

## Activity 11: Properties of the Mantle – potty putty™

### Activity:

A demonstration of the elastic, plastic and brittle properties of Potty Putty™, showing that the behaviour depends on the scale and duration of the applied stress. Potty Putty™ therefore provides a useful analogy for the rocks in the mantle, which under short duration stress, act elastically, transmitting S-waves, but under longer stress duration, act plastically – flowing.

- Break up a lump of Potty Putty™ into small pieces (e.g. 1cm diameter) and distribute to group members.
- Invite members to roll the putty into a ball and gently bounce it on the bench (elastic deformation).
- Ask them to pull it out and let it droop under its own weight (plastic deformation)
- Ask them to roll it up again and try to snap with a short sharp pull (brittle deformation).
- Optional - demonstrate shattering of the putty when hit by a hammer (use a safety screen and collect all the shattered pieces. Do not allow the pieces to fall on carpet or clothing as it will flow into the material and can never be removed! Alternatively, put the Potty Putty™ into a transparent plastic bag before hitting).
- Ask them to roll it into a ball and leave it on the bench/desk for the rest of the lesson, the ball will collapse into a round blob – ask if this is demonstrating elastic, plastic or brittle behaviour (*plastic*) and what is causing the stress (*gravitational forces*).
- Gather up all the Potty Putty™ and return it to its container. Warn students not to put it into their pockets as it will flow into the material and be there for ever!

### Student learning outcomes:

Students will appreciate that, under different scales and durations of stress a solid material can behave:

- in an elastic way (and could therefore transmit earthquake waves);
- in a plastic/ductile way (and can therefore flow or creep) and
- in a brittle way (and can therefore fracture, which could create an earthquake).

### Curriculum for Excellence Sciences and Social Studies Experiences and Outcomes:

These are given in a grid on pages 64-71.

### Student practical or teacher demonstration:

Either.

### Time needed to complete the activity:

5 minutes.

### Preparation and set-up time:

2 minutes.

### Resources:

Potty Putty™ (or Silly Putty™) a silicone polymer available from toy shops, or your own version, made from PVA glue and borax using the recipe shown below, that can be found on <http://www.esta-uk.net/jesei/index.htm>

### 'Recipe for making 'Potty putty'

#### Apparatus

- 20 cm<sup>3</sup> PVA glue (not a rubberized variety from DIY shops, a simple glue as often used in school art rooms).
- A few cubic centimetres of dilute sodium tetraborate solution (borax) (approximately 25 ml).
- A small beaker or other container in which to mix the potty putty.

#### Method

Add drops of the borax solution to the PVA glue in a small container and mix vigorously. When the polymer begins to crosslink (becomes less liquid and comes away from the sides of the container) it may be rolled between the hands to ensure complete mixing of the borax solution. If it remains sticky, then it has to be kneaded more vigorously. If it still remains sticky add a little more borax solution.

When left on the desk the potty putty will sink and spread.

However it will also bounce like a ball if enough borax is used.

It can be stretched far more than Plasticine™ if pulled gently, but can also be fractured if pulled suddenly.

#### Hints

The trick is to mix the borax solution into the PVA well, rather than to add lots of it. Adding too much will result in a hard material that will not stretch.

If the mixture remains sticky, more borax solution is required.

You are recommended to try this in advance so that you can see when the mix starts to 'go'.

Often the potty putty improves if left for 20 minutes on a surface.

It will dry out eventually so to keep a good sample, keep it in a sealed plastic bag.

A few drops of food colouring can be added to make the final product more interesting. However adding too much will dilute your mixture and make it more difficult to make into potty putty. Also handling the coloured potty putty will result in food colouring staining the hands. This will wash off eventually, but not very easily!

**Ideas for leading into the activity:**

Any discussion of the mantle:

- being able to transmit earthquake body waves (by elastic deformation);
- allowing movement of plates above (by plastic deformation);
- being the source of earthquakes, down to about 700km (by brittle deformation).

Seismic wave properties – P-waves (primary waves) can be transmitted through both solids and liquids, but S-waves (secondary waves) through solids alone.

**Ideas for following up the activity:**

Discussion of the rate of movement of plates: convection of the mantle is slow, but possible even though mantle is NOT liquid.

**Source of activity:**

Earth Science Education Unit, Keele University.



Bounce it (elastic deformation)  
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Bend it (plastic deformation)  
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Snap it (brittle deformation)  
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Shatter it (brittle deformation)  
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