example, on the South Uist machair at Kildonan [NF 725 284], south of Stoneybridge, Iron Age structures and associated palaeosols dating from 2500 to 1500 radiocarbon years BP have been exposed by subsequent deflation (Gilbertson *et al.,* 1996) and at nearby Cladh Hallan [NF 734 219], Bronze Age middens and palaeosols from 4000 radiocarbon years BP are exposed in the eroding escarpment edge of the high machair (Gilbertson *et al.,* 1999). Such palaeosols often form a layer resistant to further deflation (Ritchie, 1979a,b) although there is also evidence of periods of instability and sand-blow that extend into modern times (Gilbertson *et al.,* 1996, 1999). Hansom and Comber (1996) and Gilbertson *et al.* (1999) emphasize that although machair landforms are continually developing, they are probably more stable now than in the past. As a result it is possible that the very marked relationships that exist between the supply of fresh shell-sand, soil characteristics, vegetation and landform noted by Ritchie (1976) (Figure 9.11) may change in the future as the supply of fresh sand alters.

Conclusions

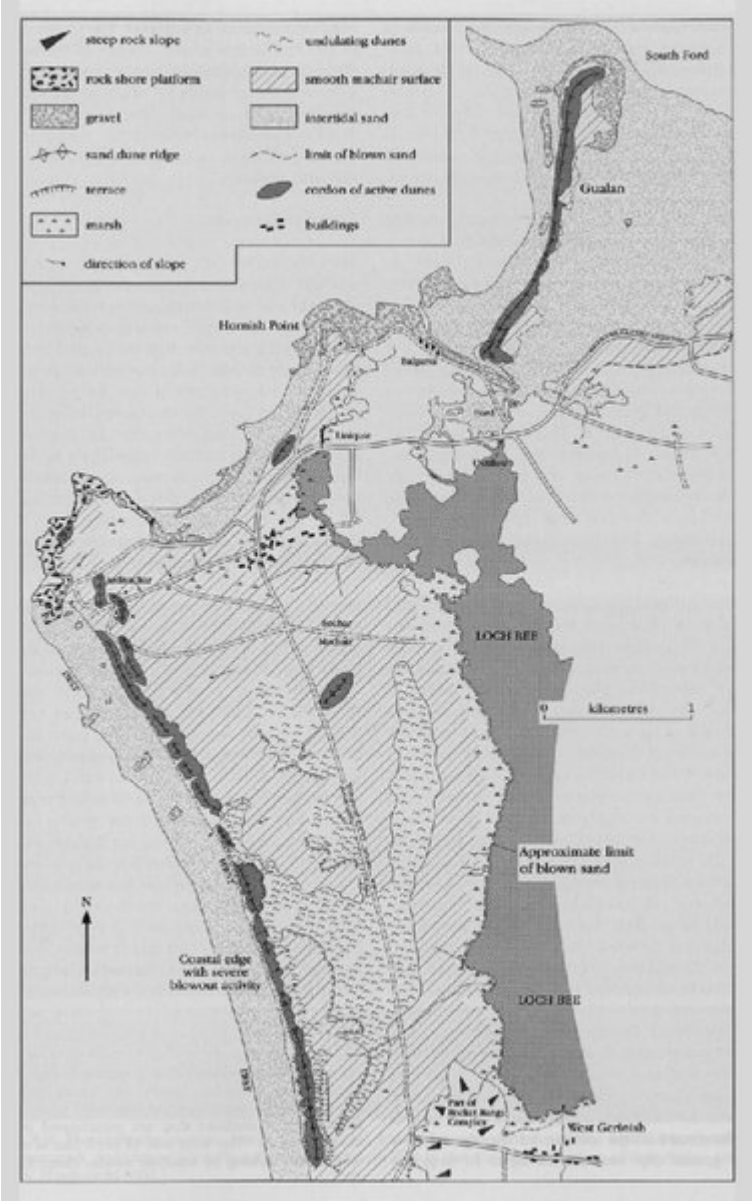
The South Uist coastline between Ardivachar Point and Stoneybridge is an exposed Atlantic coastline subject to ongoing submergence and includes excellent examples of almost every type of beach, dune and machair surface in the Western Isles. The narrow overwashed island of Gualan represents all that remains of a formerly extensive dune and machair system. South of this lies a beach, dune and machair system that is undergoing frontal erosion by wind and wave but still demonstrates a close inter-relationship between water table and landform with well-developed, low, wet surfaces together with a prominent high-machair terrace surface fronted by a conspicuous escarpment that is actively subject to wind-blow in the south the sand beach and machair is replaced by a high gravel beach backed by marsh and loch. The suite of machair landforms is extensive and the range and variety of erosional and depositional landforms is of international geomorphological importance. Interest is further enhanced by the occurrence of several archaeological sites that provide a cultural and dating context for machair development.

It is the type site on which much of the early work on machair development was based.

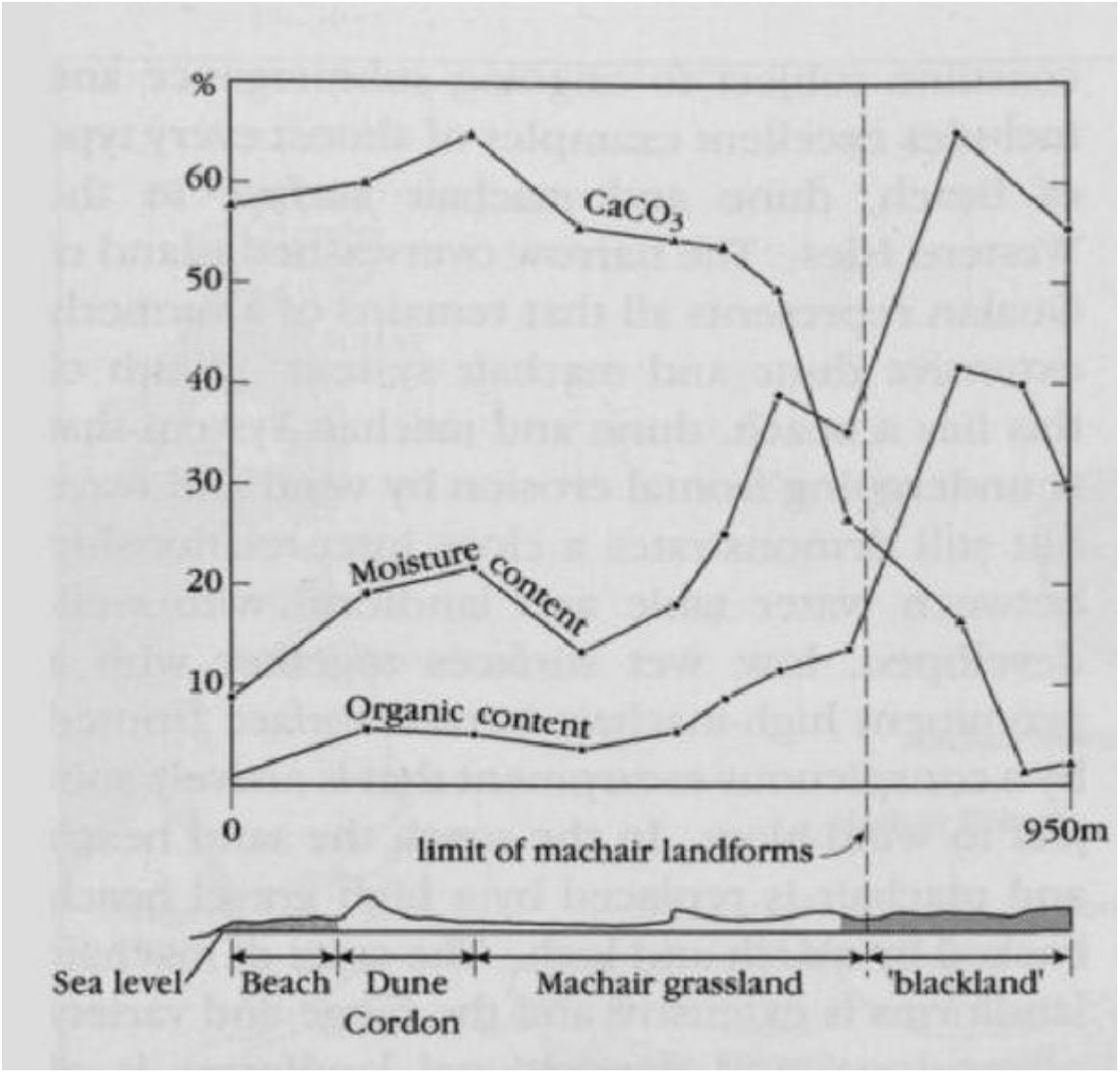


(Figure 9.1) Distribution of machair in Scotland. Other than Sandwood, Torrisdale and Balta (see Chapter 7), all the sites included in the GCR fulfil both the geomorphological and vegetational definition of machair. Small vegetational differences in the above sites have resulted in the label 'probable machair'. Ongoing work that interprets the geomorphology and botany of machair aims to provide a definitive machair diagnostic test in the future and so the above classification will be subject to slight modification (Angus, 2003, pers. comm.). (After Hansom and Angus, 2001.)

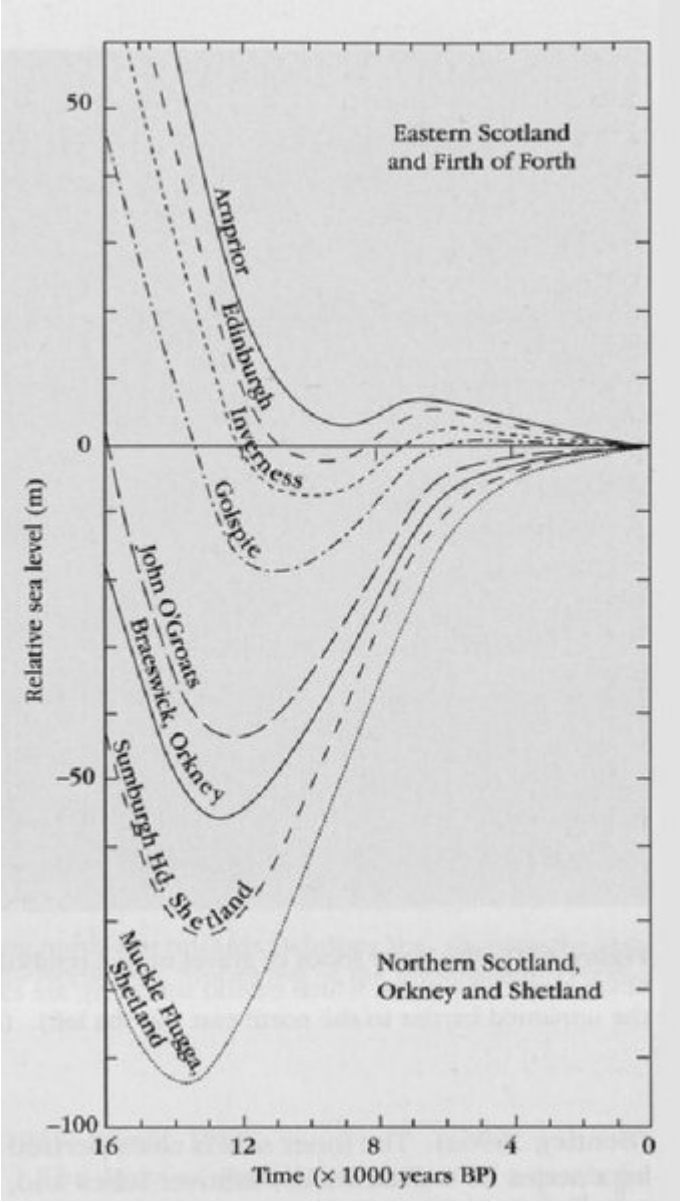
(Figure 9.9) The extensive machair lands of South Uist, looking north, with the exit of the Howmore River in the foreground, Ardivachar, Loch Bee, Gualan and North Uist in the distance at the top of the photo. (Photo: P and A. Macdonald/SNH.)



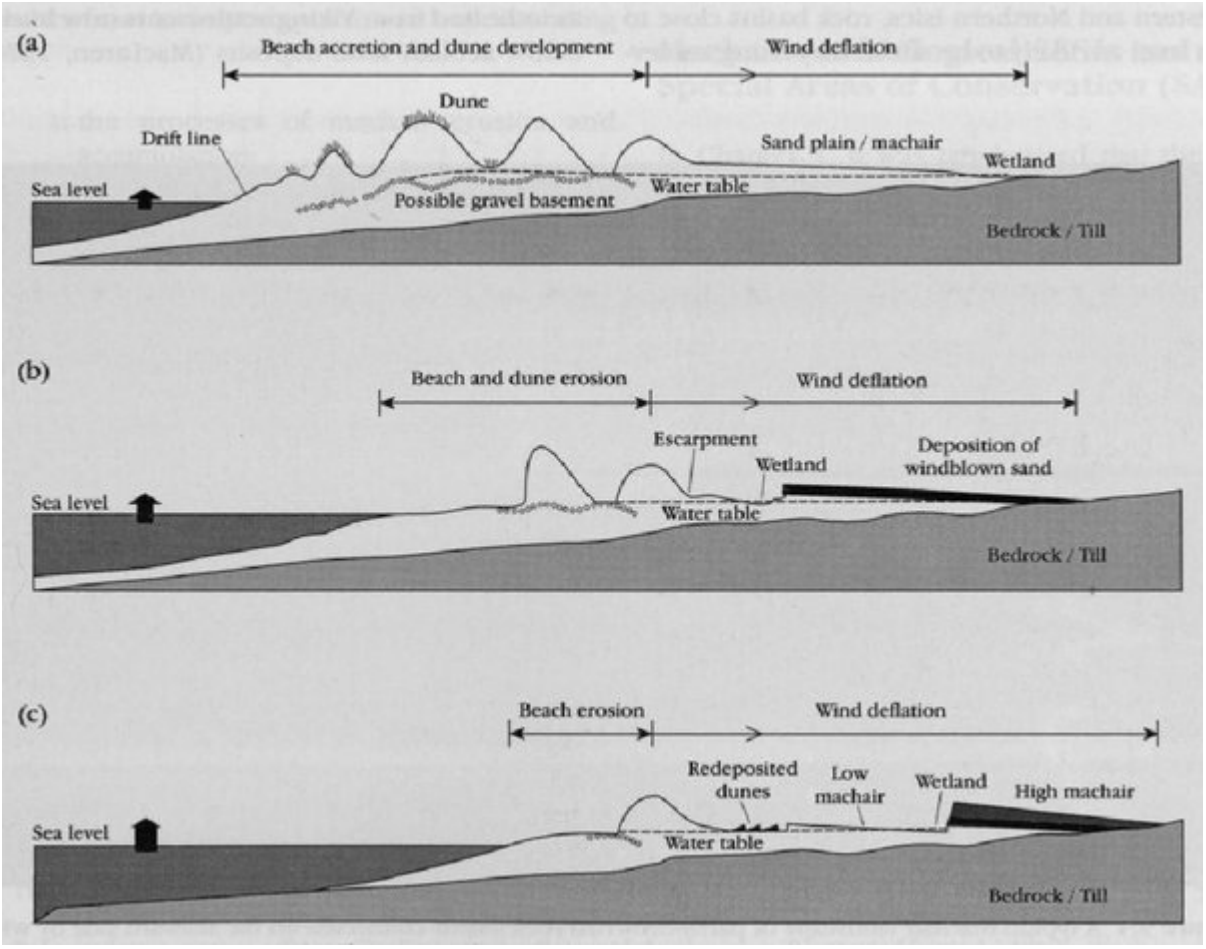
(Figure 9.10) (overleaf) The geomorphology of the area around Ardivachar, South Uist. A narrow cordon of active dunes separates the intertidal sandy beach from machair surfaces that are punctuated by erosional terraces. The west side of Loch Bee is subject to gradual infilling by machair sands. (After Ritchie, 1971.)



(Figure 9.11) A representative cross-section over Dremisdale Machair, South Uist, showing the relationship between landforms, vegetation and soil characteristics. Note the landward decline of calcium carbonate content of the sand from high values close to the beach. Dremisdale is sited just north of the Howmore River exit (see Figure 9.9). (After Mather and Ritchie, 1977.)



(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 9.3) The Holocene development of machair from approximately 6500 thousand years ago to present, showing the switch from conditions of accretion of the dunes to erosion and recycling of dune sands into machair. (a) early–mid Holocene; (b) late Holocene; (c) present day. (After Hansom and Angus, 2001.)