Alaska's Story of Radon Challenges in a Big, Arctic, Far-Flung U.S. State

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DGGS is a science-focused agency within the Alaska Department of Natural Resources. Its mission is to "determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources, the locations and supplies of groundwater and construction material, and the potential geologic hazards to buildings, roads, bridges, and other installations and structures" (AS 41.08.020). DGGS' goal is to provide unbiased scientific data and interpretations to answer important questions about the geology of the state, to benefit the health and welfare of all Alaskans.

Alaska's Arctic Geology in a Changing Climate

Alaska is a geologically active (fig. 1), jigsaw-puzzle mixture of metamorphic, igneous, and sedimentary rocks and unconsolidated sediments. Each type of earth material contains different amounts of uranium-238, which eventually decays through radioactive processes into radon. Radon gas may be liberated from the ground and released into the atmosphere or be drawn into buildings. Because inhaling radon may cause lung cancer over the long term, it is important to use testing and modeling to know more about where radon might exist in hazardous concentrations.

The composition of Alaska's earth materials often varies over short distances, which means that the potential for radon to be released from the ground also may vary over short distances. The radon potential map (fig. 2) takes into account (1) the amount of uranium in rocks and soils (fig. 3), (2) rock type (fig. 4), (3) depth to the water table (or top of permafrost; fig. 5) , and (4) radon testing results from buildings.

Figure 3.

https://pubs.er.usgs.gov/publication/ds908

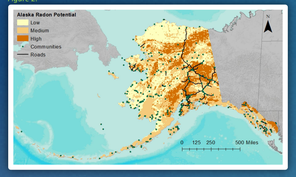
Figure 4.

https://pubs.er.usgs.gov/publication/sim3340

Figure 5.

https://www.nrcs.usda.gov/resources/data-and-reports/description-of-statsgo2-database

Figure 2.

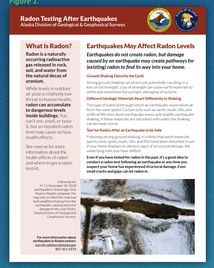


Much of Alaska is covered by continuous and discontinuous permafrost (fig. 6). Permafrost, perennially frozen soil, rock, or sediment with varying amounts of ice, acts as a barrier trapping radon below ground (fig. 7). Buildings in permafrost areas are often built on pilings to keep the permafrost from thawing (fig. 8), which also keeps radon from entering buildings.

A changing climate has the potential to dramatically change the face of Alaska. Thawing permafrost is damaging infrastructure and opening new passageways for radon to escape to the ground's surface (fig. 9). Some modelers have suggested that radon will be released at higher levels as permafrost thaws, posing greater risk to residents in the Arctic.[1] Other climate-related changes such as increased rainfall, more frequent flooding and landslides, and new groundwater flow patterns will also change how radon is released from the subsurface.

[1] Glover P. and Blouin M., 2022. Increased radon exposure from thawing of permafrost due to climate change: *Earth's Future*, https://doi.org/10.1029/2021EF002598

Figure 1.

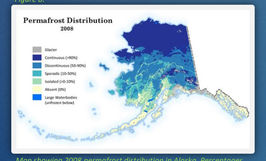


https://doi.org/10.14509/30168

Figure 8.

Free flowing air under buildings in southwest Alaska helps keep underlying permafrost frozen

Figure 6.



Map showing 2008 permafrost distribution in Alaska. Percentages indicate how much of the ground surface is underlain by permafrost in each category. Image after Jorgenson and others, 2008

Figure 9.

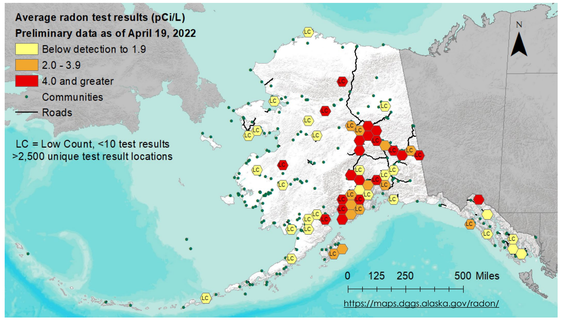
Road damage from thawing permafrost in Interior Alaska, Goldstream Community Facebook Group, posted April 30, 2022

Figure 7.

Permafrost Tunnel Research Facility, U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory

Abstract

Alaska is unique among U.S. states in size, remoteness, and climate. Alaska's radon program, therefore, has unique, interesting challenges to overcome. The typical programmatic challenges become "supersized" due to the variety of communities, cultures, and distances between them; outreach and education for multiple audiences, expensive logistics, effective radon testing for fly-in sites, mapping statewide radon potential with a low data density, etc. Alaska's radon resistant construction and mitigation techniques often differ from the rest of the country due to its cold climate, thawing permafrost, high-priced materials and fuels, economically disadvantaged residents, few regulations, and absent radon service providers. Despite these challenges, we are continuously working toward reducing residents' exposure to radon and making a difference in the health of Alaskans. As we tell our extraordinary story, please consider your own experiences and think about potential solutions to the issues presented. We are very interested in your thoughts.



The Last Frontier

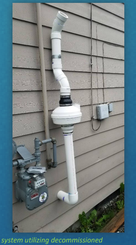
Alaskans pride themselves on their independent spirits and can-do attitudes, which serves them well in an isolated state with challenging temperatures, minimal infrastructure, and nominal services. Prices for materials, food, and fuel are notoriously high, and residents in rural areas pay disproportionally more for the same goods. "In Aniak, population 557, city officials were quoted a price of $9.10 per gallon for 5,000 gallons of bulk fuel—$5.16 per gallon more than was paid [in 2021]", according to Alaska Public media. https://akpublic.org/2022/07/27/in-rural-alaska-communities-contemplate-a-double-whammy-from-high-fuel-costs/. Because of this cost disparity and other factors, many rural Alaska residents are economically disadvantaged.

Alaska is the Wild West of building construction and radon mitigation practices. Limited municipal regulations, no statewide regulations, and limited-availability, high-priced building materials affect the design and construction of buildings, often resulting in atypical construction. The state's one radon-related regulation to disclose prior radon testing during a real estate transaction unfortunately disincentivizes residents from testing their homes—homeowners are concerned that if they receive a radon value over the EPA's Action Level, they may either not be able to sell their house or be required to pay an average $2,000–4,000 for mitigation. However, Alaska residents are largely unaware of radon as a health hazard; home buyers from outside Alaska are driving radon testing in real estate transactions.

Alaska homeowners whose radon test results are above the EPA's Action Level of 4 pCi/L and want to mitigate regularly have a difficult time finding a service provider to install a mitigation system. The few certified service providers listed on the National Radon Proficiency Program's website https://nrpp.info/pro-search/ do not necessarily conduct system installations. When uncertified or previously certified contractors can be found to install systems, there is often confusion about best practices—Alaska mitigation, which should take cold weather into consideration, is often more similar to Canadian practices than practices in the contiguous U.S. states.

Pressed-paper sub-slab heating ductwork for forced-air furnace

Rotten paper ductwork provided conduit from ground to house interior



Sub-slab depressurization system utilizing decommissioned heating ductwork (image of non-standard system)

A Big, Sparsely Populated State

Alaska is the third least populous state with the largest landmass, and it is the easternmost (across the International Date Line), northernmost, and westernmost state in the union. Great trivia question! About 1/3 of the state's population (240 villages) live rurally off of the road system, with access only by air or boat. Radon outreach and education in these areas is incredibly expensive to conduct in person; long-distance communication is often possible but less effective. Success connecting with each small village reaches only a tiny percentage of the total rural population.

Radon test result statistics in the contiguous states are usually presented by zip code or census area. Because of Alaska's sparse population and large size, test results are best represented by smaller, non-political areas such as tessellated hexagons. Inexpensive activated charcoal kits are not appropriate for radon testing in remote areas of Alaska, because the kits cannot make it back to laboratories in time for analysis. Alaska's radon program primarily uses slightly more expense, long-term alpha track test kits in rural communities.

The size of Alaska compared with contiguous U.S. states. Jones, 2011 https://pubs.usgs.gov/of/2008/1161/

Cultural Implications for Radon Outreach and Positive Health Outcomes

There are 228 tribal councils in Alaska for villages on and off of the road system. It is critical for Alaska's radon program to develop meaningful and trusting relationships with village residents and determine whether personal data can be scaled up and incorporated into statewide radon statistics. Alaska's radon program respects tribal sovereignty and the right of village councils to determine what data are collected on their land and how those data used.

Cigarette smoking in Alaska is still a common activity, particularly among rural Alaska residents (fig. 10). Radon is known to more likely cause lung cancer in people who smoke. The health effects of radon in conjunction with other airborne particles such as wildfire smoke (fig. 11), healthy home air considerations such as mold and woodburning for heat, and pollution (fig. 12) are poorly understood.

Figure 10.

Cigarette smoking in Alaska, 2019:

- 19% of Alaska adults
- 21% Aged 18-29
- 21% Men
- 30% Unemployment status
- 31% Lower socioeconomic status
- 36% Alaska Natives
- 52% Less formal education

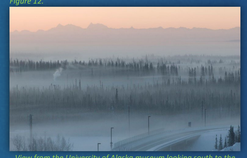
15.5% of U.S. adults smoked cigarettes in 2021

https://health.alaska.gov/dph/Chronic/Documents/Tobacco/PDF/2021_AKTobaccoFacts.pdf; https://www.americashealthrankings.org/explore/annual/measure/Smoking

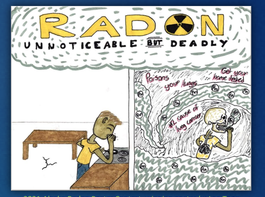
Figure 11.

Wildfire next to the Trans-Alaska Pipeline. Credit: USDA, June 22, 2015 https://www.flickr.com/photos/usdagov/20177566908

Figure 12.



View from the University of Alaska museum looking south to the Alaska Range over Fairbanks and the ice fog (-30 temps), photo by D. Sikes, February 8, 2008. https://commons.wikimedia.org/wiki/File:Ice_fog_and_Alaska_Range.jpg



2021 Alaska Radon Poster Contest, winning poster by Leo Tape from Fairbanks

Opportunities

In addition to public outreach campaigns, Alaska's radon program intends to interface with relevant industries and organizations to increase radon awareness and education in Alaska. Promoting radon awareness through public service industries and organizations should ultimately reach more respondents than through public awareness campaigns geared toward individuals. Below are some examples of our current and past collaborations.

American Lung Association. Alaska

American Lung Association in Alaska partners with Alaska's radon program on the Alaska Radon Poster Contest

Alaska Department of Health Division of Public Health

Alaska Radon Program provided radon test kits to childcare facilities in support of Alaska Division of Public Health's Choose Safe Places for Early Care and Education program, https://dhss.alaska.gov/dph/Epi/eph/Pages/safeplaces/default.aspx

FAIRBANKS NORTH STAR BOROUGH SCHOOL DISTRICT
EXCELLENCE & EQUITY FOR ALL

The Fairbanks North Star Borough School District has agreed to test several schools for radon in late 2022

FAIRBANKS NATIVE ASSOCIATION

The Fairbanks Native Association, with support from the Alaska Radon Program, is testing the homes of almost 100 Head Start families with children aged 0-5 for radon, as well as the homes of staff members

Afognak Native Corporation

The Afognak Native Corporation on Kodiak Island, Alaska is testing shareholder homes for radon, with test kits supplied by the Alaska Radon Program

2022 AARST International Radon and Vapor Intrusion Symposium
Presented by Jennifer Athey on October 24-26, 2022
Bellevue, Washington

Alaska Resources

- Radon circular with general radon information: https://doi.org/10.14509/30163
- Radon testing after earthquakes: https://doi.org/10.14509/30168
- Understanding your radon test: https://doi.org/10.14509/30467
- Mitigating radon levels at home: https://doi.org/10.14509/30474
- Radon in Alaska: What you should know (video): https://doi.org/10.14509/30745

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