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9 Août – 3 Septembre 1988

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PREFACE

One of the major problems in the study of the Earth and the Oceans is their vast dimensions and the difficulty to measure directly their physical properties. For the solid Earth the only means of in situ measurement is by drilling ; this is particularly expensive and delicate under the oceans, which cover most of the Earth surface. Moreover, drilling provides only a few shallow point measurements, insufficient to describe the deep global structure of the Earth. The use of indirect methods constitutes an attractive solution to this observational problem.

In the ocean the situation is different insofar as in situ measurements are possible and are routinely made. However the spatial density of these observations remains woefully sparse and the significant time variability of the medium would require that they be repeated frequently. This is nearly impossible on a global scale. Here again indirect methods, such as tomography, can contribute to alleviate this problem.

In geophysics tomography is a technique which deduces some physical properties of the medium from the perturbations encountered by waves propagating through it. Thus tomography draws on a variety of disciplines, such as wave propagation in heterogeneous media, statistical estimation and inverse theory, and numerical modeling. These subjects take different forms when applied to solid Earth geophysics or to physical oceanography.

The aim of the 50th session of the Summer School on Theoretical Physics held in Les Houches in the summer of 1988 was to present in detail theoretical and practical aspects of tomography in geophysics and oceanography. One of the goals was to bring together students and practitioners of the two fields to teach, discuss and exchange ideas on all the components of tomography, to point out common approaches, and to contrast various specific applications.

The four-week session included introductory lectures on inverse methods (probabilistic approach to inverse problems, Monte Carlo and least squares methods, discrete and functional inverses, inversions involving rays and waves), theoretical seismology (elastodynamic Green's function, Lamb's problem in depth dependent media, excitation and dispersion of surface waves, recent uses of higher modes), ocean acoustic tomography (general concepts, background on physical oceanography, recent experiments). More specialized lectures dealt with various aspects of the subjects, namely : global Earth tomography, seismic networks, time dependent problems in oceanography, numerical modeling in seismology and underwater acoustics, inversion of magnetotelluric data, elastic inversions on massively parallel computers, scattering tomography, and migration techniques in exploration seismology.

A glance at the table of contents of this volume will show that all the subjects are not covered as they were taught at the School. Some editorial choices have been made (because of availability of some topics in existing monographs, for instance), some material has been expanded, other reduced. The level and nature of the courses is diverse, including reviews, theoretical statements, practical considerations, and prospective developments.

Our aim in presenting these lectures on various aspects of the theory and implementation of tomography in geophysics and oceanography is to show the diversity and vitality of this field of research and to underscore the variety of disciplines involved. If this volume can serve as an introduction, a partial reference and a stimulus to further research, it will have reached its goal.

Acknowledgements

The XLth session of Les Houches Summer School and this volume of lectures would not have been possible without:

– the financial support from the Université Joseph Fourier of Grenoble, the NATO Scientific Division, the Commissariat à l'Energie Atomique and the NSF;

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– the essential role played by Nicole Leblanc and Anny Glomot in the preparation and administration of the session;

Y. Desaubies
A. Tarantola

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