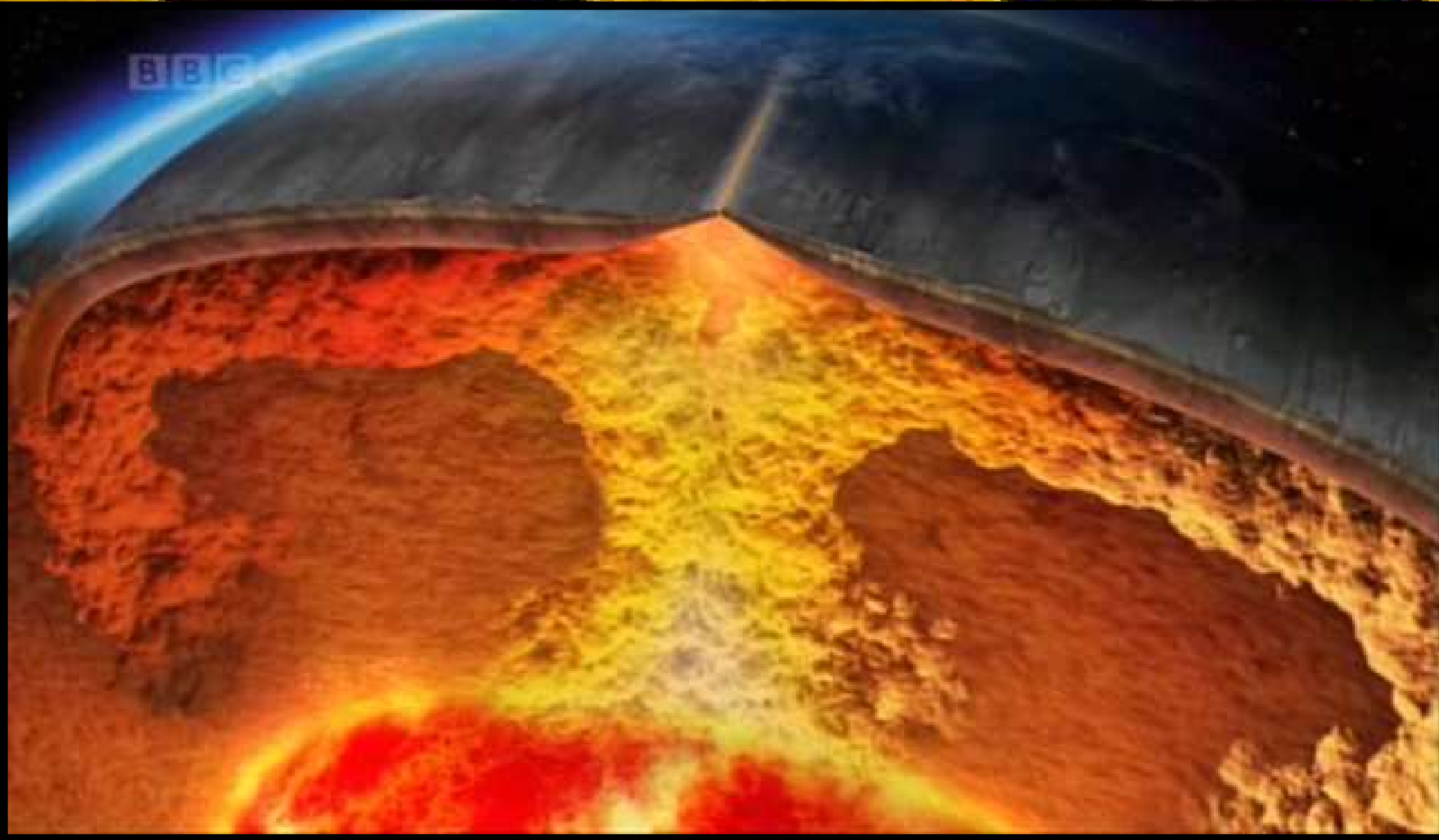
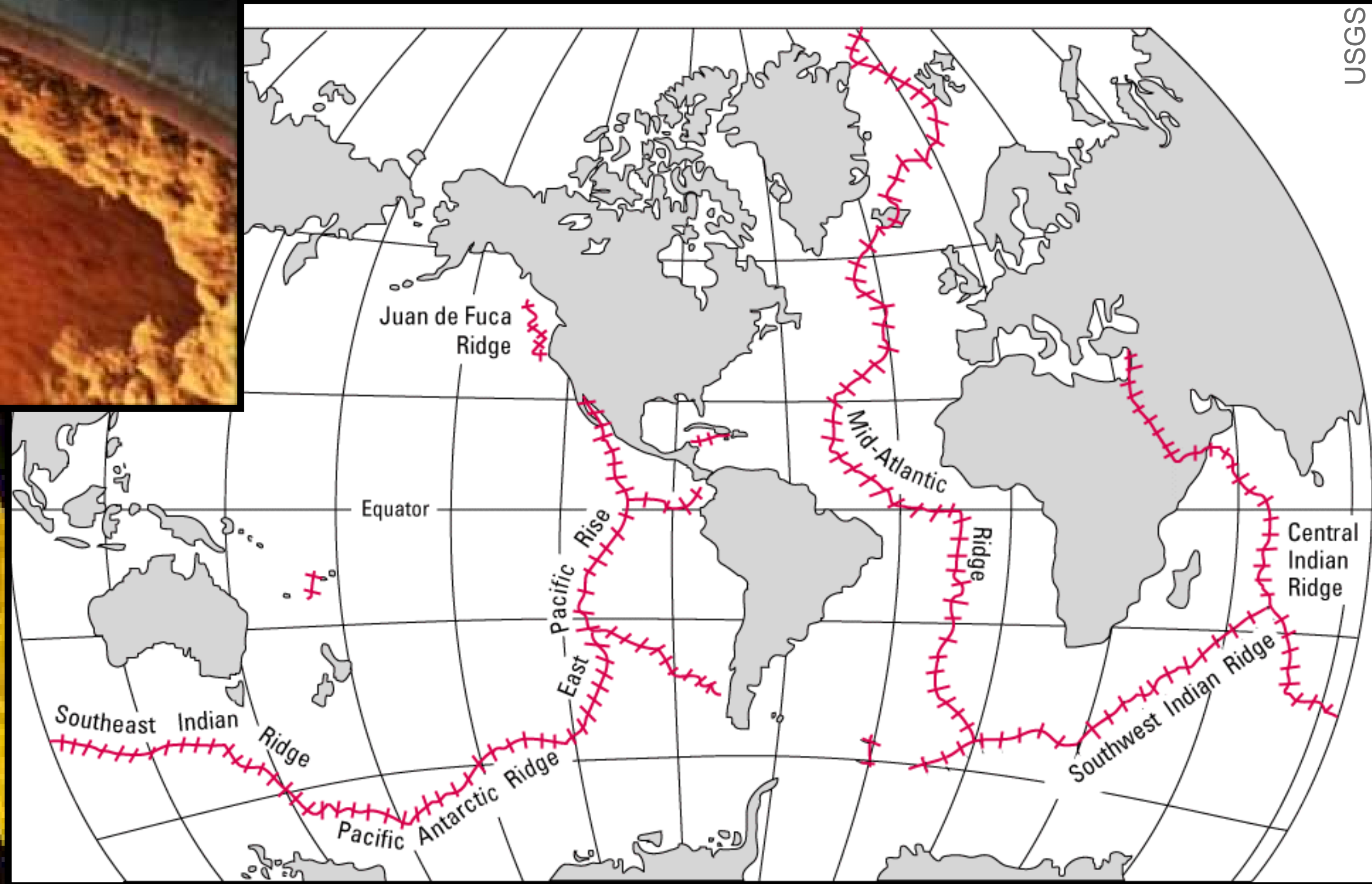


# Mid-Ocean Ridge Volcanoes

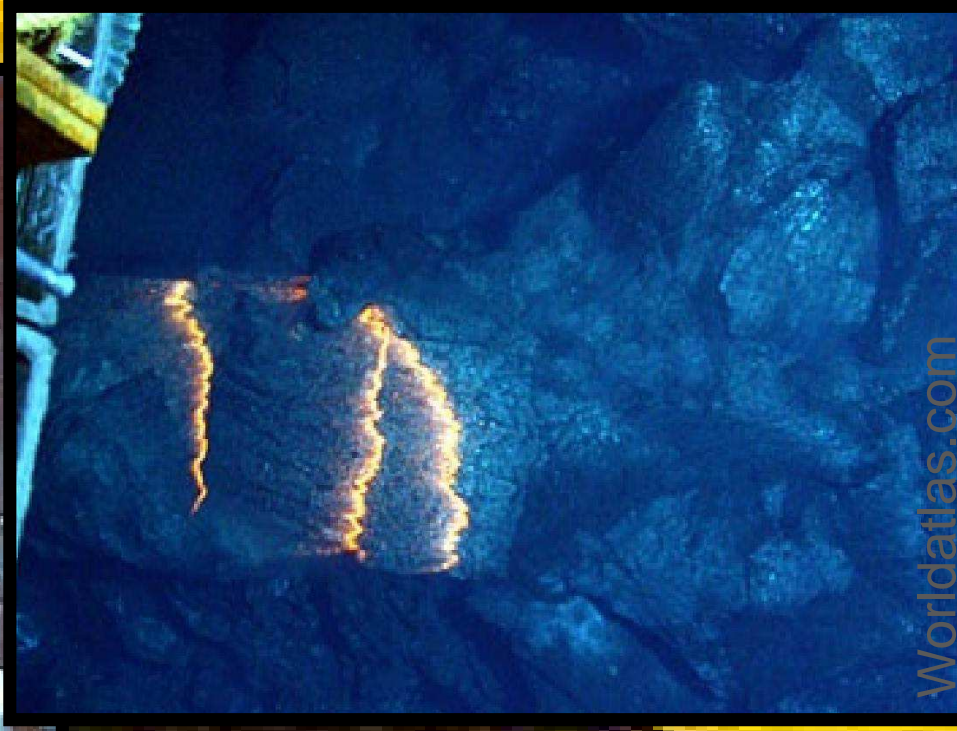
Earth's crust is made up of **tectonic plates**. **Mid-ocean ridge volcanoes** form where two plates are moving apart.



As the plates move apart, cracks form in the crust. Magma from the mantle surges up these cracks, and erupts onto the surface, forming new crust.



This new crust is very thin, so it forms an ocean basin. Only very thick crust can form land.



Mid-ocean ridges are very difficult to study because they are usually deep underwater. But occasionally, these plate boundaries run onto land, and begin slowly tearing a continent apart. This is happening now in Afar, Ethiopia.

In the Afar desert, you can see huge cracks in the ground where the crust is being pulled apart by moving plates.



Mid-ocean ridge volcanoes produce huge volumes of lava. This lava is very fluid – it pours onto the surface, and flows or forms lakes. Because it's movement is predictable, you can get quite close to this lava.

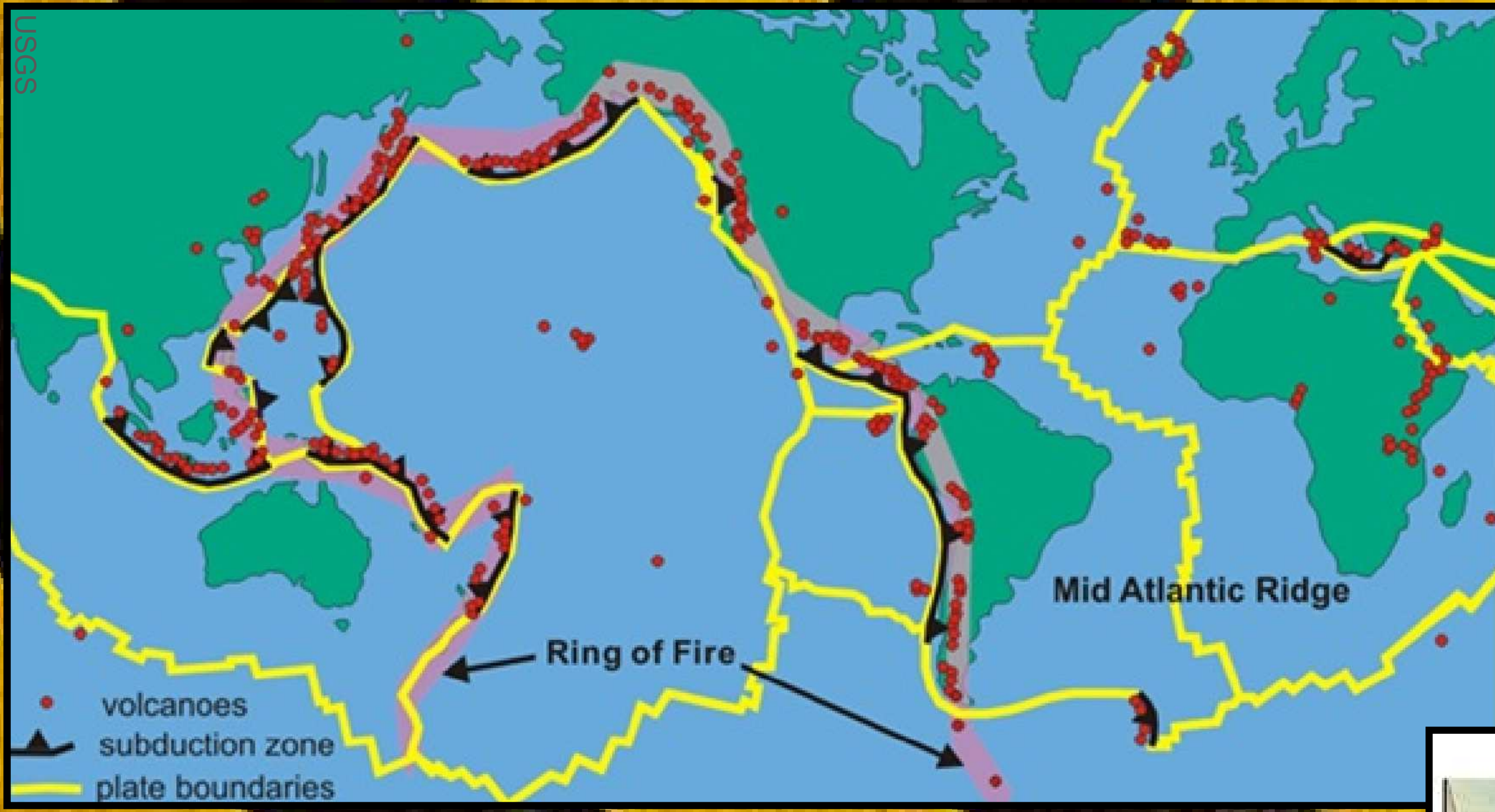


Because Afar is much easier to get to than the bottom of the sea, scientists are studying the region very carefully.



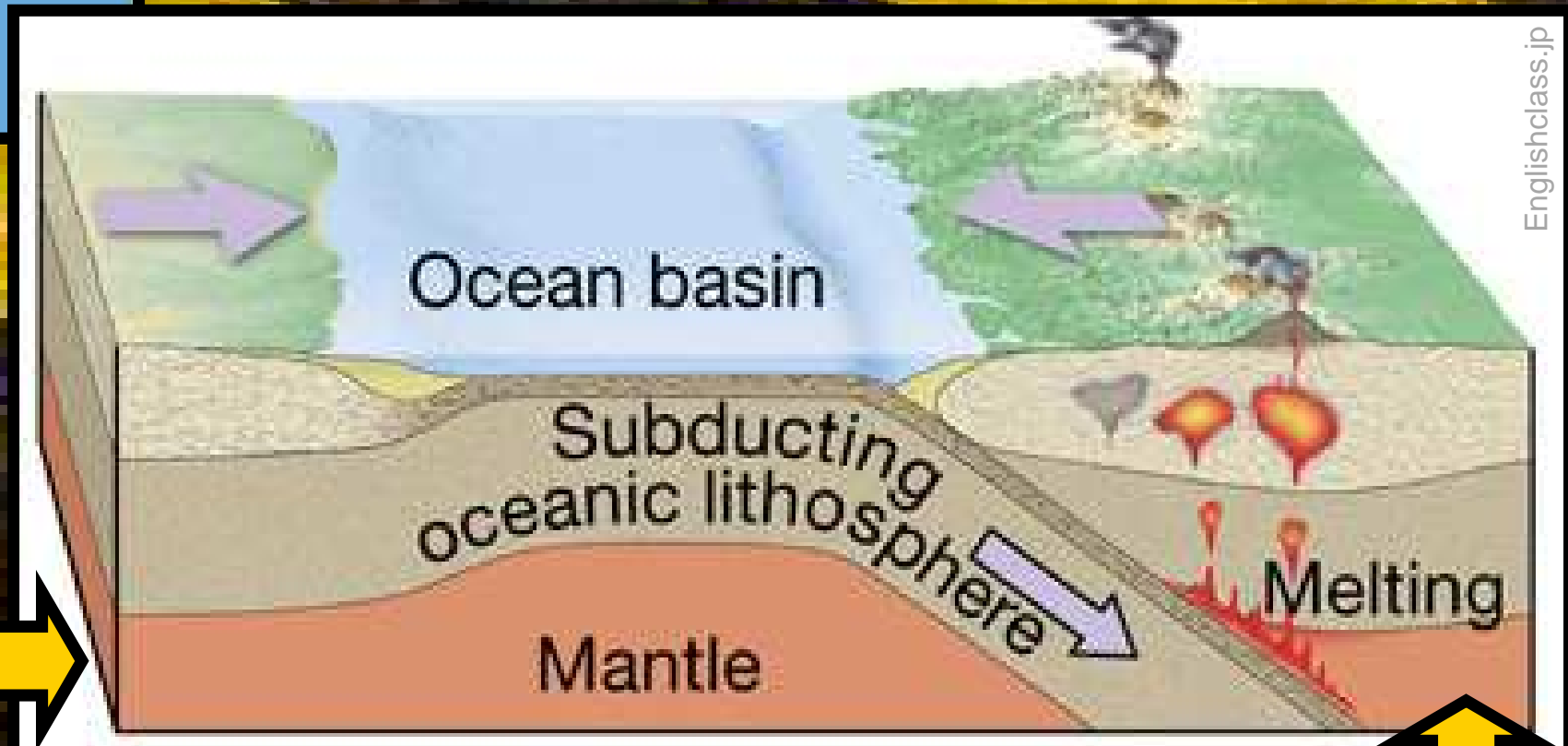


# Subduction Zone Volcanoes



Earth's crust is made up of tectonic plates – and sometimes, two plates move toward each other. If one colliding plate is thin oceanic crust, it slides underneath the other, down into the mantle. This is called **subduction**.

As the oceanic plate descends into the mantle, it heats up. All the water it contains rises upwards, mixing with the mantle rock and making it melt. This magma is full of dissolved gas – like a fizzy drink – so it forces its way upwards and explodes violently onto the surface.

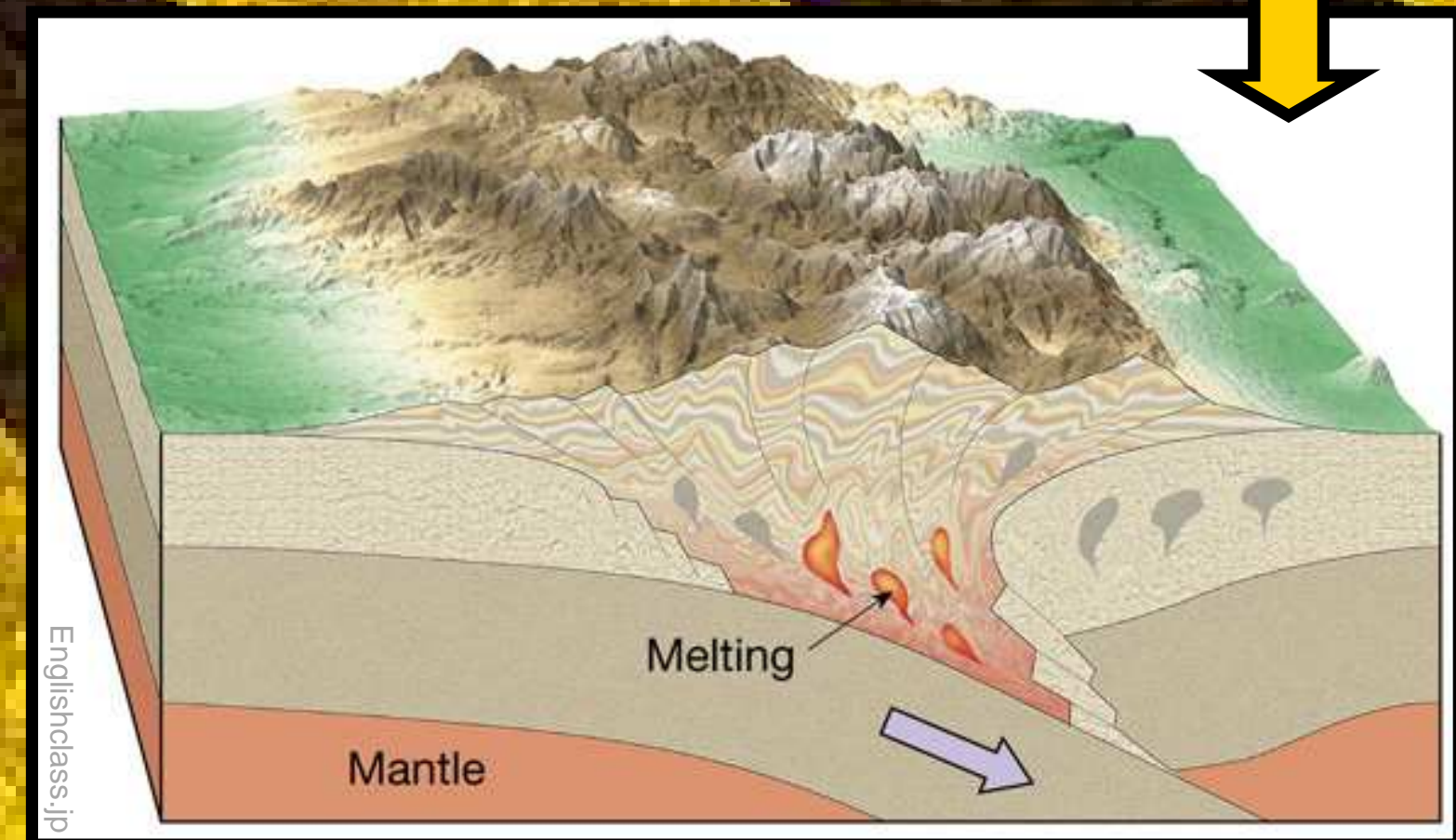


When subduction starts, the overriding crust can be quite thin (like in Central America). But millions of years of eruptions thicken the crust, creating a huge mountain range (like the Andes).



Subduction zone volcanoes often erupt explosively, sending huge columns of hot gas, ash, pumice, and rock into the air. These **Plinian columns** can be over 30 km high.

Subduction zone lava rises so slowly through the thick overriding crust that it changes its chemistry. It becomes **evolved** lava.



Evolved lava is very thick and sticky, and it doesn't flow easily. Sometimes, flows have liquid centres but crusts so thick you can safely walk on them (left); or they can be made of many solid blocks (above).



# Vesuvius & Pompeii

The 79 CE eruption of Vesuvius destroyed the nearby town of Pompeii. Excavations of the buried Roman city show just how dangerous volcanoes can be.

Poster © Jeannie Scott / NERC



The destruction of Pompeii has inspired artists for centuries.



Pompeii was preserved because much of it was buried by falling ash, pumice, and rocks. This deluge lasted for hours, so many people had time to leave the city.

The day after the eruption began, violent pyroclastic flows ripped through Pompeii, destroying the parts of the city which hadn't yet been buried and killing anyone left behind. Unfortunately, these flows travelled beyond Pompeii, catching up with many who had evacuated.



Another city, Herculaneum, was even closer to Vesuvius than Pompeii; it too was completely buried.

We have a written record of what happened at Vesuvius thanks to Pliny the Elder, who died trying to rescue people from the volcano, and his nephew, Pliny the Younger. Today, we call the big eruption columns from exploding volcanoes "Plinian".

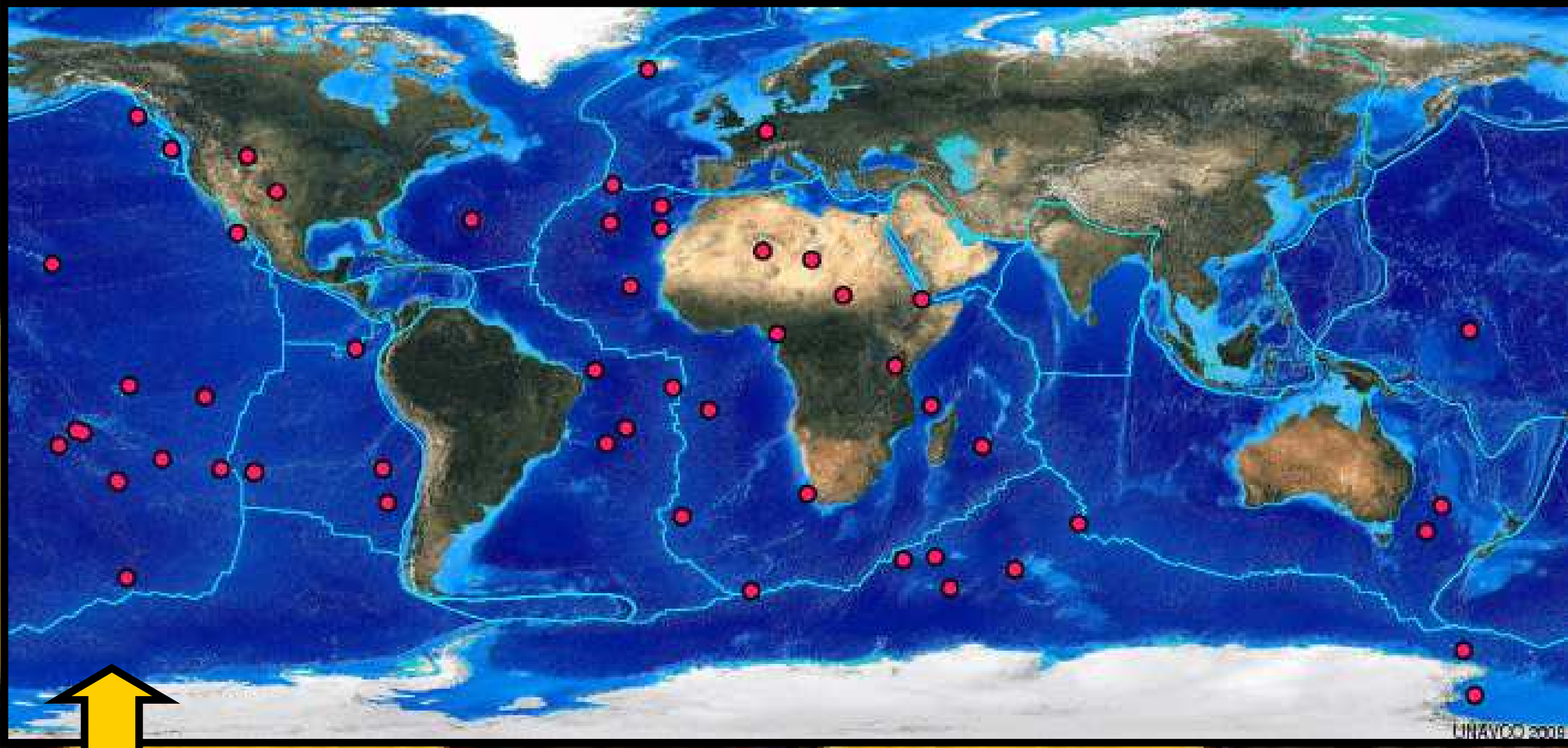


3 million people live near Vesuvius today.

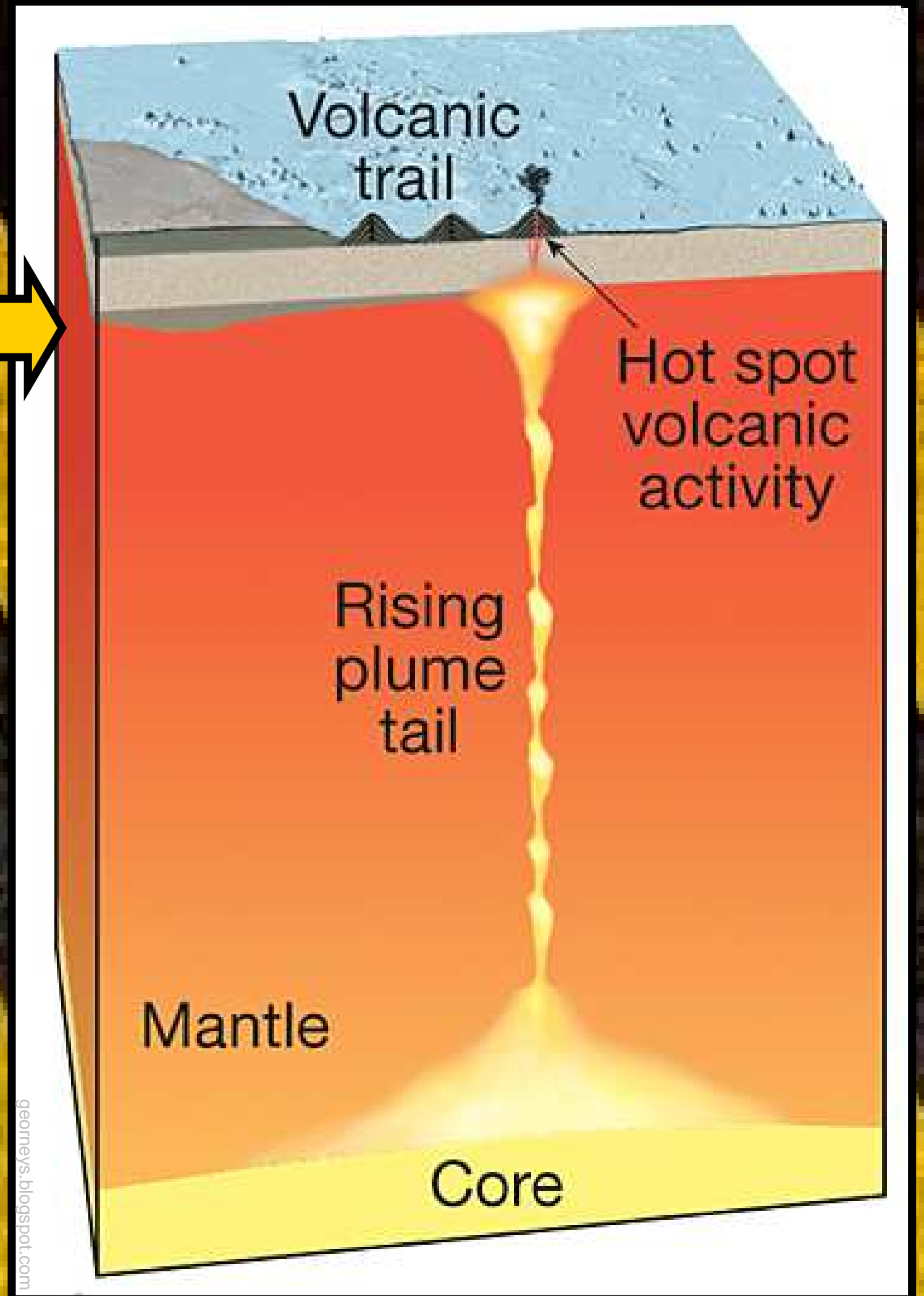


# Hotspot Volcanoes

Hotspot volcanoes form above a mantle plume, a column of unusually hot magma that rises from very deep within the Earth.



Hotspot volcanoes (red dots) aren't restricted to plate boundaries (light blue lines).



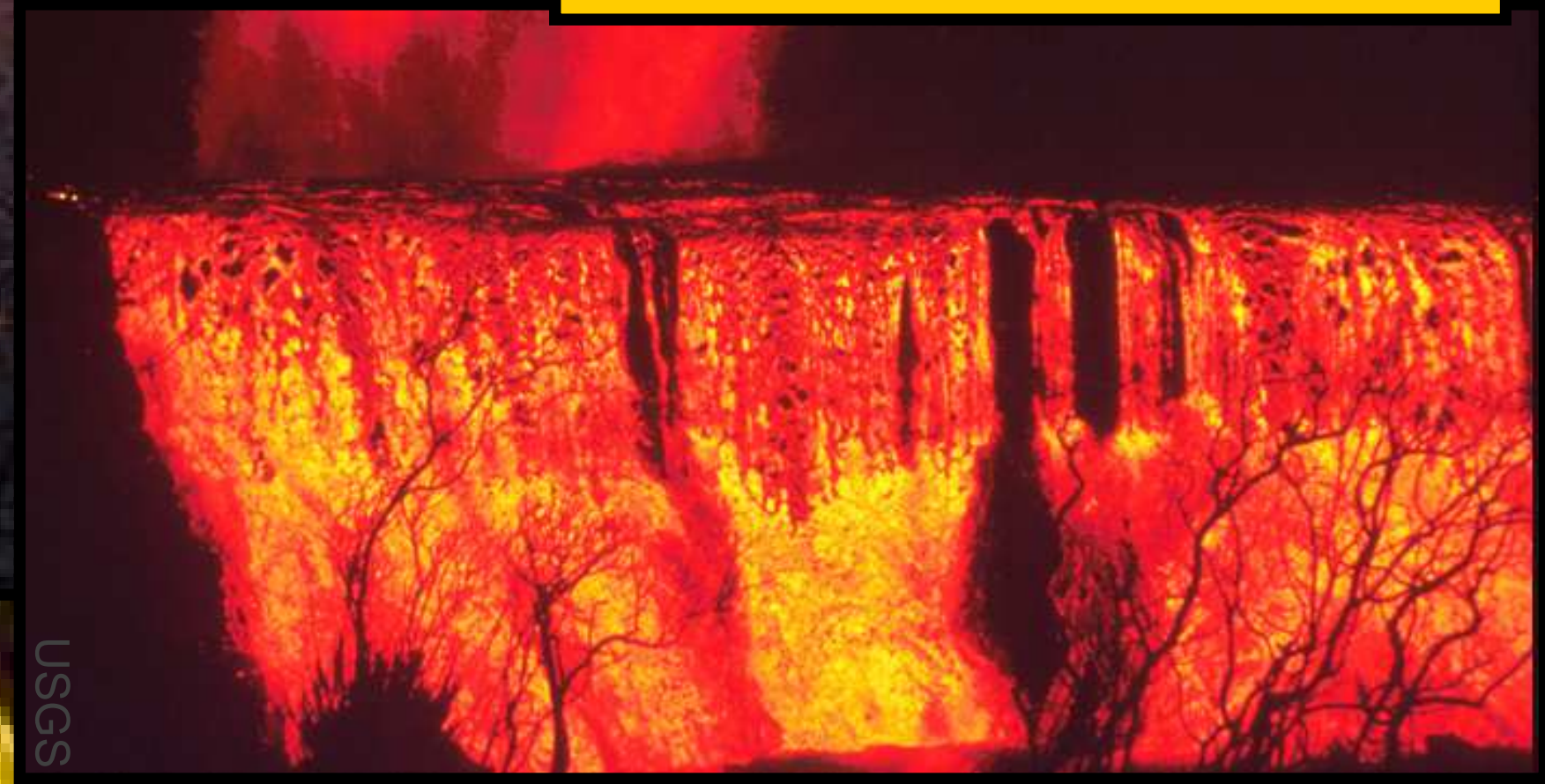
Tectonic plates move over mantle plumes, leaving a trail of volcanoes.



Hotspot volcanoes don't often erupt explosively. Instead, they erupt huge volumes of very liquid lava.



This lava can form fountains, lakes, rivers, and even cascades.



Hotspot lava can freeze quickly, preserving many different textures.



Poster © Jeannie Scott / NERC

USGS

Michelle Parks

USGS

USGS

Michelle Parks

Michelle Parks

Telegraph



# Volcanic Hazards: Ash

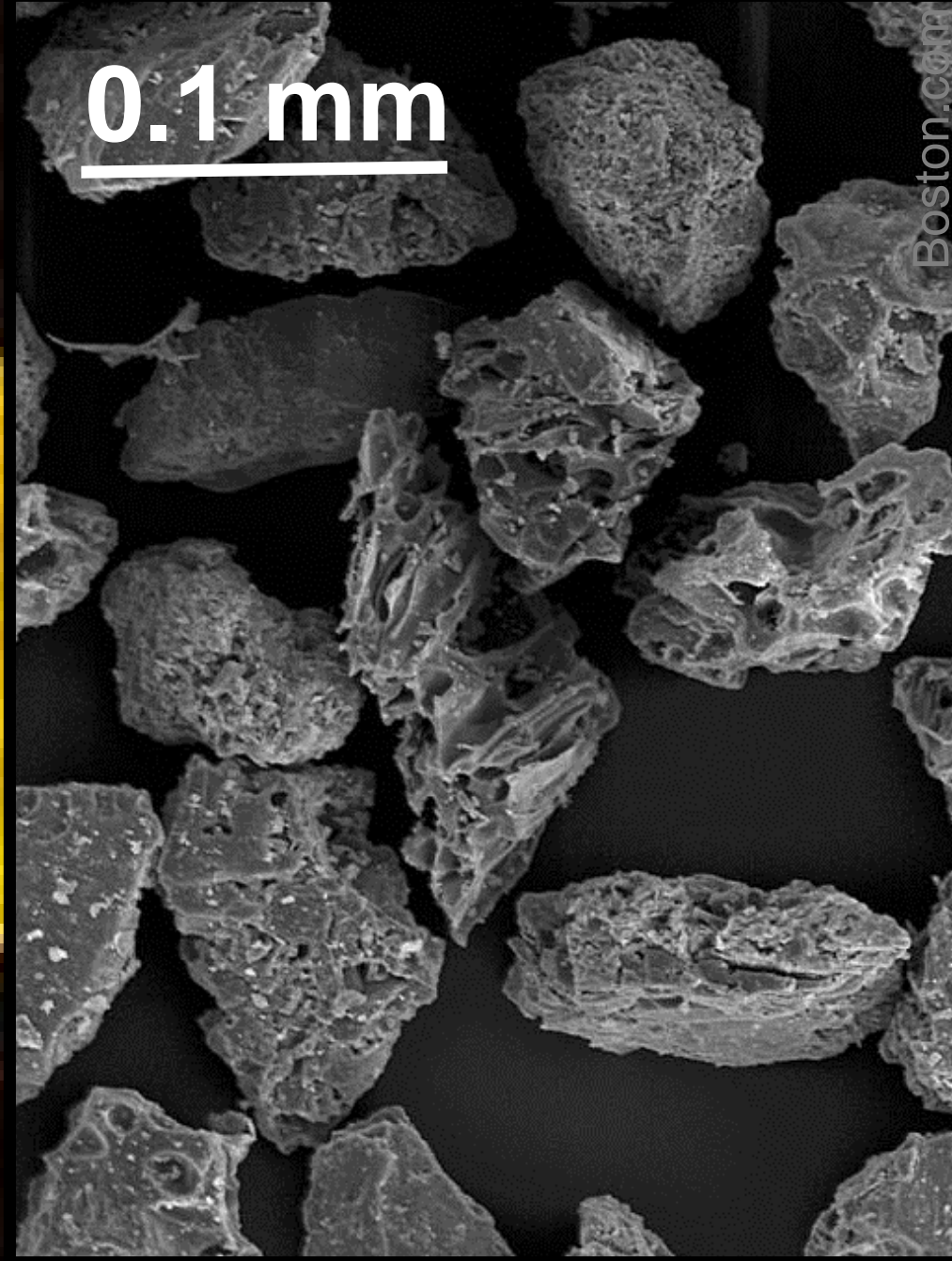


Guardian

Explosive eruptions can send huge **ash** clouds high into the air. Ash later falls back to the ground, but it can be carried hundreds of miles from the volcano.

Ash is very small grains of rock. Some ash forms when magma is blown into pieces by an explosive eruption; some forms when solid pieces of lava grind together.

0.1 mm



USGS

Small ash particles can cause breathing problems and lung disease.



© AP

Ash looks like dust, but it's actually rock – so it's very heavy. Ash fall often makes roofs collapse, and it made this plane tip over.

Ash coats everything, killing plant life and contaminating water and soil.



National Geographic

Poster © Jeannie Scott / NERC



istock.com



postsci.com

Ash clogs jet engines, and scratches the windows so it is hard to see out.



Equador Images

Ash makes driving very difficult. Not only is it hard to see through ash clouds, but it makes the roads very slippery.

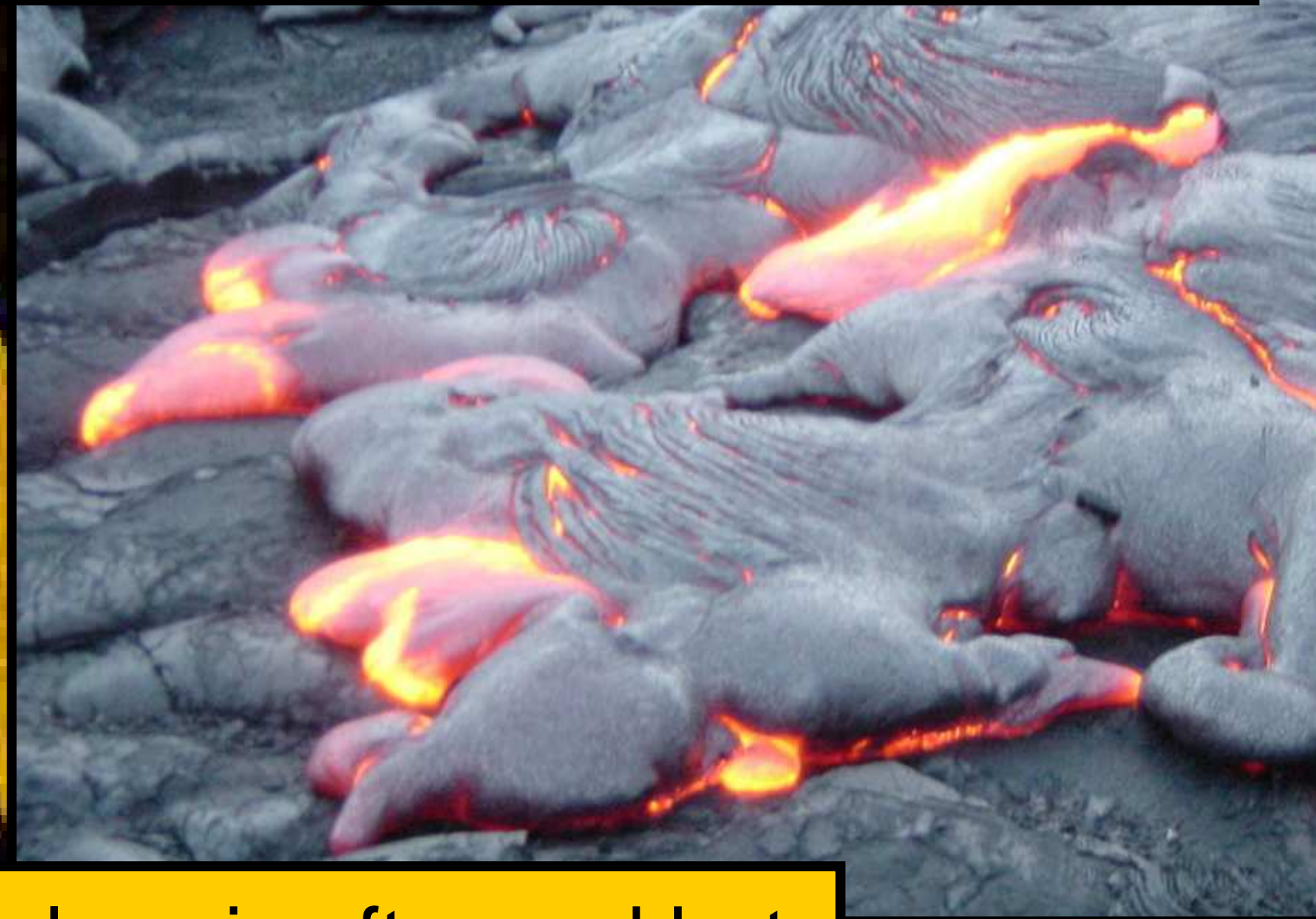




# Volcanic Hazards: Lava

The most common type of lava is called **basalt** lava. It erupts as a liquid that can flow above the ground, or in tunnels just under the surface.

Poster © Jeannie Scott / NERC



Molten rock is called **magma** before it erupts, and **lava** after it erupts.



This lava is often red hot – it can be over 1000°C. It forms a dark skin or crust as it cools. This crust can wrinkle, but it is often very smooth and glassy. It has a Hawaiian name – **pahoehoe lava** (pronounced pah-ho-ee-ho-ee).



Lava tunnels can have very thin roofs. You would not want to fall through one of these!

If basalt lava has a lot of gas dissolved in it when it erupts, it can be full of bubbles. This makes it less runny, and it has a rough, sharp surface. It is called **a'a lava** (pronounced ah-ah).



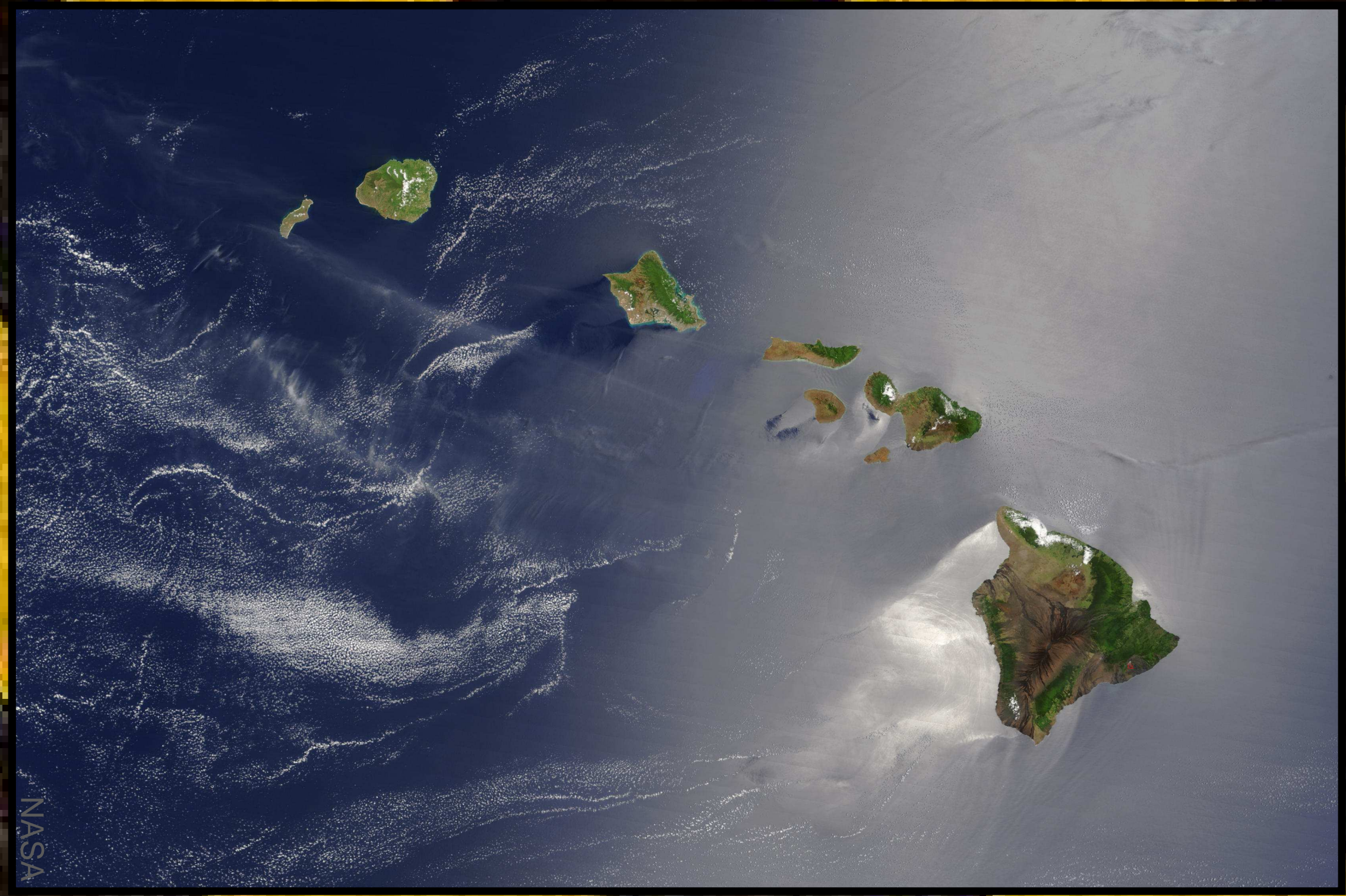
Lava flows do not move fast – you can get very close to them, if you don't mind the heat. But they destroy buildings and crops. And they seriously disrupt traffic!





# Hawaii

Hawaii is actually a chain of island volcanoes, created as the Pacific plate moved over the mantle plume.



The Big Island of Hawaii is made up of several volcanoes. The largest, Mauna Loa, is bigger than Mount Everest – but most of it is under water.

Kilauea (pronounced kill-owe-way-ah) on the Big Island is possibly the most active volcano in the world.

Hawaiian eruptions are spectacular, but because they are not as dangerous as explosive volcanoes, they are a major tourist attraction.

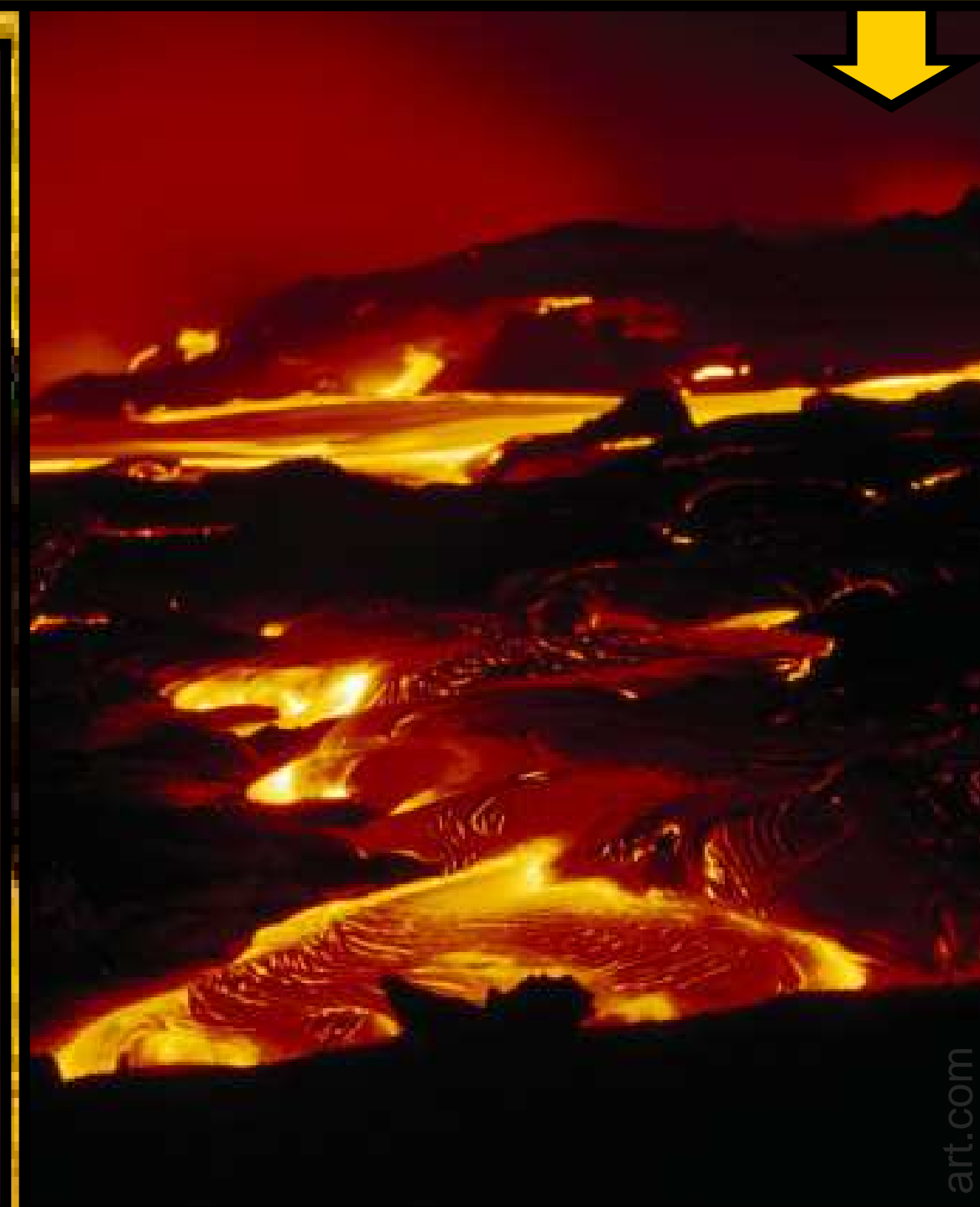


These volcanoes often have many active vents. Vents can form in craters, or in chains called **fissures**.

Lava is a major hazard on Hawaii – it often destroys buildings and roads. The other major hazard here is volcanic gas. Parts of the island are often closed due to toxic gas clouds.



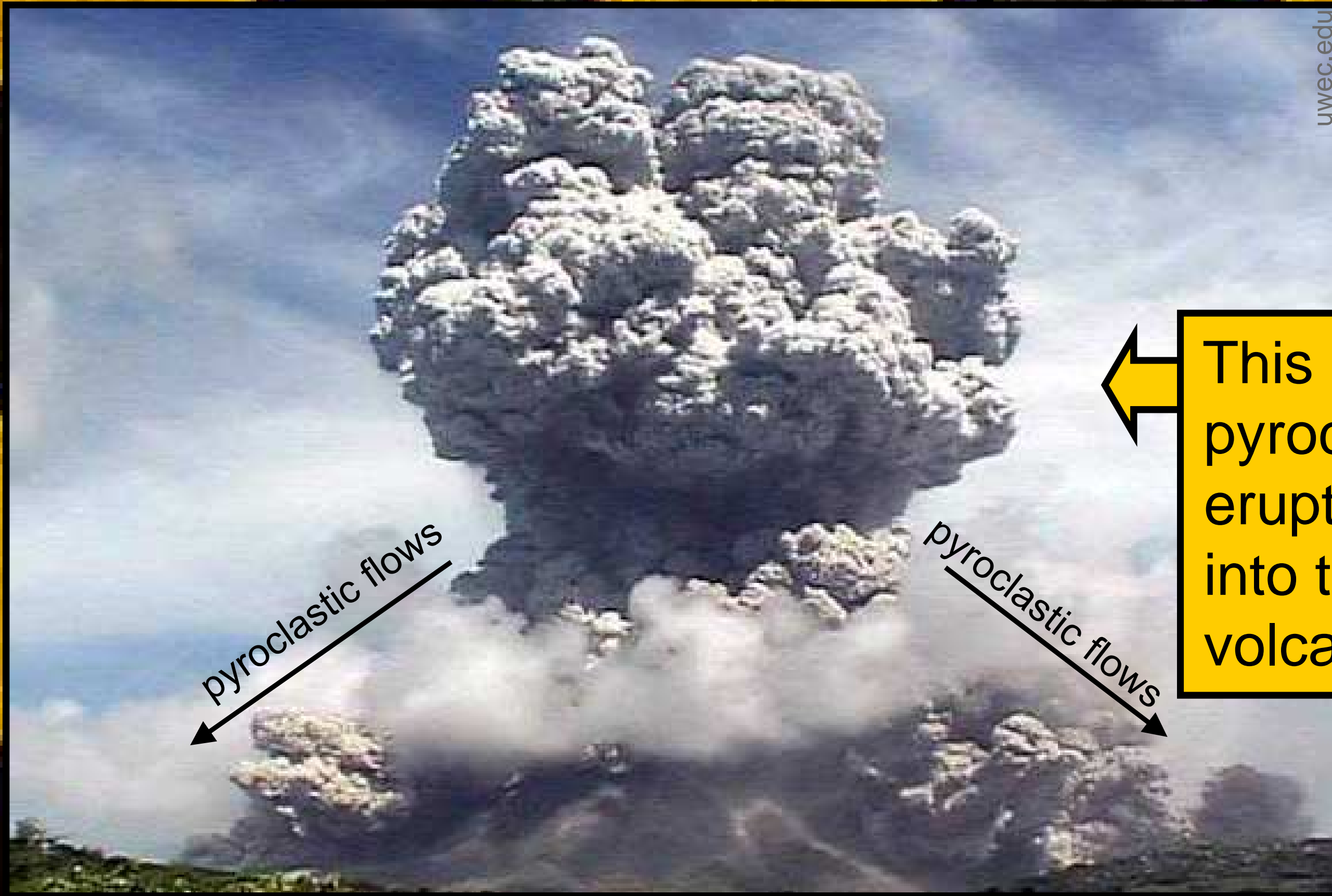
**Laze** is a lethal cloud of hydrochloric acid created when lava meets the sea.





# Volcanic Hazards: Pyroclastic Flows

A **pyroclastic flow** is a scorching cloud of gas, ash, and rocks that races along the ground at up to 65 mph, incinerating everything in its path and burying the ruins under metres of rubble. It is the deadliest volcanic hazard.



This picture shows one way that pyroclastic flows can form. Parts of the eruption cloud are too heavy to rise far into the air, collapsing back onto the volcano and racing down the slopes.

Pyroclastic flows can also form when part of a volcano collapses. Hot, glowing boulders of new rock can pile up around the vent, forming domes as big as skyscrapers. But these domes are unstable. They are so hot that when they collapse, the rubble explodes downhill as a devastating pyroclastic flow.



It isn't just their speed that makes pyroclastic flows so deadly – it's that they are so unpredictable. They can even flow uphill, and out over water.



In 1902, pyroclastic flows from the Caribbean volcano Mont Pelée destroyed a nearby city. Out of 29,000 people, only 2 survived – both with serious injuries.





# Mount St Helens

When Mount St Helens erupted in the US in 1980, we saw a volcano erupt sideways for the first time. The eruption begins with a landslide – the side of the mountain collapses.

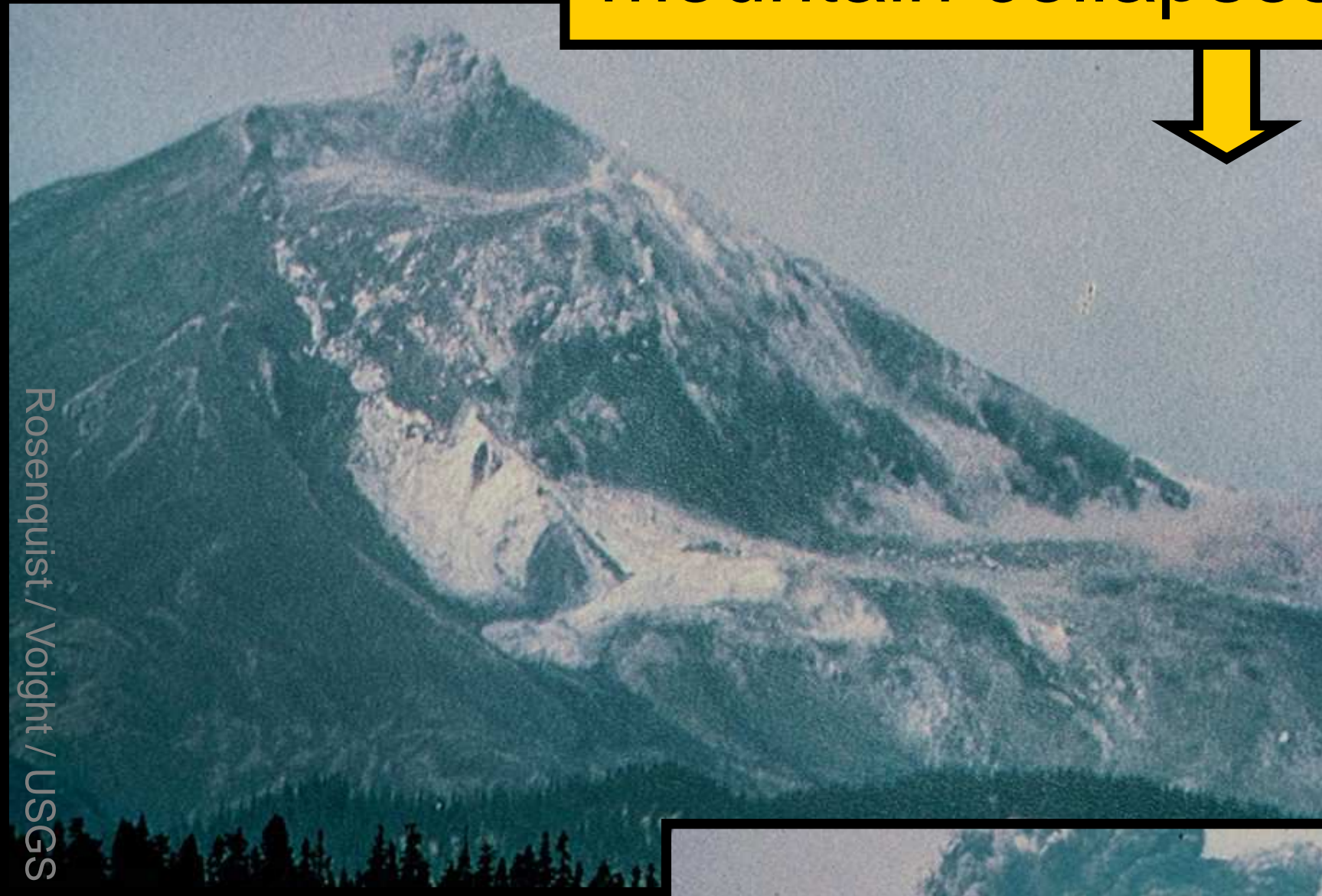
Sudden depressurization of the magma chamber triggers an explosive eruption – like uncorking a champagne bottle.

This sideways explosion is a **lateral blast**. The explosion cloud raced over the ground at over 300 mph, travelling over hills and valleys, destroying an area twice the size of Birmingham in just 3 minutes.

The volcano explodes sideways.

Mount St Helens was the first big volcanic disaster of modern times – it was filmed and photographed with modern cameras. Scientists were able to see the eruption as it happened, and it changed the way we study volcanoes. Today, there is a permanent volcano observatory at Mount St Helens, equipped with many new instruments to help monitor volcanic activity.

The eruption released 1600 times more thermal energy than the Hiroshima nuclear bomb.





# Volcanic Hazards: Gases

Volcanoes release lots of gas into the atmosphere. Some is released during eruptions; some is released between eruptions.



Jon Stone

Volcanic gas is mostly steam ( $H_2O$ ).

Volcanic gas also contains sulfur, fluorine and chlorine. These toxic gases often form acid clouds or acid rain, making the air dangerous to breathe, destroying plant life, and even corroding metal.



USGS

USGS

These rocks are covered in yellow sulfur, which crystallizes out of the hot gas.

**Fumaroles** are small vents where gas is released between eruptions. Fumarole gas can be very hot, and very toxic. But with gas masks, scientists can get close enough to take samples.



Wikipedia.org

Erupting volcanoes often smell strongly of sulfur.



USGS



Jon Stone

The chemistry of volcanic gas is analyzed with special instruments like these. Changes in the gas chemistry can tell us about the magma underneath the volcano.



USGS

Volcanoes also release carbon dioxide ( $CO_2$ ). In 1986, a cloud of  $CO_2$  escaped from a volcanic lake in Africa and flowed downhill, suffocating 1700 people.

## CAUTION

VOLCANIC FUMES ARE HAZARDOUS TO YOUR HEALTH AND CAN BE LIFE-THREATENING VISITORS WITH BREATHING AND HEART PROBLEMS, PREGNANT WOMEN AND YOUNG CHILDREN SHOULD AVOID THIS AREA

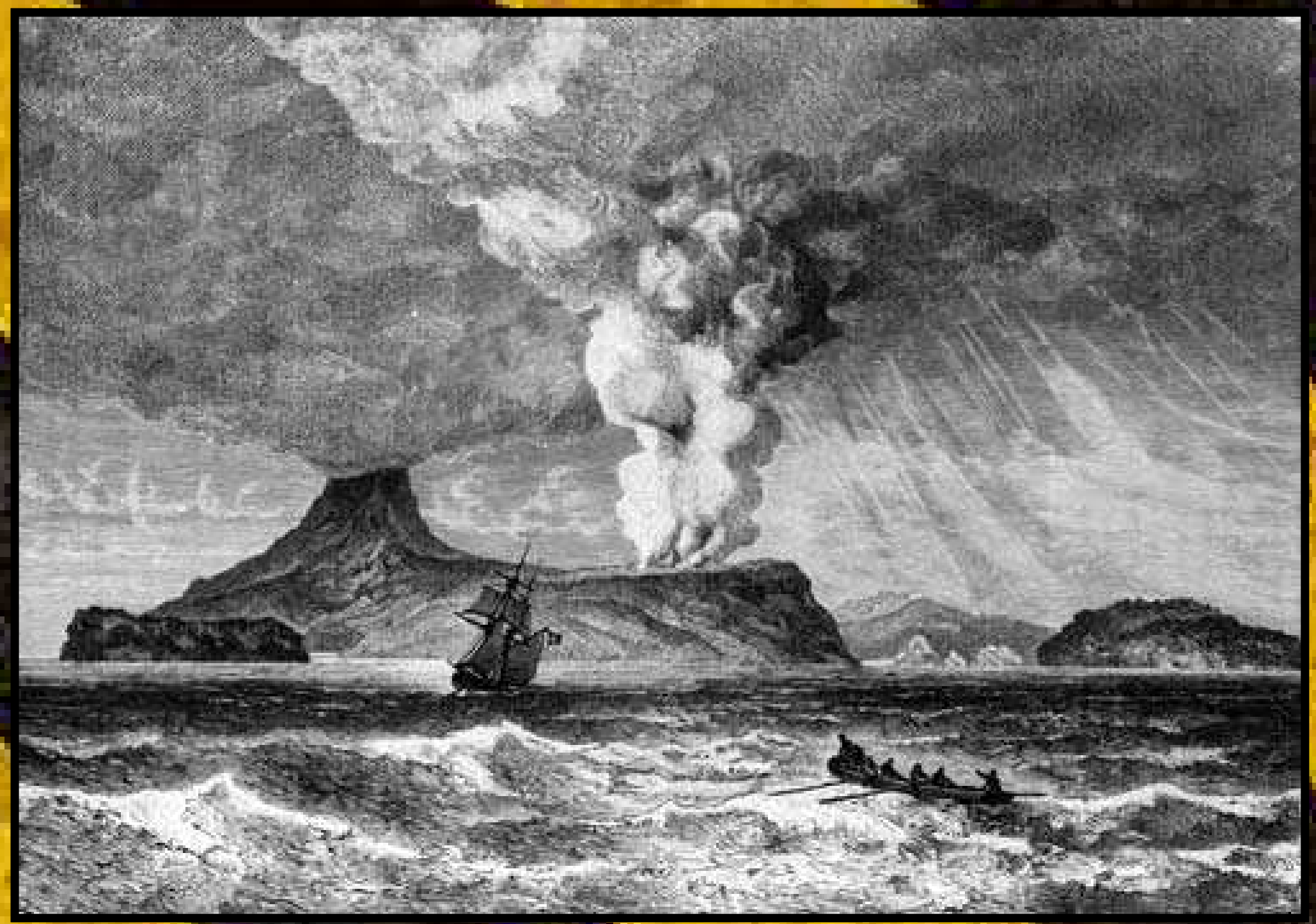
Poster © Jeannie Scott / NERC

npesmith.edu



# Krakatau

Krakatau, a small island in Indonesia, is one of the most famous volcanoes in the world. It's 1883 eruption became legendary, inspiring many paintings, books, and films.



The eruption of Krakatau lasted for about 4 months. It ended with an explosion so huge, the shockwave echoed around the entire world 7 times.



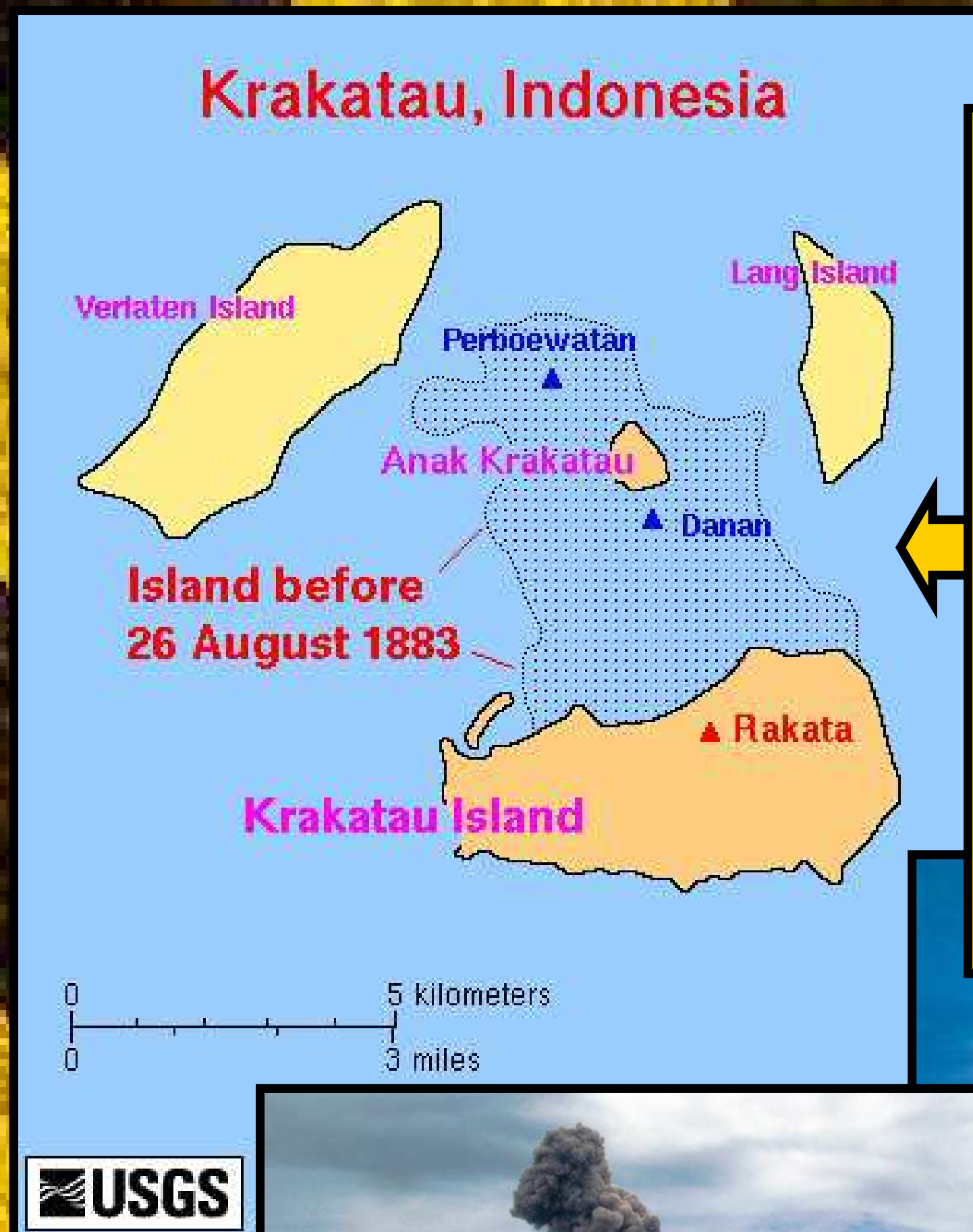
The Krakatau eruption was deadly because the explosions sent huge **tsunamis** across the sea. Some tsunami waves were as tall as 9 London buses. They destroyed more than 160 towns, killing about 35,000 people. The tsunamis were so strong, they travelled right across the Indian Ocean.



This volcano is often called "Krakatoa", probably because of a spelling mistake over 100 years ago!



Krakatau sent so much ash into the atmosphere, that sunsets turned red even in Britain. This was painted over the River Thames just after the eruption.



Most of Krakatau was vaporized in the 1883 eruption, leaving a large crater or **caldera**. A new volcano, Anak Krakatau (meaning "Child of Krakatau") is now growing in the same place.



David Bergen

Arttoo.uk

William Ashcroft

Australian Geographic



# Volcanic Hazards: Lahars

Lahars, sometimes called mudflows, are a mix of water and volcanic ash. Lahars travel along valley floors for long distances, endangering towns that might be many miles from the volcano.



Lahars can happen when fresh ash mixes with river water; sometimes, the heat from an eruption melts snow which then mixes with ash. Heavy rain can also trigger lahars by washing ash left by previous eruptions into rivers.



Lahars can bury whole towns in minutes. The flows are a thick liquid that sets hard, like cement.

If people are warned in time, they can escape a lahar by going to high ground. There was no warning system at Armero, in Colombia. In 1985, a lahar destroyed the town, killing 22,000 people.



Lahars are incredibly powerful, picking up debris like trees and boulders the size of houses.

Lahars cut through the ground, eroding deep valleys.





# Soufrière Hills, Montserrat

When a volcano awakes, eruptions can be quite small. It might be gearing up for a really big eruption, or it might just go quiet again. When no-one knows exactly what will happen or when, it is difficult to know how to stay safe.



Montserrat used to be a peaceful Caribbean island with no historic eruptions.

Then in 1995, Soufrière Hills began to erupt.

At first, eruptions were small, but scientists thought they might get bigger. So people evacuated to a safe part of the island.



N & A Dennis

Evacuees had to leave their homes and businesses. They lived in tents or churches, with little running water and they survived on foreign aid. They waited to see what the volcano would do.



David Lea

Some got tired of waiting, and moved off the island. Others went into the

danger zone, to collect their things, to work, or even to live in their own houses.



David Lea

Poster © Jeannie Scott / NERC

Two years after the first small eruptions began, the volcano exploded. 19 people were killed, and many more injured. But all those who died were in the danger zone – they had chosen to risk their lives because life in the camps was so difficult.



Montserratvolcano.org



15 years later, Soufrière Hills is still erupting. This is what's left of the capital city.



Uwec.edu

Jeannie Scott