Achanarras Quarry, Caithness

[ND 150 544]

Potential ORS GCR site

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Introduction

The disused quarry on Achanarras Hill provides a rare exposure of the Middle Devonian Achanarras Limestone Member. This distinctive unit is a lithostratigraphical marker bed separating the Upper and Lower Caithness Flagstone groups and allowing correlation of Orcadian Basin sequences from Shetland and Orkney south to the Moray Firth (Trewin and Thirlwall, 2002; Marshall and Hewett, 2003). The richest Old Red Sandstone fish site in Great Britain, the site is already a palaeontological GCR site, of international importance and renowned for its abundant and varied, well-preserved fossil fish fauna, including many whole specimens. The following account supplements that in the fossil fishes GCR volume (Dineley, 1999a). 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 (and subsequently by Scottish Natural Heritage), and strict access and fossil collecting conditions apply. The limestone member represents the fullest development of a deep-water, lacustrine lithofacies seen in the Orcadian Basin. In addition to its unique sedimentological features and fish fauna, the site has important implications for an overview of basin palaeogeography and tectonics. The broad geological setting is described by Johnstone and Mykura (1989) and Mykura (1991).

Description

The GCR site is centred on the disused quarry excavated on the north side of Achanarras Hill, about 2 km west of the village of Spinal (Figure 2.55), where (at the time of writing) flagstones are 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). In the exposed quarry section (Figure 2.56), the laminites strike approximately north–south and dip a few degrees towards the east.

The section exposed is summarized in (Figure 2.57) (after Trewin, 1986, 1993). At the base, thinly bedded, grey siltstone contains paler, silty laminae and small, isolated, rippled lenses of fine-grained sandstone; plant detritus is fairly common. These beds are the topmost of the Robbery Head Subgroup of the Lower Caithness Flagstone Group. Above, 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 (calcitic or dolomitic) laminae in varying relative proportions. The laminae are sub-millimetre in thickness, with an average clastic–carbonate pair about 0.7 mm thick; the organic laminae are very thin, and mostly less than 0.1 mm (Trewin, 1986). Trewin found six horizons of different fish diversity and relative abundance of species, and full details of the fauna are given by Dineley (1999a). The site is the type locality of *Rhamphodopsis threiplandi* Watson and *Palaeospondylus gunni* Traquair. Trewin (1993) noted that *Gyroptychius* is absent at the site, although common in the stratigraphically equivalent Sandwick Fish Bed of Orkney.

The upper part of the Achanarras Limestone Member, from which few fish fossils have been recovered, consists largely of clastic and dolomitic laminae. The fish bed and part of the overlying laminite unit are below water-level in the flooded quarry, but the topmost 50 cm of the limestone member form part of the rock face immediately above water-level (Figure

2.56). Most of the strata seen are the lowest beds of the Upper Caithness Flagstone Group (the Latheron Subgroup, locally known as the 'Spinal Beds'). They consist of thin units of clastic–dolomitic laminites, lithologically similar to those in the upper part of the Achanarras Limestone Member, alternating with beds of fine-grained sandstone ranging up to 45 cm thick. The sandstone beds are fairly massive and greenish grey where fresh, but weather brown owing to a high proportion of secondary dolomite. The bed bases are mostly sharp and some grading is common, sporadically fining upwards to 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

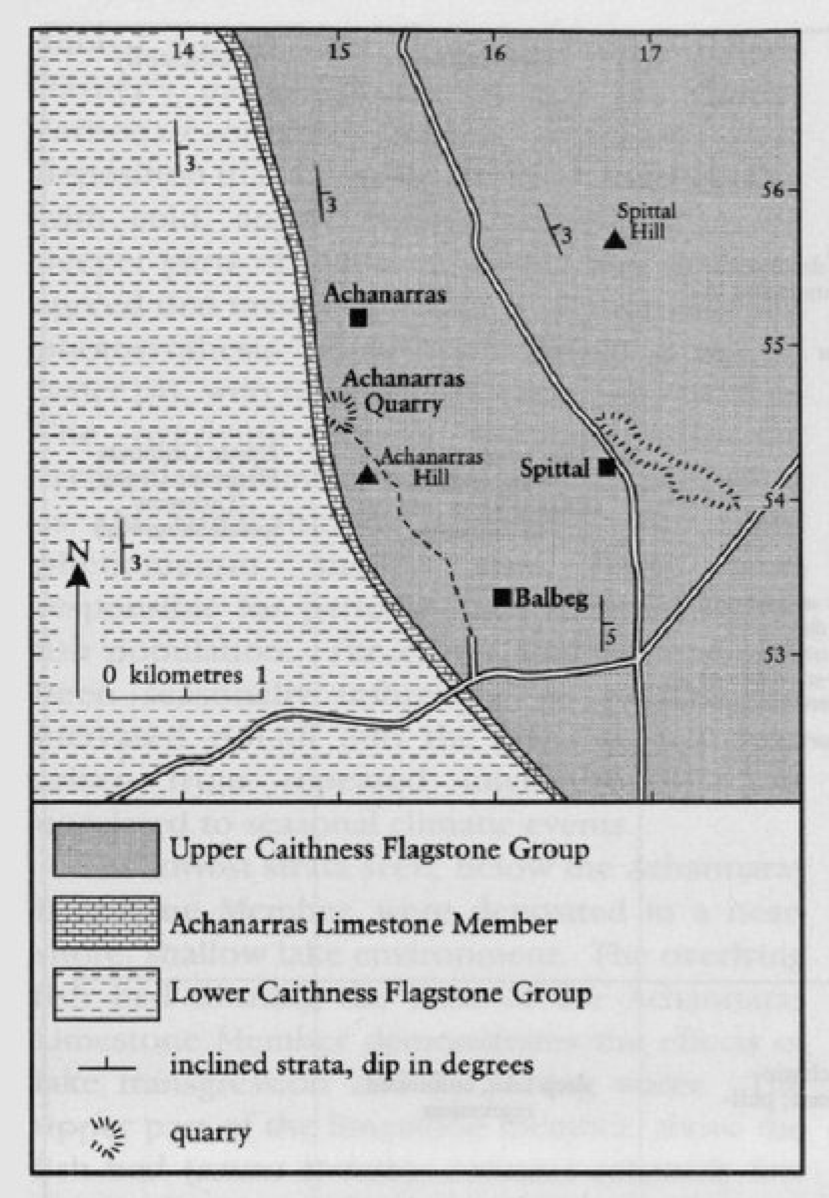
The varying lithofacies in the Achanarras section were ascribed by Trewin (1986) to the effects of lake transgression and regression. The fine laminations of the fish bed were interpreted by Rayner (1963) as lacustrine varves with an annual periodicity. Donovan (1980) refined Rayner's model, proposing that the clastic–carbonate–organic triplets resulted from deposition in a thermally stratified, tropical lake, with cold, anoxic bottom conditions in the deeper parts of the lake. Rayner and Donovan agreed that increased seasonal algal growth and photosynthesis would have caused a rise in water pH, with resulting carbonate precipitation. The overlying organic laminae were the accumulated remains of the dead phytoplankton as the algal bloom decayed. 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 increased run-off into the lake, or may have arisen from repeated microturbidite flow unrelated to seasonal climatic events.

The lowest strata seen, below the Achannaras Limestone Member, were deposited in a near-shore, shallow lake environment. The overlying fish bed forming the base of the Achannaras Limestone Member demonstrates the effects of lake transgression and deepening water. The upper part of the limestone member, above the fish bed (*sensu stricto*), contains relatively few organic laminae, reflecting a decline in plankton productivity, and a higher proportion of clastic input. This marks the beginning of 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 clastic–carbonate laminites continued. Assuming a broad seasonal control on laminite deposition, the Achanarras Limestone Member is estimated to represent accumulation over about 4000 years (Rayner, 1963; Trewin, 1986).

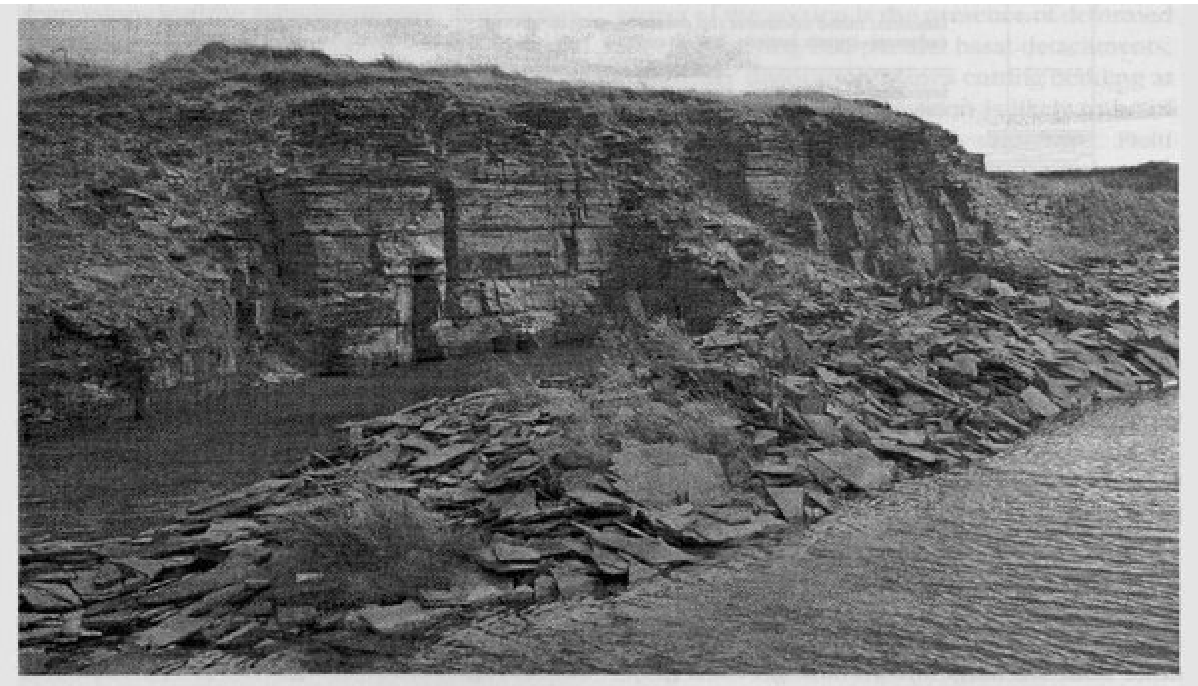
Conclusions

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 record the transgression and regression of a lacustrine environment, possibly recording the maximum transgression by the Orcadian Basin lake. Lacustrine deposition of the fine laminites was controlled by seasonal increased algal productivity and the resulting changes in lake water chemistry. The organic laminae are the product of decay of seasonal algal blooms, the carbonate laminae were deposited during periods when increased photosynthesis raised the pH of the lake waters. The fine-grained clastic laminae were deposited from suspension of material introduced to the lake, probably mainly during periods of seasonal rainfall and increased run-off.

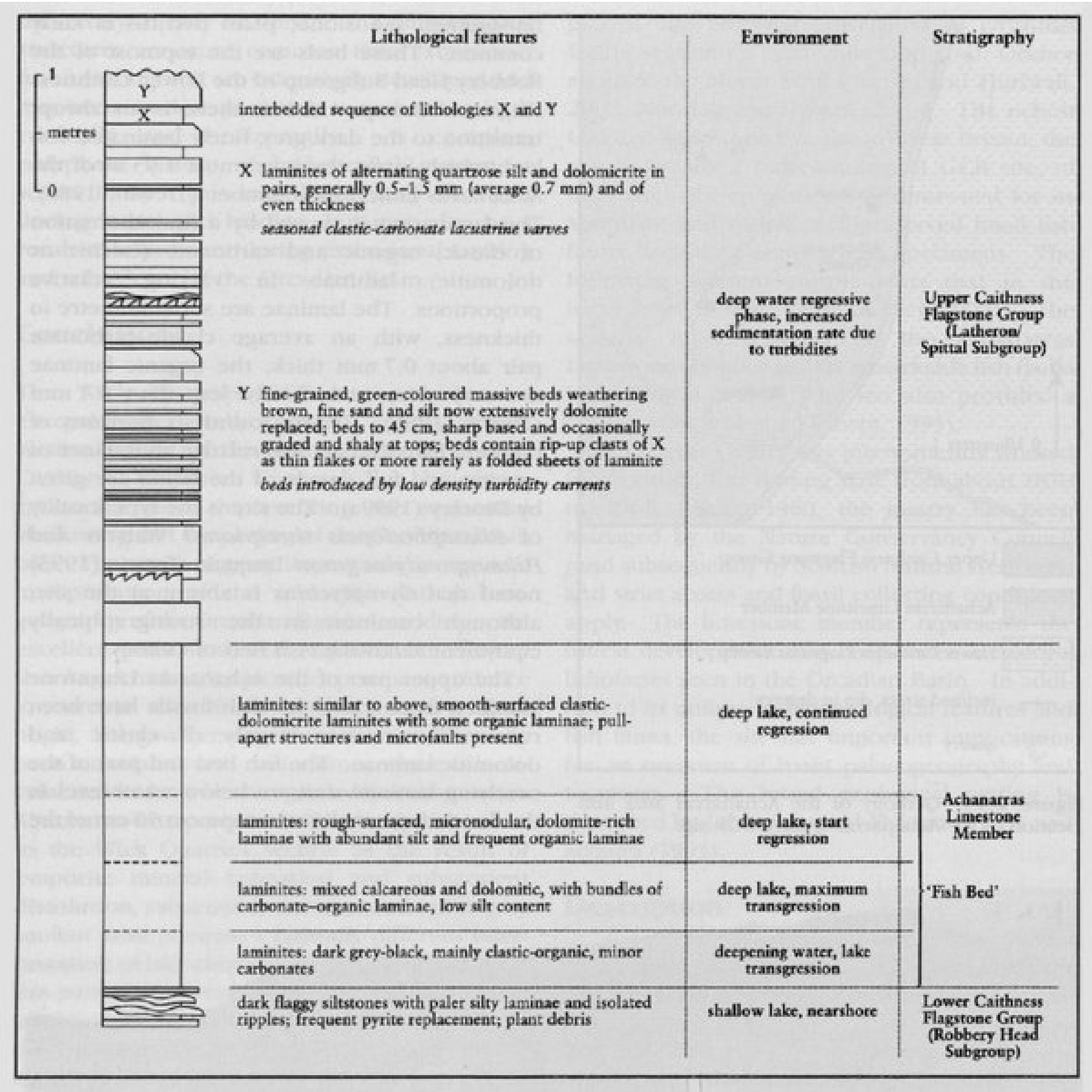
References



(Figure 2.55) Geology of the Achanarras area and location of the Achanarras Quarry GCR site.



(Figure 2.56) Part of the disused Achanarras Quarry, now flooded, showing the upper 50 cm of the Achanarras Limestone Member overlain by the basal beds of the Upper Caithness Flagstone Group. (Photo: P. Stone.)



(Figure 2.57) Section at Achanarras Quarry. After Trewin (1986, 1993).