Introduction

Volume 25 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–first year and during the twenty–second year of the project, in the period June, 2014 — May, 2015. 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 journals.

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

On the invitation of the SW3D consortium member NORSAR, Ivan Pšenčík visited Oslo, Norway in January 2015 for consultations.

Véronique Farra (Institut de Physique du Globe de Paris, France), Petr Jílek (BP, Houston, USA), Sribharath Kainkaryam (Schlumberger Petrotechnical Services, Houston, USA), Michael López (University of Bergen, Norway), Tijmen Jan Moser (Zeehelden Geoservices, ’s-Gravenhage, Netherlands) and Alexey Stovas (ROSE project, University Trondheim, Norway) visited us since the last annual SW3D consortium meeting in June, 2014.

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

The Research Programme for the current, twenty–second 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 15–16, 2015. More detailed information regarding the SW3D consortium project is available online at “http://sw3d.cz”.

Volume 25 contains mostly the papers related to seismic anisotropy (7 of 9 papers). Volume 25 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 solution, and to the construction of velocity models suitable for ray tracing and for application of ray–based high–frequency asymptotic methods.

During years 1998–1999, V. Bucha & L. Klimeš prepared the numerical algorithm of a simplified version of the nonlinear hypocentre determination which takes into account the inaccuracy of the velocity model. The testing version of the corresponding code was included in the SW3D software in the year 2000. Recently, P. Bulant & L. Klimeš wrote down the theory underlying the numerical algorithm in their paper “Nonlinear hypocentre determination”, and tested the numerical algorithm on a set of natural microearthquakes. They demonstrated how the inaccuracy of the velocity model can roughly be estimated from the arrival times of earthquakes.

V. Bucha & L. Klimeš at last completed their old unpublished manuscript “Nonlinear hypocentre determination in the 3–D Western Bohemia a priori velocity model” with the description of the numerical algorithm of the simplified version of the nonlinear hypocentre determination, and with a simple demonstration of the algorithm on four local earthquakes in the seismically active part of Western Bohemia.

Paper "Weak–anisotropy moveout approximations for P waves in homogeneous layers of monoclinic or higher anisotropy symmetries" by V. Farra, I. Pšenčík & P. Jílek is a considerably revised and extended version of paper "Moveout approximations for P waves in media of monoclinic and higher anisotropy symmetries" from the previous Volume 24 of *Seismic Waves in Complex 3–D Structures*. The paper contains a thorough and detailed discussion of the so–called weak–anisotropy parametrization of anisotropic media of arbitrary symmetry, orientation and strength. The weak–anisotropy parametrization represents an alternative to the parametrization by stiffness tensor or by parametrizations tailored for specific anisotropy symmetries. The weak–anisotropy parametrization is used for the derivation of P–wave moveout formulae of varying accuracy for monoclinic, orthorhombic or transversely isotropic media with vertical or horizontal axis of symmetry underlaid by a horizontal reflector coinciding with a symmetry plane. The accuracy of the derived formulae is tested and their results are compared with the results of commonly used nonhyperbolic moveout formulae.

V. Bucha in his contribution "Kirchhoff prestack depth migration in a homogeneous triclinic velocity model for P, S and converted waves" presents his first examples of the 3–D Kirchhoff prestack depth migration using S waves and converted waves in a generally anisotropic medium. He previously demonstrated the 3–D Kirchhoff prestack depth migration using P waves only.

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

The integral superposition of Gaussian beams can be obtained from the superposition of Gaussian packets by asymptotic integration along rays crossing the reference surface. In contribution "Superpositions of Gaussian beams and column Gaussian packets in heterogeneous anisotropic media", L. Klimeš considers arbitrary system of reference lines crossing the reference surface, and obtains the superposition of "column Gaussian packets" by asymptotic integration along the reference lines. He then demonstrates that the column Gaussian packets are regular at caustics only if they coincide with Gaussian beams.

In paper "Integral superposition of paraxial Gaussian beams in inhomogeneous anisotropic layered structures in Cartesian coordinates", V. Červený & I. Pšenčík present suitable expressions for the wave field generated by a point source with an arbitrary radiation function or by a surface source with a variable initial time along it. The receiver point may be situated anywhere in the velocity model, including structural interfaces or the Earth's surface. The formula for the integral superposition of paraxial Gaussian beams is applicable to arbitrary direct, multiply reflected, converted or unconverted waves propagating in inhomogeneous anisotropic media. It can also be applied to coupled S waves.

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

In paper "P–wave ray (group) velocities in a weak–anisotropy approximation", V. Farra & I. Pšenčík test ray–velocity formulae of varying accuracy, derived in the weak–anisotropy approximation. A special feature of the formulae, often required by users, is their dependence on the ray vector (the unit vector in the direction of the ray–velocity vector) rather than the phase vector (unit vector parallel to the slowness vector). The authors test the accuracy of the formulae, and compare their results with the results of other alternative approximations.

It may be interesting to know whether a given elastic medium is transversely isotropic or approximately transversely isotropic, and to know its symmetry axis or reference symmetry axis. One of possible solutions is proposed by L. Klimeš in his paper "Determination of the reference symmetry axis of a generally anisotropic medium which is approximately transversely isotropic".

If an elastic medium is a perturbation of a transversely isotropic medium, the SH and SV reference rays defined by L. Klimeš & P. Bulant in their contribution "Ray tracing and geodesic deviation of the SH and SV reference rays in a heterogeneous generally anisotropic medium which is approximately transversely isotropic" represent very convenient reference rays for the coupling ray theory.

The fourth and final part, **DVD–ROM with SW3D software, data and papers**, contains the DVD–R compact disk SW3D–CD–19.

Compact disk SW3D–CD–19, 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 serial *Seismic Waves in Complex 3–D Structures*. A more detailed description can be found directly on the compact disk. Compact disk SW3D–CD–19 also contains over 480 complete papers from journals and previous volumes of 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–19 is included in Volume 25 in two versions, as the UNIX disk and DOS disk. The versions differ just by the form of ASCII files.

Prague, June 2015

Vlastislav Červený
Luděk Klimeš
Ivan Pšenčík