Geology of West Virginia Aggregates

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Overview

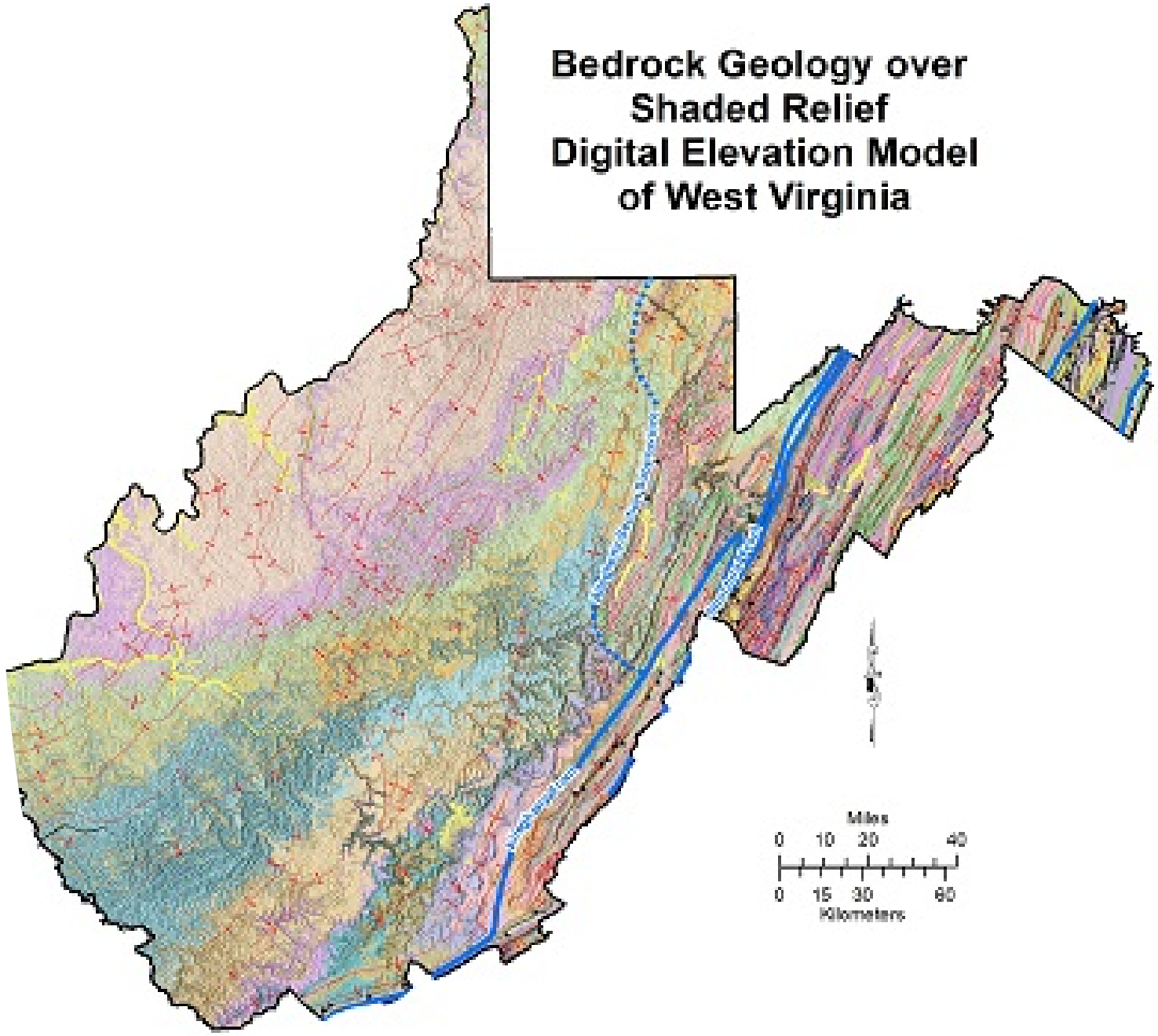
- Discuss depositional history of West Virginia
- How the quality of aggregate is tested
- How this relates to the quality and resources in West Virginia

Types of Rocks

- Igneous – Forms when lava or magma cools (extrusive and intrusive)
- Metamorphic – Forms from the application of intense heat and/or pressure to a pre-existing rock (parent rock)
- Sedimentary – Formed from the accumulation and cementation of sediments from various sources

Introduction

- Due to the geologic history of West Virginia the state is predominantly over lain with sedimentary rocks
- There are few igneous and metamorphic exposures in the state
- This is due to three orogenies through out our history:
  - Taconic, Acadian, and Appalachian Orogenies
- Most of these sediments were deposited during the Paleozoic Era
  - 542 +/- to 251.0 +/- 0.4Ma years



WVGES::WV Geology (wvnet.edu)

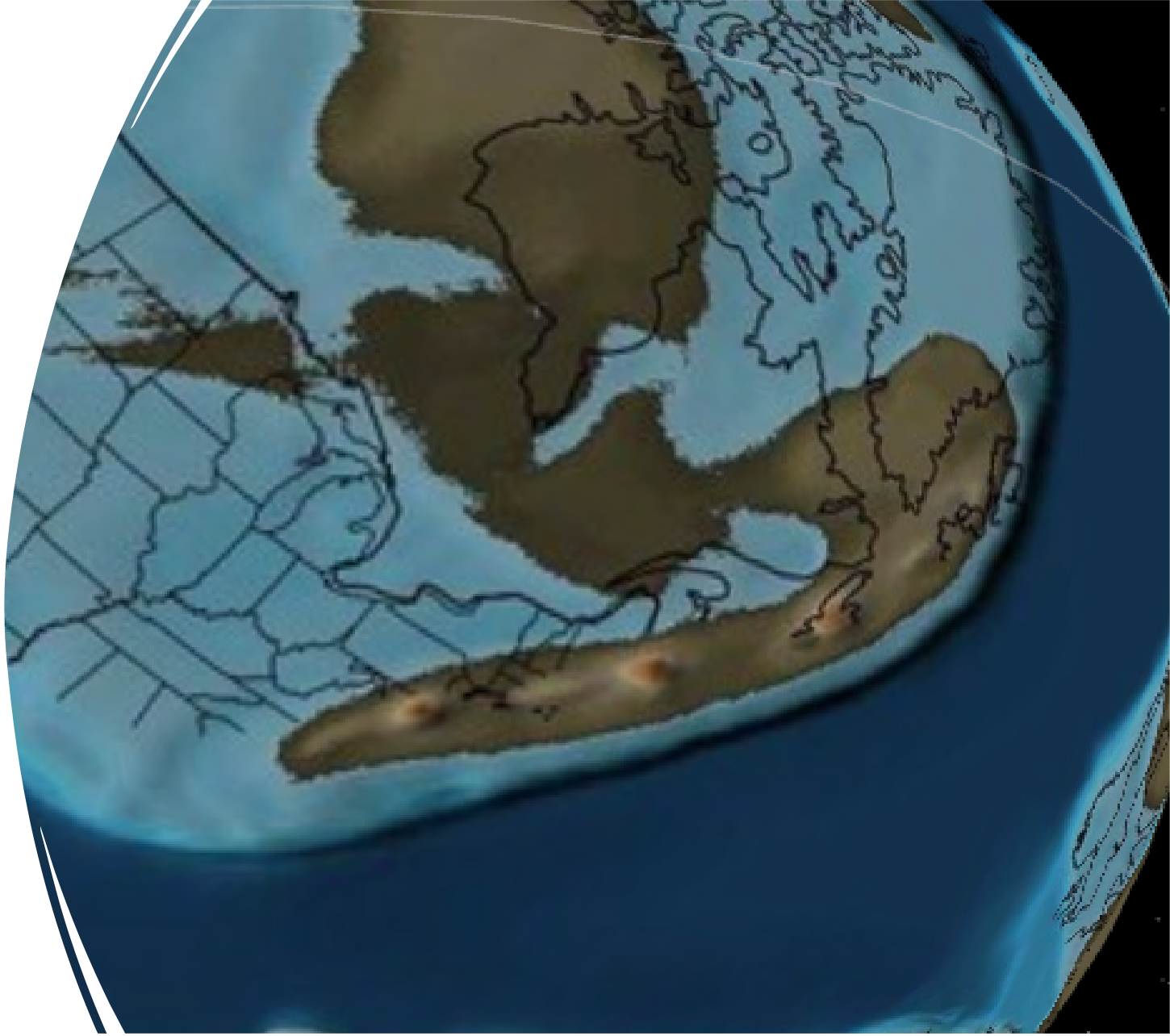
Periods of the Paleozoic Era

Paleozoic

	251.90 Ma
Permian	299.0 Ma
Pennsylvanian	323.2 Ma
Mississippian	358.9 Ma
Devonian	419.2 Ma
Silurian	443.8 Ma
Ordovician	485.4 Ma
Cambrian	541.0 Ma

Taconic Orogeny

- West Virginia was a shallow ocean during the Cambrian (Pre-Taconic)
- Taconic Orogeny began in the late Ordovician
- Subduction caused North America to collide with an island arc
- Mountain range formed east of West Virginia



The Taconian Orogeny – Historical Geology (opengeology.org)
WVGES::WV Historical Geology (wvnet.edu)

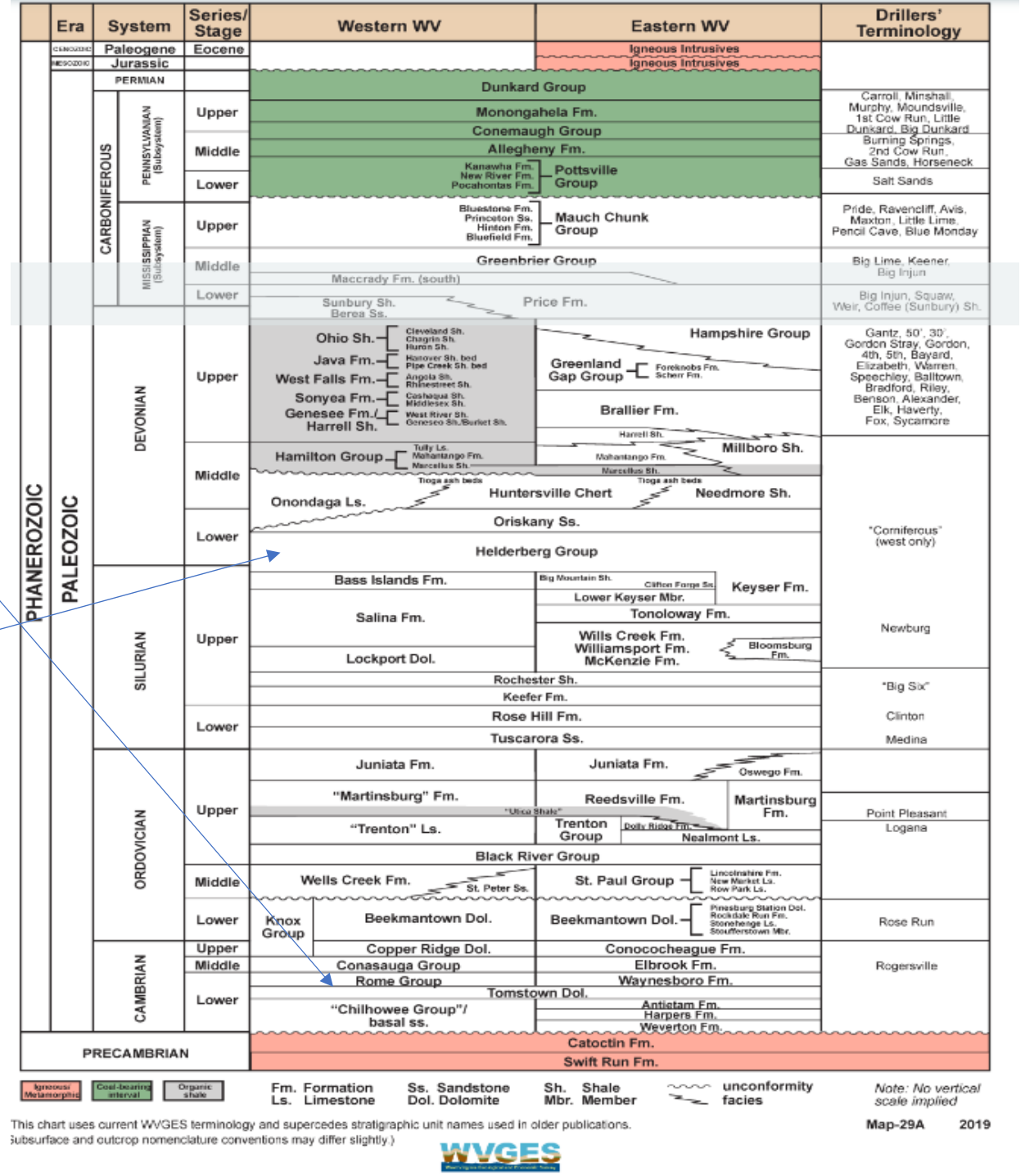
Taconic Orogeny

- Marine and nonmarine deposition through Silurian and Devonian Periods
- The newly formed mountain range provided a source for weathering and erosion
- Clastics and carbonates were deposited over West Virginia through the Silurian into the Early Devonian
- Shale, sandstone, limestones, and dolostones

[The Thrill Of Climbing At Seneca Rocks - Adirondack Explorer]
[WVGES::WV Historical Geology (wvnet.edu)]

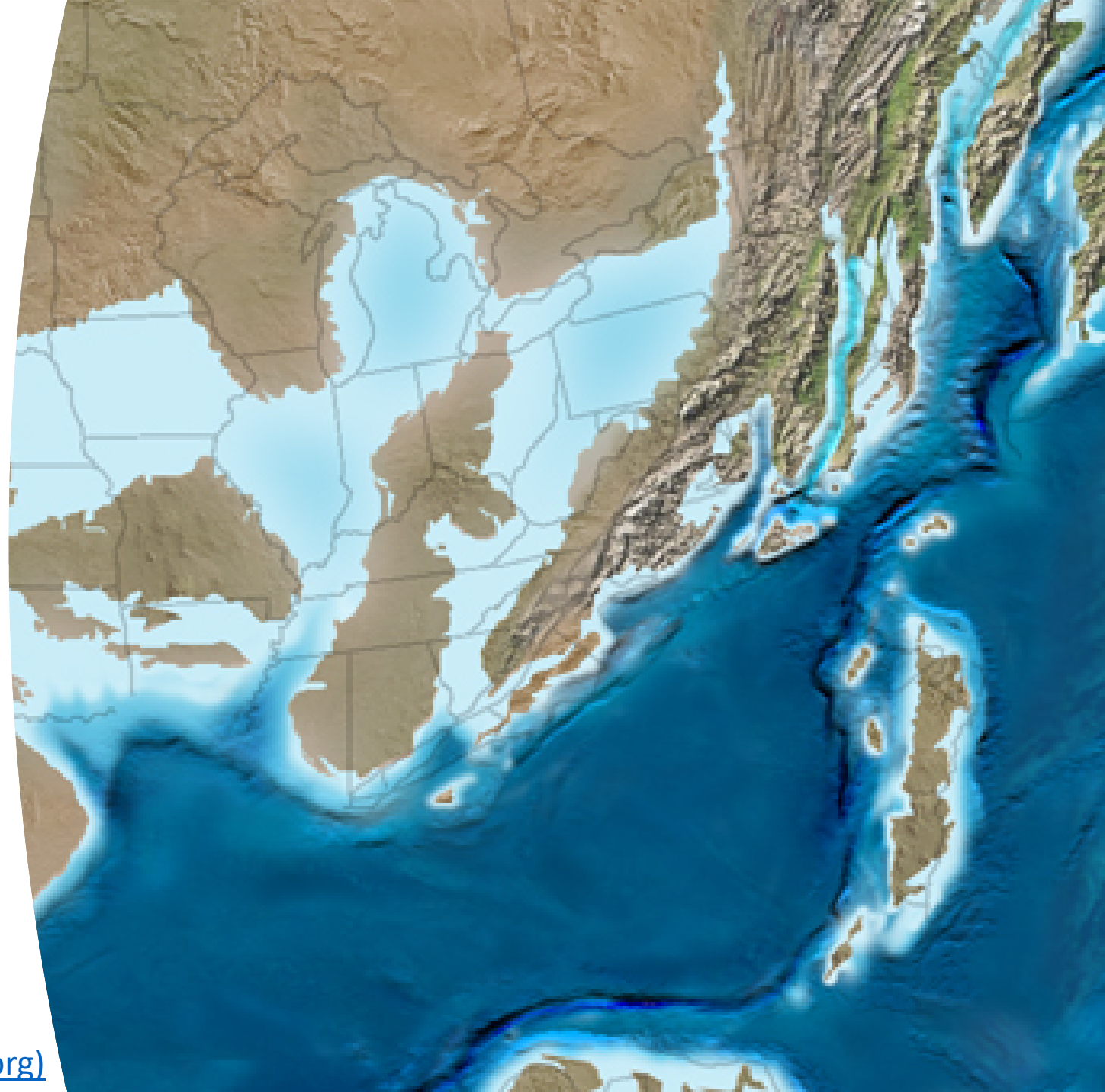
Tomstown Dolomite – low silica dolomite from Lower Cambrian

Helderberg Group – Limestone alternating with shale and sandstone, Lower Devonian



Acadian Orogeny

- This event took place from the middle to late Devonian
- ~ 397.5 +/- 2.7 to 359.2 +/- 2.5 Ma years
- Mountains uplifted northeast of modern WV
- Majority of WV was the Appalachian Basin
- Sea began regressing westward towards late Devonian



Wayback Machine (archive.org)

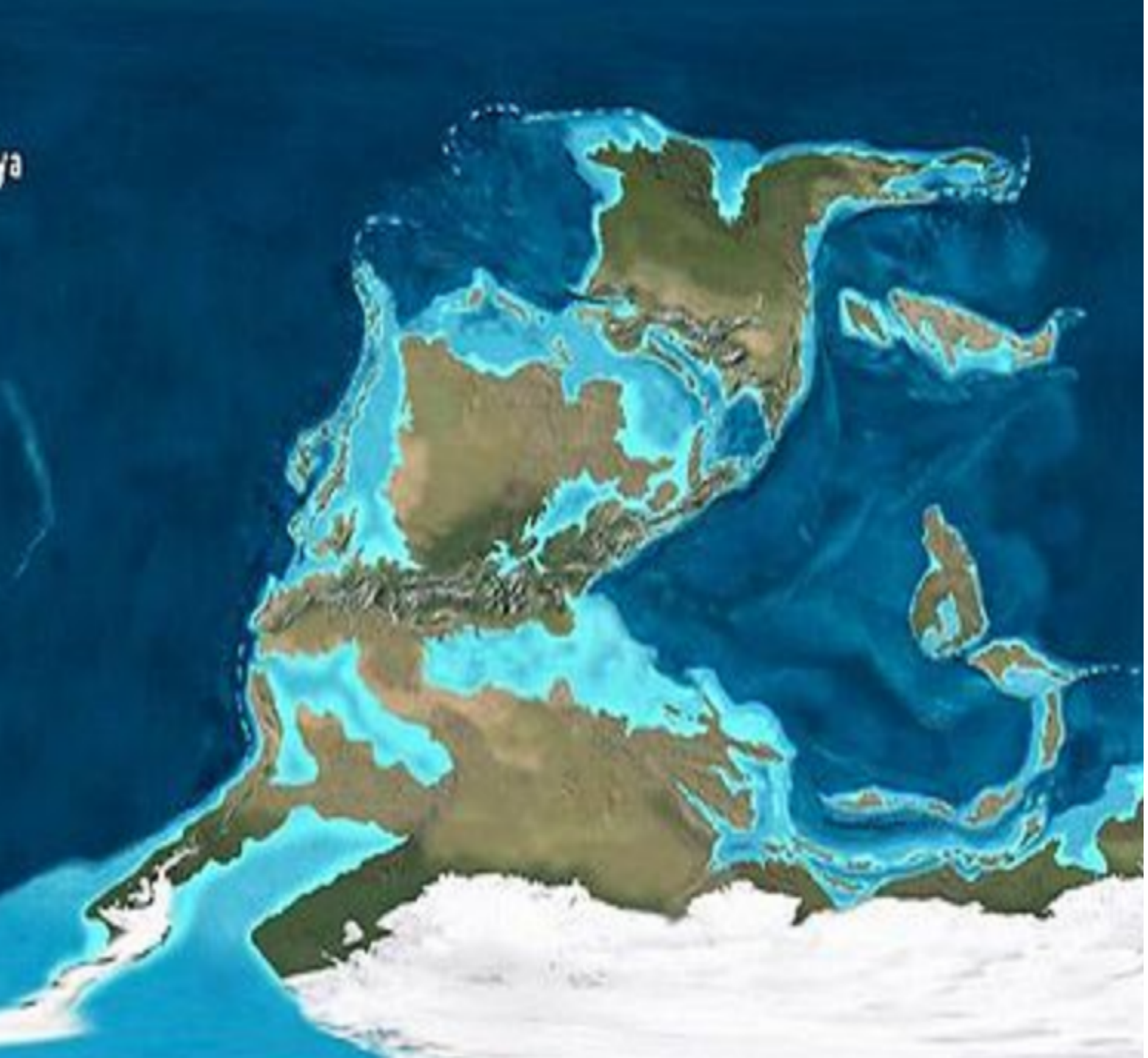
Acadian Orogeny

- Clastic marine sediments were deposited during this time
- Sea regressed westward away from WV
- Hampshire formation deposited – red shales and sandstones over most of WV

https://blogs.agu.org/mountainbeltway/2018/03/14/new-media-hampshire-fm-corridor-h-wv/

http://palaeos.com/paleozoic/carboniferous/carboniferous.html

- Sea pushed its way back into WV during the Mississippian
- Greenbrier Group was deposited, consisting mainly of limestones
- Moving into Pennsylvanian the land lowered, and Appalachia became a swamp
- This is where most of our coal came from, along with sandstone and shale deposits



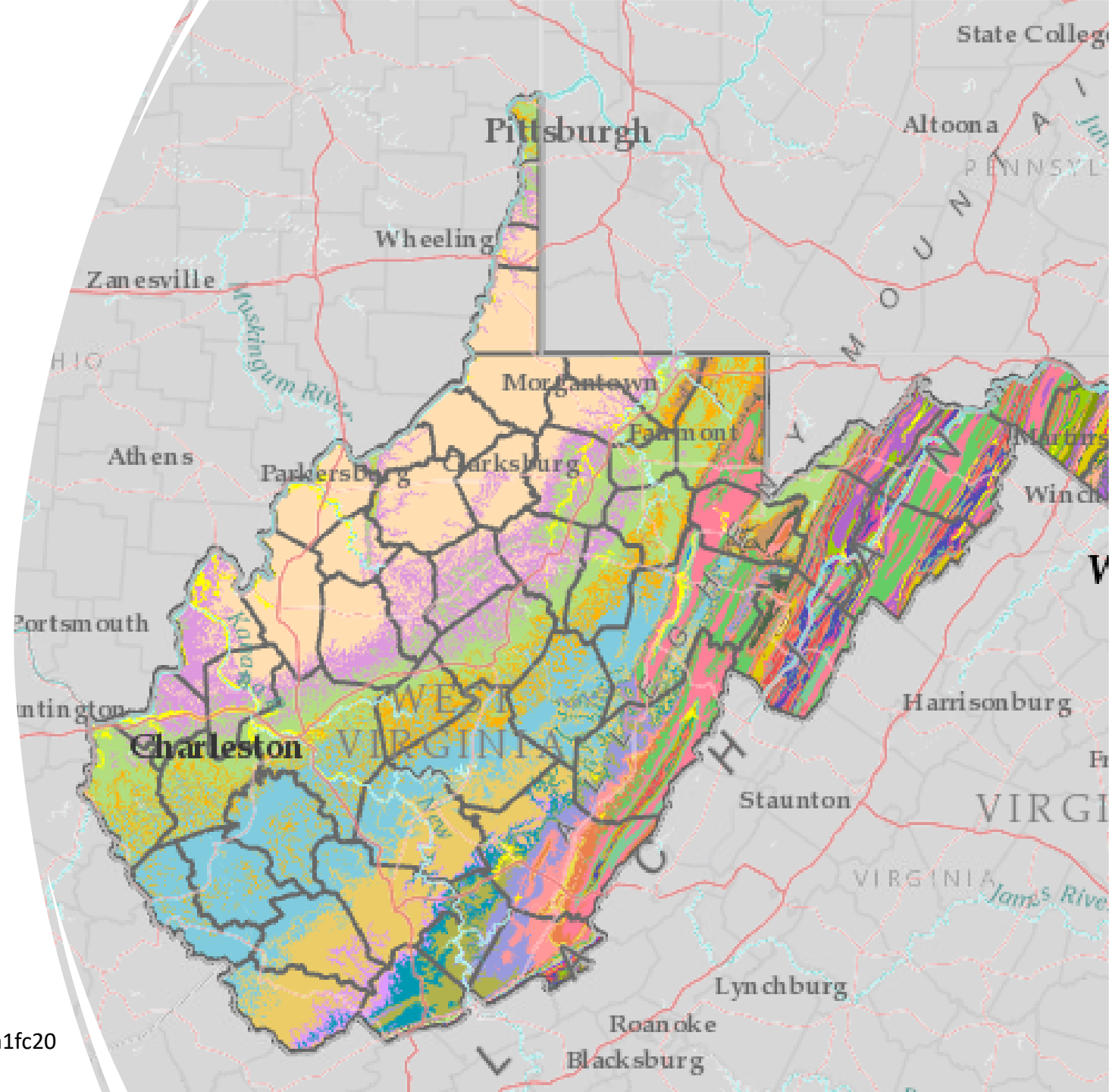
Appalachian Orogeny

- Collision of Africa and North America raised the Appalachian Mountains
- This event took place in the Pennsylvanian and Permian periods, peaking around 290 Ma years ago
- This was the formation of the “modern” Appalachian Mountains
- Left: Map of the beginning of the Appalachian Orogeny, 300 million years ago

http://palaeos.com/paleozoic/carboniferous/pennsylvanian.html
WVGES::WV Historical Geology (wvnet.edu)

Appalachian Orogeny

- After this uplift sediments were not deposited over WV anymore
- WV was no longer under the sea and erosion of the mountains began
- Folding and thrust faults occurred, predominantly in the eastern part of the state



https://atlas2.wvgs.wvnet.edu/portal/apps/webappviewer/index.html?id=ab47a1fc20e4417aa47af96b4c83be28

“Recent” Time

- Mesozoic Era 251 +/- 0.4 – 65.5 +/- 0.3 Ma years ago
- No sedimentary rocks from this time in WV, which is why we do not have dinosaur fossils
- Igneous activity in surrounding areas made some igneous dikes exposed in Pendleton County
- These dikes are from the Jurassic Period

https://dinosaurpictures.org/Cryptoclidus-pictures
WVGES::WV Historical Geology (wvnet.edu)

“Recent” Time

- Cenozoic Era 65.5 +/- 0.3 Ma – 11,700 +/-99 years
- More igneous intrusions were created during this time, which are also found in Pendleton County
- Glaciation created a lake that extended throughout WV in the Quaternary
- Lake deposits, predominantly clay, were deposited through out the region during this time

https://www.britannica.com/science/glacier

Aggregate Quality

- Aggregate used for construction must meet certain quality standards
- Durability
- Resistance
- Deleterious
- These are a few of the important quality characteristics

Los Angeles Abrasion (Abrasion Resistance)

- Aggregates used in construction must be resistant to abrasion
- Los Angeles Abrasion test obtains a percent wear result
- Aggregate is put into cylinder with steel balls
- Sample is rotated 500 times
- Material passing No. 12 sieve is percent wear

Sodium Sulfate Soundness (Durability)

- Indication of freeze thaw resistance of aggregate
- Aggregate submerged in sodium sulfate and dried
- Five cycles are completed
- This allows crystals to grow, which fractures the aggregate
- Sieving determines the percent loss

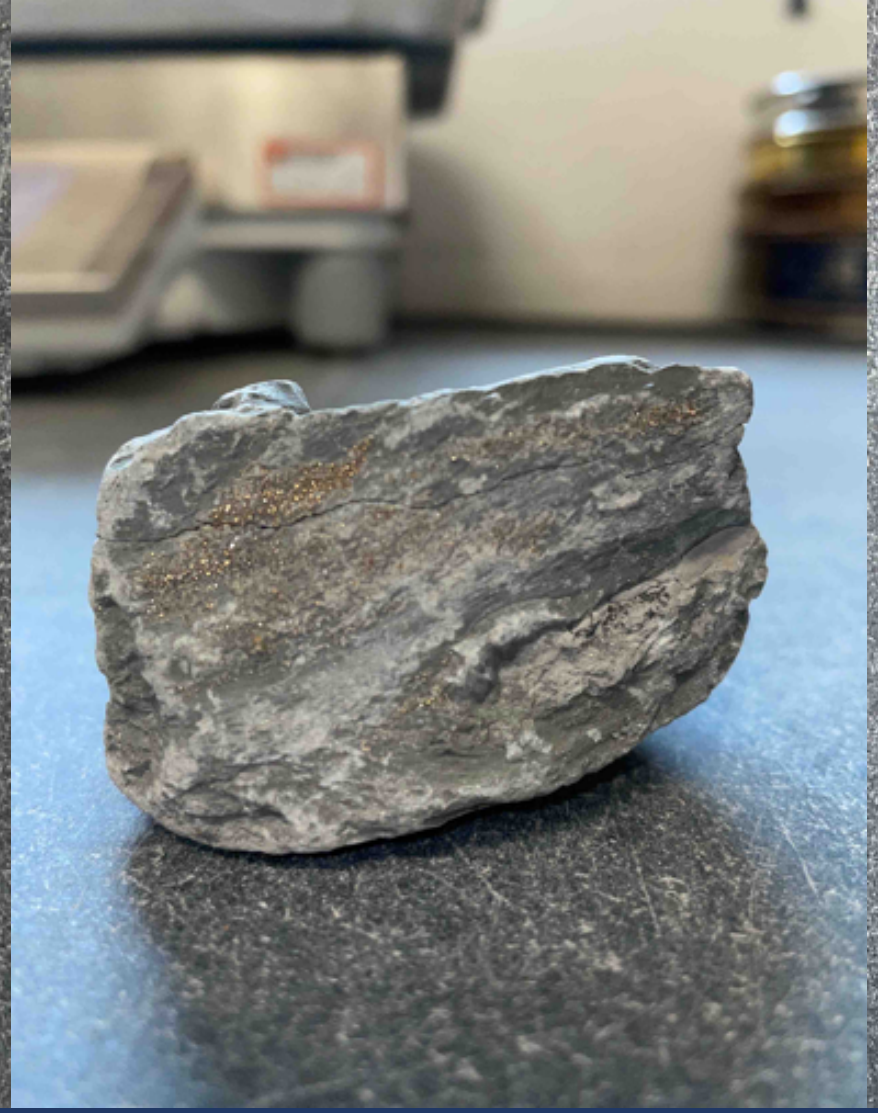
Deleterious Material

Deleterious materials are particles that can impact the strength, durability, or workability of a final product. This can include shale/shale like particles, friables/clay lumps, coal and lightweights, organic impurities, and silica content. We test for these materials to ensure there are not too many of them present.

Shale

MP 703.00.27

- Walter Huang PhD (Petrology, 1962) defines shale, “ Shale is a laminated and thinly bedded fine grained clastic rock containing mainly silt and clay and including many particles less than 1 or 2 microns”
- Slakes and disintegrates
- Absorbs water (PI)
- Softens when in contact with water
- Shale like material (exhibits some properties of shale)



Shale Like material

Shale example showing lamination

Friables and Clay Lumps MP 703.01.20

Pieces of dirt or clay that easily break down

Occur from over burden or contamination

Impacts workability of mixtures

Harder pieces impact final product

- Left: hardened clay lumps that would survive the mixing process

- Right: Softer friable particles that would cause workability issues

Coal and Lightweights MP 702.01.20

- Coal and lightweight material is determined with heavy liquid
- Causes segregation
- Creates pop outs
- Carbon in coal impacts moisture content

Lightweight material used for hydration curing – stalite

- Lightweight aggregate in river gravel
- Coal pieces found in gravel

Organic Impurities

AASHTO Designation: T 21-05

- Tests fine aggregate used for concrete
- Organic particles decay, weakening stability
- rapidly breakdown
- Samples with too much organic matter are mortar strength tested
- Determined with 3 % Sodium Hydroxide solution

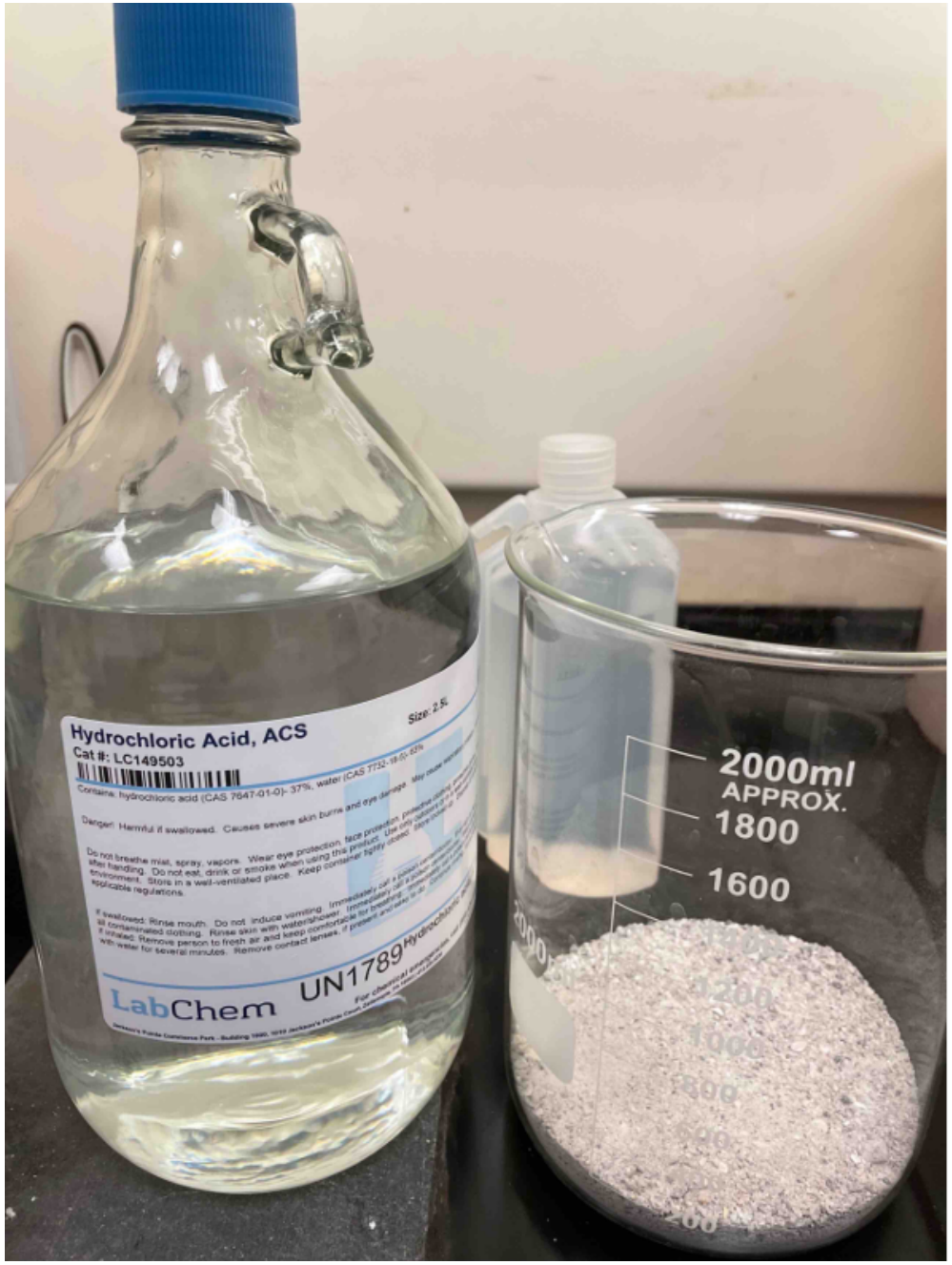
Test Results

- Jar used for solution and material
- Glass color standard
- Results of 1, 2, 3 are in the acceptable range
- Results of 4 and 5 are sent to concrete lab

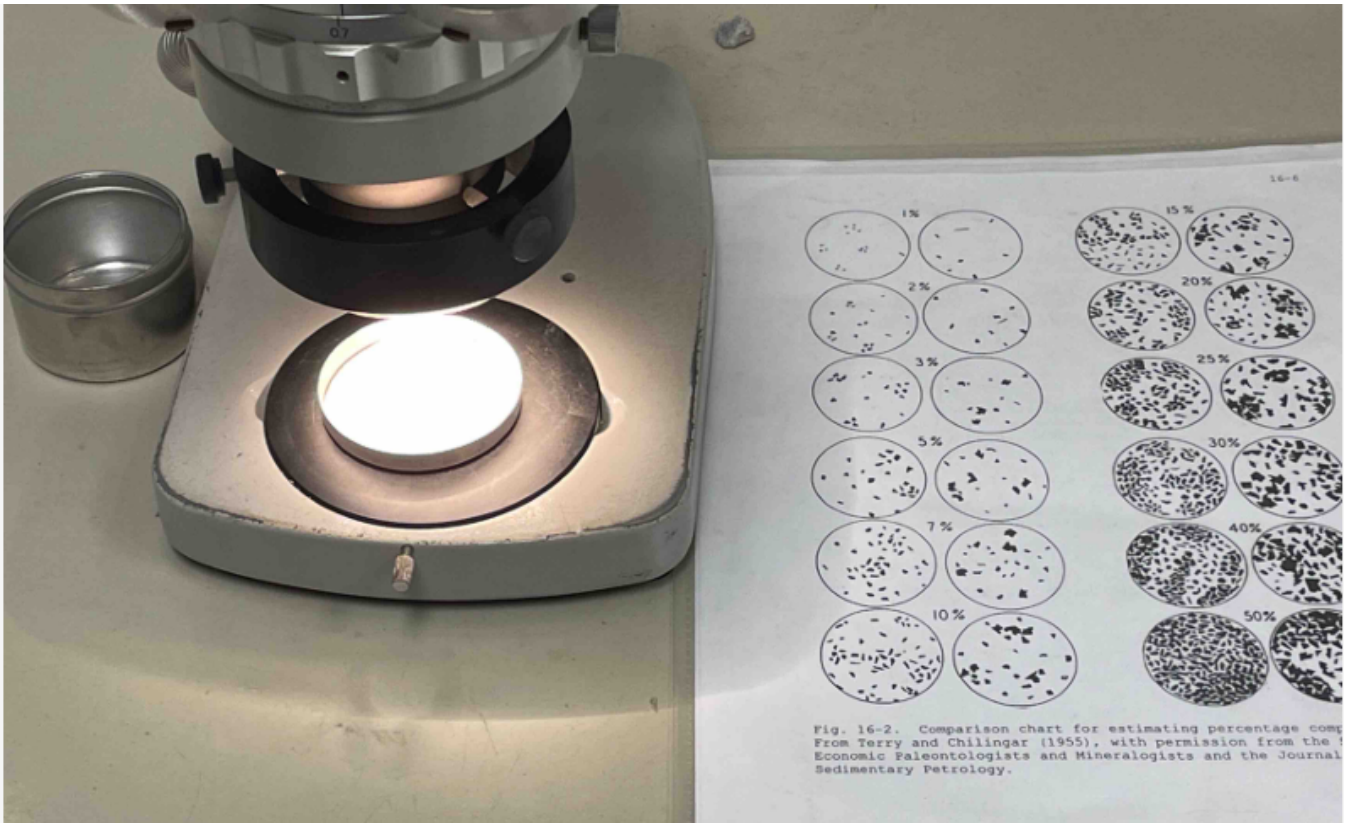
Insoluble Residue

MP 703.00.29

- skid resistant properties for HMA
- Limestone ($CaCO_3$) is not skid resistant
- Silica is what creates skid resistance in limestone
- Minimum 10 % (+200) silica content to be skid resistant
- Dolostone $CaMg(CO_3)_2$ Tested separately for elemental magnesium



- Insoluble particles are checked under microscope to make estimation of silica content
- (Almost) pure silica on right



Thin and Elongated

MP 703.00.25

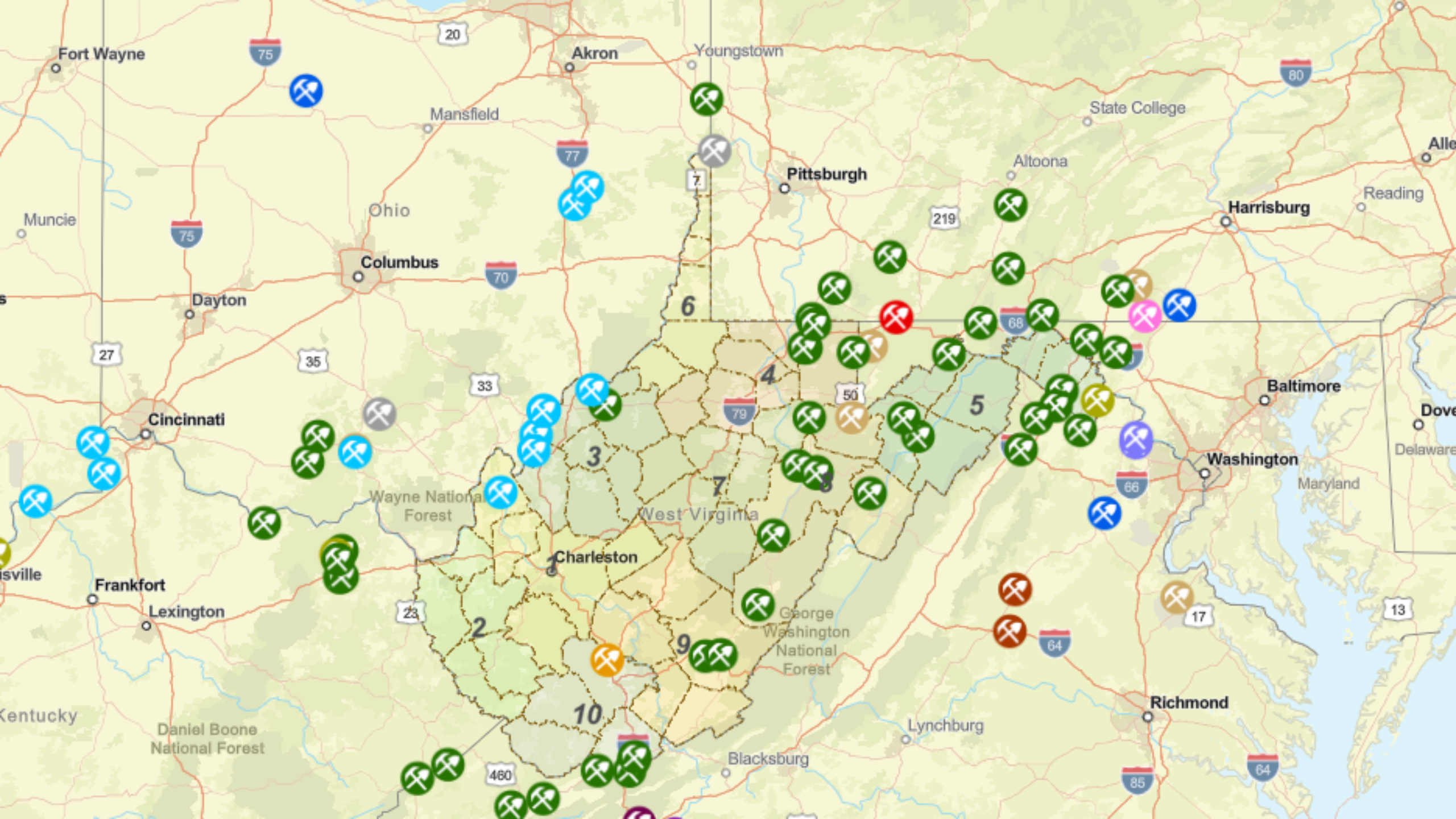
- Thin aggregate has a width 4 times greater than its thickness
- Elongated aggregate has length 4 times greater than its width
- Too many of these cause decrease of strength, skid resistance, and workability
- Internal and External damage
- Base Course, Portland cement concrete, and bituminous concrete

- French fries and Potato chips
- Thin and elongated pieces found in a limestone sample
- This test applies to natural and crushed aggregate
- Pieces like this easily fracture

Where does our stone come from?

Approved Sources for West Virginia

- WV has a list of approved and potential aggregate sources
- These sources must pass quality testing to be approved
- (Commercial & Potential Skid Resistant Sources) – under APL
- This list contains a variety of different aggregate types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Akron
Youngstown
Mansfield
Pittsburgh
State College
Altoona
Harrisburg
Reading
Muncie
Ohio
Columbus
Dayton
Cincinnati
Baltimore
Washington
Maryland
Delaware
Wayne National Forest
West Virginia
Charleston
Frankfort
Lexington
George Washington National Forest
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Daniel Boone National Forest
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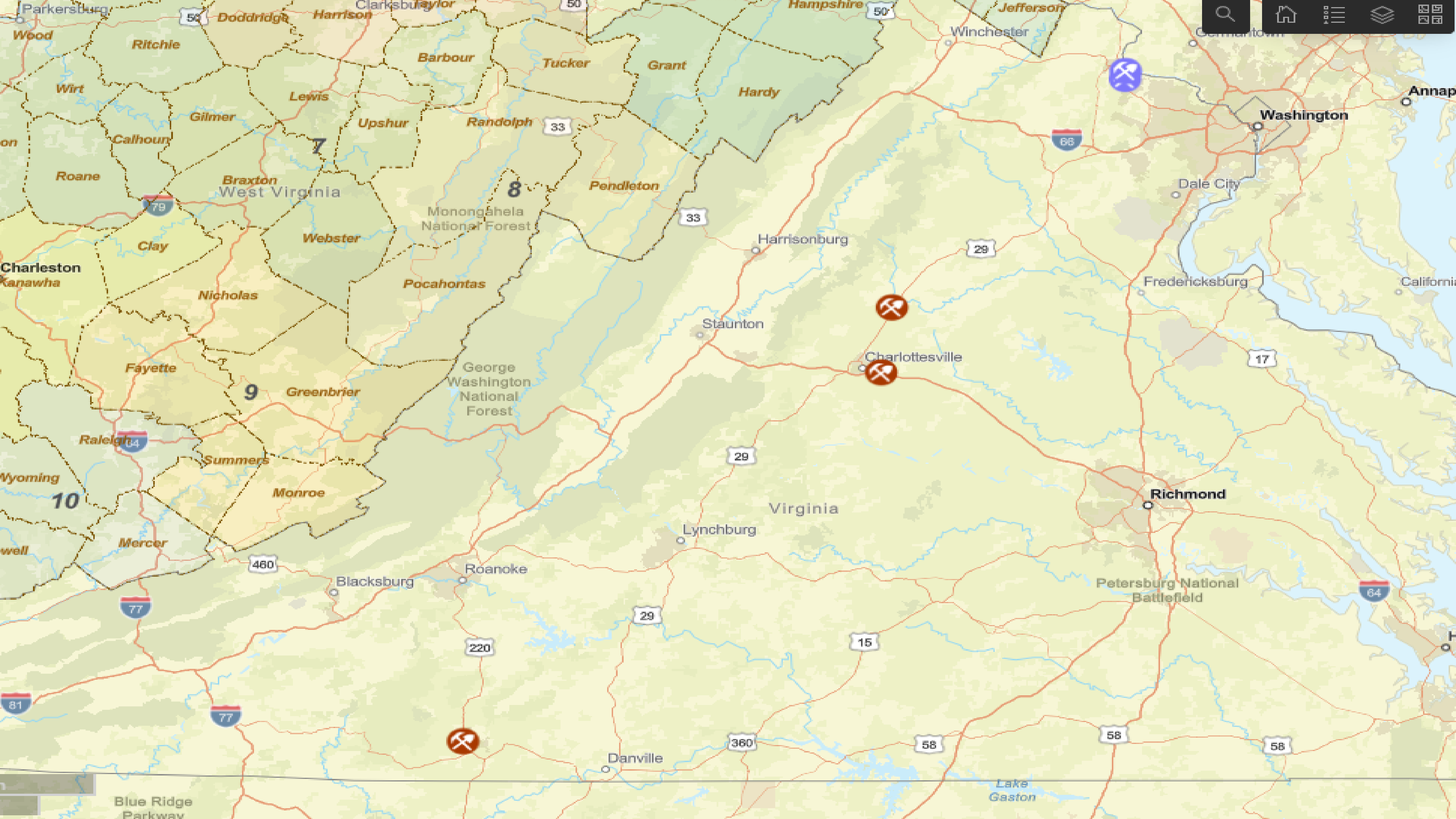
460
85

Igneous rock types

Five sources of igneous rock on approved source list

3 sources of granite 2 of diabase

All three sources are located in Virginia



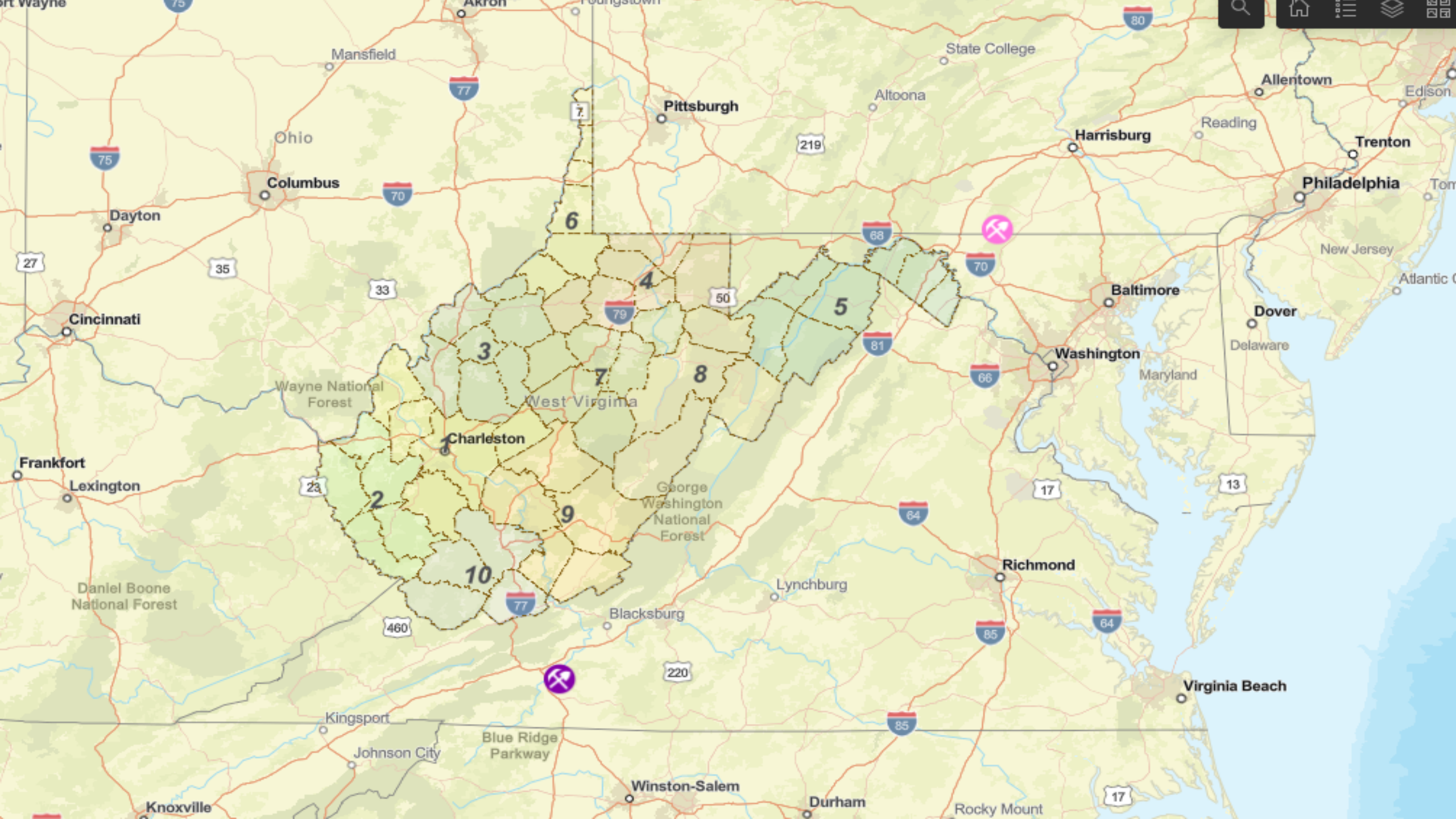
Parkersburg
Wood
Doddridge
Harrison
Clarksburg
Taylor
Hampshire
Jefferson
Winchester
Ritchie
Barbour
Tucker
Grant
Hardy
Wirt
Lewis
Gilmer
Upshur
Randolph
Calhoun
7
Roane
Braxton
West Virginia
8
Pendleton
Monongahela National Forest
Harrisonburg
Clay
Webster
Charleston
Kanawha
Pocahontas
Nicholas
Staunton
Charlottesville
Fayette
9
Greenbrier
George Washington National Forest
Raleigh
Summers
Wyoming
10
Monroe
Mercer
Virginia
Lynchburg
Roanoke
Blacksburg
Danville
Washington
Dale City
Fredericksburg
Richmond
Petersburg National Battlefield
Lake Gaston
Blue Ridge Parkway
Annap
California
Germantown

Metamorphic rocks

Two metamorphic sources

One phyllite and one quartzite

Located in Pennsylvania and Virginia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Dover
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Frankfort
Lexington
George Washington National Forest
Richmond
Daniel Boone National Forest
Lynchburg
Blacksburg
Virginia Beach
Kingsport
Blue Ridge Parkway
Johnson City
Winston-Salem
Durham
Knoxville
Rocky Mount
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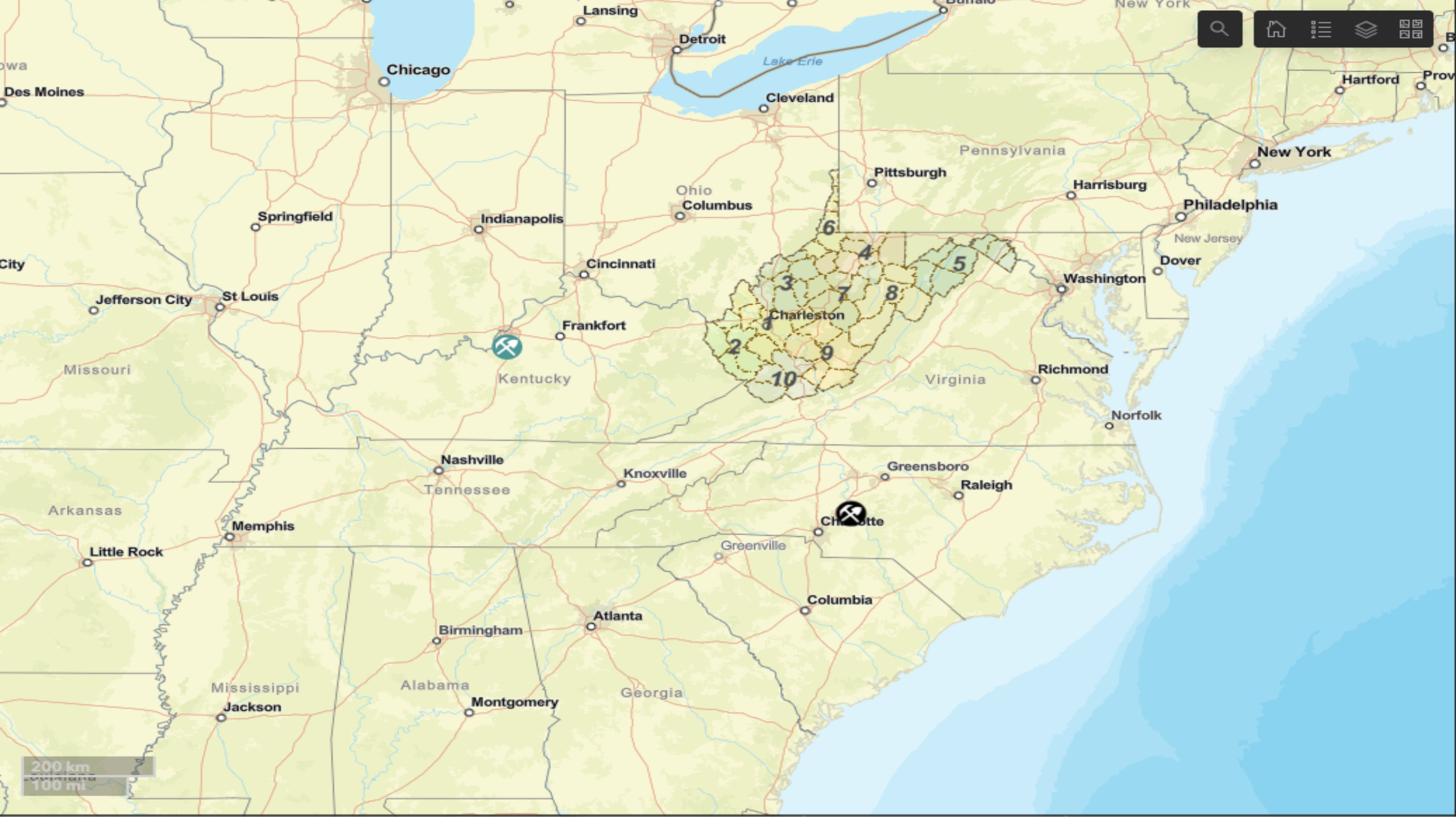
Lightweight aggregate

These are manufactured products

Expanded shale or slate

Two sources

Kentucky and Pennsylvania


Lansing
Detroit
Chicago
Lake Erie
Cleveland
Des Moines
Hartford
New York
Pennsylvania
Pittsburgh
Harrisburg
Philadelphia
New Jersey
Dover
Washington
Springfield
Indianapolis
Ohio
Columbus
Cincinnati
Jefferson City
St Louis
Frankfort
Charleston
Kentucky
Missouri
Virginia
Richmond
Norfolk
Nashville
Knoxville
Tennessee
Greensboro
Raleigh
Arkansas
Memphis
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Birmingham
Alabama
Georgia
Mississippi
Jackson
Montgomery
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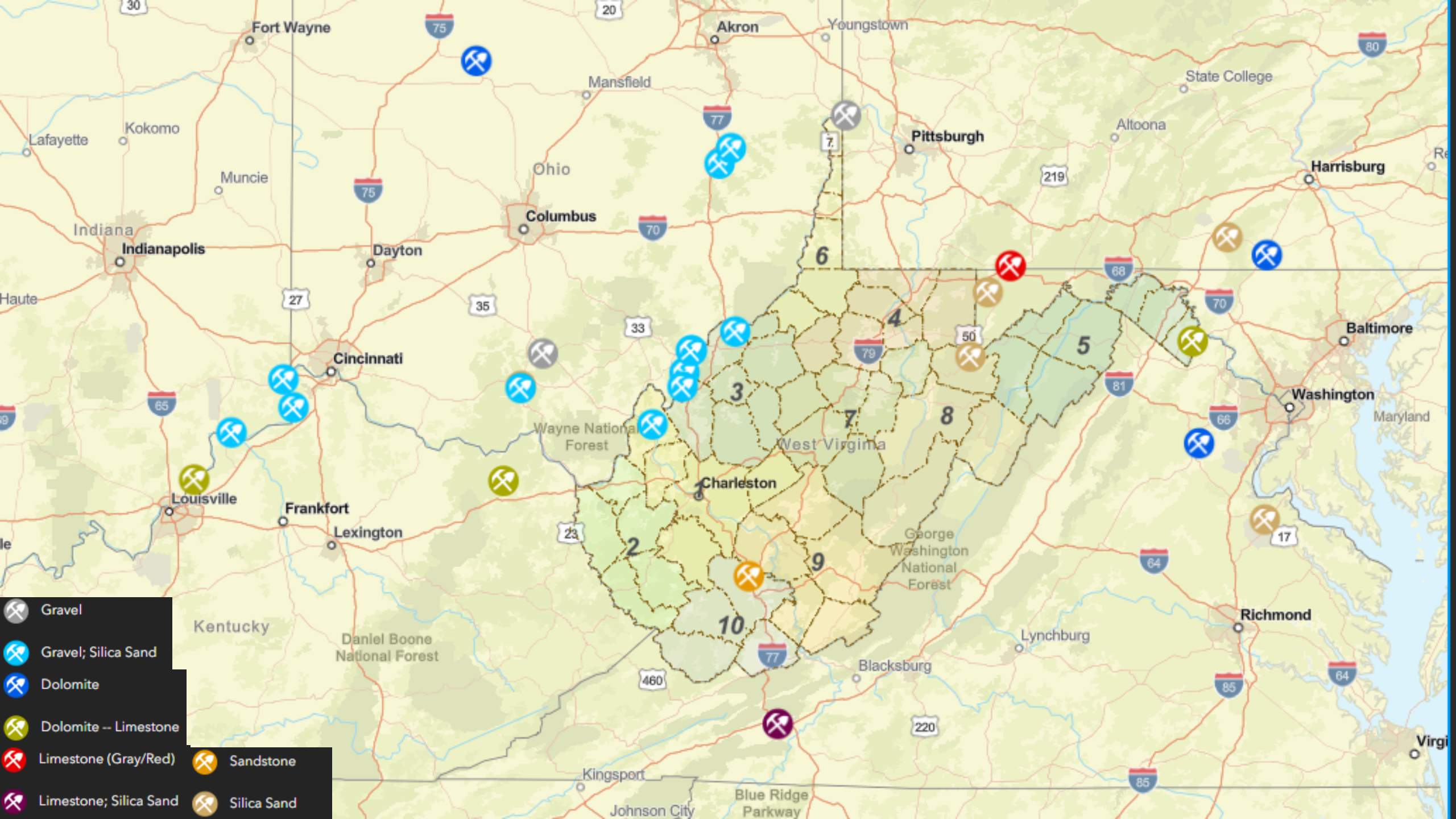
200 km
100 mi

Sedimentary Aggregates

- Dolomite
- Sandstone and silica sand
- Gray/Red limestone
- Gravel
- Limestone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Baltimore
Washington
Maryland
Wayne National Forest
West Virginia
Charleston
Louisville
Frankfort
Lexington
George Washington National Forest
Richmond
Lynchburg
Blacksburg
Kentucky
Daniel Boone National Forest
Kingsport
Johnson City
Blue Ridge Parkway
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Gravel
Gravel; Silica Sand
Dolomite
Dolomite -- Limestone
Limestone (Gray/Red)
Sandstone
Limestone; Silica Sand
Silica Sand


Pennsylvania
Pittsburgh
Harrisburg
Philade
Ohio
Columbus
Indianapolis
Cincinnati
New Jersey
Dover
Washington
Charleston
Frankfort
Kentucky
Virginia
Richmond
Norfolk
Nashville
Knoxville
Greensboro
Raleigh
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Limestone

References

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