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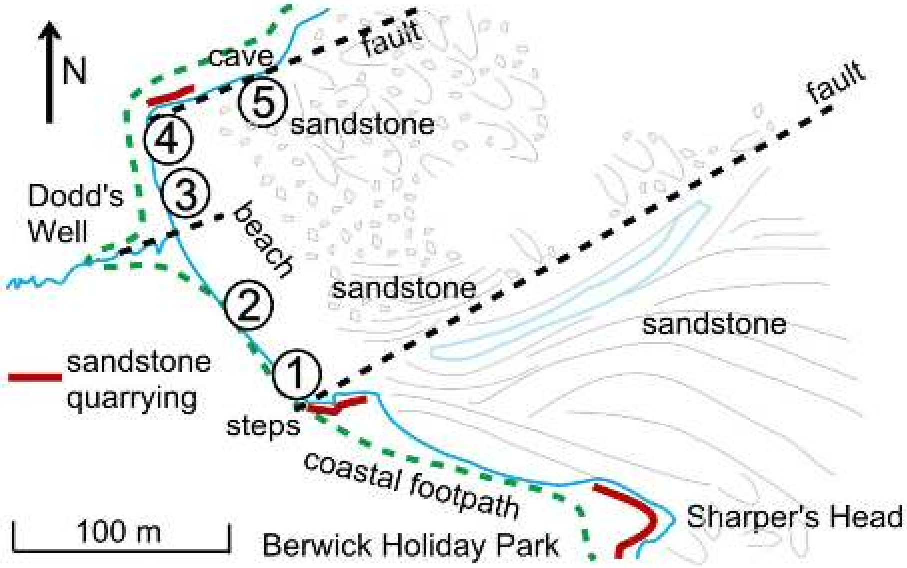
MURPHY'S BEACH, BERWICK

Murphy's Beach is the quietest of the Berwick beaches and has spectacular cliffs, with several very deep sea caves on the north side. The bay is remarkable because it has two major faults which define its shape and a third minor fault with a delightful waterfall onto the beach.



Access to Murphy's Beach (NU 001 541) is down steep steps from the coastal footpath north of Sharper's Head. The nearest parking area (for cars only) is on the single-track road between Berwick Holiday Park entrance and the Golf Club-house (NU 003 536). An ice-cream van is often parked beside the parking area and there is a toilet block (which is not always open during the week and in winter).

The numbers on the map are at locations where you can stop and look at the rocks and features of geological interest. Wear good shoes or boots and take walking poles for balance if you need them. The best time to see the features is just before or after low tide.

Walk north beside the holiday park for about 500 m past Sharper's Head until you get a good view of the bay and can see the flight of steps. At the bottom of the modern steps, it is necessary to walk down four or five old steps hewn from solid rock which is often slippery.

Photo A shows the south-east end of the bay from the coastal footpath and the position of the steps to the beach.

Photo B is a view of the north-west end of Murphy's Beach from the coastal footpath. Major **faults** lie at each end of the beach with **sandstone** cliffs on either side. In between the faults lie **shales (mudstones), siltstones** and some thinner sandstones, all of which are more easily eroded by waves than the thick beds of sand-stone which form the two head-lands on either side of Murphy's Beach.

Ordnance Survey Six-inch map Berwickshire Sheet XVIII 1862
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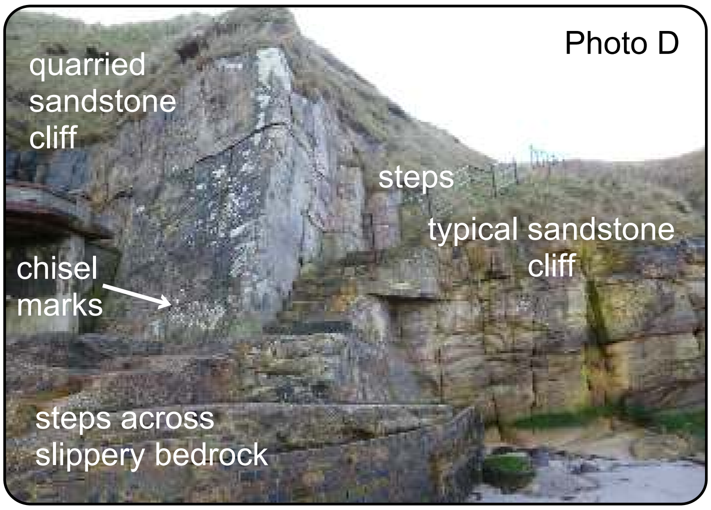
An extract from the six-inch Ordnance Survey 1862 map is shown on the left. The map uses the name Burgess' Cove, which may be a misprint for Burgess' Cave, a large cave on the north side of the bay. The significance of the name 'Dode's Well' (Dodd's Well on recent maps) is not known. There may have been a historic connection with the Guild of Freemen of Berwick-upon-Tweed, as the spelling of Burgess' Cove with an apostrophe implies that the burgesses of the town of Berwick had an interest in the cove.

As you walk down the steps (Photo B), look along the beach (Photo C). The back of the beach is made of unresistant shales (mudstones) and siltstones, with a bed of sandstone at the very top of the cliff. This is an ideal situation for the development of **landslips**, as rainfall soaks through sandstones and siltstones and lubricates the shales at the base of the cliff which become unstable and slide onto the beach.



Steps to the beach have been cut into the sandstone cliffs, which have been quarried in the past. On the rock face next to the more recent concrete structure (Photo D) are some chisel marks, evidence that the sandstone was worked by hand. Sandstone cliffs are not usually as smooth as those which have been quarried, as you can see if you compare the cliffs on Photo D.

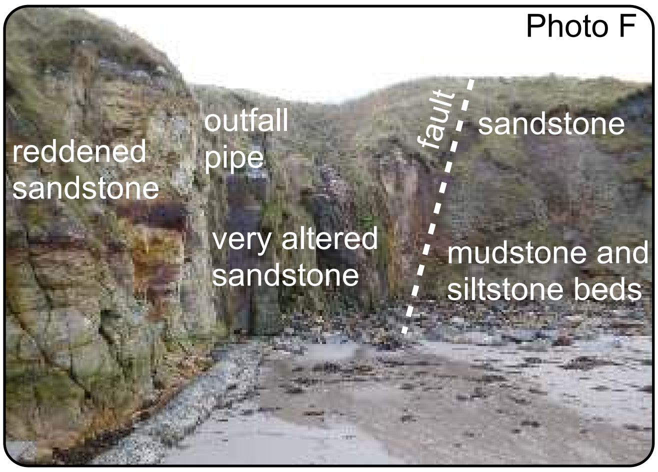
Photo E shows sinuous chisel marks between the two white lines. They are difficult to see if the light is poor.

Before the arrival of more sophisticated tools, stone was worked with chisels and hammers. First, the masons would remove the soil and clay from the top of the cliff and then start breaking the sandstone into blocks by making channels in the sandstone with chisels and hammers and levering off each block with a crowbar. This sandstone would have been easy to work because of the regular horizontal and vertical breaks in the rock which would have given rectangular blocks, ideal for building.

① *When you reach the beach turn immediately left and look at the natural sandstone crag (Photo F).*

It differs from the quarried sandstone because it has been coloured by dark red and orange iron staining. This is one of the characteristics of rocks which have been affected by **faulting**. The three faults seen in the cliffs of Murphy's Beach show different characteristics, but they are all plane surfaces along which brittle rocks have broken under stress.

Walk beyond the pumping station outfall to the corner of the beach where the first fault is exposed.



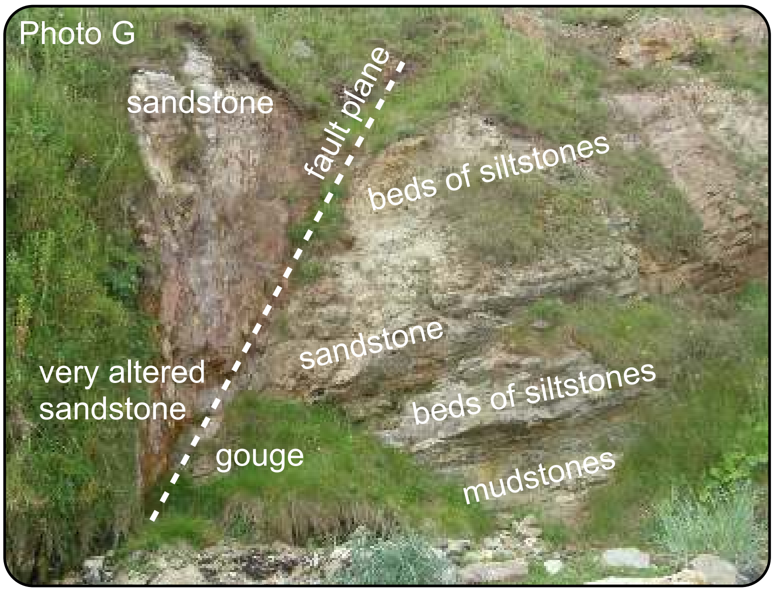
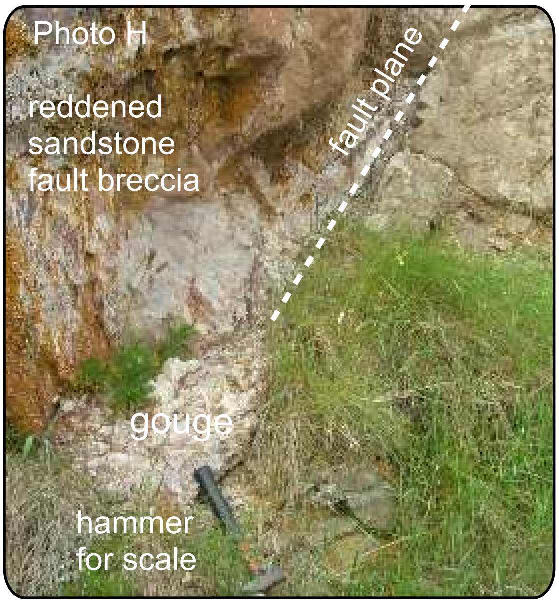


Photo G shows that shales, siltstones and a thin bed of sandstone can be seen on the right hand base of the cliff but that there is an abrupt change to reddened sandstones along a **fault plane** which runs diagonally up the cliff. The reddening by iron-rich deposits has occurred because seepage of water carrying minerals along the fault plane was able to deposit iron in the nearby rocks. The sandstones to the left of the fault plane have been smashed up so that, within a few metres of the fault plane, their original bedding has been lost. Shales and siltstones have been chewed up into a pale clay deposit called **gouge** (Photo H).



This fault is part of the system of **tectonic** features formed under stress during **Variscan mountain building** at the end of the **Carboniferous period** as a result of a plate collision across Europe, 30 million years after these rocks were formed. The three faults at Murphy's Beach were probably formed at the same time as the Green's Haven Fault and the Meadow Haven Faults (see Berwick Beach and Berwick Monocline leaflets).

Geologists are not sure of the exact amount of movement on this fault, as it is difficult to compare the rocks on either side of the fault with others elsewhere in Northumberland, as the limestone on Murphy's Beach cannot be identified with certainty (see location 3). However, the displacement on this fault is probably similar to that on the Green's Haven and Meadow Haven Faults, at about 100 m.

FAULTS AND EARTHQUAKES

Faults are breaks in the brittle part of the **earth's crust** due to local stress and occur no more than about 20 km below the earth's surface, except in areas under major **mountain chains**. When the stress exceeds the breaking point of the rocks, they crack so that energy is given off as **earthquake waves**. Rocks can break many times if the tectonic stress continues, giving a **fault zone** which is hundreds of metres wide in major faults, such as the Great Glen Fault in Scotland.

Geologists recognise faults by their characteristic features. Rocks on either side of the fault are often different, showing that there may have been movement vertically, as well as sideways. The **fault plane** is the surface along which the rocks slide and sometimes elongated scratches called **slickensides,** which show the direction of movement of the rocks on either side of the fault, are seen on the fault plane. Slickensides occur when hard rocks such as limestones or sandstones scrape past each other.

The rocks along the fault zone are often shattered by pressure and **recrystallised** by frictional heat, so that new **minerals** form and cement broken pieces of rock together to produce a new rock - a **fault breccia**. Softer rocks, such as mudstones and siltstones, are broken up by tougher rocks such as sandstones, to leave a featureless clay deposit called **gouge** along the fault plane.

Continue walking along the top of the beach.

The cliffs above the beach change considerably, depending on the height of sand and the amount of recent rainfall. Sometimes the fallen boulders from the cliff are covered when sand levels are high, while at low sand levels seaweed covers the beach. During periods of very heavy rainfall **glacial till** on the top of the cliffs slips down onto the beach, though the clay component is often removed during the next high tide, leaving pebbles and stones behind. Photo I was taken in February 2016 after very heavy rainfall over several months, during which there were many landslips. Fresh rock was exposed along the cliff because of erosion by storm waves.

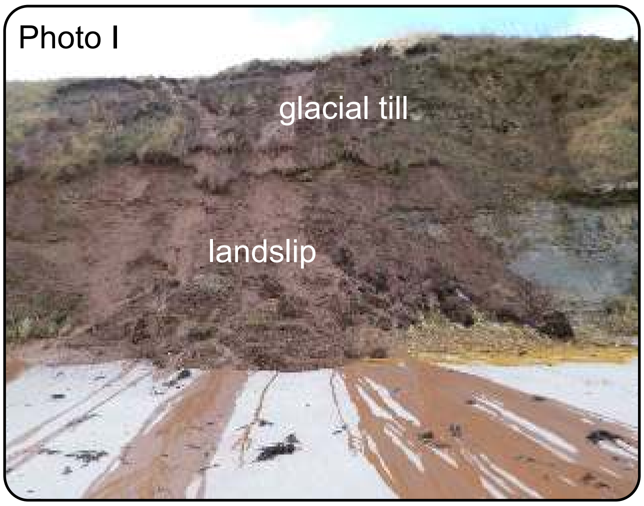


Photo I

Photo J

② Photo J shows a view of the cliffs to illustrate the general geology typical of many of the cliffs in north Northumberland, although it lacks a typical limestone.

Below the sandstone bed at the top of the cliff may be a thin coal seam or a bed of **carbon-rich shale** with fireclay beneath. The thin grey/green beds of sandstone and siltstone at the base of the cliff can be seen on the rocky foreshore at the south end of the bay; features on their bedding-planes, such as ripple marks and trace fossils, can be seen more easily there. The sandstone boulders which have fallen from the top contain plant fossils, while siltstone boulders show trace fossils of various types.

Photo K shows a boulder of pale grey siltstone with **laminations** (beds less than 1 cm thick), probably deposited in shallow water. The upper surface has evidence of invertebrate activity (**trace fossils**), perhaps feeding tracks or the resting-places of shells. Another boulder (Photo L) shows a plant root about 30 cm long, with well-preserved rootlets in their growth position. *Stigmaria* is the name given to tree roots, even if the plant species is not known.

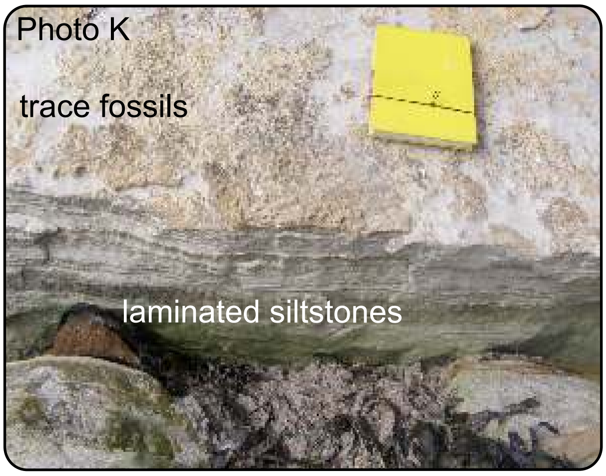


Photo K

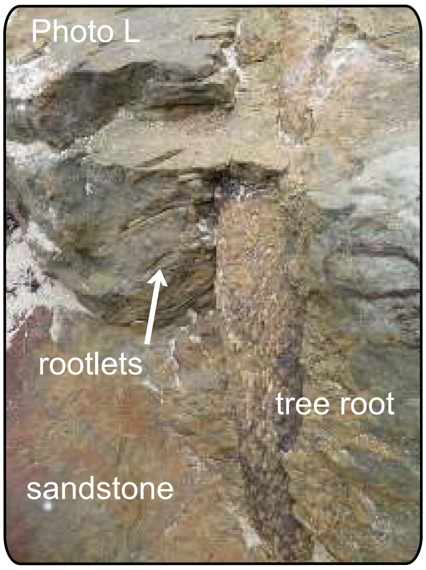


Photo L

③ *Walk along the beach until you reach the small stream and waterfall (Photo M).*

The stream, which drains a small area of the golf course on the cliffs above, has cut its way down to the sea along a fault, clearly a line of weakness. It falls over thin beds of sandstone and has eroded the softer siltstones below.

There is a change of rock type across the fault, shown by the appearance of a thick bed of sandstone on the right hand side of the fault. Immediately below the sandstone is a very thin bed of carbon-rich shale with about a metre of pale, yellow-stained **fireclay** beneath it. Below the fireclay, but sometimes covered by pale clay from above, is a tougher rock, which is a type of limestone called a **calcrete,** seen at the bottom of the waterfall.

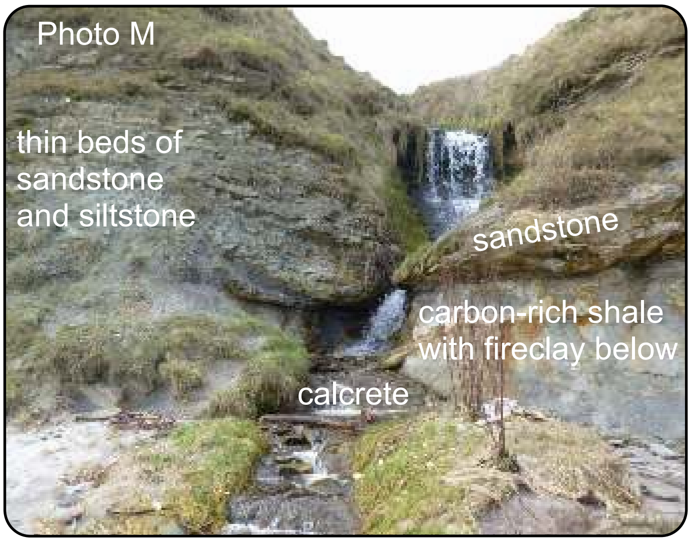
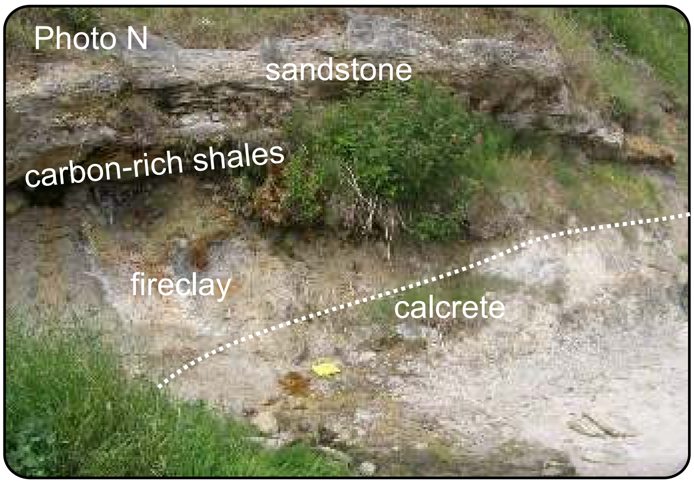
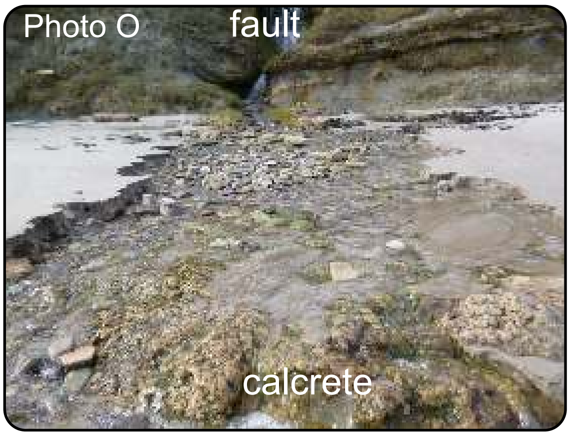


Photo M

Calcrete is formed of **concretions** of the mineral **calcite** formed when a lake or river bed dried up, suggesting that there was a dry climate change event during the other-wise warm and wet Carboniferous period.

The pale grey fireclays (Photo N) were the leached soils of wetlands in which extensive forests grew. Sometimes you can find black fossilised rootlets in the fireclays. Often **coal seams** are found above fireclays because water and gases from the organic matter in the marshy areas were driven off when the wet sediments were compressed, leaving black carbon. Here, there was not enough carbon to produce coal, but black **carbon-rich shales** lie above the fireclays.





The calcrete can sometimes be seen in the stream bed on the beach when the sand levels are not too high (Photo O). It appears greenish/yellow when washed of clay and sand and is made of nodules of calcite, rather than beds like most limestones. An excellent exposure of a similar calcrete can be seen on the fore-shore just below Pier Quarry, Spittal (see Spittal leaflet).

④ *Walk along to the corner of the beach, to see evidence of the third fault on the north side of Murphy's Beach.*

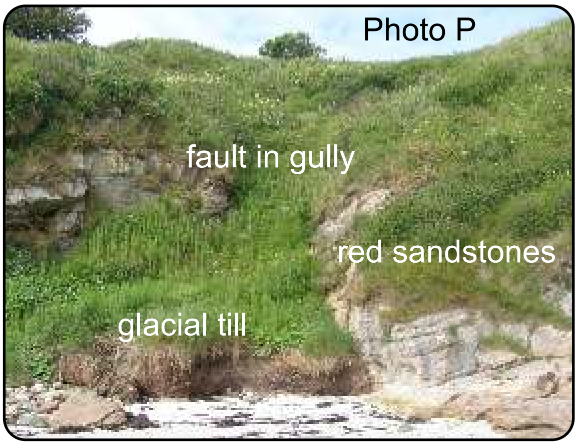
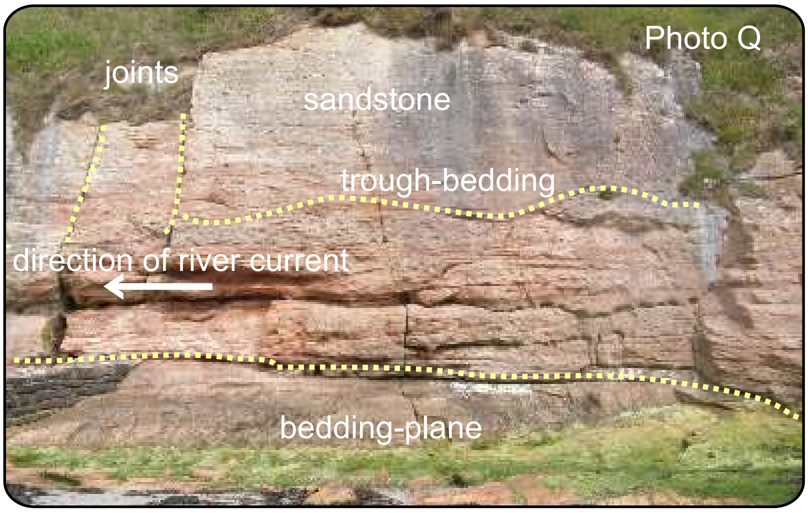


Photo P shows the point at which the fault runs into the cliffs. Here it is not possible to see many of the typical features of a fault as there has been **weathering** and **erosion** down the fault plane and the resulting gully has been filled with a landslip of glacial till, which can be studied on the beach next to the exposure of the red sandstones which form the northern side of the cove.

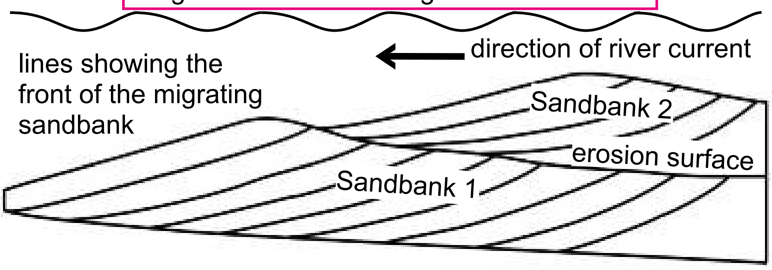


FEATURES OF SANDSTONE BEDS

The quarried face in Photo Q shows some of the typical features of sandstone exposures. As sand grains are deposited in channels or on the sea bed, they form **beds** which are separated by **bedding-planes,** which represent a period of time without deposition. The wet sediments are compressed and cemented by new materials, most likely iron and silica minerals, during burial by later sediments. The near-vertical **joints** which cut across the bedding-planes are formed by later **tectonic** activity.

Cross-bedding is formed when sand grains rolled along by currents are heaped into sandbanks on the channel bed. The curved planes of the advancing face of each sandbank, which migrate continuously in the direction of the channel current, are shown in Diagram 1 which shows the side view of a channel, as seen in the lower part of the cliff in Photo Q.

Diagram 1 Cross-bedding in a river channel



Trough-bedding shows the cross section of a river channel, as in the upper part of the the cliff. These rocks were formed in rivers which carried sand grains **eroded** from a range of high mountains to the north and east of northern Britain, about 330 million years ago during the **Carboniferous period**.

⑤ *Look along the edge of the cliffs towards the cave entrance.* At the base of the cliffs is a **wave-cut notch** with a ledge of sandstone beneath it. The notch marks the position of high tide and is formed by wave erosion, partly because waves exert pressure on the joints in the sandstone but also by **abrasion** by sand grains and pebbles hurled at the cliff as waves break, especially during storms.

Beyond the end of the beach are seaweed-covered rocks and rock pools. The cave opens up into several tall, narrow chambers which have been weathered and eroded along joints by waves at each high tide. It is possible to reach the cave entrance with difficulty but entering is not recommended as the uneven floor is very slippery.

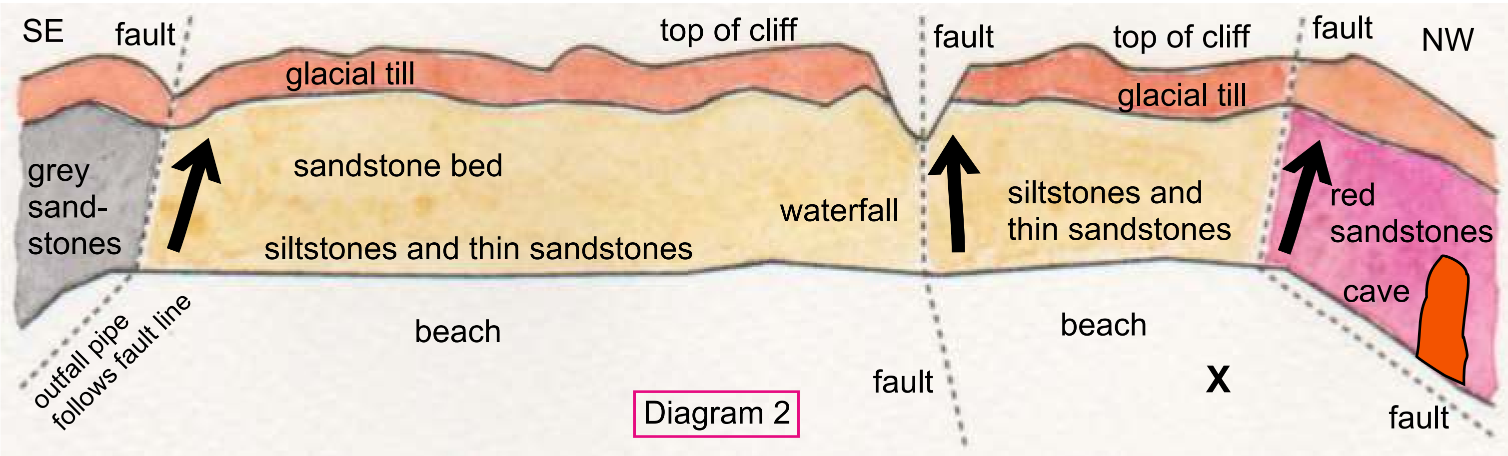


Diagram 2 shows a view of the cliffs around the Cove as if you were looking from the sea, with the main features labelled. It is difficult to imagine the faults as plane surfaces, like sheets of paper, along which the rocks have shifted vertically and possibly sideways (laterally).

The arrows show the direction of movement of one side of the fault relative to the other. Geologists make the assumption that older rocks lie below younger rocks, so the rocks on the right-hand side of the SE fault are older than those on the left-hand side of the fault and have been **displaced** (lifted upwards) by 100 m. Similarly the rocks to the right of the waterfall fault are older than those on the left-hand side, but the displacement is probably only a few metres. The NW fault is thought to have moved by about 30 m, so the red sandstones are the oldest rocks to be seen in the cliffs of Murphy's Beach.

The red sandstones form dramatic cliffs all the way to Needle's Eye, a mile to the north, and may be the same sandstones as at Pier Quarry, south of Spittal Beach (see Spittal leaflet).

From the cave you can walk along the beach to the steps or find your way back on the sandstones of the shore platform which is littered with loose boulders. Several interesting features have been seen on the sandstone bedding-planes but locating them a second time is often difficult because of the movement of boulders, sand and seaweed on the shore platform.

If you want to explore, look for the fossil of a shark's fin (approximate position is marked with an X on Diagram 1), or search for the green sandstone bedding-planes covered with ripple marks and trace fossils close to the outfall pipe at the SE end of the beach.

USEFUL REFERENCES

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

The geology of Berwick-upon-Tweed, Norham and Scremerston Fowler, A. 1926. Memoir of the British Geological Survey, Sheets 1 & 2

USEFUL MAPS

OS 1:50,000 Landranger 75 Berwick-upon-Tweed

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

British Geological Survey 1:50,000 (England) Sheets 1 & 2 Berwick-upon-Tweed and Norham