Using Paleogeographic Maps to Portray Phanerozoic Geologic and Paleotectonic History of Western North America*

Ronald C. Blakey[1]

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[1]Professor Emeritus, Northern Arizona University; Colorado Plateau Geosystems, Flagstaff, Arizona (rblakey@CPgeosystems.com)

Abstract

Paleogeographic maps provide clear, concise pictures of the evolving complex geologic events of Western North America. Time slices are selected to show critical stages in the geologic history, thereby providing a continuous view of the evolution of the region and clearly showing sequences of paleogeography and paleotectonics. The maps are particularly effective in demonstrating the geometry and history of terrane accretion and the effects of accretionary events on the growth of Western North America from Devonian to Present. The maps are also powerful tools for comparing varying or contrasting models of various terrane-accretion events and for showing cause and effect across broad geologic provinces. Other maps (isopach, paleogeology, facies, paleocurrent, etc.) can be used in conjunction with paleogeographic maps to further explain the geologic history.

The models presented here are derived and modified from the geologic literature. Data is plotted on basemaps and paleogeography is cloned from digital elevation maps to match the inferred distribution of landforms at given times and places. The paleogeography is shown in palinspastic restoration with reference to present political boundaries. The maps are finished in a fashion to show how paleogeography might have appeared as if seen from space. Colors suggest paleovegetation and inferred paleoclimate. Water depths are shown in shades of blue from evidence presented in the literature and presumed modern analogs. Although maps are assigned a specific geologic age, ranges are given to suggest the interval for which the maps are valid. The resulting series of paleogeographic maps provides a coherent picture of the geologic and tectonic history of Western North America that respects known and inferred geologic rates and geodynamic models.

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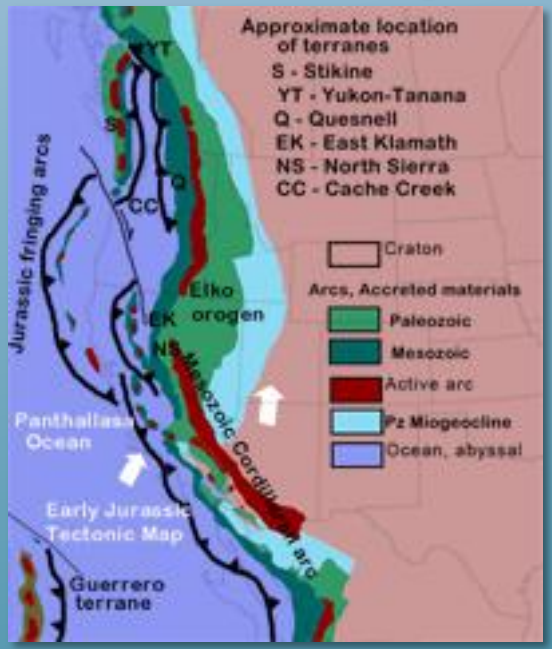
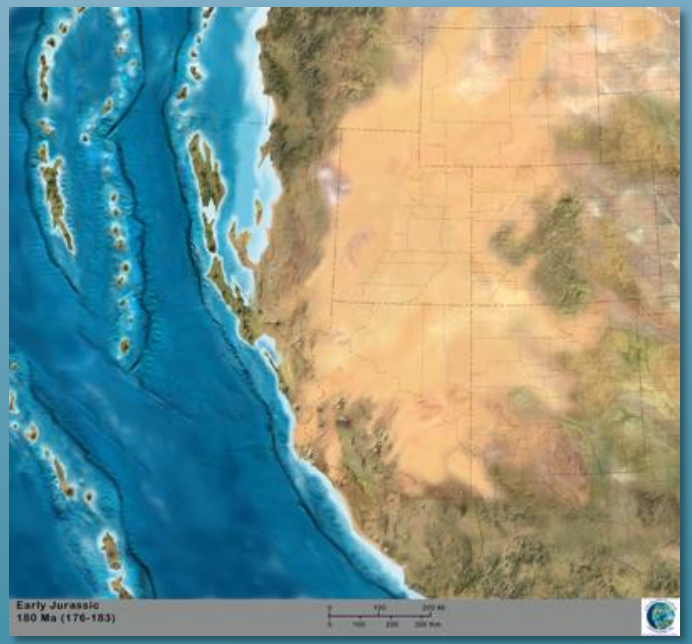
Using Paleogeographic Maps to Portray Phanerozoic Geologic and Paleotectonic History of Western North America





Ron Blakey
Professor Emeritus,
Northern Arizona University
Colorado Plateau Geosystems

American Association of Petroleum Geologists

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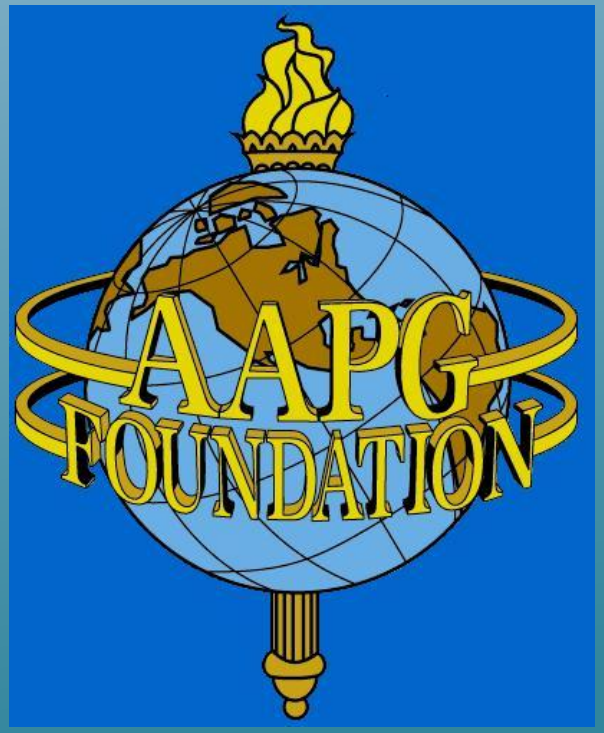


Goals and Objectives

To present a comprehensive geologic history of Western North America

- That follows modern geologic concepts, data, and models
- That adheres to geodynamic principles
- In an understandable, graphic presentation of both paleotectonic and paleogeographic events

How the maps are prepared

- Assessment and incorporation of pertinent geologic data and interpretation, especially information easily shown on maps
- Construction of base maps – scale, projection, time-slice selection
- Plot of tectonic elements
- Location of shorelines, uplands
- Plot of facies, depositional settings, climate zones
- Determination of modern analogues
- Cloning of modern analogues (DEM's) onto paleomaps
- Check and recheck

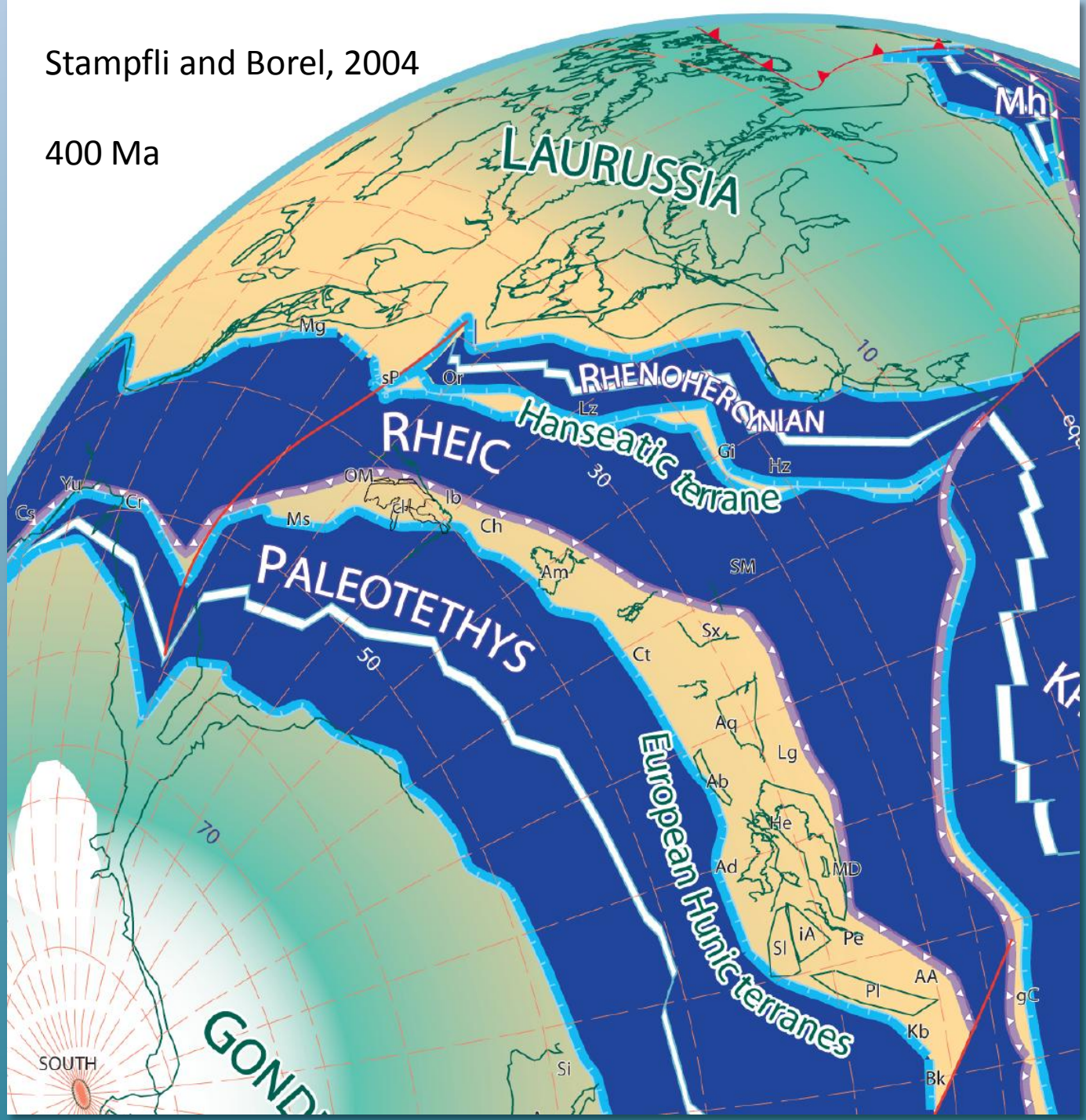

Where do I find the information
to construct this map?
N
Early Mississippian -- 345 Ma (350-340)
0
600 Mi
0
1000 Km

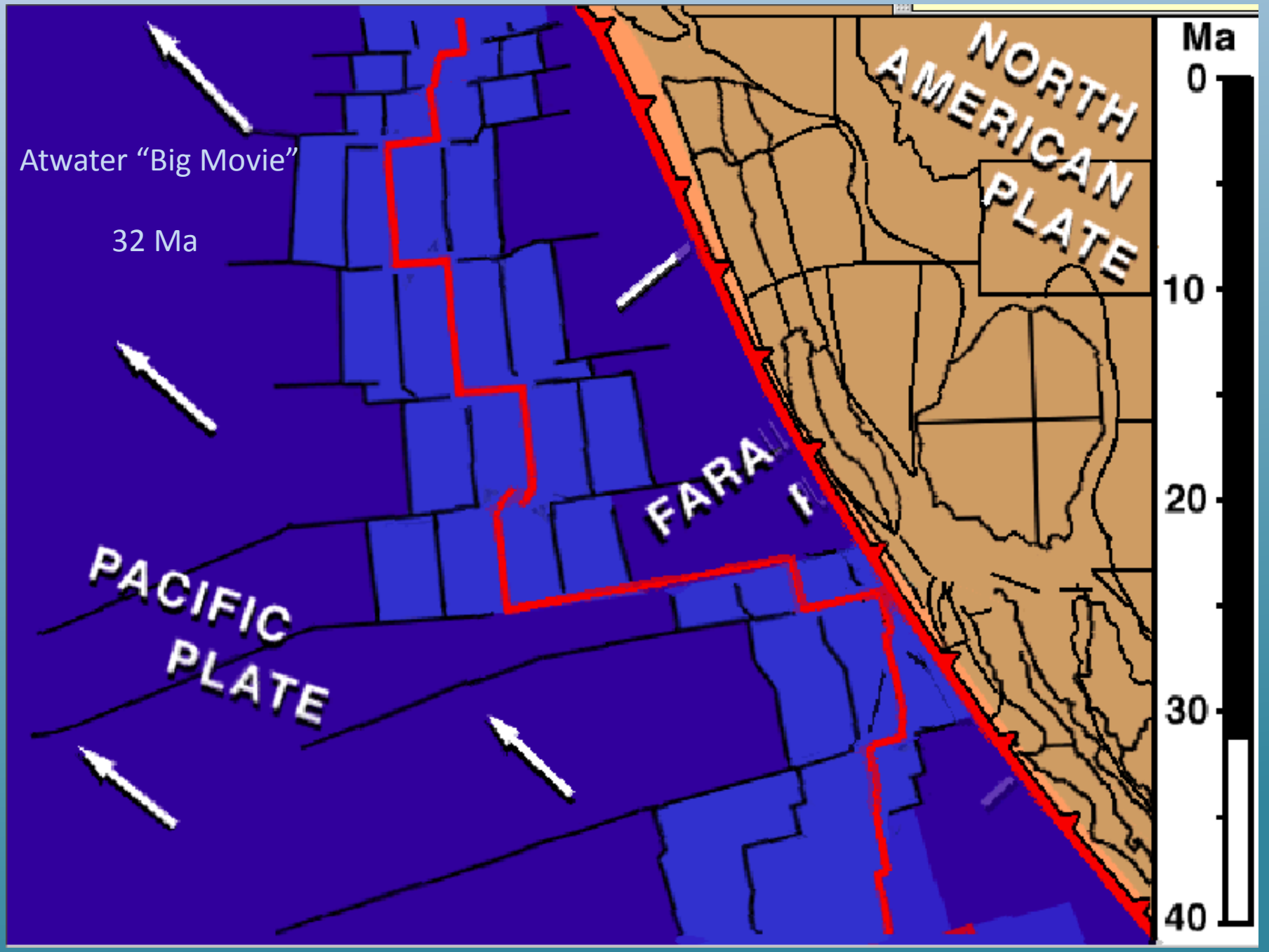
Examples of Data

- Terrane maps, plate reconstructions
- Structure-tectonic maps
- Palinspastic restoration maps
- Facies maps
- Paleoclimate maps
- Faunal/floral distribution

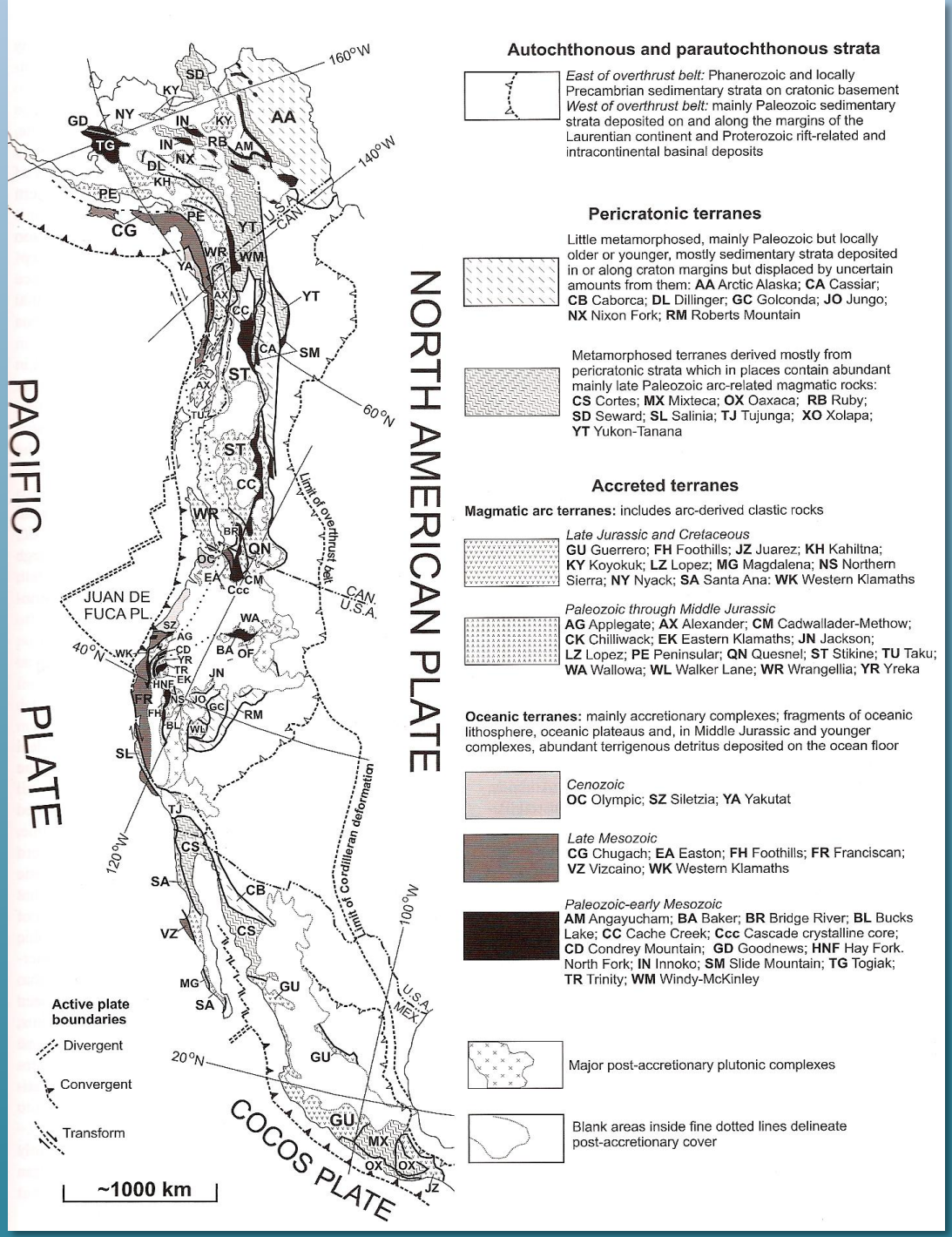
Stampfli and Borel, 2004

400 Ma



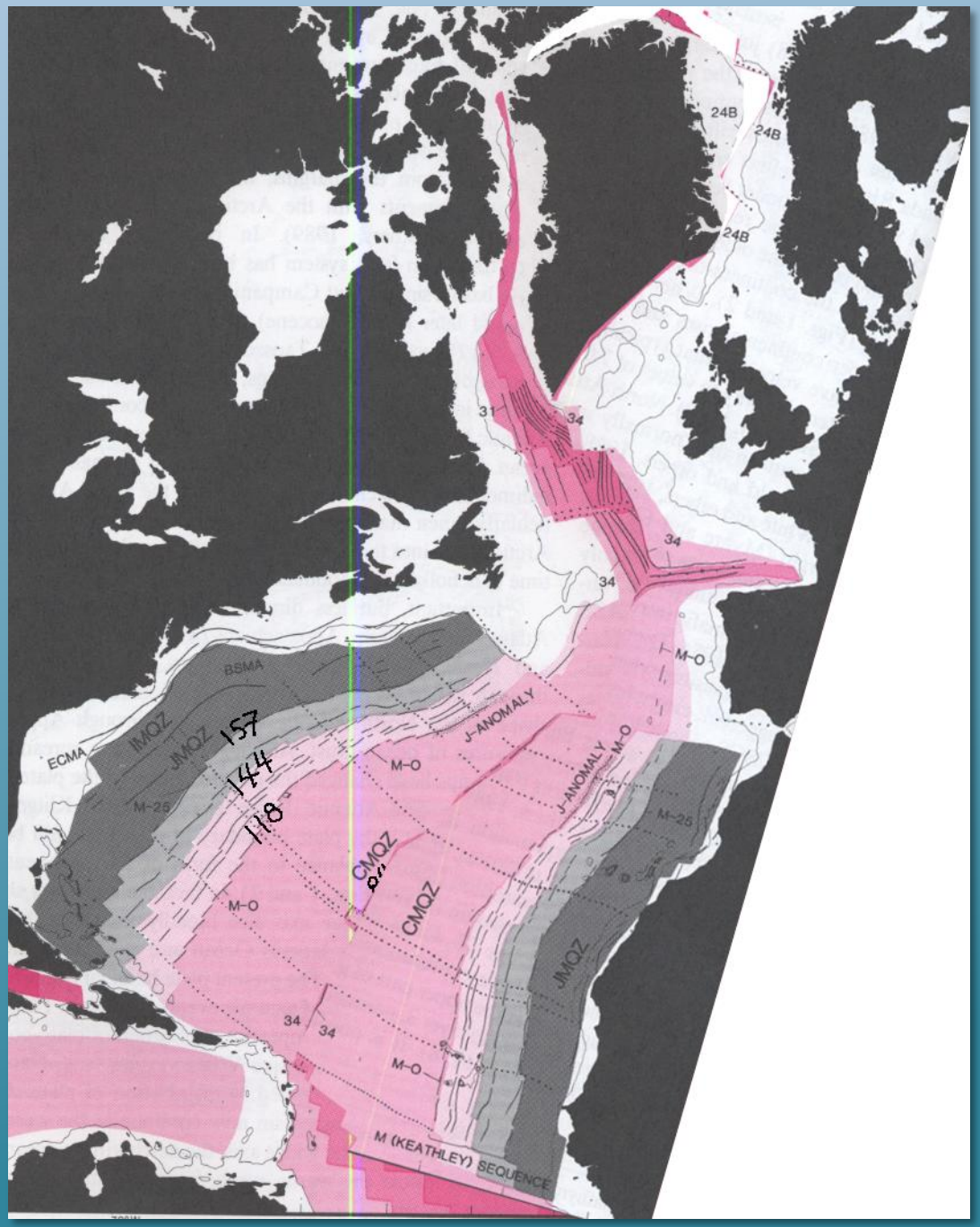

Atwater "Big Movie"
32 Ma
NORTH AMERICAN PLATE
PACIFIC PLATE
FARA
Ma
0
10
20
30
40

Silberling et al., 1992,
USGS I-2176

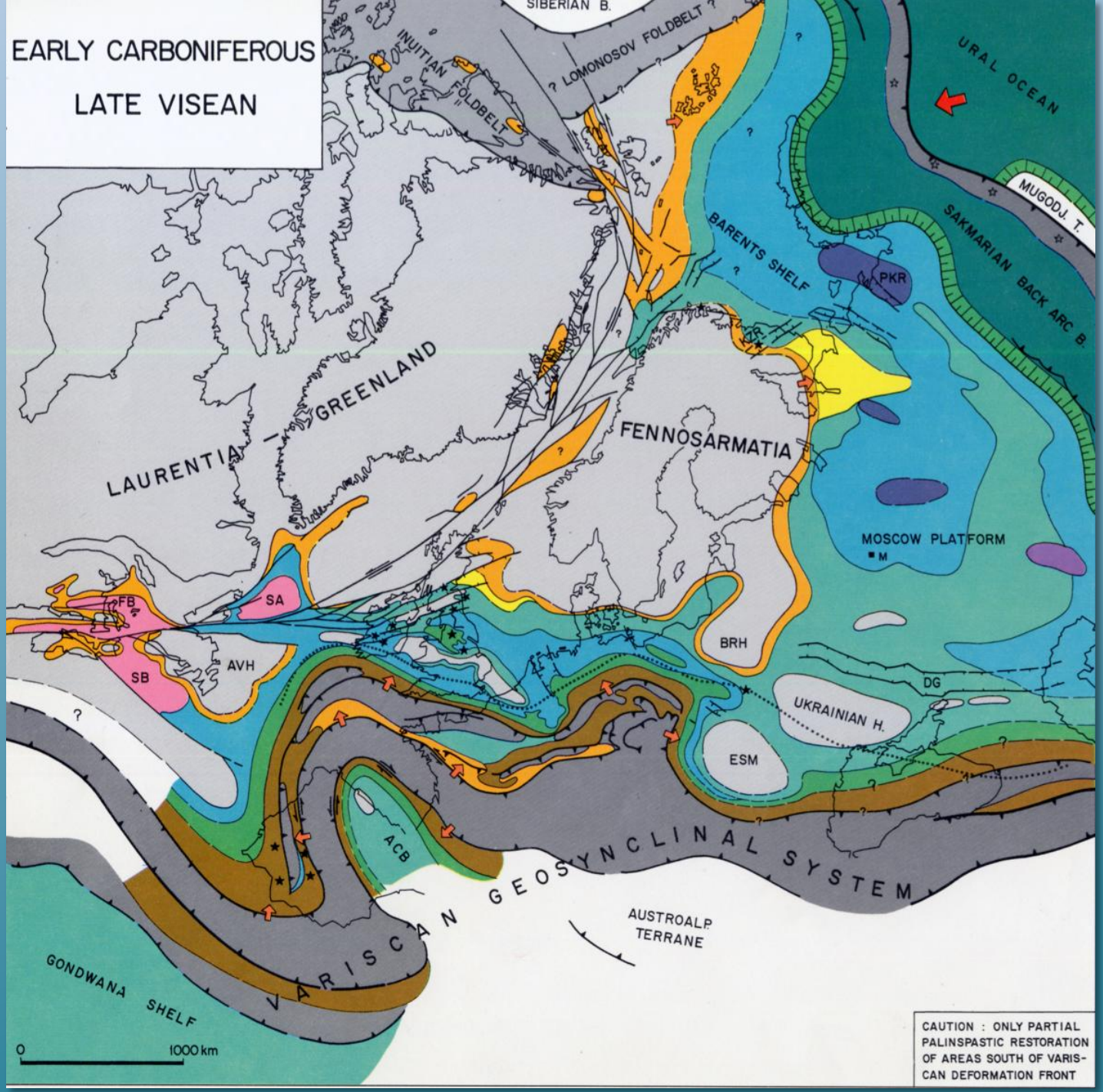


Central Atlantic Ocean at 84 Ma made by subtracting younger crust and fitting two plates together.

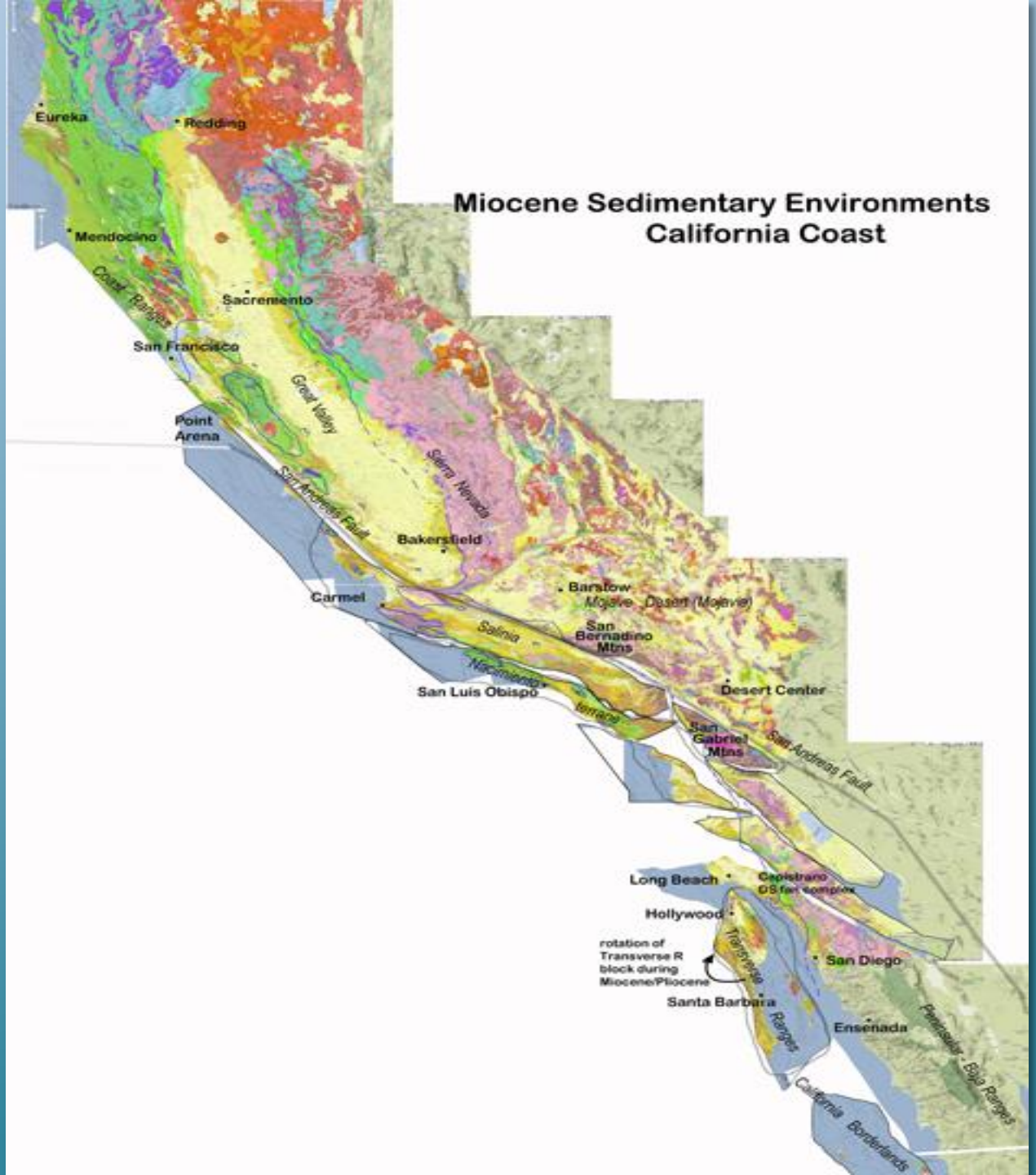
Modified from Vogt and Tucholke, 1989, DNAG vol. A



Ziegler, 1988, AAPG Mem. 43



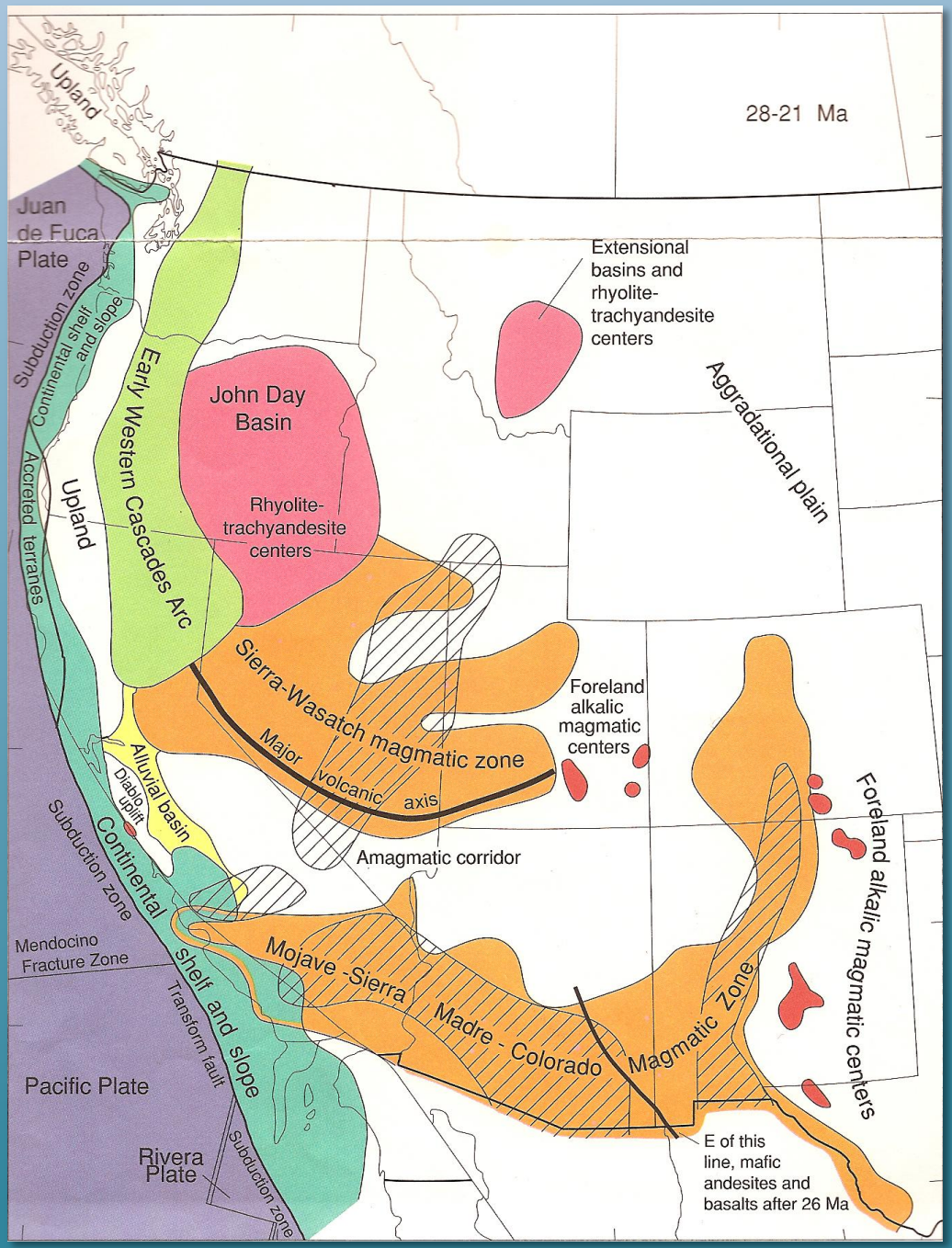
Geologic map of Calif. cut and warped to approx. Miocene terrane locations

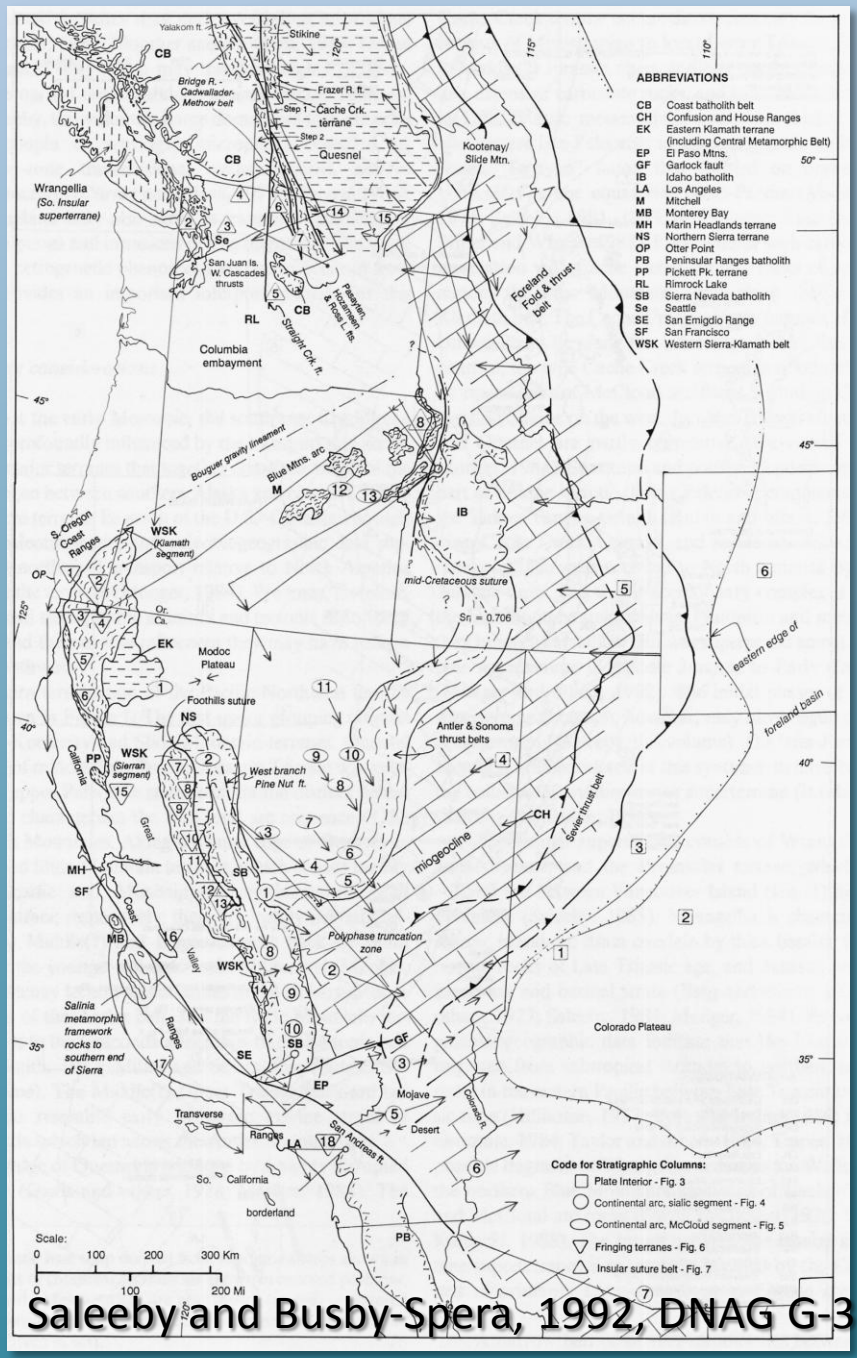


Calif. Geol map restored to Miocene with general paleoenvironments

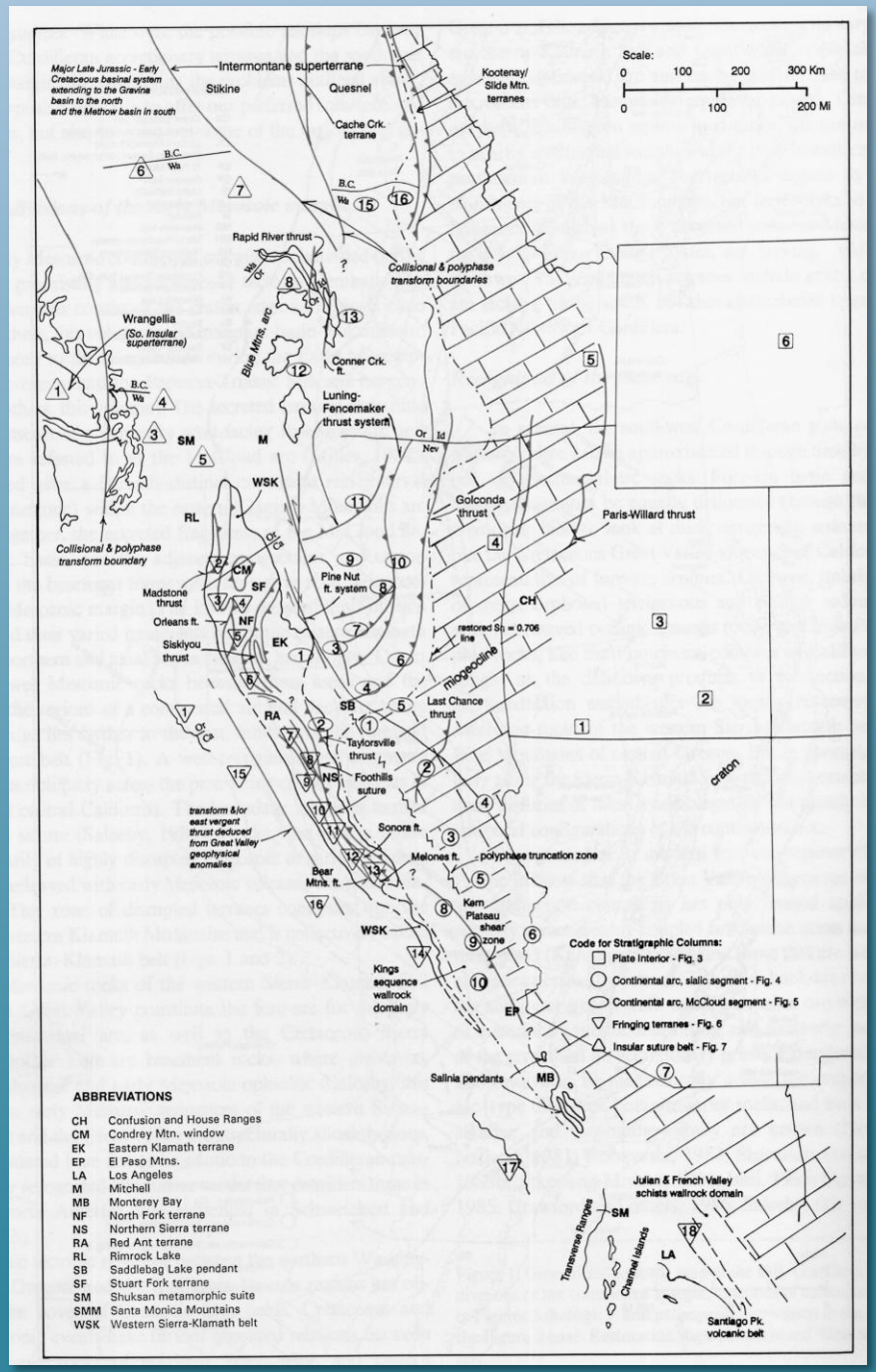
Oligocene-Early Miocene tectonics and magmatism, W. North America,

Christiansen and Yeats, 1992, DNAG vol. G-3

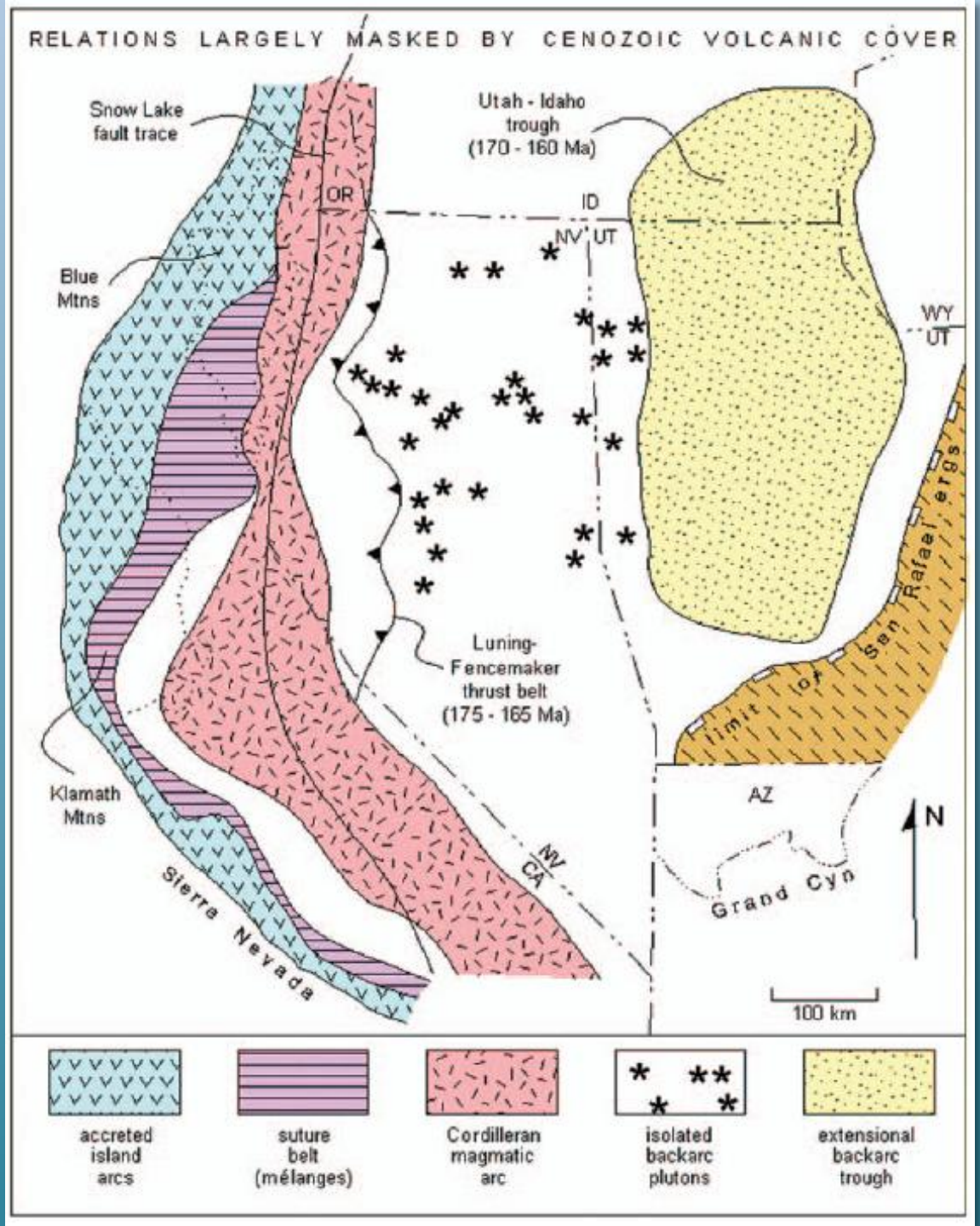




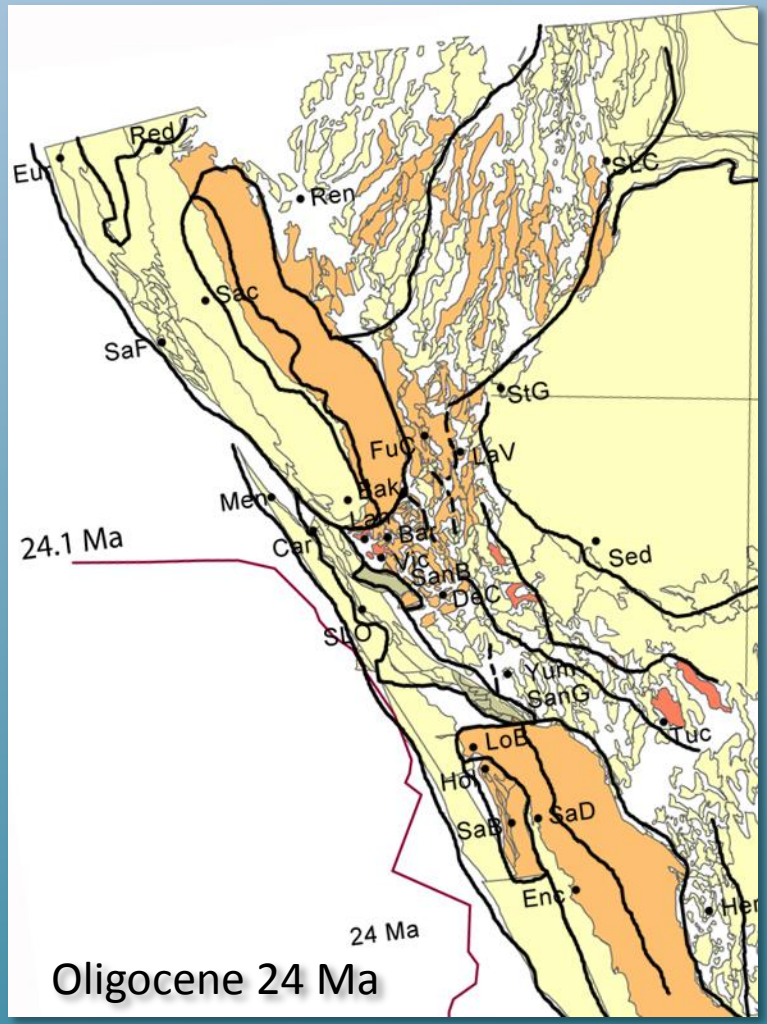
Saleeby and Busby-Spera, 1992, DNAG G-3

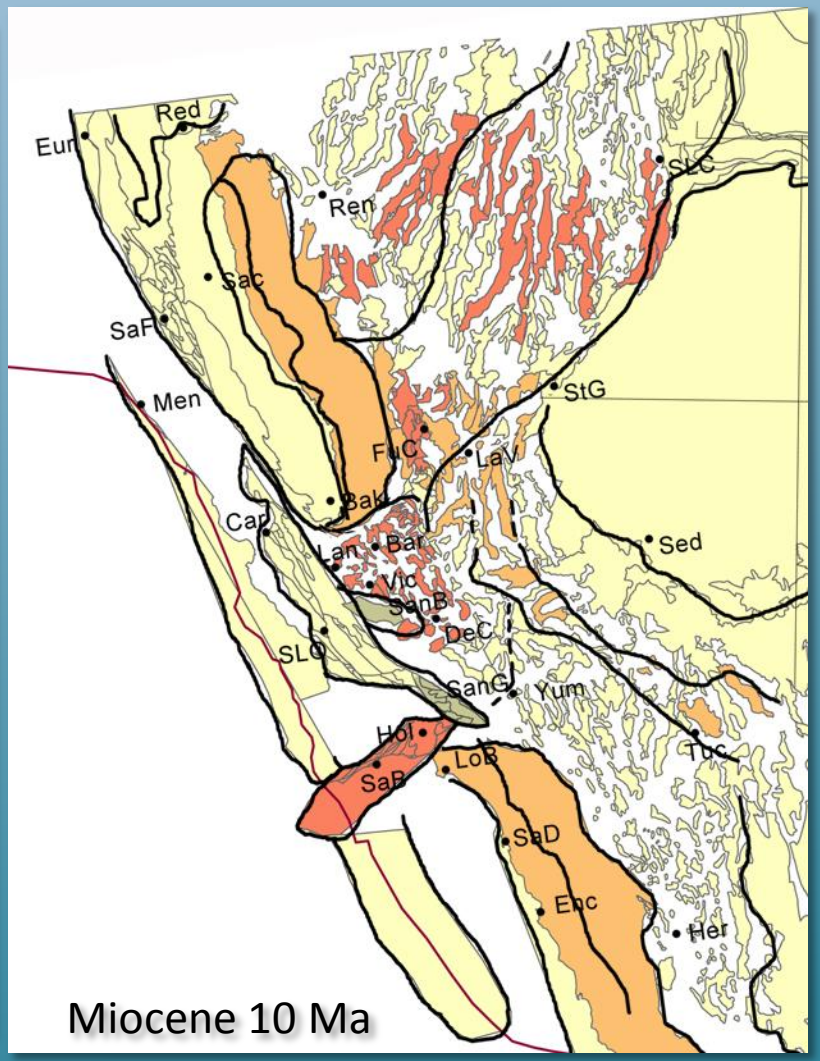


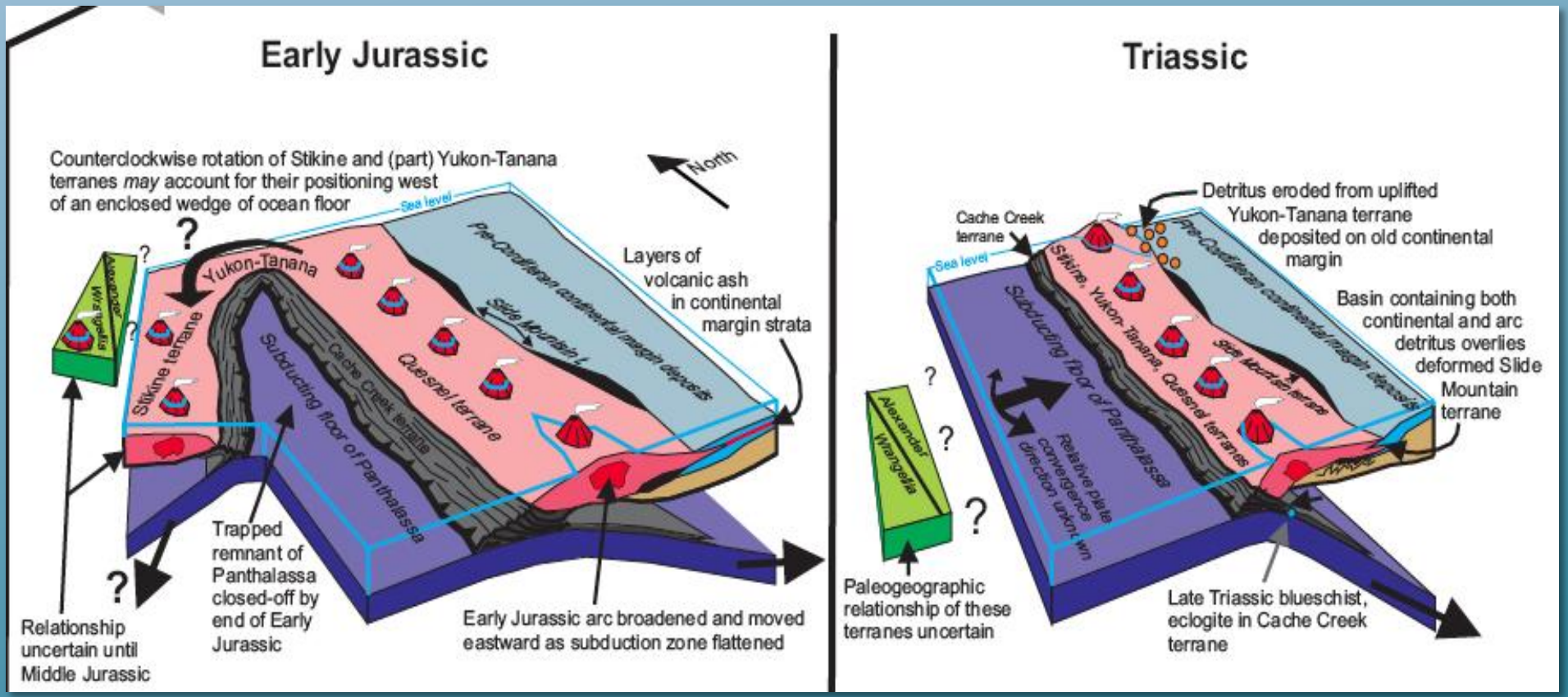
Palinspastic restoration,
175-125 Ma,
Dickinson, 2011,
Geol Soc Nev Symp vol.



Detailed Basin and Range extension, McQuarrie and Wernicke, 2005, Geosphere

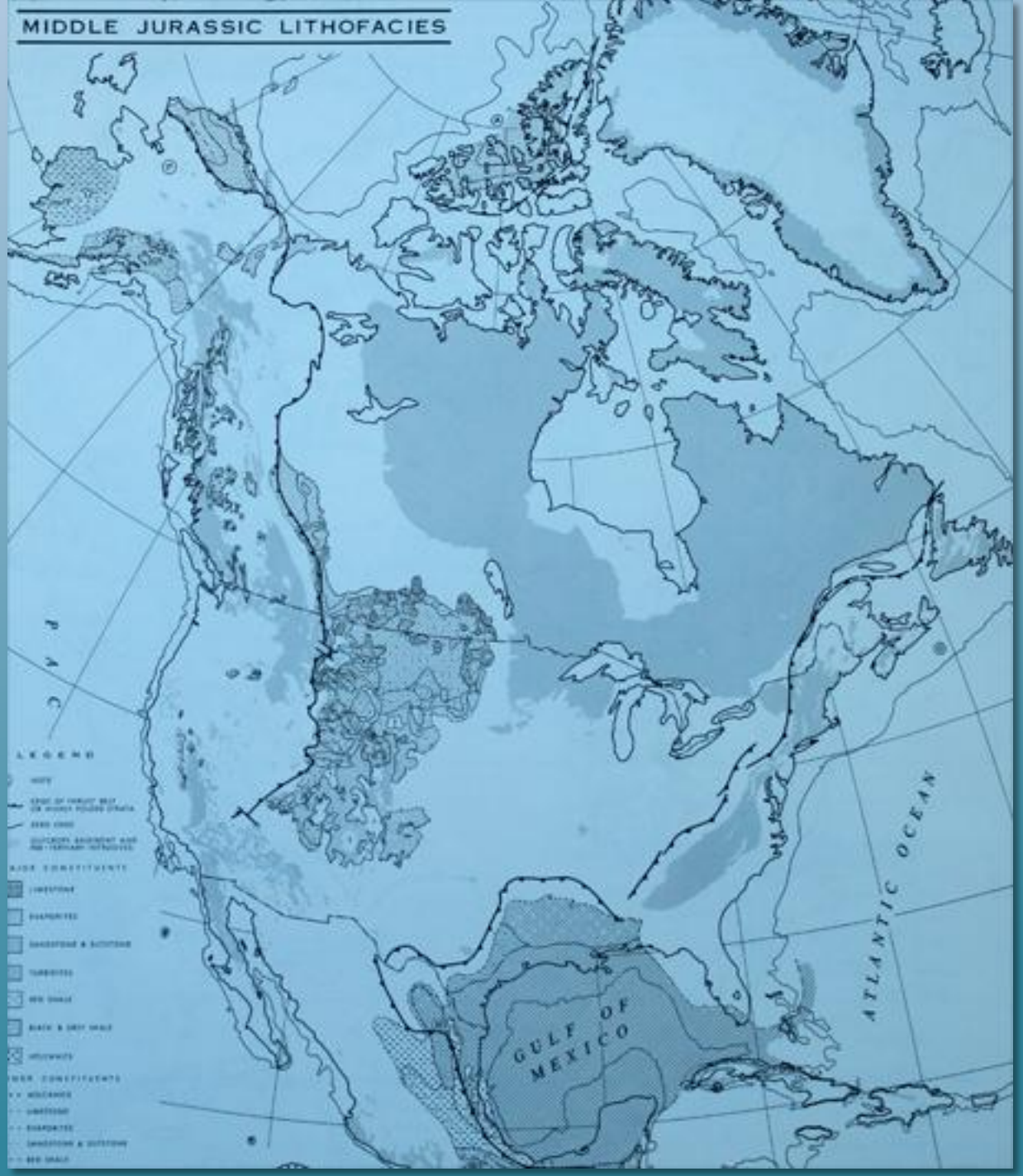




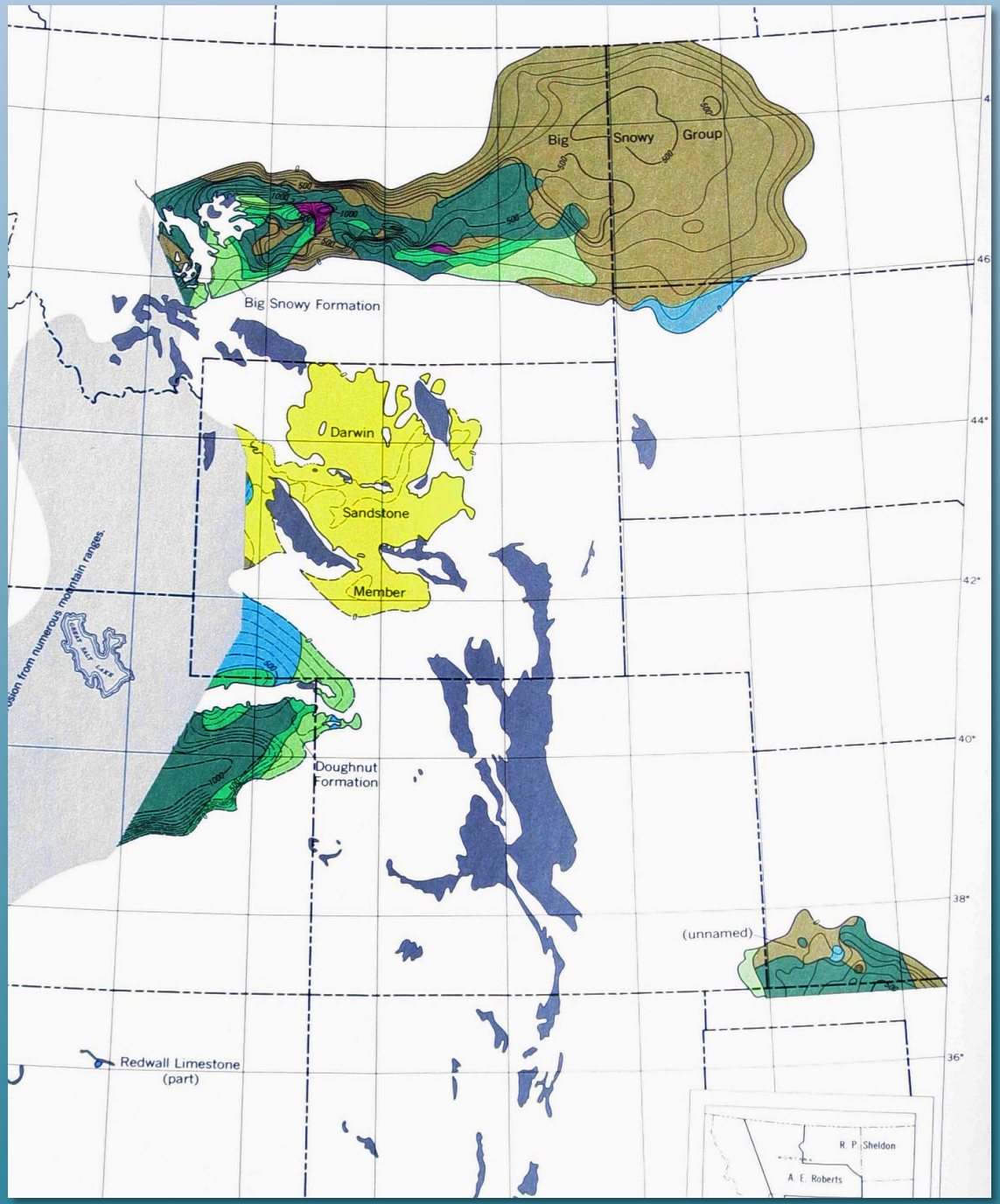


Monger, JWH, pers. Comm., 2010

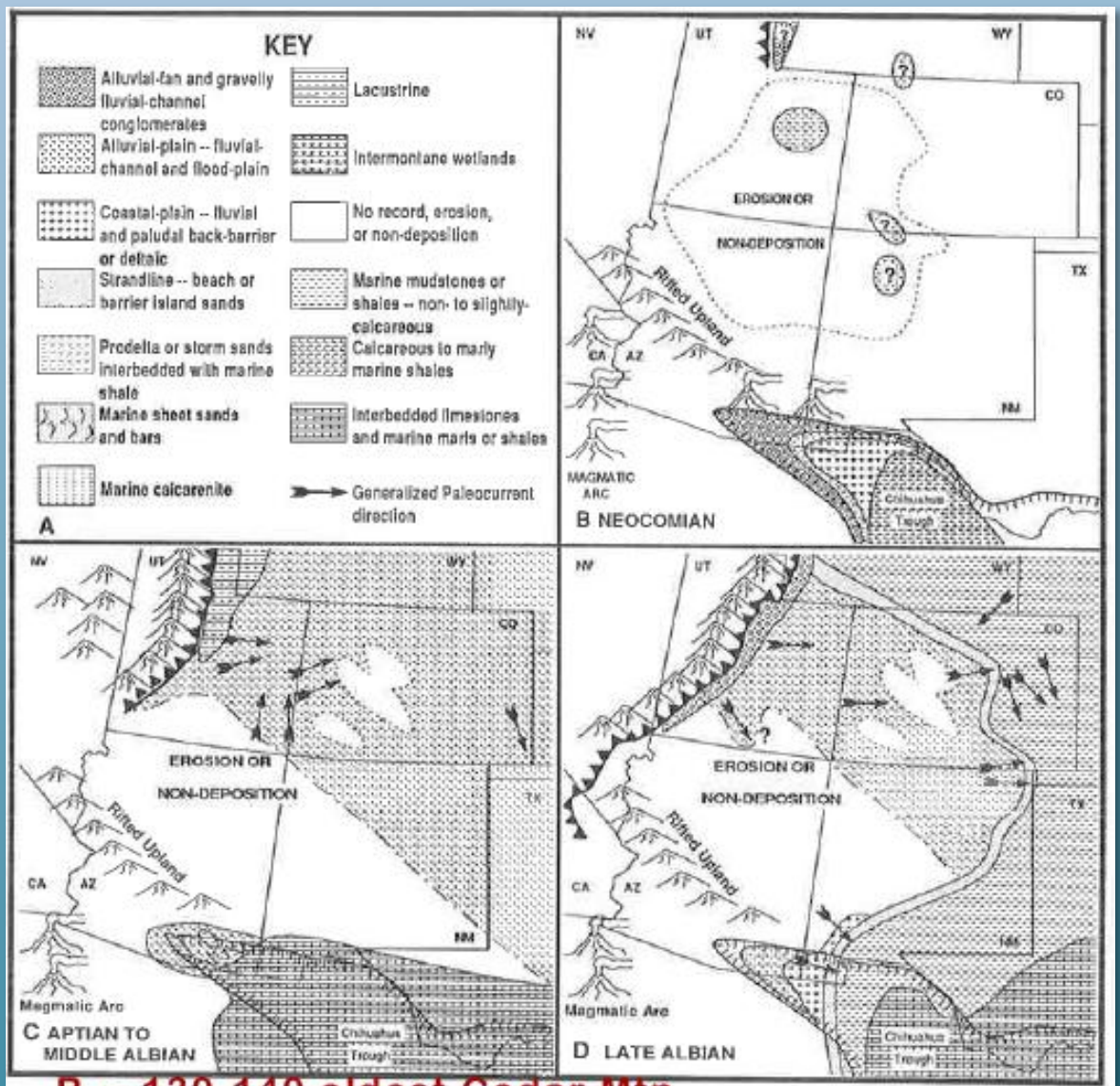
Cook and Bally, 1975
Shell Atlas of N. A.



RMAG Strat Atlas, 1972



Cretaceous paleogeography, Elder and Kirkland, 1994, RMSSEPM Palgeog vol.

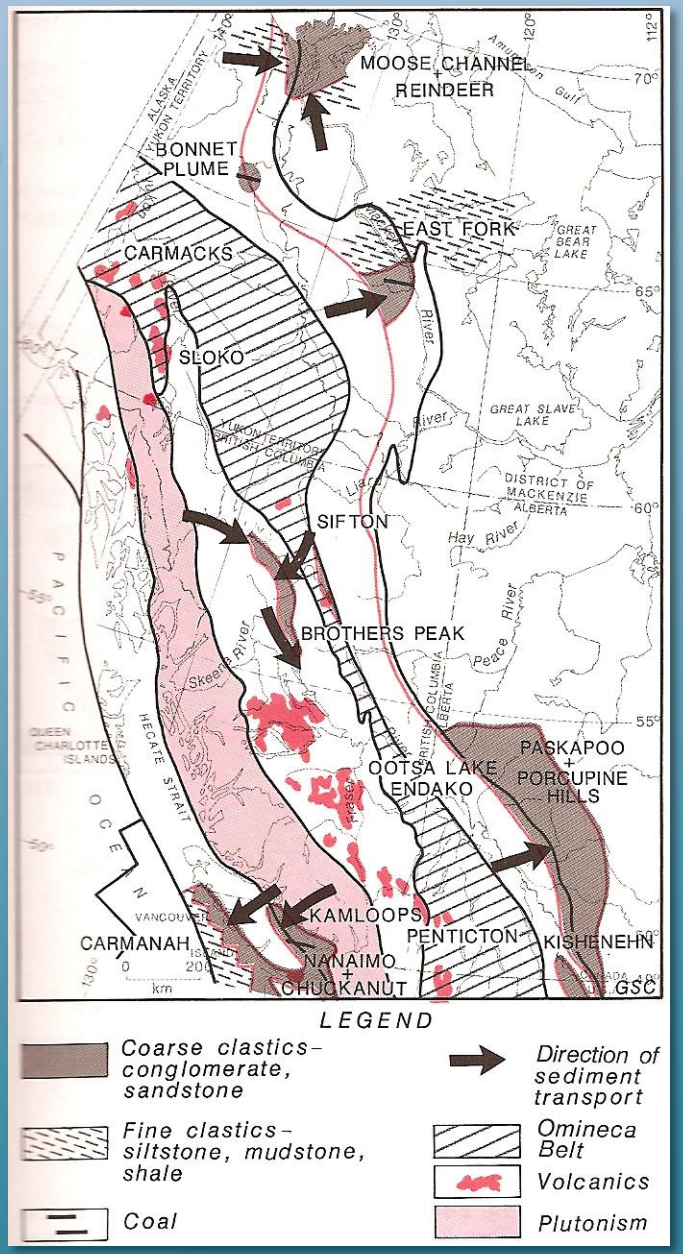


B -- 130-140 oldest Cedar Mtn

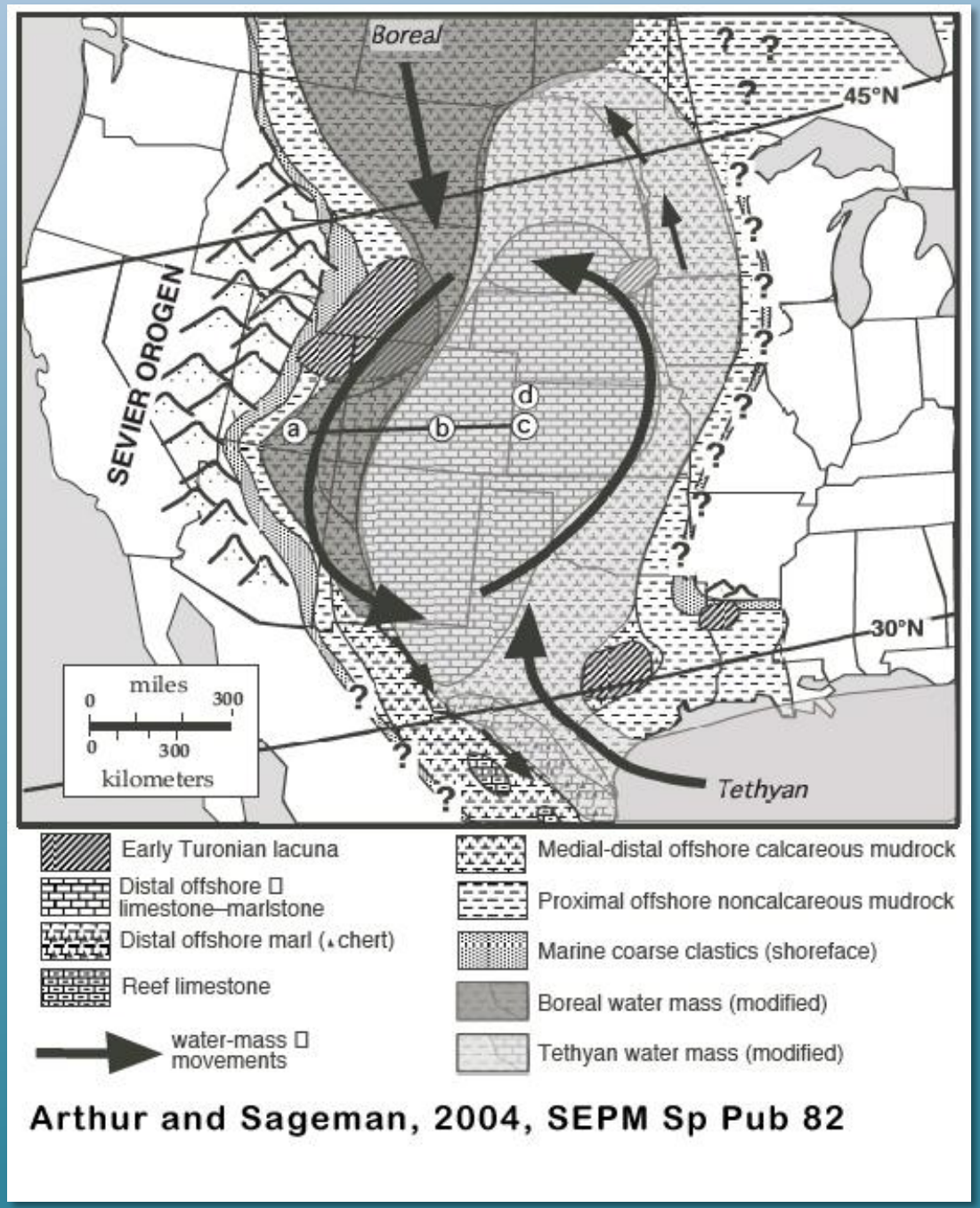
C -- 120-110 Cloverly/Fall River/Poison Strip

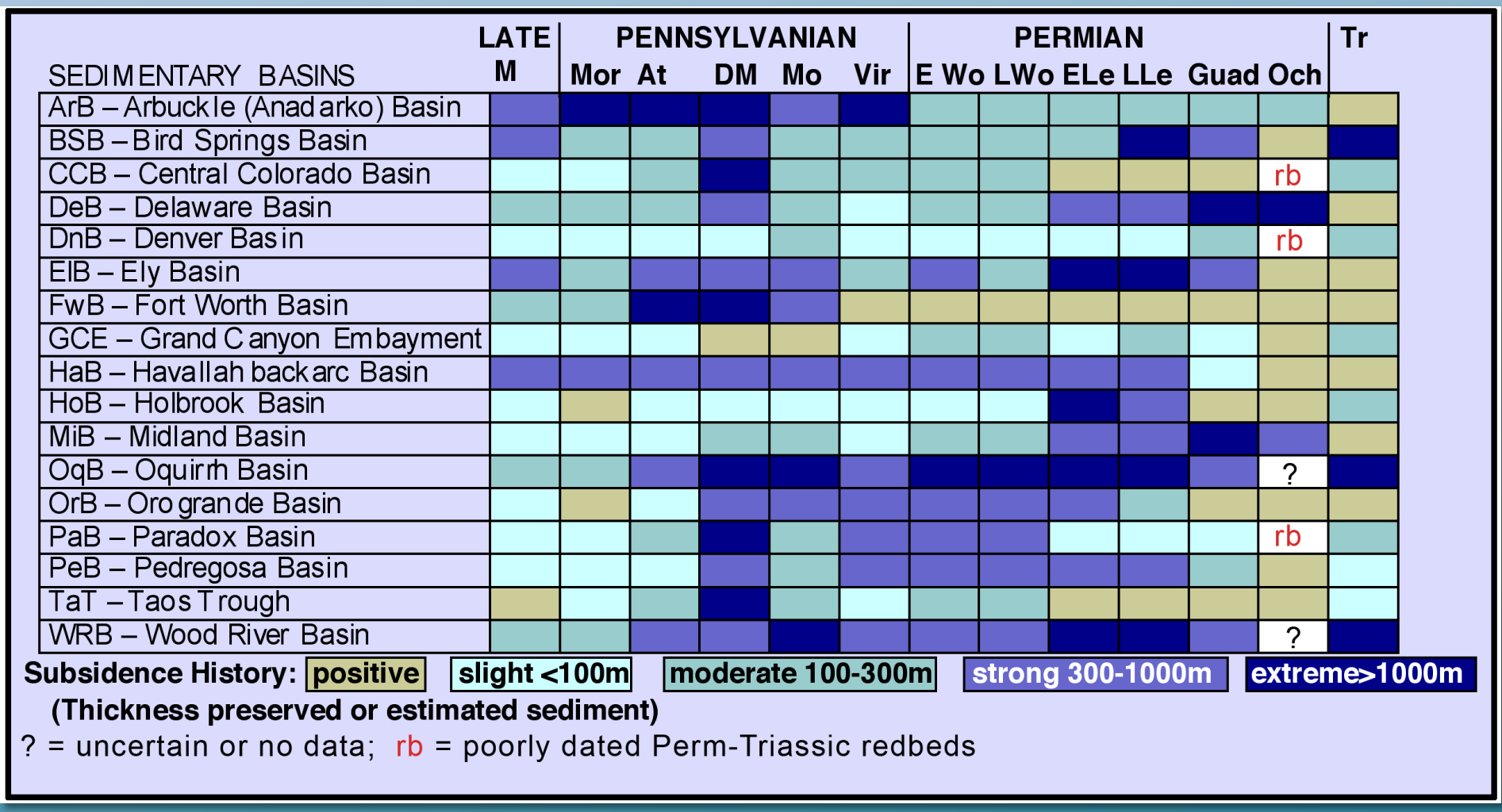
D -- 105-100 Thermopolis/Skull Creek

Late Cretaceous lithofacies, Canada, DNAG vol D-2

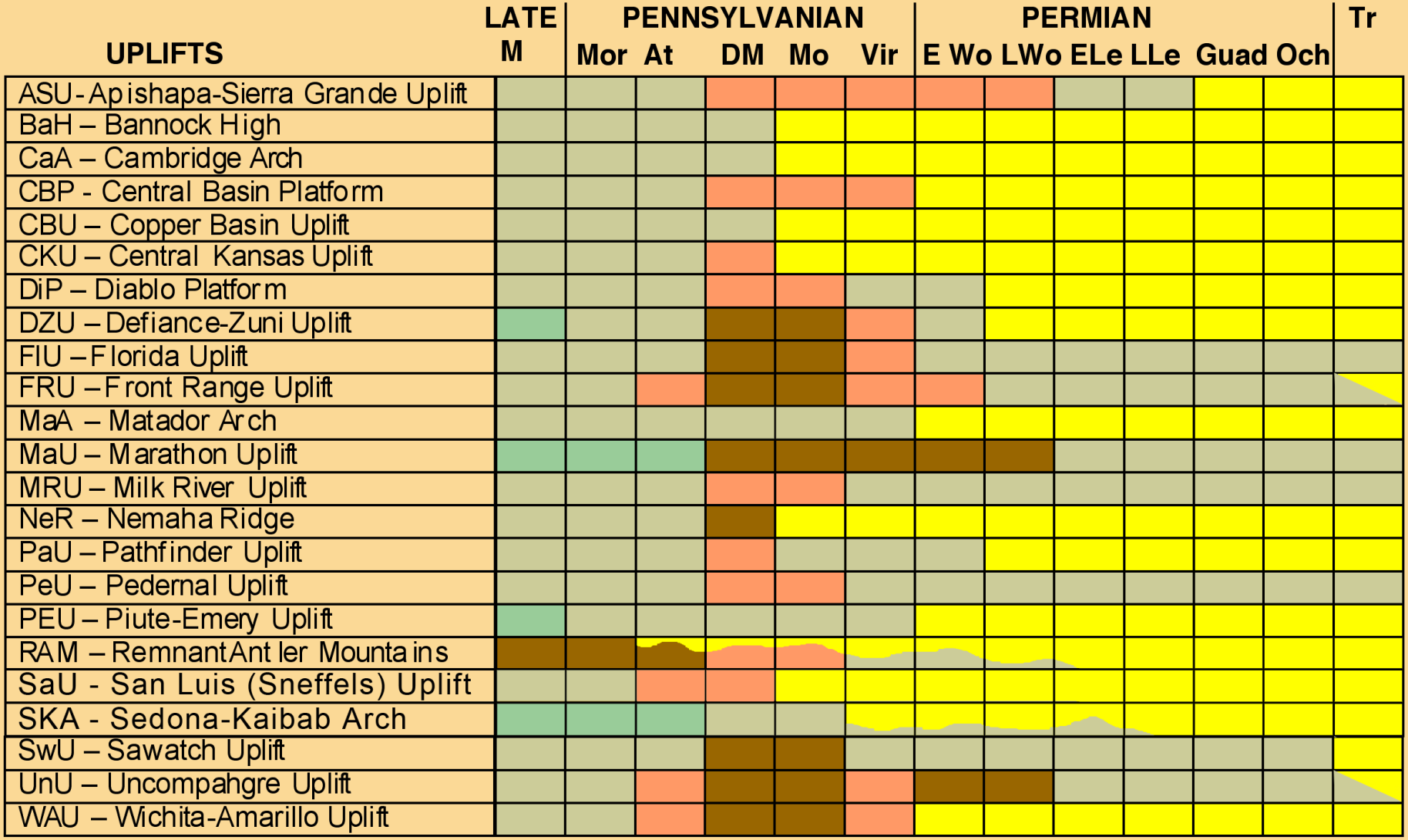


Cretaceous Turonian
Paleo-oceanography





Blakey, 2009, RMAG Sp. Pub.



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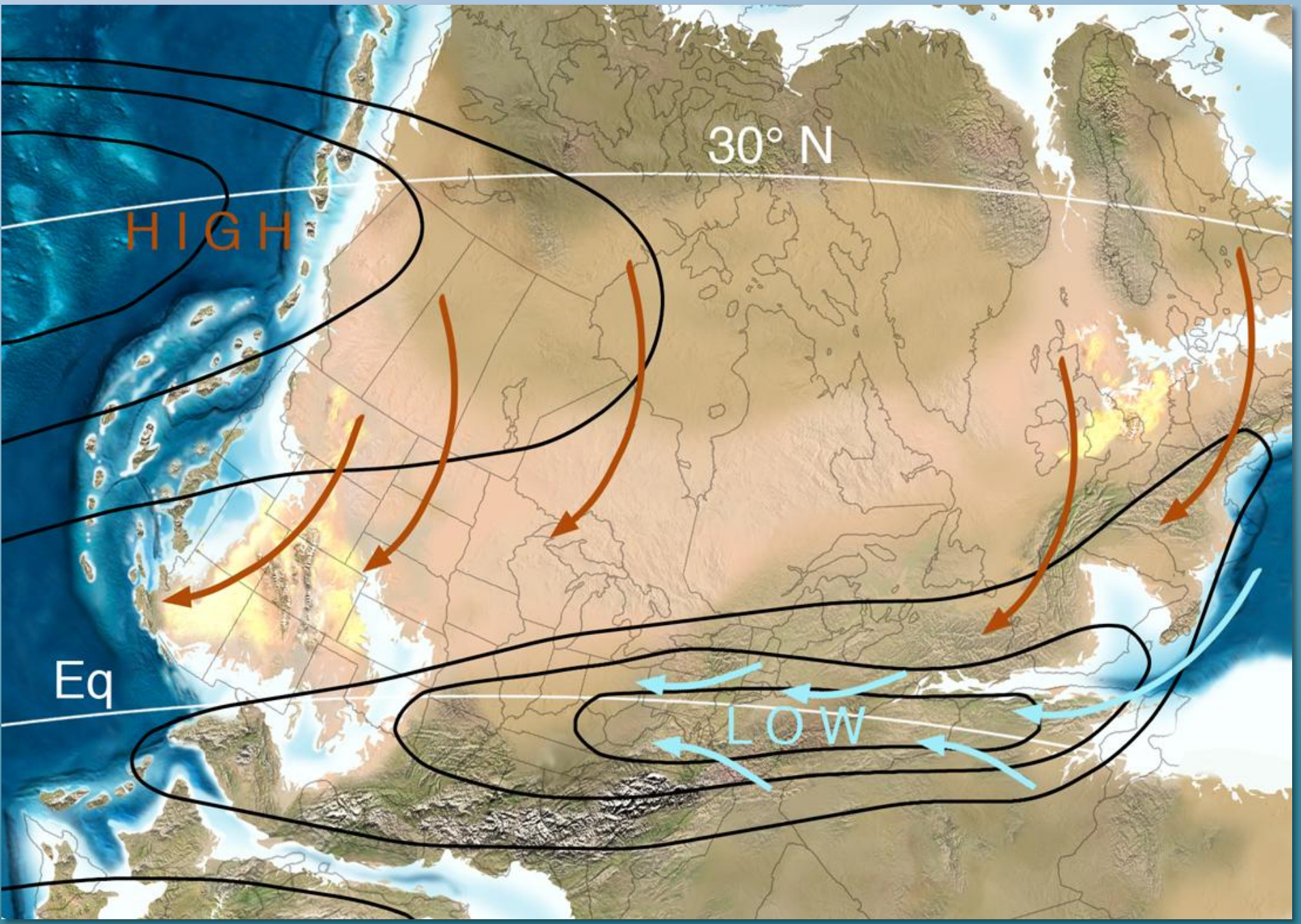
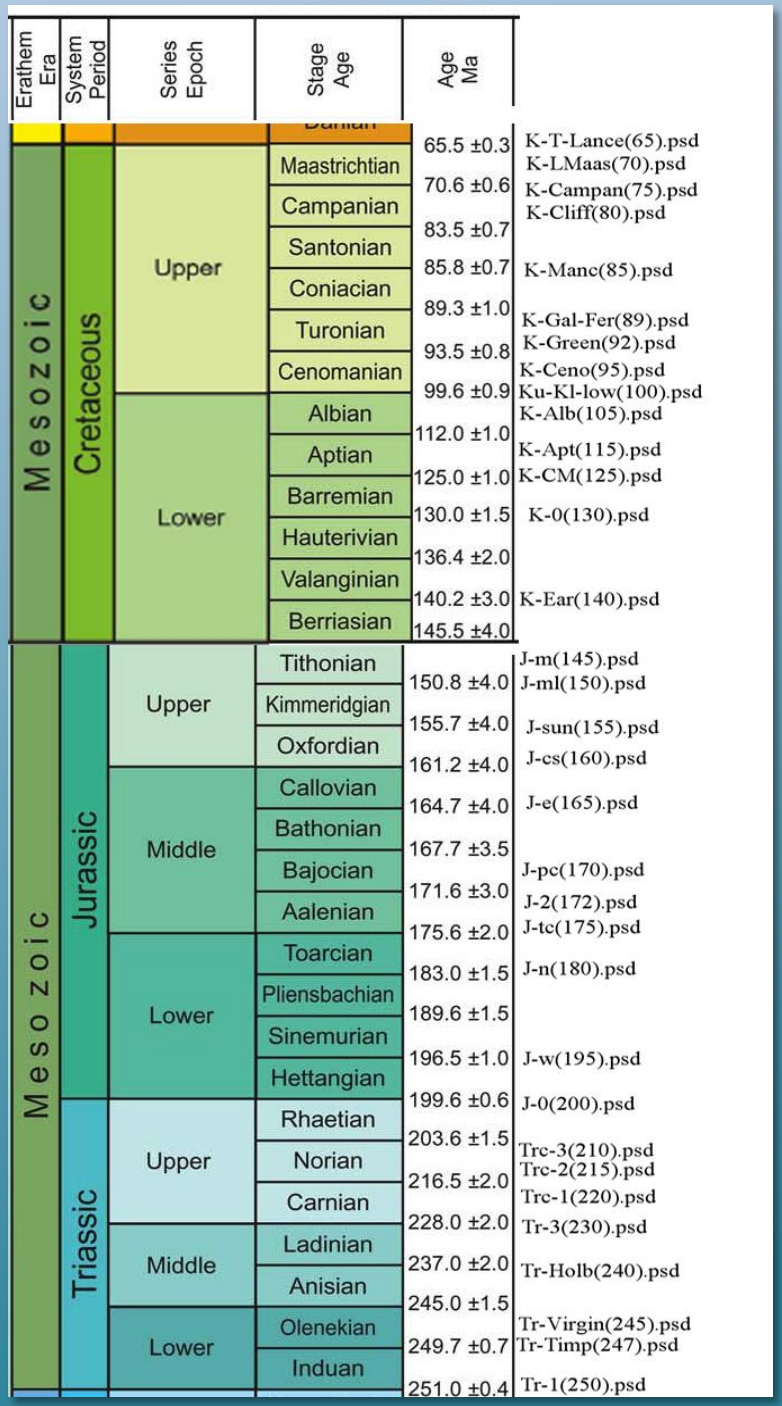
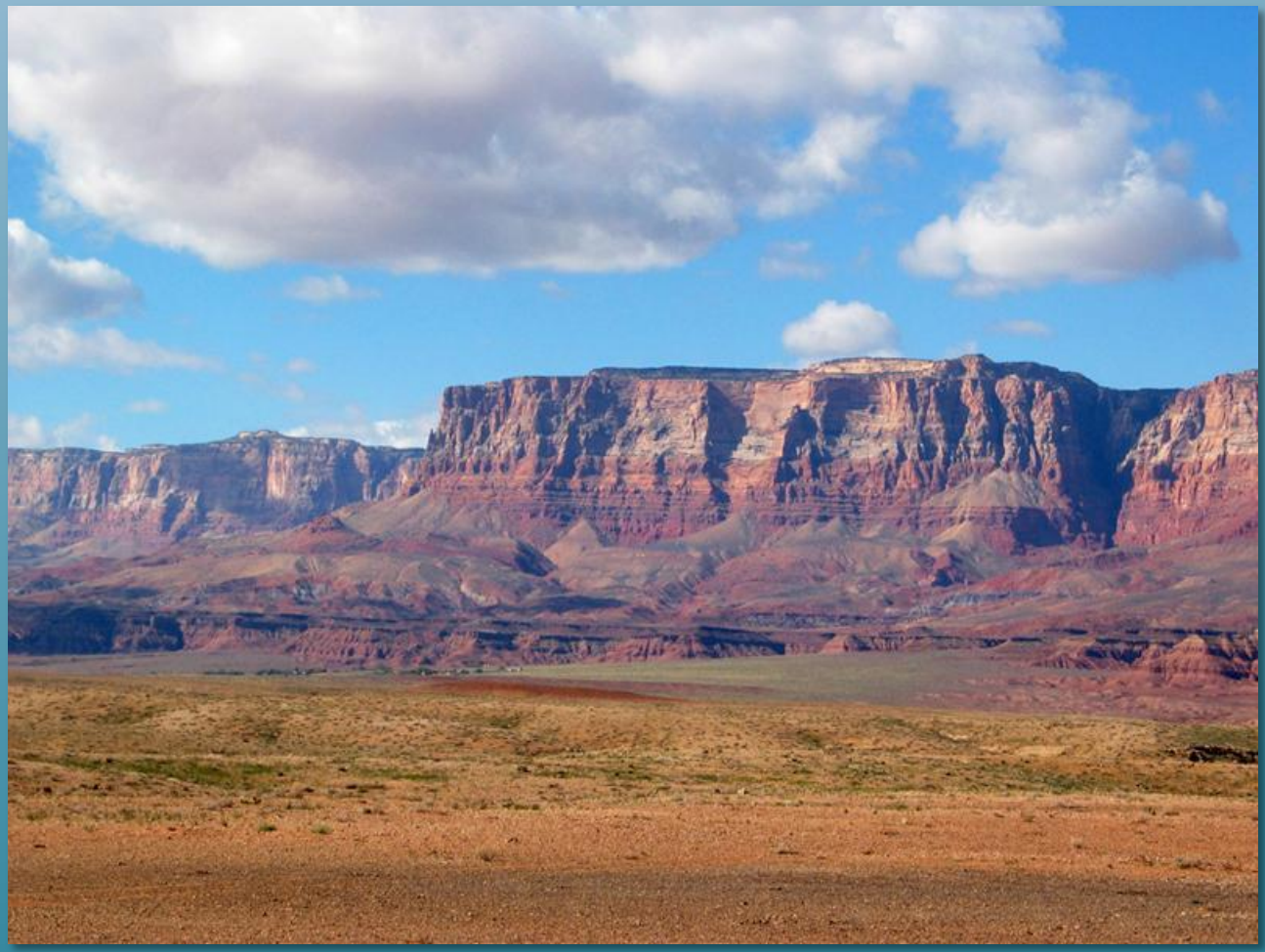

30° N
HIGH
Eq
LOW

Gradstein and Ogg, 2004, Cambridge U Press



GEOLOGIC EVOLUTION OF WESTERN NORTH AMERICA



Tectonic and Paleogeographic Evolution of Western North America

Tectonic Maps

Data, information

Tectono-stratigraphic asemblages color-keyed on each map

Plates, plate boundaries

Structure-tectonic features

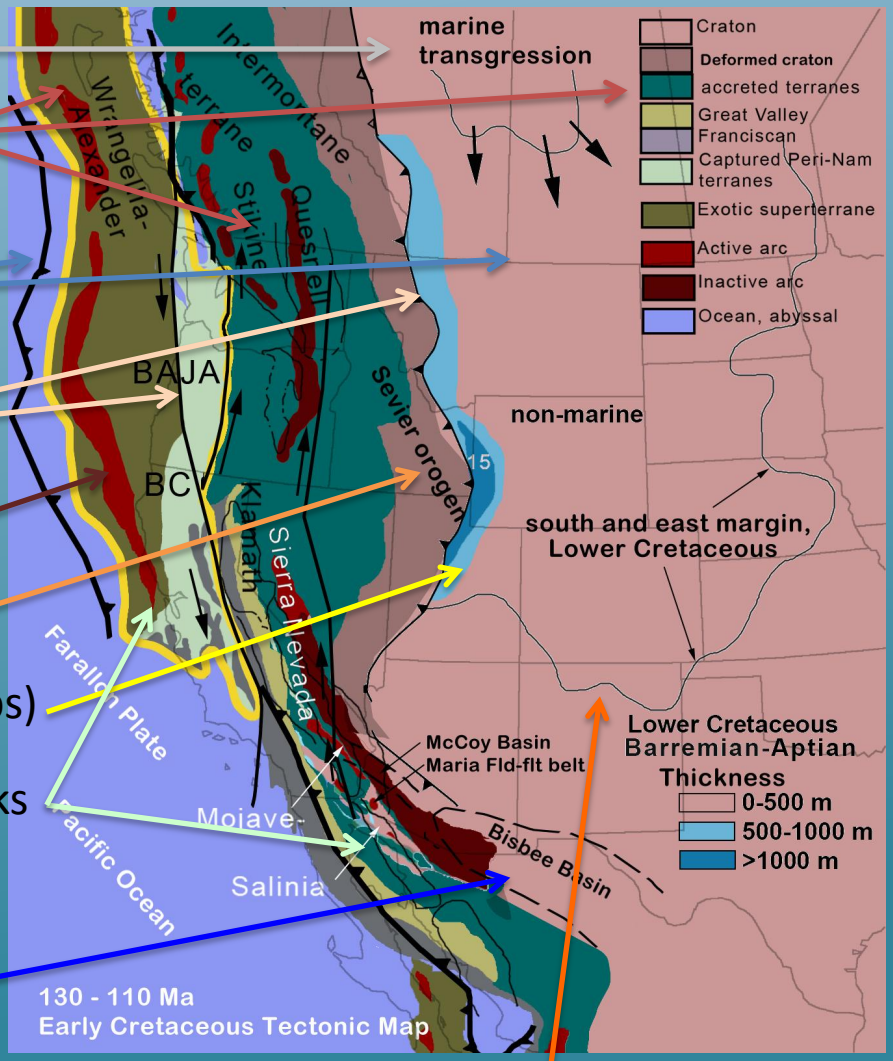
Igneous features

orogens

Thickness trends (on selected maps)

Microplates/tectonic blocks

Basins



Depositional edges (on selected maps)

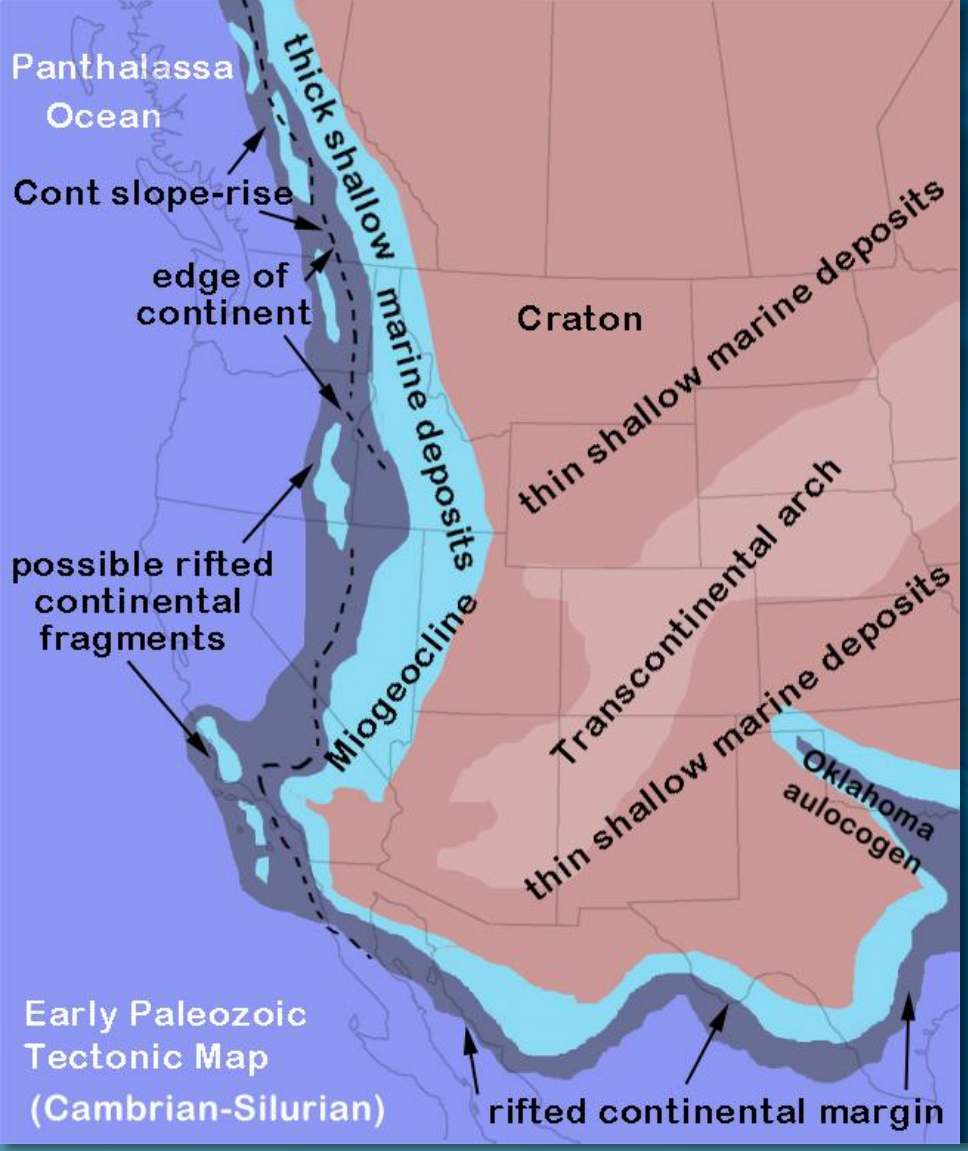
Paleogeographic maps

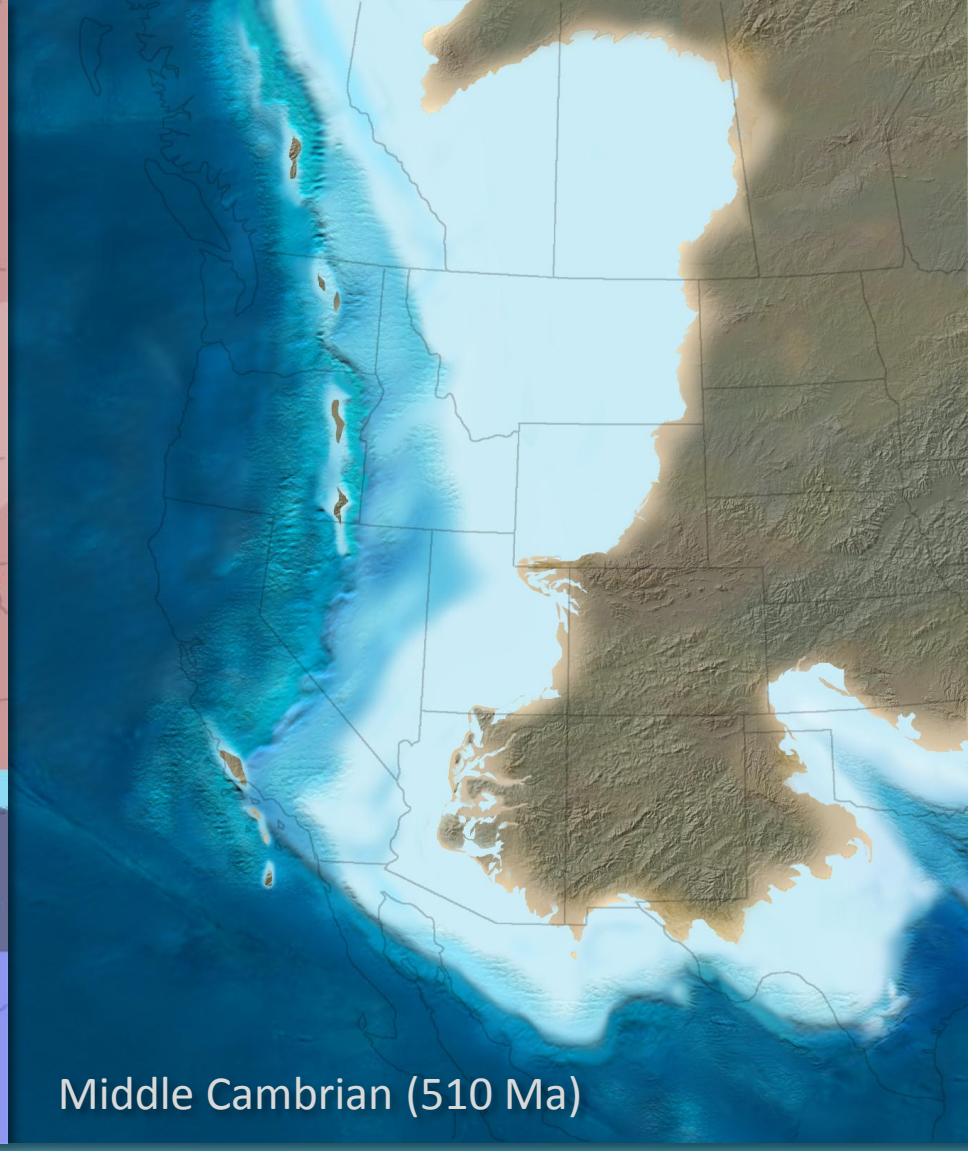
Trench

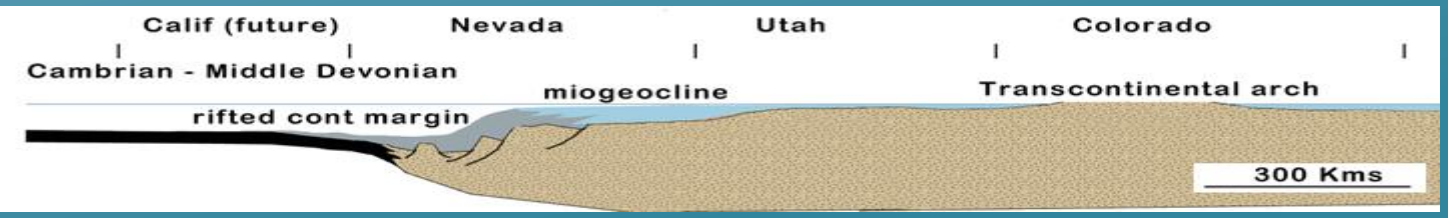
Shelf

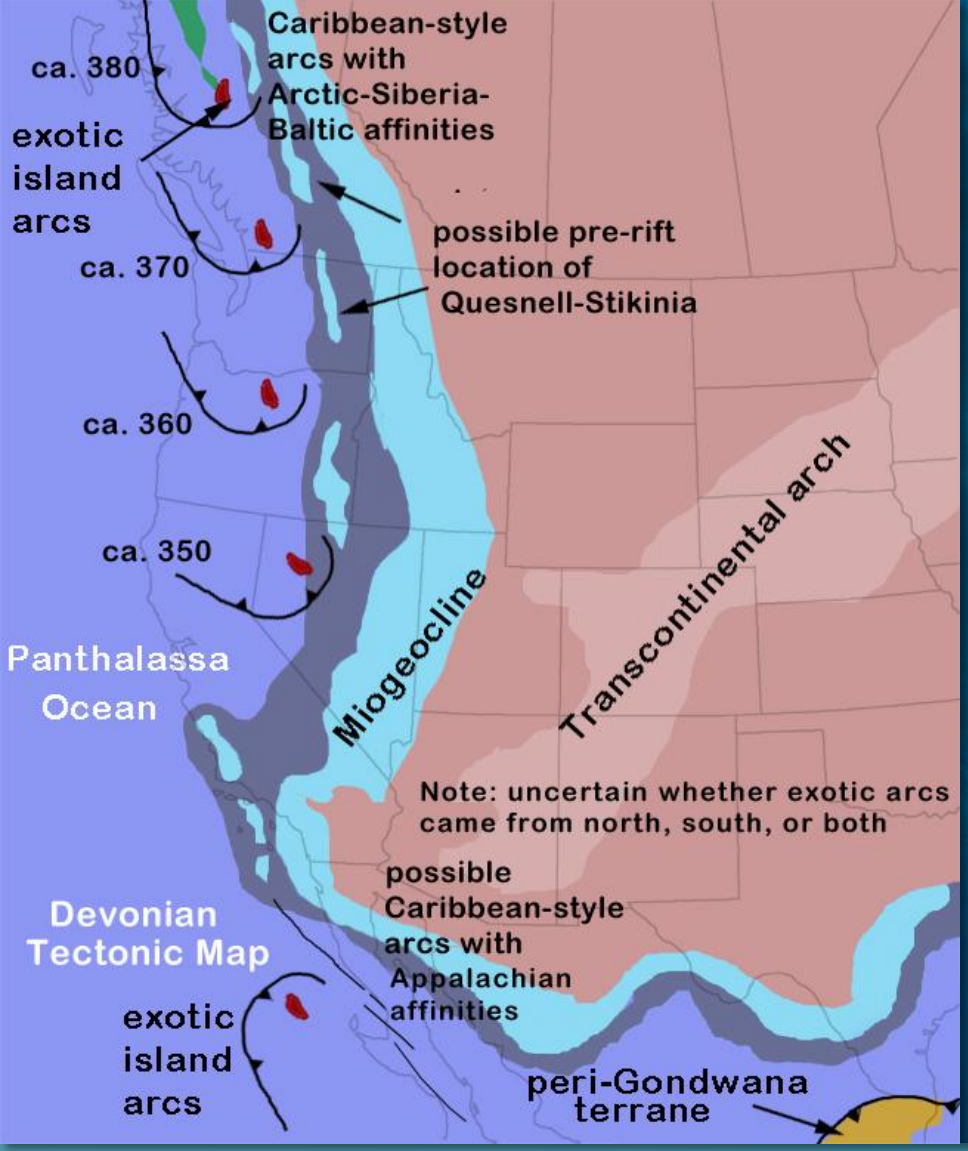
Deep marine - abyssal

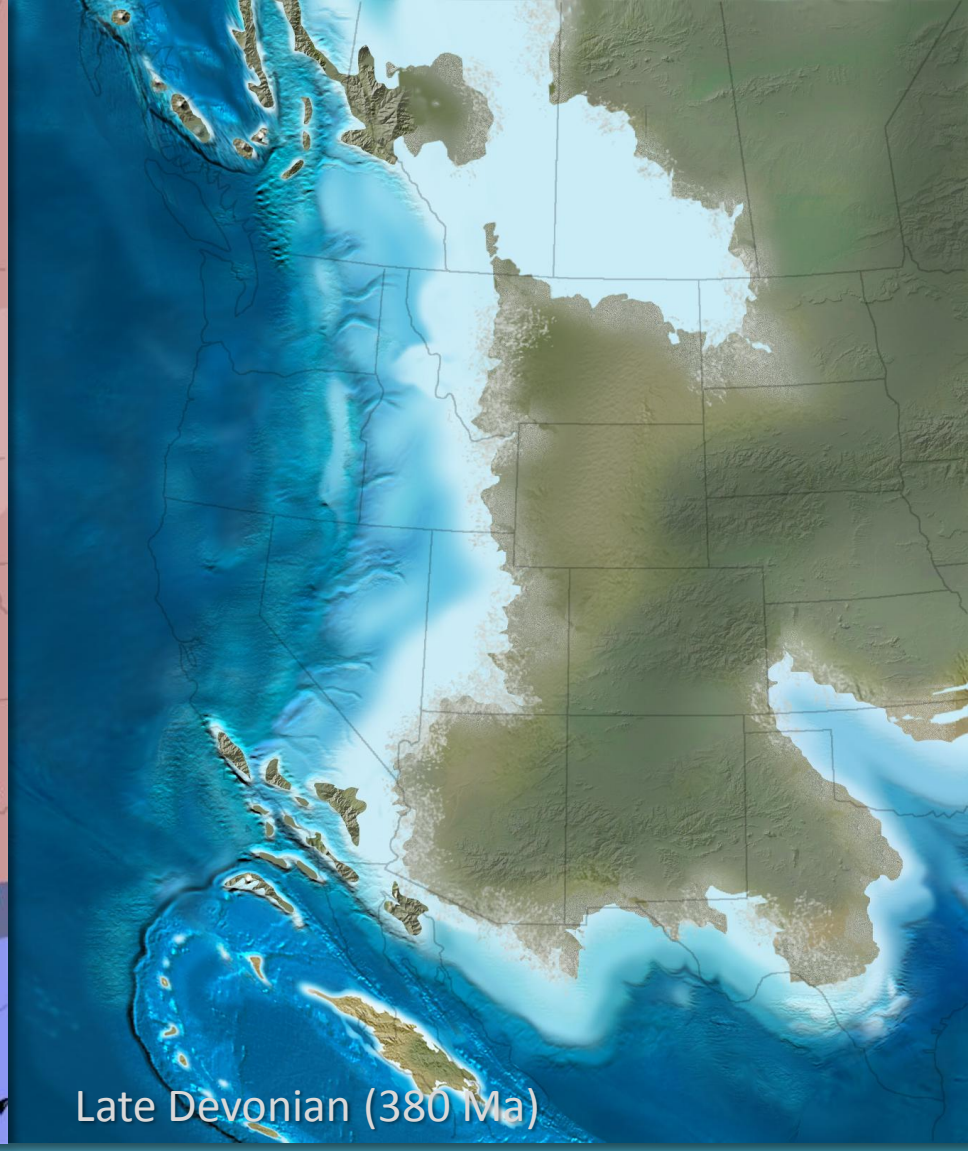
Volcano


Panthalassa Ocean
Cont slope-rise
edge of continent
thick shallow marine deposits
Craton
thin shallow marine deposits
possible rifted continental fragments
Miogeocline
Transcontinental arch
thin shallow marine deposits
Oklahoma aulocogen
Early Paleozoic Tectonic Map
(Cambrian-Silurian)
rifted continental margin

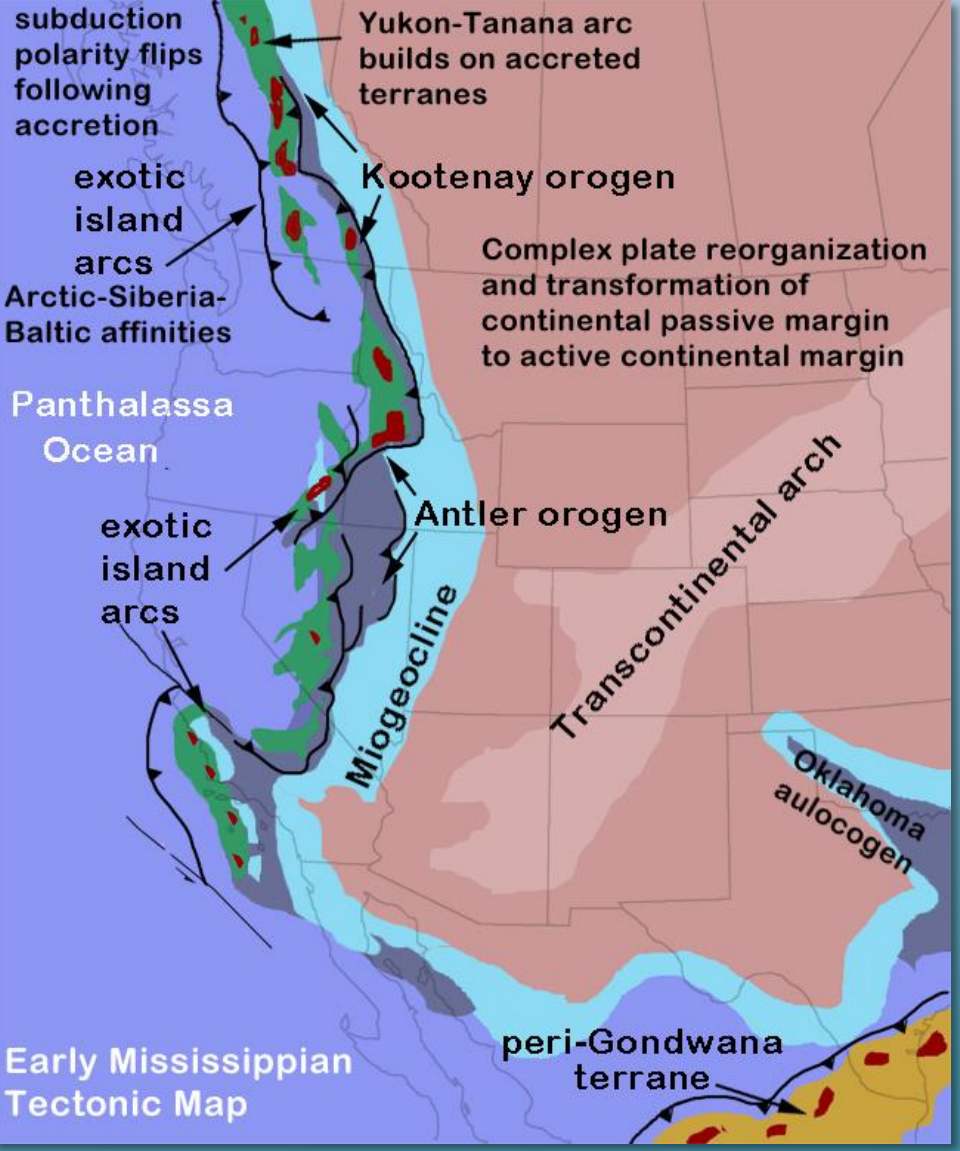

Middle Cambrian (510 Ma)

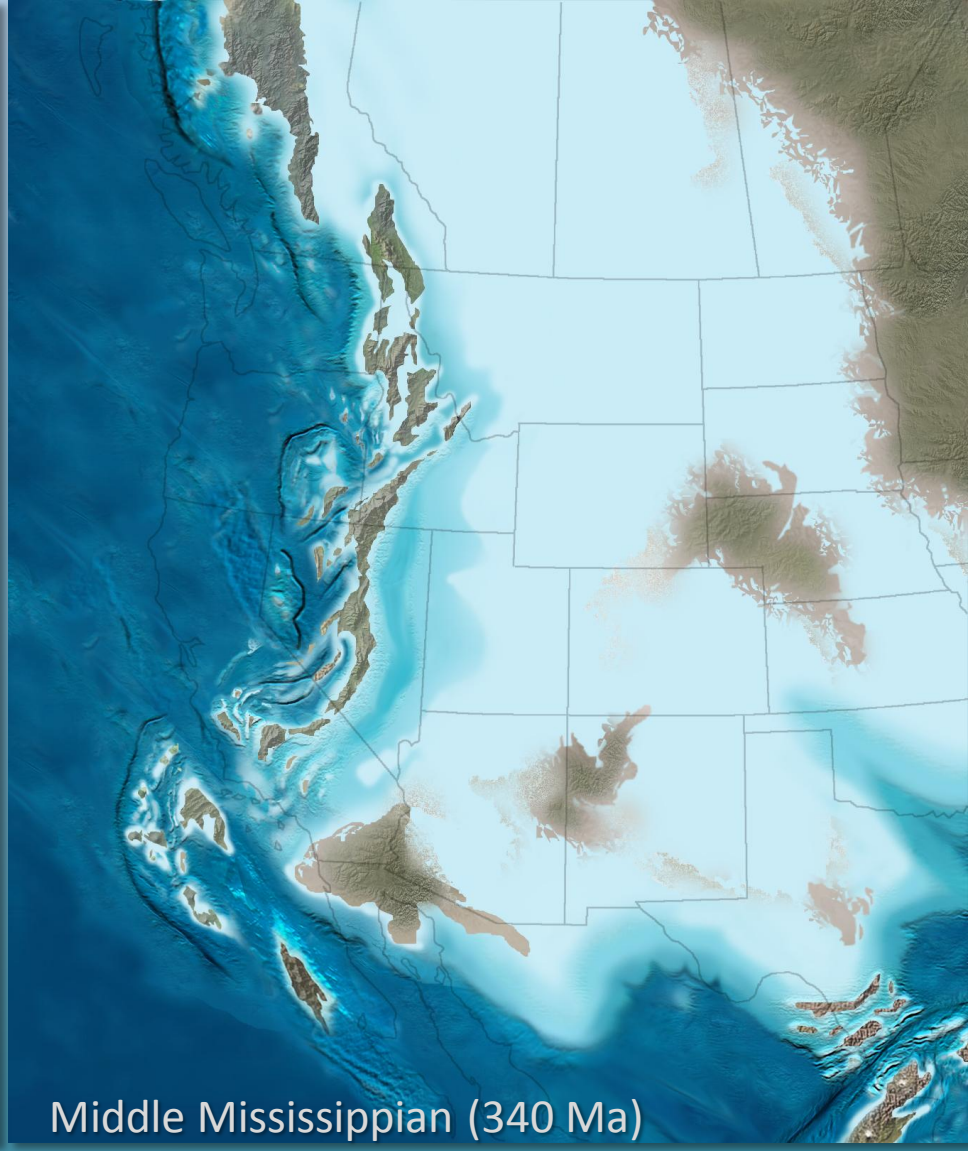

Calif (future)
Nevada
Utah
Colorado
Cambrian - Middle Devonian
miogeocline
Transcontinental arch
rifted cont margin
300 Kms

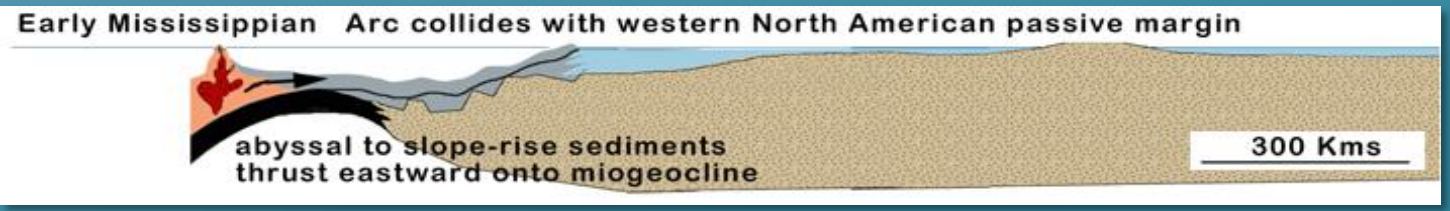

Caribbean-style
arcs with
Arctic-Siberia-
Baltic affinities
ca. 380
exotic
island
arcs
ca. 370
possible pre-rift
location of
Quesnell-Stikinia
ca. 360
ca. 350
Panthalassa
Ocean
Miogeocline
Transcontinental arch
Note: uncertain whether exotic arcs
came from north, south, or both
possible
Caribbean-style
arcs with
Appalachian
affinities
Devonian
Tectonic Map
exotic
island
arcs
peri-Gondwana
terrane

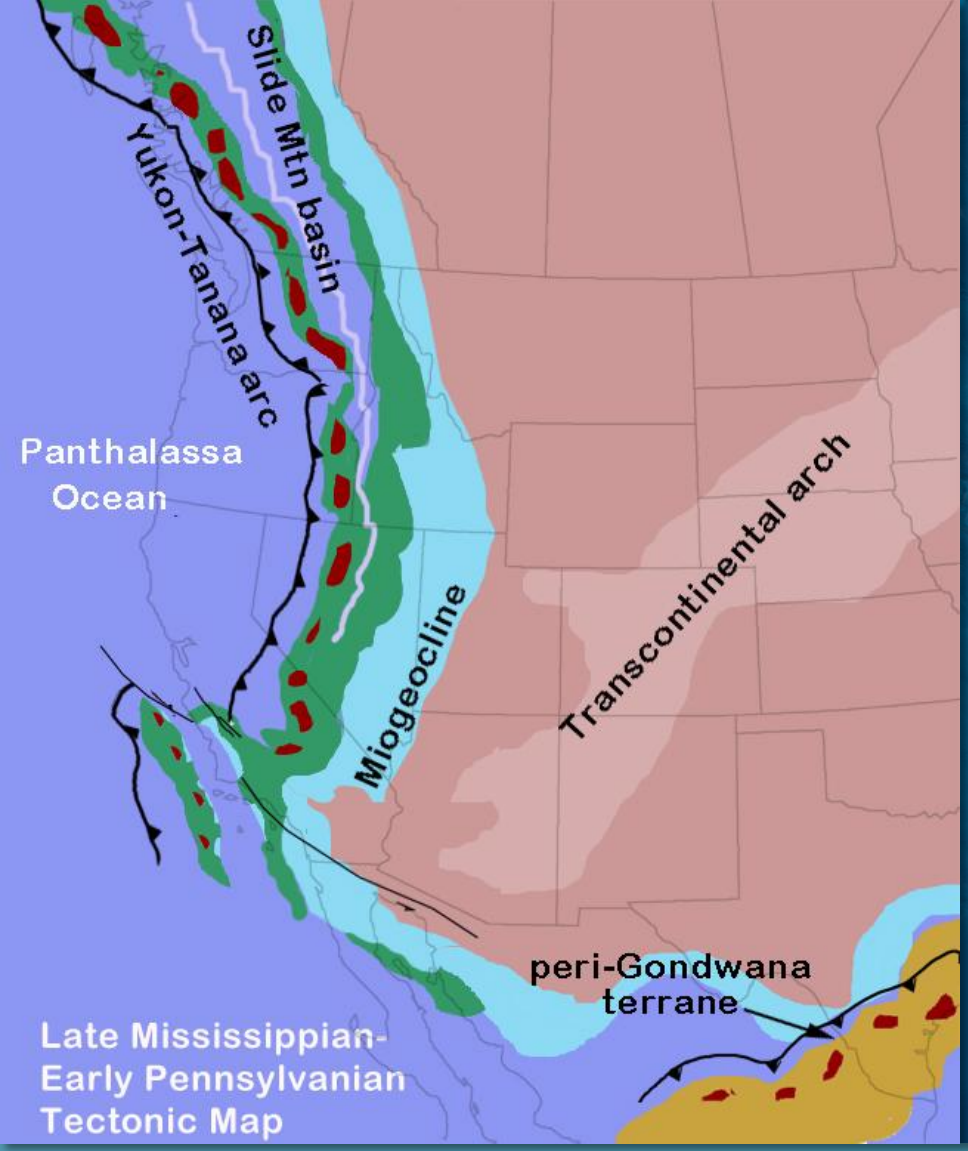

Late Devonian (380 Ma)

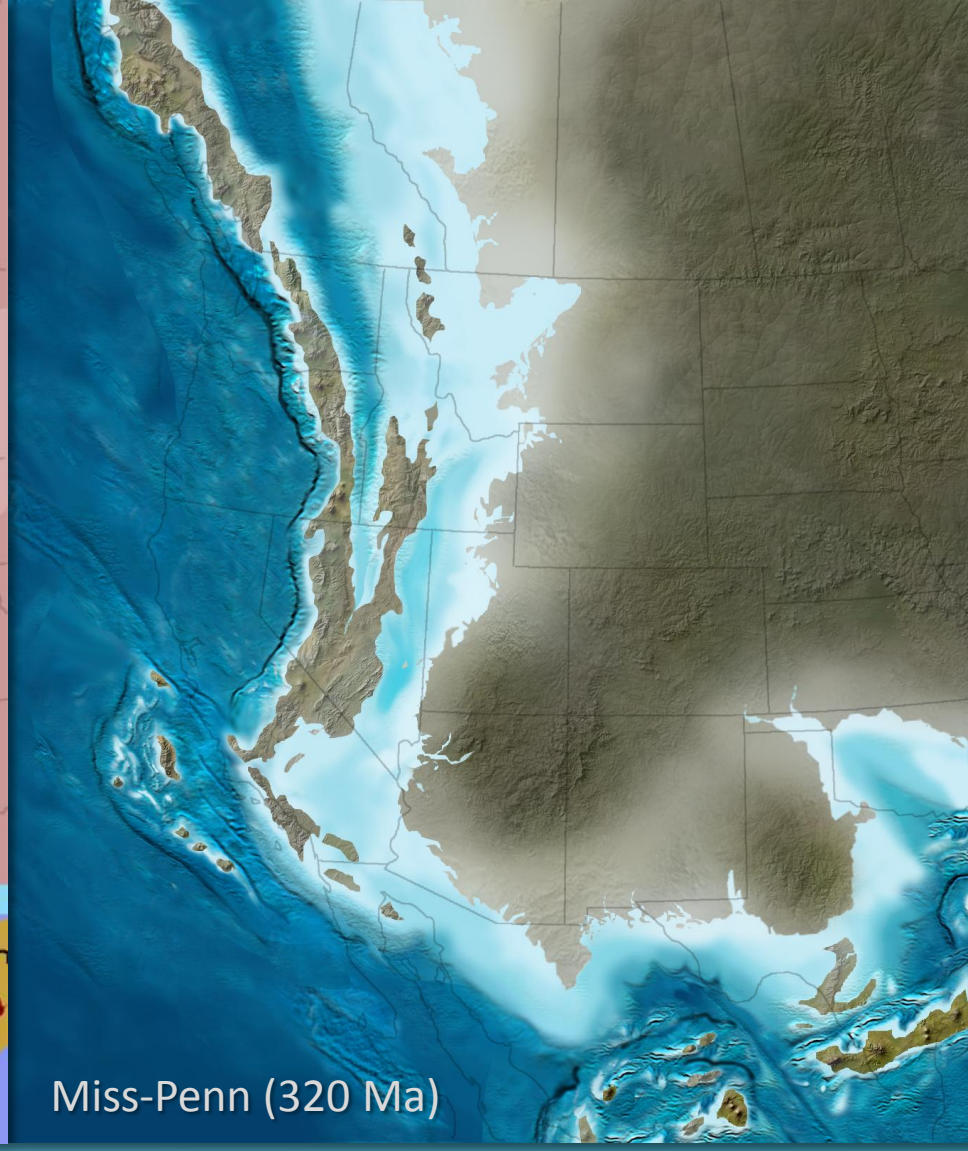

Caribbean-style, east-facing arc
w/ Gondwanan, Baltic, Siberian affinities
300 Kms

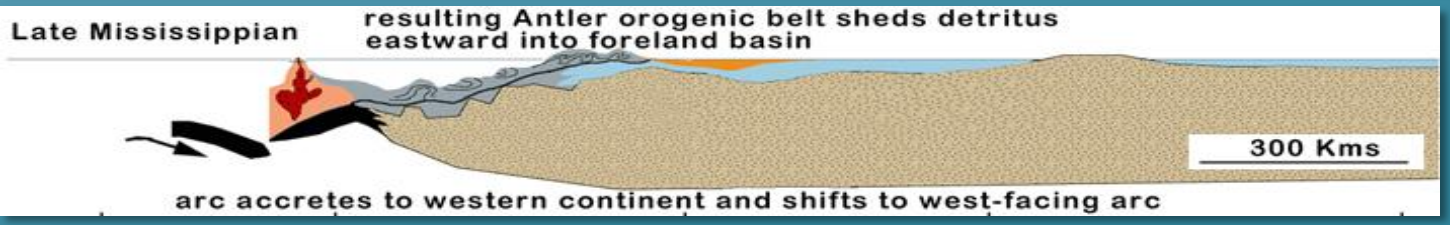

subduction polarity flips following accretion
Yukon-Tanana arc builds on accreted terranes
Kootenay orogen
exotic island arcs
Arctic-Siberia-Baltic affinities
Complex plate reorganization and transformation of continental passive margin to active continental margin
Panthalassa Ocean
Antler orogen
exotic island arcs
Miogeocline
Transcontinental arch
Oklahoma aulocogen
peri-Gondwana terrane
Early Mississippian Tectonic Map

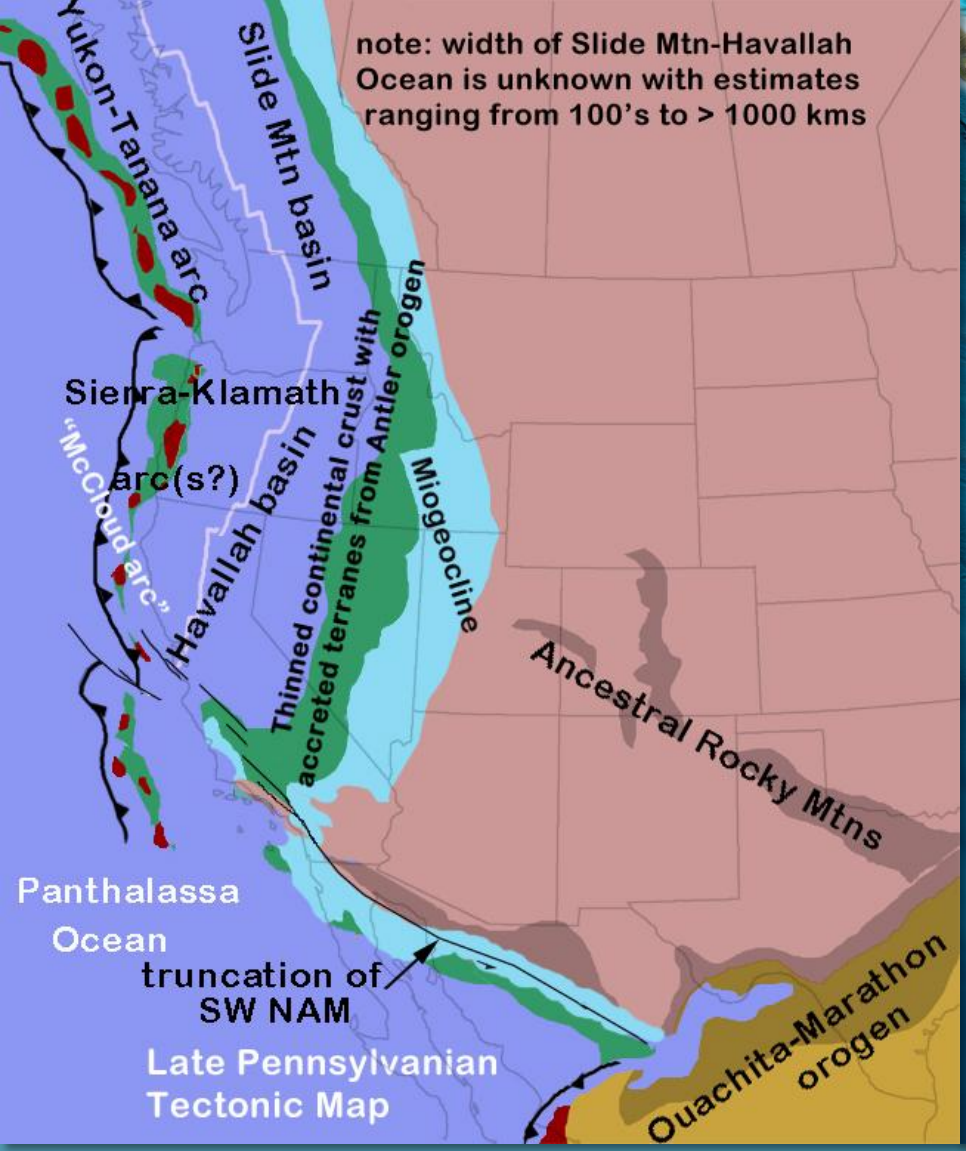

Middle Mississippian (340 Ma)

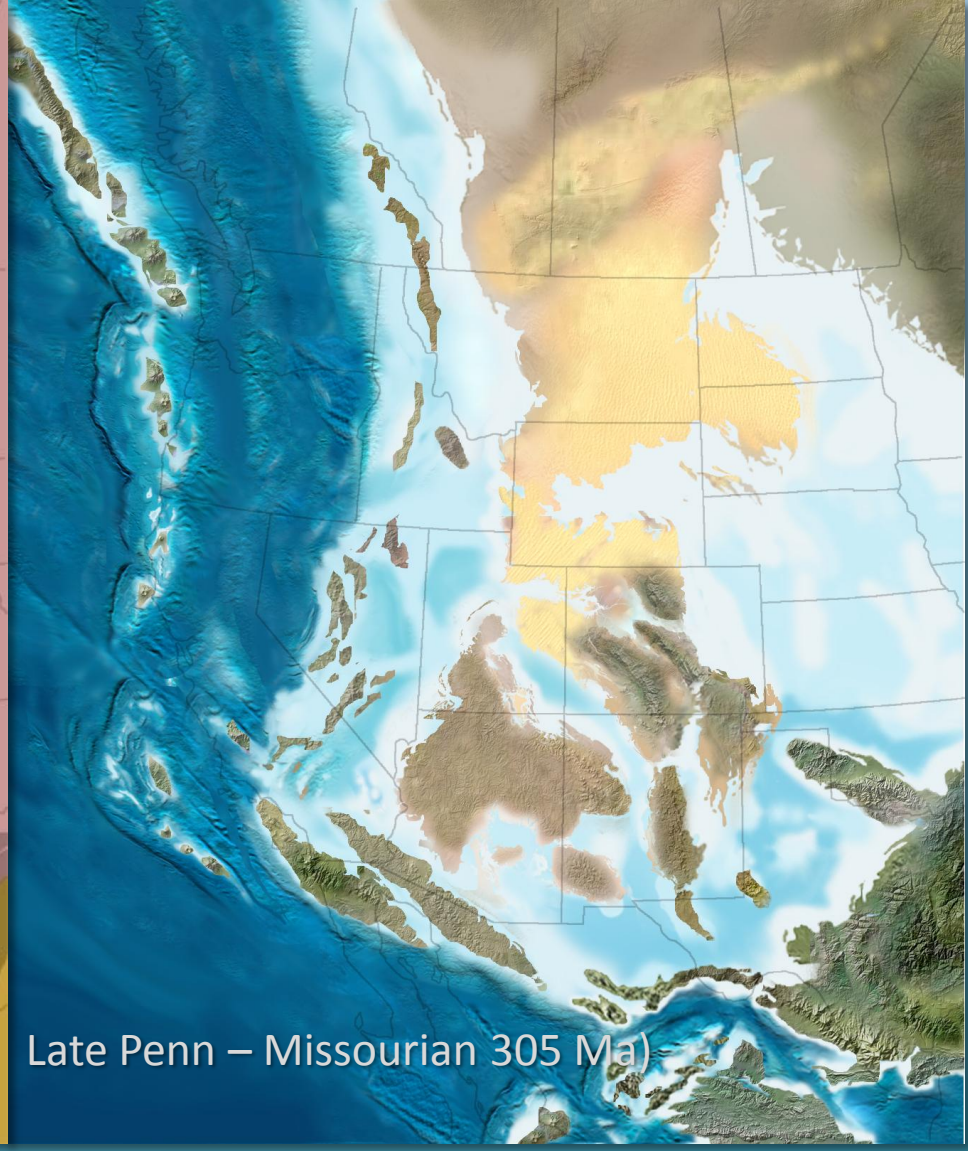

Early Mississippian Arc collides with western North American passive margin
abyssal to slope-rise sediments thrust eastward onto miogeocline
300 Kms

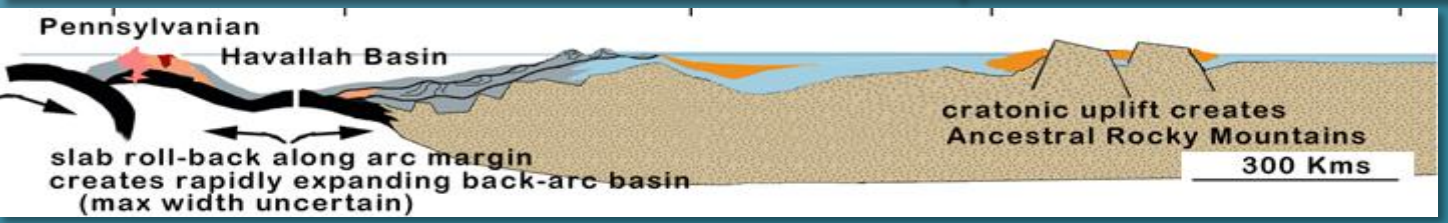

Slide Mtn basin
Yukon-Tanana arc
Panthalassa Ocean
Miogeocline
Transcontinental arch
peri-Gondwana terrane
Late Mississippian-
Early Pennsylvanian
Tectonic Map

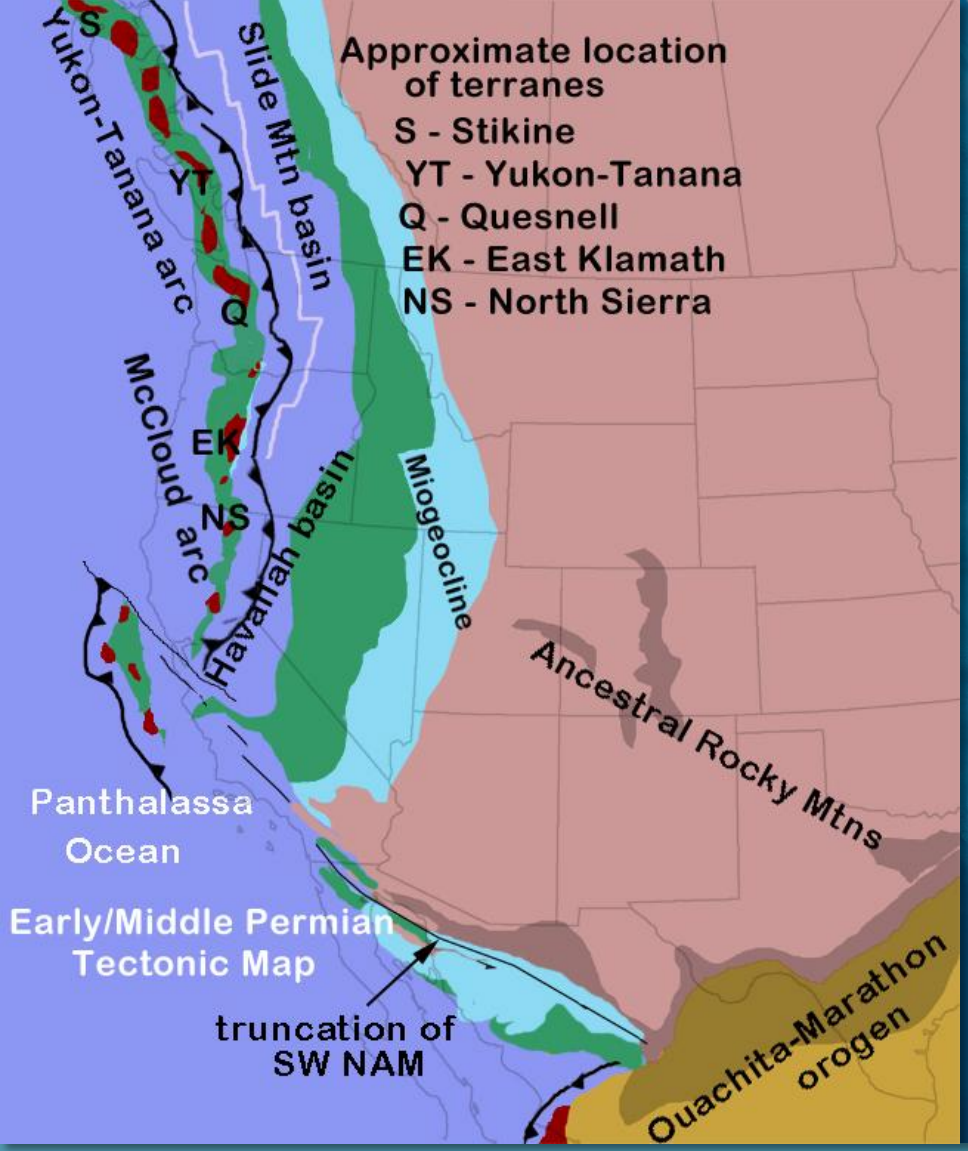

Miss-Penn (320 Ma)

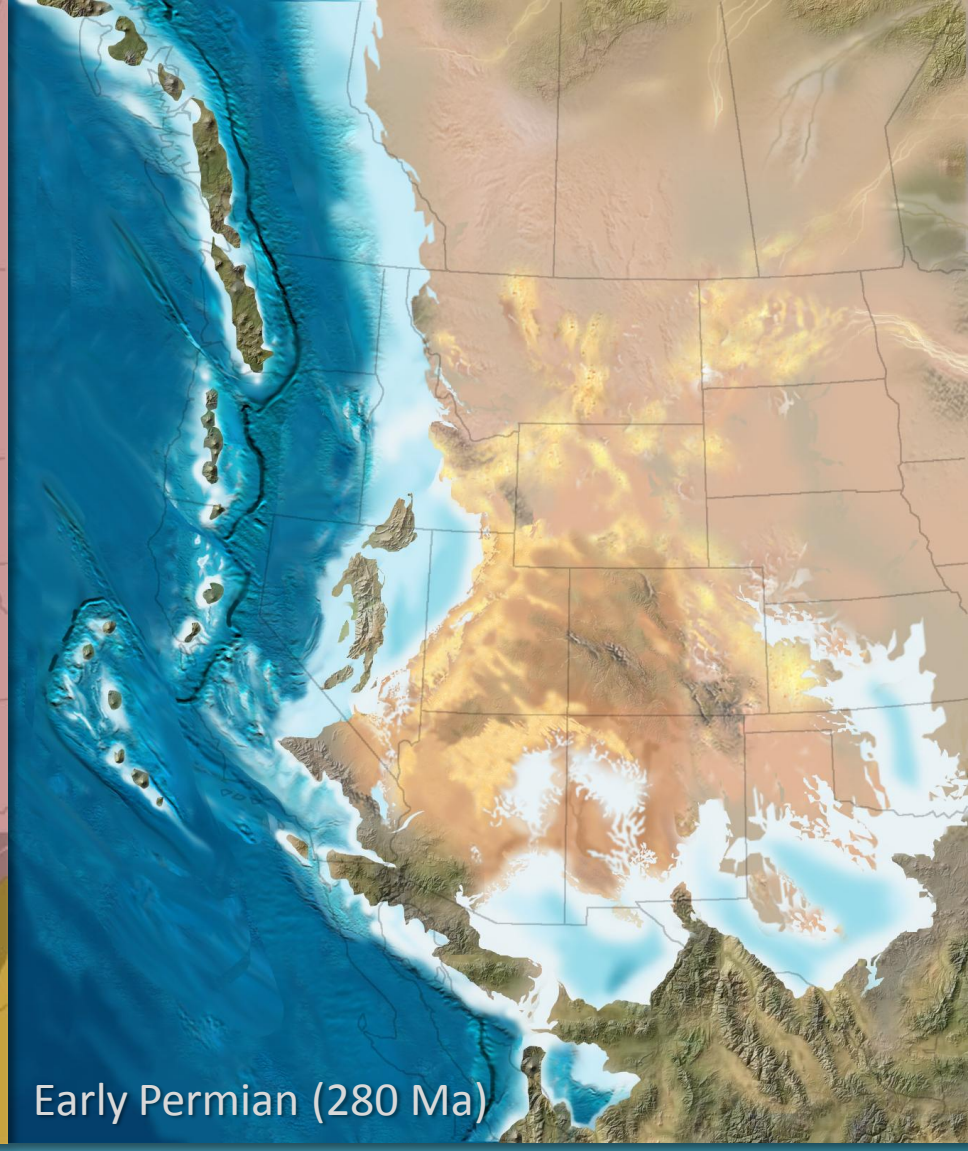

Late Mississippian
resulting Antler orogenic belt sheds detritus eastward into foreland basin
300 Kms
arc accretes to western continent and shifts to west-facing arc

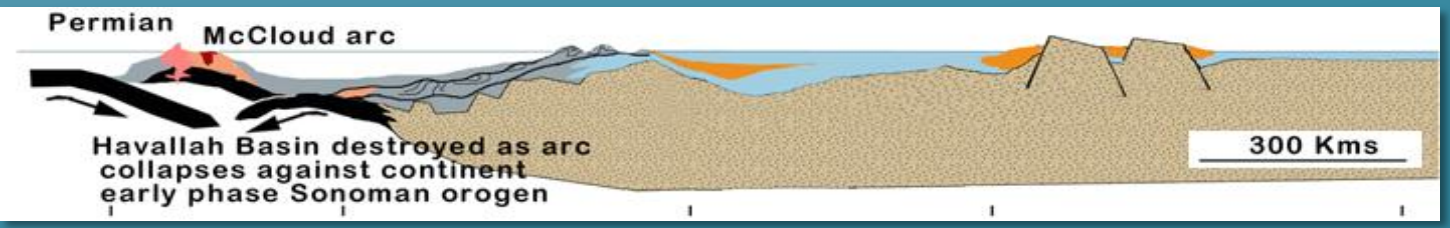

note: width of Slide Mtn-Havallah Ocean is unknown with estimates ranging from 100's to > 1000 kms
Yukon-Tanana arc
Slide Mtn basin
Sierra-Klamath arc(s?)
"McCloud arc"
Havallah basin
Thinned continental crust with accreted terranes from Antler orogen
Miogeocline
Ancestral Rocky Mtns
Panthalassa Ocean
truncation of SW NAM
Late Pennsylvanian Tectonic Map
Ouachita-Marathon orogen


Late Penn – Missourian 305 Ma)


Pennsylvanian
Havallah Basin
slab roll-back along arc margin
creates rapidly expanding back-arc basin
(max width uncertain)
cratonic uplift creates
Ancestral Rocky Mountains
300 Kms

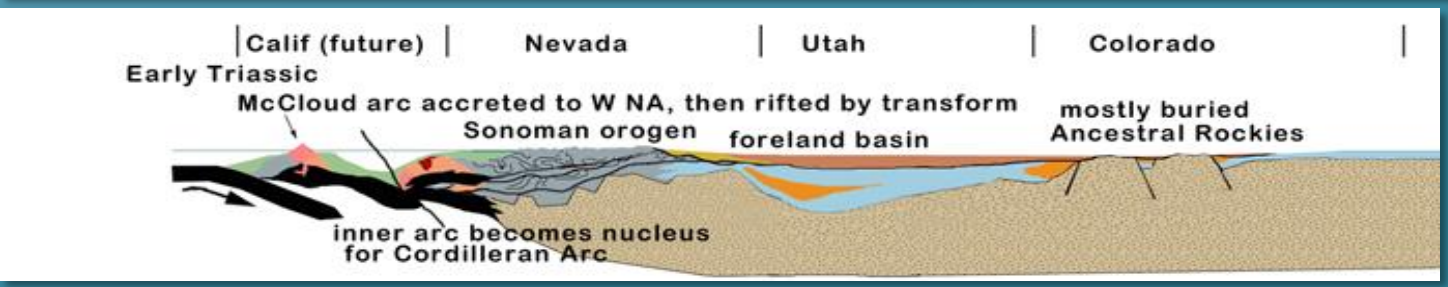

Approximate location of terranes
S - Stikine
YT - Yukon-Tanana
Q - Quesnell
EK - East Klamath
NS - North Sierra
Yukon-Tanana arc
Slide Mtn basin
McCloud arc
Havallah basin
Miogeocline
Ancestral Rocky Mtns
Panthalassa Ocean
Early/Middle Permian Tectonic Map
truncation of SW NAM
Ouachita-Marathon orogen

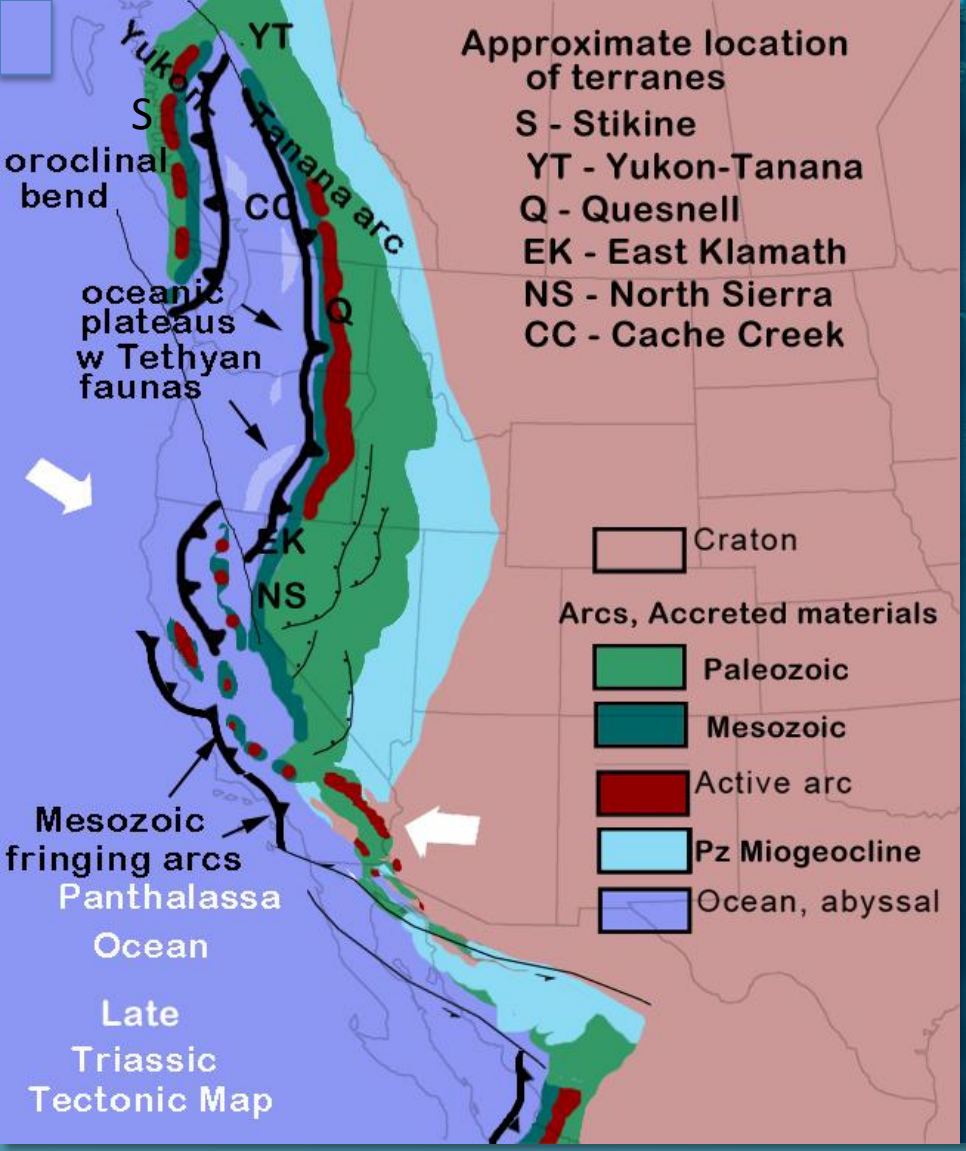

Early Permian (280 Ma)


Permian
McCloud arc
Havallah Basin destroyed as arc collapses against continent
early phase Sonoman orogen
300 Kms


Approximate location of terranes
S - Stikine
YT - Yukon-Tanana
Q - Quesnell
EK - East Klamath
NS - North Sierra
CC - Cache Creek
S
YT
Yukon-Tanana arc
CC
oceanic plateaus w Tethyan faunas
Q
Miogeocline
arc collapse
Sonoman orogen
EK
NS
thrust belt
Mesozoic fringing arcs
Panthalassa Ocean
Craton
Arcs, Accreted materials
Paleozoic
Mesozoic
Active arc
Pz Miogeocline
Ocean, abyssal
Early Triassic Tectonic Map

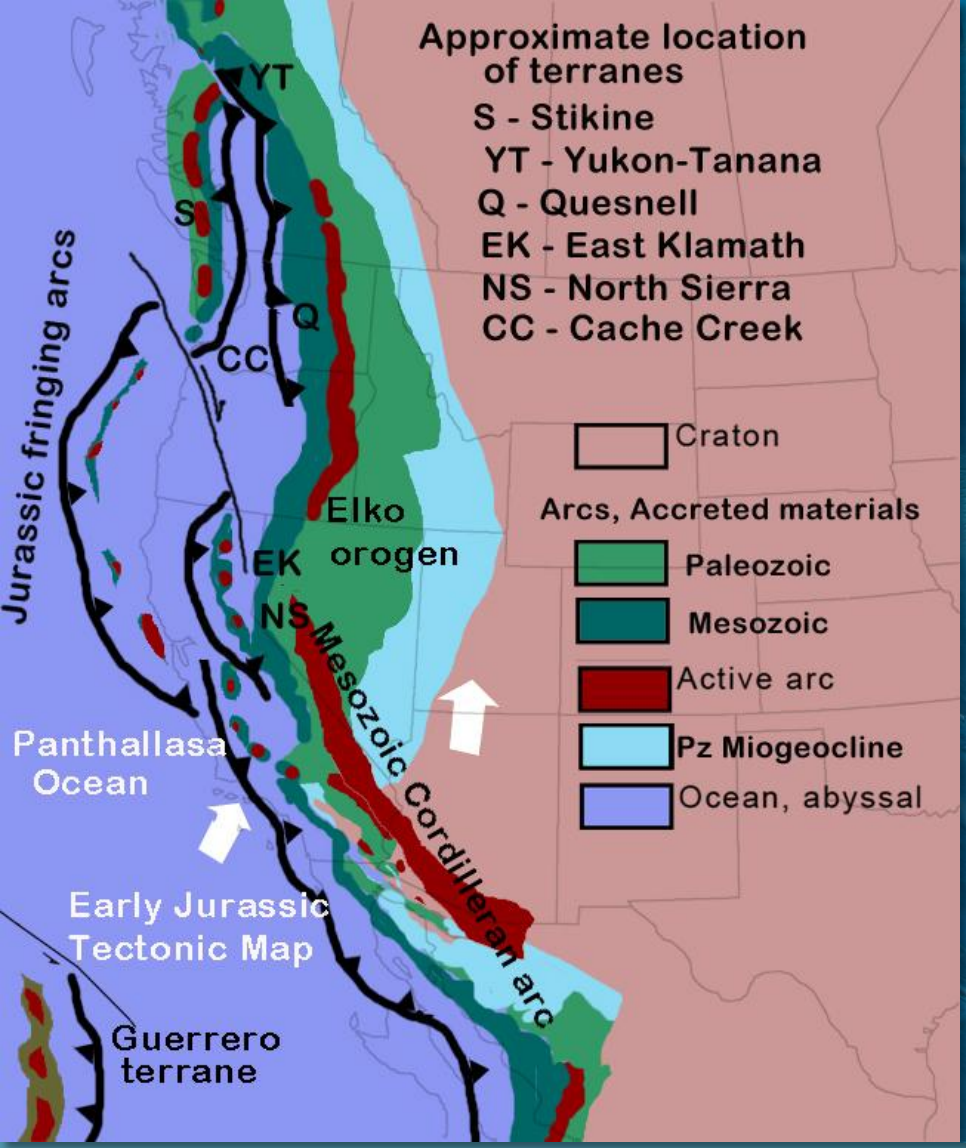

Early Triassic (245 Ma)

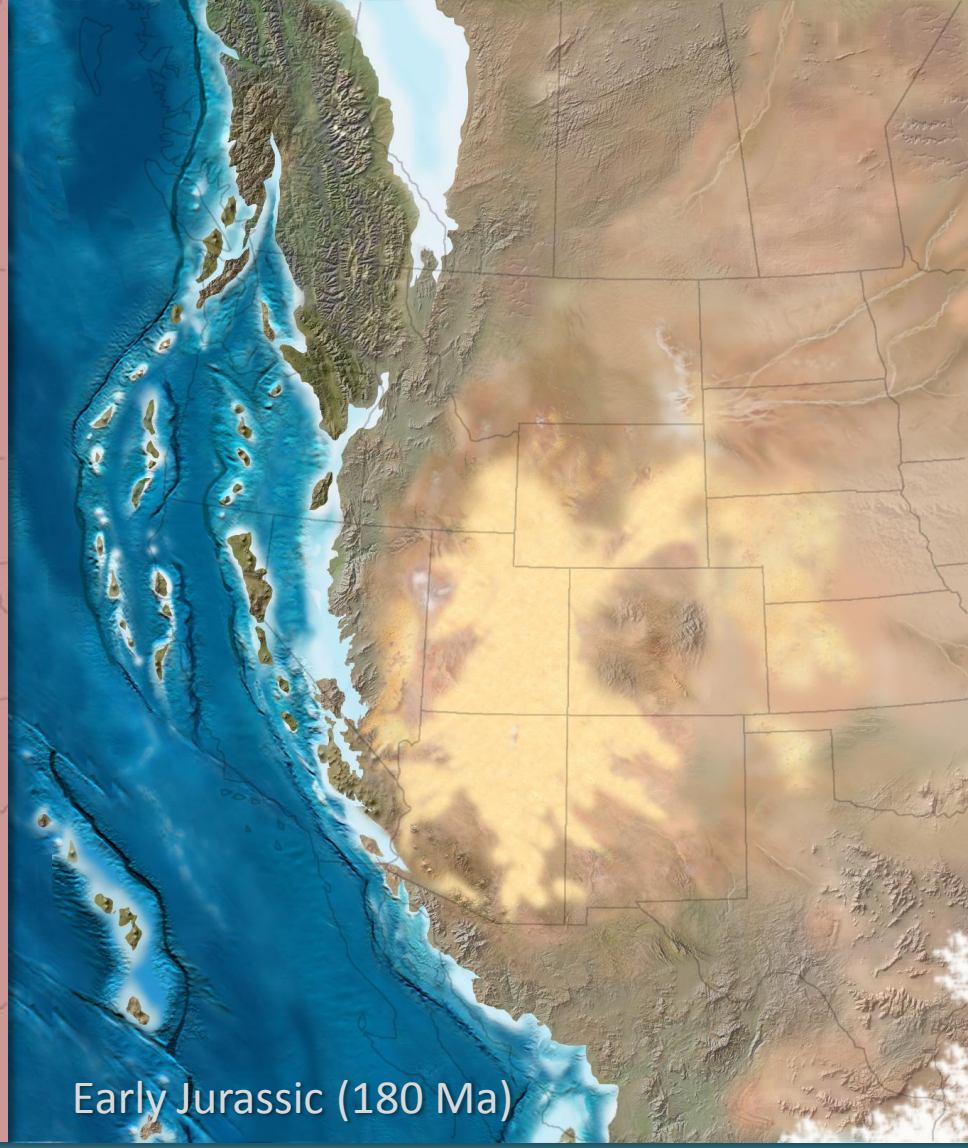

Calif (future)
Nevada
Utah
Colorado
Early Triassic
McCloud arc accreted to W NA, then rifted by transform
Sonoman orogen
foreland basin
mostly buried Ancestral Rockies
inner arc becomes nucleus for Cordilleran Arc

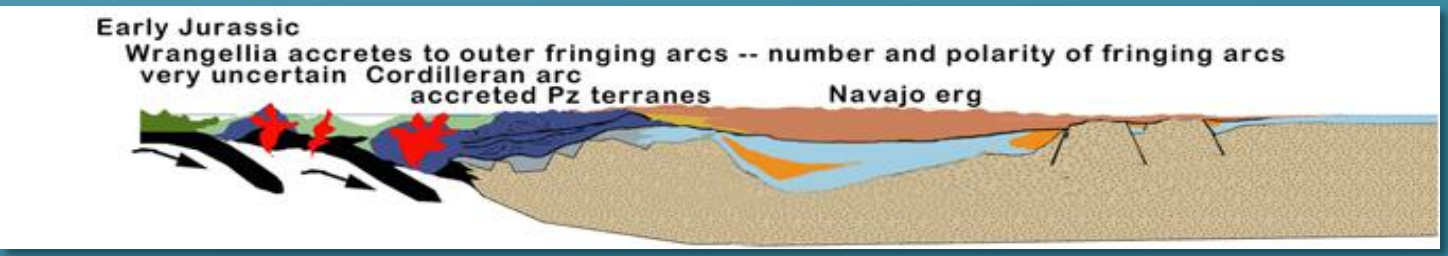

Yukon
YT
S
oroclinal bend
CC
Tanana arc
Q
oceanic plateaus w Tethyan faunas
EK
NS
Mesozoic fringing arcs
Panthalassa Ocean
Late Triassic Tectonic Map
Approximate location of terranes
S - Stikine
YT - Yukon-Tanana
Q - Quesnell
EK - East Klamath
NS - North Sierra
CC - Cache Creek
Craton
Arcs, Accreted materials
Paleozoic
Mesozoic
Active arc
Pz Miogeocline
Ocean, abyssal

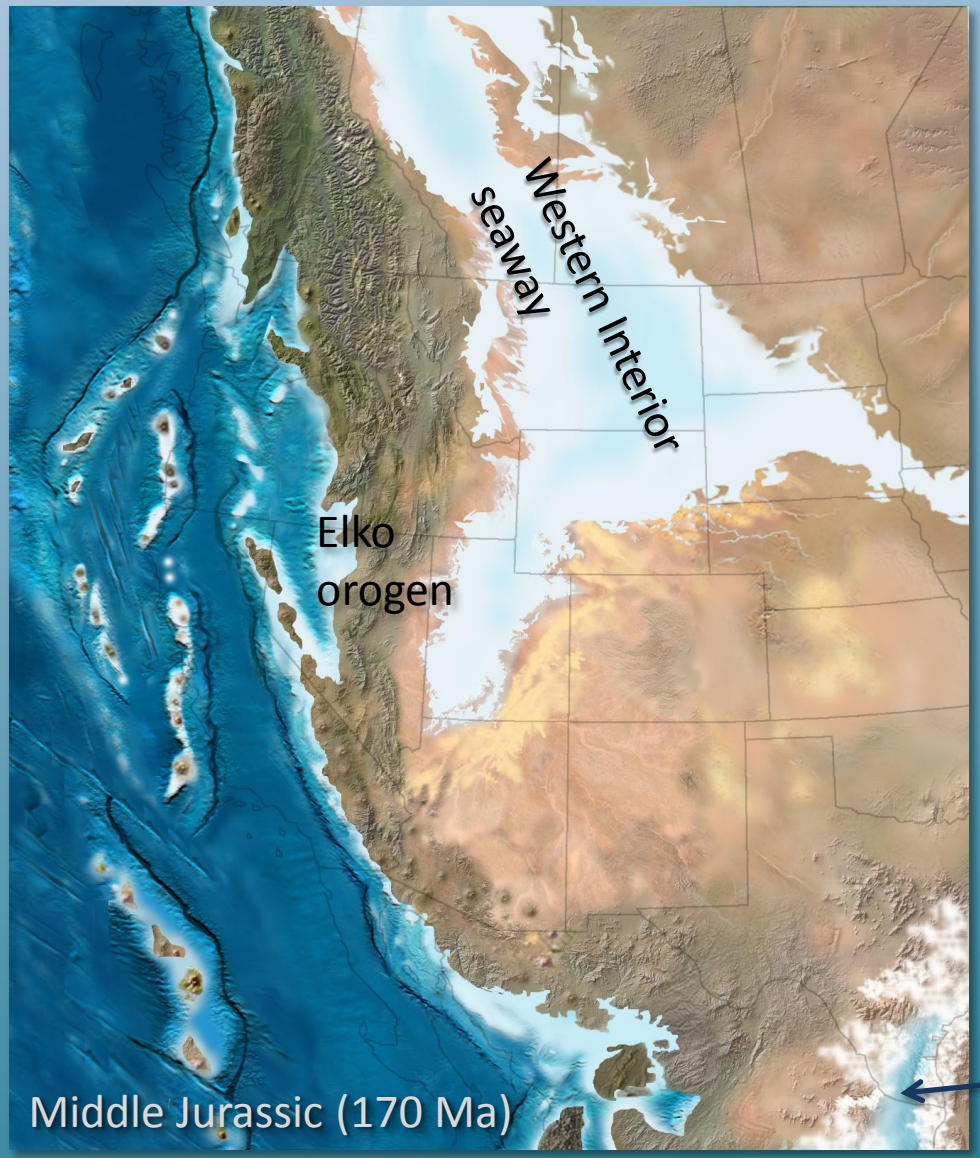

Late Triassic (215 Ma)

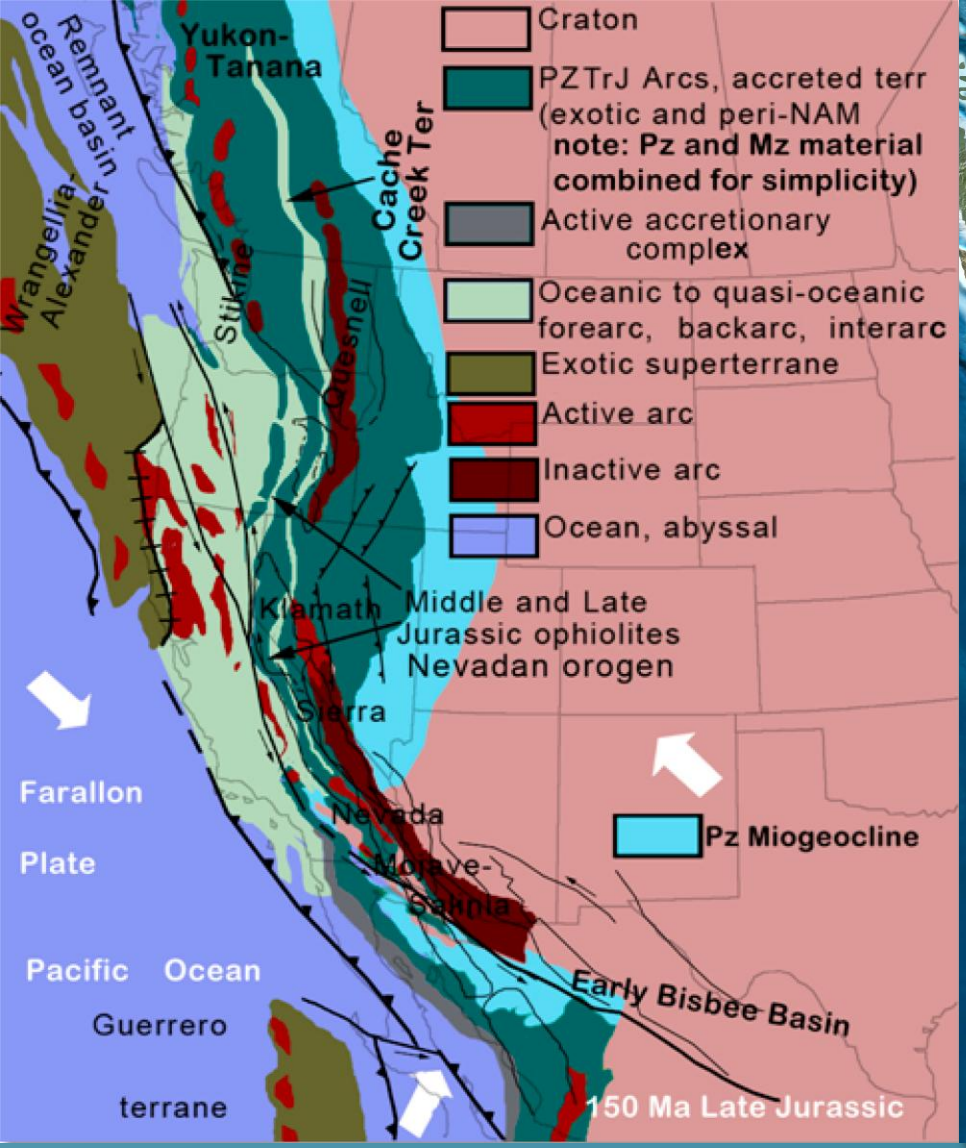

Late Triassic
McCloud arc
Wrangellia
??
(distance unknown)
Cache Creek Ocean
Cordilleran arc built on accreted Pz terranes (purple)
300 Kms


Approximate location of terranes
S - Stikine
YT - Yukon-Tanana
Q - Quesnell
EK - East Klamath
NS - North Sierra
CC - Cache Creek
Craton
Arcs, Accreted materials
Paleozoic
Mesozoic
Active arc
Pz Miogeocline
Ocean, abyssal
YT
S
Q
CC
Jurassic fringing arcs
Elko orogen
EK
NS
Mesozoic Cordilleran arc
Panthallasa Ocean
Early Jurassic Tectonic Map
Guerrero terrane

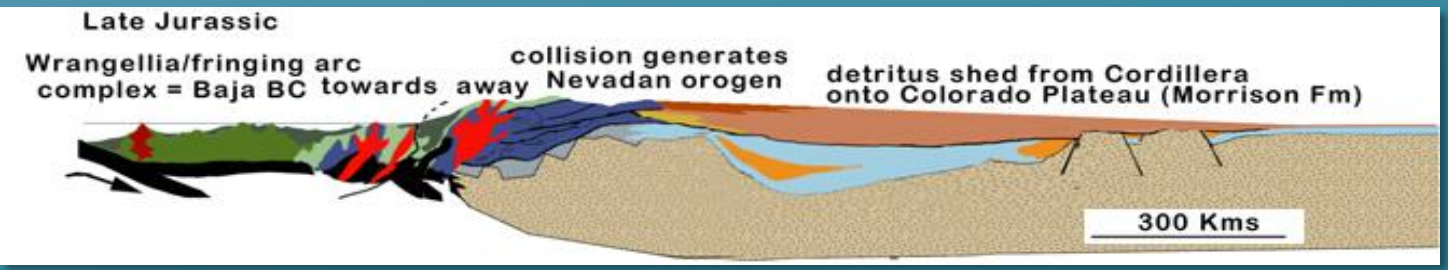

Early Jurassic (180 Ma)

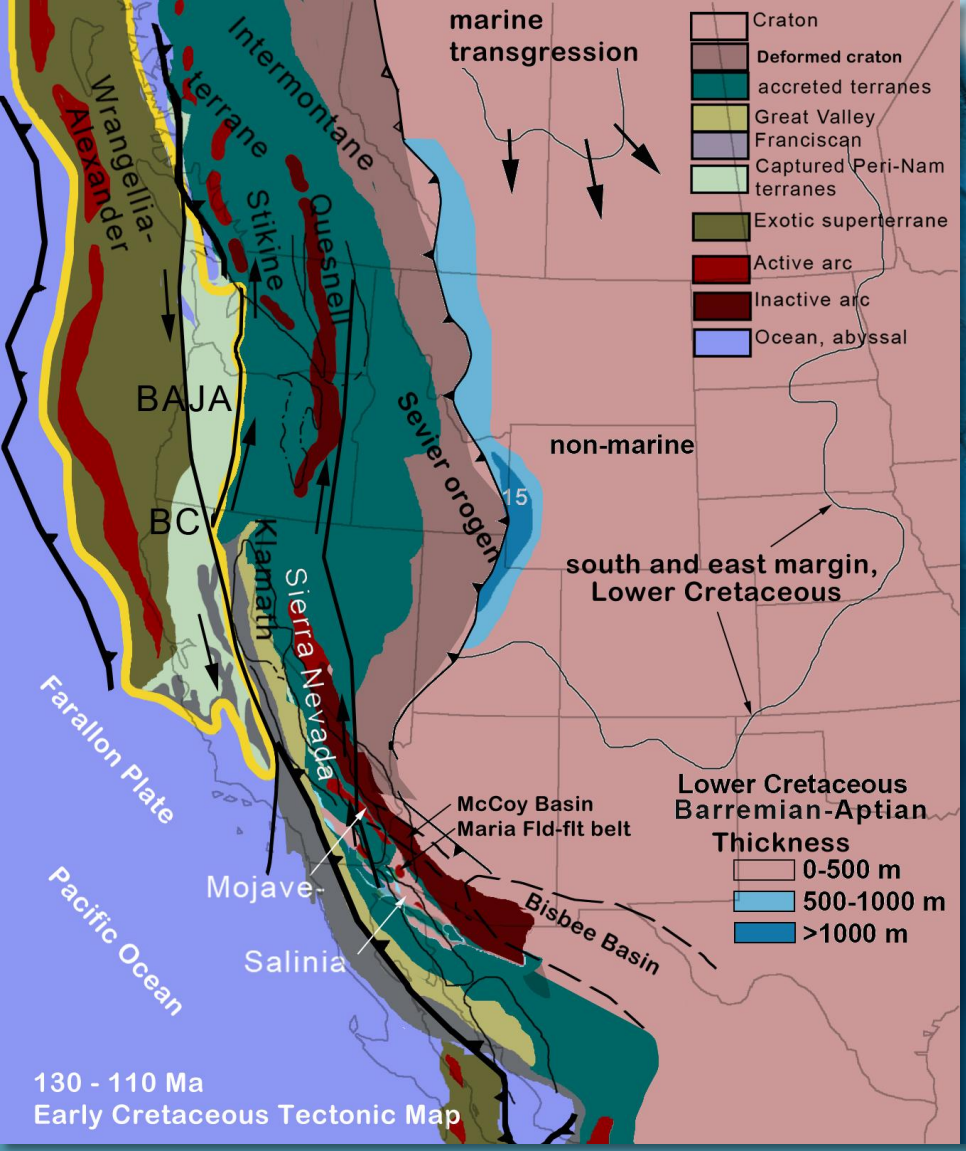

Early Jurassic
Wrangellia accretes to outer fringing arcs -- number and polarity of fringing arcs very uncertain
Cordilleran arc
accreted Pz terranes
Navajo erg


Western Interior seaway
Elko orogen
Middle Jurassic (170 Ma)
Opening Gulf of Mexico

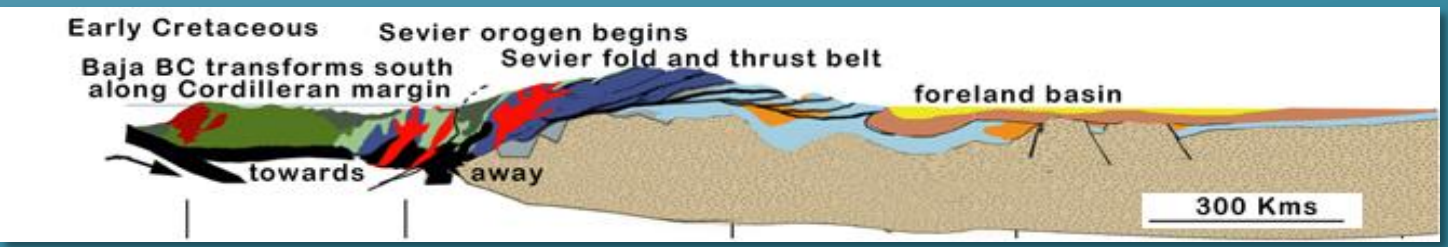

Craton
PZTrJ Arcs, accreted terr (exotic and peri-NAM note: Pz and Mz material combined for simplicity)
Active accretionary complex
Oceanic to quasi-oceanic forearc, backarc, interarc
Exotic superterrane
Active arc
Inactive arc
Ocean, abyssal
Yukon-Tanana
Remnant ocean basin
Wrangellia-Alexander
Cache Creek Ter
Stikine
Quesnell
Klamath
Middle and Late Jurassic ophiolites Nevadan orogen
Sierra
Nevada
Mojave-Sonora
Pz Miogeocline
Farallon Plate
Pacific Ocean
Guerrero terrane
Early Bisbee Basin
150 Ma Late Jurassic

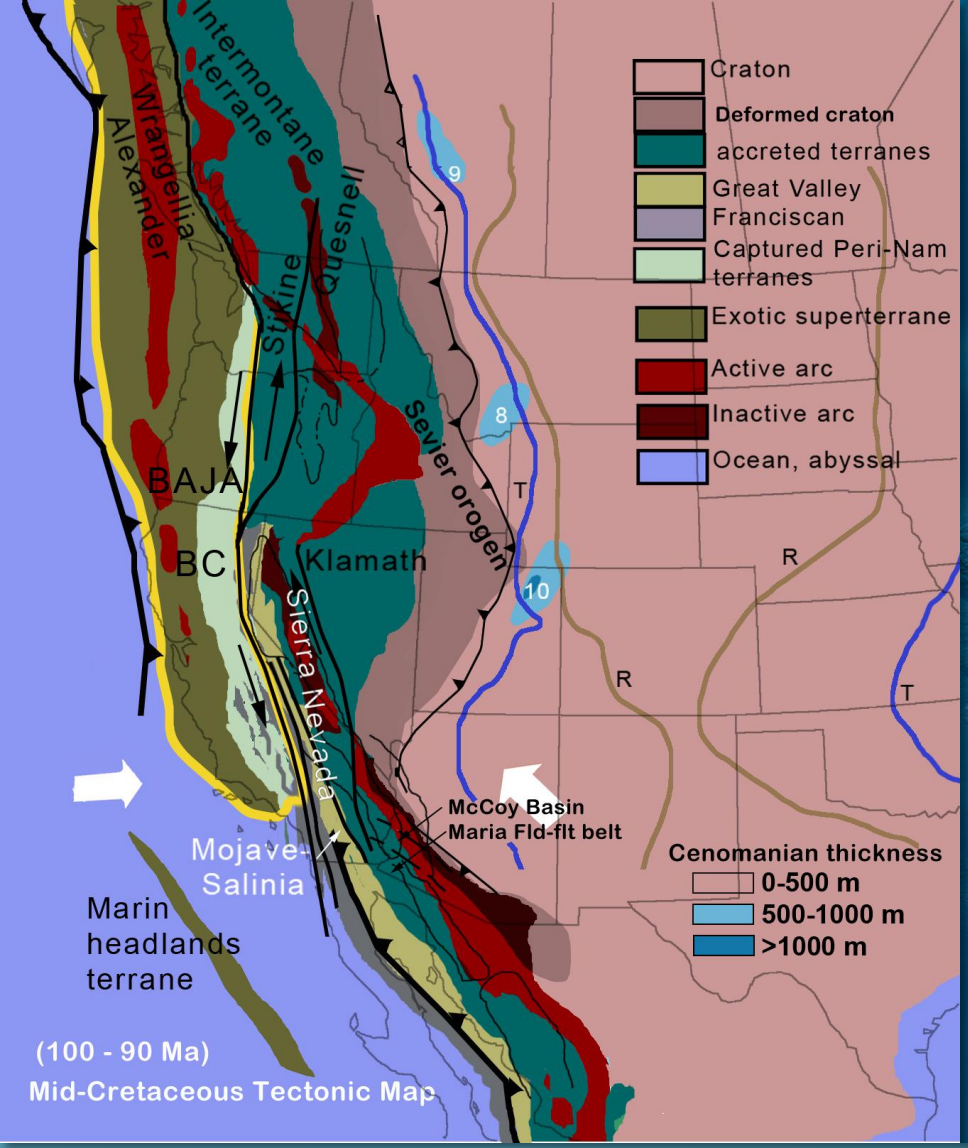

Late Jurassic (150 Ma)

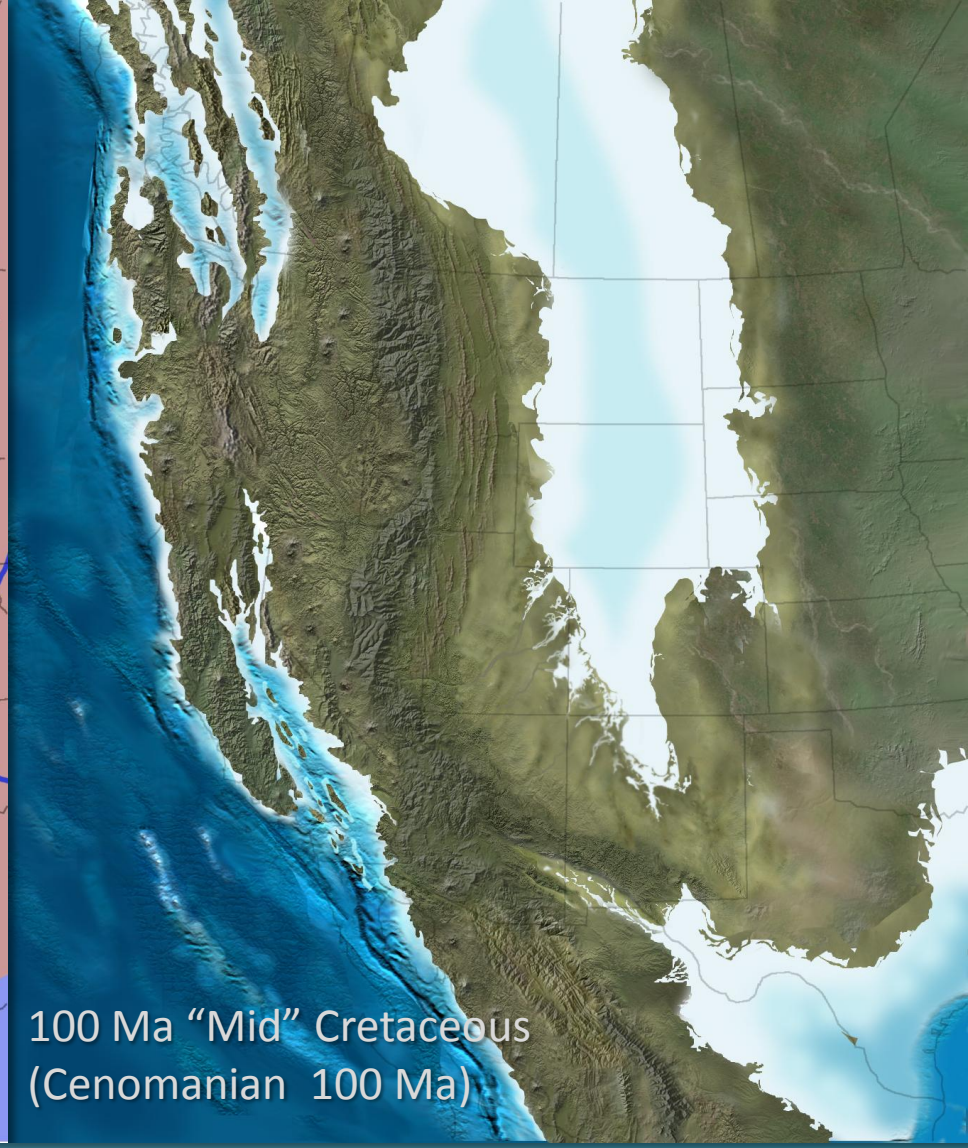

Late Jurassic
Wrangellia/fringing arc complex = Baja BC
towards
away
collision generates Nevadan orogen
detritus shed from Cordillera onto Colorado Plateau (Morrison Fm)
300 Kms

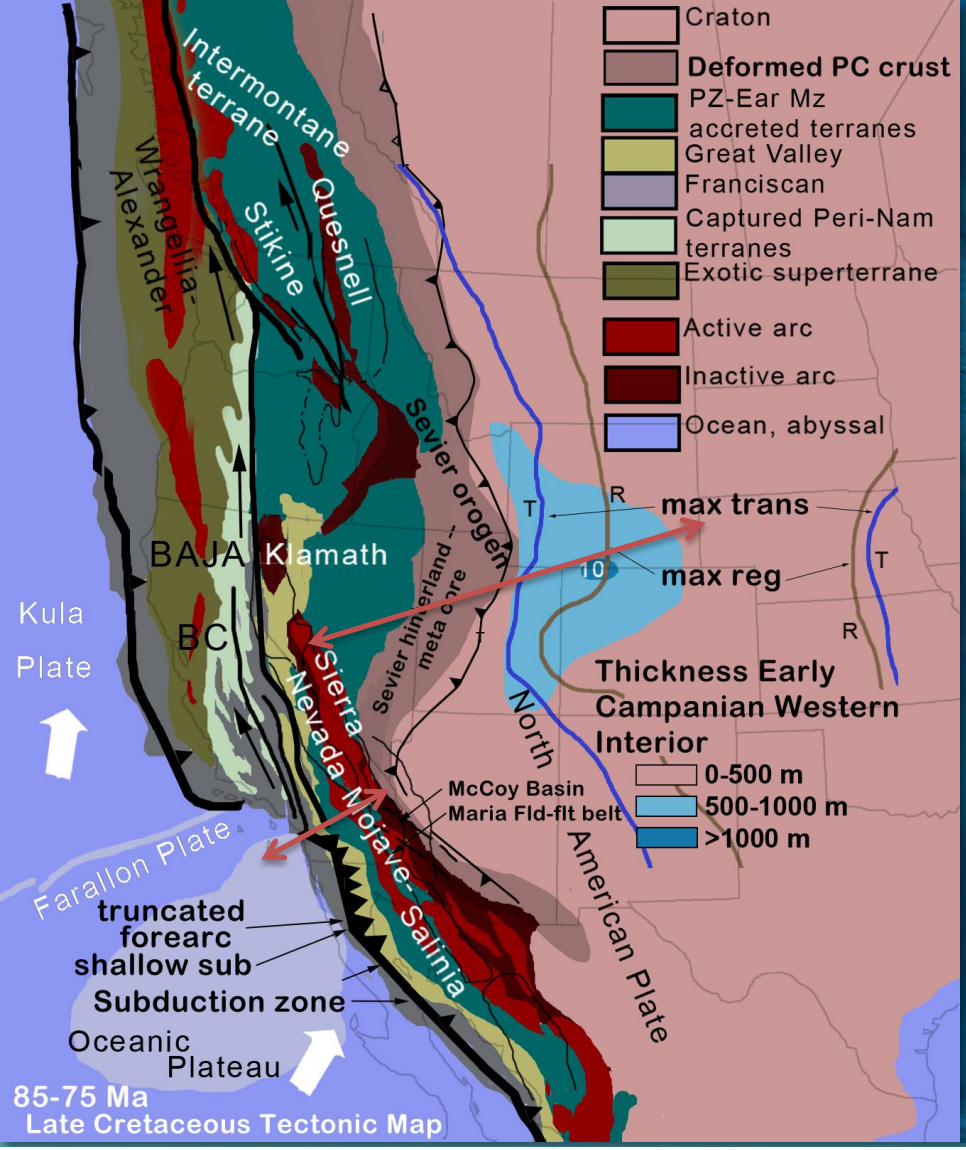

marine transgression
Craton
Deformed craton
accreted terranes
Great Valley
Franciscan
Captured Peri-Nam terranes
Exotic superterrane
Active arc
Inactive arc
Ocean, abyssal
non-marine
south and east margin, Lower Cretaceous
Wrangellia-Alexander terrane
Intermontane
Stikine
Quesnell
Sevier orogen
BAJA
BC
Klamath
Sierra Nevada
Farallon Plate
Pacific Ocean
Mojave-Salinia
McCoy Basin
Maria Fld-flt belt
Bisbee Basin
Lower Cretaceous
Barremian-Aptian
Thickness
0-500 m
500-1000 m
>1000 m
130 - 110 Ma
Early Cretaceous Tectonic Map


Early Cretaceous
(130 Ma)

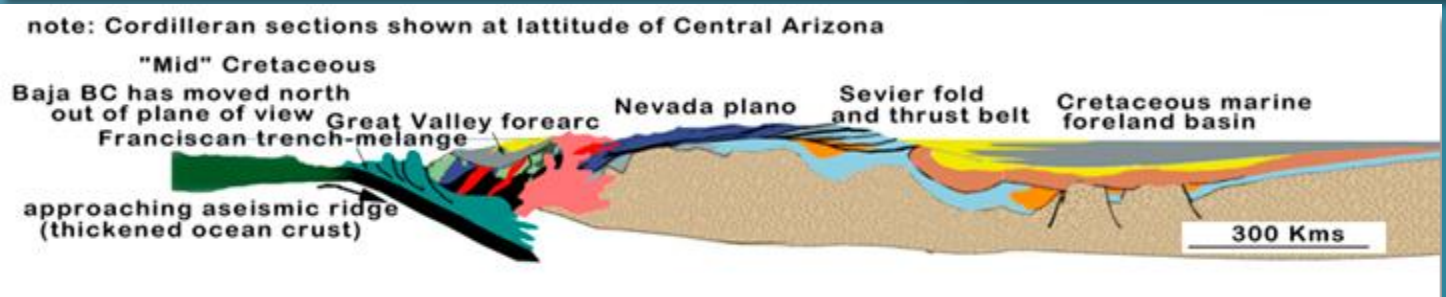

Early Cretaceous
Sevier orogen begins
Baja BC transforms south along Cordilleran margin
Sevier fold and thrust belt
foreland basin
towards
away
300 Kms

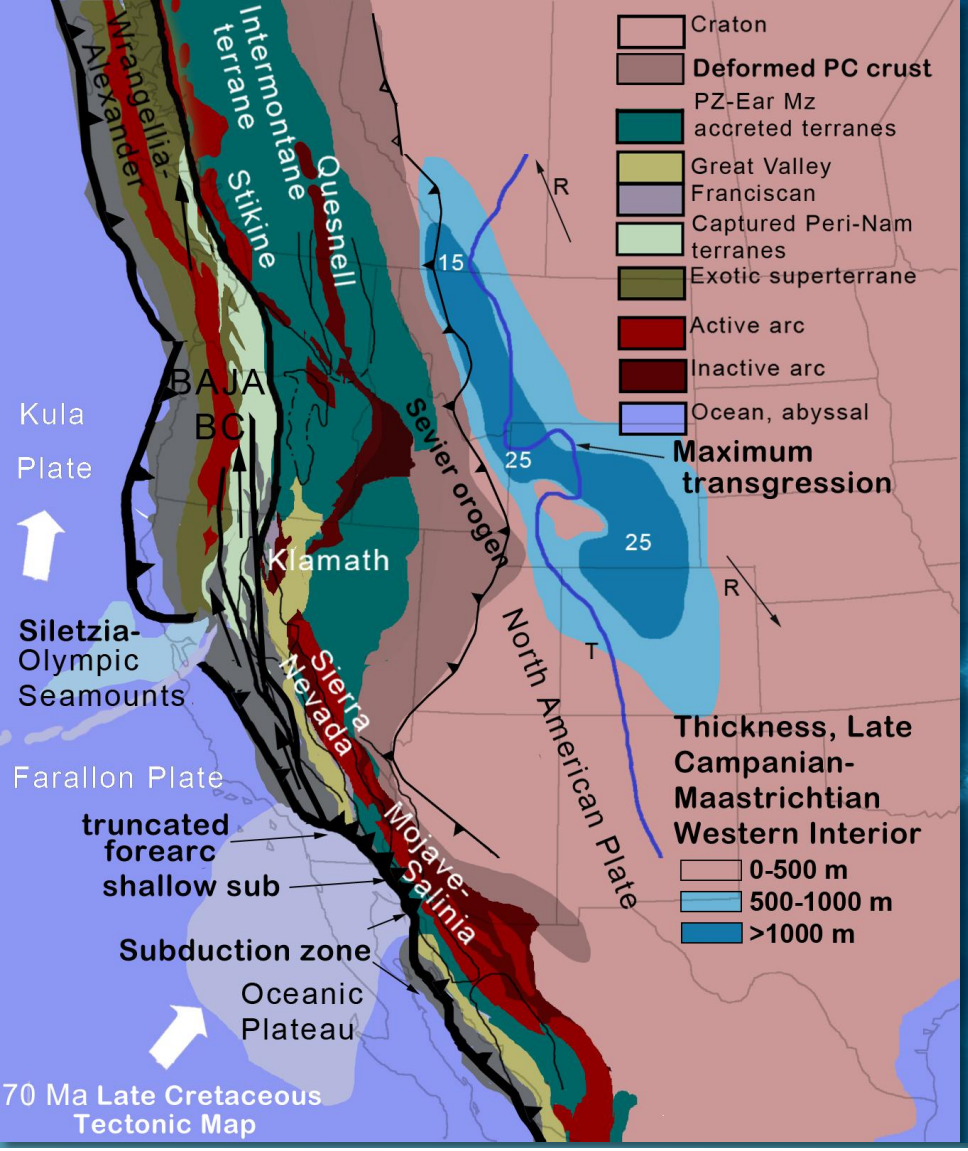

Craton
Deformed craton
accreted terranes
Great Valley
Franciscan
Captured Peri-Nam terranes
Exotic superterrane
Active arc
Inactive arc
Ocean, abyssal
Intermontane terrane
Wrangellia
Alexander
Stikine
Quesnell
Sevier orogen
BAJA
BC
Klamath
Sierra Nevada
Mojave-Salinia
Marin headlands terrane
McCoy Basin
Maria Fld-flt belt
Cenomanian thickness
0-500 m
500-1000 m
>1000 m
(100 - 90 Ma)
Mid-Cretaceous Tectonic Map

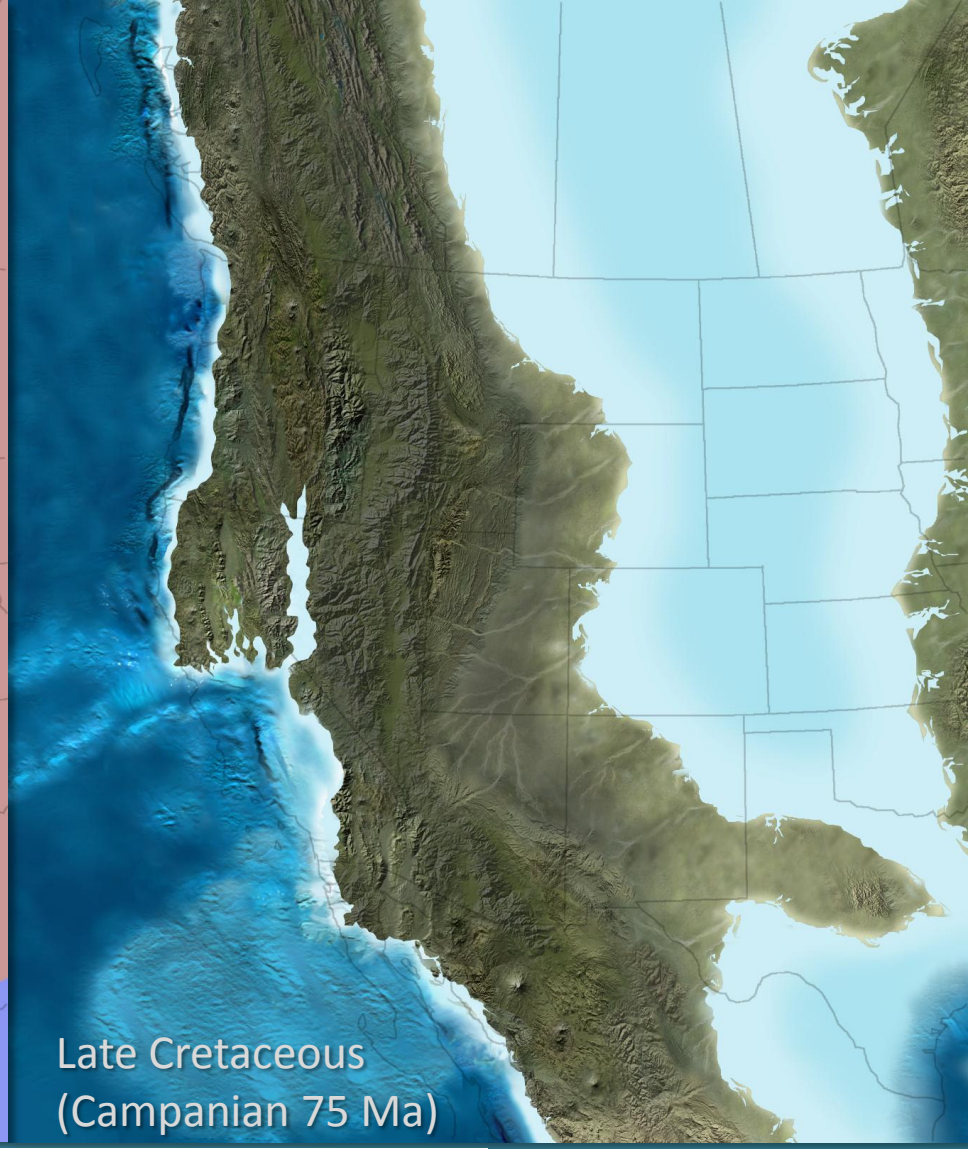

100 Ma “Mid” Cretaceous
(Cenomanian 100 Ma)

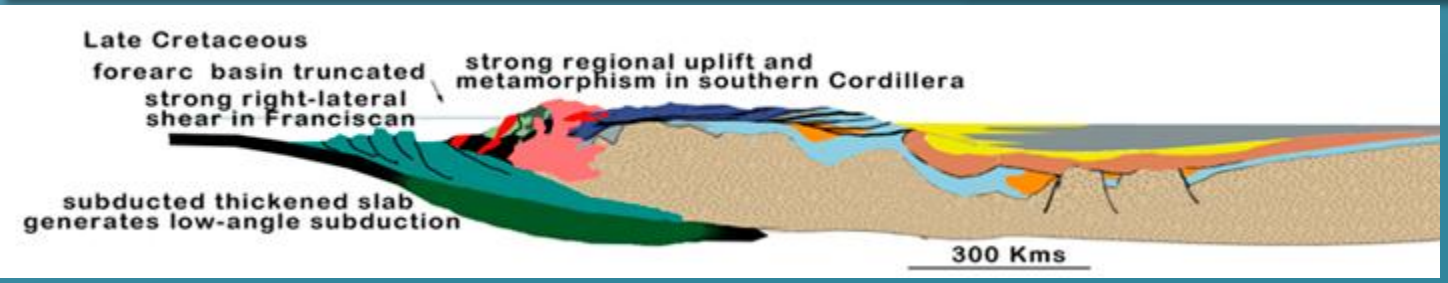

Craton
Deformed PC crust
PZ-Ear Mz accreted terranes
Great Valley
Franciscan
Captured Peri-Nam terranes
Exotic superterrane
Active arc
Inactive arc
Ocean, abyssal
Intermontane terrane
Wrangellia-Alexander
Stikine
Quesnell
Sevier orogen
Sevier hinterland – meta core
BAJA
Klamath
BC
Kula Plate
Sierra Nevada
Mojave-Salinia
North American Plate
Farallon Plate
max trans
max reg
T
R
10
Thickness Early Campanian Western Interior
0-500 m
500-1000 m
>1000 m
McCoy Basin
Maria Fld-flt belt
truncated forearc shallow sub
Subduction zone
Oceanic Plateau
85-75 Ma
Late Cretaceous Tectonic Map

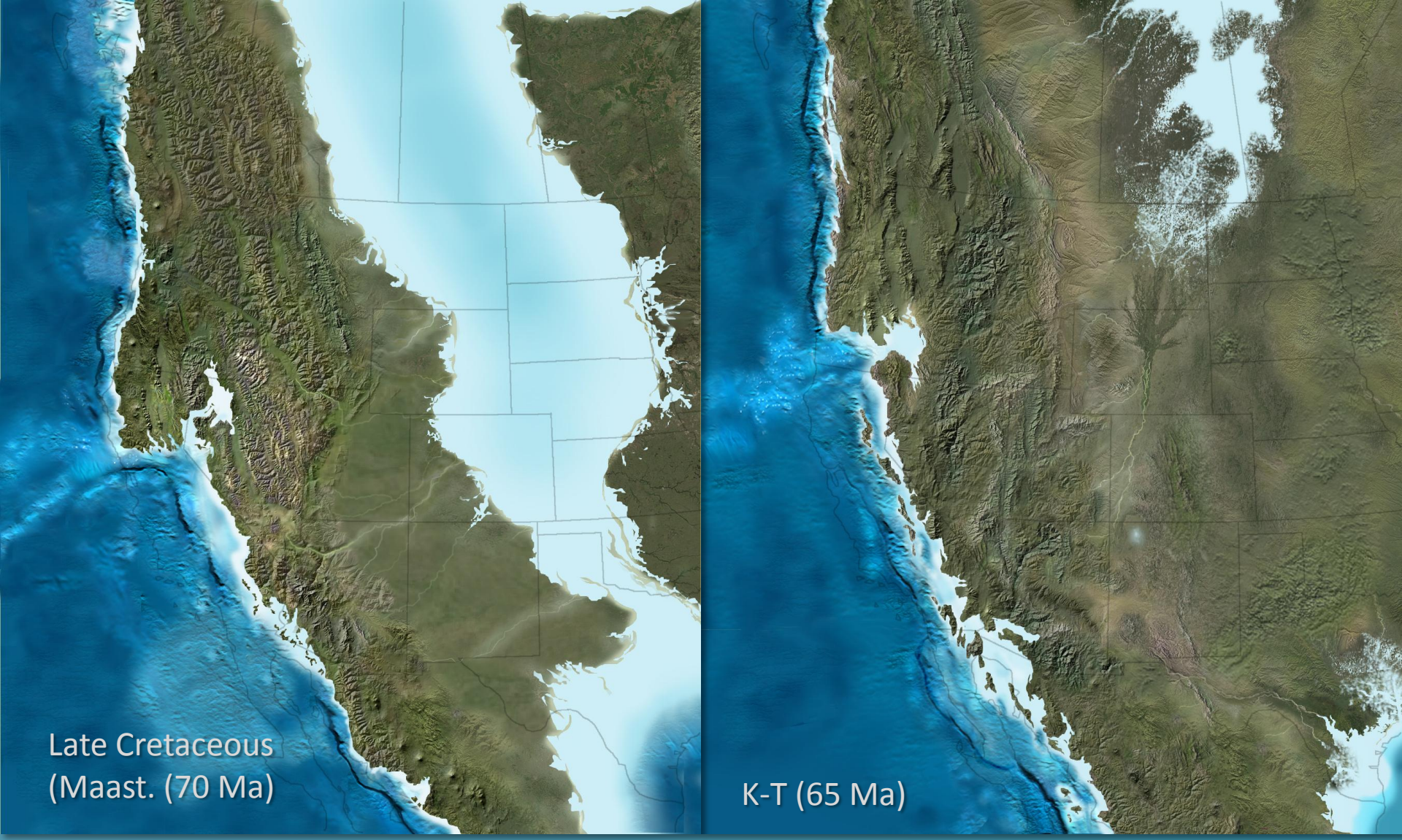

Late Cretaceous
(Turonian 90 Ma)

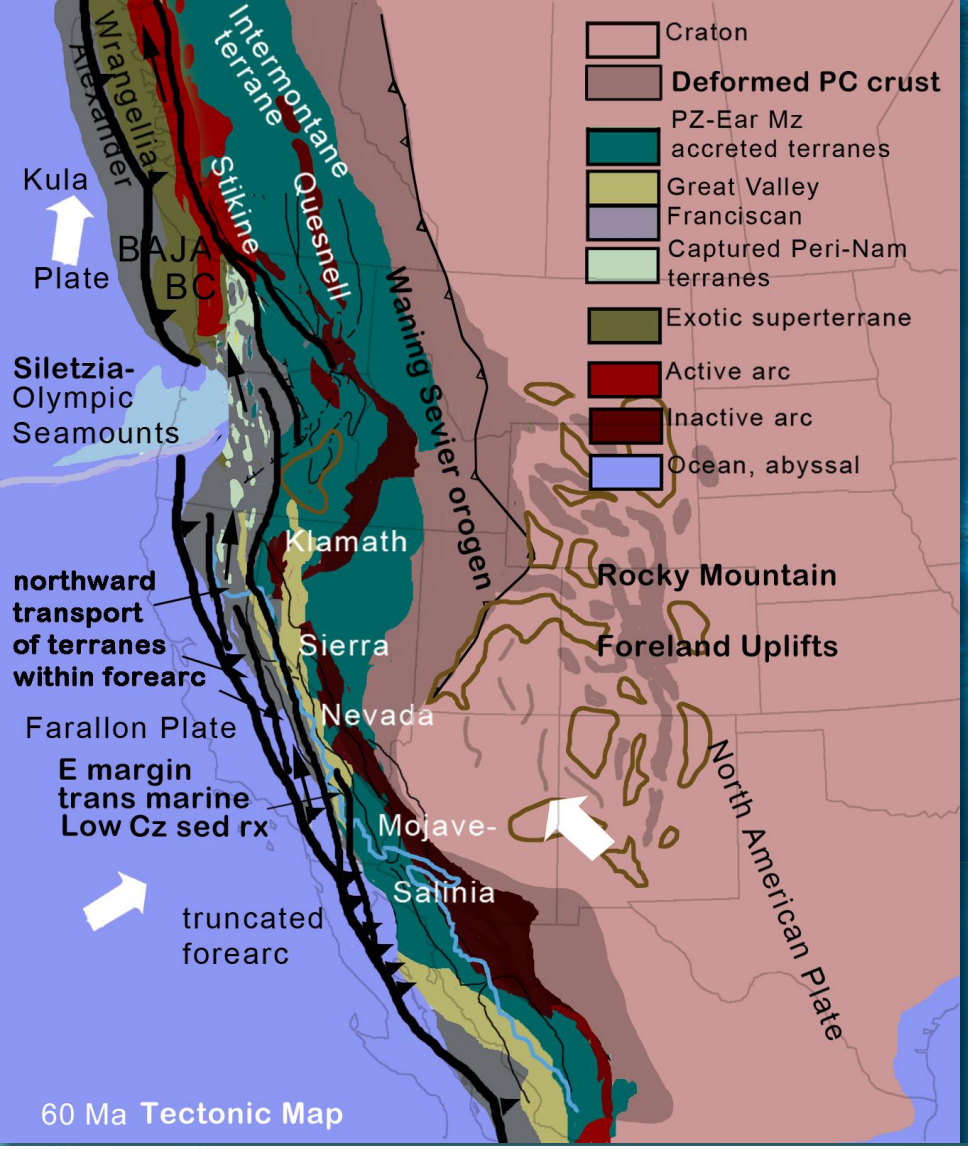

note: Cordilleran sections shown at lattitude of Central Arizona
"Mid" Cretaceous
Baja BC has moved north out of plane of view
Great Valley forearc
Franciscan trench-melange
Nevada plano
Sevier fold and thrust belt
Cretaceous marine foreland basin
approaching aseismic ridge (thickened ocean crust)
300 Kms


Craton
Deformed PC crust
PZ-Ear Mz accreted terranes
Great Valley
Franciscan
Captured Peri-Nam terranes
Exotic superterrane
Active arc
Inactive arc
Ocean, abyssal
Maximum transgression
Thickness, Late Campanian-Maastrichtian Western Interior
0-500 m
500-1000 m
>1000 m
Wrangellia-Alexander
Intermontane terrane
Stikine
Quesnell
BAJA BC
Kula Plate
Sevier orogen
Klamath
Siletzia-Olympic Seamounts
Sierra Nevada
Mojave-Salinia
North American Plate
Farallon Plate
truncated forearc
shallow sub
Subduction zone
Oceanic Plateau
15
25
25
R
R
T
70 Ma Late Cretaceous Tectonic Map

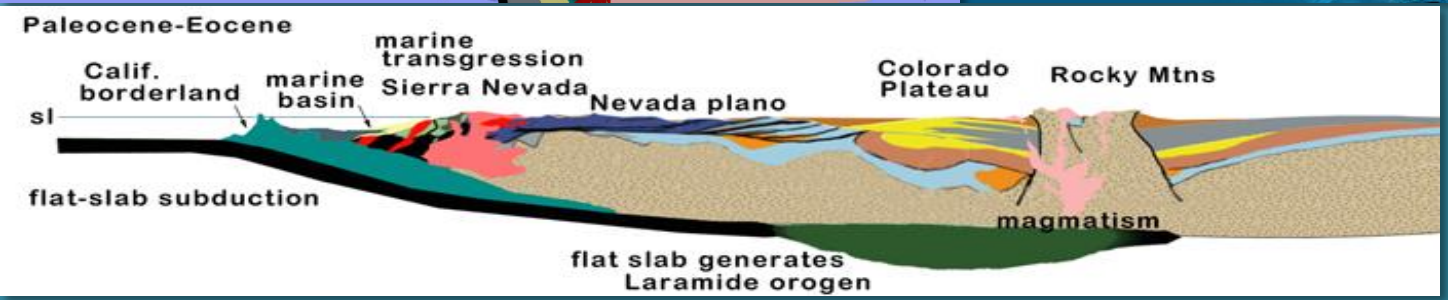

Late Cretaceous
(Campanian 75 Ma)

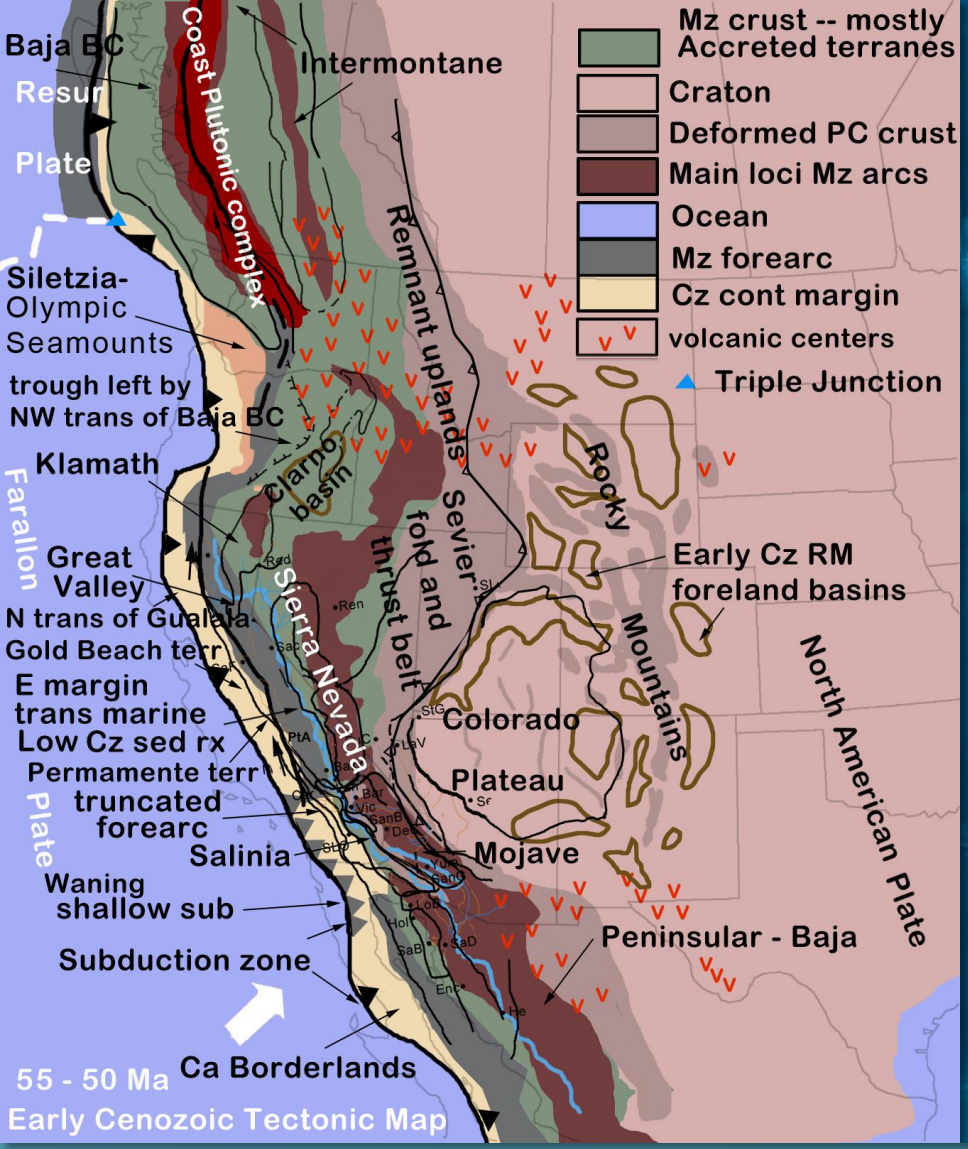

Late Cretaceous
forearc basin truncated
strong right-lateral shear in Franciscan
strong regional uplift and metamorphism in southern Cordillera
subducted thickened slab generates low-angle subduction
300 Kms

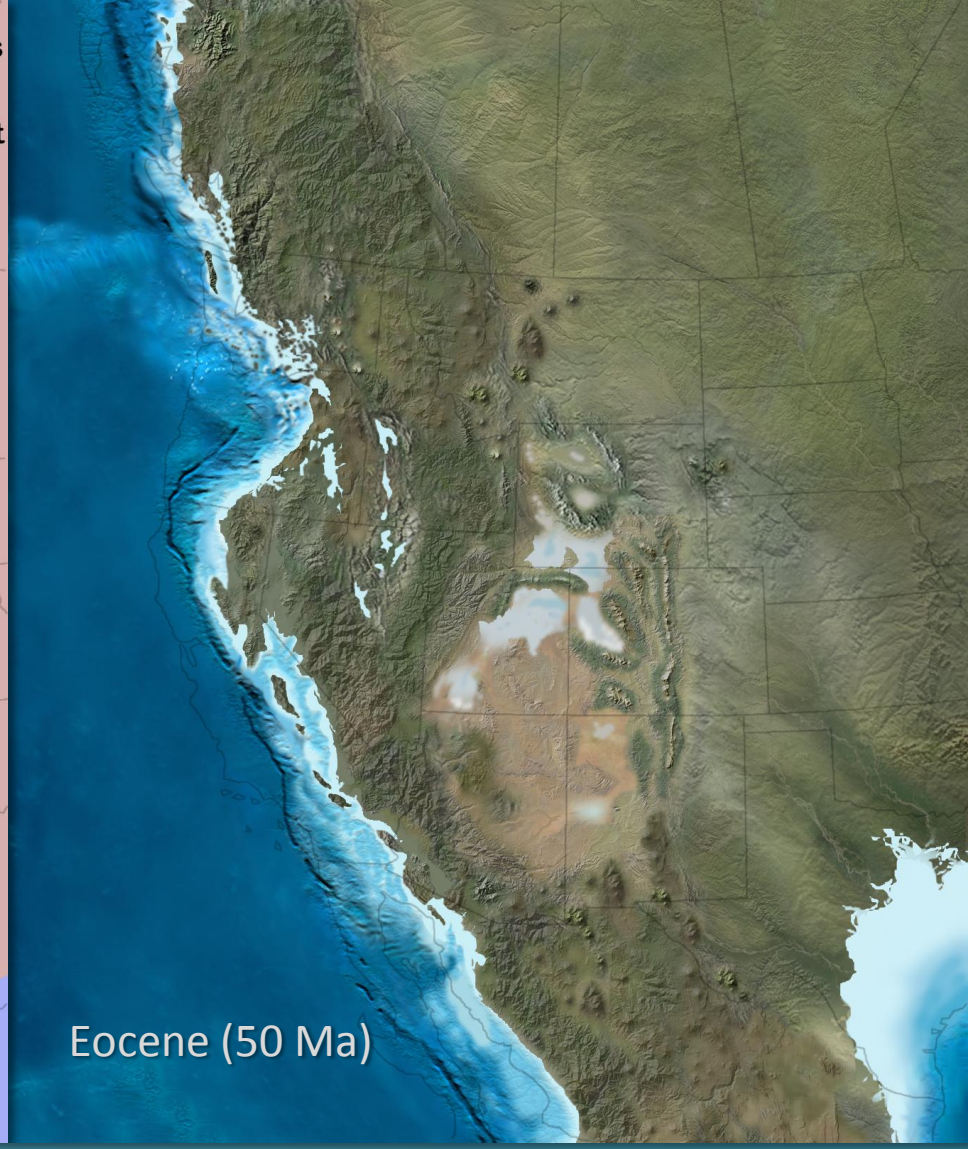

Late Cretaceous
(Maast. (70 Ma)
K-T (65 Ma)

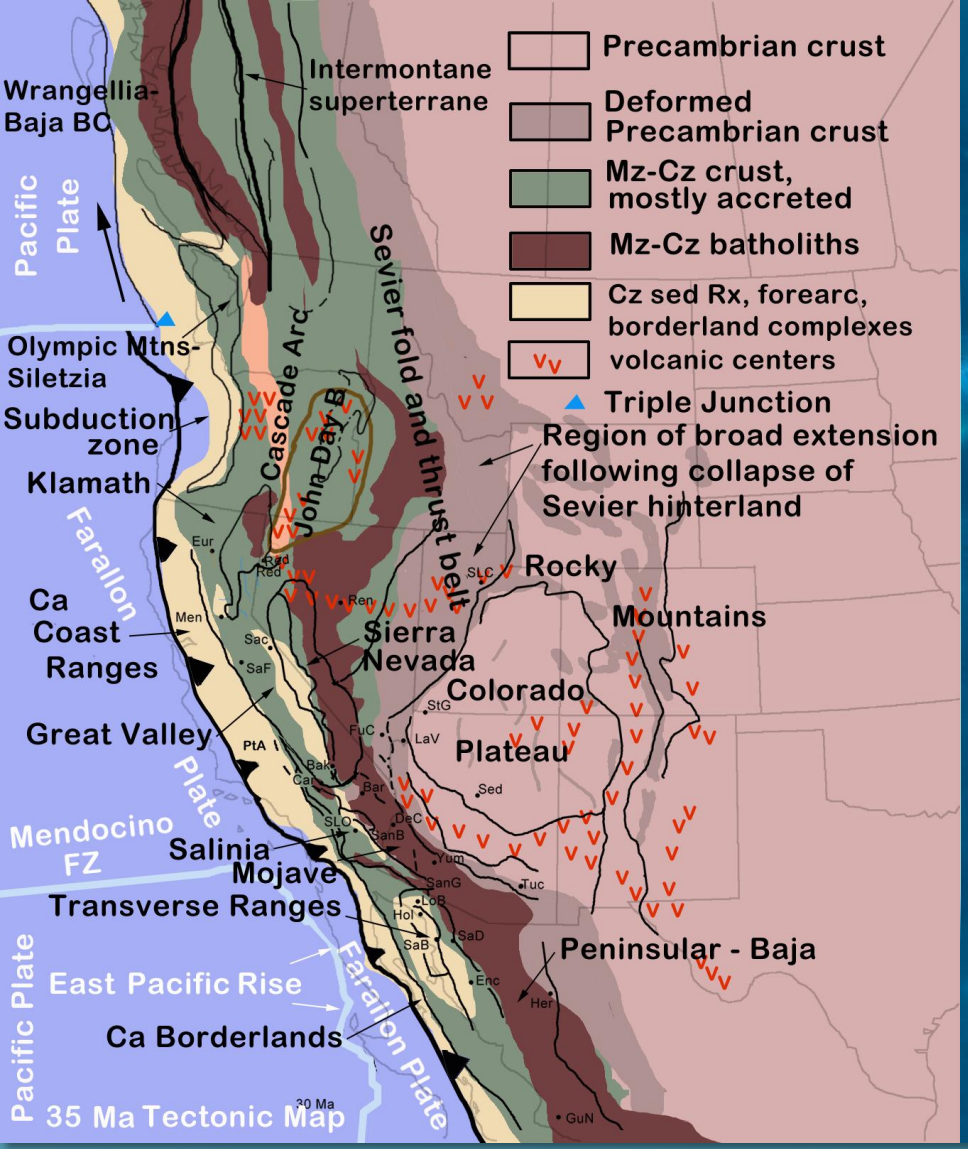

Craton
Deformed PC crust
PZ-Ear Mz accreted terranes
Great Valley
Franciscan
Captured Peri-Nam terranes
Exotic superterrane
Active arc
Inactive arc
Ocean, abyssal
Wrangellia
Alexander
Intermontane terrane
Stikine
Quesnell
Waning Sevier orogen
Kula Plate
BAJA BC
Siletzia-Olympic Seamounts
Klamath
Rocky Mountain Foreland Uplifts
northward transport of terranes within forearc
Sierra Nevada
Farallon Plate
E margin trans marine Low Cz sed rx
Mojave-Salinia
truncated forearc
North American Plate
60 Ma Tectonic Map


Paleocene (60 Ma)

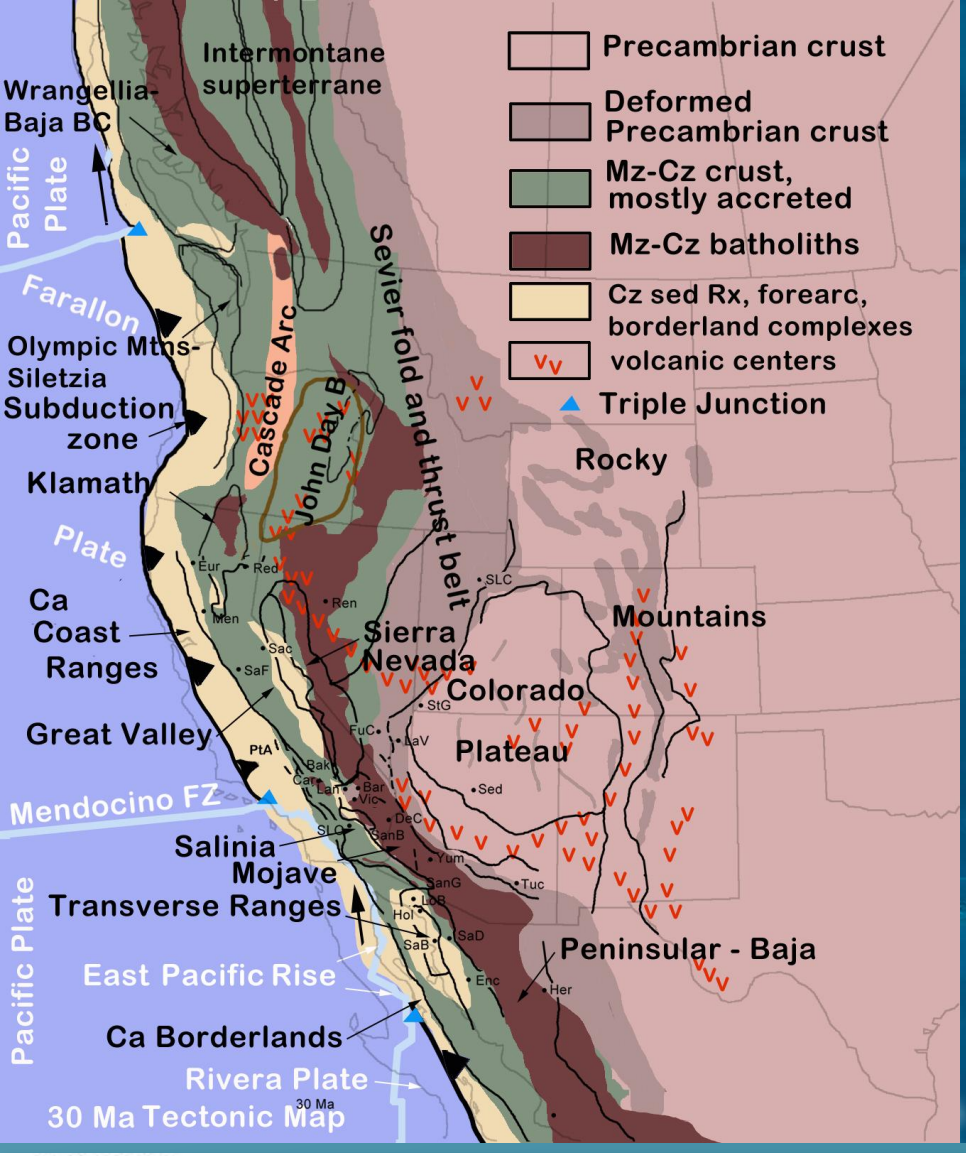

Paleocene-Eocene
Calif. borderland
marine basin
marine transgression
Sierra Nevada
Nevada plano
Colorado Plateau
Rocky Mtns
sl
flat-slab subduction
magmatism
flat slab generates Laramide orogen


Baja BC
Resur
Plate
Coast Plutonic complex
Intermontane
Remnant uplands
Sevier fold and thrust belt
Rocky Mountains
North American Plate
Siletzia-
Olympic
Seamounts
trough left by
NW trans of Baja BC
Klamath
Farallon Plate
Great Valley
N trans of Gualala
Gold Beach terr
E margin
trans marine
Low Cz sed rx
Permamente terr
truncated
forearc
Salinia
Waning
shallow sub
Subduction zone
Ca Borderlands
Sierra Nevada
Clarno basin
Colorado Plateau
Mojave
Peninsular - Baja
Early Cz RM
foreland basins
Mz crust -- mostly
Accreted terranes
Craton
Deformed PC crust
Main loci Mz arcs
Ocean
Mz forearc
Cz cont margin
volcanic centers
Triple Junction
55 - 50 Ma
Early Cenozoic Tectonic Map

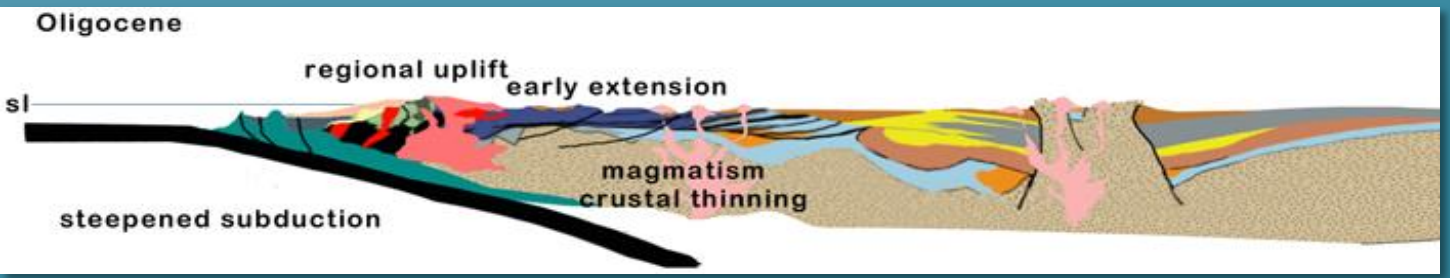

Eocene (50 Ma)

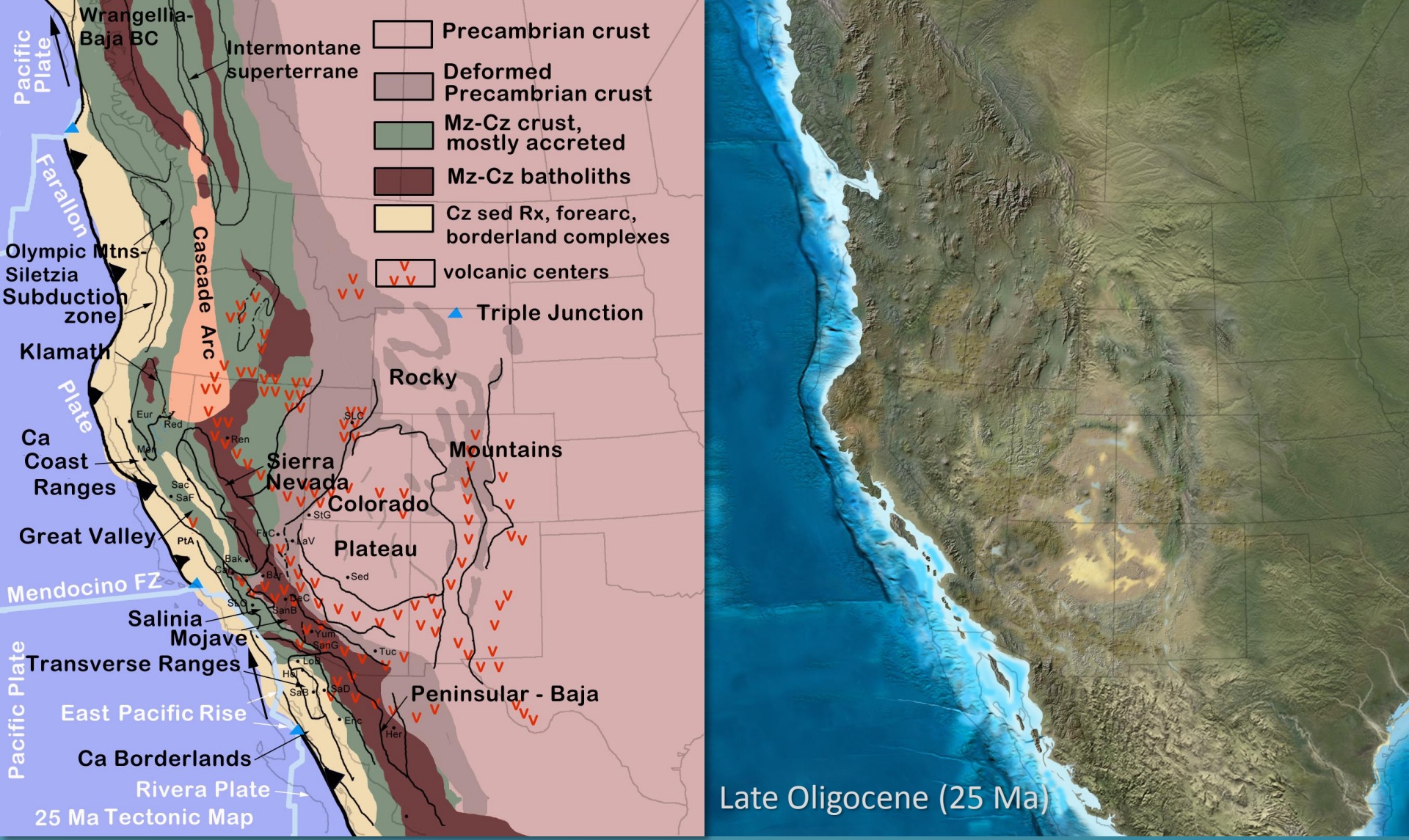

Precambrian crust
Deformed Precambrian crust
Mz-Cz crust, mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc, borderland complexes
volcanic centers
Triple Junction
Region of broad extension following collapse of Sevier hinterland
Wrangellia-Baja BC
Intermontane superterrane
Pacific Plate
Olympic Mtns-Siletzia
Subduction zone
Klamath
Cascade Arc
John Day B
Sevier fold and thrust belt
Farallon Plate
Ca Coast Ranges
Great Valley
Sierra Nevada
Rocky Mountains
Colorado Plateau
Mendocino FZ
Salinia
Mojave
Transverse Ranges
East Pacific Rise
Ca Borderlands
Peninsular - Baja
Pacific Plate
Farallon Plate
35 Ma Tectonic Map
30 Ma
Eur
Red
Ren
SLC
Men
Sac
SaF
StG
FuC
LaV
PtA
Bak
Cat
Bar
Sed
SLO
SanB
DeC
Yum
SanG
Tuc
Hol
LoB
SaB
SaD
Enc
Her
GuN

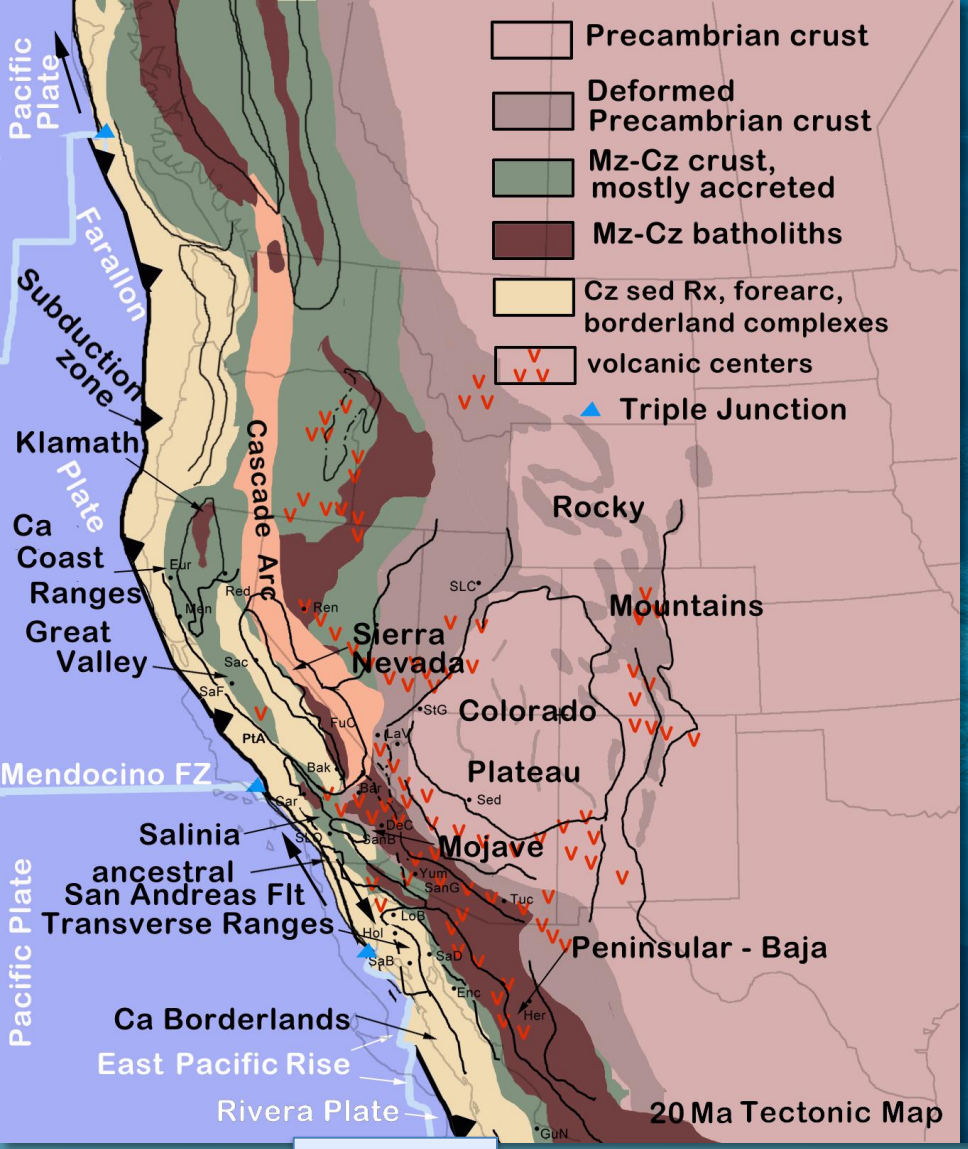

Late Eocene (35 Ma)


Precambrian crust
Deformed Precambrian crust
Mz-Cz crust, mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc, borderland complexes
volcanic centers
Triple Junction
Intermontane superterrane
Wrangellia-Baja BC
Pacific Plate
Farallon
Olympic Mtns-Siletzia Subduction zone
Klamath
Plate
Ca Coast Ranges
Great Valley
Mendocino FZ
Salinia
Mojave
Transverse Ranges
East Pacific Rise
Ca Borderlands
Rivera Plate
Cascade Arc
John Day B
Sevier fold and thrust belt
Rocky
Mountains
Sierra Nevada
Colorado
Plateau
Peninsular - Baja
Eur
Red
Men
Ren
Sac
SaF
SLC
StG
FuC
AaV
PtA
Bak
Car
Lan
Bar
Vic
Sed
SLO
SanB
DeC
Yum
SanG
Tuc
LoB
Hol
SaB
SaD
Enc
Her
30 Ma
30 Ma Tectonic Map

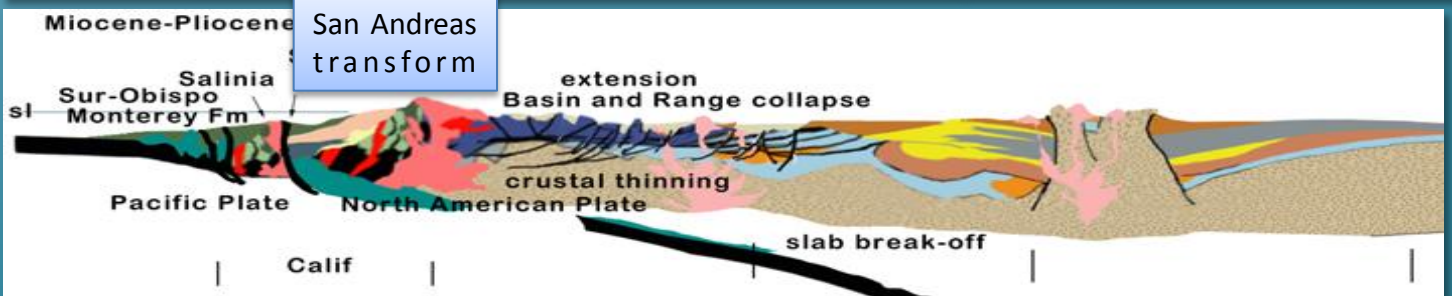

Oligocene (30 Ma)

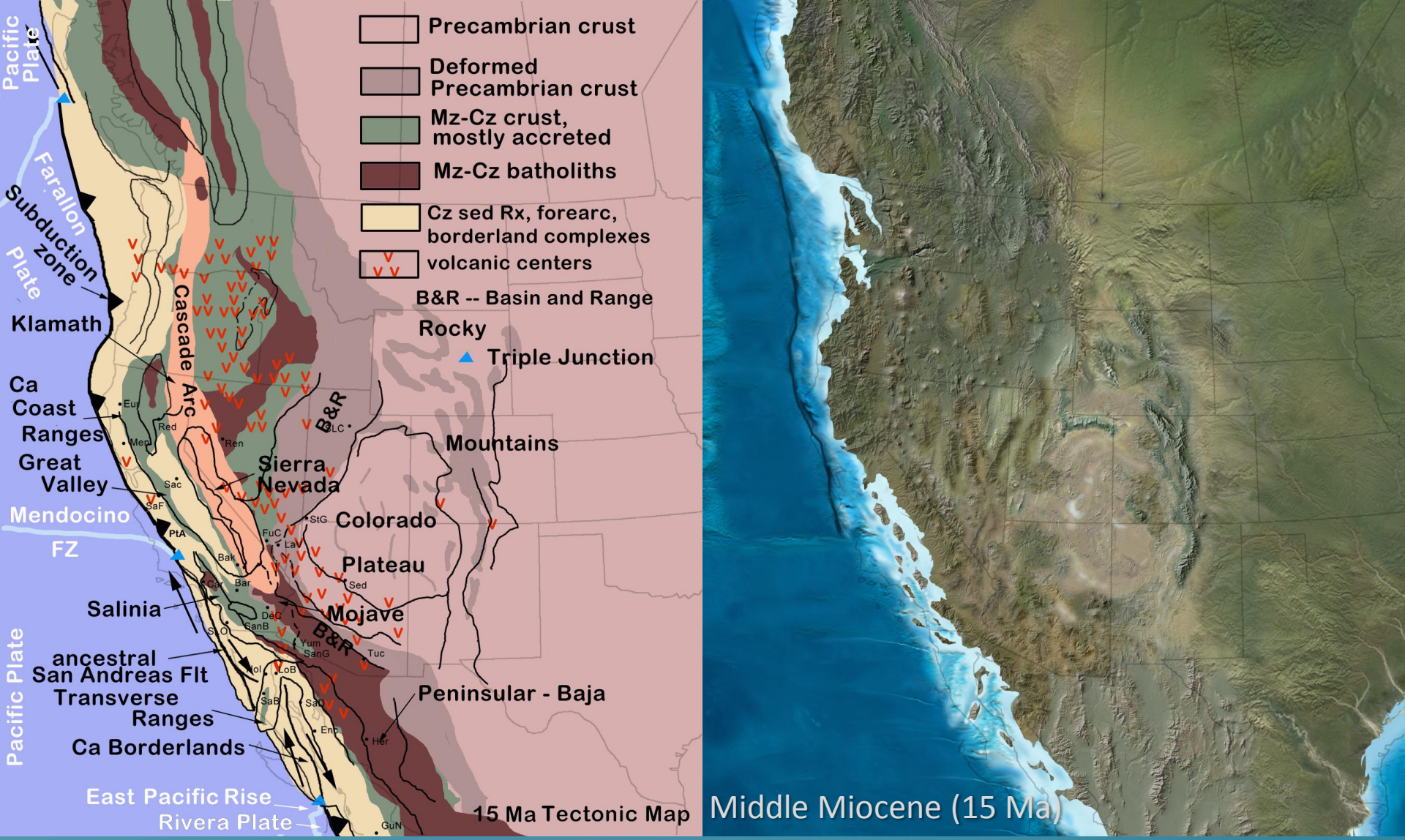

Oligocene
regional uplift
early extension
sl
magmatism
crustal thinning
steepened subduction

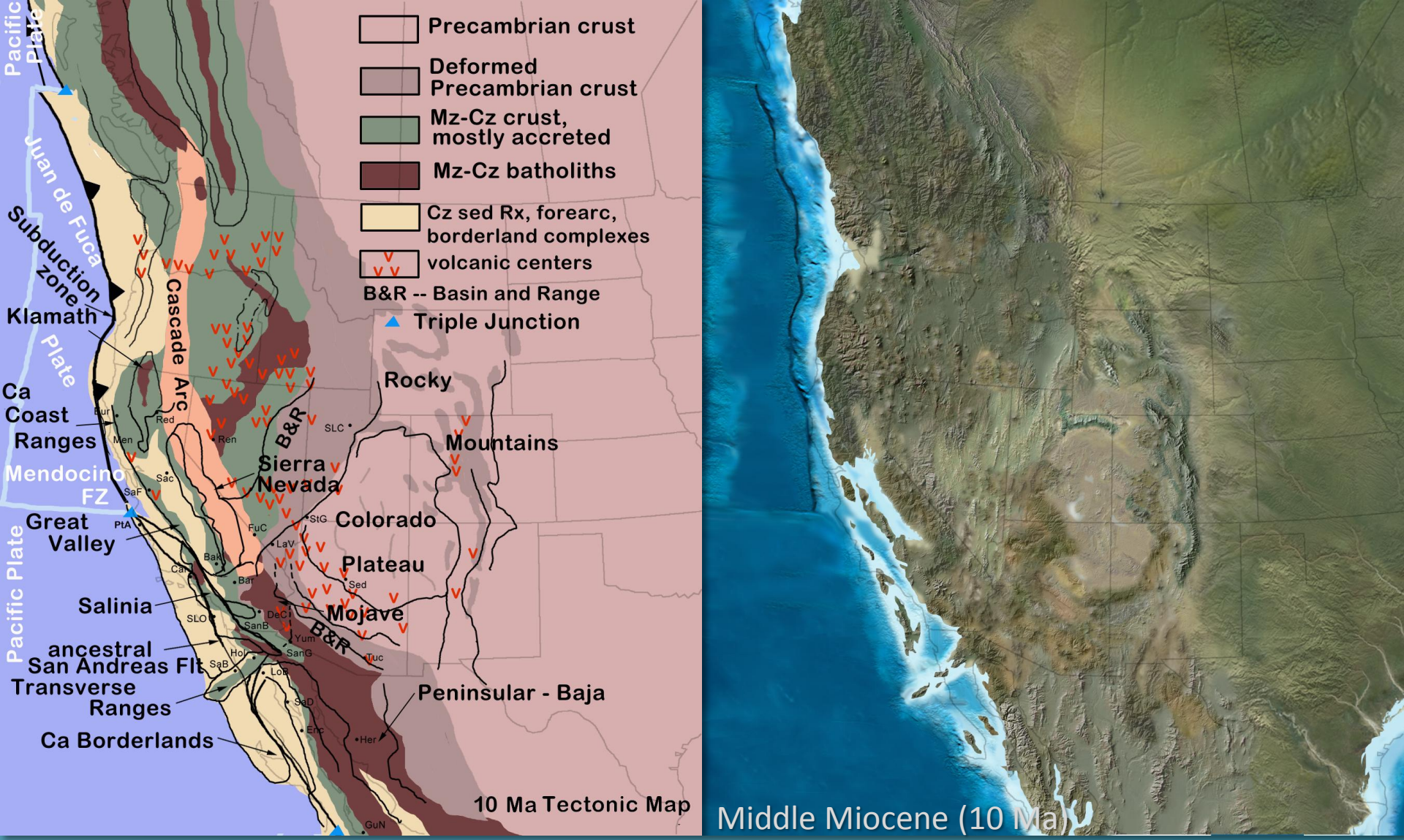

Wrangellia-
Baja BC
Intermontane
superterrane
Precambrian crust
Deformed
Precambrian crust
Mz-Cz crust,
mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc,
borderland complexes
volcanic centers
Triple Junction
Pacific
Plate
Farallon
Plate
Cascade Arc
Olympic Mtns-
Siletzia
Subduction
zone
Klamath
Plate
Ca
Coast
Ranges
Great Valley
Mendocino FZ
Salinia
Mojave
Transverse Ranges
East Pacific Rise
Ca Borderlands
Rivera Plate
Pacific Plate
Rocky
Mountains
Sierra
Nevada
Colorado
Plateau
Peninsular - Baja
Eur
Red
Ren
Mer
Sac
SaF
PtA
Bak
Bar
SnG
SanB
DeC
Yum
SanG
Tuc
Lob
Hel
SaB
SaD
Enc
Her
SLC
StG
FtC
LaV
Sed
25 Ma Tectonic Map
Late Oligocene (25 Ma)

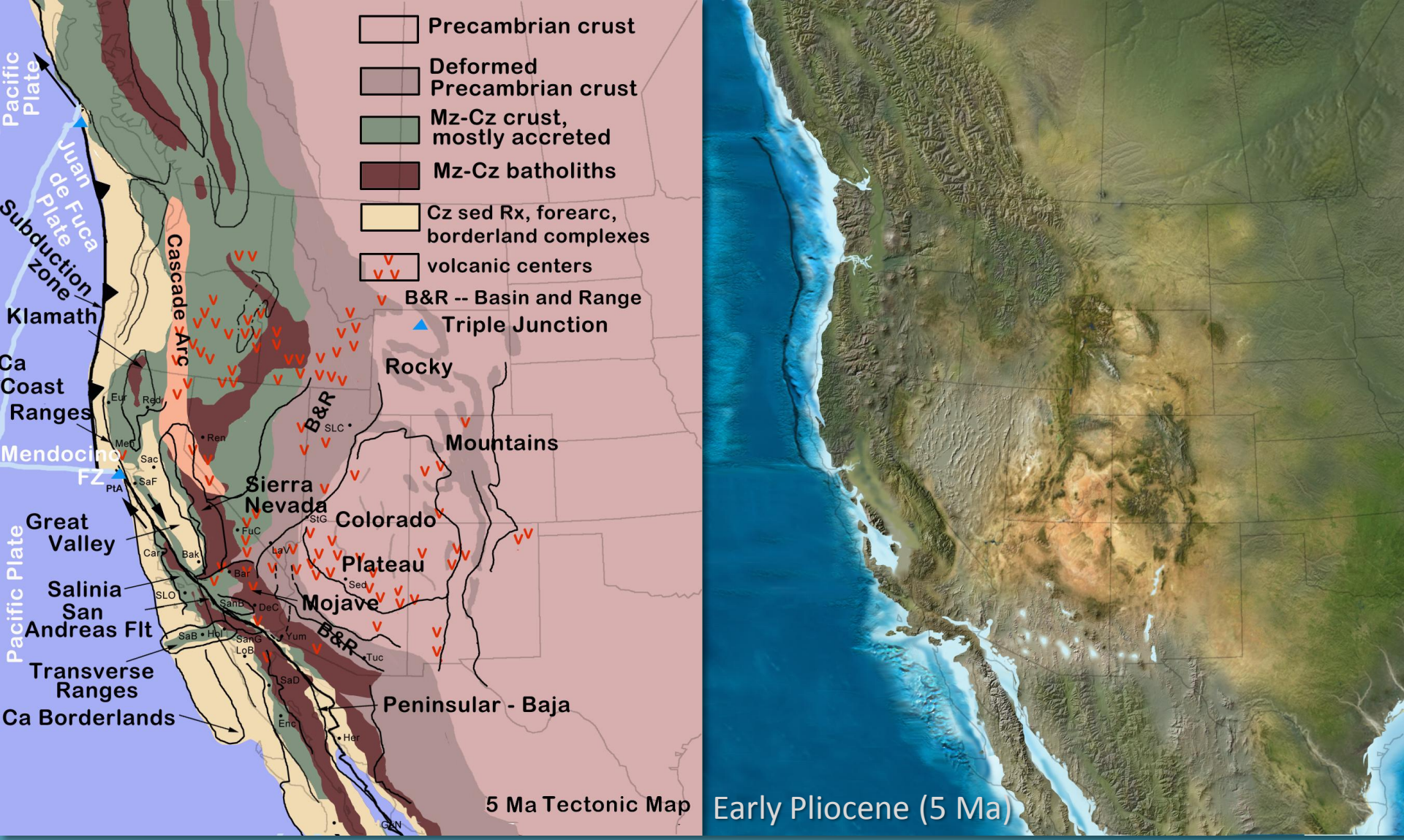

Precambrian crust
Deformed Precambrian crust
Mz-Cz crust, mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc, borderland complexes
volcanic centers
Triple Junction
Pacific Plate
Farallon
Subduction zone
Klamath
Plate
Ca Coast Ranges
Great Valley
Cascade Arc
Rocky Mountains
Sierra Nevada
Colorado Plateau
Mojave
Peninsular - Baja
Mendocino FZ
Salinia
ancestral San Andreas Flt
Transverse Ranges
Ca Borderlands
East Pacific Rise
Rivera Plate
Pacific Plate
20 Ma Tectonic Map

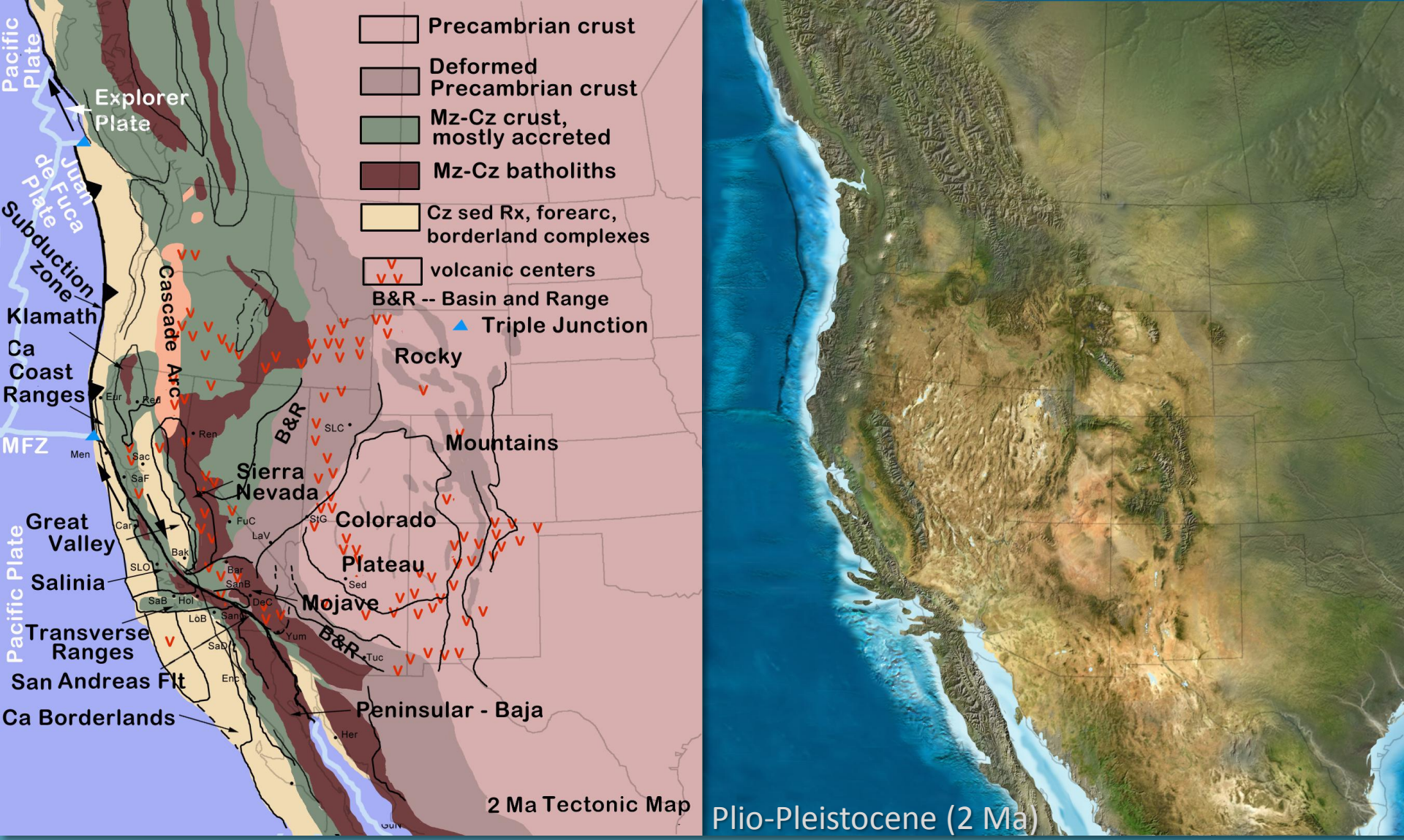

Early Miocene (20 Ma)

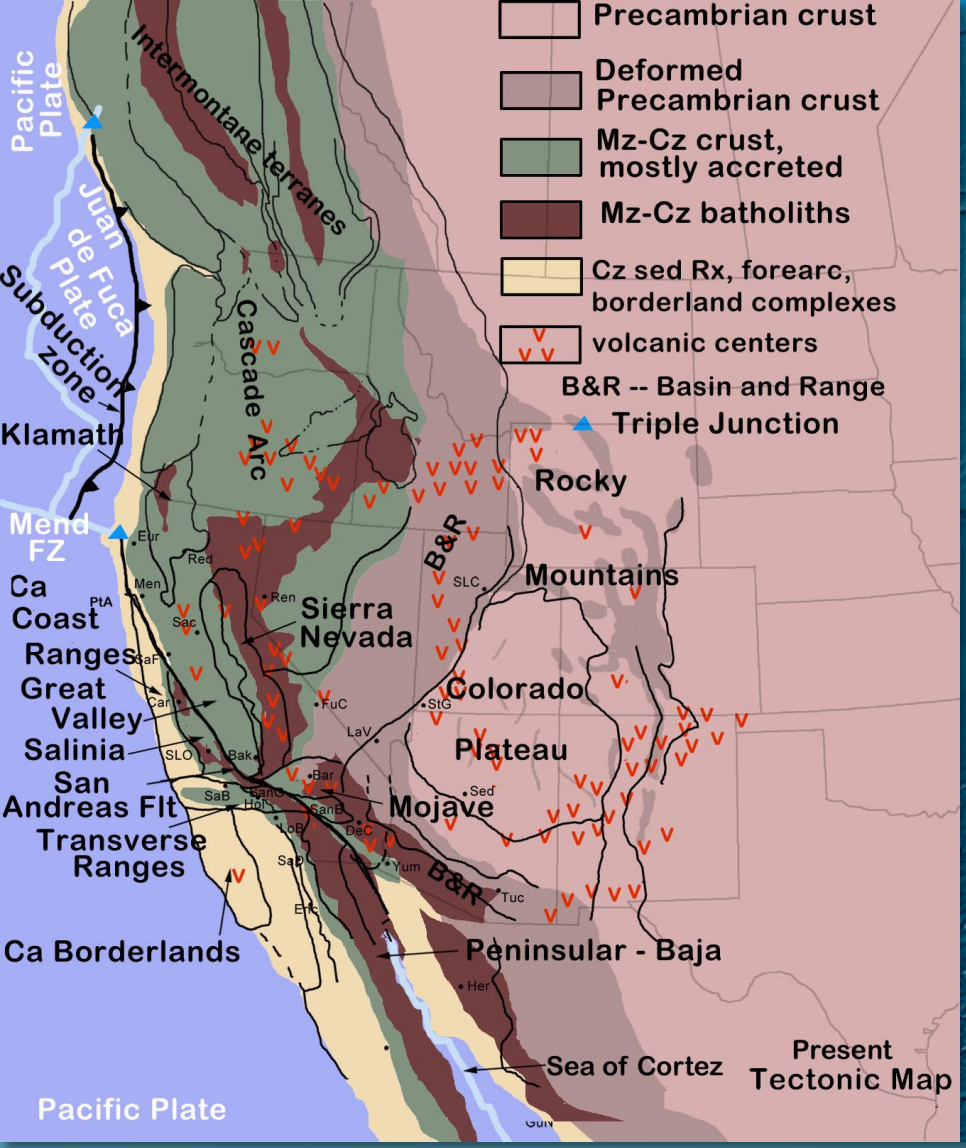

Miocene-Pliocene
San Andreas transform
Salinia
Sur-Obispo
Monterey Fm
extension
Basin and Range collapse
crustal thinning
Pacific Plate
North American Plate
slab break-off
Calif


Precambrian crust
Deformed Precambrian crust
Mz-Cz crust, mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc, borderland complexes
volcanic centers
B&R -- Basin and Range
Rocky Mountains
Triple Junction
Pacific Plate
Farallon Plate
Subduction zone
Klamath
Cascade Arc
Ca Coast Ranges
Great Valley
Sierra Nevada
Colorado Plateau
Mendocino FZ
Salinia
ancestral San Andreas Flt
Transverse Ranges
Ca Borderlands
Mojave
Peninsular - Baja
East Pacific Rise
Rivera Plate
Pacific Plate
B&R
Eur
Red
Men
Ren
LLC
Sac
SaF
PtA
StG
FuC
LaV
Bak
Bar
Cer
Sed
Del
SanB
SLO
Yum
SanG
Tuc
Nol
LoB
SaB
SaO
Ens
Her
GuN
15 Ma Tectonic Map
Middle Miocene (15 Ma)


Precambrian crust
Deformed Precambrian crust
Mz-Cz crust, mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc, borderland complexes
volcanic centers
B&R -- Basin and Range
Triple Junction
Pacific Plate
Juan de Fuca Plate
Subduction zone
Klamath
Cascade Arc
Ca Coast Ranges
Mendocino FZ
Great Valley
Pacific Plate
Salinia
ancestral San Andreas Flt
Transverse Ranges
Ca Borderlands
Sierra Nevada
B&R
Rocky Mountains
Colorado Plateau
Mojave
B&R
Peninsular - Baja
Middle Miocene (10 Ma)
10 Ma Tectonic Map


Precambrian crust
Deformed Precambrian crust
Mz-Cz crust, mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc, borderland complexes
volcanic centers
B&R -- Basin and Range
Triple Junction
Pacific Plate
Juan de Fuca Plate
Subduction zone
Cascade Arc
Klamath
Ca Coast Ranges
Mendocino FZ
Great Valley
Salinia
San Andreas Flt
Transverse Ranges
Ca Borderlands
Pacific Plate
Sierra Nevada
B&R
Rocky Mountains
Colorado Plateau
Mojave
B&R
Peninsular - Baja
Eur
Redd
Men
Ren
SLC
Sac
SaF
PtA
StG
FuC
LaV
Car
Bak
Bar
Sed
SLO
SanB
DeC
SaB
Hol
SanG
LoB
Yum
Tuc
SaD
Enc
Her
GaN
5 Ma Tectonic Map
Early Pliocene (5 Ma)


Precambrian crust
Deformed Precambrian crust
Mz-Cz crust, mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc, borderland complexes
volcanic centers
B&R -- Basin and Range
Triple Junction
Pacific Plate
Explorer Plate
Juan de Fuca Plate
Subduction zone
Cascade Arc
Klamath
Ca Coast Ranges
MFZ
Great Valley
Salinia
Transverse Ranges
San Andreas Flt
Ca Borderlands
Pacific Plate
Sierra Nevada
B&R
Rocky Mountains
Colorado Plateau
Mojave
B&R
Peninsular - Baja
Eur
Red
Ren
SLC
Men
Sac
SaF
FuC
StG
LaV
Car
Bak
SLO
Bar
SanB
Sed
SaB
Hol
DeC
LoB
Yum
Tuc
Her
2 Ma Tectonic Map
Plio-Pleistocene (2 Ma)


Precambrian crust
Deformed Precambrian crust
Mz-Cz crust, mostly accreted
Mz-Cz batholiths
Cz sed Rx, forearc, borderland complexes
volcanic centers
B&R -- Basin and Range
Triple Junction
Pacific Plate
Intermontane terranes
Juan de Fuca Plate Subduction zone
Cascade Arc
Klamath
Mend FZ
Ca Coast Ranges
Great Valley
Salinia
San Andreas Flt
Transverse Ranges
Ca Borderlands
Sierra Nevada
Rocky Mountains
B&R
Colorado Plateau
Mojave
B&R
Peninsular - Baja
Sea of Cortez
Pacific Plate
Present Tectonic Map
Eur
Red
Men
Ren
Sac
SLC
PtA
SaF
Car
FuC
StG
LaV
SLO
Bak
Bar
Sed
SaB
SanB
DeC
LoB
Yum
Tuc
Her


Present

CONCLUSIONS

- Bang not a whimper
- Complex events can be made more coherent and understandable by examining geologic history through closely spaced paleogeographic and paleotectonic maps that follow geodynamic principles
- Modern tectonic and topographic features can be used to portray the complex, ancient geologic events