CASE STUDY FOCUS:

SURTSEY

DISCOVER the WORLD EDUCATION

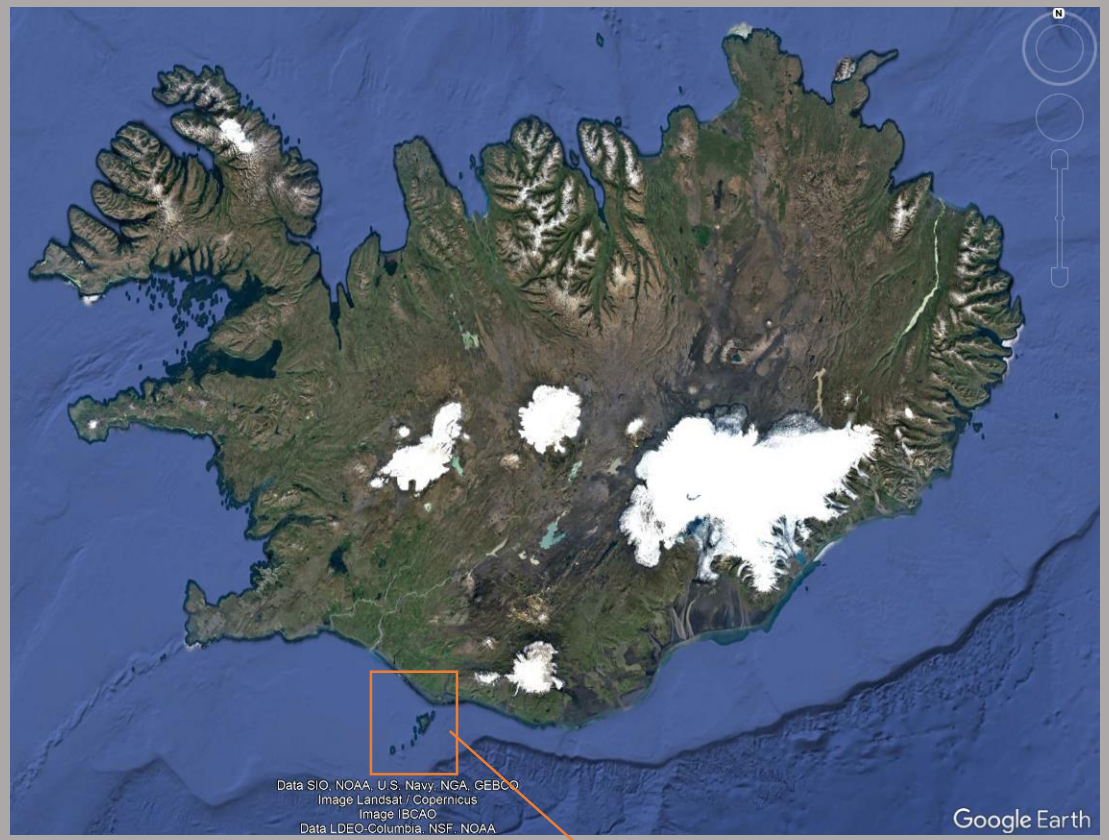
AIMS

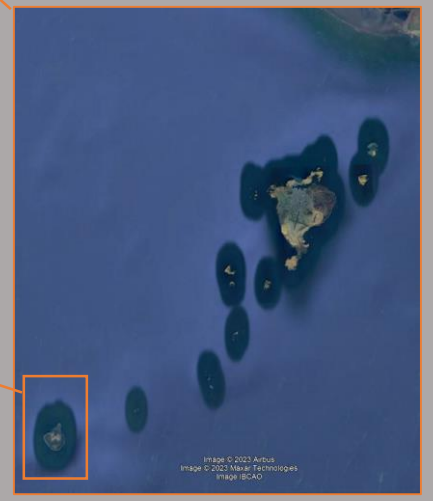
- Describe the context of the Surtsey eruption
- Understand why the eruption was significant

LOCATION

Where is Surtsey?

- Part of the Vestmannaeyjar archipelago (Westman Islands)
- Found 32km off the southern coast of Iceland
- Approximately 1,105 miles northwest from London
- The most southerly point of Iceland





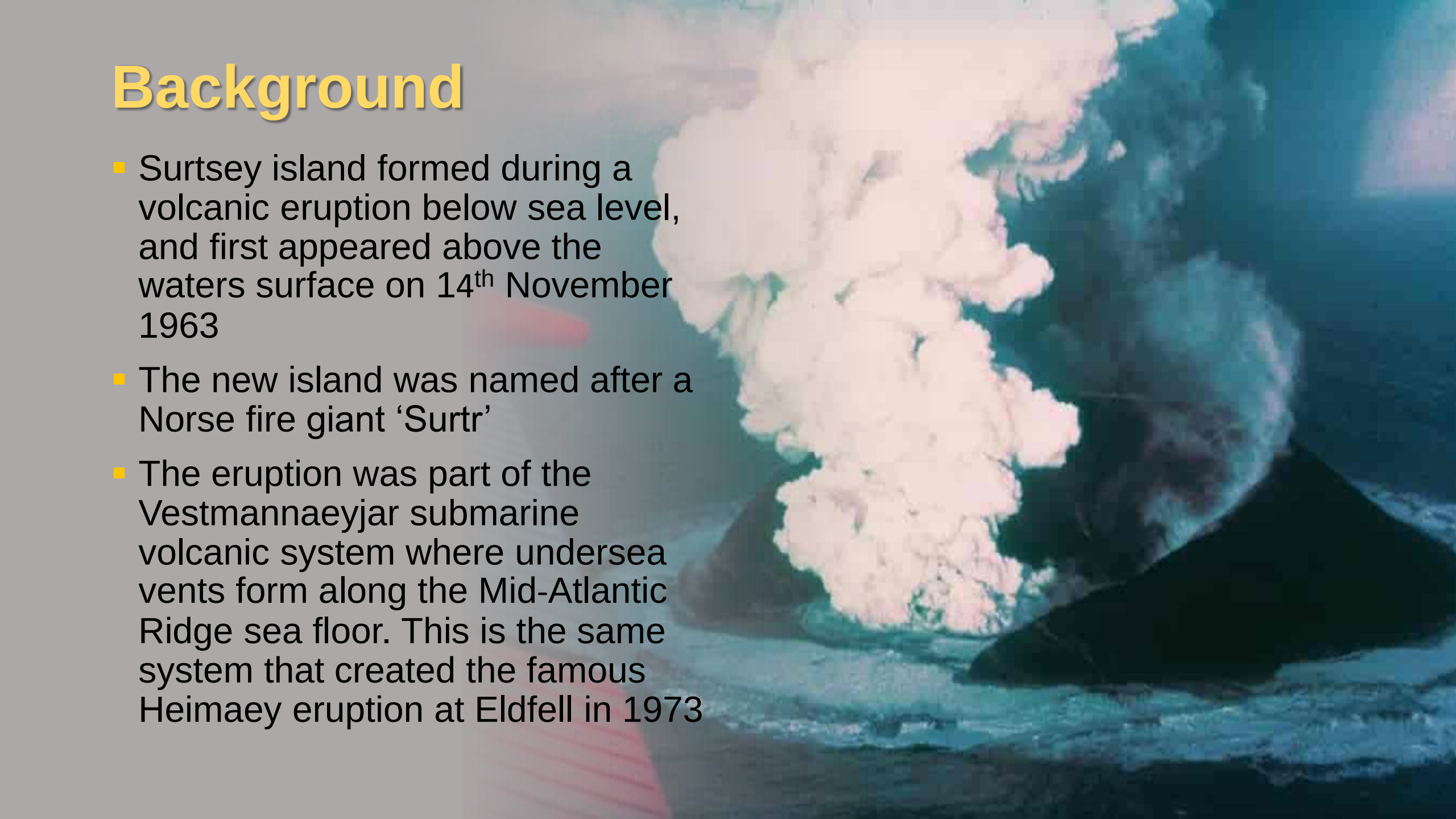
Where is Iceland?

- Iceland is located in Europe, northwest of the UK
- Iceland is formed along the Mid-Atlantic Ridge in the Atlantic Ocean
- It is part of two tectonic plates, the Eurasian and North American plates, which are diverging (moving apart)

CONTEXT

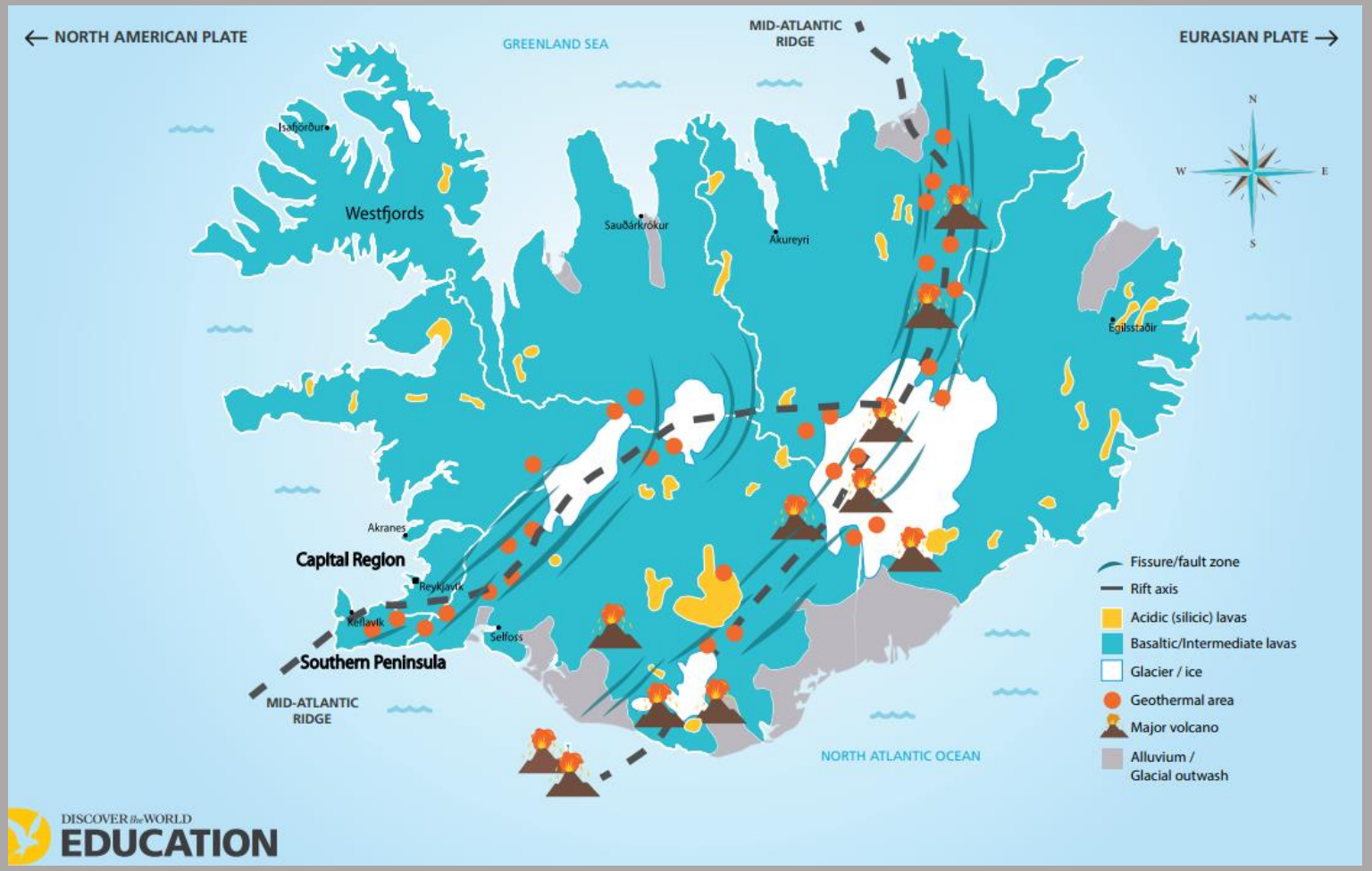
Background

- Surtsey island formed during a volcanic eruption below sea level, and first appeared above the waters surface on 14th November 1963
- The new island was named after a Norse fire giant ‘Surtr’
- The eruption was part of the Vestmannaeyjar submarine volcanic system where undersea vents form along the Mid-Atlantic Ridge sea floor. This is the same system that created the famous Heimaey eruption at Eldfell in 1973



Geology

- Like most of Iceland, Surtsey island is made from basaltic lavas
- Basalt lavas has a higher temperature than most, around 1200°C, but lower silica levels and still rich in iron and magnesium
- This type of lava is thin and runny therefore flows fast and cools quickly



The Eruption

- The eruption began some 130m below sea level
- Lava breached the surface on 14th November 1963
- The eruption last until 5th June 1967, by which time the island reached 1 square mile in area and 171m high
- Over time, erosion from waves has reduced the island to an area of just 0.5 square miles

EVENTS

The eruption was unexpected, and most likely started at the submarine vent, days before signs were detected

The sea floor at the eruption site is 130m below sea level, so the initial signs of an eruption were hard to notice

First volcanic emissions and explosions were hidden by the depth of water, until lavas built closer towards sea level

Seismic activity was first noticed on mainland Iceland on 6th November 1963, with weak tremors detected

On 12th November, weak tremors were detected as far away as Reykjavik for ten hours

On the same day, people in the southern coast town of Vik could smell the ‘rotten eggs’ of hydrogen sulphide

A fishing boat on 13th November noted that sea temperatures were 2.4°C higher near the eruption site

On 14th November a boat crew spotted dark smoke rising from the sea, followed by visible explosions

By 11am, the eruption column was several km high with eruptions along separate vents along a fissure

- Over the next week, explosions were continuous and after a few days there was a visible new island measuring over 500m long and 45m high formed from *scoria* (basaltic lava fragments)
- Gradually the eruption concentrated into one vent along the fissure, and the island began to build into a more classic and typical volcano shape

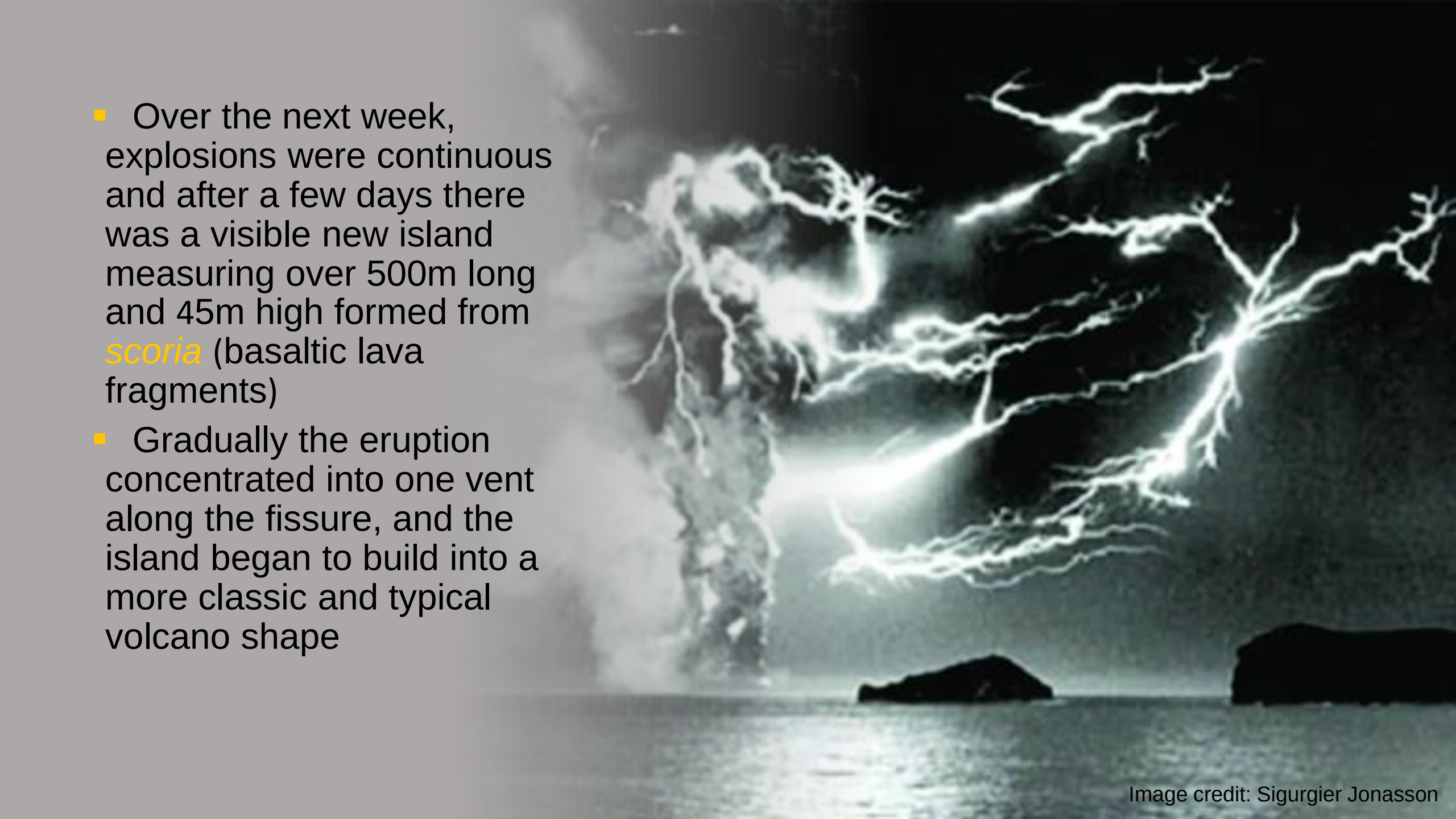


Image credit: Sigurgier Jonasson

- Basaltic eruptions are generally considered ‘effusive’ however this eruption was different
- The interaction of hot lavas and sea water created phreatomagmatic explosions, producing high steam and ash columns with lots of rocky scoria and tephra which could be easily eroded by waves. However the eruption kept pace with constant fresh magma until the island grew high enough that water no longer entered the vents

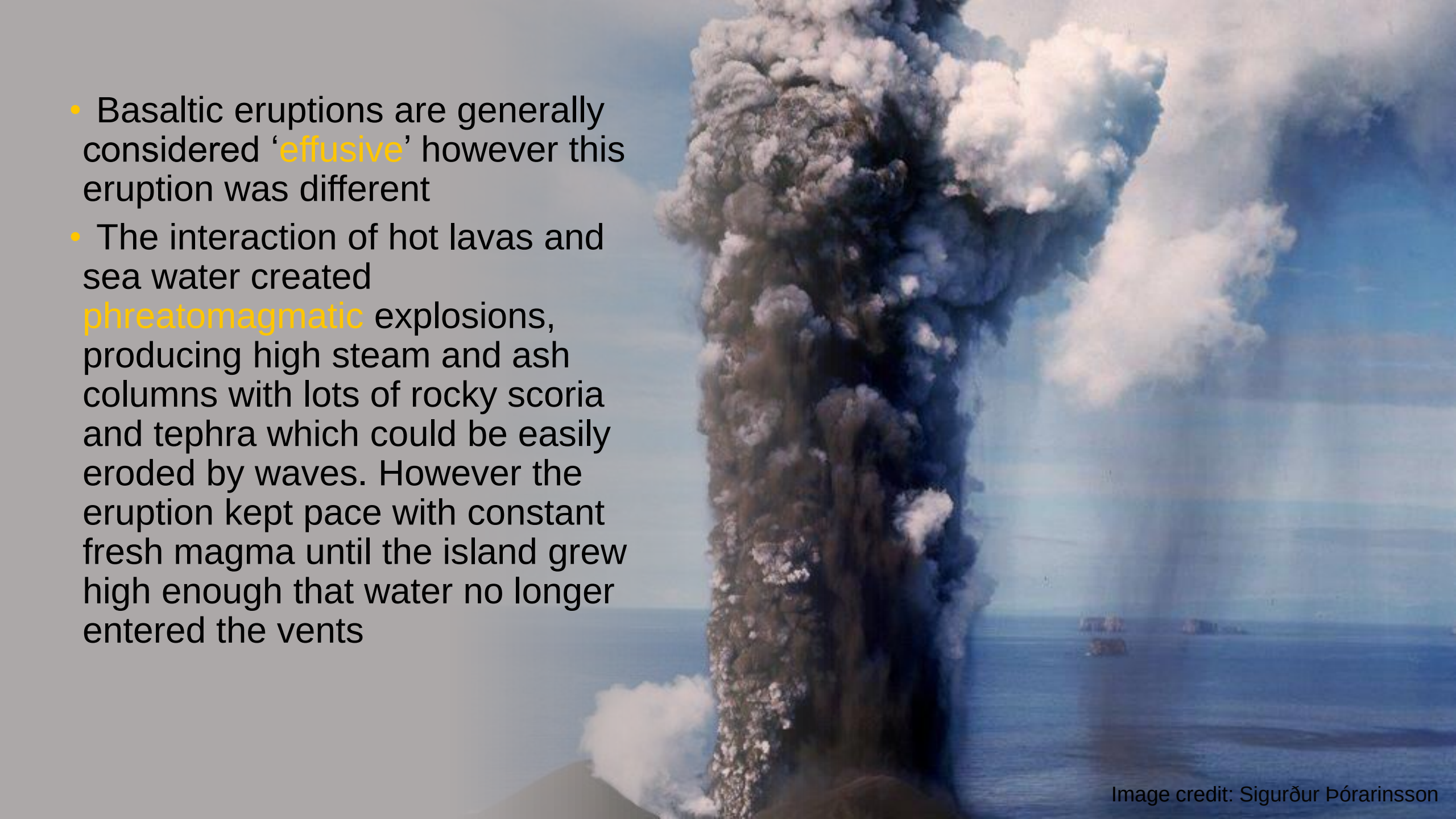


Image credit: Sigurður Þórarinsson

Continuing eruptions into 1964 built the island high enough to protect the vents from sea water

The explosive eruption phase ended once water was no longer mixing with lavas and a new phase started

More traditional basaltic effusive activity of lava fountains flows became the main activity

The lava flows created a more resistant harder cap of rock over the top of the loose scoria and tephra

This cap was very resistant to erosion, which protected the new island and prevented it being washed away

Other submarine eruptions also took place, for example creating a new ridge at Surtla, but never reached sea level

In 1965, activity declined, and submarine activity off the coast created ‘Little Surtsey’ which washed away by 1966

Throughout 1966 activity peaked and declined on Surtsey, with quiet spells and then fresh effusive activity

On 5th June 1967, after nearly 4 years, the eruption ended and the volcano has been dormant ever since

Image credit: Google Earth

The new island

- The total volume erupted was approximately 1 cubic kilometre, of which most was tephra and just 30% lava
- Further along the submarine fissure, the famous Heimaey eruption took place ten years later in 1973 at Eldfell volcano

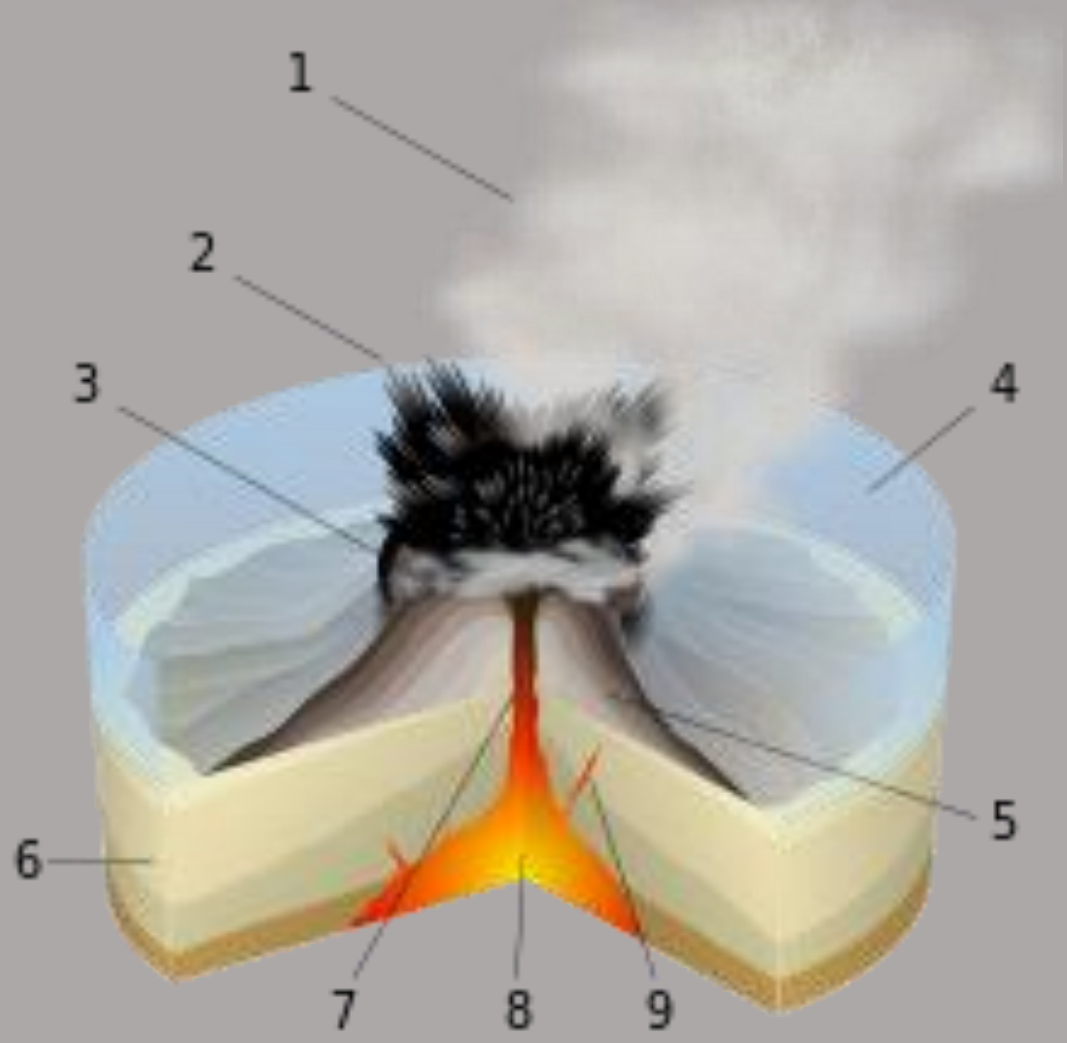
WHY IS IT FAMOUS?

A New Style!

- The eruption was the first of its kind ever witnessed
- A ‘Surtseyan eruption’ became a new category
- It is an explosive style of ‘hydrovolcanic’or ‘phreatomagmatic’eruption that happens in shallow seas or lakes when magma rises rapidly and interacts with cool water
- Hot basaltic magma mixed with cold water reacts very vigorously to fragment and create pyroclasts. The pyroclasts are then thrown out far and fast, which creates steam and ash. This then forms a hard tuff ring cone once cool
- This process creates a more energetic eruption
- As these types of eruptions often occur off-shore they pose little risk to people

Surtseyan eruptions

1. Water vapour (steam) cloud
2. Ash tephra eruption column
3. Crater vent
4. Water (shallow sea or lake)
5. Layers of lava and ash
6. Stratum (layers of rock)
7. Magma vent or conduit
8. Magma chamber
9. Vent



Protected

- This new island has been protected since its creation, and is a UNESCO site
- The land has been free from human interference, preserved as a natural laboratory for scientists to investigate and observe
- Surtsey provides unique insight into the evolution and succession of new land, and how it becomes colonized by plant and animal life
- Scientists have observed seeds arriving by ocean currents, moulds and bacteria emerging, the gradual development of the first soils and plants, and eventually animal life with invertebrates and birds appearing
- It is geographically isolated, and legally protected to ensure access is strictly controlled, making it invaluable to science

Image credit: Google Earth

Televised

- The eruption was the first to ever be televised
- For the first time, people around the world could witness the birth of new land
- This visualization made people much more aware of plate tectonics and inspired many to study the growing science of volcanology
- The eruption triggered a surge in seismic monitoring, leaving a lasting legacy and is driving Iceland’s amazing work on volcanology

The future?

- Wave action and wind erosion will always be working against Surtsey
- Surtsey island has already been eroded to just half its original size
- Although the tuff cone has hardened, it is likely the island will disappear some time after 2100 unless further eruptions take place to grow the volcano
- Other new islands along the chain are likely to be created over time, as activity continues along the Mid Atlantic Ridge and tectonic plates diverge

OVER TO YOU! ACTIVITIES

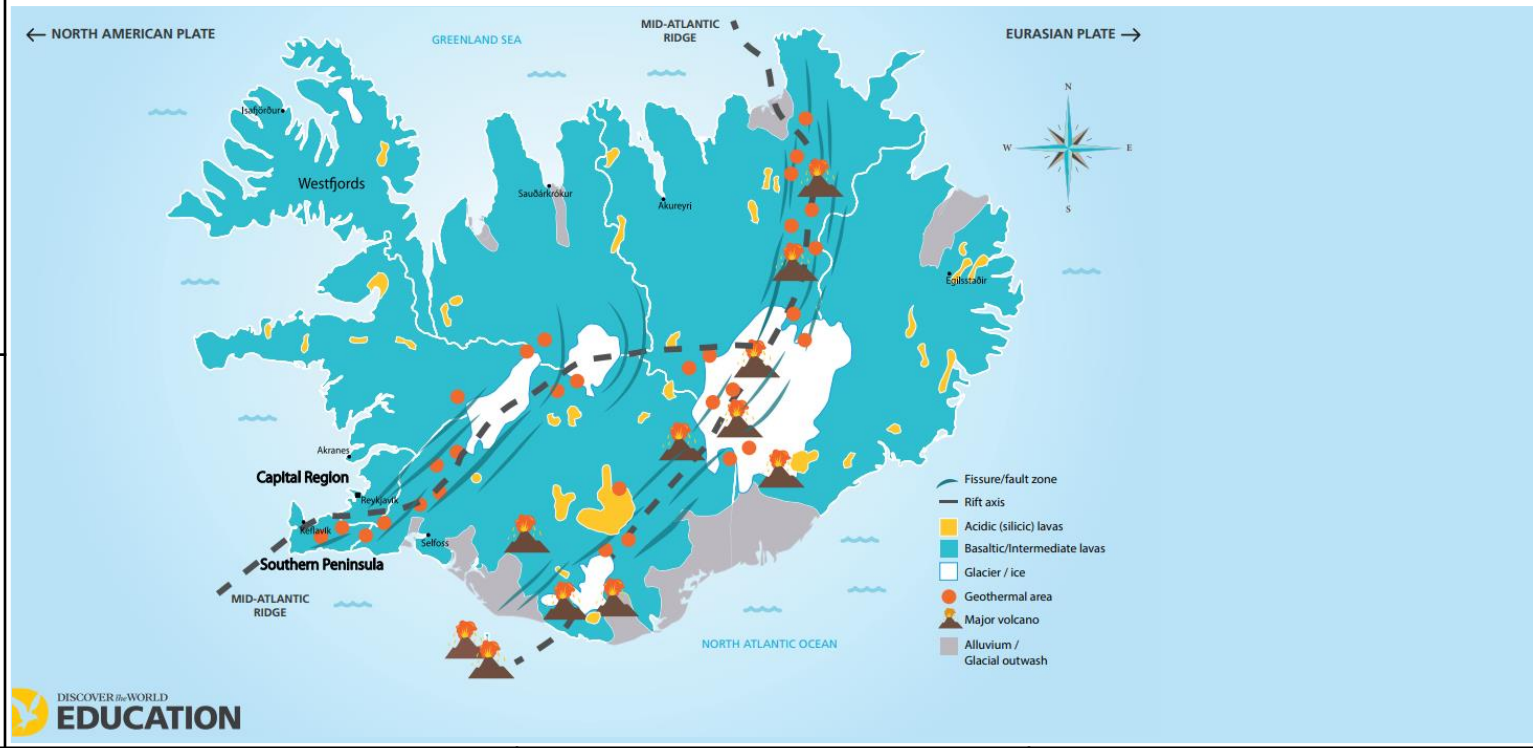
ACTIVITIES

1. Describe the location of Surtsey
2. Draw a diagram to explain how tectonic plate movement created the island
3. Write definitions for these key words:

tectonic plate *tuff cone* *scoria* *basaltic* *effusive*

hydrovolcanic *phreatomagmatic* *Surtseyan eruption*

4. Create your own timeline of events to describe the development of the volcano using the information
5. Draw an annotated sketch of a Surtseyan eruption
6. Suggest three ways that the eruption was important
7. Explain why the island has been protected
8. Suggest how and why this eruption has left a legacy

1: **Define** ‘volcanic hazard’.	2: **Identify** the name of the case study example.	3: **Date** the start of the eruption.	4: **Describe** the location of Iceland.	5: **Suggest** one of the first signs that an eruption was taking place here.
14: **Explain** why the island is a UNESCO protected site.				6: **Identify** two primary impacts of the eruption.
13: **Outline** three ways the eruption has left a legacy.				7: **Name** one secondary volcanic hazard.
12: **Select** the correct term for a tectonic plate that separates from another tectonic plate: a) Divergent b) Convergent c) Continental d) Transform	11: **Infer** how this eruption was different to a usual basalt eruption.	10: **Outline** what is meant by ‘Surtseyan eruption’.	9: **Describe** what caused the eruption.	8: **State** how long the eruption lasted.

1: **Define** 'hazard'.
e.g. A hazard is a threat or risk of something that can cause harm, e.g. a volcanic eruption

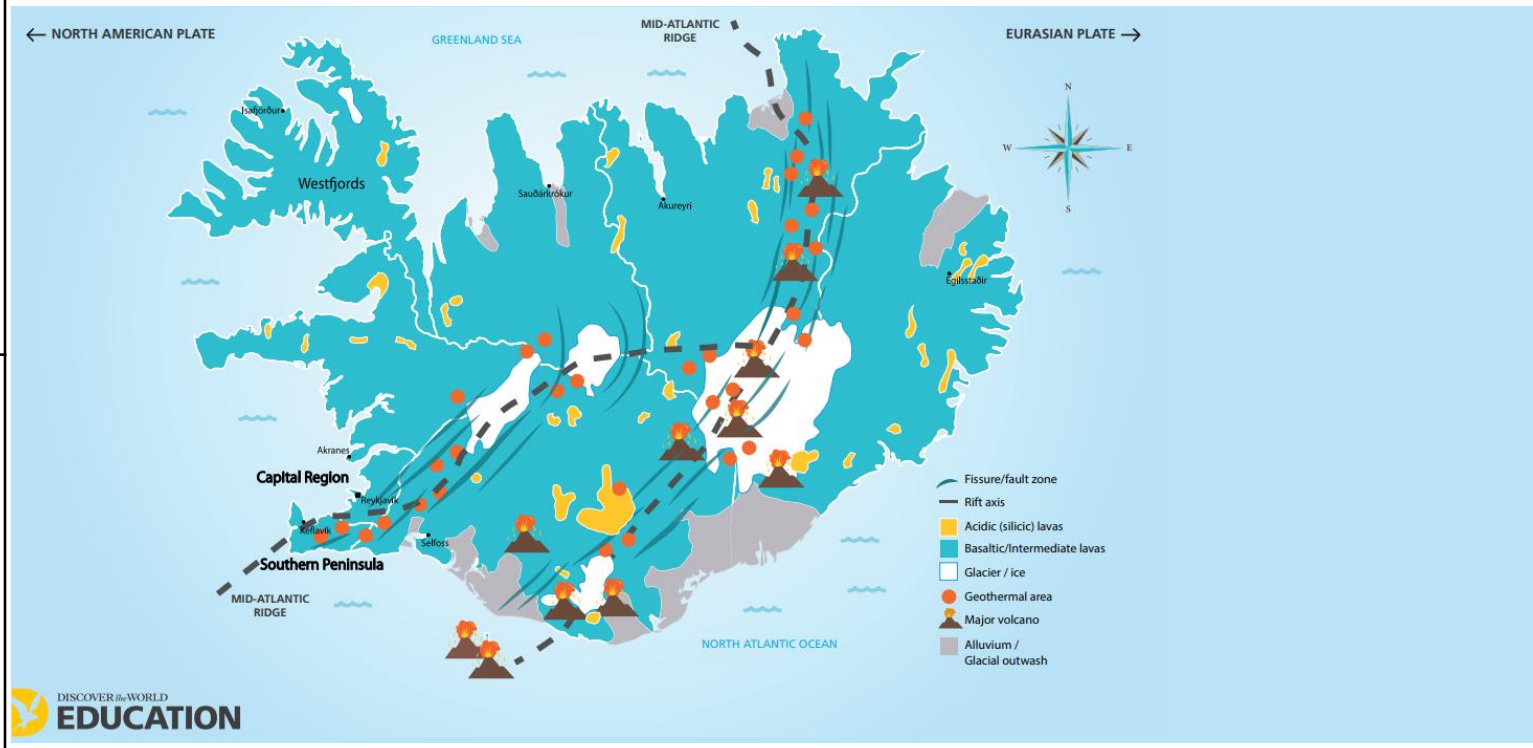
2: **Identify** the name of the case study example.
Surtsey eruption, Iceland

3: **Date** the start of the eruption.
e.g. 14th November 1963

4: **Describe** the location of Iceland.
e.g. Iceland is in northwest Europe, it is found in the Atlantic Ocean along the Mid-Atlantic Ridge, it straddles two tectonic plates, it is northwest of the UK

5: **Suggest** one of the first signs that an eruption was taking place here.
e.g. small seismic tremors felt on the mainland in Reykjavik, sulphur smell in Vik, warmer sea temperatures, etc.

14: **Explain** why the island is a UNESCO protected site.
e.g. the land is fragile and has been protected from human interference so that scientists have a unique study area for understanding evolution of land, soil, plant and animal succession, etc.



6: **Identify** two primary impacts of the eruption.
e.g. ash column, steam cloud, tephra, lava flows, explosive fragments of scoria, etc.

13: **Outline** three ways the eruption has left a legacy.
e.g. more research and scientific advances in the new field of volcanology, increased and improved seismic monitoring network in Iceland, greater global awareness, scientific advances in biology and ecology studying the new land

7: **Name** one secondary volcanic hazard.
e.g. risk of landslips on unstable ground, further secondary eruptions elsewhere, etc.

12: **Select** the correct term for a tectonic plate that separates from another tectonic plate:

a) Divergent
b) Convergent
c) Continental
d) Transform

11: **Infer** how this eruption was different to a usual basalt eruption.
e.g. basaltic eruptions are normally effusive and gentle, not explosive

10: **Outline** what is meant by 'Surtseyan eruption'.
e.g. an eruption that has hot magma interacting with cold shallow sea water or lake water, to create explosive eruptions

9: **Describe** what caused the eruption.
e.g. The Eurasian and North American tectonic plates diverge from one another, separating at the Mid Atlantic Ridge due to slab pull and ridge push, which allows magma to the surface

8: **State** how long the eruption lasted.
e.g. 3.5 years