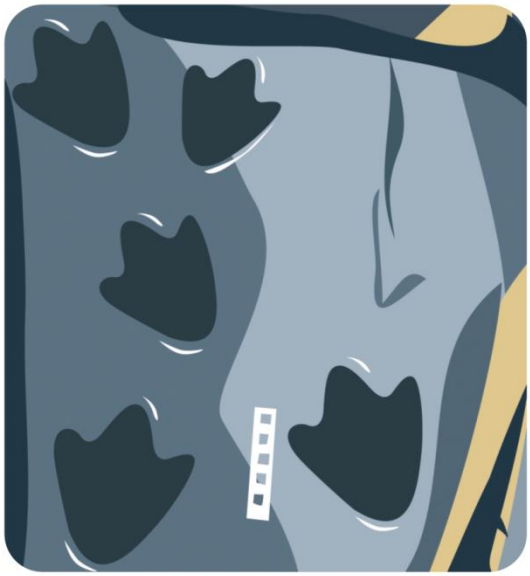
Teaching the Dynamic Earth

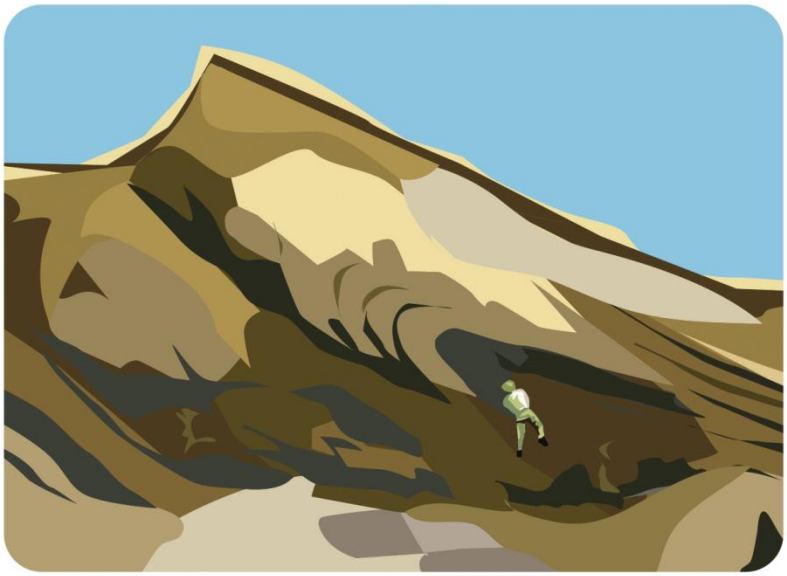
Any quarry guide: good questions to ask and answers at a quarry, cliff or rock face

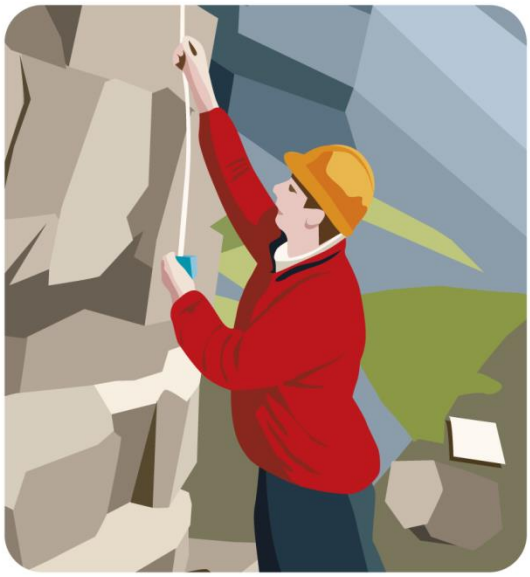
Earth science out of doors

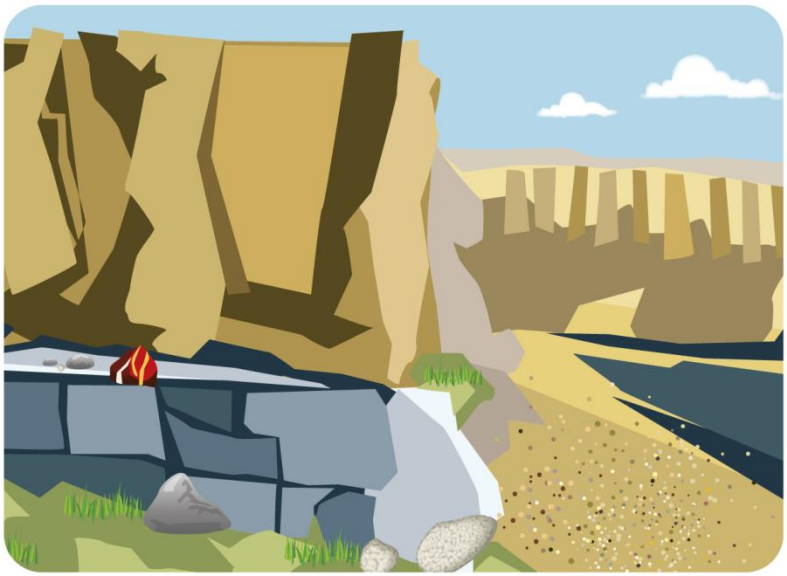
ESEU KS3 science/geography workshop material

Earth science for KS3









EARTH SCIENCE EDUCATION UNIT

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ESEU Secondary Workshops
Earth science for KS3 science/geography

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Any quarry guide:
good questions to ask and answer at a quarry, cliff or rock face

Pupil Pack
Use these sheets to select which questions apply to your own situation.

Contents

Summary

You want to take your students on a field visit to a local rock exposure, but are not sure what to do with them when you get there. This is a guide to the sorts of scientific questions you might ask to encourage them to investigate the rocks. Some will be appropriate for your site, some won't. Some require students to touch and examine a rock face closely; others can be answered from a safer distance. Select which sheets you will need for your own visit and ignore those which don't apply, e.g. don't print off questions about igneous or metamorphic rocks if you are working in area of sedimentary rocks alone. Decide whether to give each pupil all the relevant sheets or whether to ask groups to concentrate on a few Foci and compare notes before leaving the site.

Questions to Promote Investigation

Focus 1	**Weathering**
Objective(s)	• To introduce physical, chemical and biological aspects of weathering and their manifestations in the field • To provide opportunities to emphasise that weathering occurs *in situ* (in place) and movement of solid material away is not involved (although liquids can be/are removed)
Suitable site in the quarry	A place where there are clean or recently broken rock surfaces that can be compared with more weathered surfaces

Possible questions	**Possible answers**
• Are some rock surfaces more crumbly than others of a similar type?	•
• What might have caused the rock surface to crumble?	•
• Are some rock surfaces discoloured when compared with others?	•
• Are plants/lichens found on some surfaces?	•
• What is the name of the processes that loosens and discolours rock faces without removing grains?	•
• Are the rocks lightly, moderately or heavily weathered?	•

Focus 2	**Erosion**
Objective(s)	• To highlight erosion by gravity and/or water • To provide opportunities to emphasise that erosion involves the removal of solid material
Suitable site in the quarry	An area of loose rock beneath a rock face, preferably with water-formed gullies leading away

Possible questions	**Possible answers**
• How did the pile of rock fragments build up at the bottom of the rock face?	•
• How else are fragments being carried away from the rock face? • How can you tell?	•
• What is the name of the process that removes fragments from rock faces?	•
• Are the erosive processes here acting slowly, at moderate rates or quickly?	•

Focus 3	**Soil**
Objective(s)	• To consider how soil develops from the parent rock
Suitable site in the quarry	A place where a clear soil profile has developed at the top of a rock face, and can be seen in cross section

Possible questions	**Possible answers**
• How many different soil layers can you see?	•
• How does rock become changed into topsoil?	•
• Is this a rich or poor soil? (Generally, the greater the number of species, the richer the soil)	•

Focus 4	**Rock group**
Objective(s)	• To distinguish between sedimentary and igneous rocks (for simplicity, metamorphic rocks are ignored in this exercise) • To consider the main lines of evidence that can be used to tell the difference
Suitable site in the quarry	A place where the rock characteristics, either in the rock face itself or in debris at the foot of the face, are clear and obvious

Possible questions	**Possible answers**
• Can layers be clearly seen in these rocks? (Most sedimentary rocks are clearly layered; most igneous rocks are not)	•
• Does a drop of water sink in or run off the surface? (Most sedimentary rocks have gaps between the grains so that water sinks in. Most igneous rocks have interlocking grains making them waterproof)	•
• Can you scrape grains off the surface? (Grains can be scraped off the surface of most sedimentary rocks, but are much harder to remove from most igneous rocks)	•
• Does one drop of dilute acid react with the rock? (Some sedimentary rocks react with acid, but igneous rocks don't)	•
• Can you spot any fossils? (Sedimentary rocks can contain fossils, igneous rocks never do)	•
• Is this rock an igneous or sedimentary rock? How do you know?	•

Focus 5	**Grains**
Objective(s)	• To consider how grain size evidence in sedimentary rocks can be used to indicate the energy level of the environment during deposition • Using evidence from grain shape and sorting to give clues to the ancient transportation regime
Suitable site in the quarry	A place where grains can clearly be seen and preferably where there is some variety of grain size/shape. A hand lens may be helpful for finer-grained rocks

Possible questions	**Possible answers**
• How big is the largest grain you can see? • (Estimate the length in mm or cm)	•
• When the sedimentary grains were being laid down, how might they have been moved here – by wind, water, ice or gravity?	•
• Was this deposit laid down in low, medium or high energy conditions? (Large grains take more energy to move and deposit them than smaller grains)	•
• Does the rock have several sizes of grains or just one size? (The further grains are carried, the more they tend to be sorted out into coarse, medium and fine sizes)	•
• Have these grains travelled far? (Grains with sharp corners have not moved far but rounded pebbles will have travelled a long way; also, the further they have travelled, the more different sorts there are likely to be)	•
• What does the grain evidence tell you about this sedimentary deposit?	•

Focus 6	Sedimentary structures
Objective(s)	• To use sedimentary structures to bring an ancient environment 'to life'
Suitable site in the quarry	A place where sedimentary structures likely to be familiar to pupils/students are clearly visible, examples might include bedding (sedimentary layering), cross bedding (sloping beds in an otherwise flat-lying deposit), asymmetrical (current) ripples or symmetrical (wave) ripple marks, mud cracks, footprints, large-scale dune cross bedding

Possible questions	Possible answers
• If you were standing here when this sediment was being deposited, what would it have been like?	•
• Would you have been on land or in water? • If in water, how deep? Would you have needed a snorkel, scuba gear or a submarine?	
• Could you have stood up? Would the current have been too strong or the sediment too sloppy?	
• What would you have been able to see, hear, taste, smell?	•
• What is the altitude here (e.g. from a map)? • How has the altitude changed since the sediment was deposited?	•

Focus 7	Fossils

Objective(s)	• Fossil preservation depends on:
	  • the characteristics of the organism
	  • what happened straight after death
	  • what happened after burial
	• Fossils can provide useful evidence of several different sorts

Suitable site in the quarry	A place where fossils are clearly visible, the more variety, the better

Possible questions	Possible answers
• What happened to these animals/plants just after they died? • Were they buried where they were or moved around, sorted out and broken up?	•
• As they were being buried, what might they have looked like, smelled like?	•
• After they were buried, how did they change?	•
• Why are some types of organism much more commonly fossilised than others?	•

Focus 8	**Crystals**
Objective(s)	• To use crystal size to distinguish between intrusive and extrusive igneous rocks
Suitable site in the quarry	A place where the crystals in an igneous rock can be seen clearly (using a hand lens)

Possible questions	**Possible answers**
• How big is the largest crystal you can see? (Estimate the length in mm or cm)	•
• Did the melt (magma) that formed this rock cool quickly or slowly? (Slow cooling = large crystals, faster cooling = smaller crystals)	•
• Did the melt (magma) become solid at the surface (fine-grained) or beneath the surface (coarser)?	•
• Does the rock have crystals of different sizes? • How might this have happened?	•

Focus 9	**Tilted rocks**
Objective(s)	• To use evidence of local deformation to appreciate wider scale tectonic events
Suitable site in the quarry	A place where once horizontal (usually sedimentary) rocks are now tilted (dipping)

Possible questions	**Possible answers**
• Were these sediments laid down flat?	•
• What is their angle now?	•
• What might have caused a change in angle on this scale?	•
• Which came first, the deposition of the sediments or the tilting?	•

Focus 10	Folds
Objective(s)	• To show that folds are the result of compression by large scale equal and opposite forces • To indicate the scale of forces necessary to fold rocks – that can only be related to plate movement
Suitable site in the quarry	A site where sedimentary rocks are folded into simple folds, preferably several of them

Possible questions	Possible answers
• Were these sediments laid down flat?	•
• Why are they no longer flat?	•
• From which directions did the forces come that caused the rocks to crumple like this?	•
• What might have caused this scale of crumpling?	•
• How could hard rocks have been bent and folded in this way?	•

Focus 11	Faults
Objective(s)	• To highlight the differences between faults and other types of fractures • To link faulting to regional stress patterns
Suitable site in the quarry	A site where rocks are clearly faulted, preferably where beds can be matched up on either side of the fault

Possible questions	Possible answers
• How can you tell that this fracture is a fault? (Faults are fractures where the rocks on either side have moved)	•
• What types of forces might have caused this fault, squeezing, pull-apart or sliding forces? (Faults can be caused when rocks are squeezed, or pulled apart or rocks slide past one another. Faults caused by squeezing usually slope downwards at less than 60º, steeper faults are usually caused by pull-apart forces. Sliding faults are usually vertical)	•
• How can some rocks be both faulted and folded?	•
• What might have caused the squeezing, pull apart or sliding forces that fault rocks?	•

Focus 12	Metamorphism
Objective(s)	• To illustrate how metamorphic rocks formed from pre-existing rocks • To show what differences the metamorphism causes
Suitable site in the quarry	An exposure of metamorphic rocks, preferably containing evidence of their former origin

Possible questions	Possible answers
• How can you tell that this is a metamorphic rock?	•
• What clues show what sort of rock this was before metamorphism?	•
• What are the differences between this metamorphic rock and the rock it probably formed from?	•
• How might these differences have been caused?	•

Focus 13	Sequencing
Objective(s)	• To use geological 'relative dating' methods to work out the sequence of geological events at a site
Suitable site in the quarry	A site where several geological events have left clear signs

Possible questions	Possible answers
• In a layered sequence, which of the layers was formed first? Which last?	•
• Where a feature cuts across another feature, which came first, the feature that cuts through or the feature that is cut?	•
• If a rock A contains pebbles of another rock B, which came first, rock A or rock B?	•
• If a rock is tilted, folded or metamorphosed, which came first, the rock or the tilting/folding/metamorphism?	•
• What is the sequence of geological events at this site using these methods?	•

Focus 14	Tectonic plates
Objective(s)	• To consider the geological evidence from the quarry in a plate tectonic context
Suitable site in the quarry	Any site with reasonable exposures

Possible questions	Possible answers
• Are there clues that suggest that this place had a very different climate in the past?	•
• What might have caused the change in climate between then and now?	•
• Are there clues showing that this place was near a plate margin in the past?	•
• Are there clues that show whether or not this area is near a plate margin now?	•

Focus 15	Landscape
Objective(s)	• To provide a feel for how rock resistance, structure and use affect landscape
Suitable site	A viewpoint from where higher and lower land, hills and valleys or headlands and bays can be seen

Possible questions	Possible answers
• Which landform is formed of the most resistant (hardest) rocks? • Which is made of the least resistant (softest) rocks?	•
• How might ridges form?	•
• How might flat-topped plateaus form?	•
• When you walk downhill are you normally walking from softer towards harder rocks or visa versa?	•
• How can the human use of rocks affect landscape?	•

Focus 16	**Quarry economics**	
Objective(s)	• To give a feel for the commercial value of materials from the Earth – and their importance to us • To develop arithmetical and estimation skills	
Suitable site	A quarry!	
Possible questions		**Possible answers**
• What are the dimensions of this quarry (length, breadth and height)		•
• What is the volume of the quarry • (Volume (m^3) = length (m) x width (m) x height (m))		•
• What is the economic value of the rocks in this quarry at today's prices? • (Value (£) = volume (m^3) x price (£m^{-3}))		•
• Which nearby cities/towns would be most likely to want to buy these quarry products?		•
• What might they be used to build in the nearby city/town?		•
• Do you think the quarry might re-open?		•

Focus 17	**Quarry potential**
Objective(s)	• To show that abandoned quarries can have a range of different uses, some more appropriate than others • To develop decision-making skills
Suitable site	An abandoned quarry

Possible questions	**Possible answers**
• Could this quarry be used to dispose of high level nuclear waste material? If so, why? If not, why not?	•
• Could this quarry be used to dispose of household waste material? If so, why? If not, why not?	•
• Could this quarry be used to dispose of demolition rubble? If so, why? If not, why not?	•
• Could this quarry be used as a water reservoir? If so, why? If not, why not?	•
• Could this quarry be used as a nature reserve? If so, why? If not, why not?	•
• Could this quarry be used as part of a golf course? If so, why? If not, why not?	•
• Could this quarry be used as part of an orienteering course? If so, why? If not, why not?	•
• Could this quarry be used as a Regionally Important Geological/geomorphological Site (RIGS) for its scientific or educational interest or its beauty. If so, why? If not, why not?	•
• Could this quarry be re-opened to supply building material? If so, why? If not, why not?	•
• Which of these options would be the best one? Might different groups of people have different points of view?	•

Focus 18	**Recording**
Objective(s)	• To consider how a scientist (geologist) would go about making effective records of a site
Suitable site	Any site with some geological variety

Possible questions	**Possible answers**
• If this site were to be filled in or destroyed, in what ways could the geological information be recorded for future use?	•
• Which of these ways would be best? Why?	•

Resource list

Any quarry guide	**Required by**	
Resource list:	**Teacher**	**Pupil**
Optional bottle of 0.5M HCl in acid dropper (already diluted)	✓	
Wash bottle filled with tap water	✓	
Optional compass	✓	
Optional clinometer if available	✓	
Safety equipment e.g. hard hat for all if quarry face is a hazard	✓	✓
Clipboards		✓
Appropriate question sheets from this pack		✓
Hand lens –teacher and also pupils if possible	✓	✓