tend, albeit in isolation from one another. Schatz has predicted a declining role for librarians as scientists use increasingly powerful search engines themselves to search distributed network information resources (*4*). Lesk, however, sees great potential in the role of librarians as navigators (*5*).

That these many questions remain as open now as they were several years ago may seem promising; after all, it suggests that some options have not yet been consigned to oblivion. Wrong turns—in allocating primacy to certain views on the right of citizens to see and use information, the archival question, and the future of libraries and librarians—could substantially hinder scientific investigation. Articles in this book hint at the evolution of libraries, a process still underway. But, with few exceptions, they fail to grasp the nettles of the future.

References and Notes

1. W. Gardner and J. Rosenbaum, *Science* **281**, 786 (1998).
2. See http://fairuse.stanford.edu
3. Now a program of the Council on Library and Information Resources; see http://www.clir.org/programs/cpa/cpa.html
4. B. R. Schatz, *Science* **275**, 327 (1997).
5. M. Lesk, *Practical Digital Libraries: Books, Bytes, and Bucks* (Morgan Kaufmann, San Francisco, 1997).

BOOKS: GEOSCIENCES

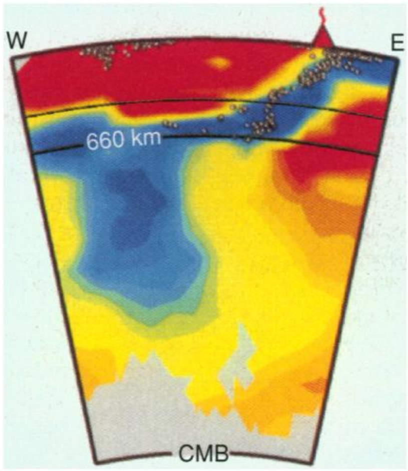
The World Between Crust and Core

David J. Stevenson

In many areas of science the "big" questions remain unanswered even though we have much knowledge and a plethora of models. The study of the mantle, which constitutes 70% of Earth's mass, is a good example. Here the important remaining questions include: What is the mantle made of? Where did the material come from as Earth formed? How was it altered during and after delivery? Is the mantle well stirred? How do mantle convection and its surface manifestation, plate tectonics, really work? How have these processes, and the mantle's composition and structure, varied through geologic time? Such questions were the central concerns of Ted Ringwood, a giant among earth scientists to whose memory *The Earth's Mantle* is dedicated. The book, written largely by his Canberra colleagues at the Australian National University's Research School of Earth Sciences, admirably conveys our current understanding of these questions, the range of possible answers, and the methods by which they are addressed.

The Earth's Mantle
Composition, Structure, and Evolution
Ian Jackson, Ed.
Cambridge University Press, New York, 1998. 592 pp. $130, £80. ISBN 0-521-56344-5.

The book's 11 chapters, contributed by 20 authors, are grouped in three parts of approximately equal lengths: The first section examines the accretion and differentiation of Earth. The second considers the dynamics and evolution of the mantle, and the third reviews the structure and mechanical properties of the present-day mantle. A recurrent theme in all three parts is the extent to which the mantle is layered. To geophysicists, "layering" means the degree to which convection is prevented from being whole mantle (that is, from top to bottom, preventing internal boundary layers). To mineral physicists, it becomes the question of whether seismic data indicate changes with depth of the mantle's elemental composition (not to be confused with undisputed mineralogical changes). And to geochemists, it means the extent to which the mantle has been degassed (of primordial noble gases or argon-40) or deprived of its large ion lithophile atoms (now residing in the continents). The personal views expressed by the contributors also represent perspectives widely held within the three communities. Geophysicists are largely agreed that the mantle is stirred from top to bottom, though with various partial impediments. Most mineral physicists see no difficulty with mantle homogeneity (for example, Ringwood's pyrolite composition), but geochemists believe that the evidence consistently favors poor stirring.



Going down. The *P*-wave velocity structure beneath the Tonga arc provides evidence for penetration of colder material (blue, showing higher-than-average wave speeds) into the lower mantle (below the 660 km discontinuity). CMB, the core-mantle boundary, is located just below 2800 km.

R. VAN DER HILST/MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The disagreement between physical and chemical arguments partly reflects the orthogonality of what is measured. Geophysicists mostly deal with a snapshot of how the current Earth functions and must rely on models of uncertain validity to extrapolate over geologic time. Geochemists are usually interested in the outcome of some integral over time, but the integrand of this expression is exceedingly uncertain because it depends on processes that are even less well understood than convection (outgassing, for example, or how continents are made). Reconciliation is suggested (as in Geoffrey Davies' chapter) by saying that the deep mantle is more sluggishly stirred than the upper mantle, and that the endothermic phase transition 660 kilometers below the surface was a greater impediment to whole mantle flow in the past than it is now. Although this explanation is suggested by theory, one is struck by the lack of a well-quantified reconciliation, here or elsewhere in the literature. One recognizes the difficulty of reconciliation by noting that most researchers believe much of Earth's heat must originate deep in the mantle, and that it must get out by mass transport if the mantle convects from top to bottom. Such mass transport would seemingly violate the geochemical constraints, especially as the heat flow was larger in the past than now. This is a good book from which to gain an appreciation of the many aspects of the problem.

In the first, and by far the longest, chapter Hugh O'Neill and Herbert Palme summarize the bulk composition of Earth and its relationship to meteorites. They discuss elaborate models for the materials from which Earth accreted (different compositions for late-arriving impactors, for example). One cannot help but suspect that this problem is insufficiently well constrained to be solvable at present. (Needed are more lab data, including those from high temperatures and pressures.) The chapter is, however, an excellent source of information on the topic. Shorter but well-crafted chapters on isotopic and noble gas constraints follow, showing how these data restrict models for the differentiation of Earth. The substantial coverage of convection, mantle plumes, and the petrology of pyrolite is predictable, given the strengths of the Canberra school. The models of partial melting (including some advocacy of high "typical" mantle temperatures) of-

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fered by David Green and Trevor Falloon are perhaps the most controversial elements of the book. Mineral physics and its relationship to seismological data, particularly for the lower mantle (the "big" question), are thoroughly treated by Ian Jackson and Sally Rigden. The seismology chapter is perhaps the one disappointment. Given the achievements of its authors, Brian Kennett and Robert van der Hilst, and the remarkable accomplishments in this field in recent decades, one might have expected a more comprehensive treatment of what we have learned and hope to learn from both tomographic (3D maps of seismic velocity anomalies) and regional radial profiles.

The Earth's Mantle fills an important niche. It is not a text, but a source for ideas and current understanding. Although it is a snapshot of a rapidly evolving field, this compilation will be useful for many years. It is well produced, well edited, and up-to-date (with references through at least 1996). It is not quite as coherent as a monograph, but lacks the idiosyncrasies that often arise in books with single authorship. It is much more cohesive than conference proceedings or a set of review papers, and provides frequent cross-referencing. (The authors appear to have read each others' contributions!) I strongly recommend the volume to researchers and students interested in Earth's mantle; others outside the field will also find it a stimulating overview of this exciting area.

NEW MEDIA: SOFTWARE

Virtual Valet

Theo Dreher and Daiki Matsuda

There are a number of excellent software packages on the market that analyze nucleic acid or protein sequences and aid the molecular biologist in experimental design and interpretation. However, these packages do not qualify as a true electronic assistant capable of performing a virtual-reality cloning experiment. Gene Construction Kit 2 (GCK2) is an excellent program that does provide this service. GCK2, which runs on a Macintosh computer, can test the feasibility of cloning manipulations and assist in their design, and also can document and archive the precise sequence rearrangements of a cloning experiment in graphical or sequence format.

Gene Construction Kit 2
by Textco Inc.
West Lebanon, NH. Retail $1399; academic $999. Phone: (603) 643-1471 www.textco.com

The essence of GCK2 is its ability to present a graphical diagram of DNA segments (for example, plasmid vectors and cloned insertion sequences) for easy interpretation, while maintaining a strict connection between all graphically displayed features and their actual DNA sequences. The view of a particular DNA construct can be readily switched from a graphical diagram to detailed sequence. DNA rearrangements mediated by restriction digestion and ligation can be performed by GCK2 using simple copying and pasting to produce files describing recombinant DNAs; ligations of incompatible termini are disallowed. Comments and descriptions can be attached to particular features of a sequence, and these are automatically retained in subsequent derivatives. All annotations, comments, and actual DNA sequences are searchable by a built-in search engine, so that an accessible archive of the recombinant clones in a laboratory can be assembled. Any clone from that archive can be graphically displayed in a number of ways.

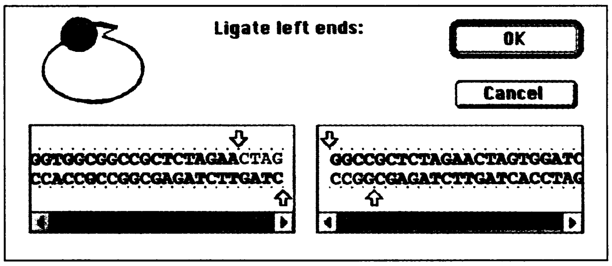

Fig. 1. Ligation Dialog Box. This box appears when ends are not compatible with insertion sites. The OK button remains inactive until the segment ends are made compatible by adjusting arrows above or below the sequences, corresponding to filling in or removing overhanging termini. In this example, one terminus has a 5′ overhang and the other is blunt.

Basic format

GCK2 is built around four window types: Construct, Gel, Illustration, and List. The Construct window, the core of the program, is used to display a DNA molecule (in sequence or diagram form) and to perform actual DNA manipulations—restriction analysis, identification of open reading frames (ORFs), introduction of silent mutations to add or remove a restriction enzyme site, and ligation of DNA segments from various sources to produce recombinant molecules. The Gel window is used for analysis of DNAs from the Construct window by restriction digestion, with output as either a simulated gel electrophoresis run or a table. The Illustration window documents information about recombinant molecules manipulated in the Construct and Gel windows. Diagrams and figures from either of those windows, or elements from other word processing or drawing programs, can be directly copied into the Illustration window. The addition of text, arrows, and other elements is also supported by the drawing features of the Illustration window itself. The most remarkable feature of this window is that elements imported from the Construct or Gel windows retain most of their functionality, permitting immediate changes or adjustments in the format or information. The output from the Illustration window can be used as a description of the steps of a cloning experiment, to be added to a laboratory notebook or included in a publication. The List files contain the information used for finding restriction sites and specifying codon tables. List windows do not need to be accessed during routine work sessions, but they permit lists to be created or modified to customize restriction enzyme lists or compile lists of protein binding sites, promoters, and other features that then can be marked on diagrams of DNA molecules.

Virtual Cloning

Most manipulations in GCK2 are performed in the Construct window. Sequence files of many formats, including GenBank, GCG, and Staden, can be imported into this window, and linear or circular sequences are diagrammed to scale in colors of the user's choice. ORFs can be identified automatically and indicated in both sequence and graphical representations. Features such as ORFs, origins of replication, and promoters can be marked separately, and text annotations and comments (almost unlimited in size) can be attached to such DNA segments. Alternative "generations" or views of a molecule can then be produced (and stored in linked form for ready access) to highlight particular characteristics, and associated comments can be separately retrieved. This feature can provide details such as descriptions of the source of a DNA segment, its intended function, or where the source molecule is stored in the laboratory. In any subsequent manipulations of a particular segment, attached comments are retained.

To begin a virtual cloning experiment, restriction enzyme sites of various cate-

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