PROVISIONAL

DELIVERY GUIDE

Theme: Hazardous Earth

June 2015

A Level Geography

A LEVEL REFORM

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Oxford Cambridge and RSA

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CONTENTS

Introduction

Delivery guides are designed to represent a body of knowledge about teaching a particular topic and contain:

- Content: A clear outline of the content covered by the delivery guide;
- Thinking Conceptually: Expert guidance on the key concepts involved, common difficulties students may have, approaches to teaching that can help students understand these concepts and how this topic links conceptually to other areas of the subject;
- Thinking Contextually: A range of suggested teaching activities using a variety of themes so that different activities can be selected which best suit particular classes, learning styles or teaching approaches.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resourcesfeedback@ocr.org.uk.

KEY

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Curriculum Content

Theme 5 - Hazardous Earth

What is the evidence for continental drift and plate tectonics?

Key Ideas	Content	Scale
There is a variety of evidence for the theories of continental drift and plate tectonics	• **Theories of continental drift and plate tectonics including:** o the basic structure of the earth including the lithosphere, asthenosphere and the role of convection currents o evidence for sea-floor spreading; paleomagnetism; the age of sea floor rocks o evidence from ancient glaciations o fossil records	**G, R**
There is a recognisable pattern of plates and their boundaries **There are distinctive features and processes at plate boundaries.**	• **Earth's crustal features and processes, including:** o the global pattern of plates and plate boundaries o the features and processes associated with divergent (constructive) plate boundaries o the features and processes associated with convergent plate boundaries to include oceanic-continental, oceanic-oceanic (destructive) and continental-continental (collision) boundaries o the features and processes associated with conservative plate boundaries	**G, R**

Curriculum Content

What are the main hazards generated by volcanic activity?		
Key Ideas	**Content**	**Scale**
There is a variety of volcanic activity and resultant landforms and landscapes.	• **Different types of volcanoes to investigate their causes and features including**: o explosive eruptions (higher viscosity magma) located at convergent (destructive) plate boundaries o effusive eruptions (lower viscosity magma) and landforms located at divergent (constructive) plate boundaries o eruptions not at plate boundaries (hot spots) such as the Hawaiian chain and the East African Rift valley o size and shape of different types of volcanoes , including super volcanoes o the volcanic explosive index (VEI) measure of assessing volcanic activity	**G, R, L**
Volcanic eruptions generate distinctive hazards	• **Different types of volcanic eruptions and the different types of hazards they generate including**: o lava flows; pyroclastic flows; gas emissions; tephra; ash o lahars; flooding associated with the melting of ice o tsunamis associated with explosive eruption	**R, L**

Curriculum Content

What are the main hazards generated by seismic activity?		
Key Ideas	**Content**	**Scale**
There is a variety of earthquake activity and resultant landforms and landscapes	• **Earthquake characteristics to investigate their causes and features including:** o shallow-focus earthquakes o deep-focus earthquakes o the different measures of assessing earthquake magnitude; Richter; moment magnitude scale; modified Mercalli intensity scale o the effects earthquakes have on landforms and landscapes including the development of escarpments and rift valleys	**G, R, L**
Earthquakes generate distinctive hazards	• **Hazards generated by earthquakes, including:** o ground shaking and ground displacement o liquefaction o landslides and avalanches o tsunamis associated with sea-bed uplift and underwater landslides o flooding	**R, L**

Curriculum Content

What are the implications of living in tectonically active locations?		
Key Ideas	**Content**	**Scale**
There are a range of impacts people experience as a result of volcanic eruptions	**Case studies** of **two** countries at contrasting levels of economic development to illustrate: • reasons why people choose to live in tectonically active locations • the impacts people experience as a result of volcanic eruptions • economic, environmental and political impacts on the country	
There are a range of impacts people experience as a result of earthquake activity	**Case studies** of **two** countries at contrasting levels of economic development to illustrate: • reasons why people choose to live in tectonically active locations • the impacts people experience as a result of volcanic eruptions • economic, environmental and political impacts on the country	**L**

Curriculum Content

What measures are available to help people cope with living in tectonically active locations?		
Key Ideas	**Content**	**Scale**
There are various strategies to manage hazards from volcanic activity	**Case studies** of **two** countries at contrasting levels of economic development to illustrate strategies use to cope with volcanic activity including: • attempts to modify the event, such as lava diversion channels • attempts to modify vulnerability such as community preparedness • attempts to modify losses, such as rescue and emergency relief	**L**
There are various strategies to manage hazards from earthquakes	**Case studies** of **two** countries at contrasting levels of economic development to illustrate strategies use to cope with hazards from earthquakes including: • attempts to modify the event such as land-use zoning • attempts to modify vulnerability such as building design • attempts to modify losses such as insurance	**L**

What measures are available to help people cope with living in tectonically active locations?		
Key Ideas	**Content**	**Scale**
The exposure of people to risks from tectonic hazards changes through time	**How and why has the risks from tectonic hazards changed over time;** • changes in the frequency and impacts of tectonic hazards over time • the degree of risk posed by a hazard and the probability of the hazard event occurring (the disaster risk equation) • possible future strategies to cope with risks from tectonic hazards. **The relationship between disaster and response including the Park model.**	**G, R, L**

Thinking Conceptually

Approaches to teaching the content

In teaching this topic, students should be given opportunities to develop a deep understanding of the processes associated with plate tectonics and the detailed causes of tectonic hazards and landforms. They should develop an understanding of the theories using a range of evidence, such as plate tectonics and continental drift, and begin to realise that some of this science is still to be understood fully (e.g. properties of the Earth's core).

Common misconceptions or difficulties students may have

Students will need to understand that the earth's crust and tectonic plates are dynamic and always changing, for example through the study of hotspots (e.g. Hawaii) and continental rifting (e.g. East African Rift Valley). Looking at the changes in continents over geological time should also help to develop this understanding (supercontinent cycling).

When considering impacts of tectonic hazards, students should also develop their skills in looking at the causes of some impacts, and consider that human and physical causes are not always clear cut and entirely separate. Comparing the impacts of a variety of up to date case studies will help to illustrate this.

Conceptual links to other areas of the specification – useful ways to approach this topic to set students up for topics later in the course.

The dynamic processes of plate tectonics govern the location of the world's oceans, continents and mountain systems. These in turn influence ocean circulation and atmospheric processes, which affect global climate. The Hazardous Earth topic therefore links intrinsically with both the Physical Systems component of the course, and the Geographical Debates component, in particular, Theme 1 Climate Change and Theme 3 Exploring Oceans. Understanding the physical structure of the Earth and the changing nature of the crust and tectonic plates is a key foundation to understanding global climate change, the world's oceans, and surface processes such as glaciation and coastal landscape systems.

Activities	Resources
Activity 1 – Evidence card sort This activity could be used as an introduction to the theories of plate tectonics and continental drift. Students will need a basic understanding of the structure of the Earth, the arrangement of the tectonic plates and the continents of today before doing this activity. Students can work in small groups. Hand out activity sheet and ask students to cut out the cards. Students should read and sort the cards as they feel is appropriate. The cards fit into 5 groups of evidence: 1. Continental fit 2. Glacial deposits 3. Geological sequences 4. Fossil evidence 5. Palaeomagnetism Students should then use the information on the cards to produce a written explanation of the evidence for these theories. Their explanations could be complimented by the inclusion/ sketching of key diagrams to explain each piece of evidence, such as those found in Monroe et al., 2006 (Chapter 2 from Physical Geology: Exploring the Earth, 2006, Monroe, Wicander and Haslett. http://usuarios.geofisica.unam.mx/cecilia/cursos/PTeCh02_Wicander-PhysG.pdf	Learner Resource 1
Activity 2 – Glossary of key terms This activity could introduce new terminology or review key terms once they have already been covered. The terms are in alphabetical order which encourages students to think about them in isolation and concentrate on understanding their meaning. Students could use their notes, dictionaries, subject-dictionaries, textbooks or the internet to produce concise definitions for each key term. As a follow-up to this activity, students could produce revision activities using these key terms and definitions, such as crossword puzzles or dominoes: - www.teachitgeography.co.uk/attachments/18948.pdf www.puzzle-maker.com/CW http://worksheets.theteacherscorner.net/make-your-own/crossword/	Learner Resource 2

Activities	Resources
Activity 3 – Sketching plate boundaries Students to work in pairs and sit back to back. One student to be handed one of the Activity cards and the other student will need paper and pencil for drawing. The student with the card must keep the image secret and describe carefully what is shown without using the words on the card. The other student must draw the picture from the description. Set a time limit of 2 or 3 minutes. Review the drawings, discussing what elements of the description were helpful/ successful, and then swap over using a different Activity card, so that each student has a chance to draw/describe. This activity will focus students on exactly what is shown by the diagrams, practice their sketching skills and also introduce or review the different types of plate boundary.	Learner Resource 3
Activity 4 – Isoline maps This is a simple introduction to the use of isoline maps for hazard mapping. Students will develop their understanding of spatial and 3D viewing of volcanic hazards. There is also a very good general introduction to isoline maps here: http://www2.hawaii.edu/~dennis/Geog101L/Isolines.pdf Following on from this activity students could discuss or investigate other types of isoline maps used for hazard mapping such as lava flows/lahars/repeated ash falls which present a more complex picture. And that could lead into discussion of land-use zoning using this type of data	Learner Resource 4
Activity 5 – Hazard mapping Use the factsheet to answer the following question: What is a National Seismic Hazard Map and what can it be used for? Students could be set a word limit of exactly 200 or 250 words, to focus them on writing concisely and accurately. The precise word limit will encourage students to review and edit their written work. United States National Seismic Hazard Maps http://pubs.usgs.gov/fs/2008/3017/pdf/FS08-3017_508.pdf Factsheet produced by the US Geological Survey on National Seismic Hazard Maps, defining what they are and what they are used for	

Activities	Resources
Activity 6 – Measuring volcanic eruptions The Volcanic Explosivity Index has a logarithmic scale. Students should use the diagram (link below) to plot the data shown in the table to produce a graphic summary of VEI and eruption magnitude. It is their choice of how they can present these data and this could be done using IT or graph paper. Their plots could be annotated with examples of each eruption type/ magnitude. Diagram from Cool Geography website http://www.coolgeography.co.uk/A-level/AQA/Year%2013/Plate%20Tectonics/Volcanoes/VEI.jpg Volcanic Explosivity Index Or from http://en.wikipedia.org/wiki/Volcanic_explosivity_index	
Activity 7 – Modelling a rift valley Students to use modelling clay in a variety of colours to build a model of the East African Rift Valley using the diagram. The model-building should focus them carefully on the key features of rifting such as thinning of continental crust and the shape and direction of faulting during the process of extension. Once the models are complete students can photograph them, then annotate the key features on their photographs. Students could design and use a scoring sheet to analyse the accuracy of each other's models and provide feedback for improvement. The video below could also be used as part of this activity. Triple-arm rifting video from The Geological Society http://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Divergent/Triple-Junction A short video showing the Triple Junction of the East African Rift Valley – how it formed and how it will change in the future.	Learner Resource 5
Activity 8 – Why do people live in tectonically active locations? Using the table as a guide, students to complete this research activity using a variety of books, textbooks and /or the internet to produce two case studies comparing the reasons why people live in tectonically active locations in ACs and LIDCs. The sheet could be enlarged to A3 size. Students could also consider these factors from physical/ social/ political/ economic perspectives. The case studies could then also be considered in terms of lack of knowledge/ choice vs. calculated risk. This activity could then be developed into an essay question, using the table as a structured plan for the content.	Learner Resource 6

Thinking Contextually

Activities	Resources
Activity 9 – Human and physical factors affecting the impacts of earthquakes on people. Using the well-known statement *"Earthquakes don't kill people, buildings do"* as a discussion starting point, students can investigate the human and physical factors affecting the impacts of earthquakes on people. Students can explain in each box how each factor affects the amount of damage and loss of life due to an earthquake. Each factor could then be annotated with two comparative mini-case studies to illustrate large/small amounts of damage/loss of life. This would hopefully also highlight that the impacts are not simply less for the richer the country. Students could use a range of textbooks or the internet to research these mini-case studies.	Learner Resource 7
Activity 10 – Factors affecting vulnerability to tectonic hazards In order for students to understand the changing patterns in the number of people affected by tectonic hazards over time, it is important for them to understand the factors affecting vulnerability. This activity requires them to consider how these factors can increase or decrease vulnerability by completing the table. Mini-case studies or short examples can also be used to illustrate these points. This activity is also designed to introduce the concept that the richest countries are not always the safest and that increasing levels of development can sometimes lead to increased vulnerability.	Learner Resource 8

Learner resource 1 Evidence for the theories of continental drift and plate tectonics

See page 12

Fossils of *Mesosaurus* are only found in parts of South America and south Africa.	Seeds of *Glossopteris* were too large to have been spread by the wind.	Continental fit is best measured along the continental shelf at 2000m depth.
Coastlines are continuously shaped by erosion and deposition.	Erosion along the continental shelf is much less than along coastlines.	Glaciers cannot form over oceans and move onto land.
Glaciation leaves behind evidence of the movement of glaciers such as scratch marks in the bedrock called striations.	Geologically recent rocks show iron-bearing minerals aligned with today's magnetic field.	Thick rock sequences including coal can only have been formed in tropical conditions near the equator.
As magma cools, magnetic minerals (those that contain iron) will become aligned with the Earth's magnetic field.	The *Glossopteris* fauna is a plant fossil found in South America, India, Australia, Africa and Antarctica.	Glaciation leaves behind deposits such as till, which is sediment deposited under a glacier as it retreats.
Rock sequences containing glacial deposits such as those in Africa and South America cannot have formed near the equator.	Matching rock sequences of glacial, marine and non-marine rocks can be found in South America, Africa, India, Australia and Antarctica.	The orientation of striations seen in the bedrock of Australia, South America and India suggest glaciers formed in the oceans and moved onto land.
Today the Earth's magnetic poles (north and south) match the geographic poles.	*Glossopteris* seeds would not have been able to survive floating in sea water.	*Mesosaurus* was a freshwater reptile.
Glossopteris would not have been able to survive in a wide range of environments.	Ancient lava flows record remnant magnetism indicating that the Earth's magnetic field was completely reversed.	Coastlines of the Earth's major continents appear to fit together like a jigsaw.
Freshwater reptiles such as *Mesosaurus* would not have been able to swim across the Atlantic Ocean.	Fossils of the land reptile *Lystrosaurus* are found on the Gondwanan continents.	The rock record of South America, Africa, Antarctica, India and Australia preserves fossils of the land reptile *Cynognathus*.
Today's continents can be fitted together to reconstruct the supercontinent Pangea.	The continents where the *Glossopteris* fauna is now found cover a range of environments from polar to tropical.	Glacial evidence is present in rocks on continents that are now located close to the equator.
At mid-ocean ridges magma rise's and cools to form new oceanic crust, preserving a record of the Earth's polarity at that time.	A good example of 'continental fit' is shown by the similarities in shape of the coastlines of South America and Africa.	Surveys to map the palaeomagnetism of sea floor rocks show a 'stripy' pattern at each side of ocean ridges (normal and reversed polarity).
As new crust is formed at mid-ocean ridges, previously formed crust is pushed away from the ridge, preserving the pattern of palaeomagnetism on each side of the ridge.		

Learner resource 2 Glossary of key terms: Evidence for Plate Tectonics and Continental Drift

See page 12

Asthenosphere	
Collision boundary	
Conservative plate boundary	
Continental crust	
Continental fit	
Convection currents	
Convergent plate boundary	
Crust	
Destructive plate boundary	
Divergent plate boundary	
Glacial deposits	
Inner core	
Lithosphere	
Magnetic reversal	
Mantle	
Mid-ocean ridge	
Mountain-building	
Oceanic crust	
Outer core	
Palaeomagnetism	
Sea-floor spreading	
Tectonic plate	
Theory of continental drift	
Transform fault	

Learner resource 2 Glossary of key terms: Evidence for Plate Tectonics and Continental Drift

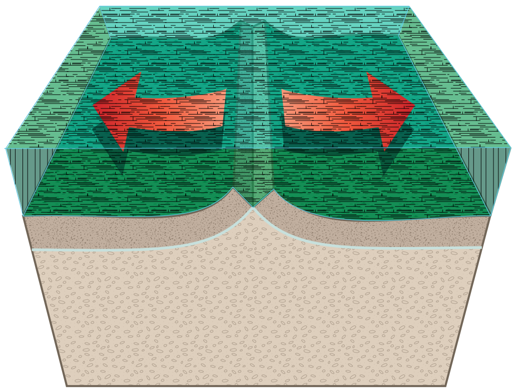
ANSWER SHEET

Asthenosphere	Part of the mantle below the lithosphere (100-400km below the surface) which is under extreme heat and pressure causing it to flow plastically.
Collision boundary	When two continental plates move towards each other neither can be destroyed in the mantle as continental crust is too buoyant, so they are pushed up to form fold mountains.
Conservative plate boundary	Plates moving in opposite directions relative to one another build up pressure which is eventually released as an earthquake. No crust is created or destroyed.
Continental crust	Crust found under continents and continental shelves which is 25-90 km thick and rich in silica and aluminium.
Continental fit	Evidence supporting the theory of plate tectonics: the coastlines of the Earth's major continents appear to fit together like a jigsaw.
Convection currents	Heat from radioactive decay causes the hottest mantle material to rise and displace cooler material which sinks, forming a convection cell.
Convergent plate boundary	When tectonic plates are moving towards each other (oceanic-oceanic crust or oceanic-continental crust), the denser oceanic crust is subducted (causing earthquakes) and partially melts forming volcanic mountain chains.
Crust	The outmost layer of the Earth which can be either continental crust (25-90 km thick) or oceanic crust (5 to 10 km thick).
Destructive plate boundary	Another name for a convergent plate boundary where oceanic crust is destroyed.
Divergent plate boundary	When tectonic plates are moving away from each other (two oceanic plates or two continental plates) bringing magma to the surface to form new crust.
Glacial deposits	Sedimentary material left underneath a glacier as it retreats.
Inner core	Solid part of the inside of the Earth, rich in iron.
Lithosphere	The solid outer part of the Earth comprising the crust and the upper, soild part of the mantle.
Magnetic reversal	Time in the geological past when the Earth's magnetic field switched to the opposite polarity than today.
Mantle	Layer inside the Earth between the crust and the core, rich in magnesium and silica.
Mid-ocean ridge	Underwater mountain range formed by creation of new oceanic crust at divergent plate boundaries.
Mountain-building	Process by which compressional forces acting on the crust form fold mountains.
Oceanic crust	Crust found under oceans rich in silica and magnesium and 5-10 km thick.
Outer core	Outer, liquid part of the Earth's core, rich in iron and at a depth of 2890 km.
Palaeomagnetism	'Historical magnetism' recorded in igneous rocks as iron-rich minerals become aligned with the Earth's magnetic field at the time they were formed.
Sea-floor spreading	Evidence supporting the theory of plate tectonics: new crust is formed at mid-ocean ridges and older crust is moved further away on each side of the ridge.
Tectonic plate	Rigid part of the Earth's lithosphere. There are 7 large plates and several smaller ones, all of which move relative to one another.
Theory of continental drift	Theory that the Earth's continents have moved significantly over geological time.
Transform fault	Fault or weakness in the Earth's crust (often found at mid-ocean ridges) where crust on each side moves in opposite directions.

Learner resource 3 Sketching plate boundaries

See page 13

Picture 1

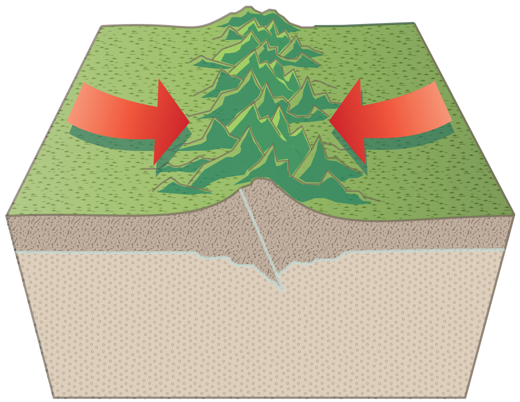


Divergent

Words you cannot use to describe this picture:

- mid-ocean ridge
- constructive plate boundary
- mantle
- oceanic crust

Picture 2

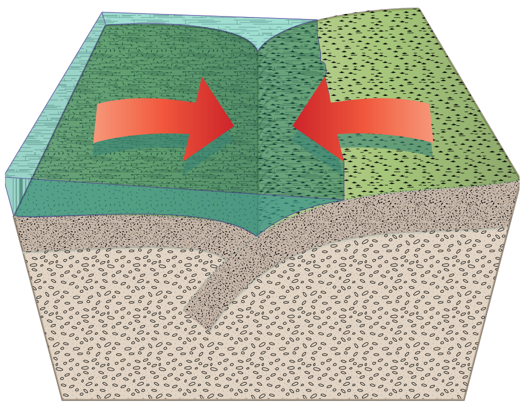


Convergent

Words you cannot use to describe this picture:

- collision zone
- plate boundary
- mantle
- crust

Picture 3

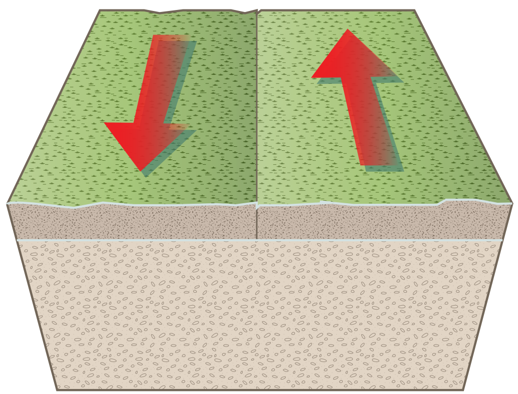


Convergent

Words you cannot use to describe this picture:

- subduction zone
- oceanic
- destructive plate boundary
- continental

Picture 4



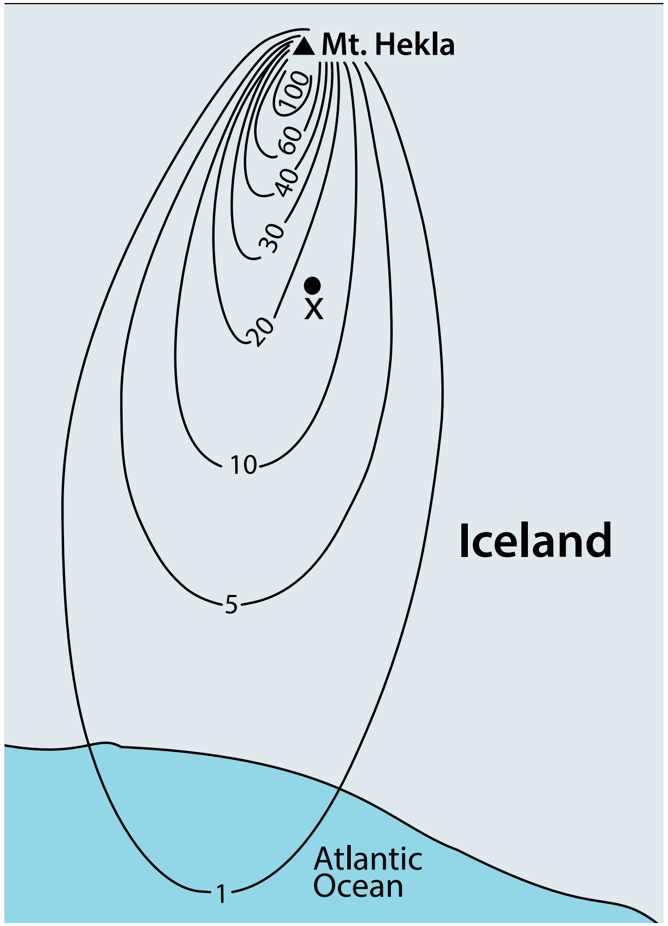
Transform/Strike-slip

Words you cannot use to describe this picture:

- continental crust
- conservative plate boundary
- transform
- strike-slip

Learner resource 4 Isoline maps

See page 13



This isoline map shows the thickness of ash (in cm) that fell after the 1947 Eruption of Mt Hekla, Iceland. The top of the map is north.

Use the map to answer the following questions:

1. What is the thickness of ash at point X?

2. What was the wind direction at the time of the eruption?

3. Draw a north-south cross section to show the thickness and distribution of the ash from this eruption. You will have to assume that the ground beneath the ash is flat.

4. How could a map like this be used in hazard planning and preparation? Are there any pitfalls?

Learner resource 5 Landscapes created by faulting: extensional tectonics and the features of a rift valley

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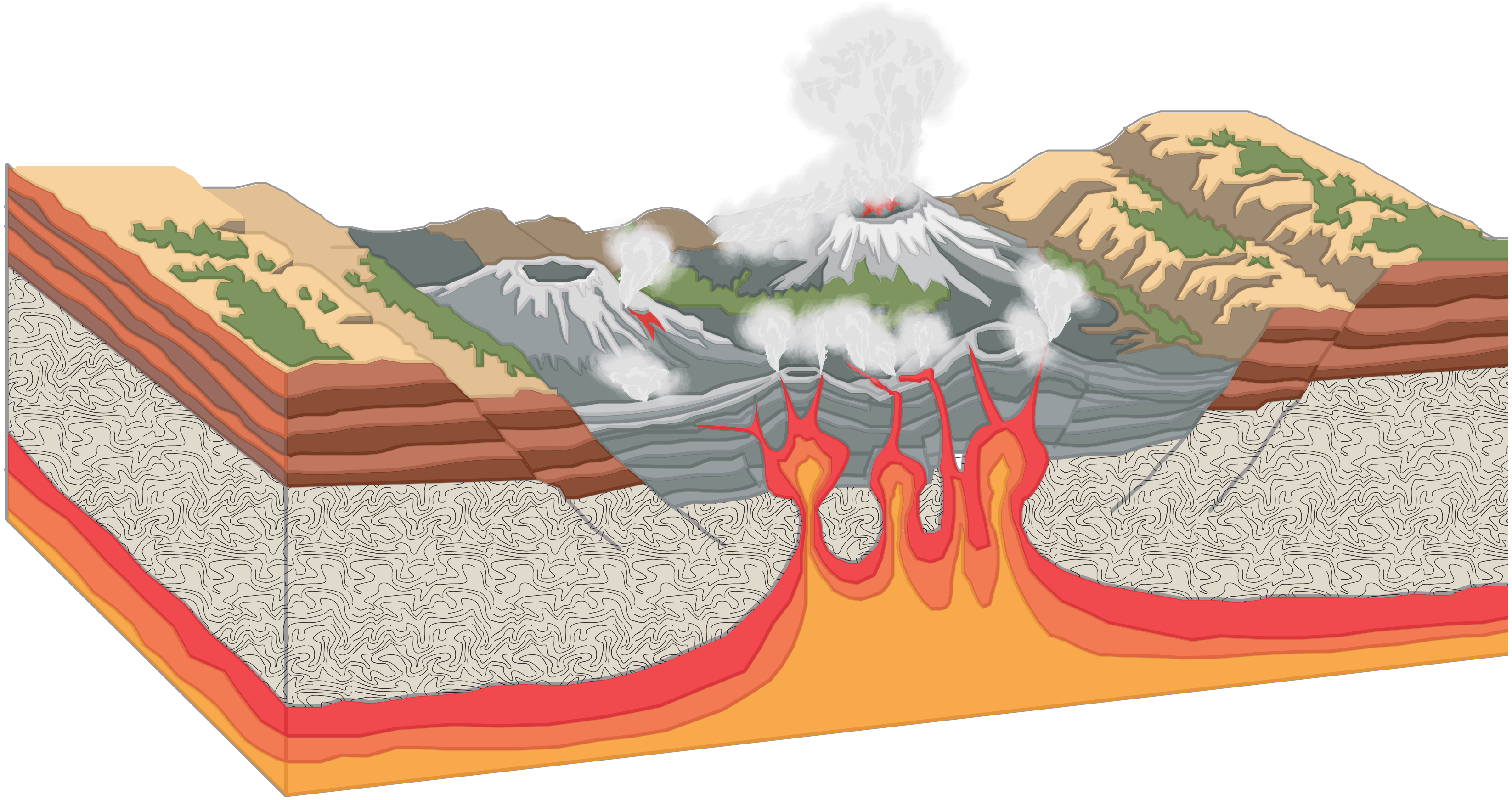


The following features must be included:

- Upwelling magma
- Thinning of continental crust
- Normal faults
- Lava flows
- Volcanic cones

Learner resource 6 Why do people live in tectonically active locations?

See page14

	AC	LIDC
Named example		
Possible tectonic hazards		
What are the advantages for people of living here?		
Why do people live here? How does this relate to levels of development of this place?		
How frequently do tectonic hazards occur here?		
How much knowledge or experience of these tectonic hazards have people here got?		
Do people living here have any choice? Why/ why not?		
Summarize why people live in this tectonically active place.		

Learner resource 6 Why do people live in tectonically active locations?

ANSWER SHEET

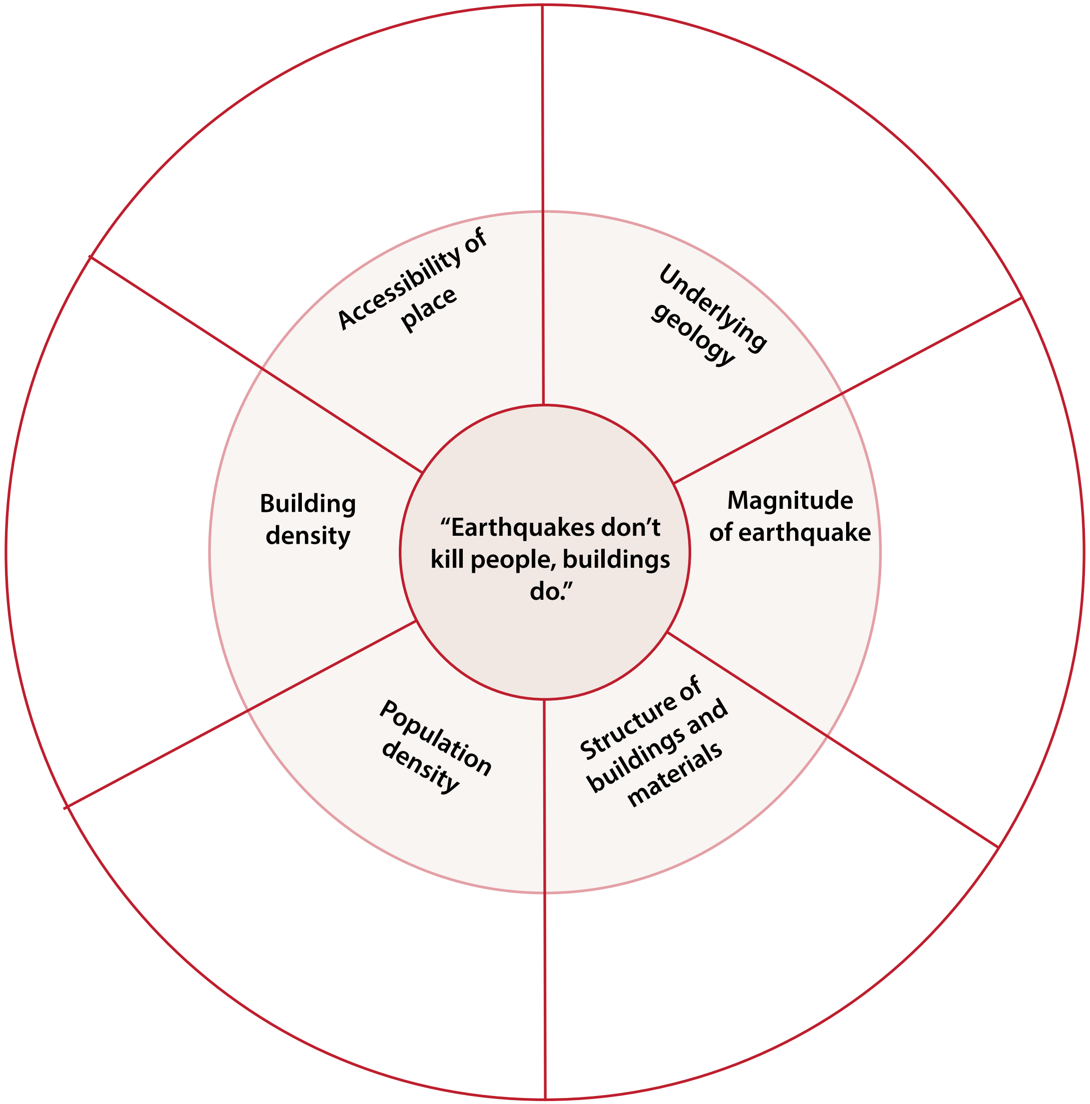
	AC	LIDC
Named example	Southern California (conservative plate margin) Mount St Helens/ Cascade Range Iceland Mount Etna and Mount Vesuvius	Montserrat Popocatepetl, Mexico East African Rift Valley Mount Elgon, Uganda
Possible tectonic hazards	Earthquakes Earthquakes and volcanic eruptions Could also include secondary hazards e.g. tsunami, lahar	Earthquakes Earthquakes and volcanic eruptions Could also include secondary hazards e.g. tsunami, lahar
What are the advantages for people of living here?	Well-paid jobs, pleasant climate Geothermal energy Fertile soils from volcanic ash Natural resources/minerals associated with volcanoes such as diamonds, gold, silver, lead, zinc and copper Tourism industry– year round landscape attraction	Fertile soils from volcanic ash Natural resources/minerals associated with volcanoes such as diamonds, gold, silver, lead, zinc and copper. Also sulphur from volcanic vents. Tourism industry – year round landscape attraction
Why do people live here? How does this relate to levels of development of this place?	People are educated and can weigh up the benefits compared to the risks Level of development means earthquake-proof buildings can be designed and built Monitoring of volcanoes means people are prepared and evacuation can be planned and managed, reducing the risk	People are unable to move away because they don't have the finances to do so Family ties/traditions Lack of awareness/understanding due to lack of education
How frequently do tectonic hazards occur here?	Depends on chosen example(s)	Depends on chosen example(s)
How much knowledge or experience of these tectonic hazards have people here got?	This will link to the frequency of the hazard Also links to level of development and amount of education/ monitoring/ communication	This will link to the frequency of the hazard Also links to level of development and amount of education/ monitoring/ communication

Learner resource 6 Why do people live in tectonically active locations?

	AC	LIDC
Do people living here have any choice? Why/ why not?	Depends on chosen example(s)	Depends on chosen example(s)
Summarize why people live in this tectonically active place.		

Learner resource 7 Human and physical factors affecting the impact of earthquakes on people

See page15



Learner resource 8 Factors affecting vulnerability to tectonic hazards

See page15

Factor affecting vulnerability	How does it increase vulnerability?	How does it decrease vulnerability?	Comparative examples (mini-case study)
Population density			
Awareness			
Cultural factors affecting public response			
Knowledge/ understanding			
Lines of communication			
Early-warning system			
Emergency service			
Building codes			
Insurance			

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