

# Middle Old Red Sandstone of Orkney, Stromness Flags

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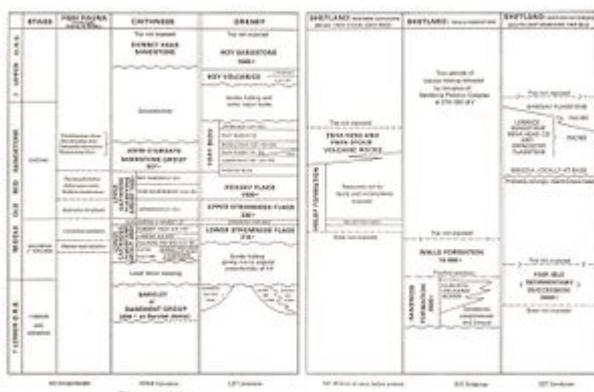
Mykura, W. 1976. British regional geology: Orkney and Shetland. Edinburgh, Her Majesty's Stationery Office.

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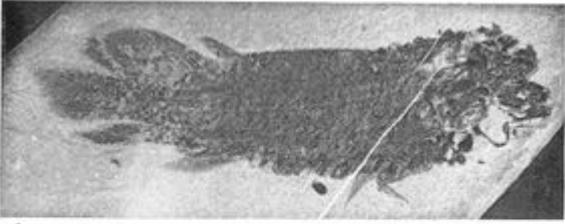
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## Introduction



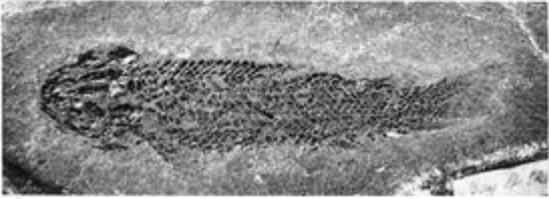
Possible correlation of the Old Red Sandstone of Shetland, Orkney and Caithness. P915600.



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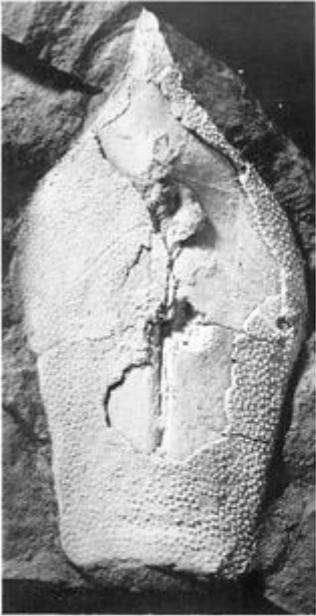


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Middle Old Red Sandstone Fish. P916222.



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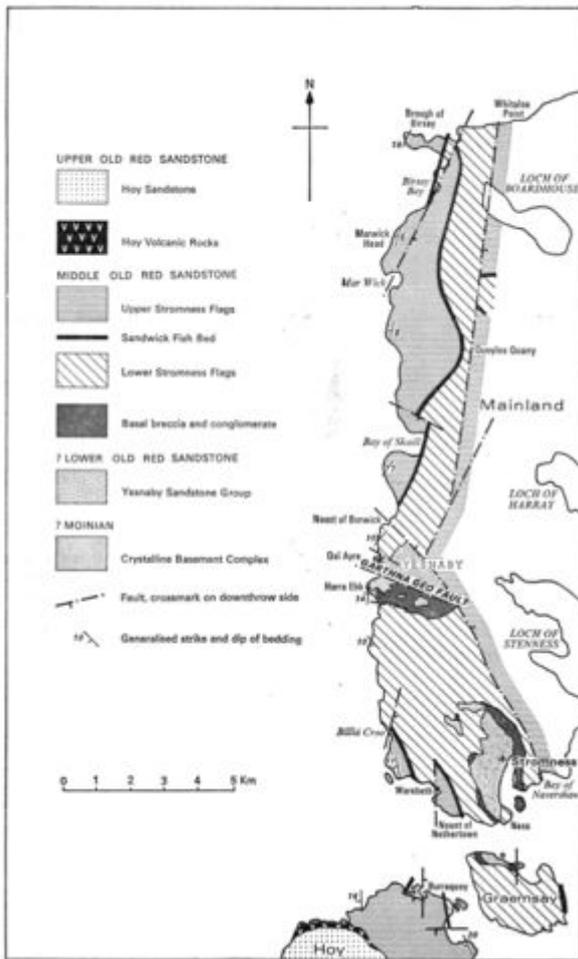


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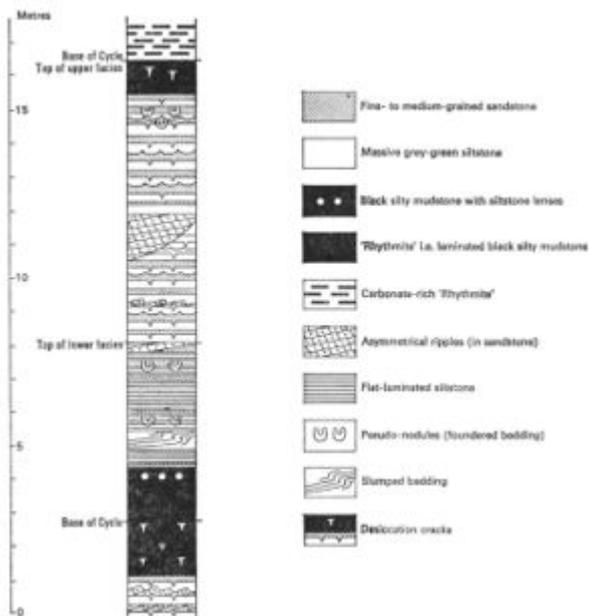


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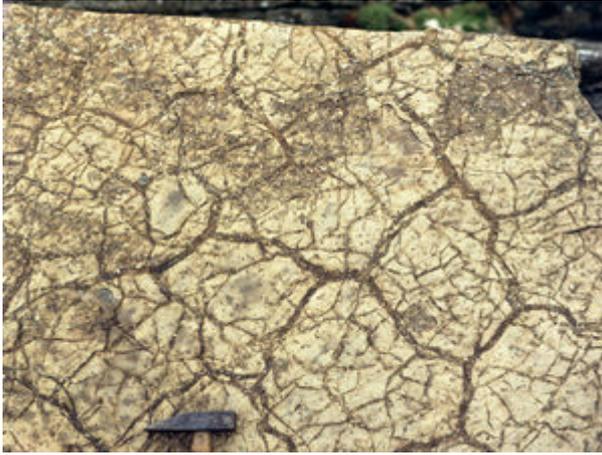
Middle Old Red Sandstone Fish. P916223.



Geological map of the western seaboard of Orkney Mainland and northern Hoy. P915581.



A measured cycle in the Stromness Flags. P915582.



Sand-filled sun cracks on bedding plane of flagstone. Rousay Flags, East Walls, Hoy, Orkney. P219004.



'Horse-tooth stone', a digitate stromatolite in Lower Stromness Flags. Yesnaby, west coast of Orkney Mainland. P219017.

The Stromness Flags are composed of what appears at first sight to be a monotonous sequence of grey and black thinly bedded, in part laminated, dolomitic siltstones, shales and subordinate thin very fine-grained sandstones. These beds have been aptly named flagstones as they are particularly suitable for the production of paving flags. Most flags are rich in ferroan dolomite, which causes them to weather to an ochreous colour. They are superbly exposed along the western seaboard of Mainland and along the north shore of Hoy, and they have been studied in detail by Fannin who has shown that the succession consists of a number of well-defined rhythmic units or 'cycles'. Fannin (1970)<sup>[1]</sup> has used the following stratigraphic subdivisions:

	<b>Approximate thickness (m)</b>	<b>Number of cycles</b>	<b>Average thickness of cycles (m)</b>
Upper Stromness Flags	190+	20+	8.5
Hoy Cycles	61-79	4	16.6
Sandwich Fish Bed Cycle (with Sandwich Fish Bed 2.5 m above base)	55-61	1	55-61
Lower Stromness Flags	215	24	8.1
Basal breccia, conglomerate and sandstone	0-20	-	-

The Lower Stromness Flags have been taken to be of Upper Eifelian age and the beds above the Sandwich Fish Bed have been classed as Lower Givetian ([P915600](#); Westoll 1951<sup>[2]</sup>; Miles and Westoll 1963<sup>[3]</sup>). Fish remains are present throughout the sequence and they are particularly abundant and well preserved in the Sandwich Fish Bed. The fauna recorded from the various subdivisions is as follows:

Upper Stromness Flags: *Cocosteus* ?, *Dickosteus threiplandi* Miles and Westoll, *Dipterus valenciennesi*, *Glyptolepis paucidens* and *Homostius milleri*.

Hoy Cycles: *Dickosteus threiplandi*, *Dipterus* sp. and *Glyptolepis* Sp.

Sandwich Fish Bed Cycle: *Cheiracanthus murchisoni* Agassiz, *Cheirolepis trailli* Agassiz, *Cocosteus cuspidatus*, *Diplacanthus striatus* Agassiz, *Dipterus valenciennesi*, *Gyroptychius agassizi*, *G. microlepidotus* (Agassiz), *Osteolepis macrolepidotus* Agassiz [P916222](#), [P916223](#) (P916222 3), *Pterichthyodes milleri* (Agassiz) and *Rhadinacanthus* sp.

Lower Stromness Flags: *Cocosteus cuspidatus* and *Dipterus* sp.

Large plant fragments are relatively rare and poorly preserved and the principal genera recognised are *Hostimella*, *Thursophyton* and *Protopteridium*. These cannot be used for accurate dating. Spores are abundant in many of the siltstones and Richardson (1965) and Fannin (1970) have recorded a large number of species. Apart from giving general support to the dating by the fossil fish, they have not so far provided any evidence for the exact age of the Stromness Flags, but may in future form the basis for a more precise stratigraphic zonation.

## **Basal breccias, conglomerates and sandstones**

The basal beds of the Lower Stromness Flags vary greatly both in thickness and in the size of their clasts. They are well exposed on the north-western margin of the Graemsay inlier and along the shore at Ness, at the south end of the Stromness inlier ([P915581](#)). In the Yesnaby area a thin layer of basal breccia rests directly on the basement rocks which form the local hills, but along the coast thin beds of pebbly sandstone at the base of the Stromness Flags rest on the sediments of the Yesnaby Sandstone Group.

At Ness and north Graemsay the basal breccia ranges from 5 to 20 m in thickness and locally fills hollows in the old land surface. The breccia passes laterally and upward into conglomerate with small pebbles, which is interfingered with pebbly sandstones and thin lenses of sun—cracked siltstone. The breccias and conglomerates are composed of unsorted angular to subrounded boulders and cobbles of locally derived granite, granite-gneiss and, more rarely, schist, set in a matrix of arkose which in places is composed entirely of fine granite debris. At Graemsay some clasts are coated with a thin layer of interlaminated dolomite and siltstone which in places has a mammillated structure. These coatings appear to be stromatolites (Fannin 1969, p. 82)<sup>[4]</sup>. The breccias with their angular clasts are interpreted as scree and talus deposits which accumulated at the flanks of the basement hills and were later partly re-worked and rounded on the shore of the lake surrounding these hills. The stromatolite coatings of the clasts were formed in shallow water and the complete coating of pebbles suggests that the latter were being constantly rolled by waves.

## **Flagstone facies**

Above the basal breccias the Stromness Flags are made up of over 50 cycles which are thought to

have been formed by the fluctuations in the level of a single large and generally shallow lake in the Orkney-Caithness area. The cycles are basically similar to those described in the Caithness Flagstones by Crampton and Carruthers (1914, pp. 89-93)<sup>[5]</sup> and the lithological characters of such a cycle are shown in [P915582](#). The base of the cycle is taken at the base of the black thinly laminated fine sediment which commonly contains fish remains and was laid down during a quiescent period when little or no coarse sediment entered the lake and when the water, though still shallow, was at its deepest. The sequence of sediments above this suggests that thereafter the depth of the lake gradually decreased and that eventually an influx of coarser sediment brought in by a river or stream pushed a delta out over the shallow or dried-up lake floor. It is believed that the Orcadian Basin was a rapidly sinking, tectonically controlled basin, and that the rhythmic sedimentation was regulated by an interplay of tectonic and climatic changes.

The Stromness Flags contain a number of features which can be used for local correlation. The most obvious for detailed correlation are the 'deepest water' fish-bearing facies of the individual cycles which are extremely persistent laterally. Individual cycles can sometimes be recognised in neighbouring sections by their total thickness, which also remains constant over long distances. There are also a number of marker horizons which maintain their character for some distance laterally. Thus in the Lower Stromness Flags two thinly laminated iron-rich beds of silty dolomite, which are rusty orange-weathering and contain large chert nodules, occur at 14 and 59 m below the Sandwick Fish Bed. A third marker horizon, just above the base of the Sandwick Fish Bed, is a 25 cm-thick calcite mudstone, which weathers to a distinctive bluish grey colour. The fourth marker is a massive 2 m-thick bed of bluish grey to black silty mudstone, which occurs at 56 m above the Sandwick Fish Bed throughout the area. In addition, several thin bands of green tuff crop out in Hoy at horizons 3 and 170 m above the Sandwick Fish Bed. These, however, thin out northwards and extend only into the southern end of Mainland.

The thickness of individual cycles commonly ranges from 5 to 10 m but the Sandwick Fish Bed cycle has a thickness of 60 m. Each cycle can be divided into two major lithological facies. The lower of these was deposited under a continuous cover of water; the upper in shallow water which at times dried up completely.

The lower facies commences with (1) up to 1 m of dark grey to black silty mudstone interlaminated with siltstone or fine sandstone. It generally has graded laminae which may have either a high bitumen and pyrite or a high carbonate (usually ferroan dolomite) content. It contains either complete or fragmentary fish remains. This deposit was laid down in relatively quiet and sometimes stagnant waters on a lake bottom undisturbed by wave action. The lake waters may, at times, have been thermally stratified and some of the graded laminae may have been deposited by turbidity currents. These 'quiescent water' beds grade upwards into (2) thinly interbedded bituminous silty mudstones and fine sandstones together with some discrete beds of massive siltstone and fine sandstone, some of which fill small erosional channels. This part of the sequence is characterised by the presence of numerous small sub-aqueous shrinkage (syneresis) cracks (see Donovan and Foster 1972)<sup>[6]</sup> which were infilled by sand or silt and were then compacted and contorted. Algal stromatolite sheets and mounds are common in these beds and scattered fish fragments are generally present. Sediments of this type were laid down in water in which bottom currents were spasmodically active. In some cycles these sediments are interbedded with massive beds of calcareous siltstone which are rich in spores and comminuted plant debris.

The massive siltstones were probably formed in relatively quiet shallow water close to the lake shore which formed traps for the accumulation of 'vegetable hash'. None of the beds in the lower facies have sun cracks, which indicates that the water of the lake never receded completely.

In most cycles the upper facies commences with (1) thinly banded sediments which are lithologically

very similar to the higher beds of the lower facies, but have, in addition, well developed sand-filled desiccation polygons ([P219004](#)). In many instances stromatolite sheets and mounds cover the cracked surfaces and extend down into the sun cracks. These beds were probably laid down in quiescent waters close to the lake margin, where the shallow water periodically receded to leave coastal mud flats. In most instances they are overlain by (2) ripple-cross-laminated sandstones and siltstones with desiccation cracks. These beds appear to be alluvial flood-plain or delta-top deposits laid down by rivers which entered the lake from the north. In some cycles, particularly in the 'Hoy Cycles' of Hoy, such fluvial spreads are interbedded with and channelled by lenticular beds of cross-bedded sandstone which represent channel-fill deposits. In some instances the thick sandstones are interpreted as filled-up river channels, in others as filled-up delta-front channels, which may have been cut in the soft muds and sands beneath the shallow water of the lake. The fluvial sediments are invariably succeeded by thinly banded silts and sands with sun cracks (i.e. mud-flat deposits) before the abrupt change to the quiescent 'deep-water' facies at the base of the next cycle.

The presence of algal stromatolites with a wide variety of growth forms (Fannin 1969)<sup>[1]</sup> appears to be a characteristic feature of Orkney flagstones, which has not been noted to the same extent in Old Red Sandstone sediments of other parts of Scotland. Stromatolites occur as:

1. sheets of limestone or dolomite ranging in thickness from a millimetre to several centimetres which cover surface irregularities such as aligned small ridges, and line small sun cracks;
2. mounds composed of stacked convex-upward hemispheres linked by laminated sheets;
3. isolated mounds.

The spectacular mounds of stromatolite made of stacked hemispheroids which are known as the 'Horse-tooth Stone' ([P219017](#)) are well exposed at the top of the cliff at Yesnaby [220 161]. They were first described by Heddle (1878, p. 117, plates xiv and xv)<sup>[2]</sup> and recognised as fossil algal reefs by Anderson (1950, p. 10, fig. 6)<sup>[3]</sup>. Fannin has shown that the shape of the stromatolites of Orkney was controlled by the currents in the lake. Conversely, once the algal colony was established it formed a tough mat which was able to influence the pattern of erosion on the lake floor.

The detailed study of palaeocurrent directions has indicated that there is a dominant trend towards the south in both the major facies, with a tendency to a south-south-westward trend in the 'fluvial' beds, particularly within the Hoy Cycles. In the Upper Stromness Flags this trend, though still present, is less pronounced. Though the interpretation of the palaeocurrent directions must be tentative, Fannin has suggested that the Orcadian lake had a roughly east-west trending shoreline and was fed by rivers entering from the north. The periodic retreat of the shoreline was probably due to the southward advance of the delta-fronts. Within the lake the dominant current flow was offshore and there is little evidence for any long-shore currents.

The 'typical' cycle described above is not universally found and there is considerable variation both in time and space. The simplest cycles occur in the Lower and Upper Stromness Flags. The Hoy Cycles are considerably thicker than either of the other two groups and they have a higher proportion of lower facies sediments. They contain channel sandstones which on Hoy reach a thickness of 11 m. This indicates that during the deposition of the Hoy Cycles a large river system persisted over or near western Orkney. By far the thickest cycle in the Stromness Flags is that which contains the Sandwich Fish Bed. It ranges in thickness from 55 m in the south to 61 m in the north, though the fish bed *sensu stricto* is a finely laminated carbonate-rich band only 50 cm thick and

located some 2.5 m above the base of the cycle. The cycle contains up to 55 m of true lacustrine (i.e. lower facies) sediments and, as it has been confidently correlated with the Achanarras and Niandt Fish Beds of Caithness and the Melby Fish Bed of Shetland (Miles and Westoll 1963)<sup>[3]</sup>, it must represent a period when the lake was considerably deeper and more extensive than at other times during the deposition of the Stromness Flags. The maximum water depth may have been 50 m.

In the past the Sandwick Fish Bed was worked in a large number of small quarries in West Mainland for paving flags and roofing slates. At present only the quarry at Quoyloo ([P915581](#)) is still active. This still yields abundant fish remains, though modern methods of quarrying are less conducive to the preservation of good specimens. The fish bed can be recognised on the quarry face by its rusty weathering. Fish remains may be evenly scattered on some bedding planes, on others they may be so abundant as to form a matted mass. On joint faces the fish can be recognised as black coal-like lenses, sometimes up to 1 cm thick. Black bituminous matter is often present along the joint planes of the fish bed, and in the more compact carbonate-rich portions of the bed a little oil is also found.

## Bibliography

### [Full bibliography list](#)

1. ↑ <sup>1.0</sup> <sup>1.1</sup> FANNIN, N. G. T. 1970. The sedimentary environment of the Old Red Sandstone of western Orkney. Ph.D. thesis, University of Reading (unpublished).
2. ↑ WESTOLL, T. S. 1951. The Vertebrate-bearing Strata of Scotland. Rep. XVIII Int. Geol. Congr., Part 11, Great Britain, 1948, 5-21.
3. ↑ <sup>3.0</sup> <sup>3.1</sup> MILES, R. S. and WESTOLL, T. S. 1963. Two New Genera of Coccosteid Arthrodira from the Middle Old Red Sandstone of Scotland and their stratigraphical Distribution. Trans. R. Soc. Edinb., 66, 179-210.
4. ↑ FANNIN, N. G. T. 1969. Stromatolites from the Middle Old Red Sandstone of western Orkney. Geol. Mag., 106, 77-88.
5. ↑ CRAMPTON, C. B. and CARRUTHERS, R. G. 1914. The geology of Caithness. Mem. geol. Surv. Gt Br.
6. ↑ DONOVAN, R. N. and FOSTER, R. J. 1972. Subaqueous shrinkage cracks from the Caithness Flagstone Series (Middle Devonian) of northeast Scotland. Jnl sedim. Petrol., 42, 309-17.
7. ↑ HEDDLE, M. F. 1878. The County Geognosy and Mineralogy of Scotland, Orkney and Shetland. Truro.
8. ↑ ANDERSON, F. W. 1950. Some reef-building calcareous algae from the Carboniferous rocks of Northern England and Southern Scotland. Proc. Yorks. geol. Soc., 28, 5-28.

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