Geographic Distribution for a Quarter of a Century of Radon Analyses

By Art Nash[1], Jennifer Athey[2], and Michael Hendricks[2]

[1]School of Natural Resources and Extension
University of Alaska Fairbanks
308 Tanana Drive
Fairbanks, Alaska 99775
Art Nash, alnashjr@alaska.edu, 907.474.6366

[2]Alaska Division of Geological & Geophysical Surveys
3354 College Road
Fairbanks, Alaska 99709
Jennifer Athey, jennifer.athey@alaska.gov, 907.451.5028
Michael Hendricks, mike.hendricks@alaska.gov, 907.451.5029

Radon, a colorless, odorless radioactive gas formed as a decay product of uranium, remains the second leading cause of lung cancer and is a recognized public health concern in Alaska. State and federal agencies need high-quality, timely, standardized data to ensure positive outcomes for Alaskans. Through a 2016 grant from the Environmental Protection Agency's (EPA) Environmental Information Exchange Network Grant Program, the Alaska Division of Geological & Geophysical Surveys (DGGS) and University of Alaska Fairbanks, School of Natural Resources and Extension (SNRE) are creating and populating a statewide database of in-door radon tests and related environmental data. Data standards and a growing repository of test data will facilitate easier data compilation and more robust scientific modeling, epidemiological studies, and new public outreach materials on a local and national scale to reduce radon exposure risk.

In 2015, SNRE compiled 3,200 results of long-term tests of radon gas samples in buildings throughout the state from the last 24 years, largely made possible through the EPA State Indoor Radon Grant program. The Alaska Department of Health and Social Services, Division of Public Health used these data to develop recommendations for health providers to reduce health risk from radon exposure (www.epi.alaska.gov/bulletins/docs/b2015_25.pdf). Because these test results are spatially associated with zip codes instead of discrete locations, test results could not be geocoded and presenting statistics as choropleths was challenging. Zip codes in Alaska may cover extremely large areas, and Post Offices, with their own designated zip code, act as central hubs for many remote addresses. Additionally, zip codes may cover multiple, non-adjacent areas. Consequently, positively identifying the area in which the test was taken is time consuming, and sometimes test locations are impossible to verify. The data indicate many homes in communities throughout Alaska have test results greater than the EPA action level of 4 pCi/L. Interior Alaska, particularly Fairbanks, Delta Junction, and Healy, contained the highest proportions of concerning levels. The Alaska Division of Public Health recommends that all Alaska residents should test their homes for radon.

As a part of the new Alaska radon database, DGGS and SNRE are collecting confidential street addresses where radon test are deployed, which are either released directly to DGGS from building owners or by private radon laboratories with varying degrees of location obfuscation. Preliminary data for 2,020 test results were geocoded and spatially analyzed with different methodologies: points varied by color and

size, hot spot analysis by census tract (polygon), maximum values in hexagonal tessellations at various scales, and inverse distance weighted interpolation (surface). Presenting test results spatially helps researchers and the public visualize where elevated levels of radon exist, potentially spurring follow-up actions such as additional testing and the release of data to DGGS. Data release forms are available from DGGS and SNRE.

Most radon tests occur in areas of higher population along road corridors, as well as at military and other federal agency buildings per OSHA; however, radon-generative rocks likely occur throughout the state. Radon test results may be examined spatially in relation to geologic units, elevation, uranium concentrations, and other factors to gain a better understanding of where radon-generative conditions may be present. Ideally, new homes located in areas of higher radon potential will be constructed with radon-reducing features so that they do not need to receive costly mitigation after the fact. For example, the Fairbanks Schist geologic unit in the Interior appears to be associated with a higher number of radon test results greater than 4 pCi/L. About 30 to 35 percent of homes built in the hills around Fairbanks have elevated radon concentrations (http://doi.org/10.14509/1439). In the final year of the EPA Exchange Network grant, an online, interactive map based on radon-generative conditions will be developed and released to the public to show citizens where concern areas are located.

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Art Nash, Assistant Professor
School of Natural Resources and Extension

Jen Athey, Geologist, Geologic Information Center
State of Alaska, Division of Geological & Geophysical Surveys

Mike Hendricks, Geospatial Analyst
State of Alaska, Division of Geological & Geophysical Surveys

Outline

- History of past radon testing in Alaska
- Radon data collection procedures
- Analysis and visualization
- Geologic considerations

Protect Your Family from Radon

Radon is a gas that you can't **see, smell**, or **taste** — but it can be dangerous. It's the second leading cause of lung cancer in the U.S.

Radon is in the ground naturally. But sometimes it gets into homes **through cracks in the floors or walls.**

Learn more about radon and how it can affect your health.
http://www.cdc.gov/nceh/radiation/brochure/profile_radon.htm

Past radon testing in Alaska- All Residential

Research past testing in Alaska has occurred in:

- 1987-tested 38 homes above Fairbanks 229m contours
- 1989-tested 1312 homes with statewide detectors
- 1996-1998- heating seasons tested 57 homes in Fairbanks

No GIS analysis on any of these…..

1989 EPA Survey

Radon concentrations over the EPA action level:

State region	% of tests over EPA action level
Interior	18
Southcentral	13
Anchorage	4
Southeast	2
Northern/Western	2

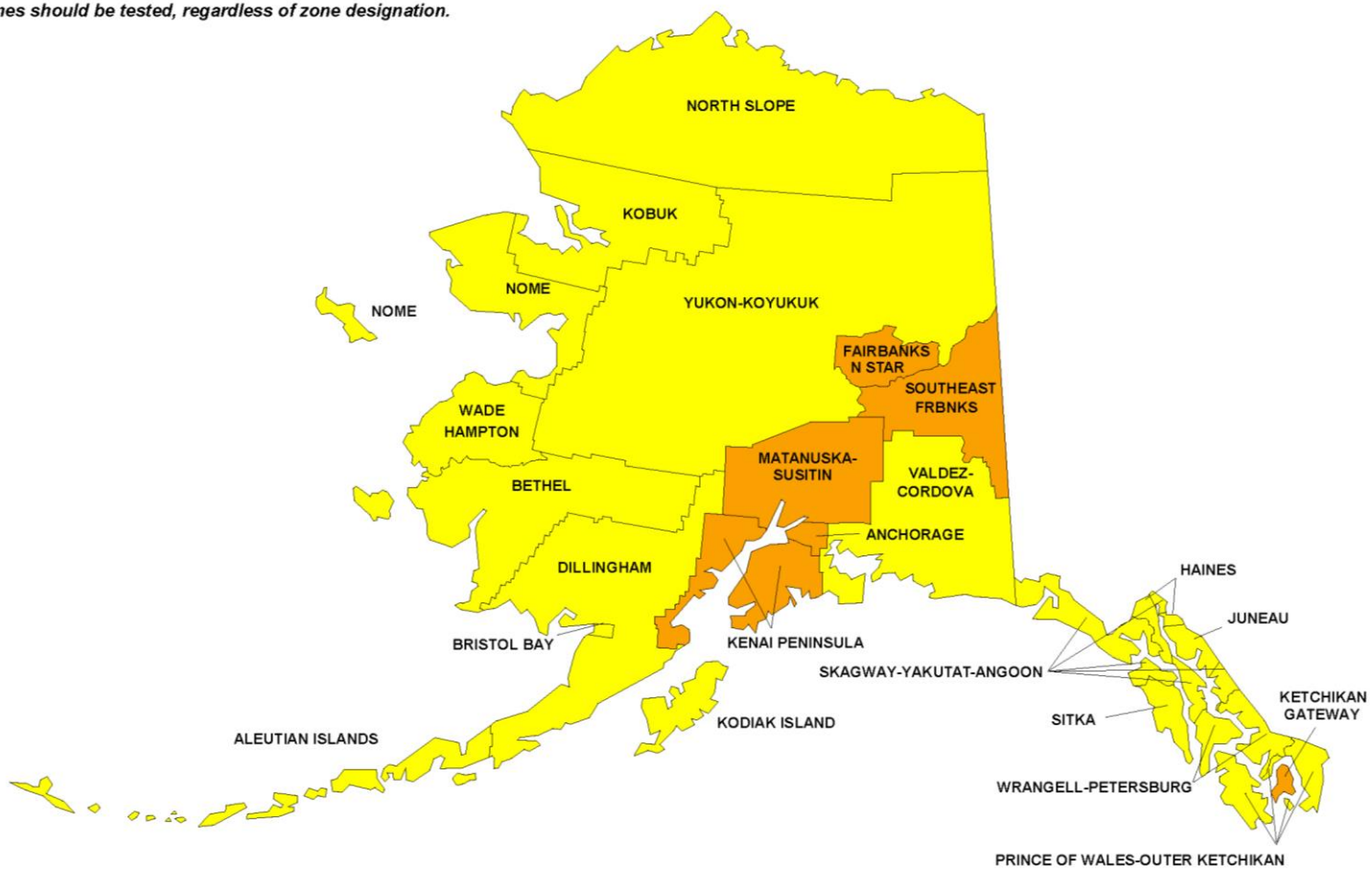
ALASKA - EPA Map of Radon Zones

http://www.epa.gov/radon/zonemap.html

The purpose of this map is to assist National, State and local organizations to target their resources and to implement radon-resistant building codes.

This map is not intended to determine if a home in a given zone should be tested for radon. Homes with elevated levels of radon have been found in all three zones.

All homes should be tested, regardless of zone designation.



Zone 1 Zone 2 Zone 3

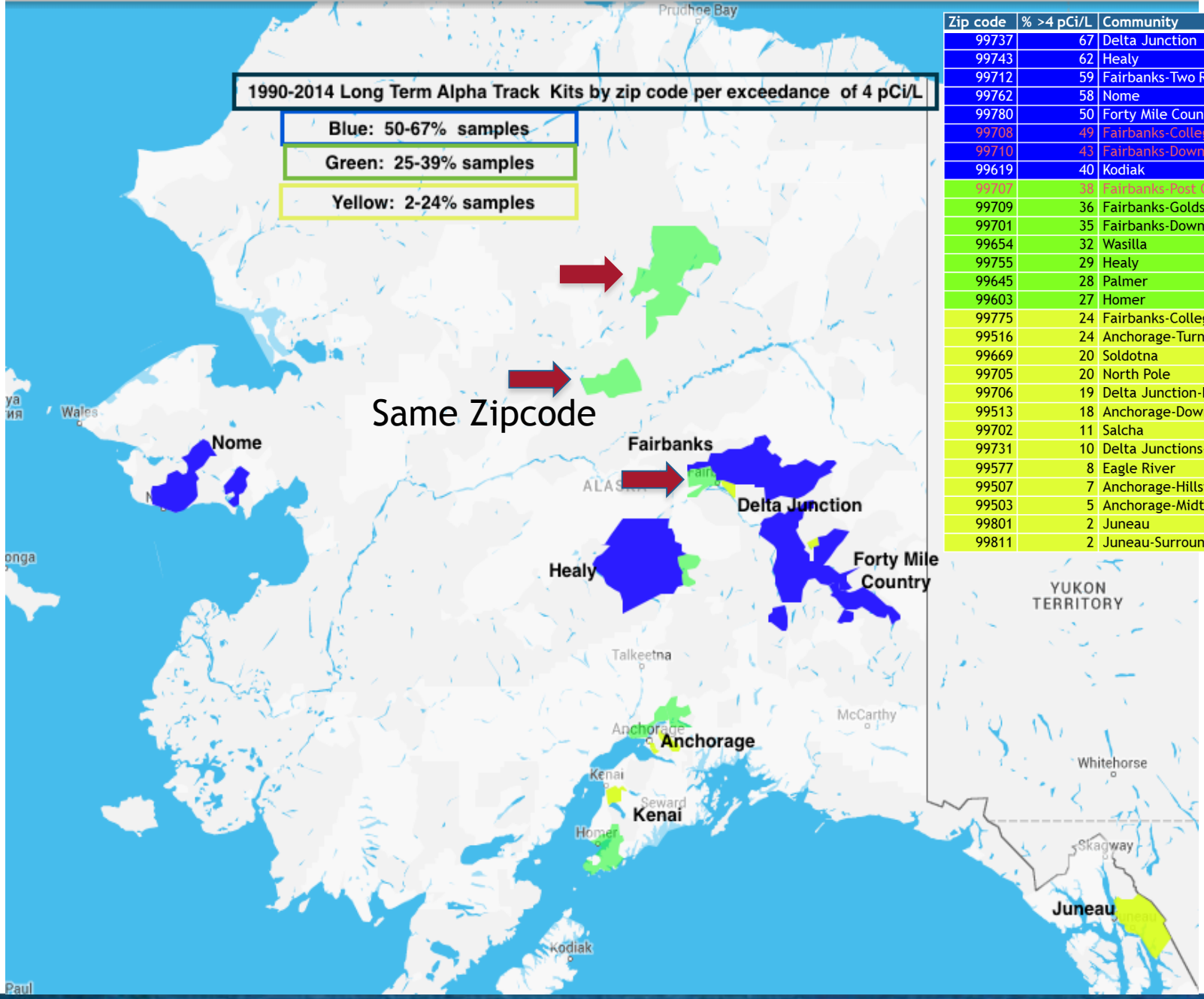
IMPORTANT: Consult the publication entitled "Preliminary Geologic Radon Potential Assessment of Alaska" (USGS Open-file Report 93-292-J) before using this map. http://energy.cr.usgs.gov/radon/grpinfo.html This document contains information on radon potential variations within counties. EPA also recommends that this map be supplemented with any available local data in order to further understand and predict the radon potential of a specific area.

Test results from 1991-2014

(Percentage of tests >4 pCi/L)

Units pCi/L = picocuries per liter

Zip code	% >4 pCi/L	Community
99737	67	Delta Junction
99743	62	Healy
99712	59	Fairbanks-Two Rivers
99762	58	Nome
99780	50	Forty Mile Country
99708	49	Fairbanks-College
99710	43	Fairbanks-Downtown
99619	40	Kodiak
99707	38	Fairbanks-Post Office
99709	36	Fairbanks-Goldstream
99701	35	Fairbanks-Downtown
99654	32	Wasilla
99755	29	Healy
99645	28	Palmer
99603	27	Homer
99775	24	Fairbanks-College
99516	24	Anchorage-Turnigan Arm
99669	20	Soldotna
99705	20	North Pole
99706	19	Delta Junction-Healy Lake
99513	18	Anchorage-Downtown
99702	11	Salcha
99731	10	Delta Junctions-Fort Greely
99577	8	Eagle River
99507	7	Anchorage-Hillside
99503	5	Anchorage-Midtown
99801	2	Juneau
99811	2	Juneau-Surrounding Area



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99503	5	Anchorage-Midtown
99801	2	Juneau
99811	2	Juneau-Surrounding Area

Issues with address-level test results

Labs each have a different protocol, for example:

- Straight release of addresses
- Release with latitude/longitude and abrogation
- Given addresses only for geocoding, obfuscated locations to be matched with lab data
- Incomplete contextual data needed for robust statistical analyses (e.g., pre- vs. post-mitigation)

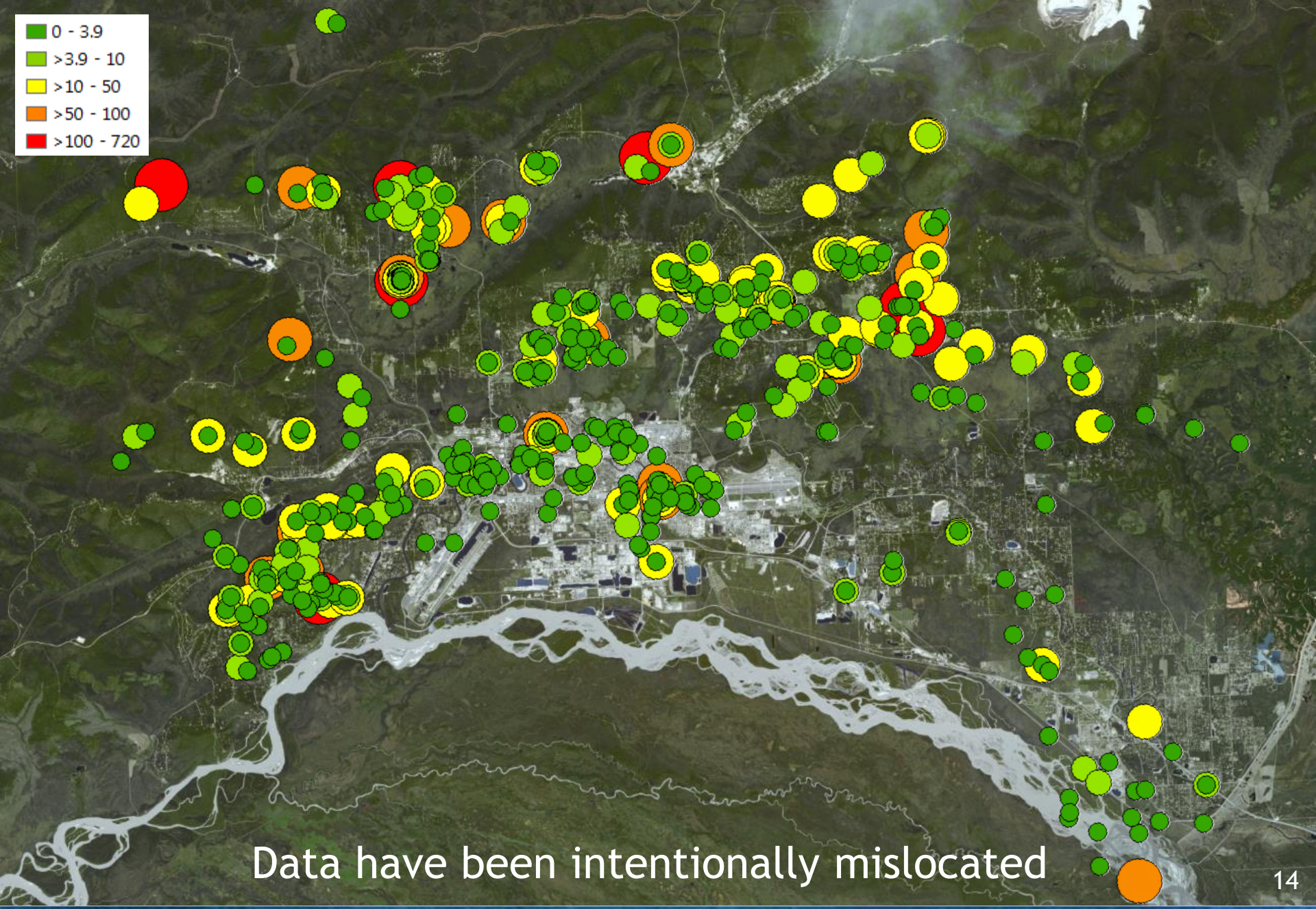
Analysis and visualization

Radon test results as:

- Points
- Polygons
- Tessellation
- Surfaces

Representing data as points

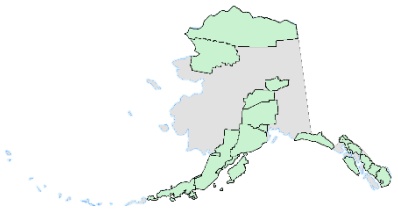
- Points at site level (can limit willingness to release data due to confidentiality)
- Scale-dependent point symbology shows high-density areas (may implicate neighbors)
- Color and size can be used to differentiate
- Could represent the standard deviation, mean, maximum value, etc.

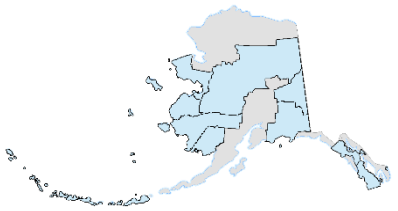


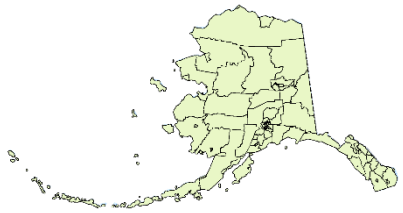
Data have been intentionally mislocated

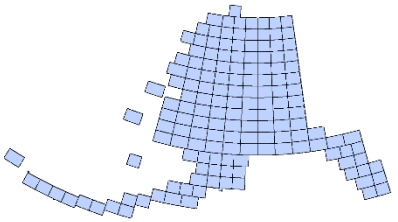
Representing data as polygons

- No counties, but rather boroughs and municipalities (which are geometrically odd and not all contiguous)
- Large swaths of ‘unorganized’ areas (largest area is bigger than Montana)
- Census tracts are large and geometrically odd
- USGS quadrangles or BLM PLSS



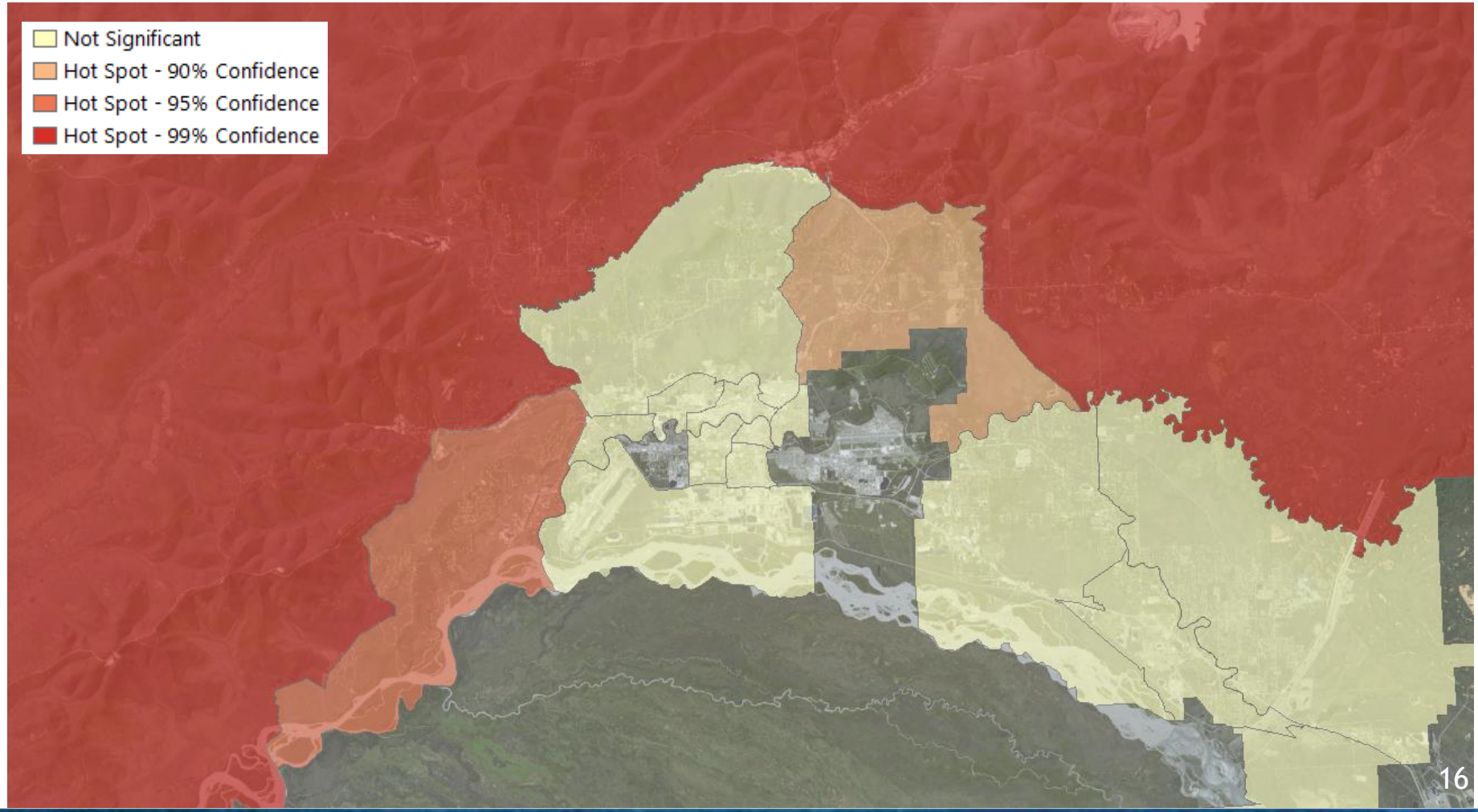






Hot Spot Analysis (Getis-Ord Gi*)

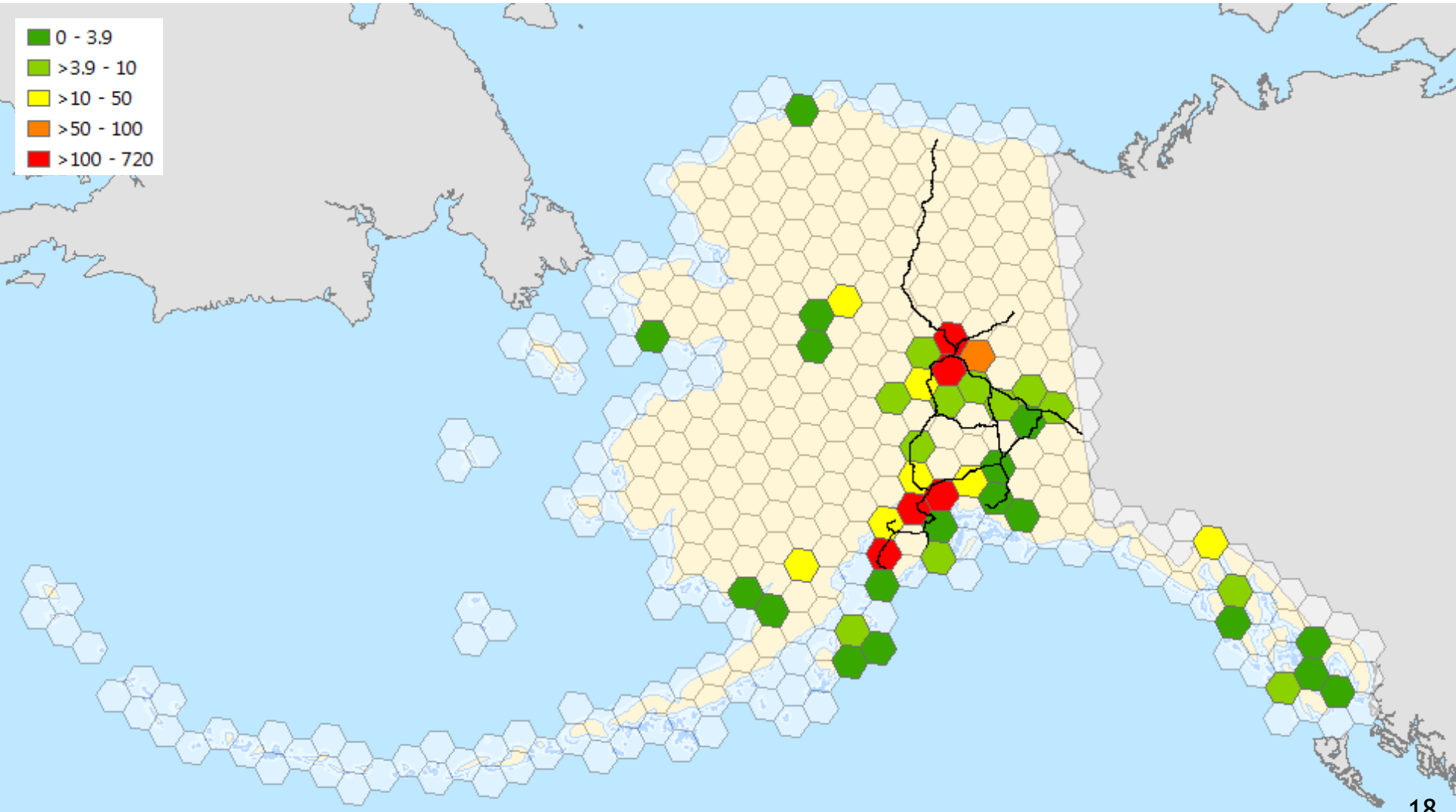
>3.9 pCi/L by 2016 census tracts

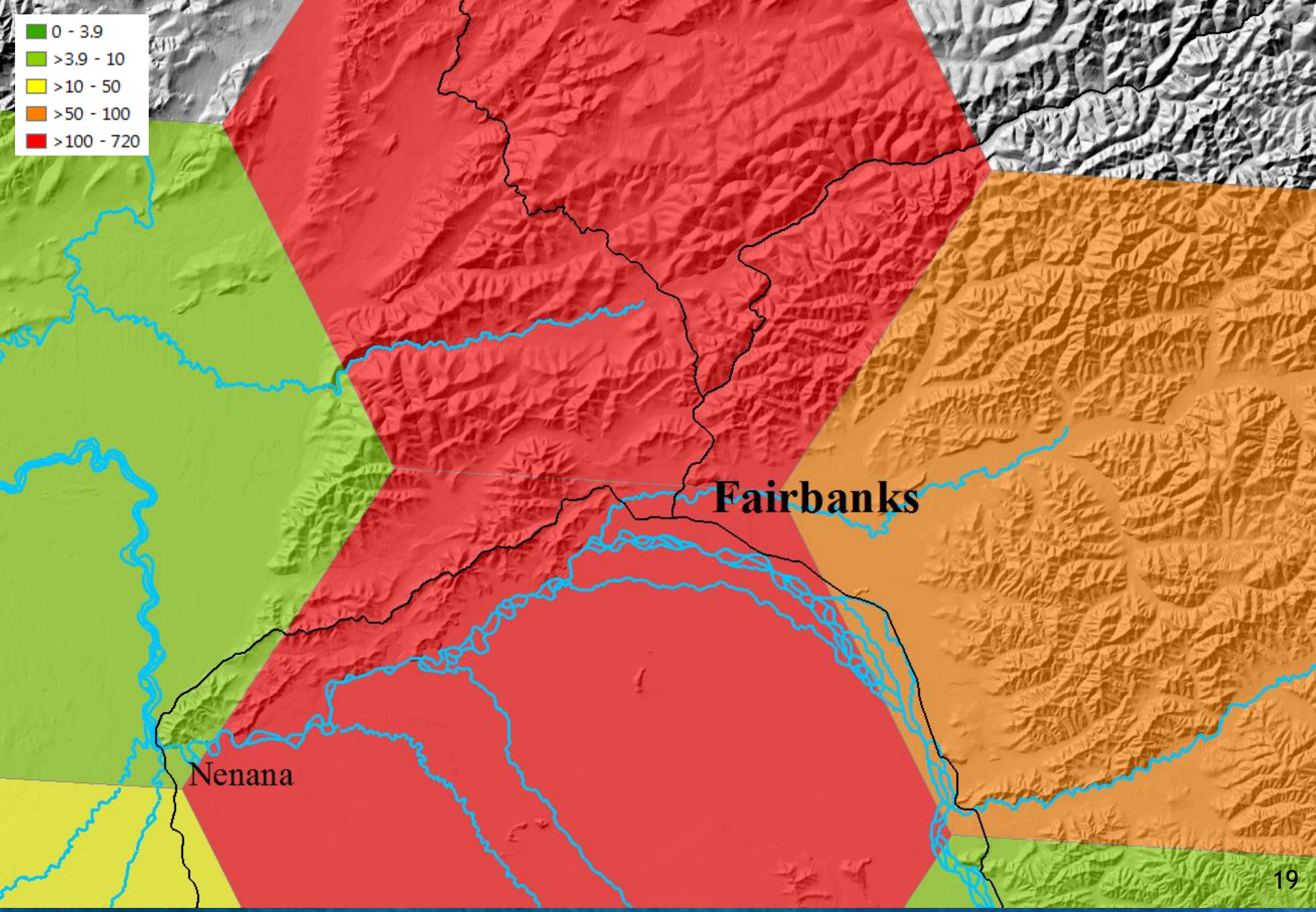


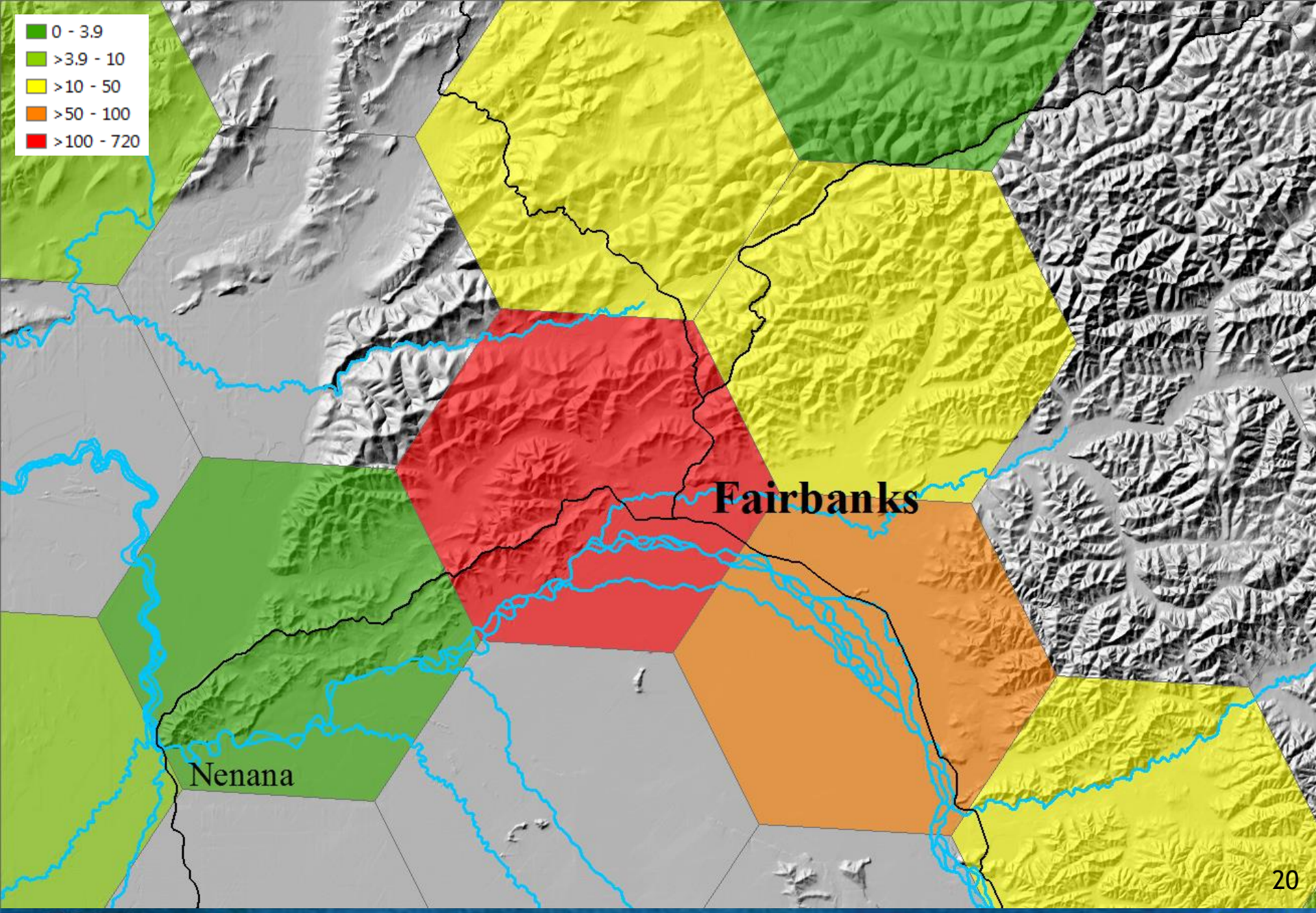
Tessellation of the data

- Creates a regular mesh of polygons over study area
- Allows for vagueness while giving meaningful choropleth qualitative appearance
- Nice zoom in adjustment
- Time series static shots can be animated

Hexagonal tessellation of radon data




0 - 3.9
>3.9 - 10
>10 - 50
>50 - 100
>100 - 720
Fairbanks
Nenana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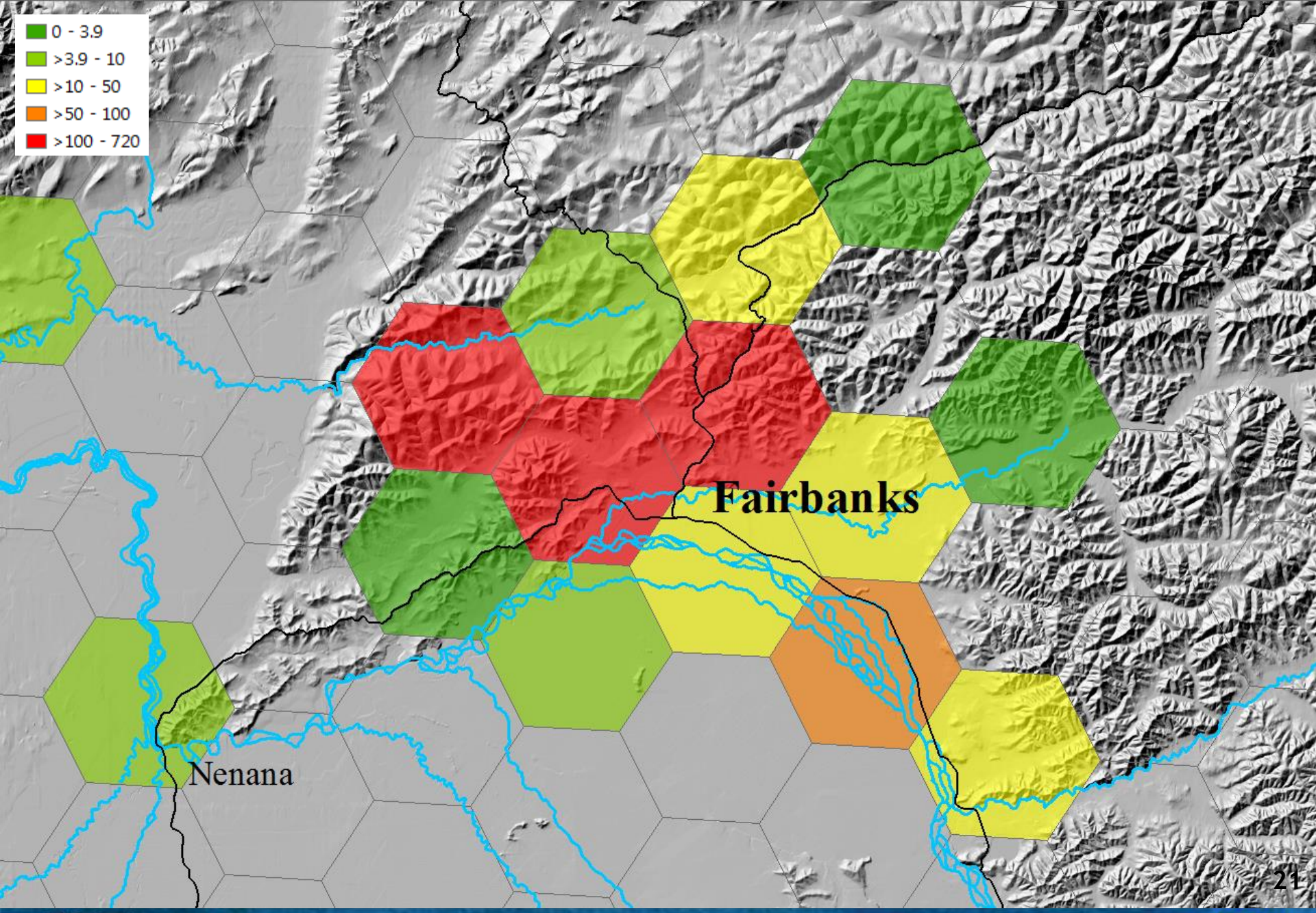
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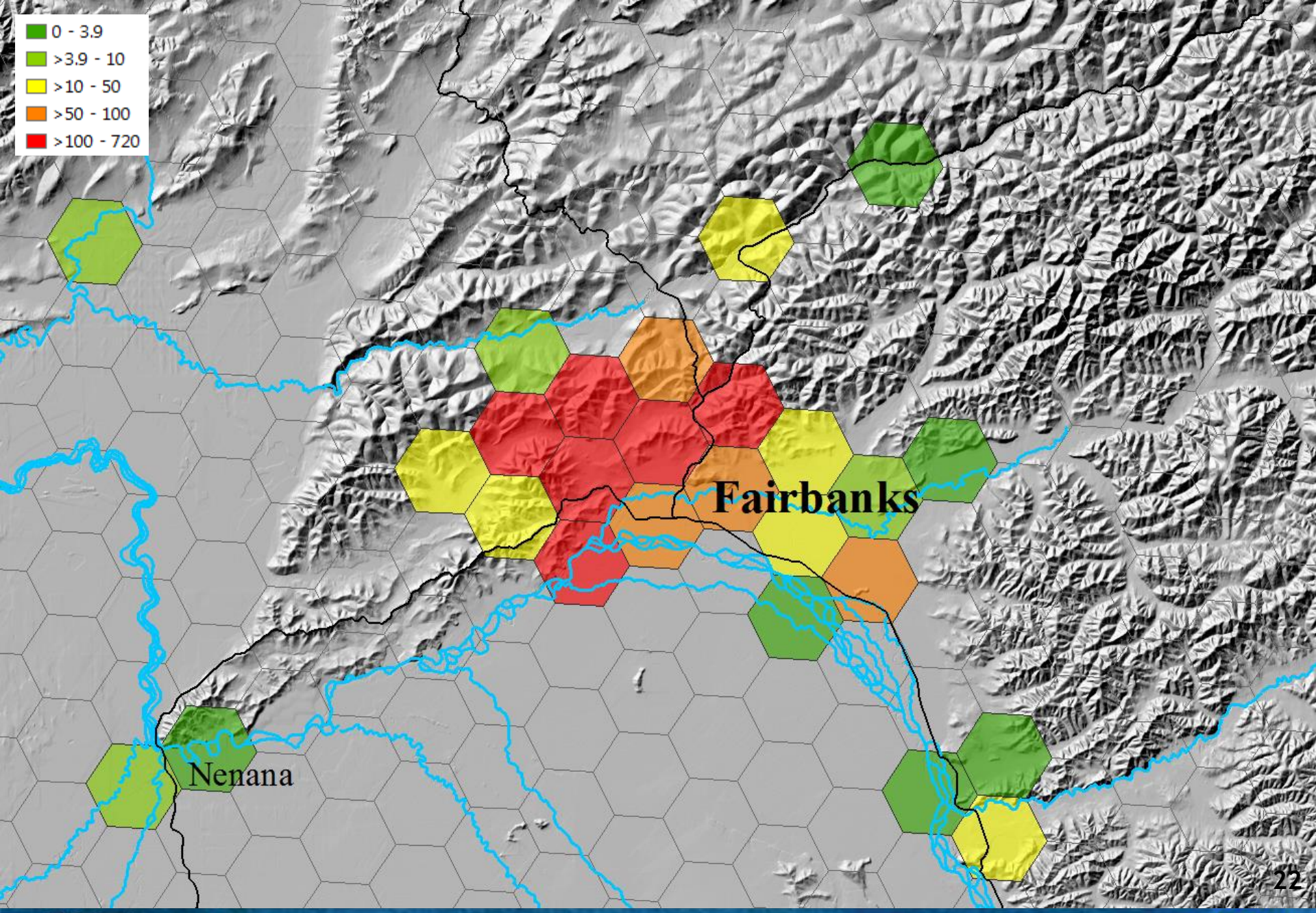
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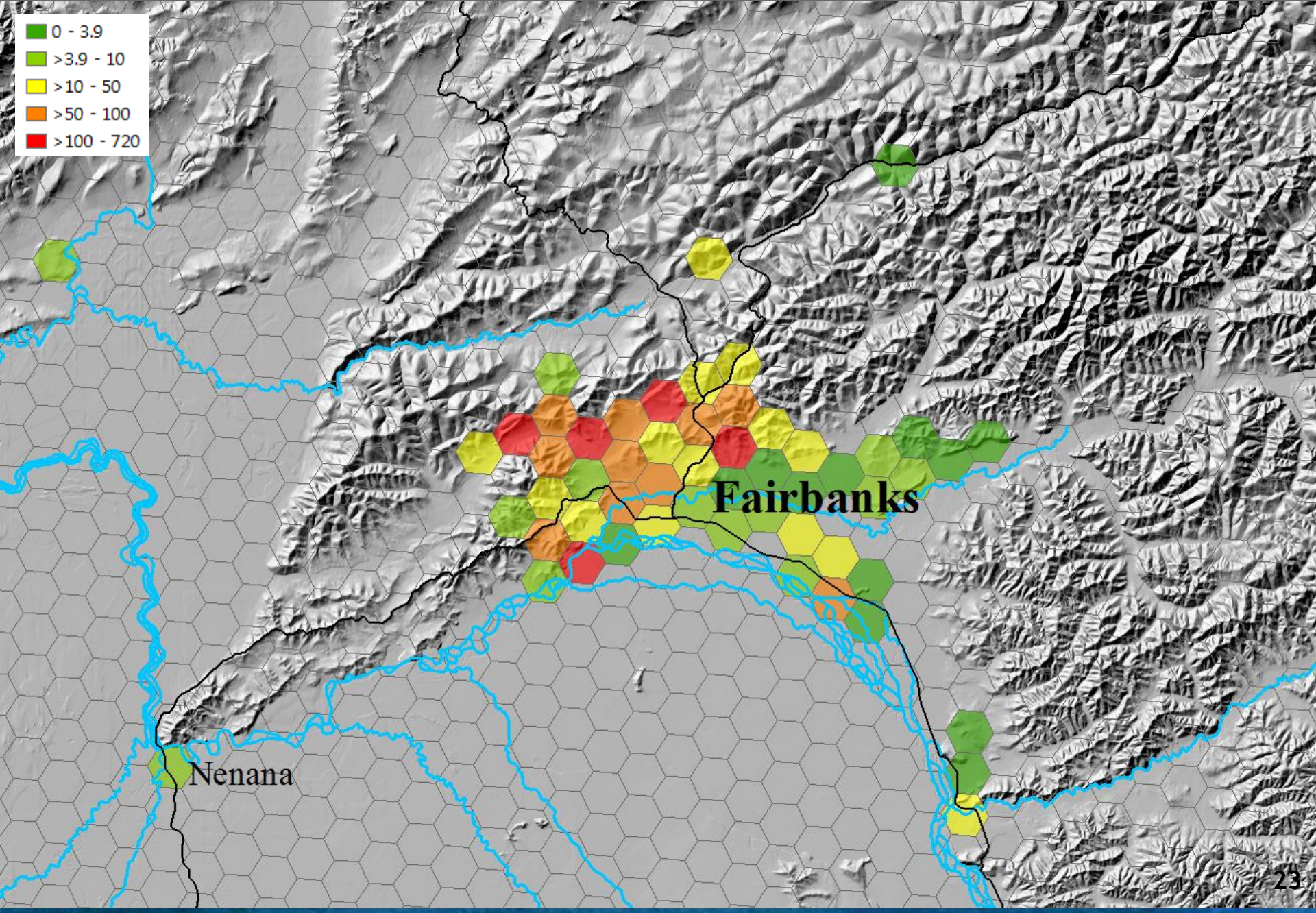
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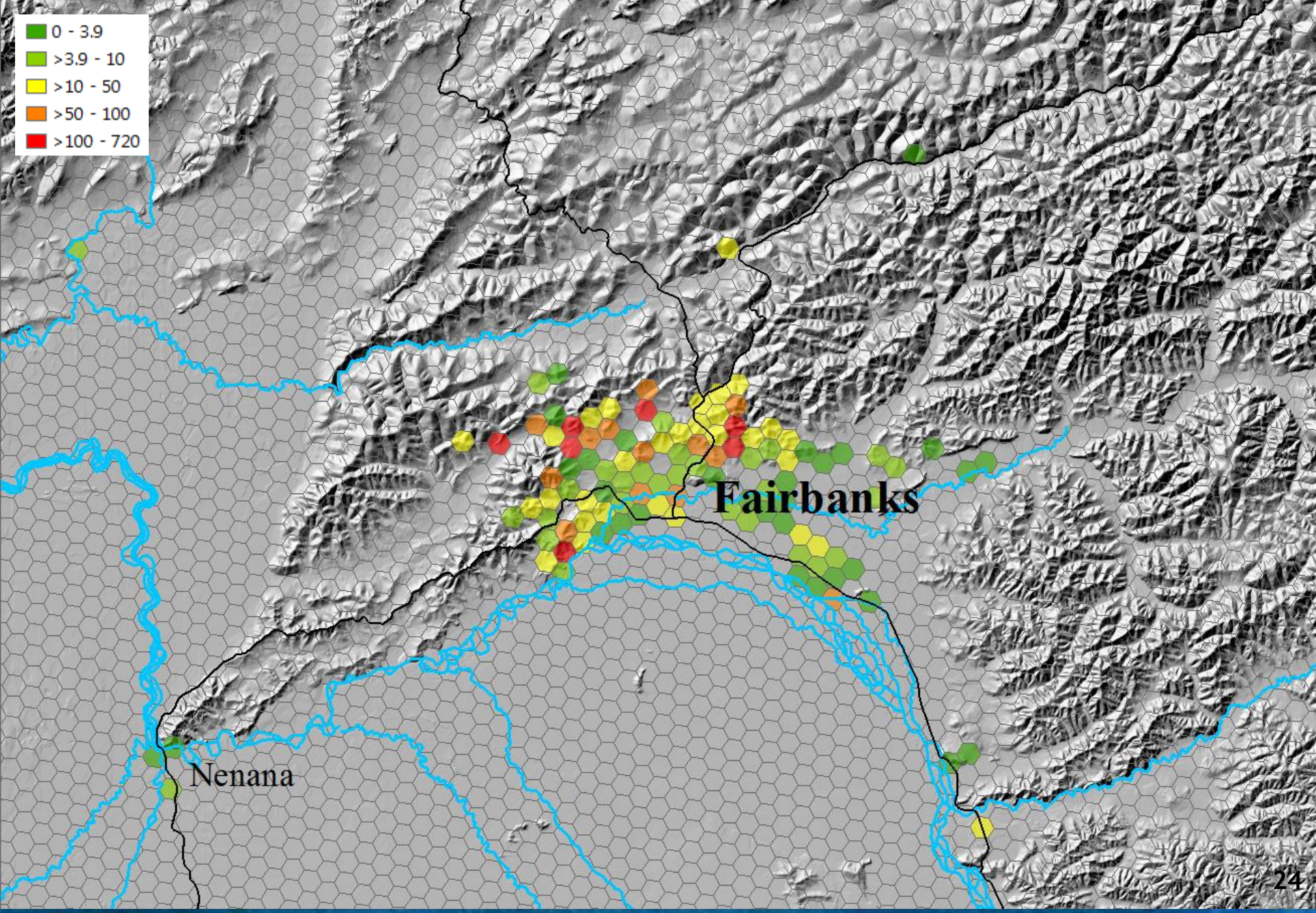
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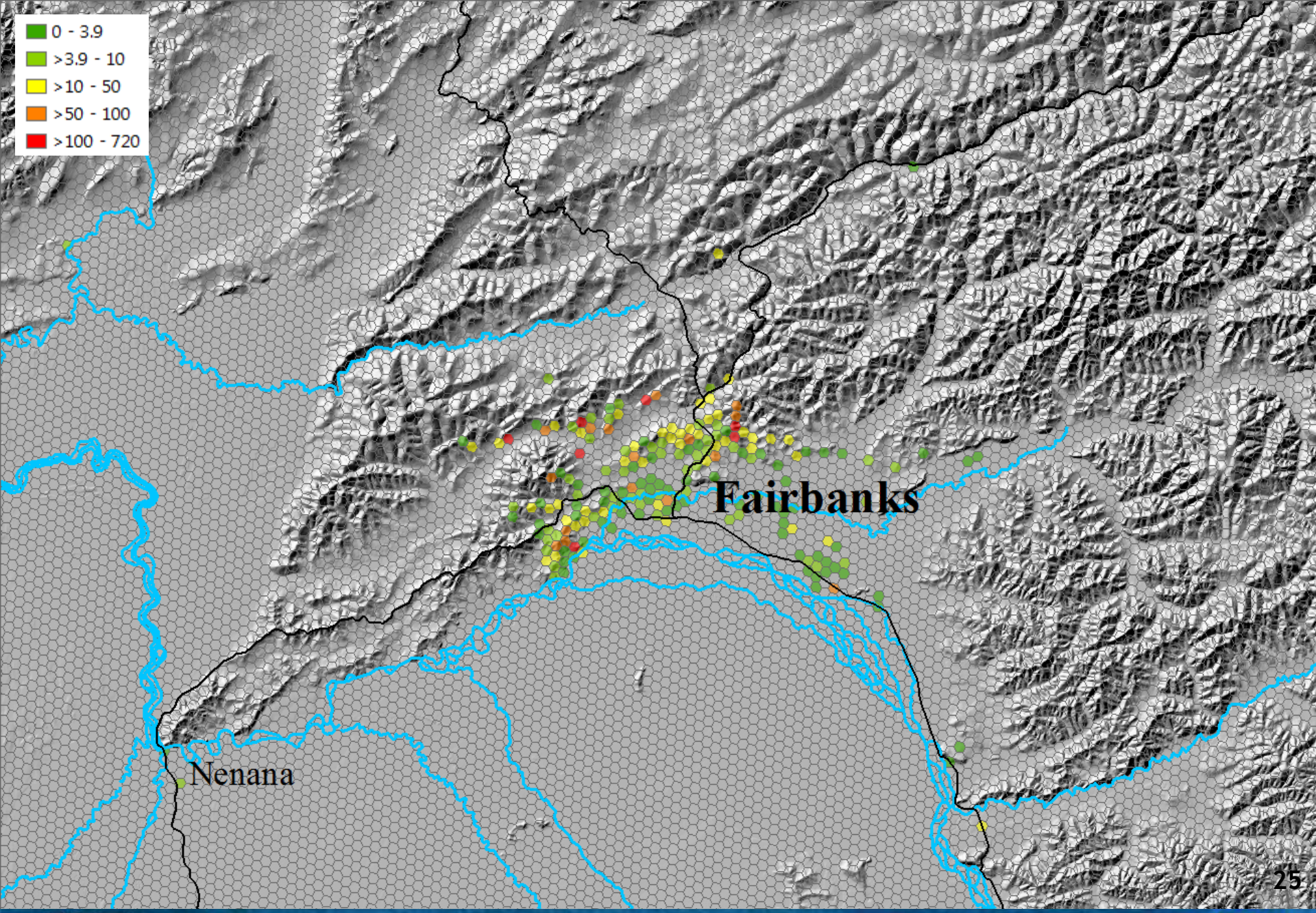
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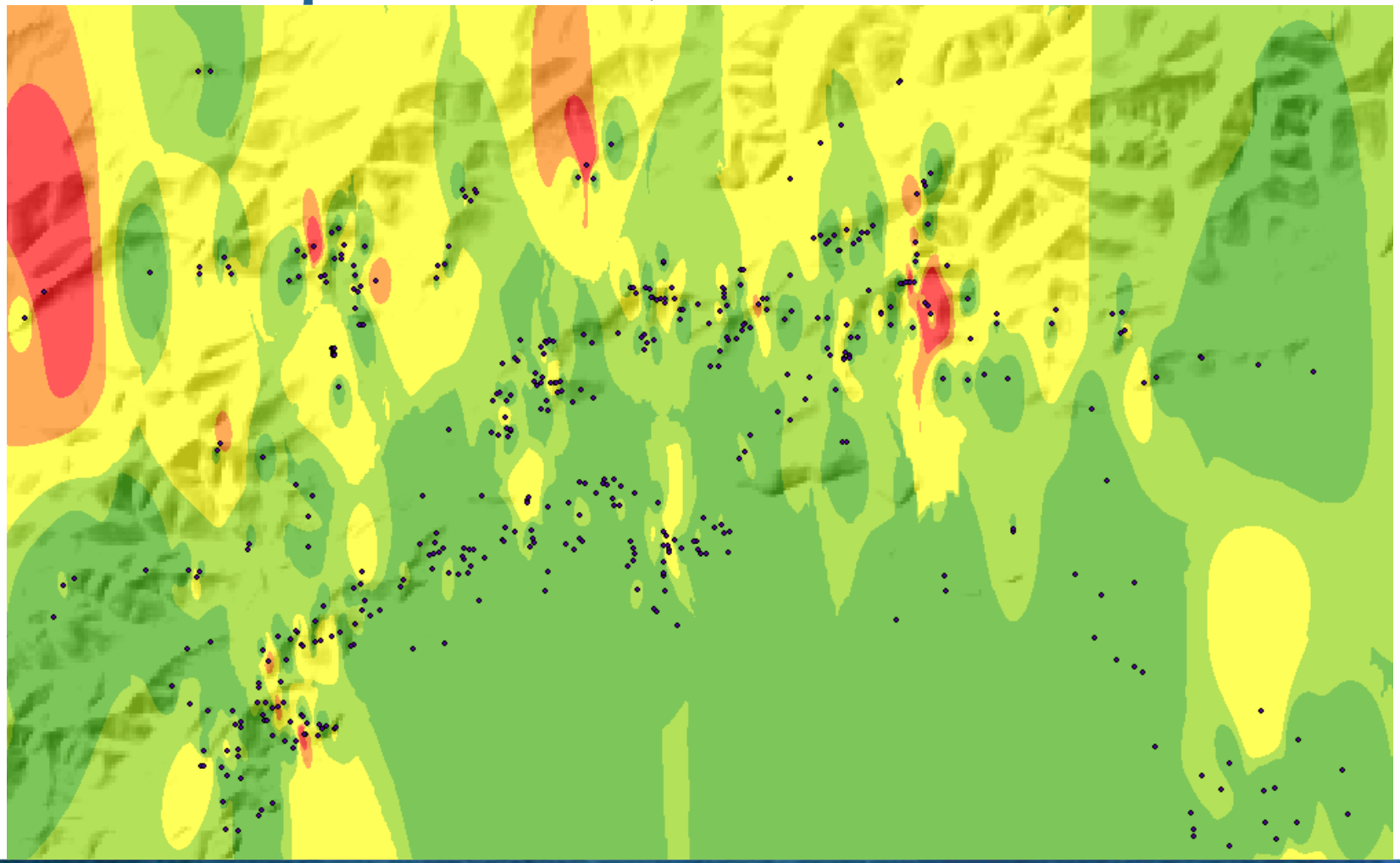
Representing data as raster surfaces

- Employ spatial statistics to communicate data (e.g., IDW, kriging)
- Use incidence data points, such as a radon test readings, to generate a surface
- What is best color ramp for radon data?
- Using a color ramp instead of discrete color values gives qualitative flow through color variation

Inverse Distance Weighted interpolation, Fairbanks area



Geologic considerations

- Uranium, the parent element of radon gas, is found in different amounts in rocks and sediments
- Fractures (cracks) in bedrock and spaces around sediment grains are the routes of delivery
- Earthquakes, water levels, melting permafrost, and seasons can alter the routing through ground and rock without any apparent surface change

ALASKA - EPA Map of Radon Zones

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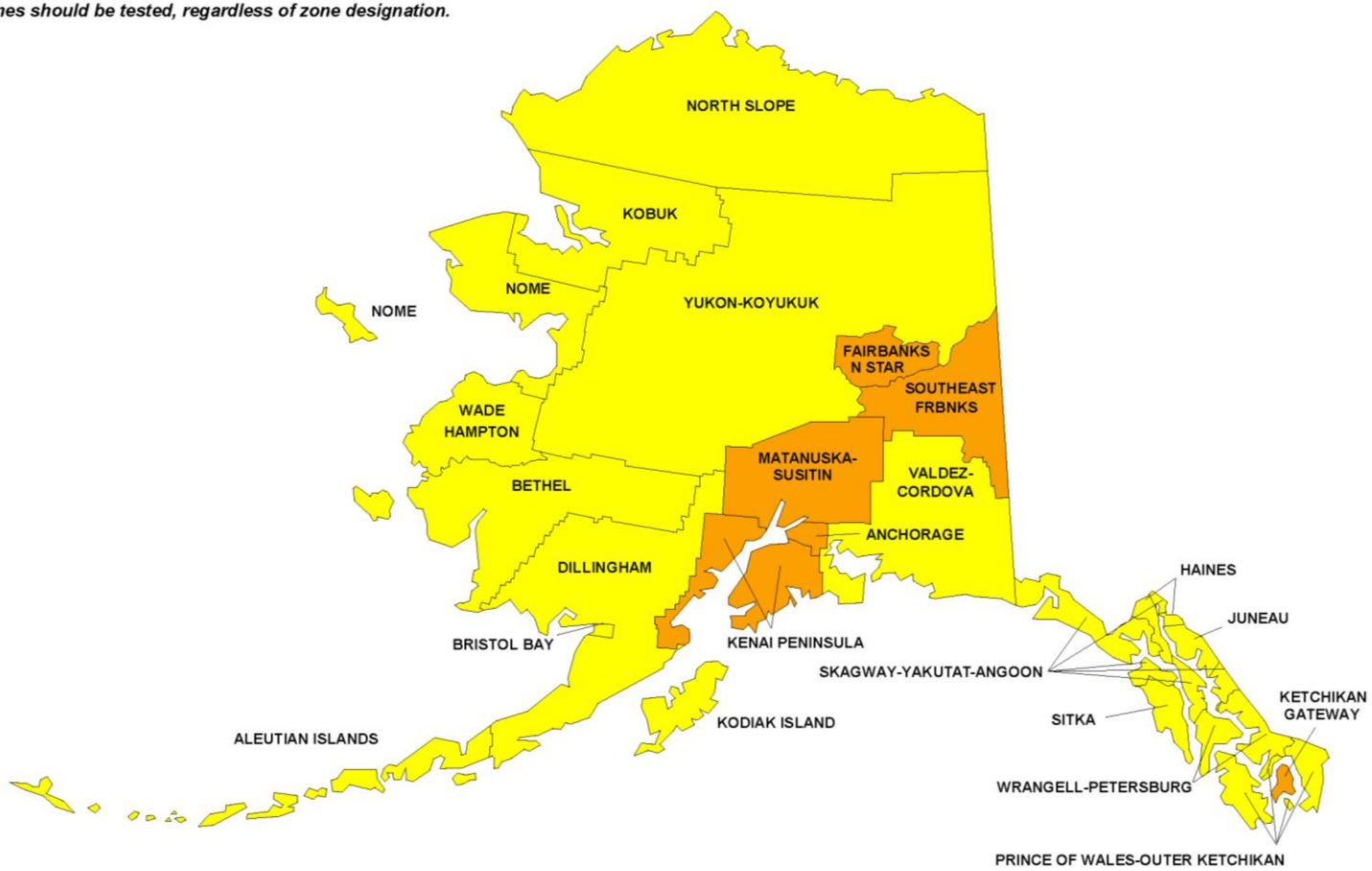

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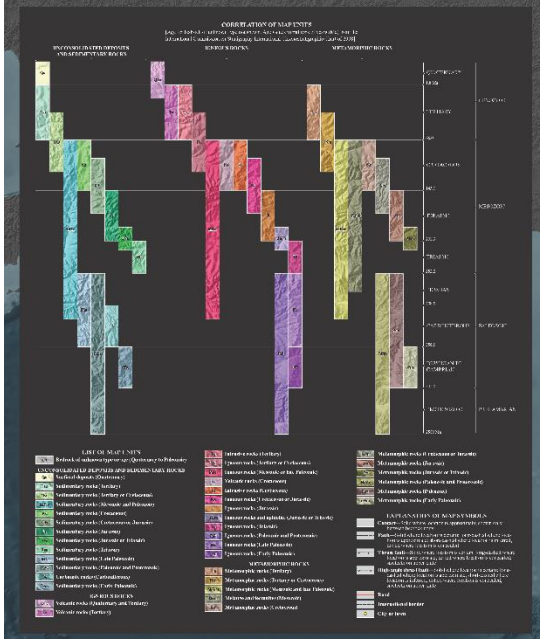
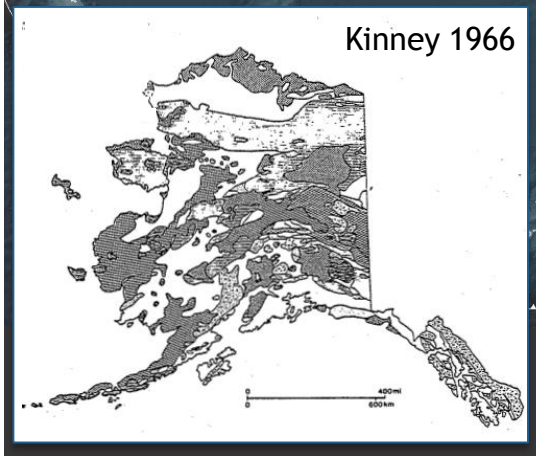
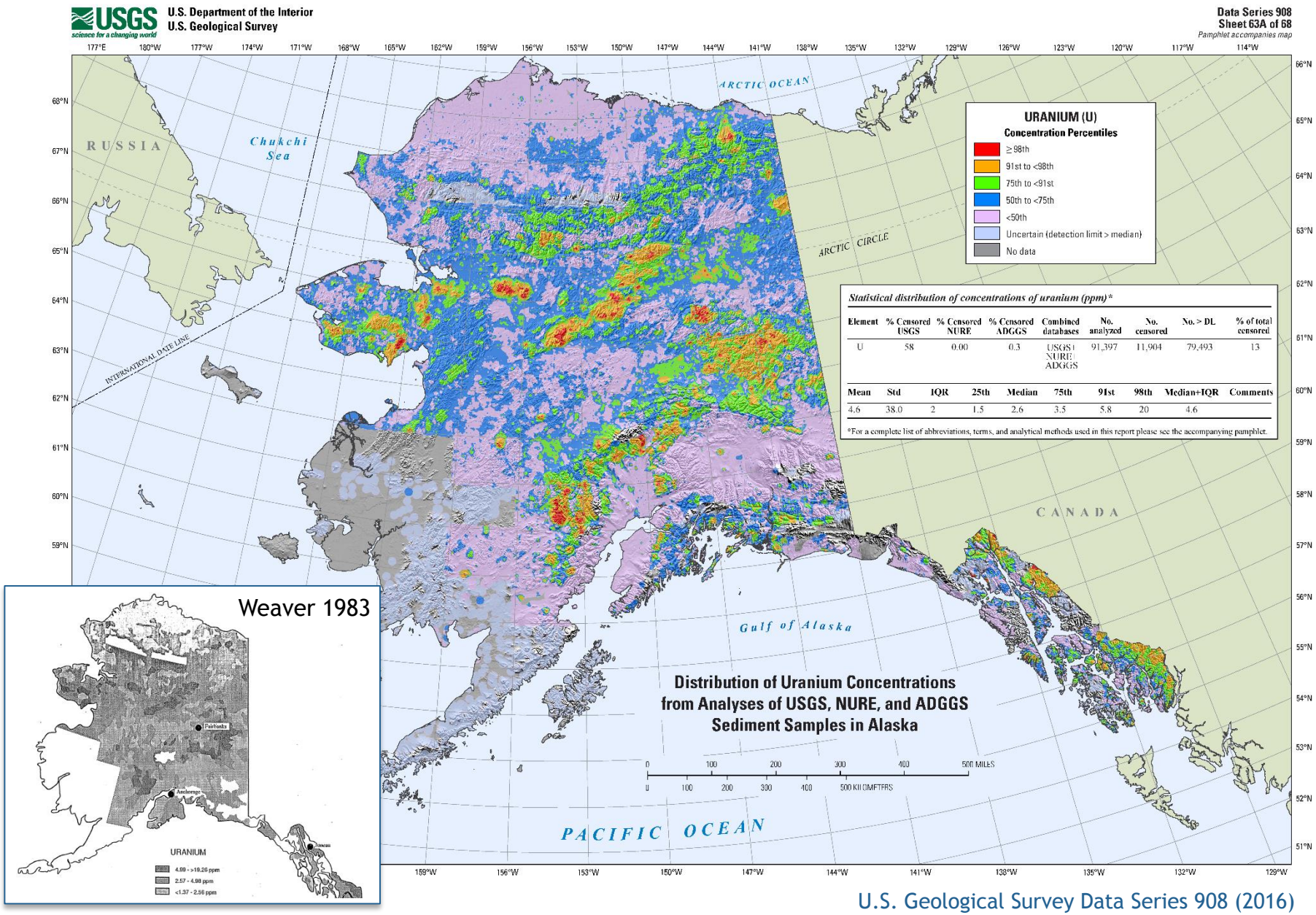




Alaska Geology Revealed

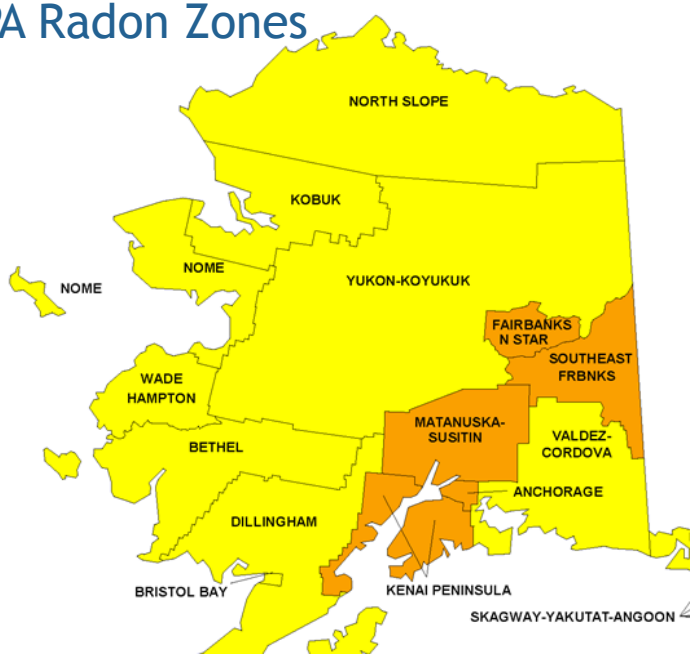
By

Frederic H. Wilson and Keith A. Labay

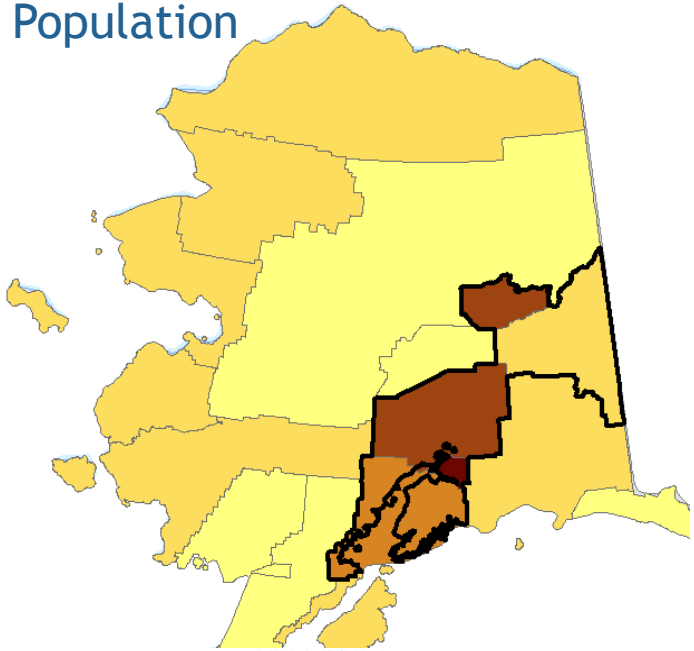


U.S. Geological Survey Data Series 908 (2016)

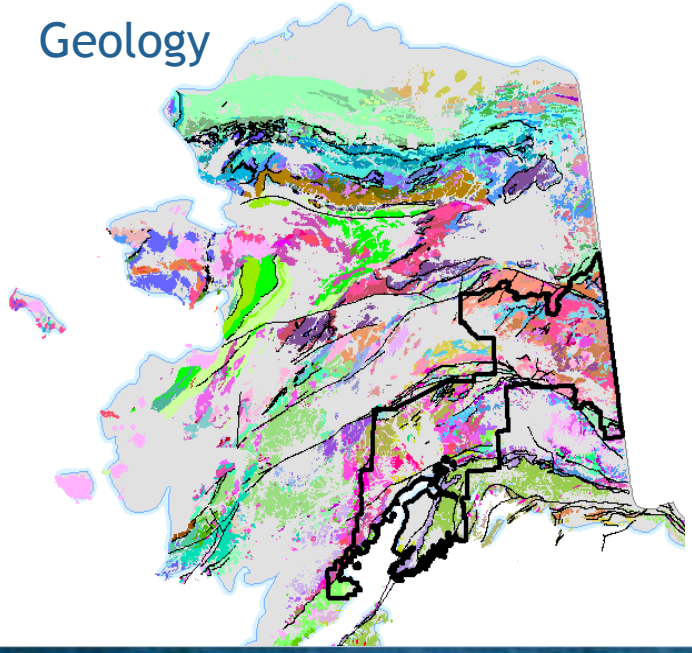
EPA Radon Zones



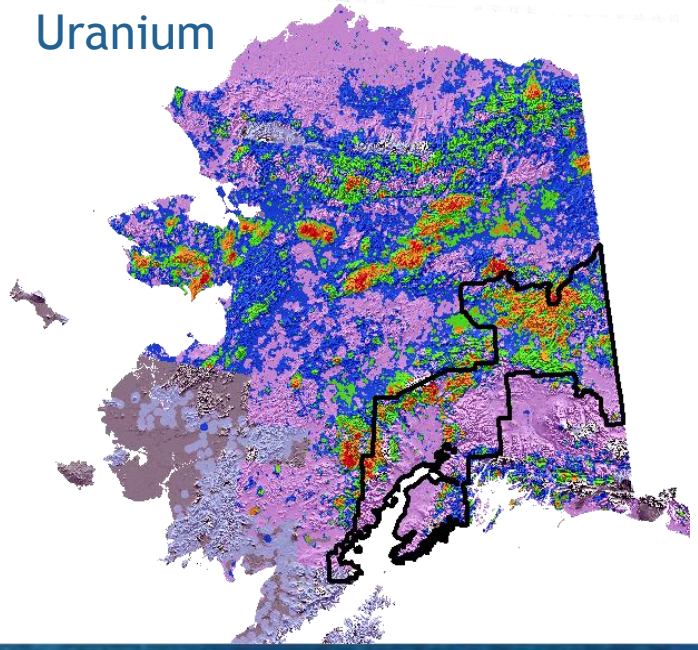
2016 Population



Geology



Uranium



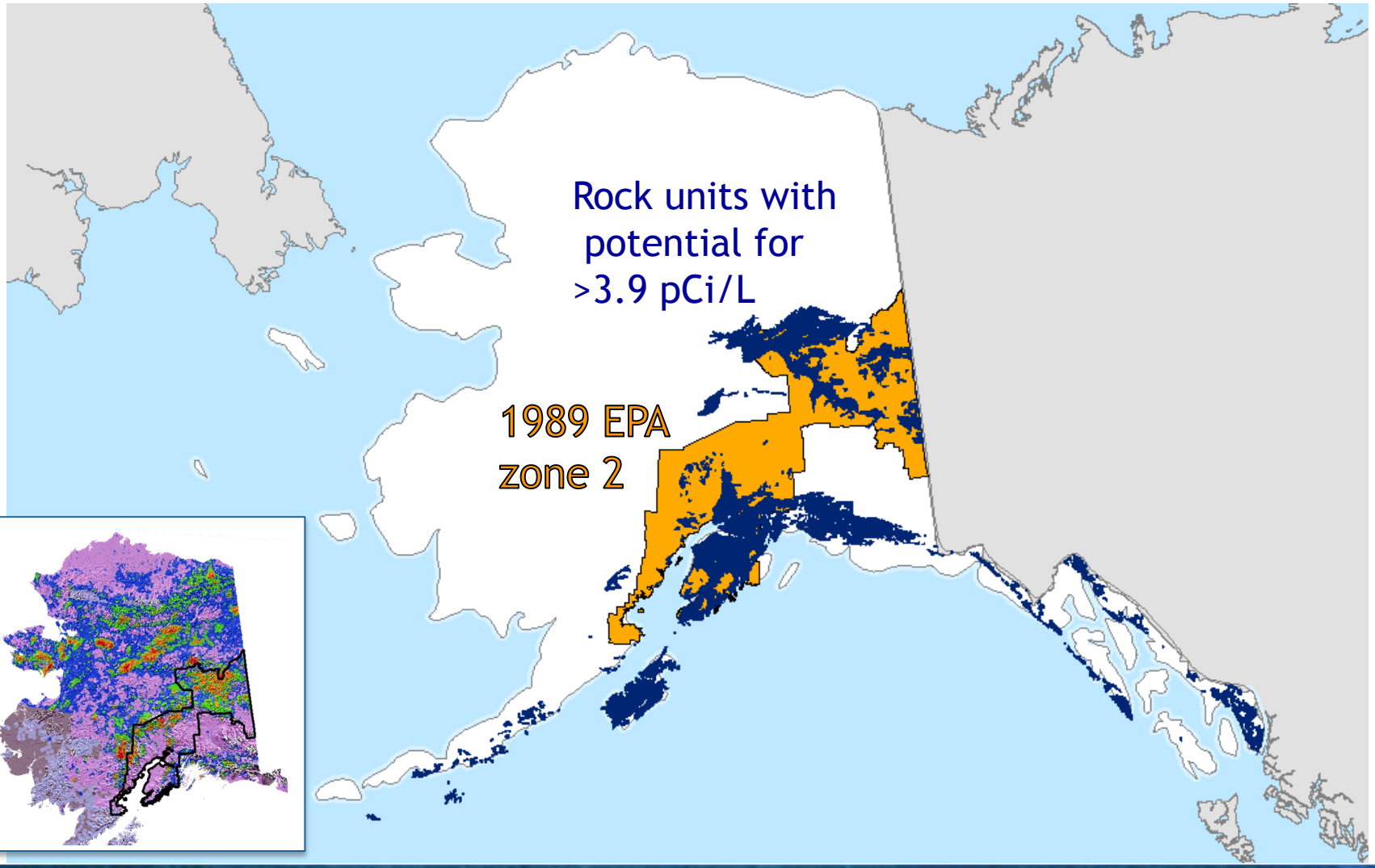
Work in process and future efforts

Problem- These maps do NOT tell where the highest levels of radon are in Alaska, as it can only be tested in existing buildings….for now.

We are:

- Creating an Alaska radon database
- Testing more remote homes
- Analyzing additional datasets to extrapolate radon potential
- Designing a web map to communicate with property owners

Draft geology and test data



Contact us

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