Picturing tectonic structures – 1 faulting
Visualise and draw fault structures from a verbal description

Encourage pupils to look carefully at fault structures and to describe them verbally so that another person can visualise them from the description.

Seat pupils in pairs, with each person holding half of the photograph cards showing a variety of fault structures at different scales, printed off from those shown below. They should NOT show each other what cards they have in their hands.

Pupil A then examines one photograph and describes it as fully as possible to Pupil B, who listens carefully and then tries to draw it. Pupil B must listen in silence and not ask any questions. Pupil B then takes a turn with another card, with Pupil A doing the drawing, also in silence. Neither person should use any technical terms such as ‘normal’, ‘reverse’ etc., but they may refer to the directions of dip of beds and faults, and in which direction they think displacement has taken place. They may tell their partner whether they are looking at a hand specimen, a geological exposure, or an aerial view. Pupils should then compare their hand-drawn efforts with the photographs.

This first round should be tried without any guidance. Then give each participant the Prompt Card, to encourage them to be more specific in further descriptions, and ask them to work through the remaining photographs, comparing their drawings with the photographs after each round. Note that some structures may be repeated on different photographs.

When all have finished, give out the descriptive cards and ask pupils to match the descriptions to the photographs which they have been using.

A. Height of cave c. 3m

B. Lens cap 50mm

C. Width of view c. 40cm

D. Figure is 1.8m tall

E. Height of face c.15m

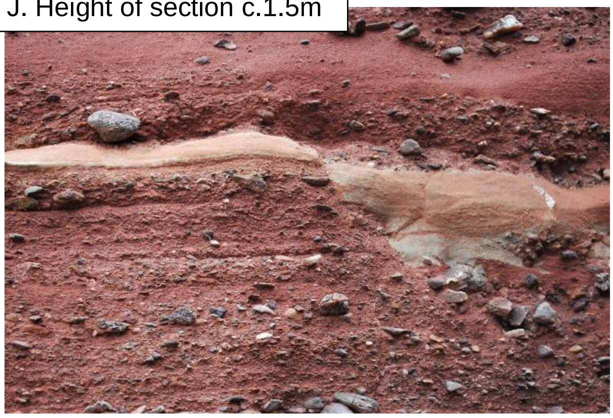
F. Scale bar is 2km

G

H. Height of face c. 3m

I. Width of view c.1m

J. Height of section c.1.5m



K. Height of cliff c.15m

L. Lens cap 50mm

Prompt Card
Use this card as a check list to aid your verbal description of your photographs to your partner
Does the photo show a hand specimen, a geological exposure or an aerial view?
What is the dip of the affected beds? Are there any folds associated with the faults?
What is the dip of the fault plane (s)?
What evidence on either side of the fault plane might enable you to say if the fault is normal, reverse, thrust or strike slip (tear)?
How much displacement is there across the fault plane? [e.g. 'throw', i.e. vertical displacement across a normal or reverse fault; or lateral displacement across a strike-slip (tear fault)].
If there is more than one fault plane visible, what is the relationship between them?

Descriptions of the photographs

1. Quarry at Skelmersdale, Lancashire. A vertical normal fault affecting dipping Coal Measures rocks. The throw is about 1.2m down to the right. Fault likely to have been caused by left-right tension.	7. The Piqiang Fault, in China, named on the satellite image, is a strike-slip (tear fault), trending NNW/SSE. Looking across the fault plane, the displacement is about 4km to the left of the viewer, so it is sinistral.
2. Bromborough, Wirral, Cheshire. There are at least two normal faults visible, throwing down a central block between them (known as a 'graben'). The fault on the left dips at 80^{o} to the right and throws down by 40cm in this direction. The fracture in the middle shows very little displacement, whilst the right hand fault dips to the left at 60^{o} and throws down to the left by about 20cm. The faults are related to the same tensional stress field and are referred to as 'conjugate' faults.	8. Blue Anchor, Somerset. A fault, dipping to the left at about 50^{o}. Unless the ages of the strata on each side are known, it is not possible to say whether this is a normal or a reverse fault. However, there appears to be some drag folding next to the fault plane, where the red beds are bent down slightly and the grey beds up, suggesting a normal fault. This is confirmed when we know that the red beds are Triassic in age and are older than the grey beds which are of Lower Jurassic age.
3. Pithouse West Opencast site, near Sheffield. Assuming that the coal seam beneath the students is the same one as where the red lorry is loading, this is a normal fault, dipping to the right at about 50^{o}. The throw is about 3m near the students, apparently reducing in the background.	9. The Lizard, Cornwall. A recumbent fold affected by a 'break thrust', when plastic deformation was overcome by brittle failure. The dip of the fault plane is about 20^{o} to the right. Matching the massive (thick) bed above the figure to the one to the right of his feet suggests displacement along the fault plane of at least 4m. Caused by intense compressional stress.
4. Seven Sisters, Sussex. A fault affecting apparently horizontal beds of Chalk with flint bands. The fault dips to the left at about 70^{o}. Matching up flint bands across the fault plane is uncertain, but the band about half way up seems to show a vertical displacement of about 50cm to the left, in which case this is a normal fault. Left-right tension.	10. Underground in Ecton Copper Mine, North Staffordshire. Beds of limestone which are nearly vertical have been displaced along a fault plane which dips at 30^{o} to the right. Three thin beds can be traced across the fault plane and have been moved up to the left, so this is a low-angle reverse fault, or thrust, caused by compressional stress.
5. Borrowdale, Lake District. Microfaults in bedded volcanic ash, now metamorphosed to slate. The dips of most of the fault planes are around 20^{o}, so they are thrust faults, resulting in the central block being raised in relation to its surroundings (known as a 'horst'). The faults are related to the same compressional stress field and are referred to as 'conjugate' faults.	11. Crackington Haven, Devon. Loose block, with cross-cutting 'vertical' veins of quartz. A strike-slip (tear) fault running from left to right across the middle has offset three veins to the left by 12mm, i.e the displacement is sinistral. At the bottom of the photo a 'N/S' vein is offset by a later 'NE/SW' vein, but this is because they cross at an oblique angle and it is not a faulted junction.
6. Paignton, Devon. This appears to be a normal fault with a dip of 75^{o}, and a downthrow to the right of about 20cm. The fault does not continue above the top of the pale-coloured bed and is probably a 'syndepositional' fault, i.e. it was active at the time the beds were being deposited and movement stopped whilst sediment was still being laid down above.	12. Underground in Ecton Copper Mine, North Staffordshire. This is a vertical fault plane in limestones, where movement of rocks on opposite sides of it has resulted in 'scratching' and alignment of minerals, known as 'slickensides'. The horizontal alignment shows that the last phase of movement along the fault plane was horizontal, but determining whether it was sinistral (to the left) or dextral (to the right) is dubious in this case.

The back up

Title: Picturing tectonic structures – 1 faulting

Sub-title: Visualise and draw fault structures from a verbal description

Topic: Enhancing pupils' skills of description and interpretation using photographs of faulted rocks at various scales

Age range of pupils: 16 years upwards

Time needed to complete activity: About 30 minutes, depending on depth of discussion

Pupil learning outcomes: Pupils can:
- examine photographs of faults carefully and describe them intelligibly;
- listen carefully to a verbal description and interpret it in a drawing;
- demonstrate their understanding of the nature and origin of faulting;
- enhance their observational skills as a prelude to field work.

Context: This could form a useful revision activity, once pupils have studied tectonic structures. Answers to the matching exercise are:

A4	B5	C12	D9	E1	F7
G3	H2	I10	J6	K8	L11

Following up the activity:
- Ensure that pupils use the same careful description and interpretation approach to geology in the field.

Underlying principles:
- This strategy provides training in careful observation and interpretation of all relevant features.
- Being obliged to give a verbal description encourages careful observation, to ensure that clues are not missed.

Thinking skill development:
Verbal dexterity and metacognition are encouraged by the need to give intelligible verbal descriptions and to interpret from them**.** Mental patterns are constructed of faulting. Applying the activity to the field situation is a bridging activity.

Resource list:
- card sets of Photographs, Prompt Cards and Description Cards, cut out from those shown above
- a ruler and protractor per pair might encourage accurate observation and description

Useful links:
https://www.earthlearningidea.com/PDF/298_Hands_faults.pdf
https://www.earthlearningidea.com/PDF/407_Picturing_folds.pdf
See the table below for other Earthlearningidea activities in the "Picturing" series.

Source: Written by Peter Kennett of the Earthlearningidea Team. Photos F: NASA faulting_oli_2013211_detail (in the public domain). H: Geograph.org.uk photo 524711 © Copyright Donald Farnworth and licensed for reuse under this Creative Commons Licence.
All other photos by P. Kennett.

Picturing………

Earthlearningidea has compiled a series of activities involving examination of photographs of geological interest and their careful verbal description to others. This table will be updated as fresh activities are added. All titles begin with: “Picturing……”

Title	Sub-title
Puzzle structures	Visualise and draw sedimentary structures from a verbal description
Trace fossils and other strange shapes	Visualise and draw trace fossils and sedimentary structures from a verbal description
Igneous rocks – 1	Visualise and draw igneous rocks from a verbal description
Igneous rocks – 2	Visualise and draw igneous rocks from a verbal description
Metamorphic rocks	Visualise and draw metamorphic rocks from a verbal description
Tectonic structures – 1 faulting	Visualise and draw fault structures from a verbal description
Tectonic structures – 2 folding	Visualise and draw fold structures from a verbal description
Minerals -1	Visualise and draw minerals from a verbal description
Minerals -2	Visualise and draw minerals from a verbal description
Fossils -1	Visualise and draw fossils from a verbal description
Fossils -2	Visualise and draw fossils from a verbal description
Landforms 1	Visualise and draw landforms from a verbal description
Landforms 2	Visualise and draw landforms from a verbal description