
Taracliff Bay to Newark Bay, Orkney

[HY 553 035]–[HY 568 043]

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Introduction

This site extends from Taracliff Bay to Newark Bay on the south-east coast of the Deerness Peninsula, in the south-eastern part of the Mainland. It exposes a long section through Middle Devonian (Middle Old Red Sandstone) strata comprising the uppermost part of the Caithness Flagstone Group and the overlying Eday Group (including the Lower Eday Sandstone, Eday Flagstone and Eday Marl formations). The section of the Eday Flagstone Formation is the thickest and best exposed in Orkney, and the site is important in containing evidence of contemporaneous volcanism. It is also particularly important for the interpretation of the depositional environments of the Eday Group and the palaeogeography of Orkney during late Mid-Devonian times, providing a comparison with the more proximal strata of the group in the Fersness Bay section on Eday (see South Fersness Bay GCR site report, this chapter).

Description

At the western end of the section, interbedded grey-green, calcareous siltstones and yellowish buff sandstones of the Caithness Flagstone Group are exposed in the vertical cliffs and on a wide shore platform (Figure 2.29). The sandstones are fine- to medium-grained, thin- to thick-bedded, planar and cross-laminated, and locally cariously weathered. The finer-grained, silty interbeds are rich in grey mudstone rip-up clasts and also display carious weathering. The Caithness Flagstone Group is overlain, with a transitional boundary, by the arenaceous Lower Eday Sandstone Formation. One of the best sections of the Lower Eday Sandstone Formation in Orkney lies west of the sea stack known as 'Muckle Castle', where over 175 m of quartzitic, well-bedded, cross-bedded and channelized sandstones with rare, scattered pebbles can be observed. A distinctive feature of these sandstones on Deerness and elsewhere is the presence of convolute or slumped bedding. The boundary between the Lower Eday Sandstone Formation and the Eday Flagstone Formation occurs just west of Muckle Castle. Muckle Castle itself [HY 562 032] is formed almost entirely of an intrusive plug of olivine dolerite that is fault-bounded on its western side (Kellock, 1969).

The thickest development and best exposures of the Eday Flagstone Formation in Orkney are found in and around the Deerness Peninsula (included in this site), where the formation is about 150 m thick. It thins northwards to 100 m in Shapinsay, 50 m in Stronsay and 10 m in Sanday. The formation comprises up to 12 cyclic sequences, which range in thickness from 2 m to several tens of metres. Most of these cycles comprise an upward-fining phase of buff, yellow, or more rarely, red sandstone and silty sandstone, and a phase of grey, black and locally purple, flaggy siltstones and mudstones (Mykura, 1976). Fish remains are common in the muddy facies at the base of some cycles, and two beds of flaggy siltstone near Muckle Camay have yielded remains of *Tristichopterus alatus* and *Pentlandia macroptera*. Desiccation cracks and small lenticular cracks, possibly pseudomorphs after gypsum, are common in the siltstones and fine-grained sandstones. Thin sandstones within the Baggy siltstones commonly have slump structures and load-casts at their bases.

Less than 200 m east of Muckle Castle, the Eday Flagstone Formation contains about 5 m of interbedded greenish tuffs and tuffaceous sandstones with sandstone and lava pebbles [HY 563 033]. These form part of the Deerness Volcanic Member, which also includes thin basalt lava flows and basaltic breccias elsewhere on the Deerness Peninsula. Analcime, natrolite (a zeolite) and alkali feldspar occur in these rocks, but Thirlwall (1979) showed that the analcime and natrolite are secondary and that the basalts are calc-alkaline.

The Eday Flagstone Formation has a faulted contact with the Eday Marl Formation near Peerie Castle, a small sea stack on the west side of Newark Bay. The Eday Marl Formation forms cliffs on the western side of Newark Bay and comprises a series of fining-upward cycles, each made up of a sandstone unit 50 cm to 2 m thick overlain by reddish calcareous

mudstones and siltstones with thin beds of convoluted sandstone (Figure 2.30). Grey-green, calcareous mudstones and siltstones are also common in the formation, some curious weathering in the mudstones testifying to the presence of carbonate. The sandstones at the base of the cycles are sharp-based, resting on erosion surfaces, and are commonly medium-grained, grading normally from coarse-grained bases. Other features include rip-up clasts of red siltstone, cross-bedding and desiccation cracks. These fining-upward sequences appear to grade upwards into more massive sandstones in the sequence exposed at Newark Bay.

Interpretation

The oldest part of the section is the Caithness Flagstone Group at the western end of the site. Although divided into the Lower and Upper Stromness Flagstone formations in the west Mainland, the group is undivided in east Mainland on the current published geological map (British Geological Survey, 1999). The Caithness Flagstone Group comprises a series of rhythmic units that record successive repeated changes in a lacustrine environment, from deep-water lake to ephemeral shallow lake with accompanying lake-beach and prograding alluvial-fan deposits. This cyclicity may have been driven by climate change (Astin, 1990).

The overlying Eday Group records the progradation of alluvial fans across the lake basin to form a regional braidplain, perhaps as a result of an episode of active extensional faulting along the basin margins (Astin, 1985). Braided river, aeolian-dune and lake-beach deposits are recognized in sequences of the Lower Eday Sandstone Formation across the east Mainland and the islands of South Ronaldsay, Shapinsay, Stronsay, Sanday and Eday (Astin, 1985).

On the basis of sedimentary structures and bed geometries, Astin (1985) interpreted the Lower Eday Sandstone Formation at Taracliff Bay as a sequence of braided river deposits. Palaeocurrent analysis of cross-bedding in the sandstones indicates that they were deposited from predominantly NE-flowing currents. Similar flow directions have been recorded in the Lower Eday Sandstone Formation on South Ronaldsay and in the John O'Groats Sandstone Group in Caithness (Astin, 1985). By contrast, palaeocurrents in the Lower Eday Sandstone Formation farther north, as exposed on Eday, Sanday, Stronsay and Shapinsay, record southeastward flow directions. These patterns were interpreted by Astin (1985) as representing a SE-flowing river system in the north and a NE-flowing one in the south. The two systems overlap, and SE-directed currents are recorded at Taracliff Bay, in this GCR site, in an area where NE-flowing currents predominate (Astin, 1985). Aeolian sandstones have not been recognized in the Lower Eday Sandstone Formation at Taracliff Bay, but the foresets of aeolian dunes in the formation in other areas (including Eday, Sanday, Stronsay, Shapinsay and northern Deerness) show that wind directions varied from south-west to NNE, with an overall NNW dominance.

The Eday Flagstone Formation marks the re-establishment of cyclic, lacustrine sedimentation. However, in contrast to the cycles of the Caithness Flagstone Group, many of the cycles contain a buff or yellow, locally pebbly, channelized sandstone phase. The formation exhibits great lateral changes in thickness and lithology, thinning northward and southwestward away from Deerness. The thinning is due to changes in fades within the individual cycles, with the sandstone phases of some cycles becoming thicker and coarser-grained away from Deerness, whereas the lacustrine phases become thinner and eventually wedge out. Contemporaneous, sporadic volcanic activity is represented by the olivine dolerite intrusion and tuffaceous sandstones at the site, which are typical of the volcanic rocks of Mid-Devonian age found in Orkney.

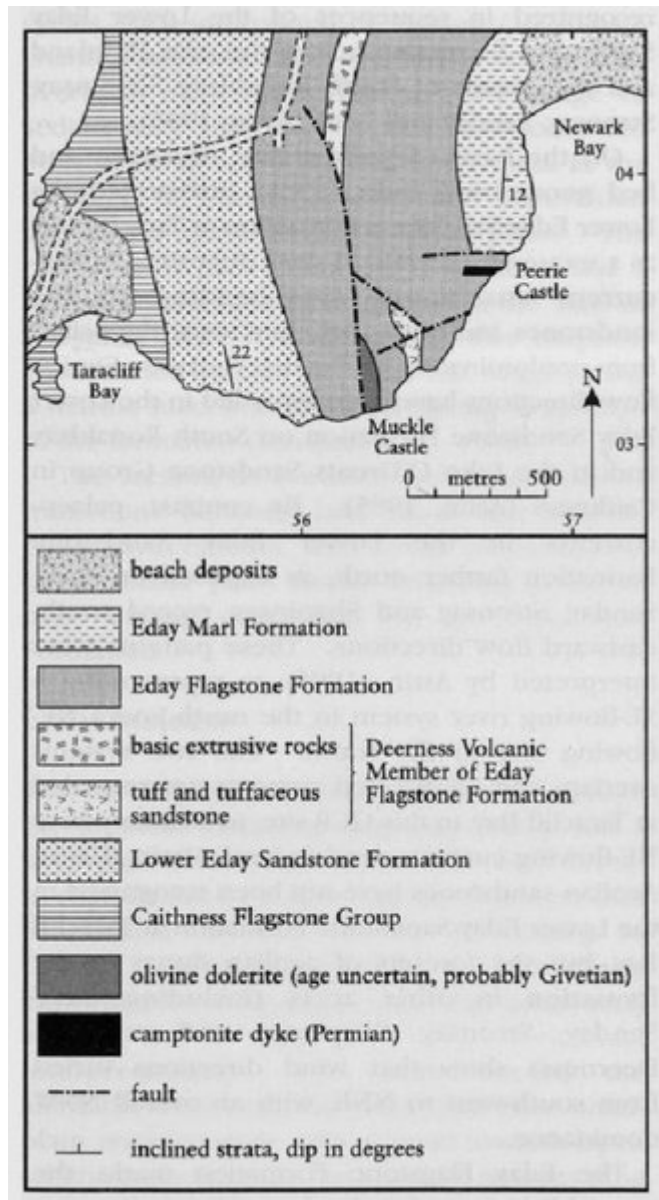
The Eday Marl Formation, at the eastern end of the section, comprises fluvial, fining-upward cycles, each interpreted by Mykura (1976) as a channel sandstone unit overlain by fine-grained overbank deposits. However, the range of sedimentary structures in the sandstones led Marshall *et al.* (1996) to interpret them as the products of fluvial channel and sheet-flood deposition on a muddy sabkha plain. The presence of pseudomorphs after halite and a marine microfauna at a locality in the Bay of Berstane (see GCR site report, this chapter), about 12 km north-west of this site, suggests that a marine incursion occurred during deposition of the formation (Marshall *et al.*, 1996).

The section, as a whole, records a series of transitions between lake basin and alluvial-plain environments, with fluvial sedimentation on a sabkha plain finally becoming predominant during deposition of the Eday Marl Formation.

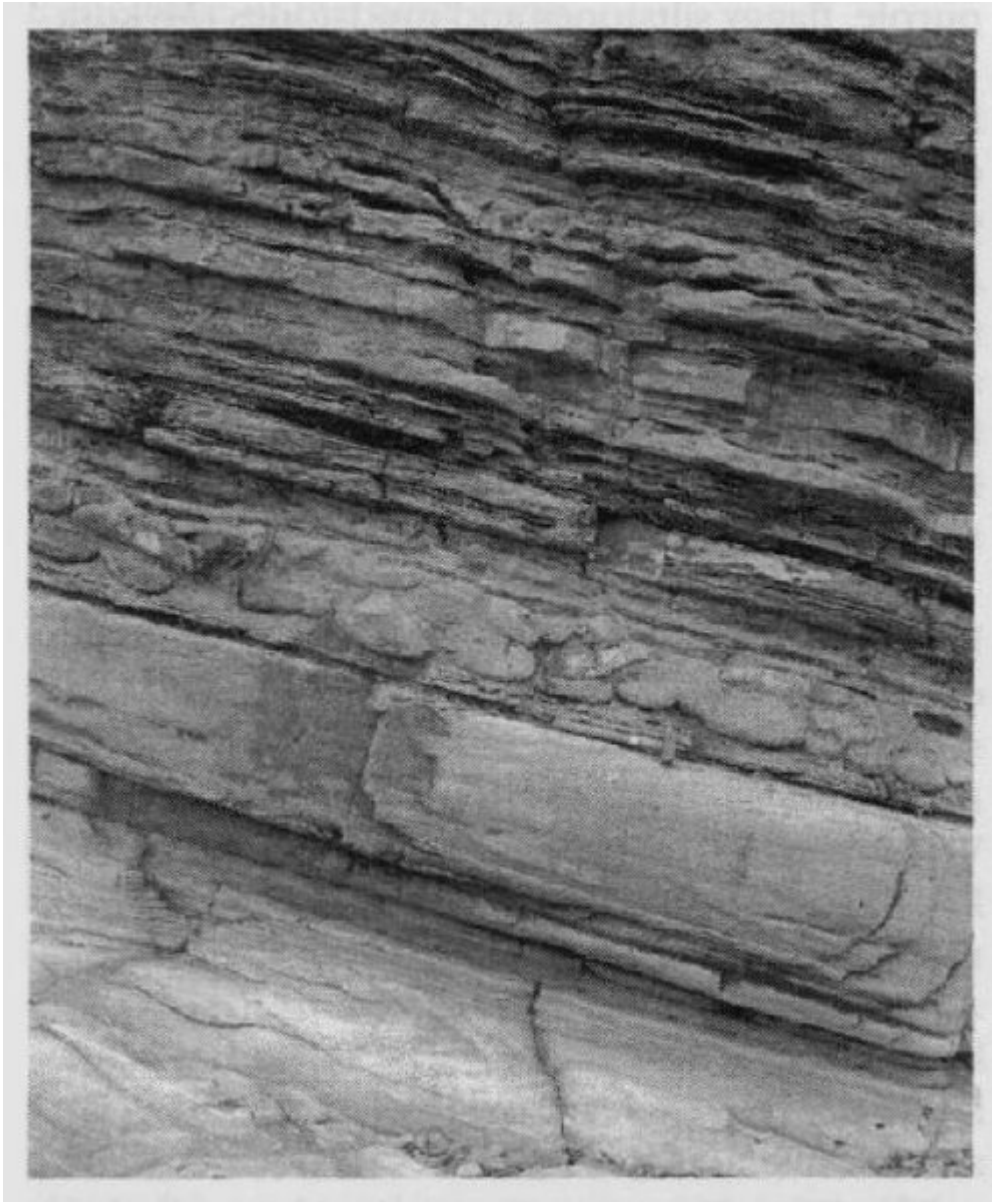
Conclusions

This site displays a well-exposed section through the topmost Caithness Flagstone Group and a large part of the Eday Group. The Eday Group is characterized by great lateral thickness and lithological variations across its outcrop in Orkney. This succession is particularly important for comparison with other areas, such as Eday, and for regional palaeoenvironmental interpretations. The strata record the alternation between lake-basin and river braid-plain environments, with a trend towards open sabkha environments. An intrusive igneous plug and related tuffaceous sandstones within the Eday Flagstone Formation are also important features, indicating contemporaneous volcanism in late Mid-Devonian times.

References



(Figure 2.29) Geological map of the Taracliff Bay to Newark Bay area. Based on Kellock (1969) and British Geological Survey (1999).



(Figure 2.30) Load structures and convolute bedding in the Eday Flagstone Formation near Muckle Castle, south-west of Newark Bay. (Photo: BGS No. D1522, reproduced with the permission of the Director, British Geological Survey, © NERC.)