Radium

Radium (chemical symbol Ra) is a naturally-occurring radioactive metal. Its most common isotopes are radium-226, radium 224, and radium-228. Radium is a radionuclide formed by the decay of uranium and thorium in the environment. It occurs at low levels in virtually all rock, soil, water, plants, and animals.

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Reference Information

People and Discoveries
Commonly Encountered Radionuclides

- Americium-241
- Cesium-137
- Cobalt-60
- Iodine-129 &-131
- Plutonium
- Radium
- Radon
- Strontium-90
- Technetium-99
- Tritium
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- Uranium

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The Basics

Who discovered radium?

Radium was discovered in 1898 by French physicist and Nobel laureate Marie Curie in pitchblende (a uranium and radium-bearing mineral). There is about 1 gram of radium in 7 tons of pitchblende. Elemental radium was isolated by Mme. Curie in 1911.

Where does radium come from?

Radium forms when isotopes of uranium or thorium decay in the environment. Most radium (radium-226) originates from the decay of the plentiful uranium-238.

In the natural environment, radium occurs at very low levels in virtually all rock, soil, water, plants, and animals. When uranium (or thorium) occurs in high levels in rock, radium is often also found in high levels.

What are the properties of radium?

Radium is a naturally radioactive, silvery-white metal when freshly cut. It blackens on exposure to air.

Purified radium and some radium compounds glow in the dark (luminesce). The radiation emitted by radium can also cause certain materials, called "phosphors" to emit light. Mixtures of radium salts and appropriate phosphors were widely used for clock dials and gauges before the risks of radium exposure were understood.

Metallic radium is highly chemically reactive. It forms compounds that are very similar to barium compounds, making separation of the two elements difficult.

The various isotopes of radium originate from the radioactive decay of uranium or thorium. Radium-226 is found in the uranium-238 decay series, and radium-228 and -224 are found in the thorium-232 decay series.

Radium-226, the most common isotope, is an alpha emitter, with accompanying gamma radiation, and has a half-life of about 1600 years. Radium-228, is principally a beta emitter and has a half-life of 5.76 years. Radium-224, an alpha emitter, has a half life of 3.66 days. Radium decays to form isotopes of the radioactive gas radon, which is not chemically reactive. Stable lead is the final product of this lengthy radioactive decay series.

What is radium used for?

In the early 1900's, when it was newly discovered, no one understood the dangers of radium. People were fascinated with its mysterious properties, especially the luminescence produced when it is mixed with a phosphor. Industries sprang up to manufacture hundreds of consumer products containing radium. Advertisements proclaimed its special powers and unique effects in such products such as hair tonic, toothpaste, ointments, and elixirs. Glow in the dark watch and clock faces were immensely popular.

Most of its original uses have been halted for health and safety reasons, but its wide use in luminescent paints continued through World War II, because the soft glow of radium's luminescence made aircraft dials, gauges and other instruments visible to their operators at night. Radium was also an early radiation source for cancer treatment. Small seeds were implanted in tumors to kill cancerous cells. Safer, more effective radiation sources, such as cobalt-60 have mostly replaced it.

Radium is a radiation source in some industrial radiography devices, a technology similar to x-ray imaging used in industry to inspect for flaws in metal parts. When radium is mixed with beryllium it becomes a good source of neutrons, useful in well logging devices and research. Radium also has been added to the tips of lightening rods, improving their effectiveness by ionizing the air around it.

Exposure to Radium

How does radium get into the environment?

Radium occurs naturally in the environment. As a decay product of uranium and thorium, it is common in virtually all rock, soil, and water. Usually concentrations are very low. However, geologic processes can form concentrations of naturally radioactive elements, especially uranium and radium. Radium and its salts are soluble in water. As a result, groundwater in areas where concentrations of radium are high in surrounding bedrock typically has relatively high radium content.

How does radium change in the environment?

All isotopes of radium are radioactive. As they decay, they emit radiation and form new radioactive elements, until they reach stable lead. Isotopes of radium decay to form different isotopes of radon. For example, radium-226 decays to radon-222, and radium-228 goes through several decays to radium-224 before forming radon-220.

How do people come in contact with radium?

Since radium is present at low levels in the natural environment, everyone has some minor exposure to it. However, individuals may be exposed to higher levels of radium if they live in an area where there is an elevated level of radium in the surrounding rock and soil. Private well water in such areas can also be an added source of radium.

The concentration of radium in drinking water is generally low, but there are specific geographic regions in the United States where higher concentrations of radium occur in water due to geologic sources. Limited information is available about the amounts of radium that are typically present in food and air, but they are very low.

People can also be exposed to radium if it is released into the air from the burning of coal or other fuels. Certain occupations can also lead to high exposures to radium, such as working in a uranium mine or in a plant that processes ores. Phosphate rocks typically contain relatively high levels of both uranium and radium and can be a potential source of exposure in areas where phosphate is mined.

In some parts of the country, former radium processing plants exist that were highly contaminated with radium. However, most of these have been cleaned up and do not pose a serious health threat any longer.

Radium emits several different kinds of radiation, in particular, alpha and gamma radiation. Alpha radiation is only a concern if radium is taken into the body through inhalation or ingestion. Gamma radiation, or rays, can expose individual even at a distance. As a result, radium on the ground, for example, can expose individuals externally to gamma rays or be inhaled or ingested with contaminated food or water. The greatest health risk from radium in the environment, however, is actually its decay product radon, which can collect in buildings.

How does radium get into the body?

People may swallow radium with food and water, or may inhale it as part of dust in the air. Radium can also be produced in the body from "parent" radionuclides (uranium and thorium) that have been inhaled or swallowed, but this is not a significant source.

What does radium do once it gets into the body?

Most radium that is swallowed (about 80%) promptly leaves the body through the feces. The other 20% enters the bloodstream and accumulates preferentially in the bones. Some of this radium is excreted through the feces and urine over a long time. However, a portion will remain in the bones throughout the person's lifetime.

Health Effects of Radium

How can radium affect people's health?

Radium emits several different kinds of radiation, in particular, alpha particles and gamma rays. Alpha particles are generally only harmful if emitted inside the body. However, both internal and external exposure to gamma radiation is harmful. Gamma rays can penetrate the body, so gamma emitters like radium can result in exposures even when the source is a distance away.

Long-term exposure to radium increases the risk of developing several diseases. Inhaled or ingested radium increases the risk of developing such diseases as lymphoma, bone cancer, and diseases that affect the formation of blood, such as leukemia and aplastic anemia. These effects usually take years to develop. External exposure to radium's gamma radiation increases the risk of cancer to varying degrees in all tissues and organs.

However, the greatest health risk from radium is from exposure to its radioactive decay product radon. It is common in many soils and can collect in homes and other buildings.

Radon
This fact sheet describes the basic properties and uses, and the hazards associated with this radionuclide. It also discusses radiation protection related to it.

Radon Home Page
This site provides information about the hazards and management of radon.

Is there a medical test to determine exposure to radium?

There are tests that can determine exposure to radium or other radioactive substances. For example, a whole body count can measure the total amount of radioactivity in the body, and urine and feces can be tested for the presence of radionuclides.

These tests are not routinely performed in a doctor's office because it requires special laboratory equipment. There is no test that can detect external exposure to radium's gamma radiation, unless the doses were very high, and cellular damage is detectable.

Protecting People from Radium

How do I know radium if I'm near radium?

You need special equipment to detect the presence of radium. However, you can buy radon detection kits at most hardware stores.

What can I do to protect myself and my family from radium?

The most effective way to protect yourself and your family is to test your home for radium's decay product, radon.

Radon Home Page
This site provides information about the hazards and management of radon.

What is EPA doing about radium?

The U.S. Congress passes laws that authorize EPA and other federal agencies, to protect public health and the environment from radium and other radioactive materials. EPA has issued a variety of regulations that limit the release of radium and other radionuclides to the environment. For example, Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA). EPA has established standards for cleaning up and managing leftover uranium ore at inactive ore-processing plants under the authority of UMTRCA. The U.S. Department of Energy is responsible for conducting the cleanups, and the U.S. Nuclear Regulatory Commission oversees and manages them.

UMTRCA
This page provides a summary and link to the full statute.

Complementing these efforts, EPA's Superfund program identifies abandoned industrial sites contaminated with radium and other radionuclides and chemicals. It then assesses the health and environmental risks the sites pose, and assigns priorities for cleaning them up based on those risks. Superfund regulations require sites to be cleaned up to the point that people living on the sites after cleanup would have no more than a 1-in-10,000 to a 1-in-1,000,000 increased risk of developing cancer from exposure to contaminants.

CERCLA
This page provides a summary and a link to the complete statute.
Superfund
This site contains information about individual Superfund sites.

Other laws passed by Congress address specific environmental media. The Clean Air Act authorizes EPA to establish annual limits, known as National Emission Standards for Hazardous Air Pollutants, for the maximum amount of radium and other radionuclides that may be released to the air. For radium the "NESHAP" is 10 millirem. The Safe Drinking Water Act authorizes EPA to limit the Maximum Contaminant Levels of radium and other radionuclides in publicly supplied drinking water. For 226 and 228 radium, the MCL is 5 picocuries per liter and for 224 radium it is 15pCi/l. Both the air and water standards limit the increased lifetime cancer risk to about 2 in 10,000.

Clean Air Act
This page provides a summary and a link to the complete act.
Safe Drinking Water Act
This page provides a summary and a link to the complete act.