

An Overview of the Geology of Britain

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The very creation of Britain as an island is a fascinating story in itself resulting from hundreds of millions of years of tectonic activity wherein land masses collided and split apart again as they moved across the surface of the globe in their tectonic ballet. Even since Precambrian times, which ended 542 million years ago, the various land masses have been pirouetting across the globe with areas which are now oceans variously covered by land and vice versa. The history of the Earth of course reaches much further back to 4,600 million years ago, but if we documented the various tectonic events just since the Precambrian period, we should have an interesting list. If just one of these events had been different, if a moving land mass had altered its course by just a few degrees, if a continental split had occurred at a slightly different position, if the timings had been slightly desynchronised, then Britain as we know it may not have been created at all. Even much later on, if ice ages, glaciations and subsequent melts had not contrived to form the North Sea and the English Channel, then there would be no Britain as a separate entity. The very existence of Britain is as a result of random tectonic and climatic activity. Consequently, Britain owes its existence as an island as much to chance as anything else. And yet, this island embodies a pocket history of much of the aforementioned activity, nicely wrapped and presented in a beautiful little package. It is indeed an island gem.

Due to the aforementioned tectonic ballet, our island gem contains remnants from land masses we now know as North America and Europe as well as oceanic and arid desert environments which were once situated in the tropics. These have all been jumbled together and fashioned by successive glaciations to produce our current distinctive land form. As a consequence, we are blessed with a rich variety of geology within a very small land mass. Similarly, a broad time period is

represented, with Proterozoic rocks of between 1,500 and 3,000 million years of age sharing the island with much younger sediments from the Palaeogene less than 60 million years of age. This diversity is readily apparent as one journeys around Britain, as has been discovered during the preparation of this book. This section provides a brief overview, with the following sections providing a greater level of detail for specific areas of interest.

If we start in East Anglia and work our way clockwise around Britain we shall discover much of this interesting geological variation. On the eastern coasts of Norfolk, Suffolk and Essex, the geology is quite young with the sedimentary layers being deposited primarily within the Palaeogene period, less than 65 million years ago. This strata sweeps along the northern shores of the Thames Estuary and extends westwards well past London. It exists of shales, mudstones, sandstones, clays and of course chalk. Combinations and variations of these may be found throughout the area, with the chalk exposed at certain sites and clays and gravels at others. The coastlines tend to be relatively soft and vulnerable, especially the eastern Norfolk coast whose cliffs of soft sandstones and mudstones are easily eroded giving cause for concern, especially with the spectre of future rises in sea level to consider.

On the northernmost Norfolk coast, as one looks towards Hunstanton, we find strata from the Cretaceous period laid down between 65 and 142 million years ago. These include sandstones and mudstones and the distinctive red chalk to be found within the Hunstanton cliffs. This Cretaceous swathe extends in a south westerly direction down to the south coast where it skirts above the coastline adjacent to the Isle of Wight and briefly touches the Dorset coast. From here it also extends eastward to cover Sussex and most of Kent,

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excluding the north Kent coastline which displays later strata. The southern part of this coastline includes the distinctive white cliffs of Dover and those of the Seven Sisters further to the west. These beautiful cliffs actually consist of many layers, often separated visually by thin seams of flint nodules, spaced fairly regularly upon the exposed cliff faces. These cliffs are also subject to erosion and one can often find sizeable chunks of the chalk which have been detached from the main cliff and are being slowly eroded by wave action. This south eastern section of the south coast nonetheless provides some interesting variation, including pebble and shingle beaches and a range of habitats atop the cliffs as one looks inland.

Moving westwards along the south coast we enter the what has become known as the Jurassic Coast, with mudstones, sandstones and limestones laid down during the Jurassic period between 142 and 205 million years

ago. At Lyme Regis the beautiful limestone pavements and associated features have long attracted fossil hunters as this area has produced some of the most significant fossils from the period. Ammonites and fossil remains of small marine creatures are to be found in abundance. Unfortunately, the adjacent cliffs are somewhat unstable and the area has been prone to mudslides and partial cliff collapse. Most recently, this activity has obscured certain parts of the beach where fossils were readily found. It is almost as though nature, having once presented us with such rich finds, is now burying them once again. On the Dorset coast, we find several well formed bays and some interesting features such as Durdle Door, where the waves have etched a beautiful archway into the limestone finger protruding out to sea. Within the adjacent bays to the east of Durdle Door, one can find similar fingers of rock stretching out to sea at low tide. The bays themselves have



Fig. 1 The chalk cliffs meet the sea at Seven Sisters

some very interesting formations of limestone and sandstone, occasionally exhibiting some distinct folding and extreme angles of stratification. Clearly there has been some dramatic underlying geological activity to form the coastline we see today. The swathe of Jurassic strata extends from the south coast in a north easterly direction to The Wash, skirting around the Cretaceous strata at the coast around Hull, before appearing again briefly in Yorkshire. In so doing, it cuts right across the lower Midlands.

As we move further westward to the Devonshire coast we find strata from the Devonian period between 354 and 417 million years of age, considerably older than the Cretaceous rocks found further east. These are mostly sandstones and mudstones which occasionally exhibit a striking visual appearance with some beautiful burnt orange and red sandstone cliffs, such as those found at Exmouth

and Sidmouth, contrasting against the hues of the adjacent sea. While relatively soft in composition, these cliffs seem to be rather more durable than those further along the coast to the east. They also exhibit some distinctive layering in places which simply adds to the beauty of this coastline. An interesting exception may be found at Beer, where the coastal rocks are composed of chalk and gleam white in the morning sun. On the adjacent beaches there are many variations of pebble and sand to be found including, at Budleigh Salterton, the particularly distinctive large dense pebbles which characterise the beach at that point. These pebbles, unlike any others found on the south coast, are composed of a hard quartzite material, similar to that of the Brittany rocks which are around 440 million years of age. Speaking of pebbles, those at Chesil beach, further eastward on the Dorset coast, reach out to sea towards Portland in a



Fig. 2 The soft sandstone cliffs at Happisburgh on the Norfolk coast

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long spit well over 20 kilometres in length which serves to protect the largest tidal lagoon in Britain. The Fleet lagoon forms a natural nature reserve within which many species thrive and are effectively protected by the pebble spit of Chesil beach.

There are so many interesting features along this stretch of coastline. Kimmeridge gives its name to a distinctive Jurassic clay which may be found within the bay. The clay is interspersed with limestone and there are some interesting limestone pavements and spits reaching out to sea which render Kimmeridge Bay a most interesting spot for those wishing to observe marine life in the shallows. The rocks are particularly distinctive with yellows, browns, greys and some very dark mudstones providing a colourful spectacle, interspersed by some equally interesting pebbles and overseen by the Kimmeridge cliffs with their distinctive layering of large swathes of Kimmeridge

clay. The area contrasts notably with that further along to the west.

Inland from the south Devonshire coastline we find the distinctive granite intrusion which is Dartmoor. Dartmoor rises up from the surrounding area in a beautiful gently undulating plateau which is broken through in many places by the granite tors. These tors range in both size and texture, some like Haytor, becoming a favourite with rock climbers anxious to practice their skills upon these small scale 'mountains'. A little further north, Houndtor presents a subtly different picture with the granite appearing more rugged and twisted as though having taken a tortuous path before finally breaking free at the surface. Each of the Dartmoor tors has its own special character however and indeed, the granite can assume a quite different appearance at various places across the moors. Often, in the riverbeds for example, the granite may be interspersed with calcite



Fig. 3 Extreme stratification and folding of the sedimentary rocks at Durdle Door

seams with individual rocks becoming particularly colourful and distinctive. This granite underpinning provides for the ideal moorland environment, supporting the moisture upon which sphagnum mosses and a variety of flora thrive. In places, particularly to the north east of the moors, peat bogs are also to be found which can make travel on foot a little precarious. The Dartmoor granite is part of a larger granite sub-system which is also evident further along the coast at Lands End in Cornwall.

Moving further west we come to the Cornish coast with its picturesque bays and cliffs founded predominantly upon rocks from the Devonian period between 354 and 417 million years of age. These include sandstones, siltstones and a great deal of slate. Part of the Variscan geological strata which runs south to Brittany and across Europe, there is much evidence of compression and folding to be found within these rocks. In addition, there

are the aforementioned granite intrusions which surface in several places, all of which serve to remind us of the dynamic processes involved in the creation of this landscape. Cornwall of course has been relatively mineral rich and mining for a variety of ores has been undertaken in the area for literally thousands of years, intensifying in the nineteenth and early twentieth centuries. The varied geology of the area has also attracted geologists with the Royal Geological Society of Cornwall established in 1814 in response to this interest. One of the areas which would have undoubtedly appealed to them is The Lizard. With its fingers of hard serpentine rock stretching out to sea it is not only the southernmost point in Britain but also a good example of an ophiolite, whereby a section of oceanic crust has been uplifted and exposed as continental crust.

As we round The Lizard and work our way around the coastline we come to Lands End,



Fig. 4 The beautiful red sandstone at Sidmouth on the south Devon coast

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where the hard Cornish granite is surfaced in a spectacular and rugged manner. From here we can explore the north Cornwall coastline with its bays and sandy beaches as it reaches up to the north Devon coast with its high cliffs which often exhibit some intense folding, as may be clearly seen at Hartland Quay where the rocks adopt a concertina like form in several places. Moving north along this coastline we shall also encounter younger rocks from the Carboniferous period laid down between 290 and 354 million years ago. However, moving back inland we encounter Exmoor with its gently rolling hills which are formed upon an anticline of Devonian strata with the associated syncline dipping down northwards into the Bristol Channel. Exmoor supports both woodlands and moorlands, providing a range of natural habitats within its boundaries. Across Somerset we encounter younger rocks from the Triassic and Jurassic periods as we move

up the Bristol Channel and continue our journey into South Wales.

The Brecon Beacons and surrounding area offer some interesting contrasts and show us that, as we head north, the geology is changing somewhat. Much of the area consists of Devonian sandstones, siltstones and mudstones including the distinctive 'old red sandstone' to be found across much of the area. However there are older rocks from the Silurian period, around 417–443 million years of age, and some strata from the Ordovician period from around 443–495 million years ago. The area also shows evidence of some severe faulting and folding among the rocks, with the faults extending in a northeastward direction right across the area. As we head westward we have the Gower peninsula to the south with its sandy beaches and interesting sedimentary strata and Pembrokeshire before us with its equally interesting coastline and cliffs of Carboniferous limestone. The



Fig. 5 The exposed granite of Haytor on Dartmoor

Pembrokeshire cliffs are notable for their erosional patterns and textures, including blow-holes, caves, arches and other features cast into these 300 million year old rocks as a consequence of weathering and marine erosion. Indeed, when the weather turns on this coastline, the combination of rain, high winds and wave action constitutes a force to be reckoned with and its effects may be readily seen in places where active erosion is under way. The combination of Carboniferous rocks and the associated folding and compression processes have exposed seams of coal in both north and south Wales, but it is the southern coalfields in particular which played a significant part in the Industrial Revolution. In fact, the earliest reference to coalmining in the Pembrokeshire area goes back to 1324 and since this time the process of extracting coal has been steadily developed, although the mines are now mostly silent. The southern coalfield extended for nearly 90 miles across southern Wales and it

is not surprising that coal mining has played such a significant part in the affected communities over the years.

Moving up into north Wales, and we find an increasingly dramatic landscape dominated somewhat by the mountains of Snowdonia but with an interesting diversity across the entire area. North Wales constitutes an interesting collection of uplifted sediments, volcanic rocks, coal seams and of course slate, which has played a significant part in the industrial history of the area. There are some ancient rocks here from the Cambrian period between 495 and 545 million years of age as well as younger Ordovician and Carboniferous strata. Indeed, the very name Cambria is derived from the Roman name for Wales. The volcanic rocks have served to shape some distinctive features on Snowdon, Cadair Idris and other peaks, providing Snowdonia with a character of its own. There are many other geological features to be found within the



Fig. 6 Waters flowing through the limestone at Aira Force in the Lake District

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area, including the Harlech Dome of Cambrian strata between Snowdon and Cadair Idris and much evidence of glacial activity which has helped to shape the north Wales we are familiar with today. A journey along the Miners Path and up to the top of Snowdon unveils many of these features, including lakes and a variety of exposed sedimentary strata as well as volcanic rock on the mountain itself. To the north west of Snowdonia lies the isle of Anglesey where some of the oldest rocks in Britain may be found, dating from the late Precambrian, early Cambrian periods between 500 and 700 million years of age. In fact, Anglesey is something of a geological mixed bag as there are a variety of interesting rocks and associated strata to be found here with evidence of fairly intense folding and compression in places. The compositions of many of the sandstones and siltstones suggest that they are turbidites, originally laid down within turbulent underwater currents and conse-

quently containing a good deal of coarse grained mixed debris. There are also quartzites and metamorphic rocks, including some which suggest an origin of undersea lava flows. The island also has limestones and a central outcrop of intrusive granite making the area particularly interesting from a geological perspective and, indeed, the island has attracted geologists since the early nineteenth century due to this interesting diversity of structures.

Across from north Wales moving inland and slightly northward we find the Peak District in Derbyshire which sits at the southern end of the Pennine hills which run like a backbone up through northern England. The southern part of the Peak District, often described as the White Peak, is limestone country with Carboniferous deposits originally laid down around 325–350 million years ago to be found, together with a good deal of quarrying activity. The northern part of the Peak District,



Fig. 7 Erratics left at High Tove in the Lake District

often described as the Dark Peak, features younger sandstones and shales overlain upon the limestone. These are the rocks exposed at the surface. However, boring activity has shown that there are lower strata of Devonian and even Ordovician origin dating back to between 350 and 495 million years ago and rocks of volcanic origin have also been found. Thus the Peak District is an interesting example of composite layers from a broad time period. Much of the landscape is moor-like with plateaus and gently rolling hills interspersed with outcrops of limestone and gritstone. There are many caves and caverns to be found within the White Peak area and minerals, especially lead, have been mined here since Roman times. Throughout the sixteenth and seventeenth centuries, millstones were also shipped throughout the country from the Peak District. It is a fascinating area of Britain, full of interesting geological features and associated history.

Continuing our journey northward and now moving back towards the west, we enter the Lake District, a wonderful example of a landscape sculpted by glacial action, beneath which lays an interesting geology. The Lake District embodies a curious combination of volcanic rock, slate, limestones, sandstones, mudstones and even granite intrusions, mixed together and garnished with, of course, a selection of beautiful lakes and tarns courtesy of the glaciations which forged through this area, scouring the softer rocks between the volcanic peaks. Some of these rocks have their origin in the Ordovician period between 443 and 495 million years ago and the combination of ancient volcanic and sedimentary rocks are to be found throughout the fells and valleys of this picturesque area. The three main groups of rocks form something of an incredibly thick sandwich with the earliest being the Skiddaw group of sedimentary rocks, overlain by the Borrowdale and Eycott

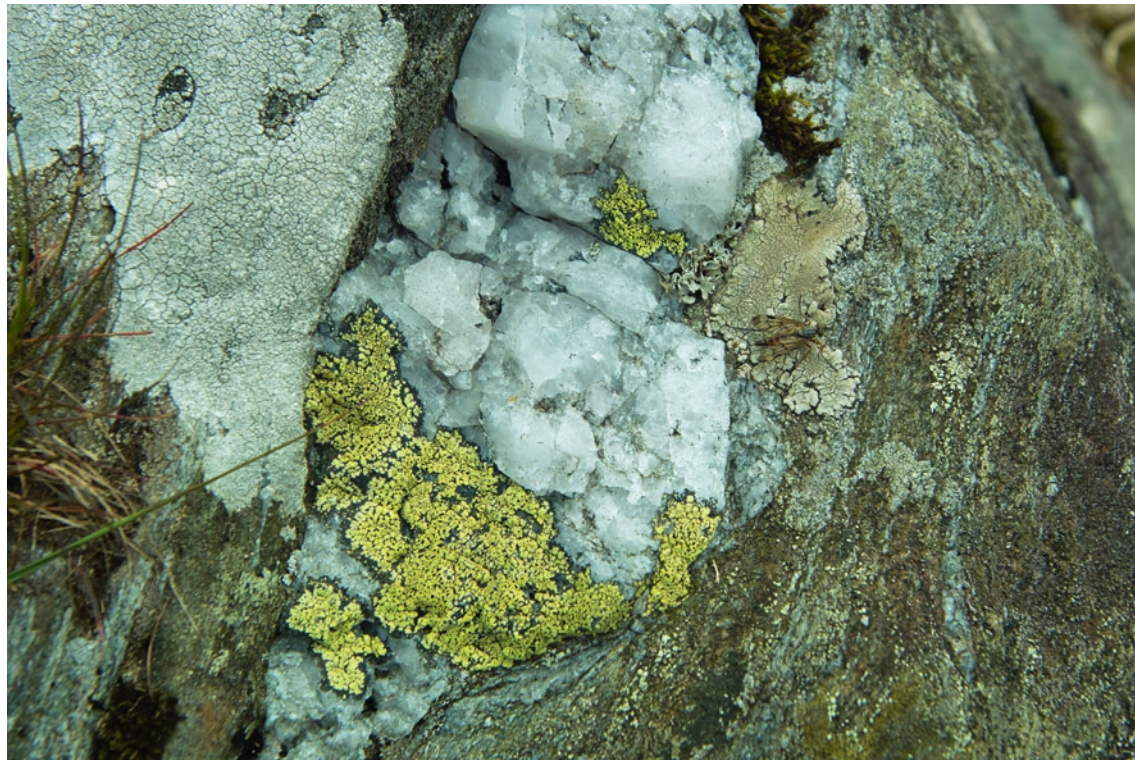


Fig. 8 Seams of calcite high up in the rocks at Arrochar in Scotland

volcanic groups which, in turn are overlain by the Windermere group of sedimentary rocks. These layers are thousands of metres in depth, creating a substantial mass of material. Around the eastern and northern periphery of this mass there are younger rocks to be found from the Devonian, Carboniferous, Permian and Triassic periods. The lakes themselves are fascinating, each with an interesting character and a story to tell as to its formation. It is an area which has inspired poets, writers and painters as well as attracting geologists from far and wide.

Moving further north through Cumbria and a patch of Jurassic rock and into the Scottish Lowlands, we come across a good deal of older strata from the Silurian and Ordovician periods between 417 and 495 million years of age. These reach across in a north-easterly direction from the west coast right up to Edinburgh, where there are also some Devonian rocks to be found as well as some

small outcrops of volcanic rock. A little further north we find further diagonal swathes of volcanic and Devonian rocks reaching right across the country. There are also of course the lochs, many of them displaying a variety of rock formations and habitats around their shores, including the impressive Loch Ness which also stretches out in a north-easterly direction across much of the country. The Cairngorms provide a mountainous landscape shaped by the various glaciations of the last ice age and feature mostly Precambrian metamorphic rocks more than 500 million years of age. Now we are discovering some of the oldest rocks, not only in Britain, but which are to be seen generally. Much of this area, right into the Scottish Highlands, feature strata from the Lower Palaeozoic and Upper Proterozoic periods formed between 500 and 1,000 million years ago. In the northern highlands and outer Hebrides we find rocks from the Lower



Fig. 9 The jagged slate pushed up adjacent to Loch Long

Proterozoic and Archaen periods around 1,500–3,000 million years of age. These are very old rocks indeed. Scotland provides a mixture of igneous, sedimentary and metamorphic rock formations, often in close proximity. It is a fascinating area from a geological perspective providing many contrasts, including across the age range of visible strata. The coastal rocks often adopt a distinct appearance due to weathering and often the attachment of a variety of lichen. The lochs which open to the sea similarly exhibit a sometimes colourful appearance at low tides as the seaweed provides a rich carpet around the exposed rocks. In the mountains, a rather more rugged expression is often to be found although there is equally often a rich diversity as one moves from area to area. Scotland also exhibits some notable faults, including the Great Glen Fault which runs right across the country. It is thus a land of contrasts in many respects, yet retains a

discernable overall character which attracts people from all over the world.

Heading back south into the north of England, Yorkshire in particular provides a wealth of interesting features. The Yorkshire Dales consist of a series of rolling hills, peaks, plateaus and rivers all with their own particular characteristics. This is limestone country of course, mostly laid down between 290 and 354 million years ago in the Carboniferous period. There are many limestone pavements to be found with some wonderful examples around Ingleton. Weathering of the limestone takes many forms and there are also underground streams and caverns in several areas as well as interesting above ground streams with several notable waterfalls. The Craven Dales have additional interest in the form of the three peaks of Wharfedale, Pen-y-ghent and Ingleborough which tend to dominate the landscape. They exhibit distinct layering, as indeed can be found throughout the Dales,



Fig. 10 The smoothly rounded landscape at Glen Lyon

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often in repeating series of limestone, sandstone and shales. This often gives the landscape a stepped appearance as the different layers have various resistance to weathering. Indeed, layering and steps are a familiar theme throughout the Yorkshire Dales, especially where rivers have cut their way through the landscape. Another familiar sight are limestone scars, often accompanied with acute weathering. Napa Scar for example exhibits a veritable avalanche of broken limestone, fairly uniform in individual rock size, many of which are relatively fossil rich. The distinctive shape of many of the crags and hills owes much to glacial activity as is the case with so much of northern Britain, and it is perhaps not surprising that humans have occupied this landscape for thousands of years, with its clear waters and diverse but easily navigated habitats.

To the east, we have the Yorkshire Moors with their gently rolling hills leading down to the

east Yorkshire coastline. This area consists mostly of Jurassic sediments laid down between 142 and 205 million years ago. There is an early limestone layer, interspersed with sandstones and shales, as outcropped along much of the coast, and a later limestone layer as exposed within the Tabular Hills. There are also gorges and, perhaps unexpectedly, a dyke of igneous rock injected into the central moorlands known as the Cleveland Dyke. The moors can be quite beautiful and colourful with their swathes of purple heather and golden grasses rolling across the contours of the land. While the upper moors tend to be raised and tilted up towards the north, it is a different story in the south and particularly along the south eastern coast where erosion can be significant. The coastline of the northern Yorkshire Moors is itself quite spectacular with its beautiful cliffs of Jurassic sandstone adopting a variety of interesting forms. Many particularly interesting fossils have been



Fig. 11 Weathered limestone at Napa Scar in Yorkshire

found along this coastline leading to its alternative name of the Dinosaur Coast.

As we head further south through areas of Jurassic underlying geology, we eventually return to the earlier rocks of East Anglia, laid down in the Cretaceous and Palaeogene periods between around 55 and 142 million years ago. Thus, within a short circuitous tour of Britain we have encountered a wide variety of rocks ranging from a few tens of millions of years of age to around three billion years of age. We have additionally encountered a variety of landscapes, from gentle moors, fens

and plateaus to magnificent mountains, valleys and lakes. We have walked upon volcanic lavas, granites, sandstones, mudstones, shales, gritstones, chalk and almost every type of rock. We have enjoyed a variety of natural habitats and walked in the shadows of our ancestors from the Neolithic and Mesolithic periods. All of this upon a relatively small island. Such is the geology of Britain. The following sections explore these areas in greater detail and allow you to witness much of this diversity for yourself via the accompanying photographs.



Fig. 12 The mudstone and sandstone cliffs at Whitby in Yorkshire



Fig. 13 Rocks tumbling down towards Thirlmere in the Lake District





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