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Field Meeting Report: Glacial Landscapes around Llangadfan, Powys, led by Andrew Jenkinson and David Pannett, 16th May 2009

Andrew Jenkinson[1], David Pannett[2], Geoffrey Thomas[3] and Michael Rosenbaum[4]

JENKINSON, A., PANNETT, D., THOMAS, G.S.P. & ROSENBAUM, M.S. (2009). Field Meeting Report: Glacial Landscapes around Llangadfan, Powys, led by Andrew Jenkinson and David Pannett, 16th May 2009. *Proceedings of the Shropshire Geological Society*, **14**, 42–46. The relation between bedrock geology and landscape has been demonstrated, considered and discussed along the valley of the Afon Banwy, between Llanfair Caereinion and Llangadfan, Powys. The Ordovician-Silurian turbidite bedrock has been folded into two broad synclines separated by an anticline, partially offset by NW-SE trending faults. The distribution of weak and strong sedimentary beds has controlled the etching by erosion of an ancient land surface, widely developed throughout central Wales. This basic landscape has been modified by a series of Quaternary ice ages and their aggressive glacial and periglacial weathering regimes.

[1]*Llety Mawr, Llangadfan, Powys. E-mail: andrew@scenesetters.co.uk*
[2]*Bicton, Shropshire. E-mail: jessicapannett@hotmail.co.uk*
[3]*Bayston Hill, Shropshire. E-mail: thoma@liv.ac.uk*
[4]*Ludlow, Shropshire. E-mail: msr@waitrose.com*

INTRODUCTION

The field excursion, led by Andrew Jenkinson and David Pannett, met at the car park besides the light railway station at Llanfair Caereinion on May 16th, 2009 [SJ 106 068]. The purpose was to enable members to consider the relation between bedrock geology and landscape, focussing particularly on the glacial features exhibited in the country between Llanfair Caereinion and Llangadfan, along the valley of the Afon Banwy which flows northeastwards to join the River Vyrnwy.

There has not been a systematic mapping of the geology of this area since the mid Victorian survey by the Geological Survey of Great Britain (1855), although it should be noted that its successor, the British Geological Survey, is currently engaged in a major revision to this Sheet. A number of specialist academic studies have meanwhile been undertaken of adjacent areas, notably by Jones and Pugh (for example, Jones, 1955).

Studies of the Quaternary processes and deposits are equally sparse. The most recent compilation is the volume edited by Lewis & Richards (2005), whose papers demonstrate the state of flux concerning our understanding of Quaternary events in this region by comparison with its predecessor published 35 years earlier (Lewis, 1970). Indeed, the importance of the role of glaciers in shaping this landscape had only been first fully appreciated just over a century earlier (Ramsay, 1860).

Recent work has focussed on the margins of the more recent ice sheets (e.g. Thomas, 2005; Richards, 2008) and on the broad glacial setting, particularly through the implications of thermal modelling (Jansson & Glasser, 2005).

The seminal work of Eric Brown (1960) set the scene for the excursion, notably his summaries of the topography (revealing the high level planar surface extending over much of the region) and the broad geological framework, notably the NE-SW Caledonian trend.

GEOLOGICAL SETTING

The general geology of the Welsh Basin is described in the recently published British Regional Geology for Wales (Howells, 2007). The bedrock of the country between Llanfair Caereinion and Llangadfan is dominated by Silurian turbidites now revealed as slightly cleaved mudstones occasionally grading up into sandstones. A zone of coarser clastic sediments (Penstrowed Grit Formation) is expressed as a prominent ridge, Mynydd Waun Fawr, striking SW-NE through the area, including the prominent peak of Moel Bentyrch. The bedrock age ranges from Ordovician (Ashgill) up to Silurian (Wenlock), folded to form broad SW-NE trending folds: a pair of synclines (centred on Llanfair

Caereinion to the east and Llangadfan to the west) with an anticline between, partially offset by NW-SE trending faults. Current mapping by the BGS of Sheet 150 (Dinas Mawddwy) (Schofield, 2009) is enabling the stratigraphy to be tied in to the newly established succession exposed in Sawdde Gorge to the south of the central Wales basin (Schofield *et al*., 2009).

The extensive planar surface noted at higher elevations by Brown (1960) could be readily appreciated from the viewpoint at the top of Mynydd Waun Fawr (Locality 5, see below). However, the reason(s) it developed and its age is not so clear. Some believe this is the result of relatively recent denudation, perhaps just prior to the Quaternary Ice Age (Maddy *et al*., 2000), others feel it dates from the early Tertiary, for instance when there was significant uplift prior to the rifting and separation of the North American continent from Europe (Cope, 1994), or even further back when there was perhaps an extensive cover of Cretaceous sediments (?possibly the chalk) (Stahan, 1902); others believe it could even date back to as long ago as St George's land, the zone of elevated ground that separated the marine Carboniferous basins in which extensive deposits of limestone accumulated some 360 million years ago.

Opinions are strongly presented within the specialist literature, but all suffer from a paucity of hard evidence. For instance, there is no trace of any chalk within Wales. Nevertheless, there are traces of deep lateritic weathering at high elevations around the margins of central Wales (for instance in the Clee Hills of Shropshire and the Carboniferous Limestones of Flint and Derbyshire) which are suggestive of exposure during periods of considerably warmer climatic conditions than at present, and a subsequent lack of erosion sufficient to have removed this evidence.

More recent geology is controversial too. How the glacial ice evolved is far from clear. The widespread distribution of moraine across central Wales indicates extensive ice coverage but, unfortunately, systematic mapping by the BGS has not yet resulted in published details of provenance. The tendency thus far has been to map glacial deposits simply as "boulder clay" (a term now superseded by "glacial till"), although it is hoped that the mapping currently in progress will help redress this situation.

Glacial modelling (Jansson & Glasser, 2005) suggests a complex sequence of ice development and retreat has taken place. The nature of any evidence is further complicated by the character of the ice itself. To main types of ice can develop: "cold" ice which is frozen onto the ground, and "temperate" ice which can co-exist with water. The latter can move much more freely and can rapidly develop extensive erosion. In contrast, cold ice tends to preserve the pre-existing landscape and deposits. However, glacial ice changes its character as it grows and wanes, with temperate ice beneath the interior of larger ice bodies (largely due to trapping geothermal heat) and cold ice further out. The margins may well see a return to temperate ice, facilitated by the latent heat released by the ingress of summer meltwater.

Whether glacial deposits are laid down and, if they are, whether they get preserved, will therefore depend on a number of interrelated factors, making it difficult to reach broad conclusions that apply throughout an area such as the one studied during this field excursion. However, clues do exist, and these are now outlined in the localities that were visited, travelling generally westwards.

LOCALITY 1: Brynglas Hall [SJ 088 094]

General roadside view westwards towards the prominent ridge of Moel Bentyrch, comprising Silurian sandstone of the Penstrowed Grit Formation.

Gaps in the ridge host the present-day river, the Afon Banwy, to the WNW (right), and west to a dry gap through which the main A458 road runs.

LOCALITY 2: Pencommins [SJ 081 101]

Roadside view of thickly bedded Silurian sandstone of the Penstrowed Grit Formation westwards, towards the right (Moel Bentyrch), with the core of the anticline in front (to the east), comprising largely Late Ordovician (Ashgill) mudstones. Although the line of the ridge ends abruptly, there is no indication of faulting shown on the current Geological Survey mapping.

The landscape of the anticline has been sculpted to reveal a classic drumlinoid field. Characteristically streamlined hills some hundreds of metres long, tens of metres wide and metres high cover the whole area, their shapes indicating glacial ice movement from WSW towards ENE. This is consistent with lineations detected on

remotely sensed imagery by Jansson & Glasser (2005).

LOCALITY 3: Llanerfyl [SJ 035 103]

Roadside view of a wide river valley, although its width downstream is constricted as it flows through a rock gorge to the east. Such lozenge-shaped valleys are characteristic of central Wales, often associated (as here) with distinct valley-side terraces. Their formation is thought to be initially due to over-deepening by glacial ice followed by choking with fluvioglacial sediments. Sometimes there is evidence of lake sediments, frequently varved, followed by clastic accumulations as deltas were deposited by rivers flowing into the lakes, subsequently filling them up completely.

Incision of the former lake sediments by the river followed during Holocene times, creating the distinctive terraces seen today. Their stratigraphy sometimes reveals a close correlation with anthropogenic activity, related to land clearance and agricultural practice from prehistoric times up to the present day (Figure 1).

Figure 1. Terraces alongside the Afon Banwy. Note the gravel and boulders in the river bed, indicative of fluvioglacial deposition rather than by the present-day river.

LOCALITY 4: Ffridd-y-Drum Forest [SJ 047 095]

The car park for forest visitors reveals a small exposure of cleaved Silurian mudstone. This demonstrates soil creep, probably caused by periglacial weathering as movement developed of waterlogged surface soil melted by summer thaw above bedrock frozen by permafrost. Slow downhill movement dragged with it shallower bedrock, creating a distinctive downhill curvature to the cleaved rock fragments (Figure 2).

Figure 2. Distinctive downhill curvature to cleaved Silurian mudstone fragments caused by soil creep, Ffridd-y-Drum.

The valley floor does not contain a river at the present day although clearly it once hosted a major water course (Figure 3). This may possibly have been initiated as a subglacial river channel or may have been developed as an ice-marginal feature, probably as the glacier "retreated", i.e. wasted away.

Drainage is still poor, and the valley hosts a medium-sized bog of relatively recent age.

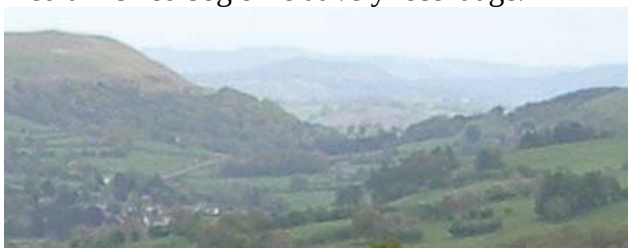

Figure 3. View looking east through the gap at Ffridd-y-Drum, where the main A458 road cuts through the escarpment of thickly bedded Silurian sandstone of the Penstrowed Grit Formation.

LOCALITY 5: Viewpoint above Glynbach [SJ 025 076]

The mountain road leads south past Glynbach and up to the top of the ridge of Mynydd Waun Fawr. This yields a good vantage point from which to appreciate the widespread planar surface of upland central Wales and to consider the relative merits of the theories concerning its origin, age and subsequent development (summarised in the introductory paragraphs, above).

LOCALITY 6: Tynewydd [SJ 025 098]

Roadside view of the Afon Banwy clearly showing a series of terraces and abandoned river channels. The debris associated with land clearance by Man is manifested as terraces along

the valley sides. It may be noted that the sediment infilling the abandoned river channels would form good targets for pollen analysis to support study of the more recent phases of valley evolution.

LOCALITY 7: Llety Mawr [SH 988 102]

General views across the valley south and west from the farm reveal a series of well preserved late glacial landforms.

Towards the top of the facing hillside of Pen Coed may be seen half a dozen nivation hollows [SH 987 093]. These are locations where snow fields gradually eroded the bedrock at their base creating shallow hollows that are now poorly drained (Figure 4).

Figure 4. Three nivation hollows along the side of Pen Coed, looking south-southwest from Llety Mawr.

Across the main valley floor of Nant Nodwydd [SH 980 094] is a series of low banks that appear to have been deposited at right angles to the trend of the valley. These are thought to be retreat moraines deposited as the valley glacier waned for the last time. It is unusual for such features to survive subsequent erosion and destruction by Man through farming practise, so this exposure is of particular interest (Figure 5).

Figure 5. Retreat moraines (the largest of which is in the centre of the valley; there are several apparently smaller ones behind, further up the valley) revealed as grass humps transverse to the line of the valley floor of Nant Nodwydd, looking southwest from Llety Mawr.

Further evidence for the presence of glacial ice is in the form of sediment-choked fractures sub-parallel to the ground surface revealed in a small quarry to the west of the farm [SH 985 100]. These may well be glacier fluid injection features (Figure 6).

Figure 6. Glacier fluid injection features exposed in small quarry west of Llety Mawr.

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Disclaimer - The information contained in this account has been prepared following a summary of the geological literature of the area and visits to all the locations described. Its sole aim is to provide a record of what was seen and provide an insight into its geology. It should not be used for any other purpose or construed as permission or an invitation to visit the sites or localities mentioned.

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