ELSEVIER
ACADEMIC PRESS

New!

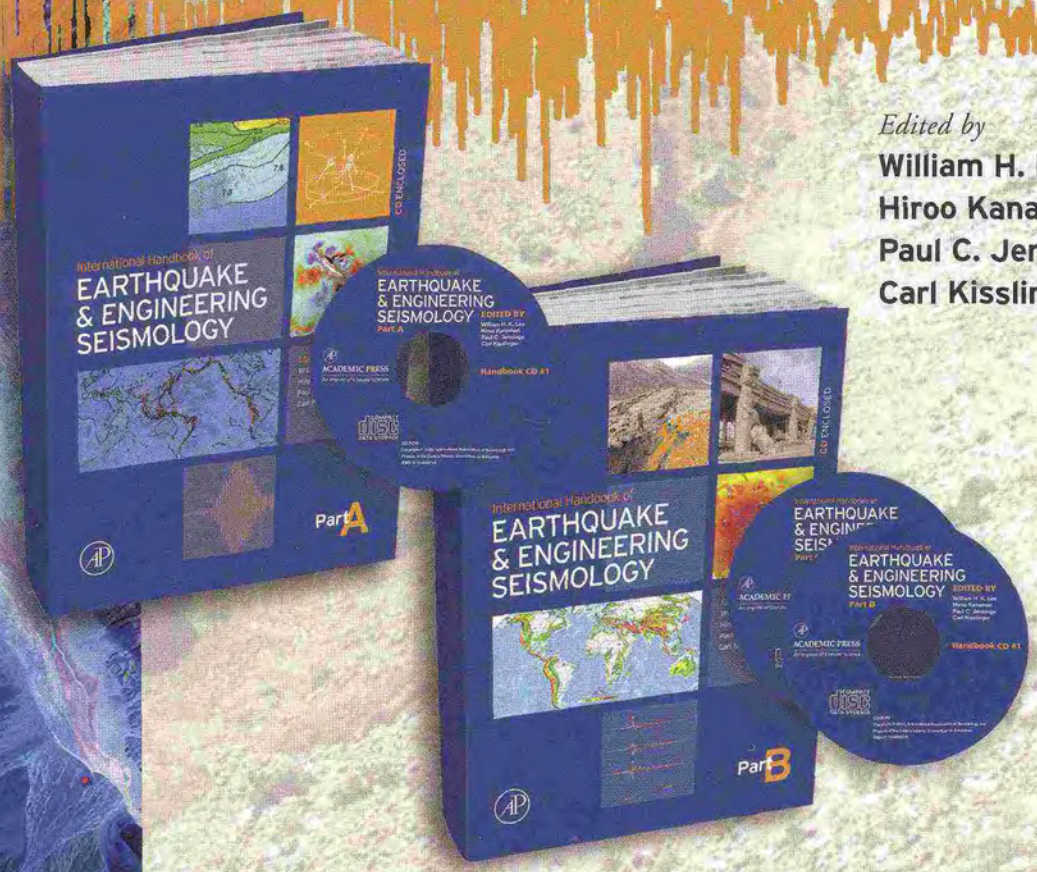
"Monumental in scope, authoritative in treatment, and historic in impact, the International Handbook of Earthquake and Engineering Seismology *will be the most important source book for seismology and its applications for years to come. This is one of those exceptional books that libraries and professionals from academia, industry, and government, cannot do without."*

—Frank Press, President Emeritus, US National Academy of Sciences

INTERNATIONAL HANDBOOK OF

EARTHQUAKE & ENGINEERING SEISMOLOGY

PARTS A and B



Edited by

William H. K. Lee
Hiroo Kanamori
Paul C. Jennings
Carl Kisslinger

http://books.elsevier.com/quake

A COMPLETE RESOURCE LIBRARY FOR ENGINEERS, GEOLOGISTS, GEOPHYSICISTS, AND SEISMOLOGISTS IN ACADEMIA AND INDUSTRY

INTERNATIONAL HANDBOOK OF

EARTHQUAKE & ENGINEERING SEISMOLOGY

Edited by:

William H. K. Lee
U.S. Geological Survey, Menlo Park, California, U.S.A.

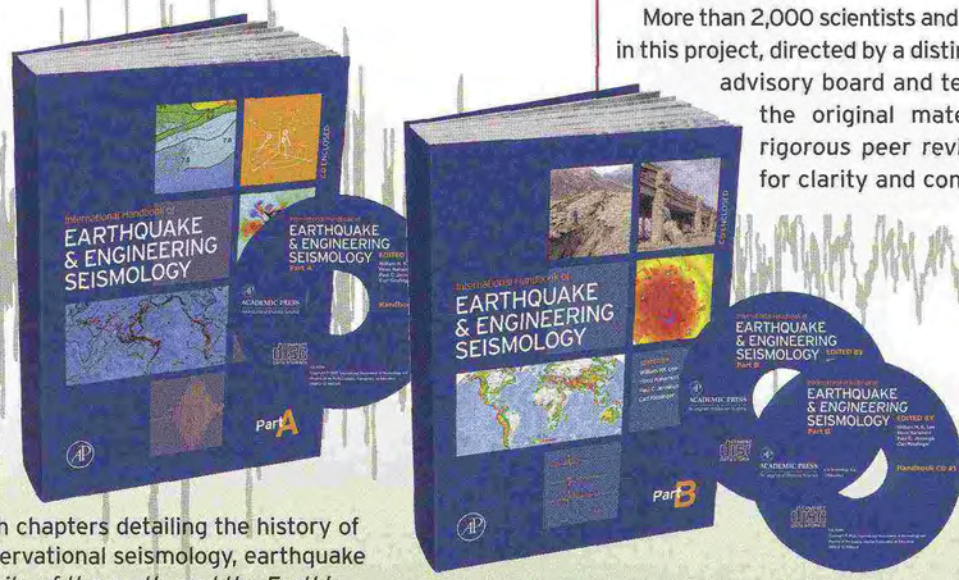
Hiroo Kanamori
California Institute of Technology, Pasadena, California, U.S.A.

Paul C. Jennings
California Institute of Technology, Pasadena, California, U.S.A.

Carl Kisslinger
University of Colorado, Boulder, U.S.A.

The two-volume **International Handbook of Earthquake and Engineering Seismology** is an encyclopedic overview of our present knowledge of earthquakes and engineering seismology. This state-of-the-art work was developed by the Committee on Education of the International Association of Seismology and Physics of the Earth's Interior (IASPEI) in collaboration with the International Association for Earthquake Engineering (IAEE). It serves as a resource library for civil and structural engineers, geologists, geophysicists, and seismologists in academia and industry around the globe. It will also be an important resource for officials who are responsible for developing and implementing worldwide earthquake hazard mitigation.

More than 2,000 scientists and engineers participated in this project, directed by a distinguished international advisory board and team of editors. All of the original material has undergone rigorous peer review, and been edited for clarity and consistency.



PART A

Part A features 56 full-length chapters detailing the history of seismology, theoretical and observational seismology, earthquake geology and mechanics, seismicity of the earth, and the Earth's structure. It includes hundreds of figures and illustrations, including a color plate section, and is accompanied by a CD-ROM containing supplementary historical and scientific information, a global earthquake database, and extensive bibliographies.

Features of Part A:

- ▲ 56 articles from more than 80 international experts provide a current review of key topics
- ▲ Chapters progress from historical information through to current studies and future trends
- ▲ More than 450 figures and color plates
- ▲ One CD-ROM included, with expanded digital versions of selected chapters, extensive bibliographies, data sets, imagery, and other archival material

International Handbook of Earthquake and Engineering Seismology, Part A
Volume 81A of the International Geophysics Series
September 2002, 932 pp., Hardcover with CD-ROM
ISBN: 0-12-440652-1
List Price: $150.00 / £99.95

PART B

Part B of the Handbook features 34 chapters detailing strong-motion seismology, earthquake engineering, quake prediction and hazards mitigation, and several essential appendices. The two enclosed CD-ROMs include expanded content from the book, plus numerous hard-to-find publications, data, and images.

Features of Part B:

- ▲ 34 articles on strong-motion seismology, earthquake engineering, prediction and mitigation, and more
- ▲ More than 300 illustrations and color plates
- ▲ Complete glossary of 1,500+ terms routinely used in earthquake and engineering seismology
- ▲ More than 150 national and institutional reports from 56 nations reviewing their accomplishments in the past century
- ▲ More than 2,500 biographical sketches of scientists and engineers, past and present
- ▲ Two CD-ROMs hold 200,000+ pages of additional text, references and data, including 1,000+ searchable reports and publications, frequently-used seismological computer codes, and a digital image library

International Handbook of Earthquake and Engineering Seismology, Part B
Volume 81B of the International Geophysics Series
June 2003, 1,040 pp., Hardcover with 2 CD-ROMs
ISBN: 0-12-440658-0
List Price: $150.00 / £99.95

http://books.elsevier.com/quake

Academic Press is an imprint of Elsevier

▲ Comprehensive seismic glossary defines 1,500+ terms (Part B)

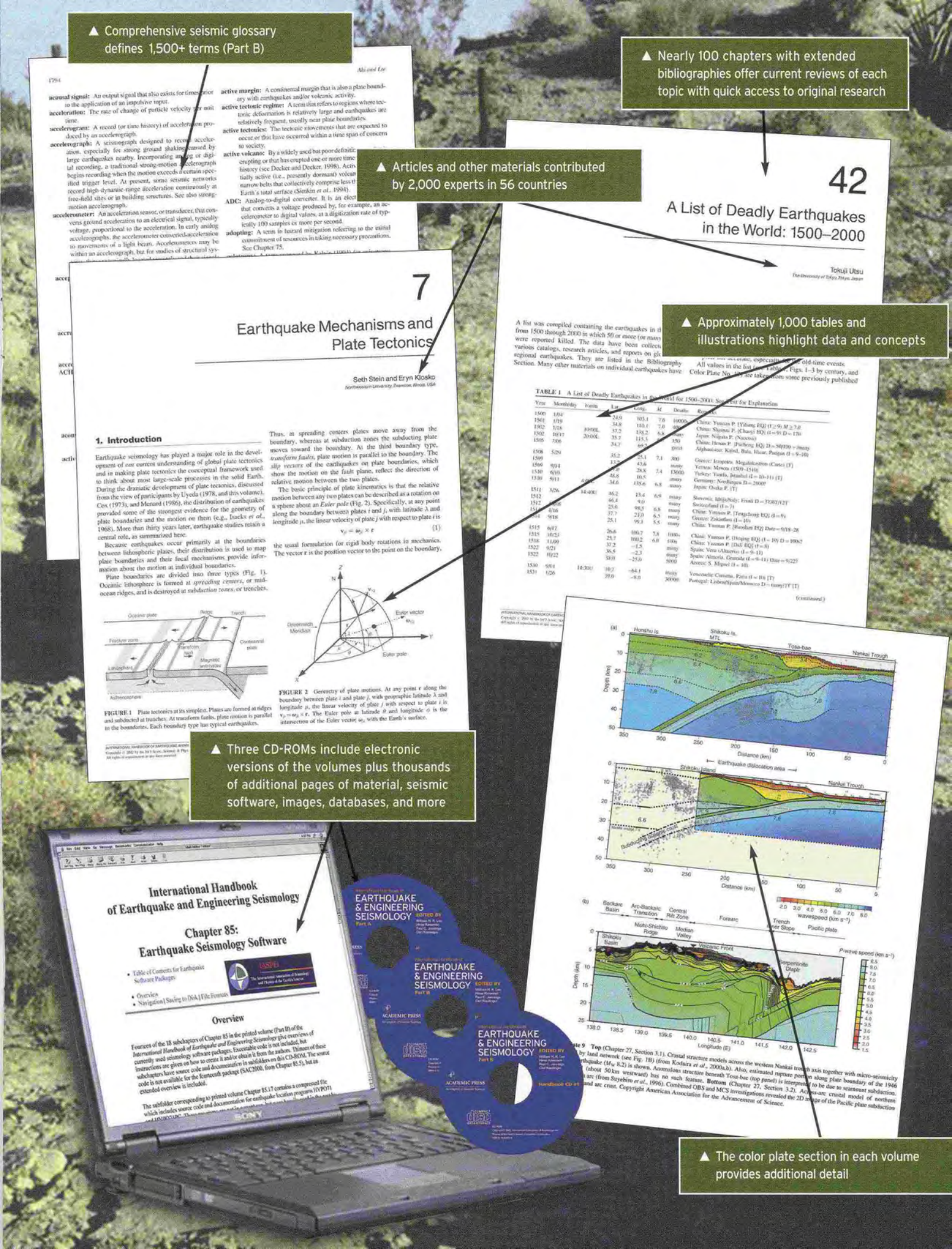
▲ Nearly 100 chapters with extended bibliographies offer current reviews of each topic with quick access to original research

▲ Articles and other materials contributed by 2,000 experts in 56 countries

▲ Approximately 1,000 tables and illustrations highlight data and concepts

▲ Three CD-ROMs include electronic versions of the volumes plus thousands of additional pages of material, seismic software, images, databases, and more

▲ The color plate section in each volume provides additional detail



CONTENTS

PART A

Contributors
Foreword
Preface

I. HISTORY AND PREFATORY ESSAYS

1. History of Seismology
Duncan Agnew
University of California, San Diego, U.S.A.

2. Historical View of Earthquake Engineering
George W. Housner
California Institute of Technology, Pasadena, U.S.A.

3. The Jesuit Contribution to Seismology
Agustín Udías
Universita Complutense de Madrid, Spain
William U. Stauder
St. Louis University, Missouri, U.S.A.

4. International Seismology
Robin D. Adams
International Seismological Centre, Berkshire, U.K.

5. Synthesis of Earthquake Science Information and Its Public Transfer: A History of the Southern California Earthquake Center
Keiiti Aki
Observatoire Volcanologique du Piton de la Fournaise, La Reunion, France

6. Continental Drift, Sea-floor Spreading, and Plate/Plume Tectonics
Seiya Uyeda
Tokai University, Shimizu, Japan

7. Earthquake Mechanisms and Plate Tectonics
Seth Stein and Eryn Klosko
Northwestern University, Evanston, Illinois, U.S.A.

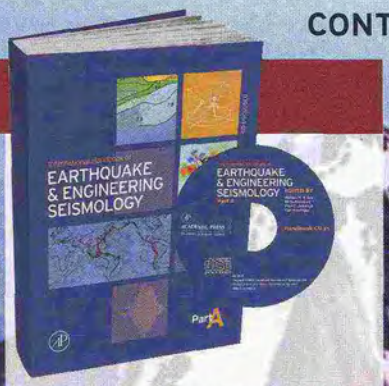
II. THEORETICAL SEISMOLOGY

8. Theoretical Seismology: An Introduction
Agustín Udías
Universita Complutense de Madrid, Spain

9. Seismic Ray Theory and Finite Frequency Extensions
Chris H. Chapman
Schlumberger Cambridge Research, U.K.

10. Normal Modes of the Earth and Planets
Philippe Lognonné and Eric Clévédé
Institut de Physique de Globe de Paris, France

11. Inversion of Surface Waves: A Review
Barbara Romanowicz
University of California, Berkeley, U.S.A.



12. Earthquake Dynamics
Raúl Madariaga
Ecole Normale Supérieure, Paris Cedex, France
Kim Bak Olsen
University of California at Santa Barbara, U.S.A.

13. Scattering and Attenuation of Seismic Waves in the Lithosphere
Haruo Sato
Tohoku University, Aoba-ku, Sendai, Japan
Michael Fehler
Los Alamos National Laboratory, New Mexico, U.S.A.
Ru-Shan Wu
University of California, Santa Cruz, U.S.A.

14. Earthquakes as a Complex System
Donald L. Turcotte
Cornell University, Ithaca, New York, U.S.A.
Bruce D. Malamud
King's College London, Strand, U.K.

15. Physics of Earthquakes
Roman Teisseyre and Eugeniusz Majewski
Polish Academy of Sciences, Warszawa, Poland

16. Probabilistic Approach to Inverse Problems
Klaus Mosegaard
Niels Bohr Institute, Copenhagen, Denmark
Albert Tarantola
Institut de Physique du Globe de Paris, France

III. OBSERVATIONAL SEISMOLOGY

17. Challenges in Observational Seismology
William H. K. Lee
U.S. Geological Survey, Menlo Park, California, U.S.A.

18. Seismometry
Erhard Wielandt
University of Stuttgart, Germany

19. Seismic Noise on Land and on the Seafloor
Spahr C. Webb
Columbia University, Palisades, New York, U.S.A.

20. U. S. Contribution to Digital Global Seismograph Networks
Charles R. Hutt, Harold F. Bolton, and L. Gary Holcomb
U.S. Geological Survey, Albuquerque, New Mexico, U.S.A.

21. The Structure and Interpretation of Seismograms
Ota Kulhánek
Uppsala University, Sweden

22. Analysis of Digital Earthquake Signals
Frank Scherbaum
Universitaet Potsdam, Germany

23. Seismometer Arrays — Their Use in Earthquake and Test Ban Seismology
Alan Douglas
AWE Blacknest, Berks, U.K.

24. Seismological Methods of Monitoring Compliance with the Comprehensive Nuclear Test-Ban Treaty
Paul G. Richards
Columbia University, Palisades, New York, U.S.A.

25. Volcano Seismology and Monitoring for Eruptions
Stephen R. McNutt
University of Alaska, Fairbanks, U.S.A.

26. Three-Dimensional Crustal P-Wave Imaging of Mauna Loa and Kilauea Volcanoes, Hawaii
Harley M. Benz
U.S. Geological Survey, Denver, Colorado, U.S.A.
Paul Okubo
U.S. Geological Survey, Hawaii National Park, Hawaii, U.S.A.
Antonio Villaseñor
University of Utrecht, Netherlands

27. Marine Seismology
Kiyoshi Suyehiro
Japan Marine Science & Technology Center, Yokosuka, Japan
Kimihiro Mochizuki
University of Tokyo, Japan

28. Tsunami
Kenji Satake
National Institute of Advanced Industrial Science & Technology, Tsukuba, Japan

IV. EARTHQUAKE GEOLOGY AND MECHANICS

29. Geology of the Crustal Earthquake Source
Richard H. Sibson
University of Otago, Dunedin, New Zealand

30. Paleoseismology
Lisa B. Grant
University of California at Irvine, U.S.A.

31. Using Earthquakes for Continental Tectonic Geology
James A. Jackson
University of Cambridge, U.K.

32. Rock Failure and Earthquake
David A. Lockner and Nicholas M. Beeler
U.S. Geological Survey, Menlo Park, California, U.S.A.

33. State of Stress within the Earth
Larry J. Ruff
University of Michigan, Ann Arbor, U.S.A.

34. State of Stress in the Earth's Lithosphere
Mark D. Zoback
Stanford University, California, U.S.A.
Mary Lou Zoback
U.S. Geological Survey, Menlo Park, California, U.S.A.

35. Strength and Energetics of Active Fault Zones
James N. Brune
University of Nevada at Reno, U.S.A.
Wayne Thatcher
U.S. Geological Survey, Menlo Park, California, U.S.A.

36. Implications of Crustal Strain during Conventional, Slow and Silent Earthquakes
Malcolm J. S. Johnston
U.S. Geological Survey, Menlo Park, California, U.S.A.
Alan T. Linde
Carnegie Institute of Washington, D.C., U.S.A.

"...of great interest to practicing engineers and researchers alike... a highly valuable source of helpful information for years to come enhancing public and industrial safety worldwide."

—William J. Hall, Professor Emeritus of Civil Engineering University of Illinois at Urbana-Champaign

37. Estimating Earthquake Source Parameters from Geodetic Measurements
Kurt L. Feigl
Centre National de la Recherche Scientifique Toulouse, France

38. Electromagnetic Fields Generated by Earthquakes
Malcolm J. S. Johnston
U.S. Geological Survey, Menlo Park, California, U.S.A.

39. Earthquake-Related Hydrological and Geochemical Changes
Chi-Yu King
Earthquake Prediction Research, Inc., Los Altos, California, U.S.A.
George Igarashi
University of Tokyo, Japan

CONTENTS

40. Case Histories of Induced and Triggered Seismicity
Arthur McGarr
U.S. Geological Survey, Menlo Park, California, U.S.A.
David Simpson
The IRIS Consortium, Washington, D.C., U.S.A.
Leonardo Seeber
Columbia University, Palisades, New York, U.S.A.

V. SEISMICITY OF THE EARTH

41. Global Seismicity: 1900-1999
E. R. Engdahl
University of Colorado, Boulder, U.S.A.
Antonio Villaseñor
University of Utrecht, Netherlands

42. A List of Deadly Earthquakes in the World (1500-2000)
Tokuji Utsu
University of Tokyo, Japan

43. Statistical Features of Seismicity
Tokuji Utsu
University of Tokyo, Japan

44. Relationships between Earthquake Magnitude Scales
Tokuji Utsu
University of Tokyo, Japan

45. Historical Seismicity and Tectonics
N. N. Ambraseys
Imperial College of Science, Technology, and Medicine, London, U.K.
James A. Jackson
University of Cambridge, U.K.
Charles P. Melville
University of Cambridge, U.K.

46. Earthquakes and Archaeology
Amos Nur
Stanford University, California, U.S.A.

47. Historical Seismology: The Long Memory of the Inhibited World
Emanuela Guidoboni
S.G.A. Storia Geofisica Ambiente s.r.l., Bologna, Italy

48. Earthquake History: Some Examples

■ 48.1 Introduction
William H. K. Lee
U.S. Geological Survey, Menlo Park, California, U.S.A.

■ 48.2 California Earthquakes of M ≥ 5.5: Their History and the Areas Damaged
Tousson Toppozada and David Branum
California Division of Mines and Geology, Sacramento, U.S.A.

■ 48.3 The Historical Earthquakes of India
S. P. Satyabala
National Geophysical Research Institute, Hyderabad, India

■ 48.4 Historical Earthquakes in Japan
Tatsuo Usami
University of Tokyo, Japan

■ 48.5 Historical Earthquakes of the British Isles
Roger M. W. Musson
British Geological Survey, Edinburgh, U.K.

49. Macroseismology
Roger M. W. Musson
British Geological Survey, Edinburgh, U.K.
Ina Cecić
Agencija Rupublike slovenije za okolje, Ljubljana, Slovenia

50. USGS Earthquake Moment Tensor Catalog
Stuart A. Sipkin
U.S. Geological Survey, Denver, Colorado, U.S.A.

VI. EARTH'S STRUCTURE

51. The Earth's Interior
Thorne Lay
University of California at Santa Cruz, U.S.A.

52. Probing the Earth's Interior with Seismic Tomography
Andrew Curtis
Schlumberger Cambridge Research, Cambridge, U.K.
Roel Snieder
Colorado School of Mines, Golden, U.S.A.

53. Seismic Anisotropy
Michel Cara
Institute de Physique du globe de Strasbourg, France

54. Seismic Velocity Structure of the Continental Lithosphere from Controlled Source Data
Walter D. Mooney
U.S. Geological Survey, Menlo Park, California, U.S.A.
Claus Prodehl
University of Karlsruhe, Germany
Nina I. Pavlenkova
Russian Academy of Science, Moscow, Russia

55. Seismic Structure of the Oceanic Crust and Passive Continental Margins
Timothy A. Minshull
School of Earth and Ocean Science, Southampton, U.K.

56. The Earth's Core
Xiaodong Song
University of Illinois, Urbana, U.S.A.

Index for Part A

Attached CD

PART B

Contributors
Foreword
Preface

VII. STRONG-MOTION SEISMOLOGY

57. Strong-Motion Seismology
John G. Anderson
University of Nevada at Reno, U.S.A.

58. Strong-Motion Data Processing
Anthony F. Shakal, M. J. Huang, and V. M. Graizer
California Geological Survey, Sacramento, U.S.A.

59. Estimation of Strong Seismic Ground Motions
Bruce Bolt
University of California, Berkeley, U.S.A.
Norman A. Abrahamson
Pacific Gas and Electric Company, San Francisco, California, U.S.A.

60. Strong-Motion Attenuation Relations
Kenneth W. Campbell
ABS Consulting and EQUECAT, Inc., Beaverton, Oregon, U.S.A.

61. Site Effects of Strong Ground Motions
Hiroshi Kawase
Kyushu University, Fukuoka, Japan

62. Use of Engineering Seismology Tools in Ground Shaking Scenarios
Ezio Faccioli
Politecnico, Milano, Italy
Vera Pessina
INGV-Instituto Nazionale di Geofisica e Vulcanologia, Milano, Italy

63. Kyoshin Net (K-NET), Japan
Shigeo Kinoshita
Yokohama City University, Japan

64. Strong-motion Instrumentation Programs in Taiwan
Tzay Chyn Shin
Central Weather Bureau, Taipei, Taiwan
Yi-Ben Tsai
National Central University, Chung-Li, Taiwan
Yeong Tein Yeh
Ching Yun Institute of Technology, Jung-Li, Taiwan
Chun-Chi Liu
Academia Sinica, Taipei, Taiwan
Yih-Min Wu
Central Weather Bureau, Taipei, Taiwan

VIII. SELECTED TOPICS IN EARTHQUAKE ENGINEERING

65. Seismic Hazards and Risk Assessment in Engineering Practice
Paul G. Somerville
URS Corporation, Pasadena, California, U.S.A.
Yoshiharu Moriwaki
GeoPentech, Santa Ana, California, U.S.A.

66. Advances in Seismology with Impact on Earthquake Engineering
S. K. Singh, M. Ordaz, and J. F. Pacheco
UNAM, Ciudad University, Mexico DF, Mexico

67. An Introduction to the Earthquake Response of Structures
Paul C. Jennings
California Institute of Technology, Pasadena, California, U.S.A.

68. Seismic Design Provisions and Guidelines in the United States: A Prologue
Roger D. Borcherdt
U.S. Geological Survey, Menlo Park, California, U.S.A.
Ronald O. Hamburger
Simpson, Gumpertz & Heger, Inc., San Francisco, U.S.A.
Charles R. Kircher
Kircher & Associates, Palo Alto, California, U.S.A.

69. Finite Element Analysis in Earthquake Engineering
John Hall
California Institute of Technology, Pasadena, California, U.S.A.

70. Liquefaction Mechanisms and Induced Ground Failure
T. Leslie Youd
Brigham Young University, Provo, Utah, U.S.A.

71. Advances in Analysis of Soil Liquefaction during Earthquakes
Jean-Pierre Bardet
University of Southern California, Los Angeles, U.S.A.

CONTENTS

IX. EARTHQUAKE PREDICTION AND HAZARDS MITIGATION

72. Earthquake Prediction: An Overview
Hiroo Kanamori
California Institute of Technology, Pasadena, U.S.A.

73. Stress Triggers, Stress Shadows, and Seismic Hazard
Ruth A. Harris
U.S. Geological Survey, Menlo Park, California, U.S.A.

74. The GSHAP Global Seismic Hazard Map
Domenico Giardini
Institute of Geophysics, Zurich, Switzerland
Gottfried Gruenthal
GeoForschungsZentrum, Potsdam, Germany
Kaye Shedlock
U.S. Geological Survey, Denver, Colorado, U.S.A.
Peizhen Zhang
China Seismological Bureau, Bejing, China

75. The Sociological Dimensions of Earthquake Mitigation, Preparedness, Response and Recovery
Paul W. O'Brien
California State University, Stanislaus, Turlock, California, U.S.A.
Dennis S. Mileti
University of Colorado, Boulder, U.S.A.

76. The Seismic Alert System of Mexico City
J. M. Espinosa-Aranda
Centro de Instrumentación y Registro Sísmico A.C., Mexico D.F., Mexico

77. The Rapid Earthquake Data Integration Project
Lind Gee, Douglas Neuhauser, Douglas S. Dreger, Robert Uhrhammer, and Barbara Romanowicz
University of California, Berkeley, U.S.A.
Michael Pasyanos
Lawrence Livermore National Laboratory, Livermore, California, U.S.A.

78. TriNet: A Modern Ground Motion Seismic Network
Egill Hauksson
California Institute of Technology, Pasadena, California, U.S.A.
L. M. Jones
U.S. Geological Survey, Pasadena, California, U.S.A.
Anthony F Shakal
California Geological Survey, Sacramento, U.S.A.

X. NATIONAL AND INTERNATIONAL REPORTS TO IASPEI

79. Centennial National and Institutional Reports: Seismology
Edited by Carl Kisslinger
University of Colorado, Boulder, U.S.A.

80. Centennial National and Institutional Reports: Earthquake Engineering
Edited by Sheldon Cherry
University of British Columbia, Vancouver, Canada

81. International Reports to IASPEI
Edited by Carl Kisslinger
University of Colorado, Boulder, U.S.A.

XI. GENERAL INFORMATION AND MISCELLANEOUS DATA

82. Statistical Principles for Seismologists
David Vere-Jones
Victoria University and Statistical Research Associates, New Zealand
Yosihiko Ogata
Institute of Statistical Mathematics, Tokyo, Japan

83. Seismic Velocities and Densities of Rocks
Nikolas I. Christensen and Darrell Stanley
University of Wisconsin, Madison, U.S.A.

84. Worldwide Nuclear Explosions
Xiaoping Yang and Robert North
Science Applications International Corporation, Arlington, Virginia, U.S.A.
Carl F. Romney
Alexandria, Virginia, U.S.A.
Paul G. Richards
Columbia University, Palisades, New York, U.S.A.

85. Seismological Software
Edited by J. Arthur Snoke
Virginia Tech and State University, Blacksburg, U.S.A.
Mariano Garcia-Fernandez
Institute of Earth Sciences "Jaume Almera," Barcelona, Spain

■ 85.1 Earthquake Seismology Software: Overview
J. Arthur Snoke and Mariano Garcia-Fernandez

■ 85.2 The IASPEI Software Library
William H. K. Lee
U.S. Geological Survey, Menlo Park, California, U.S.A.

■ 85.3 The IASPEI PC Shareware Library
Mariano Garcia-Fernandez
Institute of Earth Sciences "Jaume Almera," Barcelona, Spain

■ 85.4 ORFEUS Seismological Software Library
Torild van Eck and Bernard Dost
Royal Netherlands Meteorological Institute, De Bilt, The Netherlands
Manfred Baer
Institute of Geophysics & Swiss Seismological Service, Zürich, Switzerland

■ 85.5 SAC2000: Signal Processing and Analysis Tools for Seismologists and Engineers
Peter Goldstein, Doug Dodge, and Mike Firpo
Lawrence Livermore National Laboratory, Livermore, California, U.S.A.

■ 85.6 SEISAN Earthquake Analysis Software and SEISNET Network Automation Software
Jens Havskov
University of Bergen, Norway
Lars Ottemöller
British Geological Survey, Edinburgh, Scotland, U.K.

■ 85.7 The HYPOELLIPSE Earthquake Location Program
John C. Lahr
U.S. Geological Survey, Denver, Colorado, U.S.A.
J. Arthur Snoke
Virginia Tech and State University, Blacksburg, Virginia, U.S.A.

■ 85.8 The HYPOINVESE2000 Earthquake Location Program
Fred Klein
U.S. Geological Survey, Menlo Park, California, U.S.A.

■ 85.9 Software for Joint Hypocenter Determination Using Local Events
Jose Pujol
University of Memphis, Tennessee, U.S.A.

■ 85.10 Synthetic Seismogram Calculation Using the Reflectivity Method
Brian L. N. Kennett
Australian National University, Canberra, Australia

■ 85.11 TDMT_INV: Time Domain Seismic Moment Tensor Inversion
Douglas S. Dreger
University of California, Berkeley, U.S.A.

■ 85.12 FOCMEC: FOcal MEChanism Determinations
J. Arthur Snoke
Virginia Tech and State University, Blacksburg, Virginia, U.S.A.

■ 85.13 SMSIM: Stochastic Method SIMulation of Ground Motion from Earthquakes
David M. Boore
U.S. Geological Survey, Menlo Park, California, U.S.A.

■ 85.14 Software for Calculating Earthquake Ground Motions from Finite Faults in Vertically Varying Media
Paul Spudich
U.S. Geological Survey, Menlo Park, California, U.S.A.
Lisheng Xu
China Seismological Bureau, Beijing, China

■ 85.15 Nonlinear Inversion by Direct Search Using the Neighbourhood Algorithm
Malcolm Sambridge
Australian National University, Canberra, Australia

86. The FDSN and IRIS Data Management System: Providing Easy Access to Terabytes of Information
Timothy K. Ahern
IRIS, Seattle, Washington, U.S.A.

87. Global Inventory of Seismographic Networks
Edited by John C. Lahr
U.S. Geological Survey, Menlo Park, California, U.S.A.

88. Old Seismic Bulletins: A Collective Heritage from Early Seismologists
Johannes Schweitzer
NORSAR, Kjeller, Norway
William H. K. Lee
U.S. Geological Survey, Menlo Park, California, U.S.A.

89. Biographies of Interest to Earthquake and Engineering Seismologists
Edited by
Benjamin Franklin Howell, Jr.
Pennsylvania State University, University Park, Pennsylvania, U.S.A.

90. Digital Imagery of Faults and Volcanoes
Compiled by Michael J. Rymer
U.S.Geological Survey, Menlo Park, California, U.S.A.
David E. Wieprecht
U.S. Geological Survey, Vancouver, Washington, U.S.A.
John C. Dohrenwend
Teasdale, Utah, U.S.A.

Appendix 1. Glossary of Interest to Earthquake and Engineering Seismologists
Edited by Keiiti Aki and William H. K. Lee

Appendix 2. Key Formulas in Earthquake Seismology
Yehuda Ben-Zion

Appendix 3. Name Index of the Contributors of Biographical Sketches
Compiled by William H. K. Lee

Appendix 4. User's Manual to the Attached CD-ROMs
Michael F. Diggles

Index for Part A and Part B

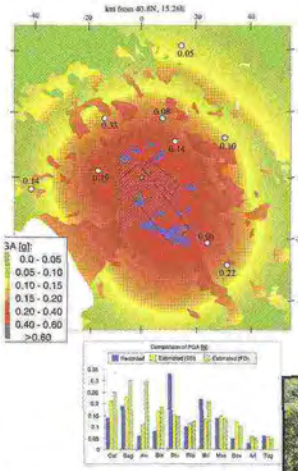
Attached CDs

"Great credit goes to the Editors for attracting... the most experienced and highly regarded experts from more than 50 countries to participate in this comprehensive and truly international work. It covers not only the history of our science, but leads to the present day frontiers of our knowledge."

—Hans Berckhemer, Past President of IASPEI, from the Foreword

Editors

Paul C. Jennings
Hiroo Kanamori
Carl Kisslinger
William H. K. Lee

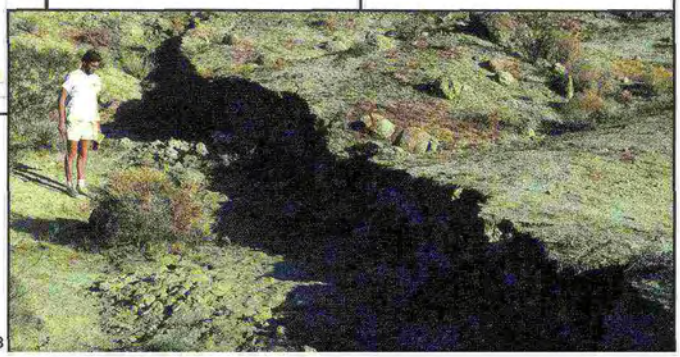


Associate Editors

Keiiti Aki
John G. Anderson
Roger D. Borcherdt
Vladimir Cermak
Sheldon Cherry
Michael F. Diggles
John E. Ebel
Benjamin F. Howell, Jr.
Mizuho Ishida
John C. Lahr
Thorne Lay
Johannes Schweitzer
Richard H. Sibson
J. Arthur Snoke
Paul Spudich

Coordinators

Yoichiro Fujii
Mariano Garcia- Fernandez
Ruth A. Harris
Vitaly I. Khalturin
Shirley L. Lee
Ritsuko S. Matsu'ura
Setumi Miyamura
Tatyana G. Rautian
Wilbur Rinehart
Michael J. Rymer
Kaye M. Shedlock
Yasunori Suzuki
Torild van Eck



Editorial Advisory Board

Honorary Chairmen: George Housner and Frank Press

Robin Adams
N. N. Ambraseys
Jesus Berrocal
Bruce A. Bolt
Enzo Boschi
Juan S. Carmona
V. Cerveny
Yun-tai Chen
C. B. Crouse
E. R. Engdahl
Luis Esteva
Claude Froidevaux
Karl Fuchs
Domenico Giardini
Slawomir Gibowicz
Harsh Gupta
Eystein Husebye
David D. Jackson
Sudhir K. Jain
Raymond Jeanloz
Edgar Kausel
Brian L. N. Kennett
Andrzej Kijko
Ota Kulhanek
Graeme McVerry
Saburoh Midorikawa
The late Tadao Minami
Alexey Nikolaev
Basil Papazachos
Barbara Romanowicz
Francisco Sanchez-Sesma
Kerry Sieh
Paul Silver
Shri K. Singh
Carl Stepp
Yi-Ben Tsai
Seiya Uyeda
Hiroshi Wakita
Raymond J. Willemann
John P. Wolf
Li-Li Xie
Mary Lou Zoback

LB/SLR/AEG—23638 6/03

"The International Handbook of Earthquake & Engineering Seismology is an impressive and comprehensive collection of articles by leaders in their fields. It is sure to be a valuable resource for students, research workers and practitioners who need a broad, reliable and up-to-date source of information and knowledge in seismological fields."

— George W. Housner, Professor Emeritus, California Institute of Technology

http://books.elsevier.com/quake

A Project of the Committee on Education, International Association of Seismology and Physics of the Earth's Interior (IASPEI) in collaboration with the International Association for Earthquake Engineering (IAEE)

IASPEI
The International Association of Seismology and Physics of the Earth's Interior

INTERNATIONAL ASSOCIATION EARTHQUAKE ENGINEERING