TIME SCALE OF ROCKS

65 MA to present	**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 (million years ago)	**Precambrian**	Gneisses, schists, sandstones, conglomerates, siltstones: Hebrides and NW Scotland coast; A few southern outcrops: Anglesey, Charnwood, and Long Mynd.

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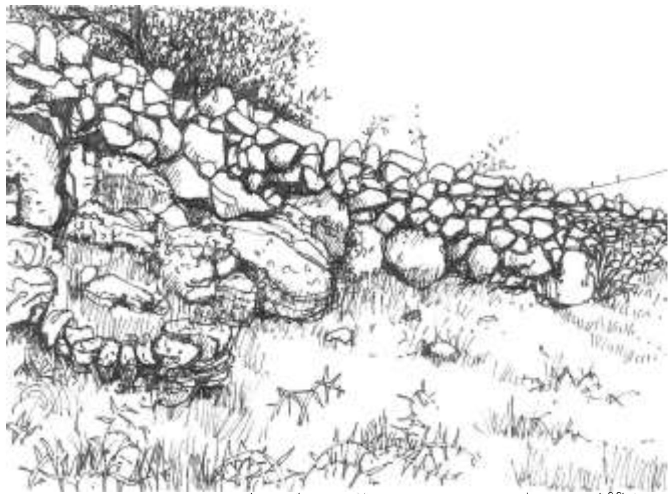
DRY STONE WALLING ASSOCIATION OF GREAT BRITAIN

GEOLOGY FOR WALLERS

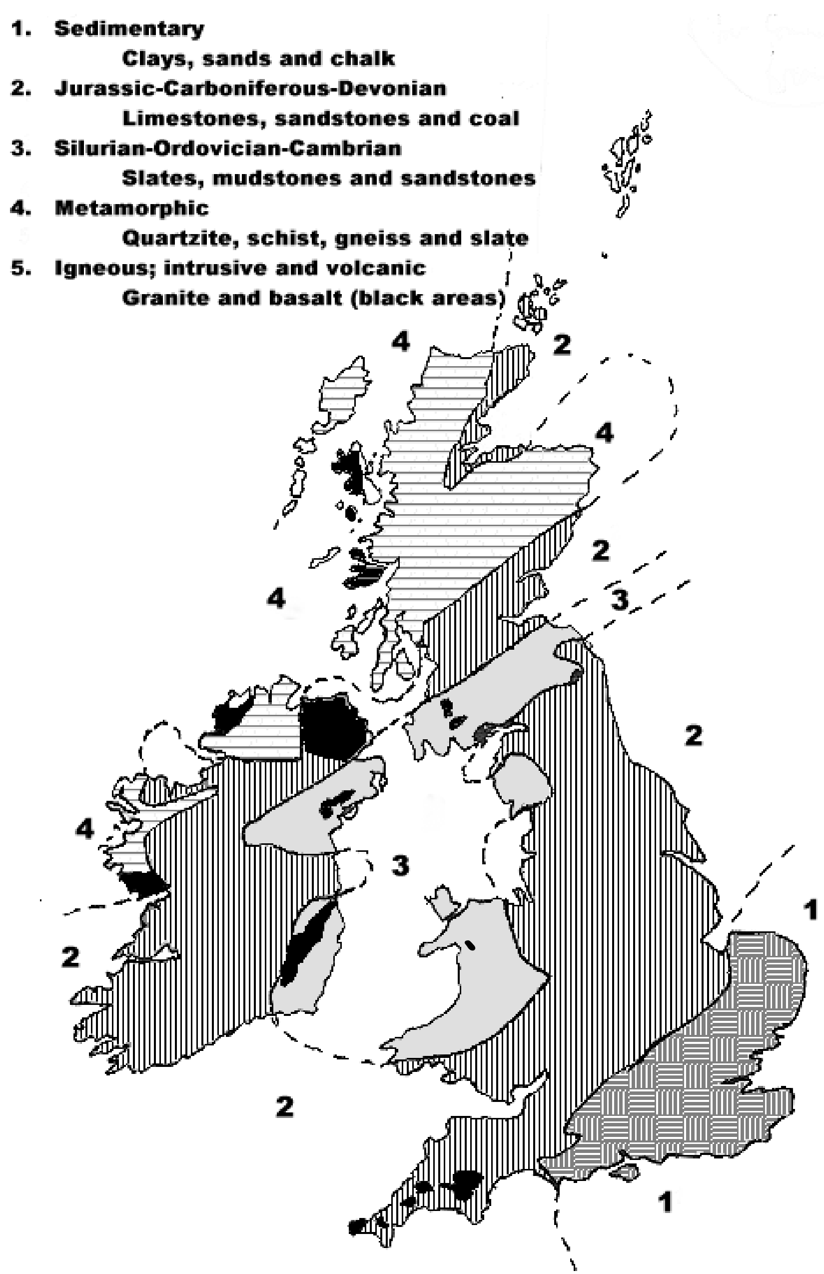


Cistercian wall 12-13C – Drawn by D Griffiths

A leaflet for all those interested in the history of stone

This leaflet has been produced with support from The Curry Fund of The Geologists' Association

Outline Geological Map of British Isles



<u>Where can I find more information?</u> 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", ie outcrops and what is below the immediate surface, some are "Drift Sheets", ie taking into account the glacier-borne deposits of boulder clay that blanked the solid outcrops of "Solid Geology".). Some of the latter have explanatory memoirs and nearly fifty "classical areas of British geology" are described at 1:25,000 . *Regional Geology Guides* are available from the BGS and also from The Geologists' Association (GA), Burlington House, Piccadilly, London W1J 0DU. The GA holds monthly lectures in London, runs field trips throughout the UK and abroad, and is a useful contact for its more than seventy affiliated societies, organisations, regional and local groups (enquiries to Professor Eric Robinson or Sarah Stafford at the GA).

There are several basic text books of British geology: try

- *Geology and Scenery in Britain* by John Whittow (Chapman and Hall);
- *Teach Yourself Geology* by Dave Rothery (Hodder & Stoughton 1997);
- *The Hidden Landscape* by Richard Fortey (Jonathan Cape, 1993).

Perhaps geology is best learned on the ground, through sections of Wildlife Trusts and other groups, or in museums and field study centres. There are evening and weekend courses run by Workers Educational Association (WEA) or Adult Education organisations, such as University of the Third Age (U3A). For anyone wanting really to apply themselves, the Open University offers an excellent, distance-learning geology course, details from the Open University direct.

The Dry Stone Walling Association of Great Britain

Founded in 1968, DSWA is an expanding charitable organisation that works to improve the knowledge and understanding of the craft of dry stone walling. The DSWA relies on its membership subscriptions for much of its income and is particularly appreciative of the support of sponsors enabling the production of leaflets that inform and raise awareness of dry stone walls and the craft of walling.

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 innumerable exceptions (eg the Scottish coalfields and parts of the English Midlands).

In many areas the successive sedimentary layers are stacked neatly on top of each other. For example, all the coalfields tend to have a variety of sandstones between and above the coal measure, layers of Millstone Grit (gritstone) below, and Carboniferous Limestone below that. So walls in coal areas tend to be similar, as are walls nearby where the older rocks have been exposed with uplift and erosion.

What other geological points are relevant to wallers? Stresses caused by new 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 journeys in or under glaciers will have rounded their corners.

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 (eg 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 (eg 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 degree. 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 especially whether 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.

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, and therefore the expert may feel that too many complexities have been omitted.

Where in Britain are dry stone walls found? In upland Britain - that is, approximately 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 line, the Jurassic Limestone Belt. 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 (and hence less suitable for 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 shaped.

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 the granite at Shap in the Lake District; or over larger areas, as on Dartmoor or in Kirkcudbrightshire. Others 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 to be easily dressed with a hammer, or brittle and splintery. Therefore, they tend to provide irregular lumps that are not suitable for regularly coursed walls. They are often to be found in boulder dykes (walls made of very big, irregular stones) and single walls, or in extremely random walls such as those made of tuffs (consolidated volcanic ash) in Radnorshire.

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 and sheet-like deposits. Some particles were also deposited on land surfaces including desert environments (e.g. New Red Sandstone in the Eden Valley). Drying out, and under pressure from overlying loads, sediments can become cemented and converted into "rock". The type of cementing material (e.g. silica, calcite, iron oxide, various carbonates) varies considerably but it is on the nature of this material that the strength and resilience of stones mainly depends.

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

The individual grains are often easily seen except in mudstones or some limestone (they are microscopic in chalk). There are recognisable fossil remains in most limestone deposits. Sandstones and shales may also contain fossils where the living matter was trapped in the sand or mud. 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 be broken into thin sheets and break up into small fragments that are only useful to the waller as thin wedges (eg slates of the Southern Uplands or Mid Wales). Layers thicker than half an inch (1cm) are known as “beds”. The rock is weak at the junction with the next bed so that when the bedding planes are completely parallel, the rocks will produce stones which make possible the most 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 Blue Pennant, the uppermost rock of the South Wales coalfield, or Old Red Sandstone, underneath it – both of which consequently need considerable dressing to make well-coursed walls. This is because the surfaces of the planes normally represent both the irregular current flows of ancient rivers, deltas and foreshores.

Some sedimentary rock 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 very unpredictably when hit by a hammer, or during natural weathering.

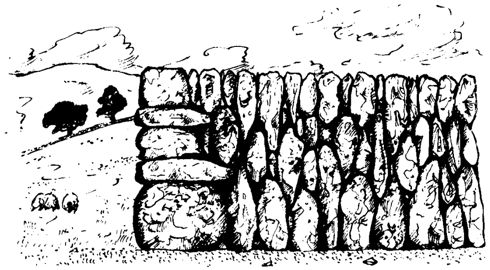
Thin sheets, whether of sandstone, mudstone or limestone, if they are thin enough for roofing, are often talked of as “slates” but this is not strictly accurate if they have not been metamorphosed (see below), or only slightly. Similarly, “granite”, a precise term (see previous), should not be used as a description for just any hard rock.

METAMORPHIC ROCKS

These were formed when the sedimentary rocks (sandstones, shales, limestones and occasionally also igneous rocks) have been subjected to high temperature and pressure. They have recrystallised to change their texture. Roughly, sandstone has become quartzite, schist or gneiss (eg over much of northern Scotland); mudstone has become slate; and limestone becomes true marble (rare in Britain – where most “marble” is actually hard limestone).

The pressure has caused most metamorphic rocks (not quartzite or marble) to develop new planes of parting, sometimes at an angle to the original bedding surfaces, which are usually fused solid and not recognisable. These “cleavage planes” can be highly useful to wallers (e.g. slate in North Wales or Cumbria) because the rock can be split as along bedding planes.

Boulder dyke typical of many regions of Scotland



Identifying rocks: A little practice, the use of a hand lens to see if a rock is crystalline or fragmentary, some knowledge of what stone may be expected in a given area, should enable the geological novice to recognise the broad categories of most common types of walling stone. However, even the expert may sometimes have problems in identifying any one particular stone.

How are these rocks distributed around Britain? 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 uprise and erosion of great mountain chains, periods when portions of the present landmass were 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 of the principal rock types.

The oldest metamorphic “Lewisian” rocks in north-west Scotland appear to be 3,300 million years old, and 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 the Old Red Sandstone of the Brecon Beacons spans the 65 million years of the Devonian period, and comes in green, grey, blue, brown, thick, thin, hard, crumbly, regular, irregular, small grained and even pebbly conglomerate.