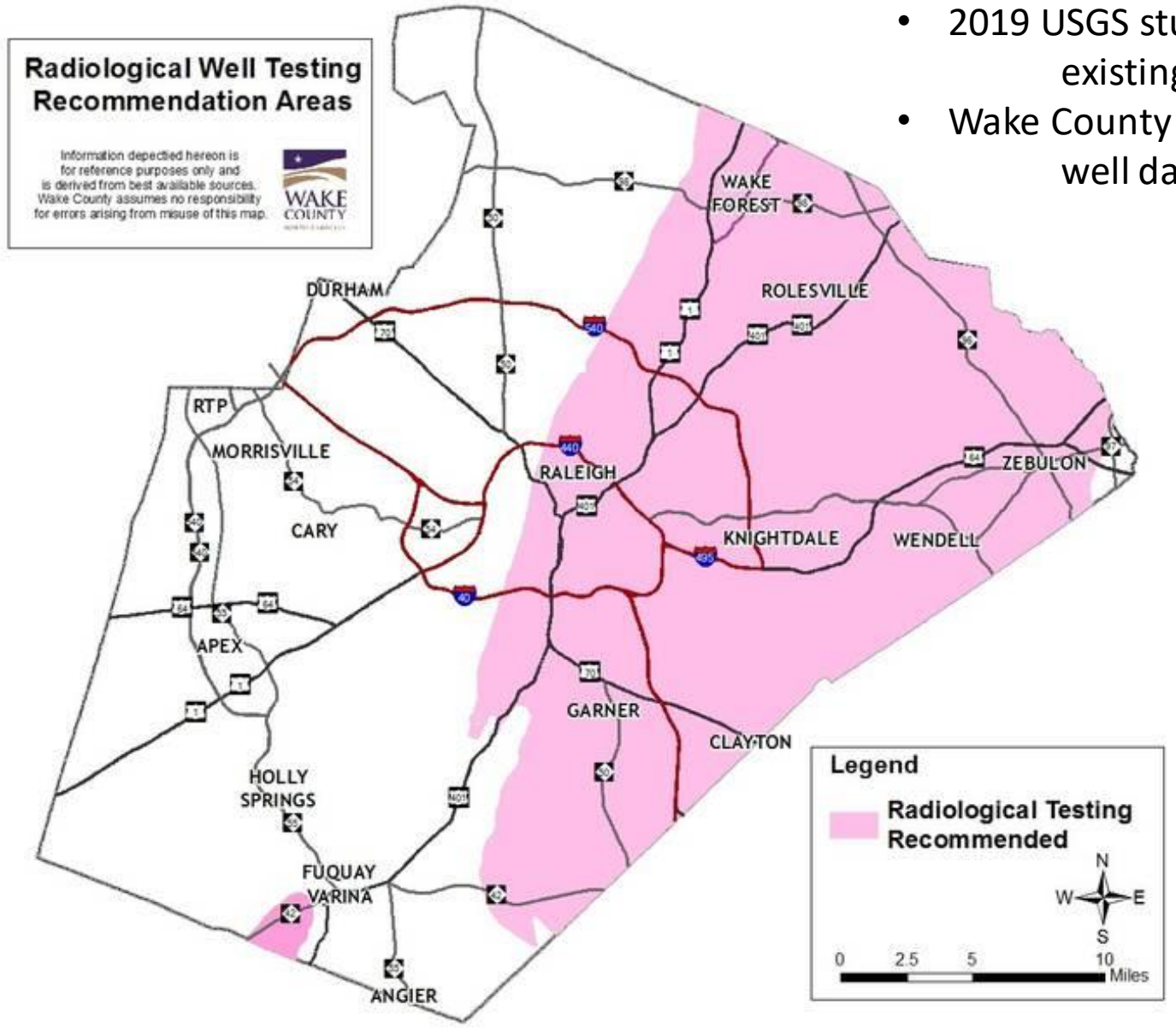
Geology-Based Radon Potential Map of North Carolina

Jim Chapman

North Carolina Geological Survey (NCGS)

Groundwater Studies Background (county-level):

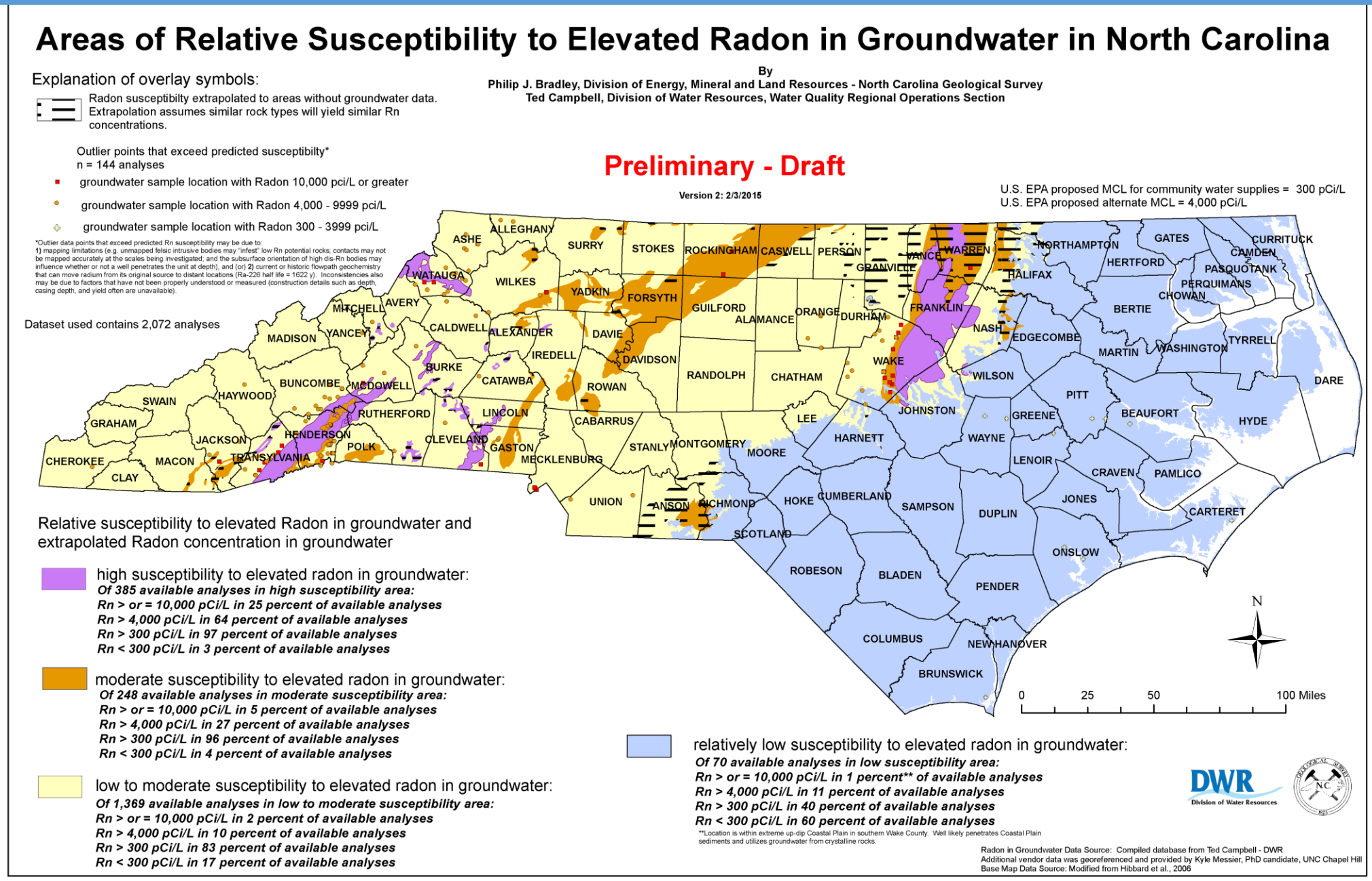


- 2019 USGS study, network of 13 existing & 6 new monitoring wells
- Wake County Environmental Services well databases

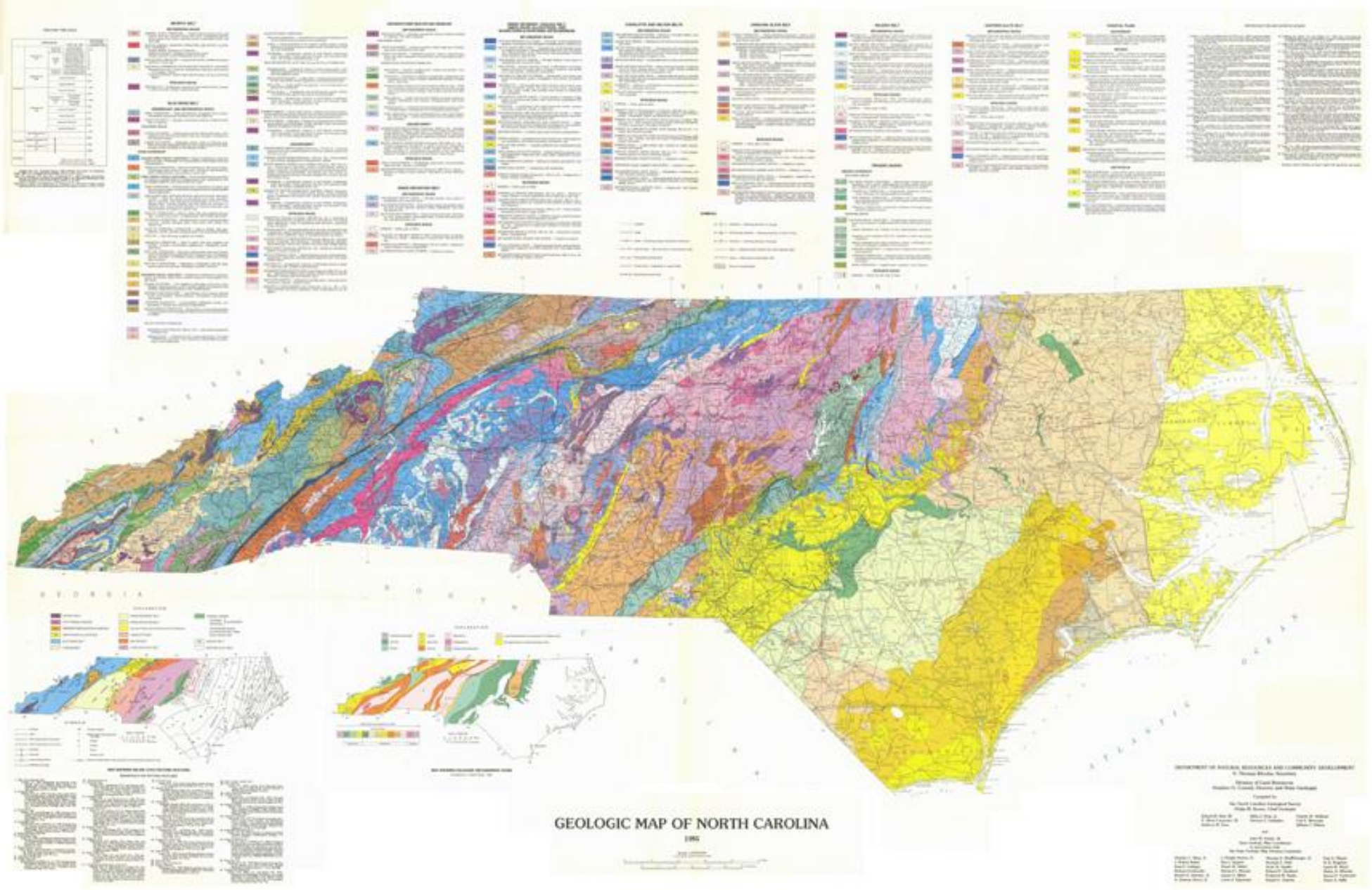
Illustration : Wake County (NC) – Department of Environmental Services

Groundwater Studies Background (State-wide):

- NC – State Government studies 2014 study – NCGS/Phil Bradley & DWR/Ted Campbell
- Numerous academic groundwater studies

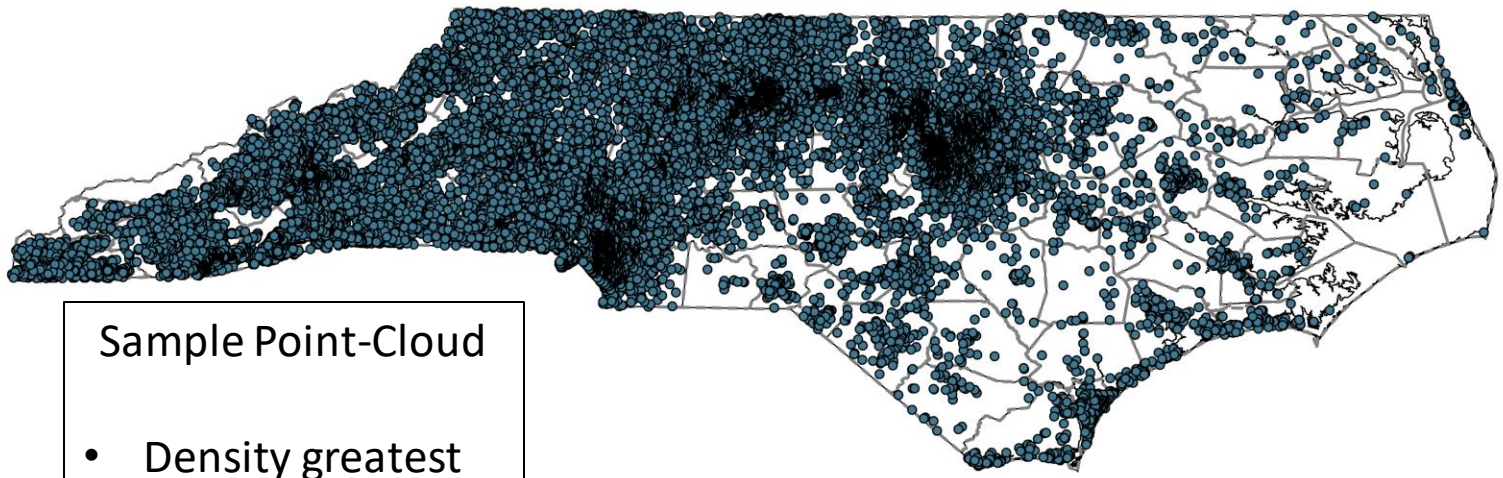


1985 North Carolina Geologic Map:



- 203 geologic units
- Scale 1:500,000
- Agency effort to improve unit delineations/descriptions over time

Building the Radon Potential Map (sample point cloud):

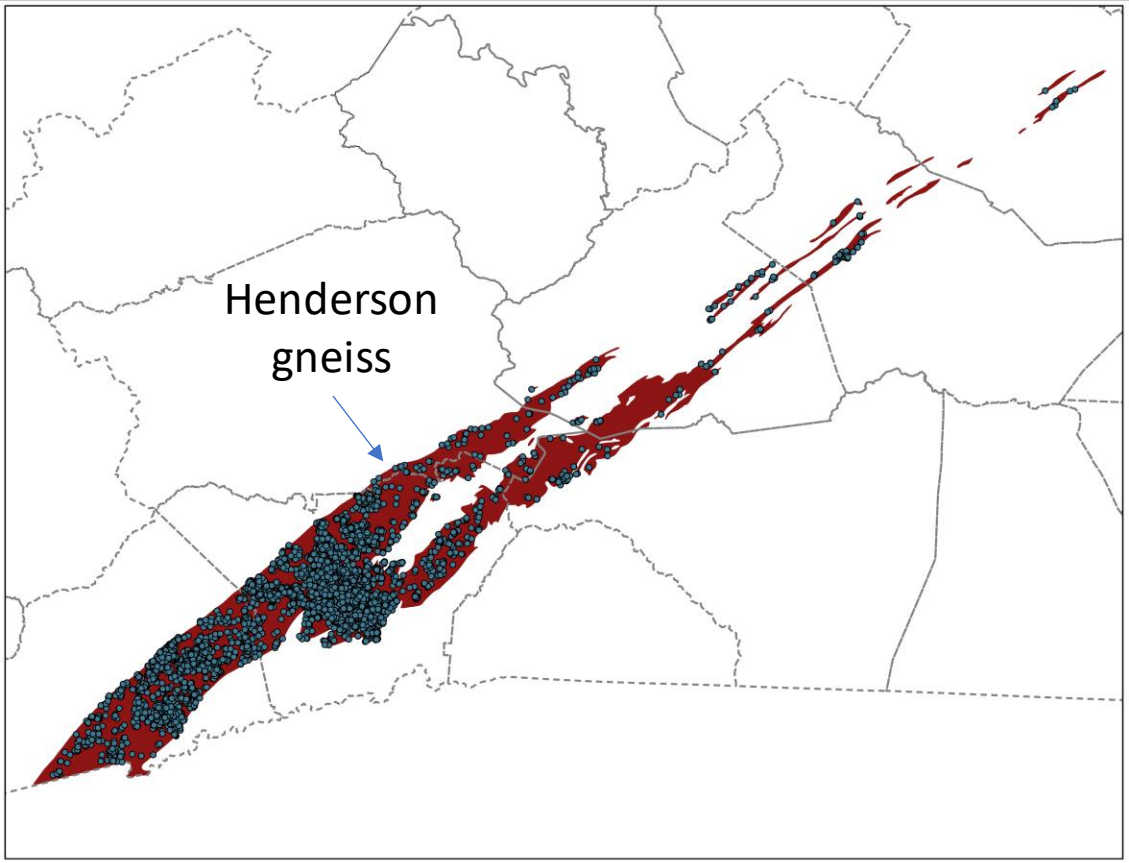


Sample Point-Cloud

- Density greatest generally in western portion of the State, greatest in the large Piedmont urban centers

- Started with 178,000+ individual sample points over 18 Excel spreadsheets
- Smoothed for: duplicate points; erroneous locations; duplicate x,y but different z, locations; “ERROR” value; <blank> cells for radon value, latitude, or longitude
- Latitude/Longitude reported to 4th decimal (approx. 11.1 meters)
- After smoothing sample point database: 154,065 sample points

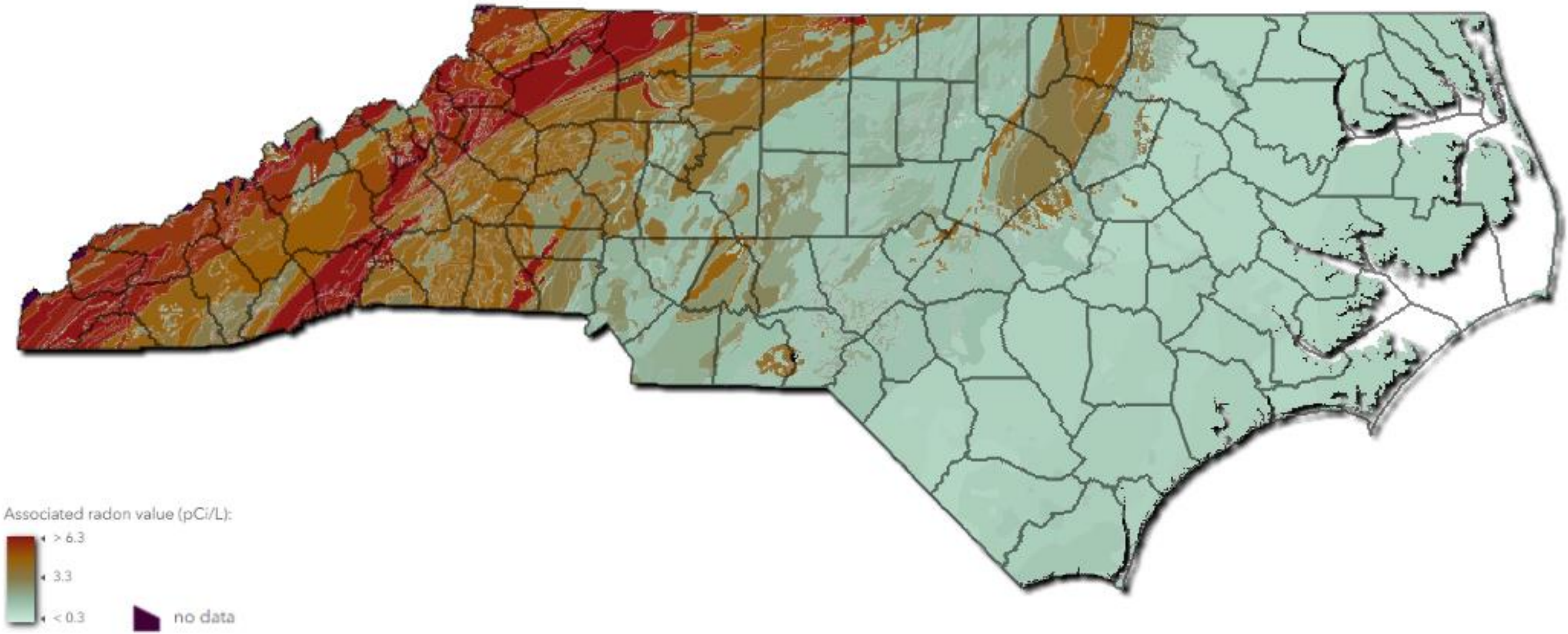
Building the Radon Potential Map (geologic map units):



Henderson
gneiss

- Geologic map unit assigned radon value: 3rd quartile (75th percentile)
- Additionally: Geologic map unit maximum, minimum, median, and mean values; sample count; & sample density
- 10/203 geologic map units without sample data points
  - Either underlying public lands or small footprint or usually both

Radon Potential Map of North Carolina – 1985 Geologic Map (basemap):



Geologic Sources of Radon:

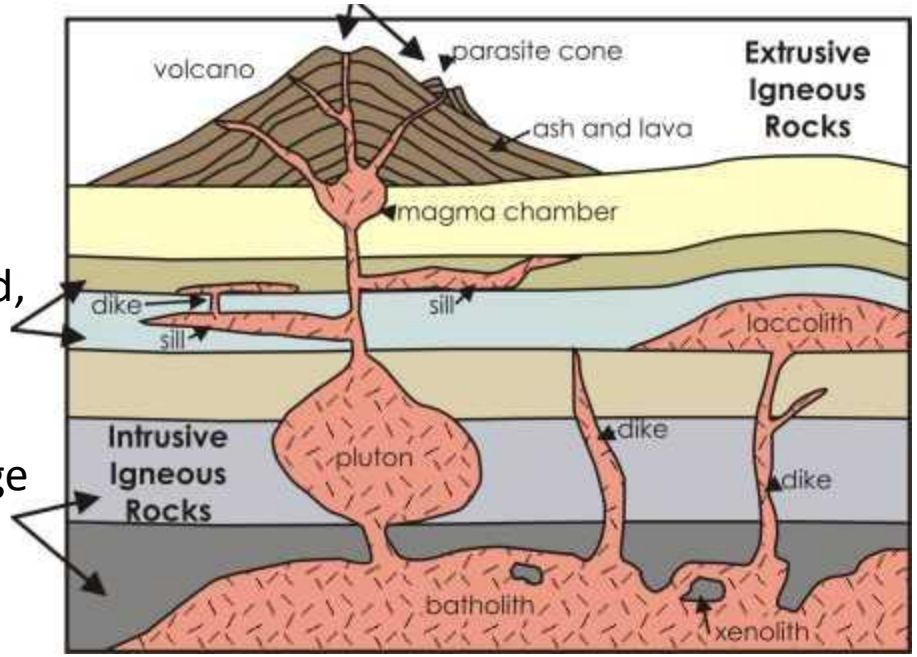
Rocks with higher radon concentration, generally:

- Granites;
- Some phosphorites (sedimentary rocks);
- Also, some volcanic rocks, with mainly quartz (felsic - ex. Rhyolite) & some dark shales;
- Metamorphic rocks derived from the above.

Fast cooling, fine crystal size

Medium cooling speed, medium crystal size

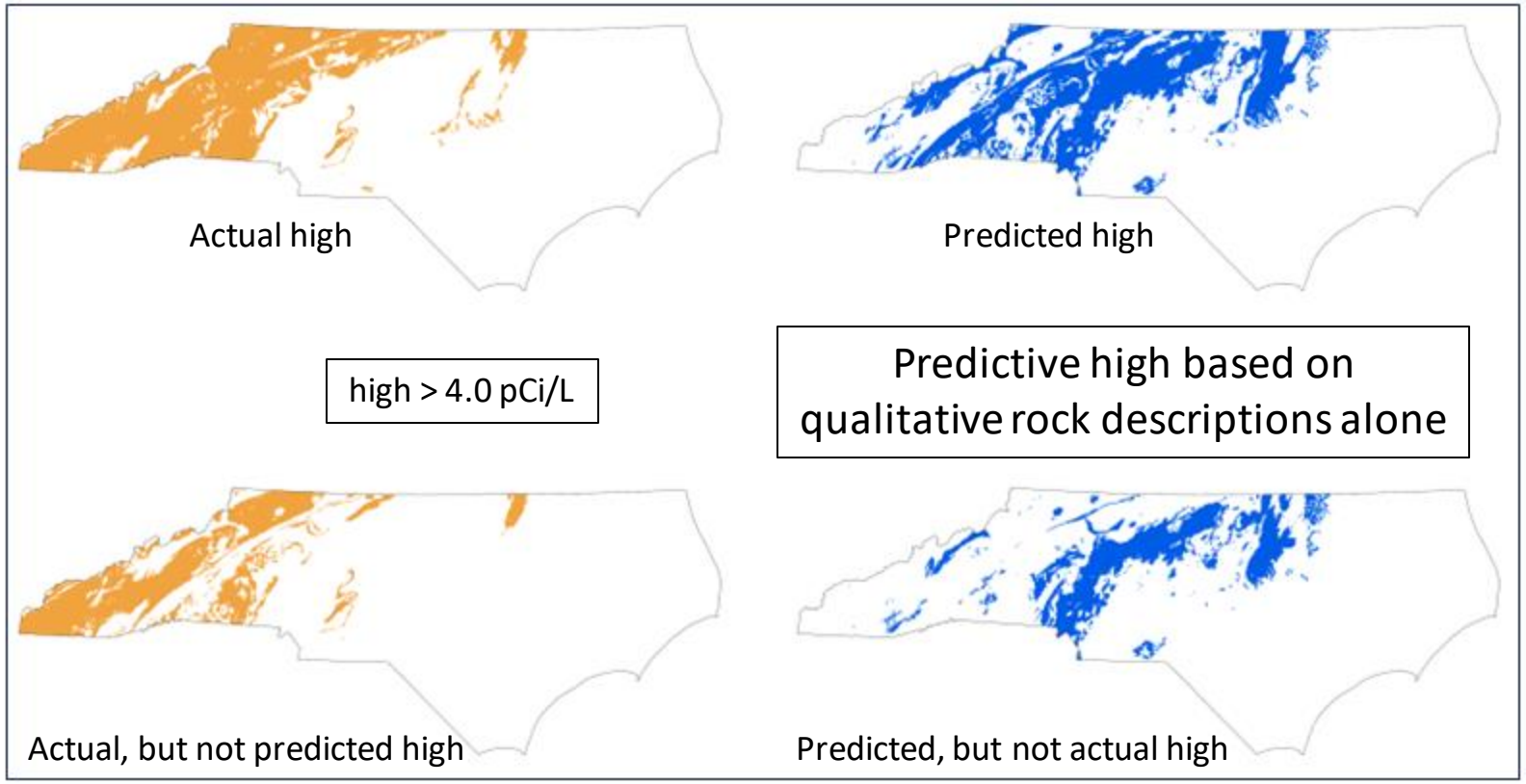
Granites } Slow cooling speed, large crystal grow



Phosphorites:

- Made of the mineral apatite, $Ca_5(PO_4)_3(F,Cl,OH)$
- Skeletons of marine animals deposited on marine floor as apatite → phosphorites
- U^{4+} replacing replacing calcium
- Interesting part . . . U in seawater mostly U^{6+} (more soluble than U^{4+})→ animal decay → reduces U^{6+} to U^{4+}

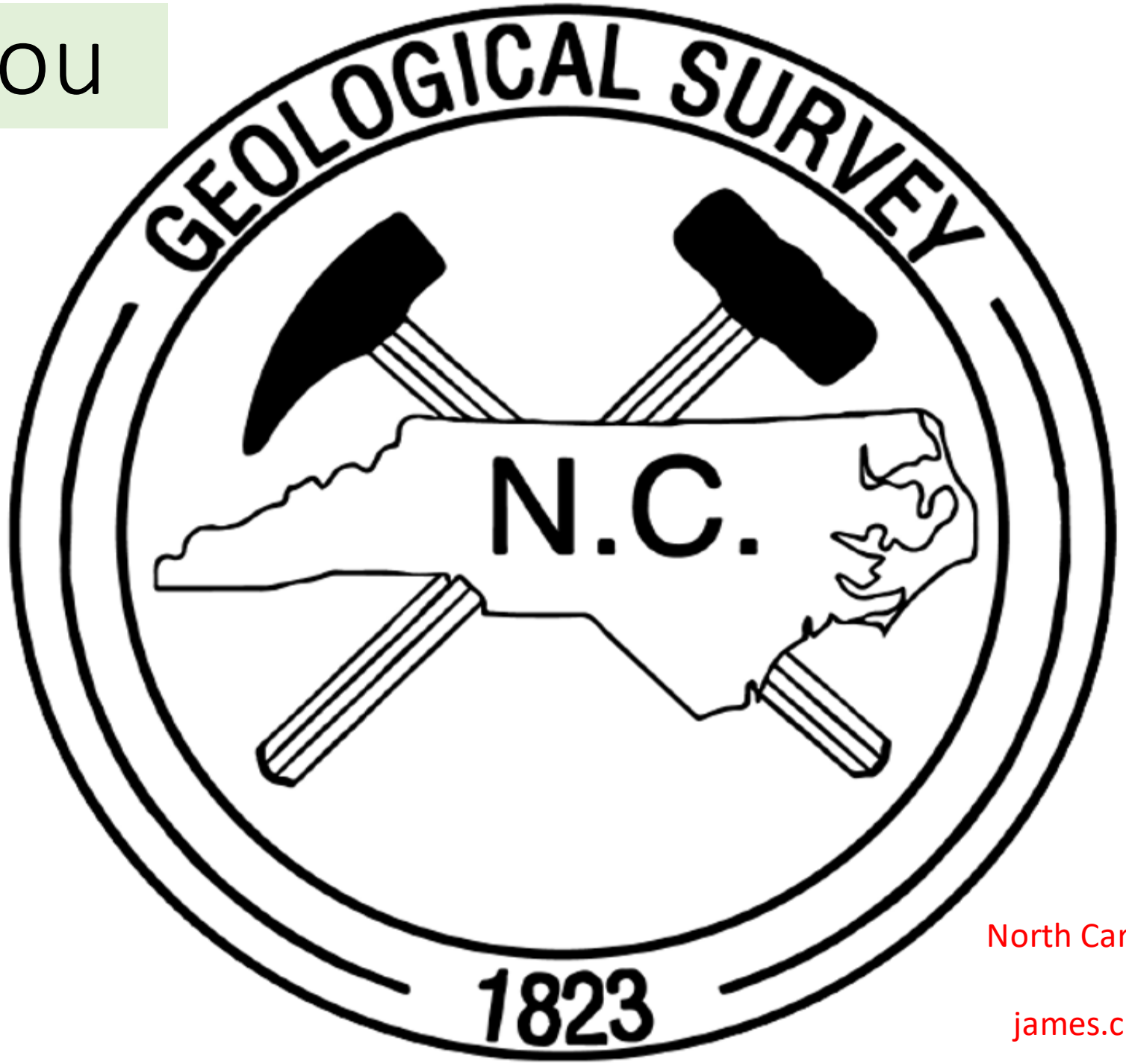
Graphic Results vs Expectations:



Going Forward with Radon Prediction Map:

- More detailed rock characterization → Geochemical analysis $$$ → More viable at local mapping scale efforts
- Crustal fracture analysis → Better understanding of natural pathways
- Synthesis of groundwater and air quality studies
- More speciality collaboration

Thank You



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james.chapman@deq.nc.gov