

normal way. Faced with this situation, I had no choice; if I wanted to pursue the heavy element research in this way, I would have to build it myself. I had often built parts of the instruments that I used but now I would have to build the major parts of SASSY2. For instance, the pole pieces would have to be milled in a complicated way to provide the necessary double-focussing. This was a daunting task but my son, Bill, persuaded me that it could be done and offered to help me with both advice and labor. He had joined the Lab about ten years before and had become an acknowledged expert in mechanical, electrical, and computer technology. His help and enthusiasm were prime reasons for the successful operation of SASSY2 and we did succeed in making a viable instrument that was used for one important last experiment. This was a search for element 110 with mass 267 produced by bombardment of ^{209}Bi with ^{59}Co ions. In a very difficult 40-day period we did find one event which we attributed to this atom and that experiment is described in Chapter 12.

Subsequently, the SuperHILAC was shut down, prematurely ending our encouraging experiments there. However, SASSY2 was especially important in that it led directly to the design and construction at the 88-Inch Cyclotron of the Berkeley Gas-filled Separator (BGS), the next generation of gas-filled separators that came on line early in 1999. (See Chapter 14.)

With this device we were able to mount an experiment to look for the isotope, $^{267}\text{110}$. In a very difficult 40-day period we did find one event which we have attributed to this atom. The experiment is described in Chapter 12.

P.3. Glenn T. Seaborg

I had almost no exposure to science in my early years. I was born of Swedish ancestry in Ishpeming, Michigan, a small iron-mining town on the Upper Peninsula. My father, H(erman) Theodore Seaborg, was born in 1880 in Ishpeming. His parents came from Sweden to Ishpeming in their youth and met and married there in 1872. His

mother, Charlotta Wilhelmina Johnson (whose family name was changed to Farrell), came to Ishpeming in 1869 at the age of 19 from Örebro with her parents and brothers and sisters. His father, Johan Erik Sjöberg (whose name was anglicized to Seaborg), came to Ishpeming in 1867 from Hällefors at the age of 23. Johan's father, Erik Sjöberg, changed his name from Olsson in 1835. As I recall my father telling me, Johan crossed the Atlantic Ocean as a steerage passenger in a cargo ship. Johan had a friend at the Hällefors Iron Workers, the grandfather of the Swedish Nobel Prize winner, The Swedberg, so I suspect that the name The and my middle name Theodore have a common origin.

The Seaborg home in Ishpeming at 639 East Division Street was occupied by members of the Seaborg family until 1914, then by members of the Kurin family until 1980, when I acquired it, and I still retain it for sentimental reasons.

My mother, Selma Olivia Eriksson (changed to Erickson), was born in Grängesberg in the southern Dalarna region of Sweden, and came to the United States (Ishpeming) in 1904, when she was 17 years old. She and my father met at a picnic on Swedish Midsummer's Day, June 24, 1908, and were married three years later on Swedish Midsummer's Day, June 24, 1911. I was born in Ishpeming on April 19, 1912 (during the presidency of William Howard Taft).

My mother's ancestors had lived in the southern Dalarna-northeastern Västmanland region of Sweden for many generations. A home in which her ancestors, Michael Hindersson and his wife, whose maiden name was Maria van Gent, lived in 1673 (as shown by an inscription on the living room wall) was moved in 1895 from Kopparberg to Skansen, where it stands with the name "Laxbrostugan" as part of the representative houses from "Bergslagen." This house has served as the rallying point for hundreds of my relatives, and has given me contact points to enable me to trace my ancestry back to the 14th century in Holland (Maria van Gent's birthplace). The Hindersson's daughter Britta married Nikolas Perner, whose family came from Augsburg, Germany. The Perner clan has formed a "Perner Society" in Sweden in which Helen and I and our children are among

the hundreds of members. Here my ancestry has been traced back to the 15th century.

Ishpeming had typical sections that were nearly all Swedish and it was in one of these that we lived. Since my father was fluent in Swedish and this was my mother's native tongue, the Swedish language was spoken in our home as it was throughout the community. I learned to speak and understand Swedish before I did English, but I am afraid that in the intervening years my facility with the language has declined. My younger sister Jeanette also spoke Swedish as her first language.

I was born in the second story rented home of my parents at 231 New York Street, in a section of town called the "Old Location," named after a nearby abandoned iron mine. (This old house is still there in 1998.) The congested "Tangletown" neighborhood, so called because of the mixed-up labyrinthine nature of the streets, contained the homes of our Swedish relatives and friends — the Swansons, Swanbergs, Hedstroms, Bjorks, Petersons, Greens, Quaals, Samuelsons, Olsons, and Dahls. When I was three and sister Jeanette one year old (Fig. 1), my parents purchased and moved into a two-



Fig. 1. Childhood picture of Glenn T. Seaborg with his sister Jeanette, ages four and two, Fall 1916.

story house about a quarter-mile north of the Old Location at 802 East Wabash Street, at the corner of 7th Street. (This old house is also still standing in 1998.) Ishpeming had severe winters with high levels of snow. I recall climbing out of my second-story bedroom window with my skis strapped on for an adventurous cruise on the top of the snow pack at near the house top level.

Here my main playmate was Clarence Larson, a classmate who lived diagonally across the street. Clarence had a younger brother Raymond who was about Jeanette's age and her (and my) close friend. My other playmates included Laurel "Dirt" Williams, Clarence "Cuckoo" Vinge, Ralph Haugland and his younger brothers "Winky" and "Coonjigger," Carl "Issy" Carlson and his sisters Anna, Esther, and Margaret (about my age and a classmate), Toive Dahl, and Eric Dahl. Most of us had nicknames. My nickname was "Lanky," an obvious appellation (a third-grade picture shows that the tallest of my classmates only came to my shoulders) (Fig. 2). On a visit to Ishpeming in 1994, I called on Dirt Williams and found him living in the same house that his family occupied when I lived there more than 70 years ago. I have kept in touch over the years with Clarence "Gom" Larson, who has lived in the neighborhood of Ishpeming throughout his life.



Fig. 2. Third Grade Class, High Street School, Ishpeming, Michigan, June 13, 1921, showing Glenn T. Seaborg as the tallest student in the back row.

Swedish customs of all kinds prevailed in our home. I remember particularly well the Swedish food that we enjoyed at our dinner on Julaften, or Christmas Eve. The fare usually included smorgasbord, which featured sil, or pickled herring. One of the mainstays was lutefisk, which was always served with boiled potatoes and a white sauce. Another feature was saffron buns and bread, usually served hot and made with glaceed fruits. This was part of a large spread of buns and cakes, including gingersnaps made in the form of goblins, piglets, stars, and other patterns. Another component which was almost always present was the Swedish lingonberries, which I still like so much. The meal was usually rounded off with risgryn, or rice pudding, which was topped with cinnamon with cream and sugar. Even in later years my mother carried on these traditions and my wife, Helen, has done her best to continue such activities for the benefit of our children.

Ishpeming during my first ten years was an isolated world of its own. I never saw, or even heard, the word "radio." I don't recall speaking into a telephone. We were served by a weekly newspaper, *The Ishpeming Iron Ore*. The dirt streets had a fringe of red color due to the iron ore "hematite," which topped underground deposits laced with miles of tunnels for the mining operations. We did have some access to nearby Marquette's daily *Mining Journal* and to the Sunday edition of the *Chicago Tribune*. I recall reading the Sunday comics featuring classics such as "The Katzenjammer Kids," "Slim Jim," and "Bringing up Father" (featuring the irrepressible Jiggs).

I started kindergarten in the High Street School in September 1917 and continued there through the first three grades. For the fourth grade I moved in 1921 to the Old Grammar School a couple of blocks west (corner of First Street and North Street). In the third, fourth, and fifth grades I was an ardent admirer of a girl named Dorice Gray. During the summers of 1920, 1921, and 1922, when I was eight, nine, and ten years old, I worked as a caddie at the Ishpeming-Negaunee nine-hole golf course (the Wawonowin Golf Club), where caddie rates were 20¢ for nine holes, paid by one category of player, and a 25¢ charge for the more affluent players. We sometimes

maintained the Ishpeming or Negaunee gate (opening the gate for an incoming automobile). A small coin (a penny, nickel, or sometimes a dime) was thrown on the ground for us. Dorice's father was the manager of the golf club, and thus I was able to admire her from a distance during my summer visits to the Club House area.

Although I had become sufficiently fluent in English to cope by the time I started kindergarten in the fall of 1917, I was so shy as to cause problems. My mother had to negotiate a special arrangement with the teacher, Mary Earle, to allow me to go directly to the restroom during class time, without having to raise my hand and speak up to ask permission (an act that was beyond my capabilities).

The flu epidemic struck Ishpeming, as it did throughout the country, in the fall of 1918. My parents and many of my neighbors were afflicted and I recall that a number of our friends succumbed. I also remember vividly being surprised that I was so sick when my turn came. My sister Jeanette's flu turned into pneumonia, which gave us great cause for concern until her recovery.

In 1922, when I was ten years old, my family, which included my younger sister Jeanette, moved to Home Gardens, now a part of South Gate, California (near Los Angeles). At this time I changed the spelling of my name from "Glen" to "Glenn." This move was made largely at the urging of my mother, who wanted to extend the horizon for her children beyond the limited opportunities available in Ishpeming. However, unlike in Ishpeming, where he would have had guaranteed employment for life, my father never found permanent employment at his trade in California, and our family found itself in continuing poor circumstances. Since the new subdivision of Home Gardens had no schools, my sister and I during the first year traveled by bus to attend the Wilmington Avenue Grammar School in the Watts district of Los Angeles. I completed my grammar school education through the eighth grade in the newly constructed Victoria Avenue Grammar School in Home Gardens, skipping a couple of semesters on the way to my eighth-grade diploma.

When I entered David Starr Jordan High School in the Watts district of Los Angeles, again traveling to school by bus, I had to

choose between a commercial and a college preparatory curriculum. My mother pressed for the commercial course; to her this was the road to a respectable white-collar job. But I started down a different road and chose the college preparatory program, with literature as my major subject. During my freshman and sophomore years, I studied the usual college preparatory subjects, such as English Literature, Oral English, and World History, as well as Algebra, Geometry, and a foreign language.

In my junior year I was required to take a laboratory science in order to be eligible for admission to the “tuition-free” University of California at Los Angeles (UCLA). Because my high school was small, Chemistry and Physics were offered in alternate years, and Chemistry was the offering in my junior year. It was fortunate for me that my first science course was taught by Dwight Logan Reid, an outstanding teacher who exerted a strong formative influence on me. Mr. Reid not only taught Chemistry, he preached it. He related some fascinating experiences he had had as a Chemistry student in college, and, when he lectured, his eyes would light up. His irrepressible enthusiasm, obvious love for the subject, and ability to inspire interest captured my imagination almost immediately. Early in his course I decided I wanted to become a scientist. As a senior I took Physics, also from Mr. Reid, and since then my interests in Physics and Chemistry have been inseparable.

Immediately after starting at Jordan High School, at the age of 13, I fell madly in love with Vivian Dawson, a slim brunette of greater than average height with flashing eyes that radiated intelligence, a fellow freshman, and a resident of Watts. We had adjoining seats in the Oral English class, which gave us a chance to communicate and get well acquainted. I believe she was also attracted to me. She shared her chocolate bars with me and was very friendly. I was too shy and inexperienced to take advantage of the opportunities to walk her home after school and after football games — stupidities that I have often, in retrospect, regretted. She left Jordan High School in the middle of the semester, when her family moved from Watts. I don't know where she went and I never saw her again. I have

always hoped that we would meet again to bring each other up to date on our subsequent activities.

Early in 1927 I saw at a basketball game Bonita Edwards (an eighth-grader) and was struck by her vivacity and brunette beauty, and her resemblance to Vivian Dawson. Although shorter than Vivian, she also had sparkling eyes that advertised intelligence. (She graduated from high school at the age of 16.) She lived in Watts, across the street from Jordan High School. To my delight in the fall of 1927 as a freshman, she was a member of Charles Hicks' Latin I class, in which I was also enrolled as a junior. (Her attractive sister, Claire, a sophomore, was also a member of this class.) During the following two years of Latin class, I had an opportunity to get well acquainted with Bonnie and Claire. I became enamored with Bonnie but was too shy to advance my cause. I was ecstatic when, in the spring of 1929, she asked permission to wear my senior class ring. I was devastated when she returned to me my ring at the end of the semester, as she had, unfortunately, promised to do. Again, in retrospect, I have often ruminated on how clumsily I handled this situation. Bonnie married a football-playing friend of mine, Bud Coffin, and we have been lifelong friends.

After I finished high school in June 1929, I was very fortunate to find employment during the summer as a laboratory assistant, working as the lone control chemist on the graveyard shift (11 p.m. to 8 a.m.) at the Firestone Tire and Rubber Company in their South Gate plant. This provided the money that made it just possible for me to enroll at the University of California at Los Angeles (UCLA) in the fall. I knew I wanted to major in either Physics or Chemistry. I believed that a physicist could make a living only by teaching in a university, and at that time university faculties had few openings. On the other hand, a chemist unable to find a university teaching position could go into industry. So I chose Chemistry, hoping to become a university teacher, but, knowing that if I did not, other career opportunities would be available.

I lived at home and commuted by car with Jordan High School friends a distance of some 20 miles to UCLA. I have continued

lifelong friendships with many of my classmates at Jordan High School in Watts. Stanley G. Thompson, who lived in Watts with his grandmother, was a sort of boisterous roughneck when I first encountered him in the ninth grade at the age of 13. He became a serious student when he reached the Chemistry class in his junior year and received the top grade in the second semester. We attended UCLA as Chemistry majors, traveling on occasion in his new Ford sedan, purchased for him by his "aunt" Bessie Brigance (who, I learned later, was actually Stanley's mother). We retained a close relationship before and during our wartime service on the Plutonium Project at the Metallurgical Laboratory at the University of Chicago, and then at the Lawrence Berkeley Laboratory (LBL) at the University of California (UC), until his death in 1976. (I had the pleasure of serving as best man at his marriage to the delightful Alice Smith, a San Diego girl, on Sunday, November 27, 1938, at Northbrae Church in Berkeley.) Stan was an extraordinarily able chemist with the best intuitive sense, *Chemisches gefühl*, for solving chemical problems of anyone I have ever known. As I shall recount later, he solved the problem of chemical separation of plutonium on the Plutonium Project. We were collaborators on the synthesis and identification (i.e., the discovery) of a number of transuranium elements.

One sunny morning in September 1929, I walked across the ravine on the bridge which served as the entrance to UCLA from the Hilgard Avenue (east) side in Westwood. This was the opening year on this site of this young campus, only ten years old. Los Angeles State Normal School, on North Vermont Avenue in Los Angeles, became the Southern Branch of the University of California in 1919 and then the University of California at Los Angeles in 1927. There were some 5000 students and the total facilities at the opening of the Westwood campus in 1929 consisted of four buildings and a couple of temporary structures, including a student bookstore and gymnasium facilities. The four buildings, situated in a quadrangle, were the Chemistry Building (now Haines Hall, housing Geology), the Physics-Biology Building (now Kinsey Hall for Physics), the

Library Building (now Powell Library), and Josiah Royce Hall (named for the famous American philosopher and accommodating the other departments, including Mathematics) (Fig. 3). We found these not-quite-completed buildings rising starkly from the bare earth. Raw lumber and sacks of cement lay stacked for use. Lawns and shrubbery were nonexistent and the dusty walks turned to lanes of gooey mud when it rained.



Fig. 3. UCLA campus and environs showing Library, Royce Hall, Chemistry Building, and Physics Building, 1929.

I recall vividly the first meeting of my freshman chemistry class in the fall of 1929 with Prof. William Conger Morgan, a formidable man, some six-and-a-half feet tall. When Prof. Morgan strode into the auditorium of the Chemistry Building he glowered at the 300 students filling the room. He finally broke his silence to announce in a stentorian voice, “Look at the student on your right.” After we had all done this, he commanded, “Look at the student on your left.” After we had all done this, he bellowed, “One of you three will not be here at Thanksgiving time.” I resolved to survive past his deadline.

In 1929, UCLA offered unique opportunities for undergraduates in Chemistry. In addition to Prof. William Conger Morgan, chairman of the Chemistry Department, Profs. William R. Crowell, G. Ross

Robertson, J. Blaine Ramsey, Hosmer W. Stone, Max S. Dunn, and a year or two later, William G. Young and Francis E. Blacet offered an extraordinary curriculum. The absence of graduate work in those years was probably the reason our able professors gave us a taste of graduate-type research by the time we had reached our sophomore or junior years.

At the end of the fall semester, in January 1931, I received a grade of 99% in the final examination for Prof. William R. Crowell's class in Quantitative Analysis (Chemistry 6A). This so impressed Prof. Crowell that he gave me the job to serve one afternoon a week as laboratory assistant in his Quantitative Analysis course for premed students (Chemistry 5). He also set me up in a job one afternoon a week in the stockroom for the freshman chemistry laboratory (Chemistry 2A and 2B for nonmajors), checking out to students chemicals, equipment, etc. These jobs, a total of six hours a week at the magnificent pay of 50 cents per hour, restored me to financial solvency. To add to my security, I received in May a letter from UCLA Recorder H.M. Showman, advising me that the UCLA Committee on Scholarships had granted me a \$150 scholarship for the academic year 1931–1932.

One day in the summer of 1932, Stan Thompson and I paid a nostalgic visit to the Long Beach home of our high school chemistry teacher, Dwight Logan Reid. Here I met his attractive daughter Beth, about a year younger than I, with whom I was very much impressed. She had attended two years of junior college in Long Beach. I was delighted when I met her about a month later, when she came to register at UCLA as a junior with a major in Physical Education. Although much interested, I didn't have my first date with Beth until the following spring, when I escorted her to a party of my professional chemistry fraternity, Kappa Gamma Epsilon, which I was serving as president (and which I later led into membership as the Beta Gamma chapter of the national professional chemistry fraternity, Alpha Chi Sigma). Over the next year or so I had dozens of dates with her — escorting her to parties, playing tennis, accompanying me to football games at the Los Angeles

Coliseum, attending noontime assemblies in the auditorium of Royce Hall, etc. We attended a “pajamarino” celebration at a bonfire on the lower UCLA campus the night before the first-ever football game between UCLA and Cal-Berkeley. Beth and I were in the Los Angeles Coliseum the following afternoon to witness the historic 0–0 tie and I witnessed the ceremony just before the kickoff when UC President Robert Gordon Sproul, student body presidents Wakefield Taylor (Berkeley) and Porter Hendricks (UCLA), and graduate managers Bill Monahan (Berkeley) and Bill Ackerman (UCLA) met on the Coliseum turf. My dating of Beth ended when I left for Berkeley in the fall of 1934, but we have remained friends and seen each other on many occasions in the intervening years.

I have an especially vivid memory of the Friday, March 10, 1933, widespread earthquake centered in the Long Beach area. Stan Thompson and I were driving home from UCLA in his Ford along Slauson Avenue when the earthquake struck at 5:55 p.m. The sensation was so severe we had to stop driving. The Huntington Park High School was on fire when we drove past and we saw many demolished buildings as we approached home. When we arrived home in South Gate my mother and father and sister Jeanette were out in the front yard, having evacuated the house. I went in our house, found our dinner (pork chops) all over the floor in the kitchen, and furniture throughout the house overturned (i.e., the radio in the living room; the typewriter which normally sat on a table in my front bedroom had been thrown over onto the bed). I slept in my Chevrolet coupe that night, and my parents and sister slept in the family Star car. The next day I drove around to view the earthquake ruins. Compton and Long Beach were hit worst, with Watts, Huntington Park, Huntington Beach, and Santa Ana also hit hard. The morning newspaper estimated the death toll at 127, with 3000 injured and \$30 million worth of property damage. Tremors continued throughout the day and the next day. However, when I returned to UCLA on Monday I found very little earthquake damage there.

While majoring in Chemistry, I took the maximum number of courses in Physics. In my senior year at UCLA I had a course in Modern Physics given by Prof. John Mead Adams (a lineal descendant of the second president of the United States), who talked to us of the exciting discoveries in nuclear science. And these lectures fixed my sights on this new frontier.

I stayed on a fifth year at UCLA, 1933–1934, taking a number of courses in Physics, which that year were started at the graduate (Master's degree) level. I hoped that graduate work would also be instituted in the Department of Chemistry. Just before the beginning of the fall semester I went to see Provost Ernest Carroll Moore to urge on him the initiation of graduate work in Chemistry, but he indicated that such a decision must be made at the level of President Robert Gordon Sproul. Therefore, I immediately visited Berkeley, brashly called on him (without an appointment) to press on him the initiation of graduate work in Chemistry in UCLA. His secretary, Miss Agnes Robb, let me go in to see Sproul. He treated me very well but was noncommittal on the graduate work questions. (On this visit I met chemistry professor Wendell Latimer, which may have helped in my admission later to graduate work at Berkeley.)

It soon became apparent that I should instead go on to graduate work at Berkeley. Ramsey urged me to go on to Berkeley, an additional incentive to that furnished by physics professor Adams in his course on Atomic Physics, in which he described the pioneering nuclear research underway at Berkeley.

For my graduate work there could be no place but the University of California at Berkeley. The very name, Berkeley, was magic; it was a distant and almost unattainable mecca. The chemistry staff at Berkeley was legendary, having written the textbooks from which we took our courses at UCLA. There were names such as Joel H. Hildebrand, Wendell M. Latimer, William C. Bray, C. Walter Porter, Gerald E.K. Branch, and, of course, the great Gilbert Newton Lewis, dean of the College of Chemistry. I had become acquainted with his 1923 book *Valence and Structure of Atoms and Molecules*, and was fascinated by it. I wanted to meet and become acquainted with

this remarkable man. The name of the rising young nuclear physicist Ernest O. Lawrence was beginning to ring through the world of science. I wanted to work as near as possible to Lewis (the great “G.N.” — “The Chief”) and to Lawrence. And again the absence of a tuition fee was consistent with the state of my finances.

Reaching this mecca was not necessarily simple. Not everyone was admitted, and so the custom was to apply to a number of graduate schools. Moreover, I had not only to be accepted but to be granted a teaching assistantship (at a salary of \$50 per month) to support me through graduate study. UCLA chemistry professor James B. Ramsey, who had done his graduate work at Berkeley, assured me that there was no need to apply to alternative institutions, that Berkeley would grant me both my wishes. And so it did, to a lingering disbelief on my part, despite Prof. Ramsey’s reassurances.

It is difficult to describe the exciting, glamorous atmosphere that existed at the University of California at Berkeley when I entered as a graduate student in August 1934. I took formal courses in Chemistry from such eminent men as Profs. Axel R. Olson and William F. Giaque, and in Physics from Raymond T. Birge and Robert B. Brode. As a teaching assistant in freshman chemistry my instructor colleagues in the laboratory sections included such men as Joel H. Hildebrand (who always gave the main lectures as well), Wendell M. Latimer, William C. Bray, Giaque and Ermon D. Eastman. Probably the high point of each week was the Tuesday afternoon Research Conference held in Gilman Hall, at which graduate students presented a research paper on a current topic from the literature, which was followed by a faculty member, postdoctoral scientist, or advanced graduate student describing his own recent research. The latter was always in the forefront of scientific research in an interesting area. Here we saw G.N. at his best, sitting at the head of the table which dominated the center of the room, chain-smoking his huge black cigars. He asked questions and stimulated discussion over the whole wide range of Chemistry and Physics in a manner which I have never seen equaled.

Another high point was the weekly evening Nuclear Seminar, covering recent articles from the scientific literature and the current work in the College of Chemistry in the area of Nuclear Science; this seminar was run by Willard F. Libby and Robert D. Fowler, who guided my research until he left. G.N. also always attended these seminars, which added considerably to the excitement. In Le Conte Hall on Monday evenings, there was the Physics Journal Club, presided over by Lawrence, including the brilliant galaxy of J. Robert Oppenheimer, Edwin M. McMillan, Luis W. Alvarez, Philip H. Abelson, Martin D. Kamen, and John J. Livingood, just to mention a few. It was in this atmosphere that I was privileged to carry out my doctoral research in the company of such fellow students as David C. Grahame (who worked with me as my research partner), Kenneth S. Pitzer, Samuel Ruben, and many others.

I made a good start toward realizing my ambition to become a nuclear scientist when I completed my graduate thesis on a nuclear physics project, regarding the inelastic scattering of fast neutrons. After starting this project with Fowler, who moved to Johns Hopkins University, I completed the work with Chemistry Professor George Ernest Gibson. Grahame and I carried out this research in the cavernous auditorium of the abandoned East Hall, an ancient building which had been moved from its original site at the present location of Le Conte Hall to a then vacant spot just to the south of Faculty Glade at about the present location of Morrison Hall. We were forced to perform our experiments during the graveyard shift, because Lewis required the use of the Chemistry Department's sole radium-beryllium source of neutrons during the daytime and evening hours. Our experiments provided what was probably the first unequivocal evidence for the phenomenon of inelastic scattering of fast neutrons. We established a minimum probability (cross section) for this type of reaction in the region of lead and bismuth, an observation that was beyond theoretical understanding at that time but was explained years later as due to the closed nucleon shells of 82 protons and 126 neutrons.

When I obtained my Ph.D. degree in May 1937, I stayed on, continuing my research even though I had no immediate prospect of a job. This was a Depression year and satisfactory positions were very difficult to obtain. Yet such was the atmosphere at Berkeley and my preoccupation with my research that I was only vaguely worried about my future. Then one day in the middle of the summer, G.N. called me in and asked whether I would like to serve as his personal research assistant. Because of his reputation and standing, he was almost unique in having such an assistant, and the position at \$1,800 per year happened to be open at that time. I was overwhelmed at this opportunity and immediately accepted, after first expressing some genuine doubts as to my adequacy. In this role, I published several papers with "The Chief" in the area of generalized acids and bases, which was his current interest and rather far from my own area and aptitude.

Some time before I began my work with G.N. I entered almost by accident the mainstream of my career as a nuclear scientist. One day in 1936 I was suddenly confronted by Jack Livingood, a physicist who was favored by ready access to that nuclear horn of plenty, the 27-inch cyclotron. He literally handed me a "hot" target, just bombarded by the machine, and asked me to process it chemically to identify the radioisotopes that had been produced. Naturally, I jumped at the chance. The facility he offered in Le Conte Hall was hardly luxurious. My best recollection is that it was the custodian's closet and that the resources consisted of tap water, a sink, and a small workbench. With some essential materials bootlegged from the Department of Chemistry, I performed the chemical separation to Jack's satisfaction. In the course of my collaboration with Livingood, covering a period of five years, we discovered a number of radioisotopes which proved useful for biological explorations and medical applications. Among the isotopes that we discovered were iodine-131 and iron-59, and among the useful isotopes that we characterized was cobalt-60.

The discovery of iodine-131 has given me special satisfaction. On one occasion during this period, in 1938, the late Dr. Joseph G.

Hamilton, one of the outstanding nuclear medical pioneers, mentioned to me the limitations on his studies of thyroid metabolism imposed by the short lifetime of the radioactive iodine tracer that was available. He was working with iodine-128, which has a half-life of only 25 minutes. When he inquired about the possibility of finding another iodine isotope with a longer half-life, I asked him what value would be best for his work. He replied, "Oh, about a week." Soon after that, using the 37-inch cyclotron, Jack Livingood and I synthesized and identified iodine-131, with a half-life, luckily enough, of eight days. This isotope is widely used for the diagnosis and treatment of thyroid disease and the diagnosis of other disorders. I have the added satisfaction that my own mother had her life extended by many years as a result of treatment with iodine-131.

Also in 1938, in a collaboration with Emilio Segrè, I was a discoverer of technetium-99m, which has become the most widely used radioisotope for diagnosis in nuclear medicine.

My experience as a radioisotope hunter led eventually to the transuranium elements, a nuclear field that was to become my lifework. My interest in the subject had been aroused soon after I arrived at Berkeley. In the fall of 1934, at the evening Nuclear Seminar presided over by Libby and Fowler, we learned of the experiments by Fermi and his group in Italy. They reported that they had bombarded uranium with neutrons and produced what they thought were radioactive isotopes of transuranium elements, i.e., elements in the periodic table that were heavier than and beyond the heaviest natural element, uranium. Somewhat later, this work was taken up in Germany by Otto Hahn, Lise Meitner, and Fritz Strassmann. I read avidly all the reports on these so-called transuranium elements. I even chose this as my topic for the Tuesday Research Conference, using one of the papers by Hahn and his associates as the basis for a complete description of the chemical properties of these transuranium elements, a nonsubject on which I considered myself already a minor expert.

Then, at the Journal Club meeting in the Department of Physics on a Monday night in January 1939, my mastery of the "field"

vanished in a moment. The information had come through by word of mouth that Hahn and Strassmann in Germany had identified some of the radioactivities as isotopes of barium and lanthanum, and that what actually happened upon the bombardment of uranium with neutrons was the splitting of the uranium nucleus into two approximately equal-sized fragments, with the release of a large amount of nuclear energy. Nuclear scientists had been looking at fission products, not transuranium elements.

I cannot possibly describe either the excitement that this produced in me or the chagrin I felt in realizing that I had failed to interpret correctly the wealth of information I had studied so assiduously for a number of years. After the seminar was over I walked the streets of Berkeley for hours, in turn exhilarated by the beauty of the discovery, despairing over my lack of insight and intrigued by the import of this exciting new fission reaction.



Fig. 4. Helen L. Seaborg and Glenn T. Seaborg, Christmas 1941 in San Francisco.

I have often said that my greatest discovery was Helen Griggs, the girl I married. I first met Helen in September 1938, when she was serving as Ernest Lawrence's secretary. I found her very winsome and felt that I wanted to get to know her better. She is five years younger than I. However, although I saw her many times during the intervening three years, I didn't succeed in dating her until the fall of 1941. I had competition from Donald Cooksey (assistant director of the Radiation Laboratory), who was dating her on a regular basis. Helen and I continued dating during the fall of 1941, and it was clear by Christmas time that I was madly in love with her (Fig. 4). Finally here was a girl that I was dating exclusively. For the first time since I came to Berkeley in 1934, I did not go home to my parents for Christmas, but had Christmas dinner with Helen in San Francisco.



Fig. 5. Helen L. Seaborg and Glenn T. Seaborg at Seaborg's parents' home, South Gate, June 5, 1942, the day before they were married.

When the decision was made that I should move to Chicago for work on the Plutonium Project, I immediately proposed to Helen, on March 23, 1942, and she accepted. The understanding was that I would make a visit back to Berkeley soon to join her for the wedding. After our reunion in Berkeley we visited my parents in South Gate, then boarded a train headed for Chicago, planning to get married en route (Fig. 5). Later Helen wrote the following account of our misadventures in getting to “the altar”:

“We had quite a time getting married but it was also very amusing; in fact, we began to feel like a movie scenario before we got through. We got off the train in Caliente, Nevada, on Saturday morning, June 6, about ten o’clock, with a great deal of confidence, without a care in the world, and a feeling that we merely had to take care of a few details and we would then have been quietly married. Little did we realize what was in store for us! We first decided to check our bags, but Caliente had no checkroom. The telegraph operator finally told Glenn that he could leave our things in his place. We deposited our junk and proceeded out to look over the town and find the place to get a marriage license. Being a little coy, we strolled around looking for the place instead of boldly asking anyone. Since we couldn’t locate the city hall or anything that remotely resembled same, we finally went in to the town telephone and asked the woman who operated it. She acted as though she had never heard of such a thing as a ‘city hall.’ We then asked where one could get a marriage license, to which she replied, ‘Why, from Evans Edwards’ in tones that clearly indicated she thought us terribly stupid not to know that. Glenn asked her where Ev was, and she said, ‘Why, down around the corner next to the drug store.’ Here her tones indicated that it was the same place it had always been, what was the matter with us anyway. So we proceeded to Ev’s to find him leaning back precariously in his swivel chair looking into space. We told him we wanted to get a marriage license. From Ev we learned that one could not

obtain a marriage license in Caliente and that the closest place to get one was Pioche, which was some 25 miles north. Ev was most uncommunicative and didn't seem to have anything to offer in the way of a suggestion for us to get over there. At this point a woman came out. Like most women, she had romance in her soul, and she told us we could probably get a ride in the mail truck, told us where to find it, and said it had not yet left. We thanked her gratefully and left.

"Glenn went to find the driver of the truck while I went to buy a pair of tennis shoes. The town was nothing but dust, and, of course, I had nothing but toeless shoes. When I came back I found him talking to a young man. The latter, it turned out, was a deputy sheriff and son of the telegraph operator, in whose place we had left our bags. Apparently the local inhabitants were somewhat suspicious of us and had asked the young fellow to check up on us. So he had come up to Glenn and asked, 'Are you a teacher?' Poor Glenn, this was a horrible shock; he thought, 'Surely it doesn't stick out all over me already,' but he admitted he was. This was followed with, 'Do you teach Chemistry?' 'Yes.' After this cautious approach the fellow admitted that he had just graduated from Cal majoring in Chemistry [*Glenn learned much later that the deputy's name was Frank White Anders*], that Caliente was his home, and that he was there for the summer before taking a job in research laboratories in Washington this fall. Then he was very nice and offered to help us in any way he could; so he and Glenn went over to the town telephone to call Pioche to make sure we could get in the county courthouse if we got there after noon (since it was Saturday). A voice at the other end of the wire said of course someone would be there — didn't he know the county commissioners were meeting that afternoon? Then we piled into the mail truck and were off, via Panaca, for Pioche. We arrived about 12:40 p.m. to find the assistant county clerk waiting for us. She told us that she would have been gone if Glenn hadn't

called; so we felt very lucky. She made out our license and was more nervous than we were. By that time we were very calm anyway — prepared for whatever might come. I am sure we were beyond the point of surprise. Then she asked us if we wanted her to call the judge, and we asked her about a minister. It turned out there was only one in town; so she tried to locate him for us, but he was nowhere to be found. We decided we had better not take further chances and asked her to get the judge for us then. Well, nobody knew where the judge was; so she told us to get in her car and she would drive us to town to find the minister or the judge. (The courthouse was about a mile from the town itself.) When we got there, she told us to go have lunch while she hunted. We invited her to have lunch with us, but she insisted on our going ahead and that she would hunt. She told us which was the better restaurant in town and went off. When we were half through lunch, she came in to tell us that she had located the judge and to come to her car when we were finished eating. A few minutes later the judge [*Glenn learned later that his name was Edgar L. Nores*] came in and told us they were right across the street waiting for us. I shall never forgive Glenn (as I tell him as frequently as I have an opportunity) for practically telling the judge that we would be there as soon as he finished his apple pie, and he sat there and calmly finished. The rest of the day was comparatively calm after that. The judge was just like the country judge one reads about in books. He was very proud of his country and told us all about the mining there. He was rather cute. When he gave me the marriage license, he told Glenn to keep his hands off — that it was mine — and told me not to let him have it. We got quite a kick out of it. Then we both forgot to pay him — after our having some discussion as to what one should give him.

“Glenn and I were both convinced that had we not the good fortune to run into the two young women with romantic souls we would never have succeeded in getting

married. The assistant clerk was a roly-poly good-natured person who told us that Pioche was not her hometown — Panaca was. (Panaca was 13 miles south.) It turned out she was married to a sailor and had been going where he did whenever she could, but he went to Ireland last summer, and she had felt lonely and had come back to Pioche to work. She had been married eight years and apparently thought it was a very good idea.

“We had to wait until 4:30 for the mail truck to take us back to Caliente; so we took a walk and proceeded up a hill and saw some beautiful cedars and got some sun. We then decided that the city folk may make suckers of the country people who come to town but that this is nothing to what the country folk do to the city guys. We met a man with a bunch of pictures of the Pioche High School band, and it seemed the band had just won some kind of an honor and that they would be able to do something else wonderful if only we bought one of the pictures. He told us that this was the only honor that had ever come to Pioche and put up a wonderful sales talk — what could we do but purchase a picture of the Pioche High School band. On the way back to town we met a very palsy-walsy fellow (slightly tipsy), but he wanted us to stop and have a cigarette with him. We gravely thanked him, told him we were very sorry we didn’t smoke. This left him feeling very sad, and he assured us he wasn’t mad and that we didn’t have to have a cigarette with him. We loafed around and drank cokes until the mail truck started back, and we arrived in Caliente about 5:30. So we say it took us all day to get married. Confidentially, I was beginning to wonder if we were really going to get married, and Glenn doesn’t deny that he conjured up these obstacles himself in the hope that he would get out of it at the last moment. The funny part is that we got married in Nevada to save time.”

Helen and I visited Caliente and Pioche again at the time of our 50th wedding anniversary, June 1992. We found some changes,

but the Caliente railroad station building was still there, changed to a museum and city offices, and the Lincoln County Courthouse in Pioche was still there, even the room where Justice of the Peace Edgar L. Nores performed our marriage ceremony. Helen and I have succeeded in locating Frank White Anders so we could tender him our belated thanks for his crucial help on June 6, 1942.

My entry into the transuranium field is described in the introductory passages of Chapter 1.