

## Geological mapwork from models 6: plain with faults in the direction of dip

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

A flat region/plain looks like this from the air:



The Kelly Plains,  
New South  
Wales, Australia.

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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 faulted rocks, version 1:** Add the following geology to the model using the shading or colours on the key on the next page. Then paper-clip it together to show the 3D geology.

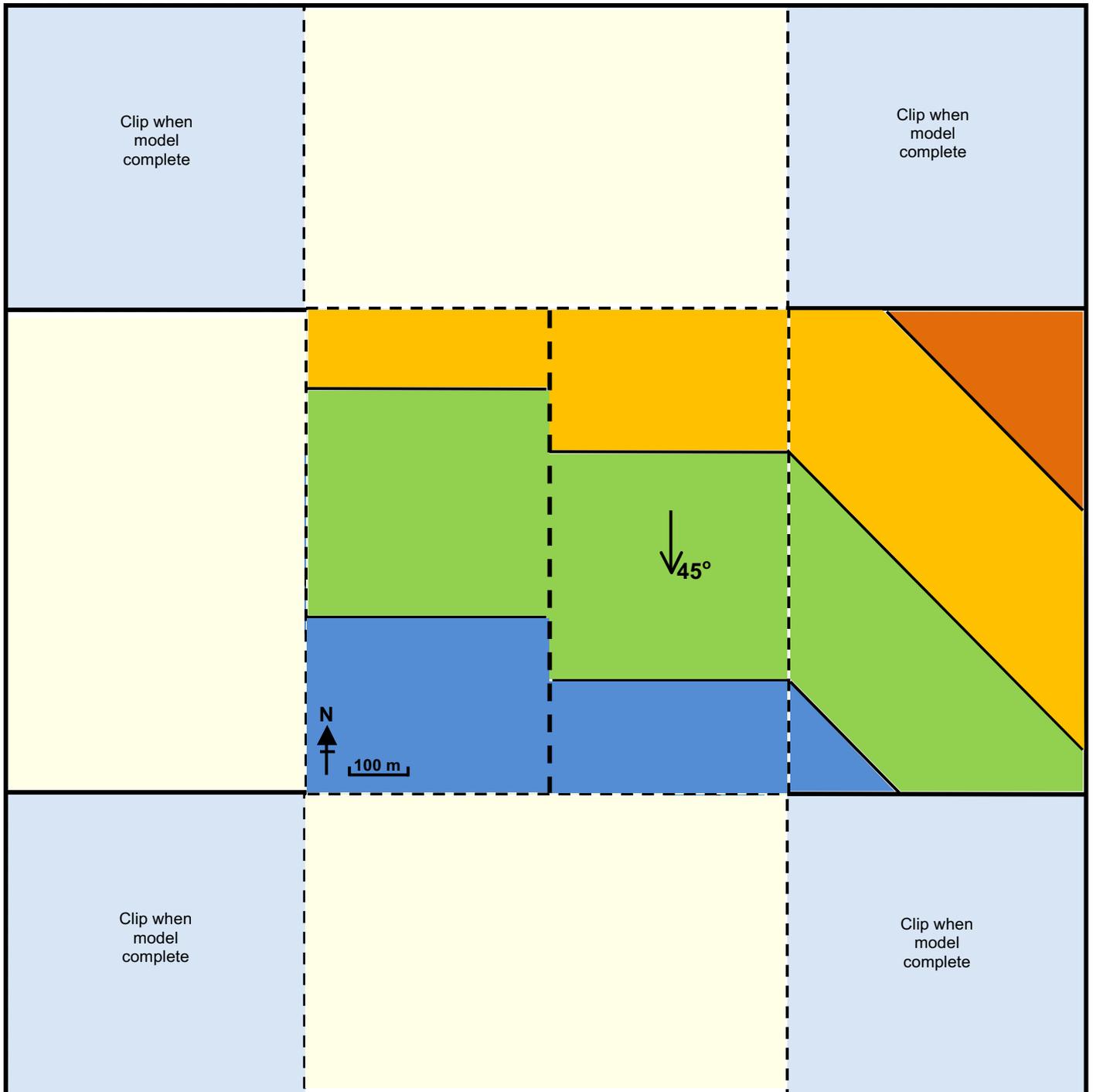
The fault is a normal fault that dips at 70° towards the west. It has downfaulted the rocks in the west of the area. Show the fault movement directions on the cross sections using two half arrows, as in the key. On the map, draw a tick on the downthrow side of the fault, like this 

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.

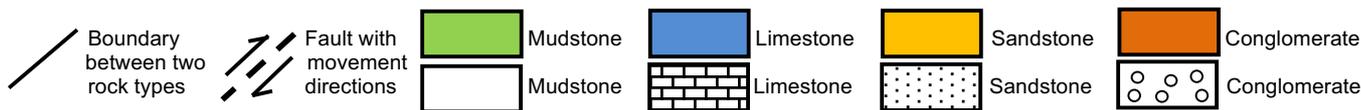
**Plain, with faulted rocks, version 2.** Add the geology to the model and clip it together showing the 3D geology.

The fault is a vertical tear fault. Show the fault movement directions using two half arrows, as shown in the key.

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 6: plain with faults in the direction of dip.

**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 or different effects on outcrop patterns.

**Context:**

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

**Plain with faulted rocks, version 1.**

With the experience from previous Earthlearningidea models, 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. Faults like this, which are parallel to the dip of the beds, are called dip faults.

**Plain with faulted rocks, version 2.**

Completion of this model is even more straightforward, since the fault is vertical and all other lines are drawn in the same places.

However, completion of the second model shows an important geological fact, that the same outcrop pattern can be produced by a normal fault as by a tear fault.

**Following up the activity:**

Ask the pupils to add a 50m wide vertical east-west trending dyke through the centre of the eastern half of the area. Then ask them to work out what effect the fault will have on the dyke and plot it in the western part of the area. They should see that:

- vertical dykes are not displaced by normal faults, but ..
- they are displaced by strike-slip faults – by the amount of displacement of the fault.

In this case, different dyke outcrop patterns are caused by the two different types of fault.

For each of the models, ask the pupils to construct a geological cross section diagonally across the block.

**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 tear faults can have similar effects on outcrop patterns of dipping rocks, but different effects on vertical features like dykes.

**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
- 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

**Useful links:**

Higher level mapwork exercises with online tutorials are available for free download from the Open University: [http://podcast.open.ac.uk/oulearn/science/podcast-s260\\_mapwork#](http://podcast.open.ac.uk/oulearn/science/podcast-s260_mapwork#)

**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).

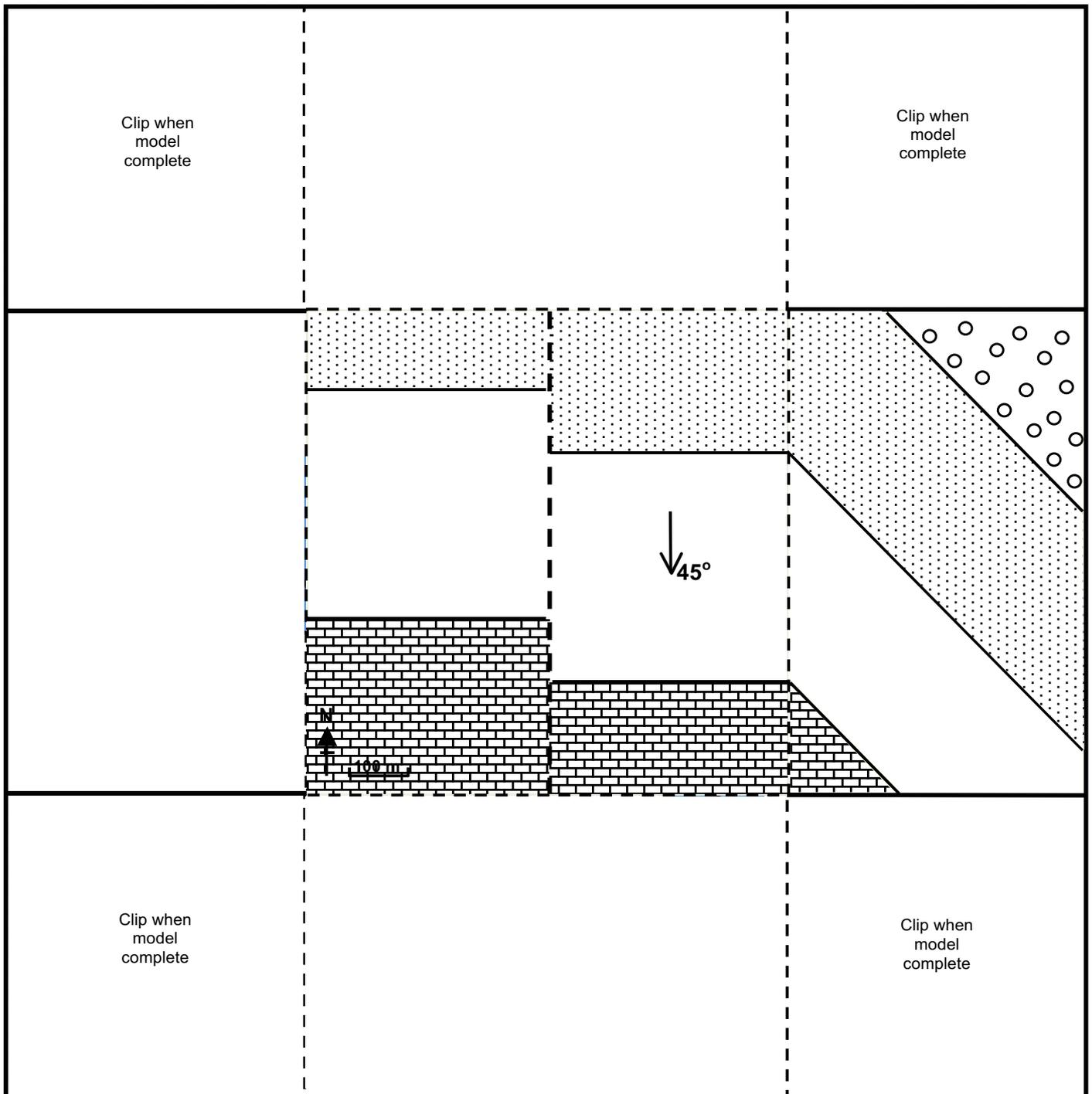
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A 3D cut out model of an area of flat ground (scale 1 cm = 100m) (a black and white version for non-colour printers)



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  | <ul style="list-style-type: none"> <li>Plot and draw simple topographic cross sections</li> <li>Add geological boundary intersections and join with straight, horizontal lines</li> </ul>   |
| Mapwork from scratch 2: valley with simple geology  |   | Sloping valley                  | Flat and horizontal  | <ul style="list-style-type: none"> <li>Plot and draw simple topographic cross sections</li> <li>Add geological boundary intersections and join with straight, horizontal lines</li> <li>Sketch geology onto a 3D block diagram</li> </ul>   |
| Mapwork from scratch 3: valley with dipping geology   |   | Sloping valley                  | Dipping surfaces   | <ul style="list-style-type: none"> <li>Draw true dip on a cross section using a protractor</li> <li>Add geological boundary intersections and join with straight lines</li> <li>Appreciate that apparent dip is always less than true dip</li> <li>Appreciate that, in valleys, geological boundaries usually 'V' in the direction of dip.</li> <li>Sketch geology onto a 3D block diagram</li> <li>Begin to compile a list of mapwork rules</li> </ul>   |
| Mapwork from models 1   | Plain version 1                           | Flat                            | Flat and horizontal  | <ul style="list-style-type: none"> <li>Add geological boundary data to cross sections and join with straight, horizontal lines</li> </ul>   |
|   | Plain version 2                           | Flat                            | Dipping surfaces; vertical feature   | <ul style="list-style-type: none"> <li>Add geological boundary data to cross sections and join with straight lines</li> <li>Use boundaries on the cross sections which intersect the topographic surface to draw a boundary on the surface</li> <li>Add a vertical feature (dyke)</li> </ul>  |
| Mapwork from models 2   | Cuesta version 1                          | Asymmetrical ridge              | Flat and horizontal  | <ul style="list-style-type: none"> <li>Add geological boundary data to cross sections to construct straight, horizontal lines</li> </ul>  |
|   | Cuesta version 2                          | Asymmetrical ridge              | Dipping surfaces; vertical feature   | <ul style="list-style-type: none"> <li>Draw true dip on a cross section using a protractor</li> <li>Add parallel geological boundaries</li> <li>Add a vertical feature (fault) that moves a geological boundary</li> <li>Appreciate the link between tough and weak geological formations and topography</li> </ul>   |
| Mapwork from models 3: valley with horizontal floor   |   | Valley with horizontal floor    | Dipping surfaces; vertical feature   | <ul style="list-style-type: none"> <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 topographic surface to 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 direction of dip</li> <li>Appreciate that apparent thickness is always greater than true thickness</li> <li>Add a vertical feature (dyke)</li> </ul> |
| Mapwork from models 4   | Ridge/valley with sloping floor version 1 | Ridge/valley with sloping floor | Dipping surfaces   | <ul style="list-style-type: none"> <li>Add geological boundary data to cross sections to construct straight lines</li> <li>Add parallel geological boundaries</li> <li>Appreciate the link between tough and weak geological formations and topography</li> <li>Interpolate approximate true dip from apparent dip</li> </ul>   |
|   | Ridge/valley with sloping floor version 2 | Ridge/valley with sloping floor | Dipping surfaces   | <ul style="list-style-type: none"> <li>Draw true dip on a cross section using a protractor</li> <li>Add parallel geological boundaries to cross sections</li> <li>Use boundaries on the cross sections which intersect the topographic surface to 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 direction of dip and the opposite is true of ridges</li> </ul>   |
| 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  | <p>The strategies and skills described in the box above and, in addition:</p> <ul style="list-style-type: none"> <li>Identify folds with equally dipping limbs, and those with limbs dipping at different angles</li> <li>Appreciate inverted topography</li> <li>Draw fold axes and fold axial planes</li> <li>Draw an unconformity and a pluton with a metamorphic aureole</li> </ul>   |
| Mapwork from models 6: plain with faulted rocks 1   |   | Flat                            | Normal and tear dip faults; dipping bedding  | <ul style="list-style-type: none"> <li>Draw the effects of a normal and a tear dip fault on cross sections</li> <li>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)</li> </ul>  |
| Mapwork from models 7: plain with faulted rocks 2   |   | Flat                            | Normal and reverse strike faults; dipping bedding                                    | <ul style="list-style-type: none"> <li>Draw the effects of normal and reverse strike faults on cross sections</li> <li>Use these to explain how different types of fault can have similar effects on outcrop patterns</li> </ul>  |
| Mapwork from models 8: plain with faulted rocks 3   |   | Flat                            | Normal, reverse, thrust and strike-slip faults at 45° to the strike; dipping bedding | <ul style="list-style-type: none"> <li>Draw the effects of different sorts of faults on cross sections</li> <li>Use this to explain how different types of fault can have similar effects on outcrop patterns</li> </ul>  |
| DIY dip and strike model  |   | Dipping surface                 | Dipping bed  | <ul style="list-style-type: none"> <li>Measuring dip, strike and apparent dip on a model dipping surface, using a DIY clinometer if no other clinometer is available</li> </ul>   |
| Geological mapwork: Surface geology and the geological map  |   | Not given, assumed fairly flat  | Relatively complex   | <ul style="list-style-type: none"> <li>Match surface geological features to places on a geological map where they might be found.</li> </ul>  |