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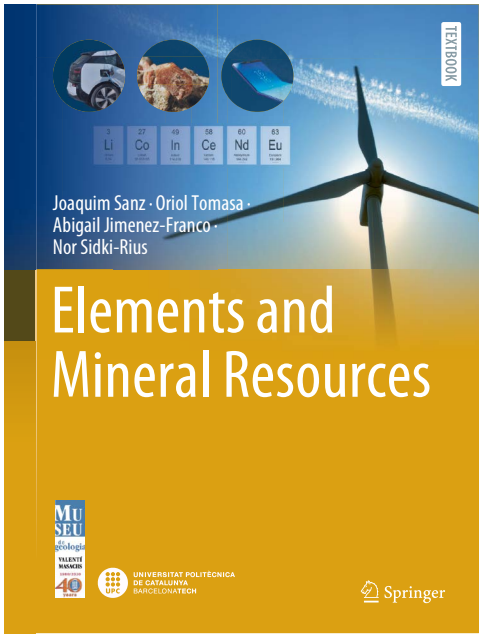
Book Review

Book Review: Elements and Mineral Resources. (2022) By Joaquim Sanz, Oriol Tomasa, Abigail Jimenez-Franco, and Nor Sidki-Rius. Springer Textbooks in Earth Sciences, Geography and Environment. ISBN 978-3-030-85888-9/ISBN 978-3-030-85889-6 (eBook). 434 pages, $59. http://dx.doi.org/10.1007/978-3-030-85889-6



Elements and Mineral Resources was published in concert with the 40th anniversary of the Geological Museum Valentí Masachs (1980–2020), which is affiliated with the Polytechnic University of Catalonia in Spain. This 434-page, lavishly illustrated volume is an expanded version of a much shorter museum guide consisting of information "cards" found on the museum's website (http://geomuseu.upc.edu/index.php/en/inici-english/). The volume is coauthored by Joaquim Sanz, a retired professor of mineralogy (Polytechnic University of Catalonia) and former director of the museum, as well as Oriol Tomasa and Nor Sidiki-Rius, Ph.D. candidates of the Polytechnic University of Catalonia at the time of publication, and Abigail Jimenez-Franco, a postdoctoral researcher from the University of Barcelona.

The book provides brief descriptions of 80 elements and 18 minerals of commercial and strategic importance. Divided into three parts—Part I. Elements (63); Part II. Rare-Earth Elements (17), and Part III. Industrial Minerals (18)—each element or mineral entry consists of a summary, its geological formation or occurrence, major mineral-producing countries with production statistics, application areas, and recycling status. References and suggested reading are limited to statistical reports, encyclopedia articles, and two nontechnical books on elements, one of which is inaccurately referenced (the author of *The Elements* is Theodore Gray, not Nick Mann). In addition to showing a close-up photograph of each mineral, the application section has images of everyday objects that either contain or are linked to the element of interest. All chapters start with the identically colored periodic table and include a color-coded world map that shows mineral-producing countries.

The introductory chapter of Part I seems inadequate for a book on mineralogy, whose intended mission is to be a "...resource for teaching earth sciences, mining, chemistry, and engineering for university, high school, and personal interest" (p. *x*). All chapters begin with the same periodic table that appears to be included as a decorative device rather than a teaching aid. For example, there is no discussion regarding the periodic table's significance, properties, or arrangement of elements; instead, we are told that the majority of these elements have been extracted from ore minerals (p. 3). This entry-level guide should have included basic definitions related to mineralogy. Within Chapter 1, we find a series of photographs of randomly selected minerals and associated objects, and price trends for 13 different elements.

The 63 entries of Part I include the most important elements in terms of their strategic or commercial value that are found in their native state or chemically bound within other minerals. The depth of informational content of element summaries runs the gamut from property data and historical background to others that are devoid of much value. For example, boron (Chapter 8) is considered "very hard," while cobalt (Chapter 18) is simply a "heavy" element.

By far, the most interesting portion of the guide is the geology section, which describes the chemical composition of associated minerals and their geological environments. Unfortunately, the information content among some entries lacks uniformity, which is not atypical of multi-authored books. For example, the acronym VMS (volcanogenic massive sulfide) is defined in some entries but not others. Furthermore, important geological terms, processes, and acronyms are not consistently defined. As such, a glossary of technical terms would have been helpful.

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Nuclear properties, such as half-lives, radioactive isotopes, and decay processes, especially for common radioactive elements, are only lightly treated, if at all.

Because of the importance of environmental factors and safety issues, a separate and more comprehensive section should have been included that focuses on the potential toxicity of elements and the minerals containing these elements.

Although element application accounts are well-written and succinctly summarized, many of the photographs are superfluous or repetitive (e.g., automobiles, airplanes, electronic devices, and sunflower fields). Nevertheless, strong associations can be formed if an appropriate photograph is used, like the one of a contented cat sitting in a litter box and the absorbent properties of sepiolite.

The seldom seen recycling section for elements and minerals is an important feature, which describes the reprocessing of elements in materials that would otherwise be discarded. For example, under "gold," we learn that extracting metals from electronic scrap, known as "urban mining," can also yield highly valued metals, such as palladium, silver, tantalum, gallium, copper, and tin. It is interesting to note that 1 ton of rock can produce between 3 and 5 g of gold, whereas 1 ton of electronic scrap can produce about 200 g of gold. Also, "the world's level of gold recycling is over 87%" (p. 97). These interesting facts and statistics are informative and bring additional value to the book.

The section on mineral-producing countries and production statistics, with its half-page, color-coded world map, is attractive for an e-book but unnecessary for a print version because of the space it takes up. The same would be true for the half-page periodic table at the beginning of each of the 80 element entries when only a single periodic table for each of the introductory chapters would suffice.

Part II presents data of 17 rare-earth elements (REEs) that have experienced phenomenal growth rates and high demand in the electrical, electronic, optical, and magnetic markets. The introductory chapter for Part II (Chapter 65) should have included a discussion of factors that contribute to the unique properties of rare-earth elements, namely their partially filled 4*f* orbital electrons. Moreover, there was no mention that most common rock-forming minerals exclude REEs because of their large ionic radii and trivalent charges. In cases where REEs are found in high concentrations within a mineral, they are usually limited to either light REEs (LREE) or heavy REEs (HREE).

Also, within this chapter, the authors should have pointed out that all elements, starting with atomic number 95 (americium) in the actinide series and continuing with period 7, group 3 of the periodic table, are too unstable to exist in nature, and must be produced in particle accelerators in highly limited amounts. Furthermore, promethium ($Z = 61$), although exceedingly rare, is nevertheless a naturally occurring element, contrary to the periodic table's labeling and entry on p. 305 (it is worth noting that most promethium is produced artificially for commercial use and scientific studies because of its rarity). Lastly, the repetitive use of the same three paragraphs of the geology section and the accompanying references for each rare-earth element is unnecessary and a distraction for both e-book and a print edition.

Part III consists of a select group of 18 industrial minerals, excluding metals, that are typically used with minimal processing other than purification and comminution. According to the authors, "[a] family home contains up to 150 tons of these industrial minerals and a car up to 250 kg; [in addition], these minerals represent 50% of the content of paint and paper, while ceramics and glass are made entirely of these minerals" (p. 333). It is of interest to note that some plastics contain significant amounts of minerals, such as calcium carbonate, clays, kaolin, mica, silica, and talc, to improve processibility, mechanical behavior, and rheological properties.

While carefully placed photos add value to the book and illustrate important mineral applications, Part III also has its share of extraneous photos. For example, there are photographs of a ceramic sink for a feldspar, a package of smoked salmon for salt (halite), and automobile interiors to indicate mica and talc plastic additives. However, it is questionable as to which plastic part, if any, contains a mineral filler.

The book appears to have been written initially as an online museum guide in conjunction with the Geological Museum Valentí Masachs in Barcelona, Spain. However, as an e-book, it would be more appropriate to have issued it as an abbreviated reference manual of strategic elements and minerals for a general audience with little or no background in Earth sciences rather than as a supplemental resource for a mineralogy or geology course. Because of its length (434 pages) and large number of high-definition color photographs, the print edition would best serve as a coffee-table book or as a present for a budding scientist rather than a supplementary text or library reference book.

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