divining rod

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Fallout leaves tracks in ground water

In 1954 the United States was exploding nuclear bombs in the Pacific while Americans were building bomb shelters in their basements. The nuclear test ban treaty has since put a stop to atmospheric nuclear testing, and the bomb shelters have been forgotten or converted to wine cellars.

Fred Phillips was born in 1954, but that's not the only reason he has taken great interest in "the bomb." The New Mexico Institute of Mining and Technology geohydrologist is using radioactive fallout from the tests to trace the rate of ground water recharge in New Mexico's desert soils.

"The recharge rate limits New Mexico's water use and, in turn, its economic development," Phillips said. Recharge is a component in setting pollution controls and in calculating pumping rates for ground water permits. Knowing how fast water moves down to the water table, Phillips said, tells how fast the ground water is being replenished.

Although chlorine is found naturally, his experiments involved chlorine-36, a radioactive isotope formed during nuclear testing.

"This type of nuclear reaction," Phillips explained, "is produced only when nuclear testing takes place near the ocean, allowing the radiation to mix with ocean chlorine. In addition, the bomb must be powerful enough to shoot radioactivity into the stratosphere where powerful winds can distribute it over the whole globe."

The fallout, which occured from 1954 to 1964, was incorporated into rain, snow and dust. This heavy concentration created a traceable "pulse" of chlorine-36. The depth of the pulse can be used to determine the recharge rate.

Because the chlorine-36 also is completely soluble, it makes an excellent tracer element. "Other isotopes stick to the rocks and stay on top of the soil without mixing, while the chlorine-36 moves through the soil along with the water," he said.

Another advantage of using chlorine-36 is its half-life. Phillips explained that a half-life is the time it takes for half the element's radioactivity to decay. Depending on the element, a half-life can be as brief as a microsecond or as prolonged as a billion years.

"The half-life of chlorine-36 is 301,000 years, so over the 30 years since the nuclear tests, the amount of decay is not measurable," he said. On the other hand, tritium, with a half-life of 12-and-a-half years, decays so rapidly it doesn't provide enough information.

Until recently, clorine-36's six-figure half-life had actually prevented its use as a tracer. "If a researcher had wanted to use chlorine-36, he would have had to collect thousands of pounds of soil to extract 1 gram of chlorine-36 and then spent a year doing the analysis," he said. With the introduction of a new technique that separates atoms by mass and atomic number, the process now requires only 10 milligrams of soil and a day or two for analysis.

Using this technique, Phillips has found that recharge in the desert soils near Socorro and Las Cruces averages 1 in. for every 14 in. of precipitation, the annual average for those areas. He adds, however, that final calculations may show the recharge rate as twice as large. In contrast, the said recharge in the humid Northwest can run as high as 3 ft. a year.

If chlorine-36 gives researchers a 30-year snapshot of recharge, a more widely known dating element -- carbon 15 -- provides a 40,000-year history of water movement. Phillips took samples from 32 wells in northwestern New Mexico's San Juan Basin to determine how long it took for ground water in the central basin to reach the San Juan River 40 miles away.

How long? Only 30,000 years. During the first 20,000 years, recharge reached as high as 4 in. a year. However, that rate dropped to 2 in. a year during the past 10,000 years. Phillips credits the cooler and wetter climates during the glacial period with the increased recharge rate.

Phillips said the findings illustrate that recharge rates are not stable over time. "Often numerical modeling assumes the system doesn't change with time. But," he said, "the findings show that changes have occured in the past and they can occur again."

Numerical modeling of ground water flow, for example, can be used to make preliminary predictions of the impact of proposed well fields for coal mining. Phillips said the recharge rate from his study shows that pumping from the ground water might have a small effect on the flow of the San Juan River.

Although the use of chemical techniques in dating ground water is relatively new, Phillips said they can provide "solid knowledge" in recharge research. "Chemical techniques often make ground water information gathering less difficult and less expensive," he said. Once the "new" wears off, he thinks they will become more widely used.

Water at issue

Protecting wildlife

A federal report has pinpointed 18 sites on or near wildlife refuges in six western states as suspected of having high levels of selenium. Two sites in New Mexico, Bosque Del Apache and Poison Canyon, are among those listed.

The Interior Department preliminary report, which was released in December 1985, responds to articles published by the *Sacramento Bee* in September 1985. The newspaper articles reported finding selenium in water and sediment samples at 23 sites in the West. Many of the sites are in or near Bureau of Reclamation irrigation projects or national wildlife refuges.

Selenium is found naturally in soils and is an essential element to all life. Like iron, however, it can become a toxicant at higher concentrations. Selenium has been blamed for waterfowl death and deformity at the Kesterson National Wildlife Refuge in California's San Joaquin Valley.

According to U.S. Fish and Wildlife Service Regional Coordinator Charlie Sanchez, comparing Kesterson to the Bosque del Apache can be misleading. "The San Luis (California) subsurface drains allowed selenium to collect and be delivered in concentrated levels at the terminus of the waste drain at the Kesterson Reservoir," he said. New Mexico's surface drainage system allowed the irrigation water to seep into the soil from the base of the surface drain. Under this wider disbursement, selenium is less concentrated. "Although selenium may be high in soils, it's not carried through the drains," he said.

The concern over selenium is an old story. Marco Polo may have been referring to alkali disease, which is caused by selenium, when he described problems with domestic livestock in China in the late 13th century. A similar disease, causing malformations in chickens and children in Colombia, South America, was reported in 1560. However, only after the discovery of selenium in 1817 were these historical accounts attributed to selenium poisoning. In the American West, loco weed, one of the plants that selectively accumulates selenium, has been blamed for thousands of livestock deaths.

The West is particularly vulnerable to selenium poisoning because selenium becomes water soluble in alkaline soils and readily available to plants. Alkaline soils are the product of low precipitation, which is also common to the West. Selenium also is found in ore bearing soils that produce coal and uranium.

Poison Canyon, one of the New Mexico sites, is located in northwestern New Mexico's uranium mining belt, about 10 miles northwest of Grants. The Interior Department report has given the area a Class A rating because of high (more than 1,500 parts per billion [ppb]) selenium concentrations in soils, sediments and water.

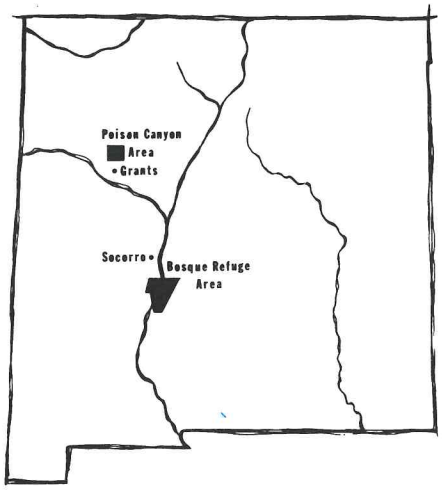
A Class A rating includes areas where information indicates reason for concern and the need for further study. Each area was rated based on samples of its water, soil sediment and mud, fish, algae, and wildlife eggs. The study found no evidence of selenium-related fish and wildlife deaths, reproductive failures or deformities in the area.

According to the report, selenium at Poison Canyon is associated with uranium ore deposits. Runoff from the Poison Canyon arroyo feeds into San Mateo Creek, which joins the Rio Puerco, which in turn joins the Rio Grande 40 miles north of the Bosque del Apache.

U.S. Geological Survey and New Mexico Environmental Improvement Division (EID) samples show that selenium concentrations in ground water in the uranium mine tailings ranged from 14,700 to 35,500 ppb. Concentrations of selenium in uranium mining or milling effluent in the arroyo were a maximum 440 ppb. However, water samples collected downstream near where the Rio Puerco enters the Rio Grand contained less than 1 ppb.

The Bosque del Apache National Wildlife Refuge received a

Canadian Geese make their winter stopover at the chilly waters of the Bosque del Apache Wildlife Refuge.



Sites listed as having potentially hazardous selenium levels.

Class B rating because selenium concentrations were high in a few samples of a single medium, or moderate in samples from several media. However, information was insufficient to warrant a Class A rating.

The bosque is located in central New Mexico, 15 miles south of Socorro. The Rio Grande flows south for about 13 miles through the refuge with irrigation and drainage canals paralleling the river.

The refuge was established in 1939 and serves primarily as a wintering ground for snow geese, mallards, pintails, shovelers, teal and gadwalls. The endangered whooping crane also uses the refuge during the winter. The bosque sees little use as a nesting ground.

The U.S. Geological Survey collected 70 soil and sediment samples in the bosque for selenium analyses. The results showed the median selenium concentration at 70 ppb, with the maximum selenium concentration at 2,450 ppb. In well tests near the Rio Grande at San Marcial and San Acacia, and springs in Socorro County, median selenium concentrations were less than 1 ppb. However, a few samples had selenium concentrations greater than 10 ppb, the Environmental Protection Agency's criteria for safe drinking water.

According to David Tague, program manager of the Surface and Ground Water Quality Bureau, EID, New Mexico's ground water standards for withdrawal for beneficial use set the allowable selenium limit at 50 ppb.

As in Poison Canyon, fish and wildlife death, reproductive and deformity rates in the bosque appear unaffected by the presence of selenium.

The federal government has plans to follow up on the findings of the December 1985 study. Three federal agencies have submitted a joint workplan to the Department of the Interior to study water quality related to irrigation return flow in 21 of the 23 original sites identified by the *Sacramento Bee.* Because the Poison Canyon problem is not irrigation related, it will not be part of the regional study.

The U.S. Geological Survey, the U.S. Bureau of Reclamation and the U.S. Fish and Wildlife Service have proposed an initial one-year study to collect sediment samples, aquatic vegetation, and animal species that consume aquatic vegetation or fish.

According to Bryan Pridgeon, environmental specialist with the U.S. Bureau of Reclamation, results of the first year's data will determine the course of further studies. "If we find we need detailed samples for problem 'hot spots,' we will propose studies for ways to cure the problem," he said. Researchers also will pinpoint areas that could be potential hot spots.

Nine sites have been targeted as priority sites. The Bosque del Apache is not one of the nine, Pridgeon said.

According to Tom O'Brien, an environmental specialist with the U.S. Fish and Wildlife Service, the collections will be analyzed for organic compounds such as selenium as well as industrial waste from the oil refining and microchip industries.

The researchers plan to begin the study by locating nests, which will be used to monitor reproductive impairment. "Chicks are a good indicator of the health of wildlife," O'Brien said. The researchers will take precautions not to disturb migrating species.

O'Brien said it is difficult to generalize about what is or is not a toxic level. "It's best to see first hand if we have a problem. The samples will tell us that. Then we will work with the agencies to alleviate the problem."

He said, for example, if high selenium runoff is the problem, then it would be logical to stop the runoff through increased vegetation in those areas. If the problem is high salinity in irrigation return flow to the refuge, then the refuge would receive more river water and less drainage water.

Pridgeon said depending on federal funding, the project could be underway as early as April 1986, "However, money is uncertain and this will be an expensive process," he said.

State should enter water market

A recent study advocates that the state of New Mexico enter the water market by appropriating ground water rights to itself. State appropriation could provide various regions of the state with the economic leverage to "plan and control their water futures," according to the study report.

The two-year study, a team effort by the University of New Mexico Law School and New Mexico State University, was commissioned by the Legislature and administered by the New Mexico Water Resources Research Institute.

The study team concludes that although current laws may not protect the state's water supplies from interstate markets, "It is legally possible for a state to enter the market as a participant by appropriating and developing its own water supplies."

New Mexico has about 150 million acre-feet of unappropriated ground water within its borders. That water is available free to both in-state and out-of-state appropriators. However, once appropriated, the water right can be sold or leased on the water rights market. At a value of $250 per acre-foot for ground water (an estimated value falling between the cost of agricultural and municipal water), the unappropriated ground water represents close to $38 billion, more than twice the value of the state's oil reserves.

If the state held these ground water rights, it could then sell or lease water according to an agreed upon plan. State-held rights would prevent out-of-state users from obtaining free New Mexico ground water. By selling water, the state could use the revenue to create water development projects, provide a reliable water supply for economic development, promote water conservation, and guarantee long-term supplies. As with any appropriator, the state would have to develop the water and put it to beneficial use.

The study found that by 2020, nearly every state bordering New Mexico faced annual water deficits greater than New Mexico's projected 600,000 acre-feet. Texas, for example, expects to run short by 10 million acre-feet a year and Arizona by 1.5 million acre-feet. Under the 1982 U.S. Supreme Court ruling that ground water is an article of commerce and open to interstate transport, New Mexico's neighboring states could have legal access to New Mexico ground water.

The report concludes that virtually every ground water basin in the state is potentially part of the interstate market. The report calculates that eight cities, including Lubbock, Texas, and Tucson, Arizona, could economically transport free unappropriated New Mexico ground water.

The next step in the proposed plan, the study says, involves looking into the costs of developing state appropriated water rights, the revenue sources for development and the type of agency needed to administer the program.

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