Between the Ice

A Geomorphology of the British Isles
Part 2 of 2

Nant Ffrancon Valley

How did such a small river create such a deep and wide valley?

How did this happen?

Silurian grits resting on Carboniferous limestone – an “erratic”.

Quaternary

The Quaternary period is the current geological period. It is a tiny sliver at the top of the geological column and began just 1.8 million years ago. It is characterised by a series of glaciations and is significant in landscape terms because the landscape we see today is predominantly a product of glacial action.

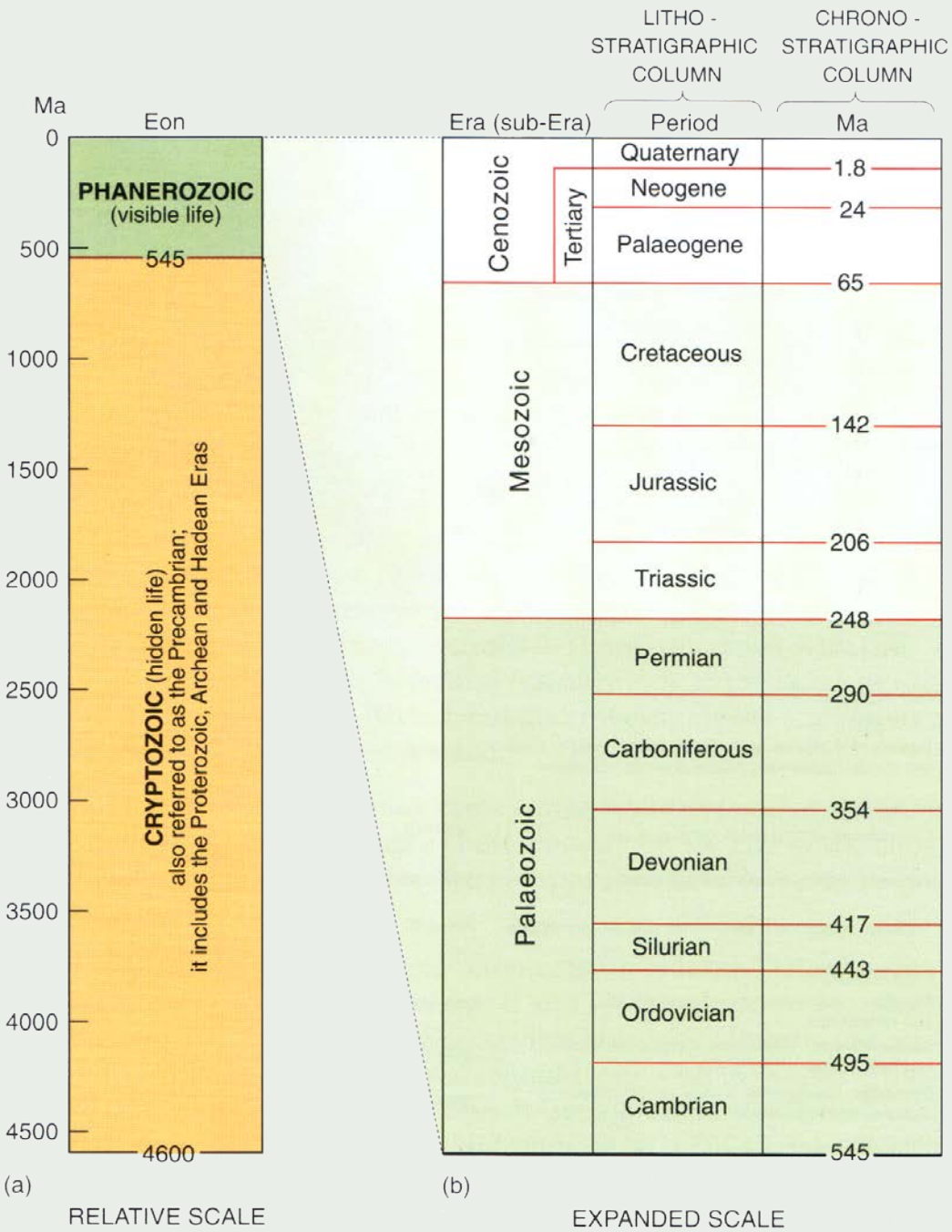


Illustration from the book *The Geological History of the British Isles* by Arlëne Hunter & Glynda Easterbrook

Global Sea-Level and Temperature

Throughout geological history, global temperature and sea-level have changed dramatically. To some degree, they are linked because during cold periods, water is locked in ice-sheets. The graphs on the right show the changes during the Phanerozoic, a period of 550 million years. However, major changes in both temperature and sea-level can take place over much shorter periods…

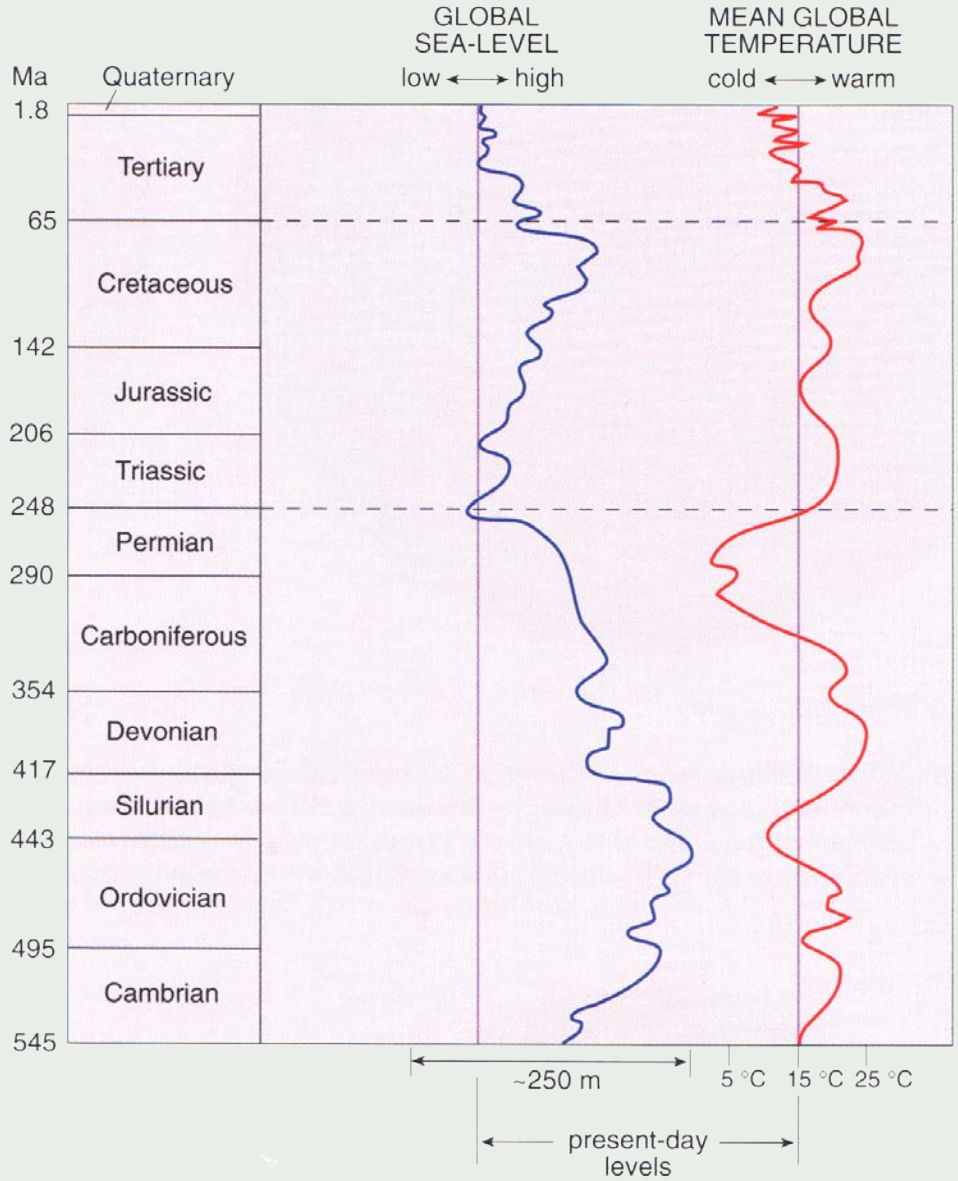
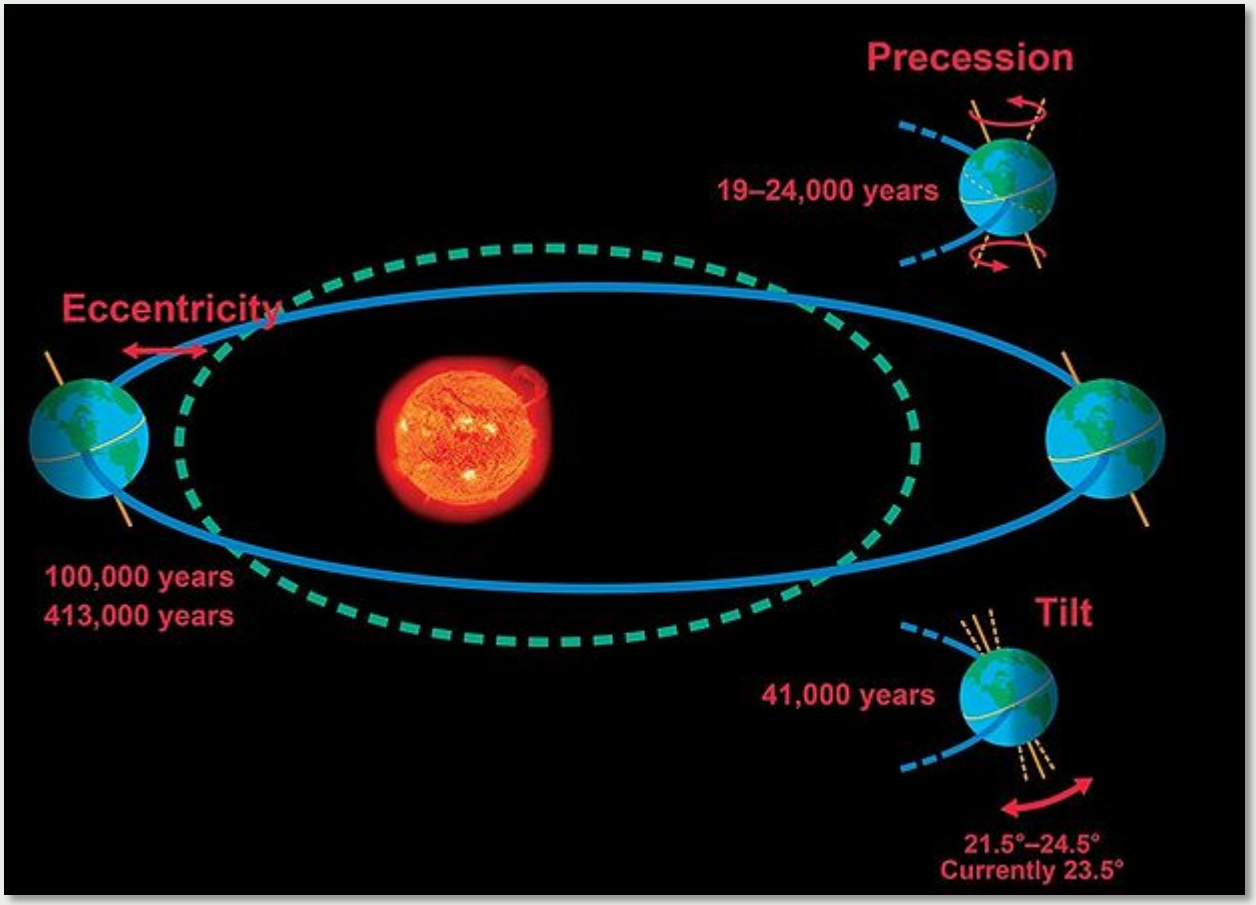


Illustration from the book *The Geological History of the British Isles* by Arlëne Hunter & Glynda Easterbrook

Climate Change

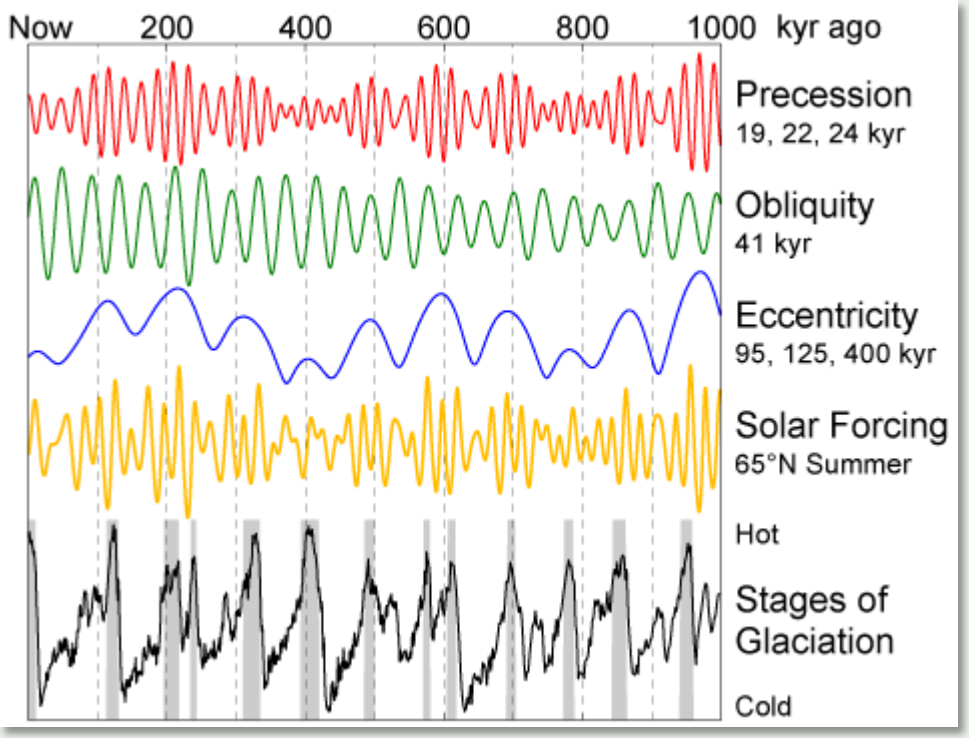
- The climate is always changing and will continue to change
- In 1920's Milutin Milanković calculated that climate change was due to 3 factors:
  - Tilt of axis of rotation of Earth (23.5°)
  - Distance from Sun (eccentricity of orbit)
  - Wobble of Earth axis
- Each factor has a different cycle of 41,000yrs; 100,000yrs and 23,000yrs respectively

Milutin Milanković



Changes in Earth's climate are caused by 3 variables, eccentricity of its orbit around the Sun, the tilt of its axis and the precession of its spin. These combine to vary the amount of solar radiation the Earth receives and this affects temperature. During cold periods, ice sheets form.

Milutin Milanković



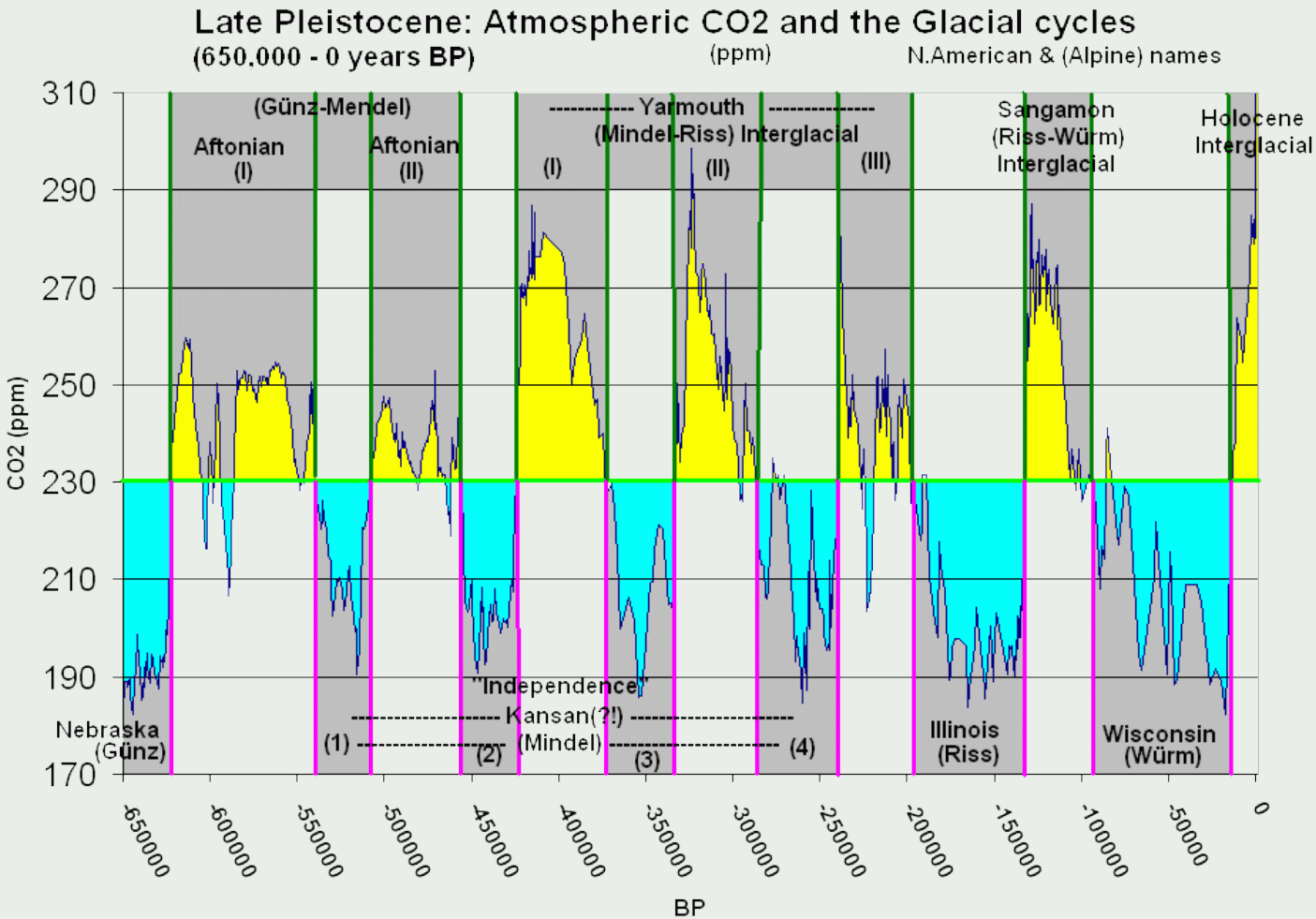
Milanković calculated the different cycles to determine historic rates of solar radiation and was able to demonstrate when cold and warm phases had occurred in the past.

Wikipedia: [Milutin Milanković]

Climate Change

- Glaciation of the landscape was first postulated at the end of the 19th century
- At that time it seemed unbelievable
- Even after Milanković, it wasn't universally accepted until 1950's
- During 1970's work on the varying ratios of light and heavy Oxygen isotopes in deep sea cores demonstrated the same pattern that Milanković had calculated

Atmospheric CO_2



A number of different measures have been used to confirm and refine Milanković's original ideas. Historic CO_2 levels and the relative proportions of O_{16} and O_{18} can be measured from ice cores.

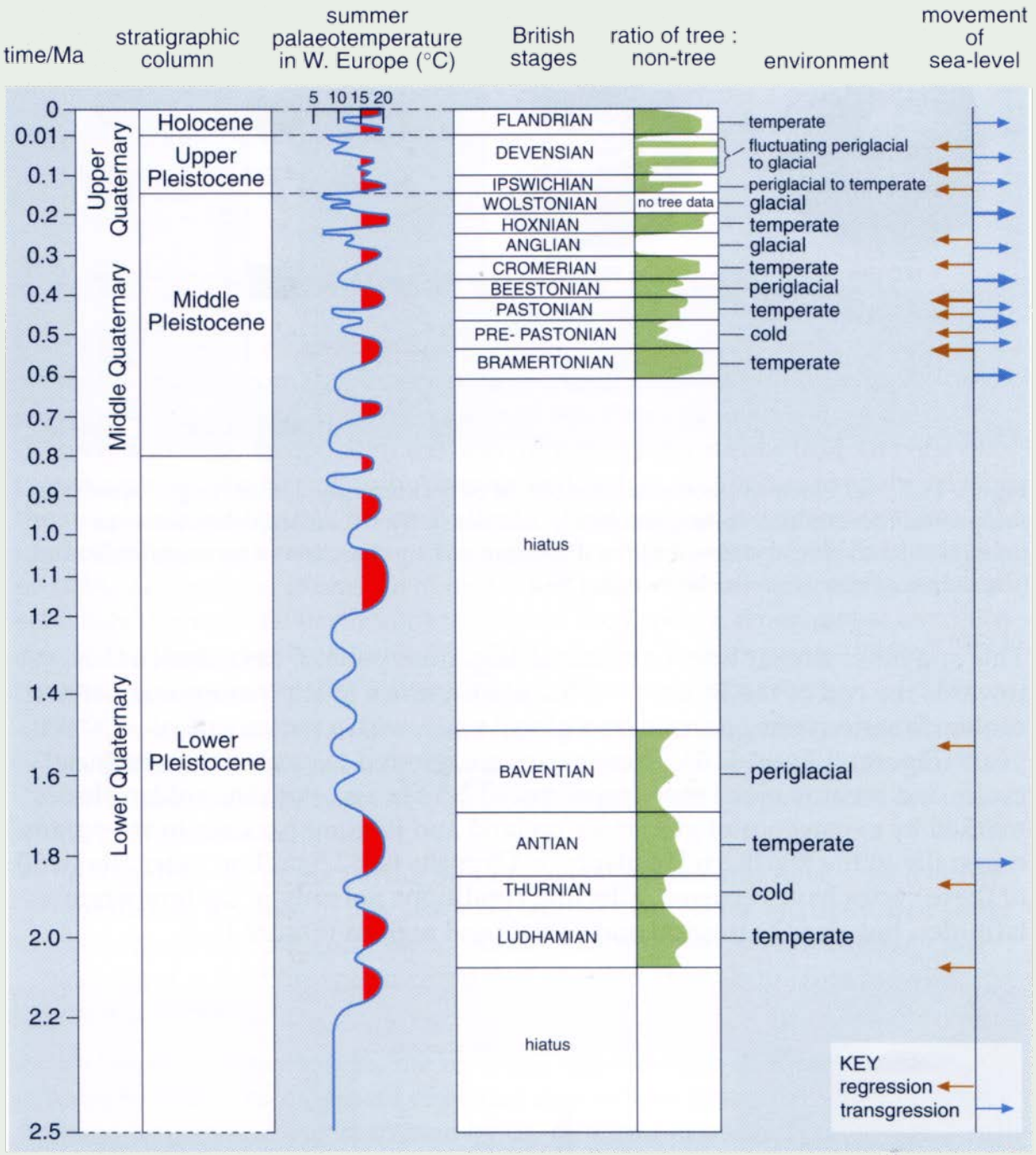
Climate Change

- Evidence of 23 cold episodes during the Pleistocene
- Most recent glacial episode, the Devensian, ended 12-15,000 years ago
- We are currently in an “interglacial” period known as the Holocene
- On average, interglacial periods last 10,000yrs and glacial episodes 90,000yrs
- Result in characteristic glacial landscapes

Quaternary Period

The Quaternary period is divided into 2 epochs, the Pleistocene (ice ages) and the Holocene (the current warm period).
We are still in a period of ice ages and there will be more in the future, so the division of epochs is purely convenient rather than significant.

There is direct evidence of 3 glacial periods but previous cold periods are also likely to have resulted in glacial conditions.



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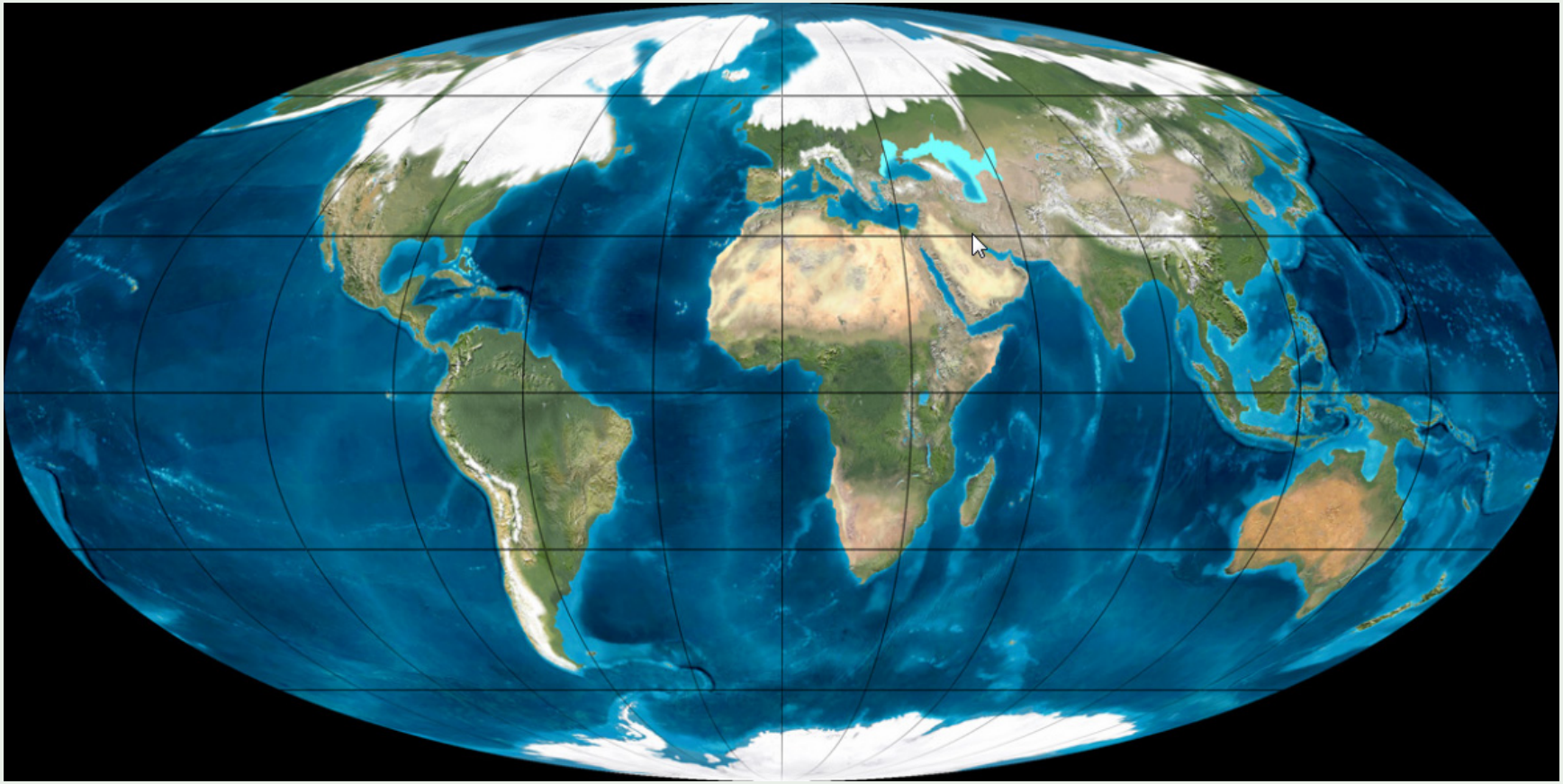
Devensian Ice Sheet



The extent of the Devensian ice sheets around 50,000 years ago. Notice that the English Channel does not exist and that the UK is joined to continental Europe.

Glacial Limits

Devensian

Anglian

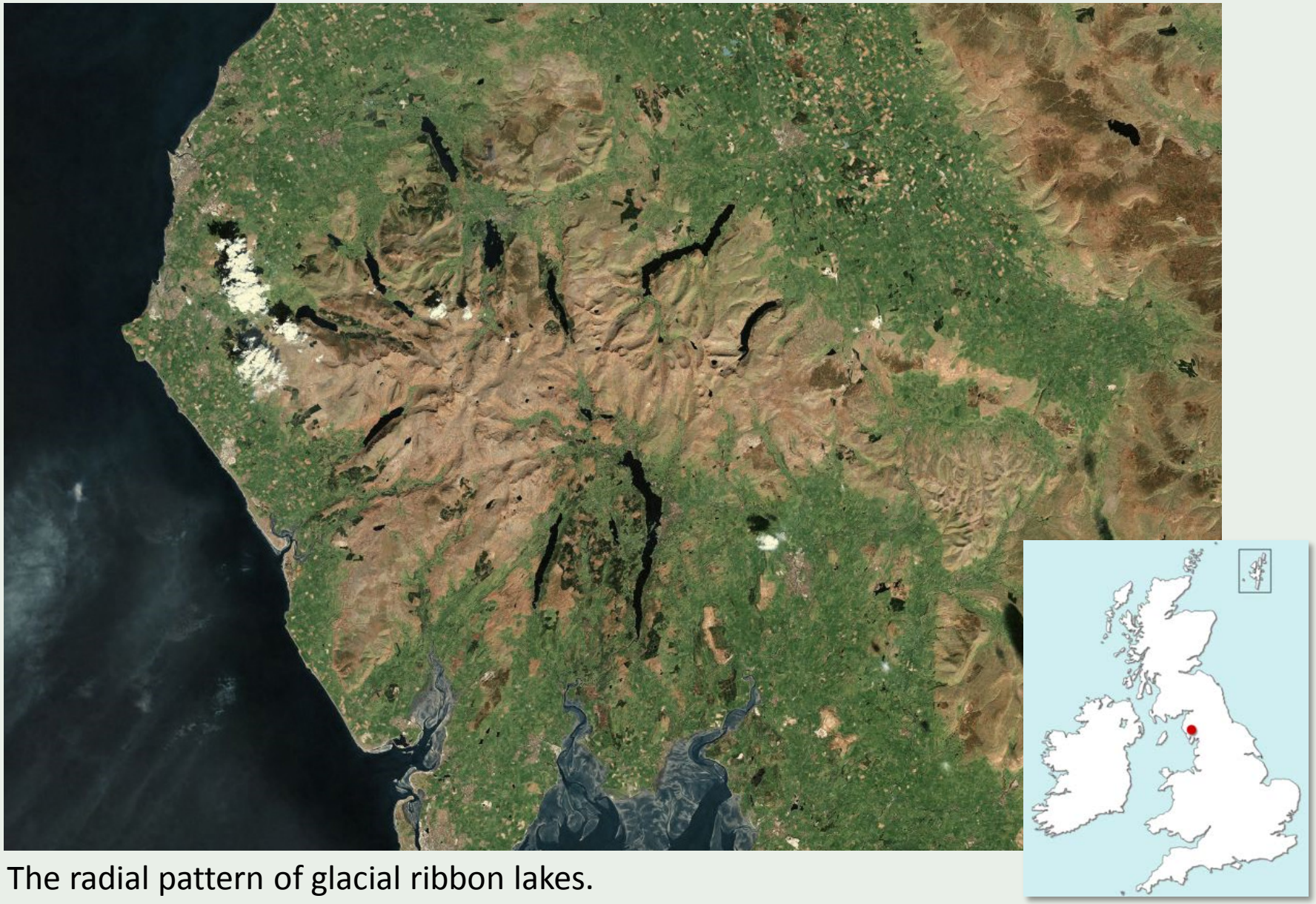
Cader Idris

A Welsh “cwm” (“corrie” in Scotland) where a glacier formed.

Cader Idris

Bing Maps: Cader Idris

The Lake District



The radial pattern of glacial ribbon lakes.

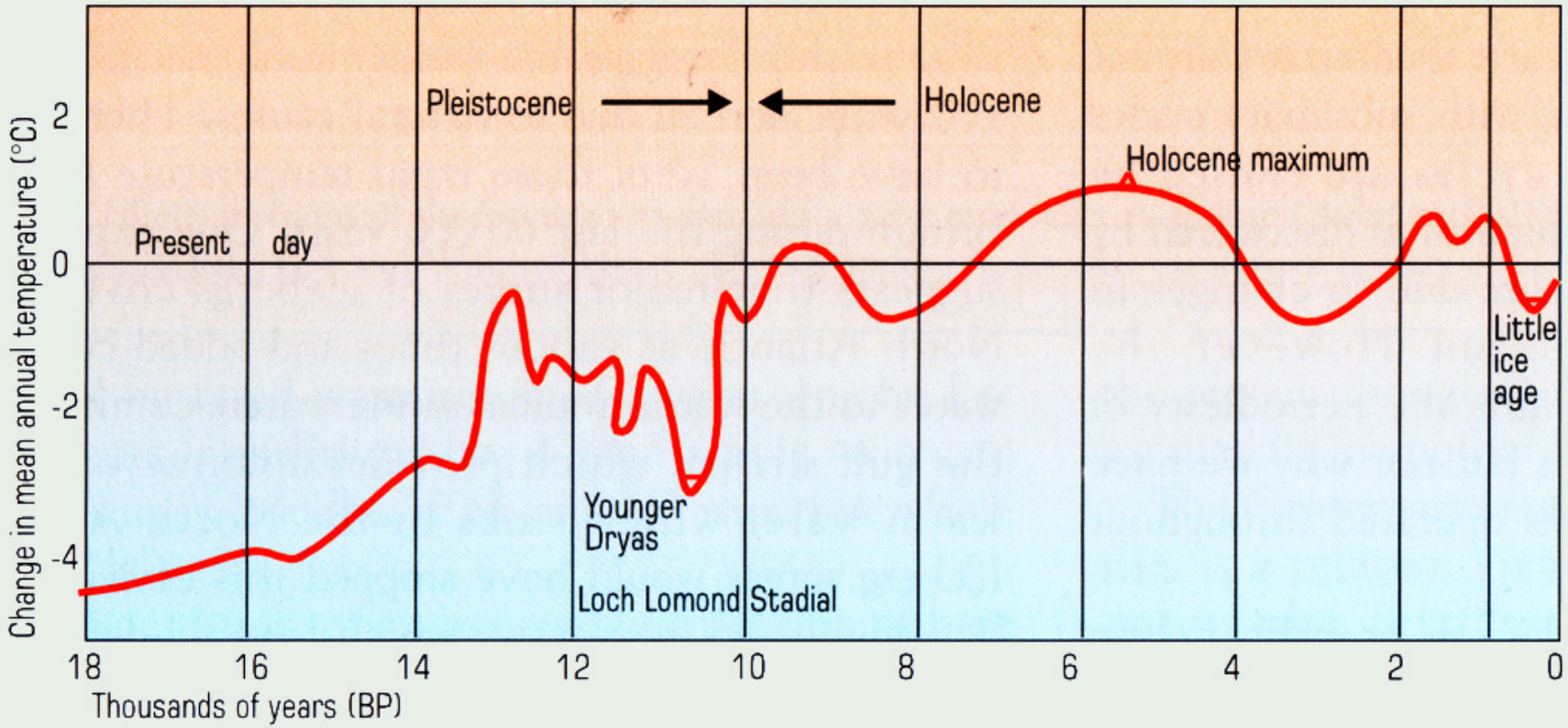
Drumlins

Mounds of glacial material dumped as the ice melted.

Isostatic Rebound

- At the height of the Devensian, ise was 2km thick over Scotland and 1km thick over North Wales and The Lake District.
- This enormous weight caused the land to sink.
- When the ice melted, Northern Britain began to rise again (rebound).
- As a consequence, Southern Britain began to fall like a giant see-saw.
- It is still falling to day by a rate of 1mm per year.

Pleistocene/Holocene Temperatures



Sea Level Rise

- When the last of the ice melted at the end of the Devensian 10,000 years ago, sea levels rose dramatically by up to 30m.
- Eustatic sea level rise is caused by ice melt and results from an increased volume of water in the oceans.
- Isostatic sea level rise is the result of land falling with respect to the sea and this varies in different locations.

Raised Beaches

Raised beach on the Isle of Islay, Scotland. The massive weight of ice caused land to sink. It has since been subject to isostatic uplift.

St. Michael’s Mount

St. Michael’s Mount was originally surrounded by woodland until the bay was flooded by the rising sea level around 1700BC.

The Submerged Forest

At Borth on the coast of Cardigan Bay, the remains of an ancient forest can be seen on the beach at low tide. Carbon dating indicates that the trees died around 1500BC.

Coastal Erosion

At Dunwich, on the Suffolk coast, the shoreline is now 500m inland compared to its position in 1587. This coast is being eroded at a rate of 1m per year.

Dunwich Heath

All Saints Church on the cliff edge in 1904.

Coastal Erosion

The road from Covehithe to a village now lost to the sea, the result of recent unconsolidated drift geology and sea-level rise.

Coastal Erosion

This house just north of Southwold has just a few years left.

The Little Ice Age

- Temperatures constantly fluctuate
- AD 1550 to 1700, temperatures in central England were more than 1 degree Centigrade colder than at present
- This is represented in contemporaneous paintings...

The Little Ice Age

Hendrick Avercamp (1585-1634) *A Scene on the Ice Near a Town*

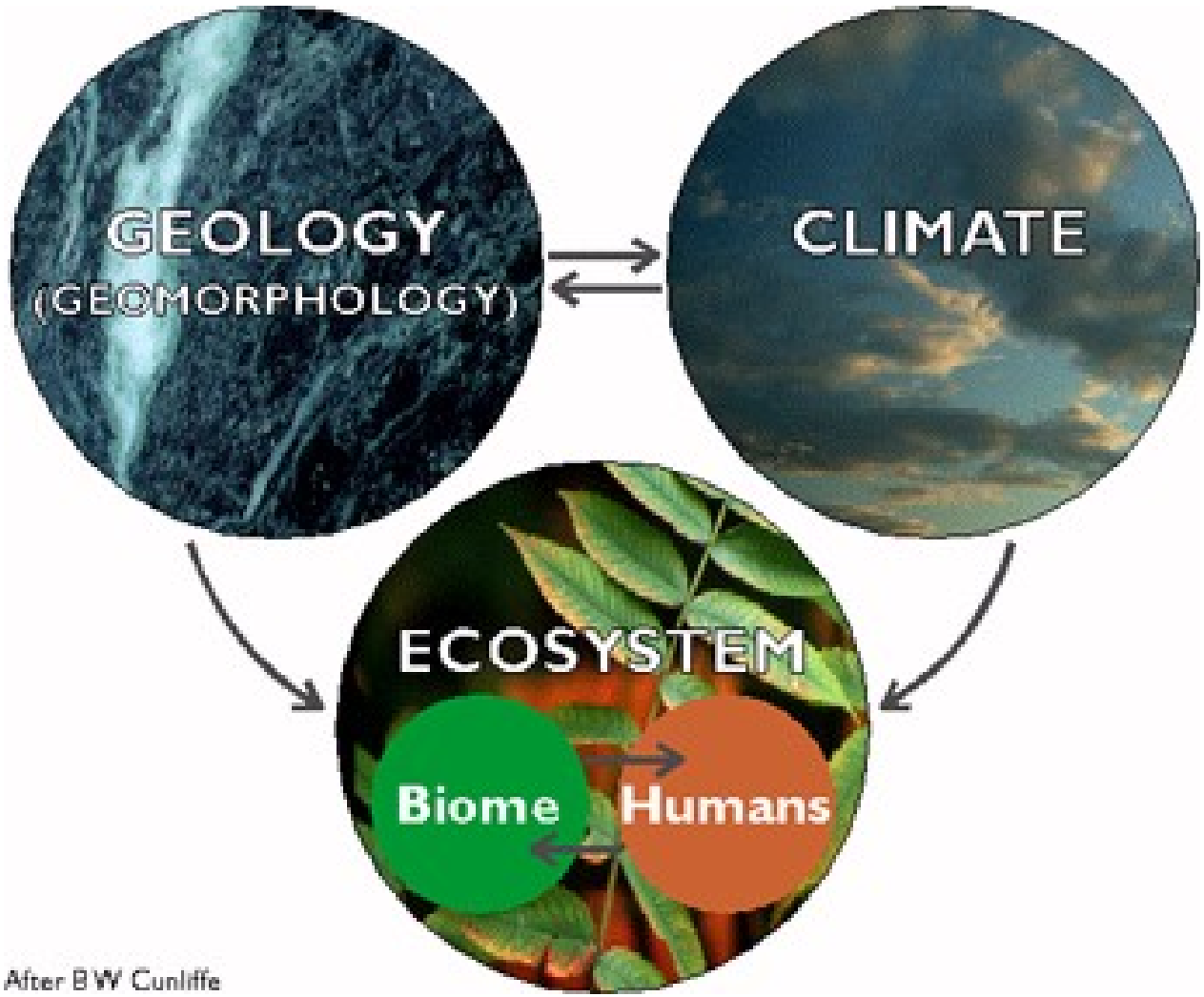
Thames Barrier

Construction of the Thames Barrier was completed in 1982, having begun 8 years earlier. It was officially opened in 1984. It is designed to protect London from storm surges and very high tides. High water levels have risen by 20cm in the last 100 years.

Between the Ice

LANDSCAPE AS ECOSYSTEM

The Ecosystem



The Ecosystem

- Includes all living organisms, including humans
- The native fauna and flora are often the most visible aspect of landscape but these are determined by geology and climate
- Human influence on the landscape has been profound

Pedogenesis

The development of soils is a function of 5 distinct factors that manifest themselves over time:

Climate (rainfall, temperature etc.)
Parent Material (rock type etc.)
Relief/Topography (aspect, slope etc.)
Fauna (animals within and above the soil profile)
Flora (woodland, grassland etc.)
Time (most soils in the UK have developed since the last glaciation)

This can be expressed as: **Soil = f(C, PM, R, O, V) x T**

There is a complex and variable interplay between all of these factors, and so "**f**" is simply some factor which is unknown.

Wikipedia: Pedogenesis

The Soil Profile

For the purposes of classification, soil profiles are broken down into **horizons**. These horizons are common to most soil types but their constituent parts and their depth will vary depending upon environmental factors. Typically, soils will exhibit 4 main horizons:

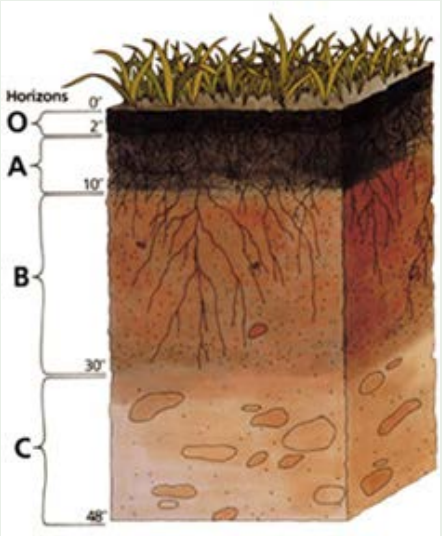
The O Horizon: Organic matter, usually the compost from leaf fall etc.

The A Horizon: The topsoil, where organic matter is mixed with mineral material. The mixing may take place as a result of earthworm activity and the action of rainwater.

The B Horizon: The subsoil, composed predominantly of mineral material, it is usually lighter in colour than the topsoil.

The C Horizon: Characterised by large fragments of parent material, usually rock.

Some soils may exhibit additional horizons. For example, peaty soils will have a “P” horizon between O and A. The zone below C is often referred to as the “R” horizon (bedrock).

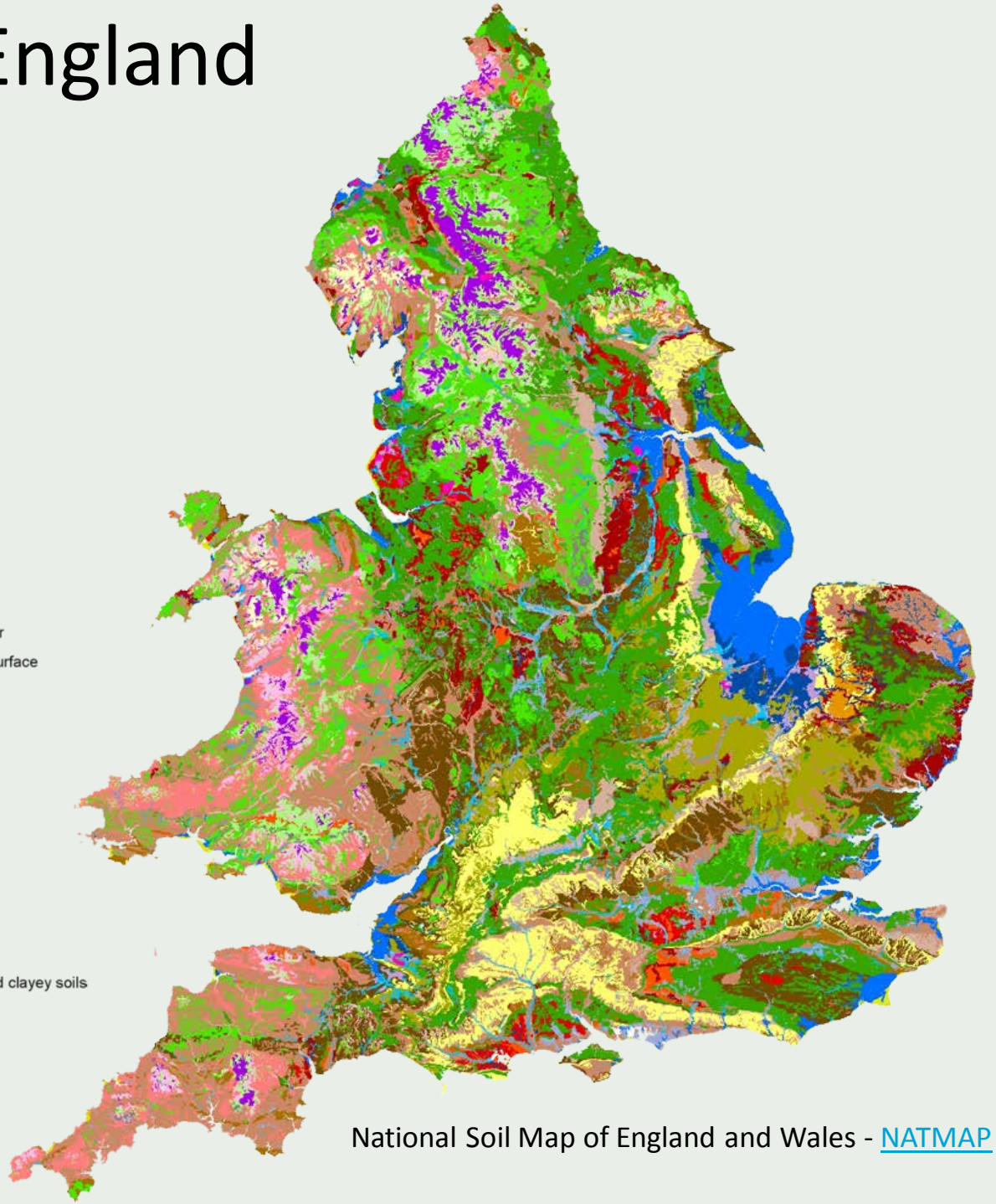


Wikipedia: Soil Horizon

Soil Map of England and Wales

Legend

- Blanket bog peat soils
- Fen peat soils
- Freely draining acid loamy soils over rock
- Freely draining floodplain soils
- Freely draining lime-rich loamy soils
- Freely draining sandy Breckland soils
- Freely draining slightly acid but base-rich soils
- Freely draining slightly acid loamy soils
- Freely draining slightly acid sandy soils
- Freely draining very acid sandy and loamy soils
- Lime-rich loamy and clayey soils with impeded drainage
- Loamy and clayey floodplain soils with naturally high groundwater
- Loamy and clayey soils of coastal flats with naturally high groundwater
- Loamy and sandy soils with naturally high groundwater and a peaty surface
- Loamy soils with naturally high groundwater
- Naturally wet very acid sandy and loamy soils
- Raised bog peat soils
- Restored soils mostly from quarry and opencast spoil
- Saltmarsh soils
- Sand dune soils
- Shallow lime-rich soils over chalk or limestone
- Shallow very acid peaty soils over rock
- Slightly acid loamy and clayey soils with impeded drainage
- Slowly permeable seasonally wet acid loamy and clayey soils
- Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils
- Slowly permeable wet very acid upland soils with a peaty surface
- Very acid loamy upland soils with a wet peaty surface
- sea
- uc
- water



National Soil Map of England and Wales - NATMAP

Soils in Britain

- Most soils in Britain date from after the end of the Devensian.
- Despite the relatively short time (10,000 years) and the relatively small area of Britain, the diverse geology and geomorphology has lead to a large number of different soil types.
- Depending on which soil classification system is used, there could be anything up to 1,800 different soil types (British Society of Soil Science).
- The National Soil Map of England and Wales by LandIS (Cranfield University) identifies just 27.

British Society of Soil Science, Land Information System

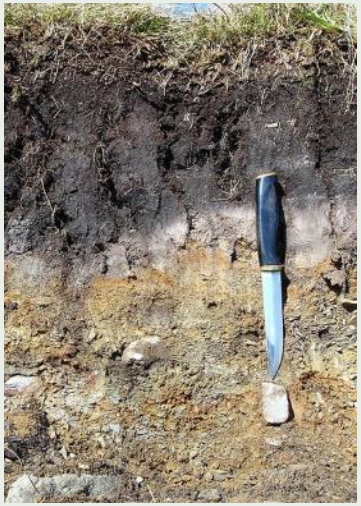
Soil Types

There are a wide range of soil types in Britain but most, fall into 3 main groups:

Brown Earths

Gley Soils

Podzols



Broadly, Brown Earths develop under deciduous woodland in free-draining conditions. They generally make good agricultural soils. Gley Soils develop where the soil is waterlogged for part or all of the year and Podzols develop where vegetation (such as coniferous woodland and heathland) creates acid conditions.

Wikipedia: Brown Earth, Gley Soil, Podzol, Soil Profiles

The Wildwood

As the climate warmed at the end of the Devensian, species migrated north from Europe. Pollen analysis from lake sediments can be used to indicate which species were dominant at particular times in the past. This indicates a sequence beginning with pioneer species and ending with Oak woodland where conditions were suitable. The species that established themselves in Britain before the English Channel formed have become our native species.

Dominant Species

8,200BC = Birch

7,500BC = Pine

then Hazel, Elm, Oak and Alder

6,600BC English Channel formed

Mesolithic People

- Middle Stone Age
- 12,000 – 5,000 BC
- Hunter-gatherers
- Evidence, mainly stone tools
- No major impact on landscape

Wikipedia: Mesolithic

Neolithic People

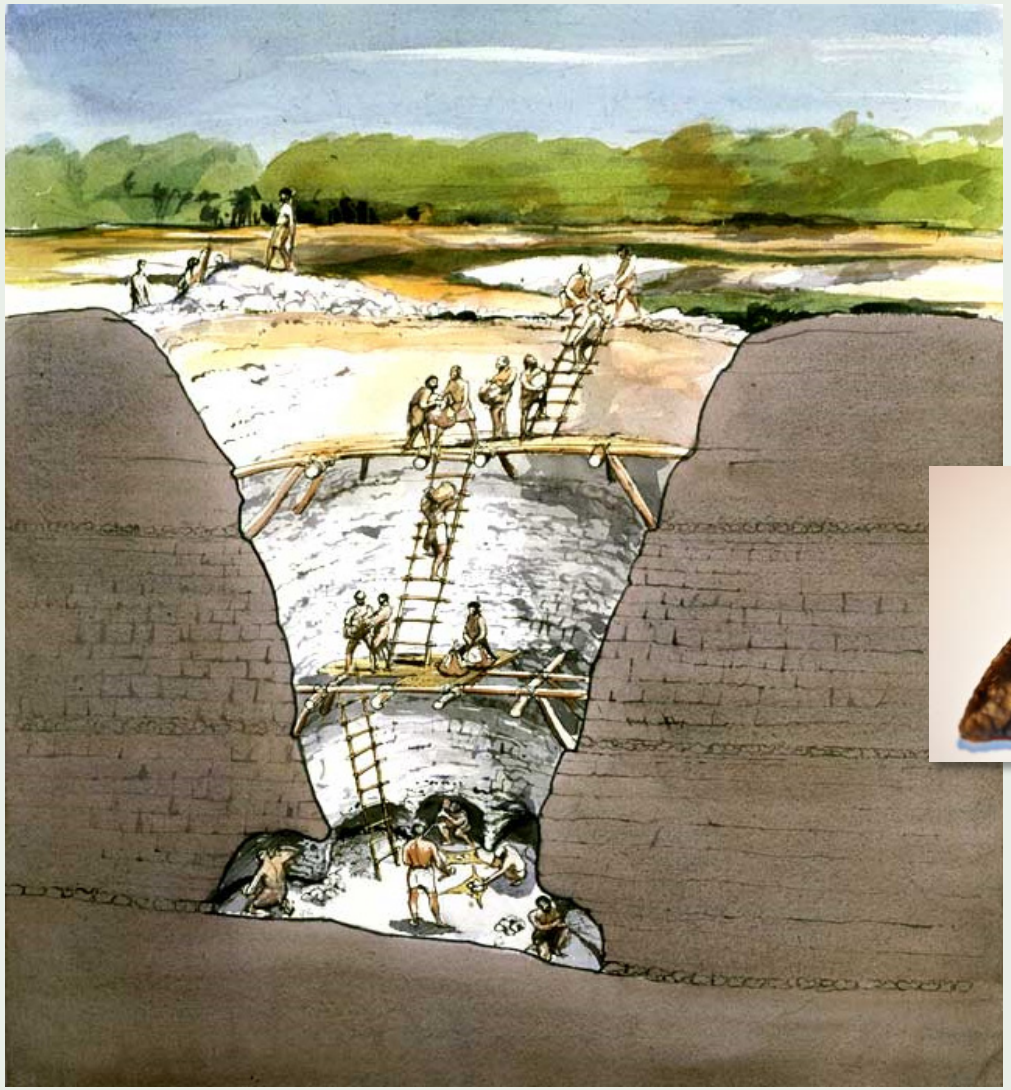
- New Stone Age
- 5,000 – 2,500 BC
- Farmers
- Stonehenge, Avebury etc.
- Clearance of Wildwood for agriculture
- First organised industry...

Wikipedia: Neolithic

Grimes Graves

Grimes Graves in Norfolk, site of Neolithic flint mining. All that remains are dozens of hollows, each of which were pit mined and were originally up to 12m deep.

Grimes Graves



Grimes Graves was worked between 3,000BC and 1,900BC or even later into the Bronze age. Miners used Red Deer antlers as picks.

A Changing Landscape

- The landscape of Britain has constantly changed and will continue to change into the future.
- Over the long-term, geological processes will continue.
- Over the medium-term, climatic changes continue.
- In the short-term, social, political and technological changes will affect the landscape.

Strip Fields

Most fields in Britain were remodelled during “enclosure” around 200 years ago but some relic strip fields remain as here at Chelmorton in the Peak District.

The future looks wet

The Telegraph

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Earth News

Sea level rise will double due to melting of Antarctica

Sea level rise could more than double due to the melting of Antarctica, threatening coastal cities like London, according to the latest study.

By Louise Gray, Environment Correspondent 8:01AM GMT 01 Dec 2009

Comment

Previous research had predicted sea levels would only rise by a couple of feet (59cm) by the end of the century, however this does not include melting ice from the South Pole.

The most comprehensive study into the impact of global warming on the region by the Scientific Committee on Antarctic Research (SCAR) found ice is already melting in the West Antarctic region due to an increase in temperatures.

The centre of the huge continent, that has been protected from the warming effect until now because of a hole in the ozone layer, is also due to warm in the future.

By the end of the century the water flowing into the oceans from Antarctica, as well as from Greenland and land glaciers like the Himalayas, will cause a sea level rise of more than four feet (1.4m).

If temperatures continue to increase in the next two to five hundred years, sea level rise could go up by 20 feet (6m) as more of Antarctica melts.

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IN EARTH

A year in Richmond Park

Parts of England see wettest January since records began

Area of England from east Devon to Kent and inland to Midlands has seen twice its average monthly rainfall, with more forecast

Matthew Weaver and John Vidal
theguardian.com, Thursday 30 January 2014 11.00 GMT

Jump to comments (363)

Article history

Flooded fields around the river Tone in Somerset. Photograph: Tim Ireland/PA

Large parts of England have endured the wettest January since records began, according to new figures released by the Met Office, as troops headed to the Somerset Levels to help deliver assistance to flood-hit communities.

A large area from east Devon to Kent and inland across parts of the Midlands has already seen twice the average rainfall for the month.

Two days before the end of the month, the figures show that south-east and central southern England have already recorded twice their average rainfall – with 175.2mm between 1 and 28 January.

This beats the previous record of 158.2mm set in January 1988. And yet more rain is forecast, prompting the Environment Agency to issue 32 flood warnings, including 11 in the Midlands and 10 in the south-west.

UK news
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More on this story

Flooding experts say Britain will have to adapt to climate change – and fast
UK won't be able to defend everywhere against flooding and higher sea levels. So what does that mean for Somerset Levels?

Army assesses task on flood-hit Somerset Levels

Interactive: soldiers deployed in flood-hit Somerset Levels

Between the Ice?

The next glacial period is due in around 5,000 years.
We are currently living in a short “interglacial” period.

QUATERNARY PERIOD

Pleistocene Epoch (Ice Age)

Up to 20 cold (glacial) phases known from deep sea cores prior to the 3 known glacials in GB

Anglian glaciation
c. 270,000 years ago

Wolstonian glaciation
c. 200,000 - 150,000 years ago

First modern humans (Homo sapiens sapiens) appear c. 130,000 - 80,000 years ago

Ice begins to retreat at the end of Devensian glaciation 15,000 - 12,000 years ago

British "native" species arrive from continental europe
First signs of humans (hunter gatherers)

c. 2.5million years ago

Holocene Epoch (Recent)

Mesolithic or Middle Stone Age
12,000 - 5,000 BC

Sea level rise by 30m due to ice melt and isostatic recoil

English Channel formed 6,600 BC

Neolithic people colonise 5,000 - 2,500 BC
(The New Stone Age) e.g. Avebury, Stonehenge
British population about 30-50,000 people

Forest clearance begins,
Farmsteads and Hilltop Forts are built

Early Bronze Age 1900 - 1600 BC
e.g. Burial mounds (Barrows)

Population explosion 1600 BC (Late Bronze Age)
many new settlements, population about 1 million

Iron Age 750 BC
e.g. Maiden Castle, Glastonbury

10,000 years ago

Prehistoric

Roman Iron Age 43-410 AD
e.g. Roman roads and Villas

Anglo-Saxon 450-1066 AD

Historic

The End

www.coursestuff.co.uk/BUIL1164/Between-the-Ice.pdf