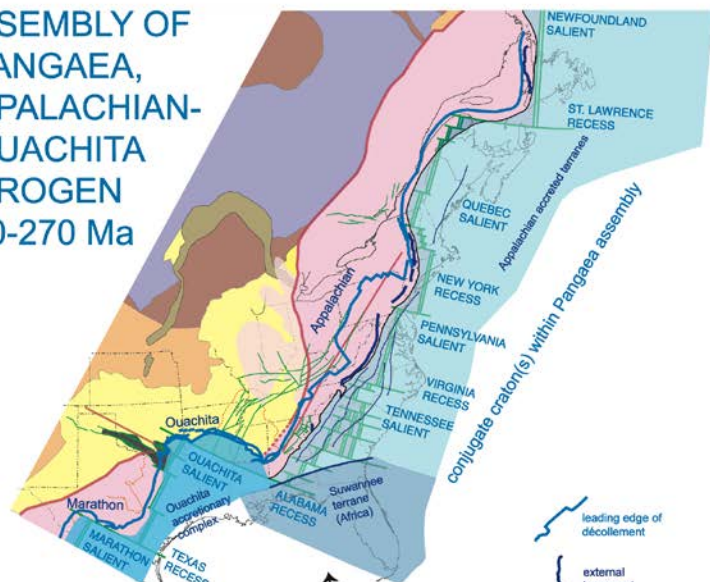


# The lithosphere of the Appalachian orogen and the Atlantic passive margin: A seismological perspective

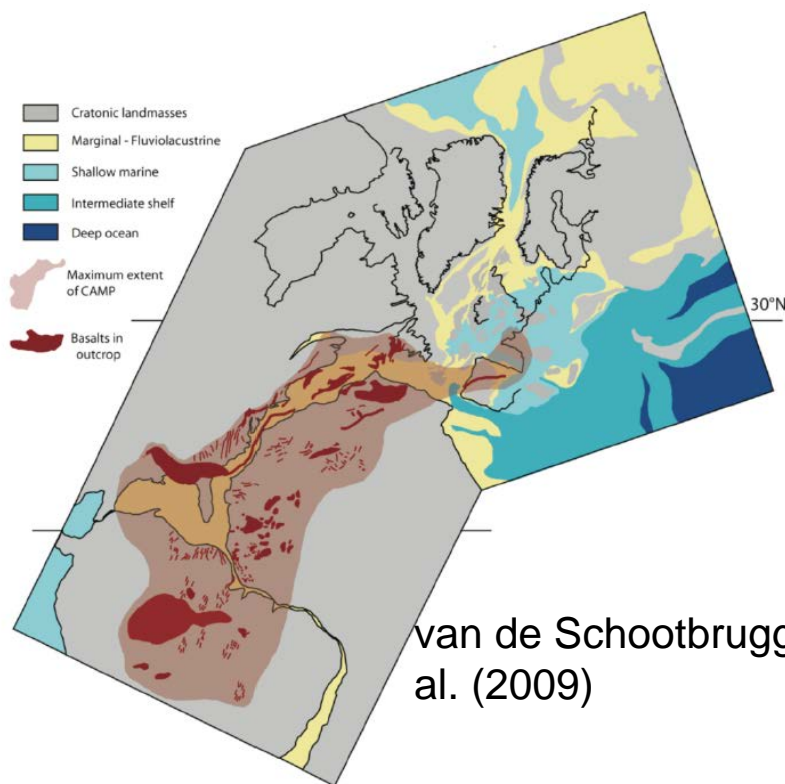
**Karen M. Fischer**

Department of Geological Sciences, Brown University

ASSEMBLY OF  
PANGAEA,  
APPALACHIAN-  
OUACHITA  
OROGEN  
470-270 Ma



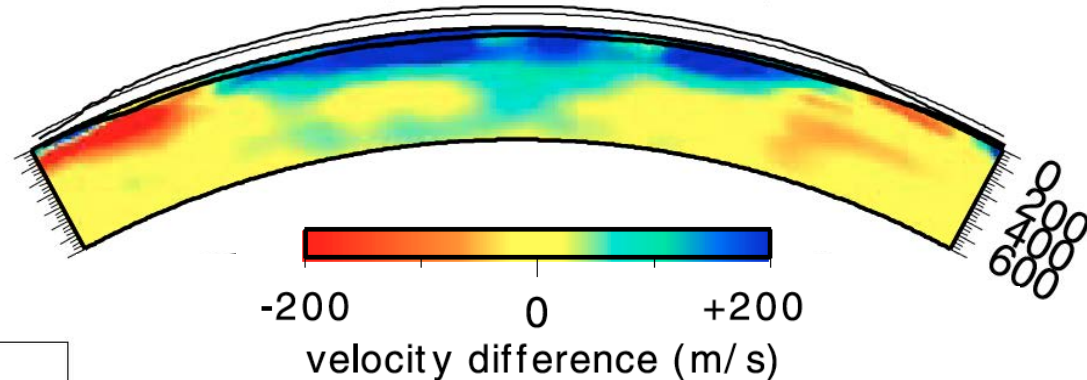
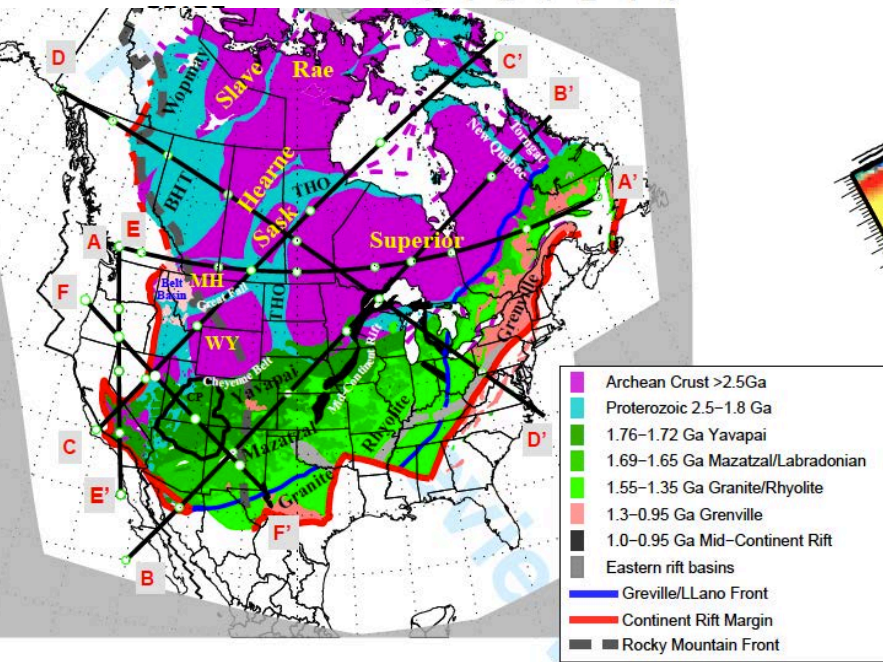
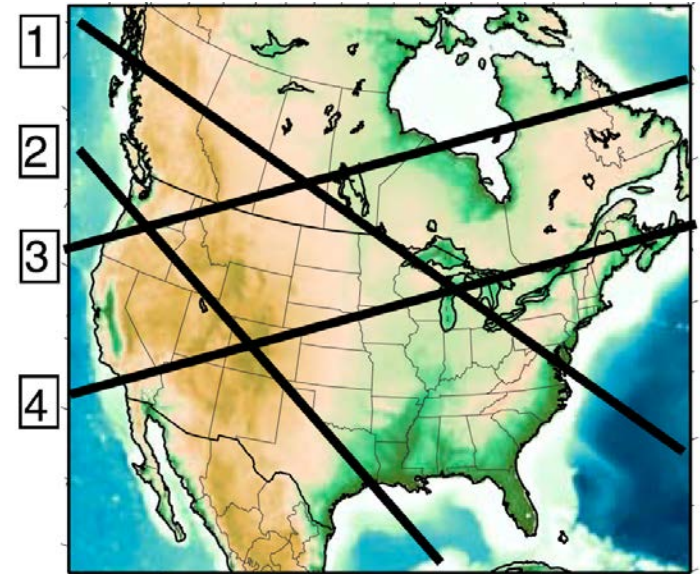
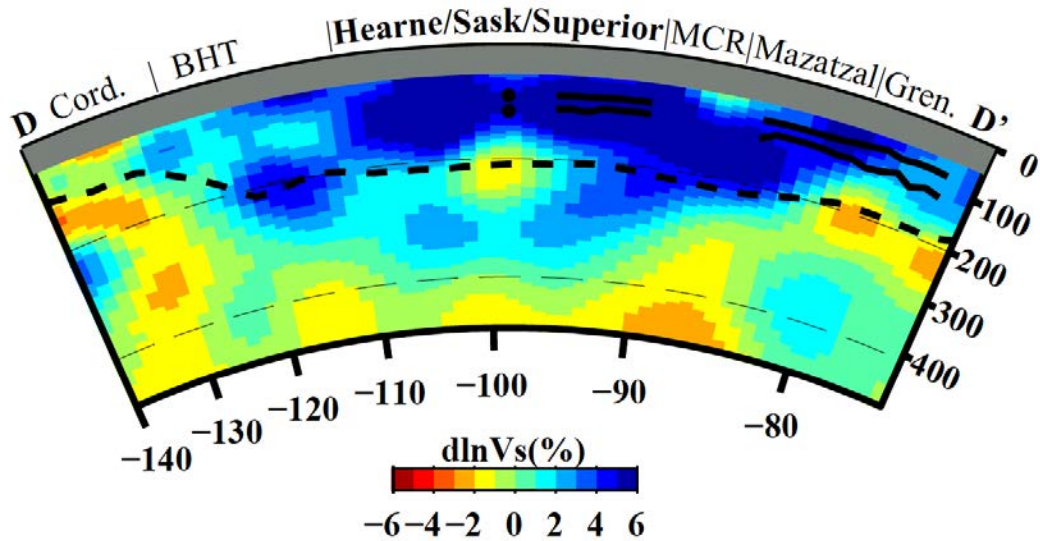
Thomas (2006)



van de Schootbrugge et al. (2009)

# The big picture...

Yuan et al. (GJI, 2011)

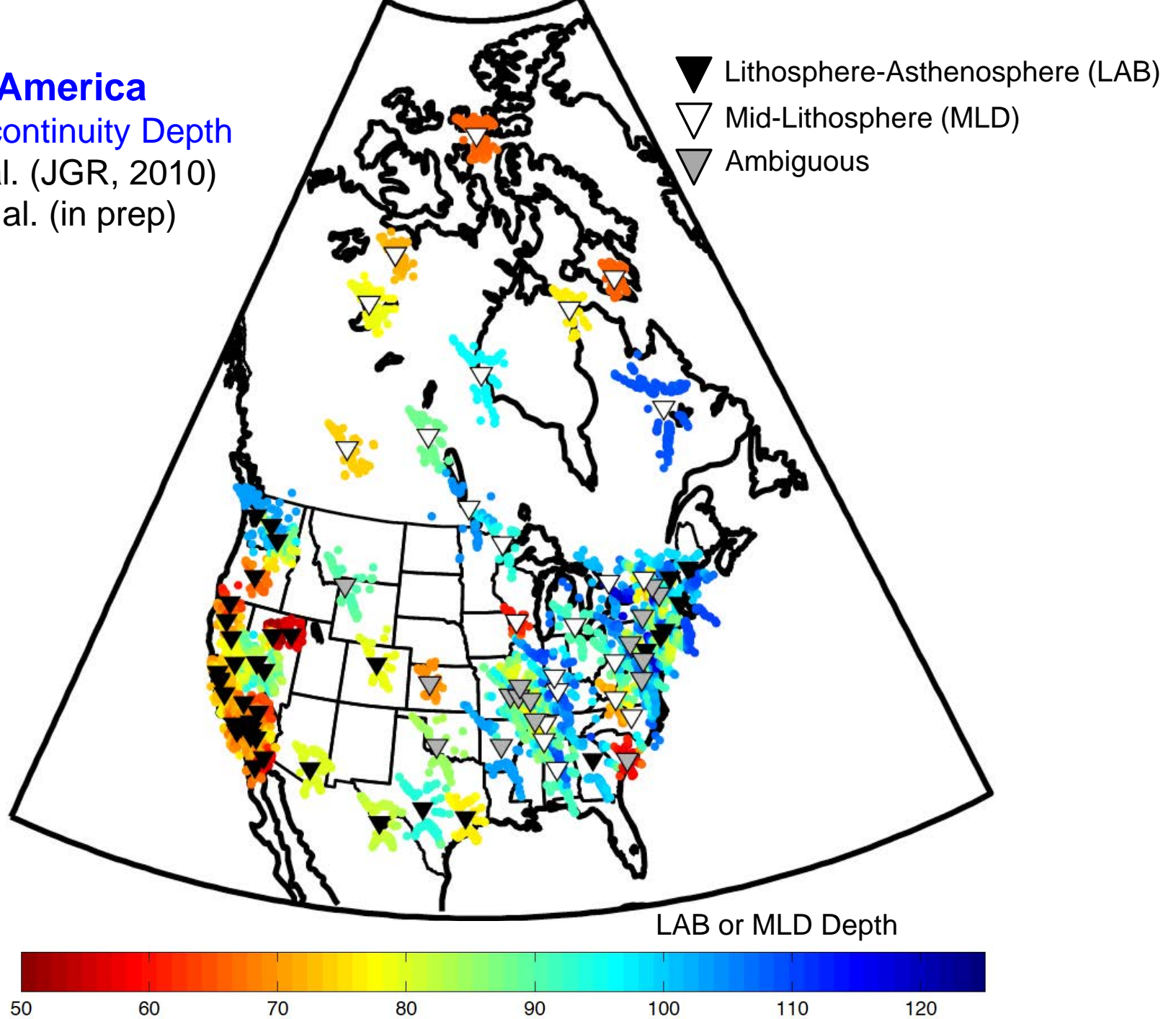


Bedle and van der Lee (JGR, 2009)





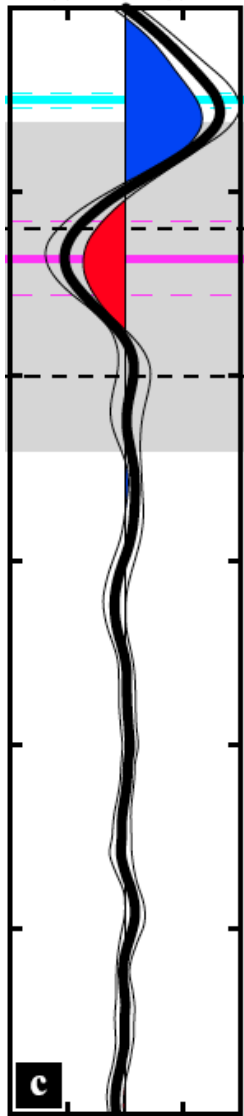
**North America**  
**Sp Discontinuity Depth**  
Abt et al. (JGR, 2010)  
Ford et al. (in prep)



# S. California

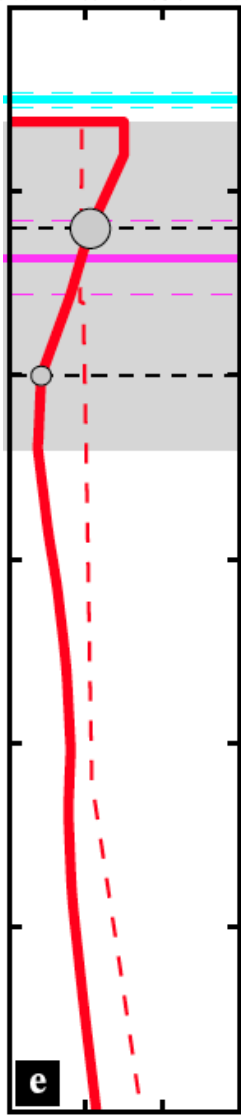
*Sp* RF Amplitude  
(Fraction of Direct-*S*)

-0.1 0 0.1



Shear Velocity  
(km/s)

4.25 4.5 4.75 5

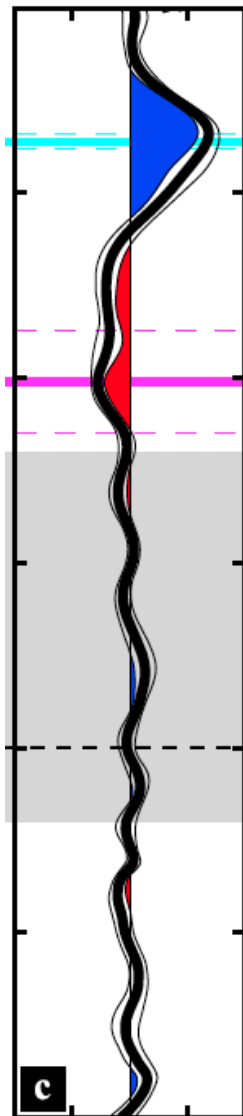


— UCB  
- - AK135

# Superior Craton

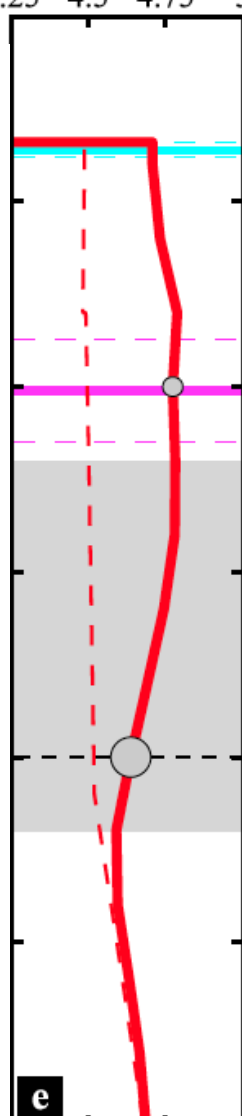
*Sp* RF Amplitude  
(Fraction of Direct-*S*)

-0.1 0 0.1



Shear Velocity  
(km/s)

4.25 4.5 4.75 5

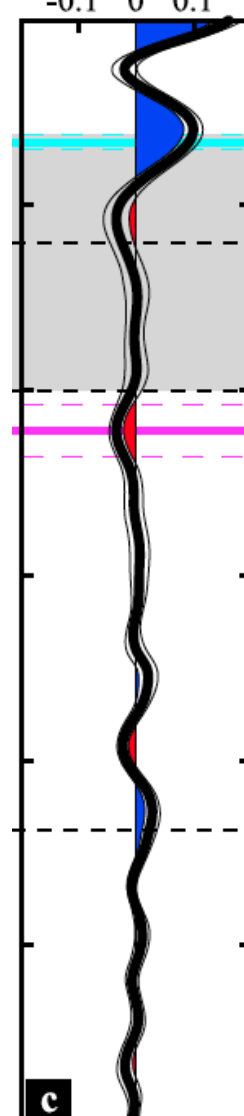


— UCB  
- - AK135

# Massachusetts

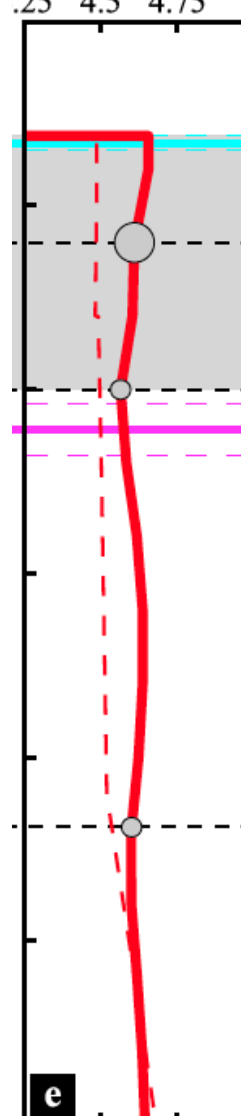
*Sp* RF Amplitude  
(Fraction of Direct-*S*)

-0.1 0 0.1



Shear Velocity  
(km/s)

.25 4.5 4.75 5



— UCB  
- - AK135

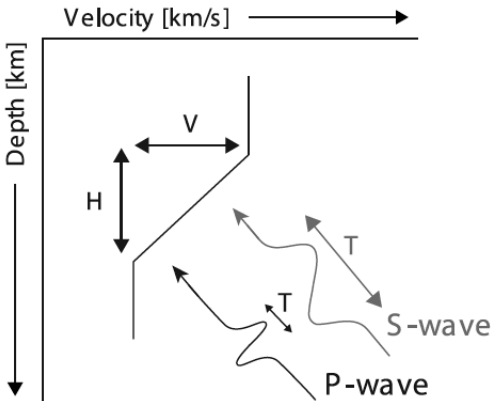
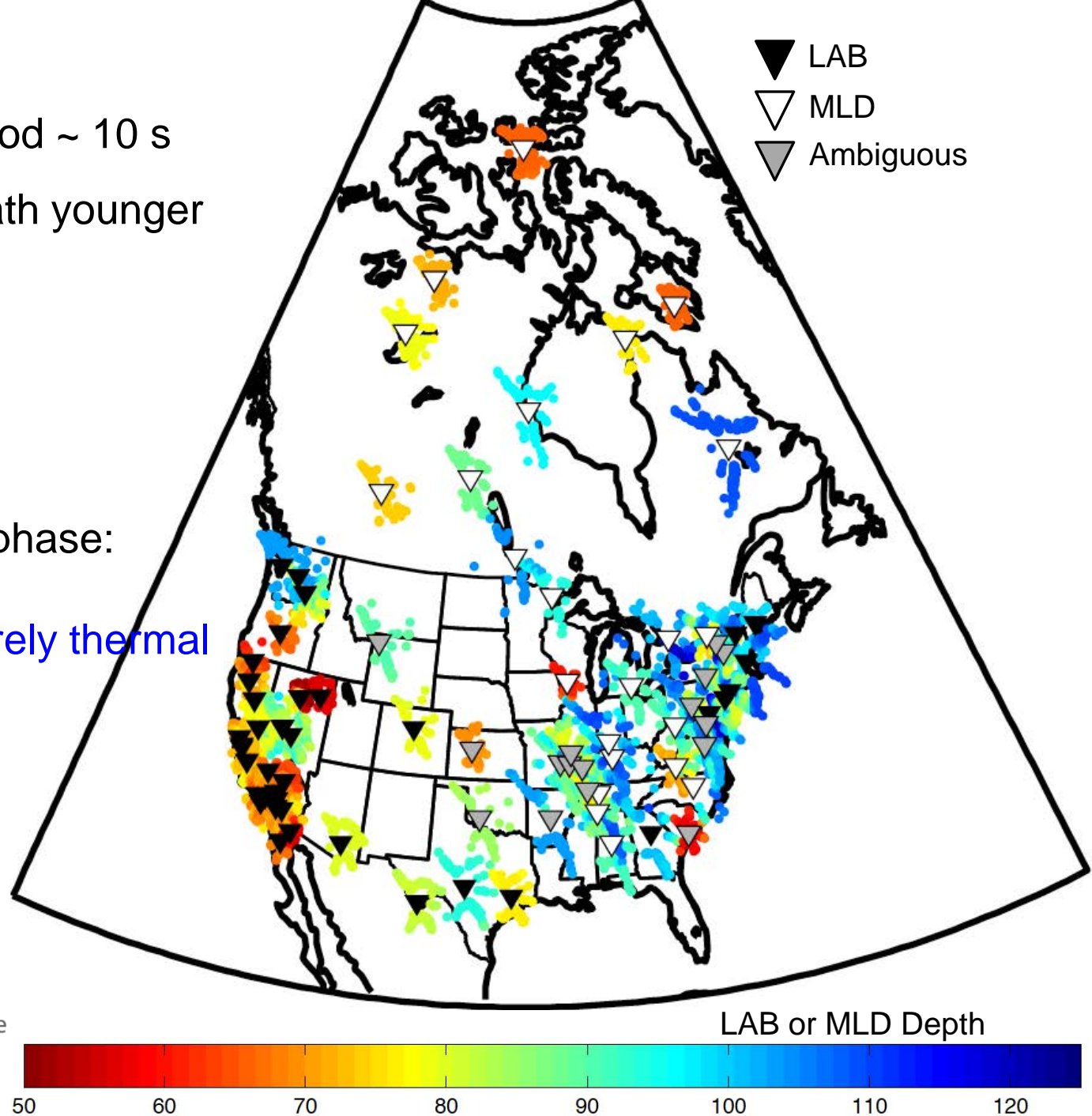
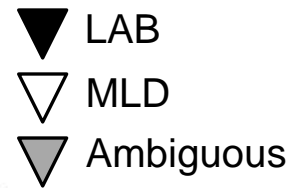


# North America

- Dominant Sp period  $\sim 10$  s
- Sharp LAB beneath younger continent:

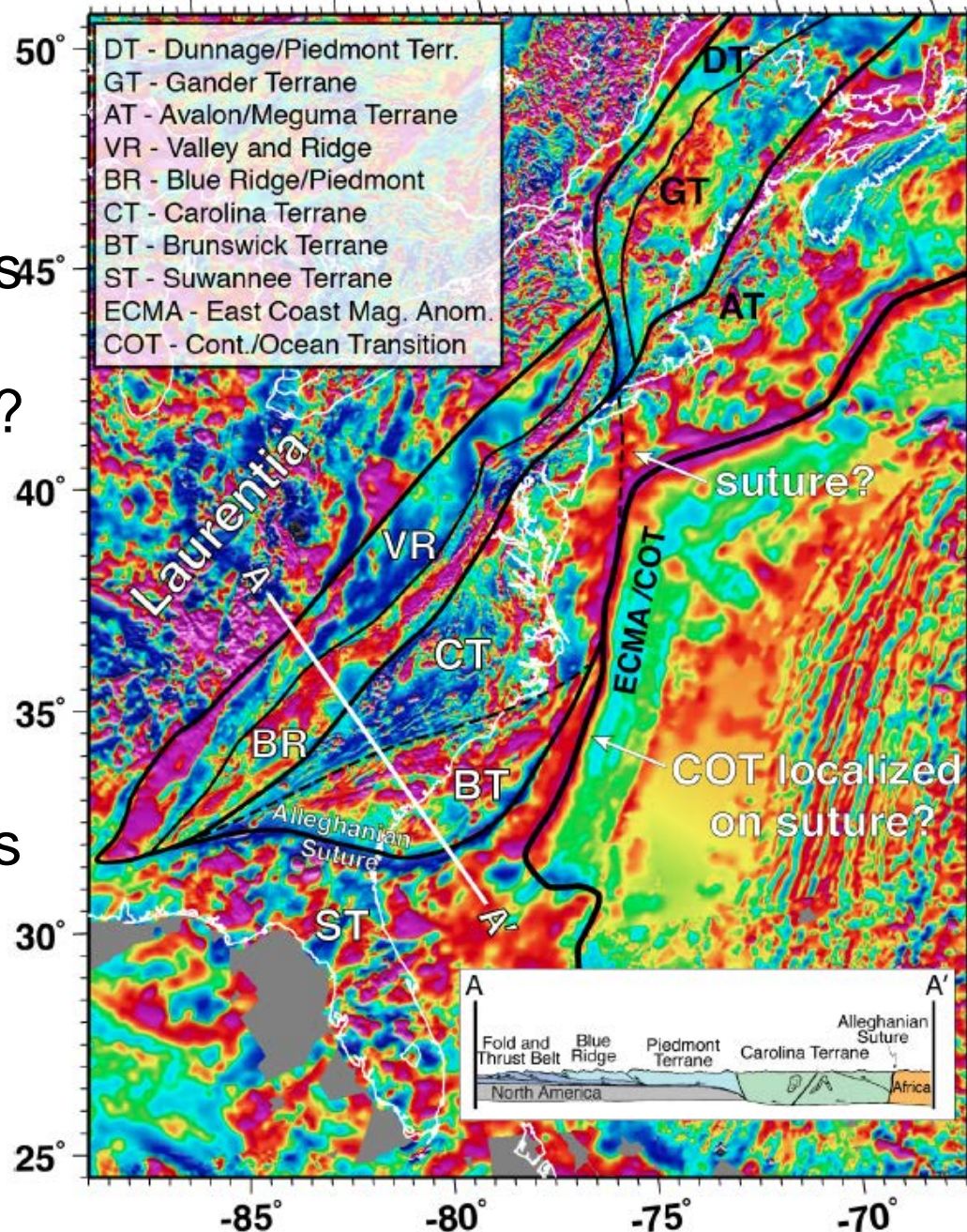
$H < 30\text{-}40$  km  
Best fits  $\leq 20$  km  
Volatiles or melt in asthenosphere

- No cratonic LAB phase:  
 $H > 50\text{-}60$  km  
Consistent with purely thermal gradient



# Orogenic processes

- What expression of collisional processes exists in the mantle lithosphere beneath the Appalachians?
- Are crustal terranes and sutures connected to mantle features?
- How do these relationships constrain models of lithospheric deformation during collision?

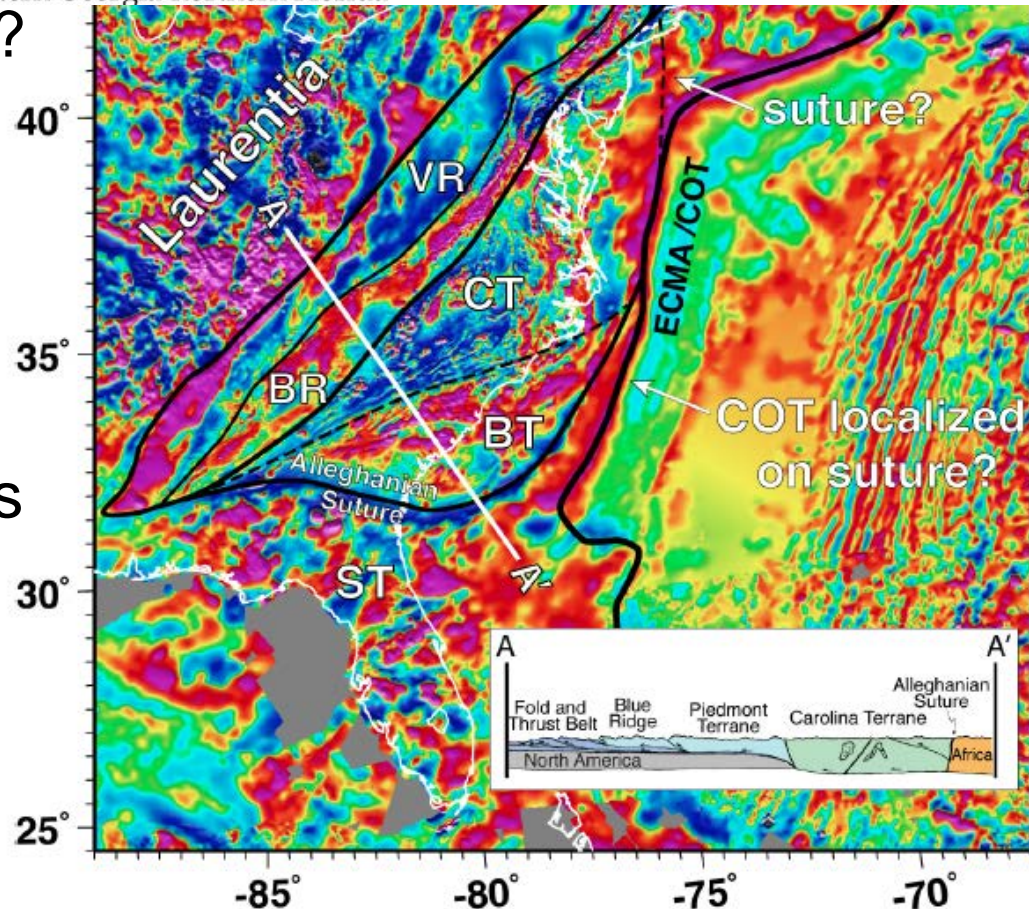
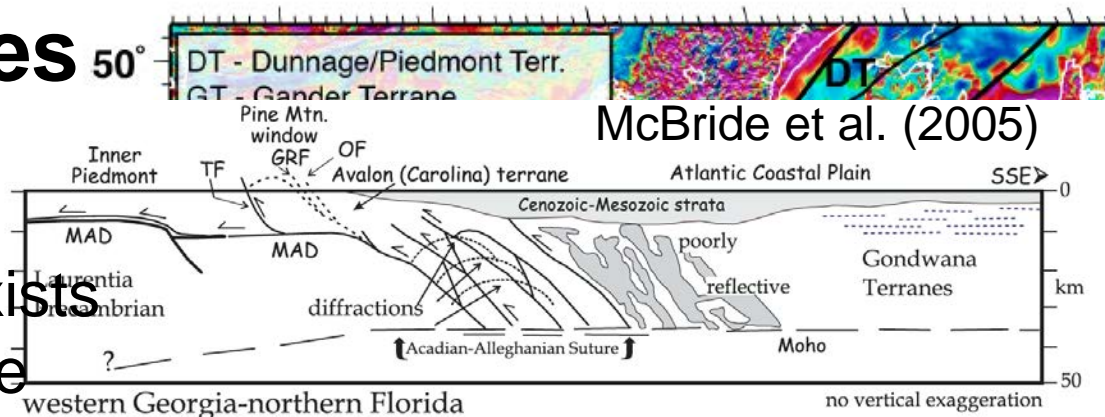


Miller et al. White Paper



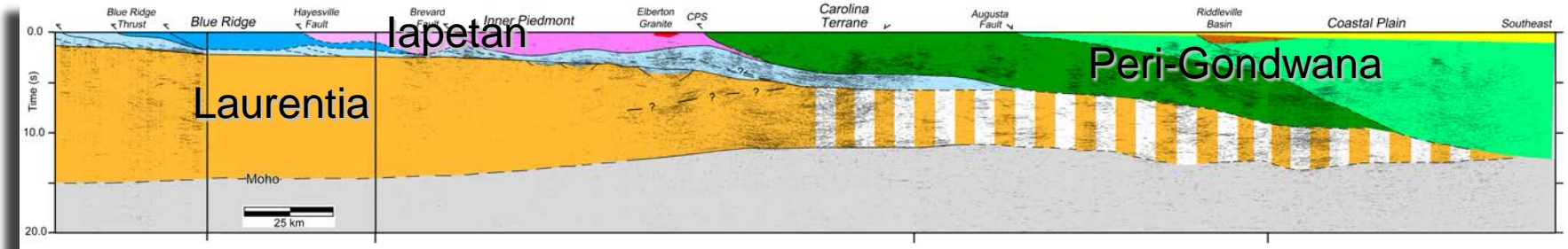
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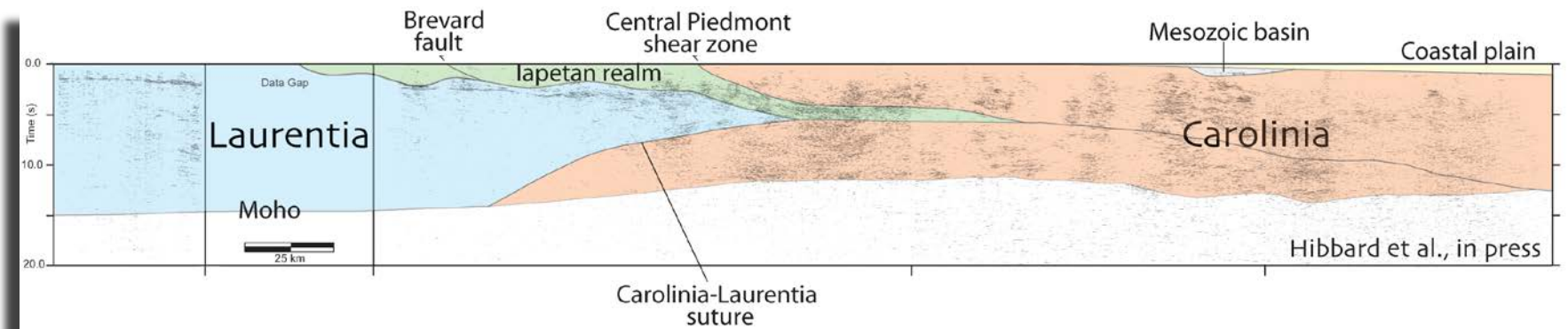


Miller et al. White Paper





(Cook and Vasudevan , 2006)

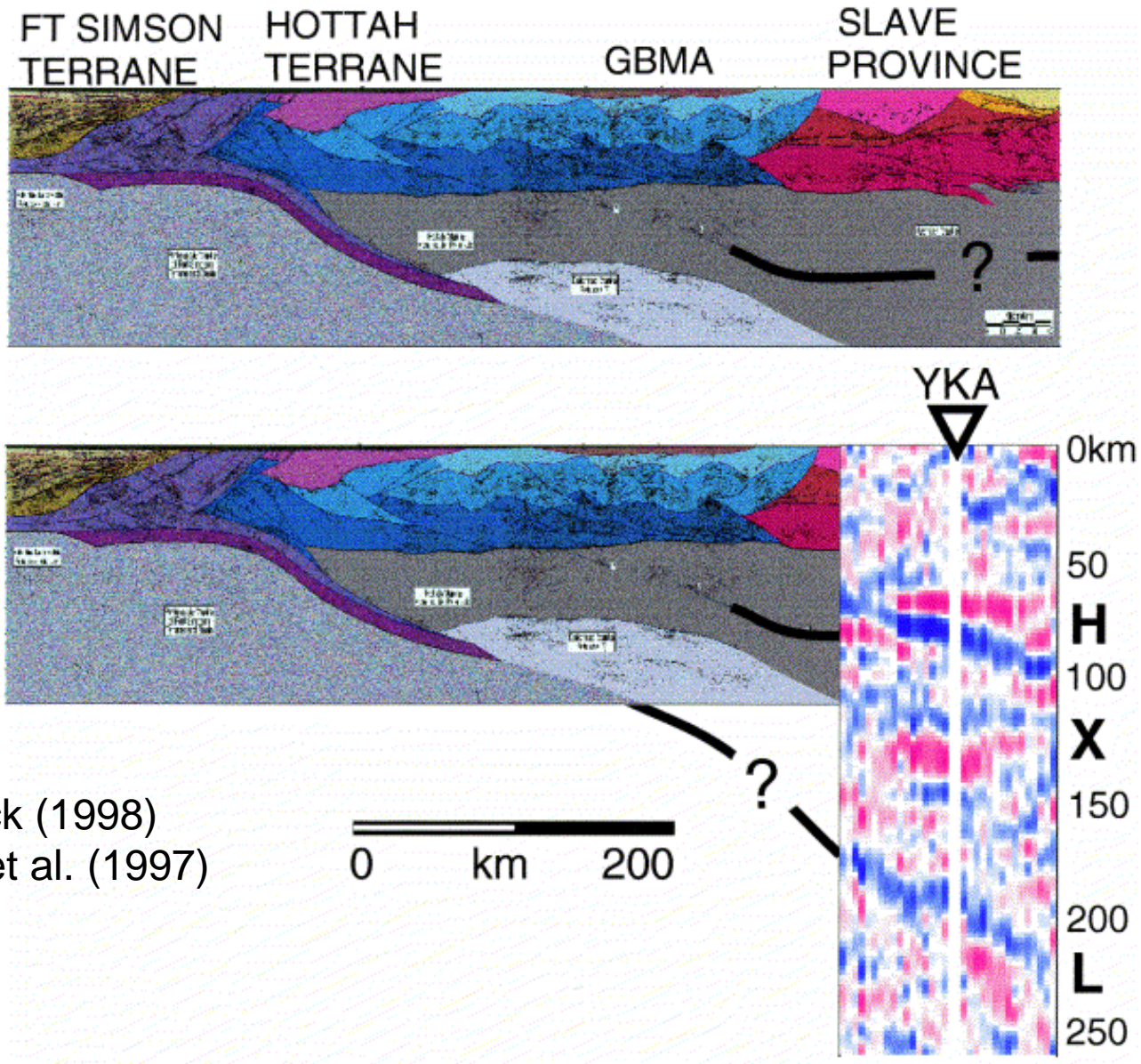


(Hibbard et al. , 2010)

(Hibbard, 2009 EarthScope Science Plan

(Workshop)

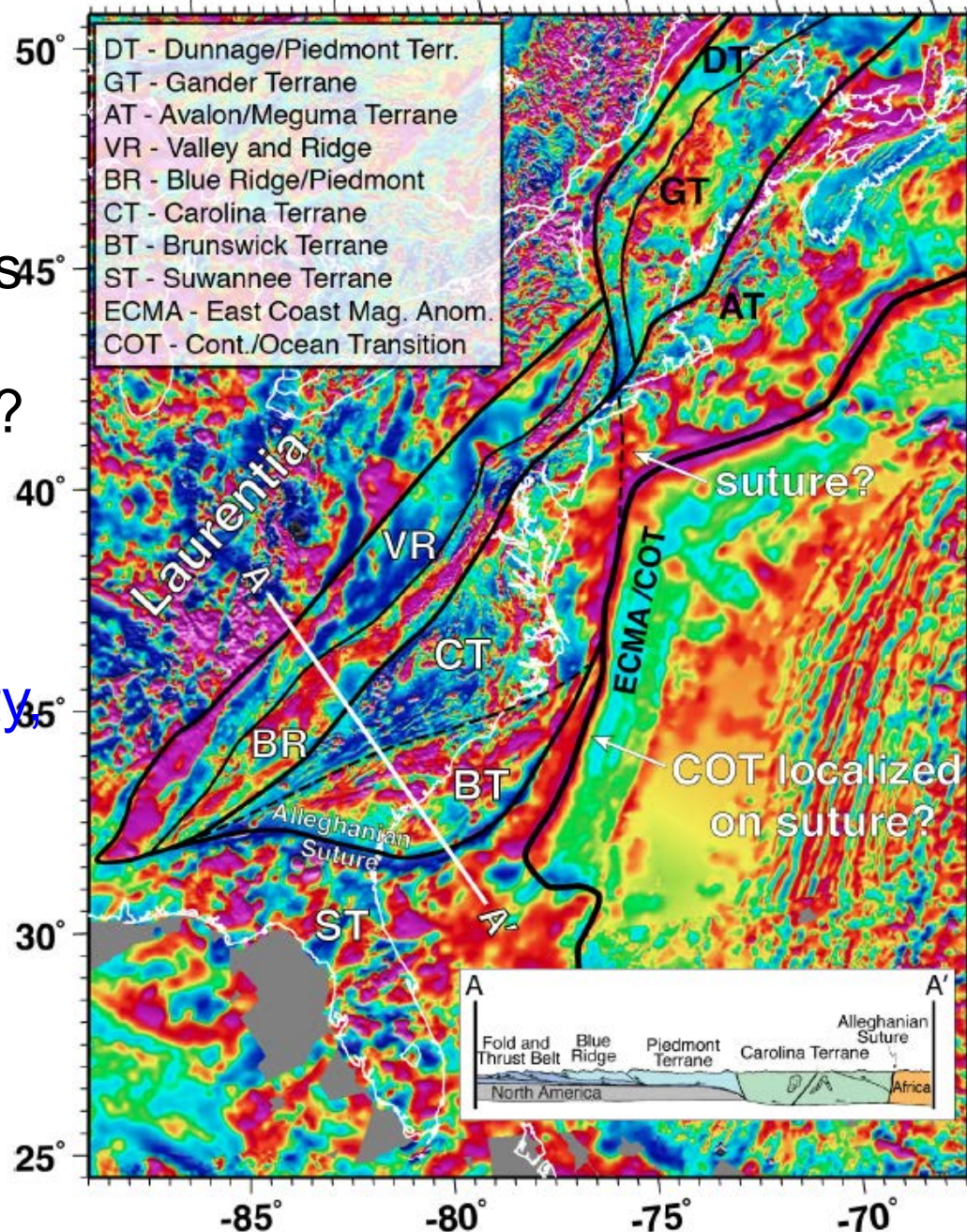
# Example from Canadian Shield





# Orogenic processes

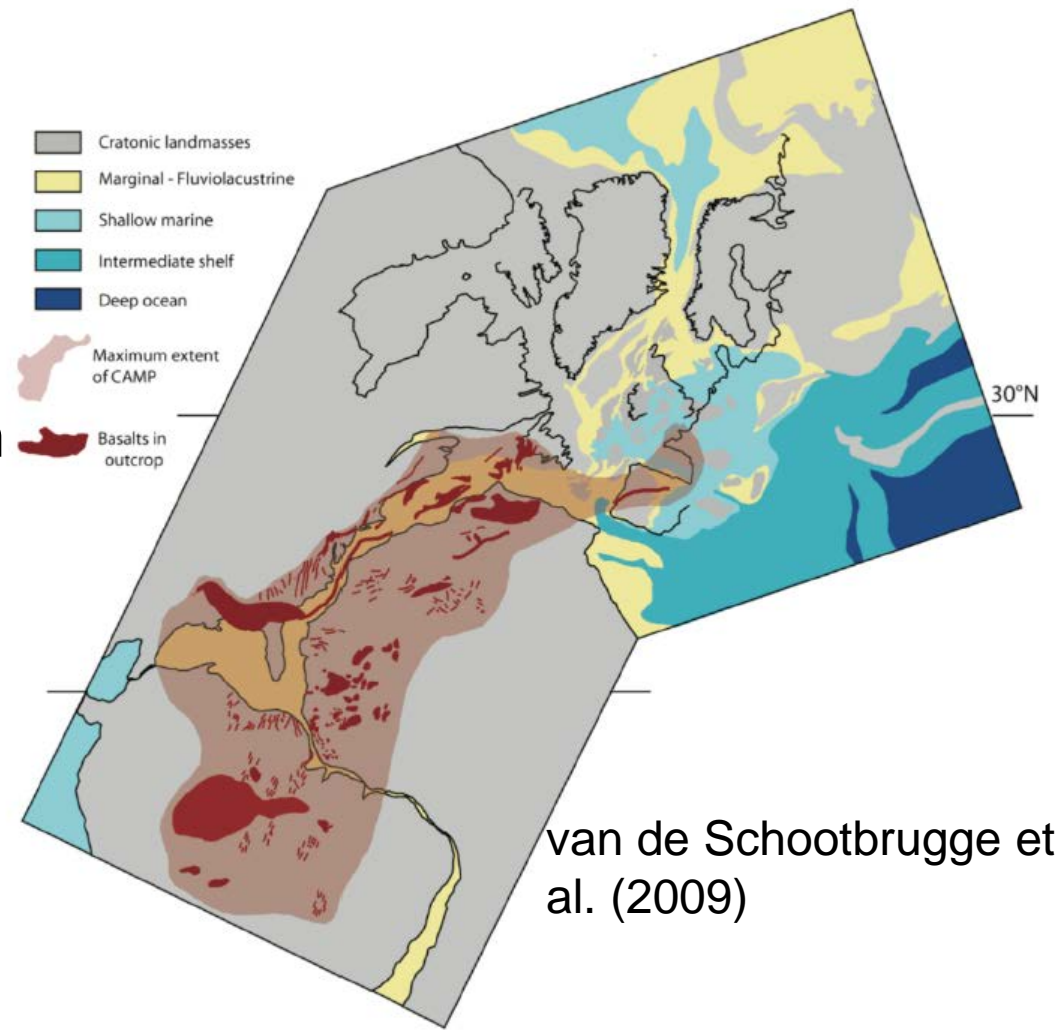
- What expression of collisional processes exists in the mantle lithosphere beneath the Appalachians?
- Look for:
  - Dipping reflectors
  - Lateral changes in velocity
  - attenuation
  - Gradients in anisotropy
  - Offsets in LAB depth



Miller et al. White Paper

# Rifting/Passive margin processes

- What expressions of rifting processes remain in the mantle?
- Reactivation of orogenic structures?
- Given Mesozoic mafic magmatism, does a corresponding region of depleted, dehydrated, high viscosity mantle lithosphere exist?
- How do rifted continental and oceanic lithosphere compare?  
Edge-driven convection?  
needed!



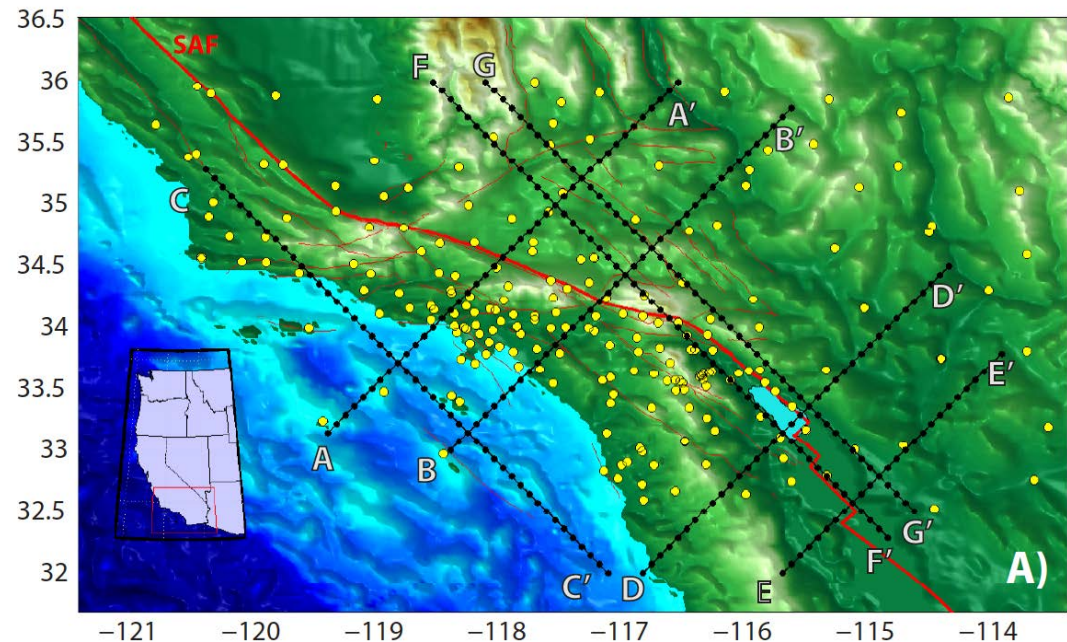
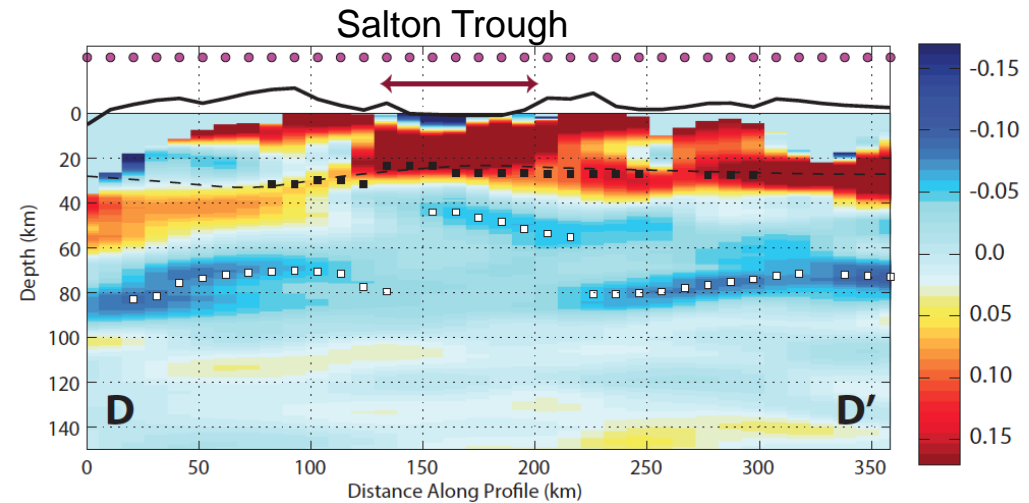


# Southern California

## Sp CCP Stack

Lekic et al. (Science, 2011)

- ~30 km of lithospheric thinning beneath Salton Trough and Inner Borderlands
- Lithospheric and crustal thinning very well-correlated with surface geology/deformation; vary over small length-scales
- High viscosity mantle lithosphere and localized strain

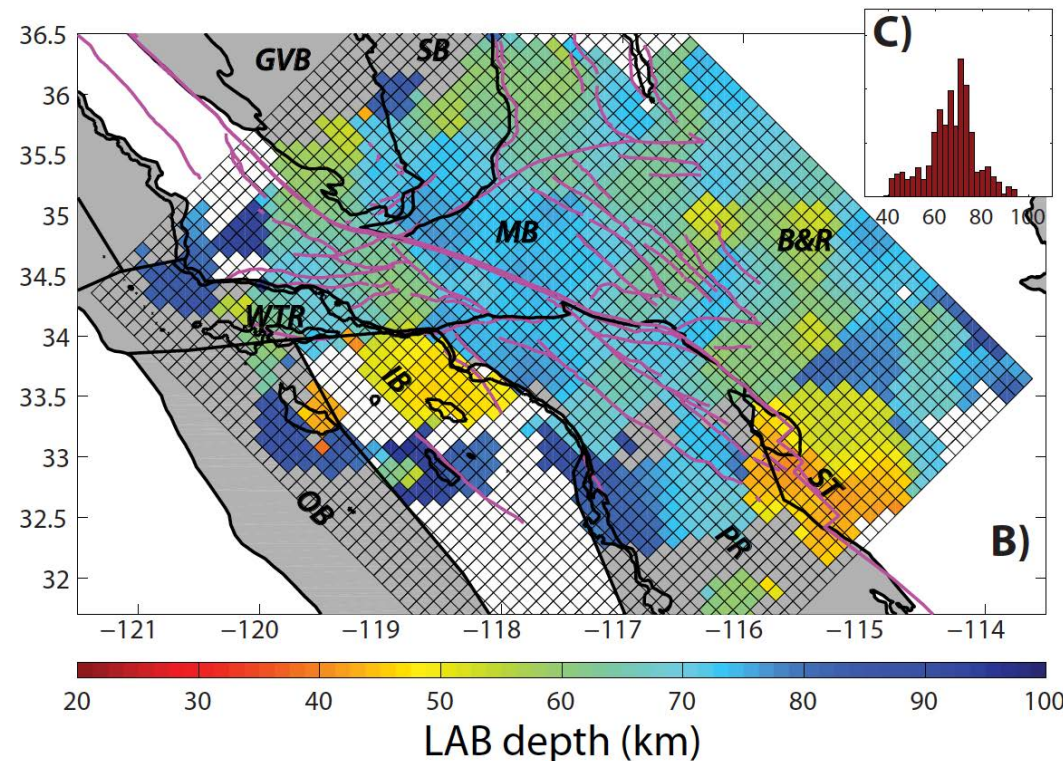
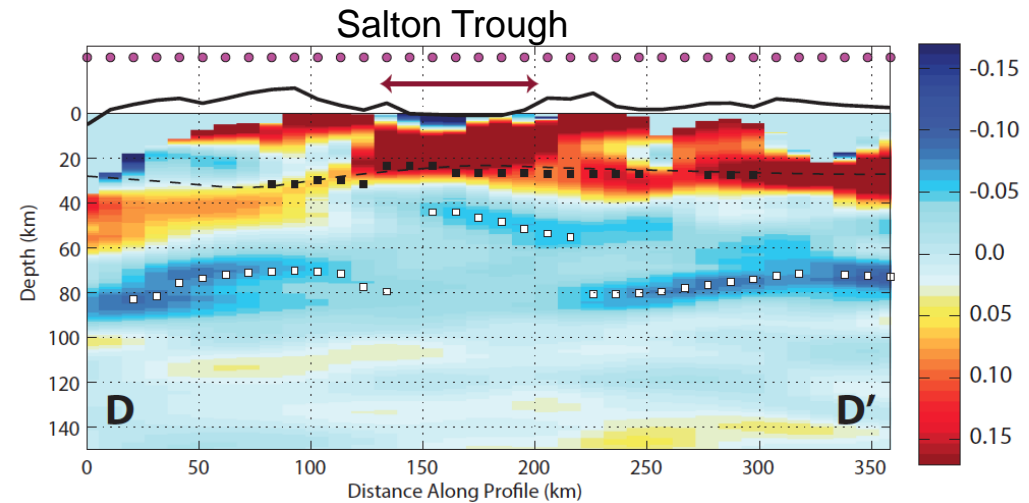


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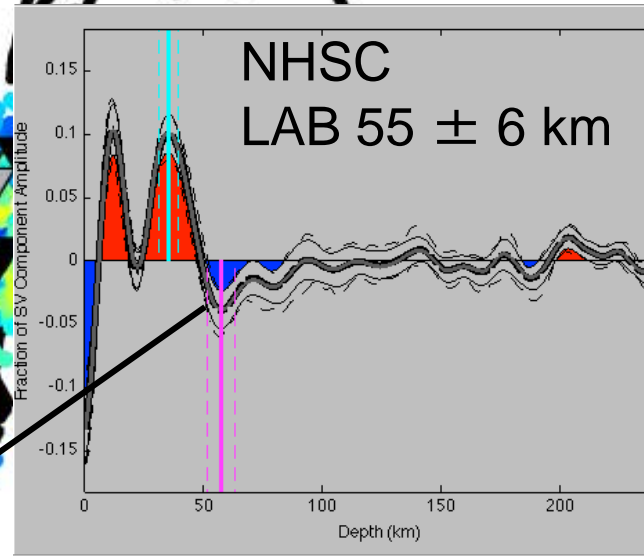
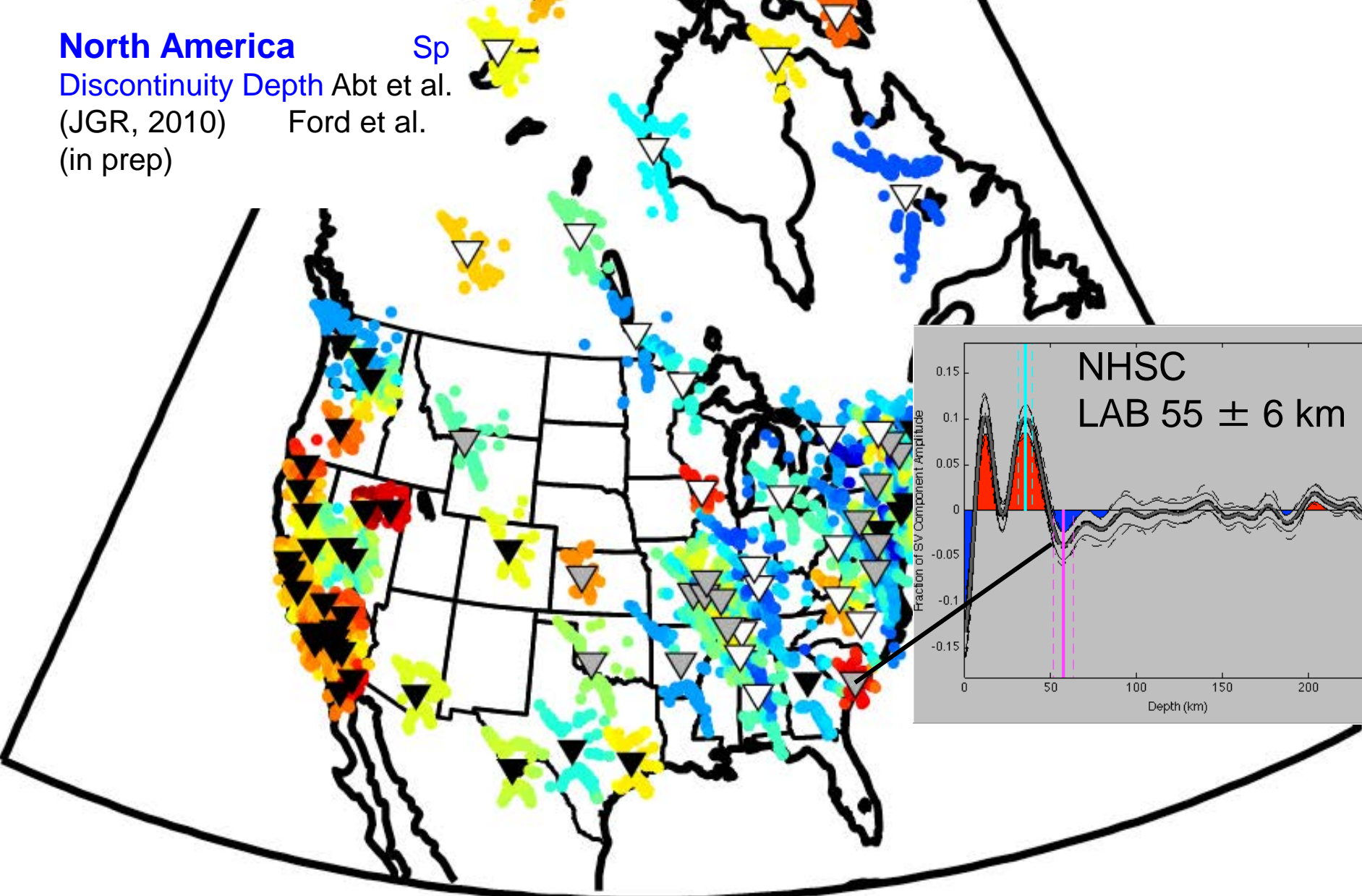




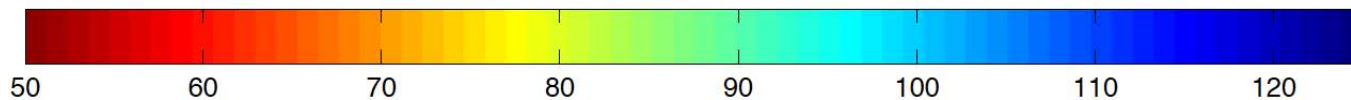
# North America

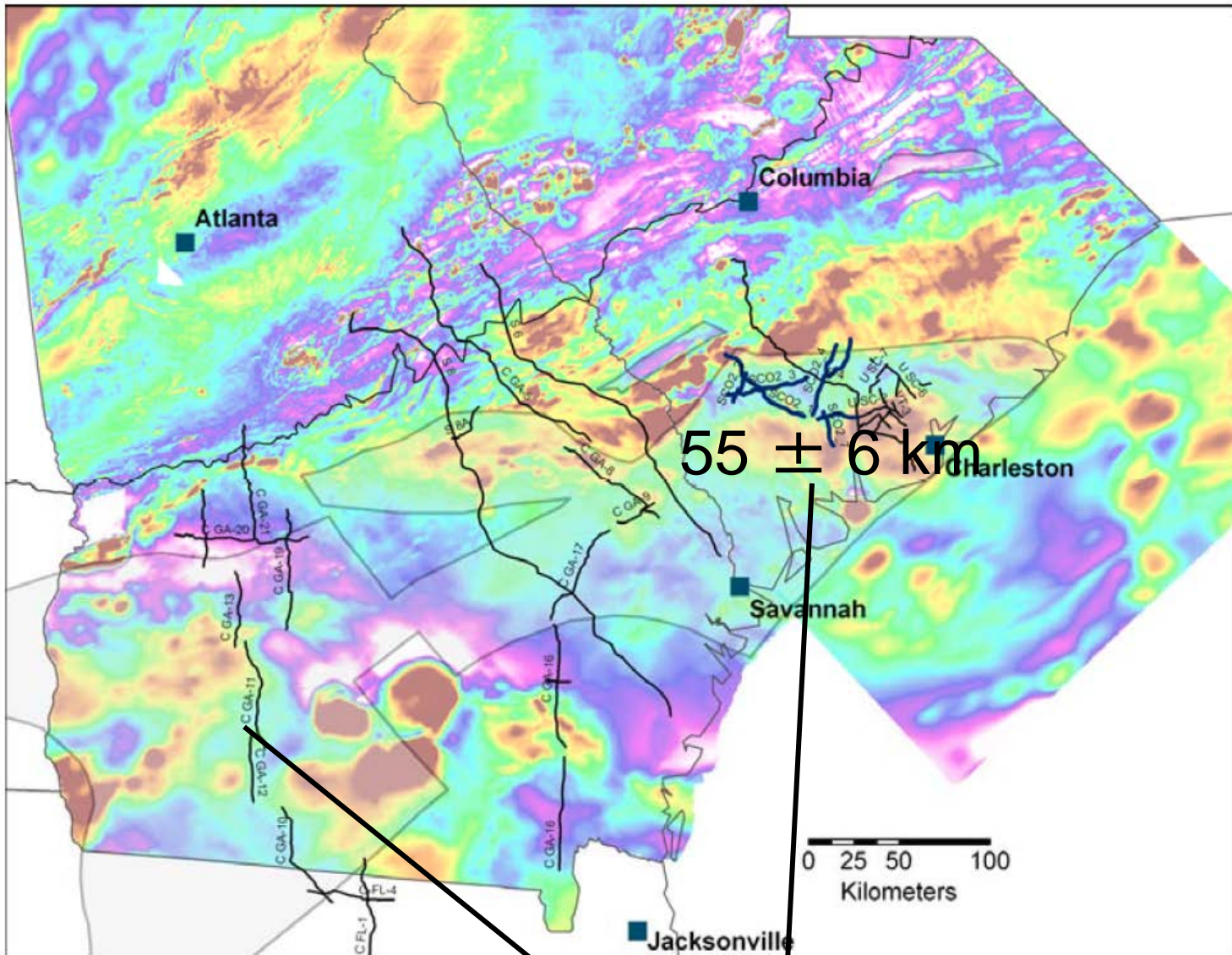
Discontinuity Depth Abt et al.  
(JGR, 2010) Ford et al.  
(in prep)

Sp



LAB or MLD Depth





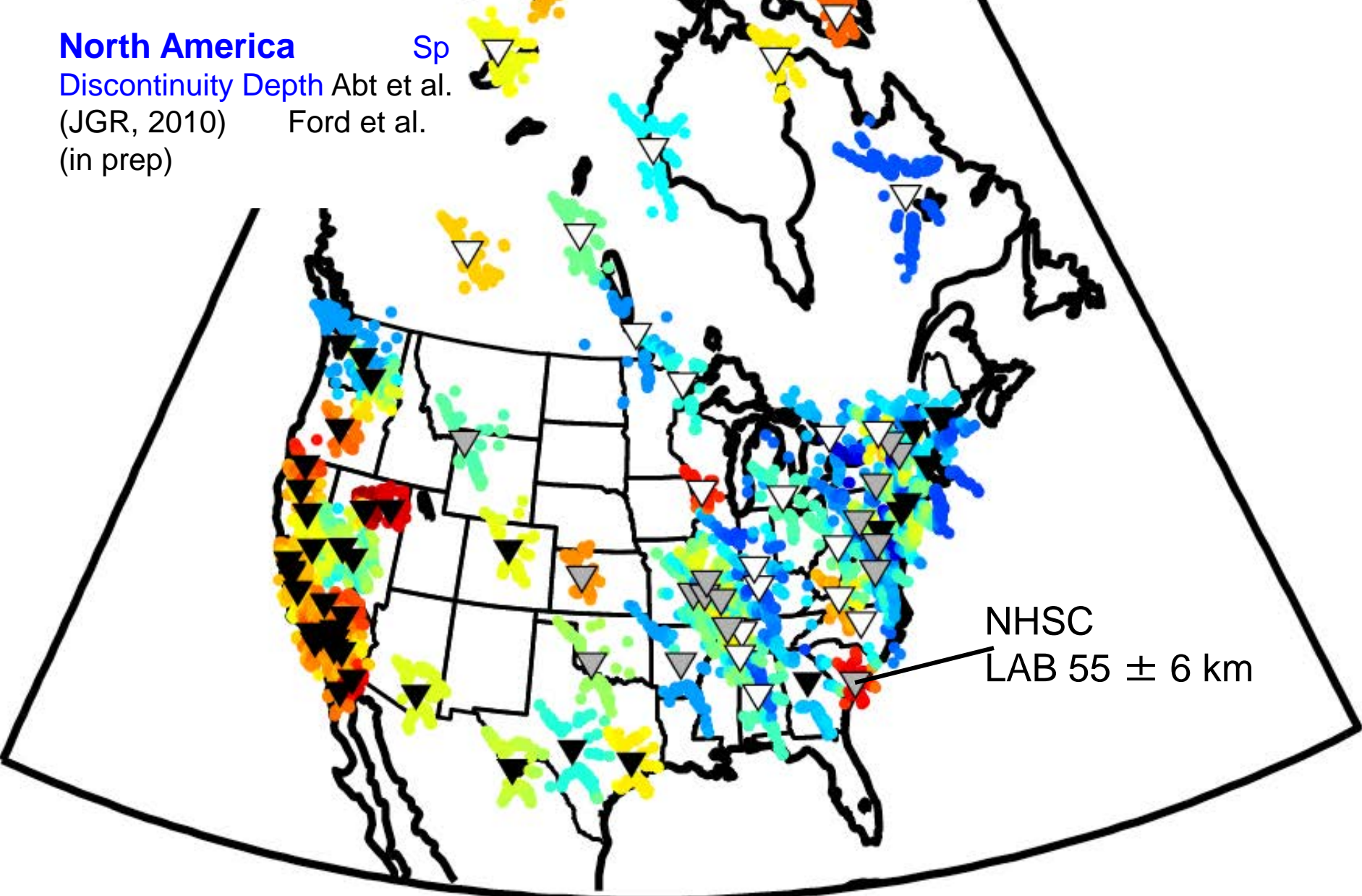
## South Georgia Rift Basin



# North America

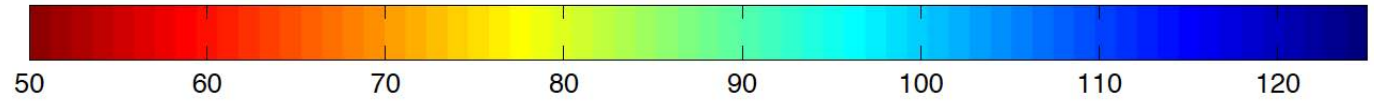
Discontinuity Depth Abt et al.  
(JGR, 2010) Ford et al.  
(in prep)

Sp



NHSC  
LAB  $55 \pm 6$  km

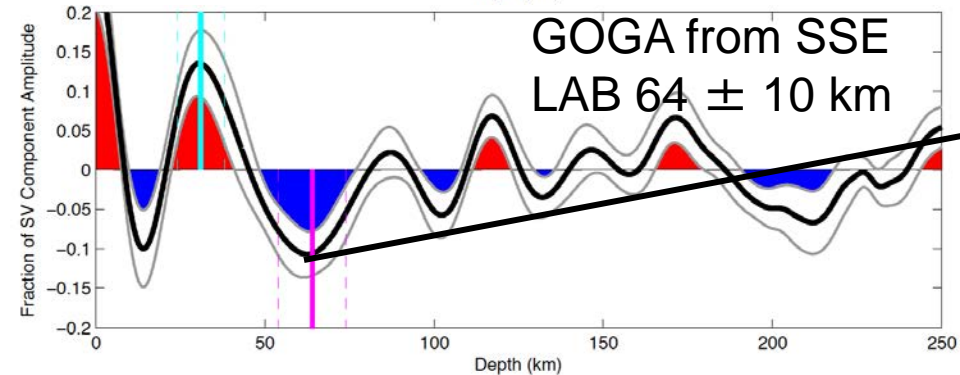
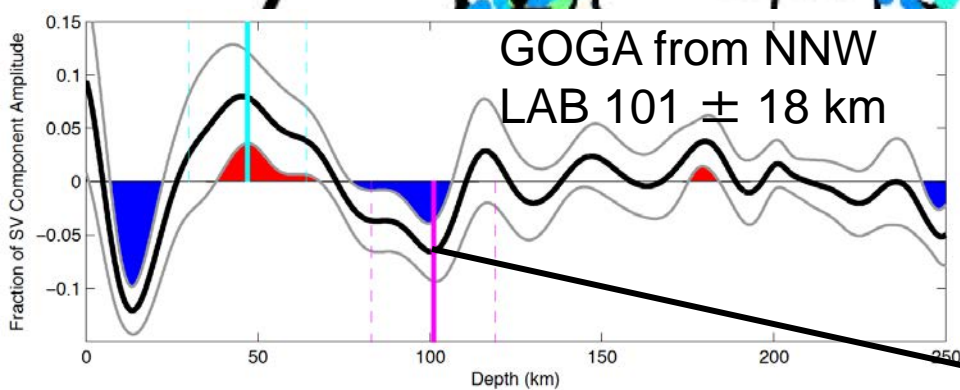
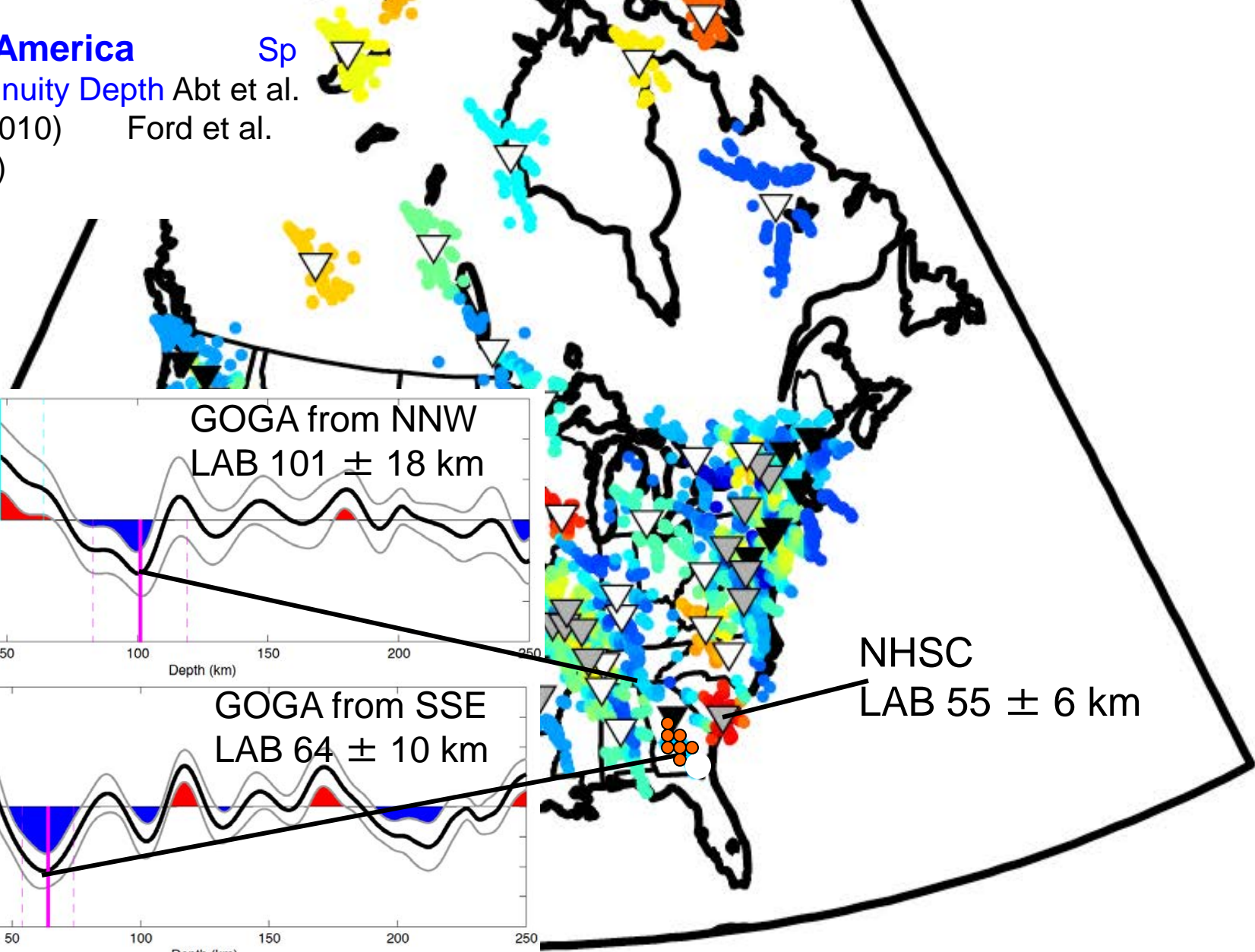
LAB or MLD Depth



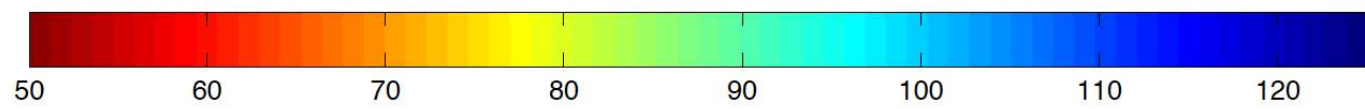
# North America

Discontinuity Depth Abt et al. (JGR, 2010)  
Ford et al. (in prep)

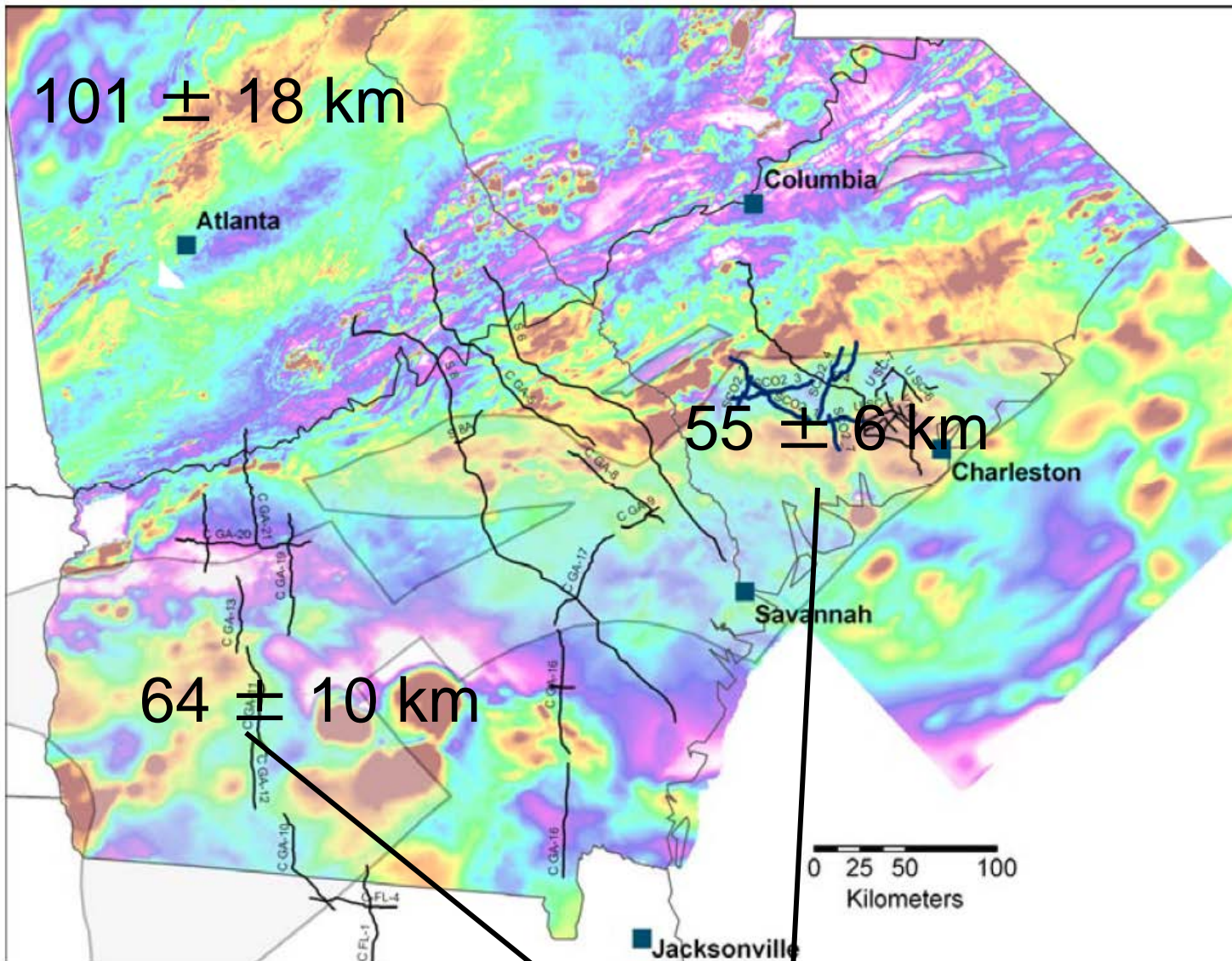
Sp



LAB or MLD Depth



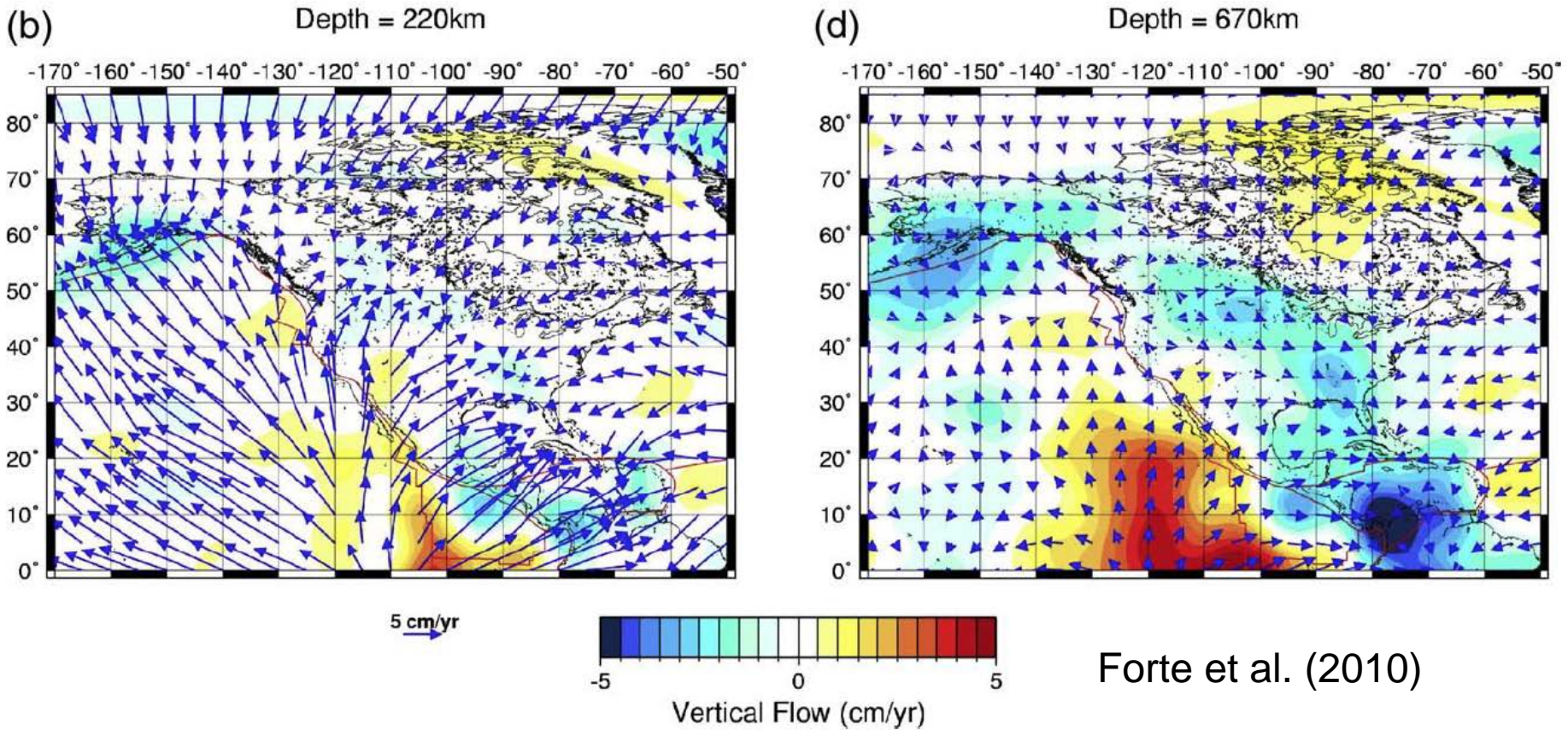




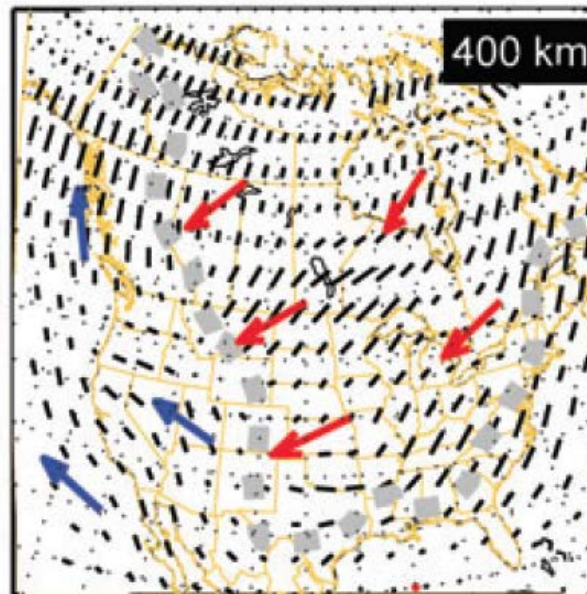
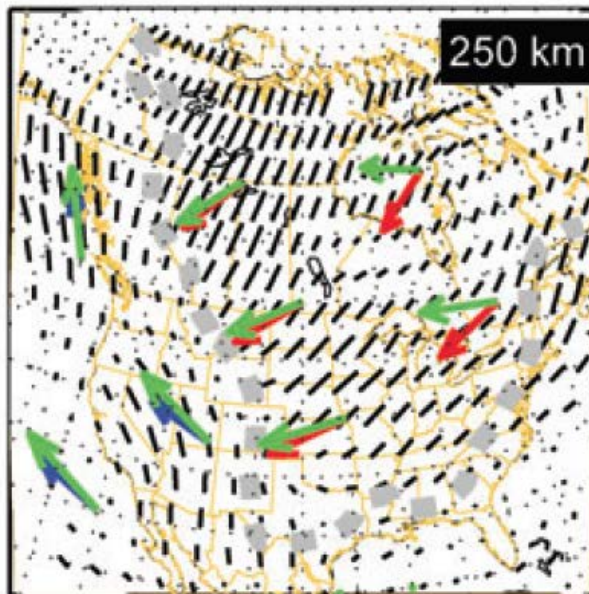
## South Georgia Rift Basin

# Longterm evolution of surface topography

- What are the relative roles of lithospheric buoyancy (crust and mantle) and sub-lithospheric density anomalies and flow?
- How have they evolved over time? Need record of erosion and uplift combined with geodynamic modeling.

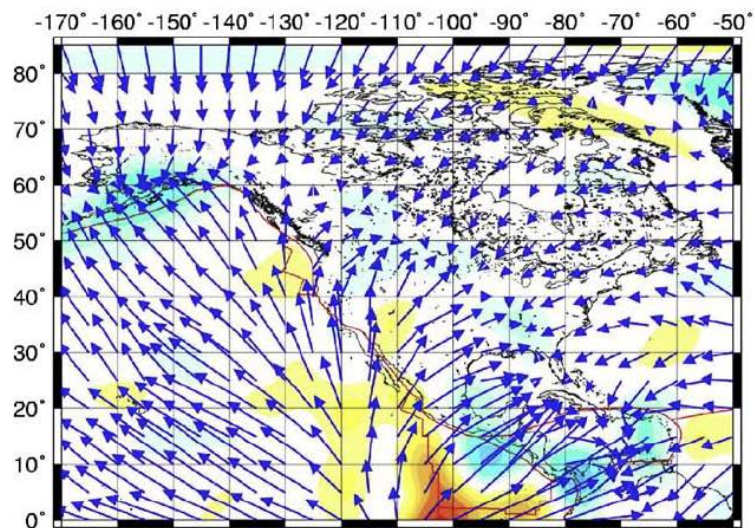




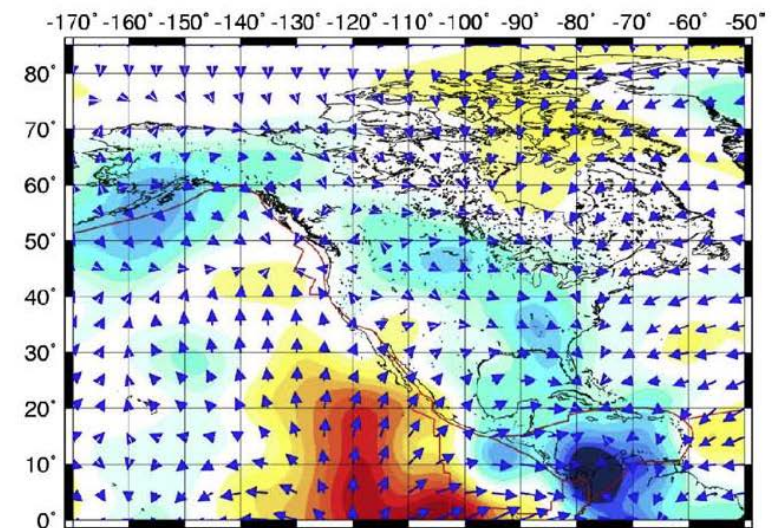


Yuan et al. (2011)

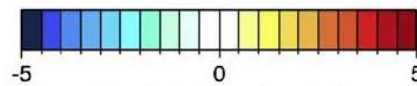
(b) Depth = 220km



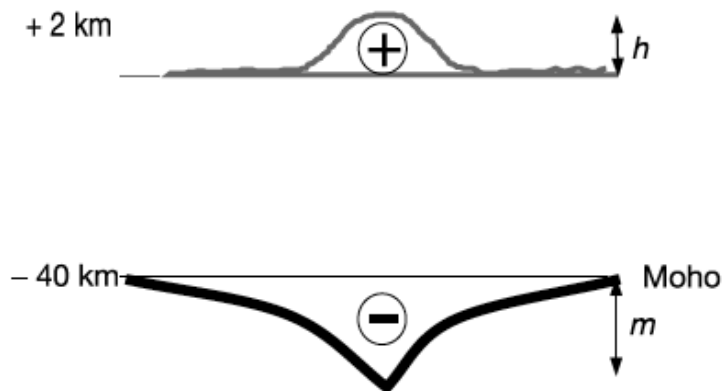
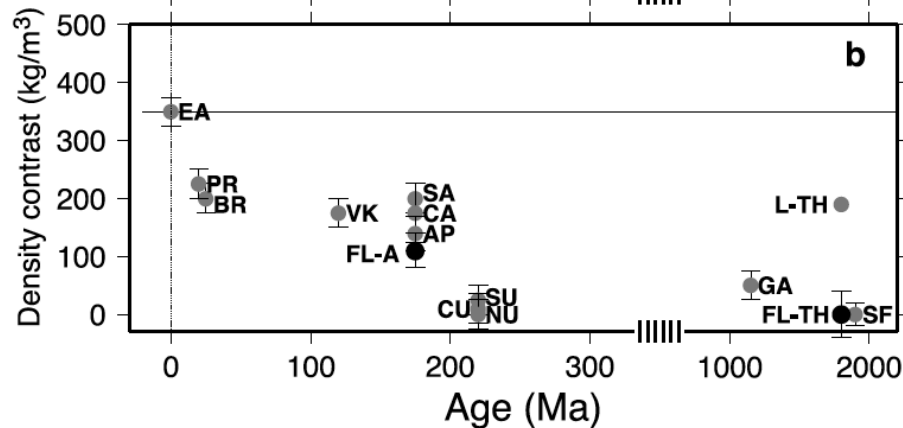
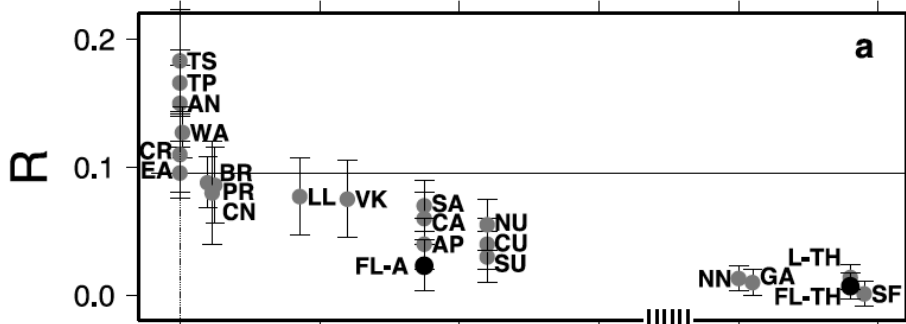
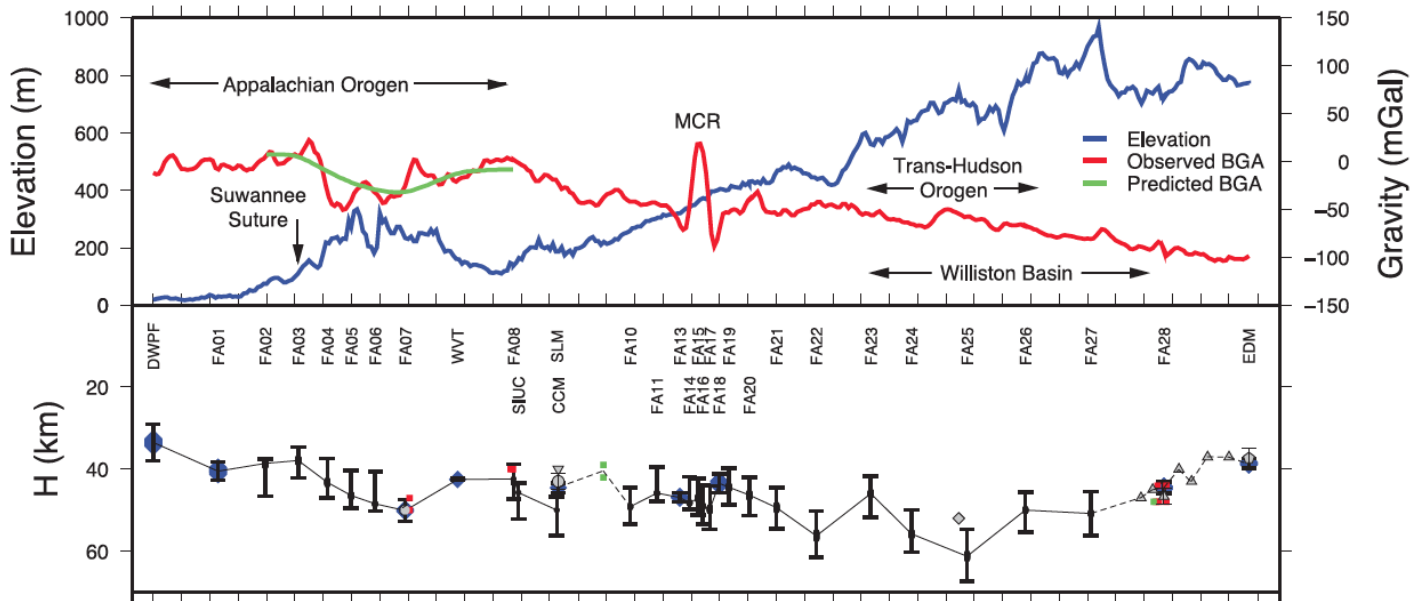
(d) Depth = 670km



5 cm/yr



Forte et al. (2010)



French et al. (2009)  
 Fischer (2002)