Foula, Shetland

[HT 940 400]

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Introduction

The island of Foula (13 km^2) lies 22.5 km west of the Shetland Mainland and is the most westerly of the Shetland Isles. The island's dramatic profile is dominated by the summit of The Kame (376 m), Britain's second-highest sea cliff. The entire coastline is exposed to the extremes of wind and wave energy as it shelves steeply into deep water (greater than 60 m). The high cliffs and fragmented cliff-foot shore platforms along the west and south-west coasts are exposed to the frequent and high-energy Atlantic storm and swell waves.

The island is primarily composed of Middle Devonian sandstones, which rest unconformably on, and are faulted against, a narrow strip of Dalradian metamorphic rocks along the east coast (Blackboum and Russell, 1981; Blackbourn, 1985). The metamorphic rocks are cut by a series of microgranitic intrusions, the topographic expression of which adds protrusions to the coastal outline of the island. Erosion and faulting of the sandstone has led to the development of a series of approximately east-west-trending gentle south-facing dip slopes and steep north-facing escarpments (Flinn, 1978; Blackbourn, 1985) that form ridges and valleys that dominate the skyline and control the form of the dramatic cliffs along the north, south and west coasts of the island. Flinn (1978) concluded that Foula had been completely overridden by ice during the last glaciation, with ice flow from the south-east that had been deflected to the north and north-west by the higher land of Hamnafield and The Sneug. Localized ice deflection to the west around The Noup influenced the glacial erosion of the Daal valley.

Although Foula may not be quite as exposed and windy as St Kilda, it shares a wind and wave climate similar to Papa Stour. At Foula, a combination of exposure to prevailing winds and deep water dose inshore produces a relatively high-energy wave climate at the shore and significant wave heights are about 3 m for 10% of the year and less than 1.5 m for 75% respectively (Draper, 1991). However, storm waves at sea reach heights well in excess of this. There are few skerries and shoals offshore and since the sea floor falls steeply away from the island to –80 m depth, onshore wave energies are high.

Description

The Foula coast is almost entirely cuffed with heights of 150 m at Wester Hcevdi [HT 937 388], 210 m at Soberlie [HT 951 410], 248 m at The Noup [HT 953 375] and 376 m at The Kame [HT 940 400]. However, the crest of the cliffline lowers dramatically along the east coast where it ranges from 50 m to below 10 m in height. Local variations in cliff form are related to the slope of the inland topography, itself controlled by the structure of the bedrock geology and, to a lesser degree, past glacial erosion. Cliff-foot shore platforms are found along some sections of the coastline, although they vary greatly in extent and are partly a function of structural control. Classic examples of caves, arches, tunnels, stacks, reefs and skerries are also present around the coast. It is convenient to subdivide the coast into seven sections on the basis of the bedrock geology and/or surface topography ((Figure 3.10), after Pirkis, 1963).

In section one the area of Dalradian metasediments and microgranite intrusions between Wurr Wick and Shoabill is geologically distinct from the sandstone bedrock that dominates the rest of the island. The two inlets of Wurr Wick and Shoabill have been cut along the line of the faulted contact between the sandstones and Dalradian metasediments and the cliffs are lower than elsewhere at no more than 50 m high. Inland limits of weathering and surface stripping associated with wave spray are variable and dependent upon the geology and inland topography. On the northern side of Strem Ness a tunnel has formed along the line of minor fault plane between Wurr Wick and Scarf geo. The nature of the cliffs around Strem Ness changes at the Head o'Ruscar, where a microgranite sill has been intruded into the host rock and is characterized by a gentle, seaward-sloping bedrock ramp, which facilitates rapid wave run-up during storms and erosion of the bedrock surface. Deep geos occur at Kubbi a'Skeld and Sloag of Ruscar, and to the south towards Ruyhedlar Head, a near-vertical cliff of granulite rises to 50 m. The coastline becomes indented by intersecting geos with many excellent examples of rock-coast landform development such as caves, arches stacks and stumps. South of Swaa Head, the altitude of the mica-schist cliff averages 20 m in height. The rocks are significantly less resistant to weathering and erosion than the psam-mites to the north and the coastal edge is a low, gently sloping platform, locally dissected by narrow geos cut along the boundaries of microgranite intrusions and scour and stripping of vegetation is evident up to 20 m above sea level and 50 m inland. Hedd o'da Baa, to the south of Ham Voe, comprises a low, flat, coastal edge up to 10 m high composed of peat resting upon glacial till, but to the south the altitude of the coast rises towards the large and complex geos of Ham Little, Selchie Puddle and Shoabill.

The second coastal section from 'Shoabill to Hellabrick's Wick (Figure 3.10) and inland has some of the lowest and flattest land on the island. The surface falls from 40 m at Heddicliff to 20 m at South Ness reflecting the gentle southerly dip of the underlying sandstone. The cliffs south from Shoabill to North Hœvdi are mainly composed of sandstones and shales capped by glacial deposits that feed debris to the cliff-foot boulder beach, known as 'South Wick', via extensive and unstable scree slopes. South of this, the coast is composed of harder sandstones capped by a thin layer of glacial till (Pirkis, 1963) and the cliffs are low, but sheer, and arc deeply indented by geos with stacks offshore. The northern part of the third coastal section from Hellabrick's Wick to Smallie is mainly composed of the Noup Sandstone, the form and height of the cliff mirroring that of the topography inland and rises to The Noup at 248 m. The cliffs are stepped and formed of a series of landslided sandstone blocks and associated scree slopes. Steeply sloping (25°) cliff-foot platforms lead up to the base of the landslides. To the north the cliff edge drops to around 70 m where the Daal, a glaciated trough, intersects the coast. Large cliff failures are currently active at the western end and several large tilted slip blocks of sandstone appear to have failed along the upper junction of the intertidal ramp of the shore platform. One of the most impressive and distinctive is the Sneck o'da Smallie, a 60 m-deep and 1 m-wide deft that extends for 50 m.

The fourth section of coast between Smallie and Wester Hcevdi is one of the most exposed parts of the Foula coastline and contains excellent examples of cliffs influenced by structural dip (Pirkis, 1963). The cliff profile shows a series of steps up to 250 m high, comprising at least one major rock slide. The southerly dip of the sandstone has produced a ramp-type shore platform along this section of coast that is narrow and structurally controlled. It is poorly developed and locally obscured by slabby boulder beaches and scree deposits. Just north of the Smallie, a large rock failure known as 'Ufshins' has slid at least 40 m down a section of cliff face defined by faults in both the east and west.

The fifth section of coast between the 150 m-high Wester Hœvdi and the 220 m Soberlie is composed of sandstone and has by far the most spectacular cliffs on Foula. The sheer face of The Kame at 376 m, is the second highest sea cliff in Britain (Figure 3.10). The cliffs at Wester Hœvdi are also sheer with numerous caves but no shore platforms. To the north, short lengths of sloping intertidal shore platform occur with skerries offshore. Beyond The Kame, the cliff crest drops rapidly to Soberlie Hill, its base indented with caves and headlands. Along the Da Nort Bank, localized accumulations of cliff-foot boulder beaches occur sourced from the joint controlled collapse of the upper cliff face. There is a general absence of shore platforms along this stretch of the coast.

The sixth part of the coast between Soberlie and Da Ness is composed of glacial till-covered sandstone into which have been eroded an abundance of caves, arches, tunnels, stacks and reefs. To the east of Da Logat, the Logat Stacks are well-developed examples of triangular stacks with rocks dipping steeply (around 45°) southwards. The stacks at Gaada, Sheepie and The Brough are similarly dip-controlled, Gaada stack being dissected by two arches the upper surfaces of which are capped by eroded and loosened boulders. The lower part of the uppermost bed remains unweathered towards the base of the landward face and protrudes as a low ridge, preventing downslope slippage of weathered material from above.

The final section of the coast to Wurr Wick is unique as it is both low-lying below 10 m and depositional being composed of a storm ridge composed of local sandstone, igneous and metamorphic *c.* 1 m-long boulders. During storms such boulders are thrown several tens of metres inland (Pirkis, 1963), for example at Boat Harbour.

Interpretation

Early work by Walton (1959) on cliff coasts along the east coast of Scotland suggested that many seemingly active cliff landforms are inherited features from earlier sea levels, buried by glacial till during the Quaternary Period, and subsequently exhumed and subject to further wave erosion over Lateglacial and Holocene times. Where conditions were favourable for preservation, even some fragile features such as stacks and arches were re-occupied and numerous examples of till-adorned stacks and till-choked emerged ('raised') stacks are known from the Scottish coast, for example at Tarbat Ness and Cullen in the Moray Firth. In Foula, cliffs with till caps and till plugs inside the heads of geos occur widely along the north and east coast and are a powerful argument in favour of the inheritance of cliffs from earlier times. This is supported by more recent analysis from a wide range of coastal settings including Antarctica, where fragile stacks have emerged as ice caps have retreated (Hansom, 1983), St Kilda (Sutherland, 1984) and Canada (Trenhaile, 1997). In spite of this, some of the more fragile features such as stacks and arches can also be shown to have developed, and in some cases were subsequently destroyed, entirely within the Holocene Epoch as marine quarrying and abrasion has progressed, for example the Old Man of Hoy in Orkney (Hansom and Evans, 1995). On Foula, The Brough stack supported an arch carrying a Bronze Age broch (fort) on its upper surface until the arch collapsed during a severe storm in 1965. This implies that whilst the overall form of a cliff coast may well be inherited from former conditions and reoccupied by present processes, the detailed form, development and change can be a relatively rapid process.

In Foula, the occurrence of inherited cliff features, especially along the north and east coasts, may be explained in terms of differential erosion rates leading to preservation. It is probably reasonable to assume the highest energies in Foula occur on the west and south coasts since these are fully exposed to waves from the dominant westerly and south-westerly directions. In comparison, wave energies may be relatively lower along the east and, possibly, north coasts. It follows that there is a greater likelihood of preferential preservation on the north and east coast and this broadly appears to hold. Foula would therefore provide an interesting site for a more detailed examination of the relative age of cliff coastlines in Scotland.

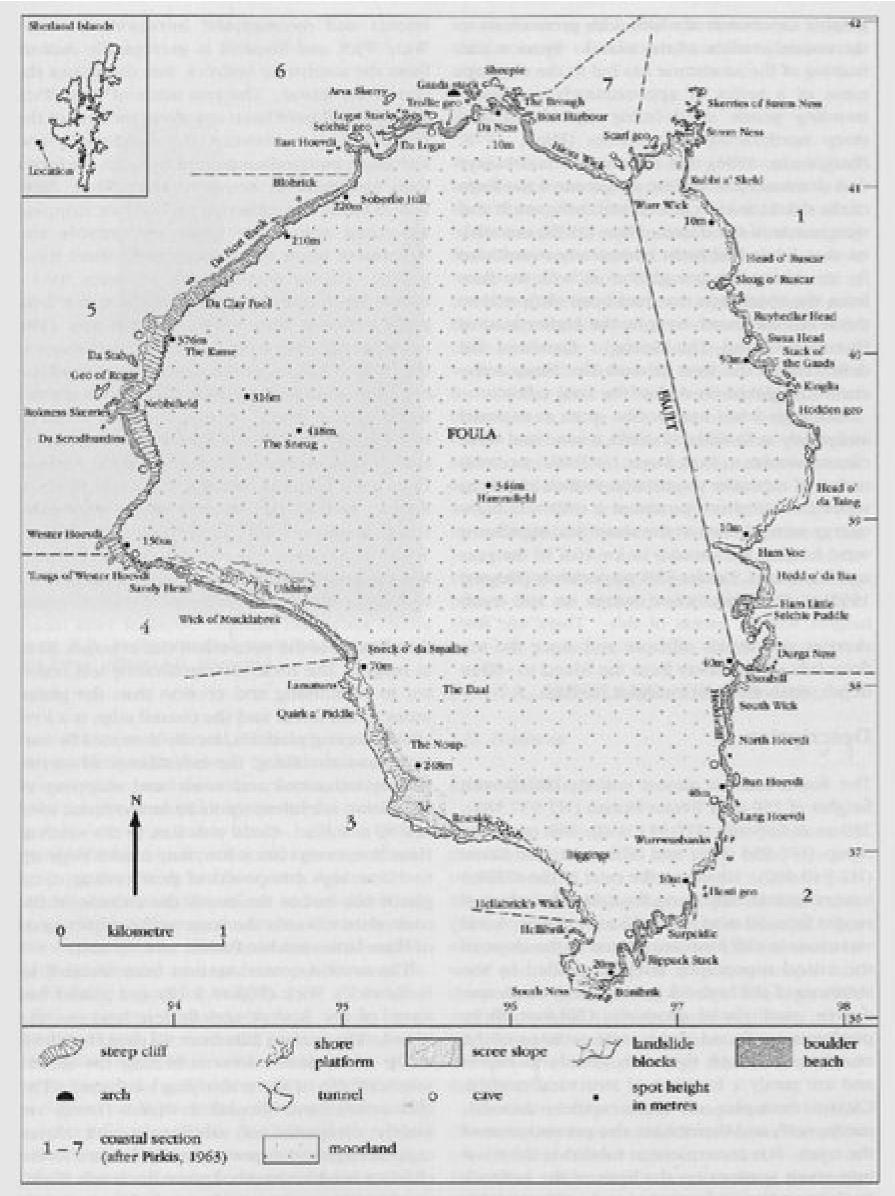
As with St Kilda, although shore platforms exist, the lack of extensive and well-developed shore platforms in such a high-energy environment as Foula, remains problematic and invokes similar arguments to those used for St Kilda. Pirkis (1963) argued that the absence of boulder beaches at the foot of the cliffs showed that erosion rates along the coast of Foula were low. However, beaches require a surface on which to develop and their absence here is probably related to the lack of an extensive and widespread cliff-foot shore platform, an absence itself related to unsuitable conditions for platform development. In Foula, where geological structures permit, limited shore platforms have developed, such as at Ufshins in the south-west. However, nowhere is there a shallow surface close to sea level from which these platforms, stacks and stumps commonly rise. Most of the cliffs of Foula plunge into deep water, and although minor erosional notching at present sea level exists, nowhere is it extensive or substantial.

In spite of the relative lack of shore platforms, several features of rock coast forms are well-represented and display good relationships with geological structure. For example, on the northern side of Strem Ness, a tunnel has been excavated headwards from two caves, one on either side of the Ness, to eventually coalesce along the line of minor fault plane between Wurr Wick and Scarf geo. At South Ness, some of the geos have deep and actively eroding caves at their head, suggesting that some geos form through cave formation and roof collapse along the lines of weakness in the sandstone. During south-easterly storms, wave action is intense within these geos, and cave formation is still active. The presence of large landslide-blocks along the west coast indicates that large-scale failure of the cliffs, which occurred in the past, probably continues as a result of failure along bedding planes in the sandstones and nowhere is this more dramatically displayed than at the Sneck o'da Smallie. Where shore platforms do exist in Foula, they tend to be structurally controlled. At the Noup, and to the north of here, the dip of the sandstone have been exploited by storm waves to produce a cliff-foot, ramp-type shore platform that is narrow and structurally controlled. This enhances wave run-up and has resulted in failure and slippage of the cliff-foot sandstone blocks.

With deep water offshore and adjacent steep cliffs, the boulders that comprise Hiora Wick beach are unlikely to be supplied with large quantities of fresh materials, and the boulders and gravels are likely be recycled. Pirkis (1963) used the distribution of clasts of different lithologies along the beach to infer that grey sandstone clasts eroded from Da Ness are fed southwards and alongshore to dominate most of Hiora Wick, whereas in the extreme south-east, igneous and metamorphic rocks sourced from outcrops in the south-east are found.

Conclusions

The island of Foula is outstanding for its assemblage of hard-rock coastal landforms, which include the second-highest sea cliff in Britain. With the exception of well-developed shore platforms, examples of most of the features and stages of coastal landform development in rock are found. The island experiences relatively high wave-energy levels and the west and south coasts are fully exposed to swell and storm waves generated in the Atlantic Ocean. These conditions have facilitated the development of a fine assemblage of sheer-faced and composite cliff forms, geos, sea caves, tunnels, arches, stacks and stumps, many of which show clear relationships with geological structure.



(Figure 3.10) Coastal geomorphology of Foula. Sections 1–7 refer to descriptions in the text. The highest and most spectacular of these are Section 3 and Section 5 where the cliffs rise to 248 m at the Noup, and 376 m at the Kame respectively. See Figure 3.1 for general location. (After Pirkis, 1963.)