
Chapter 11 Arenig to Ashgill of northern England

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Introduction

The Ordovician in northern England is exposed in a large inlier, the Main Outcrop of the Lake District, and in several groups of smaller inliers, of which the most important are those in the Cross Fell and Cautley and Dent areas. The Main Outcrop has a large area of lower Ordovician, the Skiddaw Group, which was reviewed by Cooper *et al.* (1995). This group rests on the granite batholith that underlies the Lake District; it is overlain by the thick Borrowdale Volcanic Group (which is probably referable to the lower Caradoc (Molyneux, 1988; Piper *et al.*, 1997)) and is succeeded unconformably by the upper Ordovician Dent Group (Kneller *et al.*, 1994). This is thin and stratigraphically incomplete, but some sites (such as Ashgill Quarry) are significant historically in the development of the concept of the Ashgill Series (Ingham and Wright, 1970).

Of the smaller inliers, Cross Fell has the most complete succession of upper Caradoc rocks, ranging from the Longvillian to Onnian substages, but the lithologically varied Ashgill Series is incomplete, especially in the Cautleyan Stage (Burgess and Holliday, 1979). This deficiency is made good in the Cautley inliers, the type area for the Ashgill Series (Ingham, 1966), where the Cautley Mudstones represent the greater part of the Ashgill Series in a relatively uniform facies.

Main outcrop: Skiddaw Group

The Skiddaw Group is a thick succession of mudstones, siltstones and sandstones of Tremadoc to Llanvirn age (Figure 11.1), (Figure 11.2). Although there have been difficulties in interpreting the lithostratigraphy, the succession is of particular biostratigraphical importance because it is graptolitic throughout; it has accordingly provided a zonal standard for the Arenig Series in England and Wales. This standard forms an essential link between the refined Arenig succession in South Wales, based on trilobite faunas, and the graptolitic based international sequence (Cooper and Lindholm, 1990).

Former difficulties with the stratigraphical succession (see Molyneux and Rushton, 1988, p. 46) have been resolved through a multidisciplinary survey over the whole outcrop (Cooper *et al.*, 1995, in press); the biostratigraphy has been improved by correlating new and existing graptolitic data with new studies of acritarch assemblages (Molyneux in Cooper *et al.*, 1995). Trace fossils are widely distributed and were reviewed by Orr (1996). The bioturbation indicates that the mudstones were deposited in oxygenated conditions. Frequent incursions of sand were deposited from low-concentration waning turbidity flows. A basin or slope setting that faced an open ocean is envisaged (Fortey *et al.*, 1989), and the Lake District thus represents a quite different setting from the contemporary Welsh Basin of North Wales. It affords, in fact, the best lower Ordovician graptolitic succession around western Gondwana (Figure 1.2).

The current lithostratigraphical and graptolite succession, based on the Northern Fells Belt (Cooper *et al.*, 1995), is shown in (Figure 11.2). The sites were selected with their biostratigraphical significance in mind: the Tremadoc to Arenig transition, the only graptolite-bearing transition of this age in Britain, is shown by Trusmadoor, and this is the best candidate in Britain for a fossiliferous base to the Moridunian Stage of the lower Arenig Series. The succeeding zonal assemblages for the *varicosus* and *simulans* Zones are seen respectively at the Blaze Beck and Barf sites. The lower part of the *gibberulus* Zone, characterized by *Isograptus victoriae*, is not exemplified in the GCR site series to date, but the upper part is seen at Randel Crag (see site report). The overlying *hirundo* Zone is present at Outerside, where it is adjacent to the lowest Llanvirn *artus* Zone.

[Trusmadoor](#)

[Blaze Bridge and Scawgill Quarry](#)

[Barf](#)

[Randel Crag](#)

[Outerside](#)

Main Outcrop: Dent Group

The nomenclature of the constituent formations given by Kneller *et al.* (1994) is followed here (Figure 11.6). The group consists of thin but laterally fairly persistent sandstones, mudstones and calcareous beds that transgress the eroded mass of Borrowdale Volcanic Group rocks. The basal part of the group in the south-east Lake District is shown at Stile End (see site report, below) and the upper parts are shown clearly but in attenuated form at the classic site of Ashgill Quarry.

[Stile End](#)

[Ashgill Quarry](#)

Cross Fell Inlier

Separated from the Main Outcrop by the valley of the Eden, the Cross Fell Inlier, brought up on the Pennine Fault complex, shows a comparable succession of the Skiddaw and Borrowdale groups, albeit with much more restricted outcrop (Cooper and Molyneux, 1990). A particularly important feature of the Cross Fell succession is the good development of the upper Caradoc Series (Longvillian to Onnian substages) in the Dufton Shales; in contrast, the Main Outcrop shows only an outlier of the lowest part of the Caradoc sequence (the Drygill Shales) and the Cautley inliers the highest part (see the Sally Beck site report).

[Harthwaite Sike](#)

[Pus Gill](#)

[Melmerby Road](#)

[Swindale Beck](#)

[Keisley Quarry](#)

Cautley Inliers

The Cautley and Dent areas have several small inliers of the Dent Group that show a relatively complete sequence of the Ashgill Series, which, though much faulted, serves as its type succession.

Ingham (1966) gave a detailed account of the late Caradoc and Ashgill succession in all of the Cautley and Dent inliers and outlined the historical development of its terminology and correlation, in particular the work of Marr (1913) and King and Williams (1948) in recognizing faunal divisions within the mudstone-dominated sequence. Ingham (1966) introduced the term 'Cautley Mudstones' for all but the uppermost part of the Ordovician here and subdivided the post-Pusgillian part of the succession into eight numbered assemblage biozones, largely on the basis of their trilobite faunas. Ingham and Wright (1970) assigned the Pusgillian Stage to the Ashgill Series and established the Cautleyan Stage to comprise Ingham's Zones 1–4 and the Rawtheyan Stage for Ingham's Zones 5–7. They defined the base of the Rawtheyan Stage in faulted ground in the eastern part of the Ecker Secker Beck site [SD 708 952], but more recently, Ingham (in Fortey *et al.*, 1995, p. 26) has suggested that an unfaulted base might be defined within the Swindale Limestone Formation of the Cross Fell Inlier (see the Swindale Beck site report).

Ingham and Wright (1970) revived Bancroft's Hirnantian Stage (see the Cwm Hirnant site report) for the uppermost division of the Ordovician and placed the base of the Hirnantian in the Cautley area at the base of the Cystoid Limestone of Ingham (1966). This lies above a stratigraphical break that, in the Taythes Inlier, extends down to near the base of the Rawtheyan. Subsequently, Ingham and Wright (in Williams *et al.*, 1972) reassigned the Cystoid Limestone to the top of the Rawtheyan, placing the base of the Hirnantian at the base of the overlying Ashgill Shale Formation.

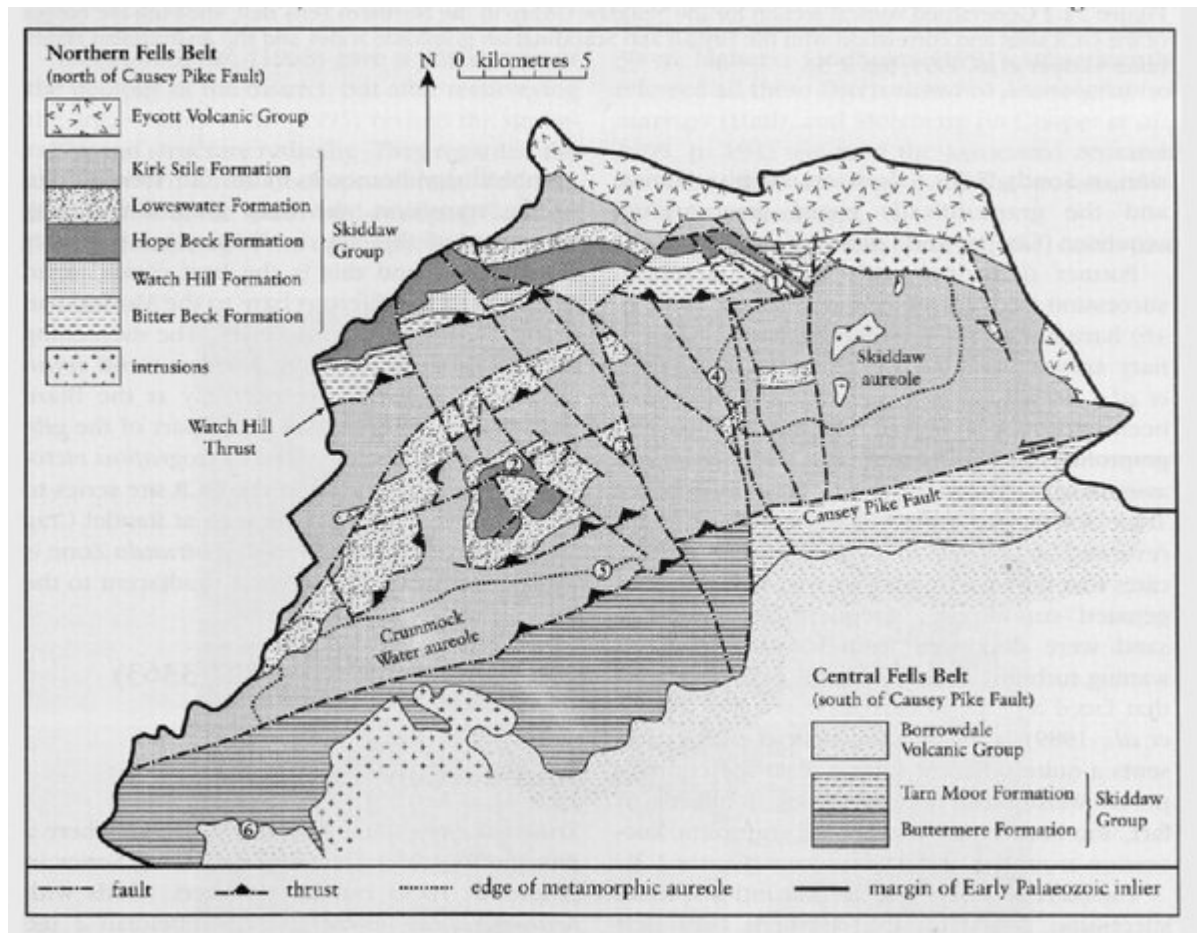
The Sally Beck site contains representatives of all parts of the succession and, in particular, displays at Foggy Gill a continuous sequence from the Onnian to Pusgillian that is taken to typify the base of the Ashgill Series. The lower Cautleyan and Rawtheyan successions are well displayed at Backside Beck and the upper Cautleyan at Ecker Seeker Beck.

[Sally Beck and River Rawthey](#)

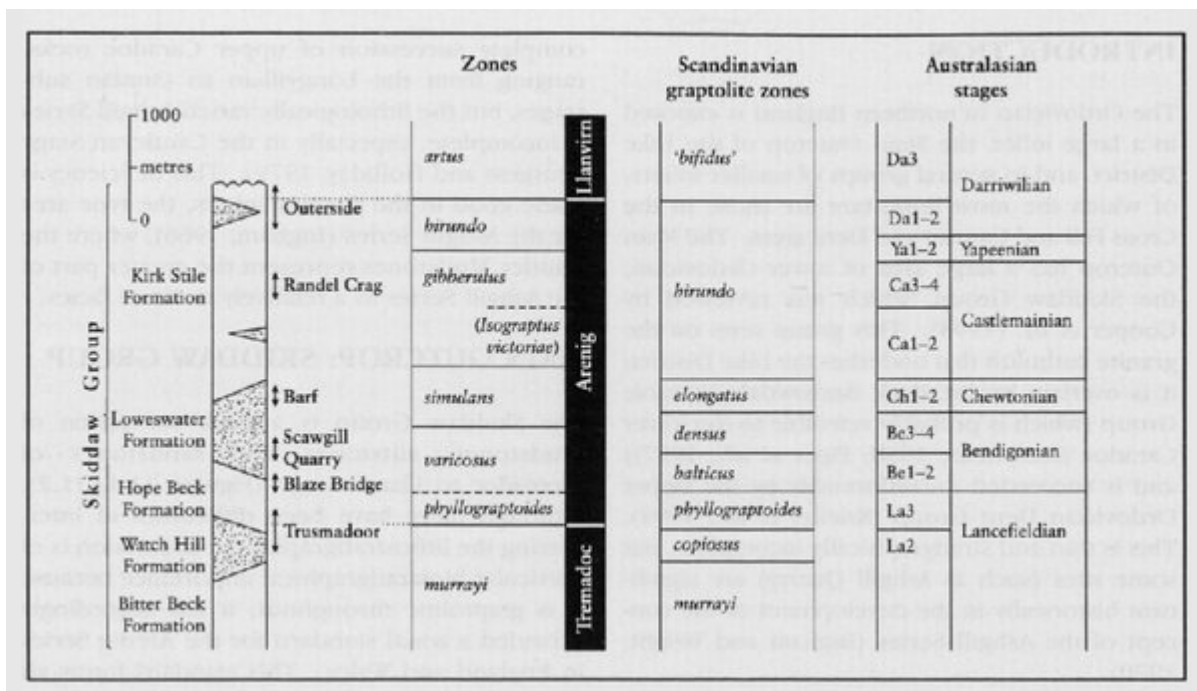
[Backside Beck](#)

[Ecker Secker Beck](#)

[References](#)



(Figure 11.1) Geological sketch-map of the Skiddaw Group in the main outcrop of the English Lake District, after Cooper *et al.* (1995, fig. 2). GCR localities: 1, Trusmador; 2, Blaze Bridge and Scawgill Quarry; 3, Barf; 4, Randel Crag; 5, Outside; 6, River Calder (Tremadoc, Chapter 7).

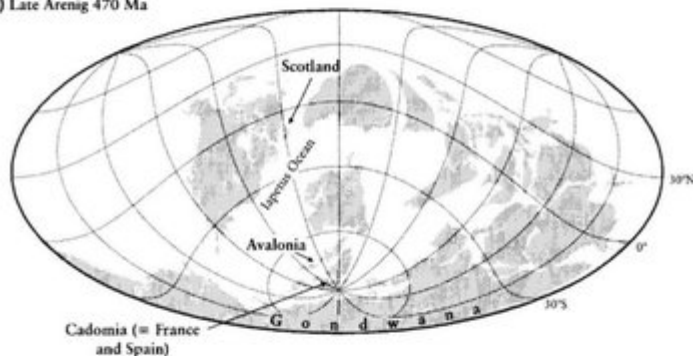


(Figure 11.2) Generalized vertical section for the Skiddaw Group in the Northern Fells Belt, showing the ranges of the GCR sites and correlation with the British and Scandinavian graptolite zones and the Australasian stages (after Cooper et al. 1995, figs 2, 3).

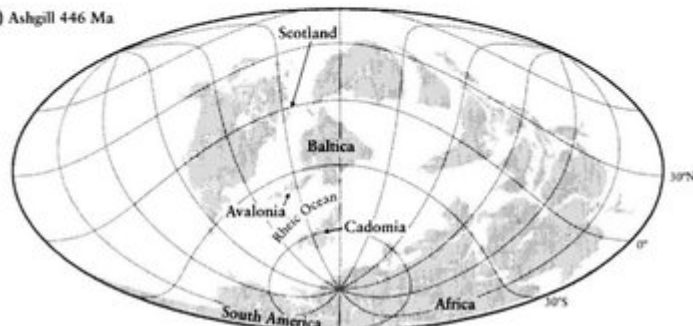
(a) Early mid-Cambrian 508 Ma



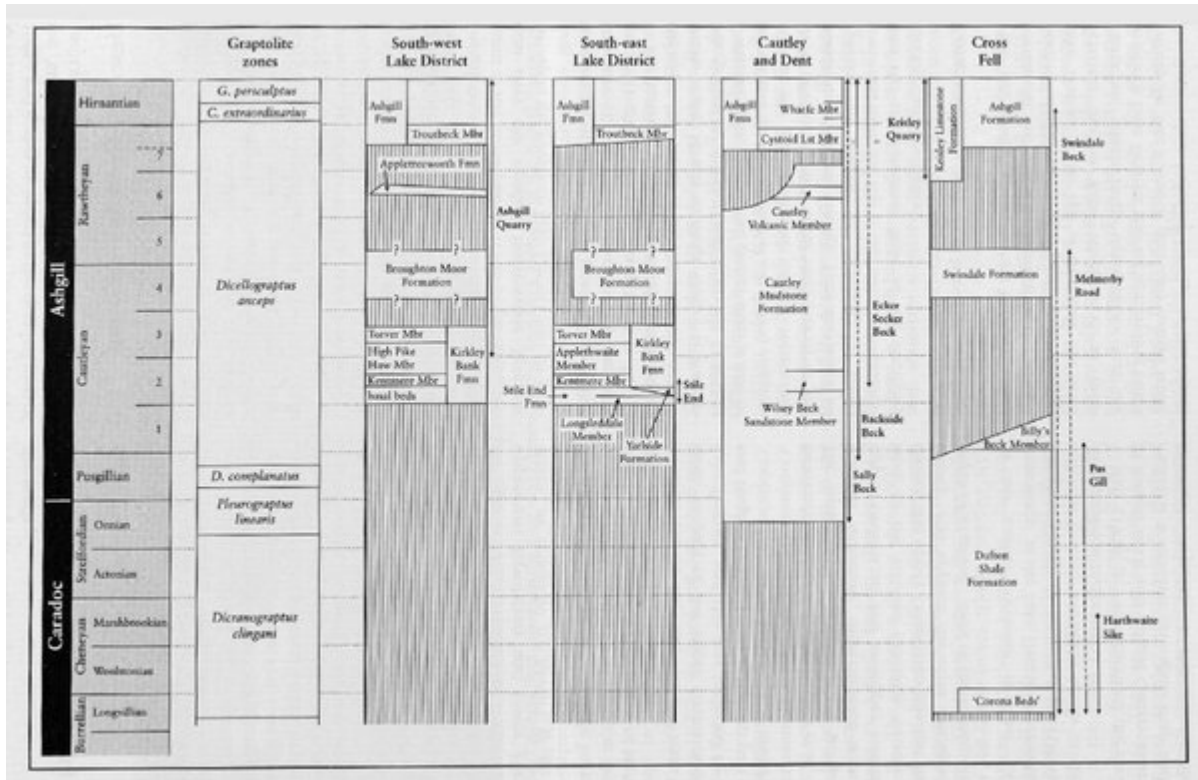
(b) Late Arenig 470 Ma



(c) Ashgill 446 Ma



(Figure 1.2) Palaeogeographical sketch-maps of the world, showing the changing relative positions of England, Wales and Scotland through the Cambrian and Ordovician. Adapted from maps generated by Dr David Lees using Atlaswinpro (Cambridge Paleomap Services).



(Figure 11.6) Correlation chart of the upper Ordovician (Dent Group) in the main crop of the Lake District, the Cautley and Dent inliers and the Cross Fell Inlier, and the stratigraphical range shown by the GCR site described herein, based on Kneller et al. (1994, fig. 5). In all areas the Dent Group lies unconformably on the Borrowdale Volcanic Group. The correlation of the graptolite zones with the stages of the Ashgill Series is subject to revision (R. B. Rickards pers. comm. 1999).