complement the publication of Spry and Gedlinske (1987, Economic Geology), with its *Tables for the Determination of Common Opaque Minerals*, which I find particularly useful.

DANIEL J. KONTAK
NOVA SCOTIA DEPARTMENT OF NATURAL RESOURCES
P.O. BOX 698
HALIFAX, NOVA SCOTIA, CANADA B3J 2T9
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Essentials of Medical Geology: Impacts of the Natural Environment on Public Health. O. SELINUS, B. ALLOWAY, J.A. CENTENO, R.B. FINKELMAN, R. FUGE, U. LINDH, AND P. SMEDLEY, EDITORS. 832 Pp. Academic Press. ISBN 0-12-636341-2. Price US.$99.95.

This attractive, well-illustrated volume contains 31 interdisciplinary chapters (articles) that weave together the geological, environmental, and public health sciences. *Essentials of Medical Geology* is global in scope: the impressive list of contributors consists of 60 international experts representing 20 countries. It is an initiative of the International Union of Geological Sciences, in response to the growing interest in the relationship between geology and human health. Classically trained geologists may be pleasantly surprised to pick up this book and discover how the tools of their profession are being applied in new territory, helping to address a diverse array of public health issues.

The introduction by Brian Davies and colleagues traces the relationship between geology, the environment, and public health from ancient China to the 21st century. They conclude with a glimpse into the future of medical geology as a discipline and provide opinions on research directions. The remaining 30 chapters are grouped into four sections. Each section deals with a different aspect of medical geology and includes a 1- to 2-page introduction that provides a context for the included chapters. These introductory pages are colored, which helps the reader flip easily to the beginning of each section.

Section 1, on "Environmental Biology," is a collection of seven chapters introduced by Ulf Lindh. This section provides an overview of the natural and anthropogenic sources of elements; the biological essentiality and functions of the major, minor, and trace elements; geological sources of mineral nutrients; and the uptake and regulation of metals in biological systems. A highlight is Robert J.P. Williams' stimulating contribution, "Uptake of elements from a chemical point of view," which traces the evolution of the chemistry of the cell since its self-generation in the primitive sea, and describes the distribution and function of elements in the modern cell as a series of adaptations to global changes in Earth chemistry.

Ron Fuge provides the introduction for the 12 chapters in section 2 on "Pathways and Exposures," which is the largest section of the book. He describes how humans and animals are directly or indirectly exposed to natural geological materials and processes, mainly through inhalation and ingestion, and to a lesser extent, skin absorption. Two outstanding contributions in this section deal primarily with the inhalation pathway, including one on volcanic toxicology by Weinstein and Cook, and the other on natural aerosolic mineral dusts by Edward Derbyshire. Both underscore the important and immediate benefits of geological monitoring and surveillance to public health protection. Several chapters discuss diseases in humans and in animals that may arise from underexposure and/or overexposure to inorganic elements in the diet. Three chapters are devoted to geological impacts on drinking water quality: the first on arsenic in groundwater and the environment, the second on fluoride in natural waters, and the third on water hardness. Chapter 10 covers radon as a natural household source of radiation in air and water. Other chapters describe human exposures related to involuntary or voluntary ingestion of soil (geophagy); factors controlling the bioavailability of trace and major elements in soil; and an overview of soil-borne pathogens including proterozoa, fungi, bacteria, viruses, and the poorly understood prions.

The five chapters in section 3, which is concerned with "Environmental Toxicology, Pathology and Medical Geology." are introduced by José A. Centano. In this section, the reader is introduced to the basics of environmental epidemiology, pathology, and toxicology. The term "environmental medicine" is used synonymously with "environmental health" to include toxicology and epidemiology, exposure assessment, risk assessment, and public health intervention. Several trace element case studies (e.g., arsenic and fluoride) are revisited and other geologically relevant examples are added, such as incidents of meningitis caused by human exposures to amoeba that dwell in New Zealand hot springs. The chapter on pathology summarizes the acute and chronic effects of toxic elements and their compounds in humans. The strengths and limitations of different types of epidemiological studies are described in chapter 21. This chapter discusses the forms of statistical bias in epidemiological studies, and includes a helpful checklist for evaluating an epidemiological study—all giving the reader a healthy respect for the difficulties in drawing conclusions about cause and effect. The final chapter in section 3, on analytical chemistry, reviews the latest trends in the speciation of trace elements relevant to public health.

Section 4, on "Techniques and Tools," introduced by Robert B. Finkelman, shows how a wide range of computational, analytical, and modeling tools, familiar to most geologists, are being applied in human health studies. The first two chapters deal with the use of geographic information systems (GIS) and remote sensing to investigate disease patterns where environmental influences are strongly suspected. Case studies show how simultaneous spatial analysis of numerous interrelated factors can assist in understanding the distribution of diseases such as Lyme disease, malaria, and sleeping sickness, or geographic variations in health impacts related to trace element distributions (e.g., arsenic and fluoride). Three chapters describe methods of instrumental analysis applied to biological systems. The first shows how X-ray diffraction, electron diffraction, and optical light microscopy are used to study the mineralogy of bones, teeth, and pathological deposits. The second summarizes inorganic geochemistry techniques including neutron activation analysis, X-ray fluorescence, atomic and mass spectroscopy; and organic geochemistry techniques including chromatographic separation in combination with mass spectrometry. The third describes

histochemical analysis, Raman and infrared spectroscopies, and electron microscopy techniques that are used to characterize mineral deposits in human tissues. The final reviews the state-of-the-art in groundwater flow, solute transport, and geochemical reaction models.

Essentials of Medical Geology has been edited meticulously by Olle Selinus and the team of associate editors. There are no formatting inconsistencies to detract from the content. Each chapter follows the same organizational framework, with its own short list of contents on the front page. At the end of each chapter is a list of other chapters in the book that contain related material. This is particularly useful where information about certain topics (notably arsenic, iodine, and fluoride) may appear in a number of different chapters. A guide to "Further Reading" is provided for each chapter, enhancing the usefulness of this book. Without exception, each author has used language that is both accessible and interesting to nonspecialists. The reader is assisted by the inclusion of an extensive glossary in the appendix that provides definitions for referenced geologic and health science terms. Most importantly, great care has been taken in the peer review of the scientific content.

This is a fascinating reference work that will inevitably find its way into earth sciences classrooms, but also will appeal to a wider readership, including public health scientists and decision makers. Anyone looking to explore the field of medical geology will be captivated by the contents of this publication.

Pat E. Rasmussen
Earth Sciences Department, University of Ottawa;
Environmental Health Sciences Bureau,
Health Canada
Tunney's Pasture 0803C, Ottawa
Ontario, Canada K1A 0L2
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