EXMOOR NATIONAL PARK

GEOLOGY ON EXMOOR

filex5

Photograph - ENPA

FILEX 5 is concerned with the Earth Science of Exmoor. It explains the underlying structure of sedimentary rocks and explains how and when this developed. There is a geological map, a cross-section, a table of local rocks and fossils with suggestions of sites for study and a useful glossary.

Words marked with an * are in the glossary. A section on minerals indicates the National Park's approach to potential mining or quarrying.

Access to beaches needs special care and preparation:

- The tidal range is considerable and tides come in rapidly: always make sure that there is an exit route from the beach.
- Cliff faces can be dangerously steep and loose: keep to recognised paths.
- Take local advice on routes and tide conditions.

Geology and the landscape

There are wonderful panoramic views from the high moorland and pastures of Exmoor. The hills are smooth, level-topped and often elongated to form ridges running approximately south east - north west. The ridges follow the alignment of the rocks underneath.

There is little rock exposure in the uplands. Quarries, scrapes and mines, originally dug to obtain local stone for building, lime or ore, are now overgrown or filled in. In contrast the dramatic beauty of the coast owes much to the variety of exposed rock types. There are magnificent cliff exposures between Minehead and Baggy Point that make it possible for a cross-section of all the *strata to be sampled.

Ripple-marked sandstones,Valley of Rocks. Photograph - Brian Pearce

Burrows Farm engine house. Photograph - Brian Pearce

The strata are divided into named rock groups according to their main rock type and fossil content. The names of the main groups are made up of the rock and a place where they can be studied, e.g. Morte Slates. Variations in the hardness of rock are picked out by the sea. The prominent headland of Hurlstone Point and Culbone cliffs are good examples. The headland and cliffs are made up of harder rock than Porlock Bay.

Porlock beach - Heather Lowther (ENPA)

Geological history

Sedimentary rocks of the Devonian *system lie under most of Exmoor. The name 'Devonian' refers to the fact that the rocks are common and accessible in Devon. It is also used to name rocks found elsewhere but formed at the same time i.e. between about 410 and 360 million years ago, the Devonian *Period.

Most of the rocks were deposited as layer on layer of mud or sand in the shallow waters of seas, lakes or river deltas, although some were formed from desert sands. These layers gradually hardened into rocks and were later squeezed between two colliding *crustal plates, one to the north and the other to the south. The intense pressure folded the rocks across the West Country into an east-west arch-like fold (anticline) and trough (syncline) within which were lots of smaller folds. The crest of the arch lies close to the coast of Exmoor but has been eroded to the west where the Bristol Channel now lies. The oldest rocks can be seen in the Valley of Rocks in the eroded core of the anticline along the northern side of the moor. Progressively younger layers become exposed towards the southern edge.

Small patches of other rocks, once more extensive, have survived erosion. In the Vale of Porlock and down the eastern edge of the exposed Devonian rocks there are some red, stony, sandy and silty sediments with no fossils. The larger fragments in these New Red Sandstone rocks are broken down pieces of Devonian rock. This shows that the New Red Sandstone sequence was formed after, and from the erosion of, the rocks of Devonian times. Their general nature suggests that the erosion took place on land in desert-like conditions.

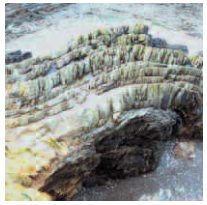
After this period when the area was dry land, about 290 to 210 million years ago, the sea once again invaded at least part of the area, for rocks of Jurassic age (210 to 145 million years ago), with many marine fossils, are preserved near Selworthy and further east.

*Unconsolidated, surface deposits are widespread and of much more recent date. One of these relates to the last Ice Age when ice-sheets were probably pressed against the West Somerset and North Devon coasts. Usually the ground would have been frozen but during times of thaw at least a surface layer melted and large quantities of frost-shattered rock fragments slid down-slope in a muddy *matrix to form an unsorted deposit on the lower valley sides.

These deposits are known as 'Head'. River-laid *alluvium covers the floors of some valley bottoms while blown sand forms Braunton Burrows and peat is found on some of the high moors.

The Rocks of Exmoor summary (page 5) incorporates some of the evidence on which the geological history of Exmoor (overleaf) is based, i.e. the sequence of sedimentary strata and their environments of deposition.

Chondrites - a trace fossil

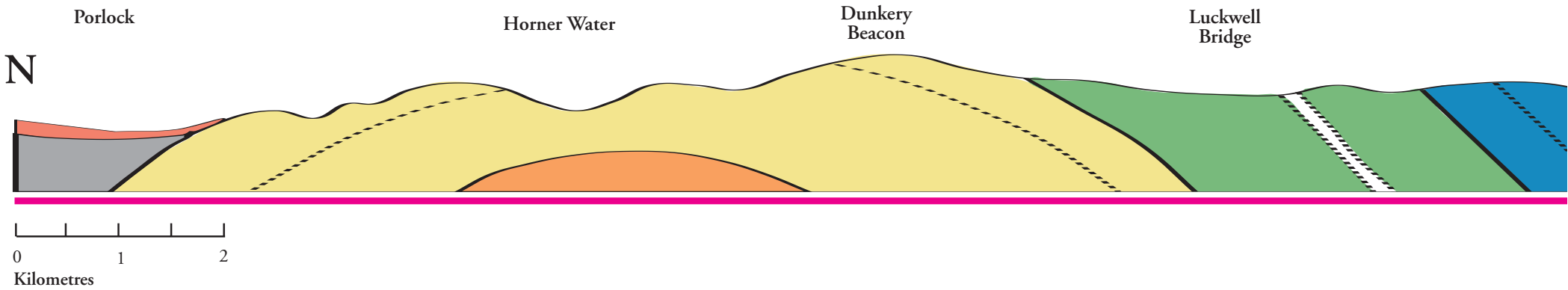


Folding at Combe Martin

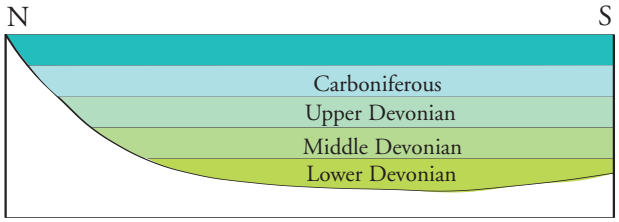
Small fault at Combe Martin

Photographs - Brian pearce

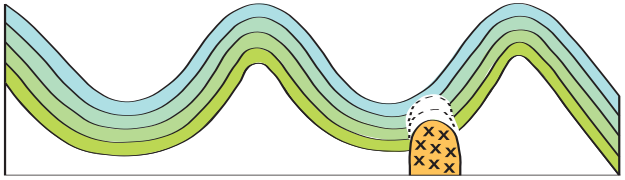
Geological cross-section of Exmoor (see page 4)



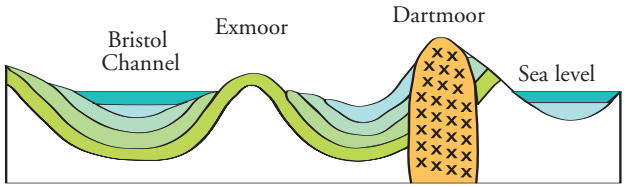
Simplified cross section of West Country showing geological history



1 Sediments laid in sea on the continental shelf.



2 The southern continental plate pushed northwards and under the northern plate, folding sediments and uplifting them. Its rocks melted at depth and rose to become the granite of Dartmoor.



3 Land submerged again, new rocks laid on sea bed. Land uplifted again and erosion revealed granite of Dartmoor and older rocks of Exmoor.

Environment

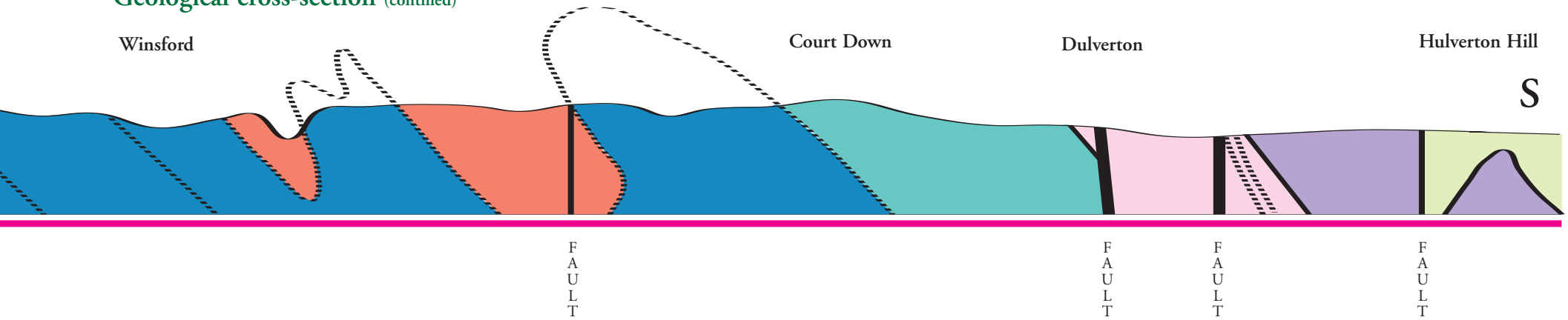
The nature of the sediments and their fossil content help us to work out what the conditions were like when the sediments were laid down. In particular, in water, coarser sediments settle out before finer ones. They are therefore found beneath or closer to land than the finer ones. Fossils are most likely to occur and be preserved in sediments formed in water rather than on land. Because corals live in clear water their presence in local limestones suggests that they grew far from the rivers that brought sediments into the sea.

Sequence

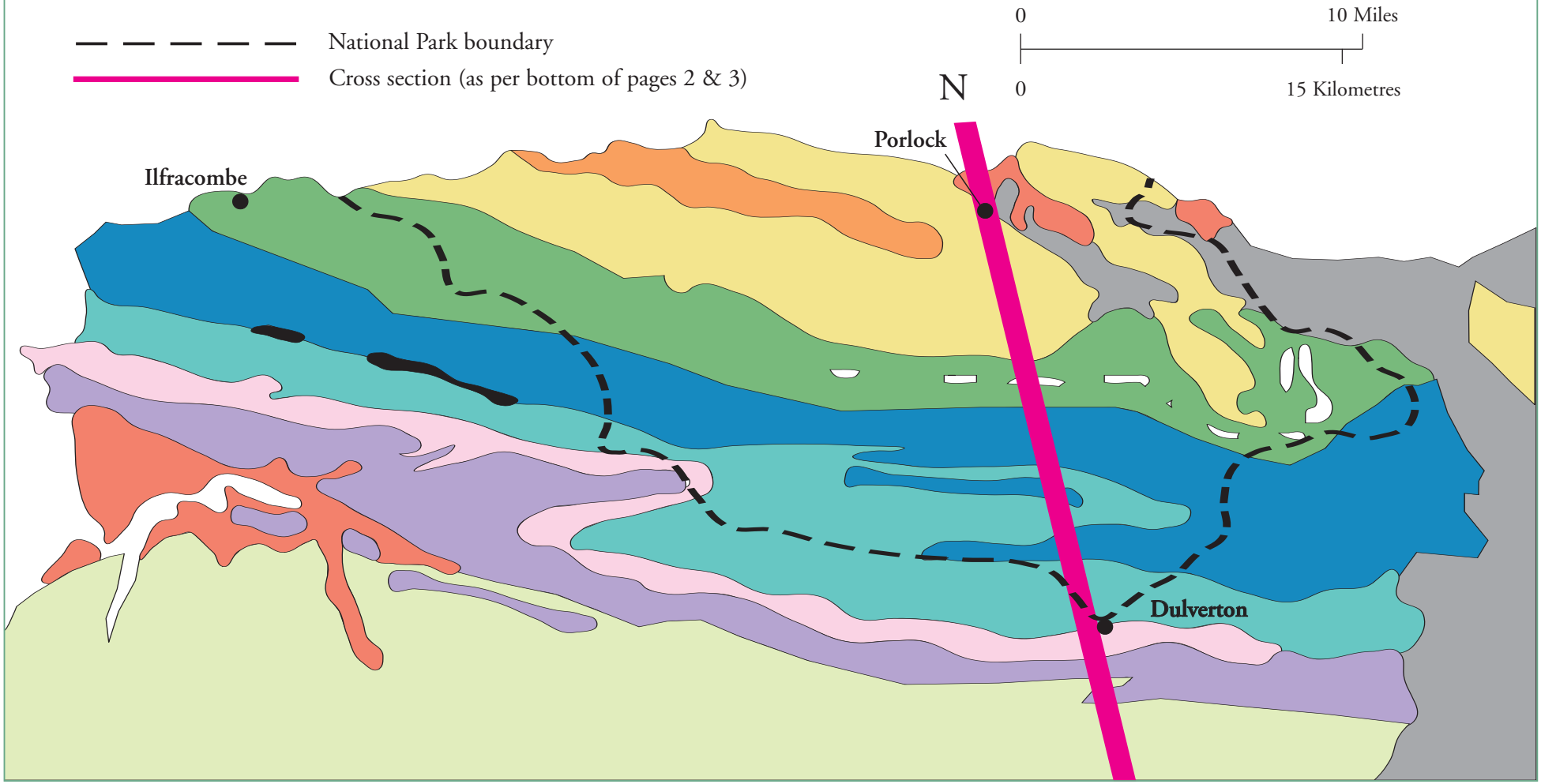
As might be expected, newer rock layers normally lie on top of older, and the rock key is arranged on this basic principle. However working this out was complicated towards the southern margin of the area because the strata are folded quite severely, as indicated on the cross-section. The northwards overturning of the folds and their decreasing severity in the same direction shows that the dominant folding push came from the south. As rocks of Carboniferous age are also included in the folding but not the New Red Sandstone (Permo-Triassic) strata, the movements are dated at about 300 million years ago.

The collision of the two crustal plates already referred to is thought to be responsible and explains why the older rocks lie in east-west bands across the area. Recognised changes in the sequence of fossilised life-forms also help to order the rock layers by age. There are some difficulties locally because fossils are generally infrequent and often distorted by the folding. The sandstones and limestones were changed little by the pressures of the earth movements but shales were hardened into slates with planes of weakness, known as cleavage, along which they tend to split.

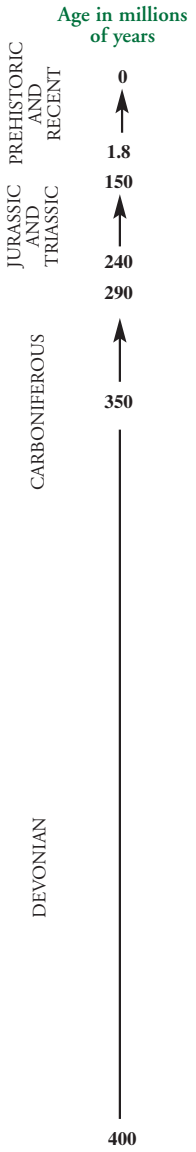
Geological cross-section (contined)



Geological map of Exmoor region



Rocks of Exmoor and the surrounding area



Rock groups	Map Key	Main rock types	Comments
Upper Head, Fremington boulder clay, and Lower Head		Peat, alluvium, brown sand, head and boulder clay	Mainly peat, head and screes on Exmoor, sand and clays around Barnstaple Bay. Raised beaches and sands contain fossil shells. Peat contains fossil plant remains, including pollen.
Lower Lias, Watchet and Langport Beds, Cotham Beds, Westbury Beds, Sully Beds, Tea Green and Grey Marls, Keuper Marl, Upper Sandstone and Pebble Beds		Shales, limestones, sandstones, marls and conglomerates	Red sandstones, conglomerates, breccias and grey jurassic shales very fossiliferous, with ammonites. Fine sediments deposited in shallow seas/lagoons, coarse sediments from rivers and screes.
Culm Measures		Sandstones, limestones, shales and cherts	Mainly purple sandstones. Some plant and fish fossils and thin coal seams. River delta and coastal lagoon deposits.
Pilton Beds		Slates, limestones and sandstones	Contain fossil shells and trilobites, often poorly preserved. Sandstones current-bedded. Shallow water marine deposits.
Baggy and Marwood Beds		Sandstones, siltstones, slates and limestone	Evidence of wave action and *bioturbation in sandstones. Plant fossils found at a few inland locations. River delta and lagoonal deposits.
Pickwell Down Beds		Sandstones and shales *Tuff	Sandstones purple, brown and green. *Basal volcanic ash has yielded fragments of armoured fish. River mouth deposits.
Morte Slates		Slates	Smooth grey or purple slates; some thin sandstone. Fossil shells infrequent and poorly preserved. Deposited in shallow sea.
Ilfracombe Beds		Sandstones and slates Limestone	Mainly grey slates. Fossil corals and crinoids in the limestones. Deposited in shallow sea.
Hangman Grits		Sandstones	Grey, purple and green sandstones, ripple-marked and channelled. Occasional shell and plant fossils. Deltaic and desert deposits.
Lynton Beds		Slates and sandstones	Dark blue-grey slates. Sandstones, ripple-marked and *bioturbated. Few fossil shells and *moulds. Deposited in shallow sea, becoming shallower.

Mining

No mining is carried out in the National Park area at the moment but remains of old workings can be seen in many places.

'Investigations have proved the existence of a series of parallel *lodes running approximately E-W. The *dip of the lodes varies from 40° to 60° South, and various experts' estimates have computed the volumes of ore at many millions of tons. Shafts have proved the existence of continuous *lenticular lodes of high quality *haematite ore'.

This 1909 'Description of the Brendon Hills Iron Ore Mines' given to the South Wales Institute of Engineers indicates the general arrangement of the mineral-bearing lodes of the Exmoor area which clearly follow the geological structure. They extend from the Brendon Hills to south west of Simonsbath. Unfortunately the iron ore was not in continuous seams but in lens-shaped masses connected by clay or quartz-filled fissures.

At Timwood mine on the Brendon Hills

The main period of their exploitation was in the second half of the 19th century, with a maximum annual output of 46,000 tons from the Brendon Hill Mines in 1877. Some remaining structures together with old photographs give an idea of what the mines and the mineral railway built to serve them were like.

Mines near North Molton yielded copper as well as iron ores, with smaller amounts of the ores of lead, zinc, antimony, manganese - and gold! These minerals entered the Exmoor rocks about 300 million years ago following an upthrust of molten rock caused by the collision of the crustal plates. They crystallised from hot vapours or solutions pushed out of the main mass of molten rock which cooled to form the granites of Dartmoor and Cornwall.

Silver-lead workings at Combe Martin are recorded from the 13th century when Edward I's daughter, Eleanor, received a dowry of 270 lbs of Combe Martin silver. In the reign of Elizabeth I a new, highly profitable, silver lode was worked and in the 19th century several brooches of Combe Martin silver were bought by Queen Victoria.

Although most of the mining activity finished towards the end of the century as workings became uneconomical, occasional operations on the Brendons didn't end until 1910. Renewed investigations during the First and Second World Wars proved to be of no long term economic value.

In 1954 Exmoor became a National Park. Any new attempts at mining would be resisted by the National Park Authority because of possible ill-effects on the beauty of the scenery and on noise, traffic and pollution levels. However exploration for minerals has continued, particularly in the North Molton and Combe Martin areas, and uranium has been discovered near Simonsbath. There has been concern about the possibility of pollution from potential oil exploration in the Bristol Channel.

Glossary

Alluvium	loose material (usually fine-grained) laid down by a river
Basal	at the base or beginning of a sequence of rocks
Bioturbation	disturbance of soft sediment by burrowing creatures
Crustal plates	huge parts of the earth's crust which are continually moving very slowly
Dip	angle made to the horizontal by a bedding plane
Haematite	a mineral ore of iron (Iron Oxide, Fe2 O3)
Lenticular	shaped like a biconvex lens or a flattened egg-shape
Lode	a sheet-like body of minerals (especially metallic ores)
Matrix	the fine-grained material within which something is embedded
Mould	impression (of fossils)
Period	a major sub-division of geological time
Strata	set of successive layers of rock
System	a group of rock layers related in time and characteristics
Trace fossil	fossil of track, burrow or deposit from an organism but not of the organism itself
Tuff	rock consisting of dust from a volcanic eruption
Unconsolidated	not hardened