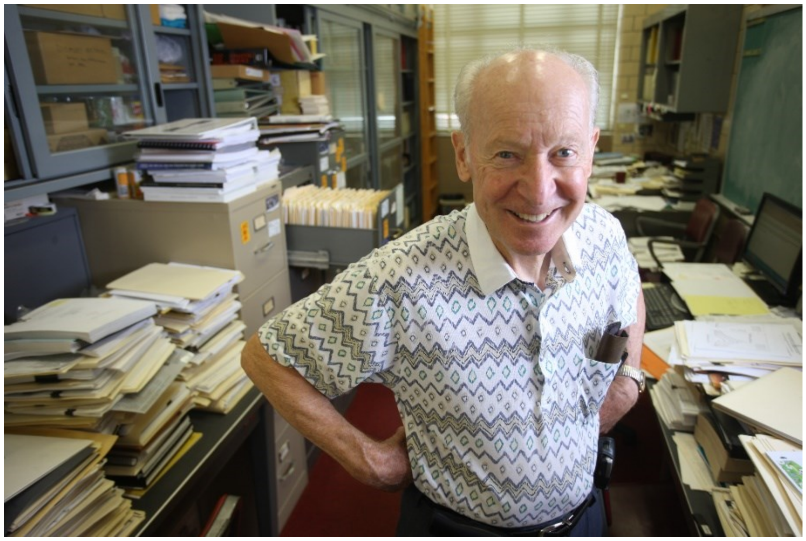
Karl A. Gschneidner, Jr. (1930 – 2016)



Karl Albert Gschneidner Jr died on 27 April 2016. Nicknamed Mr. Rare Earth, he holds an unparalleled place as the renowned authority in just about every aspect related to the science, technology and history of a very special family of elements — the rare earths. Naturally unassuming, Karl gladly shared his vast knowledge with many if not everyone he met, always bursting with excitement about his favourite subject. Leading by example but letting others show the way when ready, staying focused yet always looking for opportunities, remaining dedicated and never passing-up a chance to lend a hand, were just a few of his indisputable traits.

Karl was born in Detroit on 16 November 1930 into a family of German immigrants who came to the United States during the short break between the First and Second World Wars. He received a BS in Chemistry from the University of Detroit in 1952 and a PhD in Physical Chemistry from Iowa State University in 1957 under the supervision of Frank H. Spedding and Adrian H. Daane. Immediately after graduation, Karl and his beloved wife Melba took a long, scenic drive across the country to his first real job as a staff member of Los Alamos Scientific Laboratory of the University of California, where he soon stepped in as a section leader. When Adrian Daane moved from Ames to Kansas State University in 1963, Karl was hired as an associate professor of metallurgy at his alma mater and became a group leader at the Ames Laboratory. Little did he know that Iowa State University, Ames Laboratory and Ames would become his home for the next 50-plus years.

The fraternal fifteen — as Karl called the rare earths — were his lifelong dedication and favourite playground. He likened the lanthanides — the elements from lanthanum to lutetium — to fifteen identical houses located on Rare Earth Drive. Going up the drive one sees a house with no children first, then each of the next seven houses adds one more boy into the family, followed by seven houses each adding one more girl into the already large, seven-boy family. Associating 4*f* electrons with boys (spin +1/2) and girls (spin −1/2) proved to be an insightful metaphor. Being 'little kids', the 4*f* electrons are buried deep inside the electronic core and hence incapable of making informed decisions about what the family does; yet they have a tremendous influence on each family's behaviour. Long before developments in density functional theory revealed the roles of different electrons in the chemistry and physics of rare earth compounds, Karl had predicted that the 4*f* electrons may impart the principal influence on structure and properties of lanthanide alloys. The mechanism, as we know it today, is 4*f* electron hybridization with the atoms' own 5*d* electrons and also with valence and conduction electrons of partner atoms, which is the key to design of materials for applications that involve rare earth and transition metal magnetism.

Later, Karl realized that in the rare earth family, nature had given him the ultimate model which could add much-needed predictive power to alloy theory. In a series of seminal papers published in the mid-1980s, he analysed 21 then-known intra-lanthanide binary systems and derived a generalized phase diagram that can be used to predict phase relationships in any of the 91 possible binary intra-rare-earth alloy systems excluding divalent europium and ytterbium but including the non-lanthanide rare earth element — yttrium. Subsequent experiments have fully confirmed Karl's predictions.

Karl's research career involved two more breakthrough achievements: discovery of the giant magnetocaloric effect in a rare earth compound, $Gd_5Si_2Ge_2$, and demonstration of the first successful near-room-temperature magnetic refrigerator which operated for nearly 20 months. Both were announced in 1997, and triggered a technological revolution — numerous research clusters worldwide began investigating this effect, and their combined efforts may result in the replacement of conventional vapour-compression refrigeration systems with highly efficient, environmentally friendly solid-state caloric cooling devices.

Karl was a visionary who appreciated the value of easily accessible scientific information well before now-common online tools had entered the information mainstream. In 1966 he founded (and directed for the following 30 years) the highly regarded Rare Earth Information Center (RIC). By the time RIC closed in 2002, its database contained well over 100,000 entries, storing nearly every published piece related to rare earths. During its existence, RIC circulated a quarterly newsletter, known to many as RIC News, a monthly RIC Insight, and fulfilled tens of thousands of requests for scientific information.

His unreserved dedication to the rare earth science is also embodied in the authoritative *Handbook on the Physics and Chemistry of Rare Earths*. He edited the very first volume, published in 1978, together with his friend LeRoy Eyring. The original four-volume monograph was so successful that Karl ended up editing 41 volumes before retiring from the editorship in 2011.

Karl's legacy stays alive in many ways: volume 50 of the *Handbook on the Physics and Chemistry of Rare Earths* is due out in 2016; the one and only course in the USA on the Physical and Chemical Metallurgy of Rare Earths, that he developed and taught for many years before retiring from teaching in 1995, has been updated and once again offered at Iowa State; the Critical Materials Institute, that he helped to build from the ground up as its chief scientific officer, is going strong in its fourth year; and the caloric materials consortium named CaloriCool, a member of the US DOE's Energy Materials Network, has been launched in 2016. All Karl's friends and colleagues who had the privilege of working with him are heartbroken that Karl is no longer with us. But we believe he would be as delighted as we are to see that the influence of his research lives on.

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