NEW TECTONIC MAP OF THE SOUTHERN AND CENTRAL APPALACHIANS (v. 4.5 WIP*)

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Abstract

A new 1:1,000,000-scale tectonic map of the southern and central Appalachians (SCA) incorporates modern field and structural-stratigraphic, geochronologic (mostly SHRIMP ion microprobe and ε Nd), geochemical, and geophysical data to identify crustal boundaries and blocks. Major tectonic units include the ~735 Ma Laurentian failed rift, ~565 Ma rifted margin sedimentary-volcanic assemblage deposited on Grenvillian and pre-Grenvillian crust, the Laurentian platform, and a series of distal Laurentian terranes (Cowrock, Cartoogechaye, Tugaloo-Chopawamsic-Potomac) accreted to Laurentia during the Taconian (Ordovician) or Neoacadian (Late Devonian-Early Carboniferous) orogenies. The Dahlonega gold belt contains Ordovician arc volcanic rocks, but a mixed detrital zircon suite of Laurentian and Gondwanan affinities. The newly recognized Cat Square terrane contains Laurentian, Avalonian, and 430 Ma, detrital zircons, and considered a remnant ocean that closed during Neoacadian accretion of the Carolina superterrane (CST). The Pine Mountain terrane (southernmost exposed Appalachians) consists of Grenvillian basement and a cover sequence bearing Gondwanan detrital zircons. The CST contains numerous Peri-Gondwanan terranes that were deformed, metamorphosed, and amalgamated prior to 530 Ma, then accreted to Laurentia during the Neoacadian along the central Piedmont suture. The Raleigh-Goochland terrane contains blocks of Laurentian basement and cover moved SW (dextrally) out of the collision zone to the N as the Theic ocean closed N to S during the early Alleghanian orogeny. This event also produced the Kiokee–Raleigh belt high-grade metamorphic core in the eastern Piedmont, and NE of the Pine Mountain window. The latter is framed by Alleghanian thrust and dextral faults, formed at different crustal depths (times?). Subsurface components of the SCA are delimited by potential field and limited drill data. The CST extends beneath the Coastal Plain—possibly to the East Coast Magnetic Anomaly (ECMA). The E–W Alleghanian suture with the Suwannee terrane is recognizable to the south beneath Georgia and Alabama in potential field data, truncating all NE–SW-trending Appalachian structures.

Acknowledgments

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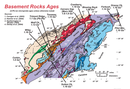
"If you do not like my model, build your own."

John Rodgers

New Geochronologic & Isotopic Data that Influence Map Construction

Basement Rocks Ages



Bottom Line from Basement Age Data

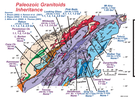
SHRIMP zircon ages of Neoproterozoic (~565 Ma) rhyolites in the Ocoee Supergroup, central Appalachians, suggest that the Laurentian failed rift, which formed the Iapetus ocean, was a limited rift basin. Data also indicate some of the Grenville to the Laurentian basement.

Detrital Zircons (all have 1.1 Ga)

Bottom Line from Detrital Zircon Age Data

SHRIMP ages of detrital zircons from mostly sandstones and quartzites in the Ocoee Supergroup, Great Smoky Mountains, Georgia and Tugaloo terrane (North Carolina to Lauraville Gneiss, Maryland) show a mixed Laurentian and Gondwanan Courses to the Laurentian basement to the west. The Gondwanan component is Neoproterozoic and Cambrian. In addition to a dominant Laurentian source population, there is a significant Gondwanan component in the Tugaloo terrane (Tugaloo province, Greenville, Alabama (Cowdrey), and Ocoee Supergroup, Great Smoky). Data in the Pelmanon Grenville of the Carolina superterrane.

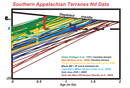
Paleozoic Granitoids Inheritance



Bottom Line from Paleozoic Plutons SHRIMP Zircon Age and Inheritance Data

Ordovician plutons intrude the Tugaloo terrane, with a dominant Laurentian inherited component. Devonian and Carboniferous plutons occur in the Tugaloo terrane and Carolina superterrane. Devonian plutons are peraluminous and alumina-rich. Neoproterozoic (565, 560–550 Ma) and Ordovician (~450 Ma) inherited components are dominant. Remarkably little Grenville in Inner Piedmont plutons. Devonian plutons are dominant (Carolina) in the eastern Tugaloo terrane (east of the Central Fault).

Southern Appalachian Terranes Nd Data



Bottom Line from ε Nd Data

Tugaloo terrane (Ocoee Supergroup) metasediments, Carolina superterrane, and Cat Square terrane have ε Nd values of -10 to -15 at the time of deposition. Mid-Ordovician arc rocks (Carolina) have ε Nd values near zero. Mid-to-late Proterozoic rocks of a rejected remnant ocean crust (Cat Square) have an expected neutral ε Nd value near zero.

Tectonic Map Explanation

(NOTE: Subsurface continuation of terranes shown in lighter shade of same color)

Triassic–Jurassic basins (rifting of Pangaea)

Laurentian Platform & Rifted Margin

Clastic Wedges
- Alleghanian (Pa-Pe)
- Acadian (Late Dev)
- Taconian
- Martinsburg–Tuscarora (Caradoc to Llandoverly)
- Blountian–Sevier–Rockmart (Llanvirn–Llandeilo)

Platform Rocks
- Cambrian-Ordovician clastic to carbonate

Rifted Margin Rocks
- Neoproterozoic–Early Cambrian clastic & volcanic rocks

Basement Rocks
- 1.1 Ga with older inheritance
- 1.8 Ga Mars Hill terrane

Terranes (Laurentian affiliy) Probably Accreted During Taconian Events

- Westminster terrane & Hamburg klipe
- Dahlonega gold belt (possible Gondwanan affinity)
- Cowrock terrane
- Cartoogechaye terrane
- Chopawamsic terrane (possible Avalonian affinity)
- (New colors will be assigned to these.)
- Potomac terrane

Plutons

- 190-170 Ma dikes, sills, & flows
- 285–265 Ma granitoid plutons (Modern age dates)
- 325–285 Ma granitoid plutons (Modern age dates)
- 350-325 Ma granitoid plutons (Modern age dates)
- 380-355 Ma granitoid plutons (Modern age dates)
- Silurian plutons (modern age dates)
- Likely Ordovician plutons (no age dates)
- Ordovician plutons (modern age dates)
- Ultramafic rocks
- 700-530 Ma arc-related granitoids (Mostly Carolina superterrane.)
- ~735 Ma failed rifting-related alkalic plutons

Terranes Accreted During Neoacadian to Alleghanian Events

- Cat Square terrane (mixed Laurentian & Avalonian) (post-430 Ma deposition)
- Possible oceanic crust in Cat Square terrane
- Tugaloo terrane (Laurentian) (Neoproterozoic-Cambrian–Middle Ordovician deposition & volcanism

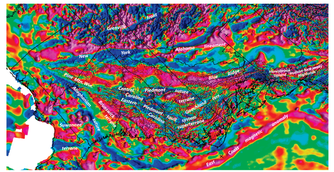
Carolina superterrane (Peri-Gondwanan)
- Supracrustal (low grade) components Neoproterozoic deposition and volcanism to Ordovician deposition
- Infracrustal (high grade) components Neoproterozoic deposition and volcanism

Suwannee terrane (Gondwanan; units and configurations aftern Thomas, 1989)
- Ordovician–Devonian sedimentary rocks
- Neoproterozoic-Cambrian felsic volcanic rrocks
- Supracrustal (low grade) components Neoproterozoic deposition and volcanism to Ordovician deposition
- Middle Proterozoic Rokelides basement

Brunswick terrane
- Rocks of largely unknown composition and provenance

Part of the Magnetic Map of North America

Interpretation by Bob Hatcher



Compiled by the geological surveys of Canada, Mexico, and the USGS

Composition of Exposed Terranes

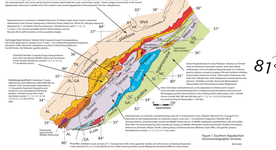
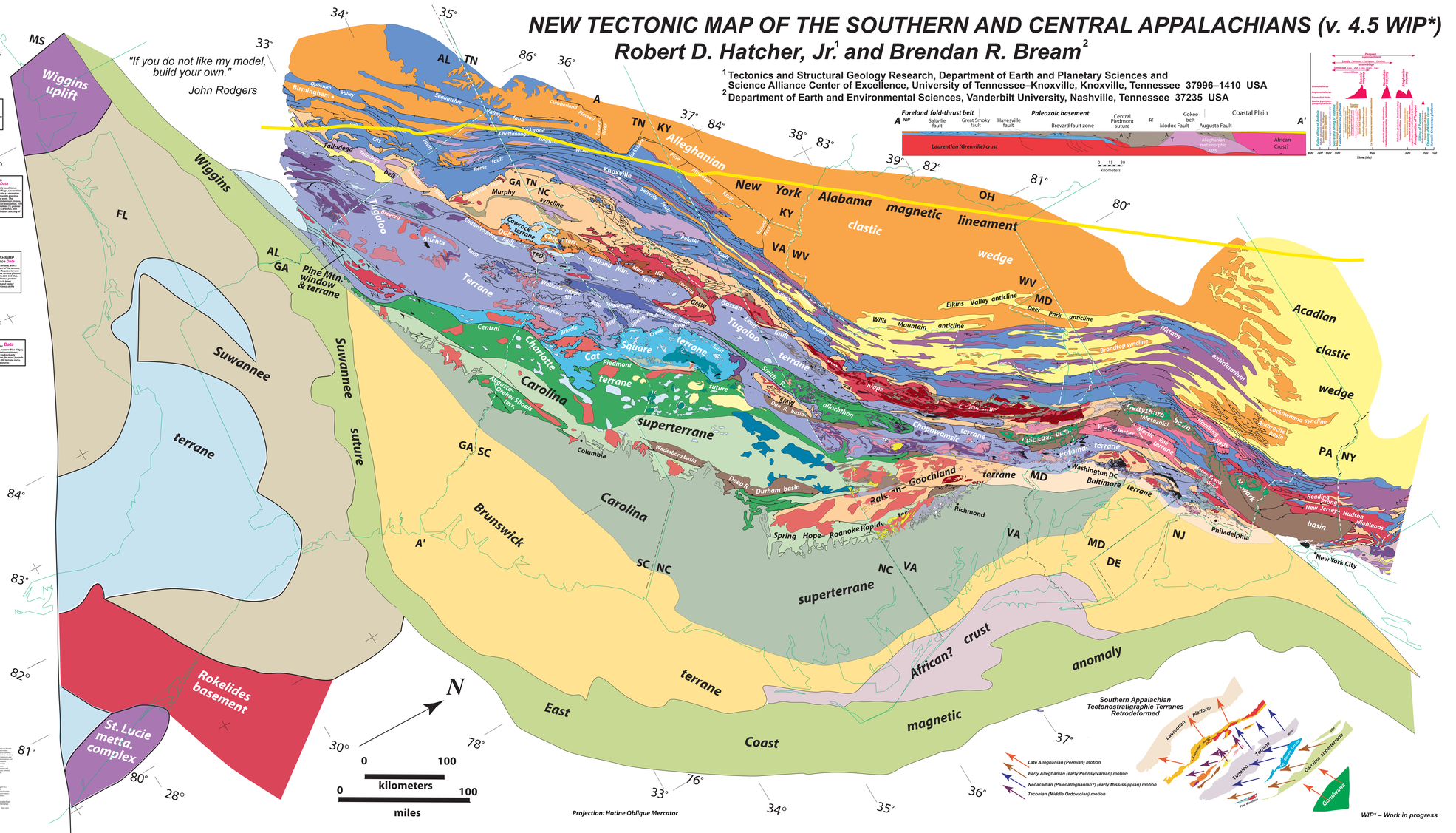


Figure 1. Southern Appalachian Microstratigraphic Terranes



WIP* – Work in progress