

# Tectonic evolution of the western US- a brief discussion

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**Grand Canyon's Precambrian basement- 1.84-1.68 billion years old**





**Black Canyon's  
Precambrian basement-  
1.78-1.45 billion years  
old**

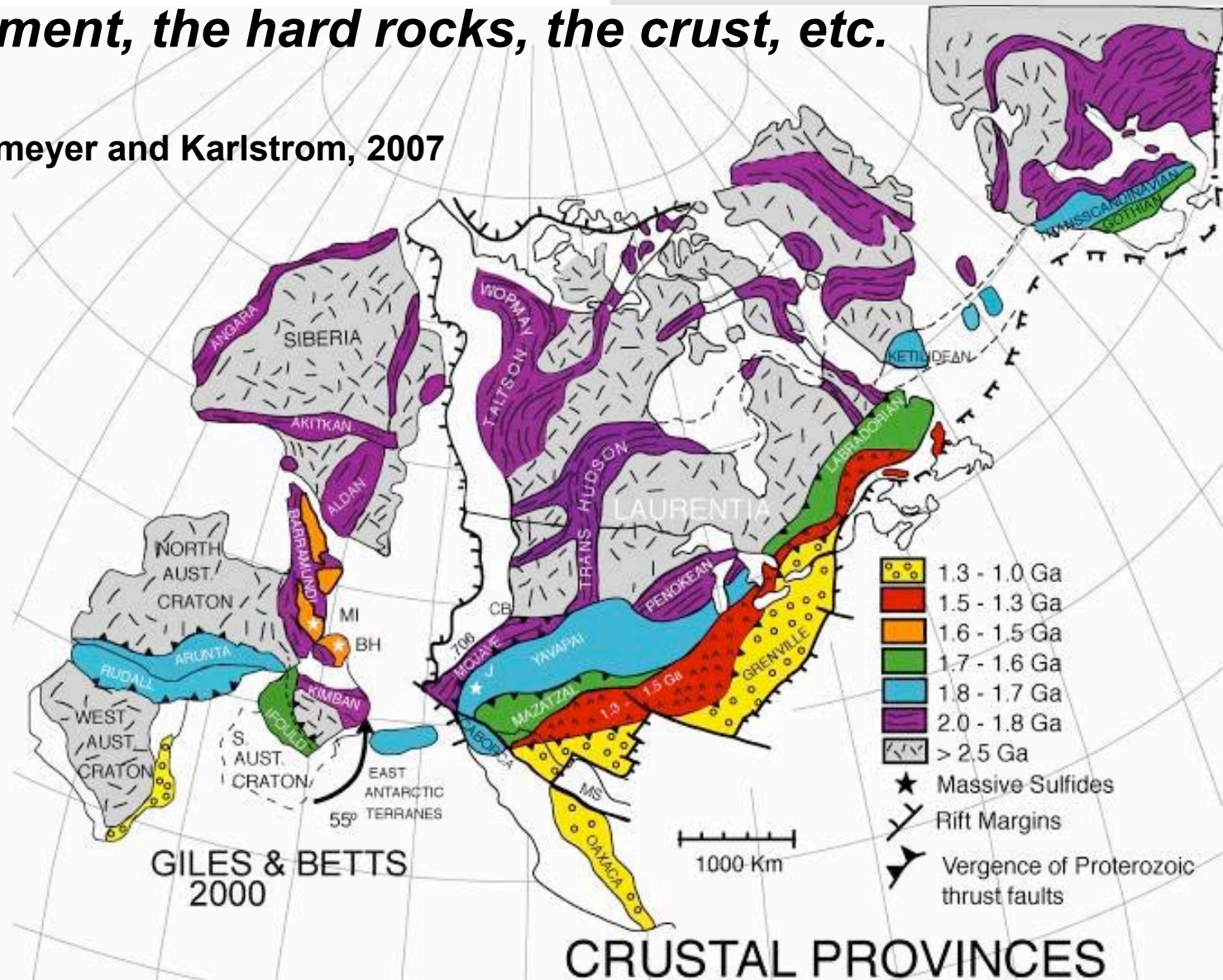


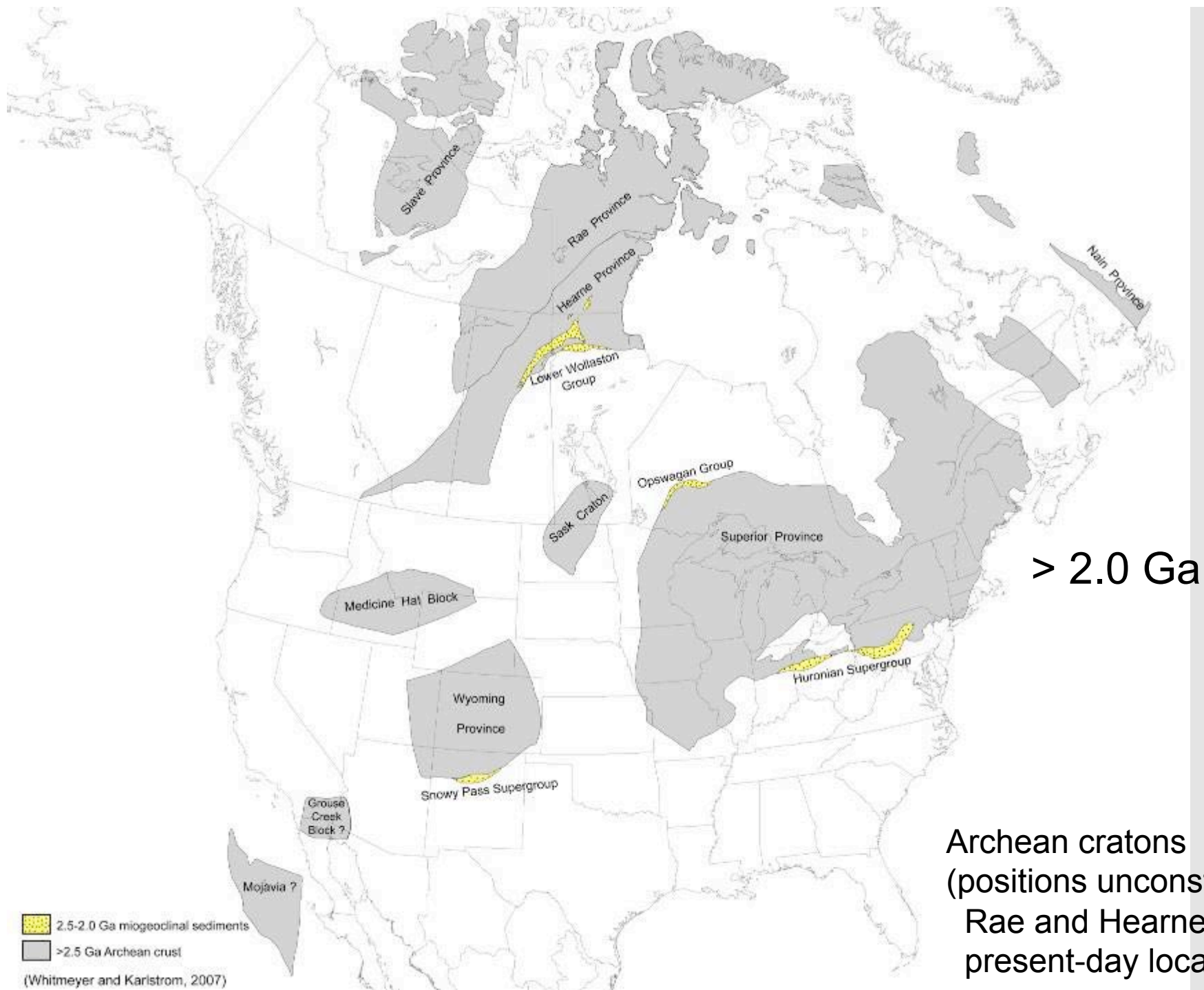
**Basement Rocks-  
evidence of flow!**



# Chapter 1- Formation of the Continent– aka *the basement, the hard rocks, the crust, etc.*

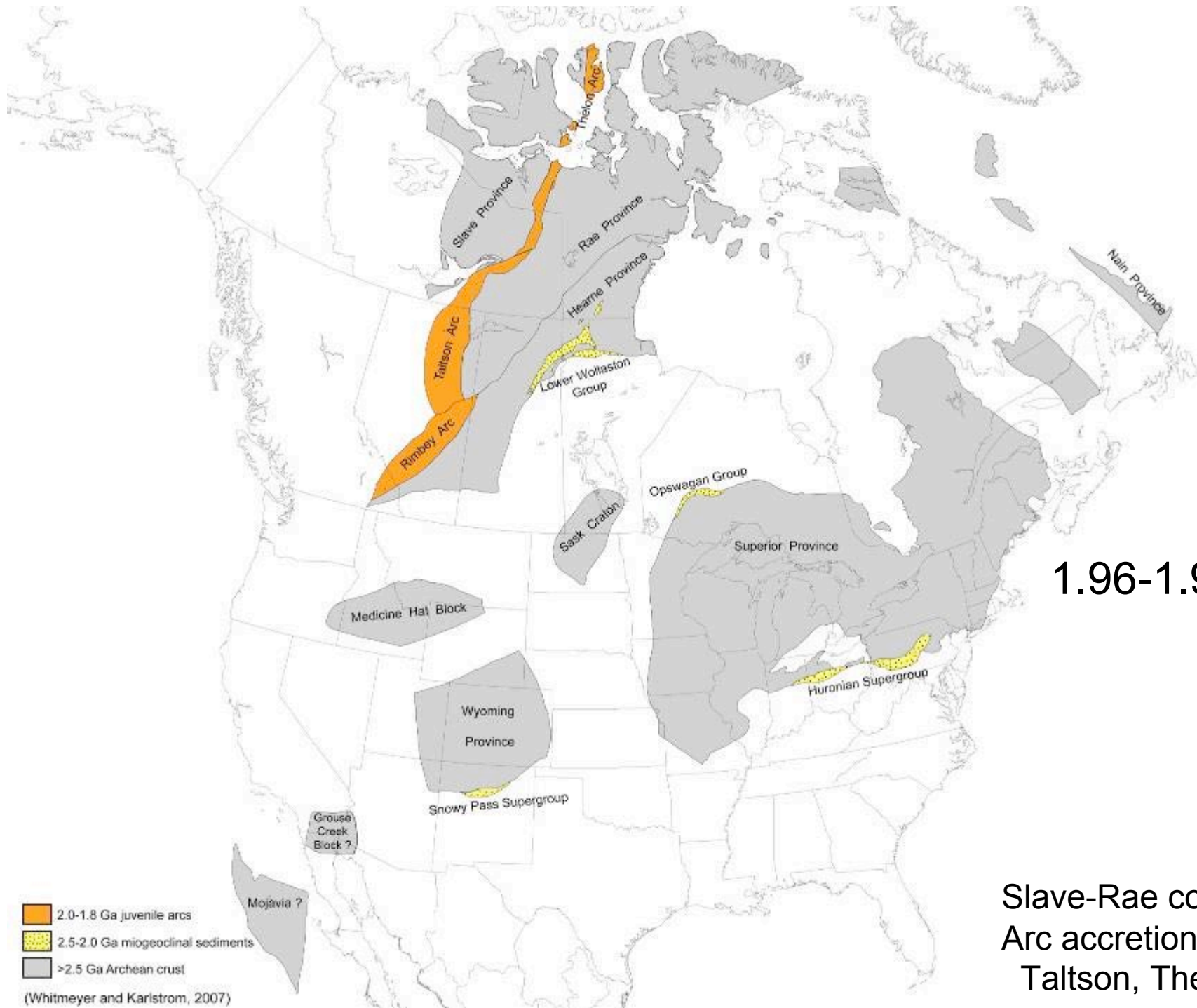
From Whitmeyer and Karlstrom, 2007





> 2.0 Ga

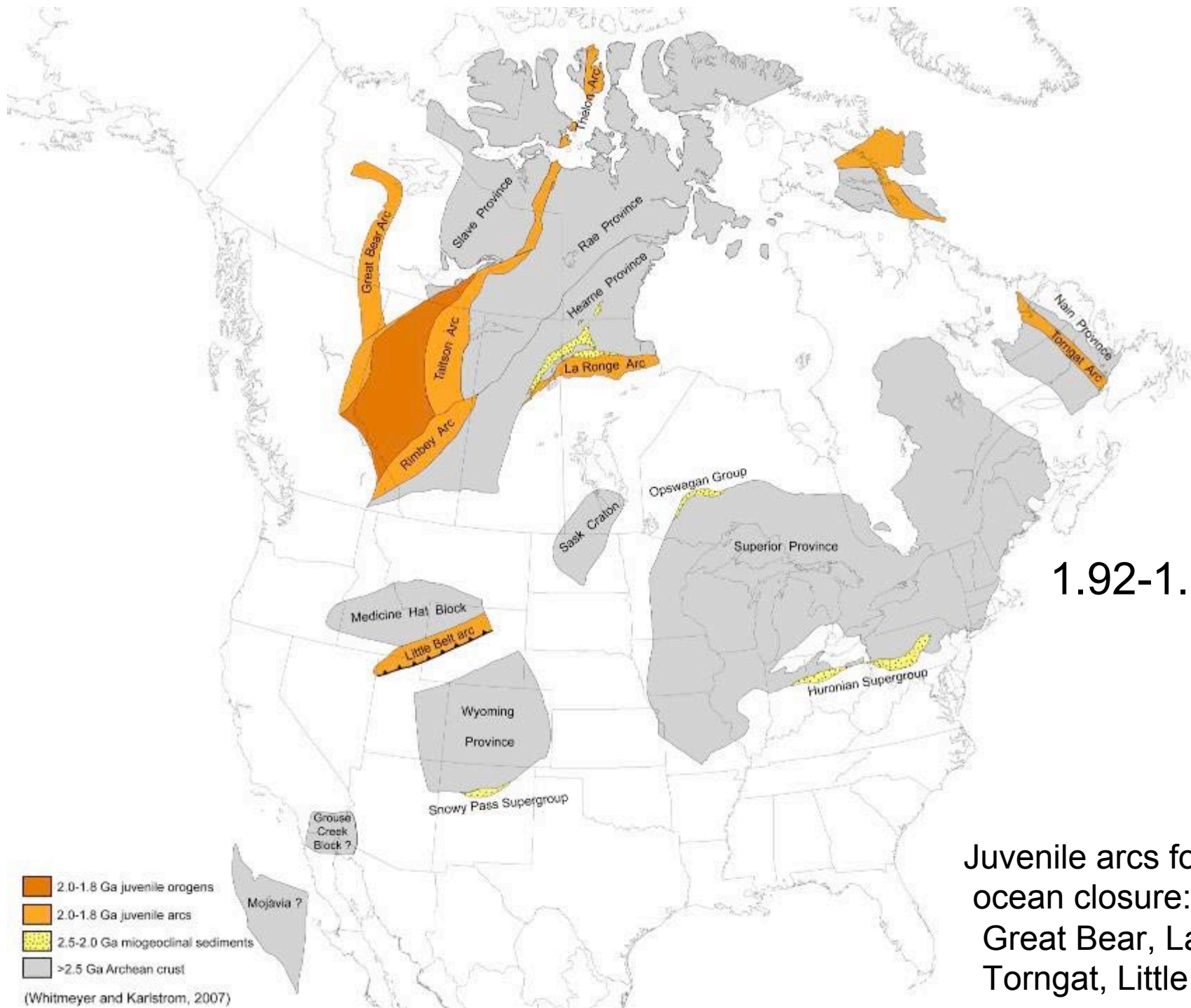
Archean cratons  
(positions unconstrained;  
Rae and Hearne in  
present-day locations)



1.96-1.92 Ga

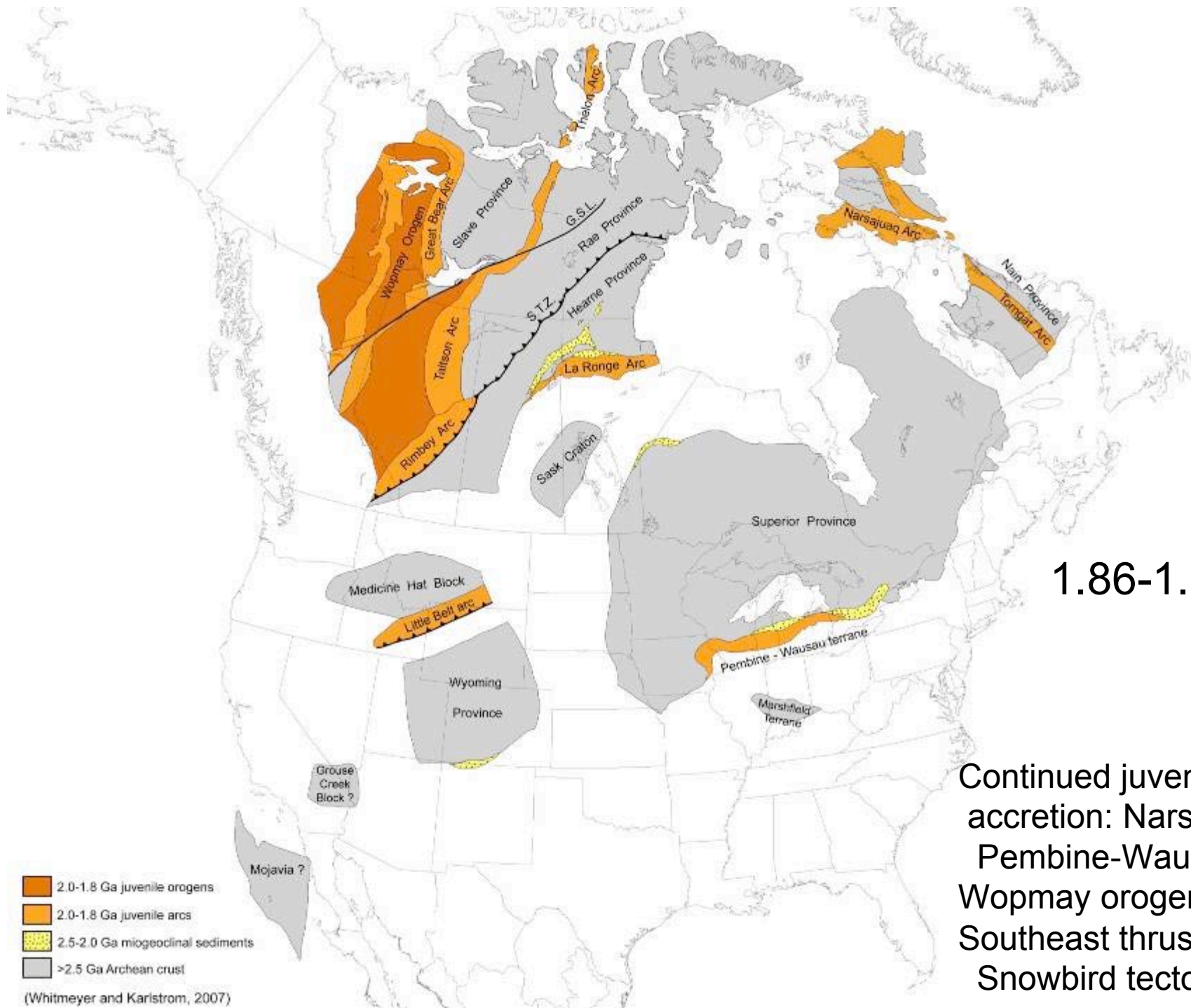
Slave-Rae collision,  
Arc accretion: Rimbey,  
Taltson, Thelon arcs





1.92-1.86 Ga

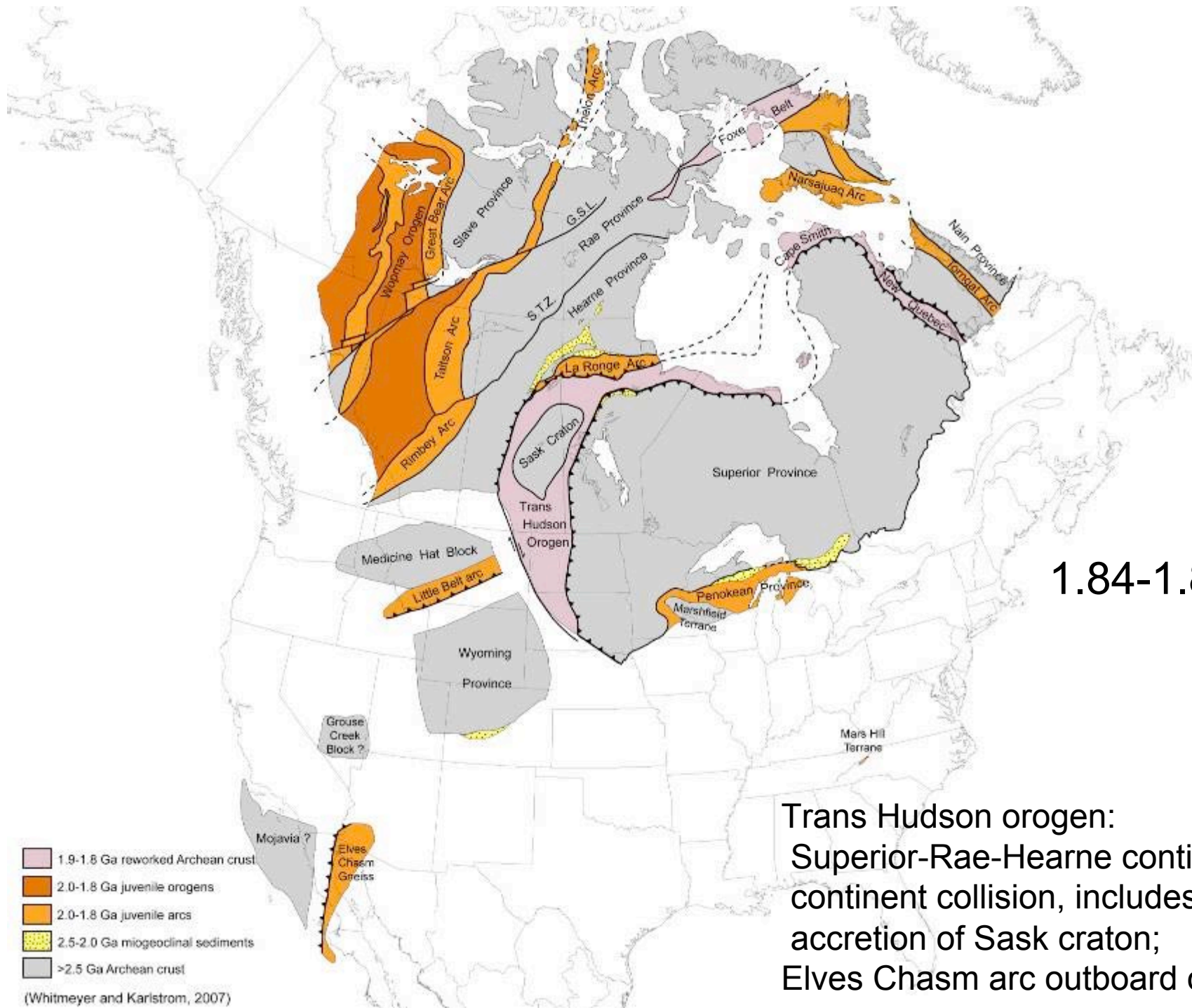
Juvenile arcs form during ocean closure:  
Great Bear, La Ronge, Torngat, Little Belt arcs



1.86-1.84 Ga

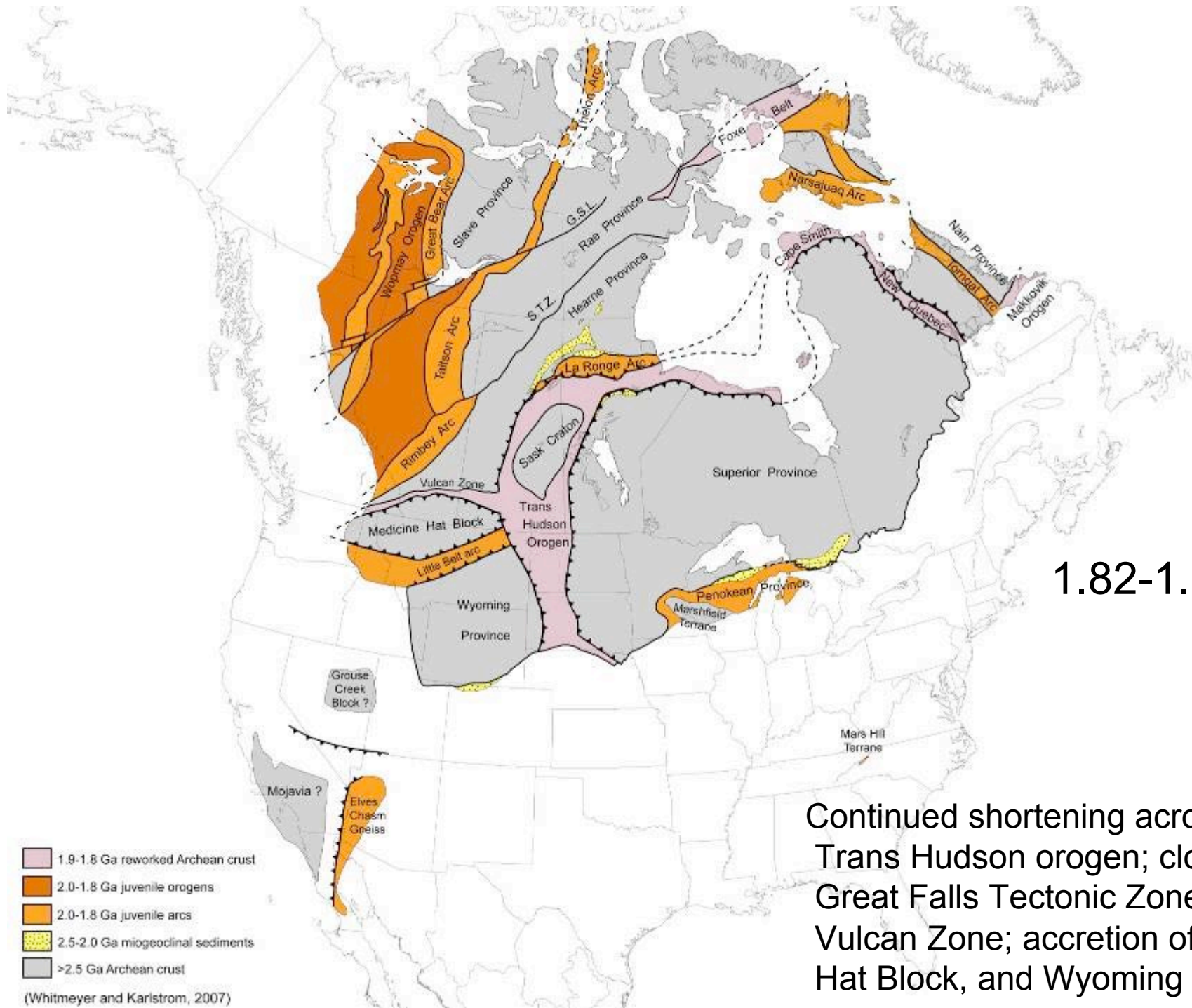
Continued juvenile arc accretion: Narsajuaq, Pembine-Wausau; Wopmay orogen; Southeast thrusting along Snowbird tectonic zone





1.84-1.82 Ga

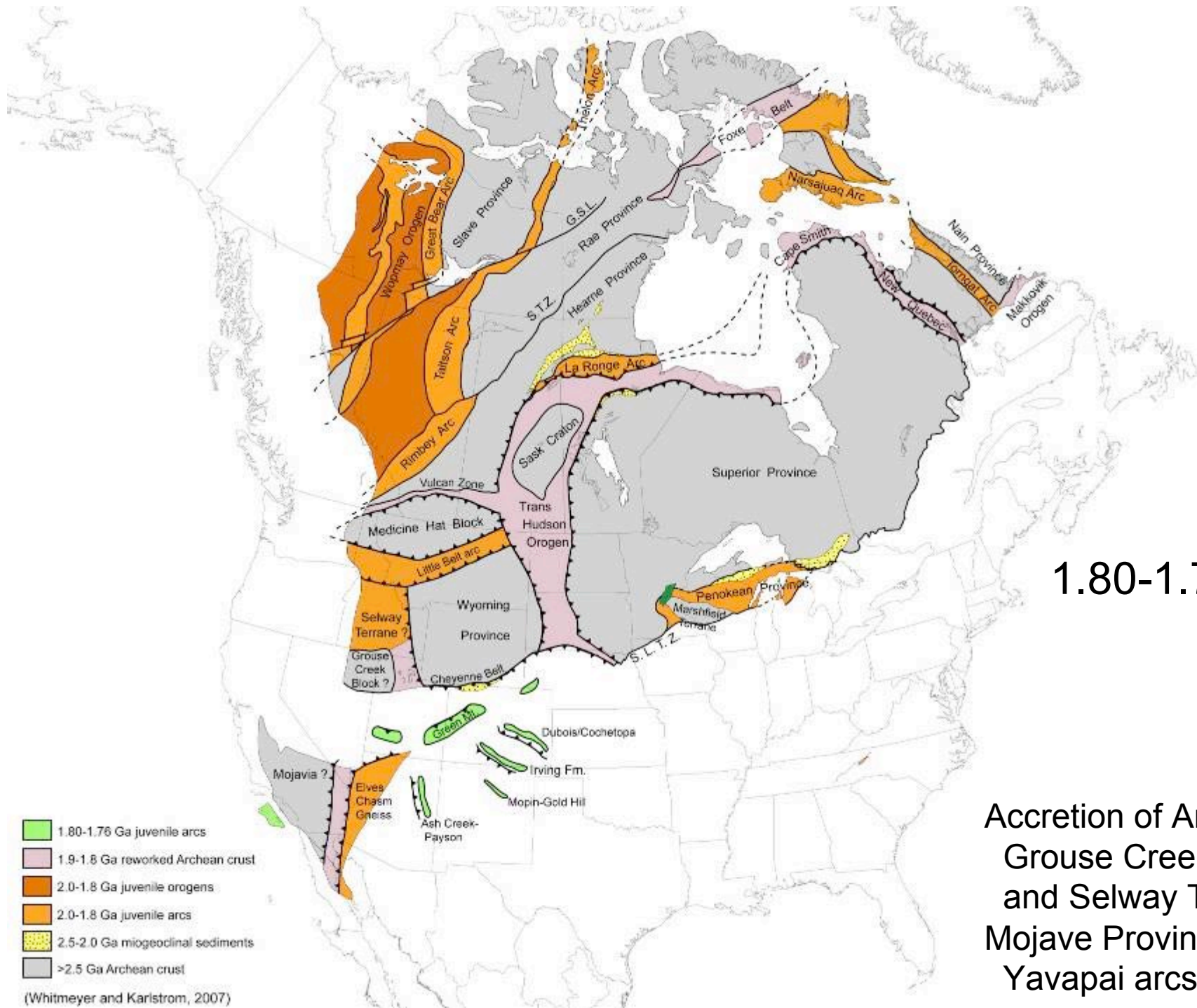
Trans Hudson orogen:  
Superior-Rae-Hearne continent-continent collision, includes accretion of Sask craton;  
Elves Chasm arc outboard of Mojavia



1.82-1.80 Ga

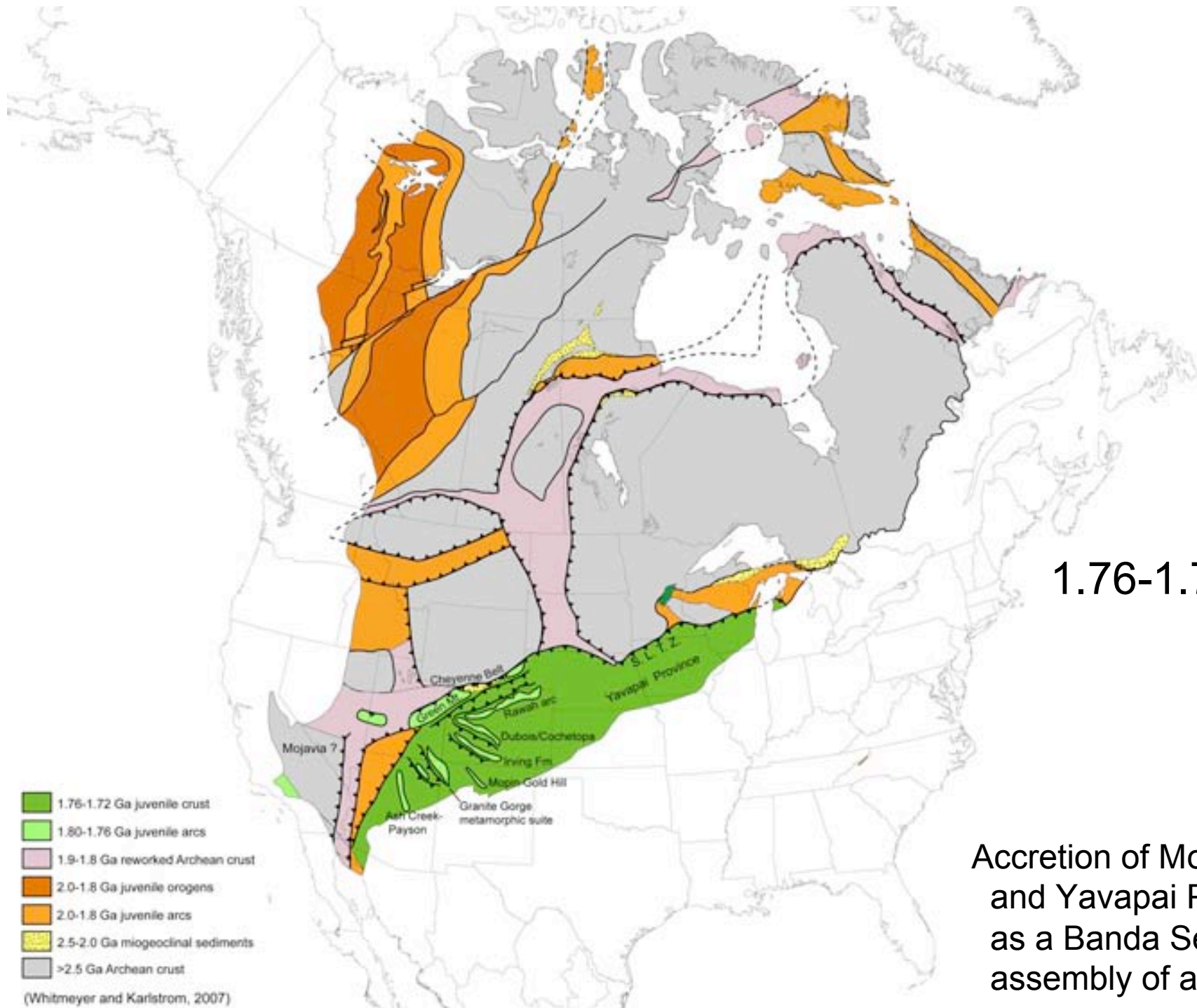
Continued shortening across Trans Hudson orogen; closure of Great Falls Tectonic Zone and Vulcan Zone; accretion of Medicine Hat Block, and Wyoming Province





1.80-1.76 Ga

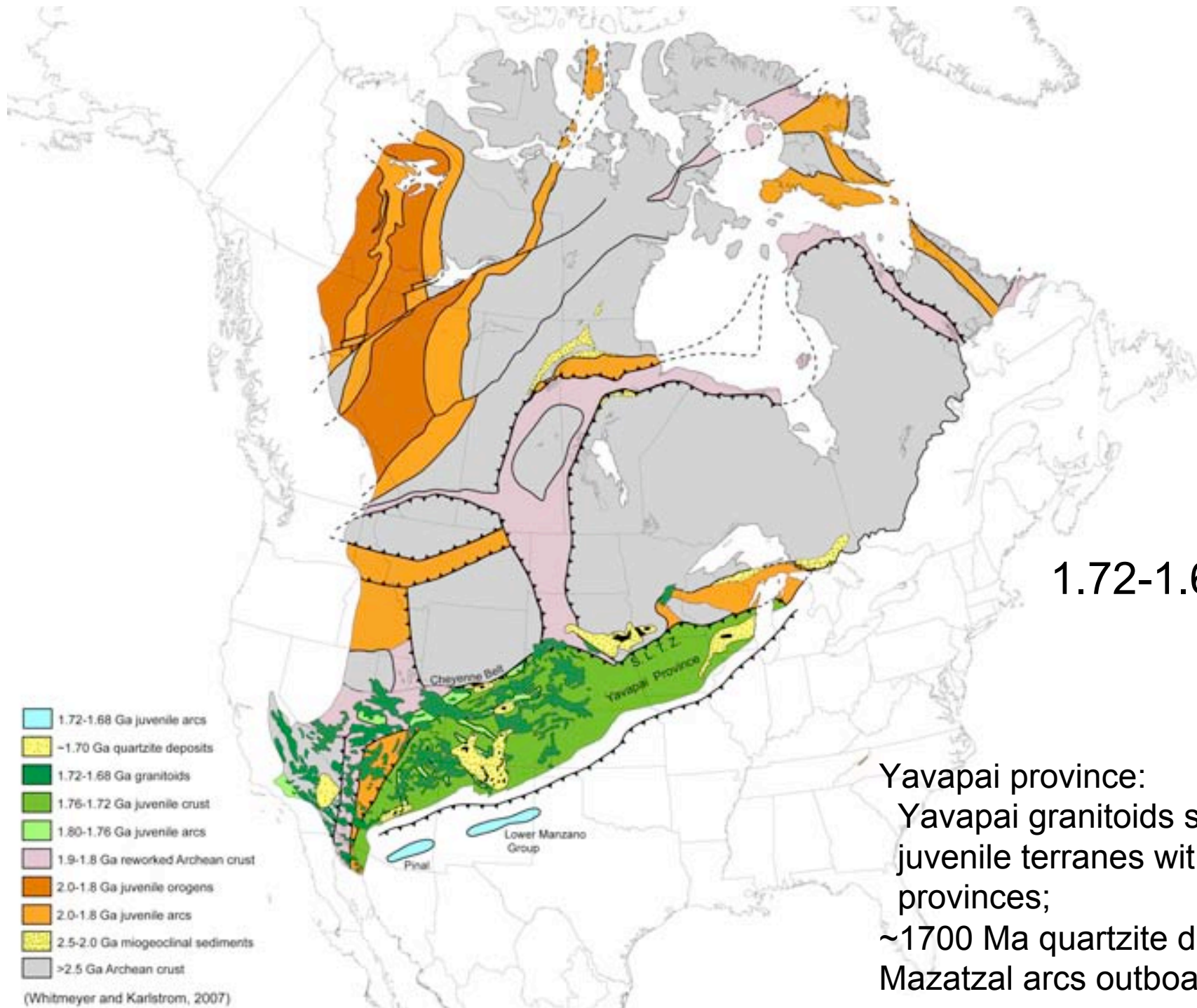
Accretion of Archean(?)  
Grouse Creek Block  
and Selway Terrane;  
Mojave Province and  
Yavapai arcs outboard

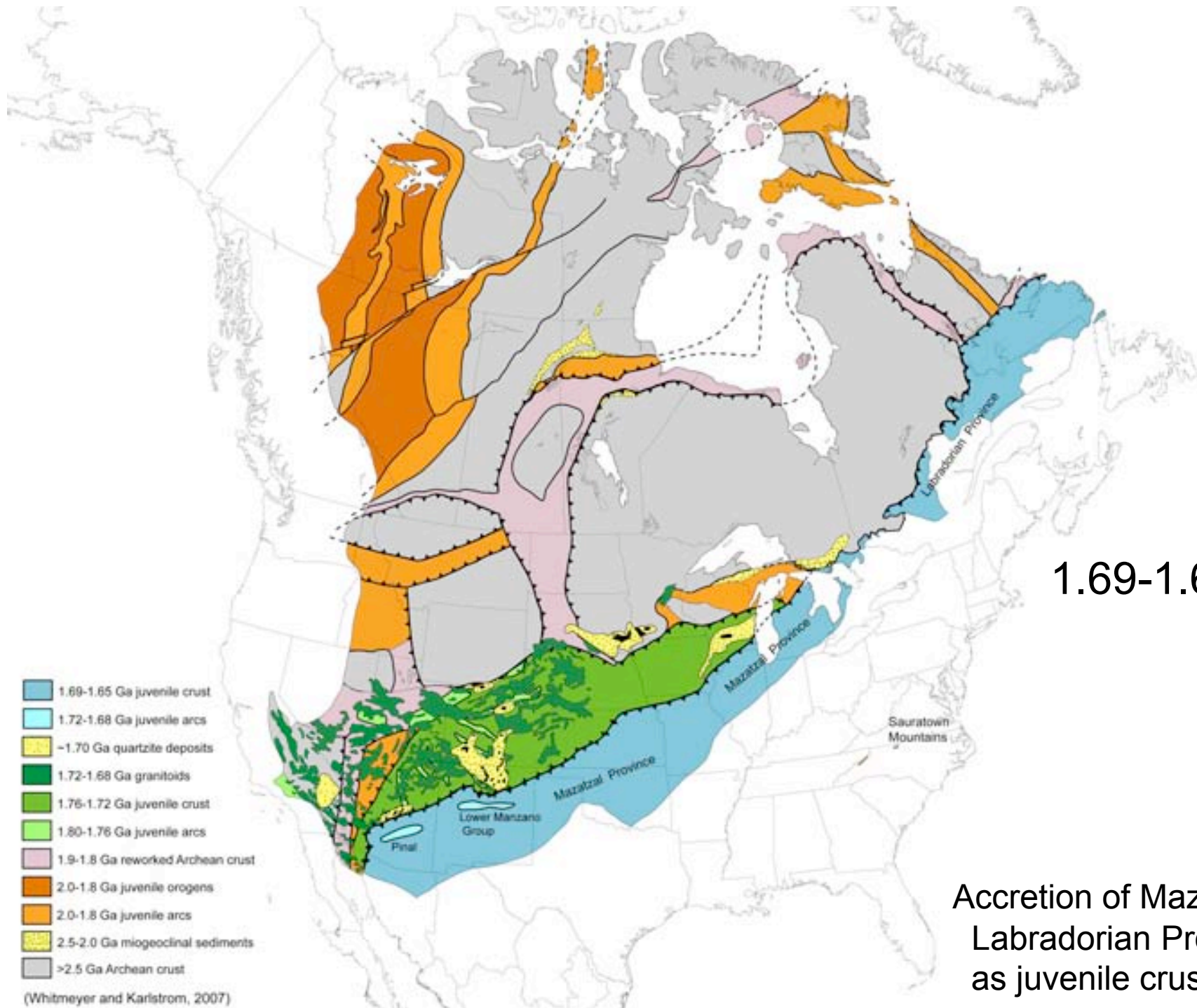


1.76-1.72 Ga

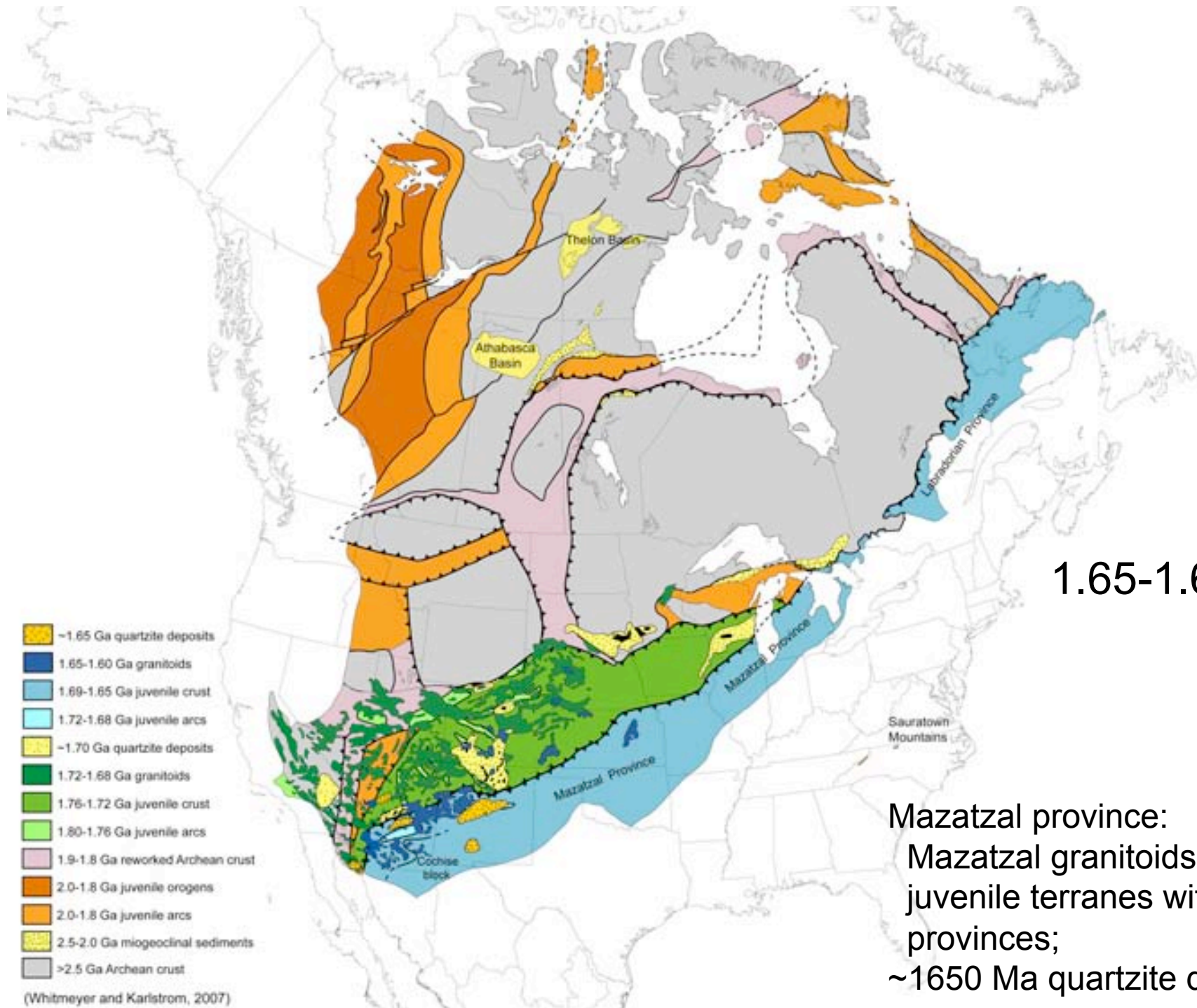
Accretion of Mojavia(?)  
and Yavapai Province,  
as a Banda Sea style  
assembly of arcs





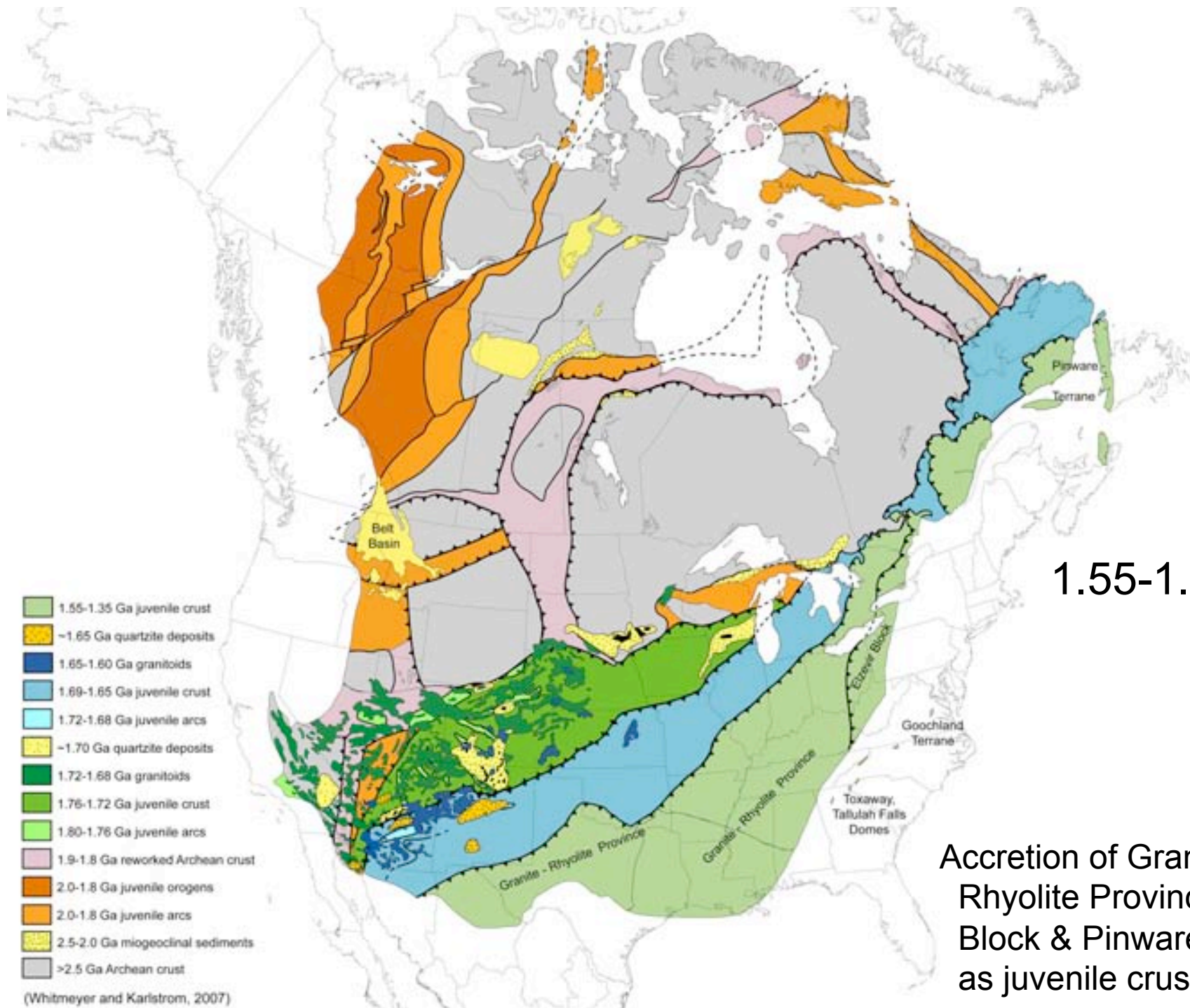






1.65-1.60 Ga

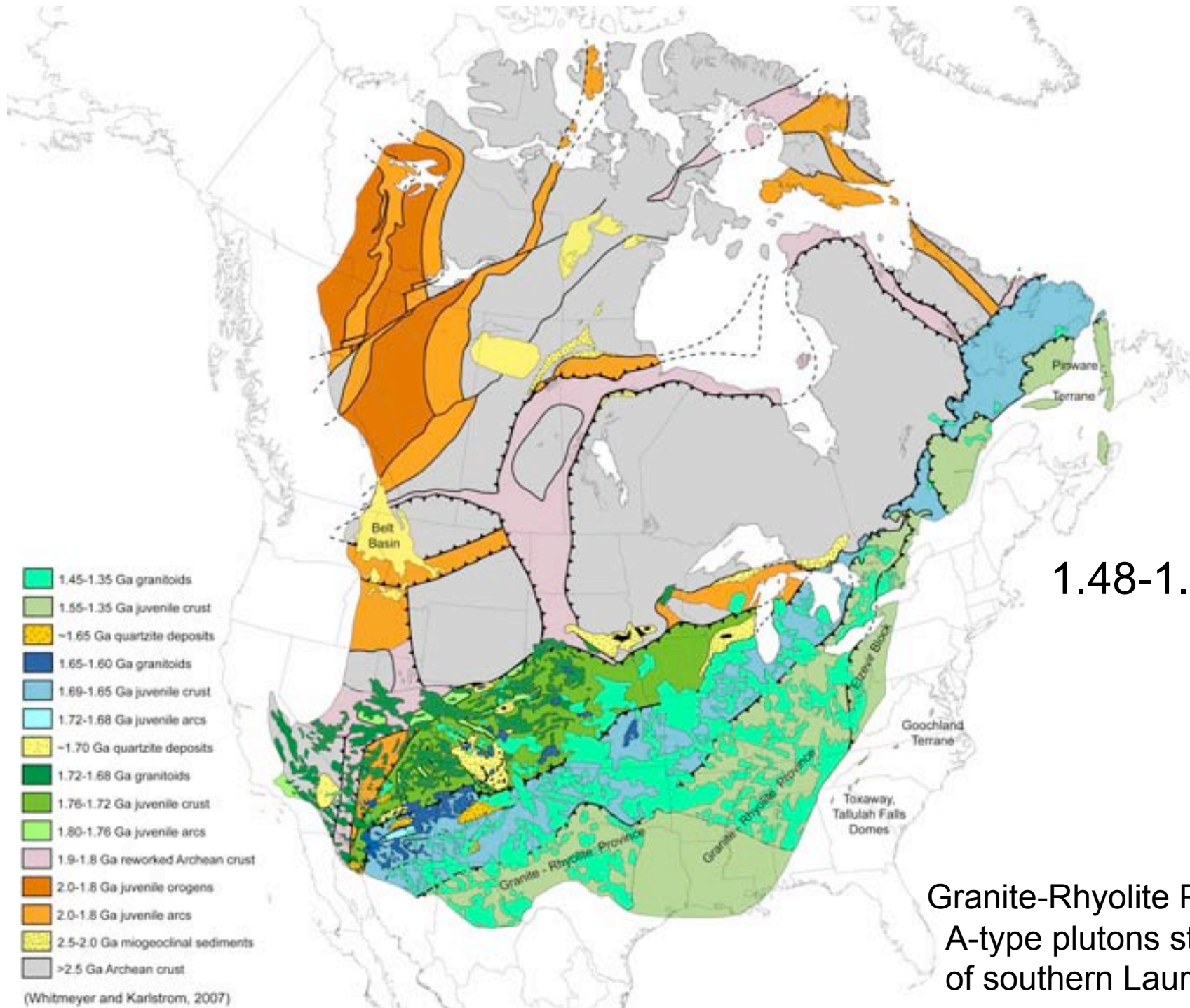
Mazatzal province:  
Mazatzal granitoids stitch  
juvenile terranes with older  
provinces;  
~1650 Ma quartzite deposition



1.55-1.35 Ga

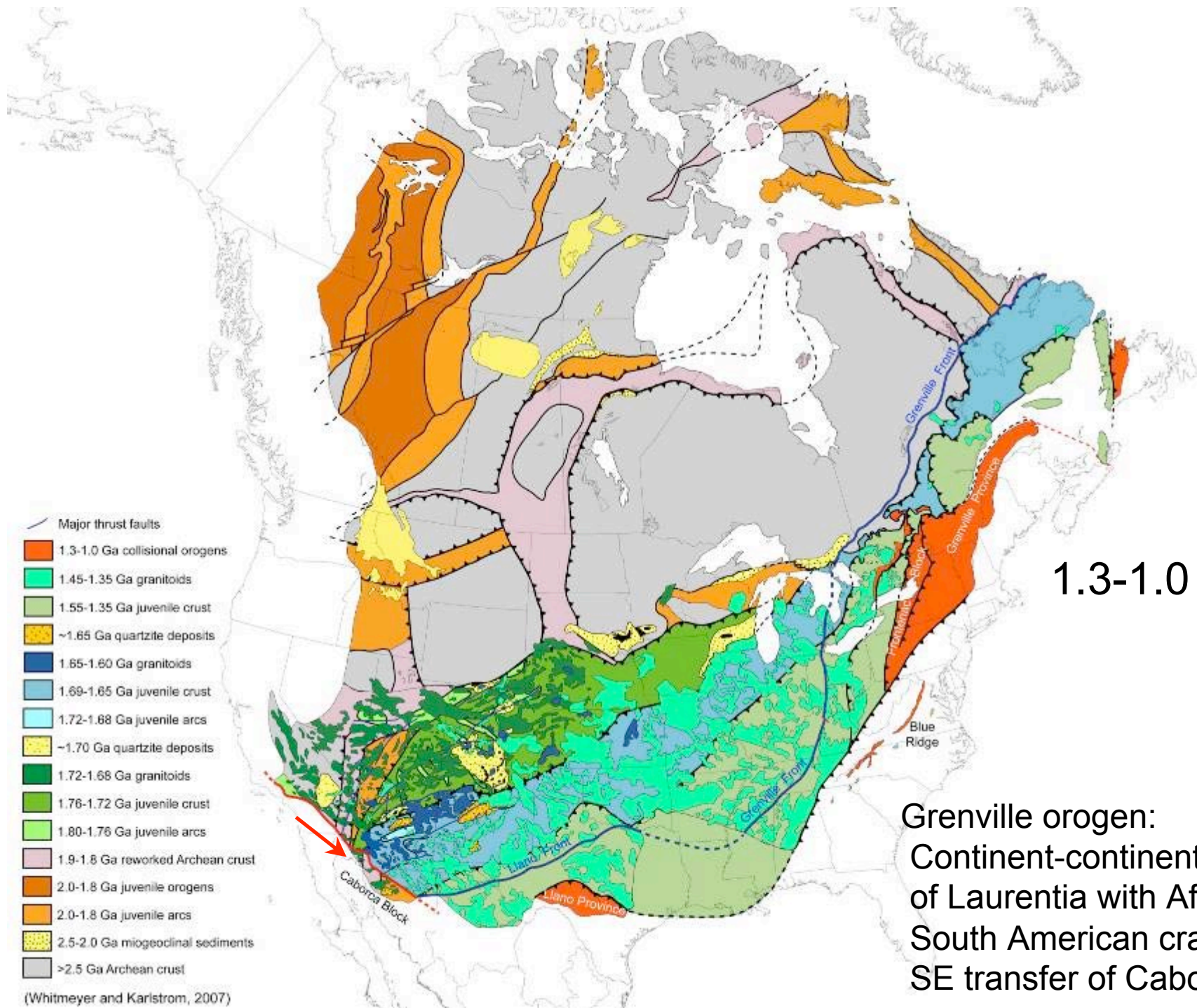
Accretion of Granite-Rhyolite Province, Elzevir Block & Pinware terrane, as juvenile crust





1.48-1.35 Ga

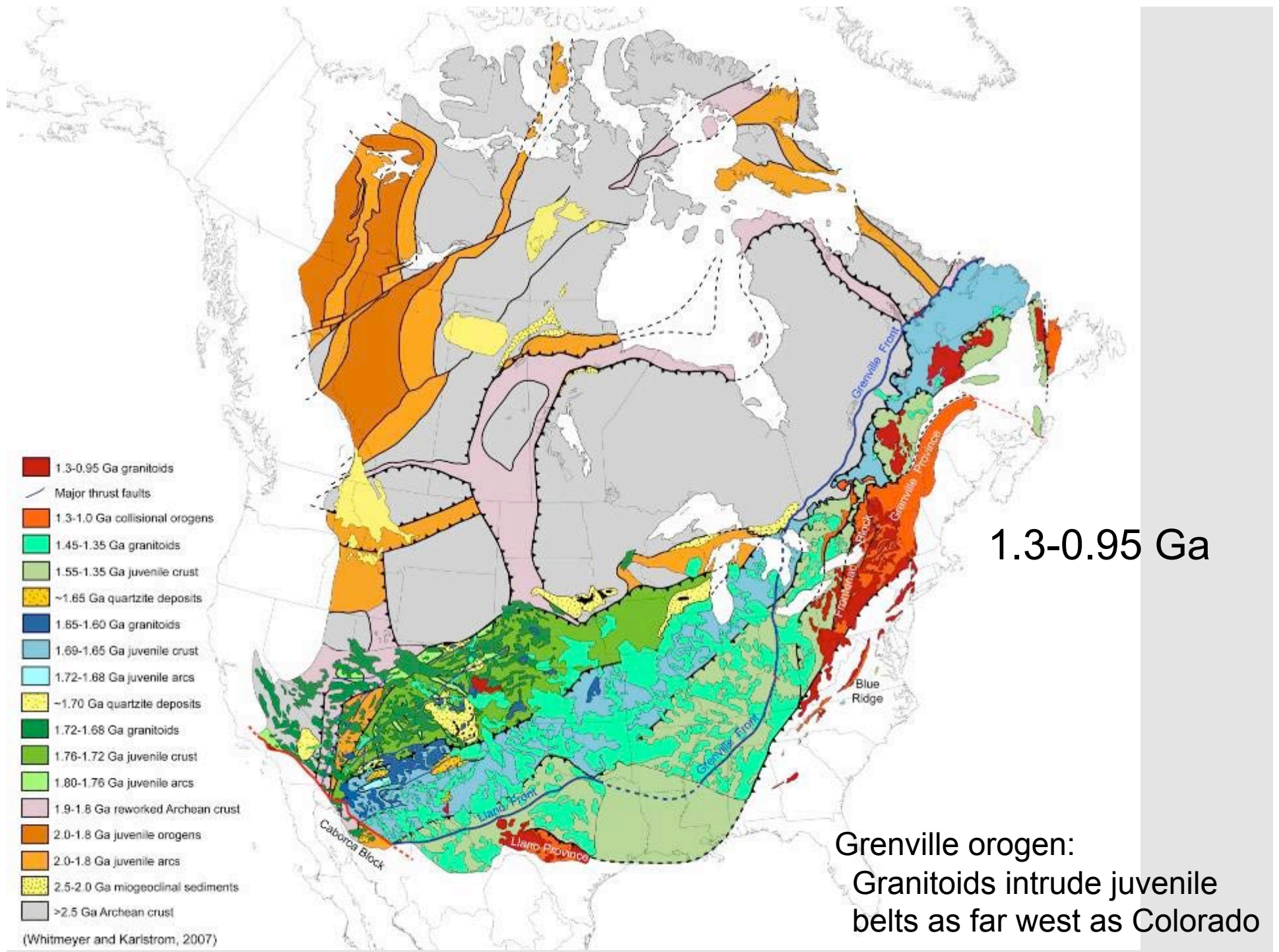
Granite-Rhyolite Province:  
A-type plutons stitch much  
of southern Laurentia



1.3-1.0 Ga

Grenville orogen:  
Continent-continent collision  
of Laurentia with African and  
South American cratons;  
SE transfer of Caborca block







Chapter 2– the sedimentary layer cake:  
the seas came in and the seas went out  
and life evolved into amazing life forms



THE TOP OF TIME  
10  
MILLION  
YEARS AGO  
A GEOLITHIC PERIOD

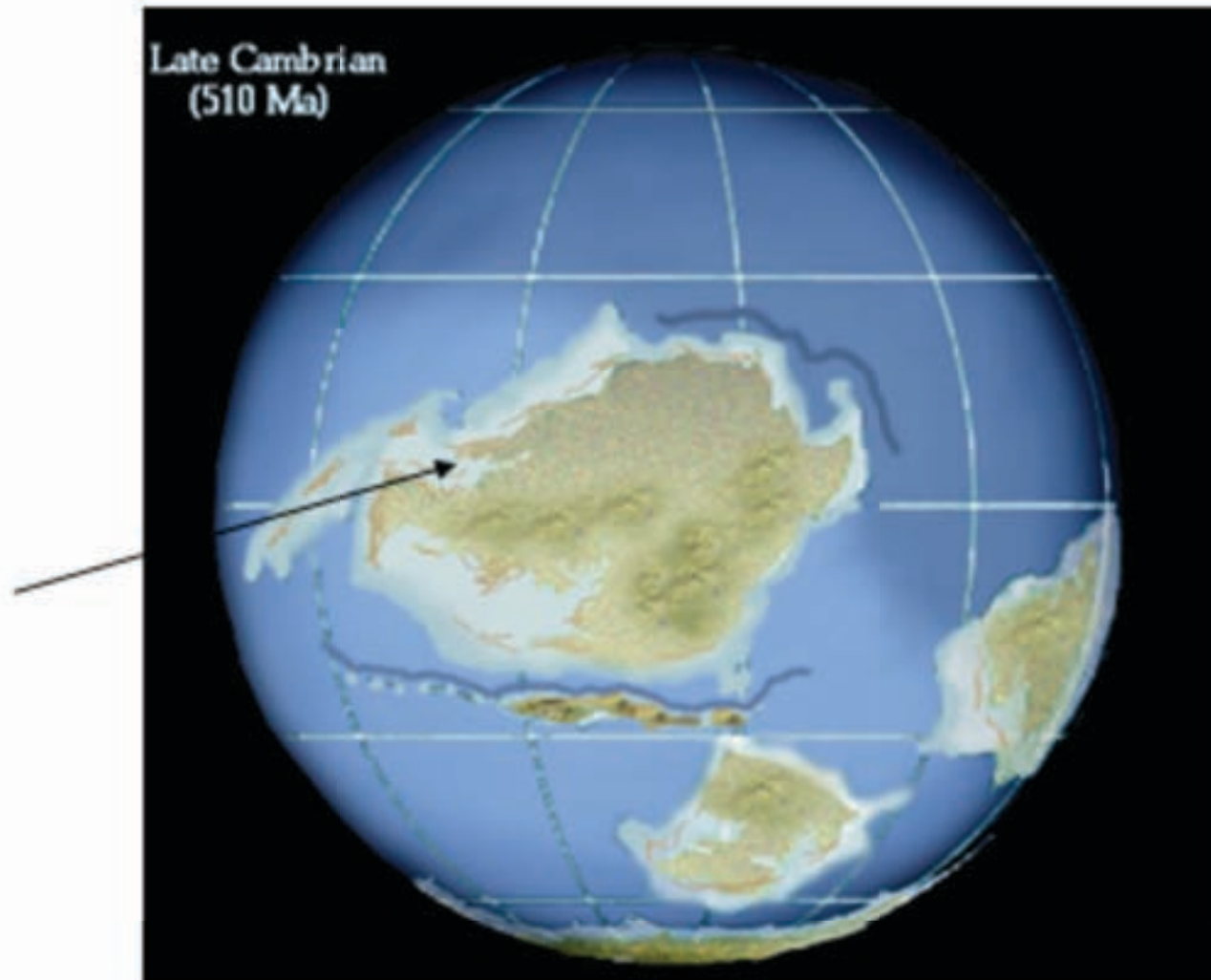
THE TOP OF TIME  
20  
MILLION  
YEARS AGO  
A GEOLITHIC PERIOD





**Basement below, the layer cake above**

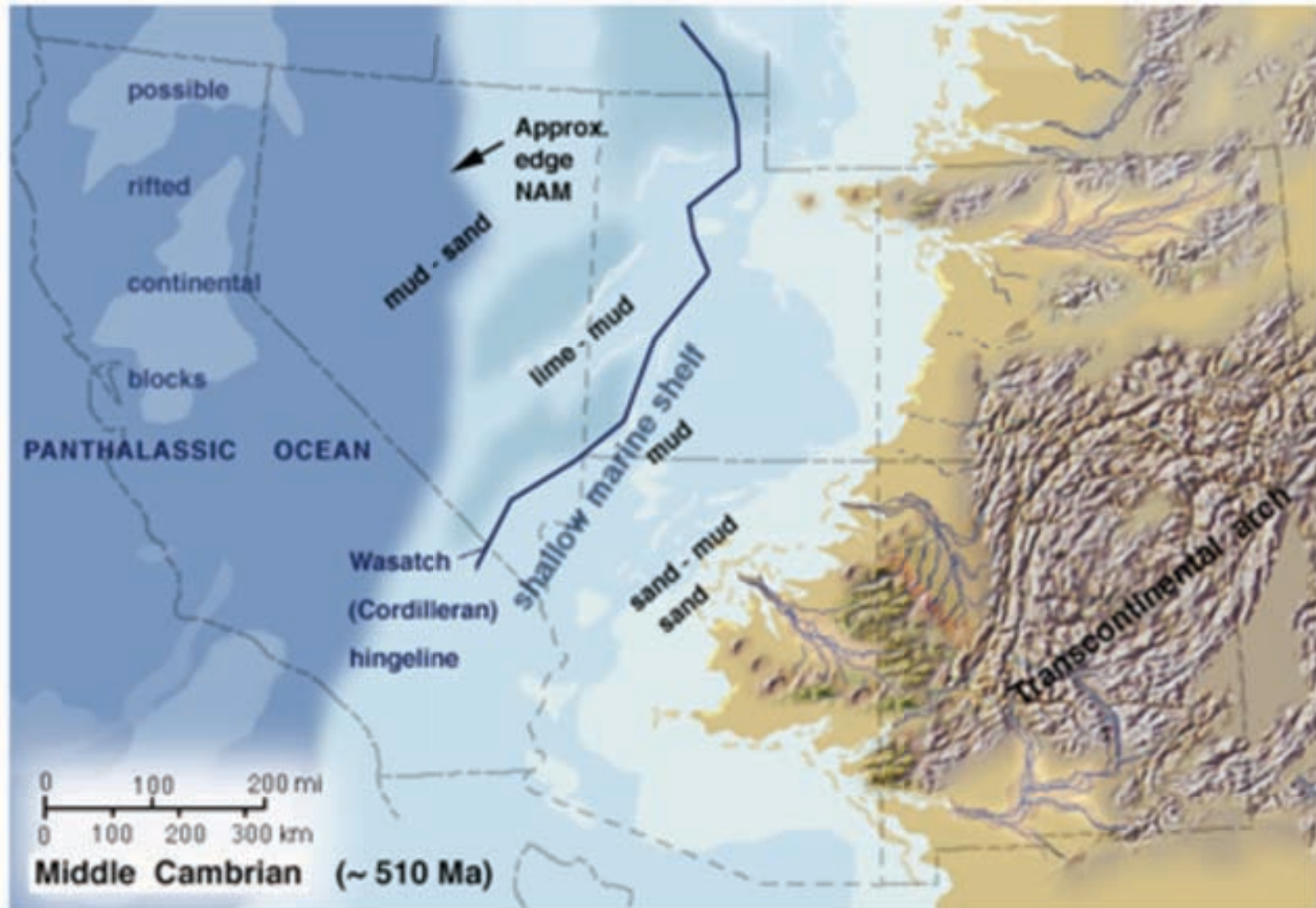
# *Cambrian Time*



**Each of the sedimentary layers tells a story of different Periods and environments**

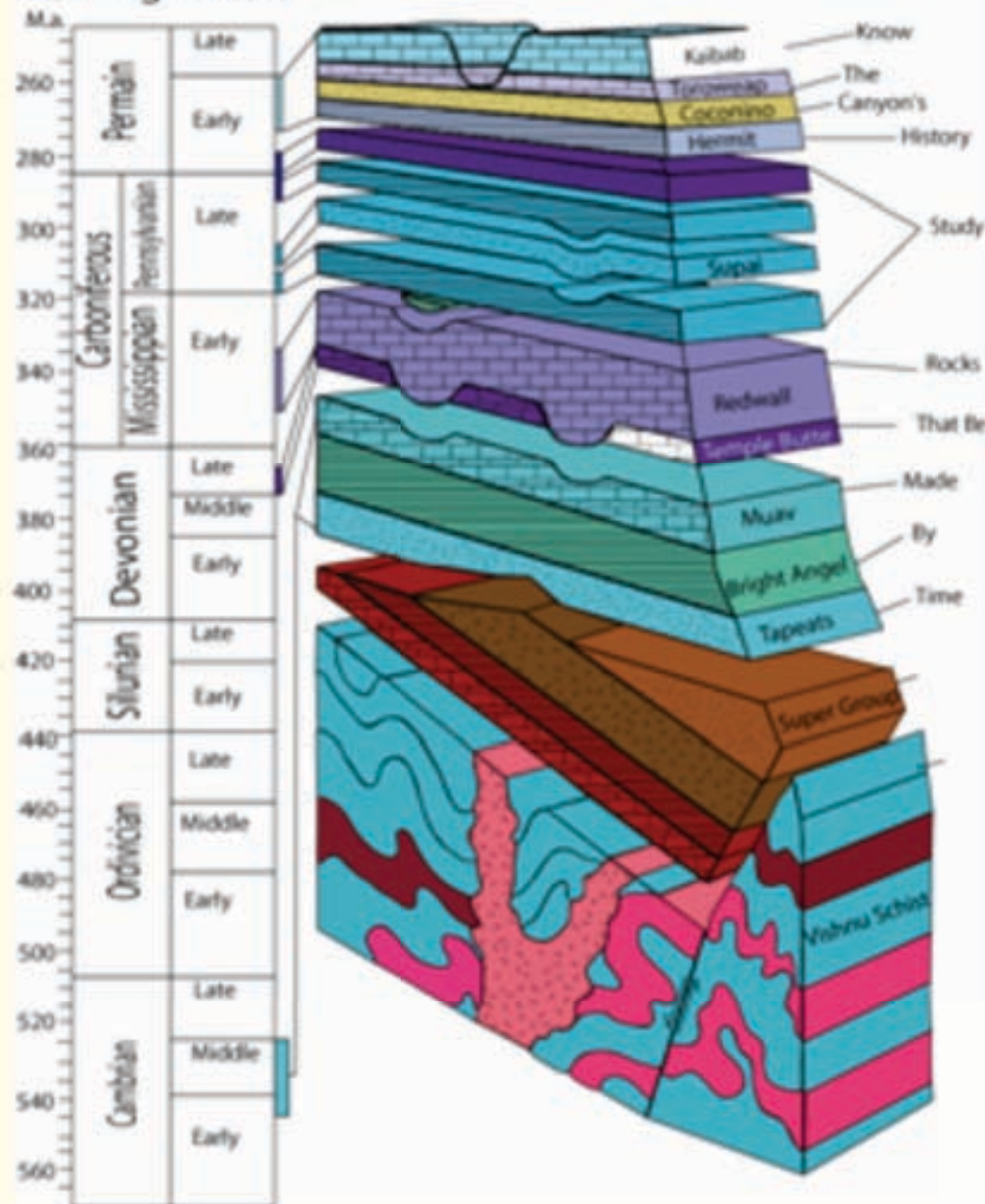


# *Cambrian Time*



The sea transgresses over cratonic North America, depositing sediments

## Geologic Time



Can you spot:

The disconformities?

The angular unconformities?

The nonconformity?



Image from David Simpson

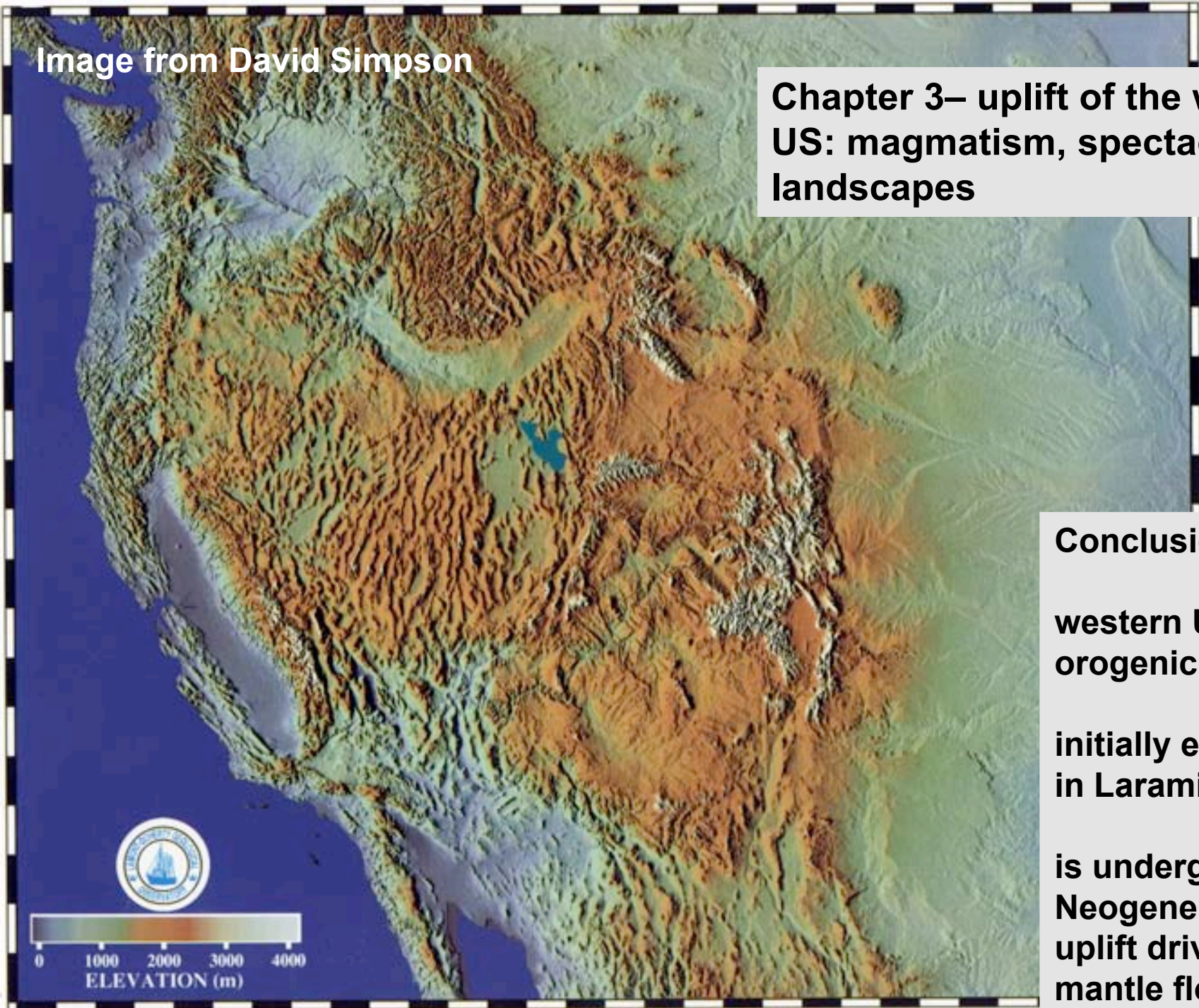
## Chapter 3– uplift of the western US: magmatism, spectacular landscapes

**Conclusion-**

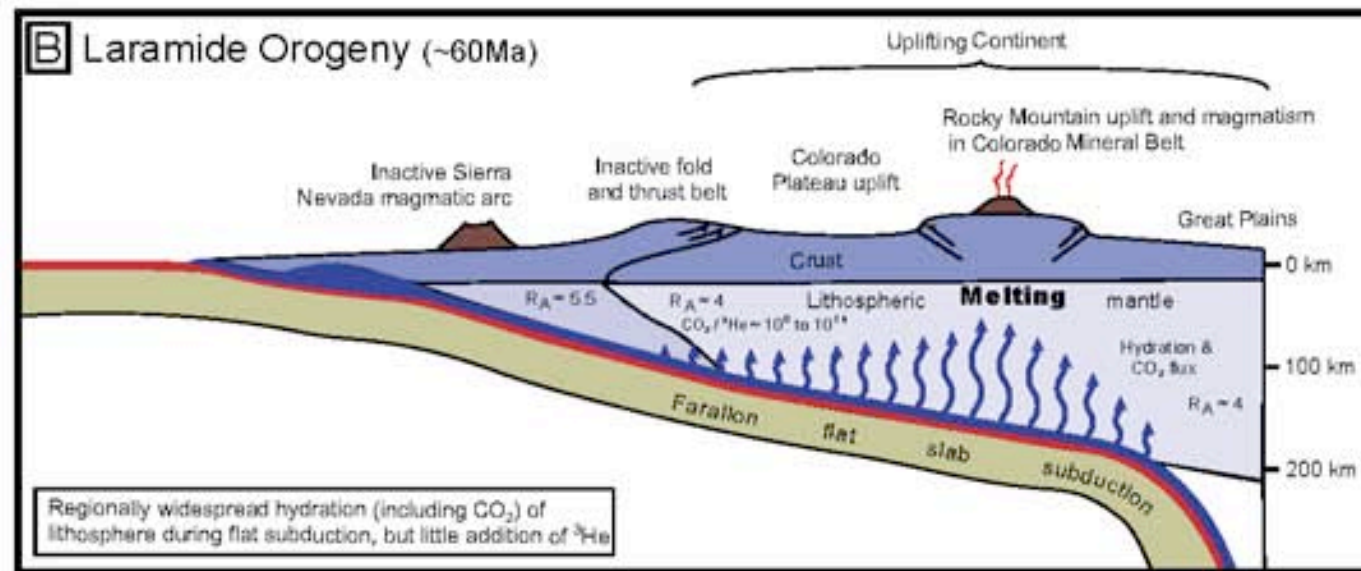
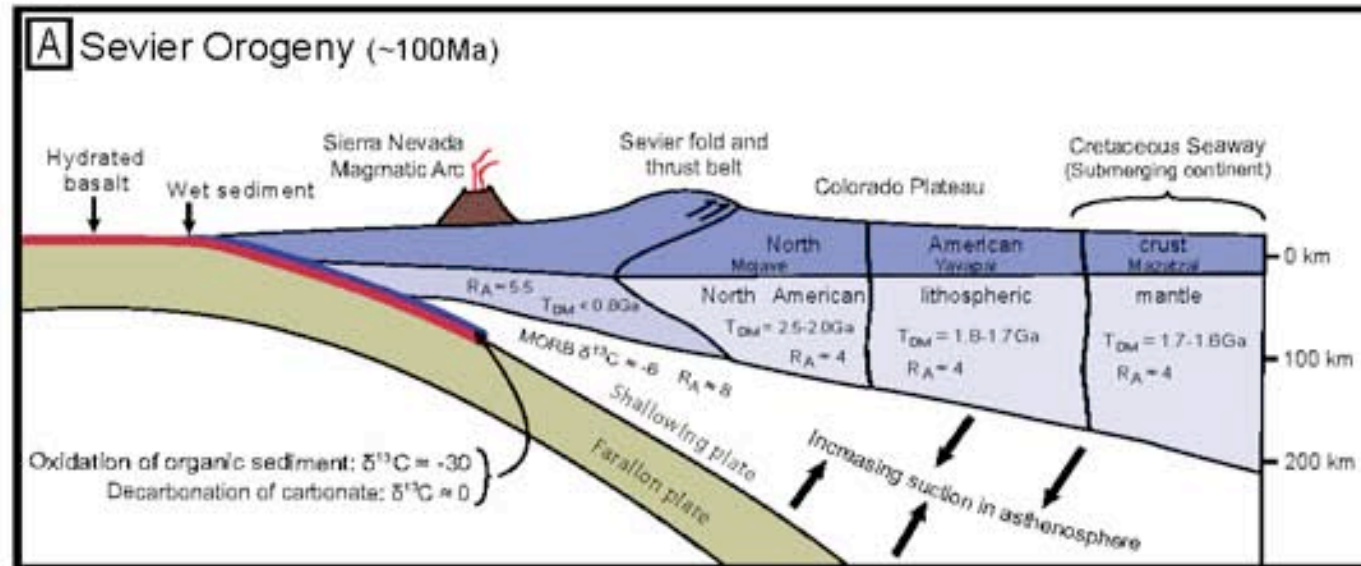
**western US  
orogenic plateau**

**initially elevated  
in Laramide**

**is undergoing  
Neogene surface  
uplift driven by  
mantle flow**

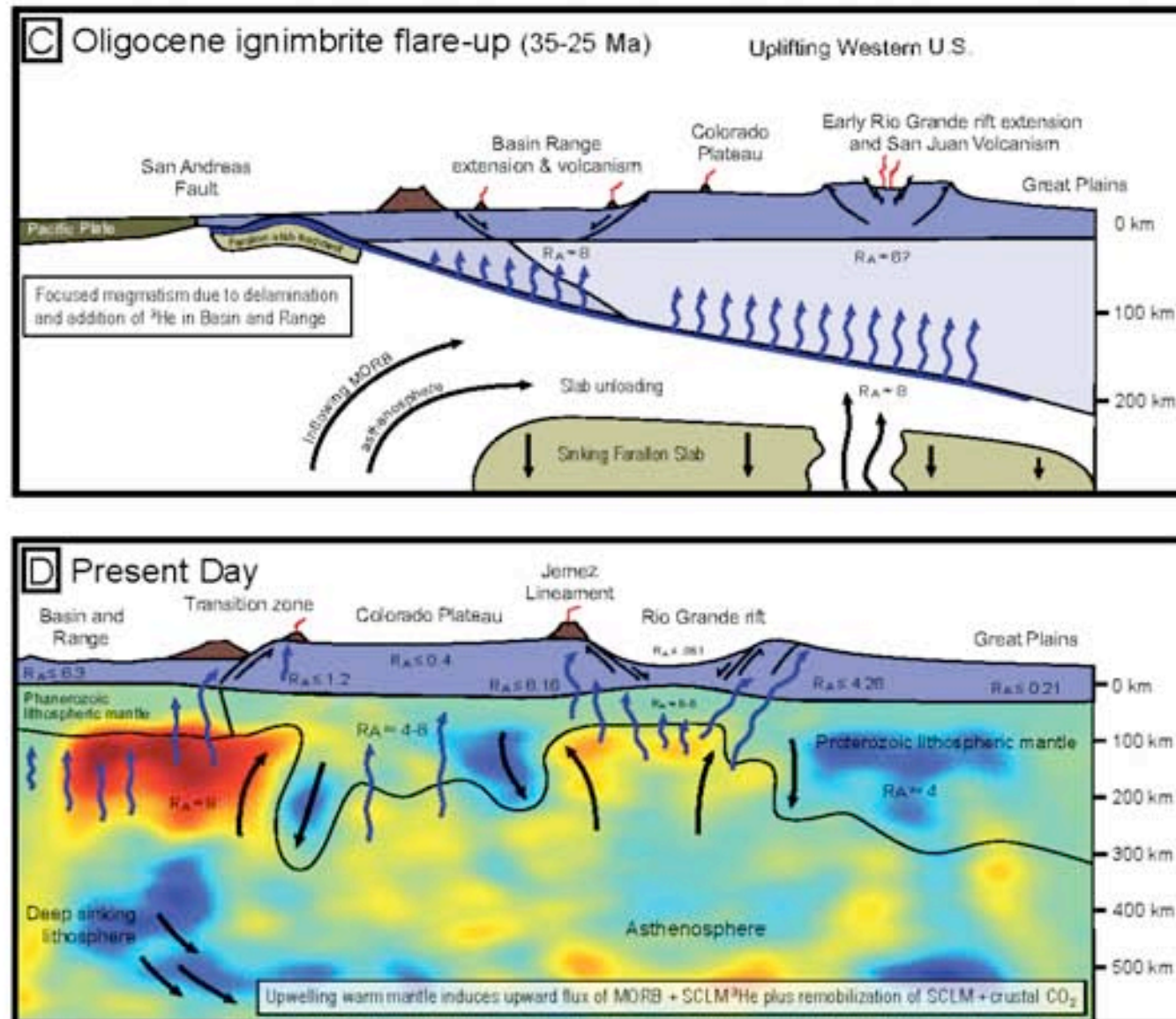


# Tectonic Devolatilization Model

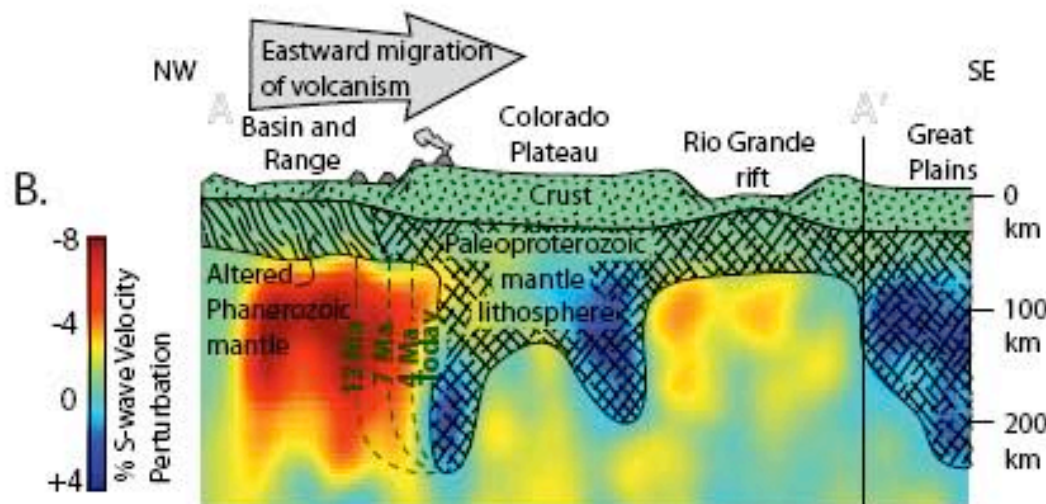
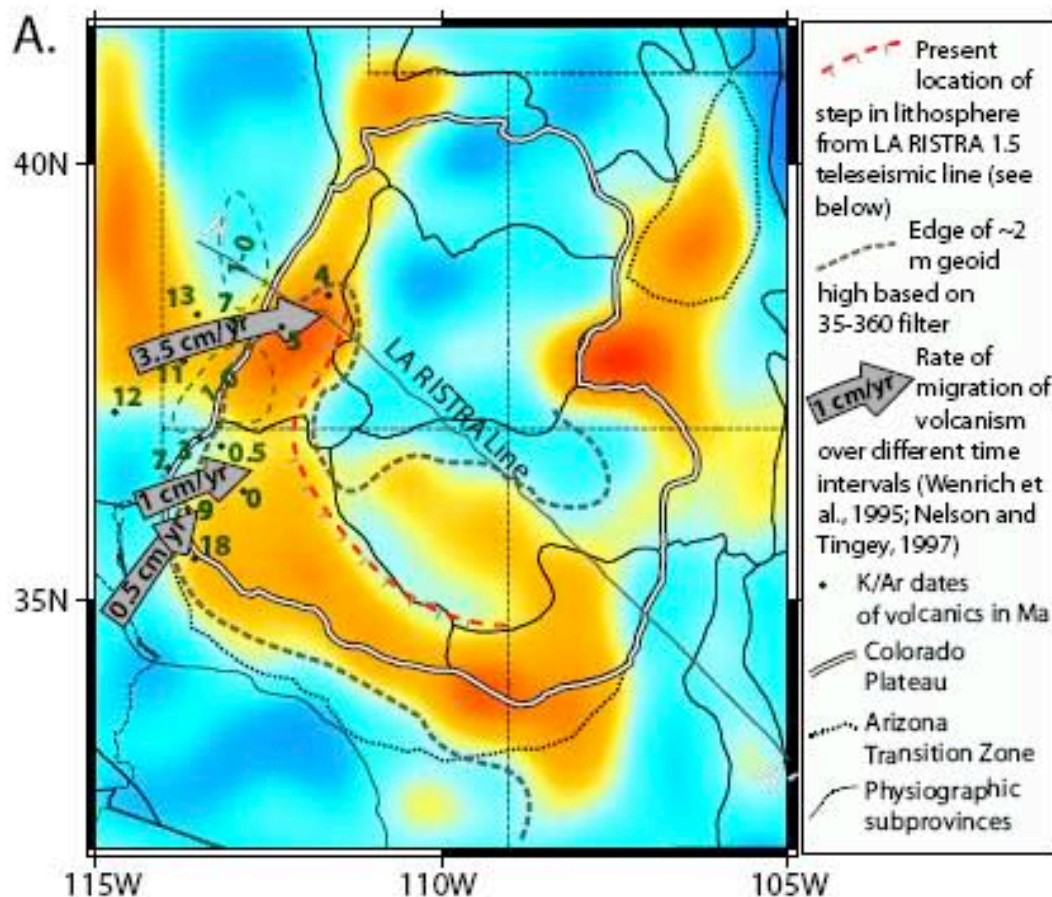




# Tectonic Devolatilization Model



Crossey et al., Fig 10



**Mantle to surface connections**

**Topographic rim of CP**

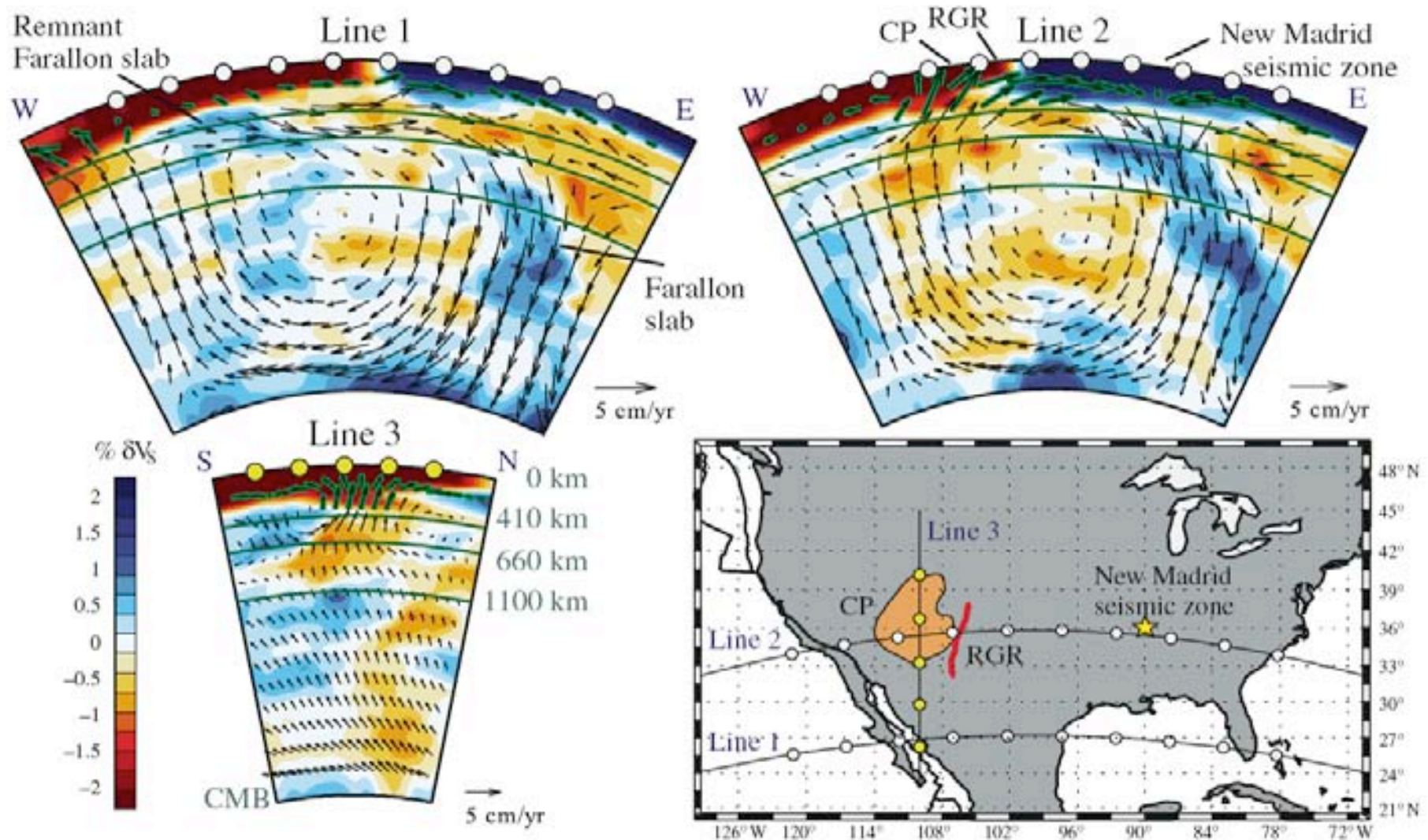
**~4 m geoid anomaly**

**Inboard sweep of magmatism**

**Sharp mantle velocity contrast under western Colorado Plateau**

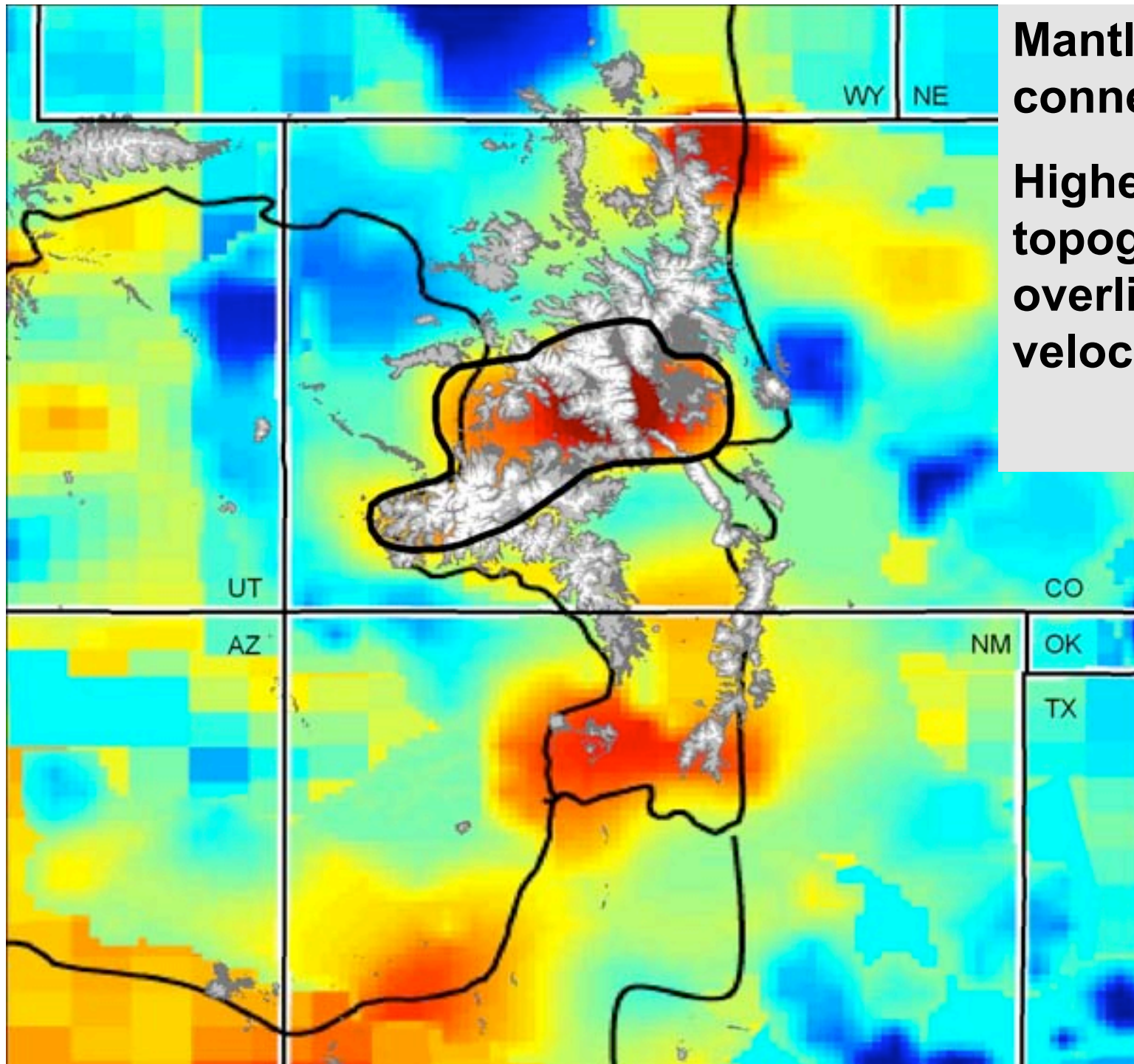
**Karlstrom et al., 2008**





**Mantle to surface connections- Deep mantle flow riving surface uplift (and tilting) of Colorado Plateau**

6. Moucha et. al, 2008, 2009

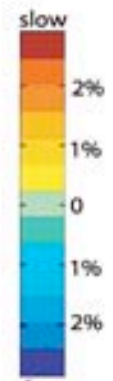


**Mantle to surface connections –**

**Highest topography overlies low velocity mantle**

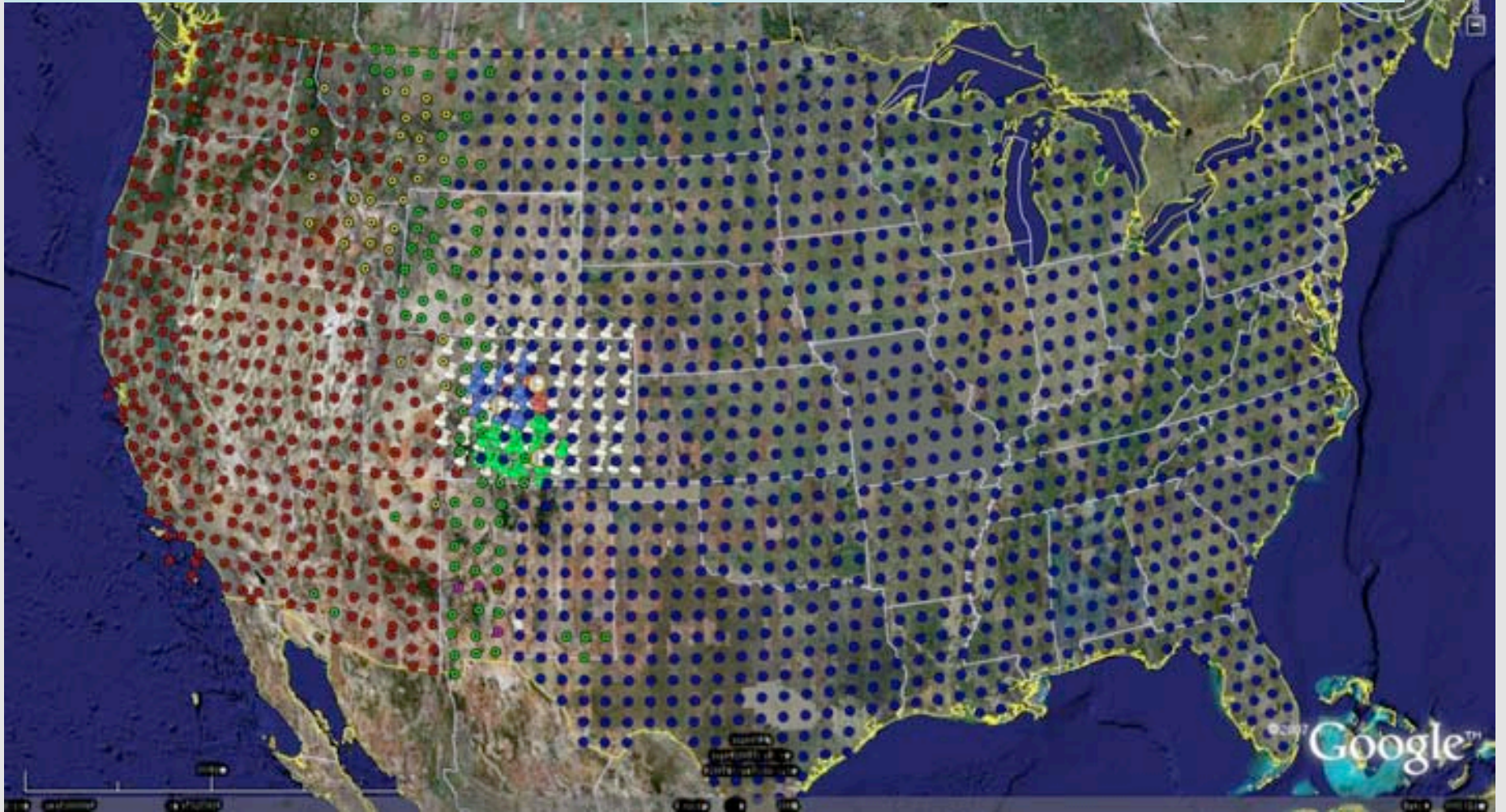
- 9,000-10,000 ft
- 10,000-11,500 ft
- > 11,500 ft

Relative P-wave velocity at 100 km



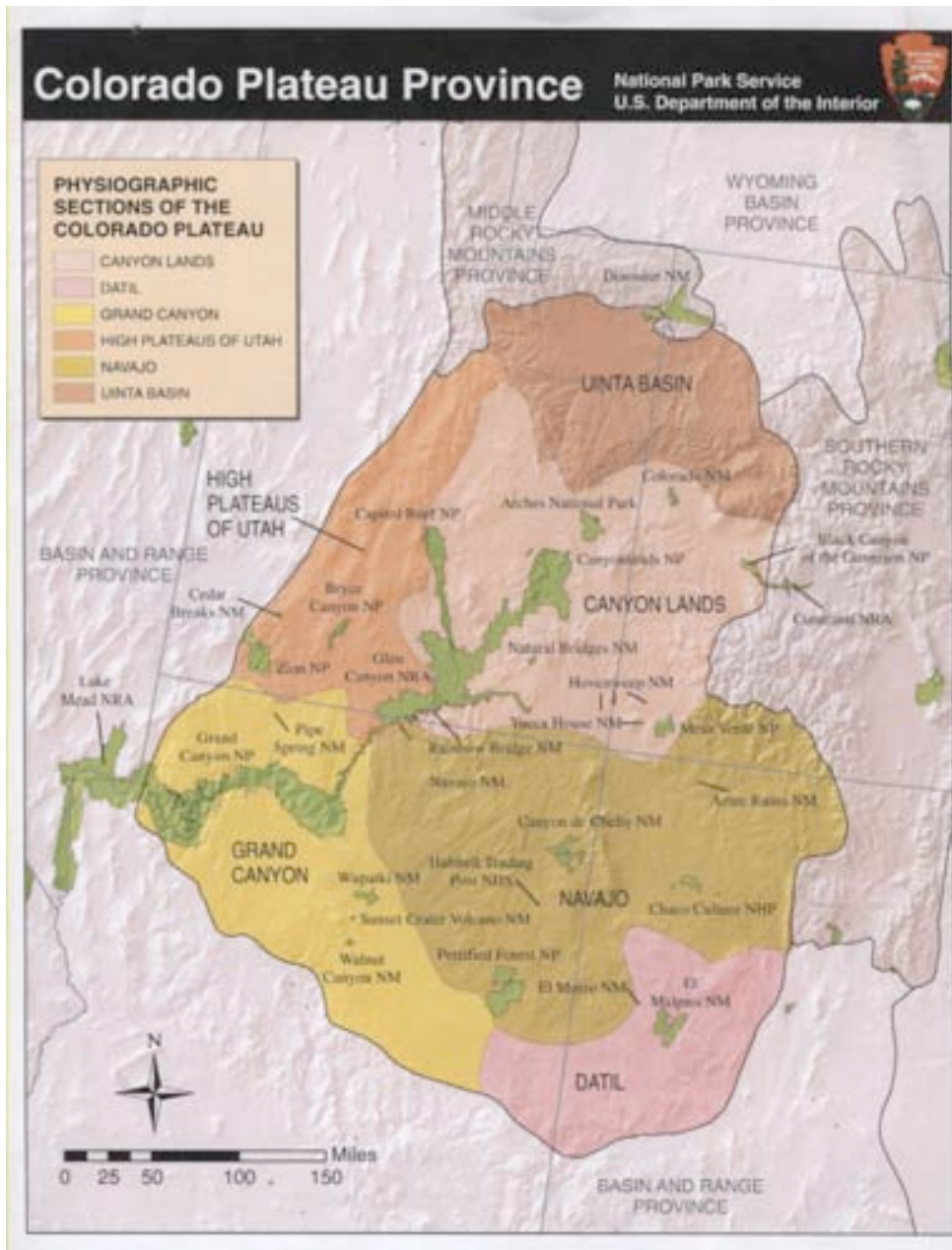


## EarthScope- new images of the US and processes that shape continents



**CREST Experiment– densification of EarthScope --94 broadband site  
(18-34 km spacing)– nearly done collecting**





**How to interface with the Parks to best convey informal geoscience education**



Image from David Simpson

**The ES goal—  
to understand  
the history  
and structure  
of our  
continent, and  
the processes  
that shape it,  
and  
communicate  
this discovery  
to the public**





