ited, however, since there can be huge variations in ground motion that depend on details of the specific rupture, details that can only be known after the fact. Alternatively, enough strong-motion data may now be available to permit empirical and statistical estimation of future ground motion if one can specify the probability of occurrence of earthquakes of various "sizes" and their expected distances from a site of interest. These two approaches, modeling and empiricism, illustrate a simplified way the deterministic and probabilistic strategies of specifying vibratory ground motion for design of structures in earthquake-prone regions. In either case, some information must be specified about the future occurrence of earthquakes. Reiter's book provides the technical background needed to fully appreciate what goes into seismic hazard analysis and thus to better understand the strengths and weaknesses of what can emerge from such analysis.

The past decade has seen significant advances in understanding the fundamental nature of the earthquake process as well as the characteristics of destructive ground motion. Each new earthquake provides lessons to be learned by the scientific and engineering communities. Often, the place where this new information on the earthquake process was first translated into policies and procedures has been in the arena of nuclear power plant licensing. The author has been active on the regulatory side of nuclear siting controversies for many years, and thus his emphasis is on the techniques used in high-visibility projects where public concern is greatest.

Seismic hazard analysis is the first part of an integrated scientific, engineering, societal, and legal process that tries to provide practical solutions for earthquake hazards at particular sites. This has to be done even when data are inadequate and the understanding of the earthquake process is imperfect. To make the problem even more difficult, the scientists, engineers, and lawyers who must work together to arrive at these solutions come from very different professional cultures. The author, with deep experience in these matters, crisply argues that the mix of these cultures and the painful process that ensues is in fact the best way to take into account all of society's needs.

Earthquakes are caused by faulting; on that there is little disagreement. Unfortunately, one cannot always identify specific faults well enough ahead of time to adequately define the earthquake hazard that they may represent. This circumstance has led to procedures, some might call them rituals, for defining *seismotectonic provinces* and *localizing structures* and to formal rules for measuring the capability of these features to produce future earthquakes. It is refreshing to see a balanced discussion of this matter, in which the author freely admits that there is some inherent unreality involved. He goes on to make a convincing case that, flawed though it may be, the current process seems to do a better job of capturing the information available and accounting for its uncertainty than does anything else that has yet been suggested.

An issue not raised, and one on which it would have been interesting to have the author's insight, involves how the system can best adapt to new data that may alter previous conclusions, particularly after a structure has already been built. No matter how extensive investigation for a particular site might be, the rapidly improving technology and evolving scientific understanding almost guarantee that there will be changes in the assessment of the earthquake hazard for it.

One of the strengths of this book is that earthquake phenomenology from the standpoint of seismologists and ground motion characterization as viewed by engineers are treated together in an integrated fashion. This has the effect of demonstrating how elements of our basic undertanding of the earthquake process are translated into seismic design. A central theme is the clarification of the different assumptions made in deterministic and probabilistic approaches to seismic hazard analysis and their implications. The concluding chapter lays out these differences and suggests ways in which the two different approaches might be integrated. In the final analysis, the approach taken must be tailored to suit the specific problem being addressed. The analysis appropriate to protect the public from radioactive release from an underground nuclear waste repository with a 10,000-year lifetime is quite different from that needed to prevent earthquake casualties during the 50-year lifetime of an office building.

STEWART W. SMITH
Geophysics Program,
University of Washington,
Seattle, WA 98195

Geologic Fluid Mechanics

Flow and Reactions in Permeable Rocks. O. M. PHILLIPS. Cambridge University Press, New York, 1991. x, 285 pp., illus. $59.50.

The role of subsurface fluid flow in geologic processes is emerging as an important theme in the earth sciences. Water participates in fluid-assisted chemical reactions, and fluid flow is a dominant factor in the redistribution of solutes and heat that controls such processes as diagenesis and ore genesis. In this book Phillips presents a set of mathematical tools and models useful for understanding ground water flow and its influence on geochemical systems and thermal regimes within the uppermost region of the earth's crust. He provides a good introduction to those principles of fluid mechanics that are needed to describe how rates and patterns of fluid flow influence geologic systems. Indeed, the strength of this book is its linkage to the analysis of geologic processes; this is not a textbook concerned primarily with ground water flow theory.

Although the appearance of the term "reactions" in the title may suggest otherwise, this also is not a book on geochemical thermodynamics. The focus is clearly on fluid dynamics and how the effects of chemical reactions are introduced into the fluid-flow equations to form the link between patterns and rates of flow and reaction kinetics. Examples are developed to quantify isothermal reaction fronts, gradient reactions, the concept of mixing zones, and isotherm-following reactions. The book will be useful to geochemists who want an introduction to fluid flow and heat transfer in porous geologic media, presented from the perspective of how some simple geochemical and hydraulic models can be linked.

Three broad topic areas are covered: fluid flow and relationships between patterns of flow and geologic structure; fluid flow and patterns of geochemical reactions; and fluid instabilities arising from temperature or salinity gradients. Mathematical results are emphasized, especially the analytic treatment of simple geometries. Rather than provide a detailed examination of field applications, Phillips develops examples that illustrate the nature of the processes involved and how they may be quantified.

The book offers a good introduction to the techniques used to analyze interface stability and fluid instabilities caused by spatial gradients in fluid density that, in turn, arise from temperature or salinity variations. Hydrologists familiar with isothermal systems will find the discussions of fluid instability and thermal convection a useful bridge to the extensive coverage of these topics in the fluid mechanics literature. The next-to-last chapter describes selective aspects of pressure-driven flows in confined and unconfined aquifers, including analytic models of the disturbance of a conductive thermal regime by advective heat transfer. The last chapter describes thermally driven flows in which the hydraulic forcing terms are of minor or no importance. Coverage of both these topics illustrates the similarities and differences in ground water flow systems

that are driven in one case by hydraulic forces and in the other by buoyancy forces.

The book's intended audience is graduate-level geologists. To gain full advantage of the material one should be familiar with partial differential equations. Though an overview of the principles governing fluid flow and heat and mass transfer is given in chapter 2, those not familiar with the concepts and notation of the fundamental balance equations may find it difficult to follow the development. The order in which some concepts are presented could also make for rough reading for the uninitiated. For example, modern concepts of dispersion in porous media are introduced before Darcy's law and the hydraulic potential. Equations of state are given as linear approximations, reflecting the author's focus on models that apply at shallow depths. Most of the discussion deals with steady-state fluid flow systems; there is little coverage of processes in which hydraulic transients are a key feature of system evolution.

This book is appropriate for a graduate course that examines the role of ground water flow in geologic media. It sets the quantitative framework. It does not stand alone, however—additional material would be needed to cover field examples and numerical simulation. Unfortunately, this aspect points to a major weakness of the book: the reference list is short and selective, with many relevant papers omitted.

LESLIE SMITH
Department of Geological Sciences, University of British Columbia, Vancouver, BC V6T 2B4, Canada

Some Other Books of Interest

Tsunami Hazard. A Practical Guide for Tsunami Hazard Reduction. E. N. BERNARD, Ed. iv, 213 pp., illus. $94. From a symposium, Novosibirsk, U.S.S.R., July 1989. Reprinted from *Natural Hazards*, vol. 4, nos. 2 and 3.

Since 1960 the International Union of Geodesy and Geophysics has sponsored 14 symposia focused on tsunamis—the destructive coastal inundations often associated with earthquakes, particularly in the Pacific. Looking back on the efforts of the past 30 years, Bernard, in his preface to this most recent proceedings volume, characterizes the 1960s as "an exciting time in tsunami research," during which "the tsunami phenomenon" was analyzed and defined, and the 1970s as a decade of experiments in computer modeling. The 1980s saw efforts to turn the results to practical use, particularly the development of a local warning system using satellites, and Bernard expresses the hope that the 1990s will prove to have been the Decade of Hazard Reduction, the major challenge being to marshal the necessary resources on an international level.

Though readers will not find in the remainder of the book the full-fledged "practical guide" that the subtitle seems to promise, steps that are being taken toward that end are indicated in what it does contain—13 papers by authors from seven countries that constitute the "highlights" of "Tsunami 89."

The three opening contributions are observational in character—Gonzalez *et al.* comparing numerical models and deep-ocean data for two recent tsunamis generated in the Alaskan bight, Kovalev *et al.* reporting on measurements made by cable bottom pressure stations on the southwestern shelf of Kamchatka, and Papazachos and Dimitriu examining the 70 major tsunamis known to have occurred in the vicinity of Greece since antiquity in the light of recent data on earthquake processes in the area. There follow six papers on numerical simulation of tsunamis, beginning with an overview by Shuto, who notes that "hindcasting" within a 15% error is now possible and sees improvement as depending most urgently on further observational data. Other simulation papers deal with tsunamis in relation to earthquake sources, aspects of bore formation and runup, and damage to aquaculture. The final four papers in the book are concerned directly with tsunamis as hazards to humans, Tinti with tsunami potential in the "Italian seas," where the phenomenon is relatively rare, both Bernard and Lorca with Project THRUST (Tsunami Hazards Reduction Utilizing Systems Technology) and its prototype enterprise, the Chilean Tsunami Warning System, and Farreras and Sanchez with efforts focused on the west coast of Mexico. The volume ends with brief reports of several meetings or workshops held in conjunction with the main symposium, including a series of recommendations that emerged. No index is provided, but each paper has an abstract.

—K.L.

Body Composition in Biological Anthropology. ROY J. SHEPHARD. Cambridge University Press, New York, 1991. x, 345 pp., illus. $69.50. Cambridge Studies in Biological Anthropology.

The body components this volume is concerned with are not the 87 cents' worth of chemical elements that folklore has it we could all be broken down into but such more organized ingredients as fat, water, muscle, and bone, measured in terms of mass or density. Before taking up the more technical aspects of the subject, the author provides an introduction beginning historically with an account of the work of Santorio Santorio (1561–1636)—who "apparently spent much of his life eating and sleeping in a specially constructed weighing chair . . . , accumulating valuable data on the mass of his ingested food and excreta over a period of some 30 years"—and ending with a consideration of issues of standardization in which somewhat arbitrary "reference" standards are contrasted with "normal" or "ideal" standards such as are espoused by insurance companies. After a chapter discussing problems with inferences based on cadavers, the author turns his attention, in successive chapters, to methodology for determination of body fat, body water, lean tissue mass, and bone mass, emphasizing not techniques as such but conceptual and interpretative problems. A similar approach is then applied to variations in body composition with body region, developmental stage or age, heredity, and environment. Final chapters are devoted to pathological disturbances that affect body composition and to issues of adaptability. The volume, engagingly written even in its most technical parts, closes with a brief glossary, an 82-page section of references, and an index.—K.L.

Books Received

Bonding and Structure of Solids. R. Haydock, J. E. Inglesfield, and J. B. Pendry, Eds. Royal Society, London, 1991. viii, 164 pp., illus. £32. From a meeting, London, Sept. 1990. Reprinted from *Philosophical Transactions of the Royal Society,* series A, vol. 334, no. 1635 (1991).

Brazil Gold '91. The Economics, Geology, Geochemistry and Genesis of Gold Deposits. E. A. Ladeira, Ed. Published for the Associaçao Organizadora do Brazil Gold by Balkema, Brookfield, VT, 1991. xviii, 823 pp., illus. $95. From a symposium, Belo Horizonte, Brazil, May 1991.

Cognition and the Symbolic Processes. Applied and Ecological Perspectives. Robert R. Hoffman and David S. Palermo, Eds. Erlbaum, Hillsdale, NJ, 1991. xviii, 545 pp., illus. $79.95; paper, $39.95.

Cognition through Color. Jules Davidoff. MIT Press, Cambridge, MA, 1991. xiv, 217 pp., illus., + plates. $32.50. Issues in the Biology of Language and Cognition. A Bradford Book.

Communicating Science. A Handbook. Michael Shortland and Jane Gregory. Longman, Essex, U.K., and Wiley, New York, 1991. xii, 186 pp., illus. Paper, $27.95.

Comparative Animal Physiology. C. Ladd Prosser, Ed. 4th ed. Liss (Wiley), New York, 1991. 2 parts. Environmental and Metabolic Animal Physiology. xii, 578 pp., illus. $44.95. Neural and Integrative Animal Physiology. x, 776 pp., illus. $44.95.

Comparison of Statistical Experiments. Erik Torgersen. Cambridge University Press, New York, 1991. xx, 675 pp., illus. $99.50. Encyclopedia of Mathematics and Its Applications, 36.

Computational Nuclear Physics 1. Nuclear Structure. K. Langanke, J. A. Maruhn, and S. E. Koonin, Eds. Springer-Verlag, New York, 1991. xii, 209 pp., illus., + disk.

Computerization and Controversy. Value Conflicts and Social Choices. Charles Dunlop and Rob Kling, Eds. Academic Press, San Diego, CA, 1991. xviii, 758 pp., illus. Paper, $34.95.

Computing for Psychologists. Statistical Analysis Using SPSS and MINITAB. Robert West. Harwood, New York, 1991. x, 234 pp., illus. $40; paper, $18.