Exploring the landscape of Charnwood Forest and Mountsorrel

Welcome to Charnwood Forest and Mountsorrel

With its rolling hills and craggy knolls, this scenic area of Leicestershire is not unlike the gentler parts of Wales or the Lake District. There are also geological similarities, in that the rocks moulding the Charnwood landscape date back through 600 million years of time, and contain fossils of some of the earliest creatures to have evolved in the Precambrian seas. This booklet and map will help you to explore these rocks through a series of walks and individual locality descriptions, giving you a glimpse of a turbulent geological past that has included volcanoes, mountains, rainforests, deserts and glaciers.

Numbered localities in the text (1) are shown on the accompanying map and on the illustrations in this book; (S) indicates the suggested start of a walk.

Walking in Charnwood Forest and Mountsorrel

The walks are mainly over easy terrain and use recognised footpaths or designated recreation areas. Rock exposures on private land are not included in this booklet. When out walking always take a compass or GPS and map (Ordnance Survey 1:50 000 scale Landranger Sheets 129 & 140 and 1:25 000 scale Explorer Sheets, 245, 246, 256 & 233). Wear outdoor footwear and carry clothing to suit the time of year and likelihood of changes in the weather. Some of the walks require hard hats to be worn. Remember that some of the walks may cross over busy country roads. Always respect the Country Code and, if you have a dog, make sure it is under control. Finally, always remember:

‘leave only footprints; take only photographs’

The geological timescale

In geology, the age of rocks has long been classified according to periods of time. Certain fossil species can be used to estimate the age of a rock, and place it within one of these periods. Some rocks can also be given an ‘absolute age’, in millions or thousands of years, measured from the radioactive decay of certain elements in the minerals that they contain.

Plate tectonics and the rocks of Charnwood Forest

England has not always been in its present position on the Earth’s surface. Over the past 600 million years it has travelled across the globe, from the southern into the northern hemisphere, experiencing climates ranging from Equatorial to Arctic. Such a history has helped to cause the great diversity of the geology of Charnwood and Mountsorrel. In order to understand how this has come about we must turn to the theory of plate tectonics.

Tectonic plates are rigid portions of the planet’s crust. They are continually moving, changing the surface of the planet, but the movements are so slow, seldom much more than a few millimetres per year, that we cannot see them happening. These movements are often felt, however, because they generate earthquakes. Along these earthquake zones, the plates fit together like a jigsaw. Where plates move apart (diverge), such as at mid-ocean ridges, molten rock *(*magma*) rises and solidifies to form oceanic crust.

**Technical terms* have been avoided where possible, but some are explained in the text.

Precambrian — volcanoes, seas and the dawn of Life

In Precambrian times, England lay within the southern hemisphere along an immense structure called a subduction zone.

This was the meeting point between two plates, one of which was forced down beneath the other causing the rocks to melt at depth. The magma rose to the surface and formed a chain of active volcanoes surrounded by the sea and known as an island arc. The erupted material settled on the sea floor, forming the Charnian Supergroup, a series of rocks that is at least 3.5 kilometres thick.

The Charnian volcanoes were sites of violent explosive activity, spewing out clouds of ash and avalanches of solid, red-hot lava debris. This debris formed pyroclastic flows that cascaded down the volcano flanks and into the surrounding sea. Eruptions of this type have been witnessed in modern times, for example on the island of Montserrat, in the Caribbean island arc.

This volcanic material now forms beds which are the layers of volcanic debris (volcaniclastic sediment) preserved in the seas around the Charnian island arc. At this time, about 575 million years ago, primitive animals, possibly akin to modern-day soft corals, first appeared. The impressions they left behind in the sediments are amongst the oldest known large fossils in the world. They are found in Charnwood Forest and many, such as Charniodiscus concentricus and Charnia masoni, are named after this area.

Cambrian — the sea advances

After subduction had ceased, the volcanoes were worn down by erosion. The sea then advanced across this landscape in Cambrian times. The layers of sedimentary rock strata forming the Swithland Slates represent its muddy floor.

For many years, the Swithland Slates were considered to be of Precambrian age. However, discoveries of trace fossils, which preserve evidence of burrowing activity by animals on the sea floor, has allowed geologists to revise their age to the younger Cambrian Period, about 530 million years ago. If you look on the many Swithland Slate gravestones in the area, you may be able to see some of these trace fossils. They are particularly well developed in Ratby churchyard [SK 5129 0593], on the southern side of Charnwood Forest.

Ordovician — more magmatism

Rocks formed from the solidification of previously molten magma are known as igneous rocks. They occur as the Mountsorrel Complex, which formed during Ordovician times (about 450 million years ago) from a new subduction zone, when England was part of a small continent known as ‘Avalonia’.

These coarse-grained igneous rocks are called granodiorites and are examples of magmas that solidified at great depths in the Earth’s crust. They cooled slowly and this resulted in the growth of large crystals that can be seen with the naked eye. The rocks form large intrusions, or ‘batholiths’, similar to the granite of Dartmoor in the West Country.

Silurian and Devonian — orogeny, and the Caledonides mountain belt

The process of mountain building, called ‘orogeny’, occurs when two very thick continental plates collide. It happened here about 420 million years ago at the end of the Silurian Period, during the final stages of the Acadian Orogeny. It is a tectonic process that involves the rocks being heated, compressed and then lifted up to form a mountain range. Structures produced by this orogeny include folds, and a prominent feature called cleavage, when crystallisation of new minerals causes the rocks to break easily along numerous parallel surfaces. This occurs in all Charnian rocks but is particularly pronounced in the Swithland Slates.

Carboniferous — warm seas and coral reefs

By the start of the Carboniferous Period, about 355million years ago, England was joined together with Scotland. This British landmass now lay close to the Equator, and it became partially covered by warm and shallow seas. The sediments that were formed are now preserved as the Carboniferous Limestone, rich in fossils of corals and shells. These rocks can be seen in the north, around Grace Dieu, but did not cover the whole of Charnwood Forest, which was

still a mountain range at this time.

The warm shallow seas were succeeded by humid swamps and Equatorial rain forests in which the Coal Measures were deposited. These rocks are known for the abundance of fossil plants and for the natural resources — coal, ironstone, fireclay — that fuelled the industrial revolution. They are now preserved to the west of Charnwood Forest, in the North-west Leicestershire Coalfield. At the close of the Carboniferous Period further impor tant earth movements occurred, during the Variscan Orogeny, and resulted in the final consolidation of a vast continent, known as Pangaea.

Permian and Triassic — deserts and mountains

The Permian Period was one of continuous erosion lasting for just over 40 million years, at the end of which the Carboniferous rocks had been stripped away from all but the northernmost parts of the Forest. At the start of the succeeding Triassic Period, however, the Earth's crust subsided and the Charnwood landscape began to be covered over by sediment. At first, large rivers flowed northwards across England and some of their tributary streams originated on the higher ground of Charnwood Forest. These rivers deposited the sands and gravels preserved as the Shepshed Sandstone. Later in the Triassic, when England had moved to a position about 20° north of the Equator, a vast desert was developed across the Pangaea continent, its climate probably resembling that of modern-day Saudi Arabia.

Unlike modern-day sandy deserts, such as the Sahara, this Triassic desert was dominated by fine, wind-borne (aeolian) dust that formed the red muds and silts of the Mercia Mudstone Group. Occasional cloudbursts caused flash floods and at times water covered large areas, forming temporary lakes known as playa lakes. When these evaporated, deposits of salt (halite) and gypsum were left behind.

The land continued to subside and the Mercia Mudstone eventually buried the Charnwood hill range. This resulted in the spectacular contact between the younger and older rocks, which is known as an erosional unconformity and is seen in many Charnwood quarries. This unconformity spans some considerable gaps in geological time before the deposition of the Triassic rocks — 300 to 350 million years in the case of the underlying Precambrian and Cambrian rocks, 200 million years for the Mountsorrel Ordovician intrusions, and about 110 million years for the Carboniferous rocks.

An interesting feature of this unconformity in Buddon Wood Quarry are the 'tors' of granodiorite showing the effects of sandblasting by Triassic desert winds.

In such harsh conditions, there were few animals around, but the Triassic rocks do contain fossils, which include those of burrowing creatures (trace fossils) and in cave deposits, reptilian bones are found. One reptile living in Charnwood Forest at this time has been called *Chirotherium*, but we only know it from its footprints on sandstone bedding planes — so far it has not yielded up any bony remains.

Jurassic and Cretaceous — tropical seas

After the Charnwood hills had finally been buried, a shallow tropical sea advanced across the whole area and deposited Jurassic and Cretaceous mudstones and limestones at least one kilometre in thickness. However, at the end of the Cretaceous Period, plate tectonic movements that accompanied the opening of the Atlantic Ocean destroyed this sea. The supercontintent Pangaea broke up and Britain, now located on the Eurasian Plate, began to drift farther northwards.

Quaternary — the Great Ice Age

By the start of the Quaternary Period, about two million years ago, the Cretaceous, Jurassic and much of the Triassic strata had been eroded from Charnwood Forest and Mountsorrel, revealing the older rocks once more. Climatic cooling ushered in Arctic conditions, and about 440000 years ago ice sheets completely enveloped the region, extending as far south as London.

In the sediments (boulder clays or tills) deposited at this time we can see evidence for two ice sheets, one coming from the north-west carrying debris mainly of Triassic and Carboniferous rocks and the other, coming from a more easterly direction, with fragments of flint and chalk.

This ice soon retreated, never to return to these parts. As recently as 30000 years ago, however, the ice did get as far as Derbyshire and Charnwood Forest's climate was extremely cold and tundra-like. Animals that thrived in such climates, such as woolly mammoth, woolly rhinoceras and reindeer, now populated England. Their remains have been found near Charnwood Forest, in the Soar valley, and include bones, tusks, teeth and antlers.

During the ice age, soft 'superficial deposits' accumulated, either by the result of ice-action (till) and weathering, or from the flow of meltwater from the ice sheets (sand and gravel). In more recent times, we have seen the development of rivers that have formed floodplains floored by clay and silt (alluvium).

Figures

(Figure 20) Granodiorite tors with wind-worn shapes revealed beneath their Triassic cover in Buddon Wood Quarry.

(Figure 21) Footprint of the Triassic reptile Chirotherium.

(Figure 22) Charnwood Forest would have resembled this Arctic landscape about 440000 years ago.

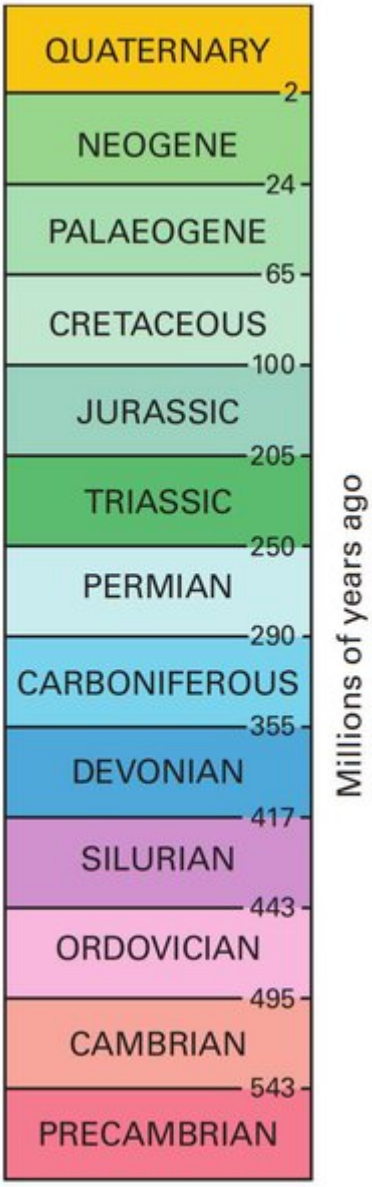
(Figure 23) At Buddon Wood Quarry, the grey deposit to the left is till, left behind by the eastern ice sheet.

(Figure 24) Till from Buddon Wood Quarry with white fragments derived form Chalk outcrops about 70miles to the east.

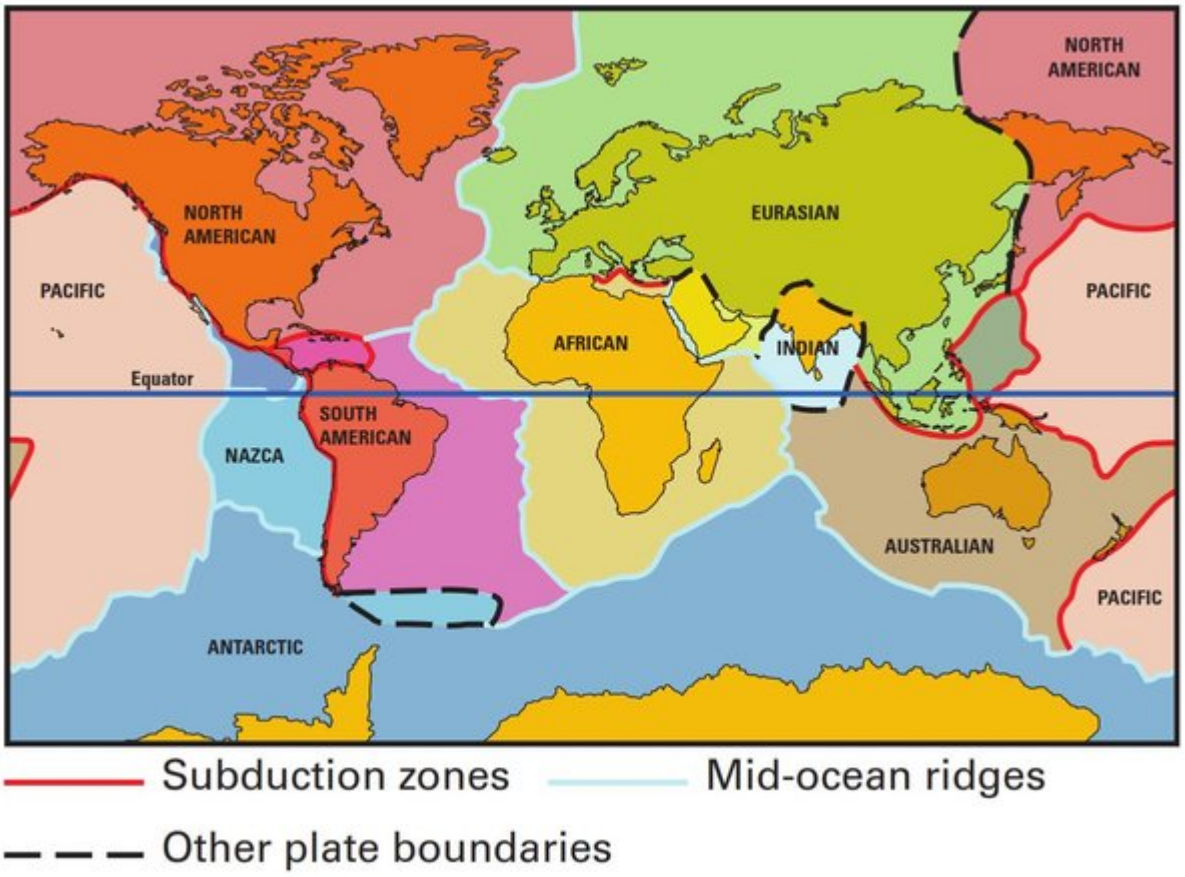
(Figure 25) Pleistocene bones including woolly mammoth tusk and tooth and reindeer antler in New Walk Museum, Leicester.

(Figure 26) Woolly mammoths like this may have wan- dered around Charwood Forest thousands of years ago.

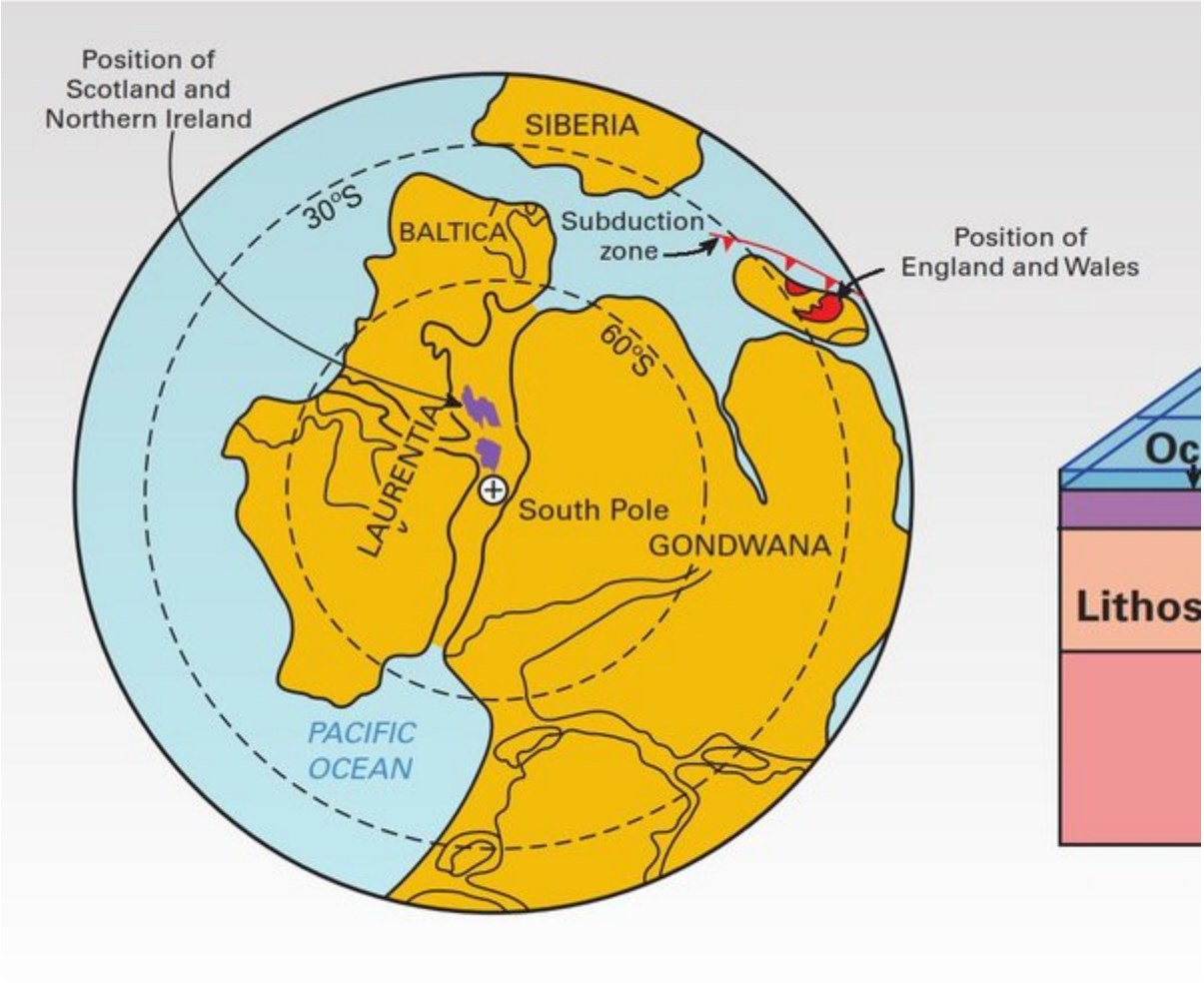
Scenery of Bradgate Park, looking south to Bradgate House and Leicester.



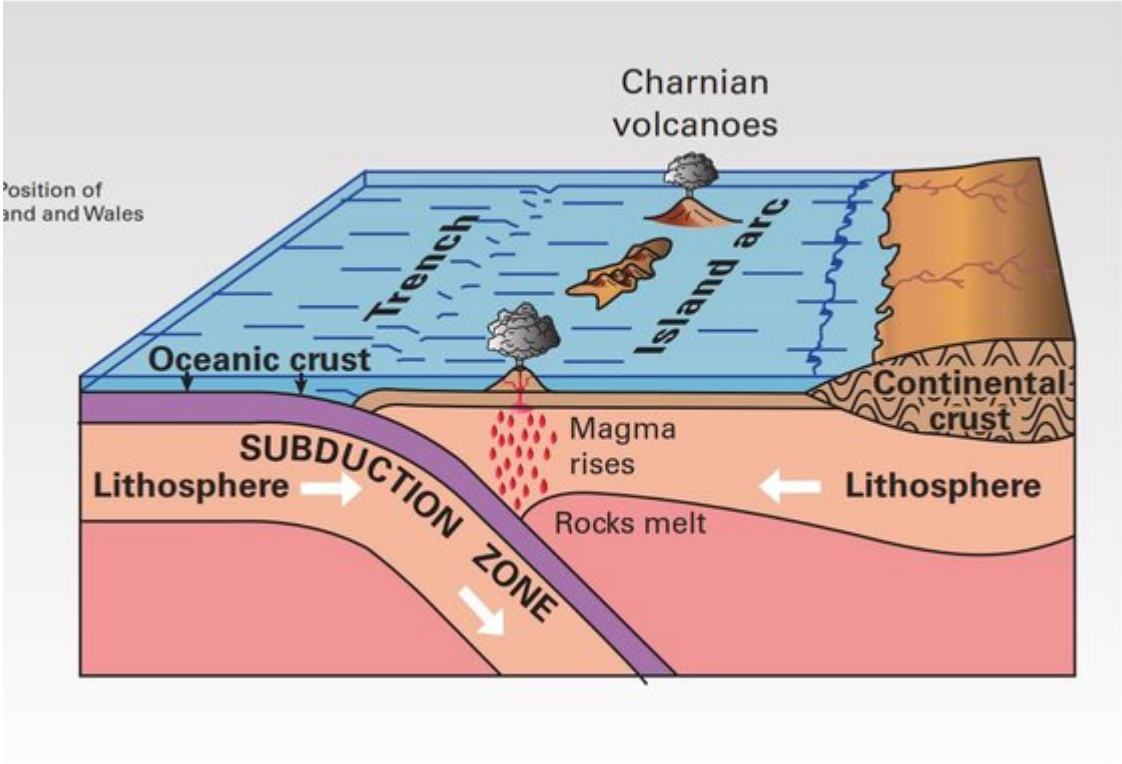
Periods of geological time.



Tectonic plates of the world.



The world in Precambrian times.

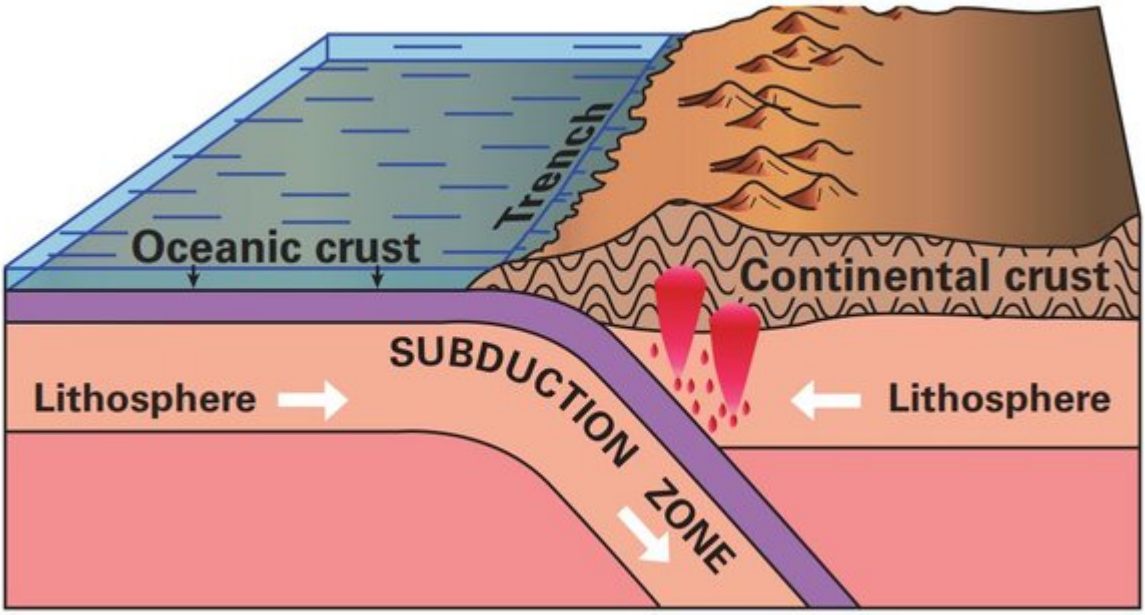


Reconstruction of the Precambrian subduction zone beneath England and Wales.

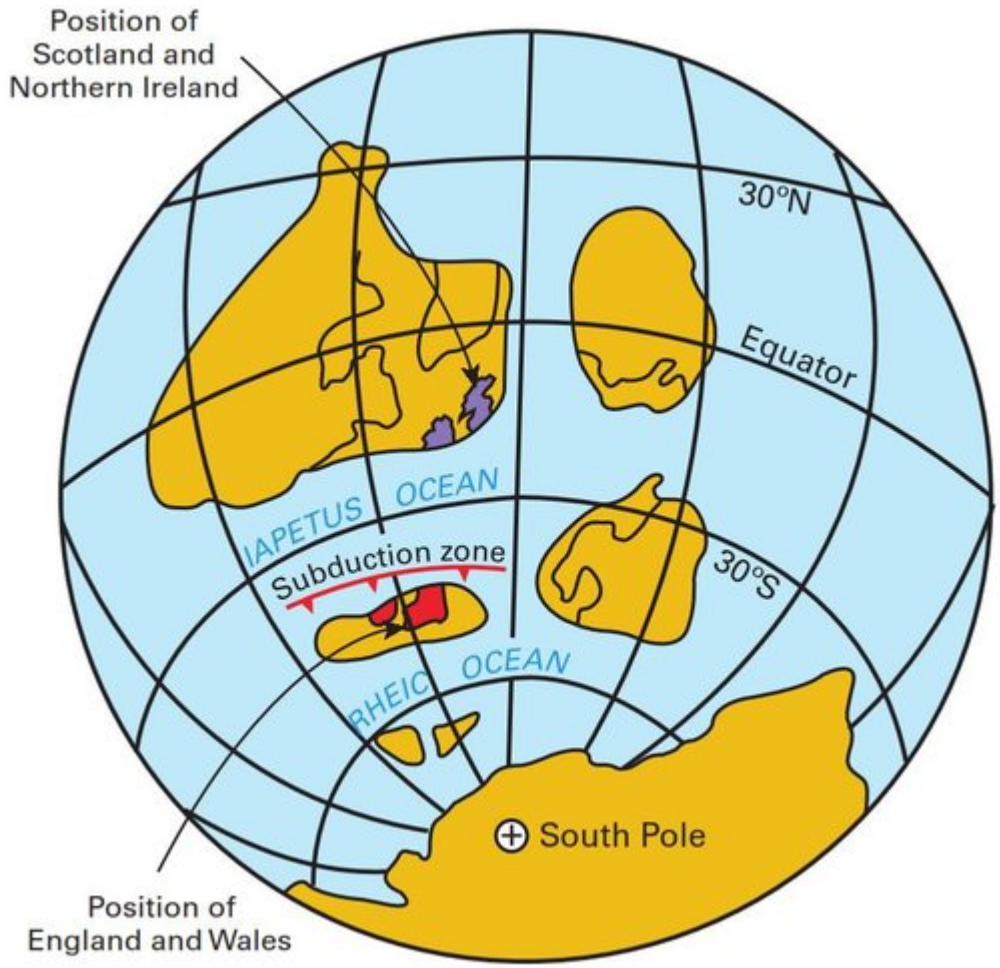
Crag on Beacon Hill (Walk 1) showing beds of fine-grained volcaniclastic sediments and a later cleavage structure.

Charnia masoni, the first fossil to be found in Charnwood Forest.

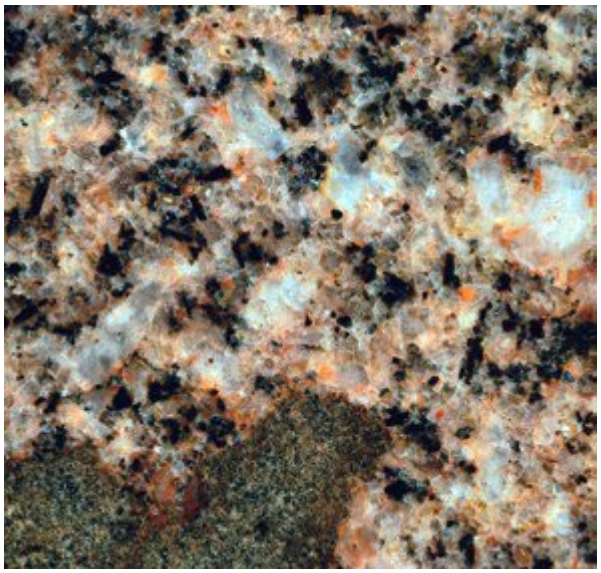
Trace fossil Teichichnus, in Ratby church- yard (dark marking to left of pencil scale).



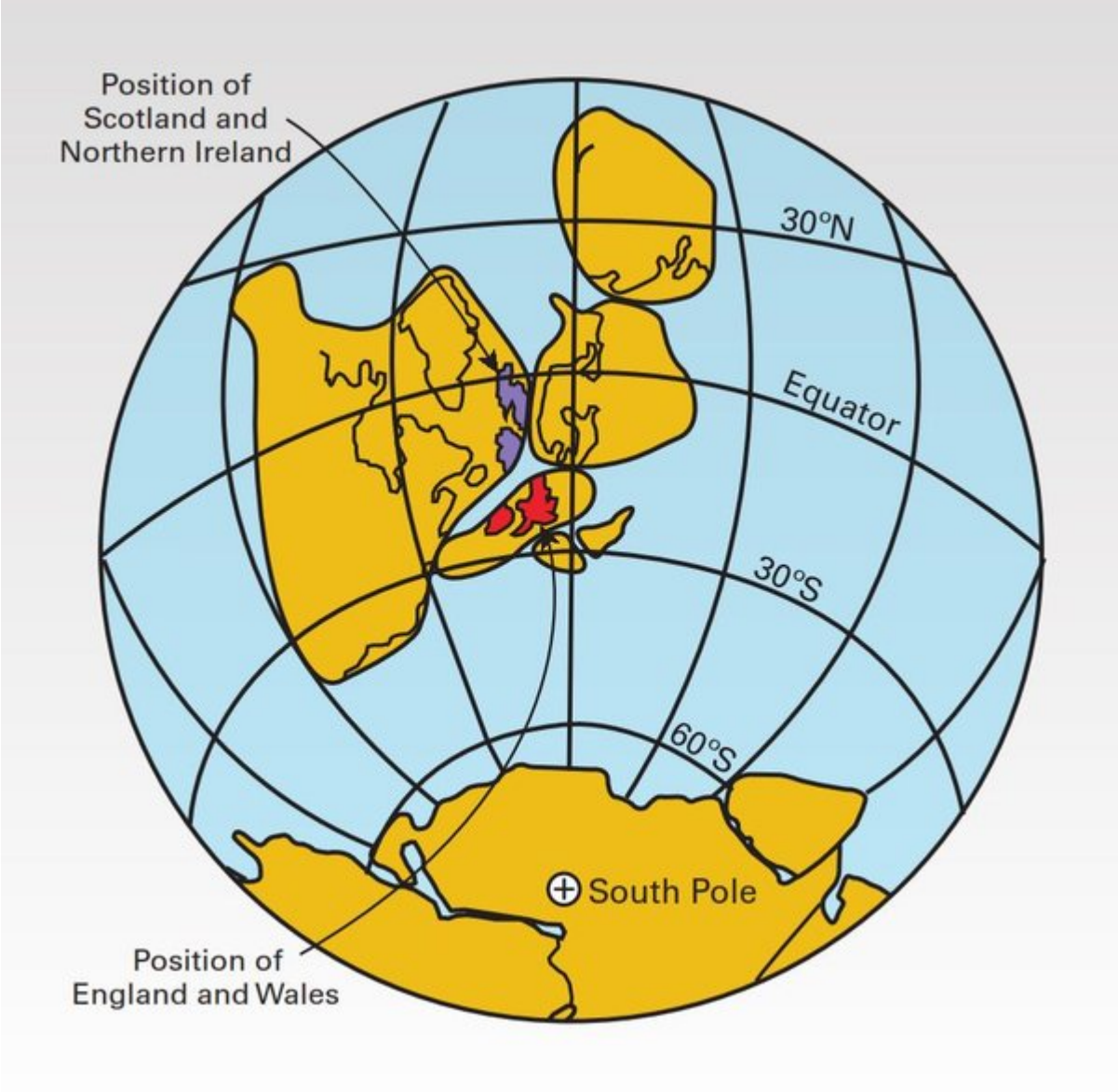
The Mountsorrel rocks formed within a mountain belt above a subduction zone like this. Compare it to the Precambrian one shown on page 4.



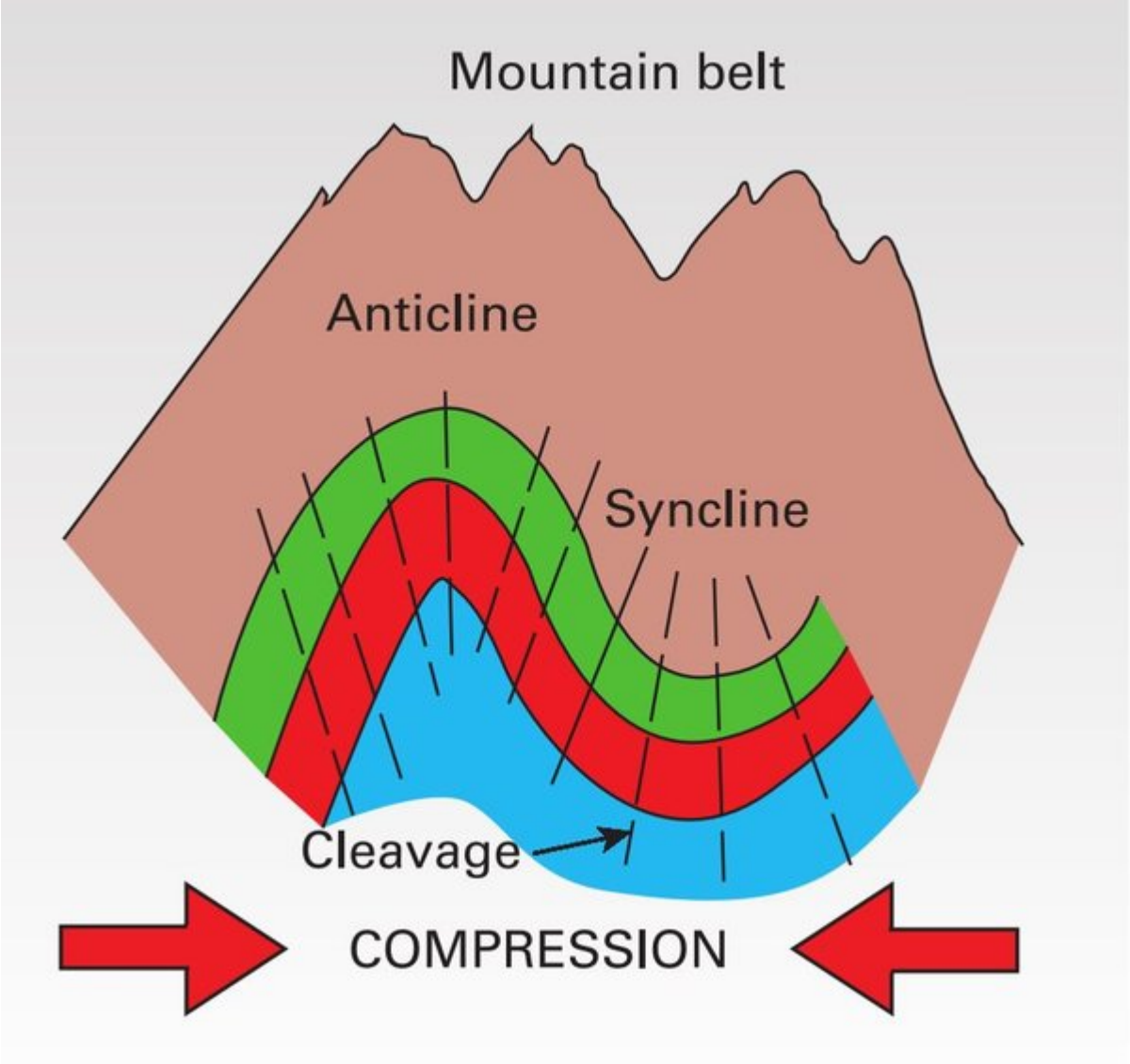
The position of various parts of the British Isles during Ordovician times.



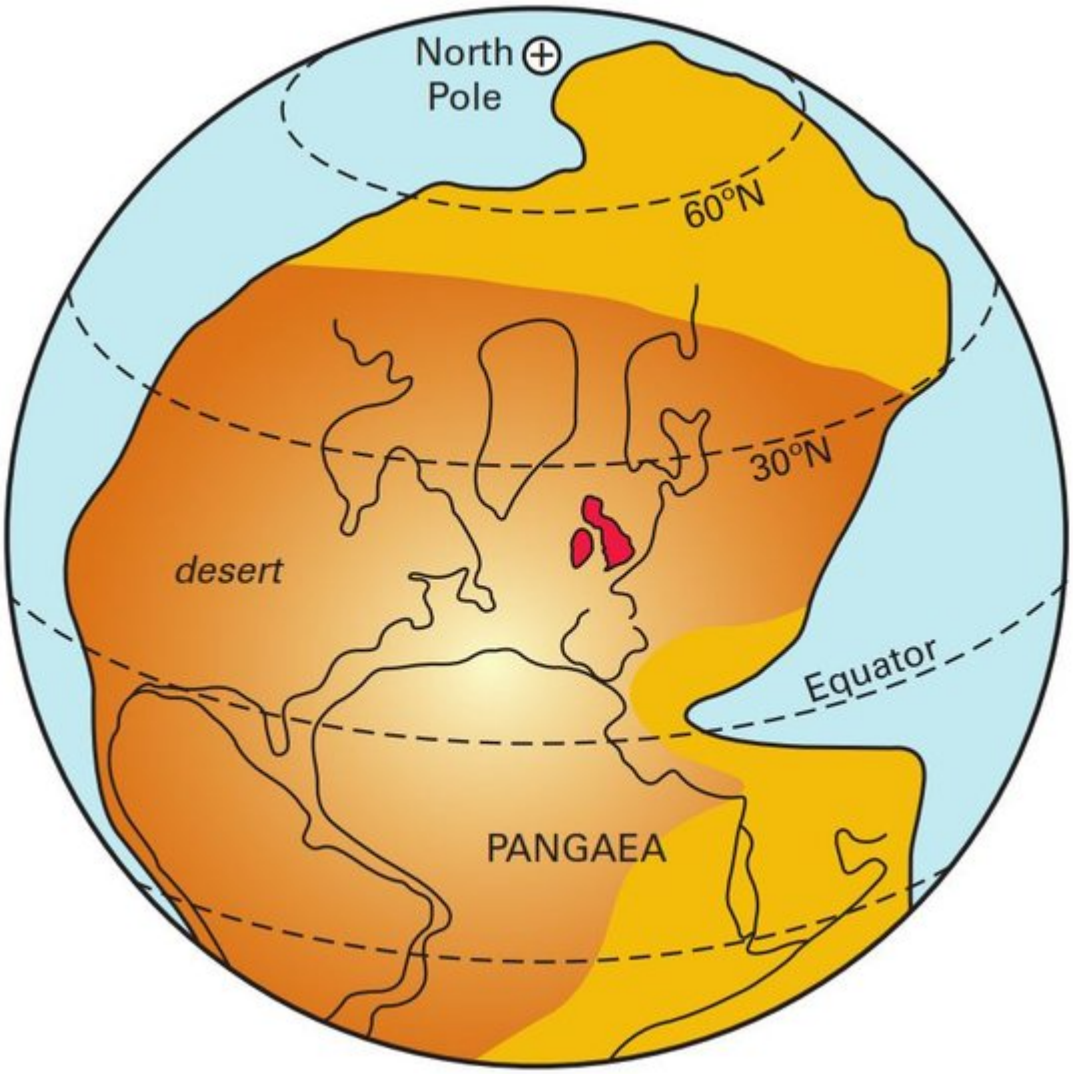
Polished slab of Mountsorrel granodiorite with a xenolith (‘foreign rock’).



The world at the end of the Silurian Period—England, Wales and Ireland are about to collide with Scotland.



The product of continental collison—fold- ing and cleavage of the type seen in Charnwood Forest.

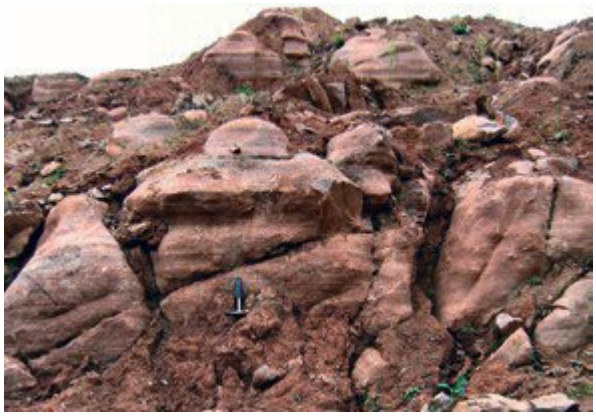


The world in Triassic times, following forma- tion of the Pangaea continent.

Charnwood Forest and Mountsorrel could have resembled this Arabian landscape (Nabitah fault zone) in Permian and Triassic times.

Triassic beds like this in Buddon Wood (Mountsorrel) Quarry, accumulated from wind-borne clouds of dust.

Cubic shapes formed from sediment that has replaced original salt crystals.



Granodiorite tors with wind-worn shapes revealed beneath their Triassic cover in Buddon Wood Quarry.

Footprint of the Triassic reptile Chirotherium.

Charnwood Forest would have resembled this Arctic landscape about 440000 years ago.

At Buddon Wood Quarry, the grey deposit to the left is till, left behind by the eastern ice sheet.

Till from Buddon Wood Quarry with white fragments derived form Chalk outcrops about 70miles to the east.

Pleistocene bones including woolly mammoth tusk and tooth and reindeer antler in New Walk Museum, Leicester.

Woolly mammoths like this may have wan- dered around Charwood Forest thousands of years ago.