

Exploring Pre-Cretaceous Terranes and Basins Beneath the Atlantic Coastal Plain: Implications for Rift Initiation and Evolution

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Introduction

Poorly known pre-Cretaceous terranes and basins beneath Atlantic Coastal Plain sediments constitute one of the last geological frontiers in eastern North America.

To evaluate pre-Cretaceous rocks beneath the coastal plain from VA to southern NJ, we are completing a geospatial data set of >400 boreholes (>330 have pre-Cretaceous rock descriptions); performing petrographic, geochemical, and isotopic analyses of drill samples; reprocessing aeromagnetic and gravity data (experimenting with derivatives, filters, data combinations, colors, shading); and producing a 1:500,000-scale basement geologic map [1][2][3].



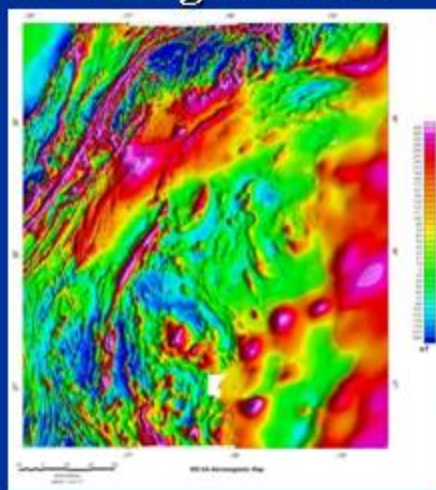
Geologic Mapping of Pre-Cretaceous Rocks Beneath the Atlantic Coastal Plain

Integrating analyses of borehole samples and their distribution with regional aeromagnetic and gravity data to produce...

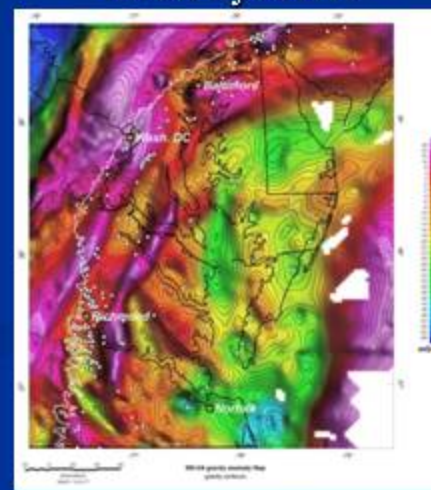
Borehole samples



Aeromagnetic data



Gravity data



- Interpretive geologic maps of rocks beneath the coastal plain
- Insights into crustal evolution, resource potential, and influence on passive-margin structure, coastal-plain aquifers, & neotectonics

Borehole Samples: Virginia to southern New Jersey

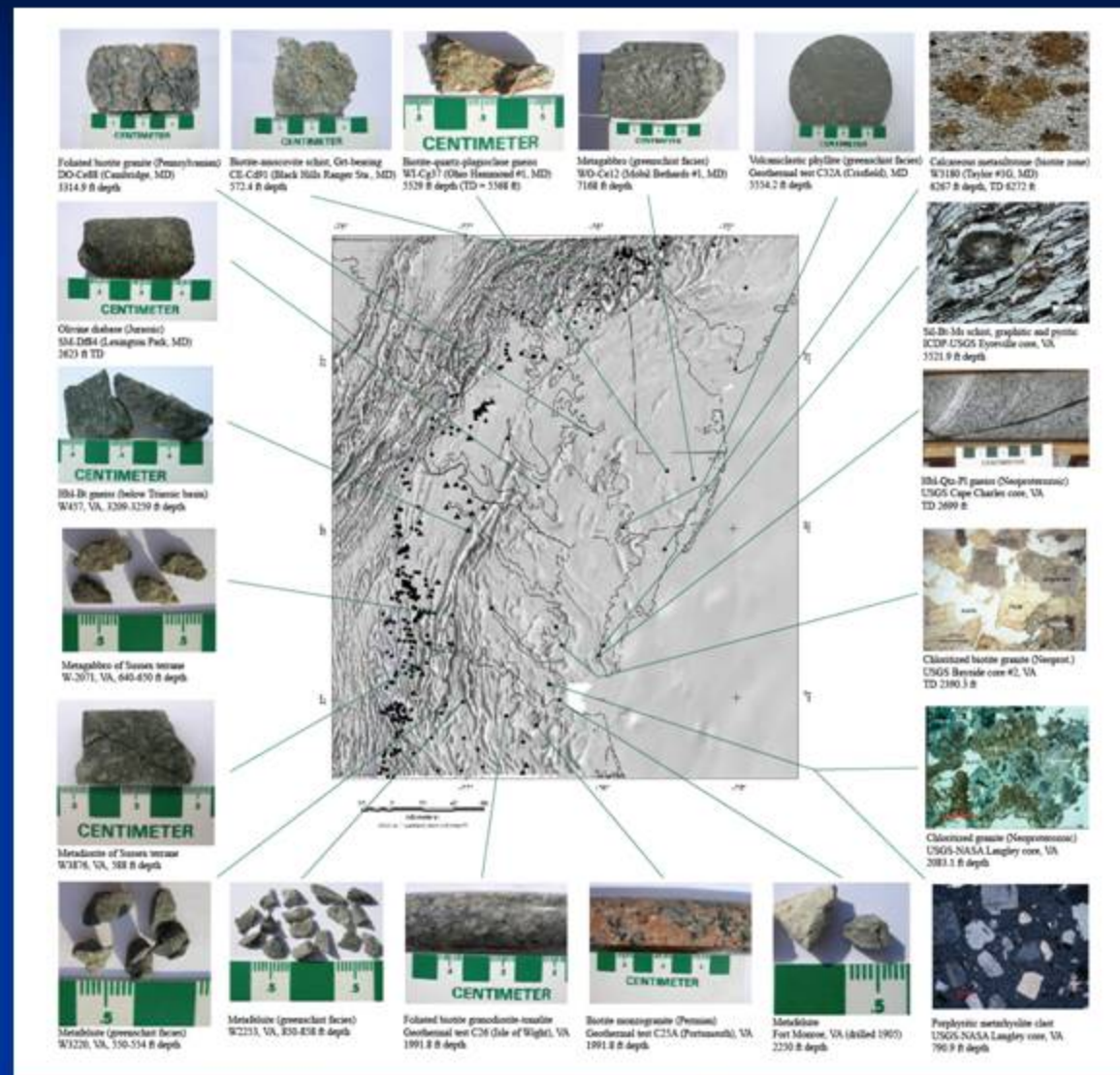
Geospatial database for
this region has:

>400 boreholes

>330 with pre-Cretaceous
rocks descriptions

Top of basement
elevations

Sources / reliability



Geologic mapping of pre-Cretaceous rocks beneath the Atlantic Coastal Plain, VA to southern NJ

Proterozoic and Paleozoic terranes

In this region, buried extensions of Piedmont terranes and early Mesozoic basins are flanked successively eastward by the concave-east Chesapeake Bay suture(?) zone and Sussex mafic complex, Neoproterozoic and Paleozoic rocks of the Chesapeake zone (mostly greenschist facies), and amphibolite-facies rocks of the Cape May (Mesoproterozoic?) and Hatteras (Neoproterozoic) zones.

Geologic mapping of pre-Cretaceous rocks beneath the Atlantic Coastal Plain, VA to southern NJ early Mesozoic rift basins

Most early Mesozoic rift basins in this area lack definitive magnetic and gravity anomalies, but the Taylorsville basin correlates with a gravity low and long-wavelength magnetic anomalies consistent with thick sedimentary rocks.

Early Mesozoic rift basins (e.g., South Georgia and Taylorsville basins) beneath the Atlantic Coastal Plain were protected from post-depositional erosion by the Cretaceous and younger sediment cap, and may preserve nearly the entire Mesozoic rift section.



Is there a Delmarva rift basin?

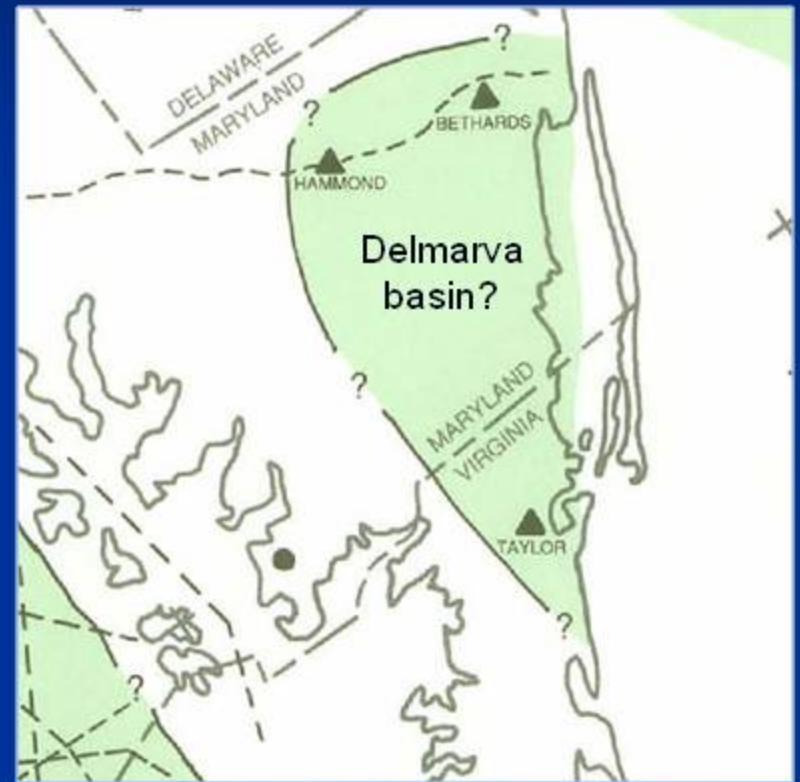
Benson's (1992) map [4] raises the question, "Is there a Delmarva rift basin?" Drilling reports from 3 deep wells suggested "Triassic" just above basement, but...

Lithology is not distinct from Cretaceous Potomac Group sands and clays.

Palynology indicates Lower Cretaceous to uppermost Jurassic [5].

Vitrinite reflectance is linearly continuous with shallower data [6].

The Delmarva basin was removed from our map, but more palynology could help.



from Benson, 1992 [4]

Structural Inheritance

Structural inheritance is exemplified by the Hylas fault zone, wherein late Paleozoic dextral transpression was followed by early Mesozoic normal faulting on the western border of the Taylorsville rift basin.

Recurrent Cretaceous to Cenozoic movements occurred on steep coastal-plain faults rooted in older structures such as the Hylas and Spotsylvania fault zones [7][8].



Looking Forward

We are interested in expanding collaboration on geospatial data sets, analyses of drill samples (e.g., geochronology, isotopic studies), geophysical studies, geologic mapping, and syntheses of pre-Cretaceous terranes and basins beneath the coastal plain beyond the mid-Atlantic region.

In GA and SC, for example, studies are needed to test the influence of older geologic features on coastal-plain structures, aquifers, and neotectonics; and improve the geologic framework for water, energy, environmental, geohazard, and CO₂ storage.

Studies are also needed to decipher buried features such as the Suwannee suture, Brunswick (Charleston) terrane [9], fault systems, and relations of late Paleozoic transpression to early Mesozoic rift initiation.



Scientific Issues for Rift Initiation & Evolution

Scientific issues for rift initiation and evolution in eastern North America include the transition from late Paleozoic transpression to early Mesozoic extension, nature of the continent-ocean transition (e.g., East Coast magnetic anomaly and seaward-dipping reflectors), and structural inheritance. For example, how did Paleozoic and older terranes and their boundaries influence the geometry of early Mesozoic extensional basins and normal faults; and how did subsequent movement on these structures during the Cretaceous and Cenozoic produce compressional, high-angle reverse faults documented in overlying coastal-plain sediments [7][8]?



Scientific Targets for EarthScope USArray

The Earthscope USArray transportable and flexible seismograph networks can potentially address variations in lithospheric structure and crustal thickness across terranes, sutures (including the Suwannee-Wiggins and proposed Chesapeake Bay sutures), failed rift basins (including the extensive South Georgia and Taylorsville basins), zones of Cenozoic faulting (e.g., Stafford and Brandywine fault zones) and intraplate seismicity, and features such as the New York-Alabama lineament [10], Altamaha magnetic anomaly [11], and Chesapeake Bay impact structure [12].

Study targets can be considered either individually or collectively in corridors.



Challenges for the EarthScope USArray

Challenges include bridging the gap between deep lithosphere and upper crustal geologic investigations (e.g., using gravity and magnetic surveys, seismic reflection and refraction, or scientific drilling) and how to best use USArray's Flexible Array to augment the Transportable Array for particular scientific issues.

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