The Variscan Orogeny

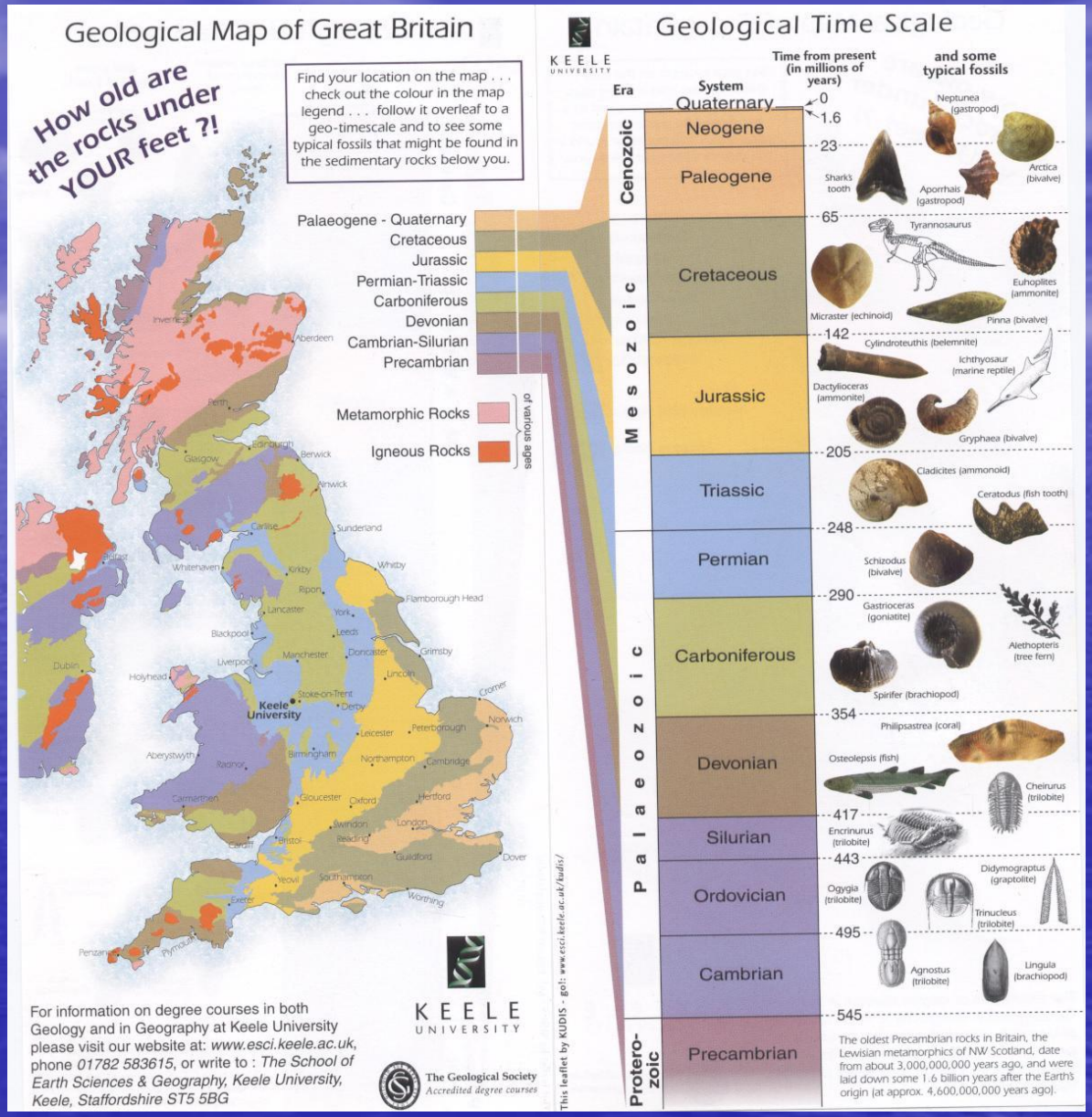
Its impact on the rocks and landscape of the south west of the British Isles.

Also known as:

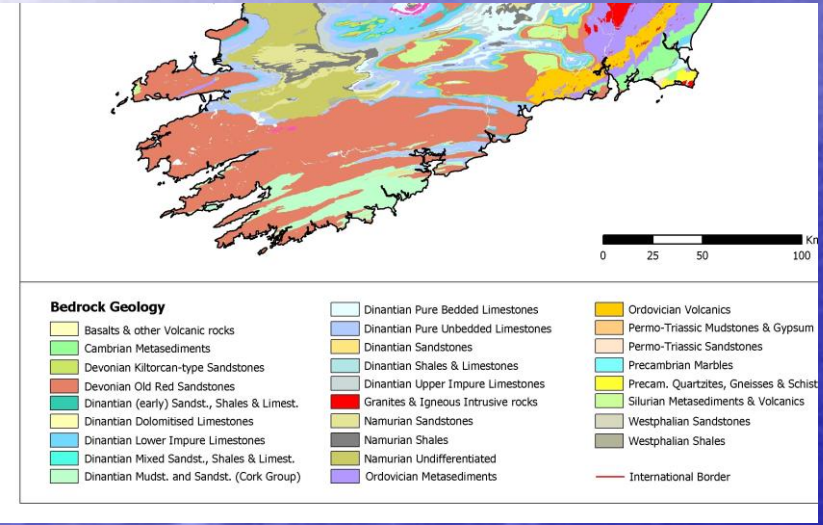
- Hercynian
- Armorican

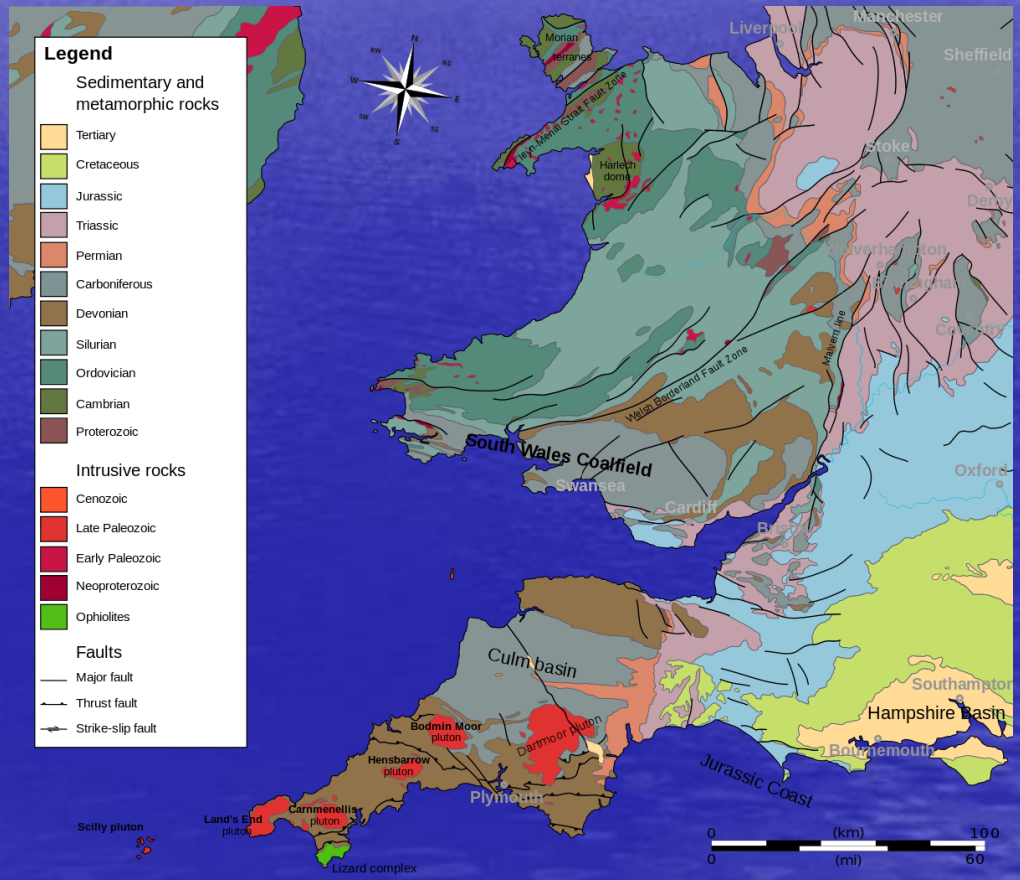
- Trend of fold structures – west / east or WNW /ESE

The distribution of rocks in the British Isles



A little more detail, SW Ireland and SW UK.



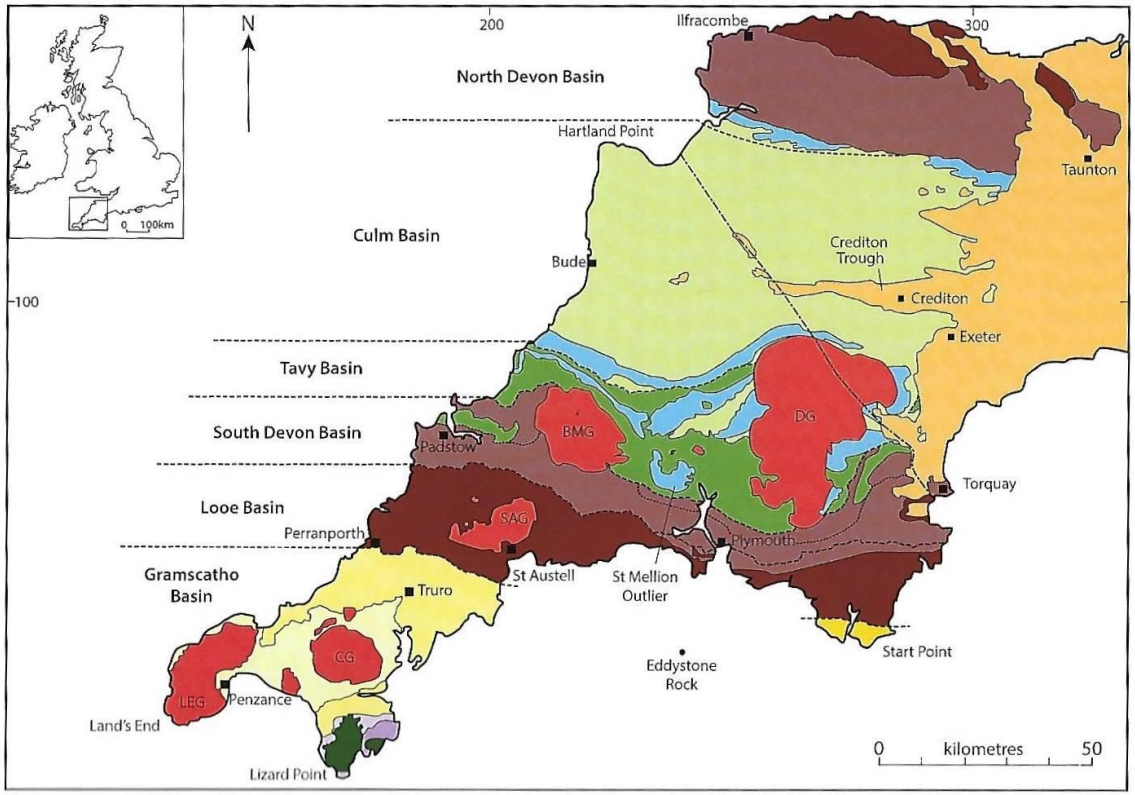


The rocks of interest continue south east but are concealed by younger rocks. They reappear in Belgium in the Ardennes region

S.W. England overall structure.

- Cornwall and Devon are part of a major complex synclinal fold structure (syclinorium!) with the oldest rocks (Devonian) in west Cornwall and north east Devon (e.g. Exmoor) and the younger Carboniferous rocks in east Cornwall and north west Devon (Hartland Point).

General geology of Devon and Cornwall demonstrating the syncline.



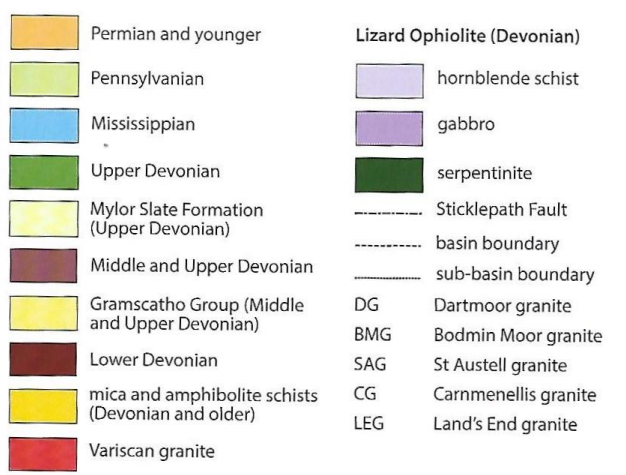
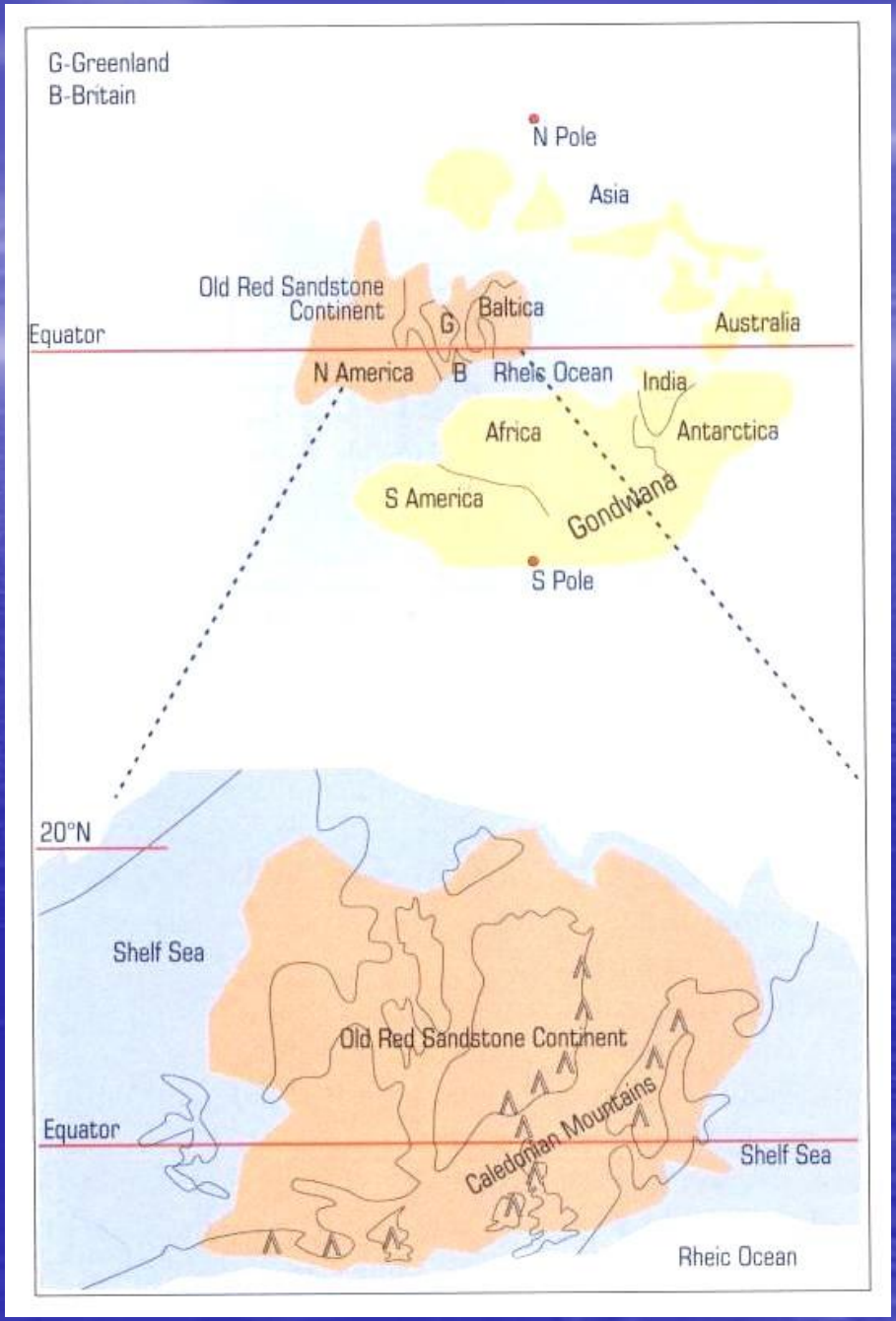


Figure 1. The principal features of the Upper Palaeozoic geology of Devon and Cornwall showing the depositional basins. Note that all Permian and post-Palaeozoic rocks are shaded the same. Modified after Leveridge and Shail (2011).

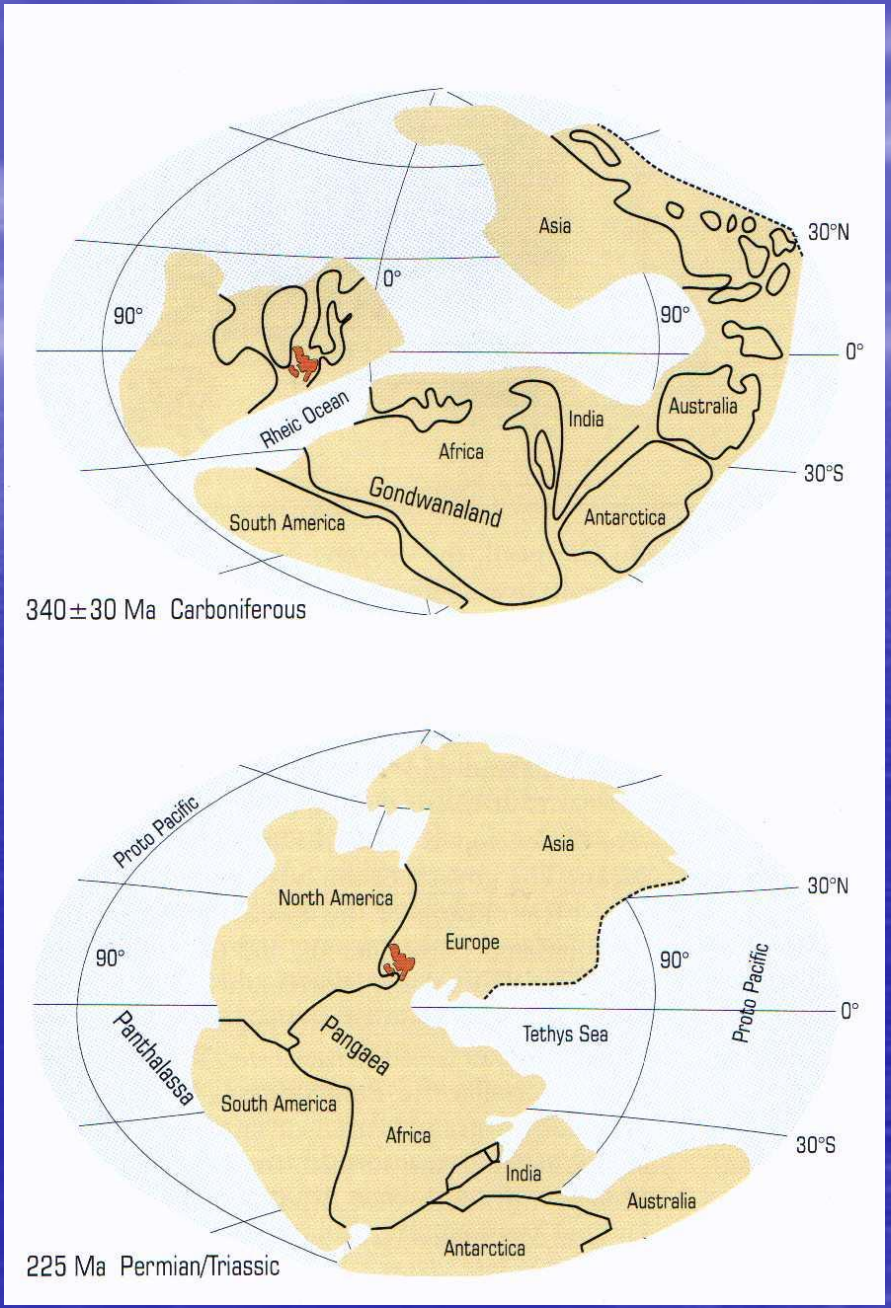
Palaeo-geographic setting.

- During the Devonian and Carboniferous periods, what we now call the British Isles was just south of or on the Equator on the northern edge of the Rheic Ocean.



The Variscan Orogeny

The Closure of the Rheic Ocean at the end of the Carboniferous Period resulted in the Variscan Orogeny and the creation of a mountain chain from southern Ireland (Kerry), through South Wales and S.W. England south eastwards into central Europe.



Caledonian and earlier structures had an impact.

Illustration from PGA paper June 2018. This emphasises the importance of the Anglo-Brabant Massif and the Welsh Massif in controlling events to the south. However there also a lot of activity across N England reactivating earlier structures.

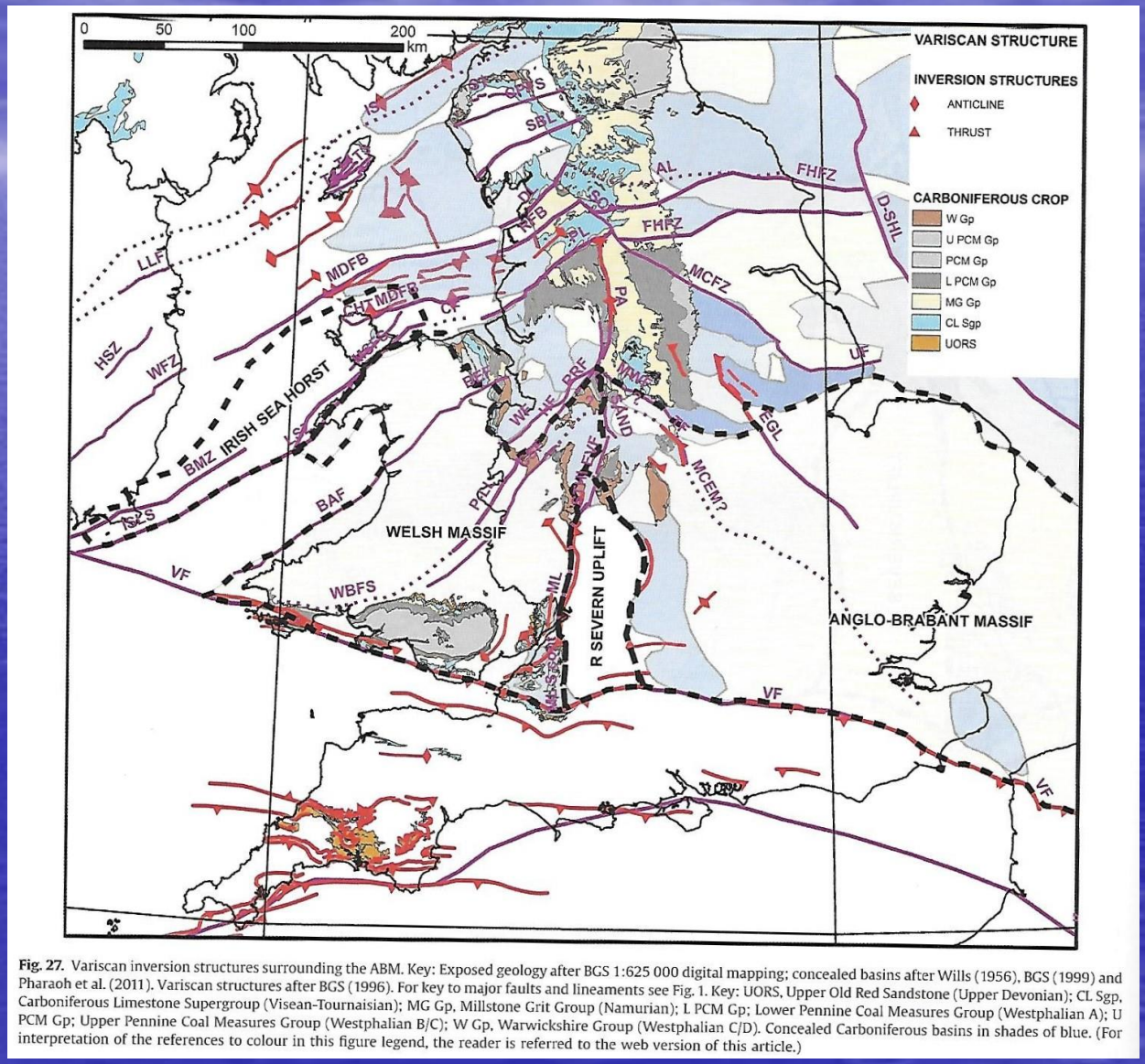


Fig. 27. Variscan inversion structures surrounding the ABM. Key: Exposed geology after BGS 1:625 000 digital mapping; concealed basins after Wills (1956), BGS (1999) and Pharaoh et al. (2011). Variscan structures after BGS (1996). For key to major faults and lineaments see Fig. 1. Key: UORS, Upper Old Red Sandstone (Upper Devonian); CL Sgp, Carboniferous Limestone Supergroup (Visean-Tournaisian); MG Gp, Millstone Grit Group (Namurian); L PCM Gp; Lower Pennine Coal Measures Group (Westphalian A); U PCM Gp; Upper Pennine Coal Measures Group (Westphalian B/C); W Gp, Warwickshire Group (Westphalian C/D). Concealed Carboniferous basins in shades of blue. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

The position of the Variscan Front, Newgale, Pembrokeshire

Events in the Devonian Period.

- Following the Caledonian Orogeny at the end of the Silurian, the erosion of the Caledonian Mountains produced large amounts of clastic sediment which was deposited in South Wales and south west England.
- Rivers flowing from north to south carried much sediment now seen in south Wales and Somerset.
- Continental sediments of this age are generally termed Old Red Sandstone.
- South Devon and Cornwall were largely experiencing a marine environment (Devonian, hence the period name).

The basic succession in west Cornwall.

- The sedimentary rocks seen are of Devonian in age.
- The sequence is mostly made up of turbidites (flysch),forming greywacke sandstone, and inter-bedded shale units formed in a marine environment.

At Black Head, Hayle, they are vertical in places but way up can be determined by fining upward sequences in the turbidites.

Evidence of turbidite features at Black Cliff, St Ives Bay.

Possible flute casts.

Rip up clasts

Dewatering structures (convolute bedding) and graded bedding.

Devonian / Old Red Sandstone in west Wales

- These molasse sediments occur widely in Scotland, the Welsh Borderland and S.W. Wales and to a lesser extent in the Mendips. These were deposited in a continental environment by rivers

Old Red Sandstone Devonian sediments at Freshwater West, Pembrokeshire.

Devonian Old Red Sandstone at Freshwater West.

Coarse sediment deposited by torrential streams flowing off the Caledonian Mountains. There was little vegetation at the time.

Conditions fluctuated:

Calcrete deposit on O.R.S. flood plain at Freshwater West.

Sediment source.

- Lower Old Red Sandstone and Upper Old Red Sandstone sediments are seen in South Wales. Middle Old Red Sandstone is absent but marine sediments are found in Devon and Cornwall. It is suggested that the northerly source was cut off in the Upper O.R.S. times.
- Also during the Devonian there was a land area in the Bristol Channel area which also provided sediment.

Devonian Old Red Sandstone material seen at Portishead, Somerset.

This section demonstrates many interesting sedimentary structures with cross-bedding features and also minor unconformities

Very variable grain size with mudstone through sandstone to conglomerate.

The Trabeg Conglomerate formation in Kerry, S.W. Ireland.

Carboniferous sediments of the Crackington Formation (Culm).

- The bedding surface shows flute casts formed by turbidity flows, triggered by earthquakes, moving over the sea floor, eroding depressions later filled with sediment.

In South Wales and the Mendips with shallower water, limestone was deposited.

Stackpole Quay, Carboniferous Limestone and a solitary coral.

Later the Coal Measures was deposited.

Part of sequence seen at Wiseman's Bridge, near Amroth, Pembrokeshire.

The Variscan Orogeny caused intense folding in Cornwall.

Folded Devonian sediments (Gramscatho Beds) at Gunwalloe Church Cove Cornwall.

Gunwalloe Church Cove,
Lizard, Cornwall.

Rock slide plane

Evidence of modern processes, compare picture taken in 2017 with 1967!

Further evidence of folding.

- Flat lying fold at Godrevy in Mylor Slates.

Folding occurred then faulting as seen at Gunwalloe Church Cove

Sweating out of quartz

- At some stage abundant quartz veins were developed by sweating out of quartz from the greywacke sandstones

More folds seen at Boscastle.

Lithology affecting style of fold – finer sediments tend to have small scale folds

Small scale folding in Late Devonian and Early Carboniferous rocks

Complex folding – refolded fold at Boscastle, north Cornwall.

Medium scale folds at Hartland Quay.

Neutral folds at Millook.

In Pembrokeshire similar intense folding is seen.

- Overturned fold complex with faulting (thrusting) at Broadhaven.
- Maximum stress from south giving asymmetric structures.

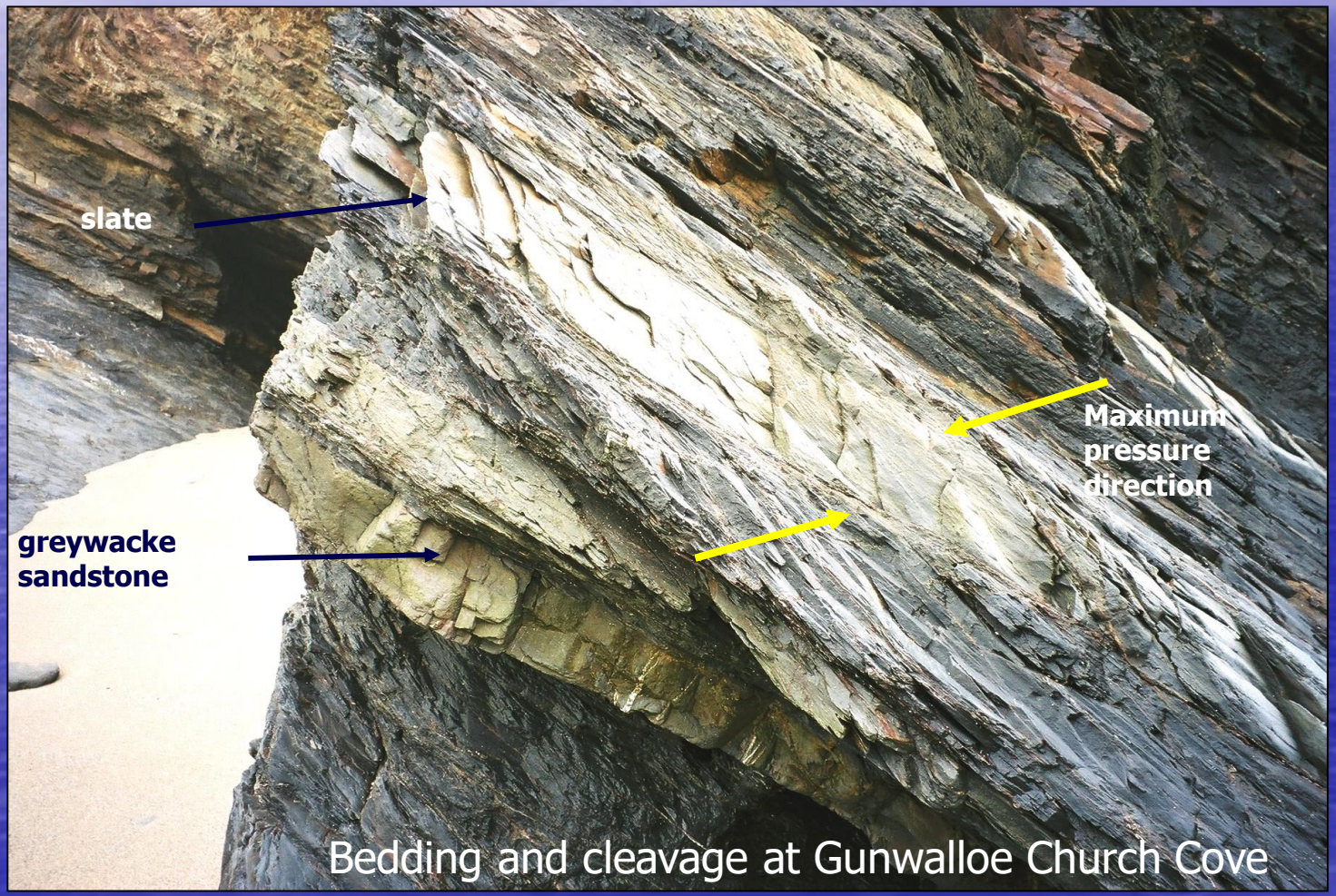
Another well known fold, the Ladies Anticline at Saundersfoot.

- These folds have a typical Variscan trend with a WNW / ESE trend at right angles to the maximum stress.

Intense folding resulted in low grade regional metamorphism in Cornwall.

- The pressure and heat from deep burial and tectonic forces caused the finer grained sediments (clay, mudstone and shale) to be altered to slate.
- The clay minerals were converted into micaceous minerals such as muscovite and chlorite.
- The mineral crystals are aligned at right angles to the pressure creating cleavage in the slate.
- This is not seen in South Wales due to the impact of less tectonic stress.

The finer the sediment the more likely it is to be altered by metamorphism.

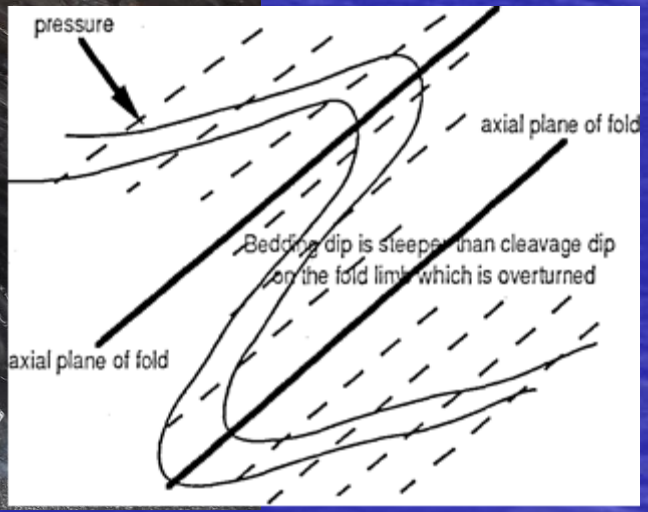


Bedding and cleavage at Gunwalloe Church Cove

Overturned strata at Gunwalloe Church Cove.

If bedding dip is steeper than cleavage dip the strata are overturned.

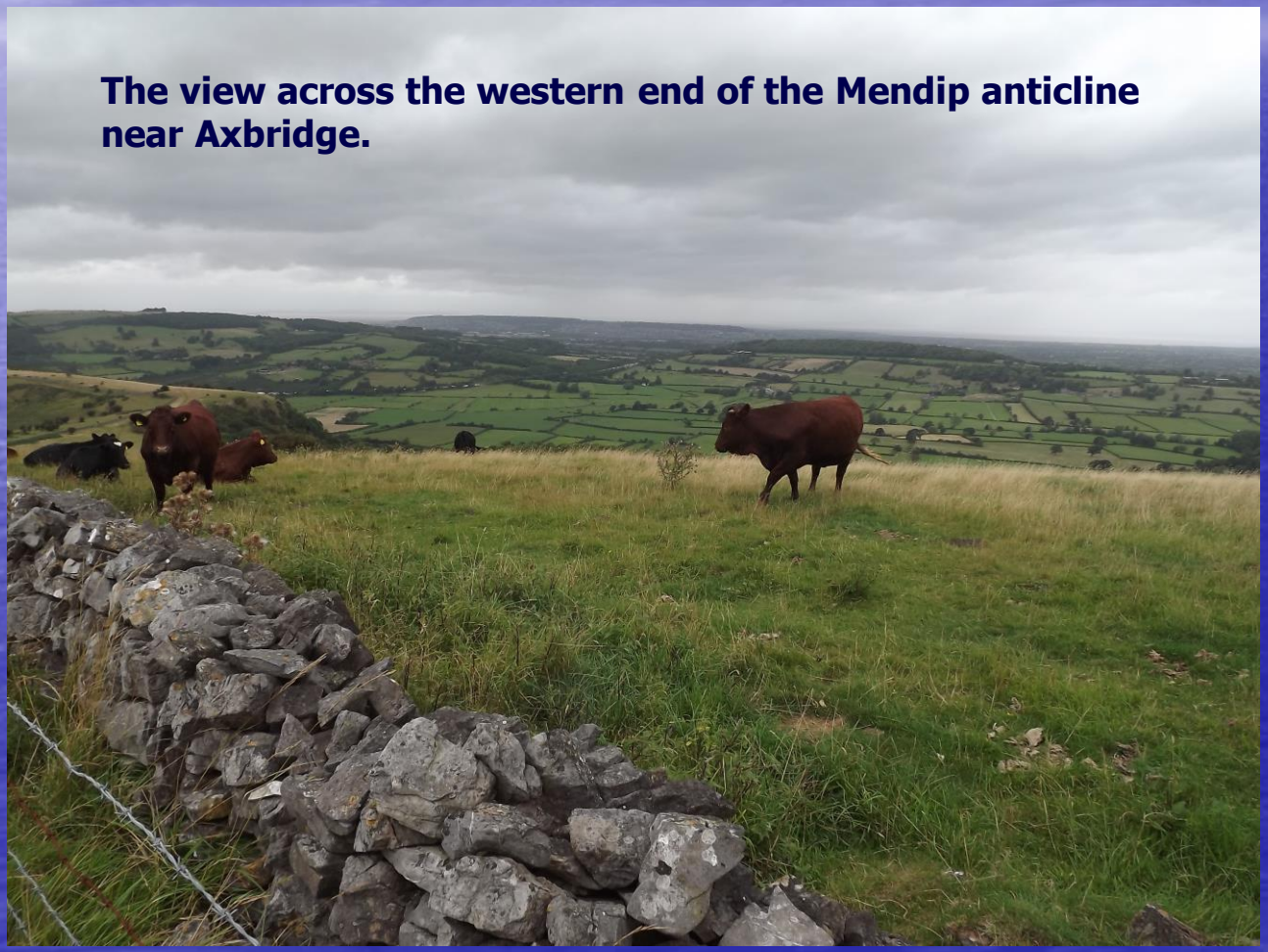
Cleavage dip is steeper than bedding dip on the fold limb which is the right way



Sometimes the geology has little impact on topography.

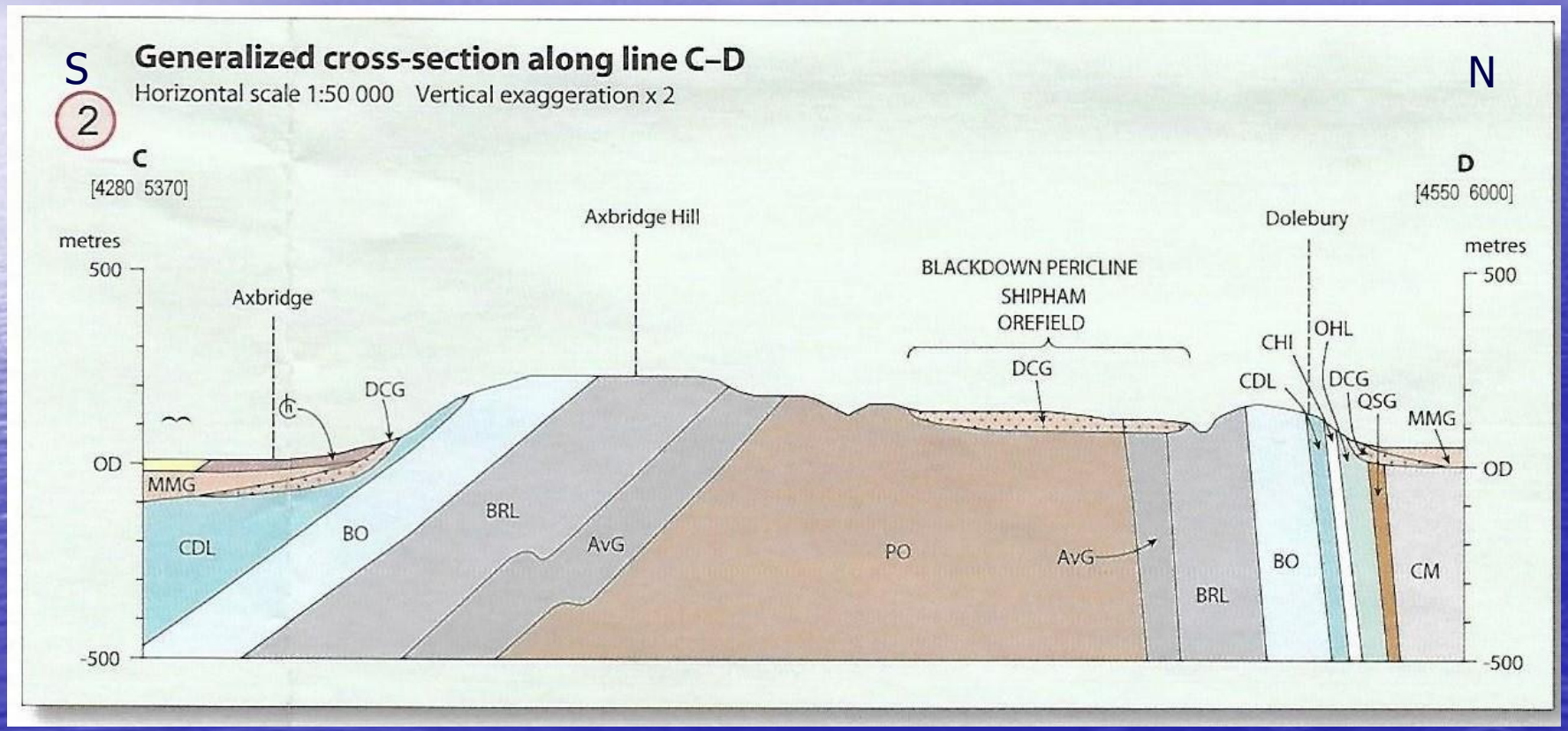
View looking south from near Porthleven towards the Lizard.

However in the Mendips it is a different story.



The view across the western end of the Mendip anticline near Axbridge.

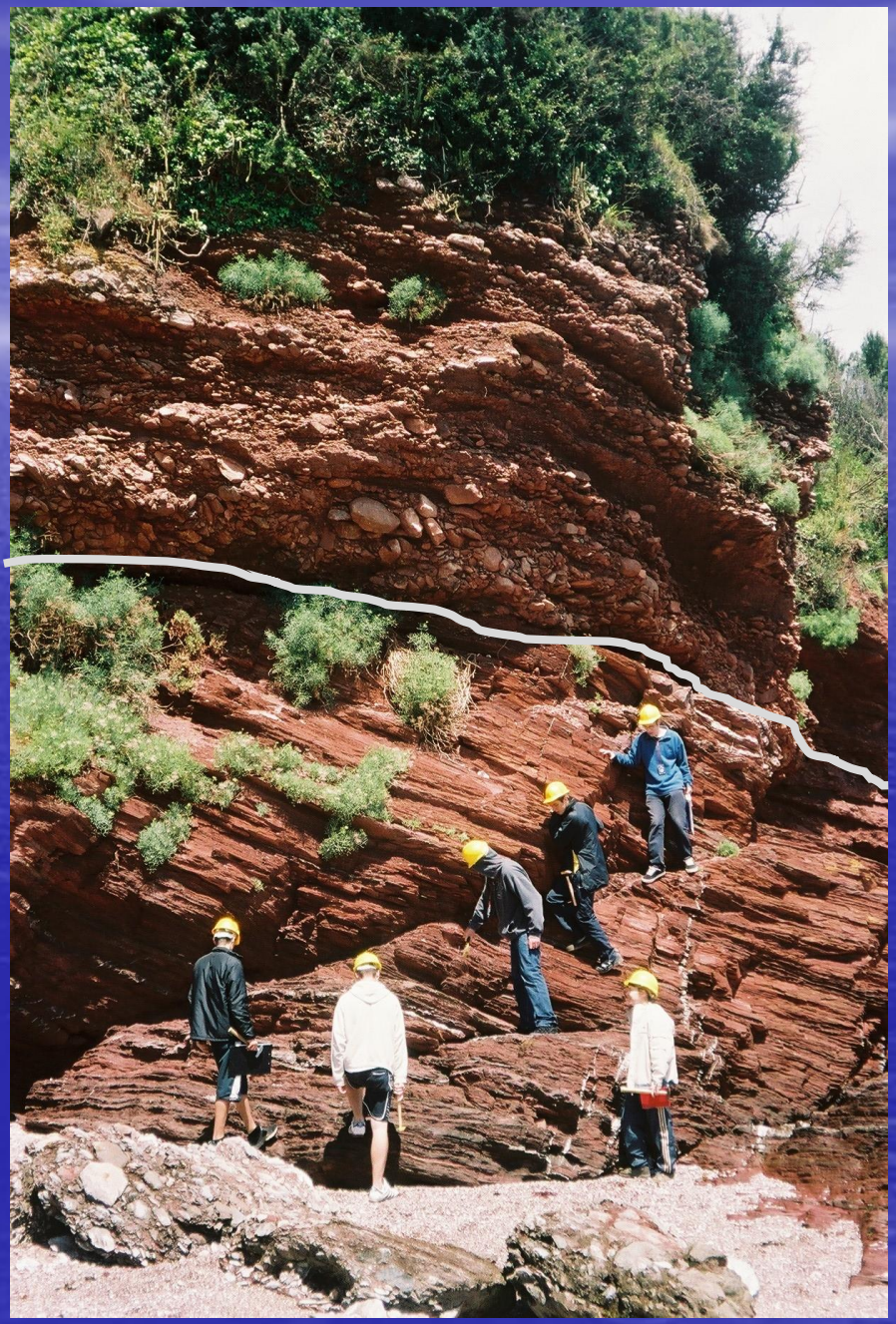
Cross-section of Mendip anticline which helps to show relief related to geology.



Unconformity at Portishead – Triassic conglomerate over ORS sandstone.

Unconformity at Oyster Cove, Paignton

Late Carboniferous or early Permian conglomerate over Devonian mudstone with slaty cleavage.



De la Beche unconformity at Vallis Vale.

Unconformity at Barry Island, Triassic conglomerate over Carboniferous Limestone.

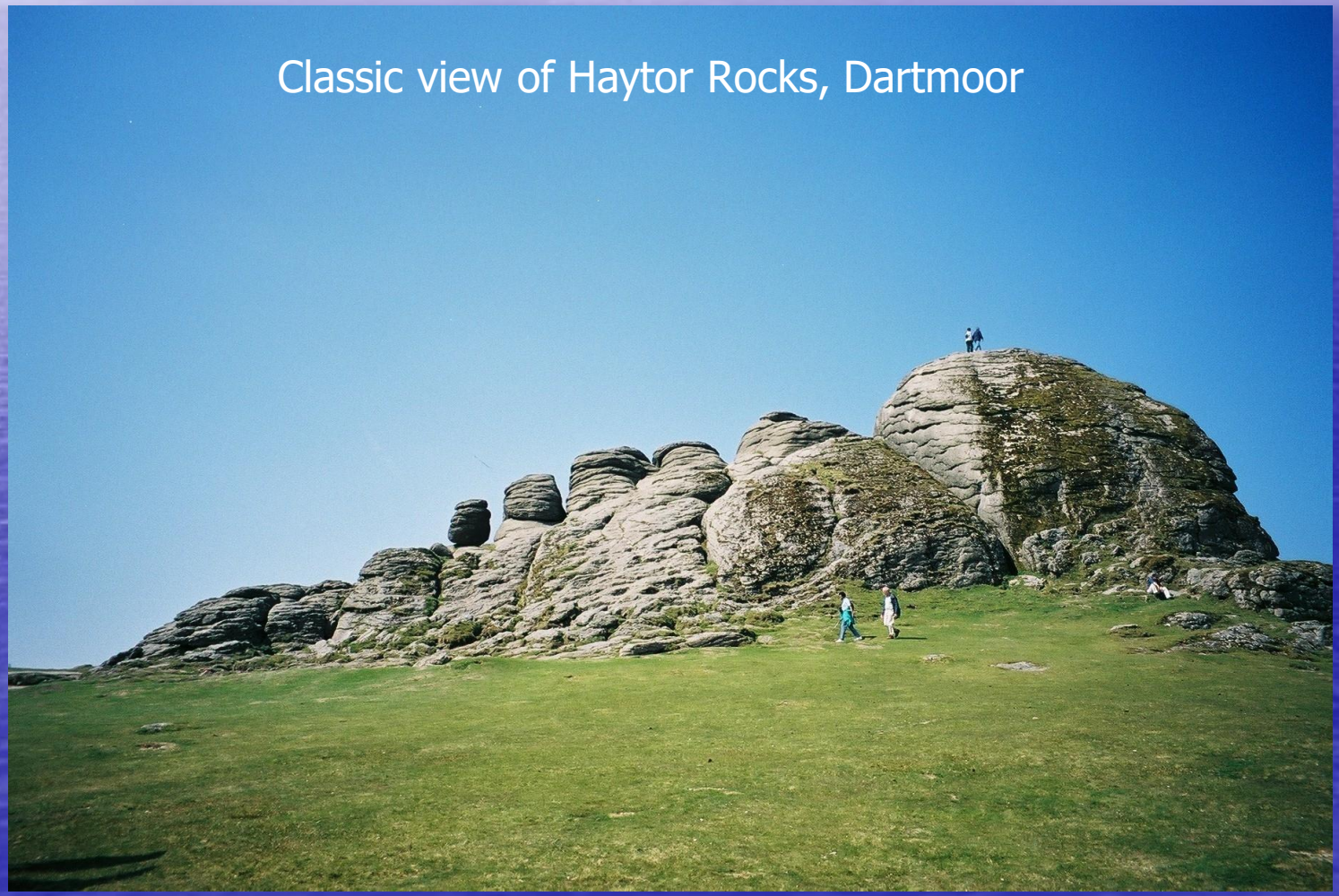
View from Haytor Rocks looking SE.

Notice the change in landscape moving off the granite onto the country rock in terms of topography and landuse.

Granitisation.

- In Late Carboniferous and Early Permian times , crustal melting occurred due to crustal thickening. A range of intrusions on differing scales were emplaced in Devon and Cornwall with a range of interesting textures.
- The emplacement of the granite into the killas (local name for the country rock) is dated at 285-290 m.a.

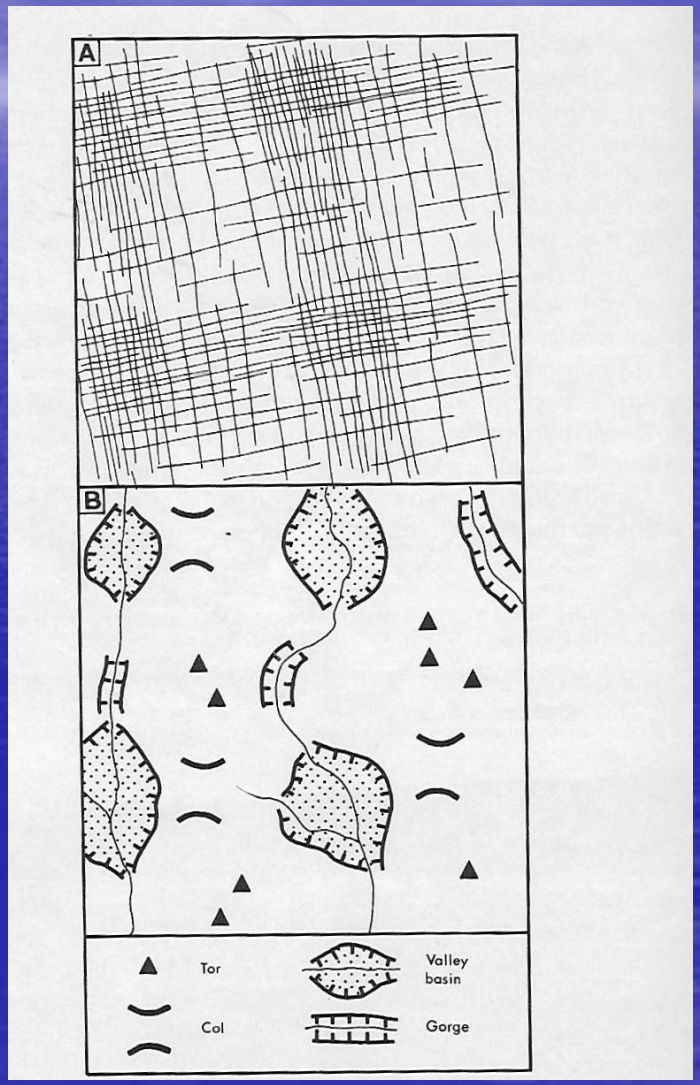
Erosion has exposed the igneous rocks at the surface.



An avenue tor controlled by joint frequency.

Tor formation diagram.

The granite landscape is controlled by joint frequency and their orientation. Higher frequency results in weaker granite and more erosion.



The top of the cupola at Porthmeor Cove with pegmatite and aplite on the northern edge of the Land's End granite

This locality provides a fascinating history of the events that occurred during the emplacement of the granite.

Closer view of the top of the cupola.

Dykes and inclined sheets at Porthmeor Cove

Xenoliths of partially melted country rock are common.

Pegmatite in an inclined sheet at Cape Cornwall.

Evidence of complex history of rocks at Cape Cornwall.

Textures in igneous rocks include flow textures with orientated feldspar crystals.

Euhedral feldspar phenocrysts at Cape Cornwall.

Granitic sills at Megiliggar Rocks .....and a xenolith!

Praa Sands, west Cornwall.

Quartz porphyry dyke with orthoclase feldspar phenocrysts.

Flow texture clearly visible when the magma was injected as the dyke was formed.

The granite intrusion also caused contact metamorphism.

The crystals show random orientation because heat rather than pressure caused the changes.

Chiastolite needles can form during contact metamorphism of pellitic sediments and can be seen at Cape Cornwall and Megiliggar Rocks

Granitisation also resulted in formation of metalliferous minerals.

- Tin and copper minerals were formed and were mined especially in the 19th and 20th centuries.

- Now there is renewed interest in wolfram deposits for tungsten and lithium for batteries.

Hemerden Tungsten Mine , Devon.

Source of lithium

- High levels of lithium were indentified in the water in Cornish mines in the 19th Century, but there was no market for it at that time.
- The metal would be extracted by drilling at least 400m (1,300ft) into rock and pumping out lithium-laden water.
- Most lithium is produced in South America, Australia and China, but the UK government has earmarked it as a metal of strategic importance to the country.

And china clay.

And a by product….the Eden Project.

The End!
Not really there is always more to learn!!

Porthmeor Cove

Just to prove it. New research from Plymouth University!

By detailed analysis of rock samples from South Devon and Cornwall compared with north Devon there is a difference of geochemistry and therefore the likely origin of the two areas.