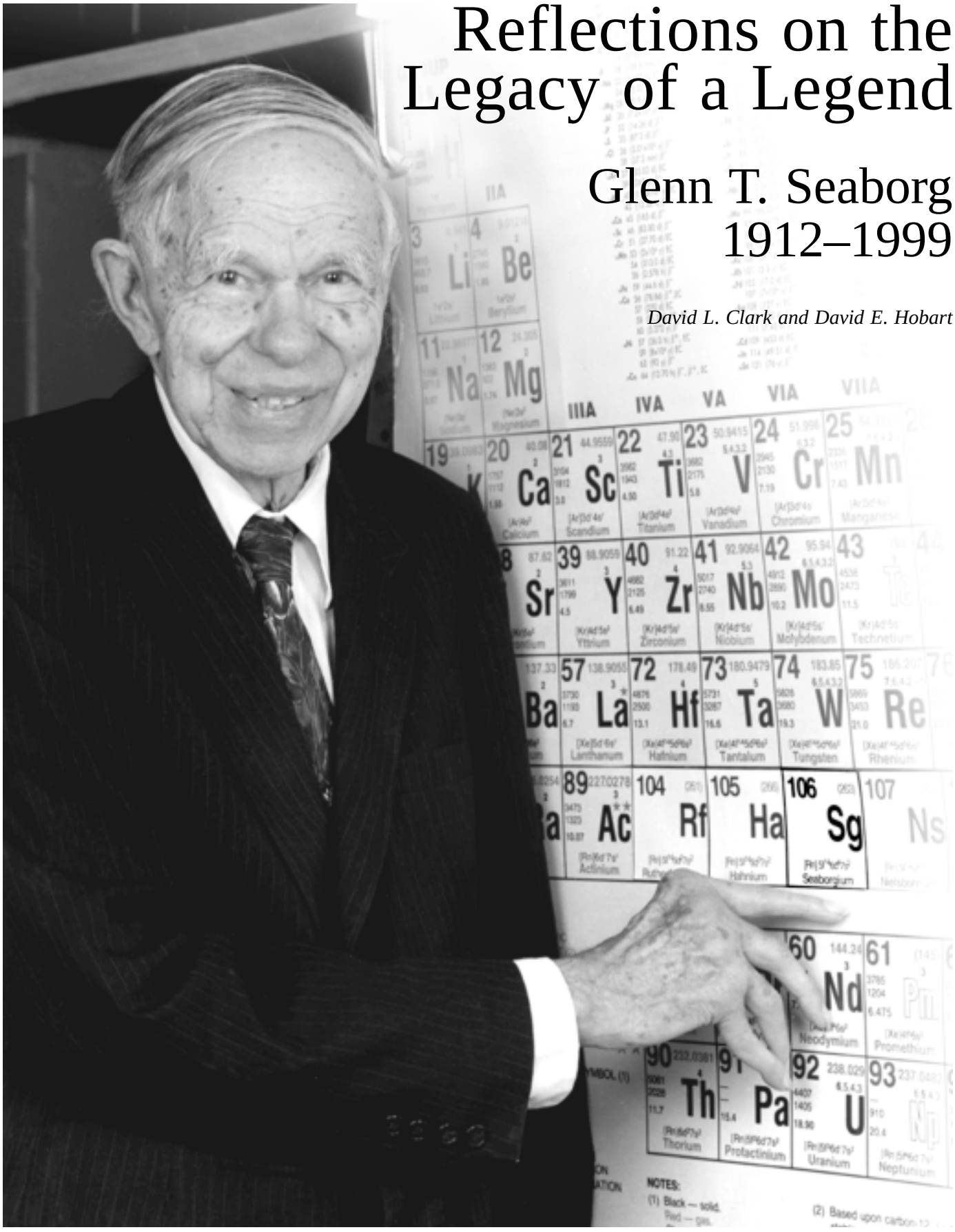
Reflections on the Legacy of a Legend

Glenn T. Seaborg 1912–1999

David L. Clark and David E. Hobart



On February 25th, 1999, chemist, educator, administrator, humanitarian, and Nobel Prize recipient Glenn T. Seaborg died in his home in Lafayette, California, at the age of 86. Many know of the scientific accomplishments of the man who has become a legend, and anyone who has attended his lectures can attest to how informative and entertaining Seaborg was. He had an enticing, whimsical sense of humor and used this talent to drive home his points and to share his passion for "hard" science and his quest for discovery. Seaborg was the architect of the actinide series of the periodic table of elements and codiscoverer of 10 transuranium elements—one of which bears his name (element 106, seaborgium)—and of numerous radioisotopes. His work and achievements have touched many lives, and his discoveries and legacy will continue to touch many lives for generations to come.

Glenn T. Seaborg was born in Ishpeming, Michigan, on April 19th, 1912. His family moved to Los Angeles, California, where Seaborg was first exposed to science in high school. Later, he dedicated his life to this endeavor. Seaborg received his A.B. degree from the University of California (U.C.) at Los Angeles in 1934 and his Ph.D. in chemistry from U.C. at Berkeley in 1937. He served as a faculty member at Berkeley from 1939 until his death and was chancellor of that campus from 1958 to 1961.

In 1940, when Edwin M. McMillan, Seaborg's fellow Berkeley researcher, was called away to the Massachusetts Institute of Technology to work on radar, young Seaborg was left in charge of the program to prepare new elements by bombarding uranium atoms with deuterons. In late 1940, working with Joseph Kennedy and graduate student Art Wahl, Seaborg succeeded in identifying element 94, now known as plutonium. A letter sent to Washington, DC, in 1941 and signed by Seaborg, McMillan, Kennedy, and Wahl described the discovery. But a self-imposed cover of secrecy shrouded the research because of the potential military applications of element 94.

In his lectures, Seaborg often noted that throughout 1941, the year that marked the beginning of the U.S. involvement in World War II, element 94 was referred to by the code name of "copper." This name was satisfactory until it was necessary to use the real element copper in some of the experiments. The scientists circumvented the problem of distinguishing between the two elements by referring to element 94 as "copper" and to real copper as "honest-to-God copper!" The naming of element 94 followed the tradition of naming transuranium elements after consecutive planets in the solar system. Element 93 was dubbed neptunium (Np) after the planet Neptune, and element 94 was named plutonium (Pu). Seaborg and coworkers considered the name "plutium" but it "…[d]idn't roll off of the tongue like the name plutonium," said Seaborg in one of his lectures. The obvious choice for the symbol would have been Pl, but facetiously, Seaborg suggested Pu, like the words a child would exclaim, "Pee-yoo!" when smelling something bad. Seaborg thought that he would receive a great deal of flak over that suggestion, but the naming committee accepted the symbol without a word.

Seaborg is at a Geiger-Müller counter and amplifier at Berkeley in 1941. A chart of isotopes with replaceable colored entry cards is on the wall in the background.

In the spring of 1941, it was determined that the newly discovered isotope plutonium-239 could undergo fission and had potential as a powerful nuclear-energy source. Consequently, Seaborg left Berkeley to head the University of Chicago's Metallurgical Laboratory (known as Met Lab) and develop the chemical separation process that would provide plutonium-239 for the Manhattan Project, which was aimed at creating a secret nuclear weapon. Still in Chicago after completion of the plutonium project, Seaborg focused his attention on looking for new elements heavier than plutonium.

At the White House, Seaborg is briefing President George Bush on cold fusion (April 14, 1989).

In an effort to prepare elements 95 and 96, now known as americium and curium, Seaborg and coworkers were unsuccessful in separating and identifying these elements from bombarded targets. Their failure was a result of assuming that the chemical properties of those elements resembled those of iridium and platinum, as suggested by their placement at that time in the d-block of the periodic table. Seaborg then considered that perhaps the actinides were in the wrong location in the periodic table and should actually be, like the lanthanides, a separate rare-earth-like series. Based on the assumption that elements 95 and 96 were rare-earth-like, Seaborg and coworkers successfully separated and identified americium and curium in 1945. Purely by chance, the announcement of the discovery of elements 95 and 96 did not take place as planned, at the 1945 American Chemical Society (ACS) meeting, but a few days earlier. Seaborg revealed the discovery on a nationally broadcast radio program, "The Quiz Kids." Seaborg subsequently prepared a communication for the periodical *Chemical and Engineering News*, proposing his actinide series theory. He ran the concept past some of his colleagues knowledgeable in inorganic chemistry, who told him something to the effect that, should he propose this revolutionary concept, he would ruin his reputation. "Fortunately, I really didn't have a reputation to ruin at that time, and even more fortunate, I was right," quipped Seaborg. He published the article and changed the appearance of the periodic table forever.

After World War II, Seaborg returned to Berkeley's chemistry department to direct the search for new elements at the U.C. Radiation Laboratory, now known as Lawrence Berkeley National Laboratory (LBNL). In 1951, Seaborg and Edwin McMillan shared the Nobel Prize in Chemistry for their discovery of plutonium and other elements. During his career, Seaborg codiscovered the actinide elements through nobelium (element 102), the transactinide element 106, seaborgium, and many new isotopes (including iodine-131, technetium-99m, cobalt-57, cobalt-60, iron-55, iron-59, zinc-65, cesium-137, manganese-54, antimony-124, californium-252, americium-241, plutonium-238, and the fissile isotopes plutonium-239 and uranium-233).

Seaborg was quite fond of telling the story (complete with the right accent) of how he was in his office at Berkeley one day, when he received a phone call from someone "claiming" to be the President of the United States. Curious and suspicious that his friends were pulling a joke on him, Seaborg listened. A man with a distinc-

tively Bostonian accent said, "Ahh, Professor Seaborg, thish ish-ah, Jack Kennedy." Seaborg was highly amused and replied, "Yeah! Right, and who are you really?" The voice said, "I'm sorry, but this ah-really ish-ah Jack Kennedy, and I would like you to come to Washington and serve as the ah chairman of the Atomic Energy Commission!" Seaborg finally realized that this was no joke, went to Washington, and served as Chairman of the Commission from 1961–1971. He also served as scientific consultant to eleven U.S. Presidents—from Franklin D. Roosevelt to William J. Clinton.

Seaborg was always eager to welcome visitors, great and small, into his LBNL office to chat about current events, discuss some late-breaking research, or to counsel young scientists. He was always quick with a joke or a twist on words and had a sharp wit till the end. Seaborg's office walls were covered with numerous photographs of himself with prominent scientists and great world leaders, as well as many of the U.S. Presidents he served. On one occasion, his staff faked an impressive photograph of Seaborg standing next to President Abraham Lincoln and unobtrusively placed it on his wall. The Lincoln photo remained unnoticed for some time until, one day, Seaborg was proudly showing a visitor his photographs and noticed this new one. He suddenly burst out laughing. More amusing was the fact that an obviously naive young student actually thought the photograph was authentic! "How old did she think I was?" Seaborg chuckled.

(Top) To Glenn from his staff on his 81st anniversary.

(Bottom) John F. Kennedy and Glenn T. Seaborg during the President's visit to the Nevada Test Site on December 8, 1962. This was one of Seaborg's favorite pictures with President Kennedy.

For all of the awards, prizes, and recognition that Seaborg received in his career, nothing surpassed the naming of element 106 as seaborgium. Indeed, Seaborg was the first living scientist to be so recognized. "This is the greatest honor ever bestowed upon me," he declared. A great deal of unnecessary controversy followed this announcement, along with helter-skelter renaming of the heaviest elements at the end of the periodic table. In effect, the International Union of Pure and Applied Chemistry (IUPAC) naming committee declared that no new elements could be named after living persons. This decision temporarily left the name seaborgium off the periodic table. Undaunted and maintaining his pervasive sense of humor, Seaborg joked that the IUPAC refused to name the element after him "because I was alive, and, furthermore, they could prove it!" In 1997, however, sanity prevailed, and the name seaborgium was reinstated for element 106. Seaborg's immortality was thus secured for as long as there is civilization and a periodic table.

As an educator, Seaborg was tireless in his efforts to inspire young people in science. "A hard working individual will succeed where a lazy genius may fail," he said to a young student concerned about her chances in science.

He was also tireless in informing the public about the benefits of nuclear energy and the use of radionuclides in industry, medicine, and the physical, chemical, and

biological sciences. He was one of the Manhattan Project scientists that advocated the use of the atomic bomb on a deserted island as a demonstration to Japan to end World War II.

Seaborg advocated a ban on nuclear weapons testing and argued for nuclear arms reduction and dismantlement. He strongly advocated the conversion of weapons-grade plutonium into mixed-oxide (MOX) fuel to "burn" in nuclear power reactors for peaceful purposes. In concert with the work of Russian counterparts, Seaborg's work would help ensure a lasting peace after the Cold War and reduce threats of proliferation and potential acts of terrorism. "I was a codiscoverer of plutonium in 1941 at Berkeley. I have always felt a parental pride in its potential for good—its ability to provide the world with a clean energy source virtually forever. But I also am fully aware of the great threat it can pose in the wrong hands…" said Seaborg (1997)

The King of Sweden presents the Nobel Prize to Glenn T. Seaborg.

Seaborg served as member of the National Commission on Excellence in Education, was active in the ACS throughout his career, and served as president of the ACS in 1976. He was also president of the American Association for the Advancement of Science and Associate Director-at-Large at LBNL. His awards include the 1951 Nobel Prize, the ACS 1979 Priestley Medal, the 1991 Medal of Science, and the George C. Pimentel Award in chemical education in 1994. The readers of *Chemical and Engineering News* voted Seaborg one of the "Top 75 Distinguished Contributors to the Chemical Enterprise" in 1998. His acceptance of this prestigious award at the ACS meeting in Boston marked one of his last public appearances. A legend has left us, but his legacy will live on forever. ■

Further Reading

Gutin, J. C. 1995. "The Man Who Would Be an Element." In *San José Mercury News West Magazine*, March 5 Issue.

Hoffman, D. C., A. Ghiorso, and G. T. Seaborg. 2000. *The Transuranium People: The Inside Story*. London: Imperial College Press.

Jacobs, M. 1999. "In Memory of Glenn Seaborg." *Chemical and Engineering News*. March 8 Issue, p. 5.

Seaborg, G. T. 1997. "Adopt Plutonium Policy of Mutual Assured Destruction." *The Washington Post*. August 24 Issue.

Wilkinson, S. L. 1999. "A Legend Has Left Us." In *Chemical and Engineering News*. March 8 Issue, p. 29.

(From left) David Clark, David Hobart, and Glenn Seaborg at a conference in Honolulu, Hawaii (December 1989).

All photos are courtesy of Ernest Orlando Lawrence Berkeley National Laboratory.

David E. Hobart received a B.S. in chemistry from Rollins College in 1971 and a Ph.D. in analytical chemistry from the University of Tennessee, Knoxville, in 1981. After spending two years as a postdoctoral research associate at Oak Ridge National Laboratory, David became a technical staff member at Los Alamos National Laboratory in the Isotope and Nuclear Chemistry Division. In 1993, David served as group leader of the Actinide Geochemistry Group at Lawrence Berkeley National Laboratory. From 1995 to 1999, as a contract consultant, David assisted in the successful licensing of the Waste Isolation Pilot Plant (WIPP). He is now a technical lead in the Analytical Chemistry Group at Los Alamos and a participating guest scientist at the Seaborg Institute for Transactinium Science. His research interests include lanthanide and actinide element solution and solid state chemistries, speciation, solubility, spectroscopy, redox behavior, thermodynamics, and complexation.

Glenn Seaborg and the Discovery of Plutonium

1789 Klaproth discovers element 92, uranium.

1869 Mendeleev arranges the then known elements in a “periodic table.”

1895 Becquerel discovers that uranium undergoes radioactive decay.

1912 Seaborg is born in Ishpeming, Michigan, on April 19th.

1934 Fermi and coworkers irradiate uranium with neutrons and mistakenly believe they have produced transuranium elements.

1937 Seaborg receives his Ph.D. degree from the University of California (U.C.), Berkeley.

1938 Hahn, Meitner, and Strassmann discover nuclear fission by bombarding uranium with neutrons.

1939 Seaborg joins the faculty at U.C. Berkeley.

1940 McMillan and Abelson synthesize neptunium, element 93 (the first transuranic element), by bombarding uranium with slow neutrons.

1940-41 Seaborg, McMillan, Kennedy, and Wahl discover element 94, plutonium, by irradiating uranium with deuterons.

1941 Seaborg heads University of Chicago’s Metallurgical Laboratory (Met Lab) to provide quantities of pure plutonium for the Manhattan Project.

1944-45 Seaborg conceives and publishes the controversial “Actinide Concept.” Seaborg, James, Morgan, and Ghiorso discover americium and curium by using separation methods based on the Actinide Concept.

1945 The plutonium bomb is detonated at Trinity, in the desert near Alamogordo, New Mexico, on July 16th.

1946 Following his return to work at the U.C. Radiation Laboratory (now known as Lawrence Berkeley National Laboratory), Seaborg prematurely announces the discovery of elements 95 (americium) and 96 (curium) on the nationally broadcasted “Quiz Kids” radio program.

1945-50 Thompson, Street, Ghiorso, and Seaborg discover elements 97, berkelium, and 98, californium.

1951 Seaborg and Edwin McMillan win the Nobel Prize in chemistry for their research in transuranic elements.

1952-58 Ghiorso, Seaborg, and others discover elements 99 (einsteinium), 100 (fermium), 101 (mendeleevium), and 102 (nobelium). The discovery of nobelium was shared by Donets et al.

1954 Seaborg becomes Associate Director of the Lawrence Radiation Laboratory.

1958 Seaborg is named Chancellor of U.C. Berkeley.

1961-71 Seaborg goes to Washington, D.C., to serve the nation as the chairman of the Atomic Energy Commission.

1971-97 Seaborg rejoins the staff at U.C. Berkeley and also serves as President of the American Chemical Society and the American Association for the Advancement of Science, Associate Director-at-Large at Lawrence Berkeley National Laboratory, member of the National Commission on Excellence in Education, and science advisor to eleven U.S. presidents.

1997 In honor of Seaborg’s contributions to science, element 106 is officially named “seaborgium.”

1999 Seaborg dies in his home in Lafayette, California, on February 25th at the age of 86.