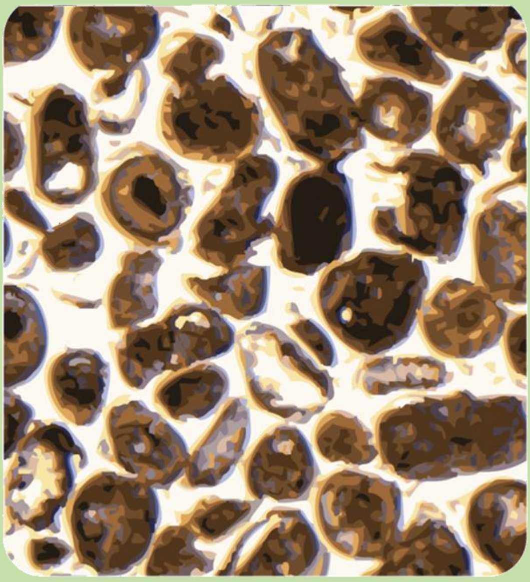
EARTH SCIENCE | GEOLOGY | ENVIRONMENTAL SCIENCE
PHYSICAL GEOGRAPHY

Practical activities • minimal equipment • teachers' back-up
FREE pdf DOWNLOADS

Spot that rock: rock identification – online workshop






Spot that rock: rock identification

Used by Earthlearningidea by kind permission of the Director, ESEU

Contents

Summary

‘Spot that rock’ leads you step by step through a series of investigative practical activities that will allow you to teach pupils to investigate and sort most rocks from first principles (and distinguish them yourself). The techniques are then applied in describing and classifying a series of unknown rocks.

Earth Science Education Unit workshops

These workshops have been devised for teachers and trainee teachers. They are intended to provide participants with a range of activities that can be used in the classroom and out-of-doors, whilst helping them to develop the skills for using the activities in an engaging and motivating way that will enthuse and educate their pupils, whilst developing their critical thinking skills. The workshops should also develop the background Earth science knowledge and understanding of the teachers involved.

The workshop format may be transposed directly into a classroom or outdoor situation, but often this is not appropriate. Similarly, individual activities, and the worksheets on which these are based, may be transferable directly into a classroom/outdoor situation, but will often require modification for the classes and situations in which they are used, during which suitable risk assessments are undertaken.

Workshop outcomes

The workshop and its activities provide the following outcomes:

- an introduction to a structured scheme of rock description and identification based upon the reliable characteristics of rocks, involving:
  - identifying key terms in describing rocks;
  - identifying key terms in describing the grains in rocks, using a magnifier/ hand lens;
  - testing for permeability;
  - modelling rock structures;
  - classifying and naming rock groups and rock types;
- practical activities giving opportunity for investigation and discussion.

The grouping of rocks on the basis of reliable characteristics

– based on the work of Duncan Hawley

Research shows that students sort out rocks by their everyday characteristics, such as “shininess”: or by using mutual opposites, e.g. rough/smooth, hard/soft, light heavy, etc. They cannot answer the question “What is a rock?” They might be able to recognise one rock type, say pink granite, but cannot recognise a white variant as granite also.

This workshop addresses these issues by asking participants/pupils to group rocks on the basis of their reliable characteristics. It is based on an analogy of an art teacher showing a picture of a famous piece of art. Why was it great? It did not make sense until the teacher explained the concepts for appreciating it. Similarly, the uninitiated cannot understand a rock until they know what to look for.

The workshop uses the following sequence of activities:

Activity 1 Rock clues	Recognise rock properties
Activity 2 Grain clues	Recognise grain properties
Activity 3 Predicting properties	Testing porosity/ permeability
Activity 4 Rocky modelling	Making 2D and 3D rock models
Activity 5 Weak or strong?	Testing strength: finding how easy it is to remove grains
Activity 6 Rock sort 1	Sorting a sedimentary from a crystalline rock
Activity 7 Rock sort 2	Sorting igneous from metamorphic rock
Activity 8 Rock sort 3	Sorting a range of rocks
Activity 9 Sedimentary to metamorphic	Sedimentary linked to metamorphic rocks
Activity 10 Naming rocks	Using sorting cards to name rocks

Spot that rock: rock identification

1. Rock clues

Divide the class into groups of three and give each group a sample of granite and a sample of sandstone. It is better not to name them at this stage, just call them the speckled rock and the grainy rock.

Ask one pupil to pick up the speckled rock and describe it (what it looks like, feels like, etc.) to a second pupil. The third pupil notes down key words that are used. When this is done, the pupils swap over, one describes the grainy rock and another makes notes.

Ask the pupils
Which key words were used in both descriptions?

Possible answers
The words often used are bits, colour, heavy and rough/smooth.

Explain that in future we will use a scientific word for the 'bits' in rocks - grains.

Conclude
Not all rocks are the same, there can be clear differences.

Note: Earth scientists use the term 'grains' for the particles of rocks, often describing them as 'coarse-grained' or 'fine-grained'. The 'grains' in igneous and metamorphic rocks are, however, also crystals. Crystals in rocks are grains that have grown during rock-formation, and thus are interlocking, as shown later in the workshop.

2. Grain clues

Run a similar activity to '1. Rock clues', but this time:

Ask the pupils
To use a magnifier or hand lens to 'describe the grains of the two rocks' to one another whilst the third makes notes.

Possible answers
The words shape, size, colour and shininess are often used.

Explain that we are going to investigate the importance of the shape of the grains further now.

Note: The correct way to use a magnifier or hand lens, is to hold the magnifier/hand lens up to your eye, and then move the object you're viewing closer and closer until it comes into focus.

Looking closely at a rock using a magnifier (*Hazel Benson*)

3. Predicting properties

<u>Ask the pupils</u>
To discuss and predict what will happen to the masses of the rocks when they are placed in water.

Give them three options - the rocks could: stay the same weight; get heavier; or become lighter. Ask the pupils to write their predictions down, then ask the class what they have written so that you can get a feel of what they are predicting.

Sandstone ‘bubbling’ in a plastic beaker (*Peter Kennett*)

Granite not ‘bubbling’ in a plastic beaker (*Peter Kennett*)

<u>Possible answers</u>
Pupils often predict that the grainy rock will get heavier but the speckled rock will stay the same. When asked why they have made these predictions, they may answer that water will get into the grainy rock and make it heavier but it won’t get into the speckled rock.

Ask them to put the samples, at the same time, into a clear plastic container of water and watch carefully to see what happens. They should take them out again after about 30 seconds.

Ask them to carefully dry the rocks on towels (paper or cloth) re-weigh them and check their results against the previous masses.

Results expected
They will find that the grainy rock (sandstone) has increased markedly in mass but that the speckled rock (granite) has not (unless very sensitive scales are used, when the remaining wetness of the granite causes a small increase in mass). So, the pupils probably predicted correctly.

If they have observed the samples carefully, they will have seen a few bubbles on the surface of the granite. But many more bubbles come from the sandstone, and continue to bubble as the air is driven out.

It is useful to have a discussion on how the air is driven out. Do most of the bubbles come from the bottom or the top? Does most of the water go in at the bottom or the top? Are the pores (gaps between the grains) likely to be interconnected?

The air rises from the top, as it has a lower density than water, this allows atmospheric pressure to push water into the bottom to replace it, showing that the pore spaces must be interconnected and the rock is permeable (permeability is the flow of fluid through a material). So, the bubbles come from the top as water is pushed into the bottom.

Note: The rate of flow of a fluid (liquid or gas) through a material is its permeability. This depends on the porosity – which is the percentage of pore space in the material.

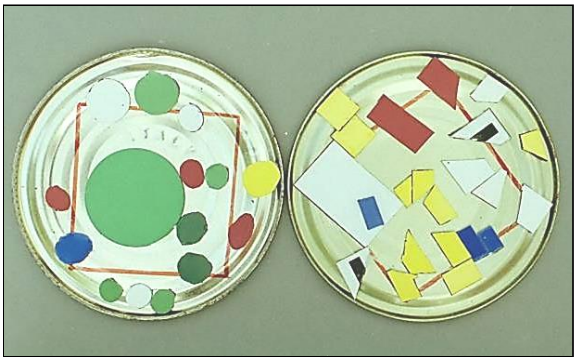
So permeability is a measure of fluid flow (e.g. 22 mm sec^{-1} through a surface area of 1 cm^2) whilst porosity is a measure of the percentage pore space (e.g. 15% porosity).

Rocks with a high percentage of porosity (lots of pore space), where the pores are interconnected and not too small for fluid to flow through, also have high permeability. Low porosity gives low permeability.

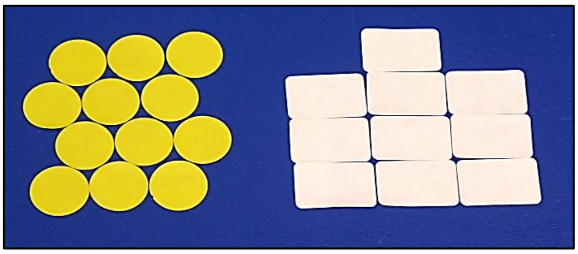
Optional extra: measuring masses
If you have time – ask each group to measure the mass of each of the rocks using an electronic balance, recording the masses, before and after the activity and then calculate the difference and the porosity.

4. Rocky modelling

Ask the pupils
To model the grains in the grainy rock and the speckled rock in a tessellation exercise using sticky shapes stuck onto paper, magnetic shapes on a magnetic board or shapes on an interactive whiteboard. They should use circular and square or rectangular shapes that don't overlap to cover up as much space as possible. It quickly becomes clear that the circular shapes leave gaps, whilst the rectangular shapes do not.



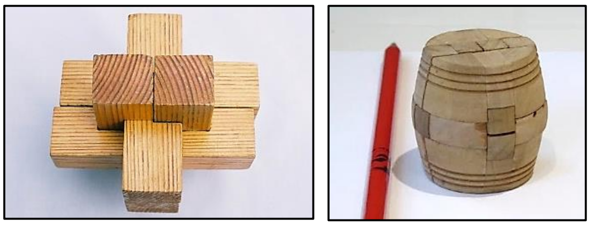
Tessellation exercise with magnetic shapes (*Peter Kennett*)



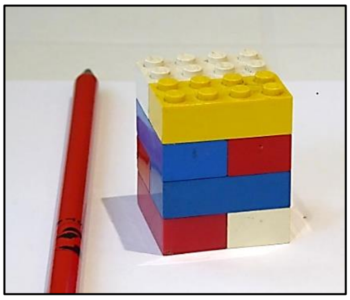
Tessellation exercise with sticky shapes (*Chris King*)

Develop this 2D pattern into a 3D concept using an interlocking wooden model (or a Lego™ model) and marbles in a clear plastic container.

Container of marbles (*Peter Kennett*)



Interlocking wooden models (*Peter Kennett, Chris King*)



Interlocking Lego™ model (*Chris King*)

Ask the pupils
How much space do you think there is in the interlocking model and in the container of marbles?

Possible answers
- the interlocking model will have no space;
- the container of marbles may have about a quarter space.

The pupils will often be amazed as you pour more and more water into the container of marbles – which is almost half space. This is a measure of porosity – the porosity here is nearly 50%. Rocks with high porosity are usually very permeable, allowing fluids to flow through (except when pore spaces are very small and water can't flow through, as in clay). The interlocking model has no pore-space.

The marbles in the container are like the sandstone – with lots of gaps between the spherical grains. The interlocking model is like the granite, made of interlocking grains with no spaces.

Optional extra 1: Calculating porosity
Ask the pupils
To calculate the porosity of the container full of marbles by weighing it 'full' and empty, calculating the difference and then calculating the porosity, using the equation:

$$\frac{\text{volume for marble container, ml} \times 100}{\text{volume for empty container, ml}}$$

Optional extra 2: More on porosity and permeability

The Lego™ model shows the difference between porosity and permeability. The model is porous (because the bricks are hollow) but impermeable because the pore spaces are not connected.

This is like a solid lava with bubbles (basalt) – the bubbles make the rock porous but they are not interconnected so it is impermeable.

It is also like clay, which has lots of pore spaces making it porous, but these are so small that fluids cannot flow though so it is impermeable.

Impermeable: lava with bubbles (left) clay (right) (Chris King)

Rock cement

Ask the pupils

When the pot is tipped the marbles fall out – but you can't tip out the grains from a sandstone. Why not?

Possible answer

The grains in the sandstone are stuck together – by some sort of 'glue'.

This natural 'glue' is called 'cement' by Earth scientists.

Note: Grains are naturally glued together to form rocks when cement is deposited between the grains. As water flows through the pore spaces minerals crystallise out, sticking the grains together. Minerals are naturally formed chemical compounds and common mineral cements are quartz (silicon dioxide), calcite (calcium carbonate) and iron minerals.

5. Weak or strong: Which are the strongest rocks?

Investigates which makes a rock stronger, having interlocking grains or cemented grains.

Ask the pupils

To compare the two rocks by scraping them with a spoon coin or other metal object onto a piece of paper.

Possible answers

The difference is usually very clear – rocks crumble if the cement between the grains is not very strong (the grainy rock), whilst having interlocking crystals makes rocks strong (the speckled rock).

Spoon (*S. Sepp*)

6. Rock sort 1 – two great groups

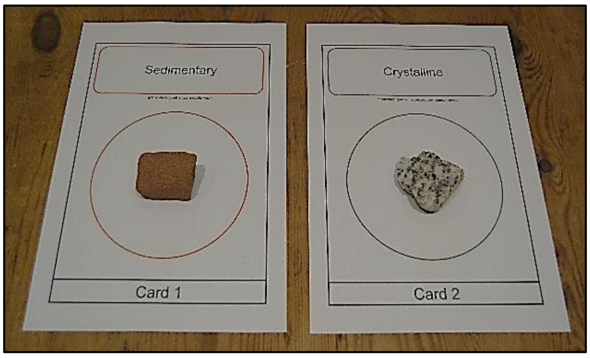
Explain that everything we have done so far allows us to sort rocks into two great groups:

- rocks with grains stuck together (by glue or cement) that are permeable and weak – sedimentary rocks
- rocks with interlocking grains that are impermeable and strong – crystalline rocks

Ask the pupils
To sort the rocks into two great rock groups using two of the rock sorting cards (on pages 14 - 23) (or the cut out rock description cards (on page 24) or written labels):

Note that:
Sedimentary rocks are so called because they are formed of sediment. Sediment grains are pieces of material which have been transported before being deposited.

Crystalline rocks are made of crystals which have grown during formation of the rock and so are interlocking. The crystals are minerals. Minerals are naturally formed chemical compounds and sometimes (although not here), chemical elements.



Rocks sort cards 1 and 2 (*Chris King*)

7. Rock sort 2 – striped rock

Ask the pupils
To test a specimen of the striped rock (gneiss) like they tested the other two (examining rock, examining grains, testing permeability, scarping)

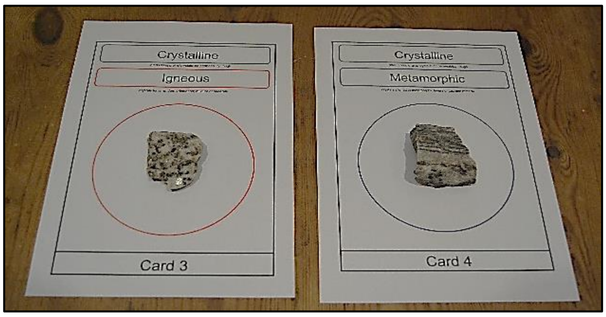
Possible answer
It is another crystalline rock with interlocking grains/ crystals, with no permeability and strong.

Ask the pupils
To sort the crystalline rocks into two major groups using two more rock sorting cards based on their grain arrangements:

- rocks with crystals having random orientation; mixture of minerals – igneous rocks
- rocks with crystals aligned in metamorphic layers or just one mineral – metamorphic rocks

Note that:
Igneous rocks are formed from cooling liquid rock called magma. As magma cools different minerals with different properties crystallise with random orientations – eventually becoming a mass of interlocking crystals with no pore spaces between the grains that is very strong.

Metamorphic rocks are formed from other rocks (sedimentary, igneous or metamorphic) in the solid state by great increases of temperature and/or pressure. Those formed by pressure have layers or bands formed by aligned minerals as they recrystallise. The interlocking crystals have no pore spaces and the rocks are very strong.



Rock sort cards 3 and 4 (*Chris King*)

To stop or to continue?

If the aim of your teaching is just to enable your pupils to investigate, name and understand the three great groups of rocks, you may want to stop this workshop here.

However, if the aim of your teaching is to enable your pupils to investigate, name and understand not only the three rock groups but a range of sedimentary, igneous and metamorphic rocks as well – then continue on through the workshop.

8. Rock sort 3 – all rocks

Ask the pupils

To take all the other specimens and test them like they tested the other rocks. Then take the new set of three sorting cards (Cards 5, 6 and 7) and use the clues in the rocks to put them onto the cards in the correct places. *Note that the right hand side of the 'Metamorphic' sorting card (Card 6) should be folded over.*

Rock sort cards 5, 6 and 7. (*Chris King*)

9. From sedimentary to metamorphic

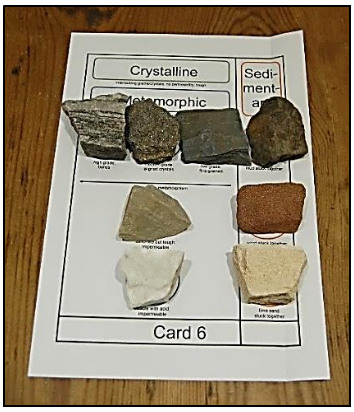
Ask the pupils

To unfold the right hand side of the 'metamorphic' sorting card (Card 6) and then put the sedimentary rocks in the right places.

This shows how different sorts of metamorphic rocks are formed from different types of sedimentary rocks.

Note that:

- *Under increasing heat and pressure, a mudstone first becomes slate, then schist, then gneiss*
- *Under increasing heat and pressure, a sandstone becomes metaquartzite (sometimes called just 'quartzite')*
- *Under increasing heat and pressure, limestone becomes marble*
- *Metamorphic rocks are not porous; they are stronger than sedimentary rocks*



Rock sort card 6, unfolded. (*Chris King*)

10. Naming rocks

<u>Ask the pupils</u>
To use the remaining set of three rock sorting cards (Cards 8, 9 and 10) or the rock naming cards (page 25) to place the rocks in the right places on the rock sorting cards or name the rocks with the naming cards.

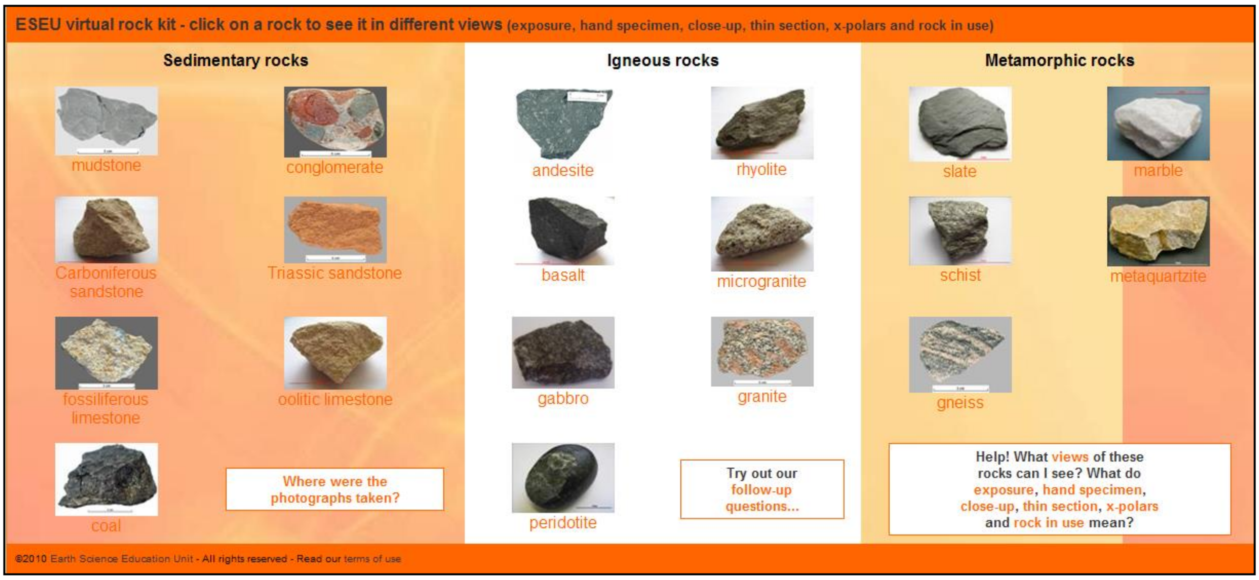
Rock sort cards 8, 9 and 10. (*Chris King*)

Note that:
- *Fine-grained sedimentary rocks are mudstones (or shale or clay); medium-grained sedimentary rocks are sandstones; coarse-grained sedimentary rocks are conglomerates. Sedimentary rocks made of carbonate minerals (react with acid) are limestones*
- *Coarse-grained igneous rock, formed by slow cooling from liquid rock (magma). If they are pale in colour they are granites, if they are dark in colour they are gabbro. Fine-grained dark igneous rock, formed by fast cooling from liquid rock (magma) in lava flows is called basalt. Gabbro and basalt are both dark in colour because they contain the same iron-rich minerals*

However, also note that as we are dealing with 'the real world', there are some important exceptions to this classification method:
- *some sedimentary rocks are well cemented with a strong cement and so are not porous or weak – but are nevertheless formed of grains stuck together;*
- *some metamorphic rocks are not formed under pressure (but mainly by heat) and so have random grain orientation;*
- *some metamorphic rocks contain only one mineral, and so banding or layering cannot be seen;*
- *some igneous rocks can be weakened by gas bubbles or weathering and so can be fairly weak.*

Virtual Rock Kit

See: https://www.earthlearningidea.com/virtual_rock_kit/START.htm to see a 'kit' of common rocks in hand specimen, enlarged, under the microscope, in exposure and in use.



Virtual Rock Kit

Resource list

Resources:	Supplied By	
	Facilitator	Institution
Per group of three pupils/participants:		
1 x permeable sandstone (sedimentary)	✓	
1 x granite (igneous)	✓	
1 x gneiss	✓	
Plus one of each selected from the following:		
Sedimentary rocks: limestone, mudstone, conglomerate	✓	
Igneous rocks: basalt, gabbro	✓	
Metamorphic rocks: slate, schist, marble, metaquartzite	✓	
2 x clear plastic containers/beakers (roughly 250ml)	✓	
Sticky labels or magnetic shapes and magnetic board - (rectangular/square and circular) (unless an interactive whiteboard is used)	✓	
1 x plastic jug/cylinder for water	✓	
1 x metal teaspoon	✓	
1 x magnifier or hand lens		✓
Rock sorting cards or rock description/naming cards (or paper/sticky notes and pen/pencil)	✓	
For class use or demonstration:		
1 x electronic balance (optional)		✓
1 x clear plastic container/beaker (250ml) filled with marbles	✓	
1 x interlocking wooden (or Lego™) toy	✓	
1 x computer and data projector		✓
1 x PowerPoint presentation	✓	

Risk assessments

Potentially Hazardous Activity	Who/What may be Harmed?	Hazard Rating (A)	Likelihood (B)	Risk (AxB)	Further Action Required?
1. Rock clues	No significant hazard	-	-	-	No
2. Grain clues	No significant hazard	-	-	-	No
3. Predicting properties	No significant hazard	-	-	-	No
4. Rocky modelling	No significant hazard	-	-	-	No
5. Weak or strong: Which are the strongest rocks?	Pupils may be hit by flying grains of rock	2	2	4	Dampen rocks before scraping
6. Rock sort 1	No significant hazard	-	-	-	No
7. Rock sort 2	No significant hazard	-	-	-	No
8. Rock sort 3	No significant hazard	-	-	-	No
9. From sedimentary to metamorphic	No significant hazard	-	-	-	No
10. Naming rocks	No significant hazard	-	-	-	No

Hazard Rating (A):
1= Insignificant effect
2= Minor Injury
3= Major Injury
4= Severe Injury
5= Death

Likelihood of occurrence (B):
1 = Little or no likelihood
2 = Unlikely
3 = Occasional
4 = Probable
5 = Inevitable

Risk Priority (AxB):
12-25 = High risk – take immediate action
6-11 = Medium risk – take action as soon as possible
Less than 6 = Low risk – plan future actions where required

Rock sorting cards

Sedimentary

grains stuck together; permeable; weak

Card 1

Crystalline

interlocking grains/crystals; no permeability; tough

Card 2

Crystalline

interlocking grains/crystals; no permeability; tough

Igneous

crystals have random orientation; mixture of minerals

Card 3

Crystalline

interlocking grains/crystals; no permeability; tough

Metamorphic

crystals aligned in metamorphic layers or just one mineral

Card 4

Sedimentary

grains stuck together; permeable; weak

mud stuck together

sand stuck together

pebbles stuck together

lime sand stuck together

reacts
with acid

Card 5

Crystalline

interlocking grains/crystals; no permeability; tough

Metamorphic

crystals aligned in metamorphic layers or just one mineral

high grade;
bands

medium grade;
aligned crystals

low grade;
fine-grained

increase in metamorphism

sand-like but tough;
impermeable

reacts with acid;
impermeable

Sedi-ment-ary

mud stuck together

sand stuck together

lime sand
stuck together

Card 6

Crystalline

interlocking grains/crystals; no permeability; tough

Igneous

crystals have random orientation; mixture of minerals

dark minerals;
fine-grained

pale minerals;
coarse-grained

dark minerals;
coarse-grained

Card 7

Sedimentary

grains stuck together; permeable; weak

mud stuck together

Mudstone

sand stuck together

Sandstone

pebbles stuck together

Conglomerate

reacts
with acid

lime sand stuck together

Limestone

Card 8

Crystalline

interlocking grains/crystals; no permeability; tough

Metamorphic

crystals aligned in metamorphic layers or just one mineral

high grade;
bands

Gneiss

medium grade;
aligned crystals

Schist

low grade;
fine-grained

Slate

increase in metamorphism

Metaquartzite

sand-like but tough;
impermeable

Marble

reacts with acid;
impermeable

Sedi-ment-ary

Mudstone

Sandstone

Limestone

Card 9

Crystalline

interlocking grains/crystals; no permeability; tough

Igneous

crystals have random orientation; mixture of minerals

dark minerals;
fine-grained

Basalt

pale minerals;
coarse-grained

Granite

dark minerals;
coarse-grained

Gabbro

Card 10

Rock group description cards for Rock sort 1

Sedimentary
Rocks with grains stuck together, permeable, weak

Crystalline
Rocks with interlocking grains; no permeability; tough

Rock group description cards for Rock sort 2

Igneous
Rocks with crystals having random orientation; mixture of minerals

Metamorphic
Rocks with crystals aligned in metamorphic layers or just one mineral

Rock naming cards for Naming rocks

gabbro (intrusive igneous rock)	**limestone** (sedimentary rock)
granite (intrusive igneous rock)	**mudstone** (sedimentary rock)
slate (metamorphic rock)	**conglomerate** (sedimentary rock)
sandstone (sedimentary rock)	**schist** (metamorphic rock)
marble (metamorphic rock)	**gneiss** (metamorphic rock)
shale (sedimentary rock)	**metaquartzite** (metamorphic rock)
basalt (extrusive igneous rock)	**clay** (sedimentary rock)