Geological Overview of Wyoming

Collin G. Jensen, M.S.

WSGS

Exploring the Past, Empowering the Future

Easy for school kids to draw Wyoming…

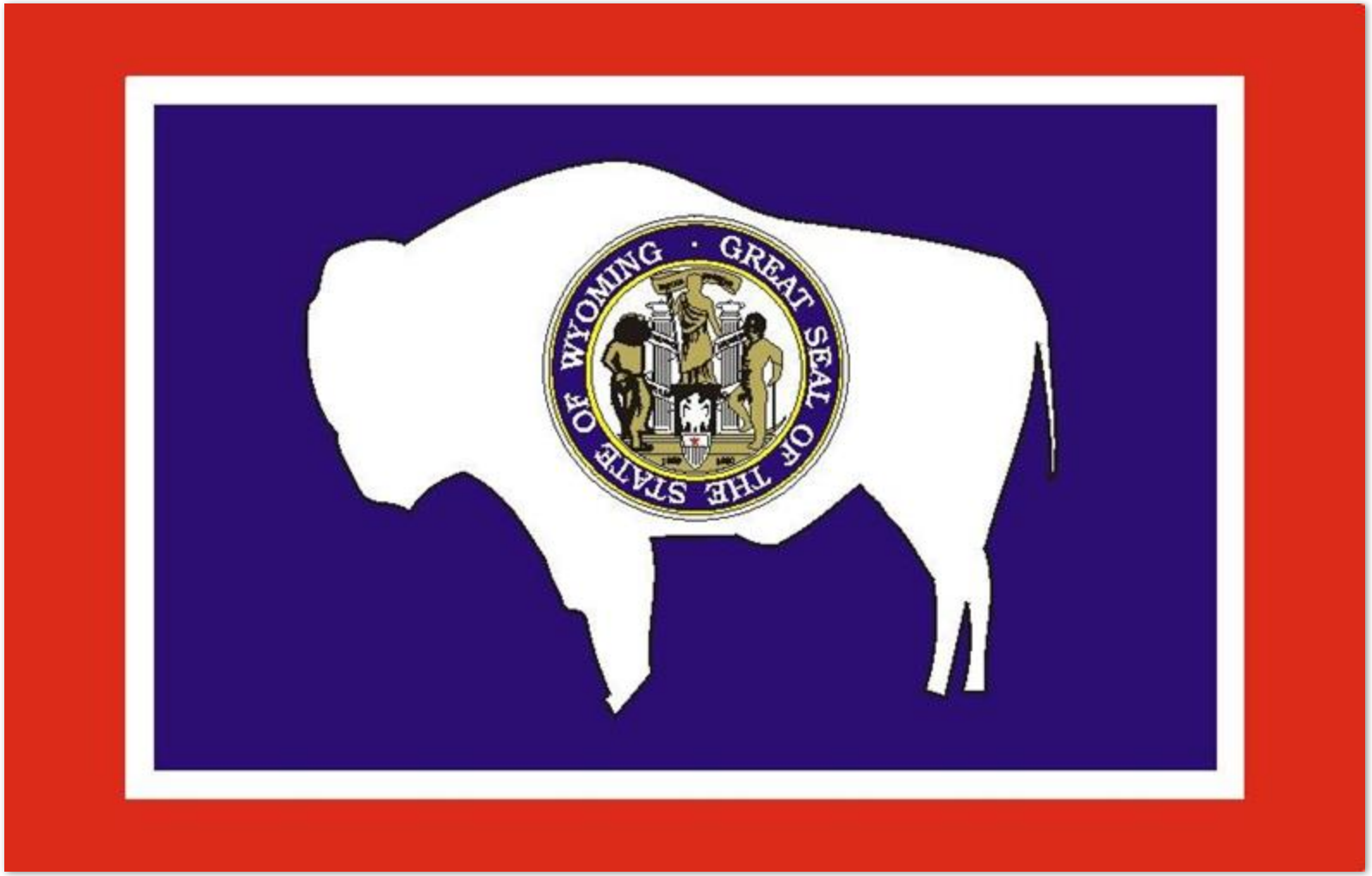
https://geology.com/world/the-united-states-of-america-satellite-im

About Wyoming (WY)

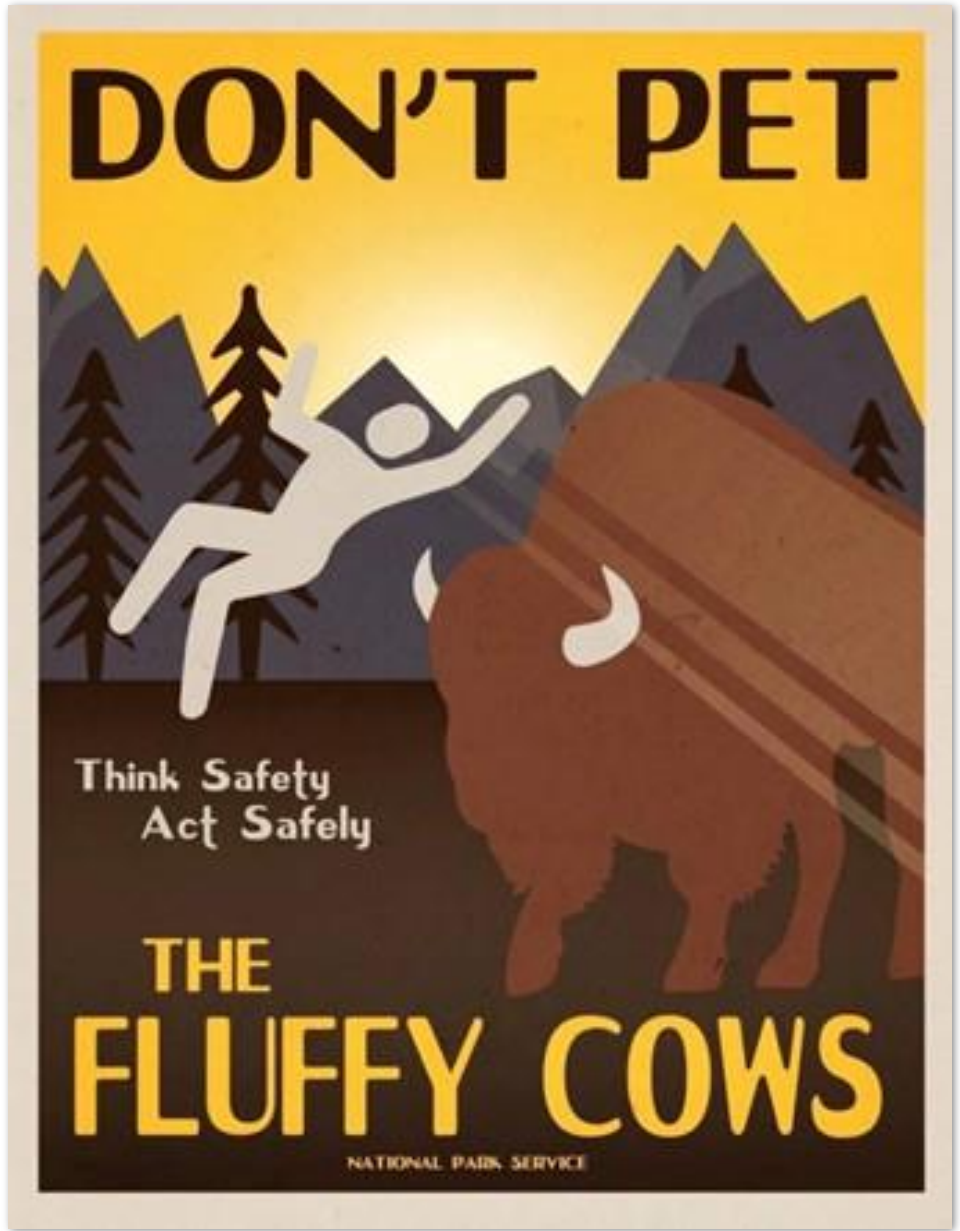
https://www.infoplease.com/atlas/north-america/united-states/wyoming-map

- 9th largest state
- 96,914 square miles
- Highest Point: 13,804 feet
- Population 590,169

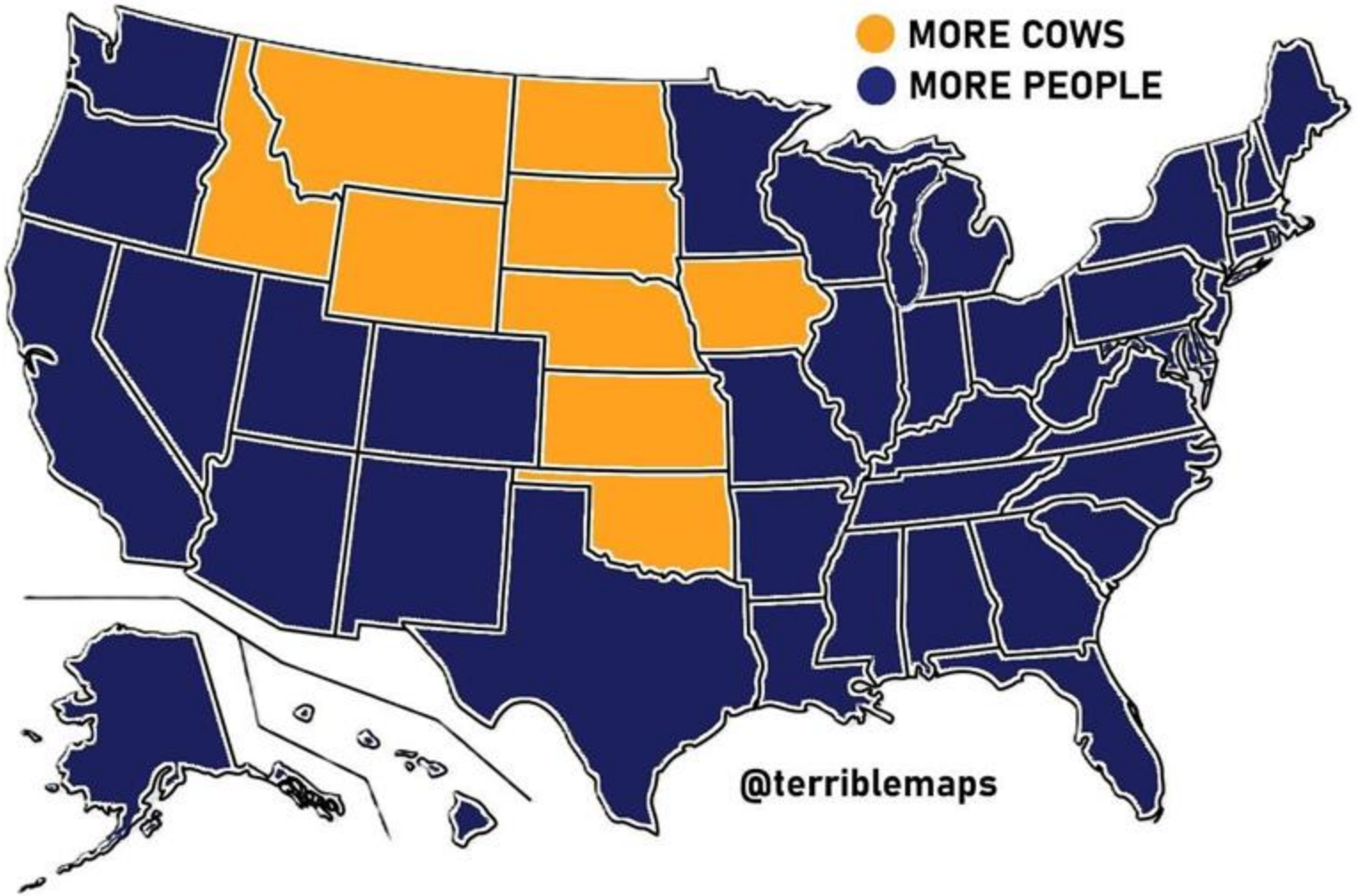
State flag of Wyoming



https://www.wyo.gov/about-wyoming/wyoming-facts-and-symbols


DON'T PET
Think Safety
Act Safely
THE
FLUFFY COWS
NATIONAL PARK SERVICE

U.S. States with more cows than people



Known for:


GRAND TETON
NATIONAL PARK


YELLOWSTONE
NATIONAL
PARK
NATIONAL
PARK
SERVICE

Also Devil's Tower

Hint: It's NOT a tree trunk….

About the Wyoming State Geological Survey

WSGS

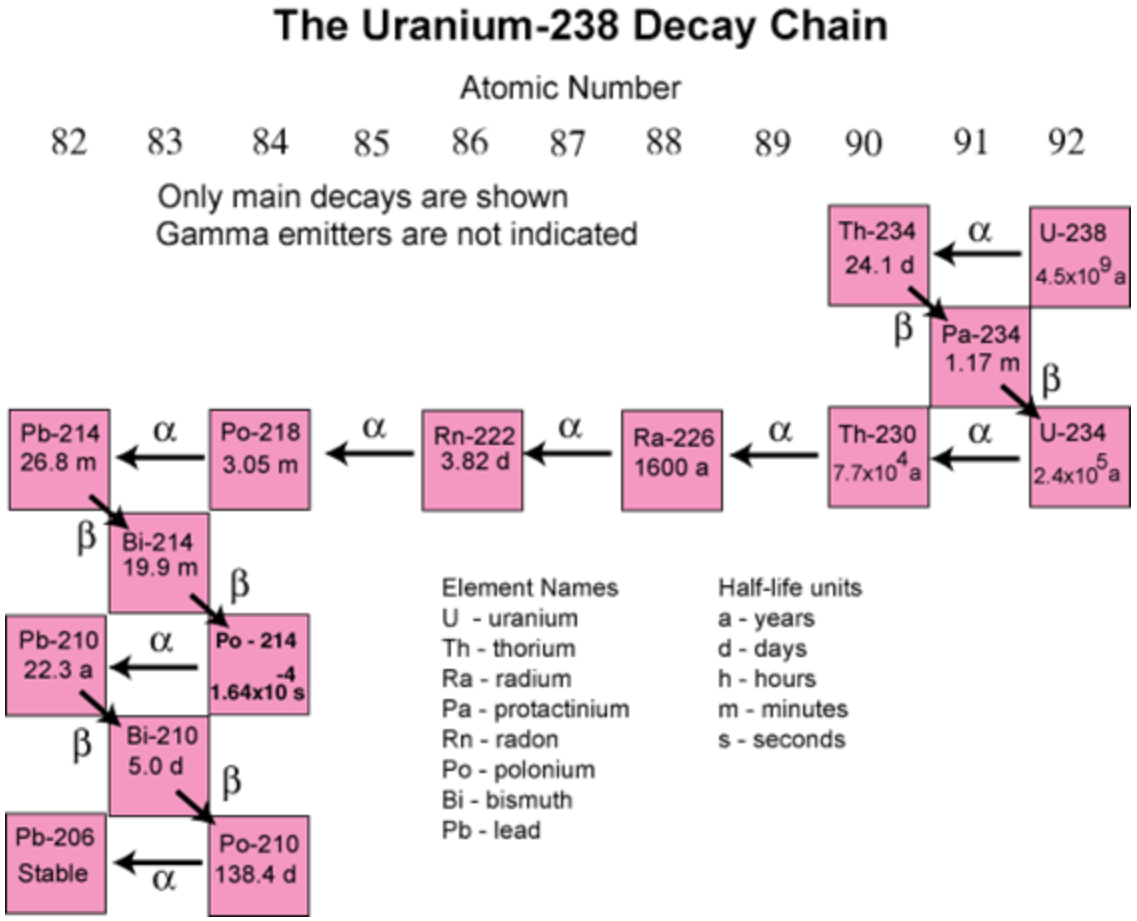
Exploring the Past, Empowering the Future

- The WSGS conducts research and disseminates information on Wyoming's geology, energy, and mineral resources, as well as geologic hazards.

- The Survey provides unbiased geologic information to promote the health, safety, and economic welfare of Wyoming's citizens.

Geologic factors that affect radon

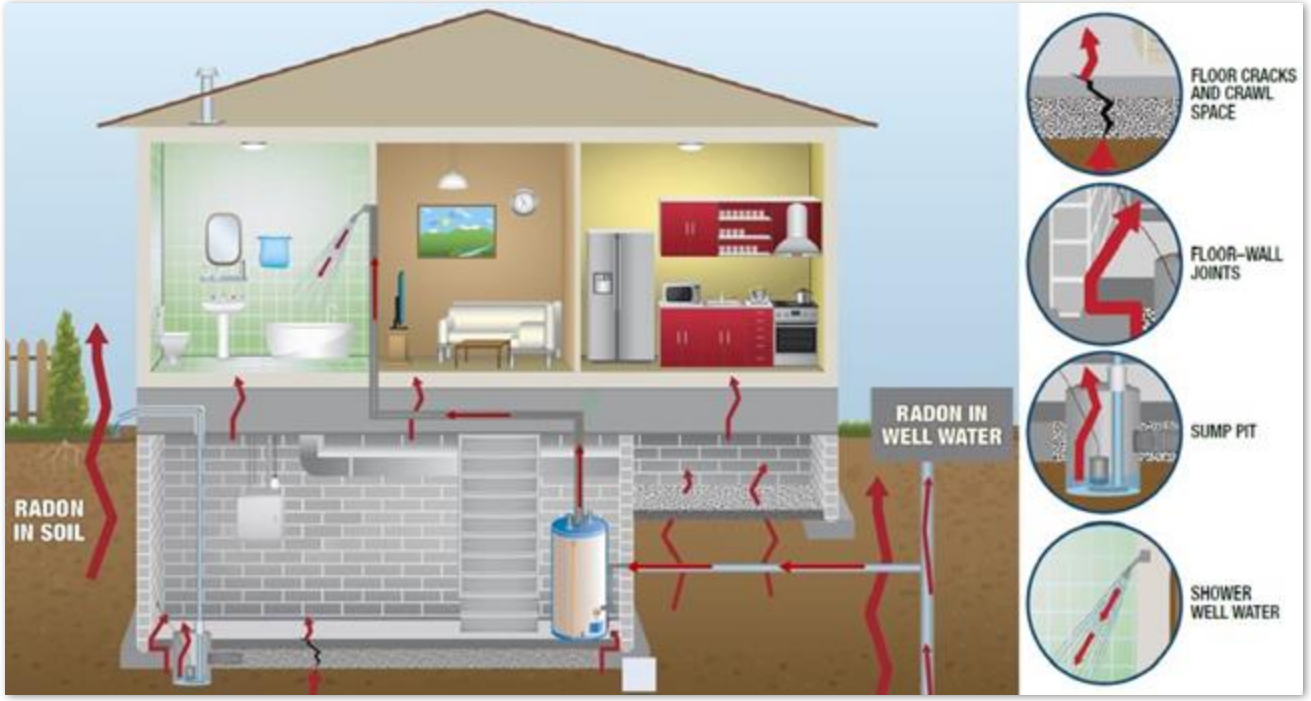
Geologic factors that affect radon



- *Source* of Uranium
  - Bedrock
  - Soil
  - Groundwater (from wells)

Geologic factors that affect radon

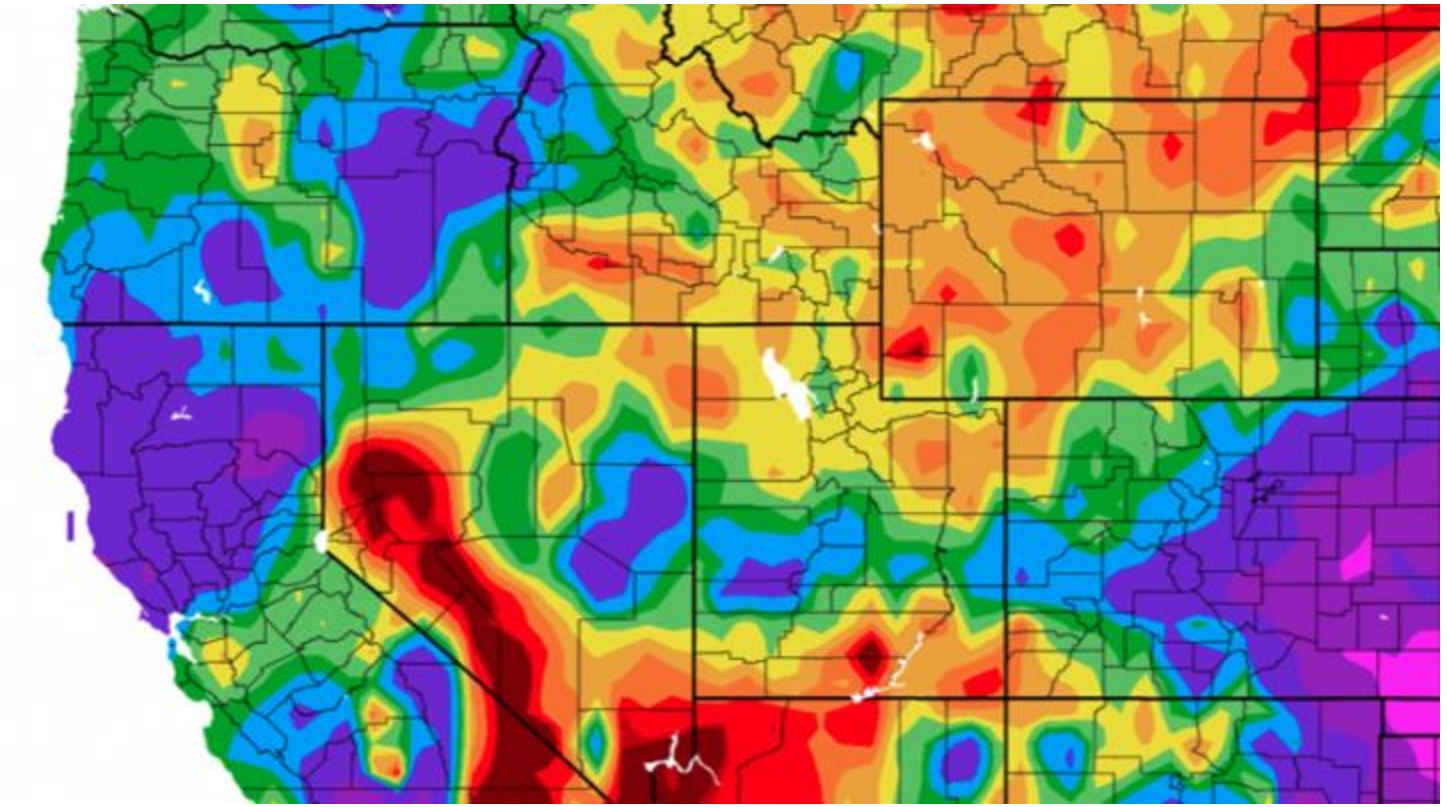
- *Permeability*-A pathway into the building
  - Fractures and faults
  - Soil permeability
  - Soil moisture
  - Geothermal areas



Environmental Protection Agency

Geologic factors that affect radon

- Climate
  - atmospheric pressure
  - precipitation
  - soil moisture

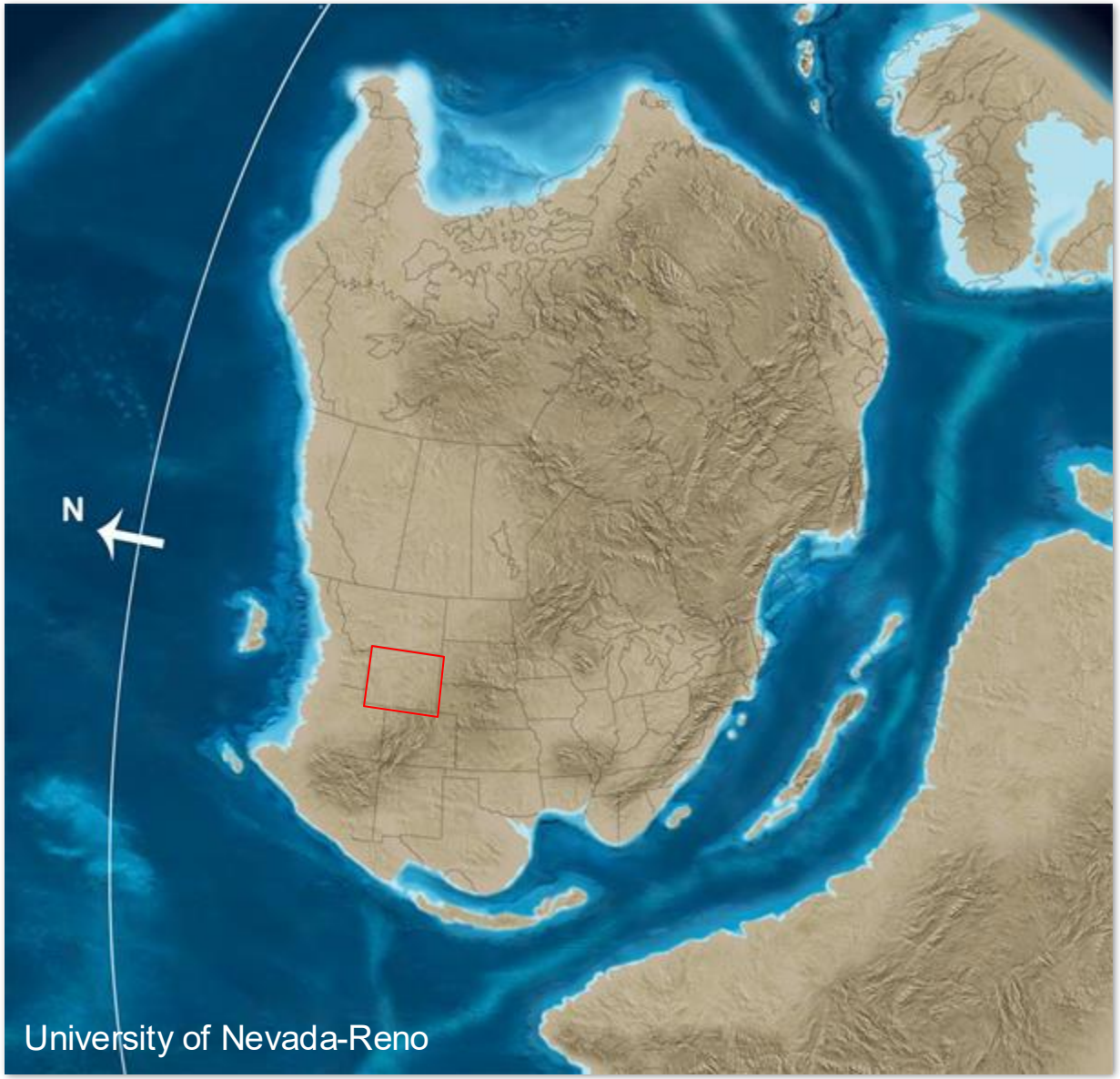


Geological history of Wyoming-and how it relates to Radon

Precambrian (4600-541 Ma)

- Some of the oldest rocks in North America

- Igneous rocks (granite and other types) and metamorphic rocks



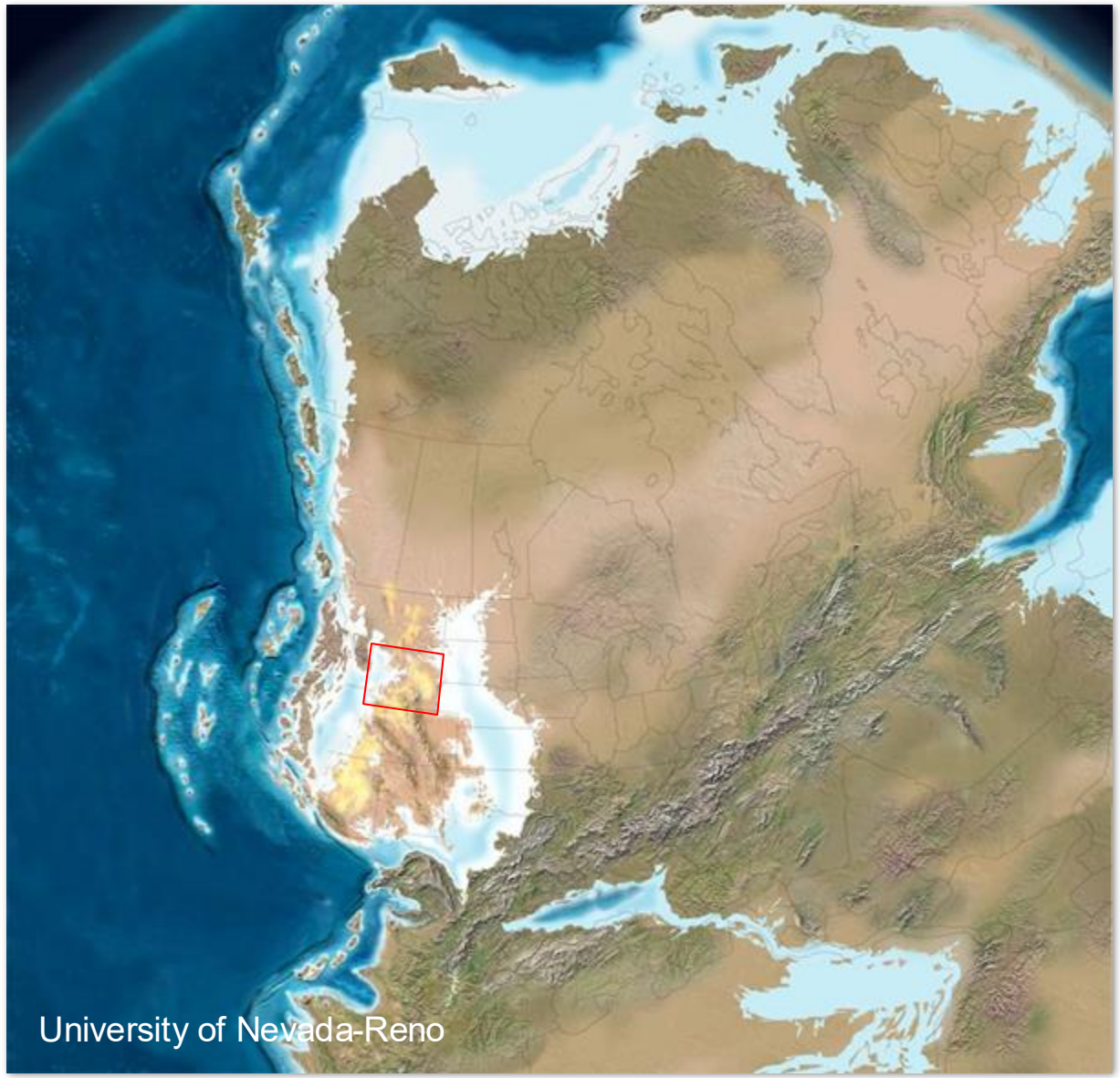
Late Precambrian (550 Ma)

Geological history of Wyoming-and how it relates to Radon

Paleozoic (541-252 Ma)

- Deposition of marine sediment and near-marine sediment

- Formed thick layers of red siltstone, shale, gypsum, and sandstone.



Early Permian (290 Ma)

Geological history of Wyoming-and how it relates to Radon

Mesozoic (252-66 Ma)

- Red sediments eventually gave way to sea-level fluctuations, alternating river and marine deposits.
- The dinosaurs came and went
- *Sevier Orogeny* began forming the Overthrust Belt

Late Jurassic (150 Ma)

Geological history of Wyoming-and how it relates to Radon

Cenozoic (66 Ma-present day)

- The Laramide Orogeny continues, forming uplifts that comprise most of Wyoming's mountains.
- Erosion filled the basins and exposed ancient rocks.
- Magmatic activity occurred.

Eocene (50 Ma)

Geological history of Wyoming-and how it relates to Radon

- Lots of granite exposed at the surface
  - Source of uranium, especially when it is eroded
- Rivers, beaches, and wind all deposited sandstone
  - Most uranium deposits in Wyoming are found in sandstone
- Orogenies (mountain-building events) created faults and fractures
  - Provides pathways for radon to travel
- Erosion of mountains deposits coarse-grained sediment
  - More *permeable*, so it lets radon pass through it more easily
  - Eroded sediment can be rich in uranium minerals
  - Sediment also is ideal for deposition of uranium

What does this mean for Radon hazard in Wyoming?

Yellow=Good
Red=Bad

WYOMING - EPA Map of Radon Zones

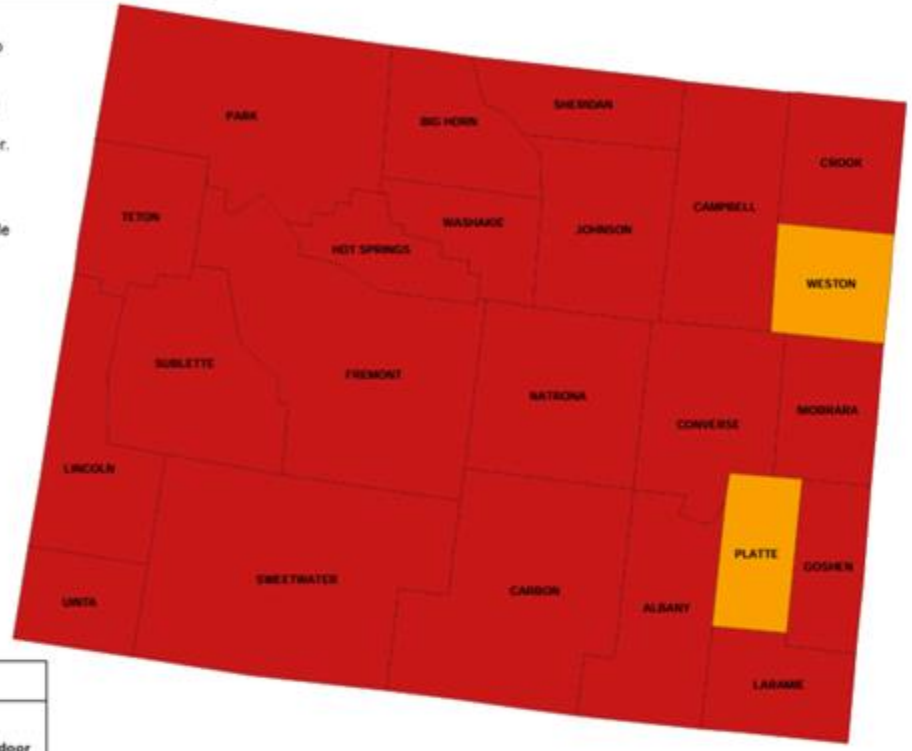
https://www.epa.gov/radon/epa-map-radon-zones

The Map of Radon Zones was developed in 1993 to identify areas of the U.S. with the potential for elevated indoor radon levels. The map is intended to help governments and other organizations target risk reduction activities and resources. The Map of Radon Zones should not be used to determine if individual homes need to be tested. No matter where you live, test your home for radon—it's easy and inexpensive Fix your home if your radon level is 4 picocuries per liter (pCi/L) (150 becquerels per meter cubed (Bq/m3)) or higher. Consider fixing if your level is between 2 and 4 pCi/L (75 - 150 Bq/m3).

The Map of Radon Zones was developed using data on indoor radon measurements, geology, aerial radioactivity, soil parameters, and foundation types. The EPA recommends that this map be supplemented with any available local data to further understand and predict the radon potential for a specific area.

All homes should be tested, regardless of zone designation.

IMPORTANT: Consult the publication entitled "Preliminary Geologic Radon Potential Assessment of Wyoming" (USGS Open-file Report 93-292-H) before using this map. See https://doi.org/10.3133/ofr93292H. This document contains information on radon potential variations within counties. The 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.



What do the colors mean?

Color	Zone	Description
	Zone 1 (red zones)	**Highest potential** Counties have a predicted average indoor screening level > (Greater) than 4 pCi/L (picocuries per liter) (150 Bq/m3 (becquerels per meter cubed))
	Zone 2 (orange zones)	**Moderate potential** Counties have a predicted average screening level ≥ (Greater than and equal to) 2 pCi/L (75 Bq/m3) and ≤ (less than and equal to) 4 pCi/L (150 Bq/m3)
	Zone 3 (yellow zones)	**Low potential** Counties have a predicted average indoor screening level < (Less than) 2 pCi/L (75 Bq/m3)

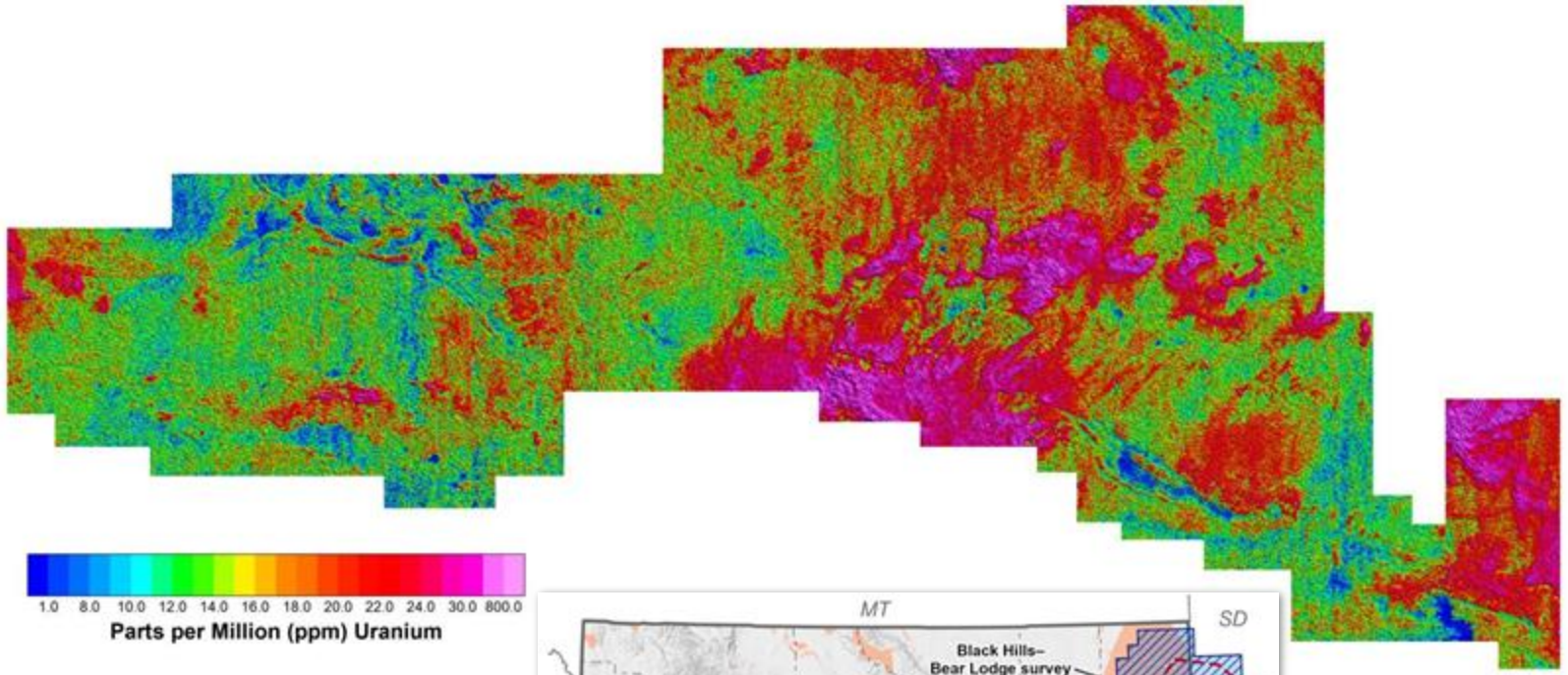
Uranium and Radon resources in Wyoming

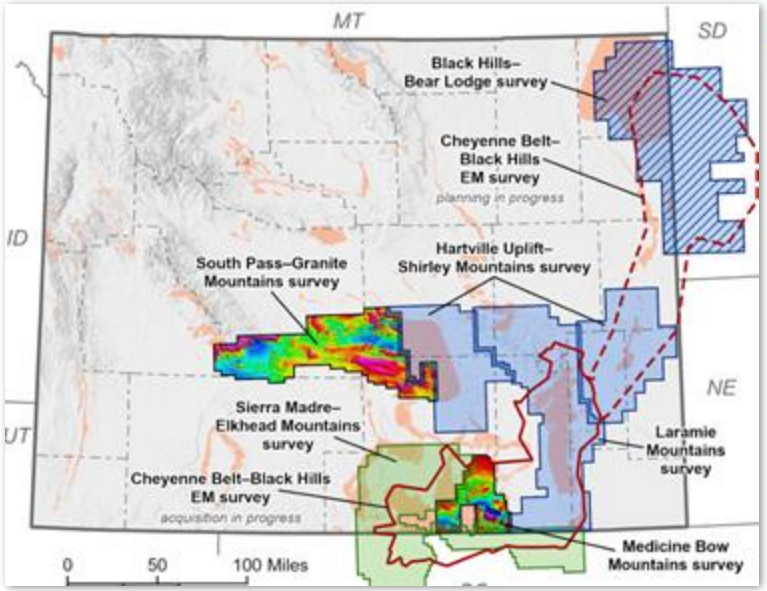
Uranium and Radon resources in Wyoming

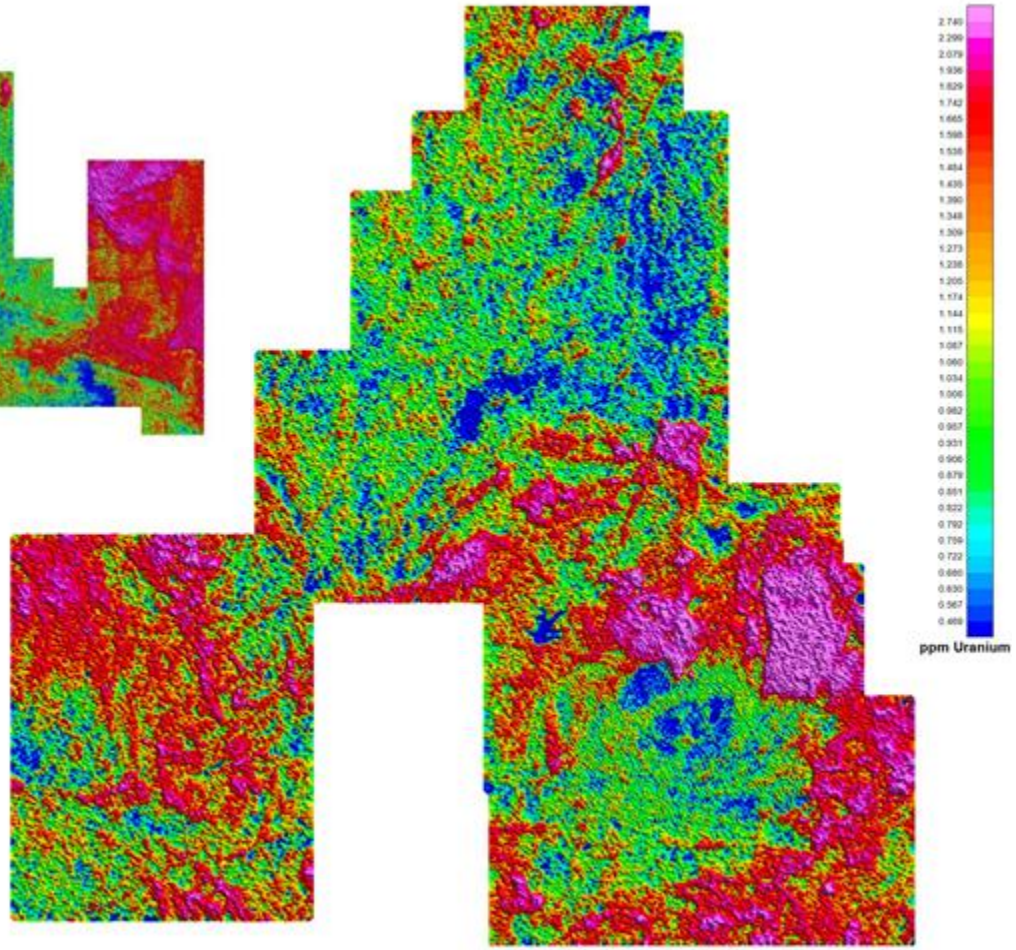
- Wyoming was historically the #1 producer of Uranium in the US

- Wyoming has the highest reserves of uranium ore in the US today (220 million pounds of Uranium oxide ore)

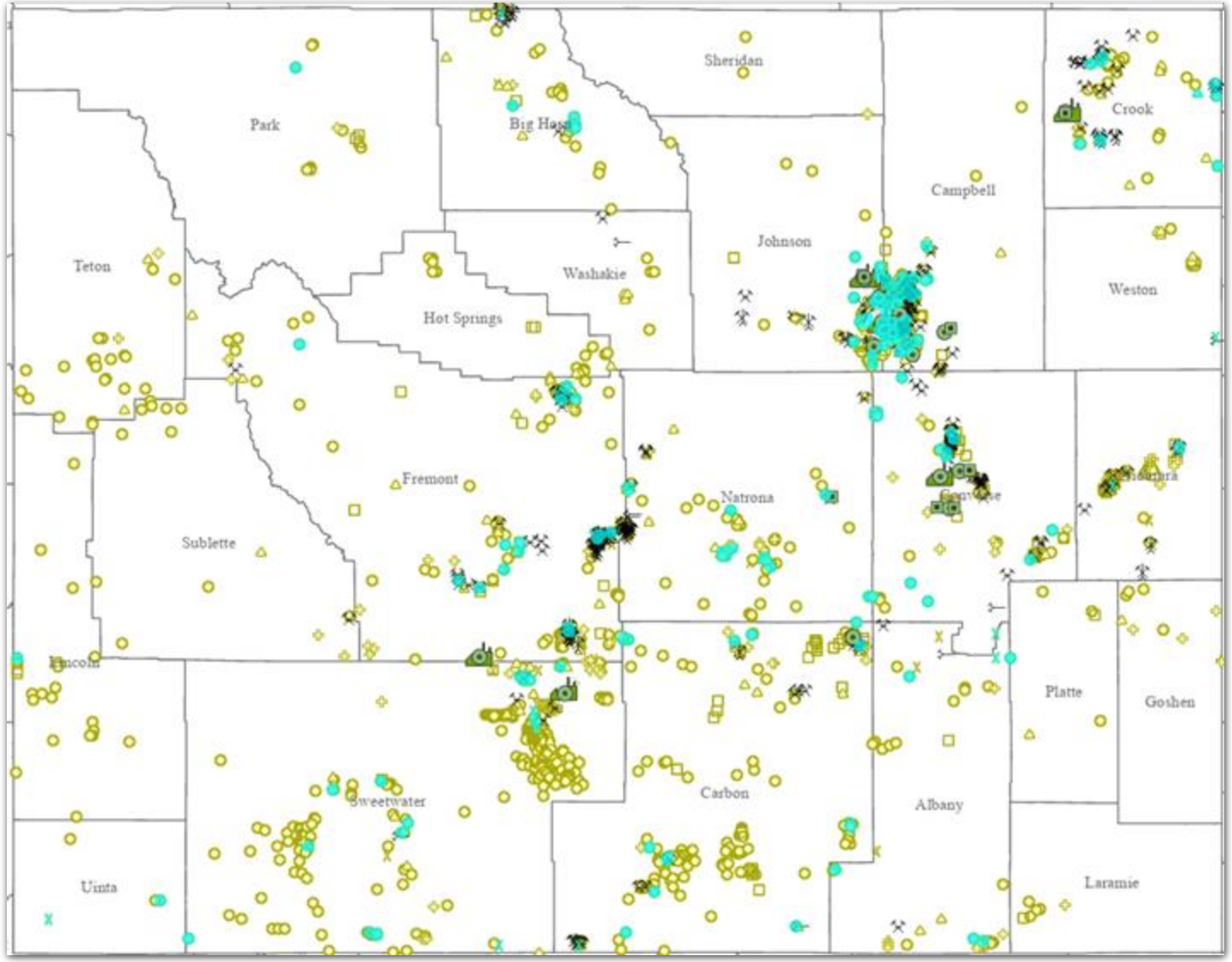
Airborne radiometric surveys



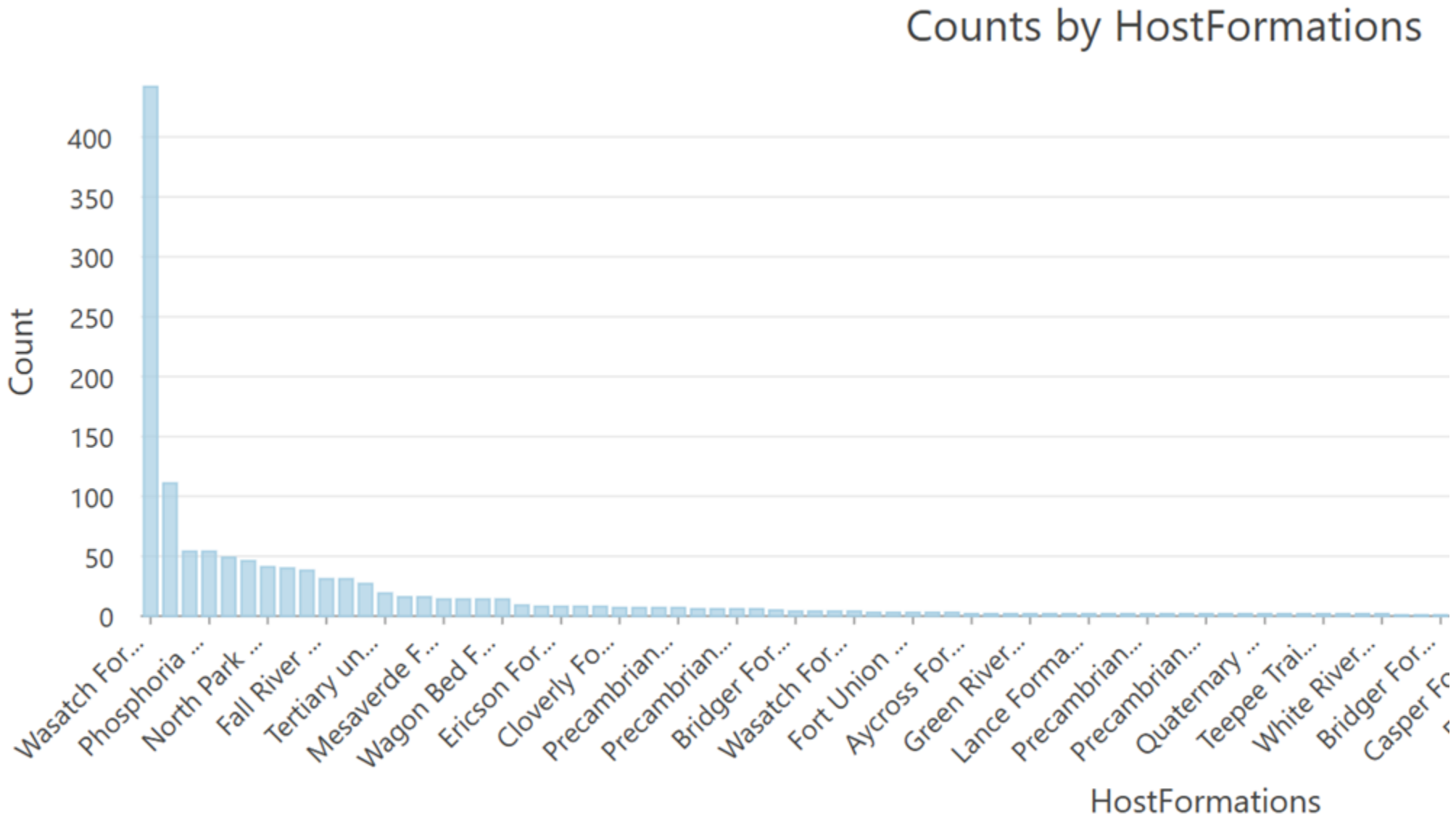




Wyoming Uranium Resource Database



Statistics from the uranium database

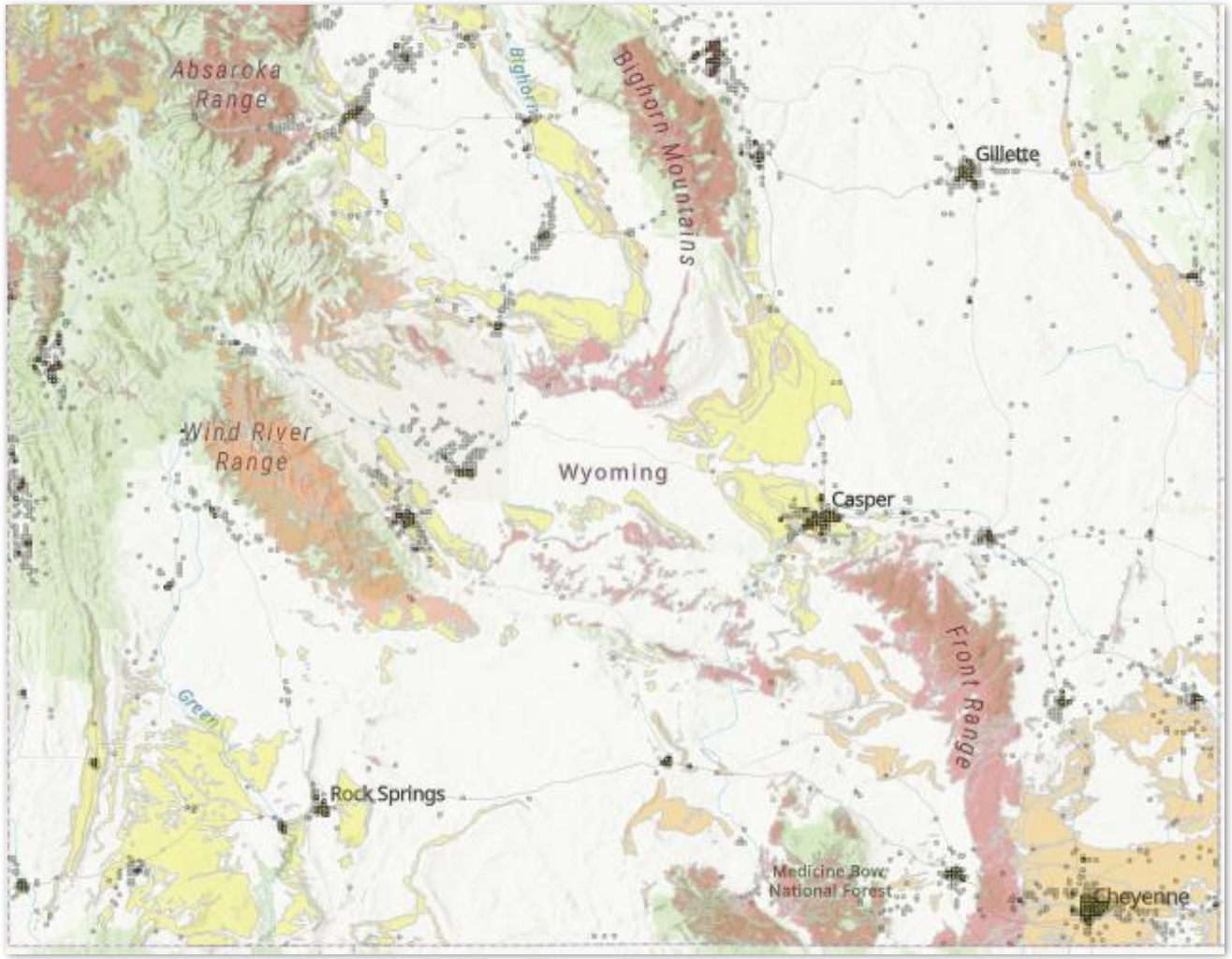


Statistics from the uranium database

Uranium Mines			
Number of Mines	**Formation**	**Age**	**Lithology**
98	Wasatch	Early Tertiary	Variegated mudstone, sandstone, and local conglomerate
61	Wind River	Early Eocene	Claystone and sandstone, local conglomerate
16	Battle Spring	Paleocene-eocene	basin-margin conglomerate
16	Fall River	Mid Cretaceous	sandstone, chert conglomerate, claystone
11	Lakota	Mid Cretaceous	sandstone, chert conglomerate, claystone
10	Madison	Mississippian	limestone and dolomite
9	Fort Union	Paleocene	sandstone, shale, coal
7	Browns Park	Late Oligocene	tuffaceous sandstone, marl, conglomerate
6	White River	Eocene to oligocene	tuffaceous claystone, conglomerate, sandstone
5	Wagon Bed	Eocene	tuffaceous claystone, sandstone, marl, shale, urano-phosphate

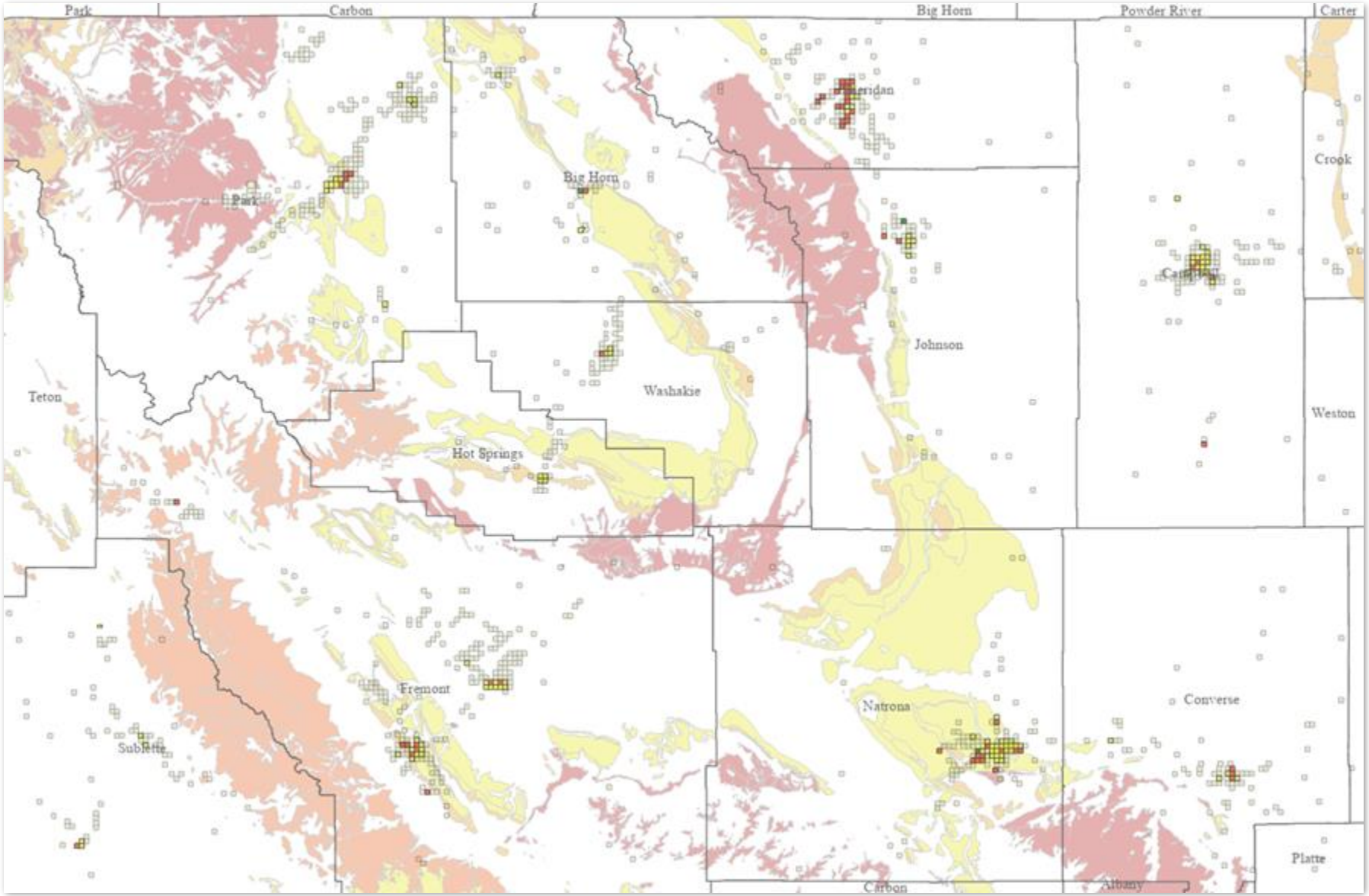
Wyoming Geologic Hazards Map

New Radon map! QR code



21,302 Records

Wyoming Geologic Hazards Map



Legend

Radon

Radon Observation Statistics

% of Observations exceeding 4 picocuries per liter (pCi/L)

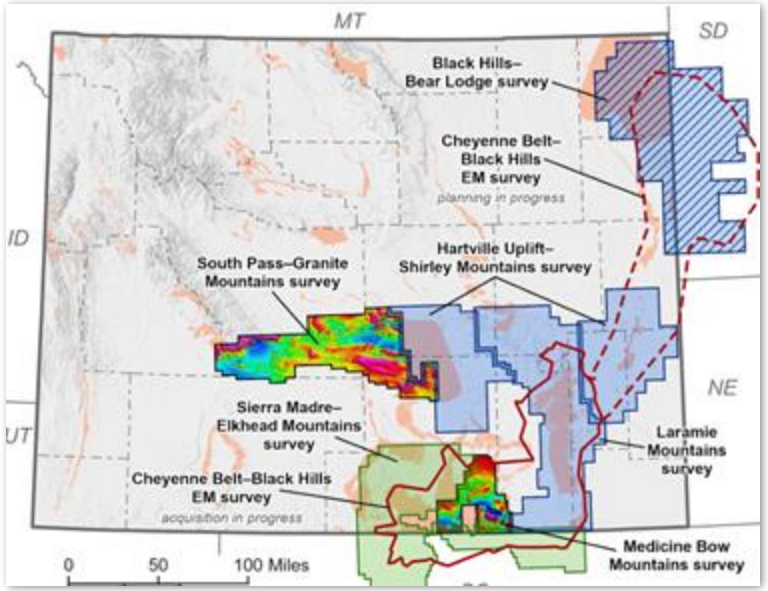
- 0% - 10%
- >10% - 50%
- >50%

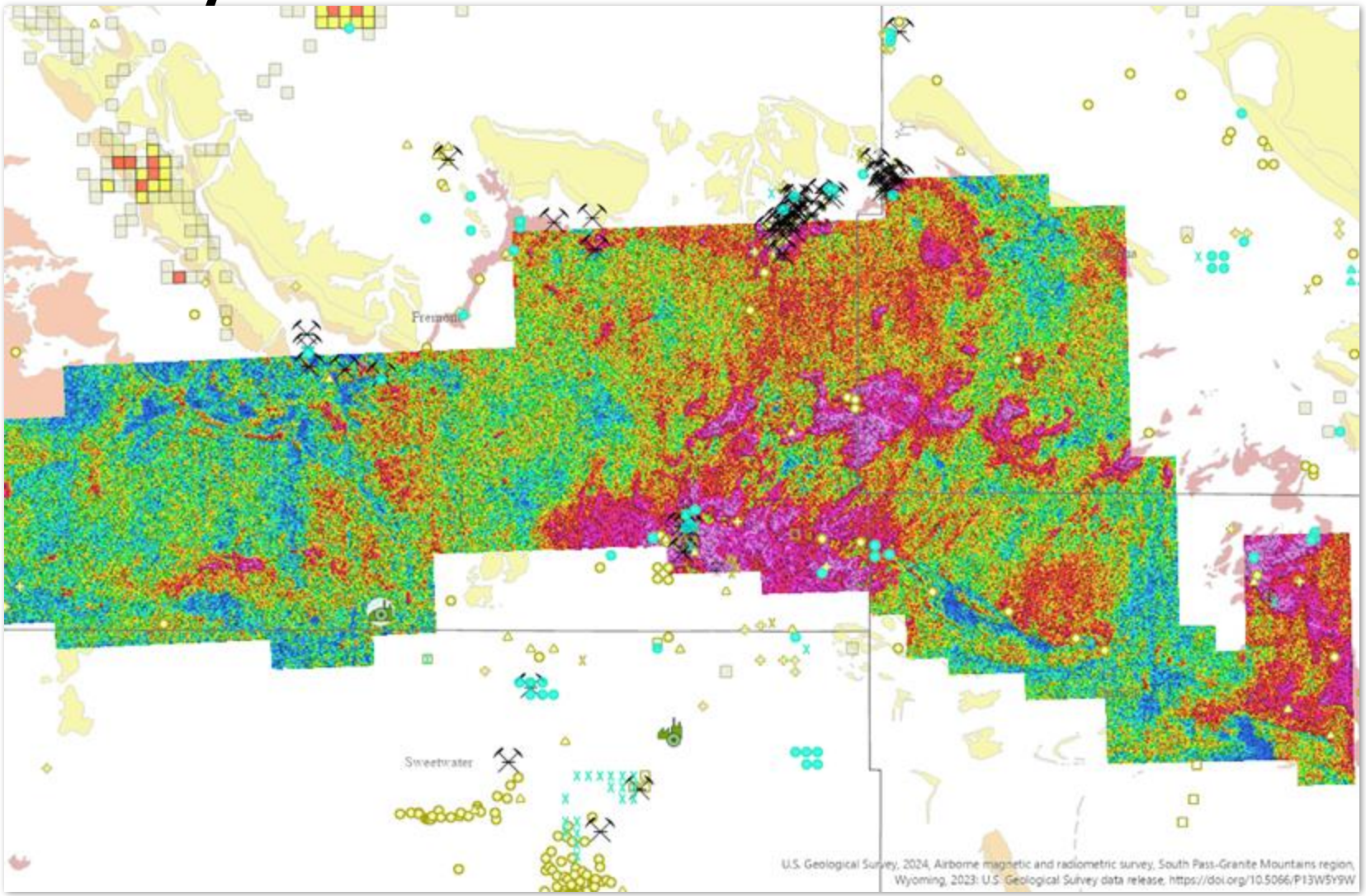
Radon Observation Statistics - Low count areas

Radon Source Potential

- HIGH
- PROBABLE HIGH
- MEDIUM
- PROBABLE MEDIUM

Uranium occurrences compared to radiometric surveys





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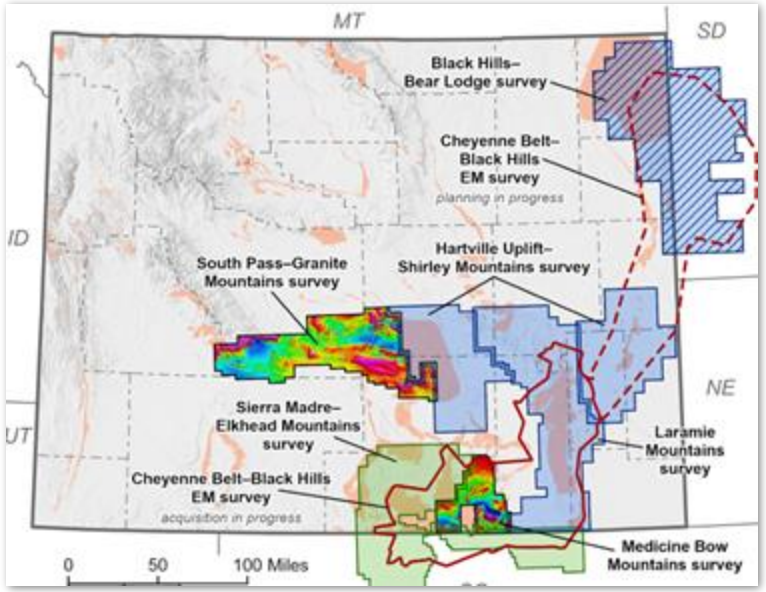
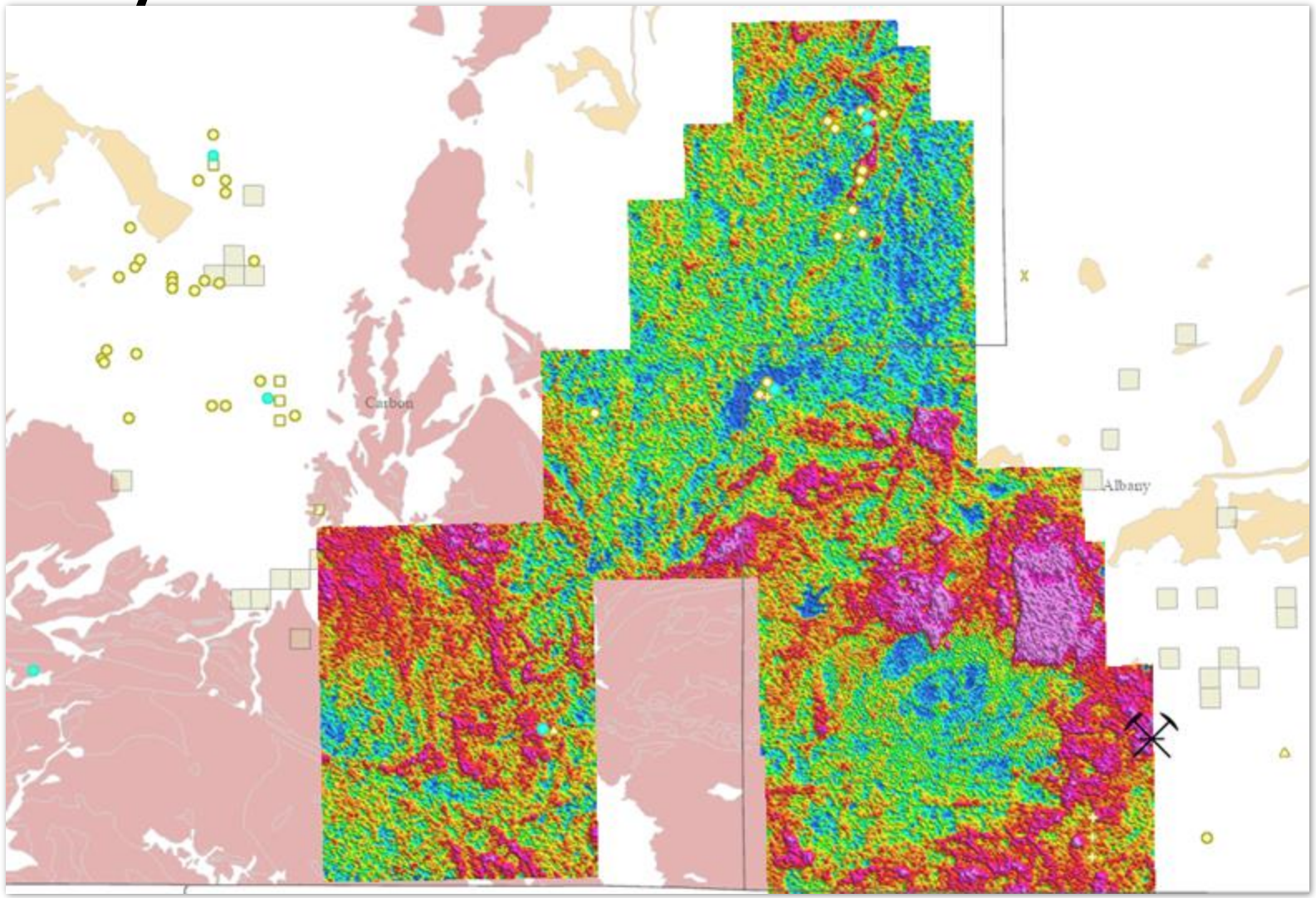




Radon in Groundwater

*For every 10,000 pCi/L of radon in water, it is estimated about 1 pCi/L is released to the air

Table 1. Radon concentrations in ground water in Wyoming, 1996-97
[radon concentration in picocuries per liter]

County	Number of samples	Radon concentrations		
		Minimum	Maximum	Median
Albany	11	210	8,200	890
Carbon	7	610	6,100	1,100
Converse	6	180	2,900	1,300
Goshen	12	270	1,100	540
Lincoln	10	150	1,600	550
Platte	6	260	7,000	520
Sublette	7	540	1,300	930

https://pubs.usgs.gov/fs/FS-079-98/pdf/fs07998.pdf

Radon in groundwater

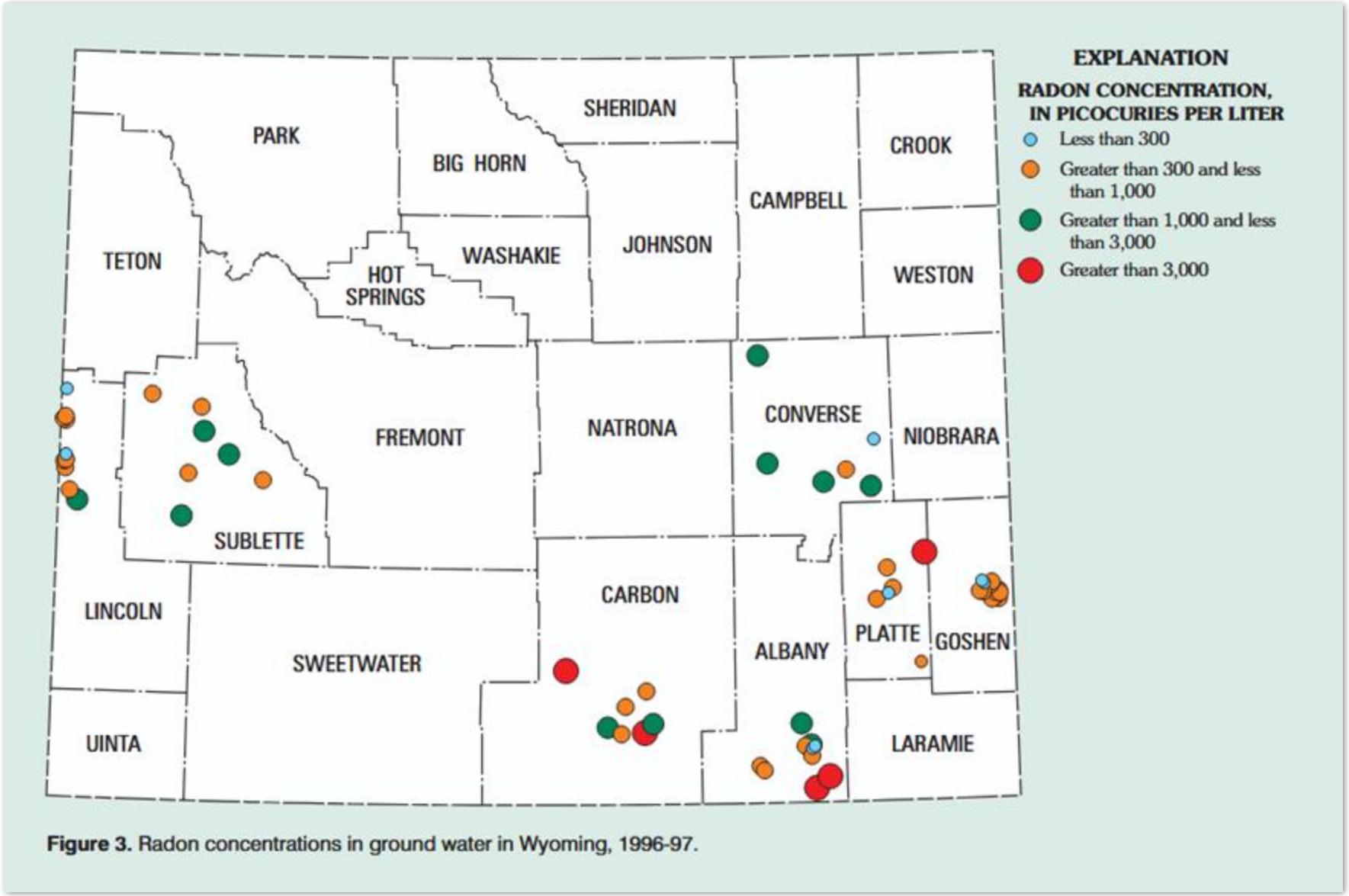
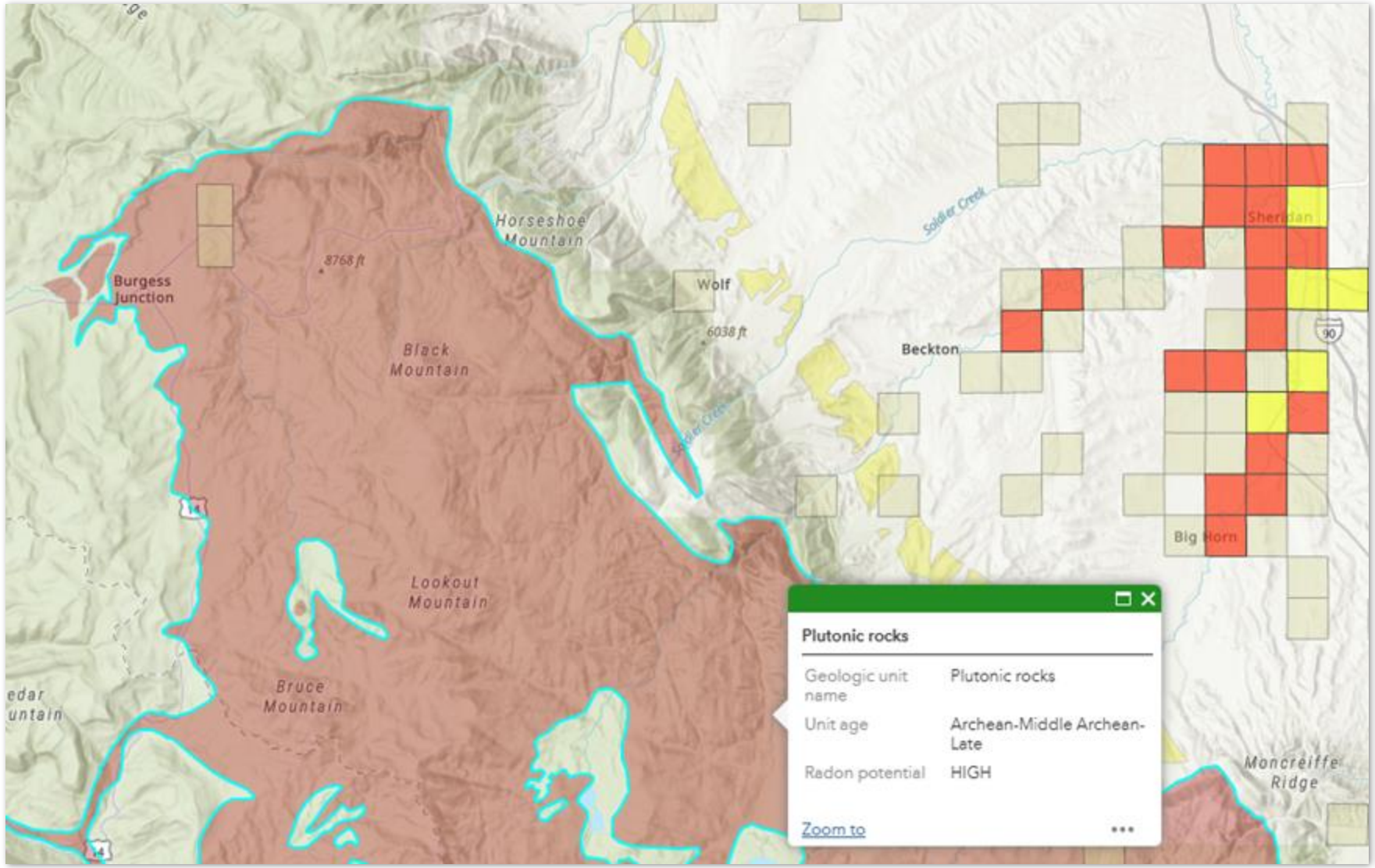
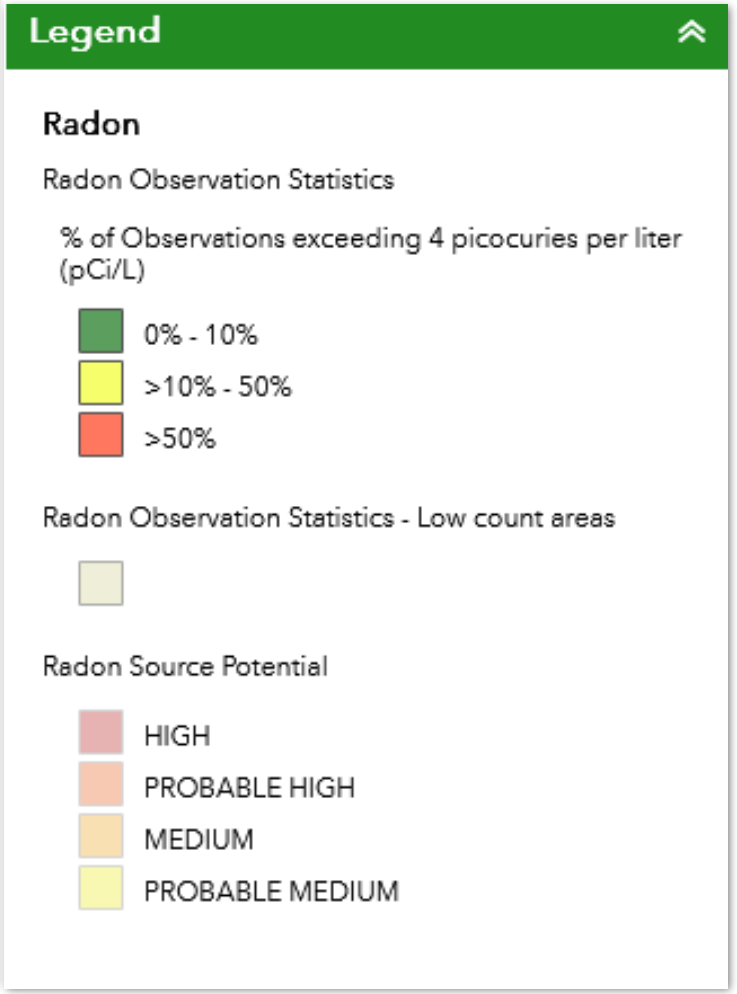


Figure 3. Radon concentrations in ground water in Wyoming, 1996-97.

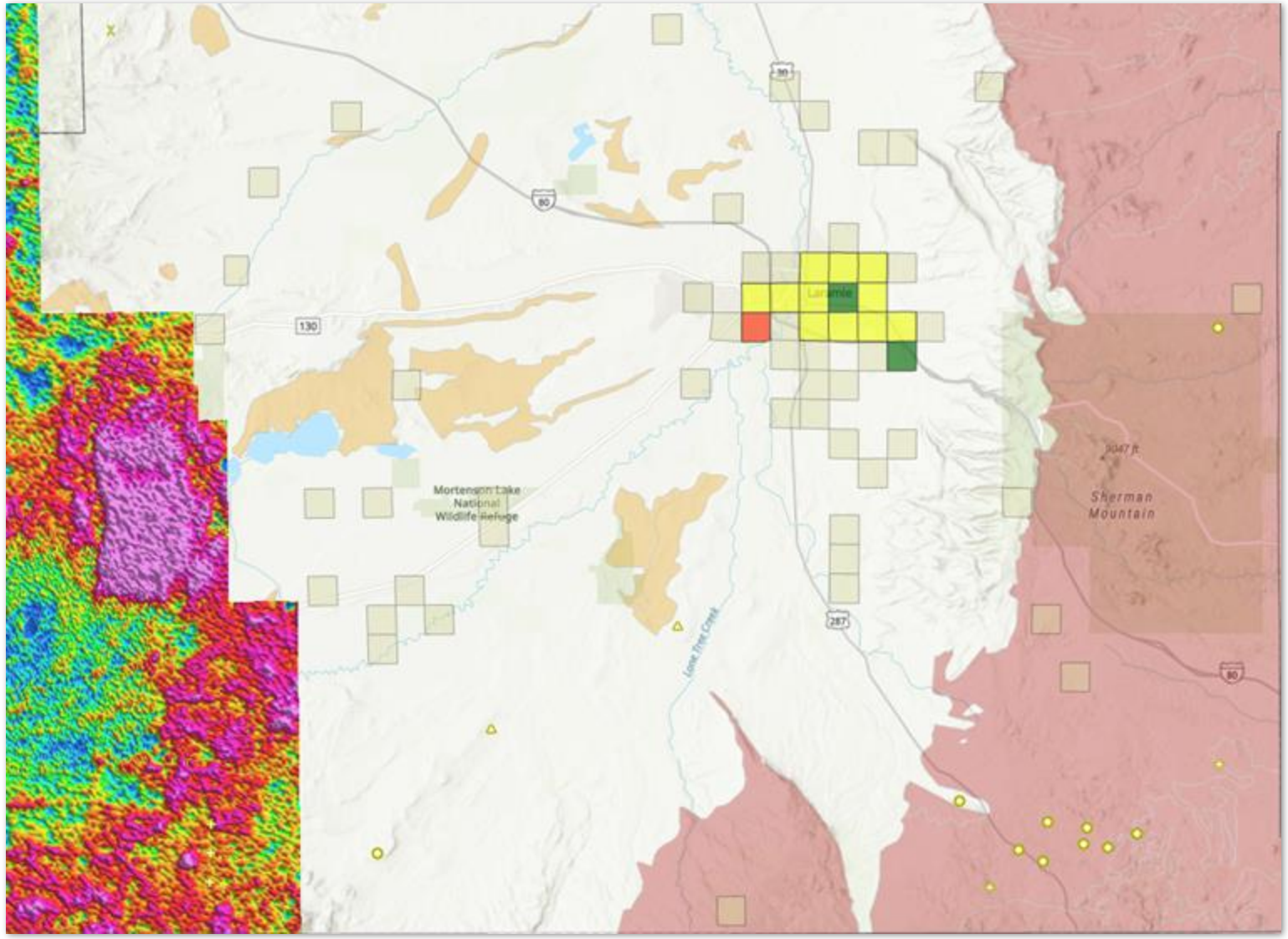
https://pubs.usgs.gov/fs/FS-079-98/pdf/fs07998.pdf

Short case study: Sheridan





Short case study: Laramie



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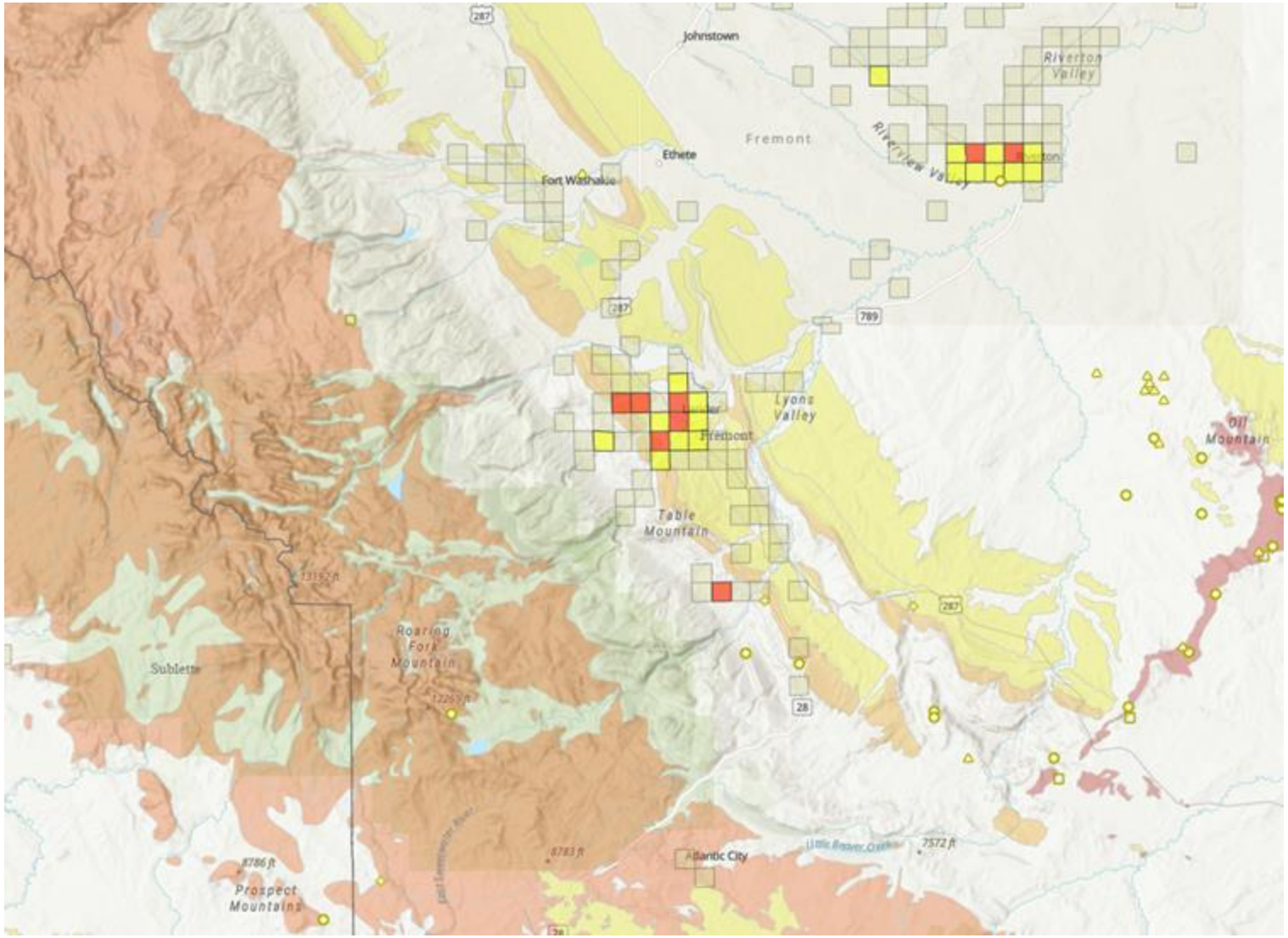
Short case study: Lander



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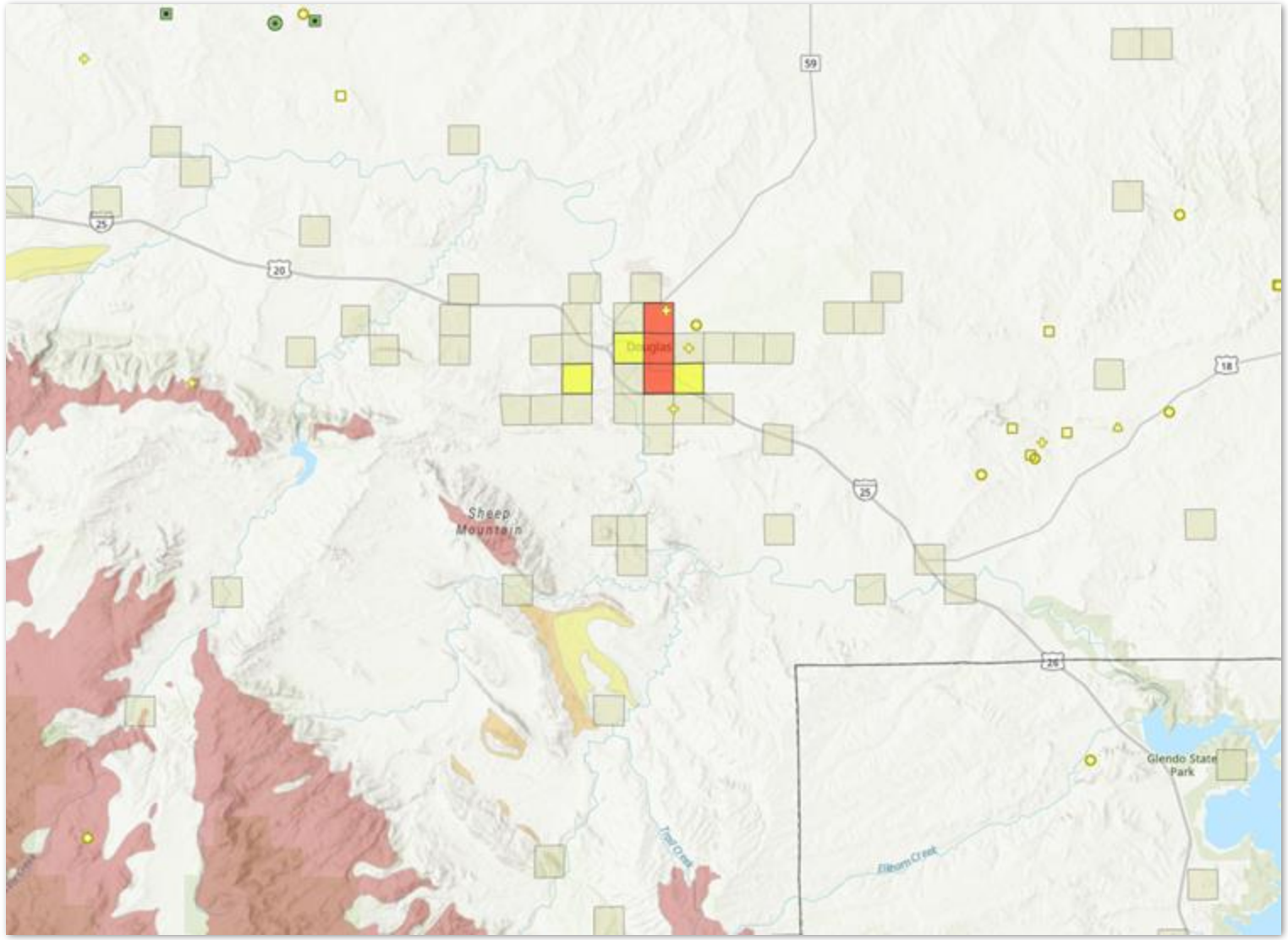
Short case study: Douglas



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Thank you to the sponsors!

- Wyoming Department of Health–Public Health Division–Wyoming Cancer program
- Kansas State University–National Radon Program Services
- Environmental Protection Agency

References

- https://main.wsgs.wyo.gov/hazards/radon
- https://pubs.usgs.gov/of/2004/1050/uranium.htm
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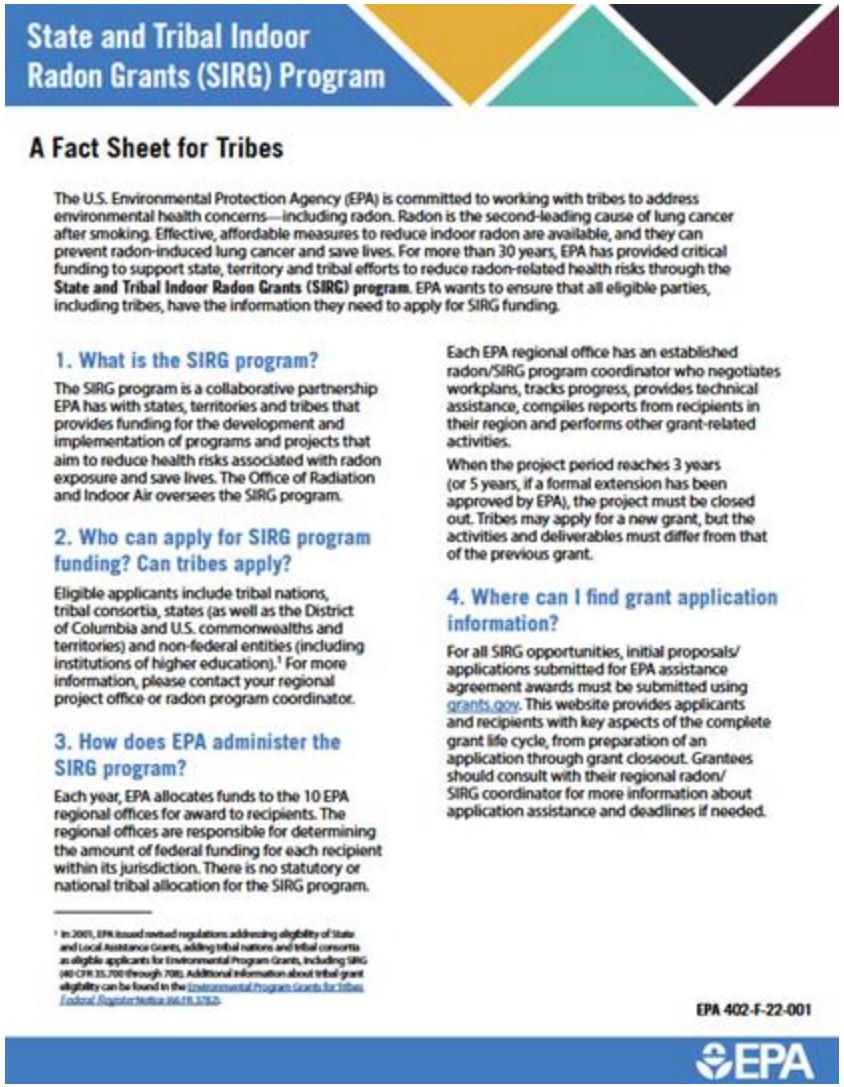
- https://pubs.usgs.gov/publication/ofr93292H
- https://pubs.usgs.gov/fs/FS-079-98/pdf/fs07998.pdf
- https://pubs.usgs.gov/gip/7000018/report.pdf
- http://neotectonics.seismo.unr.edu/0_COURSES/Geo730-2024/aapowerpoints-2020/80-Neal%20-%20North%20America%20Paleogeographic%20Maps.pdf

State and Tribal Indoor Radon Grants



State and Tribal Indoor Radon Grants (SIRG) Program

A Fact Sheet for Tribes

The U.S. Environmental Protection Agency (EPA) is committed to working with tribes to address environmental health concerns—including radon. Radon is the second-leading cause of lung cancer after smoking. Effective, affordable measures to reduce indoor radon are available, and they can prevent radon-induced lung cancer and save lives. For more than 30 years, EPA has provided critical funding to support state, territory and tribal efforts to reduce radon-related health risks through the **State and Tribal Indoor Radon Grants (SIRG) program**. EPA wants to ensure that all eligible parties, including tribes, have the information they need to apply for SIRG funding.

1. What is the SIRG program?

The SIRG program is a collaborative partnership EPA has with states, territories and tribes that provides funding for the development and implementation of programs and projects that aim to reduce health risks associated with radon exposure and save lives. The Office of Radiation and Indoor Air oversees the SIRG program.

2. Who can apply for SIRG program funding? Can tribes apply?

Eligible applicants include tribal nations, tribal consortia, states (as well as the District of Columbia and U.S. commonwealths and territories) and non-federal entities (including institutions of higher education).[1] For more information, please contact your regional project office or radon program coordinator.

3. How does EPA administer the SIRG program?

Each year, EPA allocates funds to the 10 EPA regional offices for award to recipients. The regional offices are responsible for determining the amount of federal funding for each recipient within its jurisdiction. There is no statutory or national tribal allocation for the SIRG program.

Each EPA regional office has an established radon/SIRG program coordinator who negotiates workplans, tracks progress, provides technical assistance, compiles reports from recipients in their region and performs other grant-related activities.

When the project period reaches 3 years (or 5 years, if a formal extension has been approved by EPA), the project must be closed out. Tribes may apply for a new grant, but the activities and deliverables must differ from that of the previous grant.

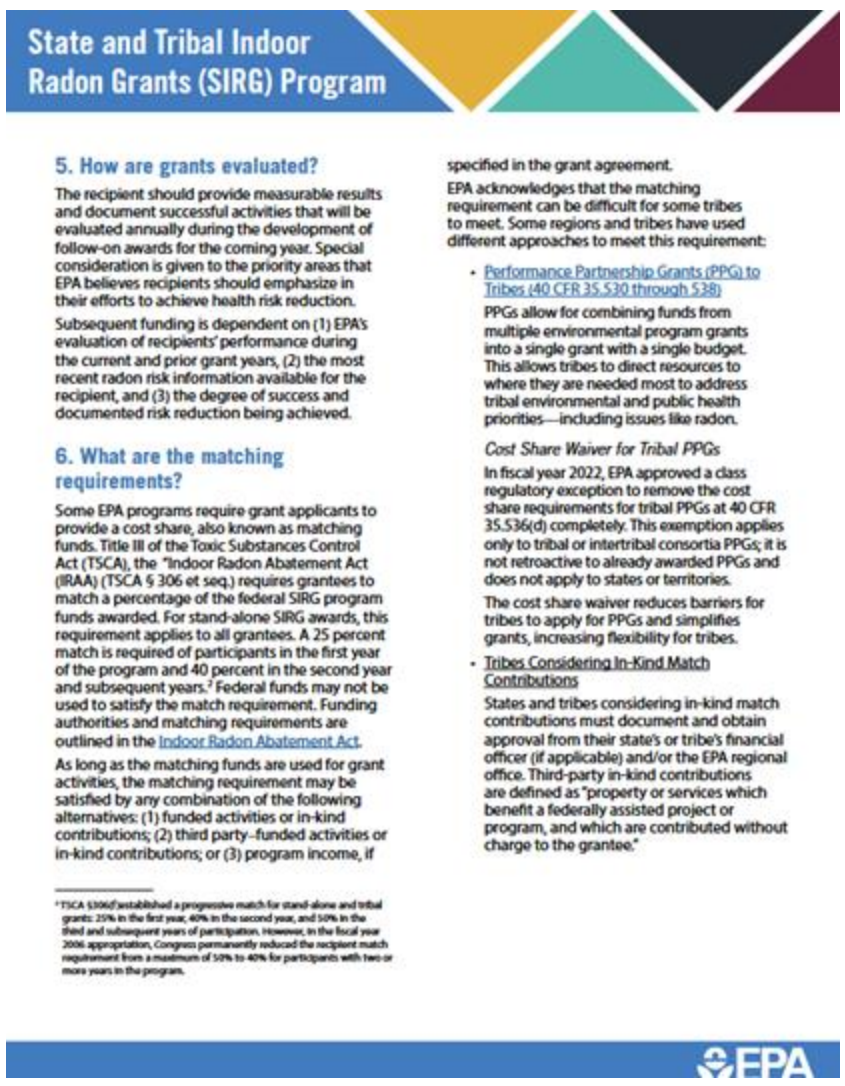
4. Where can I find grant application information?

For all SIRG opportunities, initial proposals/applications submitted for EPA assistance agreement awards must be submitted using grants.gov. This website provides applicants and recipients with key aspects of the complete grant life cycle, from preparation of an application through grant closeout. Grantees should consult with their regional radon/SIRG coordinator for more information about application assistance and deadlines if needed.

[1] In 2001, EPA issued revised regulations addressing eligibility of State and Local Assistance Grants, adding tribal nations and tribal consortia as eligible applicants for Environmental Program Grants, including SIRG (40 CFR 35.700 through 708). Additional information about tribal grant eligibility can be found in the Environmental Program Grants for Tribes Federal Register Notice (66 FR 3782).

EPA 402-F-22-001

EPA



State and Tribal Indoor Radon Grants (SIRG) Program

5. How are grants evaluated?

The recipient should provide measurable results and document successful activities that will be evaluated annually during the development of follow-on awards for the coming year. Special consideration is given to the priority areas that EPA believes recipients should emphasize in their efforts to achieve health risk reduction.

Subsequent funding is dependent on (1) EPA's evaluation of recipients' performance during the current and prior grant years, (2) the most recent radon risk information available for the recipient, and (3) the degree of success and documented risk reduction being achieved.

6. What are the matching requirements?

Some EPA programs require grant applicants to provide a cost share, also known as matching funds. Title III of the Toxic Substances Control Act (TSCA), the "Indoor Radon Abatement Act (IRAA) (TSCA § 306 et seq.) requires grantees to match a percentage of the federal SIRG program funds awarded. For stand-alone SIRG awards, this requirement applies to all grantees. A 25 percent match is required of participants in the first year of the program and 40 percent in the second year and subsequent years.[2] Federal funds may not be used to satisfy the match requirement. Funding authorities and matching requirements are outlined in the Indoor Radon Abatement Act.

As long as the matching funds are used for grant activities, the matching requirement may be satisfied by any combination of the following alternatives: (1) funded activities or in-kind contributions; (2) third party–funded activities or in-kind contributions; or (3) program income, if specified in the grant agreement.

EPA acknowledges that the matching requirement can be difficult for some tribes to meet. Some regions and tribes have used different approaches to meet this requirement:

- Performance Partnership Grants (PPG) to Tribes (40 CFR 35.530 through 538)

  PPGs allow for combining funds from multiple environmental program grants into a single grant with a single budget. This allows tribes to direct resources to where they are needed most to address tribal environmental and public health priorities—including issues like radon.

  Cost Share Waiver for Tribal PPGs

  In fiscal year 2022, EPA approved a class regulatory exception to remove the cost share requirements for tribal PPGs at 40 CFR 35.536(d) completely. This exemption applies only to tribal or intertribal consortia PPGs; it is not retroactive to already awarded PPGs and does not apply to states or territories.

  The cost share waiver reduces barriers for tribes to apply for PPGs and simplifies grants, increasing flexibility for tribes.

- Tribes Considering In-Kind Match Contributions

  States and tribes considering in-kind match contributions must document and obtain approval from their state's or tribe's financial officer (if applicable) and/or the EPA regional office. Third-party in-kind contributions are defined as "property or services which benefit a federally assisted project or program, and which are contributed without charge to the grantee."

[2] TSCA §306(f) established a progressive match for stand-alone and tribal grants: 25% in the first year, 40% in the second year, and 50% in the third and subsequent years of participation. However, in the fiscal year 2006 appropriation, Congress permanently reduced the recipient match requirement from a maximum of 50% to 40% for participants with two or more years in the program.

EPA

Examples of third-party in-kind contributions used to meet SIRG matching requirements could include the following:

- A company donates radon detectors or materials.
- A private-sector employee is sent to help staff a booth during an exhibition.
- Time and salary are contributed by a private-sector employee for other allowable activities.
- Contributions come from a local government or university to which the state or tribe is "passing through" funds.

7. What activities can be conducted using SIRG funding?

The following tasks or activities are options for grantees to consider when developing a workplan that includes radon risk-reduction objectives. Adapting these needs to respond to those of a specific reservation or tribal community is encouraged.

- Educating tribal members, Tribal Councils, tribal housing authorities, builders, local building code officials, home inspectors, real estate professionals, medical professionals and others about radon.
- Providing training and technical support on radon testing and mitigation, as well as identifying and spreading best practices for building homes, schools and other buildings that are radon resistant.
- Encouraging a Tribal Council or other tribal authority to adopt radon-resistant building codes.
- Promoting testing and mitigation in residential real estate transactions.
- Informing local school systems about radon exposure risk in schools and providing sample school testing and mitigation plans.

8. Can I use SIRG for mitigation?

The SIRG program is intended to assist states and tribes "in the development and implementation of programs for the assessment and mitigation of radon."[1] By law, SIRG funds are **not available to individuals or homeowners.**

SIRG grants may be used to fund demonstration projects on homes, schools or other buildings for the purpose of gathering information and furthering knowledge about radon mitigation. Activities may include diagnostic testing, mitigation design, implementation and follow-up testing. Approval to use funds to demonstrate an innovative mitigation technique will require close coordination and negotiation with a regional EPA project officer.

9. Where can I go for more SIRG information?

SIRG Program Guidance and Handbook:
epa.gov/sites/production/files/2014-08/documents/guidance_and_handbook.pdf

SIRG Program and Resources:
epa.gov/radon/state-indoor-radon-grants-sirg-program-and-resources

Grants.gov Website: grants.gov

Environmental Program Grants for Tribes:
federalregister.gov/documents/2001/01/16/01-219/environmental-program-grants-for-tribes

Grants.gov Informational Session for Tribes:
epa.gov/grants/grantsgov-informational-session-tribes

EPA Grants Management Training for Applicants and Recipients:
epa.gov/grants/epa-grants-management-training-applicants-and-recipients

Class Exception to the Cost Share Requirements for Tribal and Intertribal Consortia PPGs:
epa.gov/grants/rain-2022-g01

[1] The SIRG program is intended to assist states and tribes "in the development and implementation of programs for the assessment and mitigation of radon." By law, SIRG funds are not available to individuals or homeowners.

State and Tribal Indoor Radon Grants (SIRG) Program

10. Whom should I contact for indoor radon grant assistance in my region?

Region 1, Boston: CT, MA, ME, NH, RI, VT

Region 2, New York: NJ, NY, PR, USVI

Region 3, Philadelphia: DC, DE, MD, PA, VA, WV

Region 4, Atlanta: AL, FL, GA, KY, MS, NC, SC, TN

Region 5, Chicago: IL, IN, MI, MN, OH, WI

Region 6, Dallas: AR, LA, NM, OK, TX

Region 7, Kansas City: IA, KS, MO, NE

Region 8, Denver: CO, MT, ND, SD, UT, WY

Region 9, San Francisco: AZ, CA, NV

Region 10, Seattle: AK, ID, OR, WA, Tribal Nations

EPA Headquarters Contacts

Secody Hubbard
Indoor Environments Division
Tribal Coordinator
hubbard.secody@epa.gov
202-763-9016

EPA Radon Team
Indoor Environments Division
radon@epa.gov

Example of a Successful Tribal SIRG Project

Bad River Tribe

The Bad River Tribal Indoor Radon Program is funded primarily by EPA's SIRG program and is included within the tribe's PPG. The PPG process streamlines grant management for tribes that have multiple EPA grants that can fit under one workplan.

The Bad River Tribal Indoor Radon Program used SIRG funding to implement a successful radon program that provides radon expertise and tools to the tribe. To maintain community support, the tribe employs an air quality technician with radon education and certification for radon measurement and mitigation. It also provides radon testing and mitigation services—at no charge—to tribal and community members. In addition, early community involvement, such as outreach and educational presentations on radon, are provided at EPA venues and events. Other community engagement activities include an Annual Radon Fun-Run, Youth Radon Poster Contest and website development. As a result of strong community involvement, the Bad River Tribal Indoor Radon Program has achieved the following:

- Approximately 65 percent of the estimated 500 tribal homes on the reservation (323 out of 500) have been tested for radon.
- 100 percent of Bad River Housing Authority homes (171 homes) have been tested for radon and are regularly tested every 2–5 years.
- 100 percent of government-owned buildings and infrastructure on the Bad River Reservation have been tested, including one Head Start school (ages 3–5).
- Nine mitigation systems were installed in homes that tested high for radon through identification and guidance from the Bad River Tribal Indoor Radon Program.

EPA

https://www.epa.gov/system/files/documents/2022-02/sirg-factsheet-for-tribes.pdf

Geological history of Wyoming-and how it relates to Radon

Uranium Occurrences

- Wasatch (442)
- Wind River (111)
- Phosphoria (54)
- Battle Spring (54)
- Green River (49)
- Browns Park (46)
- pC granite+quartz monzonite (46)
- North Park (41)
- Morrison (38)
- White River (31)
- Fall River (31)
- Fort Union (27)
- Lakota (16)
- Pegmatite (16)
- Wagon Bed (14)
- Mesaverde (14)
- Minnelusa (14)
- pC quartz-pebble conglomerate (14)

Uranium Mines

- Wasatch (98)
- Wind River (61)
- Battle Spring (16)
- Fall River (16)
- Lakota (11)
- Madison (10)
- Fort Union (9)
- Browns Park (7)
- White River (6)
- Wagon Bed (5)