# Permian rocks — introduction

This section provides a general introduction to Permian rocks and introduces the principal divisions in use today. Details of the rocks in these divisions are described in subsequent sections.

They are rocks laid down during the Permian Period about 290 to 248 million years ago. The term Permian was first used in 1844 for strata near the city of Perm in the Ural mountains, Russia.

## Permian rocks in Great Britain

Permian rocks in Britain include both continental sediments or 'red beds' deposited mainly under desert conditions and marine sediments. The marine Permian, in particular, comprises a series of rocks which are relatively complex and can be extremely difficult for the non-specialist to identify and differentiate.

Permian rocks of desert origin occur in isolated areas throughout the length of Britain from the Hebrides to classic coastal sections in Devon. Late Permian marine and associated strata are restricted to northern England with widely scattered, but mainly small, occurrences in northwest England and extensive almost continuous outcrop from Tynemouth in North-East England southwards to the outskirts of Nottingham. The Youngest late Permian marine strata are present in situ only in the southern North Sea. They are known almost entirely from borehole evidence.

During the early Permian, northern Europe was one of the world's great deserts. Widespread barren uplands created during the preceding Variscan earth movements were gradually worn down by Permian desert erosion and up to 500 metres of Carboniferous rocks were eroded (The Geological Evolution of County Durham). The product of this prolonged phase of erosion was a mature, gently rolling plain, probably with, in present-day North-East England, a gentle eastward slope into the subsiding North Sea Basin. This plain became the Carboniferous-Permian unconformity, a surface of generally low relief on which the Permian Yellow Sands Formation was deposited. In Northern England in the late Permian, continental extension opened a seaway which flooded low-lying ground and formed inland drainage basins, the so-called Bakevillia and Zechstein seas, approximately in the areas now occupied by the Irish and North seas. Situated in tropical latitudes about 10 degrees north of the equator at the start of the Permian, the area that is today Northern England had moved to about 30 degrees north by the end of the Period. During the early Permian northern Europe was one of the world's great deserts. Widespread barren uplands created during the preceding Variscan earth movements were gradually worn down by Permian desert erosion and up to 500 metres of Carboniferous rocks were eroded. The product of this prolonged phase of erosion was a mature, gently rolling plain, probably with, in present-day North-East England, a gentle eastward slope into the subsiding North Sea Basin.

## Permian rocks in County Durham

Outcrops of Permian rocks comprise approximately 35,273 hectares, or 15.8%, of the surface area of County Durham

The primary divisions of the Durham Permian were established in the early work of the eminent geologist Sedgwick published in 1829. The classification used by geologists today has evolved gradually as successive discoveries have enabled later workers to refine to this pioneer work. Most notably, a new formalised system of names based on geographic locations was introduced in the 1980’s. However, some of the names used by Sedgwick have become embedded in both the geological literature and the general understanding of people in the county. In particular, no discussion of the Permian rocks of Durham would be complete without reference to the Magnesian Limestone, a name that is no longer in formal geological usage. It is so widely employed in descriptions of the county that the term is retained in this report. A comparison between the traditional and more recent names is given in (Table 4).

### Rotliegend Group

The oldest Permian rocks within County Durham are sands and breccias, which were formed under desert conditions and deposited only in restricted areas.

### Zechstein Group

The Zechstein Group or late Permian marine succession in Durham formed near the western margin of the Zechstein Sea. The Group is made up of four main depositional cycles traditionally interpreted as the result of flooding by, and subsequent evaporation of, the Zechstein Sea. Where complete these cycles range from carbonate rocks at the base through sulphates to chloride-bearing 'evaporites' at the top. The inferred shoreline was only slightly to the west of the present Permian outcrop and a barrier reef formed near the edge of the sea. This was broadly similar to the Great Barrier Reef of Australia today, though composed principally of bryozoa and other marine organisms, but with few corals, The reef was essentially a large, flat- topped ridge sub-parallel to the coast with the top at, or just below, sea level. It formed a barrier between the open sea and an inland shallow water lagoon in which carbonate deposition was taking place. The sea periodically became sufficiently concentrated to deposit beds of gypsum, anhydrite, halite and potash alongside and on top of the reef. However, as these evaporites are mainly soluble salts, subsequently they have been dissolved away by natural processes and are not present at outcrop in County Durham. They are only locally represented by collapsed and broken limestone beds, with faint residues in places. All younger rocks of the late Permian sequence in coastal and adjoining inshore parts of the district have foundered as a result of this dissolution of underlying and interbedded evaporites. In County Durham the Rotten Marl is seen only in collapse breccias.

Some of the lowest rocks (cycle EZ1) in Durham differ considerably from their counterparts in Yorkshire, but remaining parts of the sequence are broadly comparable.

## Wider significance

The Permian rocks of Durham are commonly extremely well exposed and have attracted so much detailed study that Durham can claim justifiably to be the type area of the marine Permian in Britain. Some of the coastal sites in Durham are without parallel in Britain and most of western Europe and are unrivalled for research and teaching purposes. They are mainly in limestones and dolomites in the upper part of the Permian marine sequence and, in addition to exposing a continuum of rock types characteristic of the varied Permian marine environments, also furnish magnificent examples of the disruptive effects of evaporite dissolution.

At depth onshore, because of their highly porous nature, the Yellow Sands are major sources of groundwater and, offshore in the North Sea they are important reservoirs for oil and gas. Interest in these rocks was renewed as a result of exploration for oil beneath the North Sea in the late 20th century, as detailed examination of the exposures onshore enabled geologists to better understand Permian rocks concealed beneath the sea-bed.

The Marl Slate of County Durham area is internationally renowned for well-preserved vertebrate fossils, most notably several species of fish, though there are also important sites for early reptile fossils.

## Selected references

Hirst and Dunham, 1963; Hutton, 1831; Magraw, 1963; Pattison, 1986; Sedgwick, 1829; Smith, 1970, 1971, 1981, 1994, 1995; Smith and Francis, 1967; Smith et al. 1974; Smith et al. 1986.

## Figures, photographs and tables

(Figure 17) Distribution of Permian rocks in Great Britain.

(Figure 18) Distribution of Permian rocks in County Durham.

(Photo 22) Crime Rigg Quarry, Sherburn Hill. Thick Yellow Sands beneath Raisby Formation and Marl Slate. DJD Lawrence, BGS, 

(Table 4) Classification of Permian rocks in County Durham.

**Full references**

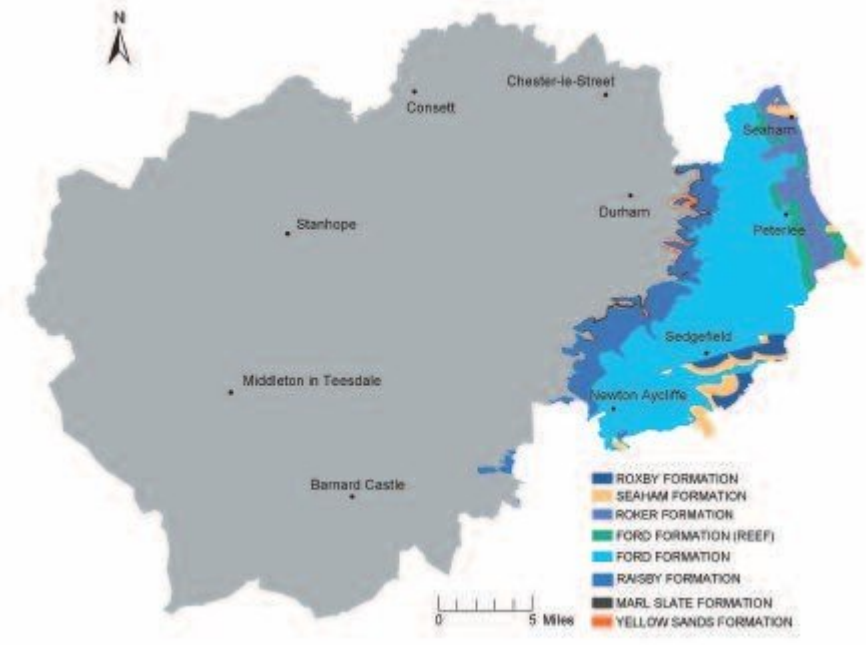
| Formal name (modified from Smith, 1989) | | Traditional name | | | English Zechstein cycle |
|---|---|---|---|---|---|
| Zechstein Group | Roxby Formation | Roxby Marl | | | |
| | Boulby Halite Formation | Middle Halite | | | EZ3 |
| | Billingham Anhydrite Formation | Billingham Main Anhydrite | | | |
| | Seaham Formation | Magnesian Limestone | Upper | Seaham Formation | EZ2 |
| | Seaham Residue and Fordon Evaporite Formation | | | Seaham Residue | |
| | Roker Dolomite Formation | | | (Hartlepool and Roker Dolomite) | |
| | Concretionary Limestone Formation | | | (Concretionary Limestone) | |
| | Ford Formation | | Middle | | EZ1 |
| | Raisby Formation | | Lower | | |
| | Marl Slate Formation | Marl Slate | | | |
| Rotliegend Group | Yellow Sands Formation | Yellow Sands (Basal Permian Sands and breccia) | | | |

Not exposed onshore in County Durham

Units described in this report

*(Table 4) Classification of Permian rocks in County Durham.*


*(Figure 17) Distribution of Permian rocks in Great Britain.*



*(Figure 18) Distribution of Permian rocks in County Durham.*

*(Photo 22) Crime Rigg Quarry, Sherburn Hill. Thick Yellow Sands beneath Raisby Formation and Marl Slate. DJD Lawrence, BGS, ©NERC, 2004.*