Introduction

Volume 26 of the serial *Seismic Waves in Complex 3–D Structures* of the annual reports of consortium project "Seismic Waves in Complex 3–D Structures" (SW3D) summarizes the work done towards the end of the twenty–second year and during the twenty–third year of the project, in the period June, 2015 — May, 2016. It also includes the DVD compact disk with updated and extended versions of computer programs distributed to the sponsors, with brief descriptions of the programs, and with the copy of the SW3D 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. The reason is that we cannot change the name of our already registered serial.

Our group working within the project during the twenty–second year has consisted of six research workers: Václav Bucha, Petr Bulant, Vlastislav Červený, Luděk Klimeš, Ivan Pšenčík and Bohuslav Růžek.

Véronique Farra (Institut de Physique du Globe de Paris, France) and Tijmen Jan Moser (Zeehelden Geoservices, 's-Gravenhage, The Netherlands) visited us since the last annual SW3D consortium meeting in June, 2015.

Ivan Pšenčík is a member of the technical committee preparing the 17th International Workshop on Seismic Anisotropy in Horseshoe Bay, Texas, USA in 2016. Petr Bulant and Ivan Pšenčík serve as two of four guest editors of the special issues of Studia Geophysica et Geodaetica with the proceedings from international workshop "Active and passive seismics in laterally inhomogeneous media" held at the Loučeň Castle in Czech Republic on June 8–12, 2015. The proceedings will be distributed to the Consortium members in summer 2016 and in early 2017.

This Introduction is followed by the list of members of the SW3D consortium during the twenty–third year of the project.

The Research Programme for the current, twenty–third year of the SW3D consortium project comes after the list of members. The Research Programme for the next year will be prepared after the discussion at the annual consortium meeting, June 6–7, 2016. More detailed information regarding the SW3D consortium project is available online at "http://sw3d.cz".

All 9 papers of **Volume 26** are related to seismic or electromagnetic anisotropy. Volume 26 may roughly be divided into six 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 solution, and to the construction of velocity models suitable for ray tracing and for application of ray–based high–frequency asymptotic methods.

Encouraged by P. Jílek from BP in Houston, B. Růžek & I. Pšenčík continued in their attempts described in Volume 24 to invert P–wave travel–time data from a vertical seismic profiling (VSP) experiment in a homogeneous medium of arbitrary anisotropy. In their contribution "P–wave VSP traveltime inversion in weakly and moderately

anisotropic media" they study under which conditions and to which extent it is possible to retrieve information about anisotropy from VSP travel–time data. Although the velocity model is oversimplified, their study brings some interesting results. First of all, it clearly demonstrates advantages of the use of the so–called weak–anisotropy parameterization. It also indicates the important role of the form of distribution of seismic sources on the surface. Their random distribution clearly outperforms the classic profile distribution. Last, but not least, it demonstrates that estimated parameters of the medium allow for reconstruction of the phase–velocity surface of the medium even for noisy travel–time data.

In their contribution "Weak–anisotropy moveout approximations for P waves in homogeneous TTI layers", I. Pšenčík & V. Farra continue in their study of non–hyperbolic moveout (approximation of travel time of reflected waves) for anisotropic media. In Volume 23 of the serial *Seismic Waves in Complex 3–D Structures*, they started with moveout formulae for P and SV waves in a transversely isotropic medium with the vertical axis of symmetry. In Volume 25, they generalized moveout formulae to P waves in monoclinic media whose plane of symmetry coincided with the reflector. In this Volume 26, they propose an approximate non–hyperbolic moveout formula for weak or moderate anisotropy of arbitrary symmetry and orientation. Such a formula is more important for higher symmetry media with inclined symmetry elements than for triclinic media. In the present paper, the general moveout formula is specified for the case of a transversely isotropic medium with the axis of symmetry of arbitrary tilt. Checks of the accuracy of the moveout formula indicate that the maximum relative error is about 2.5%.

V. Bucha in his contribution "Kirchhoff prestack depth migration in simple orthorhombic and triclinic models with differently rotated elasticity tensor: comparison with zero–offset travel–time perturbations" estimates shifts of zero–offset migrated interface caused by incorrect velocity models using travel–time perturbations and compares them with finite–offset migrated sections and zero–offset migrated sections. The paper extends the study of the sensitivity of migrated images to the rotation of the tensor of elastic moduli (stiffness tensor) around coordinate axes x_1, x_2 or x_3 presented in Volume 24 of the serial *Seismic Waves in Complex 3–D Structures*.

In paper "Feasibility of anisotropic inversion based on P–wave travel–time curves", P. Bulant studies how anisotropy influences travel times from surface refraction seismic experiments.

The second part, **Paraxial ray methods in anisotropic media**, addresses the general theoretical problems of paraxial ray approximation, including paraxial Gaussian beams and packets.

Paper "Superpositions of Gaussian beams and column Gaussian packets in heterogeneous anisotropic media" by L. Klimeš is an extended version of the paper of previous Volume 25 having the same name. The integral superposition of Gaussian beams is obtained from the superposition of Gaussian packets by asymptotic integration along rays crossing the reference surface. Arbitrary system of reference lines crossing the reference surface is considered. The superposition of "column Gaussian packets" is then

obtained by asymptotic integration along the reference lines. The resulting column Gaussian packets are regular at caustics only if they coincide with Gaussian beams. Since weighting factors of Gaussian beams in the superposition are usually expressed in ray–centred coordinates, the extended version of the paper is supplemented with new Section 5 which transforms the weighting factors of Gaussian beams from coordinates along the reference surface to ray–centred coordinates.

In paper "Green function as an integral superposition of Gaussian beams in inhomogeneous anisotropic layered structures in Cartesian coordinates", V. Červený & I. Pšenčík continue in their studies whose results were presented in previous Volumes 24 and 25 of the serial *Seismic Waves in Complex 3–D Structures.* Previous results were always somehow related to the use of dynamic ray tracing in ray–centred coordinates. Main goal of the present study is a superposition integral whose evaluation requires only quantities obtained from ray tracing and from dynamic ray tracing in Cartesian coordinates. This formulation allows for a straightforward implementation in computer codes for 3–D laterally inhomogeneous media such as program package ANRAY.

The third part, **Waves in weakly anisotropic elastic media**, addresses the problems relevant to wave propagation in heterogeneous weakly anisotropic elastic media.

In paper "Reference transversely isotropic medium approximating a given generally anisotropic medium", L. Klimeš derives the stiffness tensor of a transversely isotropic (uniaxial) medium which approximates a given generally anisotropic medium. The symmetry axis of the transversely isotropic medium is obtained using the method proposed by L. Klimeš in his paper "Determination of the reference symmetry axis of a generally anisotropic medium which is approximately transversely isotropic" of previous Volume 25 of the serial *Seismic Waves in Complex 3–D Structures.*

The fourth part, **Ray theory for viscoelastic waves in anisotropic media**, is devoted to waves propagating in anisotropic viscoleastic media.

The current ray theory for elastic or viscoelastic waves is developed under assumption that the stiffness tensor is symmetric with respect to the exchange of the first pair of indices and the second pair of indices. This symmetry has been proved for elastic media, but not for viscoelastic media. L. Klimeš thus gets rid of this symmetry assumption in his paper "Frequency–domain ray series for viscoelastic waves with a non–symmetric stiffness matrix".

The fifth part, **Ray theory for electromagnetic waves in bianisotropic media**, is devoted to electromagnetic waves propagating in heterogeneous bianisotropic media, i.e., in media where both permitivity and permeability depend on the direction of propagation.

In the only paper of this part, "Ray series for electromagnetic waves in static heterogeneous bianisotropic dielectric media", L. Klimeš proposes the anisotropic ray theory for electromagnetic waves in smoothly heterogeneous generally bianisotropic media.

The sixth and final part, **DVD–ROM with SW3D software, data and papers**, contains the DVD–R compact disk SW3D–CD–20.

Compact disk SW3D–CD–20, edited by V. Bucha & P. Bulant, contains the revised and updated versions of the software developed within the SW3D consortium 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–20 also contains over 490 complete papers from journals and previous volumes of the serial *Seismic Waves in Complex 3–D Structures* in PostScript, PDF, GIF or HTML, and 3 books by V. Červený and his coauthors in PDF. Refer to the copy of the SW3D consortium WWW pages on the compact disk. Compact disk SW3D–CD–20 is included in Volume 26 in two versions, as the UNIX disk and DOS disk. The versions differ just by the form of ASCII files.

Prague, June 2016

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