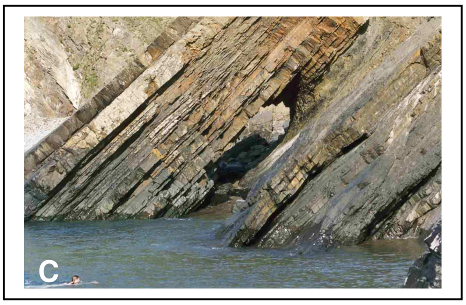
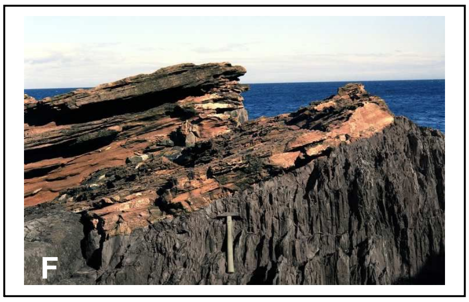
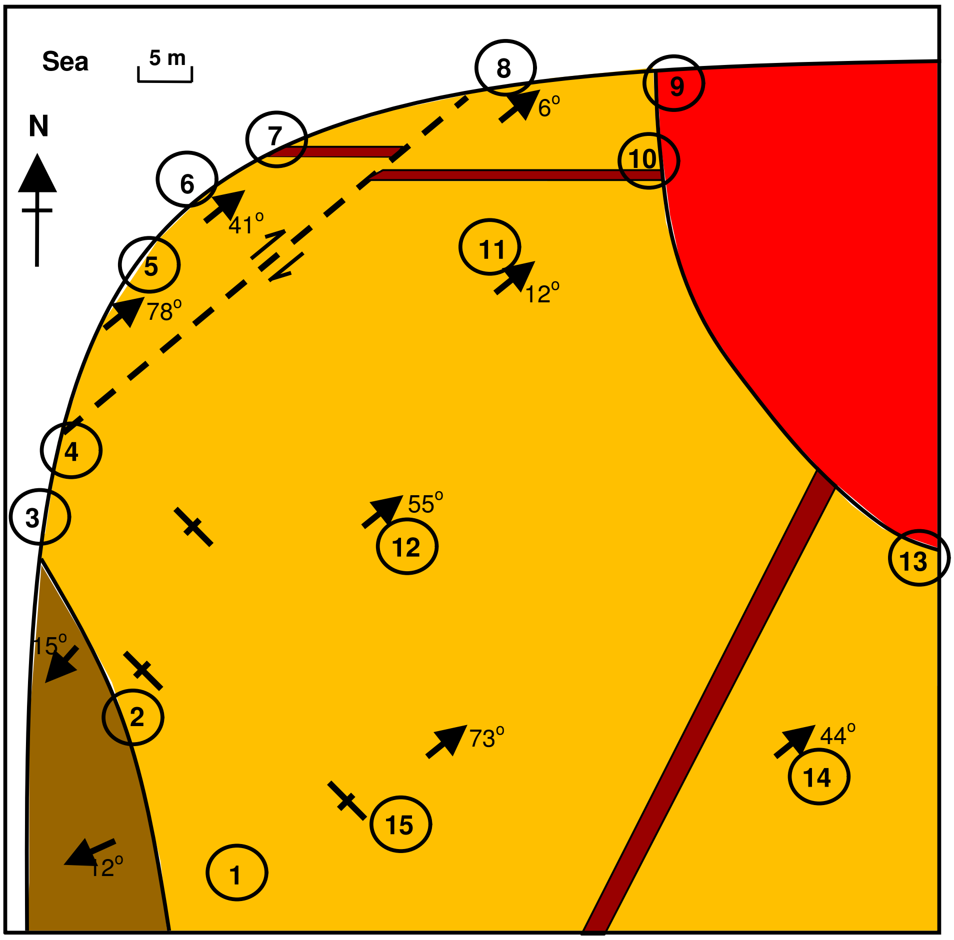
Geological mapwork: using surface geology to make a geological map
Match the photos to a map to see how a geological map works

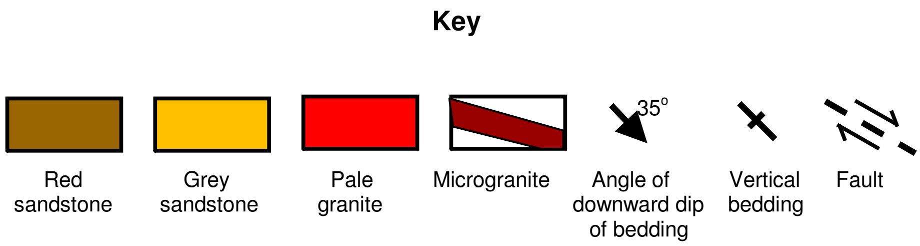
For each of the photographs:

1. Draw straight lines to link each photograph (A – G) with the locality (marked 1 – 15) on the map where you think it was taken.
2. Show with an arrow (→) at each of the localities you have chosen, the direction you think the camera was pointing when the photograph was taken.









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The back up

Title: Geological mapwork: using surface geology to make a geological map.

Subtitle: Match the photos to a map to see how a geological map works.

Topic: A photograph/map matching exercise to show how geological features are used to draw a geological map. A table of the progression and spiralling of spatial thinking skills involved through the Earthlearningidea series of mapwork exercises is given on the final page.

Age range of pupils: 14 – 19 years

Time needed to complete activity: 15 mins

Pupil learning outcomes: Pupils can:
- match geological features shown in photographs to the localities where they would be found on a geological map;
- explain how geological maps are drawn from geological evidence found across map areas.

Context:
Even when pupils are familiar with geological maps and the ways that the three dimensional geology of map areas can be shown by drawing cross sections, they can find it difficult to link these views of a geological map with the reality of the map area. This exercise asks pupils to match photographs to an imaginary map area to aid their understanding of the types of features used in geological mapping. The final photograph emphasises the point that most rock outcrops are covered by vegetation and that rocks can only be seen at the surface where there are exposures.

The activity can be used for revision of mapwork features. It can also help to bridge the divide between science and geography.

The exercise can be carried out from a coloured print-out of Page 1. For larger photographs and additional information, print out Page 4 as well, and cut out the photographs for pupil use (this approach might be suitable for pupils who find spatial thinking difficult). Alternatively, the exercise can be carried out on-screen on a computer, using Page 1, with Page 4, if necessary. The on-screen approach allows the pages to be enlarged to make the photographs easier to see.

For simplicity we have referred to just four rock types, although rather more are featured in the photographs, for those who would like the details, they are as follows:

A. *Pale granite/grey sandstone contact, locality 9.* P576679 The Scourie Dyke at Scourie Graveyard.
B. *Microgranite dyke/grey sandstone contacts, locality 7.* Peter Kennett. Pale-coloured igneous (lamprophyre) dyke cutting dark Dalradian slates, Onich coast, Argyll, Scotland.
C. *Bedding in grey sandstone dipping at 40^o, locality 6.* Peter Kennett. Upper Carboniferous sandstones, Hartland Quay, Devon.
D. *Bedding in grey sandstone dipping at 12^o, locality 11.* P517187 Fersness Bay, Eday (Orkney). View looking east at outcrop of cross-bedded Middle Eday Sandstone Formation approximately 200 m NW of Sands of Mussetter.
E. *Strike-slip fault in grey sandstone, locality 4*. Earth Science World Image Bank, Photo ID: hflmtw | Photographer © Marli Miller, University of Oregon
F. *Unconformity between red sandstone dipping at 20^o overlying grey sandstone dipping vertically, locality 2.* P218993 Siccar Point, 4 km. E. of Cockburnspath. Unconformable junction of Upper Old Red Sandstone on vertical Silurian rocks.
G. *An area where no rocks are exposed, locality 1.* Moorland. Image taken from the Geograph project collection, copyright Dave Smethurst. Licensed for reuse under the Creative Commons Attribution-ShareAlike 2.0 license.

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Following up the activity:
Pupils could be asked to sketch ideas of the geological features they might see at the other localities shown on the map.

Underlying principles:
- Geological maps are made by collecting information from geological features that are exposed at the surface (sometimes reinforced by borehole or mine information).
- Where there are no rocks exposed (being covered by soil, etc.) the geology beneath the area has to be interpreted from the surrounding exposed geological information.

Thinking skill development:
Geological maps are drawn using a range of geological evidence pieced together in three dimensions but shown on a two dimensional map. This requires high-level skills of interpretation, synthesis and spatial awareness.

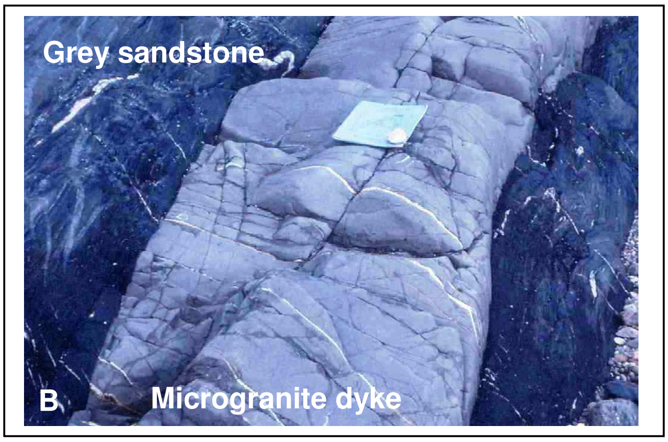
Resource list:
- **either** a coloured printout of Page 1 **or** computer access for pupils, with this activity loaded onto the computer
- **optional** a coloured printout of Page 4, cut up into individual photographs
- pencil and ruler per pupil, if using printouts

Source: Devised by Chris King of the Earthlearningidea team.

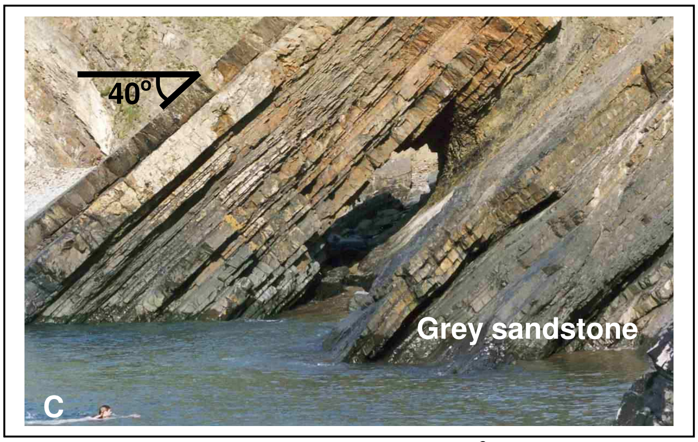
3D geological mapwork from scratch ?: Making a geological map from surface geology
Match the photos to a map to see how a geological map works

The photographs – with labels

Pale granite/grey sandstone contact, locality 9.



Microgranite dyke/grey sandstone contacts, locality 7.



Bedding in grey sandstone dipping at 40°, locality 6.

Bedding in grey sandstone dipping at 20°, locality 11.

Strike-slip fault in grey sandstone, locality 4.

Unconformity between red sandstone dipping at 20°, overlying grey sandstone dipping vertically, locality 2.

An area where no rocks are exposed, locality 1.

The progression and spiralling of spatial thinking skills shown by the Earthlearningidea 'Geological mapwork from scratch' exercises and the 'Geological mapwork from models' exercises

Exercise		Topographic surface	Geological surfaces	Strategies and skills
Mapwork from scratch 1: a conical hill		Conical hill	Flat and horizontal	• Plot and draw simple topographic cross sections • Add geological boundary intersections and join with straight, horizontal lines
Mapwork from scratch 2: valley with simple geology		Sloping valley	Flat and horizontal	• Plot and draw simple topographic cross sections • Add geological boundary intersections and join with straight, horizontal lines • Sketch geology onto a 3D block diagram
Mapwork from scratch 3: valley with dipping geology		Sloping valley	Dipping surfaces	• Draw true dip on a cross section using a protractor • Add geological boundary intersections and join with straight lines • Appreciate that apparent dip is always less than true dip • Appreciate that, in valleys, geological boundaries usually 'V' in the direction of dip. • Sketch geology onto a 3D block diagram • Begin to compile a list of mapwork rules
Mapwork from models 1	Plain version 1	Flat	Flat and horizontal	• Add geological boundary data to cross sections and join with straight, horizontal lines
	Plain version 2	Flat	Dipping surfaces; vertical feature	• Add geological boundary data to cross sections and join with straight lines • Use boundaries on the cross sections which intersect the topographic surface to draw a boundary on the surface • Add a vertical feature (dyke)
Mapwork from models 2	Cuesta version 1	Asymmetrical ridge	Flat and horizontal	• Add geological boundary data to cross sections to construct straight, horizontal lines
	Cuesta version 2	Asymmetrical ridge	Dipping surfaces; vertical feature	• Draw true dip on a cross section using a protractor • Add parallel geological boundaries • Add a vertical feature (fault) that moves a geological boundary • Appreciate the link between tough and weak geological formations and topography
Mapwork from models 3: valley with horizontal floor		Valley with horizontal floor	Dipping surfaces; vertical feature	• Draw true dip on a cross section using a protractor • Add parallel geological boundaries • Use boundaries on the cross sections which intersect the topographic surface to draw in boundaries on the surface • Construct parallel boundaries on the surface • Appreciate that, in valleys, geological boundaries usually 'V' in the direction of dip • Appreciate that apparent thickness is always greater than true thickness • Add a vertical feature (dyke)
Mapwork from models 4	Ridge/ valley with sloping floor version 1	Ridge/ valley with sloping floor	Dipping surfaces	• Add geological boundary data to cross sections to construct straight lines • Add parallel geological boundaries • Appreciate the link between tough and weak geological formations and topography • Interpolate approximate true dip from apparent dip
	Ridge/ valley with sloping floor version 2	Ridge/ valley with sloping floor	Dipping surfaces	• Draw true dip on a cross section using a protractor • Add parallel geological boundaries to cross sections • Use boundaries on the cross sections which intersect the topographic surface to draw in boundaries on the surface • Construct parallel boundaries on the surface • Appreciate that, in valleys, geological boundaries usually 'V' in the direction of dip and the opposite is true of ridges
Mapwork from models 5: plain; cuesta; valley with horizontal floor; ridge/ valley with sloping floor		All the model landforms above	Surfaces folded into open folds	The strategies and skills described in the box above and, in addition: • Identify folds with equally dipping limbs, and those with limbs dipping at different angles • Appreciate inverted topography • Draw fold axes and fold axial planes • Draw an unconformity and a pluton with a metamorphic aureole
Mapwork from models 6: plain with faulted rocks 1		Flat	Normal and tear dip faults; dipping bedding	• Draw the effects of a normal and a tear dip fault on cross sections • Use these to explain how different types of fault can have similar effects on outcrop patterns of dipping beds (but different effects of vertical features)
Mapwork from models 7: plain with faulted rocks 2		Flat	Normal and reverse strike faults; dipping bedding	• Draw the effects of normal and reverse strike faults on cross sections • Use these to explain how different types of fault can have similar effects on outcrop patterns
Mapwork from models 8: plain with faulted rocks 3		Flat	Normal, reverse, thrust and strike-slip faults at 45^{o} to the strike; dipping bedding	• Draw the effects of different sorts of faults on cross sections • Use this to explain how different types of fault can have similar effects on outcrop patterns
DIY dip and strike model		Dipping surface	Dipping bed	• Measuring dip, strike and apparent dip on a model dipping surface, using a DIY clinometer if no other clinometer is available
Geological mapwork: Surface geology and the geological map		Not given, assumed fairly flat	Relatively complex	• Match surface geological features to places on a geological map where they might be found.