MODERN APPALACHIAN TOPOGRAPHY, PRODUCT OF MIOCENE TO RECENT UPLIFT: NOT A RELIC OF PALEOZOIC OROGENY, AND NOT THE "WORLD'S OLDEST MOUNTAIN CHAIN"

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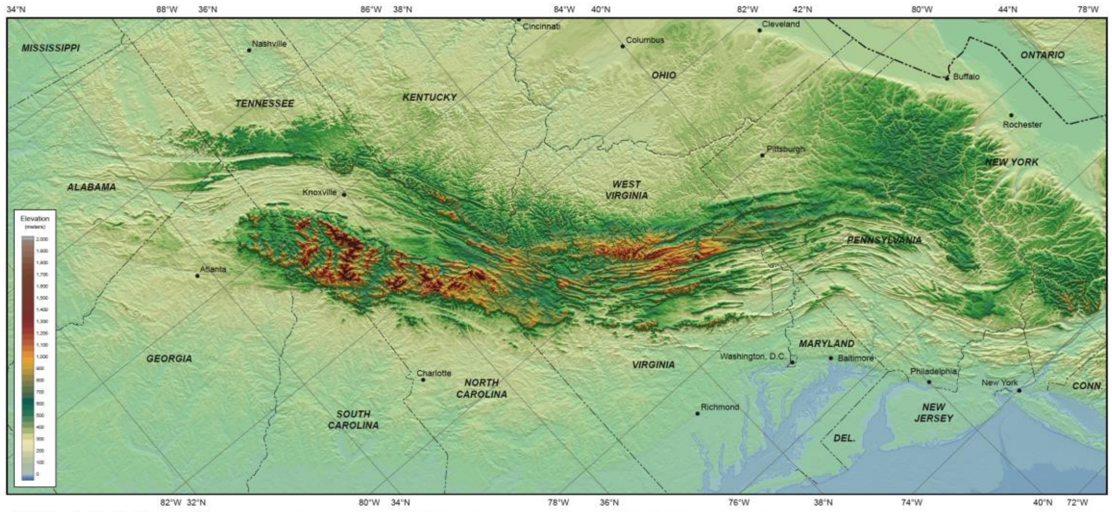
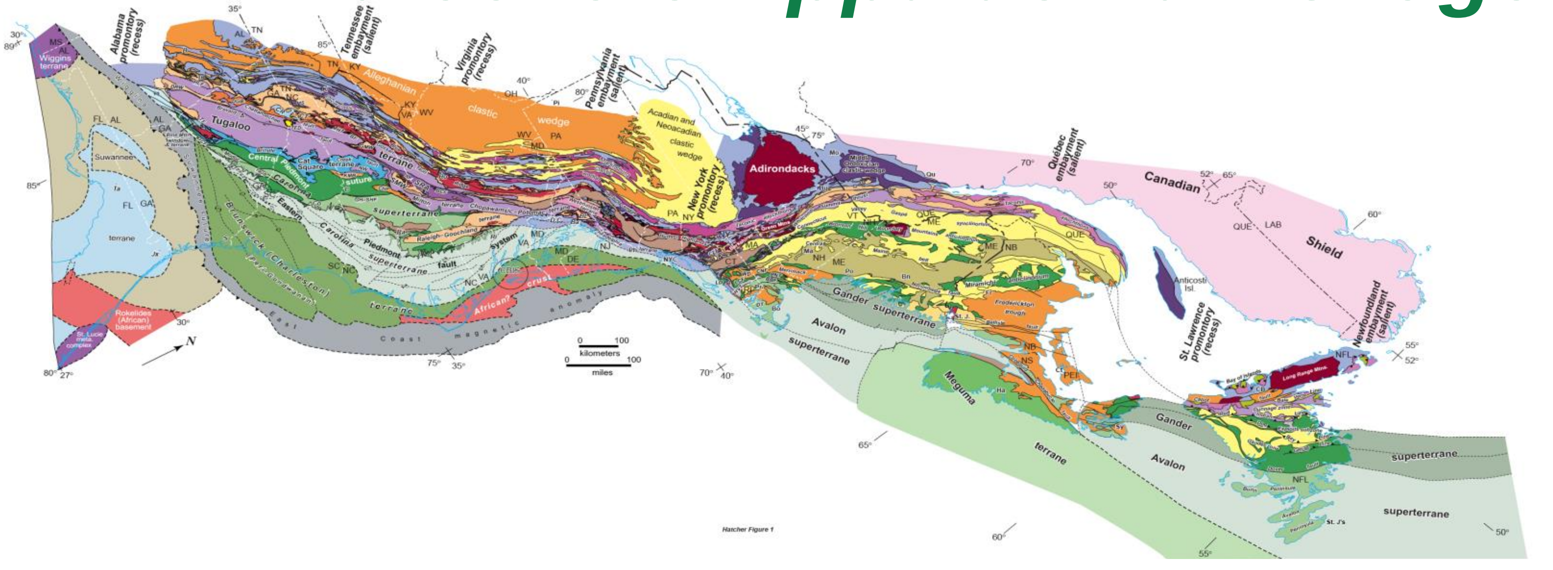
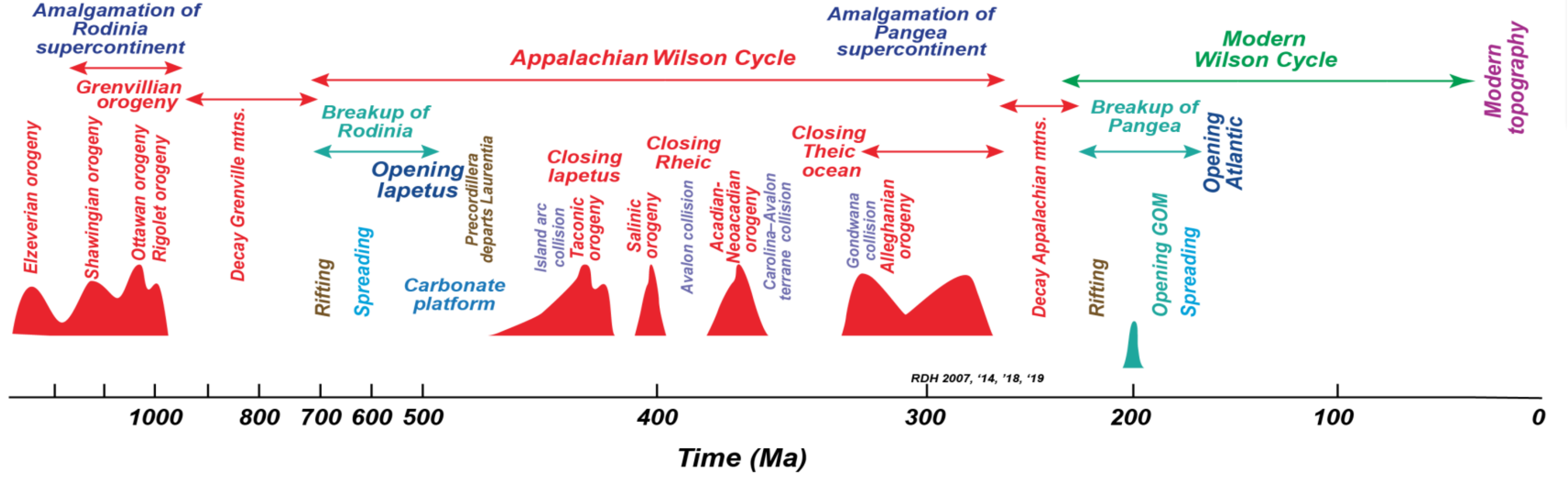
Retired



Paleozoic Appalachian Orogen



Appalachians Timeline



“Old, worn-down” mountains

“Young, rugged” mountains

View from Longs Peak , CO

Snowy Mtns, WY

Chuckachida River N-C B.C

Lukmanier Pass, Switzerland

“Old, Worn-Down” Mountains? CA

Miocene Uplift, Coast Mountains, CA

Abundant evidence indicates that tectonism has taken place in late geologic time, that is, during the late Mesozoic and Cenozoic. . . . The data also suggest that erosion was greatly accelerated during the Miocene.

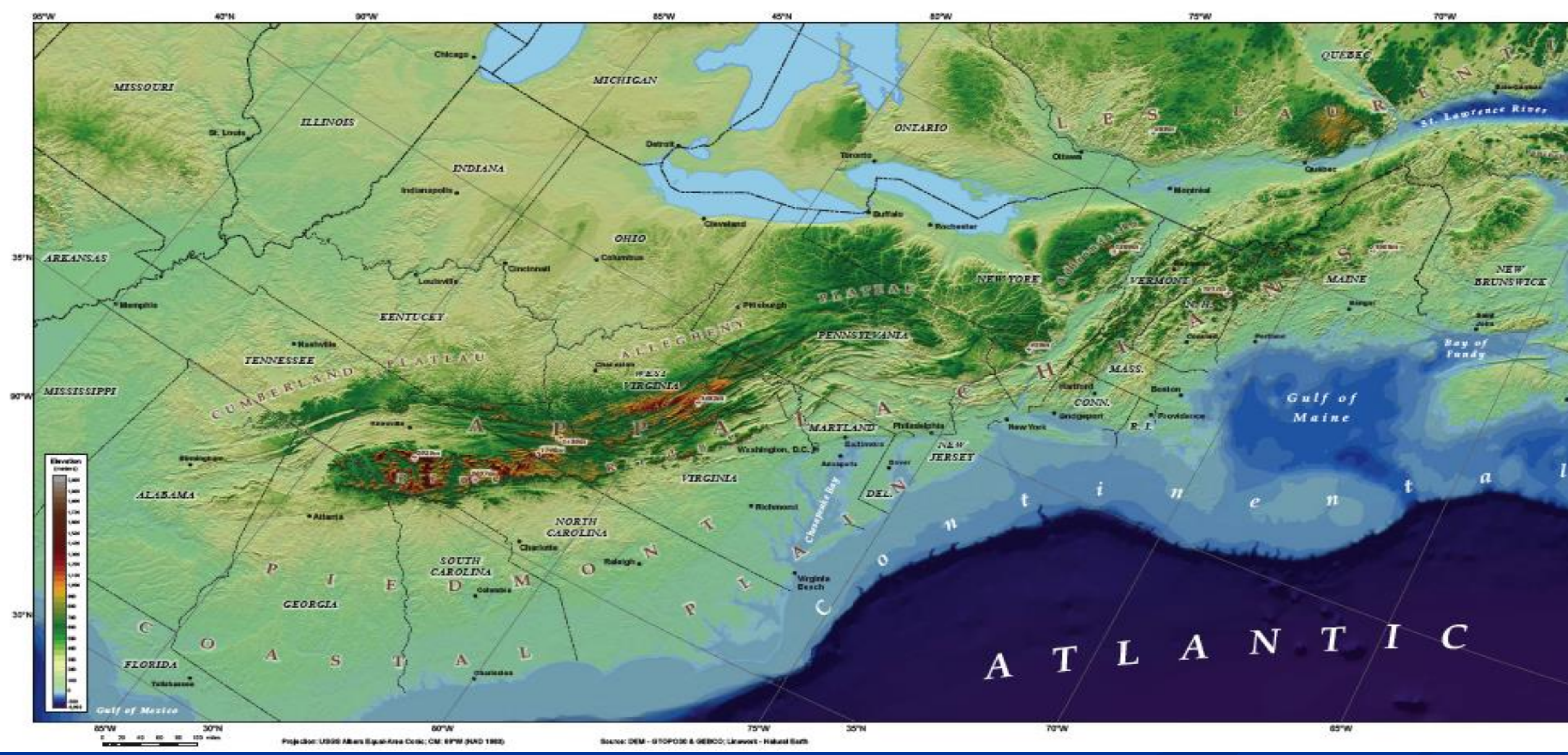
John T. Hack, 1979, USGS Prof. Paper 1126–B

Available Data that Should Make Us Suspicious—
Taken Separately Could be Dismissed

- *Pockets of young sediments—known since 1920s?*
- *Mio-Pliocene fossils—known since ~2000*
- *Present-day topography—known since late 1800s*
- *S-C Appalachians drainages—1800s, and paleodrainages late 1900s?*
- *Modern dynamic topography—2013*
- *Late Meso- Cenozoic stratigraphy & depositional patterns—1900s*
- *Provenance data from detrital zircons—2010s*
- *Crustal thickness data—2010s*
- *Modern in situ stress data—since 1970s?*

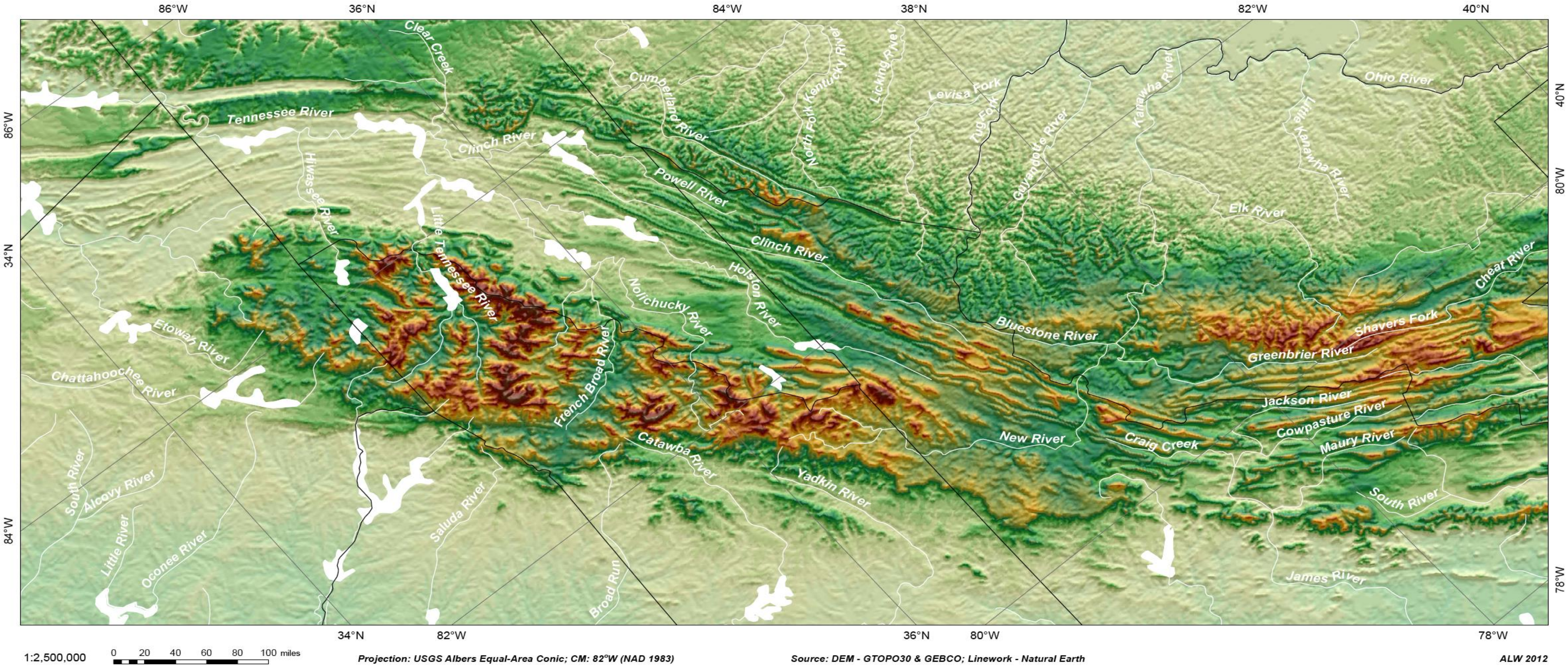
Evidence from Topography

US Appalachians Topography



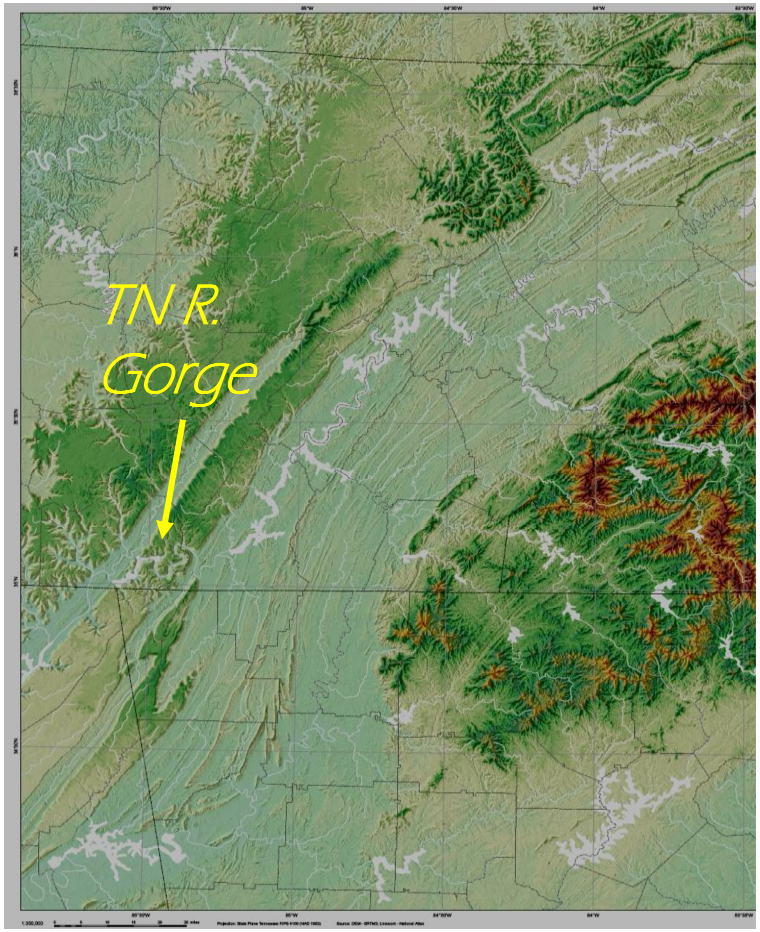
DEM compiled by Andrew L. Wunderlich

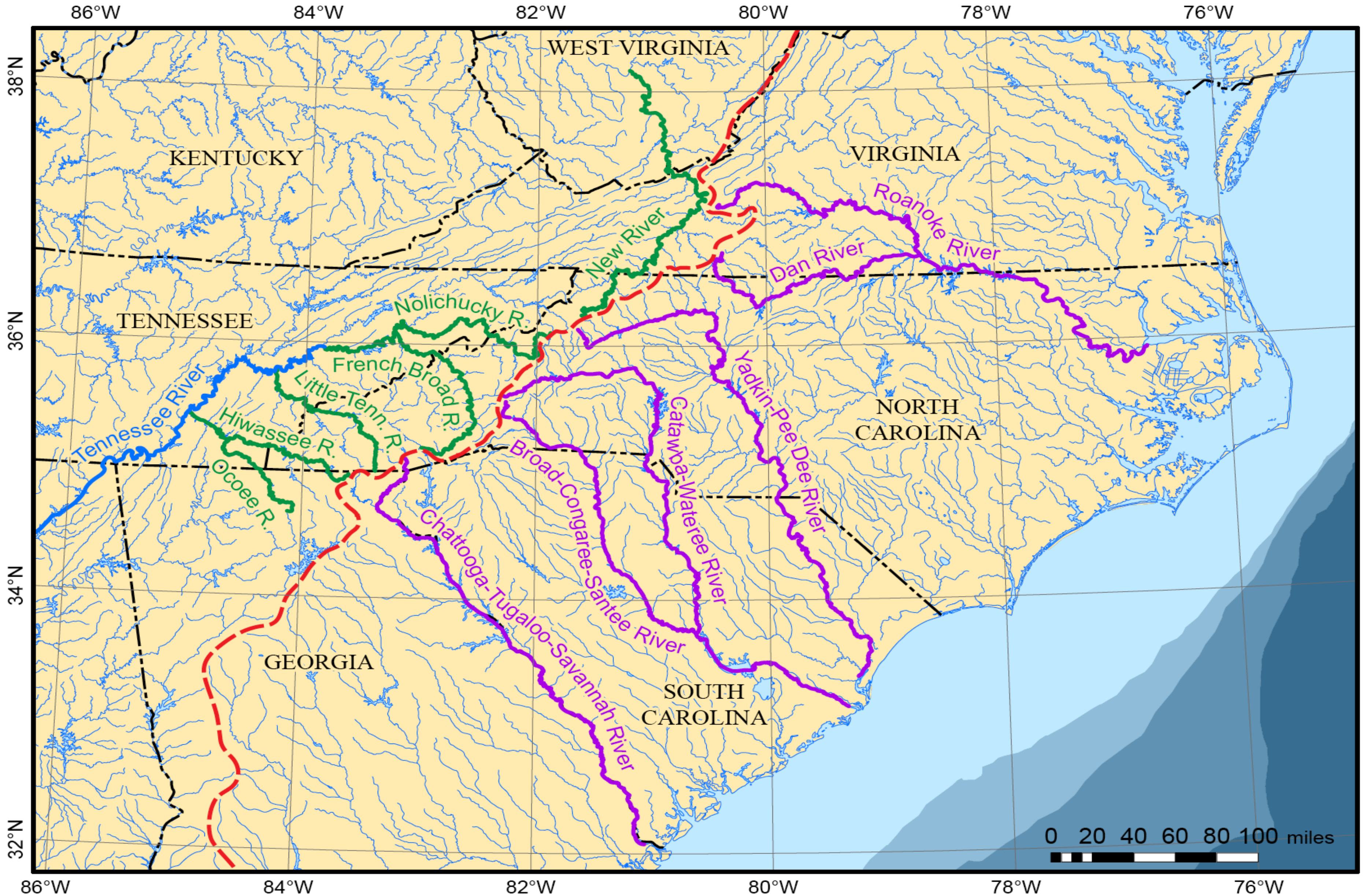
Southern–Central Appalachians Topography

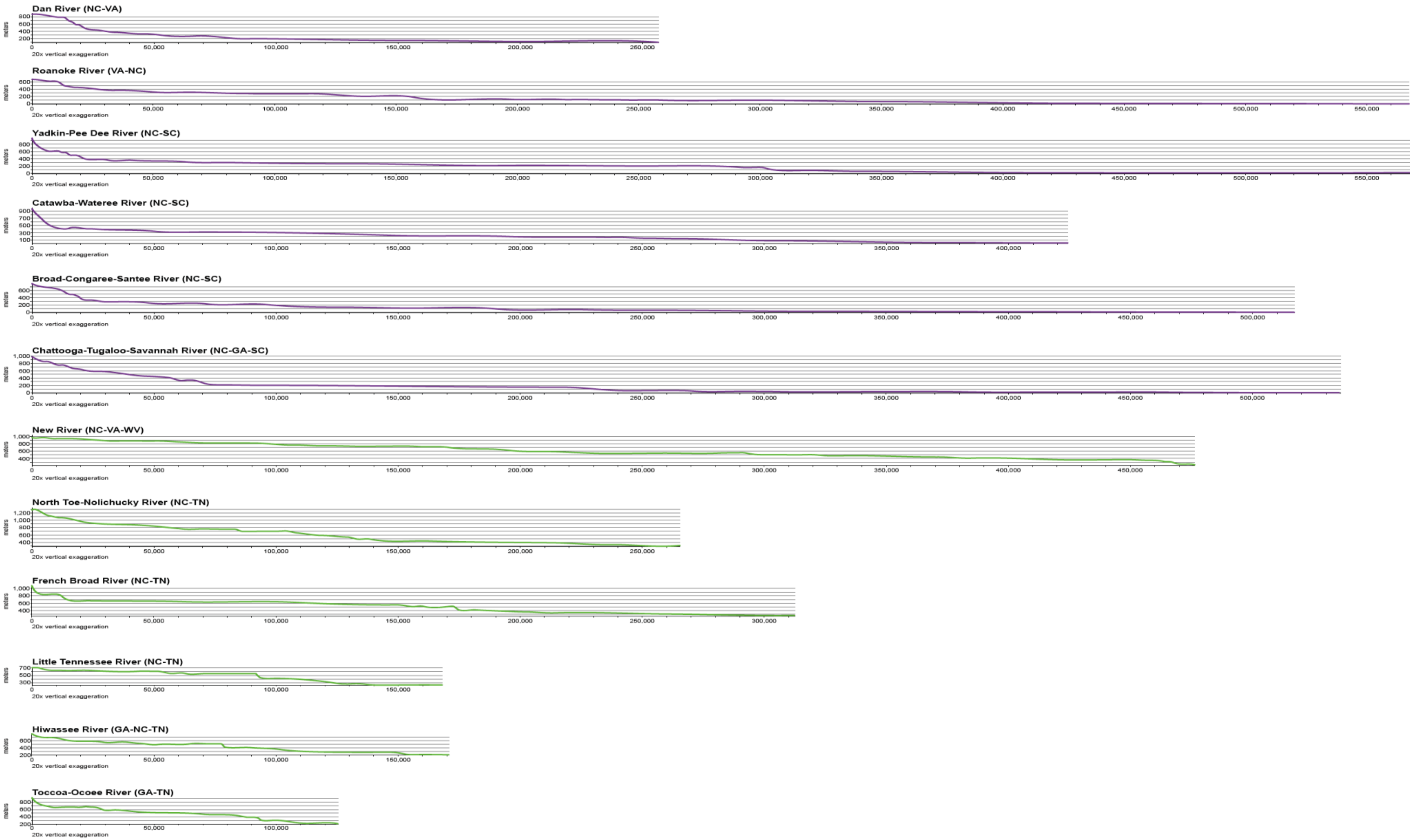


Projection: USGS Albers Equal-Area Conic; CM: 82°W (NAD 1983) Source: DEM - GTOPO30 & GEBCO; Linework - Natural Earth ALW 2012

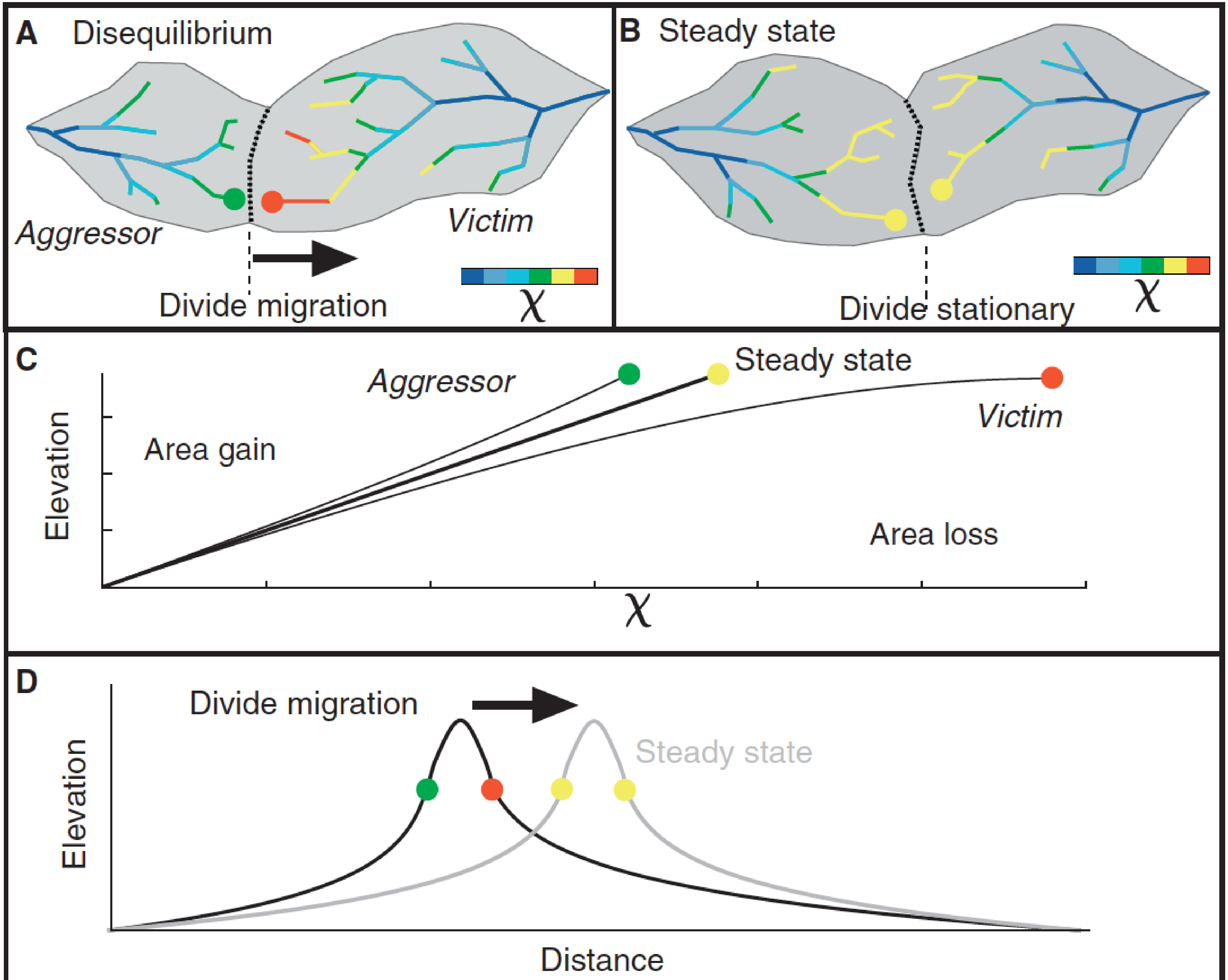
Tennessee River Gorge

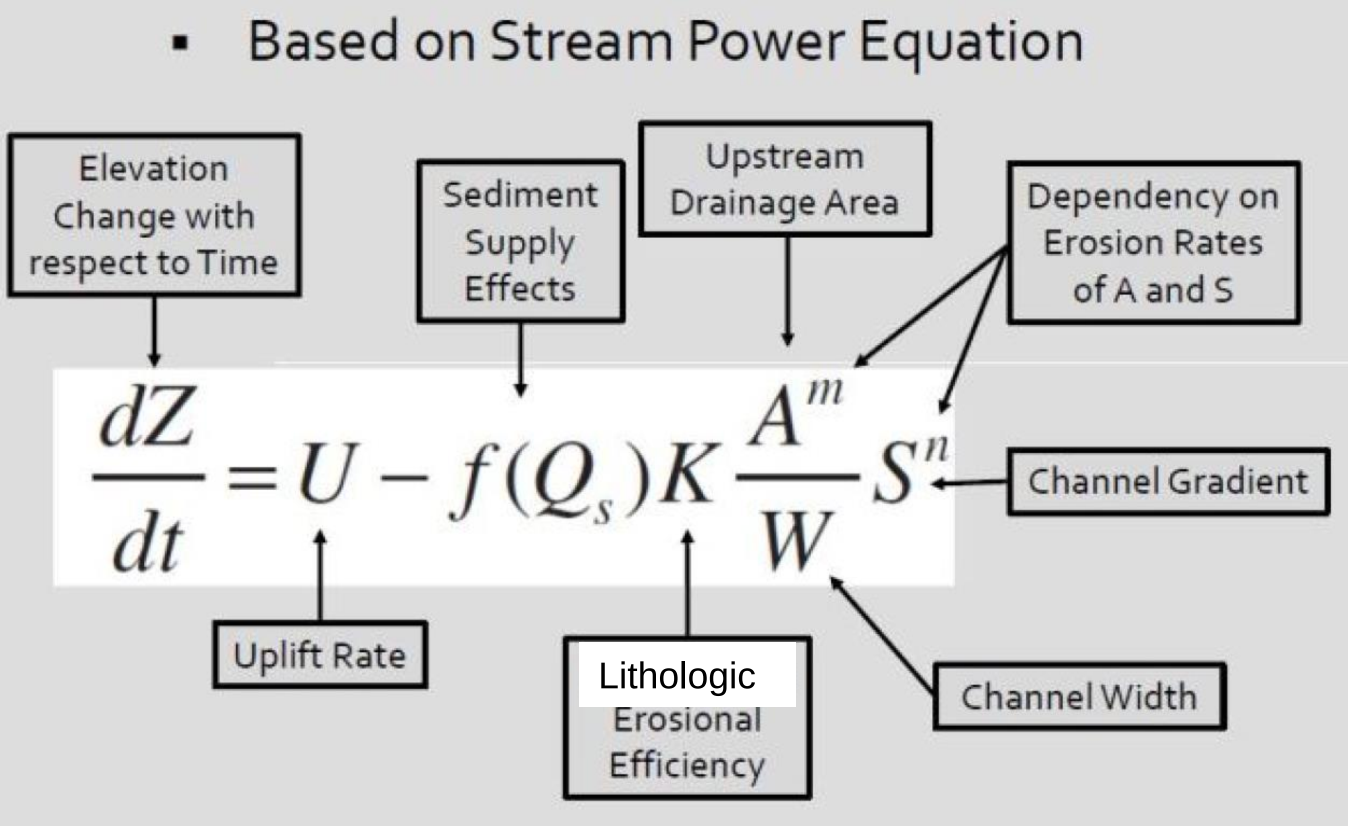



86°W
84°W
82°W
80°W
78°W
76°W
38°N
36°N
34°N
32°N
WEST VIRGINIA
KENTUCKY
VIRGINIA
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
New River
Roanoke River
Dan River
Nolichucky R.
French Broad R.
Little-Tenn. R.
Hiwassee R.
Ocoee R.
Tennessee River
Yadkin-Pee Dee River
Catawba-Wateree River
Broad-Congaree-Santee River
Chattooga-Tugaloo-Savannah River
0 20 40 60 80 100 miles



Mostly Southern Appalachian River Profiles (red– Atlantic, green–TN R tributaries)


A Disequilibrium
Aggressor
Victim
Divide migration
χ
B Steady state
Divide stationary
χ
C
Steady state
Aggressor
Victim
Elevation
Area gain
Area loss
χ
D
Divide migration
Steady state
Elevation
Distance



The parameter χ characterizes the river network topology and geometry, which determine how tectonic forcing generates variable topography

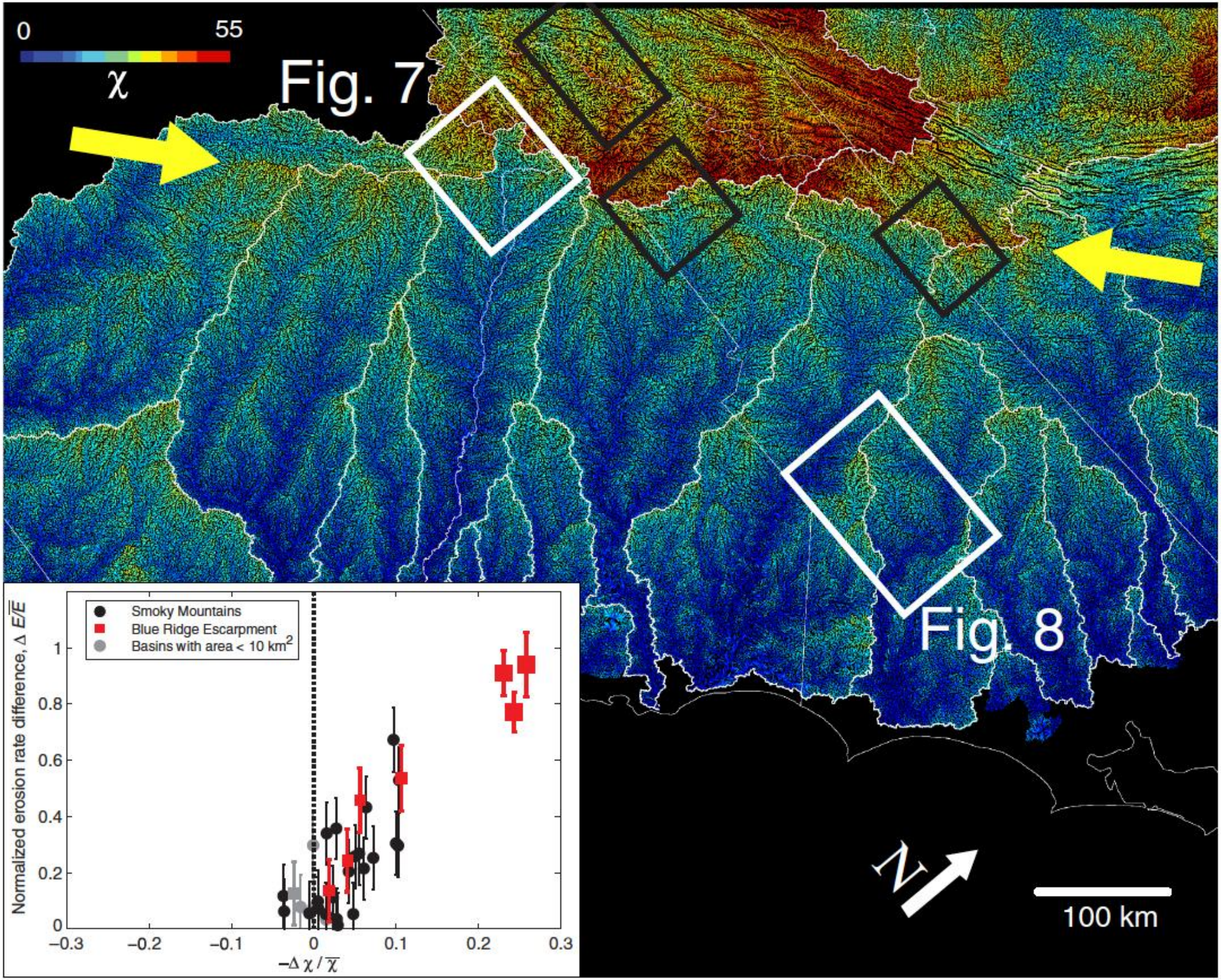
throughout a river basin. χ serves as a metric for the steady-state elevation of a channel at location x. Thus, with constant tectonic forcing and homogeneous

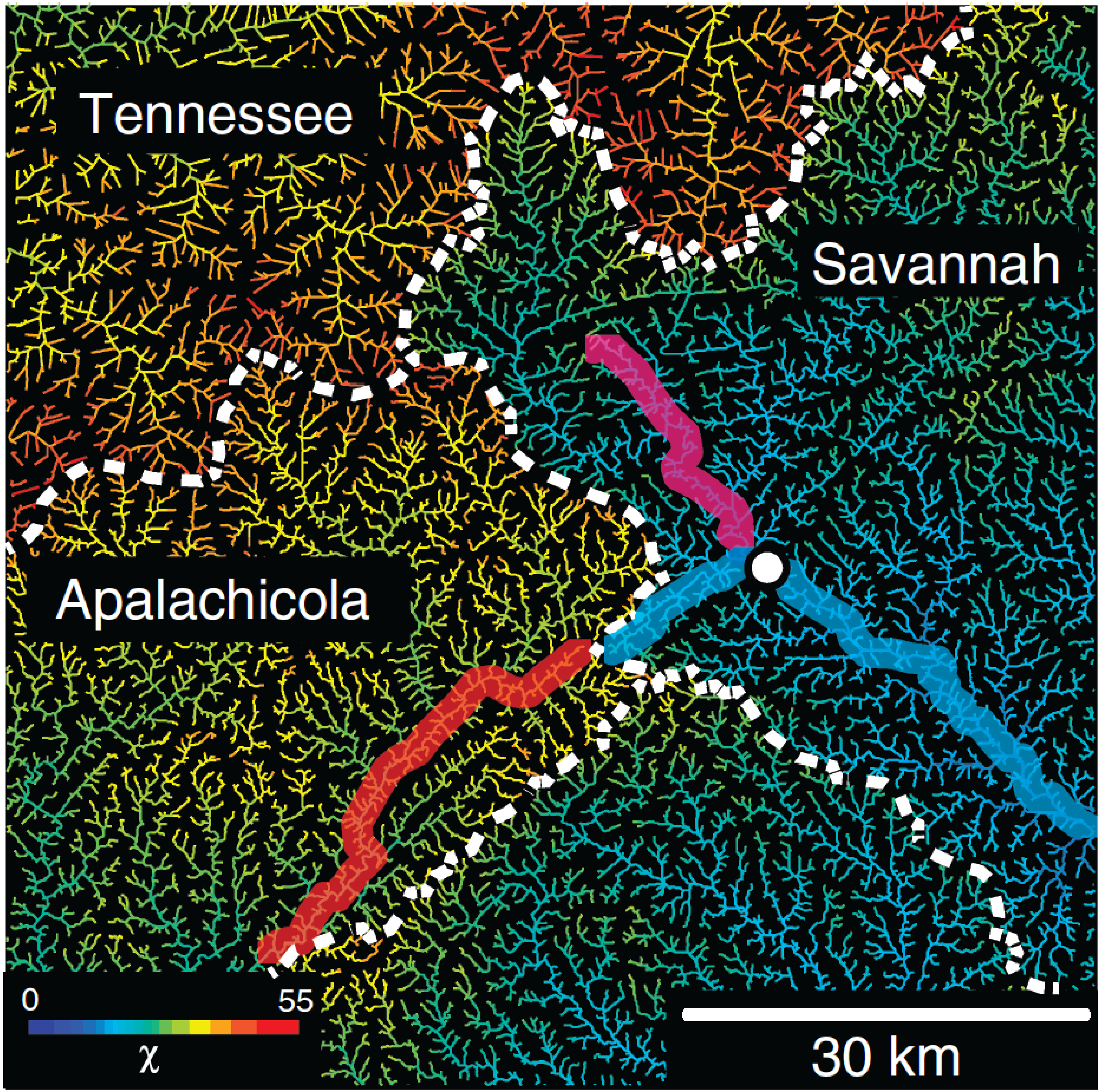
physical properties, a difference in χ across a divide implies disequilibrium and, presumably, motion of the divide in the direction of larger χ to achieve equilibrium.

or

$$\frac{\partial z(x,t)}{\partial t} = U - KA^m \left| \frac{\partial z(x,t)}{\partial x} \right|^n$$

$$z(x) = z_b + \left(\frac{U}{KA_0^m} \right)^{\frac{1}{n}} \chi$$


0
55
χ
Fig. 7
Fig. 8
N
100 km
Smoky Mountains
Blue Ridge Escarpment
Basins with area < 10 km2
Normalized erosion rate difference, Δ E/Ē
−Δ χ / χ̄
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0
0.2
0.4
0.6
0.8
1



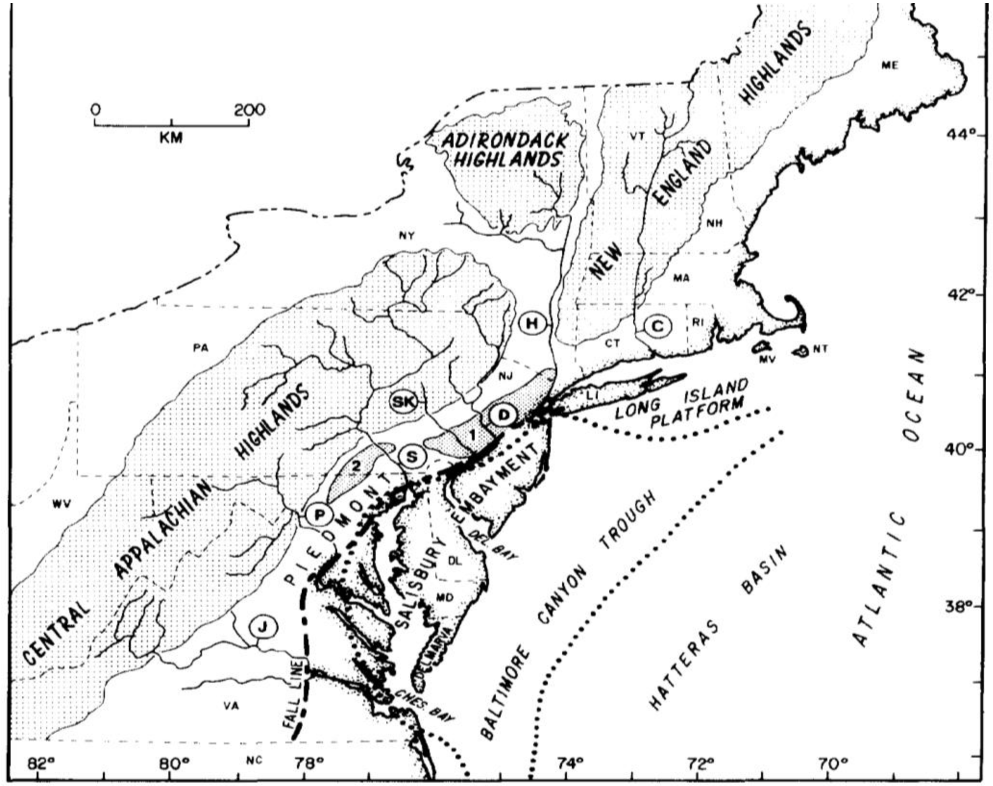
Tennessee
Savannah
Apalachicola
0
55
χ
30 km

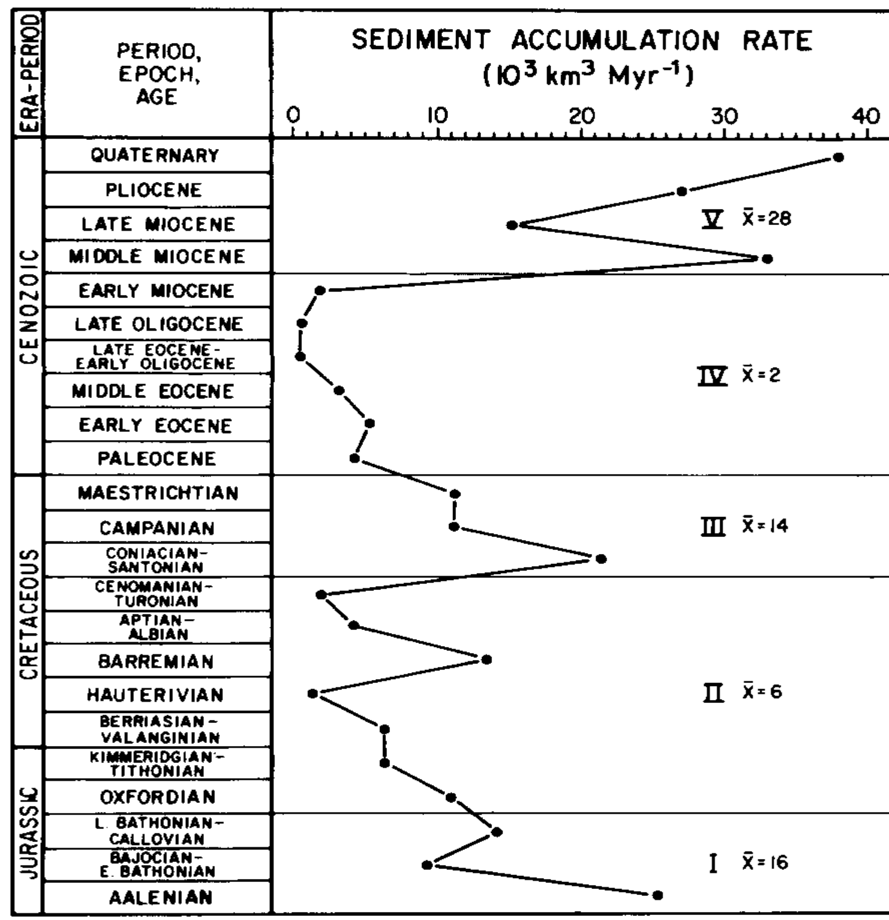
Conclusion:

Modern Appalachian topography and drainages are anomalous in too many ways to be relict Paleozoic topography. The major rivers are ancient, maybe Pleistocene or older.

Evidence from Mesozoic-Tertiary Sedimentation

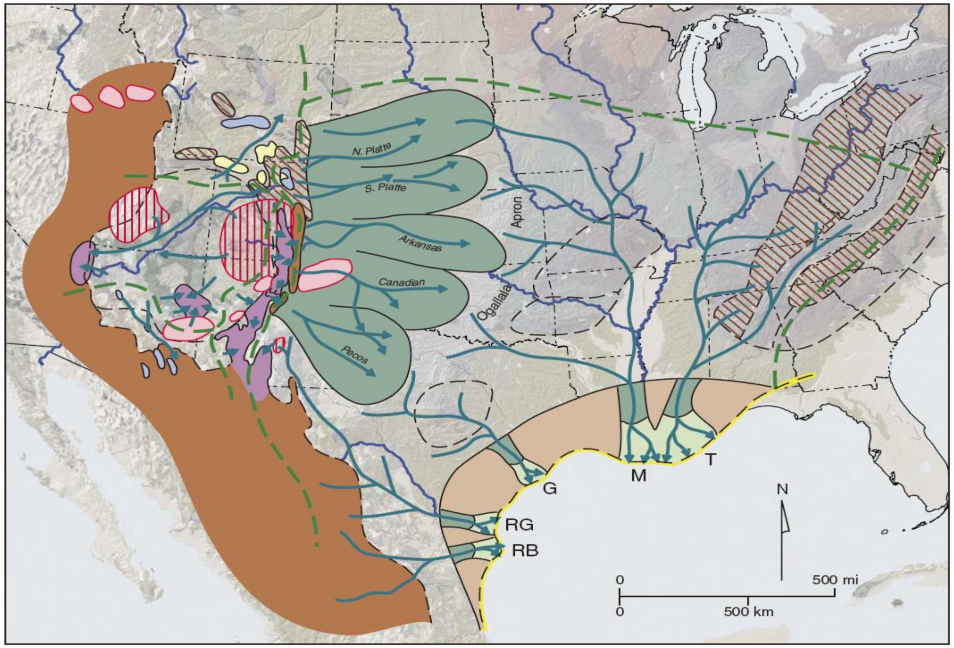
Sediment accumulation rates: Salisbury Embayment, Baltimore Canyon Trough, and Hatteras Basin

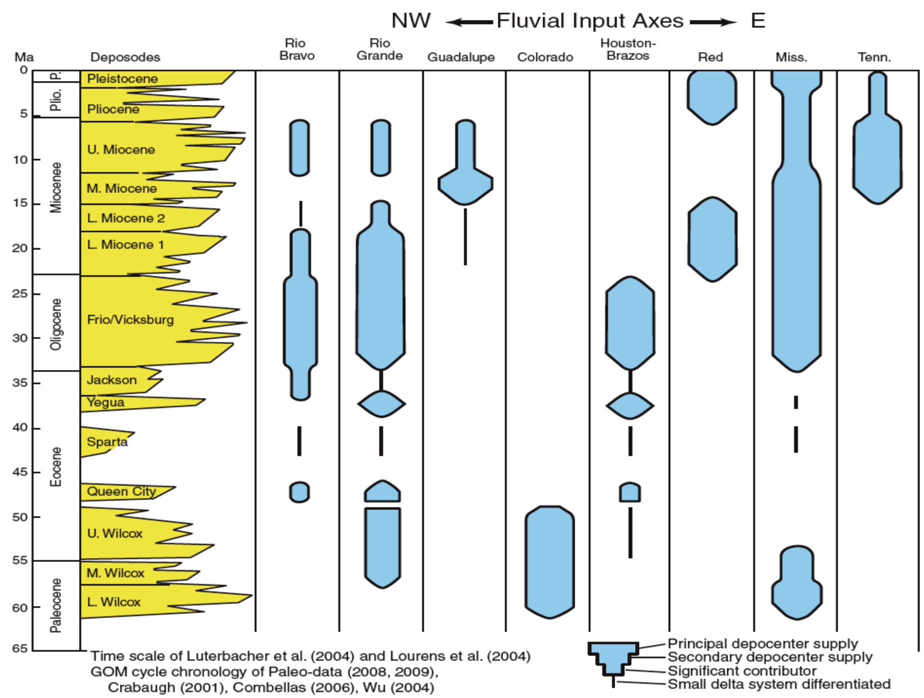




From Poag & Sevon, 1989, Geomorphology

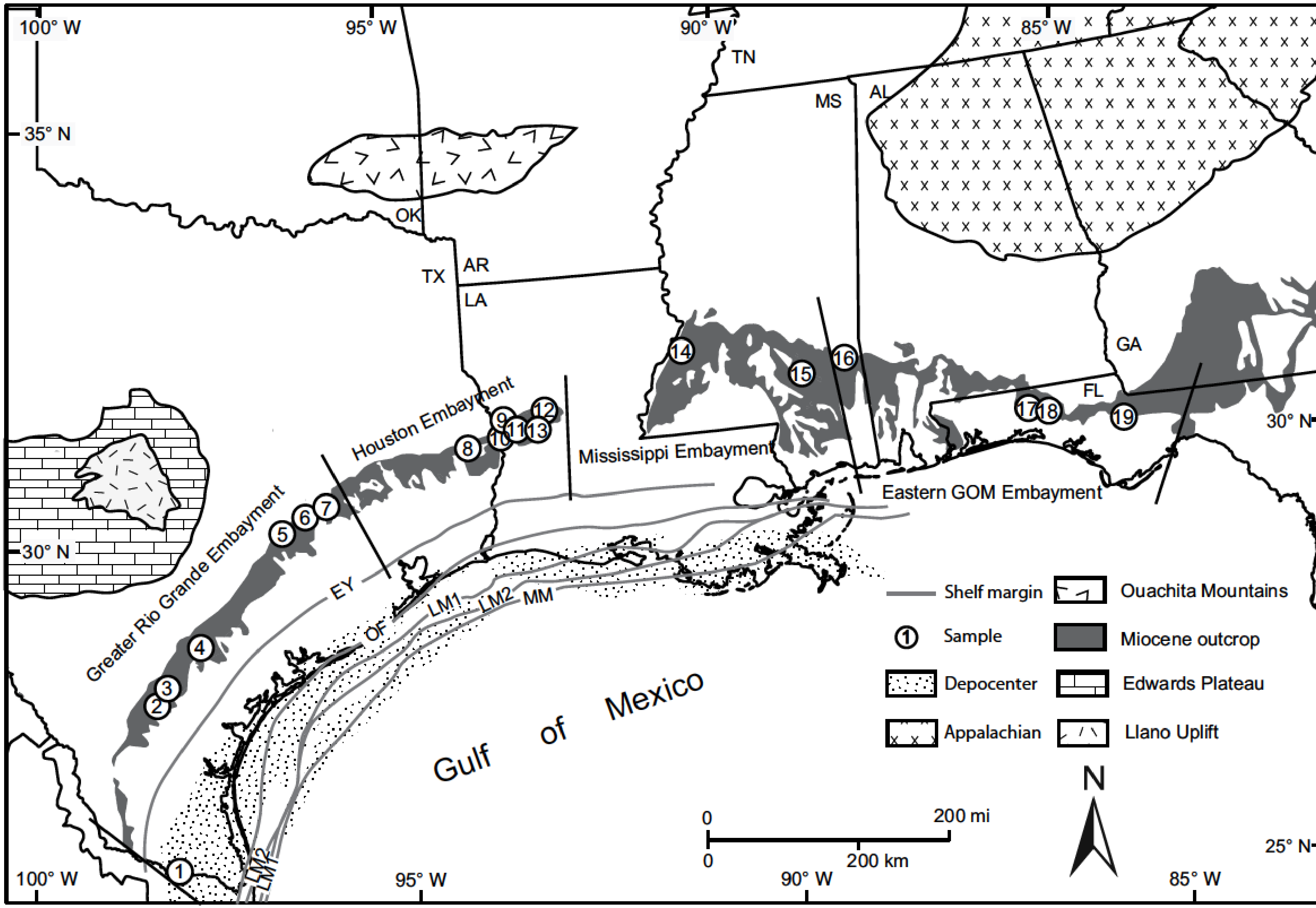
Late Miocene Paleogeography



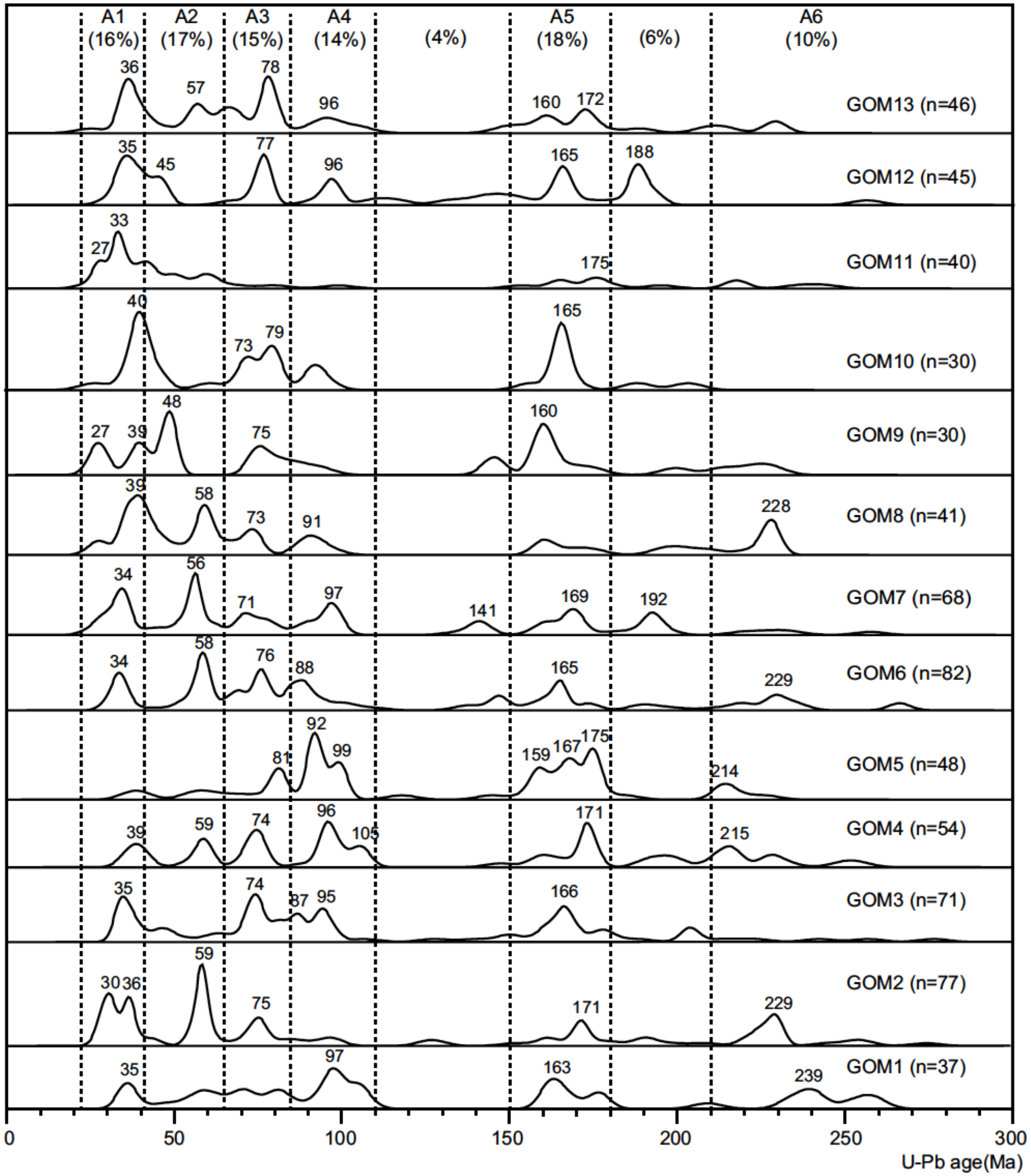


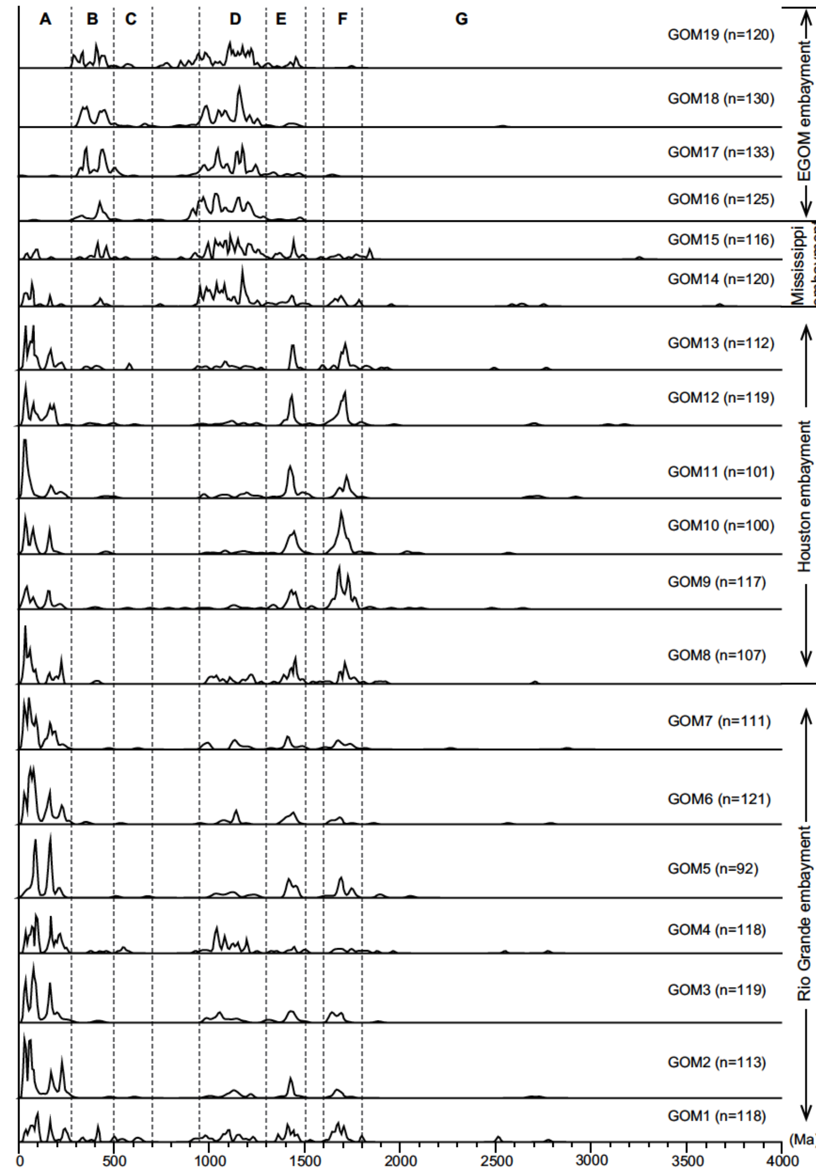
From Galloway et al., 2011, Geosphere

Provenance Data

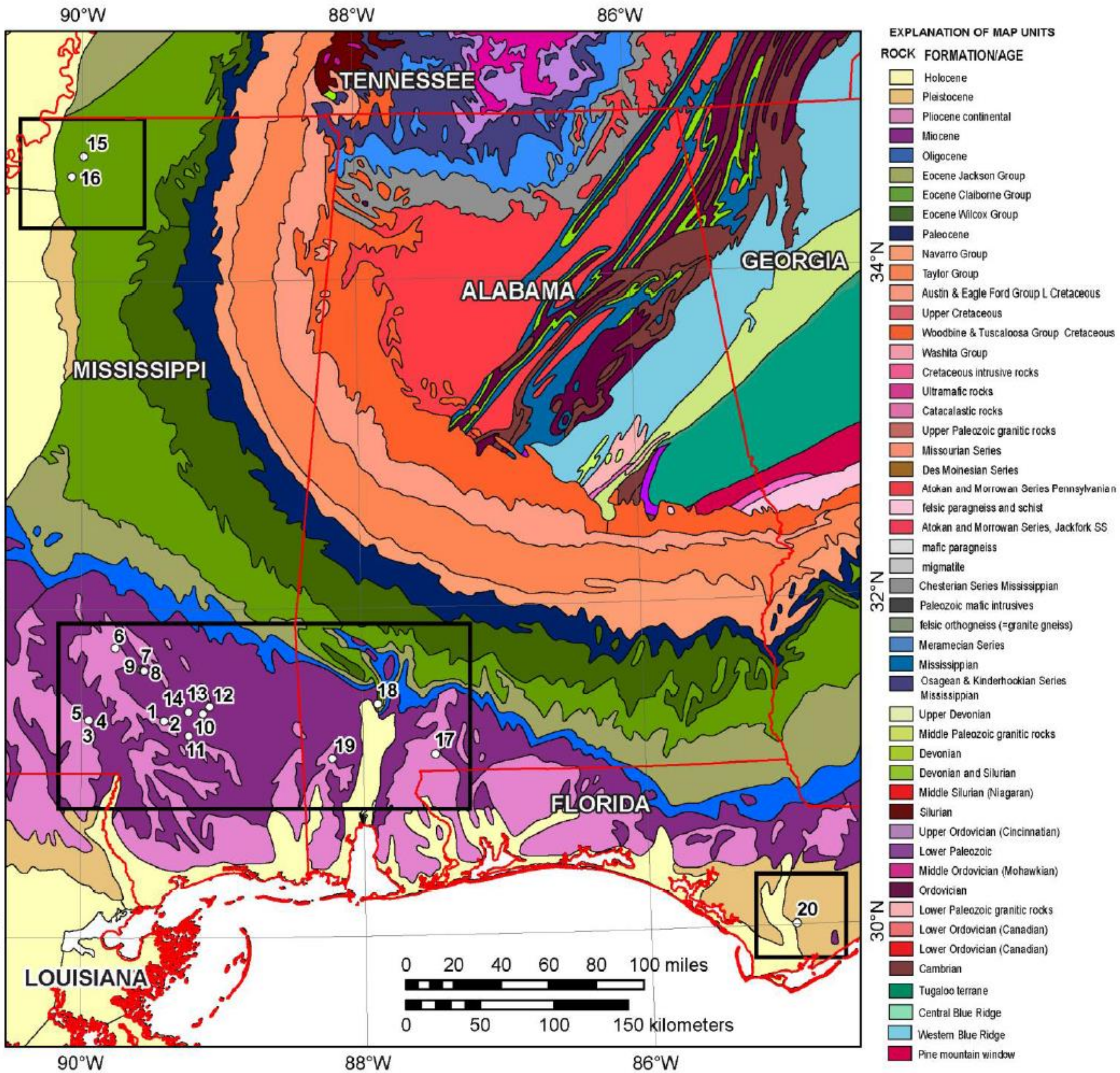


From Xu et al., 2016, GSAB



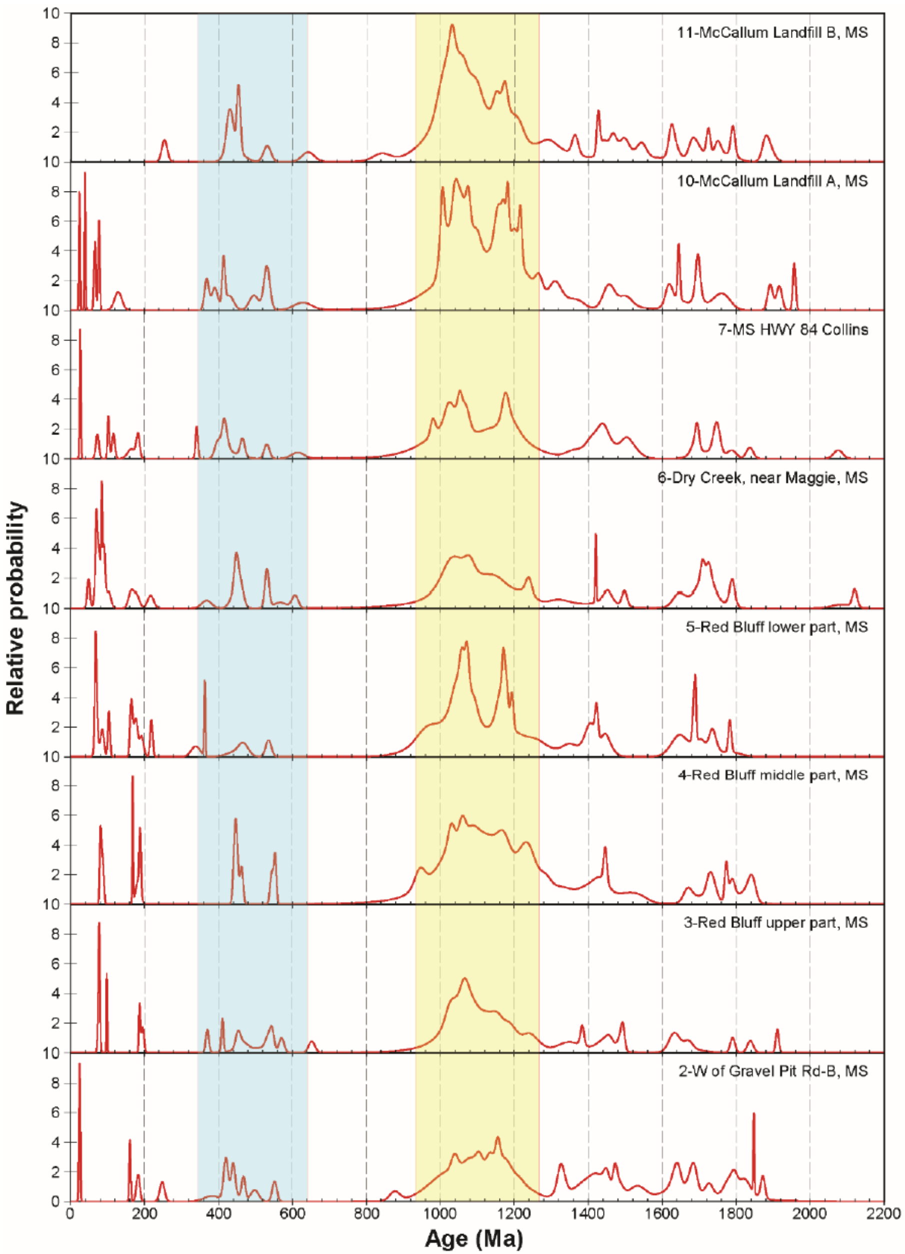


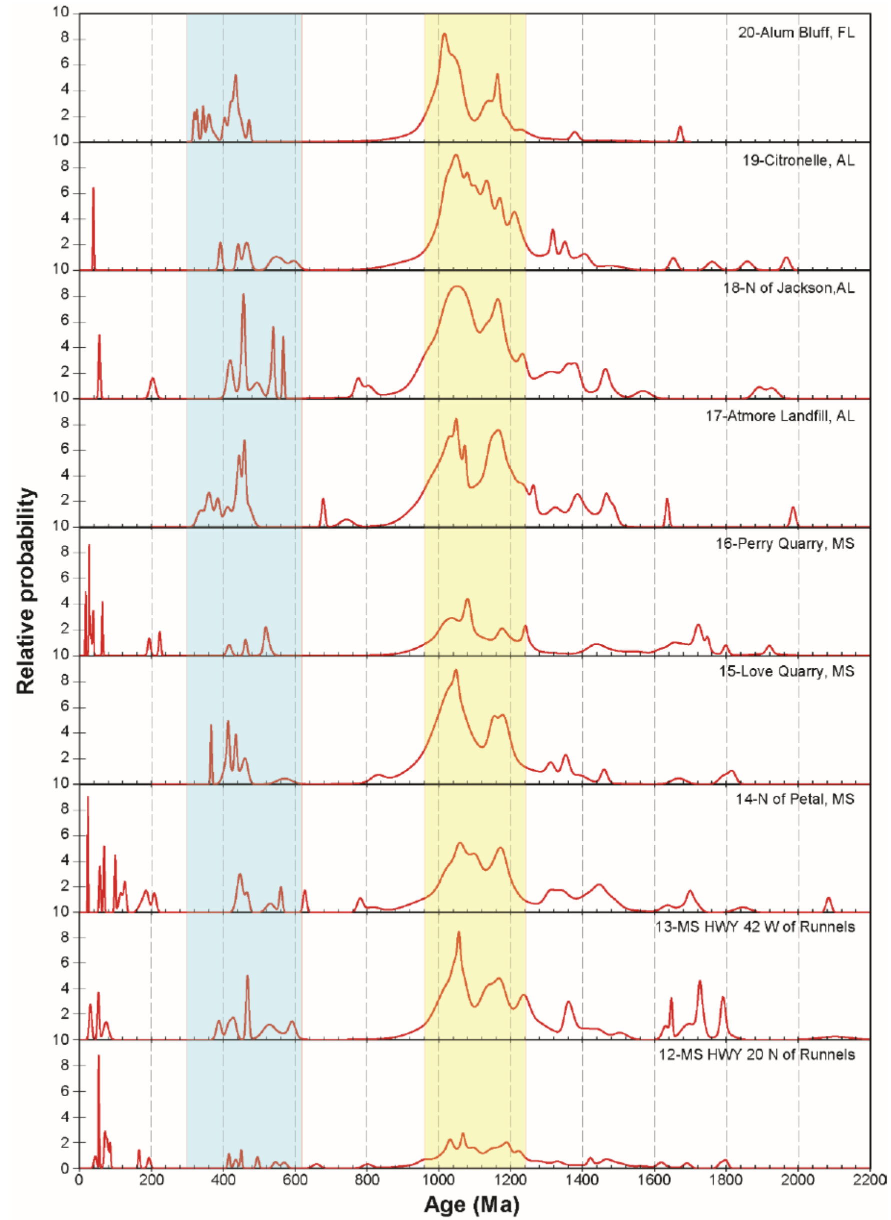
From Xu et al., 2016, GSAB



From M. S. Biswal, M.S. Thesis, Univ. TN., 2015

Pliocene (-Pleistocene?) Sediments, Red Bluff, Southern MS





From M. S. Biswal, M.S. Thesis, Univ. TN., 2015

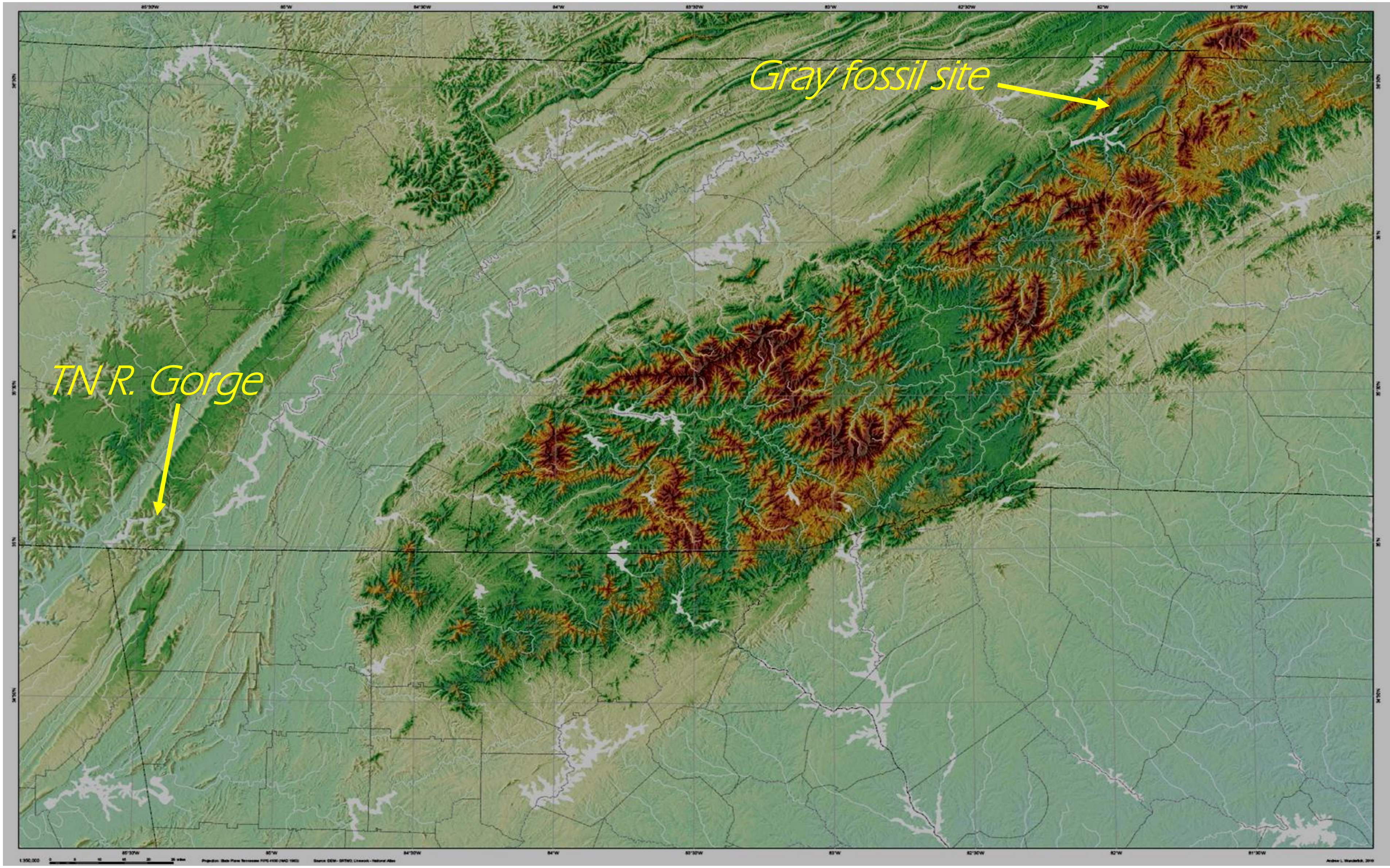
Conclusion:

Mesozoic-Cenozoic sedimentation cannot be explained by a static, eroding Paleozoic chain.

(Late Miocene-early Pliocene sedimentation coeval with the Messinian [worldwide?] event.)

Evidence from the Fossil Record

Gray Fossil Site Location



ay Fossil Site:
m.y-old former
ake, now on
illtop in NE TN

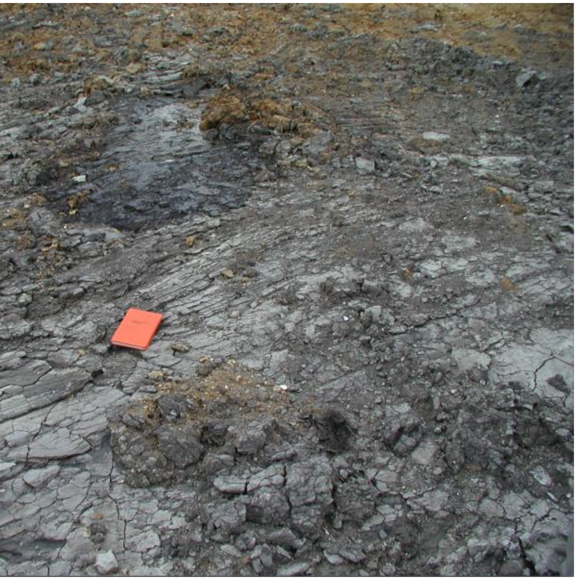
Box turtle

Red panda

Rhinocerous

Crocodilian

From Gray Site web



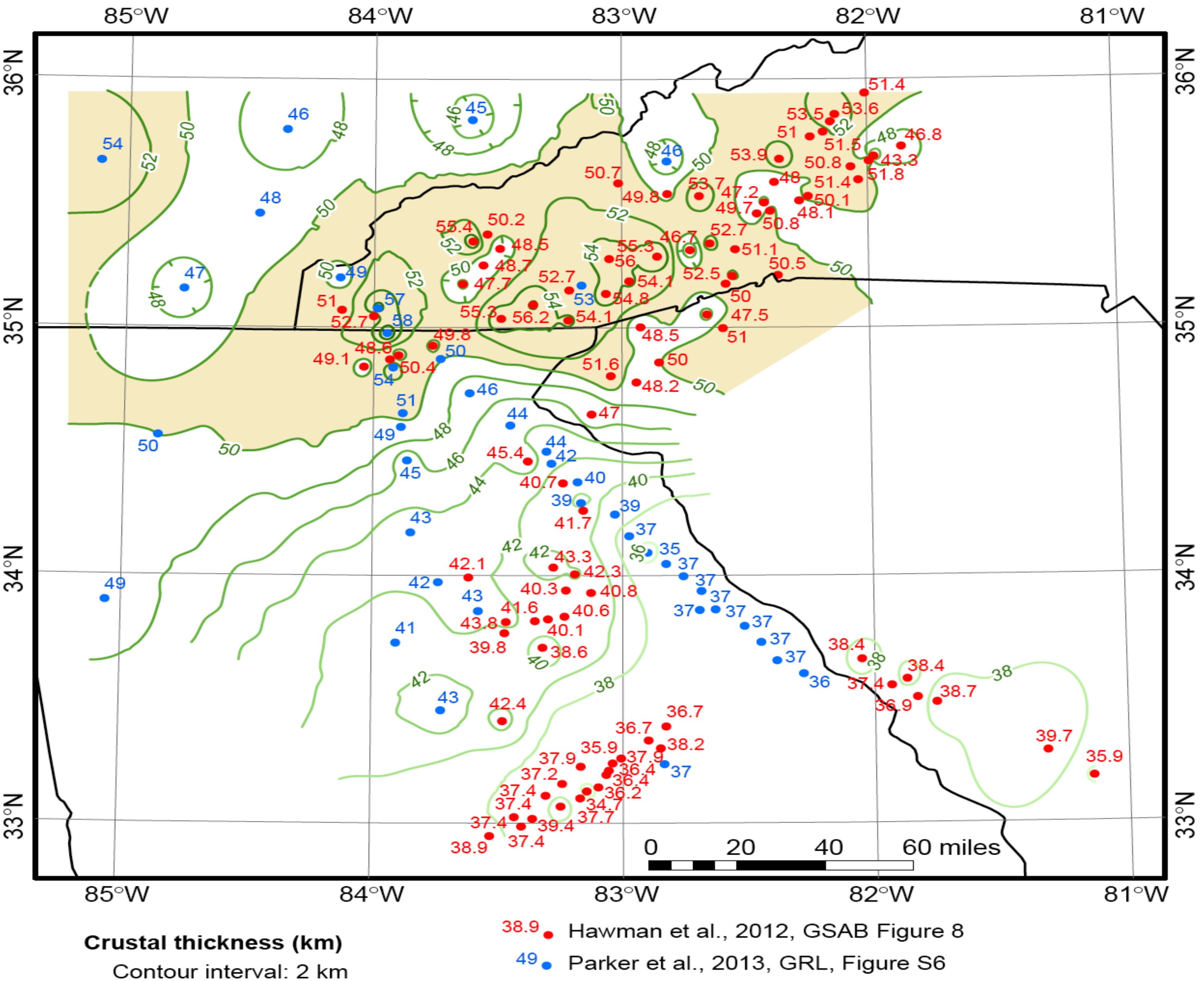
Gray Fossil Site fossil beds


Conclusion:

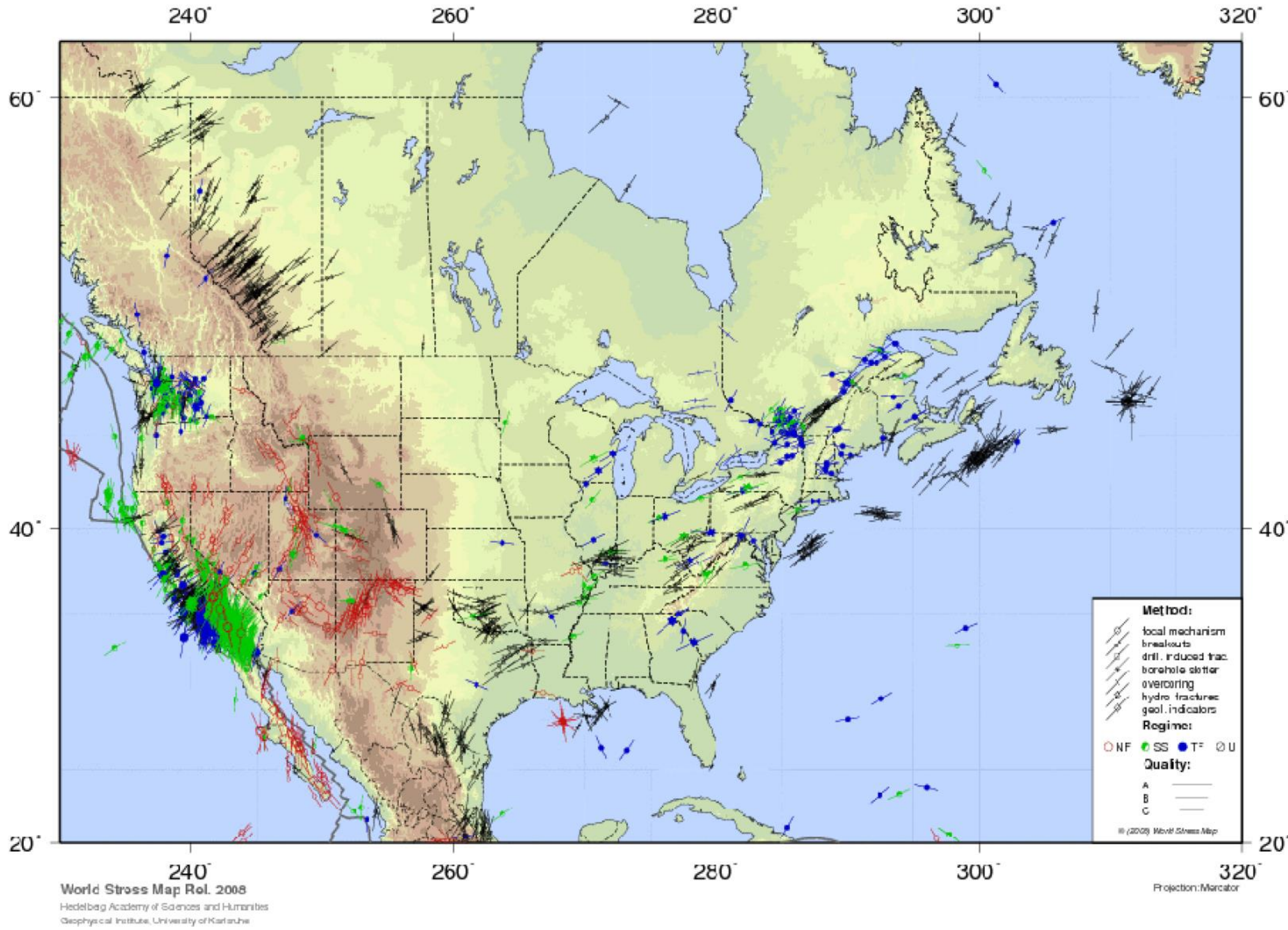
The Gray Fossil Site fauna and location in an inverted topography provides pre-uplift chronological data and a spike in time at the threshold of Appalachian late Miocene-early Pliocene uplift.

Evidence from Geophysics & Geophysical Modeling

Crustal Thickness Data



Present-Day Stress Field in N.A.



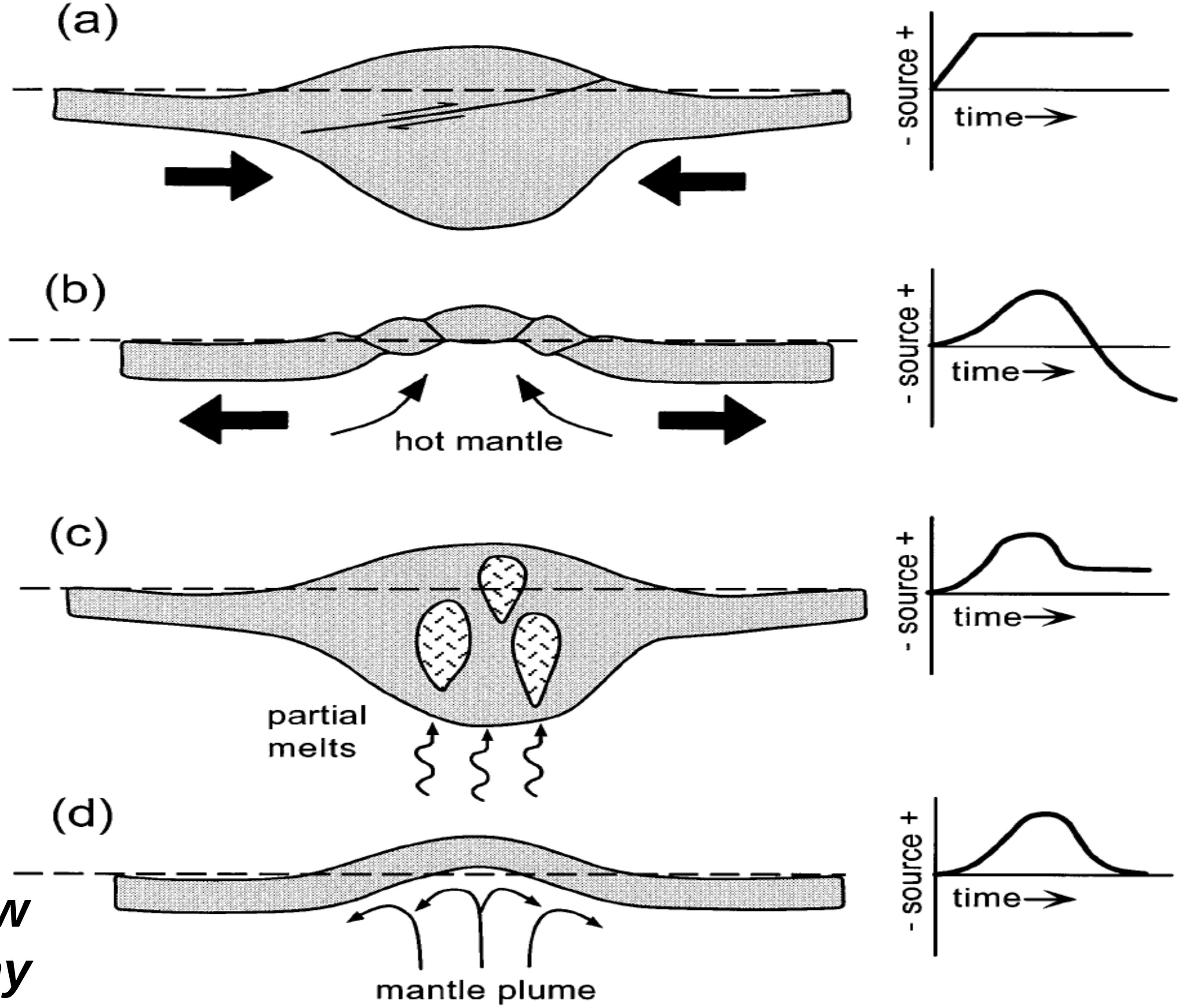
Mechanisms?

Contraction (Cont. collision)

Extension (B & R)

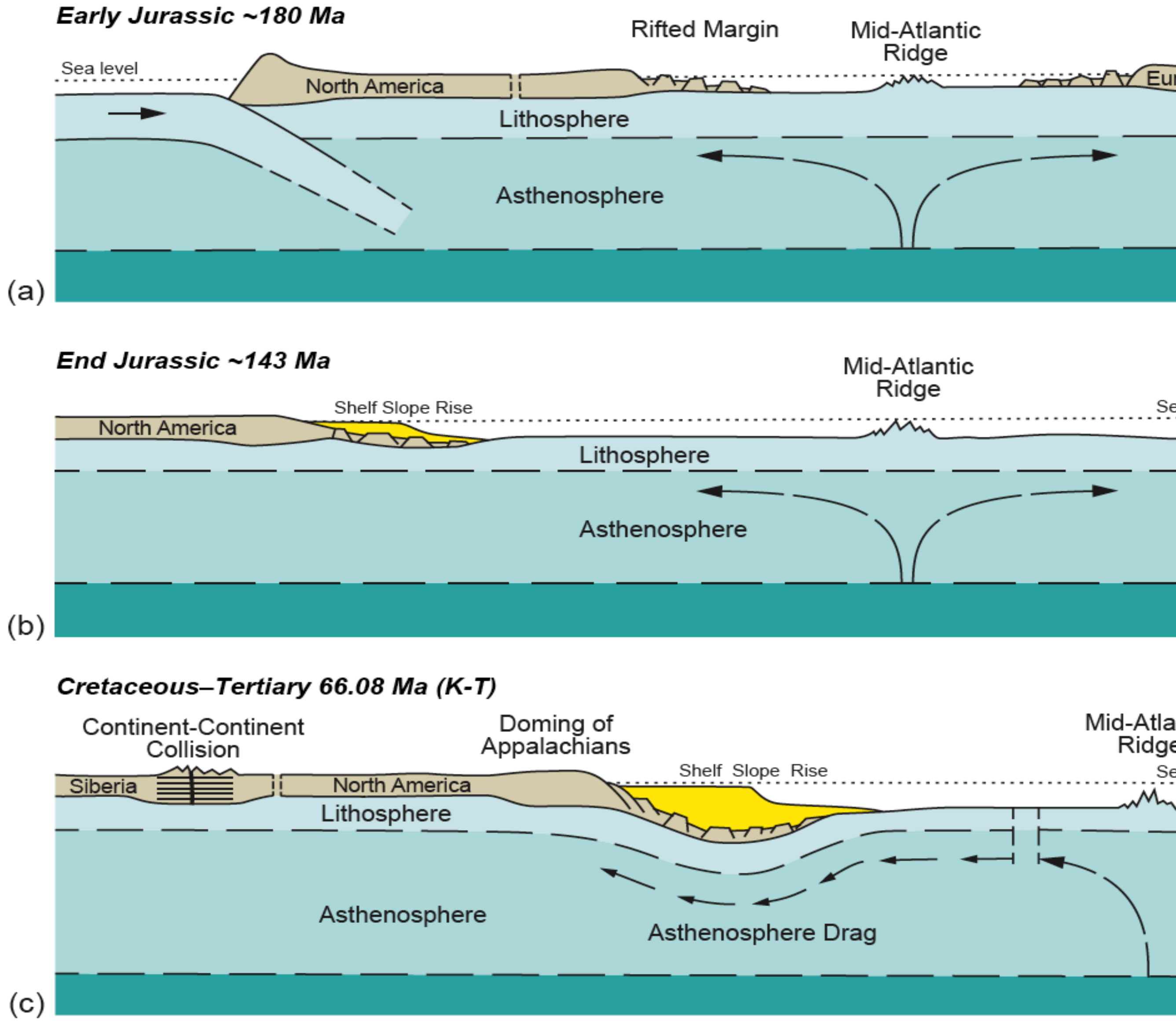
Magmatism (w/ mantle-derived Plutonism)

Asthenospheric flow Dynamic topography



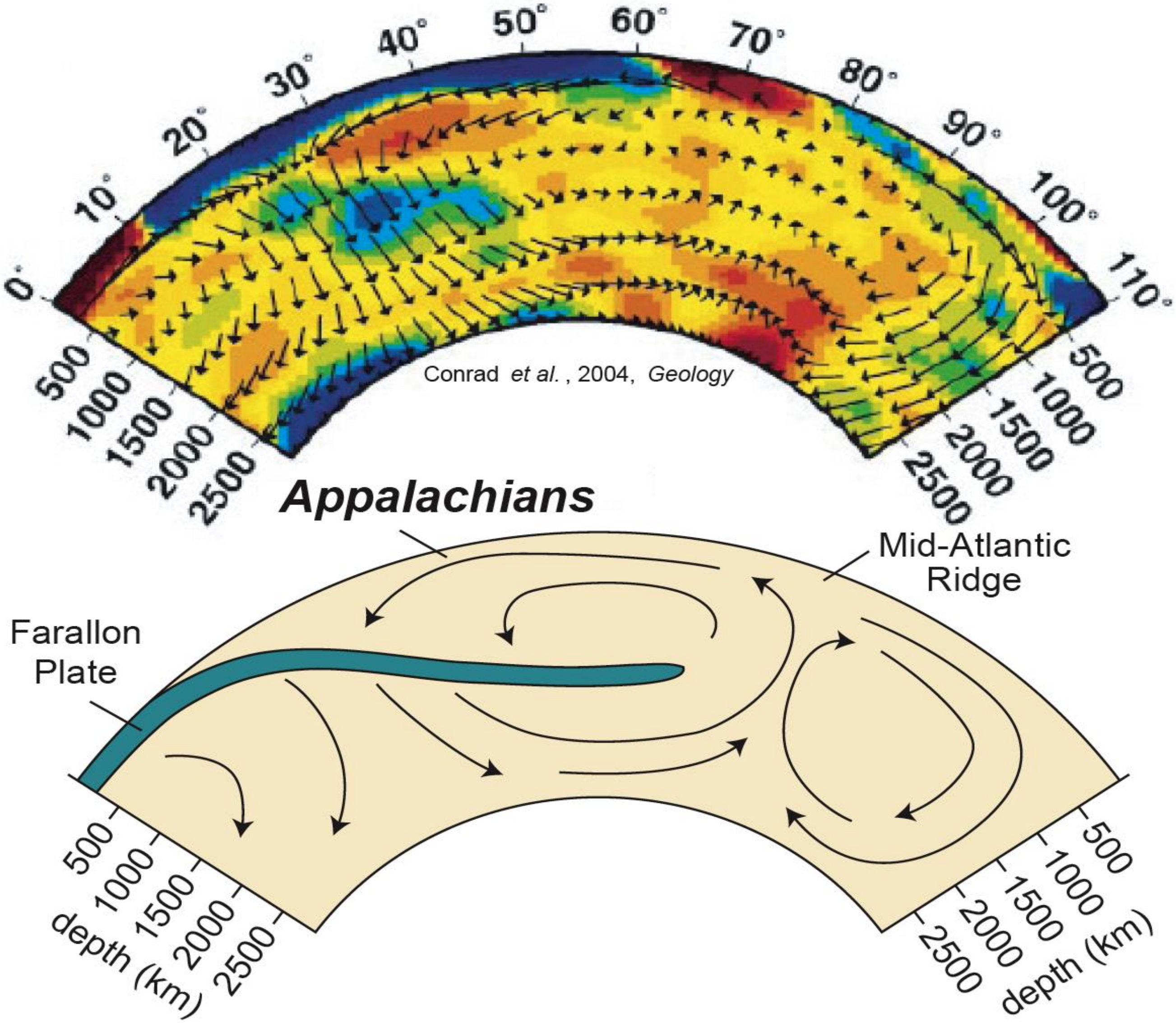
From Pazzaglia & Brandon, 1996, Basin Res

lechanism?
ediment load
response?



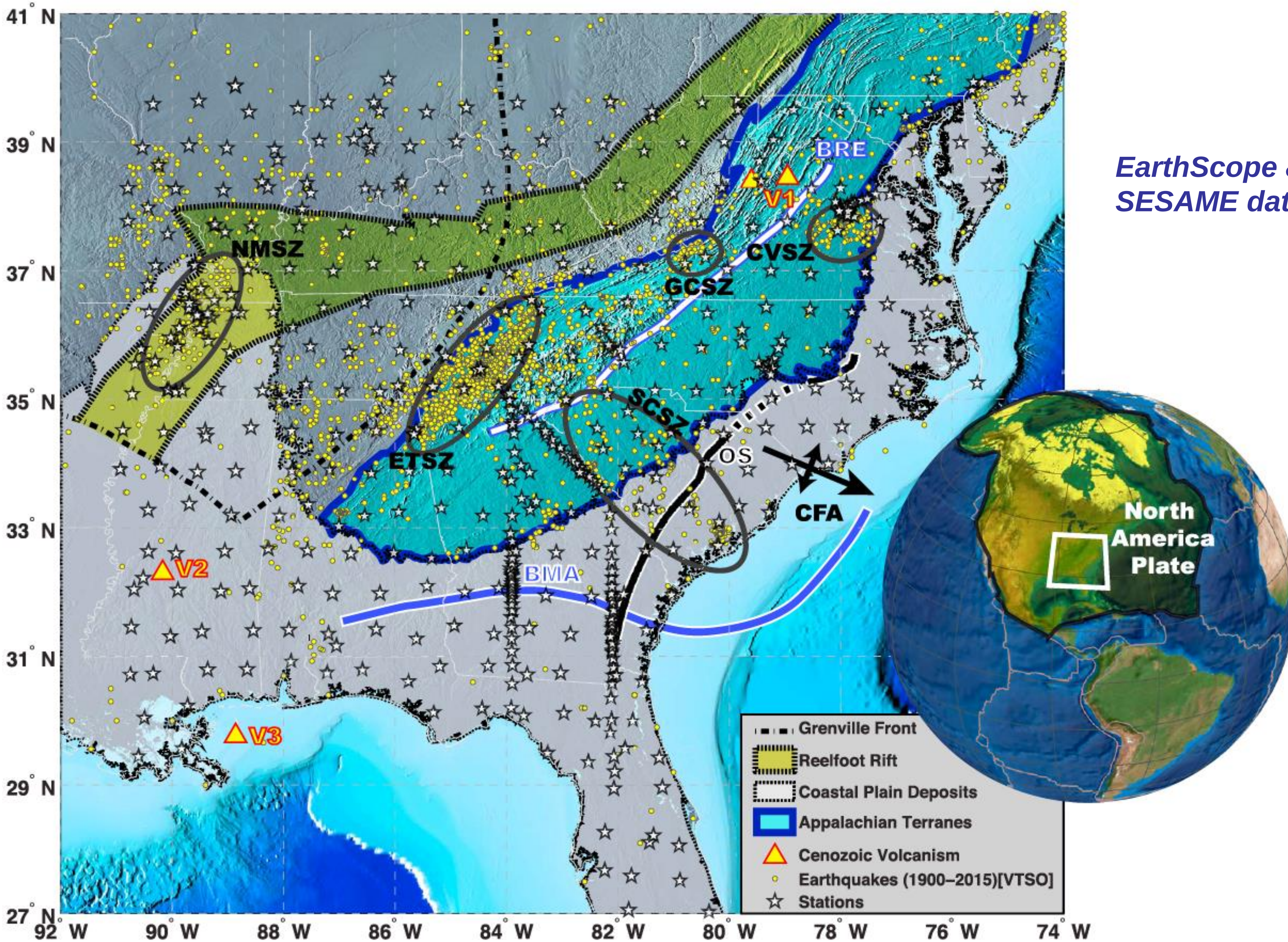
from Roper, 1980, *Tectonop*

Is the Farallon Plate the Cause of Modern Appalachians Uplift?

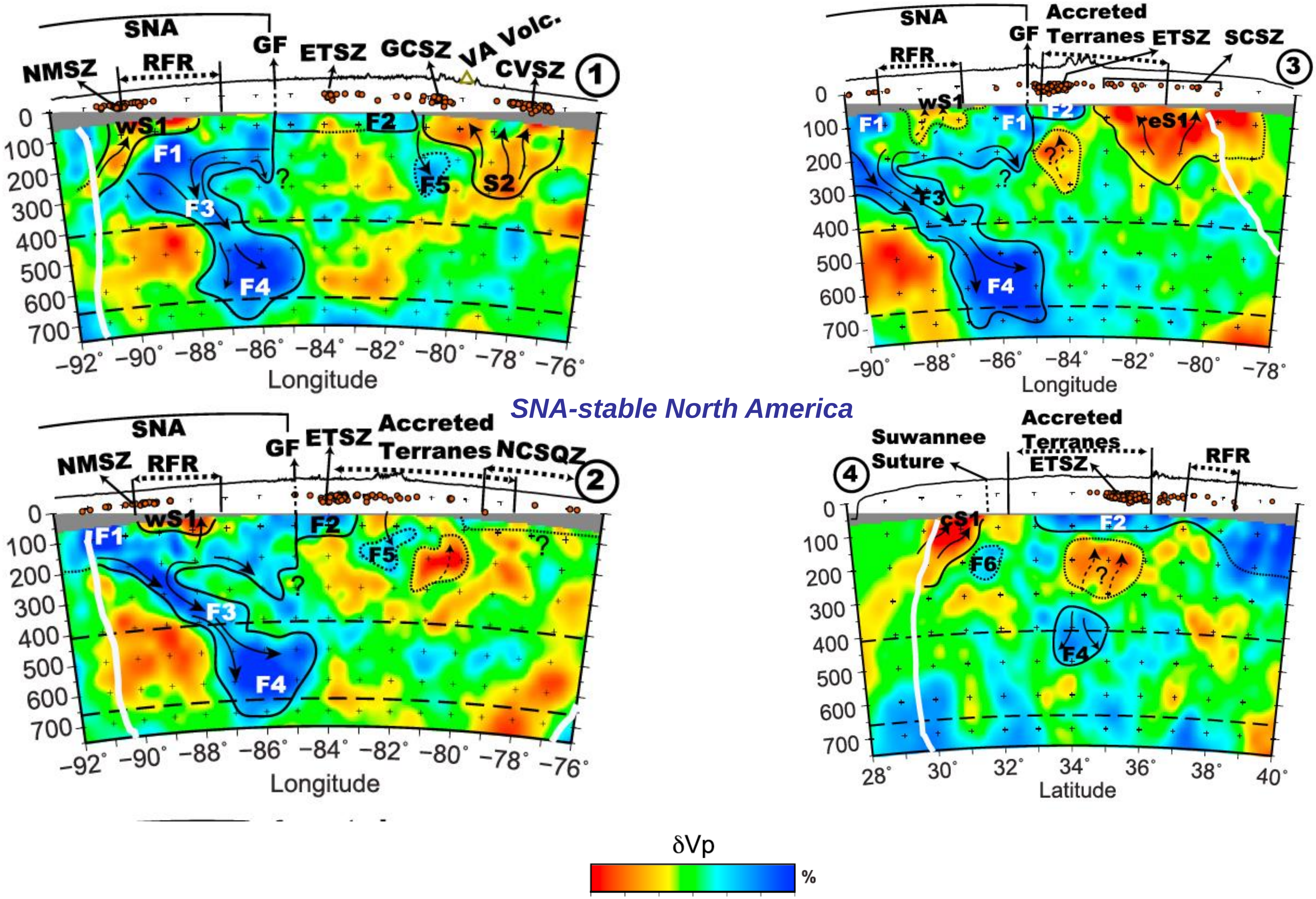


Derived from Conrad *et al.*, 2004, *Geology*, their Figure 3

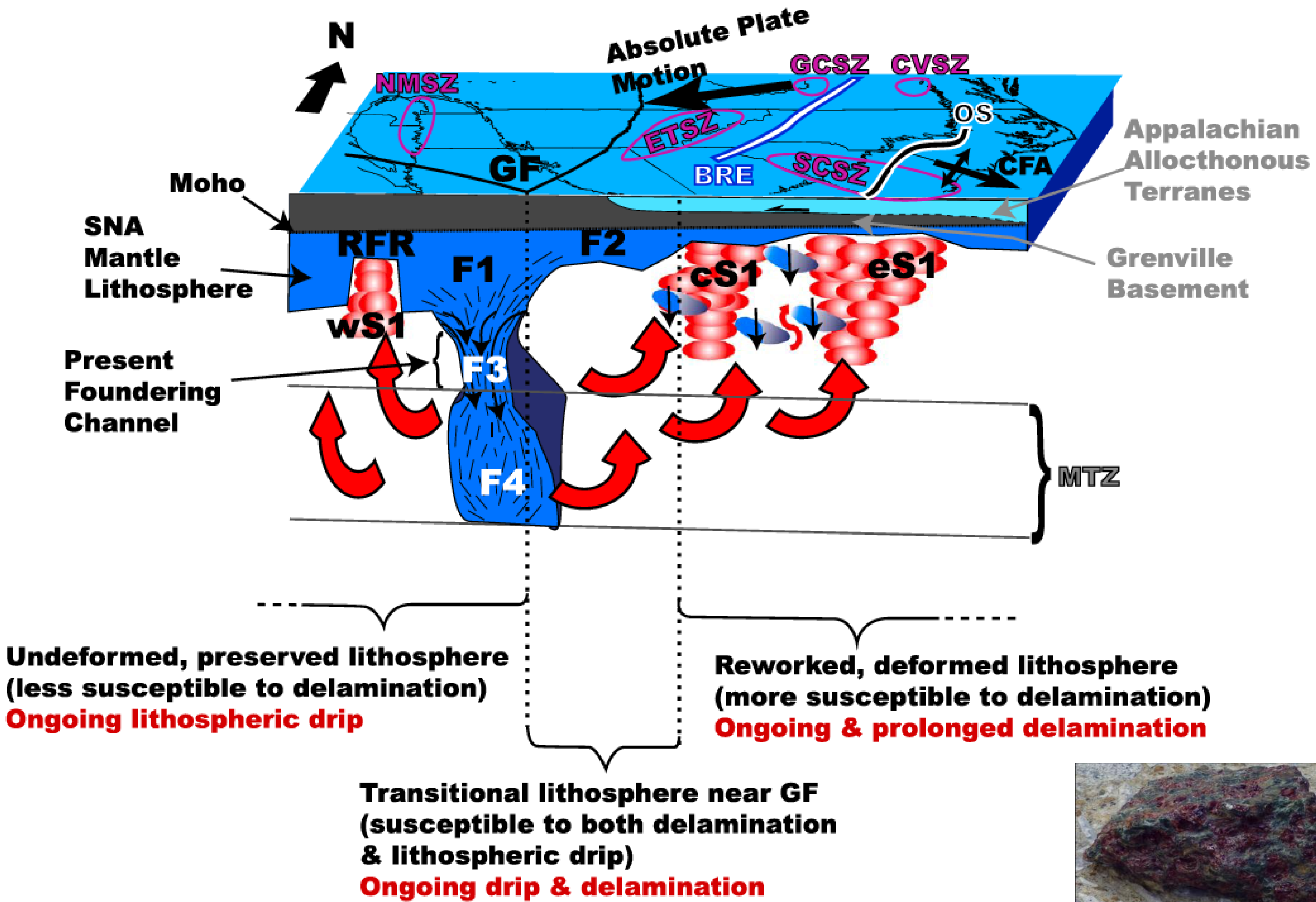
EarthScope & SESAME data



From Biryol, Wagner, Fischer, & Hawman, 2016, JGR



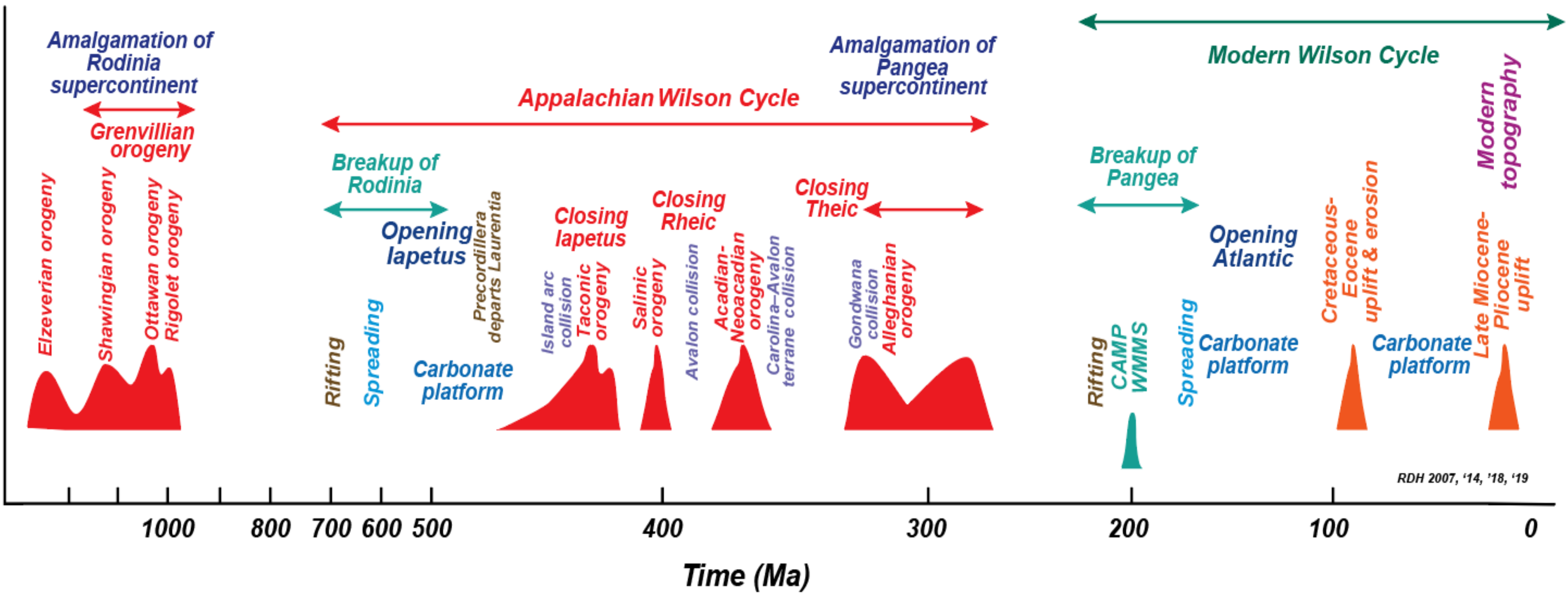
From Biryol, Wagner, Fischer, & Hawman, 2016, JGR


N
Absolute Plate Motion
NMSZ
GCSZ
CVSZ
ETSZ
OS
BRE
SCSZ
CFA
GF
Moho
SNA Mantle Lithosphere
RFR
F1
F2
cS1
eS1
wS1
F3
F4
Present Foundering Channel
MTZ
Appalachian Allochthonous Terranes
Grenville Basement
Undeformed, preserved lithosphere (less susceptible to delamination)
Ongoing lithospheric drip
Reworked, deformed lithosphere (more susceptible to delamination)
Ongoing & prolonged delamination
Transitional lithosphere near GF (susceptible to both delamination & lithospheric drip)
Ongoing drip & delamination

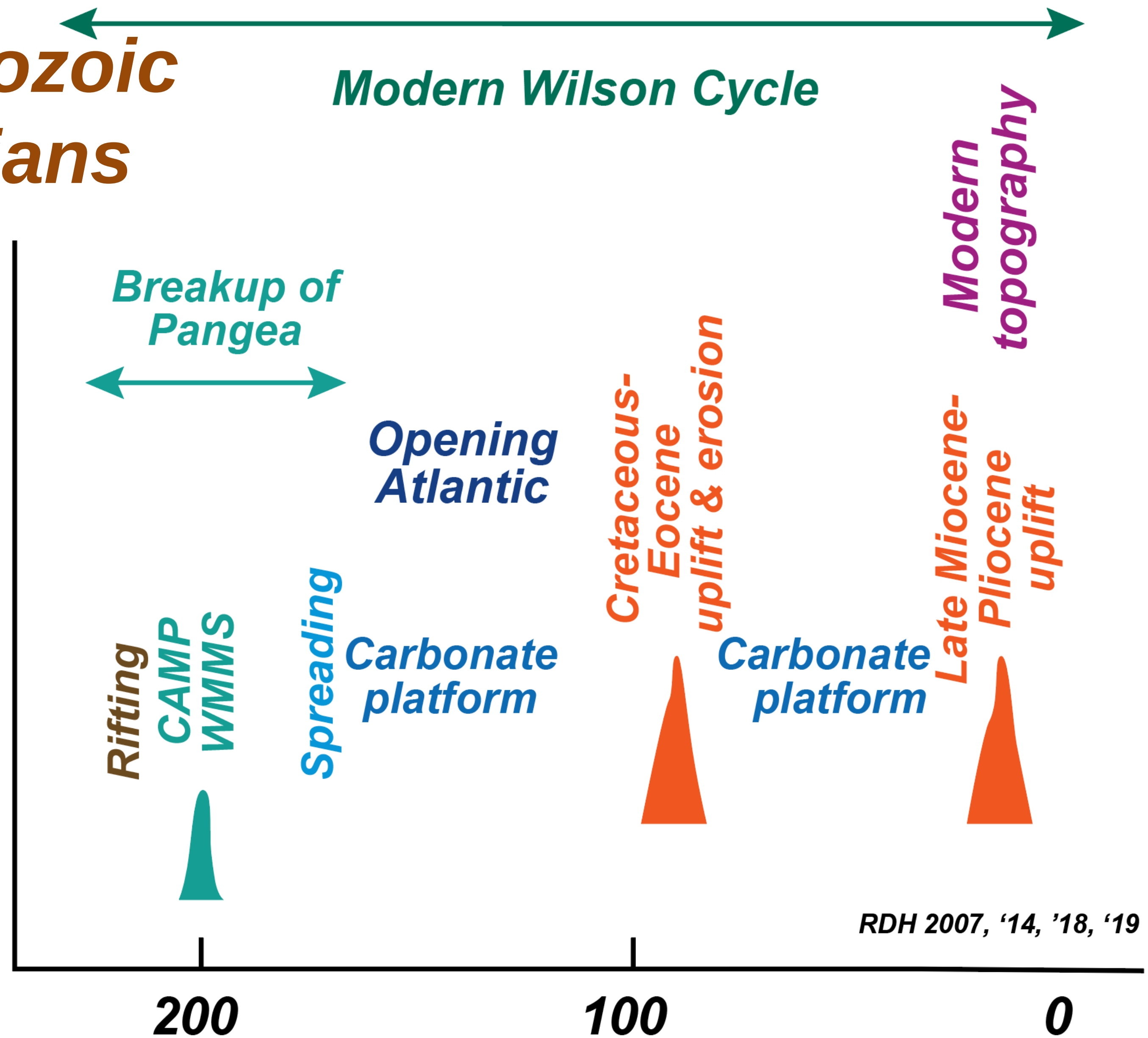
Conclusion:

The cause of Mio-Pliocene Appalachian uplift is lithospheric or asthenospheric. Resolution of mantle structure is greatly improved, but actual uplift kinematics of uplift remains unknown until tomographic/geophysical techniques resolution becomes much better.

Appalachians Timeline



Post-Paleozoic Appalachians



Conclusions

- *Present-day Appalachian topography cannot be explained as a relic of the Alleghanian assembly of Pangea.*

- *A variety of data can be brought to bear to support this conclusion: drainages, faunal data, depositional patterns, young sediments in the Appalachians, anomalous crustal thicknesses etc.*

- *Late Miocene-Pliocene uplift of the Appalachians can now be documented.*

- *Cause of uplift is lithospheric or asthenospheric, but remains unknown until tomographic/geophysical techniques resolution becomes much better.*

World's Oldest Mountains?

No!

Happy Birthday

Elizabeth!