
Knockgardner

[NS 355 036]

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Introduction

This site comprises a small field quarry some 350 m east of Knockgardner, 14 km ENE of Girvan in the south-western part of the Midland Valley of Scotland. The quarry exposes Wenlock age strata of the Knockgardner Formation within an inlier of Silurian rocks surrounded and unconformably overlain by younger Old Red Sandstone (Figure 4.66). Overall, the inlier exposes a sequence, some 700 m thick, of Silurian flags and shales passing up into grits and conglomerates.

The most significant early mapping and description of these strata by Lapworth (1882) named them as the Straiton Group and subdivided the sequence into the same basic units that are recognized today — in ascending order, Drumyork flags, Blair flags and shales, Knockgardner shales and Straiton grits and conglomerates. Peach and Horne (1899) developed their palaeontological diagnosis of the age of the strata through the discovery of new fossiliferous localities in the Blair and Knockgardner beds, and notably through the rich shelly fossil assemblage obtained from the Knockgardner beds at the present site. They recognized a Wenlock age for the Blair to Straiton beds, and for the same sequence this was refined to early Wenlock by Pringle (1948).

Lamont (1965, 1978) described and discussed trilobites from the Midland Valley of Scotland (revised by Howells, 1982). These were overwhelmingly from the Pentland and Hagshaw hills, though he also alluded to trilobites from the Knockgardner area and disputed the correlation of the Knockgardner Formation with the lower Wenlock. However, in their wide-ranging revision of the biostratigraphy of the Silurian of the Girvan area, Cocks and Toghill (1973) reaffirmed an early Wenlock age for this formation, and this has been supported by Dornig (1982) and by Wellman and Richardson (1993) on the basis of palynofacies studies. This age has also been accepted by Clarkson *et al.* (1977) in their study of Silurian phacopid trilobites from Scotland, and further endorsed most recently by Clarkson *et al.* (1998) on the basis of their review of the basal Wenlock biofacies of the Knockgardner area. These last authors developed a new palaeoenvironmental interpretation for the Drumyork through to Straiton formations, in particular for the Knockgardner Formation, and they discussed the nature and distribution of the faunas of the site within the overall context of the Midland Valley. They also formalized the stratigraphical terminology of the Drumyork Flags, Blair, and Straiton Grit formations, the Knockgardner Formation having been formalized earlier by Cocks and Toghill (1973).

The shelly fauna and microflora from the Knockgardner Formation of this site are, thus, very important in proving that the Silurian succession in the Girvan area of the Midland Valley extends upwards to include rocks of Wenlock age, and that fully marine albeit shallow water conditions existed there at this time.

Description

The site itself comprises only the Knockgardner Formation, and there are a limited number of other exposures of Straiton Group strata along the ENE–WSW strike over a distance of 4 km between Blair Farm and Knockgardner. Recent remapping of the area by Clarkson *et al.* (1998) has added considerable detail to that provided by Cocks and Toghill (1973).

The lowest unit of the Straiton Group, the Drumyork Flags Formation, consists of some 380 m of generally unfossiliferous thinly bedded siltstones and shales alternating with thicker turbidites, in which three lithofacies variants have been recognized. Above, the Blair Shale Formation, exposed around Blair Farm, is made up of alternating thin shales, silt laminae and thicker sandstones. Some units of this formation are bioturbated and a graptolite fauna recorded by Cocks and Toghill (1973) indicates, in contrast to the Wenlock age for these beds recognized by Peach and Horne (1899), the presence of the *crenulata* Biozone, which lies at the top of the Telychian Stage of the Llandovery Series. A Llandovery

age for the Blair Shale Formation has been subsequently confirmed by reassessment of its graptolite fauna by Loydell (Clarkson *et al.*, 1998).

The overlying Knockgardner Formation, which is up to 141 m thick, also consists of alternations of laminated shales, siltstones and thin-bedded sandstones. Clarkson *et al.* (1998) recognized three successive facies, of which the lowest is some 40–50 m thick with dark shales and graded sandstones up to 14 cm thick, some with shell accumulations near the base and occasionally trace fossils.

The middle facies, which is about 100 m thick, is best exposed in the stream south of Shaws Knowes and at the present quarry site. According to the sediment log of the site (Clarkson *et al.*, 1998; (Figure 4.67)), there is an equal proportion of sandstone beds (up to 16 cm thick) and shale. These laterally extensive sandstones display delayed grading, cross-stratification and herringbone cross-sets. Dark laminae within finer and lighter-coloured sandstones are highly fossiliferous in places.

The highest facies of the Knockgardner Formation, estimated at 30–40 m thickness, comprises thin shales and silts, and is best exposed in a stream near Craighens Wood, west of Straiton. Shales dominate the sequence and occasionally show desiccation cracks and abundant trace fossils.

The top unit of the Straiton Group, the Straiton Grit Formation, is some 90 m thick and is best exposed in Shiel Burn and two small quarries north of the Kirkbride–Knockgardner road. Two laterally interfingering facies can be distinguished with brown sandstones, up to 1.2 m thick, passing into coarser conglomeratic and cross-stratified sandstones, up to 1.5 m thick. The largest pebbles reach 6 cm in size and consist predominantly of quartz and jasper.

Palaeontologically, the Knockgardner Formation has long been recognized as containing a very important and interesting fauna, ever since Lapworth (1882) found abundant shells of the ostracod '*Beyrichia kloedene*' in the shales near Knockgardner Farm. Peach and Horne (1899) made the more important find of abundant brachiopods and trilobites in rocks of the same formation and, from this and associated discoveries, they assessed the age of the Silurian strata hereabouts.

Details of the fauna and sediments were not published until Cocks and Toghill (1973) published their revision of the Girvan Silurian and described from the Knockgardner Formation a shallow-water assemblage dominated by species of the brachiopods *Protochonetes* and *Resserella*, and *Atrypa reticularis* and *Howellella elegans*. Similar assemblages are found in the Anglo-Welsh Basin, the Baltic region and Bohemia. Dorning's analysis (1982) of the acritarch flora showed comparisons with early Wenlock assemblages from the Anglo-Welsh Basin and contemporary carbonate sediments on Gotland.

The shelly fauna of the Knockgardner Formation has been reviewed in further detail by Clarkson *et al.* (1998). Their analysis of the brachiopods broadly agrees with that of Cocks and Toghill (1973), with three of the above-listed species dominating the overall fauna of 12 species of brachiopod in a total fauna of 20 or so taxa, including trilobites, bryozoans, gastropods, ostracods and small solitary corals. Of the trilobites, four species occur at Knockgardner: *Podowrinella straitonensis*, the last recorded survivor of the Pterygometopidae, *Wallacia bagshawensis*, *Richterarges rolfei* and *Warburgella* (*Warburgella*) *capetos*, all of which are fully described by Howells (1982). These trilobites, named the *Podowrinella* assemblage by Clarkson *et al.* (1998), have been found to recur as a resedimented and endemic fauna throughout the Silurian inliers of the Midland Valley. The well-known Silurian trilobite assemblages of the Anglo-Welsh and Bohemian basins are quite different.

Lamont (1978), Dorning (1982), Howells (1982), Clarkson *et al.* (1977) and especially Clarkson *et al.* (1998) all figure and describe invertebrate fossils from this Knockgardner site, and it stands as the type locality for, at least, *Warburgella* (*Warburgella*) *capetos* Howells (1982).

Interpretation

The coarsening upwards sequence of Silurian strata reflects a regressive shallowing succession of marine to freshwater deposits (Figure 4.68) with associated biotic changes. The Drumyork Flags and Blair Shales were relatively deep-water marine deposits in quiet waters with repeated influxes of low-velocity density currents that brought in fine sands.

There is some dispute over the interpretation of the overlying Knockgardner Formation deposits, with Cocks and Toghiani (1973) characterizing them as relatively deep-water turbidites, whilst Dornig (1982) and Clarkson *et al.* (1998) re-interpreted them as shallow water in origin. According to this last study, the three successive facies of the formation reflect shelf–prodelta deposits, followed by intertidal and then delta-front to lagoonal conditions of deposition. The succeeding Straiton Formation represents marine to non-marine flooding of coastal lagoons, with coarse-grained sediments and the development of back-barriers on the shore-side that migrated seawards as sea level fell.

The *Podowrinella* assemblage is interpreted by Clarkson *et al.* (1998) as a specialized and mobile but endemic fauna in the Midland Valley of Scotland, adapted for life in shallow water, high-energy conditions. By contrast, the sessile benthic brachiopod assemblage of *Protochonetes*, *Atrypa reticularis* and *Howellella elegans* is much more cosmopolitan. Its main faunal elements have wide spatial and temporal distributions within mid-Silurian deposits on both sides of a closing Iapetus Ocean (Watkins, 1978b). Clarkson *et al.* (1998) speculated that the differences between the two faunal assemblages reflects contrasting reproductive strategies and larval longevity.

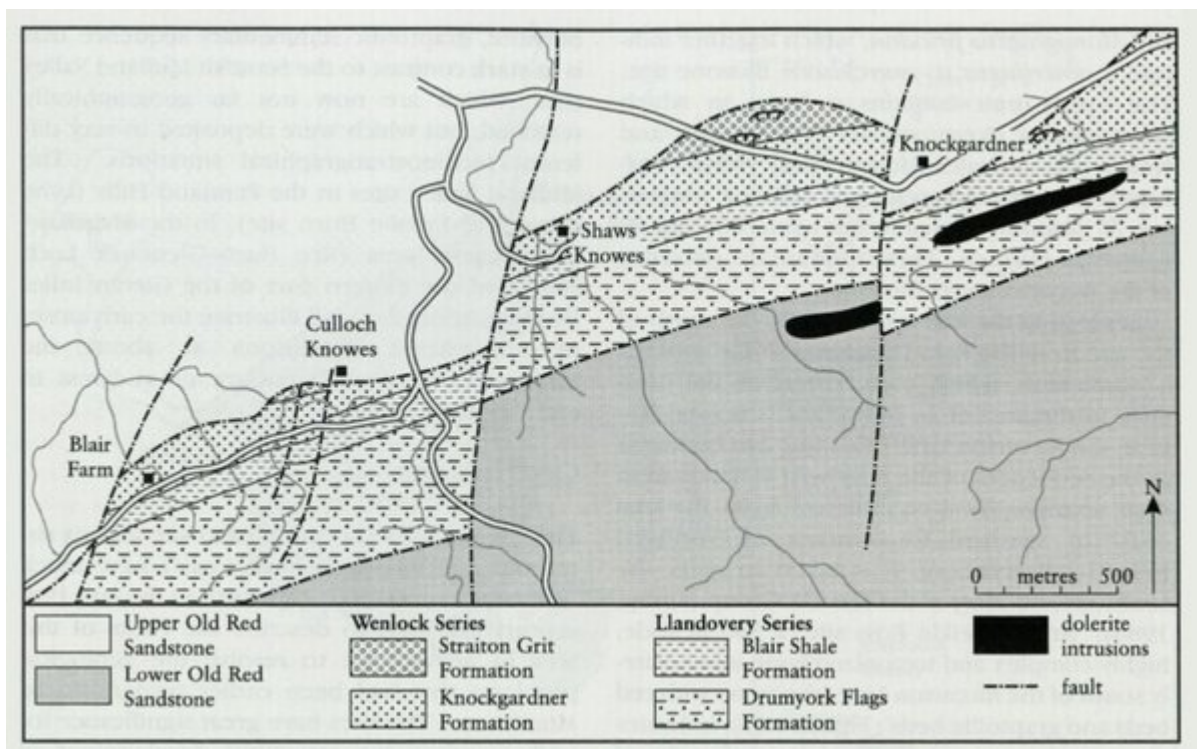
Knockgardner forms part of an important network of sites in the Midland Valley that links together various Silurian inliers, all of which have Llandovery–Wenlock sequences. In addition to the Girvan area, these inliers comprise the Hagshaw Hills, the Lesmahagow area and the Pentland Hills. The sites run from Woodland Point on the Girvan coastline in the south-west, to the Gutterford Burn and the Lyne Water and Lynslie Burn sites in the Pentland Hills in the north-east, with the Ree Burn–Glenbuck Loch site in the Hagshaws providing an intermediate link. In all of these inliers there is evidence of a regressive, marine to non-marine palaeoenvironmental transition at about the Llandovery–Wenlock boundary interval (see, for example, (Figure 3.83)). The Knockgardner, Girvan sequence, however, is the only one that indicates fully marine conditions continuing into earliest Wenlock times, though there is some suggestion of brief marine incursions in the Wenlock succession of the Pentlands.

Conclusions

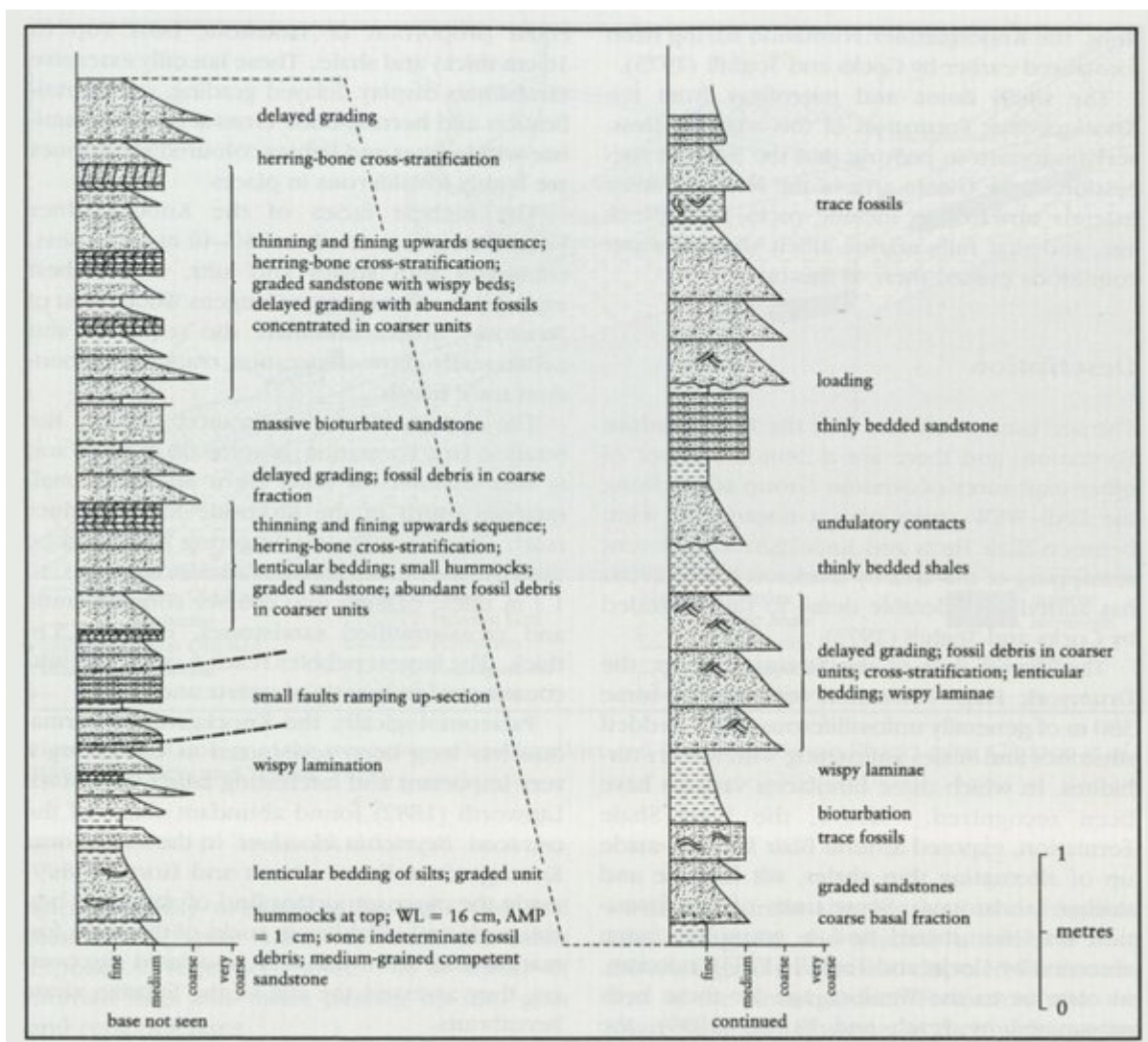
The Knockgardner Formation at this site has, importantly, yielded a microflora that indicates an early Wenlock age for what is almost the youngest part of the Silurian succession of the Girvan area, in the south-western part of the Midland Valley of Scotland. In addition, the rich shelly fauna and sediments of this formation present at the site indicate that marine conditions persisted in this area at this time, unlike in other Silurian areas (inliers) of the Midland Valley where the change to non-marine conditions has been placed at the slightly earlier Llandovery–Wenlock boundary level. The brachiopods and trilobites from the site have been interpreted as representing two different types of ecological association, the former cosmopolitan and the latter endemic to the Midland Valley.

The site can be networked in particular to two other sites in the Midland Valley (Ree Burn–Glenbuck Loch in the Hagshaw Hills, and Lyne Water and Lynslie Burn in the Pentland Hills). Altogether these sites preserve a record of the Silurian marine regression in the region as the Iapetus Ocean closed.

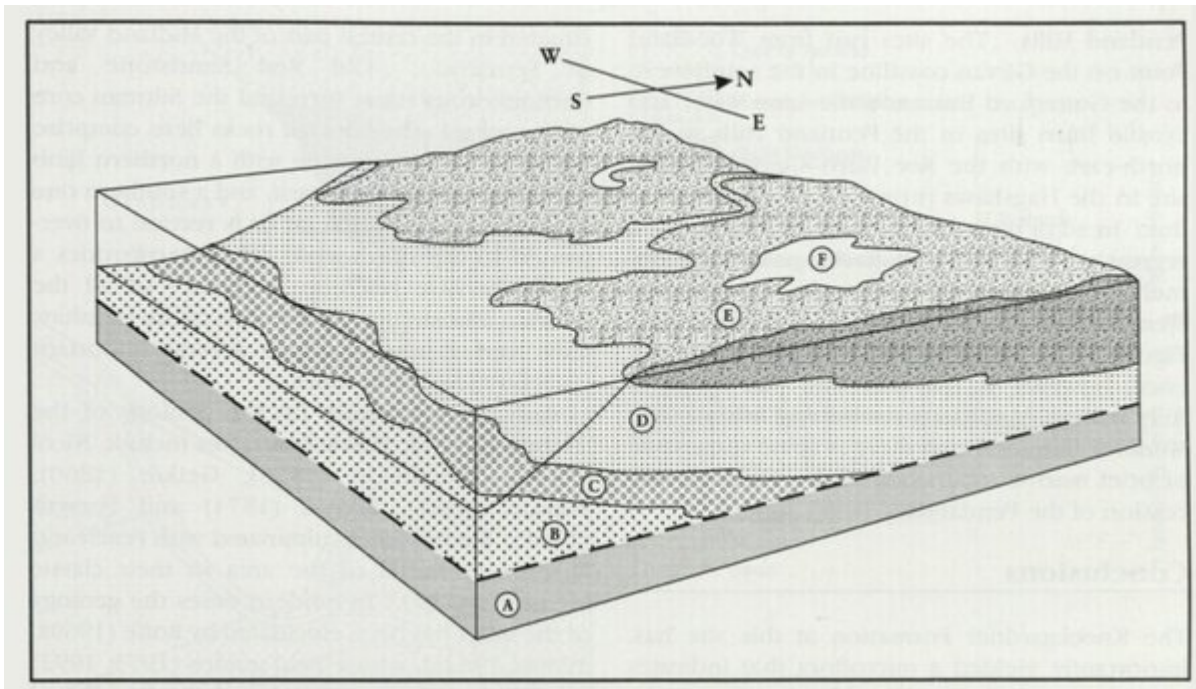
[References](#)



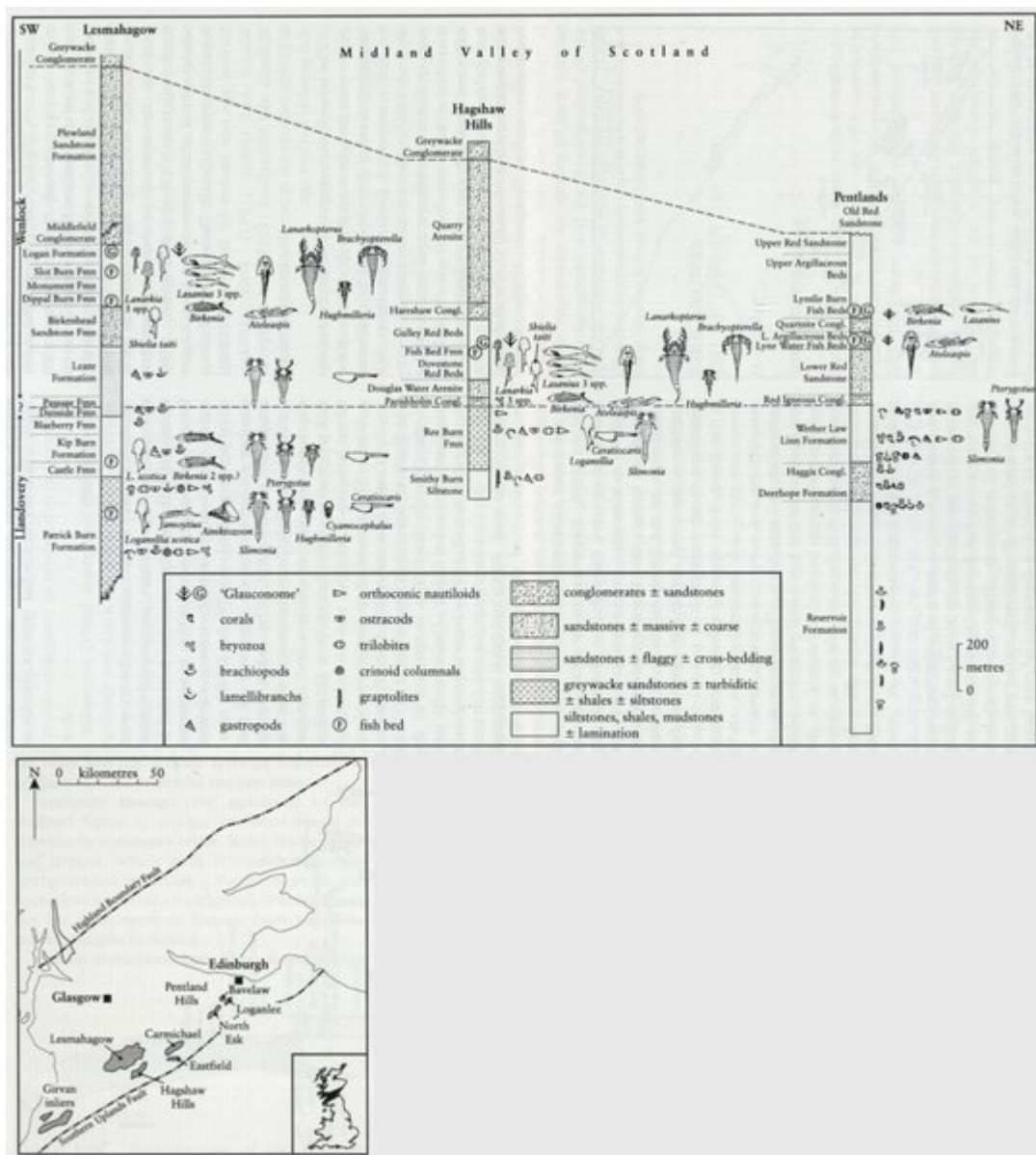
(Figure 4.66) Geology of the area between Knockgardner and Blair Farm, Girvan District (after Clarkson et al., 1998, and Cocks and Toghil, 1973).



(Figure 4.67) Sedimentary log through the Knockgardner Formation, Knockgardner Quarry, 350 m east of Knockgardner Farmhouse, Girvan district (after Clarkson et al., 1998).



(Figure 4.68) Schematic block diagram illustrating depositional environments within the middle and upper part of the Straiton Group (latest Llandovery to early Wenlock in age), Knockgardner area, Girvan district. (A), Deep water graptolitic shales of the Blair Formation. Tectonic excision along the contact with the overlying Knockgardner Formation may have removed the more proximal mid to outer shelf facies to juxtapose deep-water sediments with shallow water facies at the junction between the two formations. (B), (C), and (D), in upward sequence, through the Knockgardner Formation, shallow-water prodelta facies (B), overlain by intertidal deposits subject to storm surges (C), and then shallow-water delta front sediments (D). (E) and (F), coarse grained back barrier facies (E) and lagoonal facies (F) of the Straiton Formation (after Clarkson et al., 1998).



(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]