

“The Geological Structural Evolution of the Jurassic Coast World Heritage Site”

Vincent Sheppard

Geoscientist and Jurassic Coast Trust Ambassador

Dorset Geologists' Association Group. 24th February 2022

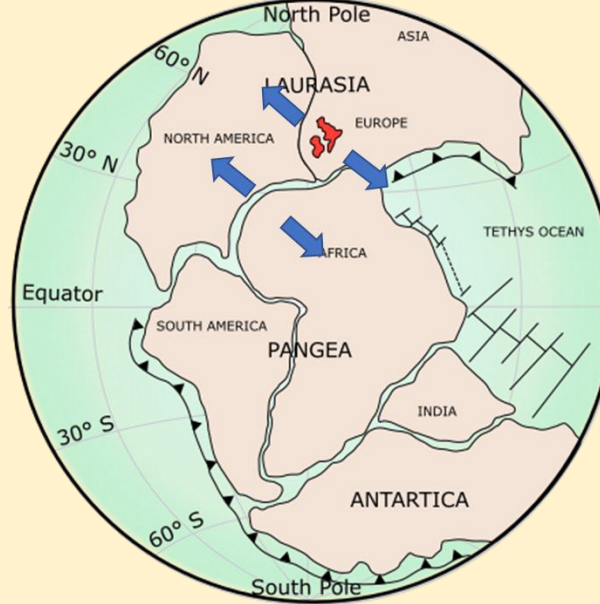
<http://mapapps.bgs.ac.uk/geologyofbritain3d/>

Shaped by polyphase tectonics.



Mid Devonian $\approx 375\text{Ma}$

1. Forming the Basement



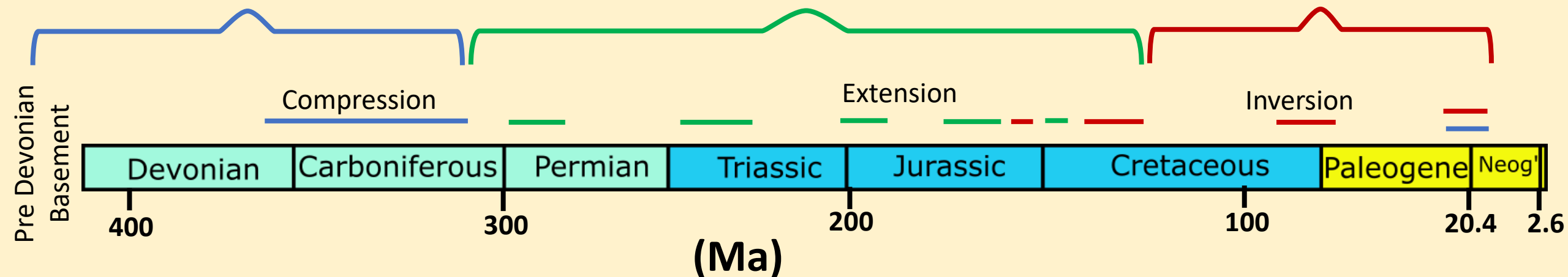
Jurassic $\approx 195\text{Ma}$

2. Basin Development

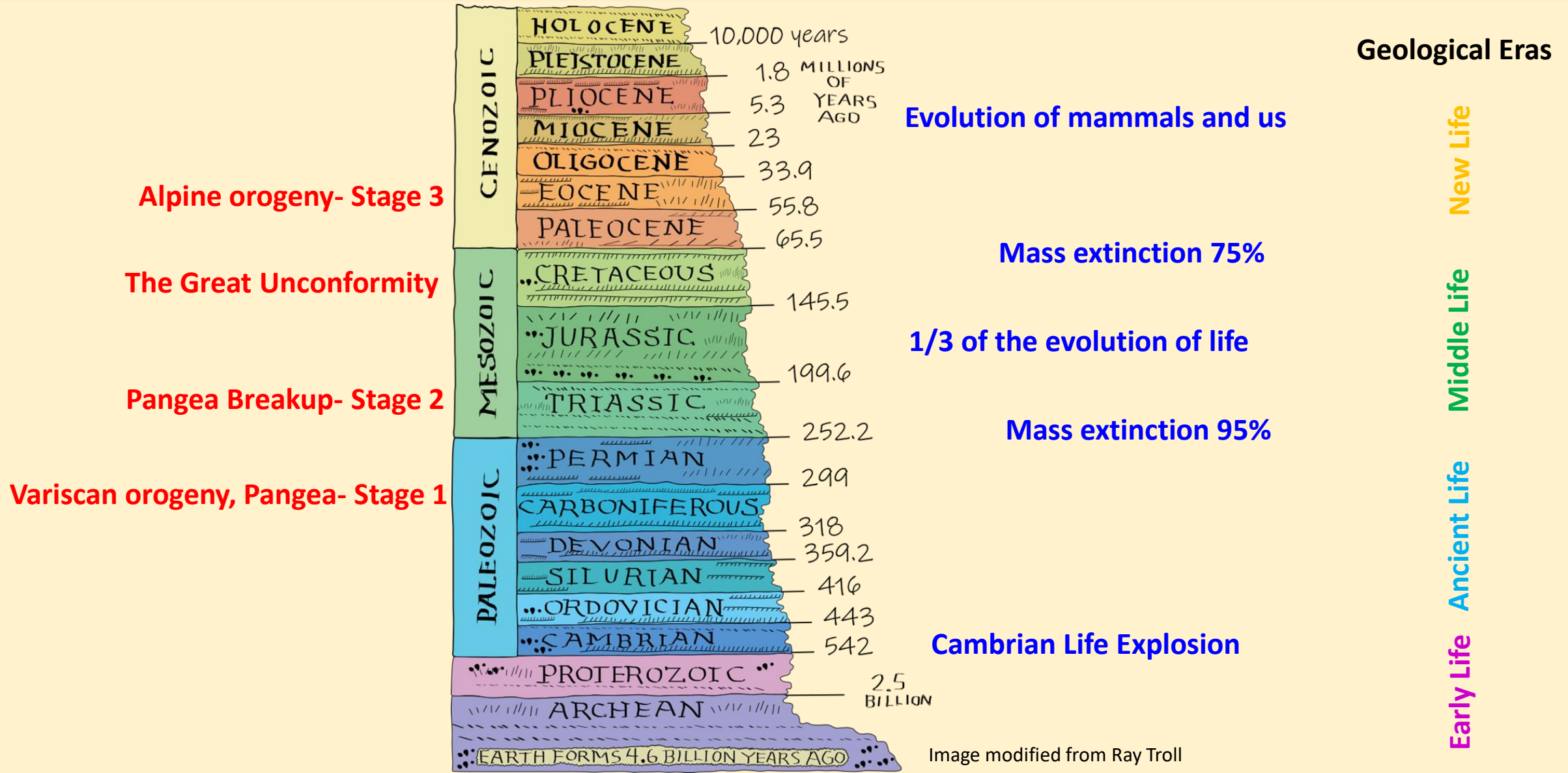


LATE CRETACEOUS/EARLY TERTIARY $\approx 65\text{Ma}$

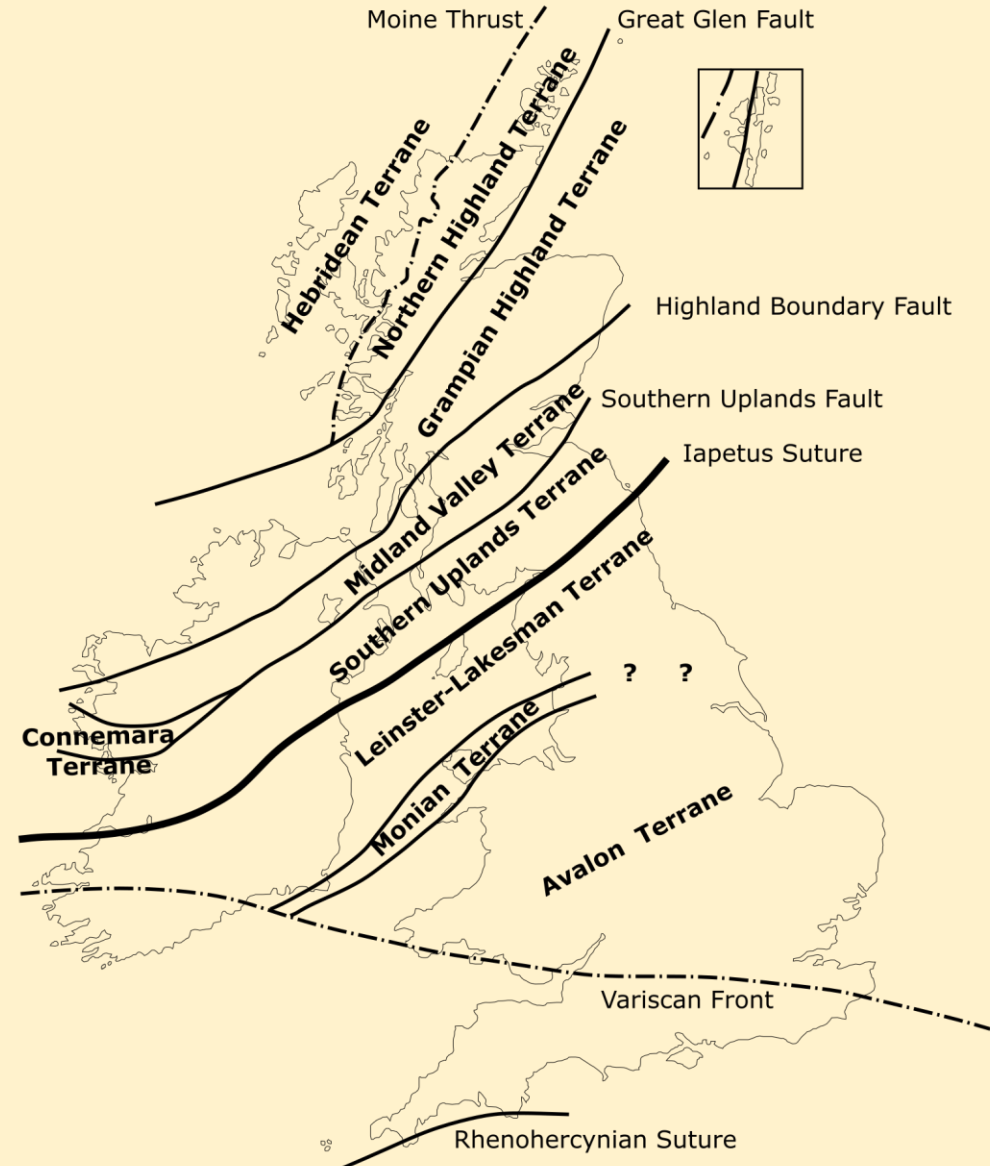
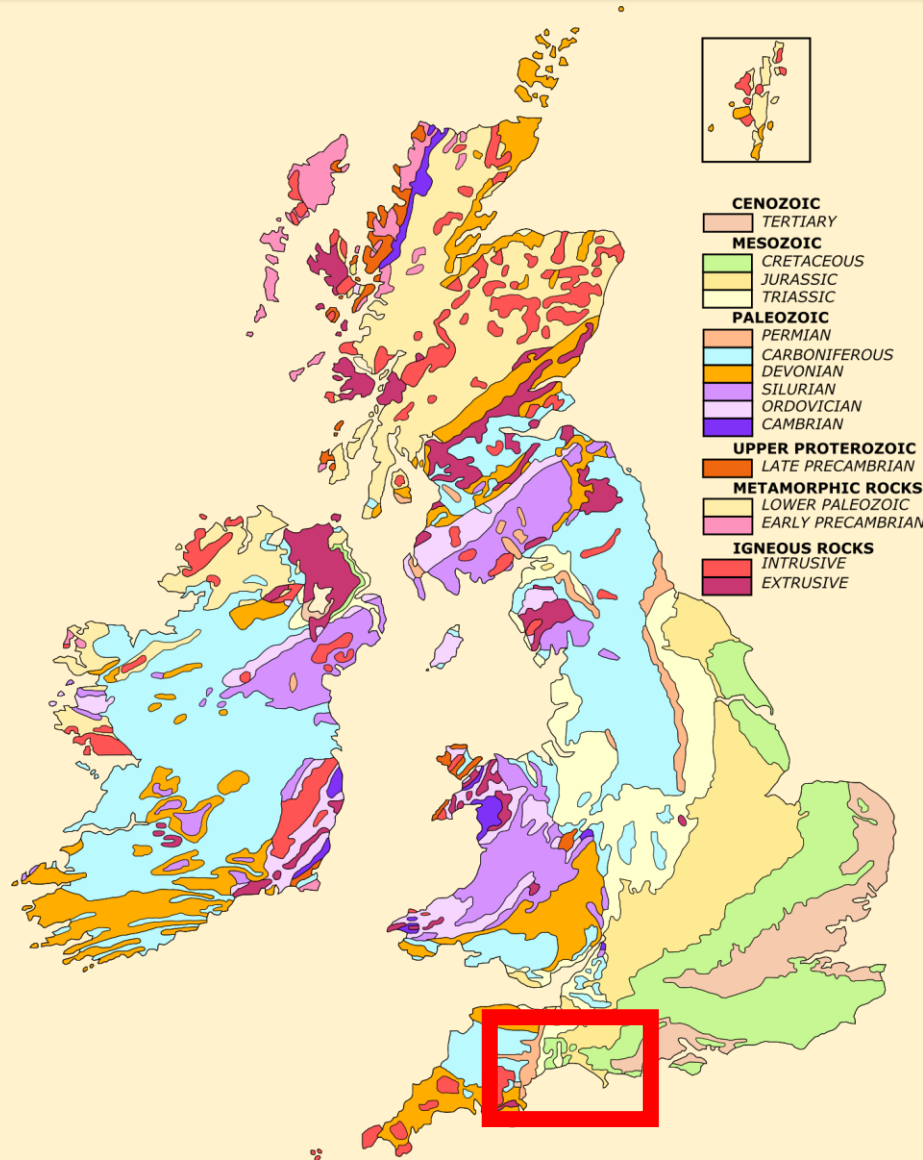
3. Basin Inversion



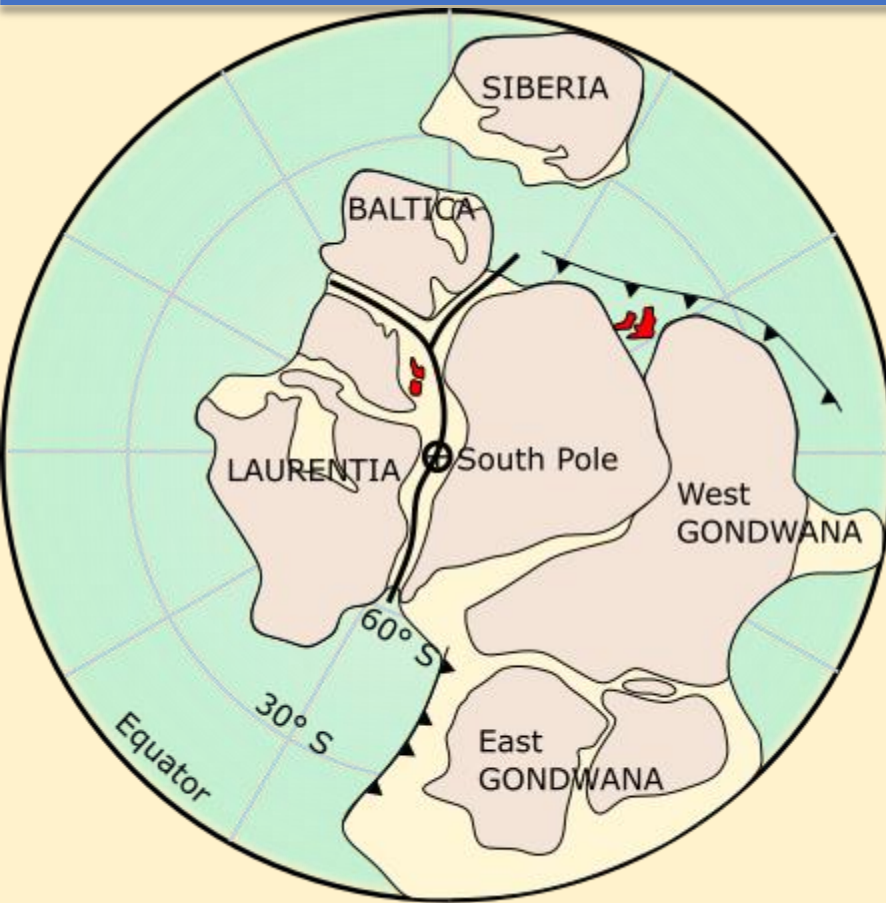
Geological Time.



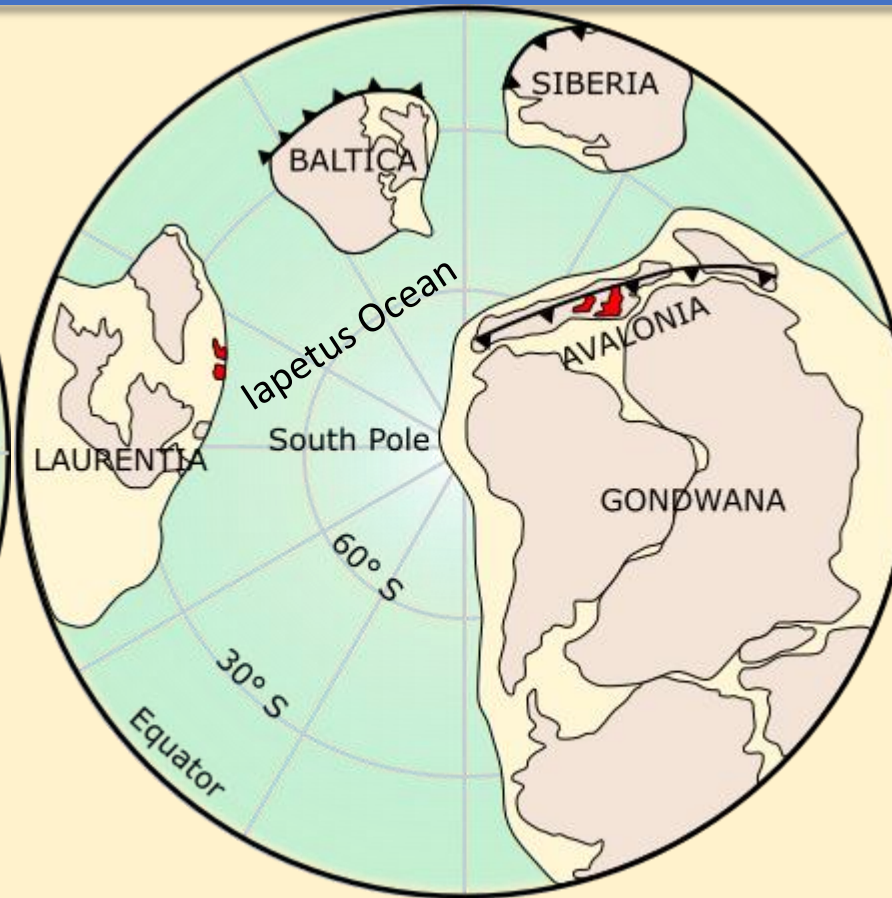
Introduction: Surface Geology of UK and Ireland.



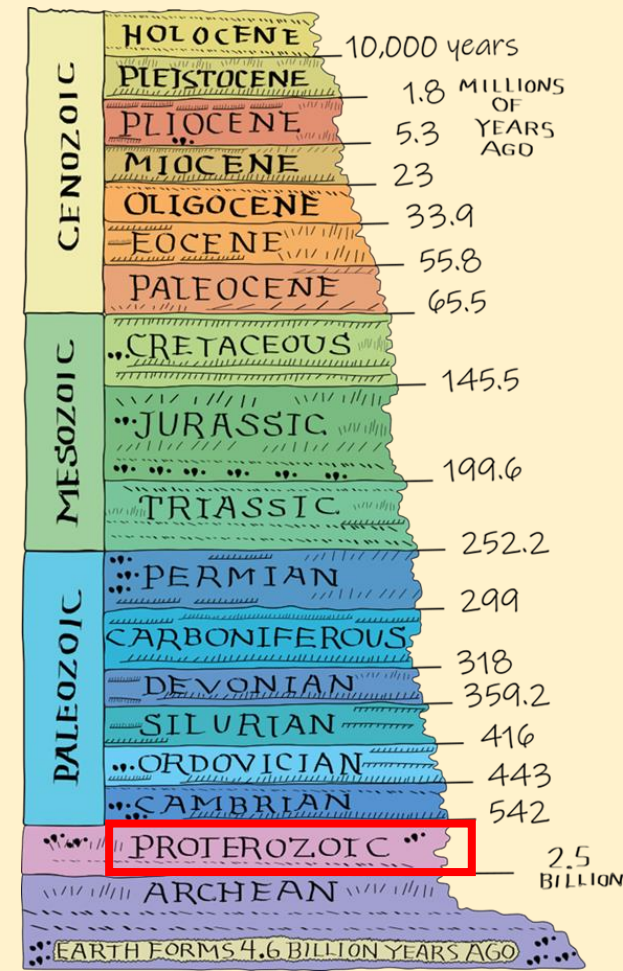
UK and Ireland. Journey across the globe.



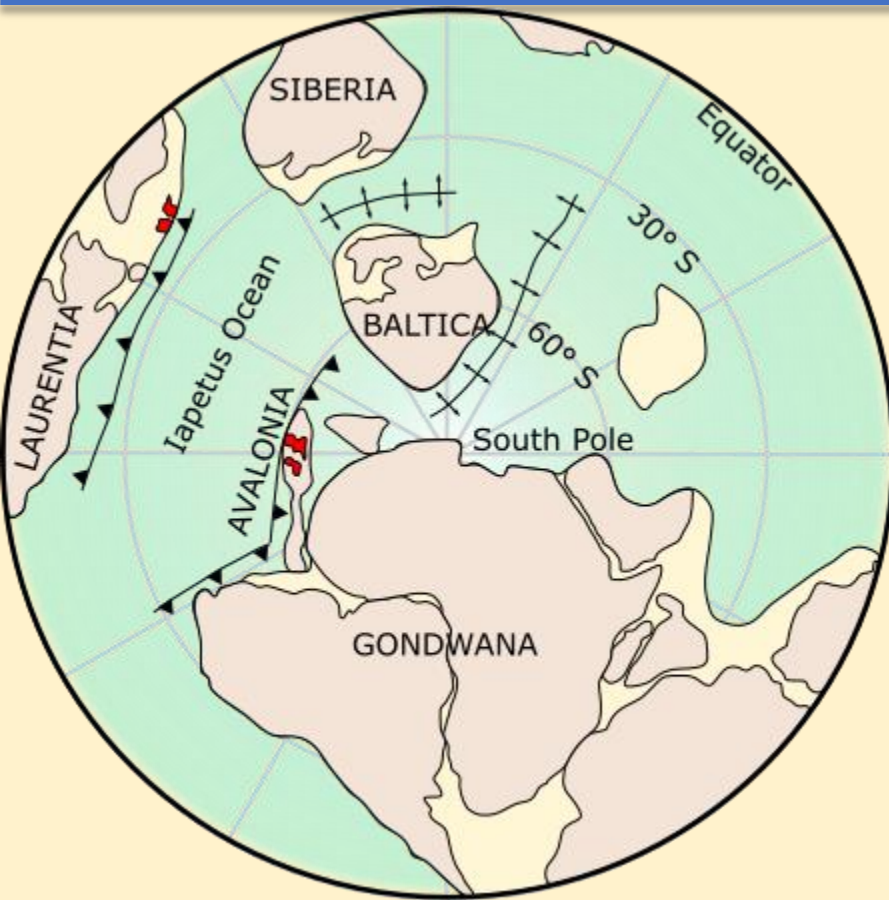
Vendian Supercontinent $\approx 580\text{Ma}$
(Pannotia / African Supercontinent)



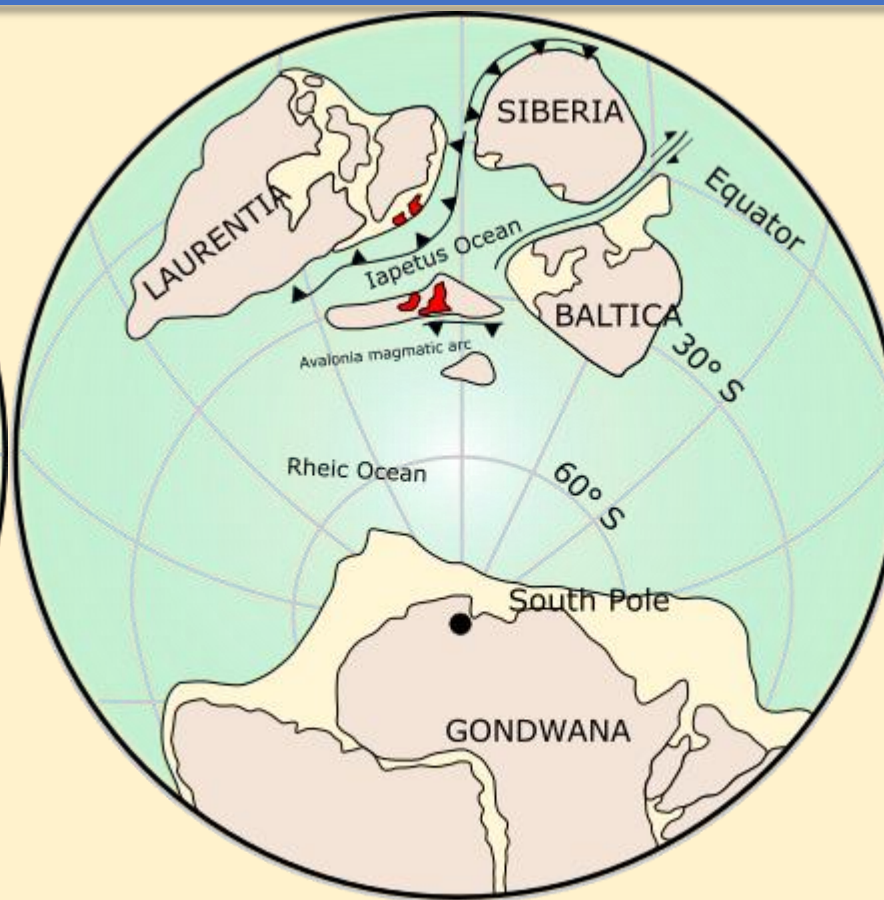
LATE PROTEROZOIC $\approx 550\text{Ma}$



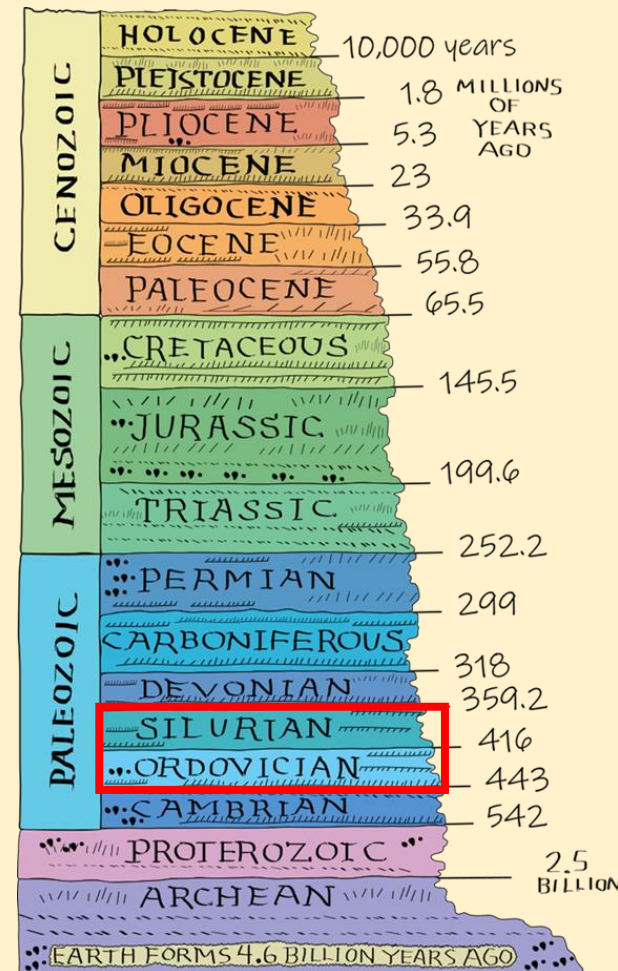
UK and Ireland. Journey across the globe.



Early Ordovician $\approx 490\text{Ma}$



Late Ordovician - Early Silurian $\approx 450\text{-}440\text{ Ma}$



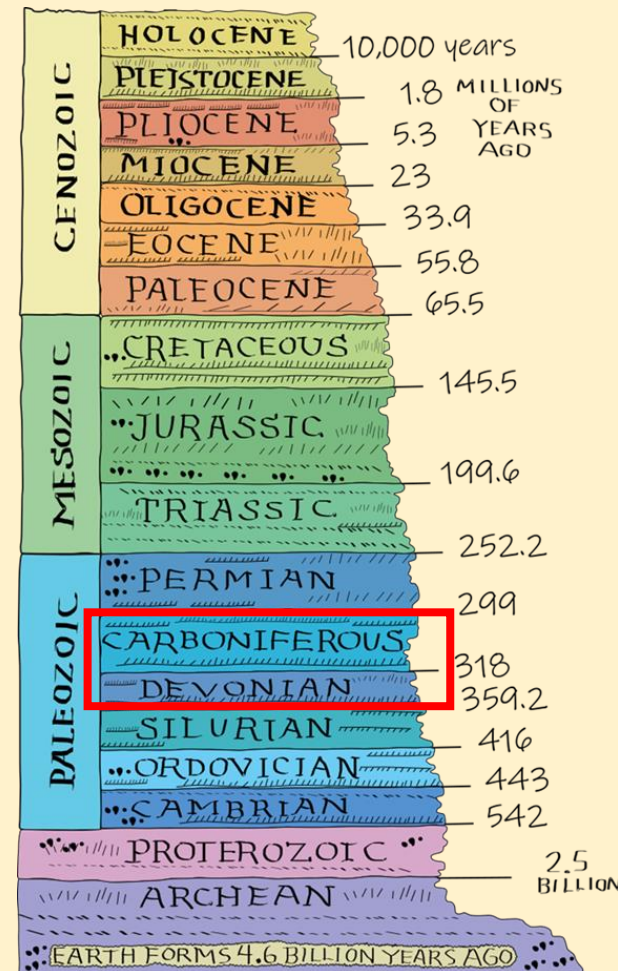
UK and Ireland. Journey across the globe.



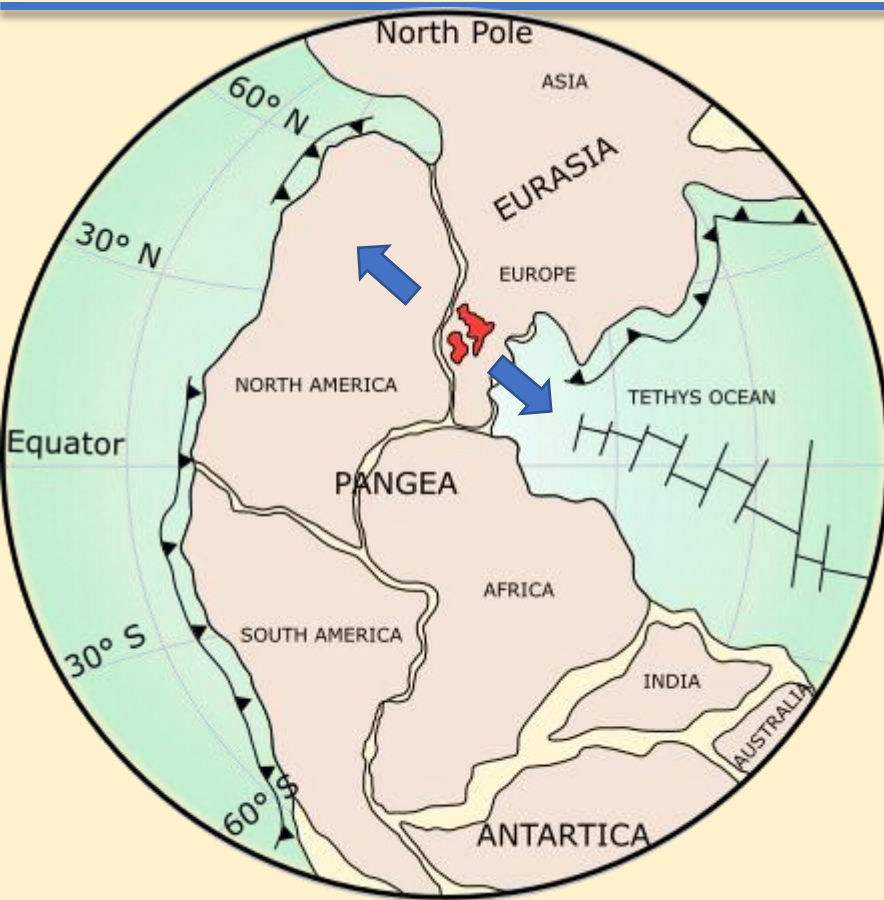
Mid Devonian $\approx 375\text{Ma}$



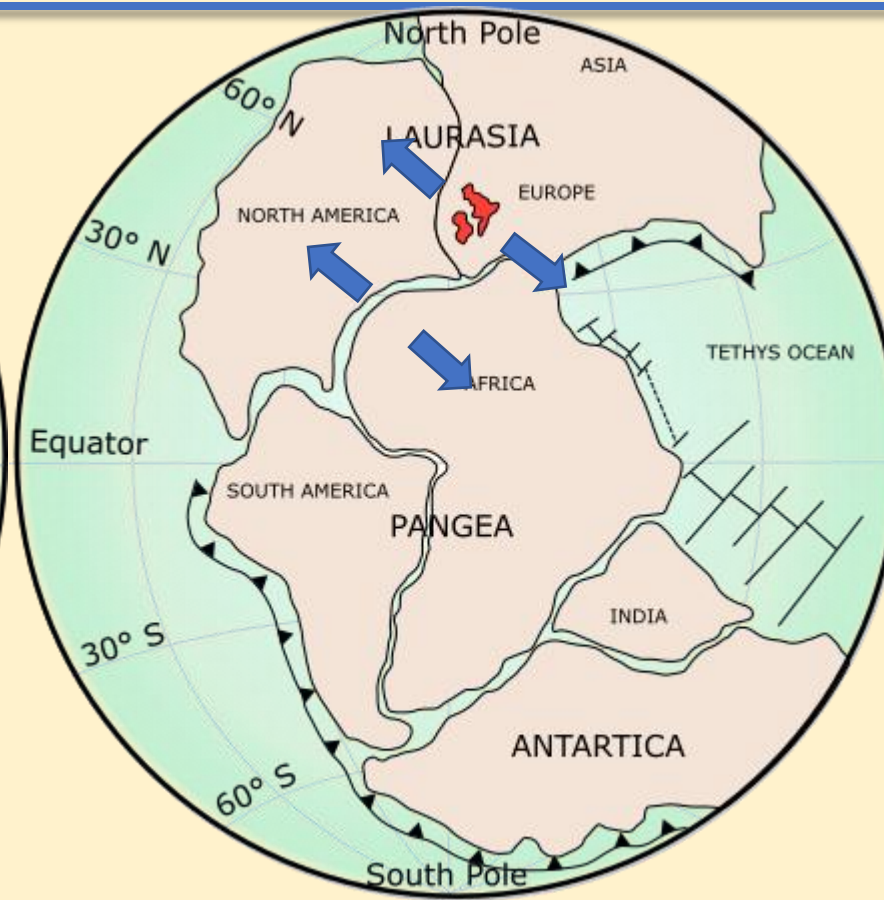
CARBONIFEROUS $\approx 302\text{Ma}$



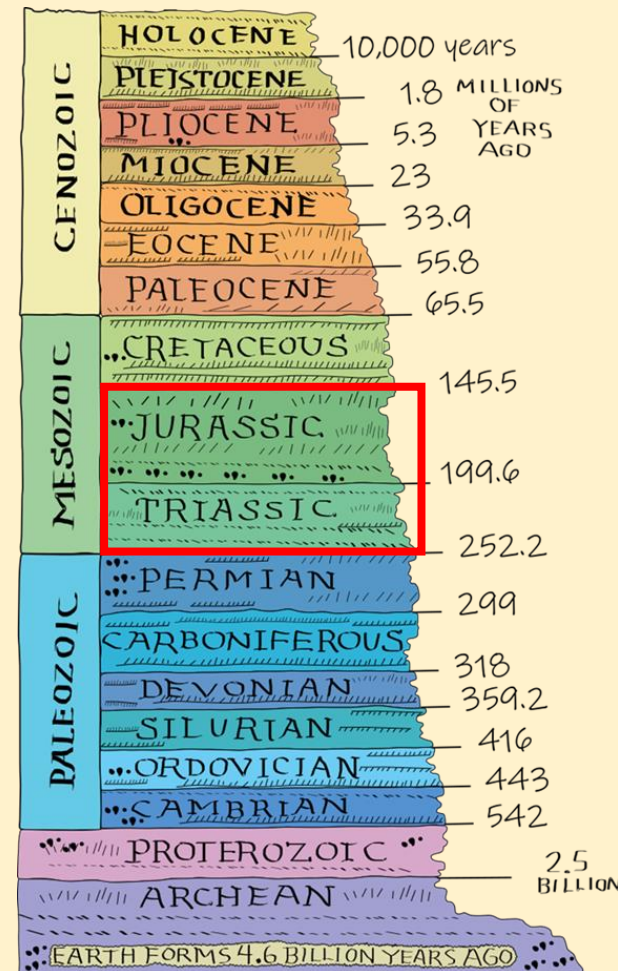
UK and Ireland. Journey across the globe.



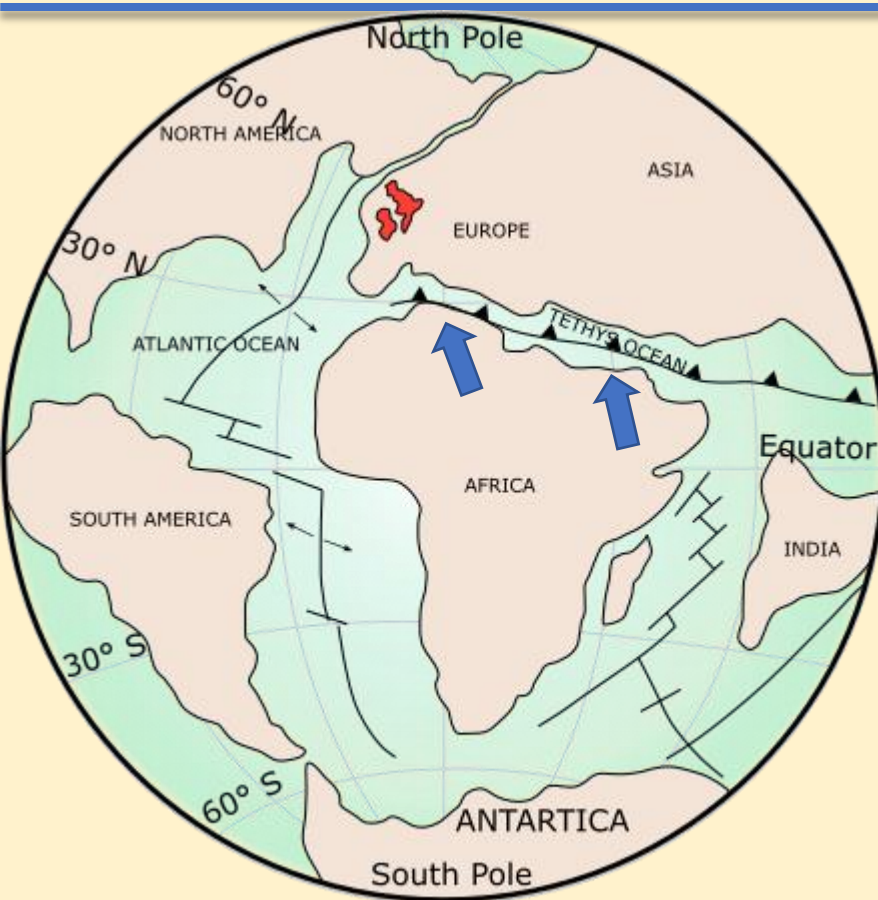
TRIASSIC $\approx 237\text{Ma}$



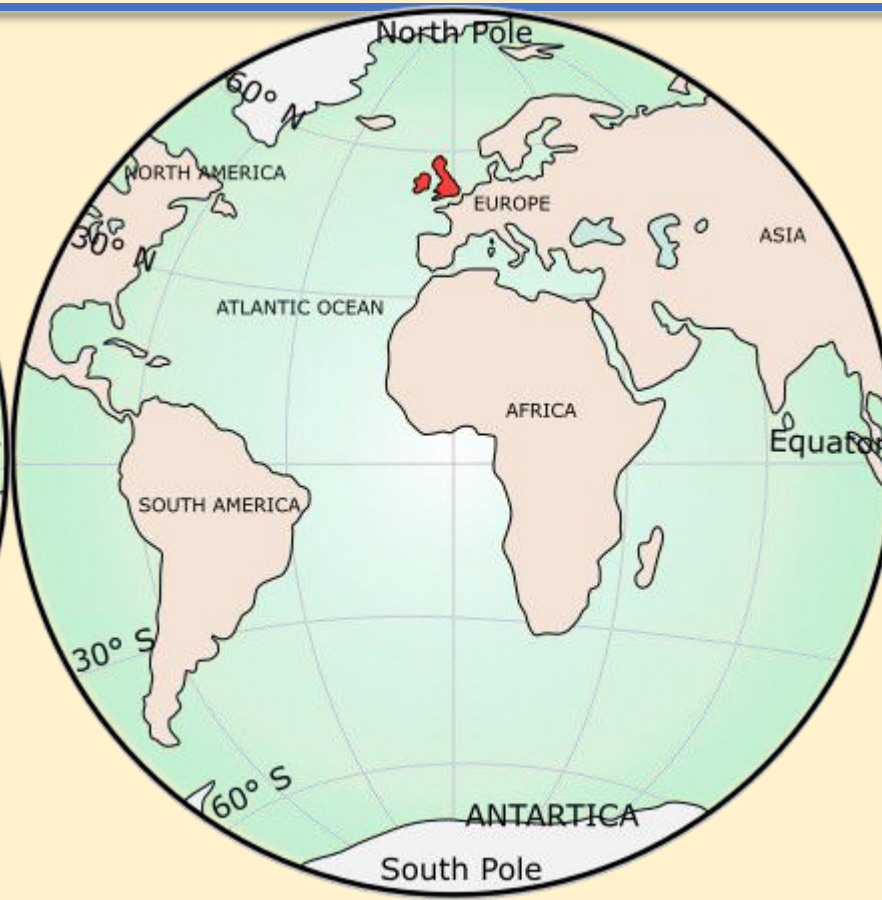
Jurassic $\approx 195\text{Ma}$



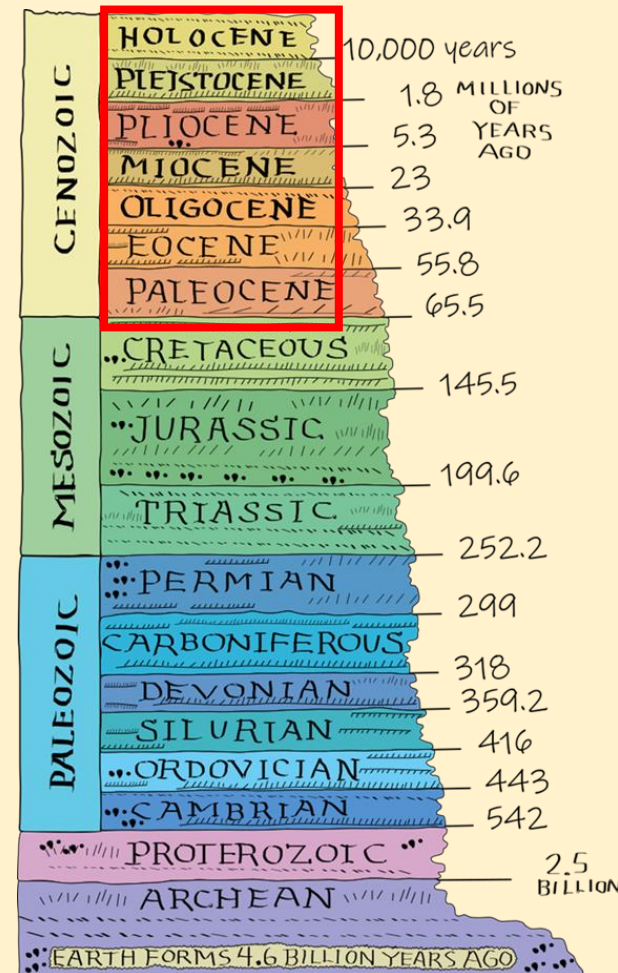
UK and Ireland. Journey across the globe.



LATE CRETACEOUS/EARLY TERTIARY $\approx 65\text{Ma}$



Present Day

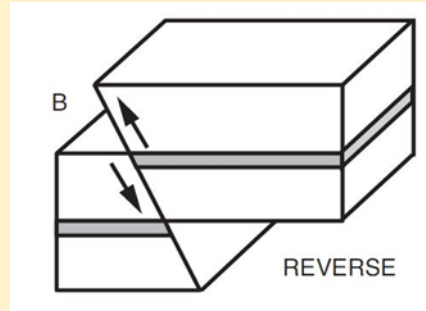


Variscan Tectonics. Forming the Basement. Stage 1.

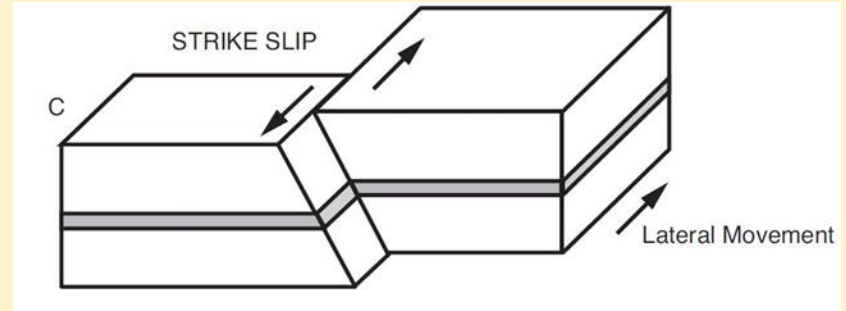


Mid Devonian $\approx 375\text{Ma}$

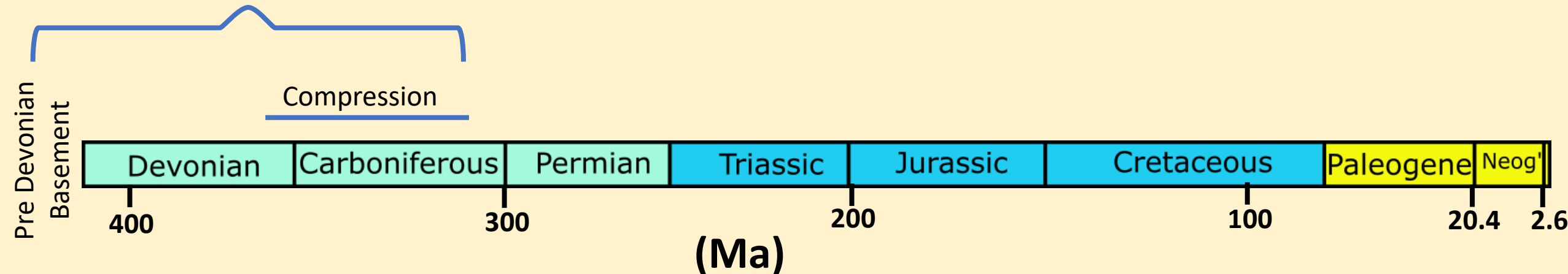
1. Forming the Basement



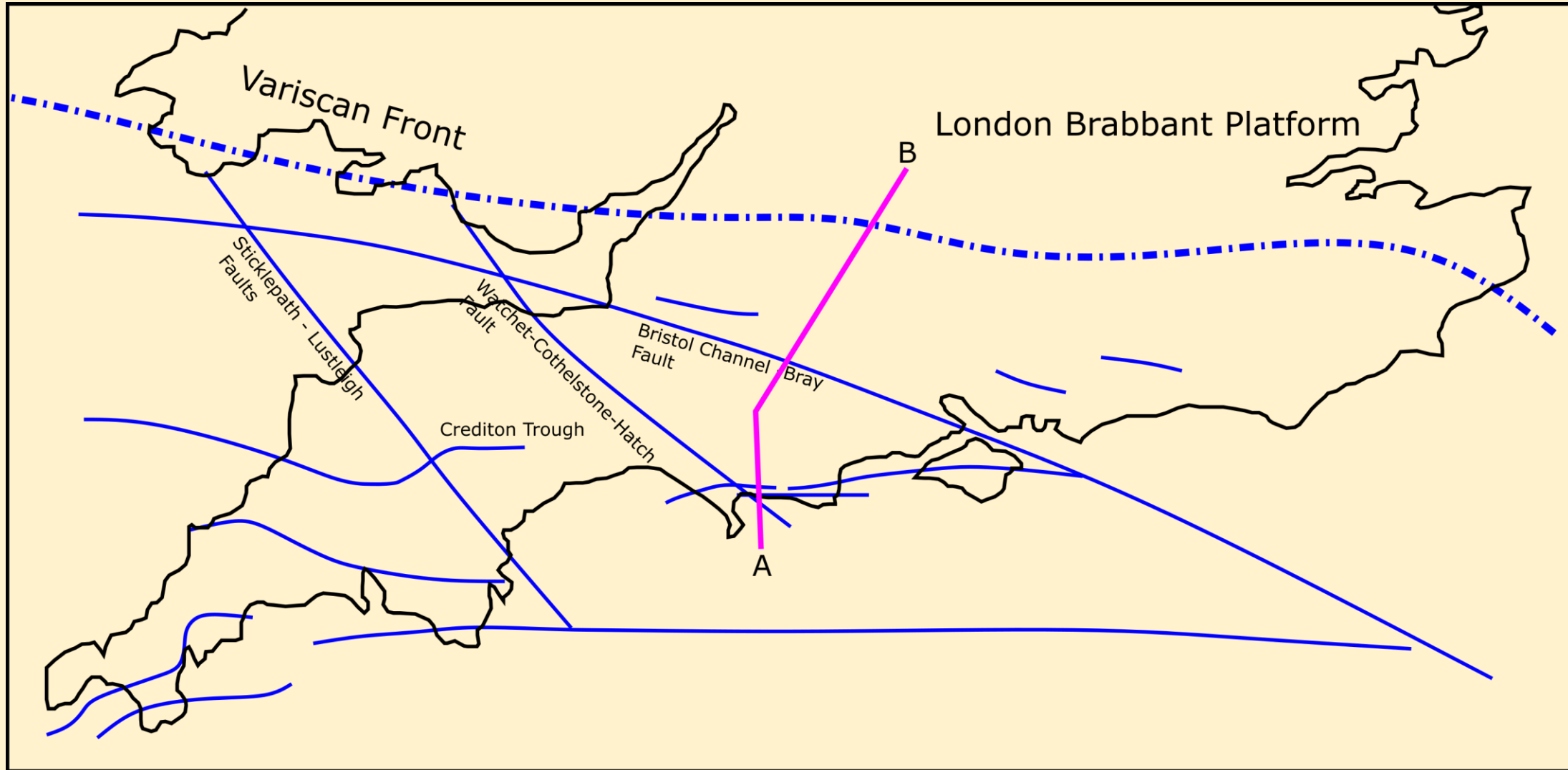
Reverse and Thrust Faults



Strike Slip Faults



Major Variscan lineaments



Variscan structures outside of our area.



Millook Haven Cornwall
Chevron folded Carboniferous sandstone and shale

Photograph Edmund Shaw

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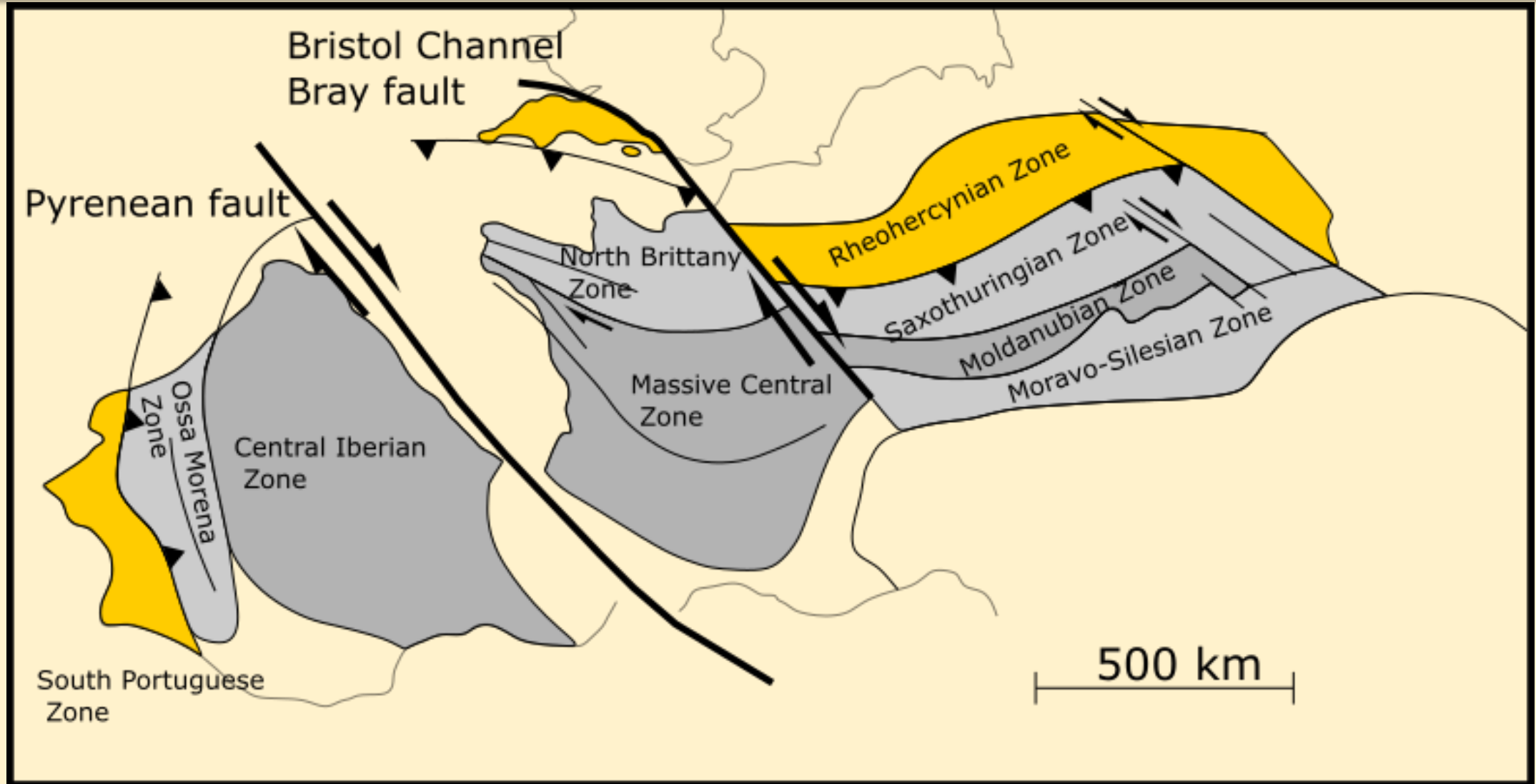


Kynance Cove, The Lizard peninsula Cornwall
Variscan thrusts of oceanic crust.

Photograph Andy Wright

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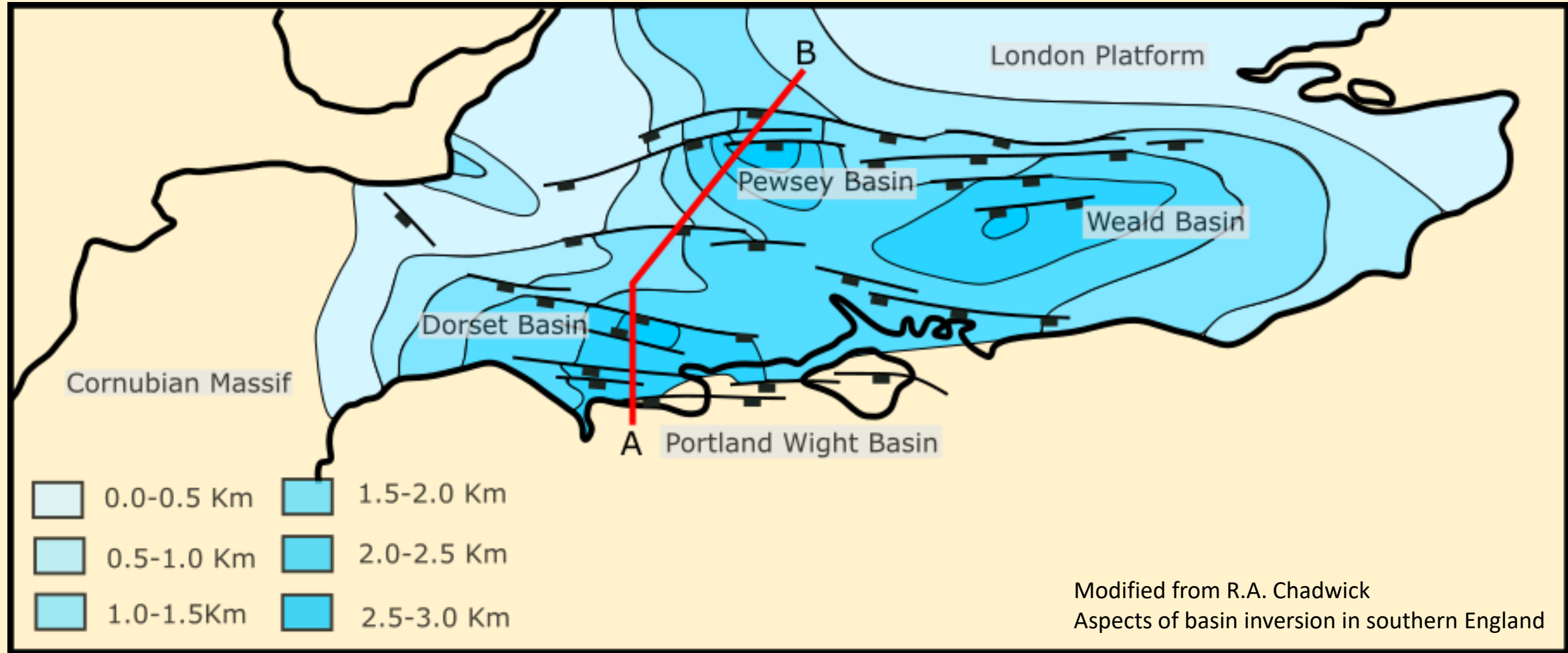
Variscan Tectonics. The final docking of SW England.



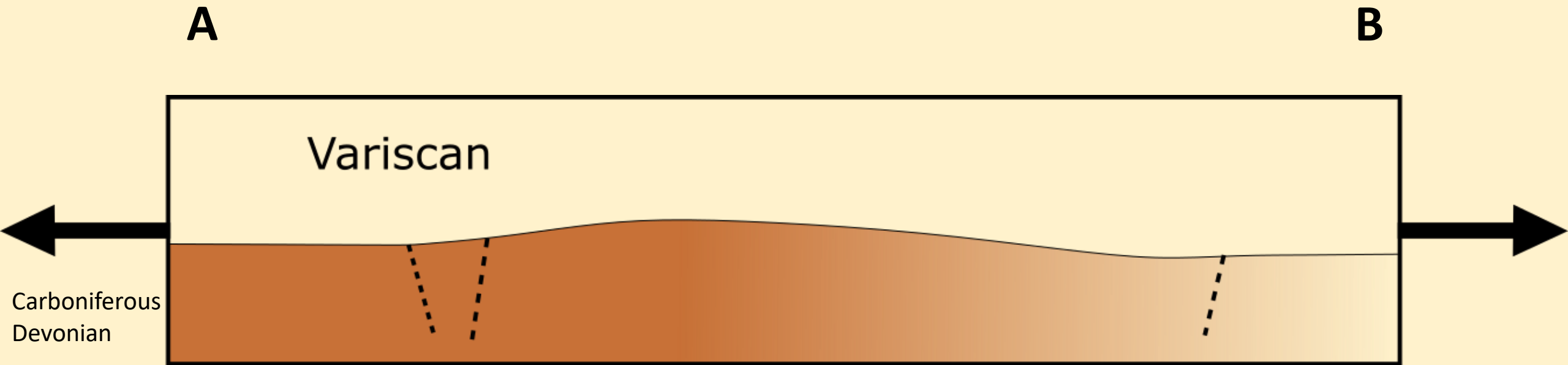
Modified from Leveridge and Hartley, 2006

The Variscan Orogeny, Development and deformation of Devonian and Carboniferous Basins in SW England and South Wales.

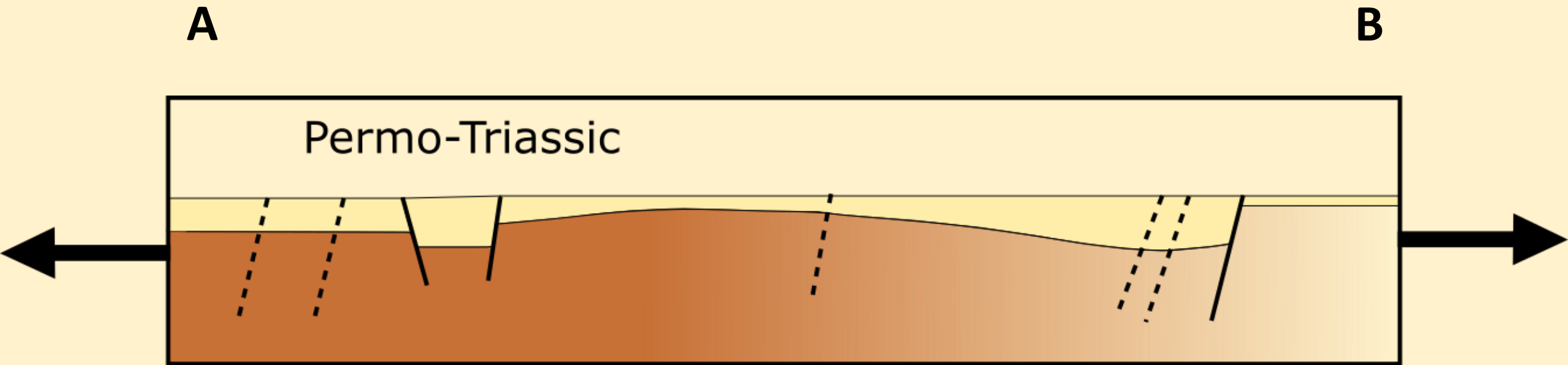
Wessex Basin. Top Variscan Basement



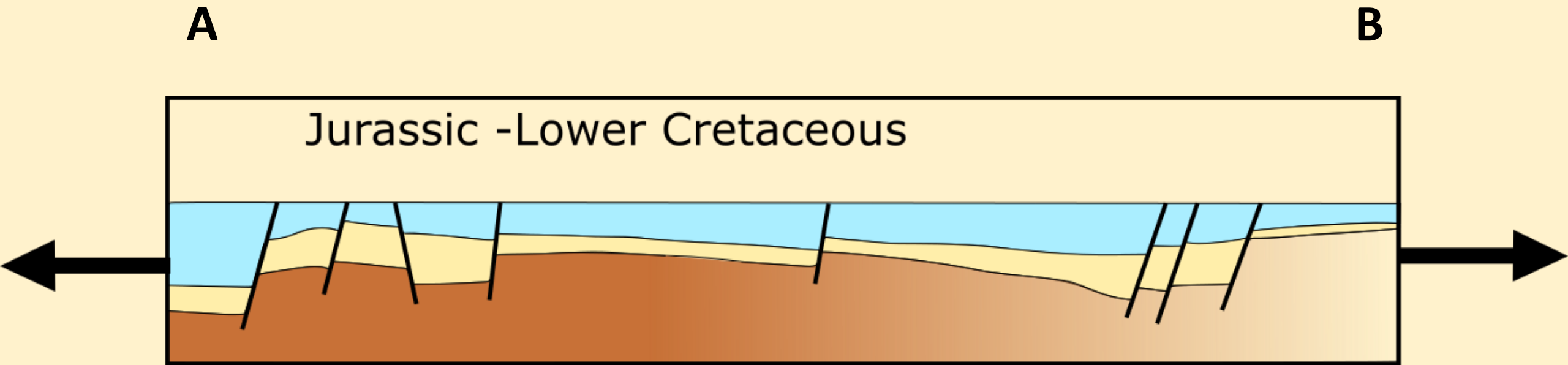
Structural Evolution. Post Variscan Topography. Stage 1



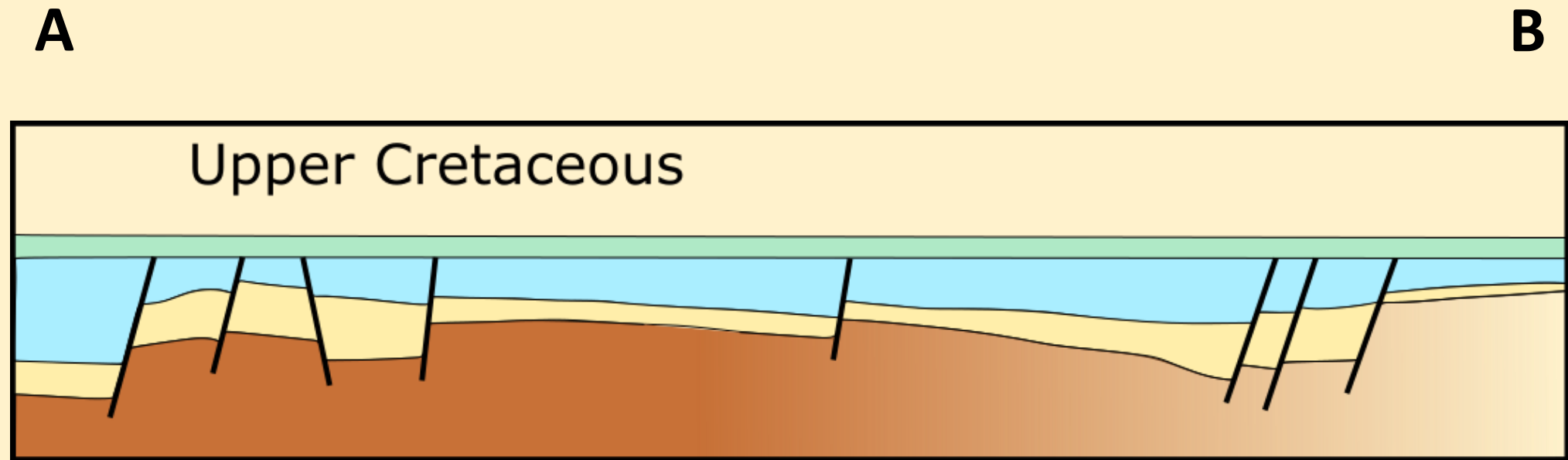
Structural Evolution. Post Permo-Triassic. Stage 2



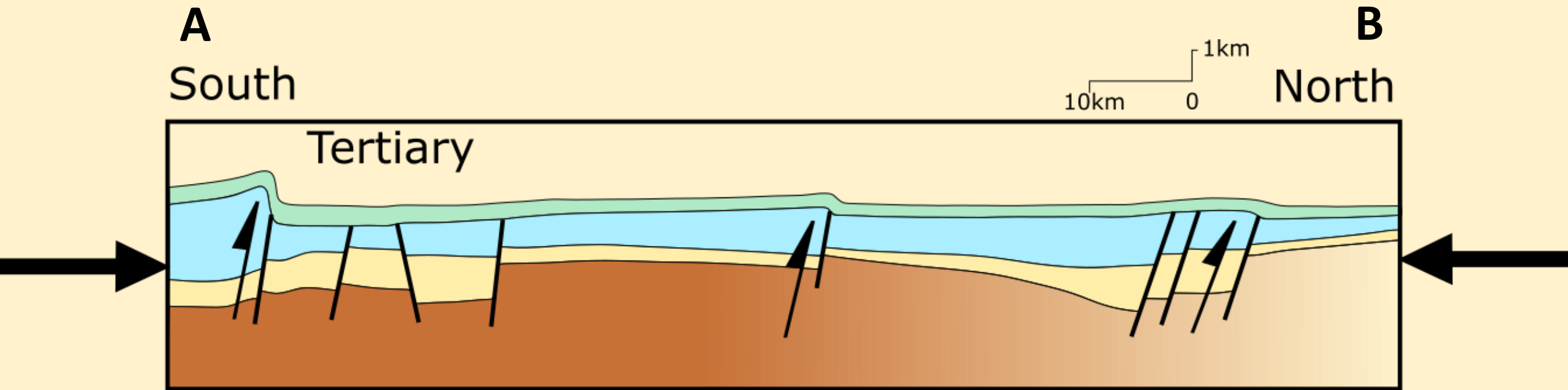
Structural Evolution. Jurassic, Lower Cretaceous. Stage 2



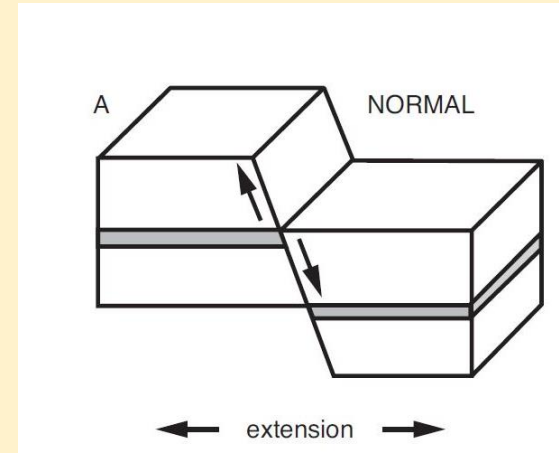
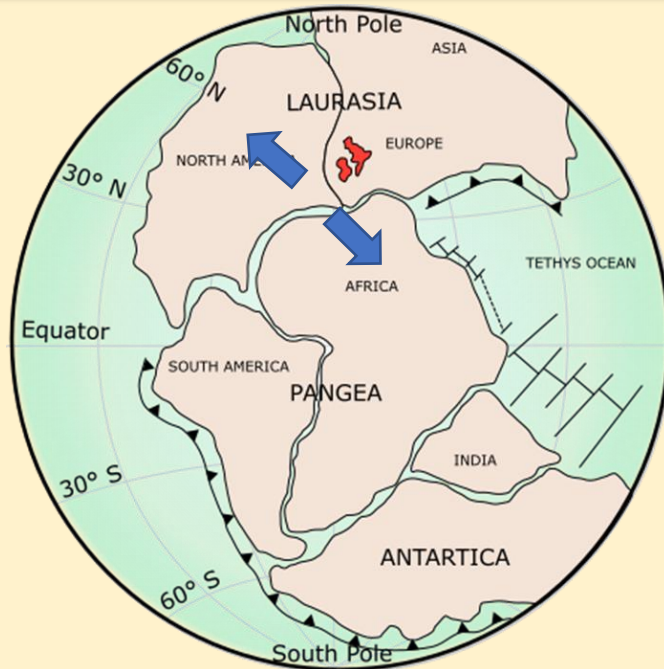
Structural Evolution. Upper Cretaceous. Stage 2



Structural Evolution. Post Pyrenean/Alpine. Stage 3



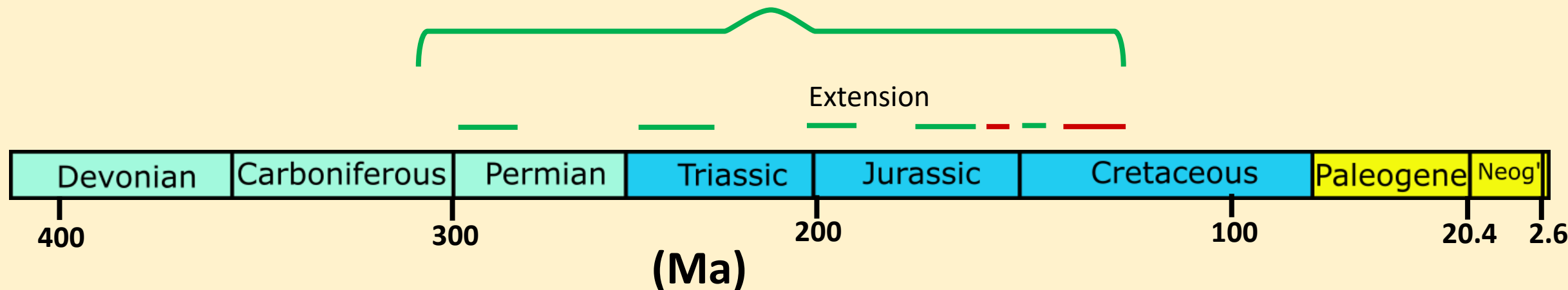
Basin formation, extensional tectonics. Stage 2



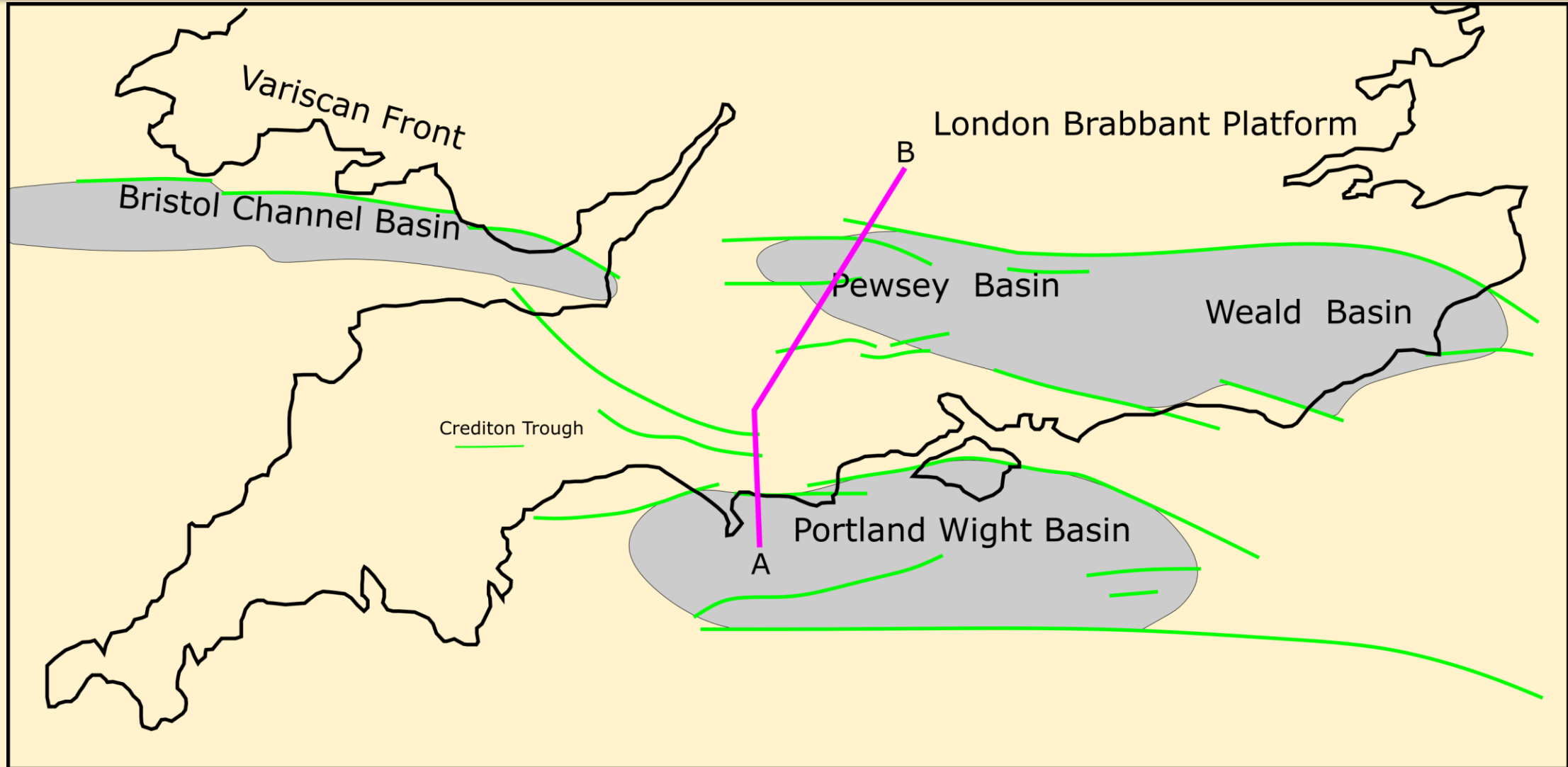
Jurassic $\approx 195\text{Ma}$

2. Basin Development

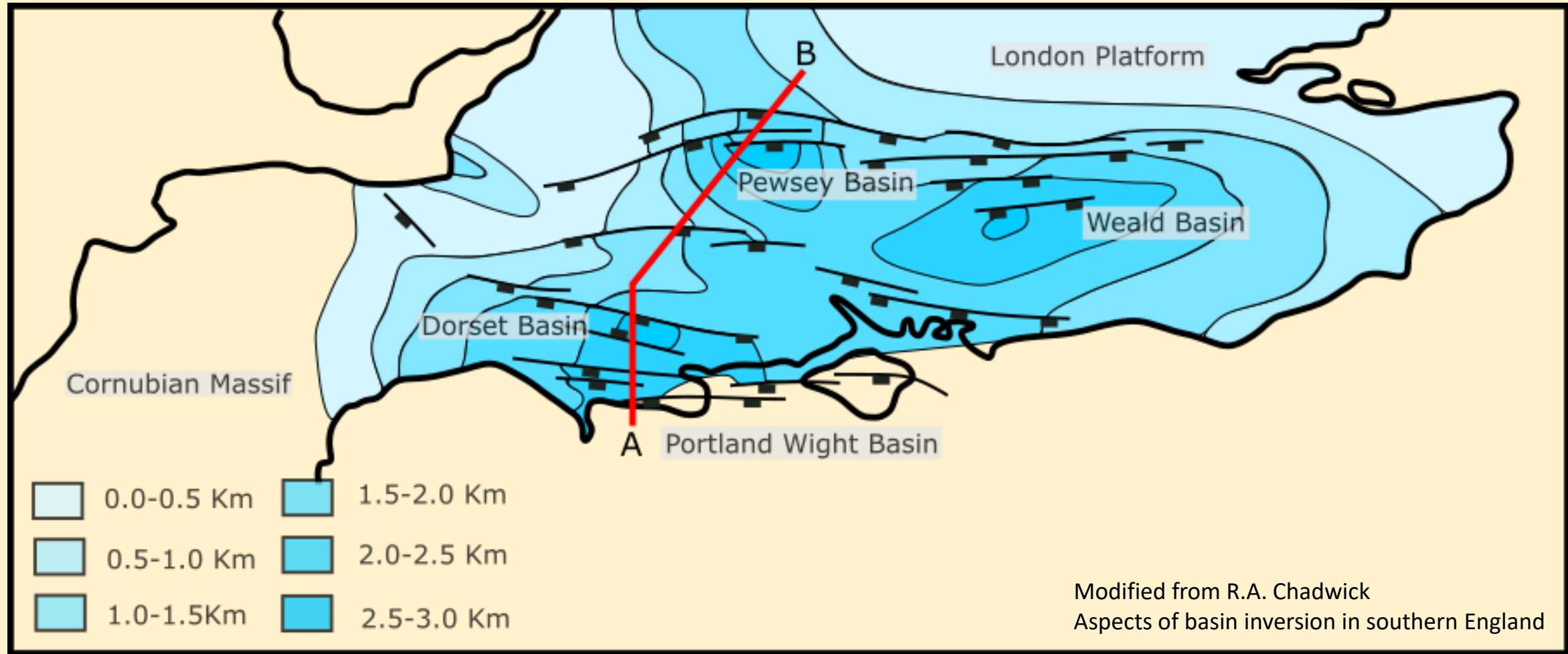
Pre Devonian
Basement



Stage 2. Extensional Tectonics. Major Lineaments



Stage 2. Extensional Tectonics

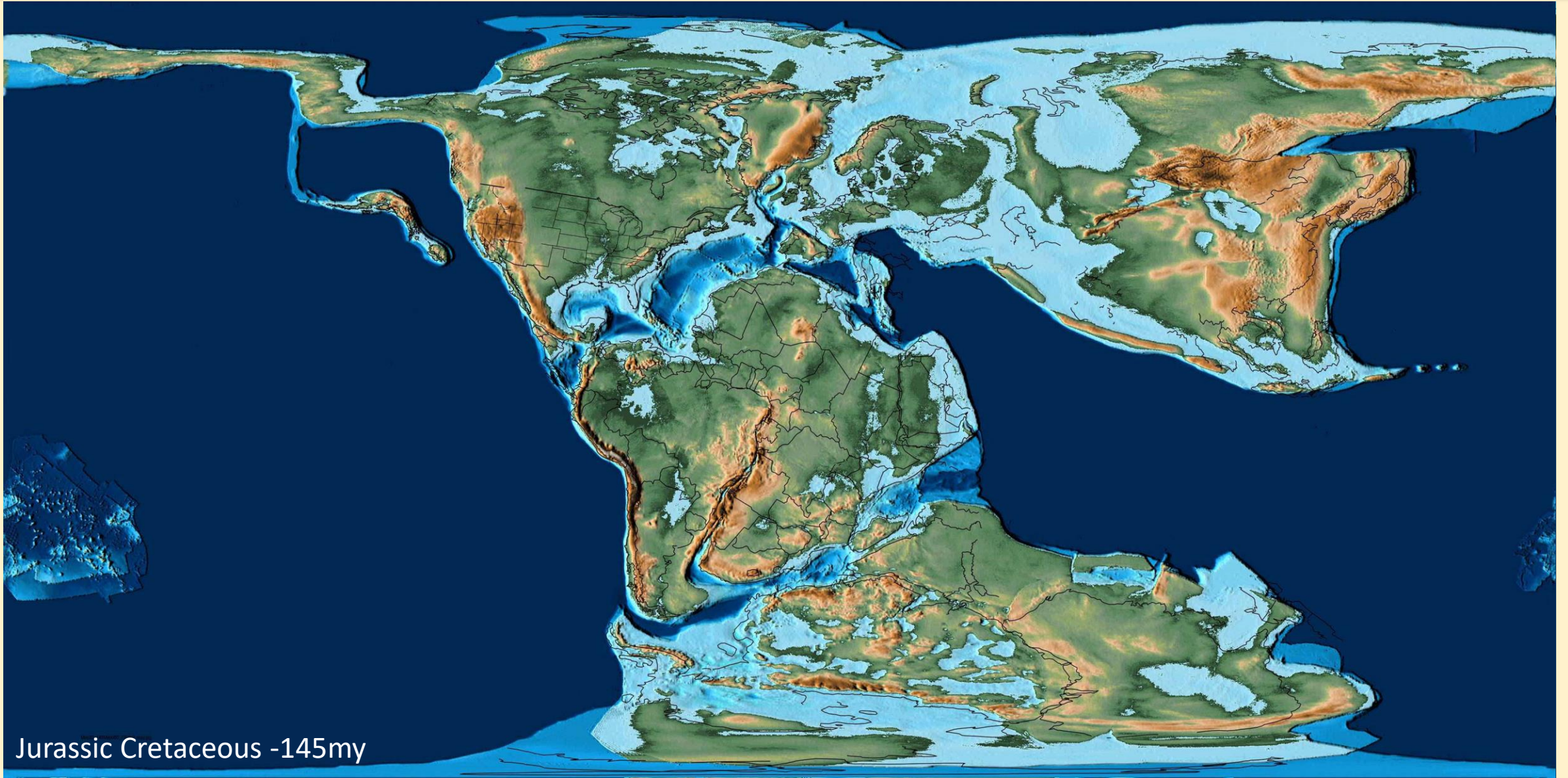


Reminder what was causing the extension? Stage 2

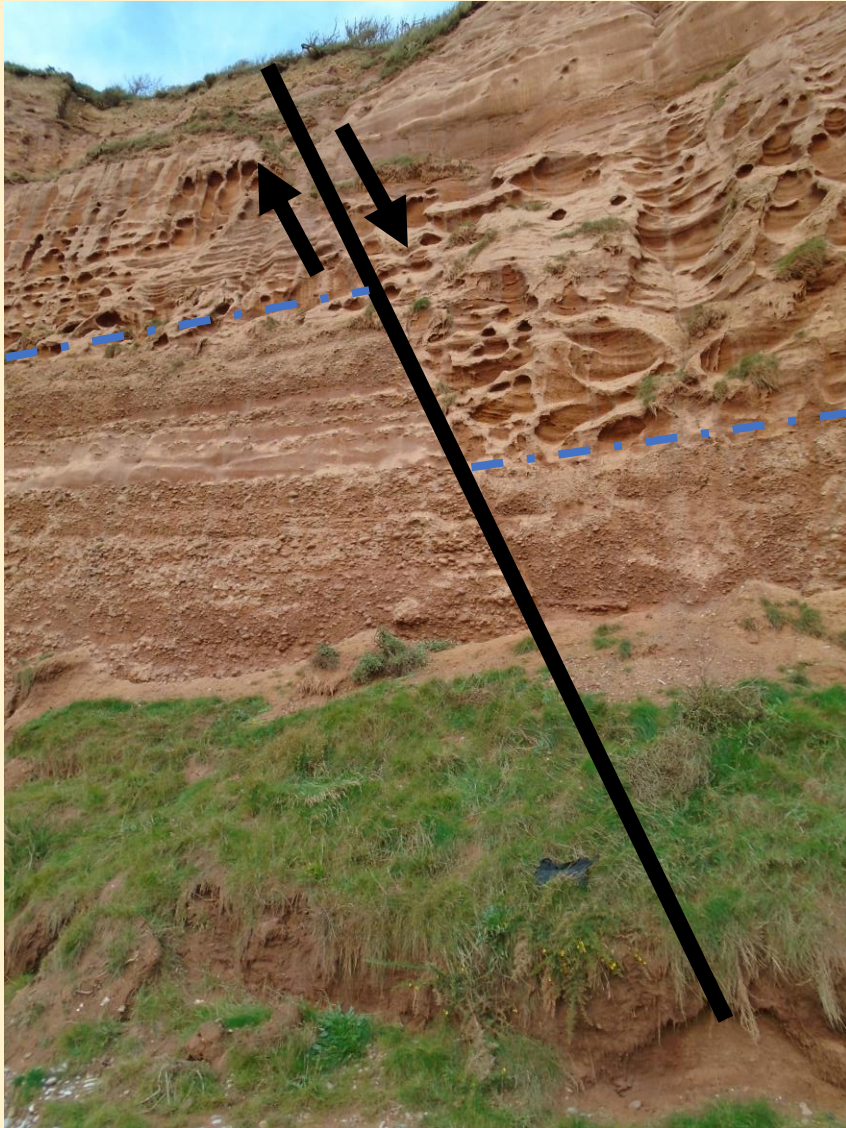
The following animation sequence has been obtained from the work of Christopher Scotese geologist and paleogeographer.

Scotese,C.R.,2016. PALEOMAP PaleoAtlas
For Gplates and the PaleoData Plotter Program,
PALEOMAP Project, <http://www.earthbyte.org/paleomappaleoatlas-for-gplates/>

What was causing the extension? Stage 2



Examples of Extensional Tectonics. Small Scale....

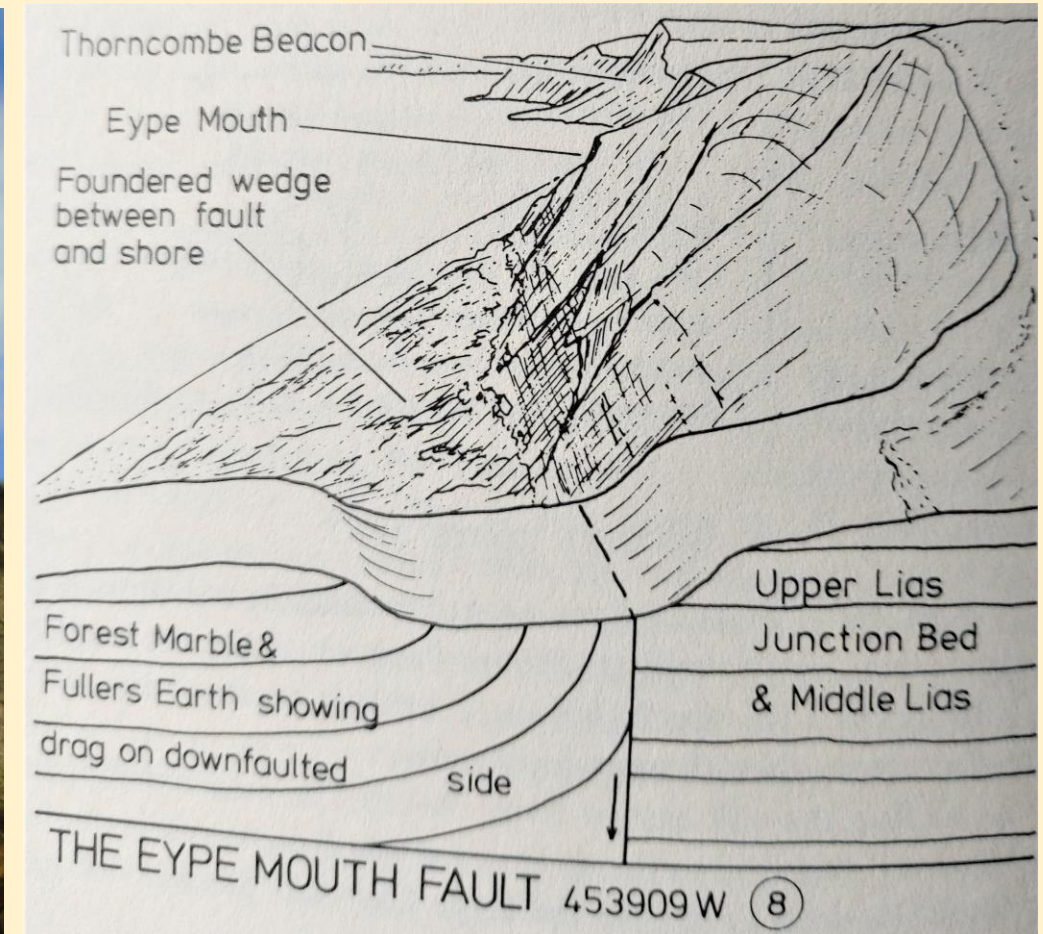


**Budleigh Salterton
Otter Sandstone
Pebble Beds**



**Seatown, Chideock
Green Ammonite bed
Ammonite Stone**

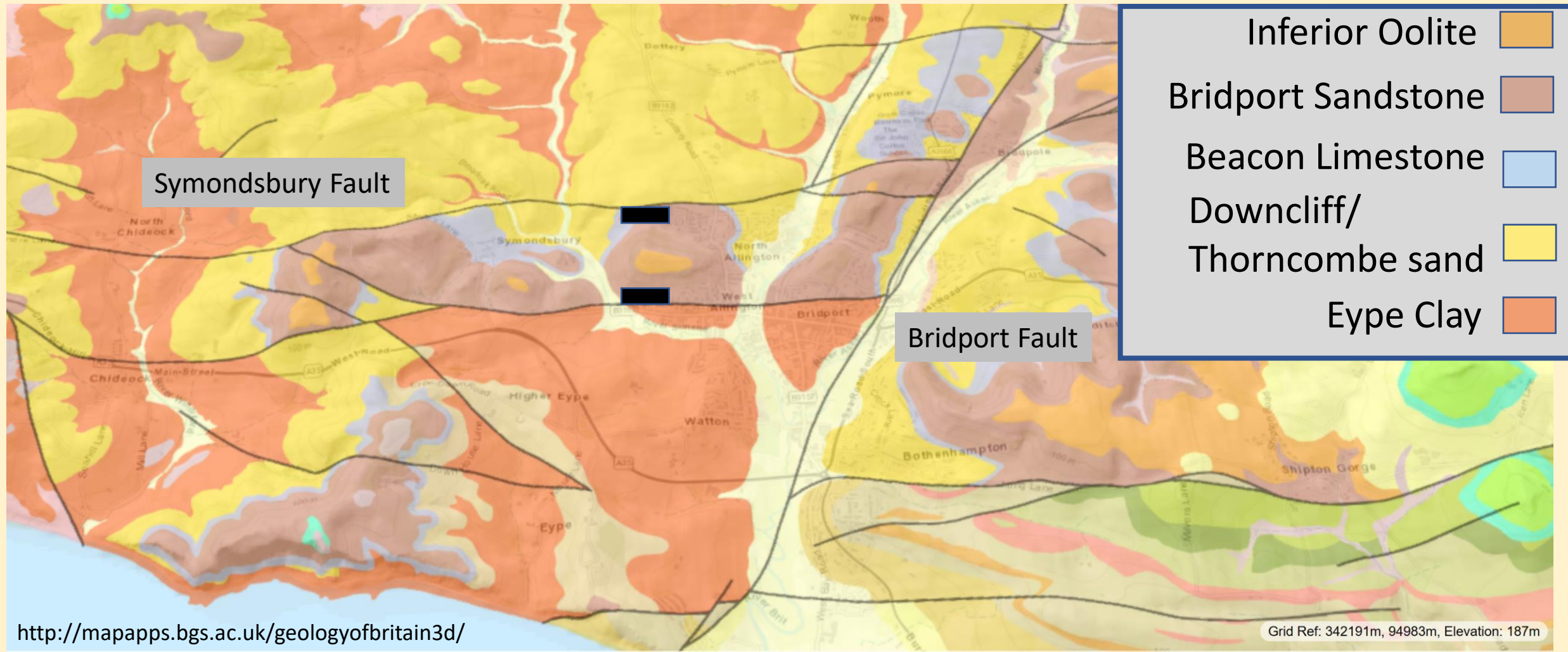
Examples of Extensional Tectonics. Large Scale...



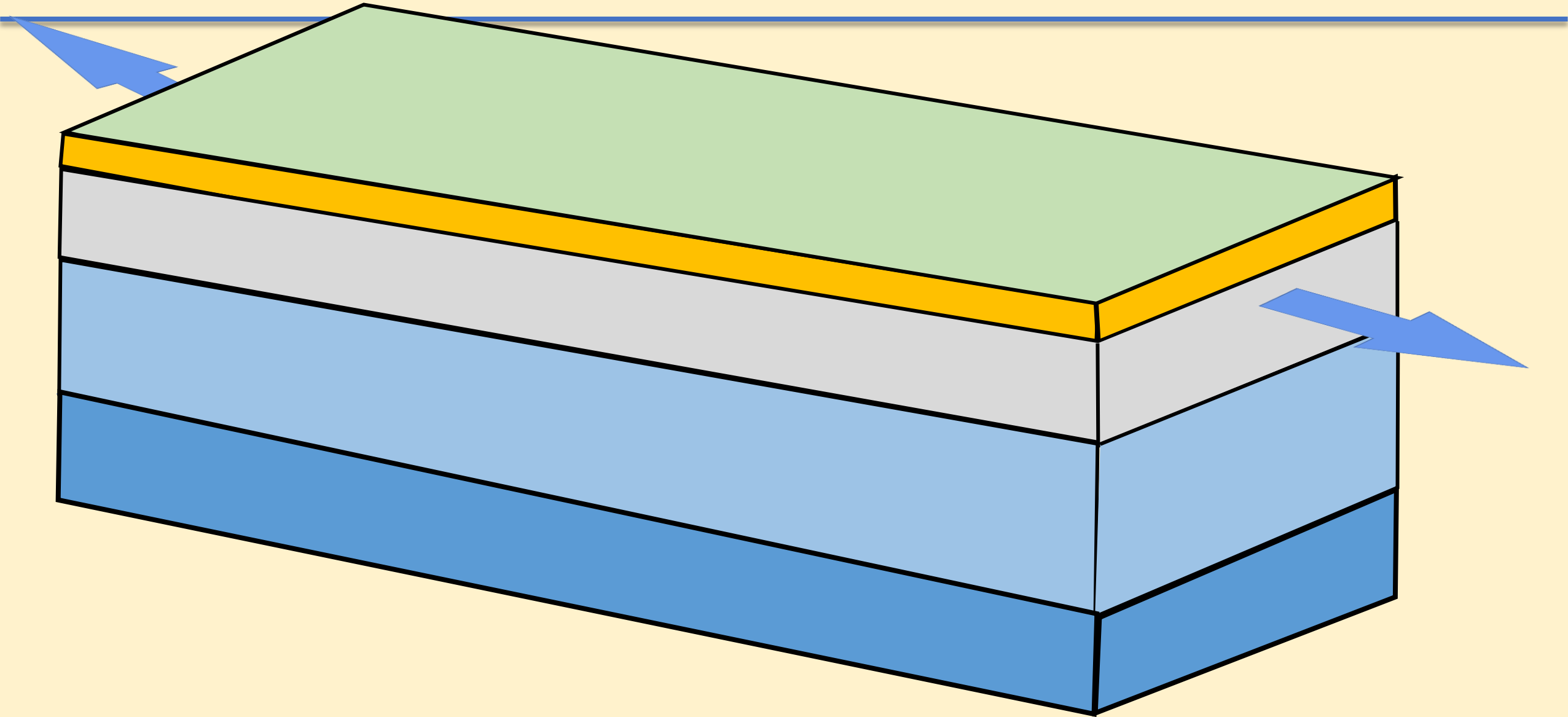
Eype Mouth Fault

Reproduced from
Geology Explained in Dorset
John W. Perkins (1977,p42)

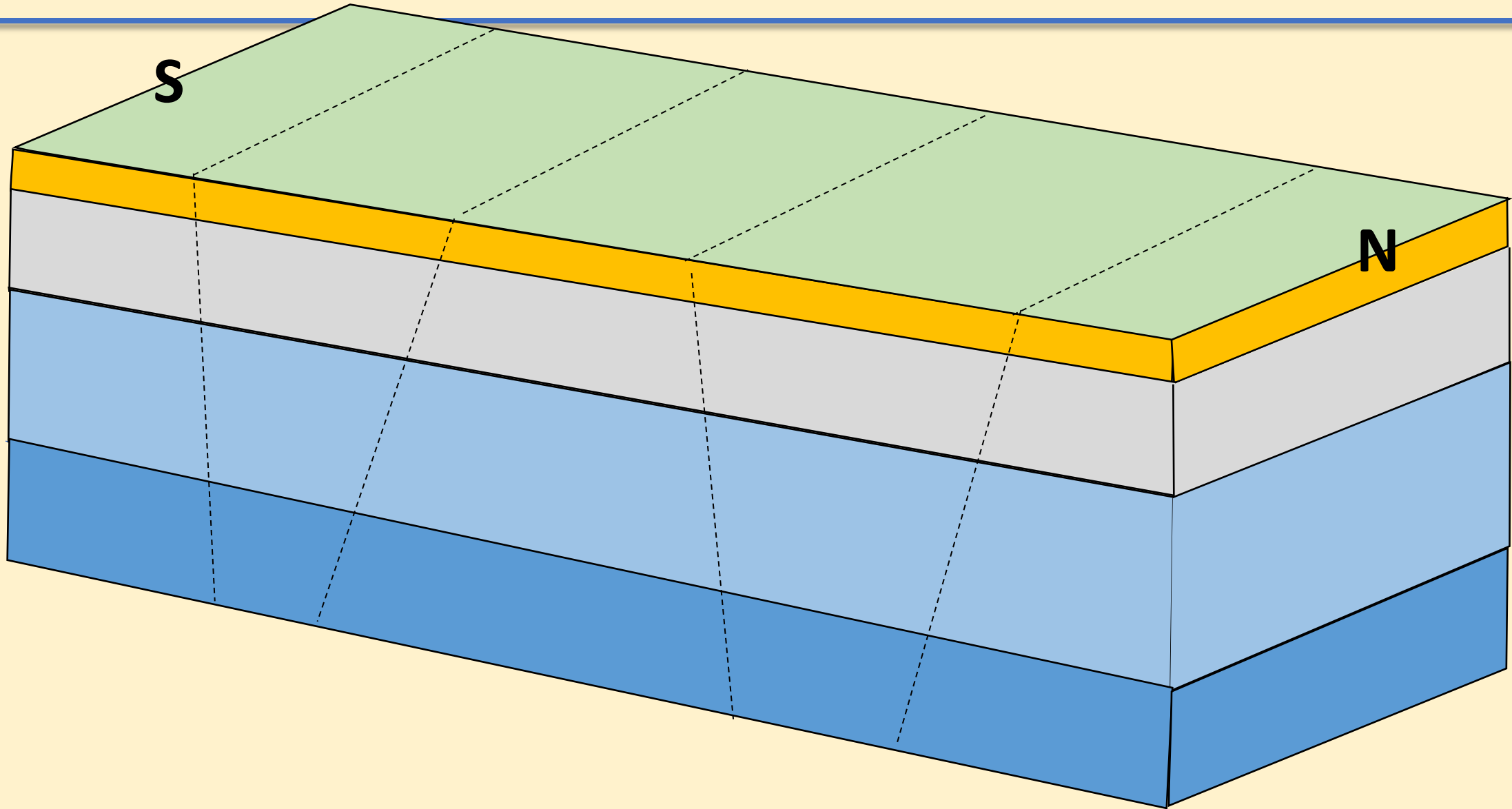
Symondsbury, west of Bridport



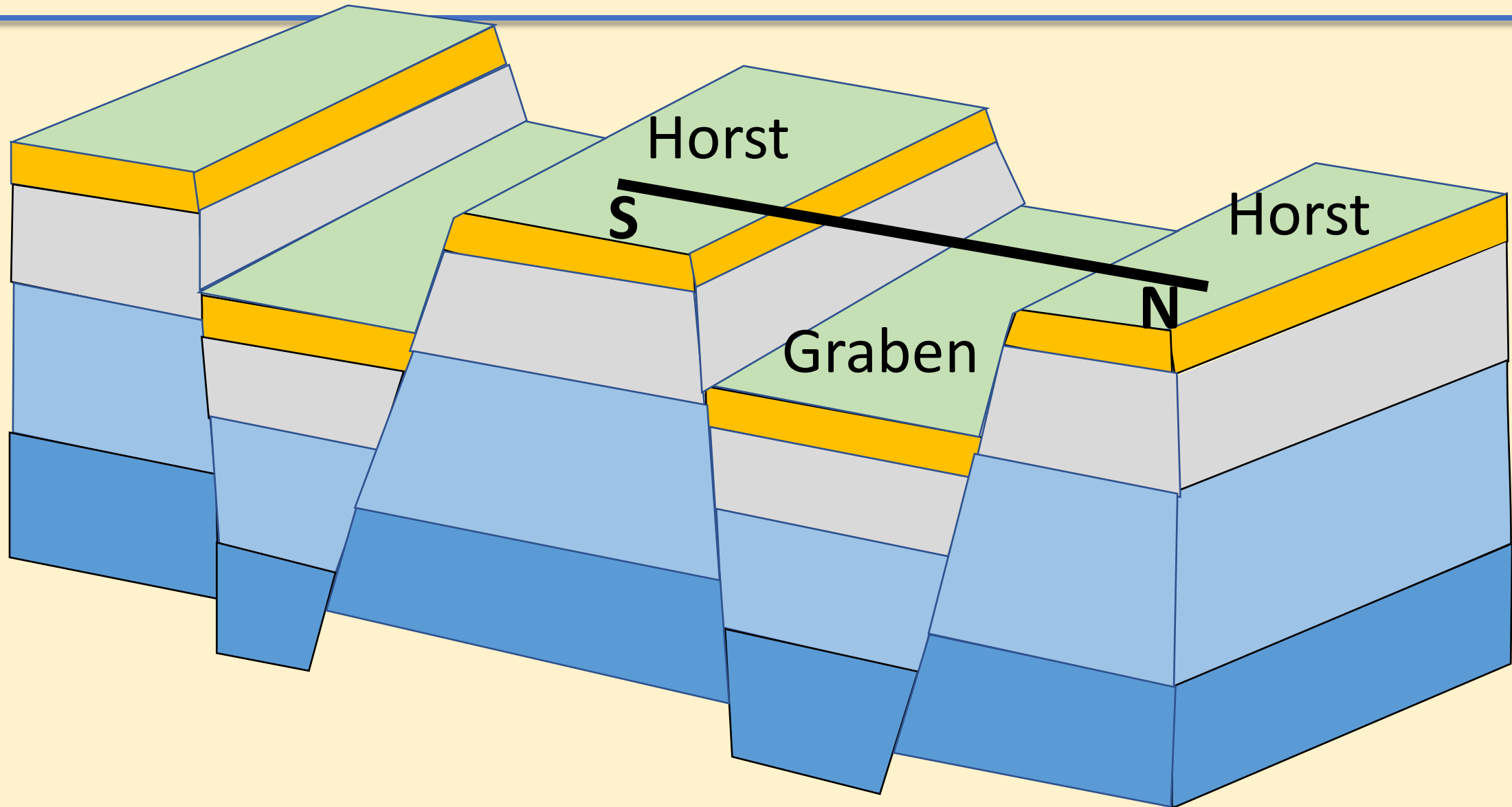
Normal Faulting



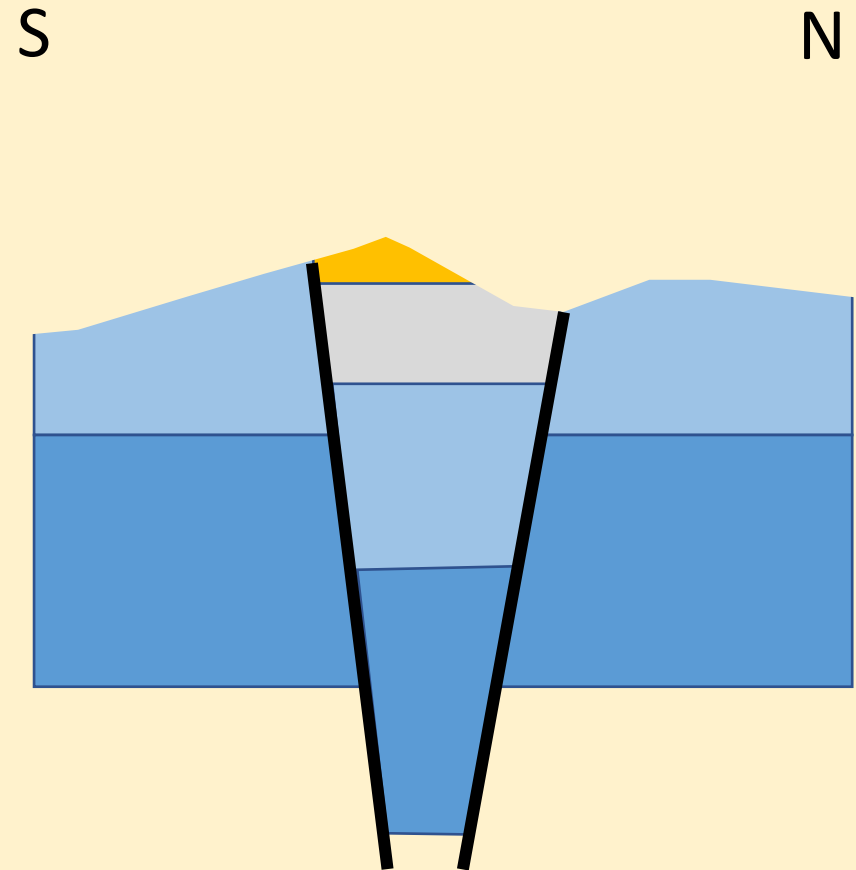
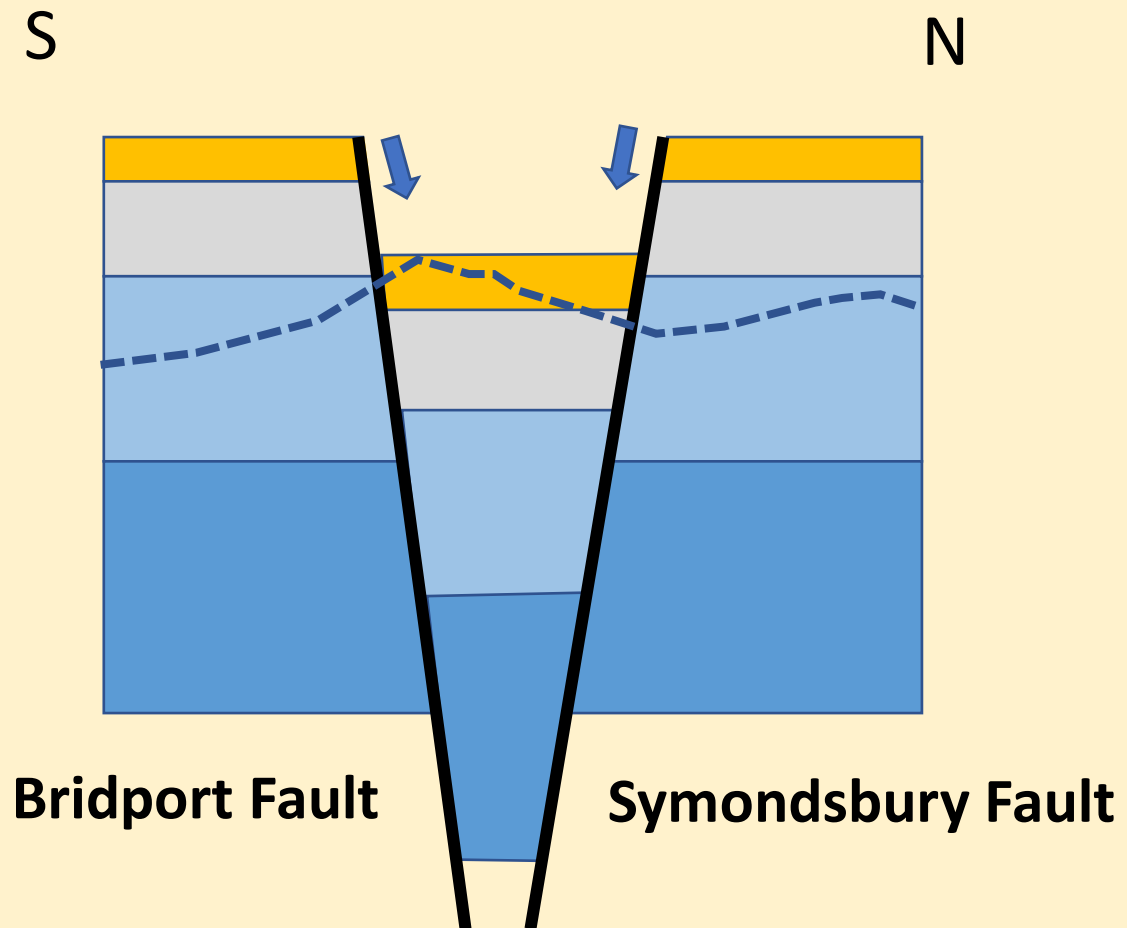
Fracture



Horst and Graben



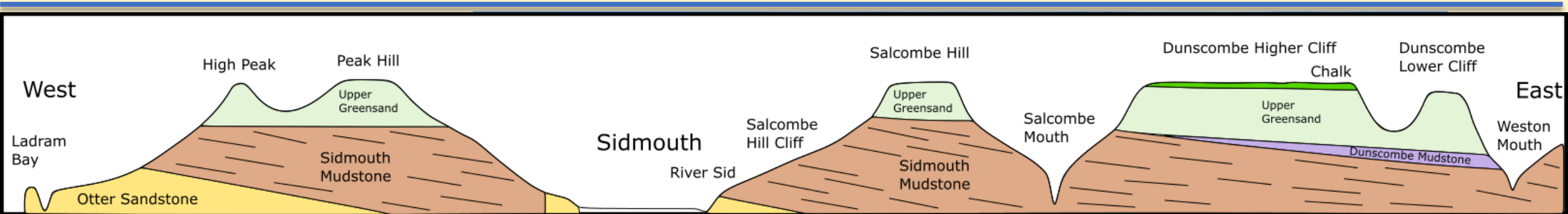
Symondsbury located in a graben



Colmers Hill, Symondsbury



Sidmouth. Where has the Jurassic gone?

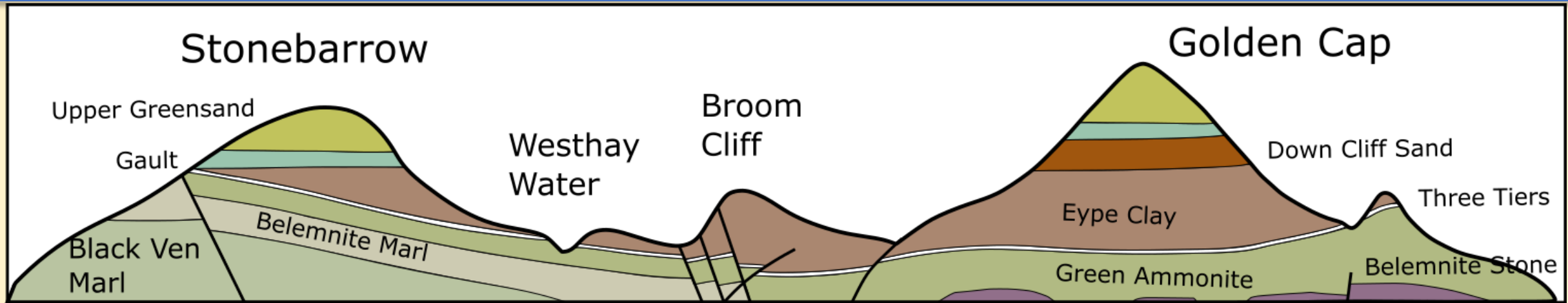


Modified from Geology of the South Devon Coast
John C.W. Cope p78



Photo courtesy of Dr. Robin Shail, Exeter University

Charmouth. Where has the Jurassic gone?



Modified from Geology of the Dorset Coast
John C.W. Cope p46



The West East Tilt and the Great Unconformity

W

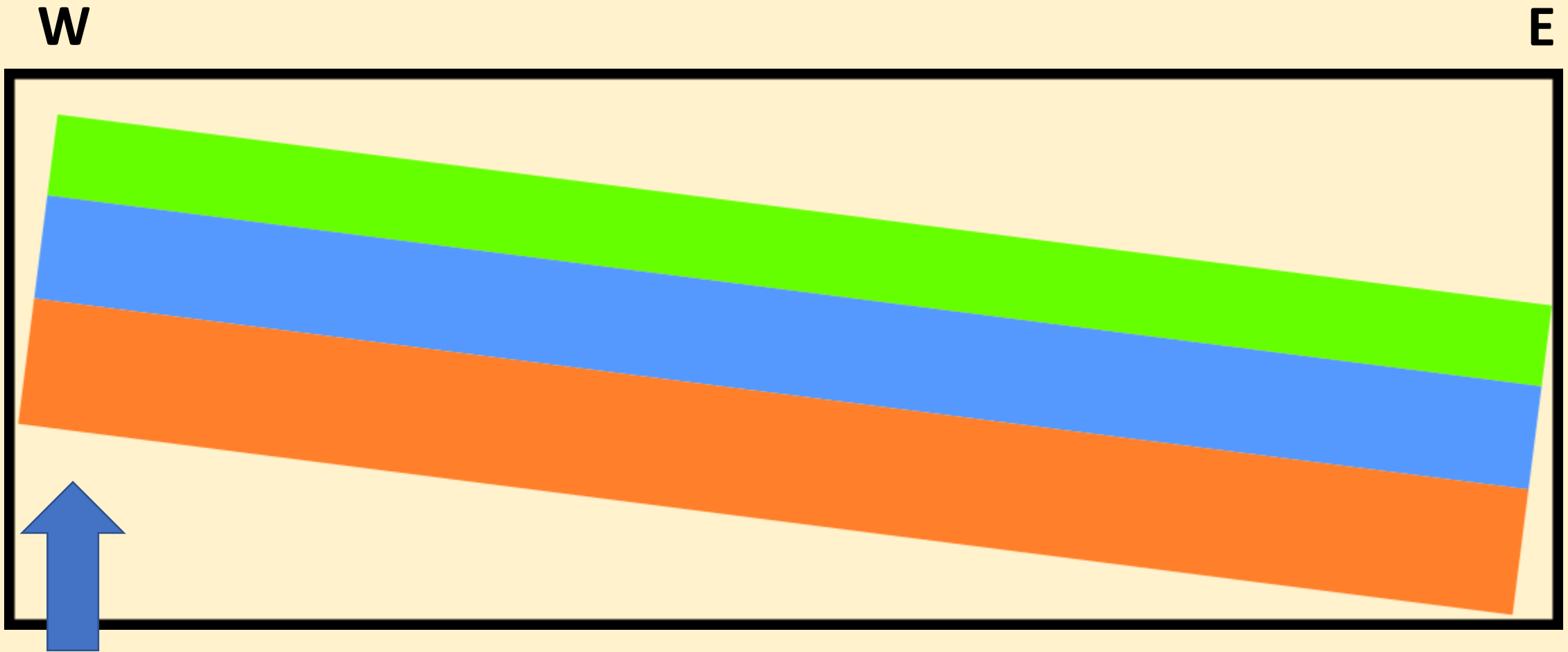
E

Lower Cretaceous - 100 -144My

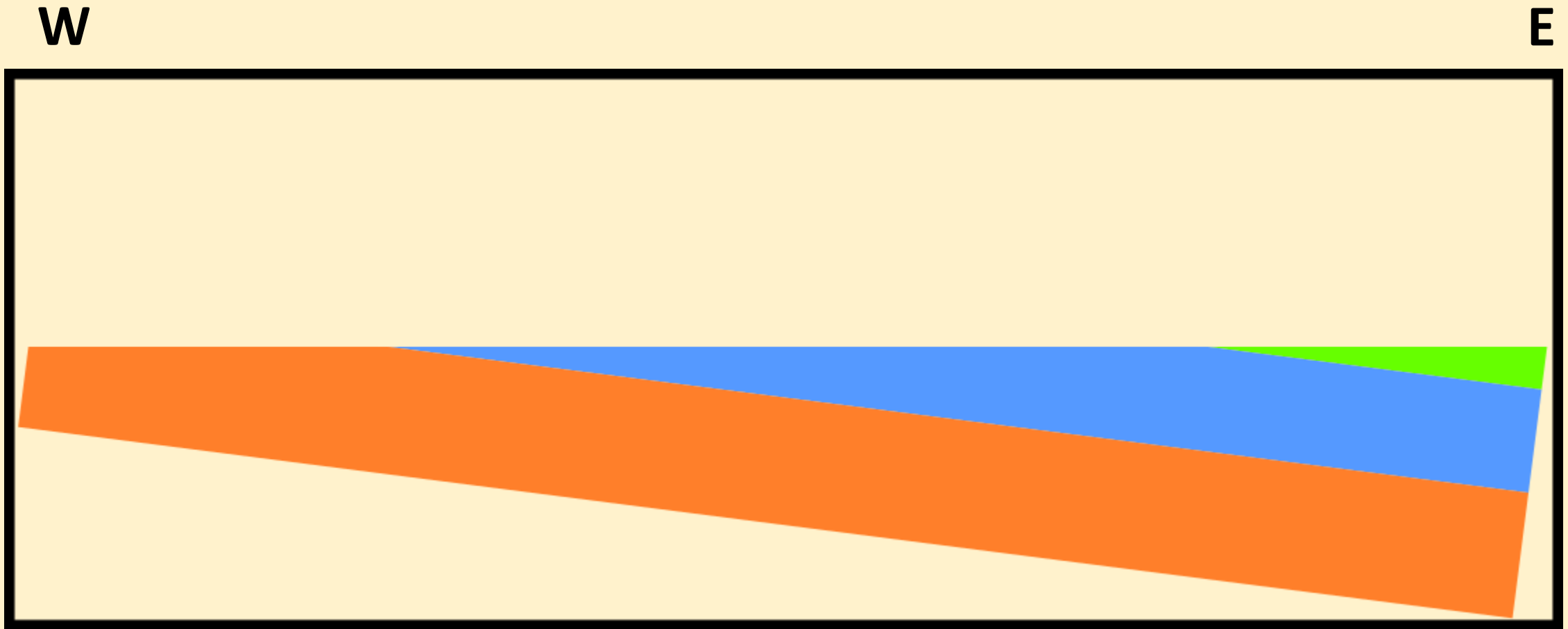
Jurassic - 144 to 200My

Triassic - 200 to 250My

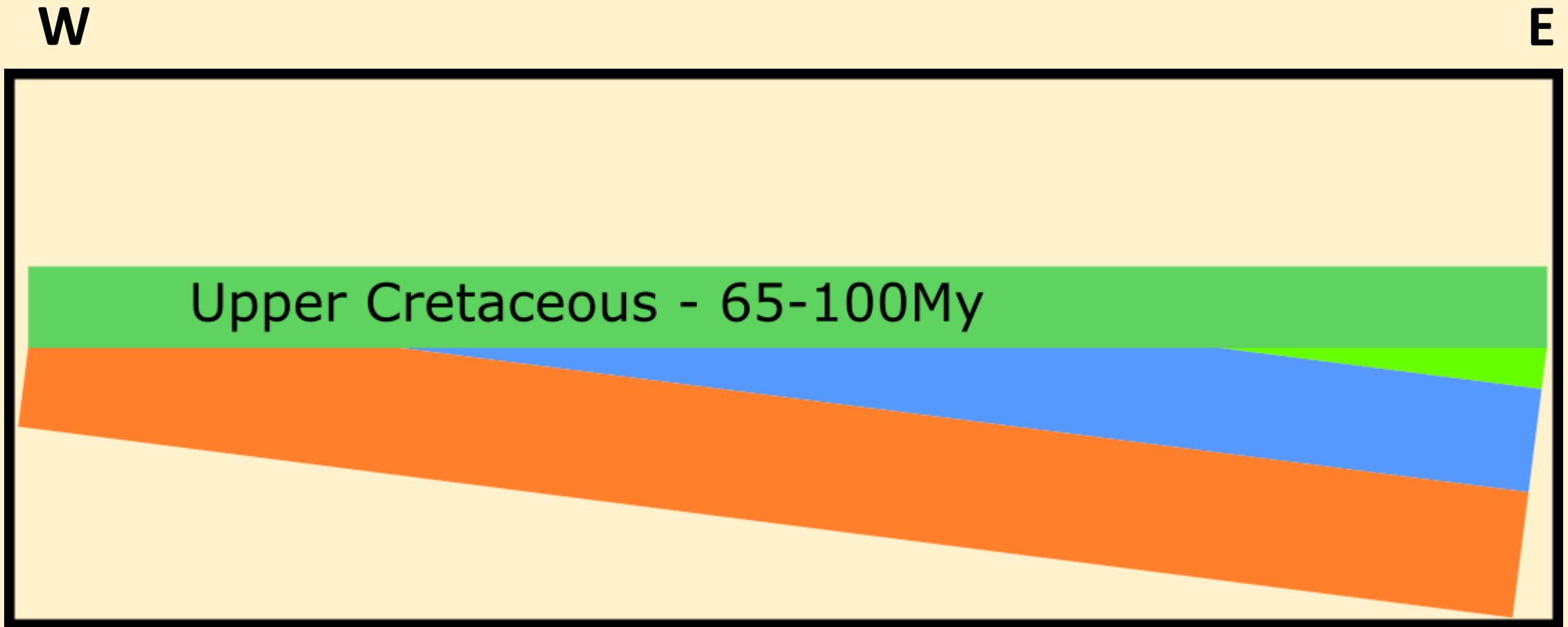
The West East Tilt and the Great Unconformity



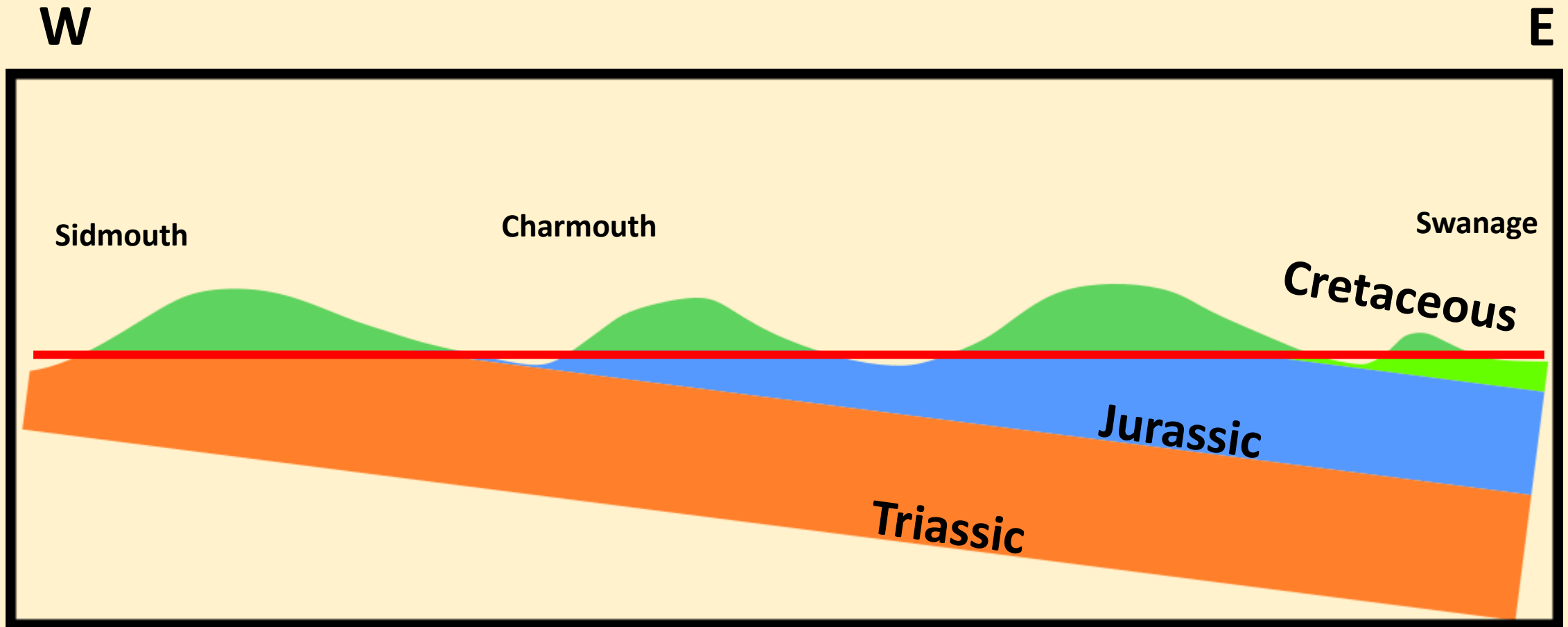
The West East Tilt and the Great Unconformity



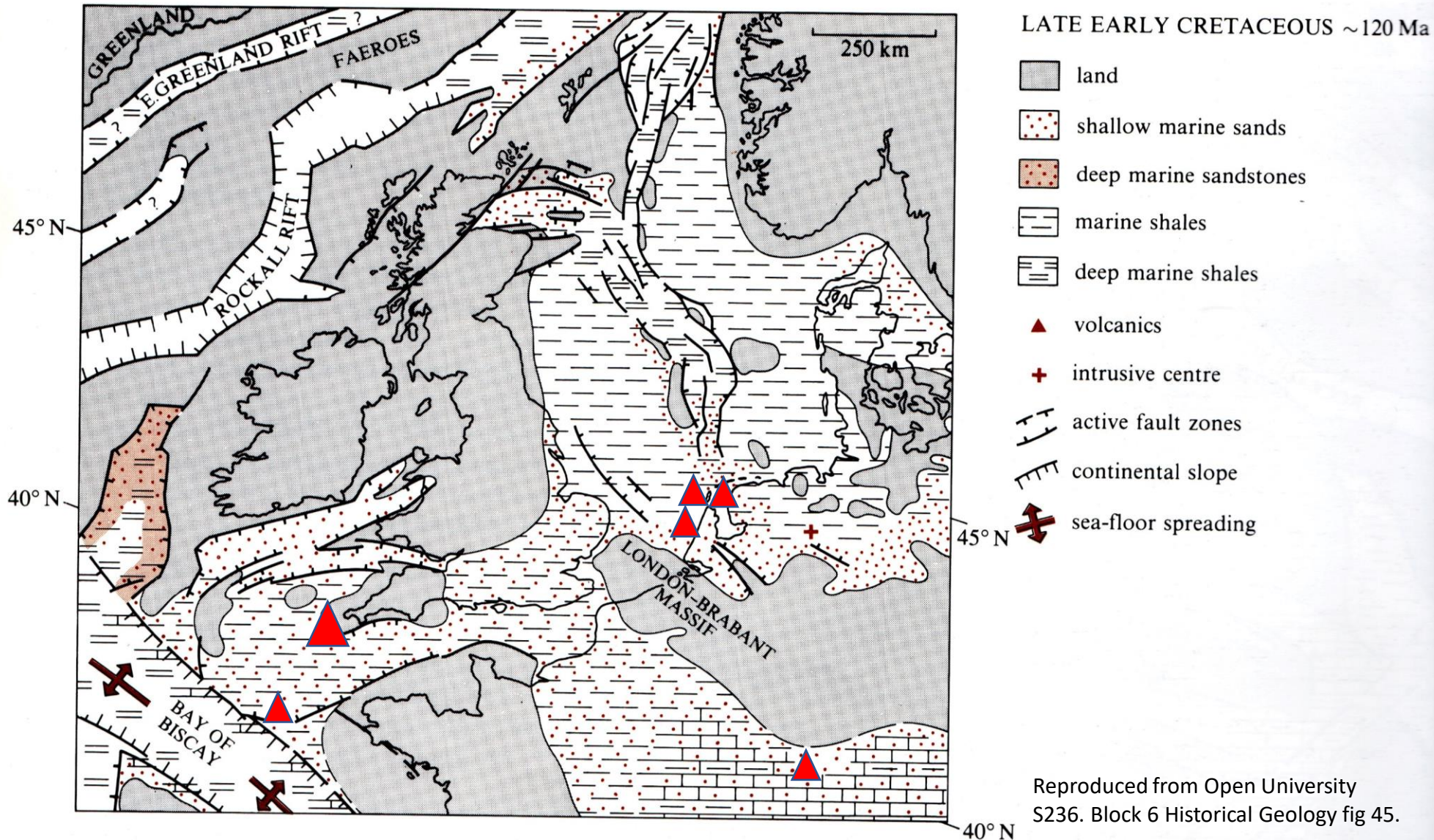
The West East Tilt and the Great Unconformity



The West East Tilt and the Great Unconformity



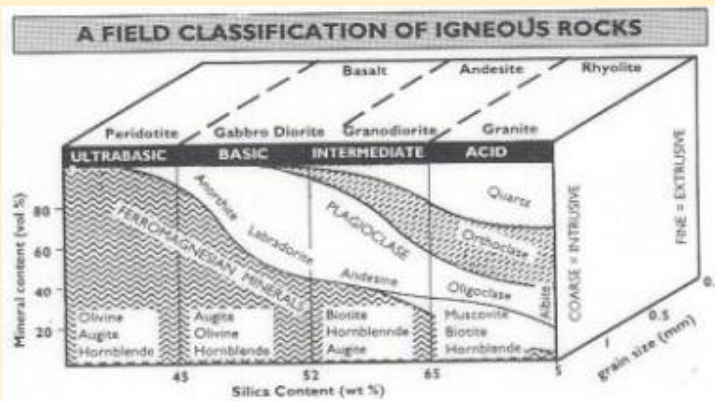
Paleogeography early Cretaceous. Lands End Wolf Rock.



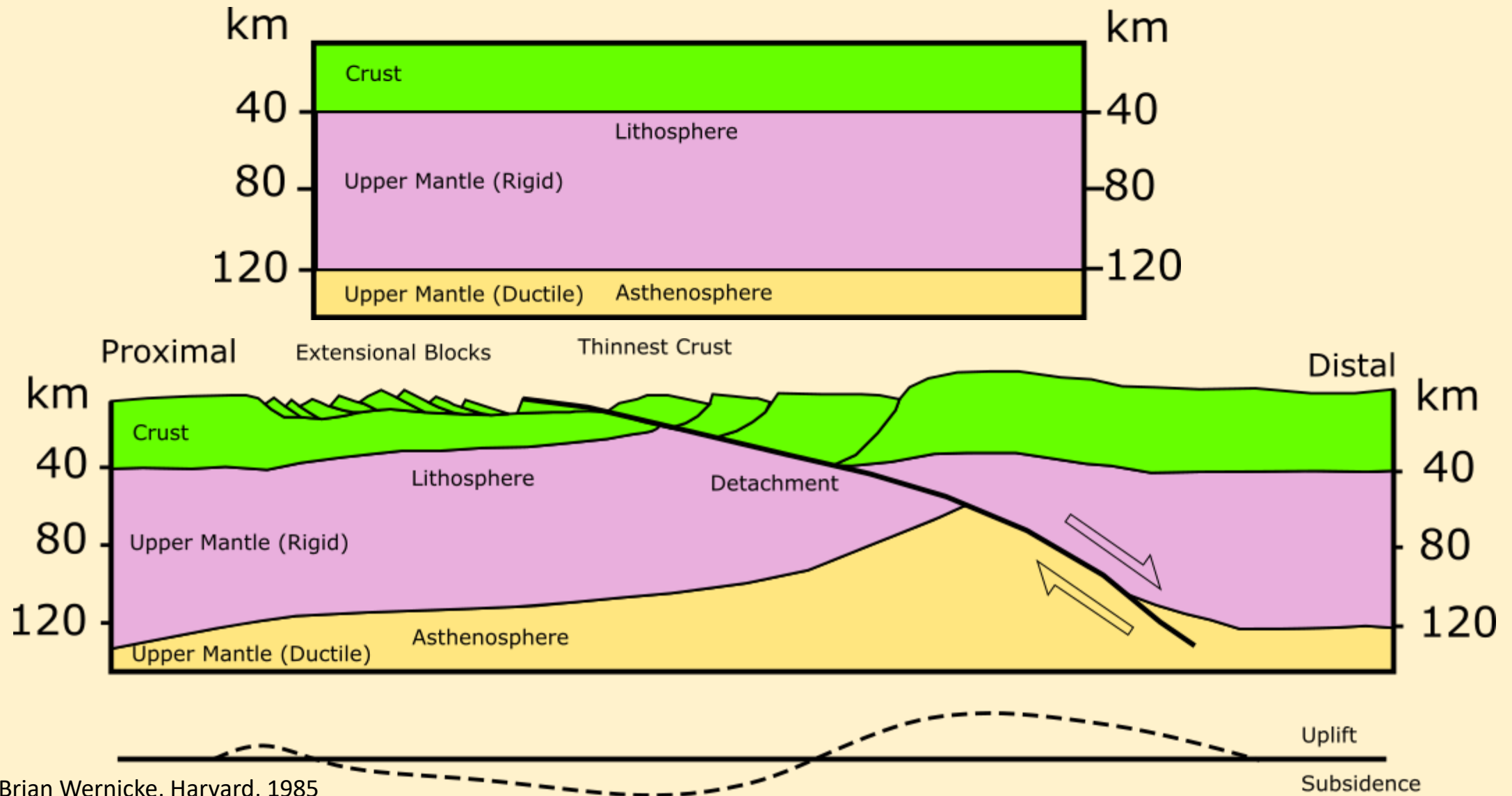
Cause of the early Cretaceous uplift.



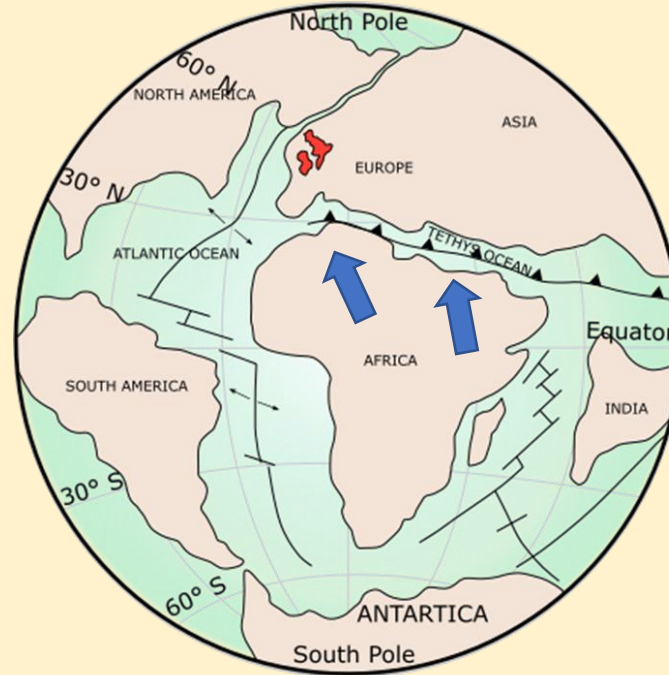
- Rifting of the continental margin, opening of Central Atlantic and Bay of Biscay caused extrusion of the Wolf Rock phonolites. Uncommon extrusive volcanic rock of intermediate composition ie between felsic (feldspar and quartz) and mafic (Ferromagnesian).
- Dated as latest Jurassic Early Cretaceous. Convenient evidence for upper crustal activity.
- Greater than 1.5km uplift centered on the Cornubian Massif (Cornwall/Devon)
- Caused permanent east ward tilt of pre-Upper Cretaceous successions followed by the increase in westward erosion of Jurassic, Triassic sediments.
- Uplift source/generation of the Wealden clastic fluvial rocks.



The Wernicke Model of Normal Simple Shear.



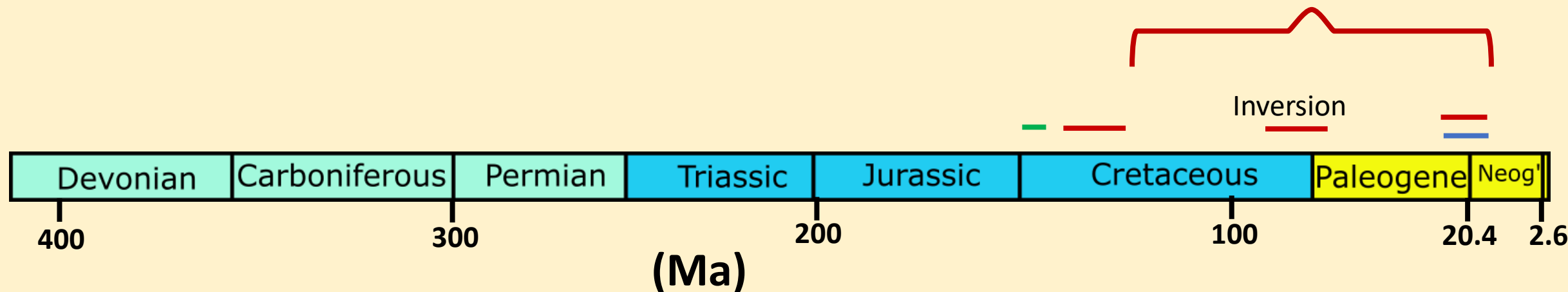
Basin Compression and Inversion. Stage 3



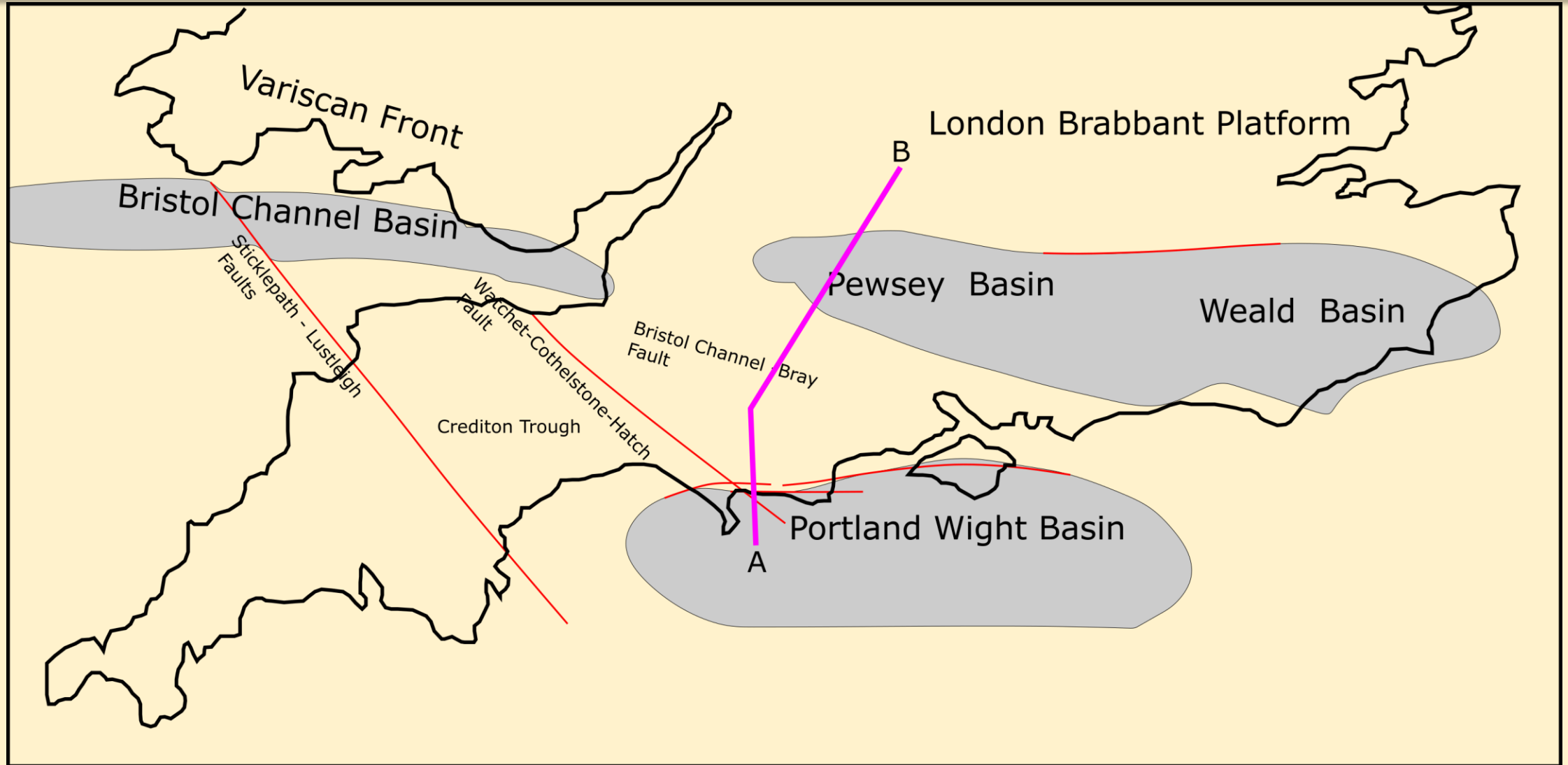
LATE CRETACEOUS/EARLY TERTIARY $\approx 65\text{Ma}$

3. Basin Inversion

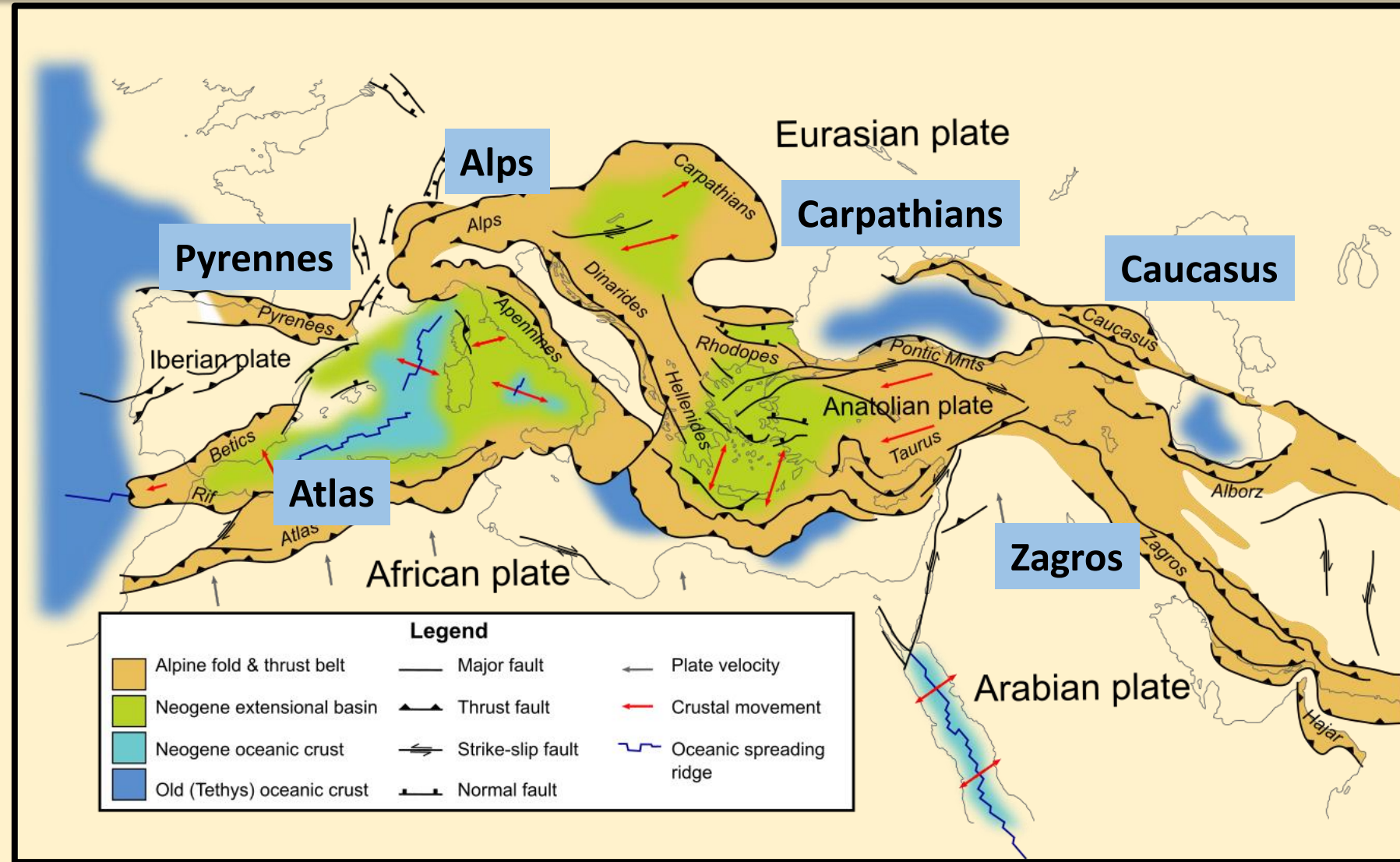
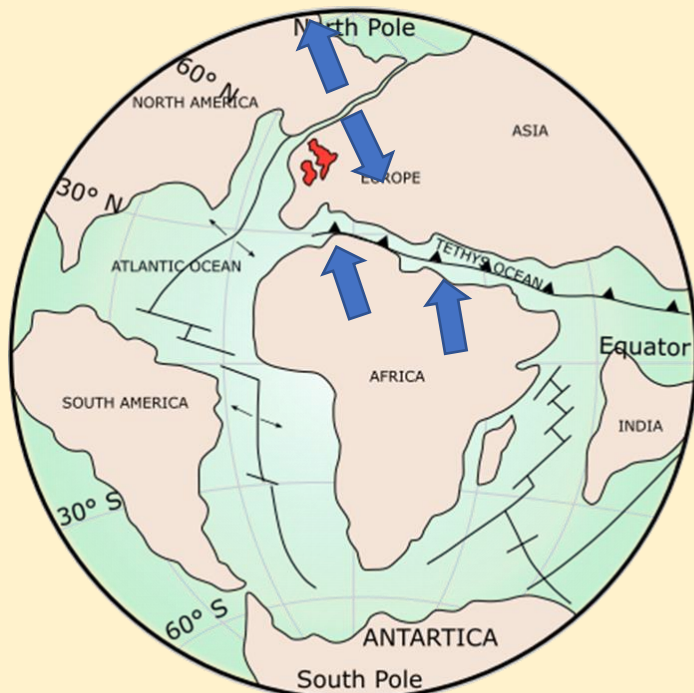
Pre Devonian
Basement



Compressional Tectonics. Lineaments Reactivated



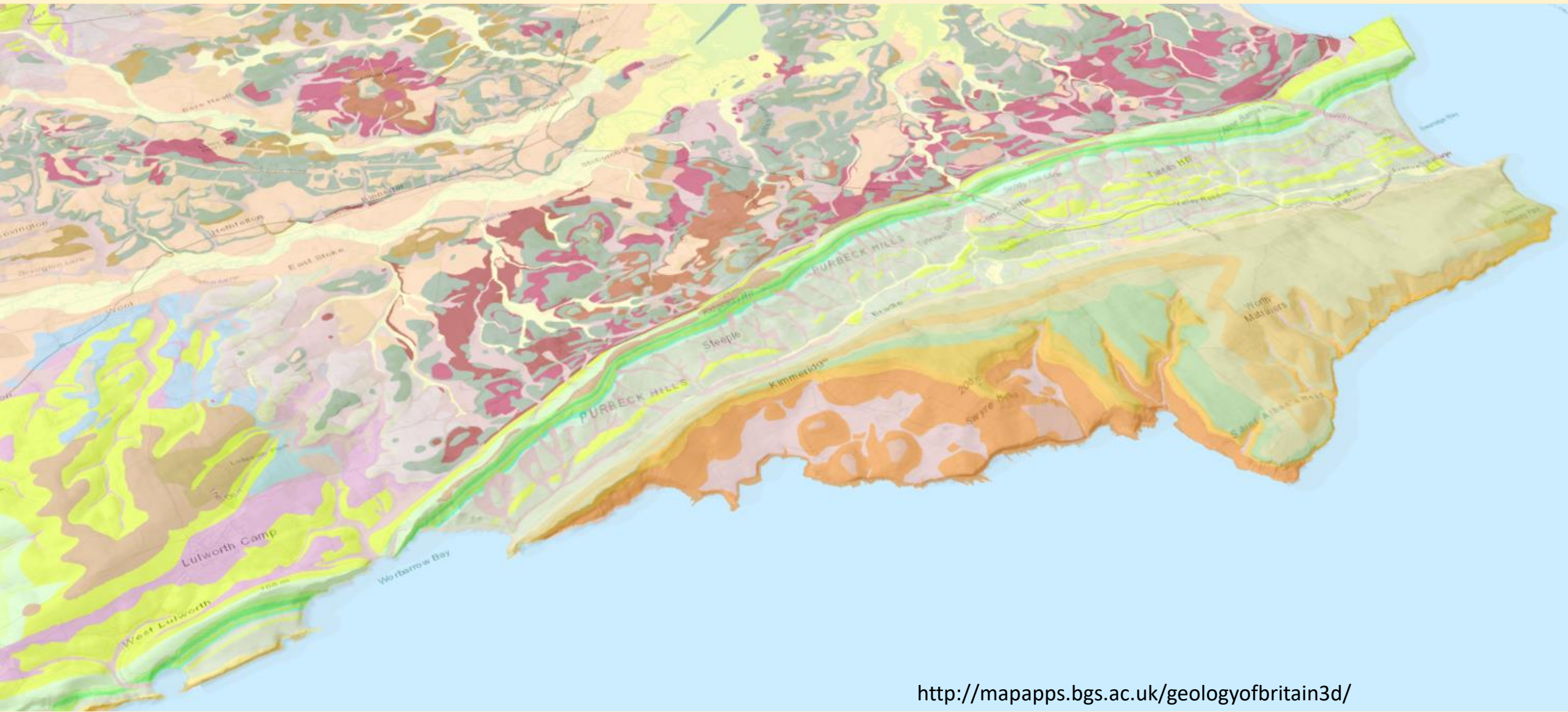
Alpine Orogeny Mountain Ranges.



LATE CRETACEOUS/EARLY TERTIARY $\approx 65\text{Ma}$

By Woudloper - Own work, CC BY-SA 1.0,
<https://commons.wikimedia.org/w/index.php?curid=6980735>

Isle of Purbeck.



Isle of Purbeck.



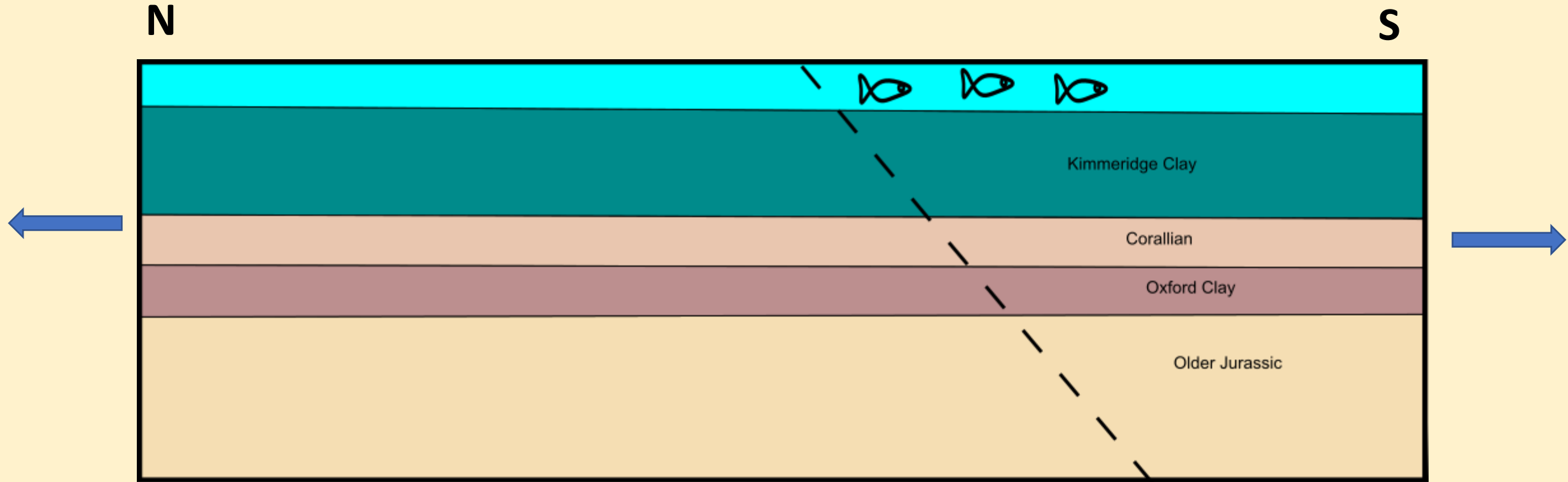
Lulworth Cove/Stair Hole.



**Folded
Chalk
Greensand
Wealden
Purbeck
Portland**

Photo courtesy of Dr. Robin Shail, Exeter University

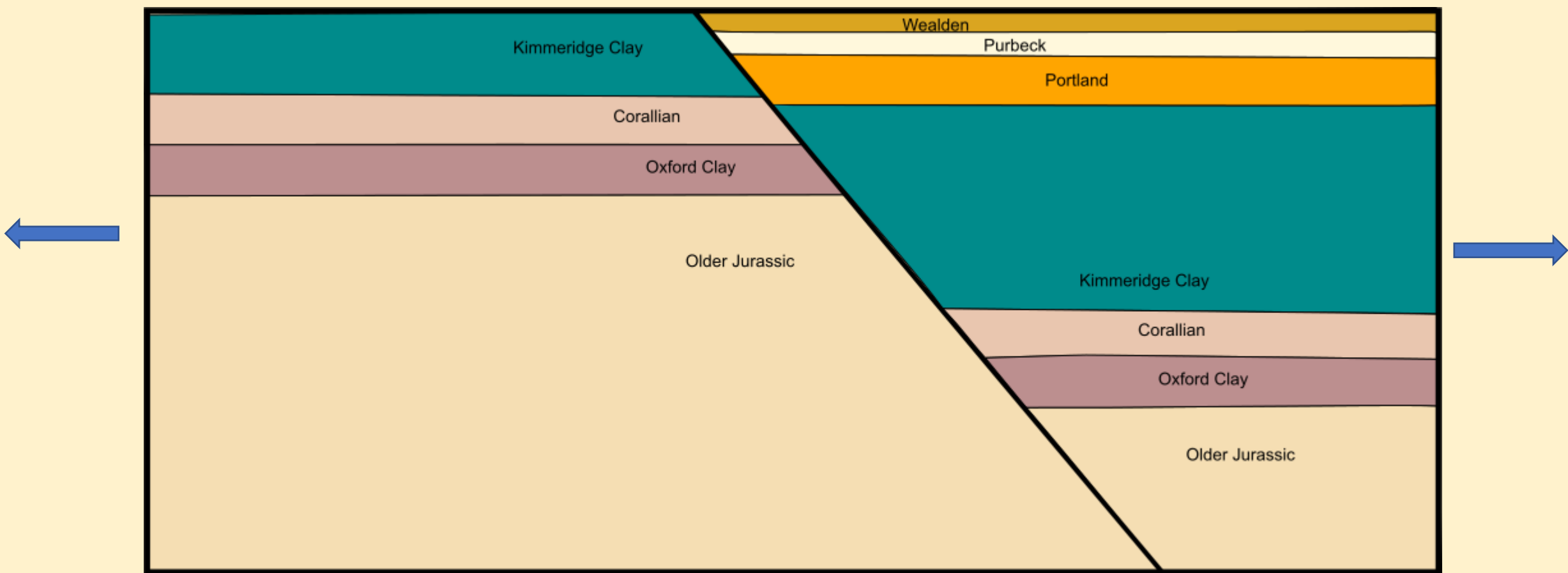
Purbeck Monocline.



Variscan Basement and lower Jurassic not included for clarity

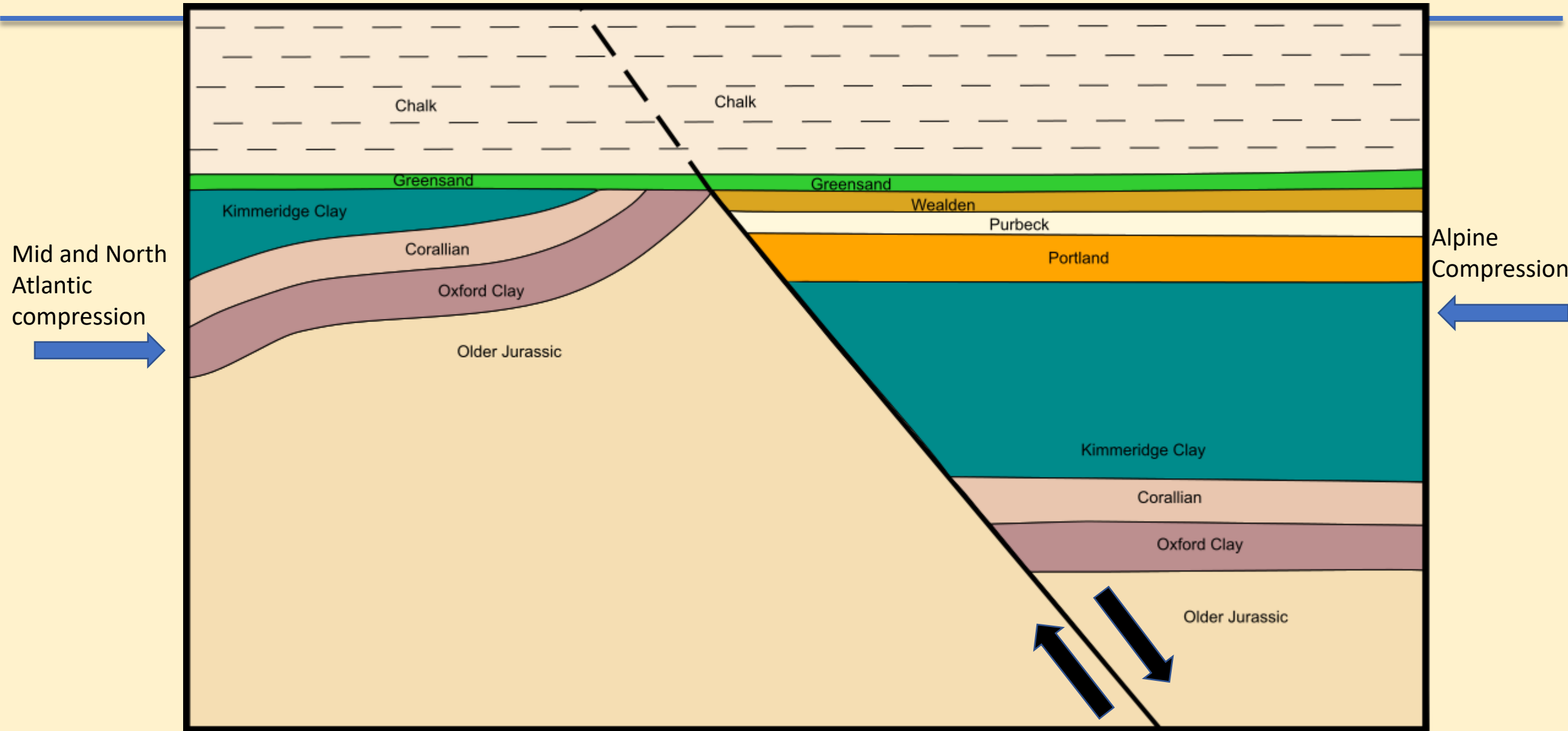
N

S



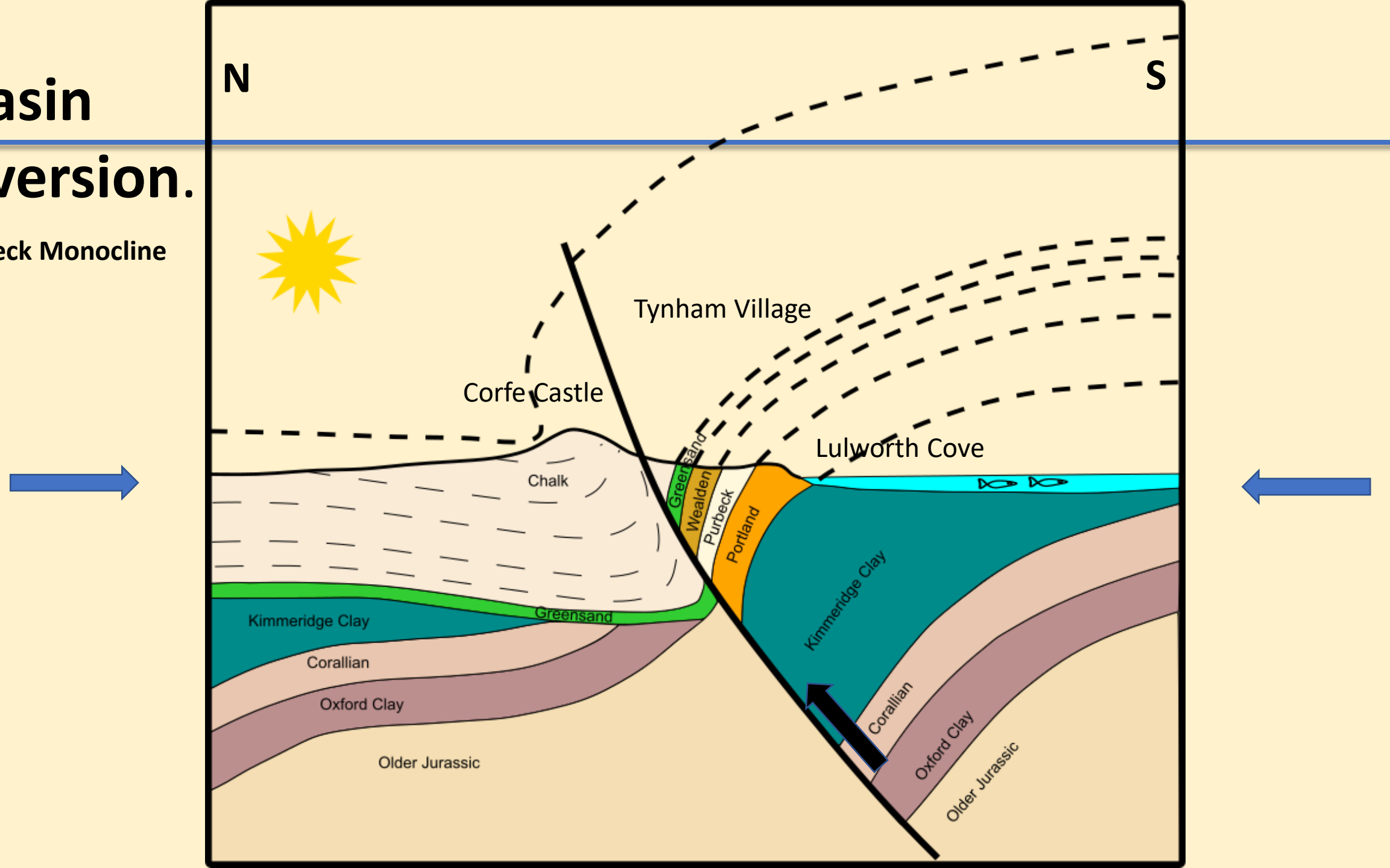
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S

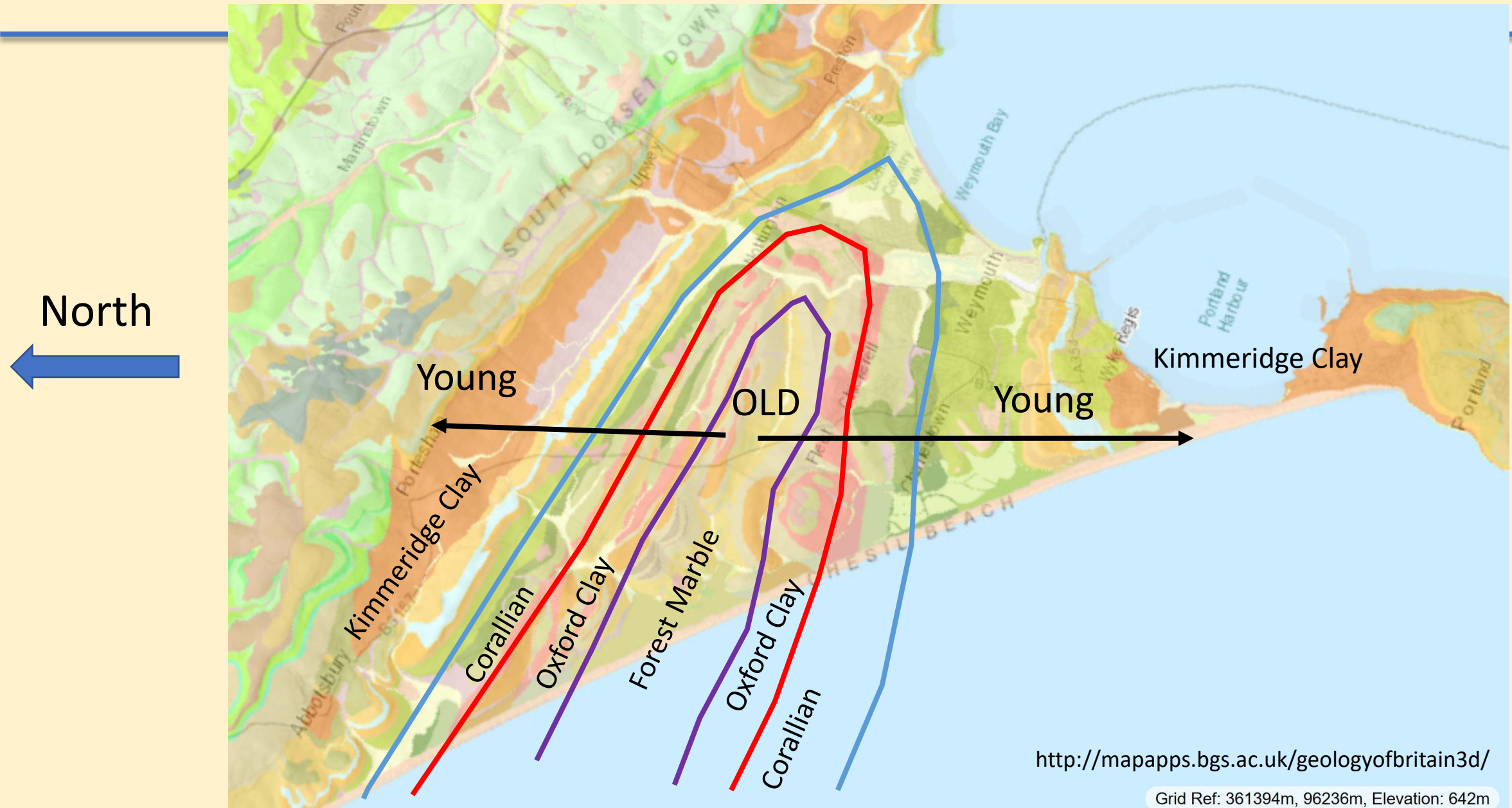


Basin Inversion.

Purbeck Monocline

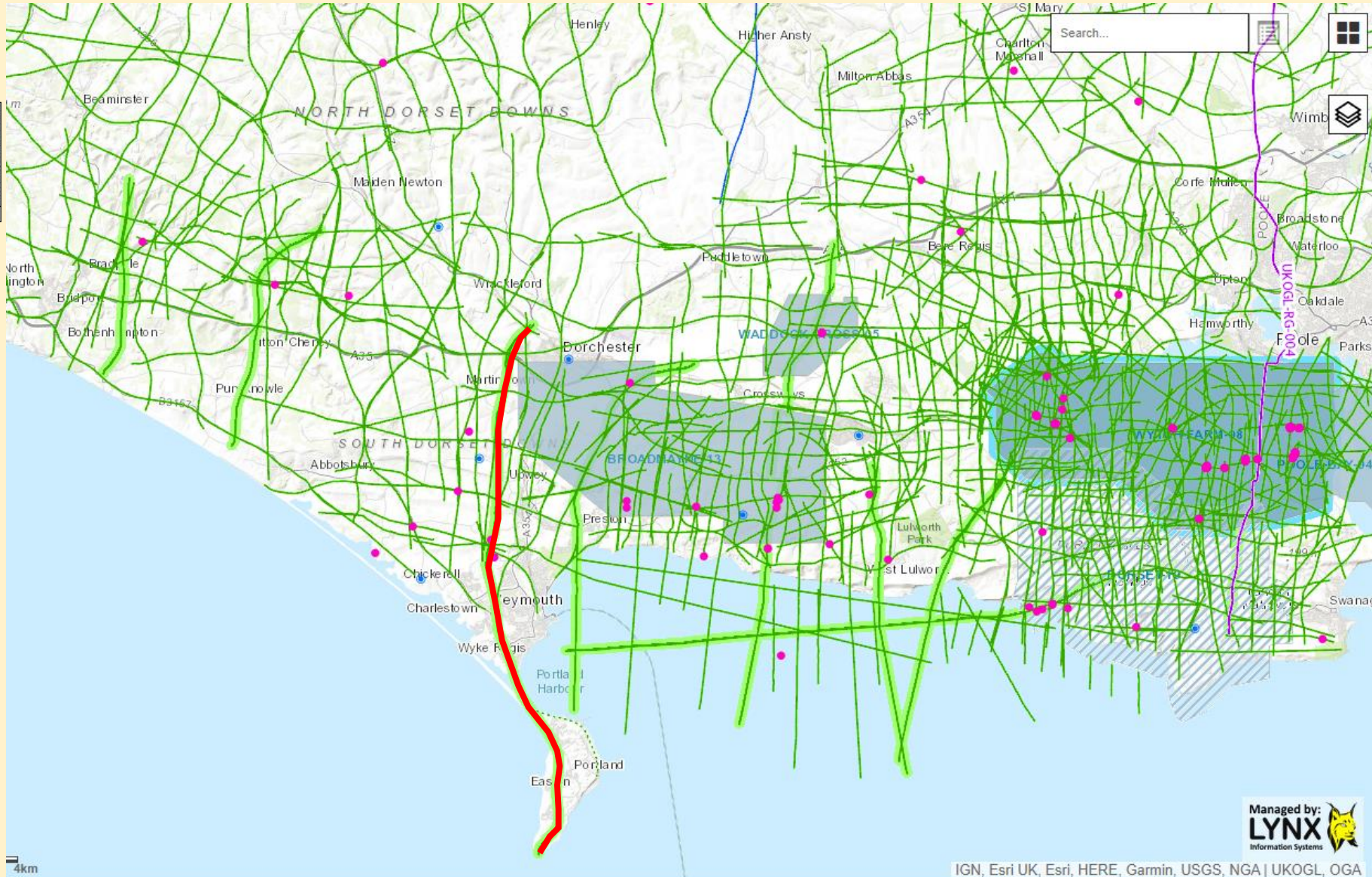


Weymouth Structure

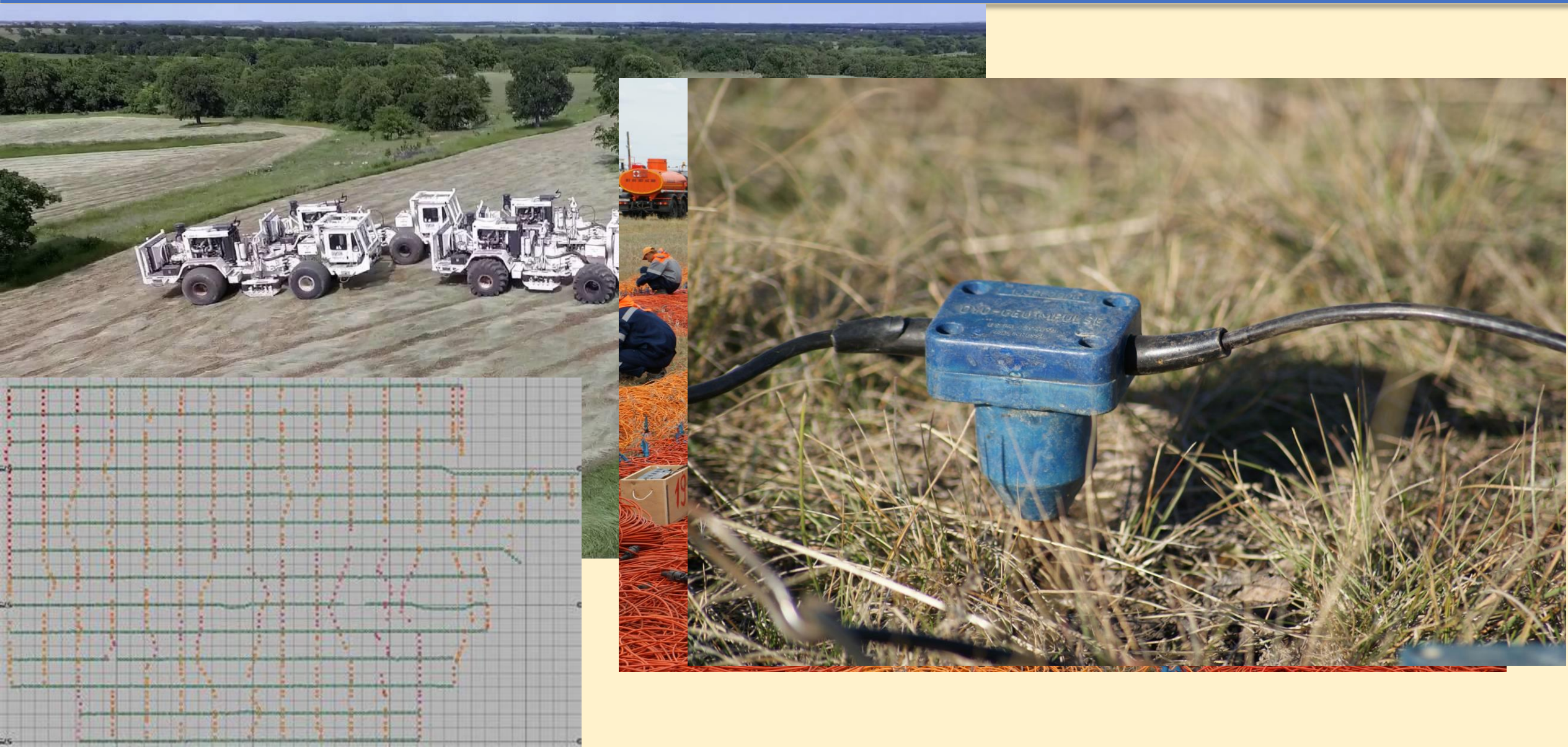


Seismic Data over the Weymouth.

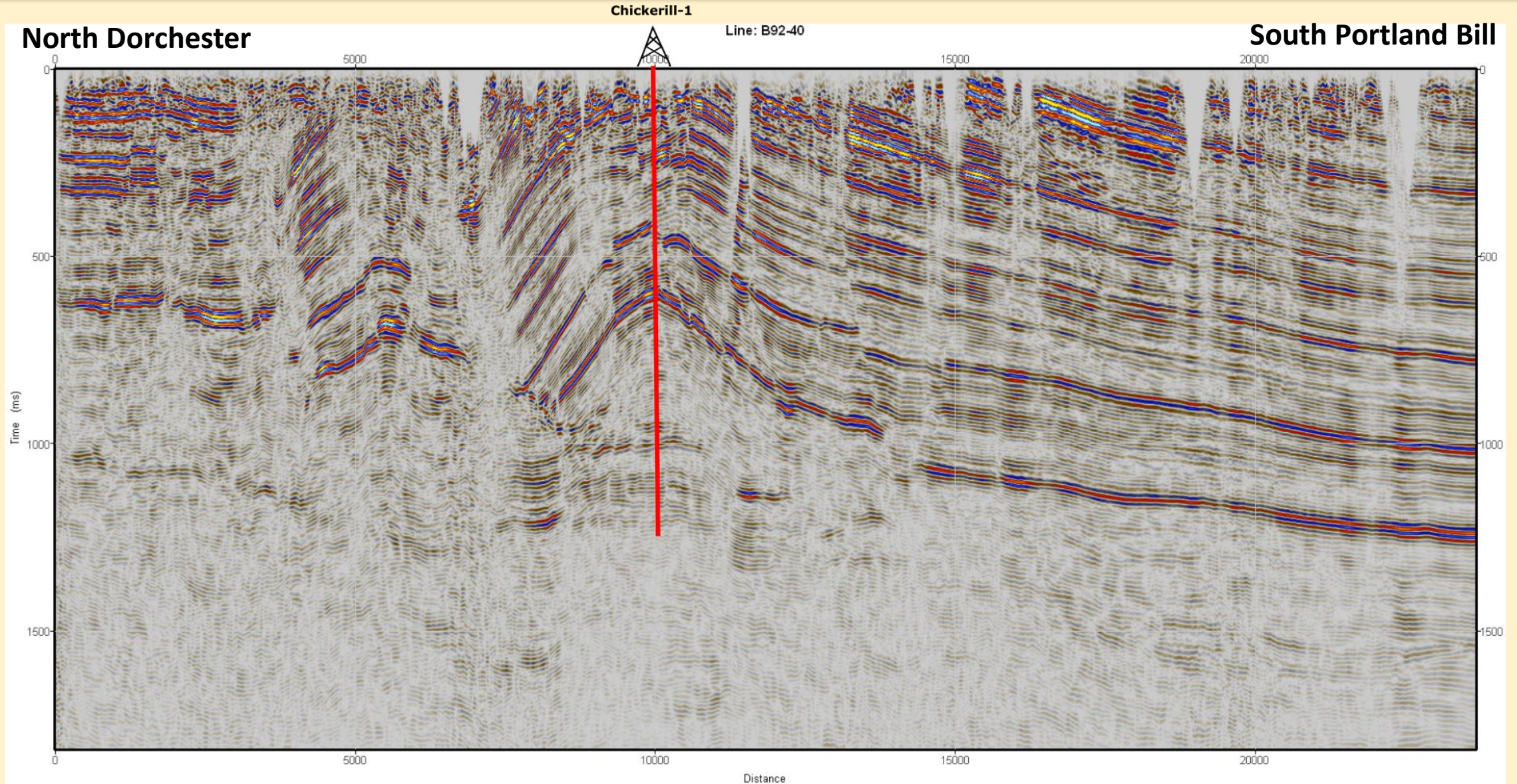
Seismic data courtesy of



Recording Seismic Data.

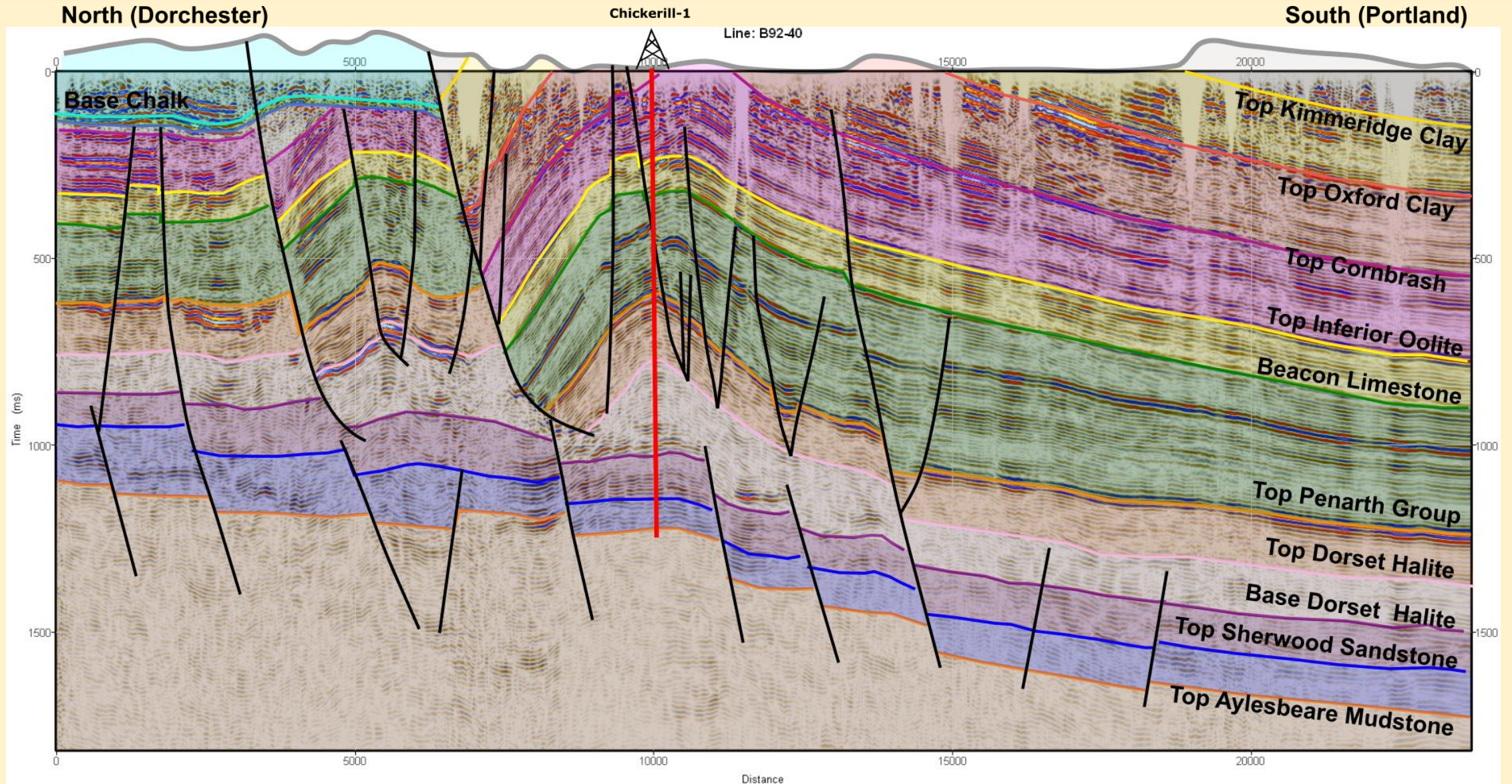


The Weymouth Anticline.



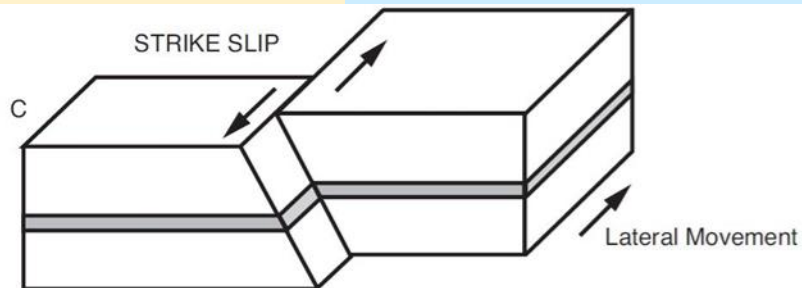
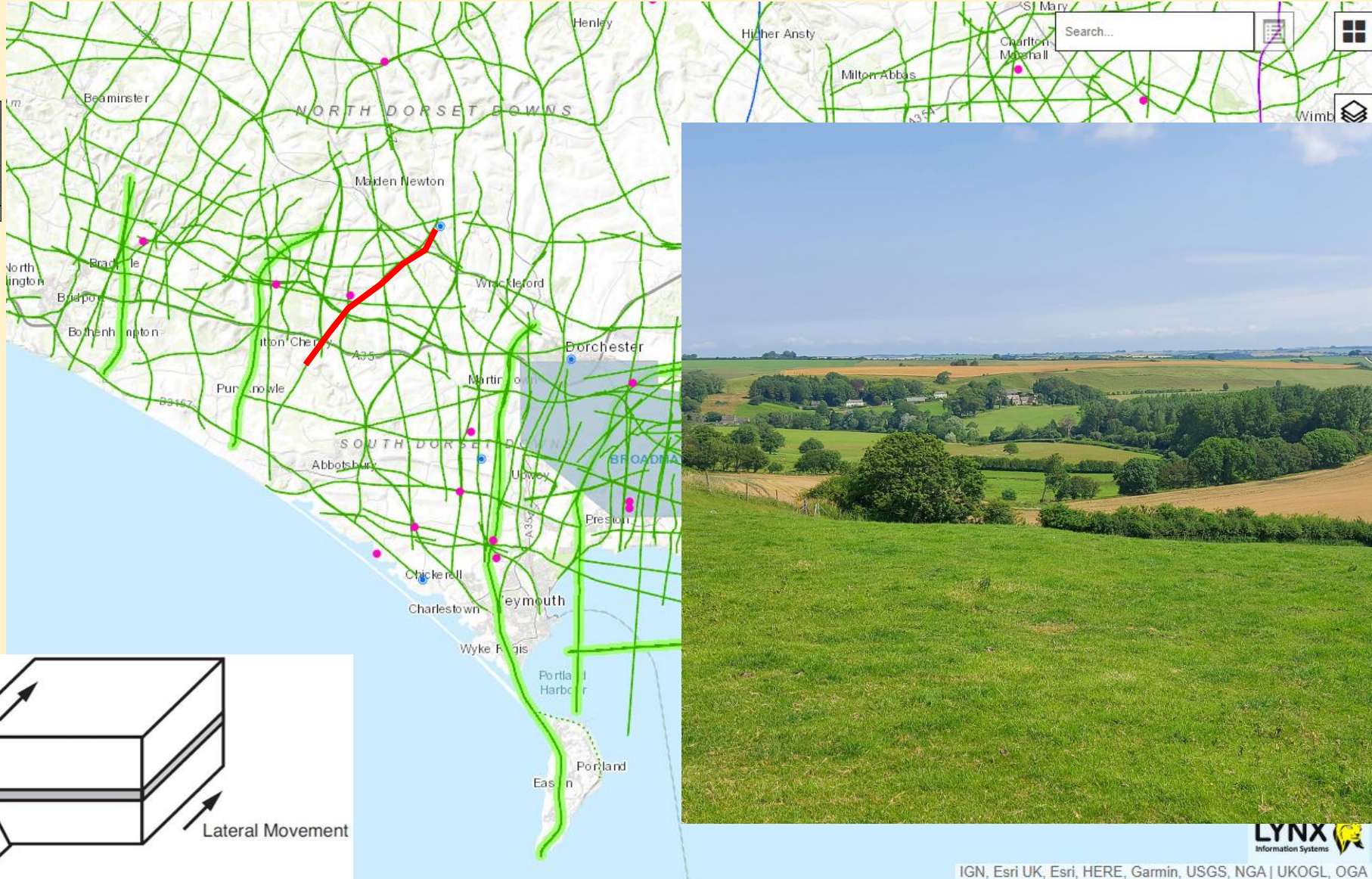
The Weymouth Anticline.

Younger ← Older → Younger

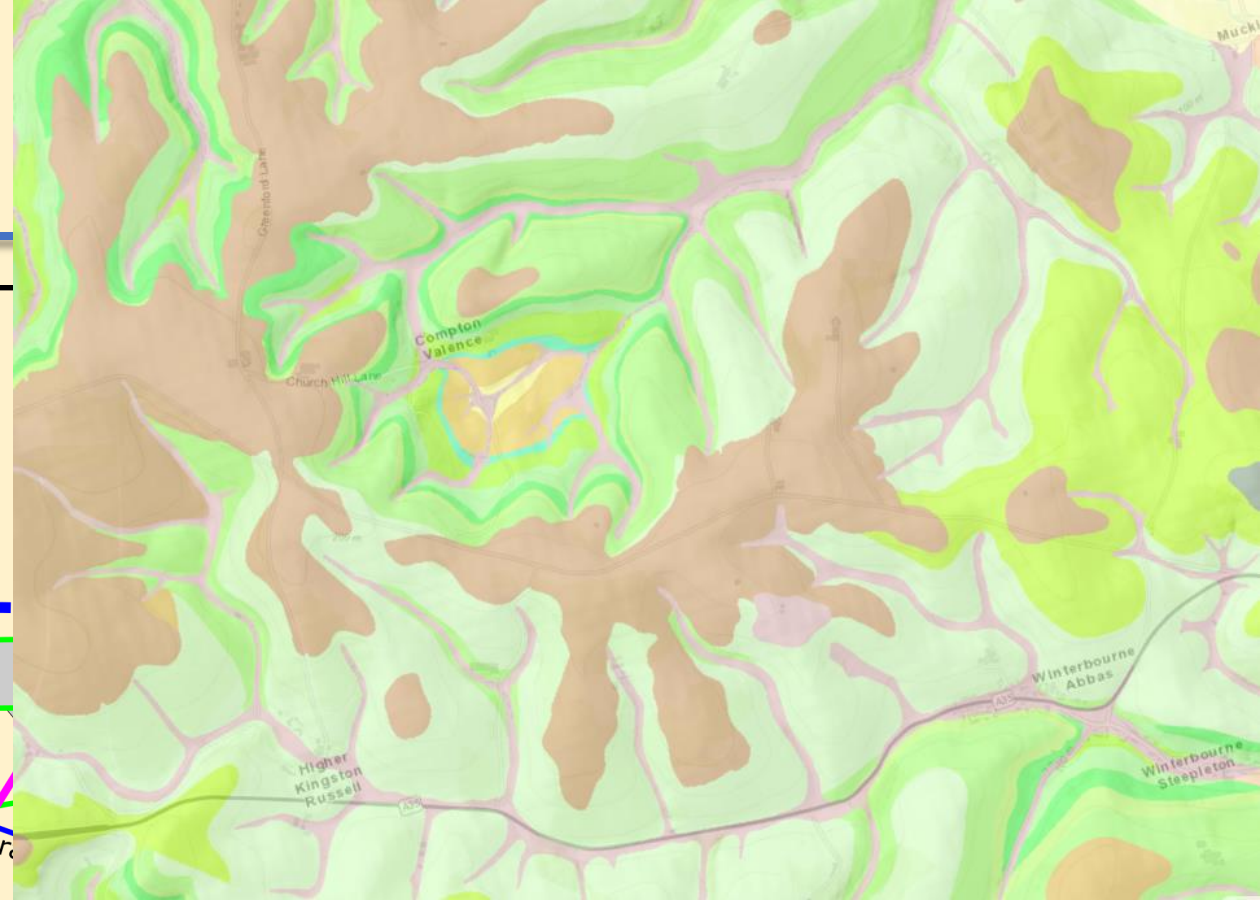
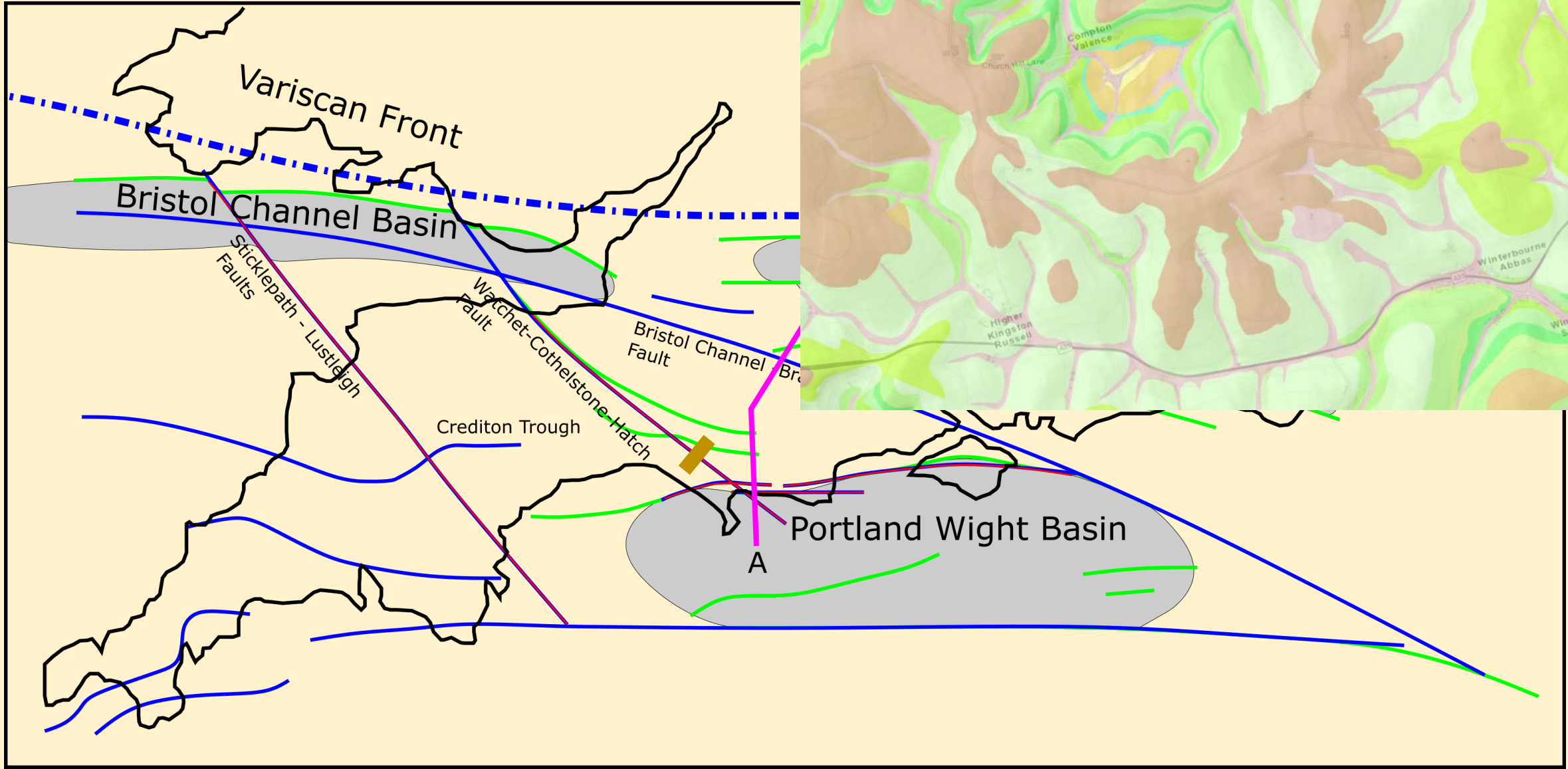


Seismic Data over the Compton Valence Dome.

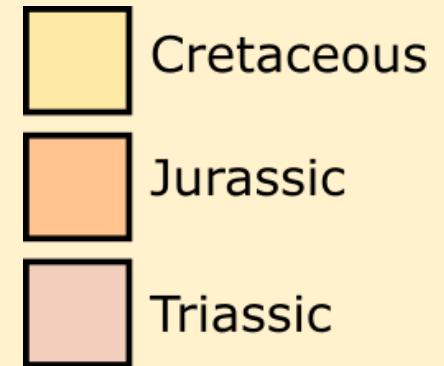
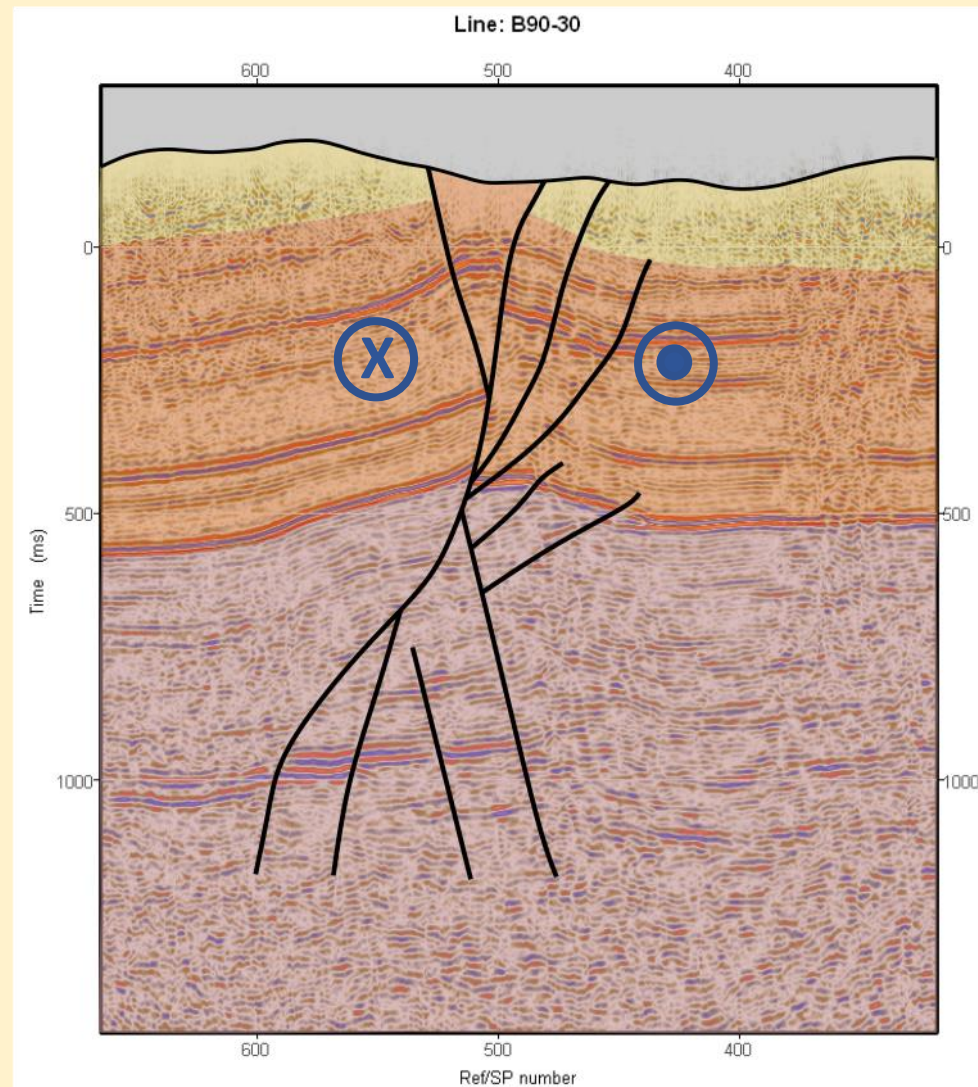
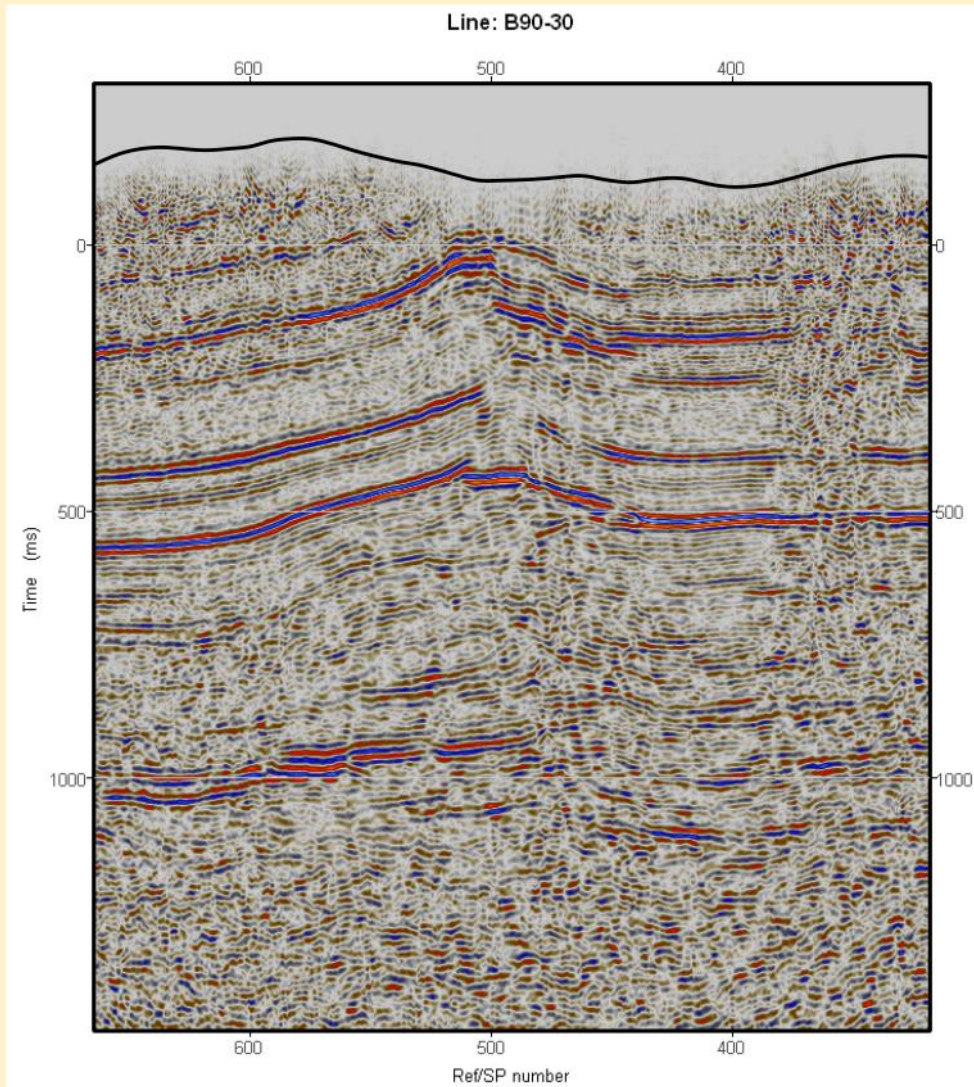
Seismic data courtesy of



Compton Valence Anticline.



Compton Valence Anticline.



Marshwood Vale.

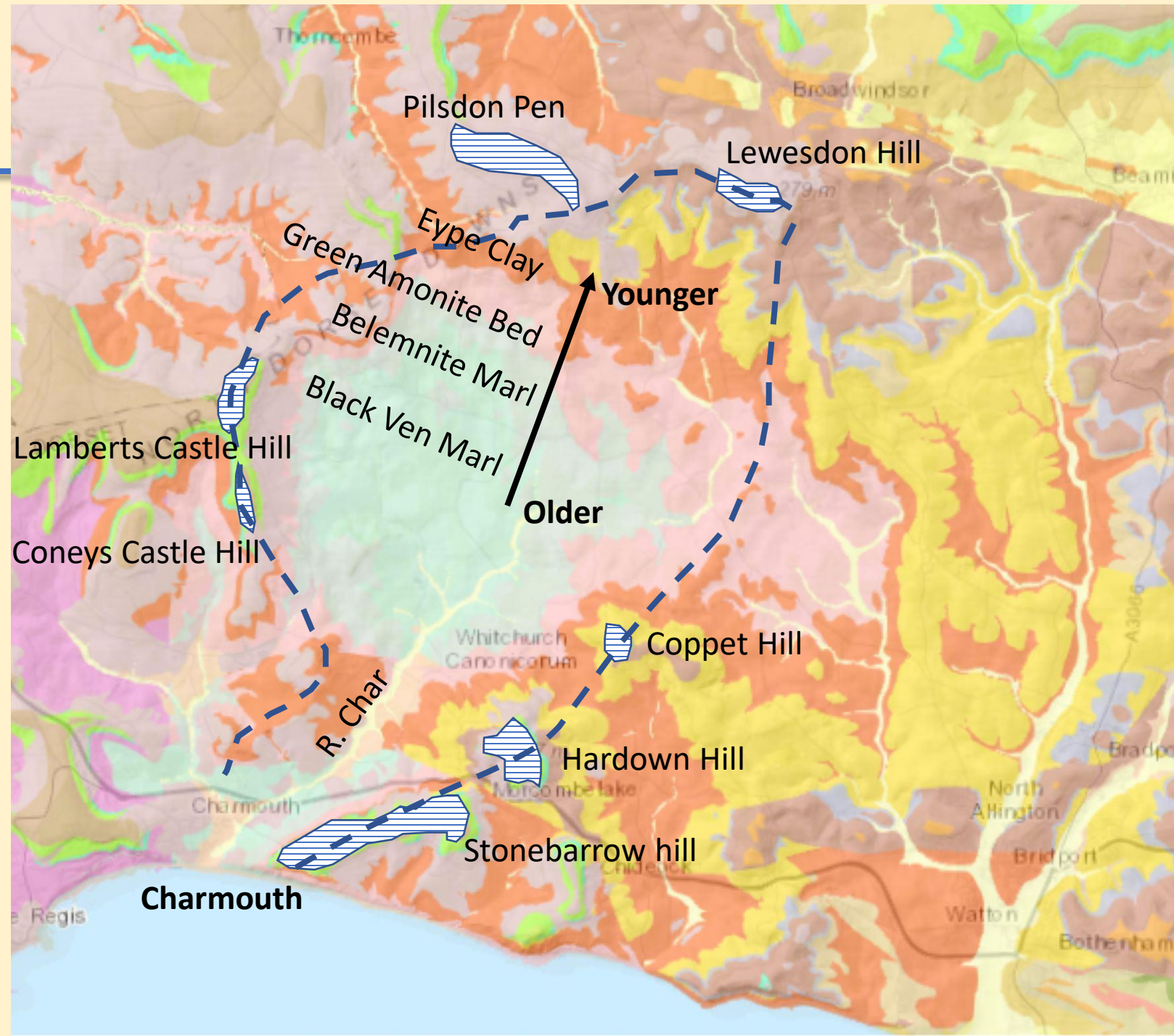
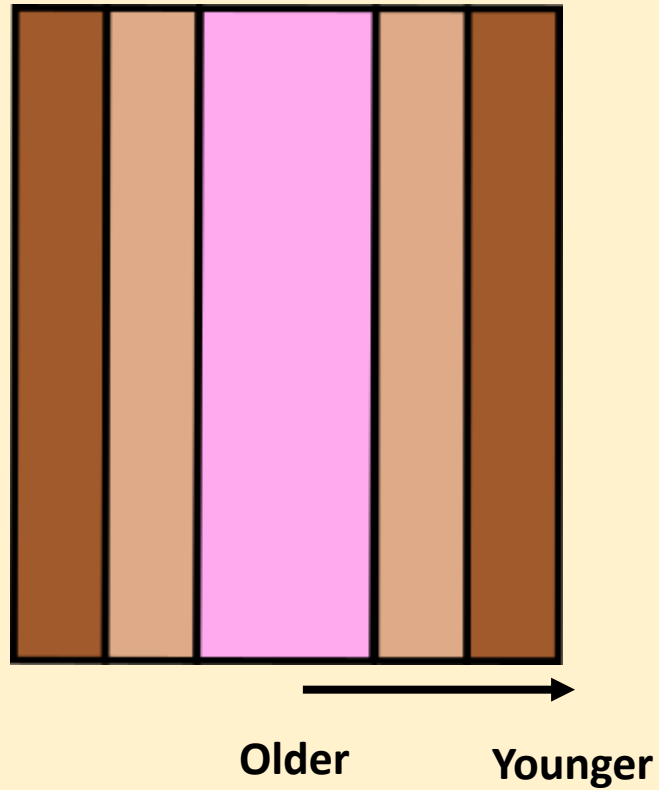


Marshwood Vale.

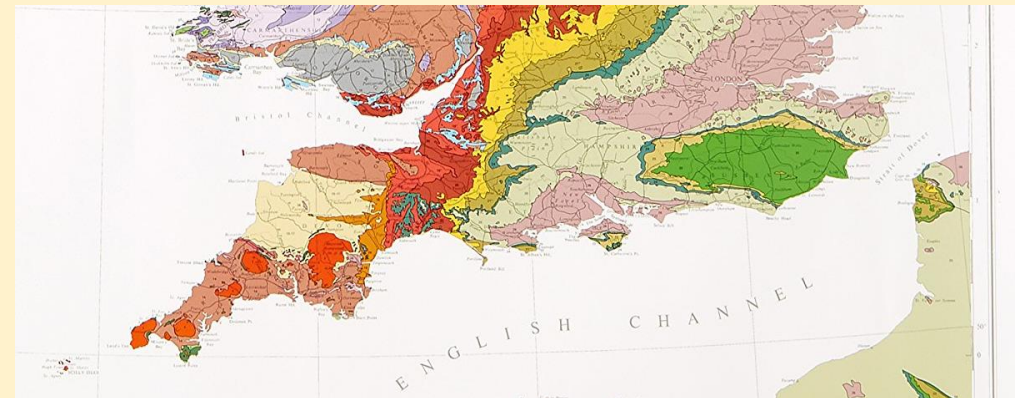
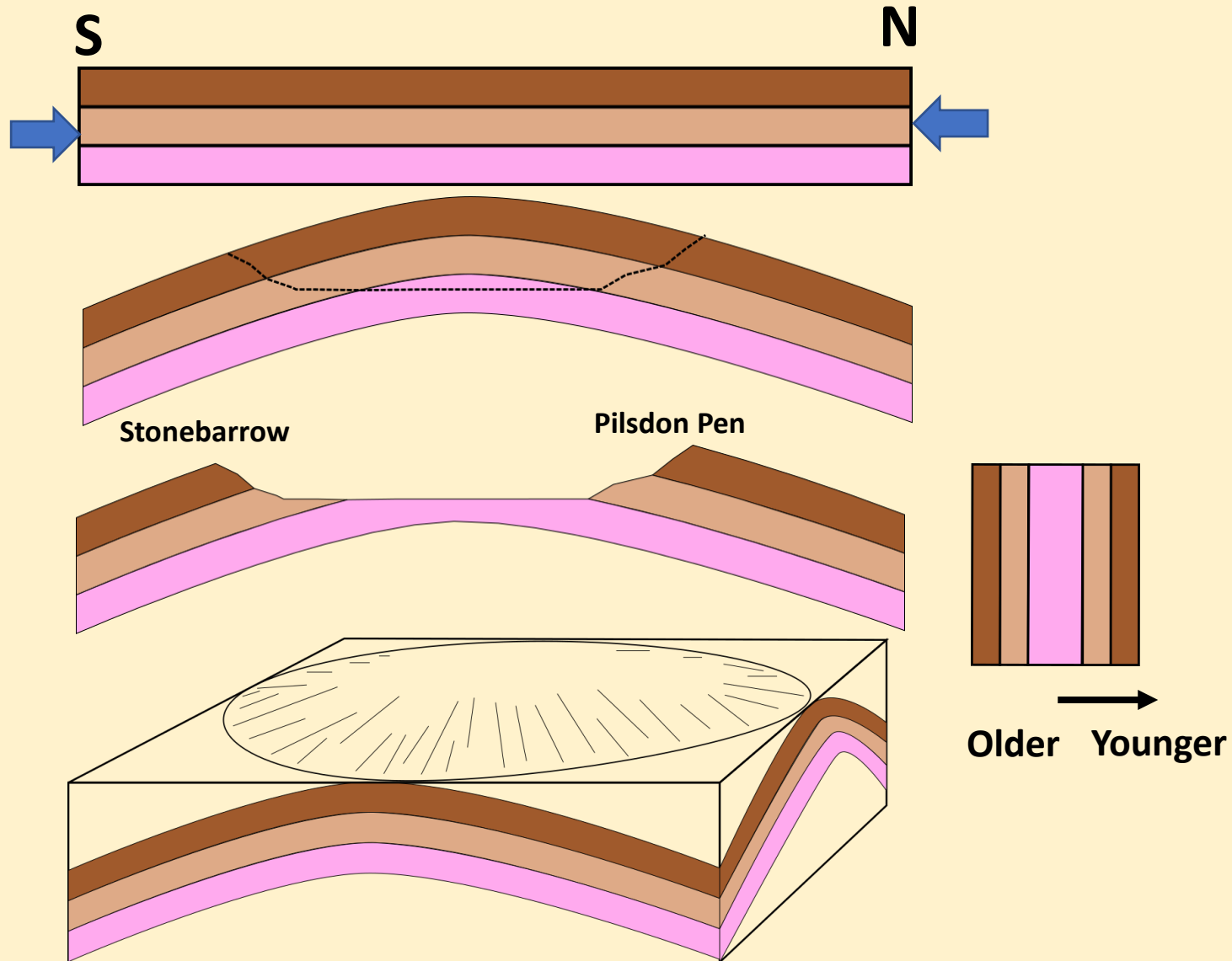
<http://mapapps.bgs.ac.uk/geologyofbritain3d/>



Marshwood Vale.



Marshwood Vale.



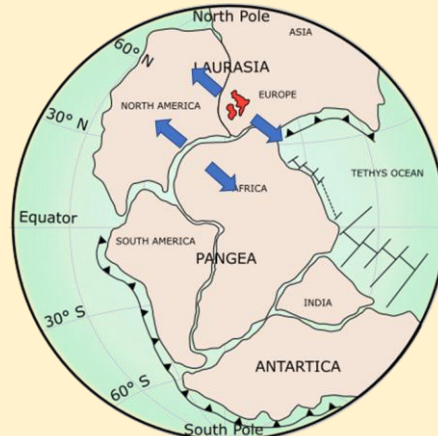
Summary.

- The structures that we see along the Jurassic Coast today are a result of polyphase tectonics (multiple episodes) over geological time.



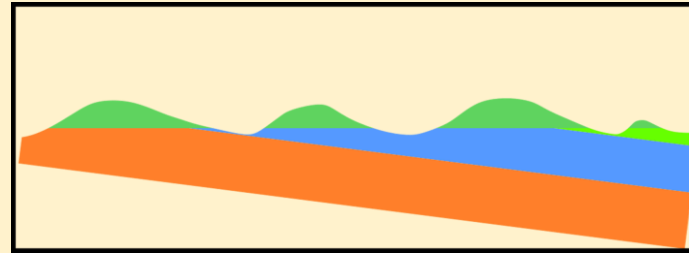
Mid Devonian $\approx 375\text{Ma}$

Stage 1
The Basement Foundation
Pangea Formation

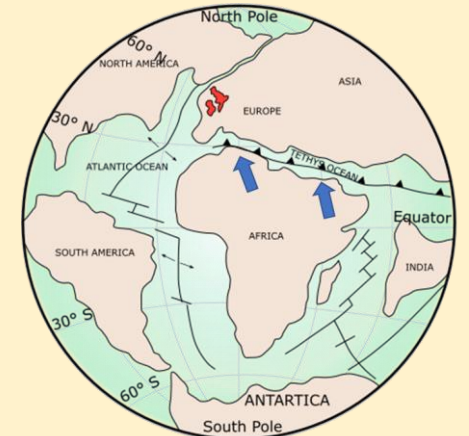


Jurassic $\approx 195\text{Ma}$

Stage 2
Basin Formation
Pangea Breakup



The Great Unconformity
Uplift and Tilt



LATE CRETACEOUS/EARLY TERTIARY $\approx 65\text{Ma}$

Stage 3
Compression and Inversion

- The three tectonic stages have moulded the Jurassic Coast World Heritage Site as we see it today.

The Jurassic Coast 20th Anniversary of World Heritage Status Celebrations In 2022

- Palaeontology related exhibitions supporting the work on the Jurassic Coast Collection. chris.reedman@jurassiccoast.org
- Celebrations of the Inferior Oolite sam.scriven@jurassiccoast.org
 - West Bay Discovery Centre exhibition in April
 - Open Day at Horn Park Quarry (July 30th). DGAG has been invited.

The Jurassic Coast 20th Anniversary of World Heritage Status Celebrations In 2022

- New exhibition from Bristol University and Sidmouth Museum on new and near complete specimens from the Otter Sandstone.
 - Charmouth Heritage Coast Centre, Exhibition of specimens from private collectors.
 - Peebles People.
 - Monthly posts on social media, short videos on geology related stories and information. Contact lauren.sewell@jurassiccoast.org
- www.jurassiccoast.org

Thanks to...



- The team at the Jurassic Coast Trust.

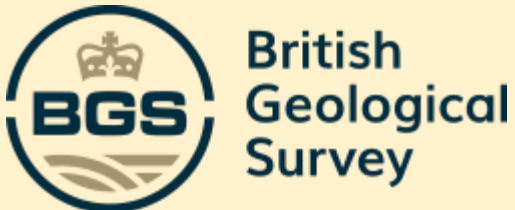
www.jurassiccoast.org



- Dr Robin Shail University of Exeter, Camborne School of Mines, for communications about the Variscan.



- Oxford University and the Beneath Britain team for seismic data access.



- British Geological Survey for the GeologyofBritain 3D surface geology map access.

Many thanks for your attention.

Questions?

Vincent Sheppard
Geoscientist