DRY STONE WALLING ASSOCIATION

GEOLOGY FOR WALLERS

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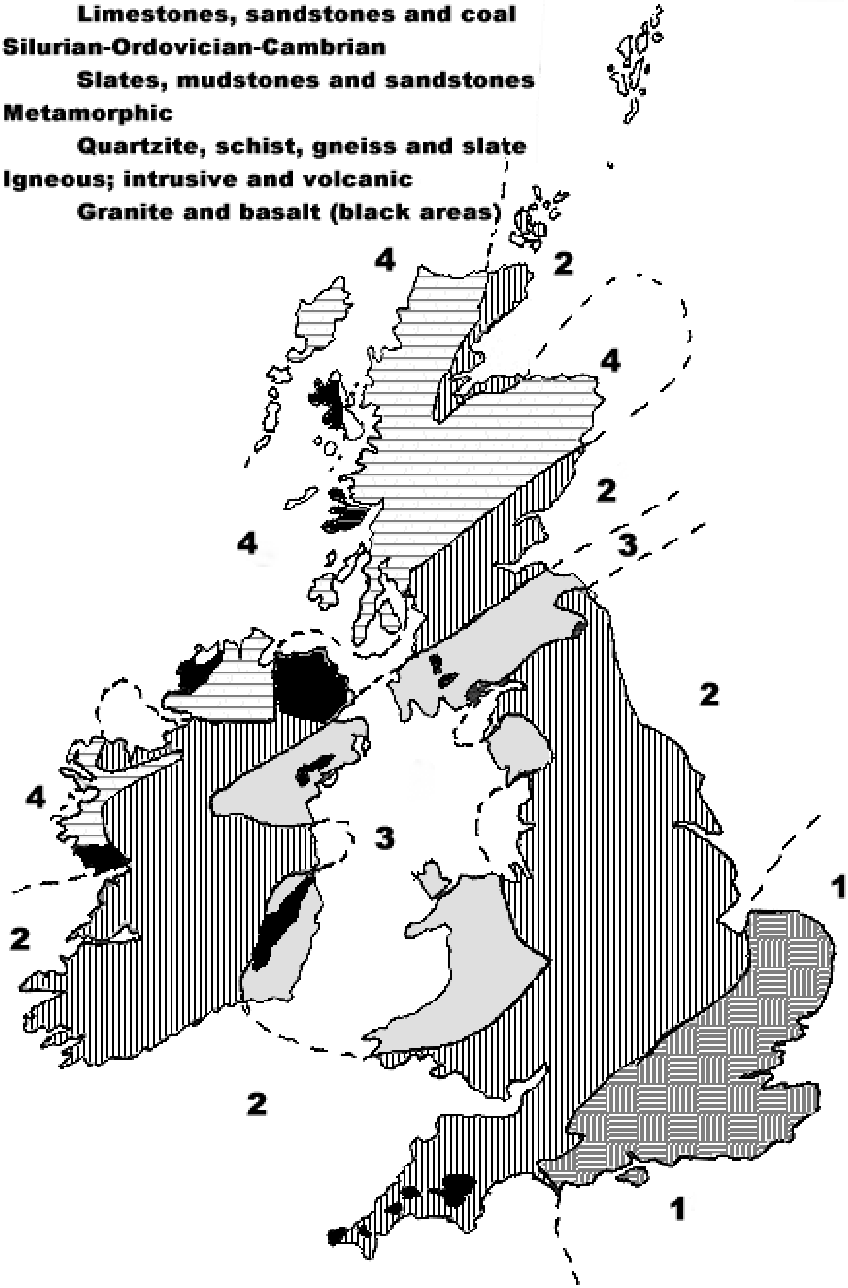
GEOLOGISTS' ASSOCIATION 1858 THE CURRY FUND

Outline Geological Map of British Isles

1. **Sedimentary**
   Clays, sands and chalk
2. **Jurassic-Carboniferous-Devonian**
   Limestones, sandstones and coal
3. **Silurian-Ordovician-Cambrian**
   Slates, mudstones and sandstones
4. **Metamorphic**
   Quartzite, schist, gneiss and slate
5. **Igneous; intrusive and volcanic**
   Granite and basalt (black areas)



Geology For Wallers

This description of the origin and properties of the rocks in Britain has been prepared for those interested in features made of natural stone. It has deliberately been kept short, although experts may feel that too many complexities have been omitted.

Where in Britain are dry stone walls found? In upland Britain - broadly north and west of a line between the coasts of Dorset and North Yorkshire, where generally the land is higher and much more stony. There is a geological significance to that dividing line, which is formed by the outcrop of Jurassic limstone. In Britain the rocks are older, harder and covered with less earth to the north and west. In the south and east the underlying rocks are younger, softer (so less suitable for dry stone walling) and have broken down to form a soil cover and are not so often exposed.

Why do the rocks of upland Britain not all make the same sorts of walls? The biggest geological difference between rocks is the way they were formed: igneous (from hot, molten origins), sedimentary (debris resulting from erosion and transport of that debris) and metamorphic (igneous or sedimentary rocks which have been altered by heat and pressure). These rocks have distinct characteristics and the different ways the rocks have been formed, and reformed, will determine the rock shape and how it can be split and worked.

Igneous Rocks

These crystalline rocks are regarded as the source of all other rocks, being the products of molten magma from deep in the earth's crust. Some have cooled slowly at depth and have then been uplifted and exposed by erosion either very locally, as seen with the granite outcrop at Shap in Cumbria; or over larger areas, as on Dartmoor or in Kirkcudbrightshire. Other igneous rocks cooled quickly when erupted from volcanoes. This was the case for the lavas of the central Lake District. The slower the cooling, the larger the individual crystals. These are very visible in granite or gabbro but very small in basalt and other lavas.

There are no bedding planes in igneous rocks, and many of them are either too hard, brittle or splintery to be easily dressed with a hammer. Therefore, they tend to offer irregular lumps that are not suitable for evenly coursed walls and are often to be found in walls made from very large stones with a random style of building.

Sometimes natural planes of weakness, joints, occur in igneous rocks, having developed originally with contraction on cooling: basalt and dolerite ('whinstone'), as in the Giant's Causeway and the Whin Sill in Teesdale, develop jointing into roughly hexagonal columns. Slower cooling granite has more massive vertical and horizontal joints. Exposed rock is vulnerable to physical and chemical weathering so these joints open up and are then exploited in quarrying processes.

Sedimentary Rocks

Sedimentary rocks have been formed from an accumulation of particles and fragments of older rocks, transported by gravity or running waters and deposited in rivers, deltas, shallow coastal waters and seas to end up as layers of sheet-like deposits. Some particles were also deposited on land surfaces including desert environments (e.g. New Red Sandstone in the Eden Valley). Over time, sediments become compacted due to deep burial and may be 'cemented' to create a hard rock. The type of cementing material (e.g. silica, calcite, iron oxide, numerous carbonates) varies considerably but it is on the nature of this cement that the strength and resilience of stones mainly depends.

Limestones are a special category of sedimentary rock, largely a build up of lime shells (fossils) bonded by a 'cement' of calcium carbonate (lime).

Individual grains of sediment in sedimentary rocks are often visible except in mudstones and fine-grained limestones, the latter essentially an accumulation of lime-rich mud often containing the remains of shells. Sandstones and shales may also contain fossils, the remains or traces of organisms that lived at the time when the sediment was being deposited. Conglomerates have pebbles or larger stones embedded in a matrix of finer grained sand or clay.

Most of these sediments were deposited in layers. Very thin layers allow stone to break into thin sheets and small fragments that are only useful to the waller as thin wedges (e.g. slates of the Southern Uplands or Mid Wales). Layers thicker than half an inch (1cm) are known as 'beds'. The rock is often weaker at the junction with the next bed (known as the bedding plane) which, when parallel, enables rock to be split into stones which makes possible their use in more regularly coursed walls. However, much well-bedded sedimentary rock has actually more or less irregular surfaces when broken naturally, or by the waller, along the bedding planes. For example, this includes the Blue Pennant and Old Red Sandstone of South Wales, both of which need considerable dressing to make well-coursed walls. This is the result of bedding planes following irregular surfaces of sediment layers deposited in turbulent conditions of ancient rivers, deltas and shorelines.

Some sedimentary rocks can have beds several feet thick with no natural bedding planes within them. Others, particularly continental shelf deposits that are the result of sudden slumps of material, have no bedding structure at all, but very irregular patterns of weakness. These can make attractive random walls, but can also shatter unpredictably when hit by a hammer, or during natural weathering.

Some sedimentary rocks can be split into thin layers or sheets that are referred to as 'slate', although the strict geological use of the word refers to metamorphosed rocks (see over). Another term imprecisely used, is 'granite', which is often taken to describe other hard rock types.

Metamorphic Rocks

Metamorphic rocks are formed when sedimentary rocks, and occasionally igneous rocks, have been subjected to high temperature or pressure or both, perhaps as a result of deep burial. The form and texture of the original rocks is often changed due to recrystallisation and the formation of new minerals. Sandstone will become quartzite, schist or gneiss (as found in much of northern Scotland), depending on the degree of metamorphism and the impurities in the original sediment. Mudstone will become slate and limestone will metamorphose into marble. True marble is rare in Britain, most examples are actually hard limestones.

Metamorphism caused by pressure will often create new 'cleavage planes' that are at an angle to the original bedding planes, along which the rock will split. This is common in slates but not in quartzites and marbles. These cleavage planes, particularly in the slates from North Wales or Cumbria, can be useful to wallers as the rock can be split more easily into regular sizes.

Identifying rocks: A little practice, the use of a hand lens to see if a rock is crystalline or fragmentary and some knowledge of what stone may be expected in an area, should enable the geological novice to recognise the broad categories of most common types of walling stone, although even the expert sometimes has difficulty identifying a particular rock type.

How are these rocks distributed around Britain and how old are they? The geological history of Britain is extremely complicated. It includes continental drift from near the South Pole to our present latitudes, the opening, and closing, of oceans, the rise and erosion of great mountain chains, and periods when portions of the present landmass was covered with tropical swamps, deserts or ice sheets. This is why our map is only a very basic approximation, giving the main outcrops of each geological era and the principal rock types.

The oldest metamorphic 'Lewisian' rocks in north-west Scotland appear to be 3,300 million years old, the oldest sedimentary rocks nearby are just under 1,000 million. The youngest walling rocks in Britain, the basalts, gabbros and other igneous rocks of Skye and elsewhere in west Scotland, are about 15 million years old. With this huge time-span there is naturally a vast variety of rock types. There are big differences even within one rock type. For example rock types represented by the Old Red Sandstone of the Brecon Beacons span 65 million years of the Devonian period. They come in a variety of colours, may be thick to thin bedded and with textures of varying grain size and hardness, including pebbly conglomerate.

The comparatively young age of igneous rocks on and around Skye is a reminder that the 'older to the north west, younger to the south east' pattern is broken by various exceptions (e.g. the Scottish coalfields and parts of the English Midlands).

In many areas, successive layers of sedimentary rocks lie one above the other providing a recognisable sequence of rocks. For example, the coalfield regions of Britain begin with lowest layers of Carboniferous limestone, followed by the Millstone Grit, which is then overlain by the Coal Measures, formed of alternating layers of coal-rich rocks and sandstone.

What other geological points are relevant to wallers? Stresses resulting from the deposition of more recent geological deposits, uplift and folding have produced vertical joints as well as horizontal bedding planes (they look similar to the joints in granite). Sometimes these joints are at right angles to each other and the bedding planes, producing useful rectangular building stones; sometimes with different stresses the natural fracture lines produce more awkward stones, with right angles between only two planes, or none. Movements within the earth's crust causes faults, such as the Craven Fault in the Yorkshire Dales, and can bring quite contrasting rock types alongside each other. Dry stone walls crossing faulted country can change in their colour, texture and character accordingly.

The extensive glaciations of the last million or so years have shaped the landscape by rounding the hills, removing the soil to reveal the rock and depositing rocks and stones far from their original outcropping, often in a cover of sticky 'boulder clay' or 'till'. These 'erratic' rocks can usefully complement the local/country rocks available to wallers, especially if a totally uniform effect is not desired. They are usually harder than the country rocks and, like rocks that have been tumbled in streams, their journey will have rounded the corners of the stones.

All stones used in walling are fragments of larger formations, reduced through natural weathering or human activity. Stones continue to weather, physically or chemically or both, once exposed. In some formations, this exposure hardens rock (e.g Cotswold Stone 'slates' – which are actually limestone). In others, it leads to rapid disintegration. Stone that has been inside a wall for many years can become very dry and then crumble (e.g. sandstones, Jurassic limestones). All stones 'breathe' or 'drink' to a varying degree, due to the pore space between their component grains. Stones in all walls will absorb water to some extent. All are then liable to some physical breakdown from frost, although this can be useful in providing hearting for a wall.

Rocks too crumbly to be chosen by a waller will probably have been too open-textured and porous. The mineral 'cement' of the stones is the critical factor, too weak or, sometimes, too strong. Experience is the best guide to how a particular stone type weathers and if it is wise to use newly quarried stone or if it should be left until a winter's or even a year's weather has confirmed its durability. Limestones, which initially occur in quite large blocks, can be fretted by 'acid rain' into the fantasy shapes of limestone pavements of the North Pennines and the Heads of the Valleys in South Wales.

Where can I find more information?

- Good maps are produced by the British Geological Survey (BGS), Keyworth, Nottingham, NG12 5GG. The most useful are the North and South sheets of the United Kingdom at 1:625,000 (10 miles to the inch). There are also maps of the whole British Isles at 1:250,000 (25 miles to the inch) and of most of Britain at 1:50,000. Some maps are 'Solid Geology', i.e outcrops and what is below the immediate surface, some are 'Drift Sheets', taking into account the glacier-borne deposits of boulder clay that covered the outcrops of 'Solid Geology'.

- BGS interactive geological maps can be accessed online with the Geology of Britain Viewer, https://geologyviewer.bgs.ac.uk/

- Geology Field Guides produced by The Geologists' Association (GA) https://geologistsassociation.org.uk/

  The GA holds monthly lectures in London, runs field trips throughout the UK and abroad, and is a useful contact for more than seventy of its affiliated societies, organisations, regional and local groups.

- British Geological Society website, Strategic Stone Survey and county by county atlases, which are a useful source of information on local stone linked to local geology, https://www2.bgs.ac.uk/mineralsuk/buildingStones/StrategicStoneStudy/EH_atlases.html

- *The Hidden Landscape* by Richard Fortey (Jonathan Cape, 1993)

Geology is best learned 'hands-on' through organisations that run talks, field excursions and educational courses. There are many geological societies, which can be found through web searches, and some adult education organisations such as the University of the Third Age (U3A).

For anyone wanting really to apply themselves, the Open University offers an excellent, distance-learning geology course, and there are courses available on Futurelearn.com

Timescale of Rocks

65 MA to present (million years ago)	Tertiary	Soft rocks in south-east of England; Volcanic rocks in west of Scotland.
150 to 65 MA	Cretaceous	Greensands, Chalk: South-east England, Yorkshire
210 to 150 MA	Jurassic	Limestones, shales: Dorset to North Yorkshire coasts.
280 to 210 MA	Permian and Triassic	Magnesian Limestone, New Red Sandstone, conglomerates: Somerset, Midlands, E & W of Pennines, N & E of Lake District.
345 to 280 MA	Carboniferous	Limestone, Millstone Grit, Coal Measures, Sandstones: S Wales, Pennines, Cumbria, Midland Valley of Scotland, Culm in mid Devon.
410 to 345 MA	Devonian	Sedimentary rocks: Cornwall and South Devon: Old Red Sandstone in S Wales, N Devon, Midland Valley Scotland, Moray Firth and Caithness.
500 to 410 MA	Ordovician, then Silurian	Shales, mudstones, some limestones: Mid-Wales, extending into Pembrokeshire and Denbighshire; central and southern Lake District, Southern Uplands. 'Caledonian Orogeny' or mountain building following continental collision caused some metamorphism south of the Border, but very extensive north of the Highland Line. Granite emplacements and volcanic rocks.
540 to 500 MA	Cambrian	Shales, slates, gritstones: Harlech Dome, Malverns, North Pembrokeshire, Isle of Man; In Scotland adjacent to Precambrian.
More than 570 MA	Precambrian	Gneisses, schists, sandstones, conglomerates, siltstones: Hebrides and NW Scotland coast; A few southern outcrops: Anglesey, Charnwood, and Long Mynd.

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