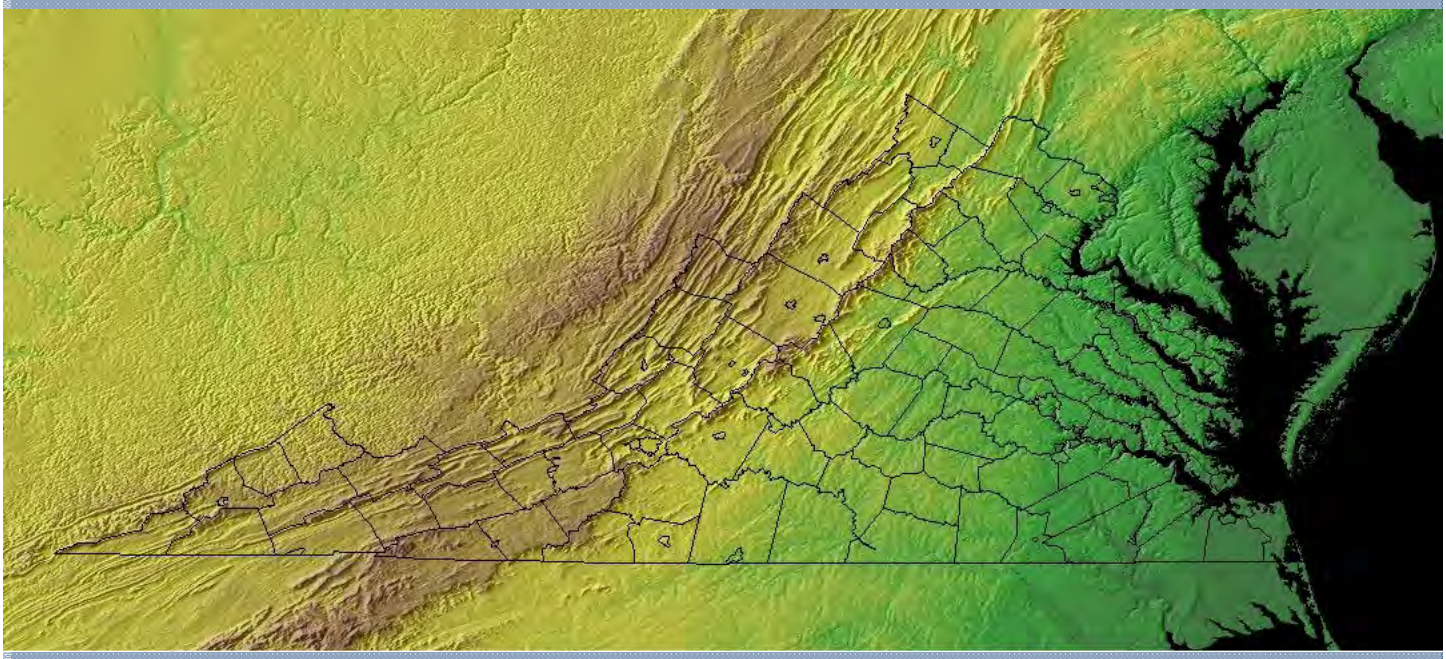
A TRIP THROUGH VIRGINIA GEOLOGY

FROM AN ENGINEER'S PERSPECTIVE



AMERICAN SOCIETY OF HIGHWAY ENGINEERS

Greater Hampton Roads Chapter

Bob Moss, PE
Principal Engineer
ECS Mid-Atlantic, LLC

The Engineer Parent

WHY IS AN UNDERSTANDING OF LOCAL GEOLOGY IMPORTANT?

It provides the engineer with site background information to plan the exploration program in the absence of specific site information.

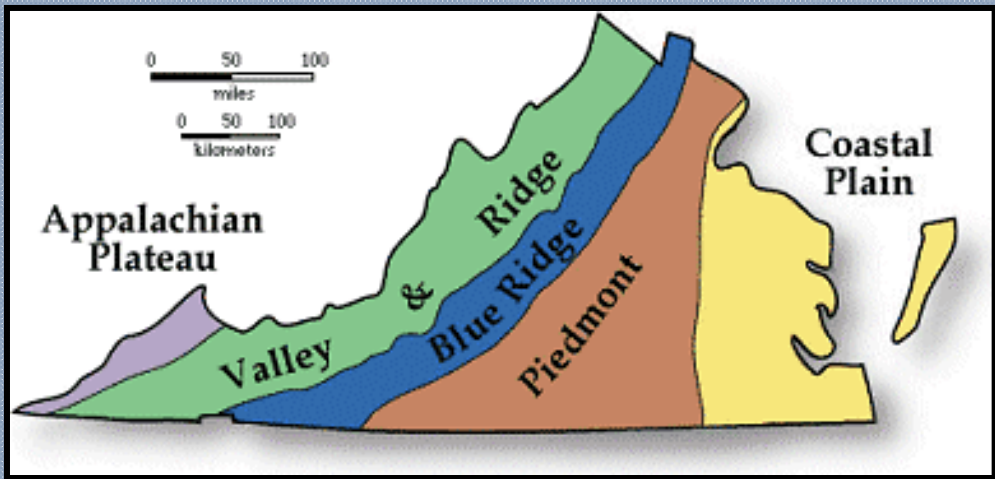
It allows the engineer to anticipate potential site hazards such as uncontrolled FILL, sinkhole development, expansive soils, compressible clays, pyritic shale, mining features, unstable soil or rock slopes, etc.

It allows the engineer to develop preliminary background on unfamiliar, distant sites located in geologic settings with which he or she is familiar.

It allows for cost planning of foundations, seismic site design, rock excavation, available borrow materials and site work in advance of site investigation.

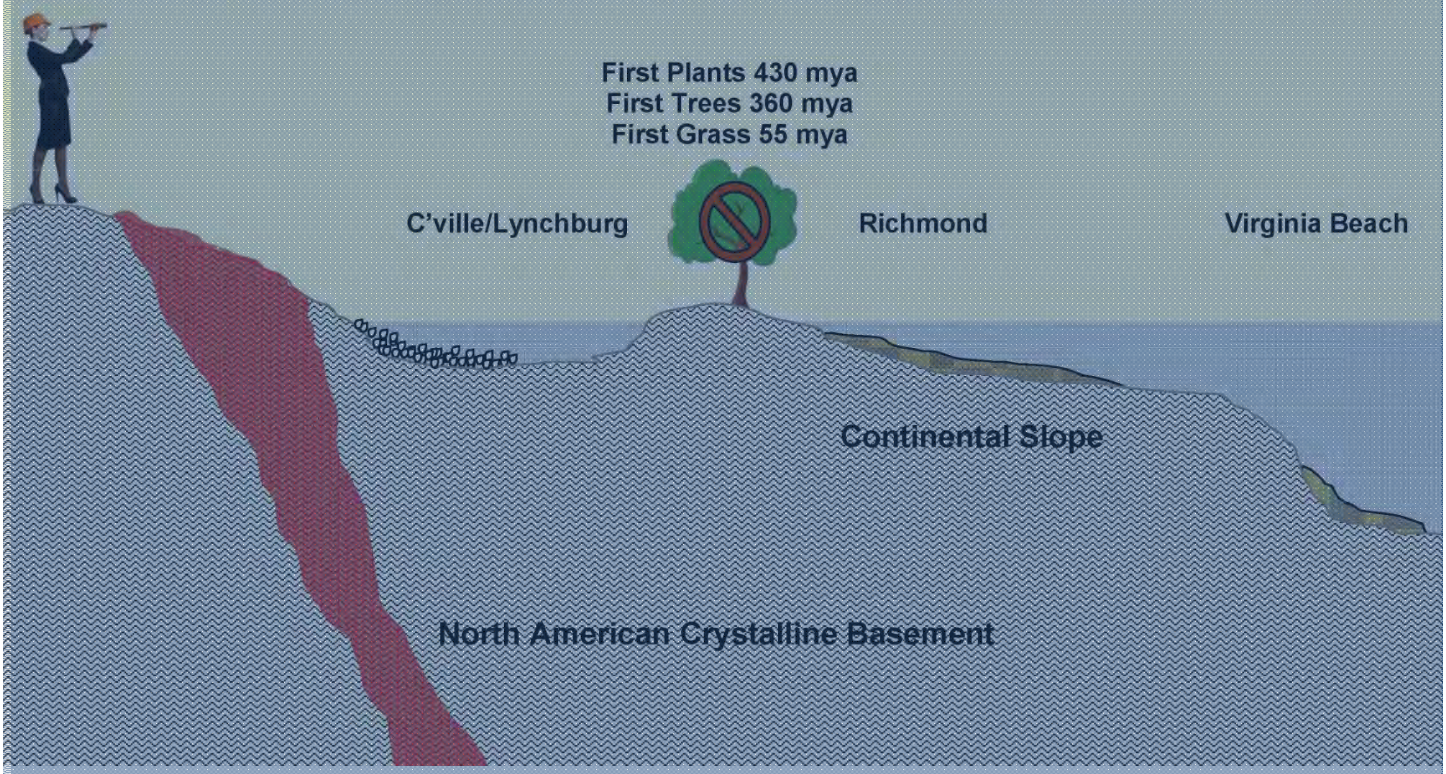
The North American Physiographic Provinces

[redacted]

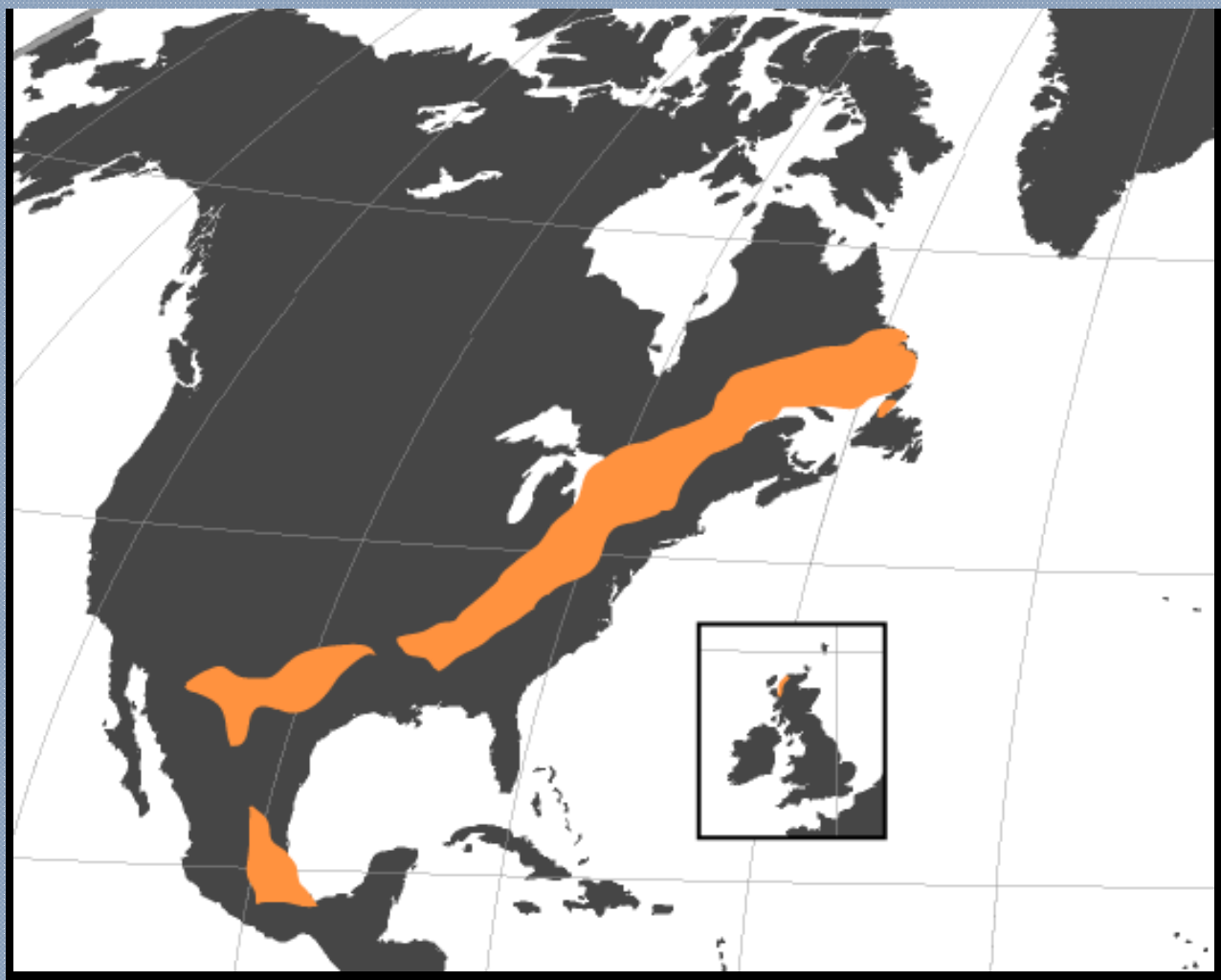


Virginia as we know her begins

Standing where the Blue Ridge will one day be, looking east (south) 600 million years ago.

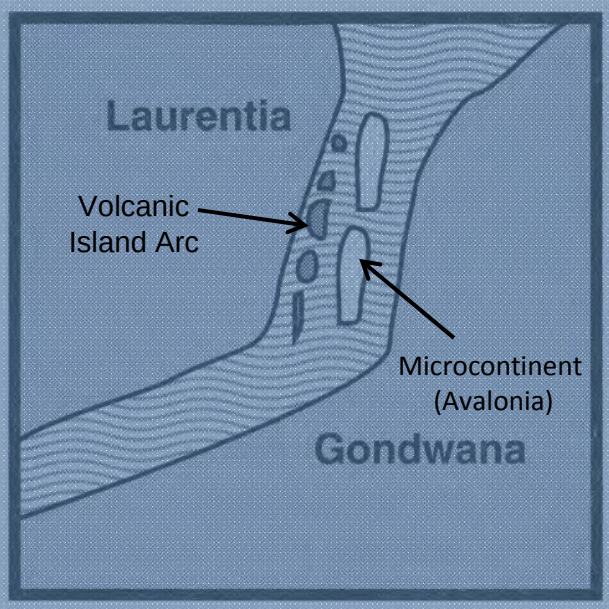


The First Rocks of Virginia
Grenville Orogeny
1.3 to 1.1 Billion Years Ago

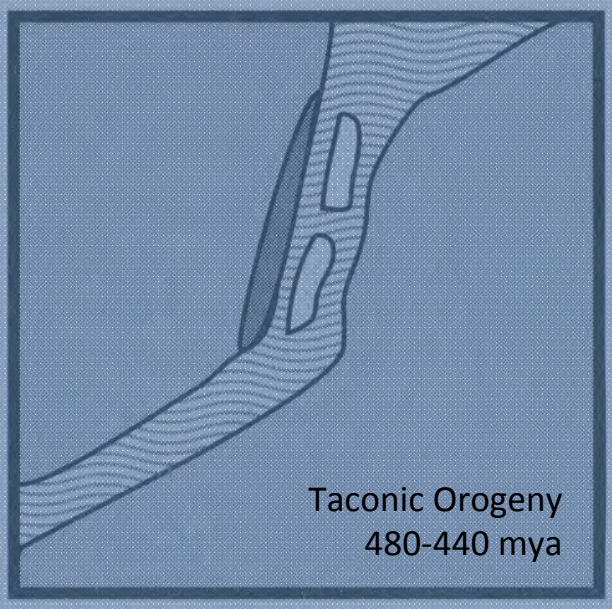


Position of North America
420 Million Years Ago

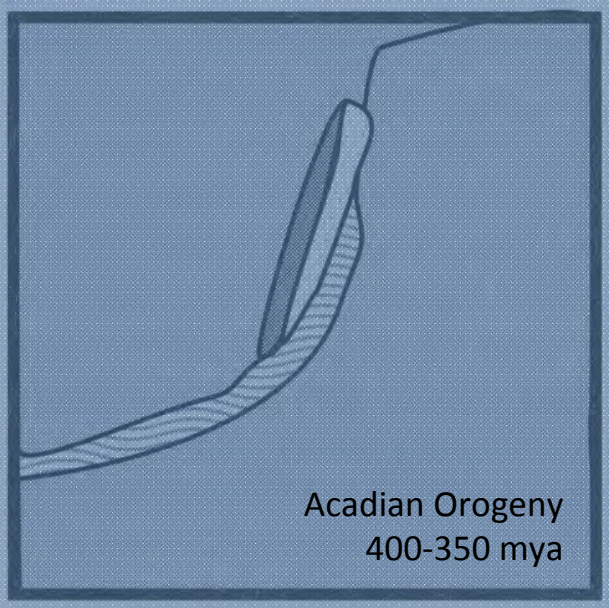
Three Appalachian Orogenies



Cambrian



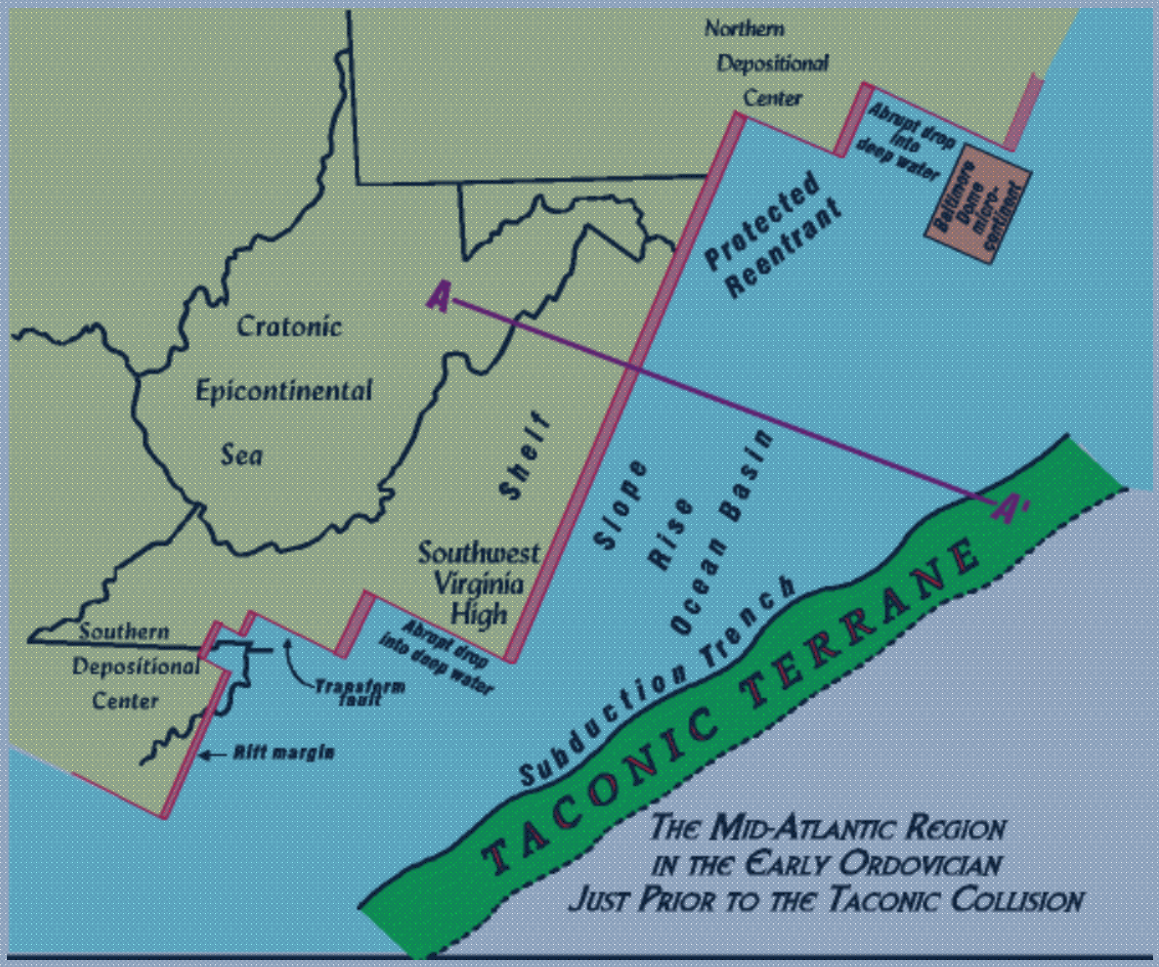
Ordovician



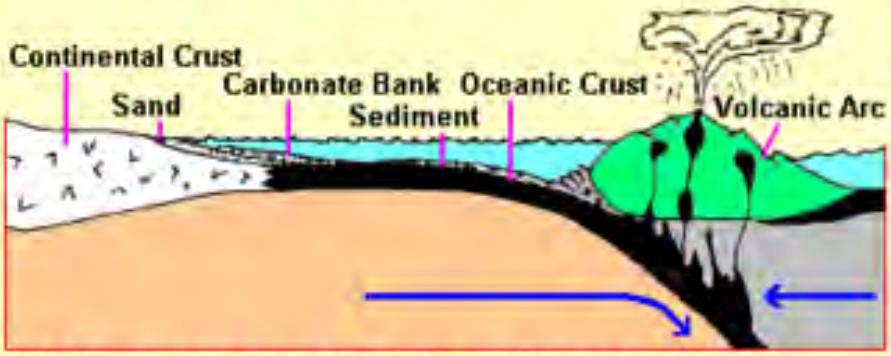
Devonian

Permian

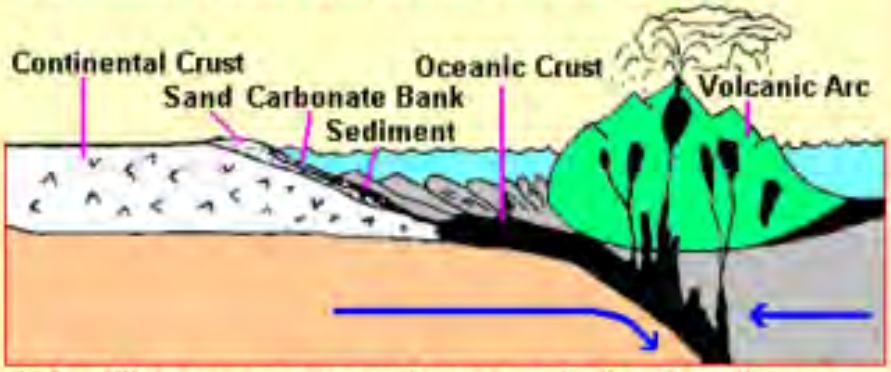
The Suture Line through Virginia



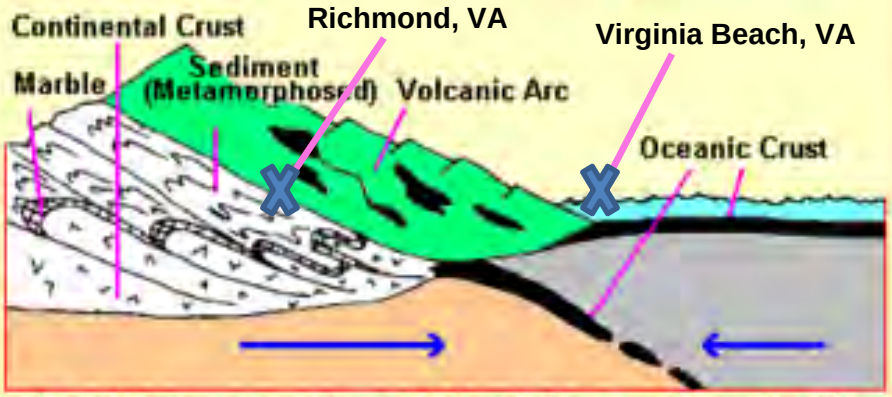
Cross Sections of Eastern North America
(as it may have looked)



543 million years ago, active volcano is offshore



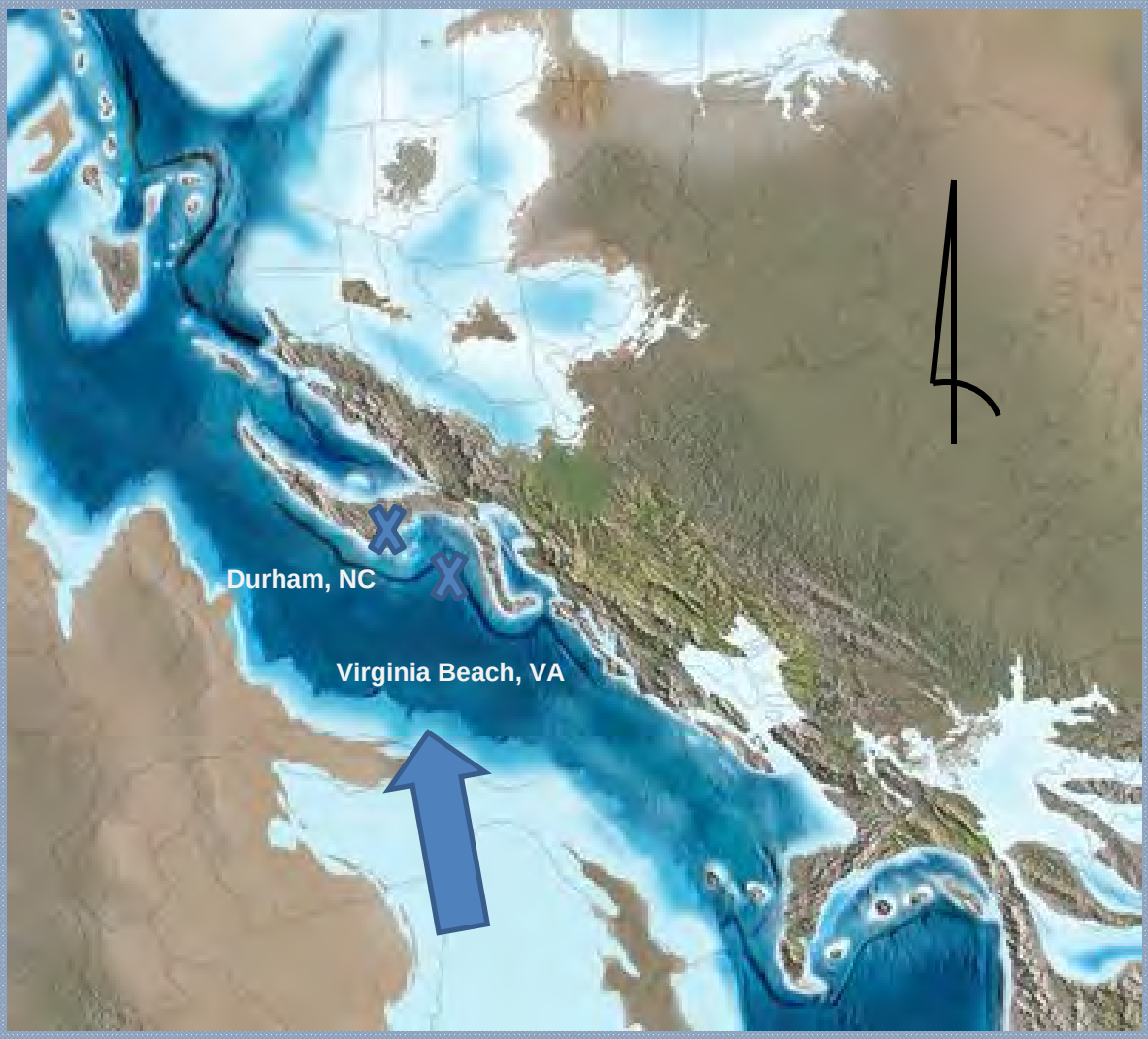
500 million years ago, volcano and pile of sediments scraped off the subducting slab are larger



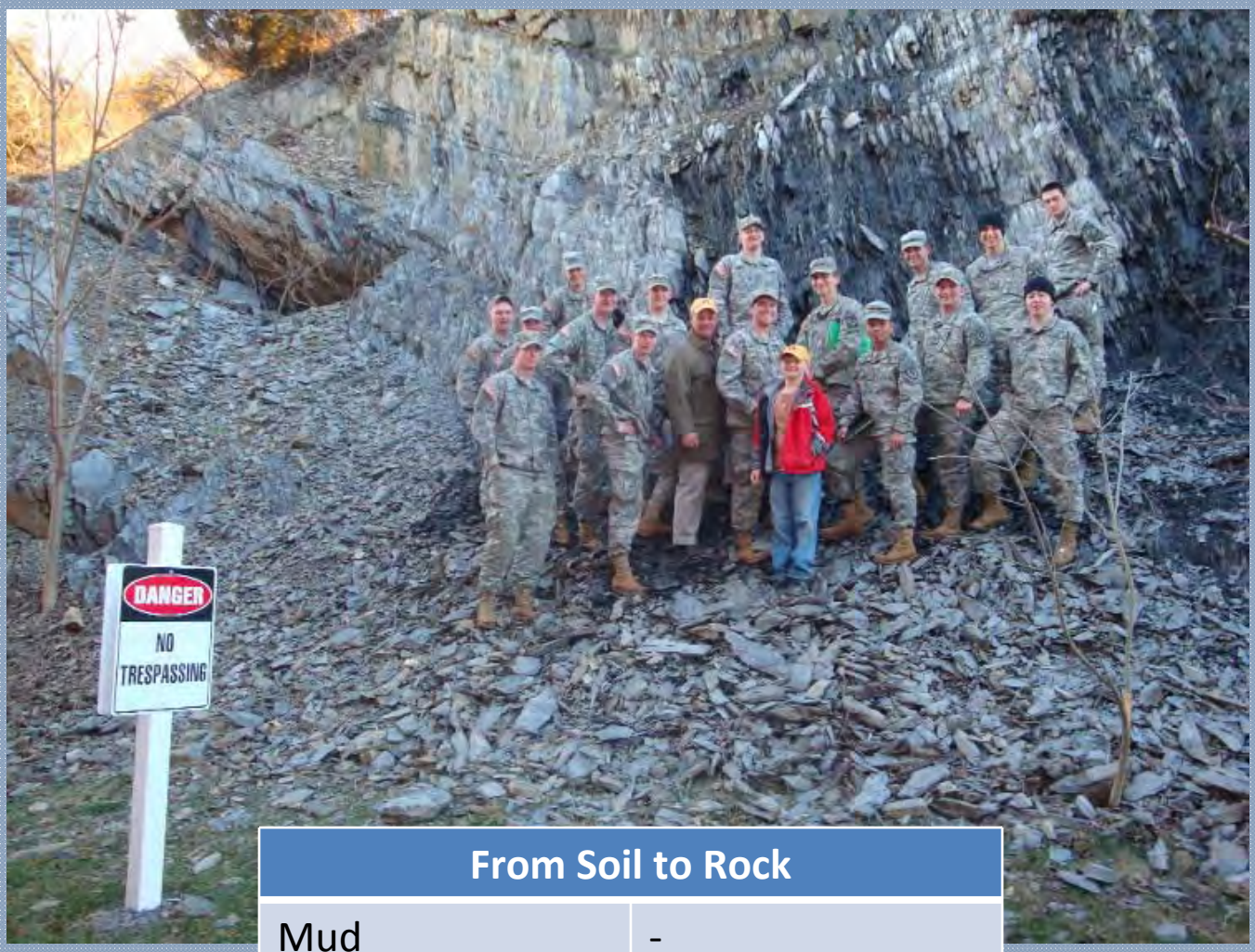
440 million years ago, collision between the volcanic islands and the ancient continent (Taconic Orogeny) formed a tall mountain range. This range has since eroded leaving its roots exposed in the rolling hills of the Eastern Piedmont

USGS *Topinka, USGS/CVO, 2001; Modified from: Plank and Schenck, 1998, Delaware Piedmont Geology, Delaware Geological Survey*

Virginia before the collisions; 350 million years ago



Virginia before the collisions; Sedimentation in a closing sea

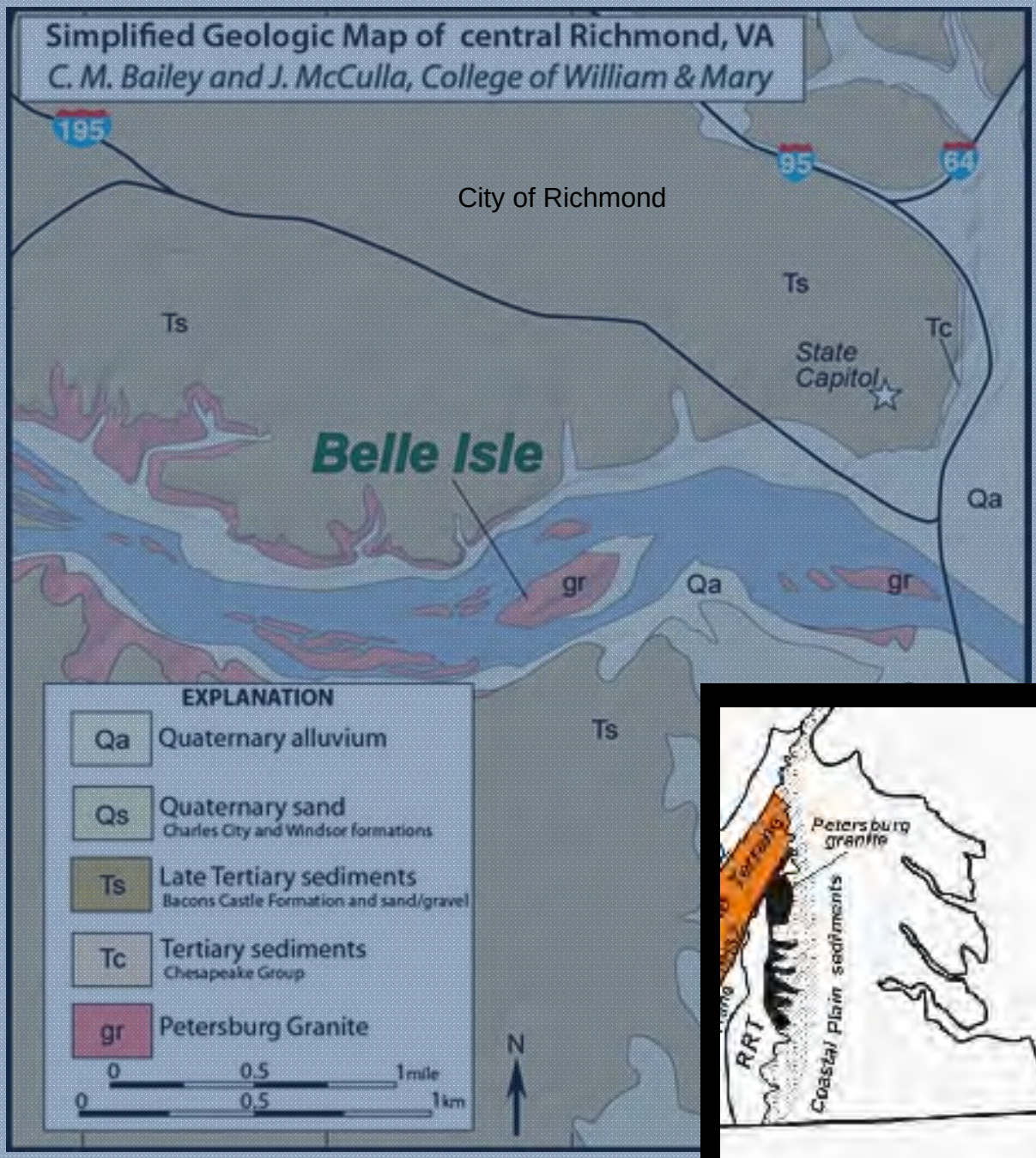


From Soil to Rock	
Mud	-
Shale	3 Miles
Slate	6 Miles
Schist	9 Miles
Gneiss	12 Miles
Hornfelds	15 Miles

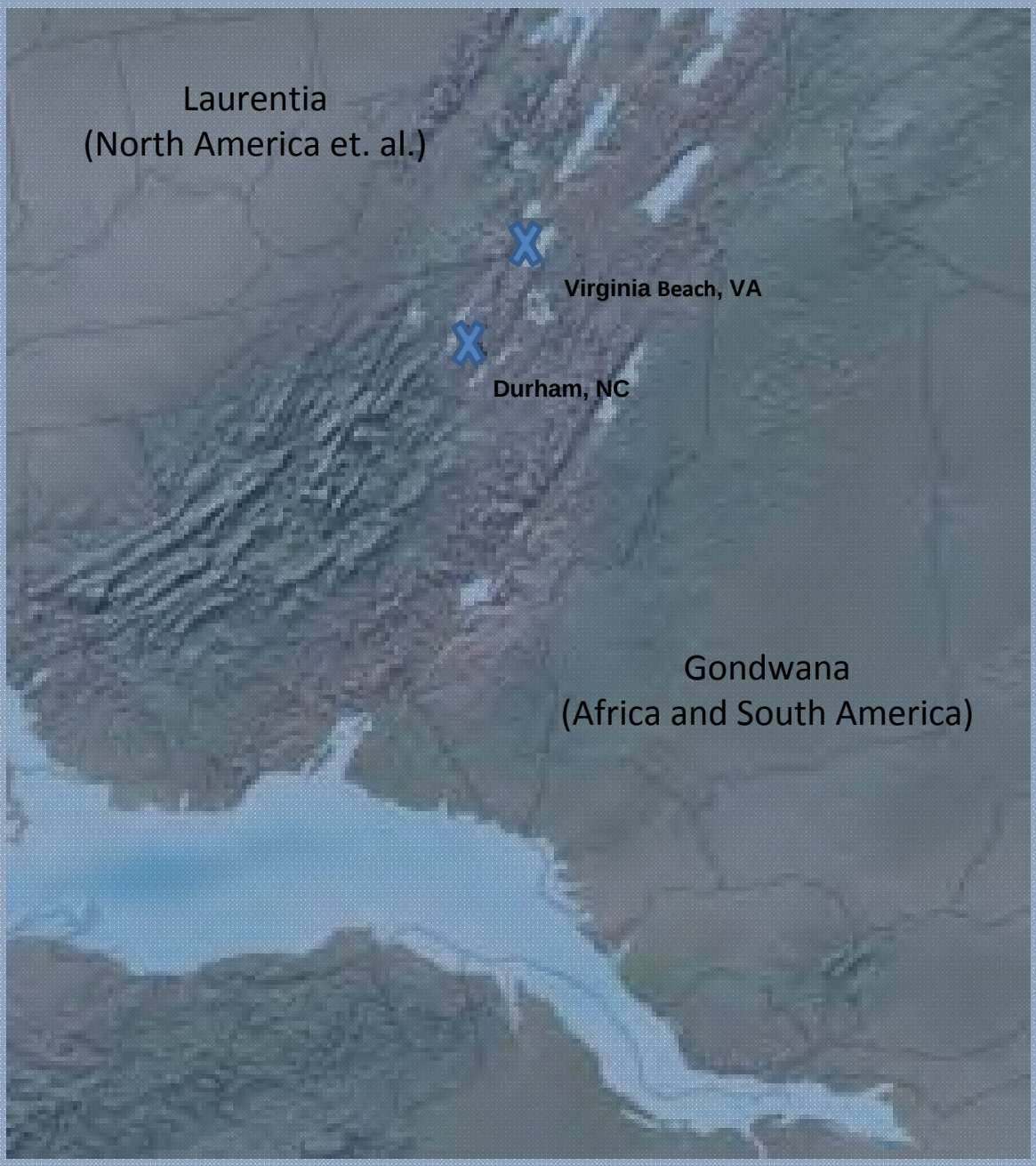
Petersburg Granite

Richmond's Foundation

A contiguous unit of 4 plutons that crop out in the Cities of Richmond and Petersburg Intruded in the final mountain building thrust (Alleghenian Orogeny). Samples from within this pluton were dated at 330 +/ 8 Ma (U Pb zircon; Wright, and others, 1975).

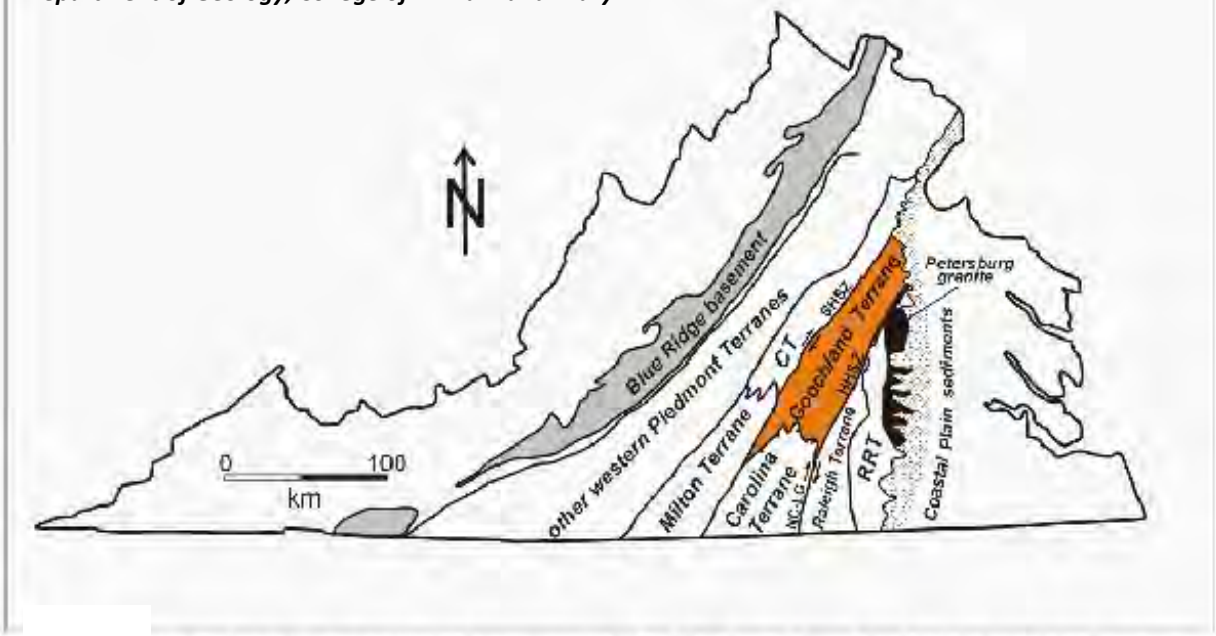


Virginia after the collision; 250 million years ago



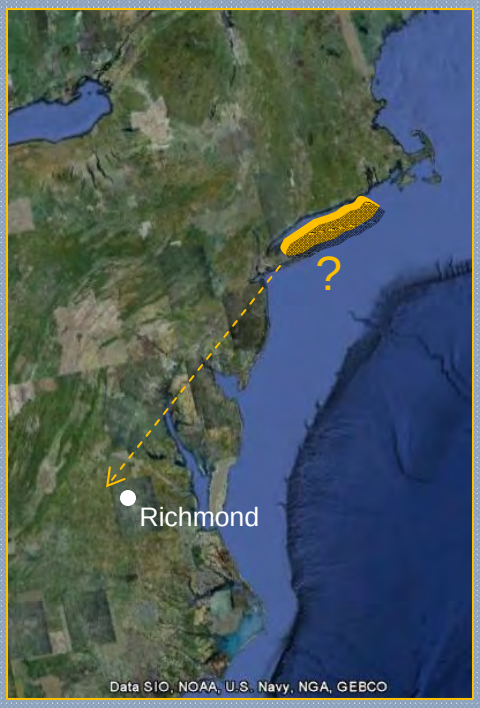
Virginia after the collision; 250 million years ago

Leah C. Cheek, Kyle J. Grimsley, Erin E. Fenlon, Katie E. Luciano,
Department of Geology, College of William and Mary

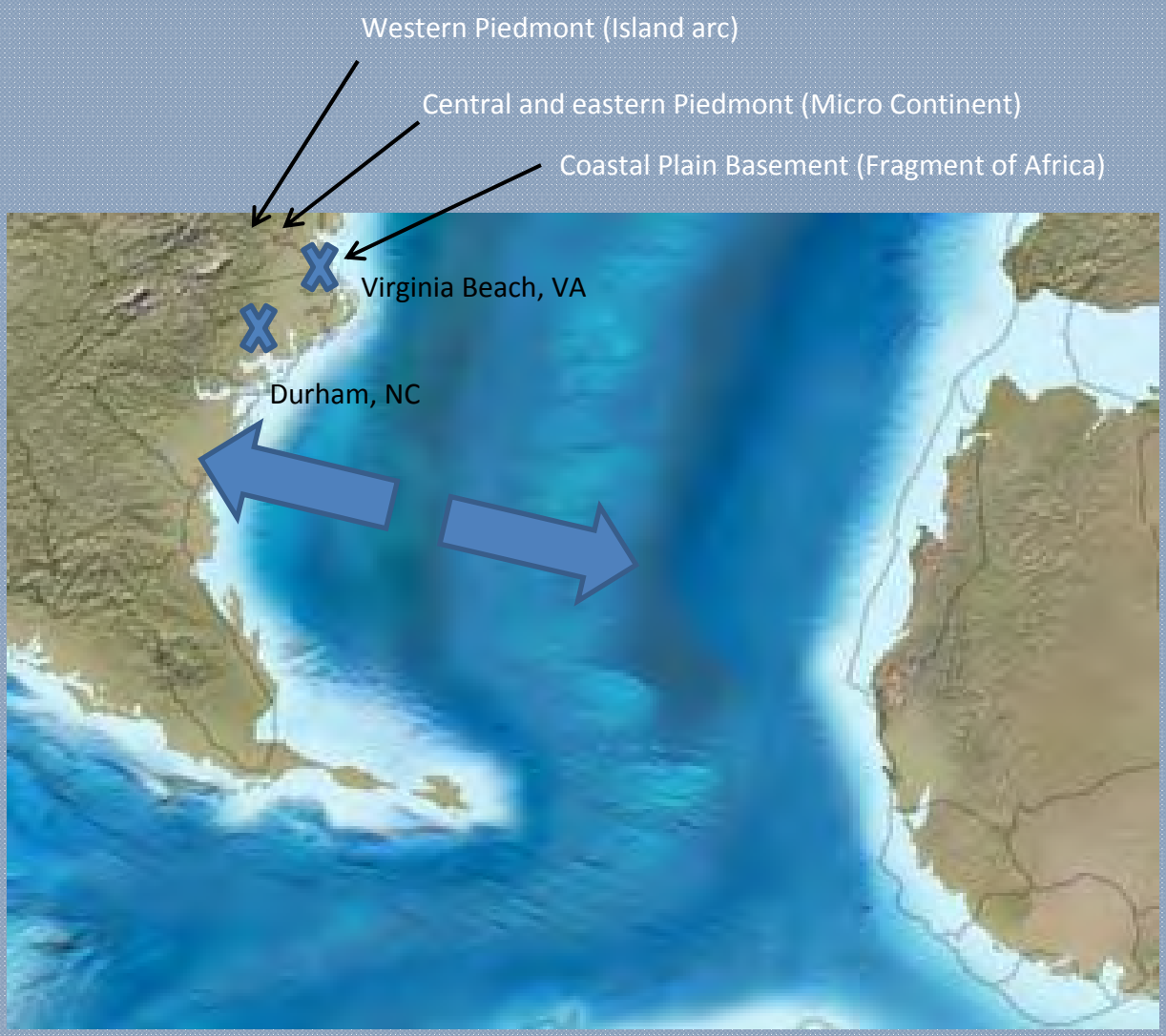


Map depicting geologic terranes in VA. The Goochland is highlighted in Orange.

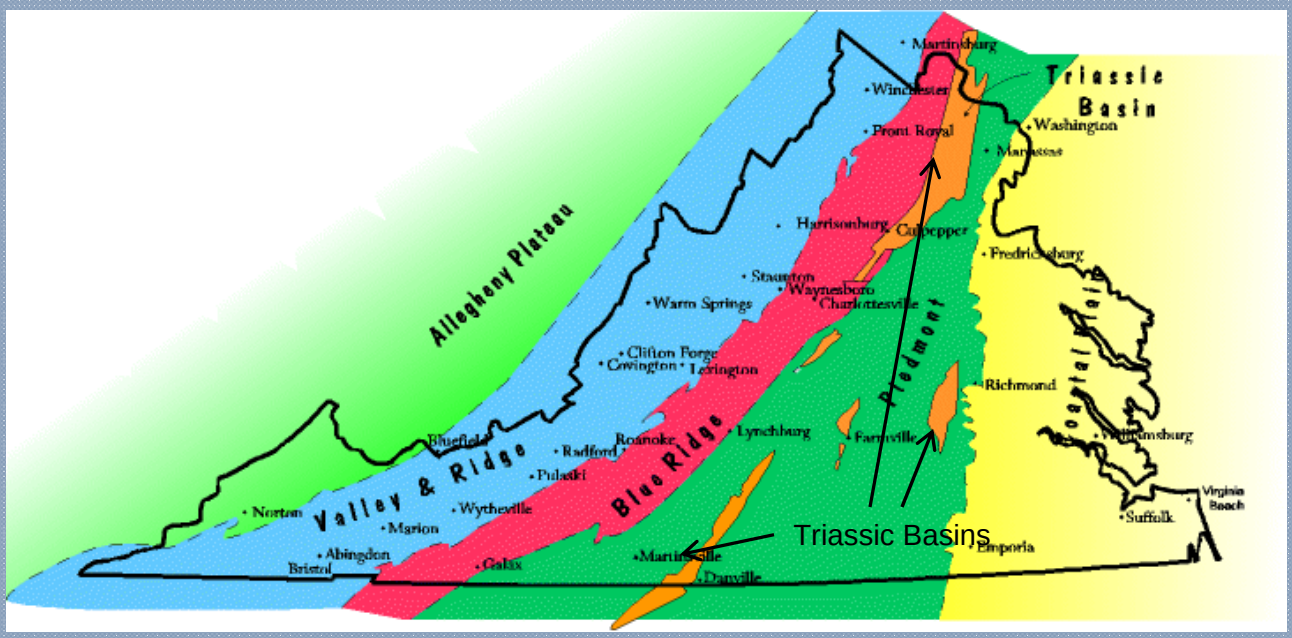
In Virginia, the Piedmont Province is comprised of a series of terranes, which are typically defined as fault-bounded regions of shared stratigraphic and tectonic character, each with a unique geologic history The Goochland terrane is considered a suspect terrane because its location prior to the Alleghanian Orogeny (330 270 Ma) is uncertain and disputed

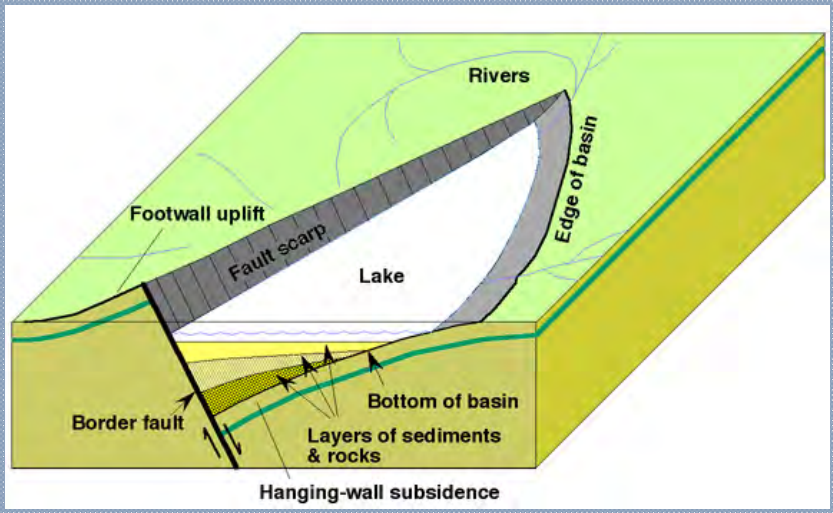


Virginia after the Triassic separation; 100 million years ago



Effects of the Triassic Separation

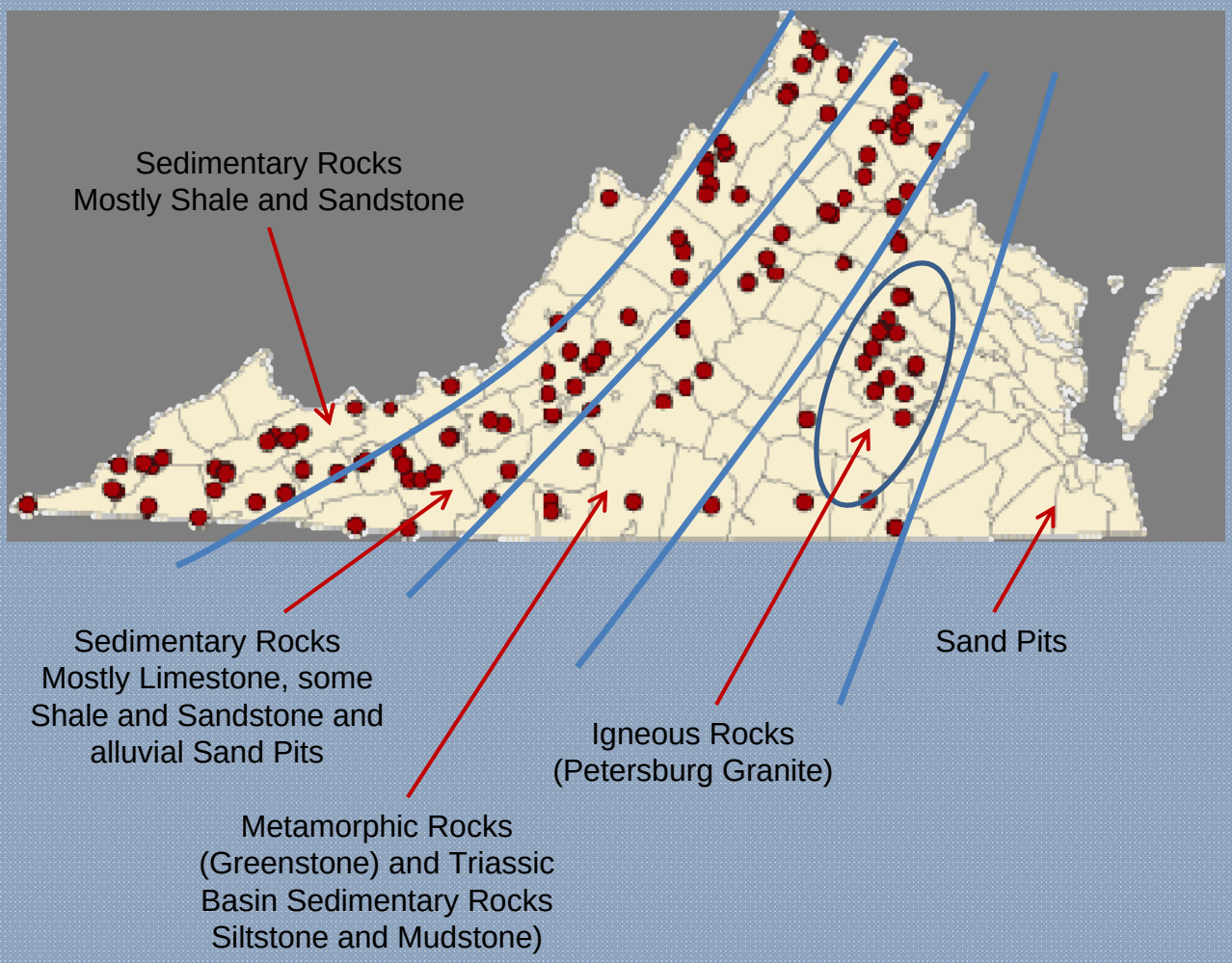




- As the Atlantic opens, west African crust remains sutured to North America to give us the Coastal Plain basement.
- Basin Formation (coal and shrink-swell soils).
- Subsidence of the Atlantic Coast

Aggregates in Virginia

So by the end of the Triassic Period about 200 million years ago, most of the rocks we will come to know ha e formed or are fo ming In 2003, approximately 75 million tons of crushed stone were produced at a value of $479 million dollars, ranking Virginia 10th in United States for crushed stone production



Virginia in the Paleocene Epoch; 65.5-55.8 million years ago

This map shows how North America appeared 60 million years ago The dinosaurs are recently departed. Earth's climate was warm relative to today. Polar ice sheets were smaller and sea level was higher The Rocky Mountains were forming in the western part of North America as the North American Plate pushes into the subducting Pacific Plate Mammals begin to dominate the animal kingdom

Virginia in the Eocene Epoch; 55.8-33.9 million years ago

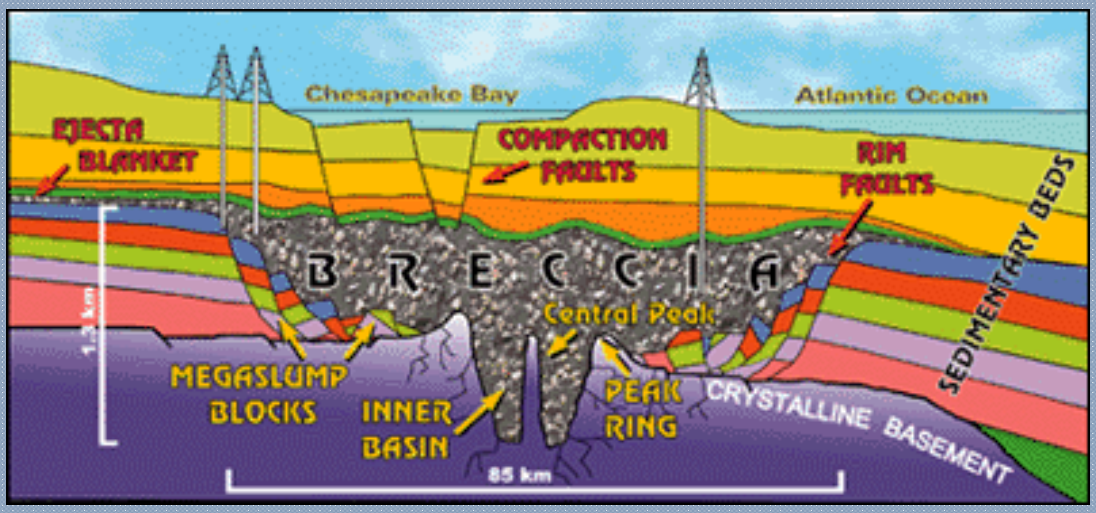
This map shows how North America appeared 50 million years ago Earth's climate was warm relative to today Polar ice sheets were smaller and sea level was higher To the west, the Rocky Mountains continued to form. Sediments shed from the uplifting mountains are carried eastward by river systems and deposited miles deep in the mid west.

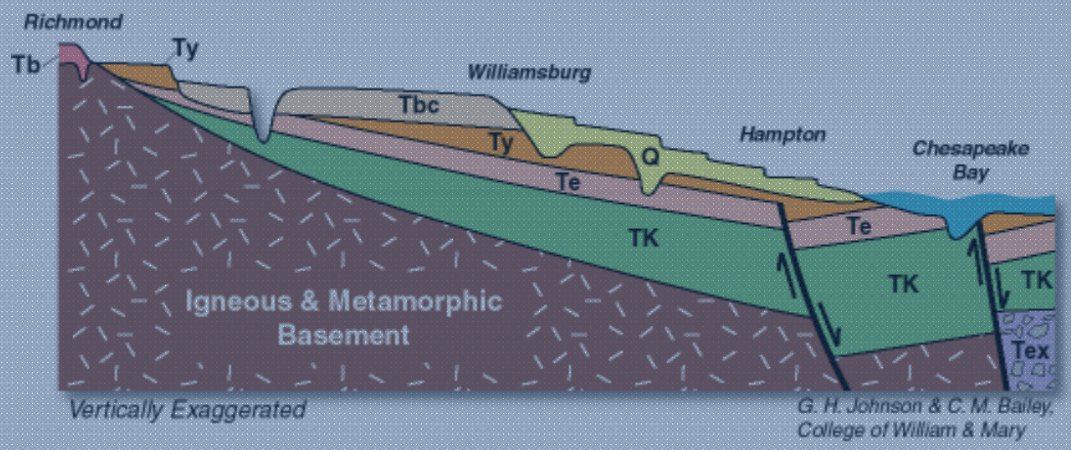
Chesapeake Invader

- Late Eocene 35 MY ago.
- Comet or Asteroid 2 to 3 miles in diameter.
- Traveling 60,000 miles per hour.
- Ground zero: Town of Cape Charles, VA
- Water depth at impact site 600 feet.
- Tsunami nearly 1,000 feet high at shore line.
- Cloud of ejecta 30 miles high and as far away as New Jersey
- Crater 50 miles wide, 1 mile deep.
- Incineration of higher life forms in 600 mile radius.

Consequences of Impact

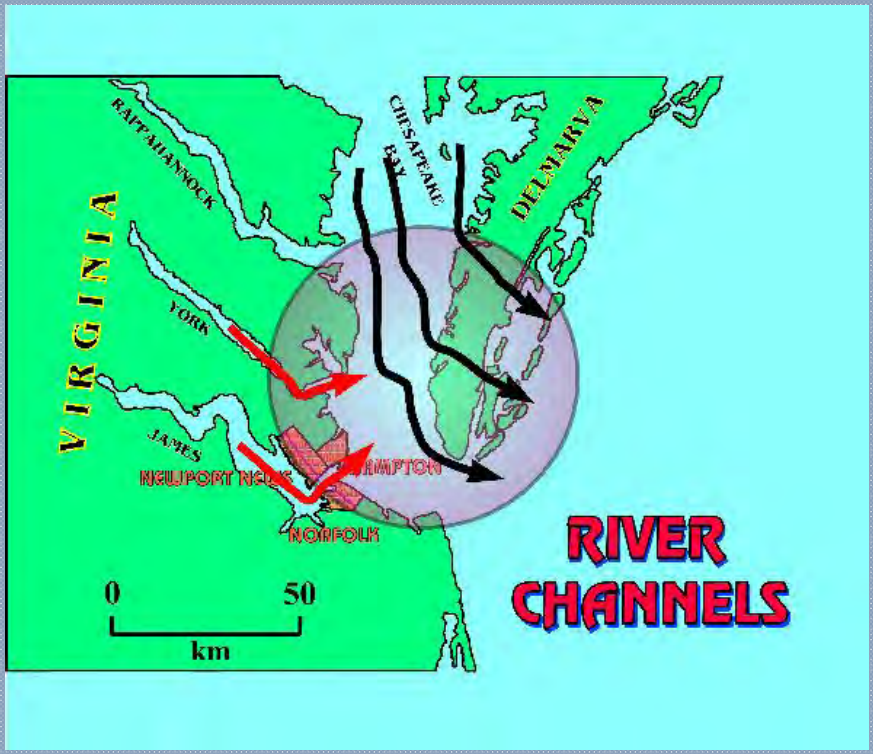
- Fracture of the basement rock,
- Accumulation of breccia,
- Ongoing crater subsidence, in excess of that of the east coast,
- Deep salt water aquifers,
- Creation of the harbor of Hampton Roads!





W&M Geology


OLDER ROCKS
LAND SURFACE
YOUNGER RX
AMES RIDGE
SUFFOLK SCARP


RAPPAHANNOCK
CHESAPEAKE BAY
DELMARVA
VIRGINIA
YORK
JAMES
NEWPORT NEWS
HAMPTON
NORFOLK
0
50
km
RIVER CHANNELS

Virginia in the Oligocene Epoch; 33.9-23.0 million years ago

This map shows how North America appeared 25 million years ago The mid-west supported a vast savannah like environment and climate was cooler and drier than during the Paleocene and Eocene Epochs Sediment from the uplifting Rocky Mountains continues to be shed across the mid west. Florida is a vast coral reef If there were people, they d be hanging out at a long since eroded away beach just east of Richmond which is still mountainous