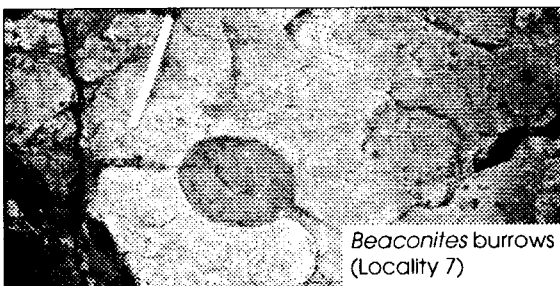


sandstone units are thick - between 5 and 10 metres. The bases of the sandstone units are lined by a layer of pebbles a few cm thick. This shows that the channels were scoured into floodplain deposits, concentrating the coarsest fragments as a **lag deposit** at the channel base.

Look at the upper part of one of the sandstone units - **take care when clambering over the rocks**. Sandstone and siltstone interfinger, indicating a gradual return to floodplain conditions as the channel filled with sediment. In places you may see circular patches about 10 cm across: these are **infilled burrows** called *Beaconites*. It is not known what animal made them but perhaps worms or primitive amphibians were burrowing - for food or hibernation - in the damper sediment of abandoned river channels.



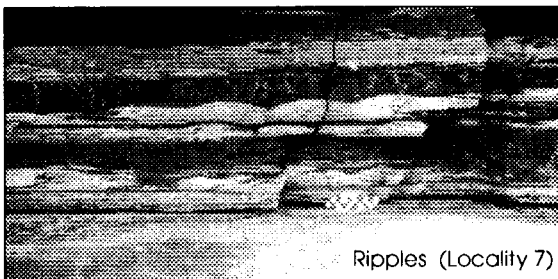
Beaconites burrows (Locality 7)

On some sandstone surfaces you can see a fine-scale layering, or **lamination**. Some laminae pick out saucer-like shapes a couple of metres across. This is **cross-bedding**, made by sand **dunes** on a river bed. Laminae form when sand rolls down the front of a dune. The saucer shapes indicate that the current was flowing into or out of the face you are looking at. The currents in these river channels 400 million years ago were flowing from north to south. An ocean lay to the south (across central Europe) and land to the north. Plate tectonic movements had recently formed mountains to the north, and erosion of these produced the sediment carried in the Old Red Sandstone rivers.

If the tide is not high continue for a further 300 m along the foot of the cliffs past St. Anthony's Cottage. Keep an eye on the tide, and return if it is coming in.

Locality 7. The cliffs south of St. Anthony's Cottage are mostly red siltstone. Locality 7 is where several green sandstone units, each 1-2 m thick, are easily accessible at the foot of the cliffs. These sandstones are channel deposits from rivers which were a couple of metres deep and about 10 m wide. Which way do the beds dip here? This is opposite to

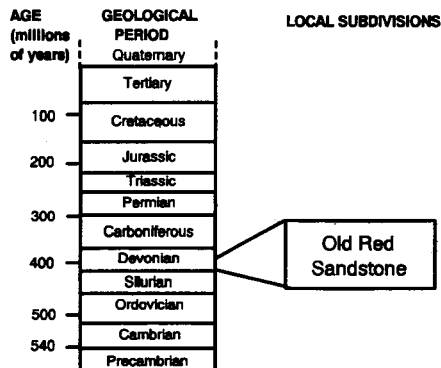
the direction at Localities 5 and 6. The rocks are deformed (**folded**) into an arch or **anticline**, the crest of which has been removed by erosion.



Ripples (Locality 7)

The rocks in the low cliffs and the boulders on the foreshore show several features that support the interpretation of the Old Red Sandstone as river deposits. Some red siltstone surfaces are covered with a network of cracks filled with grey sandstone. These are infilled **mud cracks**, and show that the floodplain sediments dried out from time to time. Infilled burrows of *Beaconites* are not uncommon. The interbedding of red siltstone and green sandstone in the cliff face shows **ripples** preserved along the tops of some thin sandstone beds.

Return to the car park, either along the foreshore or along the cliff path reached alongside St. Anthony's Cottage. From St. Anthony's Cottage look back towards Locality 7 for a clear view of the fold.



Produced by the Geologists' Association South Wales Group. If you want to know more about rocks, fossils and the geology of South Wales contact the **Geologists' Association South Wales Group** (Cymdeithas y Daearegwyr - Grŵp De Cymru) at National Museum of Wales, Cathays Park, Cardiff.

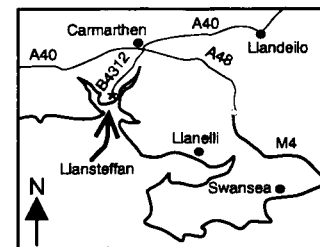
Geraint Owen, University of Wales Swansea, March 1996.

Geological Walks in Wales



Llansteffan

This short walk along the foreshore at Llansteffan beneath the Castle into Scott's Bay examines the geology of the Old Red Sandstone rocks. These reveal evidence for the environment and climate in South Wales about 400 million years ago. The return walk is about 3 km and should take less than half a day.



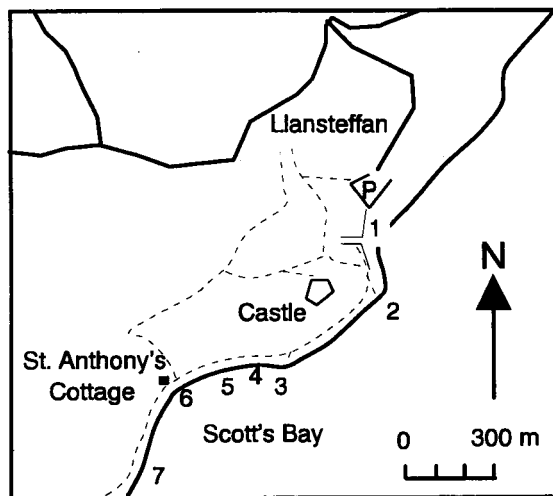
Location. Llansteffan is on the west bank of the Tywi estuary, 12 km SSW of Carmarthen on the B4312. There is a large car park below the Castle at grid reference SN 3522 1046. Turn sharply left immediately after crossing the stream on reaching Llansteffan village, and follow the narrow road to its end.

Maps. Ordnance Survey 1:50,000 Landranger sheet 159 (Swansea and Gower); Ordnance Survey 1:25,000 Pathfinder Sheets 1081 (SN21/31 - St. Clears and Laugharne) and 1105 (SN 20/30 - Pendine); British Geological Survey 1:50,000 sheet 229 (Carmarthen).

This stretch of coast is subject to severe tides. Localities 1 to 6 are accessible at most stages of the tide and escape from the shore is possible via steps onto the cliff path in several places. Pay particular attention to the tide at Locality 7. DO NOT VENTURE ROUND WHARLEY POINT WITHOUT CONSULTING TIDE TABLES. Take care when walking over rock surfaces, which may be slippery.



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Walk south from the car park onto the beach. In 100 m look at the cliff next to where a surfaced lane meets the beach.

Locality 1. The cliff is made of angular boulders in a sandy background. The boulders are made of the rocks that form the Llansteffan peninsula. This deposit must have formed much more recently than the rocks themselves. Such young deposits are called **drift** and this material was deposited in the last **Ice Age**. From about 18,000 until 13,000 years ago most of Wales was covered by ice sheets and glaciers. The ice and its meltwater caused much erosion and deposited sediments like these.

Continue along the foreshore for 200 m to the corner of the cliffs, where steps come down onto the beach.

Locality 2. The rocks at Llansteffan belong to the **Old Red Sandstone**. They are **sedimentary rocks**, which formed as sand, mud and gravel during the **Devonian Period** of time, some 400 million years ago. As more sediment was deposited, older layers were buried and sand, mud and gravel were cemented to form sandstone, mudstone and conglomerate.

The rocks here are bright red with creamy white patches. The red rock is fine-grained **siltstone**, deposited as **alluvium** on river floodplains. The red colour is due to small amounts of iron oxide in the sediment becoming oxidised, just like exposed iron oxidises to **rust**. By comparison with modern

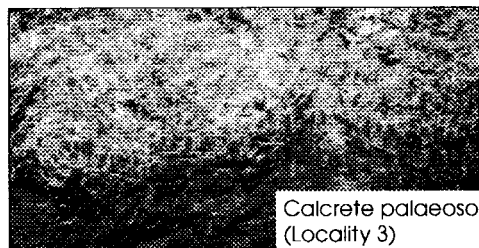
ivers, each thick layer (**bed**) of siltstone is the product of many river floods.

The irregular creamy patches are **calcite**, the mineral of which **limestone** is composed. They grew by chemical processes as **nodules** in the sediment. These nodular limestones are fossil soils (**palaeosols**) of a type called **calcrete** or **caliche**. Similar soils form today under a sub-tropical, **semi-arid climate**. During the wet season soluble minerals are dissolved. Very soluble minerals are flushed into the groundwater system and eventually contribute to the salt in the sea. Less soluble minerals such as calcite are drawn to the surface by evaporation during the hot dry season. After thousands of years calcite becomes concentrated near the surface as nodules.

The calcrete palaeosols demonstrate that this area experienced a sub-tropical climate 400 million years ago. At that time Wales lay between 10° and 20° south of the equator, where Peru, Namibia and northern Australia are today. Britain has moved to its present position through **continental drift**. The Earth's surface is broken into slabs or **plates** which move a few centimetres each year. The boundaries between plates are marked by volcanoes and earthquakes. Over hundreds of millions of years this process (**plate tectonics**) causes the continents to move.

Several palaeosols are stacked one on top of another here. Each may have taken thousands of years to form. During that time, the river stopped depositing alluvium here. The reason for this is not known. Perhaps the river plains were so vast that floodwaters did not cover the entire floodplain. Or perhaps falling sea-level allowed the river channels to cut into their floodplains, limiting the area over which they could flood. Intervening sea-level rises allowed them to deposit sediment again, filling in their incised valleys and spreading alluvium once more over all the floodplain.

Continue for about 300 m to the next corner, where there are more steps. Look at the rocks just east of the foot of the steps. **Take care on the rock platform.**



Locality 3. A calcrete palaeosol about 1.5 m thick is well exposed here. In its central part the nodules trace out saucer-shaped patterns 1-2 m across. Wetting and drying during soil formation caused the ground to swell and contract along the curved surfaces, known as **pseudoanticlines**.

Examine the rocks around and immediately north of the foot of the steps.

Locality 4. Thin beds of cemented gravel occur here. The pebbles in the gravels are pieces of calcrete, and in some beds they are rounded (**conglomerate**) while in others they are angular (**breccia**). They were carried by strong water currents eroding soils elsewhere on the floodplain. They may have been deposited by torrential floods when heavy rain fell on the floodplain, rather than in the rivers' source areas. Such reworked calcretes are known as **cornstone**, because modern weathering breaks them down into fertile soils. Floodwaters occasionally picked up fish which were living in the river channels, and rounded fragments of fish bone sometimes occur amongst the pebbles.

In some beds the pebbles are surrounded by white calcite. This is a natural **cement** which grew in the spaces between pebbles. In other beds silt percolated into the spaces shortly after deposition, so there was no space for cement to grow.

Continue along the foreshore to the centre of Scott's Bay.

Locality 5. There are several superb calcrete profiles here. Notice the varied shape of the nodules: some are almost spherical, while others form long, thin cylinders. The beds are tilted: they **dip** at about 30° to the north. They formed as sediments on a vast coastal plain, so the beds were originally horizontal. After burial beneath several kilometres of further deposits, they were tilted by compression caused by colliding plates far to the south.

Continue towards St. Anthony's Cottage.

Locality 6. For about 100 m before St. Anthony's Cottage the cliffs are made of green rock. Look closely at the surfaces of this rock (a hand lens is useful). It is **sandstone**, made of sand grains cemented together. There are 2 units of green sandstone, each over 5 m thick, separated by red siltstone. The top of the upper sandstone is adjacent to the concrete apron by St. Anthony's Cottage.

The coarser sediment of the sandstone was washed into this area by stronger currents: the sandstone units are **river channel** deposits. The channels were probably as deep as the