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# – Review –
# Rock Physics and Waves in Random Media

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***keywords:*** *anisotropy, layered media, random media, primaries and coda, poroelasticity, permeability*

*Seismic methods in random and poroelastic media: review of contributions.*

*Our main results on seismics of random and poroelastic media are described in the following five contributions.*

*Stefan Bojinski with his coauthors proposes a new method of characterizing a randomly-heterogeneous medium (e.g., a fractured reservoir or a reservoir with randomly distributed fluid patches). He shows how to find a ties between the statistics of the wavefield fluctuations with the statistics of the medium. He demonstrates his results using laboratory measurements on fractured fiber-reinforced composites. This method can be of interest for seismic reservoir monitoring.*

*Norbert Gold and Sergei Shapiro suggest an optimal way of smoothing in isotropically heterogeneous elastic media. Their smoothing procedure is optimal from the point of view of the physics of wave propagation because it is able to provide non-shifted estimations of travel times. This algorithm is of interest for ray-tracing and Green-function building in significantly heterogeneous elastic media.*

*Uli Werner and Sergei Shapiro generalized the well-known O'Doherty-Anstey formula for 1-D heterogeneous weakly anisotropic (VTI) media. Using this formula one can describe the attenuation and velocity of obliquely incident qP- and qS- waves. These solutions permit also to show that the shear-wave splitting in such media is a frequency-dependent effect. This contribution is of interest for interpretation of the shear-wave splitting observations.*

*The further generalization of the O'Doherty-Anstey formula for 1-D heterogeneous poroelastic fluid saturated media allows to describe a mechanism of seismic-wave attenuation dominant at low frequencies. This is the inter-layer flow. Sergei Shapiro and Tobias Müller show how this attenuation depends on the permeability. They also show the way how the permeability should be averaged to obtain an estimate, which controls the seismic attenuation in the case of very strong permeability fluctuations. They conclude that the permeability, which is required for reservoir modeling differs from the seismic-attenuation controlling one.*

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*Another way of the seismics-based permeability estimations (which we consider to be a new technology) is based on observations of the seismic emission during a bore-hole fluid injection. This method is proposed and described in the paper of Sergei Shapiro with coauthors. The corresponding estimates of permeability are of the same global-flow nature as needed for the reservoir modeling. The method can be further developed to the case of anisotropic media. This paper is a first result of the cooperative research between GOCAD and WIT Consortia.*

*Other two papers should be mentioned as closely related to the above described research directions.*

*Andrea Weiss explored perspectives of application of the high-order statistical analysis of reflected seismograms to problems of the seismic deconvolution. Her contribution has been also included in our report.*

*Sergei Shapiro and Sven Treitel combined the classical z-transform formalism and the statistical approach for 1-D heterogeneous media. They derived a deterministic variant of the O'Doherty-Anstey approximation as well as an approximation of the reflectivity taking into account the effect of multiple scattering. They also shown that the coda of the generalized primaries is controlled by the fourth statistical moment of reflection coefficient series. This paper is now in press (Shapiro S.A., and Treitel S., 1997, Multiple scattering of seismic waves in multi-layered structures. Physics of the Earth and Planet Interiors; special issue: Stochastic Seismology) and it has not been included in our report. However, it can be found as an enclosure to this report.*