LOCH MADDY - SOUND OF HARRIS COASTLINE

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Introduction

At its maximum extent the GCR site of Loch Maddy is approximately 10 km wide and 10 km long, extending northwards from Loch Maddy (Loch nam Madadh) in North Uist to the south part of the Sound of Harris (see Figure 3.1 for general location). It covers slightly less than 100 km² in area of intricate and complex shoreline studded with innumerable islands, skerries and intertidal rock outcrops. The coastal geomorphology is both diverse and exceptional, with low cliffs, discontinuous shore platforms, sheltered sea-loch environments, intertidal sandflats, low rocky islands, reefs, skerries, isolated rock outcrops, rock pinnacles, intertidal rock and boulder pools (Figure 3.17). Almost all of these features are related to the submergence of rock surfaces close to sea level that have undergone intense glacial scouring in and around the main sea inlets of Loch Maddy, Loch Blashaval, Loch Aulasary and Loch Mhic Phàil. The coastal landscape produced is on a scale reminiscent of the Norwegian skjaergard or strandflat, and, with the possible exception of parts of western Ireland (Guilcher *et al.*, 1986), is not found elsewhere in the British Isles. The diversity of landforms within a general trend of Late Quaternary sea-level rise and land submergence is of particular geomorphological significance.

Figure 3.1: High-cliffed coast of Great Britain, showing the location of the sites selected for the GCR specifically for coastal geomorphology features of hard-rock cliffs. Other coastal geomorphology GCR sites that include hard-rock cliffs in the assemblage are also indicated.

Figure 3.17: The submerged landscape of North Uist looking north-west over Lochmaddy. Submergence of a low undulating rock surface has resulted in a landscape of low rock basins, platforms and skerries with a range of tidal and salinity conditions. (Photo: P. & A. Macdonald/SNH.)

Unsheltered coasts in the Western Isles are exposed to high mean wind speeds, but the inner coast of the Minches is relatively more sheltered. The seabed offshore of Lochmaddy is shallow with numerous skerries and reefs. Spring tidal range at Lochmaddy is 3.5 m and maximum tidal streams are variable around 1 m s^{-1}, depending on location (UKDMAP, 1998). However, although the tides on the Atlantic side of the Sound of Harris are out of phase with those in the Minch, there are no strong currents flowing between the two. Along the east coast of the Western Isles, the irregular coastline produces a highly variable wave climate. Offshore of Lochmaddy, the outer coast of the Minch experiences moderate wave energies, particularly from the south and north-east, between Weaver's Point and Leac Na Hoe where the 20 m depth contour comes within 300 m of the shore. The inner parts of the shoreline are very sheltered and are subject only to small locally produced waves.

Description

Several types of coastline occur in this area but in essence all are the product of submergence of a glaciated rock platform close to sea level. To the east of the site lies a line of glacially scoured hills that correspond to the line of the Outer Hebridean Thrust zone (Figure3.18). Beyond this the outer Minch coast is high and rugged, reaching 281 m at South Lee but reducing in height northwards to 154 m at Leac Na Hoe. To the west of the site a line of hills rises to 190 m OD. The intervening inner Minch coastline (i.e. within the sea lochs of Maddy, Blashaval, Mhic Phàil and Aulasary) rarely rises more than a few metres above present sea level. The geology of North Uist comprises an ancient basement of metamorphic Lewisian gneiss that was intruded by basaltic sills and dykes during Tertiary times. The Outer Hebridean Thrust Plane occurs high on the west facing slopes of the hills of eastern North Uist and divides the island into two distinctive geological provinces. To the west, the rocks are relatively uncrushed gneisses, whereas in the east the rocks are crushed gneisses and mylonites.

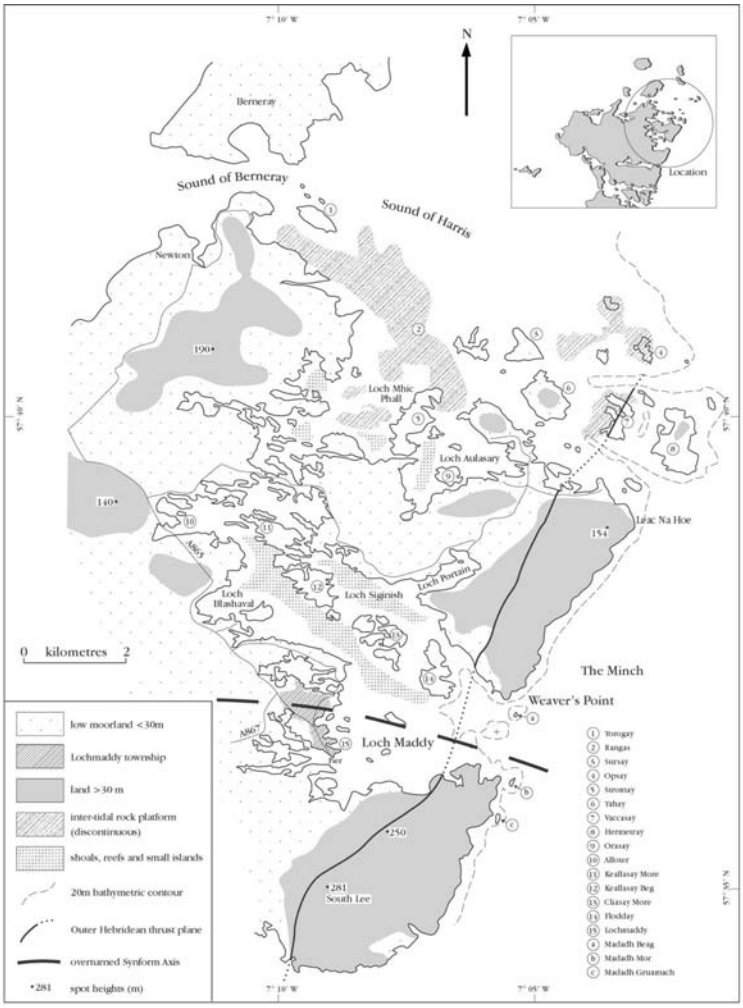

Figure 3.18: Coastal geomorphology of the Loch Maddy–Sound of Harris area, North Uist, showing the extensive areas of intertidal rock platform, small islets and skerries produced by submergence of a pre-existing low-lying rocky surface. The eastern coast is fault-controlled. (Modified from unpublished work by W. Ritchie.)

Loch Maddy, the largest sea loch of North Uist, reaches over 20 m deep and is described as a 'fjard' (Earll and Pagett, 1984). Unusual in Scotland, fjards are similar in origin to fjords but occur in areas of low-lying land that have been subject to extensive erosional scour by glacier ice and have intensely serrated shorelines, interrupted by many peninsulas and inlets (Earll and Pagett, 1984). The low and fragmented shoreline of Loch Maddy has numerous inlets and small rocky islands, while the intertidal area consists predominantly of gravel and boulders, with limited coarse sand patches and outcrops of scoured bedrock. Many of the irregular sea loch inlets link with inland freshwater and brackish lochs, particularly in the vicinity of the small town of Lochmaddy, allowing limited tidal exchange of water (Figure3.17).

The outer Minch coastline to the north and south of the entrance to Loch Maddy consists of cliffs rarely more than 30 m high and with gradients of 20–50° that continue underwater. The term 'pseudo-cliff' has been coined to describe such features. The cliff slopes are highly irregular both in plan and profile, however there are no caves, arches or stacks and only limited cliff-foot accumulations of gravel or boulders. Shore platforms are absent. There are few, if any, scree slopes. The cliffs are 'clean' bare rock cliffs and contrast markedly with most cliff areas elsewhere in Scotland.

North-westward of Loch Maddy lies the highly irregular coastline and numerous large and small islands of Loch Blashaval. Here, the seabed is made up of a series of ridges and deep, rock-floored, narrow basins (Admiralty chart 2825). The scale, alignment and relief of this submarine topography mirrors that of the patterns of adjacent subaerial lochans and ridges. The trend is mirrored in the islands of Keallasay More, Keallasay Beg, the Cliasay group, and Flodday, and several of the minor inlets and small islets. The outline of the Sound of Harris

coast is very irregular, although the north-west to south-east geological trend is evident in an extensive series of low, intertidal, shore platforms and skerries, known as ‘the Rangas', which stretch towards the island of Torogay and the Sound of Berneray. Extensive banks of submerged sand are associated with these reefs, indeed, much of the floor of the shallow Sound of Harris is sand-covered. The larger islands in the Sound (Torogay, Sursay, Tahay, Opsay, Vaccasay and Hermetray) have a patchy cover of glacial deposits. Tahay is a conical, rocky island rising to over 65 m OD, whereas Vaccasay is low and irregular with extensive intertidal rock platforms at sea level. A complex and extensive group of shore platforms, reefs, skerries and islands lie close to Opsay where a series of extensive intertidal boulder shoals combine to form a complex small-scale archipelago, with enclosed tidal pools and uneven rocky intertidal surfaces.

Two large, but shallow and wide, sea lochs, Loch Mhic Phàil and Loch Aulasary, penetrate into the north coastline either side of the low ‘island' of Stromay. Stromay is joined to the mainland for most of the tidal cycle. The low irregular coastline of Loch Mhic Phàil is characterized by a multitude of narrow interdigitations of land, sea and low rocky islets rarely rising more than a few metres above sea level, each thinly veneered by till and peat. Tidal ponds are a characteristic feature of this area. The ponds are basins whose centres lie below low tide and which remain partly flooded when the tide recedes to reveal washed perimeters of boulders and rocks within the intertidal zone. The low, rocky and peat-veneered shoreline of Loch Aulasary is similarly irregular. At low tide Loch Aulasary is almost completely land-locked as a result of broken shore platforms in the north closing the gap between the island of Stromay and the long peninsula west of Leac na Hoe (Figure 3.18).

Interpretation

The essential character of this extensive and distinctive GCR site is a product of the submergence of a low-amplitude and intensely glaciated platform of ancient metamorphic rock. Accordingly, small-scale details of rock type and structure, patterns of previous glacial action and sea-level change, are all central to the explanation of the nature of any particular stretch of this intricate rocky coastal zone. To the west of the Outer Hebridean Thrust Plane the bedrock is composed of relatively uncrushed gniesses that are highly durable and resistant to erosion. As a result the relative durability of the underlying bedrock finds morphological expression in the orientation of the coastal rock skerries, headlands and reefs, all of which are strongly linked to the north-west to south-east regional foliation of the gneiss. For example, in the Lochs Blashaval and Siginish area, both subaerial and seabed topography is made up of a series of ridges and deep, rock-floored, narrow basins, the scale, alignment and relief of which mirrors the structural trend.

Several glaciations have moulded the rocky platform of North Uist into a complex of tightly packed linear depressions and ridges (Geikie, 1878; von Weymarn, 1974). The regional dispersion of ice during the last glaciation mirrored and enhanced the north-west to south-east geological trend (Gordon and Sutherland, 1993; Mactaggart, 1997a). The size, alignment and dimensions of the depression and ridges reflects both the direction of ice movement and the relative strength of the rocks. Since deglaciation of the Western Isles about 14 000–15 000 years BP, the dominant trend in the Outer Hebrides has been one of rising relative sea level, interrupted by temporary regressions (Sissons, 1967). Ritchie (1971) believes that the Holocene sea-level rise in the Uists was of the order of 80 m, whileSteers (1973) accepts a rise in sea level of between 61–73 m. However, both agree that most of this rise took place before 5700 years BP and led to the submergence of a surface assemblage of landforms near Loch Maddy whose morphogenetic affinities lie more with the Norwegian strandflat than with any landscape in the British Isles. At this time, the low glacially eroded terrain of Loch Maddy was transformed into a multitude of islands, skerries and convoluted inlets and straits.

The lack of erosional features such as caves, arches and stacks in the pseudo-cliffs of the outer Minch coastline is also a likely result of a fairly rapid Holocene submergence (Ritchie, 1968). In spite of the relatively exposed nature of the outer Minch coast and the occurrence of crushed gniesses and mylonites, erosional features are not well developed, even in the more exposed locations. In the absence of any characteristically marine cliff-foot features, it is most likely that the ‘pseudo-cliffs' are drowned slopes that have been locally steepened by glacial and slope processes rather than by marine processes and basal undercutting.

As a result of Lateglacial and Holocene submergence, the Outer Hebrides do not show the well-developed suites of emerged ('raised') beaches and associated features so characteristic of much of the Inner Hebrides and Scottish mainland (Sissons, 1967; Ritchie, 1971; Steers, 1973). However, Godard (1965) recognized a number of shore platforms just above modern sea level (e.g. at 0.5 m above high-water mark on the south shore of Loch Maddy) which he suggested might indicate limited emergence. However, the platforms are undated and are more likely to be either interglacial in age, or glacial in origin and may be unrelated to marine processes. They may be simply rock surfaces that have been brought to their present altitude by subsequent submergence (Ritchie, 1968). Similarly, the rock platforms close to sea level in the northern part of the Loch Maddy area are also likely to be washed rock surfaces that now occur close to sea level, rather than shore platforms cut at this level by marine processes.

The inner bays of Loch Maddy are entirely sheltered from the storm and swell waves that sweep both the open Atlantic Ocean and the Minch. However, because the area experiences very strong winds, small but steep wind-generated waves are commonplace over short fetches and this results in very effective trimming of the overlying glaciogenic material and the development of boulder lags at high-water mark.

The scientific importance of this extensive coastal area does not centre on unique individual features such as the eroded remnants of Tertiary olivine rock pinnacles at 'the Maddies', the intertidal rock and boulder 'pools', or the scattered shore platforms and islands in the Sound of Harris. It is the *totality* of this diverse and low, irregular, rocky coastline that is of particular significance. The Loch Maddy–Sound of Harris coastline shows the response of various types of surfaces, essentially those shaped by glacial processes, to the submergence caused by Late Quaternary relative sea-level rise.

Conclusions

The Loch Maddy–Sound of Harris coastline displays an exceptional and distinctive range of submerged, glacially eroded, coastal landforms. With the possible exception of parts of western Ireland (Guilcher *et al.*, 1986), this assemblage of landforms is not found elsewhere in the British Isles. The low, irregular, rocky coastline with pseudo-cliffs, fjard inlets, sheltered sea loch environments, shore platforms, skerries, isolated rock outcrops and intertidal rock and boulder pools, displays many excellent examples of features produced by a marine transgression across a low glacially-scoured surface. It is this diversity of landforms, within a general trend of Late Quaternary submergence, that is of unique geomorphological and scientific significance in Britain.

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