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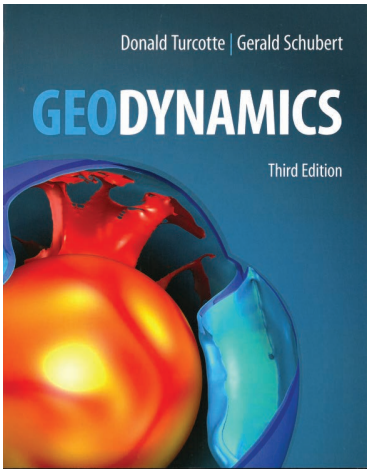
Book Review

Book Review: Geodynamics, Third edition. By Donald L. Turcotte and Gerald Schubert. (2014) Cambridge University Press. $95, 636 pages, ISBN: 978-0-52118-623-0.

Donald Turcotte is Distinguished Professor Emeritus at the University of California Davis, Department of Geology and Gerald Schubert is Distinguished Professor Emeritus at the University of California, Los Angeles, Department of Earth, Planetary, and Space Sciences. Both authors are extremely well respected in the field, are members of multiple learned societies and have won many prestigious medals and awards. Between them they have published hundreds of research papers and multiple academic textbooks including, most notably in the present context, *Mantle Convection in the Earth and Planets* (Schubert, Turcotte, and Olson, Cambridge Univ. Press 2001).

Geodynamics is the third edition of this highly respected text, which has no doubt formed the cornerstone of many successful university degree courses since the first edition appeared in 1982. In addition to fully updating the material in each chapter since the 2002 second edition, the major advance of this new edition is the introduction of programming exercises throughout the text and the addition of extra chapters on numerical modeling using Matlab. This is an excellent choice, as the Matlab programming environment is used extensively throughout earth and planetary sciences and is well suited to both numerical aspects and visualization of results. Matlab also features heavily in many undergraduate degree programs. The Matlab exercises complement the book's overall quantitative focus very well and allow the reader to develop a deeper understanding of the material and its practical application.

The content of the book can be briefly summarized as follows. Chapter 1 covers plate tectonics in extensive detail and could almost form a short book in its own right. In addition to the standard earthly topics, it also includes an up to date and engaging discussion of tectonic features on other Solar System bodies, which could be considered a taste of material in more specialist texts such as *Planetary Tectonics* (Walters and Schultz, Cambridge Univ. Press, 2010). This was a particular highlight for me and encourages the reader to think more widely and generally about the various processes. While quantitative, this chapter is very accessible and should be appropriate for undergraduates at any level. Subsequent chapters are suitable for more advanced students. Chapter 2 introduces some theoretical basics about stress and strain, which are employed later in the text, and includes a discussion of practical methods to measure stress and strain in the Earth's crust. Chapter 3 deals with elasticity and flexure, focusing on the effects of loading on the lithosphere. Chapter 4 considers heat flow and covers some of the difficulties in obtaining reliable measurements, before developing the theoretical basis further. Gravity is the subject of Chapter 5 including a discussion of gravity corrections and applications. Chapter 6 deals with fluid mechanics applied specifically to Earth science problems such as volcano plumbing, glacial rebound, and plumes. Rock rheology is covered in Chapter 7. Faulting is discussed in detail in Chapter 8. This chapter includes an engaging case study of seismicity on the San Andreas Fault and the quasi-periodic nature of earthquakes in some settings. Earthquake and faulting mechanisms are given the usual full rigorous treatment here. Chapter 9 discusses flows in porous media with application to aquifers, magma migration, and as a possible explanation for the iconic shape of many volcanoes such as Mount Fuji. The key concepts of chemical geodynamics are considered briefly in Chapter 10, which includes general geochronology methods and different types of geochemical reservoirs. However, readers, who are looking for a more in-depth coverage of geochemical topics would benefit from a more specialist text. Chapters 11 and 12, the final two, are new additions for this edition and cover numerical methods (with a geodynamics focus) and applications of computational modeling. These chapters include well thought-out case studies and examples such as glacial rebound, mantle convection, and faulting. They allow the reader to experiment with application of theory developed in the rest of the book. The book finishes with useful appendices on units, physical properties and problem set answers. Importantly for a modern textbook, supporting online material is available, which includes all the Matlab routines. Registered instructors can download images and PowerPoint files for each of the chapters, which will be invaluable for those involved in setting up a new course on this topic.



The text is clearly written in a rigorous scientific style. Throughout the book, the focus is on quantitative applications of the theory to both simplified and more realistic problems. The level is suitable for intermediate to advanced undergraduate students, postgraduate students, and researchers. The authors begin each chapter by discussing the basic concepts and supporting evidence. In many of the chapters this includes information

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on the measurement techniques used to study the topic at hand. However, full use of the material in each chapter will require the reader to have a sound grasp of mathematics and calculus, which overall makes it more suited to advanced level undergraduate or graduate courses. However, the layout of each chapter makes it possible to develop a sound understanding of the underlying problem even without delving into the quantitative detail. To aid the reader the authors provide many short problems to emphasize the important points, interspersing Matlab exercises to build familiarity and encourage further exploration. The more advanced case studies and examples in each chapter are rigorously explained and could easily provide a springboard for further and more complex research applications. Each chapter concludes with a concise summary and excellent suggestions for further reading.

While the authors make a brief attempt to introduce Matlab, readers who are new to Matlab and wish to use or modify the supplied routines would be best served by a dedicated Matlab textbook, for example *Essential Matlab for Engineers and Scientists* (Hahn and Valentine, Academic Press, 2013).

Geodynamics provides clear, comprehensive, and modern coverage of a diverse field, that is both engaging to read and advanced in scope. Quantitative aspects are handled well and complement the concepts developed early in each chapter. *Geodynamics* is a worthy successor to the previous two editions and should serve the field well for years to come. It would form an ideal basis for intermediate to advanced level undergraduate and graduate courses and is highly recommended.

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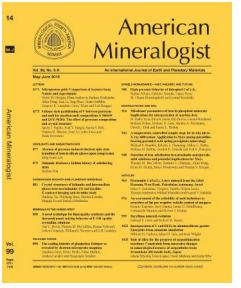

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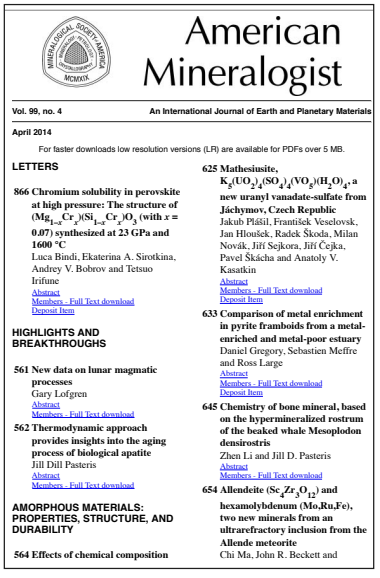
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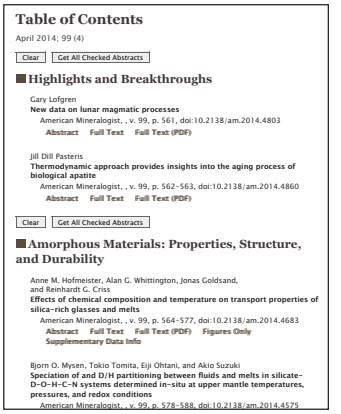
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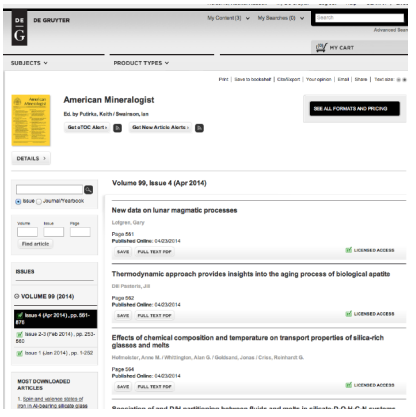

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