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Book Reviews

Ben-Menahem, A.; Singh, S.J.: Seismic Waves and Sources 1981. 307 figs. XXI, 1108 pages. Berlin-Heidelberg-New York: Springer-Verlag

Seismic Waves and Sources is a profund and comprehensive treatise on the generation and propagation of seismic waves. It has been designed both as a textbook and as a handbook for graduate students and scientists working in seismology and related branches of earth sciences. Evolving from a long-time cooperation between the two authors, it presents the mathematical theory of seismic fields in a self-contained way from basic principles to actual scientific problems.

The material is arranged in ten chapters and a part containing the appendices. Within each chapter the topics are aligned from fundamental problems and basic models to questions of growing complexity and applications to the real earth. Frequently general results are illustrated by worked out examples. Each chapter is followed by a bibliography which however is never complete by far. The reader appreciates the authors' intention to offer a theory which is self-explanatory and does not need support from other sources. Consequently there are almost no references in the text which may sometimes be felt as a deficiency.

Chapter 1 is a short recapitulation of basic facts of continuum mechanics. Special regard is payed to the seismic field equations in lossfree verticaly heterogeneous media.

Chapter 2 recalls the classical solutions of the wave equation in cartesian and orthogonal curvilinear coordinates. Vector spherical harmonics are introduced as the basic eigenvector system of a vector field described in spherical coordinates, and the decomposition of the solution of the vector Helmholtz equation in Hansen vectors is demonstrated by a variety of examples.

Wave interaction with plane discontinuities is the main subject of *Chapter 3*. The reflexion and refraction of body waves, the dispersion of surface waves as a consequence of the heterogeneity of the medium and the spectral response of a multilayered crust to incident body waves from below are investigated. The matrix method is introduced and the inverse problem for surface waves is discussed.

Chapter 4 is of central importance as a basic description of the theory of seismic sources relating the force or the displacement of the source to the displacement, stress and strain at the observation point. The inhomogeneous Navier equation is solved by determining the corresponding Green's dyadic. Many examples of special sources are discussed as illustrations of the general results. Single and dipolar point sources with stress and displacement dislocations are considered. The corresponding displacement fields are expanded in terms of spherical and cylindrical eigenvectors. Extended sources are described by the kinematic source model.

Another highlight for the specialized reader is *Chapter 5* which is devoted to the determination of surface wave amplitudes for a vertically inhomogeneous earth model. The numerical algorithms for the calculation of amplitudes and of phase and group velocities are presented. Terrestrial interferometry evolved from the study of the interference pattern of surface waves caused by the Doppler-effect of a moving source. These earthquake and source radiation studies have been one of Ben-Menahem's important original contributions to seismology.

The free oscillations of the earth are analysed in *Chapter 6*. For different types of sources the oscillations of a homogeneous elastic sphere are determined and the field equations for a radially inhomogeneous self-gravitating sphere are derived. By numerical integration the eigenperiods and spectral amplitudes for different source types are determined. The effects of rotation of the earth and of the time-function and the extension of the source are discussed.

Ray theory as geometric elastodynamic approximation of wave theory is the subject of *Chapter 7*. On the basis of the eikonal equation and the ray amplitude equation applications of ray theory to a radially heterogeneous earth are described. For weakly heterogeneous media asymptotic wave theory with WKBJ-solutions is applied, and the limits of applicability of ray theory for example at a caustic are investigated. The computation of theoretical seismograms is demonstrated and normal mode and ray solutions are compared.

In *Chapter 8* another asymptotic approximation of wave theory is developed, i.e. the representation of body waves and surface waves by normal modes. Asymptotic solutions of the normal mode equations are sought. The ray-mode correspondence is checked for simple earth models. Also the normal mode expansion is used for the computations of diffracted waves in the shadow zone. For a spherical earth model the rainbow expansion of reflection and transmission coefficients is introduced in order to describe the interaction of a spherical wave front with a spherical boundary. With this tool at hand problems involving diffraction and tunneling of waves are solved.

Chapter 9 gives a view on waves generated by explosions and earthquakes which propagate in the earth's hydrosphere and atmosphere, i.e. sound waves, gravity waves, seiches, tsunamis, and atmospheric acoustic-gravity waves. Moreover the generation of elastic surface waves by infrasonic atmospheric waves is considered. For a stratified atmosphere with uniform layers waves generated by a point source are calculated by a matrix formalism similar to the corresponding seismic algorithm. Other subjects are the resonant coupling of atmospheric waves and internal ocean gravity waves and the excitation of Rayleigh waves by atmospheric explosions.

Chapter 10 accounts for anelasticity effects in seismic wave propagation. After a short introduction to the physics of linear anelastic media the three-dimensional propagation of seismic pulses in a slightly attenuating medium is discussed. Consequences of causality regarding dispersion and attenuation are explained. Finally the attenuation of body waves, surface waves, and free oscillations in the earth is discussed.

In the *Appendices* useful functional relations and techniques are described, e.g. generalized functions, special functions, generalized spherical harmonics, asymptotic solution of the Helmholtz equation, calculus of dyadics, etc.

After the publication of Aki's and Richard's »Quantitative Seismology« every textbook on the same subject will naturally be in competition. A comparison shows that in »Seismic Waves and Sources« the theoretical aspects are dominant whereas »Quantitative Seismology« has a broader range of applications. My impression is that »Seismic Waves and Sources« as a basic treatise on theoretical seismology will become a standard tool in seismic research and teaching. Its outstanding importance is a consequence of the fact that the theory is developed from the basic laws and that all results are completely derived in the text.

Sometimes the mathematical formalism is overwhelming and the physics seems to disappear behind a mathematically painted vail. Also, some of the material of the chapters 7 and 8 could have been presented in a different but more logical context. This, however, does not diminish the indisputable value of this book which eventually fills a gap which has painfully been felt in the past.

H. Wilhelm

Structure of transition zone, edited by S. Asano. Advances in Earth and Planetary Sciences, 8. Supplement Issue to Journal of Physics of the Earth. D. Reidel Publishing Company/Dordrecht, Boston, London 1980, 184 pp.

I do not know what you would expect to find in a book with the title "Structure of Transition Zone"? I expected to find everything about the transition from the Upper to the Lower Mantle. I was actually misled: this book is a more or less loose conglomer-

ate of individual contributions to the special transition from the Pacific Plate to the Asian Continent. Why then this quite general title which promisses an even quite general treatment of the problem? The answer will remain a secret to the editor. If you would propose a title like "Structure of a Subduction Zone" in order to avoid confusion with the afore mentioned transition zone then you would probably touch the most delicate problem of this book published in 1980: The hypothesis of plate tectonics (e.g. page 77)! Here you find the USSR point of view mixed with the Western look. Soviet and Japanese authors are mixed, and so are the conclusions they draw from their geophysical measurements. And quite symbolically Big Old Beloussov is watching as one of the authors of the very last contribution all his fellows in front of him.

On page 53 the Japanese author H. Okada begins: "An island arc is one of the most important test field of the plate tectonics hypothesis." He concludes: "The present study will contribute to refinements and modifications of the mechanisms of the subduction and the magma genesis associated with the plate." On page 77 we may read: "We do not consider the focal zone to be a descending lithospheric plate, but we suggest it to be a dipping domain of stress release that occur due to the interaction of the crust-mantle megablocks of Eurasia and Pacific." The author: R.Z. Tarakanov, USSR.

It's typical: Nowhere in this book there is even the slightest attempt to listen and to talk to the "other side". Once while reading the book I had the strong feeling to read ghost stories. Because human stories should contain at least a minimum of community. It is not the difference of geophysical data, what I hope, but it is the difference of looking at the data.

And I became thoughtful because I remembered Heinrich von Kleist: If you look through a red glass the world appears to be red, if you look through a blue glass the world appears to be blue; since we do not know the colour of the glass we are looking through all our life we never will know how the world looks.

Is there no way to distinguish between wright and wrong? There cannot be two truths: I remember the philosopher Karl Popper who argues that any true scientific theory should display that item which would falsify this theory.

What could be the critical point of the theory of plate tectonics or the theory of fixism of the USSR-scientists.

It would have been an interesting frame for this issue, much more justifying this edition than just the existence of the Japan-USSR Scientific Cooperation Program and the existence of extensive research work done by the USSR scientist which has never been published by an English written journal.

The book includes 5 seismological, 3 geophysical and geological, 2 geothermal, 3 geomagnetic and 1 geodetic studies. Some of the contributions are of high quality, some of less. I recommend this book for the library of your institute.

Volker Haak

Electromagnetic induction in the earth and moon, edited by Ulrich Schmucker. Advances in Earth and Planetary Sciences 9. D. Reidel Publishing Company/Dordrecht-Boston-London, 1980, 196 pp.

This book is a non-book, and I can give you no real book review. Actually, it is a supplement issue to the Journal of Geomagnetism and Geoelectricity. This issue contains review papers and contributed papers given during the IAGA Scientific Assembly in Seattle 1977 and during the Workshop of Electromagnetic Induction of the Working Group I-3 in Murnau in Bavaria 1978. The title of this non-book is indeed the denomination of this IAGA working group I-3. The title therefore is also a non-title since it does not specify the content of this issue.

Nevertheless this collection of papers is of very high quality: I recommend it to all thinkers and workers in the field of electromagnetic induction for their private and public library. Why this?

Because the topics of the papers group around two "gravity-centers" of interest, firstly around oceanic induction and conductivity studies and secondly around studies of the upper mantle. Both themes have never been treated so extensively in the past. And since the editor and the authors have treated it so well I must recommend it to all specialists of electromagnetic induction.

What should you know about the content of the book? Of course you should know all titles and all authors since it resembles more a luxurious journal, i.e. a collection of papers, than a book. Instead of it I will tell you just my present favourites and their first author:

C.S. Cox et al.: Atlantic Lithosphere Sounding.

J.H. Filloux: North Pacific Magnetotelluric Experiments.

W.D. Parkinson: Induction by Sq.

J.C. Larsen: Electromagnetic Response Functions from Interrupted and Noisy Data.

A.A. Kovtun et al.: Deep Conductivity Distribution on the Russian Platform from the Results of Combined Magnetotelluric and Global Magnetovariational Data Interpretation.

J. Pěčová et al.: Remarks on spatial Distribution of Long Period Variations in the Geomagnetic Field over European Area.

Of course, at some time later or for somebody else, quite different papers would be favoured, e.g.:

R.C. Hewson-Browne et al.: Induction in Arbitrarily Shaped Oceans II: Edge Correction for the Case of Infinite Conductivity.

B.A. Hobbs et al.: The Effect of a Simple Model of the Pacific Ocean on Sq Variations.

If I would continue in this way, you would learn to know the complete content. However this is not necessary: If you are thinking and working in the wide field of electromagnetic induction then you MUST buy this issue in each case, as well for your private library as well for the Library of your institution.

Volker Haak