



**HAROLD W. KRUEGER (1935–1997)**

Harold W. Krueger, a founder and owner of Geochron Laboratories of Cambridge, Massachusetts, died on Sunday, August 10, 1997, at the age of 62, losing a three-year battle with cancer.

Born in St. James, Minnesota, Hal graduated with honors from the University of Minnesota, receiving a Bachelor of Science in Geological Engineering in 1957 and a Master of Science in Geology in 1959. Hal's Masters work was on the theory and techniques of K-Ar dating. He began a doctoral program in isotope geochemistry at the Massachusetts Institute of Technology in 1959, but soon left to found Geochron Laboratories along with three partners in 1960.

Geochron Laboratories, which began as a public stock company, was one of the first commercial laboratories to offer geological isotope analyses; it is the only successful one to have been started independently, without a close university association. The first analytical service Hal offered through Geochron was the K-Ar dating of rocks and minerals. In 1964 he added radiocarbon analyses to his services, and in 1969 stable isotope ratio analyses. Geochron was the first to offer these analyses on a commercial basis. Strontium isotope and tritium analyses were later added to the list of services. In 1967, realizing that Geochron Labs would never become large enough to reward his investors, Hal negotiated a merger with Orion Research Corporation in order to give them a better opportunity to profit from their investment. A few years later, Hal personally purchased Geochron from Orion, establishing his own corporation, Krueger Enterprises, Inc., as Geochron's legal owner, but still operating under the trade name "Geochron Laboratories".

During his 37 years with Geochron Labs, first as Technical Director, and then as President and owner, Hal devoted much of his time to studying New England geology and geochronology and pio-

neering the use of radiocarbon and stable isotope analyses in identifying adulteration of foods, evaluating metabolic processes in humans and animals, determining the dietary composition of human bone, and in characterizing pollutants and determining their origins and flow patterns. He also devoted his time to using the radiocarbon method to authenticate wine vintages and the ages of bonded whiskeys. As a consultant, he spent time in Morocco re-evaluating the geology of that country and its relation to the opening of the Atlantic during the Mesozoic; in Indonesia evaluating the abilities and needs of the Indonesian Geological Survey; in Puerto Rico studying groundwater flows at a major waste repository; and at Yucca Flats, Nevada, as one of the first investigators examining the proposed nuclear waste repository site. He also played an active role in the development of standards for radiocarbon dating. Together with Henry Polach, he standardized the sucrose now used as a secondary standard in laboratories around the world

Hal's first love was laboratory work, and he preferred to spend as much time in the lab as possible. He took a keen interest in the work of many of his clients, who, as a result, became his personal friends. Hal was a scrupulous investigator who liked to paraphrase an old saying into "The evil is in the details". This may be one reason that he chose as his personal line of investigation the radiocarbon dating of bones—a difficult material to work with by the  $^{14}\text{C}$  method—which was later expanded to include the carbon and nitrogen stable isotope analyses of bones and bone components for dietary studies, using both bone collagen and bone apatite. He showed the feasibility and usefulness of this method through a series of laboratory and natural experiments.

Hal delighted in having both undergraduate and graduate students come to Geochron to use his facilities in their research work, and was generous with his time in assisting and instructing them in many of the finer details of the work. Hal devoted much of his time and that of his staff to hosting instructional tours for student groups, ranging from high school to graduate students. Shortly after Geochron was founded, he instituted the annual Geochron Research Awards Program, under which graduate students are awarded free analytical services, the recipients being chosen on the basis of the research proposals they submit for consideration. This program is still active after 37 years.

Although he was failing rapidly, Hal continued to come to the lab for at least a few hours a day up until two weeks before his death. We have lost a good scientist, a great colleague, and a close friend.

*Alexander Cherkinsky and Richard Reesman*

#### SELECTED BIBLIOGRAPHY

- Krueger, H. W. 1965 The preservation and dating of collagen in ancient bones. *In* Proceedings of the 6th International Conference on Radiocarbon and Tritium Dating, Pullman, WA (USAEC Conf-650652): 332–337.
- Krueger, H. W. and Weeks, C. F. 1965 Geochron Laboratories, Inc. radiocarbon measurements I. *Radiocarbon* 7: 47–53.
- \_\_\_\_\_. 1966 Geochron Laboratories, Inc. radiocarbon measurements II. *Radiocarbon* 8: 142–160.
- Sullivan, C. H. and Krueger, H. W. 1981 Carbon isotope analysis of separate chemical phases in modern and fossil bone. *Nature* 292: 333–335.
- Krueger, H. W. and Reesman, R. H. 1982 Carbon isotope analyses in food technology. *Mass Spectrometry Review* 1: 205–236.
- Sullivan, C. H. and Krueger, H. W. 1983 Carbon isotope ratios of bone apatite and animal diet reconstruction. *Nature* 301: 177–178.
- Krueger, D. A. and Krueger, H. W. 1983 Carbon isotopes in vanillin and the detection of falsified "natural" vanillin. *Journal of Agricultural and Food Chemistry* 31: 1265–1268.
- Martin, G. E., Krueger, H. W. and Burggraff, J. M. 1985 Radiocarbon  $^{14}\text{C}$  differentiation of sparkling and carbonated wines. *Journal of the Association of Official Analytical Chemists* 68: 440–443.
- Krueger, H. W. 1991 Exchange of carbon with biological apatite. *Journal of Archaeological Science* 18: 355–361.
- Nelson, A. R. *et al.* 1995 Radiocarbon evidence for extensive plate-boundary rupture about 300 years ago at the Cascadia subduction zone. *Nature* 378: 371–374.
- Eby, G. N., Roden-Tice, M., Krueger, H. W. *et al.* 1995 Geochronology and cooling history of the northern part of the Chilwa Alkaline Province, Malawi. *Journal of African Earth Science* 20(3–4): 275–288.