Red Point, Caithness

[NC 932 659]

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Introduction

The cliff sections around Red Point provide remarkable and unique examples of Middle Devonian lake margin deposits unconformably resting on granodiorite and gneiss basement. The lithofacies relationships are important in establishing fluctuations in playa-lake conditions and their interaction with the variable topography of the basin margin. Particularly noteworthy are the lake margin carbonate and coarse breccia deposits, and their lateral transition into braid-plain sandstones and deeper-water, lacustrine, laminated mudstones. A comprehensive description of the site is given by Donovan (1975), summarized by Trewin and Thirlwall (2002). Field guides are provided by Donovan (1978), Parnell *et al.* (1990) and Trewin (1993).

The regional importance of the Red Point site lies in the exceptionally well-preserved examples of marginal lacustrine deposits. The lithofacies are unique in their diversity and the clarity of their relationships with the basement rocks. The site, along with similar exposures to the west at Port Skerra and Baligill, allows interpretation and characterization of an otherwise unrepresented part of the stratigraphy of the Orcadian Basin, and apart from its intrinsic sedimentological value, it is important for the broader interpretation of the tectonics and palaeogeography of the basin.

The relationships between irregular basement topography and lowermost Old Red Sandstone conglomerates and sandstones are also well displayed at Port Skerra [HC 878 663] (Trewin, 1993). Here, cliff exposures show locally intense fracturing in the basement that was exploited and opened by Devonian weathering. In the bay, sheet-flood conglomerates and hard silica-cemented sandstones fill hollows, drape knolls and infill a 3 m-deep fissure in the irregular gneiss surface. Sedimentary structures include excellent convolute lamination in a sandstone exposed near low-tide mark and sand volcanoes (B.P.J. Williams, pers. comm.). West of Port Skerra, outcrops at Balligill [NC 855 659] and a section in Balligill Quarry [NC 852 657] provide excellent exposures of deeper lacustrine and lake-margin facies, the latter including a limestone mantling a basement hill [NC 857 661] (Trewin, 1993). The lacustrine laminites are fish-bearing at two horizons in the quarry. Fine examples of load structures are seen in the bases of fine-grained turbidite sandstones, as well as 'flow-roll' de-watering structures, diagnostic of lacustrine deposition. Trewin (1993) provided details of these excellent localities.

The dangers of the Red Point site should be stressed. The sea cliffs around Red Point are high and precipitous with much loose rock, and most of the critical exposures are perched at the top of the cliffs in precarious positions. Visitors must therefore take appropriate precautions to ensure their safety.

Description

Red Point lies about 18 km west of Thurso on the north coast of Caithness. It provides a remarkable section through marginal lithofacies of an Orcadian Basin lake, which rest unconformably on rusty brown, granodioritic and locally gneissose basement rocks. The basement relief is at least 30 m (Donovan, 1975), with the overlying sedimentary strata dipping variably away from the elevated basement areas. Local minor faulting complicates the unconformable relationship. The outline geology of the site and a sketch cross-section illustrating the relief are shown in (Figure 2.41) and (Figure 2.42) respectively. There is no direct evidence for the age of the basin-margin strata, but they probably belong to the lower part of the Latheron Subgroup, the lowest division of the Upper Caithness Flagstone Group, and are therefore likely to be early Givetian (Mid-Devonian) in age. The deposition of the Red Point sediments was probably coincident with the maximum expansion of the Orcadian Basin lake.

Along the western side of the basement inlier ('a' on (Figure 2.41)) a remarkable limestone fades rests directly on the basement. The lowest limestone is a thin, calcite-cemented breccia of basement clasts, which is particularly concentrated in hollows in the erosion surface. Above this, up to 2 m of grey, fairly massive, limestone shows evidence for slumping, is irregularly silicified locally, and appears to merge laterally down-slope into laminated mudstone. Janaway and Parnell (1989) noted lower dolomitic and upper calcitic units and small laminated domes of possible algal origin. A coarse breccia of limestone and basement clasts in a sandy matrix overlies the limestone (Figure 2.43). Clasts are angular to subrounded and range up to about 40 cm across.

Across the central part of the basement inlier ('b' on (Figure 2.41)), breccias lie directly on the unconformity, although minor faulting affects the outcrop pattern. The breccias are cemented by calcite locally, and some beds are draped by very thin, carbonate-rich mudstone laminae. Northwards, and dipping away from the elevated basement area, the breccias are increasingly interbedded with coarse sandstone. Breccia tongues thin fairly abruptly down-dip (Figure 2.44) and pass into a sandstone-dominated sequence with lenses of breccia. Clast arrangement in the breccia tongues is mainly random, but weak clast imbrication in the lenses indicates a down-dip current flow. The sandstones are generally thinly bedded with internal, wavy and low-angle cross-bedding. Exposed bedding surfaces are rippled and have polygonal networks of desiccation cracks.

The eastern side of the basement inlier ('c' on (Figure 2.41)) is a spectacular exposure illustrating the relationship between a steep cliff of red gneiss and granodiorite, and breccias derived from it. Despite some local faulting, the sedimentary association is clearly preserved. The coarse breccia contains angular to subrounded clasts, mainly of the adjacent granodiorite, but there are also some clasts of limestone similar to that on the western side of the basement inlier. Locally, the breccia fills fissures in the steep basement cliff, and overall reaches a maximum thickness of about 10 m. The beds dip steeply away from the basement cliff, towards the east, but the dip decreases markedly in that direction and is sub-horizontal 50 m away, the decrease coincident with the breccias merging laterally with thinly interbedded sandstone and mudstone. These are variably laminated and cross-bedded, exposed bedding surfaces showing ripples and polygonal networks of desiccation cracks. Some of the sandstone beds contain sporadic, isolated clasts of red granodiorite.

Interpretation

The lithofacies assemblage at Red Point, and its unconformable relationship with the contemporary basement topography, illustrates the depositional pattern at the margin of an Orcadian Basin lake. The granodiorite–gneiss basement had significant relief in this area and so provided depositional environments that varied in response to fluctuating lake levels. The limestone to the west of the basement inlier represents lacustrine deposition at maximum lake water-level (a coincident lake margin of Donovan, 1975), when the water-level was high enough to transgress the margin of the basin. Carbonate deposition was controlled by photosynthesizing algae, with the upward transition from dolomitic to calcitic limestone probably reflecting reduced water salinity (Janaway and Parnell, 1989). Down-slope slumping of the limestone occurred prior to its complete lithification; in the same direction, it grades into the deeper-water mudstone-sandstone laminite fades.

The coarse breccias overlying the limestone were lake-margin beach deposits that prograded into the lake in response to a drop in water-level. Their angular limestone pebbles were clearly derived from fully lithified limestone. Again, there is a lateral transition, away from the elevated basement topography, as breccia tongues interfinger with thinly bedded sandstones. The sandstones may be a slightly deeper-water, nearshore lithofacies, but their sedimentary structures are equally compatible with an origin as high-energy, braided fluvial deposits. The latter interpretation is probably better suited to the current-imbricated breccia lenses within the sandstones. Wave-rippled bedding planes cut by desiccation polygons point to intermittent emergence of the lake floor.

The most dramatic example of basement relief is seen on the eastern side of the inlier. The steepness of the basement cliff against which the breccias are banked, and the abrupt transition away from the diff into laminated sandstone and mudstone, suggests a scree-like accumulation at the lake margin. The laminated sequence contains many examples of wave-rippled bedding surfaces and polygonal desiccation crack networks, indicating alternating shallow-water and

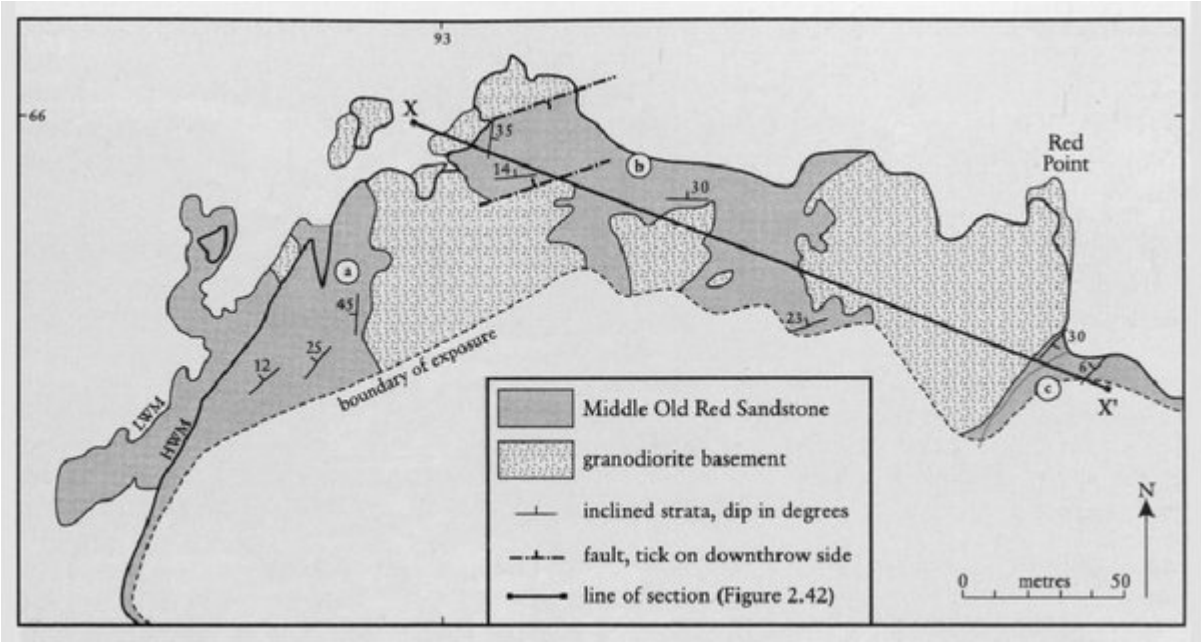
emergent conditions.

The range of marginal lacustrine lithofacies around Red Point is remarkable, but it is very hard to link the different exposures into a single, comprehensive model. Instead, it seems most likely that a range of stratigraphical levels is present, each reflecting slightly different conditions at different times in the evolution of the lake margin. The lacustrine transgressions and regressions recorded may possibly have had a climatic control. The local, minor faulting that cuts the site may also be significant in juxtaposing different parts of the sequence.

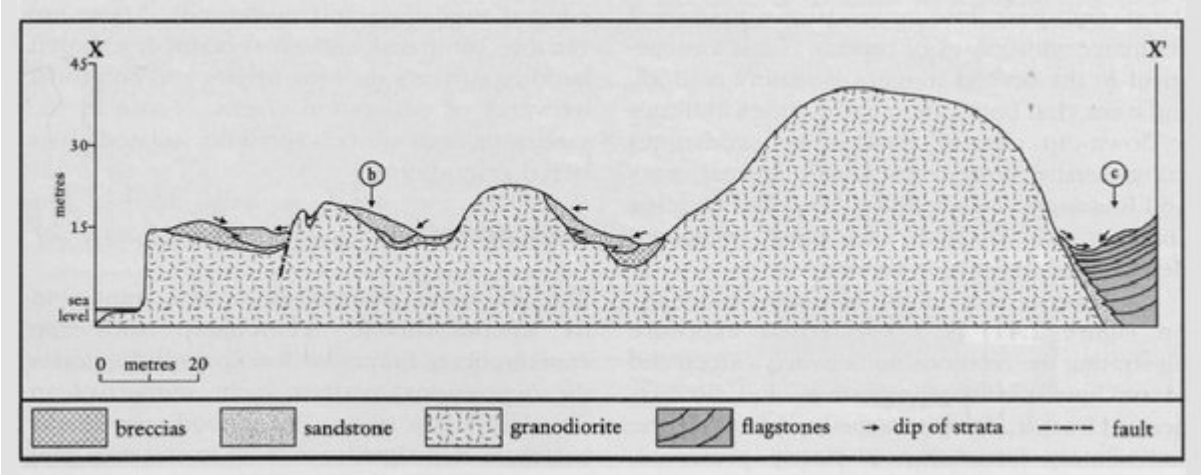
Conclusions

The Red Point GCR site exposes a unique assemblage of marginal lacustrine deposits and shows their relationships. It preserves a fragment of an Orcadian Basin lake margin, probably at the time of deposition of the earliest strata of the Upper Caithness Flagstone Group farther out in the lake and at the time of maximum lake extent in the basin. The lacustrine strata rest unconformably on a basement of red granodiorite with a visible topographic relief exceeding 30 m. Exceptional features of the site are the shallow-water limestones and coarse breccia tongues of possible beach origin. These pass laterally into high-energy, probably fluvial sandstones with clast-imbricated breccia lenses, and lacustrine mudstone-sandstone laminites. The latter display wave-generated ripples and polygonal desiccation crack networks, a combination that is strongly suggestive of a playa-lake environment. Overall, the Red Point site is critically important to an understanding of the palaeogeography of the Orcadian Basin and provides a unique insight into its lake margin environments.

References

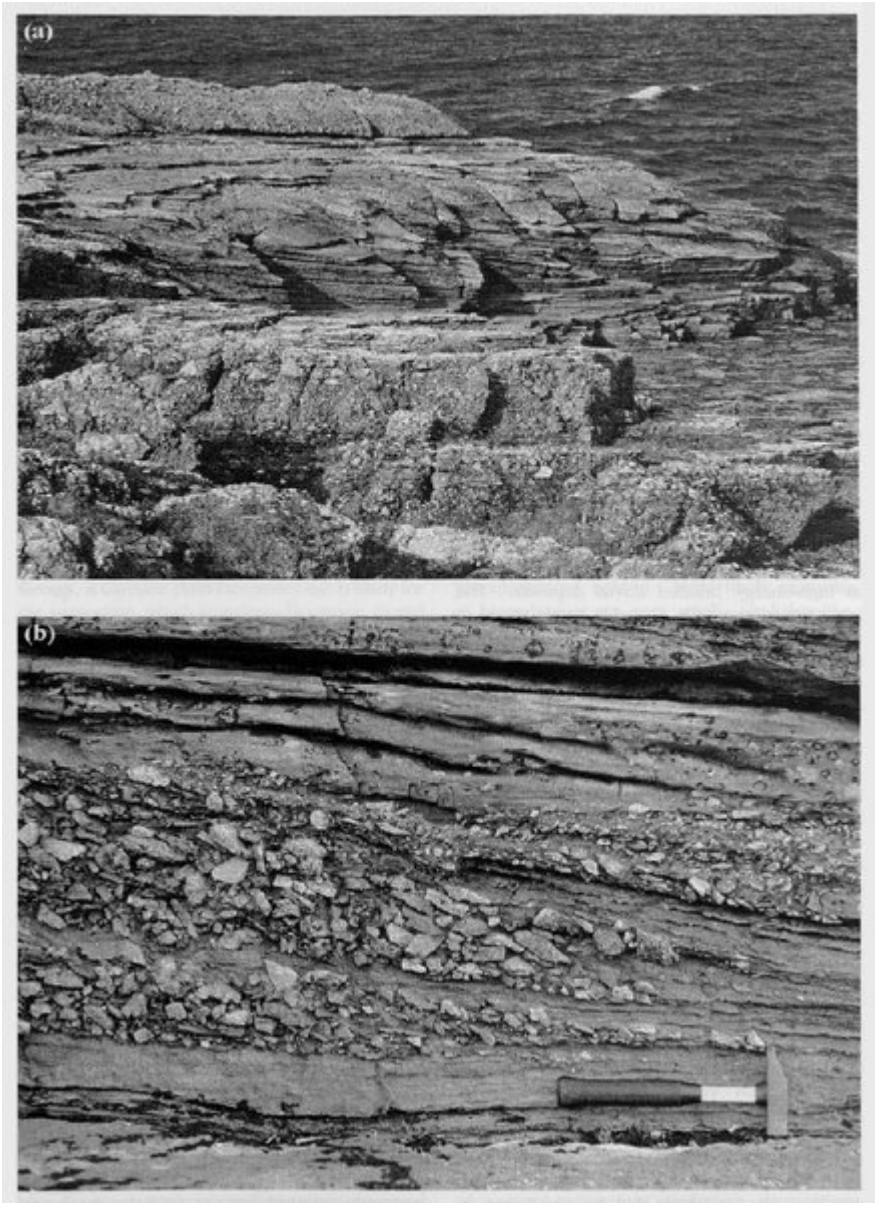


(Figure 2.41) Locality map of the Red Point area. Based on Donovan (1975) and Trewin (1993).



(Figure 2.42) Cross-section of Red Point area to illustrate basement margin features. Based on Donovan (1980) and Trewin (1993).

(Figure 2.43) Coarse breccia of basement and limestone clasts in a sandy matrix, overlying massive limestone, Red Point. (Photo: P. Stone.)



(Figure 2.44) Breccia tongues interfingering with sandstone. (a) General view; (b) detail. (Photos: P. Stone.)