Early Permian environment and lithostratigraphy, Northern England

From Earthwise
Jump to navigation Jump to search

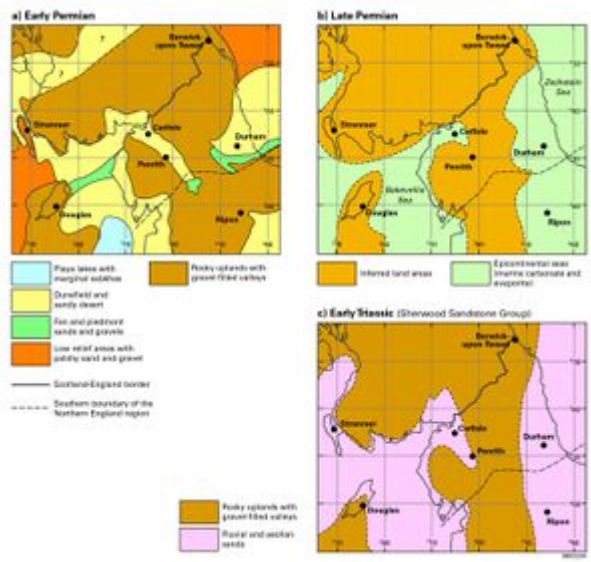
> **From: Stone, P, Millward, D, Young, B, Merritt, J W, Clarke, S M, McCormac, M and Lawrence, D J D. 2010. British regional geology: Northern England. Fifth edition. Keyworth, Nottingham: British Geological Survey.**

□

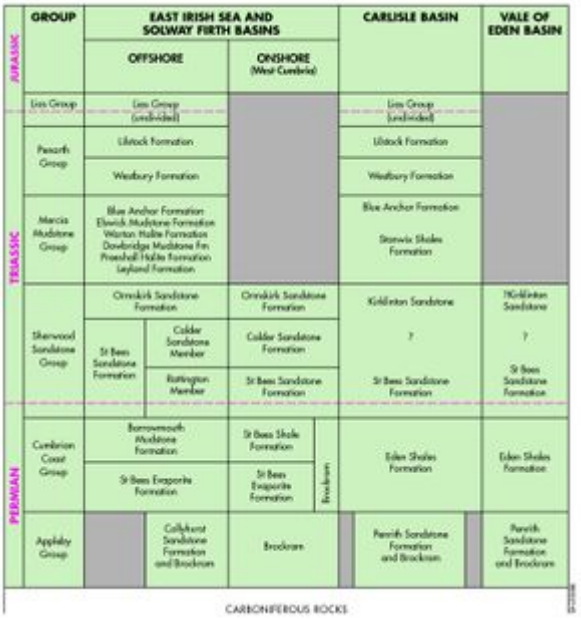
Contents

- 1 Introduction
  - 1.1 West of the Pennines: the Appleby Group
  - 1.2 East of the Pennines: the Rotliegendes Group
- 2 Bibliography

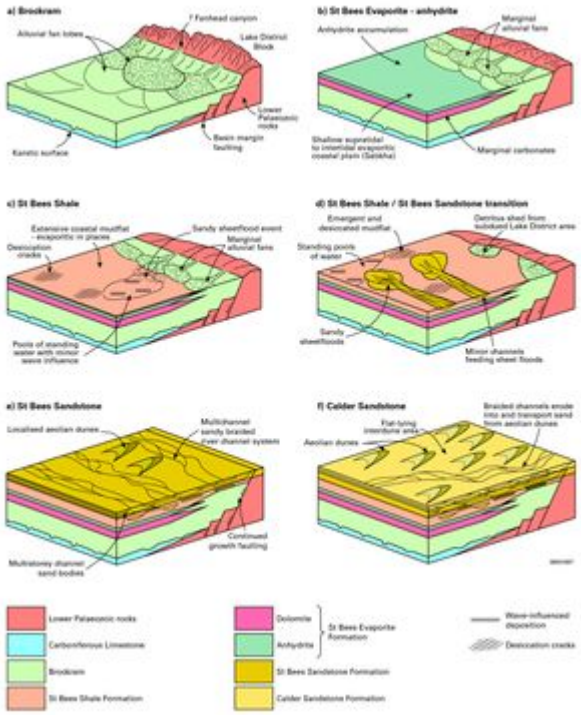
Introduction



Distribution of depositional environments across northern England during Permian and Triassic times (after Cope et al., 1992. Atlas of Palaeography and Lithofacies, Geological Society of London Memoir, No. 13). P916085.



Lithostratigraphical subdivision of the Permian, Triassic and Jurassic rocks of north-west England. P916115.



Cartoons illustrating the changes in depositional regime through Permian and Triassic times (after Akhurst et al., 1997. The geology of the west Cumbria district. BGS Memoir). P916086.

Lithostratigraphical subdivision of the Permian and Triassic rocks of north-east England. P916116.

Basal Permian unconformity near the bottom of the face in the disused (and now backfilled) East Thickly Quarry [NZ 2407 2565], County Durham. Thinly bedded dolostone of the Raisby Formation overlies the Marl Slate and Yellow Sands formations, the latter resting on thicker, cross-bedded sandstones of the Pennine Lower Coal Measures Formation. (P221601).

Old Quarrington Quarry, County Durham [NZ 338 377]. The Yellow Sands Formation, overlain by the Marl Slate Formation (here only about a metre thick) and thinly bedded dolostone of the Raisby Formation. (P548172).

In northern England, and in response to the Variscan Orogeny further south, compressive uplift of the Carboniferous basins continued from late Carboniferous times into early Permian times. As a consequence, the early part of the Permian Period saw considerable erosion and denudation of Carboniferous strata, culminating in a locally irregular, but regionally peneplanar, surface known today as the Permian Unconformity. Extensive oxidisation of pyrite and siderite within the exposed Carboniferous strata resulted in its ubiquitous reddening for several metres below the unconformity. Descriptions of 'brecciated' mudstone and porcellanous textures in old borehole journals from the coalfield areas may well indicate the presence of calcrete soils developed on the exhumed early Permian land surface. An upland area, approximately coincident with the present-day Pennines, separated lowlands to the east from those in the west.

West of the Pennines: the Appleby Group

To the west of the 'proto-Pennines', east–west orientated extension reactivated large fault structures in the underlying Carboniferous strata, generating a series of isolated rift basins that developed as major centres of Permian deposition. Thick aeolian dune fields (draa) developed within these basins, which were bounded by a low-lying, gently undulating topography cut across Carboniferous rocks. Thin deposits of aeolian sand accumulated in small hollows and depressions in this topography, some of which may have been karstic features in Dinantian limestones. The depressions were separated by broad, bare, rocky, desert surfaces (hamarda), probably with scattered stones coated in desert

varnish. Overlooking these low-lying areas were the uplands of southern Scotland, the Lake District and the Isle of Man. There, fluvial sandstones and breccias were deposited in canyons, whilst large alluvial outwash fans and flash-flood deposits spread out around the hills. The palaeogeography is summarised in (P916085)a.

The Penrith Sandstone Formation (P916115) contains the oldest Permian strata preserved in north-western England, and is of Guadalupian to Lopingian age. The base of the formation is characterised by alluvial fan and flash-flood breccias that collectively form the Brockram facies (P916086)a. These deposits comprise coarse, poorly bedded and poorly to moderately sorted breccias with angular clasts of granite, local Carboniferous and Lower Palaeozoic lithologies, and volcanic rocks from the Lake District. Where the Brockram facies is particularly thin and contains clasts coated in desert varnish, it may represent hamarda rather than flash-flood and alluvial fan deposits. The Brockram is only locally present at outcrop, but deposits up to 150 m thick are exposed in quarries in the Brough district, whilst substantial thicknesses have also been recorded in west and south Cumbria. Boreholes in the Irish Sea and at the north-east end of the Isle of Man have proved basal breccias to the Penrith Sandstone's equivalent there, the Collyhurst Sandstone Formation, that are thought to be lateral equivalents of the mainland Brockram (P916115).

Overlying and in places interfingering with the Brockram are the aeolian sandstones that comprise most of the Penrith Sandstone Formation. The deposition of these strata was strongly influenced by variations in pre-Permian topography with the major depositional centres being the intermontane basins of the East Irish Sea and the Vale of Eden. In the Vale of Eden, large sand dunes developed and are preserved at outcrop as red, fine- to coarse-grained, well-sorted, aeolian sandstone with strong cross-bedding. The orientation of the forsets implies a palaeowind direction from the east or south-east. Within these dominantly aeolian deposits are sporadic interbeds of fluvial sandstone that are thought to represent deposition in ephemeral wadis that cut the dune fields, and irregular units of bedded sandstone with sub-angular debris that are thought to represent deposition in interdune ponds.

In the East Irish Sea Basin and offshore around the Isle of Man, drilling has shown that, with the exception of the basal Brockram, the remainder of the Collyhurst Sandstone consists predominantly of aeolian dune deposits. In some areas, well-developed but sporadic mudstone and siltstone partings are present and are thought to represent deposition in a damp interdune or sabkha setting.

Elsewhere, in the Solway Firth and Carlisle basins, the Penrith Sandstone Formation is thinner. It has been proved by drilling in the Carlisle Basin to consist predominantly of red, fine- to very fine-grained sandstone of aeolian origin, with moderately rounded and sorted grains. Seismic data indicate that the Penrith Sandstone in the Carlisle Basin is not physically connected to the outcrop in the Vale of Eden. Nor is there any physical connection between either of these occurrences and lateral equivalents of the Penrith Sandstone to the north in the Dumfries Basin, or with localised occurrences around Canonbie. These spatially separated occurrences of aeolian sandstone suggest that they originated as distinct dune fields that accumulated in small basins separated by higher ground.

East of the Pennines: the Rotliegendes Group

To the east of the 'proto-Pennines', the Permian Unconformity dipped gently eastwards beneath the developing North Sea Basin and was bounded by higher ground to the north, south and the west. Strong winds swept across the barren, rocky desert landscape carrying with them abrasive sand particles and scattering small pebbles of resistant lithologies. Ephemeral sheet floods redistributed some of the pebble deposits over the barren rock and into wadi channels between large migrating belts of sand dunes. The rocks deposited in this environment form the Yellow Sands Formation, the

oldest Permian strata preserved in north-eastern England (P916116). They cover some two-thirds of the Permian Unconformity in that area and are believed to be of comparable age to the Penrith Sandstone Formation of north-west England.

The Yellow Sands Formation consists of weakly consolidated sand, sandstone and breccia. In the north-west of the outcrop most of the formation consists of unconsolidated sand but, to the south-east, breccia and sandstone dominate, with only the upper part of the formation consisting of sand. At outcrop, the Yellow Sands Formation consists entirely of weakly consolidated yellow sand (from which it derives its name) whereas the breccia and sandstone components do not form significant outcrops and are known mainly from boreholes and shafts. Quarrying activities at Eldon Hill, Middridge and East Thickley, all near Bishop Auckland in County Durham, formerly exposed the Permian Unconformity and the basal breccias and sandstone (P221601), but these quarries are now backfilled and the exposures are obscured.

The dominant lithology in the Yellow Sands Formation is an unconsolidated, coarse-grained, siliceous sand containing much pyrite. The yellow colour results from the oxidisation of the pyrite to limonite. In the subsurface, below the oxidised zone, the pyrite is fresh and accordingly the sands are predominantly grey in colour. The individual sand grains are frosted and well rounded and have the classic ‘millet seed’ appearance characteristic of aeolian transport. The thickness of the unconsolidated sand is highly variable. In general terms it appears to form up to eight east-north-east-trending discontinuous belts of aeolian dunes, each 1.5–3.5 km wide and separated by corridors averaging 1 km wide in which the sand is thin or absent. This pattern is modified locally such that in places the cross-bedded dune ridges have thick sand deposits between them (P548172). The primary shape of many of the ridges has been considerably modified by subsequent late Permian events.

The breccias contain rock fragments up to 8 cm long embedded either in a matrix of smaller rock fragments and sand, or entirely in sandstone. The fragments are angular to subangular and consist predominantly of locally derived Carboniferous limestone with some fragments of mudstone and sandstone derived from the Carboniferous Coal Measures. Bluish-grey, hard, well-cemented sandstone is often interbedded with the breccias and contains small pebbles of quartz or, more commonly, fragments of sandstone, siltstone and mudstone. The thickness of the breccia–sandstone association in boreholes is commonly about 60 cm but it is highly variable and can range from as little as a few centimetres up to 15 m. Where the breccia–sandstone association is thin, many of the rock fragments are coated in desert varnish. It is probable that the association was deposited in an arid environment on a desert rock pavement and was partially redistributed by ephemeral sheet floods. Some watercourses may have cut into the Permian Unconformity, as suggested by an exposure on the Durham motorway (A1M) at Cleasby, where 1m of breccia is exposed filling a channel-like hollow in the unconformity surface. Sporadic bands of dolomitic mudstone noted within the breccias in some boreholes probably indicate deposition in temporary ponds associated with flooding events.

Bibliography

Barnes, R P, Ambrose, K, Holliday, D W, and Jones, N S. 1994. Lithostratigraphical subdivision of the Triassic Sherwood Sandstone Group in west Cumbria. *Proceedings of the Yorkshire Geological Society*, Vol. 50, 51–60.

Benton, M J, Cook, E, and Turner, P. 2002. Permian and Triassic red beds and the Penarth Group of Great Britain. *Geological Conservation Review*, No. 24. (Peterborough: Joint Nature Conservation Committee.)

Brookfield, M E. 2004. The enigma of fine-grained alluvial basin fills: the Permo-Triassic (Cumbrian

Coastal and Sherwood Sandstone Groups) of the Solway Basin, NW England and SW Scotland. *International Journal of Earth Sciences*, Vol. 93, 282–296.

Holliday, D W, Holloway, S, McMillan, A A, Jones, N S, Warrington, G, and Akhurst, M C. 2004. The evolution of the Carlisle Basin, NW England and SW Scotland. *Proceedings of the Yorkshire Geological Society*, Vol. 55, 1–19.

Holliday, D W, Jones, N J, and McMillan, A A. 2008. Lithostratigraphical subdivision of the Sherwood Sandstone Group (Triassic) of the north-eastern part of the Carlisle Basin, Cumbria and Dumfries and Galloway, UK. *Scottish Journal of Geology*, Vol. 44, 97–110.

Ivimey-Cook, H C, Warrington, G, Worley, N E, Holloway, S, and Young, B. 1995. Rocks of Late Triassic and Early Jurassic age in the Carlisle basin Cumbria (north-west England). *Proceedings of the Yorkshire Geological Society*, Vol. 50, 305–316.

Jackson, D I, and Johnson, H. 1996. *Lithostratigraphic nomenclature of the Triassic, Permian and Carboniferous of the UK offshore East Irish Sea Basin*. (Nottingham: British Geological Survey for the United Kingdom Offshore Operators Association.)

Jones, N S, and Ambrose, K. 1994. Triassic sandy braidplain and aeolian sedimentation in the Sherwood Sandstone Group of the Sellafield area, west Cumbria. *Proceedings of the Yorkshire Geological Society*, Vol. 50, 61–76.

Smith, D B. 1989. The late Permian palaeogeography of north-east England. *Proceedings of the Yorkshire Geological Society*, Vol. 47, 285–312.

Smith, D B. 1995. Marine Permian of England. *Geological Conservation Review*, No. 8. (Peterborough: Joint Nature Conservation Committee.)

Tucker, M E. 1991. Sequence stratigraphy of carbonate–evaporite basins; models and applications to the Upper Permian (Zechstein) of northeast England and adjoining North Sea. *Journal of the Geological Society of London*, Vol. 148, 1019–1036.

Worley, N E. 2005. The occurrence of halite in the Permian A Bed Evaporite, Kirkby Thore, Cumbria. *Proceedings of the Yorkshire Geological Society*, Vol. 55, 199–203.

- Request account

Namespaces

- Page
- Discussion

☐

Variants

Views

- Read
- Edit
- View history
- PDF Export

☐

More

Search

Search Go

Navigation

- Main page
- Recent changes
- Random page
- Help about MediaWiki

Tools

- What links here
- Related changes
- Special pages
- Permanent link
- Page information
- Cite this page
- Browse properties

- This page was last modified on 5 May 2016, at 16:34.

- Privacy policy
- About Earthwise
- Disclaimers

- 
British
Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
- 
Powered By
MediaWiki
Semantic
MediaWiki