# Ash Fell Edge, Cumbria

[NY 733 050]–[NY 739 045]

## Introduction

The Ash Fell Edge GCR site lies 1.5 km ENE of Ravenstonedale on the road to Kirkby Stephen. The site offers the best available and continuous section of the upper part of the Ashfell Sandstone and lower part of the Ashfell Limestone in the Ravenstonedale district. It includes the busy A685 road cutting [NY 7360 0475], a significant part of the NW–SE-trending Ash Fell Edge escarpment [NY 7320 0510]–[NY 7392 0455] and a number of associated small but disused and overgrown quarries. The locality is renowned for the quality of its sedimentary features and the exceptional preservation of its fossils, and is important in understanding the tectono-sedimentary history of the Stainmore Basin during late Arundian and early Holkerian times. An early site description was provided by Garwood (1913, 1916) who gave details of the faunal succession. Later palaeontological work focused attention on the rich faunas and coral biostromes of the Ashfell Sandstone (Johnson and Nudds, 1975; Bancroft, 1986b; Nudds and Day, 1997), plant taphonomy (Nudds and Taylor, 1978) and conodont biostratigraphy (Higgins and Varker, 1982). Barraclough (1983) considered the sedimentology of the Ashfell Sandstone, but a comparable study of the Ashfell Limestone has yet to be undertaken. Logs of the succession are provided by Rose *et al.* (1973), Higgins and Varker (1982) and Barraclough (1983).

## Description

The exposed Ashfell Sandstone–Ashfell Limestone succession is approximately 55 m thick and dips gently to the north-east. At its base, the topmost beds of the Ashfell Sandstone (*c.* 10 m) include thin sandstones and a mix of vari-coloured (red, purple, green, grey) and highly fossiliferous mudstones and limestones capped by a massive cross-bedded sandstone (Figure 5.10). This part of the succession is decribed in detail by Barraclough (1983) (Figure 5.11). A rich coral–brachiopod fauna is known from these beds, including *Koninckophyllum ashfellense, Amplexizaphrentis enniskilleni, Siphonodendron martini, Composita ambigua, Stenoscisma isorhyncha, Syringothyris cuspidata* and *Spiriferina laminosa* (Garwood, 1913, 1916), most of which are typical of the Arundian Stage. A few metres below the massive sandstone, a prominent interbedded red mudstone–limestone interval contains the in-situ remains of *Siphonodendron martini* coral colonies (the 'Lithostrotion martini Bed' of Garwood, 1913, and Turner, 1950). The fine preservation of growth bands on these corals enabled Johnson and Nudds (1975) to use them as geochronometers and determine that there were 391 days in a Lower Carboniferous year. Later work by Nudds and Day (1997) indicated that the corals were stunted forms, their growth being inhibited by the influx of terrigenous sediment. In addition, some of these corals supported a varied epifauna. Garwood (1913) reported that some '*Lophophyllum*' *ashfellense* corallites were attached to '*L.*' *martini* corallites by 'strong roots', while Bancroft (1986b) noted corallites encrusted by various bryozoans, including the fistuliporoid cystopo-rates *Eridopora macrostoma* and *Fistulipora incrustans,* as well as an unidentified stenoporid trepostome. Above this 'biostromal' coral development, are bryozoan-rich mudstones and rare thin sandy limestones capped by a massive sandstone with a sharp erosive base. The latter unit, a prominent leaf of the Ashfell Sandstone, is a well-sorted, quartz-rich calcareous sandstone with contorted bedding and rip-up clasts at its base, cross-bedding in the middle section and rootlets at its top (Barraclough, 1983).

The overlying Ashfell Limestone (*c.* 45 m) is dominated by pale, thinly bedded and fine-grained bioclastic limestones with sparse developments of shale, siltstone and sandstone. In the lowest 20 m of the succession Ramsbottom (1974) described four minor sedimentary cycles consisting of 'fining-upward limestones' and thin shale-sandstone interbeds. Rare bands of dolomitic and/or sandy limestone and a further 'biostromal' development of *S. martini* occur towards the base of the unit (Rose *et al.,* 1973; Barraclough, 1983). Further up the sequence, laminated beds, bioturbation fabrics, mottled horizons and graded beds become more common. About 10 m above the base of the Ashfell Limestone, Nudds and Taylor (1978) discovered a micritic plant bed (0.5 m) containing leafy stem lengths of the lycopod *Archaeosigillaria kidstoni* preserved as uncompressed external casts of radial fibrous calcite in association with evaporite pseudomorphs. Rich faunas of a typical Holkerian aspect also occur in these beds including some distinctive brachiopods (*Linoprotonia* *corrugato-hemispherica, Davidsonina carbonaria*), corals (*S. martini, Syringopora geniculata*), gastropods, crinoid remains, fish teeth (*Streblodus, Psephodus*)and rare chaetetids, most of which were identified by Garwood (1913, 1916).

## Interpretation

The exposed section falls entirely within the *Productus corrugato-hemisphericus* Zone of Garwood (1913), the junction between the Ashfell Sandstone and Ashfell Limestone corresponding to the subzonal boundary between his 'Gastropod Beds' and '*Cyrtina carbonaria*' sub-zones (see (Figure 5.3); and (Figure 4.2), Chapter 4). This junction was taken by Ramsbottom (1973) as the boundary between his 'Major Cycle 3' and 'Major Cyde 4' (later the D3-D4 mesothemic cycle boundary; Ramsbottom, 1977a) and was subsequently used to define the position of the Arundian–Holkerian stage boundary in the Ravenstonedale succession (George *et al.,* 1976). The section also falls within the *Cavusgnathus* condont zone of Higgins and Varker (1982).

The Ashfell Sandstone is a diachronous unit that extends from the River Eamont (Penrith) in the north-west to Garsdale (Sedbergh) in the south (Garwood, 1913; Turner 1959a, 1963). Although a number of early workers speculated on the origin of the sandstone (George, 1958; Turner, 1959a) the generally accepted view is that it represents a complex fluvio-deltaic sand-body sourced from the north-east and linked (possibly) to the similarly aged Fell Sandstone Group incursions of the Northumberland Basin (Ramsbottom, 1974; Gawthorpe *et al.,* 1989; Leeder, 1992). Barraclough (1983) interpreted this part of the succession as part of a prograding shoreline complex at the edge of the Ashfell delta. Beds beneath the massive sandstone were regarded as offshore muds with some storm layers, whereas the massive sandstone itself was thought to represent a shoreface sand deposit. Although Turner (1950) regarded the contorted layers of the sandstone as evidence of contemporaneous slumping, Barraclough (1983) suggested that they resulted from the de-watering of the underlying mudstone. Palaeocurrent evidence indicates that the Ashfell Sandstone was sourced from the east (Barraclough, 1983).

Despite the lack of sedimentological research on the Ashfell Limestone, its character suggests that it was deposited in a shallow marine environment of variable water depth and salinity, the presence of corals and brachiopods indicating open marine conditions at some levels, while the association of calcispheres, paraparchitid ostracodes and suspected evaporite nodules suggests restricted and possibly hypersaline conditions at other levels (e.g. the A. kidstoni Plant Bed of Nudds and Taylor, 1978).

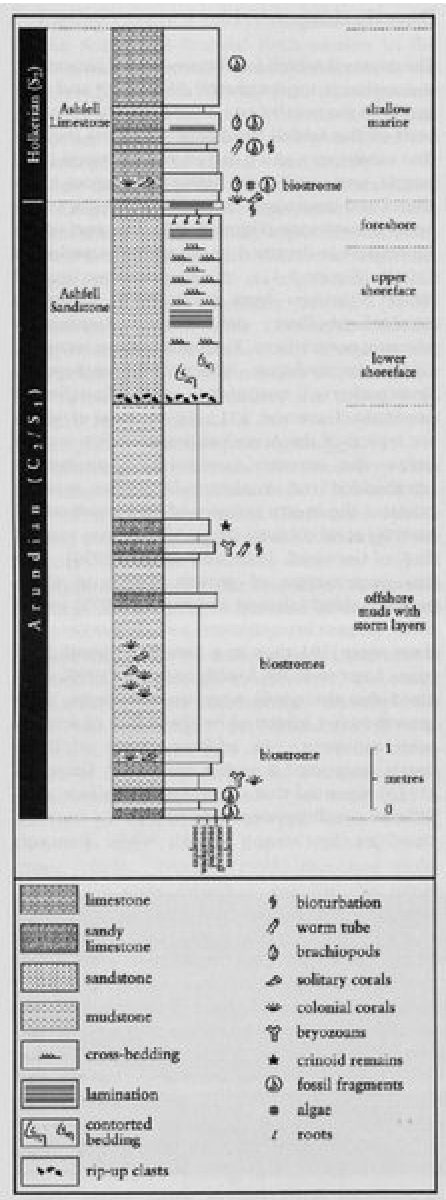
To summarize, as the Ash Fell delta was abandoned at the end of Arundian times, an early Holkerian marine incursion resulted in the formation of an extensive carbonate platform over the subsiding delta lobe, and upon it the Ashfell Limestone was deposited. It was at this time that the geomorphological expression of the 'Stainmore (Ravenstonedale) Gulf' was effectively diminished (Gawthorpe *et al.,* 1989).

## Conclusions

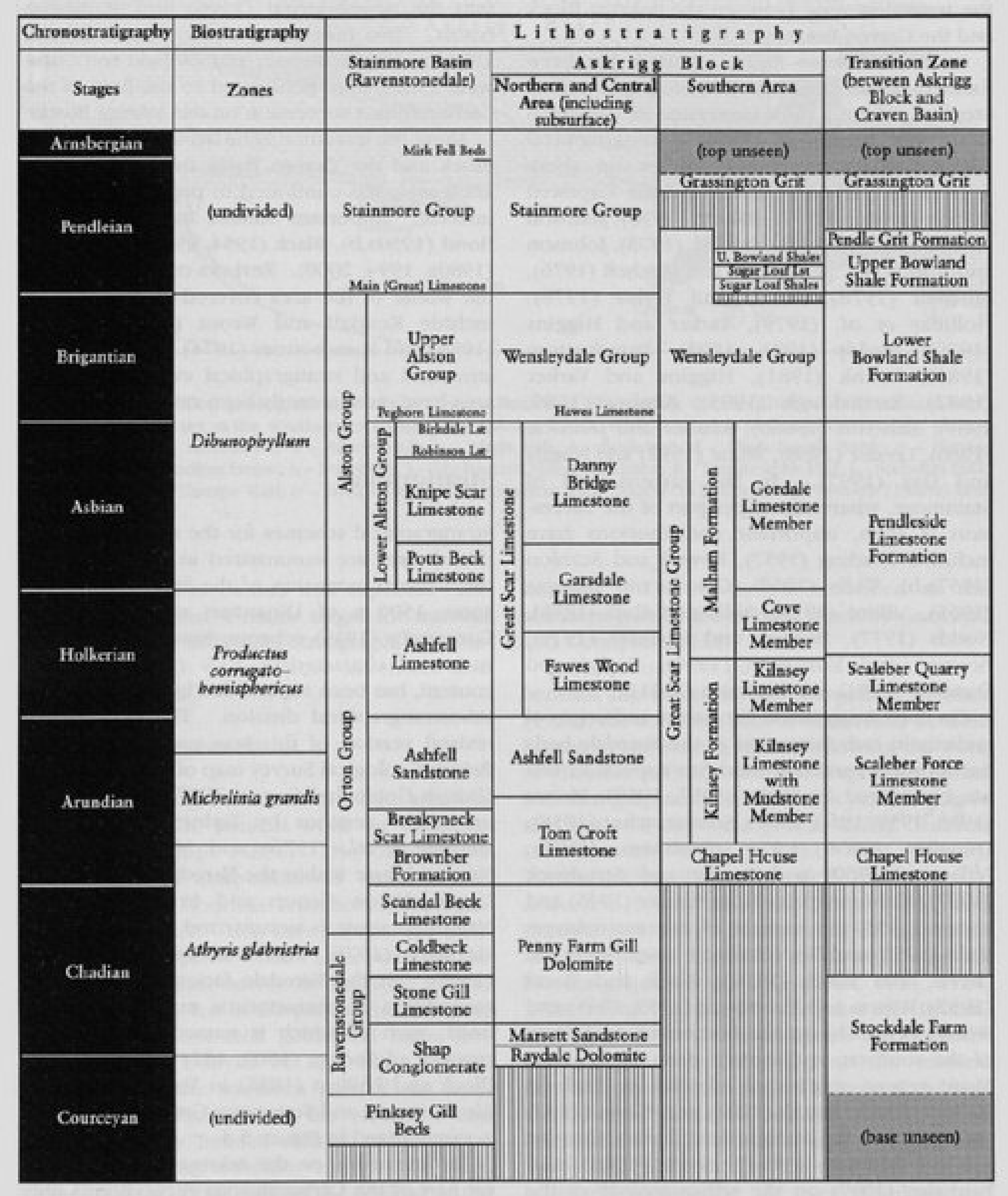
Ash Fell Edge is a classic mixed-interest site that exposes a particularly fine section of the Ashfell Sandstone and Ashfell Limestone, and a critically important exposure of the Arundian–Holkerian stage boundary. The site is vital for the correlation of successions across the Stainmore Basin and into neighbouring areas of the Askrigg and Lake District-Alston blocks. In addition, it is also of crucial significance in understanding the complex interaction between the deltaic and marine processes that influenced the formation of the Ashfell Sandstone (delta margin) and the Ashfell Limestone (marine carbonate platform) at a key stage in the evolution of the Stainmore Basin. The site remains a promising prospect for future sedimentological and biostratigraphical research.

**References**

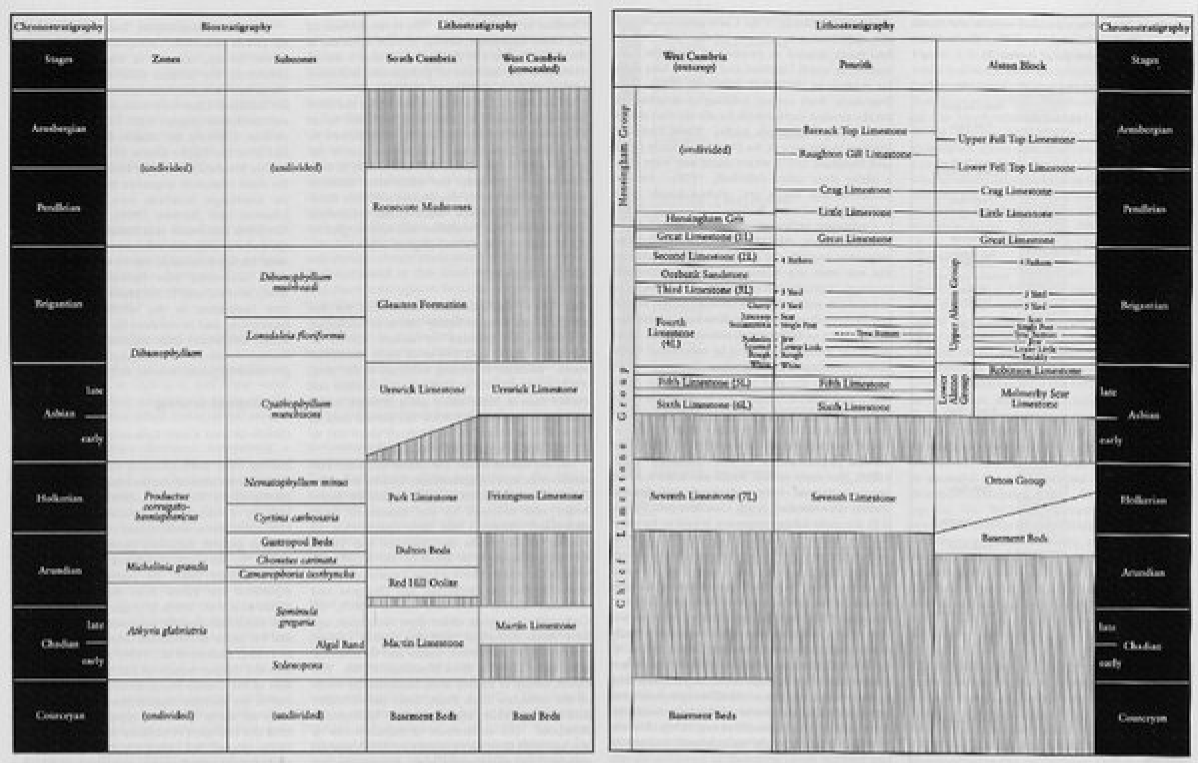
(Figure 5.10) General view of the A685 road cutting at Ash Fell Edge illustrating the transition from the top of the Ashfell Sandstone (Arundian) into the base of the Ashfell Limestone (Holkerian). Seen here, the Ashfell Sandstone includes vari-coloured mudstones (left) and a massive cross-bedded sandstone unit (centre). Higher in the sequence are the prominent limestone beds of the Ashfell Limestone (top centre and right). (Photo: P.J. Cossey.)




(Figure 5.11) Sedimentary log across the Ashfell Sandstone–Ashfell Limestone boundary at the Ash Fell Edge GCR site. After Barraclough (1983).




*(Figure 5.3) Simplified stratigraphical chart for the Lower Carboniferous sequence of the Askrigg Block and Stainmore Basin. Compilation based upon and modified after George et al. (1976), Dunham and Wilson (1985), Arthurton et al. (1988), British Geological Survey (1997b,c), and Mundy (2000). Zonal biostratigraphy (Chadian–Brigantian only) after Garwood (1913). For further details of the Wensleydale Group, Upper Alston Group and Stainmore Group successions, see (Figure 5.4). Areas of vertical ruling indicate non-sequences. Not to scale.*



*(Figure 4.2) Simplified stratigraphical chart for the Lower Carboniferous succession of the Lake District Block and Alston Block; the age of the Basement Beds is uncertain in many areas. Compilation based on information from Eastwood et al. (1931), George et al. (1976), Rose and Dunham (1977), Mitchell (1978), Ramsbottom (1978a), Arthurton and Wadge (1981), Athersuch and Strank (1989), Horbury (1989), Dunham (1990), Barclay et al. (1994), Chadwick et al. (1995) and Akhurst et al. (1997). Zonal biostratigraphy (Chadian–Brigantian only) after Garwood (1913). Areas of vertical ruling indicate non-sequences. Not to scale. Note that following text submission, the majority of those lithostratigraphical units in the 'South Cumbria' and West Cumbria (concealed)' columns have been designated as formations (Johnson et al., 2001).*