

Volcano case studies presentation – Teacher’s Notes

Learning objectives

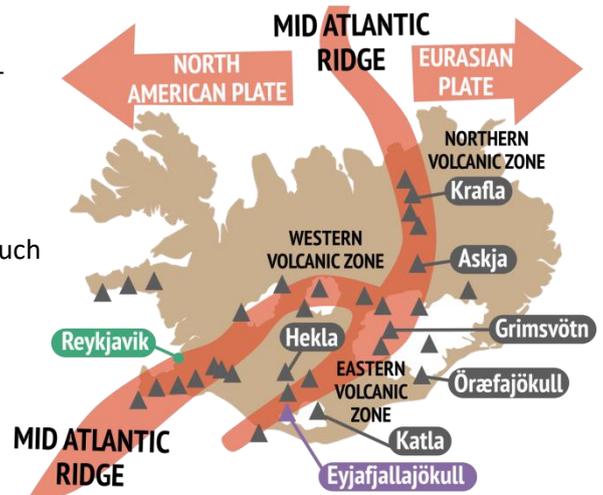
Recall volcanic eruption case studies in high and low income countries

Presenter notes

Some suggested notes for each slide and information for the presenter. Questions the presenter could ask students are highlighted in bold. The Geological Society gives permission for presentations and notes to be adapted to suit the presenter’s needs.

Iceland

Iceland is a high income country (HIC) that lies on the Mid-Atlantic Ridge, a divergent plate boundary where the Eurasian and North American plates are moving apart at approximately 25 mm yr^{-1} . As the plates separate, magma upwells and is either extruded as lava and ash from volcanoes or intruded within the crust as igneous bodies such as plutons, sills and dykes. Iceland also lies above a ‘hotspot’, an upwelling of superheated rock from the mantle which produces even more magma and volcanism. This extra magma production explains why Iceland is a significant island above sea level, while the rest of the Mid-Atlantic ridge remains underwater.



Eyjafjallajökull 2010 eruption

Eyjafjallajökull (ey-yah-fyal-lah-yo-kul) is a stratovolcano situated in southern Iceland. Like other volcanoes in Iceland, Eyjafjallajökull lies beneath an ice cap which is 200m thick and 100 km^2 in area.

On 20 March 2010, following months of increased shallow earthquake activity around the area of Eyjafjallajökull, fountains of lava began to erupt through fissures to the northeast of the Eyjafjallajökull volcano. This effusive eruption did no damage and was a welcome tourist attraction, drawing in thousands of visitors each day.

On the 14 April 2010, the site of the eruption moved abruptly from the ice-free Fimmvörðuháls region to the ice-capped crater of Eyjafjallajökull. Heat from the rising magma melted the ice in the volcano’s crater. Cold meltwater mixed with the liquid magma, chilling it rapidly and causing it to shatter into very fine ash fragments. Ash and steam exploded out from the volcano (phreatomagmatic eruption) as a huge 10km high plume. This second explosive eruptive stage lasted 39 days until 22 May.

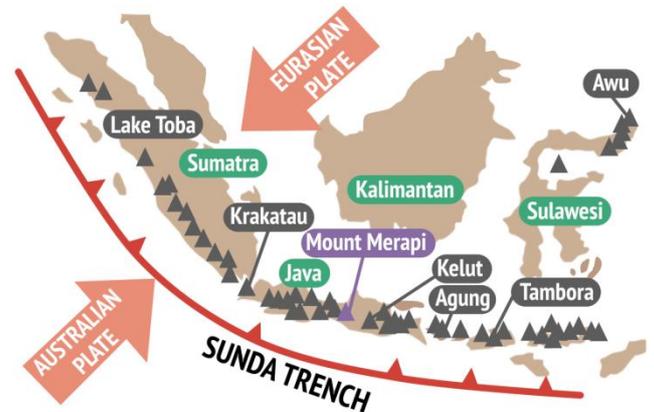
The eruption of Eyjafjallajökull was moderate in size (Volcanic Explosivity Index = 4) and in total, expelled 0.27 km^3 of airborne tephra (ash, and rock fragments). Due to north and northwesterly winds, this ash became widely dispersed over the North Atlantic Ocean and Europe.

Volcanic ash clouds, made from tiny abrasive fragments of rock, are hazardous to commercial aircraft as they erode metal, clog up fuel and cooling systems and melt to form glassy deposits inside aircraft engines. Due to this danger, much of European airspace was closed from 15-21 April. 107,000 flights were cancelled and the airline industry lost £1.1 billion according to the International Air Transport Association. Many industries relying on air freighted products were badly affected by the airspace closure and shortages of imported fruits, flowers and electronic hardware were reported.

The melting of Eyjafjallajökull ice cap triggered several large glacial floods, (or jökulhlaups) on the 14-15 April. The floods raised local river levels by 3m, flooded farmland and damaged buildings, roads and bridges. 800 people were evacuated via an automated telephone alert as a precaution. The floods transported huge volumes of volcanic sediment and completely filled in the lake at the foot of Gígjökull glacier with more than 17 million m³ of sediment.

Mount Merapi, Indonesia

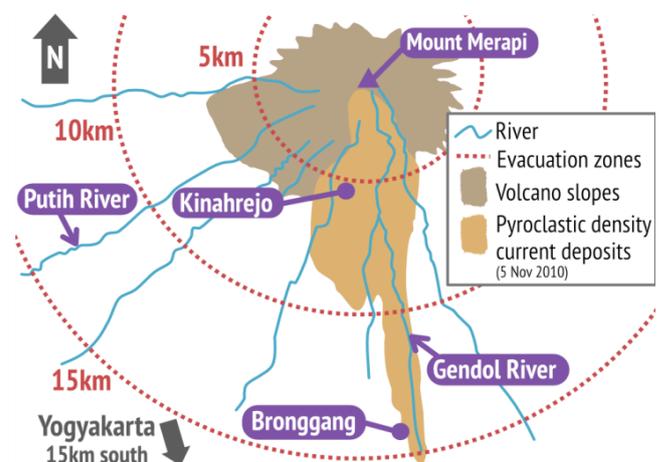
Mount Merapi is a stratovolcano on the island of Java in Indonesia. The volcano sits on the Sunda Trench, a subduction zone in which the Australian plate is being forced beneath the Eurasian plate at a rate of 60-70 mm yr⁻¹. Mount Merapi has erupted many times over the last 100 years, typically producing lava domes (mounds of viscous lava which pile up around the vent) and pyroclastic density currents. Prior to 2010, these eruptions had occurred approximately every 4-6 years. Eruptions were typically small (VEI 1-3), however it was known that larger explosive eruptions were possible and had occurred in the past (e.g. in 1872, VEI=4). 70,000 people live in the immediate vicinity of Mount Merapi and >3 million people live in the city of Yogyakarta just 30km south of the volcano, so the volcano was closely monitored by the Center for Volcanology and Geological Hazard Mitigation (CVGHM).



Mount Merapi 2010 eruption

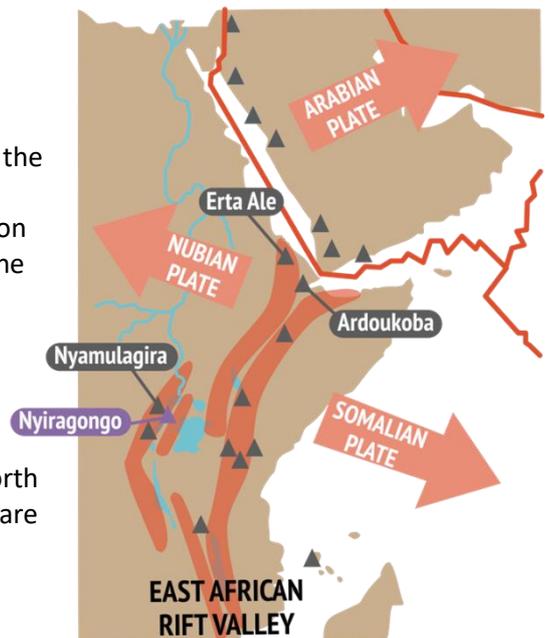
At 10:02 (UTC) 26 October 2010 Mount Merapi erupted explosively with a VEI of 4 in the first stage of a multi-stage eruption. The eruption destroyed a previous lava dome deposited in 2006 and formed a new crater by blasting out 6 million m³ of rock. An ash cloud was projected 12km into the atmosphere and pyroclastic flows swept down the volcano's southern slopes reaching distances of 8km. From 1-4 November, Merapi formed a new lava dome through the eruption of 5 million m³ of lava. During the night of 4 November an unusually large explosive eruption generated a 17km ash column and triggered additional pyroclastic flows. Volcanic activity began to decrease from 11 November and had ended by 30 November. The eruption generated ~130 million m³ of new volcanic material (lava and ash) on Merapi's slopes.

The best way of minimizing fatalities from pyroclastic flows is to evacuate people from within the risk zone. On the 25 October the CVGHM called for the evacuation of everyone within a 10km radius of Merapi's summit. This was increased to 15km and then 20km on the 5 November after the increase in explosive activity. 35 people, who refused to leave the village of Kinahrejo, 7km away from the summit, were killed by pyroclastic flows on 26 October. On 5 November a further 87 people were killed in village of Bronggang which had not yet been evacuated. In total the eruption and associated PDCs caused 367 fatalities and >400,000 people were evacuated, not able to return home for over 6 weeks. Even so, the close monitoring of the volcano, timely evacuations and good communication methods did save thousands of lives.



Nyiragongo, Democratic Republic of Congo

Nyiragongo is a volcano in the Democratic Republic of Congo (LIC), it forms part of the Albertine rift, the western branch of the East African Rift Valley. The East African Rift Valley is a developing divergent plate boundary where the eastern portion of Africa, the Somalian plate is pulling away from the rest of the continent (Nubian plate). Nyiragongo crater contains a rare persistent lava lake (only 5 persistent lava lakes exist on Earth). The lava emitted in eruptions at Nyiragongo is often unusually fluid, a type of lava called melilite nephelinite, this makes it extremely dangerous as it can flow very fast down the steep sides of the volcano. Nyiragongo lies 15km north of the city of Goma, home to 1 million people many of whom are refugees from the Rwandan genocide in 1994.



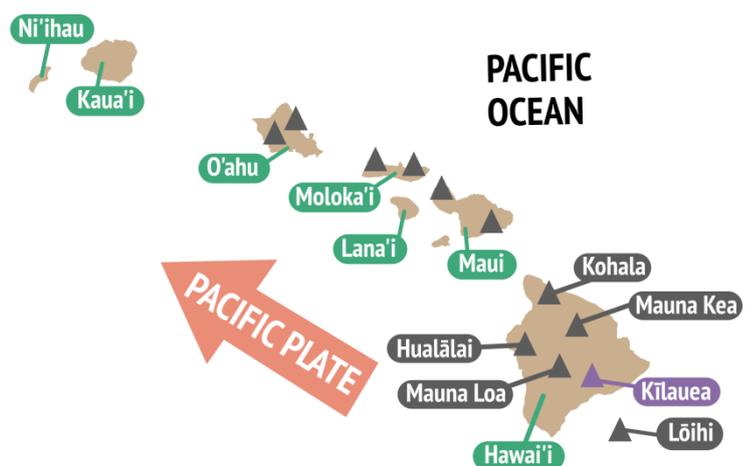
Nyiragongo 2002 eruption

A fissure eruption (effusive) occurred at Mount Nyiragongo on 17 January 2002. The fissures opened up to the south side of the volcano allowing lava from the lava lake to drain through. Lava flows reached speeds of 60 km/hr with little warning for the nearby city of Goma. The unrest in the country has made it difficult to monitor the volcano and put emergency responses in place – 3 out of 5 seismic monitoring stations had been vandalized during a civil war lasting from 1997-2003.

The volcano erupted 14-34 million m³ of lava and 45 fatalities occurred in first 24 hours due to lava flows and CO₂ asphyxiation. Lava flows covered 15% of the city of Goma. 2 hospitals, 14 villages over 4,500 buildings and part of the international Goma airport runway were destroyed by the lava flows. 120,000 people left homeless and over 350,000 people fled eastwards to Rwanda to escape the lava flows. Lava flows set alight a petrol station on 21 January. 50 people were in the petrol station trying to siphon off fuel and died in the explosion. There were cholera break outs in refugee camps from lack of clean drinking water and sanitation. In total 147 people died due to lava flows, CO₂ asphyxiation and building collapse.

Kilauea 2018 eruption

Hawaii is an island made up of five shield volcanoes: Kohala (oldest), Mauna Kea, Hualalai, Mauna Loa, Kilauea (youngest). Of these Mauna Loa and Kilauea are active. Hawaii 'Big Island' is the most south-eastern member of the Hawaiian Islands chain. The chain is located in the middle of the Pacific plate, formed due to the presence of a hotspot in the mantle, a region of unusually superheated rock. As the Pacific plate has moved over this hotspot over millions of years, new volcanic islands have formed and old volcanoes have become extinct as their magma supply runs out.



Kilauea has been erupting continuously since 3 January 1983 mostly through its Pu'u 'Ō'ō vent. In May 2018 this eruption intensified and is still on going.

Timeline so far...

30 April 2018 Pu'u 'Ō'ō crater floor collapsed

1-2 May hundreds of small earthquakes were detected and cracks appeared in the ground

3 May – magnitude 5 earthquake, steaming ground cracks opened in Leilani Estates area and began to spew lava

4 May - magnitude 6.9 earthquake, largest in Hawaii since 1975. High levels of sulfur dioxide were detected.

6 May – 26 houses destroyed, lava fountains 90m high

7 May – 1700 people evacuated

10 May - lava in Halema'uma'u disappeared from view depth of over 325m below crater floor

4 June after 30 days of eruption – lava had erupted from 24 separate fissure vents, 4 lava flows had reached the ocean, 12.2 km² of lava flows cover Hawaii, 157 houses destroyed, fastest lava flow advancement = 600m hour⁻¹

Other useful links

- Timelapse footage of lava – Kilauea 2018: <https://www.youtube.com/watch?v=wiRdr5LzbwY>
- Nyriagongo lava lake: <https://www.youtube.com/watch?v=2th8dY03Wo>
- Explosive eruption from Eyjafjalljokull, Iceland: <https://www.youtube.com/watch?v=e-TMtRh8AIs>)
- Volcano case studies factsheet: <https://www.geolsoc.org.uk/factsheets>
- Volcanoes presentation: <https://www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations>
- Volcanoes factsheet: <https://www.geolsoc.org.uk/factsheets>
- Volcano hazards presentation: <https://www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations>
- Lava flow activity: <https://www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations>
- Build a volcano activity (aimed at Key Stage 2/3 but could be a fun intro to volcanoes or homework task): <https://www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations>