St Abb's Head, Berwickshire

[NT 902 690]–[NT 917 677]

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Introduction

St Abb's Head, some 65 km east of Edinburgh, forms a coastline of magnificent rugged and precipitous cliffs cut by numerous clefts, gullies, geos, caves and coves with many offshore stacks, reefs and skerries. This serrated coastline demonstrates well the intricate relationship between marine processes and geological structure (Figure 3.24). Marine exploitation of geological weaknesses within the largely igneous rock mass has created a coastline containing a great variety of spectacular hard-rock coastal landforms, which display substantial local contrasts within a comparatively small area. In addition, the marked contrast in coastal form between the felsite headlands of Lower Devonian age at St Abb's Head and the sedimentary rocks of Silurian age to the north-west adds to the geomorphological interest of the site. Steers (1973) described this stretch of coastline, together with the steep cliffs of the Silurian sedimentary rocks, as 'one of the finest lines of cliff in these islands'. However, to date, almost all of the scientific literature concerns the geology and there has been little detailed geomorphological research.

St Abb's Head is relatively sheltered from the west and south but is very exposed to the north and north-east and so 35% of the storm and 60% of swell waves approach from between 20°N and 60°N (Ramsey and Brampton, 2000b). The only information on nearshore wave conditions is from the Torness sea-wall construction, some 18 km to the north-west, which shows the largest waves to approach from 45°N to 90°N. The nearshore seabed slope offshore of St Abb's Head is relatively steep at 1:45 out to –40 m depth and allows access of storm waves to the shore.

Description

Some 200 m inland, between White Heugh in the south and Pettico Wick in the north, the headland of St Abb's Head is bisected by a major geological fault that runs parallel to the outer coast in a north-west to south-east direction. The fault line is marked by a distinctive inland valley depression (occupied by Mire Loch) and the isolation on the seaward side of the valley of a series of volcanic ridges that reach over 75 m OD and meet the coast in a series of high cliffs. West of the fault boundary lie the Silurian sedimentary rocks, although in the south lies an area of Devonian conglomerates with inliers of Devonian-Carboniferous rocks and an area of Devonian intrusive rocks. East of the fault boundary are the Devonian extrusives of St Abb's Head, largely felsites with tuffs and grits. A series of minor faults run perpendicular to the major fault in a north-easterly direction.

The coastline is extremely serrated, complex and rugged (Figure 3.24), but can be subdivided into three sections depending on orientation. To the south-west of the fault boundary, the cliff altitude lies below 50 m OD and the cliffs are formed mainly of Silurian greywackes with a till cap. Below these lies a series of gravel and boulder pocket beaches masking an intertidal shore platform, outcrops of which appear landwards of a high elongate offshore stack (Craig Robin). At Hardencarrs Heugh, cliffs on the northern side of an inlet and deep, boulder-filled gully are matched by the high and narrow grass-covered peninsula of White Heugh on the south side. This marks the point where the St Abb's fault meets the coast. The complex and dissected headland of Wuddy Heugh lies to the north-west of the fault boundary. The cliff tops are till covered but the slope is generally steep, rocky and bare with no shore platform at the base. Small-scale structural features and minor lithological differences in the igneous rock have been etched out as numerous small indentations and irregularities at the cliff base.

The north-east coast, although only 2 km long, contains a great variety of spectacular rocky coastal landforms, displaying substantial local contrasts within a comparatively small area. The hinterland topography consists of three main ridges, each reaching over 75 m OD and sloping at various degrees towards the coast and showing distinctive benches and steep facets on the grass-covered hillsides. On the coast, local differences in rock type are translated into differences in

resistance to erosion. Horsecastle Bay and Cauldron Cove are distinctive low-lying depressions, the former characterized by a well-formed gravel storm beach and boulder-strewn intertidal zone. Between these two depressions, the steep grass-covered cliffs and inlets form part of the slope of Kirk Hill (Figure 3.24). Distinctive finger-like rock peninsulas occur here (e.g. the long asymmetric ridge of Waimie Carr, vertical on its northern side and gently-sloping on its southern side), together with blocky scree slopes, finger-like shore platforms and high, vertical cliffs. North of Cauldron Cove, the 75 m OD 'lighthouse cliffs', consist of extensive and steep grass slopes punctuated by a series of grassy benches protruding as free faces. An intertidal shore platform occurs at the base of the cliffs, although in places this is replaced by near-vertical plunging cliffs. The offshore area is complex with numerous skerries and high, frac tured stacks.

Between the lighthouse and Hope's Heugh the cliffs are generally higher, bolder and more deeply indented, with deep geos, inlets, prominent finger-like ridges and narrow peninsulas, some of which continue offshore as elongate ridges or stacks. Headland Cove is a good example of a long linear geo with near-vertical sides. At Hope's Heugh there is a spectacular example of a natural arch cut through an elongate ridge. The cliffs are commonly near-vertical at the base, below very steep (*c.* 20–25°) grass-covered inclines that slope to the main cliff tops. Between Hope's Heugh and the bay of Pettico Wick the upper parts of the high cliffs are steep and predominately grass-covered whereas the lower parts are bare rock above gravel and boulder beaches. In the south, close to the distinctive triangular-shaped stack of Staple Rock, the coast is very rugged and complex owing its morphology to the topography of the hinterland as well as marine erosion. West of the fault boundary at Pettico Wick to Broadhaven, the Silurian greywackes, siltstones and shales have steeply dipping and tightly folded sedimentary beds and the cliffs display excellent examples of bedding plane control, with high-angled, slab-like cliffs that reach heights of up to 152 m west of Broadhaven Bay. The upper cliffs are very steep and grassy although the lower parts are bare. The cliff base in Broadhaven Bay is characterized by a relatively extensive, and well-developed, intertidal shore platform, interrupted only by small embayments with gravel and boulder beaches.

Interpretation

St Abb's Head provides a good example of the effect of a major fault on the planimetry and geomorphological development of a rocky coastline. The fault marks a distinct change in lithology between the sedimentary province in the west and the St Abb's Head igneous province in the east. The hinterland topography of the headland consists of a north-west to south-east valley developed along the fault line and a series of high volcanic ridges composed of different lava flows running normal to the fault. This geological control has resulted in a serrated and intricate coast characterized by steep high cliffs that have grass-covered upper faces and bare lower faces. Marine exploitation of minor faults has produced a distinctive series of finger-like ridges, geos and inlets that trend normal to the axis of the main fault, producing a rugged coastline. In this respect, the coastline of St Abb's Head provides an exceptional example of the strong control of geological structure on coastal geomorphology.

There is a marked contrast of the cliff form on either side of the major fault. The abrupt geological transition from the felsite of the headland to the Silurian greywackes, siltstones and shales to the west of the fault is reflected dramatically in coastal form. The high-angled, slab-like cliffs cut in the sedimentary rocks strongly reflect the steeply dipping and tightly folded sedimentary beds, displaying excellent examples of bedding plane control. The unique contrast between these sedimentary cliffs and the rugged cliffs and associated forms of the igneous headland provide an excellent site for both research and educational purposes.

A complex interplay between geological structure, marine processes and subaerial processes is evident at St Abb's Head. Exposure to high-energy waves from the easterly quarter has resulted in very effective quarrying and abrasion processes that have exploited both major and minor lithological and structural differences in the igneous rock mass. Geos, caves, inlets, stacks, arches, rock peninsulas and ridges all reflect the differential resistance of the rock to marine processes. In addition, subaerial processes play a part in shaping this unique headland. The distinctive benched profile of the grassed upper coastal slopes at St Abb's Head, with numerous rock outcrops, reflects differential subaerial erosion of the sequence of lava flows that make up the volcanic headland. Free rock faces of lavas and grits often protrude from the grassy cliff slope, some of which are subject to active subaerial erosion, the rate of which is a function of minor differences in lithology and geological structure. The numerous scree slopes and boulder fields (e.g. the bay between Cleaver Rock and Foul Carr) are now largely inactive.

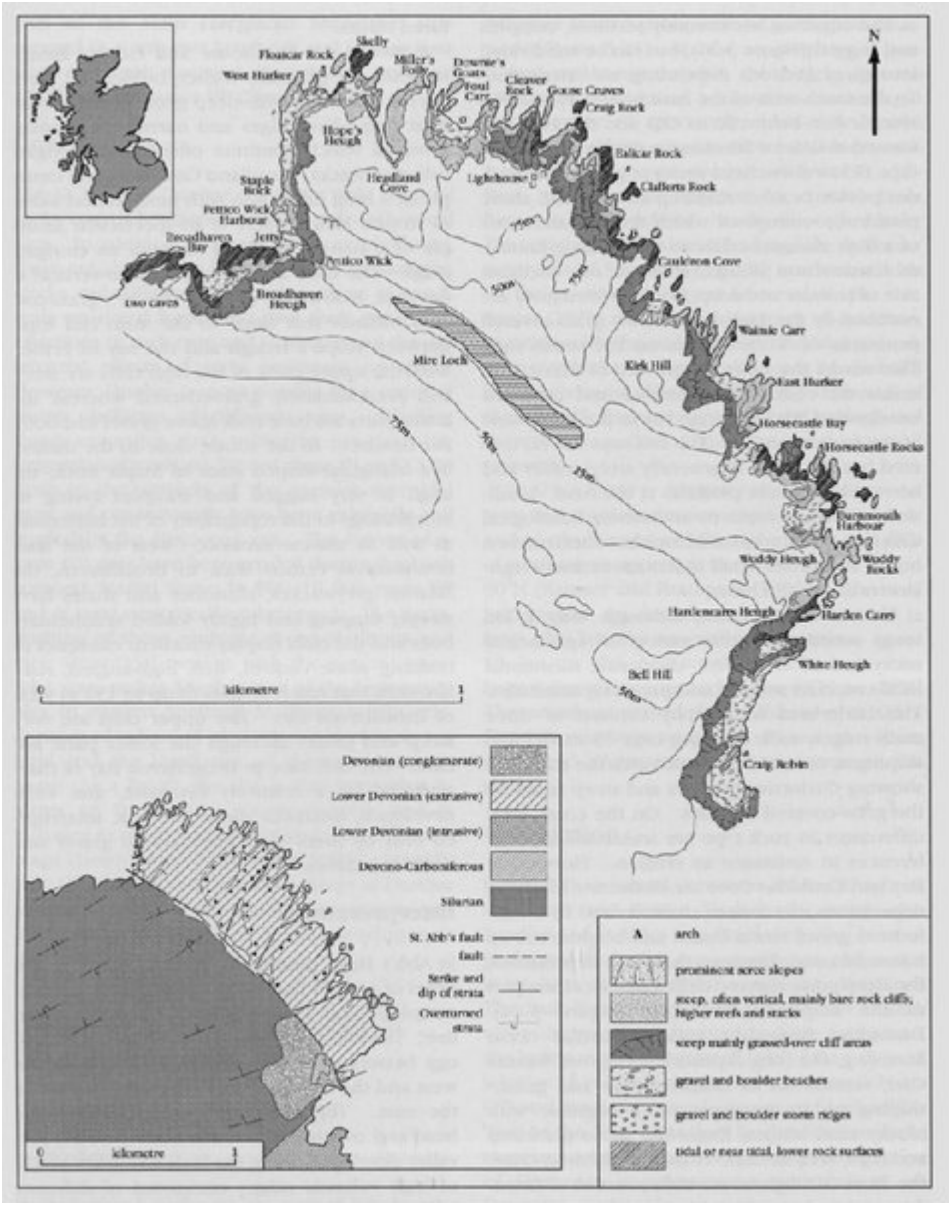
The origin of the shore platforms in this area is also worthy of note. Unlike at Dunbar, where four levels can be identified and approximately dated, only intermittent development of intertidal shore platforms occurs at St Abb's Head. The platforms appear to be best developed in both igneous and sedimentary rocks where the surface of a lava bed or bedding plane crops out in the intertidal zone. Irrespective of geology, all of the shore platforms are intertidal abrasion ramps. However, in spite of suitable structural conditions for the widespread development of platforms, the general distribution of platform remnants separated by embayments suggests that a once more extensive platform has undergone dissection. Some of these remain active under present conditions but, in common with many other east coast cliffs capped by till deposits, it is probable that both shore platforms and cliffs are exhumed features that have undergone modification by Holocene marine erosion.

In summary St Abb's Head is of high scientific importance for the following reasons:

1. The clear relationship between geological structure and coastal form.
2. The contrast between the coastal forms of sedimentary and igneous rocks indicating the strong relationship between lithology and coastal form.
3. The spectacular coastal forms produced in a large igneous rock mass.

Conclusions

The igneous mass of St Abb's head forms a spectacular rugged coastline with numerous clefts, gullies, geos, caves, stacks, reefs and skerries. Headland Cove provides a dramatic and textbook example of a near-vertical geo, the adjacent steeply benched coastal slopes rising to above 75 m. Of principal geomorphological importance is the clear relationship displayed between lithology, structure and coastal form. Marine erosion has exploited planes of weakness within the igneous rock (e.g. major and minor faults and local lithological differences) creating a complex, varied and highly indented coastline. The transition from the felsite of the headlands to the sedimentary rocks west of the fault boundary produces a dramatic and unique contrast in coastal form that enhances the geomorphological interest of the site.



(Figure 3.24) Geomorphological map and geological sketch map of St Abb's Head showing the heavily indented nature of the coast resulting from a strong structural control. (Modified from unpublished work by W. Ritchie.)