Radon

What Causes Radon Gas?

Radon gas is a radioactive element that is produced by the decay of uranium, which is present in virtually all rocks and soils, typically at concentrations of 1-4 parts per million (ppm). During the 1980s, scientists discovered that radon gas can accumulate in homes and other buildings at concentrations that are typically tens of times greater than in outdoor air. Most indoor radon gradually seeps in through cracks or other openings in the ground floor. Houses that have unusually high concentrations of indoor radon are most commonly situated on rock and soil that contain unusually high uranium concentrations.

The concentration of radon is generally measured in picocuries per liter (pCi/L), which is a measure of the number of nuclear decays per minute in a liter of air or water. One picocurie corresponds to about two decays per minute. The U.S. Environmental Protection Agency (EPA) established 4 pCi/L as a guideline for maximum acceptable indoor-radon concentration.

The ability of radon to migrate through soil is strongly dependent upon physical properties of the soil. Highly fractured rock and coarse, well-drained soil are likely to be highly permeable to radon, whereas clay and mud, particularly if wet, do not permit much radon movement. Radon originating from depths greater than a meter or two generally does not reach the surface because it decays before it can get there.

Radon typically diffuses out of underlying soil and into basements, crawl spaces, and lower levels of homes or buildings, eventually reaching upper levels as well. Water pumped from wells in uranium-rich rock and used within a week or two from the time it was pumped from the ground may release significant amounts of radon to the indoor air through a shower or sink.

Probably the most significant factor affecting radon infiltration into homes is the difference in air pressure between outdoor air and indoor air at ground level. If indoor air pressure is lower, soil-gas flows out of underlying soil and into homes. Heating of indoor air causes reduced air pressure in basements and the lowest levels of homes. Consequently, warm indoor air rises to the upper levels of a house, and soil air that may contain radon is drawn in through cracks and other openings in the floor. When evaporative coolers are in use, the indoor air pressure is increased, preventing the influx of soil-gas.

Radon In Arizona

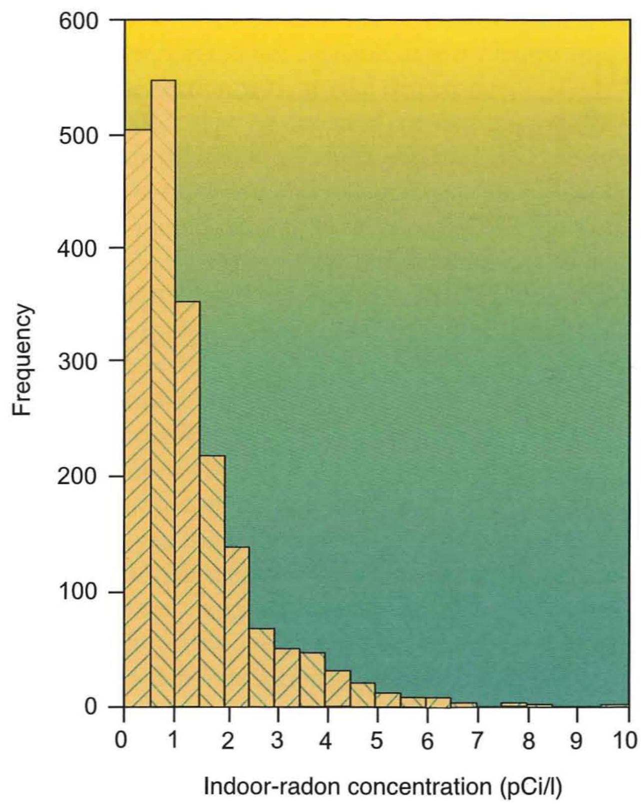
The EPA classifies the entire state of Arizona as "Zone 2", which indicates moderate radon potential. Testing with charcoal canisters (mostly in winter when windows and doors are closed and radon accumulations are highest) showed that 5.4 percent of homes statewide have radon concentrations that are higher than 4 pCi/L. Tests with alpha track detectors, which give a more meaningful long-term average, indicated that only 1.6 percent of houses exceeded 4 pCi/L.

Measuring uranium concentrations in geologic materials is probably the most accurate way to identify areas that are at greatest risk of having elevated indoor radon concentrations. Most rocks have uranium concentrations of 1 to 4 ppm. Some areas that have been identified as having uranium concentrations higher than this are located within or near urban areas. Geologists can identify these areas with moderate uranium concentrations (4 to 40 ppm) as potential radon-hazard areas.

Most homes in the Tucson and Phoenix metropolitan areas, and in many other parts of southern and western Arizona, are built on young, unconsolidated to poorly consolidated alluvial sand, gravel, and derivative soil. High uranium levels are not known for these sediments. Limestone that was deposited in lakes is exposed in many localities in Arizona and is the most common type of rock that has elevated uranium levels in or near popu-

---

This chapter summarized from *Radon Gas, a Geologic Hazard in Arizona*, by Jon E. Spencer, 1992, Arizona Geological Survey Down-to-Earth 2.



Histogram of radon levels determined using charcoal canisters. This testing was conducted by the Arizona Radiation Regulatory Agency in 1987 and 1988, primarily during winter months under low-ventilation conditions.

lation centers. Some granitic rocks also have anomalously high uranium levels. Homes built on granitic rocks and decomposed granitic rocks seem to have the greatest potential for elevated radon levels even if underlying rocks contain only average uranium concentrations. This may be because fractured and weathered granitic rocks have greater permeability than other common rock types, and a larger proportion of the radon present in the rock can escape.

Tucson Area

The only rock in the entire Tucson metropolitan area that is currently known to contain high concentrations of uranium is limestone in southwestern Tucson near the intersection of Cardinal Avenue and Valencia Road. Chemical analyses indicate that uranium concentrations are as high as 20 ppm at the center of the anomaly. Several dozen houses are built on this limestone. Many of these houses had radon levels greater that the EPA's 4 pCi/L guideline level when they were tested in 1987 by the Pima County Health Department.

Phoenix Area

The only rocks in the entire Phoenix metropolitan area that are currently known to contain high concentrations of uranium are located in the Phoenix Mountains just west of Cave Creek Road. In this area, a volcanic rock unit (basalt or basaltic andesite), exposed over approximately one eighth of a square mile, contains uranium concentrations that are two to four times greater than typical for Arizona rocks.

Cave Creek Area

Limestone in the New River-Cave Creek area contains uranium at concentrations as much as 100 times the regional background. This limestone forms a narrow, discontinuous belt along the north flank of the valley in which the town of Cave Creek is located. Because of their limited outcrop extent, these rocks are not likely to cause above-normal radon levels in many homes, but could potentially be the cause of greatly elevated levels in a small number of homes.

Verde Valley

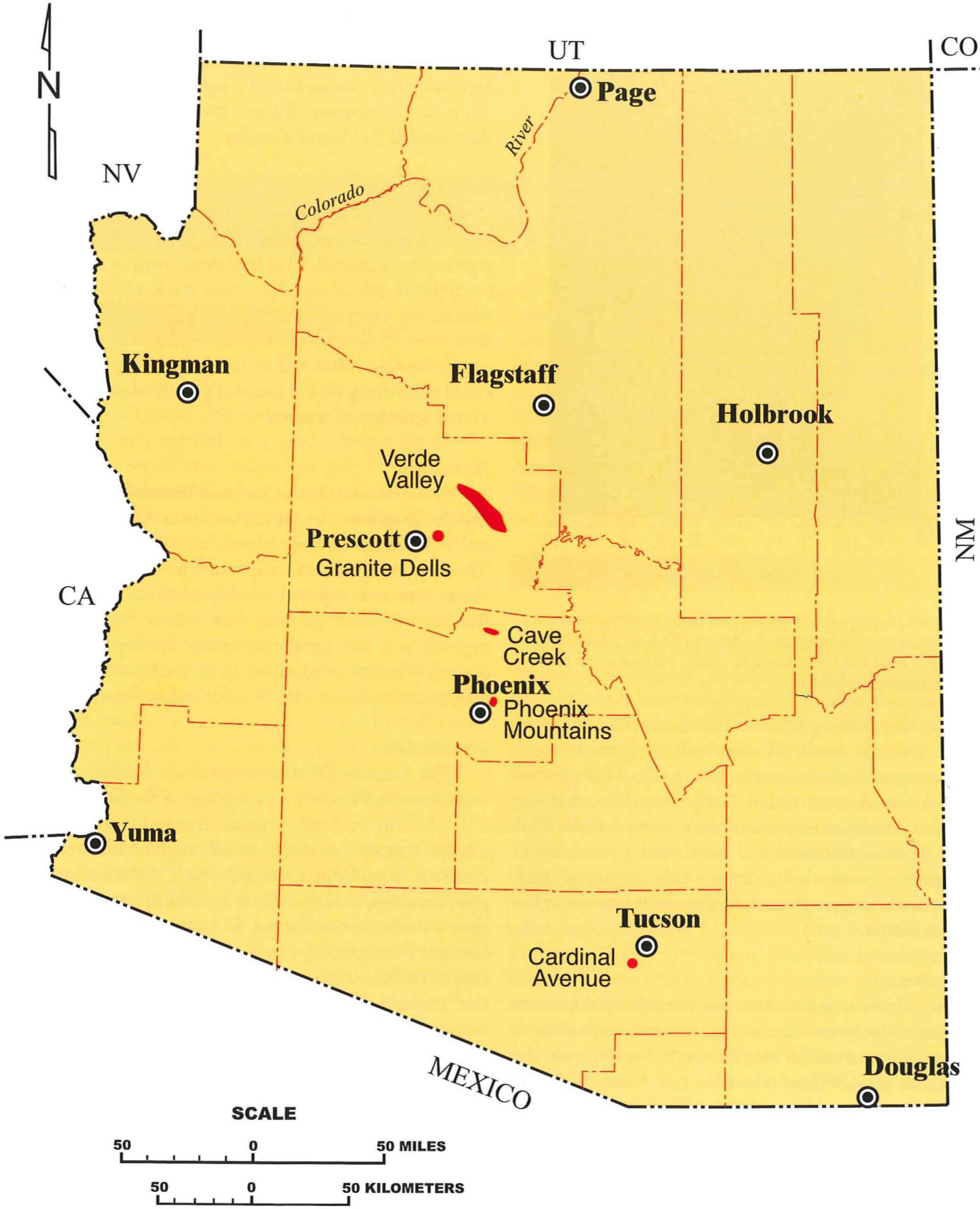
Calcareous mudstone and soft limestone that contain high levels of uranium are exposed over many square miles in Verde Valley. Uranium levels are as high as 40 ppm. These rocks, which underlie much of the town of Camp Verde, are not exposed as far north as Cottonwood. Because of the large area over which these rocks are exposed and the significant urban development that is occurring in the area, buildings throughout Verde Valley have potential for elevated indoor-radon accumulation.

Prescott Area

The Granite Dells, approximately 5 miles northeast of downtown Prescott, is composed of the Dells Granite, a 1.4-billion-year-old granitic intrusion. Many intrusions of this age contain unusually high concentrations of uranium. The Dells Granite, which contains up to 40 ppm uranium, is exposed over an area of approximately 5 square miles. In one survey, 51 homes built on the Dells Granite were tested for radon under minimum air-ventilation conditions (no open windows or running evaporative coolers). Approximately 60 percent of the tested homes had indoor radon levels above the EPA's 4 pCi/L guideline level. Water from wells in the Dells Granite contains unusually high radon concentrations.

How To Detect And Reduce Radon

Testing is the only way to determine whether a home has a high level of indoor radon. Two types of radon monitors are commercially available for use in homes and other buildings. One is the charcoal canister, a small can that is placed in the home for several days and returned to the manufacturer for analysis. Though useful for a quick "spot check," this type of detector does not measure average



Radon potential is low in most of Arizona. Areas in red have higher potential for radon (based on uranium concentrations in underlying bedrock and sediments).

radon levels over longer time periods. Do-it-yourself charcoal canister test kits are available at most hardware stores, in the same section with smoke detectors.

The other type of detector consists of a plastic film that records the tracks of alpha particles that are emitted by atmospheric radon and its decay products. The detector can be placed in a home for months or even a year, to record the long-term average radon concentration, which more accurately reflects health hazard. These detectors are more expensive ($30 to $50) than charcoal canisters ($15) and are not very accurate at determining low radon concentrations. As a result, they are most useful for follow-up measurements where a canister test has indicated concentrations above the 4 pCi/L guideline.

The most common method of reducing indoor-radon levels is to seal the floor so that soil-gas cannot easily enter the home. Other methods include ventilating the basement or crawl space, using fans to suck air from the basement or crawl space to the outside, and placing pipes under the home (sub-slab ventilation) to remove soil gas before it reaches the home. Use of evaporative coolers and electrostatic dust filters also reduces radon levels.

Where To Go For Information

Information about radon gas—such as guidelines for maximum acceptable indoor-radon concentrations, lists of certified commercial vendors for radon measurement and mitigation, methods for lowering radon concentrations in homes, and EPA radon publications—can be obtained from the Arizona Radiation Regulatory Agency in Phoenix. Levels of radionuclides in water supplies are monitored by water companies or utilities and are compiled by the Arizona Department of Environmental Quality.

Information about the distribution of uranium and radon in rocks and soil in Arizona is available at the Arizona Geological Survey (AZGS). Check out the AZGS website for information about the geology of radon, online radon publications, links to other sources of information, and contacts.

Selected References

Radon Gas, a Geologic Hazard in Arizona, by J.E. Spencer, 1992: Arizona Geological Survey Down-to-Earth 2, 17 p.

Radon in Arizona, by J.E. Spencer, editor, 1993: Arizona Geological Survey Bulletin 199, 96 p.

A Citizen's Guide to Radon, 1992, second edition: U.S. Environmental Protection Agency pamphlet, 15 p.

Consumer's Guide to Radon Reduction - How to Reduce Radon Levels in Your Home, 1992: U.S. Environmental Protection Agency pamphlet, 17 p.

A Home Buyer's and Seller's Guide to Radon, 1993: U.S. Environmental Protection Agency pamphlet, 32 p.

The Geology of Radon, by J.K. Otton, L.C.S. Gundersen, and R.R. Schumann, 1993: U.S. Geological Survey pamphlet, 29 p.

Radioactive Occurrences and Uranium Production in Arizona, by R.B. Scarborough, 1981: Arizona Bureau of Geology and Mineral Technology Open-File Report 82-1, 296 p.