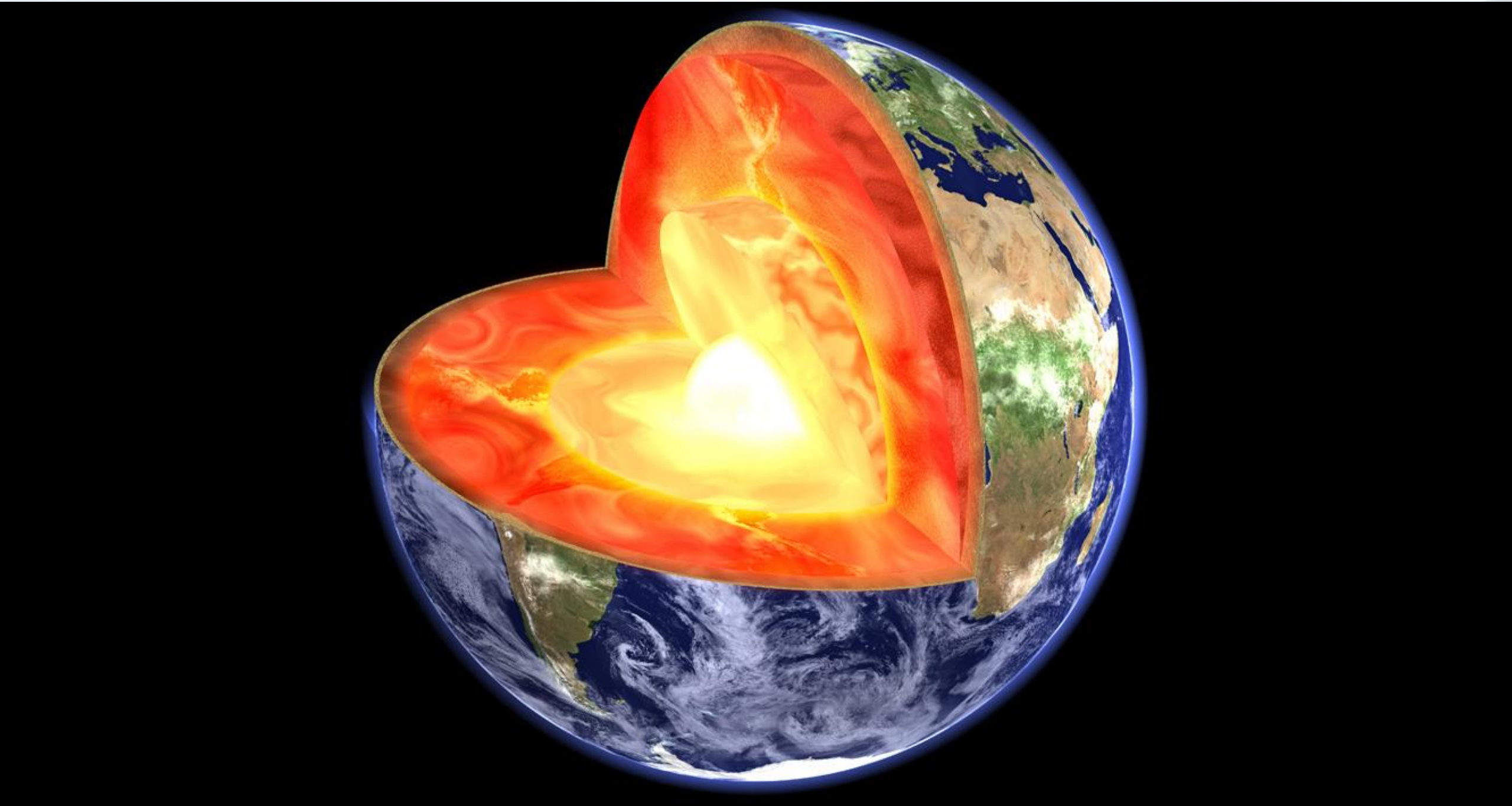
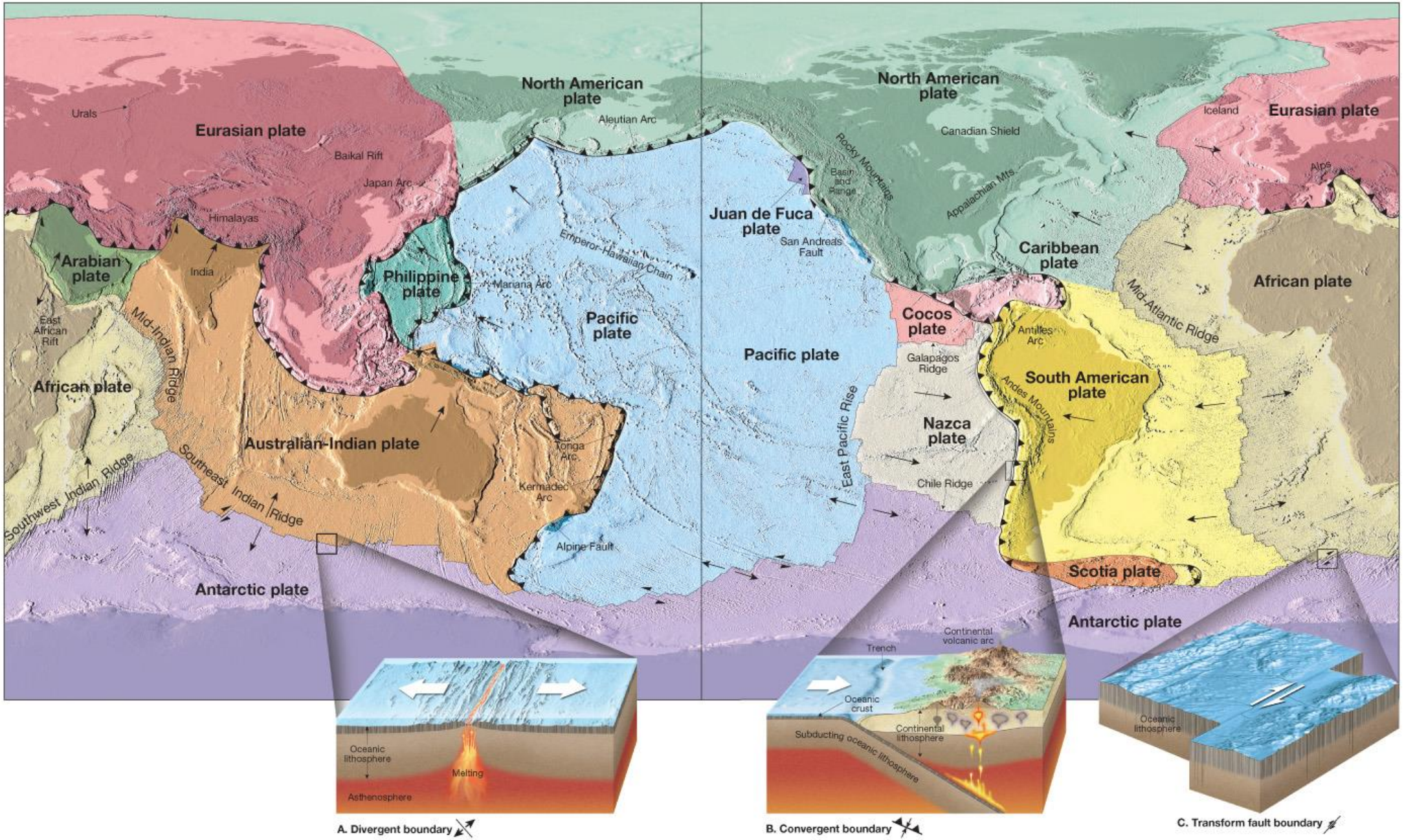
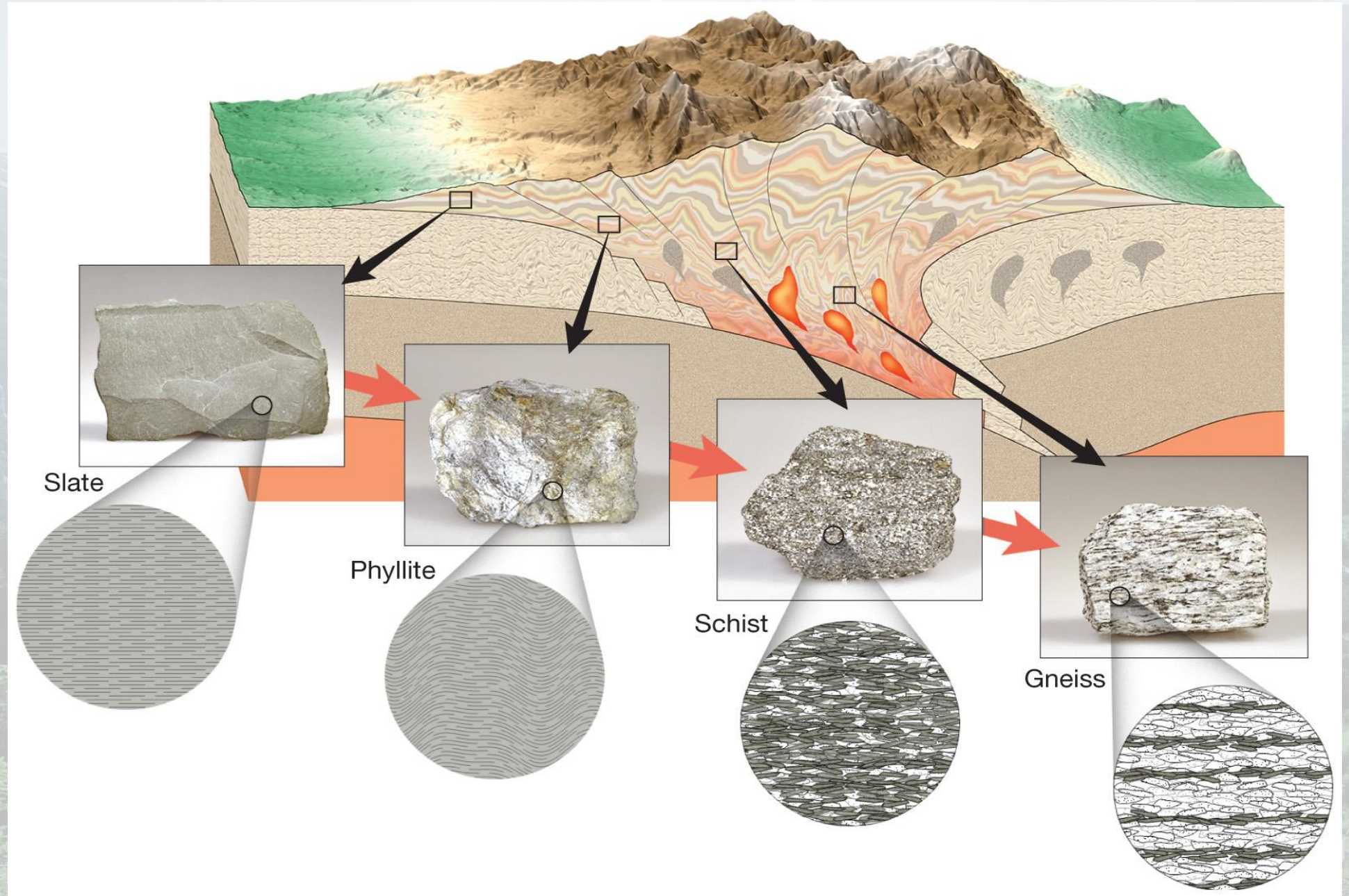
GY4051 Earth Science and Society

Tropical Ireland

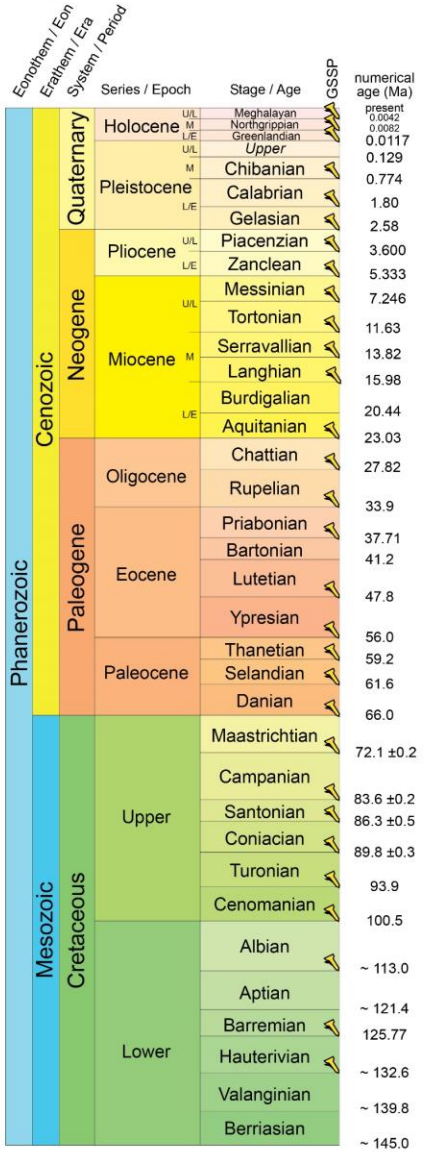


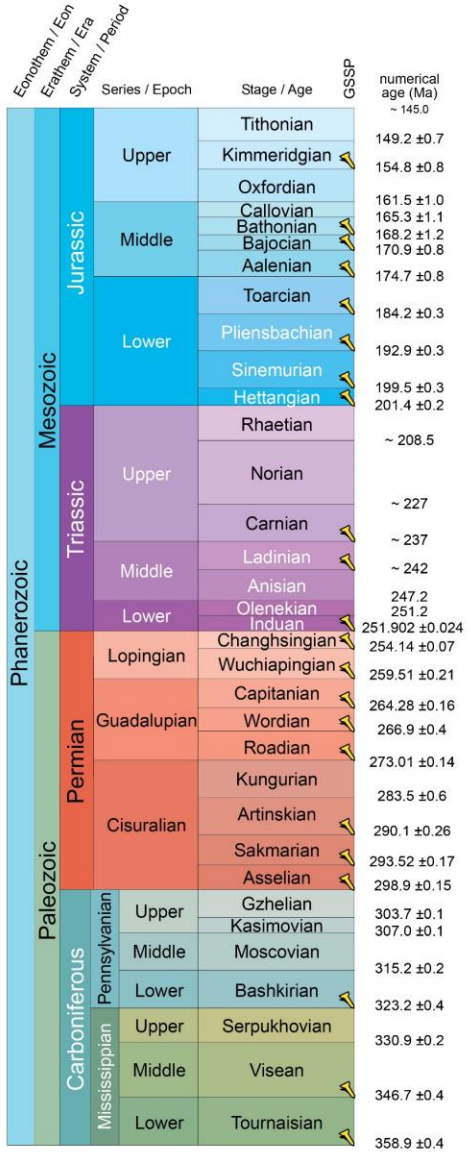


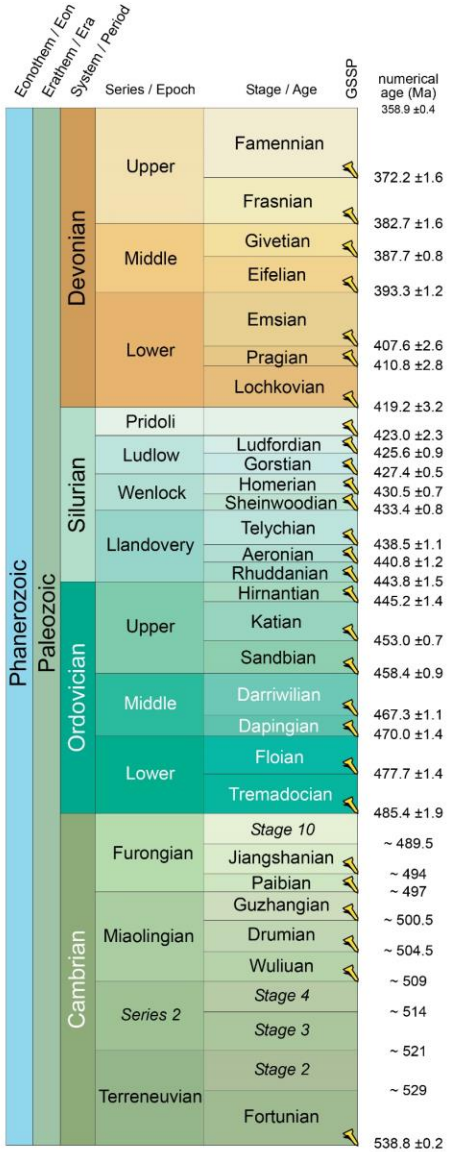


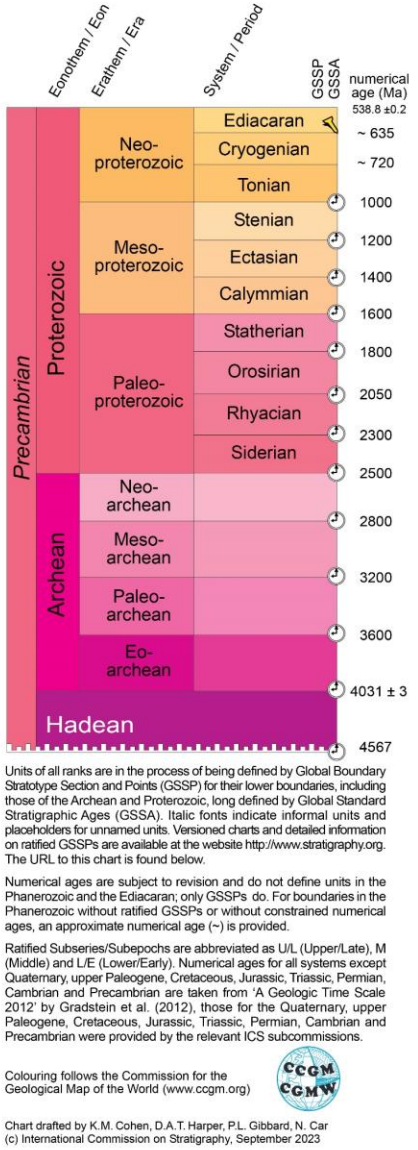
INTERNATIONAL CHRONOSTRATIGRAPHIC CHART

IUGS www.stratigraphy.org International Commission on Stratigraphy v 2023/09









Units of all ranks are in the process of being defined by Global Boundary Stratotype Section and Points (GSSP) for their lower boundaries, including those of the Archean and Proterozoic, long defined by Global Standard Stratigraphic Ages (GSSA). Italic fonts indicate informal units and placeholders for unnamed units. Versioned charts and detailed information on ratified GSSPs are available at the website http://www.stratigraphy.org. The URL to this chart is found below.

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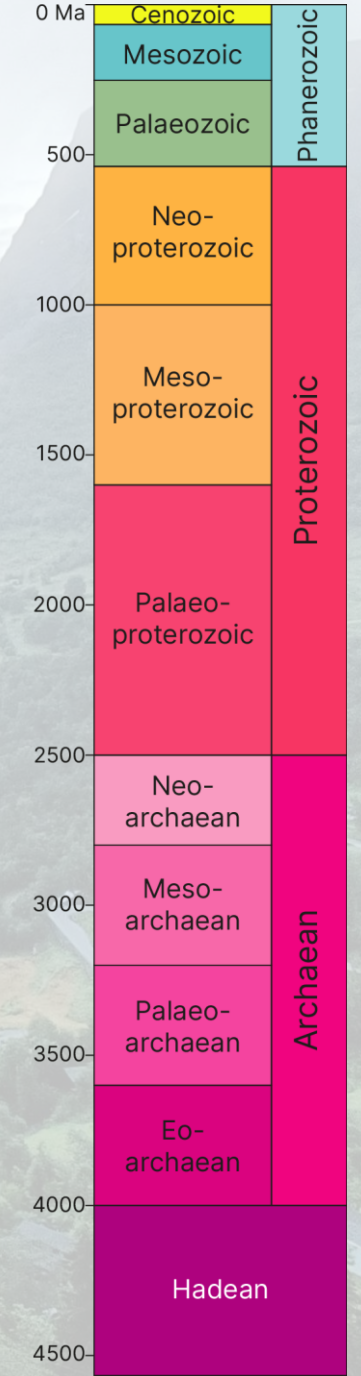
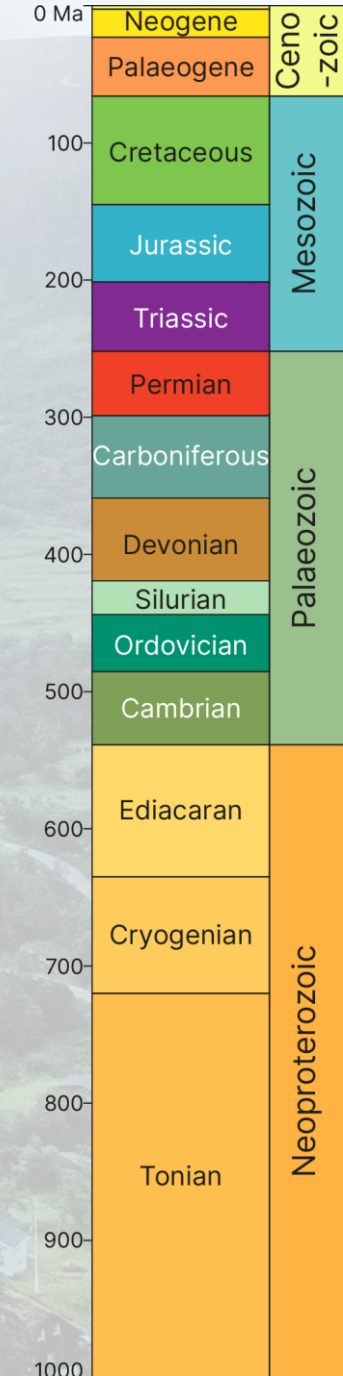
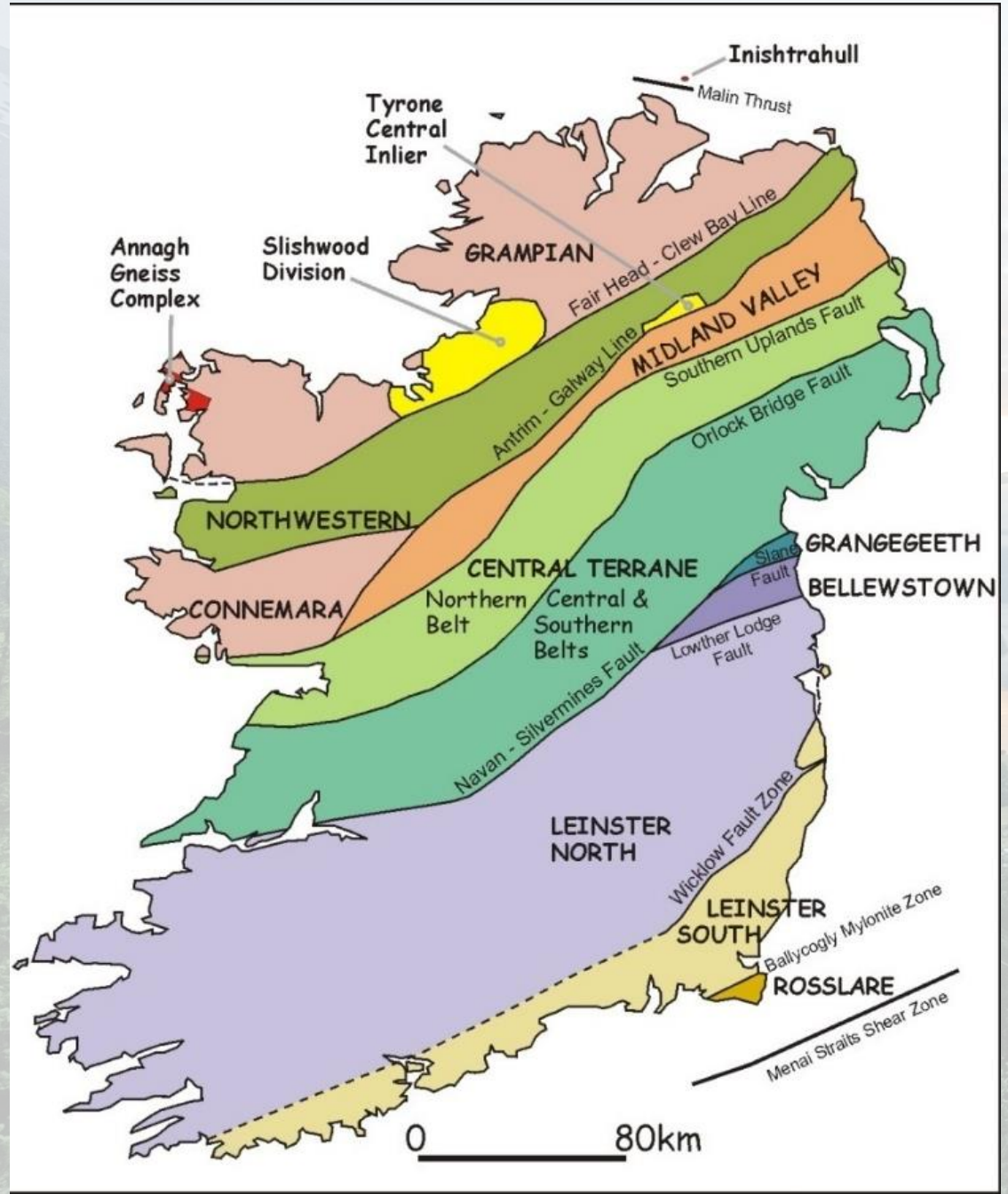
Colouring follows the Commission for the Geological Map of the World (www.cgmw.org)

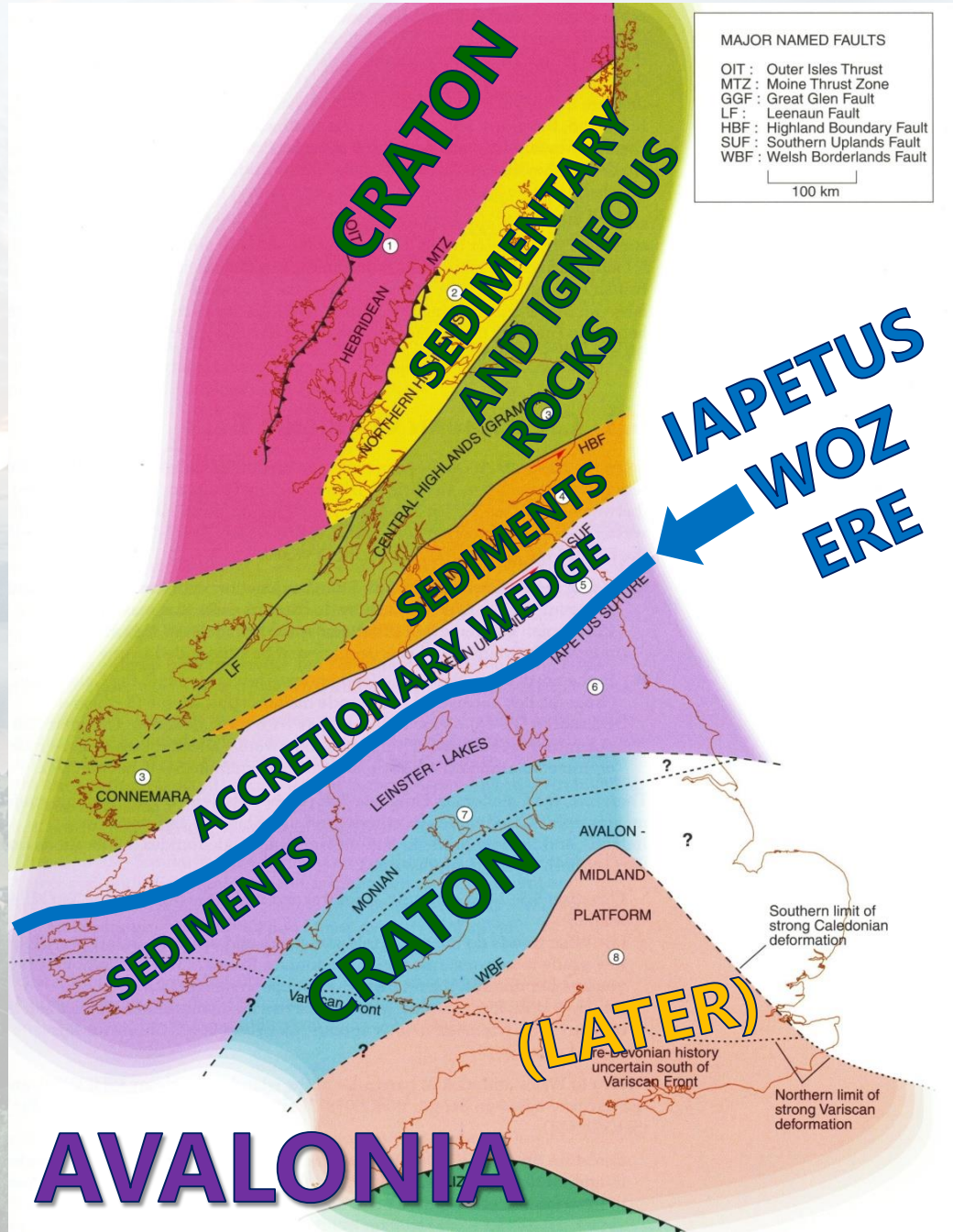
To cite: Cohen, K.M., Finney, S.C., Gibbard, P.L. & Fan, J.-X. (2013; updated) The ICS International Chronostratigraphic Chart. Episodes 36: 199-204.

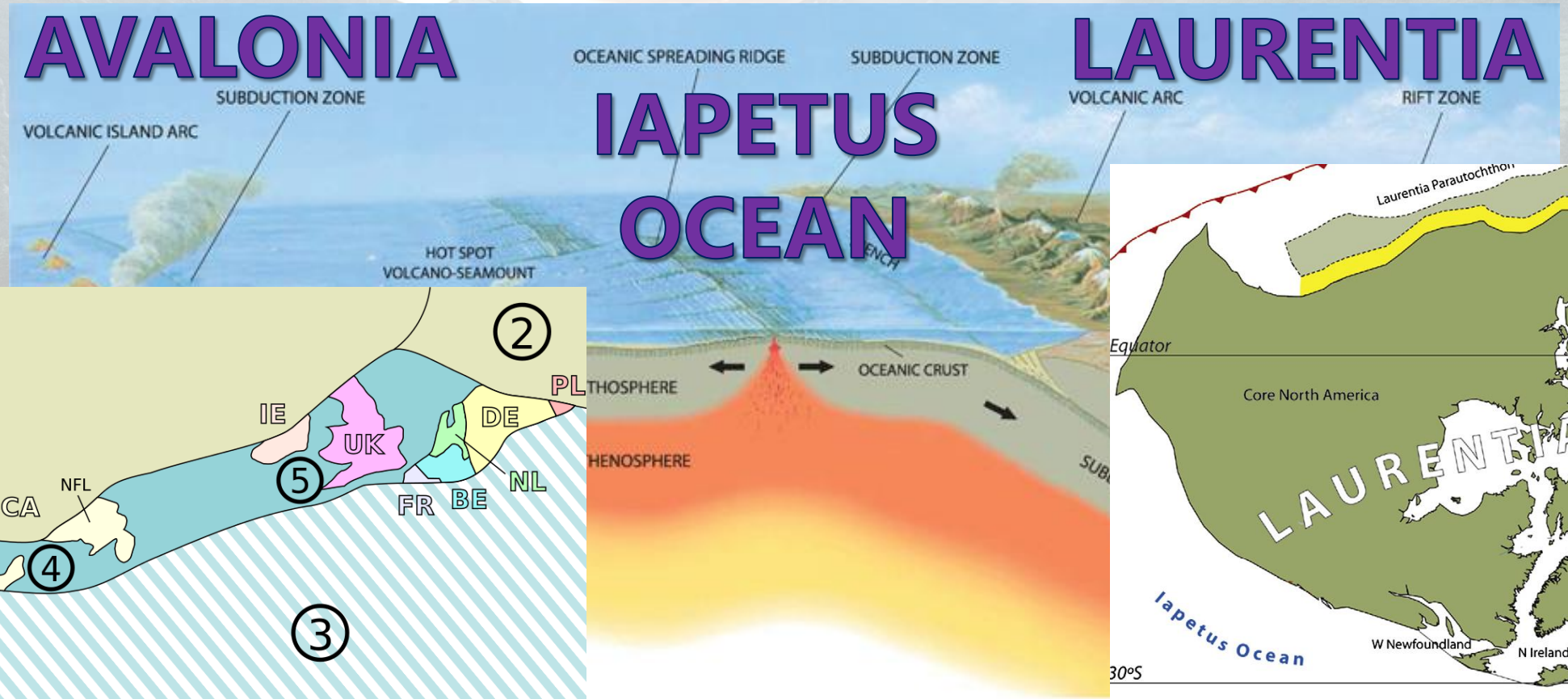
URL: http://www.stratigraphy.org/ICSchart/ChronostratChart2023-09.pdf

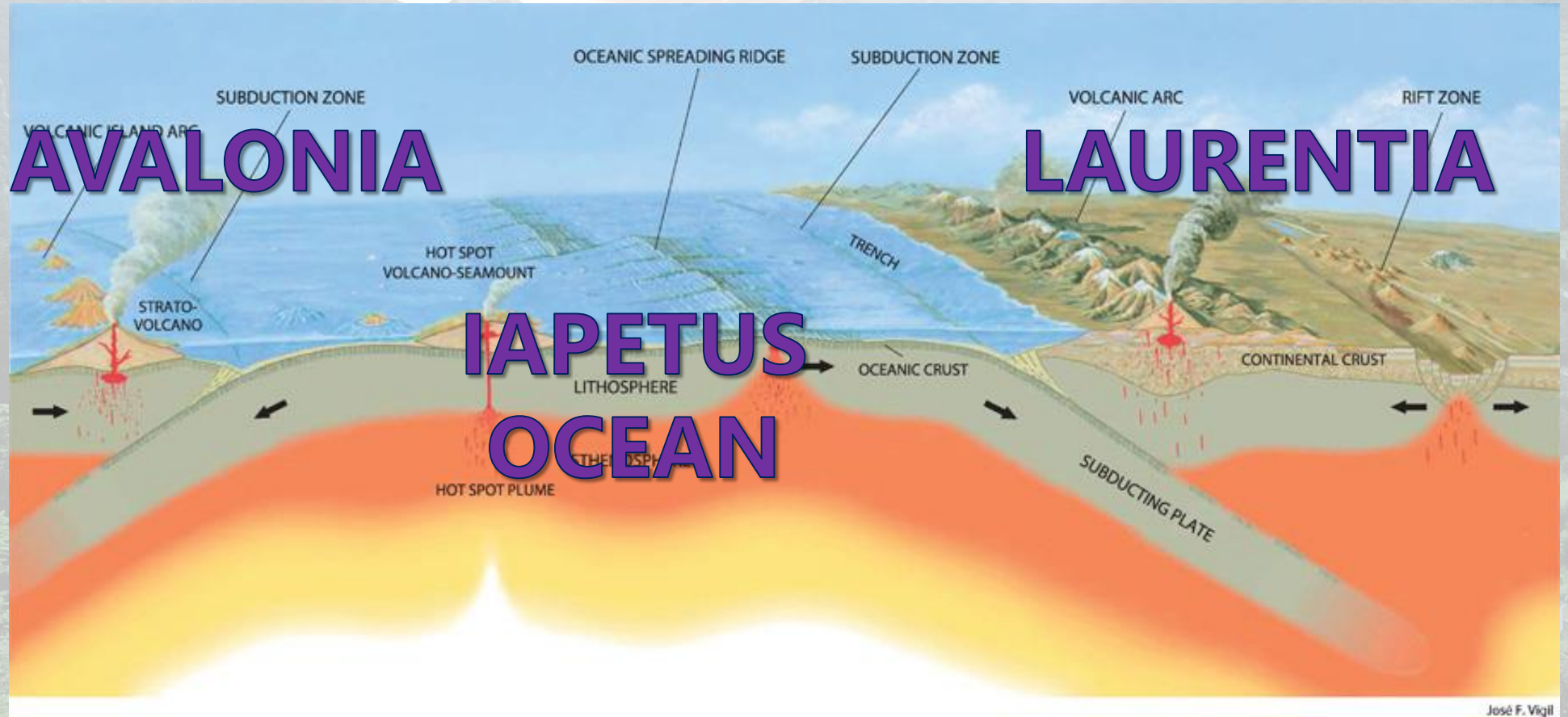


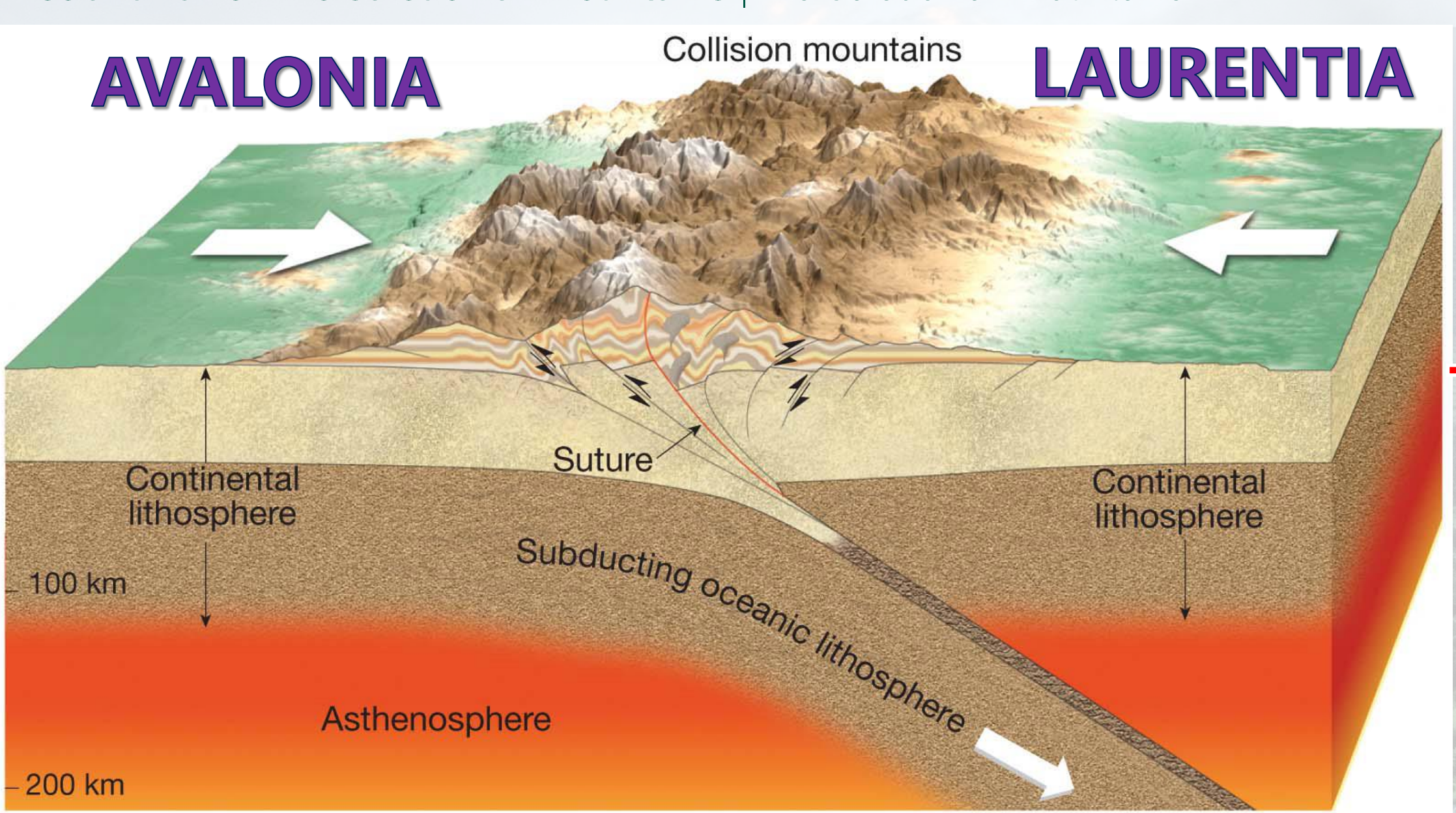



Inishtrahull
Malin Thrust
Tyrone Central Inlier
Annagh Gneiss Complex
Slishwood Division
GRAMPIAN
Fair Head - Clew Bay Line
MIDLAND VALLEY
Antrim - Galway Line
Southern Uplands Fault
Orlock Bridge Fault
NORTHWESTERN
CENTRAL TERRANE
Northern Belt
Central & Southern Belts
CONNEMARA
Slane Fault
GRANGEGEETH
BELLEWSTOWN
Lowther Lodge Fault
Navan - Silvermines Fault
LEINSTER NORTH
Wicklow Fault Zone
LEINSTER SOUTH
Ballycogly Mylonite Zone
ROSSLARE
Menai Straits Shear Zone
0
80km

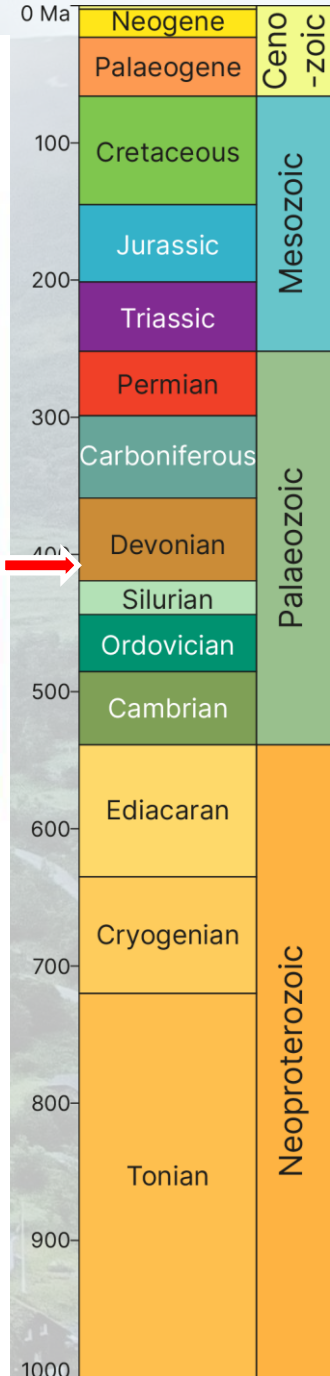

MAJOR NAMED FAULTS
OIT : Outer Isles Thrust
MTZ : Moine Thrust Zone
GGF : Great Glen Fault
LF : Leenaun Fault
HBF : Highland Boundary Fault
SUF : Southern Uplands Fault
WBF : Welsh Borderlands Fault
100 km
CRATON
SEDIMENTARY AND IGNEOUS ROCKS
IAPETUS WOZ ERE
SEDIMENTS
ACCRETIONARY WEDGE
SEDIMENTS
CRATON
(LATER)
AVALONIA
HEBRIDEAN
NORTHERN HIGHLANDS
CENTRAL HIGHLANDS (GRAMPIAN)
HBF
SUF
LF
IAPETUS SUTURE
CONNEMARA
LEINSTER - LAKES
MONIAN
AVALON - MIDLAND PLATFORM
WBF
Variscan Front
Southern limit of strong Caledonian deformation
Pre-Devonian history uncertain south of Variscan Front
Northern limit of strong Variscan deformation


AVALONIA
SUBDUCTION ZONE
VOLCANIC ISLAND ARC
OCEANIC SPREADING RIDGE
SUBDUCTION ZONE
IAPETUS OCEAN
LAURENTIA
VOLCANIC ARC
RIFT ZONE
HOT SPOT VOLCANO-SEAMOUNT
OCEANIC CRUST
THOSPHERE
HENOSPHERE
1
2
3
4
5
US
ME
NH
MA
CT
RI
NB
PE
NS
CA
NFL
IE
UK
PL
DE
NL
FR
BE
Laurentia Parautochthon
SW Ellesmere & Devon
Equator
Core North America
Ellesmere
West Svalbard
LAURENTIA
Greenland
East Svalbard
Jan Mayen
W Newfoundland
N Ireland
Scotland
Iapetus Ocean
30°S
Iapetus Ocean


AVALONIA
LAURENTIA
IAPETUS OCEAN
OCEANIC SPREADING RIDGE
SUBDUCTION ZONE
SUBDUCTION ZONE
VOLCANIC ARC
RIFT ZONE
HOT SPOT VOLCANO-SEAMOUNT
TRENCH
STRATO-VOLCANO
OCEANIC CRUST
CONTINENTAL CRUST
LITHOSPHERE
HOT SPOT PLUME
SUBDUCTING PLATE
José F. Vigil

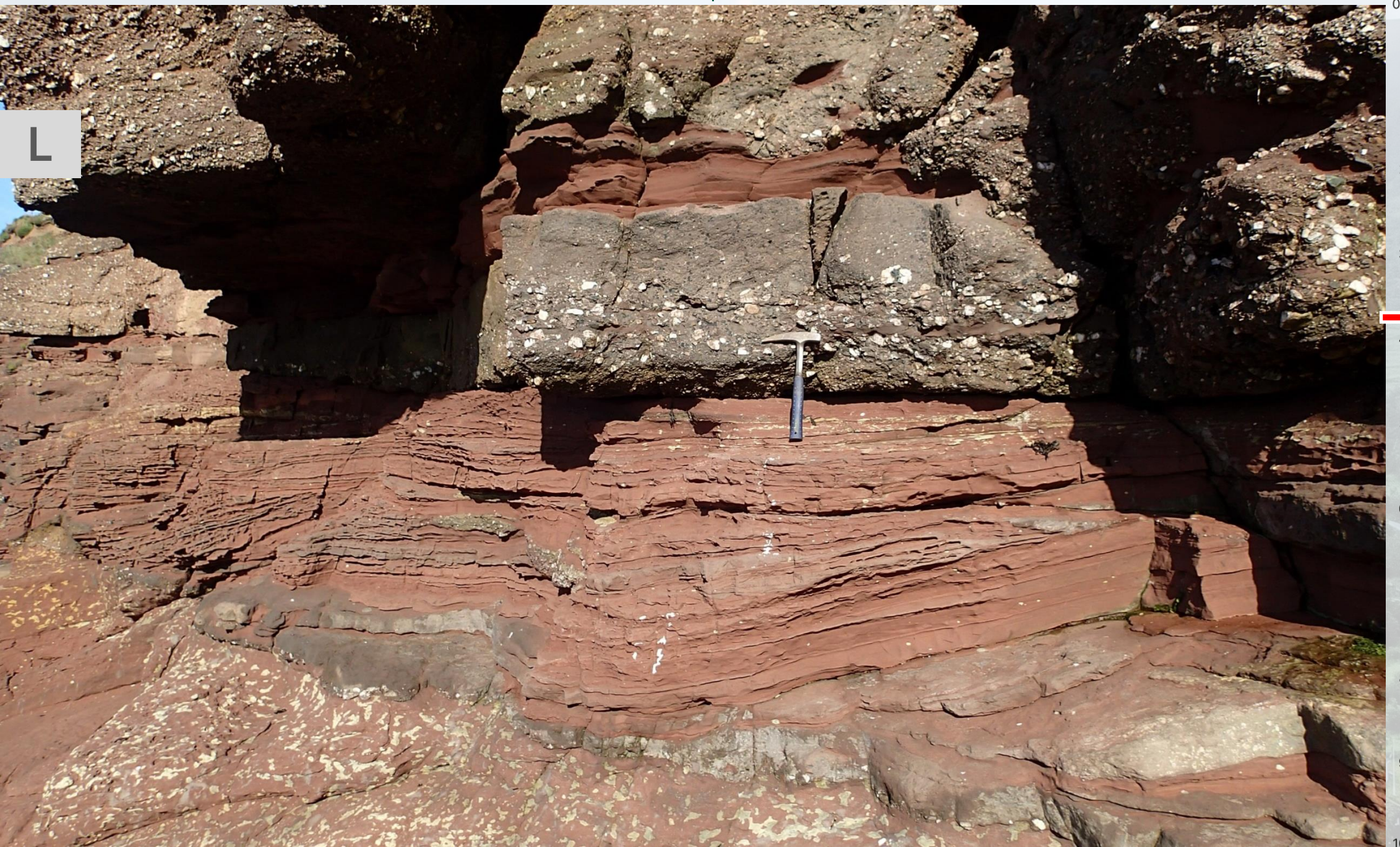


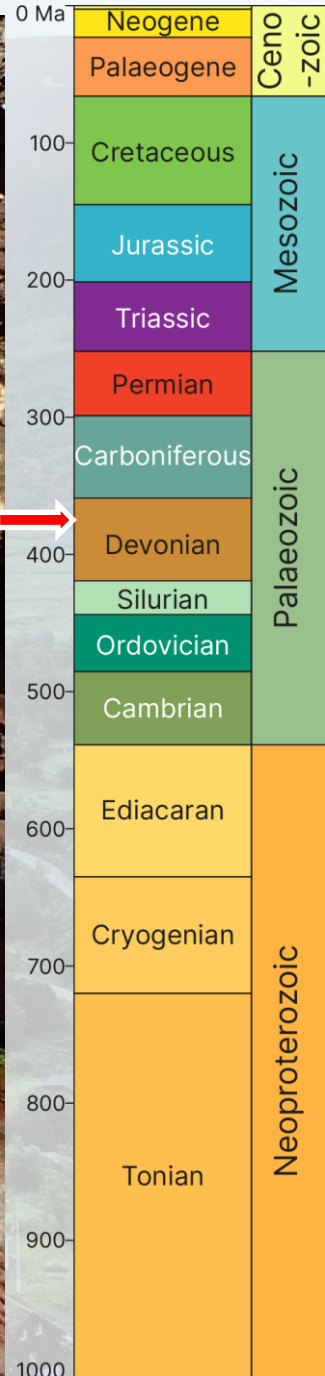
C.



Rise and Fall of The Caledonian Mountains | *Devonian of Ireland*

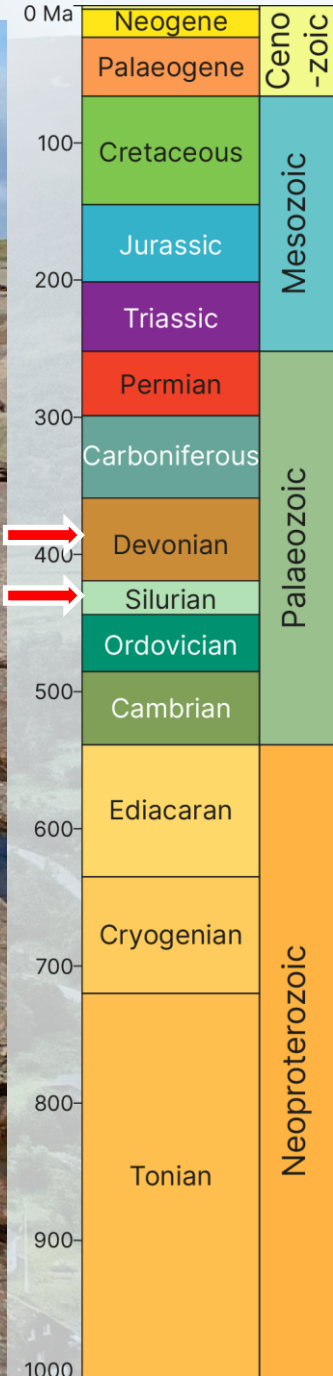
GY4051





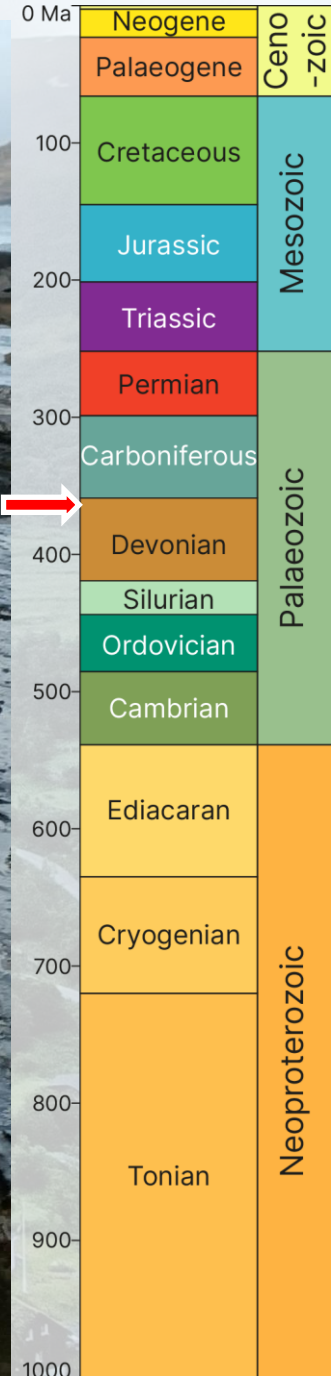
Rise and Fall of The Caledonian Mountains | *Caledonian Granites*

GY4051



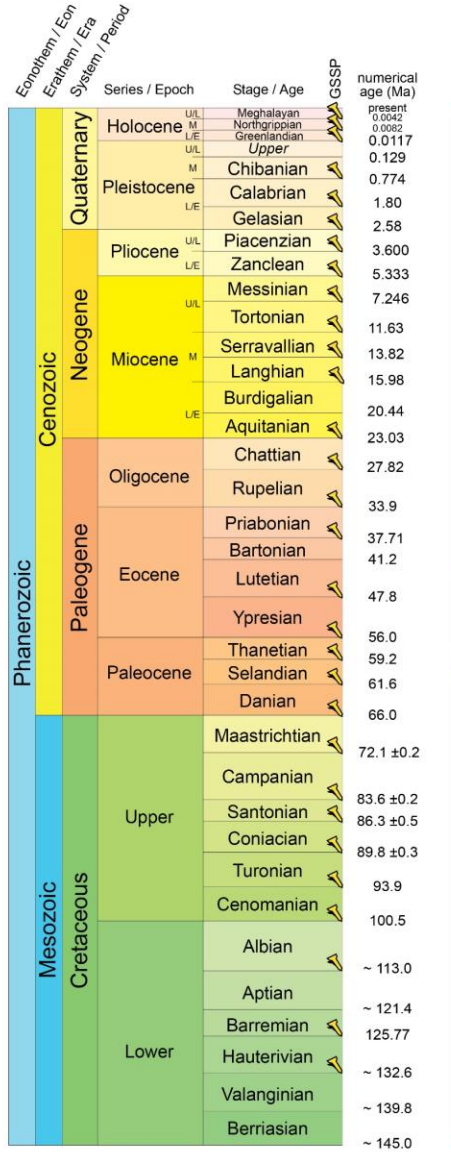
Rise and Fall of The Caledonian Mountains | *Marine Transgression*

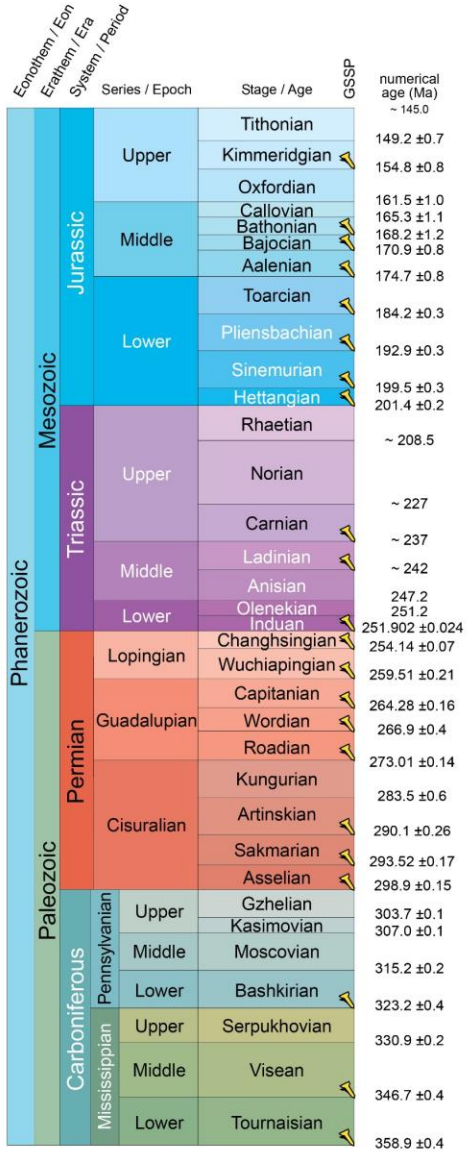
GY4051

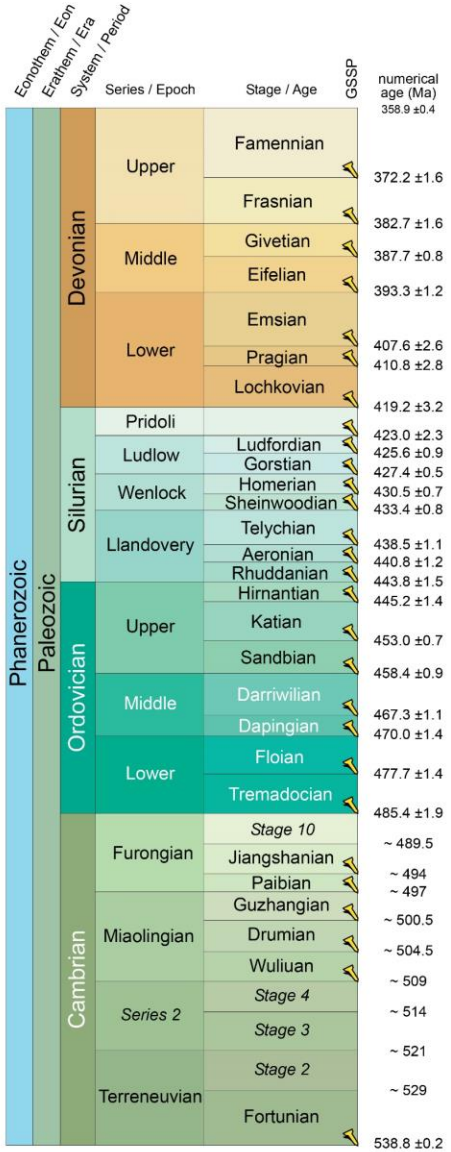


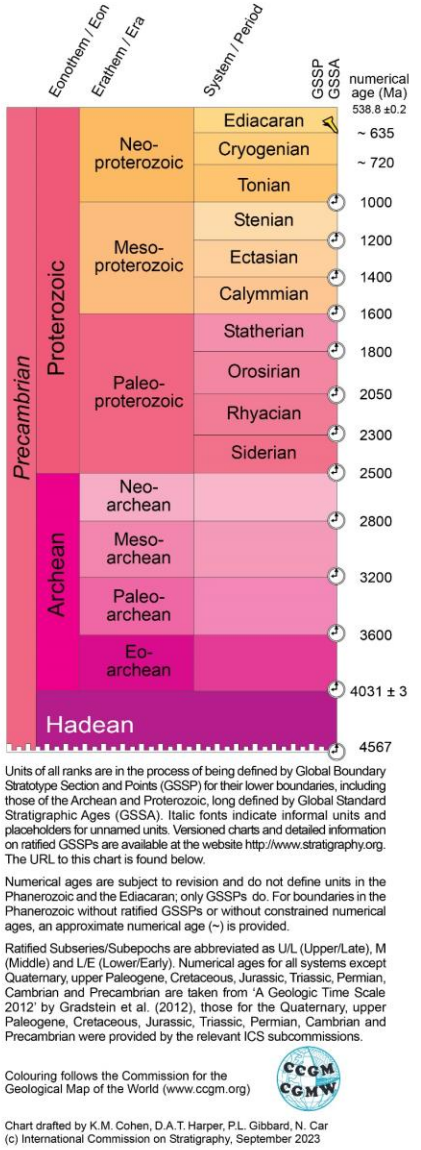
INTERNATIONAL CHRONOSTRATIGRAPHIC CHART

IUGS www.stratigraphy.org International Commission on Stratigraphy v 2023/09









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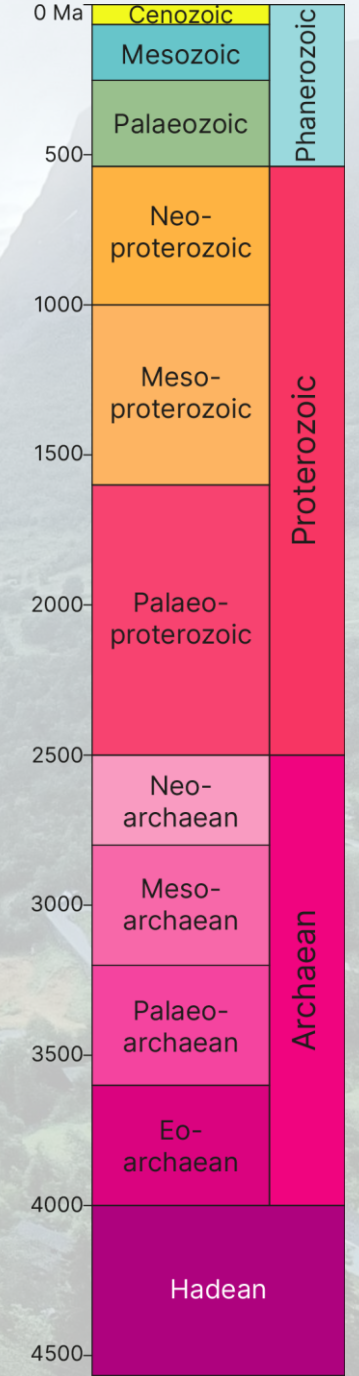
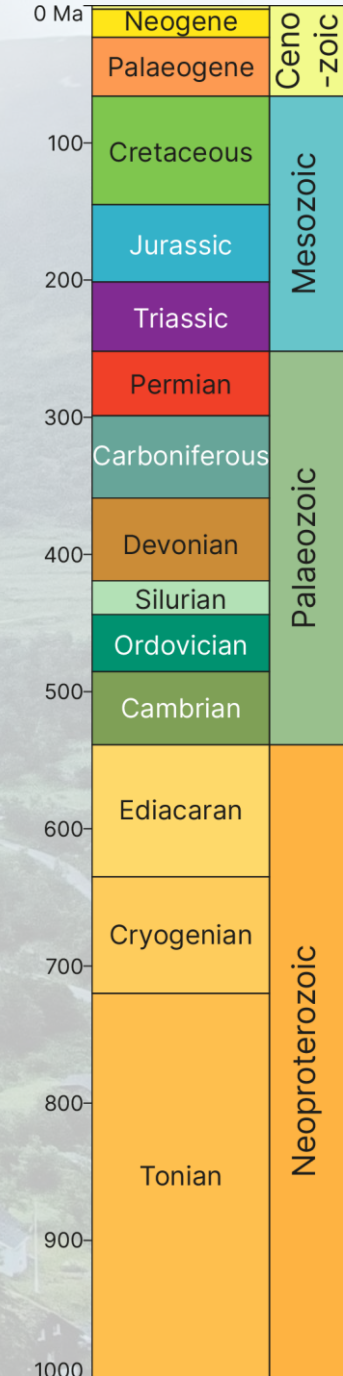
Colouring follows the Commission for the Geological Map of the World (www.cgm.org)

Chart drafted by K.M. Cohen, D.A.T. Harper, P.L. Gibbard, N. Car
(c) International Commission on Stratigraphy, September 2023

To cite: Cohen, K.M., Finney, S.C., Gibbard, P.L. & Fan, J.-X. (2013; updated) The ICS International Chronostratigraphic Chart. Episodes 36: 199-204.

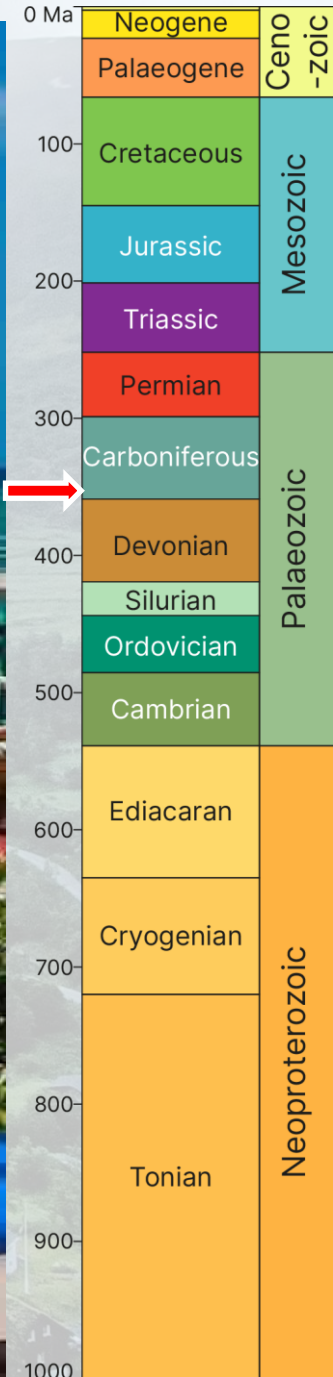
URL: http://www.stratigraphy.org/ICSchart/ChronostratChart2023-09.pdf

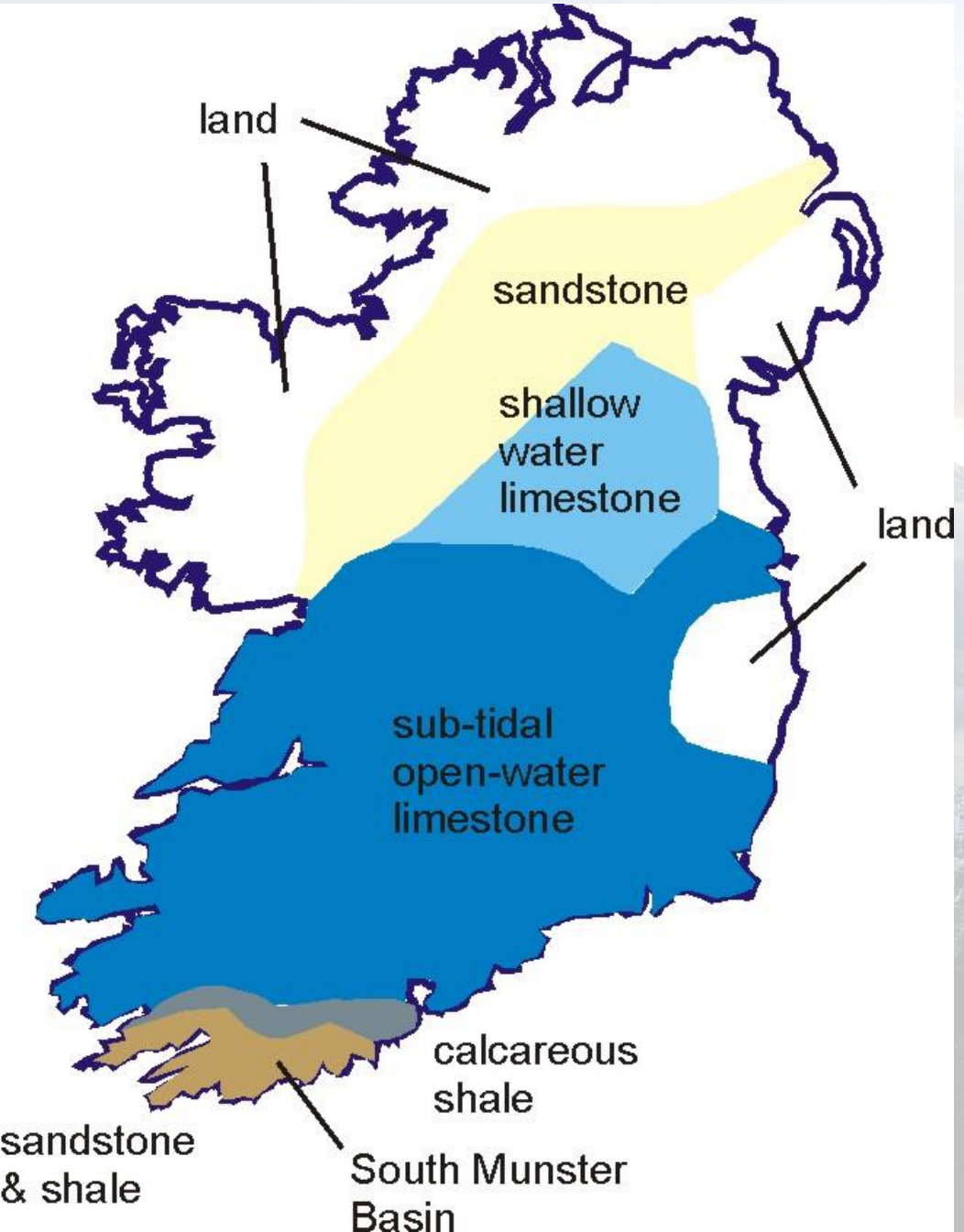




Tropical Ireland | *Insert witty joke about the weather here*

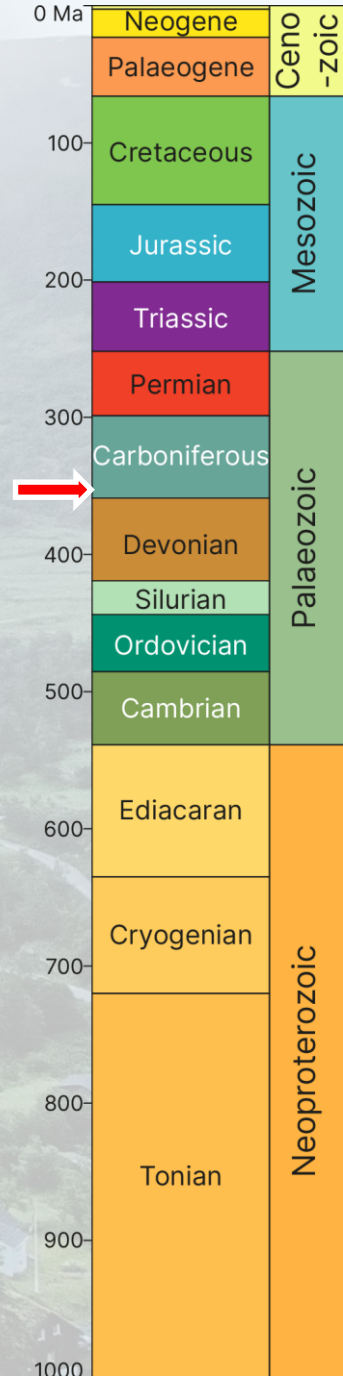
GY4051





Marine transgression

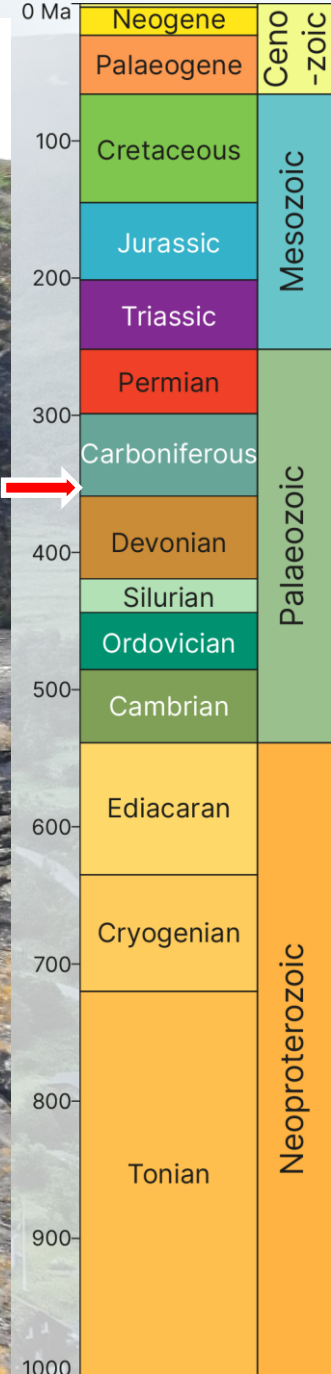
- Some highland areas remain emergent
- Former alluvial plains gradually covered by shallow seas
- Mostly shallow marine carbonate sedimentation, with common fossils



Tropical Ireland | *Early Carboniferous*

GY4051

P



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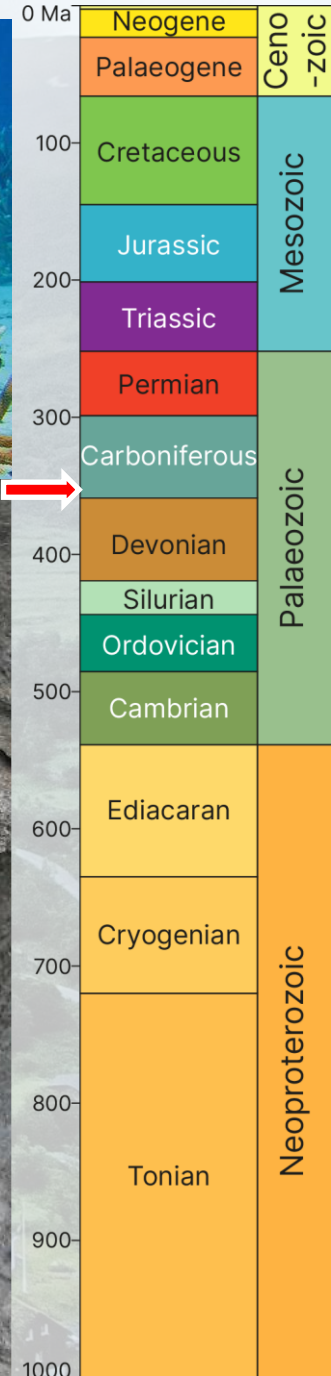
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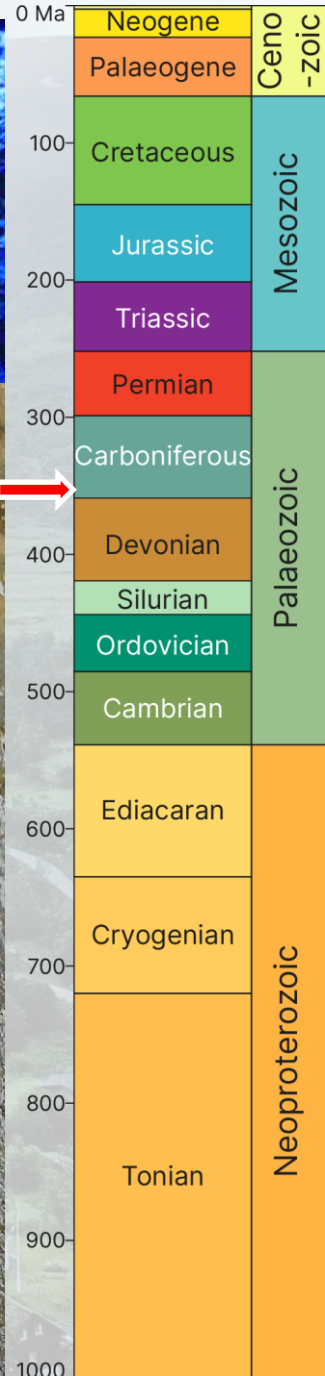
Neogene
Palaeogene
Ceno -zoic
100
Cretaceous
Jurassic
200
Triassic
Permian
300
Carboniferous
Devonian
400
Silurian
Ordovician
500
Cambrian
Mesozoic
Palaeozoic
Ediacaran
600
Cryogenian
700
Tonian
800
900
1000
Neoproterozoic

P


0 Ma
Neogene
Palaeogene
Ceno -zoic
100
Cretaceous
Jurassic
Mesozoic
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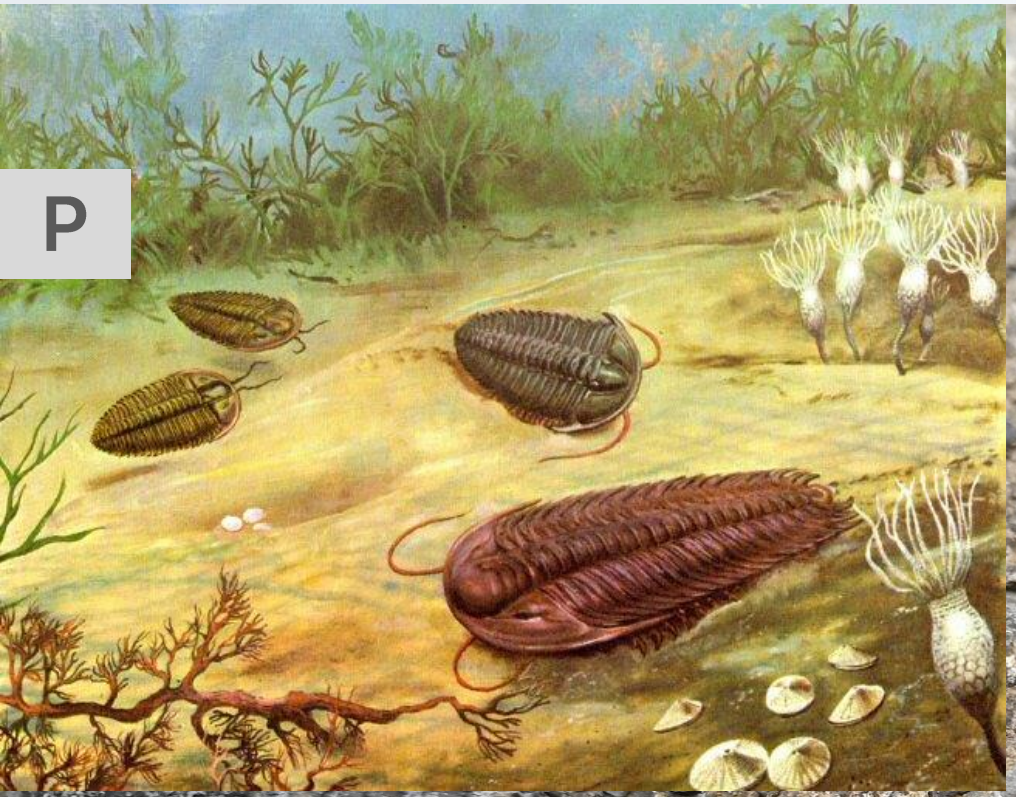
Triassic
Permian
300
Carboniferous
Devonian
400
Silurian
Ordovician
Palaeozoic
500
Cambrian
Ediacaran
600
Cryogenian
700
Tonian
800
900
Neoproterozoic
1000

Tropical Ireland | *Trilobites*

GY4051



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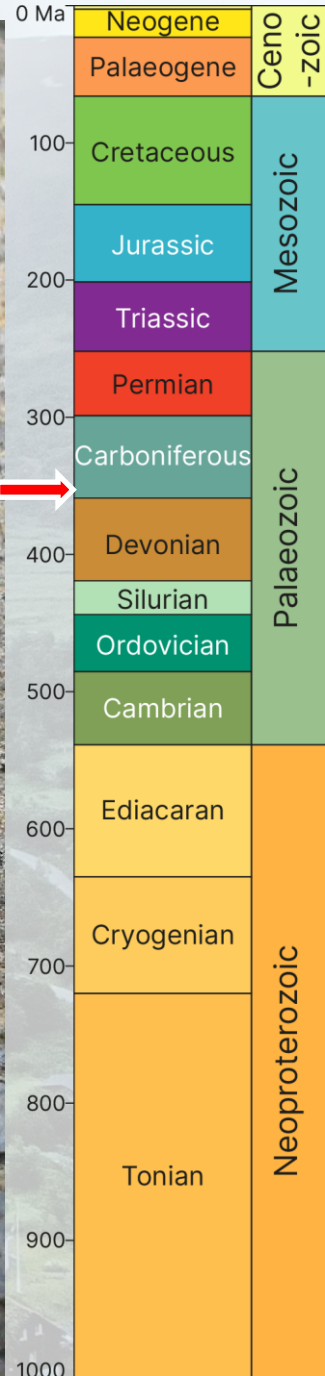

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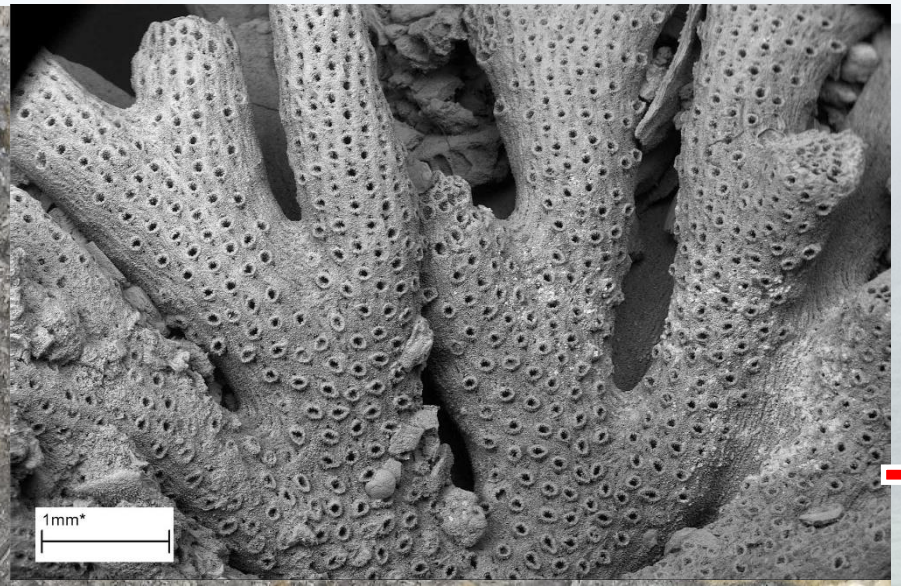
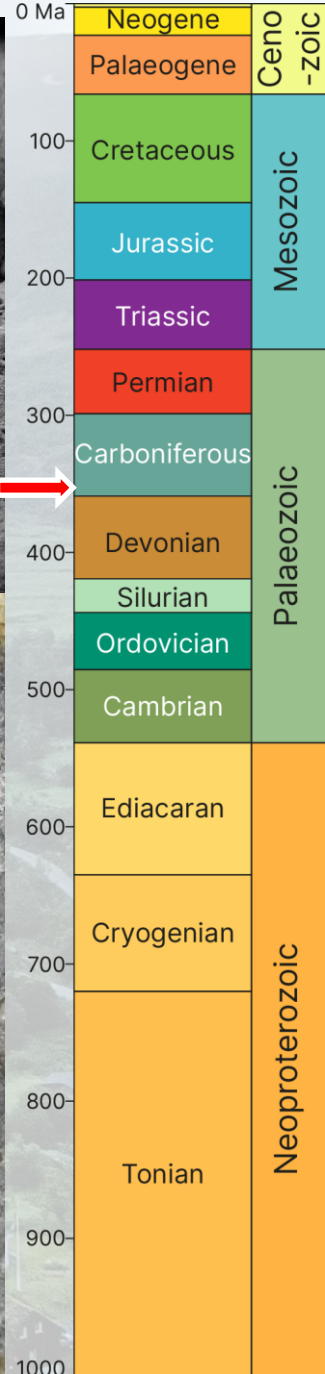

1mm*


0 Ma
100
200
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400
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600
700
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1000
Neogene
Palaeogene
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
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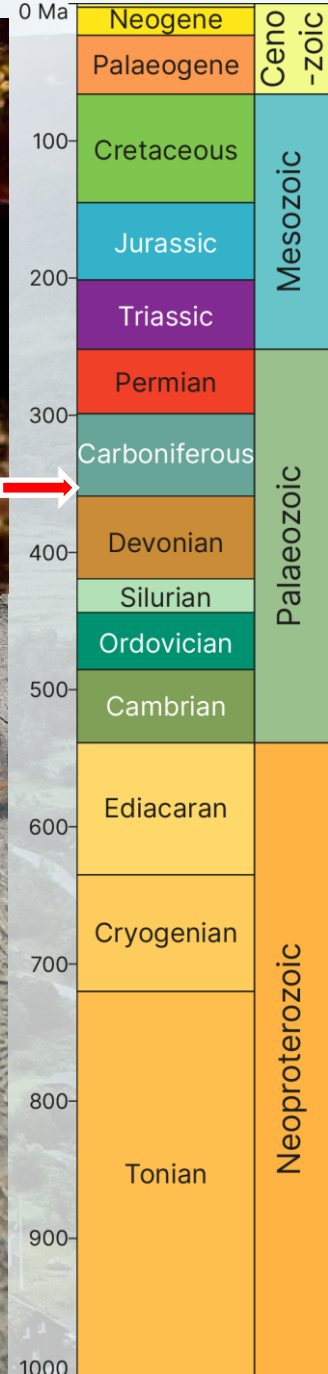
Cryogenian
Tonian
Ceno -zoic
Mesozoic
Palaeozoic
Neoproterozoic

P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Palaeogene
Ceno-zoic
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Triassic
Permian
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Carboniferous
Devonian
400
Silurian
Ordovician
Palaeozoic
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Cambrian
Ediacaran
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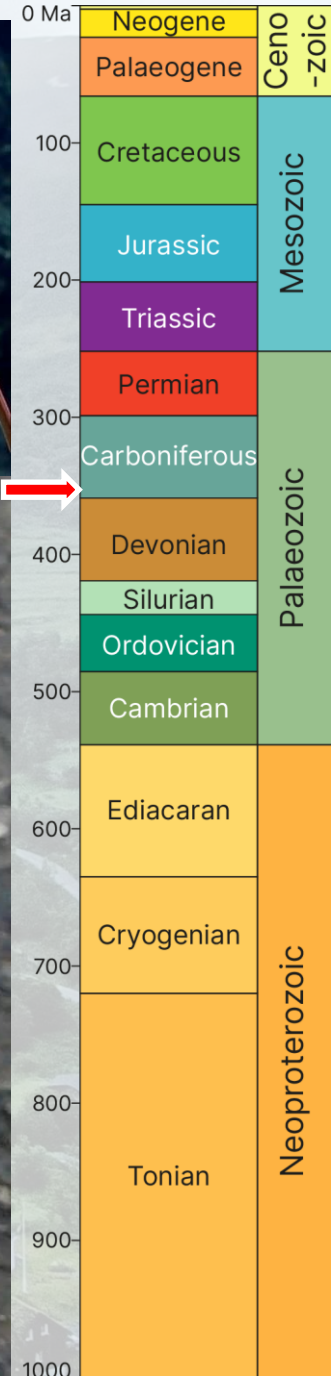
Cryogenian
700
Tonian
800
900
Neoproterozoic
1000

P


OKEANOS EXPLORER 2017


0 Ma
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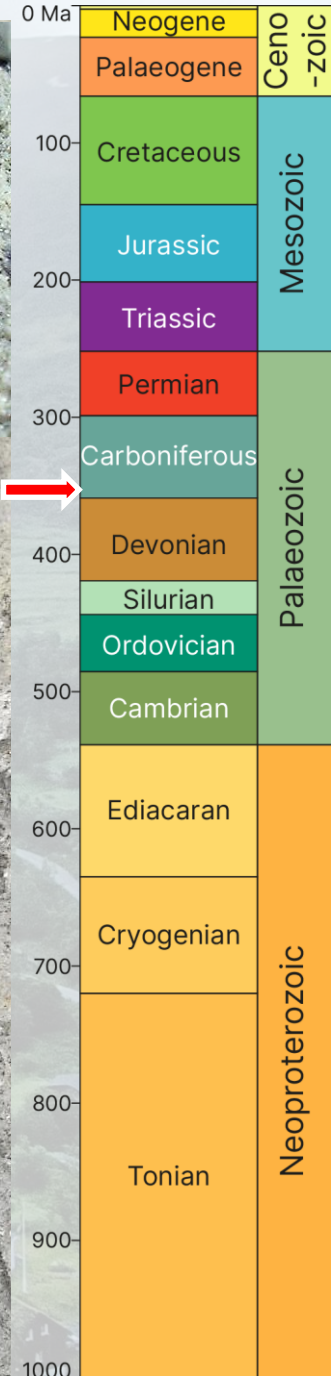
Carboniferous
Devonian
400
Silurian
Ordovician
Palaeozoic
500
Cambrian
Ediacaran
600
Cryogenian
700
Tonian
800
900
Neoproterozoic
1000

Tropical Ireland | *Gastropod*

GY4051



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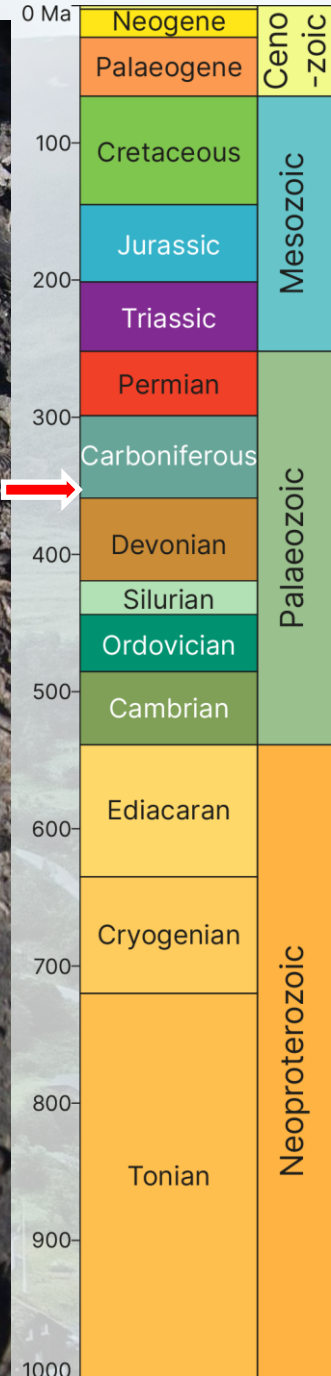
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Cretaceous
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Silurian
Ordovician
Palaeozoic
500
Cambrian
Ediacaran
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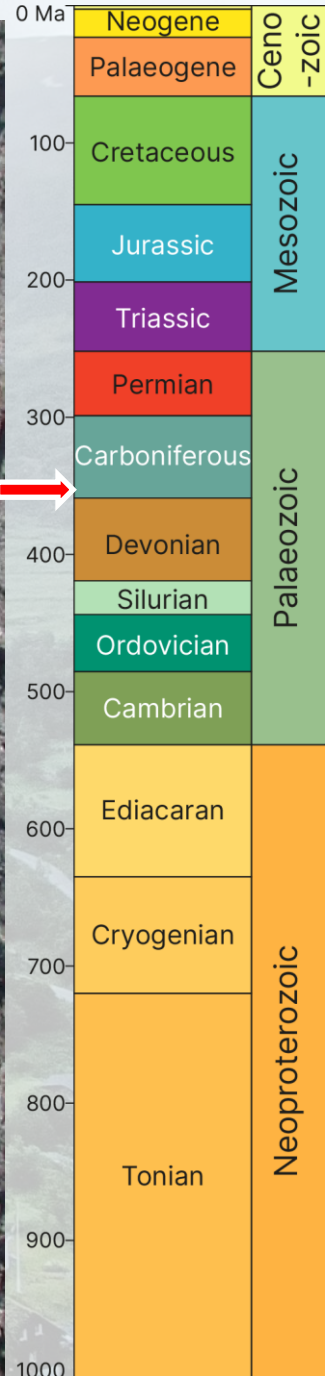
Cryogenian
700
Tonian
800
900
Neoproterozoic
1000

Tropical Ireland | *Crinoid, gastropod, brachiopod*

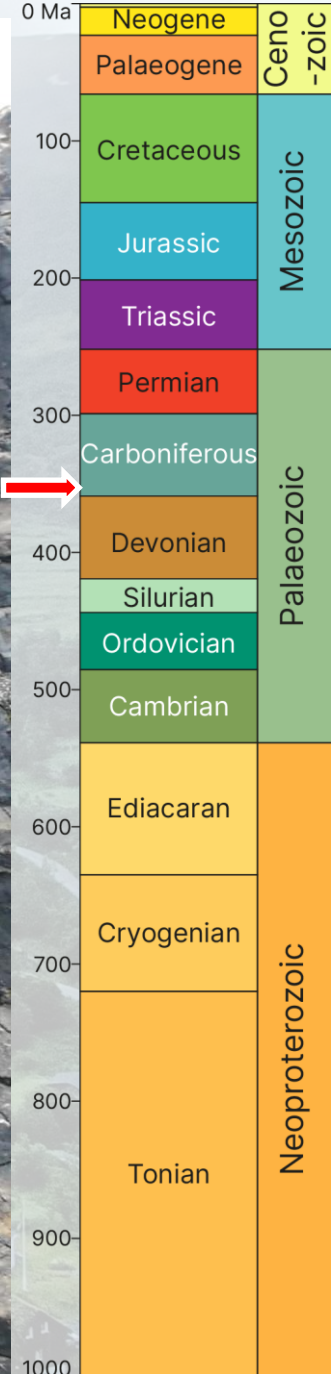
GY4051

P



Tropical Ireland | *Shelf Limestones*

GY4051



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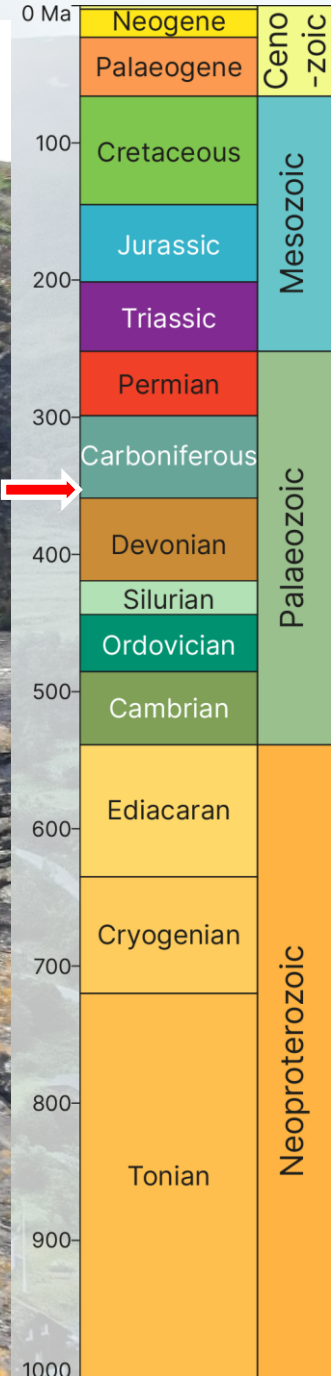
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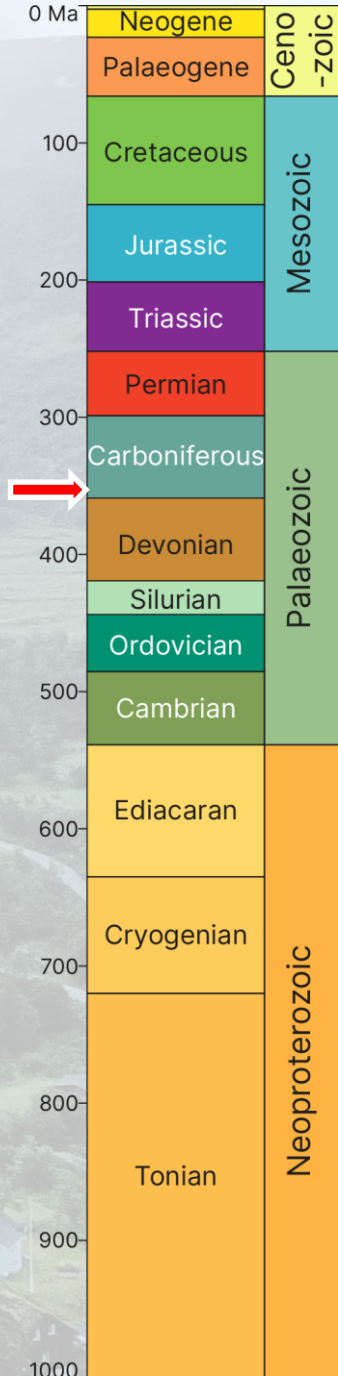
Neogene
Palaeogene
Ceno -zoic
100
Cretaceous
Jurassic
Mesozoic
200
Triassic
Permian
300
Carboniferous
Devonian
400
Silurian
Ordovician
Palaeozoic
500
Cambrian
Ediacaran
600
Cryogenian
700
Tonian
800
900
Neoproterozoic
1000

GY4051

P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Cretaceous
Jurassic
Mesozoic
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Triassic
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Devonian
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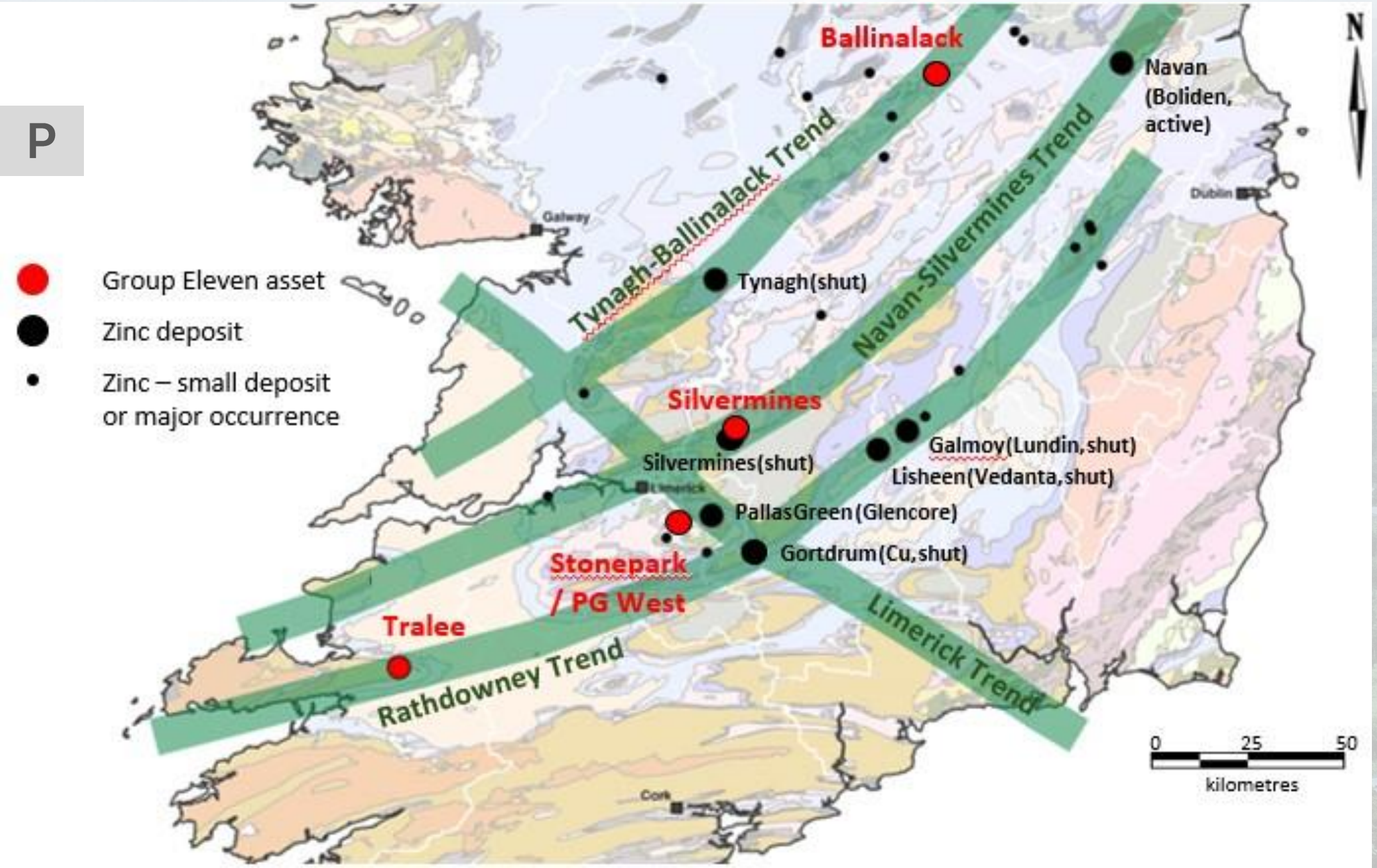
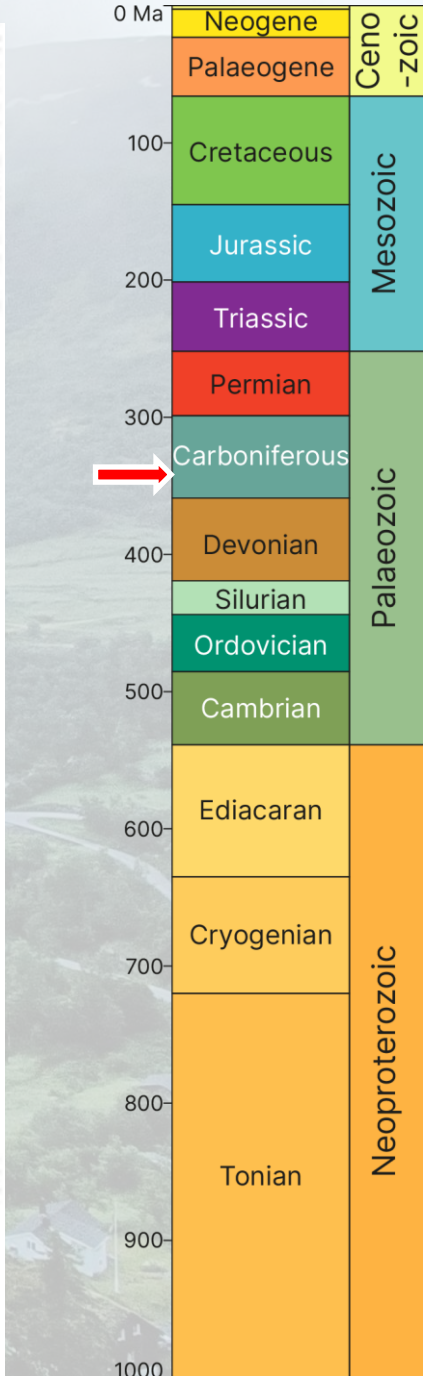
Cambrian
Ediacaran
600
Cryogenian
700
Tonian
800
900
Neoproterozoic
1000

P


Group Eleven asset
Zinc deposit
Zinc – small deposit or major occurrence
Ballinalack
Navan (Boliden, active)
Tynagh-Ballinalack Trend
Navan-Silvermines Trend
Tynagh(shut)
Silvermines
Silvermines(shut)
Galmoy(Lundin,shut)
Lisheen(Vedanta,shut)
PallasGreen(Glencore)
Gortdrum(Cu,shut)
Stonepark / PG West
Tralee
Rathdowney Trend
Limerick Trend
Galway
Dublin
Cork
N
0 25 50
kilometres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Palaeogene
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Mesozoic
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Permian
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Cambrian
Ediacaran
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Cryogenian
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Tonian
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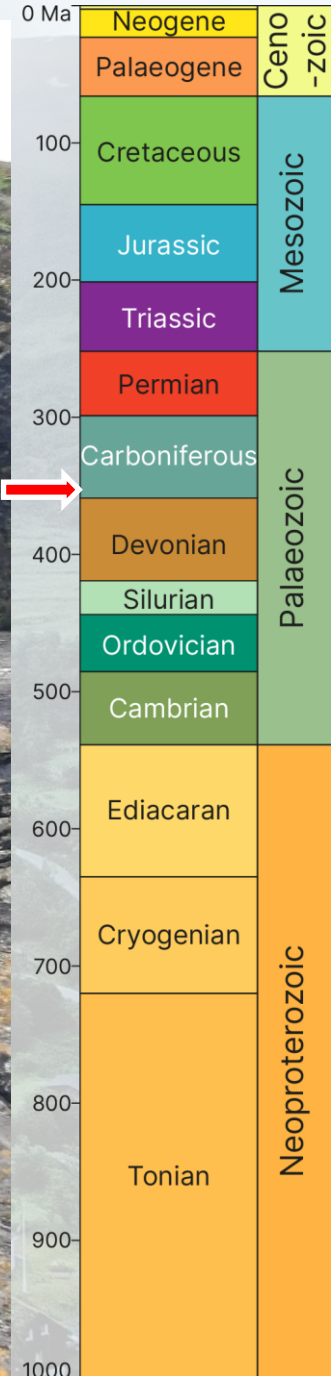
Neoproterozoic
1000

P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Cambrian
Ediacaran
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Cryogenian
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Tonian
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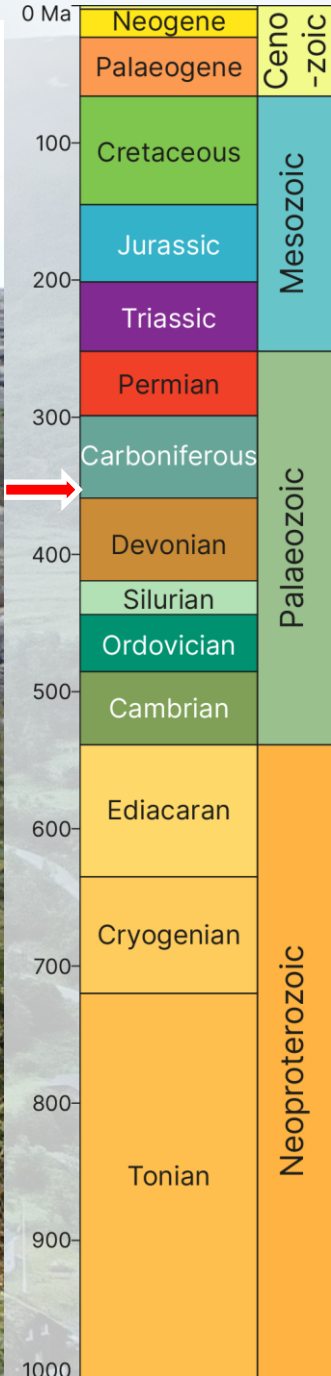
900
Neoproterozoic
1000

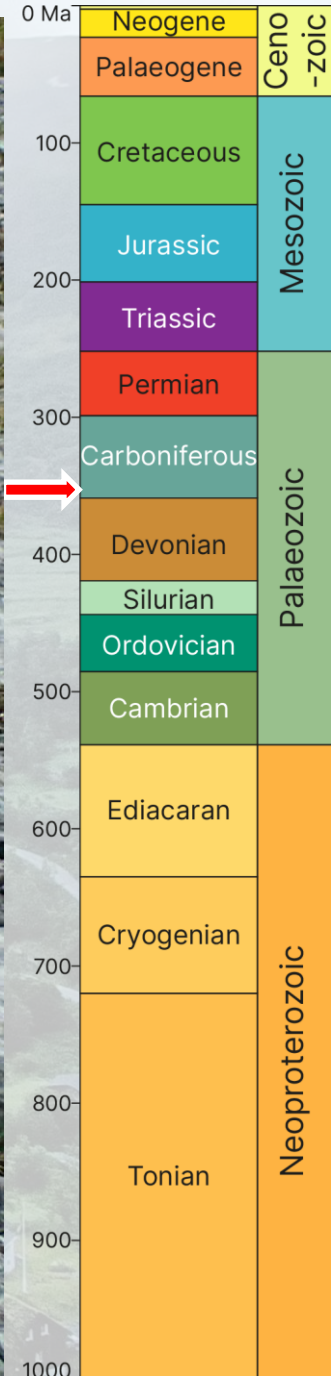
Tropical Ireland | *Shelf Limestones*

GY4051



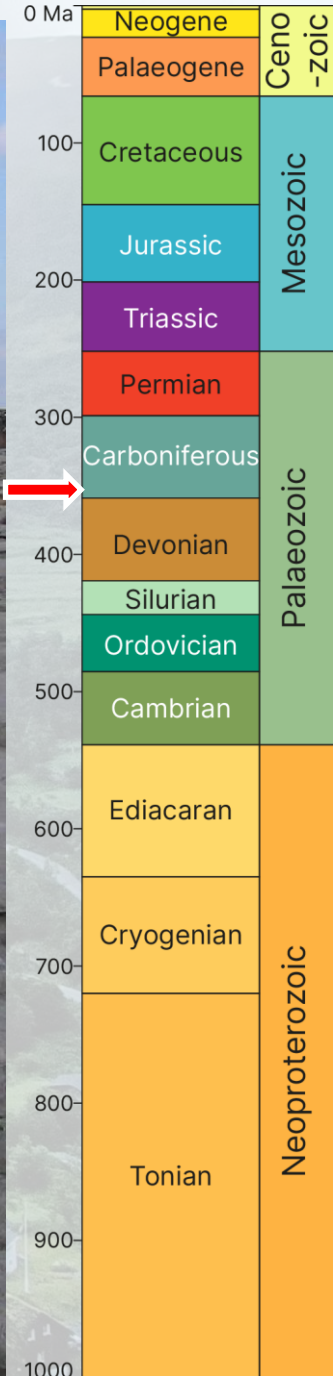
Tropical Ireland | *Shelf Limestones*

GY4051



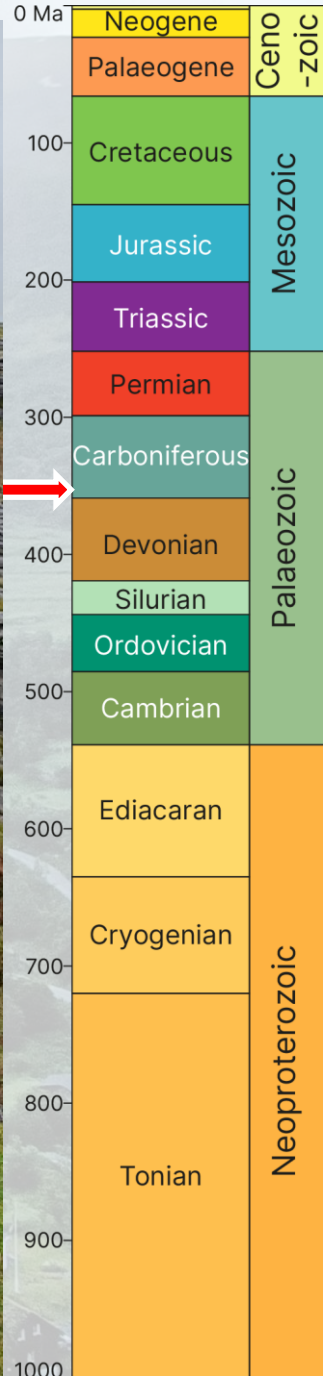
Tropical Ireland | *Shelf Limestones - The Burren*

GY4051



Tropical Ireland | *Shelf Limestones - The Burren*

GY4051

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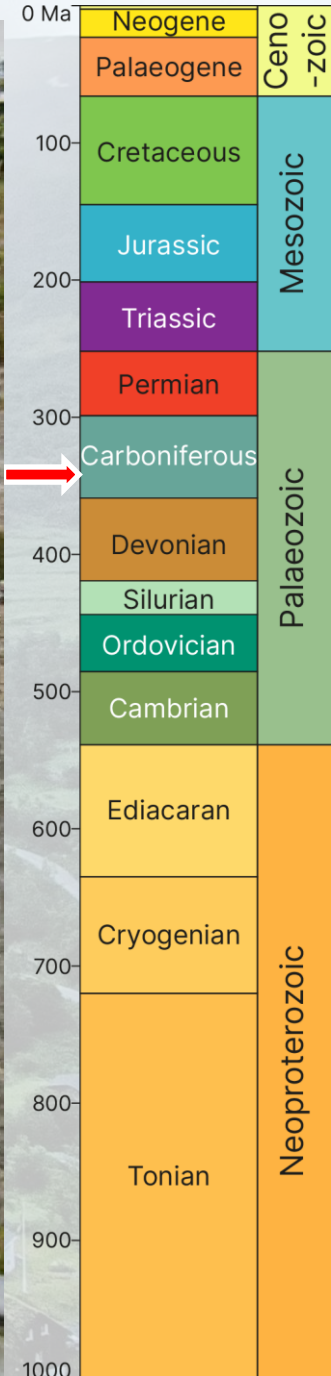
0 Ma
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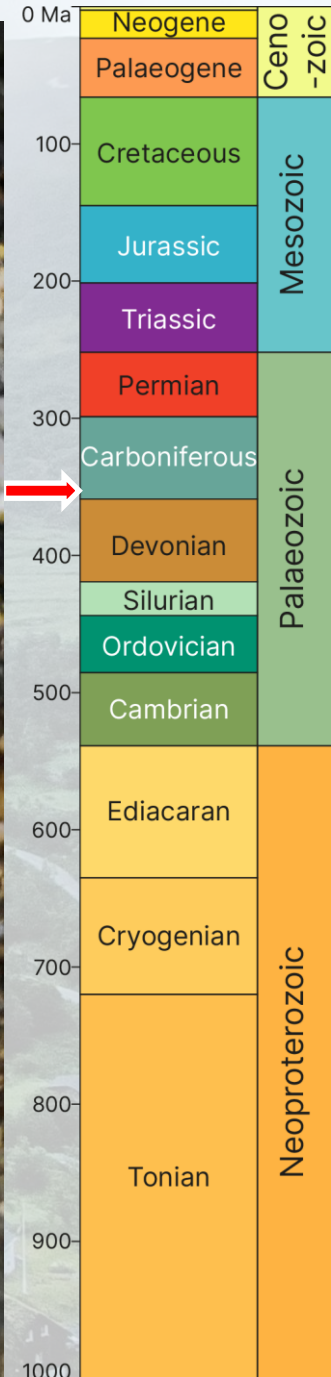
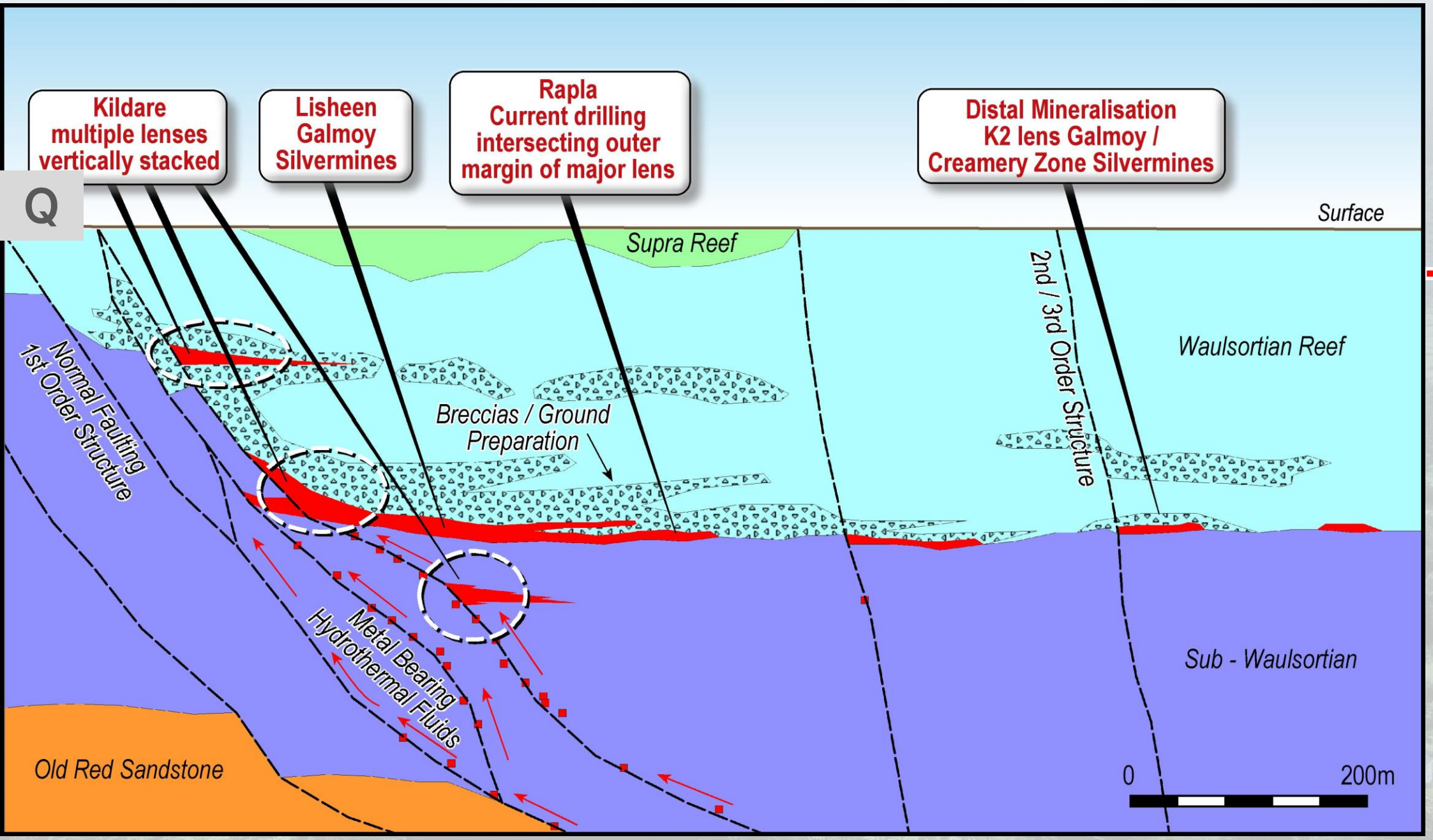
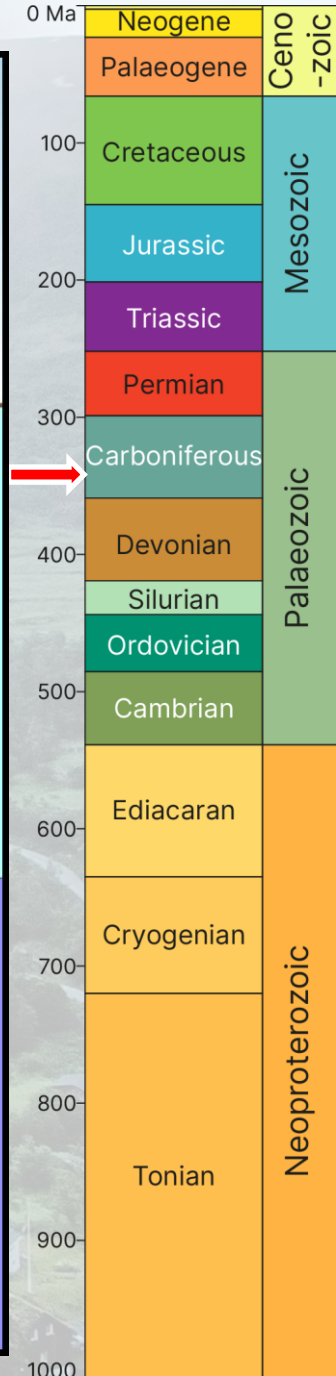
Neogene
Palaeogene
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Ediacaran
Cryogenian
Tonian
Ceno -zoic
Mesozoic
Palaeozoic
Neoproterozoic

Tropical Ireland | *Shelf Limestones – LEAD AND ZINC*

GY4051




Kildare
multiple lenses
vertically stacked
Lisheen
Galmoy
Silvermines
Rapla
Current drilling
intersecting outer
margin of major lens
Distal Mineralisation
K2 lens Galmoy /
Creamery Zone Silvermines
Q
Surface
Supra Reef
Waulsortian Reef
2nd / 3rd Order Structure
Normal Faulting
1st Order Structure
Breccias / Ground
Preparation
Metal Bearing
Hydrothermal Fluids
Sub - Waulsortian
Old Red Sandstone
0
200m


0 Ma
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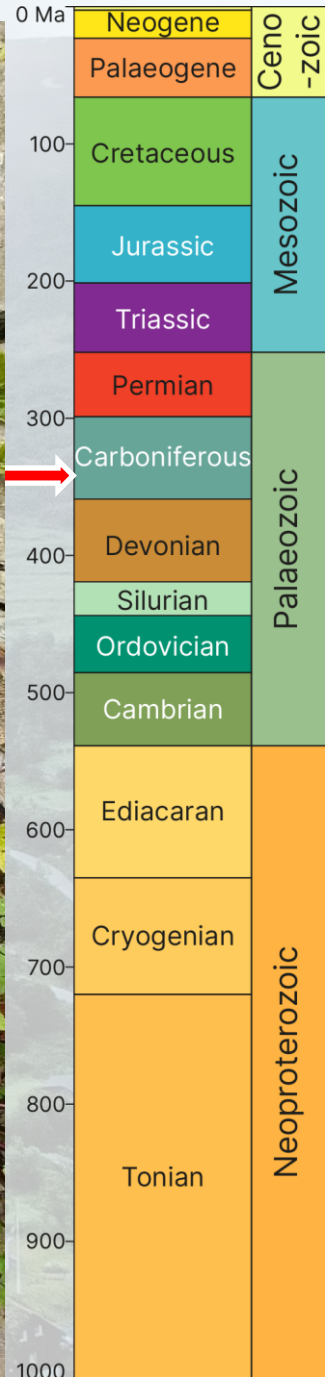
1000
Neogene
Palaeogene
Ceno
-zoic
Cretaceous
Jurassic
Triassic
Mesozoic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Palaeozoic
Ediacaran
Cryogenian
Tonian
Neoproterozoic


R


0 Ma
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200
300
400
500
600
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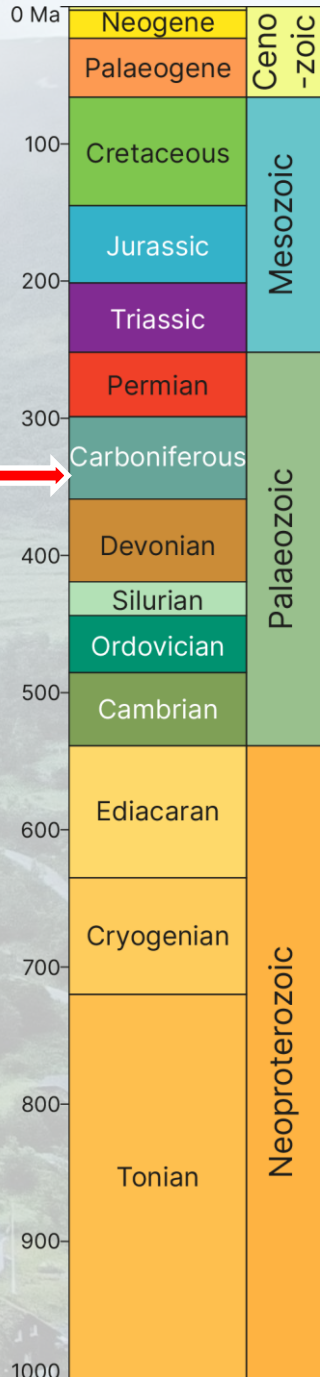
800
900
1000
Neogene
Palaeogene
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Ediacaran
Cryogenian
Tonian
Ceno -zoic
Mesozoic
Palaeozoic
Neoproterozoic


R


0 Ma
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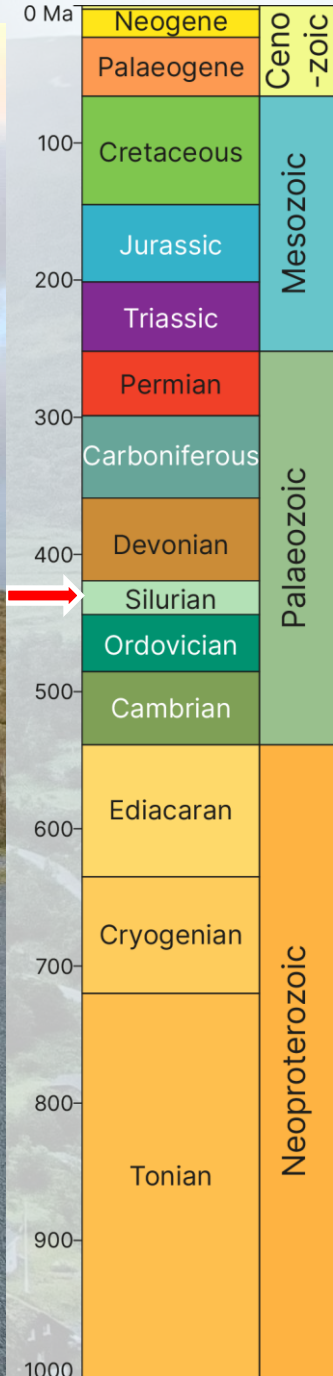
Neogene
Palaeogene
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Ediacaran
Cryogenian
Tonian
Ceno -zoic
Mesozoic
Palaeozoic
Neoproterozoic

Tropical Ireland | *Subduction volcanics and clastics in Laurentia*

GY4051

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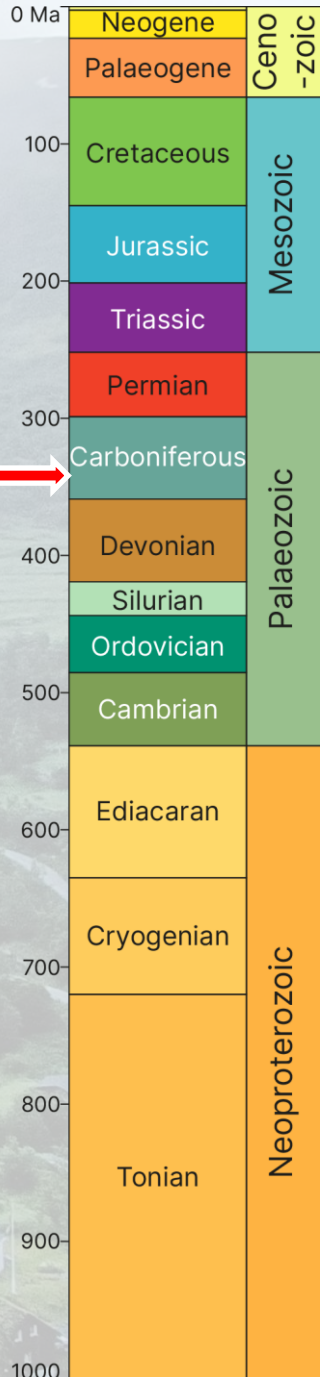
0 Ma
100
200
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Neogene
Palaeogene
Cretaceous
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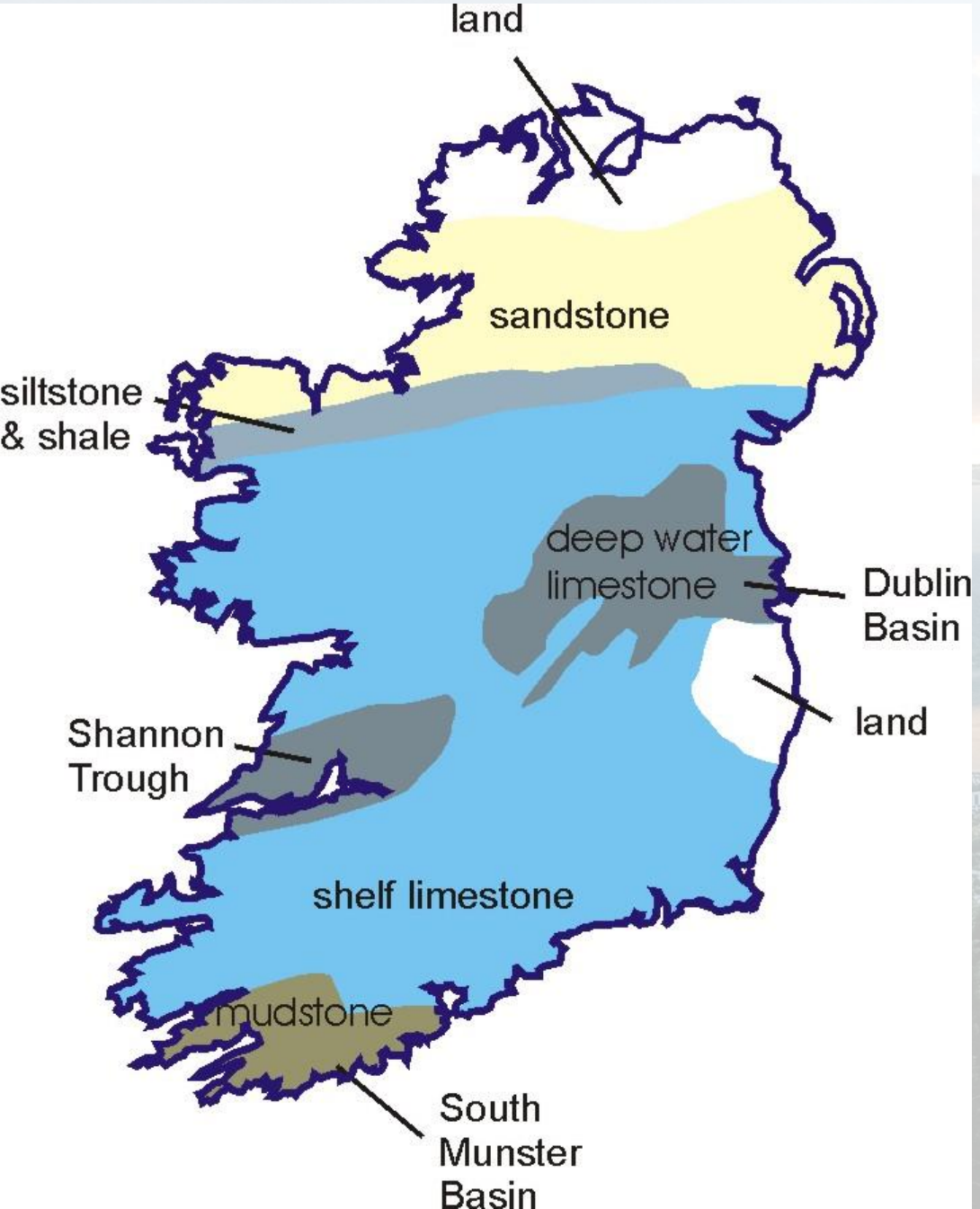
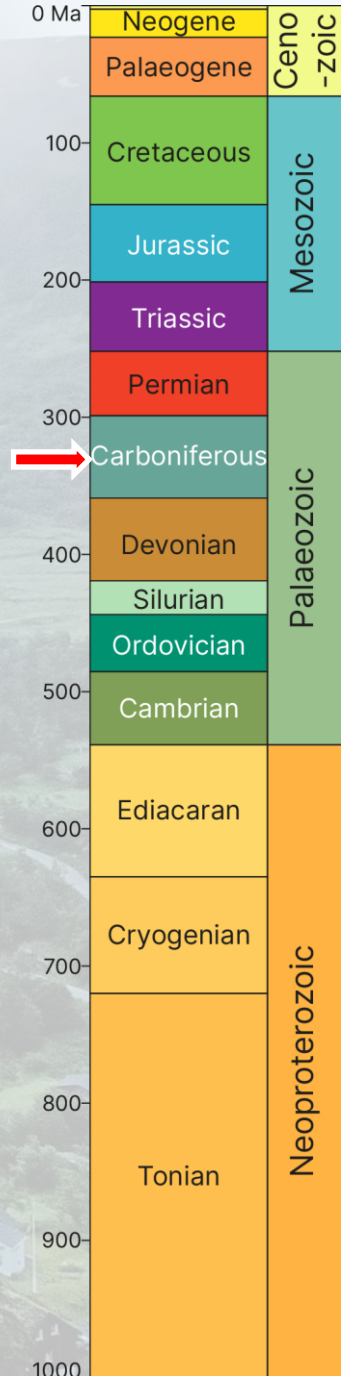
Silurian
Ordovician
Cambrian
Ediacaran
Cryogenian
Tonian
Ceno -zoic
Mesozoic
Palaeozoic
Neoproterozoic



Marine transgression reaches maximum

- Some highland areas remain emergent, but much reduced
- Shallow seas have become quite deep in some places



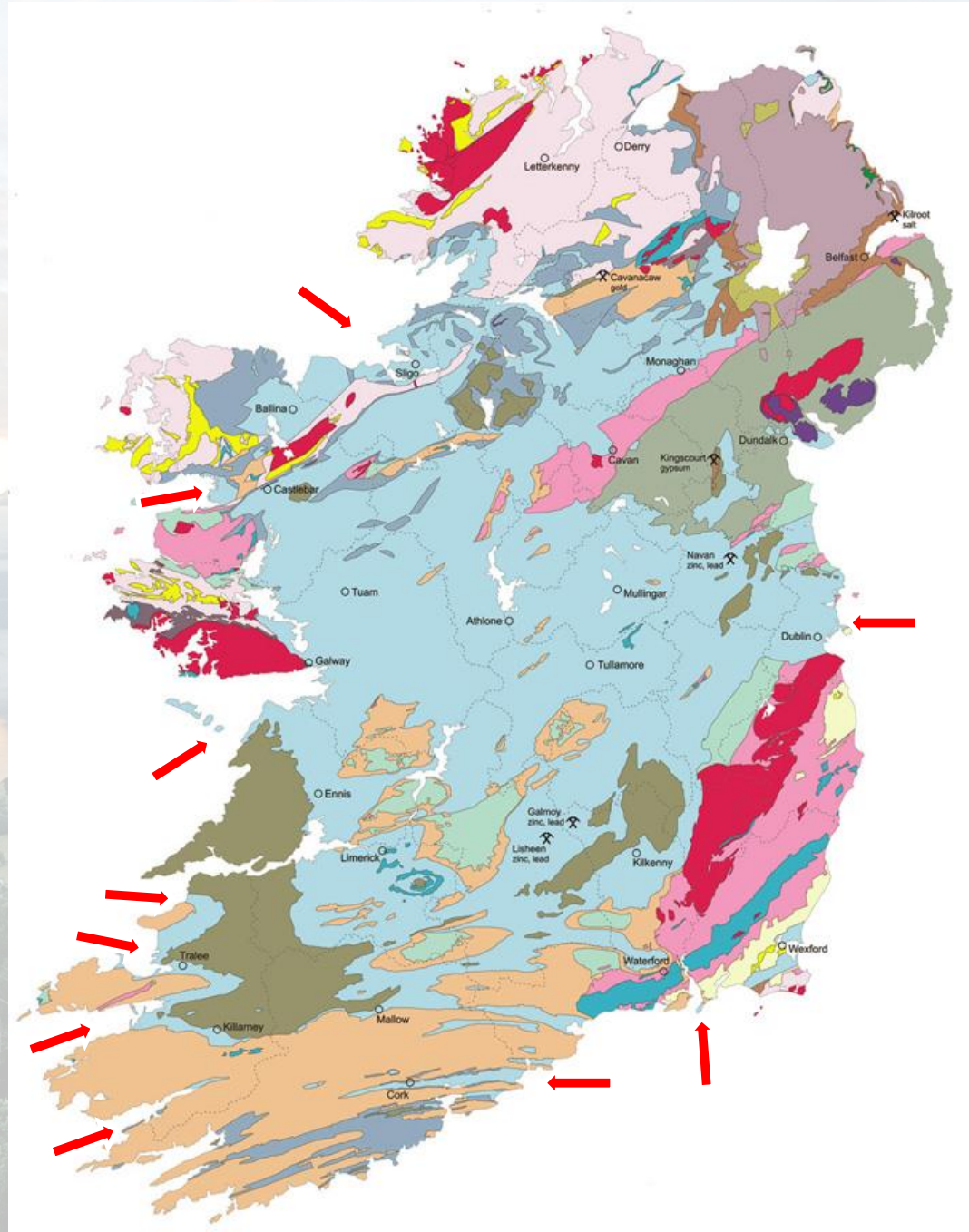
Tropical Ireland | *Middle Carboniferous*

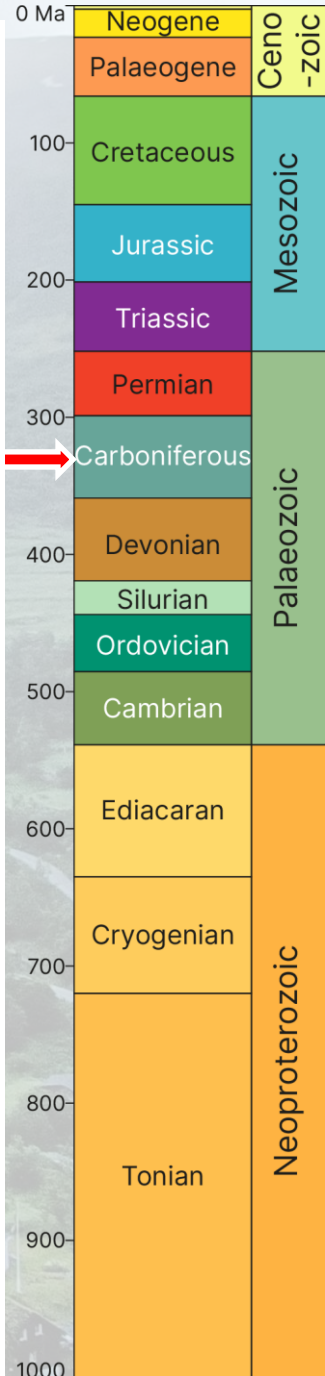
GY4051

P

Q

R





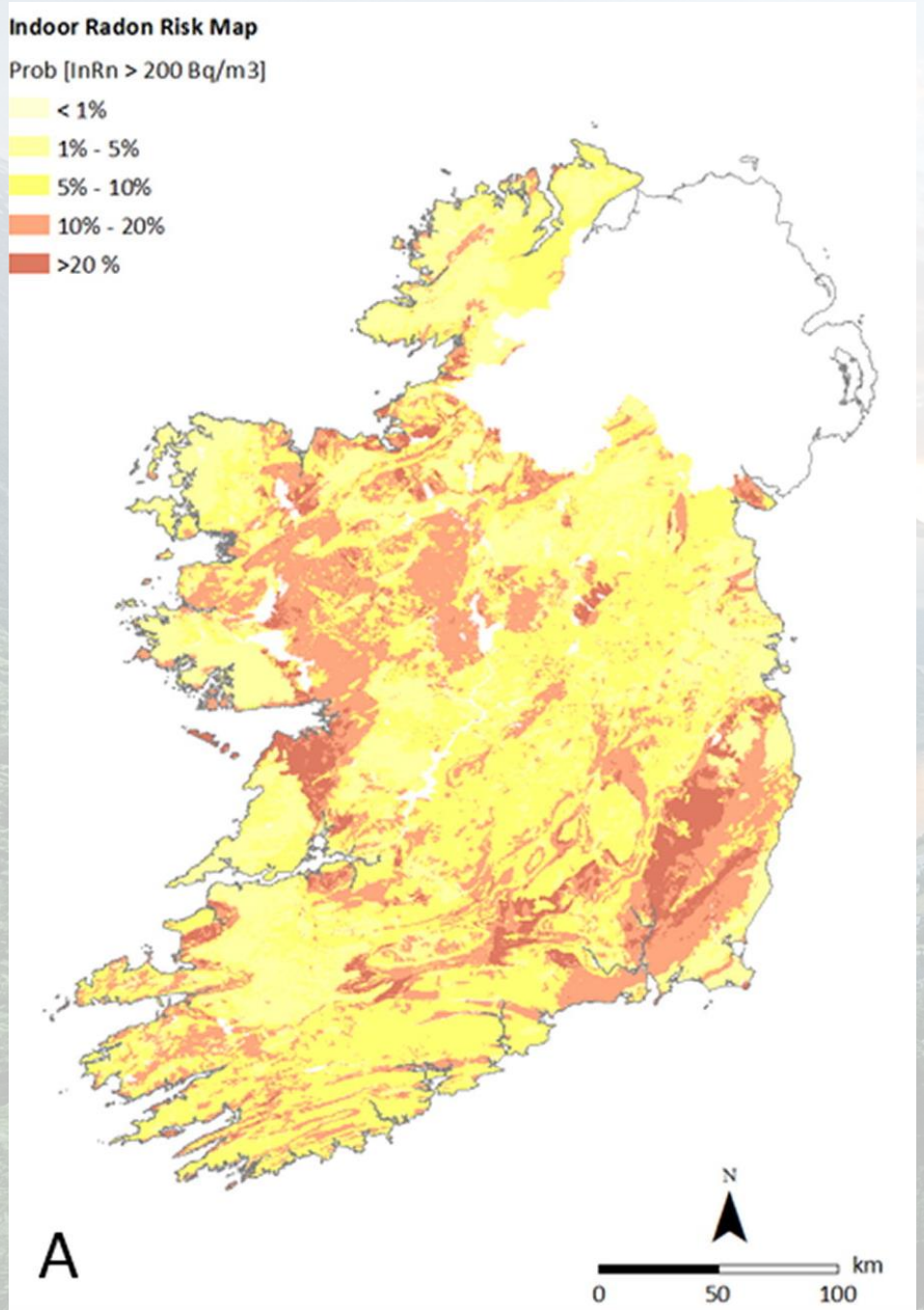
Tropical Ireland | *Middle Carboniferous*

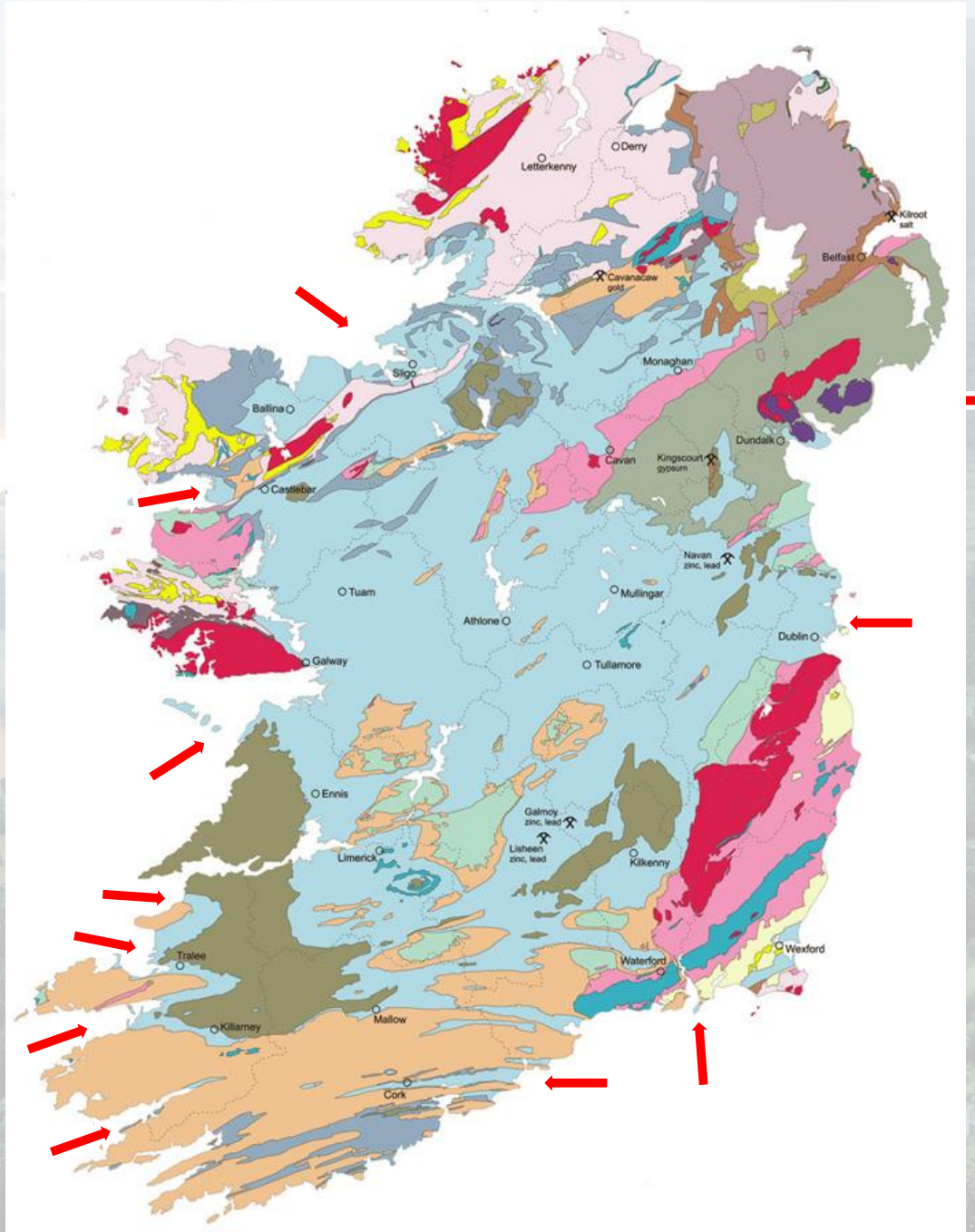
GY4051

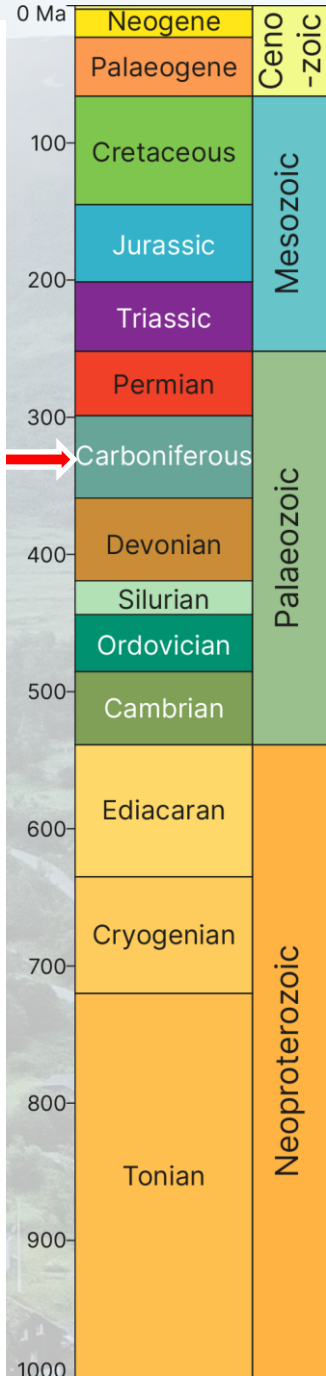
P

Q

R



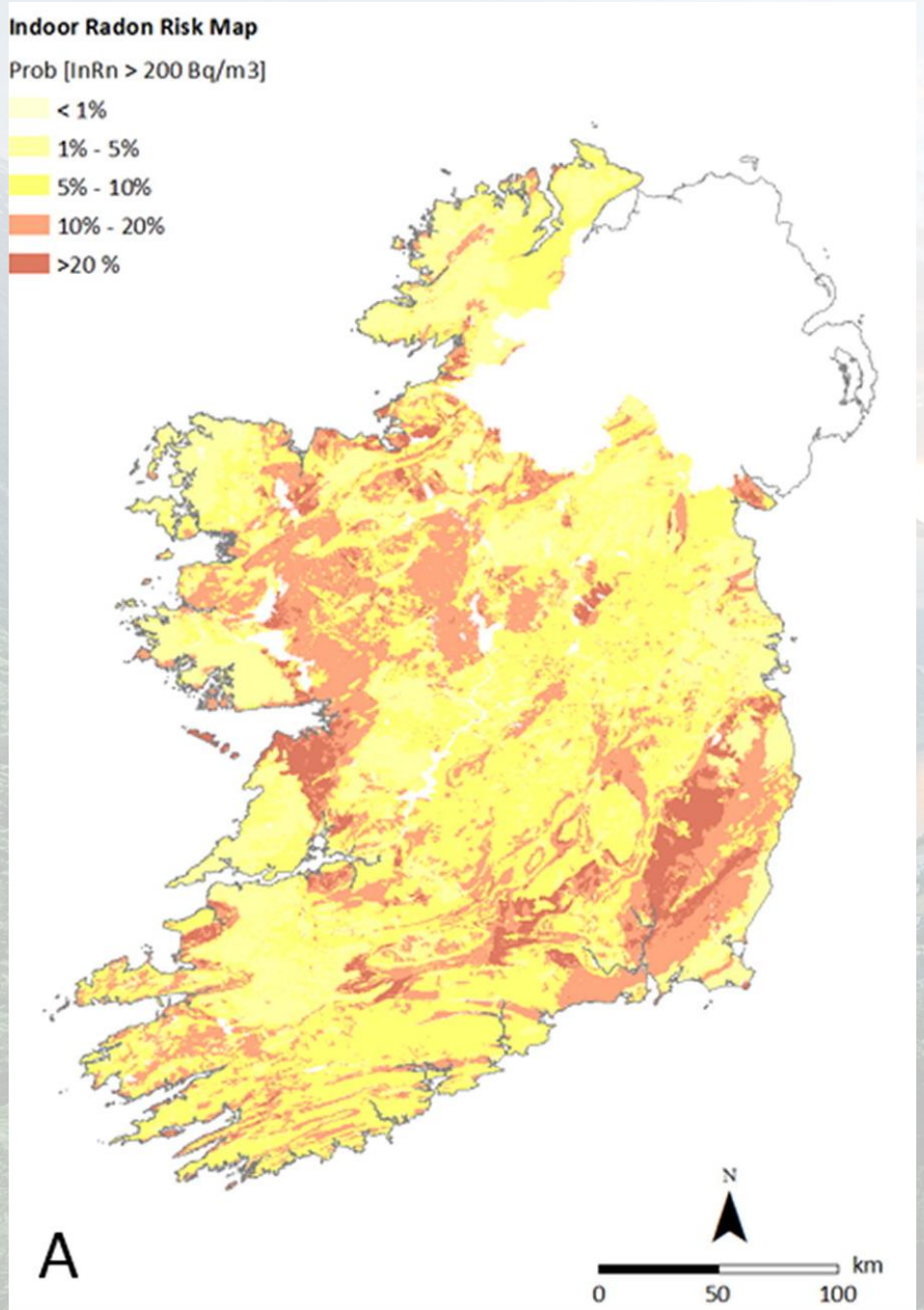


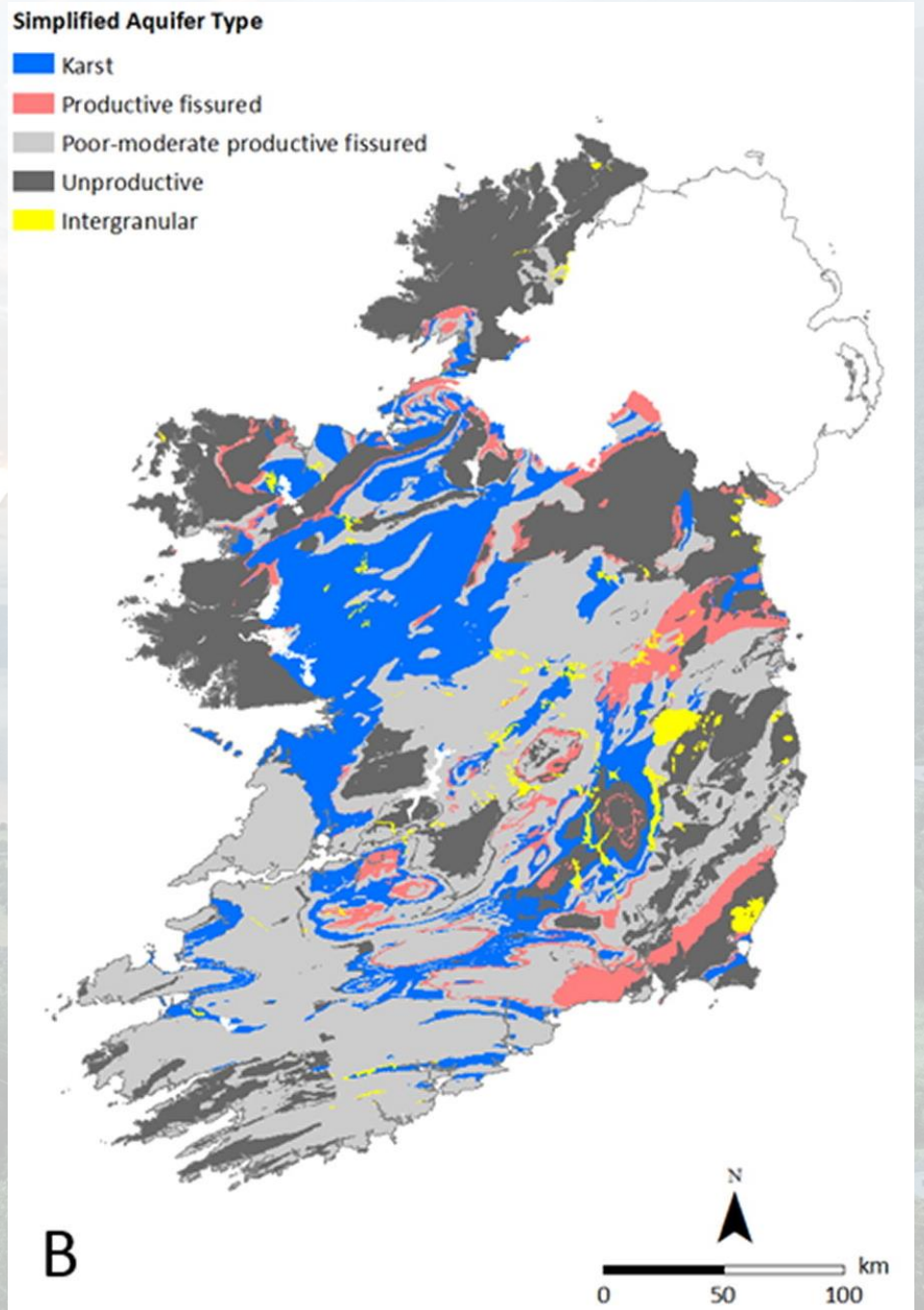


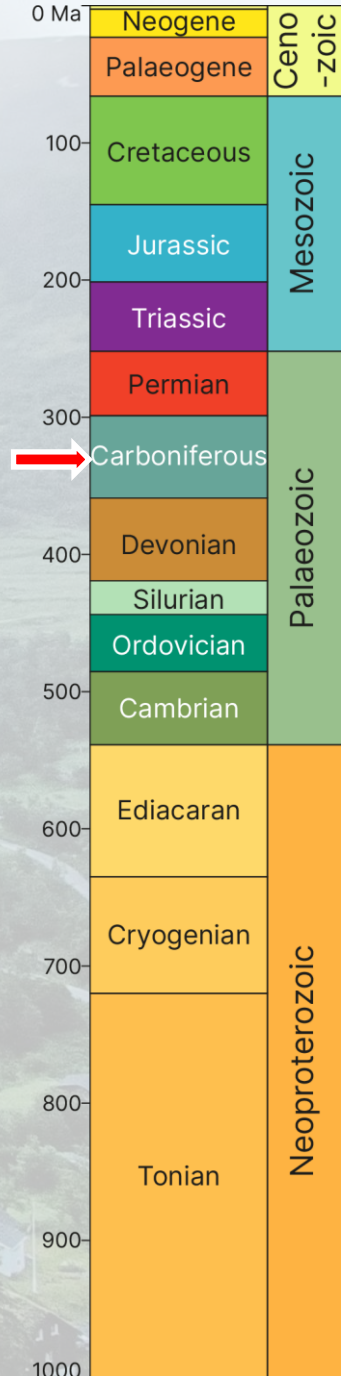
P

Q

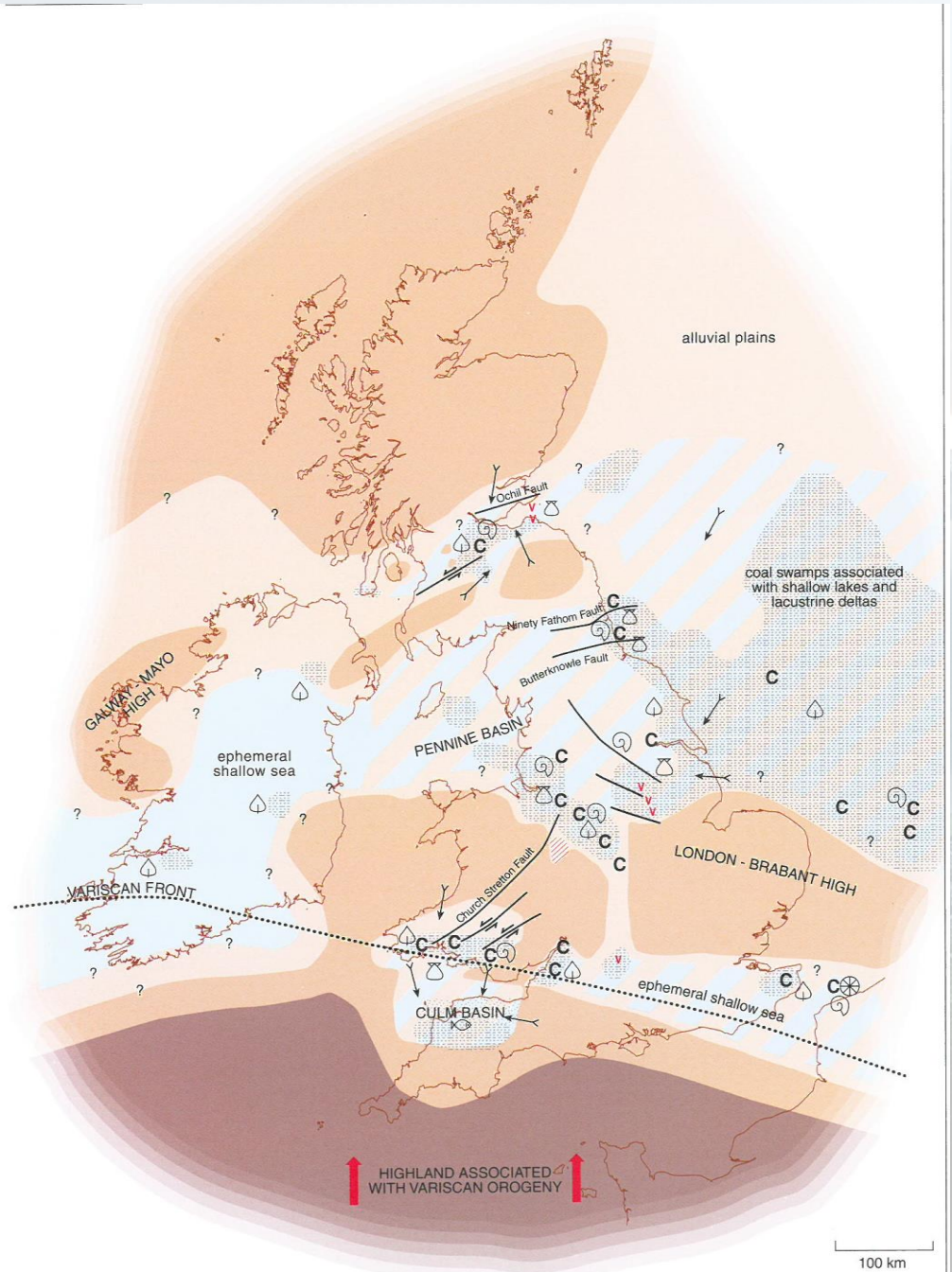
R


Indoor Radon Risk Map
Prob [InRn > 200 Bq/m3]
< 1%
1% - 5%
5% - 10%
10% - 20%
>20 %
A
N
km
0
50
100


Simplified Aquifer Type
Karst
Productive fissured
Poor-moderate productive fissured
Unproductive
Intergranular
B
N
km
0
50
100

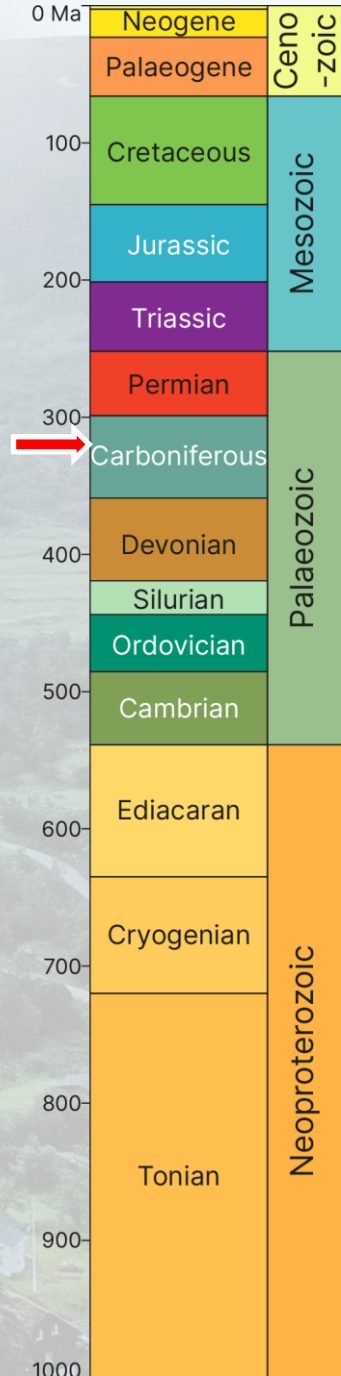

0 Ma
Neogene
Palaeogene
Ceno -zoic
100
Cretaceous
Jurassic
Mesozoic
200
Triassic
Permian
300
Carboniferous
Devonian
Palaeozoic
400
Silurian
Ordovician
500
Cambrian
Ediacaran
600
Cryogenian
700
Tonian
800
900
Neoproterozoic
1000

Tropical Ireland | *Late Carboniferous*



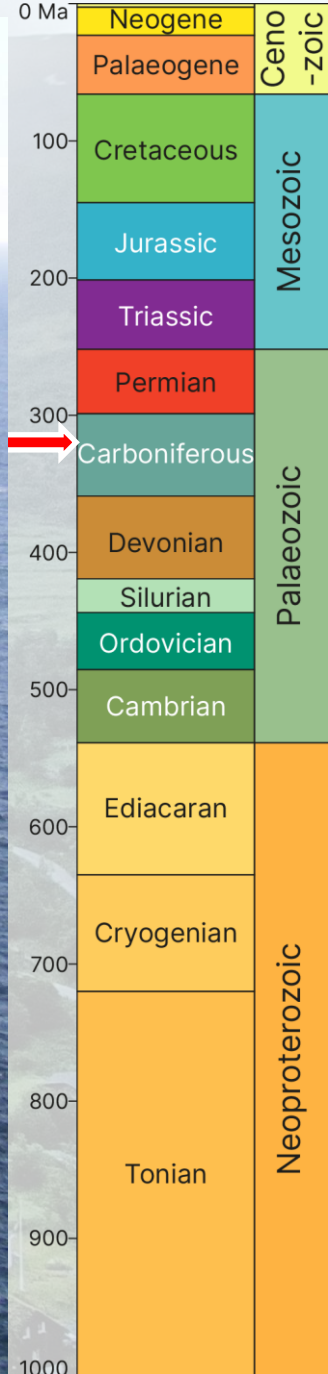
Marine transgression reverses

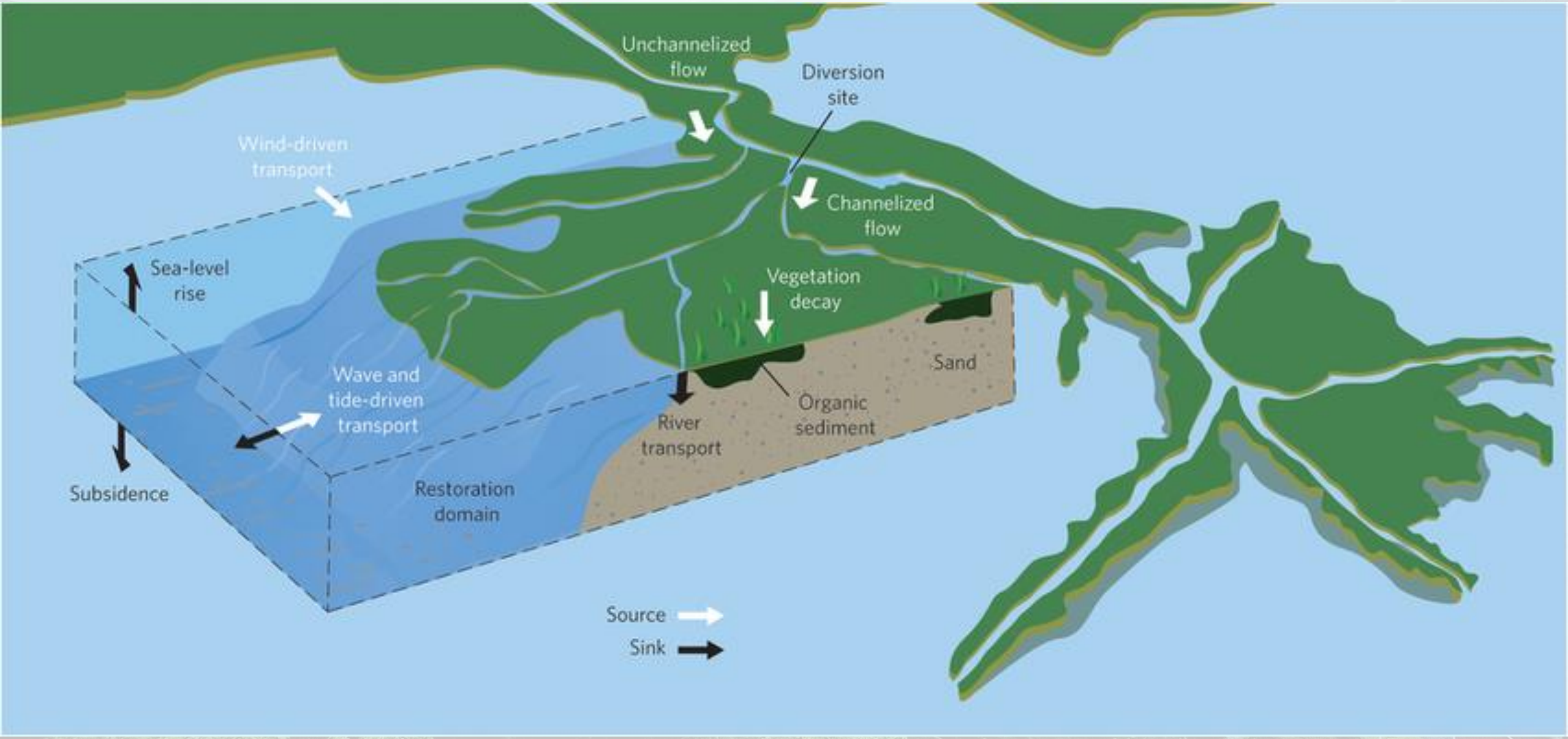
- Significant shallowing of sea levels
- N. England, S. Scotland, and Ireland covered in ephemeral shallow seas
- Marine deltas common
- Swamps widespread



Tropical Ireland | *Deltas – the Cliffs of Moher*

GY4051

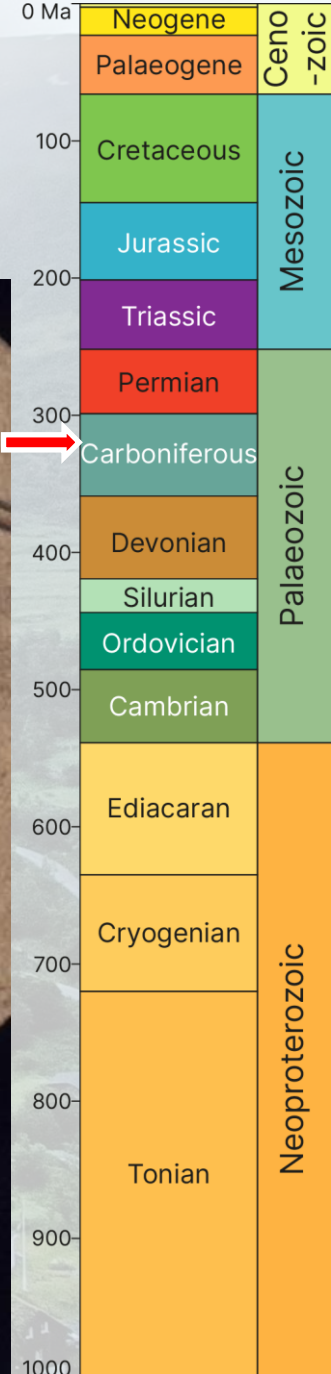



Unchannelized flow
Diversion site
Wind-driven transport
Channelized flow
Sea-level rise
Vegetation decay
Sand
Wave and tide-driven transport
River transport
Organic sediment
Subsidence
Restoration domain
Source
Sink

Jean Lafitte National Historical Park, Louisiana, USA http://featherbyfeather.com/2013/03/26/swamp-things/

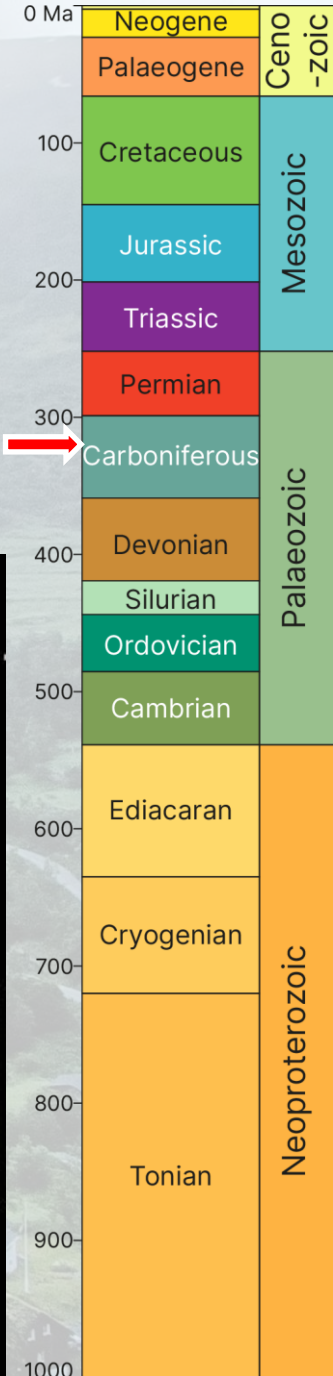
Sphenopsids

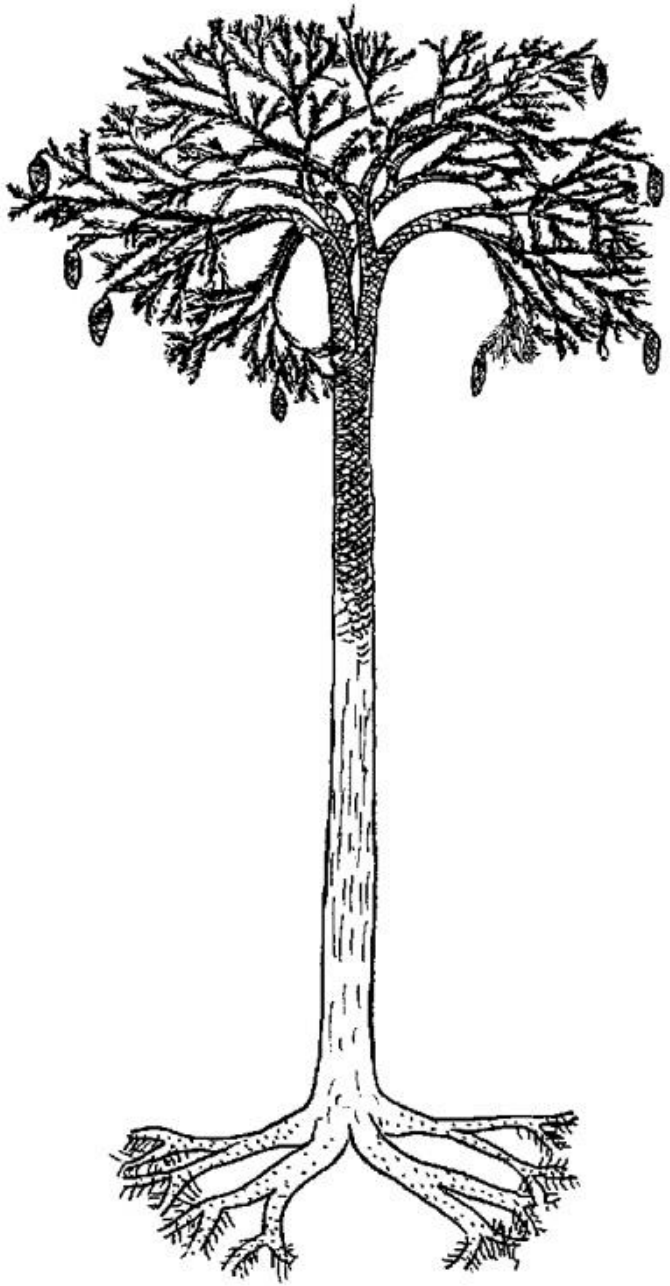
- Similar to living horsetails



Cordaites

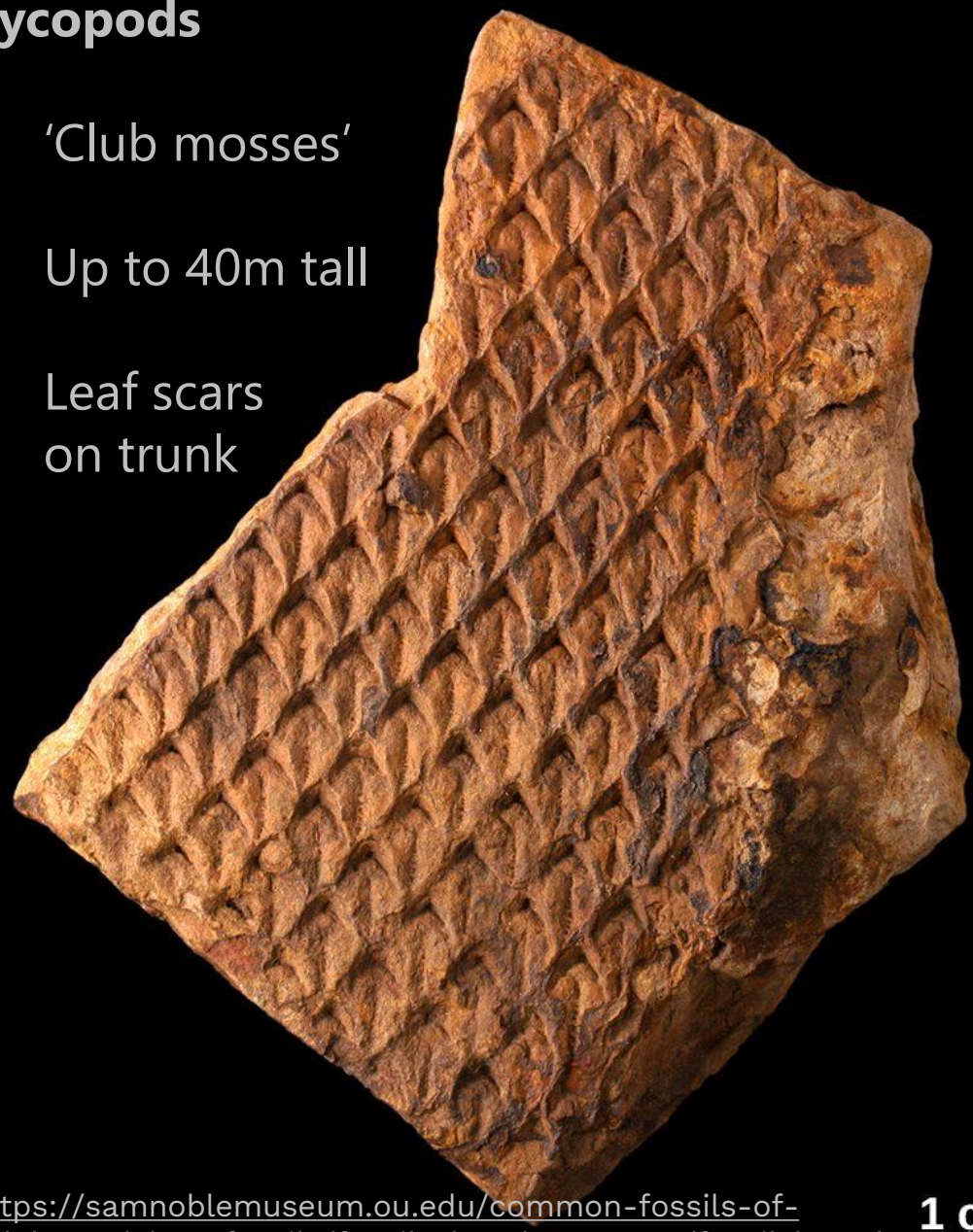
- Seed plant with straplike leaves, increasing in width towards tip, veins parallel to length
- Primitive trees: no modern descendants





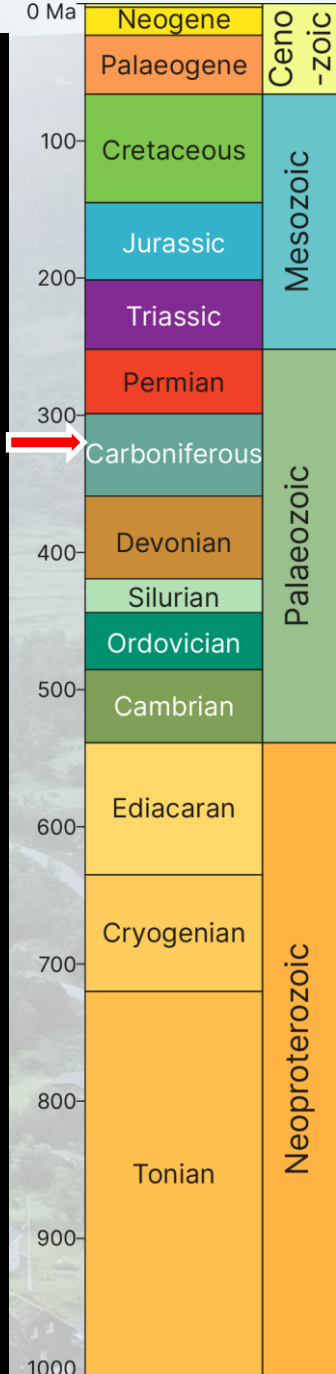
Lycopods

- 'Club mosses'
- Up to 40m tall
- Leaf scars on trunk



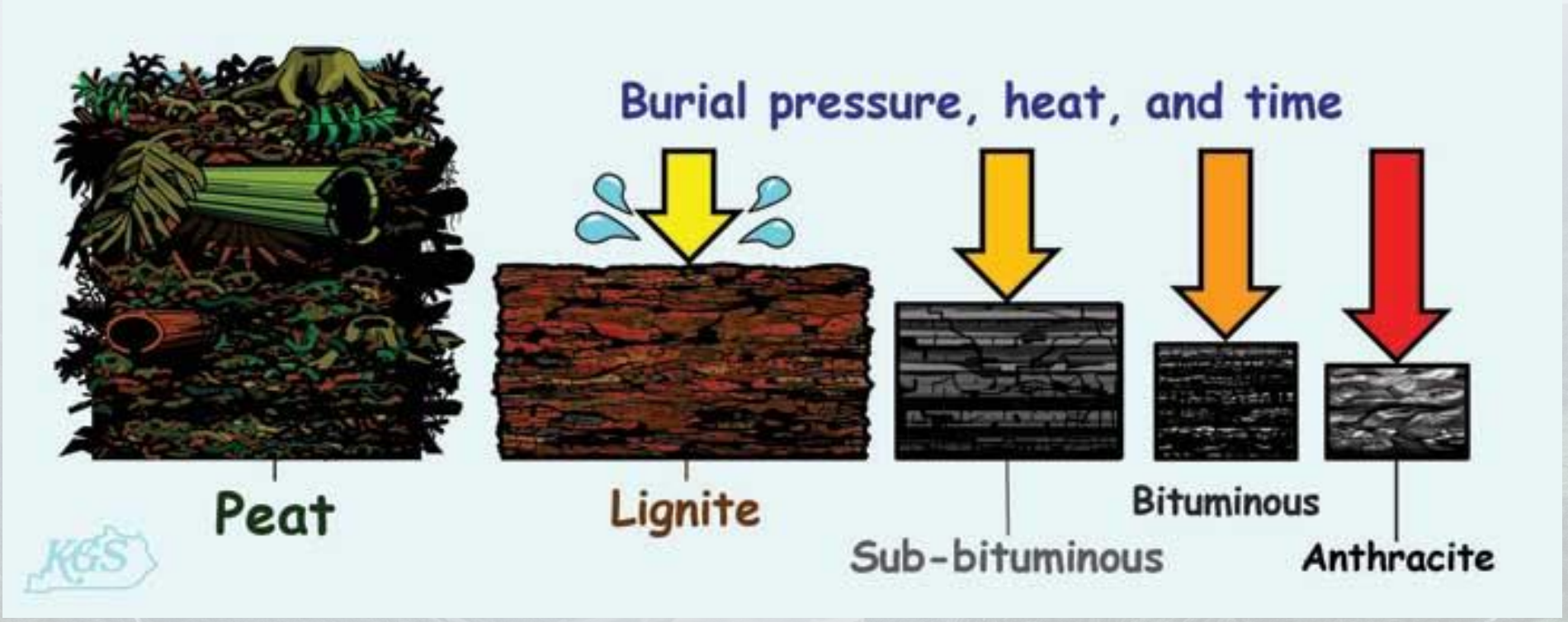
https://samnoblemuseum.ou.edu/common-fossils-of-oklahoma/plant-fossils/fossils-by-plant-group/fossil-lycophytes/

1 cm



Jean Lafitte National Historical Park, Louisiana, USA http://featherbyfeather.com/2013/03/26/swamp-things/

http://www.littlebitofblue.com/2011/05/bog.html

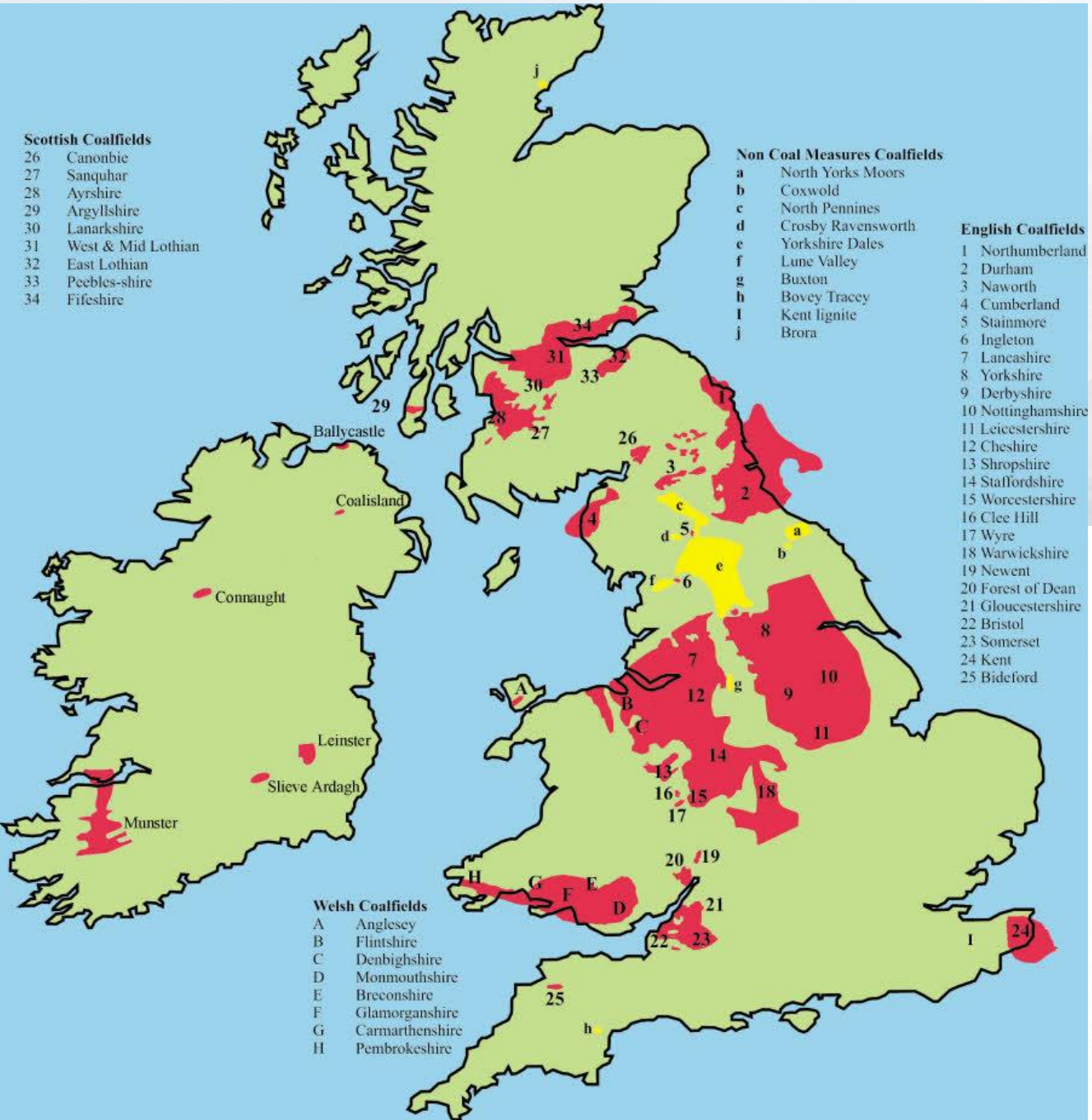


Peat/turf

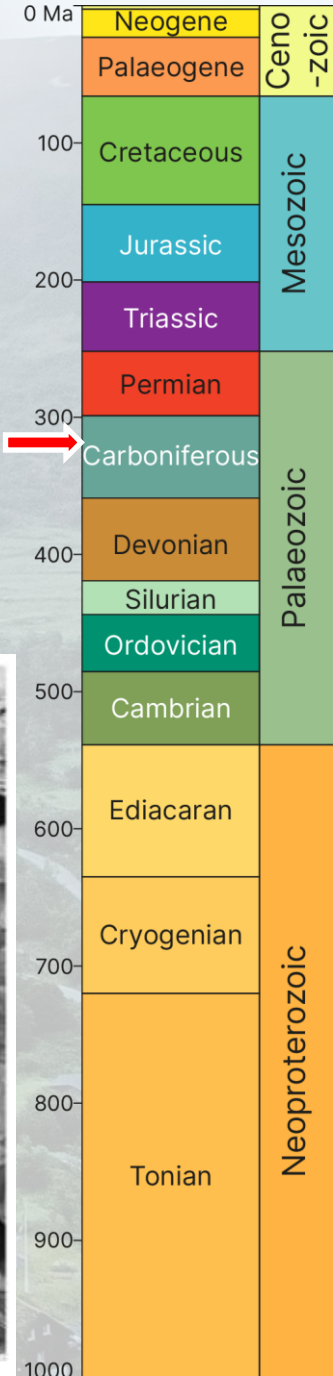
Lignite

Bituminous coal

Anthracite

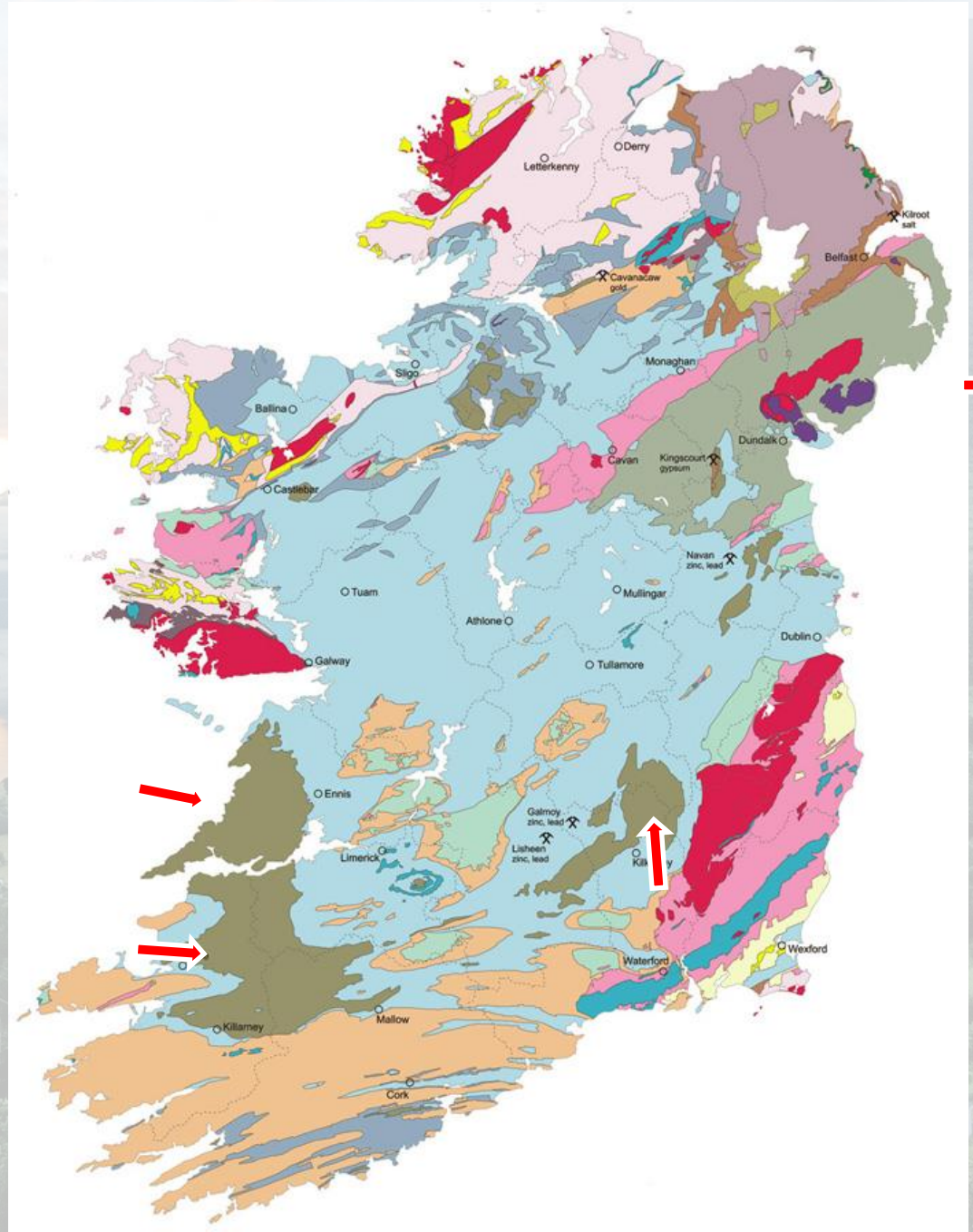


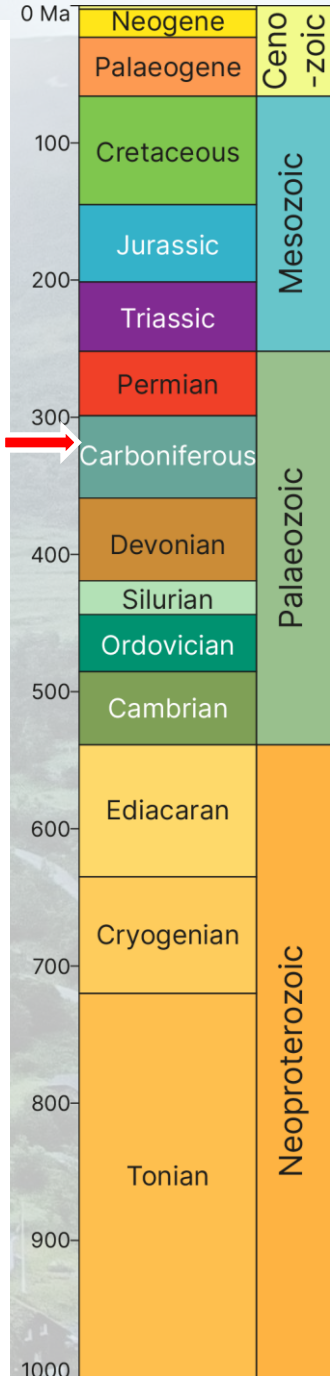
Irish coalfields have thin coal seams, which are relatively uneconomic to work



Tropical Ireland | *Middle Carboniferous*

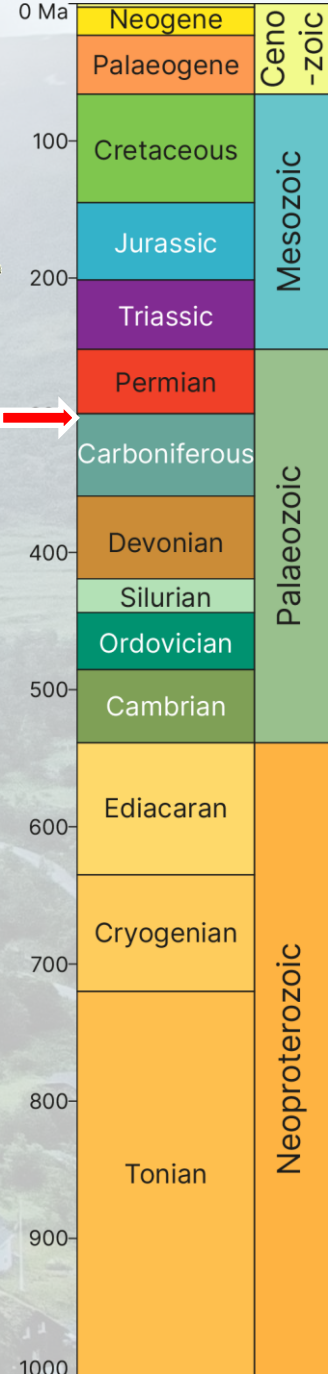
GY4051





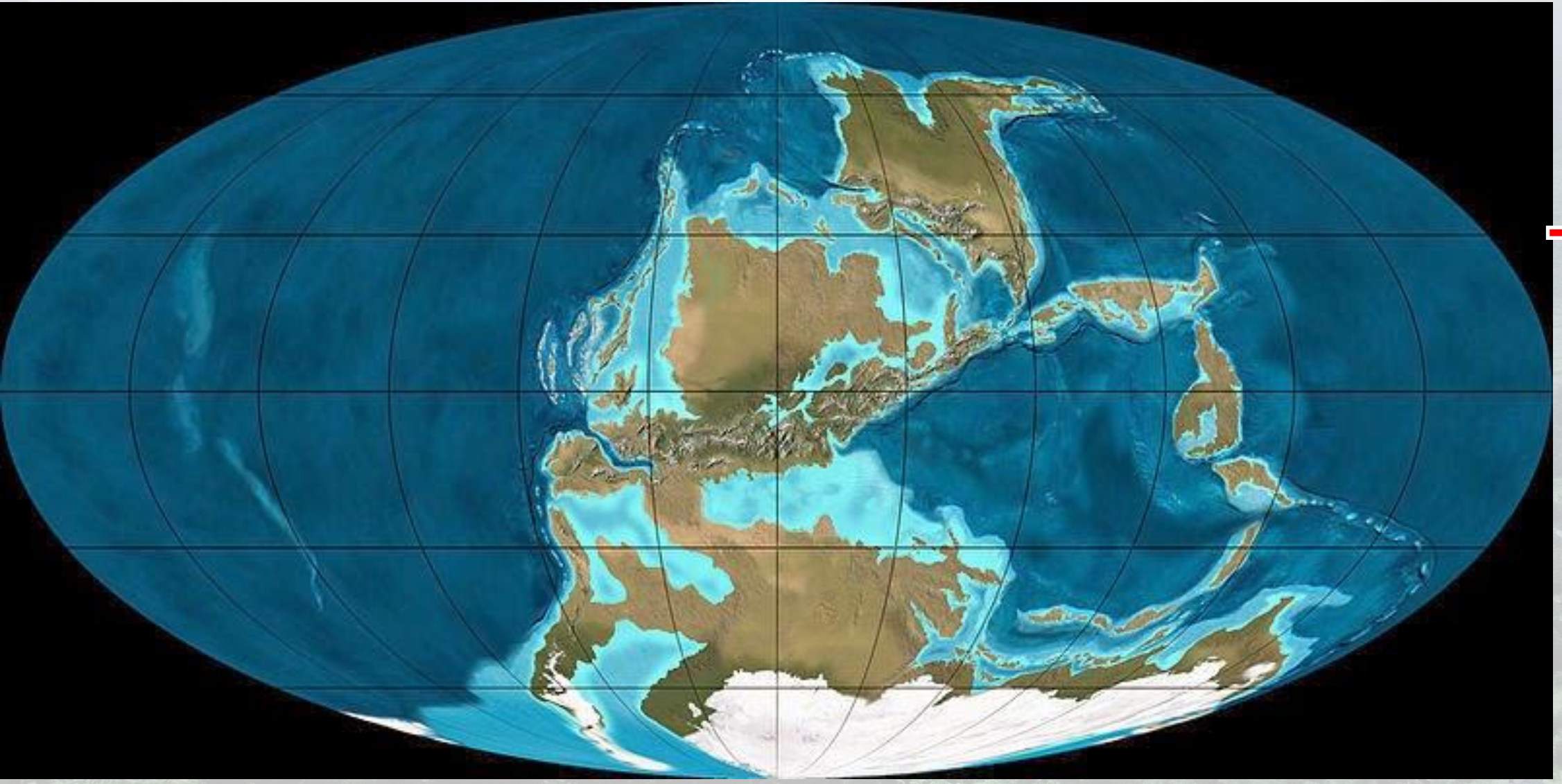
Tropical Ireland | *Carboniferous Rainforest Collapse*

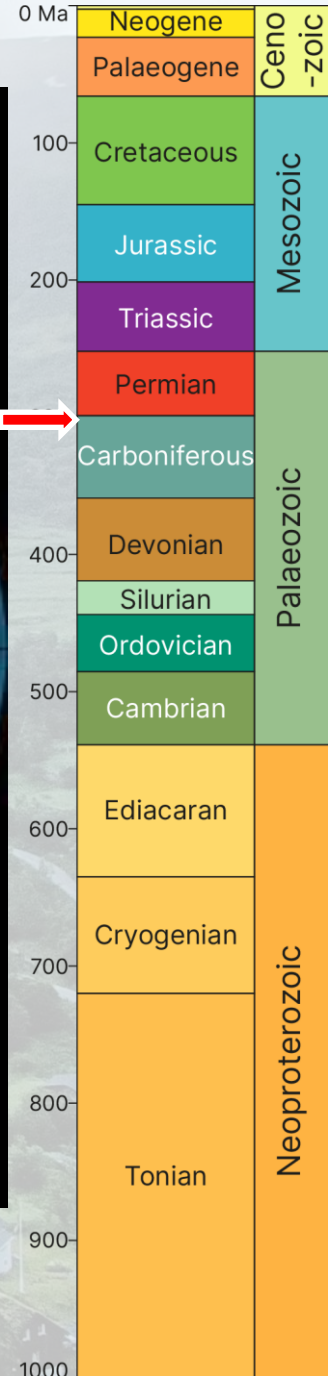
GY4051

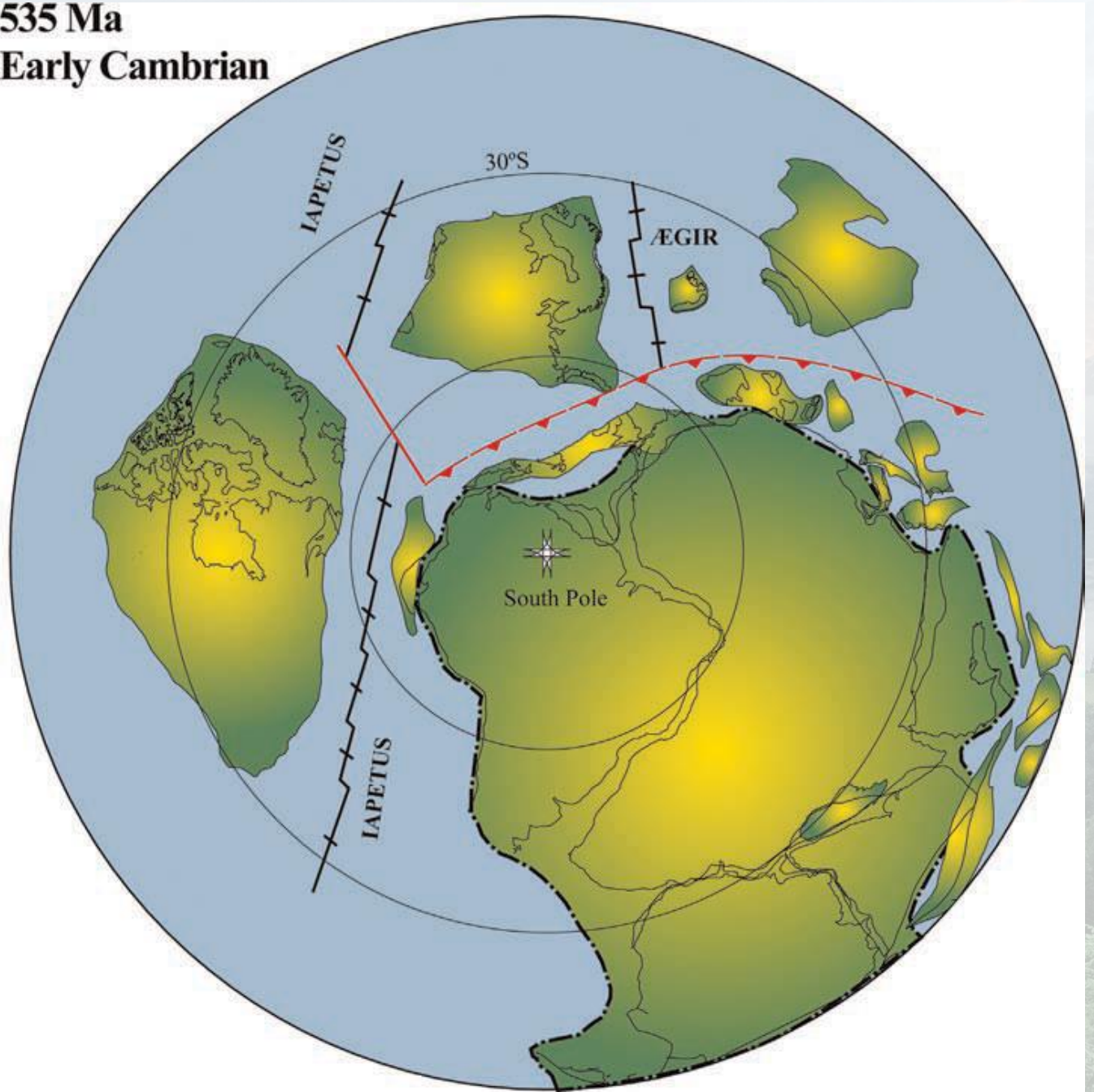


Tropical Ireland | *Carboniferous Glaciation*

GY4051

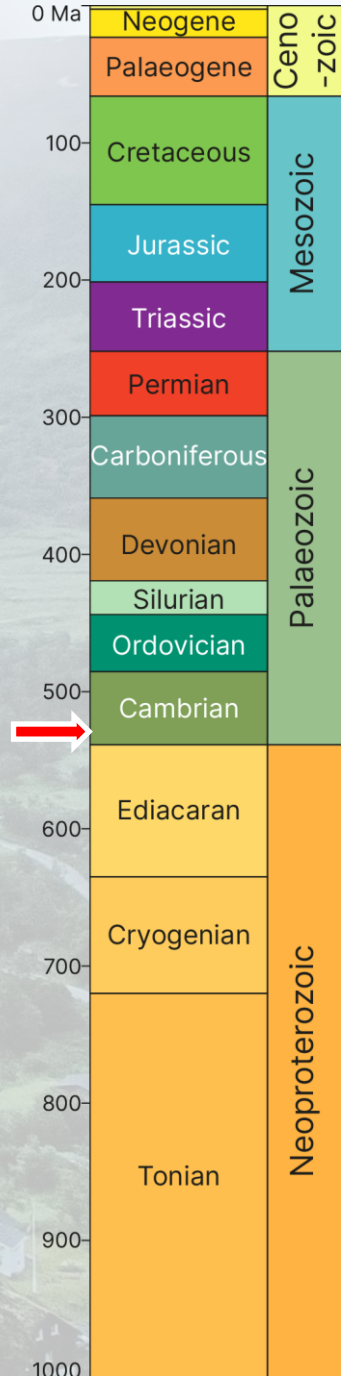


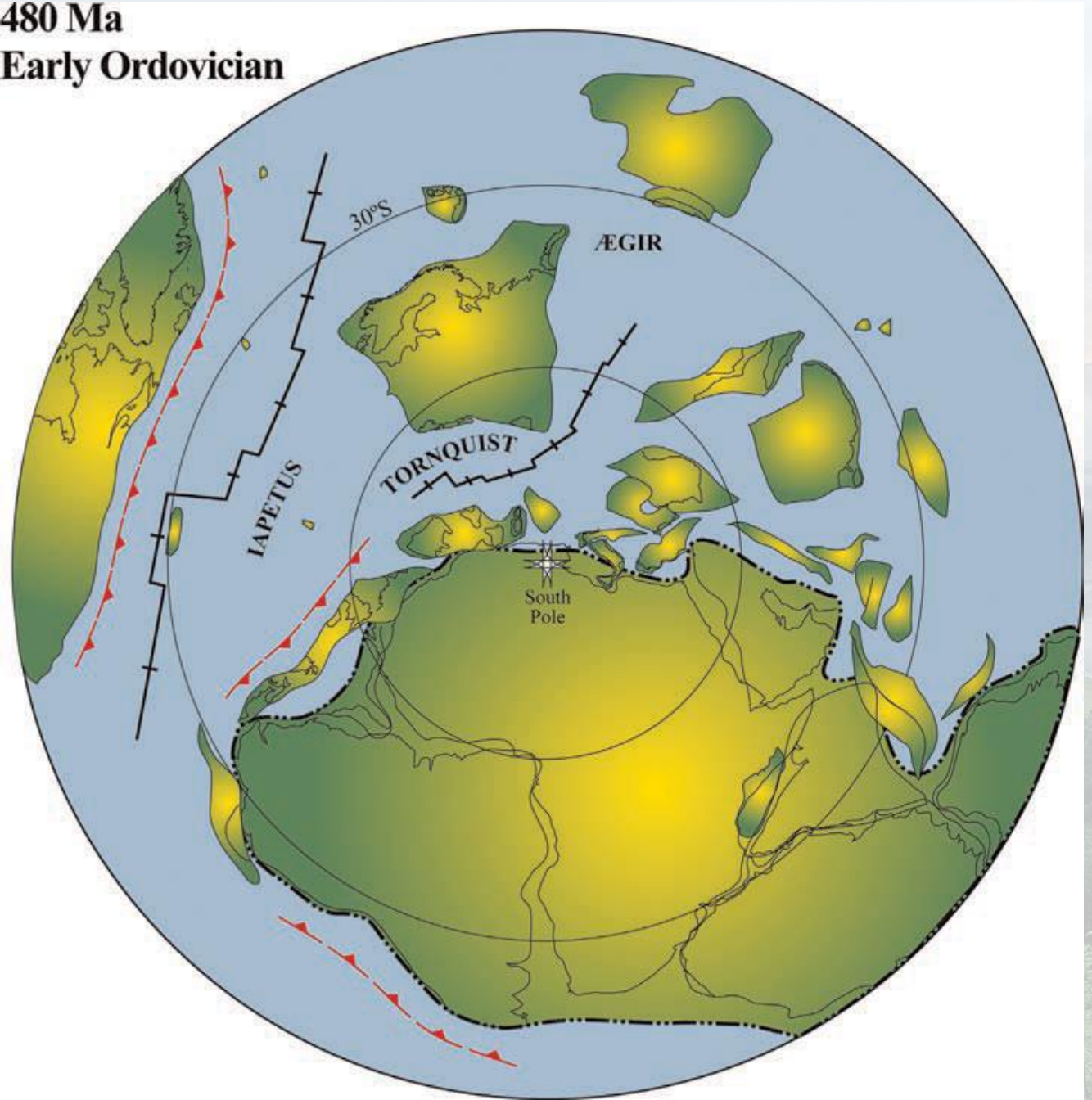




Rifting of Rodinia

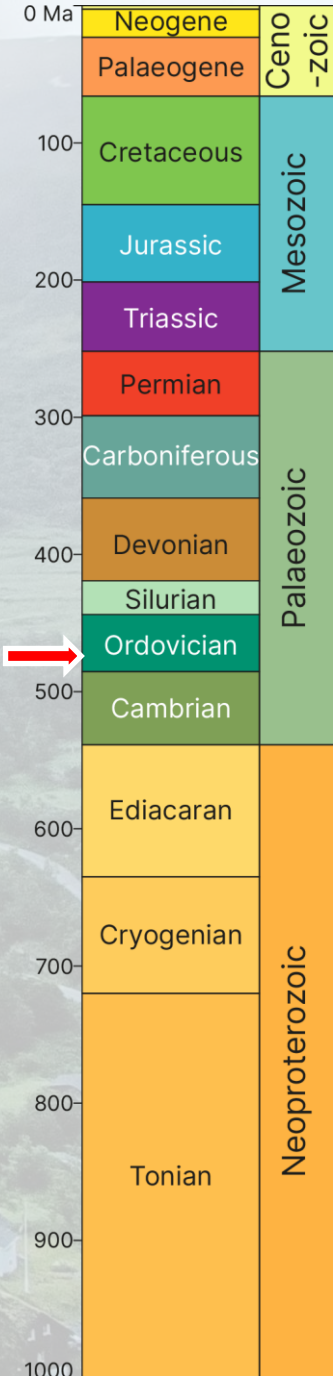
- Iapetus Ocean opening
- Northern Britain and Ireland part of Laurentia
- Southern Britain and Ireland still part of Gondwana

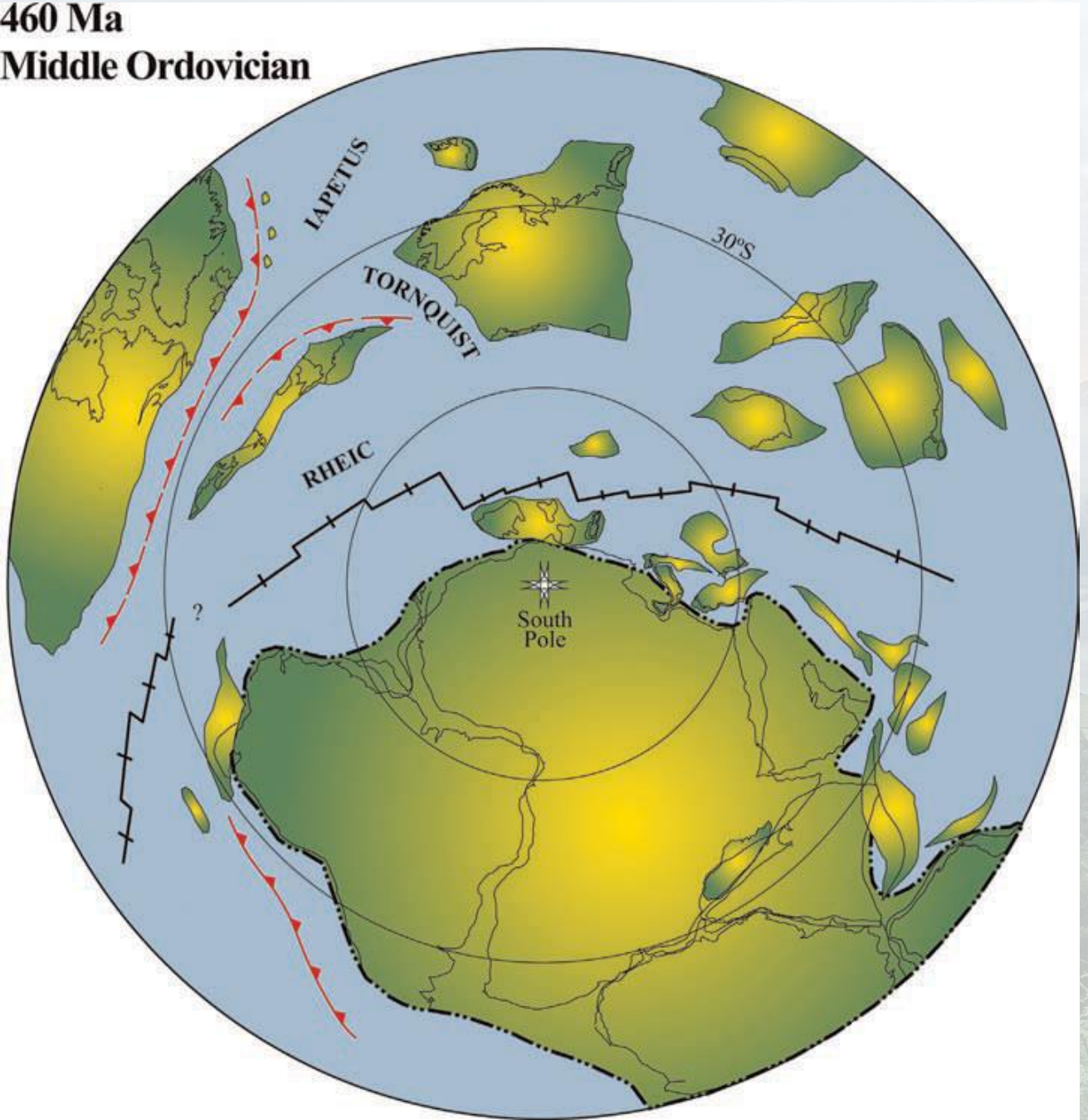




Iapetus Ocean starts to close

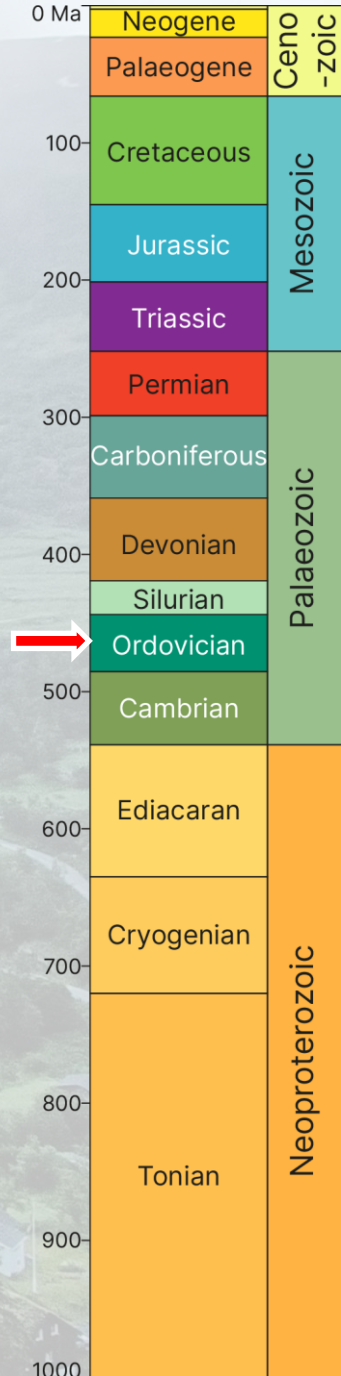
- Southern Britain and Ireland starts to rift from Gondwana
- Becomes microcontinent of Avalonia

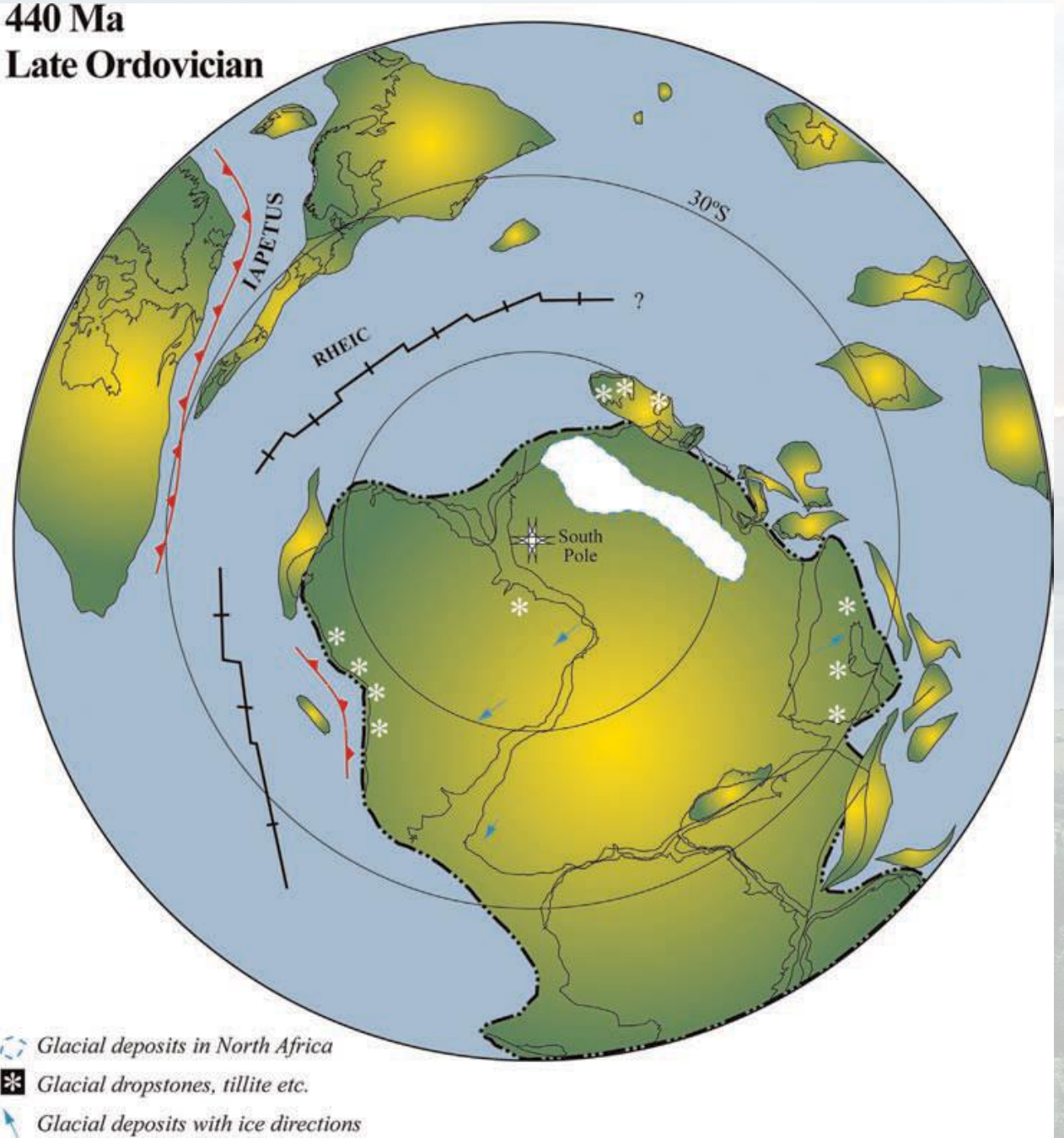




Iapetus Ocean continues to close

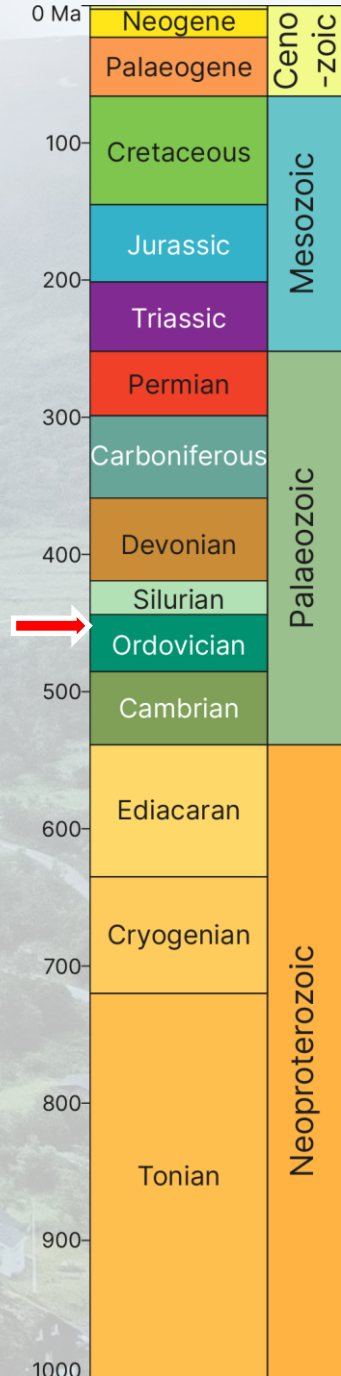
- Rheic Ocean opening between Avalonia and Gondwana
- Avalonia moving north towards Laurentia as Iapetus narrows

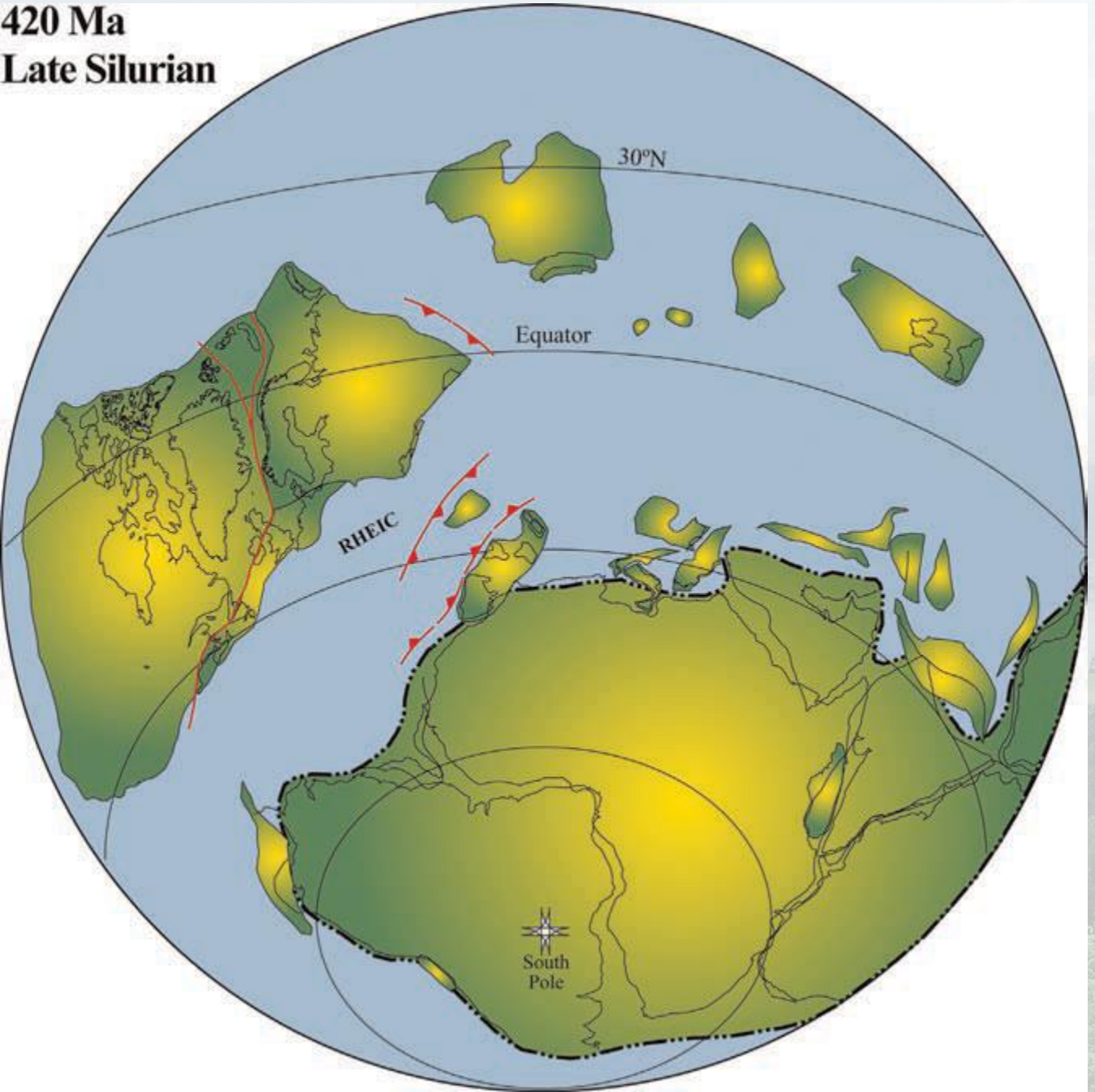




Iapetus Ocean nears the end

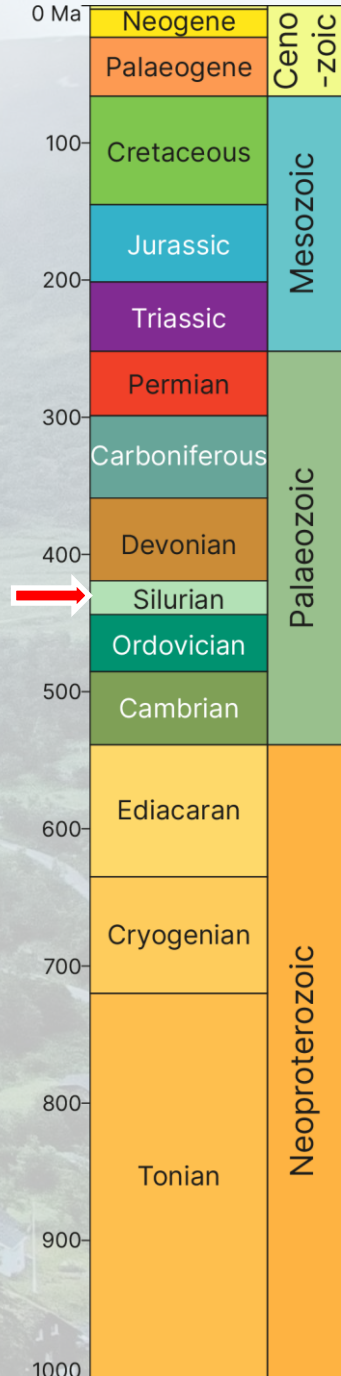
- Two halves of Britain and Ireland very close
- Baltica starts to collide with Eastern Avalonia
- Rheic Ocean widening

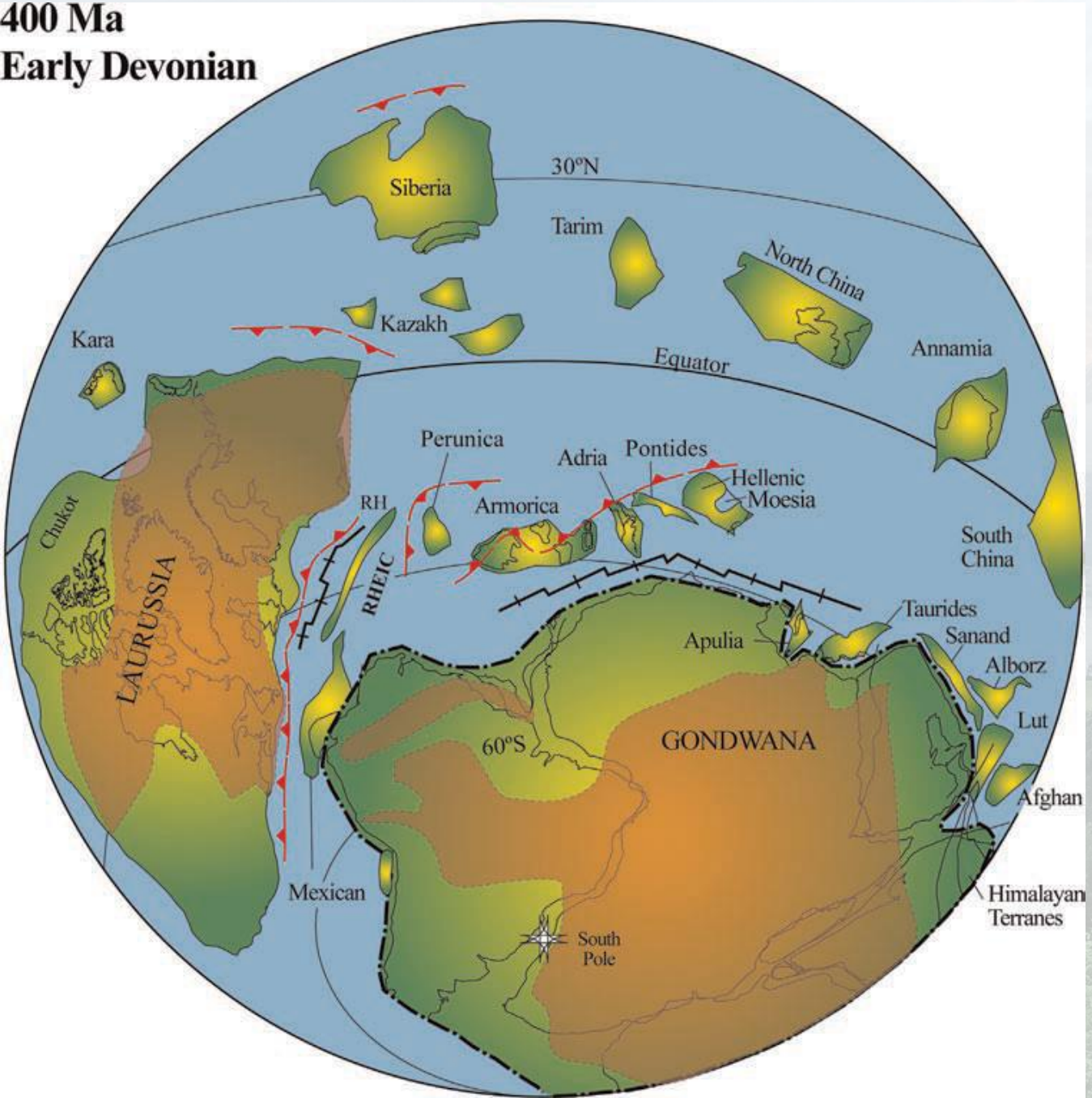




Iapetus Ocean is gone

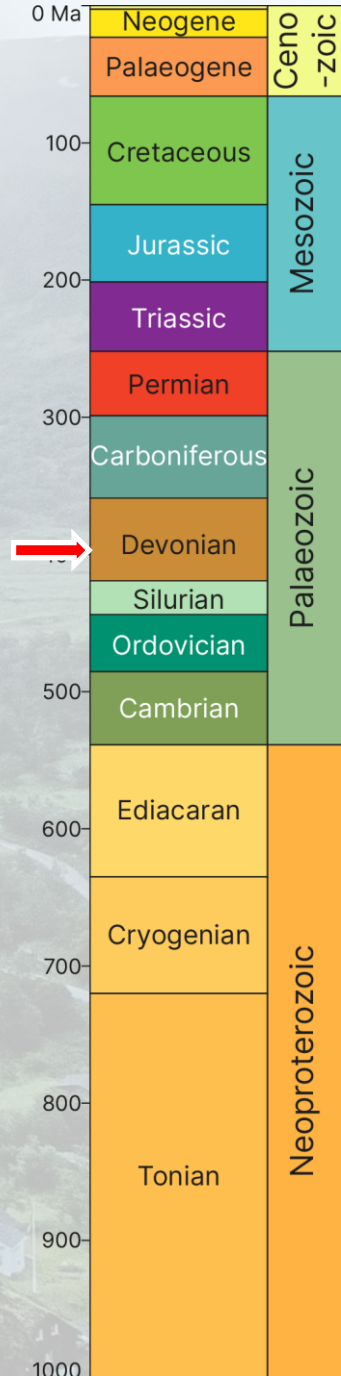
- Avalonia has collided with Laurentia and Baltica in the Caledonian Orogeny
- Continent of Laurussia
- Britain and Ireland joined, separated from Gondwana by the Rheic Ocean

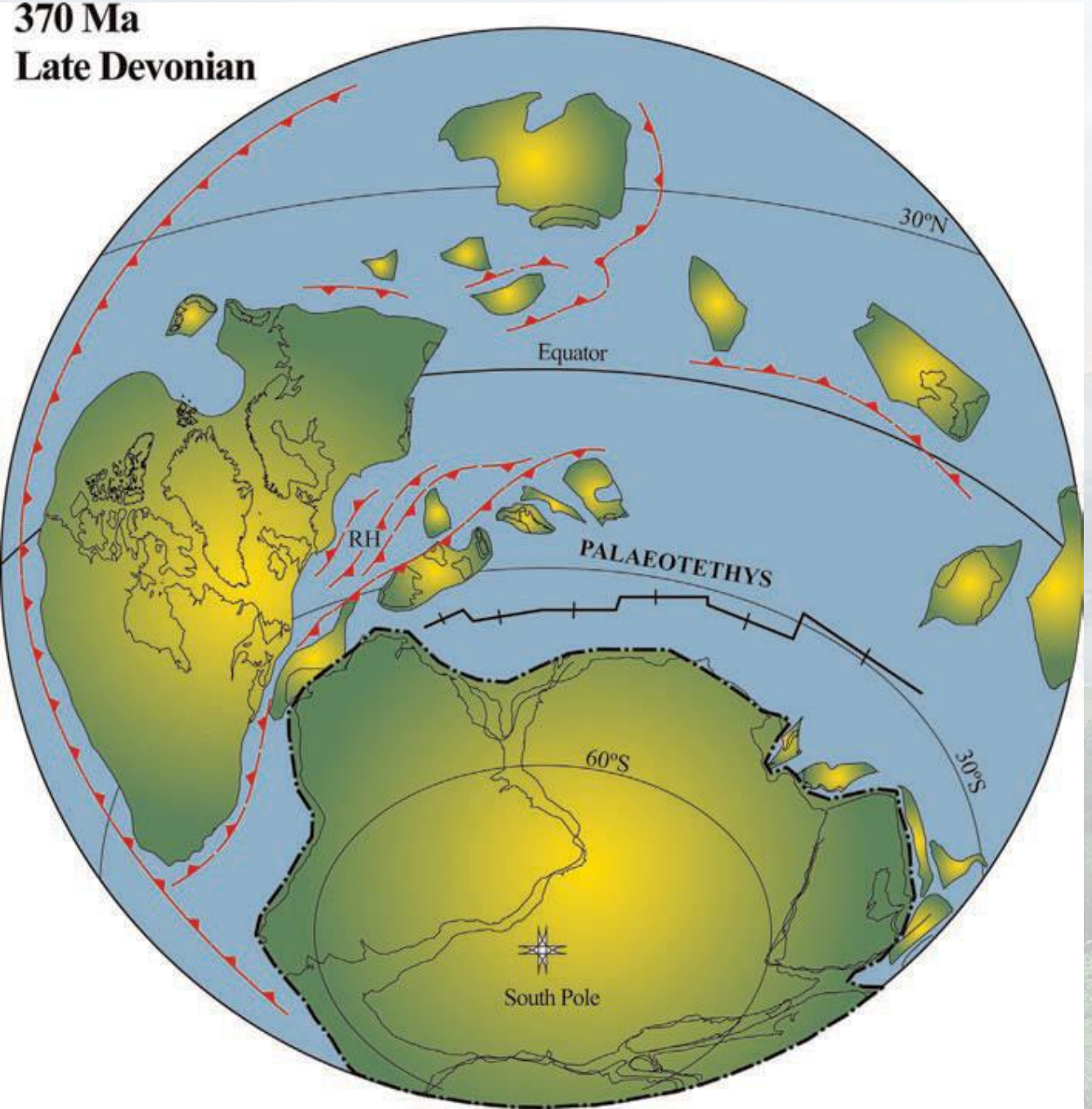




Rheic Ocean closing

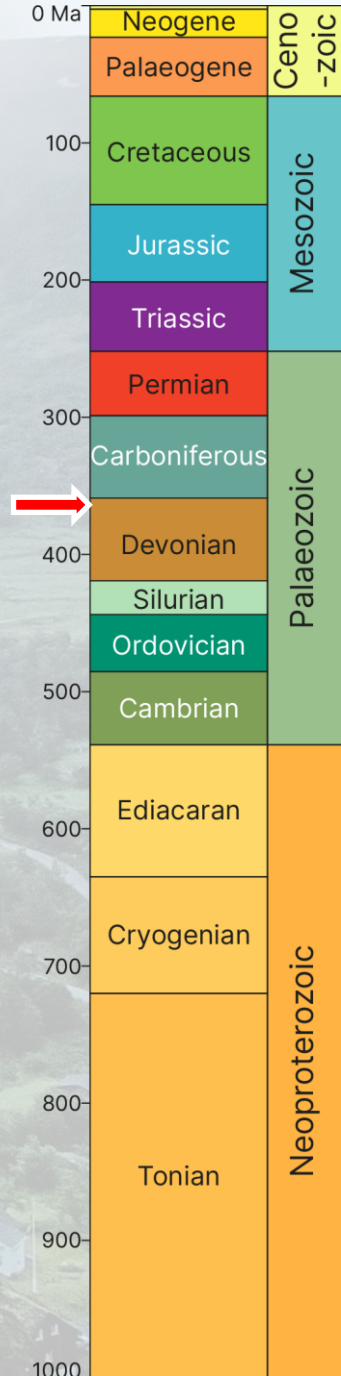
- Laurussia – the Old Red Sandstone Continent – mostly emergent
- Southernmost Britain and Ireland on the continental margin
- European microcontinents rifting from Gonwana as the Tethys Ocean opens

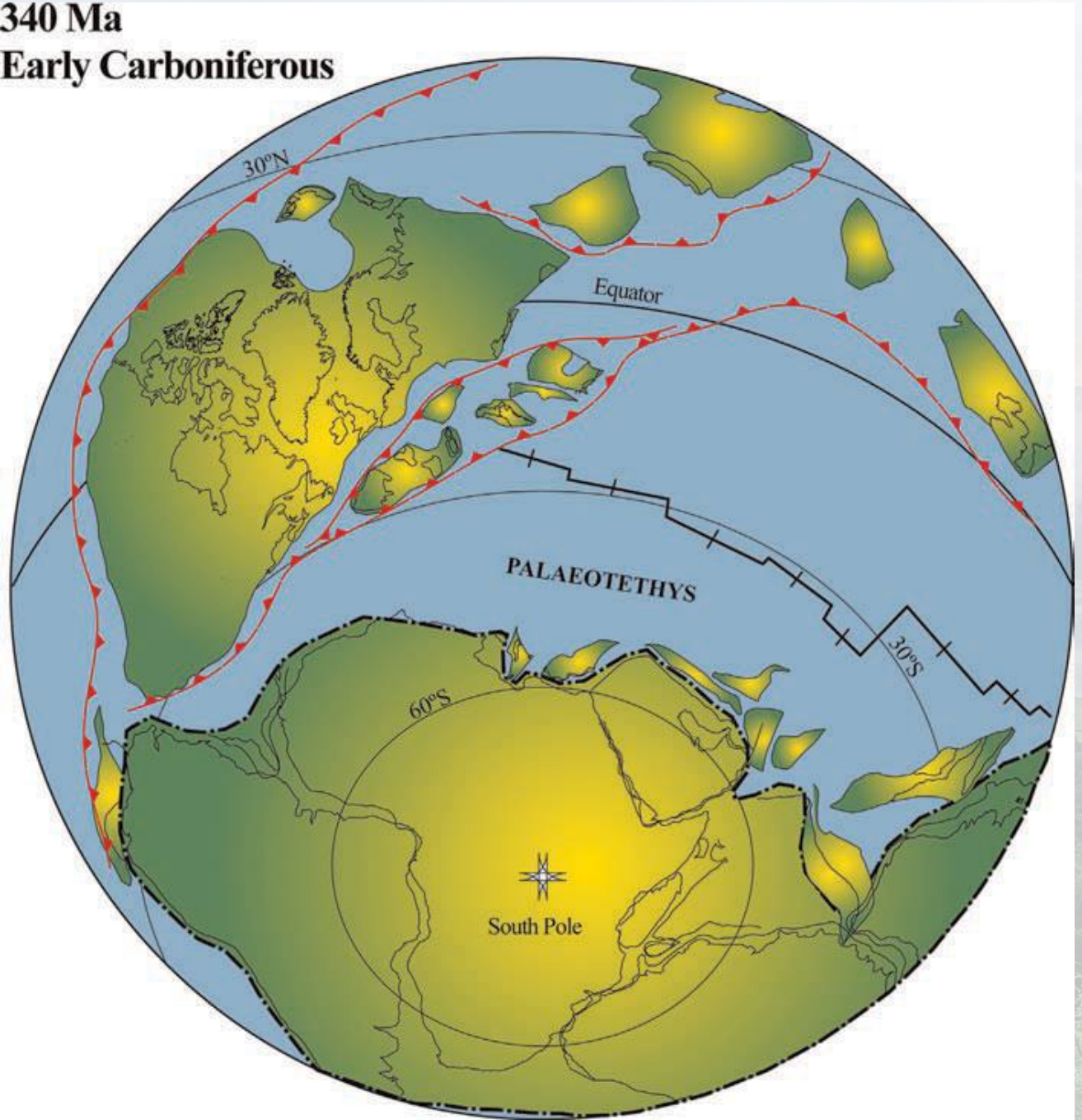




Tethys Ocean continues to open

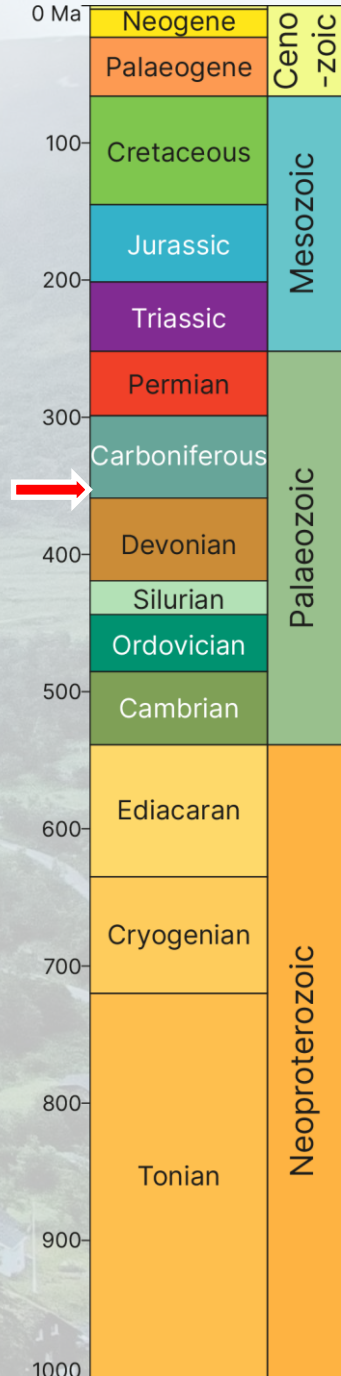
- Rheic Ocean is nearly gone
- European microcontinents approaching Britain and Ireland

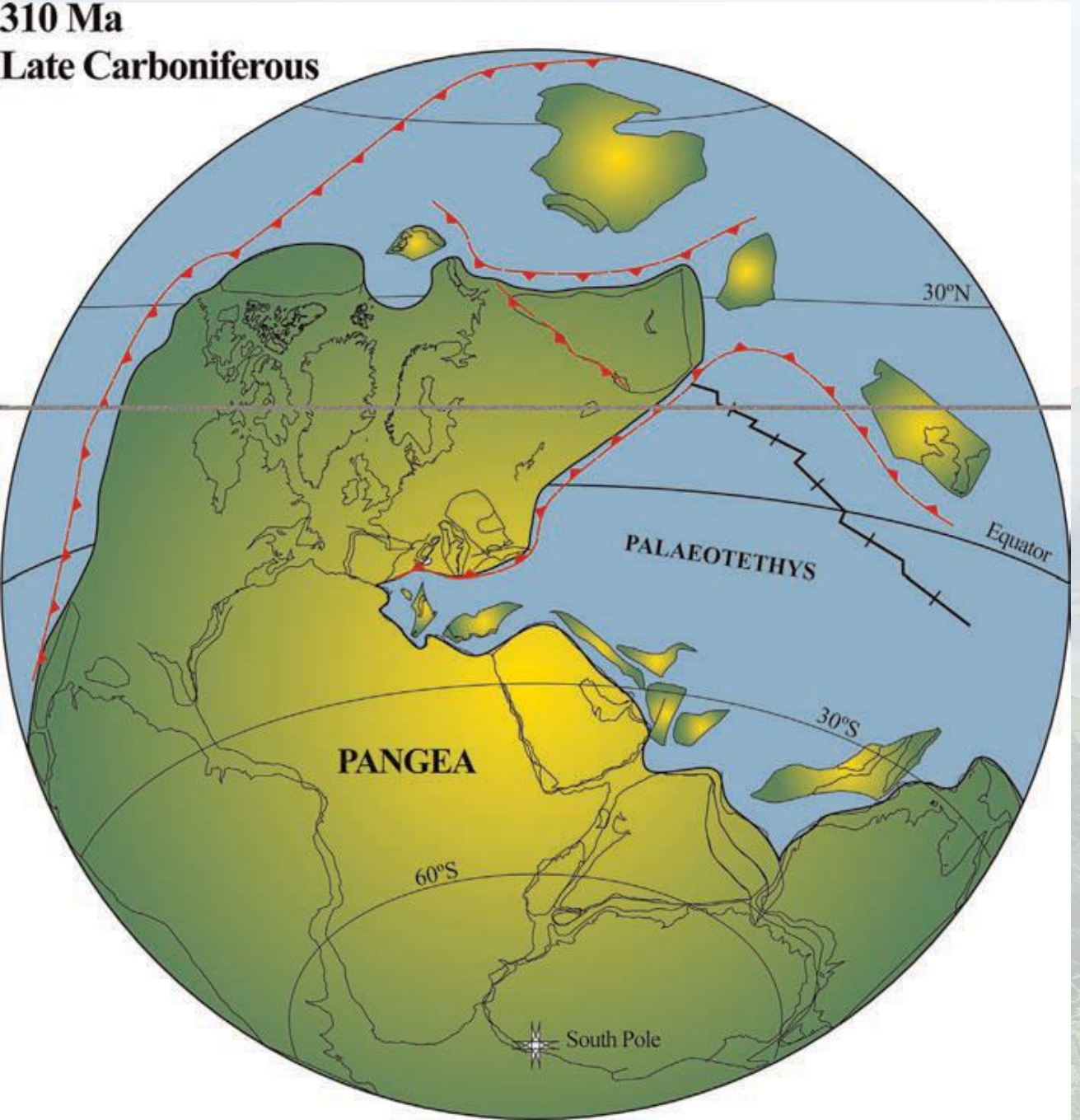




Rheic Ocean almost closed

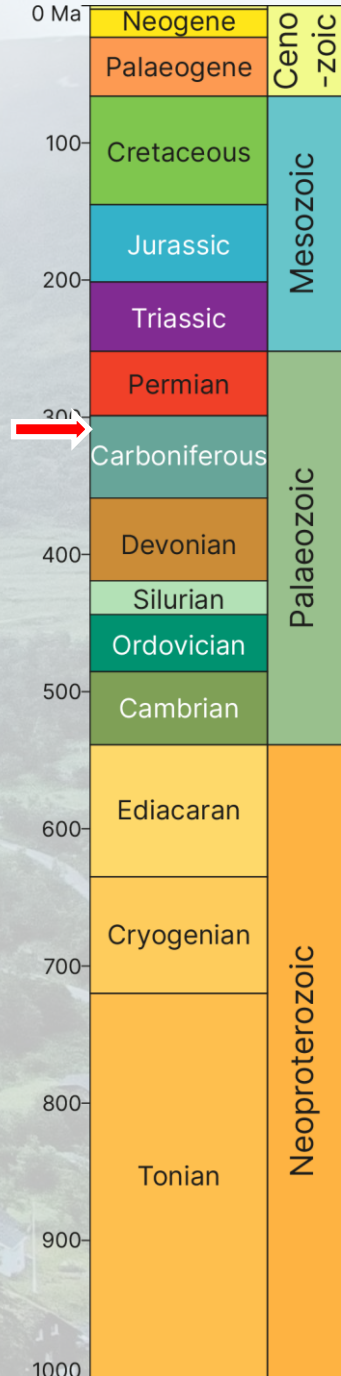
- Tethys Ocean very wide
- Britain and Ireland tropical
- Gondwana closing on Laurussia

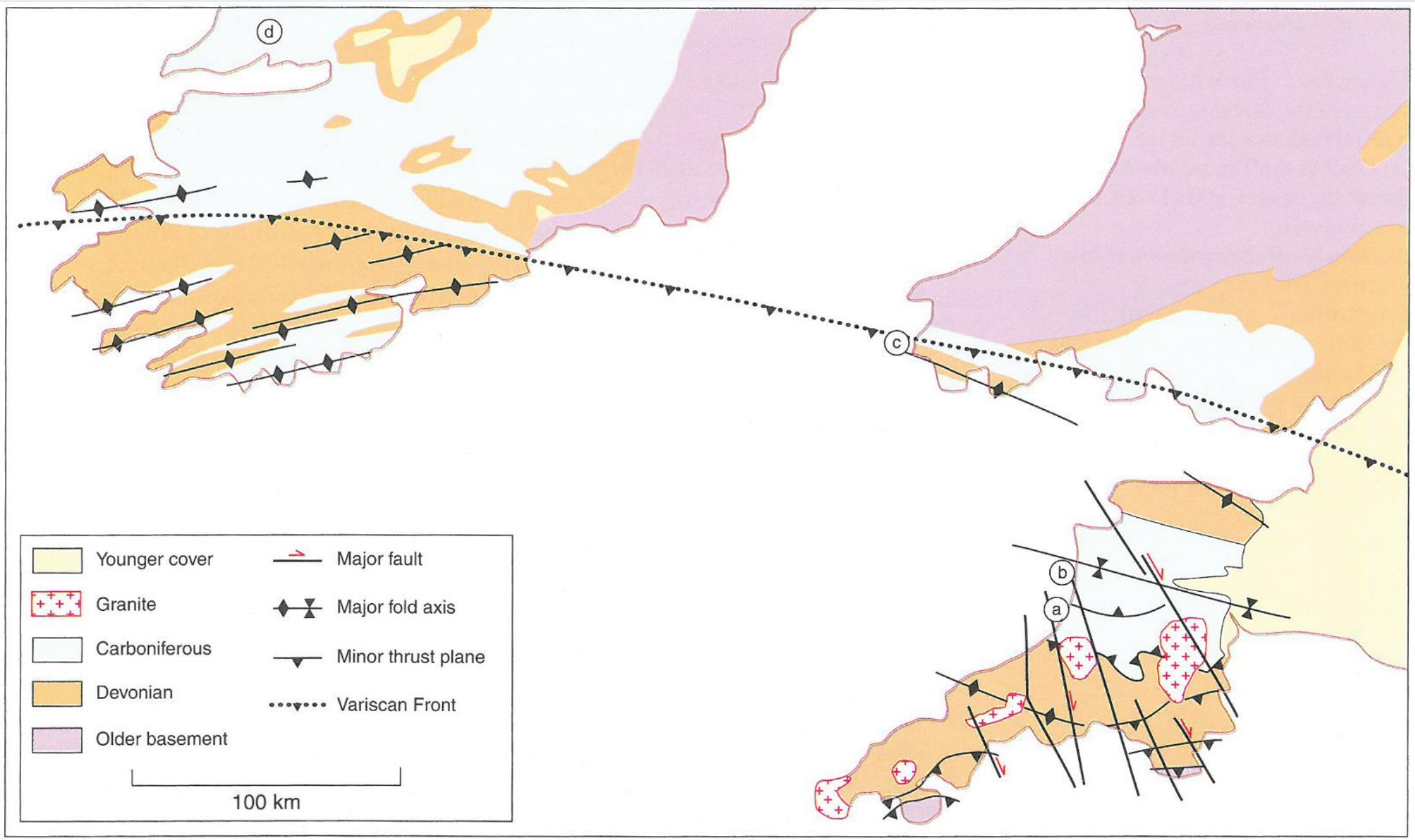


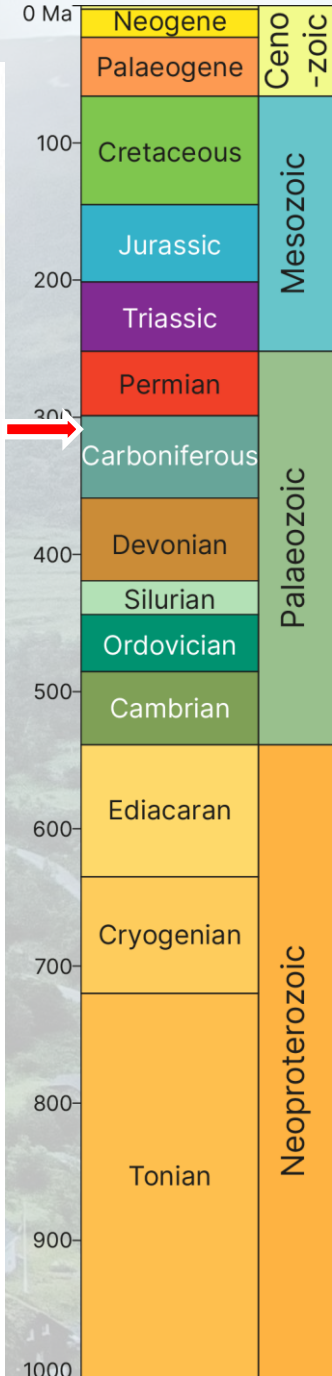


Variscan Orogeny

- Gondwana collided with Laurussia
- European microcontinents collided with Laurussia
- Supercontinent of Pangaea




d
c
b
a
Younger cover
Granite
Carboniferous
Devonian
Older basement
Major fault
Major fold axis
Minor thrust plane
Variscan Front
100 km


0 Ma
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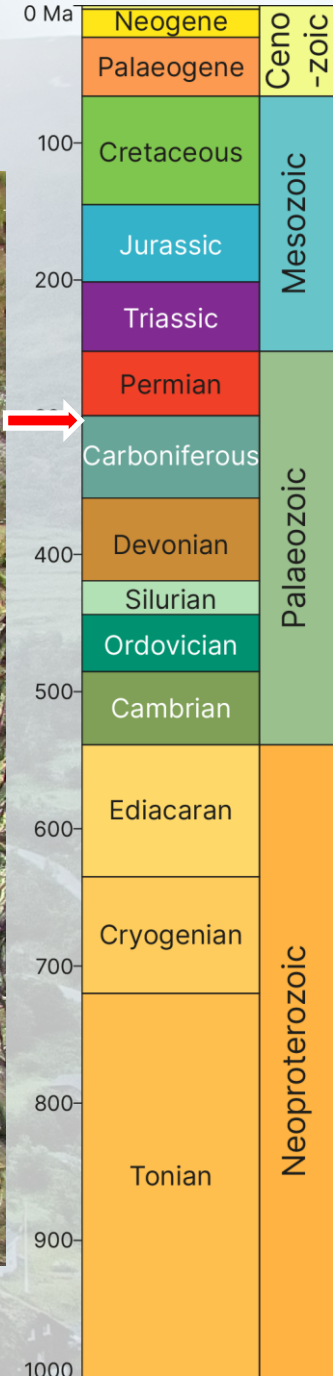
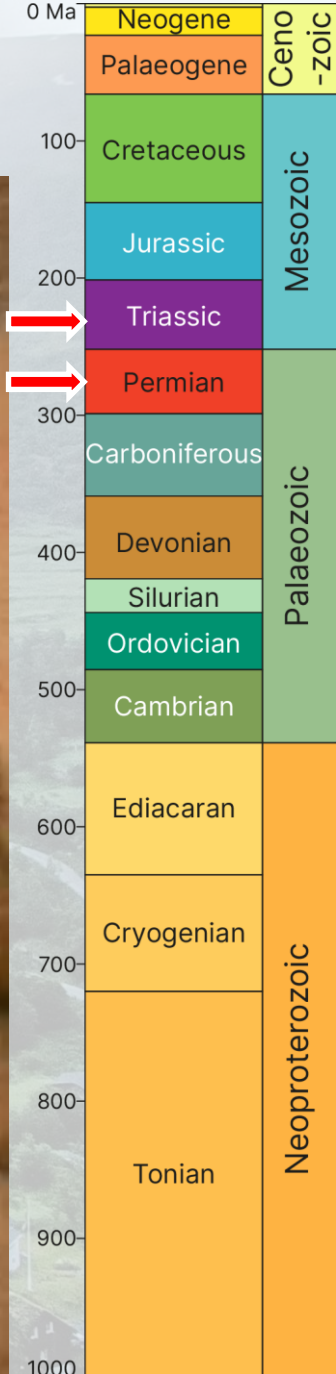
1000
Neogene
Palaeogene
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Ediacaran
Cryogenian
Tonian
Ceno -zoic
Mesozoic
Palaeozoic
Neoproterozoic

Folded Limestones | *Loughshinny, Co. Dublin*

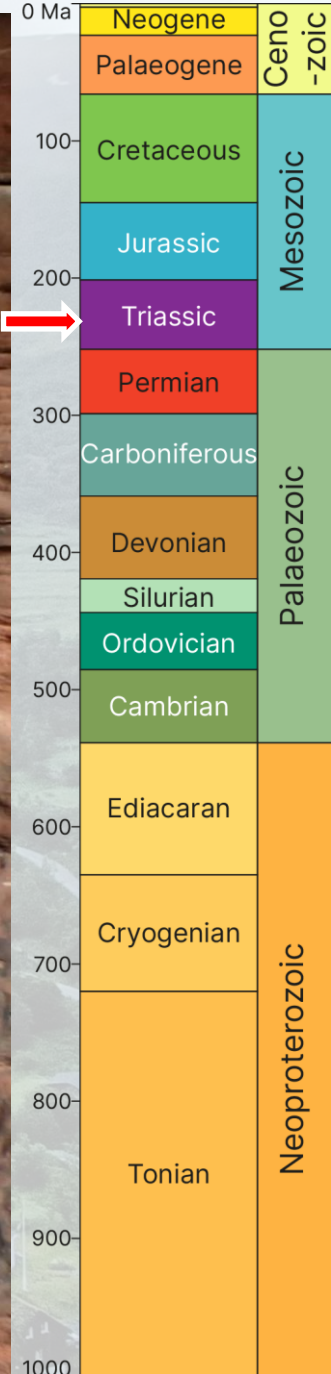


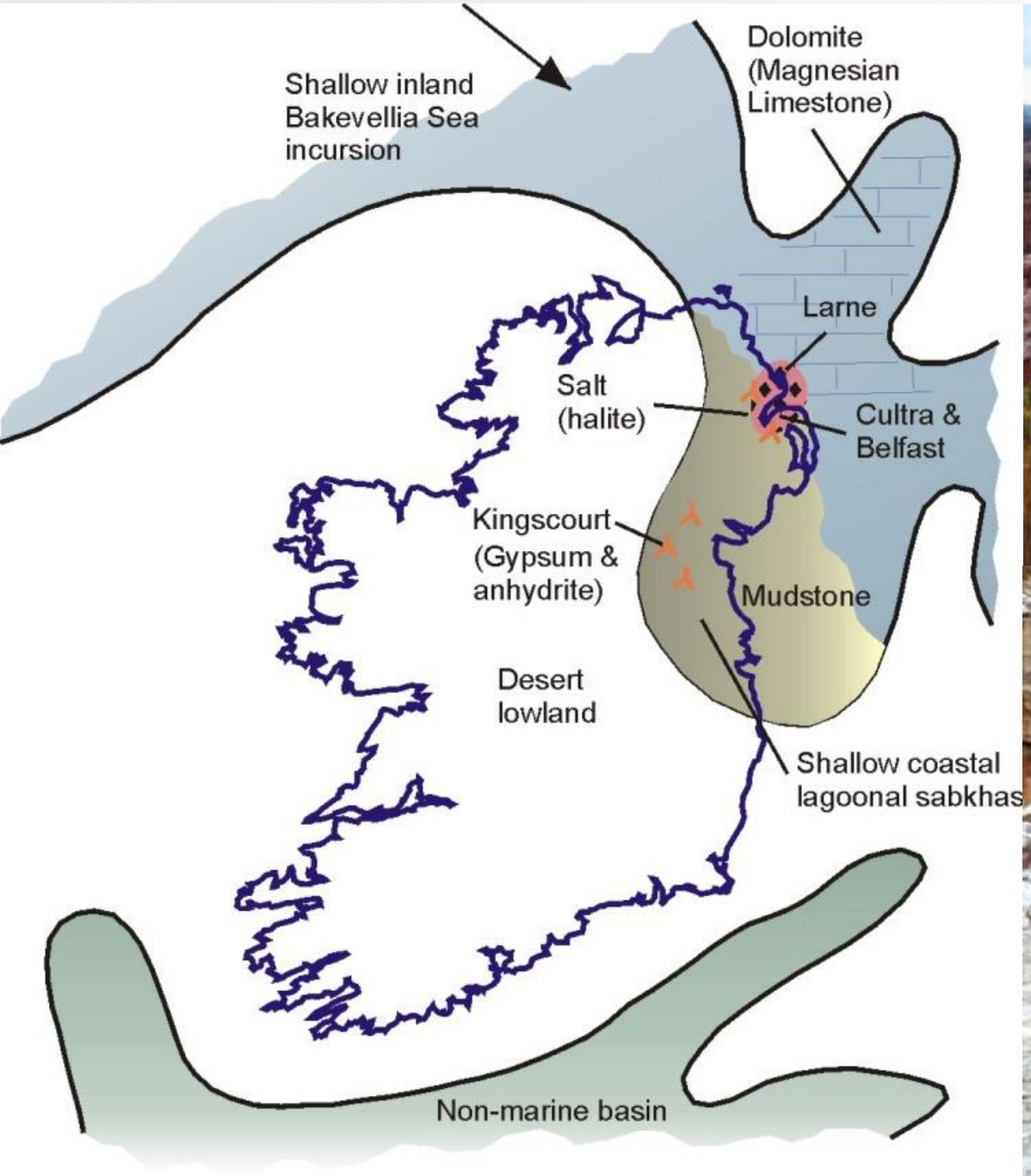
Desert sandstone | *Belfast, Co. Antrim*

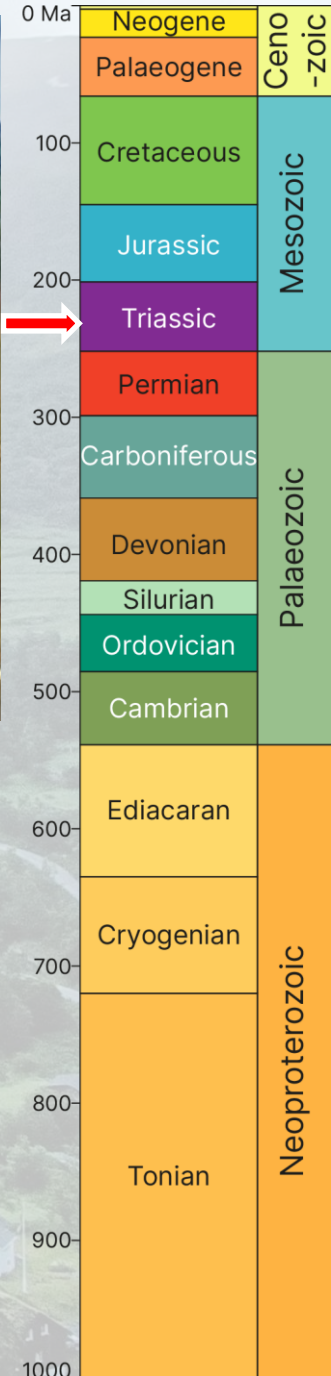


Desert sandstone | *Merseyside, England*

K

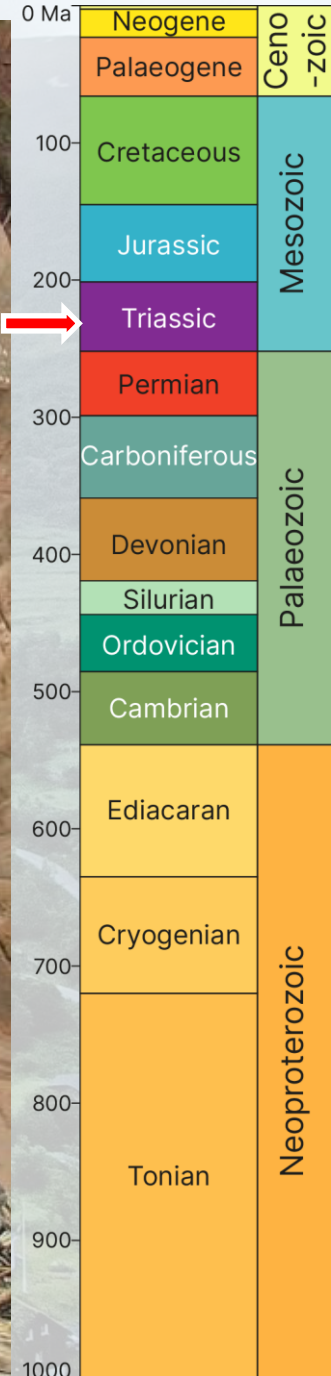



Shallow inland
Bakevellia Sea
incursion
Dolomite
(Magnesian
Limestone)
Larne
Salt
(halite)
Cultra &
Belfast
Kingscourt
(Gypsum &
anhydrite)
Mudstone
Desert
lowland
Shallow coastal
lagoonal sabkhas
Non-marine basin

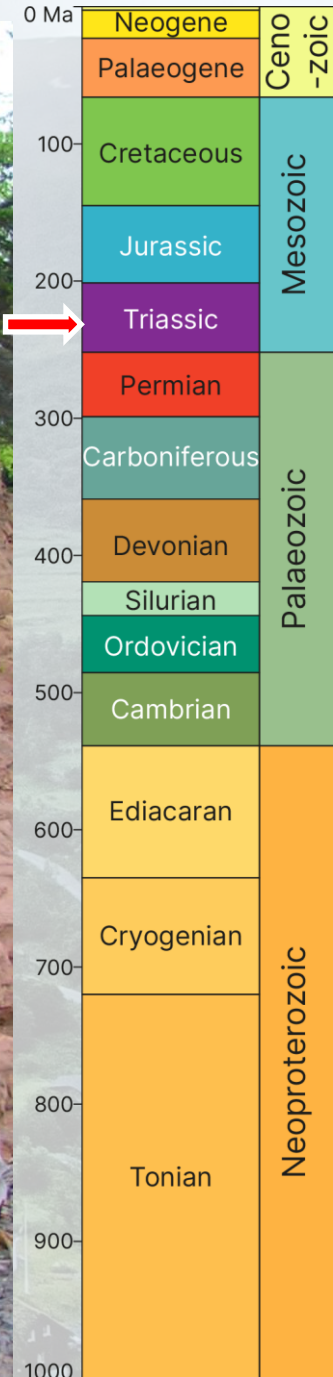

0 Ma
Neogene
Palaeogene
Ceno
-zoic
100
Cretaceous
Jurassic
200
Triassic
Mesozoic
Permian
300
Carboniferous
Devonian
400
Silurian
Ordovician
500
Cambrian
Palaeozoic
Ediacaran
600
Cryogenian
700
Tonian
800
900
1000
Neoproterozoic


SPREADING
ROMAQUIP

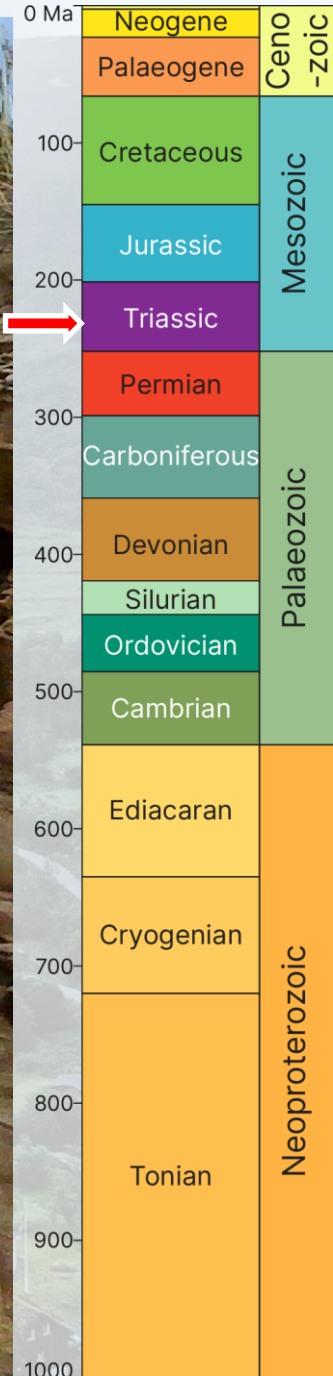
Desert sandstone | *Bay of Fundy, Nova Scotia, Canada*



Desert sandstone | *Bay of Fundy, Nova Scotia, Canada*



Desert sandstone | *Scotland*



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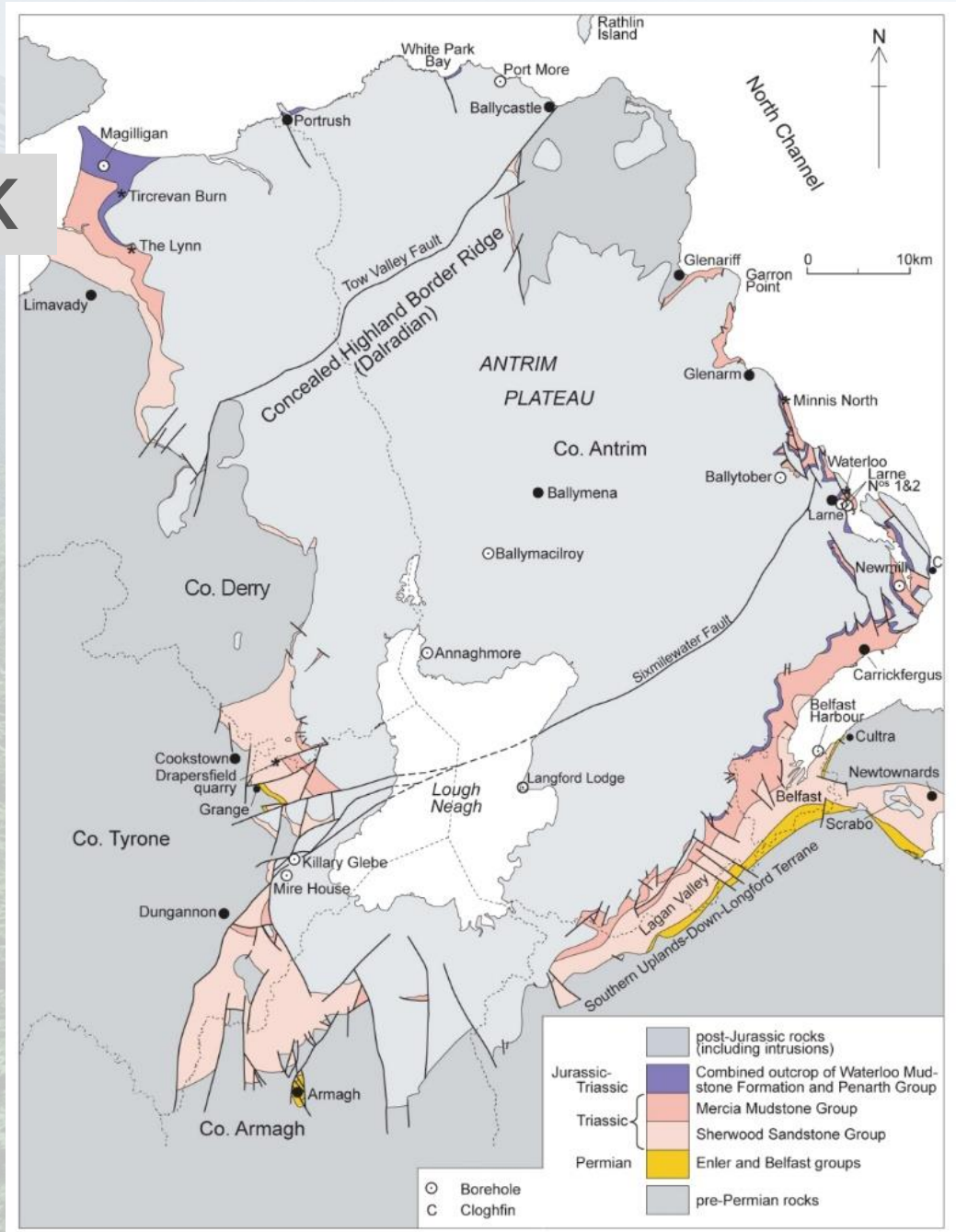
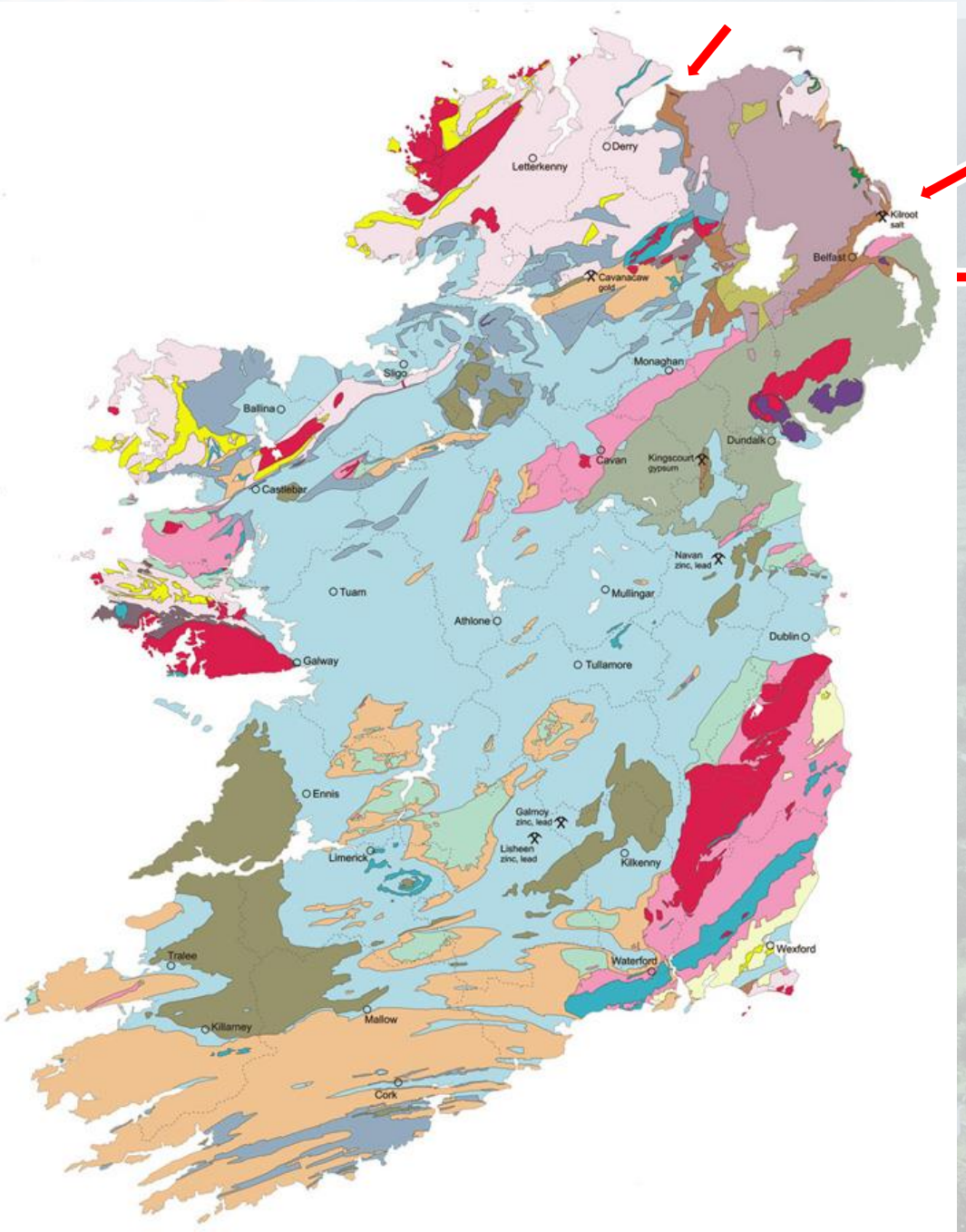
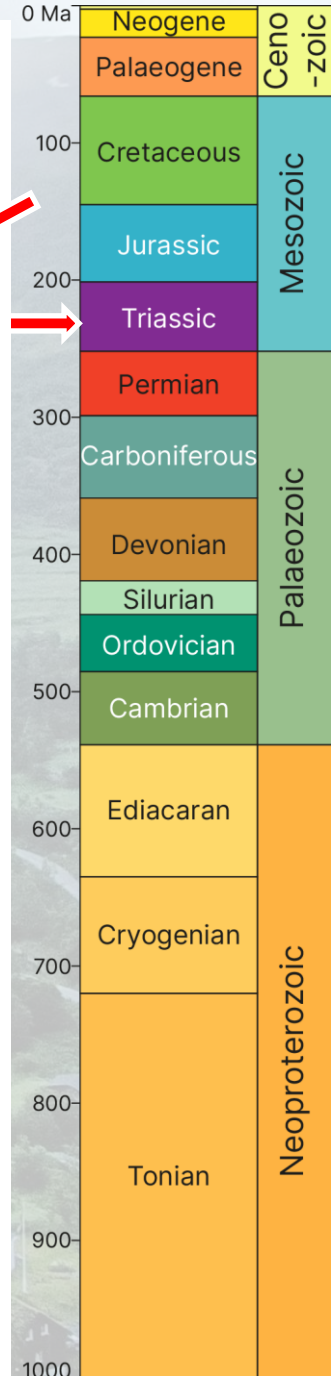

Rathlin Island
White Park Bay
Port More
Ballycastle
Portrush
Magilligan
Tircrevan Burn
The Lynn
Limavady
Tow Valley Fault
Concealed Highland Border Ridge (Dalradian)
North Channel
N
0
10km
Glenariff
Garron Point
ANTRIM PLATEAU
Co. Antrim
Glenarm
Minnis North
Waterloo
Larne Nos 1&2
Ballytober
Larne
Ballymena
Ballymacilroy
Co. Derry
Newmill
Annaghmore
Sixmilewater Fault
Carrickfergus
Belfast Harbour
Cultra
Newtownards
Belfast
Scrabo
Cookstown
Drapersfield quarry
Grange
Langford Lodge
Lough Neagh
Co. Tyrone
Killary Glebe
Mire House
Dungannon
Lagan Valley
Southern Uplands-Down-Longford Terrane
Armagh
Co. Armagh
post-Jurassic rocks (including intrusions)
Jurassic-Triassic
Combined outcrop of Waterloo Mudstone Formation and Penarth Group
Triassic
Mercia Mudstone Group
Sherwood Sandstone Group
Permian
Enler and Belfast groups
pre-Permian rocks
Borehole
C Cloghfin


Letterkenny
Derry
Kilroot salt
Belfast
Cavanacaw gold
Sligo
Monaghan
Ballina
Dundalk
Cavan
Kingscourt gypsum
Castlebar
Navan zinc, lead
Tuam
Mullingar
Athlone
Dublin
Galway
Tullamore
Ennis
Galmoy zinc, lead
Lisheen zinc, lead
Limerick
Kilkenny
Tralee
Waterford
Wexford
Killarney
Mallow
Cork


0 Ma
Neogene
Palaeogene
Ceno-zoic
100
Cretaceous
Jurassic
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Triassic
Mesozoic
Permian
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Carboniferous
Devonian
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Silurian
Ordovician
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Cambrian
Palaeozoic
Ediacaran
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Cryogenian
700
Tonian
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Neoproterozoic