# Reviews

COORDINATED BY WILLIAM GREEN

**Exploiting Seismic Waveforms: Correlation, Heterogeneity and Inversion,** by Brian L. N. Kennett and Andreas Fichtner, ISBN 978-1-108-82878-9, 2021, Cambridge University Press, 502 p., US$69.99 (print), $56 (e-book).

The authors of this volume are recognized internationally for their many fundamental contributions to global and exploration geophysics. They have succeeded admirably in producing a volume that straddles both disciplines and commenting on the often-ignored relationships and differences between them. They state in the preface, "… the work therefore endeavors to provide links between the applications of seismology to earthquakes, ambient noise, regional and global studies, and seismic exploration."

As the subtitle suggests, the book deals with recent exciting developments in seismic interferometry, which is a correlation-based computational approach. By invoking heterogeneity, the authors refer to the spectacular recent increases in computing power, which enables us to simulate seismic wave propagation on nonuniform 3D numerical grids. This allows us at long last to move beyond oversimplified horizontally stratified media. Finally, by their treatment of inversion, they not only deal with the most recent developments in seismic inverse theory, but describe how these ideas have evolved, dating all the way back to the fundamental work of the late Albert Tarantola.

The book contains many fine examples, illustrating how the various seismic approaches work with practical problems. Almost all graphics are drawn from global seismology, but future editions could be complemented with more examples from exploration seismology. Some figures could have benefited from color, but on the other hand, the present paperback version is reasonably priced and affordable for students who will find its content invaluable for their professional careers.

*Exploiting Seismic Waveforms* is bound to become a standard reference in both theoretical and computational seismology. Both aspects of the subject are eloquently treated in its 19 chapters. The theory is presented with the eloquence and crispness we have already known to be associated with previous writings by these two authors. The numerical work is well illustrated with a wealth of examples.

Rather than tackle the Herculean task of checking every equation in the book, I have chosen the chapter on adjoint methods and sensitivity analysis for more intensive scrutiny. I have seen countless efforts to explain this popular method to construct the Jacobians needed to solve most geophysical inverse problems. However, I have yet to see one that explains the theory with the clarity and elegance that the present authors have mustered. Allow me therefore to extrapolate to the remaining chapters and grade this beautiful volume with an A+.

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**Hyperspectral Remote Sensing: Theory and Applications,** by Prem Chandra Pandey et al., ISBN 978-0-081-02894-0, 2020, Elsevier, 506 p., $160 (print), $160 (e-book).

This impressive book is a broad-ranging and detailed summary of the current capabilities and uses of remote sensing systems to explore and monitor the earth's surface. Although most types of geophysical measurements can be considered remote sensing, in that the observing instruments are not directly connected to the source, the term now refers mostly to measurements of reflected electromagnetic waves from aircraft or satellites. These technologies became available widely following World War II, particularly with the advent of global imaging satellites, starting with ERTS (later LANDSAT) in 1972.

The first-generation satellites recorded a few broad channels of the electromagnetic spectrum, mostly in the visible and near-infrared wavelengths, to produce a pseudophotographic image. With ever-improving electronics, it became possible to record a broader range of the spectrum in many narrow frequency bands, enabling a detailed analysis of the surface materials under the path of the sensor. These hyperspectral systems (e.g., the Hyperion satellite sensor launched in 2000) have hundreds of channels, compared to perhaps a dozen in multispectral devices (e.g., LANDSAT). Both types are often used together because the detailed spectral resolution of hyperspectral systems comes at the cost of reduced spatial resolution.

The book has five main sections containing 20 chapters followed by a brief summary of challenges and future perspectives. Section I (five chapters) looks at system characteristics, the complex data corrections required for both airborne and satellite detectors, detection of anomalies, and classification of images. Section II has four chapters on identifying types of vegetation, with application to forest management, precision agriculture, and effective use of fertilizer on grasslands. The three papers in section III cover methods to evaluate water resources and quality in snowfields, inland waters, and wetlands. Section IV (four chapters) reviews mineral and soil exploration, including monitoring heavy metal contamination. Finally, there are four chapters on specific problems, such as remote monitoring of cocoa bean crops, detecting parasitic nematodes, and detecting hydrocarbon pollution and its effect on vegetation.

Several key themes reappear throughout the text. First is the importance of applying and verifying data corrections before attempting physical interpretation of the survey results. Equally important is acquiring sufficient ground truth to calibrate the remote sensing data and being aware of the substantial costs involved. Correlating hyperspectral surveys with other data is often key to the success of a project. Finally, the broad range of applications is impressive, and there are often lessons to be learned from projects that at first glance address a very different type of problem.