River Esk, Glencartholm, Dumfries and Galloway

[NY 377 792]–[NY 376 799]

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Introduction

The River Esk at Glencartholm, some 5 km south of Langholm, is the type locality of the Glencartholm Volcanic Beds (Figure 3.17). These are the only preserved record of significant pyroclastic activity associated with development of the Northumberland, Solway and Tweed basins. Also, these beds are the youngest of three chronologically distinct volcanic episodes within the Dinantian succession of the Langholm area ((Figure 3.2); the other two are the Birrenswark Volcanic Formation and the Kershopefoot basalts; see Langholm–Newcastleton Hills and Kershope Bridge GCR site reports). All of these volcanic successions are critical to our understanding of Late Palaeozoic crustal and mantle processes, during the development of the Northumberland, Solway and Tweed basins.

The Glencartholm Volcanic Beds were formed during the later part of the syn-extensional phase (Chadwick *et al.,* 1995).

The Glencartholm Volcanic Beds comprise a 150–180 m-thick sequence of tuffs, localized lavas and interbedded mudstone and sandstone (many of which are volcaniclastic) and thin limestones, that occurs at the base of the (Visean) Upper Border Group. Palaeontological data from the interbedded lithologies suggest an age close to the Holkerian–Asbian boundary (George *et al.,* 1976).

Brief accounts of the volcanic beds were included in publications by Peach and Horne (1903), Barrett and Richey (1945), Elliott (1960), Lumsden and Wilson (1961) and Leeder (1974); the most comprehensive description, including the type locality, is that of Lumsden *et al.* (1967).

Glencartholm has been credited as being the richest fossil fish site within the Carboniferous rocks of the British Isles, and in an international context is one of the most important Palaeozoic vertebrate sites in the world (see Dineley and Metcalf, 1999). It is also an important palaeobotanical site (see Cleal and Thomas, 1995).

Description

The Glencartholm Volcanic Beds are the basal unit of the Upper Border Group, a succession mainly composed of sedimentary rocks and in total probably up to 800 m thick. The group may be divided into a lower unit comprising the volcanic rocks, marine mudstones, limestones and subordinate sandstones and coals, and an overlying upper unit dominated by arenaceous rocks with only subordinate argillaceous strata and thin limestones. These, and equivalent strata of early Asbian age, are known to crop out widely in the western and central parts of the Northumberland Basin, and along the northern margins of the Solway Basin.

The Glencartholm Volcanic Beds form a disconnected series of narrow outcrops extending over a distance of about 10 km from the Irvine Burn north-eastwards to the Muir Burn. Owing to the relatively soft and easily weathered nature of these fragmental volcanic rocks, there are few exposures other than in stream sections. The most extensive sections are found in Haw Gill, Pow Gill and Rae Gill, all streams at the head of the Muir Burn, but the best known, and the designated type locality, is between the Heck's Burn and Mumbie faults in the River Esk at Glencartholm (Figure 3.17).

The best section is seen on the east bank of the River Esk. Here, the strata dip mainly towards the south or SSE at 5° to 60°, but the section is complicated by numerous small faults and folds. The lowest beds, at least 21 m thick, are poorly bedded blue-grey tuffs with thin beds of fine- to coarse-grained volcaniclastic sandstone. Both contain altered fragments of igneous and sedimentary rock. The larger fragments in the tuffs, up to 7.5 cm across, are mostly of sandstone, quartz, chert and 'cementstone'; the igneous clasts are considerably smaller. These are succeeded by interbedded tuffs,

tuffaceous sandstones and siltstones, and 'cementstones'. There are numerous thin beds of chert, cherry sandstone and limestone.

The richly fossiliferous beds that have yielded internationally important arthropods and fish, first noted by Peach and Horne (1903), are exposed over a distance of 46 m about 460 m upstream from the mouth of Heck's Burn [NY 3764 7960]. They are a gently dipping sequence of fissile calcareous sandstones with thin 'cementstones', and fine-grained sandy limestone up to 15 cm thick. Beyond these beds, and across a couple of faults, there is a gently folded sequence of soft sandstones, tuffa-ceous sandstones and thin tuffs. Some of the tuffaceous beds display upward-fining graded bedding. The highest beds in the section are exposed upstream from the Heck's Burn Fault. These comprise thinly bedded, multicoloured, tuffaceous siltstones and silty sandstones with numerous thin 'cementstones', limestones and rare coal.

The petrography of the volcaniclastic rocks in the River Esk section has been described by R.W. Elliot (in Lumsden *et al.,* 1967). Descriptions of similar rocks in the Archerbeck Borehole [NY 4157 7815] were described by D.C. Knill (in Lumsden and Wilson, 1961). The igneous clasts in the tuffs provide clues to contemporary volcanism in the region. They include basalt, spilitic basalt, andesite, mugearite, trachyte and scoria. Other clasts include sandstone, quartz, chert and 'cementstone'. Small crystals of cassiterite have been found in samples from the borehole.

Effusive volcanic activity was not a major feature of this volcanic episode as there are few occurrences of lavas within the Glencartholm Volcanic Beds. None are noted from the River Esk section, but there are subordinate basalt occurrences up to 15 m thick elsewhere in the area. These include olivine-clinopyroxene-plagioclase-phyric basalt in Palling Burn *c.* [NY 305 788], some distance west of Glencartholm and, to the east, some very altered olivine-clinopyroxene-phyric basalts at Rae Gill [NY 4493 8240] and hawaiite or mugearite at Pow Gill [NY 4493 8289]. All occur at or near the base of the volcanic sequence and, upon brecciation or erosion, may have supplied some of the clasts in the tuffs at higher levels.

Interpretation

The Glencartholm Volcanic Beds have a wide, but variable, distribution across the Northumberland and Solway basins and were proved at depth in the Archerbeck Borehole near Canonbie (Lumsden and Wilson, 1961). The Oakshawford Tuff of the Bewcastle Anticline (Day, 1970) is probably its lateral equivalent. The sequence in the Archerbeck Borehole is greater than 152 m thick, whereas only a metre of tuff at Oakshawford suggests an abrupt thinning to the south (Leeder, 1974). None of the natural sections is complete, being either faulted or poorly exposed.

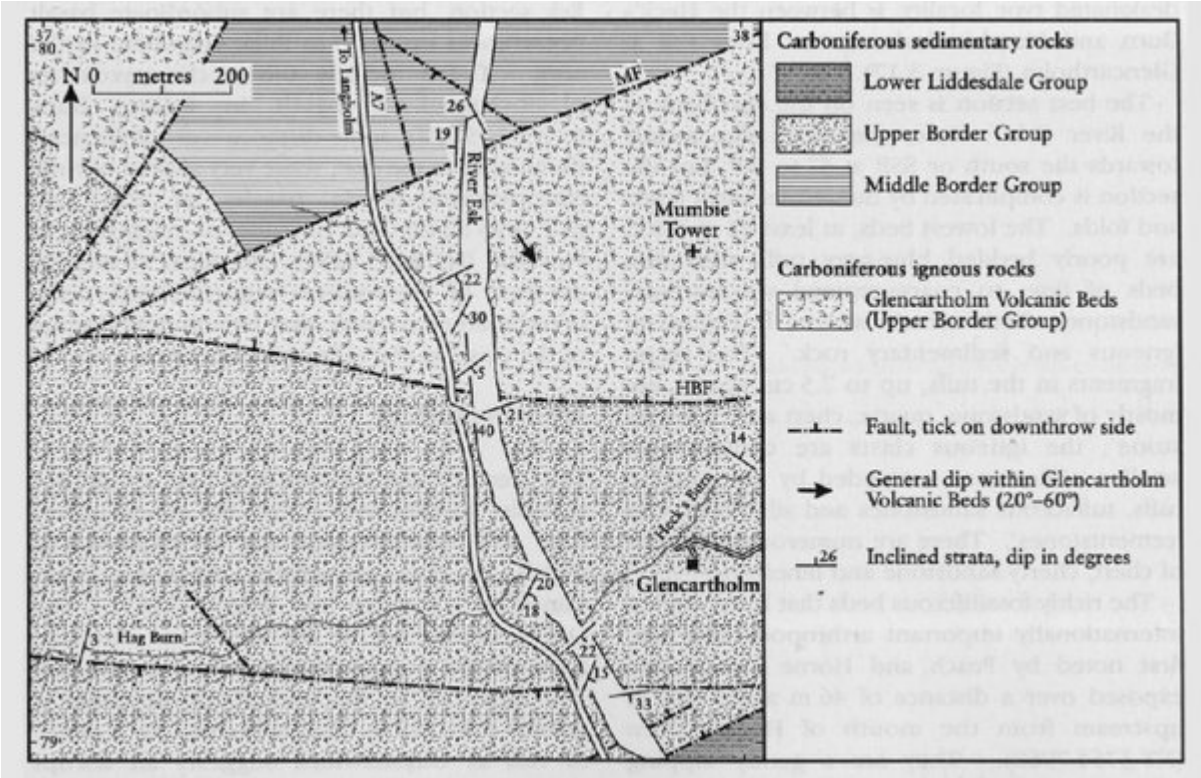
The volcanic beds are predominantly of pyroclastic and volcaniclastic sedimentary origin; fine-grained crystal- and lapilli-tuffs in beds a few centimetres to over 20 m thick are typical. The thinner beds, often with upward-fining profiles, are dominated by volcanic material whereas many of the thicker units include a high proportion of non-volcanic detritus. The interbedded, commonly spectacularly fossiliferous, sedimentary rocks were interpreted by Lumsden *et al.* (1967) as lagoonal to shallow marine sequences that were buried periodically by volcanic, predominantly ash-fall, deposits. The volcanic eruptions effectively contaminated these sedimentary environments, killing off any biota for significant periods until re-colonization could take place.

Volcanic necks and associated minor intrusions in the region appear not to cut strata younger than the Glencartholm Volcanic Beds and have consequently been suggested as possible sources for the volcanic rocks (McRobert, 1920; Lumsden *et al.,* 1967). As much of the igneous detritus is compositionally distinct from the associated lavas, D.C. Knill (in Lumsden and Wilson, 1961) suggested that it may have been derived from the erosion of pre-existing volcanic rocks. However, this scenario was dismissed by Lumsden *et al.* (1967) on the grounds that similar detritus is not present in the interbedded sedimentary rocks and such rapid and repeated changes in provenance were unlikely to have occurred.

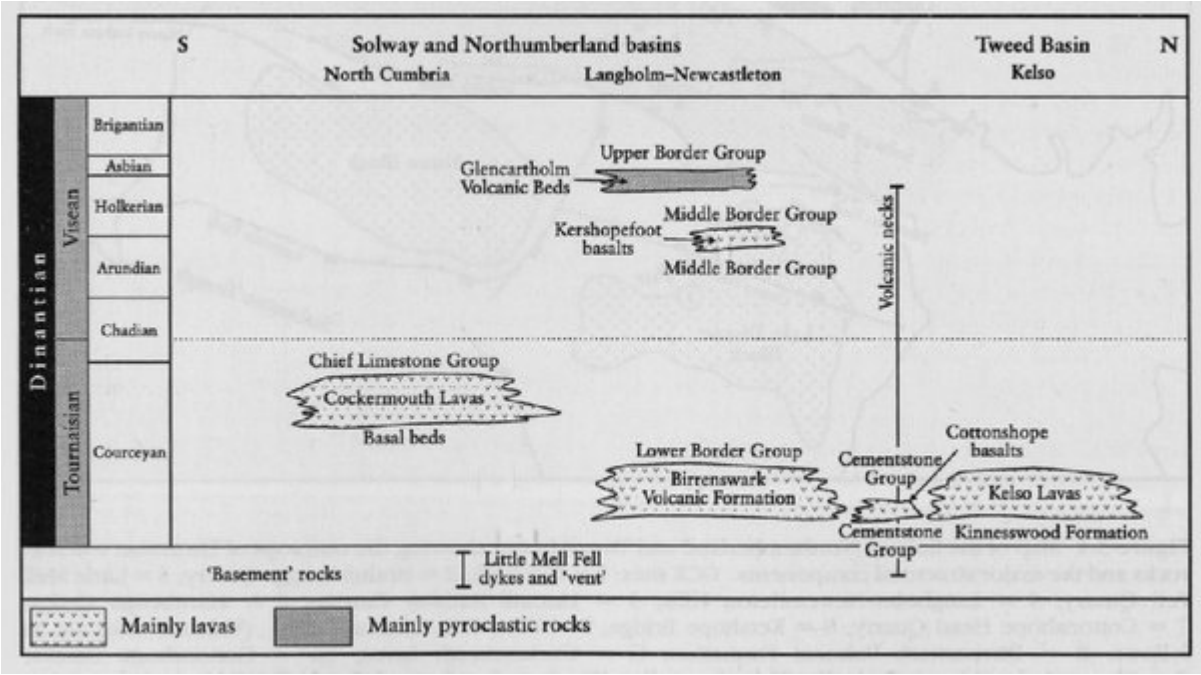
Conclusions

The section in the River Esk at Glencartholm is the type locality for the Visean Glencartholm Volcanic Beds. These predominantly bedded tuffs and volcaniclastic sedimentary rocks, in a succession 150–180 m thick, represent the latest and only significant volcaniclastic event during Dinantian volcanism associated with the early evolution of the Northumberland, Solway and Tweed basins. Fossil plant, arthropod and fish remains within the marine and lagoonal strata interbedded with these rocks are of international importance.

References



(Figure 3.17) Map of the area around the River Esk, Glencartholm GCR site. (HBF = Heck's Burn Fault; MF = Mumbie Fault.) Based on Geological Survey 1:10 560 Sheet NY 37 NE (1967).



(Figure 3.2) Stratigraphy of the volcanic rocks of the Solway, Northumberland and Tweed basins. The range of strata cut by intrusions and volcanic rocks is also shown. After Gawthorpe et al. (1989).