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## Chapter 4 The Wenlock Series

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### Introduction

The second series of the Silurian System, the Wenlock Series, takes its name from the Wenlock area in Shropshire, which includes the small town of Much Wenlock and Wenlock Edge. Bassett *et al.* (1975) undertook the important stratigraphical revision of this ground that provided the basis for its formal acceptance as the type area. The historical background concerning the decisions by the Silurian Subcommittee of the International Commission on Stratigraphy, which concluded with the international ratification of the Wenlock as the second series (Martinsson *et al.*, 1981), has been fully documented by Holland (1989).

Murchison (1833) was the first to use the term 'Wenlock' in a stratigraphical context, when he referred to the Wenlock Limestone occurring in the region of Wenlock and Wenlock Edge. A year later (1834) he introduced the term 'Wenlock Shale'. Shortly afterwards he employed both these terms again, firstly when he (1835) presented in outline his Silurian System, and then in his (1839) *magnum opus* on the rocks and fossils of this period. Since the publication of *The Silurian System*, the name 'Wenlock' has been virtually universally used to refer to strata of this interval of time in Earth history. The Salopian of Lapworth (1880a), a stratigraphical term introduced for strata of Wenlock and lower Ludlow age, has long been abandoned (see Cocks *et al.*, 1971). Further comment on the historical usage of the term 'Wenlock' can be found in Whittard (1961), Bassett (1974a, 1989a), Bassett *et al.* (1975), and D.A. Bassett (1991).

The Wenlock Series contains two stages, the Sheinwoodian and the Homerian. The basal boundary stratotype for the series, which is also coincident with that of the Sheinwoodian Stage, occurs at Leasows, which forms part of the Hughley Brook GCR site. The stratotype for the base of the Homerian Stage occurs at Whitwell Coppice, also a GCR site. The type area also takes in numerous sections which effectively act as body stratotypes for the series and which, too, are all GCR sites, for example Eaton Track and the Longville–Stanway Road Section.

### Occurrence

Wenlock Series strata crop out in the UK in the West Midlands of England, the Welsh Border land, Wales, the Lake District, the western flank of the Pennines and the Southern Uplands and Midland Valley of Scotland (Cocks *et al.*, 1971, 1992). Subsurface records of rocks of this age are also known from East Anglia and Hertfordshire (Woodcock and Pharaoh, 1993). In the West Midlands (Walsall–Dudley district) and throughout much of the central Welsh Borderland, these two areas comprising the main outcrop (e.g. Wenlock Edge) and inliers (e.g. Malverns, Woolhope, May Hill), many Wenlock age sequences are uninterrupted and are assumed to be reasonably complete, though full biozonal control is rare. In some of the areas within this region, for instance the Mendips and Cardiff, the upper and/or lower part of the Wenlock is missing or remains unproven. To the south-west, in Pembrokeshire, there is uncertainty as to where the Wenlock–Ludlow boundary should be drawn within the local succession. Much of central and north Wales has thick sequences of Wenlock rocks, with the Denbigh–Conway district having the most biostratigraphically refined sequence.

Wenlock sequences in the main Lake District (Coniston to Ashgill, and Windermere areas) and the Howgill Fells immediately to the east are largely complete, but the Horton-in-Ribblesdale and particularly the Cross Fell (Pennines) inliers have breaks in the succession, with Cross Fell, additionally, lacking deposits of Homerian age.

The Southern Uplands as a whole has a fairly full Wenlock succession, with only the youngest, post *lundgreni* Biozone horizons being unrepresented. Of the many Silurian inliers present in the Midland Valley of Scotland, those of Lesmahagow, the Hagshaw Hills, Carmichael, and the Pentlands all contain presumed Wenlock strata, though the age constraint on many of these sequences is often found wanting due to their essentially non-marine nature. The Girvan district includes provable Wenlock (Cocks and Toghill, 1973; Dorning, 1982) and, also, does the Stonehaven area (Marshall, 1991), the Silurian deposits of the latter being regarded until recently as Pídolí in age.

## Palaeoenvironmental setting

The Wenlock deposits of the UK were laid down in several major sedimentary basins and associated platform areas (Chapter 1, (Figure 4.1) herein; Bassett, 1974a; Hurst *et al.*, 1978; Siveter *et al.*, 1989; Holland, 1992). The West Midlands and Welsh Borderland inliers, together with the Wenlock and Ludlow districts and the southern Wales (Cardiff) and Pembrokeshire areas, were all variously situated during this time on some part of the shelf associated with the Midland Platform or on the shoreline area of the Welsh Basin. Central Wales was the site of the deeper part of this basin, which was dominated during this period by the Montgomery and Denbigh troughs. The deposits of the Anglian Basin on the north-east side of the Midland Platform have been related to those of similar age in the Ardennes and Brabant massifs in Belgium (Pharaoh *et al.*, 1987). The Lake District Basin occupied an offshore area to the north-west of the Midland Platform. The Welsh, Anglian, and Lake District basins are all associated with eastern Avalonia, whereas Wenlock rocks of the Southern Uplands of Scotland were deposited to the north of the Iapetus Suture. The sediments of the Midland Valley of Scotland are, in the main, indicative of non-marine environments, though shallow marine conditions persisted into the early Wenlock in the Girvan area.

The Wenlock Epoch saw the development of a wide range of elastic and carbonate facies. In the Anglo-Welsh region limestones predominated during the early and, in particular, the late Wenlock in the shelf areas to the west and southwest of the Midland Platform, that is the West Midlands and the Welsh Borderland areas. Carbonate mud deposition prevailed during mid-Wenlock times in the same areas, which were mostly characterized by shelly faunas. Siltstones and sandstones are typically present adjacent to the south and south-west margin of the Welsh Basin, as evidenced by sites in Tortworth, Cardiff, and Pembrokeshire. In the deeper, central parts of the Welsh Basin, turbidites and hemipelagites were deposited, and associated there with the planktonic graptolites. Some areas on the upper slope region, around Builth and the Long Mountain for example, show a more mixed facies and fauna: muds and graptolites together with carbonates and shells. Algal limestones developed on offshore topographical highs of Precambrian rocks in Radnorshire. Mudstones and to a lesser degree turbiditic sands characterize the Lake District Wenlock, whilst in the Southern Uplands deep marine turbidites are preponderant. The early onset of non-marine conditions in the Midland Valley at this time produced red beds — conglomerates, sandstones and siltstones — which are notable for their early fish fauna. Red beds of possible uppermost Wenlock age are also found in Pembrokeshire. Volcanic rocks are poorly developed with the exception of the Mendips area and, elsewhere in the British Isles, in the Dingle Peninsula, south-west Ireland.

In the Welsh and Lake District basins at least, in terms of sea-level change the Wenlock represents a transitional period between the flooding that occurred during the Llandovery transgression (this rise is manifest in the Southern Uplands and Midland Valley sequences of this age too), and the regressive and final silting-up phase of these basins through the Ludlow and into the Pridoli. This basin filling and the formation of red beds generally are associated with the closure of the Iapetus Ocean.

## Biostratigraphy

Wenlock strata in the UK are in general very fossiliferous. Historically the biozonal scheme for subdividing the Wenlock was established on the basis of graptolites from the Welsh Borderland, mainly those from the Builth and Long Mountain districts (Elles, 1900; Wood, 1900); this has since been refined (see Rickards, 1976, 1989b; Bassett *et al.*, 1975; Bassett, 1989a; Chapter 1 herein), and remains that most widely applied for strata of this age both here and abroad. Other groups, particularly of microfossils, have proved useful in adding to the biostratigraphical framework at certain levels or in particular sedimentary facies. For example, the conodont, ostracod, foraminiferan, chitinozoan, and acritarch distribution across the Llandovery–Wenlock boundary interval of the type section has been determined (Mabillard and Aldridge, 1982, 1985), and the biostratigraphy of non-palaeocene ostracods of the type Wenlock area has been documented (Lundin *et al.*, 1991), as has that of certain ostracods through the British Wenlock in general (Siveter, 1978). Discussion of all fossil groups that have biostratigraphical use in the type Wenlock area has been provided by Bassett (1989a). Palynomorphs are particularly useful in dating red bed sequences, and sometimes they can also be put into a biozonal context, such as in the study of sporomorphs from the Silurian inliers of the Midland Valley of Scotland (Wellman and Richardson, 1993), which microflora also shows remarkable similarity with the one from the early Wenlock of the type

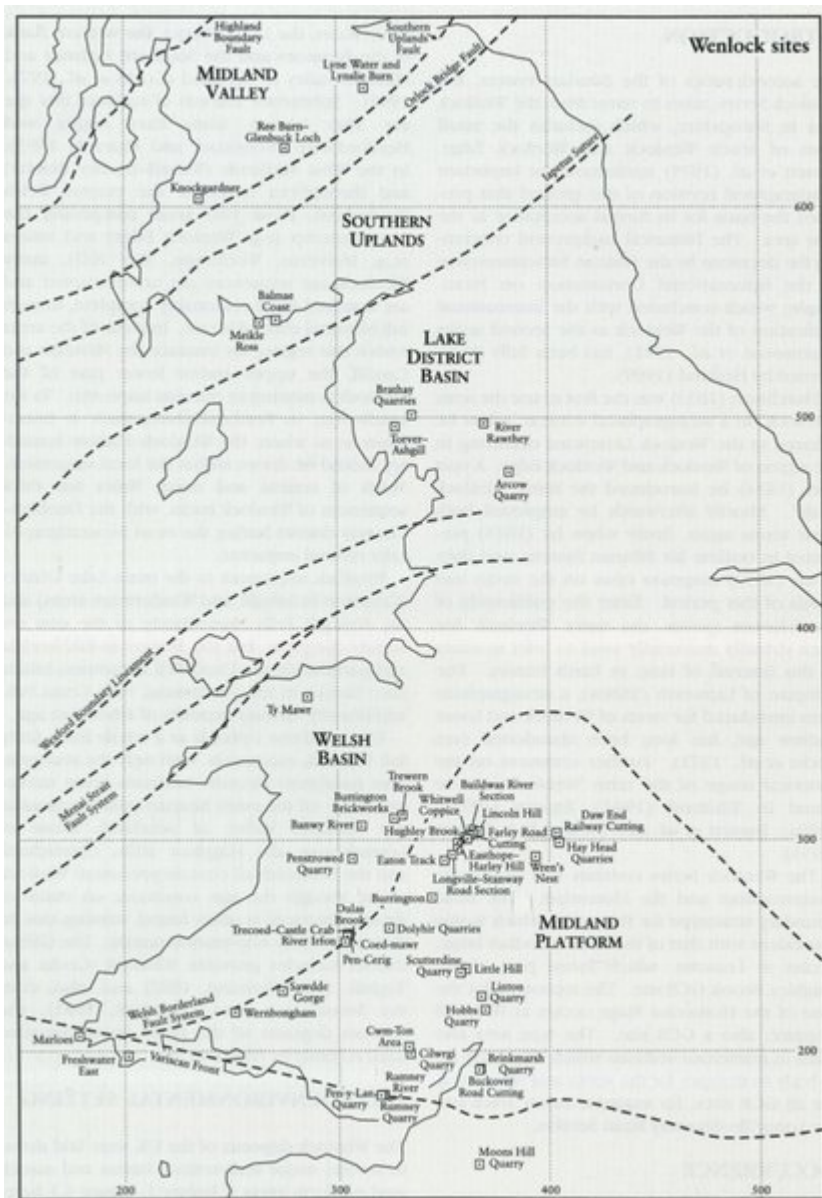
area (Burgess and Richardson, 1991). Thus correlation of Wenlock strata can sometimes be direct, or is sometimes achieved by a chain of correlation using several fossil groups by way of geographically intermediate sequences.

## **Site selection**

Most of the GCR sites described here were listed over several decades through the work of the former Nature Conservancy Council as part of the Geological Conservation Review that it instigated. During assessment for this volume, a few of the original GCR sites have been found wanting and omitted, whilst a small number of others have been proposed. Inevitably, some of the sites of Wenlock age encompass Llandovery and/or Ludlow rocks and, occasionally, Pridoli strata as well. The rocks of these other series may form the basis for independent site listing and description in this volume, such as the Ludlow of the Sawdde Gorge section. Where a Wenlock section is continued into deposits of a different series which are less significant, often brief mention is given of the latter in the Wenlock site description, for the sake of completeness.

Several criteria have determined site selection (see Chapter 1), and sometimes sites have been found worthy of inclusion for more than one criterion. The primary reason for selection has been to cover, through the GCR network system, all of the main palaeoenvironments and palaeogeographical and stratigraphical aspects of Wenlock strata that crop out in the UK. Shoreline and platform to basin centre sites are covered for the Welsh Basin. The sites in the Lake District provide adequate facies and stratigraphical coverage, as do those for the Southern Uplands and the Midland Valley. Network coverage has taken into account the international importance of sites in the Wenlock Edge area to Wenlock stratigraphy. Sites significant for historical reasons include, for example, that at Buildwas, which traditionally acted as the unofficial type section for the Llandovery–Wenlock boundary. Palaeontological sites of importance include several in the Builth area, which were used in the establishment of the Wenlock graptolite succession, and Dudley (Wren's Nest) in the West Midlands, which has a worldwide reputation for yielding numerous and various invertebrates of outstanding preservation. Lastly, a small number of sites have been included in the GCR to complete the network coverage that have no particularly unique features, but are necessary complementary sites, so as, usually, to have fully representative palaeogeographical coverage.

## **References**



(Figure 4.1) Distribution of the Geological Conservation Review sites for the Wenlock Series, set against the palaeogeographical elements of Silurian Britain.