# COLDINGHAM SANDS

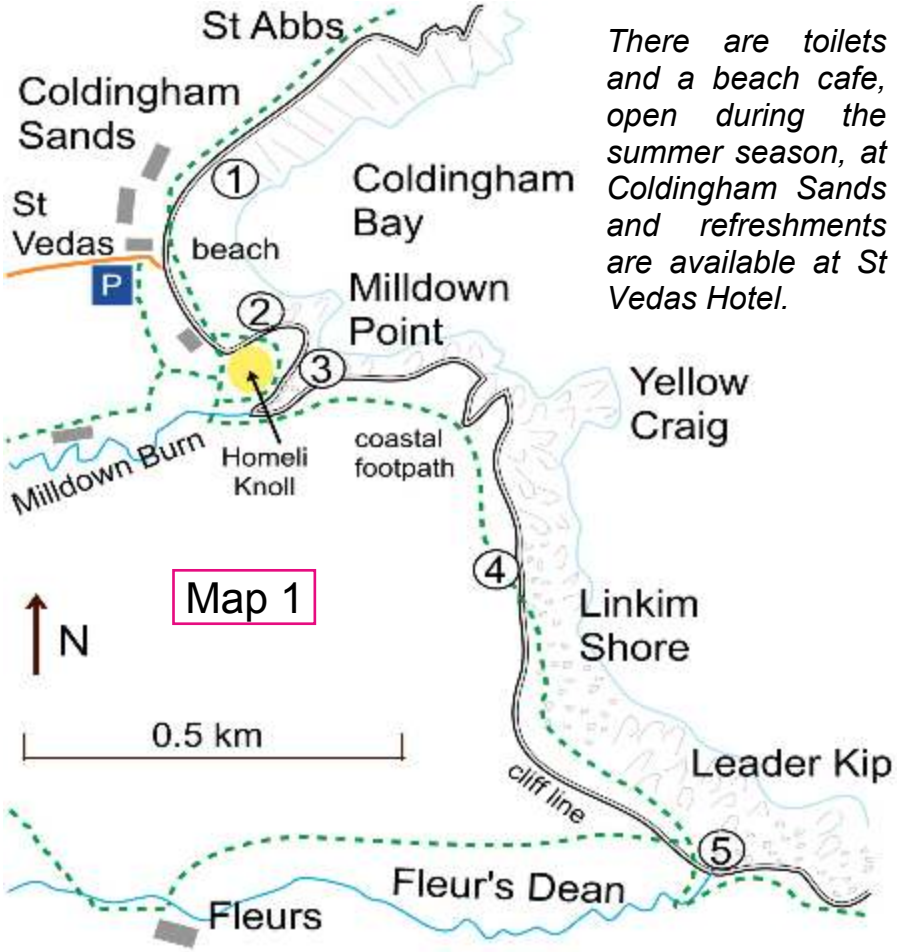
**The shoreline between Coldingham Sands and Eyemouth is a geologically exciting area because rocks like the Coldingham and Linkim Beds are not found anywhere else in the south of Scotland. This walk will show you some of the places along the coast where the complex rocks and structures can be seen.**

*The main geological features can be seen from the coastal footpath from Coldingham Sands to Linkim Shore. The walk from the car park near St Vedas to Fleurs Dean is about 1.5 km along the coastal footpath, which is narrow and rocky in places and includes some steep steps.*

*Car and coach parking is available at Coldingham Sands opposite St Vedas Hotel [NT 915 666]. Buses from Berwick and Eyemouth (235) stop in Coldingham village and at St Abbs so you can walk to Coldingham Sands along lanes or use the coastal footpath.*


Photo A

Coldingham Sands




*There are toilets and a beach cafe, open during the summer season, at Coldingham Sands and refreshments are available at St Vedas Hotel.*

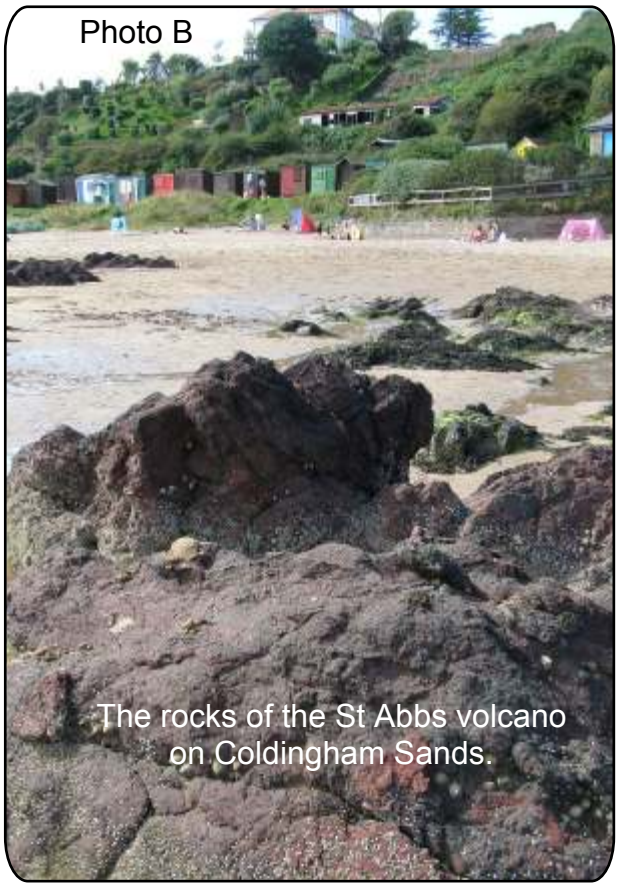


Photo B

The rocks of the St Abbs volcano on Coldingham Sands.

*The numbers on the map are at locations where you can stop and look at the features of geological interest. You may find binoculars useful to look at the shore line from the coastal footpath at the top of the cliffs. It is possible to visit the five locations when the tide is high, but you can see the rocks in more detail if you visit at low tide and in good weather conditions. Printed tide tables for Eyemouth are available from the Fisherman's Mutual Association and Chandlery, Dock Road, Eyemouth. This coastline is part of the Berwickshire Coast Site of Special Scientific Interest and it is illegal to remove pebbles from beaches.*

① *From the Coldingham Sands car park, walk down the road towards the beach, passing the toilet block and other facilities. Turn left past the beach huts and walk towards the rocks on the north side of the bay (Photo C).*

The rocks here are purple or mauve in colour where they are found at the top of the beach, but become much darker, almost black, below high tide level. They are broken up into irregular blocks by **joints**, which run in all directions (Photo D). The lack of regular spacing suggests that these are **igneous** rocks.

Igneous rocks are formed from the crystallisation of liquid rock called **magma** in the upper part of the crust. If magma reaches the earth's surface and a **volcano** forms, the resulting rocks are **volcanic lavas** and **ashes**. Volcanic rocks can be seen at St Abbs and at Eyemouth (see the St Abbs and Eyemouth West leaflets). The rocks seen at the north end of Coldingham Sands are part of the St Abbs volcano.



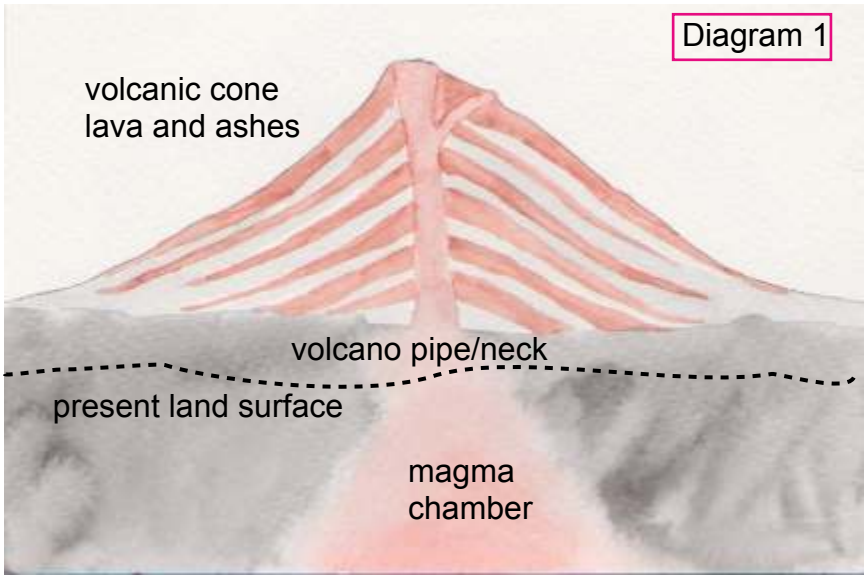
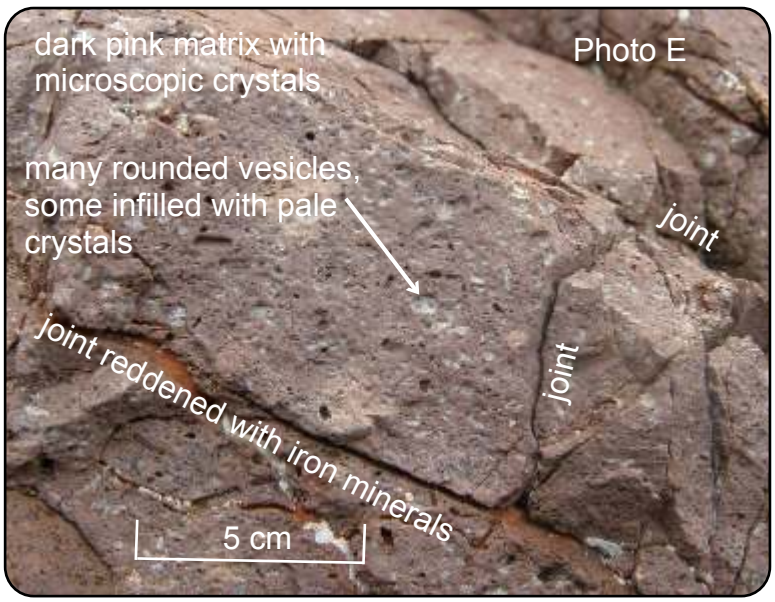



Diagram 1 shows the structure of volcanoes like the St Abbs volcano. The **volcanic neck,** the pipe that fed magma to the surface from the **magma chamber** below the volcano, was filled with a chaotic mixture of magma and local rocks, as a result of violent eruptions which would have covered the area with ash.

Where the sea has smoothed the rocks (Photo E) you can see that the rock has crystals which are so tiny that you cannot see them without using a hand lens. It also contains many rounded bubbles, called **vesicles,** some of which are filled with pale crystals. The bubbles in the magma were filled with gases which exploded when the pressure in the magma chamber was released during an explosive eruption, rather like taking the top off a bottle of fizzy water.




This rock is called **vent agglomerate** and is all that is left of the St Abbs volcano which erupted 400 million years ago. The chemistry of the rock tells geologists that this magma was intermediate in composition between silica-rich and silica-poor magmas and is called **andesite** (named after the Andes mountains). The crystals are tiny because the magma cooled rapidly close to the surface.

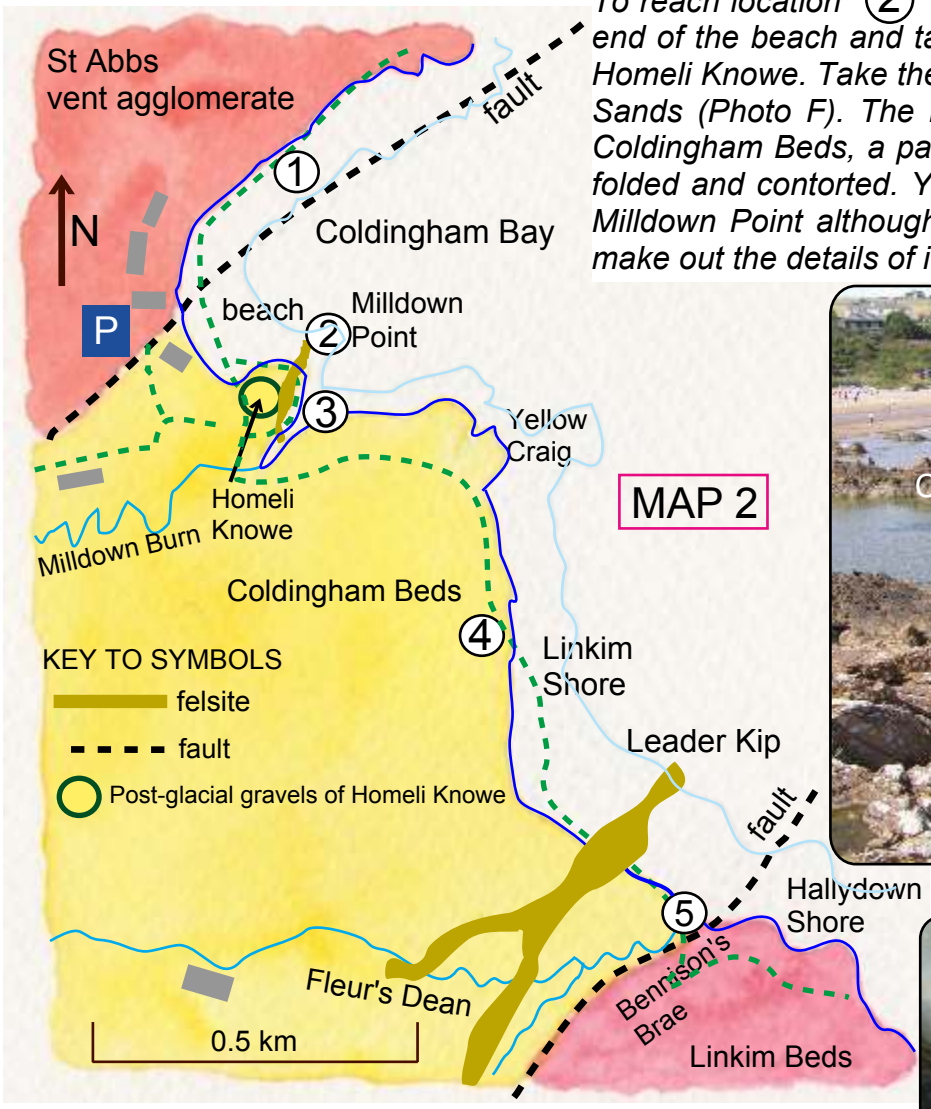
The rocks have been much altered in the last 400 million years while they have been buried by more recent rocks. Reddening by iron **minerals** and the infilling of vesicles with other minerals has occurred as warm water soaked the rocks. More recently, the sea has washed away the minerals in some of the vesicles so that they look like gas bubbles again.

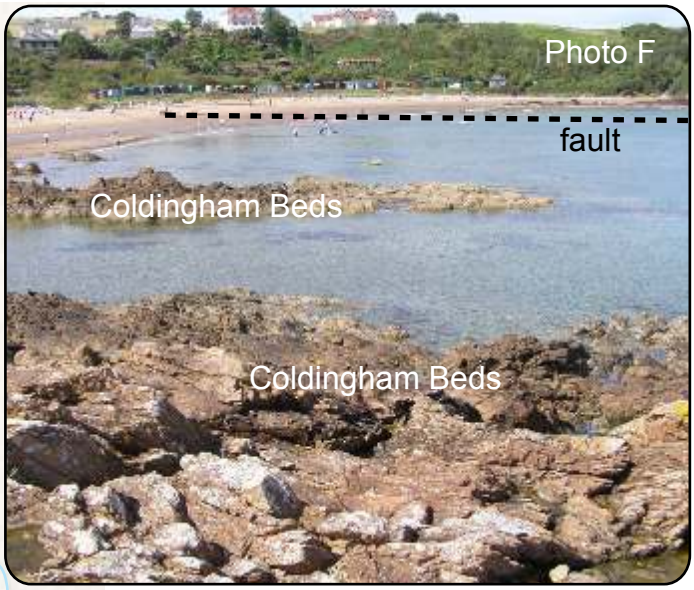
Since the eruption the **volcanic cone** has been eroded away, leaving only the rocks of the pipe as

*Walk across the beach towards Milldown Point.* Map 2 shows that the fault which divides the St Abbs vent agglomerate from the Coldingham Beds cuts across the bay in front of you.

The hill on the top of Milldown Point is called Homeli Knowe and was used as a site for medieval civil courts by Coldingham Priory. Excavations, looking for evidence that the hill is man-made, have taken place in the past. However it is a geological feature formed at the end of the last glacial event about 12,000 years ago. **Meltwater** from **ice-sheets** that covered east Berwickshire deposited thick sheets of sand and gravel. The layers of fine sand and gravel in Homeli Knoll have been washed out by waves to give Coldingham Bay its golden beach.

*To reach location ② at the end of Milldown Point walk to the end of the beach and take the footpath on the left hand side of Homeli Knowe. Take the opportunity to look back at Coldingham Sands (Photo F). The rocks in front of you are formed of the Coldingham Beds, a pale yellow rock which has been intensely folded and contorted. You can have a good look at its folds on Milldown Point although it is very hard, even for geologists, to make out the details of its structures.*





## GEOLOGY MAPS

Geology maps are not easy to understand but it helps to use colours to distinguish different rocks. There are only four rock types on this map: the **vent agglomerates** of the St Abbs volcano; the Coldingham Beds and the Linkim Beds which are both **greywackes;** two small areas of an igneous rock called **felsite;** the Post-glacial gravels of Homeli Knoll.

## THE COLDINGHAM BEDS

The unfossiliferous Coldingham Beds are made of **sedimentary rocks** called greywackes. Sedimentary rocks are generally made of particles of mud, sand or pebbles. They are usually laid down in layers (**beds/strata**) and the break between each bed is called a **bedding plane**. Greywackes (pronounced 'greywackies') are sandstones, made of quartz grains and fragments of rock that have been eroded from mountain chains and volcanoes, then deposited in deep oceans. The silt found in **siltstones** is composed of very fine quartz grains. The Coldingham Beds have a high proportion of the mineral **calcite** in between the grains of sand and silt and this acts as a **cement** to hold the grains together. The calcite is often pink in colour and sometimes fills in cracks in the greywackes (Photo G). The greywackes are pale grey when fresh but weather to a yellow colour.

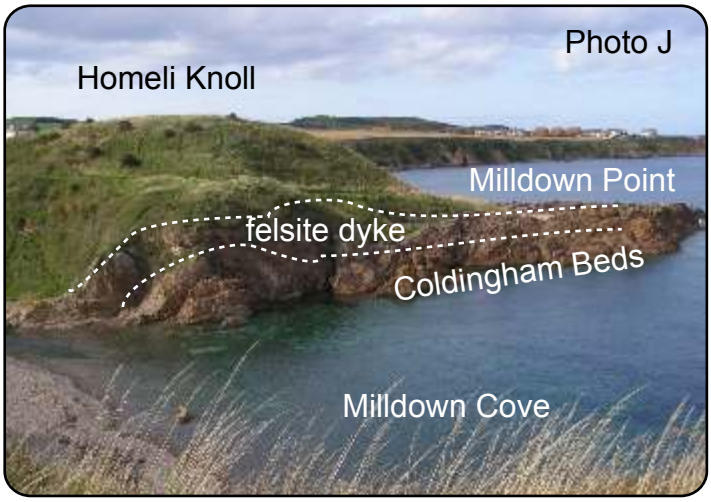
② *At the end of Milldown Point is an area where you can look for folds in the rugged Coldingham Beds (Photo H).* Find a single bed of rock and see how far you can follow it before it disappears. It will almost certainly be contorted in shape and you will probably lose it after a few metres. These rocks have been intensely folded and faulted by earth movements (**deformation**).

The flat area of pale sand (Photo H) is a quartz-rich volcanic rock called **felsite** which was forced (**intruded**) as a magma into the Coldingham Beds and forms a **dyke** (Map 2). It is a pale yellow rock and has very fine crystals that can't be seen without a hand lens. As the felsite magma cooled it contracted and cracked into closely-spaced joints (Photo I).



See if you can follow the junction of the felsite dyke with the Coldingham Beds greywackes. Unfortunately both are pale in colour, but their features are very different.

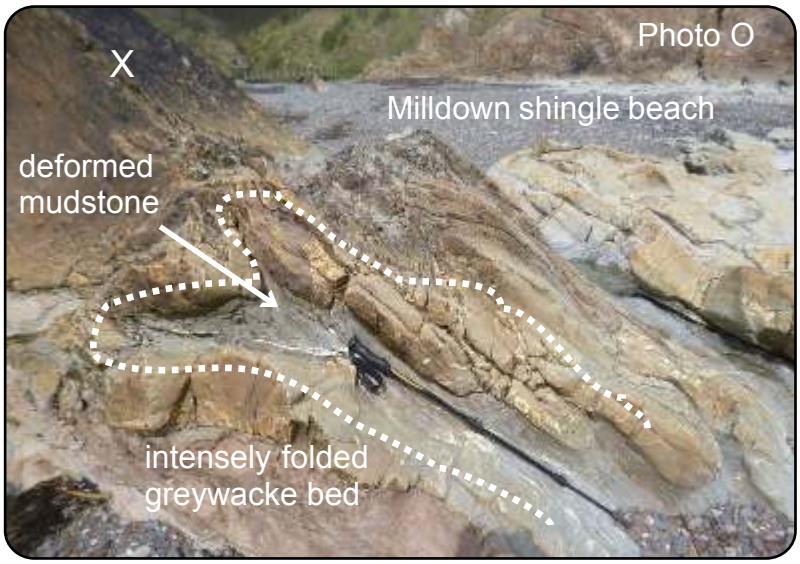
The felsite dyke is exposed from the headland on Milldown Point into Milldown Cove, varying in width along its length (Photo J). Where it crosses Milldown Burn it is about 2 m wide (Photo K). The rock can be dated to about 400 million years and was intruded after the Coldingham Beds were folded which is probably why it has an irregular course and a variable width.




③ *Continue along the path around Homeli Knoll to Milldown Cove, crossing Milldown Burn by the bridge or the stepping stones (Photo K)*


The Coldingham Beds greywacke pebbles which have survived erosion by waves are noticeably yellow in colour after weathering and erosion and often have pale veins through them (Photo L). However, the majority of the pebbles on the beach are typical 'grey' greywackes of the Lammermuir Hills transported by ice or rivers from the north west. Their pebbles are often criss-crossed by joints filled with pink calcite. Photo L includes a dark red pebble, probably from the Abbs volcano. The beach also has an astonishing selection (Photo M) of 'man-made' pebbles to delight you !


*Walk across the pebble beach to see the dipping greywacke beds in the cliffs on the far side of Milldown Cove. They appear to have a uniform dip towards the north into the sea, but you have already seen that the folding of the Coldingham Beds is very complex. There is an example of this folding behind the rock marked X on Photo N. You will only be able to reach this exposure at low tide.*



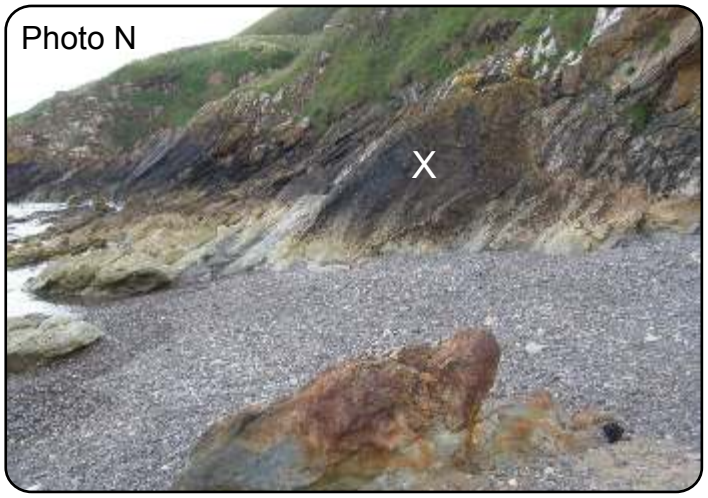




Photo O [NT 919 664] at the east side of Milldown Cove's shingle beach shows a thin greywacke bed which has been **folded** back on itself like a hairpin. The mudstone in the core of the fold used to be a uniform bed of rock, but has now been squeezed between the limbs of the greywacke bed and completely deformed. The black walking pole lies along the middle of the fold.

Diagram 2 shows how two identical folds made of tough greywacke (yellow) keep the same thickness when they are intensely folded. However, the mudstone layer (grey) in between them is deformed because the clay particles in the mudstone can slide over each other. Diagram 2 also shows how beds which are intensely folded can look as if they dip in only one direction (Photo N).

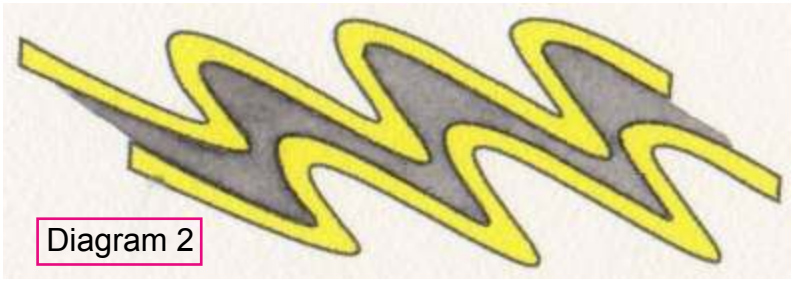


Diagram 2

## COLDINGHAM BEDS DEFORMATION

Research has been carried out to find out why the Coldingham Beds are much more deformed than the typical greywackes of the Southern Uplands, as you can see if you compare the zig-zag folds of the greywackes at Pettico Wick (St Abb's Head leaflet) with the folds at Coldingham. The sand particles which form the Coldingham Beds were deposited in the sea but were put under great pressure as the sea bed was pushed beneath a large continent. Soft sediments slid over each other and were intensely folded (**soft sediment deformation**). Eventually they were **lithified** into solid rocks which preserved the chaotic folds. As the rocks became more brittle, they were smashed up under pressure by many small **faults**, so it is not easy to trace each individual bed.

## THE CALEDONIAN PLATE COLLISION

Diagram 3

Drawn from Scotese palaeomap

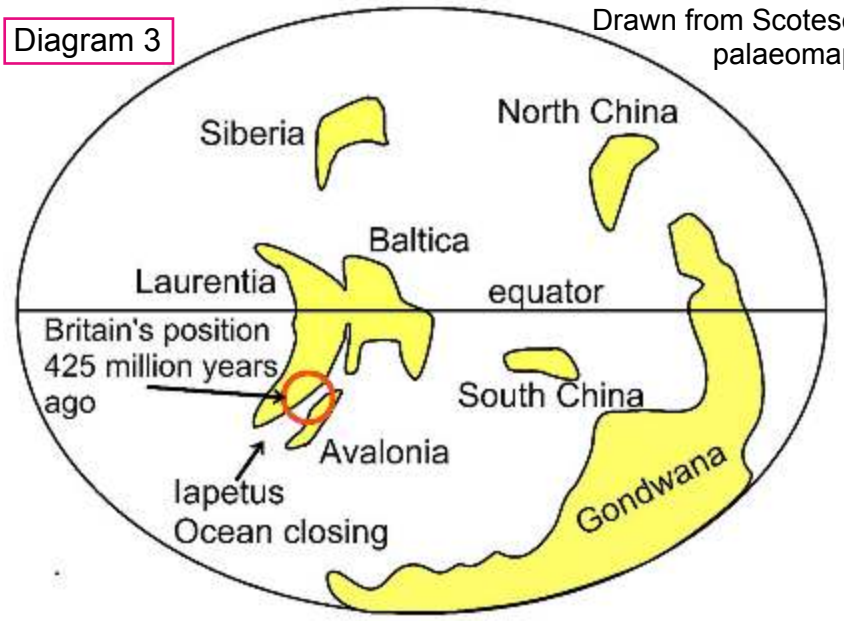
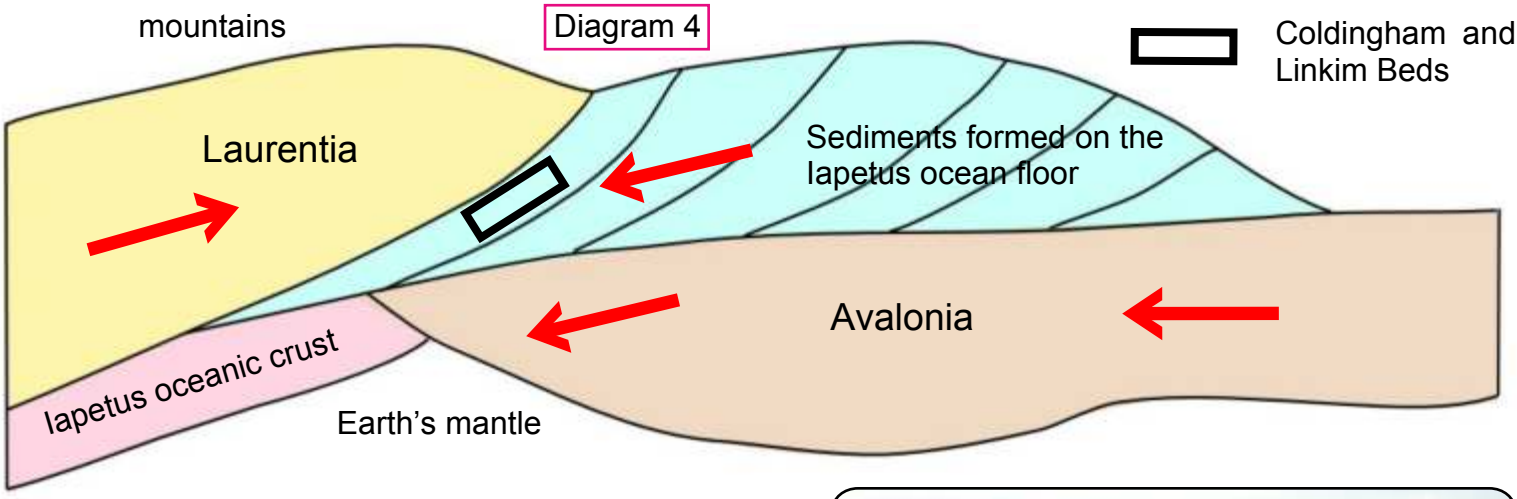



Diagram 3 shows the two continents which collided 425 million years ago. **Laurentia** was a huge continent which lay astride the equator, but the small continental mass of **Avalonia** moved north as the **Iapetus Ocean** between them closed.

The collision zone lies below northern England and southern Scotland, probably passing under Northumberland and the Solway Firth. The range of mountains formed by the collision is called the **Caledonides** and the present rocks of the Scottish Highlands represent the roots of this mountain chain.

Diagram 4 gives a cross-section of the situation when Laurentia and Avalonia collided after the closure of the Iapetus Ocean. As the Iapetus ocean crust slid beneath Laurentia, ocean floor sediments were stripped off, **folded** and **faulted**. The box shows where the rocks of the Coldingham and Linkim Beds were probably formed. They were subjected to considerable sideways pressure, as the red arrows show, but it is thought that they were not buried very deeply because their minerals and structures have not been altered by heat deep in the crust.



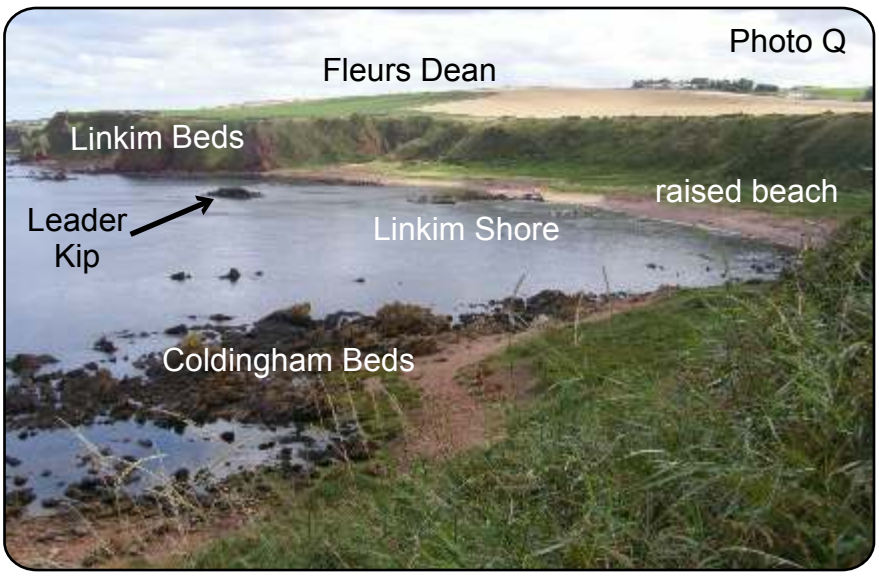

*Continue along the coastal footpath passing the Yellow Craig headland, so called because of the typical yellow colouration of the Coldingham Beds when they are weathered.*

At a suitable point, look down to the shore below (Photo P). The pebbles on the beach are the typical red and yellow colours of the St Abbs Head andesites and the Coldingham greywackes. The beach has fewer 'grey' greywacke pebbles than at Milldown Cove.

If you have binoculars you will be able to see the random folding of the beds on the skerrs out to sea.


④ *Walk south along the coastal footpath until the path descends to Linkim Shore. There is a magnificent view towards Eyemouth and you should be able to see Eyemouth Holiday Park on the volcanic headland of Eyemouth Fort, with lava rocks forming the steep cliffs below the caravans (see Eyemouth West leaflet)* (Photo Q).

Linkim Shore lies in front of you and the rocks on the foreshore are all part of the Coldingham Beds. The cliff line lies behind a flat, grassy **raised beach**, a shingle beach formed at the end of the last glacial event about 12,000 years ago. Raised beaches such as this are found all around the Scottish coast because the Earth's crust was depressed by the weight of ice to a greater extent than in the rest of Britain. Beaches which were formed when the ice melted were lifted above present sea level as the land surface rebounded once the weight of ice was removed.



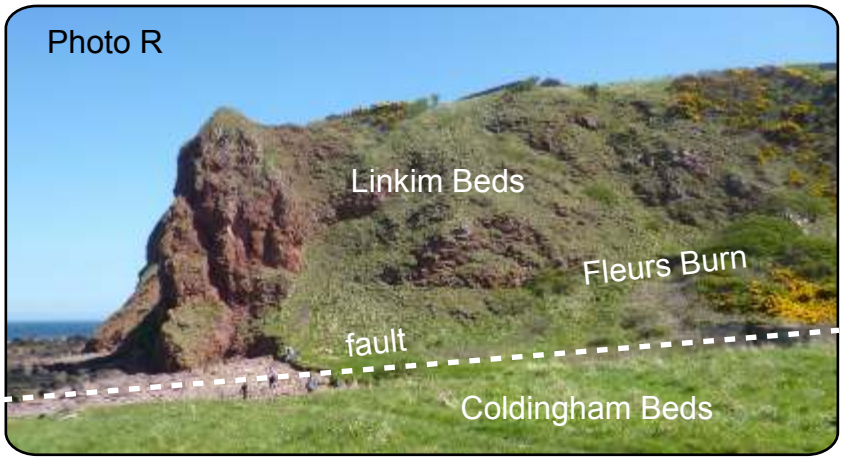

Leader Kip is part of a complicated igneous body of magma which was intruded into the folded rocks of the Coldingham Beds at the end of the Caledonian mountain building event. It divides into two branches with a variable width from 40 - 100 m (Map 2). The rock is similar in composition to the felsite dyke at Milldown Point so they may have been intruded at about the same time.

This particular **igneous intrusion** is more resistant to erosion than the surrounding greywackes of the Coldingham Beds, so it forms a stack on the shore.

*Enjoy the view in front of you while you walk down the path to Linkim Shore.*

⑤ *Walk along Linkim Shore to the headland of dark red rocks at the foot of Fleur's Dean (NT 925 654) (Photo R).*

The 30 m high headland of dark red rocks in front of you is formed from the Linkim Beds. The valley of Fleurs Dean runs along the fault which divides the Coldingham Beds from the Linkim Beds (Diagram 5). The Linkim Beds form the cliffs from Fleurs Burn to Callercove Point along Hallydown Shore and can be reached by a path which leads off the coastal footpath from Eyemouth.




## THE LINKIM BEDS

The Linkim Beds consist of greywackes which have been reddened throughout by iron at a late stage in their formation. They differ from the Coldingham Beds in several ways;

A. the rocks contain more volcanic grains, in addition to quartz grains,

B. each bed is much thicker,

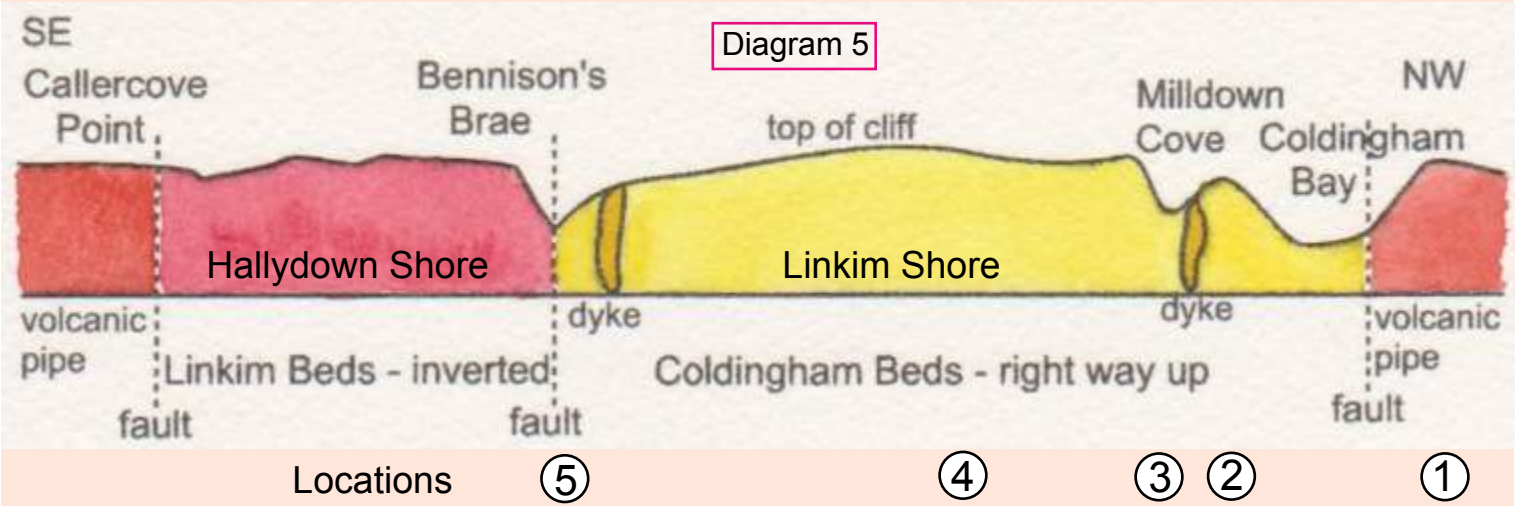
C. there is less calcite in the greywackes,

D. the folding is less intense,

E. the rocks have been turned completely upside down (inverted).

All this evidence suggests that the Linkim Beds were formed during the same plate movements as the Coldingham Beds, but under different conditions of pressure and temperature in slightly different places (but still in the black box in Diagram 4) and that the two rock formations were brought together by major faulting at the end of the Caledonian plate collision.

Diagram 5 is a way of showing the view of the shoreline looking from the sea, to show the geology and features, and is adapted from a paper by K.A.G. Shiells and W.R Dearman published in the *Proceedings of the Yorkshire Geological Society* in 1963.




*At the end of the walk, you may wish to continue along the coast to Eyemouth, so take the path up Fleurs Dean until you reach the coastal footpath going south.*

*There are several ways of returning to Coldingham Sands. You can return the way you came, along the coastal footpath. If you want a longer walk (2.5 km), take the steep path from the shore diagonally up the raised cliff line towards the east to reach the settlement at Fleurs and then follow the footpath towards Coldingham Priory. From there you can walk though the village, turning right to pass the shop and right again just after Scoutscroft Leisure Park, onto the lane which takes you to Coldingham Sands.*

## USEFUL REFERENCE BOOKS

*Lothian Geology - An excursion guide* 1996 A.D.McAdam & E.N.K.Clarkson

*Geology of the Eyemouth district*. Greig, D.C. 1988 Memoir of the British Geological Survey, Sheet 34 (Scotland)

## USEFUL MAPS

OS 1:50,000 Landranger 67 Dunbar

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

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