the sole text in, for example, an advanced undergraduate-level course on the Copernican revolution. For that purpose, Olaf Pedersen's *Early Physics and Astronomy* provides substantial coverage of the development of scientific thought, although it sacrifices comment on technical issues and unfortunately does not include Kepler. For a truly inspiring account of the pitfalls and triumphs of the Copernican revolution, Julian Barbour's *Absolute or Relative Motion?*, Volume 1, provides a superb and insightful explanation that brings out the full richness of the subject. Thurston's book is a useful complement to Barbour and to Pedersen, providing extra insight on some of the technical issues and filling in gaps in our knowledge of ancient astronomy that are not treated by the other two authors.

In summary, although *Early Astronomy* is probably not a first choice for an overview of the history of theories of celestial motion, it provides an excellent description of much of the technical material. In that regard it will be a valuable resource for those interested in obtaining a deeper understanding of early astronomy. —*James A. Rose, Physics and Astronomy, University of North Carolina at Chapel Hill*

Handbook of Optics. Volume I: Fundamentals, Techniques, & Design; Volume II: Devices, Measurements, and Properties. Second Edition. Michael Bass, Editor in Chief; Eric W. Van Stryland *et. al.*, Assoc. Eds. 1,400 pp. McGraw-Hill, 1995. $99.50, each.

The field of optics is of great practical importance for scientists and professionals, from astronomers to zoologists. Publication of the second edition of the *Handbook of Optics*, sponsored by the Optical Society of America, will therefore be welcomed, especially since it is a comprehensive and useful reference. The field of optics has undergone an astonishing explosion in recent years, considering its venerable history, and the new edition reflects that outburst. The doubling in size of the second edition over the first (published in 1978) has come about in three ways. Some basic topics originally covered in one chapter are now dealt with in greater depth in several chapters. For example, "Image Formation: Geometrical and Physical Optics" has become four chapters: "General Principles of Geometric Optics," "Interference," "Diffraction" and "Coherence Theory." Some chapters dealing with instrumentation have become multiple-chapter sections including many new kinds of devices. For example, "Optical Radiators and Sources" has become a five-chapter section covering light-emitting diodes, lasers and semiconductor lasers, lamps and other incandescent sources, blackbodies, arcs and more. Some topics are completely new, such as the eight-chapter section on "Optical Design Techniques."

There is much here to recommend this handbook to a wider audience than the first handbook might have served. For example, in the first edition the chapter on "The Eyes and Vision" primarily addressed ophthalmological subjects. The new edition has a six-chapter section on "Vision" which includes not only the optics of the eye but also detailed treatments of visual performance and optical generation of the visual stimulus, a discussion of color monitors and liquid-crystal displays, and a chapter on psychophysical methods. This more extensive treatment would appeal to people concerned with visual response, either from the fundamental or the practical point of view. There are some topics, however, one might have hoped to see covered that are given only very cursory and scattered treatment or are omitted entirely. This is particularly true of topics related to astronomy. Active optics and wave correction are nowhere mentioned, and many telescope designs important to modern ground-based and satellite astronomy are also missing.

The point of view taken in each chapter seems to depend on the nature of the topic and on the contributor. In some cases, such as the material on geometrical optics, an extensive theoretical treatment is presented, but the application of the mathematics to real systems is omitted. In others, such as psychophysical methods and optical fabrication, the approach is more of a user's guide with practical advice rather than analytical justification. This is particularly true in those sections dealing with optical elements, instruments and measurements, which make up the bulk of Volume II.

As is inevitable in an active field, some chapters have been overtaken by events. In "Semiconductor Lasers," the most recent reference given is from 1993 and few are later than 1991, which is unfortunate given the especially rapid progress in the blue-green wavelength range. Similar problems arise in chapters that refer to specific, commercially available instruments or software, and those sections of the handbook will date most quickly. Nevertheless, these chapters treat the factors one must consider in choosing an instrument for a particular application, and so will remain useful after particular models are superseded.

The editors of the volumes have taken care to make the presentations of the chapters reasonably uniform. Each is prefaced by a list of symbols and their definitions, and efforts have been made to standardize the use of symbols and sign conventions, which are always problematic in this field.

A few minor annoyances appear, which is all the more surprising in a set that appears to be well produced overall. For example, many of the tables and figures are very poorly printed and annotated. Many are reproduced from other works, but that is no excuse for lines that look as if half of the toner had fallen off the page before they were printed. The figures and tables often include acronyms or quantities referred to nowhere in the text, leaving the reader puzzled. The text itself shows signs of having been spell-checked but not proofread: "nobel metals," "effected" where "affected" is meant, "model" instead of "mode." A sampling of both volumes found no more than two or three such errors per chapter, and they do not obscure the meaning, but to a keen-eyed reader they can be irritating.

In sum, this edition is a worthwhile addition to the library of any institution where students and professionals deal with topics in optics.—*Laurie E. McNeil, Physics and Astronomy, University of North Carolina at Chapel Hill*

Petrology: The Study of Igneous, Sedimentary, and Metamorphic Rocks. Loren A. Raymond. 742 pp. William C. Brown Publishers, 1995. $78.80.

Petrology is the study of rocks, and there are many, many different kinds of rocks. Middle-level undergraduate texts can stress principles, or the descriptive aspects or the nomenclature. Or they can concentrate on the igneous or the sedimentary rocks. A complete course in petrology, assuming that crystallography, mineralogy and basic geology have already been assimilated, would cover crystal growth, chemistry, thermodynamics, petrography, isotopes, classification, some advanced mineralogy and the rock environment, and it would include igneous, metamorphic and sedimentary aspects, which are basically different fields of inquiry.

The classification of igneous rock has had a controversial and often hilarious history. Nearly every petrology book seems to feature a different scheme, and those that have tried to honor the logic in petrologic by devising sensible classification schemes have failed to make an impact. Classification implies an artificial subdivision of a continuum and a forced marriage of diverse properties such as color, texture, origin, chemistry and mineralogy, which themselves are continua. Many common rocks were named before any classification was attempted.

S. J. Shand (1949) decried the "witless practice of giving a new name to every rock that is slightly different from any rock seen before and thus to extend the list of specific names that already includes more than 600 items and includes such gems as Katzenbuckelite and leeuwfonteinite, anabohitsite and sviatoynossite...." He advocated a return to the language of babyhood and the coinage of words by putting together unrelated syllables, such as olivine-pyroxene-biotite-nepheline-melilite rock to replace olpybinemelite (petrobabble).

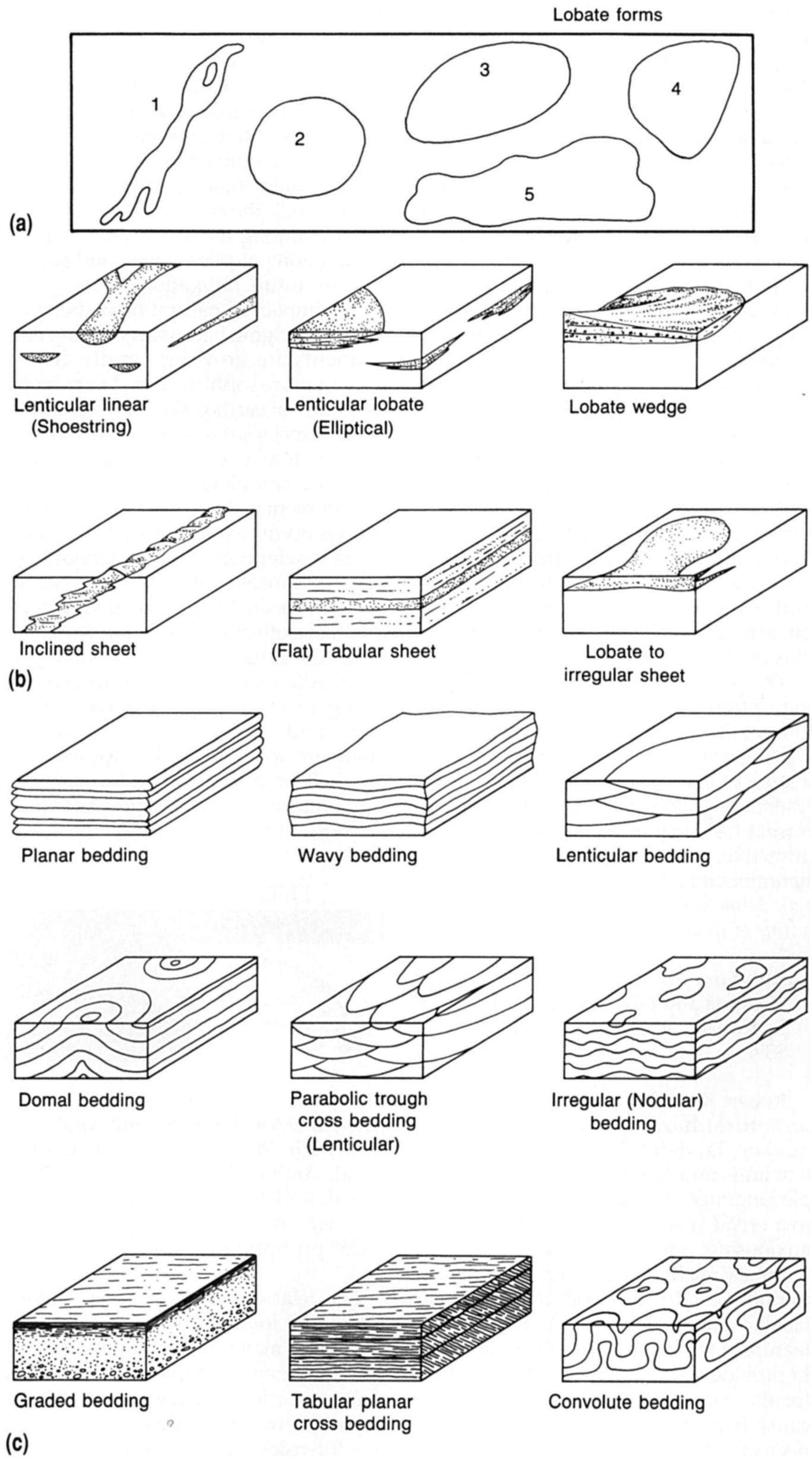
About 40 terms have been devised to describe igneous rock textures, including pilotaxitic, glomeropophyritic, spinifex, poikilititic, symplectic, trachytoidal and epitaxial. Texture is the basis of classification used by many petrologists, and descriptors, such as porphyritic, phaneritic, aphanitic and porphyritic with phaneritic ground mass, must be dutifully learned by the apprentice petrologist.

There are about 300 igneous rock names and comparable numbers for sedimentary and metamorphic rocks. There are dozens of technical terms used to describe colors, fabrics, textures, associations and origins. A card-carrying petrologist must expand her vocabulary beyond that necessary in most other disciplines, and a working knowledge of Latin and Greek doesn't help much. Petrology is a science but it is also a language, and to some extent it must be taught as a language.

Loren Raymond subscribes to the view that one must know the vocabulary of a subject in order to effectively communicate in that subject. An effort is made to define large numbers of terms and to gradually evolve from baby talk to advanced petrological jargon. The trouble with having specialized words for shades of difference is that petrologists can communicate precisely with one another but not with their geological and geochemical colleagues. Most earth scientists can make do with only a dozen rock names by describing variations using common words from their native language. Petrologists and interior decorators have much in common: a rich language for fabrics, textures and colors.

The solid part of the earth consists of minerals, and rocks are assemblages of minerals. In order to understand rocks, one must understand processes on and in the interior of the earth. Rocks themselves contain the history of the earth and are the results of already performed natural experiments. It is difficult to read a rock, even if one knows the language. One must understand the culture, the context, the history ... just as is the case for ordinary books.

Raymond has the following philosophy: Before the individual rock families are discussed, or can be discussed, one must review generalities of structure, texture, chemistry and mineralogy. Then the various classification schemes must be learned, even the archaic ones, because there are remnants of old terminology in the current petrological literature. Then thermodynamics, the phase rule and simple silicate systems must be understood. All of this takes six chapters and 87 pages in the present book, before one reaches the simple igneous rocks, such as basalts



Five plain views of bed shapes (a); three-dimensional views of formation (and member) shapes; and block diagrams with cross-sections of beds (c). From *Petrology*.

and ultramafic rocks. Similar background is given for sedimentary and metamorphic rocks: structures, textures, mineralogy, chemistry, classifications, processes and environments.

The language (syntax and word choice) is taught in this book and taught very well. The scope is breathtaking. But one learns only very gradually why petrology is so central to earth sciences. The shortest chapter in the book is the first, "Rocks and Earth Structure." All of earth structure and dynamics is covered in three pages, mainly by defining 16 terms including petrography, magma, Moho, lithosphere, plates and triple junctions. The book ends with a three-page epilogue that attempts to tie everything together by discussing petrotectonic assemblages and plate boundaries. This is not enough context for a 742-page book. Even when the course is completed, the student will not appreciate the power to understand the earth that she now holds. But she will be able to communicate very well with other petrologists.

Fortunately, the book is organized into bite-size chapters, usually about 10 pages long. A given rock type, such as andesite, granite, carbonate or eclogite, is introduced and defined, the composition and texture are discussed, and then the origin and examples are treated. Numerous photographs and line drawings are used effectively.

The publisher provides several binding options, including paperback separates of the three major sections. This will considerably reduce the interclass load of a student backpack. Otherwise she must transport a three-centimeter thick, large format 1.4-kilogram, coffee-table size, but attractive, burden across campus. Add a hammer and a few rocks.—*Don L. Anderson, Seismological Laboratory, California Institute of Technology*

Earth's Fury: An Introduction to Natural Hazards and Disasters. 214 pp. Robert L. Kovach. Prentice-Hall, Inc., 1995. $39.

Robert Kovach's book covers all kinds of natural hazards (volcanoes, earthquakes, landslides, drought, weather, tsunamis and floods) concisely in a simple language; it is highly recommendable to a broad spectrum of students who are anxious not only to understand the cause of these dreadful natural hazards but also to understand the physics of some spectacular natural phenomena. The notable feature of this book is that the author tries to provide a simple physical explanation for the various natural phenomena that cause hazards. He explains the mechanism of earthquakes, atmospheric circulations, tornadoes and tsunamis at a level that can be easily understood by most undergraduate and graduate students. Of course, it is not possible to provide a very rigorous explanation in a book of this type, but the explanations given in the book would be sufficient to motivate interested students to explore further details from other, more specialized books. As is usually the case with this type of book, it has many tables that show the statistics of various hazards. Although these statistical data are important, they tend to be somewhat boring if they are presented as numbers alone. In this book, the data are often presented with some anecdotal accounts, which may help students sustain their curiosity in the subject. Overall, the book has struck a good balance among its presentations of fact, explanations of phenomena and suggestions for future mitigation efforts.

The impact of natural hazards on our lives is changing because our living environments are growing rapidly and becoming more sophisticated. For example, the effects of earthquakes and floods near modern major urban centers are more far-reaching than ever before because of the increased complexity of economical and environmental structures of modern society. It is becoming increasingly important to train scientists who understand the physical causes of these natural hazards and who desire to apply their knowledge to achieve effective mitigation work.

All the illustrations are in black and white. Although they are effective enough, the use of a few color photographs would have made this book more attractive. There are some typos, but we trust that they will be corrected in future editions.—*Hiroo Kanamori, Seismological Laboratory, California Institute of Technology*

LIFE sciences

Ancient DNA: Recovery and Analysis of Genetic Material from Paleontological, Archaeological, Museum, Medical, and Forensic Specimens. Bernd Herrmann and Susanne Hummel, eds. 263 pp. Springer-Verlag, 1994. $34.95.

The relatively recent development of techniques for detecting minute amounts of genetic material from tissue remains, bone fragments, samples of dried blood, amber inclusions and fossils has created an exciting new tool for medicine, anthropology, forensics and evolutionary biology. In just the past five years or so, an explosion of studies of "ancient" DNA—most making use of the polymerase chain reaction (PCR)—has spawned a new subfield of genetics that is concerned with methods to detect and analyze partially degraded DNA from preserved tissues. This book is both a review of the systems and tissue types to which these methods have been applied, as well as a primer of techniques and protocols for working with ancient DNA (aDNA).

At first one might consider it a novelty to obtain a small piece of the genetic code from a long-since-dead mammal skin in a museum drawer or from dried blood at a crime scene, but applications using ancient DNA have already provided valuable evidence to genetic and evolutionary research. Portrayed as science fiction in Michael Crichton's *Jurassic Park*, these methods have recently made it possible to view genetic variation locked in time by preservation, verify the identity of a murderer and document genetic changes in diseases diagnosed in patients long dead before the advent of molecular biology. The amount of information available for any given specimen will undoubtedly remain small—probably precluding the realization of anything like Crichton's dinosaur-reassembly theme park—but the ability to identify and use trace genetic material has now made accessible genetic comparisons that were once considered completely unattainable.

In the book's introduction, the editors define aDNA as "any bulk or trace of DNA from a dead organism or parts of it, as well as extracorporeally encountered DNA of a living organism." This definition allows the term ancient DNA to be applied to any sample that may have been subject to degradative processes occurring at cell death or to DNA subject to various forms of preservation. Genetic material is damaged by oxidative agents, ultra-violet radiation, pH, temperature, moisture and mechanical stress, all of which lead to mutation or degradation of the genetic code. The editors and authors are optimistic about the power of new methods to obtain and use aDNA, but nearly all are also realistic about its limitations. Extreme care is required to avoid and detect contamination of samples from modern sources of DNA and to verify positive results as such. These factors make finding aDNA especially sensitive and occasionally suspect. Commendably, most of the authors in this volume describe the methods each used to avoid or account for these problems. DNA degradation also places a severe limit on the amount of information attainable from a given source tissue, thus limiting the resolving power for any given question. Despite these limitations, exciting insights on genetics and evolution have been made from remarkably small amounts of genetic data.

This volume of contributed papers chronicles the wide diversity of sources