Focus on Blocking Strontium

DEPARTMENT OF ECOLOGY
State of Washington

Nuclear Waste Program **Revised July 2010**

All About Apatite

Apatite is a common type of mineral with the ability to capture and hold radioactive and metal contaminants. Large amounts of apatite are in bones and smaller amounts are in rocks. Apatite and apatite-like minerals make up most of our teeth and bones.

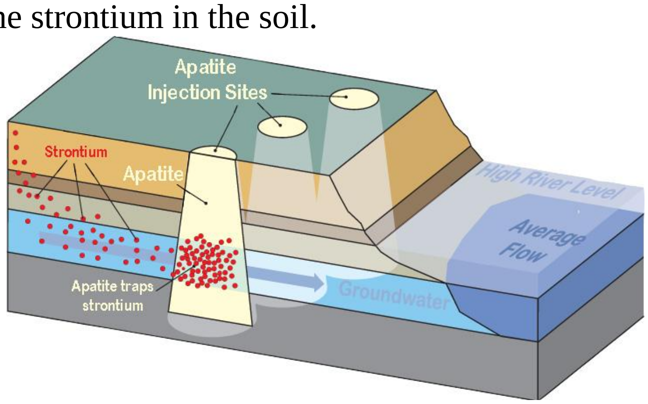
Apatite has many uses. Often, apatite is used in fertilizers because it is a rich source of phosphorus. Sometimes apatite is used in gems for jewelry. It has a hardness rating of 5 on a scale where talc has a hardness of 1 and diamond has a hardness of 10. Apatite also is used to fluoridate water and to put protective coatings on metals to prevent rust.

Apatite minerals are very stable and do not readily dissolve in the natural environment.

How will apatite help in Hanford's cleanup?

The Washington State Department of Ecology (Ecology) and the United States Department of Energy (USDOE) have explored many technologies to address strontium-90 in the soil and groundwater to prevent its migration to the Columbia River. The use of apatite is one of the newer technologies Ecology proposed to remediate groundwater contaminated with strontium-90.

Apatite chemically attracts strontium. In 2004 and 2005, scientists at Hanford looked at using apatite to isolate or capture the strontium in the soil.



Apatite barrier

WHY IT MATTERS

Soil and groundwater near Hanford's 100 N Reactor are contaminated with large amounts of strontium-90, a radioactive form of strontium.

The N Reactor was the last and the largest reactor to make plutonium for the nation's nuclear weapons program, which is run by the United States Department of Energy (USDOE).

In the reactor, cooling water became contaminated as it circulated around the nuclear fuel rods and in the storage basins for irradiated fuel.

Millions of gallons of cooling water were discharged to the ground into two unlined trenches near the shoreline. Discharges to the ground near N Reactor ended in 1992.

Strontium-90 in groundwater poses a threat to human health and the environment. It is radioactively toxic, and mimics calcium by replacing it in bones. It can cause cancer in bones, skin, and blood (leukemia). Because it lodges in bones, strontium-90 can lead to anemia, abnormal bleeding, and inability to fight diseases.

Strontium-90 has a half-life of 29 years. This means every 29 years, half of its remaining radioactivity decays away. It takes 10 half-lives for a radioactive material to decay completely. The strontium at Hanford will pose a risk for many generations.

Scientists call this process "sequestration." Laboratory and small-scale tests yielded good results.

The apatite absorbs into its crystals any strontium it contacts, which locks up that strontium and removes it from the groundwater. These crystals will continue to remove strontium, holding it in place for the decades it takes to decay to harmless levels.

What's the plan?

In short, apatite is removing strontium-90 from the groundwater entering the river.

In 2006, USDOE built a 300-foot test barrier. Workers pumped apatite-forming minerals into the soil column near the shoreline when the river was highest to study whether the apatite would form in intermittently wet and dry soil. They monitored strontium levels in test wells and took core samples of the barrier to see if it captured strontium.

In 2007 workers injected a mix with a low-concentration of apatite-forming minerals. In 2008 they injected a mix with a high-concentration of apatite-forming minerals.

Cribs that discharged strontium near N Reactor.

Monitoring has shown the apatite barrier has significantly reduced strontium in groundwater.

Today the proposed plan for the N Reactor shoreline is to extend the apatite barrier to about 2500 feet of shoreline, where the strontium-90 levels are higher than drinking water standards.

What other efforts have been tried to keep strontium from reaching the river?

Efforts to remove strontium-90 from the groundwater began in 1995 with pump-and-treat systems. These systems pumped groundwater to the surface, removed the strontium-90, and returned the clean water to the aquifer.

These efforts did not lower the levels of strontium at the shoreline. While they removed strontium from the groundwater, the strontium in the soil re-contaminates the groundwater again and again. USDOE put the pump-and-treat system on standby in 2006 to carry out the apatite tests. Plans now call for the system to be removed altogether.

In addition to pump-and-treat efforts, USDOE tried to insert an underground metal barrier along the shoreline to intercept strontium migration to the river. Hanford scientists also studied the idea of freezing the aquifer and flushing the soil. These efforts did not succeed.

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