ACHANARRAS QUARRY
(ND 150 544)

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Introduction

The old disused quarry on Achanarras Hill provides a rare exposure of the Middle Devonian Achanarras Limestone Member. This distinctive unit provides a lithostratigraphical marker bed separating the Upper and Lower Caithness flagstone groups, but the site is best known for its rich and varied fossil fish fauna. This is of international importance and allows correlation within the Orcadian basin from Shetland and Orkney south to the Moray Firth. For these reasons the locality has been separately scheduled under the GCR for Fossil Fish of Great Britain (Dineley and Metcalf, 1999) and this short account is supplementary to that of Dineley (1999) carried therein. The seminal modern work on the Achanarras Limestone Member and its remarkable fish fauna is by Trewin (1986) who has also provided a field guide to the site (Trewin, 1993).

Achanarras Quarry was intermittently worked for flagstone and roofing slate from about 1870 to 1961. Since 1980 the quarry has been managed by the Nature Conservancy Council; strict access and fossil collecting conditions apply. The limestone member represents the fullest development of a deep-water, lacustrine lithofacies to be seen in the Orcadian basin. Quite apart from the unique sedimentological features that are preserved, the site has implications for any overview of basin palaeogeography and tectonics. The broad geological setting is described by Johnstone and Mykura (1989) and by Mykura (1991).

Description

The GCR site is centred on the disused quarry excavated on the north side of Achanarras Hill, about 2 km west from the village of Spittal (Figure 1) where (at the time of writing) flagstones are still being quarried from a stratigraphical level slightly above that seen at Achanarras. At Achanarras Quarry the worked rock faces provide exposure through the Achanarras Limestone Member, a distinctive, 3.6 m thick unit of fish-bearing, carbonate-rich laminites taken to mark the top of the Lower Caithness Flagstone Group (Donovan *et al.*, 1974; Trewin, 1986). The fish bed is at or slightly below the Eifelian-Givetian boundary

(Paton, 1981) within the Middle Devonian. In the exposed quarry section (Figure 2) the laminite beds strike approximately north-south and dip a few degrees towards the east. There is no significant rock exposure apart from that in the disused quarry.

The section exposed at Achanarras Quarry is summarised in figure 3 (after Trewin, 1986 and 1993). At the base, thinly bedded, grey siltstone contains paler, silty laminae and small, isolated rippled lenses of fine sandstone; plant detritus is fairly common. This assemblage is the uppermost part of the Lower Caithness Flagstone Group, the Robbery Head Subgroup. Above the thinly bedded siltstone, there is an abrupt transition to the dark grey, finely laminated fish bed, which forms the lowermost 1.95 m of the Achanarras Limestone Member (Trewin, 1986). The lamination is caused by a fine alternation of clastic, organic and carbonate laminae in varying relative proportions; the carbonate may be calcitic or dolomitic. Laminae are sub-millimetre in thickness, with an average clastic-carbonate pair about 0.7 mm thick; organic laminae are very thin, usually <0.1 mm (Trewin, 1986).

The upper part of the member, from which few fish fossils have been recovered, consists largely of clastic and dolomitic laminae. In figure 2, the fish bed and part of the overlying laminite unit are below water level in the flooded quarry but the topmost 50 cm or so of the limestone member form that part of the rock face immediately above water level. Most of the exposed rock in figure 2 comprises the lowest beds of the Upper Caithness Flagstone Group (the Latheron Subgroup, locally known as the Spittal Beds). Therein, thin units of clastic-dolomitic laminites, lithologically similar to those in the upper part of the Achanarras Limestone Member, alternate with beds of fine-grained sandstone ranging up to 45 cm thick. The sandstone beds are fairly massive, greenish-grey when fresh but weather brown due to a high proportion of secondary dolomite. The bed bases are usually sharp and some grading is commonly present; sporadically this develops upwards to give a thin mudstone at the top of the bed. Rip-up clasts of clastic-dolomitic laminite are fairly common in the lower parts of the sandstone beds.

Interpretation

The varying lithofacies seen in the Achanarras section were ascribed by Trewin (1986) to the effects of lake transgression and regression. The fine laminations of the fish bed were interpreted by Rayner (1963) as lacustrine varves with an annual periodicity. Donovan (1980) refined Rayner's interpretation in terms of a clastic, carbonate and organic triplet resulting from deposition in a tropical lake, with thermal stratification ensuring that bottom conditions in the deeper parts of the lake were cold and anoxic. Rayner and Donovan agreed that increased seasonal algal growth and photosynthesis would have caused a rise in water pH with resulting carbonate precipitation, the subsequent organic laminae then arising by the accumulation of dead phytoplankton as the algal bloom peaked. The latter phenomenon might also have been responsible for periodic mass mortality in the fish population. The clastic laminae may have been seasonally influenced by rainfall and run-off into the lake, or may have arisen from repeated microturbidite flow unrelated to seasonal events.

The lowest strata seen, below the limestone member, were deposited in a nearshore, shallow lake environment. Thereafter, the overlying fish bed demonstrates the effects of lake transgression with deepening water. The upper part of the limestone member, above the fish bed (s.s.) contains relatively few organic laminae, reflecting a decline in plankton productivity, and a higher proportion of clastic laminae. This change marks the beginning of significant lake regression but the fully developed, deep-water regressive phase is represented by the abrupt incoming of substantial, low-density turbidite sands at the base of the Upper Caithness Flagstone Group. Between turbidity flows deposition of the laminated lacustrine lithofacies (clastic-carbonate) continued. Assuming a broad seasonal control on laminite deposition, the Achanarras Limestone Formation represents about 4 000 years of accumulation (Rayner, 1963; Trewin, 1986).

Conclusions

The GCR site at Achanarras Quarry provides a rare section through the Achanarras Limestone Member and its contacts with the overlying and underlying strata of the Upper and Lower Caithness Flagstone groups. The limestone member is a valuable stratigraphical marker bed for correlation within the Orcadian basin, and contains a remarkable fossil fish fauna of international importance. The lithofacies present record the transgression and regression of a lacustrine environment; possibly the maximum recorded transgression by the Orcadian basin lake. Lacustrine deposition of fine laminites was controlled by the seasonal influence of increased algal productivity, and hence increased photosynthesis, resulting in changes in water acidity. The organic and carbonate laminae were produced in this way and alternate with the fine-grained clastic laminae that may have been introduced by seasonal increases in rainfall and run-off.

References

Dineley 1999

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Donovan 1980

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Rayner, D.H. 1963. The Achanarras limestone of the Middle Old Red Sandstone, Caithness. Proceedings of the Yorkshire Geological Society, Vol. 34, 117-138.

Trewin 1986