coloured and black-and-white diagrams and has a commendable get-up. The volume would interest earth scientists, particularly seismologists and geologists alike, who are interested in the study of earthquakes. It will be a welcome addition to all earth sciences libraries.

T. M. MAHADEVAN

Sree Bagh,
Ammankoil Road,
Kochi 682 035, India
e-mail: enk_mahadev@sancharnet.in

The Dynamic Structure of the Deep Earth: An Interdisciplinary Approach. Shun-ichiro Karato. Princeton University Press, 41 William Street, Princeton, New Jersey 08540, USA. 2003. 241 pp. Price not mentioned.

The theory of plate tectonics revolutionized our perception of the solid earth – from static to dynamic. It also explained most earth processes such as mountain-building, earthquakes and volcanic activity and went farther, to explain more enigmatic processes such as the deep earthquakes. Today, we know that the earth's interior is as active as its exterior, and what we see on the surface are the results of deeper processes. Clearly, we can appreciate the dynamic processes in the earth's interior, only by understanding the properties of materials in the conditions prevalent there. There are many books that deal with these issues in rather conventional ways, but few that go into details of how the material properties change dramatically in the deep interiors of the earth, and how these properties drive the engine of plate tectonics. The book under review is an effort in that direction and it is an authoritative summary of current researches in this field; with the author's own critical evaluation on some of the theories. He has diligently translated the dynamics of some of the complex processes that go on within the earth, into a well-researched and easy-to-understand account. This book takes us on a journey, starting from the atomic-level behaviour of earth materials, effortlessly guiding through its transformations under extreme conditions of temperature and pressure, finally leading to a global-scale assessment. The author knows that some of us who are unfamiliar with the turf, may find this a tough going, and therefore he provides us with all the necessary tools, excellent illustrations and more information in the boxes, to make this journey easier.

The first chapter of this book, the structure of earth and its constituents, reviews various models that explain the radial structure, chemical composition and phase transformations. Starting with early theories on chemical and geophysical models, this chapter brings up many later ideas such as the layered structure of the earth and phase transitions. At this early part of the book, the author introduces many concepts that are derived from observations of seismic waves. This chapter deals with geochemical, geophysical and seismological models (such as the Preliminary Reference Earth Model). Results from high-temperature mineral-physics experiments and observations from seismic waves (body waves, surface waves and free oscillations) are integrated to obtain an image of the earth's interior. A good part of this chapter is devoted to discussions on the thermal structure of the earth. Fundamentals of heat transfer, and the concept of anelasticity and how it affects attenuation of seismic waves are lucidly explained. The section on rheological structure is particularly well-written.

Mechanical layering in the upper mantle as the strong lithosphere and weak asthenosphere, is the key to the operation of plate tectonics on earth. Traditional understanding of the existence of asthenosphere is based on ideas of partial melting. Recent views based on studies in mineral physics, particularly simulations in the laboratory suggest how a small amount of water can have dramatic effects on the physical properties of minerals. The second chapter of this book reviews various models on the origin of the structures in the upper mantle and demonstrates the role of water in its mechanical stratification. Several interesting questions are raised in this chapter; some of them are addressed in detail, on the basis of new experimental data. For example, what is the cause of the drastic change in elastic and plastic properties of the asthenosphere? Why is there a distinct low-velocity and high attenuation in the upper mantle? A review of the current ideas and new experimental results presented in this chapter exposes the reader to the lattice-levels of plastic deformation, providing newer insights to the process within the asthenosphere. In the new lithosphere–asthenosphere model, various geophysical anomalies (low seismic velocity, high electrical conductivity and low viscosity) are caused by the large amount of water dissolved in mantle minerals.

In the third chapter on seismic tomography and mantle convection, the author summarizes the recent results of seismic tomography and other high-resolution seismological experiments. Tomography, the most recent tool that uses seismic wave velocities to map structures, has given us vivid images of the upper-mantle heterogeneities (caused by physical environment as well as chemical composition). This chapter examines results of such high-resolution experiments that have provided the most efficient tools to understand the structure of the earth. The way anisotropy is handled in this chapter is an illustration of how the author develops an idea from the atomic-level, taking it to grain-level and finally to the global scale. Results from high-pressure mineral and rock physics and seismology merge here, to give us a clearer view of the dynamics of some of the earth processes.

About 70% of the heat flux from the earth is released by plate tectonics, and there is a fairly good understanding of how materials have been circulated by plate tectonics for the past ~ 200 million years, at least to about 700 km, the depth to which the fate of the subducted slabs can be traced (also the limiting depth of earthquakes). One of the important processes in mantle circulation is the recycling of the oceanic crust. An intriguing question is whether the subduction of the oceanic lithosphere is limited to 700 km. And what mechanism can separate these geochemically distinct portions for 2–3 billion years? Improved understanding of the rheological properties of the earth aided by the developments in experimental techniques of high-pressure deformation may provide more insights into these problems, as the author predicts in the end of this chapter.

One of the intriguing questions on earth processes concerns the origin of deep earthquakes, the topic of the fifth chapter of this book. All the three mechanisms proposed for the origin of deep earthquakes – dehydration embrittlement, faulting induced by phase transformation from olivine to spinel, and adiabatic shear instability and the resulting strain softening – are discussed. All of these ideas are reviewed, with the author's views on how and why each of the models fails to explain all the characteristics of deep earthquakes. Touching upon the limitations of each of these models, the author chooses the thermal runaway instability (adiabatic shear) model, which he believes, has a clear physical basis and also satisfies other conditions of slab rheology and physical conditions of mantle materials.

While the studies of the earth's mantle made substantial progress, especially during the last two decades, the study of the earth's core has been rather limited and somewhat isolated from other areas of earth sciences. Recent developments in seismology, high-pressure studies on core material, progress in dynamo theory and improved understanding of the cores and magnetic fields of other planets have added to our understanding of the earth's core. In the sixth chapter of this book, the author reviews the recent developments in the study of the earth's core – its evolution, composition and structure, and the dynamo theory. Although there have been breakthroughs, many fundamental questions remain, most of all, the validity of geodynamo calculations. This chapter summarizes the difficulties and challenges in modelling the enigmatic central portion of the earth. Progress may be slow, but the vision is clearly getting refined, as elucidated by this book.

The contents of this book truly justify its title. Through an interdisciplinary approach using classical theories, experimental results from mineral physics and seismological observations, the author provides an updated overview of the theoretical aspects of solid earth sciences. As stated in the preface, graduate students in earth sciences, physics and material sciences may be the targetted audience of this book, but I think it is a useful general reading for all earth scientists. To a practising seismologist, it gives tremendous insights into the micro-level processes that eventually lead to what may be observed using advanced, high-resolution tools. This book is a welcome addition to our libraries.

KUSALA RAJENDRAN

Centre for Earth Science Studies,
Akkulam,
Thiruvananthapuram 695 031, India
e-mail: kusala@vsnl.com

Iladevi Cataract & IOL Research Centre

Gurukul Road, Memnagar,
Ahmedabad 380 052

Requires

Middle level scientist having at least 10 years postdoctoral research experience with good publication record in modem biology (preferably in molecular genetics, immunofluorescence, protein isolation and characterization) to work on lens tissues. Terms and conditions are negotiable. Apply within a month with full details to Dr P. D. Gupta, Director (Research).

Edited and published by P. Balaram and S. Ramaseshan, Current Science Association, Bangalore 560 080.
Typeset by WINTECS Typesetters (Ph: 3327311), Bangalore 560 021 and Printed at Printek Printers, Bangalore (Ph: 3287763)