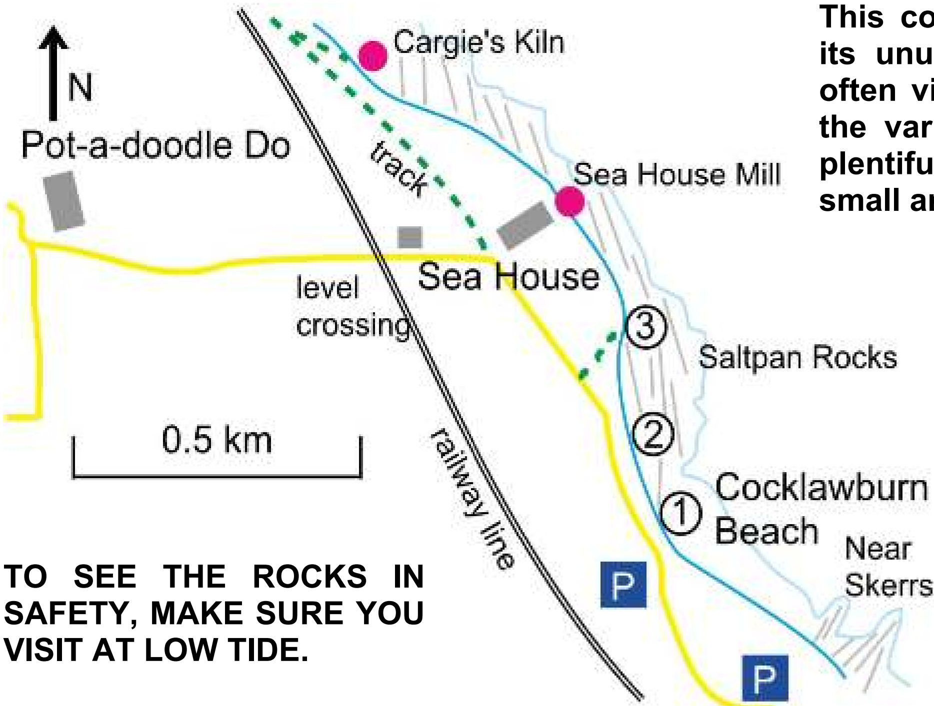
SALTPAN ROCKS, COCKLAWBURN



This coastline is particularly well-known for its unusual folds in the limestones and is often visited by geological groups who love the variety of colourful rock types and the plentiful fossils, all of which can be seen in a small area of the shoreline.

To see the rocks in the cliff at close quarters there is some scrambling over rocks and walking across shingle. You must wear good shoes or walking boots and take walking-poles for balance, if needed. The numbers on the map are places where you can stop and look at features of geological interest.

TO SEE THE ROCKS IN SAFETY, MAKE SURE YOU VISIT AT LOW TIDE.

Visitors can park at lay-bys along the minor road to the beach (NU 025 488). The whole coast is accessible by bike from Route 1 between Berwick and Holy Island. A bus from Berwick takes you to Scremerston, followed by a 2 km walk to Sea House on footpaths. From the road you can walk across the beach to Saltpan Rocks.

This coastline is a small section of the Northumberland Coast Area of Outstanding Natural Beauty and has sand dune and beach habitats which attract a wide range of plants and birds, so please enjoy and respect the wildlife. Leave rocks, fossils and pebbles on the beaches for other people to enjoy.

① *Walk a short distance on the beach towards the rocks at the north end of Cocklawburn beach (NU 025 489). The next few hundred metres along the shore has a great variety of rocks, fossils and sedimentary structures and could take you an hour to walk, if you want to look at everything!*


Photo A
Three Yard Limestone

There are two main **limestone** beds in these cliffs and the Three Yard Limestone is the first limestone that you see (Photo A). Be careful when you walk onto it because it slopes at 20° and is often covered with sand grains, which means that shoes/boots can't get a good grip on the smooth surface.


Photo B
Joint pattern in the Three Yard Limestone

Photo B shows the unusually regular pattern of **joints** (breaks in the solid rock), which were formed when the rigid limestone was cracked under stress during tectonic plate movements about 30 million years after it was formed.

HOW DOES LIMESTONE FORM?

The Three Yard Limestone was deposited as **lime mud** in the warm seas of the Carboniferous period 330 million years ago. The area that is now northern England was lying close to the equator and was covered by clear shallow water teeming with animal life, such as **corals**, invertebrates with shells and **crinoids**, the extinct ancestors of sea urchins. When the creatures died, calcite in their shells dissolved into the warm water. When the concentration of calcite in the water was high enough, lime mud was precipitated on the sea bed. The smooth surface of the limestone is called a **bedding-plane** and was the surface of the sea bed as lime mud was being deposited in the clear water.

CARBONIFEROUS CRINOID FOS-

The many beds of limestone in north Northumberland were deposited at slightly different times and in different parts of the shallow seas which existed during the **Carboniferous** period, so they often have different **fossils**. The Three Yard Limestone is full of crinoid fossils. The animal lived in a cup of calcite plates **(calyx)** above the sea bed on a stem made of **ossicles** (whose scientific name is columnals) fixed to the sea bed by a **holdfast**. They lived in shallow, clear lagoons where there were few waves or currents and found their food from microscopic animals living in the water.

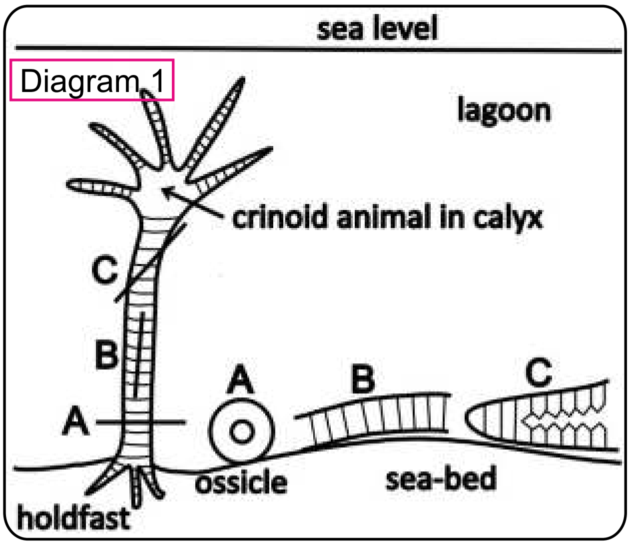


Diagram 1


Photo C


Photo D

Photos C and D show how the stems of crinoids appear after fossilisation. If the ossicles separated after the animal died, they would settle on the limey mud of the sea-bed at random (Diagram 1) (A). If there is little wave action, the unbroken crinoid stem will fall to the sea bed (B). Once the lime mud has crystallised into a limestone, erosion of the bedding-plane cuts the stems at different angles, often obliquely (C) (Photo C). It is very rare to find fossils of the calyx, the cup of calcite plates lived in by the animal.

Walk carefully over the next bed of rock, which is a sandstone that dips at 20° towards the east (Photo E).

Photo E

The sandstone is a pale yellow colour when fresh, but looks pink because of the amount of red iron that it contains. If you look closely at the bedding-plane surface you can see that it is roughened, probably by the activity of invertebrates living in the wet sand of a sandy delta or sand flats (Photo F).

Photo F

The burrows are an example of **trace fossils**, which tell geologists about the behaviour of an animal, rather than its shape or size. We do not know what kind of soft-bodied invertebrate left these marks, as its remains have decomposed or been consumed by an animal higher up the food chain. Some of the burrows are infilled with red iron which was washed through the sand after it was buried under later sediments (Photo F).

*Walk carefully towards the cliff over rocks and shingle (Photo G). You can have a close look at the junction between pale **fireclays** and the dark grey **shales** above. If there has been rainfall recently, take care as the shales are loose and fall onto the beach once they are lubricated.*

The rocks of the cliff lie above thin beds of interbedded dark grey **mudstones/shales** (clay particles) and pale grey **siltstones** (fine quartz sand grains). They are full of many types of invertebrate burrows and tracks. The very dark bed seen on the edge of the cliff looks like a black coal seam but it is a black **carbon-rich shale**.

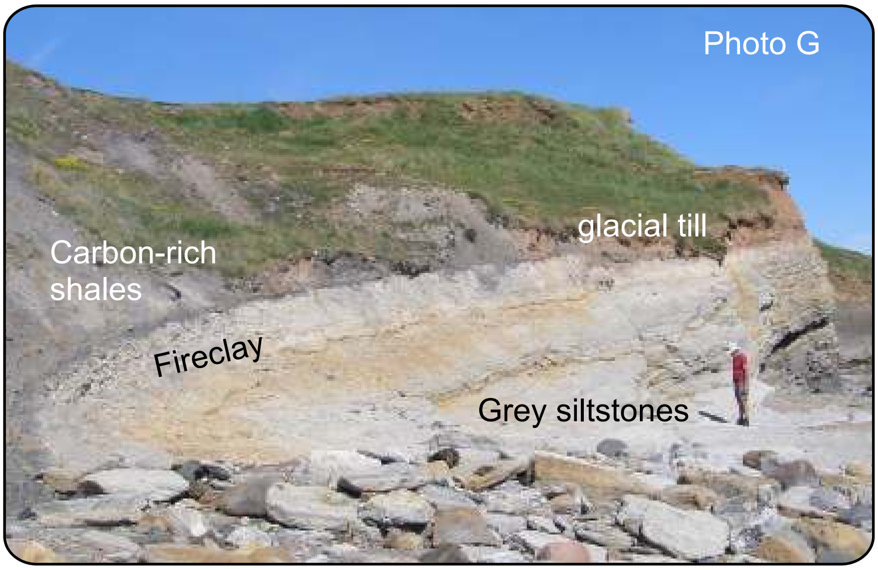
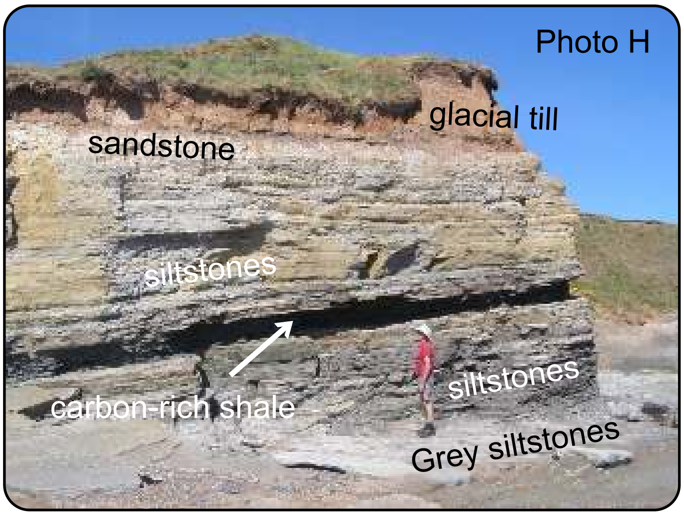


Photo G

HOW DOES COAL FORM?

The pale grey clays (fireclays) in the cliff (Photo G) were leached soils in which forests grew in muddy swamps filled with debris from decomposing plants. 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 marshes were driven off when the wet marsh sediments were compressed, leaving black carbon. However, there is no coal at this level as thick forests did not grow in this particular area for long enough to produce a coal seam. The bed of dark-grey carbon-rich shales above the fireclays shows that there was a rise in sea level so that water engulfed the forest, killing the vegetation. Black muds were deposited in deeper water. Changes in sea level occurred because a huge **ice sheet** over the South Pole was expanding or melting, roughly every 100 thousand years. When sea level fell, thick forests could grow in parts of the land surface that had been shallow seas.

Walk closer to the cliff to see the details of the rocks and their fossils. Because sea levels were fluctuating, the rock types also change with time. At the bottom of this cliff face (Photo H) are burrowed grey siltstones deposited on sand flats close to sea level. The dark siltstones just above them are younger (**Law of Superposition**) and it is likely that they were deposited in swamps or lagoons just above sea level. Thin pale beds of siltstone are interbedded with the dark siltstones, suggesting that small rivers occasionally carried fine quartz sand grains. The conspicuous black bed of carbon-rich shales represents a marsh or swamp filled with vegetation debris. The sandstone at the top of the cliff shows that sand was washed in by rivers and covered the swampy vegetation.



FLUCTUATIONS IN SEA LEVEL DUE TO CLIMATE CHANGE

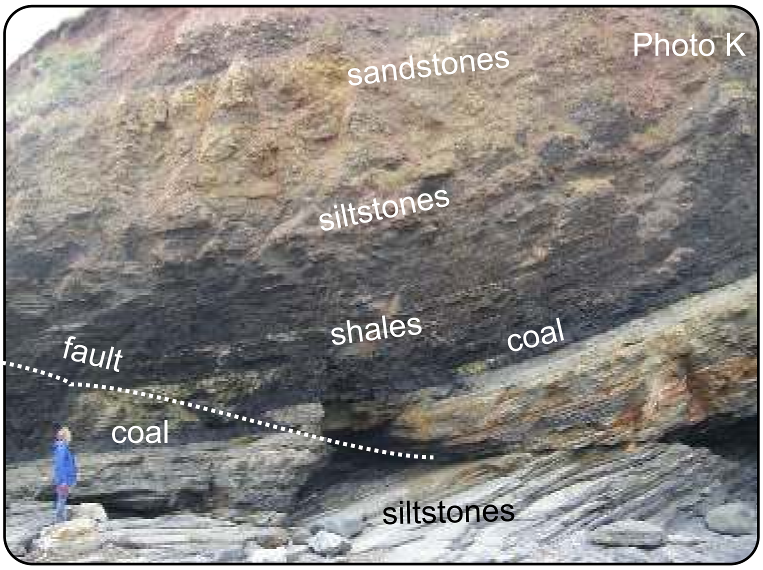
At the top of the cliff is a red deposit of **glacial till,** a clay with stones and pebbles, deposited by an ice sheet over Northumberland about 15,000 years ago when global temperatures were much colder than they are now. Our most recent ice age started 2.6 million years ago and temperatures have fluctuated between mild **interglacials** and very cold **glacial events** at least 20 times since then. When large ice sheets develop, the snow that forms the ice remains on the land surface and, as it is not returned to the sea as water in rivers, sea level falls. When ice sheets melt, sea level rises. The difference in sea level between a world with no ice sheets and a world with extensive ice sheets is roughly 100–120 m. During the Carboniferous period an ice sheet started to grow over the huge continent of **Gondwana**, which was positioned at the South Pole. The area that is now Britain was part of a large continent which straddled the equator, so temperatures were hot and rainfall was high, as in equatorial areas at present. Even though this area was not covered by ice during Carboniferous times, it was affected by sea level changes, for which we see evidence in the rocks of the north Northumberland coast.

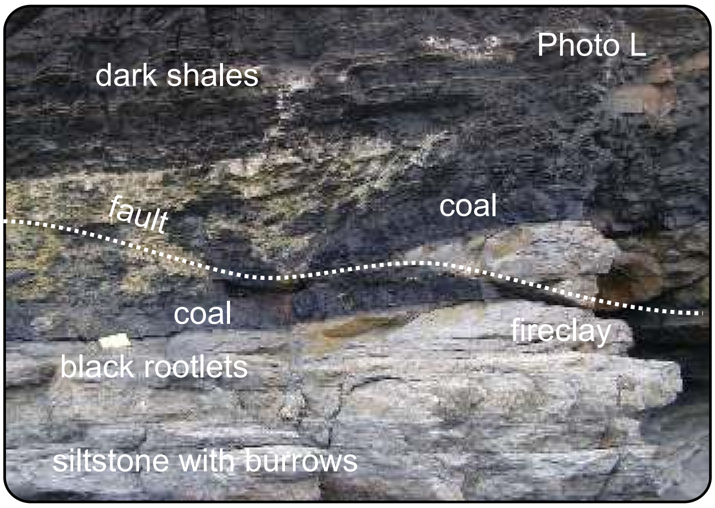
The large, flat siltstone boulder at the base of the cliff is covered with trace fossils, probably invertebrate burrows (Photo I).

The grey siltstones contain a variety of trace fossils, such as feeding tracks and burrows (Photo I). There was plenty of animal and plant life, enjoying a warm, moist climate on a land surface close to sea level.

Photo J shows a block of rock from thin beds of siltstone in the base of the cliff face. The dark spots are regularly spaced and are thought to be the roots of plants which grew in swamps, in the same way in which reeds and sedges grow today.

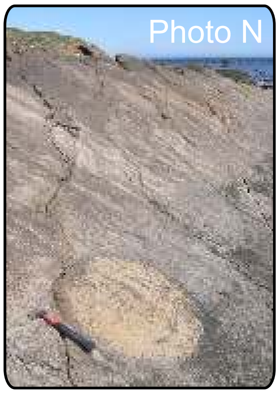
② *Walk around the end of the cliff and stand back to look at the cliff face shown in Photo K. This cliff has been undercut by the sea and may not be stable, particularly after rain, so stand well back on the siltstones at the foot of the cliff to see the features.* At the base of the cliff is a very dark bed of **coal,** formerly known as the Acre Coal, which lies below the Three Yard Limestone. Photo L shows that the 30 cm coal seam is underlain by a pale fireclay, with traces of black plant roots. Above the coal are beds of black shale, probably carbon-rich, which gradually grade into paler siltstones and yellow sandstones at the top of the cliff.



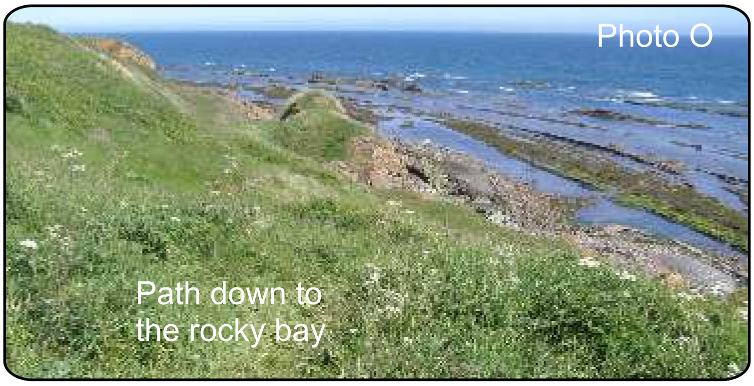


The coal seam has been **faulted** (Photo L). The fault extends up the cliff, shown by the dashed line. This fault is due to pressure as the rocks were squeezed together and is one of several features in these cliffs which show that the area was involved in plate tectonic activity at the end of the Carboniferous period. More evidence is shown by the dip of the local rocks which have been tilted, as you can see if you turn to face the Thin Limestone bedding plane (Photo M).

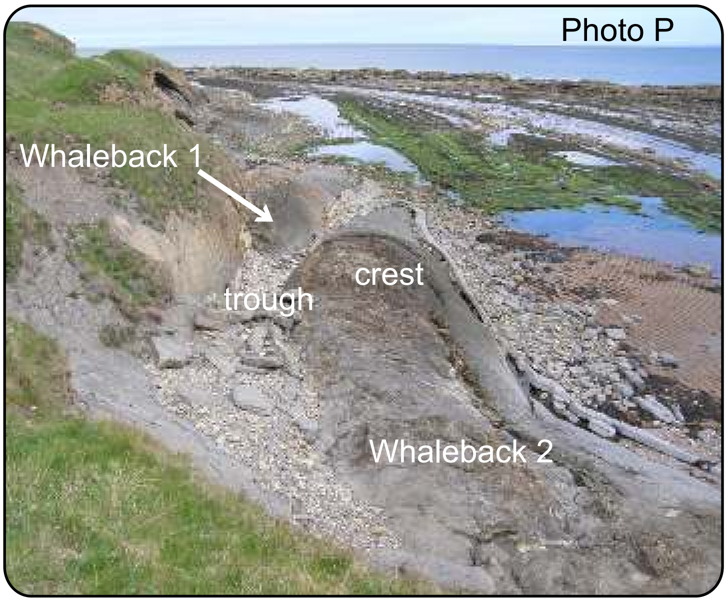
The Thin Limestone bedding-plane dips at about 20° and has scattered coral fossils which are not easy to distinguish on the grey rock. Towards the seaward end of the limestone are several raised domes of a yellow colour (Photo N) which may have been formed as water was expelled from wet lime mud as it was compacted by sediments which were deposited above.



To reach location ③ it is best to return the way you came, across the beach and back to the road. While it is possible at low tide to walk around the Eelwell Limestone headland, the going is rocky and steep in places and is not generally recommended. When you reach the road, walk up the hill until you see the old road on the seaward side, now largely destroyed by erosion of the cliff. At the end of the top section of old road there is a rough path which goes down through scrub towards a rocky bay (Photo O).



On your way down the path, veer to the right to look over the cliff for a view of the **whalebacks**, folded rocks which have also been tilted northwards. The folds have rounded **crests** but the **trough** between them is sharp, with nearly vertical sides (Photo P).



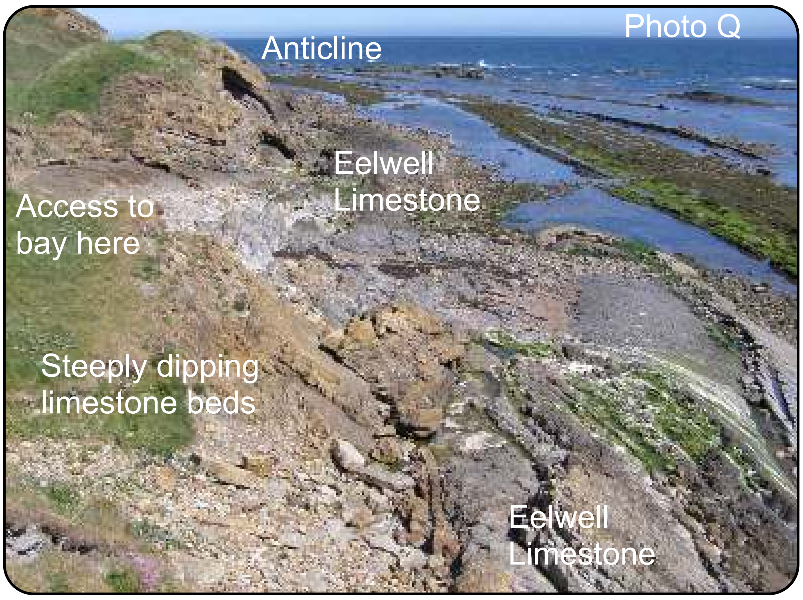


Photo Q

The Eelwell Limestone consists of several thick beds which show the folding clearly. The less resistant rocks around them have been eroded away by the sea. The whalebacks are the rounded crests of two anticlines which have also been tilted so they **plunge** towards the north (see arrow in Photo R). The syncline between them is angular and limbs are nearly vertical in places.

③ *As you approach the rocky bay, you will be walking down steep grass and scrub slopes to the Eelwell Limestone below. If you don't feel confident of your balance, stand at the edge of the cliff to look at the features on Photo Q.*

Pressure on the rigid beds of Eelwell Limestone has squeezed them into folds. Upfolds are called **anticlines** and downfolds are called **synclines** by geologists (Diagram 2).

Diagram 2

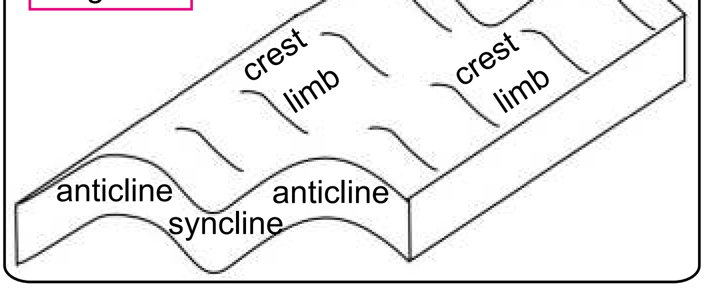


Photo S shows the folded rocks at the end of the bay. The **limbs** of the anticline are steeper than the limbs of the syncline and the anticline is broken at the crest.

Photo R

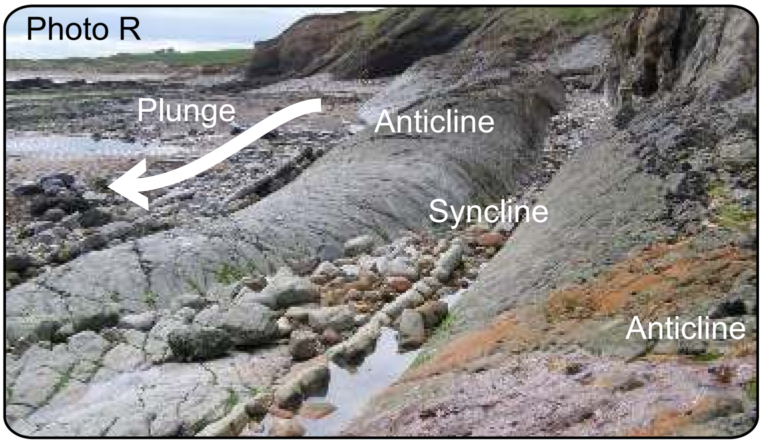
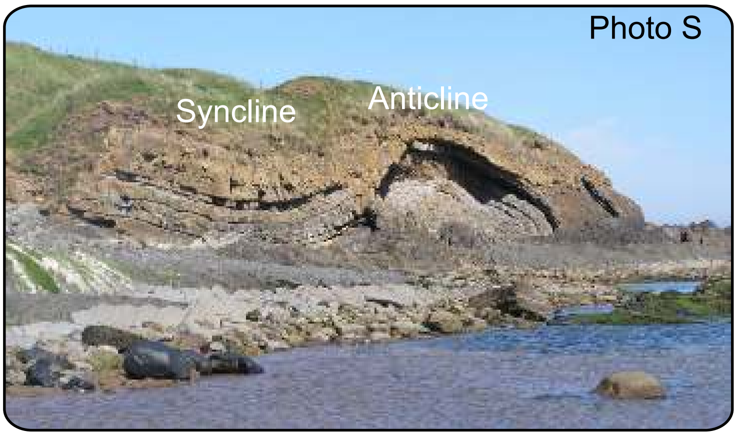


Photo S



THE VARISCAN PLATE COLLISION

This shoreline shows that the Carboniferous limestones and sandstones were involved in a tectonic plate collision after they had been deposited and buried under several kilometres of younger rocks. They were put under pressure and squeezed into folds (Diagram 2) by pressure from the east against the much older rocks of the Southern Uplands. This folding event took place at the end of the Carboniferous period 300 million years ago when two large continents to the south of the area that is now Britain collided, creating a chain of high mountains. The folds on this shoreline are the marginal effects of this **Variscan** plate collision.

There are plenty of interesting features to see amongst the rocks and a chance to look closely at the Eelwell Limestone and its folds. If you want a longer walk, you can continue north-west along the shore across more folds in the Eelwell Limestone, to reach Cargie's Kiln north of Sea House, where there is a path up the cliff onto the coastal footpath.

To return to Cocklawburn beach directly, retrace your steps up the path to the road. Alternatively you can walk back along the shoreline if the tide permits, crossing the whalebacks, past the features that you have already visited. This route involves some scrambling which could be hazardous if the lime-stone is wet, so take care.

USEFUL REFERENCE BOOKS

Northumbrian Rocks and Landscapes - A Field Guide 1995 (ed. C. Scrutton) Yorkshire Geological Society, p. 51.

Peregrini Lindisfarne: An Anthology 2017. Peregrini Lindisfarne Landscape Partnership, p. 97.

http://www.northumberlandcoastaonb.org/

USEFUL MAPS

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

OS 1:25,000 Explorer 340 Holy Island and Bamburgh

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