A Man Beyond Elements:
Glenn T. *Seaborg*

The Khwarzimic Science Society

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The periodic table is the roadmap of chemistry and the fountain-head of humankind's understanding of his natural surroundings. The Russian chemist Dmitri Mendeleev first formulated the periodic law (1869) and envisaged the modem periodic table. The periodic tables that proudly hangs in our classrooms, laboratories and is inserted in many of our chemistry textbooks follows, more or less, the same pattern. Mendeleev was the first *modern* chemist who brought about the true music of elements. The periodic law states that elements with similar properties repeat themselves after regular gaps, if they are arranged in a regular manner (of increasing atomic number). This arrangement is coined the *"Periodic Table"*.

The most significant departure from *conventional periodic wisdom* came this century, by a magnitude nothing less than a *chemical cataclysm*. Seaborg changed the face of the periodic table and in the face of orthodox dogmatism, transformed the worldview. He discovered ten transuranic elements called the actinides and numerous radioisotopes. He was the only *inventor* whose patents included two elements: *americium* and curium and was the only living person, whose name carries forever in the name of an element, *seaborgium.* The latter, he regarded as an honour to him, even of greater prestige than the bestowment of the Nobel Prize.

Our interest in Seaborg was flared up when we had the opportunity to communicate with him, congratulating him on his recent accolades two years ago (1998), and to our dear surprise and extreme delight, we received an autographed letter from his desk: *A Letter to Students Interested in Science*. Two years have passed since his death in 1998 – a few months after we had been in brief but a memorable touch with him. His demise has rendered a great loss to chemistry and international education.

The Khwarzimic Science Society also takes the opportunity to pay a silent but sincere tribute to the most diversely faceted chemist, scientist, politician, environmentalist and political strategist of the modem age. To us, more inspiring than the preeminent positions he held in the U.S. Departments of State, Energy and the Manhattan Nuclear Project, is his passionate indulgence in science, which to him, was the key to a brighter and better future, "*The intellectual satisfaction, the thrill of discovery and the sense of worthwhile effort are a rich reward and a strong stimulus to continued work*", says Seaborg in his coveted Letter.

Seaborg, at a tender age, loved physics but took up chemistry at the University of California at Los Angeles, because chemistry could secure him a job, as he thought. That was just the beginning of a golden era of marvel and discovery. He started work at the University of California at Berkeley under the supervision of G.N. Lewis, the pioneer of physical chemistry and with him developed the concept of primary and secondary electrolytes. At this juncture, he also had the opportunity of meeting the living

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legends of his time – Ernest Lawrence, the inventor of the cyclotron, a giant atom-smashing machine and Robert Oppenheimer, the frontline scientist in America's nuclear programmer. But Einstein had always remained as Seaborg's ideal and he often reminisced over their maiden rendezvous.

Nuclear experiments are nowadays routine procedure carried out by radiochemists. The idea lies in bombarding nuclei of atoms with lighter particles and to analyse the outcome – reaction products, energy changes, identity transformations and decays. Nuclear experiments, in addition, may yield unknown elements which are produced in miniscule amounts and to identify them, they must be separated. "*This is like choosing the right magnet to picking up one needle from a haystack of similar needles.*" The turning point in Seaborg's life came when he was assigned a similar task – to perform a chemical separation of a suspected element produced as a result of a nuclear projectile experiment. The enthusiastic chemist, after days of hard work, finally succeeded. This opened an altogether new world for the young experimenter.

Soon there was a rapid succession of discoveries made by Seaborg. By *discovery* we mean the proactive *'synthesis, separation and characterization'* of isotopes that had hitherto existed only in oblivion. Isotopes are variants of the same element, with the same atomic number but different mass numbers. One after the other, *iodine* 131, *cesium* 137, *cobalt* 57 and 60, *technetium* 99m, *zinc* 65 and *iron* 55 and 59. Today, these isotopes have transformed modem medicine. For example, it is the healing power of gamma rays from cobalt sources that is nowadays used in the treatment of cancer, saving thousands of lives each year. Thyroid treatment using radioiodine tracers now prolongs lives of many a victim of goiter, and so did the element save Seaborg's mother herself!

1940 remains the most important and distinct year in Seaborg's life. One anxious night, Seaborg and his co-workers (McMillan, Kennedy and Wahl) discovered *plutonium*. America went on war with Axial powers and Seaborg soon realised the devastating capabilities of his new chemical species. Soon the chemist was engaged in the mountainous task of building America's first nuclear device. The wartime laboratories had themselves waged a war against time. They were consumed, day and night in a secret affair in materialising their nuclear designs. Sometimes these laboratories were even oblivious of the presence of sister organisations. *Plutonium* had fueled the first wartime atomic explosions in August 1945.

With military devastation, *plutonium* also harboured its *benevolent* advantages. Its abundant availability marked its indelible stamp of superiority over *uranium*. Its ease of fission also added to its vitality and hence, opened new doors for safe, clean and efficient energy production. The same element was also the fuel for nuclear batteries used in space exploration. Seaborg's political career started here when he re-emerged as the prime vocalist vowing for *peaceful plutonium*. He offered his advice to American Presidents, the U.S. Congress and international agencies. During his tenure as the Chairman of the U.S. Atomic energy Commission, the number of nuclear reactors in the country sore from just a couple to over seventy. Nuclear safety and disarmament were prior incentives for Seaborg. He initiated the worldwide campaign to safe dumping of nuclear waste. In addition he played the middleman in the IBM Treaties and the SALT Talks and was a severe critic to the United States' double standards in maintaining a nuclear hegemony. This chicanery, unfortunately, still stands the test of criticism and evaluative critique.

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Seaborg investigated the chemistry of heavy elements and synthesised ten new elements: *americium*, *curium*, *berkelium*, *californium*, *einsteinium*, fermium, *mendelevium*, *nobelium* and *seaborgium*, in addition to, of course *plutonium*. These elements have atomic numbers from 94 through 102. Seaborgium stands at 106. They are coined actinides (*seaborgium* is an exception), since they follow actinium in the periodic table. It was Seaborg's major contribution to insert this series of elements into the periodic table at the most appropriate position. This opened doors to the search for new and newer elements. To date 112 elements have been reported and the quest, we believe, would never end. This seems to be a shining example of restless human endeavour, especially when we compare it with the day when Seaborg was about to name element no. 94 (*plutonium*) as *extremium* or *ultimium*. He admitted that it would have been a foolish mistake on his part and luckily, he was saved from the chagrin.

Seaborg was the first author of the 17-page Table of *Isotopes*. Today this table is covered in 2 volumes and over 3000 pages. It is also available on the web and in compact disk with inline nuclear structure data. The Table is of Biblical wealth to researchers in radio and elemental chemistry. His contributions also sent shockwaves in the fields of fission research and deep inelastic scattering of nuclear projectiles. He also coined the term *spallation* for nuclear reactions that gave out a bursting rain of several isotopes.

Seaborg believed in the youth and their aspirations. He had become a role model for his students. Even till his death at 86, he was truly young at heart. What fascinates us is that despite his esteemed stature and Chancellor ship of the UCB, he used to purposely take the freshman chemistry class. This highly contrasts with the attitude that we see around us, in our and many other countries of the world where Chairmen hardly take any classes at all. His contemporary, Richard Feynmann was also a man whose passion was to teach undergraduate students in physics. Such luminaries, when came in direct contact with the younger pupils, printed indelible impressions in their minds of the fascination, excitement and zest, that education in science calls for. These marks were saved from the transgression of time and hour.

In short, let us see what we can distill from the life of this man: *the elements of purposeful existence are sheer hard work, dedication and devotion to learning and knowledge and a firm sense of Belief.* The epitome of success needs no clarification. Success only awaits our appraisal. We should go beyond mere lip service to education and science in our country. Let us go beyond the mere recital of the praises of the *forbidden wonders* of science. We have as an example, a man who was truly **beyond elements**.

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