The do-it-yourself dip and strike model (with DIY clinometer)
Using a model to measure and understand dip, dip direction, strike and apparent dip

Bedded rocks are often exposed in the field like this:

A bedding plane in the Hoy Sandstone, Witter Quarry, Orkney, Scotland.

Photo: Peter Kennett.

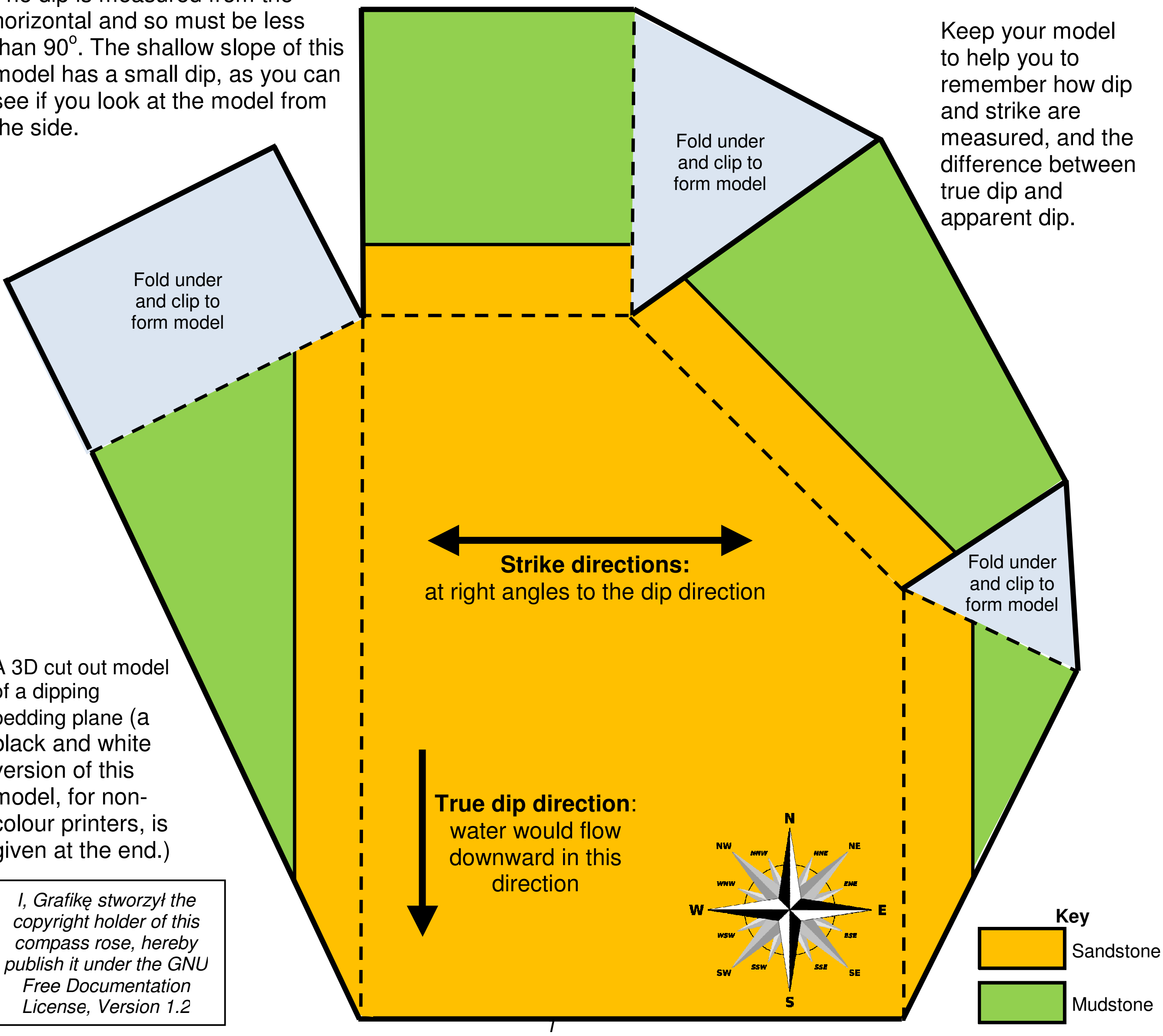
Since these rocks are dipping (sloping downwards towards the right) – a geologist would measure the angle of dip and either the dip direction or the strike directions.

Cut out the model of a dipping bed along all the solid lines, fold it along the dashed lines (with the dashes on the outside) and use paper clips to clip it together into a 3D model.

Then measure the model and record the results, like this:

- Use a clinometer to measure the amount of dip of the top surface of the sandstone bed by lining the clinometer up with the 'True dip direction' arrow on the model and reading off the angle. The dip is measured from the horizontal and so must be less than 90°. The shallow slope of this model has a small dip, as you can see if you look at the model from the side.
- If you have no clinometer, make your own 'DIY clinometer' from the instructions on the next page.
- Use the compass rose on the model to work out the true dip direction of the sandstone bedding plane.
- Use the compass rose to work out the strike directions; strike is at right angles (90°) to the dip direction and always has two directions (such as North-South or ESE-WNW) and can be measured as compass directions or bearings (like 000° – 180° or 045° – 225°)
- Use the model to:
  - work out the angle of dip in the strike directions (these apparent dips are seen on the cross section forming the north face of the model);
  - measure the apparent dip towards the south east (as seen on the cross section forming the north east face of the model) – the apparent dip is the dip measured in any direction apart from the true dip direction;
  - measure the apparent dip towards the west south west (WSW);
  - use your measurements to complete this sentence: 'Every sloping surface has one true dip but many apparent dips; apparent dips are always *less than/ more than* true dip.'

Keep your model to help you to remember how dip and strike are measured, and the difference between true dip and apparent dip.



A 3D cut out model of a dipping bedding plane (a black and white version of this model, for non-colour printers, is given at the end.)

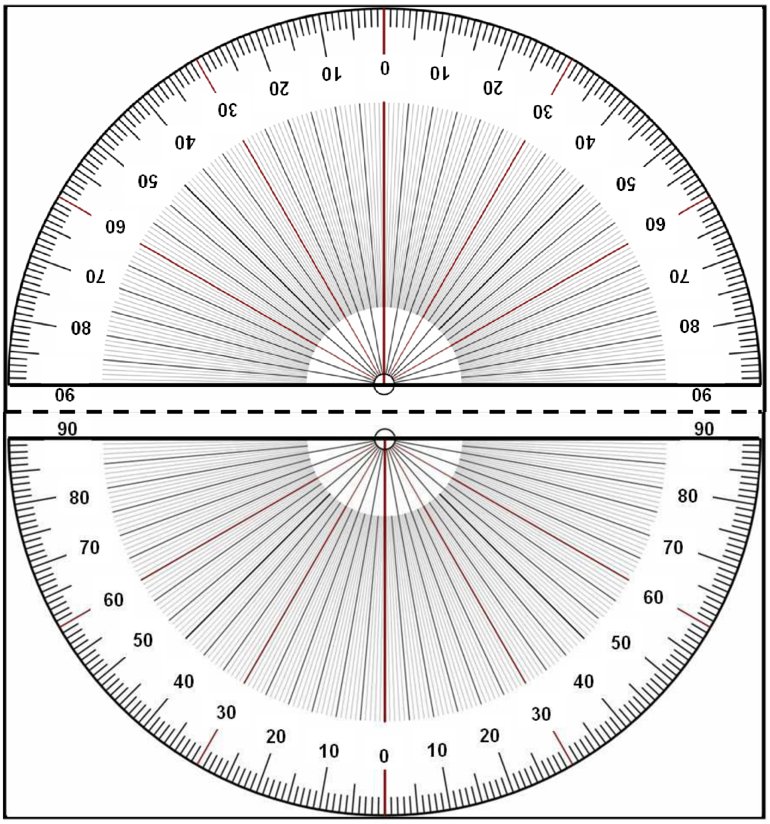
A Do-It-Yourself clinometer

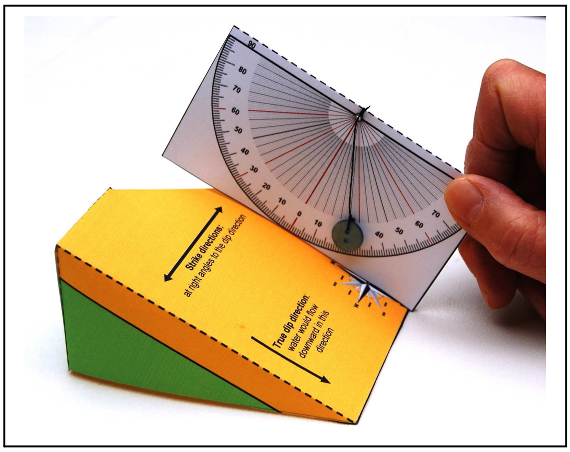
Make your own DIY clinometer by:

- cutting out the square clinometer diagram below;
- folding it along the dashed line and sticking the two halves together;
- making a small hole in the centre of the circle in the middle top (using a pin or needle);
- tying a piece of thread through the hole;
- tying a small button to the other end of the thread so it swings just above the bottom of the clinometer.

Use the clinometer by:

- putting the base of the clinometer on to the sloping surface;
- reading off the angle of dip from the position where the thread is hanging, as shown.





The clinometer and bedding plane model in use.

Photo: Chris King; fingers, Phoebe King!

The back up

Title: The do-it-yourself dip and strike model (with DIY clinometer).

Subtitle: Using a model to measure and understand dip, dip direction, strike and apparent dip.

Topic: Making and using a model that explains dip, strike and apparent dip, and gives exercises on these measurements.

Age range of pupils: 14 – 19 years

Time needed to complete activity: 20 mins

Pupil learning outcomes: Pupils can:

- use the model to describe amount of dip, dip direction, strike directions and apparent dip;
- make measurements of these variables on the model.

Context:

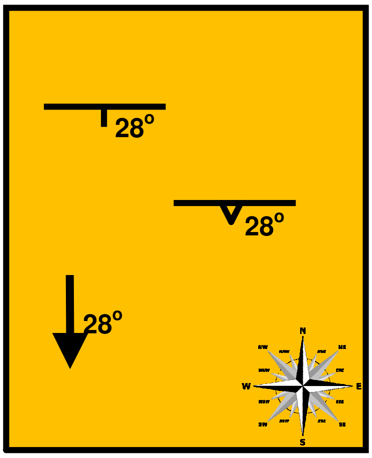
Pupils are asked to make a model that they can then keep, reminding them how dip and strike are measured and how apparent dips differ from true dip.

The measurements on the model are:

- the amount of dip (or 'the dip' or 'the true dip') is 28°;
- the true dip direction is south or 180°;
- the strike directions are east-west or 090°-270°;
- the angles of apparent dips of the strike directions are both 0° – the bedding plane appears horizontal;
- the angle of apparent dip towards the south east is 18° – the angle of dip of the bedding as seen on the north east face of the model;
- the angle of apparent dip towards the west south west is about 10°.

The correct sentence is: 'Every sloping surface has one true dip but many apparent dips; apparent dips are always *less than* true dip.'

When dips measured on a bedding surface like this are plotted on geological maps, they can be plotted in a number of ways, as shown below:



A geological map of the model (a bird's eye, plan view of the top surface) showing different methods used to plot dip amount and direction.

Following up the activity:

1. Pupils could be asked to measure apparent dips in other directions on the model.
2. A new copy of the compass rose could be stuck on top of the existing rose, with a different orientation, and pupils asked to measure the new dip direction and strike directions.
3. The back of the model could be placed on a block to give a steeper bedding plane, and the new dips measured.

Underlying principles:

- The true dip of a sloping surface is the maximum angle of dip.
- The direction of dip is the compass direction or bearing of the downward slope.
- The strike directions are at right angles to the dip direction.
- Apparent dips are any dips that are not parallel to the true dip, including dips of 0° along the strike.
- Geologists make these measurements on bedding planes and plot them on geological maps.

Thinking skill development:
This exercise requires 3D spatial thinking skills.

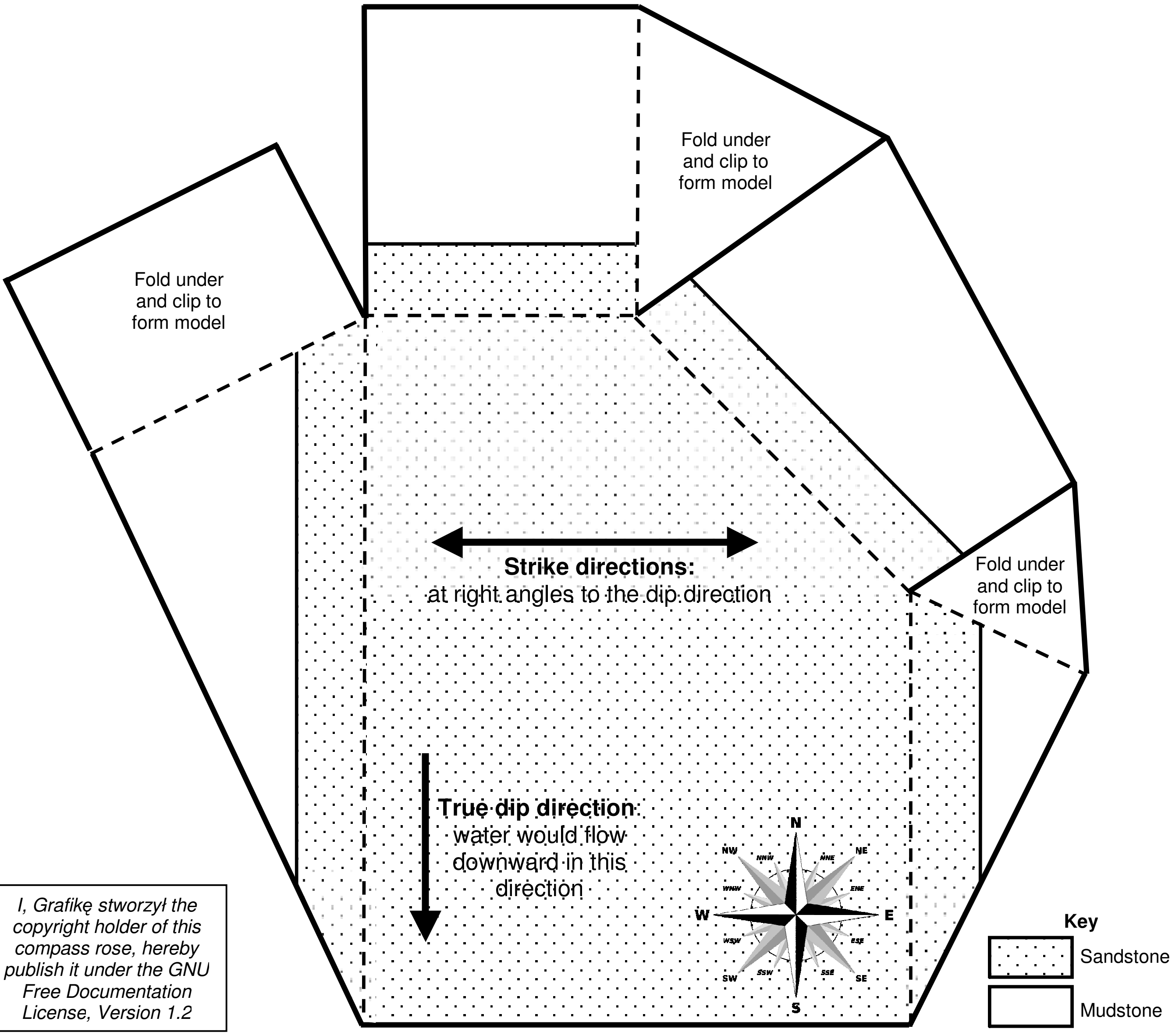
Resource list:

- a print-off of the page containing 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, three per model
- a clinometer (either bought commercially or the DIY version – requiring thread, a pin and a button)

Useful links:
See the Wikipedia definition of dip and strike, with diagrams, at: http://en.wikipedia.org/wiki/Strike_and_dip and a video of measuring dip and strike on a bedding plane in the field at: http://naturebytesvideo.com/bytes_G-J/geomap-strike-dip.html
If you have a smart phone, you can download a clinometer application (app).

Source: Chris King of the Earthlearningidea Team.

A 3D cut out model of a dipping bedding plane (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.