

## A “mantle plume” in a beaker

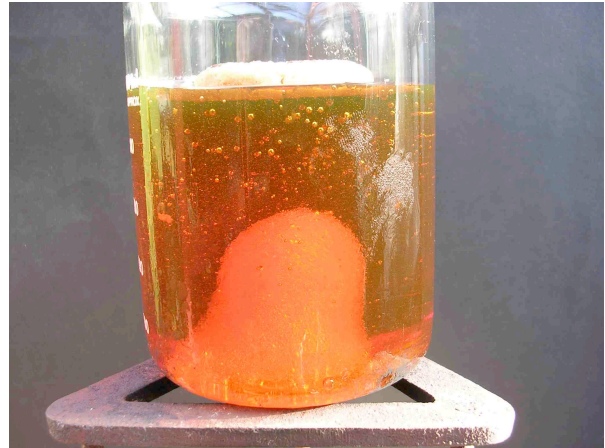
## Modelling processes at a constructive (divergent) plate margin

A plate tectonic constructive (divergent) margin is marked by a ridge with a rift valley running down the middle of it. It is also associated with shallow focus earthquakes, high heat flow and vulcanicity. Where a constructive plate margin occurs on land, the land masses on either side of it are moving apart at a rate which can be measured directly, as in Iceland (usually at a rate of a few centimetres per year).

Ask your students to try to visualise what might be happening out of sight, below the plate margin. Then explain that we are going to try to model some of the processes. Remind them that the mantle is essentially solid, but that we shall be using a viscous liquid, in order to speed things up to fit the time scale of the lesson!

Take a 600 ml beaker of Golden Syrup™ which has been placed in a freezer for about one hour, so that its viscosity has been considerably increased (ie. it is much less runny than at room temperature). Break a biscuit into two halves and place these together on top of the syrup. Place the beaker on a tripod (without a gauze) and heat over a Bunsen burner (cautiously, at first). Ask the students to predict what will happen as the syrup heats up, and then to watch carefully. They should be told to look at the side view, as well as observing the broken biscuit.

As the syrup warms, it becomes paler in colour and a “plume” of warm syrup begins to rise towards the surface. Gradually, the plume widens, reaches the surface, and then almost begins to convect down again at the edges, although the container is not large enough for this to happen to any great extent. At the same time, the biscuit halves begin to drift away from each other, which most students will readily associate with continents being moved apart.



A plume of hot syrup in a 600 ml beaker



Drifting continents!

An alternative approach is to set the scene as above but then to show a series of photographs or a video of the activity.

## The back up

**Title:** A “mantle plume” in a beaker

**Subtitle:** Modelling processes at a constructive (divergent) plate margin

**Topic:** Investigating what happens when a viscous material (Golden Syrup™) is heated and rises, with the resultant moving apart of floating objects (broken biscuit) above it. This can be related to a rising plume of hot material beneath a constructive plate margin.

**Age range of pupils:** 12 – 18 years

**Time needed to complete activity:** 15 minutes to run the actual activity or 5 minutes to watch and discuss the sequence of photographs.

**Pupil learning outcomes:** Pupils can:

- make predictions based on their previous experience of heating materials;

- explain how the vertical flow of a viscous medium can cause lateral movement of the floating objects above;
- describe how the model relates to reality.

**Context:** The activity can be used during the course of both science and geography lessons to illustrate the principles of constructive (divergent) plate margin activity.

### Following up the activity:

Carry out the activities in the related titles in the Earthlearningidea series, e.g. *Geobattleships – do earthquakes and volcanoes coincide?*; *Magnetic stripes – modelling the symmetrical magnetic patterns of the rocks of the sea floor*; *Partial melting – simple process, huge global impact*; *The continental jigsaw puzzle – can you reassemble a super-continent from a “jigsaw puzzle”?*; *A valley in 30 seconds – pulling rocks apart*.

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### Underlying principles:

- The mantle beneath constructive margins is a region of high heat flow.
- Raised temperatures and reduced pressures at constructive margins result in an increase in the volume of the rocks, partial melting, and the localised production of magma.
- As material cools, it moves outwards from the constructive margin. Plate movement in general takes place at a few centimetres per year and is driven by:
  - slow-moving convection cells in the solid mantle beneath constructive margins;
  - new plate material sliding off the higher oceanic ridges (sometimes called 'ridge-push');
  - the mass of the subducted plate at the destructive margins dragging the surface part of the plate along laterally (sometimes called 'slab-pull').

### Thinking skill development:

Relating the model to the real world is a bridging activity.

### Resource list:

- 600ml heat-proof glass beaker
- about 900g of Golden Syrup™ or similar syrup
- Bunsen burner with gas supply (**or** camping gas stove), tripod, heat proof mat, matches
- a biscuit

### OR

- photographs from this activity (see page 3), transferred to a computer, using slide show software e.g. Microsoft PowerPoint, OpenOffice Presentation or a video
- data projector

### Useful links:

The US Geological Survey has published a useful downloadable book about the plate tectonics on its website, called '*This dynamic Earth: the story of plate tectonics*' available at:

<http://pubs.usgs.gov/gip/dynamic/dynamic.html>

**Source:** First published as the '*Mantle convection moving plates: the golden syrup / hobnob teacher demonstration*' as part of the Joint Earth Science Education Initiative (JESEI) that has 40 other Earth science activities published on the JESEI website: <http://www.esta-uk.net/jesei/index.htm>

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See Page 3 for photographs of the activity



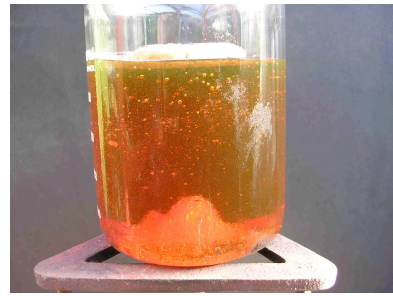
**Successive side views of the plume of hot syrup rising through the mass of colder syrup**



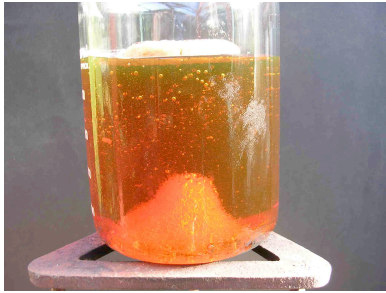
1. Before heating starts



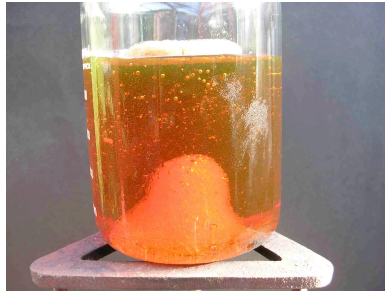
2. The plume begins to form



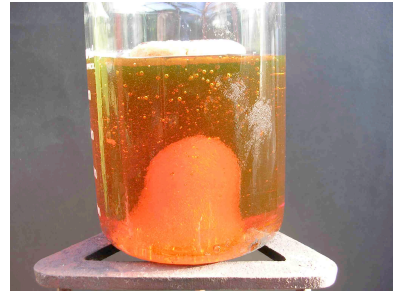
3.



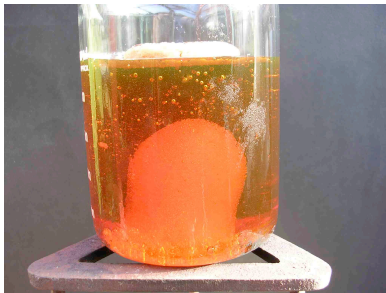
4.



5.



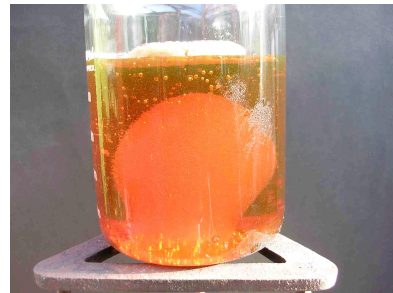
6.



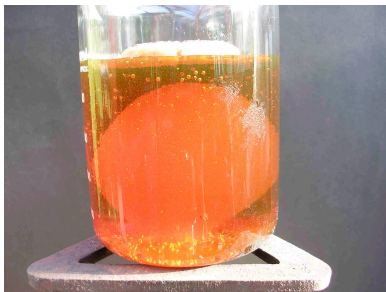
7.



8.



9.

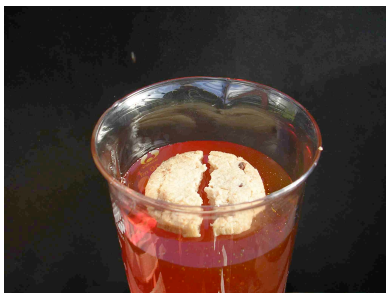


10.



11.

**The broken biscuit “continent” splitting above the rising plume and the two halves moving apart**



1.



2.



3.