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## Mineral Dusts and Radon in Uranium Mines

**T**he Environmental Protection Agency (EPA) continues to assert that radon is a major cause of lung cancer in this country. EPA is fostering a radon program that could entail huge financial and emotional costs while yielding negligible benefits to public health. Justification for the program was the occurrence of lung cancer in men exposed to huge amounts of radon, mineral dusts, and other lung irritants in uranium mines on the Colorado Plateau. Lung cancer has been reported in about 356 cigarette smokers and in about 25 nonsmokers.\*

The circumstances under which uranium miners were exposed is described in a book entitled *Uranium Frenzy* by Raye C. Ringholz.<sup>†</sup> I have confirmed and extended her comments through conversations with geologists, a public health officer (Howard Kusnetz), and others who were active on the Plateau during the 1950s.

After World War II and with the beginning of the Cold War, obtaining large-scale domestic supplies of uranium became urgent. By statute the Atomic Energy Commission was the sole purchaser, and it established a guaranteed price calculated to expedite large-scale exploration for and mining of uranium. A region of particular interest was the arid, sparsely settled Colorado Plateau. Uranium compounds often in association with lung irritant vanadium minerals and the carcinogen selenium sulfide occurred there in sandstones (about 90% SiO<sub>2</sub>). Amateurs carrying Geiger counters were soon finding and mining hundreds of prospects (ultimately more than 2000). Their goal was to maximize the amount of valuable ore while minimizing the removal of worthless wall rock. Thus, much of the mining was conducted in tiny openings so small that they were locally called “dog holes.” In many of the mines there was little or no ventilation. Thus, radon and its daughter products accumulated in the holes, together with excessive SiO<sub>2</sub> dust. Typically, the miners did not wear respirators. The men had a macho attitude, and respirators interfered with efficient work. About 72% of the miners were smokers. Nonsmokers with them could not avoid heavy passive smoking. From 1948 to 1960, inadequate ventilation was common even in large company-owned mines. Some improvements in conditions in the mines occurred during the 1960s, but it was only in 1968 that federal regulations dictated levels of radon that could be attained only by carefully designed ventilation.

During the era of high radon levels, monitoring was sporadic. Conditions in only a small fraction of the mines were measured, and that on a few separate occasions. Later, cumulative exposure to radon was calculated on the basis of measurements involving only a tiny fraction of the miners. Some were exposed to more than 15,000 pCi/liter of radon and its products. The level in the average home is about 1.5 pCi/liter. In making extrapolations from mine to home, the assumption is made that residents are in their dwellings most of the time and that miners spend only 170 hours a month in the mine. This assumption may be valid for miners working for wages, but not for dog-hole operators, whose income depended on the amounts of uranium mined.

Two major questionable assumptions are involved in extrapolations from high doses of radon in the mines to low doses in homes. One is that no threshold is involved; that is, that humans have no remediation mechanism for  $\alpha$  particle damages. There is evidence to the contrary. The most unrealistic assumption is that heavy exposure to silica has no effect on inducing lung cancer. Many studies have shown that silica dust causes lung cancer in animals. Exposure to silica dust produces silicosis and other pathologies. Exposure of human culture cells to silica has resulted in formation of neoplastic tissue. Two articles,<sup>‡,§</sup> provide evidence for a relation between silicosis and lung cancer and an enhanced effect of exposure to silica on incidence of lung cancer in cigarette smokers. EPA is on shaky ground when it attempts to frighten the public about radon using as a basis a large extrapolation of data obtained from mines laden with mineral dusts.

EPA has no solid evidence that exposures to 4 pCi/liter of radon causes lung cancer in either smokers or nonsmokers. Indeed, there is abundant evidence to the contrary in the fact that in states with high levels of radon, inhabitants have less lung cancer than those in states with low levels.—PHILIP H. ABELSON

\*G. Saccomanno, G. C. Huth, O. Auerbach, M. Kuschner, *Cancer* 62, 1402 (1988). †R. C. Ringholz, *Uranium Frenzy: Boom and Bust on the Colorado Plateau* (Norton, New York, 1989). ‡H. E. Amandus, C. Shy, S. Wing, A. Blair, E. F. Heineman, *Am. J. Ind. Med.* 20, 57 (1991). §H. Amandus and J. Costello, *Arch. Environ. Health* 46, 82 (1991).

## Mineral dusts and radon in uranium mines

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Uranium minerals are always associated with more radioactive elements such as radium and radon in the ore which arise from the radioactive decay of uranium over a few million of years. Therefore, although uranium itself is barely radioactive, the ore which is mined, especially if it is very high-grade such as in some Canadian mines, is handled with some care, for occupational health and safety reasons. Mining methods, tailings and run-off management and land rehabilitation are subject to Government regulation and inspection.Â In Australia all uranium mining and milling operations are undertaken under the Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing.