Lyne Water and Lynslie Burn

[NT 1300 5626]–[NT 1380 5772]

David J. Siveter

Introduction

This site is within the SSSI named Baddingsgill Reservoir and is situated in the south-western part of the North Esk Inlier (Figure 4.72), the largest and most west of three Silurian 'windows' in the central part of the Pentland Hills, about 25 km south-west of Edinburgh. The inlier is surrounded by Lower and also Upper Old Red Sandstone clastic sediments and volcanics of Devonian age, its north-west margin being marked by a major fault that downthrows in the same direction. In common with other Silurian inliers in the southern part of the Midland Valley of Scotland, the North Esk Inlier has a Llandovery and Wenlock sequence and lacks upper Silurian rocks. The site itself consists of many small exposures along the north shore of Baddingsgill Reservoir and the course of Lyne Water and its tributary Lynslie Burn. The rocks included in the site belong entirely to the (Wenlock) Henshaw Formation, the youngest Silurian formation in the inlier.

Notes on the geology of the Pentland Hills were published as early as 1839, in MacLaren's account of Fife and the Lothians. The area was subsequently mapped by the Geological Survey — first by Howell and Geikie (1861) then, most notably, as a part of Peach and Horne's classic study on the Silurian rocks of Scotland (1899), and more recently by Mykura and Smith (1962). Members of the Edinburgh Geological Society have also made important contributions to unravelling the geology of the North Esk Inlier (e.g. Haswell, 1865; Brown and Henderson, 1867; Henderson and Brown, 1870). In modern times detailed collecting and high resolution mapping has produced a much clearer picture of the stratigraphy, faunal assemblages and palaeoenvironments of deposition of the Silurian of the inlier (see especially Tipper, 1975, 1976; Robertson, 1989). There are also several field guides on the geology of the Pentlands and North Esk Inlier (Mykura, 1986; Robertson, 1986; Clarkson and Taylor, 1989). Walton and Oliver (1991) reviewed the stratigraphy of the Pentlands in context with other Silurian areas in the Midland Valley. The early to mid-Palaeozoic tectonic evolution of the Silurian inliers of the Midland Valley has very recently been analysed by Phillips *et al.* (1998).

Several localities in the inlier are richly fossiliferous and many of the major groups of fossils found here, which include fish, brachiopods, bivalves, crinoids, echinoids, graptolites, trilobites, eurypterids, ostracods and microflora, have been described, at least in part. Clarkson and Howells (1981), Clarkson and Taylor (1989), and Siveter and Vannier (1990) list many of the relevant publications, added to which are the papers and other references therein of Clarkson *et* al. (1995; molluscs), Wellman and Richardson (1993; palynomorphs) and Märss and Ritchie (1998; fish).

The Silurian sequence at North Esk is almost entirely elastic and, overall, coarsens upwards, from mudstones, siltstones and silty sandstones through to dominantly sandstones and conglomerates. In establishing four formally defined lithostratigraphical divisions for the Silurian of the inlier — the Reservoir, Deerhope Burn, Wether Law Linn and Henshaw formations — Tipper (1976) replaced the more informal scheme of Mykura and Smith (1962). Subsequently, Robertson (1989) established the Cog Rig Formation in between the Deerhope and Wether Law Linn formations and divided the last of these into three members.

The exact age of the Silurian rocks of the Inlier has generated much debate, with many early authors maintaining that not only Wenlock but also Ludlow and possibly 'Downtonian' rocks are represented (e.g. Henderson and Brown, 1870; Peach and Horne, 1899). Lamont made valuable contributions (though often published privately) to our understanding of the stratigraphy and palaeontology of the North Esk Inlier. It was he (1947a, b) who first demonstrated the currently held view that the Silurian deposits here are largely of Llandovery age. The four oldest Silurian formations contain graptolites, assigned with various degrees of certainty to the late Llandovery (Telychian Stage) *Monograptus crenulata* Biozone (Bull, 1987). The Llandovery–Wenlock boundary is generally thought to approximate to, or lie slightly below, the base of the Henshaw Formation. Challenging the latter view is the occurrence of *Pterospathodus amorphognathoides* conodonts in the 'Gutterford Burn Limestone' of the Reservoir Formation (Aldridge, unpublished), which would imply that most of the

Silurian sequence of the inlier is of Wenlock age. Plant microfossils of the *?chulus-nanus* spore assemblage Biozone support an early Wenlock assignment for at least the middle part of the Henshaw Formation (Wellman and Richardson, 1993). The youngest exposed horizons of the Henshaw Formation are considered to be no younger than Wenlock.

Description

The beds at this site, as throughout the inlier, are generally steeply inclined, strike NE–SW and young to the north-west. The Henshaw Formation (minimum thickness 724 m) was divided into six divisions by Mykura and Smith (1962). It conformably overlies the marine Wether Law Linn Formation, and consists mostly of sandstones and laterally thinning conglomerates, together with greyish finer elastics that occur predominantly in its middle and upper parts (Figure 4.73). The type section of the Henshaw Formation occurs along the north bank of Baddingsgill Reservoir and along Lyne Water (Tipper, 1976); other exposures occur in Lynslie Burn and, farther north in the inlier, along the upper North Esk River and Henshaw Burn.

Fossiliferous siltstones of the Upper Member of the Wether Law Linn Formation crop out in the small stream that enters the north-east corner of Baddingsgill Reservoir (Robertson 1986, 1989). The southernmost part of the site itself, along the north shore of Baddingsgill Reservoir [NT 1300 5626], has exposures of the distinctive near basal unit of the overlying Henshaw Formation, the Igneous Conglomerate, there interbedded with thick beds of red medium-grained sandstones. This conglomerate, which contains well-rounded, haematite-stained clasts of granite, various lavas, porphyry, cherts, and quartzites, has been considered to be the lateral equivalent of similar coarse clastic horizons in other Silurian inliers of the Midland Valley; for example, the Parishholm Conglomerate of the Hagshaw Hills and the Fence Conglomerate of the Carmichael Inlier. Farther along the shore of the reservoir, towards Lyne Water, the red sandstones predominate.

Exposures in the lower reaches of Lyne water, below its junction with Lynslie Burn, also show the virtually unfossiliferous red sandstones and mud-flake conglomerates that overlie the Igneous Conglomerate. The sandstones are micaceous, ripple-marked and contain desiccation cracks.

The Henshaw Formation also contains an upper Quartzite Conglomerate (7.5 m thick), as seen for example in the North Esk River section about 2.5 km north-east of Lynslie Burn. This upper conglomerate may be a lateral equivalent of the Kirk Hill (Carmichael), Hareshaw (Hagshaw Hills) and Middlefield (Lesmahagow) conglomerates along strike to the south-west.

Above the red sandstones in Lyne Water, finer-grained sediments — olive, grey and reddish-brown shales and siltstones and fine sandstones — characteristic of the middle part of the Henshaw Formation, are exposed. The celebrated Lyne Water Fish Bed occurs in this part of the sequence, in fine grey-green laminated siltstones on the east bank of Lyne Water, about 25 m north of the sheepfold. One of Traquair's (1899) fish localities, it has yielded disarticulated and broken specimens of the fish *Birkinia elegans, Ateleaspis tessellata, Lasanius problematicus, Shielia taiti,* and *Lanarkia* spp. (Märss and Ritchie, 1998 and references therein), fragments of the crinoid *Pisocrinus campana* and *Glauconome,* a fossil of problematic affinity. Cryptospores, miospores and rare acritarchs have also been recovered from the Fish Bed horizon (Wellman and Richardson, 1993).

The red, trough cross-bedded sandstones that overlie the Fish Bed are well exposed in a strike section farther upstream in Lyne water. In Lynslie Burn, just above its junction with Lyne Water, there is another outcrop of the Fish Bed (Robertson, 1986, 1989). Some authors (e.g. Peach and Horne, 1899; Mykura and Smith, 1962) have regarded this as a separate fish-bearing horizon (the Lynslie Burn Fish Bed; see discussion in Märss and Ritchie, 1998). In the upper part of Lyne Water, above its junction with Lynslie Burn, the youngest exposed beds of the Henshaw Formation are red, trough cross-bedded sandstones. They are overlain with angular unconformity by Lower Old Red Sandstone deposits, including conglomerates.

Interpretation

The Silurian of the North Esk Inlier is generally accepted to have accumulated in one of a series of linear Silurian sedimentary sub-basins in the southern part of the Midland Valley, with land areas at times probably to the north and south. These sub-basins, which were possibly connected at various times, also encompass the Silurian deposits of the Hagshaw Hills, Carmichael, Lesmahagow Hills and the Girvan area and may have continued into Northern Ireland (e.g. Pomeroy and Charlestown areas) and south-west to County Mayo. In broad terms, the southern Midland Valley Scottish inliers show a history of early Silurian regression, in which distal turbidites are succeeded by a variety of shallow marine, mostly clastic sediments and, finally, terrestrial (alluvial) deposits. However, the particular tectonic setting of these sub-basins of deposition, on the southern margin of the Laurentian continent (see Pickering *et al.,* 1988; Pickering and Smith, 1995; Phillips *et al.,* 1998), has provoked much discussion. Leggett (e.g. 1987) envisaged that these Silurian sediments formed in an upper slope basin of deposition to the north of an emergent accretionary prism (Southern Uplands of Scotland) and associated northerly dipping subduction zone. Bluck (1984) considered that the Silurian deposits of the Midland Valley accumulated in inter-arc basins sourced mainly from the south-east. The various tectonic models are discussed by Phillips *et al.* (1998), who demonstrated that within the Midland Valley Terrane sinistral strike-slip controlled basin development, sedimentary facies distribution, and deformation from Ordovician through to, at least, early Devonian times.

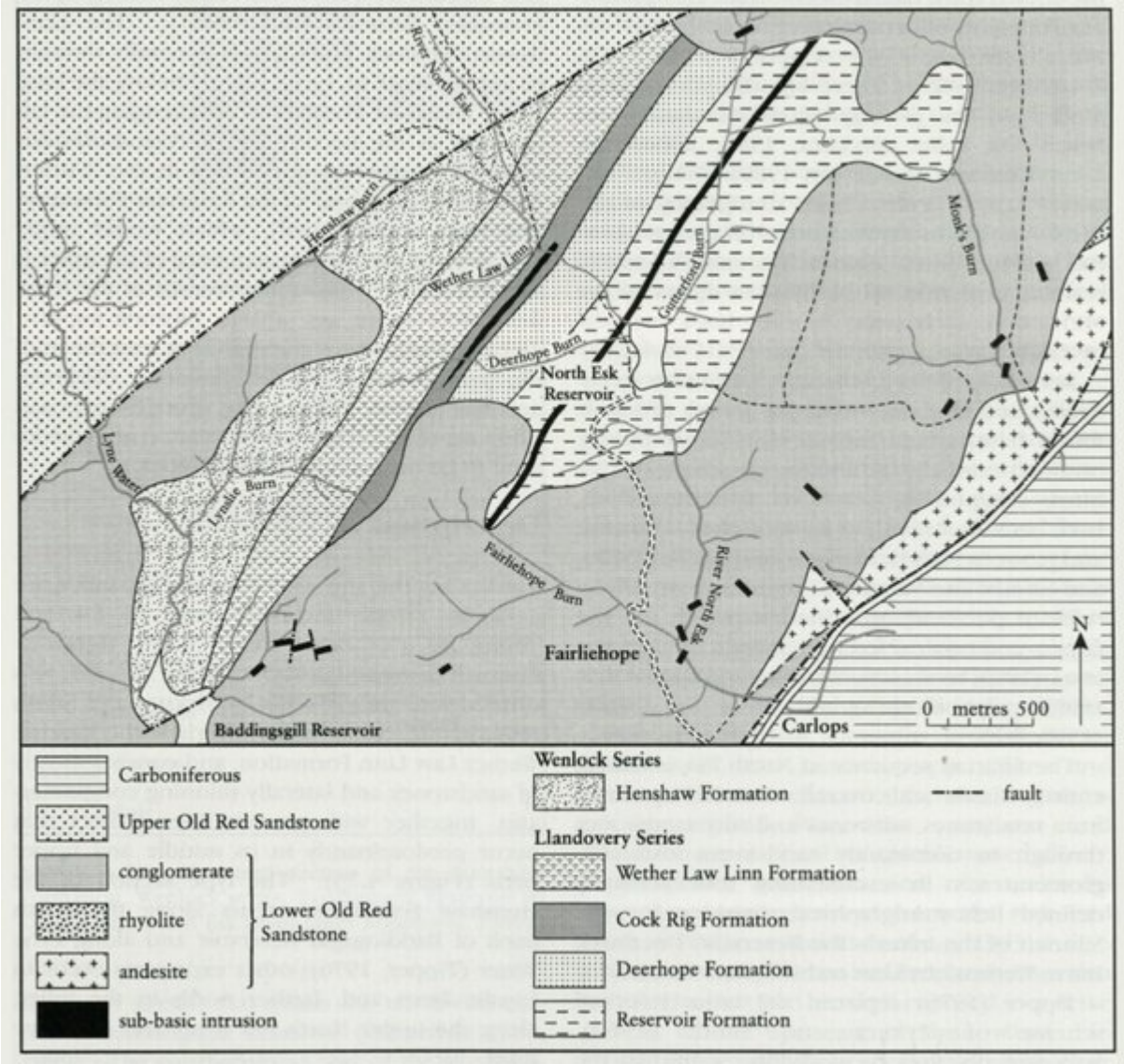
The predominantly red-coloured and mostly unfossiliferous Henshaw Formation succeeds marine deposits and is thought to largely represent terrestrial deposition in arid, fluviatile-influenced environments typical of the Old Red Sandstone facies (Robertson, 1989). The Igneous Conglomerate was probably deposited as part of an alluvial fan. The overlying sandstones are regarded as stream sediments and some of the siltstones and mudstones are viewed as lacustrine deposits. Palynomorphs recovered from the Fish Bed of the Henshaw Formation (Wellman and Richardson, 1993) in some cases provide a non-marine signature (land-derived cryptospores and miospores), but the presence of rare acanthomorph acritarchs corroborates evidence (Robertson, 1989) derived from crinoid associates that the Fish Bed probably represents a brief marine incursion. The disarticulated nature of the fish and other fossils in the Henshaw Formation Fish Bed suggests that they were transported before deposition. By way of contrast, the equivalent fish-bearing horizons at Lesmahagow and the Hagshaw Hills are thought to have accumulated in lakes or lagoons (see Wellman and Richardson, 1993). Another point of view has it that these particular fish in all three inliers in question are marine forms, transported in by short-lived marine incursions (Blieck and Janvier, 1991). The red beds above the Fish Bed at North Esk represent a return to terrestrial conditions.

The GCR site Gutterford Burn contains the oldest (Llandovery age) and deepest water rocks in the North Esk Inlier. The other GCR Silurian sites in the Midland Valley of Scotland are Ree Burn–Glenbuck Loch in the Hagshaw Hills, Birk Knowes of the Lesmahagow Inlier, and Roughneck Quarry, Blair Farm, Penwhapple Burn, Woodland Point, and Knockgardner Quarry in the Girvan district. Collectively these sites comprise a network that gives evidence of an early to mid-Silurian marine to non-marine transition. The Wenlock strata of the Ree Burn–Glenbuck Loch site, like those of the Lyne Water and Lynslie Burn site, are essentially non-marine (Figure 3.83), but definite shallow water marine rocks of basal Wenlock age are present at Knockgardner Quarry.

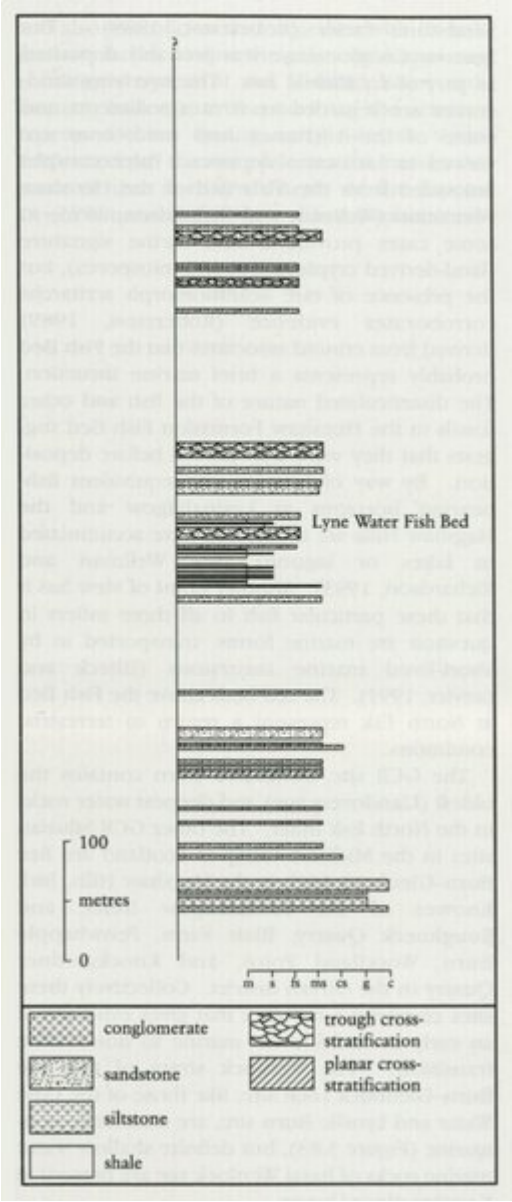
Conclusions

This is an internationally known site from which fossils have been collected for more than a century. It provides the type section for the youngest Silurian lithostratigraphical unit, the Renshaw Formation (Wenlock Series), in the North Esk Inlier. It has early vertebrate faunas and also microfloras that, together with its sedimentary facies, outline the palaeoenvironmental conditions typical of the Midland Valley sedimentary basin(s), to the north of the remnant Iapetus Ocean, during early Silurian times. Evidence from the site endorses the notion that parts of this northern margin of the Iapetus Ocean witnessed the onset of non-marine conditions very early in the Silurian compared to other British Silurian basins. The sporomorph (plant microfossil) assemblages found here (and in the younger horizons of other Midland Valley Silurian inliers) are of much palaeobotanical significance, because they represent globally rare, early, lower Silurian occurrences of presumed continentally-derived forms.

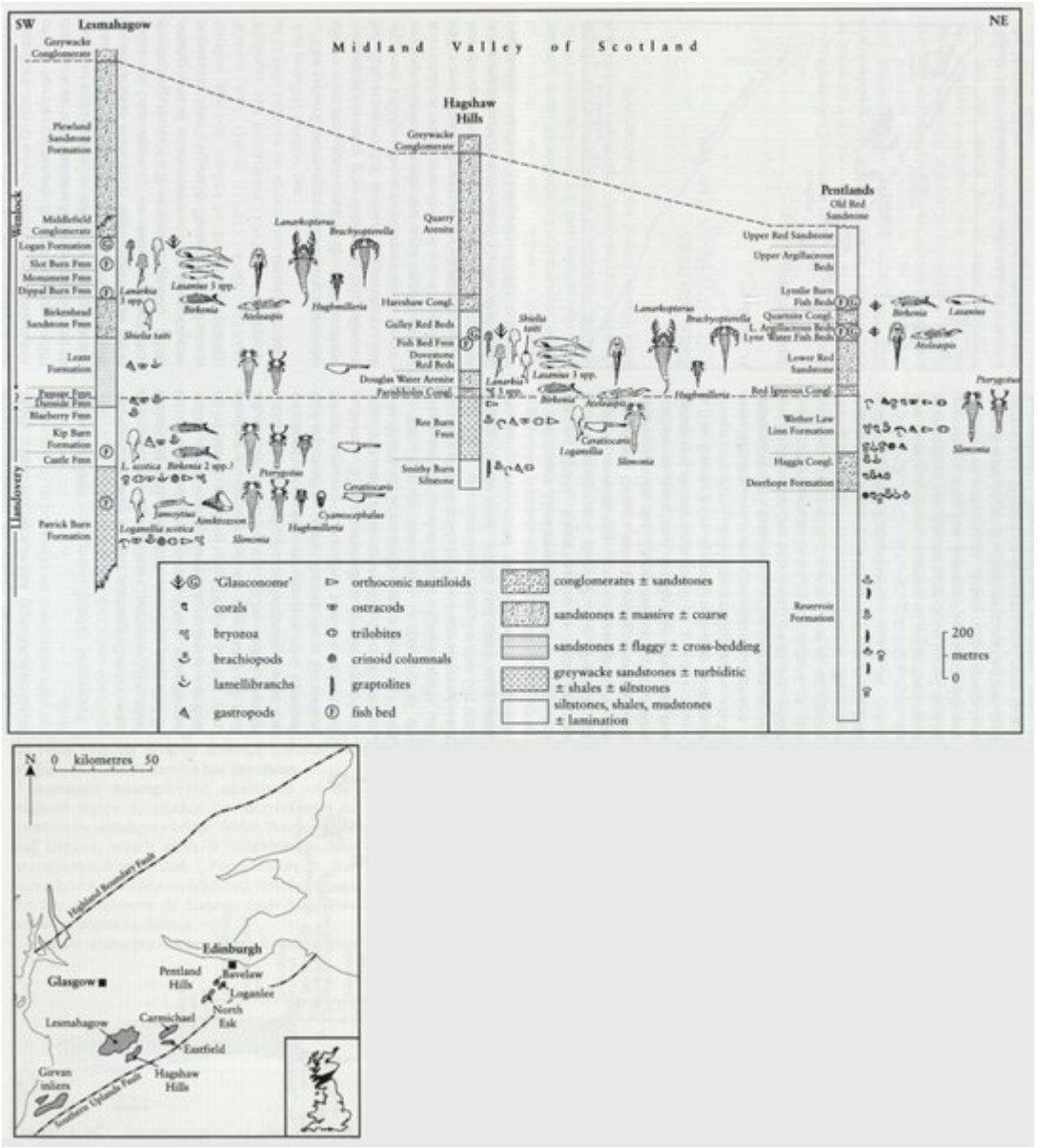
References



(Figure 4.72) Geology of the North Esk Inlier and location of Lyne Water and Lynslie Burn (after Robertson, 1986, and the British Geological Survey, 1977).



(Figure 4.73) Measured section of the Henshaw Formation, Wenlock series, Baddingsgill Reservoir to Lyne Water, North Esk Inlier (after Robertson, 1989).



(Figure 3.83) [Correlation of faunal succession across the main Silurian inliers of the Midland Valley of Scotland, Lesmahagow, Hagshaw Hills, Pentlands. 2023 Note: Figure is incorrectly captioned in the Book and PDF]