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

ADCOH Seismic

COCORP Seismic

Piedmont Profile
Magnetic anomalies for suture zone between Laurentian and Amazonian terranes

Paleozoic Gabbro plutons in Amazonian arc terrane
## Densities Used in Gravity Forward Modelling

<table>
<thead>
<tr>
<th>Unit</th>
<th>Density (g/cc)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allochthonous Crust (Carolina Terrane)</td>
<td>2.79</td>
<td>Warren et al. (1966); Christensen (1989)</td>
</tr>
<tr>
<td>Mafic Intrusions</td>
<td>2.8-2.9</td>
<td>Christensen (1989); Duff (2014)</td>
</tr>
<tr>
<td>Paleozoic Sediments</td>
<td>2.6-2.8</td>
<td>Johnston and Christensen (1992)</td>
</tr>
<tr>
<td>Laurentian Crust</td>
<td>2.68-2.7</td>
<td>Warren et al. (1966); Christensen (1989)</td>
</tr>
<tr>
<td>Proterozoic Cambrian Graben Fill</td>
<td>2.7</td>
<td>Ginzburg et al. (1983); Christensen (1989)</td>
</tr>
<tr>
<td>Grenville Basement</td>
<td>2.96-3.04</td>
<td>Warren et al. (1966); Christensen (1989)</td>
</tr>
<tr>
<td>Mantle</td>
<td>3.4</td>
<td>Warren et al. (1966); Christensen (1989)</td>
</tr>
</tbody>
</table>
Previous Models of the Appalachian Paired Gravity Anomaly

1) Low density crustal root

2) Dense accreted block

(Cook, 1984)

(Thomas, 1983)
ADCOH Seismic (Costain and Hatcher, 1985)

Appalachian Decollement
COCORP Seismic Data

Uninterpreted Seismic

Interpreted Seismic

Interpreted Seismic Merged with 2D Potential Field Forward Model Profile

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

(Cook and Vasudevan, 2006)
Gravity (mGal)

Appalachian Decollement

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

Magnetics (nT)

East Coast High

Appalachian Low

0

+ 0.09 g/cc

38 km (Hawman, 1996)

49 km (Parker, 2012)
Gravity (mGal)

Depth (km)

-27 mGal

2.8 g/cc

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
Gravity (mGal) and Depth (km) graphs are shown. The Gravity graph indicates an anomaly that matches the shape of the seismically imaged footwall anticline. The required model density of 2.96 g/cc is too dense to be Paleozoic shelf strata.

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

2.96 g/cc
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).
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
- 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

- Hatcher, Robert D., Peter J. Lemiski, and Jennifer Whisner, Character of rigid boundaries and internal deformation of the southern Appalachian fold and thrust belt, 2007, GSA Special Publication 433.
Velocity Structure of BR, IP, CT

(Cook, 1984)

(Hawman Khalifa, 2012)
Shelf Strata under CPS