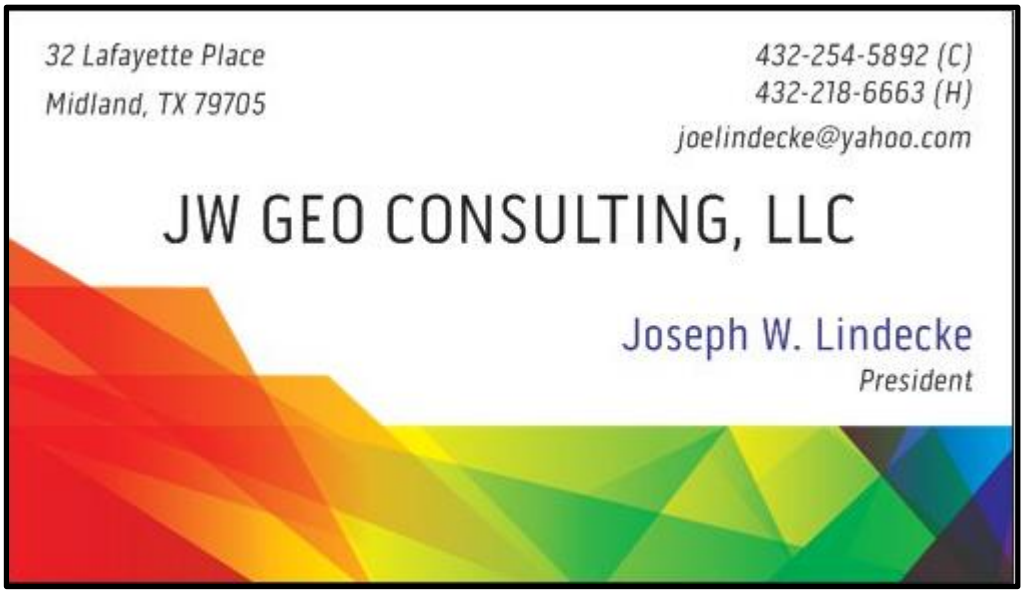
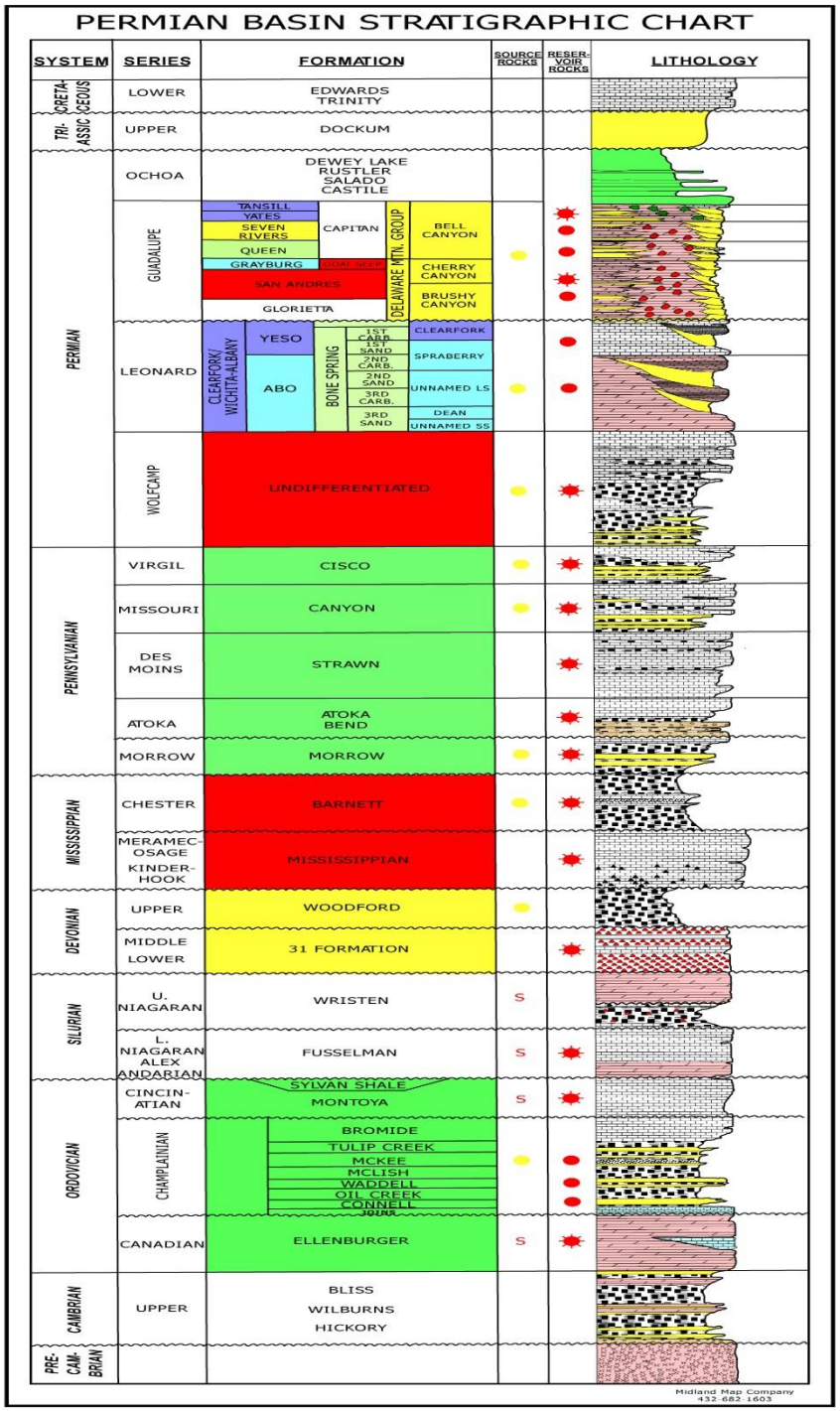


GEOLOGIC HISTORY OF THE PERMIAN BASIN USING PALINSPASTIC RESTORATION

PERMIAN BASIN STRATIGRAPHIC COLUMN



Courtesy Midland Map Company

Continental Drift



In the 1912, Alfred Wegener proposed a hypothesis termed “kontinentalvershiebung” which translates as “Continental Drift”

He proposed that all continents had at one time formed one large land mass which he called Pangaea, which subsequently broke up into the continents we see today

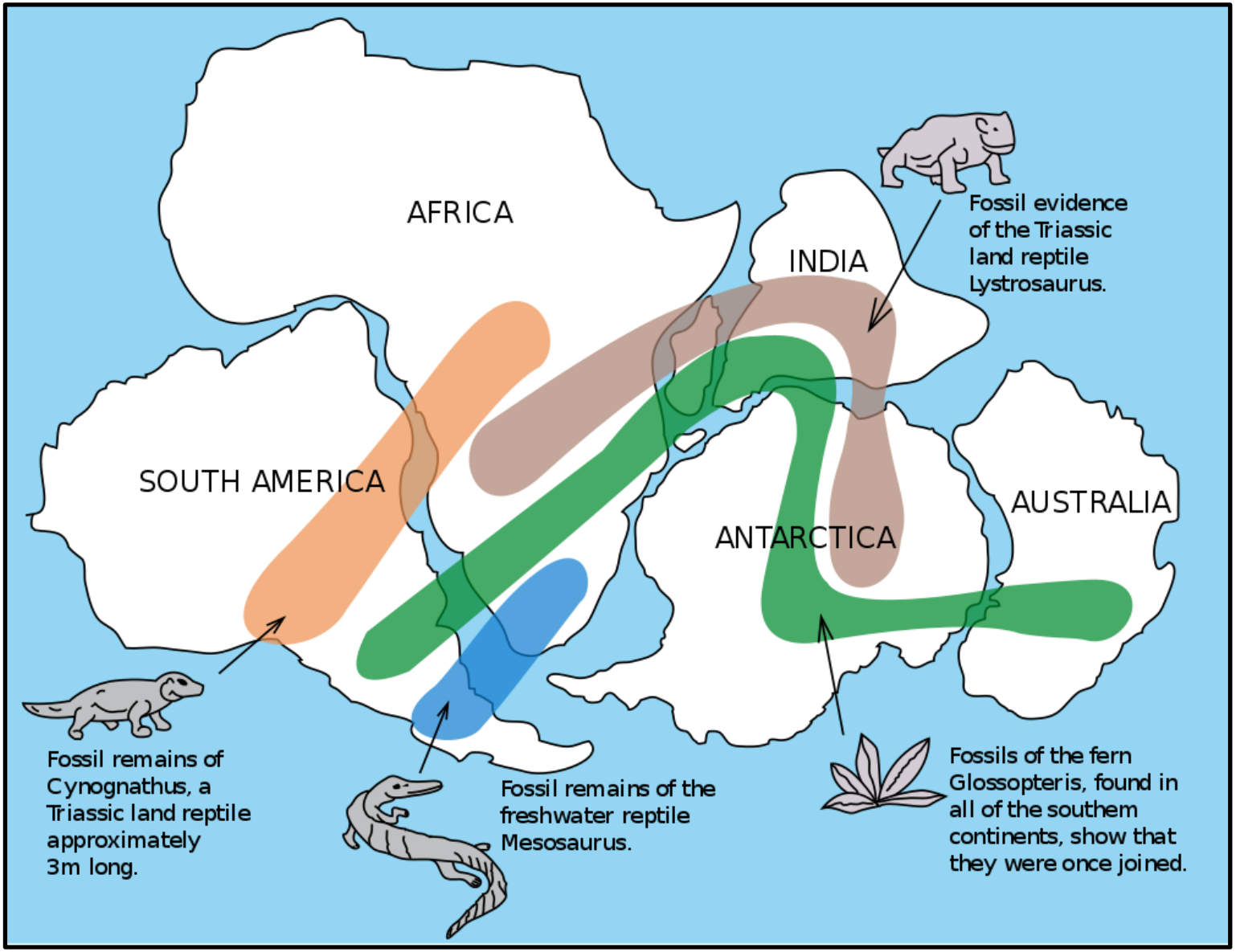
His evidence was that the coastlines of the continents matched each other – look on the map at the eastern coastline of South America and the western coastline of Africa – and that the rocks, fossil ranges, and climate also matched across the boundary

Unfortunately, he did not know how the continents could move!





The ranges of fossil organisms crosses between continents

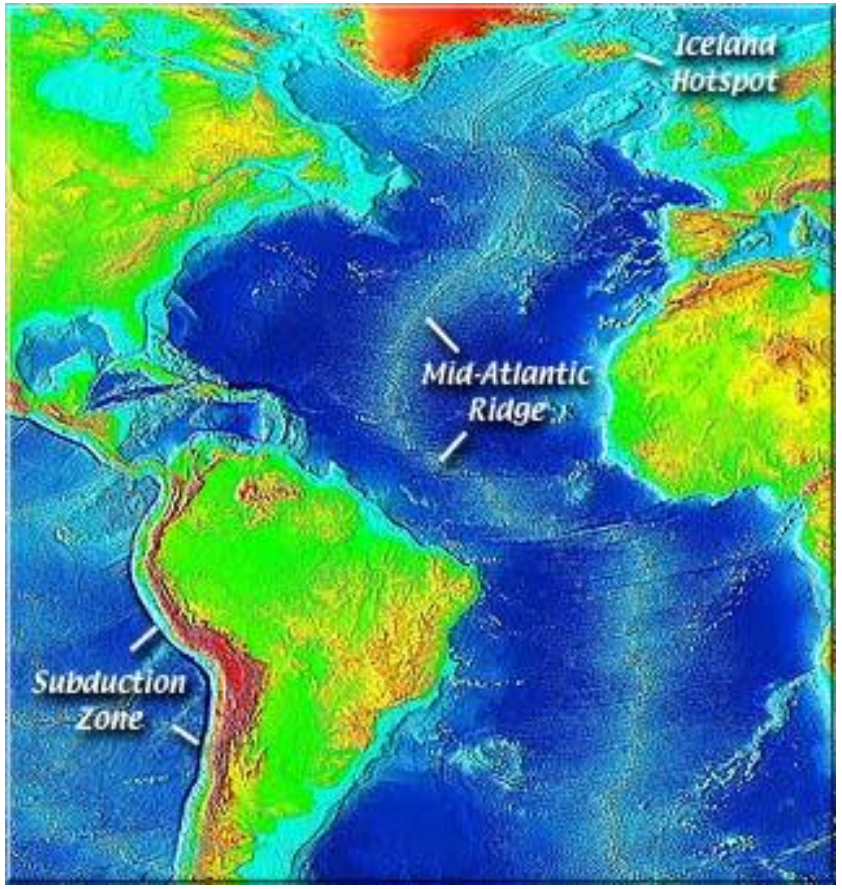


Mapping of the ocean floor began in the late 1940's

A large, sinuous crack was found running through the middle of the Atlantic

Age dating the oceanic crust led to the discovery that the crust nearest the rift was the youngest

As they moved away from the rift, the age of the oceanic crust became older

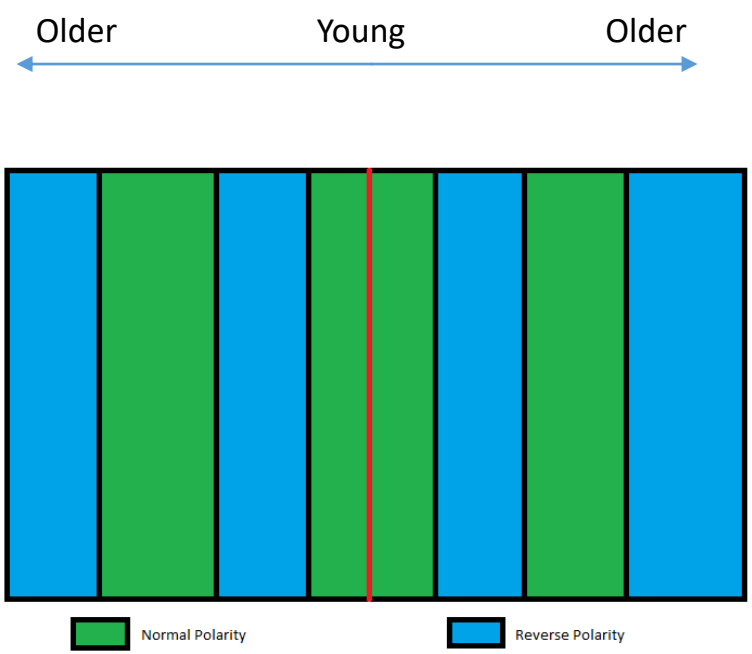


Earth's magnetic field reverses periodically
Currently we are in a period of 'normal' polarity, meaning that our compasses point north
During periods of 'reverse' polarity, a compass needle would point south

When Fe-rich minerals crystallize in a lava, they orient with the magnetic field, thereby acting like a compass needle

When researchers looked at these minerals in oceanic rocks, they noticed that, as they moved away from the rift, the magnetic orientation of minerals in the oceanic crust changed

The pattern of reversals was symmetric on each side of the rift and matched the age progression



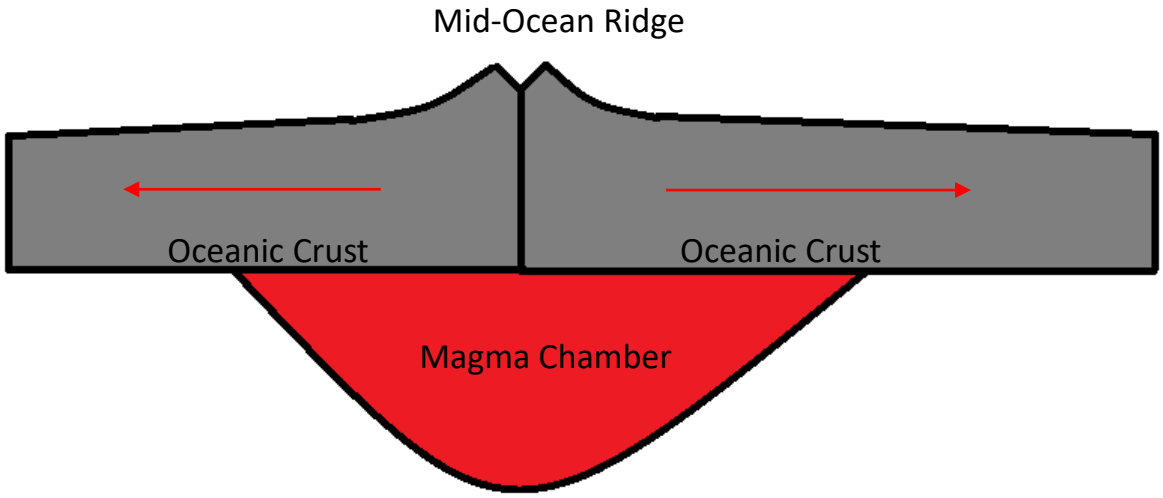
As new crust is formed at the rift, it records the magnetic signature in place at that time

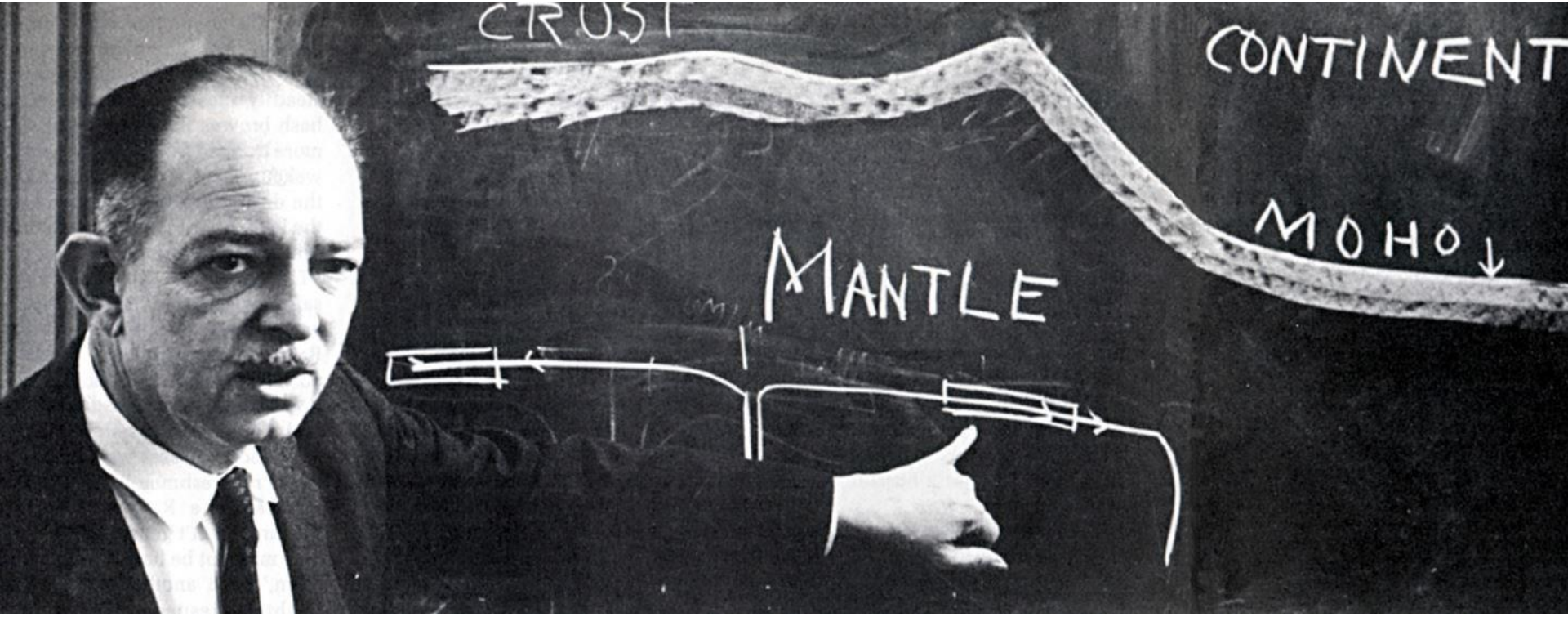
As the process continues, the crust is pushed away from the rift and new crust is again formed

Eventually a magnetic reversal occurs and any new crust formed has the reversed magnetic signature

We end up with a symmetric pattern of polarity reversals on either side of the mid-ocean ridge that matches with the age dating

Harry Hess, a US Navy officer and geologist, termed this process Sea Floor Spreading





Now we have a mechanism for moving the continents apart

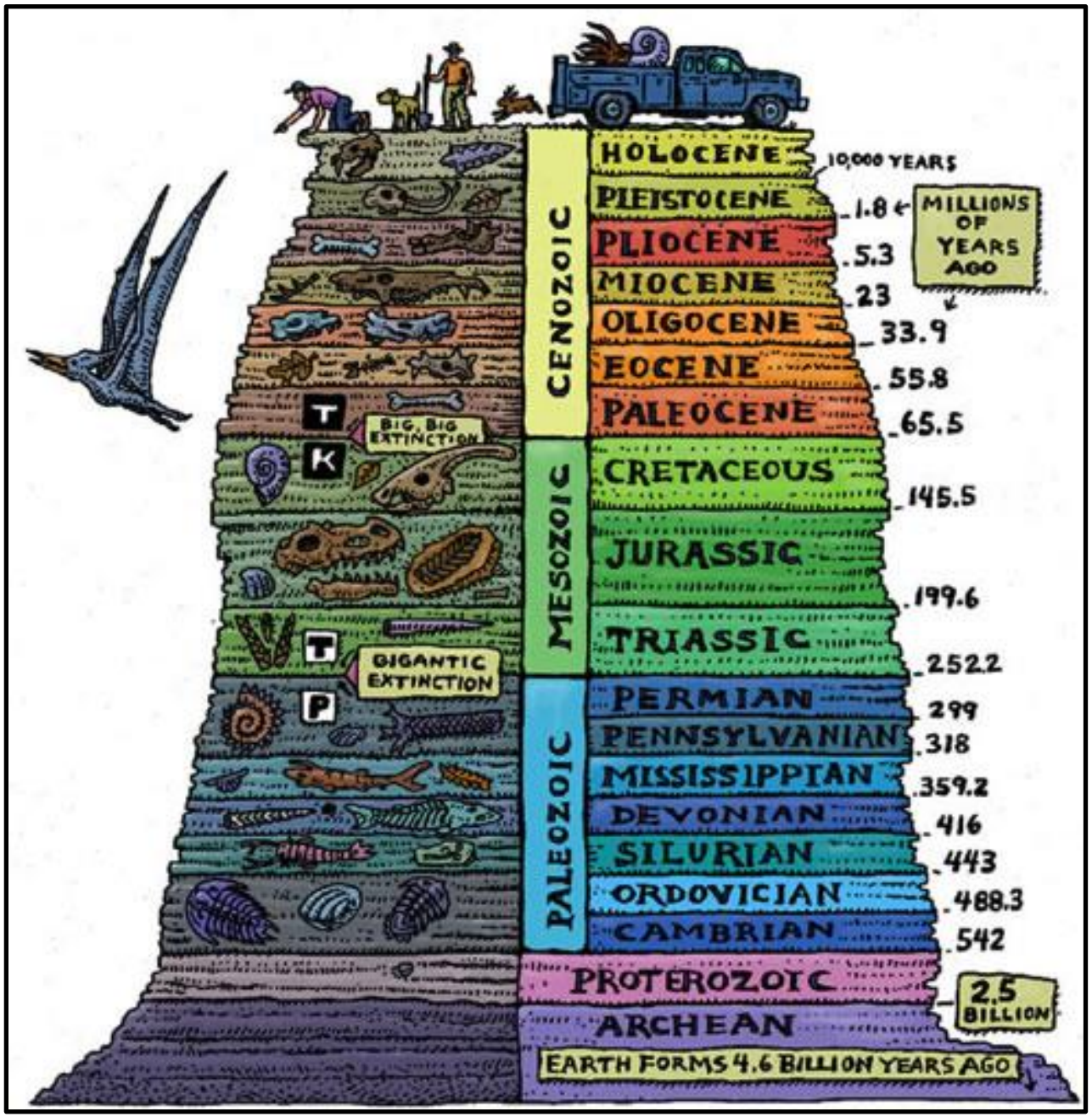
The research performed by Harry Hess led to the development of Plate Tectonic Theory

FOSSIL RECORD

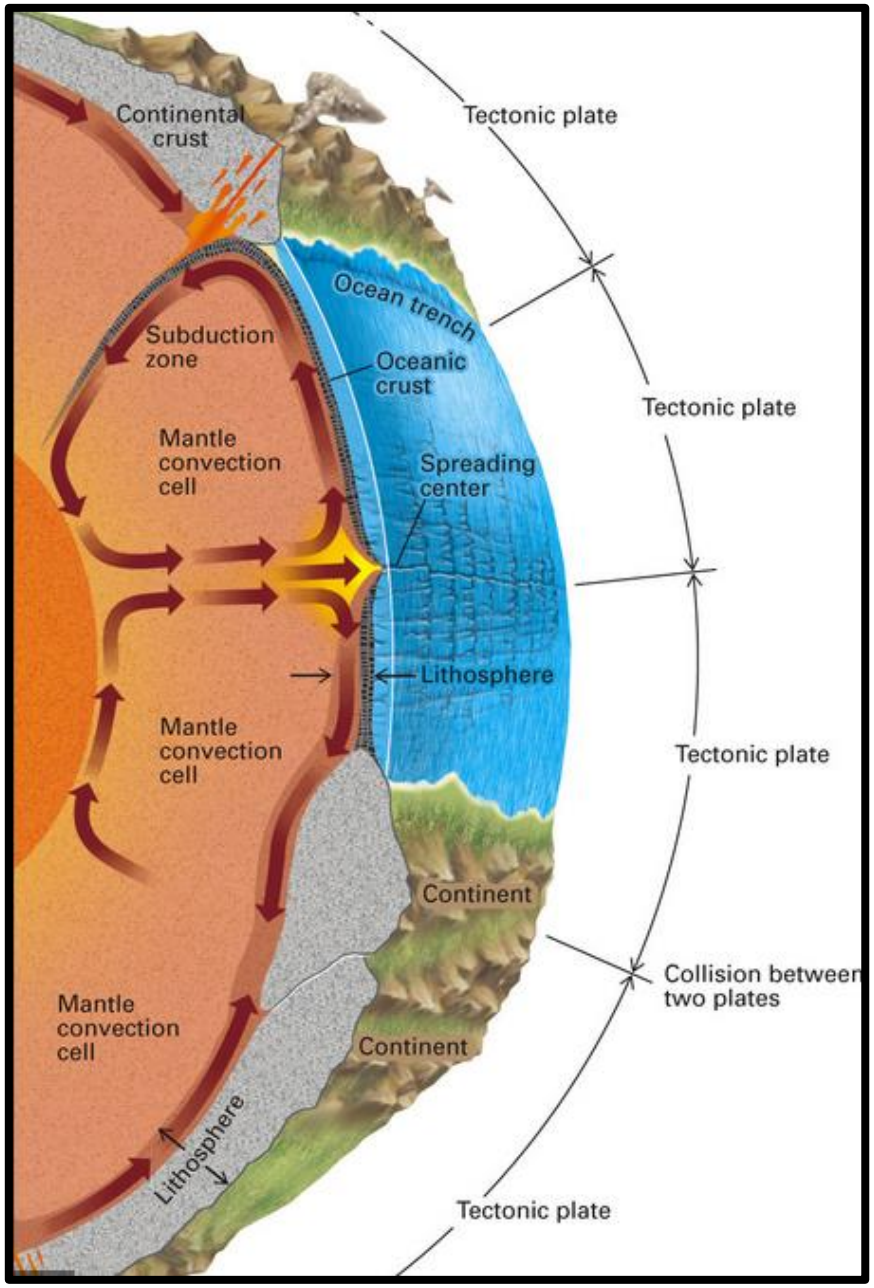
CENOZOIC ERA
AGE OF MAMMALS

MESOZOIC ERA
AGE OF DINOSAURS

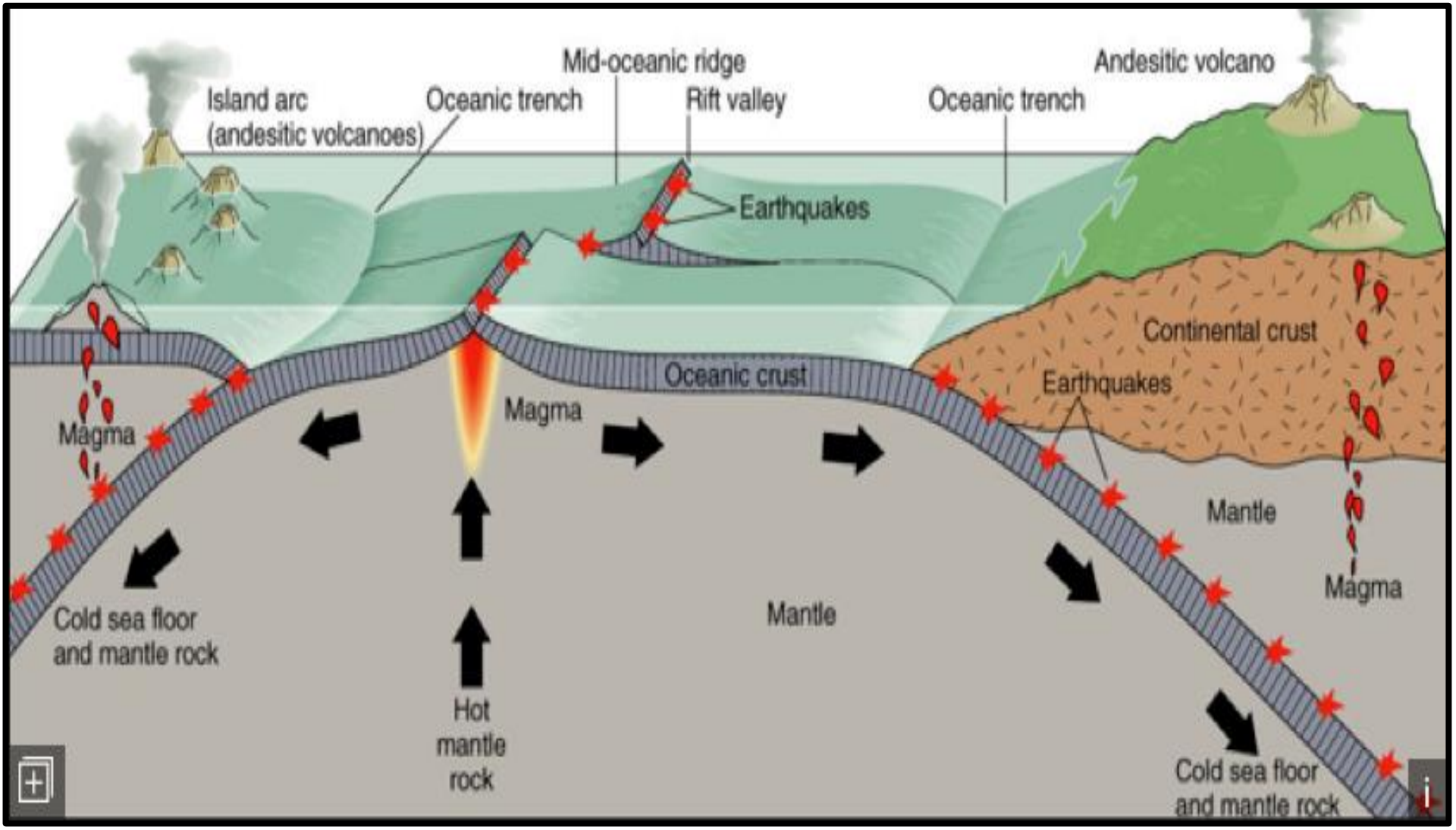
PALEOZOIC ERA
AGE OF PRIMITIVE LIFE



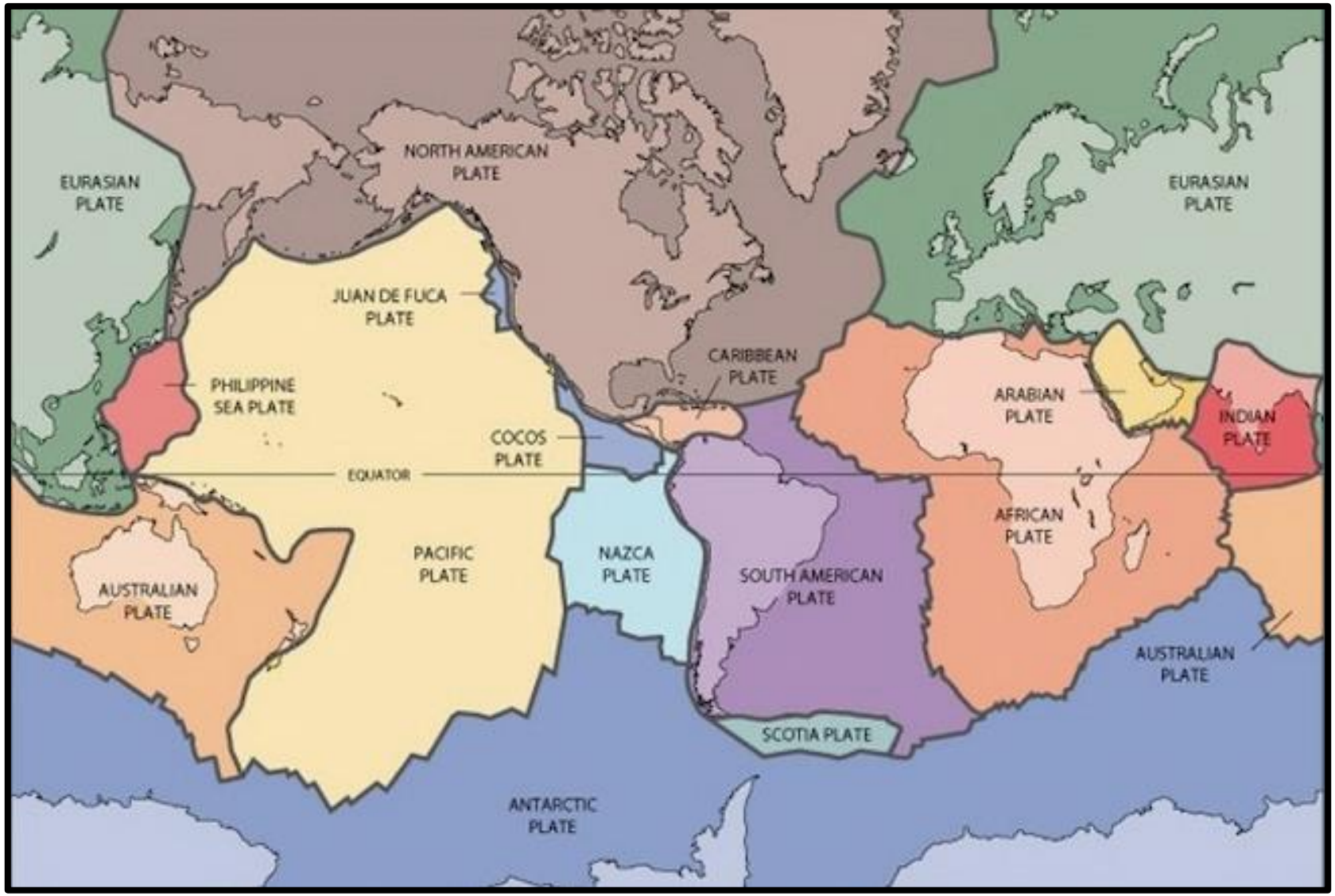
3D VIEW SHOWING TECTONIC PLATES AND KEY EARTH LAYERS



CROSS SECTIONAL VIEW SHOWING TECTONIC PLATES



MAJOR TECTONIC PLATES

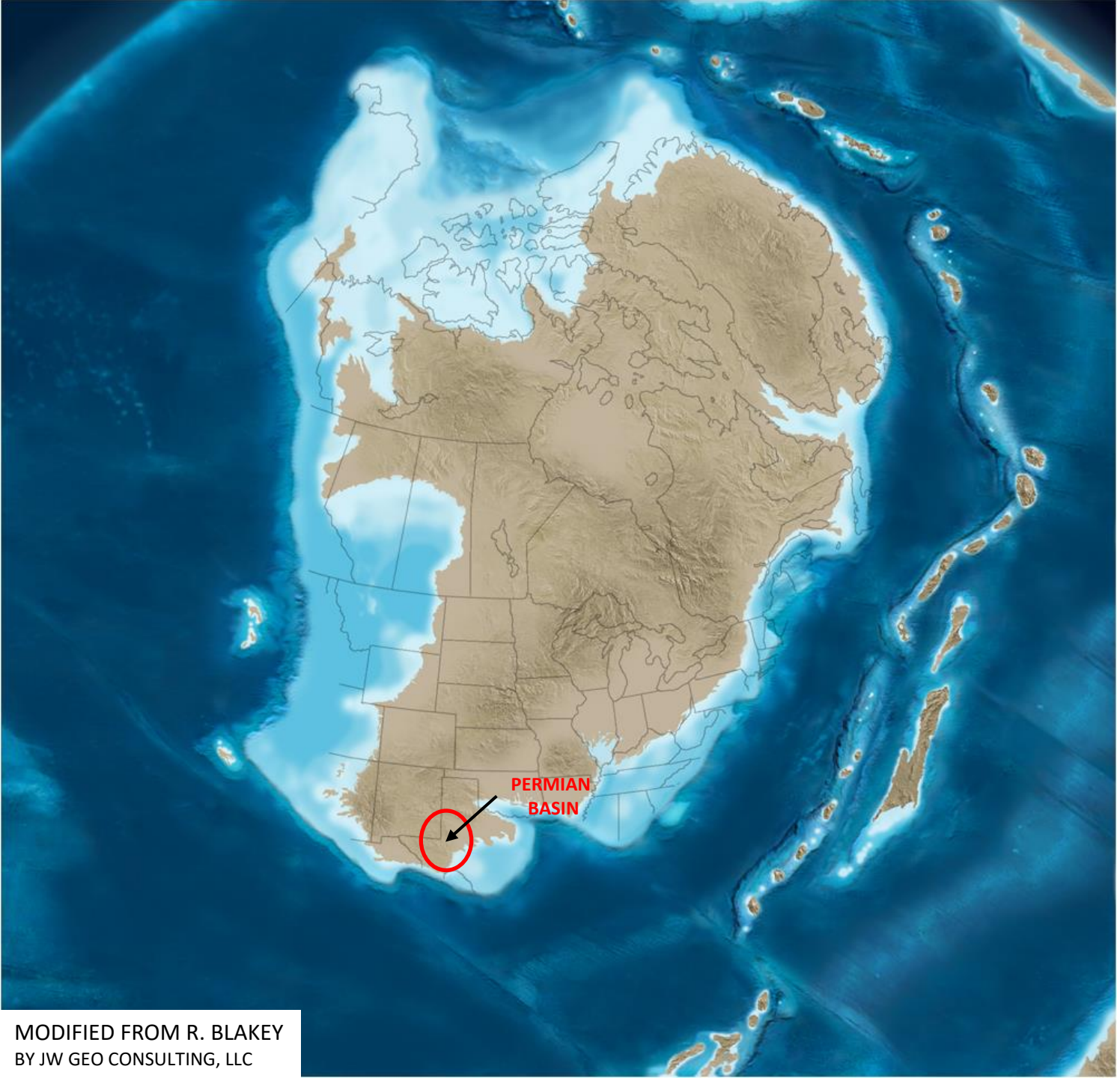




L. Precambrian
550 Ma

Permian Basin Area
Terrigenous Period
(Non-deposition)

MODIFIED FROM R. BLAKEY
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E. Cambrian
510 Ma

Permian Basin Area
Mostly Exposed
(Period of Non-deposition
Except in SE portion – Riley SS)

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Early Ordovician
485 Ma



Permian Basin Area
Shallow Shelf Platform Sea
Deposition of
Ellenburger Limestone

ORDOVICIAN	Upper	Montoya	Montoya
	Middle	Simpson	Simpson
	Lower	Ellenburger Group	Ellenburger Group

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Middle Ordovician
470 Ma



Permian Basin
Shallow Shelf Platform Sea
Deposition of
Simpson Limestone

ORDOVICIAN	Upper	Montoya	Montoya
	Middle	Simpson	Simpson
	Lower	Ellenburger Group	Ellenburger Group

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Late Ordovician
450 Ma

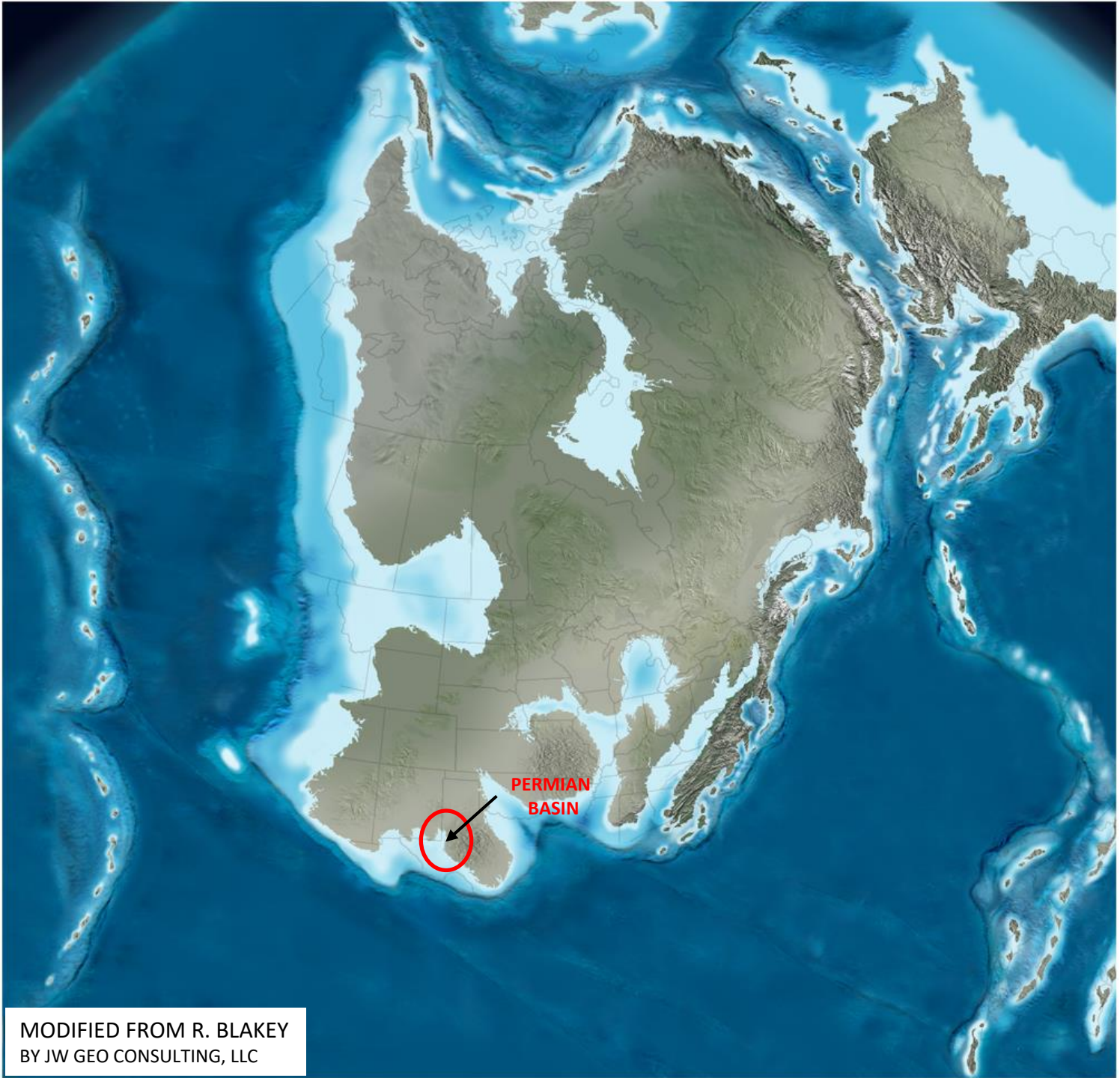


Permian Basin
Shallow Shelf Platform Sea
Deposition of
Simpson/Montoya Limestone

ORDOVICIAN	Upper	Montoya	Montoya
	Middle	Simpson	Simpson
	Lower	Ellenburger Group	Ellenburger Group

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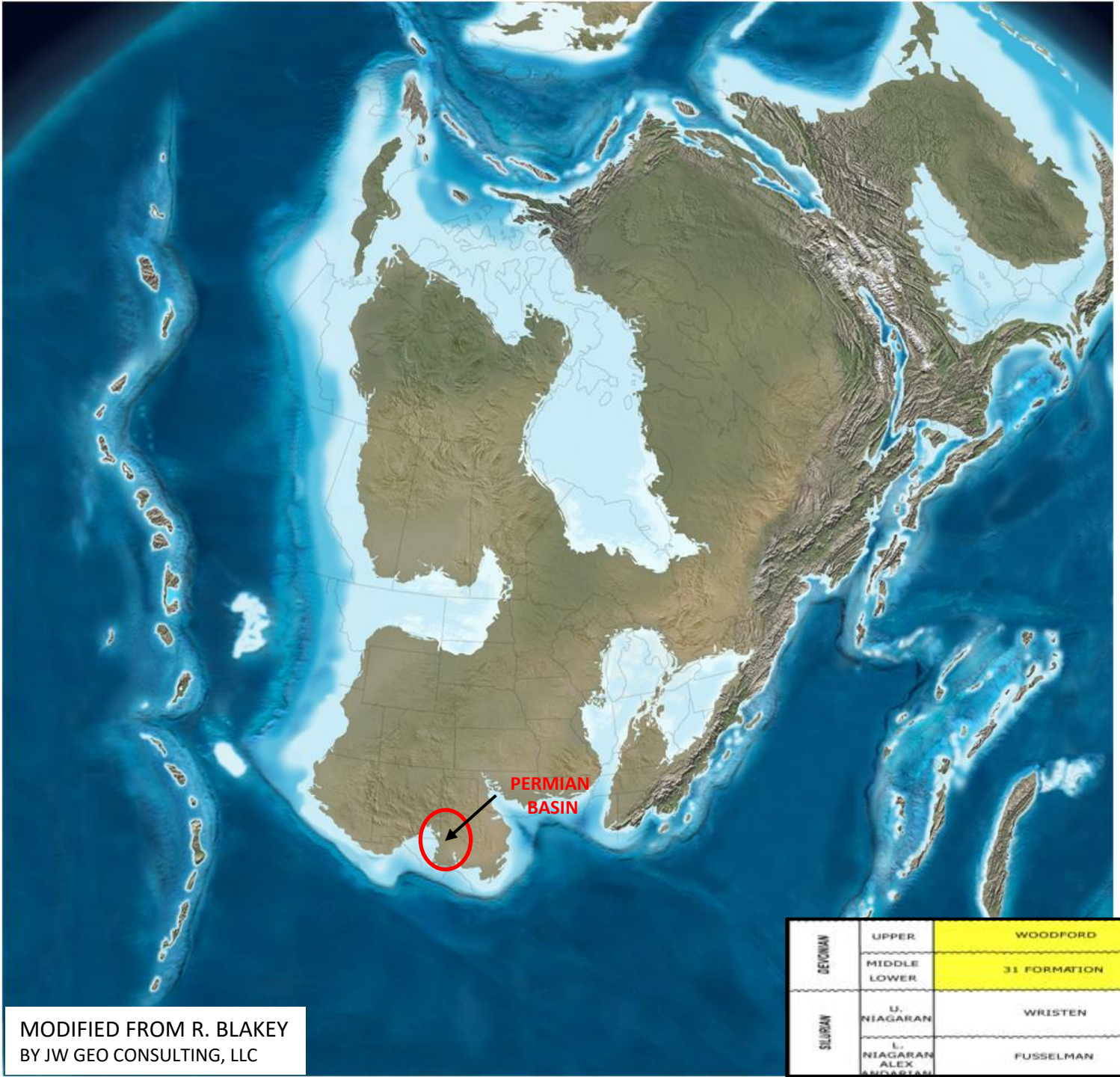
Early Silurian
430 Ma



Permian Basin
Sub-Aerial Exposure
Erosion & Karsting of
Ellenburger Limestone

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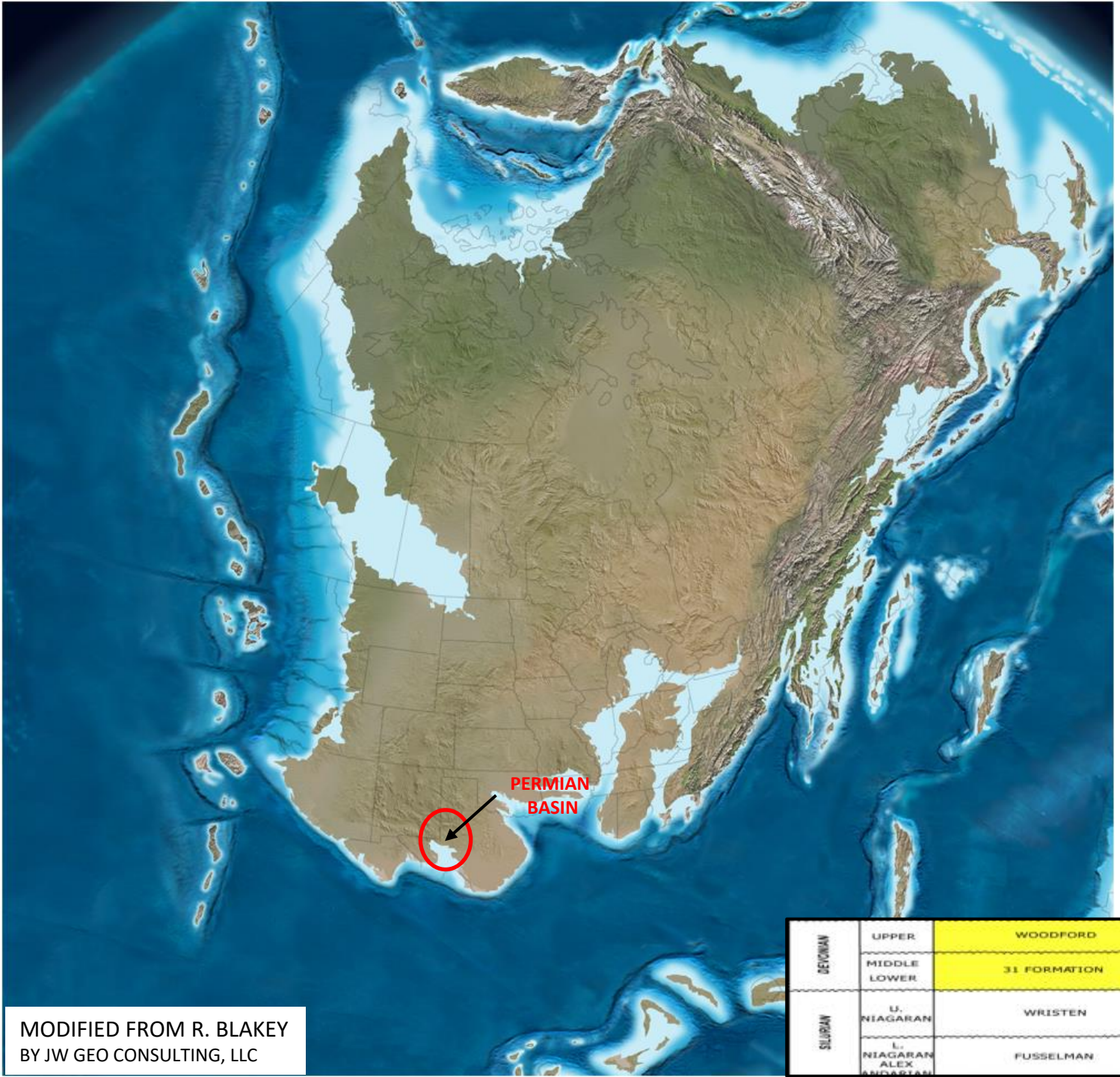
Late Silurian
420 Ma



Permian Basin
Sub-Aerial Exposure
Erosion & Karsting of
Ellenburger Limestone

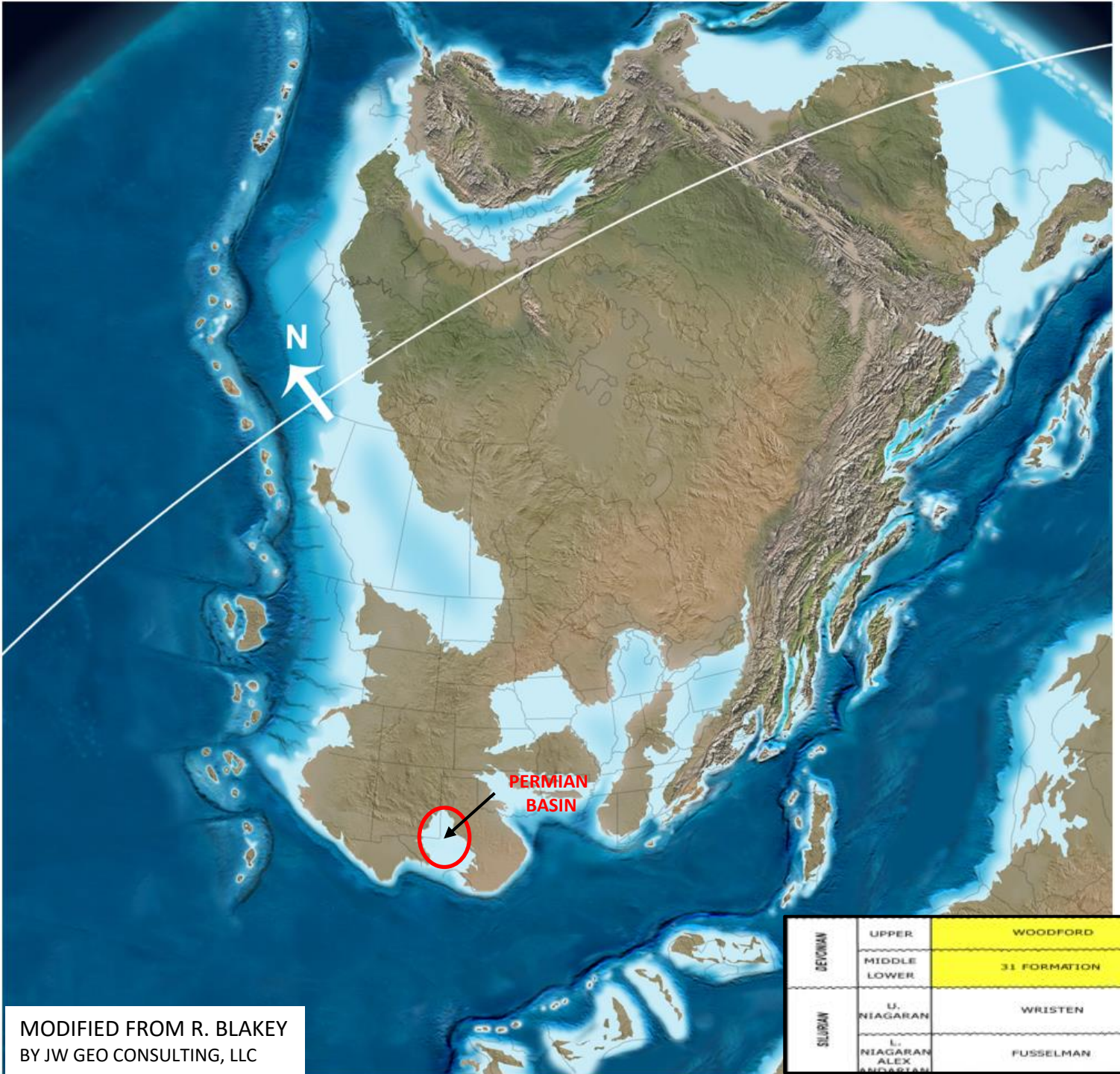
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Early Devonian
400 Ma



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Middle Devonian
385 Ma



Permian Basin
Shallow Shelf Restricted Sea
Deposition of Fusselman,
Wristen & Thirtyone Limestone
Notice Convergence of
Continents Beginning

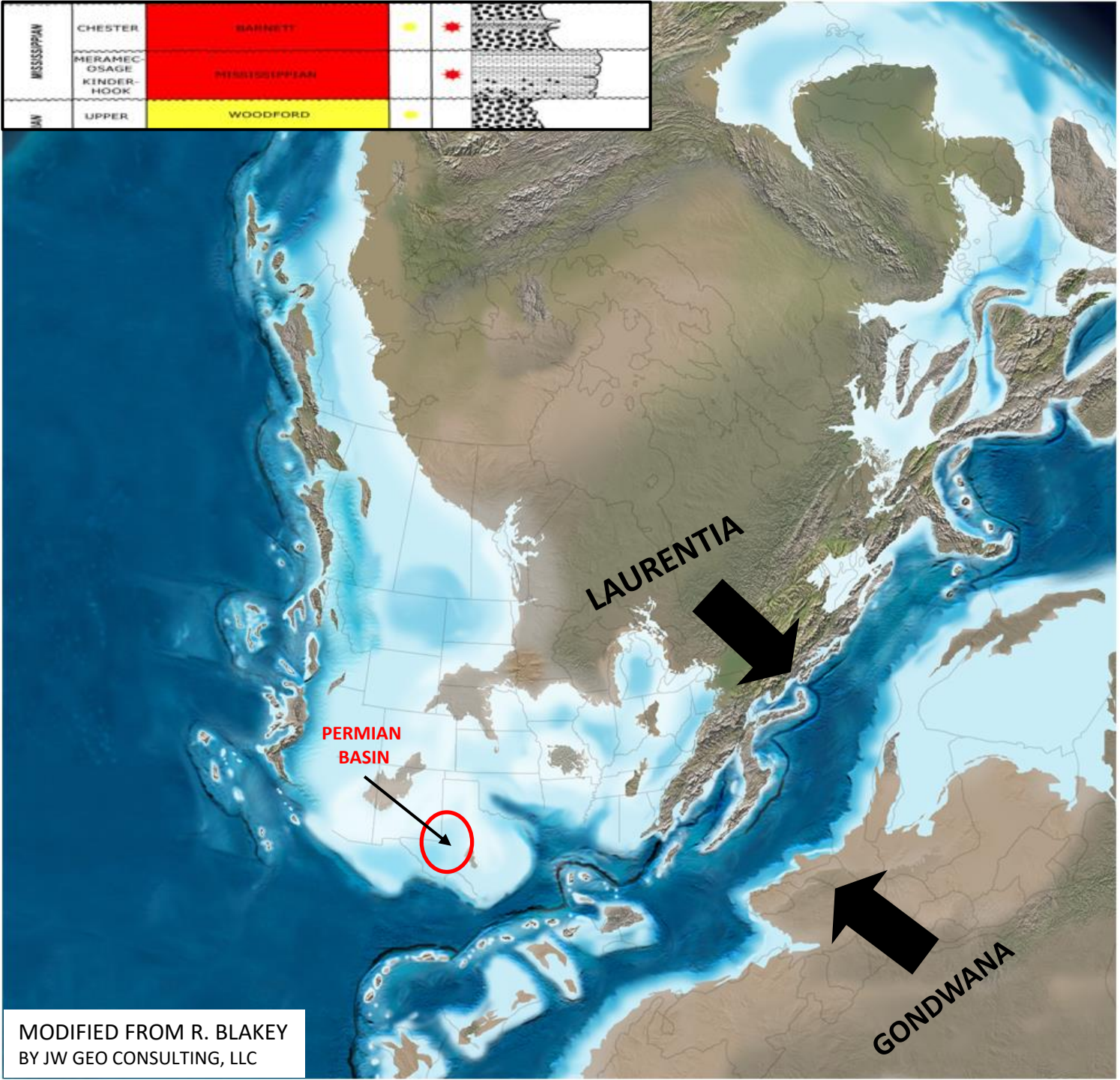
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Late Devonian
360 Ma

Permian Basin
Shallow Shelf Sea
Early Deposition of
Woodford Shale/Siltstone

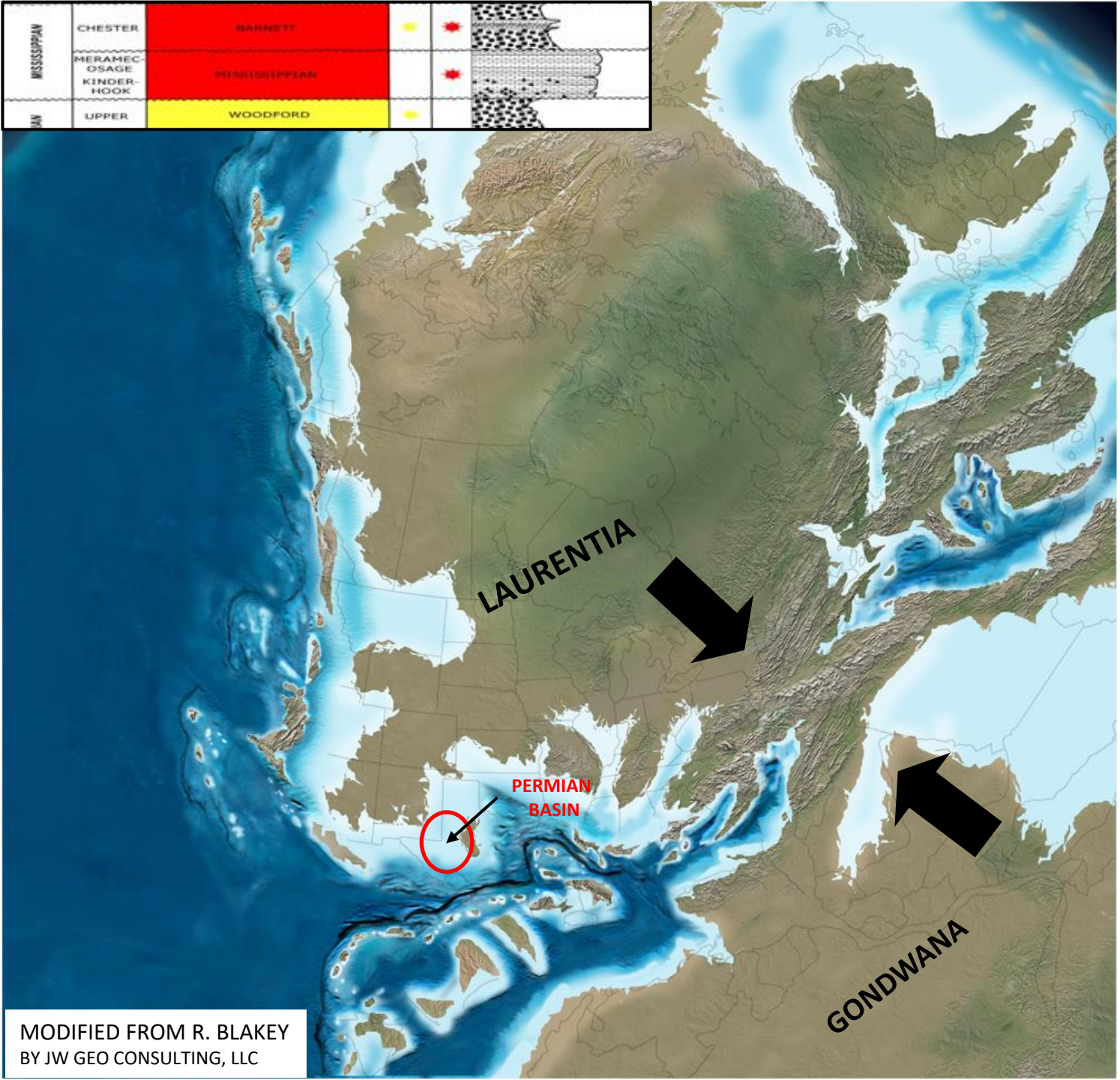
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Early Mississippian
345 Ma

Permian Basin
Shallow Shelf Sea
Later Deposition of
Woodford Shale &
Mississippian Limestone

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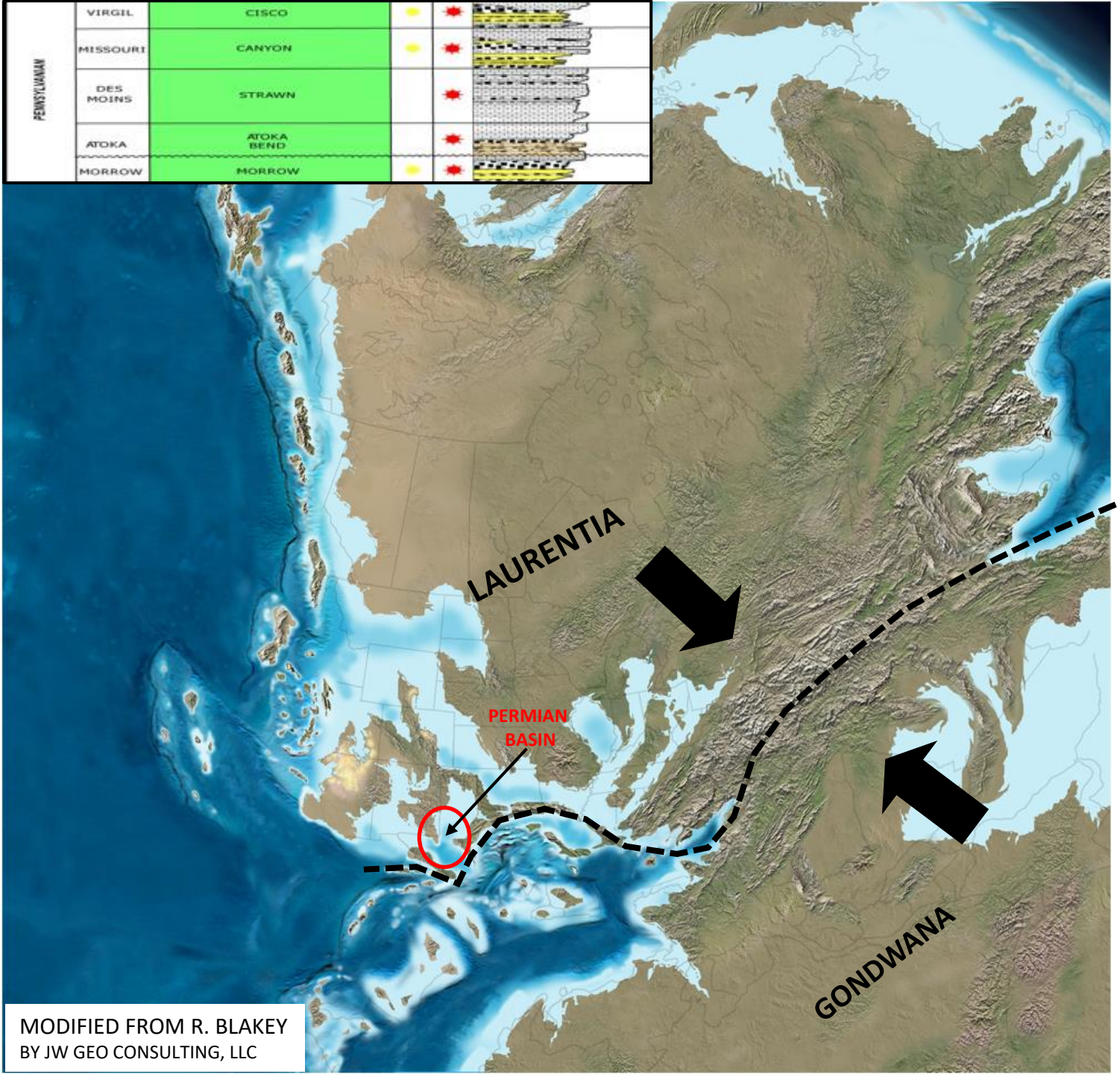
Late Mississippian
325 Ma

Continental Collision Begins
Starts in Appalachians &
Zippers Down Into Ouachitas
Failed Arm/Rift Starts to
Form Anadarko Basin &
Wichita Uplift

Permian Basin
Shallow Shelf Sea
Deposition of
Mississippian Limestone

BEGINNING OF THE FORMATION OF SUPERCONTINENT PANGEA!

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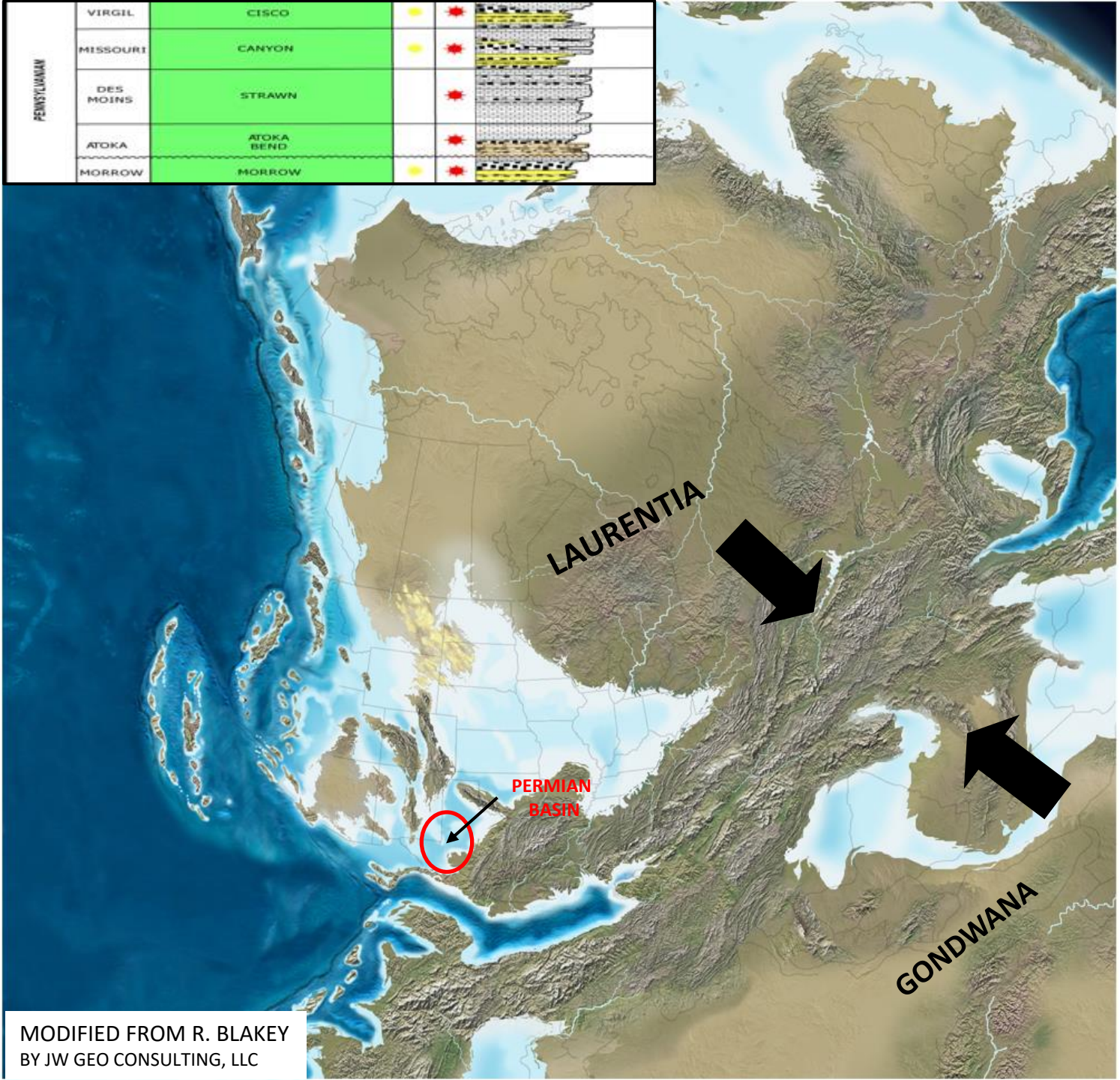


Early Pennsylvanian
315 Ma

Collision Continues
Zippers Down Into Ouachitas & Farther Southwest Into Marathon Overthrust

Permian Basin
Restricted Basin
Anoxic Environment
Organic Shale Deposition
(Atoka Shale, Strawn Shale & Limestone)

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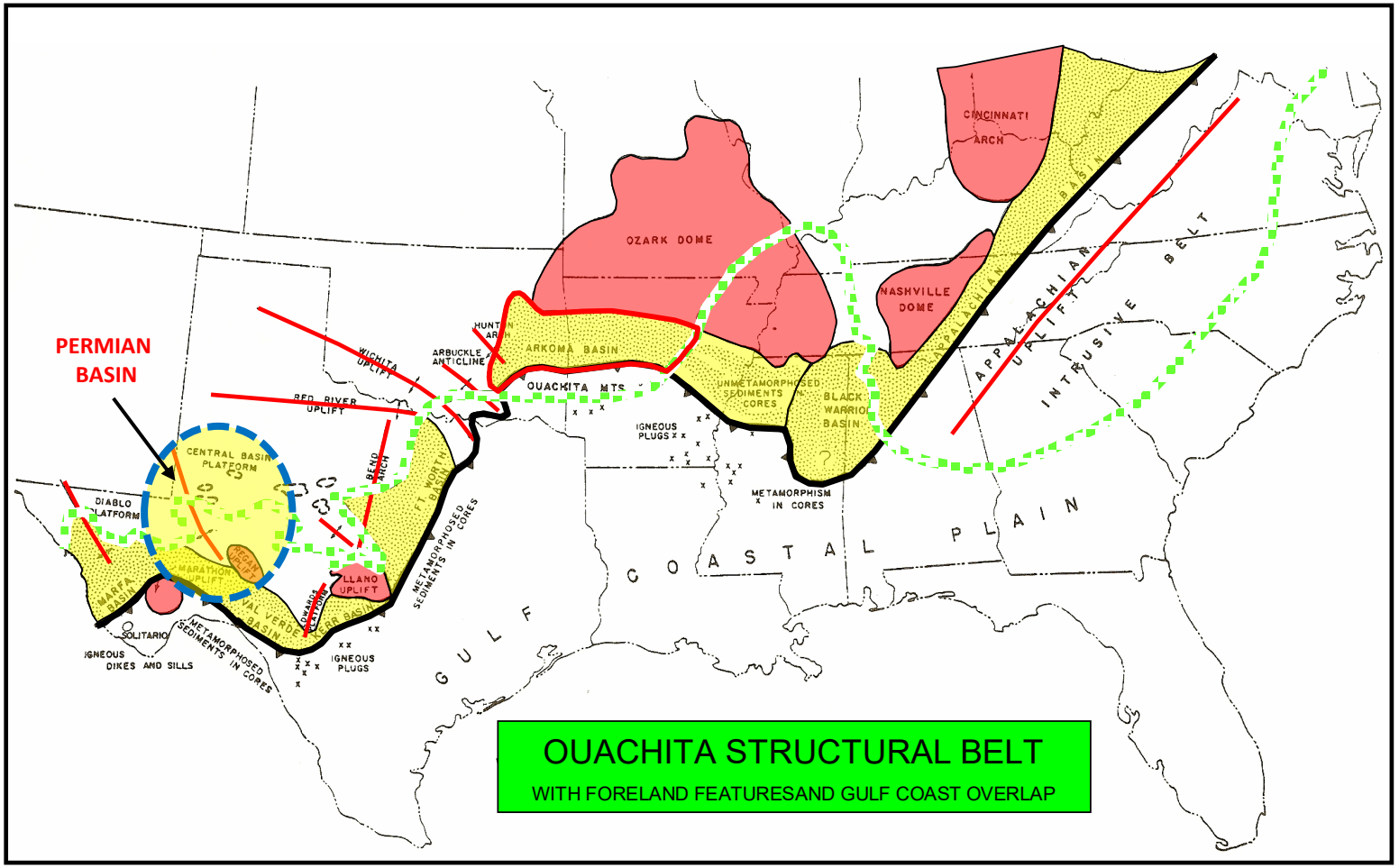


Late Pennsylvanian
300 Ma

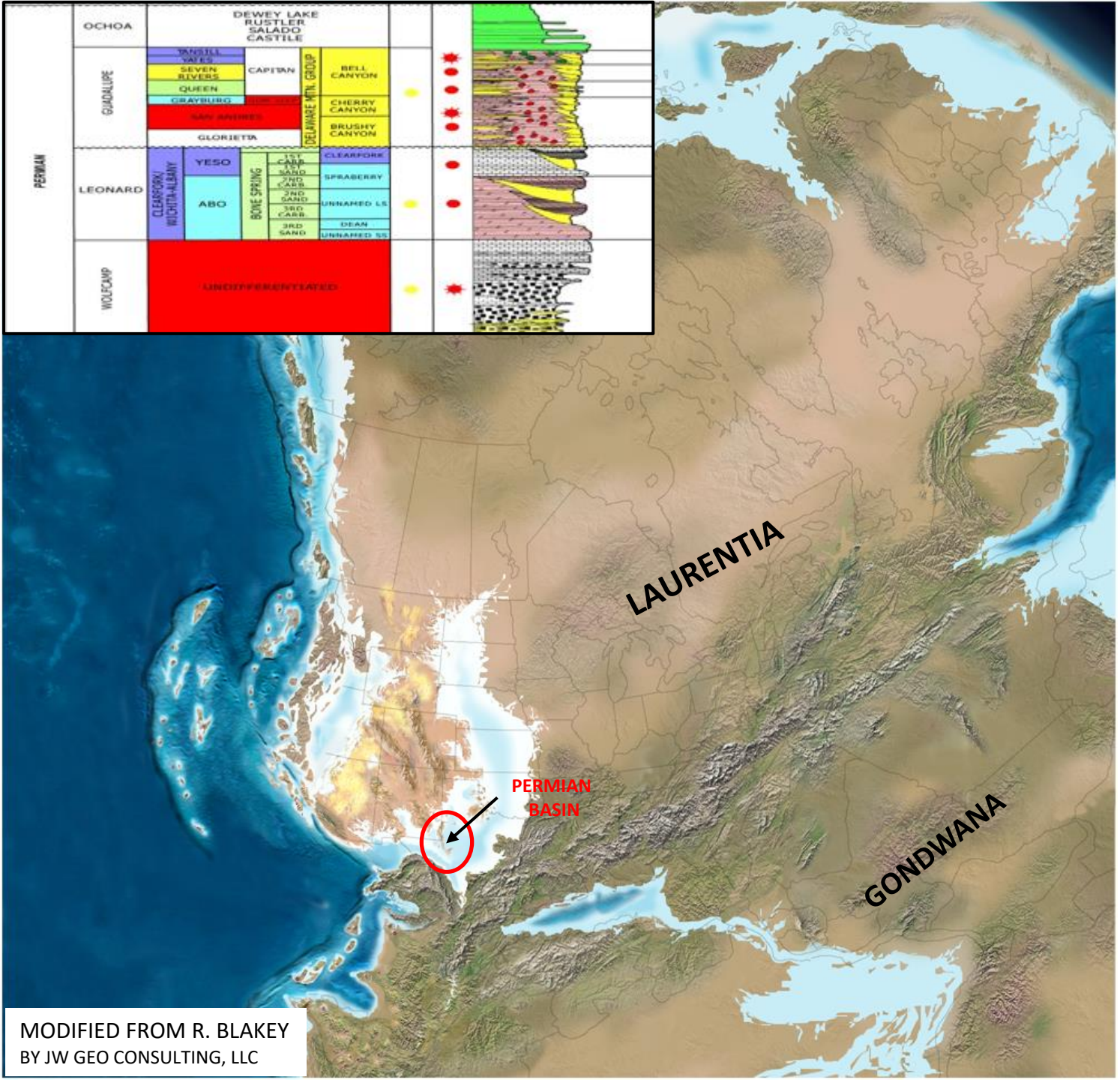
Permian Basin
Restricted Basin
Anoxic Environment
Organic Shale Deposition
(Cline Shale)
Cisco/Canyon

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EFFECTS OF PENNSYLVANIAN AGE CONTINENTAL COLLISION



Crustal Shortening (Overlap) Estimated at >25 miles
(Lindecke & Patterson 2005)

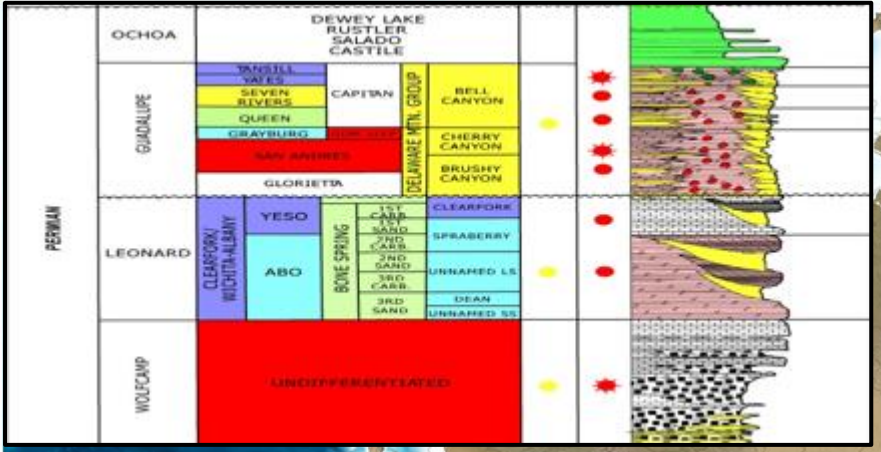


Early Permian
290 Ma

Permian Basin
Inland Basin (Sea) Develops
Shallow Water Carbonates
Wolfcamp Platform, Reef &
Detrital Carbonates
Exposure of Central Basin
Platform

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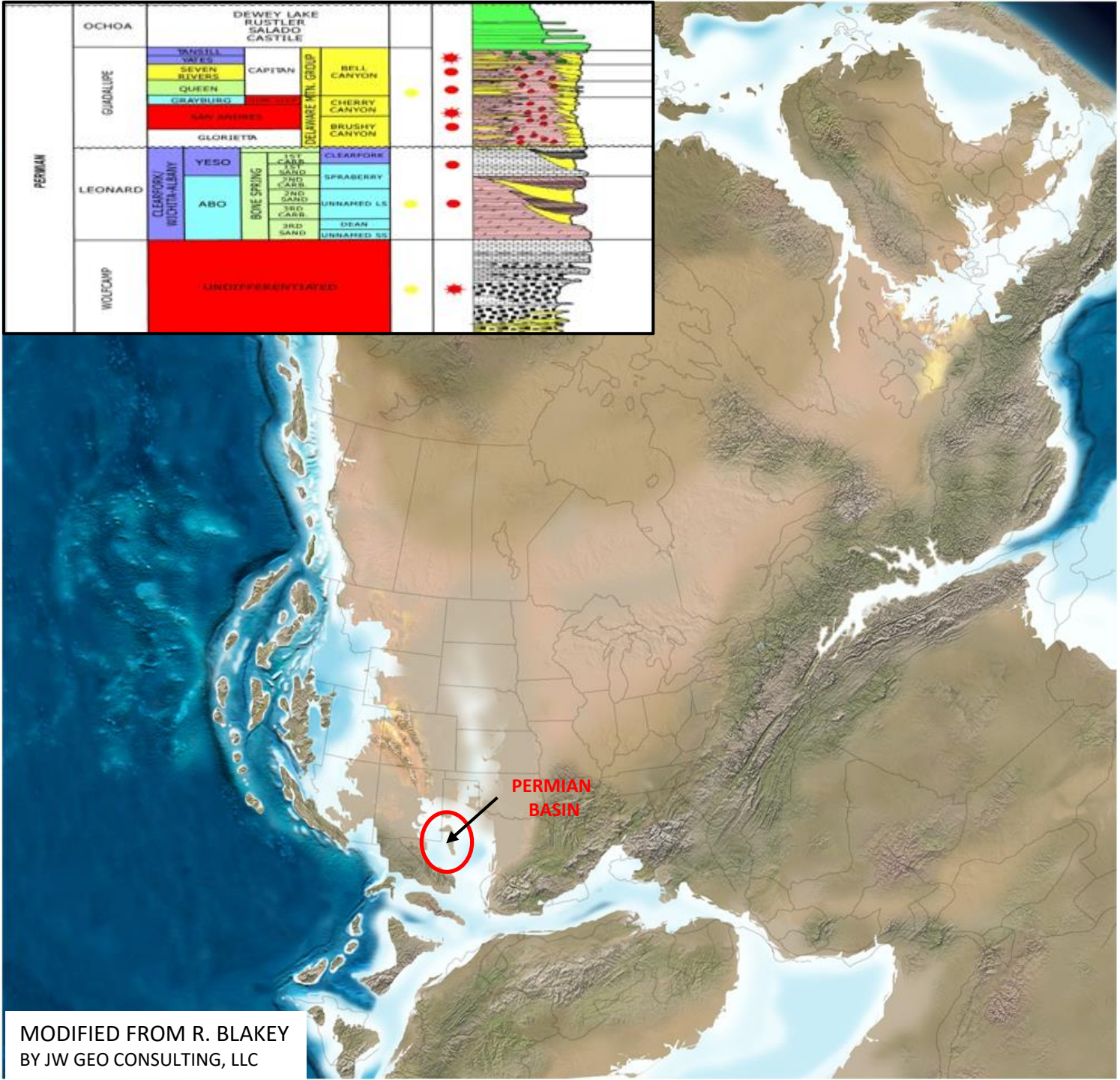
Middle Permian
275 Ma



Permian Basin
Pronounced Separation of Delaware & Midland Basins By Central Basin Platform Deposition of Wichita Albany & Clearfork

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Late Permian
260 Ma



Permian Basin
Deposition of Spraberry
(Main Transport Direction
North to South)
Before Uplift & Erosion

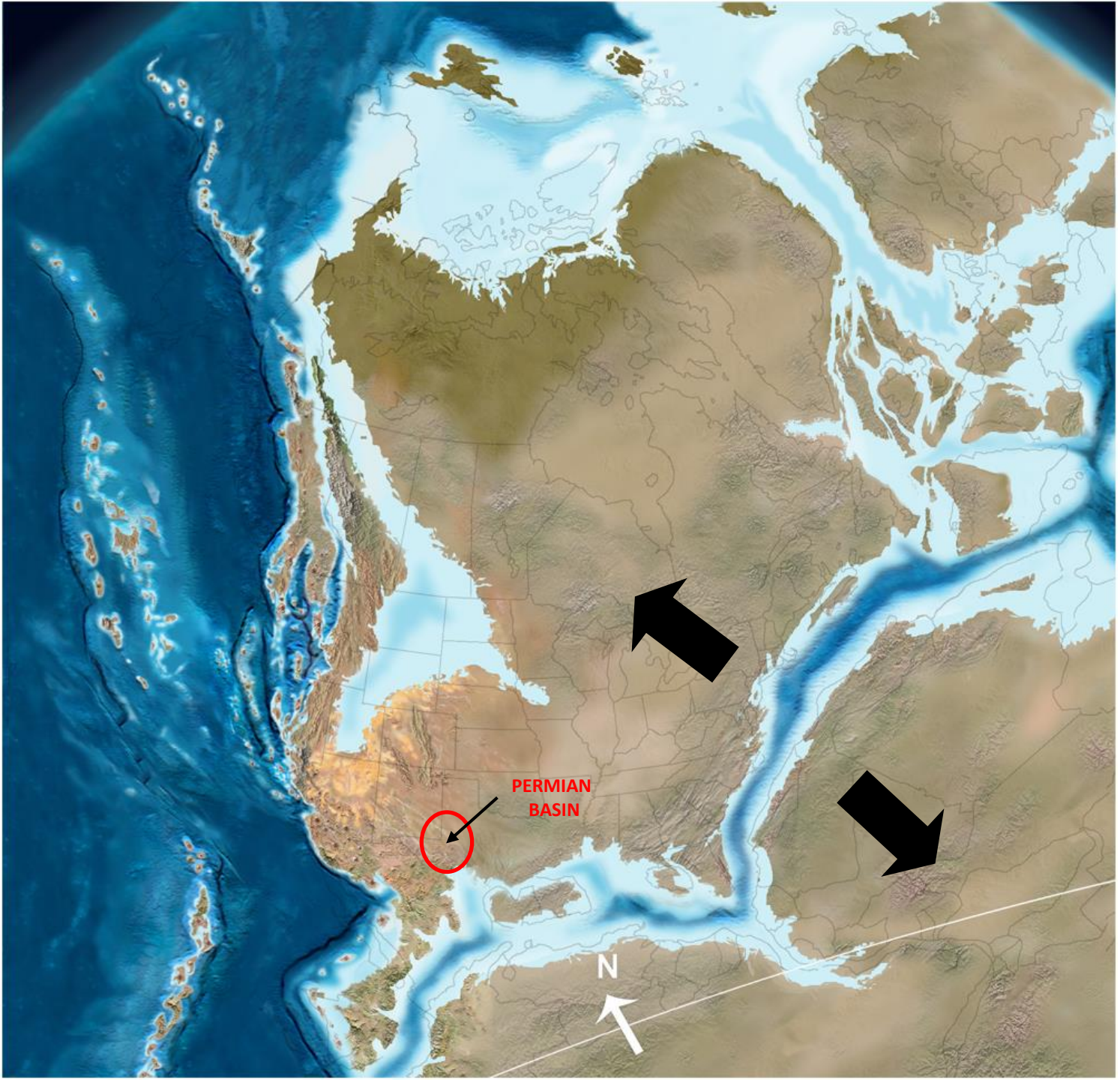
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E. Triassic
245 Ma

Permian Basin
Entire Basin Sub-Aerially Exposed
Near Equator

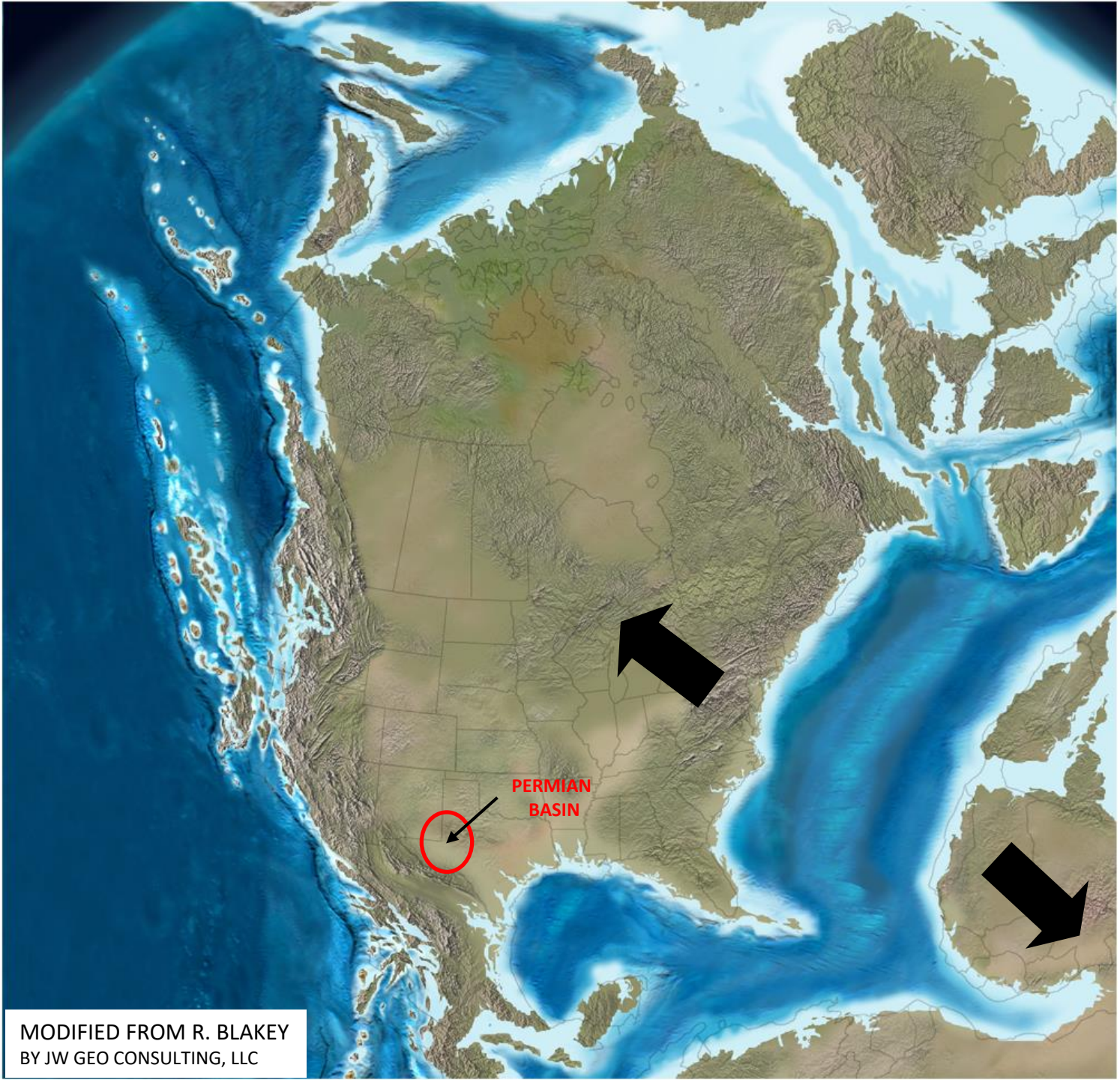
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M. Jurassic
170 Ma

Permian Basin
Exposed

Continents Begin to Pull Apart Again



E. Cretaceous
130 Ma

Permian Basin
Exposed

Note Beginning Development
Of Gulf of Mexico and
Florida Peninsula
Rocky Mountains Forming

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L. Cretaceous
85 Ma

Permian Basin
Part of Inland Shallow Sea

Relative Sea Level Rise
SE US Shallow Shelf Sea

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K/T Boundary
65 Ma

Permian Basin
Exposed Again

Pacific Plate Convergence
And Subduction Causes
Western Mountain Ranges
And development of Alaska

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Miocene
15 Ma



Prior to Ice Age
Notice No Polar Ice Cap
No Great Lakes
Florida is a Shallow Sea Platform
East Coast is a Flooded Shoreline

Notice Alaska Attached To Russia

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Pleistocene
0.126 Ma

ICE AGE



Polar Ice Cap Covers
Most of Canada & Northern
US & Greenland

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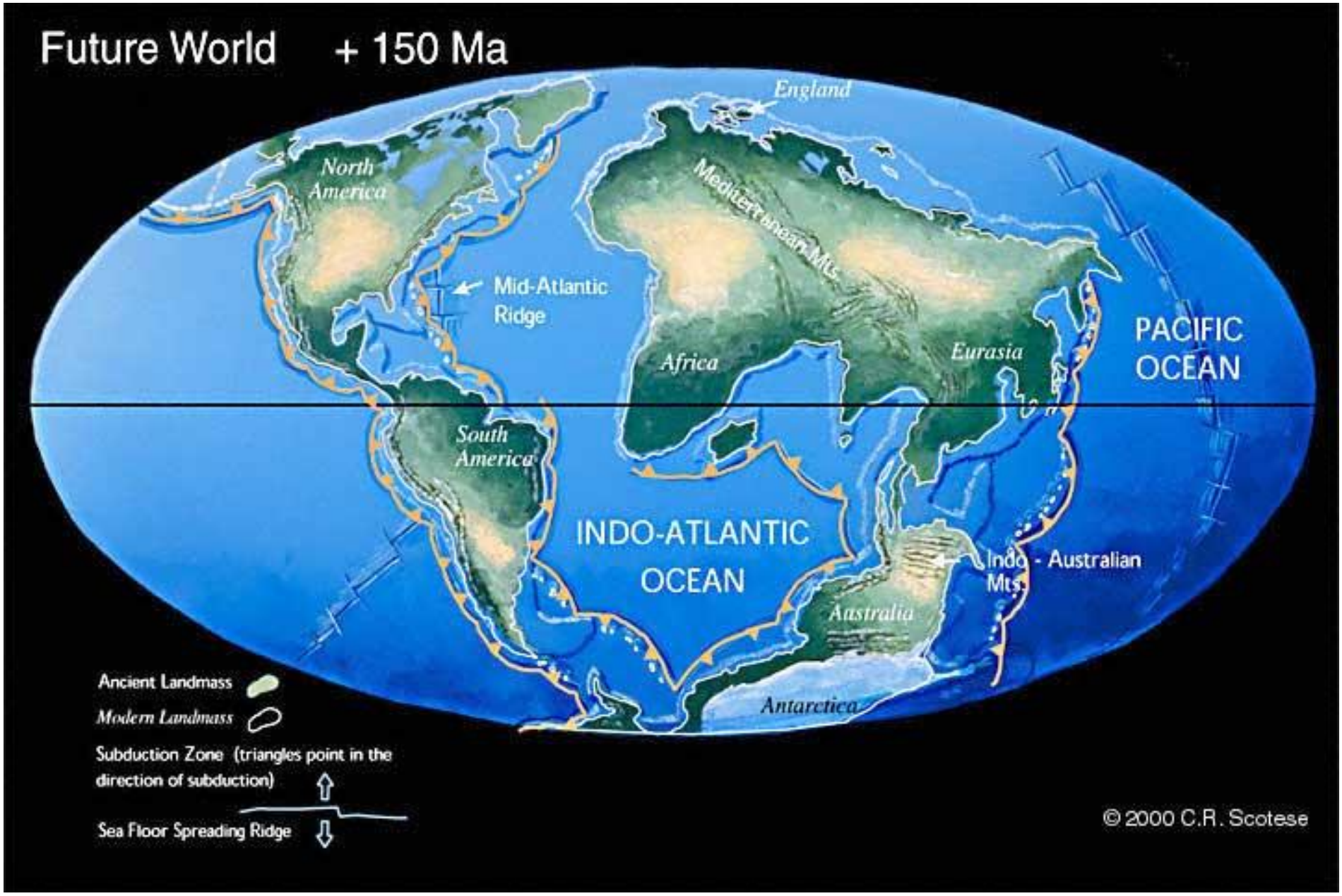


Holocene
0 Ma

PRESENT DAY

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A PREDICTION OF WHAT THE EARTH WILL LOOK LIKE IN 150 MILLION YEARS



Depositional Environment

Upper Cambrian to Mississippian

This period is characterized by passive margin tectonics following the post-rifting stage of the breakup of the Precambrian supercontinent Laurentia.[3] There was significant shallow marine deposition into the ancestral Tobosa Basin during this time, resulting in thick shelf carbonate and shale accumulations.

Upper Mississippian to lower Permian

Most of the present day structural elements of the Permian Basin were formed during Variscan collision in the Upper Mississippian. This differentiated the Delaware and Midland basins with a central structural high, and led to significant siliciclastic deposition in the deeper basins, particularly in the Pennsylvanian.[3] During the lower Permian, significant carbonate shelf deposits formed, particularly along the edges of the basins and in the Central Basin Platform.[4] Carbonates such as these are exposed at the Capitan Reef outcrop locales in Guadalupe, Glass and Apache Mountains of New Mexico.

Upper Permian

Through the Permian, several kilometers of sediment accumulated in the Delaware and Midland basins. There are essentially five different types of deposits which correspond to the five sub-environments of deposition found in the region. The low-energy deep basin deposits are comprised primarily of organic-rich shales and siltstones, with occasional turbidite sheet sands. In the slope environment, a combination of shales and reworked shelfal sediments were deposited. The shelf margin environment is characterized by reworked transgressive sediment and high-energy carbonate buildups. The shallow marine shelf environment was dominated by bioturbated limestones, while in the supra tidal environments beach and bar facies are interbedded with algal mat deposits.[3]

Tectonic History

Lower Paleozoic

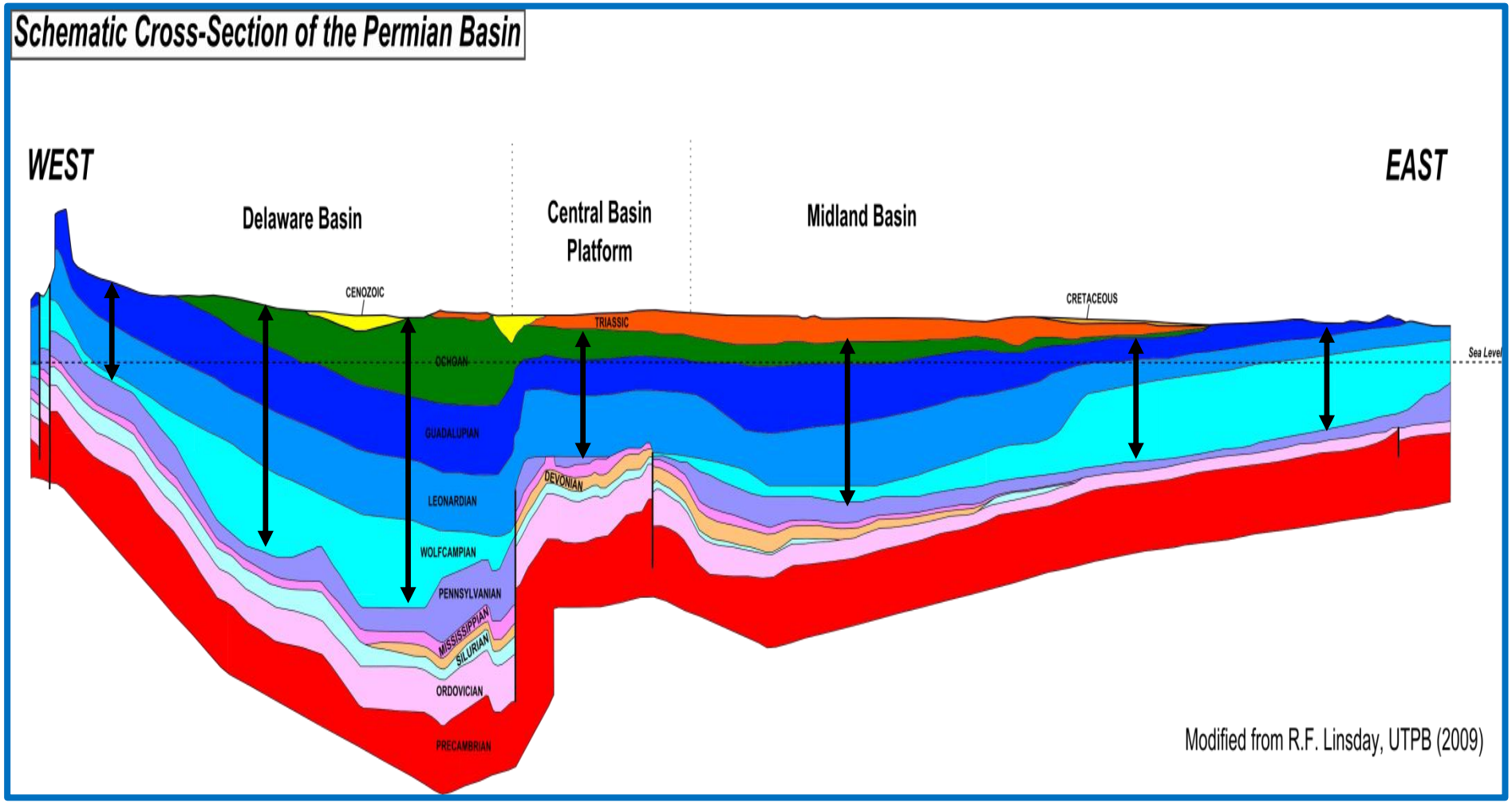
In the lower Paleozoic, the Permian Basin region was home to a passive continental margin following the breakup of Laurentia. Slow subsidence formed the Tobosa Basin. This continued until the upper Mississippian.[3]

Ouachita-Marathon Orogeny

Towards the end of the Mississippian, the Hercynian Orogeny formed the Oauchita-Marathon thrust belt and deformed the Tobosa Basin into two foreland basins (Delaware and Midland basins). These basins were separated by a structural high, the Central Basin Platform. Uplift of areas surrounding the new basins provided provenance for large volumes of siliciclastic sediment to be deposited in both the Midland and Delaware basins through the Pennsylvanian.[3]

Permian Basin Stage

Through the Permian, stable tectonic conditions combined with subsidence of the Delaware and Midland basins allowed for the fill of these basins with nearly four kilometers of sediment. It is these thick accumulations that produce many of the hydrocarbons of the region, and give the basin its name.[1]



WEBSITES TO EXPLORE:

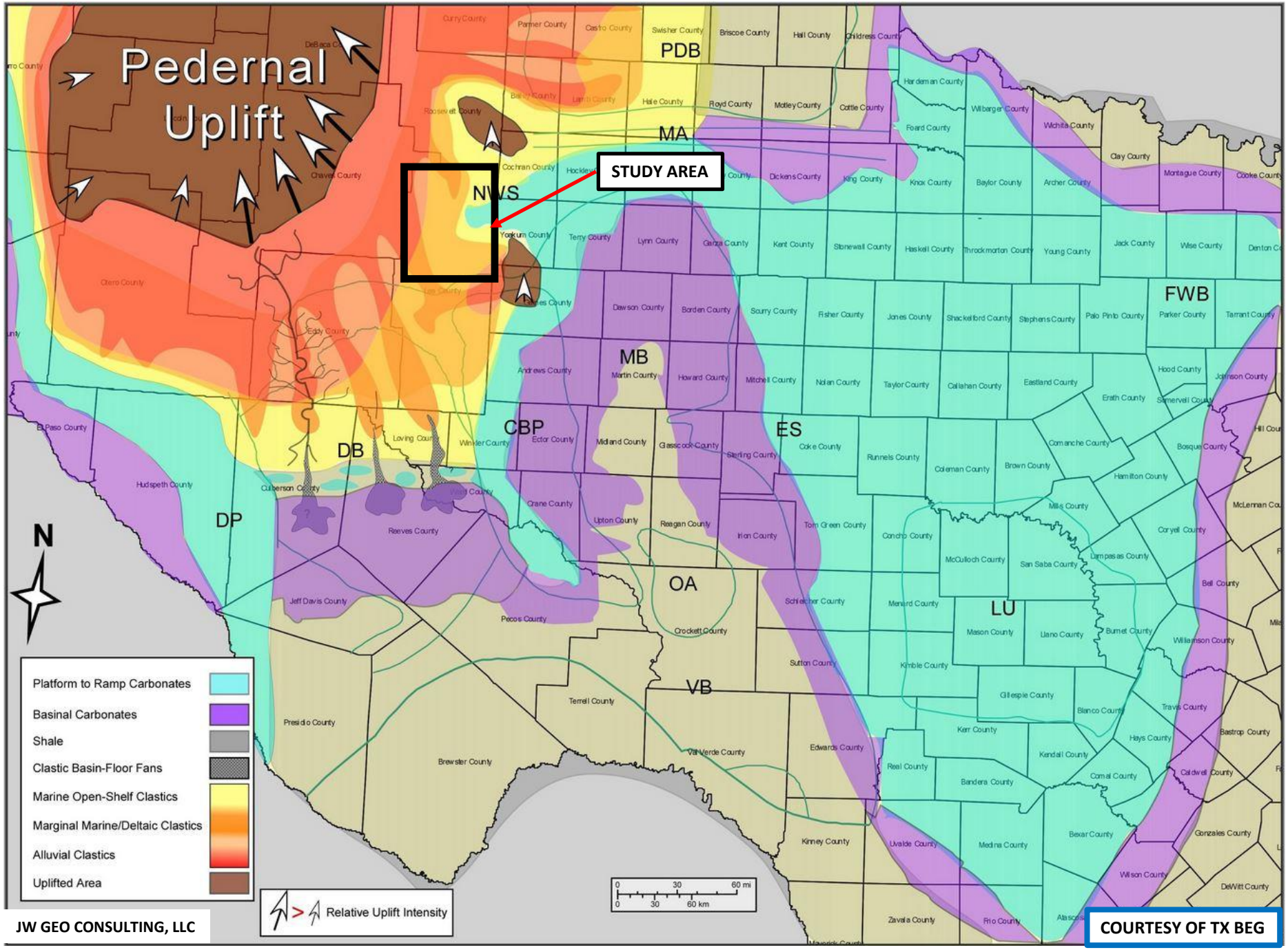
www.deeptimemaps.com

www.scotese.com

Home | Bureau of Economic Geology

BACK UP SLIDES

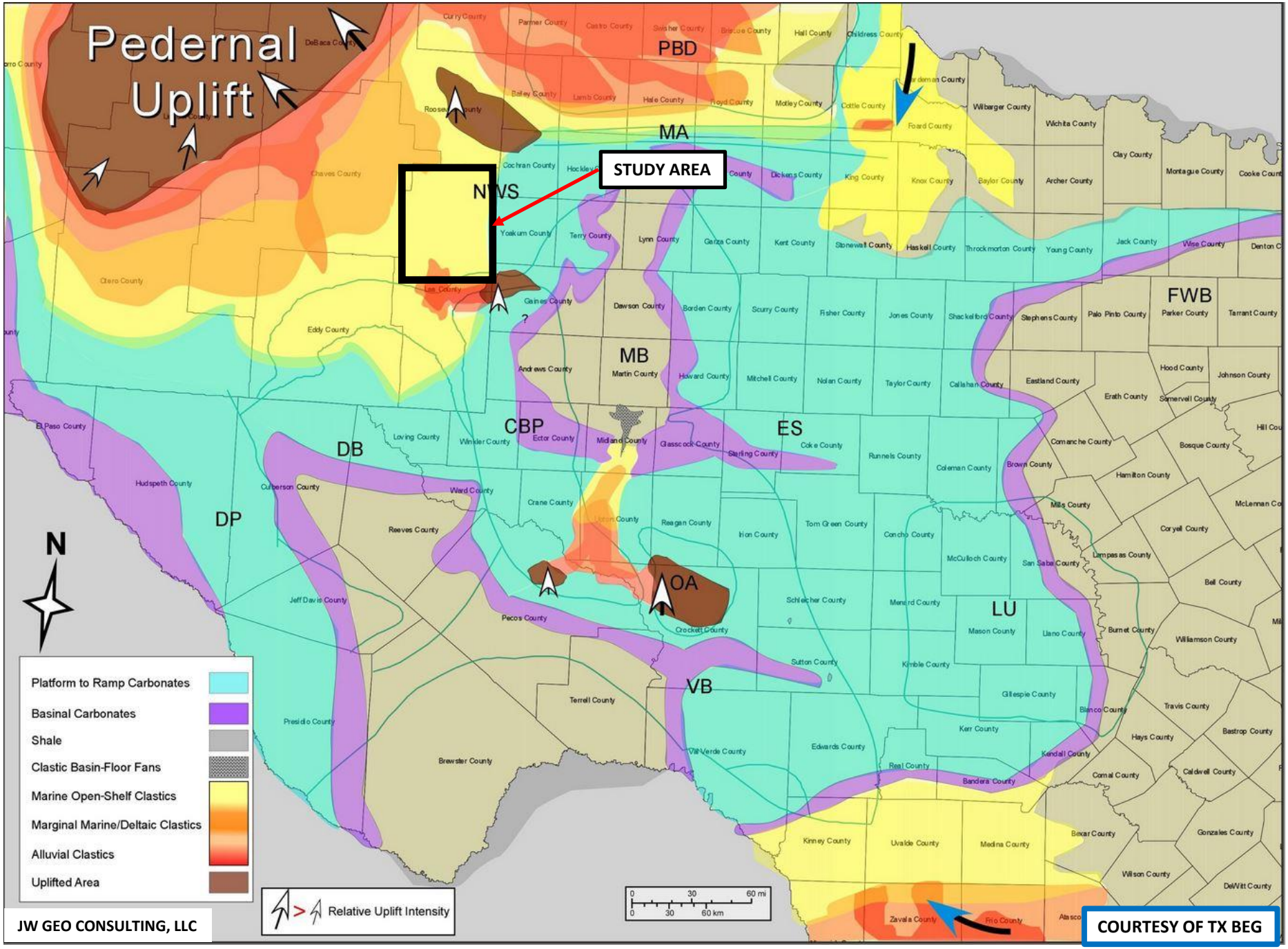
PENNSYLVANIAN MORROW PALEOGEOGRAPHY



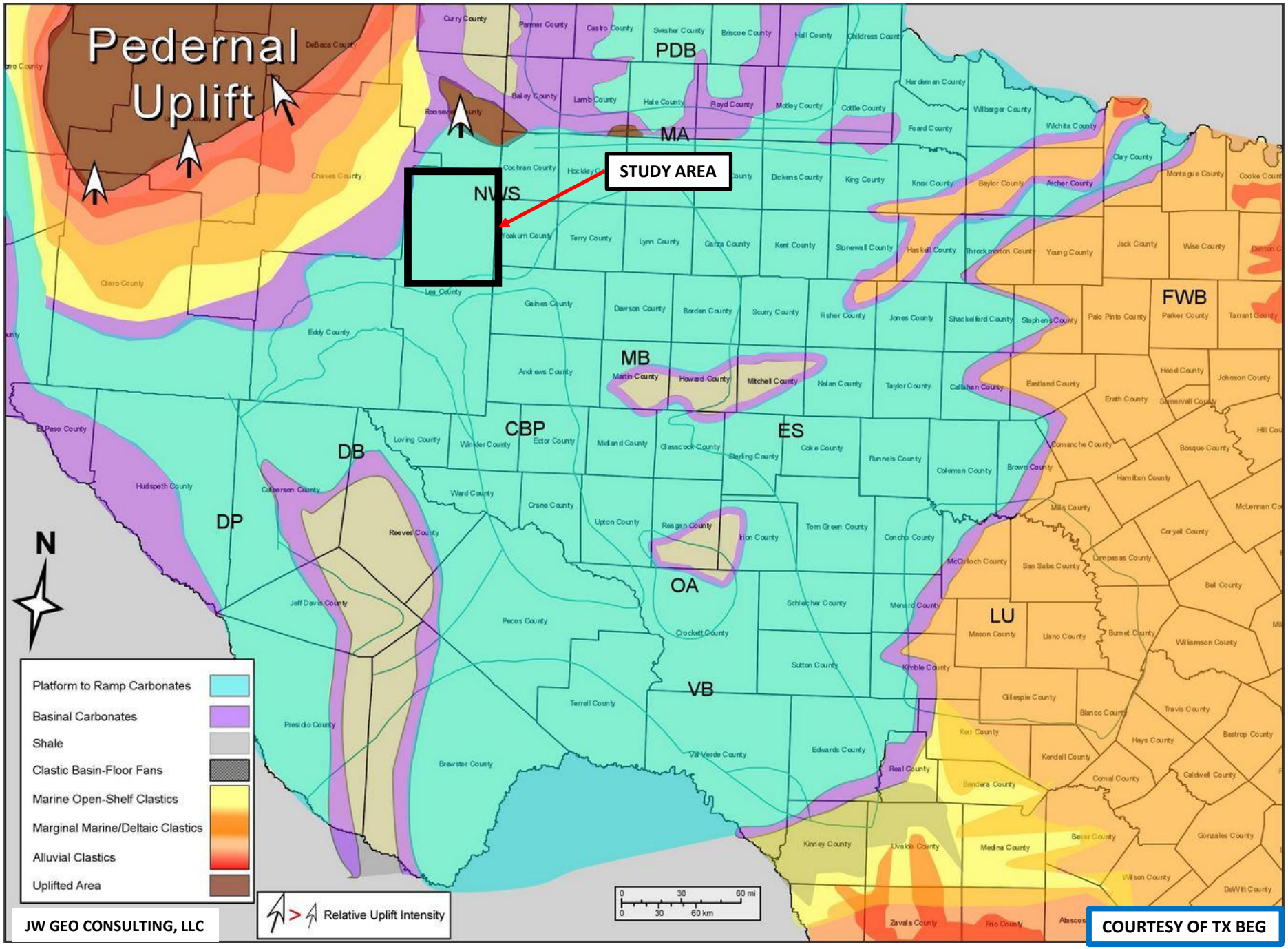
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COURTESY OF TX BEG

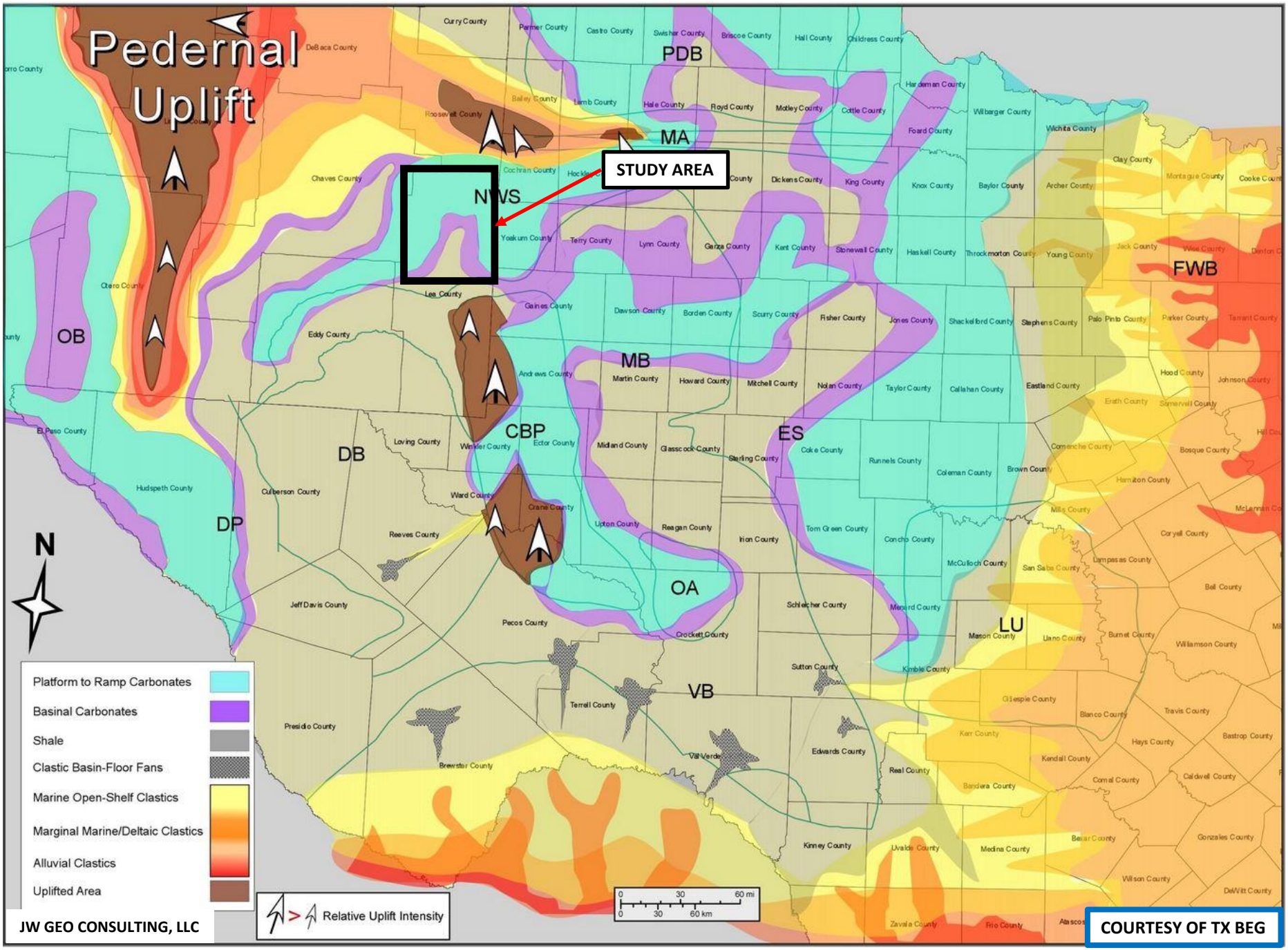
PENNSYLVANIAN ATOKA PALEOGEOGRAPHY



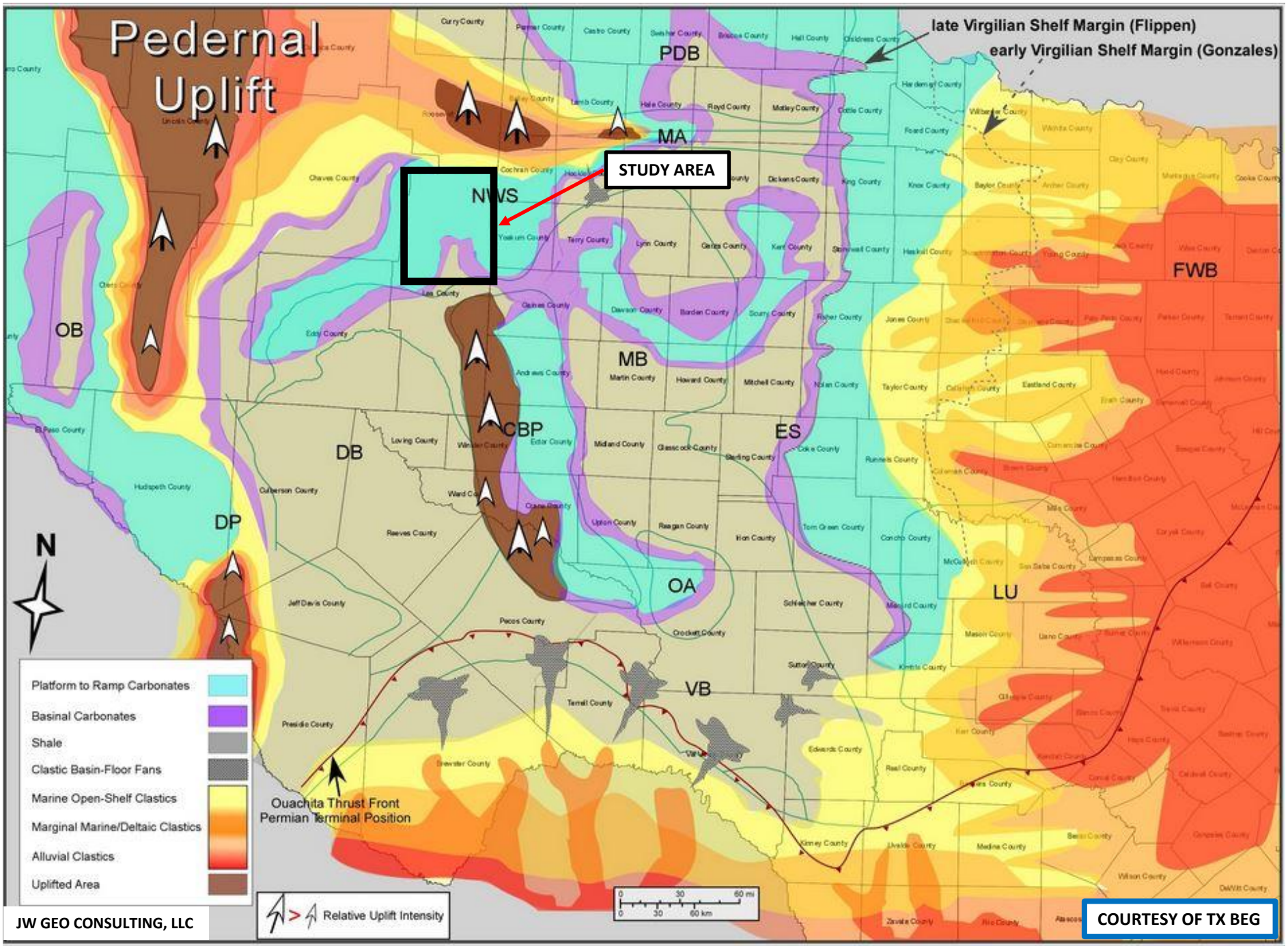
PENNSYLVANIAN STRAWN PALEOGEOGRAPHY



PENNSYLVANIAN CANYON PALEOGEOGRAPHY



PENNSYLVANIAN CISCO PALEOGEOGRAPHY



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PERMO – PENN SHELF MARGIN TRENDS

