

Questions for any rock face 9: metamorphic rock

What questions about metamorphism might be asked at any metamorphic rock exposure?

The ELI* series of ‘Questions for any rock face’ helps teachers to plan investigative fieldwork at any rock exposure**. In each case some possible questions are given, with some likely answers, to help you to decide whether the questions might work well at your site, or whether they would be asked better elsewhere. Answering the questions will provide basic understanding of the evidence preserved in rocks of the processes that formed them.

Metamorphic rock

Metamorphic rocks were formed from other rocks (sedimentary, igneous or metamorphic) under the Earth’s surface by increased temperature and/or pressure.

Take your pupils to an exposure of metamorphic rocks where the features are clearly visible and preferably, where there is also evidence of the former rock type, and ask these questions:

Possible questions	Possible answers
How can you tell that this is a metamorphic rock?	<ul style="list-style-type: none"> • Having recrystallised under great heat and/or pressure, metamorphic rocks are usually hard and non-porous. • Most metamorphic rocks (formed by regional metamorphism) have aligned crystals but some (thermal metamorphic rocks) have randomly orientated crystals
Was this rock metamorphosed by regional or thermal (contact) metamorphism?	<ul style="list-style-type: none"> • Pressure-formed metamorphic rocks, which formed on a regional scale, have crystal alignments producing cleavage in slates, “layering” effects in schists and banding in gneisses (formed by regional metamorphism) • Metamorphic rocks formed mainly by heating have randomly-orientated crystals (formed by thermal or contact metamorphism)
What clues show what sort of rock this was before metamorphism?	<ul style="list-style-type: none"> • Sedimentary rocks may retain original bedding or cross bedding traces • Marble reacts with dilute acid, like the limestone from which it formed • Low-grade metamorphic rocks (slates and some marbles) may retain fossils which may have been distorted (squashed)
What are the differences between this metamorphic rock and the rock from which it probably formed?	<ul style="list-style-type: none"> • Harder and less permeable • Original traces may be distorted/destroyed • Crystals may be larger than original grains or crystals • Coarser varieties have clear interlocking crystals, either aligned (regional) or randomly-orientated (thermal)
Where might these differences have been caused?	<ul style="list-style-type: none"> • In the roots of mountains during plate collision and mountain formation (regional) • Baking adjacent to a hot igneous intrusion (thermal)



Slates in the Smokey Mountains, USA.



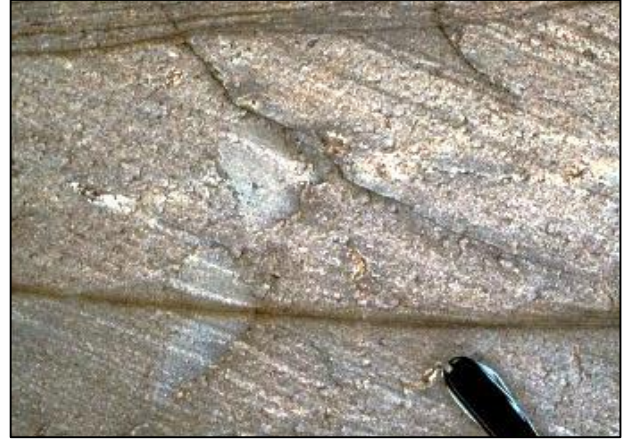
Alternating layers of schist (formed from mudstone) and metaquartzite (formed from sandstone) in Brittany, France.

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Banded Lewisian Gneiss, Torran Raasay, Scotland, UK (lens cap = 50mm) (Peter Kennett).



Sedimentary cross bedding preserved in the metamorphic Cambrian Prospect Mountain metaquartzite, USA.

Earth Science Image Bank h320z5. ©
Marli Miller, University of Oregon.

* ELI = Earthlearningidea

** An exposure is where rocks can be seen at the Earth's surface, exposed by natural or artificial means; anywhere where a rock reaches the surface, even if it is covered by soil, etc. is an outcrop, so an exposure is also part of an outcrop.

The back up

Title: Questions for any rock face 9: metamorphic rock

Subtitle: What questions about metamorphism might be asked at any metamorphic rock exposure?

Topic: Questions to help pupils distinguish metamorphic rocks and understand the processes by which they formed.

Age range of pupils: 9-16 years

Time needed to complete activity: 10 minutes

Pupil learning outcomes: Pupils can:

- distinguish between non-metamorphic, regional metamorphic and thermal metamorphic rocks;
- explain how rocks become metamorphosed;
- describe the evidence of the pre-existing rock types which metamorphic rocks may retain.

Context:

Metamorphic rocks are formed by increased heat and/or pressure from pre-existing rocks, as follows:

Pre-existing rock	Regional metamorphic rock	Thermal metamorphic rock
Mudstone/shale	Low grade slate High grade schist gneiss	hornfels
Sandstone	metaquartzite	metaquartzite
Limestone	marble	marble
Granite	gneiss	X

Regional metamorphic rocks are formed in the roots of mountains during the mountain-building episodes related to plate collisions. Thermal metamorphic rocks form by the baking of nearby igneous intrusions; small intrusions have narrow baked zones, whilst larger intrusions have much

wider metamorphic zones, called metamorphic aureoles.

Remember to carry out a risk assessment before taking anybody to any rock exposure.

Following up the activity:

Continue with other 'Questions for any rock face' Earthlearningideas

Underlying principles:

- Having recrystallised under increased heat and/or pressure, metamorphic rocks are usually hard and impermeable.
- They can be formed by regional (linked to mountain-building) or thermal (baked by intrusions) metamorphism.
- They may contain evidence of the pre-existing rocks.

Thinking skill development:

Pupils need to construct a mental model of metamorphism and then bridge that model to the metamorphic rocks and features they see.

Resource list:

- the resources needed for pupil fieldwork listed in the Earthlearningidea activity '*Planning for fieldwork: Preparing your pupils before setting out to "ask questions for any rock face"*'

Useful links:

Further simple descriptions of metamorphic processes have been produced by the Geological Society of London at:
<http://www.geolsoc.org.uk/ks3/gsl/education/resources/rockcycle/page3576.html> with an animation at:
<http://www.geolsoc.org.uk/ks3/gsl/education/resources/rockcycle/page3768.html>

Source: Devised by Chris King of the Earthlearningidea Team.

The 'Questions for any rock face' series of Earthlearningideas
and the sites where they may be applicable

'Questions for any rock face' Earthlearningidea	Site
Planning for fieldwork	Preparation in school beforehand
1: weathering	Any exposure (cliff, coastal exposure, quarry, cutting) or weathered constructions (wall, gravestone, monument)
2: erosion	Any exposure and many walls
3: soil	Some exposures have a useful soil profile at the top (but many do not)
4: rock group (igneous or sedimentary)	Any exposure of igneous or sedimentary rock or both; also applicable to sedimentary and igneous building stones, gravestones or monuments
5: sedimentary grains	Any exposure of sedimentary rock and also building stones, gravestones or monuments
6: fossils	Any exposure containing readily found and obvious fossils, including some building stones, gravestones or monuments
7: tilted or folded rocks	Any exposure of clearly tilted or folded rocks
8: faults	An exposure where rocks are clearly faulted, preferably where beds can be matched up on either side of the fault
9: metamorphism	An exposure where metamorphic features are clearly visible and preferably, where there is also evidence of the former rock type
10: sequencing	An exposure where a sequence of geological events can be relatively dated using 'Stratigraphic Principles'
11. tectonic plates	An exposure of sedimentary rocks containing evidence of deposition in different climates and altitude/depths from today, with further evidence of plate margin processes
12. quarry/ cutting potential	An exposure in any quarry or cutting
13: quarry economics	An abandoned (or working) quarry
14: recording	Any exposure

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