



Explosive and Effusive Volcanoes

The type of volcanic eruption is largely determined by magma composition. Flux-mediated melting at subduction zones creates a felsic magma with high levels of carbon dioxide and water. These dissolved gases explode during eruption. Effusive volcanoes have a hotter, more mafic magma with lower levels of dissolved gas, allowing them to erupt more calmly (effusive eruption).

Sinabung (Indonesia)

Mount Sinabung is a stratovolcano located 40 km from the Lake Toba supervolcano in North Sumatra. It lies along the Sunda Arc, where the Indo-Australian plate subducts beneath the Sunda and Burma plates. After 1200 years of dormancy, Sinabung began erupting intermittently in 2010. Major eruptions have occurred regularly since November 2013.

In November and December 2015, ash plumes reached 6 – 11 km in height on multiple occasions. Pyroclastic flows and ashfall blanketed the region in January 2014 and lava flows travelled down the south flank, advancing 2.5 km by April 2014. Pyroclastic flows in February 2014 killed 17 people in a town 3 km from the vent. In June 2015, ash falls affected areas 10 – 15 km from the summit on many occasions. A lahar in May 2016, caused fatalities in a village 20 km from Sinabung. Pyroclastic flows occurred frequently throughout 2016 and 2017

Major eruptions occurred in 2018 and 2019. In February 2018, an eruption destroyed a lava dome of 1.6 million cubic metres. At least 10 pyroclastic flows extended up to 4.9 km and an ash plume rose more than 16 km in altitude. Ash plumes were frequent and ash fall was reported to be covering the leaves of plants in communities near the volcano. Ash fall was reported as far as 260 km away from the volcano.

In May 2019, a series of eruptions produced ash plumes that extended 4.6 km (7 May), 15.2 km (24 May), and 6.1 km (25 May) in altitude. A major eruption June 9, 2019 produced an ash plume that reached 16.8 km and pyroclastic flows extending 3.5 km southeast and 3.0 km south from the vent. The Volcanic Explosivity Index (VEI) of the May and June eruptions was VEI = 4. Significant ash falls were produced by volcanic activity in May and June. Lahars occurred in March, April, May and July of 2019.

Sinabung has released large quantities of sulfur dioxide since the current eruptions began. Mass of sulfur dioxide was measured by satellite as:

- 17.8 kt on 19 Feb 2018
- 10.6 kt on 20 Feb 2018
- 0.4 kt on 7 May 2019
- 4.5 kt on 25 May 2019



Eruption of Sinabung 6 October 2016
(Y Ginsu, public domain)



Kilauea (United States)

Kilauea is a shield volcano that overlaps the eastern flank of the massive Mauna Loa shield volcano and is one of five volcanoes that make up the big island of Hawaii. The volcano was created as the Pacific plate moved over the Hawaiian hotspot. It has been Hawaii's most active volcano in historical times, with activity reported in Polynesian oral history and continuous eruptions since 1983. Volcanic glass is commonly formed by lava fountains on Kilauea and local ash falls occur. Lava flows cause fires as they overrun vegetation.

From January 1983 – January 2011, the eruption had produced 3.5 km³ of lava, covering 123 km² of the volcano flank and adding new coastline to the island. In 2008, an explosive eruption formed a new crater known as Overlook Crater.

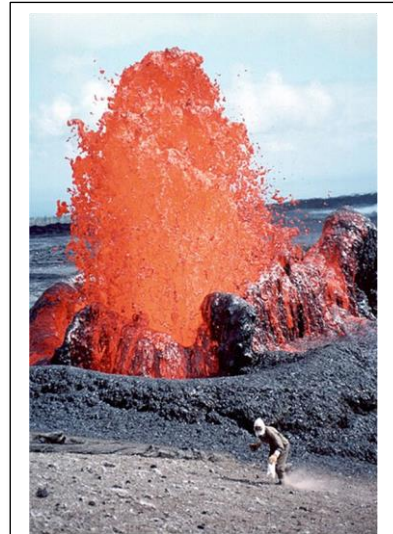
Activity at Pu'u 'Ō'ō crater on Kilauea's summit began to increase in March 2018, leading to collapse of the crater on 30 April 2018. Magma migrated underground to the east rift zone and new fissures formed in May. These released lava flows that reached the Pacific Ocean, creating thick clouds of 'laze' – a volcanic haze made up of hydrochloric acid and glass particles.

The lava lake at Halema'uma'u on Kilauea's summit began to drop on 2 May 2018. The drop caused lava to interact with the underground water table and produced an explosive eruption on 17 May. The ash plume extended 9 km in altitude. The lava subsided and a water lake formed at the summit in July 2019. This reached a depth of approximately 49 metres before being replaced by a lava lake during an eruption on 20 December 2020.

Kilauea eruptions generally have a VEI of 0 – NOT explosive. Of 90 eruptions that have been assigned a VEI, 74 had a VEI of 0. The 1983-2018 eruption has a VEI of 3 due to two explosive events (2008 and 2018).

As one of the most intensely monitored volcanoes in the world, there is a great amount of data available on gas emissions from Kilauea. Mass of sulfur dioxide measured by ground-based and airborne instruments was:

- 6 kt on 3 July 1983
- 46 kt on 19 Aug 1984
- 18 kt on 26 July 1985
- 5 kt on 22 Mar 1986
- 37 kt on 26 June 1986



Lava fountain at the base of Kilauea's Pu'u 'Ō'ō vent
(CC Heliker, USGS, 1993, public)



Eruption of Kilauea's Pu'u 'Ō'ō crater October 1997
(B Snelson, Creative Commons)



Questions

1. Complete the summary table with information from the reading

Feature	Sinabung	Kilauea
Tectonic setting		
Volcano type		
Explosive or effusive		
Date(s) of major eruption(s)		
Maximum height of ash plume		
Volcanic hazards and products observed		
Maximum distance for hazard effects		

2. List ways these volcanoes affect the atmosphere. _____

3. Distinguish between the atmospheric effects of explosive versus effusive volcanoes based on the information provided. _____

4. Sulfur dioxide may cause cooling if it reaches the stratosphere (approx. 10 – 50 km in altitude).

Which volcano is more likely to cause cooling and why? _____



5. Sulfur dioxide causes acid rain in the troposphere (<10 km in altitude). Which volcano is more likely to cause acid rain and why? _____

6. Summarise possible effects of volcanic hazards on the biosphere (animals and plants).

Hazard	Biosphere effect	Explosive or effusive volcano?

7. Overall, which type of volcano has the greatest effect on the biosphere and atmosphere? Justify your answer. _____

References:

Global Volcanism Program, Smithsonian Institution

Sinabung <https://volcano.si.edu/volcano.cfm?vn=261080>

Kilauea <https://volcano.si.edu/volcano.cfm?vn=332010>

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