VILLIANS OF HAMNAVOE

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OS Grid Reference: HU240810–HU242840

Introduction

The Villians of Hamnavoe, north-west Shetland, consist of over 3 km of almost vertical cliffs that rise from a height of 12 m OD at Whal Wick in the south to 45 m OD in the north. The coast is fully exposed to the west and north-west and receives the full violence and power of Atlantic storm waves. As a result, a range of cliff erosion features have developed along this stretch of coastline. The cliffs are cut in Devonian extrusive rocks, largely andesitic tuffs overlain by andesite lavas. In places the lavas, which are less resistant than the underlying tuffs, have been eroded to form a second cliffline fronted by a wide terrace up to 20 m above sea level, and yet remains so affected by storm waves that large blocks and slabs have accumulated to form a storm beach at the junction of the tuffs and lavas. In addition, differential erosion of the lava and tuff beds has led to a stepped cliff profile and marine exploitation of numerous cracks and fissures has resulted in the erosion of several geos and a large blowhole. Other parts of the site are characterized by large areas of wave-scoured bedrock that extend to altitude, together with individual wave-moved boulders, clusters of boulders and boulder beach ridges, all of which exist at altitudes well above those normally associated with wave processes (Figure 3.5).

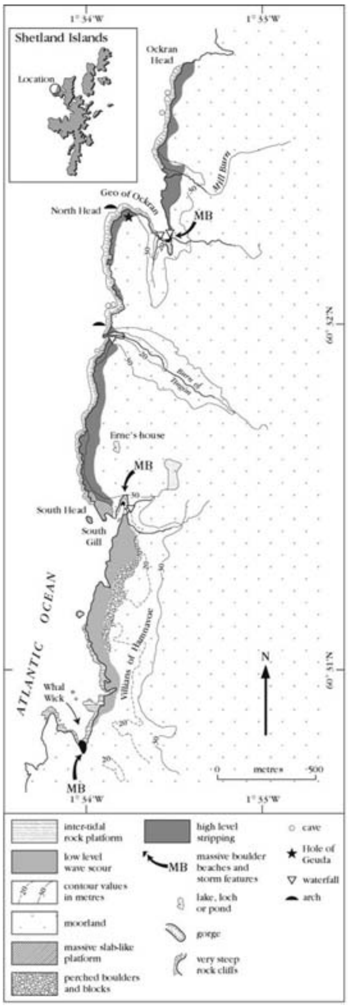

Figure 3.5: Geomorphological sketch map of the Villians of Hamnavoe showing extensive surfaces affected by both low-level wave-stripping in the south, and high-level wave-stripping in the north. For general location see Figure 3.1. (Modified from unpublished work by W. Ritchie.)

The most characteristic feature of the Shetland climate is the frequency of strong winds. The mean wind speed is 6.5–7.5 m s^{-1} and gales occur on average for 58 days per year. Although not quite as exposed and windy as St Kilda, for 75% of the time the hourly mean wind speed exceeds 4 m s^{-1} with the most frequent strong winds from the south-west (BGS 1977a). Along the western coast of Shetland, a combination of exposure to prevailing winds and deep water close inshore produces a high-energy wave climate at the shore. For example, at the Villians of Hamnavoe, the sea floor falls steeply to depths of –50 m within 500–700 m of the shore.

The Holocene evolution of the Shetlands is dominated by submergence (Hoppe, 1965; Flinn, 1964, 1974; Mykura, 1976; Birnie, 1981), and numerous examples of intertidal and subtidal peats support this. As a result, the cliffs of Shetland are not characterized by features such as emerged ('raised') shore platforms or notches. The Villians of Hamnavoe was selected for the GCR because it vividly demonstrates the effects of high-energy storm-wave conditions on a low cliff coast. The high altitude abrasion and scour features, associated wave-shifted slabs and boulders and high-altitude contemporary storm beaches are of outstanding geomorphological significance. Even so, as with much of the hard-rock coast of Scotland, remarkably little geomorphological research has been carried out on these distinctive and outstanding examples of high-energy landforms.

Description

The near-vertical cliffs of the Villians of Hamnavoe, north-west Shetland, rise from a height of 12 m at Whal Wick in the south to 45 m in the north. South Gill (a boulder-filled geo) marks the boundary between the higher (*c*. 20–45 m OD), steeper and sometimes overhanging cliffs, with a narrow basal intertidal platform to the north and the generally lower (*c*. 10–18 m OD) coastal rock platforms to the south that are adorned with wave-shifted slabs and boulders that comprise the contemporary storm beaches.

In the northern part, the Burn of Tingon cuts through the plateau in a ravine-like valley, which falls to sea level as a stepped waterfall, a dramatic illustration of the influence of geological structure on coastal erosion and fluvial forms. Additionally, along this section of cliff coast, there are numerous examples of caves, natural arches and a blowhole (the Hole of Geuda) whose roughly circular vent falls some 30 m from the cliff-top plateau. However, the most distinctive feature of these cliffs is the extent and height of contemporary cliff-top surface stripping. Stripping of turf and scouring of bedrock occurs up to 30 m inland of cliff edges that are themselves some 30 m OD. The exposed rock surfaces and the cliff edges are remarkably rough and irregular, reflecting variations in rock hardness and structure. In places on the cliff top, vesicles in the bedrock have been exploited by the high-level spray to produce micro-forms that seasonal frost action and solution have exploited.

At South Head (Figure 3.6), to the west of South Gill, an unusually wide, gently-sloping, smooth and slab-like platform, is backed by a vertical cliffline set back some 50 m from the coast. This 30 m-wide sloping terrace co-incides with the junction of lavas that overlie tuffs. Although the terrace is around 18 m OD, it is affected by storm waves, and large blocks and slabs of up to 2 m in diameter form a contemporary storm beach at the base of the cliffline. To the south of South Gill, the bare rock coastal edge is more ramp-like in appearance, reaching 20 m some 200 m inland, but is heavily scoured with surface vegetation having been stripped. However, the scoured rock surface is strewn with excellent examples of shifted rock fragments in the form of both individual boulders and imbricate clusters of boulders, as well as perched slabs at heights of up to 20 m OD and, where lower heights occur, up to 100 m inland. In all the above cases, the imbricate clusters demonstrate common orientations that are consistent with the general orientation of the host coastline, although minor local variations in boulder cluster orientation and dip reflect intricacies of the cliff top and cliff-edge gradient (Table 3.2). In several cases the boulder clusters incorporate modern human debris, such as fishing floats and timber spars wedged between, behind and underneath the boulders (Hansom *et al*., in press).

Figure 3.6: The Villians of Hamnavoe looking north towards South Head. The scoured surface is littered with both eroded boulders and debris thrown up by waves. Since some of this debris is of modern human origin (plastic fishing floats etc.) the waves that sweep the surface and emplace the debris and boulders are likely to be recent. (Photo J.D. Hansom.)

To the south of the Villians of Hamnavoe, at Eshaness, Hansom (2001) has described the boulder deposits on the cliff tops. The most spectacular of these, at the Grind of the Navir, reach almost 20 m OD and are situated some 50 m inland at the rear of a 15 m OD sub-horizontal rock platform, which is itself fronted by 15 m-high vertical cliffs. Three boulder ridges have been formed, the seawardmost of which reaches 3.5 m high and is composed of angular boulders of local ignimbrite that reach up to 2.1 m in length (Figure3.7). Fresh scars of these dimensions occur in the cliff edge and on the sub-horizontal surface of the cliff top.

Figure 3.7: The largest of three wave-emplaced boulder ridges that occur on top of a 15 m-high cliff some 50 m inland of the cliff edge at the Grind of the Navir, to the south of the Villians of Hamnavoe. Note 1.8 m-high figure for scale. (Photo J.D. Hansom.)

Interpretation

The Villians of Hamnavoe demonstrate the dramatic effects of high-energy storm waves on hard-rock cliffs, the relationship between geological structure and the high-energy process environment resulting in a distinctive and, in the British Isles, unique coastal geomorphology. The staircase cliff profiles, natural arches, caves and geos reflect a strong lithological and structural control, yet the resultant concentration of wave energy and power in geos and coastal valleys and the extensive wave run-up slopes on seawards-dipping rock platforms provide dramatic evidence of the extreme wave conditions experienced on these cliffs and shore platforms. The landforms that have developed in this high-energy wave environment are of great geomorphological significance and include: high altitude abrasion and scour features; contemporary storm beaches at the junction between the andesite tuffs and lavas; and the wave shifted slabs and boulders at high altitude.

In the north the stepped stairway inlet, together with the vertical blowhole of the Hole of Geuda, is a dramatic feature, particularly during storm conditions. The wave-quarried excavation of the inlet has proceeded inland along faults in the bedrock structure and intersected a fault or failure plane in the vertical dimension to result in the collapse of the cave roof to form the blowhole. To the south, the lower elevation of the cliffs, together with the low angle and exposure of the rock surface, facilitates wave run-up inland to remarkable distances and heights and this has resulted in wave-stripping of vegetation, together with wave-movement of boulders and gravels. Stripping by wind is also likely to play an important part in propagation of the stripping limit inland during storms. Turf edges at 40 m OD on South Head may mark the limit of wave wash of a major storm that occurred in 1991/2, gravel thrown through the air during the same storm occurring up to 100 m inland of the upper limit of wave wash.

However, Hansom *et al*. (in press) show that the limits of scoured bedrock, and the clusters of imbricate boulders, closely follow the indentations of the cliff edge and are thus likely to be mainly related to extreme wave processes. Detailed wave-refraction modelling at The Grind of the Navir also indicates that deep-water offshore waves of between 15 and 20 m in height undergo enough nearshore refraction only to reach breaking at the cliff face itself and so they achieve maximum erosive power at this point. The implication is that 20 m-high, deep-water storm waves fairly regularly impact on the 15–20 m-high cliffs along this coast and are capable of constructing boulder beaches above 15 m OD and 50 m distance from the cliff edge (Hansom, 2001). Since the Holocene evolution of the Shetlands is dominated by submergence (Birnie, 1981), the boulder beaches are not emerged features. Other than the 7000 years BP tsunami produced by the Storegga slide (Smith, 1997), there is no convincing evidence of other tsunamis reaching this coast and so the most probable explanation for the high beaches relates to the effect of extreme waves during storm events suggested byHansom (2001). The fresher blocks in the beaches are almost certainly excavated from fresh sockets in the fronting ramp and cliff top and the inclusion of modern fishing equipment wedged within the clusters of imbricate boulders strongly suggests a modern date. The distribution of larger, older blocks above and landward of the fresher blocks, suggests that storms of greater intensity have affected the coast of Shetland over the last 3000 years. Sands from underneath these boulders have yielded an Optically Stimulated Luminescence date of 1605 AD, and so may have been emplaced during the stormy conditions of the Little Ice Age (Sommerville*et al*., in press).

Other than the very recent research noted above, there has been no other geomorphological work published for this outstanding environment, in spite of the geological and geomorphological importance of the site having been highlighted in the past (NCC, 1976). There remains great scope for research of international significance at the Villians of Hamnavoe, including: identification and measurement of the range and rates of processes operating on hard-rock coasts in extreme high-energy conditions; and assessment of the frequency of extreme storms and their effect on the rate of cliff retreat, denudation of the scoured rock surface, and transport of large fragments of rock.

Conclusions

One of the most exposed coastal sites in Mainland Shetland, the Villians of Hamnavoe provide some the best examples of the power of high-energy storm waves. Well-developed, high-altitude scour features occur at a range of heights above 15 m OD and up to 100 m inland, with associated wave-shifted slabs and boulders. Similar high energies occur during major storms on St Kilda, but the overall height of the cliffs reduces the amount of potential wave run-up and washover and so may reduce erosion since the waves reach the cliff unbroken. At the Villians of Hamnavoe, nearshore water depths are sufficient to allow breaking on the cliff and a higher net erosion rate. The products of erosion are evident in the accumulation of high-altitude contemporary beaches constructed out of large boulders at distance from the cliff edge. In addition, a unique staircase waterfall and associated system of arches, caves and overhung cliff ledges, together with the spectacular blowhole, the Hole of Geuda, demonstrate the strong lithological and geological control in this extremely high-energy wave environment.

Reference list

Birnie, J. (1981) Environmental changes in Shetland since the end of the last glaciation. Unpublished PhD thesis, University of Aberdeen.
Flinn, D. (1964) Coastal and submarine features around the Shetland Islands. Proceedings of the Geologists' Association, **75**, 321–40.
Flinn, D. (1974) The coastline in Shetland. In The Natural Environment of Shetland: Proceedings of the Nature Conservancy Council Symposium held in Edinburgh, 29–30 January 1974 (ed. R. Goodier), Nature Conservancy Council, Edinburgh, pp. 13–25.
Hansom, J.D. (2001) Coastal sensitivity to environmental change: a view from the beach. Catena, **42**, 291–305.
Hansom, J.D., Hall, A., Barltrop, N. and Jarvis, J. (in press) Extreme storm waves in the North Atlantic and their impact on cliff-top processes in the Shetland Islands. Science.
Hoppe, G. (1965) Submarine Peat in the Shetland Islands, Institute of British Geographers

Special Publication, No. **7**, Institute of British Geographers, London, 197–210.
Mykura, W. (1976) British Regional Geology. Orkney and Shetland, Natural Environment Research Council, Institute of Geological Sciences, HMSO, Edinburgh, 149 pp.
Smith, D.E. (1997) Sea-level change in Scotland during the Devensian and Holocene. In Reflections on the Ice Age in Scotland (ed. J.E. Gordon), Scottish Association of Geography Teachers/Scottish Natural Heritage, Glasgow, pp. 136–51.