Duncansby to Skirza Head, Caithness

[SD 398 710]

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Introduction

One of the finest stretches of cliff coastline in mainland Britain extends southwards for 6 km from Duncansby Head on the north-east extremity of the Scottish mainland (Steers, 1973). The spectacular cliffs and related forms provide excellent examples of the characteristic cliff forms of the Old Red Sandstones of north-east Scotland and show clear relationships between geological structure and coastal morphology. The cliffs, caves, gcos, arches and stacks provide a dramatic coastline and the famous Stacks of Duncansby are cited frequently in the international literature (e.g. Trenhaile, 1987). In spite of this, there has been no detailed geomorphological research on these spectacular cliffs, although numerous descriptive accounts exist (e.g. Steers, 1973) and the geological memoir provides an account of the relationships between geological structure and coastal form (Crampton and Carruthers, 1914).

Similar in many ways to Orkney, the most characteristic feature of the Caithness climate is the frequency of strong winds. The prevailing winds are from between west and south-east for 60% of the year. Winds greater than 8 m s^{-1} occur for over 30% of the year and gales occur on average for 29 days per year. However, the exposure of this east-facing coast is less than that of the west and north and for much of the time the winds blow off the land and so help reduce wave energies. The sea floor falls away from the mainland to 60 m depth by about 5–10 km offshore. Along the eastern coast, shelter is afforded by the mainland and the Orkney Islands, and so the wave climate is not as severe as in the north or west and significant wave heights off Duncansby Head are 2 m for 10% of the year and about 0.5 m for 75% of the year (Draper, 1991).

Description

The coastal geomorphology is dominated by horizontal beds of Old Red Sandstone that are classified locally into a block of resistant Thurso flagstones cropping out between Skippie Geo and Fast Geo and the more variable, but generally weaker, John o'Groats Sandstone Series to the north and south. The coastline is best described using four geologically defined sections from south to north (Figure 3.14):

1. Skirza Head to Skippie Geo: a *c.* 1 km stretch of cliffs and deep geos cut in the John o'Groats Sandstones in the south.
2. Skippie Geo to Fast Geo: a *c.* 1 km stretch of Thurso Flagstones.
3. Fast Geo to Gibbs Craig: a *c.* 3 km stretch of cliffs in the John o'Groats Sandstones, with magnificent stacks.
4. Gibbs Craig to Duncansby Head: a *c.* 1 km stretch of cliffs and geos of the horizontally bedded Thurso Flagstones in the north.

From Skirza Head to Skippie Geo, the compact, fissile, near-horizontal flagstones produce a coastal scenery dominated by 40 m-high cliffs, and an abrasion-ramp shore platform that extends more or less continuously for almost 1 km northwards from Skirza Head in the south to Sailor's Head. Four deep, near-vertical geos indent this stretch of coastline. Long Geo is the largest; farther north two shorter and rock-floored geos occur, one with a scree and boulder beach. Skippie Geo is an inlet part of which is raised *c.* 20 m above sea level. Flat skerries and an extensive intertidal shore platform are exposed below the caves, overhangs and slab-like walls of Skippie Geo.

Between Skippie Geo and Fast Geo the cliff height increases from 40 m to 55 m and the vertical cliffs are cut by Wife Geo, a 250 m inlet where an association of caves, arches, plunging vertical cliffs, rock pinnacles and buttresses have resulted in one of the finest compound geo features in Scotland.

Between Fast Geo and Gibbs Craig, the John o'Groats Sandstones form the famous high cliffs and stacks of Duncansby (Figure 3.15). The cliffs reach almost 80 m OD at Hill of Crogodale. In the south, between Girn and Hill of Crogodale, the steep cliffs rise from 55 m to 75 m and consist of vegetated slopes alternating with near-vertical rock buttresses. Low-gradient shore platforms form abrasion ramps of up to 100 m wide along much of this coastline, although north of Fast Geo and north of Crogodale, the shore platform is covered by extensive gravel and boulder beaches. Elsewhere the boulder beaches form a relatively narrow fringe at, or just above, the high-water mark. In the north, the impressive Stacks of Duncansby rise as pyramidal structures from the surrounding shore platform less than 100 m from the cliff base. The southernmost stack reaches in excess of 50 m and is higher than the adjacent cliff, on account of the landward slope of the mainland cliff edge. The stacks have distinctive outlines of almost square, castellated blocks of red sandstone.

The adjacent cliffs display considerable local variation in form and profile with steep buttress-type rock cliffs alternating with relatively low-angled vegetated slopes developed on a continuous cover of superficial materials. At the base of the extensive apron of slumped materials is a low rock cliff succeeded by a low-angled shore platform with a variable cover of boulders and cobbles. Northwards, the cliffs gradually decline to c. 25 m OD at Gibbs Craig and the Duncansby fault boundary.

Between Gibbs Craig and Duncansby Head, the land rises to the north but the horizontally bedded flagstones display similar coastal forms to the flagstone area to the south (Section 2, (Figure 3.14)). The coastline is characterized by vertical, often overhanging, cliffs with irregular profiles formed as a result of differences in hardness and susceptibility to erosion of the flagstone beds. Pillar-like stacks occur close to the 35 m-high cliffs at Gibb's Craig and The Knee. The Geo of Sclaites, south of Duncansby Head Lighthouse, is a textbook example of this type of inlet with a natural arch at its entrance and a basal cave at its narrow head. Between the geo and Duncansby Head to the north, the vertical or overhanging cliffs display excellent examples of basal notches. Long Geo, north of the lighthouse on the north-facing coast of the headland, is long and steep sided with a distinctive overhanging profile. Farther west, at The Glupe, a large blowhole has developed, similar in form, although smaller, than The Pot at the Bullers of Buchan (see GCR site report).

Interpretation

The cliff coastline from Skirza Head to Duncansby Head is of high scientific and educational value for the following features:

1. The clear relationship displayed between coastal form and geological structure.
2. The spectacular and diverse range of plunging cliffs, stacks, arches, and caves.
3. The numerous deep, long, vertical-sided geos, some of which provide textbook examples (e.g. the Geo of Sclaites).
4. The erosional extension of the shore platform landwards into the cliff base.

Geological variations such as strike directions and dip angles at the coast, fault and joint patterns, differential hardness and resistance to erosion, and differential susceptibility to the processes of terrestrial and marine weathering and erosion all affect coastal form. At this site, the contrast between the fine-grained calcareous and argillaceous flagstones and the more-easily weathered, friable and varied sandstones appears to play a large part in determining coastal form. For example, Crampton and Carruthers (1914) assert that the slight embay-ment that extends between the outcrops of Thurso flagstones at Gibbs Criag and Fast Geo, and includes the Stacks of Duncansby, is a result of the more rapid erosion of the intervening higher, but softer and more variable, John o'Groats sandstones. However, the rate of cliff retreat is unknown. The sandstone stretch (Section 3, (Figure 3.14)) appears to have retreated somewhat more than the flagstones to the north and south, probably due to lower resistance of the sandstone blocks allowing more effective wave erosion of the cliff base. Additionally, slope processes play an important part in the form of the sandstone cliffs, with frequent landslides and screes that alternate between rock buttresses, features that may have their origin in the pattern of master joints and other vertical lines of weakness. Erosion along bedding planes, in conjunction with the numerous vertical cracks and fissures, give rise to the often blocky and castellated appearance of the Jiffs and stacks, best seen in the Stacks of Duncansby. The overall pyramidal shape of the stacks implies that subaerial weathering and the exploitation of joints and bedding planes higher up has been more effective than wave erosion of the base of the stack.

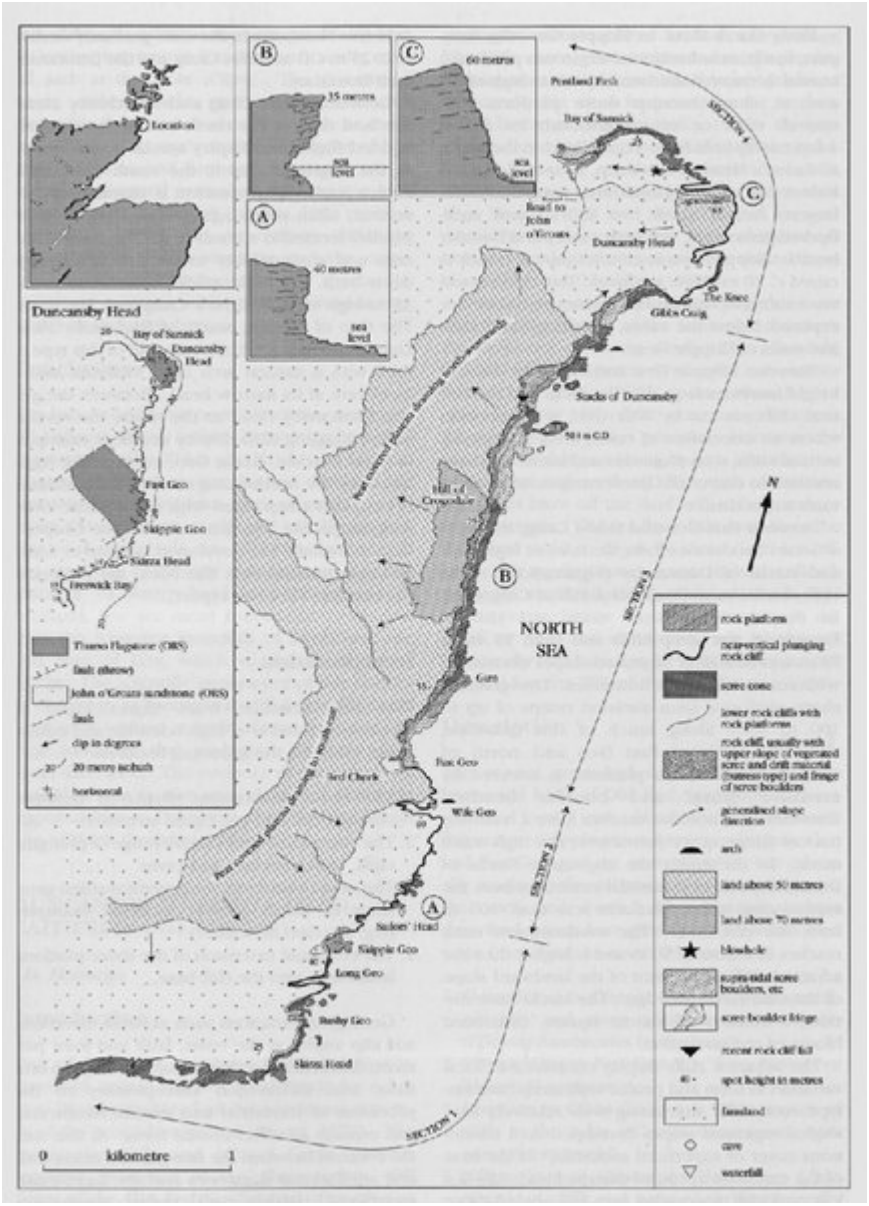
Large-scale structural weaknesses partly explain the formation of the numerous deep-set geos and rectangular stacks that are typical of the flagstone areas. The crush zones, rucks and strong vertical joints of the flagstones provide structural weaknesses that are exploited by marine action to form long geos, often with caves excavated in the backwall (e.g. at the Geo of Sdaites), although several geos have depositional beaches at their heads. Others have well-developed scree slopes indicating a local reduction in the efficiency of wave erosion and a relative dominance of subaerial slope processes. The irregular cliff profile characteristic of the flagstone cliffs again demonstrates the strong geological control on coastal geomorphology, the irregular stepped profile reflecting subtle differences in hardness and susceptibility to lateral weathering of the flagstone beds.

In both the sandstone and flagstone areas, shore platforms are relatively well-developed and in places are relatively shallow in angle, reaching 100 m wide. They appear to be best developed where the bedrock dips are low or horizontal in both lithologies and so their form is aided by structural control, in spite of extensive evidence of active abrasion of their surfaces. In the area between Fast Geo and Hill of Crogodale, the platforms appear to be actively extending the cliff base landwards, in spite of an intermittent covering of debris from above.

Conclusions

The cuffed coastline between Duncansby Head and Skirza Head is one of the finest and most spectacular stretches of cliff coast in mainland Britain. Lithological and structural control is important in determining cliff morphology. The flagstone cliffs cropping out in the north and central section are typically steep, near-vertical and sometimes overhanging, with irregular stepped profiles and numerous deep, long, vertical-sided geos. Although less steep, the cliffs of the John o'Groats sandstones are higher. The magnificent castle-like Stacks of Duncansby rise to above 50 m, but are less than 100 m from the base of the sandstone cliffs (Figure 3.15). Well-developed and actively evolving shore platforms extend along much of the cliff base.

This dramatic stretch of cliff coastline, with its complex of deep geos, caves, arches, stacks and shore platforms, provides textbook examples of many cliff forms and demonstrates the strong structural control on cliff morphology. It is also easily accessed via the road at Duncansby and so can be appreciated by most visitors. The scientific and geomorphological interest is very high, although, as with the majority of hard-rock coastal sites, it has not been thoroughly investigated. In this respect, the GCR site is of immense scientific importance, both in terms of its educational value and research potential.



(Figure 3.14) Coastal geomorphology of north-east Caithness, Duncansby to Skirza Head GCR site. Descriptions of sections 1–4 and of representative profiles A-C are in the text. The geology of the area is predominantly composed of horizontally bedded Old Red Sandstones (ORS), which have been eroded into steep cliffs. (Modified from unpublished work by W Ritchie.)

(Figure 3.15) The three large stacks of Duncansby stand in stark contrast to the otherwise bleak and smooth landscape of the north-east coast of Caithness. Looking north towards Duncansby Head and South Ronaldsay, Orkney, in the background. (Photo: courtesy of Ken Crossan.)