Papa Stour, Shetland

[HU 170 600]

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Introduction

The small island of Papa Stour (3.5 x 3 km), separated from the western Mainland of Shetland by the narrow Sound of Papa, contains a remarkable assemblage of hard-rock coastal forms of national importance (NCC, 1976). In many ways the coastal landforms of Papa Stour represents in microcosm the coastal landforms of the Shetland Isles and most of the distinctive features of the Shetland coastline are represented. Cliffs of various types, geos, stacks, skerries, subterranean passages, caverns, caves, natural arches and blowholes are all found within this relatively small, but highly scenic, area. Papa Stour and its surrounding seabed also displays many of the features of a submerged dissected plateau, which, on a rising relative sea level, has been actively and selectively eroded by a wide range of wave-energy environments.

Although Papa Stour is not quite as exposed and windy as St Kilda, it shares a wind and wave climate similar to the Villians of Hamnavoe and Foula. 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). At Papa Stour, a combination of exposure to prevailing winds and deep water close 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 are less than 1.5 m for 75% respectively (Draper, 1991). However, storm waves at sea reach heights well in excess of this. The sea floor falls steeply away from the island to 50 m at about 1 km offshore but there are numerous skerries and stacks in the nearshore that serve to reduce wave energy. Wave energies are further reduced by the North Shoals and Ve Skerries that lie at 20–30 m depths to the west and south-west of Papa Stour.

Although the scientific interest of Papa Stour has been recognized for many years and the research potential is great, it has not attracted any detailed geomorphological research. Nevertheless, the cliffs and related features of Papa Stour warrant further investigation.

Description

The island of Papa Stour is composed almost entirely of Devonian extrusive igneous rocks, mostly rhyolites and ignimbrites, with smaller outcrops of basalts, tuffs and agglomerates. Locally, there are numerous small-scale changes in structural alignment and lithology. Small faults and fissures abound, facilitating differential erosion and differing levels of rock breakdown.

Although the entire coastline of Papa Stour is of geomorphological interest, an 8 km stretch of the western part of the island contains an impressive assemblage of hard-rock coastal land-forms. The description that follows concentrates on this dramatic stretch of coast from Wilma Skerry (a low gradient wave-scoured promontory) on the south-west coast, clockwise round to Lamba Ness on the north coast (Figure 3.8).

At Wilma Skerry and around the offshore skerry of Swarta, the wave-scoured rock surfaces above the high tide line give way to sloping intertidal shore platforms, although why this should be the only development of sizeable shore platforms on the west coast of Papa Stour is unknown. North of Wilma Skerry, the cliffs are up to 20 m high and indented with caves, natural arches and geos. The three Galti Stacks, protrude prominently from the sea at the mouth of a narrow geo, all four features corresponding to exploitation of a distinctive fault line. Selective erosion of the many vertical joints in the rocks makes caves a common feature along this stretch of coast. North of the Galti Stacks, the relatively wide Bret Geo indents the coastline with steep, almost vertical, sides that increase in height to almost 35 m at the head of the inlet.

The coastline between Brei Geo and North Lunga Geo is highly indented, with alternating small geos and promontories. North Lunga Geo widens inland and has an isolated rock pillar (over 10 m high) in the centre of the inner geo. The backwall of the geo reaches *c.* 35 m high some 70 m from the outer coast and a gravel storm beach occurs at its base. This widening-inland characteristic is common to many geos on Papa Stour.

To the north, Christie's Hole provides a dramatic example of a geo inlet with a subterranean passage and collapsed cavern ((Figure 3.8), inset). Complex relationships between marine erosional features and the structurally controlled pattern of shallow lochs on the plateau are clearly demonstrated at Christie's Hole. Marine erosion along a structural line of weakness has cut geos, caverns and subterranean passages that underlie depressions on the surface. The collapse of the roof of one of these subterranean passages resulted in the instantaneous drainage of one of the flooded depressions and the loss of an inland loch.

Farther north, two geos indent the coastline to the south of Aesha Head. Binnie Geo is a smaller version of North Lunga Geo and Hirdie Geo, with its extensive blocky scree slopes and basal boulder accumulations; it lies along a major fault-line. North-west of the fault the control of rock type on general coastal shape and evolution is perfectly demonstrated in the bay south of Aesha Head, where erosion of the basalt has produced a gently sloping and wide valley in the plateau and low-angled cliffs sloping inland. At low tide, a wide boulder beach extends almost as far as the low offshore rocky skerries where the two irregular-shaped stacks of Aesha and Sula protrude from the sea beyond. Aesha Head itself is a distinctive narrow promontory composed of rhyolite. A spectacular natural arch spanning the narrow neck of the promontory marks the rhyolite-basalt junction.

Northwards from Aesha Head the land rises steeply to over 50 m OD at Stourhund, with its horn-like point. The view from here to the caves, arches and cliffs of Lyra Skerry and, the larger, Fogla Skerry to the west, provides striking and dramatic coastal scenery. These islands contain numerous subterranean passages. The north headland of Fogla Skerry contains a magnificent series of buttresses, arches and inter-linked caves and many of the cliffs are much steeper than those on the adjacent mainland.

The steep, almost vertical, cliffs north and east of Stourhund are over 50 m high, with no shore platform or basal apron of boulders. Offshore there are spectacular narrow rock pinnacles and stacks, including an impressive natural arch at Snalda. The high basalt cliffs are indented with the spectacular geos of Hund Geo and Akers Geo, whose high, vertical rock walls extend far inland, again corresponding to erosion along faults. Access to the inner part of Akers Geo is restricted by a rock promontory lying transverse to the long axis of the geo and which is pierced by a natural arch. Even so, powerful waves rush into the geo, creating an extensive, wide, boulder beach at the base of the 40 m-high inner wall.

A 400 m-long subterranean passage extends through the outer cliffs close to the headland of Bordie that marks the north point of the island. East of this headland is the Geo of Bordie, not a geo in the true sense, but a compound north-facing bay. The distinctive and narrow promontory of Redbeard subdivides the bay of Bordie into two unequal parts. High, vertical, and often overhanging, cliffs, of uniform basalt lithology extend for over 500 m at the western side of the bay of Bordie, declining in elevation to the east. East of the precipitous cliffs of Redbeard, the bay is wider and lower and has a cobble beach. Here the free face of the rock cliff is masked with recent rock falls and screes and occurs up to 100 m from the beach. This represents the sub-aerial recession of the basalt cliff top by failure and rock fall rather than by marine undercutting, such that the debris delivered to the cliff foot is reworked into beach deposits.

The low peninsula of Cribbie, to the east of the Geo of Brodie, is wave-scoured, with highly dissected sloping rock surfaces. Shore platforms are virtually absent. Indeed, the outer peninsula is almost detached as marine erosion has carved a narrow, deep geo on the east side, which terminates in a distinctive blowhole (the Kiln) in the plateau surface. Near the Kiln, there is a block field 15–20 m above sea level on the south side of the narrow geo. There is also a spectacular natural arch at Cribbie.

The relatively low rocky coastline from Cribbie to Lamba Ness is highly indented and irregular, with numerous small inlets, geos, reefs, low stack-like pinnacles and wave-scoured rock surfaces with only small fragments of shore platform in evidence on the east side of Sholma Wick. A boulder beach is present on the west side of the inlet of Sholma Wick. The low, rough, bare rock headland of Lamba Ness is severely wave-scoured for almost 100 m inland and to over 12 m

OD. Wave action from the north-west is clearly an extremely effective erosional process in this exposed location and numerous stacks have been created by erosion, commonly along fault lines (Figure 3.9).

Interpretation

Erosion of the mainly basaltic rocks of the island of Papa Stour has produced an impressive series of geos, stacks, blowholes, cliffs and sea caves (NCC, 1976). This site provides textbook examples of almost all of the main hard-rock coastal landforms and the juxtaposition of these and the wide range of landforms found on Papa Stour without doubt justify its inclusion in the GCR.

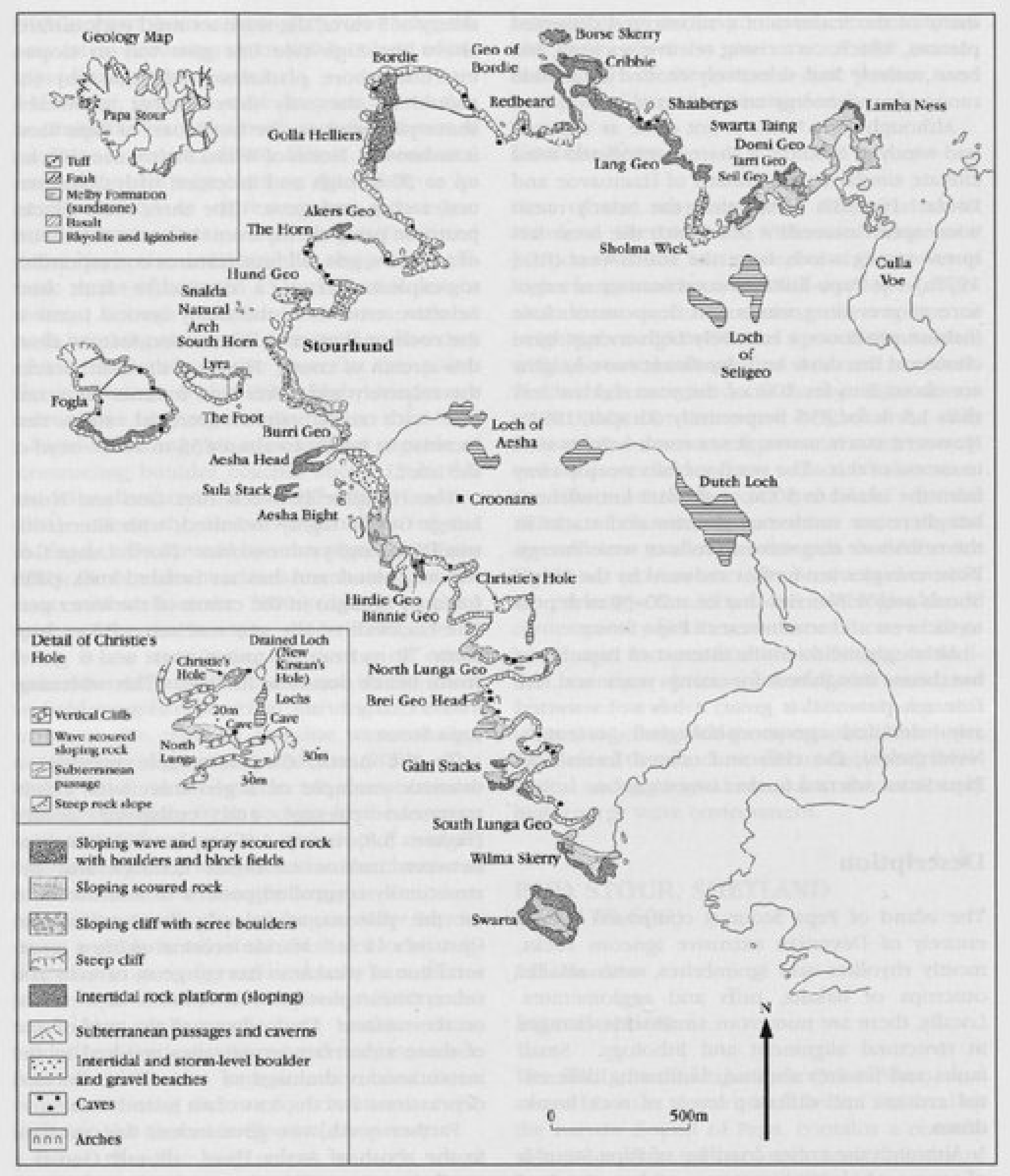
The coastal landforms of Papa Stour represent a microcosm of the Shetland archipelago and display many of the distinctive features of the Shetland coastline. The origin and evolution of the Shetland coast has been much debated (e.g. Flinn, 1964, 1969, 1974; Steers, 1973). Flinn (1964) highlights the absence of modern shore platforms at the foot of the cliffs of Shetland, echo-sounding showing that the cliffs descend below present sea level often to considerable depths. The sea floor around the archipelago is stepped or terraced with common occurrences of nearly horizontal surfaces commonly at depths of 24 m, 46 m and 82 m below present sea level (Flinn, 1964). These terraces are regarded as indicating erosional surfaces produced by earlier sea levels before submergence took place (Flinn, 1964). The lack of shore platforms at present sea level with the steep cliffs plunging directly into deep water to submerged platforms also implies that conditions are no longer suitable for the planation of platforms, either because sea level has been too mobile or that the processes of planation have changed as was suggested in the St Kilda GCR site report.

The surfaces at 46 m and 82 m below sea level have parallels with those at St Kilda but not the surface at 24 m and this may reflect a divergence of the relative sea-level histories of the two locations in late Quaternary times. Flinn (1974) regards Shetland as an erosional remnant standing above the North Sea floor with sea-level rise gradually drowning the valleys and re-activating the relict cliffs of former sea levels. Certainly, the cliffs are likely to be inherited features of earlier higher sea levels, an argument put forward in the GCR site report for St Kilda.

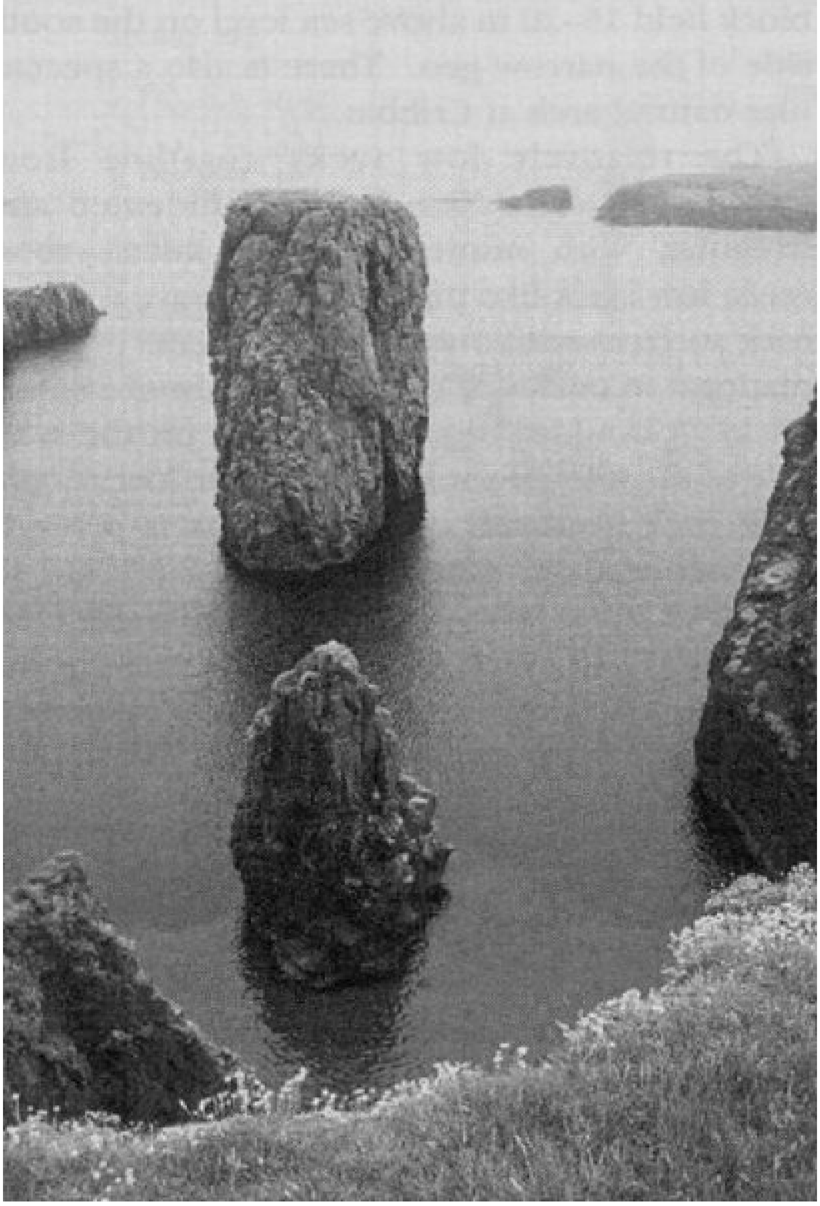
The erosional features of Papa Stour have great potential for research into the ways in which lithology and structure control the geomorphology of hard-rock coasts. Well-developed geos on Papa Stour often coincide with the axes of major faults (e.g. Hund Geo and Akers Geo), while wave erosion differentially exploits the small-scale faults and fissures, local changes in lithology, alignment and bedding planes to produce geomorphological diversity. This, combined with the variations in exposure to wave energy of Papa Stour, produces a spectacular range of structural and erosional situations.

Conclusions

Papa Stour is of national geomorphological importance owing to the juxtaposition of a diverse range of excellent examples of almost all of the main hard-rock coastal landforms; ranging from low wave-washed skerries to impressive near-vertical cliffs. Within an 8 km stretch of coastline, the western part of Papa Stour contains a spectacular range of coastal forms, with: cliffs of a range of altitudes, some of which are wave-scoured, some with well-developed scree formations; geos and inlets of varying size and orientation, some with inlet head beaches and others with sheer cliffs; subterranean passages, some over 400 m long; caverns; caves; natural arches; blow-holes; offshore islands; skerries and stacks. This dramatic pattern of diversity has its roots in differences in wave exposure, the presence of major and minor faults and subtle changes in lithology, alignment and bedding planes that are unmatched elsewhere in Britain (NCC, 1976).



(Figure 3.8) Geomorphological sketch map of Papa Stour showing extensive wave-scoured cliff-top surfaces, together with stacks, caves, arches and geos. For general location, see Figure 3.1. (Modified from unpublished work by W Ritchie.)



(Figure 3.9) Fault-controlled stacks at Lamba Ness, Papa Stour. (Photo J.D. Hansom.)