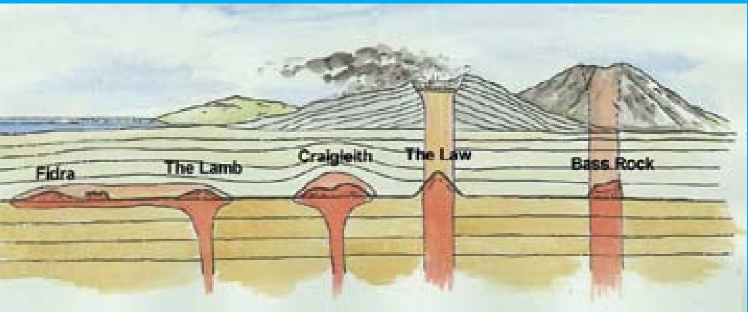
Islands visible from the shore



The offshore islands are all composed of igneous rocks formed as molten rock (magma) cools and hardens underground. They are called intrusions, unlike most of the rocks seen on the shore which were formed at the surface as volcanic extrusions. There's been lots of erosion to allow us to see these rocks that formed beneath the surface. Intrusive rocks forming under volcanoes today might not be seen for millions of years.

Bass Rock and Berwick Law are made of an unusual rock called phonolite, a "sounding stone", so called because it makes a metallic noise if hit with a hammer. If you get up close to the rock, it appears lighter in colour and has larger crystals which cooled more slowly than the basalt. These big masses of rock are ancient plugs, bodies of magma that solidified in the neck of a volcano.

Craigleith is lower with sloping sides, and is an example of a laccolith, a mushroom-shaped body of magma that has intruded into surrounding layers of rock and cooled.

Fidra and Lamb can be seen farther to the west. They are part of another intrusion forming a sheet of basalt rock called a sill.

How to get there

North Berwick, 25 miles east of Edinburgh, is easily accessible by train, bus or car. For details of public transport contact Traveline on 0800 608 2 608 or visit www.traveline.org.uk. This leaflet describes a walk eastwards along the shore from the Scottish Seabird Centre at North Berwick harbour, close to the town centre. The Seabird Centre is well sign-posted. There's plenty of free parking nearby, both along the beach and at car parks in the town. There are public toilets at the Seabird Centre (inside and out) and at the Melbourne Place car park.

Safety and conservation

The beach is accessible at all states of the tide but some of the features are covered at high tide. You should be aware that the shore is slippery and has loose materials, with the risk of tripping, slipping and falling. North Berwick shore is part of a Site of Special Scientific Interest because of its geology and hammering of the rocks is not encouraged.

Acknowledgements

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SESEF scottish earth science education forum

our dynamic earth education

Scottish Seabird Centre

Scottish Natural Heritage All of nature for all of Scotland

Mapwork based on Ordnance Survey Licence number 100033582

North Berwick

Volcanoes

Geological Walk

Local Geodiversity Site

UKRIGS SCOTLAND GEOCONSERVATION ASSOCIATION

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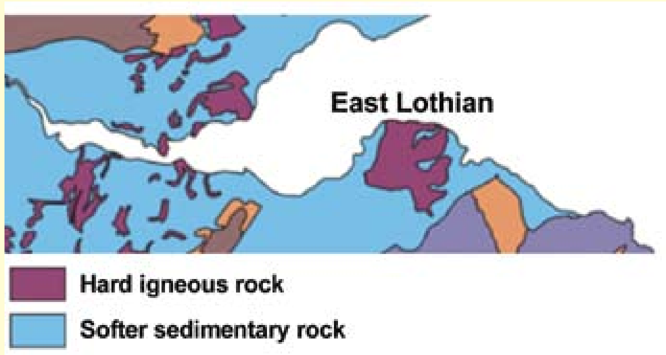
Introduction

North Berwick is known for its seabirds, offshore islands and its prominent hill, Berwick Law. What you may not know is that this was once an area of intense volcanic activity. This leaflet takes you on a walk along the shore, exploring different parts of these ancient volcanoes and finding out why what happened in the past is important today – helping to create the local scenery, giving a safe anchorage and safe homes for seabirds.

So where are these volcanoes? If you stand outside the Seabird Centre and take a look around, you'll see plenty of evidence for volcanoes in the shape of the land. Berwick Law rises steeply above the town, and is the remains of an extinct volcano. Volcanoes create hard rock, called igneous rock, made of tiny crystals that lock together and are difficult to break apart. All igneous rocks start out as magma, hot molten liquid rising from inside the Earth. If the magma reaches the surface it cools quickly and erupts from a volcano as lava or ash. If magma gets trapped underground it will cool more slowly, resulting in larger crystals and a tougher rock – the islands offshore formed like this.

The Scottish Seabird Centre sits on top of lava flows that erupted around 345 million years ago. These lava flows make a headland jutting out to sea. A great site for the Seabird Centre, and also for a sheltered harbour.



On a larger scale, North Berwick lies at the northern edge of East Lothian, which juts out into the Firth of Forth. The coast is shaped this way because of the local igneous rocks, formed by the volcanoes that erupted here in the past.

Rocks as clues to the past

In studying rocks, geologists are trying to unravel the stories of the past – detectives working with limited information. There are many different kinds of rock, made of different chemicals and with varying minerals and texture. How can we work out how they formed? By using knowledge of what's happening around the world now to understand North Berwick's rocks, and work out what happened in the past in Scotland.

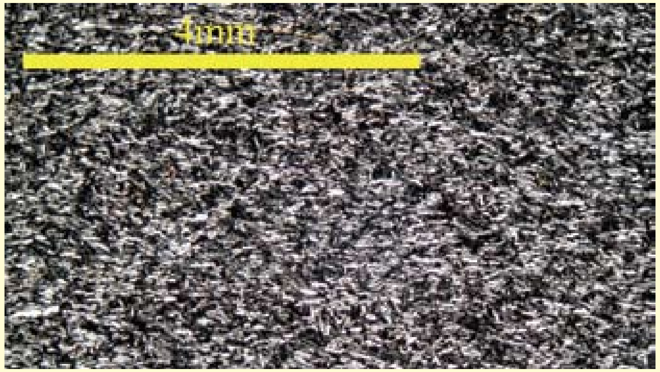
When a volcano erupts in places such as Iceland and Hawaii, the lava often cools to create a smooth, dark rock called basalt. The basalt layers under the Seabird Centre formed in the same way - the present provides a key to understanding the distant past.

Above: recent lava flow at Krafla in Iceland.

Rocks under the microscope

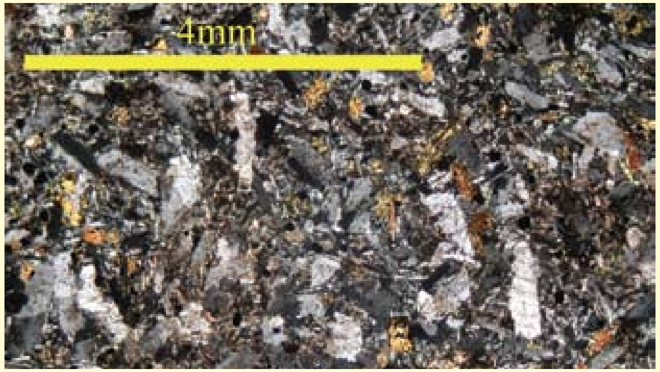
Geologists often take rocks back to the lab and cut them into slices, called thin sections. Under the microscope and with light shone through them, the rock's minerals and their shapes can be seen more easily.

These photos of thin sections from North Berwick are all taken at the same scale to show different sizes of grains. Each individual patch of colour is a single mineral grain.

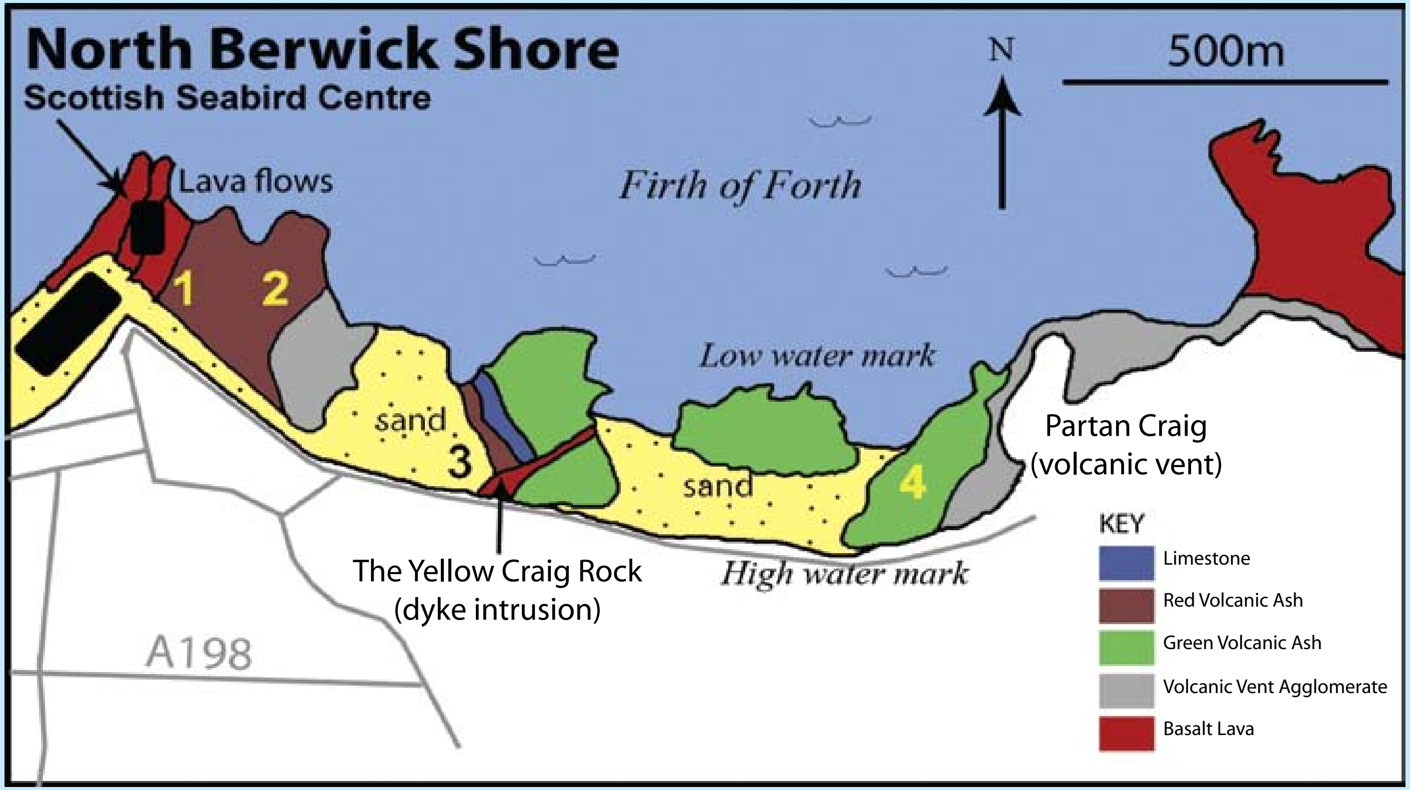


Above: Basalt from lava flow at North Berwick pier. Out of the three rocks shown here, this one cooled the fastest, giving small crystals.

Above: Basalt from Lamb Island. The few larger crystals formed first and cooled more slowly than the many smaller crystals that formed later.



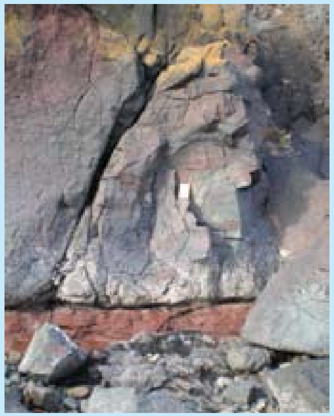
Above: Bass Rock phonolite, which cooled relatively slowly and so has larger crystals than the basalt.



The walk along the shore takes you through the different parts of ancient volcanoes. We'll walk back through time, down through the layers that used to be inside the volcano, and end up in an ancient crater. You don't have to worry about flying lava bombs or red hot lava flows. These volcanoes have been extinct for 340 million years! But do watch out for slippery rocks underfoot.

Stop 1: Lava flows

The Seabird Centre was built on a layer of rock which can be seen from the beach next to the Centre.



Look closely and you might see small shiny crystals within the rock; a sign that it has crystallised from magma. Most of the crystals are tiny and best seen using a microscope (see pictures overleaf).

This rock is called basalt, and it formed as part of a lava flow, which spread out over the landscape while molten and cooled quite quickly, forming small crystals.

Basalt is very different from sedimentary rocks such as sandstone, which are formed from grains of eroded rock cemented together.

As you stand looking at the lava, you can imagine the scene around 340 million years ago, when a fast-moving lava flow came out of a nearby crater and spread across the landscape. North Berwick used to be even more exciting than it is today!

Stop 2: Layers of volcanic ash

Look at the flat red rocks next to the lava flow of stop 1, on the foreshore near the paddling pool (they are covered when the tide is in). These rocks are softer than the basalt cliffs.

The red rocks formed in a very different way than the basalt, when volcanic ash was erupted and settled into layers that were slowly turned to rock. It is known as tuff.

The red layers lie underneath the lava, and they tell us that before the lava flows erupted, the volcano was very active.

Time after time, showers of ash and rock fragments were blasted into the sky. This probably happened because there was lots of water around: magma and water make an explosive mix.

Stop 3: The Yellow Craig Rock

A short walk along the beach to the east will take you to the Yellow Craig Rock, a lone cliff that protrudes out of the sand like a ship's keel.

Named because of the colour of the lichen, it is another resistant igneous rock feature. Up close, the rock looks similar to the cliff at stop 1 – it is basalt. This rock has a different shape, though, and is an example of a dyke intrusion (illustrated in section below).

The Yellow Craig Rock shows us what happens underground when a volcano erupts – not all the magma makes it to the surface, and it doesn't all come up in the main crater of the volcano. Here we can see what happens when magma forces its way along a vertical crack through older rocks underground.

There used to be older, softer layers of volcanic ash around the Yellow Craig Rock, but this has now mostly been worn away, leaving the hard rock behind. You can still see some of these layers by walking towards the sea and looking back inland. The low ridges of rock are the edges of beds that tilt towards the road. The rocks are red and green volcanic ash with one thin band of limestone between them, which is quite tricky to pick out. Look out for a rounded, knobbly appearance, which is typical of this limestone.

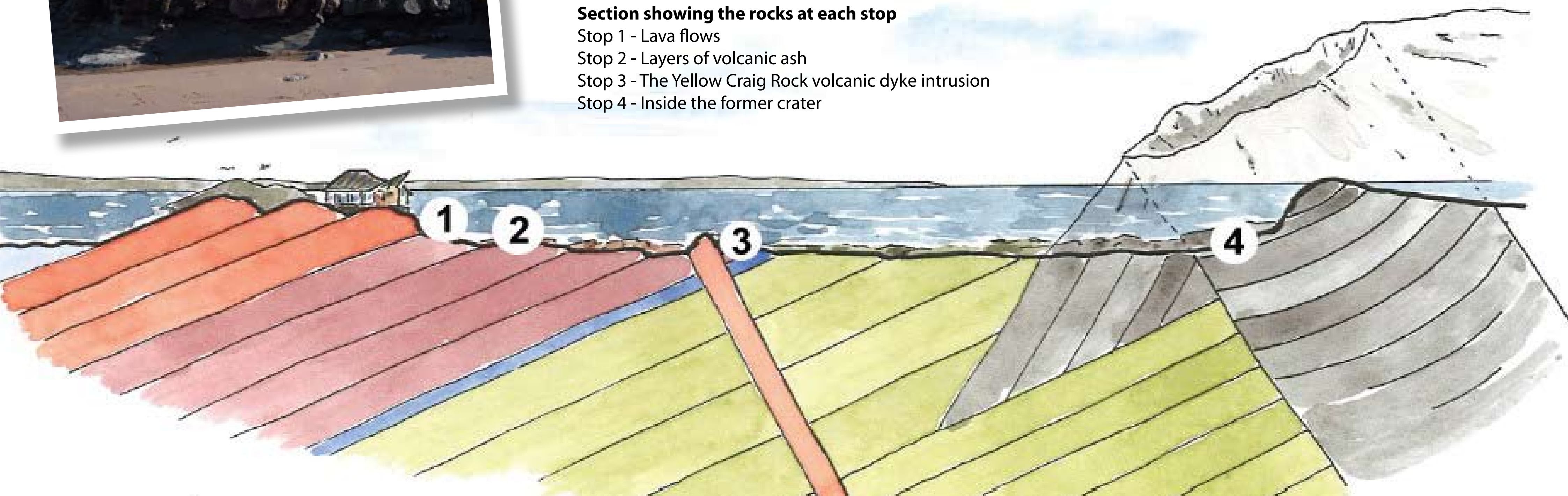
Around 20 metres to the east of the Yellow Craig Rock you can find flat exposures of green volcanic ash. White lines that cut the rock in different directions are veins of the mineral calcite that have formed when hot fluids moved along cracks. Here, there are a range of sizes of rocks embedded in the ash.

Stop 4: Partan Craig volcanic vent

At the far end of the shore, facing west, lies a green-grey cliff. The layers in this cliff are mostly made of green volcanic ash, and form a broad bowl shape, with a steeper right hand side.

On closer inspection, it is possible to see large blocks of material embedded in the volcanic ash. The curved layers and enclosed lumps of rock are the main clues that tell geologists that this rock is a vent agglomerate – a jumbled mass of rock fragments and ash that have fallen back into the vent of a volcano.

So you are now standing inside an ancient volcano's crater – something we can't do in a modern volcano! Imagine the scene as this volcano erupted, with all these blocks on the move, being thrown up into the air by violent explosions. Later, as the volcano came to the end of its life all this material slumped down into the volcanic vent, where we see it today.



Section showing the rocks at each stop
Stop 1 - Lava flows
Stop 2 - Layers of volcanic ash
Stop 3 - The Yellow Craig Rock volcanic dyke intrusion
Stop 4 - Inside the former crater