The Newer Elements

The Elements Beyond Uranium. GLENN T. SEABORG and WALTER D. LOVELAND. Wiley, New York, 1990. xiv, 359 pp., illus. $49.95. A Wiley-Interscience Publication.

Today the distinctions between the fields of nuclear physics and nuclear chemistry are so blurred as to be nonexistent, but that was not so in the 1940s when a small band of nuclear chemists participated in one of the great adventures of scientific research—the creation of new elements. Those must have been heady days, which became years and then decades. In a period of a little over 40 years, beginning with the production of element 93—neptunium—in 1940 and ending, at least for the nonce, with element 109 in 1982, 17 new elements were fashioned where none had been before—10 of them by the end of the 1950s. One of these, plutonium-244, was later found in nature but in negligible amounts. Plutonium-239, one of the explosive ingredients of fission weapons, has now been produced artificially in quantities that must amount to many metric tons.

The story of this modern-day alchemy is recounted in this 12th volume of a series on transuranium elements with which coauthor Glenn Seaborg, who has played a key progenitorial role in the forging of most of the new elements, has had a close association.

The techniques for the production of the elements are varied, as are the methods used in their identification and the exquisitely refined microchemical techniques required to deal with samples sometimes involving only a few atoms. All these are described in the book. Production methods include slow neutron irradiation in reactors, bombardment with light projectiles (hydrogen and helium isotopes) from cyclotrons and other accelerators, thermonuclear explosions, and bombardment by a whole arsenal of heavier stable projectiles from boron to xenon, again from a variety of accelerators. Concerning the means both of physical and chemical extraction and of detection, the investigators had to contend not only with vanishingly small samples but with samples that actually vanished, sometimes in a matter of minutes, owing to their nuclear instability.

To this reviewer the two most interesting chapters in the book are the one on details of the synthesis of the new elements and the one on superheavy elements (in the region of atomic number 114). The former includes black-and-white photographs of the proud progenitors and is liberally laced with their reminiscences as well as the criteria for the discovery of a new chemical element. In the chapter on the superheavies the authors lament that these elements still elude detection even though their creation should be possible and some, at least, should survive long enough to make their presence known. Another chapter on practical applications of uranium and the transuranium elements is also to be commended. Much of the book, involving as it does chemical and nuclear properties of elements in the periodic table in general and of the transuranics in particular, is too detailed for nonexperts in the field and not detailed enough for the experts. The latter deficiency is mitigated by extensive bibliographies.

The book, in general, is a quite readable account of an exciting chapter in scientific endeavor. Some of us in atomic and nuclear science have spent a large part of our lives attempting to elucidate the properties of atoms and nuclei. The nuclear chemists featured in this book did more than that; they first manufactured those elements whose properties they proceeded to study.

HARRY E. GOVE
Nuclear Structure Research Laboratory, University of Rochester, Rochester, NY 14627

Codiscoverers of Element 106, Lawrence Berkeley Laboratory, 1974. Left to right: Matti Nurmia, Jose R. Alonso, Albert Ghiorso, E. Kenneth Hulet, Carol T. Alonso, Ronald W. Lougheed, Glenn Seaborg, Joachim M. Nitschke. [From *The Elements Beyond Uranium*]

Patterns of Change

Evolutionary Trends. KENNETH J. MCNAMARA, Ed. University of Arizona Press, Tucson, AZ, 1990. xviii, 368 pp., illus. $45; paper, $24.95.

To the layperson, evolution is nearly synonymous with directional change. The history of life is thought of as a more or less steady progression toward "higher" forms culminating in *Homo sapiens*. Although such a simplistic view is now discredited, debates still rage among evolutionists about whether long-term evolutionary trends exist and, if so, what they mean and how they are brought about.

Evolutionary Trends is a potpourri of opinion pieces, essays, and overviews dealing with patterns of evolution. The first part of the book and the epilogue comprise general chapters on the nature, measurement, and causes of evolutionary trends. The remainder contains reviews of trends and other evolutionary patterns in some groups of invertebrates (part 2) and vertebrates (part 3). Many important groups in which trends have been well documented, including protists and plants, are left out.

Debates about evolutionary trends cannot be resolved satisfactorily until three things happen. First, methods must be developed for distinguishing long-term trends from other evolutionary patterns. Second, these methods must be applied to the fossil record systematically, to provide more than just a large catalogue of examples. Third, we must