Geological mapwork from models 8: plain with different types of fault

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

A flat region or plain looks like this:

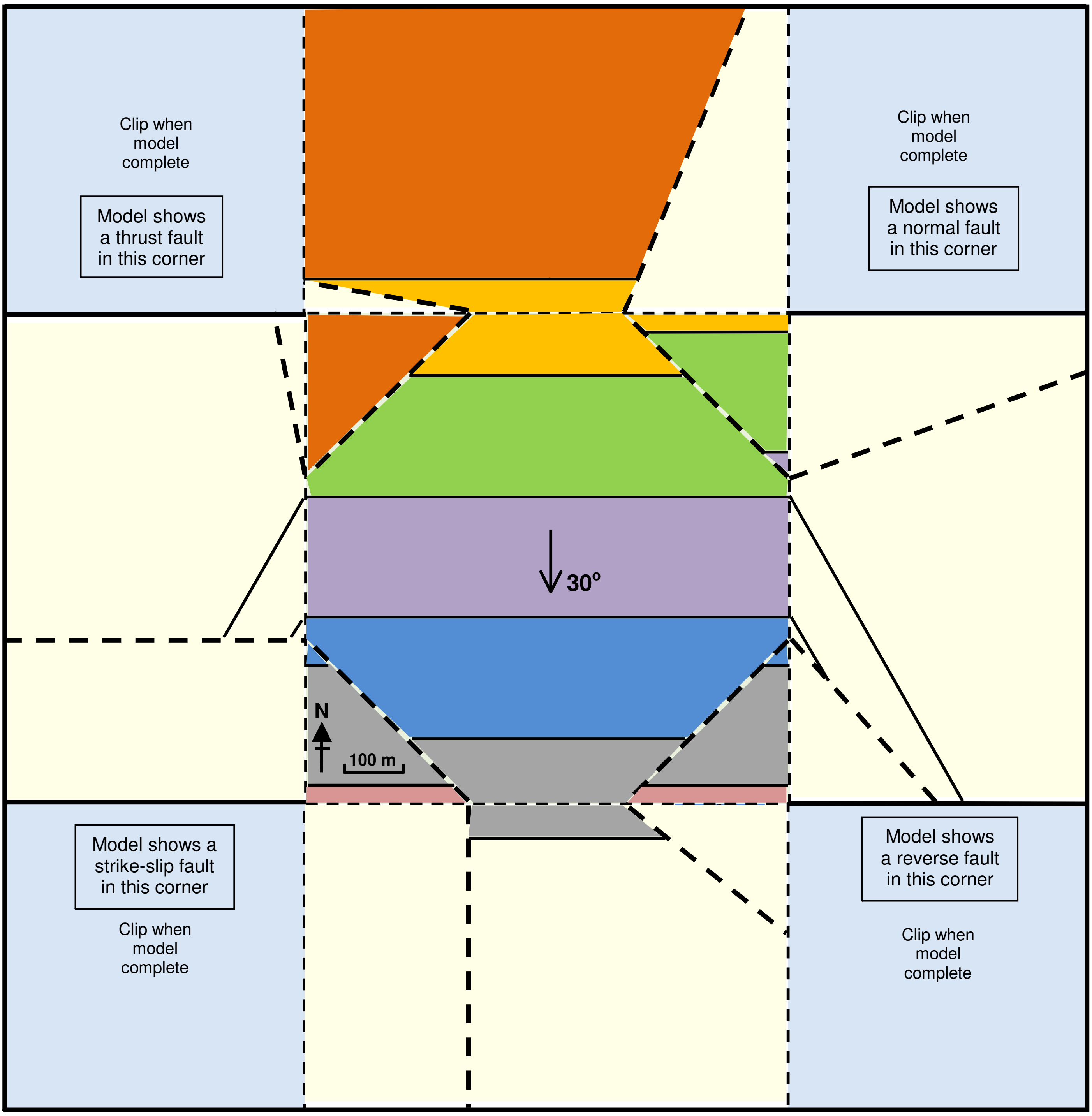
A flat plain with distant mountains, the Hoanib Plain, Namibia.

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.

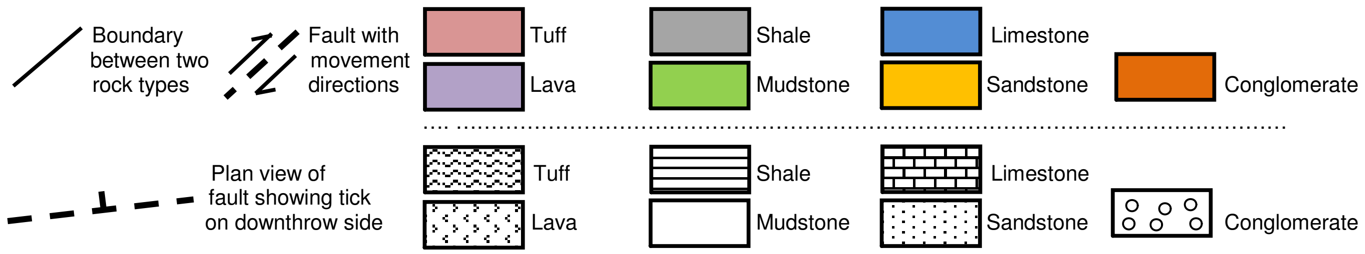
The model shows the four main types of faults and how these affect the geology of a flat area with a sequence of dipping rocks.

- Complete the model by drawing/ colouring/ shading in the missing parts of the sides.
- Add the correct symbols to the faults (from the key) to show the directions of movement.
- Use the model to write these sentences correctly, writing one sentence for each fault: *Normal/ reverse/ thrust/ strike-slip faults typically dip at around 45°/ are vertical/ dip steeply at 65-85°/ dip at 10° or less.*

3D cut out model of an area of flat ground (scale 1 cm = 100m).



Key for coloured and black and white versions of the model



The back up

Title: Geological mapwork from models 8: plain with different types of fault.

Subtitle: Draw and make your own 3D model 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 are asked to cut out a 3D paper model of a flat plain-like area. They should then complete the model and use it to write the sentences about faulting correctly.

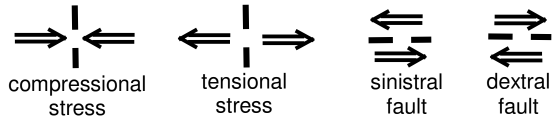
The model shows how different sorts of faults can affect outcrop patterns; in particular:
- that different sorts of faults can have similar effects on outcrop patterns; here the strike-slip fault and the reverse fault have the same effects;
- that the movement on thrust faults is likely to be greater than the movement on other sorts of faults.

Note that strike-slip faults can also be called wrench, tear or transcurrent faults.

The correct sentences are:
- *Normal faults typically dip steeply at 65-85°.*
- *Reverse faults typically dip at around 45°.*
- *Thrust faults typically dip at 10° or less.*
- *Strike-slip faults typically are vertical.*

However, normal faults can be shallower and reverse faults can have a variety of angles; whilst some faults can first move in one direction and then be ‘reactivated’ to move in another.

Following up the activity:
Pupils could be asked to draw on the top of the model the directions of maximum stress for each of the faults, using these symbols:



On the model, final movement of the normal fault was caused by tension, the reverse and thrust faults by compression and the strike-slip fault by dextral shear stress (dextral because, looking across the fault, the rocks on the other side have been moved to the right).

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.
- Different types of faults can have similar effects on outcrop patterns.

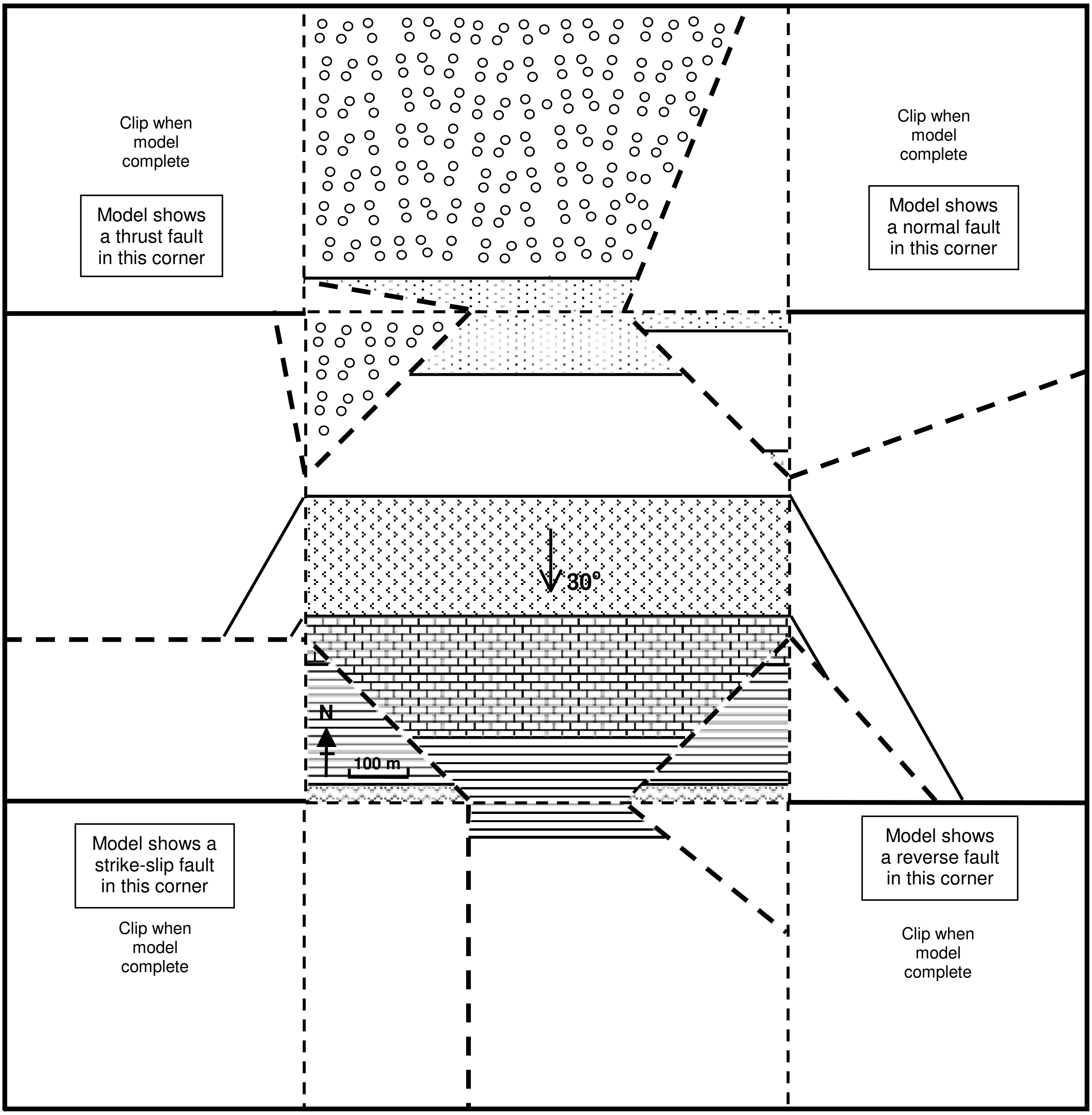
Thinking skill development:
The drawing of geology onto three dimensional models involves spatial thinking skills. The more complex the geology becomes, the more spatial interpretation is needed, including interpolation and extrapolation skills.

Resource list:
- a print out of the block diagram cut-out, per pupil
- scissors (if these are not available, 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#

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° 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.