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# Ty Mawr

[SH 815 681]–[SH 823 685] and [SH 824 679]

Potential GCR Site

## Introduction

The Denbigh Moors region is underlain entirely by Silurian sediments; to the north and east it is surrounded by Carboniferous rocks, and to the south and west by the Ordovician. The Silurian is mostly of Wenlock or Ludlow age, though Llandovery strata are also present on its southern and western flank. Above the eastern side and at the southern end of the Conway Valley, about 6 km north of Llanrwst, there are two small headwater streams which unite immediately south of the farm at Ty Mawr to form an unnamed tributary which flows west into the Afon Hiraethlyn. Upper Wenlock (Homerian) through to lower Ludlow (Gorstian) strata, beds of the Lower and Upper Nantglyn Flags groups respectively, are exposed in the bed and along the banks of this tributary and its headwaters, which together form the Ty Mawr site.

Work on the Silurian of this general region of north Wales can be traced back to Bowman (1838, 1841a), but Sedgwick (1843a) provided the first reasonably full account of the rocks here. Other important 19th century contributions were those of the British Geological Survey, who (1850) published maps and (Ramsay, 1866, 1881) memoirs on the area. The next major period of investigation into the Silurian of the Denbigh region dates from the work of Boswell, who researched this theme intensively between 1921 and 1961, producing 19 publications on it, most notably his book of 1949 in which he referenced all previous work on the subject. Jones (1937, 1940, 1943) was particularly interested in the origin of the Silurian slumped horizons in the district. The Silurian sediments there were then addressed by Cummins (1957, 1959a, b), who determined their petrography and provenance. The most comprehensive, significant and recent work on the Silurian geology of the Denbigh area is the detailed account and accompanying maps of Warren *et al.* (1984). Slightly earlier, Holland *et al.* (1969) and Warren (1971) presented data on the graptolite biostratigraphy of the district.

McKenny Hughes (1879, 1885, 1894), who worked on the Silurian of the adjacent Vale of Clwyd area, may be said to have introduced the term Nantglyn Flags (Warren *et al.*, 1984). Boswell (1926) divided these rocks into a lower and an upper part, the latter including only the Nantglyn Flags of the type area and their correlatives (lower *nilssoni* Biozone), to which in his *magnum opus* (1949) he restricted the term. Warren *et al.* (1984) failed to justify a lithological division of the Nantglyn Flags, but on chrono- and biostratigraphical grounds they found it convenient to subdivide the sequence into upper and lower groups at the base of the *nilssoni* Biozone. They also recognized several formations within the lower group, and within both upper and lower groups noted several disturbed beds.

That part of the Lower Nantglyn Flags Group exposed at the Ty Mawr site is of *lundgreni* to *ludensis* Biozone age and includes the Upper and Lower Mottled Mudstone formations together with the Brynsylldy Formation — an uppermost Wenlock, disturbed unit (Figure 4.55). The site is principally important for indicating the nature of some of the sediments and the fauna of Wenlock age of the Denbigh Trough, a major depositional area in the offshore part of the Welsh Basin during this time.

## Description

Boswell (1949), Holland *et al.* (1969) and Warren *et al.* (1984) all provided data specifically on the geology of the Ty Mawr stream section. In the Denbigh area overall, the thickness of the Lower Nantglyn Flags Group ranges from about 325 m to an estimated maximum of 660 m, with the Lower and Upper Mottled Mudstone formations being 12–76 m and 12–64 m thick respectively. In the general area of Ty Mawr, the group is about 600 m thick.

The stratigraphically lowest horizons of the site — measures of the Lower Nantglyn Flags Group of *lundgreni* Biozone age beneath the Lower Mottled Mudstone — occur in the lower part of the tributary which flows into the Afon Hiraethlyn. These beds consist largely of ribbon-banded mudstones, a lithology comprising a regular alternation of three elements:

silty mudstone bands, laminated muddy siltstone bands, and thin, locally developed calcareous siltstones. The silty mudstone bands are tough, poorly fissile, blue-grey rocks that weather to brown; they lack sedimentary structures and fossils. The laminated muddy siltstones are of the same colour but they are coarser grained, the silt fraction being mainly quartz, and they are relatively carbon-rich and yield graptolites. The calcareous siltstones are generally lenticular, show load-casts, have graded bases and sharp tops, may display cross-bedding and weather deeply, changing from a pale grey to a yellow ochre colour. Calcareous concretions are characteristic of the ribbon-banded mudstone lithology.

The succeeding Lower and Upper Mottled Mudstone formations and intervening beds, which together are of *nassa to ludensis* Biozone age, crop out to the south and south-east of the farm at Ty Mawr. The mottled mudstone beds are massively bedded silty mudstones (coarser grained than the silty mudstones of the ribbon-banded mudstones), with mottling. They consist of patches of pale and darker grey-green siltstone–mudstone. The paler patches consist mainly of silt-grade quartz; the darker patches of fine-grained clay material. Characteristic weathering features of the mottled mudstones are a pale brown colouration with veinlets of iron, and an irregular fracturing. One set of fractures is sub-parallel to bedding, another set approximately normal to bedding. This gives rise to beds composed of phacoidal masses averaging 2–5 cm thick and 15–23 cm across. Small calcareous concretions are present, and shelly fossils occur sporadically, with evidence of bioturbation also. Both Mottled Mudstone units include, in addition to the dominant mottled mudstone lithology *sensu stricto*, calcareous siltstone, dark grey mudstone and silty mudstone, and ribbon-banded mudstone components.

The intervening beds between the Mottled Mudstone formations consist of ribbon-banded mudstones that produce graptolites.

Beds of the Lower Nantglyn Flags Group above the Upper Mottled Mudstone Formation, which are of *ludensis* Biozone age, occur in the two headwater streams to the north-east and south-east of Ty Mawr. The southerly of the two headwaters exposes 4.5 m of the Brynsylldy Formation. This unit, along strike, lensing out to the north but continuing to the south as a resistant, feature-forming horizon. With the exception of the Brynsylldy Formation, which consists of disturbed silty mudstones, this part of the sequence is entirely one of ribbon-banded silty mudstones, with graptolites.

Graptolites from the Ty Mawr section have been used, in part, to compile species range charts for the Wenlock of the Denbigh area and north Wales (Holland *et al.*, 1969; Warren, 1971; Warren *et al.*, 1984).

Corfield *et al.* (1992) have recently sampled the Ty Mawr section for whole rock isotope analysis, which indicated a very weak  $\delta^{13}\text{C}$  decline across the Wenlock–Ludlow boundary.

## Interpretation

The Denbigh Trough, elongated approximately east–west, is one of two main areas in the more distal part of the Welsh Basin to have had significant sediment input during the Wenlock, the other being the approximately NNE–SSW aligned Montgomery Trough.

The following interpretation of the sediments of the Ty Mawr site is that of Warren *et al.* (1984). The ribbon-banded mudstones were deposited by weak turbidity currents (the silty mudstones), far travelled turbidity currents (calcareous siltstones) and turbid suspensions (laminated muddy siltstones) in a relatively shallow water environment, in the main devoid of oxygen. The calcareous siltstones of this lithological type possibly had a southerly derivation source, with the silty mudstones and laminated muddy siltstones probably being derived from a land mass located to the west, in a position occupied at the present day by the Irish Sea. Thus there was both axial and lateral sediment input.

The various elements of the irregular mottled mudstone (calcareous siltstone, silty mudstone, dark mudstone) can be seen as bands either within the mottled mudstone units or the adjacent ribbon-banded mudstones. Such bands probably give rise to the mottled divisions as witnessed by ghost bands of dark mudstone. The calcareous siltstone bands in the mottled mudstones are, as in the ribbon-banded mudstones, thought to have been derived from turbidity currents that have travelled long distances. However, the darker mudstone element of the mottled mudstones, which was probably derived from turbidity currents, is relatively rich in carbonaceous matter and so possibly had a more proximal origin.

There are many disturbed horizons in the Silurian of the Denbigh area and their genesis has been the subject of much historic debate (Boswell, 1932, 1949, 1953; Jones 1937, 1940, 1943). Warren *et al.* (1984) supported the generally accepted view, put forward by Jones, that such deposits represent the result of penecontemporaneous slumping or sliding across the sea floor. They also concluded that the general sense of movement of the Silurian slumps, including that of the Brynsylldy disturbed bed, was from west to east within an E-W 'trough'. This was in contrast to Jones' view, who believed the movement to have been from north to south.

The distinctive lithologies of the mottled mudstone and disturbed bed horizons enable stratigraphical control and correlation on a local basis, thus supplementing that achieved by means of the graptolites, which in the upper Wenlock rocks of the region allow correlation with the Welsh Borderland and areas farther afield in central and eastern Europe (Warren, 1971). A notable feature of the shelly fauna from the mottled mudstones (and to some extent from the ribbon-banded mudstones adjacent to them) from within the Denbigh region in general, is that there are several species, for example *Bractoleptaena bracteola*, which are unknown in the Welsh Borderland but which are present in approximately coeval horizons in Bohemia and Scania. The trilobite fauna of the Mottled Mudstone formations has elements in common with other contemporaneous offshore locations in the UK (for example the Long Mountain, Builth and the Lake District), and with Scania and central and eastern Europe (Thomas, 1978, 1980, 1981; Thomas *et al.*, 1984).

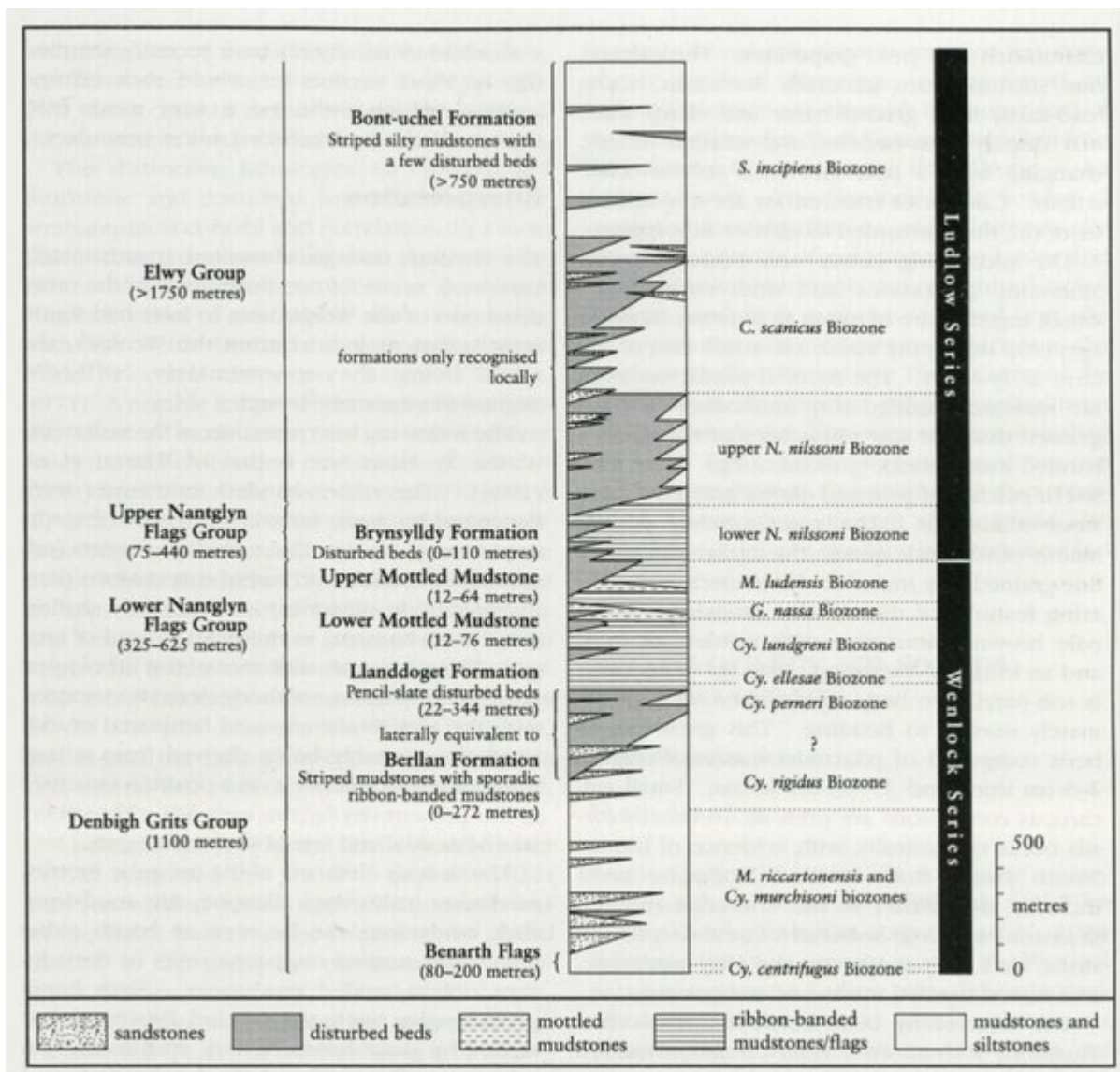
Corfield *et al.* (1992) and Corfield and Siveter (1992) suggested that the  $\delta^{13}\text{C}$  depletions that they recorded in various upper Wenlock sections in the Welsh Basin may be related to the global decline in the graptolite plankton after *lundgreni* Biozone times.

The Ty Mawr site is networked most closely to Penstrowed Quarry in the Newtown area of central Wales, where lower Wenlock turbidites of the Denbigh Grits Group deposited within the Montgomery Trough are exposed. In contrast to the deposits of that group, the younger sediments of the Lower Nantglyn Flags were deposited, overall, during a period of relatively quieter sedimentation. The Mottled Mudstone formations show similarity to the Glyn Member of the Trewern Brook Mudstone Formation, Trewern Brook site, Long Mountain area: both are late Wenlock, relatively carbonate-rich mudstone horizons in offshore, respectively basin and slope, settings.

## Conclusions

This site is important for indicating the nature of late Wenlock sediments and fauna from an offshore location within the Welsh Basin — the Denbigh Trough. It shows a more or less completely exposed sequence, of *lundgreni* to *ludensis* Biozone age, through the upper part of the Lower Nantglyn Flags Group, extending into the overlying Upper Nantglyn Flags Group of the Ludlow Series. The Wenlock rocks consist of mudstone, muddy siltstone and calcareous siltstone. Two bands of mudstone, the Lower and Upper Mottled Mudstone, are recognized as formations, and there is also a disturbed unit, the Brynsylldy Formation, the top of which is at the Wenlock–Ludlow boundary. The majority of the sediments in the sequence were deposited from relatively weak turbidity currents; the disturbed bed was formed by penecontemporaneous slumping or sliding. Graptolites are characteristic of the sequence, though shelly fossils also occur, particularly in the Mottled Mudstone formations.

## [References](#)



(Figure 4.55) Stratigraphical section of Wenlock and Ludlow strata, Denbigh Region, north Wales (after Warren et al., 1984).