Geological mapwork from models 7: plain with faults parallel to the beds

Draw and make your own 3D models of the geology of a flat region with faulted rocks

A flat region/plain looks like this:

View in southern Skåne, Sweden.

Cut out the model of a flat region along all the solid lines. Then fold it along the dashed lines and flatten it out again.

A 3D cut out model of an area of flat ground (scale 1 cm = 100m) (a black and white version for non-colour printers, is given at the end)

Plain with faults, version 1: Add the following geology to the model using the shading or colours on the key on the next page. Paper-clip it together to show the 3D geology.

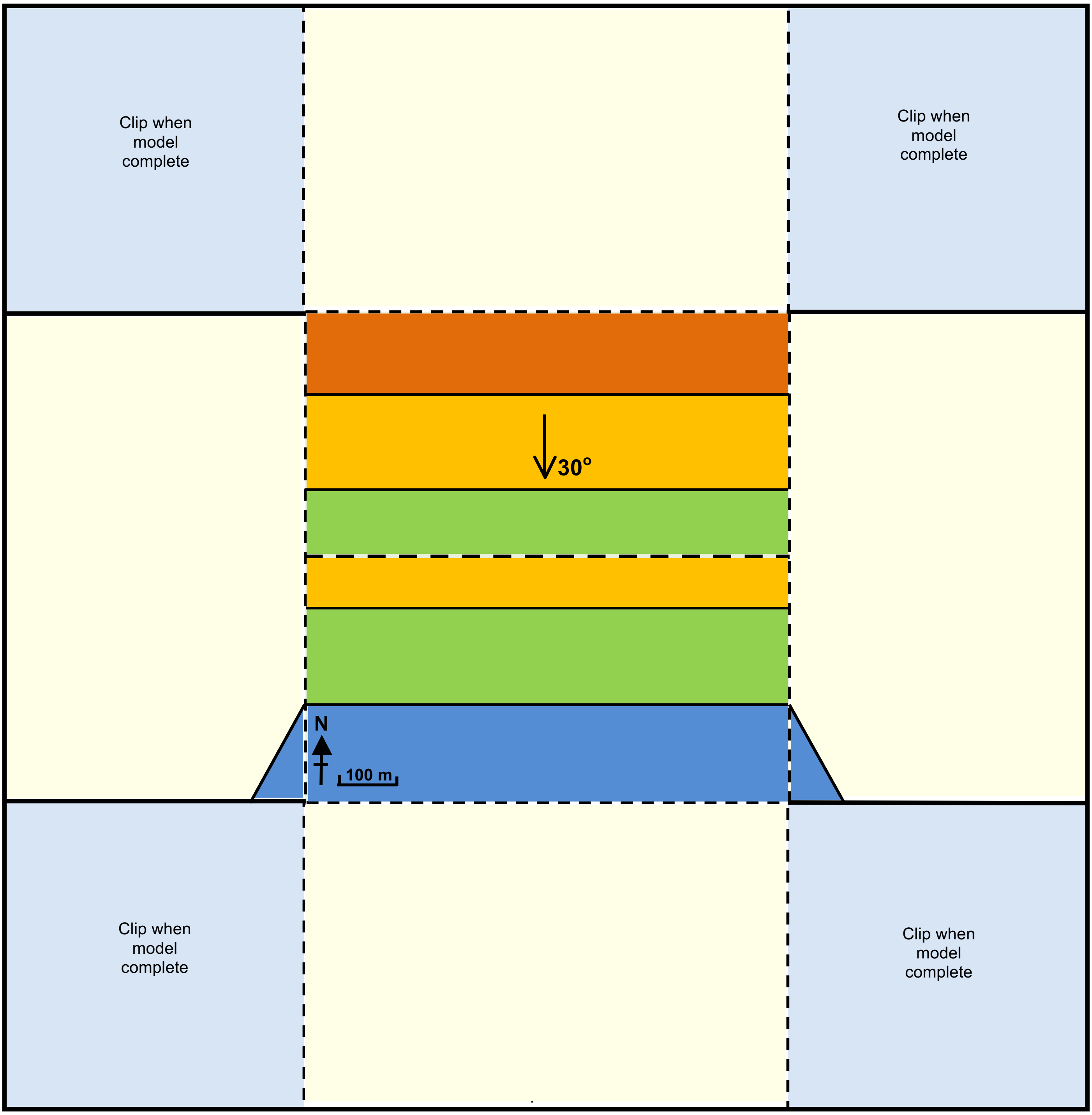
The fault is a normal fault that dips at 70° towards the north. It has downfaulted the rocks in the north of the area. Show the fault movement directions on the cross sections using two half arrows, as in the key. On the map, draw a tick on the downthrow side of the fault, like this ▬ ┸ ▬

Then either cut out a new model or turn the version 1 model inside out and draw on/trace through the North arrow, scale and geology so you can use it to make version 2.

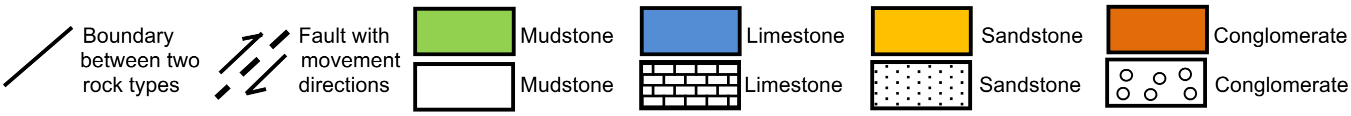
Plain, with faults, version 2. Add the following geology to the model and clip it together showing the 3D geology.

The fault is a reverse fault that dips south at 45°. Show the fault movement directions on the cross sections using two half arrows, as in the key. On the map, draw a tick on the downthrow side of the fault, like this ▬ ┸ ▬

Use the models to show how the same surface geology can be caused by two different types of faults.



Key for coloured and black and white versions of the model



The back up

Title: Geological mapwork from models 7: plain with faults parallel to the beds.

Subtitle: Draw and make your own 3D models of the geology of a flat region with faulted rocks.

Topic: Part of a series introducing simple geological mapwork – through 3D models. A table of the progression and spiralling of spatial thinking skills involved through the series is given on the final page.

Age range of pupils: 14 – 19 years

Time needed to complete activity: 40 mins

Pupil learning outcomes: Pupils can:
- add geological data to a 3D block model of a flat area;
- link up the data with geological boundaries;
- interpret these into a 3D picture of the geology;
- explain how different types of faults can have similar effects on outcrop patterns.

Context:
Pupils are shown a photograph of a plain and then cut out a 3D paper model of a flat plain-like area. They should use the cut-out to make the first version, then cut out another model, or turn the first model inside out, and trace the geology to make version 2.

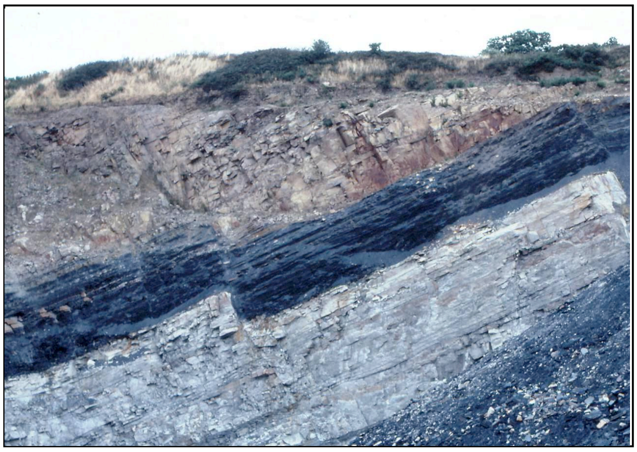
Plain with faults, version 1.
Pupils should realise that when dips are known (as for the fault) they can be drawn using a protractor, and that dipping beds appear horizontal for cross sections drawn at right angles to the dip direction (strike-sections). This makes completing the model fairly straightforward. Note that faults like this, which are parallel to the outcrop of the beds, are called strike faults.

Plain version, version 2.
This model is completed in a very similar way to version 1. Completion of the second model shows an important geological fact, that the same outcrop pattern can be produced by a normal fault and a reverse fault.

Following up the activity:
Provide the pupils with a blank print of the model (with no geology shown) as used in the Earthlearningidea, *'Geological mapwork from models 1: plain with simple geology'*, and ask them to use it to discover for themselves what happens when:
- a normal strike fault dips in the same direction as the dip of the beds; they could draw the same geology as in Versions 1/2 on the northern part of the area, then the fault, and work out what happens to the geology in the southern part of the area – this would be Version 3;
- a reverse strike fault dips in the opposite direction to the dip of the bedding (eg. Version 4).

Then ask them to complete the four versions of the following sentence correctly:
When a *normal fault/ reverse fault* dips in the *same direction as/ opposite direction to* the bedding, *the beds are repeated/ the beds are cut out*.

The correct answers are:
- *Normal fault - opposite dip direction – bed repeated (from Version 1 – see photo);*
- *Reverse fault – same dip direction – repeated (from Version 2);*
- *Normal fault – same dip direction – beds cut out (Version 3);*
- *Reverse fault – opposite dip direction – beds cut out (from Version 4).*



A normal strike fault dipping in the opposite direction to the dip of the bedding – showing how beds can be repeated. A Carboniferous coal seam in an opencast coal mine, Skelmersdale, Lancashire, UK.

Photo: Peter Kennett.

Underlying principles:
- The three dimensional geological structure of an area can be plotted on block diagrams.
- The surface of a 3D block diagram with a flat surface is a geological map, whilst the sides are geological cross sections.
- Normal and reverse strike faults can have similar effects on outcrop patterns.
- Depending on how strike faults are orientated to the bedding, beds are either repeated or cut out.

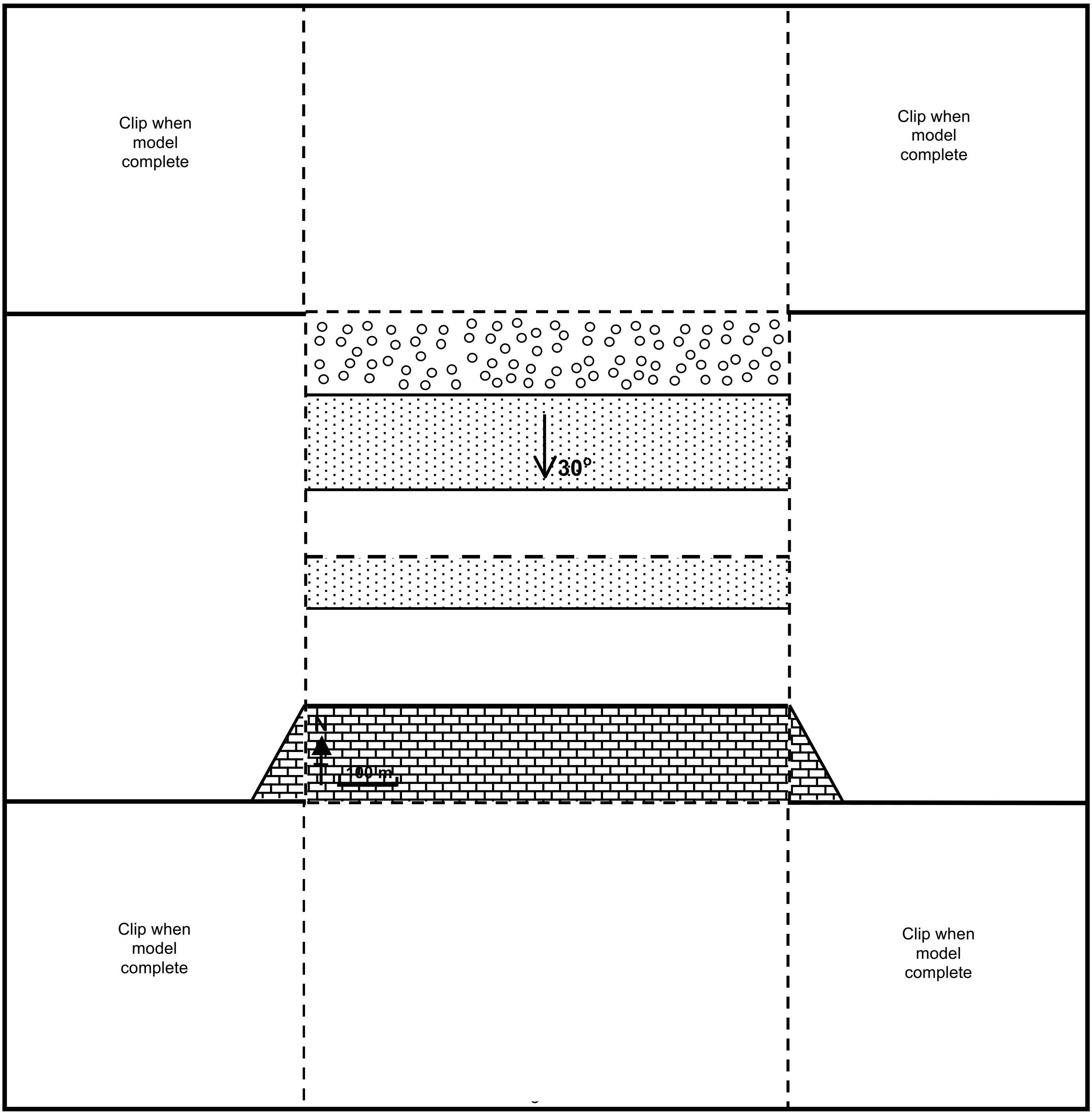
Thinking skill development:
The drawing of geology onto three dimensional models involves spatial thinking skills. The more complex the geology becomes, the more spatial interpretation is needed, including interpolation and extrapolation skills.

Resource list:

- one or two print-offs of the page containing the block diagram cut-out, per pupil
- For follow-up, print out of *'Geological mapwork from models 1'*
- scissors (or place a ruler flat along the edge to be cut, and tear the paper along the ruler)
- paper clips, four per model
- drawing materials, including pencil, eraser, ruler, protractor and pencil crayons

Source: Devised by Chris King of the Earthlearningidea team, based on exercises published in '*Geology Teaching'* the journal of the Association of Teachers of Geology in 1980 (Volume 5, No. 1, pages 15 – 19).

A 3D cut out model of an area of flat ground (scale 1 cm = 100m) (a black and white version for non-colour printers)



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.