Introduction

The research project “Seismic waves in complex 3–D structures” (SW3D) started on October 1, 1993. The project reached the end of its twenty–fifth year on September 30, 2018, and still continues.

The Volume 28 of the serial *Seismic Waves in Complex 3–D Structures* of the annual reports of research project “Seismic waves in complex 3–D structures” summarizes the work done in the period June, 2017 — December, 2018. It also includes the DVD compact disk with updated and extended versions of computer programs, with brief descriptions of the programs, and with the copy of the SW3D research project WWW pages containing papers from previous volumes and articles from other journals.

In spite of its name, the serial *Seismic Waves in Complex 3–D Structures* (ISSN 2336–3827) is also devoted to the ray methods for electromagnetic waves studied by our group simultaneously with the ray methods for elastic or viscoelastic waves.

Our group working within the project during the twenty–fifth year has consisted of six research workers: Václav Bucha, Petr Bulant, Vlastislav Červený, Luděk Klimeš, Ivan Pšenčík and Bohuslav Růžek. Ivan Pšenčík is the supervisor of PhD studies of Miłosz Wcisło, with the PhD thesis on “Seismic waves in inhomogeneous, weakly dissipative, anisotropic media”.

Véronique Farra (Institut de Physique du Globe de Paris, France), Xingguo Huang (University of Bergen, Norway), Einar Iversen (University of Bergen, Norway), Morten Jakobsen (University of Bergen, Norway), Petr Jílek (BP–America, Houston, USA), Tijmen Jan Moser (Zeehelden Geoservices, ’s-Gravenhage, The Netherlands), Mohan Sharma (Department of Mathematics, Kurukshetra University, India), Bjorn Ursin (University of Bergen, Norway) and Umair bin Waheed (King Fahd University of Petroleum and Minerals, Az Zahran, Saudi Arabia) visited us since June, 2017.

Ivan Pšenčík served as a member of the technical committee and participated in the 18th International Workshop on Seismic Anisotropy in Kibbutz Ma’ale Ha’Hamisha near Jerusalem in November 2018. He is going to serve as a guest editor of the special part of Geophysical Prospecting devoted to the workshop proceedings.

The Research Programme for the twenty–fourth year of the SW3D research project, published in the previous Volume 27 of the serial *Seismic Waves in Complex 3–D Structures* has not changed yet, because there has been no consortium meeting in the meantime. More detailed information regarding the SW3D research project is available online at “http://sw3d.cz”.

The **Volume 28** contains mostly the papers related to seismic anisotropy (5 of 7 papers). The other two papers are devoted to attenuation. The Volume 28 may roughly be divided into four parts, see the Contents.

The first part, **Velocity models and inversion techniques**, is devoted to various kinds of inverse problems, to the theory developed for application to their solving, and to constructing velocity models suitable for ray tracing and for application of ray–based high–frequency asymptotic methods.

In their contribution “Practical concept of arbitrary anisotropy applied in traveltime inversion of simulated P–wave VSP data”, I. Pšenčík, B. Růžek, & P. Jílek introduce an alternative, practical approach to the inversion for seismic anisotropy, in which they seek a set of anisotropy parameters without any prior information about anisotropy symmetry and orientation. Several results of "blind tests" (tests, in which interpreters have no knowledge of the model) made with synthetic VSP data with realistic noise are presented. Quality of estimated parameters allows reconstruction of phase–velocity surfaces with a high degree of accuracy. Resulting velocity function can later be used in migrations, modeling, or full waveform inversion.

In their contribution "P–wave reflection moveout approximation in layered media of arbitrary moderate anisotropy", V. Farra & I. Pšenčík extend their former studies of the non–hyperbolic reflection moveout (analytic approximation of travel times of reflected waves). After presenting alternative formulae to commonly used Taylor series expansions for P and SV waves in weakly or moderately anisotropic transversely isotropic media with the vertical axis of symmetry (VTI) (Volume 23), for P waves in monoclinic media whose planes of symmetry coincide with the reflector (Volume 25), for P waves in anisotropic media of arbitrary symmetry and orientation (Volume 26), and for converted P–SV or SV–P waves in weakly or moderately VTI media (Volume 27), they propose approximate formula applicable to layered media of arbitrary, but moderate or weak anisotropy.

V. Bucha in his paper "Kirchhoff prestack depth scalar migration in a simple triclinic velocity model for three–component P, S and converted waves" extends his contribution of the Volume 25, in which he imaged vertical components of seismograms only, to imaging radial and transversal components of P, S1, S2 and converted waves.

The contribution "Kirchhoff prestack depth scalar migration of complete wave field in a simple inhomogeneous weakly anisotropic velocity model: preliminary tests" by V. Bucha demonstrates the first migration results of complete wave field calculated using the seismic modelling code for inhomogeneous media of arbitrary anisotropy by Ekkehart Tessmer. A simple two layer velocity model with inhomogeneous weakly anisotropic upper layer is used. V. Bucha migrated the complete wave field without its decomposition into P, S1 and S2 waves, which means, e.g., that both recorded S waves were migrated as a P wave and vice versa. In spite of this brutal simplification, the images look reasonably well, which represents the important message of this paper. The unwanted images caused by spurious arrivals cancelled to a reasonable extent by a destructive interference thanks to stacking individual common–shot prestack depth migrated images.

The second part, **Elastic waves in anisotropic media**, addresses the problems relevant to heterogeneous anisotropic elastic media.

V. Bucha summarizes improvements in testing the 3–D anisotropic seismic modelling code for inhomogeneous media of arbitrary anisotropy by Ekkehart Tessmer in his paper "Comparison of Fourier pseudospectral method seismograms and ray–theory travel times in a simple triclinic model: revealed direct wave" which represents an updated version of the related paper of the Volume 27. The snapshots of the wave field and ray–velocity surfaces helped him to identify an unknown S wave. After many tests, better parameters of absorption stripes at the sides of the velocity model have been found and unwanted reflections have better been suppressed.

The third part, **Elastic waves in isotropic attenuating media**, is devoted to waves propagating in isotropic attenuating media.

With the goal to extend applicability of the weak–attenuation concept (WAC) to layered media, I. Pšenčík & M. Wcisło apply WAC to the simplest case, reflection and transmission of SH waves at an interface separating two anelastic isotropic media, in their contribution "SH–wave reflection/transmission coefficients in isotropic, weakly attenuating media". They illustrate the proposed approximation using three models M1, M2 and M3, which were already used in the Volume 7. They demonstrate that, except for angles close to the critical incidence in the reference elastic medium, WAC provides accurate results even for attenuation factors specifying attenuation which cannot be called weak. The accuracy of approximate formulae seems to be more sensitive to the inhomogeneity of incident wave than to anelasticity of the medium. Planned steps are to use WAC in the computation of ray synthetic seismograms in layered attenuative isotropic and later also anisotropic media.

Paper "Effects of attenuation, velocity and density on SH–wave reflection/transmission coefficients in isotropic, weakly attenuating media" by M. Wcisło represents a continuation of the above paper. M. Wcisło takes the model M2 of the above paper, varies different parameters around it, and displays the changes of the SH–wave reflection/transmission coefficients. Unfortunately, this correspondence to the above paper is obscured by multiplying the S–wave velocities and densities of model M2 by constant factors, and by a negligible modification of model M2.

The fourth and final part, **DVD–ROM with SW3D software, data and papers**, contains the DVD–R compact disk SW3D–CD–22.

Compact disk SW3D–CD–22, edited by V. Bucha & P. Bulant, contains the revised and updated versions of the software developed within the SW3D research project, together with input data related to the papers published in the serial *Seismic Waves in Complex 3–D Structures*. A more detailed description can be found directly on the compact disk. Compact disk SW3D–CD–22 also contains over 530 complete papers from journals and previous volumes of the serial *Seismic Waves in Complex 3–D Structures* in PostScript, PDF, GIF or HTML, and 2 older books by V. Červený and his coauthors in PDF. Refer to the copy of the SW3D research project WWW pages on the compact disk. Compact disk SW3D–CD–22 is included in the Volume 28 in two versions, as the UNIX disk and DOS disk. The versions differ just by the form of ASCII files.

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