Radioactive waste: the hunt for a grave

"Before the people of Deaf Smith County will glow in the dark, sparks will fly." So said Governor Mark White of Texas when informed by the U.S. Department of Energy (DOE) that this Panhandle county west of Amarillo had been chosen as a possible "dump" for radioactive wastes.

The DOE has also marked two other western sites for study as nuclear-waste depositories, but the responses of local residents were not always as extreme as that of Governor White. The mayor of Richland, Washington, a town near the Hanford Nuclear Reservation, responded to that region's selection for radioactive-waste study by stating: "I think this is a real shot in the arm for the city of Richland."

Reactions were mixed from the third site selected, the sparsely populated Yucca Mountain area of Nevada. Regardless of the various reactions, most people agreed that some place had to be found to dispose permanently and safely of the mounting pile of nuclear waste being produced by the power industry and the military. The seeds for an agreement had been planted many years before and had finally come to life in the form of the Nuclear Waste Policy Act of 1982. This act triggered a concentrated effort to find a permanent resting place for nuclear wastes by the year 1998.

A number of government agencies were drawn into the search. The Environmental Protection Agency (EPA) had already been struggling to develop rules for the choice of nuclear-waste sites, and after nine years of investigation had produced a set of criteria in the summer of 1985. The criteria included the requirement that nuclear wastes stored underground would stay put for a least 10 000 years. This, officials of the EPA reasoned, would result in an average of only one death per decade due to radiation leaks from the underground dumps. The task of researching and building the radioactive-waste depositories fell to the DOE, which was supervised by the Nuclear Regulatory Commission (NRC). But where could DOE scientists and engineers look for nuclear-waste dumps that met EPA standards?

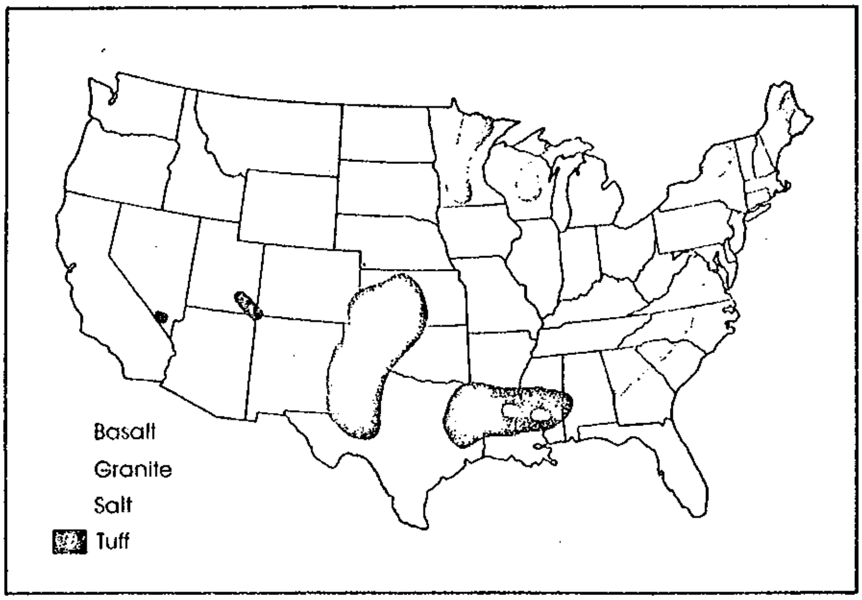
Work had been going on for some time to solve the problems associated with the safe disposal and storage of nuclear wastes, which are some of the most toxic and long-lived substances known. Their toxicity and longevity are joined by a third property that compounds the problem. Radioactive wastes can be extremely hot—not simply hot in radioactive terms, but hot in thermal terms. Teams of geologists were given the responsibility of probing the Earth—theoretically and physically—for a place to hide nuclear wastes.

The negative reactions of local citizens in certain areas led to a brief search for such alternative sites as outer space, the Antarctic ice sheet, and the floor of the ocean. None had proved satisfactory.

Advocates of shooting nuclear waste into space suggested that waste-laden space vehicles be fired into orbits between Earth and Venus. There, the wastes would orbit the sun for millions of years. However, critics pointed to the huge costs of such a project and the potential for accidents at or after launch, which could spew tons of radioactive materials across the Earth.

Although 2500 meters thick in some places, the Antarctic ice sheet was also rejected as a radioactive dump. Geologists pointed out that the ice can move very rapidly and unexpectedly. Pieces of it might eventually split apart, releasing the toxic chemicals. Moreover, the tremendous heat generated by the radioactive materials would almost certainly melt large volumes of ice, which might lead to the escape of radiation into the oceans or into the atmosphere.

Planting radioactive wastes far from populated areas under the ocean floor seemed attractive. There are layers of rock under the sea that might be able to hold radioactive wastes for many years. But there are also unanswered questions about the behavior of such rocks, the volcanic activity under them, and the effects of ocean forces above them that give scientists and engineers serious doubt. In addition, the technology to deposit the wastes in the sea floor does not yet exist and would be very costly and time-consuming to develop. Time has become a key factor in the hunt for a graveyard for nuclear wastes, which are being produced at ever-increasing rates. So, the ground below became the focus of the search for drilling and creating a nuclear trash "bin." But this could not be ordinary ground. It had to be a geological "strong box." Its "walls" had to be leak-proof, heat-resistant, and virtually unbreakable. This ruled out areas where earthquakes could be expected. Finally, the site had to be deep.



Potential underground storage areas for nuclear-waste material.

After concentrated study, four types of underground sites at nine locations in the United States were chosen for consideration. These sites are deposits of either salt, granite, basalt, or tuff. Salt is the white mineral familiar to you at mealtime. Granite is a very hard bedrock. Basalt and tuff are volcanic rock. But what properties do such materials have that make them potential "strong boxes" for radioactive wastes? What, if any, are their drawbacks?

Salt—which lies under the Texas Panhandle as well as under other places in the United States-has a plastic quality. That is, it can flow! This property, geologists and chemists point out, allows salt to fill up cracks, a useful built-in property of a radioactive waste "strong box." Salt, however, is soluble in water and salt beds contain a salt solution called brine. The heat of radioactive wastes could draw the brine toward them, causing the formation of radioactive brine pockets. Fluid from these pockets might escape from the salt beds and contaminate nearby areas. Whether this actually would happen requires further investigation.

The hardness of granite makes it a prime candidate for a radiation "strong box." Unfortunately, granite seems to be a gathering place for water. Since granite is not self sealing, as is salt, the water passing through the granite might carry off radioactive wastes with it. In addition, the very hardness of granite makes it difficult and costly to bore through—too difficult and too costly for practical purposes, say critics.

Basalt, which underlies the Hanford, Washington, region, is attractive because it is relatively waterproof. It also holds together well even at the very high temperatures that would be generated by radioactive wastes. Furthermore, a chunk of basalt is very dense and strong. But, unfortunately, layers of basalt separate at joints, allowing water to flow through, picking up and transporting nuclear wastes as it travels. Would this actually happen? Again, more study will have to be undertaken to find the answer.

Tuff makes up the basement under Yucca Mountain in Nevada. Tuff is made up of countless bits of volcanic minerals that are sometimes tightly welded together. Another form of tuff—nonwelded tuff—has a property of trapping certain radionuclide ions, such as those in nuclear wastes. Both kinds of tuff hold water. At the Nevada site, this could be a positive quality, geologists suggest: The welded tuff would form the inside layer of the radioactive waste "strong box"; the nonwelded tuff would form an outer layer. Heat would be dissipated by the inner layer, and radioactive materials would be contained by the outer layer. The idea makes some scientific sense, but only by drilling holes into the tuff and filling them with radioactive wastes can the idea be tested. That has yet to be done.

All this drilling and testing is going to be very expensive. Robert L. Morgan, a DOE official, estimates that each hole could cost $100 million to dig. Financing for the drilling comes from a special tax on energy paid by companies in the nuclear-power industry. The tax is one-tenth of a cent for each kilowatt-hour of electricity produced by nuclear-power plants. This brings in about $400 million dollars a year for drilling test shafts. According to Morgan's estimate, that would provide four shafts a year. Will this be enough to find a permanent resting place for nuclear waste by 1998? No one knows the answer.

In the meantime, officials of the nuclear industry are raising questions. Speaking of the DOE's efforts to find a nuclear-waste dump, Edwin Wiggin of the Atomic Industrial Forum asks: "Is the money being well-spent?" He further expresses the view that delays are being caused by researching a problem "to death." And he worries about problems created by "political and social matters."

There is no question that politicians are playing an important role in the development of the nuclear-waste program. And social concerns, such as those of the citizens of the Texas Panhandle, who worry about radioactive contamination of well water, will also influence where and when nuclear-waste dumps will be found. Citizens politicians, and industry officials all wonder where the money should come from to finance the search—from industry, from government, or from the people via taxes? But one thing no one wonders about, although they may worry about it, is that a place to lock away nuclear wastes must be found, and soon!

FURTHER STUDY

1. Where are the three western sites chosen as possible nuclear-waste depositories? What kind of material underlies each? What are the pros and cons of each material as it relates to the permanent disposal of nuclear wastes?

2. Write a research paper on waste products of nuclear reactions as they relate to nuclear-power plants. Identify the starting and decay products, their quantities, nature of radiation emitted, and half-lives. Include a discussion of how these wastes are now stored.

3. Discuss the positions of citizens, office holders, environmentalists, and representatives of industry as they relate to the choice of locations for nuclear-waste sites. Use one of the sites designated by the DOE (Texas, Washington, Nevada) as an example.

FURTHER READING

Peterson, I. "Standby Storage for Nuclear Waste." *Science News*, May 4, 1985, p. 277.

Peterson, I. "Finding a Resting Place for Radwaste." *Science News*, January 5, 1985, p. 6.

Peterson, I. "Radwaste Program: A Delay in Plans." *Science News*, January 7, 1984, p. 5.

Peterson, I. "Keeping Radwaste Out of Sight." *Science News*, January 2, 1982, pp. 9-11, 15.

"Ruling on Nuclear Waste." *Science News*, August 24, 1985, p. 119.