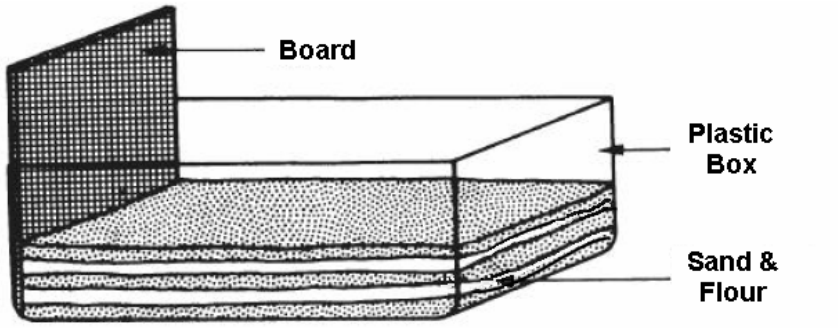
Deformation:
Making folds and faults.

The aim of this experiment is to find out how squashing (compressing) the Earth's crust can lead to faulting and folding of rock layers. Investigating these processes helps Earth scientists not only to understand how ancient continents moved and collided to build mountains in the past, but also to predict where earthquakes may be about to happen in areas where mountains are forming today.

You will need: a large beaker of dry sand, a plastic sieve or tea-strainer, a small beaker of flour, a transparent plastic box and a piece of wood that fits into the box.

You will also need: a plastic tray or plenty of newspaper to avoid covering the lab bench with sand and/or flour.

First you need to carefully build up a series of layers of sand and flour in the box as described below:



(i) Place the board at one end of the box as shown above.

(ii) Place the box in a plastic tray (or on newspaper) and, using the sieve, sprinkle a layer of sand, *as evenly as you can*, until it is about 8 to 10 mm thick.

(iii) Lift the plastic box and carefully put it out of the way so that all the spilt sand can be returned to its container.

(iii) Now place the box in the tray again and, using the sieve, sprinkle a *thin* layer of flour, about 1 or 2 mm thick. Again, make it as even as you can.

(iv) Do the same with the spilt flour as you did for the sand.

(v) Repeat steps (ii), (iii) and (iv) and then finish with a last layer of sand.
You should end up with a series of layers a bit like those in the diagram.
Draw what the layers look like from the side in **BOX *1*** below

(vi) Now, *keeping the board vertical*, gently move it about 2 to 3cm towards the other end of the plastic box – in other word, squashing up the layers to about 3/4 of their original length
Draw what the layers look like from the side in **BOX *2*** below.

1.

2.

Label clearly, on **BOX 2**, at least one FOLD and/or one FAULT.

Teacher/Technician Notes:

1. ***Background:***
   See web pages on Deformation, and Background notes in Teachers' Zone on Rock deformation experiments.

2. ***Apparatus & Materials:***
   The most readily available sources of suitable clear plastic boxes (ideally about 10 cm x 5 cm) are the drawers from spares cabinets (used for screws, electronic bits etc) available from any DIY shop as well as from lab suppliers. Ply/hardboard "paddles" for squashing up the sand/flour are easily made to fit. The experiment seems to work rather better if a fairly fine, even-grained sand is used, rather than a gritty sand (Builders' Merchants usually stock both sorts).

3. ***Preparation for experiment:***
   Some preparatory discussion is clearly required to introduce students to the experiment, and could be based around pictures of folds and faults such as those in the relevant web pages on this website. Most folds, and many faults, result from horizontal compression of the Earth's crust and are most clearly defined where these processes affect sedimentary rock layers; this experiment models such processes but on much smaller spatial and time scales. As always, the nature of the model itself (how close is it to the "real thing"?) is worth discussion with more able students.
   All students will probably need to be shown how to fill the sandbox successfully so as to make reasonably even horizontal layers; the technique requires a bit of practice beforehand on the teacher's part. Less able students may find the care and time needed exceeds their concentration span!
   An additional sandbox experiment (crustal stretching) is also suggested in the background notes for teachers, and could be demonstrated.

4. ***Additional questions:***
   Due to the space required for instructions, the worksheet only asks students to draw and label observations. Many more questions could be asked, including:
   "What type of fold(s) have you produced?" (answers - anticline, zig-zag [folds).
   "What type of faults?" (answer - reverse or thrust faults).
   How much 'crustal shortening' has taken place (fraction or percentage)?
   Labelled, explanatory close-up drawings of each structure could be produced.

   Finally, do let students observe effects of further compression by moving the paddle further forward, and/or relaxation of compressive stress by moving the "paddle" back to the start position (this may produced observable "normal faults" – the faults formed by tension).

5. ***Follow-up:***
   Deeper enquiry into the nature of geological structures goes well beyond KS3, although it is a fascinating subject. Leeds University has some interesting stuff – try *http://earth.leeds.ac.uk/learnstructure/index.htm* .