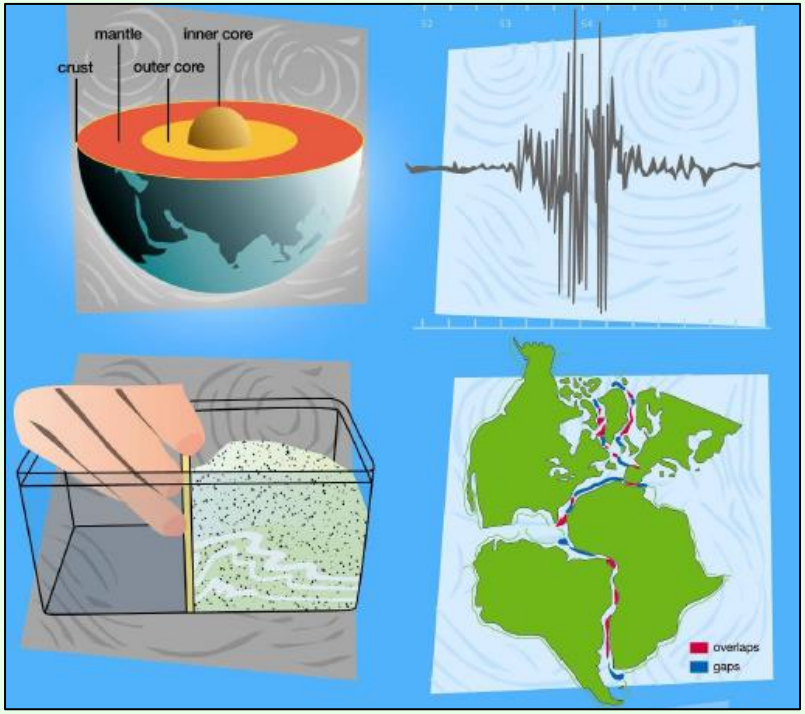
The Earth and plate tectonics – online

Part 1

Earth Science for science and geography – video workshop



Developed from the Earth Science Education Unit 'The Earth and plate tectonics' workshop, with permission

Earthlearningidea online video workshops

Purpose – ESEU background

- Most Earthlearningidea online video workshops are based, with permission, on workshops originally developed by the Earth Science Education Unit (ESEU)
- These were designed as interactive workshops for teachers and trainees, involving interaction, discussion and presentations by participants to others
- Global research into professional development workshops shows that these aspects are critical to success
- ESEU research shows that this workshop approach is highly successful in changing teaching in schools; evaluation feedback has also been very strong

Earthlearningidea online video workshops

Purpose – Earthlearningidea development

- The Earthlearningidea Team has developed the ESEU workshops into online video workshops for those unable to take part in face to face interactive workshops
- Each workshop is led by a PowerPoint presentation and has an accompanying booklet that contains all the activity background details, resource lists, risk assessments, etc.
- The individual workshop activities have been published for open access online at the website: https://www.earthlearningidea.com/
- Each workshop activity has a question script and a video keyed into CASE principles, that can be accessed through the PowerPoint hyperlinks
- The aim is to facilitate online Earth science learning

Earthlearningidea online video workshops

Teaching Earth science using the Cognitive Acceleration through Science (CASE) approach

- The activities in this workshop are keyed into the CASE approach – to develop thinking skills while teaching key Earth science material
- If you are unfamiliar with the case approach, you can access a video introduction at: https://www.earthlearningidea.com/Video/CASE.html
- An exemplar Earth science teaching activity with a question script using the CASE approach is at: https://www.earthlearningidea.com/Video/Atmosphere_ocean.html

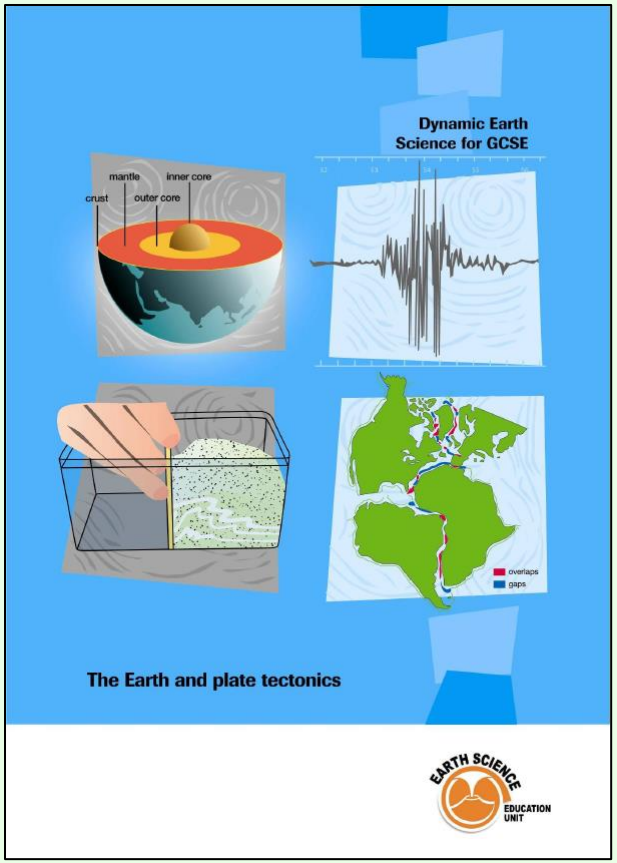
Earthlearningidea online video workshops

Running Earthlearningidea online video workshops

- Each workshop is led by a PowerPoint presentation
- Launch the PowerPoint
- Some slides contain hyperlinks to MP4 video files
- Run the hyperlinked files and then return to the PowerPoint, flick through any slides you have already seen, and continue
- The workshop is presented in this way so that the workshop itself, or individual videos, can be used in classroom teaching

The Earth and plate tectonics

Workshop video run times		m	s	m	s
The Earth and plate tectonics, part 1				**57**	**45**
From clay balls to the structure of the Earth				10	01
From, an orange to the whole Earth				2	30
Earthquakes – the slinky simulation				3	37
Wave motion – the pupil molecules				3	07
Big picture, ‘facts’ earthquakes and plates	Big picture and ‘facts’	2	56	6	47
	Earthquake volcano earthquake evidence	3	06		
	China plate summary	0	45		
Seismic evidence and potty putty mantle	Seismic evidence	3	18	8	43
	Solids that flow	4	19		
	Skateboard summary	1	06		
What drives the plates?				4	27
The wax magnetic field and magnetic Earth	Frozen magnetism	2	08	13	18
	Magnetic Earth	6	30		
	Sponge ball	4	40		
Heat flow, age of ocean floor and plate speed	Heat flow evidence	2	17	5	15
	Age of ocean floor	2	58		
The Earth and plate tectonics, part 2				**37**	**56**
Divergent margins	Divergent margins	2	03	4	32
	Faults in a Mars Bar	2	29		
Magnetic stripes				5	21
Convergent margins	Convergent margins	3	42	8	06
	Deformation	4	24		
Continental jigsaw puzzles				4	40
Brickquake				4	59
Party popper eruption				6	29
Plate plenary				3	49
The Earth and plate tectonics – both parts together				**95**	**41**



The Earth and plate tectonics

Earth science for geography and science

The workshop is based on this pdf booklet originally prepared by the Earth Science Education Unit and now available on the Earthlearningidea website. It contains a workshop summary, the outcomes, teacher guidance, risk assessments and resources lists – as in the following slides

The Earth and plate tectonics

Summary

‘The Earth and Plate Tectonics’ workshop gets to grips with the wide-ranging evidence for the theory that underpins our detailed modern understanding of our dynamic planet – the theory of **Plate Tectonics**. The workshop begins with an introduction and progresses through a series of activities that are designed to help students develop their understanding. It uses several independent sources of evidence supporting the theory, including using rock and fossil evidence, seismic records, geothermal patterns, geomagnetism, and large-scale topographical features, both above and below sea-level. The workshop concludes by investigating some of the Earth hazards linked to plate tectonics, and how we can reduce loss of life.

The Earth and plate tectonics

Workshop outcomes

The workshop and its activities provide the following outcomes:

- an introduction to plate tectonics;
- distinction between the ‘facts’ of plate tectonics and the evidence used to support plate tectonic theory;
- a survey of some of the evidence supporting plate tectonic theory;
- an introduction to the evidence for the structure of the Earth and the links between the structure of the outer Earth and plate tectonics;
- explanation of some of the hazards caused by plate tectonic processes - earthquakes and eruptions;
- methods of teaching the abstract concepts of plate tectonics, using a wide range of teaching approaches, including practical and electronic simulations;
- approaches to activities designed to develop the thinking and investigational skills of students;
- an integrated overview of the plate tectonic concepts.

The Earth and plate tectonics

Think through the processes using this wide range of activities:
Note: practical activities needing apparatus/materials are shown with a *

The Earth and plate tectonics, part 1

- The big picture and the ‘facts’ of plate tectonics
- Earthquake and volcano distribution evidence*
- China plate summary*
- From clay balls to the structure of the Earth*
- From an orange to the whole Earth*
- Earthquakes – the slinky simulation*
- Wave motion – pupil molecules
- The seismic evidence
- Solids that flow*
- Skateboard summary
- What drives the plates?
- Frozen magnetism*
- Magnetic Earth*
- Magnetic Earth using a sponge ball globe*
- The heat flow evidence
- The age of ocean floor and plate speed

The Earth and plate tectonics, part 2

- Divergent plate margins
- Faults in a Mars™ Bar*
- Magnetic stripes*
- Convergent margins*
- Continental jigsaw puzzles*
- Brickquake*
- Party popper eruption*
- Plate plenary

Investigating Earth's structure

Carry out risk assessments before the following activities:

Wave motion – pupil molecules
Magnetic Earth
Magnetic Earth using a sponge ball globe
Magnetic stripes
'Brickquake' – can earthquakes be predicted?
How predictable are volcanic eruptions? - party popper simulation

Teaching Earthlearningideas

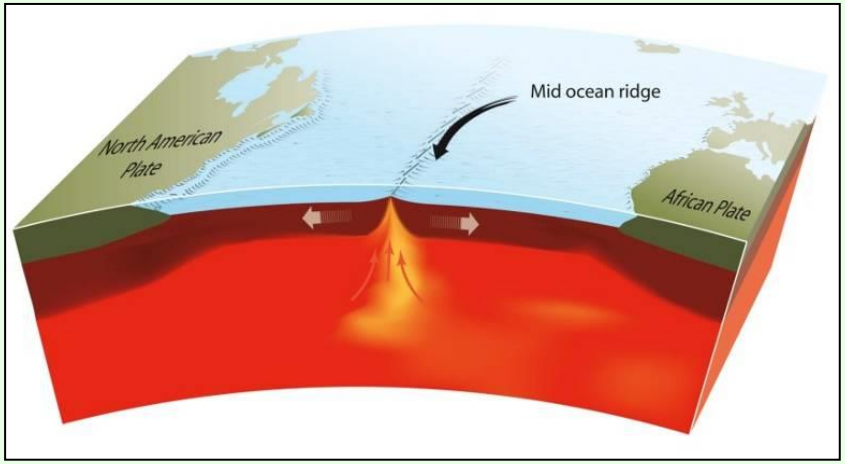
The plate tectonic story

- **The big picture and the ‘facts’ of plate tectonics**

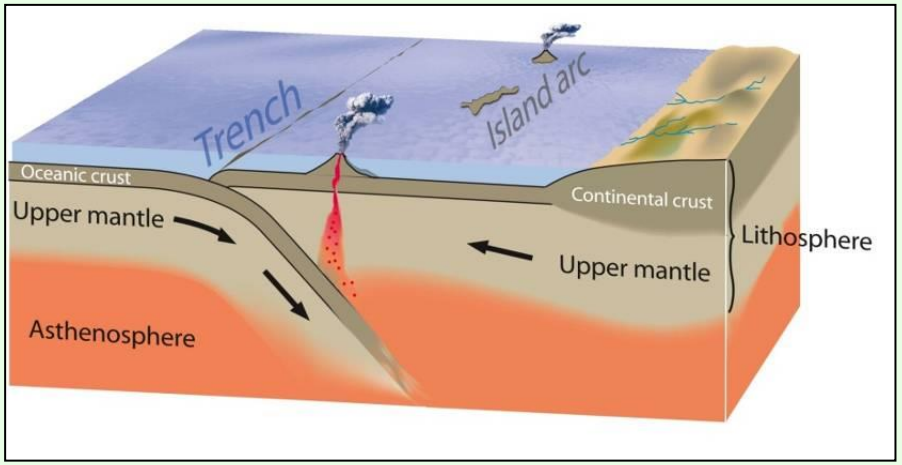
Go to: https://www.earthlearningidea.com/Video/V21_Big_picture.html hyperlink

The Earth and plate tectonics

The big picture
and the ‘facts’ of plate tectonics



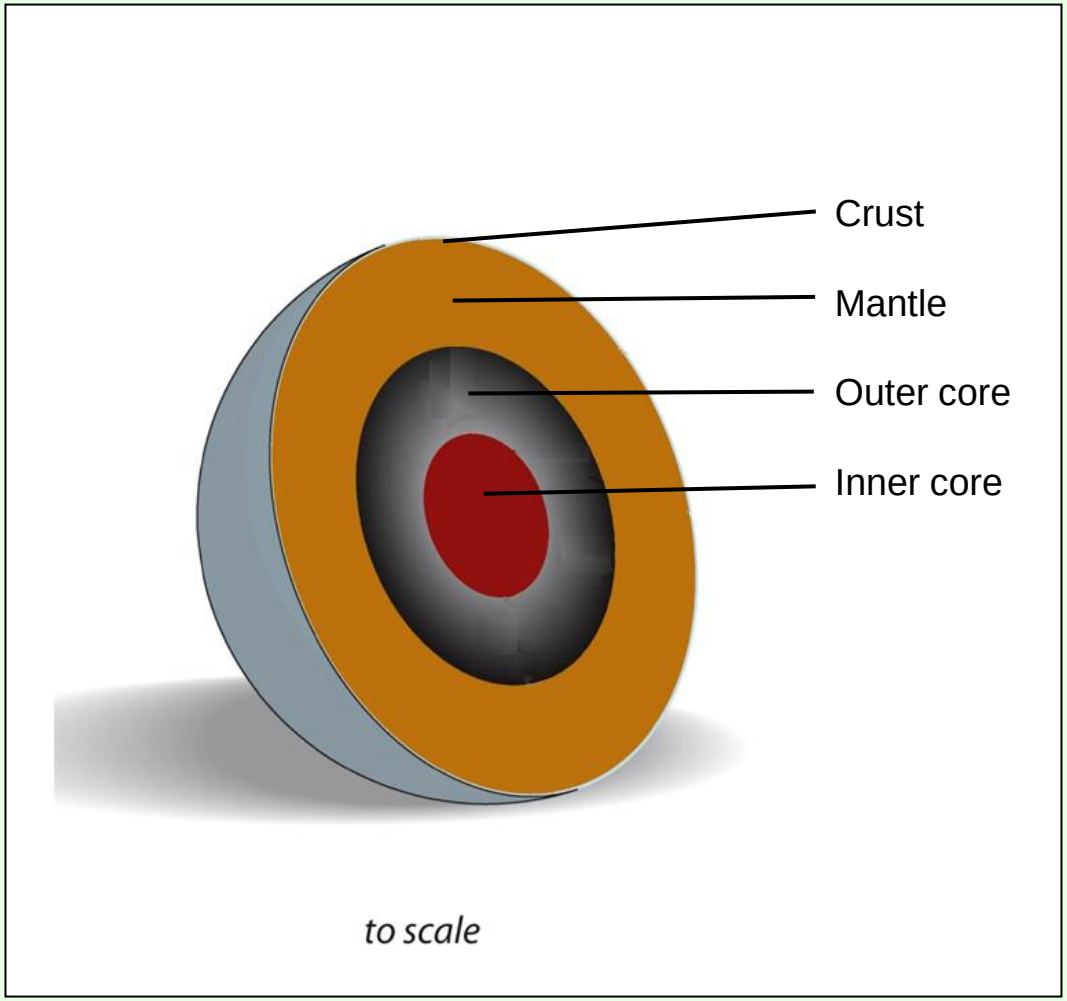
An oceanic ridge © Press & Siever, redrawn by ESEU



Continental plate collision zone. Reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

The Earth has a crust, mantle, outer and inner core

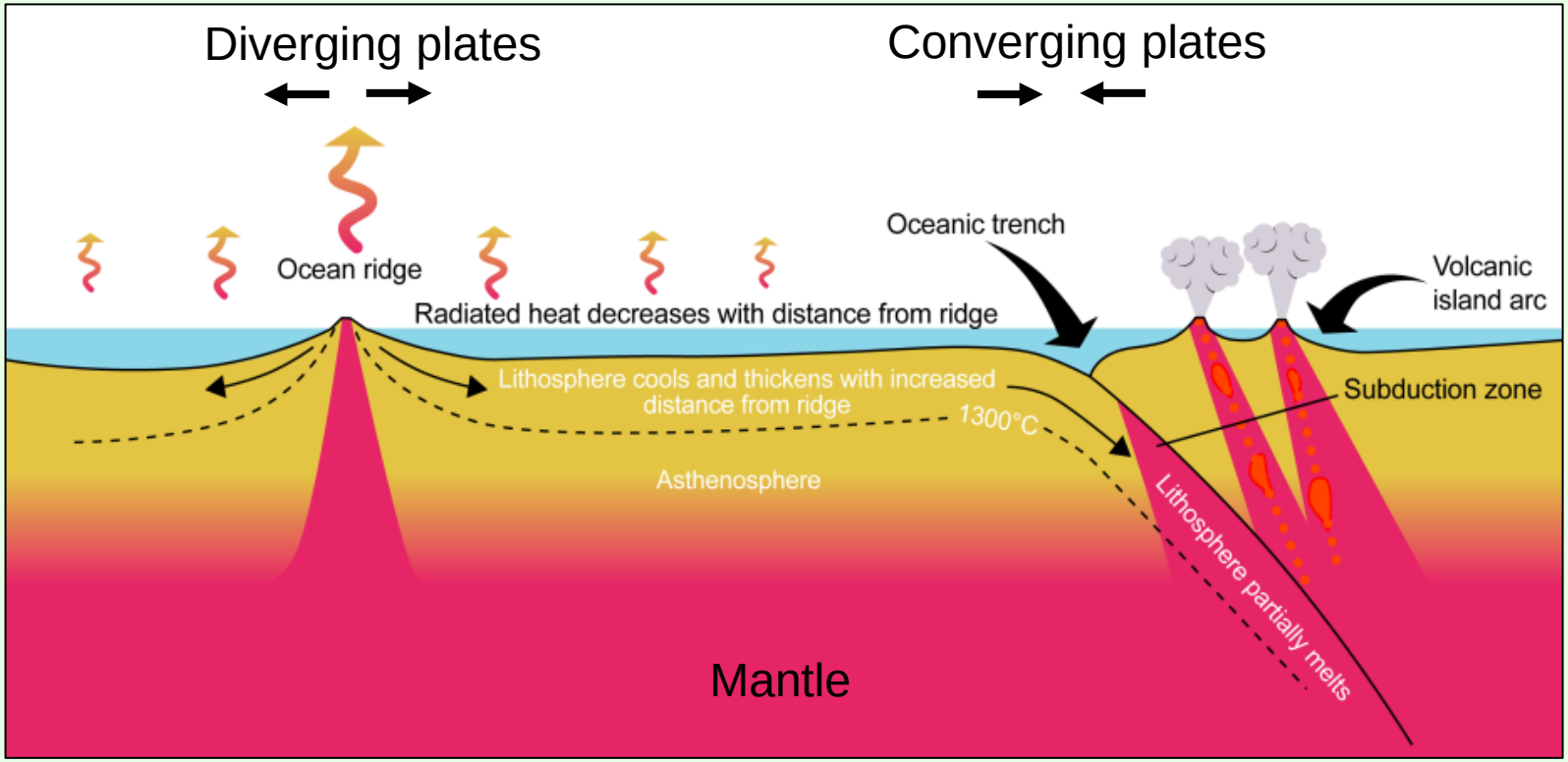


The Internal structure of the Earth - reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

The upper part of the mantle and the crust look like this

Over geological time the mantle can flow

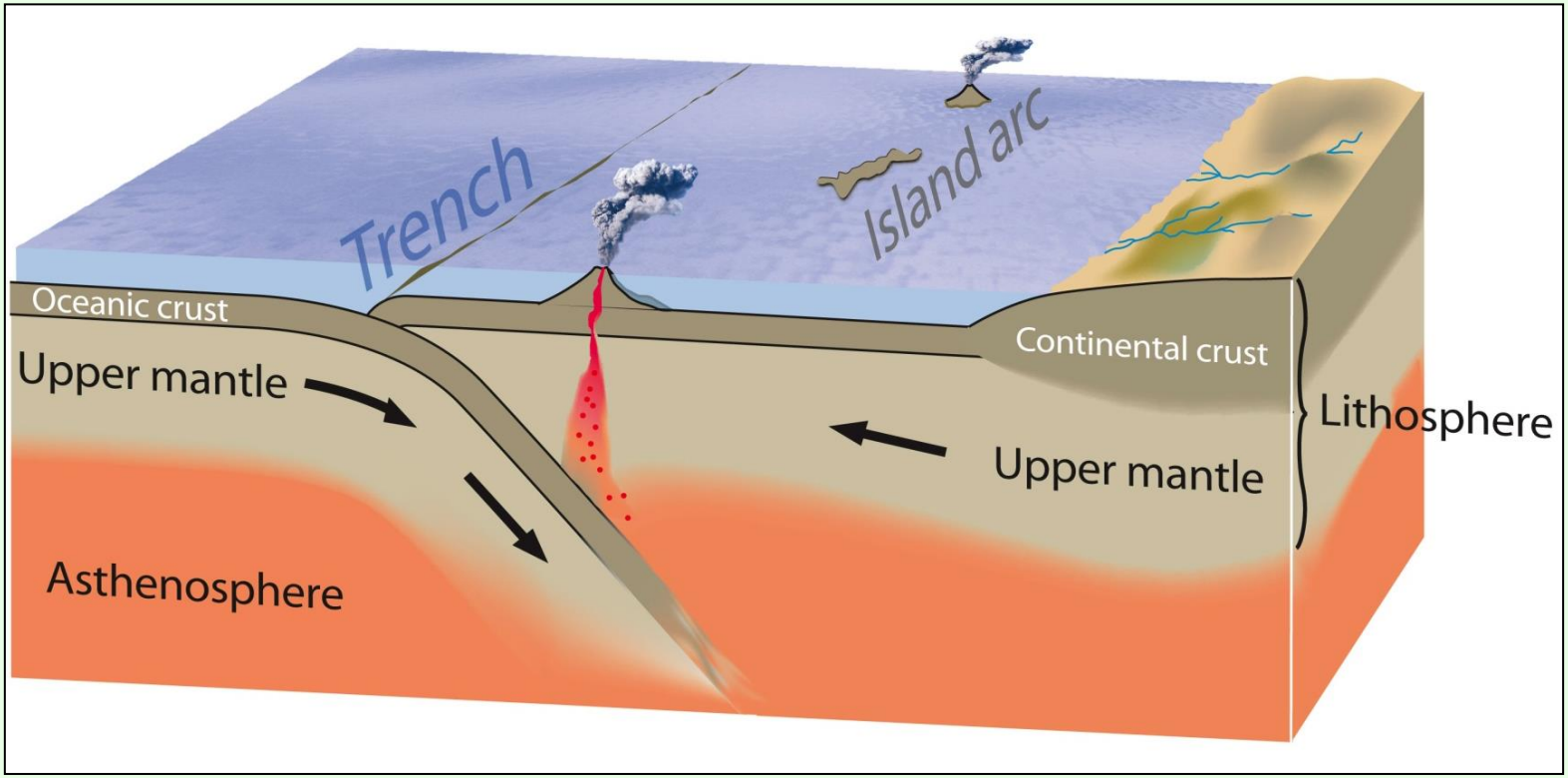


The upper part of the mantle and the crust © Chris King and Dee Edwards, redrawn by ESEU

The Earth and plate tectonics

A subduction zone looks like this

When one plate goes down -
partial melting occurs and volcanoes are produced

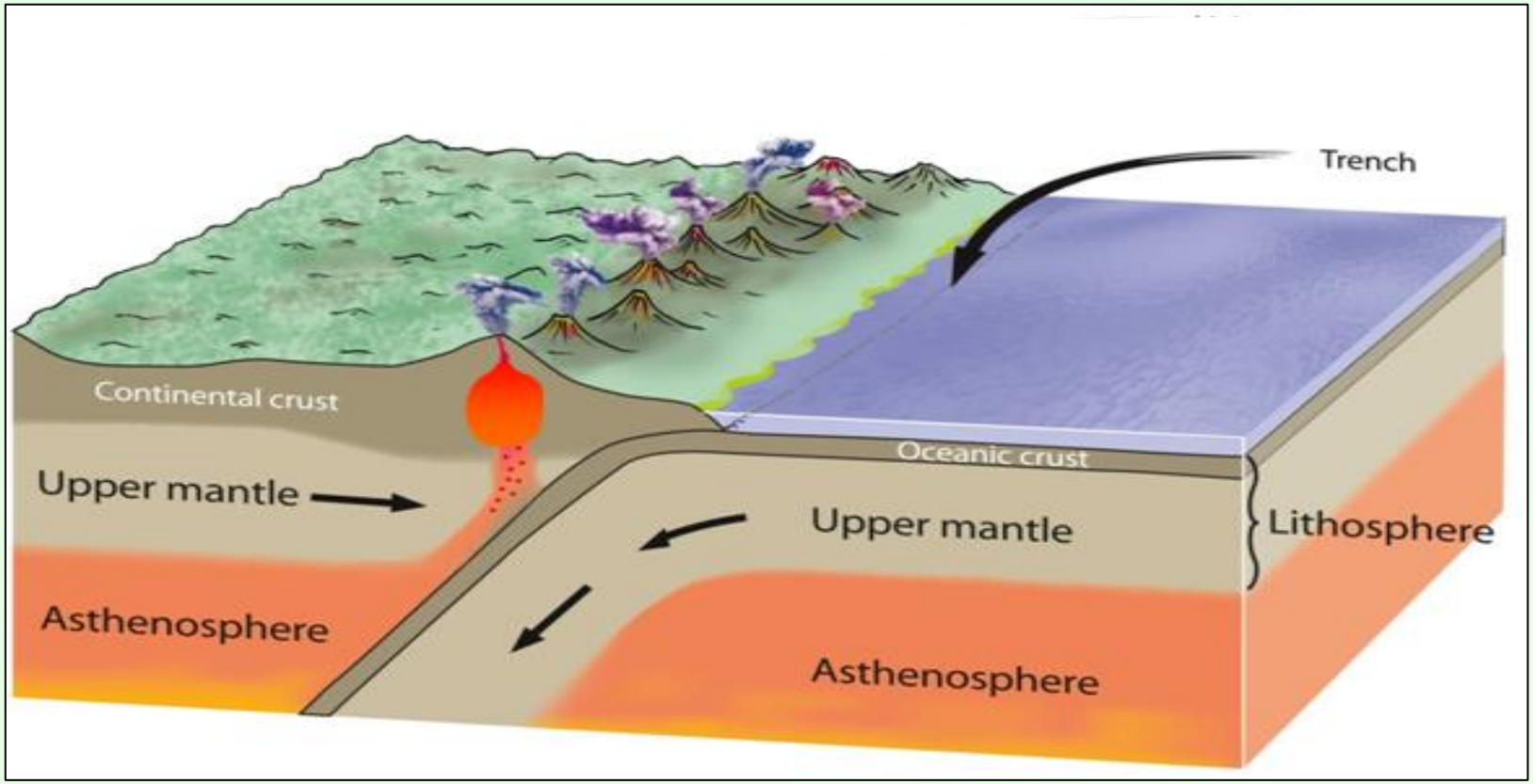


Subduction zone ('partially melts and volcanoes are produced' 'molten rock cools down below the surface')
- reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

A subduction zone with a continent on one plate

Sometimes the molten rock cools down below the surface

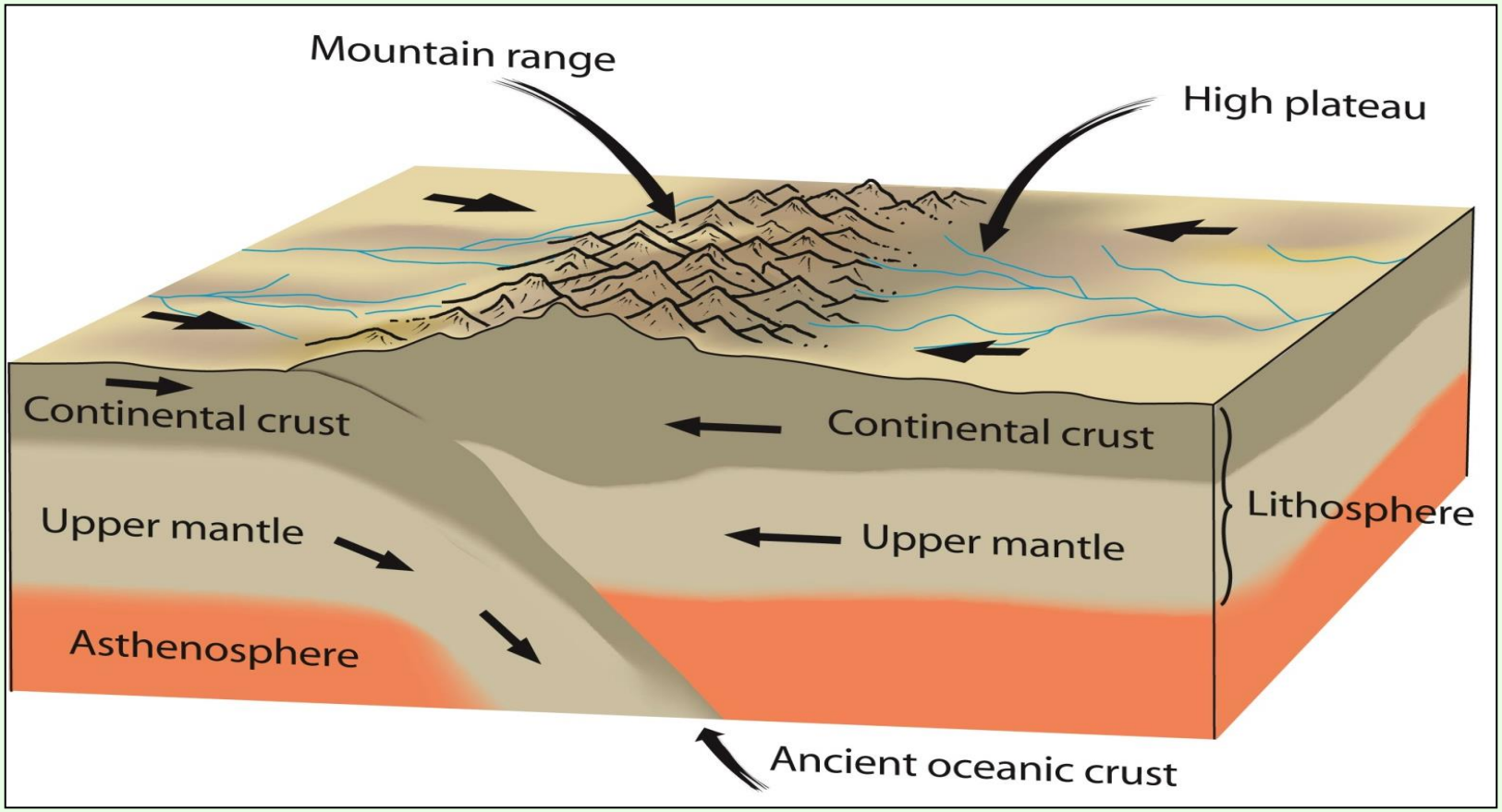


Subduction zone ('partially melts and volcanoes are produced' 'molten rock cools down below the surface') - reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

A subduction zone with continents on both plates

When two plates carrying continents collide – mountain chains are built

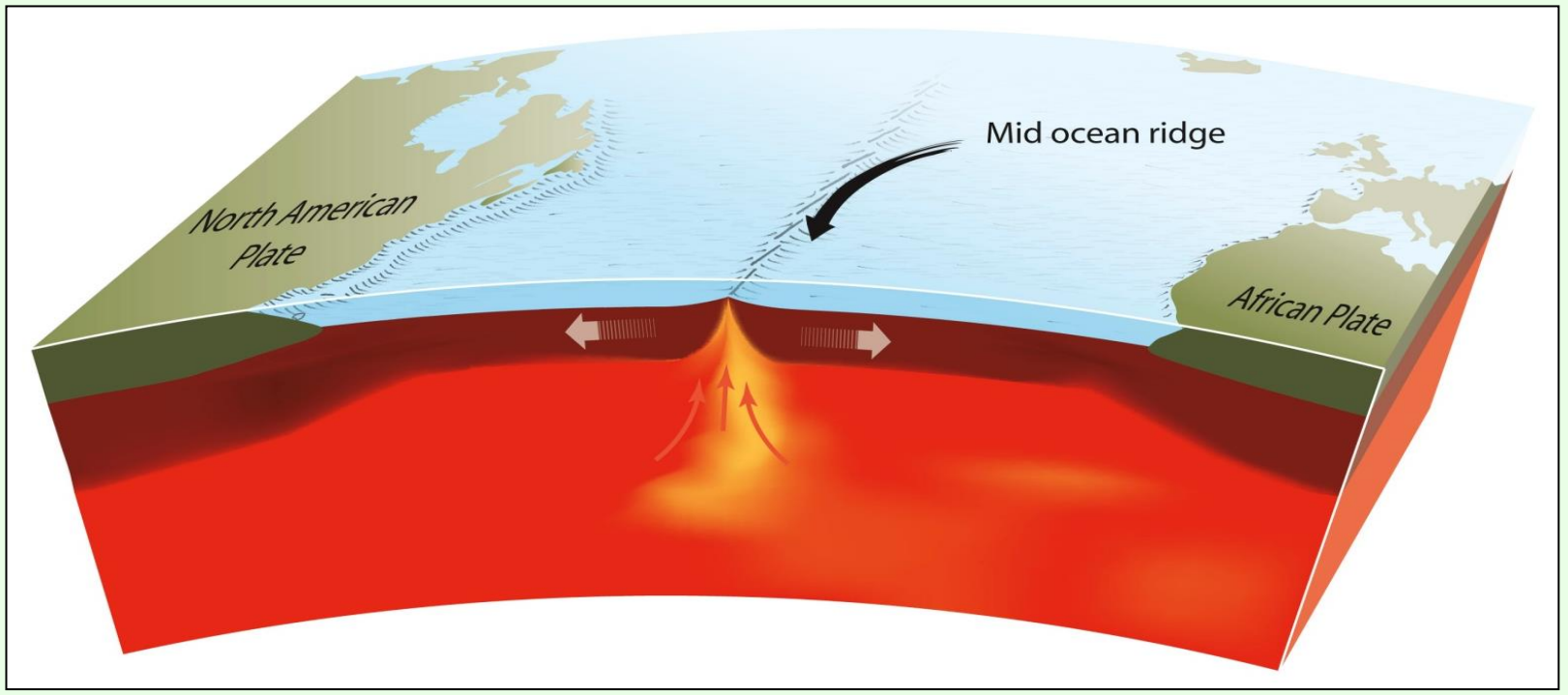


Continental plate collision zone. Reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

An oceanic ridge

If plates are converging, there must be somewhere on Earth where plates are moving apart, or diverging – where new plate material is being made

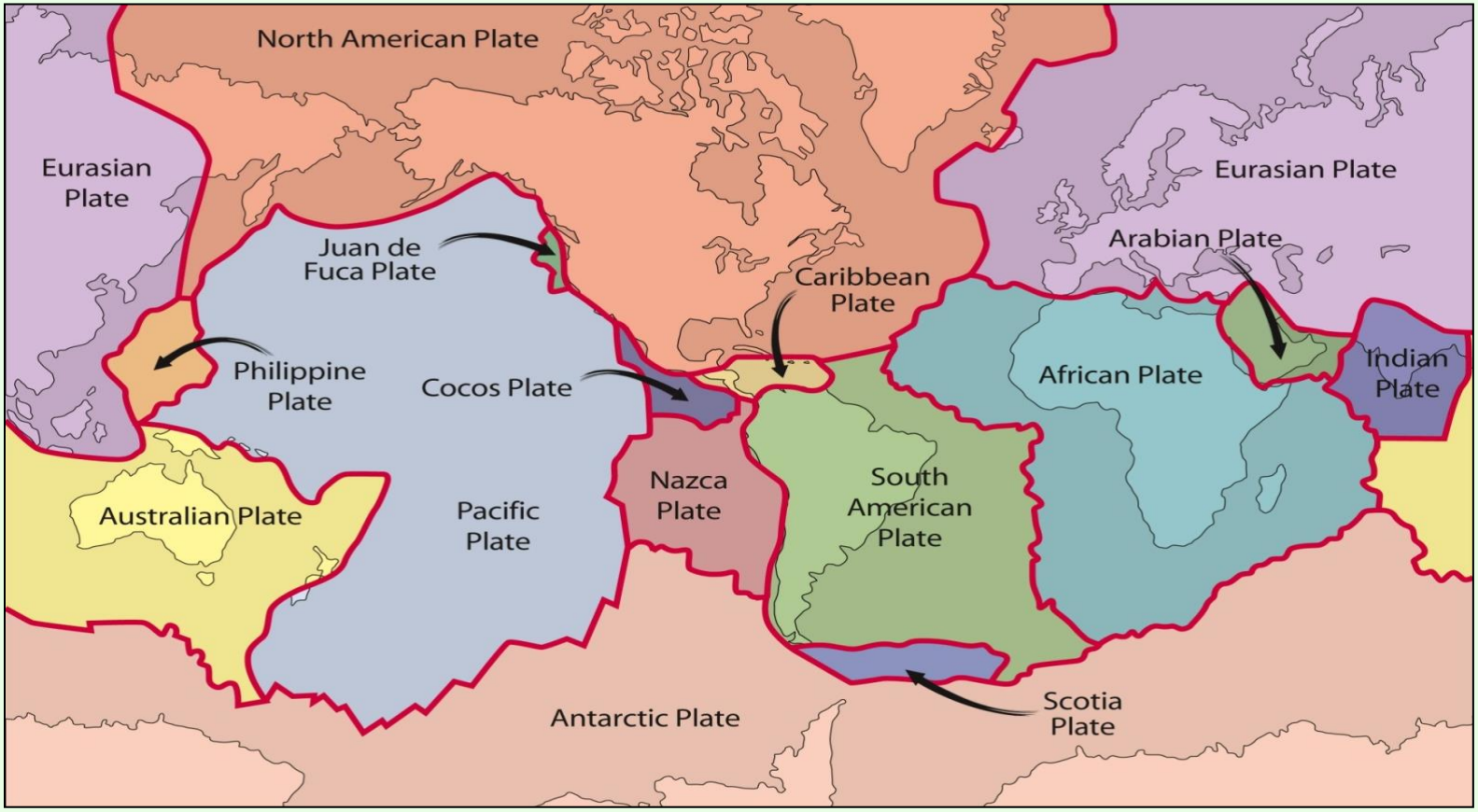


An oceanic ridge © Press & Siever, redrawn by ESEU

The Earth and plate tectonics

Map of plates

The result is - the map of plate margins today



Map of plates - reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

- So – that is the ‘big picture’ of plate tectonics
- But plate tectonics is not a series of facts, as suggested in the story above, but is a theory supported by evidence
- But what is this evidence and how does it support the theory?

Note: The theory of plate tectonics is outlined in narrative form as the ‘Story for teachers: plate tectonics’ on an early page of the ‘The plate tectonic story’ booklet.

Teaching Earthlearningideas

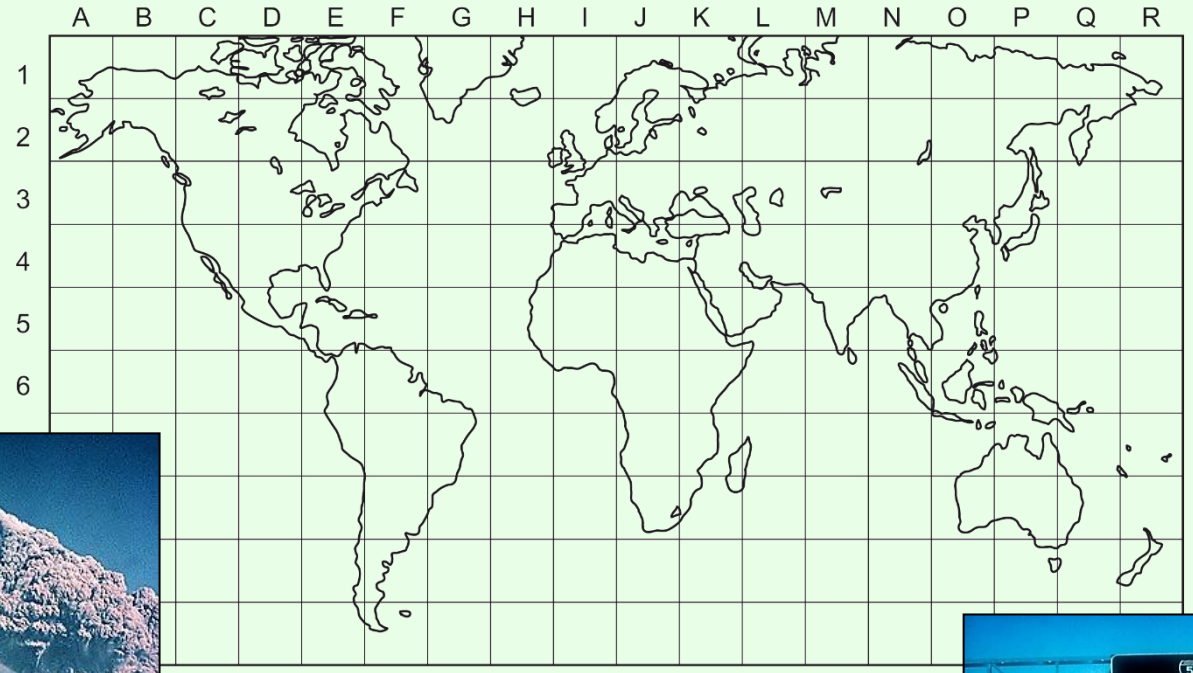
The plate tectonic story

- **Earthquake and volcano distribution evidence**

Go to: https://www.earthlearningidea.com/Video/V21_Equ_volc_evid.html
hyperlink

The Earth and plate tectonics

Where on Earth are earthquakes and volcanoes?
- geobattleships



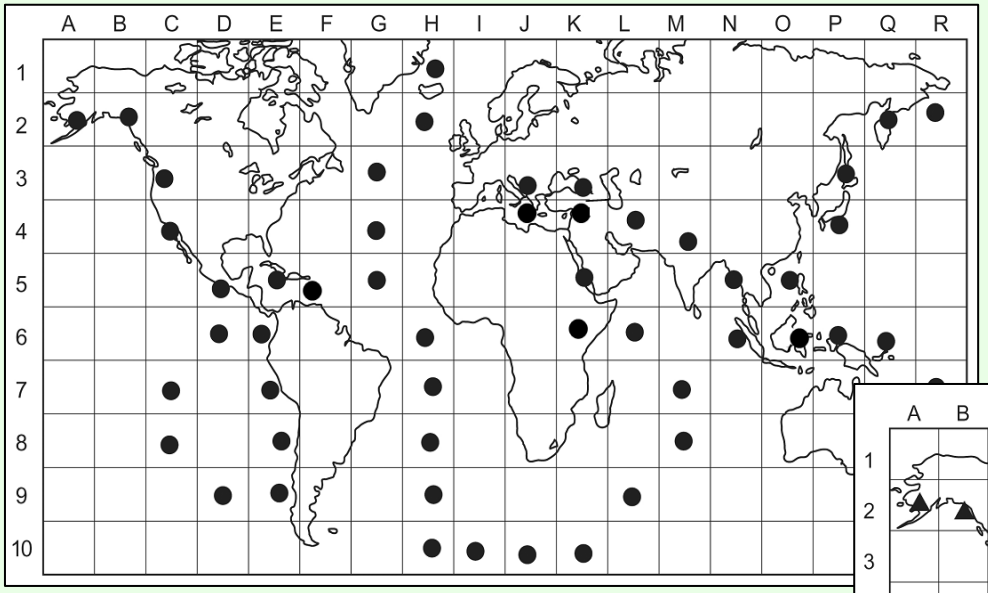
Battleship grid for Geobattleships © Dave Turner

Galunggung eruption by USGS, public domain

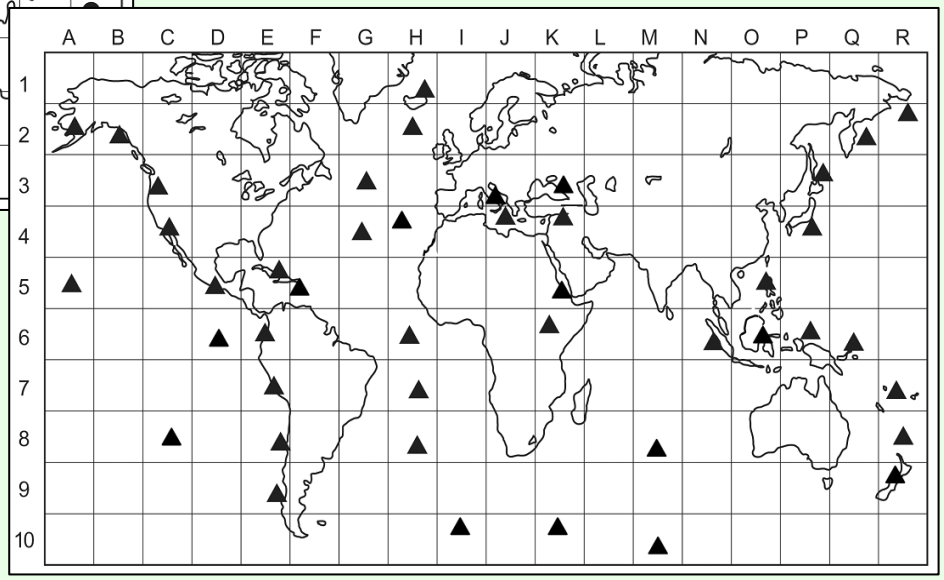
'North All Trucks' © USGS

The Earth and plate tectonics

Where on Earth are earthquakes and volcanoes?
- geobattleships



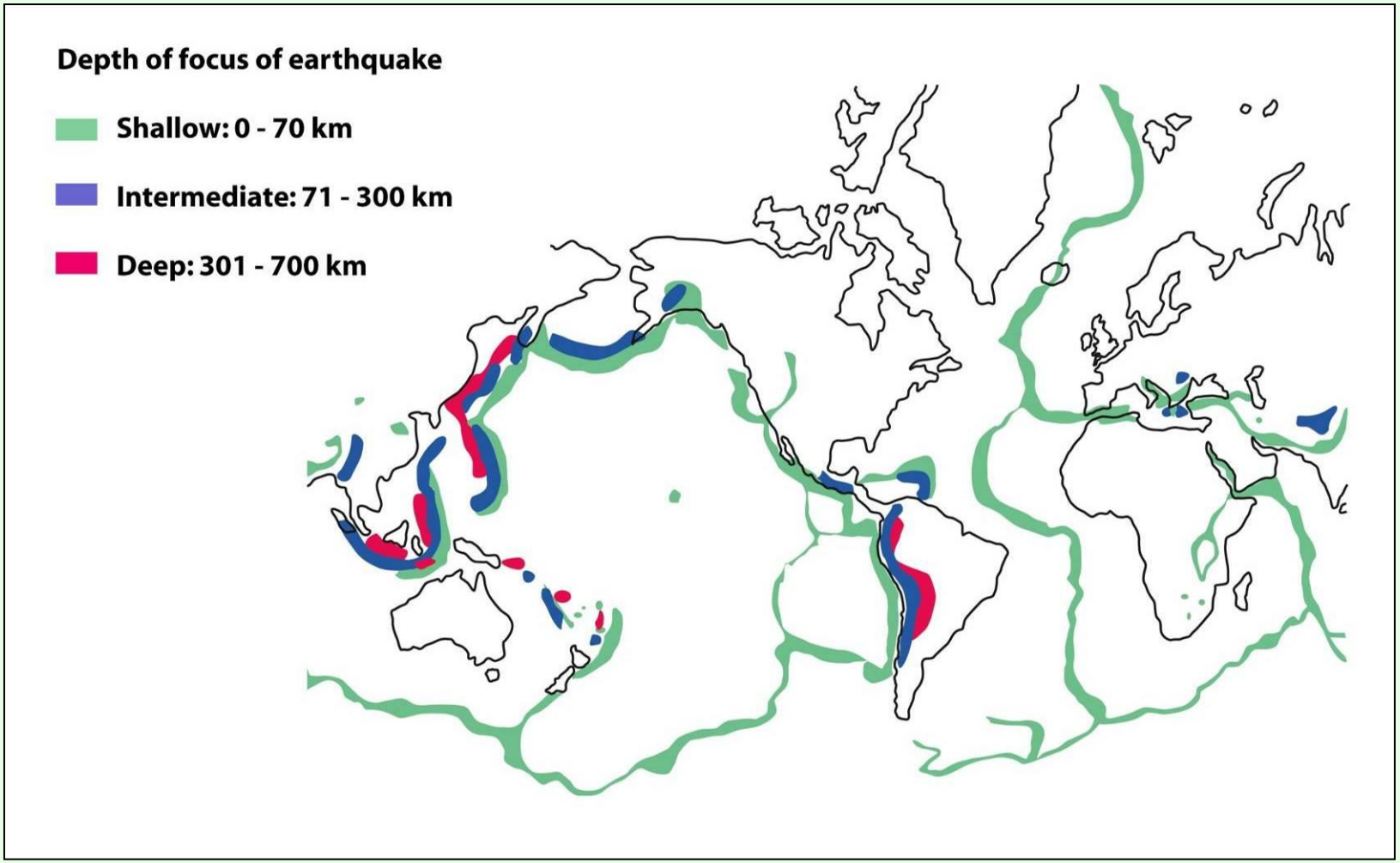
Earthquakes



Volcanoes

The Earth and plate tectonics

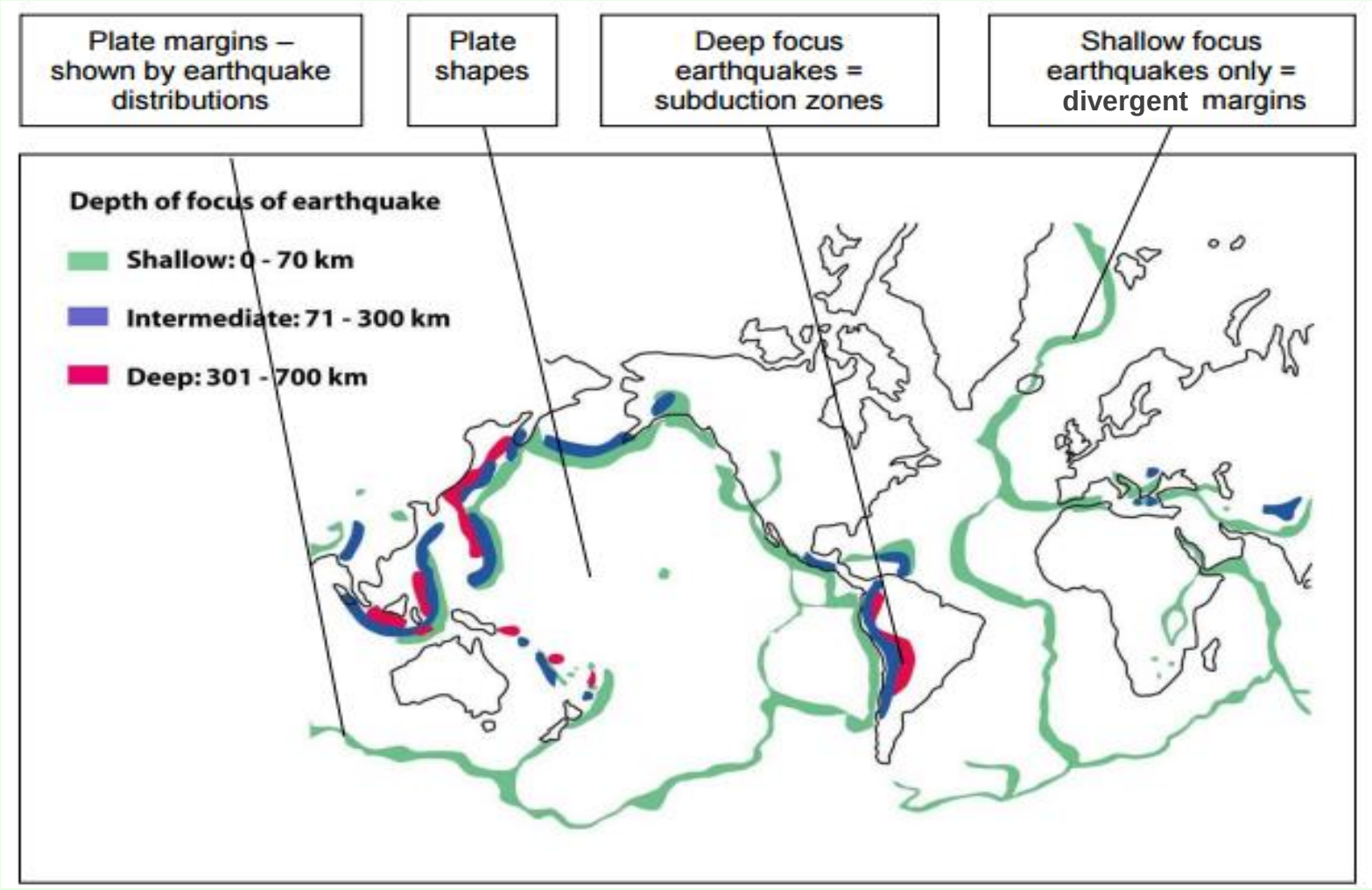
Distribution of earthquakes – what does the distribution show?



Distribution of earthquakes – source unknown, redrawn by ESEU

The Earth and plate tectonics

Distribution of earthquakes – what does the distribution show?



Distribution of earthquakes – source unknown, redrawn by ESEU

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The plate tectonic story

- **China plate summary**

Go to: https://www.earthlearningidea.com/Video/V21_China_plate.html hyperlink

The Earth and plate tectonics

Why are the Earth's tectonic plates called plates?

Picture of a plate © Peter Kennett

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Earth's structure

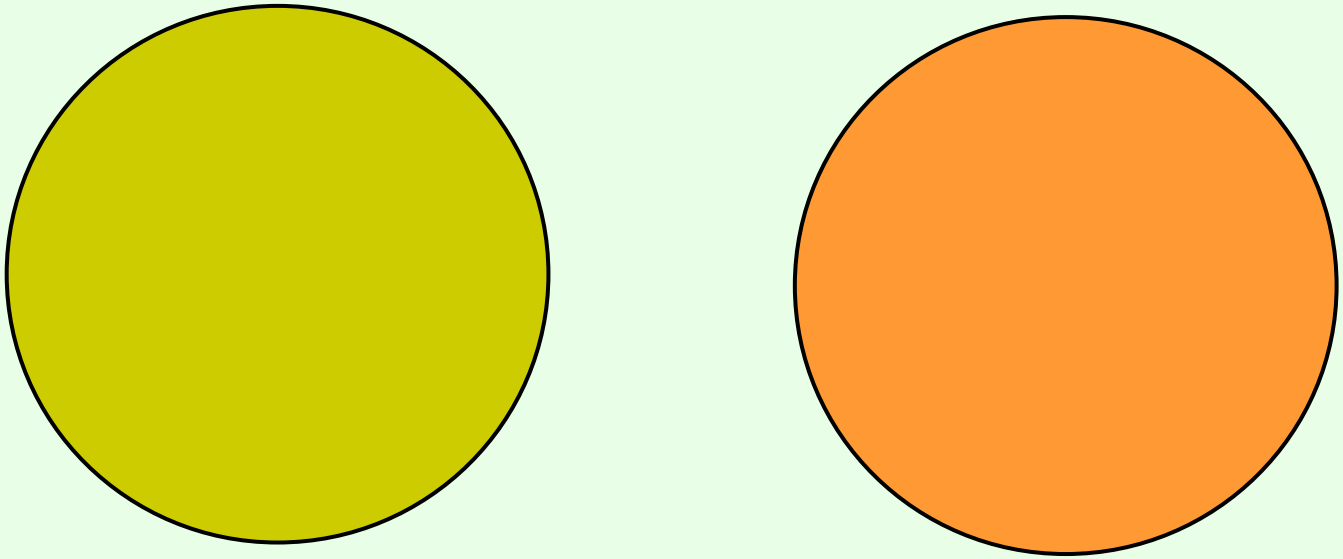
- **From clay balls to the structure of the Earth**

Go to: https://www.earthlearningidea.com/Video/V20_Clay_balls.html hyperlink

The Earth and plate tectonics

From clay balls to Earth's structure

- Two spheres, different colours - other differences?



- One ball seems heavier than the other
- How could you find out if you are right?

The Earth and plate tectonics

From clay balls to Earth's structure

To find out if one ball is heavier than the other, you could:

- Weigh both balls – you would find that one has a greater mass than the other
- Spin or roll the balls – one should spin or roll better than the other because it is heavier and has more inertia

The spin/roll test doesn't work because the Plasticine™ will not allow free spinning/rolling

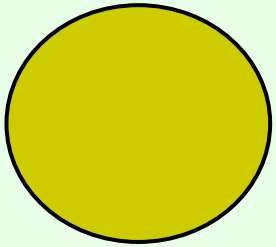
One ball is heavier than the other. Why? There are five different ideas (hypotheses) that could account for this – discuss the possibilities

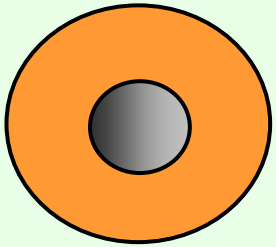
The Earth and plate tectonics

From clay balls to Earth's structure

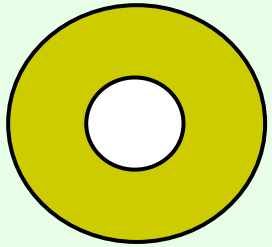
One feels heavier, and it is - reasons could be:

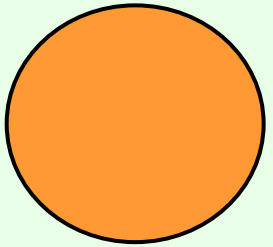
something heavy in the centre of the heavy one



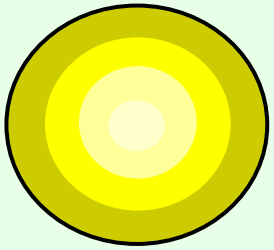


something light in the centre of the light one





one gets steadily lighter towards the centre



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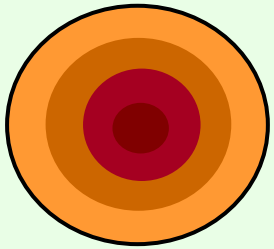
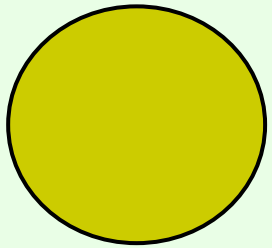
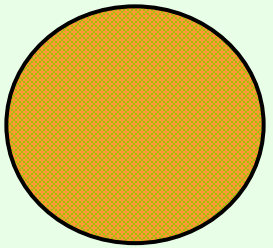


one is made of heavier 'stuff' than the other

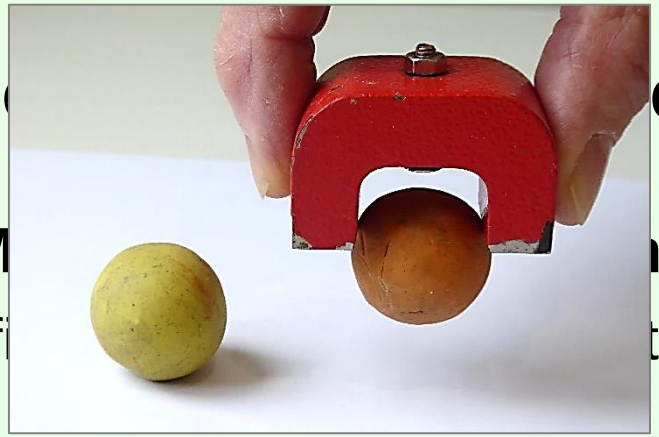




How could you find out which is right - without destroying the ball?

Th ect

M e™



How could you f thou

- Stick a pin in
- Take a small piece of the surface and test its density
- Test with a magnet
- Test its inertia
- Test it with ultrasound
- X-ray it
- Test it with ionising radiation (α, β, γ)

The pin would stop at the ball bearing

The densities would be the same

The magnet would attract the ball bearing

The inertia test does not work with clay

Ultrasound would find the ball bearing

X-rays would find the ball bearing

Ionising radiation would find the bearing

Which of these could you use on the Earth in an attempt to find out what is in the middle?

The Earth and plate tectonics

From clay balls to Earth's structure

Which of these could you use on the Earth to find in an attempt to find out what is in the middle?

- Stick a pin in - no, can't drill that deep
- Measure density * - yes, crustal density less than whole Earth density
- Magnetism * - yes, measure and interpret effects
- Inertia * - yes, measure and interpret effects
- Ultrasound - no, can't penetrate that far
  - Sound (sonar) - no, bounces off seafloor
  - Infra-sound * - yes, low frequency sound = seismic waves – gives the best evidence for the core
- X-ray - no, can't penetrate that far
- Ionising radiation - no, can't penetrate that far

* Gives evidence for the Earth's core

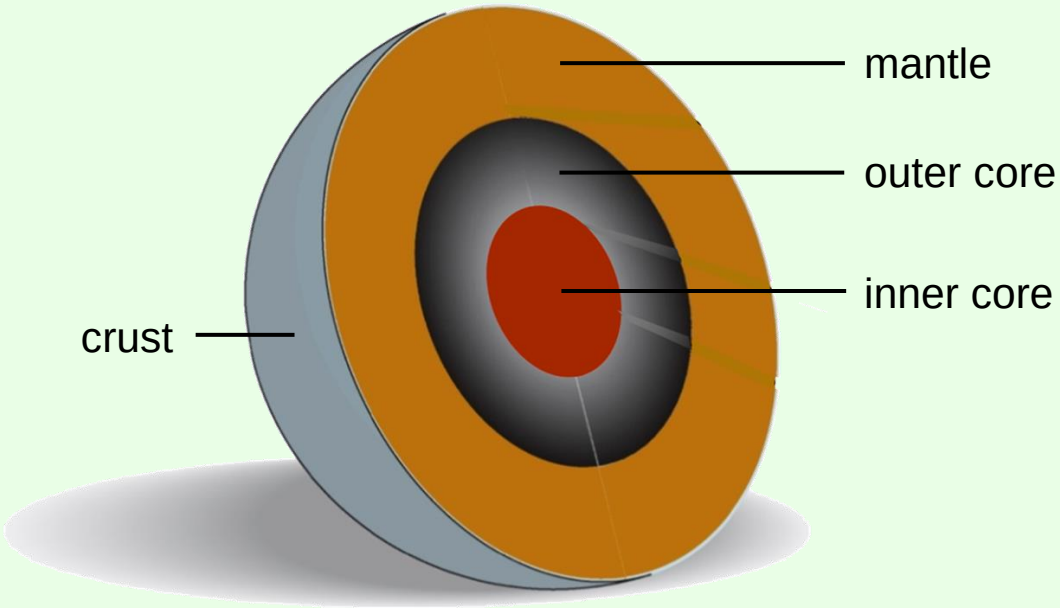
Note: The activity is fully explained in, King, C. (2002) The secrets of Plasticine balls and the structure of the Earth: investigation through discussion, published in *Physics Education,* 37 (6), 485 – 491.

The Earth and plate tectonics

From clay balls to Earth's structure

Through this activity – have we been learning about science/geography or 'doing science/geography'?

When learning about the Earth's core, you might have been asked to draw and label a diagram like this:



…. or you could have done the activity we have just done

The Earth and plate tectonics

From clay balls to Earth's structure

Through this activity – have we been learning about science/geography or 'doing science/geography'?

When scientists or geographers 'do' science/geography they:

- ask questions
- come up with ideas to answer these questions (develop hypotheses)
- think of ways of testing these ideas (observations or experiments)
- think about what these are likely to tell us

… just as we have been doing here

So – is this way of exploring Earth's core 'doing science/ geography' – or just learning about it?

Teaching Earthlearningideas

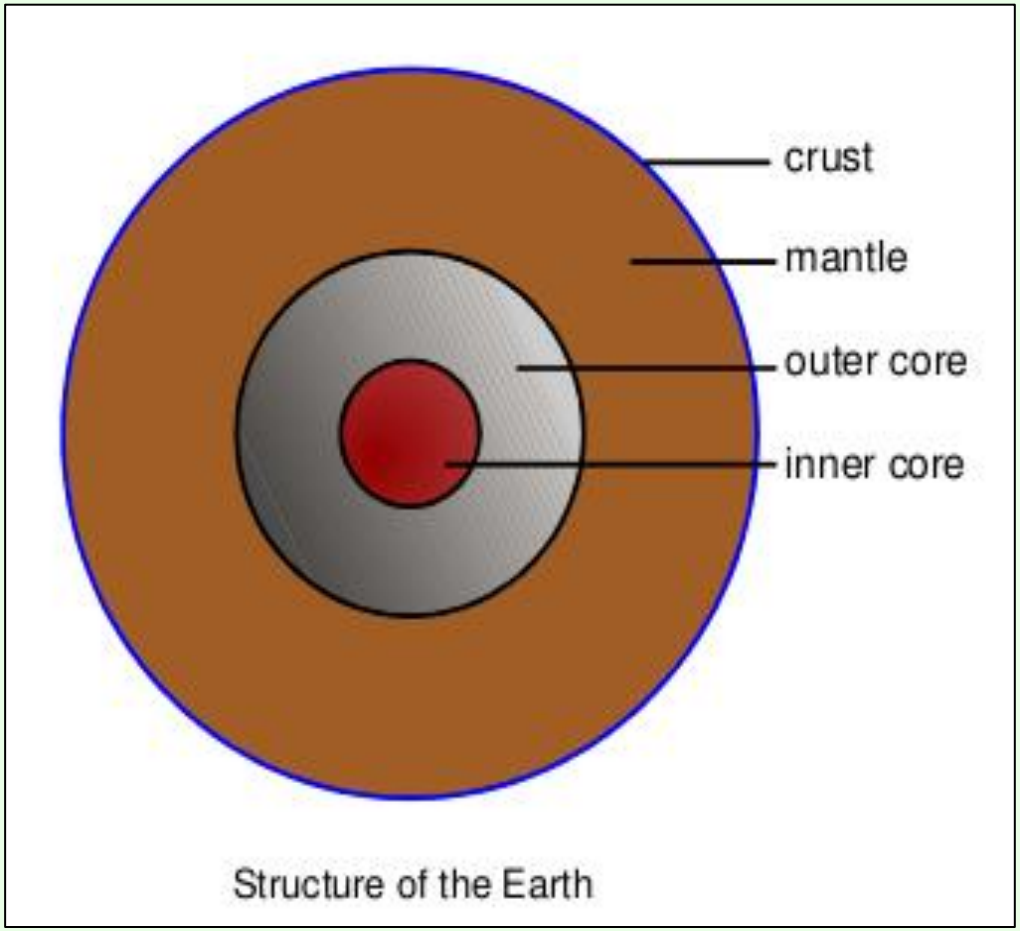
Earth's structure

- **From an orange to the whole Earth**

Go to: https://www.earthlearningidea.com/Video/V23_Orange_to_Earth.html hyperlink

The Earth and plate tectonics

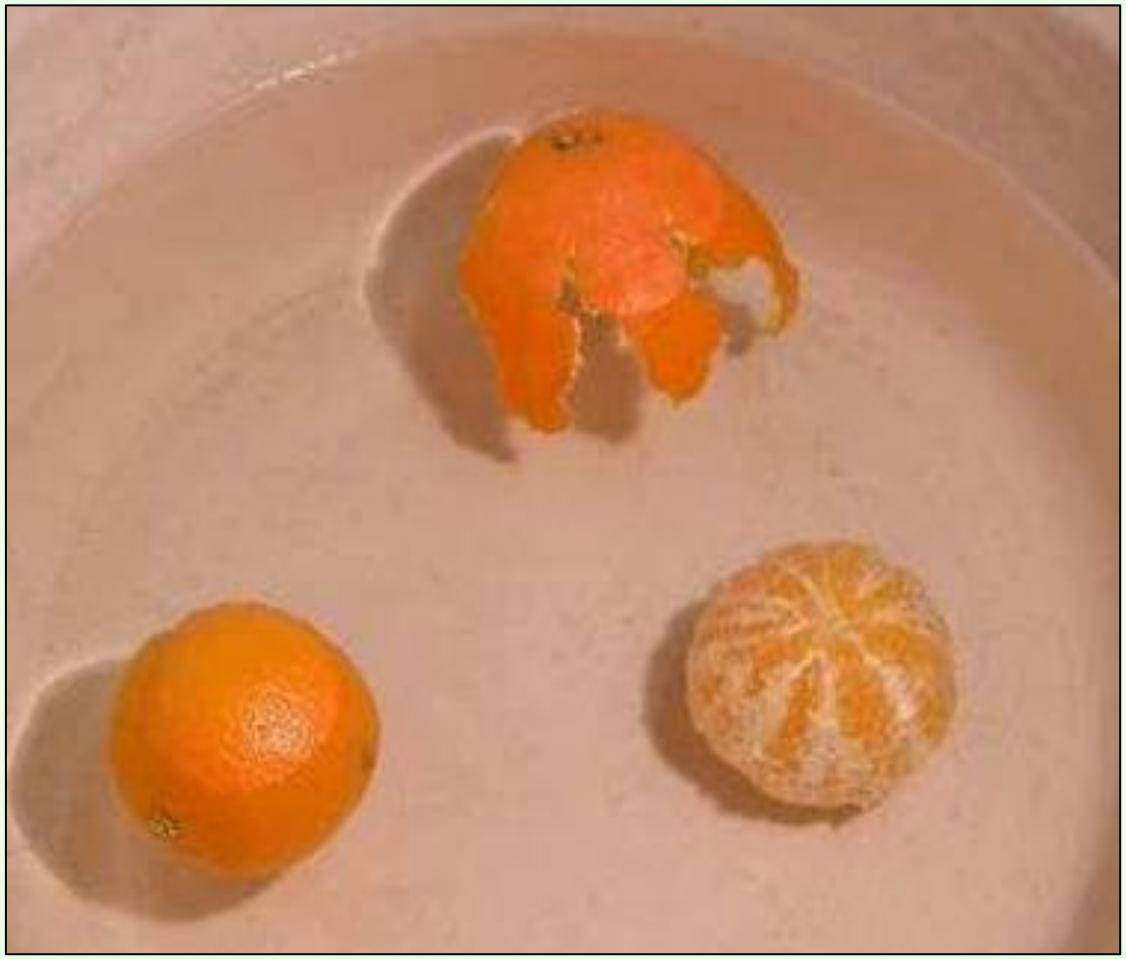
From an orange to the whole Earth



Structure of the Earth

The Earth and plate tectonics

From an orange to the whole Earth



The Earth and plate tectonics

From an orange to the whole Earth

Density of the Earth and its layers – the figures:

Earth Layer	Density, gcm^{-3}
Crust	2.7 (oceanic) – 2.9 (continental)
Mantle	3.3 – 5.7
Outer core	9.9 – 12.2
Inner core	12.6 – 13.00
Whole Earth	5.5

Teaching Earthlearningideas

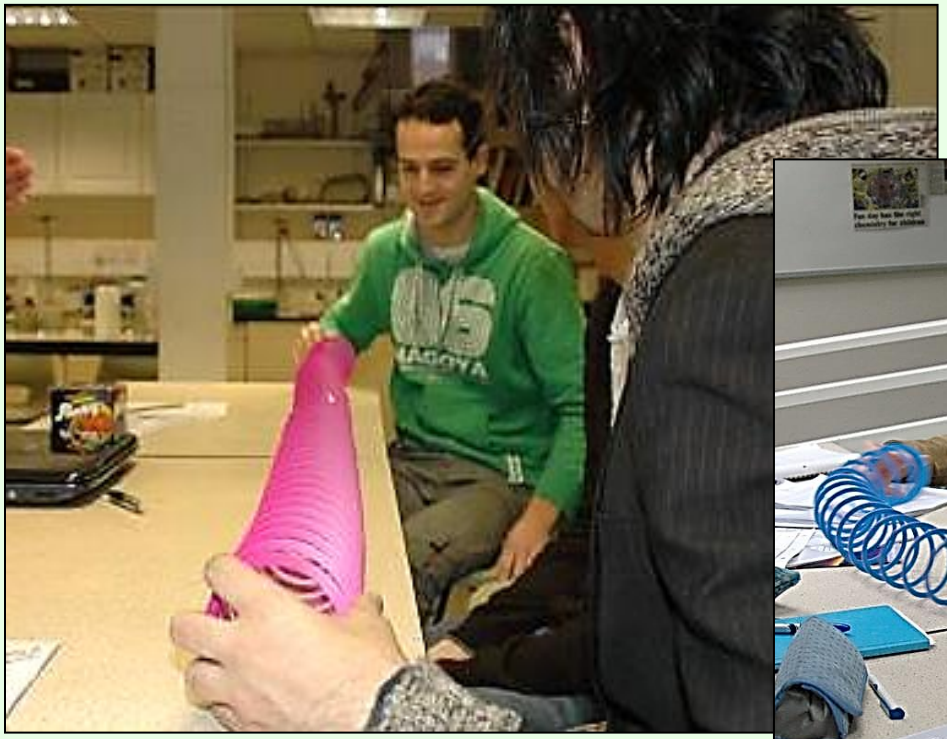
Earth's structure

- **Earthquakes – the slinky simulation**

Go to: https://www.earthlearningidea.com/Video/V22_Slinky_simulation.html
hyperlink

The Earth and plate tectonics

Earthquakes - the slinky simulation
How earthquakes produce **P**- and **S**-waves



The Earth and plate tectonics

Earthquakes - the slinky simulation
How earthquakes produce **P**- and **S**-waves

The Earth and plate tectonics

Seismic wave summary

Wave type	**Primary wave**	**Secondary wave**
Name meaning	fastest wave, so arrives first, called primary	slower wave, arrives second, called secondary
Other names	longitudinal – travels by vibration along the material	transverse – travels by lateral movement
	push/pull wave; comPressional wave	shake wave; shear wave; sideways wave; slow wave
Transmission	through solids and fluids (liquids and gases)	through solids only

Earthquake damage is caused mainly by seismic **surface waves**, and not by primary or secondary waves

Teaching Earthlearningideas

Earth's structure

- **Wave motion – pupil molecules**

Go to: https://www.earthlearningidea.com/Video/V22_Pupil_molecules.html hyperlink

The Earth and plate tectonics

Wave motion – pupil molecules
How **P**- and **S**-waves are transmitted

Teaching Earthlearningideas

Earth's structure

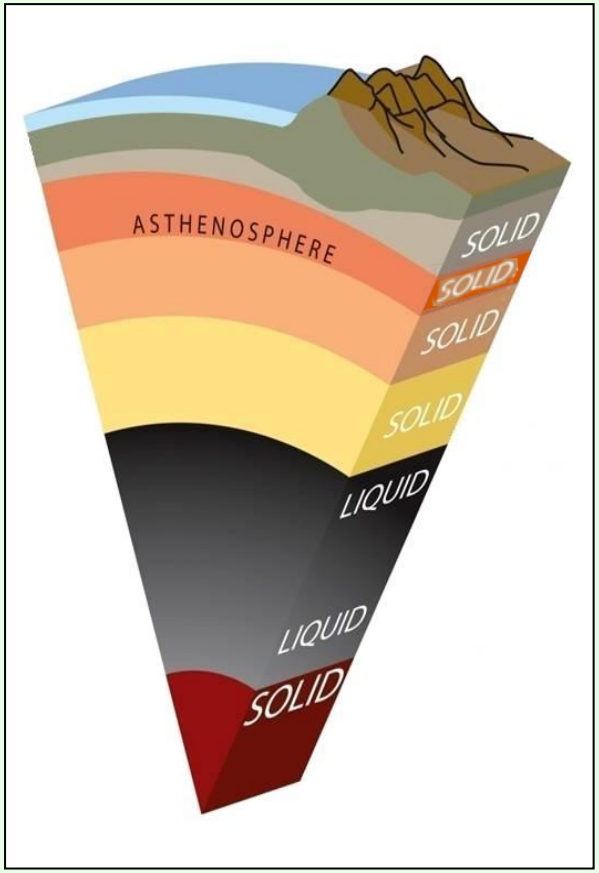
- **The seismic evidence**

Go to: https://www.earthlearningidea.com/Video/V26_Seismic_evidence.html
hyperlink

The Earth and plate tectonics

Seismic evidence

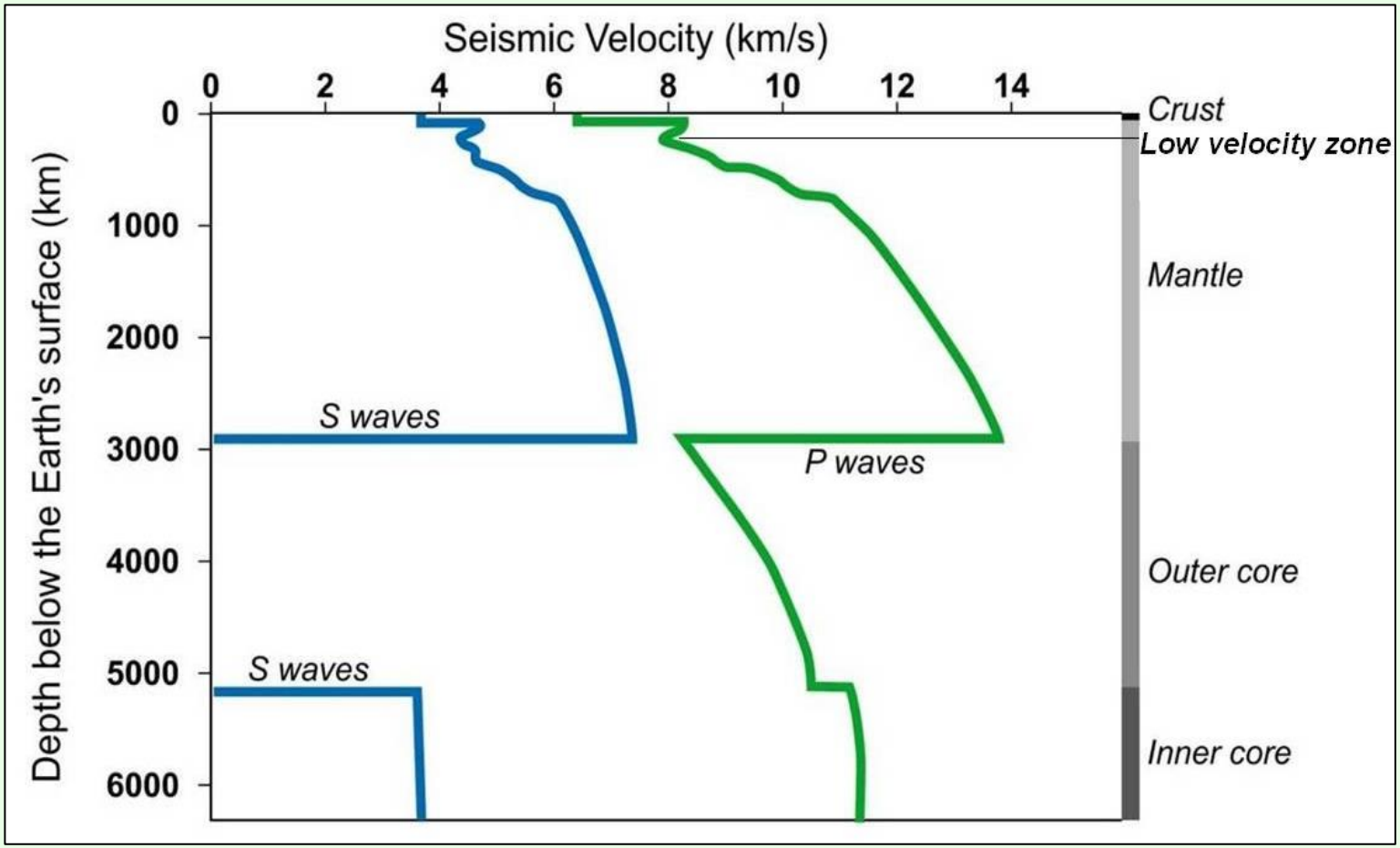
- Seismic waves are shock waves that pass through and around the Earth
- Seismic waves are generated naturally by earthquakes
- There are three main types:
  - P-waves – travel through solids and fluids (liquids and gases); pass through the Earth
  - S-waves – travel only through solids (not fluids); pass through the Earth
  - Surface waves – formed when P- and S-waves reach the Earth's surface; these cause most damage



The Structure of the Earth – from the seismic evidence – reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

Velocities of P- and S-waves as they travel into the Earth



Graph of 'Velocities of P and S waves as they travel into the Earth © ESTA, redrawn by ESEU

- P-waves – travel through solids and fluids (liquids and gases);
- S-waves – travel only through solids (not fluids);

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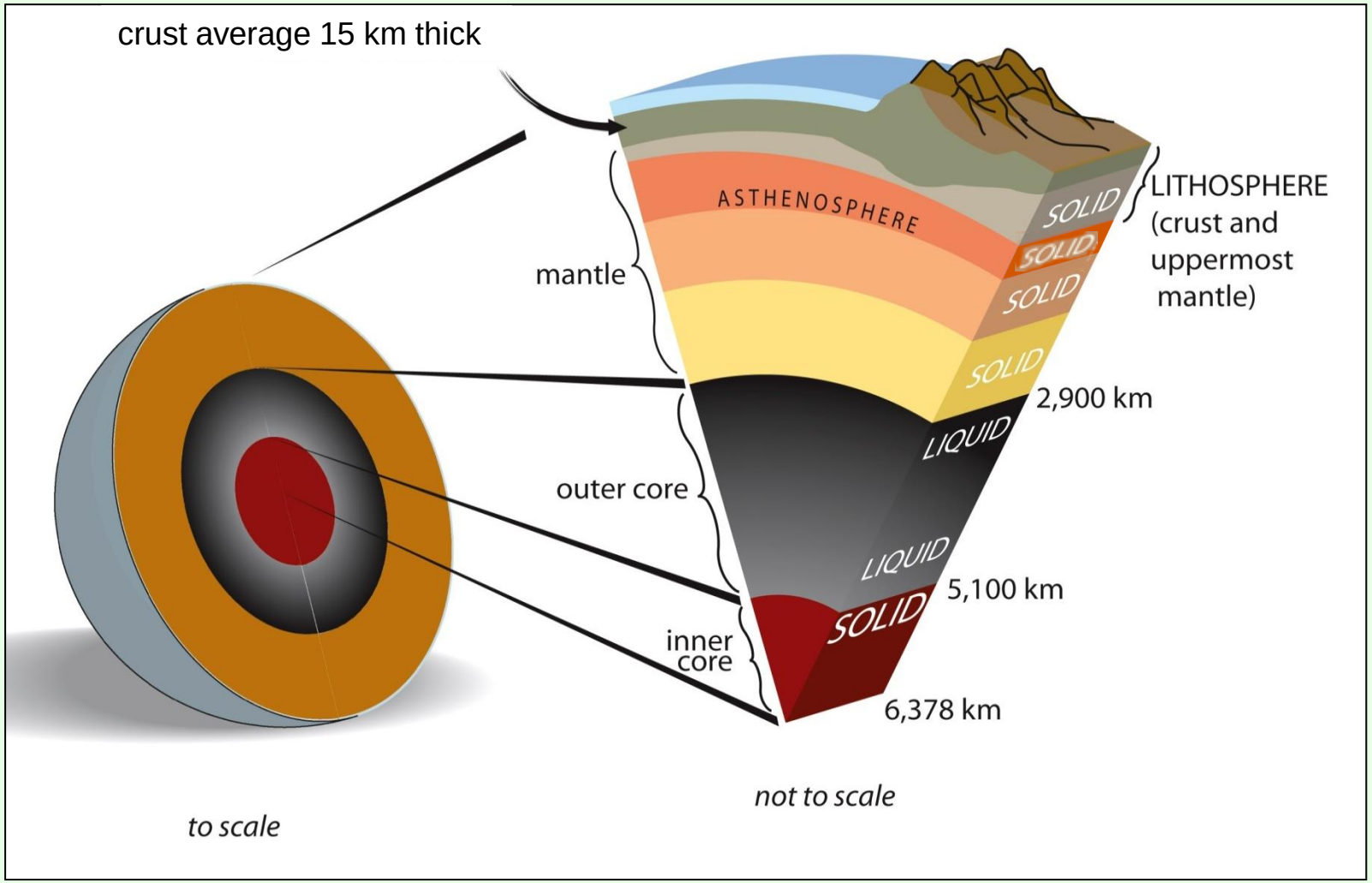
The structure of the Earth – from the seismic evidence

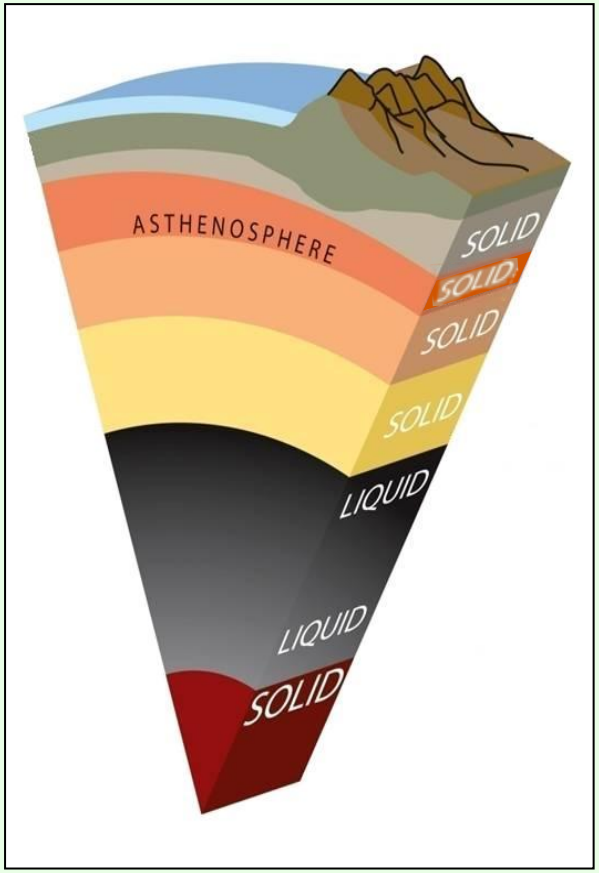


The Internal structure of the Earth - reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

Seismic evidence – summary

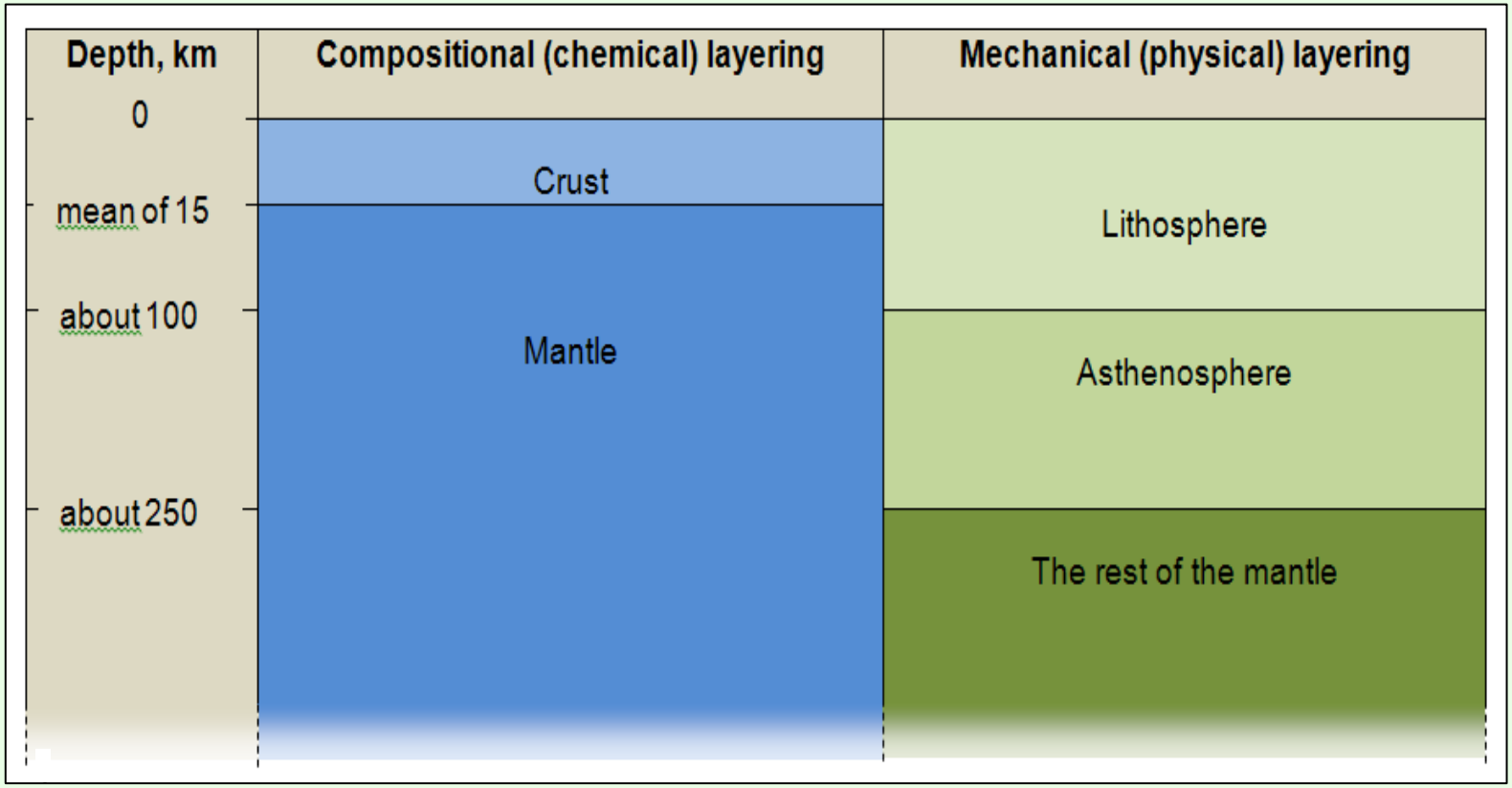
- The outer core is liquid (no S-waves transmitted)
- The inner core is solid (transmits S-waves)
- The rest of the Earth is also solid – the crust, the lithosphere, the asthenosphere and the rest of the mantle (transmits S-waves)
- Seismic waves slow down in the asthenosphere (low velocity zone) because the solid asthenosphere is near its melting point and so is plastic and can flow



The Structure of the Earth – from the seismic evidence – reproduced with kind permission of USGS, redrawn by ESEU

The Earth and plate tectonics

The lithosphere, asthenosphere and below:



The lithosphere, asthenosphere and below © ESEU

Note 1. The crust has a mean thickness of 35 km beneath continents and 6 km beneath oceans giving an overall mean of about 15 km.

Note 2. The crust is too thin to form plates – plates are made of rigid lithosphere – around 100 km in thickness

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Earth's structure

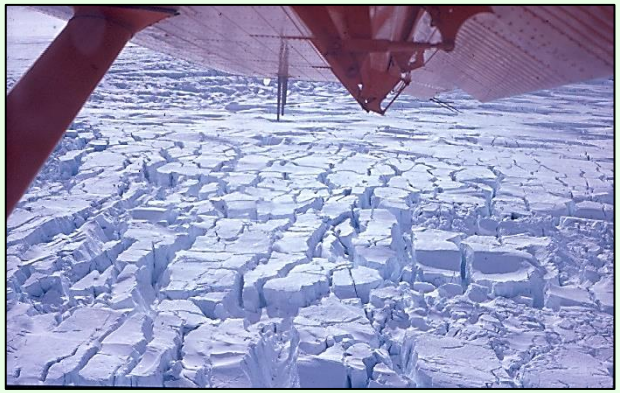
- **Solids that flow**

Go to: https://www.earthlearningidea.com/Video/V26_Potty_putty.html hyperlink

The Earth and plate tectonics

Can solids flow?

- Can you think of a common solid that flows?
- Answer = ice
- Ice is solid – and can break (fracture)
- Ice is solid – but when near its melting point in a glacier on a mountainside – it flows
- It flows even in polar glaciers – which are frozen to the ground



Fractured ice – seen from a plane in Antarctica

A glacier flowing downhill in Norway

The Earth and plate tectonics

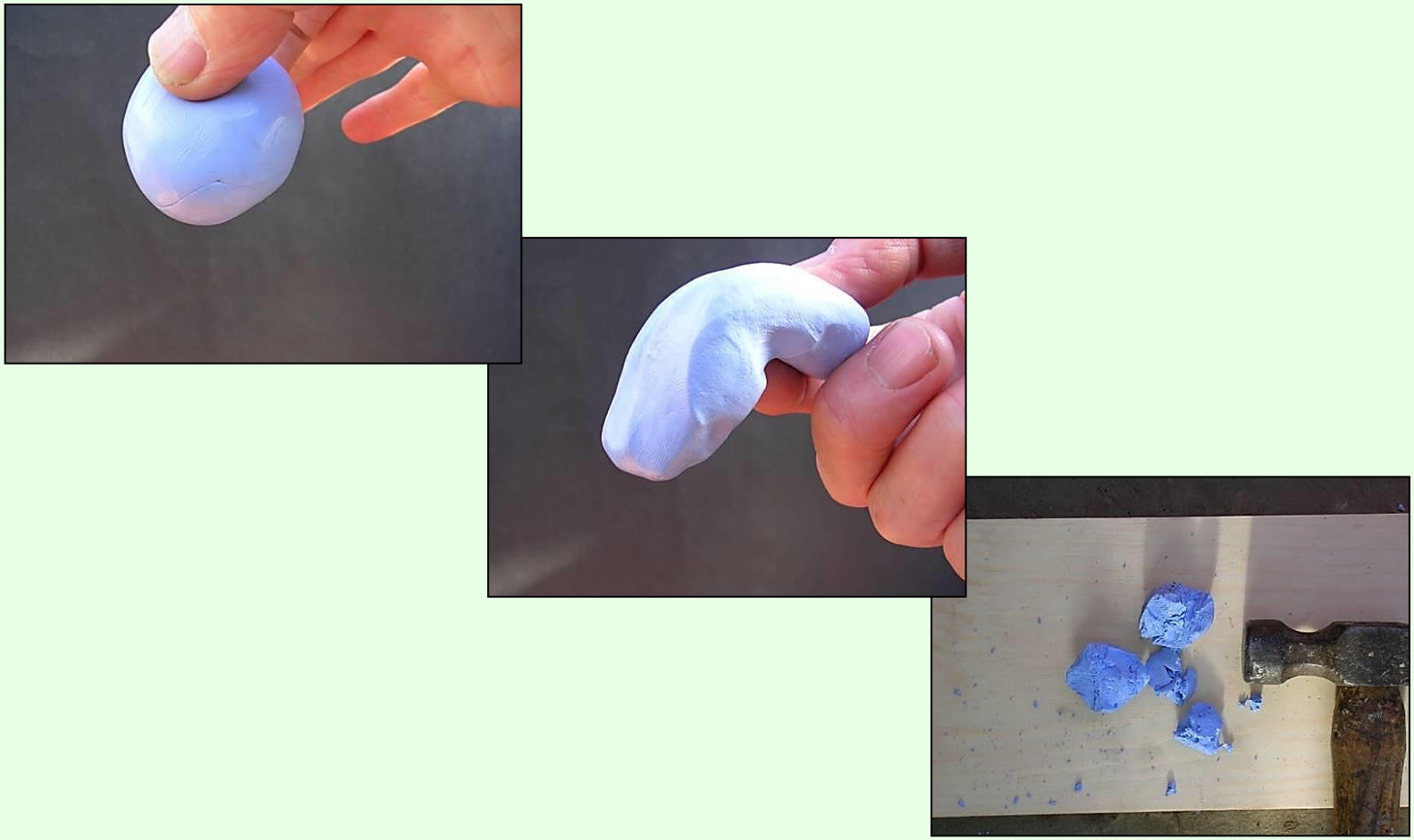
Properties of the mantle – potty putty™

Showing how the solid mantle can flow

Student pulling Potty Putty™ © ESEU

The Earth and plate tectonics

Modelling the mantle



Photographs of potty putty™ © Peter Kennett

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Modelling the mantle - summary

- How are ‘potty putty’ and the mantle similar?

Potty putty	The mantle
Breaks – brittle behaviour	Mantle in the lithosphere breaks – causing earthquakes
Bounces – elastic behaviour	Transmits earthquake (seismic) P- and S-waves
Bends, flows – plastic behaviour	Can flow (over geological time)

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Earth's structure

- **Skateboard summary**

Go to: https://www.earthlearningidea.com/Video/V26_Skateboard.html hyperlink

The Earth and plate tectonics

Modelling the lithosphere and asthenosphere (?)

Skateboard © Peter Kennett, ESEU

The Earth and plate tectonics

Modelling the lithosphere and asthenosphere (?)

The crust – trainers	The extreme upper mantle – skateboard	The asthenosphere - wheels

Skateboard © Peter Kennett, ESEU

The asthenosphere (wheels) flows, carrying the plate of lithosphere = trainers (crust) + extreme upper mantle (skateboard) along

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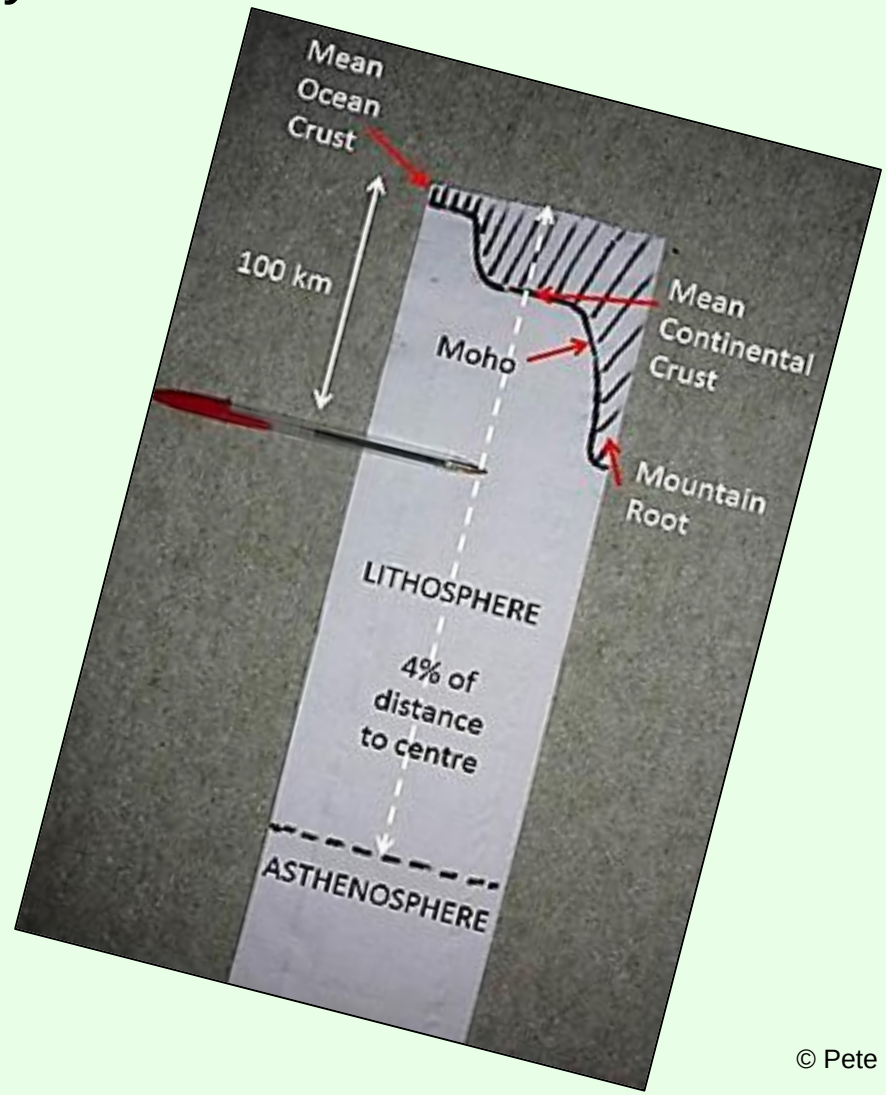
Earth's structure

- **Journey to the centre of the Earth – on a toilet roll**

Go to: https://www.earthlearningidea.com/Video/V27_Journey_toilet_roll.html
hyperlink

The Earth and plate tectonics

Journey to the centre of the Earth – on a toilet roll



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The plate tectonic story

- **What drives the plates?**

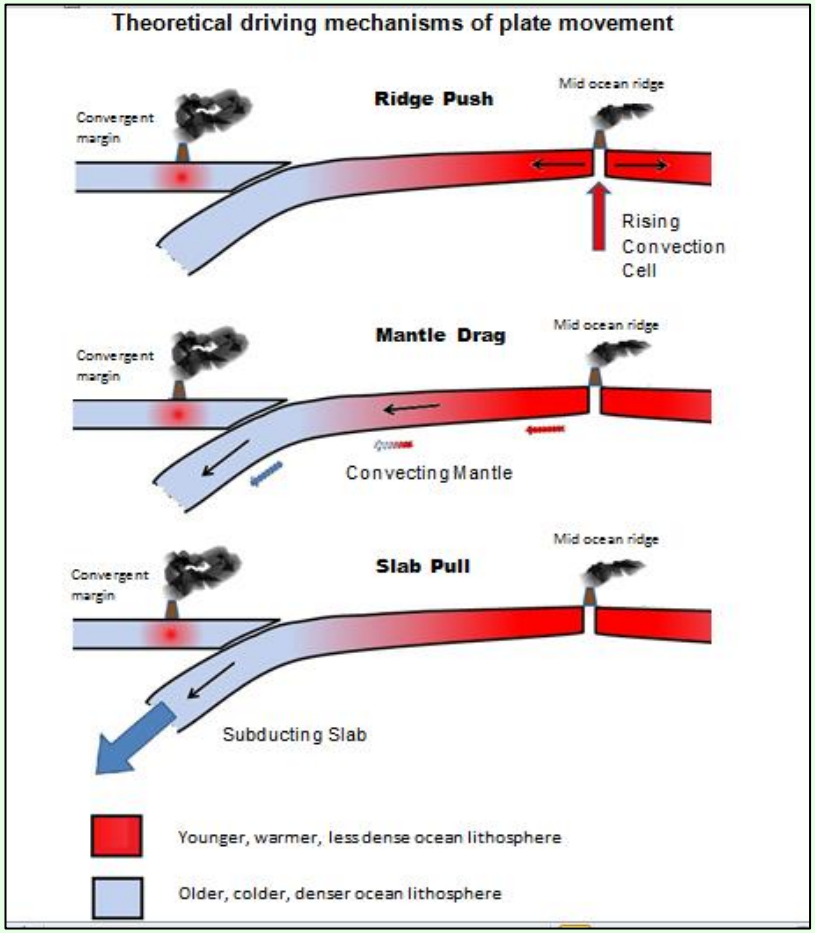
Go to: https://www.earthlearningidea.com/Video/V25_What_drives_plates.html
hyperlink

The Earth and plate tectonics

What drives the plates? – different theories

- **Ridge push** – plates form on oceanic ridges, higher than the surrounding area – the plate slides off, pushing the plate along
- **Mantle drag** – the convection current theory – a convection current flowing in the mantle drags the plate above along
- **Slab pull** – the subducting plate material is more dense than the mantle beneath and so sinks and subducts, pulling the plate along

What does the evidence show is the best theory?



Theoretical driving mechanisms of plate movement © Pete Loader

The Earth and plate tectonics

What drives the plates? – different theories

- **Ridge push –** plates form on oceanic ridges, higher than the surrounding area – the plate slides off, pushing the plate along
  - plates where divergent margins form the greatest percentage of a plate margin should be moving fastest
- **Mantle drag –** the convection current theory – a convection current flowing in the mantle drags the plate above along
  - plates on either side of diverging margins should be moving at the same speed
- **Slab pull –** the subducting plate material is more dense than the mantle beneath and so sinks and subducts, pulling the plate along
  - plates where subduction zones form the greatest percentage of a plate margin should be moving fastest

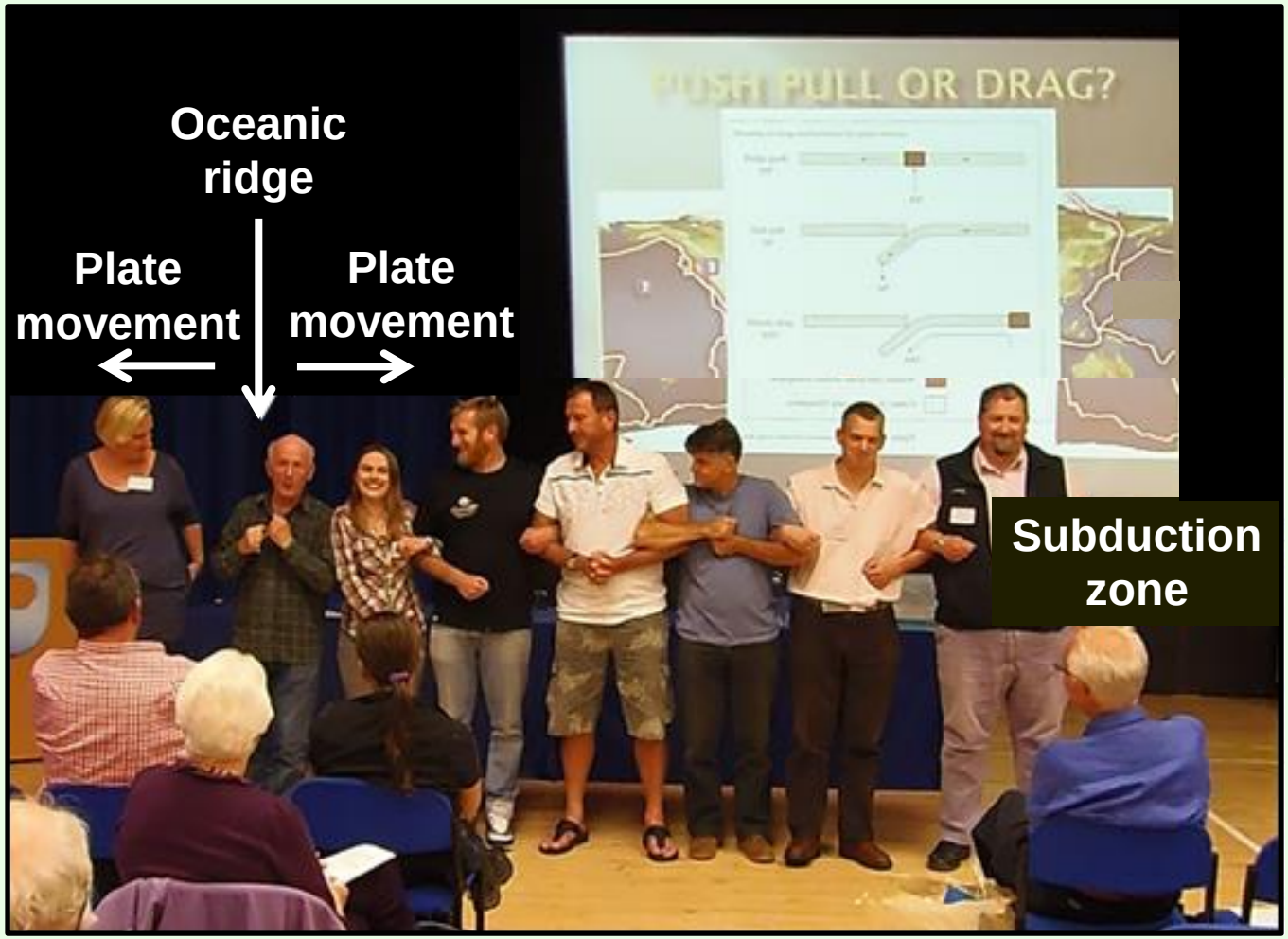
The Earth and plate tectonics

What drives the plates? – different theories

- **Little correlation –** but this may be important for plates with little subduction
  - plates where divergent margins form the greatest percentage of a plate margin should be moving fastest
- **Different speeds –** plates on either side of divergent margins move at different speeds
  - plates on either side of diverging margins should be moving at the same speed
- **Strong correlation –** thought to be the main driving force for most plates
  - plates where subduction zones form the greatest percentage of a plate margin should be moving fastest
- The convection current model, as still shown by many diagrams, has no evidence – our thinking has moved on

The Earth and plate tectonics

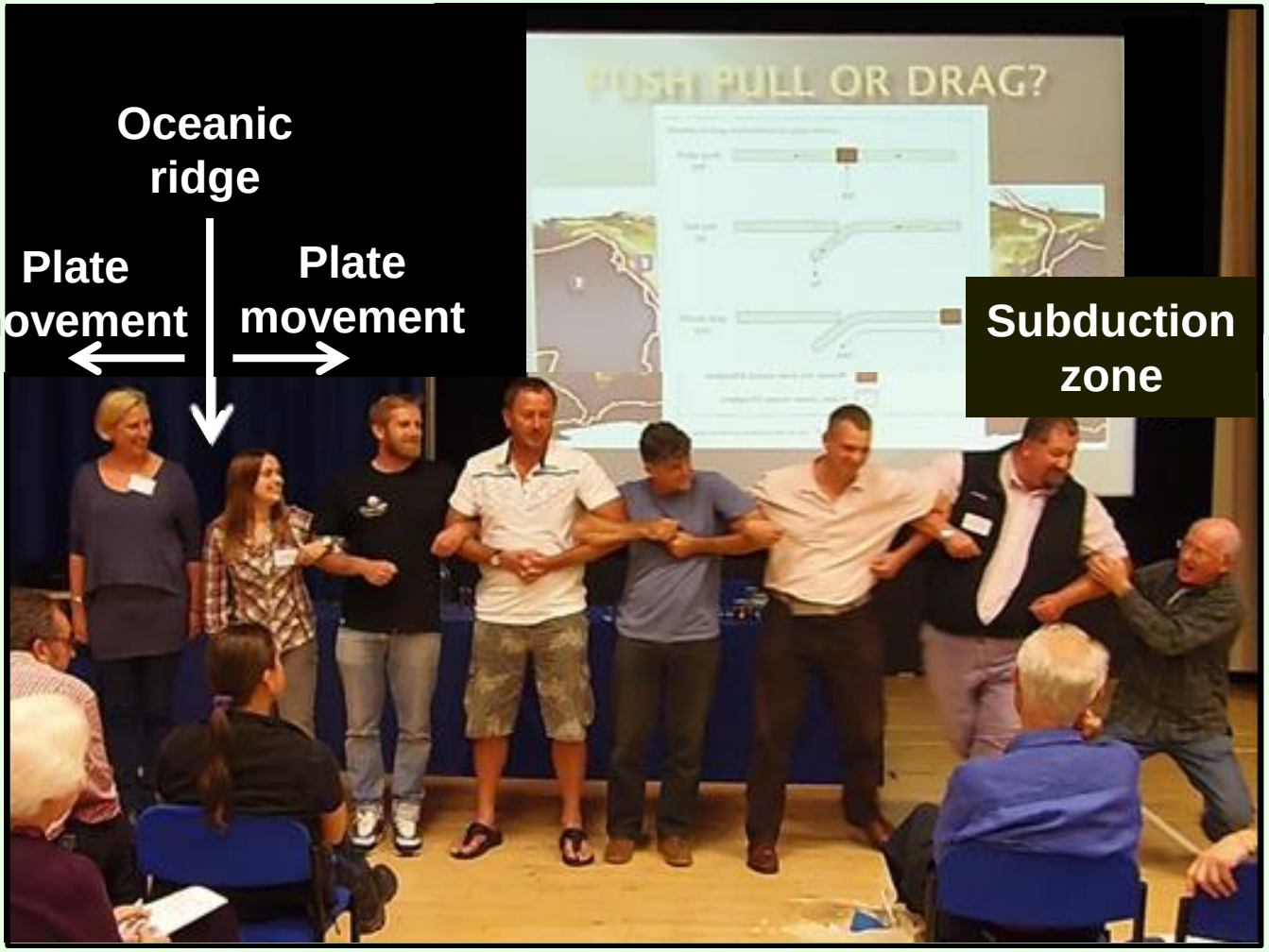
What drives the plates?



Stab pull © David Bailey

The Earth and plate tectonics

What drives the plates?



Stab pull © David Bailey

For more information about these processes, consult the: 'All models are wrong – but some are really wrong: plate-driving mechanisms' Earthlearn-ingidea

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Earth's structure

- **Frozen magnetism**

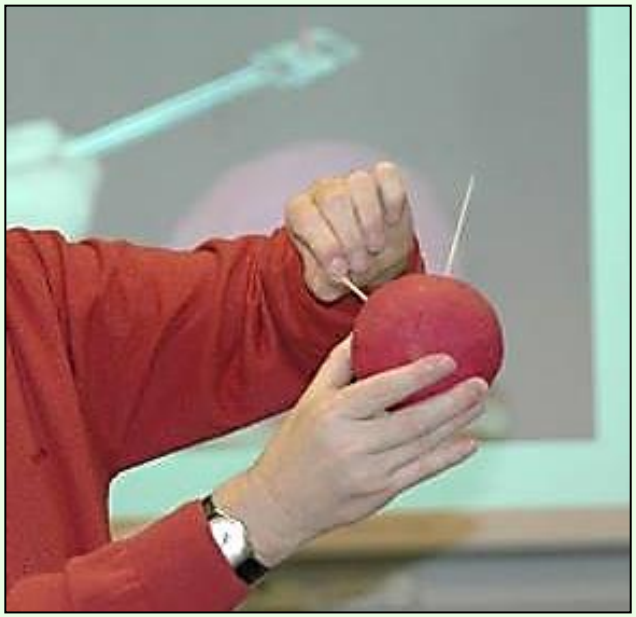
Go to: https://www.earthlearningidea.com/Video/V24_Magnetism1.html hyperlink

The Earth and plate tectonics

The magnetic evidence

From magnetic globe to magnetic rock evidence

Petri-dish magnetic field preserved in iron filings in wax © Michèle Bourne, ESEU



Model magnetic Earth (ESEU)

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Earth's structure

- **Magnetic Earth**

Go to: https://www.earthlearningidea.com/Video/V24_Magnetism2.html hyperlink

The Earth and plate tectonics

Model magnetic Earth

Model magnetic Earth (ESEU)

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Model magnetic Earth

- How many degrees does the magnet on the Magnaprobe™ rotate through as it is moved from one pole to the other?
- 360^{o} or back to the start = 0^{o}

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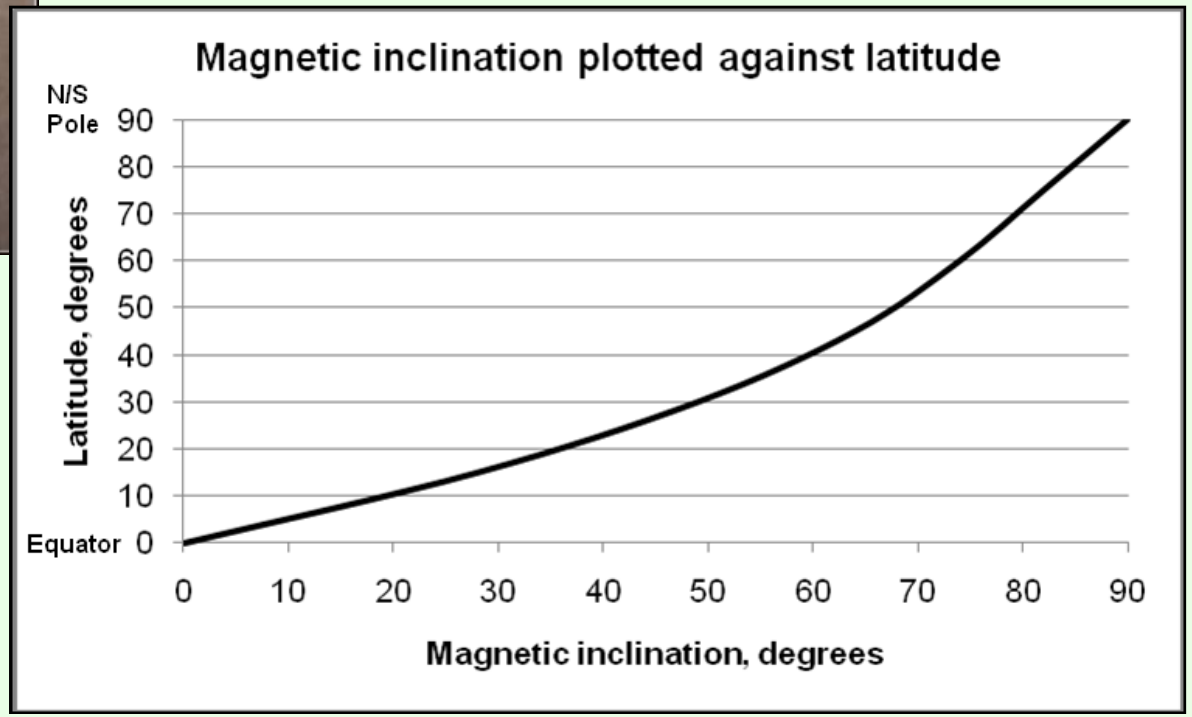
Model magnetic Earth

- If a volcano erupted at the North Pole, what angle (dip) would the magnetism recorded there have (the remanent magnetisation)?
- Vertical (90^o)
- If a volcano erupted at the South Pole, what dip would the remanent magnetisation there have?
- Also vertical (90^o)
- If a volcano erupted at the Equator, what dip would the remanent magnetisation there have?
- Horizontal (0^o)
- Some lavas of Carboniferous age in the UK have horizontal magnetisation. Where was the UK when the lavas erupted?
- On the Equator

The Earth and plate tectonics

Preserving remanent magnetisation

Petri-dish magnetic field preserved in iron filings in wax © Michèle Bourne, ESEU



Magnetic inclination plotted against latitude (graph) © Chris King

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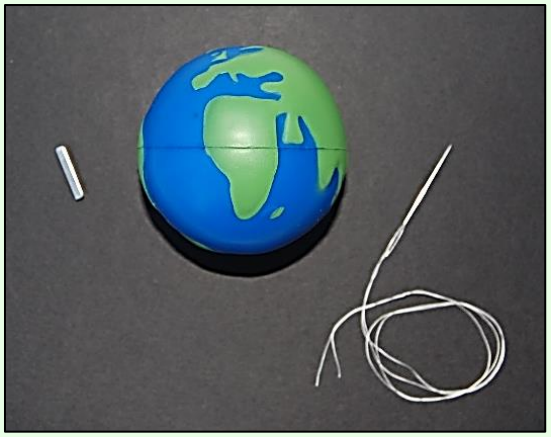
Earth's structure

- **Magnetic Earth using a sponge ball globe**

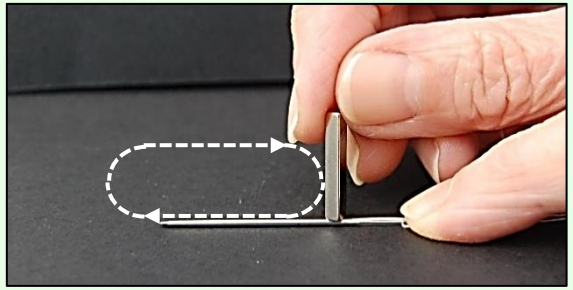
Go to: https://www.earthlearningidea.com/Video/V24_Magnetism3.html hyperlink

The Earth and plate tectonics

Recipe for a magnetic Earth and a magnetic detector



- Collect a needle and thread, a small magnet and an ‘Earth’ stress ball.
- Thread the needle with the piece of thread.
- Make the needle into a magnet, by laying it flat on the table, holding a magnet upright, and stroking it in the same direction ten times, as in the photograph.
- Push a sharp pencil or pen into the North Pole of the stress ball until it reaches just over half way
- Remove the pencil/pen and push a small magnet into the same hole until it reaches half way
- You now have a model magnetic Earth and a magnetised needle ‘magnetic detector’



The Earth and plate tectonics

Recipe for a magnetic Earth and a magnetic detector

- Find one of the magnetic poles of the Earth by hanging the needle from the thread, and finding where the needle is pulled straight down
- Find the pole on the other side of the model Earth, where the two magnets (the needle magnet and the one in the Earth) repel, so the needle is pushed away from the pole and circles around it at an angle
- Find the Equator, where the needle is upright beside the side of the Earth

Note: We need to teach pupils that Earth's magnetism is **NOT** caused by a bar magnet inside the Earth – the evidence is that it is caused by currents in the core. This is just a model of how Earth's magnetism works

Teaching Earthlearningideas

The plate tectonic story

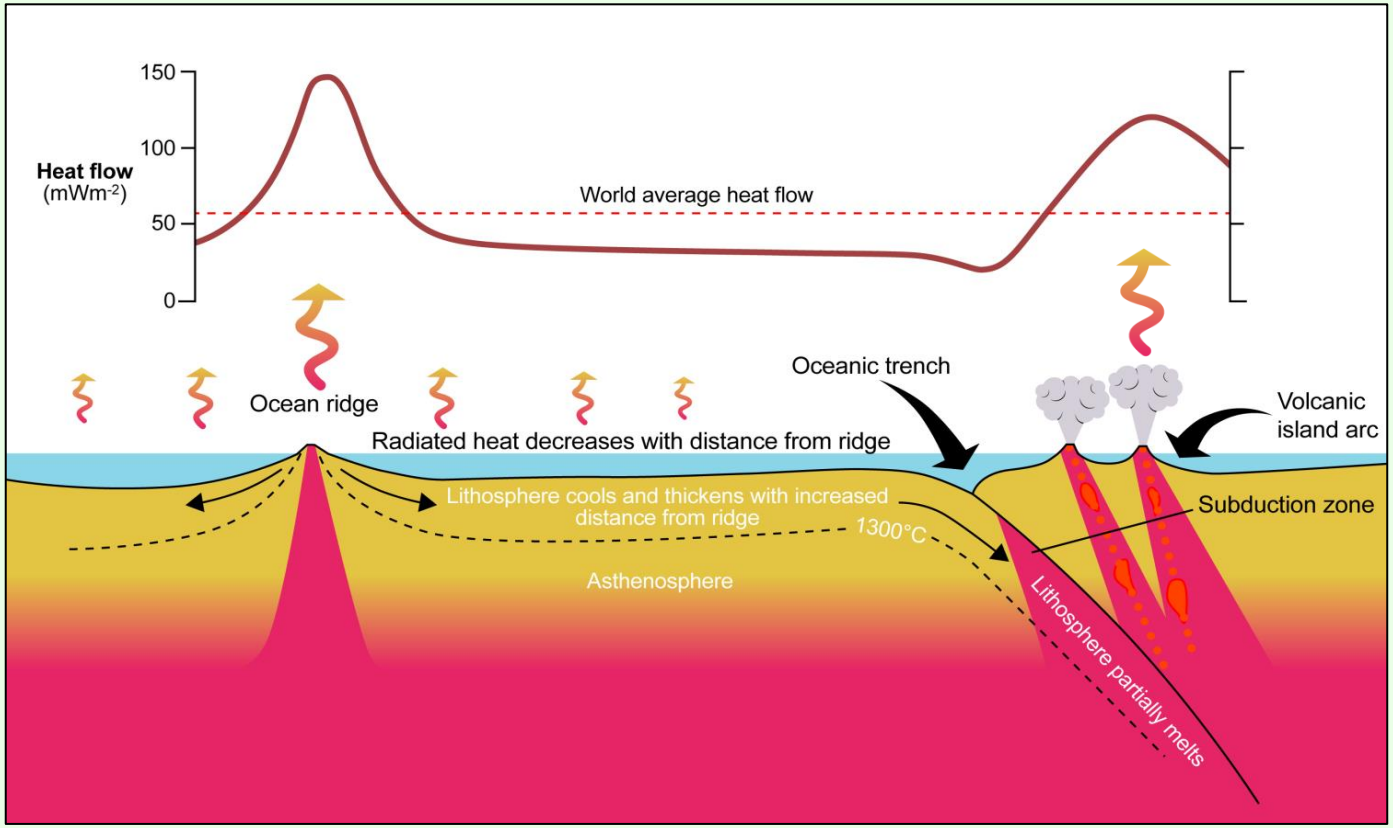
- **The heat flow evidence**

Go to: https://www.earthlearningidea.com/Video/V28_Heat_flow.html hyperlink

The Earth and plate tectonics

The heat flow evidence

The pattern of heat flow from the Earth



The pattern of heat flow out of the ocean floor and the upper part of the mantle and the crust © Chris King and Dee Edwards, redrawn by ESEU

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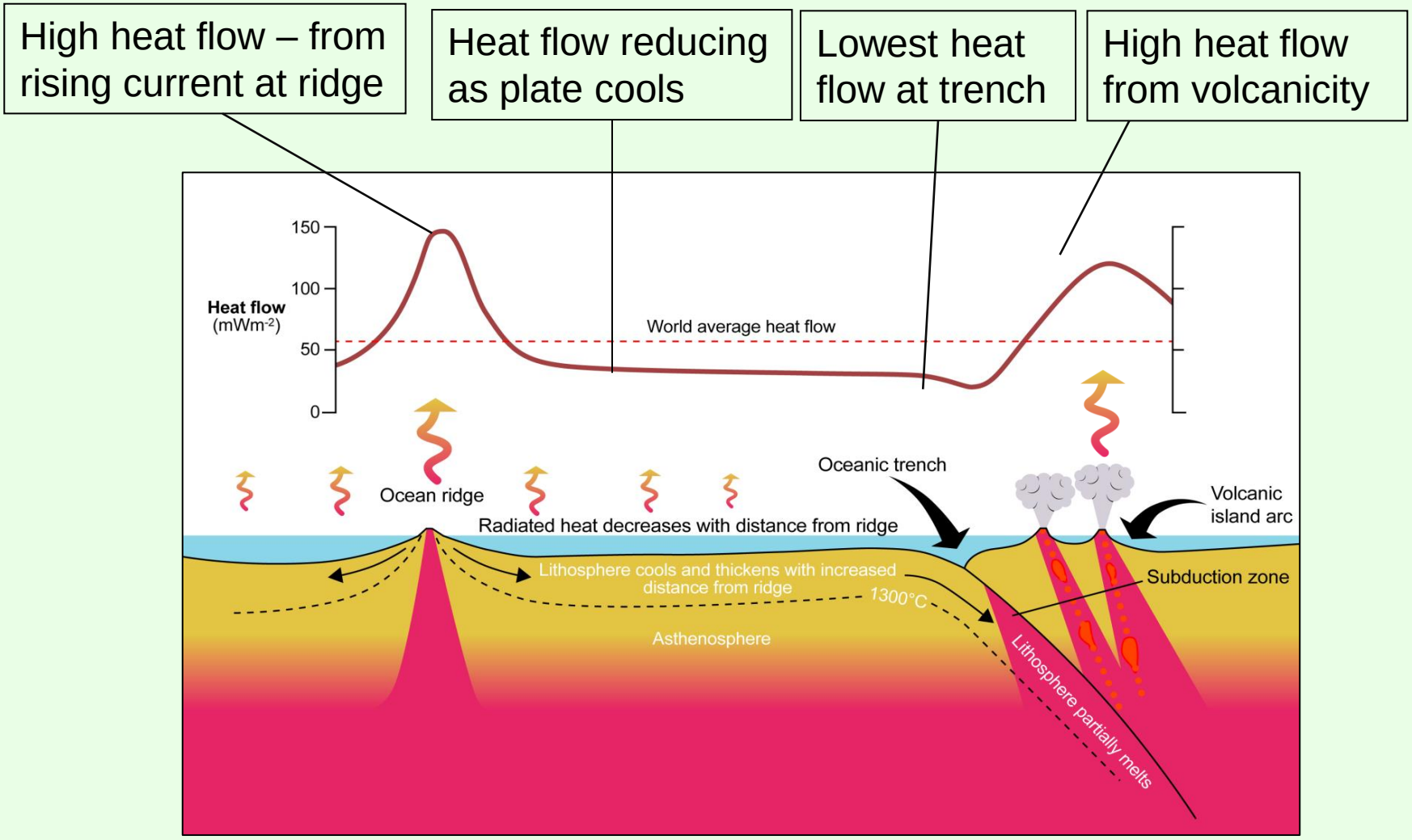
The pattern of heat flow from the Earth



The pattern of heat flow out of the ocean floor and the upper part of the mantle and the crust © Chris King and Dee Edwards, redrawn by ESEU

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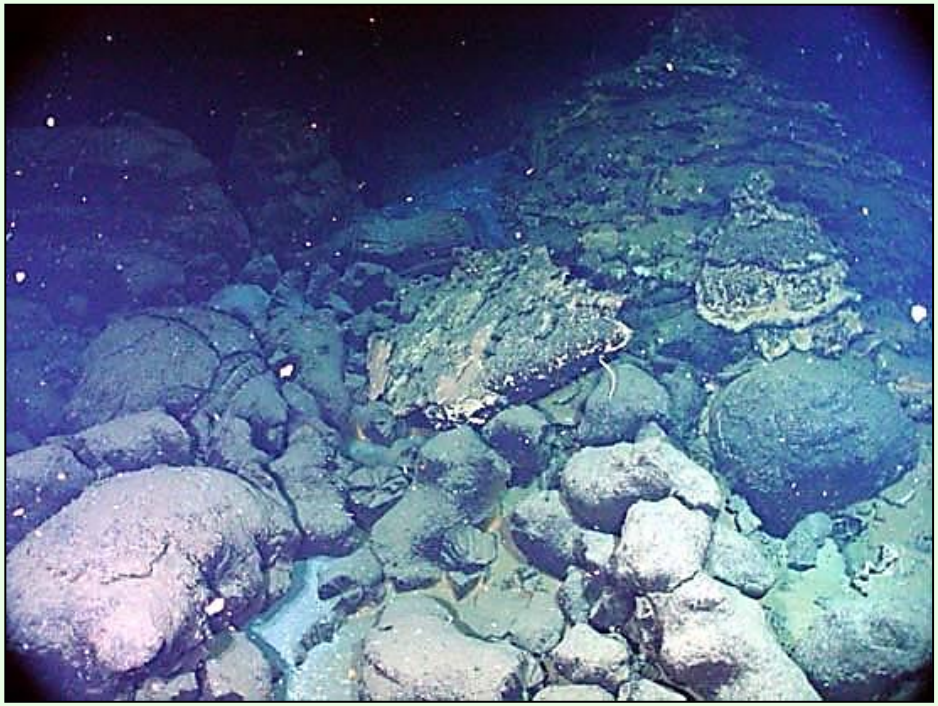
The plate tectonic story

- **The age of ocean floor and plate speed**

Go to: https://www.earthlearningidea.com/Video/V28_Age_ocean_floor.html
hyperlink

The Earth and plate tectonics

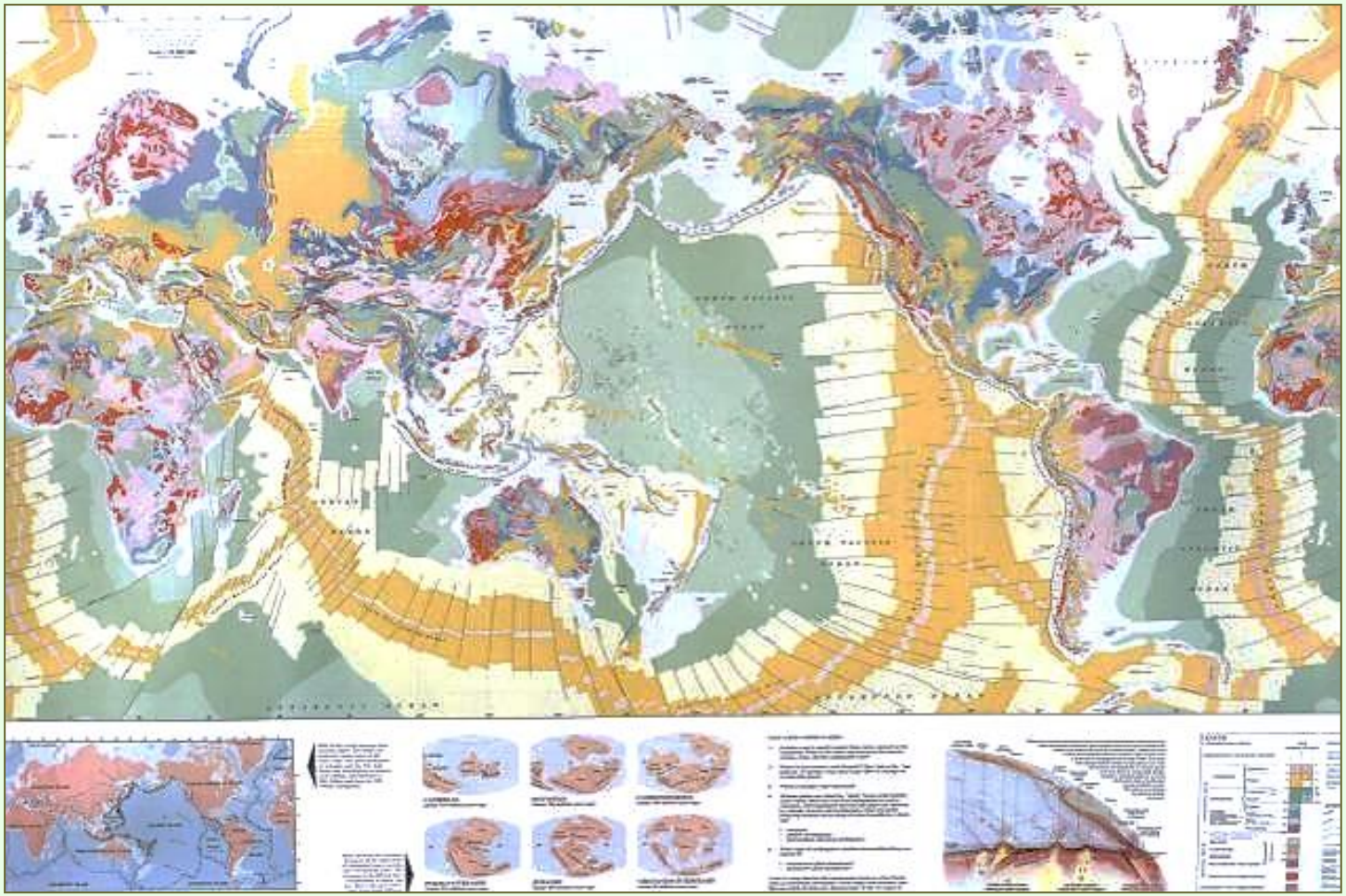
The age of the ocean floor evidence: ocean floors are young where new plate is being formed, becoming older outwards



‘Ancient pillow lava’ by US National Oceanic & Atmospheric Administration – image in the public domain

The Earth and plate tectonics

Evidence from the age of the sea floor

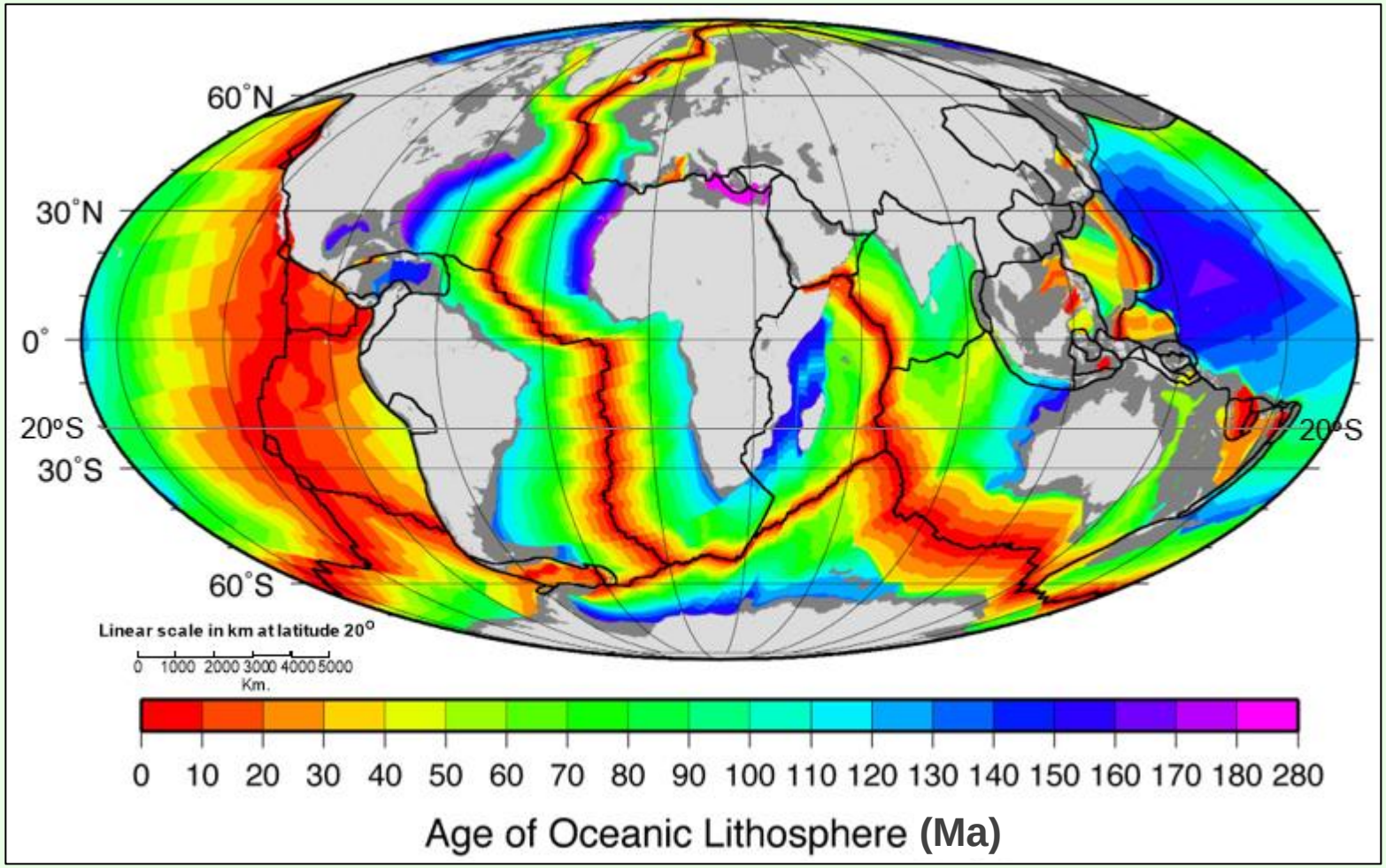


Photograph of 'The Geological Map of the World'. © Open University

Age of the sea floor – youngest = dark yellow, oldest = pale green

The Earth and plate tectonics

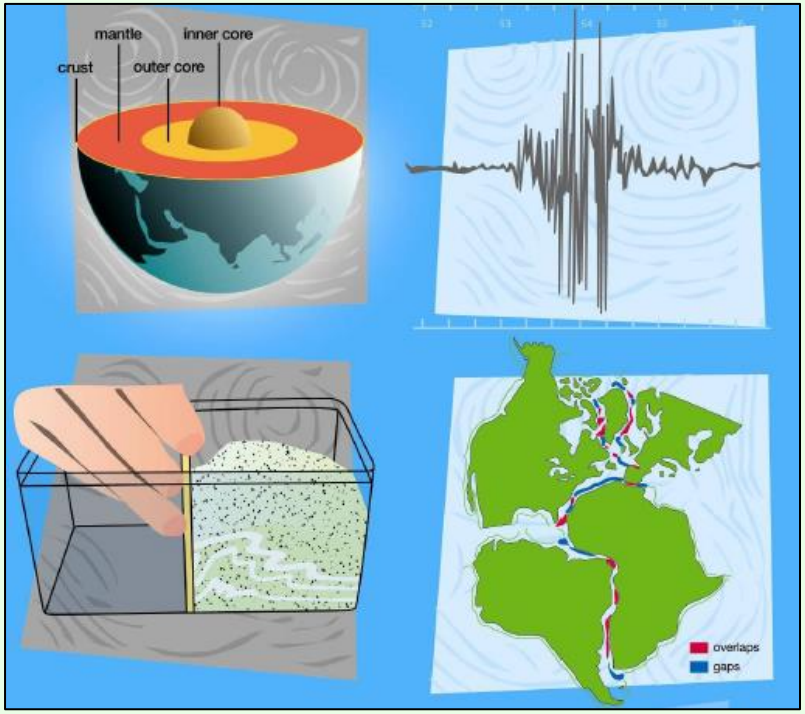
Which is the fastest-spreading oceanic ridge?



The Earth and plate tectonics – online

End of Part 1

Earth Science for science and geography – video workshop



Developed from the Earth Science Education Unit 'The Earth and plate tectonics' workshop, with permission