BOOK REVIEWS

CRUSTAL HEAT FLOW: A GUIDE TO MEASUREMENT AND MODELING. G.R. Beardsmore and J.P. Cull. Cambridge University Press, 2001, 324 p. $100.00 hardback ($37.95 paperback).

Crustal Heat Flow (2001, Cambridge University Press) is an engaging volume, an inexpensive introduction to geothermal techniques and applications. This text was intended by the authors to be "a handbook for geologists and geophysicists who manipulate thermal data, particularly for petroleum exploration." It is also considered by the authors to be a text that would form the basis of a course on these topics. The book provides important information in a format accessible to specialists and lay-scientists interested in thermal methods, but suffers from some inconsistent handling of basic concepts.

The book is divided into three primary sections: the Thermal State of the Earth, Measurement Techniques, and Modelling Techniques. The first section includes background information on the origin and thermal evolution of our planet, units and fundamental theory, and mechanisms by which heat is created and transported. The second section describes methods for measuring thermal gradients, thermal properties, and paleo-thermal indicators (thermal maturity). The third section of the book describes calculation of heat flow from field and lab measurements, common corrections, correlations between heat flow and other geological parameters, models for lithospheric creation and evolution, numerical methods, and sedimentary basins.

Is there a need for a book like this? Absolutely. A check of the University of California library system and of books available online suggests that the time is right for an up-to-date summary of available methods and models, one that could be used in an upper level undergraduate or introductory graduate course. Other options for those interested in these topics include mainly older (dated) contributions that are very expensive and/or highly specialized.

Beardsmore and Cull are generally true to their goal of writing to an upper-level undergraduate audience with limited mathematical expertise. Most of the ideas are introduced as concepts first and as equations next, which is helpful, but the way in which ideas and equations are explained is sometimes confusing. For example, when introducing equations for heat transport, the authors give the mathematical definition of a thermal gradient (dT/dz) and note that "…a positive gradient is in the direction of increasing temperature." Actually, the sign of a gradient depends on the (arbitrary) selection of a positive direction. One-dimensional, conductive heat flow, q, is defined (Fourier's first law, uncredited) as $q = -k\ dT/dz$, where k is thermal conductivity, and the authors state that "positive heat flow is conventionally taken to be in the direction of decreasing temperature." In fact, whether heat flow is positive or negative also depends on the selected reference frame, although I agree that heat flow out of the Earth is generally written in the literature as a positive quantity. It would be better to introduce the theory here in a more consistent way, then to explain conventions of the discipline. I was also surprised to see the thermal conductivity chapter jump right into phonon conduction, a choice that will baffle nonspecialists. Pedagogically, it would be better to treat thermal conductivity in the way it was derived, as an empirical construct relating a gradient to a flux, and then to discuss its theoretical basis later in the chapter.

Data examples in the marine heat flow sections are out of date, and some explanations of methods are incorrect. For example, the authors suggest that equilibrium temperatures are reached during multi-penetration surveys after several minutes in the seafloor, but in fact the Bullard "F-function" is generally used to extrapolate in-situ measurements to equilibrium values. In the chapter called Lithospheric Models, the authors state that "the lithosphere is that section of the upper mantle that exhibits gross plastic behavior under stress," which suggests that the crust is not part of the lithosphere. This chapter would have benefited from a figure showing cross sections through continental and oceanic lithosphere, identifying primary layers, materials and properties. The limited discussion of geothermal evidence for climate change, one of the most interesting developments in crustal heat flow studies in the last 20 years, is dated and incomplete. And there is barely a mention of bottom-simulating reflectors or gas hydrates, although heat flow studies have played a major role in understanding the significance of these important (hydrocarbon-based) features.

The book is strongest in discussion of thermal maturity techniques and explaining how these techniques compare in terms of accuracy and assumptions. I found the fission track section to be particularly lucid. The section on thermal conductivity laboratory methods is also nicely arranged, and I appreciate the integration of well-log data in this chapter. The section on modeling techniques and applications is thin and will not be very helpful to nonexperts, particularly since the authors emphasize two- and three-dimensional simulation. Since heat conduction theory is developed in 1-D, why not develop the modeling section in 1-D?

The figures are generally clear, although I found a few of the examples from the oil patch to be cryptic. I found the typeset equations difficult to read in some cases. Many equations are written on a single line, using a "slash" to indicate division

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and an "x" to indicate multiplication, and would be easier to read if type set with an equation editor. Also, it is curious that some mathematical quantities are indicated using bold symbols for no particular reason (generally they are not vectors). The final chapter on sedimentary basins would benefit from addition of a few case study examples.

An interesting component of this book is the provision of a web site containing supplemental material. At this web site there are spreadsheets for many analytical functions, but no example of a finite-difference code, which is easy to craft in a spreadsheet. The web site is a nice feature, and includes links to compilations of heat flow data, selected references, high-resolution figures from the text, and other useful resources. With some additional effort to address inconsistencies and bring a few sections up to date, the authors could make the second edition of this text essential reading for a wide range of Earth Scientists, and perhaps spark a resurgence in teaching of thermal methods.

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MINERALOGICAL TABLES by Hugo Strunz and Ernest H. Nickel. E. Schweizerbart'sche Verlagsbuchhandlung, 2002, Stuttgart, Germany (9th edition). 870 p. ISBN number 3-510-65188-X. $142 (EUR 148)

At last! The long-promised and eagerly-awaited new edition of this classic work has finally appeared (the first edition was published by the senior author as *Mineralogische Tabellen* in 1941, with subsequent editions in 1949, 1957, 1966, 1970, 1977, 1978, and 1982). One must congratulate Hugo Strunz on the authorship of this work over some 60 years. He has been fortunate in obtaining another distinguished mineralogist, Ernest Nickel, as co-author of this, the first edition in English. This edition is a complete revision of the fifth (1970) edition, since subsequent editions were essentially reprints of that work. Compared to the fifth edition, this edition more than doubles the number of species (from 1740 to approximately 4000), has increased in size from 621 to 870 pages, and now costs more than six times as much.

In this new edition the minerals treated seem complete through 1999, with a few from 2000; additional minerals described in 2000 are given in an appendix.

The authors define the plan of the book in the following terms: "In this section the world of minerals is divided by chemical features into ten classes, each of which is subdivided, on chemical-structural principles, into divisions, subdivisions, groups of isotypic and homeotypic minerals, or individual minerals with unique structure types" (Preface, page v). "Each mineral is listed by name, chemical formula, space group designation (and number), crystallographic parameters and unit-cell contents (Z). One or more references relating to the data are given, with the structural reference(s) indicated" (page 14). "An alphanumeric scheme, from 1AA.05 to 1AA.10 . . . [etc.] encompasses groups rather than individual minerals . . . In this scheme the first numeric digit represents a Class, the first alphabetic character represents a Division, and the second alphabetic character respresents a Subdivision. The final two numeric digits represent a Group or individual mineral" (page 17).

Within this system, related Groups may be designated as a Family. A Family may comprise a Division (e.g., Zeolite Family, 9G), a single Subdivision (e.g., Pyroxene Family, 9DA), or several Subdivisions (e.g., Amphibole Family, 9DD-9DE).

Since I have the utmost confidence in the authors' competence, I have not attempted to systematically check their data for the individual minerals. The following notes were made during a general inspection.

There are few problems with layout, but the diagram on the inside front cover should have been printed with an explanatory caption.

Polytypes are listed as individual species, although this is contrary to the IMA Commission on New Minerals and Mineral Names, which does not regard polytypes as individual species. As a result, for example, there are listed seven species of högbomite and ten species of cronstedtite (however, there is only one entry for each in the Index).

Some entries in the tables are given in quotation marks, but this usage is not explained. In some instances this appears to indicate synthetic non-minerals (e.g., "borazon", p. 55); in others, a species of doubtful validity (e.g., "volfsonite", p. 80). The book appears to be remarkably free from misprints. Although I did not make a thorough search for them, I noted one—chundrodite for chondrodite (p. 549). The Index (134 pages long) is excellent, including not only recognized species (in boldface) but also obsolete and redundant names, each with a brief elucidation.

This edition is a superb accomplishment, an up-to-date and complete work on systematic mineralogy. Alphabetic compilations, while having their uses, have the serious shortcoming of failing to indicate systemic relationships. Therefore, for those who need or prefer a more scientifically based compendium, this is the book. It is unfortunate that its high price may greatly inhibit the wide circulation that it deserves.

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CALL FOR PAPERS

In an era of rising public awareness of and scientific interest in the environmental and health effects of human activity, mineralogists clearly have an exciting new role in a multidisciplinary field. In keeping with this emerging role, the Editors of the American Mineralogist are pleased to announce the inaugural Environmental Mineralogy issue to be published in 2003. We encourage the submission of papers covering a range of environmental issues including, but not limited to, the following general research topics:

Effects of minerals on human health
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Interpretation of minerals as monitors of the surficial environment
Biominerals as recorders of the biological and geological environment
Minerals that form in surficial, acidic environments
Microbe-mineral interactions of environmental significance
Environmental applications of clay minerals.

Letters, full-length research papers, and review articles will be considered for publication in this special "green" issue. This issue will be published in addition to the regular issues. Depending upon the response from the mineralogy community, it might prove necessary to publish more than one green issue or to set aside sections of regular issues for papers on environmental mineralogy. Authors considering the submission of a review paper should consult one of the editors beforehand regarding the suitability of the proposed subject. All submissions for this issue will go through the regular peer-review process.

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The development of this special issue reflects a commitment on the part of the Editors to make environmental mineralogy an important part of the journal.

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