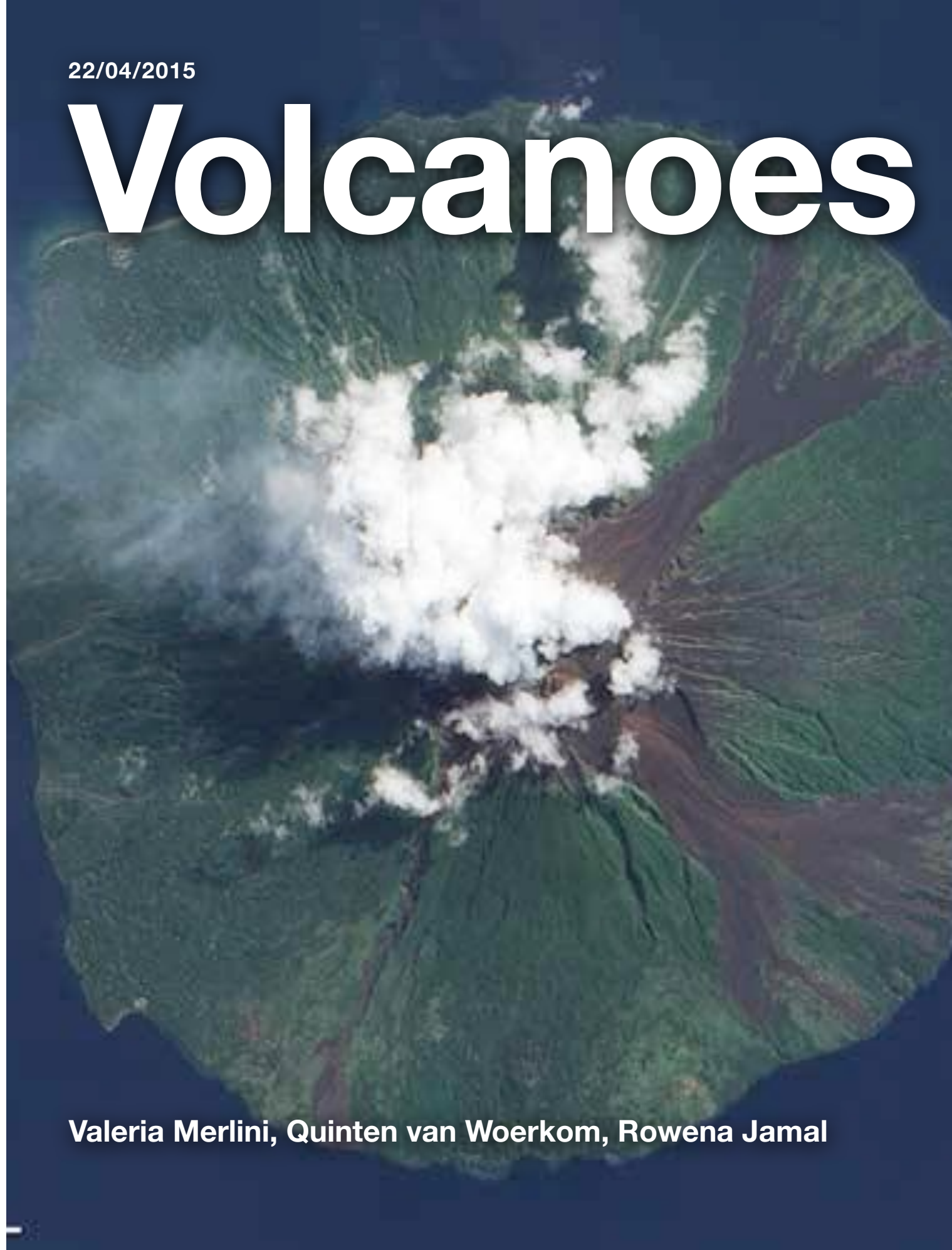


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Volcanoes



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<http://www.esa.int/>

Chapter 1

An introduction to volcanic activity

Volcanoes are holes in the surface of the crust of the earth, in which hot molten rock and gases can be found.



A quick look at volcanoes

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The word volcano comes from the Roman god of fire, Vulcan. Vulcan was said to have had a forge on Vulcano, an active volcano on the Lipari Islands in Italy.

Tectonic plates

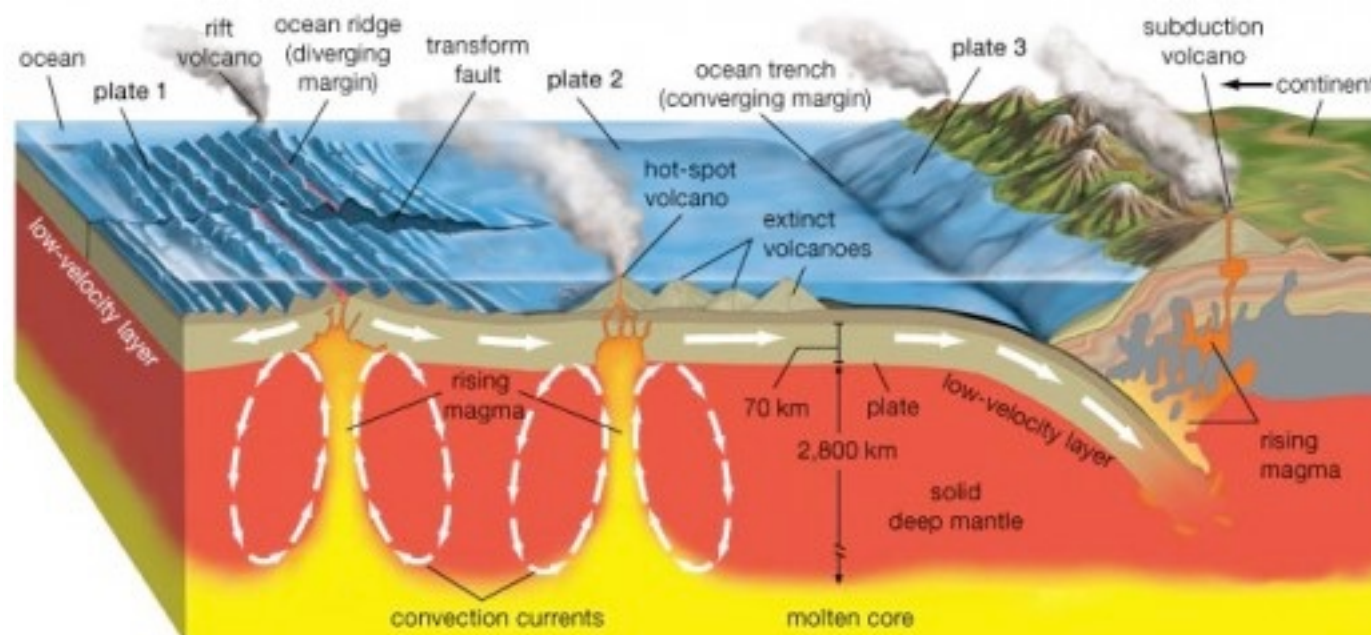
The surface of the Earth is divided in 17 tectonic plates. These plates are moving constantly. Thanks to the fact that these plates converge and diverge, meaning they move towards and away from each other, volcanoes develop, as a result of respective collision of these plates when they are moving towards each other, or the thin crust that is left behind when they diverge. Now a volcano is born.

Eruptions

During an eruption, volcanoes violently expel lava and hot, poisonous gases along with clouds of ash, from its chamber. This is the result of a constant buildup of pressure in the magma chamber. Sometimes, this pressure is so high that it can lift the volcano up to a couple of centimeters.

There are 3 types of eruptions:

- Magmatic eruptions, as the result of decompression of gas within the magma
- Phreatomagmatic eruptions, as the result of compression of gas within the magma



- Phreatic, as a result of the superheating of steam via contact with magma. this type of eruption does not lead to the expulsion of magma.

Apart from this division, the eruptions can also be divided in smaller subgroups, relying on their explosiveness, ranging from effusive to apocalyptic:

- **Hawaiian** - Hawaiian type eruptions are characterized by quiet emissions of lava, due to their low viscosity (silica content) which allows the escape of gas.

- **Strombolian** - If the lavas are more viscous and gases can not readily escape, moderate explosions can occur. This type of eruption occurs consistently and at regular intervals throughout recent history. Mount Etna is an example of a volcano with strombolian eruptions.

- **Vulcanian** - The lava is more viscous than the Strombolian type and therefore after an eruption the magma in the conduit quickly solidifies. Gases subsequently accumulate beneath the solidified lava that obstructs the vent until they reach a pressure that exceeds the strength of the obstructing lava. This results in an explosion.

- **Peléan** - The Peléan type of eruption is associated with extremely viscous magma which results in catastrophic

explosions. Once again, the central conduit becomes clogged with viscous lava, allowing the build up of magma with highly charged gas pressures. Pyroclastic flows travel along the sides of the volcano with tremendous velocity, destroying everything in its path.

- **Plinian** - With a plinian eruption lava fountains reach heights of 1 km and the violent explosion of gas sends an eruption cloud to heights of at least 12 km, where they disperse, level out and form a canopy.

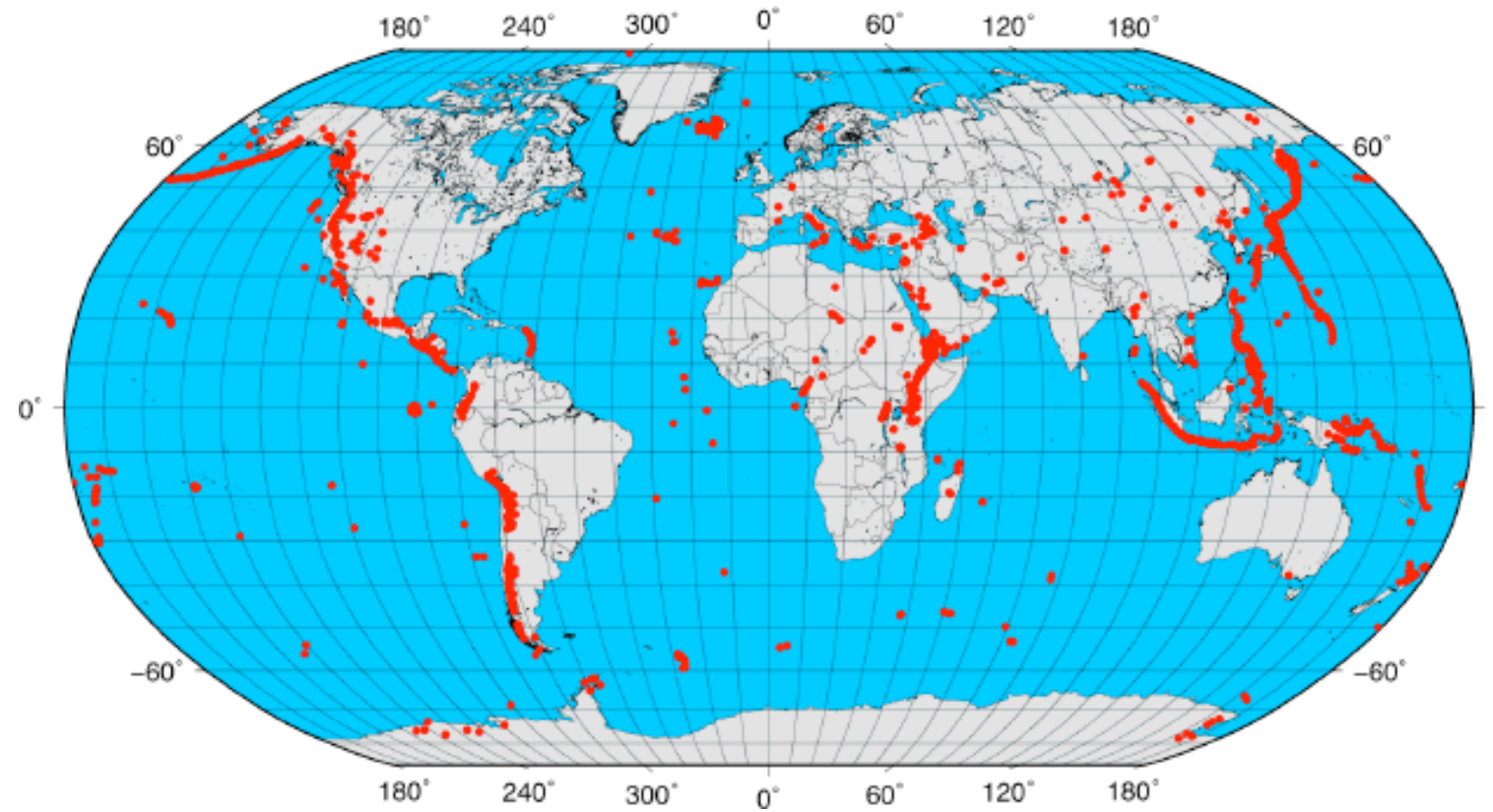
- **Ultra-Plinian** - They are defined by ash plumes over 25 km high and a volume of erupted material 10 km³ to 1,000 km³ in size.

- **Supervolcanic** - The volume of the erupted material during a supervolcanic eruption is larger than 1000 km³.

Composition of gases

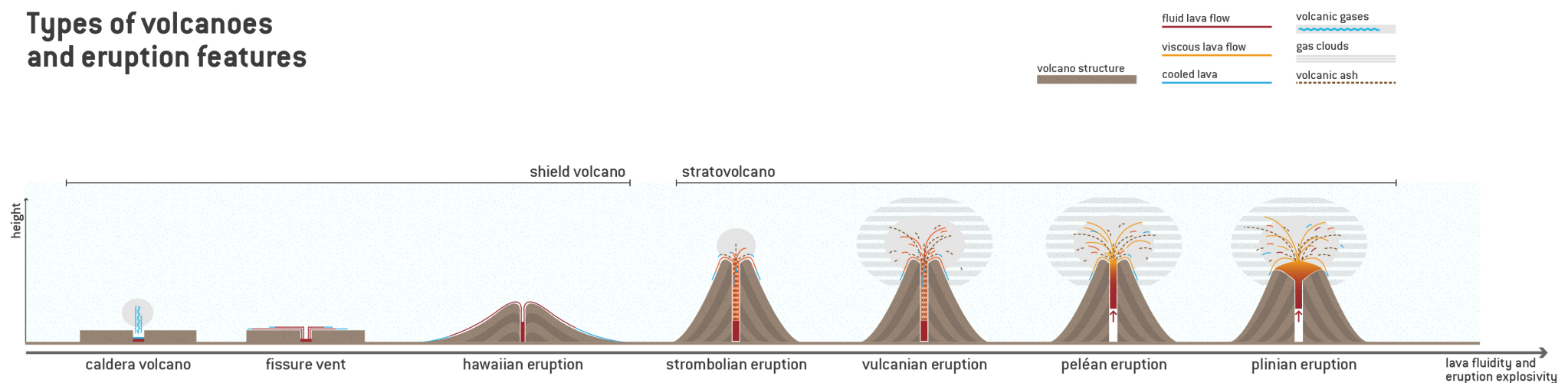
The composition of the gases that are released in a volcanic eruption vary hugely across different volcanos, though most volcanos release a gas composed of mainly water vapor, carbon dioxide, sulfur dioxide and hydrogen chloride.

World Volcanoes



This is a map in which can be seen where all the volcanoes on our precious, lovely Earth are located

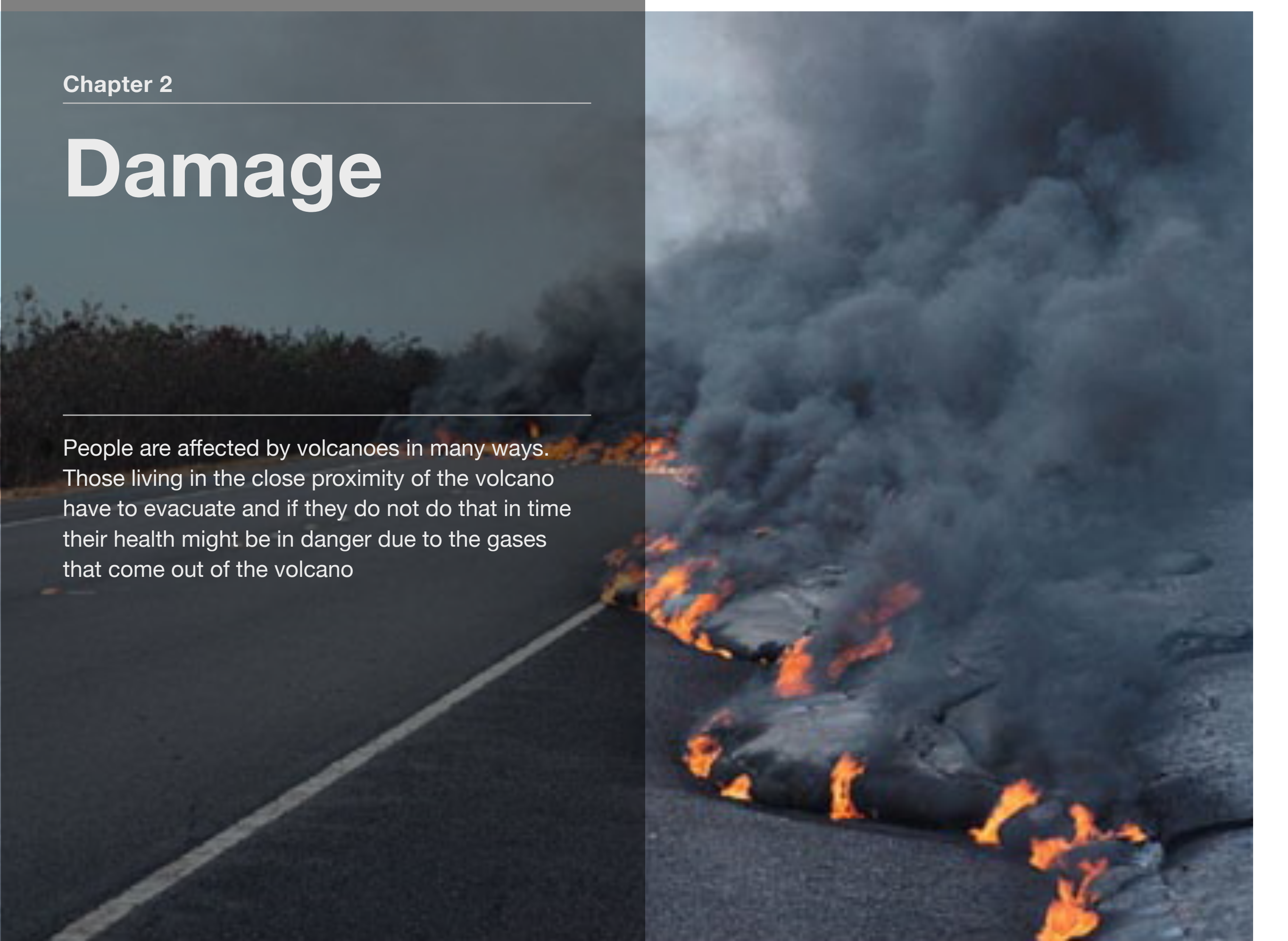
Types of volcanoes and eruption features



This picture shows the different types of eruptions and volcanoes

Damage

People are affected by volcanoes in many ways. Those living in the close proximity of the volcano have to evacuate and if they do not do that in time their health might be in danger due to the gases that come out of the volcano



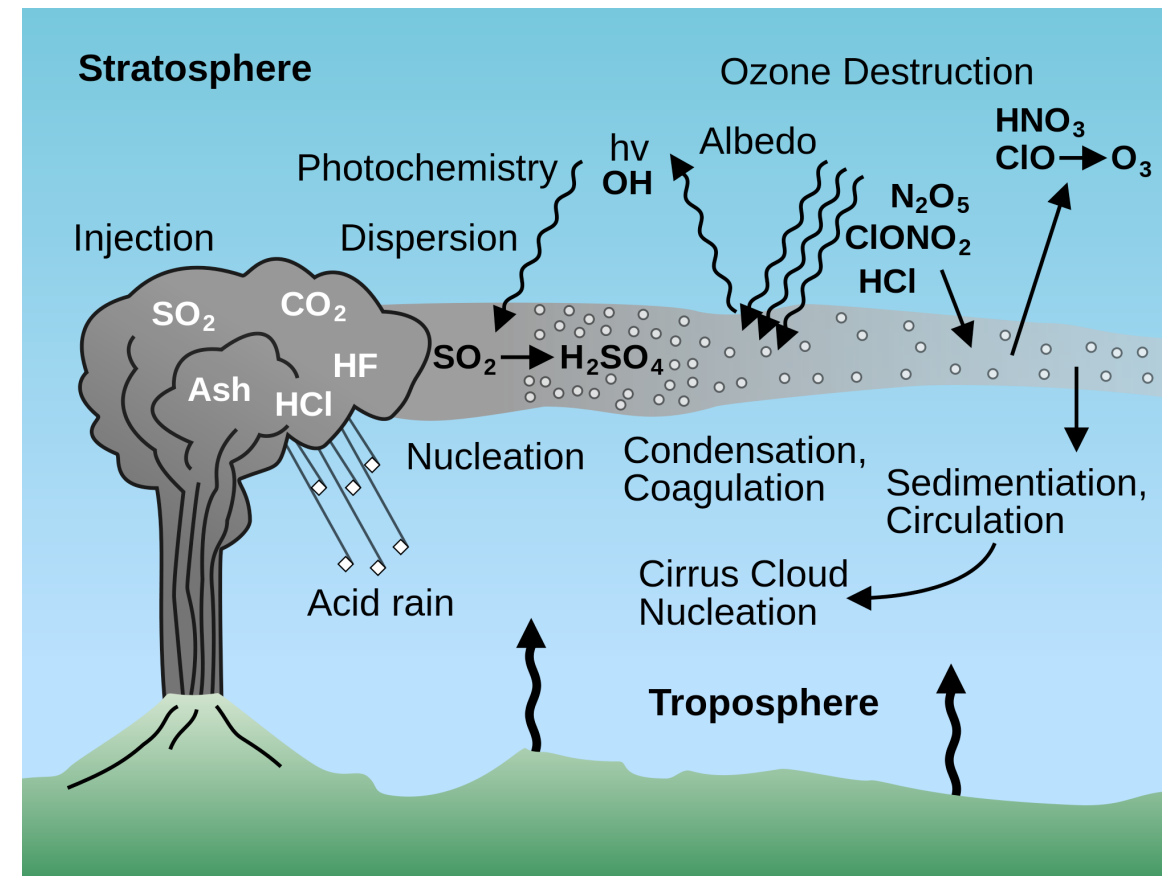
Dangerous gases

The biggest problem as a result of an eruption of a volcano is the gas that is released. These clouds of gas and ash can rise up to kilometers in height, sometimes rising up so high that air traffic is influenced. These gases can so be extremely hot that they can destroy the engines of planes, meaning that planes cannot fly in the close proximity of these gas clouds. To ensure that this does not happen, satellites are used to monitor the size, location, height, and other characteristics of clouds that have formed, relaying their data to relevant organizations, such as airlines. A secondary effect of these clouds is that the huge amount of carbon dioxide that resides in the cloud increases the greenhouse effect, accounting for 1% of global annual emission. Other components of the gases, mainly water vapor, contribute to the greenhouse effect as well. Another danger of these clouds is asphyxiation, since these clouds contain very little oxygen, resulting in the death of animals and humans that are not timely evacuated.

Lava flows

A second danger arising after an eruption is the creation of lava flows. The behavior of these flows is mainly determined by its composition. Three types of lava flows can be distinguished, depending on this composition:

- Felsic; Felsic lava is rich in silica, aluminum, potassium, sodium and calcium, and is very viscous.



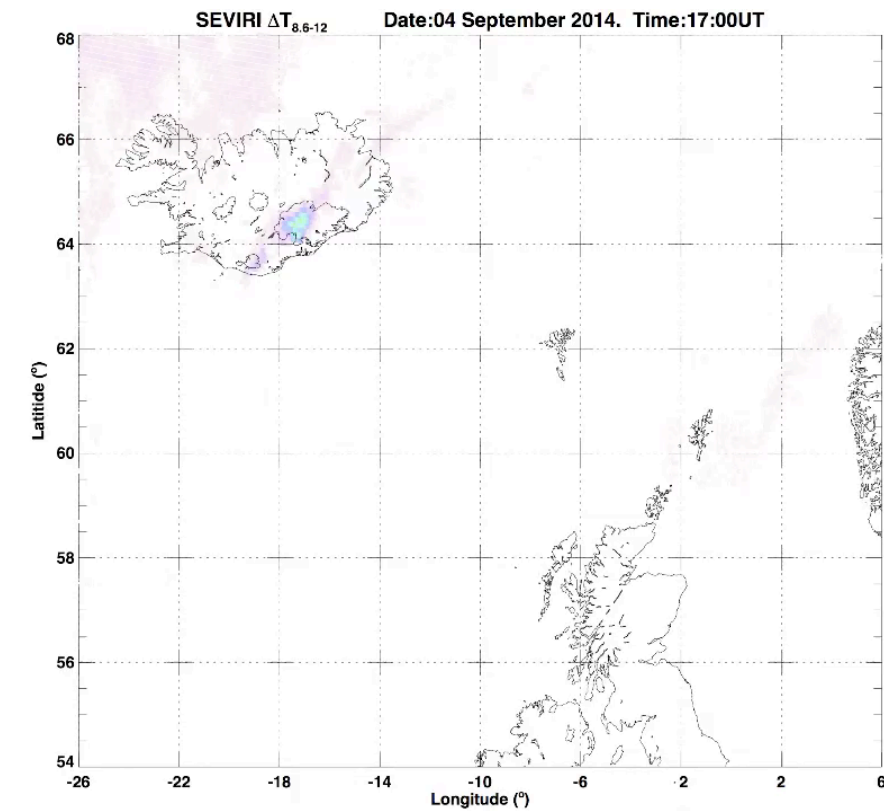
- Intermediate; Intermediate lava contains less aluminum and silica, but usually more magnesium and iron, making it less viscous than Felsic lava. It is most commonly hotter as well.
- Mafic; Mafic lava contains a very high amount of magnesium and iron and is usually hotter. As a result of its heat, it is also less viscous, often flowing huge distances.

A video of Mount Etna erupting in 2014

Due to the destructive nature of these lava flows, it is important that their flow is constantly monitored, and sometimes regulated by placing barriers, altering the path of the flow. This way, events like the destruction of Mascalì in 1928 by a lava flow can be prevented, or if that is not possible, the inhabitants of populated areas can be warned and evacuated before the flow hits.

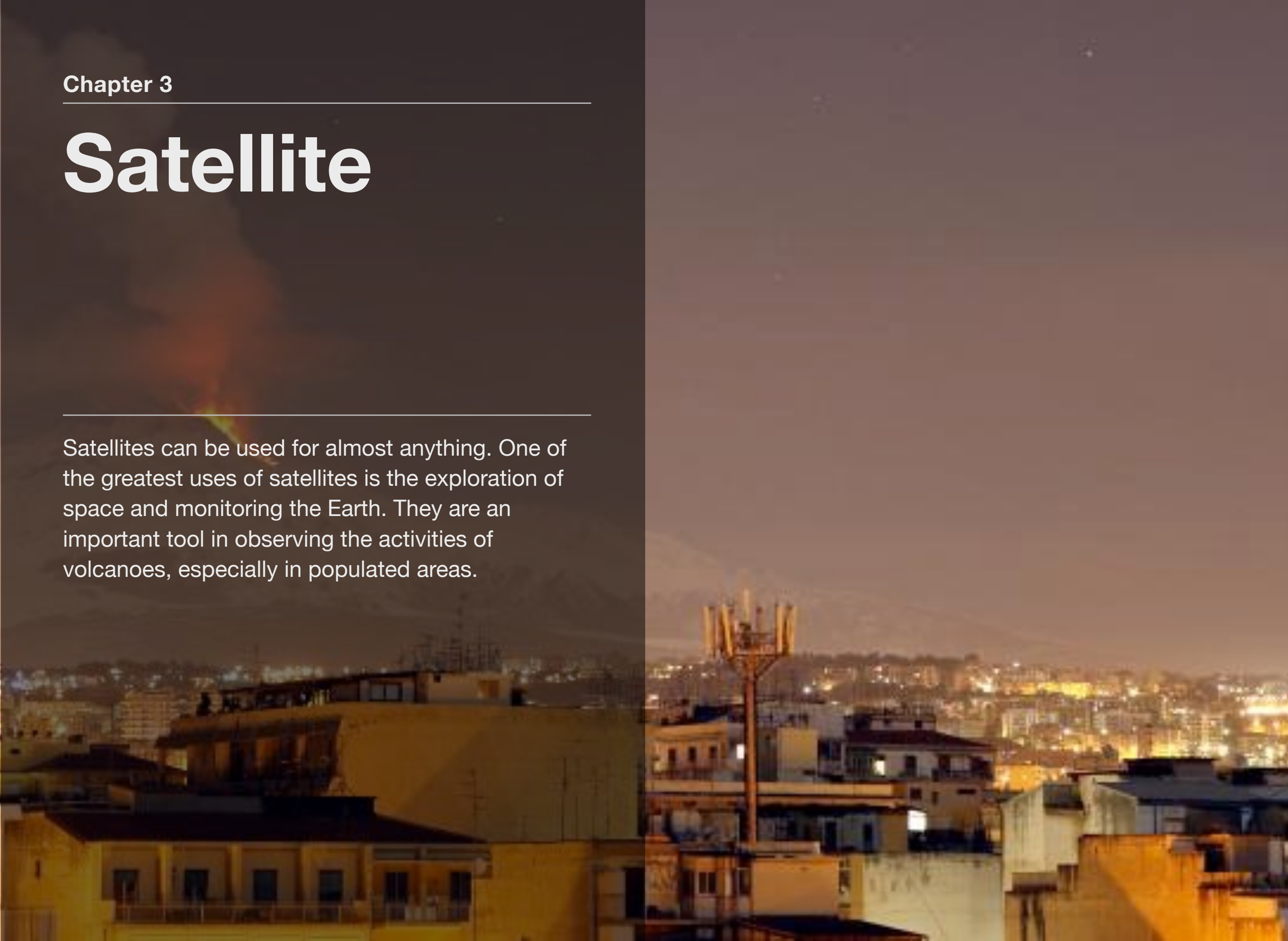
ESA's satellites monitored the Bardarbunga volcano in Iceland during September 2014 when the volcano began showing signs of eruption. They detected a cloud of sulphur dioxide drifting towards Europe.

Sulphur dioxide cloud above Iceland during September 2014



Satellite

Satellites can be used for almost anything. One of the greatest uses of satellites is the exploration of space and monitoring the Earth. They are an important tool in observing the activities of volcanoes, especially in populated areas.



Observing volcanoes from space

- [Video](#) (without sound)

Observing through satellites

Volcanology has come a long way since the days of Pompeii. Now, satellite-based systems have the ability to measure whether a volcano is likely to erupt soon.

Of the about 1500 active volcanoes on Earth, about 50 erupt each year. Though most volcanoes can be monitored from the ground, sometimes it is just not practical or possible, and

sometimes it is even dangerous. Therefore, they need to be observed from space. Using satellites, we can look for the signs of a coming eruption and, in case of an eruption, create images of the lava flows, mud flows, gas clouds etc. that come with it. Since the 1990s, satellites have been using a method called Interferometric Synthetic Aperture Radar, or InSAR, to monitor ground deformation. In this technique, a satellite uses a radar wave to look at a point on the ground. On its next pass over the spot, the signal is repeated. If two waves have moved out of phase, this means the ground has shifted. By performing this test on many points on the Earth's surface, InSAR can build up a picture of the ground deformation over hundreds of square kilometers, without requiring the installation of any instruments on the ground. Over the two decades of InSAR observations, 198 volcanoes had been regularly observed.

Not only can satellites be used for forecasting eruptions by analyzing the movements of the surface, but they can also be used to observe gas and ash clouds and lava flows that are created during an eruption.



What ESA has done

April 3 2014, Sentinel-1A was launched into space by the European Space Agency, with the mission to observe and monitor the surface of the Earth. Together with Sentinel-1B, it can create better pictures of the surface of the Earth than the similar InSAR satellites, due to the fact that they can create images in a much shorter time interval.

ESA's Volcanic Ash Strategic Initiative Team (VAST) and Support to Aviation Control Service (SACS) are monitoring the situation closely, and have detected sulphur dioxide emissions since early September. A small cloud of sulphur dioxide has been drifting toward Europe since late last night.

Most volcanoes on Earth are not monitored effectively. Satellites that observe the Earth, such as ESA's Envisat, can detect movements on volcanoes that are currently unmonitored.



