Introduction to the Mathematics of Inversion in Remote Sensing and Indirect Measurement. Development in Geomathematics, 3. S. Twomey. Elsevier, Amsterdam, 1977, 263 pp., US $ 80.50, Dfl. 165.00.

Remote Sensing is a term with widely varying meaning in different scientific and engineering fields. In many cases it is understood to be the study of our environment using some sort of imagery and photo-interpretation techniques as well as direct and indirect measurements. There is, however, a large group of geophysicists who investigate phenomena — for example in the atmosphere — by remote observation whereby it is immaterial whether measurements are in image form or not. This is also denoted by remote sensing but is very different from the former image-oriented technique. With images one employs concepts such as shape, texture, tone and studies objects on the Earth's surface; in the other case, one studies volume properties such as temperature distribution in the atmosphere, or seismic properties of the Earth's interior. Therefore studies often do not concern the Earth's surface.

Prof. Twomey in his book addresses the latter interpretation of remote sensing. At issue is the Fredholm integral equation which, for example, relates the amount of electro-magnetic radiation received at a satellite to the temperature distribution throughout the atmosphere, or the measured optical transmission to aerosol-size distributions. It may be trivial to compute a value for the received radiation on the basis of a known temperature distribution; it may be very difficult to do to reverse: solutions ("inversions") of the integral equation are difficult to obtain due to the near-singularity or instability of the problem. Consequently solutions must be obtained by defining additional constraints. It is the aim of the book to present concisely and completely the methods and associated mathematical techniques currently in use to obtain meaningful inversions of the Fredholm integral equation.

The book is organized in nine chapters which could be grouped into three distinct parts. The first part consists only of an introductory chapter that presents rather independently a number of experiments where an integral equation has to be inverted. This chapter unfortunately is not tied in with the remainder of the book but enables the reader to see part of the broad scope of "remote sensing" problems to which the same mathematical tools must be applied.

Chapters 2 through 5 deal with some basic tools for inversion problems: large systems of linear equations, vector and matrix algebra, functions and function space. The author leads the reader at widely varying speed and into varying depth: some topics are treated at length at low level, others in an abbreviated form requiring prior understanding of advanced mathematics.

Actual inversion is treated in Chapters 6 through 9, which thus constitute a third part of the book. The problems caused by instability of the physics of the system are initially demonstrated. It is here that a small excursion into the Gaussian method of least squares takes place, essentially to show that lack of stability cannot be compensated for by repeated measurements. This then leads to an inversion with an expanded mathematical model using constraints to reduce instability. The smoothest solution is arbitrarily chosen and a smoothness constraint therefore formulated. Other solutions are also described e.g., the Gilbert-Backus method, the Prony-algorithm, the Landweber-iteration. The questions of measurement errors and independence of measurements are separately dealt with in Chapter 8, while the final Chapter 9 treats specific questions such as prediction, underdetermined systems and the case where additional information (constraints) is available beyond the measurements.

The student and research worker must be grateful for a book, written by a single author, on a subject that was previously covered merely by journal papers. Too often in a new field like remote sensing does one find books that are a mere collection of individual papers by different authors. Such books then exhibit incoherence among its parts, lack of completeness and didactic style. Prof. Twomey is to be commended on his effort to produce his book without these drawbacks.

My greatfulness towards the author should not prevent me from mentioning some weaknesses of the book: references to existing work are not used very much in the text, only some papers and books are listed at the end of each chapter. Illustrations are at times difficult to interpret: as an example there are several instances where descriptions of diagram axes are missing. The level of sophistication varies too widely to make sense.

On reading the book one may be tempted to ask why the author chose to limit himself to a narrow segment of remote sensing. Many of the techniques which are discussed could also be employed in other remote sensing applications. However, one would need for this a more elaborate treatment of observations, theory of errors, least squares and formulation of mathematical as well as stochastical models.

The publishers rightfully claim that the book will be valuable for "courses on remote sensing and satellite techniques". However, this applies only for a segment of the entire field of remote sensing.

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Rock Friction and Earthquake Prediction. J.D. Byerlee and M. Wyss (Editors). Birkhäuser, Basel, 1978, pp. 586—991, S.Fr. 100.00.

It is now generally accepted that shallow earthquakes are caused by fractures of the crustal materials or by sudden stick-slip motion on pre-existing faults. For understanding earthquake source mechanisms, recently considerable effort has been made in the research of stick-slip and stable sliding of rocks in laboratory. This book is a compilation of review and research papers presented at a conference on "Experimental studies of rock friction with application to earthquake prediction", held in April, 1977, sponsored by U.S. Geological Survey, under the auspices of the National Earthquake Hazard Reduction Program in USA. This is supplemented by several papers solicited by the editors. The same material has been published as a special issue of Pageoph (Vol. 116, 1978).

One of the remarkable results of experimental studies in this volume is that rock friction under high effective pressure is largely independent on mineralogy, temperature, loading rate, the presence of water, and the character of the sliding surface. This may be applicable to estimate the friction strength of fault. (At low effective pressure, the friction strength is much more dependent on surface conditions.) However, it should be noted that if the sliding surfaces are separated by gouge composed of montmorillonite or vermiculite, the friction can be very low under high effective pressure.

A number of papers are concerned with sliding behavior, that is, stick-slip and stable sliding. The sliding behavior is markedly affected by various factors, such as effective pressure, temperature, mineralogy, system stiffness, the presence or absence of gouge and its characters. Interesting aspects of the time-dependence of friction are also discussed in detail in a number of