Significant Events in the formation of the Sydney Basin

Lake Macquarie and the Central Coast – Part of the Northern Sydney Basin

Swansea Heads – Petrified Forest and Tuff
&
The End of Permian or Permian Triassic Extinction

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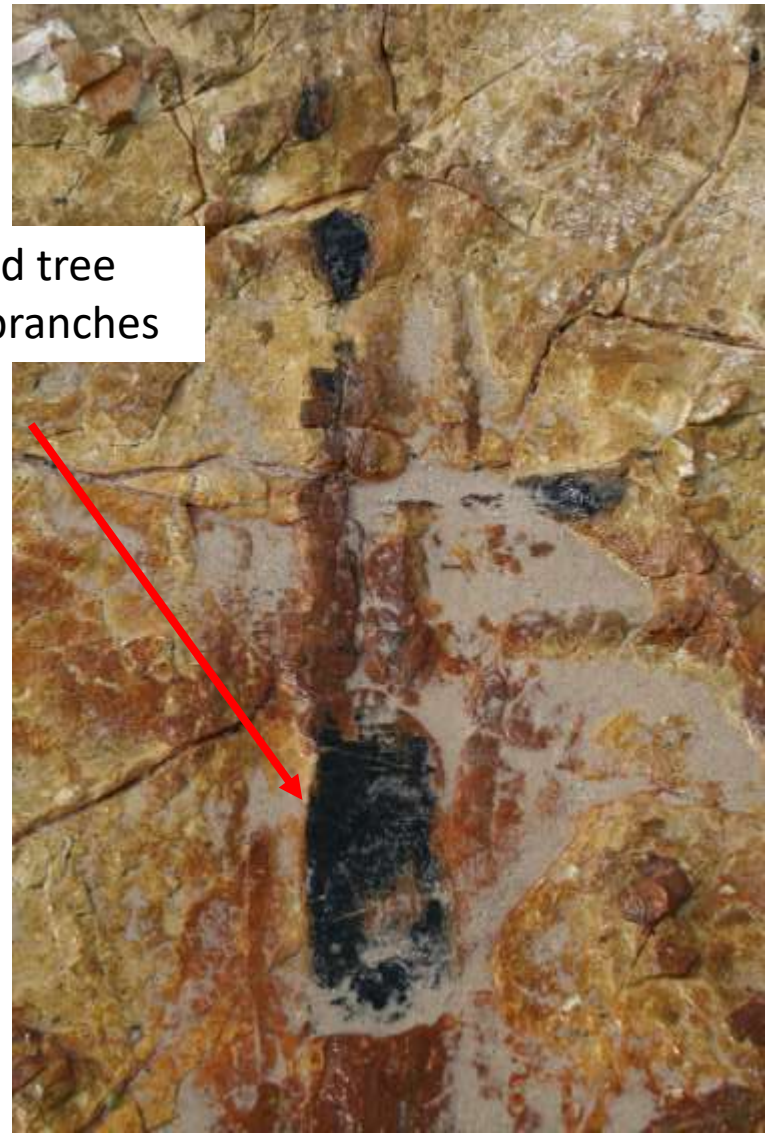
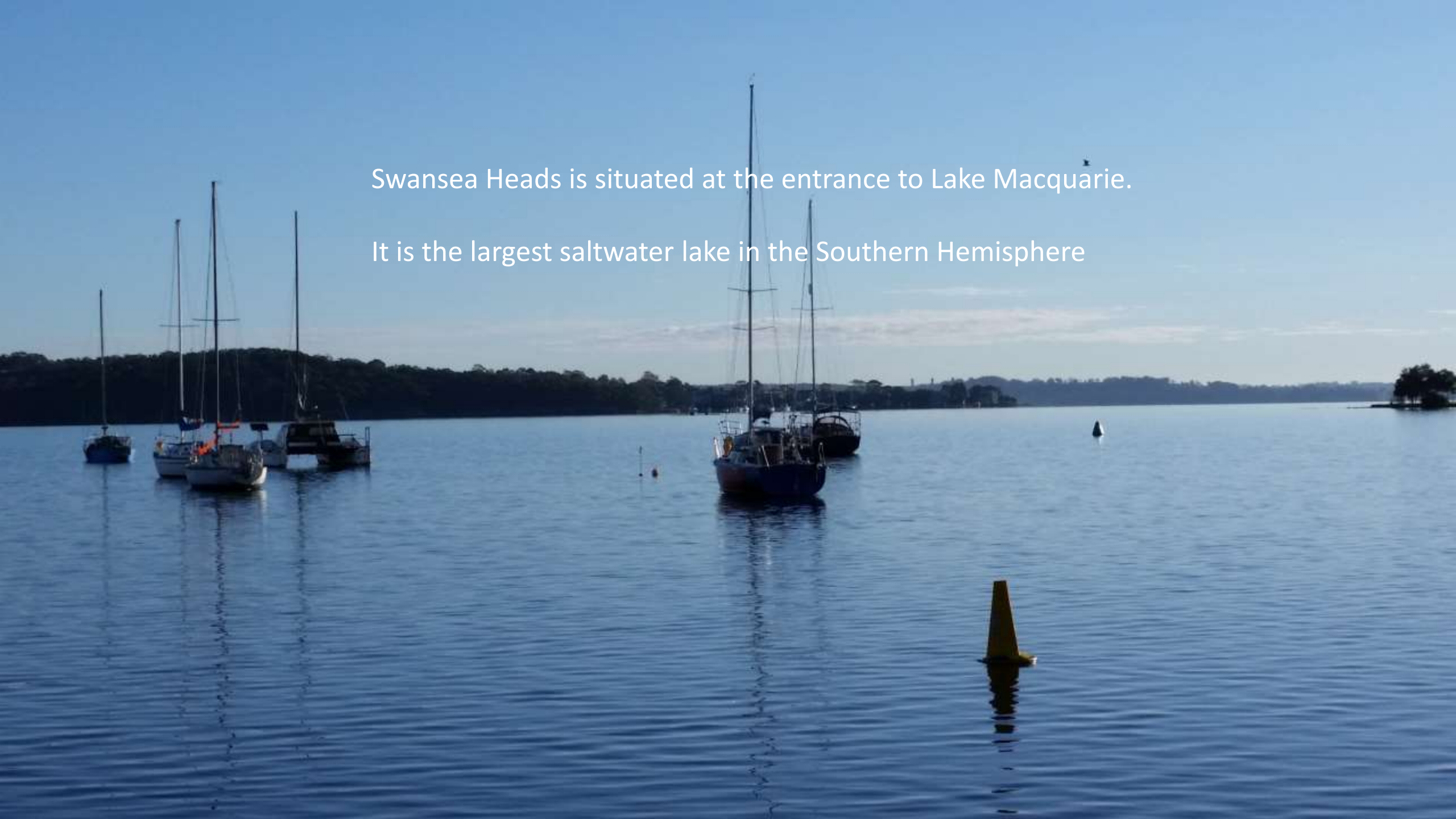
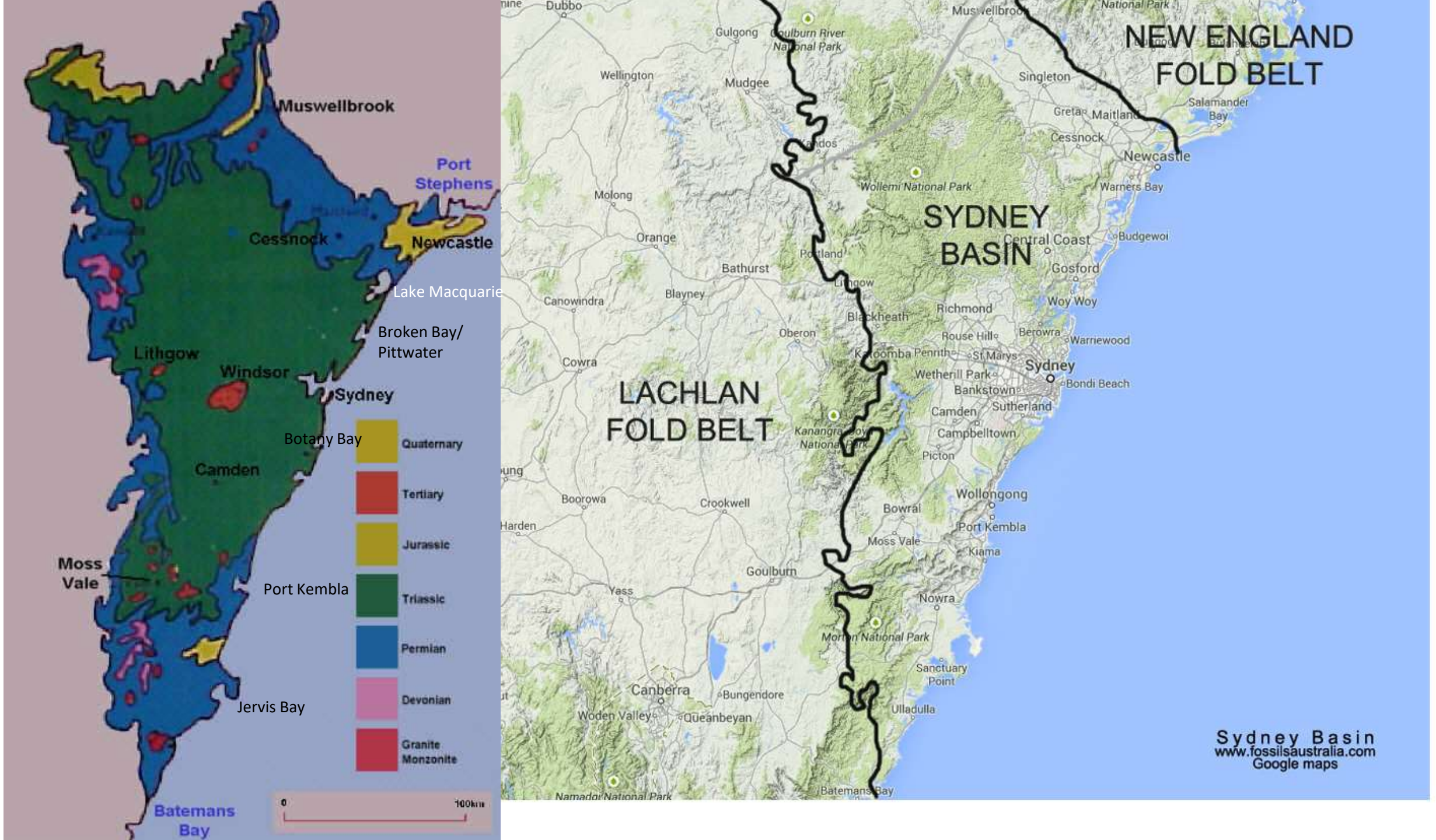
The Swansea Heads Petrified Forest

Fossilised tree trunks/branches



Fossilised tree stumps


Swansea Heads is situated at the entrance to Lake Macquarie.
It is the largest saltwater lake in the Southern Hemisphere


Muswellbrook
Port Stephens
Cessnock
Newcastle
Lake Macquarie
Broken Bay/ Pittwater
Lithgow
Windsor
Sydney
Botany Bay
Camden
Moss Vale
Port Kembla
Jervis Bay
Batemans Bay
Quaternary
Tertiary
Jurassic
Triassic
Permian
Devonian
Granite Monzonite
0
100km
NEW ENGLAND FOLD BELT
SYDNEY BASIN
LACHLAN FOLD BELT
Dubbo
Gulgong
Goulburn River National Park
Wellington
Mudgee
Singleton
Maitland
Cessnock
Newcastle
Salamander Bay
Wollemi National Park
Warners Bay
Molong
Orange
Central Coast
Budgewoi
Bathurst
Gosford
Canowindra
Blayney
Woy Woy
Richmond
Oberon
Rouse Hill
Berowra
Warriewood
Cowra
St Marys
Sydney
Wetherill Park
Bondi Beach
Bankstown
Sutherland
Camden
Campbelltown
Kanangra-Boyd National Park
Picton
Boorowa
Crookwell
Wollongong
Bowral
Harden
Port Kembla
Moss Vale
Kiama
Goulburn
Yass
Nowra
Morton National Park
Sanctuary Point
Canberra
Bungendore
Ulladulla
Woden Valley
Queanbeyan
Batemans Bay
Sydney Basin
www.fossilsaustralia.com
Google maps


NEW ENGLAND
FOLD BELT
SYDNEY
BASIN
Swansea
Gulgong
Mudgee
Singleton
Greta
Maitland
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Bay
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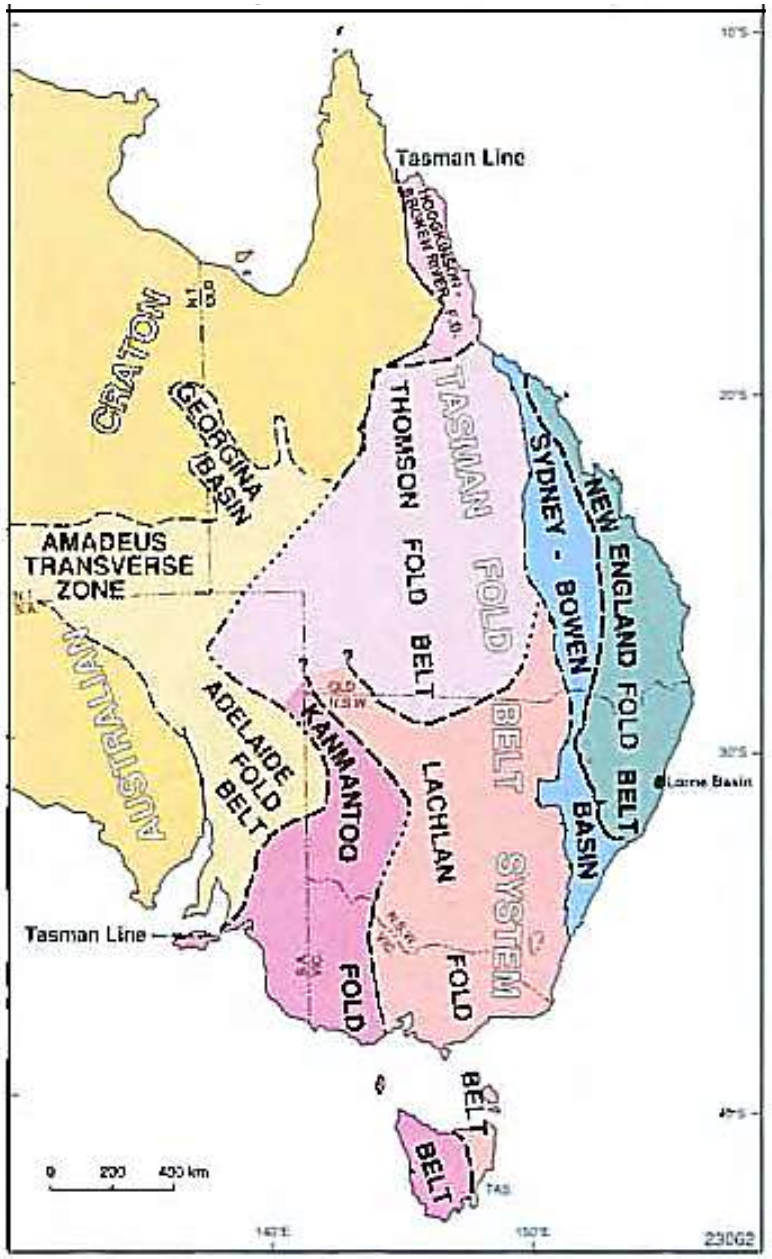
Blackheath
Oberon
Rouse Hill
Berowra
Warriewood
Penrith
St Marys
Sydney
Wetherill Park
Bondi Beach
Bankstown
Sutherland
Camden

Geologist C.F.K Diessel mapped the orientation of the fossilised tree trunks and found they were lying approximately to the South West of their stumps.


Direction of fall



Continental Australia grew from West to East. The surface in the East is generally less than 541 Ma while in the West it can be 2400 Ma

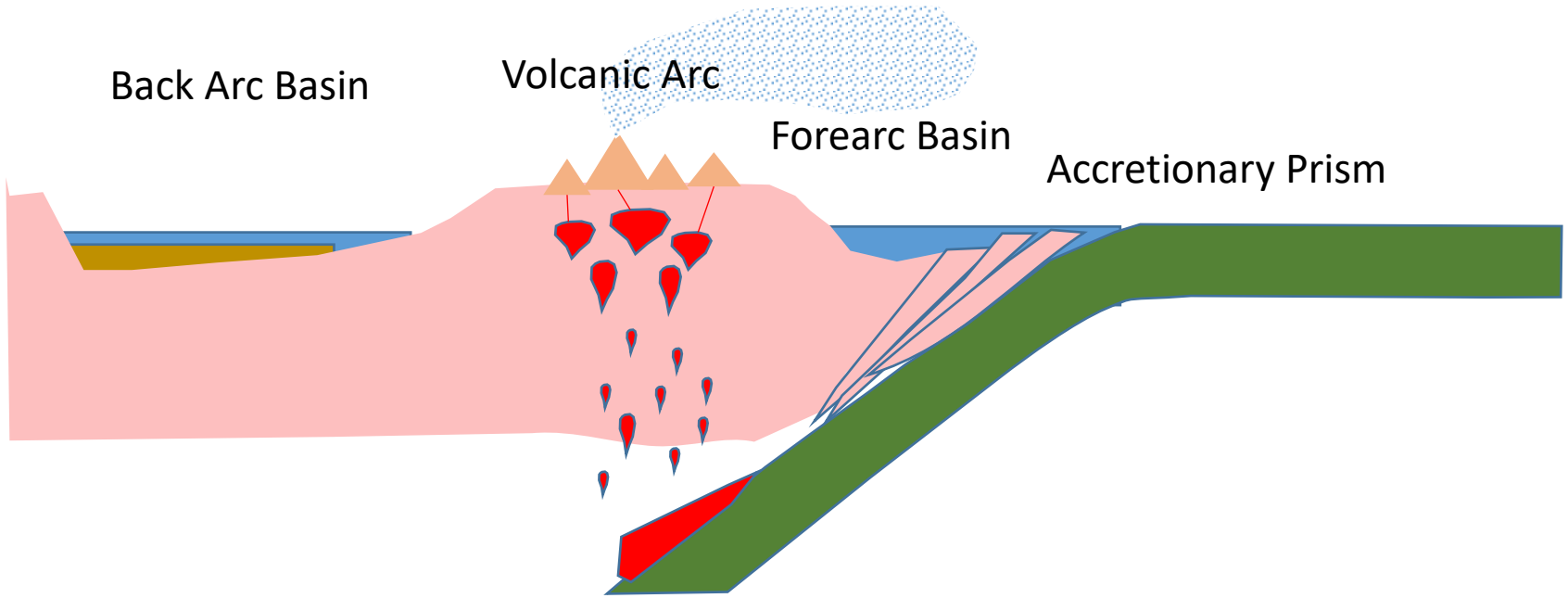
Swansea Heads is part of the **Sydney Bowen Basin**

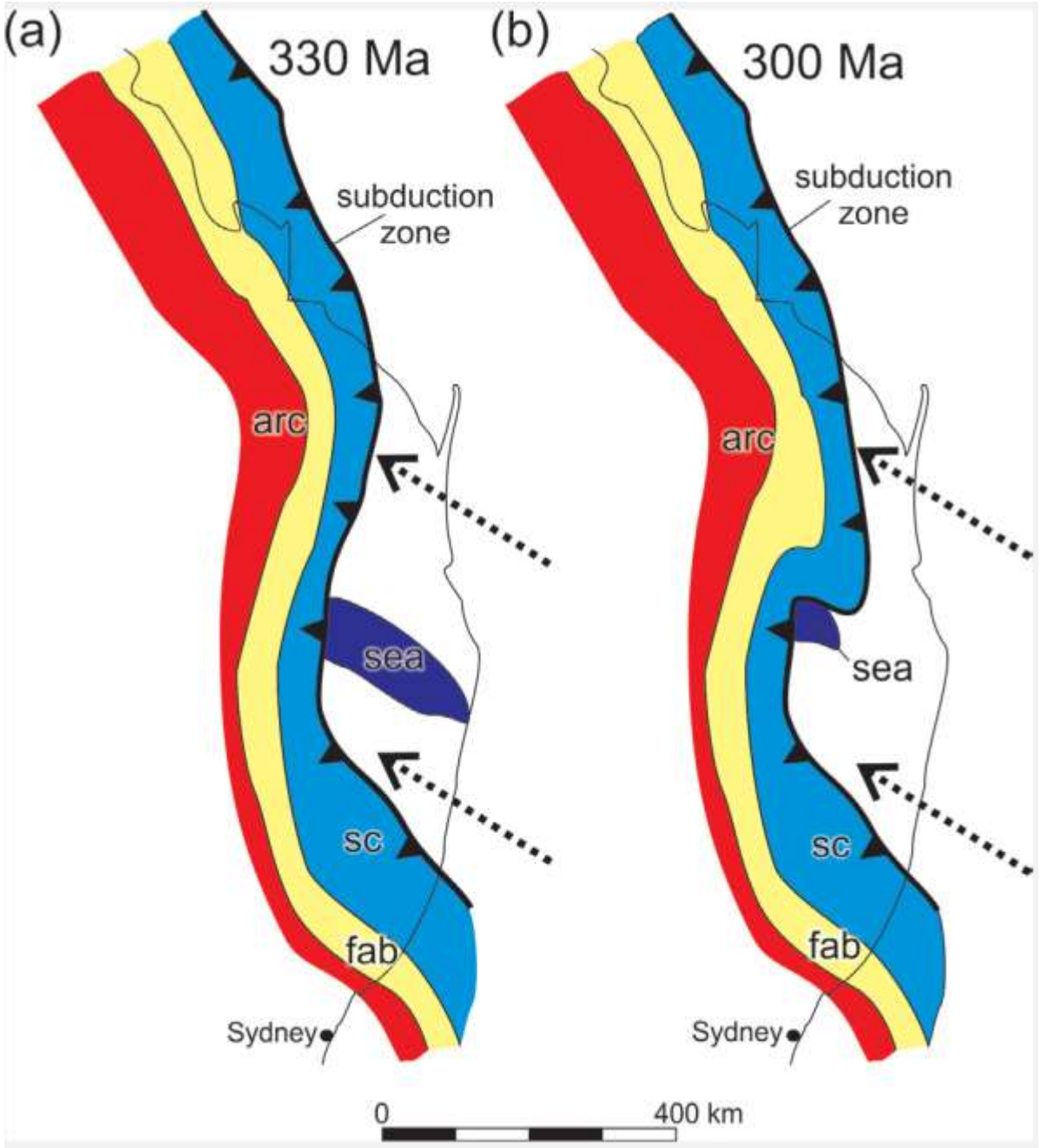
This was formed was formed when the subduction zone off the coast of Gondwanaland was congested and bent into an **Orocline**

For much of its geological history the Basin was either under water or covered by large floodplains and wetland swamps.

About 350 Ma, at the beginning of the Carboniferous, a subduction zone existed near the present coastline. It had features like those in the diagram below.

The volcanic arc stretched along the coast. Sediment eroded from it washed into the forearc and back arc basins.





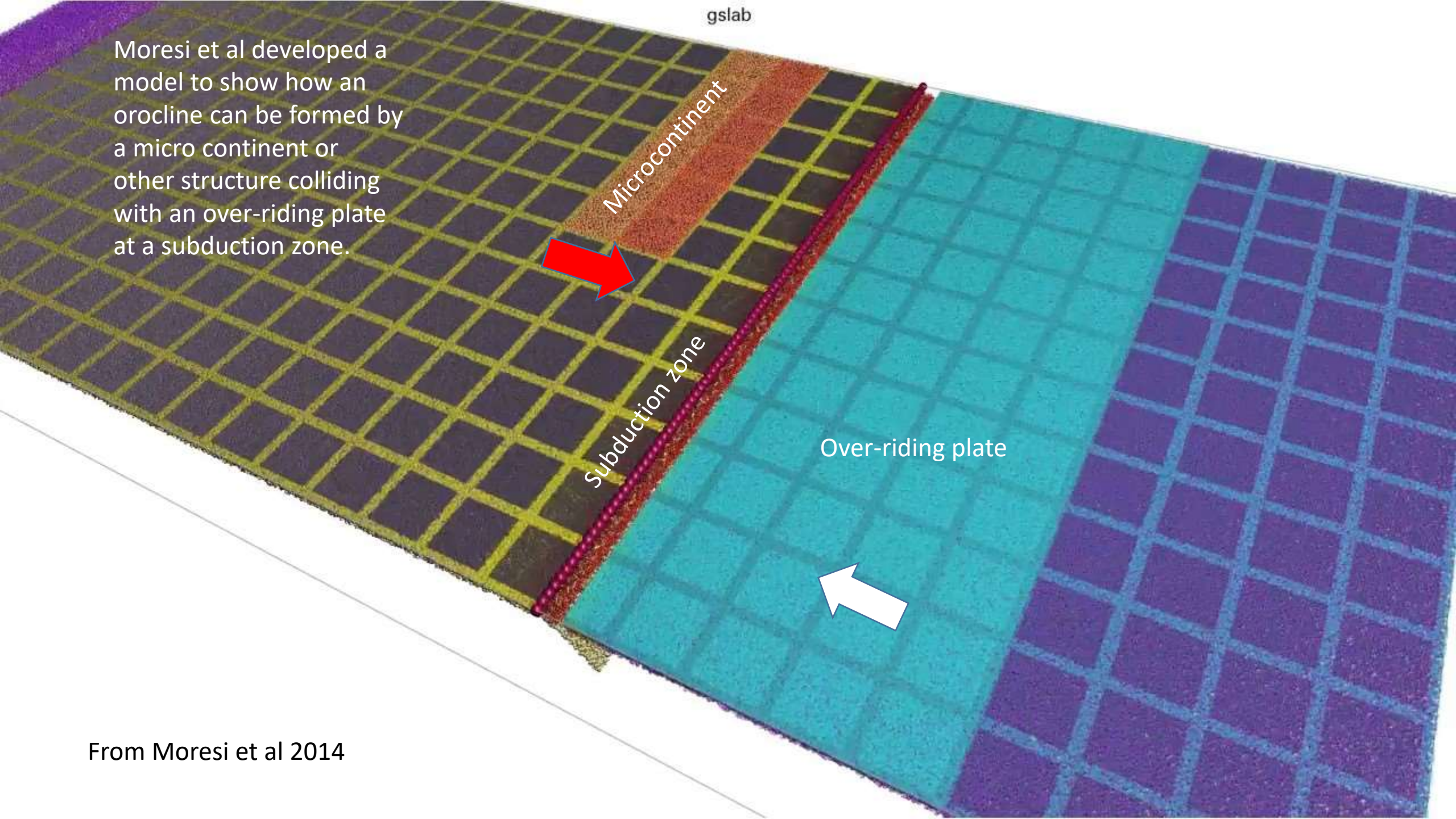
An Orocline is a bend made in a mountain chain but after it was initially formed.

Fergusson 2019 suggests that the Orocline was initiated by collision with a seamount.

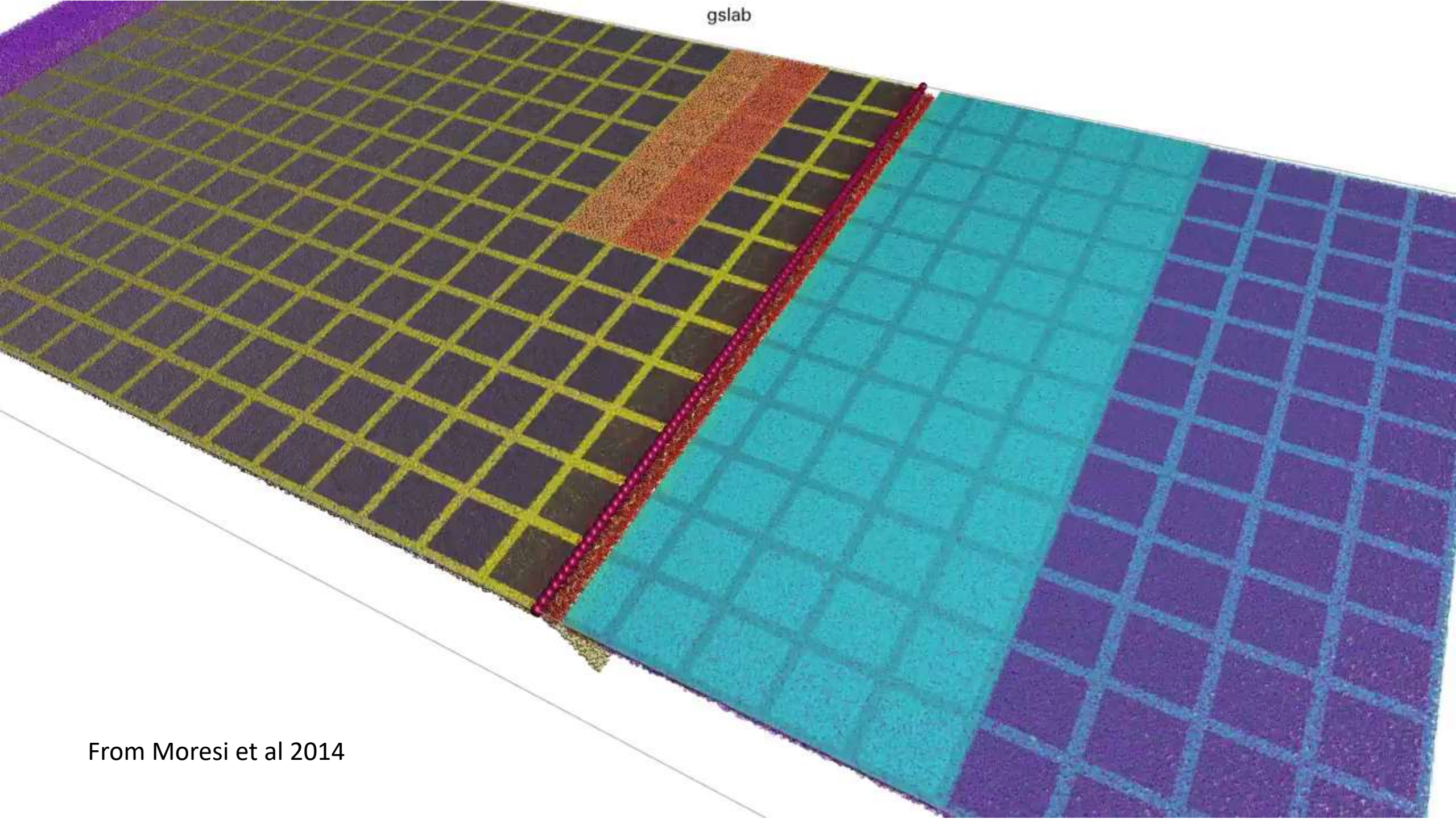
Subduction of the seamount chain he says is shown by the existence of abundant outcrops of limestone in the core of the Texas Orocline but absent elsewhere. The limestone was associated with ocean island basalts in the seamount.

Abbreviations:

fab	forearc basin
sc	subduction complex
sea	seamount chain



From Moresi et al 2014



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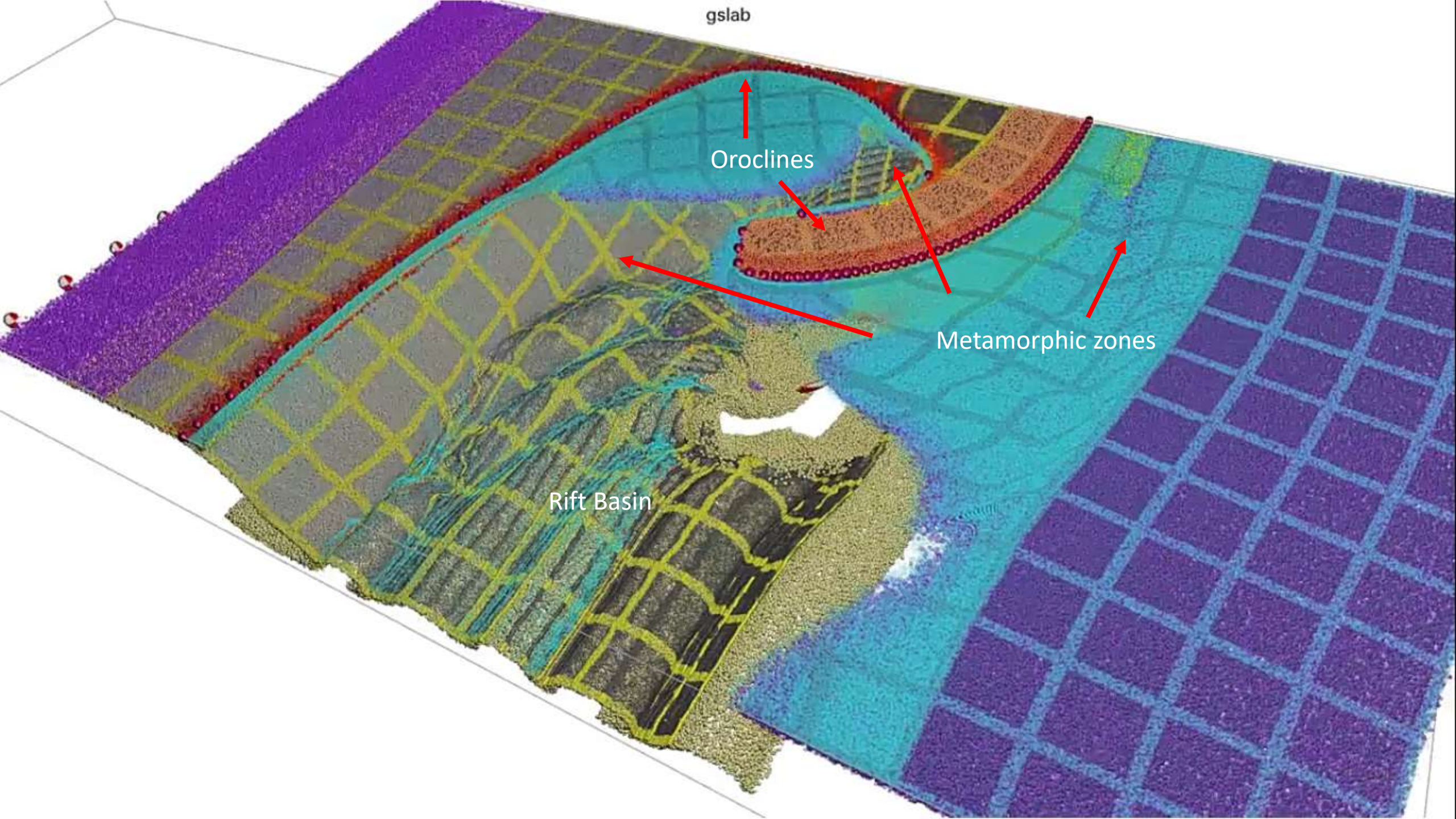
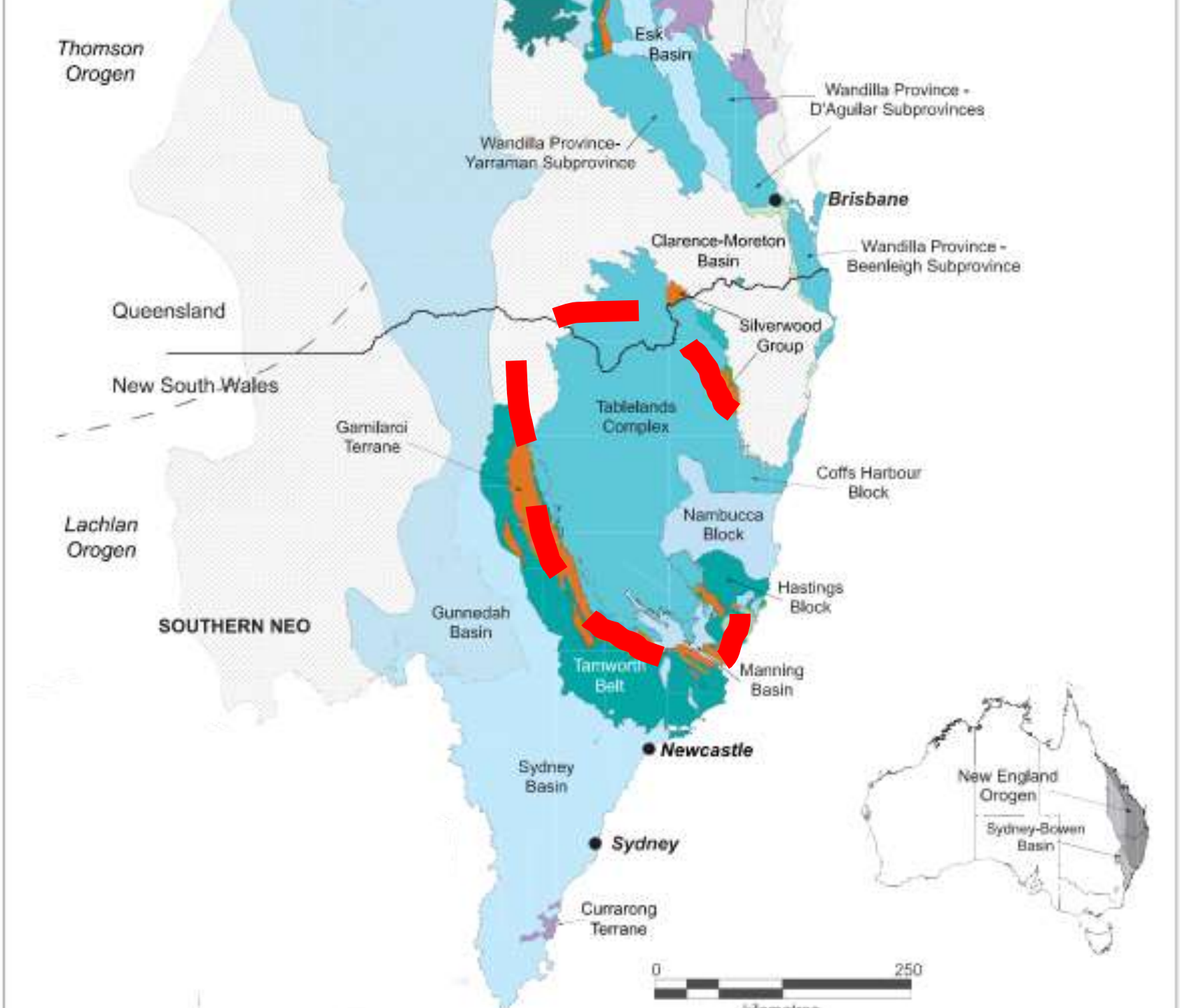

gslab
Oroclines
Metamorphic zones
Rift Basin

The orocline n the Southern New England Orogen (SNEO) is shown by the red dashes.

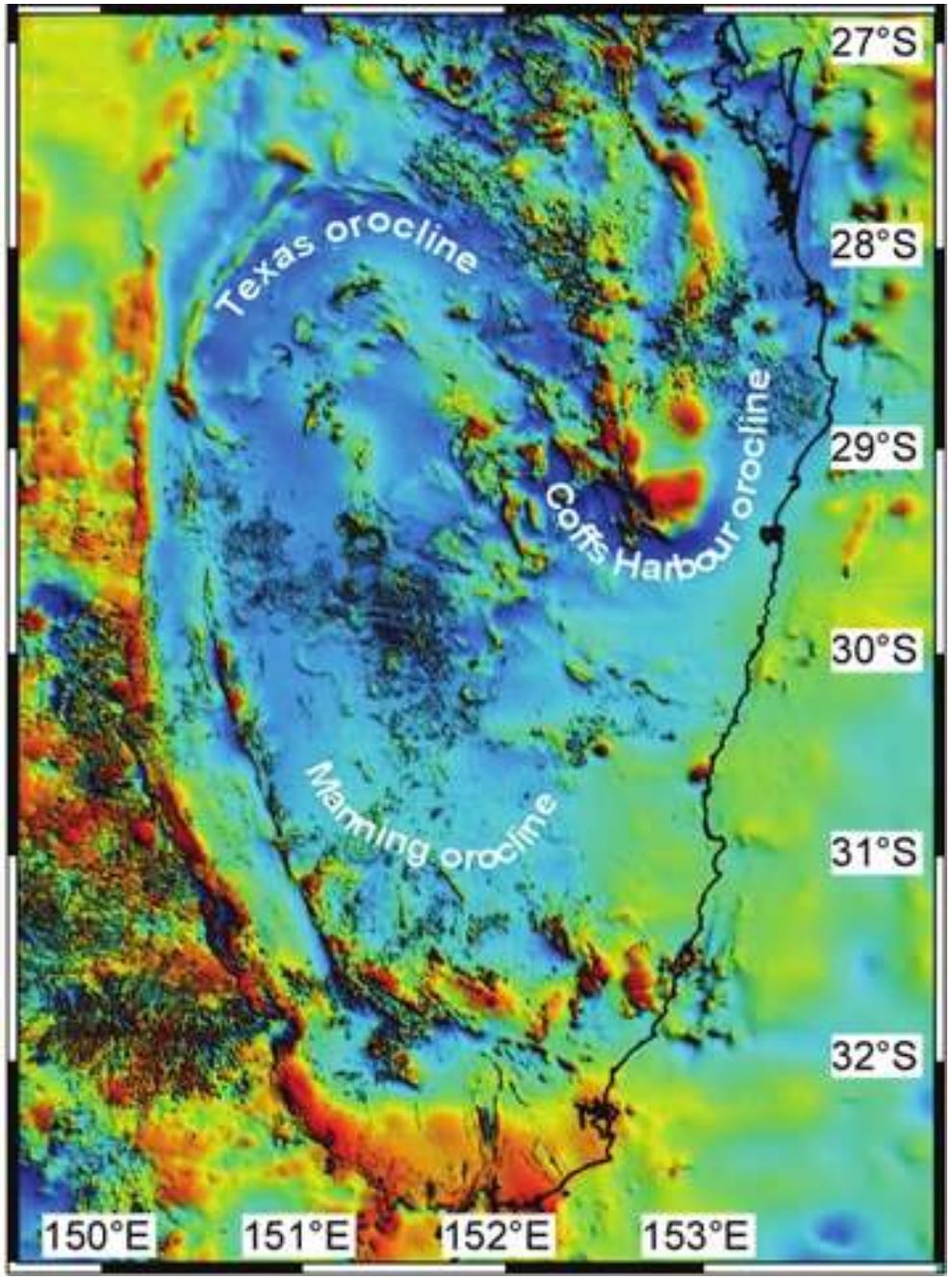
The remains of the volcanic arc are found here.

This formation can be seen in the following magnetic image.



The map shows variations in the intensity of the Earth's magnetic field that are caused by the contrasting content of rock-forming magnetic minerals in the Earth's crust.

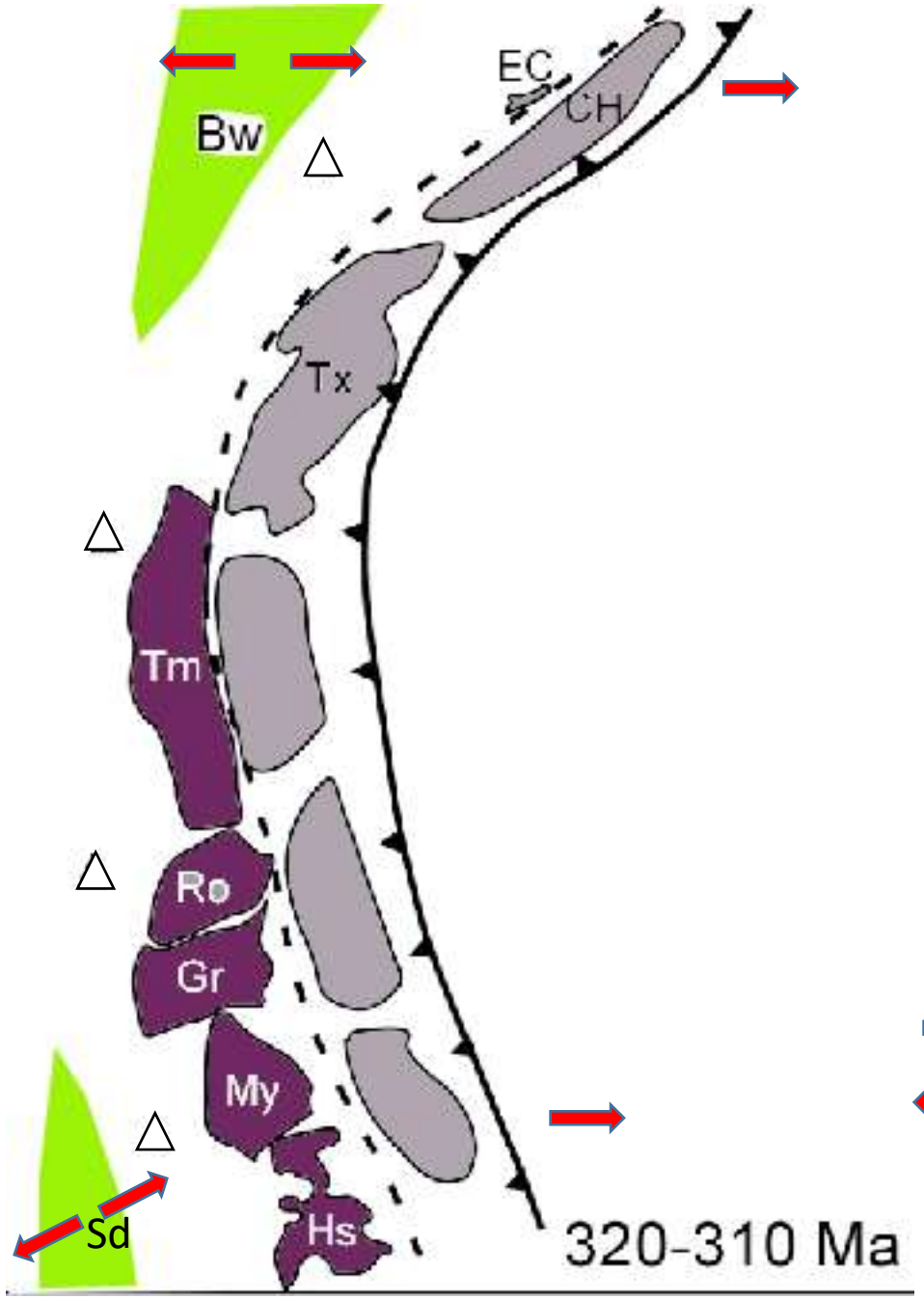
The content of magnetic minerals ranges from almost nothing in most sedimentary rocks to significant amounts in igneous and metamorphic rocks.

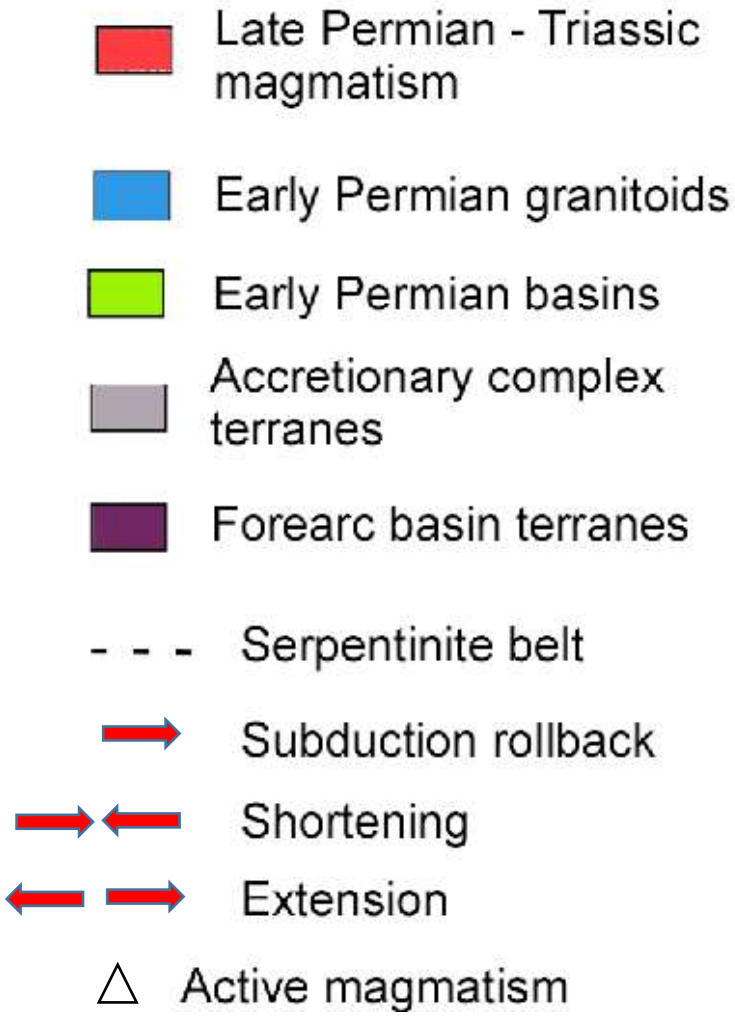


Rosenblum et al (2012) have proposed a model to explain the development of the Orocline.

The original westward dipping subduction zone in the Southern New England Zone was approximately parallel to the edge of Gondwanaland.

Bw Bowen Basin
EC Emu Creek Block
CH Coffs Harbour Block
TX Texas Block
Tm Tamworth Belt
Ro Rouchel Block
Gr Gresford Block
My Myall Block
Hs Hastings Block
Sd Sydney Basin

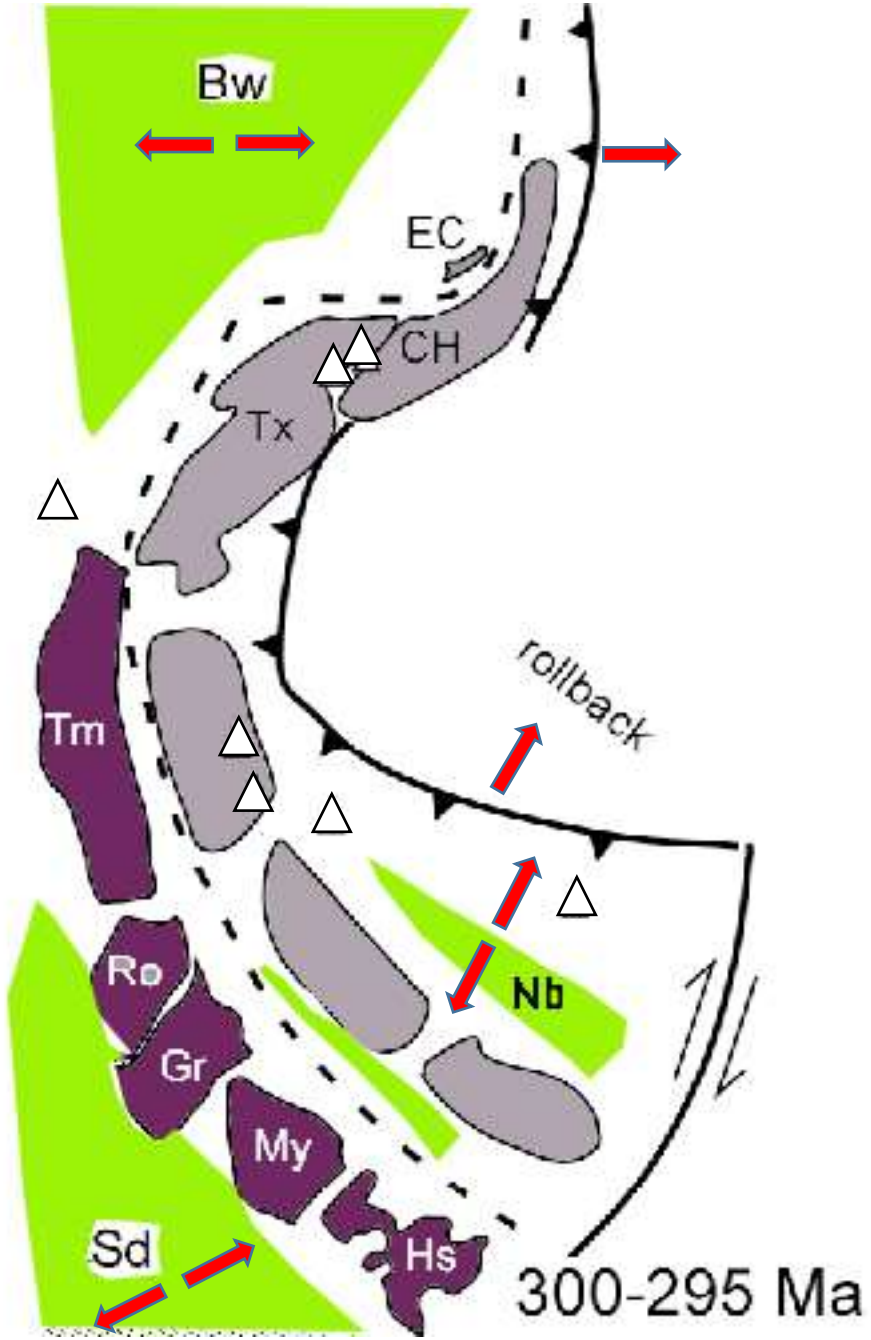


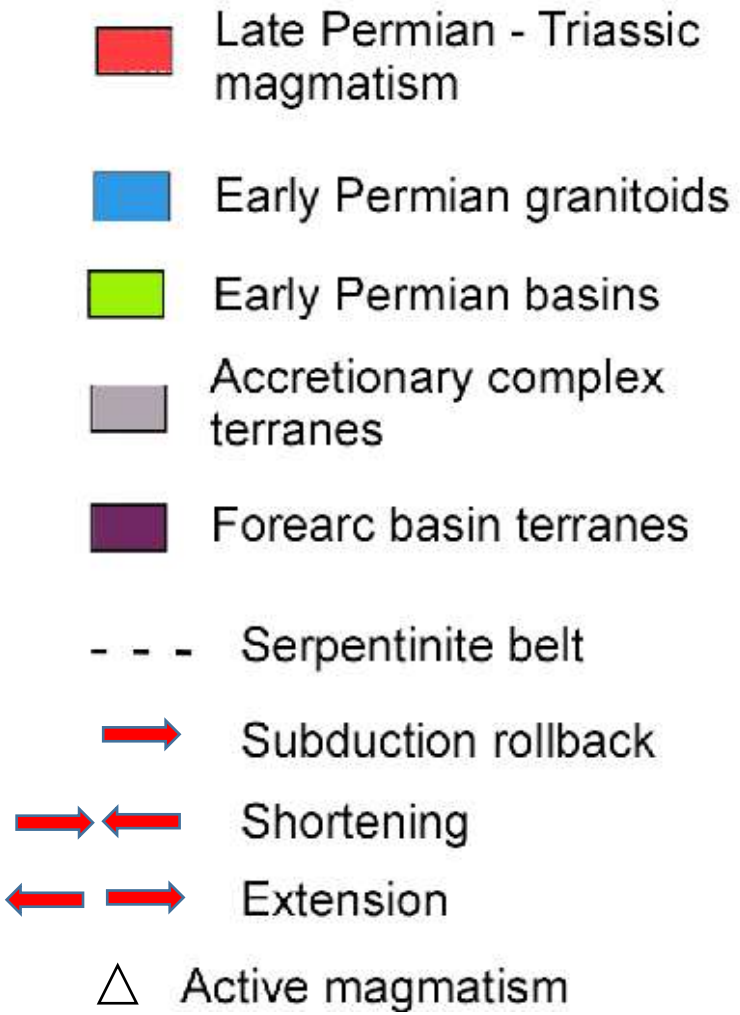


Subduction roll back in the north produces extension in the Bowen Basin.

The roll back in the South is faster and extension opens the Sydney Basin and also the Nambucca Block

Bw Bowen Basin
EC Emu Creek Block
CH Coffs Harbour Block
TX Texas Block
Tm Tamworth Belt
Ro Rouchel Block
Gr Gresford Block
My Myall Block
Hs Hastings Block
Sd Sydney Basin
Nd Nambucca Block

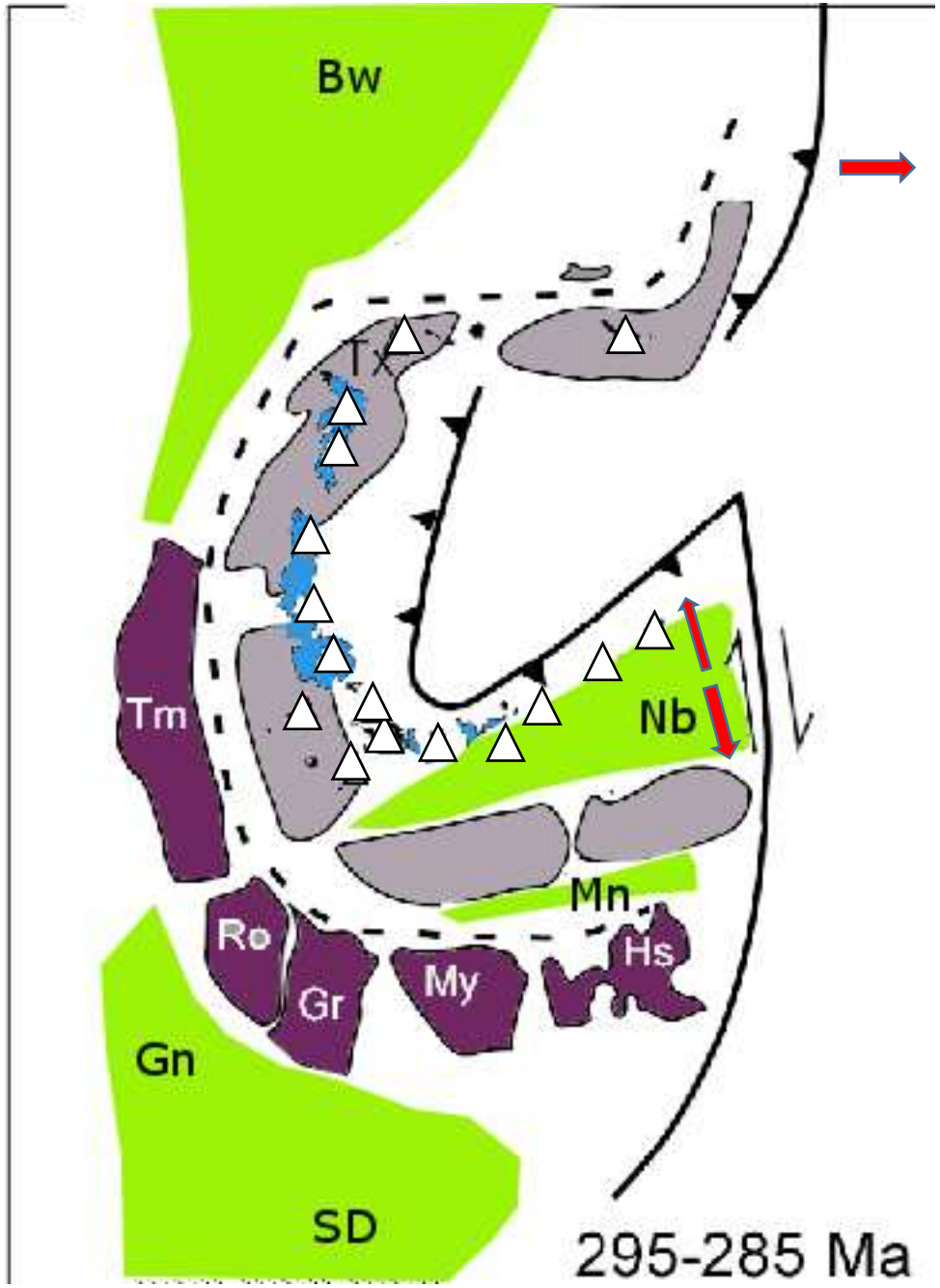




Crustal extension continues, with greater roll back continuing in the South.

The Manning Orocline is formed in the South.

Bw Bowen Basin
EC Emu Creek Block
CH Coffs Harbour Block
TX Texas Block
Tm Tamworth Belt
Ro Rouchel Block
Gr Gresford Block
My Myall Block
Hs Hastings Block
Sd Sydney Basin
Nd Nambucca Block
Gn Gunnedah Basin
Mn Manning Block



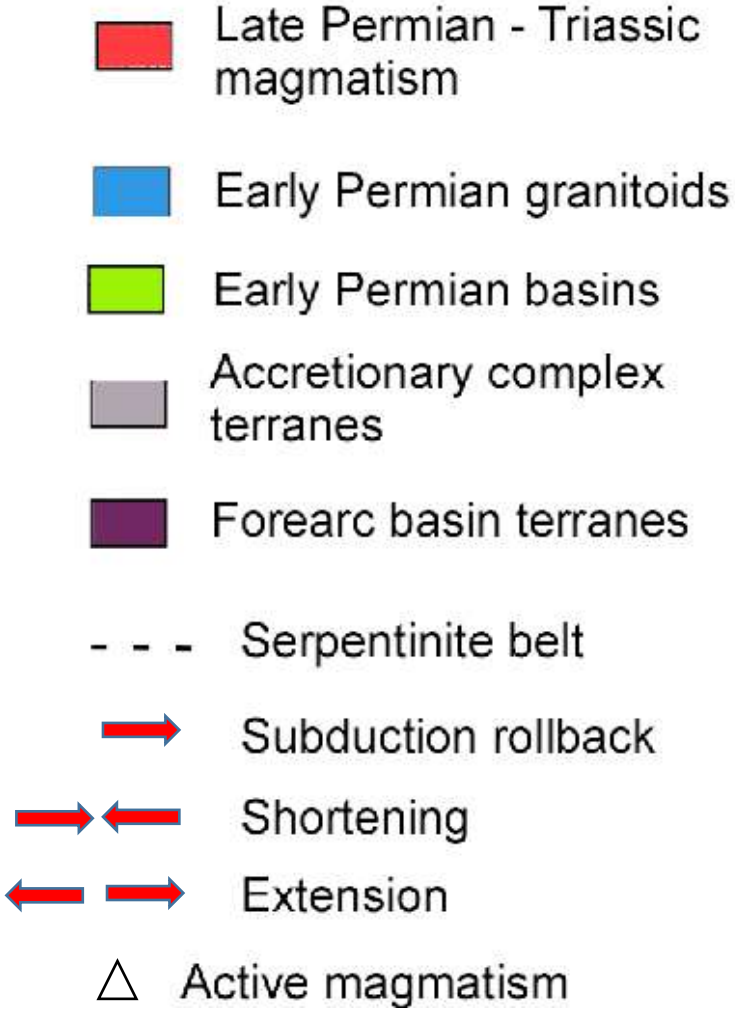


Plate reorganisation then occurs, initially producing a dextral transform boundary and the formation of the Texas, Coffs Harbour and Nambucca Oroclines.

Bw Bowen Basin
EC Emu Creek Block
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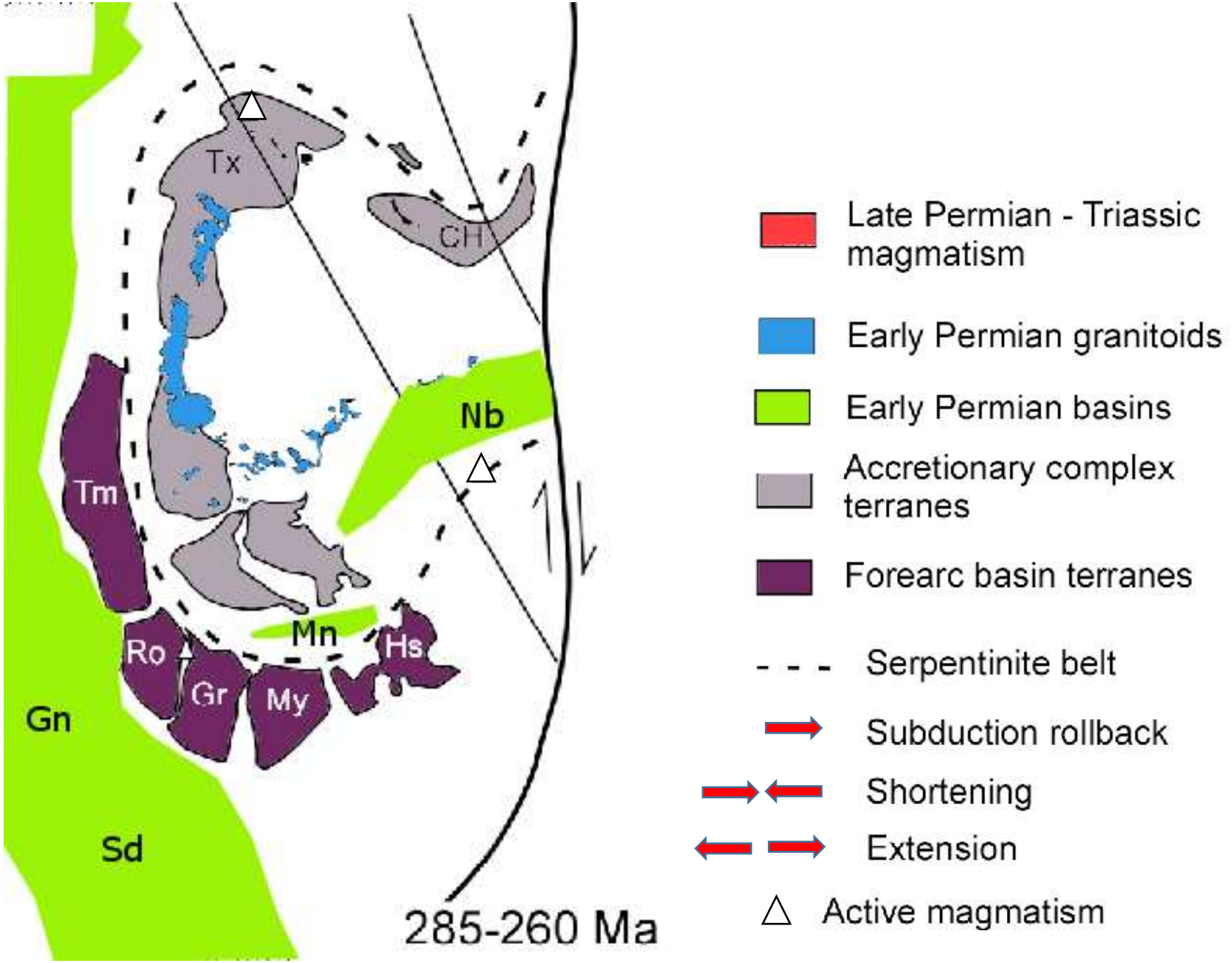
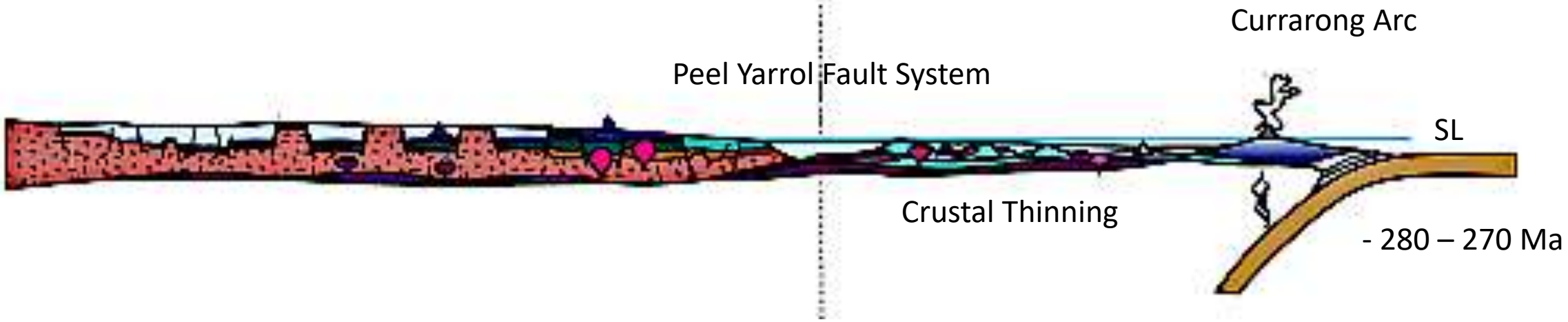


A subduction zone then begins to re-establish and produces a new volcanic arc. In the SNEO this is called the Currarong Arc.

This arc was initially positioned well off the present coast but the subduction zone then began to advance. At approximately 260 Ma an eruption produced the pyroclastic flow that knocked down the forest at Swansea Heads.



The original form of the subduction zone is re-established and crust shortening resumes in the Late Permian.

It is at this time that the petrified forest is formed.

Bw Bowen Basin
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TX Texas Block
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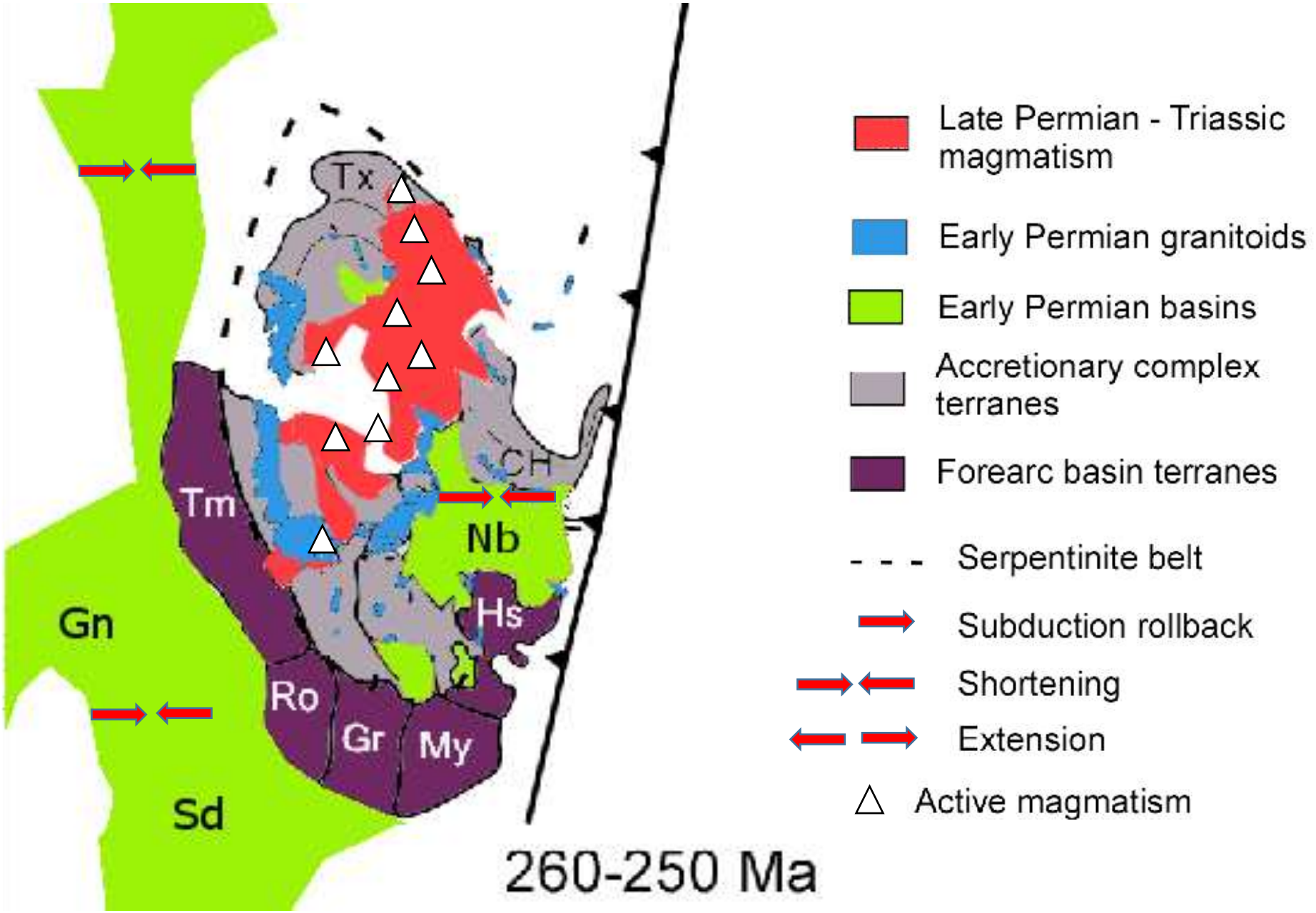
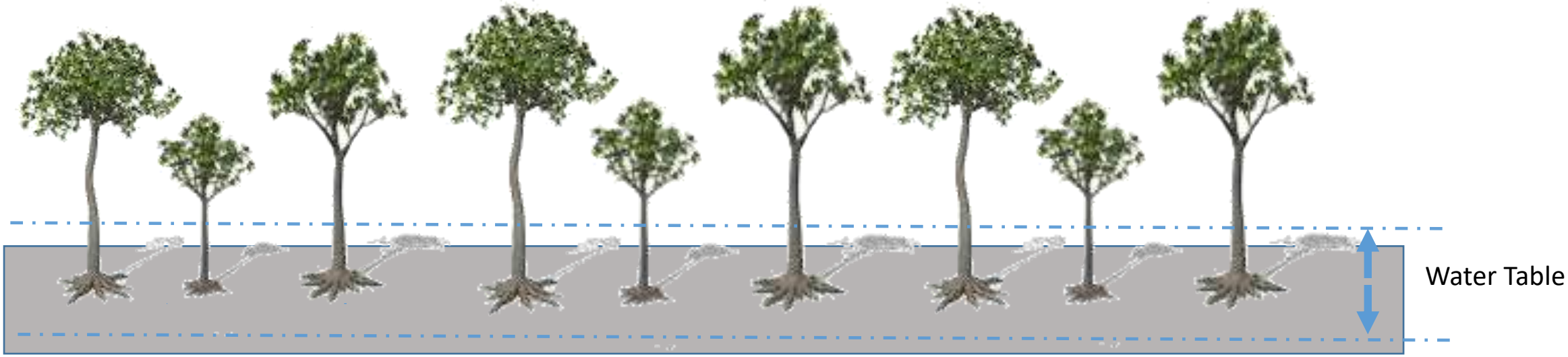
Ro Rouchel Block
Gr Gresford Block
My Myall Block
Hs Hastings Block
Sd Sydney Basin
Nd Nambucca Block
Gn Gunnedah Basin
Mn Manning Block



In the cool wet winters of the Late Permian, Glossopteris trees were able to grow in the swampy ground. They are thought to have been deciduous trees and their leaves produced large peat deposits which where later turned into coal beds. The ground was also able to support ferns and mosses.

Some of the coal beds, such as the Great North Seam, which lies under present day Sydney, are very thick. It is often more than 3m deep. Others seams only reached a few centimetres before they were buried by new sediment.



In the swamps and adjacent areas of high water table, trees, shrubs and Glossopteris grew. The Glossopteris had specially adapted aeration roots to allow them to grow in boggy conditions and Mangroves use the same type of roots to grow along the present coasts.

Glossopteris (Ancient Greek: γλώσσα glossa, **meaning** "tongue", because the leaves were tongue-shaped, and pteris, Greek for fern or feathery) is the largest and best-known genus of the extinct order of seed ferns known as Glossopteridales (also known as Arberiales or Ottokariales).


Newcastle
Fennells Bay
Watagan Mts
Swansea Heads
Wybung Head
5
0
5
10
15 km

The area between Moon Island and the headland (Reid's Mistake) is shallow and was once part of the rock platform but has been eroded by waves.

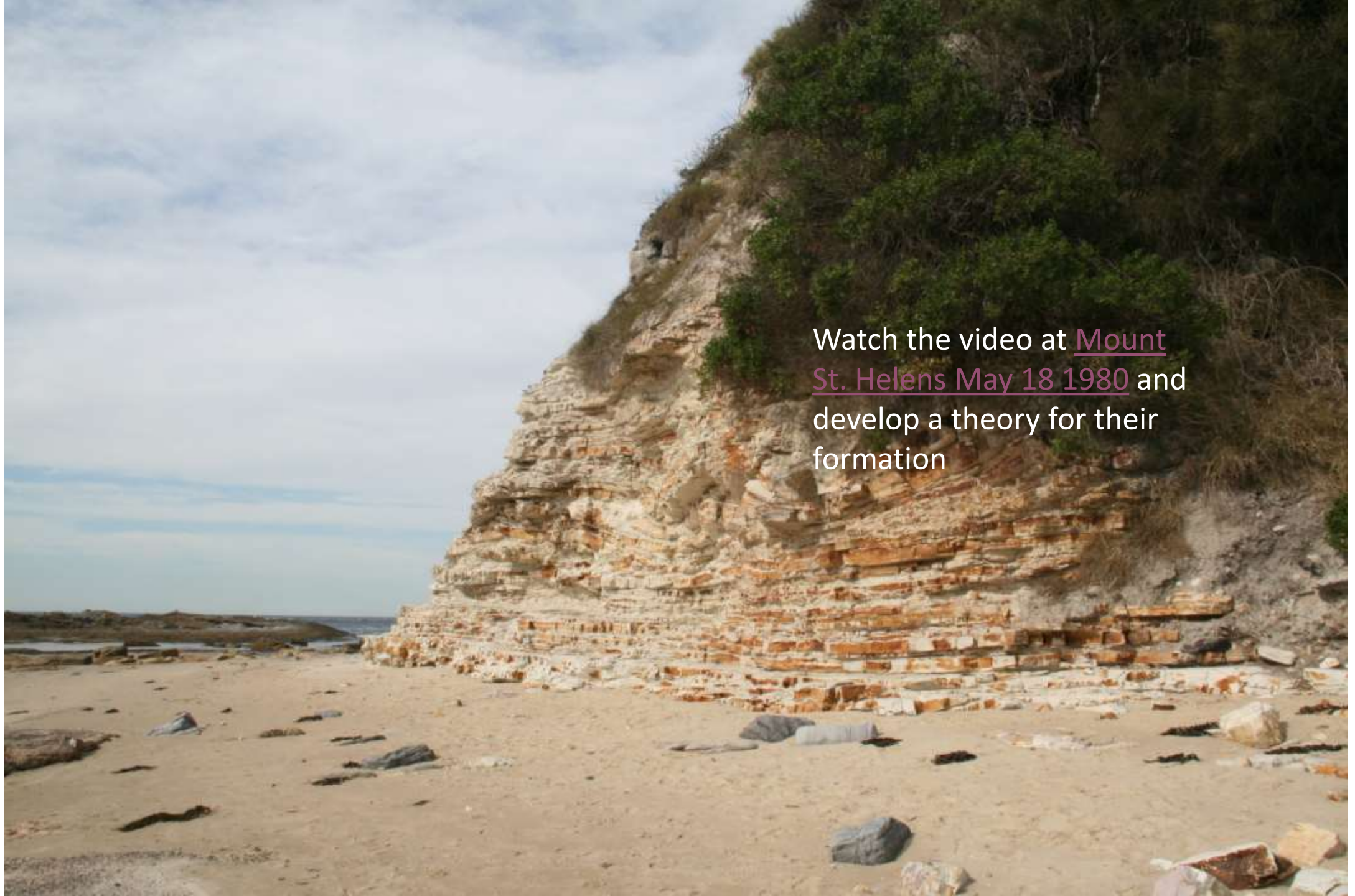

It was in this Seam
that the Glossopteris
Forest was growing
The original land surface
with its peat bed is now a
thin coal seam called the
Lower Pilot Seam

There are two distinctive rock types that now cover the old peat bed

The first is a tan coloured rock and in this are the fossilised remains of the Glossopteris tree trunks


Above the rock platform and forest is an 8 metre thick layer of white rock called Tuff.

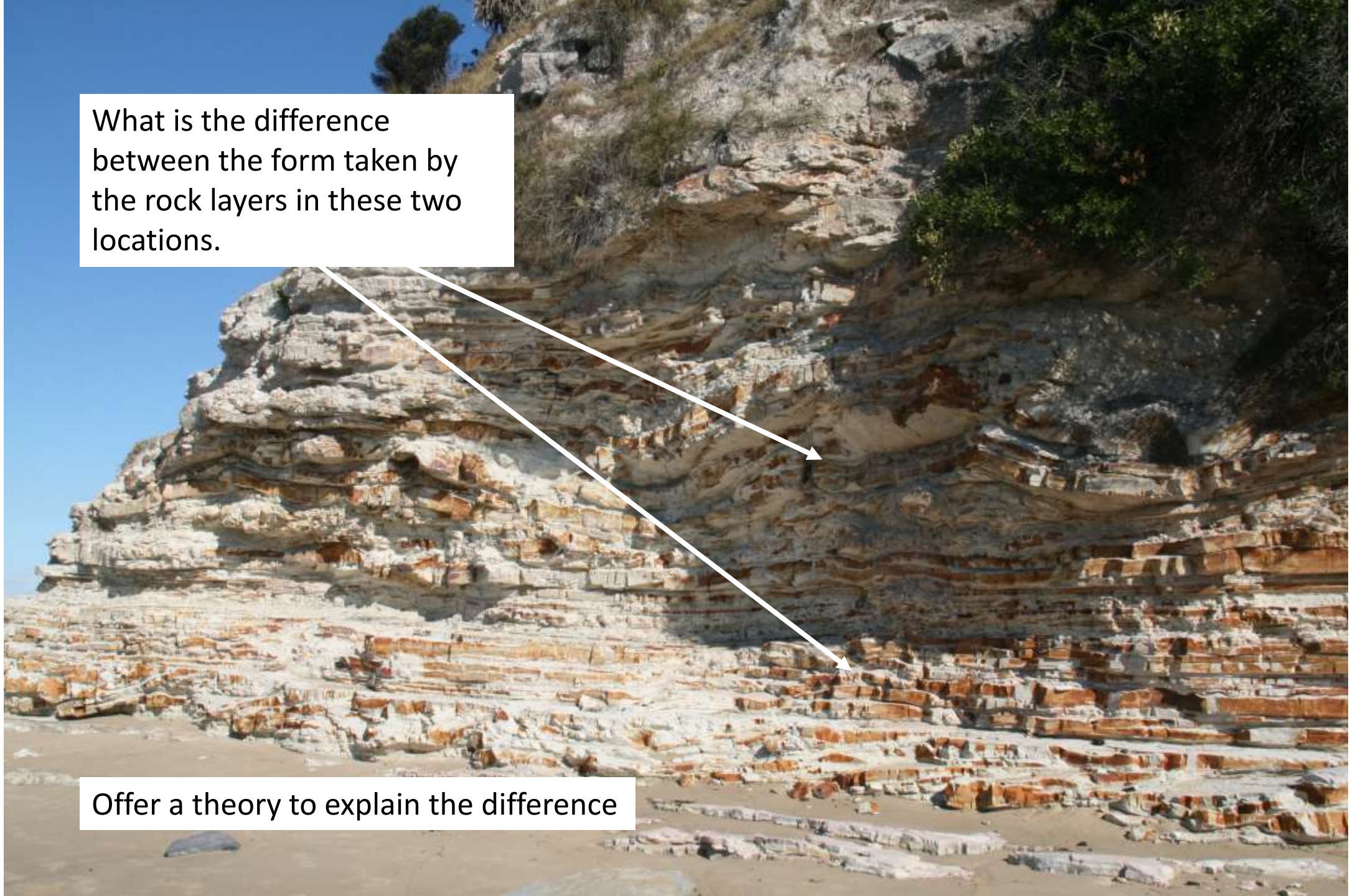
This remnant of Tuff sits on the platform to the south of Swansea Heads and is known as “Chaulkies”.


Watch the video at Mount St. Helens May 18 1980 and develop a theory for their formation

About 260 Million Years Ago a volcanic explosion, similar to the explosion of Mt St Helens in the USA in 1980, occurred off the coast about 20km to the North East of Swansea Heads.

It buried the forest of Glossopteris Trees and covered the surrounding area in approximately 8m of ash. When later covered by sediment this ash was turned into Tuff.

How do you account for the difference in the rock near the base of the trees and that on the headland?


What is the difference between the form taken by the rock layers in these two locations.
Offer a theory to explain the difference

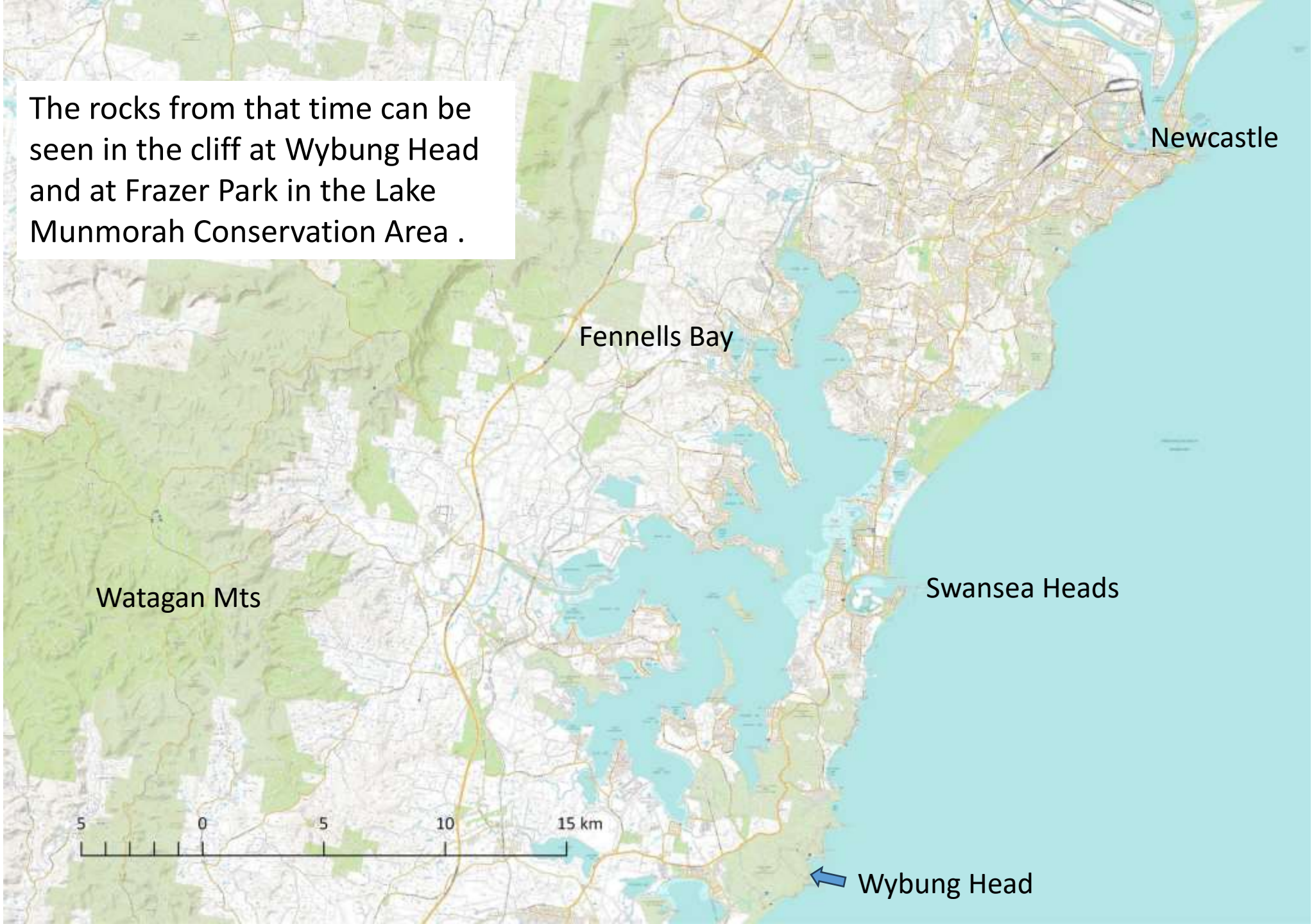

On the cliff above the Tuff is another thin band of coal called the Upper Pilot Seam
What has happened to the land surface for this coal seam to have formed?

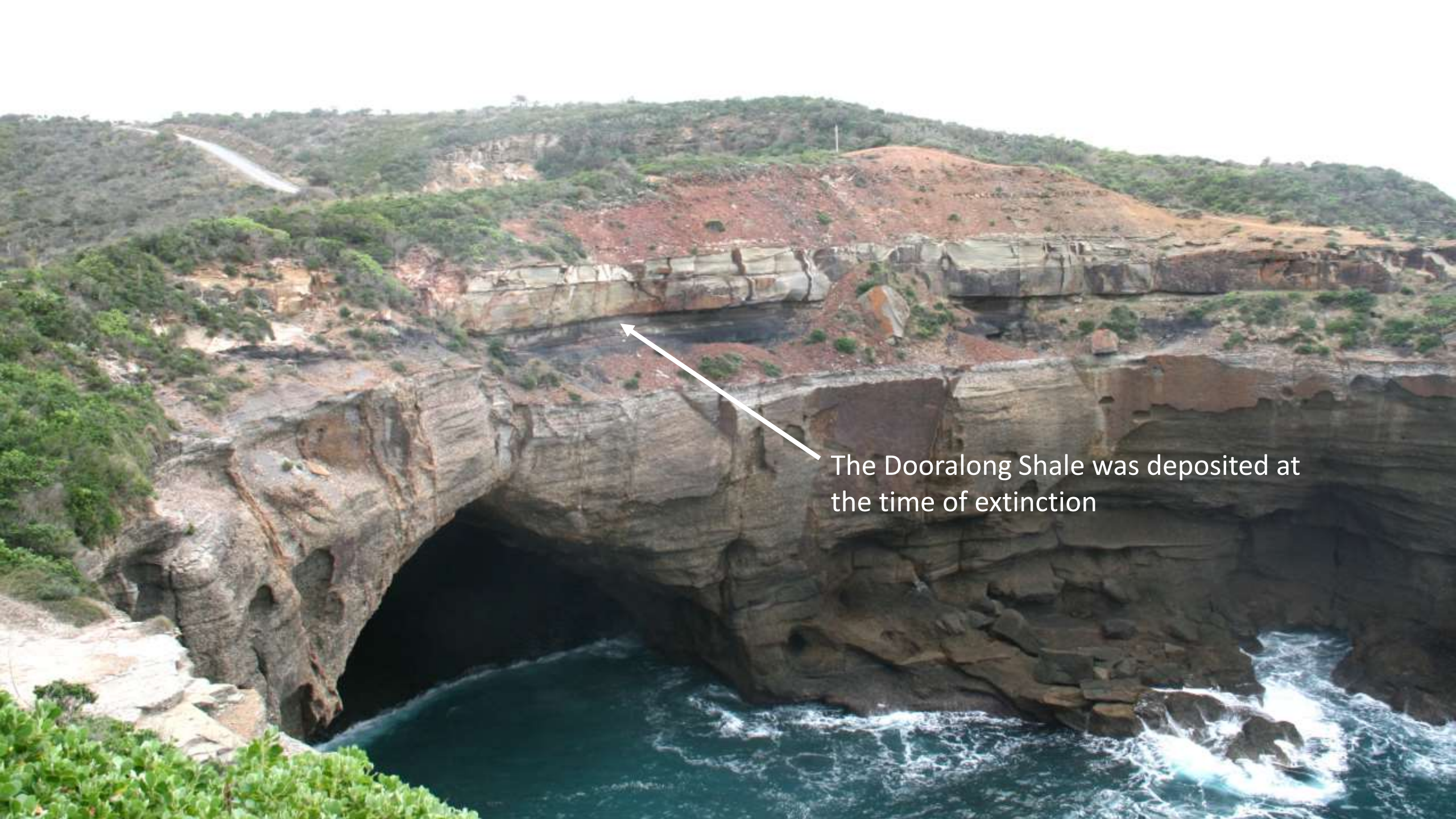
The Great Dying

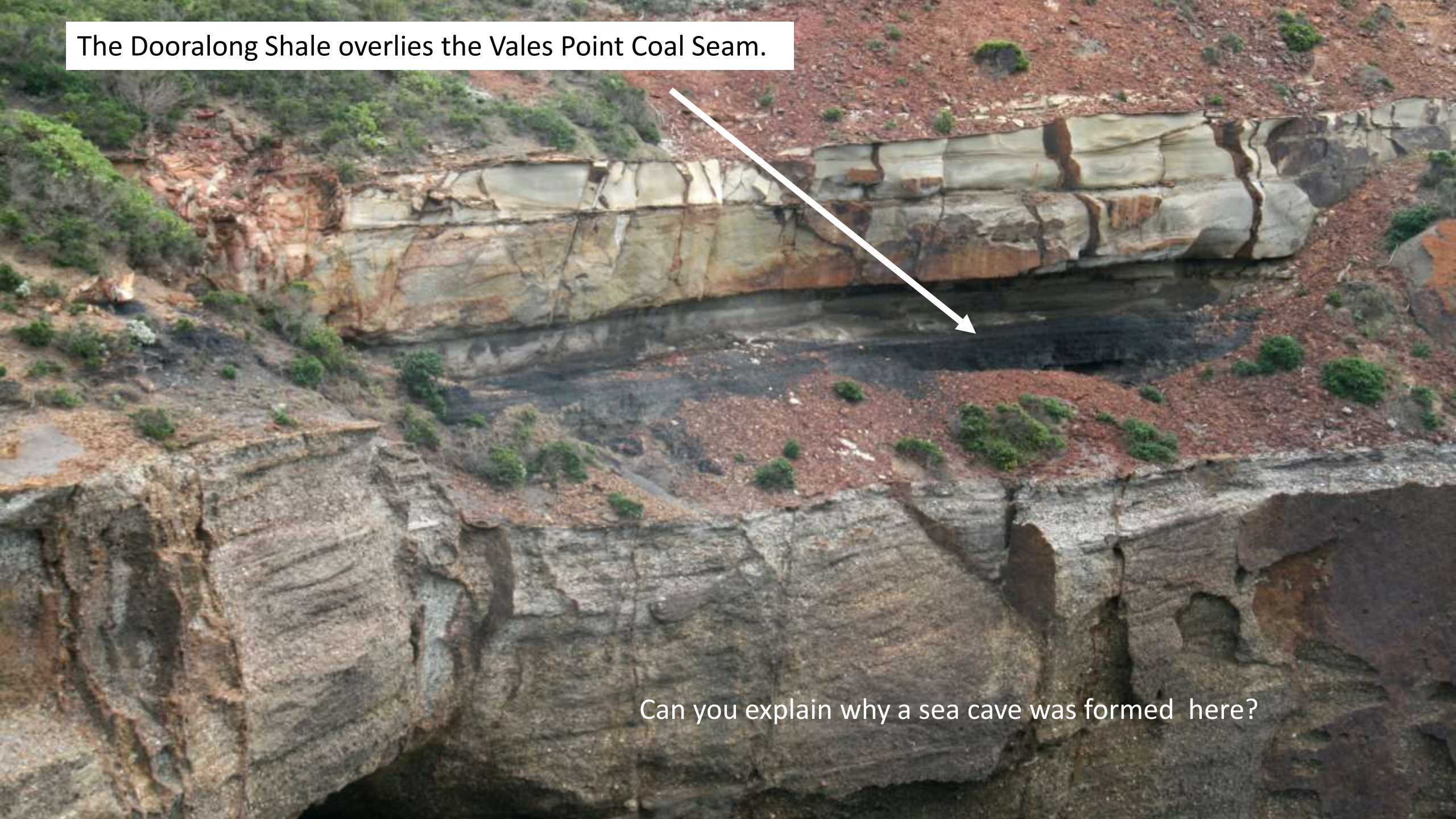
The volcanic eruption at Swansea would have eliminated most of the living environment for many kilometres but at the end of the Permian there was a more general mass extinction.

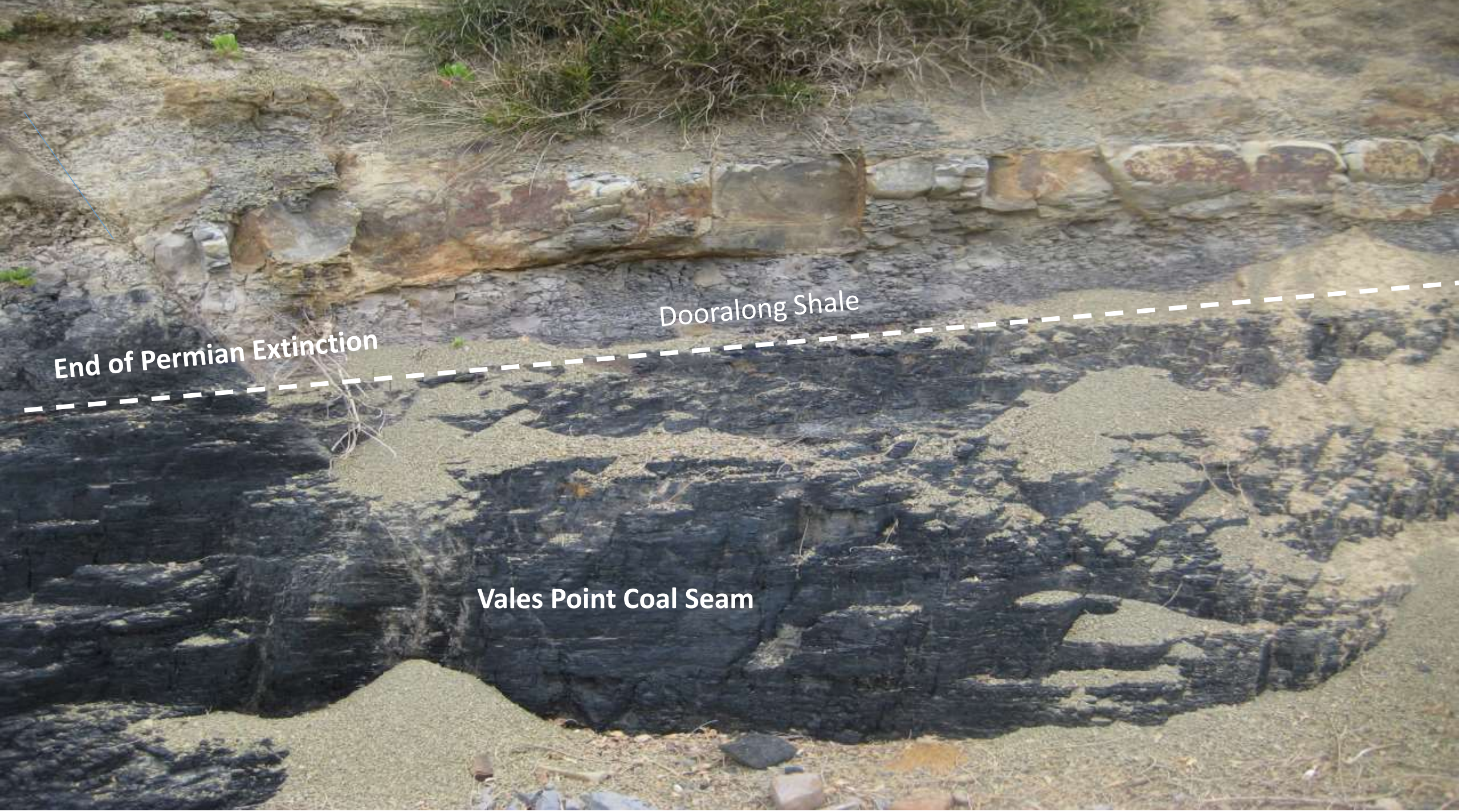
The **End of Permian Extinction (EPE)** eliminated up to 96% of all species on Earth, and over 50% of all families of living things. Many geologists often refer to this event as ''the Great Dying‘’.

This extinction affected plants, terrestrial animals, marine animals, and even bacteria. Everything that has existed since the EPE has evolved from the 4% of species that survived.

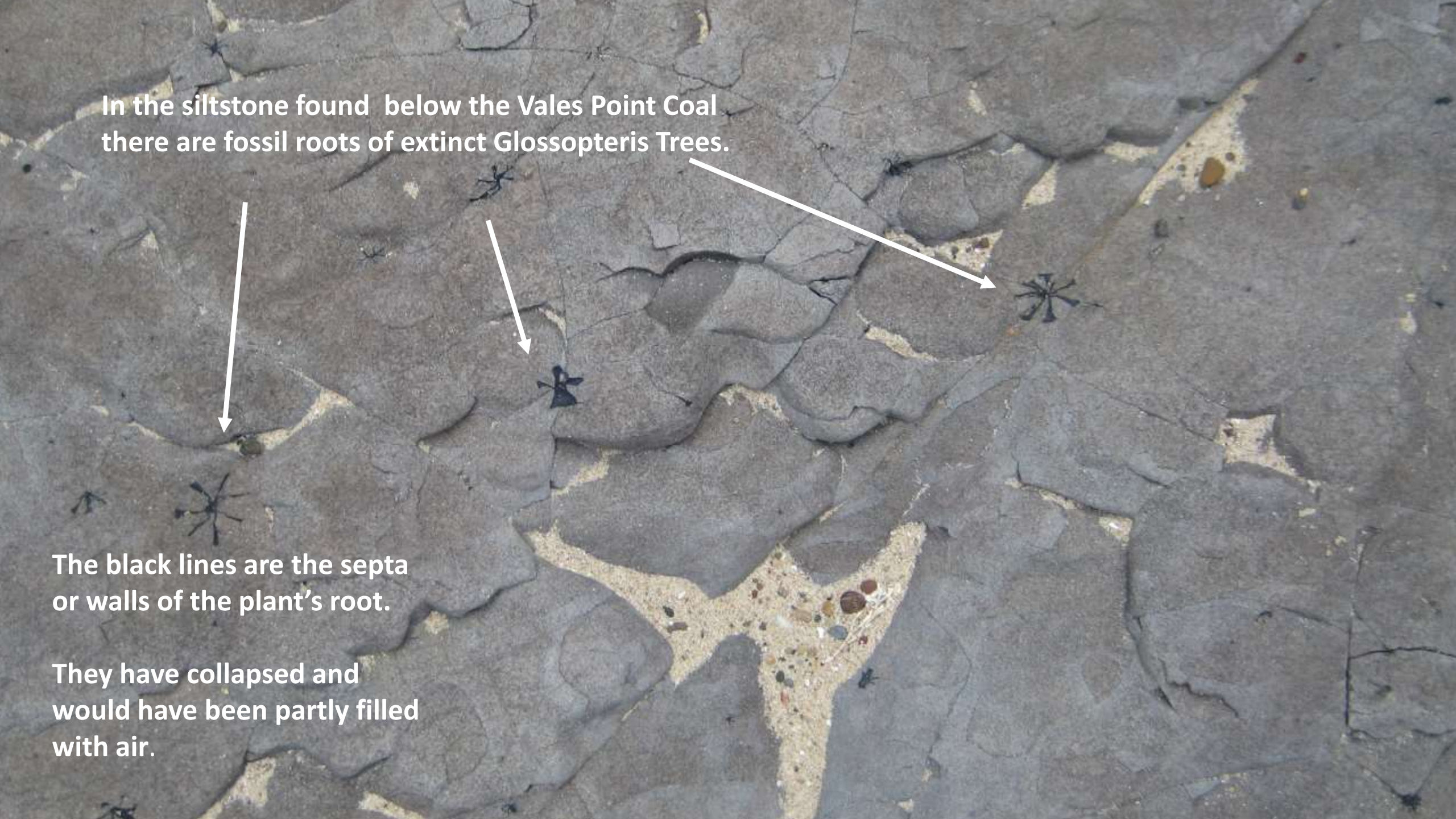

The rocks from that time can be seen in the cliff at Wybung Head and at Frazer Park in the Lake Munmorah Conservation Area .
Newcastle
Fennells Bay
Watagan Mts
Swansea Heads
5 0 5 10 15 km
Wybung Head


The Dooralong Shale was deposited at the time of extinction


The Dooralong Shale overlies the Vales Point Coal Seam.
Can you explain why a sea cave was formed here?


End of Permian Extinction
Dooralong Shale
Vales Point Coal Seam


Life begins again here
Dooralong Shale


In the siltstone found below the Vales Point Coal there are fossil roots of extinct Glossopteris Trees.
The black lines are the septa or walls of the plant's root.
They have collapsed and would have been partly filled with air.

What caused the Permian-Triassic Extinction ?

Geologists think that the entire Permian-Triassic extinction occurred in less than one million years and some believe that nearly all of life on Earth died out in less than a hundred thousand years, and some even believe it may be under ten thousand years.

Geologists are not certain about the causes of the extinction but have evidence for four causes:

1. Climate Change:

Geologists have found evidence that the Permian period contained consistent global warming. If this happened dramatically enough, it could have shifted weather patterns, causing horrible storms in some places and massive droughts in others.

2. Pangaea:

A popular theory is that the creation of Pangaea itself led to the mass extinction. Pangaea was a supercontinent formed in the Permian as landmasses were pushed together by tectonic activity.

The theory is that the creation of this supercontinent eliminated inland seas that sustained terrestrial life. The joining of the continents also reduced the amount of near-shore marine habitats, disrupted normal currents and weather patterns, and could even have resulted in a depletion of oxygen in the ocean. In short, it took millions of years to form Pangaea, but once it existed, things changed rapidly and were out of control.

3. Impact Theory:

In 2001, Geologists with NASA discovered evidence of an asteroid impact at the end of the Permian period. While most evidence has been erased over the last 250 million years, researchers now believe that this space rock was about the size of Mount Everest when it collided with Earth.

Still, relatively few geologists believe this actually caused mass extinction. It certainly wouldn't have helped, but likely wasn't the direct cause.

4. Volcanoes. The Siberian Traps

250 million years ago, right at the Permian-Triassic boundary, the **Siberian Traps** were formed. These were massive lava flows created by a **plume eruption**. Magma rose through the earth's crust onto the surface, exploding with hundreds of thousands of cubic kilometers of lava.

This is incredibly rare, only happening eight times in the last 250 million years, but the result is a massive outpouring of magma in violent eruptions. The event that created the Siberian Traps lasted between 1 and 2 million years.

This event caused the Earth to undergo lethally hot global warming.

Air and sea temperatures were raised and, over a very short period of time, toxic amounts of greenhouse gases were emitted into the atmosphere.

Equatorial ocean temperatures exceeded 40 °C.

The area covered by lava and ash is shown here