

MODERN APPROACHES IN GEOPHYSICS

ALEXANDER I. SHEMENDA

# **Subduction**

## **Insights from Physical Modeling**



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# Subduction Insights From Physical Modeling

**Susanne Janita Henriët Buiters, Guido Schreurs**



## **Subduction Insights From Physical Modeling:**

**Subduction** Alexander I. Shemenda, 1994-09-30 This book is devoted to the quantitative physical modeling of subduction and subduction related processes It presents a coherent description of the modeling method including similarity criteria and a novel applied experimental technique results from model experiments theoretical analysis of results on the basis of continuum mechanics and their geodynamic interpretation Subduction is modeled in general as well as applied to particular regions using both 2 D and 3 D approaches with both slab push and slab pull driving forces The modeling covers all stages from subduction initiation to death different regimes of subduction producing back arc extension and compression blocking of subduction and jumps of subduction zone arc continent collision and continental subduction This work is for geologists and geophysicists interested in geodynamics of the convergent plate boundaries and in mechanics of the lithosphere Soft

Plate and Impact Tectonics Antonio Ribeiro, 2012-12-06 Structural geology is a core component of knowledge needed for intelligent living with our planet truly sustainable development It gives me great pleasure to write this brief foreword for the work by Antonio of Lisboa When we consider the foundations of our life support systems cli Ribeiro mate the biosphere soil materials energy waste management and today in the word of cities structural stability we require exact knowledge of the structure of our planet and change in these structures Homo sapiens has lived on our planet for a very short period Our planet is cooling by conduction and convection and it is the structures that result from these processes that control the global climate our resource base and even soil quality and food security etc etc As the title of this book suggests some processes are slow and some fast I was born on a farm in Southern New Zealand quite close to the magnificent had a profound influence Southern Alps I often think that watching that environment ce on my mental development **Arc-Continent Collision**

Dennis Brown, Paul D. Ryan, 2011-06-29 Arc continent collision has been one of the important tectonic processes in the formation of mountain belts throughout geological time and it continues to be so today along tectonically active plate boundaries such as those in the SW Pacific or the Caribbean Arc continent collision is thought to have been one of the most important process involved in the growth of the continental crust over geological time and may also play an important role in its recycling back into the mantle via subduction Understanding the geological processes that take place during arc continent collision is therefore of importance for our understanding of how collisional orogens evolve and how the continental crust grows or is destroyed Furthermore zones of arc continent collision are producers of much of the worlds primary economic wealth in the form of minerals so understanding the processes that take place during these tectonic events is of importance in modeling how this mineral wealth is formed and preserved This book brings together seventeen papers that are dedicated to the investigation of the tectonic processes that take place during arc continent collision It is divided into four sections that deal firstly with the main players involved in any arc continent collision the continental margin the subduction zone and finally the volcanic arc and its mineral deposits The second section presents eight examples of arc continent collisions that

range from being currently active through to Palaeoproterozoic in age The third section contains two papers one that deals with the obduction of large slab ophiolites and a second that presents a wide range of physical models of arc continent collision The fourth section brings everything that comes before together into a discussion of the processes of arc continent collision

Geodynamics of the Lithosphere Kurt Stüwe, 2013-03-09 The large scale structure of the earth is caused by geodynamic processes which are explained using energetic kinematic and dynamic descriptions While geodynamic processes are understood to include a large variety of processes and the term is used by earth scientists quite loosely the methods of their description involve well defined fields Energetic descriptions are involved with distribution of energy in our planet typically expressed in terms of heat and temperature Kinematic descriptions describe movements using velocities strains and strain rates and Dynamic descriptions indicate how stresses and forces behave As structural and metamorphic geologists we document in the field only the consequences of geological processes The underlying causes are much harder to constrain directly However it is absolutely crucial to understand these causes or driving forces if we are to explain the tectonic evolution of our planet This book deals with the dynamic description of geological processes Our descriptions relate causes and consequences tectonic processes with field observations In many cases we will use equations as a concise form to describe processes and observations in nature As we will be dealing mostly with large scale tectonic questions the observations that we shall use are also on a large scale For example we shall use observations on the elevation Fig 1 1 1 2 and heat flow of mountain ranges the thickness of continents and the water depth of the oceans

Tectonics of Sedimentary Basins Cathy Busby, Antonio Azor Pérez, 2011-12-07 Investigating the complex interplay between tectonics and sedimentation is a key endeavor in modern earth science Many of the world's leading researchers in this field have been brought together in this volume to provide concise overviews of the current state of the subject The plate tectonic revolution of the 1960s provided the framework for detailed models on the structure of orogens and basins summarized in a 1995 textbook edited by Busby and Ingersoll Tectonics of Sedimentary Basins Recent Advances focuses on key topics or areas where the greatest strides forward have been made while also providing on line access to the comprehensive 1995 book Breakthroughs in new techniques are described in Section 1 including detrital zircon geochronology cosmogenic nuclide dating magnetostratigraphy 3 D seismic and basin modelling Section 2 presents the new models for rift post rift transtensional and strike slip basin settings Section 3 addresses the latest ideas in convergent margin tectonics including the sedimentary record of subduction initiation and subduction flat slab subduction and arc continent collision it then moves inboard to forearc basins and intra arc basins and ends with a series of papers formed under compressional strain regimes as well as post orogenic intramontane basins Section 4 examines the origin of plate interior basins and the sedimentary record of supercontinent formation This book is required reading for any advanced student or professional interested in sedimentology plate tectonics or petroleum geoscience Additional resources for this book can be found at [www.wiley.com/go/busby](http://www.wiley.com/go/busby)

sedimentary basins      Analogue and Numerical Modelling of Crustal-scale Processes Susanne Janita Henriët Buiters, Guido Schreurs, 2006 The crust of the Earth records the deformational processes of the inner Earth and the influence of the overlying atmosphere The state of the Earth's crust at any time is therefore the result of internal and external processes which occur on different time and spatial scales In recent years important steps forward in the understanding of such complex processes have been made by integrating theory and observations with experimental and computer models This volume presents state of the art analogue and numerical models of processes that alter the Earth's crust It shows the application of models in a broad range of geological problems with careful documentation of the modelling approach used This volume contains contributions on analogue and numerical sandbox models models of orogenic processes models of sedimentary basins models of surface processes and deformation and models of faults and fluid flow      Paleomagnetic Principles and Practice L. Tauxe, 1998-12-31 Paleomagnetic data are useful in many applications in Earth Science from determining paleocurrent directions to analyzing the long term behavior of the geomagnetic field In this book an attempt has been made to draw together the various principles and practices within paleomagnetism in a consistent and up to date manner It includes many practical examples that illustrate various applications of paleomagnetism A companion software package implements the theory explained in the text Audience This volume is aimed at professional Earth Scientists using paleomagnetic data for their research It is also suitable for use as a text book for students in courses with a paleomagnetic content In addition this volume will be of value to other professionals with an interest in the analysis of vector and tensor data in general      **Formation and Applications of the Sedimentary Record in Arc Collision Zones** Amy E. Draut, Peter D. Clift, David W. Scholl, 2008-01-01 Inspired by a GSA Penrose Conference held in 2005 cosponsored by the International Association of Sedimentologists and the British Sedimentological Research Group the 17 papers in this volume explore sedimentary environments in arc collision zones and their utility in recording the evolution of modern and ancient convergent margins The first set of papers in the collection focuses on formation and evolution of the sedimentary record in arc settings and arc collision zones concentrating on modern intra oceanic examples Papers include studies of flexural modeling and factors that affect development of siliciclastic and carbonate deposits around modern arcs The second half of the volume presents new applications of arc sedimentary records These relate primarily to constraining tectonic events in the evolution of arc systems but also concern the links among tectonic uplift collision and geomorphic and climatic feedback mechanisms in arc collision zones Publisher's website      **Geology and Geophysics of an Arc-continent Collision, Taiwan** Timothy Briggs Byrne, Char-Shine Liu, 2002-01-01      **Orogenic Curvature** Aviva J. Sussman, Arlo B. Weil, 2004-01-01      Himalaya and Tibet Allison Macfarlane, Rasoul B. Sorkhabi, Jay Quade, 1999-01-01      **Neogenic Evolution of the Mediterranean Region** Enzo Mantovani, Marcello Viti, Daniele Babbucci, Caterina Tamburelli, 2024-07-13 This book deals with a controversially discussed topic about the Mediterranean tectonic evolution underlying the basic role of extrusion processes

Alternative interpretations of Mediterranean back arc basins are discussed to complete the picture The kinematics of the confining plates is discussed as well Understanding the geodynamics that determined the evolution of the Mediterranean area may have important implications for other regions of the world The recognition of the ongoing tectonic processes may help to identify possible regularities in the distribution of major earthquakes allowing a better estimate of the long period seismic hazard

*Submarine Mass Movements and Their Consequences* Yasuhiro Yamada, Kiichiro Kawamura, Ken Ikehara, Yujiro Ogawa, Roger Urgeles, David Mosher, Jason Chaytor, Michael Strasser, 2011-10-13 Submarine mass movements represent major offshore geohazards due to their destructive and tsunami generation potential This potential poses a threat to human life as well as to coastal nearshore and offshore engineering structures Recent examples of catastrophic submarine landslide events that affected human populations including tsunamis are numerous e g Nice airport in 1979 Papua New Guinea in 1998 Stromboli in 2002 Finneidfjord in 1996 and the 2006 and 2009 failures in the submarine cable network around Taiwan The Great East Japan Earthquake in March 2011 also generated submarine landslides that may have amplified effects of the devastating tsunami Given that 30% of the World s population live within 60 km of the coast the hazard posed by submarine landslides is expected to grow as global sea level rises This elevated awareness of the need for better understanding of submarine landslides is coupled with great advances in submarine mapping sampling and monitoring technologies Laboratory analogue and numerical modeling capabilities have also developed significantly of late Multibeam sonar 3D seismic reflection and remote and autonomous underwater vehicle technologies provide hitherto unparalleled imagery of the geology beneath the oceans permitting investigation of submarine landslide deposits in great detail Increased and new access to drilling coring in situ measurements and monitoring devices allows for ground truth of geophysical data and provides access to samples for geotechnical laboratory experiments and information on in situ strength and effective stress conditions of underwater slopes susceptible to fail Great advances in numerical simulation techniques of submarine landslide kinematics and tsunami propagation particularly since the 2004 Sumatra tsunami have also lead to increased understanding and predictability of submarine landslide consequences This volume consists of the latest scientific research by international experts in geological geophysical engineering and environmental aspects of submarine mass failure focused on understanding the full spectrum of challenges presented by submarine mass movements and their consequences

**Instrumentation in Earthquake Seismology** Jens Havskov, Gerardo Alguacil, 2010-02-11 This work offers a unique coverage of modern seismic instrumentation It provides not only detailed information on the basic understanding of seismic instruments but it also includes an overview of current equipment on the market Furthermore the following topics are included installing seismic stations networks and arrays working with portable instruments calibrating instruments dealing with response information and teaching about seismic instruments This book is primarily intended for seismologists and technicians working with seismological instruments The aim is that it should be used as a practical tool with only the amount

of theory needed to understand the basic principles and the answers to most practical problems should be found here This book is written in such a way that it is understandable for a broad range of professionals working with seismological instruments and seismic data whether students engineers or seismologists Both practical and theoretical topics are covered with the main emphasis on practical aspects The book is based on the authors seismologist and physicist experience working in this field for more than 25 years Includes SEISAN and SEISLOG software systems that are available from [http extras springer com](http://extras.springer.com) and [http www geo uib no seismo software software html](http://www.geo.uib.no/seismo/software/software.html) **Of Poles and Zeros** F. Scherbaum, 2012-12-06 Digital signal processing has become an integral part of observational seismology Seismic waveforms and the parameters commonly extracted from them are strongly influenced by the effects of numerous filters both within the earth and within the recording system With the advent of numerous software tools for the processing of digital seismograms seismologists have unprecedented power in extracting information from seismic records These tools are often based on sophisticated theoretical aspects of digital signal processing which to be used properly need to be understood This book is aimed at observational seismologists and students in geophysics trying to obtain a basic understanding of those aspects of digital signal processing that are relevant to the interpretation of seismograms It covers the basic theory of linear systems the design and analysis of simple digital filters the effect of sampling and A D conversion the calculation of true ground motion and the effects of seismic recording systems on parameters extracted from digital seismograms It contains numerous examples and exercises together with their solutions **Advances in Seismic Event Location** Clifford H. Thurber, Nitzan Rabinowitz, 2013-11-11 Advances in Seismic Event Location provides a broad overview of the fundamental issues involved in seismic event location and presents a variety of state of the art location methods and applications at a wide range of spatial scales Three important themes in the book are seismic monitoring for a Comprehensive Nuclear Test Ban Treaty CTBT seismic event location in three dimensional Earth models and methods for multiple event location Each chapter contains background material to help readers less familiar with the topics covered as well as to provide abundant references for readers interested in probing deeper into a topic However most of the emphasis is on recent advances in methodology and their application Audience The book is intended primarily for academic and professional researchers and graduate students in seismology **Resonances in the Earth-Ionosphere Cavity** A.P. Nickolaenko, M. Hayakawa, 2002-07-31 This book on electromagnetic resonance phenomena describes a general approach to physical problems ways to solve them and properties of the solutions obtained Attention is given to the discussion and interpretation of formal and experimental data and their links to global atmospheric conditions such as the dynamics of global thunderstorm activity variations of the effective height of the lower ionosphere etc Schumann resonance is related to worldwide thunderstorm activity and simultaneously to global properties of the lower ionosphere Transverse resonance is predominantly a local phenomenon containing information on the local height and conductivity of the lower ionosphere and on nearby thunderstorm activity Transient events in ELF VLF radio propagation are

also treated These are natural pulsed radio signals and or abrupt changes of manmade VLF radio signals The transients associated with cloud to ionosphere discharges red sprites blue jets trolls are discussed and clarification of the underlying physical ideas and their practical applications to pioneer results achieved in the field recently are emphasised

**Geothermal Engineering** Arnold Watson, 2013-10-11 This book explains the engineering required to bring geothermal resources into use The book covers specifically engineering aspects that are unique to geothermal engineering such as measurements in wells and their interpretation transport of near boiling water through long pipelines turbines driven by fluids other than steam and project economics The explanations are reinforced by drawing comparisons with other energy industries

*Tectonic Geodynamics* Thorsten Becker, Claudio Faccenna, 2025-11-11 A comprehensive integrative approach to tectonics and geodynamics for students and researchers Over the past half century major achievements have been made in the study of Earth's surface structure and kinematics and the internal dynamics of the lithosphere and mantle Many of these advances have relied on the integration of data and models from plate tectonics and geodynamics yet traditional divisions persist in how these two disciplines are taught and practiced This textbook bridges the gap connecting geophysical and geological approaches to understand the physical processes that shape our planet's evolution from mantle convection to orogeny and earthquakes An innovative approach to the solid Earth system *Tectonic Geodynamics* provides a basis to explore the fundamental connections between the planet's deep interior dynamics and the surface The first textbook to integrate tectonics structural geology geodynamics geodesy and seismology in a single volume Offers a physics focused guide for understanding how the solid Earth system operates Uses a no prerequisites approach supported by an extensive appendix that includes a calculus and linear algebra primer and coverage of key topics such as coordinate systems and spectral analysis Includes a wealth of exercises and end of chapter review questions An ideal textbook for advanced undergraduates and graduate students in geology geophysics and related fields such as physics and engineering Invaluable for self study and as a self contained resource for researchers Supporting materials provided for instructors including an instruction guide full color illustration package and sample syllabi

The Complex Faulting Process of Earthquakes J. Koyama, 2013-06-29 In seismology an earthquake source is described in terms of a fault with a particular rupture size The faulting process of large earthquakes has been investigated in the last two decades through analyses of long period seismograms produced by advanced digital seismometry By long period far field approximation the earthquake source has been represented by physical parameters such as seismic moment fault dimension and earthquake magnitude Meanwhile destruction often results from strong ground motion due to large earthquakes at short distances Since periods of strong ground motion are far shorter than those of seismic waves at teleseismic distances the theory of long period source process of earthquakes cannot be applied directly to strong ground motion at short distances The excitation and propagation of high frequency seismic waves are of special interest in recent earthquake seismology In particular the description and simulation of strong ground motion are



very important not only for problems directly relevant to earthquake engineering but also to the fracture mechanics of earthquake faulting. Understanding of earthquake sources has been developed by investigating the complexity of faulting processes for the case of large earthquakes. Laboratory results on rock failures have also advanced the understanding of faulting mechanisms. Various attempts have been made to simulate theoretically and empirically the propagation of short period seismic waves in the heterogeneous real earth.

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