

Questions for any rock face 7: tilted or folded rocks

What questions about tilting and folding might be asked at any 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.

Tilted or folded rocks

Bedded sediments that were originally laid down horizontally, often became tilted as part of the limbs of larger folds; sometimes the folds themselves can be seen in the rock face. Take the pupils to some tilted or folded rocks and ask them these questions.

Possible questions	Possible answers
Were these sediments laid down flat?	Yes – the majority of sediments were; exceptions include cross bedding, bedded scree deposits and reef slope deposits
What is angle of the rocks now? If you can see a fold in the rock, what is the angle of the rocks on both sides?	Estimate or measure the dip – the angle of slope measured from the horizontal <i>To measure the dip, find the steepest part of the rock surface (e.g. by seeing the direction in which water flows down the surface) and measure this ‘true dip’ angle with a clinometer</i>
From which directions did the forces come that caused the rocks to tilt or crumple like this?	Equal and opposite forces are likely to have acted horizontally parallel to the dip direction and at right angles to the axis of the fold
What might have caused this change in angle (or changes in the angles if you are looking at a fold)?	Dipping and folded rocks are evidence of regional deformation – which can normally only be caused by the collision of tectonic plates. This produces intensely folded rocks in the collision zone and broad folds of different scales, with tilted rocks, on the margins
If you can see a fold, how could these hard rocks have been bent and folded in this way?	The rocks may have been more plastic (less brittle) at the time, and would certainly have been more deeply buried and so warmer - but this is evidence of the enormous stresses and high temperatures involved in plate collisions
Which came first, the deposition of the sediments or the tilting/folding?	Sediments must have been deposited before tilting/folding. This question encourages pupils to begin sequencing events

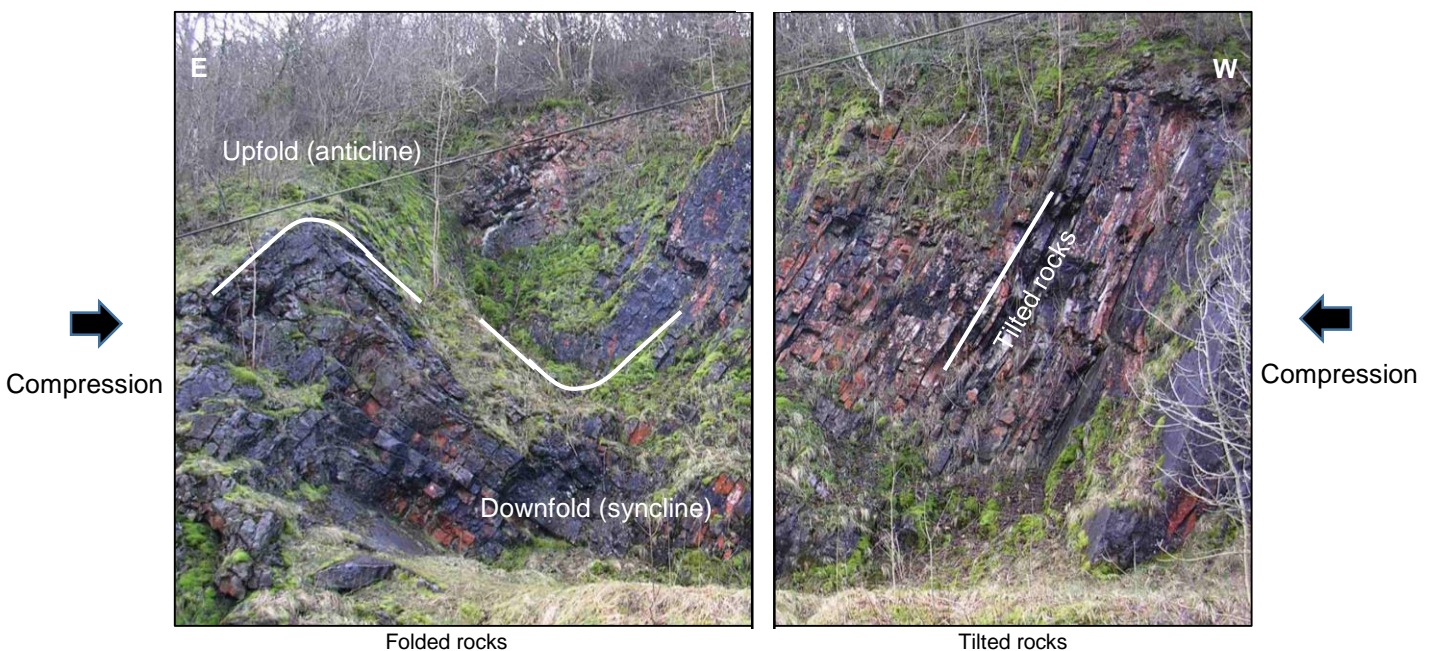
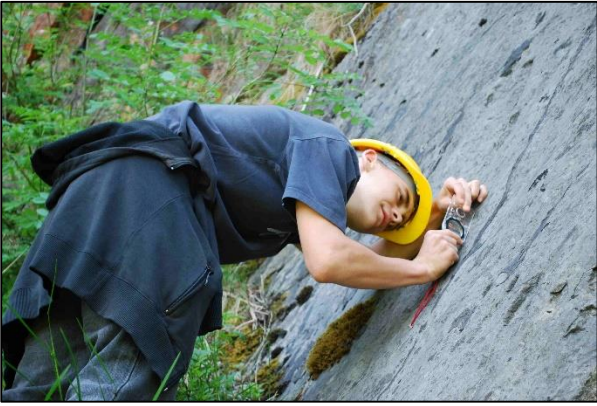
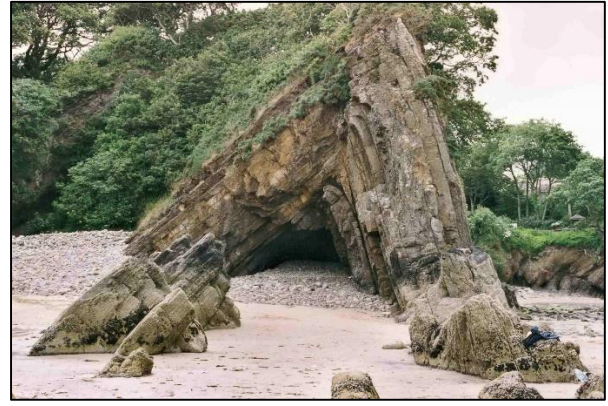


Photo showing how folded rocks become tilted rocks on the limb of a fold, Apes Tor, Staffordshire. (Peter Kennett).
The folding and tilting were caused by East-West compressive forces. (Peter Kennett).



Measuring angle of dip on tilted rocks. (Peter Kennett).



Folded rocks, anticline, Saundersfoot, South Wales, UK. (Peter Kennett)

* 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 7: tilted or folded rocks

Subtitle: What questions about tilting and folding might be asked at any rock exposure?

Topic: Questions to aid pupil understanding of tilted and folded rocks.

Age range of pupils: 9-16 years

Time needed to complete activity: 10 minutes

Pupil learning outcomes: Pupils can:

- explain how tilted rocks form parts of larger-scale folds;
- work out the directions of the stresses which caused the deformation of the tilted and folded rocks;
- explain how hard rocks may have been deformed in the geological past;
- explain how rock deformation results from enormous stresses – stresses only possible from plate collision.

Context:

The questions enable pupils to develop their understanding of rock deformation and the folds and tilted beds it produces. They help pupils to begin to appreciate the enormous deformation stresses necessary to produce folded and tilted rock sequences.

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:

- Sedimentary rocks were usually originally deposited as horizontal beds.
- Sedimentary beds are folded and tilted by tectonic forces.
- The directions of the tectonic stresses which deformed the rocks can be interpreted from their orientation today.
- The tectonic stresses necessary to deform rocks were enormous – and could only have been caused by plate tectonic collision forces.

Thinking skill development:

Pupils have to develop an abstract three dimensional picture of deformed rocks and the processes which deformed them to be able to understand how the deformation was caused.

Resource list:

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

Useful links:

There is a 'Do it yourself' fold animation at:

<http://www.bioygeo.info/Animaciones/FoldingV2.swf> and further folding animations at:

<http://www.algebra4children.com/Geography/faulting-folding.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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