Eyemouth: volcanoes and greywackes — a geology walk

Lothian and Borders GeoConservation

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(Front cover)

Visiting Eyemouth

Location map

Parking in Eyemouth

Two free public car parks in Eyemouth can be found in the centre of the town, one next to the Co-op on the sea front and the second close to the harbour. Groups wanting to walk the coastal footpaths should park at the car park above Gunsgreen House (NT 9479 6443) which is convenient for the second part of the walk. For the first part of the walk, start at the ramp down to the beach near to Eyemouth Leisure Centre and Swimming Pool (NT 9428 6453).

SAFETY WARNING Use the coastal footpaths at your own risk. The sea cliffs are steep and rocky. Grass slopes may be hazardous in wet and wintry conditions. Please do not use hammers.

Useful references

Scottish Borders Geology - An excursion guide 1993 A.D. McAdam, E.N.K. Clarkson & P. Stone

Northumbrian Rocks and Landscapes - A Field Guide 1995 (ed. C. Scrutton) Yorkshire Geological Society

berwickshirerocks www.berwickshirerocks.org.uk

Useful maps

OS 1:50,000 Landranger 67 Duns, Dunbar & Eyemouth

OS 1:25,000 Explorer 346 Berwick-upon-Tweed

British Geological Survey 1:50,000 Scotland Sheet 34 Eyemouth (Solid)

Acknowledgements

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The geology of the Eyemouth coast

Eyemouth Bay and the cliffs to east and west provide a variety of rocks and structures of great interest. Short walks along the coastal footpaths with frequent stops will give walkers a taste of Eyemouth's geology as well as the enjoyment of superb coastal scenery.

Geological history

The Iapetus Ocean lay between two continents that moved towards each other until they finally collided about 420 million years ago. As the Iapetus oceanic crust slid beneath a huge continent the greywackes, made of oceanic floor sediments, were stripped off, buried, intensely folded and faulted.

The thickened crust rose to form mountains. During the final phase of the collision, about 400 million years ago, a line of small volcanic cones erupted lavas onto the plains and river valleys. Old Red Sandstone conglomerates and sandstones were deposited in valleys as the mountains were weathered and eroded.

The view from the sea shows the rocks of the Eyemouth coast. The numbers show the order in which the rocks were formed from 1 (oldest) to 4 (youngest).

This area has been just above or below sea-level for most of the last 300 million years and any rocks deposited on top have been eroded away. In the last two million years, the area has been regularly covered by ice sheets. Since the ice of the last glacial event melted, weathering, rockfall and marine erosion has shaped the coastal landscape, forming cliffs and caves where rocks are more resistant to erosion, and bays and inlets where there are weaknesses such as faults or joints.

Rocks of the Eyemouth area

Sedimentary rocks

Sedimentary rocks are made of particles of mud, sand or pebbles. They are usually laid down in layers (beds or strata). Conglomerates are sedimentary rocks made from rounded pebbles, stones and cobbles in a sandy matrix. The cliffs east of Eyemouth are composed of greywackes (pronounced 'grey-wackies') which are sandstones made of fragments of volcanic rock and mud grains weathered and eroded from mountain chains and volcanoes and then transported into the sea.

Around 430 million years ago (the Silurian period), a deep ocean (Iapetus Ocean) lay between two continents. Buried under thick layers of muds and sands, water was driven out and the particles were squashed together. Water moved through the sediments carrying minerals which cemented the particles to produce tough greywackes which are resistant to erosion. Pink calcite is found along the joints of greywackes of this age, which are named the Hawick Group by geologists and are found widely across the Southern Uplands of Scotland.

Caledonian plate collision

A plate collision between the two continents either side of the Iapetus Ocean which culminated 420 million years ago, created high mountains. In the process, the greywackes were folded and faulted under great pressure. Cliffs with asymmetrical folds, shown below, are found south of Whalt Point.

Turbidity flows and flute casts

During the plate collision rock fragments deposited on the continental shelf of the Iapetus Ocean were disturbed by earth tremors so that unstable piles of sediment tumbled down the continental slope in rapid flows called turbidity flows (Diagram 1). As the speed of the flow decreased the larger rock and sand fragments were dropped first and finer mud particles were deposited above once the current had stopped flowing. Each turbidity flow created a bed of greywacke.

Because the turbidity current was moving at great speed, up to 100 km per hour, the current scoured into the sediment on the sea bed, picking it up and leaving streamlined hollows. The flute casts are the 'lumps' that you see at Stop 12 and are the infilling of the hollows with sediment deposited on the sea bed from the turbidity flow when the speed reduced.

Igneous activity

Igneous activity is the term used for rocks and features formed when magma crystallises above or below the surface. Active volcanoes have magma chambers a few kilometres below the surface (Diagram 2). Magma reaches the surface through pipes and fissures which cut through the surrounding rocks and is either erupted as lava or explodes as volcanic ash through the necks.

Igneous rocks

Rocks are made of minerals. Magmas which contain a high proportion of silica crystallise into rocks which are paler in colour, such as andesite, which is a very common volcanic rock, usually red, pink, grey or mauve in colour with a pale weathered surface. The crystals are too small to be seen without a microscope. Dacite is an unusual lava type which is very similar to andesite but contains a higher proportion of silica.

The Eyemouth volcano

Several volcanic necks, the pipes below a volcano that carry magma up to the earth's surface, are found in the St Abbs and Eyemouth area (Diagram 3). Necks are filled with volcanic agglomerate, made of assorted blocks of local rocks carried by magma and gases as they force their way up the neck of a volcano during an eruption.

It is likely that the St Abbs and Eyemouth volcanoes erupted andesite and dacite lavas. Killiedraught Bay is eroded out of agglomerate, seen in the jagged stacks along the shoreline.

How old are these rocks?

Lavas can be dated using radiometric dating which measures the rate of decay of the radioactive minerals that they contain. An unusual rock called a lamprophyre, found on St Abb's Head, has been dated radiometrically and gives an age of about 400 million years which is assumed to be close to the age of the St Abbs and Eyemouth volcanoes.

Glaciation

During the last glacial event, at its maximum about 25,000 years ago, ice sheets covered northern Britain, including the Southern Uplands and the adjacent North Sea area. Glacial till, a mixture of boulders, sand and clay, was left behind when the ice sheets melted and can sometimes be seen on the top of the cliffs. There are several deep valleys which probably pre-date the last ice advance, such as the channel seen in the cliff on the west side of Eyemouth Bay, now infilled with sediment such as sands and pebbles and later topped by glacial till.

Geology walk around Eyemouth

Map showing walk locations around Eyemouth

1 Eyemouth Beach [NT 94289 64536]

Start at the ramp down to the beach near to Eyemouth Leisure Centre and Swimming Pool. At the foot of the ramp look at the smoothed, rounded rocks which are exposed on the beach to right and left. They may be covered by sand! These pinkish-grey rocks are made of fragments of andesite lava, which were carried along in a lava flow. They were formed when the upper surface of a slow moving lava chilled in contact with air, crystallised and became incorporated in the hot lava as it flowed (Diagram 4), giving a rock with many angular fragments.

2 Eyemouth Beach [NT 94251 64692]

Walk along the beach and look at the pale grey rocks in the cliff. They are dacite lavas, similar to andesite except that the minerals contain more silica. They contain tiny pale crystals which grew in molten magma below the surface before the eruption of the volcano. They were fragmented as they flowed. Sometimes bright green copper minerals can be seen.

3 Eyemouth Beach [NT 94254 64759]

Walk further along the beach until you find the orangey-red beds which lie above the dacite lavas. At the base of the cliff is pale grey dacite lava. Directly above lie several metres of coarse gravels with pebbles and boulders, seen on the left of the photo below, with several metres of sand above. The centre of the cliff face is occupied by a channel which is filled with gravel and sand. The channel was probably eroded into the local lavas before the most recent ice advance. Glacial tills from the last ice sheet, which melted about 12,000 years ago, can be seen at the top of the cliff. Unconformities mark an interval of erosion.

4 Eyemouth Beach [NT 94349 64811]

Continue to walk over rocks and pebbles until you reach the foot of the cliffs where there is room to stand and examine the Old Red Sandstone rocks. TAKE GREAT CARE AS THIS PATH IS BELOW HIGH TIDE LEVEL AND THE ROCKS ARE SLIPPERY.

At the top of the cliff are conglomerates (rounded pebbles) of Old Red Sandstone age, deposited in rivers flowing across lowland plains from the Caledonian mountains about 360 million years ago. The large boulders at beach level are bedded breccia.

5 Fort Point [NT 94253 64912]

At the first inlet facing west, you can see the horizontal beds of the Old Red Sandstone at the top of the cliff. If the tide is low you will be able to see that the sandstones lie above andesite lavas. The crystalline lavas are more resistant than the Old Red Sandstone and are less likely to be eroded by waves.

Breccia has angular pebbles and is made of material which infilled the valleys in the high Caledonian mountain range during Devonian times. Each bed represents a flood of water carrying sand and pebbles. The grey-green pebbles are greywacke and there are also some red sandstone pebbles.

Retrace your path to the steps, climb to the top of the cliff and walk towards the headland through the remains of the fort built here in 1557. There are many footpaths to choose from.

5 Fort Point [NT 94253 64912]

This headland was used as a quarry to extract pink pebbly sandstone above the lavas leaving smooth vertical quarry faces. Rusty iron supports for ladders can still be found high up on the quarry face.

6 Weasel Loch [NT 93935 64930]

Stop at the wooden steps going into a fault-guided inlet.

The cliffs are made of andesite that formed thick lava flows which solidified quickly, so that each sticky pulse of lava collapsed over the previous flow giving 'cushion-like' structures which can be seen in the cliffs below.

7 Killiedraught Bay [NT 93904 64987]

Follow the path until you can see Killiedraught Bay.

This is the site of the Eyemouth volcano. The rocks of the neck are volcanic agglomerates and are made of a chaotic mixture of local rocks and lavas as a result of a violent eruption which would have covered the area with volcanic ash. TAKE CARE ON THE FOOTPATH AND FOLLOW THE DEVIATION SIGNS.

The dotted line shows the rough outline of the volcanic neck.

Return to Eyemouth

Return the way you came or continue along the coastal path and turn left to follow Pocklaw Slap (footpath, then road) down to the main road, then turn left to reach the sea front. For stop 8, walk through the town, around the harbour, crossing the red footbridge, to Gunsgreen House and follow paths up to a car park [NT 9479 6443] off the new harbour road. Cross the new harbour road to the footpath across the golf course to reach the cliffs. Binoculars are useful to see the features on this coast.

8 Ramfauds Cove [NT 94959 64442]

As you reach the cliffs, turn right along the coastal path.

You can see down into the cove. The beds of greywacke are sloping (dipping) steeply towards the west and vary in thickness from 10–100 cm. Careful study shows that they are folded into sharp folds like hairpins. As you walk beyond Tee 6 you can see finely bedded mudstones to the left of the footpath.

The narrow inlets are eroded along fault lines. To have a close look at the greywackes, walk down the grassy slope into the inlet, taking care if it is wet. Look at the bedding planes (the surface between each bed) which are uneven and knobbly in places. Some of them are covered by the pink mineral calcite, which is also seen in the joints, irregular cracks running through the rocks.

9 Elgy Rocks [NT 95206 64348]

Follow the red or green marker posts on the coastal path around the golf course and watch for flying golf balls. Farther along the coastal footpath you reach several narrow inlets adjacent to the fairway between two footpath marker posts.

A well-studied series of folds is seen on Elgy Rocks, where a fold in a thick bed of greywacke has a rounded crest, as shown on the photo. Thinner beds, shown by arrows, are folded into tight, angular folds.

10 John's Roads [NT 95282 64218]

Continue walking along the coast path. The wide bay seen from the corner of the wall is John's Roads and there is a dramatic view along the coast.

The shore rocks from here to beyond Agate Point are best seen at low tide. They are intensely folded and have been carefully studied by geologists. The folds lie between two faults which trend north-south along the shoreline. This rugged coastline is washed by strong waves.

Wave erosion is more pronounced along the many faults and joints in the rocks, giving inlets and caves and leaving the most resistant rocks as jagged stacks offshore.

11 Agate Point [NT 95362 64042]

Beyond John's Roads is a narrow peninsula, Agate Point, stretching out to sea. Walk along to the end of Agate Point so that you can look back at the cliffs in John's Roads and identify more folded rocks. The narrow inlet to the right/east of Agate Point has steeply dipping rocks with ripple marks and flute casts on the bedding planes, showing that currents were moving sand and clay particles on the Iapetus Ocean sea bed. It is not easy to see them if they are in shadow.

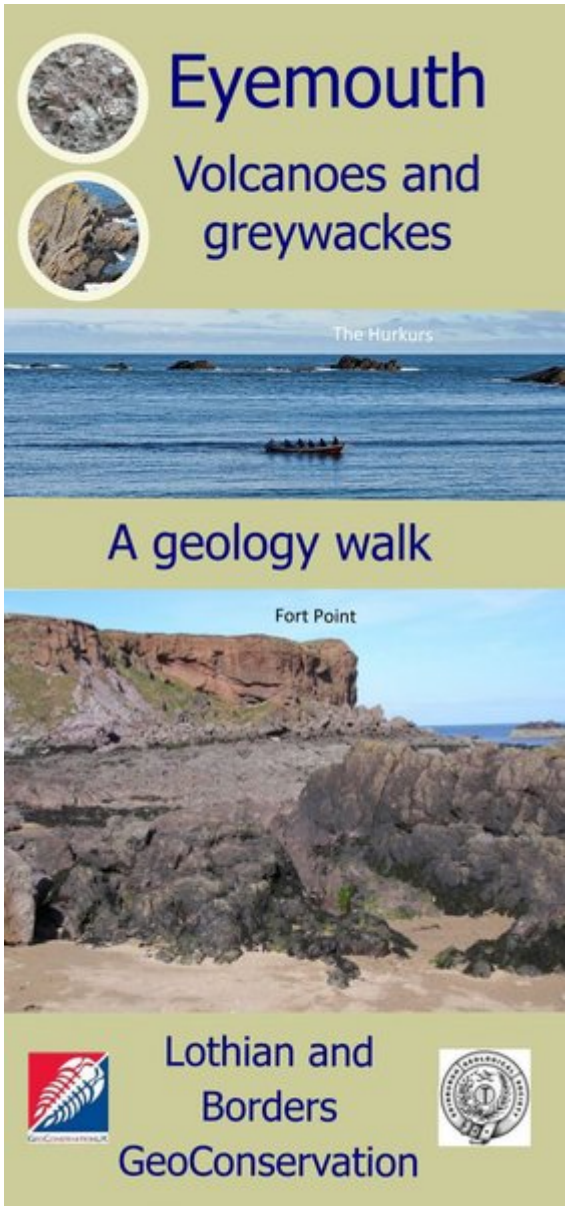
12 Whalt Point [NT 95464 63876]

Continue along the path until it leaves the cliffs and goes through the wall. At this point, leave the coastal footpath and stay to the left of the wall around the head of a steep gully. After 10 m take the small path on the left down to some low rocks where you can examine greywacke beds more closely.

In front of you on a low vertical face of rock are some elongated, aligned 'lumps' called flute casts. The photo shows the flute casts in direct sun, but they may be more difficult to see when the face is shaded. The note book is 20 cm long.

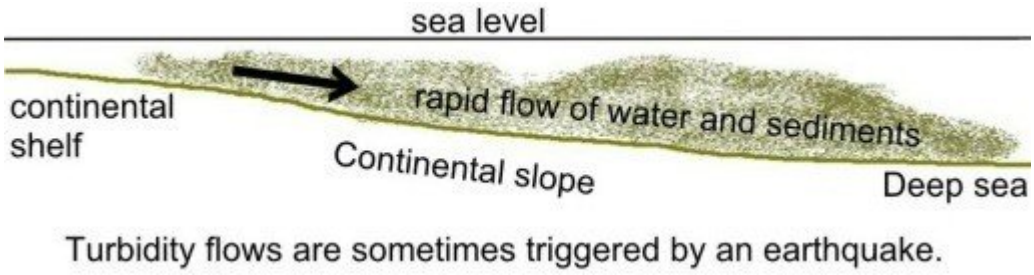
Return to Eyemouth

You can return to the car park along the coastal footpath or take the footpath at John's Roads, then turn right onto the new harbour road and walk back to the car park or make your way back into Eyemouth past Gunsgreen House.



Front cover.

Location map.



Turbidity flows are sometimes triggered by an earthquake.

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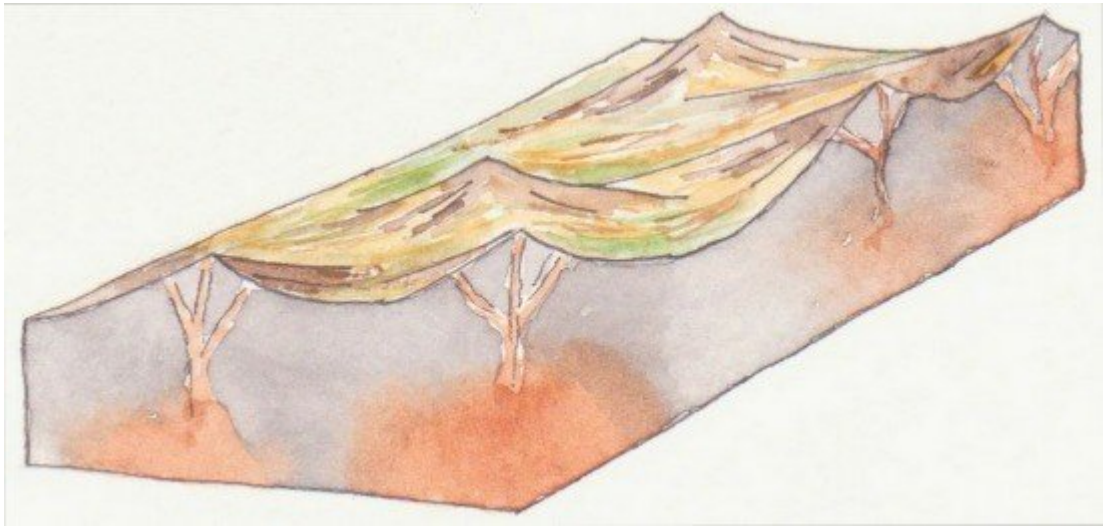

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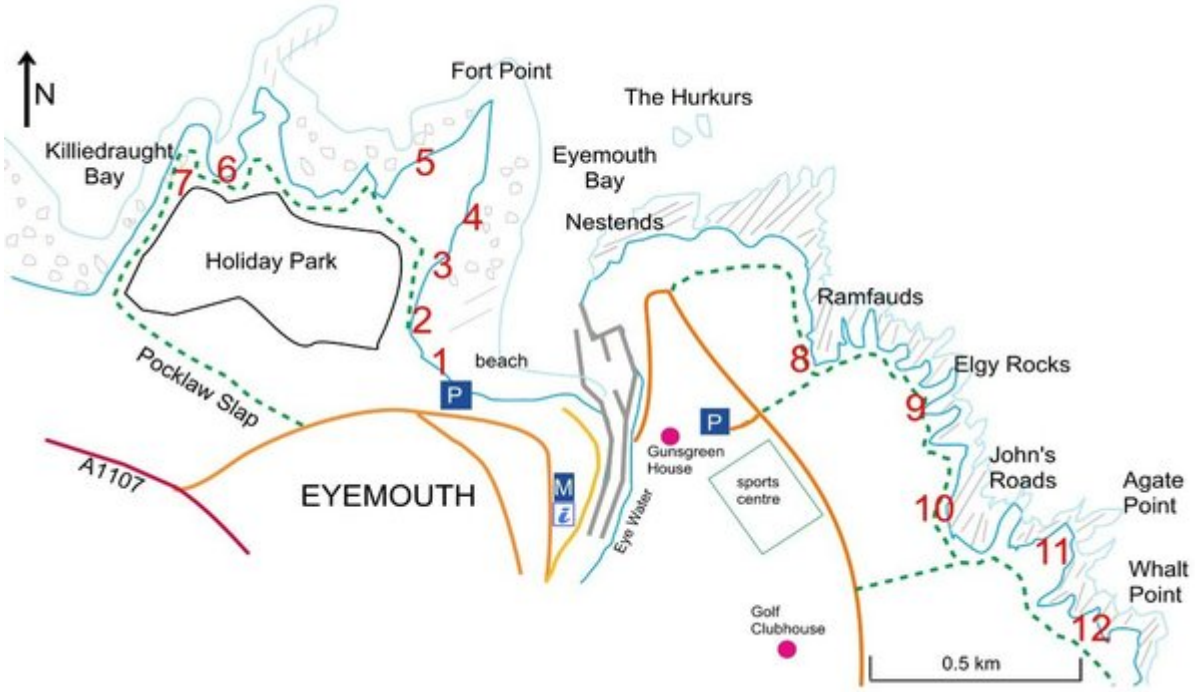
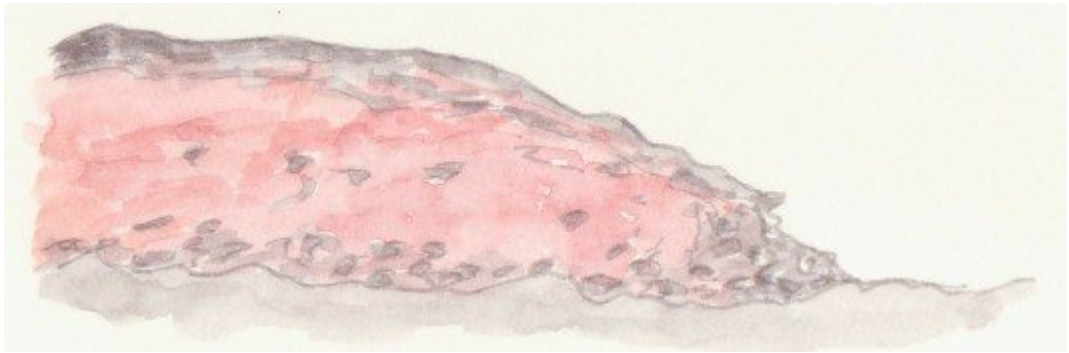


Map showing walk locations around Eyemouth.



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