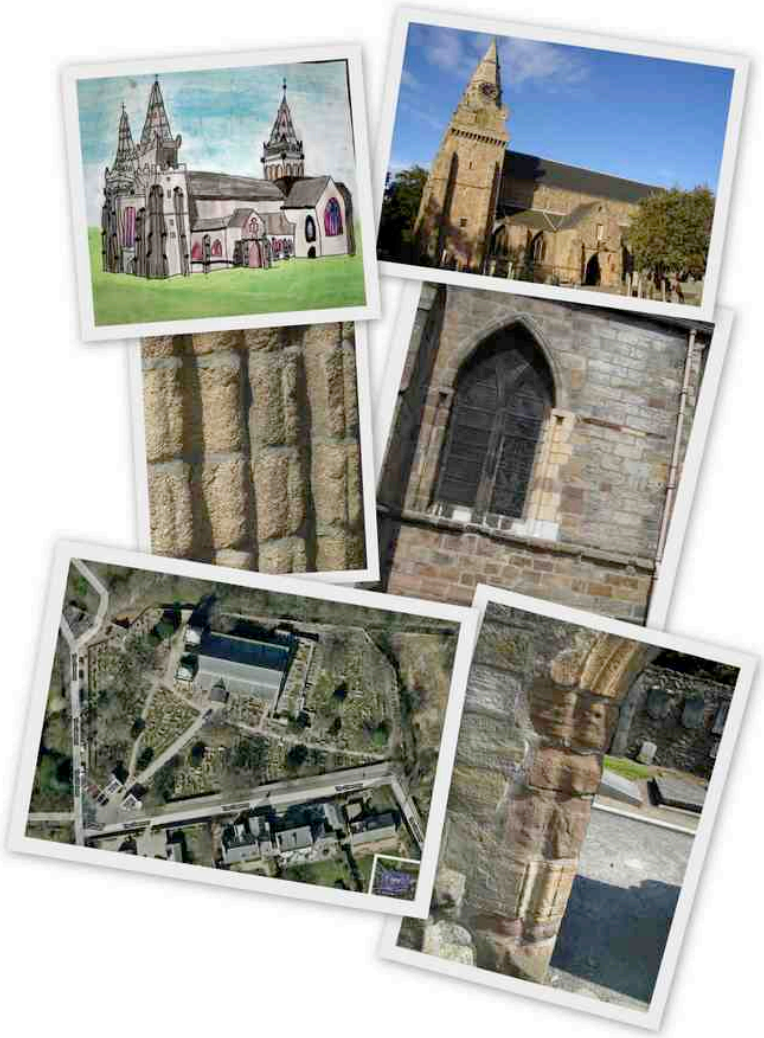
TEACHER NOTES and PUPIL MATERIALS

for

The St Machar's Cathedral Stone Detectives Trail

Use this field trip guide to learn more about Earth Science and local history by exploring the area around St Machar's Cathedral Church and learning about the stories told by the stones that were used to build it.



Devised and written by Peter Craig and Juliet Robertson as part of the Scottish Earth Science Education Forum's *Earth Science Outdoors* Project.

The St Machar's Cathedral Stone Detectives Trail

Explore the stories behind the stones used to build St Machar's Cathedral Church.

These notes are provided to enable teachers to take groups of pupils on a field trip to St Machar's. The main focus of the notes is on developing skills of observation, recording and interpreting. Although geology and history are the main areas of the curriculum that are highlighted, the Cathedral provides a rich context for studying many other areas of the curriculum and for developing general outdoor study skills. There is also scope for modifying the materials for levels other than Two and Three which are the main targets for the suggested activities.

CONTENTS




Teacher Notes

Background information

St Machar's Cathedral is a lively church. It is an important historic monument and an active place of worship. Lots of information can be found on the website: http://www.stmachar.com, including a link to a wonderful *Virtual Tour* of the inside of the cathedral. This can be found at the top of the *Building & History* page.

St Machar's Cathedral has two small rooms in the Cathedral Gatehouse which can be used by schools as a base for their work. Contact the Cathedral Secretary, telephone 01224 485988 to arrange a school visit.

Existing educational resources

Educational resources available at St Machar's include worksheets, factsheets and other useful information for schools. This material focuses on religious & moral education, and the history of St Machar's Cathedral. There is also a graveyard trail.

The Cathedral Church of St Machar – A Guide can be purchased from the church shop priced £3 and provides useful background reading.

The Granite Trail and *Old Aberdeen Trail* leaflets are also helpful and worth obtaining from Aberdeen City Council. They are free. Contact Aberdeen City via their website for further information: www.aberdeencity.gov.uk/acc_data/service/cd_trails.asp

The much missed Aberdeen Environmental Education Centre (AEEC) produced three education packs which schools might find useful in terms of building upon and extending the studies recommended in this pack:

- *Exploring Buildings*: This pack helps children look closely at building designs and gives very good advice about sketching and drawing buildings based on the seven elements of art and design.
- *Victorian Aberdeen*: This pack looks at Victorian architectural features.
- *Exploring Old Aberdeen*: A street trail to help pupils learn more about Old Aberdeen.
- *St.Machar's Cathedral & Tillydrone Motte*: This pack takes a social studies approach.

General advice about visiting

- Contact the church and arrange a booking.
- If you are going to the expense of hiring a bus, you should consider combining the *Stone Detectives Trail* with one of the other activities listed above. Allan Paterson (formerly of AEEC) can be contacted at allpaterson@aberdeencity.gov.uk and can advise about the current availability of supporting resources – and possible personal guidance.
- Undertake a site visit in advance so that you know where to go and what to look for.
- Remember to undertake a risk/benefit assessment (a prepared one may become available through Allan Paterson.

- Prepare your children for the visit. They will benefit much more from the excursion if it relates to ongoing project work and makes connections to their own lives.
- Ideally each group of four children should have a digital camera. If this is possible then remember to bring plenty of spare batteries.

When visiting the church, it is important to reinforce with the children that calm, responsible behaviour is important. Splitting a large class into smaller groups will lessen the impact and presence of a class both in the cathedral and outside. Check with the Cathedral Secretary about which areas of the graveyard are safe to visit.

There are rules about working in the graveyard:

1) WALK around the gravestones. Don't run.
2) DO NOT lean against the stones. They might fall!
3) Only take rubbings from stones which are lying down.
4) If you are not sure, ASK!

What to bring

Each child should wear sensible clothing and footwear appropriate to the weather and time of year.

The following items are needed for each group:

- Clip board
- Map of St Machar's (photocopy sheet supplied in this pack)
- Pencil (bring plenty spare)
- Digital camera (bring plenty of spare batteries)
- Laminated photographs and description cards (these can be obtained from St Machar's Cathedral, if booked in advance)

Additional items are needed for the additional activities:

- Magnifying glasses
- Wax crayons and paper or fine material for rubbings of stones and gravestones

Why look at the stonework? What's so special about St Machar's Cathedral Church?

This project pack can be used to enhance a variety of projects increasing either the breadth or depth of study in a cross-curricular manner. It can be part of:

- A local history project, particularly in relation to Aberdeen's growth as the Granite City
- A buildings and technology project
- A project about rocks and landscapes
- An interesting dimension to a place of worship study. The importance of stones is reflected in the Cathedral Church literature which states:

  "*St Machar's is not simply a building of stones which provides protection, a safe place for the community to gather, but an edifice of stones whose voices enfold the community in centuries of praise and prayer, worship and witness…. the stones of the Cathedral bear*

testimony to a variety of ways of worship, expressions of faith and discipleship emanating from different ecclesial traditions and times..."

St Machar's Cathedral is situated where there has ben a religious site for almost 1500 years. The present building has been extended and rebuilt during its 800 year existence using different building stones, according to the availability of local stone, craftsmen and equipment developed for obtaining, cutting, and carving stone. The stones used tell a story about human interaction with the local environment. Many different styles and types of stonework have been used over the centuries. Pupils should enjoy the detective work involved in studying these in order to unravel some of the building's unusual history. Careful observation skills are required!

A Curriculum for Excellence Experiences and Outcomes (EOs)

This project can link to many different EOs depending on the learning and teaching emphasis and delivery. It is aimed particularly at Levels 2 and 3. It is hoped that teachers will use the activities specifically to cover:

Level 2

When I engage with others, I can respond in ways appropriate to my role, show that I value others' contributions and use these to build on thinking. ***LIT 2-02a***

I can interpret historical evidence from a range of periods to help to build a picture of Scotland's heritage and my sense of chronology. **SOC 2-02a**

I can describe the major characteristic features of Scotland's landscape and explain how these were formed. **SOC 2-07a**

As I extend and enhance my knowledge of features of various types of software, including those which help find, organise, manage and access information, I can apply what I learn in different situations. **TCH 2-03a**

Level 3

I am developing confidence when engaging with others within and beyond my place of learning. I can communicate in a clear, expressive way and I am learning to select and organise resources independently. ***LIT 2-10a / LIT 3-10a***

I can respond in ways appropriate to my role and use contributions to reflect on, clarify or adapt thinking. ***LIT 3-02a***

Through evaluation of a range of data, I can describe the formation, characteristics and uses of soils, minerals and basic types of rocks. **SCN 3-17a**

Having investigated processes which form and shape landscapes, I can explain their impact on selected landscapes in Scotland, Europe and beyond. **SOC 3-07a**

I enhance my learning by applying my ICT skills in different learning contexts across the curriculum. **TCH 3-04a**

There are lots of other possible links which may evolve through doing the project, depending on the emphasis which teachers (and their class) may wish to take.

Outline History of St Machar's Cathedral

These notes provide a timeline which can help you identify which features and stone types link to different time periods.

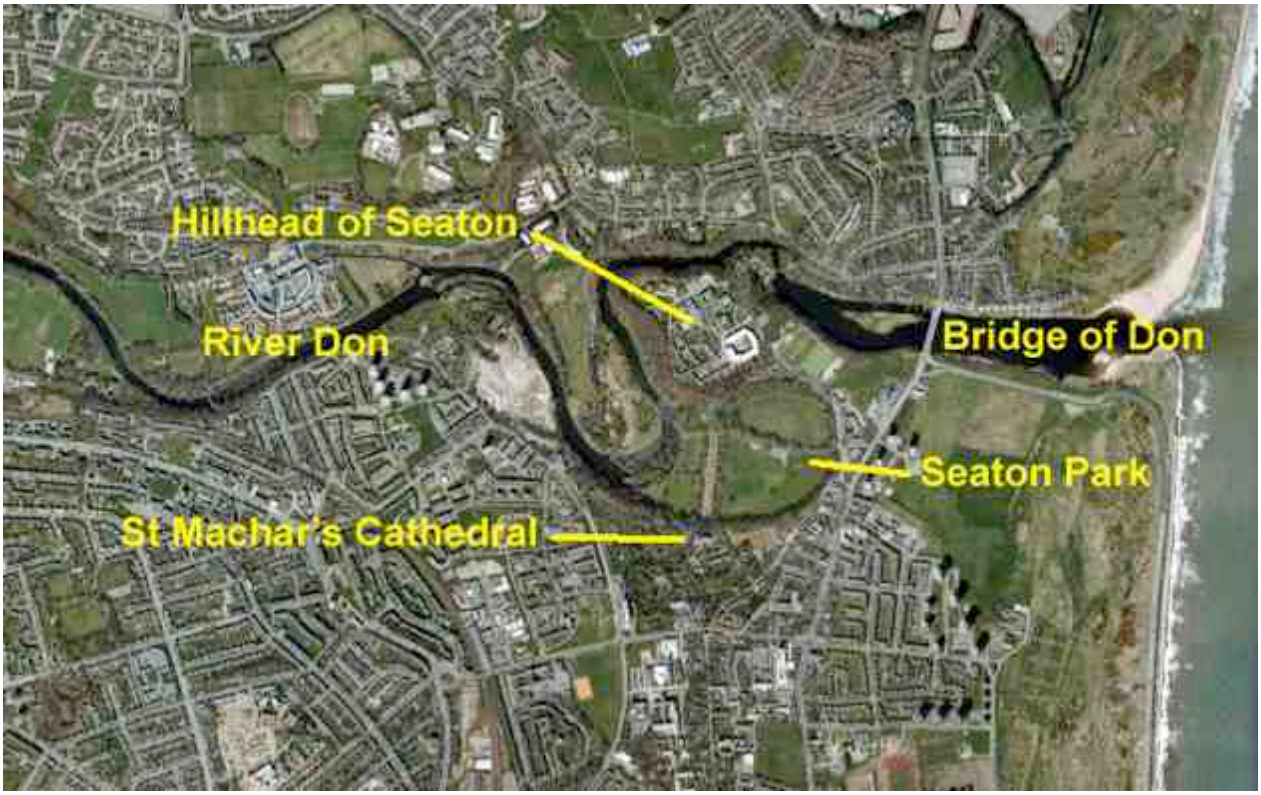
Around 580AD

A Celtic church is established by St Machar, a Celtic monk. However no hard facts are recorded. It is believed that St Machar was one of the monks who accompanied Columba on his journey from Ireland and helped him found the monastery at Iona. It was said that St Machar had miraculous healing powers which made other monks envious.

Columba had a dream in which he saw that Machar's life was in danger. He told Machar to travel east until he came to a river with a bend that resembles a bishop's crozier. There he was to build a church.

Whilst this legend can be debated, there is evidence of a Pictish settlement on the riverbank around 580AD. Within the cathedral, there is a stone incised with a Pictish cross which was found locally and dates back to that period.

Below is a Google maps satellite image of the lower Don providing striking confirmation of how curiously shaped the river's course is at this point. Instead of flowing eastwards through Seaton Park directly towards the sea, the Don swings sharply back on itself to flow through a channel cut into bedrock to the north of Hillhead of Seaton. It is this tight bend in the river's course that is referred to in the legend related above.



In fact, the satellite image shows that Seaton Park itself used to be on the north bank of the Don, with the river swinging even further east before doubling back on itself to form an extraordinarily looped bend. The former steep south bank is preserved today around the perimeter of Seaton Park and is clearly defined in the satellite image by a line of trees. Indeed,

this former river bank defines the northern boundary of the Cathedral site itself where the tree-covered slope drops steeply down to the flat expanse of Seaton Park about 10 metres below.

Borehole evidence suggests that a buried river channel exists to the east of Seaton Park and that the Don abandoned this older channel before the height of the last Ice Age. It is possible that the Don was forced to find its present alternative northerly route towards the sea because this original channel was dammed by a local mass of ice. All of this pre-dates St Machar and even the Pictish settlement by around 10 to 20 thousand years.

From about 1130 until the Reformation of 1560

By 1165, a Norman style of cathedral stood on the site. It was a Roman Catholic Cathedral with a bishop in charge. Work began in 1290 to replace this with an Early English style cathedral, but it took until about 1450 for this new building to be completed. Little trace now remains of the Norman cathedral, and what is standing today is only a part of the Early English style of building.

Between 1355 and 1380 work, started on building the two western towers. This created a good example of a fortified church and is the earliest surviving use of dressed granite masonry on the site. In the 1490s, a spire was added to the central tower. In the1520s, spires were added to the western towers and the ceiling was put up.

The two images below show what the Cathedral may have looked like around 1530. The one on the left is copied courtesy of the St Peter's school website at: http://www.st-peters.aberdeen.sch.uk/. The one on the right is a detail from a 1661 map by James Gordon showing St Machar's as it was then. See the map section of the National Library of Scotland: http://maps.nls.uk/towns/detail.cfm?id=209

Following the Reformation of 1560, the roof lead and bells were removed in 1567 and the church fell into disrepair.

After the Reformation of 1560

In 1688, the central tower crashed down during a storm and damaged the east end of the nave. This may have been a consequence of Cromwell's troops removing stonework to construct their fortifications during their occupation of Aberdeen in 1654.

By 1704 the nave was made wind and watertight.

In the 1860s, the Cathedral closed for months whilst repairs were done.

In 1953, work to repair the damage caused by the central tower collapsing almost 300 years earlier was finally completed when a new wall with three stained glass windows was inserted into the arch at what is now the east end of the nave.

The photo opposite shows St Machar's Cathedral Church as it looks today. Compare its shape with that shown in the two images above. The tower and its steeple have gone, along with the transept and everything to the east.

The damage to the eastern end of the building in 1688 was considerable. As you will see in the next photo below, repairs carried out after that used a mixture of stone types. Although the entire original nave and western towers were constructed of granite, the subsequent repairs used a seemingly *ad hoc* mixture of granite, local reddish brown sandstone and a paler yellow variety brought by sea all the way from Covesea, near Hopeman. The patchwork nature of the later stonework appears to have been carried out in several separate phases, clearly with the aim only of securing the building and with scant regard to its original architectural style.

What a 'mixter-maxter'!

OG = original field granite
RG = fresh Rubislaw granite
ORS = Old Red Sandstone
NRS = New Red Sandstone (old and fresh)
1 - ORS with obvious pebbles
2 - this block has been placed with its layering vertical, unlike all the other ORS blocks
? - uncertain from photo evidence, but these look like field boulders of various types, including metamorphic

The next two photos show the east gable of the cathedral. Although from the inside, this end of the cathedral has the same style of granite stonework as the rest of the interior, the exterior stonework is very different. There is a very confusing conglomeration of architectural features and styles of stonework that reveal a complex history of restoration and rebuilding. The most recent phase dates from 1953 and uses a synthetic stone made by crushing granite and then reforming it into standardised blocks using cement and a yellowish dye. This is the stone that surrounds the three tall stained glass windows.

East gable of the Cathedral Compare the stonework inside and outside.

Information about the rocks that can be seen at St Machar's Cathedral

Although St Machar's Cathedral is often wrongly described as the only granite cathedral in the world, it is certainly one of very few built with this very hard, difficult-to-work building stone. And, anyway, there are some parts of the building which are very obviously constructed using other types of building stone. In fact, the different rock types used to construct particular parts of the Cathedral reveal much about the building's complex history. They also provide a unique opportunity to examine common rock types and to learn about how they were formed – and even to learn about Scotland's surprising geological past. St Machar's is just a great place for learning to be a *Stone Detective*!

All three 'rock families' are represented at St Machar's:

Rock Family	**Rock Type**
Sedimentary	sandstone
Igneous	granite
Metamorphic	slate and marble

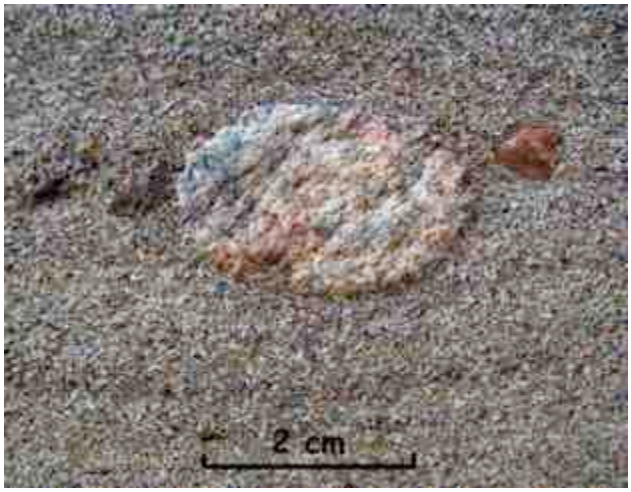
In addition to these natural rocks, 'man-made rock' in the form of an early version of *Fyfestone* was used around the three stained glass windows inserted in the East gable in the 1950s.

Sandstone

This is normally a reddish brown or yellow coloured rock made of sand grains. You can often see the layers that were formed as more and more sand accumulated a long time ago. Some time later, the grains became cemented together to form the solid rock we see today. Sometimes, the cementing chemical isn't very strong and you can feel sand grains coming off when you rub the rock.

Sandstone was used to form the archway opposite because it is one of the easier rocks to carve into special shapes. As you can see, it also soft enough to wear away quite noticeably during the centuries since it was carved.

Very rarely, if you look closely at some of the reddish brown sandstone building blocks in the east gable, you may spot small rounded pebbles that were washed into the layers of sand. These provide good evidence that the sand that forms this sandstone was originally laid down by flowing water, most probably in a shallow river bed. This type of sandstone can be seen (with difficulty!) as outcrops of bedrock on the steep south bank of the River Don, downstream from the Brig o' Balgownie. In fact, the sandstone layers in most of the visible outcrops at that locality contain lots and lots of pebbles and small boulders, so much so that the rock is more properly called a conglomerate or pudding-stone.

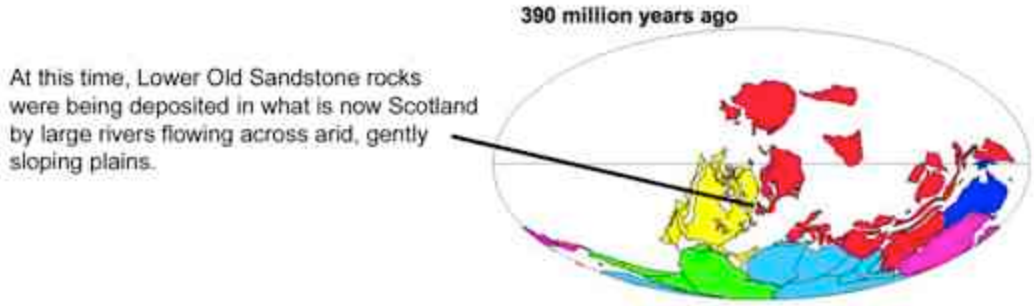


Close-up of rounded granite pebble in sandstone

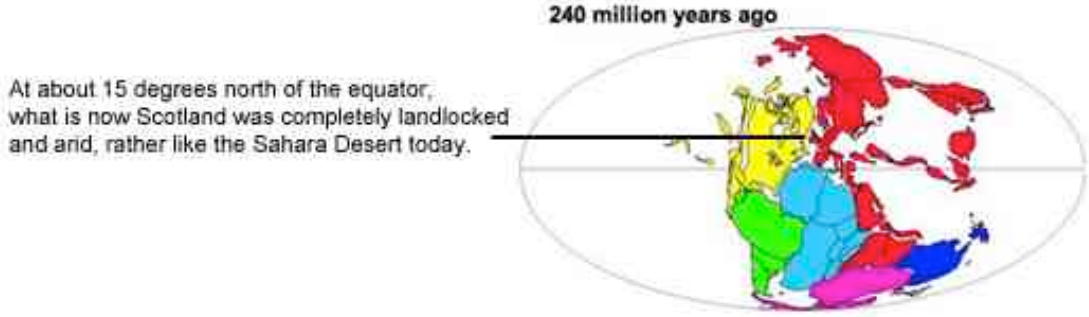
Very probably, when the cathedral was being built, a quarry would have been opened nearby from which the sandstone would have been extracted and then shaped into the desired building blocks. Like many old quarries, it has long since been filled in and no trace of it now remains.

The yellow-brown sandstone in the picture of the archway above has a very different origin. It is a desert sandstone whose layers were formed when sand was blown across the surface of an ancient desert and deposited on the lea side of a large sand dune. The stone masons clearly valued its properties highly since it was brought by sea all the way from Covesea quarry, near Hopeman, on the Moray Firth. The same stone was used in the construction of nearby King's College Chapel when it was built 500 years ago.

The two different sandstones provide information about two very different periods in Scotland's geological history. The reddish-brown sandstone is around 400 million years old and belongs to the group of rocks known as Lower Old Red Sandstone. These rocks are common in many parts of Scotland and were formed when the part of the Earth's crust that is now Scotland was located around 15 degrees south of the equator.



The paler desert sandstone belongs to the New Red Sandstones and was deposited around 250 million years ago when Scotland was around 15 degrees north of the equator. The area around Hopeman and Elgin is the nearest source of this very uniform and high quality building stone.



On the south wall of the Cathedral, you will find a window which shows many different types of building stone used over the centuries to repair and renovate the stonework. This window is close to where the central tower collapsed in 1688. The strange dovetailing of granite and sandstone here may date from restoration work carried out after the collapse. Much more recent restoration highlights the huge difference between recently quarried Rubislaw granite and the original granite scavenged from the surrounding countryside. It also shows the contrasting appearance of fresh New Red Sandstone from Covesea and the blocks which have weathered over many centuries.

For more information about how skilled stone masons go about restoration work today, the following website has two excellent photo-galleries of recent restoration work carried out at nearby King's College Chapel and at the Brig o' Balgownie:
http://www.traditionalmasonry.co.uk/ProjectCaseStudies/CaseStudiesMainMenu.aspx - follow *Project* links at bottom of page to Kings College Crown – and Brig o' Balgownie.

Granite

Granite is the rock type from which nearly all of the interior and most of the exterior of the existing building at St Machar's is constructed. It is an igneous rock made of crystals which have formed below the Earth's surface from cooling magma. The larger the crystal size, the more slowly the magma cooled when the rock was being formed.

Granite is mostly made up of three crystal types. The main one is known as *feldspar*. This mineral ranges in colour from white, though various shades of cream and pink, to red. The mineral *quartz* is the second most common constituent. Although crystals of quartz can be as clear as glass, they tends to look grey when embedded in granite. *Mica* is the third common crystalline mineral in granite and comes in two varieties, silvery white or dark black.

Granites from around Aberdeen show a wide range of colours and appearances. Colours range from light white-grey to blue-grey, dark grey, pink and red. These colour variations mostly arise from differences in the proportions and types of feldspar crystals present. Some granites are fine grained and uniform looking. Others are coarse grained, and sometimes have especially prominent large feldspar crystals up to a few centimetres across.

Granite is a very durable building stone and has been used to build many different types of buildings and structures. Its hardness, however, means that it is difficult to quarry and work. Before advanced quarrying techniques were developed in the 19th century, stone was often gathered as suitable boulders from fields or split from surface outcrops and very simply dressed. The term *dressed* means that the stones were shaped using a hammer and chisel (puncheon), or other hand tools, to make them fit together more precisely. A lot of the granite blocks used to build St Machar's were sourced and shaped in this way.

Granite can be seen used for various purposes within the Cathedral, in the graveyards and around Old Aberdeen. Most granite used in buildings constructed before the 19th century was either worked from surface outcrops or fetched to the building site as field boulders. Granite from these sources would already have been exposed to natural weathering processes for thousands of years. This has made them more permeable and less durable as a building stone than the freshly quarried granites used in Victorian times. Granite quarried from deeper quarry holes, as at Rubislaw, is particularly fresh and durable.

The granite stonework shown opposite illustrates the weathered and pitted surfaces typical of the original granite blocks. The variety of colours and textures seen in these blocks also indicates that they were not quarried from a single quarry hole, but were collected from a variety of different locations.

The appearance of this granite stonework differs markedly from the uniform grey Rubislaw granite that characterises so much of Victorian Aberdeen.

With the Industrial Revolution of the 18th century came an increase in demand for granite especially for road surfaces. Aberdeen was able to export a lot of granite by sea, especially to London. Harbour works and bridges were often built of granite too. Meanwhile, granite became popular for creating imposing buildings with decorative features.

In the 1830s, a significant breakthrough happened. Alexander MacDonald designed a steam driven polishing machine. It revolutionised the production of polished granite slabs and enabled large-scale production to take place. He showed that a smooth surface could be achieved by running sand and water beneath an iron polishing head.

MacDonald also designed a steam-powered saw and lathe. Gradually the granite trade became mechanised. In the 1880s, chilled iron replaced sand, and this speeded up the cutting process significantly. A block of granite could now be cut in as little as 10 days, whereas previously it had taken months. Further development of this technology enabled very thin slabs of granite to be cut. When polished, these slabs made high quality decorative fronts for buildings.

By the end of the 19th century, Aberdeen was the world's major producer and exporter of granite. Quarries throughout the North East provided stones used in building roads, sculptures, buildings and memorials. Thousands of granite gravestones were manufactured, ranging from the simplest markers to elaborate polished tombs.

Then changes began to happen. The USA began to restrict imports of stone. Concrete and steel became popular for building. Roads started to be made using tarmac, an oil based product. Cremations rather than burials became more popular. All this had a significant impact on the granite industry in Aberdeen. By the 1970s, only a few working quarries remained and most of the granite yards had closed.

One of the biggest granite quarries was Rubislaw Quarry. When this quarry closed in 1971 ,it was about 450 feet deep. It had been worked for over 200 years, producing hundreds of thousands of tons of grey granite. It has been estimated that at least 50% of Aberdeen's buildings are built from Rubislaw stone.

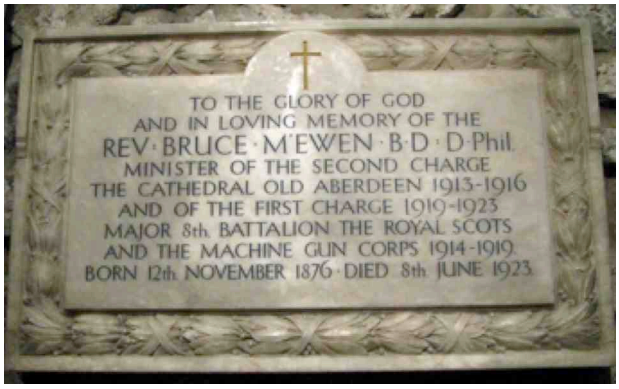
Marble

Marble is a rock that forms naturally when limestone is altered by heat and pressure over a long period. Scottish marbles such as those from Skye and Ledmore (NW Highlands), were originally layered limestones that were completely altered and recrystallized when large bodies of hot magma rose up through them from deeper levels within the Earth.

The original limestones were formed as layers of carbonate mud on ancient sea floors. The remains of sea creatures such as shellfish and corals often became buried in these layers of

mud. When the mud gradually hardened to form limestone as a result of slow chemical cementing, these remains of once living creatures were preserved as fossils.

Marble used for gravestones and sculptures is usually white or pale cream coloured. Some marbles, however, show swirling patterns of colours such as pink, brown, grey or green. Marble is mostly made of tightly interlocking crystals of calcium carbonate. Compared with harder rocks such as granite, it is much easier to cut, shape and polish. Very pure marbles such as the Carrera marble from Italy have been used for thousands of years to make statues. As well as being good for making very precise shapes, the surface can be polished to create a very beautiful translucent finish.



A marble memorial plaque inside the cathedral

Marble is not a common rock at St Machar's. You will need to be very sharp-eyed to spot it. The main clue is its colour (almost white) and its smooth surface.

Slate

Slate is another metamorphic rock, frequently found as a roofing material. It is formed when mudstone is subjected to high pressure and moderate temperatures over long periods. The flaky clay minerals in the original rock become lined up parallel with each other at right angles to the direction of squeezing. This creates slate's characteristic *cleavage*, the term used to describe the way in which slate can easily be split in one direction – but not in any others. This means that very thin slabs of slate can be prised from a large block to makes very effective roof tiles. The other properties of slate that make it suitable for roofing material is its *impermeability* (waterproofness) and resistance to weathering.

Scottish slates were worked on a really large scale at several Scottish localities – quarries at the Glens of Foudland, Ballachulish, and Seil Island near Oban, all produced millions of roofing slates. The photo opposite is of slate rock before being split at Ballachulish Quarry. When the railways were developed, higher quality, more easily worked slate from Wales became available and the Scottish slate industry died out. Nowadays, if you see new slates being laid on a roof, the chances are that they have come from China, India or Canada.

Finely layered slate being worked at Ballachulish Quarry

If you look up, you will see that St Machar's Cathedral has a slated roof, like nearly every other building in the area which is more than about fifty years old.

Activities – Things to Do Before a Visit to St Machar's Cathedral

Prior to visiting St Machar's, the children should undertake some work on rocks. There are lots of ideas in the *Primary Earth Science Outdoors* file which is downloadable from the following website at: http://www.geowalks.co.uk/iearthscienceoutdoors.html . Activities 4 to 7 are particularly relevant and can be readily adapted to suit particular circumstances.

There are also three 'no fee' CPD courses designed to help Scottish teachers who wish to engage their pupils in Earth Science related activities. Participating schools receive free Scottish rock specimen collections (depending on available sponsorship) and a large scale geological map of Scotland. Details are on the ESEU website: www.earthscienceeducation.com/

The rocks beneath our feet

Geological maps show what type of rock lies 'beneath your feet' and are available at various scales. They are constructed from information gathered by geologists painstakingly surveying every aspect of the landscape and from information obtained from boreholes, mines and satellite imagery. In the Aberdeen area, there are relatively few surface outcrops of bedrock that can be readily inspected. Over most of the area, the bedrock is obscured by thicknesses of up to 30 metres of *drift*, the general term used for unconsolidated sands, gravels, peat and glacial boulder clay. The map below is thus an interpretation of which rock types are believed to lie beneath the drift in various parts of the city. It is taken from Google Earth with geological data from the British Geological Survey (www.bgs.ac.uk) superimposed upon a satellite map:

From the map, it can be seen that the oldest part of the city was built on an area largely underlain by rocks belonging to the Old Red Sandstone group (see page 9 above). The presence here of this relatively soft rock accounts for the low ground stretching between the mouths of the Rivers Don and Dee and for the existence of Aberdeen Bay. Note that the geological data shown above near the Brig o' Balgownie is in error, since Old Red Sandstone strata can be seen outcropping in the south bank of the river at this locality. The published BGS maps for the area are entirely accurate and there seems to a be a slight mis-registration between the topographic and geological data on Google Earth at this locality.

Most higher parts of the city such as Hilton and Hazlehead are underlain by granite, an altogether tougher rock than sandstone. Schists and gneisses are also resistant to erosion, and account for the high ground at Kincorth and west of Hazlehead.

The Rivers Dee and Don occupy ancient valleys whose positions may be related to geological features and rock formations long since eroded away. There is, however, a significant geological *fault* (major rock fracture) which defines the southern boundary of the Aberdeen granite and along which the lower part of the Dee's course appears to be aligned.

Reference has already been made (pages 4 & 5) to the way in which the River Don takes a difficult and circuitous route to the sea via Balgownie rather than flowing directly to the sea through what is now Seaton Park. The River Dee has also been diverted from its former channel which reached the sea at Nigg Bay. Both diversions are thought to result from damming by ice masses during the last Ice Age.

Pupil activities that might help them to think in more detail about what is 'under their feet', include:

- comparing the above geological map with a topographic one at the same scale (though finding a simple contour-only map of the city area does not appear to be easy!)
- alternatively, it may be simpler to identify main roads which have steeply sloping sections and relating those in a very general way to bedrock variations
- describe what is under their feet on Aberdeen beach (and in the sand dunes of Queen's Links and Broad Hill) – and then come up with ideas where all the sand and pebbles might have come from (washed down the River Dee, with sand then blown inland)
- think of places where rock can be seen as *outcrops* (ie places where bedrock is NOT covered by drift deposits) – examples include sea cliffs, mountain crags, waterfalls, gorges, open cast mining pits, quarries – local examples include where the railway crosses the Dee, the coast leading to Girdleness and beyond to Nigg Bay, the coastline south from Cove, Rubislaw Quarry, prominent granite outcrop in Stewart Park

Locating St Machar's Cathedral

Pupils should try locating St Machar's Cathedral on a variety of maps. According to legend it was built on this site because it was close to a meander on the River Don which has the same shape as a bishop's crozier. If you Google Image "bishop's crozier" you can see one and compare this with the map - see the photo-map on page 4 for instance.

The satellite map reproduced below from Google Maps shows the cathedral itself, along with its surrounding graveyard. Making a sketch map of the Cathedral area from an image like this is a good exercise for working with scales and compass directions. One important property of a

sketch map is that it can be designed to show only those features of direct interest or relevance. Irrelevant features are filtered out and the map is then easier to use.

Another exercise that might be relevant would be to have a brainstorming session about factors that might influence the siting of any place of worship - or of St Machar's in particular.

Possibilities are varied but may include:

- a person having a dream or vision
- a vantage point - the need to see and be seen from miles around; this makes a church an important focal point
- available building materials
- a site with a sound foundation for a large building (King's College chapel required a raft of oak beams before its foundations could be built on boggy ground!)
- shelter
- close to other buildings of importance
- availability of land to farm and provide food for the proposed religious community
- availability of people able to construct the building.

Helping Your Pupils to become Stone Detectives at St Machar's Cathedral

These Teacher Notes and the suggested activities are designed to support outdoor activities at St Machar's Cathedral that will help your pupils to develop skills of observation, recording, interpretation and researching. They will have opportunities to learn about local rock types and the stories they tell about Scotland's surprising geological past. They will also learn about the history of Aberdeen's development and the technological changes that led to Aberdeen becoming renowned world-wide as the Granite City.

The main activity is a 'detective hunt' with the following mission for pupils to:

- use provided photos to identify specific locations and mark them accurately on a map of St Machar's Cathedral
- take new photos as evidence that their group has been to each location
- match given descriptions and interpretations of the stonework at each location to their own observations
- to undertake other stone related activities (see finishing off activities)

Online access to all the photo files used in these Teacher Notes and in the Pupil Materials can be obtained by contacting Peter Craig at pmcraig@gmail.com Peter is also willing to help with queries relating to any aspect of Earth Science education and has lots of other resources and photos to share on request.

In groups of four, the children will have the following jobs which can be rotated at each stopping place:

1) **Recorder**

   Equipment: clipboard, pencil (have 2 in case one breaks), map of St Machar's Cathedral and graveyard

2) **Photographer**

   Equipment: digital camera with a carrying strap

3) **Keeper of the Photos**

   Equipment: Laminated photos of each piece of evidence that must be acquired by the group. Each photo has a number. The keeper of the photos must ensure that that the group complete the tasks in numerical order

4) **Keeper of the Words**

   Equipment: Laminated descriptions of each piece of evidence that must be matched to the photos. Each description should have a letter on it.

If there is an odd number of children, make groups of three pupils with one having more than one job. By allocating specific tasks, children each have a purpose in terms of their contribution to the group effort. By rotating the jobs at each stopping place, every child experiences every role. With older children, you may wish to let them decide what roles are needed in order to complete the task effectively and how they wish to ensure every pupils gets an opportunity to undertake each role.

The groups of pupils should follow the numbered photos in order. Each photo represents a stopping place where the group should:

1) Take a photo which is exactly the same as the laminated photo. This can be part of the challenge.

2) Record on the diagram of St Machar's Cathedral and graveyard, the location of the stopping place. It should be given the same number as the laminated photo.

3) Match the description to the photo. The letter on the description can be written on the diagram too beside the number. If the weather is not good, this can be done afterwards inside one of the education rooms.

Each group should begin at a different number. By doing this, the class is spread out. If your class needs firm supervision, then the other option is for each adult to take two groups and complete two numbers simultaneously, e.g. 1 & 2 together, 3 & 4 together, etc. The activity

has been set up so that stopping places are close together for each pair of numbers, e.g. Photos 1 & 2 are both indoors.

Prior to the activity

1) Go through safety procedures and behaviour expectations:
   - calm, responsible behaviour is important
   - always stay within sight of the adult working with your group
   - WALK around the gravestones; don't run
   - DO NOT lean against the stones; they might fall!
   - only take rubbings from stones which are lying down
   - if you are not sure, ASK!
2) Explain the mission:
   - get children to find the letters on the description cards and the numbers on the photographs
   - show the children how to record the information on the diagram
   - demonstrate and let children practice looking after the digital cameras and passing them carefully between each other.
3) Arrange a meeting place and time for reviewing the activity.

Photo – Description Link Up

Photo	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Description	**C**	**A**	**I**	**G**	**F**	**B**	**J**	**E**	**H**	**D**

Other Stone Activities at St Machar's

The groups may well finish at different times. Below is a series of activities which can be undertaken whilst waiting for groups to complete the Stone Detectives activity.

1) During the stone detective work, you were asked to look mostly at the Cathedral building and gravestones. However there are many more uses for stones and rocks within the grounds. Write down five other uses of stone. (Ideas might include gravel, pavestones, edging material, pots for holding flowers at the gravestones, gargoyles, door stoppers, statues, and effigies.)

2) Have a look around the church. There are many effigies (sculptures) of different bishops and other religious leaders. Find one which has been carved from sandstone and another from granite. Note down the details of each effigy.

3) At the west end of the aisle, above the vestry door, is a Celtic cross-stone of the 6th or 7th century associated with the first church on this site. See if you can find this and take a photo.

4) All that glitters is not gold. Granite is known to sparkle. This due to the presence of a mineral called mica in the rock. Have a look at some unpolished granite stone in the walls and gravestones. See if you can see the mica sparkling. You may want to use a magnifying glass.

5) Using magnifying glasses, have a look at several different types of granite. See which have the largest crystals and which have the finest crystals. Is there a pattern? For example are the crystals most easily seen in pink granite?

6) Choose a gravestone that is stable and lying flat. Carry out a rubbing using paper and wax crayons. On wet days, small squares of fine material such as thin cotton can be used as an alternative to paper. Rubbings can also be taken of different stonework. If these are taken at the different stopping places, they can be matched to photos later, back in school. Children will need to work in pairs to do this effectively. One child holds the paper firmly whilst the other one takes the rubbing.

7) Sketching activities. Have a look at the *Exploring Buildings* pack from the Aberdeen Environmental Education Centre. There are sheets about roofs, wall bonds, doors, windows, special features, texture and patterns which could all be completed whilst at St Machar's.

8) There are gargoyles both on the inside and outside of the cathedral. Children can go on a gargoyle hunt. By making quick sketches, the children can use the ideas back in the classroom for clay work and further investigations.

Review Session

Review the work covered once all the groups have completed the stone detective work.

Pupil Materials

Be a Stone Detective at St Machar's Cathedral!

INSTRUCTIONS

Your group must follow the numbered photos in order. If you are told to begin at Photo 3, then you will move to Photo 4 next. After Photo 10 you move on to Photo 1.

Each photo represents a stopping place where your group must:

- take a photo which is exactly the same as the laminated photo; extra points are given for accuracy
- record the location of the stopping place on your map of St Machar's Cathedral and graveyard; it should be given the same number as the laminated photo
- match the description to the photo; the letter on the description can also be written on the diagram beside the number. If the weather is not good this can be done afterwards inside one of the education rooms.

Safety procedures and behaviour expectations:

- calm, responsible behaviour is important
- always stay within sight of the adult working with your group
- WALK around the gravestones - don't run
- DO NOT lean against the stones - they might fall!
- only take rubbings from stones which are lying down
- if you are not sure, ASK!

Descriptions and Photos

Photo One

C

Marble

Marble is usually a white to grey coloured metamorphic rock. It is made when limestone is heated and calcite crystals are formed. Marble is a very attractive stone and often used for making statues and memorial stones. Its surface can be polished to a very smooth finish.

Photo 2

A

Carving granite

Granite has been used to build many different kinds of buildings and structures. Its hardness makes it difficult to quarry and carve, but it lasts a very long time. It lasts a lot longer than other softer types of rock like sandstone and limestone. These particular gravestones have lots of detail that required a lot of skill to carve.

Photo 3

I

Dressed granite

The word *dressed* here means that the granite has been carefully shaped, using a hammer and chisel (puncheon), or other hand tools. Stones are dressed so that they look attractive and fit together very neatly. Dressed granite has been used for pillars and archways in the interior of the cathedral. This granite is fresher than the granite outside because it has not been exposed to centuries of weathering. The many different colour variations of the granite blocks tell us that they have not come from a single quarry like most granite buildings in Aberdeen. They were gathered instead as boulders from the land nearby.

Photo 4

G

It's rough

The stonework on the inside of the Cathedral walls looks very different from the carefully squared-off blocks on the outside. Little attempt was made to shape or finish the stones on the inside. However, small fragments of granite (known as *pinnings*) have been used to wedge blocks at the right angle so that their surfaces more or less line up with each other.

Photo 5

F

Weathering in action

Sandstone comes in various shades of brown and is a rock made of sand grains. You can usually feel these grains when you rub your finger on sandstone. Sandstone is often *porous*. This means that it has tiny holes or spaces in between the sand grains where water and air can enter.

Once water has got inside the stone, freezing and thawing in winter can make the outer layers of the sandstone separate and flake off. This is described as *weathering*. Headstones made of porous sandstone do not last as long as granite ones. It is often hard then to read the inscriptions on old headstones made of sandstone.

Photo 6

B

Pristine condition

In the 1830s, Alexander MacDonald designed a steam driven polishing machine. It revolutionised the production of polished granite slabs and enabled large-scale production to take place. He showed that a smooth surface could be achieved by running sand and water beneath an iron polishing head. This allowed for much more elaborate headstones with a polished surface to be produced. The writing on most granite headstones remains easy to read even after 150 years or more.

From 1830 onwards, most buildings in Aberdeen were built of granite worked from quarries using steam-driven machinery. Deep quarries such as Rubislaw produced very high quality granite that was fresh and totally unweathered, unlike the granite boulders used previously.

Photo 7

J

A 700 year old wall

Granite is an igneous rock formed below the Earth's surface from cooling magma. The more slowly the magma cools, the larger the crystals that are formed. Rubislaw Granite is finer grained than many other granites and must have cooled more quickly.

In this photo you can see original granite stonework from the 14th and 15th centuries. The surfaces of the granite blocks are weathered and pitted. This granite was fetched as loose blocks from the land nearby. They were already a bit weathered before they were shaped and dressed. Their varied colours and textures indicate that they didn't come from a single quarry. If they had, they would all look the same.

Photo 8

E

Decorative features

As granite weathers, its surface becomes rougher in texture. Softer minerals tend to break down and get washed out by rain. This leaves pits where the softer minerals used to be and lumps where the harder minerals are left. The carefully carved granite in this doorway has weathered badly over the centuries with small pieces loosening and getting knocked off. Although the detail of the carving is less clear than it would have been originally, this granite has survived better than the carved red sandstone in the arched gateway on the south-east side of the Cathedral. This gateway isn't so old and has already had to be repaired with blocks of paler yellow sandstone.

Photo 9

H

Stonework with a story

St Machar's Cathedral has had quite a history of being built, extended, neglected and restored over the centuries since its likely foundation around 580AD. In this photo, there is evidence of many phases of patching and repairs to the masonry (stonework). Above and to the left of the window is mostly original (?14th Century) granite. To the right of the window, all the blocks used are made of sandstone. Two types of sandstone have been used. One is reddish-brown and the other is yellow-brown, though often rather weathered and dirty looking. Can you spot small pebbles in some of the reddish-brown sandstone below the window?

The carved stone around the window is a complete mixture of rock types! Old granite is still in place at the top. In other parts, there is old weathered sandstone of both kinds. Recent patches have been made using very clean looking yellow sandstone from near Elgin and pale grey granite from Rubislaw Quarry.

Photo 10

D

Mish-mash!

This east gable of the Cathedral shows an extraordinary mishmash of stone types, stonework styles and remnants of different architectural features. Can you put your hand on the following types of rock used in the masonry?

- Granite – both as large blocks and as the smaller 'packing' fragments called *pinnings*
- Pale yellowish sandstone – often weathered and soot stained
- Reddish-brown sandstone – with and without pebbles

There is also another type of building stone here that was used in the 1953 restoration. The yellowish stone blocks used round the three very tall stained glass windows is actually a man-made stone. It is made of crushed granite and cement, with a yellow colouring dye added. It is similar to *Fyfestone*, now widely used as a cheaper alternative to granite.

Can you also count the numbers of stone pillars you can see from here? And the number of stone arches?Stone Detectives 2012