Ree Burn–Glenbuck Loch

[NS 7618 2737]–[NS 7604 2865]

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Introduction

This site consists of numerous exposures along Ree Burn and the eastern shores of Glenbuck Loch in the Silurian inlier of the Hagshaw Hills, situated in the central part of the Midland Valley

of Scotland. Old Red Sandstone and Carboniferous strata surround the Silurian core of the inlier. The Silurian rocks here comprise an asymmetrical anticline with a northern limb that dips steeply north-west, and a southern one that dips to the south-east or is vertical to overturned to dip north-west. The site provides a comprehensive reference sequence of all the Silurian lithostratigraphical units of the Hagshaw Hills and it also includes several important palaeontological localities.

Early commentators on the geology of the 'Haughshaw' or 'Hawkshaw' Hills include Nicol (1844), Murchison (1856), Geikie (1860), Slimon (1864), Brown (1874) and Forsyth (1881). Such studies culminated with Peach and Horne's appraisal of the area in their classic Memoir of 1899. In modern times the geology of the inlier has been elucidated by Rolfe (1960a, 1960b, 1962a), whose field guides (1973, 1992) provide excellent summaries of the Ree Burn–Glenbuck Loch site.

The specific age of the Silurian strata of the Hagshaw Hills and their correlation with those of other Midland Valley Silurian inliers is often somewhat uncertain. The rocks of nearby inliers at Lesmahagow, Carmichael and the Pentland Hills are of broadly similar age and facies to those of the Hagshaw Hills. Dating and correlation has focused particularly on the use of lithostratigraphical markers, such as conglomeratic beds, and the occurrence of horizons with fish, arthropods, and rare graptolites and various other invertebrates. Papers by Lamont (e.g. 1947a, 1947b, 1952), Rolfe (1960a, 1962a, 1973, 1992b), Walton (1965), Rolfe and Fritz (1966), Clarkson *et al.* (1977), Bull (1987), Walton and Oliver (1991), Cocks *et al.* (1992), Wellman and Richardson (1993) and Lovelock's thesis (1998) detail the evolution of views on the age of the Silurian of the Hagshaws and associated inliers. The current consensus is that 'much of what was called Downton by Peach and Horne (1899) is now regarded as no younger than Wenlock, or perhaps early Ludlow, and that considerable thicknesses of Llandovery are present' (Cocks *et al.,* 1992). The lower to mid-Palaeozoic tectonic evolution of the Silurian inliers of the Midland Valley has been analysed by Phillips *et al.* (1998).

The Silurian fauna of the Hagshaw Hills is summarized in Rolfe (1962a, 1973, 1992b). Papers featuring particular fossil groups include those on fish (e.g. Westoll, 1951; Ritchie, 1963, 1967; Blieck and Janvier, 1991; Märss and Ritchie, 1998), arthropods (e.g. Lamont, 1955, 1965; Rolfe, 1962b; Ritchie, 1968; Clarkson *et al.,* 1977; Rolfe and Beckett, 1984), and palynomorphs (Wellman and Richardson, 1993).

Description

The Silurian at Ree Burn–Glenbuck Loch (Figure 4.69) mostly youngs to the north-west with dips between 45° and 80°. It is essentially an uppermost Llandovery and Wenlock elastic sequence in which fossils are typically disarticulated, fragmentary and not especially common. The following description is mostly derived from papers by Rolfe (1962a, 1992b).

In the southern part of Ree Burn, about 460 m south of its confluence with Douglas Water (Rolfe, 1992b, locality 1), there are vertical sandstones of the youngest Silurian unit of the inlier, the Quarry Arenite (maximum thickness 610 m) of Wenlock age, which consists mainly of subgreywackes showing some cross-stratification. The topographically higher area farther south is formed of the basal unit of the local Devonian Old Red Sandstone, the Greywacke Conglomerate. These two units essentially form the southern limb of the anticline. The other stratigraphical units of the Ree

Burn–Glenbuck Loch section are on the northern limb.

Cropping out north of the Quarry Arenite in Ree Burn are the two oldest Silurian units in the inlier, both of them Llandovery in age (Cocks *et al.,* 1992), the Smithy Burn Siltstone (120+ m thick; base not seen) and the overlying Ree Burn Formation (275 m). These are cut by minor Caledonian igneous intrusions that include at least eight sills (e.g. as at locality 4 of Rolfe, 1992b). A major reverse fault, which dips north and trends along the axis of the anticline, brings up the Smithy Burn Siltstone about 46 m north of the exposure of the Quarry Arenite. Immediately to the north of this fault a dyke cuts through a tiny outcrop of the (Wenlock) Hareshaw Conglomerate, the unit that underlies the Quarry Arenite.

The Smithy Burn Siltstone consists of dark grey, homogenous siltstones, silty mudstones and shales, with a very sparse fauna. An outcrop of this unit in the left bank of Ree Burn has yielded, extremely rarely, graptolites, the specimens being indicative of the uppermost Llandovery *crenulata* Biozone (Rolfe and Fritz, 1966; Rolfe, 1992b, locality 2).

The Ree Burn Formation consists of sparsely fossiliferous medium grey greywackes (typically showing graded bedding), siltstones, mudstones and shales, which display a variety of depositional, bottom and soft-sediment deformational structures (e.g. at [NS 762 277]; Rolfe, 1992b, locality 3a, 3b). Rock fragments in the greywackes include rhyolites, spilites, andesites and metamorphic rocks. The formation has yielded numerous brachiopod species, bivalves, gastropods, trilobites, ostracods, hyolithids and tentaculitids. Just south of the confluence of Ree Burn with Douglas Water (Rolfe, 1992b, locality 5), the Ree Burn Formation consists of laminated siltstones containing calcareous concretions from which plant fragments, orthoconic nautiloids, fish (the agnathan *Loganerna scotica;* see Märss and Ritchie, 1998) and, most notably, both complete and disarticulated remains of the phyllocarid crustacean *Ceratiocaris papilio* have been recovered (Figure 4.70). About 150 m south-west of Parishholm, the waterfall in Douglas Water is formed by a 20 m thick Tertiary dolerite dyke cutting through the Ree Burn Formation, some 18 m south of which thick sandstones show well-developed load moulds (Rolfe, 1992b, locality 6).

The Parishholm Conglomerate (the 'Igneous Conglomerate' of Peach and Horne, 1899) contains highly coloured pebbles and cobbles and is typical of the so-called 'haggis rock' type of lithology found in the Midland Valley Silurian inliers. Its grey-green sandy matrix contains a wide variety of metamorphic, sedimentary, and especially igneous (> 80%) fragments, some of which are matched with possible sources in Ordovician exposures within 20 km to the south (McGiven, 1968). Clasts include keratophyres, quartz-feldspar porphyries, andesites, spilites, tuffs, adamellites, granites, diorites, and granodiorites; greywackes, mudstones, cherts, vein quartz, and rare limestones; quartzites, phyllites, and schists. The limestone clasts are from a locality 320 m west of Ree Burn; they are rare but have yielded stromatoporoids and bryozoans of probable Wenlock age. The conglomerate, which is some 40 m thick, can be examined at the bluff along the south side of the track between Parishholm and Glenbuck Loch (Rolfe, 1992b, locality 7).

The stratigraphically succeeding Silurian units, namely the Glenbuck Group (330 m thick, comprising Douglas Water Arenite, Dovestone Redbeds, Fish Bed Formation and Gully Redbeds) and the Hareshaw Conglomerate (75 m), occur along the east and south-east shores of Glenbuck Loch (e.g. Rolfe, 1992b, localities 8–10). The Douglas Water Arenite is a pale red to (when weathered) light brown sandstone-greywacke containing mudstone clasts and displaying current bedding. The Dovestone Redbeds (Figure 4.71) consist of reddish and chocolate coloured, rippled and cross-stratified sandstones and mudcracked siltstones and mudstones that are mostly arranged into about 25 cm thick fining-upwards cycles. The Gully Redbeds are lithologically very similar to the Dovestone Redbeds. The overlying Hareshaw Conglomerate (Quartzite Conglomerate of Peach and Horne, 1899) contains well-rounded pebbles and cobbles of granite, rhyolite, schist, chert, pyroclastics, mudstones and especially metamorphic quartzite and vein quartz; the upper part of this unit displays cross-stratification.

The base of the Fish Bed Formation is marked by a 6.5 m thick subgreywacke (seen 110 m north of the dam on the loch), but most of the unit consists of fining-upwards cycles of grey-green sandstones, siltstones, and mudstone, with some desiccation cracks. The unit also contains two fish-rich laminated siltstone levels, one 12 m stratigraphically above a lower horizon, which sits on top of the basal subgreywacke. These celebrated deposits have yielded remains of the fish *Lasanius,* the eurypterid *Lanarkopterus* (Figure 4.70), *Spirorbis* worm tubes, and the probable calcareous alga *Glauconome.* Another famous fossil locality in the Fish Bed Formation, that at Shiel Burn about 2 km to the north-east (NS 777 291; see Rolfe, 1992b, locality 12), has produced material, including complete specimens, of the same and

additional species; its biota includes the fish *Birkenia, Lanarkia, Shielia,* and *Ateleaspis* ((Figure 4.70) and see Märss and Ritchie, 1998); the eurypterids *Brachyopterella, Parastylonurus,* and *Hughmilleria;* the crustacean *Dictyocaris;* and remains of the algae *Pachytheca* and *Tatia.* Palynomorph assemblages comprising sporomorphs and cuticle-like sheets and tubular structures of probable early Wenlock age also occur in the Fish Bed (Wellman and Richardson, 1993).

Interpretation

This site shows the transition during the Silurian from fully marine sedimentation to terrestrial, Old Red Sandstone conditions, this reflecting the closure of the Iapetus Ocean. The sediments were deposited in one of what was possibly a linear series of sub-basins that occupied much of the southern part of the present day Midland Valley, and which lay on the southern margin of Laurentia (North American palaeocontinent) and north of a possibly emergent accretionary prism centred on the Southern Uplands (see discussion under Pentland Hills GCR site Lyne Water and Lynslie Burn). The onset of red bed sedimentation in the Hagshaw Hills and other Midland Valley inliers is relatively early in the Silurian compared to its timing elsewhere in Britain, such as in the Lake District and most parts of the Welsh Basin. Accretion of the Midland Valley Terrane to the Laurentian continent by sinistral strike-slip controlled the development of the various Midland Valley Silurian sub-basins through to early Devonian times (Phillips *et al.,* 1998).

The Smithy Burn Siltstone and Ree Burn Formation are marine. Most of the sediments of especially the greywacke-dominated lower part of the Ree Burn Formation are turbidite-generated and derived from the south. Much of the fauna of the Ree Burn Formation, which is preserved chiefly as moulds at the bases of the greywackes, is essentially of shallow water aspect and has clearly been transported down-slope. The 'concretion fauna' (fish, orthocones, crustaceans) in the siltstones in the upper part of the Ree Burn Formation accumulated in somewhat less energetic regimes. "I'he Parishholm Conglomerate and the younger Hareshaw Conglomerate probably represent alluvial fan deposition, formed by sheet- and stream-floods derived largely from the south and south-east (McGiven, 1968). Much of the Dovestone Redbeds and the younger Gully Redbeds are thought to reflect terrestrial playa-type environments, which were subject to frequent flooding and drying-out episodes. The sandstones of the Quarry Arenite probably formed in braided streams, and the intercalated and in places sun-cracked mudstones are interpreted as overbank 'fines' (McGiven, 1968).

The Fish Bed Formation may have formed in a lagoonal or lacustrine setting and the fish faunas of these laminated ('varved') deposits may be explained by 'mass killing off due to rapid (? seasonal) overturning of thermally stratified waters of the lake bringing up anaerobic waters' (see Rolfe, 1992b). Other explanations have it that many of the fish from the various Silurian fish beds in the Midland Valley are marine forms that were transported in by marine incursions (Blieck and Janvier, 1991). Palynofacies evidence supports the traditional view that the red bed sequence of the Hagshaw Hills is 'entirely non-marine and that they are probably lacustrine and fluvial rather than marginal marine deposits' (Wellman and Richardson, 1993). Some of the fish taxa are also known from rocks along strike in Clew Bay, Ireland, thus suggesting that the Midland Valley and western Ireland were once part of the same basin(s) of deposition during the Silurian (Palmer *et al.,* 1989).

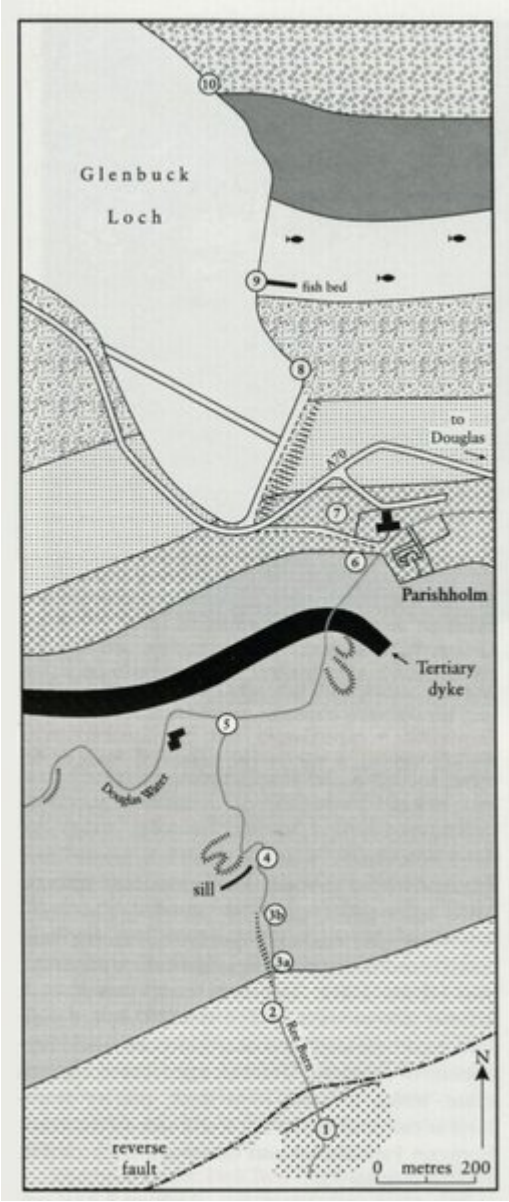
Ree Burn–Glenbuck Loch is the only GCR Silurian site in the Hagshaw Hills. This and other Silurian GCR sites in the Lesmahagow Hills (Birk Knowes), the Pentland Hills (Gutterford Burn, and Lyne Water and Lynslie Burn) and the Girvan area (Roughneck Quarry, Blair Farm, Penwhapple Burn, Woodland Point and Knockgardner Quarry) form a network that provides an overview of the geological evolution of the Midland Valley region during the Silurian. With reference to other Midland Valley sites listed specifically for their Wenlock interest, the Lyne Water and Lynslie Burn site in the Pentlands has, palaeoenvironmentally, similar Wenlock deposits to those of Ree Burn–Glenbuck Loch in having an essentially non-marine sequence (Figure 3.83), whereas Knockgardner Quarry in the Girvan area has lowermost Wenlock deposits that are of shallow water marine origin.

Conclusions

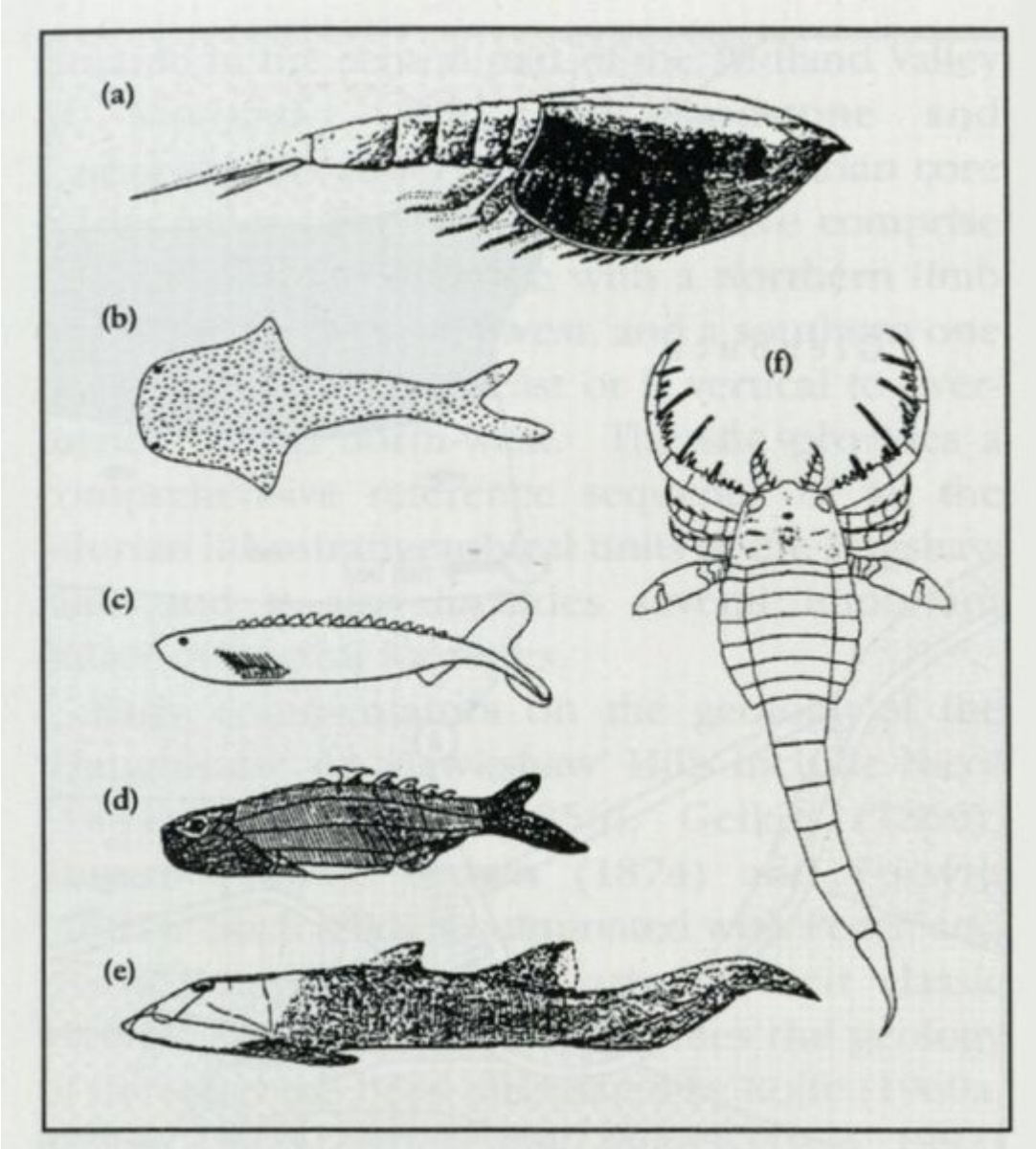
This site excellently displays the lithostratigraphical divisions of the Silurian of the Hagshaw Hills in the Midland Valley of Scotland. For more than 100 years it has yielded fossils of international importance, including rare arthropods and some

of the best, earliest fish faunas in the world. Moreover, the plant microfossil assemblages of this site (together with those of other Midland Valley Silurian localities) has much palaeobotanical significance: it provides one of the few Wenlock palynomorph assemblages globally that has been interpreted as being of continental origin and as such provides important evidence about the nature of early land plants. The Ree Burn–Glenbuck Lock sequence also superbly demonstrates the marine to non-marine palaeoenvironmental changes which characterized the Midland Valley area of the northern margin of the Iapetus Ocean during early to mid-Silurian times.

References

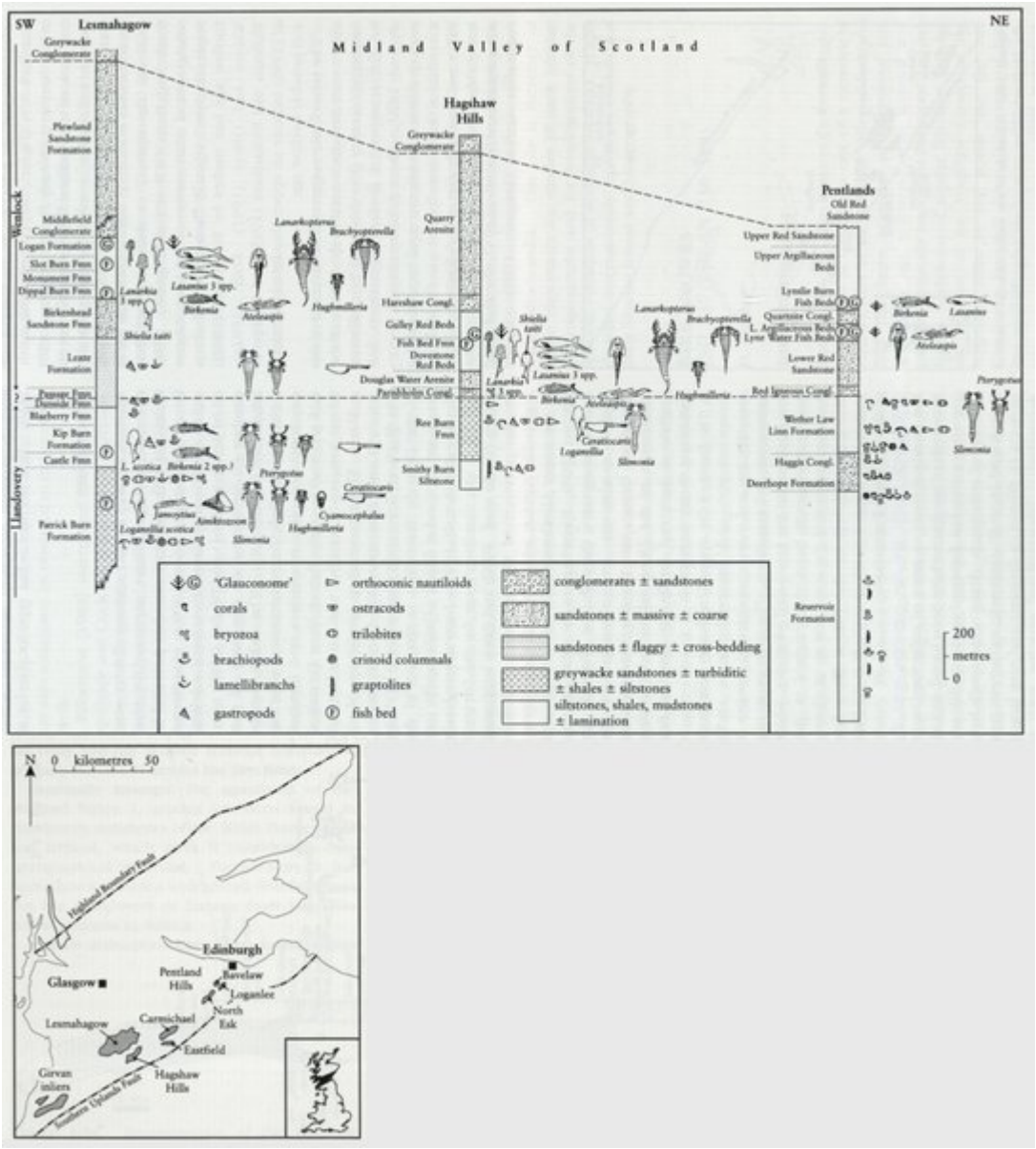


(Figure 4.69) Geology of the Ree Burn–Glenbuck Loch area, Hagshaw Hills (after Rolfe, 1962a, 1992).



(Figure 4.70) Some arthropods and fish from the Ree Burn (a) and Fish bed Formations (b-e), Glenbuck Group, Wenlock Series, Hagshaw Hills. (a) Ceratiocaris papilio, a phyllocarid crustacean; (b) Lanarkia horrida, a thelodont fish; (c) Lasanius problematicus and (d) Birkenia elegans, anaspid fish; (e) Ateleaspis tessellata, a cephalaspid fish; (f) Lanarkopterus dolichoschelus, a eurypterid (modified from Rolfe, 1992, and Märss and Ritchie, 1998).

(Figure 4.71) Glenbuck Loch, Hagshaw Hills. Dovestone Redbeds, Glenbuck Group, Wenlock Series. (locality 8 of Rolfe, 1992). (Photo: Derek J. Siveter.)



(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]