Squeezed out of shape
Detecting the distortion after rocks have been affected by Earth movements

Ask pupils if we can ever tell by how much a rock has been squeezed by Earth movements. One way is to look at fossils in deformed rocks. The original shapes of these are usually well known, so they can be used to work out the extent to which they have been deformed. If the fossils have been deformed, then so has the rock in which they are found.

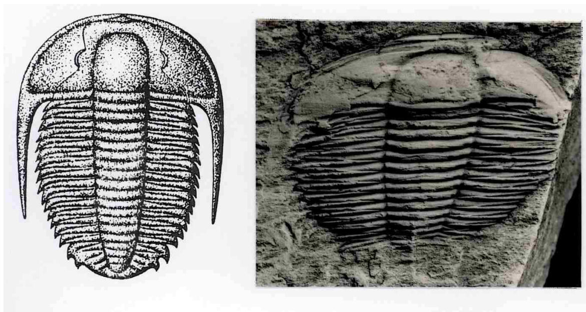
Give each small group of pupils a shell, e.g. from a snail or a bivalve seashell, and ask them to make a mould of it using clay. They should then take the shell out, and without showing anyone else, squeeze the mould, so as to distort the proper shape of the shell. The squeezing may come from the sides, from top to bottom, or by applying a shear force, at the pupils' discretion.

Mix up some Plaster of Paris in an expendable cup, to a thick but runny consistency. Go round the class, filling up their prepared moulds quickly, before the plaster sets, to make a plaster cast of their squeezed 'fossil'.

When the plaster has set, ask the members of each group to mark the base of their 'fossil' to identify it and to remove it from the mould. Each group should then swop its own cast for that of another group and should then try to say how the other group's 'fossil' has been distorted. Can they state the directions of the forces which were used to make the distortion? The makers of the 'fossil' can then tell the others if they were correct or not.

Caution: Take care that loose plaster powder does not get into people's eyes. When plaster sets, it generates heat – large quantities could cause burns, but the small amounts being used here are unlikely to cause any problem. Do not wash surplus plaster down sinks, as it might block them.

The materials needed for the activity and three 'fossils' produced by varying forces of distortion. (*Photo:: P. Kennett)*



A trilobite fossil before and after being squeezed in the Earth. In this case, the forces came from the top and bottom of the photograph. (*Photo: Dr M. Romano, Sheffield University)*

The back up

Title: Squeezed out of shape

Subtitle: Detecting the distortion after rocks have been affected by Earth movements

Topic: A carefully made mould of a shell is deliberately distorted before a plaster cast is made, producing an artificial 'fossil'. This represents the squeezing which often takes place when sedimentary rocks, with their included fossils, are affected by strong lateral pressures in the Earth, e.g. during mountain-building at active plate boundaries.

Age range of pupils: 12 – 18 years

Time needed to complete activity: 20 mins

Pupil learning outcomes: Pupils can:
- make an accurate mould of an object and then choose how to distort it;
- use the evidence in a distorted 'fossil' to determine the distortion;
- assess the relative amount of distortion, as well as the directions of the forces which created it;
- appreciate that the host rock will have been distorted by the same amount as the fossil contained within it.

Context: This activity could be used to extend a physics lesson on forces, or to encourage pupils to look for all available evidence in rocks regarding the history of the rock sequence. Pupils might also understand that a fossil can be either a cast or a mould of the original organism.

Following up the activity:

Slate showing colour banding from the bedding within the original mudstone. The slaty cleavage is parallel to the base of the specimen.
(*Photo*: *P. Kennett)*

Show the pupils a piece of slate with a colour band in it (or use the photo). Ask them if they can tell where the pressures came from that created the cleavage of the slate (the direction in which it can be split). Can they determine where the original bedding was in the layers of mudstone from which the slate was later formed? (*it was parallel to the colour banding).*

Underlying principles:

- Forces produce deformation of the rocks that they are acting upon, as well as any objects that the rocks may contain.
- Extreme pressures may produce a metamorphic rock and may destroy much evidence of its origins.
- Fossils are rare in metamorphic rocks, but when they are present, as in some slates, they can give valuable information about the geological history of the rock itself.
- Metamorphism by increased pressure may produce new 'platy' minerals in the rocks. These are aligned with their flat surfaces at right angles to the pressure. The rock cleaves more readily along the platy minerals than along the original bedding – this is how cleavage forms
- It is sometime possible to calculate the amount of the distortion of the rock mass from the proportions of the fossils in it, and thus reconstruct the true extent of the original rock mass.

Thinking skill development:
Making a mould of a shell establishes a pattern. Determining a distortion from another group's cast poses a challenge (cognitive conflict).
Applying the conclusions to real rocks is a bridging exercise.

Resource list:

- modelling clay, or moist clay from the ground
- some shells, or other objects of well-known proportions
- Plaster of Paris powder
- expendable cups and stirring sticks
- water to mix plaster

Useful links: Try the Earthlearningidea activity 'The Himalayas in 30 seconds, published on 28th January 2008, and 'Metamorphism – that's Greek for change of shape, isn't it?', published on 22nd September 2008.

See
http://www.eseu.org.uk/workshops/rock_cycle/metamorphism.htm for drawings of distorted fossils.

Source: Earth Science Teachers' Association (1990) *Science of the Earth 11-14: Hidden changes in the Earth.* Sheffield: Geo Supplies.