

increase the accuracy of the measurement of the fission cross section, this sample, which had about five milligrams of rare-earth carrier materials, was subjected to an oxidation-reduction chemical procedure that reduced the amount of carrier to a few tenths of a milligram. A fission cross section for plutonium-239, some 50 percent greater than that for uranium-235, was found, agreeing remarkably with the accurate values that were determined later. This result was communciated to Washington on May 29, 1941, and this served as the basis for the later publication of an expurgated version by Kennedy, Segrè, Wahl and me (10).

### **First Isolation of Plutonium**

The observation that plutonium-239 is fissionable with slow neutrons provided the information that formed the basis for the U.S. wartime Plutonium Project of the Manhattan Engineer District (MED) centered at the Metallurgical Laboratory of the University of Chicago. Given impetus by the entry of the United States into the war in December 1941, I and some of my colleagues moved to Chicago in the spring of 1942. The mission of the Met Lab was to develop (1) a method for the production of plutonium in quantity, and (2) a method for its chemical separation on a large scale.

The key to solving the first problem was the demonstration by Enrico Fermi and his colleagues of the first sustained nuclear chain reaction in uranium on December 2, 1941.

Important to the solution of the second problem was the determination of the chemical properties of plutonium, an element so new that little was known of its characteristics, and the application of these to the design of a chemical separation process to separate the plutonium from the enormous quantity of fission products and the uranium. I served as leader of the large group of chemists who worked in collaboration with the chemical engineers to solve this problem.

The earlier tracer chemical investigations at Berkeley, continued at Chicago, served to outline the nature of the chemical separation process. The key was the oxidation-reduction cycle in which plutonium is carried in its lower oxidation state(s) by certain precipitates and not carried by these same precipitates when it is present in its higher oxidation state. Thus, it is separated from the fission products, which do not exhibit this difference in carrying behavior from oxidizing and reducing solutions. However, the carrying properties of plutonium at tracer (extremely small) concentrations might be different at the macroscopic concentrations that would exist under actual operating conditions in the chemical separation plant.

It occurred to me that central to the achievement of such a separation process would be chemical work on concentrations that would exist in the chemical separation plant. This seemed a very far-out idea, and I can remember a number of people telling