In 1928, Harrison Martland was the chief medical examiner for Essex County, New Jersey. Part of his job was to determine causes of illness and death. Read the excerpt about investigations into the health effects of the element radium and answer the questions that follow.

RADIUM

by Deborah Blum

1 The industrial landscape of New Jersey provided Martland with a profusion of workplace safety issues to investigate. His research helped prove that workers in explosives factories were poisoned by nitroglycerine; he wrote the first paper showing that exposure to beryllium—a flexible metallic element used in the emerging electronics industry—could lead to fatal lung diseases. Due in part to his own relentless pressure (he was a man who liked to see his research put to use), those findings would eventually result in regulatory reform.

2 In 1928 he was pursuing yet another industrial health hazard, one that would challenge the standard definition of a poisonous material. It was this puzzling investigation that prompted Martland to contact the New York City office. He had some aging bones in his possession, belonging to a former New Jersey factory worker. He wanted to know whether the better-equipped laboratories at Bellevue could answer this: were the bones radioactive?*

3 To make real sense of that question, one had to look back some thirty years, to when scientists in France had announced a startling discovery. The rocks of the Earth's crust, they declared, were not all cold dead chunks of metal and mineral. Some were strangely alive. Some sizzled with energy and even emitted radiation.

4 The French physicist Henri Becquerel reported the first such discovery in 1896. He'd conducted experiments showing that the element uranium emitted tiny atomic particles that could pass through metal foil, creating a spatter of light spots on photographic film. Two colleagues, newly married physicists named Pierre and Marie Curie, took up Becquerel's work. Marie especially found these living rocks fascinating. Sifting through trays of uranium tailings—a fine radioactive rubble left over when uranium ore is processed—and carefully measuring "uranium rays," she realized quickly that the emission levels were too high to be explained by the uranium alone.

5 After two more laborious years of sifting, testing, and recording light spatter on film, the Curies announced that they had discovered two new elements, both of which emitted particles at a greater rate than uranium. One they named polonium, after Marie Curie's native Poland. The

* *radioactive* — emitting radiation during the process of decay

second they simply named for radiation itself, calling it radium. They proposed that elements like radium and polonium, with their peculiar atomic snap and sizzle, should be known as "radioactive" elements.

6 It was radium—"my beautiful radium" as Marie called it—that seemed the most promising of these new materials. Polonium was too intensely active, burning itself away within a year. Uranium was more stable but less energized, dribbling its radiation comparatively slowly away. Radium, on the other hand, glowed with promise. It decayed slowly; its half-life was sixteen hundred years, yet it spat and sparked with a steady release of energy. The Curies had measured radium's intensity at some three thousand times that of uranium. It was rather like finding a tiny star buried in the dirt. A very tiny star—the Curies had isolated only 100 milligrams of pure radium from some three tons of uranium ore. But that gave it the allure of something truly rare.

7 Within two years physicians had learned that the application of radium salts to a tumor would shrink the cancer. "Radium therapy" was introduced into hospitals shortly after the turn of the twentieth century. Physicians reported healing effects that seemed miraculous, especially compared to the therapies of old. The newspapers compared radium's magic to the golden healthful rays of the sun. Everyone wanted to stand in what seemed a naturally healing light.

8 Radium use spread quickly into consumer products. There were bottles of radium water (guaranteed to make the drinker sparkle with energy), radium soda, radium candy, radium-laced facial creams (to rejuvenate the skin), radium-sprinkled face powder (in four clearly labeled tints: white, natural, tan, and African), soaps and pain-relieving liniments and lotions. Researchers discovered that the European hot springs, famed for their healing powers, contained radon, a gas created by the decay of radium, released as water dissolved minerals in the rocks that lay beneath the springs. Perhaps, scientists suggested, the health effects of the mineral hot springs came from radioactive elements in the ground. Spas in upstate New York rushed to compete by dropping uranium ores into their swimming pools. A New Jersey company grew rich selling hundreds of thousands of bottles of Radithor: Certified Radioactive Water as a tonic that guaranteed new vigor and energy.

9 Radiant health, the ads proclaimed—beautiful skin, endless vigor, and eternal health—ingesting radium seemed the next best thing to drinking sunlight.

10 Martland found radium to be neither beautiful nor inspirational.

11 He'd been drawn into researching it by a peculiar health crisis in Orange, New Jersey, a community just northwest of Newark. Situated on a main turnpike to Pennsylvania, Orange had long been a bustling little industrial city. It was a popular stop on the Delaware, Lackawanna, and Western railroad line. The trains made a flurry of stops at the Orange terminal, picking up and dropping off passengers, delivering Pennsylvania coal, and carrying away factory products: clocks, pencil sharpeners, boxes of shoes. Until Prohibition, the Orange Brewery had shipped its beer out on the DL&W. The old building stood dark now. But other businesses thrived in its place. The U.S. Radium Corporation, which had opened a plant there in 1917, was busier than ever.

12 The Radium Corporation had gotten its start in the Great War, with its new technological demands. Soldiers, huddled in the muddy trenches of Europe, learned quickly that the pocket watches they carried were unsuited to battlefields. They fell out of pockets and were crushed

by the next crawling soldier; if the watches somehow weren't smashed, they were hopelessly unreadable at night. Driven by military need, watch companies began putting watches on straps, which could be safely buckled onto wrists, and they looked for a way to make watch faces glow in the dark.

13 Luckily, some years before the war, German scientists had developed a "self-luminous" paint. This paint glowed, due to a rather neat little cascade of chemical interactions: if radium salts were mixed with a zinc compound, particles emitted by the radium caused the zinc atoms to vibrate. The vibration created a buzz of energy, visible as a faint shiver of light. This pale greenish glow was easily outshone by daylight, but in the dark it was just luminous enough to make an instrument readable without making it easily detectable to a watching enemy.

14 After American troops joined the war in Europe, the factory in Orange won a contract to supply radium-dial instruments to the military. By the time the war ended, wristwatches with their glowing dials and handy wristbands were all the style. So were luminous-faced clocks, nicely dressed up in gold and ebony for elegant homes. The corporation's business was as healthy as ever—as healthy, you might say, as radium itself.

15 Hardly a quibble, hardly a doubt was raised, that radium might not really be the golden child of the elements.

16 At the factory the dial painters were taught to shape their brushes with their lips, producing the sharp tip needed to paint the tiny numbers and lines of watch dials and the lacy designs of fashionable clocks. Each worker was expected to paint 250 dials a day, five and a half days a week. They earned about twenty dollars a week for that work, at a rate of one and a half cents per completed dial.

17 The painters were teenage girls and young women who became friendly during their hours together and entertained themselves during breaks by playing with the paint. They sprinkled the luminous liquid in their hair to make their curls twinkle in the dark. They brightened their fingernails with it. One girl covered her teeth to give herself a Cheshire cat smile when she went home at night. None of them considered this behavior risky. Why would they, when doctors were using the same material to cure people? When wealthy spa residents were paying good money to soak in the stuff? When a neighboring company promoted the popular tonic Radithor? No one—certainly not the dial painters themselves—saw anything to worry about.

18 Until one by one the young workers began, mysteriously, to fall ill. Their teeth fell out, their mouths filled with sores, their jaws rotted, and they wasted away, weakened by an apparently unstoppable anemia. By 1924 nine of the dial painters were dead. They were all women in their twenties, formerly healthy, with little in common except for those hours they had spent, sitting at their iron and wood desks at the factory, painting tiny bright numbers on delicate instruments.

. . .

19 In New Jersey . . . worries about the element grew as illness spread among the dial workers. Ironically, they began falling ill shortly after Curie's triumphant American tour. By 1924, as the painters continued to die, managers at the U.S. Radium Corporation hired a team of scientists from Harvard University to investigate the inexplicably accelerating deaths.

20 The Harvard scientists discovered that the watch factory was thick with radium dust. The employees were frequently covered in it. In the dark, one researcher said, the dial painters glowed like luminous ghosts. The researchers concluded that the deaths were connected to the factory work. *Connected to* rather than *caused by*: radium had a safe reputation, and they were reluctant to blame it completely. Even this cautious assessment did not go over well with factory management. The U.S. Radium Corporation refused to allow the study to be published, saying the information was too sensitive to be released.

21 The same year, though, a team of less cooperative scientists pursued the problem at U.S. Radium, running tests on many of the ailing workers, some still employed, others who had moved on to other jobs. The doctors from the New Jersey Consumers' League, already well known for its uncompromising positions on worker safety, published their findings, summing up with a declaration that the factory in Orange was incubating a new, strange, and terrible occupational disease.

22 At this point Harrison Martland decided to conduct his own investigation, one that would be uncolored by claims of pro-management or pro-worker bias. He soon agreed that radium exposure had to be the source of the problem. In his examination of the young dial painters, he'd discovered a fact that was impossible to dismiss.

23 The women were exhaling radon gas.

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