Reinterpretation of ADCOH and COCORP Seismic Reflection Data with Constraints from Detailed Forward Modeling of Potential Field Data

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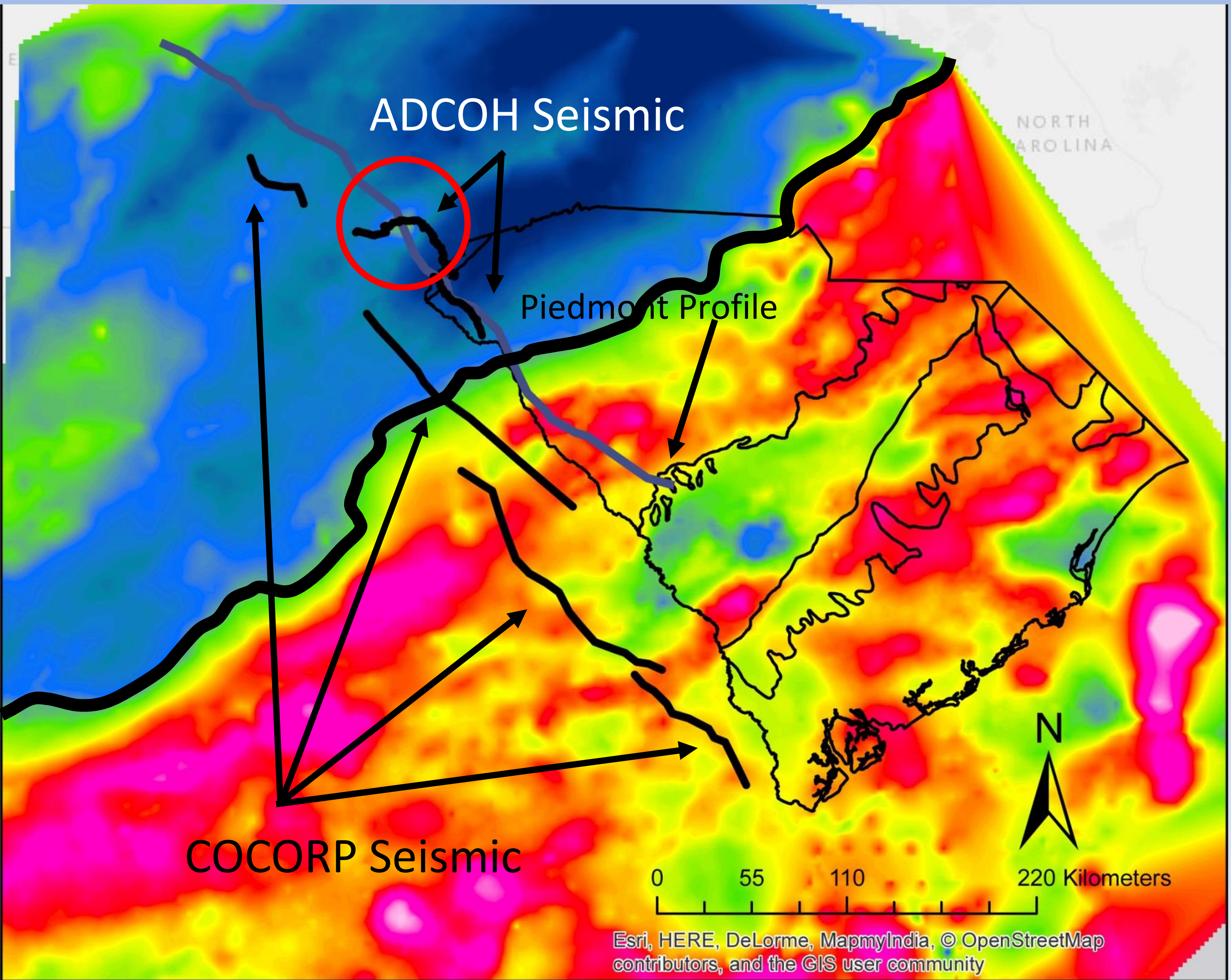
Major Findings

- Grenville basement extends at least as far east as the Carolina Terrane.
- Appalachian Paired Gravity Anomaly can be explained without a change in lower-crustal density (Grenville basement).
- The low-density Piedmont Blue Ridge Allochthon over-thrusts dense footwall duplex structures (Grenville basement) and not platform sediments.

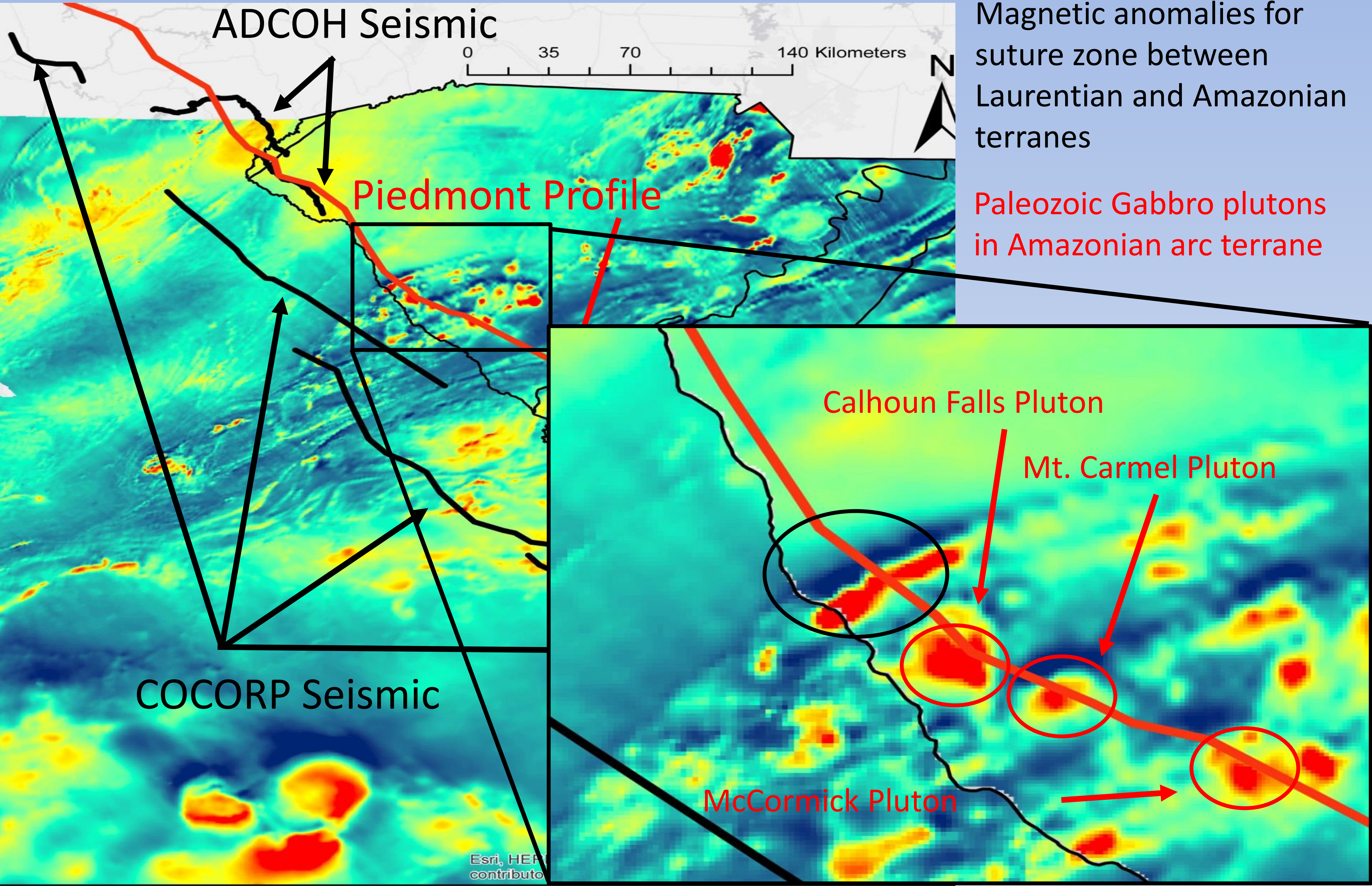
Regional Gravity Anomaly Map



Appalachian Paired Gravity Anomaly

Relative Gravity High within Appalachian Low

Regional Magnetic Anomaly Map



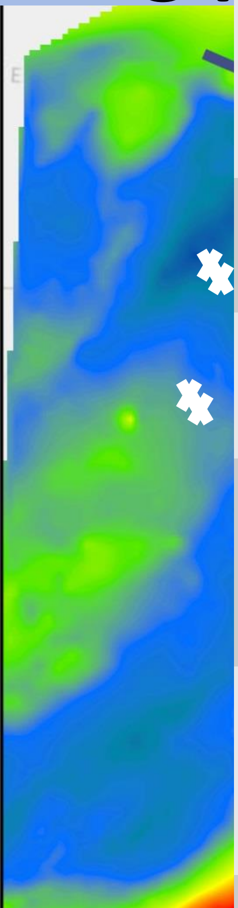
Magnetic anomalies for suture zone between Laurentian and Amazonian terranes

Paleozoic Gabbro plutons in Amazonian arc terrane

Ov… …Data

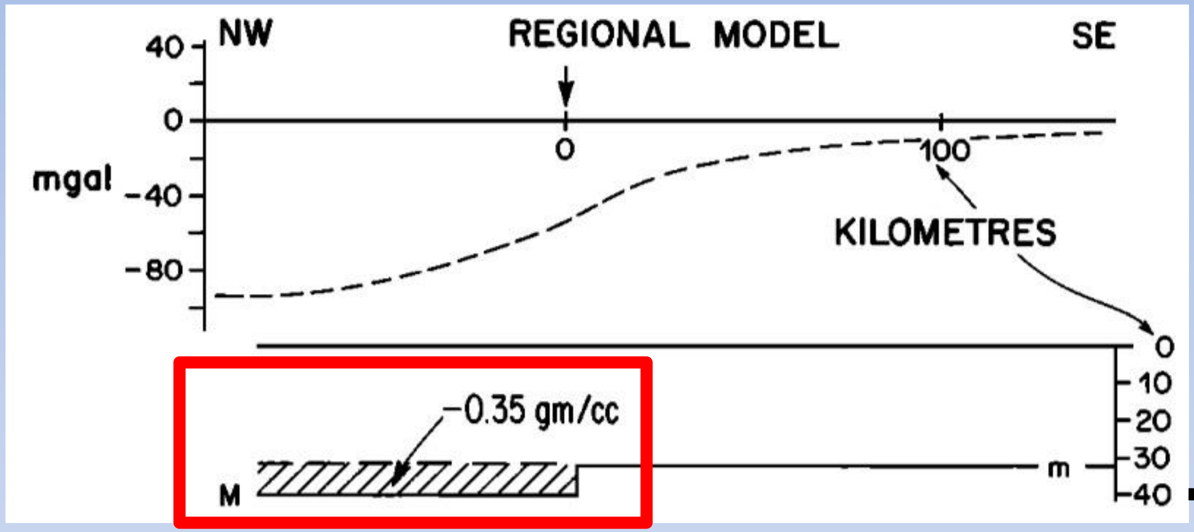
Densities Used in Gravity Forward Modelling

Unit	Density (g/cc)	Reference
Allochthonous Crust (Carolina Terrane)	2.79	Warren et al. (1966); Christensen (1989)
Mafic Intrusions	2.8-2.9	Christensen (1989) Duff (2014)
Paleozoic Sediments	2.6-2.8	Johnston and Christensen (1992)
Laurentian Crust	2.68-2.7	Warren et al. (1966); Christensen (1989)
Proterozoic Cambrian Graben Fill	2.7	Ginzburg et al. (1983); Christensen (1989)
Grenville Basement	2.96-3.04	Warren et al. (1966); Christensen (1989)
Mantle	3.4	Warren et al. (1966); Christensen (1989)



Seismic Refraction S…
(Parker and Hawma…
(Hawman and Khali…
(Hawman, 1996)
(Luetgert, 1994)

Previous Models of the Appalachian Paired Gravity Anomaly

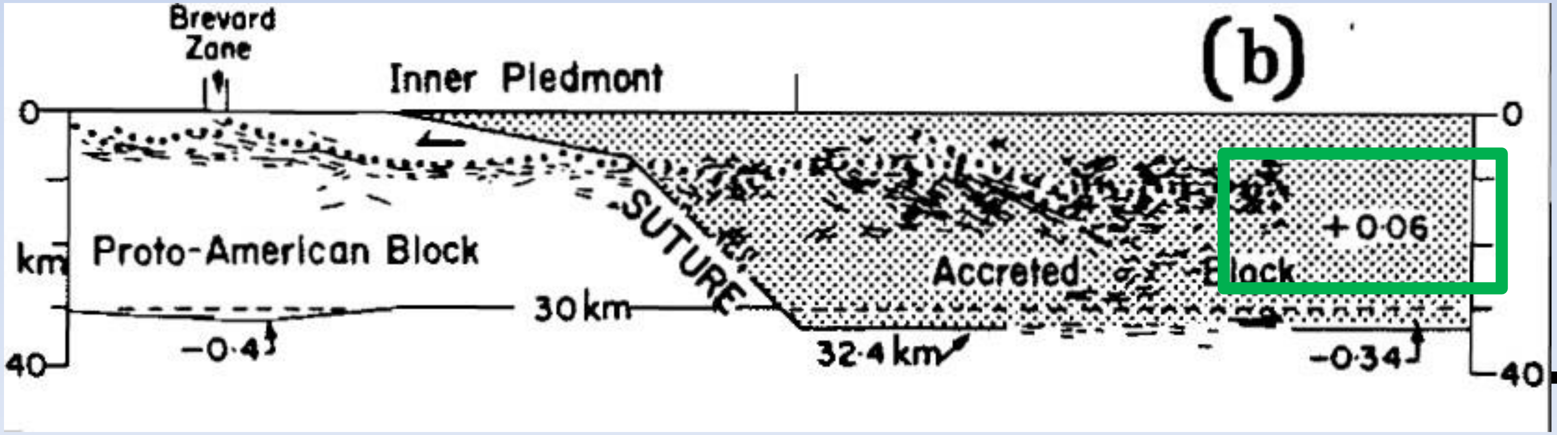


1) Low density crustal root

2) Dense accreted block

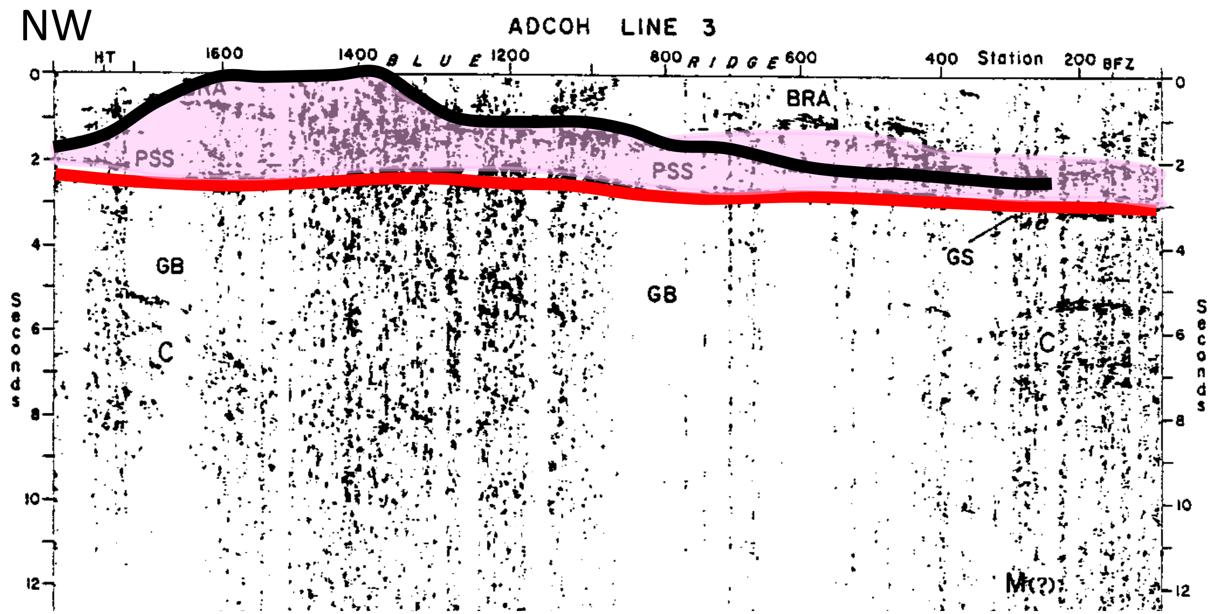
40 km

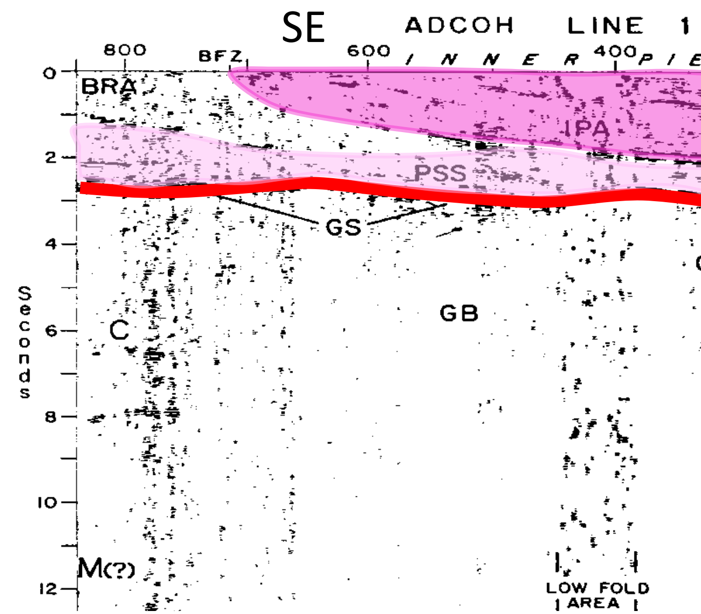
(Cook, 1984)



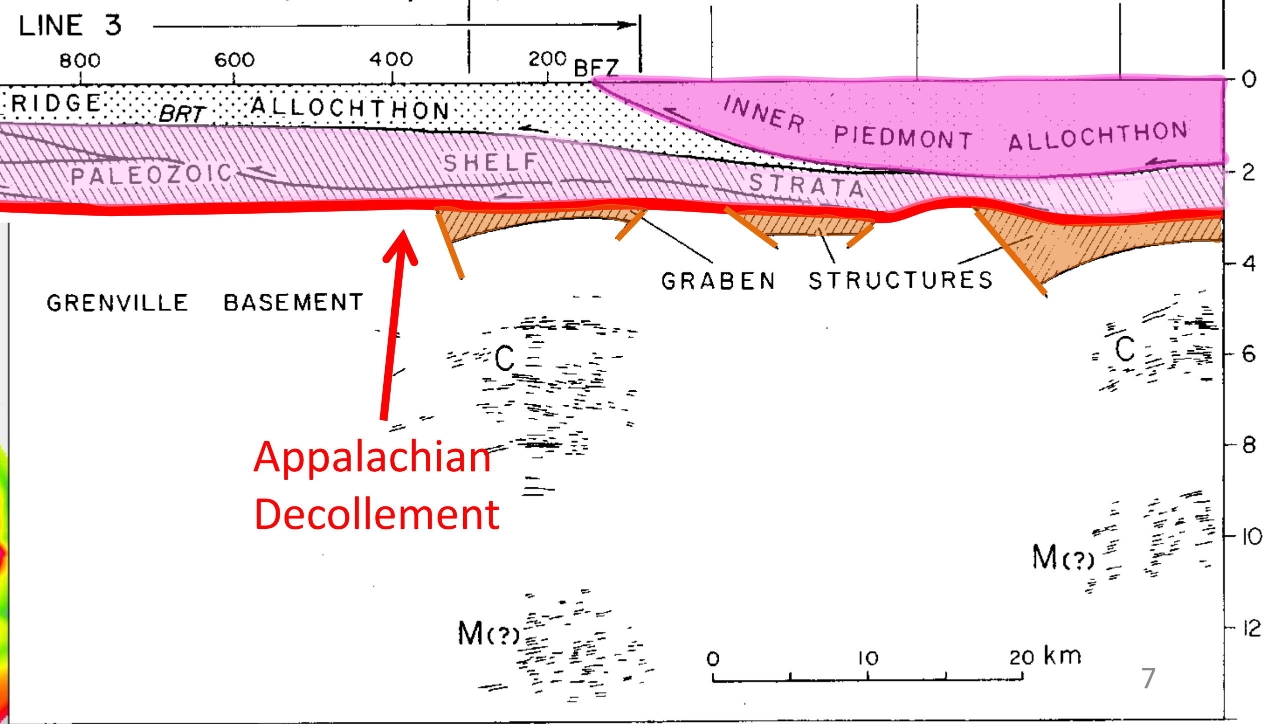
40 km

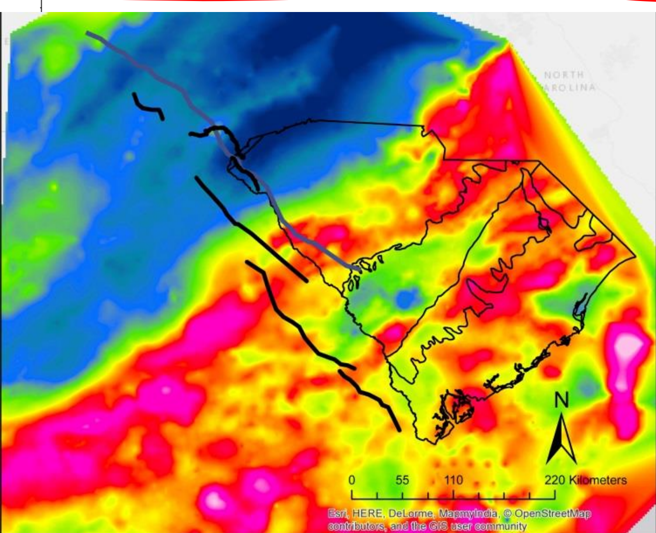
(Thomas, 1983)



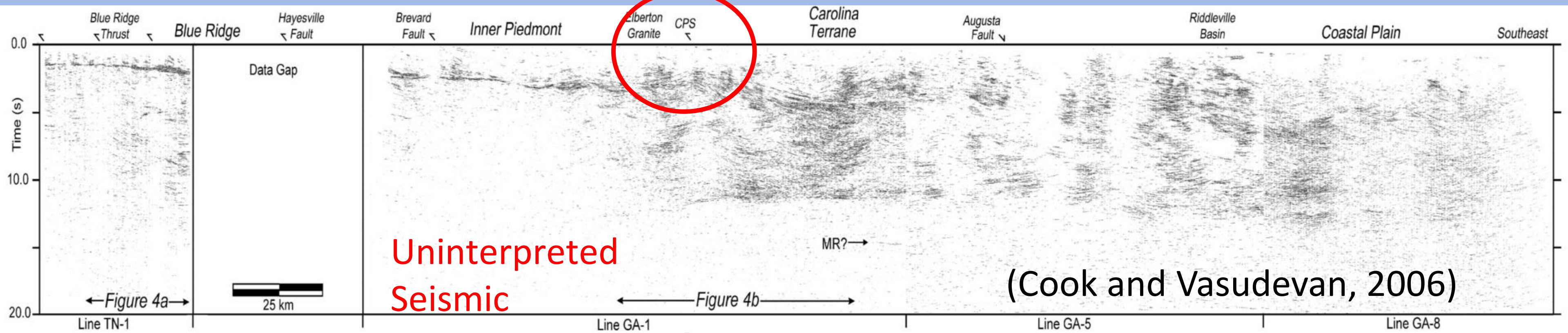


ADCOH Seismic (Costain and Hatcher, 1985)

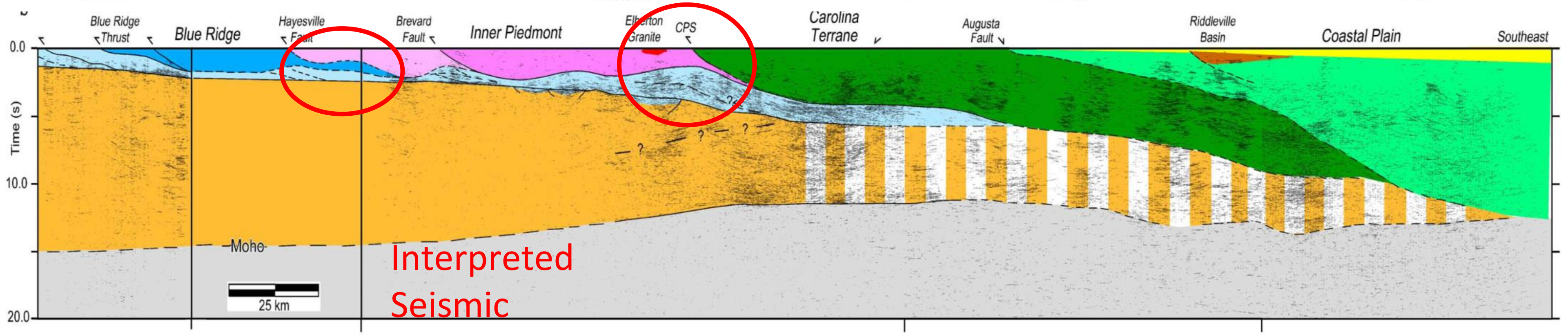


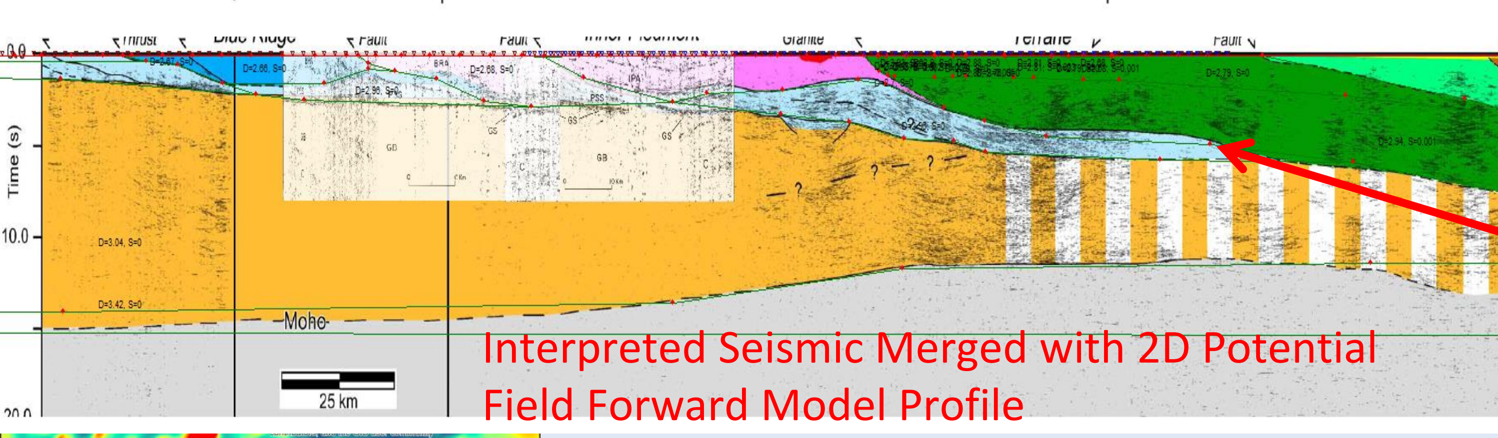


COCORP Seismic Data

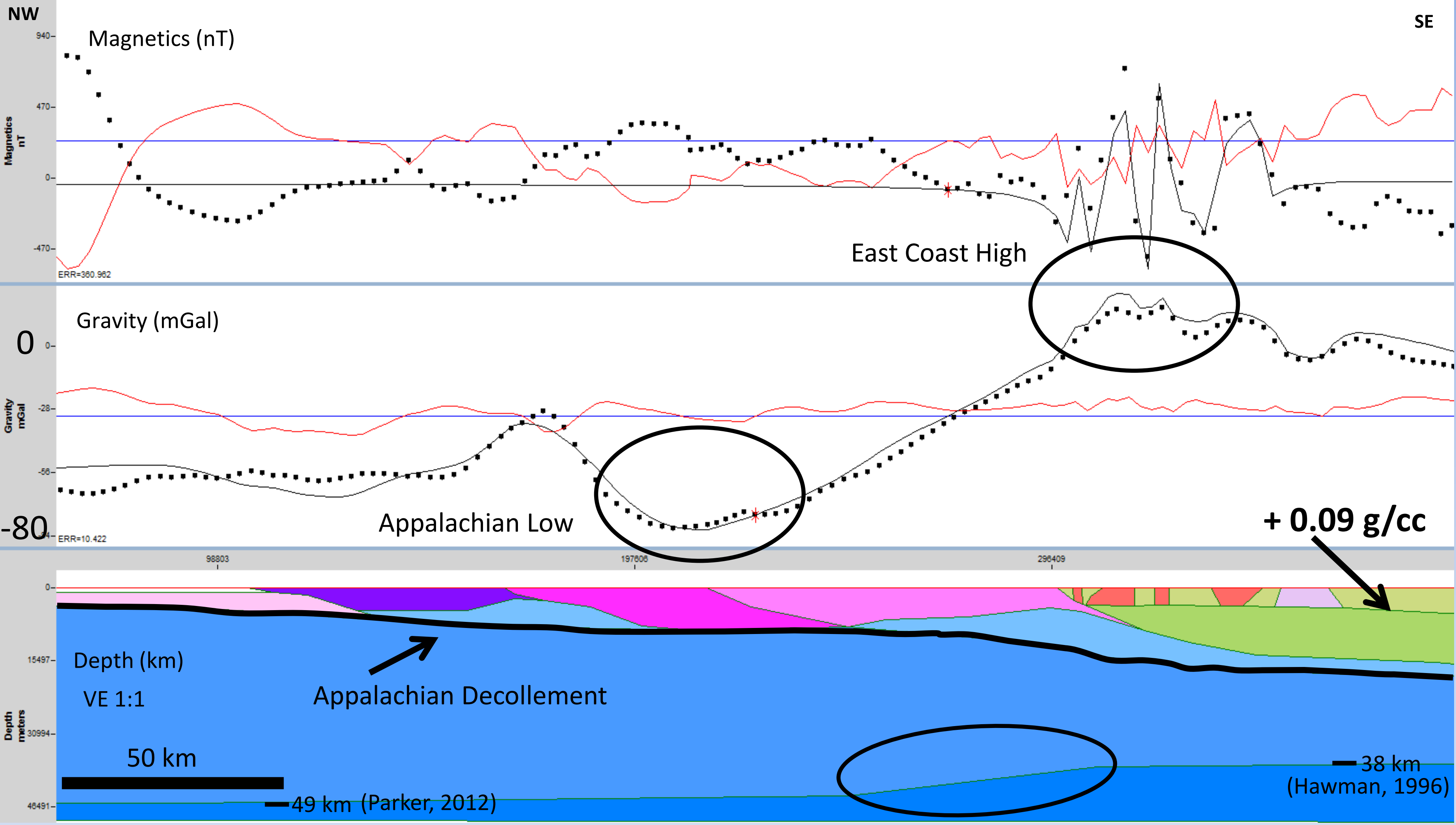


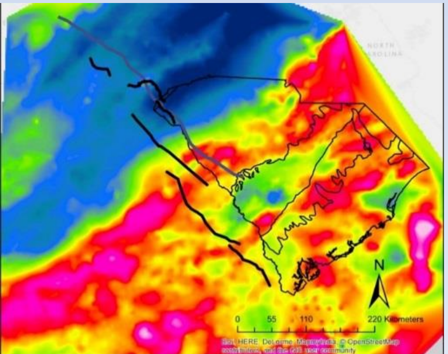
(Cook and Vasudevan, 2006)





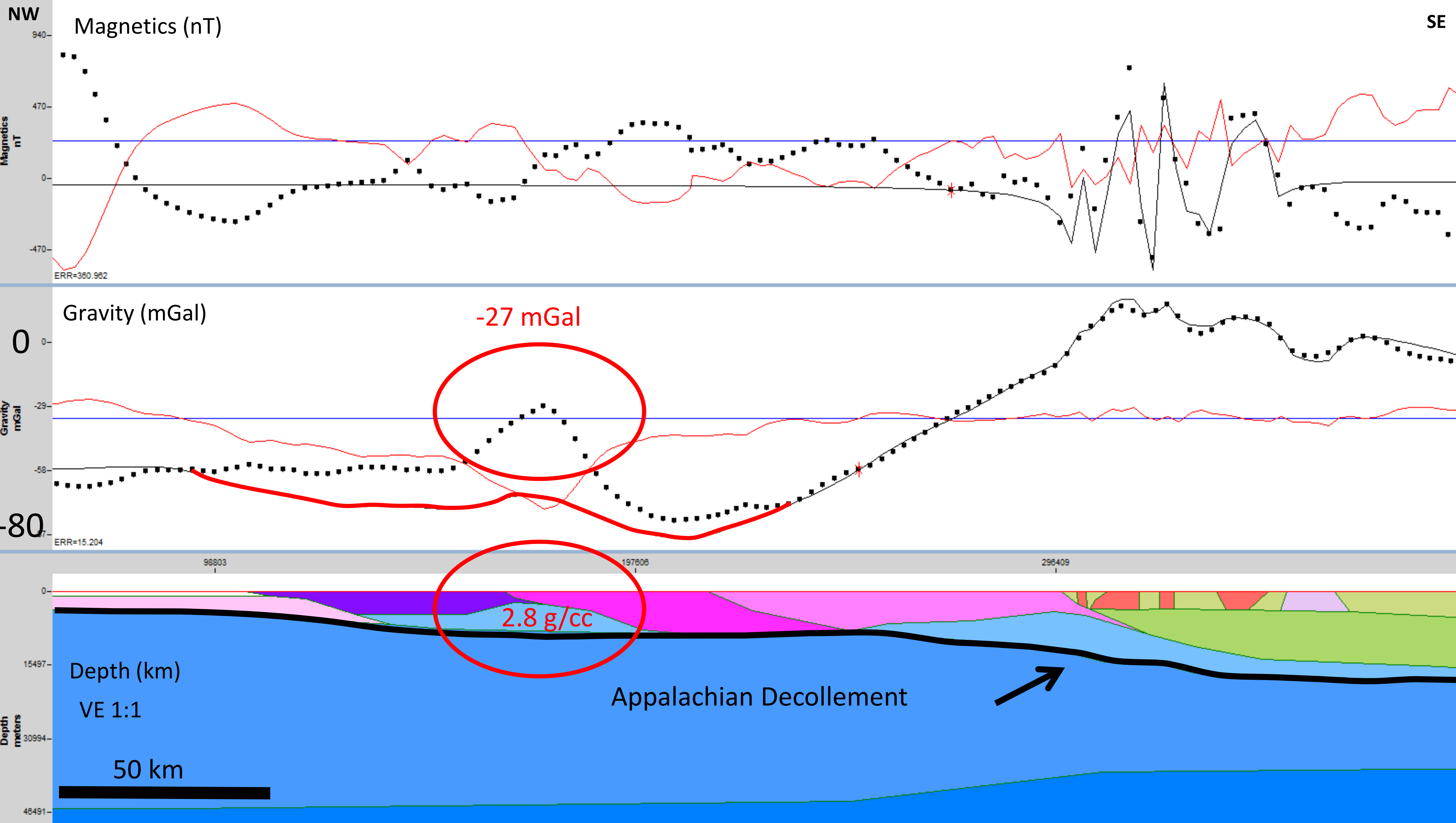
Model polygons are represented by red points and thin green lines.

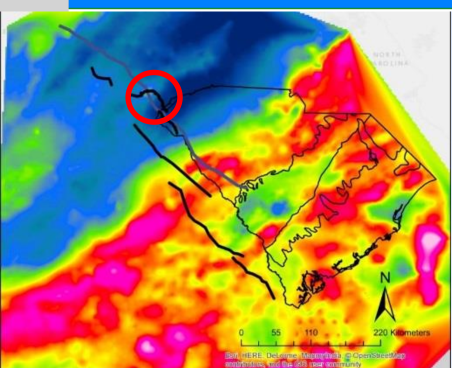




Appalachian Paired Gravity Anomaly - explained by:

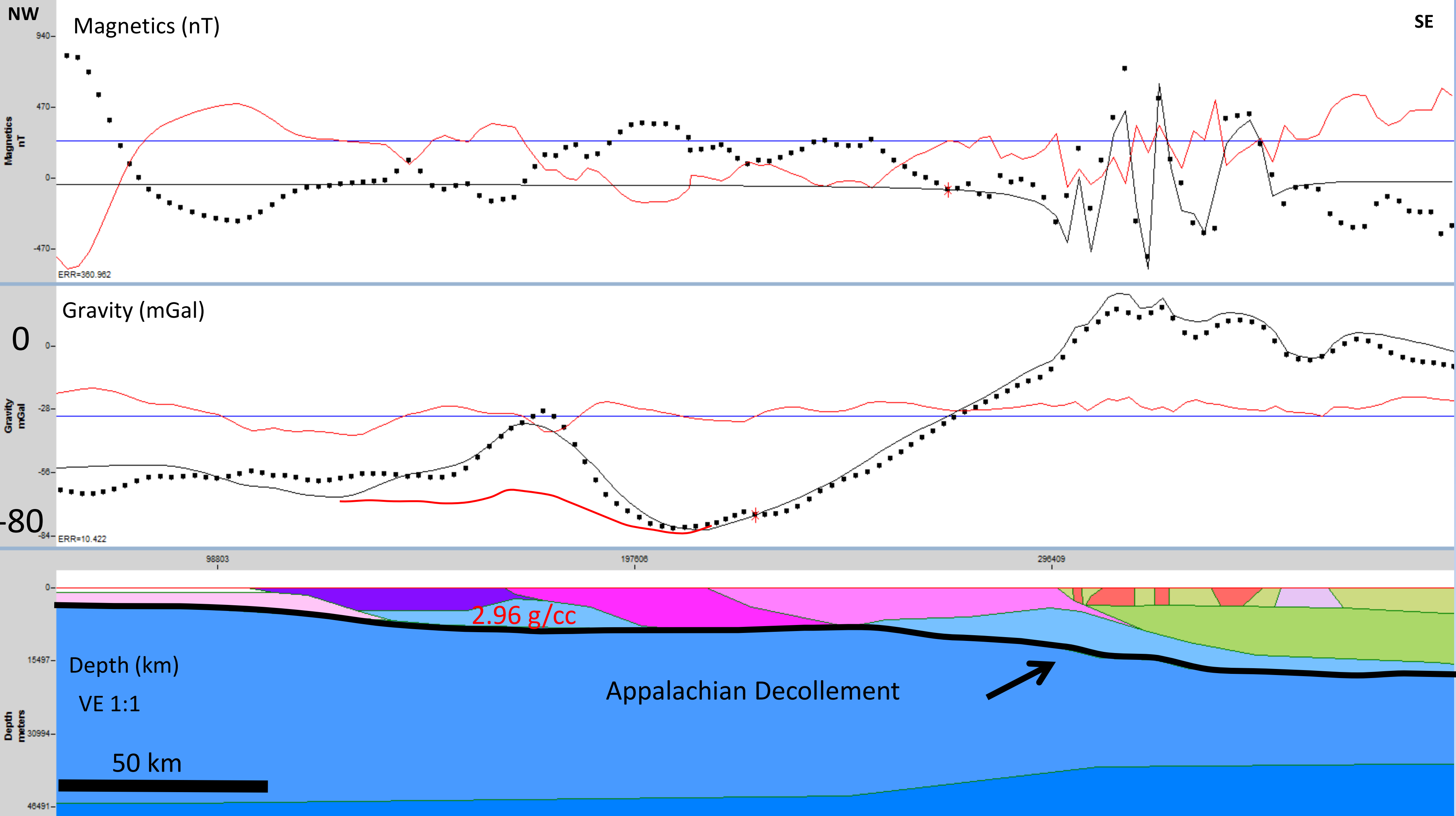
- thinner crust to the SE
- increase average density of the Carolina Terrane.
- does **not** require density change in lower crust

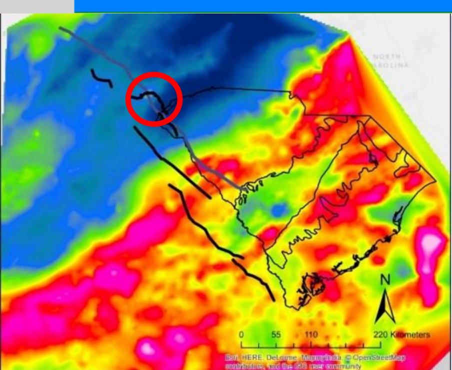




Relative Gravity High within Appalachian Low:

- Anomaly matches the shape of the seismically imaged footwall anticline
- Model density of 2.8 g/cc (Dolomite) is insufficient to model the anomaly

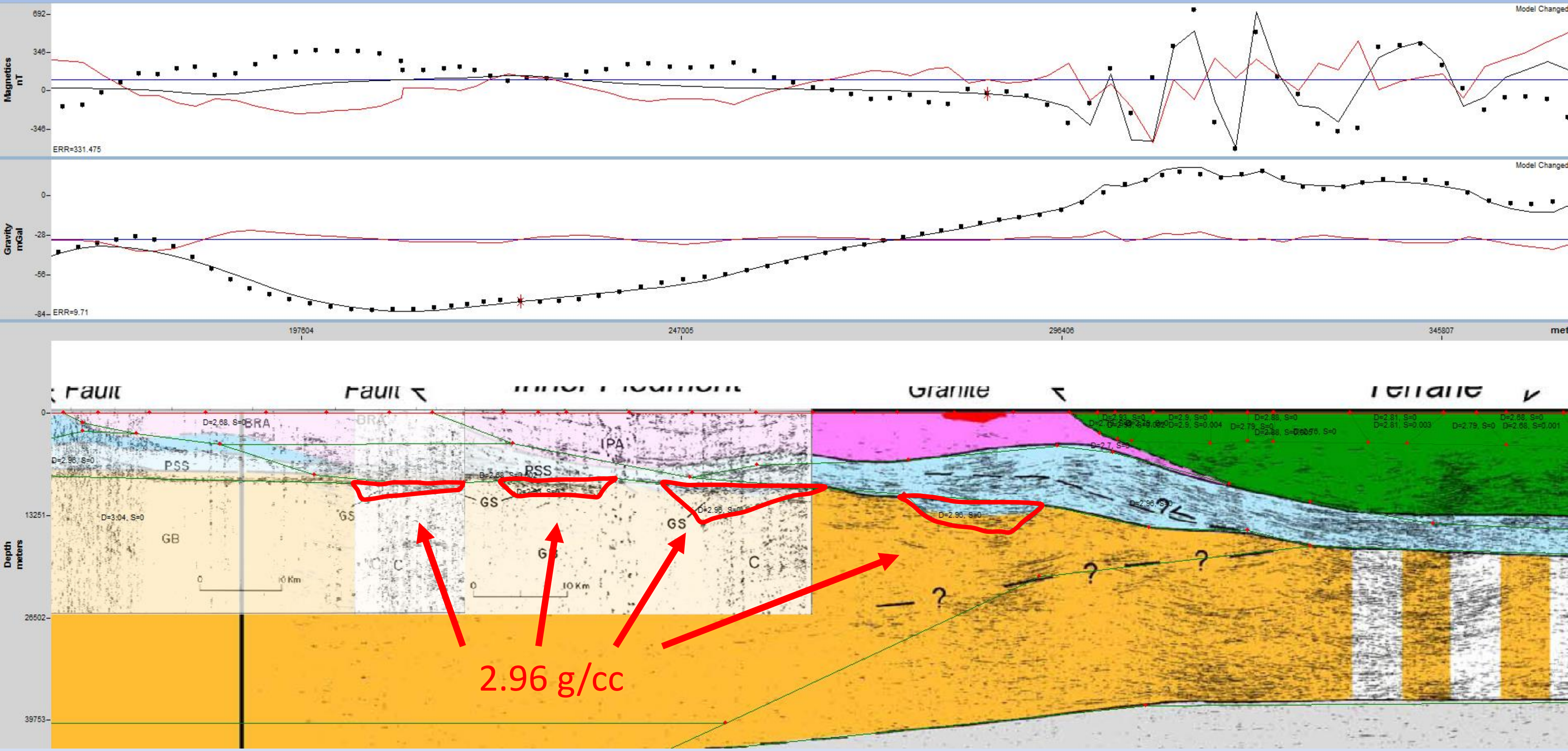




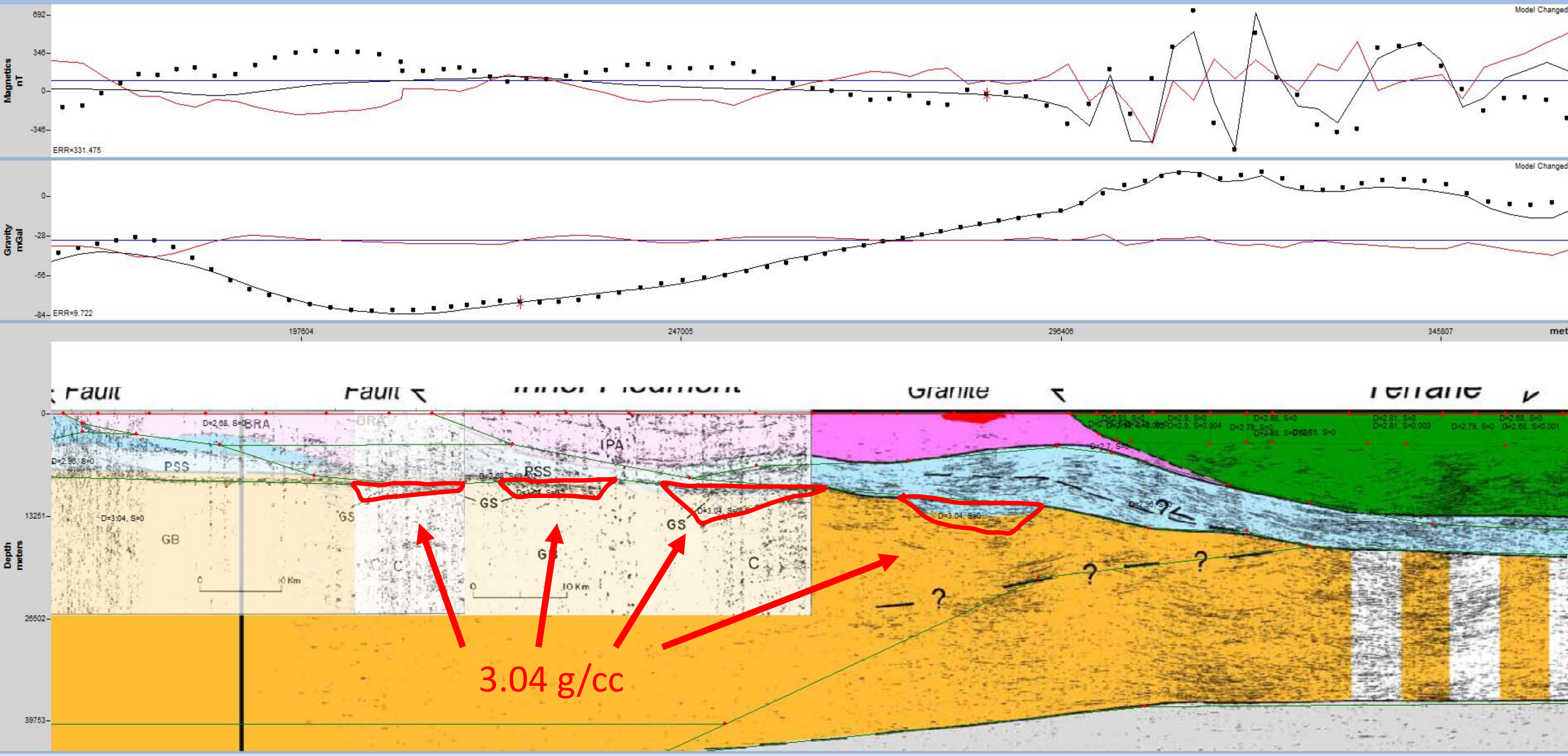
Relative Gravity High within Appalachian Low:

- Anomaly matches the shape of the seismically imaged footwall anticline
- Required model density of 2.96 g/cc is too dense to be Paleozoic shelf strata

Model with Basement Grabens

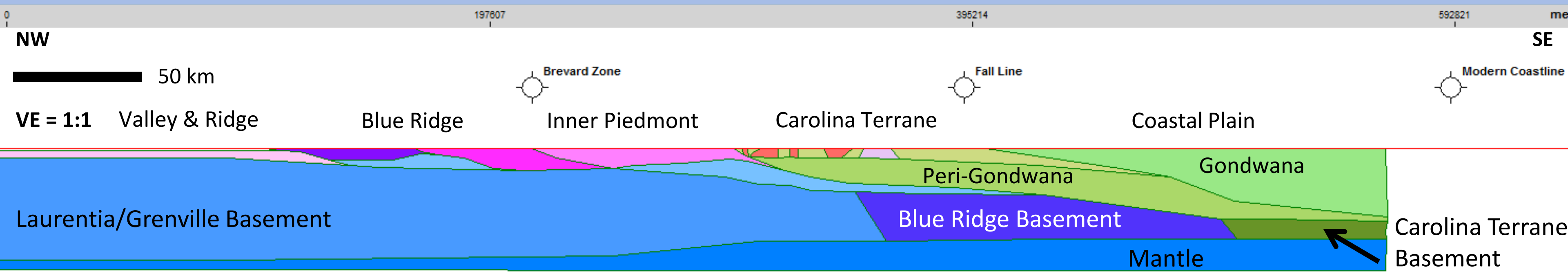


Model without Basement Grabens



Seismically defined basement grabens only produce a ~ 1 mGal anomaly, and cannot make a major contribution to the Appalachian gravity gradient as proposed by Favret and Williams (1988).

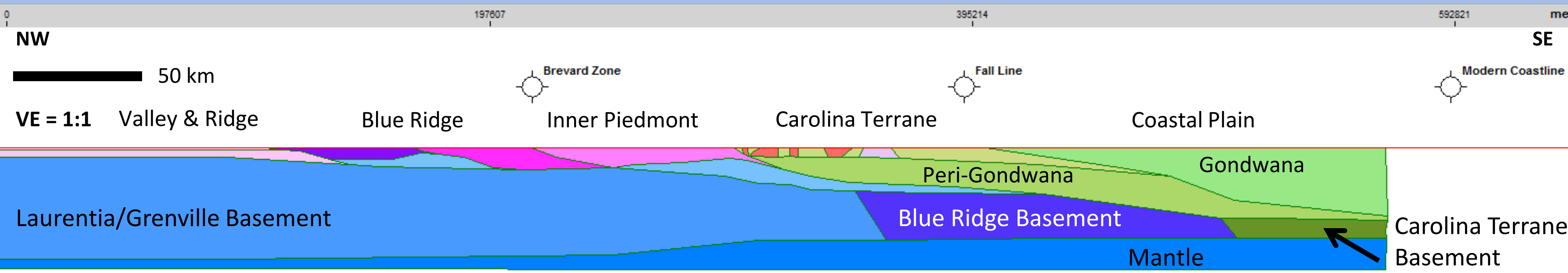
Conclusions and Implications



Appalachian Paired Gravity Anomaly -

- explained without a density contrast in the lower crust
- possible that Grenville basement rocks extend at least as far east as the Carolina Terrane

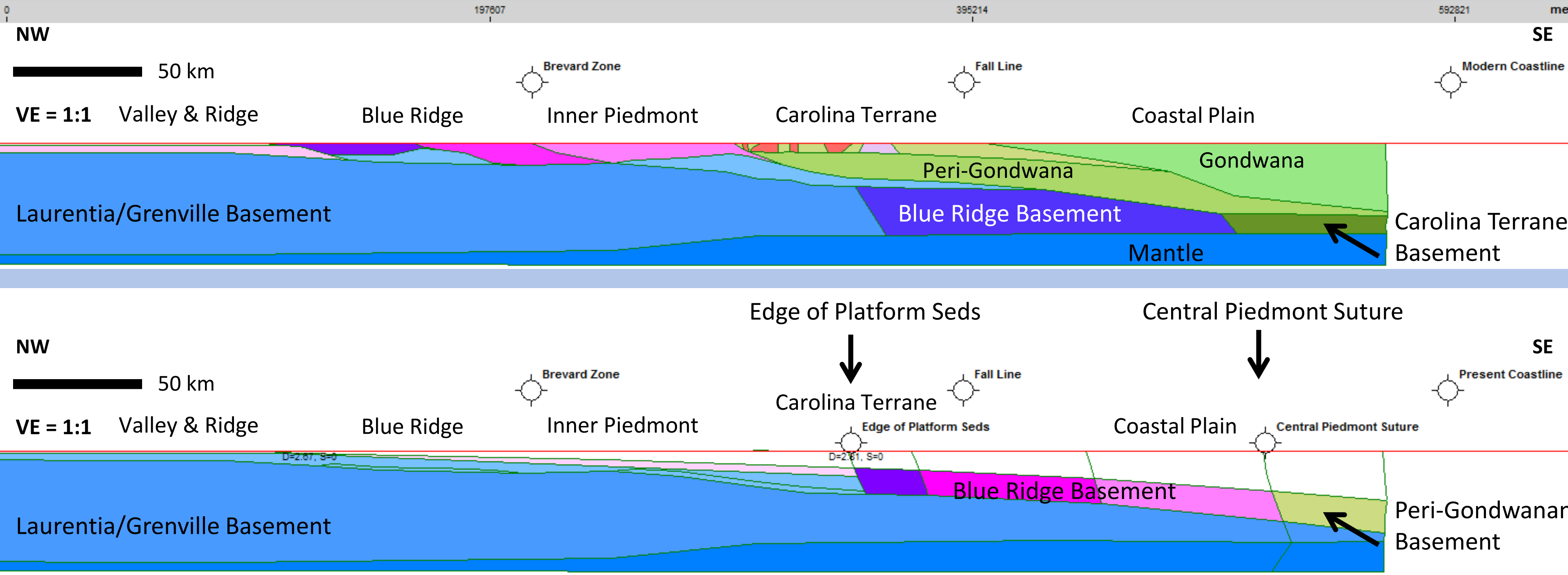
Conclusions and Implications



Relative Gravity High within Appalachian Low –

- dense material required is unlikely to be platform sediments
- eastern edge of platform sediments does not underlie the Blue Ridge, as previously assumed
- instead, the material forming the basement duplex or imbricate structures proposed by Costain and Hatcher (1985) may need to be reinterpreted as basement horse blocks and not Paleozoic shelf strata

Retro-Deformed Model



- Model illustrates block configuration at ~ 330 Ma, prior to final closure of the Paleo-Atlantic and Alleghanian Orogenesis.
- Retro-deformation was created by pulling out the 210 km of crustal shortening in the Appalachian Fold/Thrust Belt (Valley and Ridge), proposed by Hatcher (2007).
- Crustal shortening in the Blue Ridge, Inner Piedmont, and Carolina Terrane is not taken into account.
- Thus, this model represents minimum estimates of the eastward extent of platform sediments and the Central Piedmont Suture.

Acknowledgements

Thank you to SCDNR – SC Geological Survey, Bill Clendenin and Scott Howard, for supporting this research.

References

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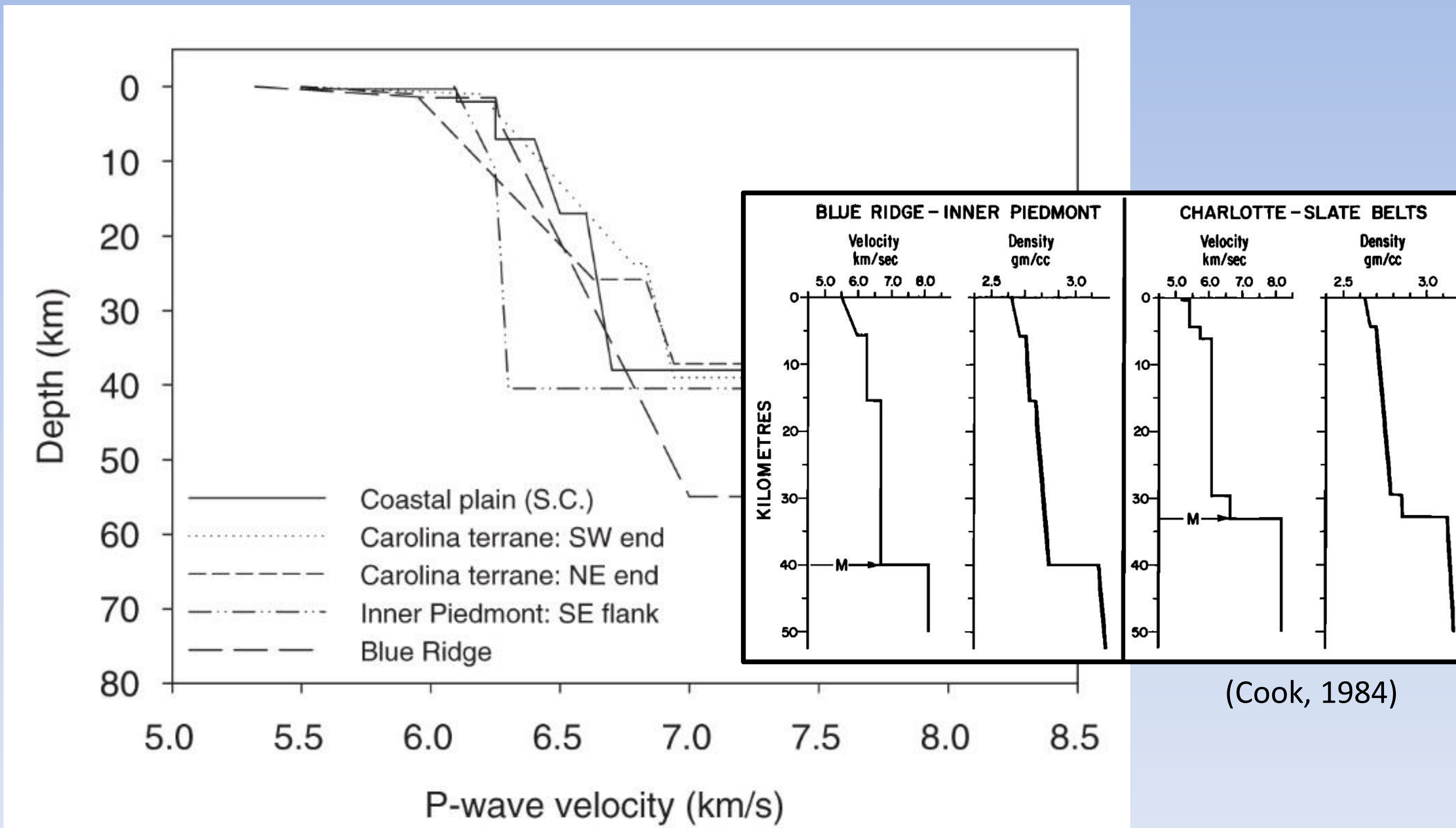
Velocity Structure of BR, IP, CT



(Cook, 1984)

(Hawman Khalifa, 2012)

Shelf Strata under CPS