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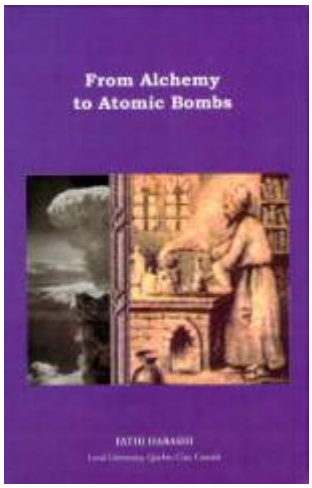
From Alchemy to Atomic Bombs: History of Chemistry, Metallurgy, and Civilization. By Fathi Habashi. Métallurgie Extractive Québec: 800 rue Alain #504, Sainte Foy, Québec, Canada G1X 4E7, 2002; distributed by Laval University Bookstore "Zone": Cité Universitaire, Sainte Foy, Québec, Canada G1K 7P4; email: martine.tardif@ul.ca. Illustrations, viii + 357 pp.; 15.6 × 23.2 cm. Can.$70.00, U.S.$50.00 plus postage (hardbound). ISBN 2-922-686-00-0.



Fathi Habashi, Professor of Extractive Metallurgy at Laval University in Québec City, Canada, received a B.Sc. degree in chemical engineering from the University of Cairo (1949), a Dr. tech. degree in inorganic chemical technology from the Technische Universität Wien (1959), and an honorary D.Sc. from the St. Petersburg Mining Institute. He has taught at the Montana College of Mineral Science & Technology and has worked in the Extractive Metallurgical Research Department of the Anaconda Company in Tucson, Arizona before joining Laval in 1970. He has been a guest professor at a number of foreign universities and a consultant to the United Nations Development Program. He is a prolific author and editor, and *From Alchemy to Atomic Bombs* is one of his latest books [1].

This attractive volume is a popular panoramic history of chemistry, physics, and metallurgy from the beginnings of alchemy to the latest developments in the discovery of superheavy elements, all treated in the full context of social, political, religious, and cultural events. Seven of its eleven chapters are expanded versions of eight of Habashi's articles published between 1989 and 2000, the references to which are cited below, while four additional chapters (Chapters 4, 5, 7, and 9) were written especially for the volume to fill in gaps in the historical sequence. Almost half of the book has not been published previously.

There is some inevitable overlap between the chapters, but each can be read as an independent story. The chapters begin with introductions and conclude with epilogues or summaries as well as suggested readings from books and articles (many are Habashi's earlier articles), some as recent as 1996.

In Chapter 1, "Mythology" (21 pp.) [2], Habashi explores the relationship between mining and metallurgy, which played an important role in developing civilizations, and mythology, which ancient peoples used to explain all sorts of natural phenomena. After discussing the deities of miners and metallurgists, he discusses 15 elements named after mythological figures. Chapter 2,

“The Four Elements” (24 pp) [3], deals with the well-known concept of the four elements (earth, air, water, and fire) traditionally ascribed to the Greek philosophers, for example, Empedocles, ca. 440 B.C. However, Habashi traces its origin to two centuries before Aristotle—to the Persian philosopher Zarathustra (630–553 B.C.) of Nietzschean fame, whose name was corrupted by Greek writers to Zoroaster. He emphasizes that although these four material entities were useful as a theoretical construct, they have nothing to do with our chemical elements

Chapter 3, “Alchemy” (53 pp) [4], traces this pseudoscientific predecessor of chemistry from its origins in antiquity to 1777 when the true nature of combustion was understood. No fewer than a dozen beliefs that gave rise to alchemy are considered, and mining and metallurgy in the East, alchemy in the East, the transfer of alchemy to the West, and seminal discoveries in the West are all discussed. Chapter 4, “The Alchemists” (54 pp, the longest chapter), deals with the lives and contributions of both well-known and more obscure figures—17 Arab alchemists of the East, seven Arab alchemists in Andalusia (Muslim Spain), and 33 alchemists of the West, ending with Joseph Priestley, whom Habashi considers the last of the alchemists.

Chapter 5, “Reform in Chemistry, Mineralogy, and Metallurgy” (28 pp), traces attempts at reform from Torbern Bergman through Antoine-Laurent Lavoisier, John Dalton, Jöns Jacob Berzelius, and others, the Karlsruhe Conference, and culminating in modern chemistry and metallurgy. Chapter 6, “Discovery of Electricity” (28 pp) [5], explores developments from the ancient Greeks, through electrochemistry, electrometallurgy, and the electric furnace.

Chapter 7, “Classification of the Elements” (24 pp), details the evolution of the periodic system from Johann Wolfgang Döbereiner’s triads, through Alexandre Émile Beguyer de Chancourtois’ telluric screw, John Alexander Reina Newlands’ law of octaves, Dmitrii Ivanovich Mendeleev’s periodic law and its later modifications, to discoveries of elements through element 106. Page 233 shows a modification of the periodic table that Habashi has devised (His customary modesty prevents his mentioning himself in connection with this table [6]).

Chapter 8, “The Modern Physics: Discovery of X-Rays” (22 pp) [7], begins with Wilhelm Conrad Röntgen’s discovery in 1895, backtracks to William Crookes and his vacuum tube, and deals with J. J. Thomson’s discovery of the electron and early development of X-ray tubes. The remainder of the chapter considers the consequences of Röntgen’s discovery, including radioactivity, the determination of crystal structure, Henry Gwyn Jeffreys Moseley’s atomic numbers, and analytical applications such as X-ray fluorescence, electron microprobe analysis, and X-ray photoelectron microscopy.

Chapter 9, “Radioactivity: Chemistry and Physics United” (15 pp, the shortest chapter), treats Antoine Henri Becquerel’s discovery of radioactivity in 1896 in a similar manner. Its consequences include the discoveries of polonium, radium, actinium, deuterium, artificial radioactivity, uranium fission, and plutonium as well as applications such as radioactive dating and radioactive tracers. I was particularly intrigued by the section (pp 268–270) on the life and work of Claude Félix Abel Niepce de Saint-Victor (1805–1870), who was completely unknown to me. As Habashi has pointed out elsewhere [8], this cousin of the French photographic pioneer Joseph Nicéphore Niepce, observed the effect of uranium salts on photographic plates in the dark three decades before the similar observation of Becquerel, who is generally credited with the discovery of radioactivity.

Chapter 10, “Uranium Fission” (22 pp) [9], depicts the contributions of Enrico Fermi, Ida Noddack, Otto Hahn, Fritz Strassmann, Lise Meitner, and Otto Frisch, among others. A long section, “Germany and Uranium Fission” (pp 274–282), deals with the problems encountered by Jewish scientists during the years of the Nazi régime and includes an unusual and useful table (p 280) listing 35 notable physicists and chemists who fled Germany or Nazi-occupied countries, with the years of their departures, and their destinations. Habashi notes, as he has written elsewhere [10], that Ida Noddack (née Tacke), who had discovered rhenium with her future husband Walter Noddack in 1925, criticized Fermi’s article on the purported—and incorrect—

first discovery of a transuranium element (No. 93, then called eka-rhenium); her interpretation of Fermi's work made her the first to conceive of the idea of nuclear fission.

Chapter 11, "Atomic Bombs" (44 pp) [11], concludes Habashi's volume with discussions of various aspects of the history of nuclear weapons from their earliest years to the present: the possibility of a bomb; the Uranium Committee; the Thomson Committee; the Directorate of Tube Alloys; the Canadian Research Council's contributions; the Metallurgical Laboratory; the Manhattan Project; Los Alamos; the uranium, plutonium, and hydrogen bombs; the Nuclear Club; fallout; the possibility of nuclear accidents; the National Atomic Museum near Albuquerque, New Mexico; and uranium as a strategic metal. I was surprised to learn that on May 7, 1945, more than two months before the well-known Trinity Site test of the first nuclear bomb on July 16, 1945, 100 tons of TNT were detonated as a trial run for the bomb (p 321). Habashi provides full coverage of peace movements by which humankind is attempting to prevent a nuclear holocaust.

Habashi's book is lavishly illustrated; 32 of the 223 figures, which include portraits (familiar and unfamiliar), woodcuts, title pages, tomb paintings, reliefs, classic paintings, chemical plants, monuments, memorial plaques, maps, etc., are in color. An avid philatelist and coauthor of a book on postage stamps [12], Habashi has included photographs of eight stamps among the figures as well as a 10,000 lire Italian banknote depicting Alessandro Volta and his Voltaic pile (p 190). There are also five tables that summarize material from the text (actually there are more because some of the figures are actually tables). A name index (7 double-column pages) and a subject index (11 double-column pages) make this volume extremely user-friendly.

Although the book is intended for a general readership, formulas and equations are provided whenever necessary. Considering its scope, it is virtually error-free; most of the errors that inevitably creep into a book of this length are "typos" or misspellings in proper names and should cause no problems: "H. C." for "A. C." (Wahl, pp 3, 19, 266, 345), "Godolin" for "Gadolin" (pp 157, 341), "Wilhelm Konrad" for "Wilhelm Conrad" (Röntgen, pp 234, 235, 254, 258, 344), "Engen" for "Eugen" (Goldstein, pp 241, 341), "Lawernce" for "Lawrence" (Bragg, p 247), "Merinsky" for "Marinsky" (pp 248, 343), and "Delbruck" for "Delbrück" (pp 280, 340). Also, Berzelius died in 1848 not 1818, but admittedly the correct date is given several times on the same page (p 3), and Röntgen's discovery of X-rays appeared in the *Sitzungsberichte der physikalisch-medicinischen Gesellschaft zu Würzburg* not the *Sitzungsberichte der physikalisch-medizine Gesellschaft* (p 236). These minor errors should be corrected in a future printing.

This popular history will be of interest to anyone concerned with the mutual interactions, both positive and negative, between chemistry, physics, and metallurgy and civilization from earliest times to the present, which should include just about everyone. Its numerous illustrations will make it especially attractive to a younger audience. Although it contained much information that was familiar to me, I also found many historical and biographical nuggets of which I was previously unaware. Thus it will also be useful to chemists, physicists, and metallurgists, those interested in the history of these disciplines, historians of science, and specialists in the social and governmental aspects of science.

References and Notes

1. Habashi's *Schools of Mines: The Beginnings of Mining* and *Metallurgical Education and Metals from Ores: An Introduction to Extractive Metallurgy,* both published by Métallurgie Extractive Québec, a nonprofit publisher devoted to the diffusion of extractive metallurgy literature, which has published many of Habashi's 17 books, appeared in 2003.
2. Habashi, F. Mining, Metallurgy, and Mythology. *Bull. Can. Inst. Min. & Met.* **1992,** 85, 79–83.
3. Habashi, F. Zoroaster and the Theory of Four Elements. *Bull. Hist. Chem.* **2000,** 25, 109–115.

4. Habashi, F. The Age of Alchemy. History of Chemistry, Metallurgy, and Civilization. *Interdiscip. Sci.* Rev. **1998,** 23, 348–361.

5. Habashi, F. Two Hundred Years Electric Current. The Impact on Metallurgy. *Bull. Can. Inst. Min. & Met.* **1999,** 92, 86–92.

6. After his March 4, 1999 seminar, "A New Look at the Periodic Table," for the CSUF Chemistry Department, Fathi kindly presented me with a T-shirt depicting this table.

7. Habashi, F. Hundred Years X-Rays. *Bull. Can. Inst. Min. & Met.* **1995,** 88, 31–36; reprinted in *Interdiscip. Sci. Rev.* **1996,** 21, 36–44.

8. Habashi, F. Niepce de Saint-Victor and the Discovery of Radioactivity. *Bull. Hist. Chem.* **2001,** 26, 104–105.

9. Habashi, F. Fiftieth Anniversary of Uranium Fission. Contribution of Two Women Scientists. *Bull. Can. Inst. Min. & Met.* **1989,** 82, 80–84; Habashi, F. A Note on the Discovery of Nuclear Fission. *Bull. Hist. Chem.* **1989,** 3, 15–16.

10. Habashi, F. Ida Noddack (1896–1978). *Bull. Can. Inst. Min. & Met.* **1985,** 78, 90–93.

11. Habashi, F. Fifty Years Atomic Bombs. *Bull. Can. Inst. Min. & Met.* **1995,** 88, 97–105.

12. Habashi, F.; Hendricker, D.; Gignac, C. *Mining and Metallurgy on Postage Stamps;* Métallurgie Extractive Québec: Quebec, 1999 (paperback).

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