What drives the plates? Modelling slab pull

Modelling and discussing the slab pull plate-driving mechanism in the classroom

Watch the video linked to this Earthlearningidea https://www.earthlearningidea.com/Video/V25_What_drives_plates_model.html of a Lego™ model built to show how the slab pull mechanism works. An image of the model is shown below.

Ask your pupils to point out or label on a photograph answers to the following:

- What part of the model represents an oceanic plate?
  A. The black layer.
- What does the mass represent as it drives the model?
  A. The pull of the descending plate at a subduction zone, caused because the descending plate is more dense than the surrounding mantle).
- What does the brown material that moves as the black layer moves, represent?
  A. The moving brown material represents the natural convection current patterns in the asthenosphere that are driven by the movement of the subducting plate.

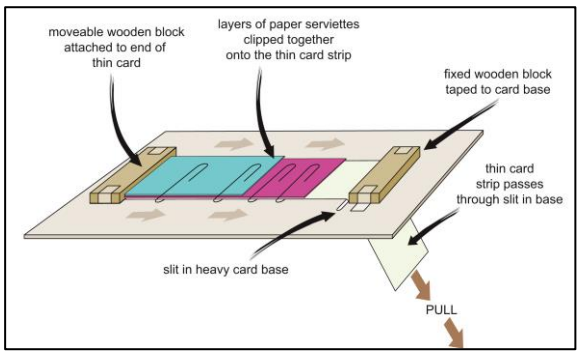
Your pupils will probably realise that the mantle drag or convection current theory for the plate-driving mechanism, saw these two features the other way around. In the 'mantle drag model' it is the movement of the brown material (convection current in the mantle) that drags the plate above along. There is no evidence to support this model. So, any currents in the mantle are likely to be caused or aided by plate movement, rather than the opposite.

- Why does the mantle naturally convect without subduction driving it?
  A. At divergent margins there are rising plumes of hot solid mantle, that cause currents in the whole mantle – but there is no evidence that these affect plate movement.

Then ask your pupils:

- What are the causes of the two different types of volcanic activity shown on the model.
  A. a) Volcanic activity at the divergent margin on the left hand side of the model is caused by a rising plume of solid mantle beneath. Here, as pressure is released by rising, the mantle can partially melt, generating basaltic magma which then rises to form new oceanic plate material and volcanic eruption;
  b) Volcanic activity on the right hand side of the model is caused because water from the subducting plate rises into the plate above, reducing the melting point of the rock and so allowing partial melting to produce intermediate or silicic magma (shown in red on the model); on rising this causes island arc or convergent margin mountain chain volcanic activity.
- How could the model be improved?
  A. They may suggest a) adding a blue 'ocean' above the plate and between the two volcanic areas; b) adding more labelling to the model; c) adding arrows to show plate movement or stress directions; d) labelling the dimensions of the model; e) making the left hand side of the plate near the divergent plate margin slightly higher, so that the ridge push mechanism can be discussed; f) putting another model as a mirror image on the other side, to show a full divergent margin; g) adding two more models, but offset, to show a transform fault (conservative margin) – or even more fanciful ideas.

If you are not able to show the video to pupils or if you want to further extend their thinking, show them the cardboard model used in the '*Continents in collision'* Earthlearningidea https://www.earthlearningidea.com/Video/V31_Convergent_margins.html below, and ask how this could be adapted to show the slab pull plate-driving mechanism.



They may respond by suggesting that a mass should be tied to the end of the 'subducting plate'

cardboard tab, in a similar way to the mass which drives the plate movement in the Logo™ model used above, as shown in the photograph opposite.

They could then discuss what each of the different parts of this model represent, in the same way as for the Lego™ model above.

(Photo: Chris King.)

The back up

Title: What drives the plates? Modelling slab pull.

Subtitle: Modelling and discussing the slab pull plate-driving mechanism in the classroom.

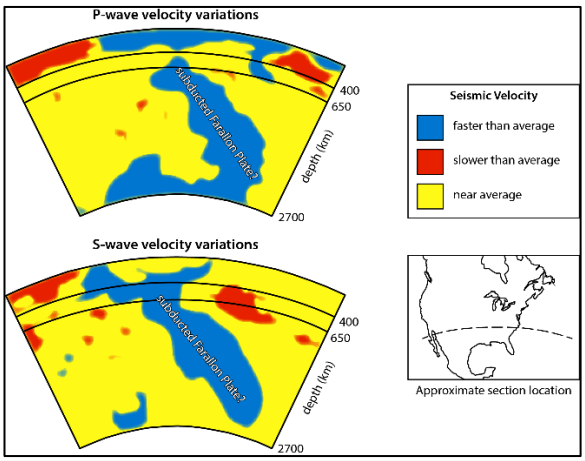
Topic: Different ways of modelling the slab pull plate-driving mechanism are used in classroom discussion.

Age range of pupils: 14 years upwards

Time needed to complete activity: 15 minutes

Pupil learning outcomes: Pupils can:
- describe different models showing slab pull;
- explain how the models work and how close to reality they are;
- describe ways of improving the models to reflect reality more effectively.

Context:
Seismic wave velocity measurements show that some subducting plates sink right down to near the mantle/core boundary, pulling the surface part of the plate behind them, as shown in this diagram:



Simplified and interpreted P- and S-wave velocity variations in the mantle across southern North America showing the subducted Farallon Plate.

See the video at:
https://www.earthlearningidea.com/Video/V25_What_drives_plates.html

This is the third of four Earthlearningidea activities focussed on the mechanisms driving plates. The others are shown in the table on page 3.

Following up the activity:
Try the fourth Earthlearningidea activity in the series, namely, '*What drives the plates? using a pupil model'.* (See table on page 3).

Underlying principles:
- The slab pull plate-driving mechanism works because plates, as they are moved away from divergent margins, become cooler and denser, eventually becoming more dense than the underlying mantle. At this point they sink into the mantle beneath and it is this sinking which pulls the plate along the surface behind them.

Thinking skill development:
Making links between the model and reality requires bridging skills. Thinking of ways to improve the model involves constructing the pattern of the process and then comparing that with the attributes of the model.

Resource list:
- the video of the Lego™ model in action https://www.earthlearningidea.com/Video/V25_What_drives_plates.html or the cardboard '*continents in collision'* model https://www.earthlearningidea.com/Video/V31_Convergent_margins.html or both

Useful links:
Access the other Earthlearningideas on plate tectonics at:
https://www.earthlearningidea.com/home/Teaching_strategies.html#platetectonics

Source: The Lego™ model and some of the questions were devised by Pete Loader; the activity was written up by Chris King of the Earthlearningidea Team.

The Earthlearningidea "What drives the plates" activities	
What drives the plates? The evidence. Examine the evidence for the different plate tectonic driving mechanisms.	https://www.earthlearningidea.com/PDF/347_What_drives_plates1.pdf
What drives the plates? In slab pull, what is it that pulls? Understanding how slab pull works through examining the data.	https://www.earthlearningidea.com/PDF/348_What_drives_plates2.pdf
What drives the plates? Modelling slab pull. Modelling and discussing the slab pull plate-driving mechanism in the classroom.	https://www.earthlearningidea.com/PDF/349_What_drives_plates3.pdf
What drives the plates? Using a pupil model to demonstrate that slab pull is the main plate-driving force.	https://www.earthlearningidea.com/PDF/217_Slab_pull.pdf