DEEP EARTH EXPLORERS – EXPERIMENT INSTRUCTIONS

1 Silly-Putty

In this experiment we will make silly putty, and investigate its material properties.

You will need: Silly putty (PVA glue, contact lens solution (make sure it has boric acid and sodium borate listed in the ingredients), bicarbonate of soda, measuring jug, bowl, spoon, optional: food colouring & glitter), a tray, a stack of books, your hands

Notes: If you already have some silly putty, you can always skip straight to step 2!

Step 1: Make the silly putty.

1) Pour 6 floz (180ml) PVA glue into a bowl.
2) Mix ½ tsp (2.5ml) of bicarbonate of soda into the glue.
3) (Optionally) mix in any food colouring and glitter as desired.
4) Mix 1½ tbsp (22.5ml) of contact lens solution into the glue.
5) Stir together as the glue forms a putty.
6) Once it all comes together, knead it for a few minutes until it's smooth.

Step 2: Play with the silly putty.

This is hopefully fairly self-explanatory - have a go at squishing, throwing, pulling, moulding, and leaving the putty. While you're playing with the silly putty, have a think about its material properties.

How does it behave on different timescales (e.g. if you throw it against something, versus if you leave it alone for a few minutes)?

Is it a solid? What makes you come to that decision?

Once you've finished playing with it, prop one end of your tray up on a pile of books to make a slope, and put your silly putty in a blob at the top of the slope. Leave it there for at least hour.

Step 3: After ~1hr, come back to the silly putty on the slope.

How has the silly putty changed/moved since you left it?

When you've finished with your silly putty, and if you want to keep it, it should be stored in a plastic, airtight container (e.g. Ziplock bag, Tupperware).

Figure 1 - Newly made silly-putty slowly flowing out of a hand

Extensions/other things to try with the silly putty you now have:

Try adding some rod-shaped sprinkles to some silly putty. When the putty flows, what happens to them?

You can add up to 2tbsp water at step 3. Why not try making silly putties with different amounts of water added and racing them down the slope?

How does the angle of the slope affect how fast the silly putty flows to the bottom of it?

2 Convection

In this experiment we will visualise the convection in small clear container of water, heated in one corner and cooled in another, using two colours of food colouring.

You will need: Four glasses, Clear plastic container (e.g. tupperware), Water, Red and green food colouring, Tealight candle, Matches, Ice cubes

Notes: Food colouring should be liquid and water based. If you have the gel-type food colouring this can still work, you just have to dissolve ~5 drops of it in ~1tsp of water in a glass before using it.

Figure 2 - Set-up for steps 1-3 of the convection experiment

Instructions:

1) Light the tealight with the match. Place it in one of the glasses.
2) Place a second glass, upside-down, beside the glass with the candle in it.
3) Fill the box with water, and rest it on the two cups (figure 1). Ensure that there is space for air to get into the cup with the candle in it, otherwise it will go out.
4) Place ~5 ice cubes (fewer for larger ice cubes) in the box on the opposite side to the candle (figure 2).

Figure 3 - Relative position of ice and candle in the convection box for step 4

5) If you have a brightly coloured or 'busy' background it can be helpful to put something white behind the box so you can see the next steps better.
6) Pour ~1tsp of red food colouring into the side of the box with the candle beneath it (figure 3)
7) Pour ~1tsp of green food colouring into the side of the box with the ice in it (figure 3)

Figure 4 - A) (left) adding red food colouring, B) (right) adding the green food colouring

8) Wait and watch

What happened? Why did it happen? (hint: think about how temperature affects density)

Would this happen if the candle and ice weren't there?

Figure 5 - Expected patterns of colour seen in the convection box

3 Making hotspot tracks

In this experiment we will make our own Hawaiian hotspot tracks using tealights and paper. Because this experiment carries a high risk of fire, it should be done outdoors, or at least in a room with a sink.

You will need: A tealight candle, or other small candle, matches, hotspot track printout printed onto plain paper, bucket (or sink) with water in it

Safety warning: If you have long hair, tie it back. If at any point the paper sets on fire (with flames) put the sheet into the water. Always tell an adult before doing any experiment with fire.

Instructions: On the hotspot track printout is a map of the North of the present-day Pacific Ocean, showing Alaska, Russia, Japan, and Hawaii. On it is marked a dashed line, the Hawaiian ridge. The task is to reproduce how a series of volcanoes like this might have formed above a hotspot.

In the experiment the tealight represents the hot mantle plume, the paper represents the Pacific tectonic plate, and scorch-marks represent volcanoes.

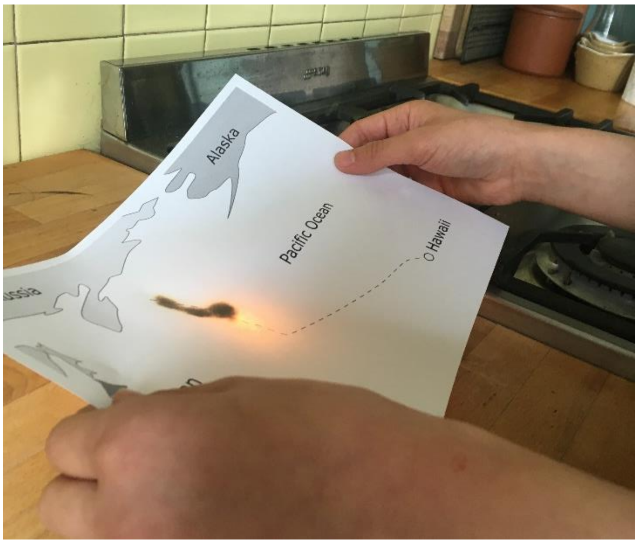

Figure 6 - Making a hotspot track with paper held over a tealight

1) Light the tealight with the match.
2) Place the sheet of paper ~2m above the flame, with the flame directly below the end of the dotted line near Russia.
3) Keeping the paper no closer than 2cm from the flame, slowly move the paper over the flame so that a line of scorch marks forms along the dotted line towards Hawaii. Make sure to keep the paper moving– if a patch begins to look black and smokes you need to move it along.

Figure 7 - A sage warning to not bring the paper to close to the flame/not leave it in place too long (a.k.a. Why You Need A Sink!)

Why did you get burnt spots rather than a continuous brown stripe? Do you think we get one long volcano, or lots of discrete ones?

Why might the Hawaiian hotspot track have a bend in it? (hint: did you keep moving the 'plate' in the same direction the whole time?)

4 Creep

In this experiment we will race 'solid materials' by flowing by 'creep'. This experiment can be done alone, against the clock, or with multiple people in two teams.

You will need: 30 books, DVD boxes, or similar (these objects should be 3D, stackable, and unable to roll), Floor space (outdoors is best), a finish line

Instructions:

1) Choose a finish line for the race.
2) Make piles of your objects ~1.5m away from the finish line. If you're playing by yourself, make one pile of 30 objects. If you've got several people, make two piles of 15 objects each.
3) If you're playing in a group, spilt yourself into two equal teams. Each team gets one of the piles.
4) Start the race. Move the objects in your pile according to the rules below, in order to get at least one object over the finish line.
5) First team to get an object over the finish line wins!

Rules for moving objects:

- Only one person in the team may move an object at any time.
- You may only move one object at a time
- Objects can only be moved a maximum of half their length in one go.
- Every object in the pile must remain connected to the pile, by touching other objects in the pile.

In this experiment, each object (book, DVD case etc.) represents a crystal in the mantle. Each time you move an individual object, it is like one crystal sliding past another, or dissolving and re-crystallising further on. These tiny movements added up to overall motion of the 'solid' towards the finish line, exactly like the mantle itself creeps.

Why have the objects ended up in a line? How does this compare to the shape the silly putty made when it flowed down the slope in experiment 1?