

named polonium and radium, from pitchblende. Curie later won the Nobel Prize for her discovery, but at the time, she was troubled by the seemingly constant energy source of the radioactive process that had led her to the new elements. As she wrote in 1900:

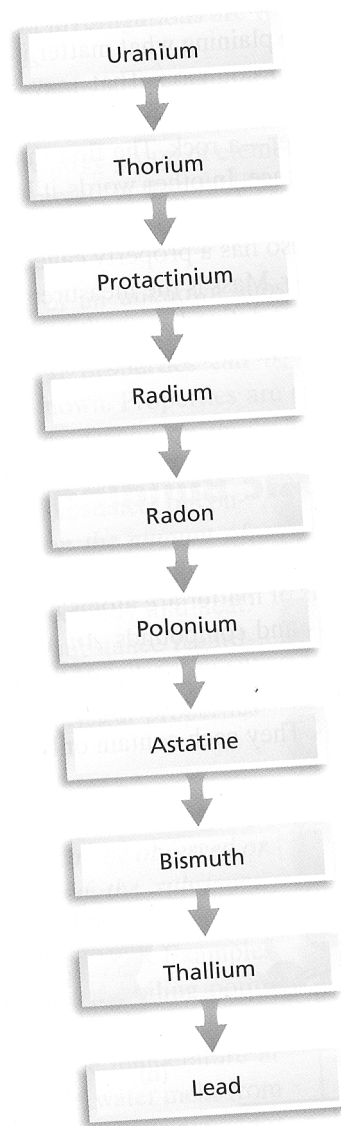
The emission of the uranic rays is very constant . . . The uranium shows no appreciable change of state, no visible chemical transformation, it remains, in appearance at least, the same as ever, the source of the energy it discharges remains undetectable. . . .

The Revival of Transmutation

While Marie Curie was making her momentous discoveries, other scientists were establishing that the chemical elements were actually different types of atoms. The connection between this emerging theory of matter and radioactivity was made by the famous scientist Ernest Rutherford.

In 1902, Rutherford and his assistant, Frederick Soddy, reported that the radioactivity of a sealed sample of thorium (a known element determined to be radioactive by the Curies) had actually *increased* over time. This increase was accompanied by the simultaneous evolution of a radioactive gas. The two investigators began to question whether radioactive elements were as stable as elements were supposed to be. After further studies, Rutherford and Soddy presented their shocking explanation:

The cause and nature of radioactivity is at once an atomic phenomenon and the accompaniment of a chemical change in which new kinds of matter are produced. The two considerations force us to the conclusion that radioactivity is a manifestation of subatomic chemical change.



A simplified decay diagram for uranium

Rutherford and Soddy's "subatomic chemical change" was nothing less than transmutation. Nature had turned out to be an alchemist!

The New Alchemy Explained

Rutherford later showed that the spontaneous transmutation, or decay, of radioactive atoms involves the emission of nuclear particles or high-energy waves known as gamma rays, or both. The atom's nucleus is consequently reconfigured, changing the atom into that of another element.

Thus, the source of energy in Marie Curie's uranium sample came from within the radioactive atoms. And although it seemed as if the energy output was constant, the sources of the radiation were continually changing as one radioactive element decayed into another.

Years later, it would be shown that the transmutation of certain elements could be deliberately initiated by bombarding nuclei with accelerated subatomic particles. But the goal of modern alchemy is no longer gold, as Soddy remarked in 1917:

If man ever achieves this control over Nature, it is quite certain that the last thing he would want to do would be to turn lead or mercury into gold—for the sake of gold. The energy that would be liberated, if the control of these sub-atomic processes were possible . . . would far exceed in importance and value the gold.