

## BOOK REVIEWS

ASBESTOS AND OTHER FIBROUS MATERIALS. By H. Catherine W. Skinner, Malcolm Ross, and Clifford Frondel. Oxford University Press, New York, 1988. 204 pages. \$35.00.

This is a unique reference for a field that has been getting significant national attention in recent years. It attempts to review the physical and chemical features of asbestos and other inorganic fibers, and the biological aspects of exposure to these fibers, and therefore provides an essential background for anyone working in fields related to health effects of exposure to fibrous materials. This was an ambitious undertaking, and the authors have succeeded in producing a brief, readable account, supplemented with a substantial amount of reference material.

The book starts with an introduction to fibers in general, with a discussion of terminology, classification, and overall physical properties. The rest of the main body of the text is divided into two chapters, one dealing with the structural and chemical aspects of fibers and the other being devoted to the anatomy and physiology of the respiratory system and responses of the human body to exposure to inorganic fibers. The remainder (about 20% of the book) consists of appendices, glossary, etc.

Chapter 2, entitled "Fibrous minerals and synthetic fibers," includes a comprehensive discussion of the mineralogy, crystallography, and chemistry of chain and sheet silicates as well as a less detailed account of other minerals that can have fibrous habit. Some attention is given to the basis for classifying minerals according to their structures, introducing concepts of polymorphism and of atomic substitutions. Tables include site chemistry (mineral formulae), crystal systems, and polytypes (for serpentines) for a complete list of amphiboles and serpentine minerals. For asbestiform varieties, additional tables provide unit-cell parameters, optical properties, and chemical analyses. A variety of structural drawings (including polyhedral projections and I-beam representations) and high-resolution transmission-electron-microscope images are presented that help explain the habits of the asbestos minerals. Crystal-structure drawings of other chain and sheet silicates, zeolites, and quartz are also included, and crystal-structure data are presented for fibrous zeolites.

One thing that did seem to be lacking here is a discussion of the occurrence of the various minerals discussed. The origin of chrysotile is only very briefly mentioned in a section on olivine.

The chapter concludes with a discussion on synthetic fibers, dealing primarily with composition, manufacture, growth mechanisms, and physical characteristics.

The chapter on "Health effects of inorganic fibers" starts with a historical background for current concerns of exposure to fibrous material and proceeds with an overview of the physiology of the respiratory and lymphatic systems, illustrated with numerous figures. The responses of these systems to the inhalation of inorganic fibers is discussed in detail, together with the possible mechanisms for respiratory diseases. Tables are included with statistical data on number of deaths attributed to these various diseases. No attempt has been made to discuss any of the current regulations concerning exposure limits or testing procedures for asbestos, or even to draw many conclusions from the available data.

Appendices include lists of all synthetic fibers and minerals described as having fibrous or acicular forms, together with

chemical formulae and references, and a complete description of brucite to illustrate the type of information available for minerals in standard texts. A reasonable glossary completes the volume.

One negative aspect of this book is the numerous typographical errors throughout. Reference is made to  $Yt_2O_3$  in Appendix I (p. 184), a figure caption describes the "10 Å or 0.01 nm form" of halloysite (p. 61),  $\beta$  angles are listed under *B* in all tables, and there is reference to "tetranedra and octanedral layers" (Table 2.2) to list a few. With so many obvious errors that were overlooked, one has to wonder how many not-so-obvious errors there may be in data tables, etc.

However, at \$35.00, hardcover, this book does provide, at a reasonable cost, enough information to understand the complexities of determining health effects of inorganic fibers. The book can be recommended to geologists, physicians, health officials, and even members of the general public who are involved with or interested in this highly debatable subject.

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ECLOGITES AND ECLOGITE-FACIES ROCKS. Edited by D. C. Smith. Elsevier Science Publishers, Amsterdam, 1988. 534 pages. \$115.75.

The continued fascination of petrologists and mineralogists with eclogite (a rock consisting essentially of omphacite and garnet) has produced an inordinate amount of research in relationship to the areal exposure of these unusual rocks. Justification for this concentrated research becomes immediately apparent when the student of petrology learns that coexisting garnet and clinopyroxene compositions reflect the depth and temperature for the formation of eclogitic rocks. Microprobe analyses on a small chip together with mineral assemblages can provide nearly instant barometry and thermometry that then can be translated into *P-T* histories of both prograde and retrograde recrystallization. Such *P-T*-time paths have been explored for eclogite xenoliths from the mantle and for eclogite pods within high-grade metamorphic terranes. Experimental studies have corroborated the chemical changes of the garnet and pyroxene at measured pressure and temperature in laboratories; within analytical and thermodynamic uncertainties, there appears no real controversy on the validity of using coexisting garnet and pyroxene to establish fossil *P-T* conditions. There has been, however, a long-term and sometimes bitter disagreement as to where and how eclogitic rocks form. What is the tectonic mechanism that brings the lower-crustal or upper-mantle rocks to the surface? How can they preserve evidence of such extreme crustal or mantle conditions? Melting of eclogite has also been interpreted as an important process in the generation of basalt magmas within the Earth's mantle. Because of its unusually high density of 3.4, when gabbro or basalt is converted to eclogite, geophysicists have also utilized this phase change to explain velocity anomalies in the upper mantle.

This book is the first to deal exclusively with eclogites and eclogite-facies rocks. The editor, David C. Smith, has been in-

involved in mineralogical, petrological, and tectonic research on eclogitic rocks for the past twenty years and is himself often the center of the eclogite controversy. The book is divided into eight chapters with the first chapter (over 200 pages in length) by Smith, who gives a detailed and scholarly review of the Norwegian coesite-eclogite province using crystal-chemical, petrological, geochemical, and geodynamic arguments that in some passages reveal his fervor. Eclogites from classic Norwegian localities most often occur in small discrete bodies tens of meters in size over a wide area in the Western Gneiss region. The presence of relict coesite inclusions in both garnet and omphacite requires pressures of  $28$  to  $32 \pm 5$  kbar, and Smith asserts that these pressures are only obtainable within the mantle or lower crust, leading to his interpretation that the eclogite pods must be "foreign" and that they are introduced by "lithospheric interdigitation" of mantle or deep-crustal fragments in the upper crust. This tectonic or melange concept of Smith has not been accepted by all Norwegian eclogite experts; some contend that the field relationships indicate that the protoliths for the eclogites are minor mafic dike and still intrusions emplaced high into the Western Gneisses and later tectonically buried to great depths ( $>70$  km) and metamorphosed together with the surrounding gneisses as part of a continent-continent collision during Caledonian time (early Paleozoic). Smith makes a plea for re-evaluation of nonlithostatic overpressures and underpressures and suggests a possible compromise hypothesis for formation of ultrahigh-pressure rocks. Perhaps one of the first steps to resolve the eclogite controversy is to produce more detailed maps of these eclogite localities along with precise structural histories so as to reconstruct past stress fields and deformation histories for both eclogites and their surrounding gneisses. In fact, there is no single geologic map in his chapter to illustrate such relationship between metamorphism and deformation. No table listing mineral assemblages in different eclogite pods and their country rocks is given. Both geologic maps and mineral parageneses are essential for readers to assess the validity of different tectonic models.

Many peculiar minerals (e.g., h ogbomite, kandite, lisetite, nyb ite, etc.) and their chemical and petrographic characteristics are described and illustrated in numerous photomicrographs. Several new compositional plots such as "clinoamphibole half-cube," "sphene pyramid," and "mica hexagon" are also proposed; however, many of these are complicated and graphically difficult to portray. Chapter 1 summarizes many of his previous observations and interpretations, which appeared mainly in abstract form in Smith's previous publications. The detailed descriptions of petrographic features, crystal-chemical properties of the common and rare eclogitic minerals, and diverse geochemical interpretations of crystallization provide a wide-ranging menu for the eclogite experts. For example, we were able to identify coesite and its quartz pseudomorphs from eclogites in central China by comparing textural and morphological features in these rocks to the photomicrographs presented in his chapter.

The succeeding chapters provide a rather uneven coverage of the eclogite problem. Ghent in Chapter 2 provides an elegant review of chemical zoning in the garnets as a function of both temperatures and volume diffusion rates for each element involved. He addresses the use of solid inclusions in zoned garnets to deduce the  $P$ - $T$  evolution of eclogites as well as the limitations and problems of such methods. He also examines the different variables involved in the homogenization of garnets and attempts to quantify closure temperatures from existing volume diffusion data. Compared to previous summaries of zoning in metamorphic minerals, this chapter addresses more specifically the applicability of the various diffusion models to garnet zoning

in eclogites. Rossi in Chapter 3 provides a similar review on the eclogite clinopyroxenes and gives a really useful account of their chemical variation as well as the crystal structure. He suggests that the degree of order-disorder with respect to compositions of clinopyroxene could be used to decipher the thermal (and cooling) history of the rocks. The use of solvi and exsolution in clinopyroxenes may prove to be a useful geospeedometer. However, this chapter does not address the effects of order-disorder in clinopyroxenes on geobarometry, particularly in the light of some recent experimental results.

Godard in Chapter 8 presents a detailed summary of the occurrence and petrology of Hercynian eclogites from the southern Armorican massif in France where he proposes that three distinct groups of high-pressure rocks may have quite distinct origins and metamorphic histories. This chapter presents two useful techniques that are seldom used by petrologists: a combination of mineral modes, compositions, and bulk-rock chemistry to identify the protoliths and a petrofabric study to define the distinct stages of deformation in relation to the growth of various minerals in eclogites. Some eclogites, such as kyanite-rich and quartz-rich eclogites, may have formed in situ by crustal metamorphism, and nearly all retrograded to blueschist and epidote amphibolite. However, at least some of the eclogites have oceanic-crust affinities and amphibolite precursors; their present position within continental crust may require abnormal transport or "lithospheric interdigitation" as Smith suggests.

The long-standing problem of "What are the silica-rich isofacial rocks of the eclogites?" has been clearly brought out by studies of Black, Yokoyama, and Brothers on the assemblages of eclogite-facies meta-acidites in northern New Caledonia in Chapter 4 and by Schliestedt and Okrusch on the silica-rich metamorphics associated with eclogites and glaucophanites in Sifnos in Chapter 5. In these two separate regions, the assemblage quartz + jadeite  $\pm$  garnet + phengite (paragonite) is considered isofacial with eclogites, but no maps or photos corroborate that they indeed were metamorphosed together. In fact, these descriptions and our own personal observations in these same areas reveal tectonic imbrication of the various units.

Chapter 6, on xenolithic eclogites brought to the surface in kimberlites and alkali basalt pipes from southeastern Australia and the Colorado Plateau by Arculus and others, discusses their mantle origin on the basis of REE distribution and  $^{87}\text{Sr}/^{86}\text{Sr}$  and  $^{143}\text{Nd}/^{144}\text{Nd}$  isotopic characteristics. The lower-crustal geochemical evolution of granulites and eclogites was shown to be complementary. In Chapter 7, Helmstaedt and Schulze describe eclogite-facies rocks as xenoliths in Colorado Plateau diatreme breccias that have affinities to metamorphosed ophiolites from high-pressure orogenic belts. They suggest that these xenoliths may represent earlier subducted oceanic rocks that became underplated to the North American plate during earlier subduction of Pacific Ocean crust.

This book is neither a compilation of case studies of eclogites and eclogite-facies rocks throughout the world, nor is it an exclusive study of new mineralogical, crystal-chemical, or geochemical tools applied to solve petrological problems related to eclogites. Nevertheless, it contains many references and a series of reviews and incorporates a large quantity of petrographic detail accompanied by previously unpublished data that are certainly of interest to most petrologists and mineralogists. We highly recommend that they have a copy on their bookshelf. For the earth scientists who have only a casual interest in eclogites and want to learn more about them, this book will only tend to confuse. The eclogite facies is not clearly delineated nor are the  $P$ - $T$  conditions of formation of the different types of eclogite

clearly outlined. The models for eclogite formation are fuzzy and conflicting. Geophysicists will have their worst fears confirmed that petrologists become entangled in endless discussions on unimportant issues and often fail to address the physical and tectonic parameters that may provide answers to the problem.

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**MONTEREGIAN TREASURES: THE MINERALS OF MONT SAINT-HILAIRE, QUEBEC**, by J. A. Mandarino and V. Anderson. (Cambridge University Press), 1989, \$85.00 (U.S.). Hardcover, 281 p., 90 color prints, 75 crystal drawings, black-and-white photomicrographs, and sketches.

This book, which brings together data from several sources, gives a complete description of the 221 minerals found to date at Mont Saint-Hilaire. The main part of the book is devoted to the descriptive mineralogy of each species; included are appearance, physical properties, occurrence and associated minerals, chemical data, crystallography, optical properties, and illustrations. Accompanying each individual description are some very useful comments on the distinguishing features that have proved

to be invaluable to the many individuals trying to characterize material from this locality. The book also gives a brief description of the general geology and petrology of the locality and a more detailed description of the chemical classes of the various species. The five appendixes consist of (1) single-crystal data, (2) X-ray powder-diffraction data, (3) occurrences at Mont Saint-Hilaire, (4) classified list of Mont Saint-Hilaire species, and (5) chemical analytical data. Of the five appendixes, the most important will be the X-ray powder-diffraction data. This appendix is arranged into two sections: the first gives an alphabetical listing of all known species found at Mont Saint-Hilaire with their six strongest lines, and the second gives a search index that lists the X-ray data in decreasing order of intensity for each species. Unfortunately, the authors did not include any data on the many potentially new species, designated as "UK"; it would have been extremely useful to other researchers if, at least, the six strongest lines of these compounds were listed.

The 90 color prints are of excellent quality and, except for a few prints, are photomicrographs of minerals taken through the microscope. The prints show good resolution and color, making them an important addition to the book.

This book on Mont Saint-Hilaire minerals is a very valuable addition to the field of mineralogy and is an essential reference for both amateurs and professionals who have acquired samples from this world-famous mineral locality and need data to help identify their material.

However, in light of the cost, its large size (25 × 34 cm), and excellent cover appearance, the book is more of a "coffee table" publication rather than a working manual.

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