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Plate tectonics passport activity – Teachers notes

These notes have been designed be used with the plate tectonics powerpoint presentation and passport activity. The presentation and activity materials can be downloaded from www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations

- This activity works best in room with access to a smartboard/overhead projector to run through the presentation.
- The activity and presentation can be used in conjunction with the plate tectonics floor map available to download as 16x A4 sheets on our resources page (A0 size once stuck together). if your printer allows A3 printing you could blow up the A4 images to A3 to make your map even bigger!
- Suitable for KS2 pupils (age 7-11) – but could be adapted for other key stages.
- Some suggested questions to ask are highlighted in **bold**
- Estimated activity time 1 hour

The Geological Society gives permission for the presentation and notes to be adapted where appropriate.

Learning Objectives:
- To understand that the Earth is made up of four different layers
- To understand that the Earth's crust and uppermost mantle are split into tectonic plates which can move over time
- To understand that there are 3 main different types of plate boundaries which are intrinsically linked to the Earth's distribution of earthquakes and volcanoes

Subject Content Areas:
- Locational knowledge – name and locate different countries, continents, tectonic plates, volcanoes and mountain ranges.
- Physical geography - geological timescales, rocks, volcanoes and earthquakes.
- Human geography - how natural disasters can affect human population
- Geographical skills and fieldwork - interpretation of maps and keys

Notes on how to run the passport activity
- Run through the introduction (up to slide 8) as a whole class. Get students to find different plates, continents, plate margins etc. on the floor/wall map as the notes suggest.
- Split students into 5 groups
- Each group starts at a different site (e.g. Iceland) and answers the questions in the passport using the **site information sheets** (downloadable from Geological Society website) – students can move around the floor map or have different tables for each site.
- Depending on available time each group may not be able to complete all 5 sites – but all sites will have been covered by at least one group.
- Assemble students together again to go over booklet answers and discuss the different tectonic scenarios they have looked at. Summaries of each tectonic site and answers to passport questions and are found in slides 10-19.

Detailed information for presentation

Slide 1: Plate Tectonics, Earthquakes and Volcanoes

Slide 2: Structure of the Earth

- The Earth is made up of four different rock layers (a bit like an onion!). These layers are the inner core, outer core, mantle and crust.
- Right in the centre of the Earth is the inner core - a huge solid ball of iron and nickel metal. It is thought to be around 6000°C in temperature, as hot as the surface of the Sun! These temperatures on land would be easily hot enough to melt metal but due to the immense pressure of the other layers squashing down on it, the inner core is completely solid.
- The next layer is the outer core - a layer of liquid nickel and iron at 4500-6000°C. The outer core can flow and is what causes the Earth to have a magnetic field.
- The next layer is the mantle. It is a 2900km thick layer of solid rock, it is <u>not a liquid</u> but parts of the mantle can sometimes melt to form pockets of liquid rock called magma. The mantle is cooler than the inner and outer core but still very hot with temperatures between 200 and 4000°C.
- The thinnest and outermost layer of the Earth is called the crust and it's where we are. All of the Earth's oceans, rivers, mountains, volcanoes, hills and valleys are part of the crust. The Earth's crust is made up of heavy oceanic crust (made from basalt), which mainly forms the ocean basins, and lighter material (granite) which forms the continental crust.

Slide 3: Plate tectonics

- The Earth's crust and uppermost mantle (known as the lithosphere) are brittle, meaning they can be buckled and fractured. The crust and uppermost mantle are broken up into slabs called lithospheric plates which fit together like a huge jigsaw puzzle.
- The red lines on the map show the edges of the plates which are called plate boundaries.
- Plate boundaries are where most of the volcanoes and earthquakes occur, so they are extremely important for geologists to study.
- Lithospheric plates are referred to as oceanic plates when most of the crustal part of the plate is composed of oceanic crust (show on the map) and continental plates where a large part of the crust forming the plate is composed of continental crust (show on map). Most of the plates are named after the continents and oceans.
- **If you have the floor/wall map get students to place names on the correct plates (some are more difficult than others!) otherwise use map on the slide.** Next slide shows plate names.

Slide 4: Plate tectonics (2)

Plates move by sliding over the hotter mantle below the plate which, although solid, is more able to bend, like a chocolate bar in a warm room. This happens very slowly at a rate of a few mm per year, (about the same rate your fingernails grow).

- Over millions of years the plates can end up moving around thousands of kilometres. They can be pushed together to form mountain belts and spread apart to create ocean basins.
- At plate boundaries plates can either be moving towards each other, away from each other, or alongside each other.

Slide 5: Divergent boundary

- Plate boundaries where plates are moving **away from each other** are called divergent (or constructive) plate boundaries.
- When plates pull apart hot magma rises up to fill in the gap and new crust is created between the two plates. The Mid Atlantic ridge is an example of a divergent plate boundary on Earth.
- **Get students to find the Mid Atlantic Ridge (runs down middle of Atlantic Ocean) and place arrows in appropriate directions to show divergent margin, i.e. North American and Eurasian plates moving away from each other – note also that Iceland is on the Mid Atlantic Ridge.**

- ## Slide 6: Convergent boundary
- Boundaries where plates are moving towards each are called a convergent (or destructive) plate boundaries.
- When plates cool they get thicker until their weight causes them to sink down into the mantle and become recycled or get scraped off onto the continent to become part of the mountain ranges that form.
- When plates sink down into the Earth's mantle they create a subduction zone.
- Here,water within the rock making up a plate is heated and seeps into the mantle directly above causing it to melt and form magma. This magma then rises through the lithosphere and erupts explosively on land as lava and forms volcanoes (left diagram)
- As well as having lots of volcanic activity, subduction zones also get a lot of earthquakes. As one plate sinks downwards it grinds against the plate above and can become stuck due to friction. Pressure builds up and eventually the plates jolt past each other with a tremendous amount of force. The built-up energy is released as seismic waves which shake the Earth – this is an earthquake.
- **Get students to find the Andes mountain range (runs down the western edge of South America) and place arrows showing a convergent margin i.e. South American and Nazca plate moving towards each other. This is an example of a subduction zone where one plate (Nazca) is being subducted under another (South American) forming volcanoes (left diagram).**
- **Get students to find the Himalayas (mountain chain between India and Asia) and place arrows showing a convergent margin between the Indian and Eurasian plates– both plates are being forced upwards here and form mountains rather than volcanoes (right diagram)**
- **Note how there are lots of earthquakes and volcanoes at the convergent boundaries.**

Slide 7: Transform boundary

- The third type of boundary is called a transform or conservative boundary. Here the plates do not move towards or away from each other but instead slide past each other.
- Lots of earthquakes occur at transform boundaries but no new crust is made and no old crust is subducted.
- **Get students to find San Andreas Fault (California, West USA) and place arrows on map to show plate movements at a conservative boundary – both Pacific and North American plate moving North West but North American plate is moving more slowly.**

Slide 8: 'Hot spots'

- Most volcanic activity occurs at plate boundaries; however sometimes volcanoes can form in the middle a plate far away from any plate boundary. An example of this is the Hawaiian Islands which are located in the middle of the Pacific Plate, 3,200km away from the nearest plate boundary.
- **Get students to find Hawaiian islands on map (Pacific Ocean, west of Mexico)**
- These volcanoes form due to the presence of a 'hot spot', a region of super-heated rocks in the Earth's mantle caused by a plume rising from the core-mantle boundary. This region of hot mantle causes magma to rise and erupt as lava on the ocean floor, creating underwater volcanoes called seamounts. When these seamounts grow tall enough, they breach the surface of the ocean and become volcanic islands like the Hawaiian Islands.
- The chain of Hawaiian Islands has been created because the Pacific Plate has been gradually moving, like a conveyor belt, over the 'hotspot' for millions of years. As new oceanic crust is positioned over the 'hotspot', volcanic islands are formed from the rising magma. As the crust then moves away from the 'hotspot' these volcanoes lose their supply of hot magma and become extinct. Therefore, the youngest island in the chain, which is currently Hawaii, is the only volcanically active island.

Students should now be able to complete page 1 'What is plate tectonics' in the passport booklet

Slide 9: Plate boundaries

Get students to find each of the five sites (Iceland, Himalayas, Japan, San Andreas Fault, Hawaiian Islands) on the floor map and recall which plate boundaries they represent. (Japan is a destructive margin)

Slide 10: Now it's your turn.

Split students into 5 groups. Start each group at a different site on the floor map. Students will need to read the site information sheets to be able to answer the questions in the passport booklet.

Slide 11: Iceland

Iceland is located on the Mid Atlantic ridge, what type of plate boundary is this? Divergent (constructive) boundary, Eurasian and North American plates are moving away from each other
What geological landforms do we find in Iceland? Volcanoes
Why do we get volcanoes in Iceland? Volcanoes are formed because as the plates move apart, hot mantle rock oozes upwards directly underneath the Mid-Atlantic Ridge above Iceland. When this hot rock gets close to the surface it melts and then erupts as lava on the surface forming the volcanic island of Iceland.

Slide 12: Iceland (2) – answers from passport

Q1. Can you name any of Iceland's volcanoes? Any from Katla, Eyjafjallajökull, Krafla, Grimsvotn, Hekla, Bardabunga (may also know others)
Q2. How might eruptions form Iceland's volcanoes affect air travel? Ash particles from volcanic ash clouds can damage aeroplane engines
Q3. How is Iceland's volcanic energy used in people's homes? Geothermal energy from the Earth can used to heat homes and generate electricity

Slide 13: Himalayas

Where are the Himalayas and what are they? Nepal/India, highest mountain range on Earth
What is the name of the highest peak in the Himalayas? Mount Everest (8848m)
If we get a mountain range being pushed up what directions do you think these plates are moving in? Towards each other. In this case the Indian plate is moving north.

Slide 14: Himalayas (2) – answers from passport

Q1. What type of plate boundary created the Himalayas? Convergent (destructive) plate boundary
Q2. What devastating natural disaster occurred in Nepal in April 2015? A huge earthquake occurred in Nepal in April 2005
Q3. How do we know that some of the rocks that now form the Himalayas used to be part of the sea floor? The rocks at the top of Mount Everest contain fossils from ancient sea creatures. These rocks must've been formed under the sea before they became part of the mountain.

Slide 15: Japan

What did you notice about Japan on the floor map? Japan is covered with so many earthquakes and volcanoes that you cannot see its outline on the map properly
Why do you think there are so many earthquakes and volcanoes in Japan? It's at the boundary of four different plates: Pacific plate, North American plate, Philippines plate Eurasian plate.

All of these different plate boundaries make Japan's tectonics very complicated to understand, we are going to focus on the northern part of Japan. Here the Pacific plate is moving towards and being pushed under the North American plate.
When one plate sinks beneath another plate what do geologists call this? Convergent (destructive) boundary, subduction zone, subduction

Slide 16: Japan (2) – answers from passport

Q1. What type of plate boundary causes volcanoes and earthquakes in Japan? Convergent (destructive) plate boundary

Q2. What are tsunamis and why are they dangerous? Tsunamis are huge waves that can be triggered by earthquakes. When they crash on land they can kill and injure thousands of people and completely wipe out buildings and homes.
Q3. What do we call the region on Earth where most volcanic eruptions and earthquakes occur? Pacific Ring of Fire

Slide 17: San Andreas Fault

Where is the San Andreas Fault? California
How are the plates moving at the San Andreas Fault? Same direction, North West
What natural hazards occur due to the plates rubbing alongside each other? Earthquakes are common because as the plates grind past each other they can become stuck due to friction (if you have any sandpaper you can demonstrate this pressure then builds up and suddenly the plates jolt into a new position causing an earthquake.

Slide 18 – San Andreas Fault (2) – answers from passport

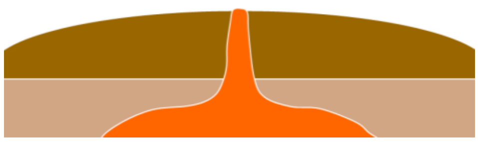
Q1. What is a transform boundary? A transform boundary is where plates are moving alongside each other
Q2. What equipment do geologists use to detect earthquakes? Geologists can measure the magnitude of earthquakes by using an instrument called a seismometer.
Q3. Which direction are the North American and Pacific plates moving in? North West

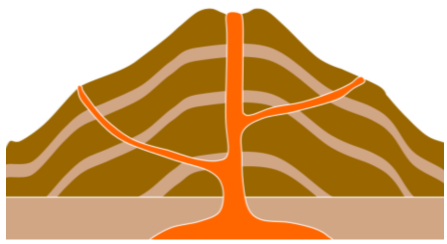
Slide 19: Hawaii

What do you notice about the Hawaiian Islands compared with the other sites? They are not near a plate boundary.
Why do we get a chain of volcanic islands instead of one huge volcano? The Pacific plate is moving over the hotspot so a chain of volcanoes is created.

Slide 20: Hawaii (2) – answers from passport

Q1. Can you draw the shapes of a shield volcano and a stratovolcano?





Q2. What type of rock forms from lava erupted at shield volcanoes? Basalt

Slide 21: Extra!

Extra task for homework/further lesson – make an earthquake or volcanic eruption fact file.
Ask the pupils to focus on the tectonic setting of their example, making sure they link where it occurred with a plate boundary and the type of eruption or the intensity of the earthquake
Possible case studies to research:

Volcanic eruptions
Mount Vesuvius, Italy - AD79
Mount St Helens, Washington, USA - 1980
Mount Pinatubo, Phillipines - 1991
Nevado del Ruiz, Columbia – 1985
Eyjafjallajokull, Iceland - 2010
Mount Etna - December 2018

Earthquakes
Los Angeles earthquake - 1994
Japan/Tohoku earthquake - 2011
Nepal/Gorkha earthquake - 2015
Haiti earthquake - 2010
Mexico City, Mexico 2017