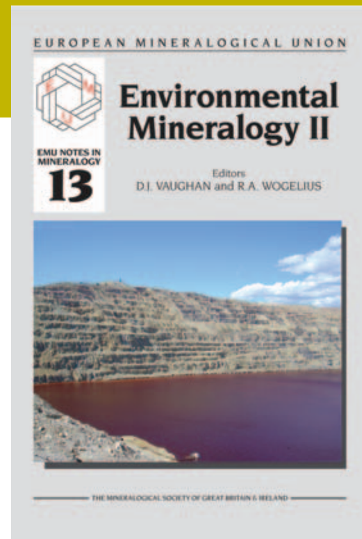
ENVIRONMENTAL MINERALOGY II[2]



When I accepted the task of reviewing this well-written, informative, well-referenced, and somewhat expanded (an additional 55 pages) and updated sequel to *Environmental Mineralogy* (EMU Notes in Mineralogy 2, published in 2000), I decided to explore the early history of environmental mineralogy. One source I examined was Herbert and Lou Henry Hoover's translation of Georgius Agricola's *De Re Metallica*, which was first published in Latin in 1550. This classic work by Agricola (aka Georg Bauer)—a physician, author of the first mineralogy textbook (*De Natura Fossillium,* 1548), and natural scientist—served as the main textbook and guide to miners and metallurgists until 1738, when Andreas Schlüter's work on metallurgy appeared. In hindsight, the beginnings of what is now called "environmental mineralogy" were evident in Agricola's time. For example, the miners of this period recognized that arsenic derived from naturally occurring orpiment was a "powerful poison" to humans (fast-forward to the arsenic pollution problems in Southeast Asia derived from the natural breakdown of arsenopyrite in the Himalayas, the cause of the largest mass poisoning in human history). They also knew from experience that if the mineral dust breathed by miners in dry mines "has corrosive qualities, it eats away the lungs and implants consumption in the body" (fast-forward to lung diseases common among underground coal miners today). Even earlier, in Roman times, the dangers of mineral dusts and the need for protective masks on miners were known, as pointed out by Pliny the Elder. These early examples of environmental problems caused by mining, beneficiation, and smelting of ores show a strong connection between extracting metals from minerals and their impact on the environment and human health.

Like the earlier version, this volume helps define the modern field of environmental mineralogy, which is still in its infancy, as pointed out by coeditor David Vaughan in the introductory chapter. The volume's 11 chapters cover the same topics as the first edition by essentially the same group of authors plus several new ones. These chapters encompass various aspects of environmental mineralogy, including the modern analytical, experimental, and computational methods used to study minerals and the chemical processes occurring at mineral surfaces (Roy Wogelius and David Vaughan), the role of minerals in the development of soils (David Manning), and the types of minerals found in marine sediments (Andrew Alpin and Kevin Taylor). The important impact that microbial organisms have on the mineralogy of the environment is dealt with in a chapter by Susan Welch and Jillian Banfield, and the types of mineral aerosols that occur in Earth's troposphere and their role in various environmental processes are the subjects of a comprehensive chapter by Mihály Pósfai and Agnes Molnar. The mineralogy of mine wastes, acid mine drainage, and strategies for remediating abandoned mine sites are covered in a chapter by David Blowes, Carol Ptacek, and John Jambor. In a chapter on the mineralogy of municipal waste deposits, Rita Hermanns Stengele and Michael Plötze discuss the multibarrier approach in landfill design and the impact of waste disposal facilities on groundwater quality. The role of mineralogy in long-term nuclear waste management is summarized in a brief chapter by Charles Curtis and Katherine Morris, and the role of modern analytical methods in conservation of cultural heritage is discussed by Giacomo Chiari. The final chapter, by Catherine Skinner, focuses on the impact of biominerals on human health in both positive ways (e.g. hydroxylapatite in bones and teeth) and negative ways (e.g. pathological hydroxylapatite in human arteries).

It would be difficult to cover all the important areas that comprise modern environmental mineralogy in one manageable volume, and this is true of the current volume. For example, the discussion in chapter 2 of quantum chemical and molecular dynamics modeling of mineral structures, mineral–aqueous solution interfaces, and chemical reactions at mineral surfaces is relatively brief. However, this is offset by a very nice summary of many of the modern experimental methods used to study the geometric and electronic structures of minerals and mineral surfaces and the bulk and surface compositions of minerals, as well as by useful summaries of reaction kinetics and reaction path modeling in the same chapter. Other topics that are largely ignored in this volume include the impact of mineral dusts on human health; nanogeoscience (which focuses on minerals in the nanometer size range, i.e. 1–100 nm in at least one dimension); and important environmental areas such as CO_2 sequestration through mineral carbonation, the mineralogy of fly ash, and the release of toxic metals such as mercury, arsenic, and selenium from coal combustion. However, these and other related topics are covered in detail in the recent environmental mineralogy/geochemistry publications listed in the appendix at the end of chapter 1. In spite of this minor criticism concerning coverage, I recommend this volume for a beginning-level graduate course on environmental mineralogy, supplemented by the lecturer's own experience and material from some of these other recent publications.

Having been a player in the field of mineralogy for the past 40+ years, I have enjoyed watching its evolution from a somewhat descriptive science in the 1960s and 1970s—including the description of the crystal structures of minerals based on X-ray crystallographic studies (I used to do this)—to a more quantitative science in which mineralogists employ the principles of physical chemistry, molecular modeling, solid-state physics, and molecular geomicrobiology to focus on more fundamental issues, such as the bonding forces in minerals, the nucleation and growth of minerals, chemical and microbiological reactions at mineral–water interfaces, and the processes that transform minerals under different conditions. Major developments in computational and experimental methods and theory over the past 30 years have had a significant impact on most areas of science and engineering, including mineralogy and the related field of environmental mineralogy/geochemistry. For example, the development of synchrotron light sources that emit extremely intense beams of X-rays, the advance of density functional theory, and the continuing improvement in computers, the fastest of which now operate in the petaflop range, have revolutionized the way chemists, geochemists, mineralogists, and other scientists and engineers approach the problems in their fields. This is especially true in environmental mineralogy/geochemistry, as is evident in several chapters in *Environmental Mineralogy II*. My prediction is that this field will continue to benefit from applications of modern experimental and computational methods to complex environmental problems involving minerals. This new volume showcases many of these problems and methods. The good news is that there are plenty of important unanswered questions left for the next generation of environmental mineralogists/geochemists to tackle using this modern toolbox of molecular methods.

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2 Vaughan DJ, Wogelius RA (eds) (2013) Environmental Mineralogy II. European Mineralogical Union Notes in Mineralogy 13, ISBN 978-0-903056-32-8, xv + 489 pp, £40 (institutions) /£25.50 (individuals)