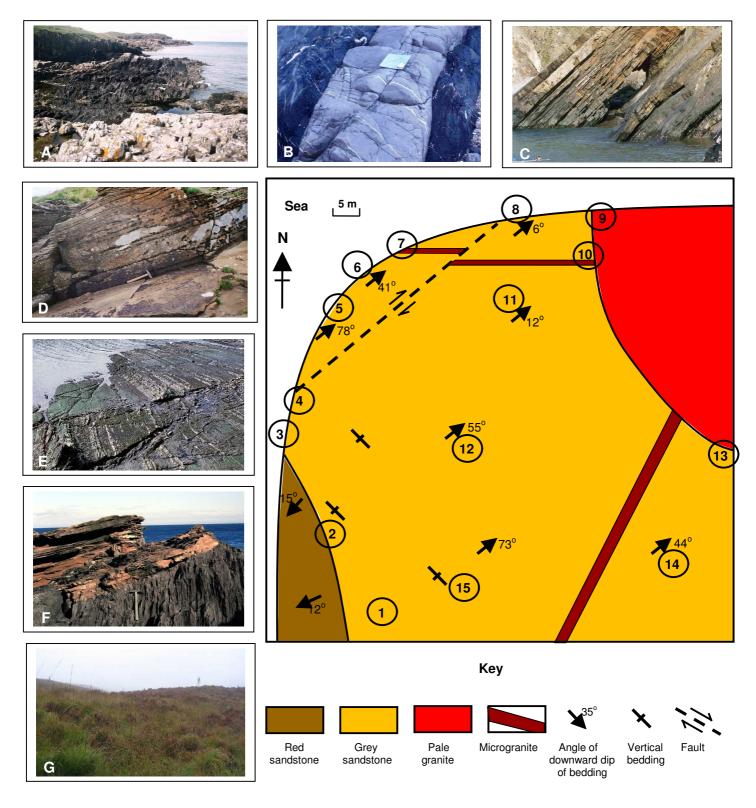
# Geological mapwork: using surface geology to make a geological map Match the photos to a map to see how a geological map works

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.
- 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 onscreen 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°, locality 6. Peter Kennett. Upper Carboniferous sandstones, Hartland Quay, Devon.
- D. Bedding in grey sandstone dipping at 12°, 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° 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.

We are grateful to acknowledge that photographs with a P number are used with the permission of the British Geological Survey, for non-commercial use in schools.

# 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.

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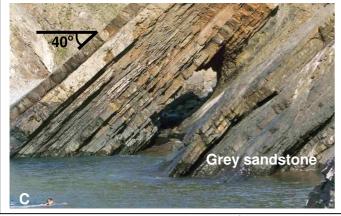
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3D geological mapwork from scratch ?: Making a geological map from surface geology Match the photos to a map to see how a geological map works

The photographs - with labels



Pale granite/grey sandstone contact, locality 9.



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



Strike-slip fault in grey sandstone, locality 4.





Microgranite dyke/grey sandstone contacts, locality 7.



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



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

Magwork from scratch 1: a conical hill       Conical hill       Flat and horizontal <ul> <li>Plot and draw simple topographic cross sections</li> <li>Add geological boundary intersections and join with straight, horizontal</li> <li>Plot and draw simple topographic cross sections</li> <li>Add geological boundary intersections and join with straight, horizontal</li> <li>Plot and draw simple topographic cross sections</li> <li>Add geological boundary intersections and join with straight, horizontal</li> <li>Stepting elogy with dipping</li> <li>geology</li> </ul> Magwork from scratch 3: valley with dipping       Stoping valley       Dipping surfaces <ul> <li>Draw true dip on a cross section using a protractor</li> <li>Add geological boundaries usually 'V' in the dip on a cross sections and join with straight lines</li> <li>Appreciate that, in valley, geological boundaries usually 'V' in the dip on a cross sections and join with straight lines</li> <li>Add geological boundary data to cross sections and join with straight lines</li> <li>Add geological boundary data to cross sections and join with straight from wersion 1</li> </ul> Magwork from scratch 2:       Flat and horizontal <ul> <li>Add geological boundary data to cross sections and join with straight from surfaces; vertical feature (dyke)</li> <li>Cuesta version 1</li> <li>Cuesta version 2</li> <li>Asymmetrical frature frage</li> <li>Add geological boundaries</li> <li>Add a vertical feature (dyke)</li> <li>Add a vertical feature (dyke)</li> <li>Add geological boundaries</li> <li>Add a vertical feature (dyke)<th>tal lines irection of dip. t, horizontal t lines ic surface to . horizontal line</th></li></ul>	tal lines irection of dip. t, horizontal t lines ic surface to . horizontal line
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version 2       ridge       surfaces; vertical feature       • Add parallel geological boundaries         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         Mapwork from models 4       Valley with horizontal floor       Dipping surfaces; vertical feature       • Draw true dip on a cross section using a protractor         Mapwork from models 4       Valley with sloping floor       Dipping surfaces; vertical feature       • Draw true dip on a cross section using a protractor         Mapwork from models 4       Valley with sloping floor       Dipping surfaces; vertical feature       • Draw true dip on a cross section using a protractor         Mapwork from models 4       Valley with sloping floor       Dipping surfaces       • Ocostruct parallel geological boundaries         Mapwork from models 4       Ridge/ valley       Dipping surfaces       • Add geological boundaries is always greater than true thicknes         Mapwork from models 4       Ridge/ valley       Dipping surfaces       • Add geological boundaries         Mapwork from models 4       Ridge/ valley       Dipping surfaces       • Add geological boundaries         Image: sloping floor version 1       Pipping surfaces       • Add geological boundaries         Image: sloping floor version 1       Dipping surfaces       • Add geological boundaries	nd topography
Mapwork from models 3: valley with horizontal floor       Valley with horizontal floor       Dipping surfaces; vertical floor       Dipping surfaces; vertical feature       Dipping surfaces; vertical feature       • Draw true dip on a cross section using a protractor         Mapwork from models 3: valley with floor       Valley with horizontal floor       Dipping surfaces; vertical feature       Dipping surfaces; vertical feature       • Draw true dip on a cross section using a protractor         Mapwork from models 4       Ridge/ sloping floor       Particity feature       • Draw true dip on a cross section using a protractor         Mapwork from models 4       Ridge/ sloping floor       Dipping surfaces; vertical feature       • Draw true dip on a cross section using a protractor         Mapwork from models 4       Ridge/ sloping floor       Dipping surfaces; Pipping surfaces       • Draw true dip on a cross sections which intersect the topographi draw in boundaries on the surface         Mapwork from models 4       Ridge/ sloping floor       • Dipping surfaces floor       • Add geological boundary data to cross sections to construct straight • Add parallel geological boundaries         • Appreciate the link between tough and weak geological formations a • Interpolate approximate true dip from apparent dip	nd topography
Mapwork from models 3:       Valley with horizontal floor       Dipping surfaces; vertical feature <ul> <li>Add parallel geological boundaries</li> <li>Use boundaries on the cross section which intersect the topographidraw in boundaries on the surface</li> <li>Construct parallel boundaries on the surface</li> <li>Appreciate that apparent thickness is always greater than true thickness is always greater than true thickness to construct straight with sloping floor</li> </ul> Mapwork from models 4         Ridge/ valley with sloping floor         Dipping surfaces <ul> <li>Add parallel geological boundaries</li> <li>Use boundaries on the surface</li> <li>Construct parallel boundaries is always greater than true thicknes</li> <li>Add a vertical feature (dyke)</li> <li>Mapwork floor</li> <li>Sloping floor</li> <li>floor</li> <li>Dipping surfaces</li> <li>Add parallel geological boundaries on the surface</li> <li>Appreciate that apparent thickness is always greater than true thicknes</li> <li>Add a vertical feature (dyke)</li> <li>Add parallel geological boundaries</li> <li>Add parallel geological boundaries</li> <li>Appreciate the link between tough and weak geological formations a</li> <li>Interpolate approximate true dip from apparent dip</li> </ul>	nd topography
Mapwork from models 3:       Valley with horizontal floor       Dipping surfaces; vertical feature <ul> <li>Draw true dip on a cross section using a protractor</li> <li>Add parallel geological boundaries</li> <li>Use boundaries on the cross sections which intersect the topographi draw in boundaries on the surface</li> <li>Construct parallel boundaries on the surface</li> <li>Appreciate that, in valleys, geological boundaries usually 'V' in the di</li> <li>Appreciate that apparent thickness is always greater than true thicknes</li> <li>Add parallel geological boundaries on the surface</li> <li>Appreciate that apparent thickness is always greater than true thicknes</li> <li>Add a vertical feature (dyke)</li> </ul> Mapwork from models 4       Ridge/ valley with sloping floor version 1 <ul> <li>Dipping surfaces</li> <li>Add geological boundaries</li> <li>Appreciate the link between tough and weak geological formations a</li> <li>Interpolate approximate true dip from apparent dip</li> </ul>	nd topography
valley with horizontal floor       horizontal floor       surfaces; vertical feature       • Add parallel geological boundaries         floor       floor       feature       • Add parallel geological boundaries         Use boundaries on the cross sections which intersect the topographi draw in boundaries on the surface       • Construct parallel boundaries on the surface         • Construct parallel boundaries on the surface       • Construct parallel boundaries on the surface         • Add parallel geological boundaries on the surface       • Appreciate that, in valleys, geological boundaries usually 'V' in the di         Mapwork from models 4       Ridge/ valley with sloping floor version 1       Dipping surfaces floor         Valley with sloping floor version 1       Bioping floor floor floor version 1       Dipping surfaces floor fl	
floor       floor       feature       • Use boundaries on the cross sections which intersect the topographid draw in boundaries on the surface         • Use boundaries on the cross sections which intersect the topographid draw in boundaries on the surface       • Ose boundaries on the surface         • Construct parallel boundaries on the surface       • Ose boundaries on the surface         • Appreciate that, in valleys, geological boundaries usually 'V' in the di         • Add a vertical feature (dyke)         Mapwork from         walley with         sloping floor         version 1         Dipping surfaces         • Add parallel geological boundaries         • Appreciate the link between tough and weak geological formations a         • Interpolate approximate true dip from apparent dip	
Mapwork rom models 4       Ridge/ sloping floor version 1       Ridge/ sloping floor       Ridge/ valley with sloping floor       Ridge/ valley with sloping floor       Dipping surfaces floor       Dipping surfaces version 1       Dipping surfaces sloping floor       Add a vertical feature (dyke)	
<ul> <li>Construct parallel boundaries on the surface</li> <li>Appreciate that, in valleys, geological boundaries usually 'V' in the di Appreciate that apparent thickness is always greater than true thickness Add a vertical feature (dyke)</li> <li>Mapwork from valley with sloping floor version 1</li> <li>Ridge/ valley with sloping floor</li> <li>Dipping surfaces Add geological boundaries Add parallel geological boundaries</li> <li>Appreciate the link between tough and weak geological formations a Interpolate approximate true dip from apparent dip</li> </ul>	c surface to
<ul> <li>Appreciate that, in valleys, geological boundaries usually 'V' in the di</li> <li>Appreciate that apparent thickness is always greater than true thicknes</li> <li>Add a vertical feature (dyke)</li> <li>Add geological boundary data to cross sections to construct straight</li> <li>Add parallel geological boundaries</li> <li>Add parallel geological boundaries</li> <li>Add parallel geological boundaries</li> <li>Appreciate the link between tough and weak geological formations a</li> <li>Interpolate approximate true dip from apparent dip</li> </ul>	
Mapwork from models 4       Ridge/ valley with sloping floor version 1       Dipping surfaces floor       Add a vertical feature (dyke)         Image: A preciate that apparent thickness is always greater than true	rection of din
Mapwork from models 4       Ridge/ valley with sloping floor version 1       Dipping surfaces       • Add a vertical feature (dyke)         • Add a vertical feature (dyke)       • Add geological boundary data to cross sections to construct straight         • Add a vertical feature (dyke)       • Add geological boundary data to cross sections to construct straight         • Add a vertical feature (dyke)       • Add geological boundary data to cross sections to construct straight         • Add parallel geological boundaries       • Add parallel geological boundaries         • Interpolate approximate true dip from apparent dip       • Interpolate approximate true dip from apparent dip	
from valley with sloping floor version 1 valley and weak geological formations a Interpolate approximate true dip from apparent dip	
models 4       sloping floor version 1       floor       • Appreciate the link between tough and weak geological formations a         • Interpolate approximate true dip from apparent dip	lines
version 1     Interpolate approximate true dip from apparent dip	
- interpolate approximate true up nom apparent up	nd topography
Bidde/ I Bidde/ Valley I Dippind Suffaces I • Draw true dip on a cross section using a protractor	-
<ul> <li>valley with sloping floor</li> <li>sloping floor</li> <li>floor</li> <li>Add parallel geological boundaries to cross sections</li> <li>Use boundaries on the cross sections which intersect the topographi</li> </ul>	io curfaco to
version 2 draw in boundaries on the surface	C Surface to
Construct parallel boundaries on the surface	
<ul> <li>Appreciate that, in valleys, geological boundaries usually 'V' in the di</li> </ul>	rection of dip
and the opposite is true of ridges	
Mapwork from models 5: All the model Surfaces folded The strategies and skills described in the box above and, in addition:	
plain; cuesta; valley with landforms into open folds or ldentify folds with equally dipping limbs, and those with limbs dipping angles	at different
horizontal floor; ridge/ above angles valley with sloping floor • Appreciate inverted topography	
Appleciate inverted topography     Draw fold axes and fold axial planes	
Draw an unconformity and a pluton with a metamorphic aureole	
Mapwork from models 6: Flat Normal and tear dip • Draw the effects of a normal and a tear dip fault on cross sections	
plain with faulted rocks 1 faults; dipping bedding • Use these to explain how different types of fault can have similar effe	ects on outcrop
patterns of dipping beds (but different effects of vertical features)	
Mapwork from models 7: Flat Normal and reverse - Draw the effects of normal and reverse strike faults on cross sections	
plain with faulted rocks 2 strike faults; dipping bedding • Use these to explain how different types of fault can have similar effe	ets on outcrop
bedding         patterns           Mapwork from models 8:         Flat         Normal, reverse, thrust              • Draw the effects of different sorts of faults on cross sections	
plain with faulted rocks 3 and strike-slip faults at • Use this to explain how different types of fault can have similar effect	·
45° to the strike; patterns	
dipping bedding	
DIY dip and strike model Dipping Dipping bed • Measuring dip, strike and apparent dip on a model dipping surface, u	
surface clinometer if no other clinometer is available	ts on outcrop
Geological mapwork: Not given, Relatively • Match surface geological features to places on a geological map who	ts on outcrop using a DIY
Surface geology and the assumed fairly complex be found.	ts on outcrop using a DIY