

## Building Stones 1 – a resource for several Earthlearningidea activities

### Use a key to identify many different attractive-looking rocks

**Note:** This file is intended to provide an ongoing resource, as well as a basic activity in itself. It consists of a number of cards showing a wide range of rocks used in buildings such as shops, offices and banks; in work surfaces and in gravestones. A simple key is included, to enable pupils to identify the main types of rock, before they really take note of the detailed differences between them. The activity may be carried out using the cards in the classroom, or, preferably, ‘in the field’, i.e. in a town or city centre or a graveyard.



The late Fred Broadhurst showing teachers how to make use of the Trafford Centre, Manchester (Photo: Peter Kennett)

We hope to add to the variety of rock types as time and opportunity allow. We are also publishing activities based around each major group of rocks, i.e. sedimentary, metamorphic and igneous rocks, using the same cards, but asking pupils to develop their experience more fully. (See chart on page 7).

#### Building Stones 1

Give each small group of pupils a copy of the rock key and a complete set of photographs of building stones, printed individually onto card and trimmed to remove the labels. Point out that the coin is 2cm across, and that the photographs are all at

natural scale. Arrange the cards in each set so that all the limestones (including travertine) and marble are separated. Since testing with acid is clearly not appropriate with photographs, tell pupils that the rocks shown on the separated cards would all react (fizz) with dilute hydrochloric acid, but that the others would not. (It will also be necessary to give this information when out with the class in a city centre, unless permission has been obtained to apply a drop of acid. Most graveyard managers will give permission for this test to be carried out on gravestones, since it merely results in a slightly cleaner-looking spot on the marble or limestone).



Building stones in a city centre – red sandstone and ‘granite’ make up the front of the café, whilst granites and buff sandstones form the paving. St Paul’s Parade, Sheffield (Photo: Peter Kennett)

Ask the groups to work through all their cards to see how many of the rocks they can use the key to identify correctly, compared with the ‘master sheets’, which you have retained without cutting up. This could form the basis of a simple competition. All the rock types named on the key are represented at least once among the cards.

#### The back up

**Title:** Building Stones 1 – a resource for several Earthlearningidea activities.

**Subtitle:** Use a key to identify many different attractive-looking rocks.

**Topic:** A small group activity in the identification of a wide range of rock types, using natural-scale photographs of rocks used as building stones or for ornamental purposes. The sheets of photographs are intended for use as the basis for several further activities.

**Age range of pupils:** 8 – 80 years

**Time needed to complete activity:** 20 minutes for simple use of the key in the classroom, but much more for an outdoor visit to a town or city centre or a graveyard.

**Pupil learning outcomes:** Pupils can:

- follow a branching key;
- learn the criteria by which rocks are distinguished;
- identify a wide range of rock types;
- avoid the temptation to make a sample fit the key if it is inappropriate;
- (if using the photographs and not real specimens) – realise the limitations of using photographs without the opportunity to examine the real rock.

**Context:** As written, this activity is best regarded as preparation for an actual visit to a town centre or a graveyard. On its own, however, it can be used to sharpen pupils' awareness of the wide variety of rock types. It can be used as a discussion starter around the theme of design and aesthetics using natural stone.

#### Following up the activity:

- Pupils could use the cards to play 'Snap', playing in pairs and calling 'Snap' when two sedimentary rocks coincide; two metamorphic rocks, or two igneous rocks.
- Make a visit to a town centre or a graveyard to put into practice the skills learnt in the classroom.

#### Underlying principles:

- In simple terms, sedimentary rocks are mainly non-crystalline and consist of fragments or grains cemented together. Metamorphic and igneous rocks are largely formed of interlocking crystals and so are impermeable. In igneous rocks the crystals usually show random alignment, but in metamorphic rocks they are often aligned. Some metamorphic rocks which do not show alignment e.g. marble, are made of one mineral but impurities sometimes show streaky patterns.
- Rocks containing carbonate minerals, i.e. marble and limestones, will react with dilute hydrochloric acid. (This should only be done with permission, although it leaves very little sign on the stone – and gravestones are sometimes cleaned using acid).
- Igneous and most metamorphic rocks are less porous than sedimentary rocks. They resist weathering better and are more capable of taking a polish on the displayed surface.
- Igneous and metamorphic rocks are often attractive in themselves, owing to the range of colours of their constituent minerals.
- The overall colour of an igneous or metamorphic rock is often controlled by small amounts of trace elements in the minerals. In a sedimentary rock, the composition of the (natural) cement which binds the grains together usually influences the colour of the rock.

#### Thinking skill development:

- The use of a key involves pupils in thought processes of construction.
- The fact that rocks such as granite may occur in many different colours may involve cognitive conflict.
- Working out of doors provides a good opportunity to make a bridge with normal classroom studies.

#### Resource list:

##### a) In class

- For the teacher's reference: one copy of each of the sheets of photographs and their descriptions
- Per small group of pupils – a complete set of photographs of the rocks at natural scale, printed onto card and cut into separate pictures, without any captions.
- A copy of the key for the identification of building stones

##### b) In a town centre or graveyard

- For the teacher (optional) a small dropper bottle of dilute hydrochloric acid and a wash bottle of water
- Per small group of pupils – a complete set of uncut sheets of photographs, with captions
- A copy of the key for the identification of building stones

#### Useful links:

'Will my gravestone last?' from

<http://www.earthlearningidea.com>

<http://www.nationalstonecentre.org.uk>

[http://geoscenic.bgs.ac.uk/asset-bank/action/viewAsset?id=344745&index=96&tota\\_l=110&view=viewSearchItem](http://geoscenic.bgs.ac.uk/asset-bank/action/viewAsset?id=344745&index=96&tota_l=110&view=viewSearchItem)

**Source:** Devised by Peter Kennett of the Earthlearningidea team, inspired by the enthusiasm of Eric Robinson and the set of sixteen postcards of Building Stones produced by Fred Broadhurst, Richard Porter and Paul Selden for the University of Manchester, and obtainable from Manchester Museum.

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## Building stone notes

(These brief notes are intended mainly for the teacher's use, and have been written in a more technical style than the rest of the text. The date is the year in which the photographs were taken).

### Igneous rocks - 1

#### **South West England Granite, England** (Ecclesall Churchyard, Sheffield, 2012)

There are many large outcrops of granite of Variscan age (late-Palaeozoic, 380-280 Ma, million years old) in Devon and Cornwall, linked underground in a vast batholith. The specimen consists of white to buff-coloured feldspar, colourless quartz and dark ferromagnesian minerals, mostly biotite mica. The texture is slightly porphyritic i.e. some of the feldspars are larger than the average crystal size.

#### **Kemnay Granite, Aberdeen, Scotland** (Ecclesall Churchyard, Sheffield, 2012)

This granite is of Caledonian age (mid-Palaeozoic, 490-390 Ma). It is composed of quartz, feldspars and micas, in this case, mostly muscovite mica, which results in a pale grey colour, often with a hint of oatmeal colour. This rock has been used for the new Scottish Parliament building in Edinburgh.

#### **Rubislaw Granite, Aberdeen, Scotland** (Ecclesall Churchyard, Sheffield, 2012)

Rubislaw Granite is another Caledonian granite and is similar to the Kemnay Granite, except that a higher proportion of dark ferromagnesian minerals results in it being a darker grey colour. It usually exhibits some foliation (alignment of minerals), resulting from a later phase of Earth movements. The quarry from which it came is now a deep flooded hole, but it still retains the 'Blondin Wire' running across it, by means of which blocks of granite were lifted up from the quarry floor for cutting. It was very popular for gravestones in the Victorian period.

#### **Rubislaw Granite with xenolith, Aberdeen, Scotland** (Ecclesall Churchyard, Sheffield, 2012)

The dark inclusion within the granite is known as a xenolith (Greek for 'rock stranger'). It represents some older rock broken off by the granitic magma as it intruded. The molten magma heated the loose block of rock so much that it became highly metamorphosed.

#### **Balmoral Red Granite, Finland** (Ecclesall Churchyard, Sheffield, 2012)

This rock was given the name 'Balmoral Red' at a time when Queen Victoria had made the Highlands of Scotland very popular, even though its only connection with Scotland was that it was imported from Finland via Aberdeen! The deep red feldspar and clear quartz, of uniform texture, makes this a popular rock for ornamental work. It is still quarried in Finland for use in repairs, but a similar-looking granite is now obtained in large quantities from China, much more cheaply.

#### **Shap Granite, Shap Fell, Cumbria, England** (Sheffield Law Courts, 2012)

Shap Granite is of Caledonian age and is noted for its highly porphyritic texture, where large pink well-formed crystals of feldspar are set in a ground mass of clear quartz, pink feldspars and micas. Xenoliths (known as 'heathen' to the quarry staff) are common, although not shown here.

### Igneous rocks - 2

#### **Ross of Mull Granite, Scotland** (Ecclesall Churchyard, Sheffield, 2012)

Another distinctive pink granite, again due to the colour of the orthoclase feldspars. The clear mineral (which can appear quite dark at times) is quartz and the greenish mineral is hornblende. It was quarried on the Isle of Mull, right next to the sea, which made transport by ship very easy.

#### **Imperial Mahogany Granite, Red Hills, South Dakota, USA** (Jessops shop front, Sheffield, 2012)

The attractive red-brown colour comes from the feldspars, and the pale blue is quartz. The dark minerals are ferromagnesian minerals. The presence of blue quartz in an igneous rock usually indicates that it has undergone some degree of metamorphism after it had cooled. This is borne out by the appearance of subtle banding in the rock when seen in bulk. It is of Precambrian age (i.e. more than 542 Ma).

#### **Rose Swede Granite, Graverfors, Sweden** (Ecclesall Churchyard, Sheffield, 2012)

Again, the feldspars give the striking red colour to this rock, and the unusually deep blue of the quartz crystals provides the clue to a later phase of metamorphism. This is a Caledonian granite.

#### **Peterhead Granite, Peterhead, Scotland** (Ecclesall Churchyard, Sheffield, 2012)

As ever, the pink colour comes from the feldspars, and the clear, greyish mineral is quartz. There are very few ferromagnesian minerals in this Caledonian age granite, although it frequently contains dark xenoliths of older rocks which became caught up in the rising magma. It is a very popular stone in city centre buildings and gravestones, although it is no longer quarried.

#### **Rosa Porrino Granite, Spain** (Pisani plc, Cromford, Derbyshire, 2012)

This granite is actively extracted today from quarries in Spain, near the border with Portugal, and is frequently seen in shop fronts, gravestones and kitchen work surfaces. The usual combination of pink

feldspars, clear quartz and dark ferromagnesian minerals make up the rock, with the feldspars tending to clump together somewhat.

#### **'Baltic Brown' Granite, Finland** (Bank front, Yorkshire Bank, Sheffield, 2012)

This Precambrian granite (i.e. more than 542 Ma) displays orbicular texture. The pink orthoclase feldspars have been made roughly spherical, probably by movement within the magma, and have then become coated with a greenish plagioclase feldspar as they cooled and the surrounding rock solidified. The dark minerals filling the spaces between the feldspars are ferromagnesian minerals. The rock is nicknamed the 'Scotch Egg Rock', from its resemblance to a British delicacy, a hard-boiled egg encased in sausage meat! The Finnish name is Rapakivi Granite, and the rock is currently popular in work surfaces in the U.K.

### **Igneous Rocks - 3**

#### **Larvikite – Blue Pearl, Oslofjord, Norway** (Shop front, Pinstone Street, Sheffield, 2012)

The only source in the world of Larvikite, both the Blue Pearl and the Emerald Pearl, is near the town of Larvik, on Oslofjord. However, huge quantities are shipped to India and China for processing and are then re-exported, which can cause confusion. Although related to granite, Larvikite has a smaller percentage of silica making up its minerals, so it is classed as an Intermediate igneous rock. (i.e. intermediate between silica-rich granites and iron/magnesium-rich gabbros). It consists mostly of feldspars and ferromagnesian minerals. The distinctive blue iridescent sheen comes from the feldspars and is called schillerisation.

#### **Larvikite – Emerald Pearl, Oslofjord, Norway** (Ecclesall Churchyard, Sheffield, 2012)

See the notes for the Blue Pearl, above. Both colours of Larvikite are popular for work surfaces. There is considerable variation in colour, in both Emerald Pearl and in Blue Pearl, depending on which parts of the quarries are being worked

#### **Alentejo Granite, Portugal** (Kerbstones in Sheffield City Centre, 2012)

The finer texture of this blue-grey granite means that it should correctly be called a microgranite, if not an intermediate igneous rock, to judge from the abundance of ferromagnesian minerals. It is now commonly used for kerbstones and rainwater channels at ground level.

#### **Gabbro, 'Bon Accord', South Africa** (Ecclesall Churchyard, Sheffield, 2012)

This is known as 'black granite' in the trade but it is not a granite at all, although it is of slow-cooled igneous origin. The silica content of the minerals is lower than in granite and so the main minerals are grey feldspar and dark ferromagnesian minerals. There is no quartz. This example probably comes from the Bushveld Complex, near Johannesburg and is of Precambrian age (i.e. more than 542 Ma). A wide range of 'black granites' is now imported from India and China for ornamental purposes, for gravestones and for work surfaces.

#### **Dolerite, source unknown** (Ecclesall Churchyard, Sheffield, 2012)

Dolerite is the medium-grained equivalent of gabbro, so the same comments apply as above. It is found in minor intrusions, such as dykes and sills, at no great depth below the Earth's surface, where it cooled more quickly than gabbro, resulting in smaller crystal sizes.

#### **Basalt, Italy** (Pisani plc, Cromford, Derbyshire, 2012)

Basalt is the fine grained equivalent of gabbro and dolerite, mostly formed when a magma of gabbroic composition reached the Earth's surface, and erupted to form basalt lava. The rapid cooling resulted in a much finer grain size than either gabbro or dolerite. The sample in the photograph has been cut smooth, but has not been polished.

### **Sedimentary Rocks – 1**

#### **Portland Limestone, Isle of Portland, England** (Sheffield City Library, 2012)

Portland Stone was popularised by Sir Christopher Wren, when he used it in the rebuilding of St Paul's Cathedral after the Great Fire of London in 1666, and it now features in many public buildings throughout the U.K. Examination under a hand lens shows that it is often composed of spherical ooids of calcium carbonate, 1mm or so in diameter. These were produced by the action of algae on a warm sea floor, and subjected to the action of currents, during the Jurassic Period (200-146 Ma). Shelly fossils of oysters resist weathering rather better than the bulk of the limestone and the extent to which they stand proud of the surface allows an estimate of weathering rates to be made when the age of the building is known, e.g. by using a tyre depth gauge.

#### **Roach Rock, Isle of Portland, England** (The Economist building, St James' Street, London, 2012)

The Roach Rock is part of the Portland Stone as described above, except for the remarkable preservation of the fossil gastropods and bivalves. (The gastropods are the 'screw stones' occupying most of the field of view: the 'dimpled' shape in the right hand corner is a bivalve, of *Trigonia* type). The fossils are preserved as moulds, formed where the actual animal shells pressed into the limey mud of the sea floor at the time. Later, the shells dissolved and the space was not taken up by other minerals, as usually happens. The gaps left in

the stone make weathering more likely, but this example has been in place since the 1960s without any obvious sign of deterioration.

#### **Ancaster Limestone, Lincolnshire, England** (Seat in Fargate, Sheffield, 2012)

The Jurassic limestone belt which crosses England from the Dorset Coast to Yorkshire contains many different building stones, many of them oolitic, like the Portland Stone. The public seat comprises white, blue-grey and reddish Ancaster Limestone sections, which respond differently to weathering, and already after only 13 years, this reddish variety is looking rather degraded.

#### **Crinoidal Limestone (Carboniferous), Derbyshire, England** (Portion of a work surface, 2012)

In this example of a limestone of Carboniferous age, virtually all the rock is composed of the debris produced by the break up of countless crinoids. These crinoids were animals, related to sea urchins, although they grew from the sea floor on a 'stalk'. In Derbyshire, it is mainly the 'stalks' and 'arms' which become preserved, and the body chamber of the animal is very rarely seen – presumably they were destroyed by the violence of water currents at the time. This specimen comes from Once-a-Week Quarry near Sheldon.

#### **Travertine (Pleistocene), Italy** (Front of a former McDonalds café, Pinstone Street, Sheffield, 2012)

Travertine is produced where hot springs bring mineralising fluids to the surface, which precipitate out as they cool. This often happens in association with algae and other plants, resulting in the layers and curved surfaces seen in the photograph. Elsewhere in the same shop front, fragments of newly formed rock had broken off by shrinkage of local movement and had then been incorporated in the deposit as it continued to form. Many McDonalds' outlets use travertine as their facing stone.

#### **Bath Stone Limestone ('Stoke Ground, Top Bed'), Bath, England** (A sample slab provided by the Bath Stone Group, 2012)

This limestone from Bath is of Middle Jurassic age (176-161 Ma) and is another oolitic limestone (See Portland Limestone above). The photograph shows its even texture and lack of fractures, which make it an excellent freestone (a type of rock which can be cut to shape in any direction). In this example, most of the ooids on the surface have weathered out, leaving tiny holes. Bath Stone is often more brown in hue than this sample, and is associated with old 'mellow' looking buildings. It is still worked at Limpley Stoke near Bath, Avon and at Box in Wiltshire.

### **Sedimentary Rocks - 2**

#### **Cross-bedded sandstone (Carboniferous), Stanton Moor, Derbyshire, England** (Crucible Corner, Sheffield, 2012)

This Carboniferous (359-299 Ma) sandstone has similar composition to the gritstone described below, but is of finer grain size. This sample shows cross bedding, produced by currents in an ancient river moving the sand grains along its bed and forming them into underwater dunes. The cross beds slope to the right, indicating an ancient current flowing from the left. Near the top of the photograph, the horizontal plane indicates where the water velocity increased enough to erode the top of the underlying dune, before more sand was deposited. The sharp junction indicates that this specimen is the right way up.

#### **"Rockingstone", shot-sawn sandstone, (Carboniferous), Huddersfield, England** (Peace Gardens, Sheffield, 2012)

The iron oxides present in the natural cement of this sandstone are clearly indicated by the rusty brown colour of the rock. In order to make a rough non-slip surface for paving a public area, the stone has been 'shot-sawn'. A series of steel blades, like a huge bread slicer, are drawn backwards and forwards across the block of stone, whilst steel shot is sprayed onto the block in a slurry of water.

#### **St Bees Sandstone (Triassic), Cumbria, England** (Shop front on St Paul's Parade, Sheffield, 2012)

Like the Stanton Moor sandstone, this Triassic (251-200 Ma) rock is also cross bedded and the gently curving layers indicate that it has been placed the right way up in the building (although nearby blocks are upside down!). The deep red colour (enhanced by spraying with a little water) suggests that the conditions at the time of its formation were rather arid, and it was probably deposited in an ephemeral river, such as occurs after heavy rainfall in desert regions. This is one line of evidence to show that the British Isles were at one time in desert latitudes, 20° to 30° from the Equator.

#### **'Millstone Grit' coarse sandstone (Carboniferous), Derbyshire, England** (Sheffield Cathedral, 2012)

The photograph shows part of a new block of gritstone, used to replace badly weathered stone on the south wall of the Cathedral. The vertical lines are mason's tool marks. It probably comes from Stancliffe Quarries in Derbyshire. A gritstone is a very coarse sandstone, with angular grains of quartz and feldspar, cemented together with a largely iron oxide cement. This example shows sub-rounded granules of pink feldspar and grey quartz. Millstones made from it were formerly used for grinding grain.

#### **'Yorkstone', flaggy sandstone (Carboniferous), West Yorkshire, England.** (This flagstone was being laid as part of the pavement outside the Geological Society, Piccadilly, London on 3<sup>rd</sup> May 2012!)

West Yorkshire is noted as a supplier of flagstones to England's major cities. The trade name 'Yorkstone' does not imply that it came from the city of York itself. The surface in the photograph has been sawn, not riven with a chisel, as it would have been in former times. It displays faint grey swirling marks, which show where underwater ripples were formed in the ancient river currents at the time when the sand was being deposited. The brown section on the left of the photograph shows where weathering by oxidation has occurred. Although the edge of the slab has been trimmed, there was probably a natural joint nearby, which allowed the passage of oxygenated water through the rock.

**Rudistid limestone (Cretaceous), probably Portugal**, (Café front, formerly Norwich Union building, St James' Street, London, 2012)

Although loosely called 'marble', because it takes a polish, this rock is actually a limestone, with well preserved fossils, set in a reddish lime mud. The fossils are strange, thick shelled bivalves known as rudistids, which are typical of the Cretaceous deposits of the ancient Tethys Ocean. They are common in southern Europe, but are not found further north. This example was probably quarried in Portugal.

## Metamorphic Rocks

**Slate, North Wales** (from a loose specimen, 2012)

Slate is produced by the low grade metamorphism of an original mud-grade rock such as shale. Increased lateral pressure is normally considered as a more important factor than raised temperature. New platy minerals are formed at right angles to the direction of the forces involved. This may be totally different from the original bedding, so a slate will tend to split along the new cleavage planes, and not the original bedding. This is well seen in the specimen, where the bedding is picked out by a colour change, whilst the penny lies on a cleavage plane, along which the slate has been split by the quarry worker.

**Broughton Moor Slate, Lancashire, England** (Paving at the fountains in the Peace Gardens, Sheffield, 2012)

This slate could be classified as a sedimentary, igneous or metamorphic rock! It was formed when volcanic ash was blasted out of a volcano in Ordovician times (488-444 Ma). The ash settled in surrounding water, with the coarser particles settling first, grading up to the finer ones. It later underwent metamorphism at a destructive plate margin in the Caledonian Orogeny (mountain-building episode) and acquired a cleavage at a high angle to the original bedding.

**Gneiss ('Paradiso classico'), India** (Pisani plc, Cromford, Derbyshire, 2012)

By contrast with slate, gneiss is a high grade metamorphic rock, formed under higher temperatures and greatly increased lateral pressures deep in the Earth's crust. In spite of the extreme conditions, the rock never became molten, apart from localised patches within the overall rock mass. The distinctive banding of quartz, feldspars and ferromagnesian minerals is evident in this natural scale photograph. This is one of a wide variety of gneisses imported from India for use in ornamental work, such as gravestones. The rock takes a good polish and is resistant to weathering.

**Verde Ematita, Argentina** (Marks and Spencers' department store, Fargate, Sheffield, 2012)

At first sight, this attractive blue-green rock, with a texture resembling tapioca, looks as though it is of igneous origin. However, it is actually a metamorphic rock. The blue mineral is cordierite, which is associated with metamorphism at high temperatures, but without melting. Verde Ematita comes from the High Andes in Argentina, and was proposed for all major Marks and Spencer stores – until the quarries ran out of reserves!

**Marble, Carrara, Italy** (Ecclesall Churchyard, Sheffield, 2012)

The term 'marble' is often wrongly applied to any rock which takes a good polish. However, geologists restrict the word to metamorphosed limestones, whether this took place in contact metamorphism close to a major igneous intrusion, or whether increased pressure at a destructive plate margin was involved. This sample is typical of marble from Carrara in Italy. When fresh it is dazzling white, with subtle grey swirling marks ('marbling'), resulting from the metamorphism of impurities within the original limestone. It tends to suffer from weathering and this sample shows some algal staining.

**Serpentinite, source unknown** (office front of 18, Pall Mall, London, 2012)

The name serpentinite derives from the supposed similarity of the rock to snakeskin! It consists largely of ferromagnesian minerals, which have been altered considerably during Earth movements. It probably derives from an igneous origin in the Earth's mantle, but the alteration is so severe that serpentinite is justifiably classed as a metamorphic rock by most authorities. It is best used for ornamental work indoors, since it is badly affected by weathering and is often considerably paler than this fresh example.

**Footnote:**

The natural scale photographs of building stones were taken using a Nikon D60 digital SLR camera, with the lens on the 55mm zoom setting. The front of the lens was kept at a standard 23cm from rock surface, using a short stick cut to length. The 1p coin is 2 cm in diameter.

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The following chart shows the relationship between each of the activities on the theme of building stones. Each activity can be taken as a free-standing entity, since photographs and details of rocks are repeated. However, it is hoped that pupils will deepen their understanding of the topic and their enthusiasm for looking at the built environment around them by following all the activities in sequence, if this is appropriate to their local setting. The photographs were mostly taken using local opportunities in the U.K., but many of the building stones have come from across the world.

<b>Title of activity</b>	<b>Topic</b>	<b>Resources provided</b>	<b>Indoor activity</b>	<b>Outdoor activity</b>
Building Stones 1 - a resource for several Earthlearningidea activities. ("BS1")	Identification of building stones from each of the three groups of rocks.	Six sheets of photographs of building stones at natural scale, to be cut into separate photographs; Descriptions of all the stones; Key to the identification of building stones.	Identifying all the stones from the photographs, using the key; Competitive approach; opportunity for playing games with the photos.	Identifying building stones from the complete sheets of photographs, in a graveyard or town/city centre.
Building Stones 2 – igneous rocks	Using the photographs of igneous rocks to investigate their features in more detail and to comment on the conditions under which some of the rocks were formed.	Three sheets of igneous rocks, (taken from the whole set in BS1); Photographs of igneous rocks in use in a city centre; Descriptions of igneous rocks, as in BS1; A simple classification chart for the igneous rocks featured in the activity.	Grouping the photographs according to a) grain size; b) colour (and hence mineral content); Assessing the value of igneous rocks for ornamental or functional purposes.	Identifying building stones of igneous origin, from the sheets of photographs, in a graveyard or town/city centre; Explaining detailed features seen in igneous rocks used in buildings.
Building Stones 3 – sedimentary rocks	Using the photographs of sedimentary rocks to investigate their features in more detail and to comment on the conditions under which some of the rocks were formed.	Two sheets of sedimentary rocks, (taken from the whole set in BS1) Photographs of sedimentary rocks at outcrop, in use in a city centre and being processed for use as building stones; Descriptions of sedimentary rocks, as in BS1.	Relating the sedimentary rocks to their environments of deposition; Discussing their relative merits in resisting weathering; Showing how sedimentary rocks are cut for use, and why matching stones used in older buildings may be difficult.	Identifying building stones of sedimentary origin, from the sheets of photographs, in a graveyard or town/city centre; Explaining detailed features seen in sedimentary rocks used in buildings.
Building Stones 4 – metamorphic rocks	Using the photographs of metamorphic rocks to investigate their features in more detail and to comment on the conditions under which some of the rocks were formed.	One sheet of metamorphic rocks, (taken from the whole set in BS1) Photographs of metamorphic rocks at outcrop and in use in a city centre; Descriptions of metamorphic rocks, as in BS1.	Using evidence from photographs at natural scale and of metamorphic rocks outdoors to decide how they were formed and the factors affecting their use.	Identifying building stones of metamorphic origin, from the sheets of photographs, in a graveyard or town/city centre; Explaining detailed features seen in metamorphic rocks used in buildings.
Will my gravestone last?	Using a local opportunity to enable pupils to see a wide range of rock types and to investigate different scientific hypotheses.	An outline of how to conduct a graveyard survey, including suggested preparation and follow up activities; a plotting chart for pupils' observations; Hypotheses which might be tested are suggested. The sheets from Building Stones 1 should be used for this activity.	Preparing for the graveyard visit, by revising pupils' knowledge of sedimentary, igneous and metamorphic rocks. Following up the visit by assessing the validity of hypotheses about weathering rates etc and plotting graphs of data gathered during the visit.	Identifying ornamental stones from the complete sheets of photographs in a graveyard; Testing hypotheses regarding the rates of weathering of different rock types and the choice of different rock types over time.

## Igneous rocks - 1



South West England Granite, England



Kemnay Granite, Aberdeen, Scotland



Rubislaw Granite, Aberdeen, Scotland



Rubislaw Granite with xenolith



Balmoral Red Granite, Finland

(1p coin is 2 cm in diameter)



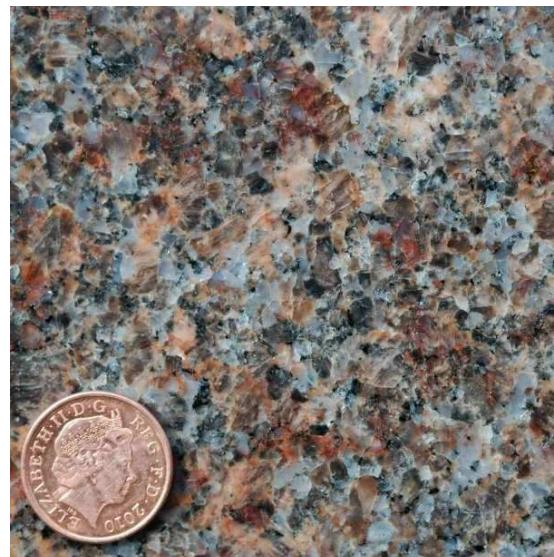
Shap Granite, Cumbria, England

All photographs by Peter Kennett

## Igneous Rocks - 2



Ross of Mull Granite, Scotland



Imperial Mahogany Granite, South Dakota, U.S.A.



Rose Swede Granite, Sweden



Peterhead Granite, Peterhead, Scotland



Rosa Porrino Granite, Spain

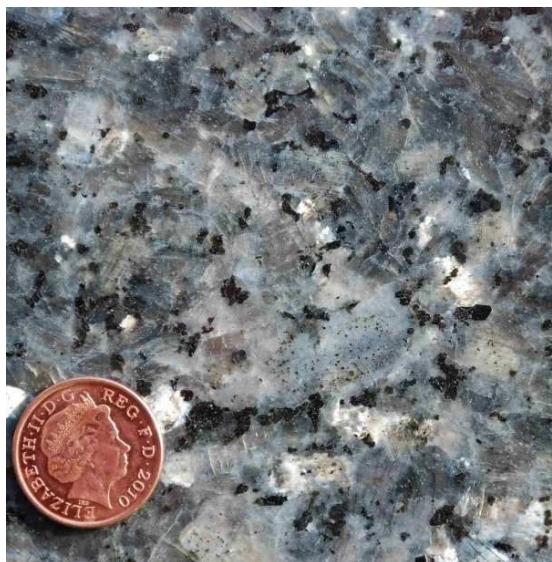
(1p coin is 2 cm in diameter)



‘Baltic Brown’ Granite, Finland

All photographs by Peter Kennett

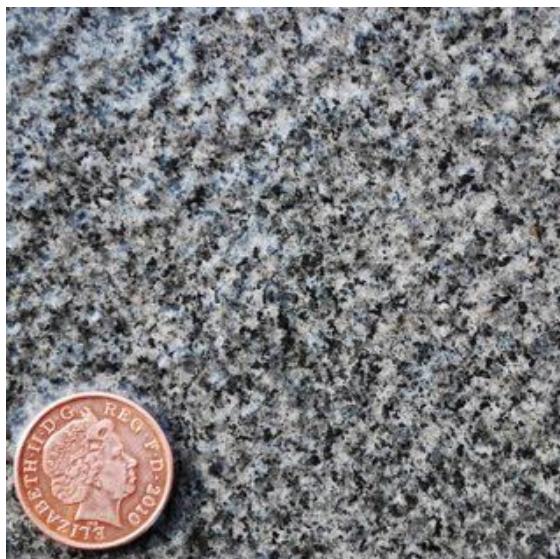
### Igneous Rocks - 3



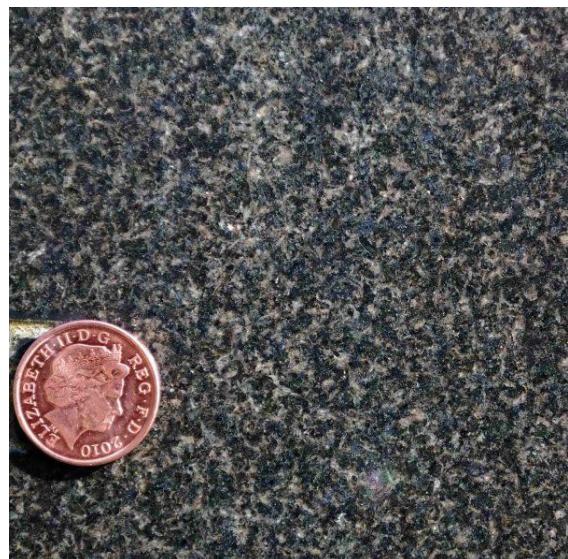
Larvikite – Blue Pearl, Oslo region, Norway



Larvikite – Emerald Pearl, Oslo region, Norway



Alentejo Granite, Portugal

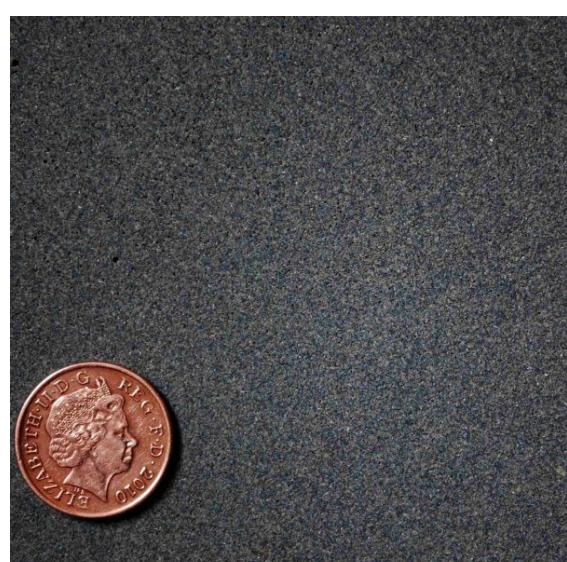


Gabbro, South Africa



Dolerite, source unknown

(1p coin is 2 cm in diameter)



Basalt, Italy

All photographs by Peter Kennett

## Sedimentary Rocks - 1



Portland Limestone (Jurassic), Isle of Portland, England



Roach Rock (Jurassic Limestone), Isle of Portland, England



Ancaster Limestone (Jurassic), Lincolnshire



Crinoidal Limestone (Carboniferous), Derbyshire, England



Travertine mineral spring-limestone (Pleistocene), Italy

(1p coin is 2 cm in diameter)



Bath Stone Limestone ('Stoke Ground, Top Bed', Jurassic), Bath, England

All photographs by Peter Kennett

## Sedimentary Rocks - 2



Cross-bedded sandstone (Carboniferous),  
Stanton Moor, Derbyshire, England



"Rockingstone", shot sawn sandstone, (Carboniferous),  
Huddersfield, England



St Bees Sandstone (Triassic), Cumbria, England

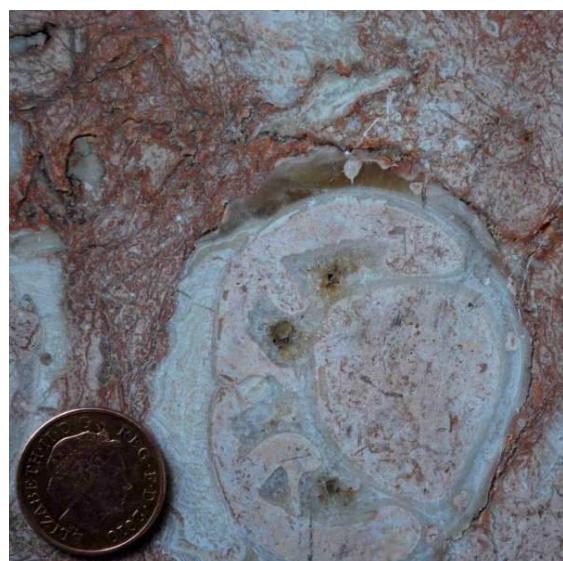


'Millstone Grit' sandstone (Carboniferous), Derbyshire, England



'Yorkstone', (Carboniferous), West Yorkshire, England

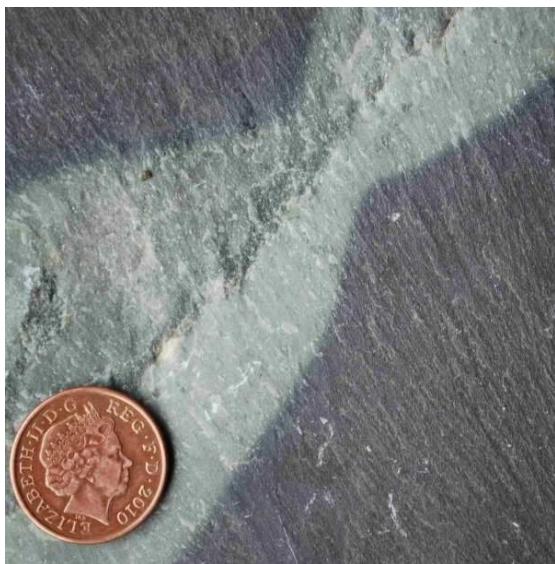
(1p coin is 2 cm in diameter)



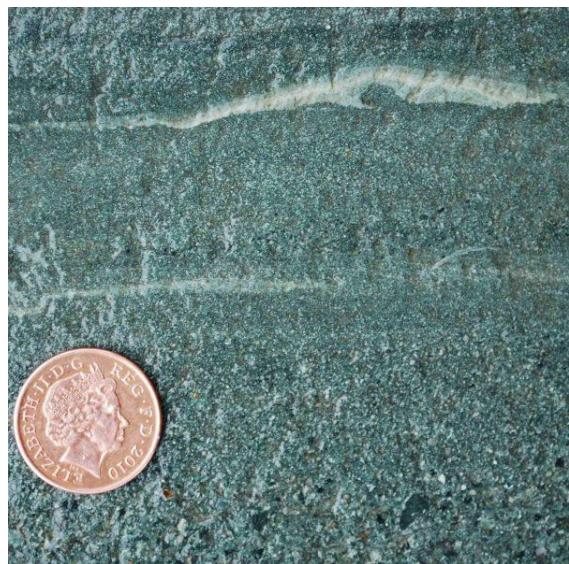
Rudistid limestone (Cretaceous), probably Portugal

All photographs by Peter Kennett

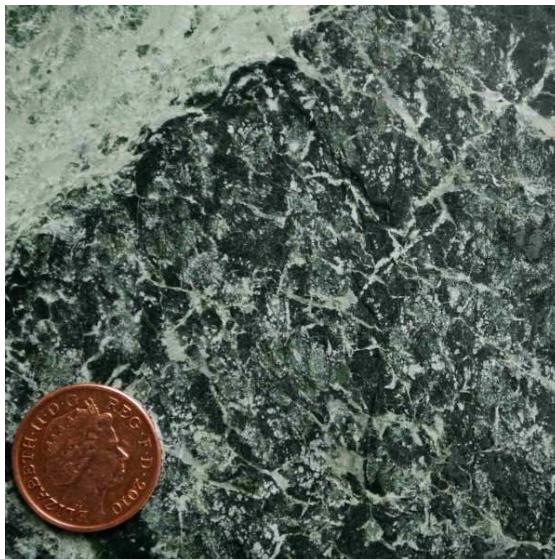
## Metamorphic Rocks



Slate, with colour band from original bedding, North Wales



Broughton Moor Slate, Lancashire, England



Serpentinite, locality unknown



Gneiss, ('Paradiso classico'), India



Verde Ematita, Argentina

(1p coin is 2 cm in diameter)



Marble, Carrara, Italy

All photographs by Peter Kennett

**Key to some rocks commonly used for ornamental purposes**

