

# TRIASSIC PEBBLE BEDS, SANDSTONES AND MUDSTONES

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Budleigh Salterton Pebble Beds overlain by Otter Sandstone, exposed in high cliffs to the west of Budleigh Salterton, and a Site of Special Scientific Interest (SSSI) for its geology. © DJC Laming

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## 1. BRIEF DESCRIPTION

The pebble beds, sandstones and mudstones which date from the Triassic geological time period are mainly red rocks which formed in tropical desert conditions dominated by wide river floodplains and temporary lakes, between about 250 and 200 million years ago.

The first small dinosaurs appeared in late Triassic times, though there had been more primitive reptiles and amphibians before then.

The Triassic geological time period was named after the three-fold series of similar rocks found in Germany, of which only two are represented in Britain.

The Triassic red rocks in Devon are above the red breccias and sandstones of the Permian time period; together they are known as the New Red Sandstone. At the top of the rock series there are greenish-grey mudstones and limestones, followed by younger Jurassic aged strata marking the incoming of marine conditions due to submergence of the land.

Triassic rocks of east Devon, and from Exmouth eastwards along the sea cliffs to Axmouth form an important part of the Jurassic Coast World Heritage Site known as the

Red Coast. Triassic rocks probably once spread across much of the lower-lying parts of Devon, covering the older harder rocks, and formed part of a desert plain extending over much of central England and beyond into the North Sea area.

Otter Sandstone is porous and fractured and holds groundwater which provides local supplies of drinking water from boreholes in the Otter Valley.

Unstable sea cliffs occur in the mudstones and sandstones, especially along the coast east and west of Sidmouth, and east of Exmouth.

## 2. GEOLOGICAL DETAIL

The Triassic period (251-200 million years ago) was remarkable for the tranquillity of the geological environment across Britain and most of Europe and also because the Age of the Dinosaurs began in the latter part of the period. Large four-legged reptiles had developed in the Permian, and amphibians even earlier, but the earliest dinosaurs were smaller and nowhere near as large as they would become in Jurassic times.

Desert conditions were widespread in Britain in Triassic times but, in contrast to the mountainous terrain and alluvial fans of the Permian, much of it consisted of wide plains over which river floods spread on rare occasions. These laid down floodplain deposits, mainly red-brown mudstone but with red channel sands forming horizontal beds at intervals, prominently seen in the cliffs of Exmouth. Near the base of the succession are pebble beds and sandstone deposited by a large delta fan.

The position of the boundary between the Permian and Triassic in Devon is uncertain. Formerly it was taken at the base of the Pebble Beds, but study of rare microfossils has indicated the boundary is lower, at the base of the Exmouth Mudstones. This is not only a boundary between two periods of geological time, but also between the Palaeozoic Era and the Mesozoic Era, characterised by ancient and intermediate life-forms respectively. The boundary also marks the time of a great mass extinction of marine life worldwide.

The upward succession of Triassic rocks in Devon is as follows:

- Exmouth Mudstone and Sandstone Formation is the lowest part of the Triassic (within the Aylesbeare Mudstone Group) and is seen at Exmouth. Both mudstone and sandstone layers make up the cliffs and are visible on the foreshore. Sandstone beds in the cliffs create prominent headlands such as Orcombe Point, but the bays in between are backed by mudstone which is much more vulnerable to erosion. There are some good examples of small scale faults in the cliffs and foreshore, displacing sandstone beds. Rare copper minerals have also been found.
- Budleigh Salterton Pebble Beds (in the Sherwood Sandstone Group) is a very prominent and distinctive gravel (or conglomerate as it should properly be called), with hard and rounded pebbles and cobbles and a substantial proportion of sand deposited by a large river flowing from a distant source. Fossils in the pebbles show that they came from mountains of much older Ordovician age in northern France. The large river continued north into the English Midlands. It ceased flowing into Devon when subsidence created an early version of the English Channel.
- Otter Sandstone lies above the Pebble Beds. It is also of river origin except for a layer of wind-blown sand at the base. Petrified fossil plants are cemented by calcareous encrustations.

- Mercia Mudstone is a group of mainly mudstone strata but thin siltstone and sandstone layers are found, together with gypsum and rock-salt deposits below ground. Previously known as Keuper Marl, the soft mudstone often weathers to clay.
- At the top of the Triassic succession, some marine and brackish-water sediments of Rhaetian age form the Penarth Group, including green-grey mudstone and limestone beds, and the White Lias, which passes up into Jurassic strata of the Blue Lias.

Fossils have been found in the Triassic, notably several bones of rhynchosaurs, reptile antecedents of the dinosaurs, found in the Otter Sandstone. Plant fossils, poorly preserved, have been found at Orcombe Point, Exmouth, as have a number of worm tubes similar to those seen in the Permian.

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Spectacular large sea stacks can be seen at Ladram Bay. These were previously sea caves in a former cliff headland, which enlarged into cliff arches, which then collapsed due to further sea erosion that separated them from the shore.

### **3. USES**

The Budleigh Salterton Pebble Beds is a valuable source of high quality aggregate used for variety of essential end products such as houses, schools, hospitals, etc. It is worked in several large quarries where the pebble beds outcrop on the plateau ridge extending northwards from Budleigh Salterton to the Somerset border. The gravel is extracted by heavy excavator and the stone and sand is crushed and processed to produce a variety of products for different uses.

The mudstones of Exmouth were formerly used for brick-making, but quality and price could not compete with better bricks from elsewhere.

The sandstone was used as building stone in many buildings, including churches, though better stone was obtained where possible for church towers. Much of the extraction was done on the seashore, and incised cart-wheel tracks can still be found from such activity. In areas where harder rocks were not available, mudstone was dug from numerous marl pits and used for traditional Devon cob construction in houses and farm buildings using horsehair as a binder.

### **4. PLACES TO VISIT**

Please refer to the safety guidance about visiting geological sites on our website before visiting the places listed below.

The coastal exposures of Triassic rocks are excellent but are accessible at only a few localities from Exmouth eastward; they lie within the Jurassic Coast World Heritage Site and are well described in resources available online.

#### **Orcombe and Rodney Points, Exmouth [SY 019796]**

Resistant sandstone layers form these headlands, with the interbedded mudstones backing the coves in between. The sandstones show extensive cross-bedding, a clear

indication of river delta deposition, while the mudstones were laid down as floodplain deposits. Rare plant fossils and copper minerals (malachite and native copper) have been found here in the past

The start of the World Heritage Site is marked by the *Geoneedle* on the headland, in the central column displaying stone types from the main rock formations seen along the coast

### **West Cliff, Budleigh Salterton [SY 060816]**

The Budleigh Salterton Pebble Beds form the prominent cliff, and pebbles eroded by wave action form the beach. The beds, about 25m thick, dip beneath the beach to the east, but rise up the cliff westward to form West Down Beacon. Small faults have displaced the bedding in places, as shown by the Otter Sandstone (wind-fretted) appearing lower down adjacent to pebble beds on the left.

### **Ladram Bay [SY 097852]**

The bay has good exposures of Otter Sandstone in the cliffs and (at low tide only) to the south. Occurrences of calcrete beds, many of them shaped like plant roots, can be found there. The massive sea stacks were once joined to the cliffs by natural arches.

### **Chit Rocks and Jacobs Ladder, Sidmouth [SY 120869]**

The Otter Sandstone dips below the beach 1 km west of this locality, but reappears here because of a north-south fault, upthrowing to the east. Cross-bedding and other features of the Otter Sandstone can be seen along the foot of the cliffs, and Mercia Mudstones behind the beach to the west.

### **Pennington Point, Sidmouth [SY 129873]**

The Otter Sandstone reappears here due to a fault along the valley of the River Sid, and striking bedding features are easily visible from the small jetty by the river. This cliff has suffered considerable erosion in recent years and should not be approached. Further along the beach (only at low tide) the Mercia Mudstone can be examined in the cliffs.

## 5. PHOTOGRAPHS



Otter Sandstones dipping gently east and overlain by Mercia Mudstones in the very unstable sea cliffs at Pennington Point, Sidmouth. © DP Roche



Local small faults cut across the boundary of the Otter Sandstones over the Pebble Beds, at Budleigh Salterton West. © DJC Laming



Sandstone and mudstone cliffs at Orcombe Point, east of Exmouth, with fault visible in foreshore. © DJC Laming



Dreikanter pebbles shaped by wind erosion at top of Pebble Beds overlain by yellow wind deposited sands of the Otter Sandstones. © DJC Laming



Pebble Beds – poorly sorted and coarse rounded quartzite pebbles in sand matrix. © SJ Parkhouse