OFR 93-64

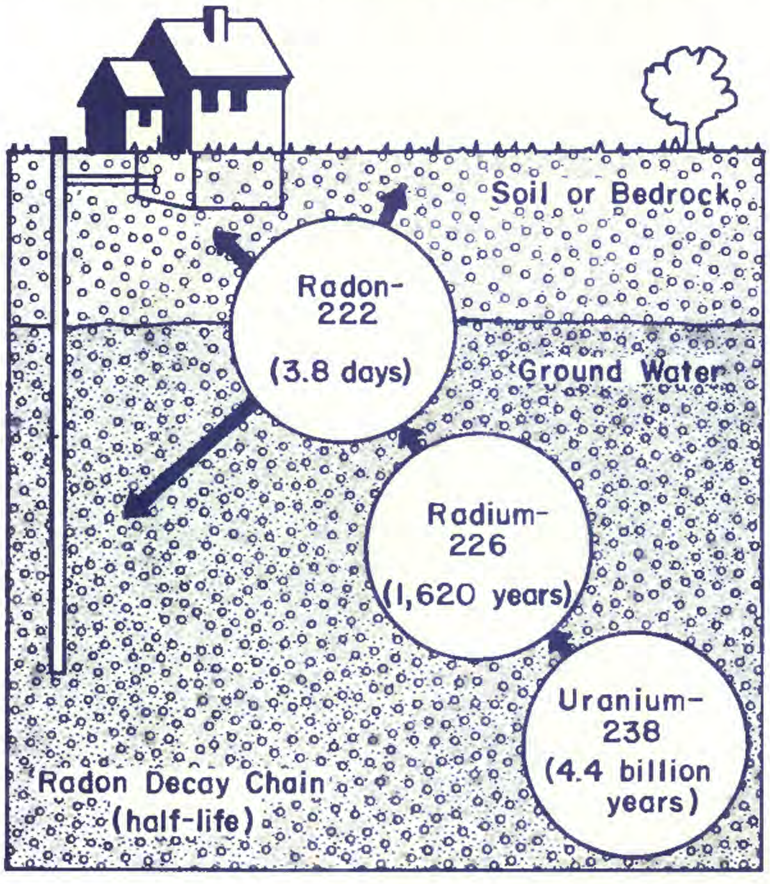
WATER FACT SHEET

U.S. GEOLOGICAL SURVEY, U.S. DEPARTMENT OF THE INTERIOR

RADON IN GROUND WATER OF WESTERN MONTANA

WHAT IS RADON AND HOW DOES IT OCCUR?

Radon is a naturally occurring, odorless, tasteless, inert gas. Radon-222, the only abundant isotope, is formed by the natural radioactive decay of uranium, which is present to some extent in nearly all rocks. Uranium-238 decays through a series of daughter products to radium-226, which in turn decays to radon-222 with a half-life of 3.8 days. Radon-222 (referred to as radon in this report) can enter pore spaces in the rock and from there, (1) is dissolved in ground water, (2) is released to the atmosphere at the land surface, or (3) is trapped in confined spaces. The quantity of radon that can dissolve in ground water is proportional to the quantity of uranium available for decay, the physical properties of the rock, and the flow rate of ground water. The concentration of radon in the atmosphere is small, about 0.4 picocuries per liter (pCi/L), and is not considered harmful. In confined spaces such as houses and other buildings, however, radon in the air can increase to large concentrations relative to the atmosphere. Radon can enter buildings through cracks, vents, joints, or other openings in basement floors and walls. Radon also can enter the air in buildings by degassing from well water used for household purposes. A simplified version of the radon decay chain and some of the possible migration paths radon can take is shown in the diagram below.

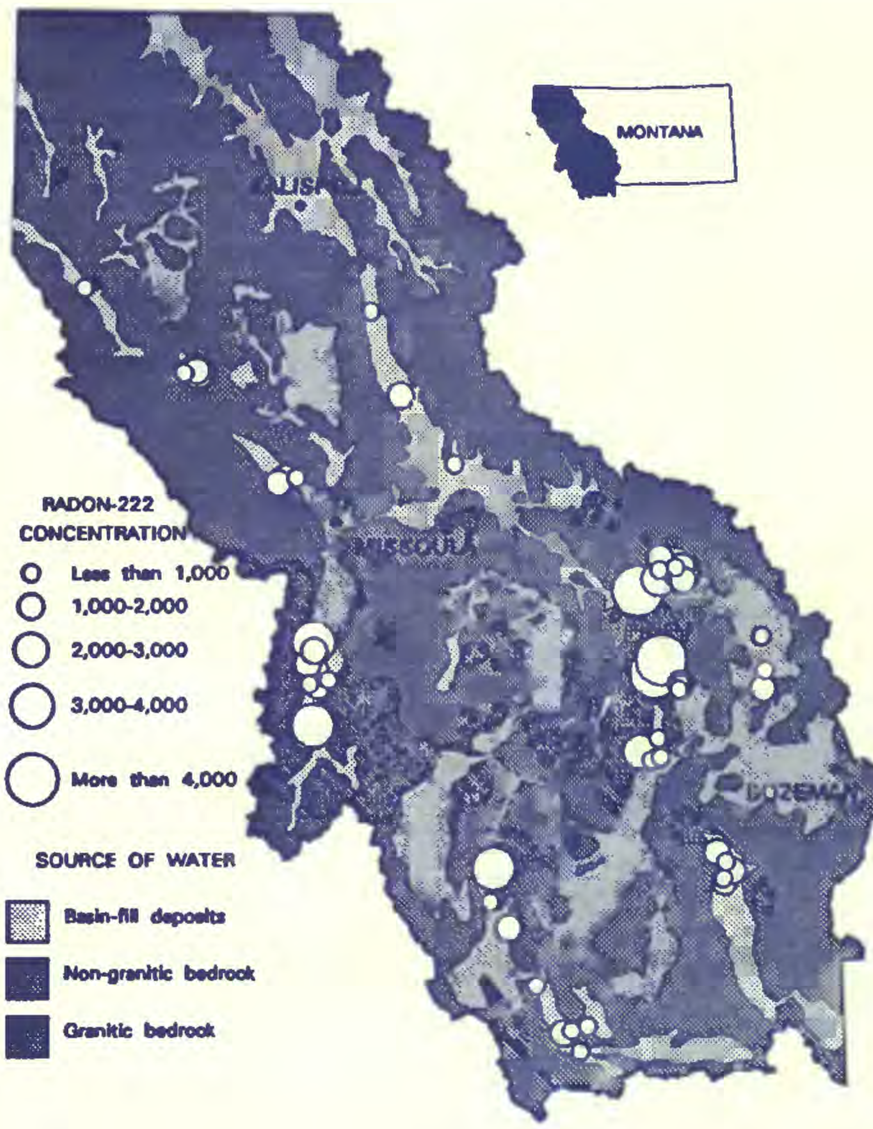


The concentration of radon is measured in pCi/L of air or water. The average concentration of radon in ground water in the United States is less than 1,000 pCi/L. Many regions of the country, however, contain concentrations of radon in ground water in excess of 10,000 pCi/L and concentrations exceeding 1,000,000 pCi/L have recently been detected in some areas, including the Rocky Mountains.

WHY IS RADON A PROBLEM?

Radon is thought to be the second leading cause of lung cancer (smoking is number one) in the United States, and is estimated by the U.S. Environmental Protection Agency (EPA) to cause from 7,000 to 30,000 lung-cancer deaths per year. Recent surveys by the EPA have indicated that houses in Montana have some of the largest concentrations of radon in indoor air in the United States. To minimize exposure and possible health risks, the EPA recommends that the average concentration of radon in indoor air not exceed 4 pCi/L. This concentration was established as a guideline based on lung-cancer risks and remedial actions that can readily and economically decrease the concentration in indoor air.

Ingesting water containing radon is considered to be a minor health risk when compared to the risk from breathing air containing radon. Any process that exposes ground water to air releases dissolved radon, especially when the water is heated. The released radon increases the radon concentration of indoor air and increases exposure. The EPA estimates that, as a general rule, the concentration of radon in indoor air will increase by 1 pCi/L for every 10,000 pCi/L of radon in household water, and that household water accounts for an average of about 2 to 5 percent of the radon in the house. The percentage will fluctuate, depending on the radon concentration in the water and in the air, the quantity of water used, how much the water is heated or aerated, and the type of house construction. In severe situations, however, as much as 75 percent of the radon in indoor air may be contributed by household water. To keep radon concentrations in indoor air to a minimum, the EPA has proposed that the concentration of radon in public water supplies not exceed 300 pCi/L. Recent studies indicate that radon in water from perhaps as many as half of the public-supply wells in the United States might exceed that concentration. Households or public supply systems that use surface-water sources generally do not have a problem with radon in the water because radon dissolved in surface water rapidly escapes to the atmosphere.



WHAT IS KNOWN ABOUT RADON IN GROUND WATER OF WESTERN MONTANA?

During summer 1992, the U.S. Geological Survey (USGS) collected water samples for analysis of radon concentrations from 56 wells in western Montana including wells used for public-supply, domestic, stock, and irrigation purposes. Of those wells, 47 are completed in basin-fill deposits, 6 in granitic bedrock, and 3 in non-granitic bedrock. The depths of the sampled wells ranged from 40 to 390 feet. The approximate location of the sample sites and a relative indication of radon concentrations in ground water at those sites are shown on the map (above). Radon concentrations in water from the sampled wells ranged from 280 to 9,900 pCi/L. All water samples but one had radon concentrations that exceeded the proposed EPA standard for public-supply wells.

No apparent correlation was observed between radon concentrations in water and well depth; however, an apparent correlation does exist between radon concentrations and the type of geologic unit in which the well is completed. The five water samples having the largest radon concentrations are from wells completed in granitic bedrock (map), which is probably the major source of radon in the water. Other water samples having large concentrations of radon appear to be correlated with basin-fill deposits that are at least partly derived from granitic bedrock. However, the apparent correlation of granitic rock to a large concentration of radon may not be representative of all situations, as indicated by a water sample from granitic bedrock that contained only a relatively small concentration of radon.

Large concentrations of radon in water from granitic-type rocks primarily are related to the concentration of uranium in those rocks. Granitic bedrock in parts of western Montana is known to contain 10 parts per million of uranium, which is as much as 5 times the concentration of uranium known to be a likely source of radon for ground water or indoor air. Non-granitic rock types in western Montana that are a potential source of radon include metamorphic rocks, organic or phosphate-rich sedimentary rocks and, to some extent, glacial deposits and carbonate rocks such as limestone.

WHAT CAN BE DONE ABOUT RADON IN WATER?

Many households in western Montana rely on ground water from wells as the principal source of water. For those households having private water supplies, it is the homeowner's decision whether to test and begin remedial action for radon. The most common remedial actions are aeration and granular activated-carbon systems, both of which are efficient in removal of radon. Aeration methods require agitating the water and exposing it to air before use, but it cannot be housed indoors and can be costly. Granular activated-carbon systems are similar in appearance and function to a water-softener tank, with dissolved radon and other radioactive elements attaching to the carbon. Whereas these systems are efficient and cost effective, disposal of the carbon can be a problem due to a buildup of radioactivity if radioactive elements other than radon are present in the water source.

For additional information on radon and household testing, residents can contact the offices of the Occupational and Radiological Health Bureau or the Water Quality Bureau, Montana Department of Health and Environmental Sciences, Cogswell Building, Helena, 59620. Other contacts are the Montana office of the EPA, Federal Building, Helena, 59626, or the Radiation in Indoor Air Branch, EPA Region 8 Office, Denver, Colorado, 80202-2413.

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1993