

difficult to mimic the mine environment in the lab, and lung cancers were not easily induced in experimental animals under any circumstances.

Interest in the question of what exactly was causing the *Schneeberger Krankheit* was renewed in 1933, when Schneeberg's mines were reopened in anticipation of a Nazi-inspired economic recovery. (Most had been closed in 1928 for economic reasons; the need for war-critical metals such as radium and tungsten boosted interest in the operations). Boris Rajewsky, director of Frankfurt's Institute for the Physical Foundations of Medicine and later an important health and safety officer in Germany's atom bomb project,* showed that radiation in the mines was often on the order of 10,000 pCi/l—an extraordinary level.⁸⁹ Erich Neitzel of Berlin, working for the Reich Labor Ministry, found similar results and concluded that long-term work in air containing even very low levels of radon could be dangerous. Neitzel was already aware that the primary danger came not so much from the gas itself, but

* Rajewsky in February of 1943 was awarded a grant from the Army Weapons Office (Heereswaffenamt) to investigate "the biological effects of corpuscular radiation, including neutrons, with regard to the possibility of their use as a weapon." The weapon in question was a conventional explosive surrounded by highly radioactive nuclear waste intended primarily for use against American civilian populations. The bomb was originally intended to be delivered as the payload in the two-stage A9/10 intercontinental rocket (the "New Yorker"), a gargantuan missile planned for launch from silos in France. With the suspension of the A9/10 in October of 1942, efforts were concentrated on delivery by smaller rockets launched from submarines. The radionuclides used for the bomb had to be chemically separated from nuclear reactor waste products, a hazardous procedure for which thousands of forced laborers from concentration camps were conscripted. In September of 1943, the Army Weapons Office forced 15,000 inmates from Buchenwald and Natzweiler and 2,000 engineers to construct a huge subterranean factory at Niedersachswerfen in the Harz Mountains to assemble the radiologic bombs. Construction of the *SS-Mittelwerk*, as the new facility was known, was supervised by SS-Brigadeführer Hans Kammler, who had earlier supervised the construction of the Auschwitz satellite camp at Birkenau. V-2 rockets and V-4 bombs were both assembled in the facility, the largest underground factory in the world. Geoffrey Brooks in his history of the project notes that the radiation protection provided for the prisoners "is best left to the imagination"; see his *Hitler's Nuclear Weapons*, pp. 68 and 122–25.

rather from its "daughter products" (the offspring of radioactive decay), which tend to lodge in the lungs, where they continue to emit radiation.⁹⁰ Experiments were launched to determine how much radioactivity was present in the urine and exhaled air of miners, and how the radioactivity of the air varied with changing weather conditions.⁹¹

Experiments were also performed that finally produced—for the first time anywhere—lung cancers in animals raised in the mines. Julius Löwy had failed at this task as recently as 1936: the German-Jewish professor in Prague had earlier, in 1929, been the first to show that the disease faced by Joachimsthal miners was the same as the *Schneeberger Krankheit*;⁹² in 1936, however, he reported that the rabbits and rats he had forced to breathe pitchblende dust had all died from the acute effects of radiation.⁹³ Arthur Brandt, an industrial physician working for the government in Dresden, was apparently the first to reproduce the cancer hazard under laboratory conditions. His results, published in 1938, showed that 25 percent of the mice raised for one year in the shafts evidenced tumors upon dissection.⁹⁴ This was the first conclusive animal experimental evidence that breathing air in the mines could cause lung cancer.

Radon by this time was generally regarded as the most likely cause of the *Schneeberger Krankheit*. The chief physician of the German Labor Front, Hermann Hebestreit, stated unequivocally in a 1939 review that "the lung cancer of the Joachimsthal uranium miners is traceable to exposure to radioactive materials."⁹⁵ Not everyone agreed: Franz Strnad in Prague in 1938, for example, stated that while radium emanation (radon) was the most likely cause of the *Schneeberger Krankheit*, the issue was "not yet finally decided."⁹⁶ The more common view, however, was that radon was in fact the primary cause. Germans were the first in the world to recognize—officially—that radon was the cause of the uranium miners' lung cancer; American health officials as late as the 1950s, by contrast, were still questioning the link. German uranium miners were obtaining compensation for occupational lung cancers by the end of the 1920s; Americans had to wait until the passage of the Radiation Exposure Compensation Act in 1991.⁹⁷