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Media Spectacles

Marjorie Garber, John Morko, and Rebecca L. Walkowitz, editors

Secret Agents

The Rosenberg Case,
McCarthyism, and
Fifties America

Edited by
Marjorie Garber
and
Rebecca L. Walkowitz

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18. See for example, Arthur D. Little, *The Relations of Research to Industrial Development* (Boston, 1913), 33. Conway, "Solomon of Pure Science to Industry and Research," *Science*, 44 (1915): 511–19. Little, who taught at MIT near the turn of the century, was the founder of the Arthur D. Little Company. Conway was the chief engineer of the Western Electric Company laboratories and, as such, was the director of one of the precursors to the Bell Telephone Laboratories. See Stanley Goldberg, "American Attitudes toward Basic Research and the Rise of the Industrial Research Laboratory" (forthcoming).

19. In recent years the issues surrounding the justification of scientific research have been further muddled by the military's enthusiastic support of abstract scientific work immediately following World War II, support that was sustained, during the period we refer to as the "Cold War." It should be pointed out that such support assured the military of access to some very clever people. At the same time, scientists were known to brag among themselves about their cleverness in writing research proposals that gave the appearance of providing practical applications to potential military funders but that in reality provided a cover for allowing the scientists to pursue their own interest in "pure," abstract science. See, e.g., Paul Forman, "Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940–1960," *Historical Studies in Physical and Biological Science* 18 (1987): 149–229.

The ultimate rationale for public or private support of scientific work has to be the same as the rationale for support of artistic or humanistic work: It is one of the things that separates us from other species. We are driven to pursue such questions. We cannot turn those drives off. They are defining features of humanity and of civilization.

Censorship of American Uranium Mine Epidemiology in the 1950s

Robert N. Practor

Danger is foremost in our minds when we think of atomic radiation

—Heinz Hobe, *The Walt Disney Story of Our Friend the Atom*

A great deal of attention has focused on the radiation experiments that the U.S. Army, the Atomic Energy Commission, the Public Health Service, and other branches of government conducted on unsuspecting American citizens in the 1940s. The timing of the revelations is, as one might imagine, politically much to do with the appointment of a new Department of Energy secretary, Hazel O'Leary, who has promised an open book at this darker side of history. Much also has to do with the end of the Cold War: it is perhaps not entirely accidental that the most celebrated revelations coincided with the joint decision, in December 1993, of the governments of Russia and the United States no longer to point their missiles at one another. There is also the levity of distance: the same forces that have allowed a younger generation of German scholars to explore the Nazi past now allow a younger generation of historian-critics to unearth this seamy side of American history.¹

I have recently published a book on what causes cancer—what cancer has to do with not just bad habits but also bad business, bad government, and even bad science. Radiation occupies a special place in the history of the human body. Radiation causes cancer, though how and to what extent have been controversial since radiation cancers were first observed in the early

years of this century. The adventurous use of X-rays produced some of the first such cancers,² and the tragic outcome of the 1920s radium craze³ alerted a formerly guileless public to the danger—especially after hundreds of radium dial painters contracted cancer of the jaw from ingesting radioactive paint.⁴ The Manhattan Project vastly increased the scale of nuclear exposures, and the postwar nuclear boom allowed cancers to be planted in the lungs of thousands of uranium miners and millers.

The story I want to tell here, however, is about deception. The politics of knowledge often lies in the structure of our ignorance: not just who knows what, why, when, and where, but also who keeps quiet about—or fails to investigate—this, that, or another thing. Ignorance, like knowledge, is a manufactured product: it is important to ask why “we” know certain things, and don’t know others. In the 1950s, McCarthyites argued that the secrets of the atom bomb had fallen into enemy hands, with the help of domestic traitorous agents such as Ethel and Julius Rosenberg. As it turns out, there were other nuclear secrets governments were eager to protect—deadly secrets concerning the magnitude of the hazards of nuclear-related work, especially uranium mining.

EARLY EPIDEMIOLOGY

It is important to realize that uranium mining is unlike most other kinds of mining in that during the course of blasting and digging for ore, radioactive radon-222 gas is released. Radon-222 is a natural decay product of uranium, with a half-life of about three and one-half days. Radon gas by itself poses no real danger: as a noble gas, it is chemically inert and is simply exhaled. But its radioactive “daughter products”⁵ can settle in the lungs and injure those tissues. The primary hazard comes from polonium-218 and 214, alpha-emitting radionuclides that lodge in the lining of the lung. Uranium miners are also bombarded by gamma radiation, but the primary danger, again, stems from the ingestion and inhalation of alpha emitters. Smoking in combination with uranium mining can prove especially dangerous. Geno Saccamano, a resident of Grand Junction, Colorado, and an internationally known pathologist, showed in the 1960s that uranium mining in combination with cigarette smoking could increase one’s odds of getting lung cancer by as much as thirty times. More recent studies have shown that nonsmokers are also at risk: Robert J. Roscoe of the National Institute for Occupational Safety and Health has shown that nonsmoking uranium miners followed from 1950 to 1984 were thirteen times more likely to die from lung cancer than a comparable group of nonsmoking U.S. veterans.⁶

Knowledge of the health hazards of uranium mining, however, dates back to long before the time that Americans became involved in the enterprise.

Indeed, the hazards were appreciated prior even to the discovery of X-rays, primarily through epidemiological studies of the silver and uranium mines in the *Erzgebirge* (ore mountains) of Germany and northern Czechoslovakia, near the towns of Schneeberg in Saxony and Joachimsthal in Bohemia. These mines had been worked since the sixteenth century, first as a source of silver (the word “dollar” is derived from *thaler*, a shortened form of *Joachimsthaler*, a coin made from the very pure silver of this region) and later as a source of nickel, cobalt, bismuth, uranium and arsenic. Miners from this region had long been known to suffer from a painful and “consumptive” lung disease locally known as *Bergknarkheit* (mountain sickness),⁷ correctly identified by E. H. Härtig and W. Hesse in 1879 as lung cancer. Härtig and Hesse found that miners lived only about twenty years after entering the mines and that about three-quarters of all miners in this region were dying from lung cancer. This latter figure would be even higher, they suggested, were miners not also dying prematurely from other causes, such as accidents.⁸

For most of the nineteenth century the uranium miners’ *Bergknarkheit* was most commonly attributed to foul air, “consumption,” or “miner’s phthisis” (probably silicosis or silico-tuberculosis). The ailment was correctly diagnosed as cancer in the 1870s, but it was not until the 1920s that the specific cause was identified as the inhalation of radioactive gases. Even after the disease was recognized as cancer, scientific belief commonly blamed the inhalation of arsenic (Härtig and Hesse’s view), fungal spores on wooden mine supports, or “genetic predispositions” fostered by inbreeding in these remote mountain regions.⁹ The first measurements of radioactivity in the air at the Schneeberg mines were published in 1924 in one of Germany’s leading popular journals by P. Ludewig and S. Lorenser.¹⁰ Subsequent studies confirmed that the radioactivity in any given mine could vary by several orders of magnitude but was generally highest, as one would expect, near the drill holes where new ores were ripped from the rock face. According to one calculation, workers were inhaling an average of 12.4 mg of radium per year, an extremely toxic dose. Wilhelm Hueper, author of the pathbreaking *Occupational Tumors and Allied Diseases*, pointed out in 1942 that mine workers had long been aware that certain shafts were more hazardous than others: the shift found to have the highest radioactivity, for example, was popularly known as the *Todesscharbt*, or “death mine.”¹¹ Ludewig and Lorenser’s 1924 survey had found between two thousand and nine thousand ergs/cm² per liter in this mine; this was convincing evidence, in their view, that radon inhalation was the primary cause of the miners’ cancer.

THE AMERICAN EXPERIENCE

In the United States, concern about the health effects of exposure to radon

emerged largely after World War II in response to the rapid growth of the U.S. military's demand for uranium. U.S. bomb production, driven at a frenetic pace by Cold War fears and military-industrial enthusiasm, required the extraction of huge quantities of ore,¹² all of which—by law—had to be sold to the Atomic Energy Commission (AEC). Ores were eventually found throughout the world, but the most important U.S. source for many years was the arid "four-corner" region best known as the Colorado Plateau stretching across Utah, Colorado, New Mexico, and Arizona. Skyrocketing demand set off a uranium rush, though smaller investors were soon driven out by larger companies, and by the end of the 1950s five or six large corporations—notably Kerr-McGee, Union Carbide, Anaconda, United Nuclear, and Homestake Mining—dominated the industry. After the Arab oil embargo of 1973 oil companies joined in the search for uranium, including Exxon, Gulf, Mobil, Conoco, Getty Oil, Atlantic Richfield, and Standard Oil of Ohio. In 1966 there were six hundred uranium mines in the United States (all on the Colorado Plateau) employing twenty-five thousand miners, 90 percent of whom worked underground.¹³ Many of these were Navajos, the long-standing native residents of this part of the world.

Given the European experience, the emergence of a radon hazard in U.S. uranium mines should not have been difficult to predict. Gaseous emissions from radium had been recognized as a potential health hazard since early in the century, and by the end of the 1930s efforts had already been made to establish a "tolerance concentration" for inhaled radon.¹⁴ Wilhelm Hueper in 1942 presented an elaborate historical review of the discovery of the radon-lung cancer link in European mines along with a convincing refutation of efforts to attribute the disease to other factors, like inbreeding.¹⁵ A 1944 review by Egon Lorenz for the *Journal of the National Cancer Institute* concluded that "the radioactivity of the ore and the radon content of the air in the mines are generally considered to be the primary cause" of the European *Berghknankheit*.¹⁶ In 1947 an expert on occupational cancer predicted that "one will see cases of cancer and of leukemia in our newest group of industrialists, workers in the field of fissionable materials."¹⁷

Knowledge, however, does not necessarily result in action. In the late 1940s, several scientists tried to alert the federal government of the uranium mining hazard, but without success. Bernard Wolf and Merrill Eisenbud, the first and second directors of the AEC's Medical Division, traveled to Colorado in April of 1948 to inspect the mines and recommend protections for the workers but were rebuffed when they tried to alert their superiors to the problem: "Much to our surprise, we were told by Washington that the health problems of the mines were not the responsibility of the AEC, and that there should be left to the discretion of the local authorities." The AEC had been

assigned by Congress the responsibility for radiation safety in the nuclear program but, according to a bizarre interpretation of the 1946 Atomic Energy Act, the commission was bound only to regulate radiation exposures after the ore had been mined. Responsibility for the health and safety of uranium miners was left up to individual states, a situation that Merrill Eisenbud rightly recognized as "absurd," given their lack of equipment and expertise to deal with the expected health problems.¹⁸

This was not a good time to cross the AEC on matters of radiation safety. The radiologist William E. Bale in 1949, for example, was ignored by the AEC when he presented evidence that U.S. miners were being exposed to levels of radioactivity high enough to cause lung cancer. H.J. Muller, the Nobel laureate celebrated as both the "founder of radiation genetics" and (later) the first president of the American Society of Human Genetics, was barred from speaking at the International Conference on the Peaceful Uses of Atomic Energy at Geneva in 1955. Muller had been involved in publicizing the threat posed by radiation to the genetic integrity of the species and for that reason was feared by the commission, which twisted his ideas and sought to present a more benign view of the health effects of radiation.¹⁹

The most dramatic case of censorship, however, is that of Wilhelm C. Hueper, founding director of the National Cancer Institute's Environmental Cancer Section (1948–64). Hueper had begun an investigation of the health of uranium miners in the spring of 1948, only to see his research blocked when the AEC heard about his plans to publicize the work. The case is interesting, so if the reader will indulge me, I shall go into some detail.

Paul Starr's well-known book *The Social Transformation of American Medicine* states that American scientists in the early postwar years "enjoyed autonomy within the constraints of professional competition." This was indeed the position of officials in charge of the NIH Division of Research Grants, Hueper's superior, who in 1951 wrote: "The investigator works on problems of his own choosing and is not obliged to adhere to a pre-conceived plan. He is free to publish as he sees fit and to change his research without explanation if he finds new and more promising leads. He has almost complete budget freedom as long as he uses the funds for research purposes and expends them in accordance with local institutional rules."²⁰ Hueper's own experience shows, though, that political pressures were not entirely foreign to the setting. The German émigré and former Du Pont employee had already sunk many careers for his efforts to track down industrial carcinogens: shortly after joining the NCI in 1948, for example, he had received a letter from the Federal Loyalty Commission informing him that he was under investigation for disloyalty to the United States. Du Pont's medical director had accused him as a Nazi, a trumped-up charge that was dismissed when

Hueper was able to show that it had come from a colleague jealous of the acclaim he had won for his work on occupational bladder cancer. Hueper was later accused of harboring "communistic tendencies," though this, too, was shown to have no more substance than the Nazi charge.

In April of 1948 Hueper had begun a project to study the health of uranium miners, well aware of the fact that European uranium miners had long suffered from very high rates of lung cancer. His efforts in this area were stymied, however, by the fact that all NIH papers dealing with radiation had to be cleared by the Atomic Energy Commission. When Hueper sought to present evidence of the threat at a 1952 meeting of the Colorado State Medical Society, the AEC's Director of Biology and Medicine, Shields Warren, ordered the head of the NCI to instruct Hueper to delete all references in his paper to the hazards of uranium mining. Hueper initially refused on the grounds that he had not joined the institute to become a "scientific liar"; pressed with the demand, though, he felt he had no alternative but to withdraw from the conference. He did send a copy of his paper to the society's president, explaining his decision. When word got around that he was not silently accepting his censorship, Warren again wrote the director of the NCI, this time asking for Hueper's dismissal. Hueper stayed on at the institute but was soon thereafter barred from all epidemiological work on occupational cancer. The order came from the surgeon general. Hueper was henceforth allowed to do only experimental work on animals, and was prohibited from further investigations into "the causation of cancer in man related to environmental exposure to carcinogenic chemical, physical, and parasitic agents."²¹ As Victor Archer recalls the incident, Hueper was essentially barred from research travel west of the Mississippi.²² Hueper later complained that government censorship of studies on the health effects of uranium mining had delayed measures to remedy the situation, leaving countless men to die who otherwise could have been saved. It would be ten years before a comprehensive report identified lung cancer as a hazard for this occupation, and this only after the governor of the state of Colorado had urged its writing.²³

The U.S. Public Health Service (PHS) began to study the environmental hazards of the mines and the health of underground miners in 1949 and 1950, but this agency, too, was hamstrung by apathy, bureaucratic conservatism, and government censorship. In the early 1950s the service launched an educational program to inform mining companies and state agencies of the health risks posed by uranium mining but—incredibly—the miners themselves were never informed of the hazard.²⁴ The service recommended improved ventilation and the wearing of masks, though none of these recommendations is mandatory, and the effect was a development of little consequence. In

the summer of 1952 a PHS team measured radon levels in 157 mines in Colorado, Utah, Arizona, and New Mexico and found median concentrations ranging from 8 pCi/l (at Eastern Slope) to 9,000 pCi/l (at Bull Canyon). The highest levels recorded were at Bull Canyon and Marysville, where peak readings of 59,000 pCi/l and 48,700 pCi/l were obtained.²⁵ In 1957 the service proposed a standard of one "working level" (WL)—equivalent to 100 picocuries of radon daughters per liter of air—as the maximum safe level of radioactivity in a working mine; by its own admission, 64 percent of all workers were exposed to levels at least ten times this high, levels that were predicted to cause lung cancers.²⁶ As late as 1961, nearly a third of all U.S. uranium miners were still breathing more than 1,000 pCi/l at work.²⁷

Victor Archer and three of his colleagues at the Public Health Service published the first major study of U.S. uranium miner epidemiology in 1962. The miners had now been followed for over a decade, and the first excess cancers were beginning to appear. Accidents and heart disease were still the primary hazards, but five of 907 miners with more than three years experience underground had already died from lung cancer, when only one such death was expected.²⁸ These preliminary results were confirmed a year later, when an updated analysis of the PHS data showed that uranium mine workers were more than five times as likely to die from respiratory cancer than the normal population, and that men who had been exposed to the highest levels of radiation showed lung cancer rates up to forty times higher than expected. These and subsequent studies confirmed what had been known to European physicians for the better part of a century—that improperly ventilated uranium mining causes cancer.²⁹

THE "DEAD BODY APPROACH"

It is sometimes said that firm proof of a radiation hazard in U.S. mines emerged only in the 1960s,³⁰ and it is true that published reports of American cancer deaths did not appear until this time. But, as we have seen, good evidence that such deaths would occur was available much earlier and was ignored or even suppressed by the Public Health Service acting on orders of the Atomic Energy Commission. European journals were filled with warnings, and Americans familiar with this literature had amply warned the agencies who should have acted to lessen the exposures. The Public Health Service Report of 1957 called for "the immediate application of corrective measures,"³¹ and half a dozen scientists had warned—since the late 1940s—of an impending public health disaster.³² But nuclear authorities were reluctant to push for anything that might impede the flow of uranium from mines to tanks to weapons. Duncan A. Holliday, the PHS's health physicist responsible for monitoring the radiation in U.S. uranium mines, became frustrated. He

the failure of the AEC to warn the miners or to force the industry to clean up its act: in 1953 he complained that "the only way we can ever get anything done is to collect [dead] bodies and lay them on somebody's doorstep." Victor Archer, the epidemiologist who from 1956 to 1968 supervised the PHS's study of cancer among the uranium miners, used similar language to express his own frustration. In the mid-1970s, as the trial of former Navajo miners and their families suing the federal government for compensation, Archer testified that he and his colleagues had caved in to AEC and PHS pressures not to publicize the hazard: "We did not want to rock the boat... [W]e had to take the position that we were neutral scientists trying to find out what the facts were, that we were not going to make any public announcements until the results of our scientific study were completed."³³ Official pressures to "monitor" the disaster without informing those at risk or forcing the companies to reduce the hazard led PHS scientists to characterize their study as a "death watch" or "dead body approach." A federal judge involved in the Navajo case charged that U.S. atomic authorities had failed to warn the miners in order to guarantee "a constant, uninterrupted and reliable flow" of uranium ore "for national security purposes."³⁴

Local physicians were certainly not unaware that something was amiss. Lung cancer had always been rare among the Navajos as it still is, relatively speaking, today. By the mid-1950s physicians on the plateau began to see increasing numbers of Navajos with the disease: "It got so I didn't need to wait for the tests. They would come in—the wife and the six kids were always there, too—and they would say they had been spitting blood. I would ask and they would answer that they had been in the mines. Then I didn't need to wait to make the diagnosis, really, I already knew." Of course, not everyone knew, or wanted to admit they knew: as late as 1979, Kerr-McGee spokesmen were still denying that Navajos who had worked in the mines had contracted cancer from their work.³⁵

The Atomic Energy Commission and Public Health Service were not the only agencies unwilling or unable to tackle the problem. The Bureau of Mines had long regulated health and safety standards in the nation's coal mines, but it was not until 1966 that it was authorized to regulate health and safety in uranium mines. The Labor Department was equally negligent, despite the powers granted its secretary under the Walsh-Healey Act of the 1930s to stop government purchases from hazardous mines. During the years of federal neglect, responsibility for monitoring and regulating the radiation hazard in mines was left up to individual states. Utah state officials in 1949 tried to have one company, Vanadium, install ventilation equipment, but without success.³⁶ Colorado was the only state to recognize radon-induced lung cancer as a compensable disease—an acknowledgment by the state in

the mid-1960s calculated that by 1985, 1,350 cases of lung cancer would have arisen from radiation exposure in the mines. These figures assumed, rather optimistically, that exposures would cease after 1966.

Federal action finally came on May 5, 1967, when President Johnson's secretary of labor, W. Willard Wirtz, announced that the U.S. government would purchase no more uranium from mines in which there was more than 0.3 WL of radiation. Wirtz's decision immediately ran afoul of the government's Joint Committee on Atomic Energy, a Senate body charged with both supervision and promotion of the nuclear industry—a relationship labor union critics characterized as "the fox guarding the henhouse." The committee, siding with the AEC, made it clear it wanted to retain the Public Health Service's standard of 1.0 WL. At hearings before the Joint Committee on Atomic Energy, Paul C. Tomkins, executive director of the Federal Radiation Council, testified that the labor secretary's recommendation of 0.3 WL "could do nothing but close up the [nuclear] industry." A Kerr-McGee physician testified that miners could sustain up to three working levels of radiation without harm. Wirtz was ultimately forced to accept the AEC/PHS standard; critics of the sequence of events observed that miners, the weakest of all the participants in the drama, would have to continue "their deadly life affair with the daughters of radon."³⁷

It is strange that miners were treated so shabbily by government health, labor, and atomic authorities. An indoor occupational radon standard of ten picocuries per liter had been established by the National Bureau of Standards in 1941; the National Council on Radiation Protection in 1953 recommended that this same standard be extended to mines.³⁸ The International Council on Radiation Protection adopted the PHS's standard of one hundred picocuries per liter (equal to one working level) in 1959, but a subsequent survey showed that the average for U.S. uranium mines remained as high as 2.0 WL in 1966 (down from about 7.0 WL in 1957). In 1971 the newly created Environmental Protection Agency reduced the maximum allowable level of indoor radon to one-third of a working level, or four working-level months (WLMs) per year. Exposures at the mines dropped significantly, but in 1975, a monitoring blitz by the Mine Safety and Health Administration (MSHA) found that miners were still being exposed to 4.6 WLMs per year on average, slightly above the EPA limit and several times higher than what was being claimed by the companies. Risk assessments later showed that even the EPA standard of 4.0 WLM/year more than doubled one's risk of lung cancer after thirty years of exposure.³⁹

Costumetries continue to ebb and flow over the precise shape of the dose-response curve, but no one doubts that miners are still dying. By 1978, 226 of the thirty-four hundred white miners followed by the Public Health Service

since the early 1960s had died of lung cancer; by 1990 this number had grown to nearly twice that figure. Given that thirty to forty thousand men have worked in the U.S. uranium mines since the 1940s, it is probable that four or five thousand Americans have died, or will eventually die, from lung cancer caused by that line of work. Hundreds of others have had a lung removed or been otherwise debilitated.⁴⁰

CRIME AND PUNISHMENT

Why were systematic efforts to monitor the hazard not even set up until the 1960s? Why, even after this time, were miners allowed to suffer ten to thirty times the legal levels? Why were the miners never warned? Many of these mines were on Navajo lands and many miners were Native Americans; some have suggested that racism may have played a role in the failure to establish effective standards early on. The fact that the thirty-four hundred miners originally studied by the PHS were all white lends credence to such a theory, as does the fact that Navajo miners were not studied until the 1960s.⁴¹ Fear of losing a reliable labor source, though, was probably also a factor. In 1985, in a case brought by non-Indian miners against the federal government, Judge Aidon Anderson of the U.S. district court in Utah ruled that the AEC failed to warn uranium miners out of a misguided sense of national security: "The AEC feared that informed miners would flee the mines and thereby threaten the nation's uranium supply."⁴²

The problem, in other words, was not simply one of ignorance. Duncan A. Holaday, a Public Health Service scientist who warned federal officials about the danger early on, has testified that "by the late 1940s, there was no question in anybody's mind that radiation in the mines was a real problem.... But nobody in the Atomic Energy Commission wanted to pay attention." Holaday calculated in 1954 that mine operators could install ventilation equipment at a cost of only five or six cents per pound of processed uranium—a cost that easily could have been passed on to the AEC. (The AEC bought more than three million pounds of the metal that year at about twelve dollars per pound.) Holaday's advice was ignored by the AEC and mine operators, however, on the grounds that ventilating the mines was "unnecessary and too expensive."⁴³ The AEC and the commercial nuclear establishment wanted uranium on the cheap. Security was given a much higher value than safety, and the end result was the loss of workers' lives. Wayne Owens (D-Utah), one of the congressional sponsors of the 1991 Radiation Exposure Compensation Act (and whose own brother-in-law died from lung cancer caused by uranium mining) has put the matter rather simply: "These people were used as pawns pawns in the life-and-death struggle with 'youth as consumers'"⁴⁴

Efforts to obtain compensation for the injured miners or their families have been made since the 1970s. Compensation, though, has been slow in coming—when it has come at all. (Ironically, compensation has been easier to obtain in certain former East bloc countries—such as Czechoslovakia—where uranium mining abuses were far more severe than in the United States.)⁴⁵ In 1991, after decades of unsuccessful efforts to obtain federal compensation for injured miners, Congress finally passed the Radiation Exposure Compensation Act, setting up a \$30 million trust fund to compensate uranium miners along with other victims of radiation exposure—notably "downwinders" of southern Utah, participants in nuclear tests, and certain workers at atomic plants. The text of the act included a formal apology: "The Congress apologizes on behalf of the Nation to the individuals...and their families for the hardships they have endured."⁴⁶ Congress in 1991 and 1992 voted to increase the total fund to \$200 million. Miners who suffered from lung cancer are now, theoretically, entitled to \$100,000 compensation from the fund. Families may be compensated if the victim is no longer living. Bureaucratic red tape has thus far made it difficult, however, to obtain compensation. The forms one must fill out are daunting, running to more than one hundred pages. Written proof must be provided that one was exposed and got cancer from that exposure. Only lung cancers are compensable, and smokers must prove that their exposure was "excessive." Most of those who worked in the so-called dog holes (very small mines with little or no ventilation) have no way of proving they worked in such places, and medical records may be even harder to come by. The Indian Health Service, to whom many Navajo miners turned for treatment, generally destroyed records after twenty-five years, and elderly widows of victims may not even have written evidence of their marriage. As a result of these and other problems, it has been difficult for families to obtain compensation. By mid-1992 only half a dozen claims had been successfully paid out, though the rate has increased since then. By May of 1993 compensation claims had been approved for 328 miners and 348 Nevada Test Site participants. Many claims have been denied, and many more are pending.

Money has finally begun to trickle into the communities where lung cancers were bred, but the process has been slow. Stewart L. Udall, the former uranium secretary who has served as a lawyer for many victims, recently characterized the administration of the process as "a bureaucratic legal maze designed to prevent compensation to Navajo miners. There's no pity for what happened to these people. No understanding. You have a compassionate program administered in an utterly uncompassionate manner." Jon John, a Navajo man who lost his father to lung cancer in 1973 when his father was only thirty-four, put the matter bluntly: "It's a bad thing that happened here.

It's a bad thing for anybody to do. It destroyed lives. It took the beauty away from this mountain."⁴⁷

CODA

In February 1950 FBI agents questioned David Greenglass about the disappearance of some uranium from Los Alamos when he was stationed there. Greenglass later admitted that he had taken a piece of uranium as a souvenir but had thrown it into the East River when he became frightened of discovery. On June 15, 1950, two FBI agents came to his apartment and renewed their questioning. At some point in the twelve-hour period during which they spoke, emphasis apparently shifted from the stolen uranium to a supposed visit by Harry Gold and, ultimately, to the suggestion that David's sister Ethel and her husband Julius Rosenberg were guilty of passing on bomb secrets to the Russians.⁴⁸

Nowhere in the trial record does the theft of the uranium appear, even though it arguably gave David Greenglass a motive for incriminating another person instead of himself in the business of espionage. Greenglass's brother Bernard signed an affidavit attesting to the stolen uranium on May 31, 1953, a document contained in the record of the Rosenbergs' final appeal.⁴⁹ Clearly, more than one kind of censorship, and more than one kind of health hazard, attached to close contact with uranium in the decade of the fifties.

NOTES

A more extensive discussion of uranium mine epidemiology can be found in my book, *Cancer Wars: How Politics Shapes What We Know and Don't Know About Cancer* (New York: Basic Books, 1995), from which parts of the present essay have been taken.

- 1 Eileen Welsome, "The Plutonium Experiment," *Albuquerque Tribune*, Nov. 15-17, 1993; Geoffrey See, "The Radiation Story No One Would Touch," *Columbia Journalism Review*, Mar./Apr. 1994, 37-40.
- 2 The first German report of a radiation-induced cancer concerned a 33-year-old worker at a roentgen tube manufacturing plant; see Albert Fritsch, "Carcinoid des rechten Handgelenks," *Deutsche medizinische Wochenschrift*, *Verlags-Berlage* 28 (1902): 435. His arm was amputated at the shoulder in 1902, and he died from a recurrence of the disease in 1906. In the United States, Clarence Dally, Thomas A. Edison's assistant, became the first American known to have died from exposure to X-rays. He had developed cancer in his arm and hand, both of which were amputated shortly before his death in 1904 (he also reported X-ray burns to his face and the blanching of his skin, but did not describe what

he say it off had done"). See Catherine Caulfield, *Multiple Exposures: Chronicles of the Radiation Age* (New York: Harper, 1989), 13. In 1911 two German reviews documented fifty-four separate cases of radiation-caused cancers (mostly among physicians and their assistants), and a French review three years later listed more than a hundred cases. See Otto Hase, *Symptomologie, Pathogenese und Therapie des Röntgenkarzinoms* (Leipzig, J. A. Barth, 1911); Paul Krause, "Zur Kenntnis der Schädigung der menschlichen Haut durch Röntgenkunde und Radiumforschung," *Zeitschrift für Röntgenkunde und Radiumforschung* 13 (1911): 236-64; Sophie Feyrin, *De cancer radiologique* (Paris, 1914).

- 3 An expensive radium tonic sold under the brand name "Radiothor" was marketed in the 1920s; a well-known Pittsburgh industrialist, Eben Byers, drank a bottle a day from 1926 until 1931, when he contracted cancer of the jaw. His death in 1932 took much of the wind out of the radium-cure sails, though treatments of this sort continued on a smaller scale into the post-World War II era and, to a limited extent, even today. In certain Montana mines, for example, you can still breathe radon gas as an arthritis "therapy"; radon therapy also remains very popular in certain resort areas of the former Soviet Union. The Pyatigorsk Superior Radon Center in Georgia still prepares radon drinks, baths, enemas, and vaginal and nasal irrigations for more than one thousand patients per day. See David J. Brenner, *Radon, Risk and Remedy* (New York: W. H. Freeman, 1989), 76.
- 4 Angela Nugent, "The Power to Define a New Disease: Epidemiological Politics and Radium Poisoning," in *Dying for Work*, ed. David Rosner and Gerald Markowitz (Bloomington: Indiana University Press, 1986), 177-91; William D. Sharpe, "The New Jersey Radium Dial Painters: A Classic in Occupational Carcinogenesis," *Bulletin of the History of Medicine* 52 (1979): 560-70.
- 5 The equating of females and sexual danger in the 1950s is exposed in Elaine May, *Homeward Bound: American Families in the Cold War Era* (New York: Basic Books, 1988). For a critique of the use of the term "radon daughters" by "macho photon-jocks" see K. J. Kearfoot, "Health Physics Language and Professionalism," *Health Physics* 66 (1994): 235-36.
- 6 Robert J. Roscoe et al., "Lung Cancer Mortality among Nonsmoking Uranium Miners Exposed to Radon Daughters," *JAMA* 262 (1989): 629-33.
- 7 Georgius Agricola was a physician in Joachimsthal from 1527 to 1533; his famous *De Re Metallica* (1556) described the health effects of silver mining in that region, where miners inhaled a corrosive dust that "eats away the lungs, and implants consumption in the body; hence in the mines of the Carpathian mountains women are found who have married seven husbands, all of whom this terrible consumption has carried off to a premature death" (trans. H. C. Bone and E. C. Bone in [London: Dover, 1912], 264).

- 8 C.H. Harting and W. Hesse, "Der Lungenkrebs, die Bergkrankheit in den Schneeberger Gruben," *Vierteljahrsschrift für gerichtliche Medizin* 30 (1879): 302, and 31 (1879): 129-12, 325. Lung cancer was recognized as a compensable occupational disease for miners in 1926 in Schneeberg (Germany) and in 1932 in Joachimsthal (Czechoslovakia). See Wilhelm C. Hueper, *Occupational Tumors and Allied Diseases* (Springfield, Ill.: Charles C. Thomas, 1942), 435-59.
- 9 On the inbreeding hypothesis, see M.-S. Vesin, "Cancer pulmonaire provoqué par les émanations radioactives," *Archives des maladies professionnelles* 9 (1948): 285-83; M.T. Macklin and C.C. Macklin, "Does Chronic Irritation Cause Primary Tumor of the Human Lung?" *Archives of Pathology* 30 (1946): 924-55; Egon Lorenz, "Radioactivity and Lung Cancer: A Critical Review of Lung Cancer in the Miners of Schneeberg and Joachimsthal," *Journal of the National Cancer Institute* 5 (1944): 13.
- 10 R. Ludewig and S. Lorenser, "Untersuchung der Grubenluft in den Schneeberger Gruben auf den Gehalt an Radiumemanation," *Zeitschrift für Physik* 22 (1924): 178-85.
- 11 Hueper, *Occupational Tumors*, 441.
- 12 Uranium-235 is the fissile isotope required for bomb production; extraction of U-235 from the more common U-238 requires a formidable separation process involving industrial facilities of unprecedented size and expense. The Piketon uranium enrichment facility north of Portsmouth, Ohio, for example, at one mile long and more than ten stories tall, is still today the largest building in the world. In the early 1980s, its enormous magnets, used to accelerate ionized uranium ions, to separate the lighter and more fissile U-235, consumed about one percent of all U.S. electricity—roughly the amount consumed by the entire city of Los Angeles. Two other enrichment facilities—the "Y-12" facility at Oak Ridge, Tennessee, and the facility at Paducah, Kentucky—were of comparable dimensions. See Geoffrey Bernstein's extraordinary "Cascade: Worker Resistance at the Portsmouth Uranium Plant," senior thesis, Harvard University, 1981.
- 13 Milton Viorst and J.V. Reistrup, "Radon Daughters and the Federal Government," *Bulletin of the Atomic Scientists*, Oct. 1967, 25-29.
- 14 E. S. London, "Über die physiologischen Wirkungen der Emanation des Radiums," *Zeitschrift für Physiologie* 18 (1924): 185-88; John Read and J.C. Mottram, "The 'Tolerant Concentration' of Radon in the Atmosphere," *British Journal of Radiology* 12 (1939): 54-60.
- 15 Hueper, *Occupational Tumors*, 435-59.
- 16 Lorenz, "Radioactivity and Lung Cancer," 3, 13.
- 17 Fred W. Stewart, "Occupational and Post-Traumatic Cancer," *Bulletin of the New York Academy of Medicine* 20 (1947): 146.
- 18 David Friedman, *An Unconquered Cancer* (Seattle: University of Washington Press, 1990), 60-62.
- 19 Elif A. Carinou, *Genes, Radiation, and Society* (Ithaca: Cornell University Press, 1981), 6, 356-67.
- 20 Paul Starr, *The Social Transformation of American Medicine* (New York: Basic Books, 1982), 340-44.
- 21 Wilhelm C. Hueper, "Adventures of a Physician in Occupational Cancer: A Medical Cassandra's Tale (1976), unpublished autobiography, Hueper papers, National Library of Medicine, 174-79 and 264-65.
- 22 Telephone interview with Victor E. Archer, April 10, 1992.
- 23 Hueper, "Adventures," 243-47.
- 24 Keith Schneider, "Uranium Miners Inherit Dispute's Sad Legacy," *New York Times*, January 3, 1992.
- 25 Duncan A. Holaday et al., *Control of Radon and Daughters in Uranium Mines and Calculations on Biologic Effects* (Washington, D.C.: U.S. Public Health Service, 1957), ix-x and 2-4.
- 26 Ibid. Holaday had first proposed a "working level" equal to 100 picocuries per liter in his *Interim Report: Health Study of the Uranium Mines and Mills* (Washington, D.C.: U.S. Public Health Service, 1952), coauthored with W. David and H.N. Doyle.
- 27 Duncan A. Holaday, "History of the Exposure of Miners to Radon," *Health Physics* 16 (1969): 547-52, esp. 551.
- 28 Victor E. Archer, Harold J. Magnuson, Duncan A. Holaday, and Pope A. Lawrence, "Hazards to Health in Uranium Mining and Milling," *Journal of Occupational Medicine* 4 (1962): 55-60. This paper dealt with deaths through 1959.
- 29 Joseph K. Waggoner et al., "Unusual Cancer Mortality among a Group of Underground Metal Miners," *New England Journal of Medicine* 269 (1963): 244-47; Victor E. Archer, Joseph K. Waggoner, and Frank E. Lundin, "Lung Cancer among Uranium Miners in the United States," *Health Physics* 25 (1973): 351-71.
- 30 An official history of U.S. radiation safety asserts that "it took eleven years in a single experiment to establish some of the really long-term effects of inhaled uranium"; see J. Newell Stanford, *Radioactivity and Health* (Springfield, VA: Charles C. Thomas, 1969), 409.
- 31 Holaday et al., *Control of Radon*, 4.
- 32 Holaday had concluded as early as 1951 that a human health tragedy was unfolding in consequence of the failure of the AEC and the mining companies to mechanically ventilate the mines. See Howard Ball, *Cancer Factories: America's Toxic Quest for Uranium Self-Sufficiency* (Westport, CT: Greenwood, 1994), 43-51.
- 33 Holaday is cited in Robert R. Englehardt, *Cancer from a Radon and Radium*

the Colorado Plateau (Albuquerque: University of New Mexico Press, 1989), 148; Archer is cited in Ball, *Cancer Factories*, 46 and 59-60. Ball's book is the best history of the efforts of uranium miners to obtain compensation for lung cancers caused by mining for the AEC.

- 34 Ball, *Cancer Factories*, 11-12, 49. See also the insightful legal analysis in George J. Annas, "The Nuremberg Code in U.S. Courts: Ethics vs. Expediency," in *The Nazi Doctors and the Nuremberg Code* (New York: Oxford University Press, 1992), ed. George J. Annas and Michael A. Grodin, 209-10.
- 35 Molly Ivins, "Uranium Mines in West Leave Deadly Legacy," *New York Times*, May 20, 1979; compare also Ringholz, *Uranium Frenzy*, 166-222.
- 36 Ball, *Cancer Factories*, 49.
- 37 Viost and Reistrup, "Radon Daughters," 26-27; Miller.
- 38 The Public Health Service in 1952 had proposed a temporary standard of 100 pCi/l, ten times higher than the 1941 NCRP figure. See Holaday, David, and Doyle, *Interim Report*.
- 39 Richard W. Hornung and Theodore J. Meinhardt, "Quantitative Risk Assessment of Lung Cancer in U.S. Uranium Miners," *Health Physics* 52 (1987): 417-30.
- 40 Caulfield, *Multiple Exposures*, 84-86; Schneider, "Uranium Miners."
- 41 Rosalie Bertell, *No Immediate Danger?* (London: Women's Press, 1983), 83-88; Ball, *Cancer Factories*, 50. Joseph Wagoner in 1979 suggested a possible racial bias in the government's dealings with Navajos: "In 1978, the government started notifying all shipyard workers and others who had been exposed to asbestos, but nothing like that has been done for the miners. Is it because they are Westerners with little power in their Congressional representation, because they are Indians so no one needs to care?" (Ivins, "Uranium Mines"). Native Americans in the early 1980s owned about half of the nation's privately owned uranium reserves; see Sandra E. Bergman, "Uranium Mining on Indian Lands," *Environment*, Sep. 1982, 6-35.
- 42 Ball, *Cancer Factories*, 12.
- 43 Schneider, "Uranium Miners."
- 44 Sandra D. Atchison, "These People Were Used as Guinea Pigs," *Business Week*, Oct. 15, 1990, 98. Compare also the statement of a Colorado health inspector concerning the 1950s that "anybody that said a thing against uranium mining was suspected of being a communist"; cited in Harvey Wasserman and Norman Solomon, *Killing Our Own: The Disaster of America's Experience with Atomic Radiation* (New York: Delacorte, 1982), 149.
- 45 In the Soviet Union and in other parts of Eastern Europe, prisoners were literally worked to death in mines, apparently as part of a deliberate plan to kill them. Outside North America, the biggest single producer of uranium in the world was the German Democratic Republic, where, from 1946 to the end of

- the 1980s half a million workers produced some two hundred thousand tons of enriched uranium for Soviet atomic bombs and reactors. The authority responsible for coordinating the East German effort was code-named *Wismut* (literally "bismuth") to disguise the fact that uranium was the primary object of interest. With its own Communist Party organization, hospitals, secret police, and propaganda apparatus, Wismut was, as a 1993 *Science* news feature put it, "an all-powerful state within a state," shrouded in secrecy. See Patricia Kahn, "A Grisly Archive of Key Cancer Data," *Science* 259 (1993): 448-51; "The Legacy of Schneeberg," *Nuclear Engineering*, Feb. 1991, 7; also Werner Schümann, "Deutsche Opfer für Moskaus Atombombe," *Der Tagesspiegel*, Jan. 13, 1991. A somewhere smaller program existed in Czechoslovakia, on the southern slopes of the *Erzgebirge*. Tens of thousands of political prisoners were forced to work in seventeen uranium "concentration camps" from the late 1940s through the early 1960s; epidemiological studies were conducted, but the State Security Police barred their publication. See my letter, "The Oberrothenbach Catastrophe," in *Science* 260 (1993): 1676-77. Czechoslovakian scientists in the 1970s published several reports on the hazards of uranium mining but never mentioned the fact that forced labor had been used.
- 46 U.S. Congress, Senate Committee on Labor and Human Resources, "Radiation Exposure Compensation Act," 101st Congress, 2d session (1990), 2. On the "dowwinders," see Howard Ball, *Justice Downwind: America's Atomic Testing Program in the 1950s* (New York: Oxford University Press, 1988); Carole Gallagher, *American Ground Zero: The Secret Nuclear War* (Cambridge, MA: MIT Press, 1993).
 - 47 Keith Schneider, "Valley of Death: Late Rewards for Navajo Miners," *New York Times*, May 3, 1993.
 - 48 Walter Schuir and Miriam Schneir, *Invitation to an Inquest: A New Look at the Rosenberg-Sobell Case*. (Garden City, NY: Doubleday, 1965), 359-61; John Wexley, *The Judgment of Julius and Ethel Rosenberg* (New York: Cameron and Kahu, 1955), 85.
 - 49 The confidential interoffice memos of the Greenglasses' attorney, O. John Rogge, did contain both a mention of the "sample of uranium" and the information that he had thrown it into the East River. But the details of this petty theft were omitted from the trial record. See Wexley, *Judgment*, 100.