U.S. Geological Survey
Energy Resource Surveys Program

Natural Radioactivity in the Environment

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"The distribution of naturally-occurring uranium, radon, and other radioactive elements, radionuclides, depends on the distribution of rocks from which they originate and the processes which concentrate them. The key therefore is to know the distribution of source-rock materials containing elevated levels of radionuclides and to understand the physical and geochemical processes that concentrate radionuclides."

Dr. James K. Otton, U.S. Geological Survey

Humans are exposed every day to radioactive elements that occur naturally in the environment.

Gamma and alpha radiation emitted by radioactive elements in rocks and soils, especially those that decay quickly (such as radon), pose a health risk. This radiation is implicated in cancers of the lung, bone, and of other organs. The health threat posed by uranium alone primarily as a heavy-metal chemical poison similar to arsenic. This is known as chemotoxicity and is implicated in kidney disease. Radon is especially dangerous because it is a gas and can easily enter the lungs. Although natural concentrations of these radioactive materials are usually less than established threshold health values, human activity often inadvertently exposes us to radionuclides at dangerous levels. The Environmental Protection Agency (EPA) estimates that as much as 30 percent of the public drinking-water supply in the United States exceeds their recently-established maximum contaminant levels for radon. An even greater percentage of private water supplies, unregulated by EPA, may contain elevated levels of radioactive materials.

Radionuclides are present in all rocks in varying amounts, and they are easily mobilized in the environment.

The high geochemical mobility of radionuclides in the environment allows them to move easily and to contaminate much of the environment with which humans come in contact. Uranium, in particular, is easily mobilized in ground water and surface water. As a result, uranium and its decay product, radium, enter the food chain through irrigation waters, and enter the water supply through ground-water wells and surface-water streams and rivers. The health risks to humans are real, but the level of risk involved is not clearly defined because we do not yet know enough about the distribution and concentration of these radionuclides.

The U.S. Geological Survey (USGS) maintains a worldwide database on the occurrence and distribution of uranium and other radioactive materials.

Since 1940, USGS scientists have maintained a global database of naturally occurring radioactive materials in the environment. Following completion of the Department of Energy's (DOE) National Uranium Resources Evaluation, the USGS agreed to archive geophysical and geochemical data derived from the program. Maps and reports detail the distribution of radioactive materials and describe the geochemistry of radionuclides in rocks, sediments, and ground and surface waters. Complete ore-deposit files that allow rapid geological analysis of non-domestic resources, especially in the countries of former Soviet Union, reside in the database. Cooperative work with EPA in the National Assessment of Indoor Radon has resulted in a State-by-State assessment of potential for indoor radon presented in the form of reports and maps. USGS, EPA, DOE, and the Lawrence Berkeley Laboratory cooperate to study where "hot" homes are most likely to occur in the U.S., based on statistical and geological analysis. A complete geological analysis will provide new understanding about why clusters of homes have higher than background levels of radon occur. For example, Linda Gundersen and her colleagues have determined that shear zones in many rocks concentrate radionuclides and can be an important natural source of excessive radiotoxicity.

USGS studies show that uranium frequently and preferentially concentrates in wetland environments where uranium-rich rocks occur.

Concentrations of uranium in dead and decaying organic material in wetlands is a potential threat to the health of humans and to wetland habitats. Although many wetlands serve as natural filters protecting surface waters from uranium contamination, disturbances of wetlands from such events as hurricanes, dredging, draining, road building, and water recovery, may allow uranium to become mobile, contaminating water which is subsequently consumed by humans and other animals.

Uranium contaminates surface waters in many irrigated lands.

In irrigated areas along the Arkansas River Valley in southeastern Colorado, uranium and salts are actively leached from marine shales. These contaminated, saline, irrigation waters eventually return to the river where uranium levels increase to concentrations as high as 200 parts per billion and, because of the accompanying high salinity, wetlands in this area are not trapping uranium. In other much-publicized wetland areas such as the Kesterson Wildlife Refuge in California, uranium and selenium contamination is responsible for wildlife death and deformities. Many other irrigation systems in semi arid areas that drain farmland on marine shales face similar stresses on water quality.

USGS scientists have undertaken intensive studies of the geochemistry of uranium.

Dissolved uranium complexes in water with dissolved fluorides, phosphates, and carbonates. When phosphate precipitates from water uranium goes with it. As a result, for example, uranium is a serious contaminant in phosphate fertilizers that are ubiquitous in crop farming. As irrigation water containing uranium is used, fertilizers that also contain uranium serve to compound the potential toxicity. Although most crops resist uptake of radioactive materials in their leafy (above-ground) components, those crops whose roots are consumed (such as potatoes, peanuts, carrots), are susceptible to contamination by uranium. Geochemical sampling and detailed geological mapping are essential early steps to knowing where irrigation water, contaminated by underlying rocks or by fertilizers may be a problem.

For More Information:

Dr. James K. Otton
U.S. Geological Survey
Box 25046
MS 939
Denver Federal Center
Denver, CO 80225

Email: jkotton@usgs.gov