
Old Man of Hoy Coast, Orkney

[HY 211 052]–[ND 174 991]

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Introduction

This site includes about 8 km of the spectacular coastline of north-western Hoy. It extends from Rora Head to Hamar Hellia and includes the 137 m-high Old Man of Hoy sea stack and the 350 m-high cliffs at St John's Head (Figure 2.37). The cliff sections, which are largely inaccessible from inland, show the basal volcanic part (Hoy Volcanic Member) of the mainly Upper Devonian Hoy Sandstone Formation resting unconformably on the Middle Devonian Upper Stromness Flagstone Formation. The Hoy Volcanic Member has been dated as 379 ± 10 Ma (Halliday *et al.*, 1982) which places it close to the Mid-Late Devonian boundary and of probable Givetian age. The site is important because the Hoy Volcanic Member, seen only on Hoy, allows comparison with other Middle Devonian volcanic rocks of the Orcadian Basin. It is described in the GCR volume on the Caledonian igneous rocks (Stephenson *et al.*, 1999). Above the lavas lies a thick succession of sandstones of the Hoy Sandstone Formation, forming the impressive red sea-cliffs that dominate this site. These cliffs, where accessible, show excellent examples of the braided stream and aeolian facies that are typical of the Late Devonian of the Orcadian Basin. Sedimentary structures within the aeolian sandstones suggest wind directions different from those that prevailed in Early Devonian times (on the evidence of the unique aeolian sandstones at the Yesnaby and Gaulton Coast Section (see GCR site report, this chapter) and Mid-Devonian times (see South Fersness Bay GCR site report, this chapter). This site is therefore of great importance in the interpretation of the palaeoenvironments and palaeogeography of the Orcadian Basin.

Description

The oldest part of the exposed sequence is the cross-bedded, faulted and gently folded Upper Stromness Flagstone Formation, which is exposed at the base of the Old Man of Hoy sea stack [HY 176 008] and from the Geo of Hellia [HY 190 042] northwards (Figure 2.37). A particularly good section of the rhythmites of the formation is at the Bay of the Tongue [HY 207 047], near the northern end of the site. The cliffs at Kame of Hoy and the Bay of the Stairs consist mainly of cyclic sequences of mudstones, siltstones and sandstones of the formation. At Yelling Geo, about 300 m northeast of the eastern end of the site, Fannin (1970) noted thin (up to 4 cm) beds of tuffaceous siltstone in the formation.

The Upper Stromness Flagstone Formation is truncated by an undulating surface and unconformably overlain by the Hoy Volcanic Member of the Hoy Sandstone Formation, the unconformity being well exposed at the base of the Old Man of Hoy. The basal part of the Hoy Volcanic Member consists of tuffaceous sandstones and breccio-conglomerates. Between the Bay of the Tongue and the Geo of Hellia the tuffaceous sandstones are up to 15 m thick, brownish red, locally cross-bedded and contain angular blocks and pebbles of basalt and finely comminuted basaltic material (Mykura, 1976). At the Geo of Hellia and the Old Man of Hoy, these basal tuffaceous rocks are absent and the Upper Stromness Flagstone Formation is directly overlain by lavas.

The lavas of the Hoy Volcanic Member form five disconnected outcrops in the north-west of Hoy and one on the south coast of the island. McAlpine (1978) recognized five separate lava flows, although Mykura (1976) thought it impossible to determine whether the outcrops represent one or several flows. The lavas are alkali olivine basalts with porphyritic crystals of olivine and feldspar in a groundmass of iron oxides, augite and plagioclase (Wilson *et al.*, 1935). They are nepheline-normative (Thirlwall, 1979, 1981) and have been dated at 379 ± 10 Ma (Halliday *et al.*, 1982). A maximum exposed thickness of about 90 m is seen at Hellia, where the lavas form part of the impressive cliffs. They comprise a grey-weathering, vesicular lower part, a massive 60 m-thick columnar-jointed central portion and an upper, 15 m-thick, purplish slaggy zone (Mykura, 1976). At the Old Man of Hoy, the lavas are 3 m to over 7 m thick, and the lateral variations in the lavas can be seen particularly well at their base. Their upper surface at the Old Man of Hoy is a fairly

even plane that appears to have been eroded before deposition of the overlying sandstones (Wilson *et al.*, 1935).

Above the Hoy Volcanic Member, the Hoy Sandstone Formation comprises over 1000 m of medium- to thick-bedded, medium- to coarse-grained, red and yellow sandstones with thin interbedded siltstone partings (Figure 2.38). The sandstones display planar and trough cross-bedding with individual cross-sets up to 1.2 m in height. Slumping and convolute bedding are locally common. Many cross-sets contain dasts of red and purple siltstone, and intraformational conglomerates at the bases of troughs are common. There are also rare small lenses of extraformational conglomerate containing pebbles of quartz, schist and gneiss.

McAlpine (1978) subdivided the sandstones into four members — the Lang Geo Sandstone, Lyre Geo Sandstone, Haist Pebbly Sandstone and Trowie Glen Sandstone. The Hoy Sandstone Formation in the northern part of the site is undivided, whereas the Lang Geo Sandstone Member and the overlying Lyre Geo Sandstone Member have been recognized in the southern part (British Geological Survey, 1999). The Lang Geo Sandstone Member, which forms the cliffs at the Old Man of Hoy, is distinguished from the Lyre Geo Sandstone Member mainly by its thinner-bedded and better-cemented sandstones. Both members contain fining-upward sandstone units and subordinate siltstones and mudstones.

A further feature of interest at the site is a microsyenitic ('bostonite') sill of uncertain age which cuts the Upper Stromness Flagstone Formation at the base of the cliff at Bay of the Stairs [HY 203 047]. The sill consists predominantly of feldspar (mainly orthoclase) and some chlorite and carbonate (Mykura, 1976).

McAlpine (1978) correlated in detail the Hoy Sandstone Formation with the Dunnet Head Sandstone Group at Dunnet Head on the Caithness mainland, which can be seen from Hoy. The cliffs at Dunnet Head provide spectacular exposure of laterally continuous fluvial (braided river) sandstones (Trewin, 1993).

Interpretation

The coarsening-upward rhythmic cycles in the Upper Stromness Flagstone Formation at the base of the succession record changes in environment from relatively deep-water to ephemeral, shallow lake and prograding alluvial-fan. This cycle was repeated many times and may have been driven by a combination of cyclic climate change and tectonic activity (see South Stromness Coast Section GCR site report, this chapter). Thin bands of tuffaceous siltstone within the Upper Stromness Flagstone Formation near the eastern end of the site may represent the start of Mid-Devonian volcanic activity that culminated in the extrusion of the volcanic rocks at Hoy and those in the Eday Flagstone Formation at Deerness on the Mainland (Fannin, 1970). The tuffaceous layers thin and wedge out northwards, suggesting that they emanated as small ash eruptions from a volcanic centre that lay farther south (Fannin, 1970).

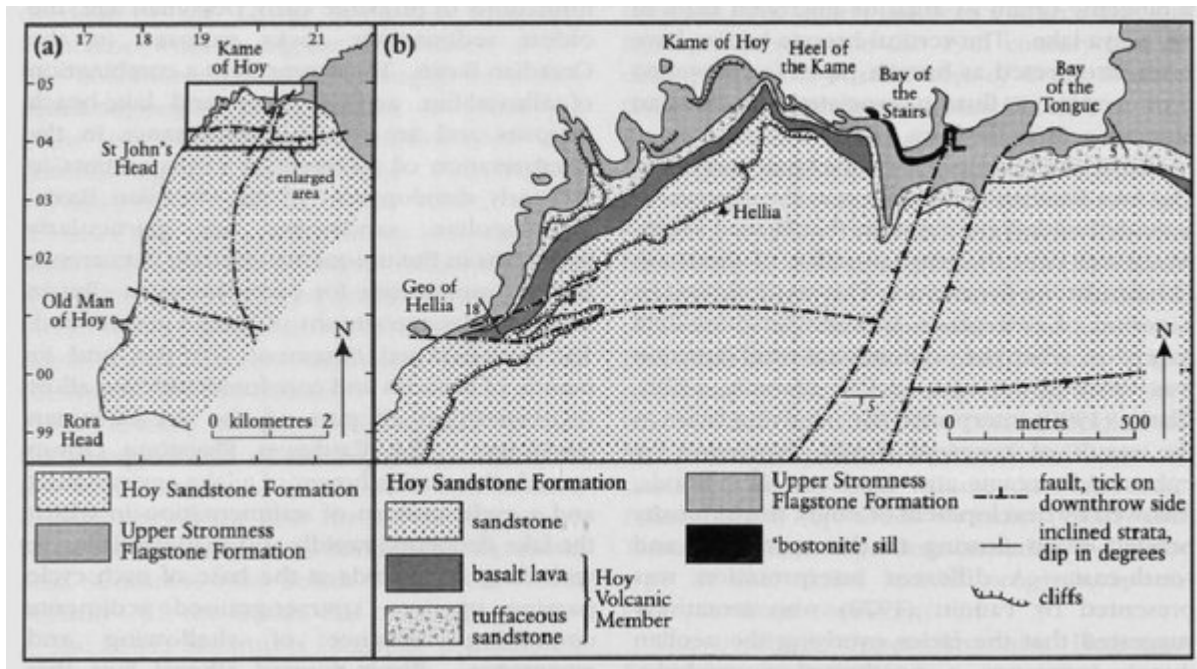
The basal tuffaceous sandstones and conglomerates of the Hoy Volcanic Member were deposited on an undulating erosion surface. Mykura (1976) suggested that most of the volcanoclastic rocks were deposited as subaerial ash falls, since their bedding planes are parallel to the slopes of the underlying hummocky basement surface. However, McAlpine (1978) interpreted the tuffaceous beds as shallow-water deposits. Extrusion of basaltic lavas followed, probably as several flows. The planar upper surface of the lavas suggests that some erosion occurred before deposition of the overlying sandstones.

The Hoy Sandstone Formation records a period when over 1000 m of sands and subordinate silts were deposited in a predominantly fluvial, probably braided stream environment (Mykura, 1976). The great thickness of the formation has important implications for the subsidence history of the Orcadian Basin in Late Devonian times. The common fining-upward fluvial sequences are interbedded with sabkha and playa-lake siltstones and poorly cemented aeolian sandstones. McAlpine (1978) suggested a system of active wadi fans in which sediments were deposited as wadi-flood deposits. Beyond the distal margins of the wadi fans, sand accumulated as small barchan dunes while sand and silt accumulated in playa lakes and sabkhas in the interdune areas. Palaeocurrent analysis of the fluvial sandstones indicates north-east flow, and the aeolian sandstones appear to have formed by reworking of the fluvial sands by winds that blew predominantly towards the south-west (McAlpine, 1978).

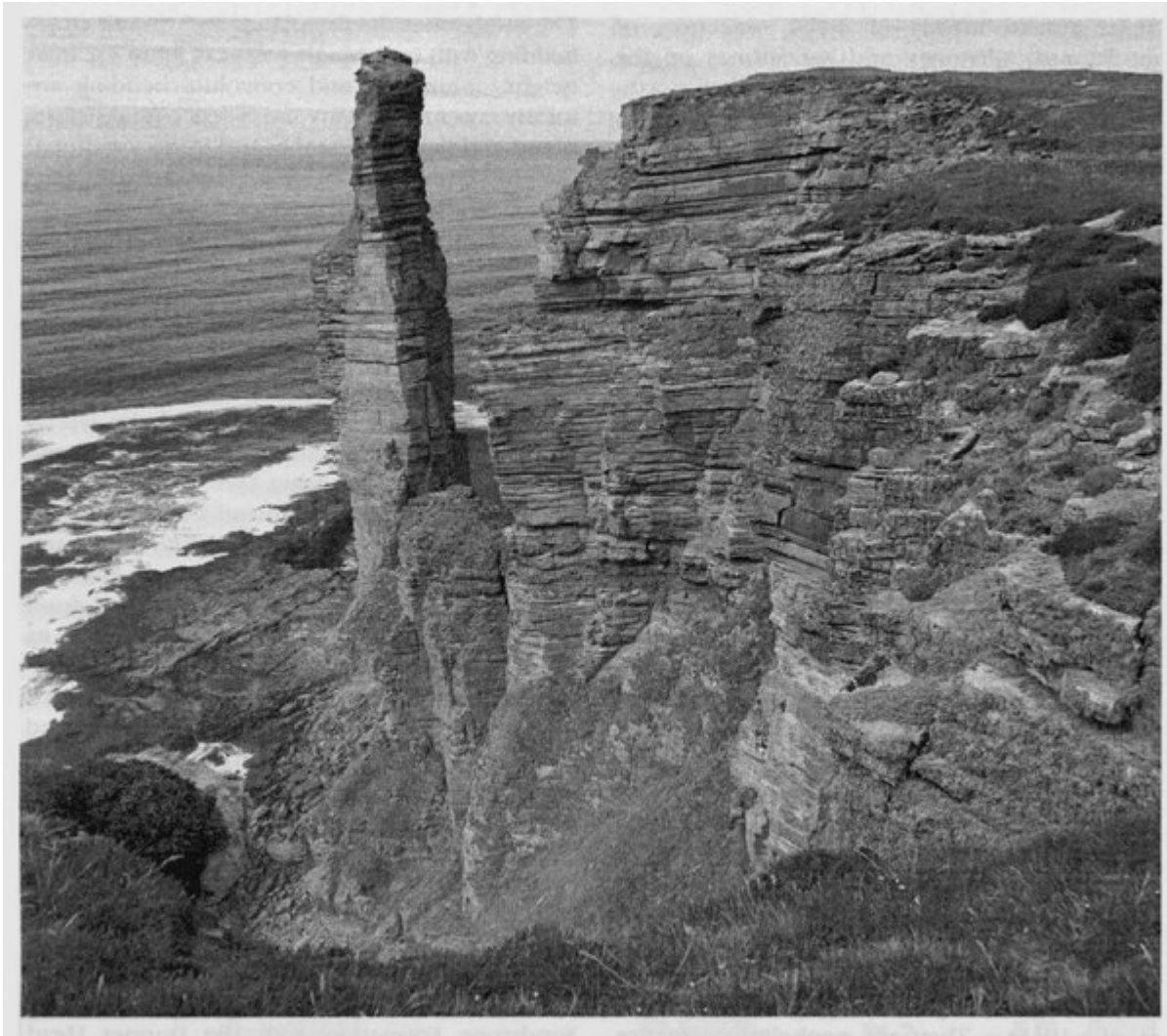
Conclusions

The island of Hoy is the only locality in the Orcadian Basin where the Hoy Sandstone Formation and its basal member, the Hoy Volcanic Member, are exposed. For this reason Hoy, and more specifically this GCR site, are of great significance in the regional interpretation of the Devonian Orcadian Basin. Along a coastline of spectacular and commonly inaccessible cliffs, this large site exposes a series of important stratigraphical contacts and fine sections through the succession. At the base of the Old Man of Hoy, fluvial sandstones of the Upper Stromness Flagstone Formation are unconformably overlain by tuffaceous sandstones and basaltic lava of the Hoy Volcanic Member. Although a significant period of erosion probably occurred between deposition of the sandstones and eruption of the lavas, volcanic activity had already started during deposition of the Upper Stromness Flagstone Formation, as shown by the presence of thin tuffaceous sandstones. Volcanic activity ceased by Late Devonian times, when the Orcadian Basin was a wide plain with braided rivers, wadis, lakes, sabkhas and small dune-fields. The sediments laid down in these environments are preserved in the cliffs at this site. Sedimentary structures show that rivers flowed towards the north-east and dune-forming winds blew towards the south-west. These directions contrast with data from Lower Devonian and Middle Devonian rocks of the Orcadian Basin, thus making this site important for interpreting the palaeogeographical and palaeoenvironmental evolution of the basin through the Devonian Period.

References



(Figure 2.37) (a) Simplified geological map of north-west Hoy (after British Geological Survey, 1999). (b) Detailed geological map of the northern part of the GCR site (after Mykura, 1976).



(Figure 2.38) The Old Man of Hoy, a sea stack of Hoy Sandstone Formation lying just off the spectacular cliffs of north-west Hoy. The basal member, the Hoy Volcanic Member, lies at the base of the stack where it overlies the Upper Stromness Flagstone Formation. (Photo: BGS No. D1539, reproduced with the permission of the Director, British Geological Survey, © NERC.)