

STRATEGIC STONE STUDY

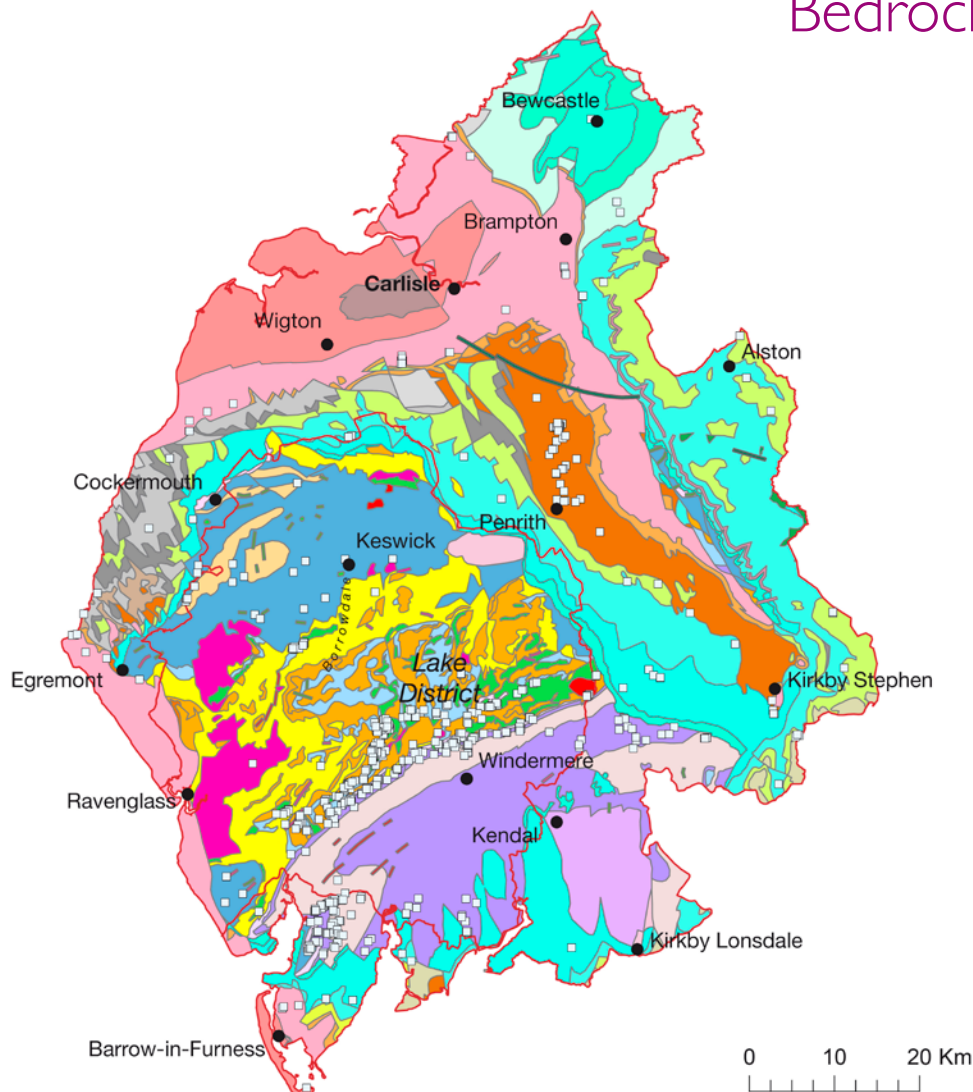
A Building Stone Atlas of
CUMBRIA & THE LAKE DISTRICT

Published August 2013



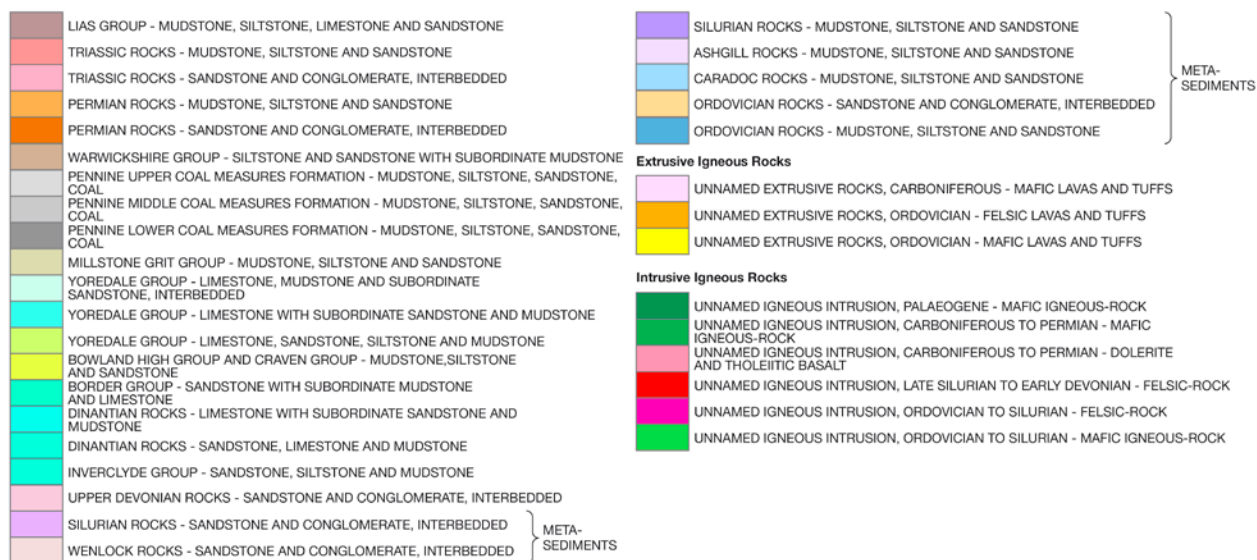
ENGLISH HERITAGE

Cumbria — Lake District Bedrock Geology



Bedrock Geology of Cumbria and The Lake District

□ BUILDING STONE SOURCES



Click on this link to explore the geology of Cumbria and the Lake District and the area's known building stones, stone structures and building stone quarries (opens in new window <http://maps.bgs.ac.uk/buildingstone?County=Cumbria>)

INTRODUCTION

Cumbria and its local authority, Cumbria County Council, were created in 1974 through the amalgamation of the historic counties of Westmorland (to the north) and Cumberland (to the south). The 'new' county also incorporated the Lake District National Park established some two decades earlier. As a result, Cumbria boasts not only some of England's most attractive and unspoilt scenery, but represents an area of highly varied geology. The various rock types present have been used extensively to construct its unique assemblage of vernacular stone buildings and, in some cases, have been exported to markets located much further afield (both national and international).

Given the wealth and range of **LITHOLOGIES** present, it is not surprising that stone-built structures dating back to Prehistoric times are found within Cumbria e.g. the Late Neolithic to Early Bronze Age 'Long Meg and her Daughters' (comprising, respectively, a silica-cemented red Penrith Sandstone monolith and in excess of 50 large igneous erratics). A more organized approach to the quarrying of stone and building construction was introduced by the Romans in the C2, as is evident from the remains of their many forts and other buildings at, for example, Hardknott (comprising various igneous lithologies of the Borrowdale Volcanic Group), Ambleside (of Borrowdale Volcanic Group **SLATE**), Ravenglass (where the bath house is of red St Bees Sandstone block) and Bewcastle (of Carboniferous **LIMESTONE** and **SANDSTONE**, the blocks of which were reused in the C11 for the castle on the same site). By far the most impressive of all the Roman remains in Cumbria, however, is Hadrian's Wall, constructed to protect the northernmost limits of the Roman Empire and built in large part of local stone types which are as varied as the geology of the formations that it crosses.

After the departure of the Romans in c. 400 AD, there followed a long period during which there appears to have been little significant use of building stone, except for the 'recycling' of material from earlier Roman structures. However, it is evident from the decoratively carved Anglo-Saxon (C8 to C10) stone crosses found, for example, at Bewcastle and Kirkby Stephen (both of Carboniferous sandstone) and also at Great Urswick (of red St Bees Sandstone) that the skills associated with the selection, quarrying and carving of stone lived on in Cumbria during the 'Dark Ages'. A return to the use of stone for large-scale building projects awaited the

arrival of the Norman barons in the late C11. The local stone resources were employed to great advantage at this time in the construction of defensive castles (e.g. those at Carlisle and Brough). Subsequently, many of the area's churches were established, and these were built primarily of locally quarried stone.

During medieval times, the remoteness of much of Cumbria attracted monastic communities, who made extensive use of the locally available stone types in the construction of their abbeys and priories. Remnants of these often substantial buildings survived The Dissolution in the C16, and were left either as 'picturesque' ruins (now much-visited) or were in part re-vitalised as parish churches e.g. Barrow-in-Furness (red Triassic Sherwood Sandstone), Lanercost (grey Carboniferous and red St Bees sandstones) and Cartmel (grey Carboniferous sandstone yielded by the Alston Formation).

Cumbria's late medieval buildings reflect the turbulent nature of these times. Long fought over by factions from Scotland and England, the surviving stone architecture from this period comprises massive defensive towers and castles, including those at Appleby-in-Westmorland (of local Carboniferous sandstone), Brough (of variegated Carboniferous sandstone, in part reused, and red Permian Penrith Sandstone) and Carlisle (of red Lazonby, red St Bees and grey Kirklington sandstones). These structures were later joined by a wide range of smaller fortified tower houses (Peel, or Pele, houses) e.g. Clifton (of pink Carboniferous sandstone) and Dalton-in-Furness (of pale grey Carboniferous limestone and red-brown Sherwood Sandstone). By the C17, C18 and on into the C19, more peaceful times saw the construction (or remodelling) of some of Cumbria's best known and now most visited stately homes, including Lowther Castle (of Carboniferous sandstone) and Naworth Castle (of grey Carboniferous and red Triassic sandstones).

The last of Cumbria's major stone-building projects were undertaken by the C19 Victorian architect-builders, including leading lights of this period such as Butterfield, Gilbert Scott, Pugin, Christian, Salvin and Waterhouse, whose work is seen across the county. These architects in large measure oversaw the construction or reconstruction of many of the churches, great houses and other buildings that typify the 'Lakeland' stone architecture seen today in Ambleside, Bowness-on-Windermere, Keswick and Troutbeck, for example.

Geological context

The geological history of Cumbria is complex and as yet is not fully understood. Modern **STRATIGRAPHICAL** re-appraisals have resulted in both interpretational changes and significant revisions to the nomenclature applied to the area's rock successions. It is the current stratigraphical terminology that is used in this atlas. An up-to-date account of the geology of Cumbria is provided in the 5th Edition of BGS's Regional Guide to Northern England (Stone *et al.* 2010), and descriptions of the stratigraphical units herein referred to are contained within the BGS Lexicon of Named Rock Units (<http://www.bgs.ac.uk/lexicon>).

The oldest rocks occurring within Cumbria crop out in the Lakeland Fells around Borrowdale and are well exposed on the high peaks of Skiddaw, Scafell Pike and Great Gable. These rocks – comprising a thick, deformed and faulted sequence dominated by metamorphosed **MUDSTONES**, **SILTSTONES** and **VOLCANICLASTIC** rocks (the Cumbrian 'slates') – form a Lower Palaeozoic (Siluro-Ordovician) 'core' to the area. This is intruded by a variety of igneous rocks, including **GRANITES** and **DIORITES**. Surrounding the mountainous 'core', which typifies the scenery of the Lake District National Park, are lower-lying areas underlain by younger sedimentary rocks that include the thick Carboniferous successions of Alston, Kirkby Stephen and the Cumbrian (or Whitehaven) Coalfield, and the deep Permo-Triassic basins of the Vale of Eden, Carlisle and Barrow-in-Furness.

Much of Cumbria's present-day topography is a reflection of the climatic instability that has characterized the last 2.5 million years. During Pleistocene times, glaciers episodically radiated outwards from the central 'highlands', deeply eroding these parts and mantling the valley floors and adjacent areas with thick blankets of unconsolidated **TILL** and fluvio-glacial sediments. In the west, this thick succession extends to the coastal plain and beyond, while to the east it drapes the Permo-Triassic rocks of the Eden Valley.

Local quarrying of stone in Cumbria dates back to Roman times as is widely evident from its use in Roman buildings and structures across the area (see below). However, the quarrying of building stone as an industry came relatively late in Cumbria owing to the varied and often extreme topography of the county. Prior to the mid-C19, only a few quarry operators with ready access to a suitable means of transportation – principally the sea – were able to move their commodities any great distance. Some Cumbrian roofing

slate producers, for example, were regularly shipping their products to London and the south of England by the C17, while the coastal quarries around St Bees (working red Triassic sandstone) were exporting building stone to America, Australia and Scotland during the first half of the C19. Further growth of the Cumbrian stone quarrying industry had to wait for the development of the local road and rail networks in the C19 and C20, thereby enabling access to wider national markets.

SILURO-ORDOVICIAN

LOWER–MIDDLE ORDOVICIAN

Skiddaw Group

The Skiddaw Group consists primarily of dark coloured 'slates' (more specifically, metamorphosed siltstones and mudstones with sporadic beds of greywacke). These have been widely used as a vernacular building stone, often in crudely dressed **RUBBLESTONE** form. Finely cleaved lithologies capable of serving as good quality roofing slate are not generally present, however. The largest town located on the **OUTCROP** is Keswick, which is very much characterized by its distinctive stone buildings. Keswick expanded considerably during the C19, with the 'new' buildings being constructed of a wide range of stone types 'imported' from other areas of Cumbria



In common with many of the Victorian buildings in Keswick, the Police Station and adjoining Magistrates Court (1901–2) are constructed of 'imported' building stones. A commonly used combination of stone types, as seen here, was olive green coloured Borrowdale Volcanic Group slate and brick red Permo-Triassic sandstone.

(suggesting indifference to the local Skiddaw Group 'slates'). It is consequently a town that has some of the most interesting, varied and colourful Victorian stone architecture in Cumbria. The Victorians were nothing if not adventurous in Keswick! Polychromatic fabrics are commonplace and make the town one of the more interesting and challenging building stone 'trails' in Cumbria.

UPPER ORDOVICIAN

Borrowdale Volcanic Group

The Borrowdale Volcanic Group comprises a substantial thickness of sub-aqueously deposited volcanoclastic sediments (**TUFFS**, coarse-grained volcanoclastic sandstones and **AGGLOMERATES**), with abundant interbedded sequences of lava flows and sills. These rocks crop out most impressively in and around the high peaks of the National Park at, for example, Scafell and Great Gable. Both the mapping and correlation of the Borrowdale Volcanic Group rocks across the area have always been problematic owing to the lack of stratigraphically useful marker horizons within the succession.

The tectonic deformation of the Borrowdale Volcanic Group 'strata' during the Lower Devonian (associated with the Acadian (orogenic) Event) imprinted a cleavage that is particularly well developed in the finer grained volcanoclastic horizons. It is these strongly cleaved rocks, which occur at several different stratigraphic levels, that are one of the principal sources of the renowned blue, grey and green 'Lakeland' (a.k.a. 'Cumberland' or 'Westmorland') roofing slates. The slate beds are still quarried in large surface workings, or are mined along deep adits which follow the target slate bands.

Historically, the major slate quarrying areas lay in and around Ambleside, Skelwith Bridge, Little Langdale, Elterwater, Grasmere, Coniston and Honister. At the Honister Slate Mine, located towards the eastern end of the Honister Pass, production of the eponymously named olive green roofing slates continues today by traditional means. In addition to the Honister operations (where the Eagle Crag Sandstone Formation is worked), current slate quarrying activities within the Borrowdale Volcanic Group are concentrated in the Coniston, Tilberthwaite and Elterwater areas (all working the Seathwaite Fell Sandstone Formation).

The cleaved lithologies in general have been employed for vernacular building purposes, both as a roofing and as a walling



Production of olive green coloured roofing slates continues today by traditional means at the Honister Slate Mine. The slates are worked from the Eagle Crag Sandstone Formation of the Borrowdale Volcanic Group.

material. Indeed, there is evidence of the use of Borrowdale Volcanic Group rocks as rubblestone walling dating back to at least Roman times (e.g. Hardknott Fort). Whereas the stone used for walling tended to originate from the coarser grained, more poorly sorted and imperfectly cleaved beds, the highest quality roofing slates originated from the fine-grained and finely cleaved tuff bands. These could be split along their natural cleavage to produce large, heavy 'slabs' of uniform colour and thickness. It was common practice to lay the roofing slates in diminishing courses from eaves to ridge.

Initially, the roofing slates could only be supplied to the local market, but as transportation networks developed they became much sought after for use in the construction of higher status buildings across the rest of England and in parts of Scotland. Slates from the quarries located near Troutbeck Park had reached London (e.g. Chelsea Hospital and Kensington Palace) and other southern markets by the mid-C17, having been transported first by pack animals and carts, then by boats along local river courses, and finally by sea.

The vernacular cottages and farms of the Borrowdale Volcanic Group outcrop area are characterized by coursed and uncoursed 'slate' rubblestone wall fabrics (which sometimes incorporate other more tractable stone types such as Carboniferous sandstones and limestones as window lintels, mouldings and door surrounds). At Elterwater, the rubblestone cottages feature massive, irregularly shaped window lintels and quoins of the local green 'slate'. These old, highly distinctive vernacular building styles were subsequently



© Stephen Parry

Bridge House, built over Stock Ghyll in Ambleside during the C17, is constructed of Borrowdale Volcanic Group rubblestone, including vesicular andesite.

copied in the architecture of the rapidly expanding Victorian 'resort' towns including Windermere, Troutbeck, Ambleside, Skelwith Bridge and Keswick.

UPPER ORDOVICIAN AND SILURIAN

Windermere Supergroup

The Windermere Supergroup includes strata of Upper Ordovician (Ashgill) and Silurian (Llandovery to Pridoli) age. It comprises a very thick (c. 4.5 km) succession of shallow to deep water lithologies, which are in part volcanoclastic and are often strongly tectonized. As a result, the rocks of the Windermere Supergroup tend not to be particularly suitable for use as a general purpose building stone. A total of five groups are recognized within the succession as a whole viz. the Dent, Stockdale, Tranearth, Coniston and Kendal groups.



© Stephen Parry

The buildings of the Chapel Hill–How Head area of Ambleside commonly boast fabrics of Borrowdale Volcanic Group rubblestone. This cottage on Chapel Hill has conspicuous massive quoins and lintels of poorly cleaved 'slate'

Tranearth Group

Strongly cleaved, **HEMPELAGIC** silty mudstones dominate the Tranearth Group lithologically. The traditional source of blue-grey 'Burlington' slate, it has provided very substantial quantities of roofing slate not only for Cumbria itself but also for areas located further afield. Indeed, from the C17, 'Brathay' slates were exported by boat to London and elsewhere in the south of England via Lake Windermere and the River Leven. The slate quarries were located to the north of Lake Windermere, near Troutbeck and around Applethwaite Common. The Wray Castle Formation (sitting at the top of the Tranearth Group) is still worked for slate at Kirkby Quarry, near Kirkby-in-Furness, but evidence of far more extensive former quarrying operations is seen nearby, notably in the vicinity of the 'Burlington' quarries, which were principally concentrated between Wall End and Gawthwaite Moor.

Coniston and Kendal groups

Both the Coniston and Kendal group successions, lying at the top of the Windermere Supergroup, are represented by thick accumulations of deep water **TURBIDITIC** sandstone and hemipelagic mudstone. The sandstone-dominated beds of the Gawthwaite Formation (Coniston Group) were worked at Eccle Riggs Quarry near Broughton in Furness and also along strike to the north-east near Torver. At stratigraphically higher levels, the Bannisdale Formation (Kendal Group) comprises metamorphosed fine-grained sandstones, banded siltstones and (nodule-bearing) mudstones. These 'slates' were used locally as a vernacular building material across their outcrop area in southern Cumbria, although few definite building stone-producing quarries have been identified. The several hundred metre thick succession of fine-grained sandstones that comprises the Kirkby Moor Formation (at the very top of the Kendal Group) has been worked extensively for roadstone—and possibly also for building stone—at the Roan Edge and Holmescales quarries to the east and south-east, respectively, of Kendal.

ORDOVICIAN AND LOWER DEVONIAN IGNEOUS INTRUSIONS

A number of medium- to coarsely-crystalline granitic intrusions have been exploited for building and decorative stone in Cumbria.

'Eskdale Granite' (Upper Ordovician)

This sizeable intrusive complex, now referred to as the Eskdale Intrusions, is lithologically dominated by medium- to coarse-grained granite and granodiorite. It crops out in the Eskdale Fell, Muncaster Fell and Waberthwaite areas. The complex was the source of the pale pink microgranite used to build the Victorian mansion house known as Muncaster Castle (the stone having likely been produced at Beckfoot Quarry) and various lineside buildings erected by the Whitehaven & Furness Junction Railway (e.g. the 1850 station at Millom).

The grey 'Broad Oak Granodiorite' has been both quarried and gathered (in the form of 'fieldstones') around Waberthwaite for use as a building stone and, occasionally, as an ornamental stone. The large quarry to the west of Broad Oak itself is



Millom railway station, opened in 1850 by the Whitehaven & Furness Junction Railway, is constructed of angular blocks of 'Eskdale Granite' with dressings and bands of red-brown Sherwood Sandstone.

not in regular production at present, but limited amounts of stone can be supplied to meet specific requirements.

'Ennerdale Granite' (Upper Ordovician)

The 'Ennerdale Granite' (now known as the Ennerdale Intrusion) crops out to the north and south of Ennerdale Water, covering an area of some 50 km². It comprises variably **PORPHYRITIC**, **GRANOPHYRIC** granite and microgranite, with zones of diorite, dolerite and **HYBRIDIZED ROCKS**. The pink and grey-green granitic rock used for the mid-C19 Church of St. James (and some of the farm buildings) in Buttermere is believed to originate from this intrusive body.

'Threlkeld Granite' (Upper Ordovician)

This body of porphyritic grey microgranite (the 'Threlkeld Intrusion') forms a series of outcrops to the south of Threlkeld. The granite was used locally to a limited extent in farm buildings and for quoins. It is also seen in Keswick, most notably featuring in the Roman Catholic Church of Our Lady of the Lakes and St Charles (C20). The large areal extent of the modern Threlkeld quarry (located to the south-east of Birkett Mire) is the result of its C19 production activities,

when it supplied stone for the construction of nearby Thirlmere Reservoir and ballast for the developing local railway networks.

'Shap Granite' (Lower Devonian)

The coarsely crystalline, pink and occasionally grey granite (strictly biotite-monzogranite) of the Shap Pluton is characterized by its large, pink, K-feldspar megacrysts. The quarrying and exploitation of Shap Granite as a decorative stone (see p.14) began in the early C19, and it is still worked to order today and exported around the UK as polished ornamental stone. Only rarely is the granite seen locally in the exposed rubblestone fabrics of older cottages and farm buildings; it was not generally quarried and dressed as a blockstone. Polished Shap Granite headstones and monuments are a fairly common occurrence in Victorian and Edwardian graveyards across the country.

'Skiddaw Granite' (Lower Devonian)

Sporadically exposed within the valleys of the Skiddaw Forest area, the Skiddaw Pluton is a small (< 3 km²) intrusive body of grey-brown, medium-crystalline, variably porphyritic biotite-granite. It has in the past been quarried to a limited extent for building purposes.

MINOR IGNEOUS INTRUSIONS

A compositionally varied range of minor igneous intrusions, including occasional **LAMPROPHYRE DYKES**, locally intrude the Siluro-Ordovician rocks across Cumbria (e.g. in the Cross Fell, Cautley and Cleator areas). Boulders originating from these minor intrusions are occasionally seen in nearby rubblestone field boundary walls and older farm buildings.

CARBONIFEROUS

The major tectonic reorganization that commenced during late Devonian times saw the relative uplift of the Cumbrian area and the development of a series of depositional basins across Northern England. The Carboniferous succession of Cumbria consequently rests with marked unconformity upon, and oversteps onto or is faulted against, the earlier Palaeozoic successions.

The outcrops of Carboniferous strata lie along the present day eastern border of Cumbria, stretching from the vicinity of Bewcastle in the north to Mallerstang Common in the south, before continuing northwestwards along the western side of the Vale of Eden from Kirkby Stephen to near Caldbeck, and thence swinging westwards to the coast at Whitehaven. Isolated, fault-bounded outliers of Carboniferous rocks also occur along the southern coastal fringes of Cumbria, extending from Kirkby Lonsdale in the east to Barrow-in-Furness in the west. The succession in general is sub-divided into the Ravenstonedale, Great Scar Limestone, Yoredale and Pennine Coal Measures groups, and building stone has been quarried extensively from each of these units. Individual quarries, however, have tended to supply only their surrounding areas with stone.

Great Scar Limestone Group

The outcrop of the (Chadian–Pendleian) Great Scar Limestone Group encircles the mountainous Lower Palaeozoic 'core' of the Lake District on its northern, eastern and southern sides. Exposures of grey limestones extend sporadically from Egremont (through Cleator Moor, Frizzington and Rowrah) to Lamplugh, but in general the significant buildings in these areas are of red St Bees Sandstone or local limestone rubble (occasionally with Carboniferous sandstone **DRESSINGS**). Isolated limestone exposures were quarried near Hensingham and also at Dean, Padshaw, Bradshaw, Eaglesfield, Brigham, Bridekirk, Tallentire, Plumland and Bothel. To the north-east of Cockermouth, the Great Scar Limestone outcrop adopts an east–west trend and continues from Whitrigg to Uldale (where whitewashed cottages are common) and then on to Whelpo. At Caldbeck, the outcrop changes direction once more, turning southeastwards towards Haltcliff Bridge and extending on to Hutton Roof, Penruddock, Stainton, Hardendale, Crosby Ravensworth and Crosby Garrett (where the viaduct carrying the Settle to Carlisle railway is of local Great Scar Limestone), before ultimately reaching Kirkby Stephen and Ravenstonedale. In the older buildings of Kirkby Stephen, Great Scar Limestone has been used extensively as a building stone, often in conjunction with locally sourced red sandstone and breccia rubble; the window and door mouldings are commonly of sawn Penrith Sandstone.

In southern Cumbria, fault-bounded outcrops of Great Scar Limestone are found between Kendal and Levens. This same limestone is also present around Heversham, Milton,

Milnthorpe (where Laburnum House is constructed of limestone **ASHLAR** and rubble), Arnside (its C15 Tower is of local limestone rubble), Burton-in-Kendal (the walling of the Church of St. James is of local limestone rubble), Kirkby Lonsdale, Grange-over-Sands, Ulverston and Dalton-in-Furness. The local limestone has been widely employed both as ashlar and rubblestone in and around these settlements. In the case of some buildings, such as Witherslack Hall (School) and Dalton Castle, the grey limestone stonework has been 'enlivened' with red-brown Sherwood Sandstone dressings.



Pale grey coloured 'Great Scar Limestone' dominates the walling of Dalton Castle, a C14 Peel house located in Dalton-in-Furness. The fabric has been 'enlivened' with red-brown Sherwood Sandstone.

The local Great Scar limestones are well displayed in a wide range of buildings in Kendal. The fabrics of the houses and business premises here, whether they be of ashlar or rubblestone, are dominated by hard, creamy grey coloured, variably **FOSSILIFEROUS**, Dalton Formation limestone. This contrasts markedly with the distinctive, rather darker fabrics which arise from the use of the nodular, pseudo-brecciated, bioturbated Urswick Formation limestones (see below). These latter limestones were often sawn for use as window and door mouldings.



Sawn blocks of dark grey, pseudo-brecciated limestone yielded by the Urswick Limestone Formation have been used as lintels and sills in The Miles Thompson public house (Shearman House) in Kendal.

Urswick Limestone Formation

This sub-unit of the Great Scar Limestone Group crops out in southern Cumbria around Great Urswick, Baycliff, Stainton with Adgarley, and Newton. It largely comprises pale grey, coarse-grained, **BIOTURBATED** limestones, which commonly feature in buildings in and around the aforementioned locations. The nodular limestone beds of the Urswick Limestone are currently worked for building and decorative stone at Baycliff Hags Quarry to the west of Baycliff.

Yoredale Group

The (Visian to Namurian) Yoredale Group crops out in northern and southwestern parts of Cumbria. Although limestones predominate, the group includes a number of beds of slightly **CALCAREOUS**, medium- to coarse-grained, grey and pinkish grey sandstone (formerly assigned to the 'Calcareous Sandstone Series'). These sandstones were locally important sources of building, and occasionally roofing, stone. Examples of villages and buildings in which the Yoredale sandstones (and to a lesser extent the limestones) feature prominently as rubblestone and occasionally ashlar include Dacre (and nearby Dalem House), Greystoke, Yanwath Hall, Alston and Brough. The Yoredale Group sandstones are also seen in the older

houses of Appleby-in-Westmorland and Penrith, where they contrast strongly with the dark red Penrith Sandstone fabrics. At the former lead-mining community of Garrigill, the older houses are similarly constructed of coursed Yoredale Group Sandstone (albeit yellow-brown here), and have flagstone roofs. However, a long terrace of former miners' cottages is



These terraced cottages lying along the east side of Boroughgate in Appleby-in-Westmorland are chiefly constructed of pale pink Yoredale Group sandstone. This stands in contrast to the much darker Permo-Triassic sandstone used for the window and door 'frames', and indeed for nearby buildings.



Yoredale Group lithologies feature prominently in the buildings of Garrigill, including these former miners' cottages. Note the horizontal bands of dark grey limestone inserted for decorative effect.

seen to be constructed of sandstone and limestone blocks, with distinctive decorative string courses of dark grey limestone.

Amongst the other sandstones of the group are the Orebank Sandstone (Brigantian in age) and the Hensingham Grit (Pendleian in age), both of which have been quarried near Cockermouth. These sandstones were used for a number of nearby buildings and also feature extensively in the fabric of Cockermouth Castle. The siting of the castle on the River Derwent aided access to the quarries at Brigham and Eaglesfield, although it is believed that some of the castle's sandstone was 'recycled' from the nearby Roman Fort of Papcastle (Derventio). Further quarried outcrops of the Hensingham Grit occur to the south-west (e.g. around Dean, Distington and Whitehaven), and this was indeed a locally important building stone source.

In the far south of Cumbria around Holker, a small outcrop of calcareous mudstones and sandstones currently assigned to the Yoredale Group (Alston Formation) is present. The grey, siliceous sandstone beds were quarried during the medieval period to build the priory at nearby Cartmel.

Millstone Grit Group

Sandstones referred to the (Namurian) Millstone Grit Group are poorly developed in Cumbria, and are restricted to the county's southeastern margin. Unlike in Lancashire and West Yorkshire, this unit was therefore not a significant source of building stone.

Pennine Coal Measures Group

The strata of the Cumbrian (or Whitehaven) Coalfield, which are assigned to the (Westphalian) Pennine Coal Measures Group, form a broad arcuate outcrop in the north and north-west of the county, running from near Cleator to Southwaite. The Coal Measures succession in general comprises an interbedded sequence of carbonaceous mudstones, siltstones and sandstones with local developments of coal. The latter were worked from at least the C16 and encouraged settlement across the outcrop area, particularly during the late C18 and C19. This population influx resulted in a major phase of building, and saw the local Coal Measures sandstones being put to common use. The principal sandstone units—including the Harrington Four Foot and Six Quarters rocks of the Pennine Lower Coal Measures Formation and

the Main Band, the Bannock Band, the Ten Quarters Rock and the Countess Sandstone of the Pennine Middle Coal Measures Formation—were locally quarried and, together with ‘imported’ red Permo-Triassic sandstones, used to construct the numerous terraced houses, places of worship and business premises required by the expanding coalfield communities.

Warwickshire Group

Whitehaven Sandstone Formation

This formation, of uppermost Westphalian age, comprises more than 300 m of red to purple-brown, **CROSS-BEDDED** sandstones and variegated mudstones and siltstones. These rocks crop out near the coast at Whitehaven and further inland to the east, being seen in both natural exposures and the many small quarries which are found over much of the central part of the Cumbrian Coalfield. Where readily accessible, Whitehaven Sandstone was worked and used extensively as a local building stone, most notably in Whitehaven itself and in the nearby settlements.

PERMIAN

The Permian strata of Cumbria occupy a series of fault-bounded basins formed in response to regional east–west directed crustal extension. These sandstone-dominated rocks variably include, at their base, the alluvial fan and flash-flood breccias that represent the ‘Brockram’ facies. Both the ‘Brockram’ breccias and the aeolian sandstones of their host Penrith Sandstone Formation have been widely used as building stone close to where they crop out. The local red Permian sandstones are notably conspicuous in the Vale of Eden. Elsewhere, they have seen common use both as ashlar blocks and as window and door framings/mouldings. In more recent times, these sandstones have been ‘exported’ further afield to the likes of Glasgow and Edinburgh.

Appleby Group

Brockram Breccia

The distinctive ‘Brockram’ (literally ‘broken rock’) facies comprises coarse-grained, matrix-supported breccias that contain abundant angular clasts ranging from small pebble to cobble size. The clast lithologies are varied and include

dolerite, quartzite and Carboniferous limestone (i.e. they reflect the pre-Permian rocks of the Vale of Eden area, and thereby indicate a local provenance), while the rock matrix can be mud-rich, silty and/or sandy. Examples of the use of Brockram Breccia as a walling stone are provided by a number of the buildings in the centre of Kirkby Stephen.



The highly distinctive ‘Brockram’ breccia, blocks of which are seen here in close-up, has been used to construct many of the buildings in the centre of Kirkby Stephen.

Penrith Sandstone Formation

The Brockram breccias pass laterally into the dark red, cross-bedded, aeolian sandstones of the Penrith Sandstone Formation. These medium- to coarse-grained sandstones were widely used for building purposes across the whole of their outcrop, and were also ‘exported’ to markets further afield. In general, the sandstones tend to be weakly cemented and soft, but some beds are well-cemented by silica. The

harder sandstones were intensively worked in the past at Lazonby Fell, for example, where numerous old quarries are still visible in the landscape. In addition to the 'Lazonby' and 'Lazonby Fell' stones produced in this particular area, the Penrith Formation sandstones had a number of other 'trade' names in the past, including 'Plumpton Red' and (the more generic) 'Penrith Sandstone'.

Penrith Sandstone features prominently in towns, villages and isolated (farm)houses located on or close to its outcrop. It has been used for many of the substantial buildings in Penrith itself, including the Castle. Appleby-in-Westmorland, meanwhile, boasts a fine display of both dark red (i.e. Penrith Sandstone) and pinkish buff (Carboniferous 'Califerous Sandstone') sandstone fabrics along its largely C17–C19 main street (Boroughgate). There are numerous examples of older villages that are constructed almost entirely of locally quarried red Permian sandstone, including Renwick, Melmerby and Kirkoswald. At Great Salkeld, a thinly bedded horizon occurring within the surrounding Penrith Sandstone has been widely used as a roofing material. The large, thick and heavy sandstone slabs produced are seen on the roofs of cottages, the Church of St. Cuthbert and nearby farm buildings, and are quite unique to the area.



'The Red House' (number 30, Boroughgate) in Appleby-in-Westmorland dates to 1717. It boasts a fine display of brick red Penrith Sandstone ashlar.



The Norman Church of St. Cuthbert in Great Salkeld, with its imposing tower (a Peel tower added in the C14), has a stone flag roof comprising thinly bedded slabs of Penrith Sandstone.



The same thinly bedded slabs of Penrith Sandstone that have been used to roof the Church of St. Cuthbert in Great Salkeld are seen on dwelling houses and farm buildings throughout the village.

TRIASSIC

The Penrith Sandstone Formation is succeeded by the Late Permian Eden Shales Formation, which in turn gives way diachronously to the latest Permian to Early Triassic St Bees Sandstone Formation. This lowermost unit of the Sherwood Sandstone Group is dominated by fine- to medium-grained,

reddish brown but occasionally greenish grey or variegated sandstones. These are conformably overlain by the fine- to medium-grained, red (although locally white), strongly cross-bedded sandstones of the Kirklington Sandstone Formation. The arcuate outcrop of Triassic strata in Cumbria runs almost uninterrupted from Kirkby Stephen to Maryport, continuing onwards to Barrow-in-Furness along the coastal strip to the south of Whitehaven. Quarrying of these sandstones has taken place widely, locally on a prolific scale, and they represent a major Cumbrian building stone resource.

Sherwood Sandstone Group

St Bees Sandstone and Kirklington Sandstone formations

The St Bees and Kirklington sandstones are not easily distinguished when seen 'in isolation' within buildings, but the Sherwood sandstones generally have been widely quarried and used extensively as a building stone across their entire outcrop area since at least medieval times. By the late C19, very large commercial quarrying operations had been established near St Bees in order to meet the demands of a growing local and national market. C19 buildings—particularly churches and commercial premises—were commonly constructed of this red sandstone (in either ashlar or rubblestone form), which is ubiquitous in the larger villages and towns located along and near the outcrop (e.g. Aspatria, Dalston, St Bees, Egremont, Haile, Seascale, Drigg and Barrow-in-Furness). In the north-east of the county, to the east of Carlisle, the Sherwood Sandstone was quarried and used for building around Wetheral and Hayton (in the latter case since Roman times).

A contemporary description of the Sandwith/Birkhams quarries (near St Bees Head) made towards the end of the C19 refers to operations extending for about 'three quarters of a mile' along the coast, with a vertical face of 300–350 ft. The sandstones here are horizontally bedded, with the individual beds averaging 5–6 ft in thickness, but reaching 11 ft on occasions, and the widely spaced natural joints allowed blocks of considerable size to be obtained. A direct rail connection to Whitehaven Docks served to facilitate 'export' of the quarried stone not only to cities across the UK but to North American markets.

The medieval abbey ruins at Barrow-in-Furness provide arguably the best example of large-scale use of Sherwood

Sandstone in Cumbria. The stone for the abbey is believed to have been produced at the quaintly named Vale of Nightshade quarries located just to the north of the site. Several hundred years later, during the late C19, ashlar Sherwood Sandstone was again put to impressive use in Barrow, this time in the form of the massive Town Hall building. The supplying quarries were those at nearby Hawcoat.



© Graham Lott

Locally quarried Sherwood Sandstone was used between 1127 and c. 1500 to construct Furness Abbey, a Cistercian abbey (now in ruins) in Barrow-in-Furness.



© Stephen Parry

The Town Hall in the centre of Barrow-in-Furness (1882–87) serves as another example of a very substantial building that is constructed of locally quarried Sherwood Sandstone.

Sherwood Sandstone is still actively worked in several quarries near St Bees (viz. the Birkhams, Bank End and Grange quarries). It has seen use in many UK buildings during recent times (e.g. Liverpool Cathedral), and has also been exported overseas for use in connection with both new-build and conservation projects (e.g. the restoration of New York's early 'Brownstone buildings' in Albany).

QUATERNARY

Boulders, cobbles and 'fieldstones'

Rounded boulders and/or cobbles feature prominently in a number of the walls and cottages found within the low-lying coastal areas of Cumbria, most notably in the settlements overlooking the Solway Firth (e.g. Port Carlisle, Bowness-on-Solway, Newton Arlosh and Kirkbampton). Having been reworked from the thick Quaternary boulder clay deposits that mantle large swathes of both the Irish Sea floor and adjacent coastal plain, these were subsequently deposited along the shoreline by storm activity. The cobbles/boulders themselves are lithologically varied and represent both relatively local and distal sources. These were gathered and sorted, then carted inland before being split, dressed and/or trimmed ahead of use. Occasionally, the boulders and cobbles were used 'in the round', which necessitated the in-building of levelling courses comprising slabs of thinly bedded or cleaved lithologies.

Away from the coast, rounded boulders and cobbles have locally been put to similar use. Indeed, there are some good examples of early farm buildings featuring boulders and cobbles obtained from nearby Quaternary fluvial deposits. At Brough, certain of the farm buildings and cottages boast 'fieldstones' (lithologically varied field clearance debris) used both in their natural rounded state and in squared and coursed form. Buildings built wholly or in part of rounded 'fieldstones' or stream boulders are also encountered in Soulby, Thornthwaite and Broughton in Furness.

A far more common practice in the rugged highland 'core' of the Lake District, however, was to use angular rubblestone gathered and/or 'quarried' from surface outcrops. There are numerous farm buildings (dating to the C17 and C18) constructed of 'slate' rubble, which often have conspicuously large 'slate' quoins and lintels. Many of these buildings also have roofs of local 'slates' (generally laid in diminishing courses). Specific examples include farm buildings at Troutbeck [NY 40 03], Boon Crag (near Coniston), High



Rounded boulders and cobbles, used 'raw' or with minimal dressing, are commonly seen within the small settlements overlooking the Solway Firth. This cottage in Port Carlisle serves as a good example, and highlights the lithological variability of the clasts.



Removal of the render from this recently renovated building in Brough has exposed its wall fabric, which is seen to comprise locally gathered 'fieldstones' and/or stream boulders. As in the villages located along the Solway Firth, the clasts have been used 'raw' or with minimal dressing.

Oxen Fell and Loweswater. Other non-agricultural buildings of this type include Coniston (Old) Hall and Hawkshead Courthouse. In some cases, the windows and doors of such buildings are framed with better quality, sawn slabs of Lower Palaeozoic 'slate' lithologies, Carboniferous sandstones and limestones, and red Permo-Triassic sandstones.



Farm buildings constructed of slate rubble and crudely dressed 'fieldstones' are commonly encountered within the highland 'core' of the Lake District. This particular example has conspicuously large quoins comprising squared boulders of various lithological types.



Angular rubblestone and boulders, principally of Borrowdale Volcanic Group lithologies, dominate the walling fabric of Hawkshead Old Hall. 'Imported' Permo-Triassic sandstone has been used for the window mouldings and other decorative work.

Calcareous tufa

Isolated blocks of white, highly porous, calcareous TUFAs appear sporadically in some wall fabrics (e.g. Brough Castle), but this particular building stone is not commonly encountered across Cumbria, suggesting that it was never available in any great quantities.



The keep of Brough Castle locally features blocks of white, highly porous calcareous tufa, presumably worked from local deposits.

Reused stone

Natural stone, particularly dressed natural stone, is a valuable commodity. Stone reuse effectively defrays the initial financial outlay associated with quarrying and dressing blocks, making this a very cost effective practice (especially for 'new build' projects such as isolated farmhouses or churches). Some of the best examples of stone reuse in Cumbria are provided by the buildings that are constructed (partly or wholly) of materials 'cannibalized' from old Roman structures. The most substantial and certainly best known Roman structure in Cumbria was Hadrian's Wall (AD 122–130). This particular structure, now designated a World Heritage Site, defined the then northern frontier of the Roman Empire in Britain. The Cumbrian section of Hadrian's Wall extends from the milecastle at Birdoswald to the coastal fort at Bowness-on-Solway. In the east, the Wall was constructed of local stone, but close to the Solway estuary only the turrets of the

milecastle forts were of stone—the 'wall' itself was largely of turf. The Wall crosses a range of geological units, many of which were exploited to provide stone for its construction. Roman quarry faces with contemporary carved inscriptions are found in the Triassic Sherwood Sandstone exposed alongside the River Gelt near Hayton. At Birdoswald (near Gilsland), meanwhile, enough remains of the Fort there to show that the evidently highly skilled Roman masons were working the grey Carboniferous sandstones (Yoredale Group) exposed nearby. Physical evidence of many of the Roman quarries, however, has been lost as a result of later urban development, for example at Carlisle.

There are numerous examples of buildings located close to the line of Hadrian's Wall that make use of blocks which once formed part of either the Wall itself or its associated milecastles/forts. Specific examples include: the Church of St. Michael in Burgh by Sands, which was constructed of Carboniferous stone taken from the wall and nearby fort (Aballava); Drumburgh Castle, in part a C13 Peel tower, which was built from a mix of squared and little-dressed blocks of red Permian sandstone and; Lanercost Priory (C12), which was constructed from a mixture of red St Bees Sandstone and grey Carboniferous sandstone 'robbed' from the wall plus supplementary material (in view of the large volumes of stone required) newly quarried from the original Roman sources.

Imported stones

With the exception of the highly distinctive Shap Granite, igneous lithologies and marbles amenable to polishing and use thereafter as a decorative stone are a comparative rarity in the Cumbrian geological succession. Victorian architects in particular overcame this problem by 'importing' a range of polishable stones for decorative work. The Church of St. Stephen in Kirkby Stephen, for example, has an ornate pulpit (dating to c. 1871) constructed of polished Shap Granite and a variety of colourful Italian marbles and alabaster. Shap Granite also features (as columns) in the Church of St. Augustine in Alston, in addition to dark, fossiliferous 'Frosterley Marble' (a Carboniferous limestone from County Durham). William Butterfield's C19 font within the Church of St. Mary and St. Bega in St Bees is a massive carved block of veined, grey-brown limestone from Devon, while the alabaster reredos within the Church of St. Mary in Ambleside possibly originate from Chellaston in Derbyshire.



© Stephen Parry

Blocks of red St Bees Sandstone and grey Carboniferous sandstone 'robbed' from nearby Hadrian's Wall were used to construct Lanercost Priory, an Augustinian monastery founded in c. 1169. The nave of the former Priory was restored and re-roofed during the C18, and this now serves as the parish church (dedicated to St. Mary Magdalene).



© Graham Lott

The ornate pulpit (dating to c. 1871) of the Church of St. Stephen in Kirkby Stephen is constructed of polished Shap Granite and a variety of colourful imported Italian marbles and alabaster. The pulpit was probably a gift from the local Masonic Lodge.

Glossary

Agglomerate: A coarse-grained volcanic rock dominated by rounded fragmental debris.

Ashlar: Stone masonry comprising blocks with carefully worked beds and joints, finely jointed (generally less than 6mm) and set in horizontal courses. The blocks within each course are of the same height, though successive courses may be of different heights. 'Ashlar' is often wrongly used as a synonym for facing stone.

Bioclastic: Applied to a limestone containing the fragmental debris of calcareous organisms.

Calcareous: A rock which contains significant (10–50 %) calcium carbonate, principally in the form of a cement or matrix.

Cross-bedding: A feature principally of sandstones reflecting the movement of sand grains in currents, often producing a layering oblique to the margins of the beds.

Diorite: A coarse-grained igneous rock comprising plagioclase feldspar, amphibole ± pyroxene and <10% quartz.

Dressings: To say a building is constructed of brick with stone dressings means that worked stone frames the corners and openings of the structure.

Fossiliferous: Bearing or containing fossils.

Granite: Coarsely crystalline igneous rock composed primarily of quartz, feldspar and mica.

Granophyric: A descriptive term applied to an igneous rock in which there is a fine, irregular intergrowth of quartz and alkali feldspar.

Hemipelagic: Descriptive term applied to a silt-bearing muddy sediment deposited in a deep-sea environment.

Hybridized rocks: Igneous rock types that represent the crystallized products of ('hybrid') magmas formed as a result of magma-mixing.

Lamprophyre: A name applied to various dark coloured, porphyritic igneous rocks that contain abundant phenocrysts of Fe-Mg mica and/or amphibole ± pyroxene ± olivine, set within a matrix of the same minerals; any feldspar, usually alkali feldspar, is restricted to the groundmass.

Limestone: A sedimentary rock consisting mainly of calcium carbonate (CaCO₃) grains such as ooids, shell and coral fragments and lime mud. Often highly fossiliferous.

Lithology: The description of a rock based on its mineralogical composition and grain-size e.g. sandstone, limestone, mudstone etc.

Mudstone: A fine-grained sedimentary rock composed of a mixture of clay and silt-sized particles.

Outcrop: The area where a rock unit is exposed at the ground surface.

Porphyritic: A textural term applied to an inequigranular igneous rock consisting of conspicuously large crystals (phenocrysts) set within a much finer grained groundmass.

Rubble: Rough, undressed or roughly dressed building stones typically laid uncoursed (random rubble) or brought to courses at intervals. In squared rubble, the stones are dressed roughly square, and typically laid in courses (coursed squared rubble).

Sandstone: A sedimentary rock composed of sand-sized grains (i.e. generally visible to the eye, but less than 2 mm in size).

Siltstone: A sedimentary rock composed of silt-sized grains (i.e. only just visible to the eye).

Slate: A compact fine-grained metamorphic rock with a closely spaced cleavage formed by the alteration of a mudstone or siltstone by heat and pressure.

Stratigraphy: Branch of geoscience dealing with stratified rocks (generally of sedimentary origin) in terms of time and space, and their organisation into distinctive, generally mappable units.

Till: An unconsolidated, heterogeneous mixture of clay, sand, pebbles, cobbles and boulders deposited directly by glacial ice and showing no stratification.

Tufa: A highly porous encrustation of limestone formed by the precipitation of carbonate minerals from springs, streams or other water bodies.

Tuff: A fragmental volcanic rock dominated by ash-grade debris.

Turbiditic: Descriptive term applied to sediment laid down by a turbidity current (a variety of density current).

Volcaniclastic: A term referring to the entire range of fragmental volcanic products, whether deposited directly from eruptions or subsequently reworked.

Acknowledgements

This study, written by Drs. Graham Lott and Stephen Parry (British Geological Survey), is Cumbria's contribution to the Strategic Stone Study, sponsored by English Heritage.

Further Reading

Bailey, B.J. 1982. *Stone Villages of England*. Robert Hale Ltd.

Cramp, R. & Bailey, Y.R.N. 1988. *The Corpus of Anglo-Saxon Sculpture: Cumberland, Westmorland and Lancashire North-of-the-sands, Vol. 2*. Oxford University Press.

Brambles, G. 2001. The Building Stones of Kendal: an excursion 05.08.01. *Proceedings of the Westmorland Geological Society*, **29**, 33–34.

Brunskill, R.W. 1978. *Vernacular Architecture of the Lake Counties: A Field Handbook*. Faber & Faber.

Cameron, A. 1996. *Slate from Coniston: A History of the Coniston Slate Industry*. Cumbria Amenity Trust Mining History Society.

David, R. 1987. The Slate Quarrying Industry in Westmorland (Part I): The valleys of Troutbeck, Kentmere and Longsleddale. *Transactions of the Cumberland & Westmorland Antiquarian & Archaeological Society*, **87**, 215–235.

David, R. & Brambles, G.W. 1991. The Slate Quarrying Industry in Westmorland (Part II). A Field Survey of selected sites in Troutbeck and Longsleddale. *Transactions of the Cumberland & Westmorland Antiquarian & Archaeological Society*, **91**, 213–227.

Geddes, R.G. 1975. *Burlington blue-grey: A history of the slate quarries, Kirkby-in-Furness*. Richard Stanley Geddes.

Hughes, T. 2003. Stone roofing in England. *English Heritage Research Transactions*, **9**, 32–127.

Johnson, G.A.L. 1997. *Geology of Hadrian's Wall*. Geologists' Association Guides, **59**. 89 pp.

McCarthy, Y.M.R., Summerson, H.R.T. & Annis, R.G. 1990. *Carlisle Castle: a Survey and Documentary History*. English Heritage Archaeological Report, **18**.

Mitchell, M. 2001. The building stones of Cartmel and its Priory: an excursion 23.06.01. *Proceedings of the Westmorland Geological Society*, **29**, 26–27.

Moseley, F. (ed.) 1978. *The Geology of the Lake District*. Yorkshire Geological Society, Occasional Publications, **3**.

Penoyre, J. & Penoyre, J. 1978. *Houses in the Landscape: A Regional Study of Vernacular Building Styles in England and Wales*. Faber & Faber.

Tyson, B. 1984. The Troutbeck Park Slate Quarries: their Management and Markets, 1753–1760. *Transactions of the Cumberland & Westmorland Antiquarian & Archaeological Society*, **84**, 167–190.

Tyson, B. 1998. Transportation and the Supply of Construction Materials: An Aspect of Traditional Building Management. *Vernacular Architecture*, **29**, 63–81.

Wright, G.N. 1985. *The Stone Villages of Britain*. David and Charles.

BGS Memoirs and Sheet Explanations

Athurton, R.S. & Wadge, A.J. 1981. *Geology of the country around Penrith*. Memoirs of the Geological Survey of Great Britain (England and Wales), Sheet 24.

Aveline, W.T., Hughes, T.McK. & Tiddeman, R.H. 1872. *The geology of the neighbourhood of Kirkby Lonsdale and Kendal*. Memoirs of the Geological Survey of England and Wales, Explanation of quarter-sheet 98 SE.

Aveline, W.T. & Hughes, T.McK. 1888. *The geology of the country around Kendal, Sedbergh, Bowness and Tebay*. Memoirs of the Geological Survey of England and Wales, Explanation of quarter-sheet 98 NE (New Series Sheet 39).

Burgess, I.C. & Holliday, D.W. 1979. *Geology of the country around Brough-under-Stainmore*. Memoirs of the Geological Survey of Great Britain (England and Wales), Sheet 31 and parts of sheets 25 and 30.

Dakyns, J.R., Tiddeman, R.H., Russell, R., Clough, C.T. & Strahan, A. 1891. *The Geology of the country around Mallerstang, with parts of Wensleydale, Swaledale and Arkendale*. Memoirs of the Geological Survey of England and Wales, Explanation of quarter-sheet 97 NW (New Series Sheet 40).

Dakyns, J.R., Tiddeman, R.H. & Goodchild, J.G. 1897. *The geology of the country between Appleby, Ullswater and Haweswater*. Memoirs of the Geological Survey of England and Wales, Explanation of quarter-sheet 102 SW (New Series Sheet 30).

Dixon, E.E.L., Maden, J., Trotter, F.M., Hollingworth, S.E. & Tonks, L.H. 1926. *The geology of the Carlisle, Longtown and Silloth district*. Memoirs of the Geological Survey of England and Wales, Explanation of sheets 11, 16 & 17.

Eastwood, T., Dixon, E.E.L., Hollingworth, S.E. & Smith, B. 1931. *The geology of the Whitehaven and Workington district*. Memoirs of the Geological Survey of England and Wales, Explanation of Sheet 28.

Rose, W.C.C. & Dunham, K.C. 1977. *Geology and hematite deposits of South Cumbria*. Economic Memoir for 1:50 000 geological sheet 58 and southern part of sheet 48.

Stone, P., Millward, D., Young, B., Merritt, J.W., Clarke, S.M., McCormac, M. & Lawrence, D.J.D. 2010. *British Regional Geology: Northern England* (Fifth edition). British Geological Survey, Keyworth, Nottingham.

Trotter, F.M. & Hollingworth, S.E. 1932. *The Geology of the Brampton District*. Memoirs of the Geological Survey of England and Wales, Explanation of Sheet 18.



**British
Geological Survey**
NATURAL ENVIRONMENT RESEARCH COUNCIL



ENGLISH HERITAGE