# The Geology of Chudleigh

A Brief 500 Million Year History

# Overview of Talk

**Part 1**

- **Our Local Geology Map**

  **- a look at the features of a geology map**

- **Our Dynamic Earth**

  **– a look at geological time and plate tectonics**

- **Appearance of Life on Earth**

  **- the effect of life on the atmosphere and oceans**
  **- the Cambrian Explosion**

Part 2

- The Devonian – the formation of coral reefs and Chudleigh limestone
- The Carboniferous – shallowing seas, volcanics and igneous intrusions
- The Permian – desert flood deposits
- The Cretaceous – on the edge of the chalk sea
- The Cenazoic – erosion & formation of the Bovey Basin

# Our Local Geology Map

British Geological Survey
1:50,000 scale map 339

History of mapping

William Smith – first nationwide geology map in 1815

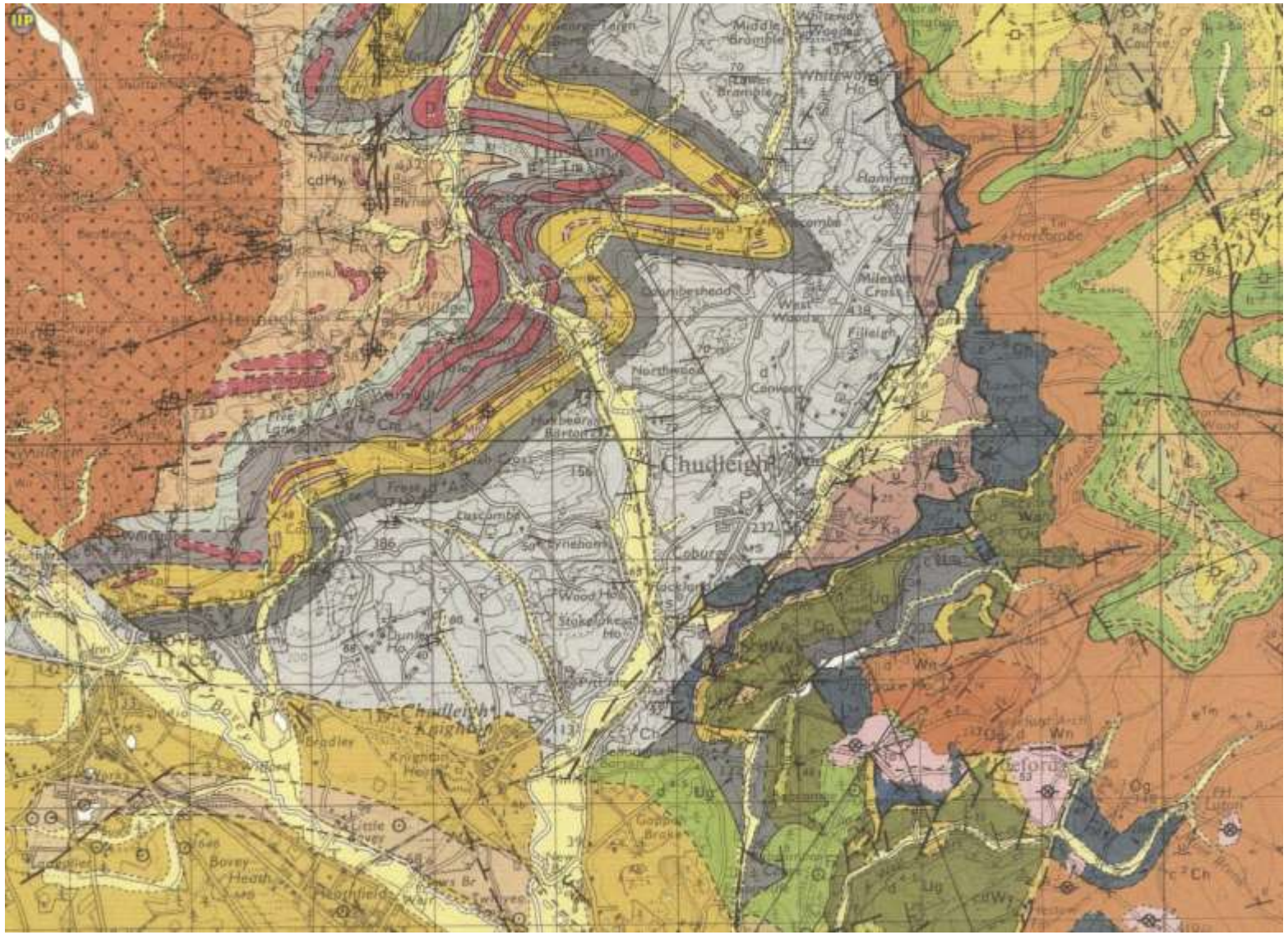
Core work undertaken in 19th C

Resurveyed between 1966 and 1971 (Exeter University & BGS)

Driven by economy & minerals

Industrial revolution (where is the coal, iron & other metals??)

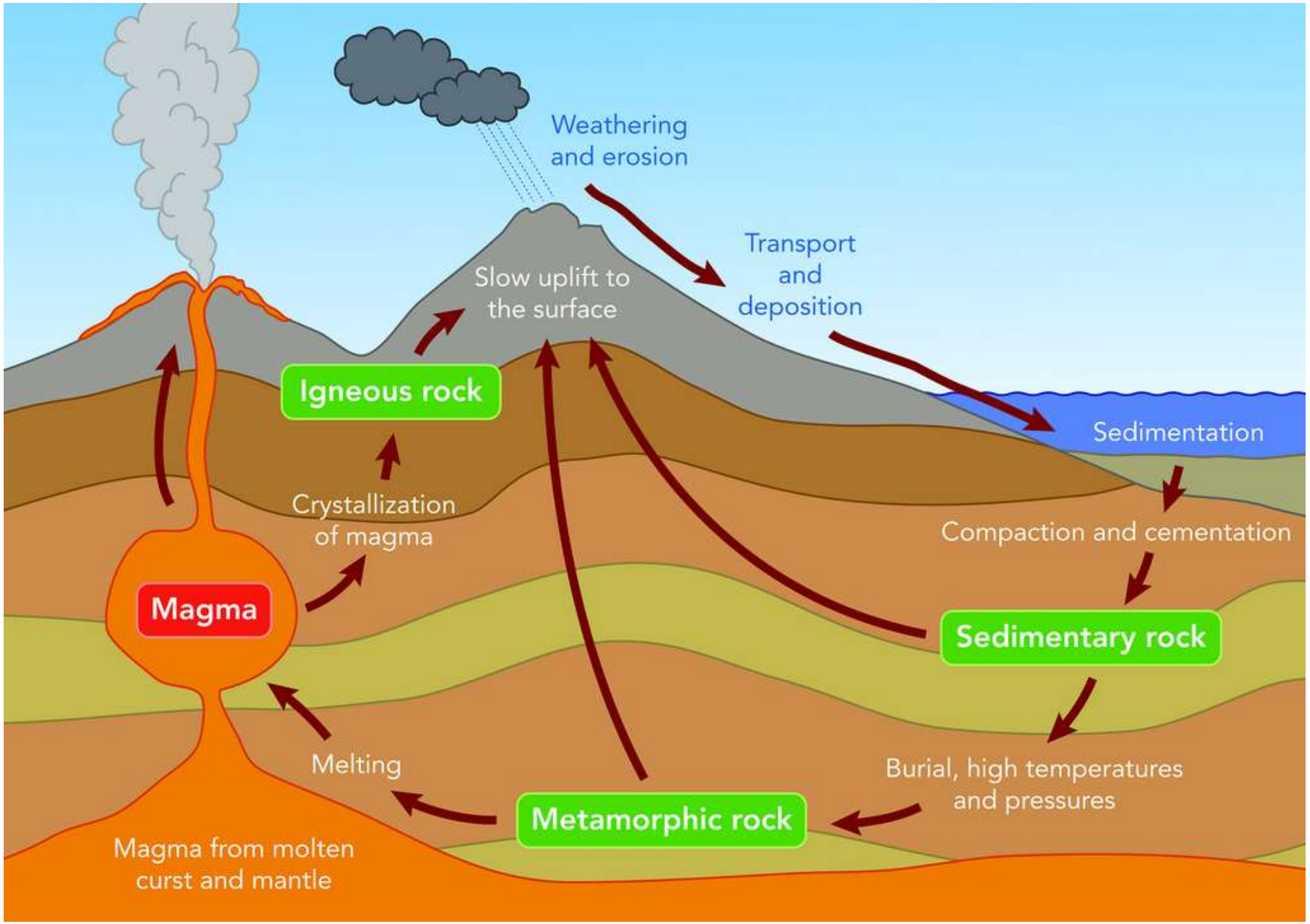
Useful as a starting point for engineering projects



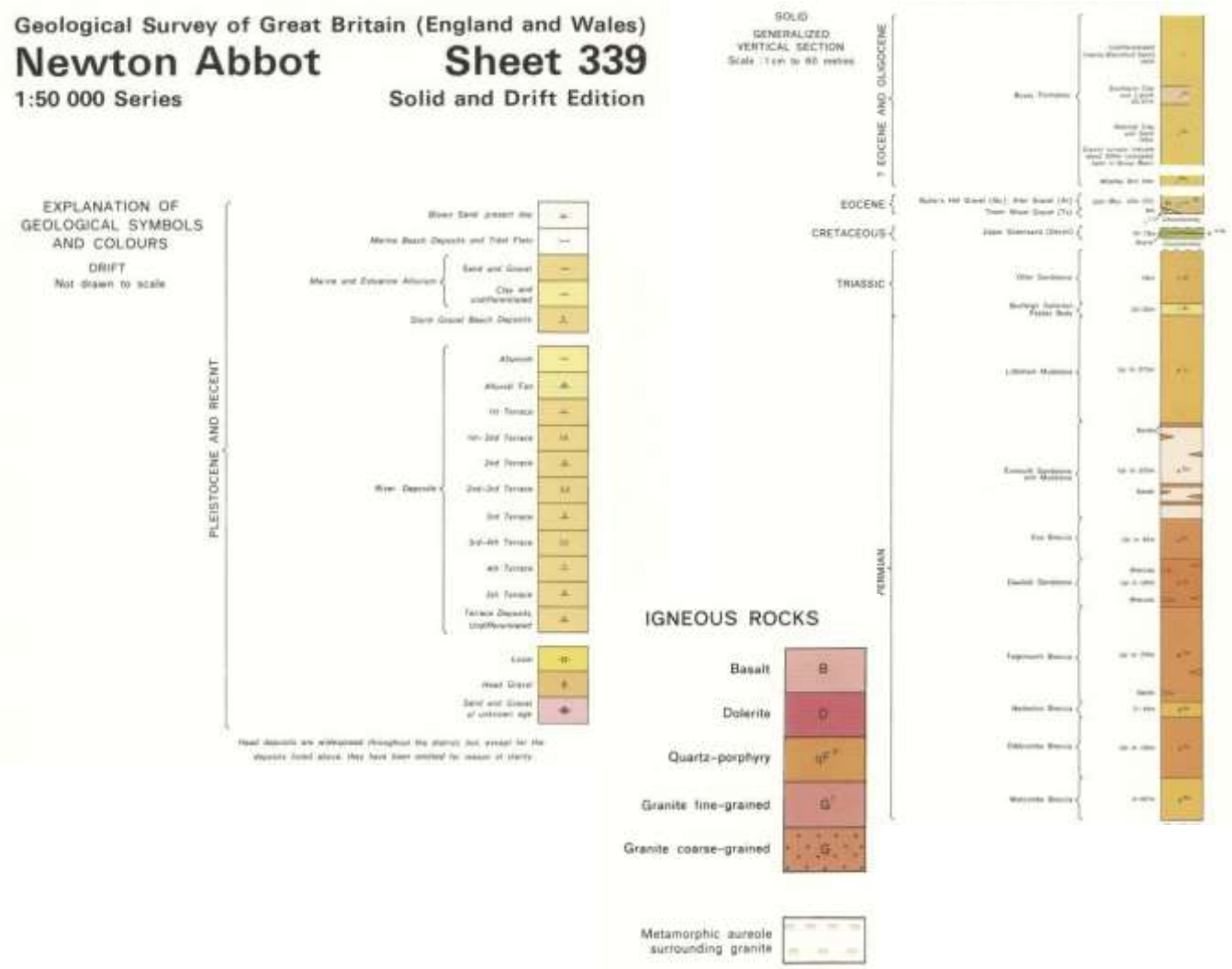
# TYPES OF ROCKS

| IGNEOUS | SEDIMENTARY | METAMORPHIC |
| --- | --- | --- |
|  Granite |  Sandstone |  Marble |
|  Scoria |  Limestone |  Slate |
|  Pumice |  Shale |  Quartzite |
|  Obsidian |  Conglomerate |  Gneiss |
| |  Gypsum | |

# The Rock Cycle



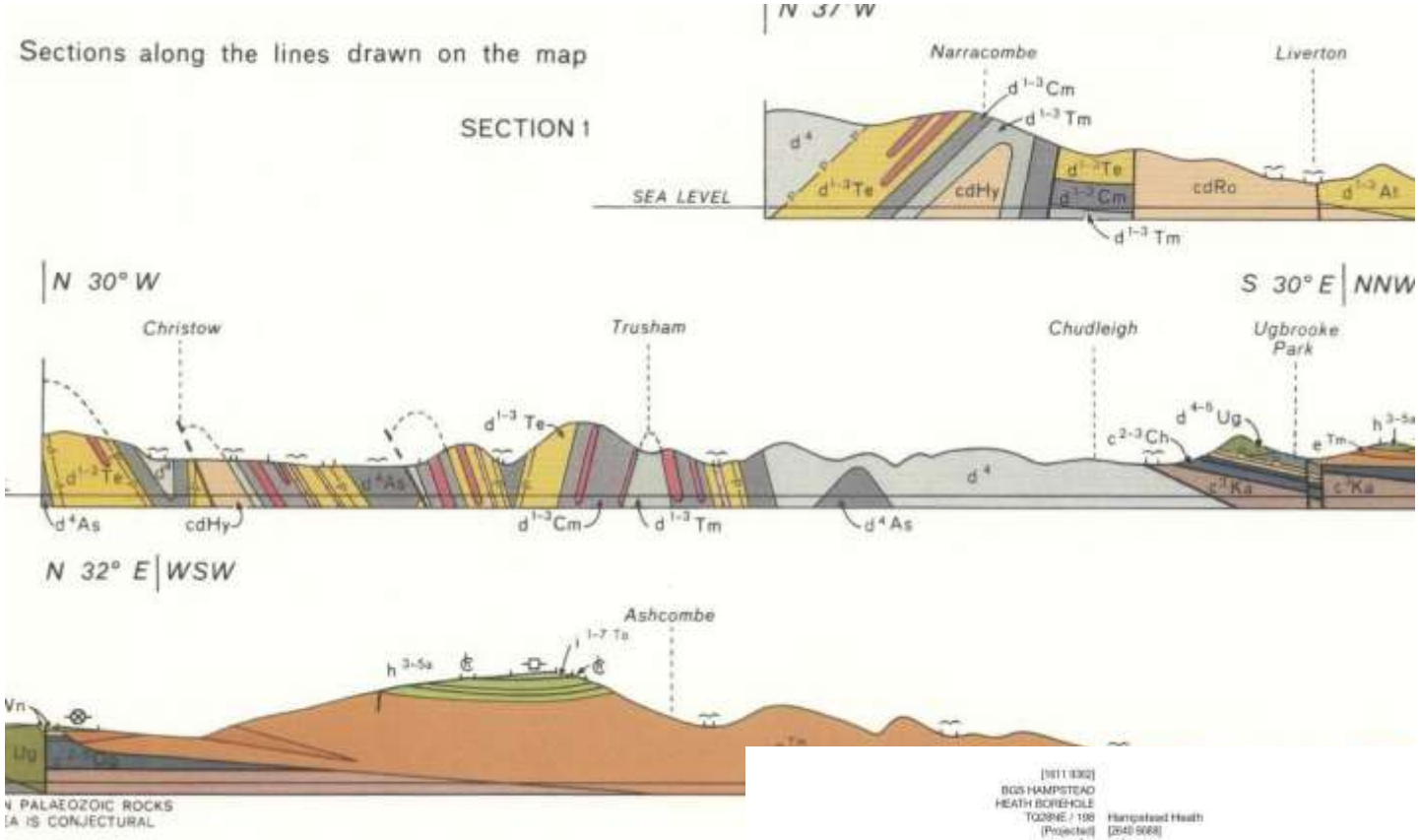
# Features of Geology Maps




## The Legend or Key

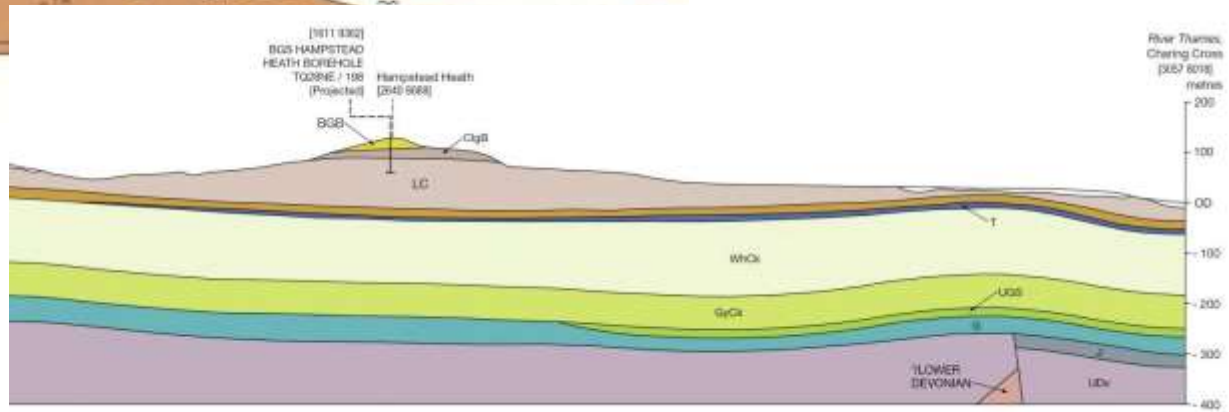
- Usually split into Solid and Drift Deposits
- Drift (also called Superficial) deposits are mainly those associated with rivers (gravel & alluvium) and glacial processes (clays and gravels).
- Solid geology is the sedimentary and metamorphic deposits in age order (youngest at the top)
- Igneous (formed from molten) rocks are usually separate on the legend

# Features of Geology Maps




## Cross Sections

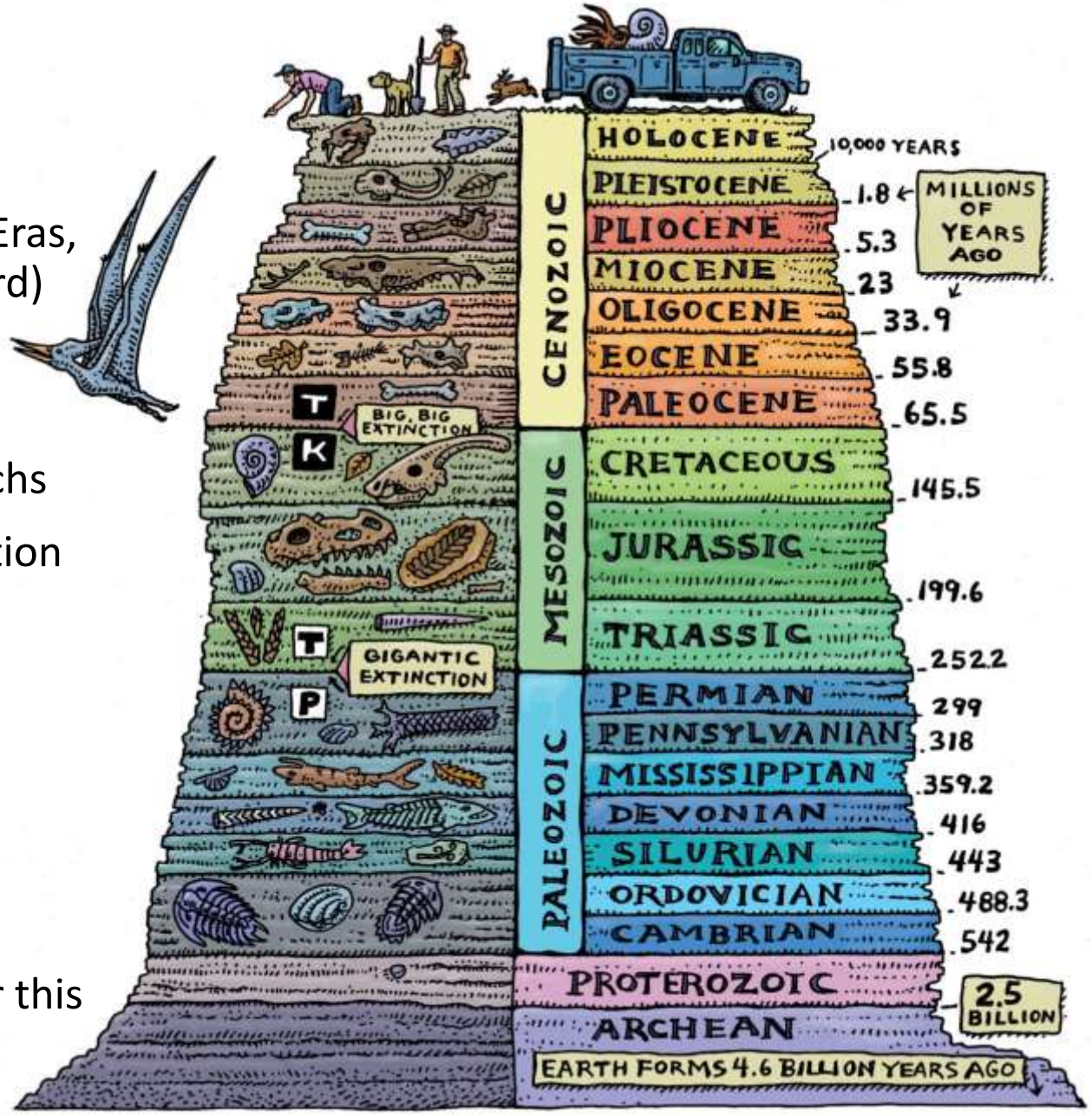
- Show simplified geology at depth
- Show relationships between rock types
- Our area is very complicated
- Others are much more mundane

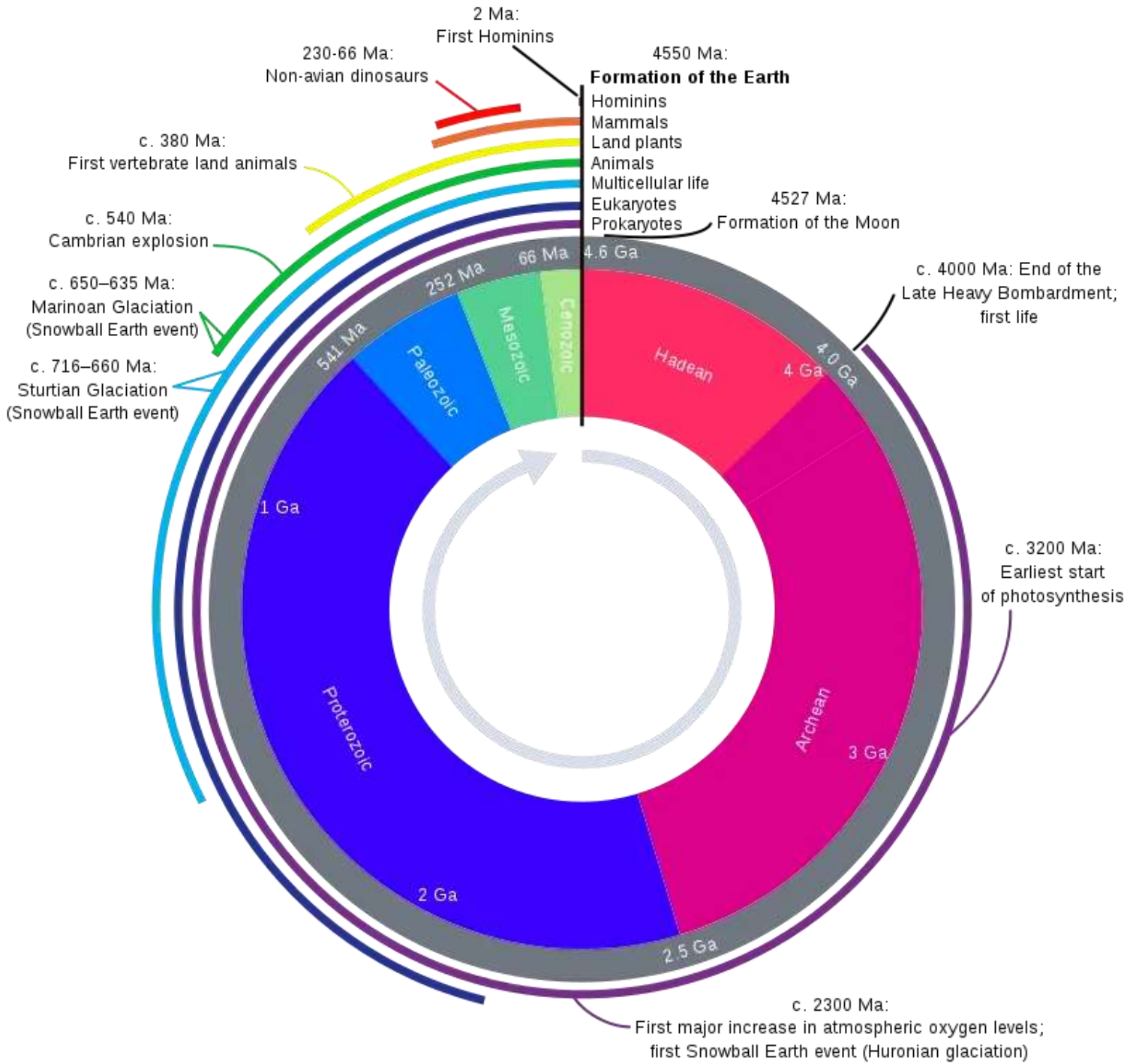


# Geological Time

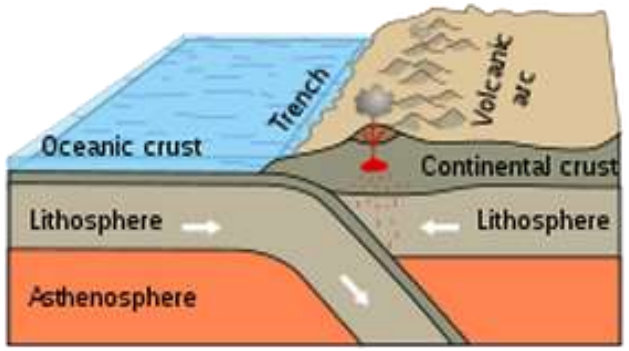
- The Earth formed 4.6 Bya (4,600,000,000 years)
- Geologists have divided up geological time into Eras, Periods and Epochs (mostly based on fossil record)
- For geology older than 65 million years they generally only refer to the Periods
- For younger geology they generally refer to Epochs
- The divisions between Eras are big global extinction events

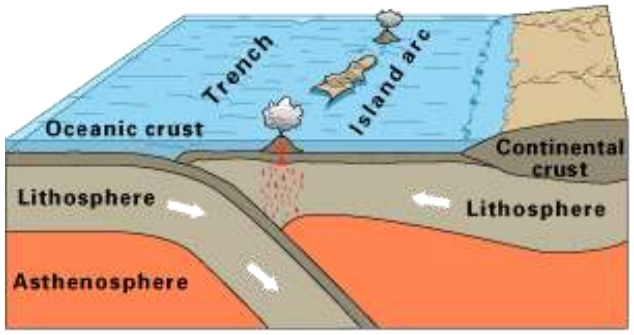
- Geology maps and Stratigraphy
- Geologist compare fossils across the world to understand age relationships between rocks formations
- Radio-isotopes & paleo-magentism also used for this
- Putting it all together is one big puzzle!



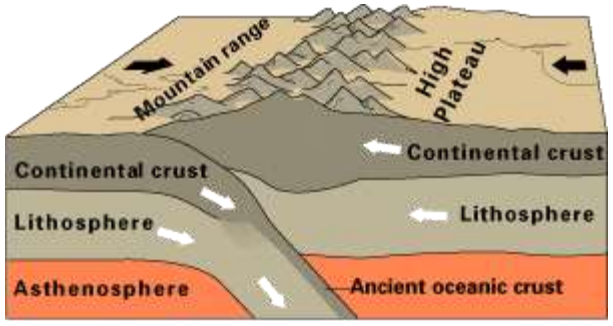

2 Ma:
First Hominins
230-66 Ma:
Non-avian dinosaurs
4550 Ma:
Formation of the Earth
Hominins
Mammals
Land plants
Animals
Multicellular life
Eukaryotes
Prokaryotes
c. 380 Ma:
First vertebrate land animals
4527 Ma:
Formation of the Moon
c. 540 Ma:
Cambrian explosion
c. 650–635 Ma:
Marinoan Glaciation
(Snowball Earth event)
c. 716–660 Ma:
Sturtian Glaciation
(Snowball Earth event)
66 Ma
4.6 Ga
252 Ma
541 Ma
Cenozoic
Mesozoic
Paleozoic
Hadean
Archean
Proterozoic
4 Ga
4.0 Ga
3 Ga
2.5 Ga
2 Ga
1 Ga
c. 4000 Ma: End of the
Late Heavy Bombardment;
first life
c. 3200 Ma:
Earliest start
of photosynthesis
c. 2300 Ma:
First major increase in atmospheric oxygen levels;
first Snowball Earth event (Huronian glaciation)

# Our Dynamic Earth



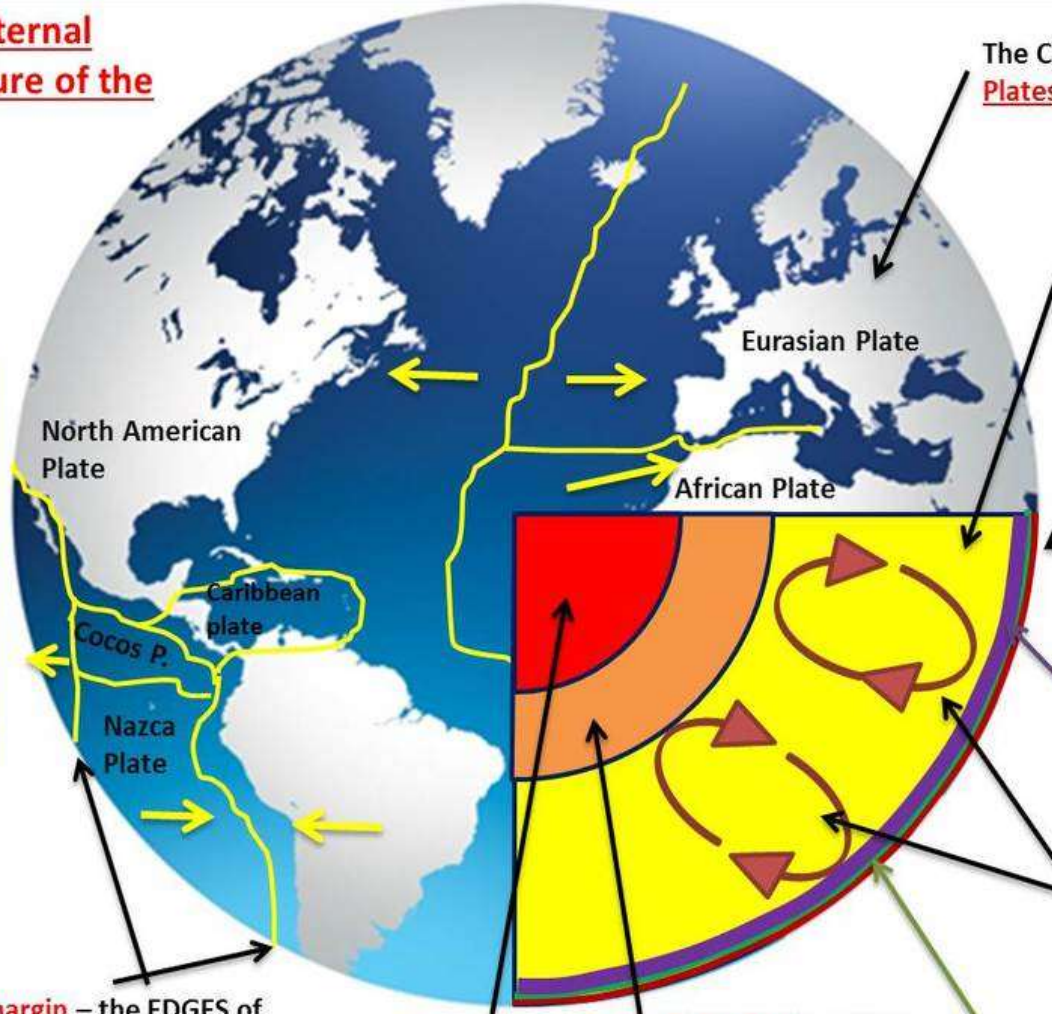




Oceanic-oceanic convergence




Continental-continental convergence

## The Internal Structure of the Earth




The Crust is fractured into Tectonic Plates such as the Eurasian

The Mantle, a zone of molten Silicates and other minerals. Molten so it moves, the source of this is the Earth's intense inner heat which sets up convection currents. 2,900km thick

The Crust – 2 types – Oceanic (denser, newer, thinner) and Continental (older, thicker & less dense)

Asthenosphere - The upper part of the mantle approximately 80km deep where rocks are kept in a semi-molten state

Convection currents – heat currents in the molten magma that move the crust above very slowly

Plate margin – the EDGES of plates where 2 plates are either moving apart, colliding together or sliding past one another

Outer Core – under slightly less pressure

Solid core of Iron and Nickel, which is solid despite temperatures of 3700°C because of the intense pressure there.

Mohorovičič or Moho Discontinuity – the junction between the Earth's crust and the mantle where seismic waves are modified

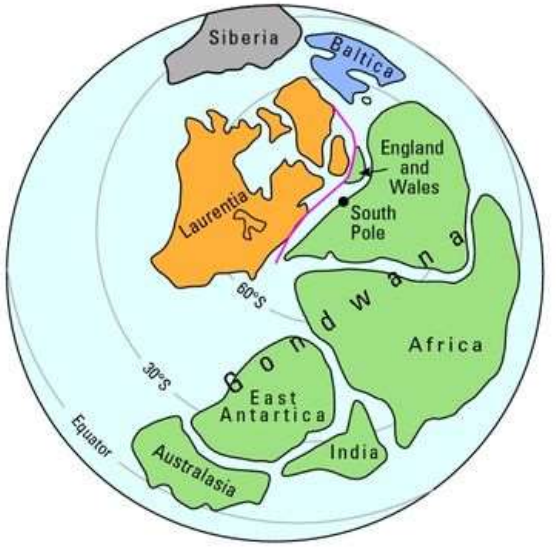
# Movement of Continental Plates – 600 to 420 Mya

Two main continents

- Gondwana
- Laurentia (aka Laurussia and Laurasia)

- Britain is divided between the two
- NW Scotland and N Ireland was part of Laurentia
- England and Wales was part of Gondwana and split away as a micro-continent known as Avalonia

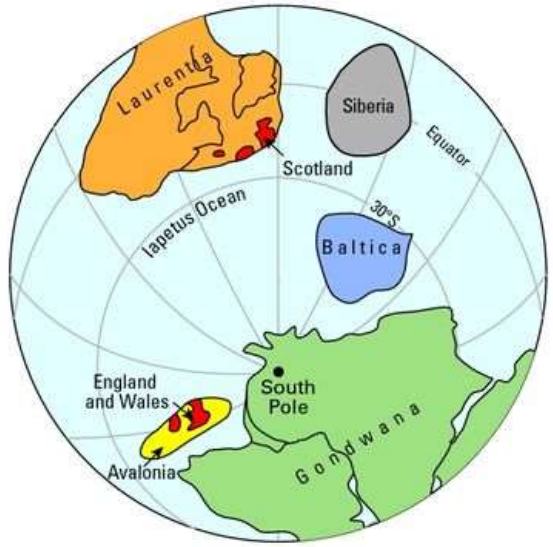
- Over 120 million years Laurentia moved from close to the South Pole followed by Avalonia



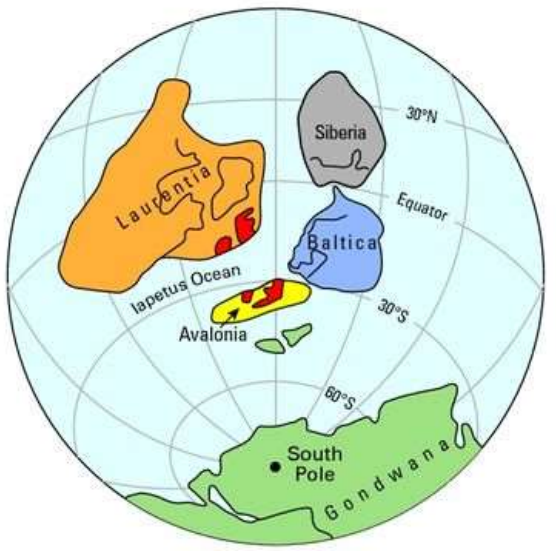

Late Proterozoic (c.600 ma)

Line along which Iapetus opened

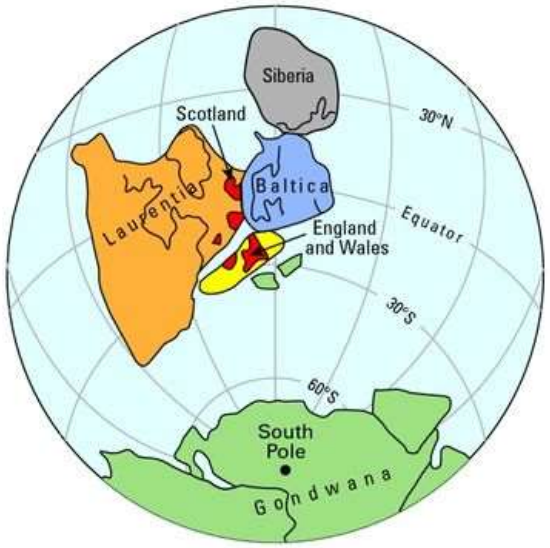
British Isles greatly exaggerated




Early Arenig (c.480 ma)



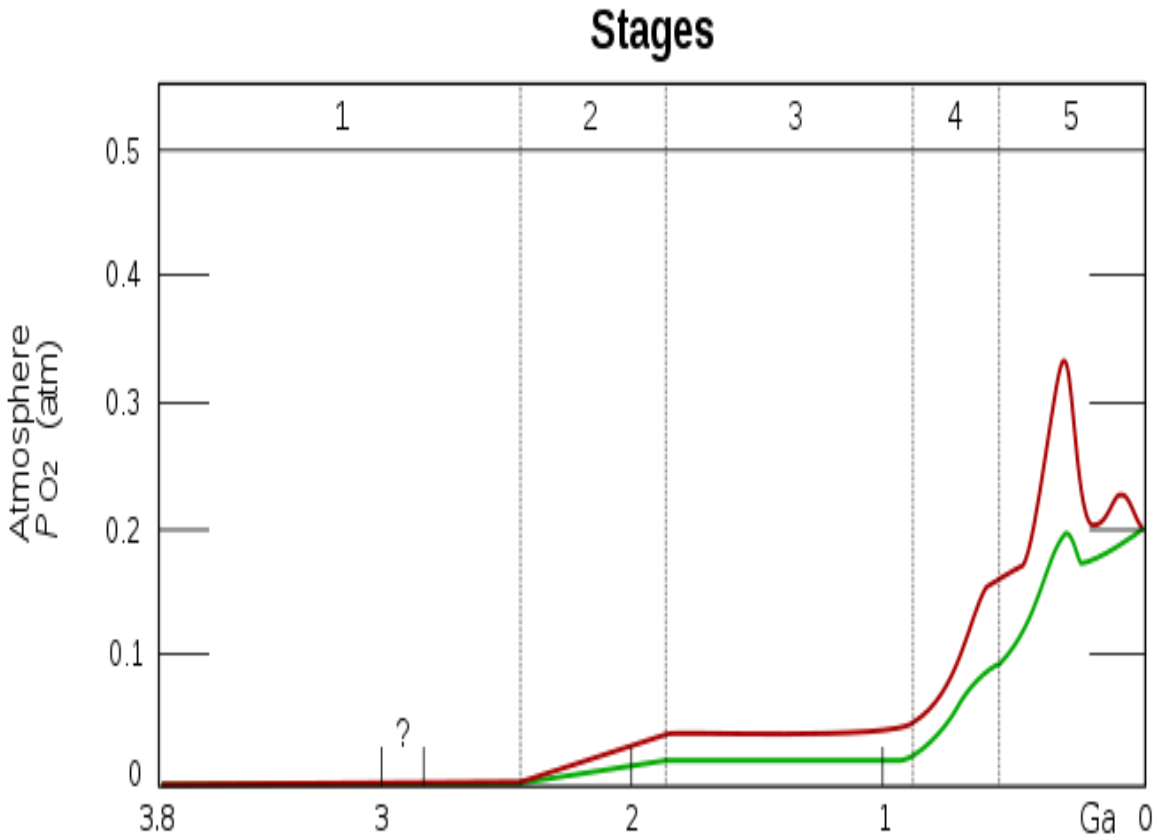

Late Ashgill (c. 443 ma)




Late Silurian - early Devonian(c. 418 ma)

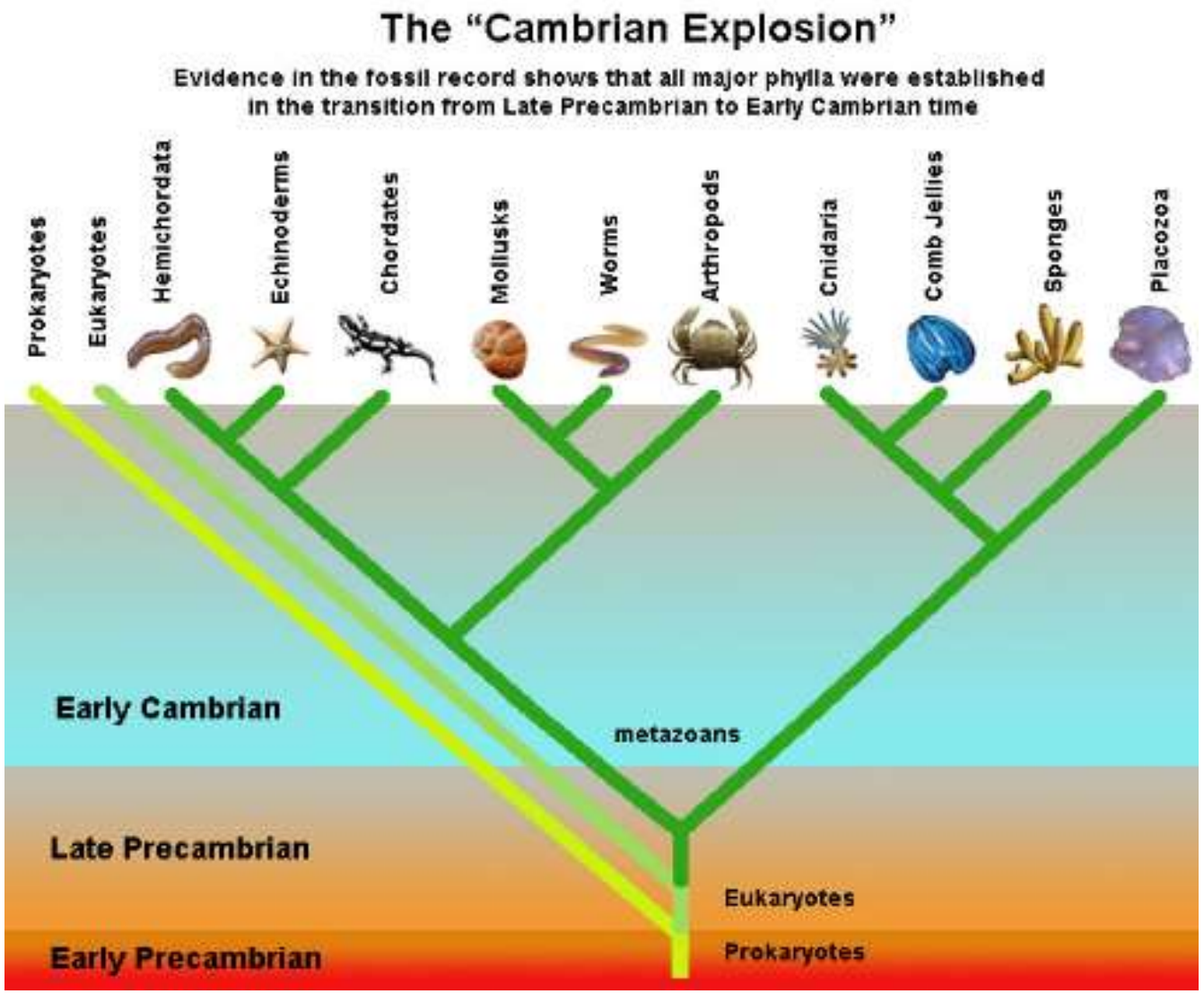
# Evolution of the Atmosphere

- It is thought that microbes evolved & produced $O_2$ as early as c.3.8 Bya?
- Slow oxygenation of the oceans over c.2.0 Bya (1 & 2)
- $O_2$ starts to gas out of the oceans, but is absorbed by land surfaces (3)
- Other $O_2$ reservoirs filled; $O_2$ gas accumulates in atmosphere (4)
- $O_2$ levels similar to today – rising to 35% in Carboniferous!? (5)



# The Cambrian Explosion

- Occurred 540 Mya
- Lasted 13-25 My
- All large multicellular life evolved
- All main body plans formed
- Complex ecosystems created



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**Part 2**

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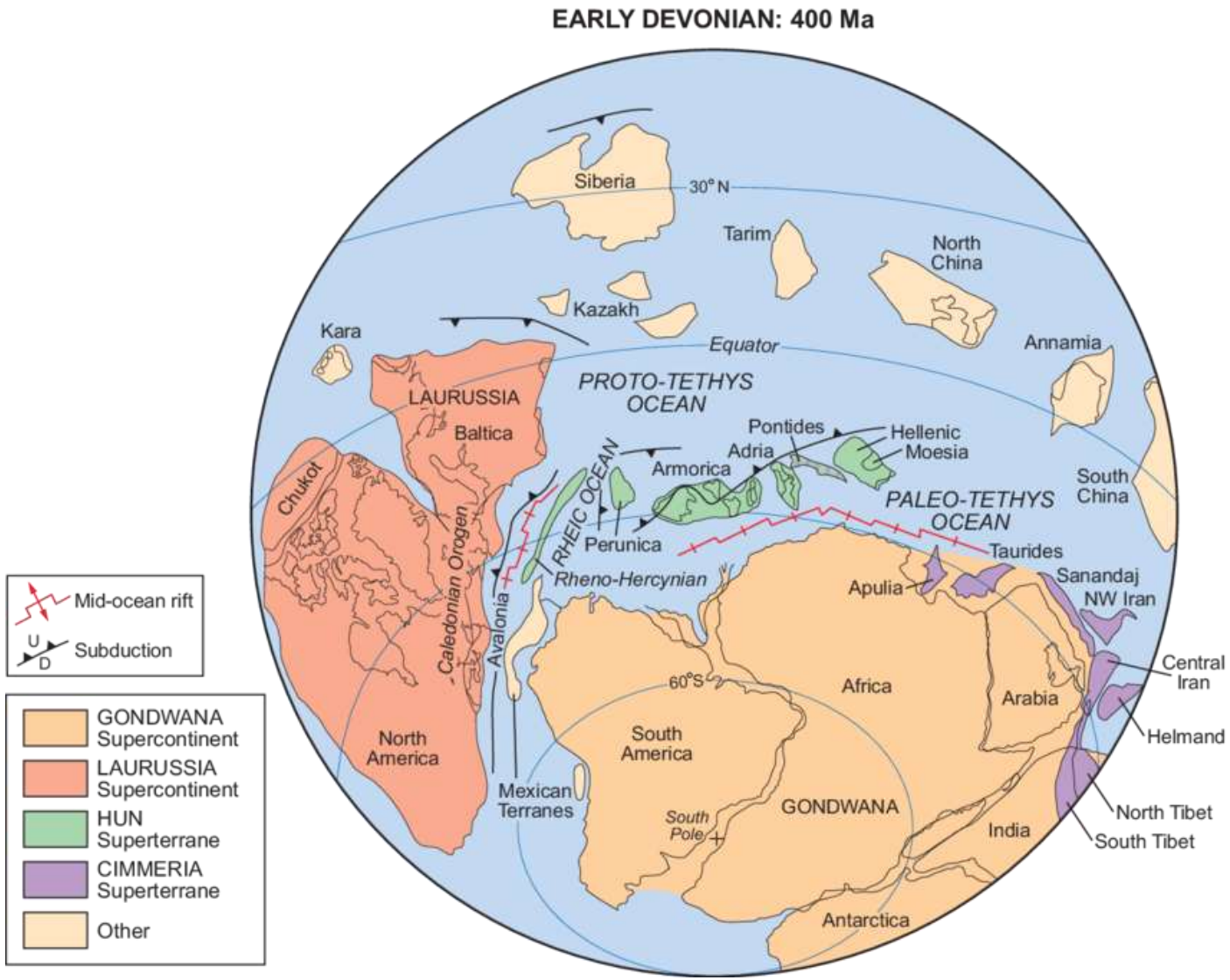
- **The Carboniferous – shallowing seas, volcanics and igneous intrusions**
- **The Permian – desert flood deposits**
- **The Cretaceous – on the edge of the chalk sea**
- **The Cenazoic – erosion & formation of the Bovey Basin**

# The Devonian - Chudleigh Limestone

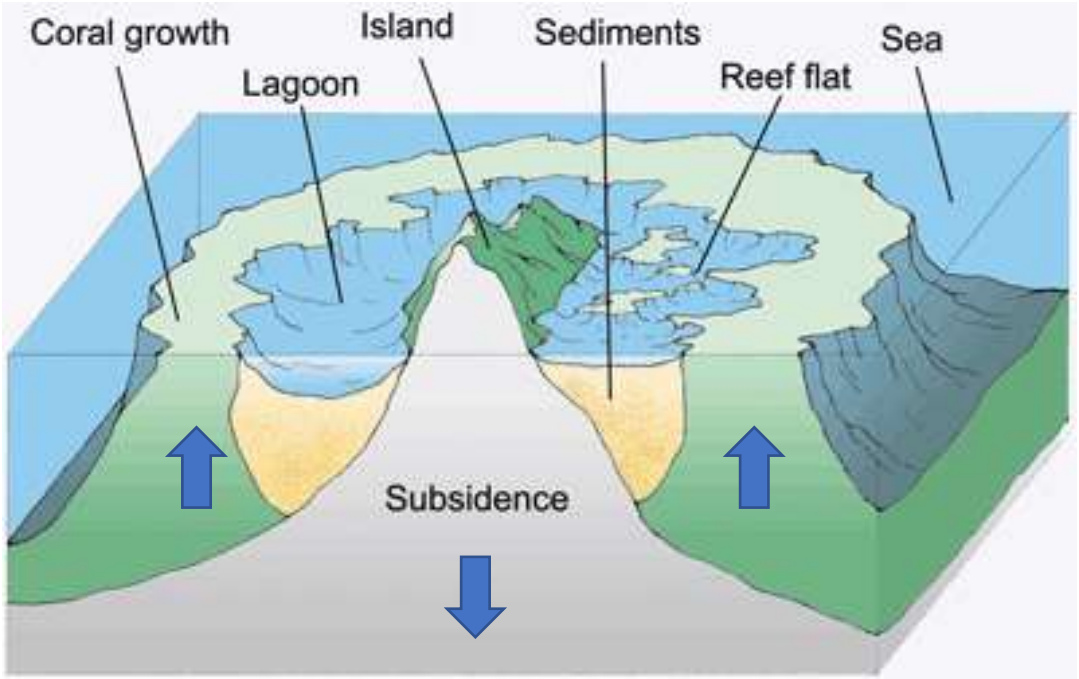
420 to 360 Mya

# The Devonian – the formation of coral reefs

- Gondwana & Laurentia continents moving together
- Britain's land mass is south of the equator
- (Most of) Britain in Avalonia micro-continent
- NW Scotland in Laurentia
- Volcanic activity due to subduction of oceanic plate



# The Devonian – the formation of coral reefs



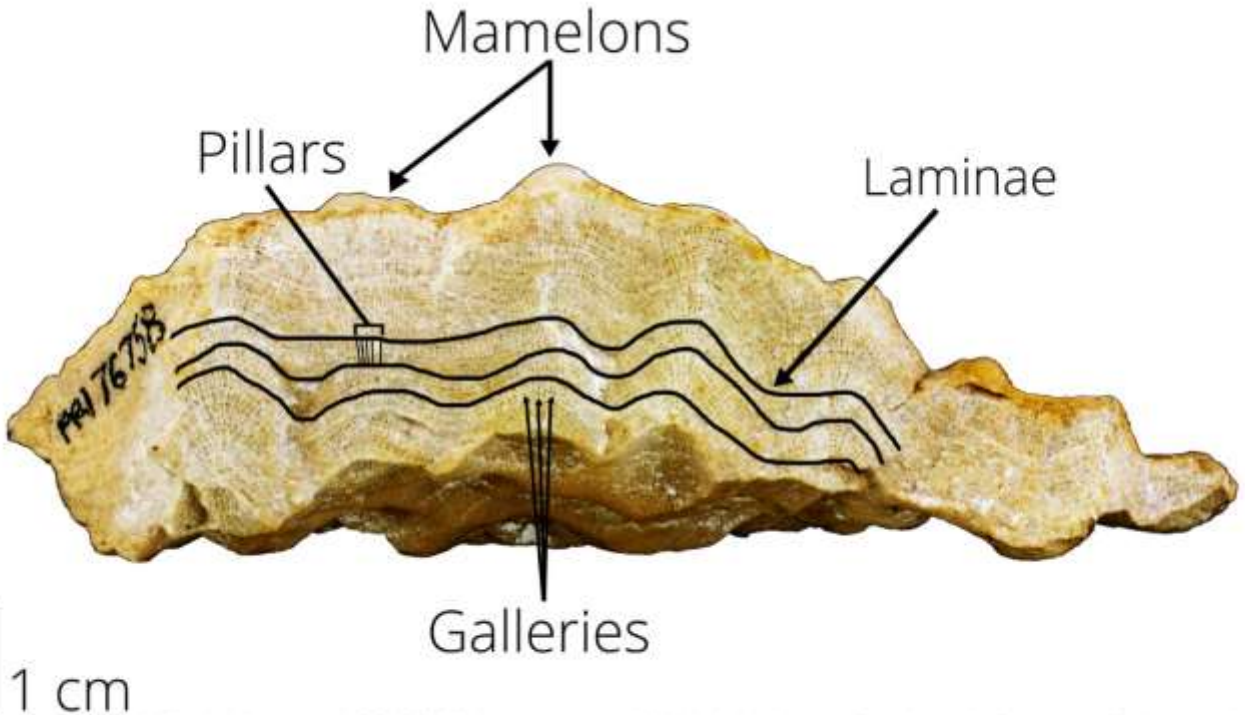

Modern day colonial corals (Red Sea)

Modern day stromatolites (Australia)

# Coral reef fossils


*Acinophyllum stramineum*, from the Devonian Onondaga Limestone of Erie County, New York. Specimen is from the collections of the Paleontological Research Institution, Ithaca, New York (PRI 76812).

# Stromatoporoids

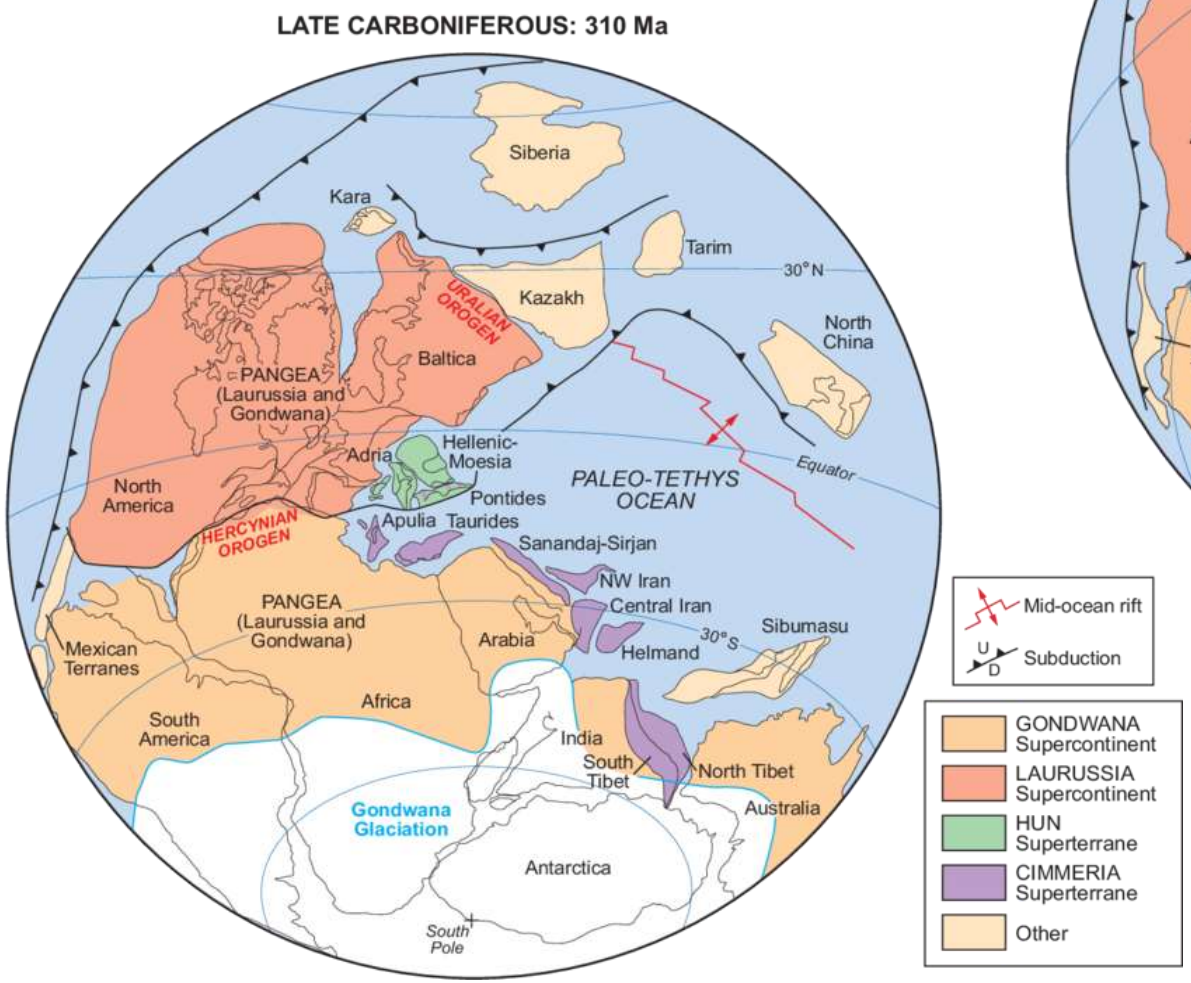


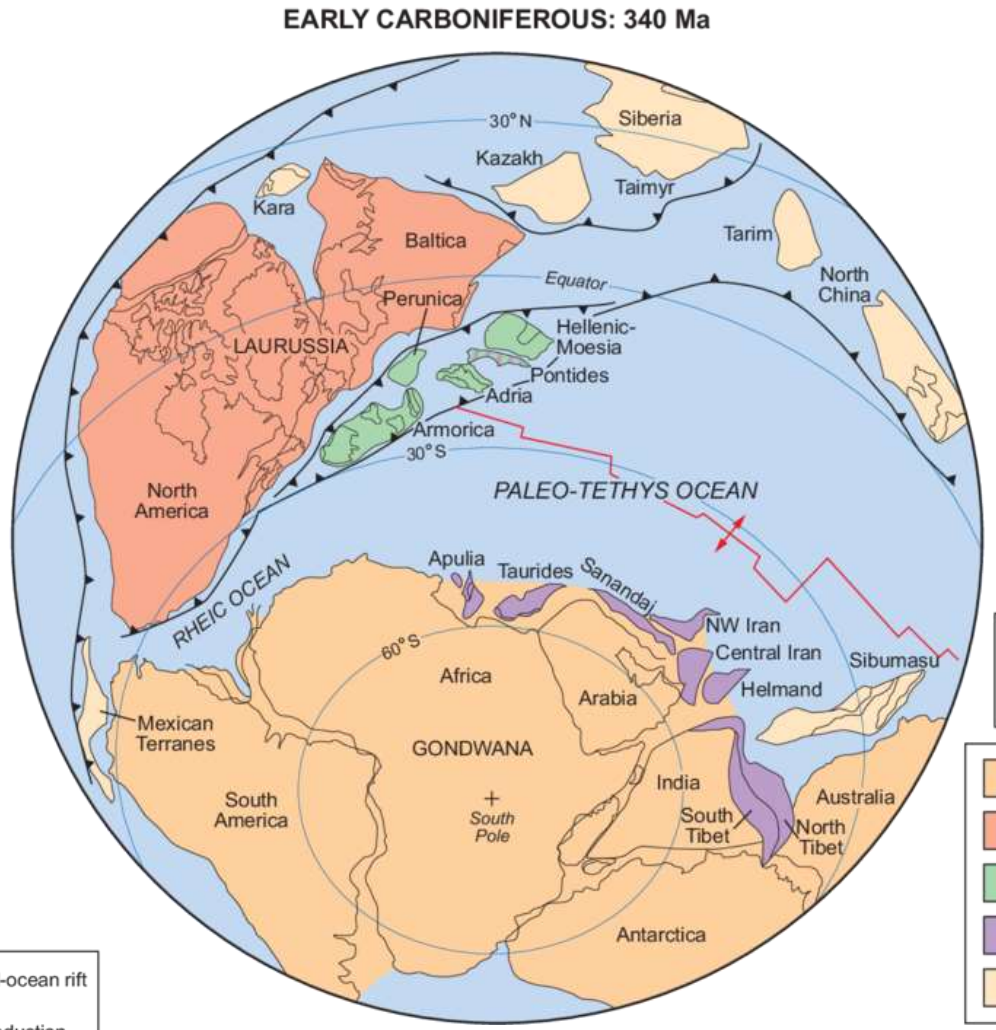

Cross section of *Clathrodictyon sp.* (PRI 76758) stromatoporpoid highlighting layers. Specimen is from the collections at the Paleontological Research Institution, Ithaca NY. Image by Jaleigh Q. Pier is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Bivalve shell

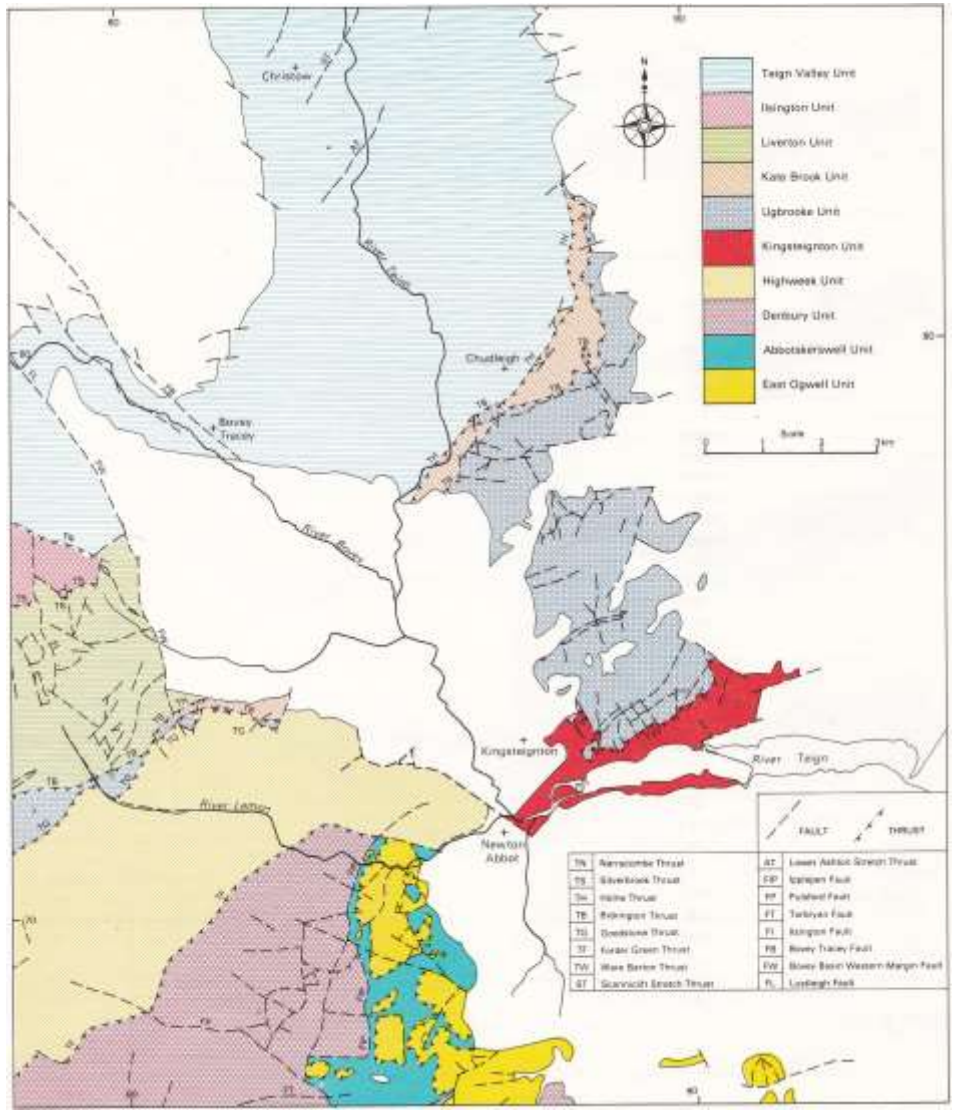

The Carboniferous
360 to 300 Mya

# The Carboniferous – shallowing seas, volcanics and igneous intrusions



# Carboniferous Folding and Faulting



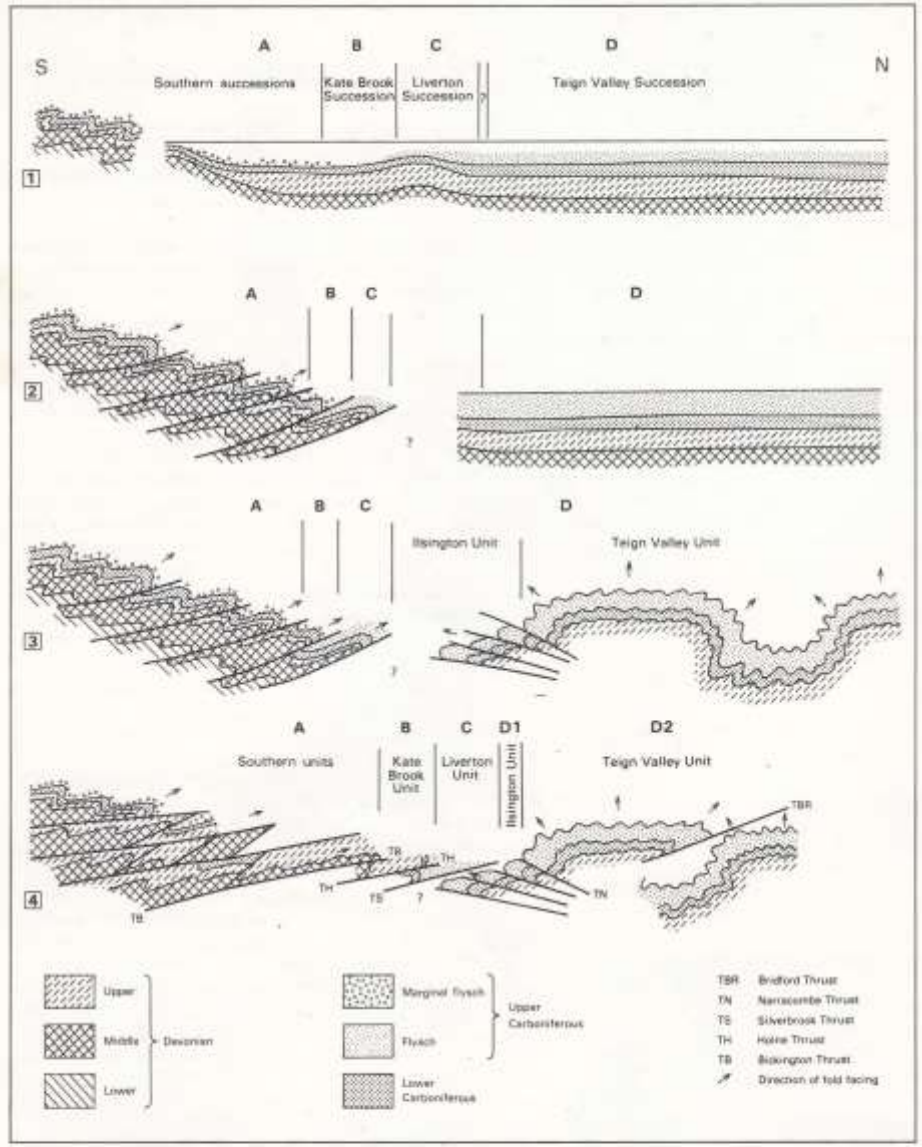




**Figure 4** Structural evolution of the Devonian and Carboniferous rocks of the Newton Abbot district

1 Mid Namurian. Upper Devonian and Lower Carboniferous deformation resulted in uplift and erosion south of Torquay
2 Late Namurian. Deformation of the southern successions, the Kate Brook Succession and the Liverton Succession was accompanied by northward thrusting
3 Late Westphalian. The Teign Valley Succession was deformed for the first time
4 End Westphalian. Northward sliding and thrusting of the southern units and the Kate Brook and Liverton units brought them into juxtaposition with the Ilsington and Teign Valley units

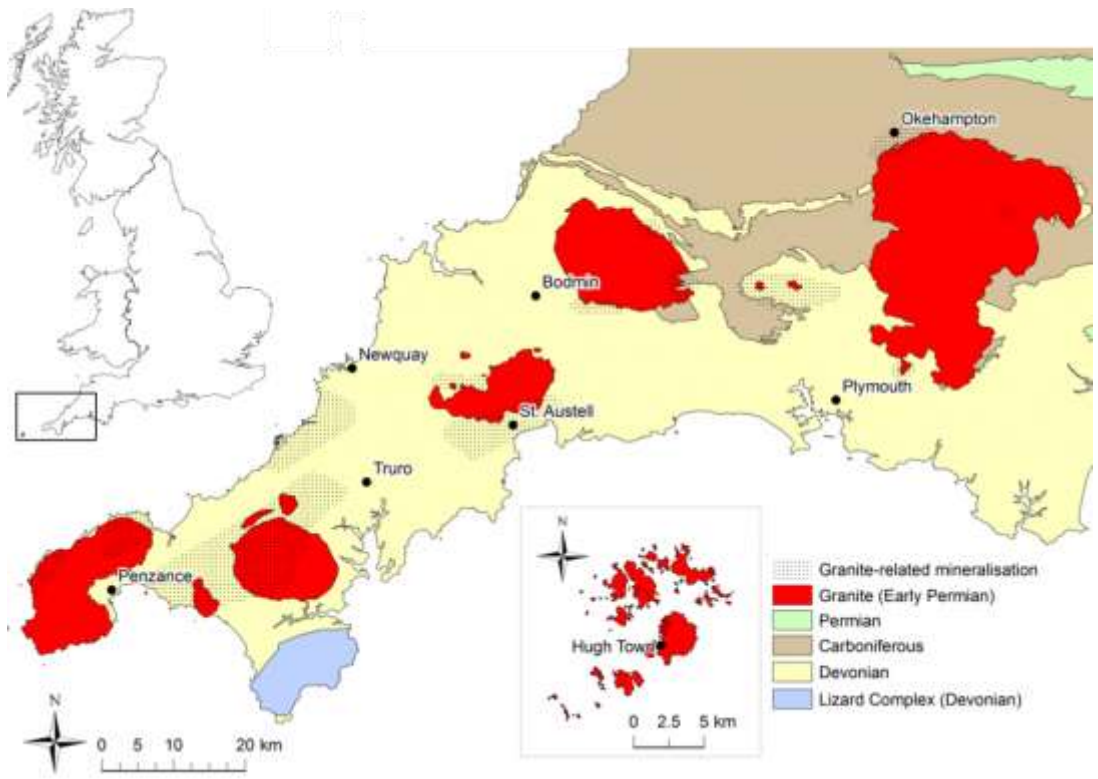
Scale diagrammatic but horizontal scale increases from 1 to 4
Folds in the Ilsington Unit are arbitrarily assumed to face south

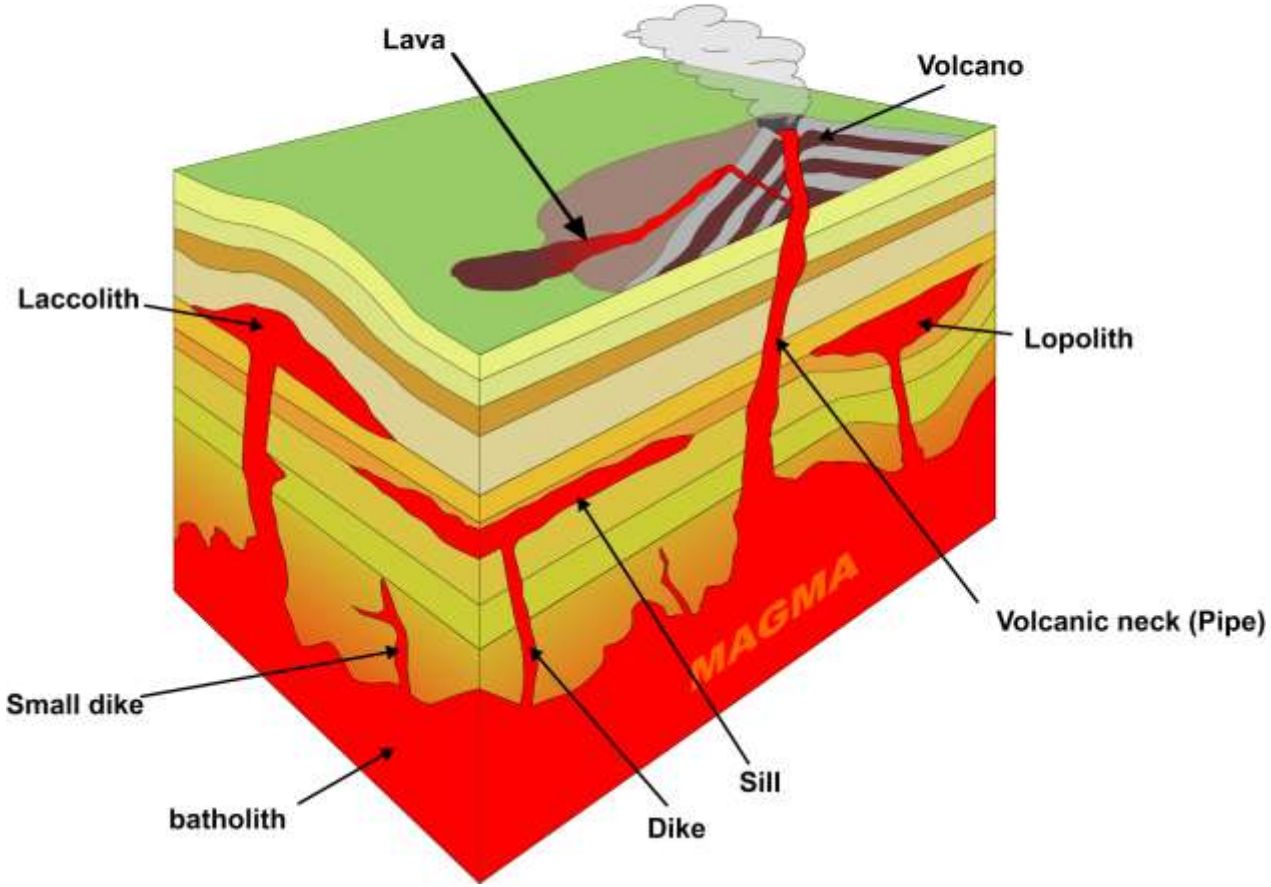

Millook Haven Cliffs, North Cornwall Coast

# Dartmoor Granite

280 Mya

# Dartmoor Granite and Igneous Intrusions



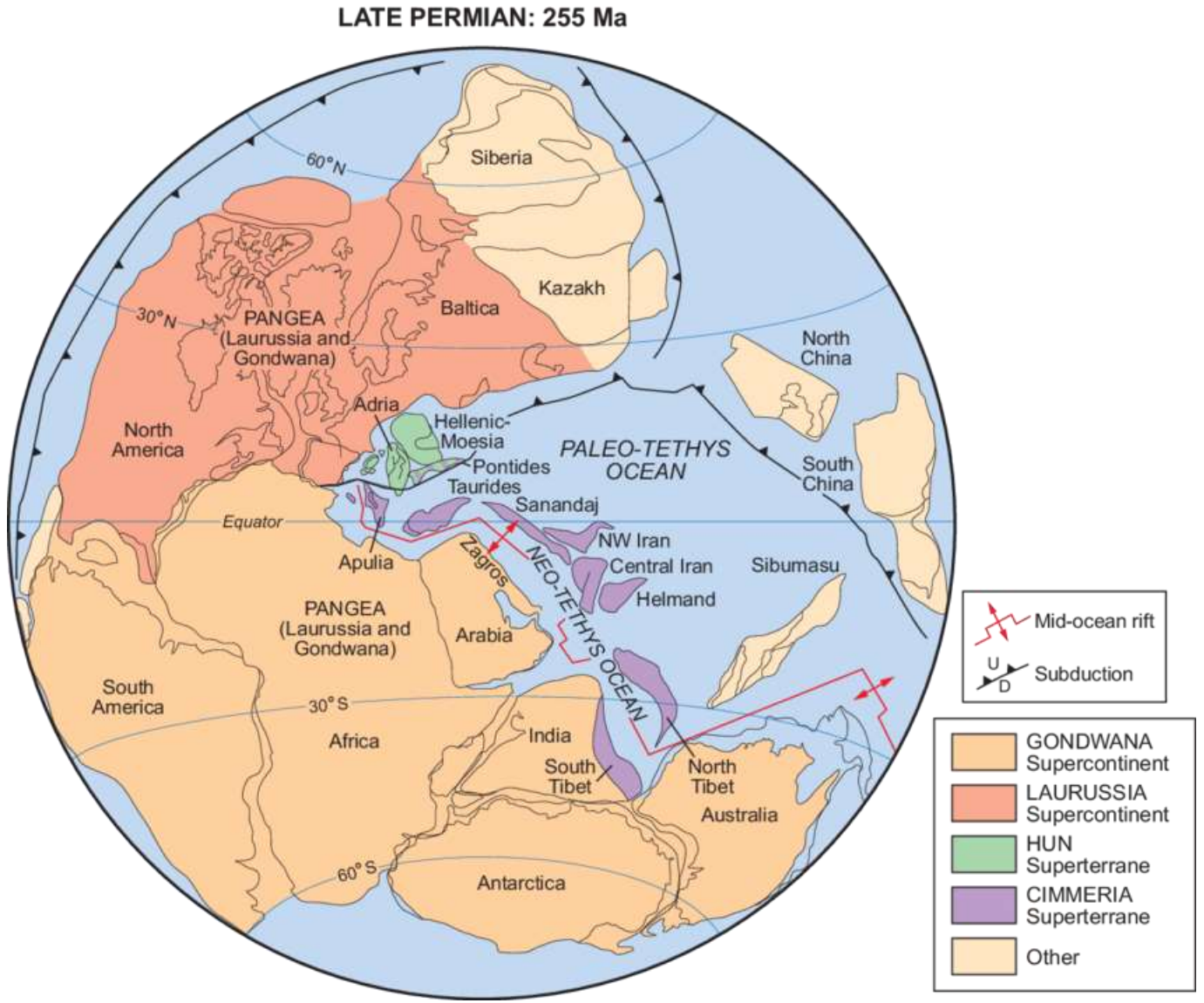



300 to 250 Mya

# The Permian – formation of Pangea

- The Permian Period occurred
- Most of Earth's landmass is now in one supercontinent – Pangea

- Britain's land mass is now north of the equator



# The Permian – desert flood deposits

- Southern Britain in central Pangea
- Mountainous desert
- Deep canyons
- Desert plains to east
- Flash flooding and high erosion
- Chunks of limestone in lower beds
- Beds formed rapidly

Chunks of limestone easily visible in breccia deposits at Goodrington Sands

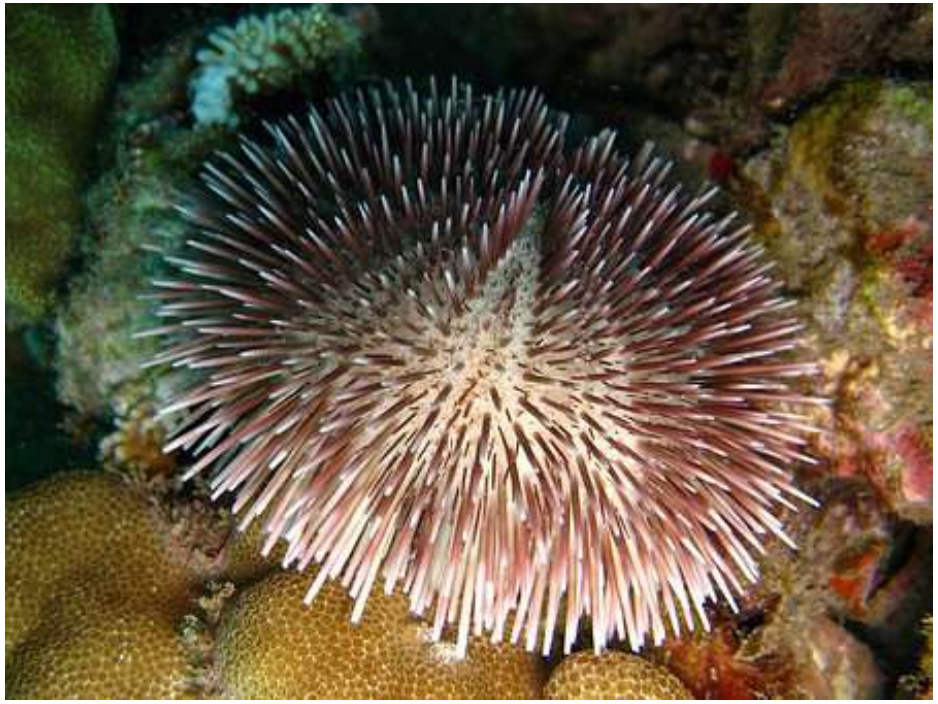
# The Cretaceous

145 to 65 Mya

# The Cretaceous – on the edge of the chalk sea

- Most Cretaceous rocks in the area cap Haldon Hill
- Formed in warm shallow seas
- The sea would have been extensive across much of Britain
- Upper Greensand is overlain by flint gravels from remains of weathered Chalk
- Upper Greensand contains chert (flinty) beds
- The gravels (named after the quarries, such as Buller's Hill and Tower Wood) contain excellently preserved sea urchins
- Upper Greensand also seen in remains of Devonian limestone sea caves (A380)
- The thickness varies of the Upper Greensand on Haldon Hill varies from 16m to 84m (due to faulting)

# Chalk sea fossils



# End of Cretaceous

Huge meteorite hit the Earth causing extinction of the dinosaurs

Atlantic Ocean started to open up

Britain and America split apart – now on different continents

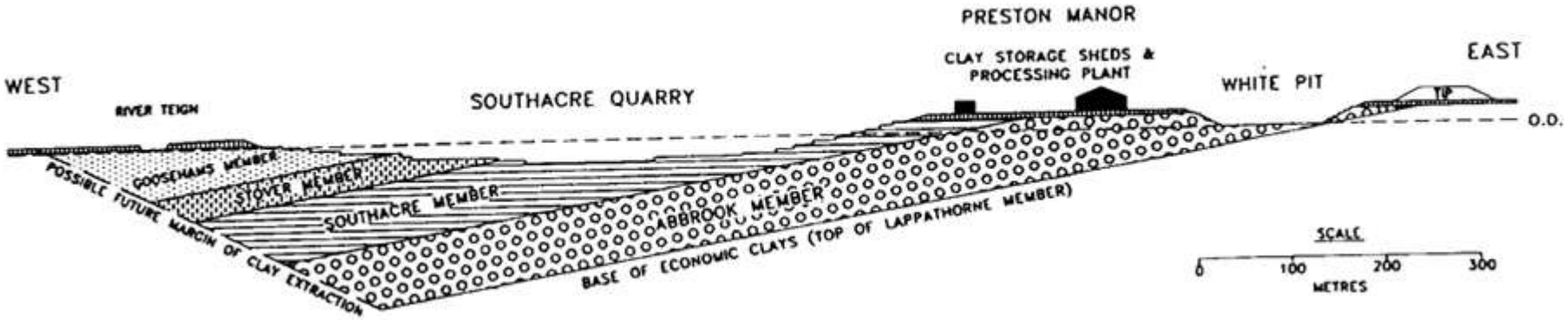
# The Cenazoic

65 Mya to Present

# Cenazoic

- Cenozoic - 66 Mya to present
- No more dinosaurs ☹
- The Age of Mammals
- Characterised by very high rates of erosion in Britain
- Likely to have removed over 1.5 km of rocks from the Chudleigh area
- Uplift in area of Irish Sea
- Due to igneous intrusion
- Tilted Southern Britain’s geology to the southeast

# Formation of the Bovey Basin




- Shallow seas to the east
- Bovey Basin opens up
- Reactivation of old fault line
- Erosion of Dartmoor progressively fills Bovey Basin
- Interbedded clay and lignite deposits
- Over 1 km at its deepest!
- Only the top c.300m known

# The End

Thank you!