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# Bullers of Buchan, Aberdeenshire

[NK 103 362]–[NK 116 388]

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## Introduction

The granite cliffs at the Bullers of Buchan in north-east Scotland contain fine examples of many of the typical features of rocky coasts, such as the exploitation by erosion of joints, cracks and dykes in massive igneous rock. Selective erosion of lines of weakness in the otherwise uniform rock, such as intrusive dykes, and marine exploitation of minor differences in hardness and structure, has produced a wide variety of rock coastal landforms. The range of features is impressive at a variety of scales with numerous geos, inlets, caves, arches, stacks, platforms and cliffs. Unfortunately however, and in spite of a substantial body of regional knowledge of past sea level and climatic changes, there has been no detailed geomorphological research carried out in this area.

The coastline of the Bullers of Buchan faces east and so is exposed to North Sea gales from the north-east and east. The dominant wave approach directions on this coast are from the north-east to south-east (Buchan, 1976). Water depths offshore reach 60 m depth at about 5–10 km offshore. The indented nature of the coast results in a great degree of variability in the actual wave climate at any one location.

## Description

This 3 km stretch of coastline is composed of pink granite and, although uncertainties exist concerning age, it is likely to be pre-Lower Old Red Sandstone. The rocks have rectangular jointing patterns with a dominant near-vertical and horizontal pattern and a secondary pattern that is inclined at *c.* 45° (Figure 3.21). Exploitation by marine and subaerial processes along these joints, fissures and cracks has resulted in angular, near-vertical and triangular cliff forms. In addition, later intrusion of igneous dykes has further weakened the host rock, leading to rapid erosion at such sites and a likely explanation for many of the geos and inlets (Steers, 1973). The coastal plateau is capped by a 1–3 m-thick cover of till and is subject to mass movement and failure at the coastal edge.

The cliffs of this dramatic coastline vary in height from between 20 m to 40 m OD. Bevelled cliff profiles occur over about 50% of the coastal length. The lower cliff is steep and cut in bedrock, while the upper part of the cliff is often composed of a more gently sloping till surface that has been subject to slumping and mass movement (Figure 3.21). The cliffs consist of two distinctive types.

The cliffs to the north of the island of Dunbuy are steep, although rarely vertical, with discontinuous intertidal or submerged shore platforms that are best-developed adjacent to the geos. The cliffs are capped by a relatively thin and sometimes absent till cover (e.g. on the exposed headland of Grey Mare the till cover has been stripped away for up to 100 m inland).

South of Dunbuy the cliffs are lower (*c.* 20 m OD) and have a more irregularly dissected plan and profile. These low cliffs often have a composite profile with a low gradient upper slope, a steeper (*c.* 45°) middle section and a much steeper basal element. The granite cliff top is severely weathered in exposed areas, but this may represent the exhumation of an ancient pre-glacial weathering surface that is widespread in north-east Scotland.

The otherwise continuous sweep of the cliffs is punctuated by the occurrence of several deeply incised geos of which three types are found:

1. Long, narrow and deep inlets with steep rocky sides and a rock headwall. These typically have little or no beach and may have caves or enlarged fissures at the head. Long Haven, in the south, provides a spectacular example of such

- a geo: the 300 m-long, narrow, steep-sided inlet has a small scree slope and boulder beach at its head and contains an extensive shore platform on its north side. Perhaps the best example of this is The 'Pot, where a deep rock-enclosed inlet is separated from the sea by a tunnel-like arch. The Pot resembles an enlarged blowhole and during storms this dramatic feature, which is c. 60 m deep and 15 m wide, is awash with a froth of white water as waves crash against the precipitous cliffs (Figure 3.22).
2. Wider more complex inlets (e.g. Robie's Haven, North Haven and Twa Havens) typically contain residual pinnacles, buttresses, skerries or stacks. Boulder beaches, till or scree slopes and slumped debris are often well developed at the inlet heads. The boulder beach in North Haven extends to c. 6 m above present sea level. Dunbuy is a large till-capped stack with the same summit elevation as the adjacent mainland plateau surface 30 m away.
  3. Numerous smaller irregular indentations in the cliffs also occur and usually have less steep walls and a more serrated and uneven surface (e.g. at Partans, south of Dunbuy).

The intertidal shore platforms are characterized by a jagged but gently sloping morphology. However, they are discontinuous and tend to occur in association with geos in the north and south of the area. The cliff coastline is characterized by so many geos, skerries, stacks, reefs, caves and arches that a detailed description of each is impossible. Perhaps the best example of a conical stack is the Temptin' at [NK 110 384] on the north side of North Haven. Skerries at two distinct levels occur between here and the Grey Mare headland to the south. Jagged linear reefs are characteristic offshore from the narrow rocky headlands between Bowness Castle and Dunbuy. The caves of North and South Seals provide the best examples of caves, while spectacular natural arches can be found at Robie's Haven and Long Haven. However, the most dramatic example is the natural arch cut through the island of Dunbuy. Though now above high tide level, the Dunbuy arch may not be entirely an abandoned feature since the collapsed remains of part of the roof litter the base.

Where a supply of material has been available from above, boulder beaches have developed at the heads of the inlets and geos. Some of these are only accessed by waves in the severest of storms, such as the beach at North Haven, which lies at 6 m OD. Others are composed of well-sorted and rounded gravels such as at Two Havens and Dunbuy.

## Interpretation

The range of hard-rock coastal landforms found in the Bullers of Buchan area reflects an interplay between geological structure and exposure to wave activity. The rectangular joints of the mainly uniform granite, together with the presence of intruded dykes, have resulted in planes of weakness in the host rocks that are susceptible to differential marine quarrying and abrasion. The characteristic angularity of the cliff profiles appears to be the result of erosion along the main joint directions in the granite, a dominant near-vertical and horizontal pattern and a secondary pattern that is inclined at c. 45°. Steers (1973) states that some of the caves and inlets have been cut along dykes of dolerite, which are eroded more easily than the granite, specifically referring to the geo at Dunbuy as a good example. Buchan (1931) describes the exploitation of two porphyrite dykes at Robie's Haven and Lammylair. Although fully exposed to storm waves from the north-east to south-east (Buchan, 1976), the degree of development of particular erosional features is probably influenced more by detailed differences in structure than by differences in degree of exposure to waves. In addition, subaerial processes on the cliff faces, such as mass movements induced by cold and wet conditions or frost action, may also be of considerable importance.

A noticeable feature of this coast is the contrast between the higher cliffs in the north where a mantle of slumped till masks the upper section of the cliffs and the lower cliffs in the south where wave and spray action has removed most of this superficial layer. Cliff-top stripping occurs up to c. 30 m OD in Orkney and Shetland and where cliff heights are low and wave exposure is high at the Bullers of Buchan, it may not be unreasonable to expect stripping of cliff-edge till, at least on the cliffs in the south. Most of the tops of the narrow peninsulas and stack-tops are stripped of till cover but they are also occupied by nesting birds whose activities may accelerate the stripping process.

The presence of till on top of isolated islands, such as at Dunbuy, might be used to argue for an entirely Holocene age for the geos that now separate islands and stacks from the mainland. However, the glacial legacy in the north-east of Scotland is predominantly one of till deposition and of preservation of pre-glacial surfaces, rather than of glacial erosion.

For example, Devensian glaciation failed to remove or substantially modify the Tertiary weathered bedrock surface and in places a substantial thickness of saprolite or superficial weathering material has been preserved (Hall, 1986). As a result, it is possible that pre-existing stacks, islands and geos may have been similarly preserved only to be re-occupied by the Holocene rise in sea level. Such an interpretation infers that the plugs of till that once filled and flanked such sites have subsequently been removed by Holocene processes and the rock landforms exhumed.

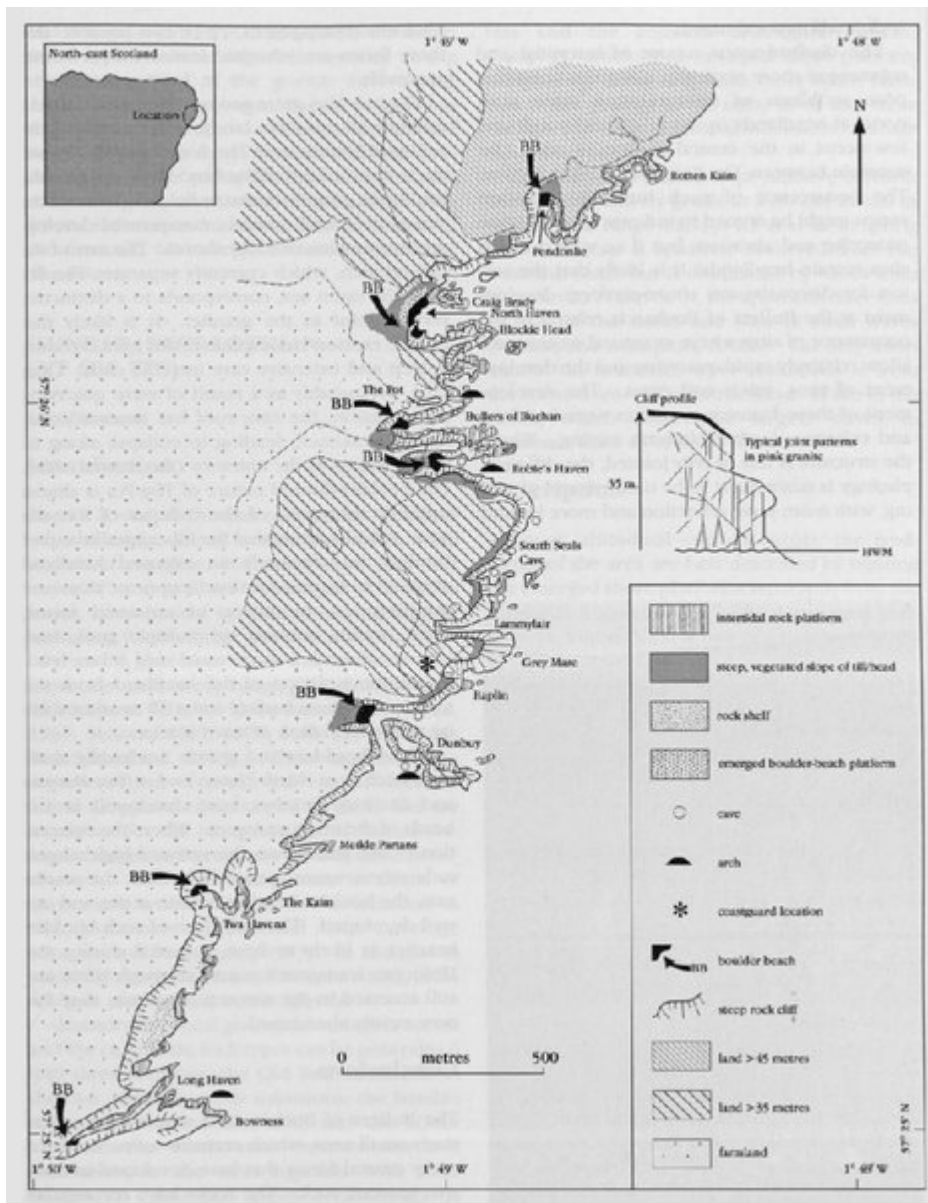
The discontinuous nature of intertidal and submerged shore platforms along this coast also pose problems of interpretation since most occur at headlands in the north and south and few occur in the central section of coast, for example between The Kaim and Meikle Partans. The occurrence of such intertidal abrasion ramps might be argued to indicate efficient wave quarrying and abrasion, but if so why do such sites remain headlands? It is likely that the reason for discontinuous shore-platform development at the Bullers of Buchan is related to the occurrence of sites where structural weaknesses allow relatively rapid quarrying and the development of geos, inlets and caves. The development of these features promotes wave-breaking and enhances further platform cutting. Where the structure is less heavily jointed, the cliff morphology is more likely to be uniform and plunging, with more wave reflection and more limited platform development. It is also possible that these forms are inherited features from former sea levels.

There is also great geomorphological interest related to specific landforms, such as the enlarged blowhole of The Pot (Figure 3.22) and the isolated island of Dunbuy. These spectacular landforms provide dramatic field evidence of the strong structural control on sequential development of erosion of rocky shores. The axis of the natural arch, which currently separates The Pot from the open sea, corresponds to a distinctive vertical joint in the granite. It is likely that marine erosion has exploited this joint, eroding a deep and extensive cave into the cliffs. Over time, presumably as a result of wave quarrying and abrasion, the cave roof has become structurally weakened, leading to collapse along its length except at the entrance (the natural arch). The boulder-floored nature of The Pot is almost certainly the result of the collapse of this sea cave. It is also likely that the till-capped island of Dunbuy was formerly an exposed headland exposed to marine erosion from more than one direction. A succession of erosional forms, caves, arches, tunnels or multiple geos, may have developed, with eventual roof failure leading to the isolation of the headland from the mainland plateau surface some 30 m away, similar to the formation of many stacks.

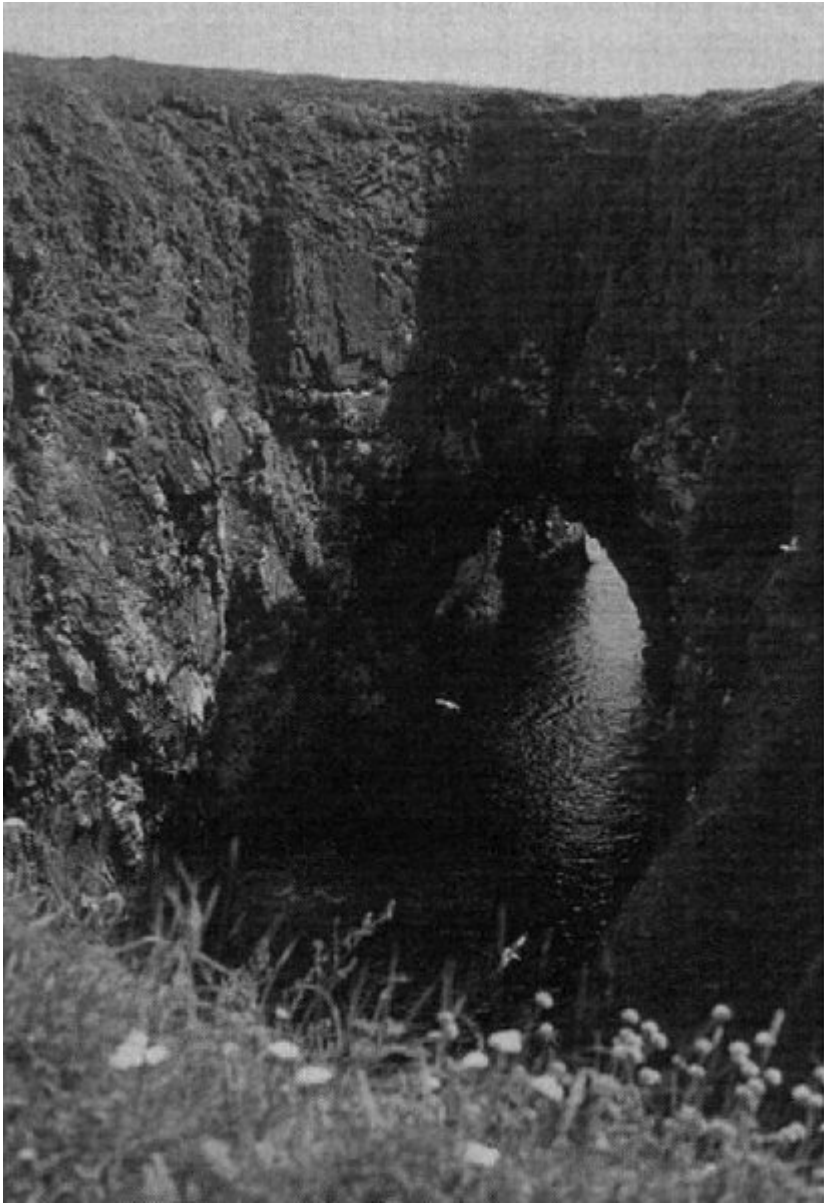
Where boulders and gravels are locally available, such as at North Haven and at Tkva Havens and Dunbuy, beaches have developed at the heads of the inlets and geos. Where the orientation of the geo allows the entry of high magnitude storm waves, particularly from the southeast, the boulder beaches remain active and are well developed. The inception of such boulder beaches is likely to have occurred during the Holocene transgression and although some are still accessed in the severest of storms, they are now mostly abandoned.

## **Conclusions**

The Bullers of Buchan GCR site is a comparatively small area, which contains a fine range of rocky coastal forms that have developed in massive igneous rock. The rocks have rectangular jointing patterns with a dominant near-vertical and horizontal pattern, together with a secondary pattern inclined at c. 45°. Exploitation by marine and subaerial processes along these weaknesses has resulted in angular, near-vertical and triangular cliff forms. The landforms reflect the complex relationships between the strong structural control of the granite and varying degrees of wave exposure. Marine erosion has selectively eroded igneous dykes and exploited minor differences in geological structure, producing a complex and spectacular coastline with numerous geos, caves, arches, stacks, shore platforms, skerries and isolated islands, including the dramatic, 60 m-deep, enclosed sea inlet of The Pot.



(Figure 3.21) Geomorphological map of the Bulters of Buchan, north-east Scotland. The inset on the right shows the typical cliff profile relative to high-water mark (HWM). Much of the cliff tops are veneered by glacial till. (Modified from unpublished work by W Ritchie.)



*(Figure 3.22) The Pot, Bullers of Buchan is a 60 m-deep enlarged blowhole connected to the sea by a 15 m-wide tunnel-like arch. (Photo J.D. Hansom.)*