Introduction

Report 21 of the Consortium project "Seismic Waves in Complex 3–D Structures" (SW3D) summarizes the work done towards the end of the seventeenth year and during the eighteenth year of the project, in the period June, 2010 — May, 2011. 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 reports and articles from journals.

Consortium project "Seismic Waves in Complex 3–D Structures" has a new and simple address **sw3d.cz** of its WWW pages since November 13, 2007.

Our group working within the project during the eighteenth year has consisted of five research workers Václav Bucha, Petr Bulant, Vlastislav Červený, Luděk Klimeš, Ivan Pšenčík, and of MSc student Libor Šachl, who works on the ray–based Born approximation.

Andrey Bakulin (SaudiAramco, Dhahran, Saudi Arabia; SEG distinguished lecturer), Norman Bleistein (Colorado School of Mines, Golden, USA), Adriano Cesar (Universidade Federal de Pará, Belém, Brazil), Adrianus T. de Hoop (Delft University of Technology, Netherlands), Véronique Farra (Inst. Physique du Globe de Paris, France), Ellen Gomez Souza de Nazare (Universidade Federal de Pará, Belém, Brazil), Einar Iversen (NORSAR, Kjeller, Norway), Ivan A. Molotkov (IZMIRAN, Moscow, Russia) and Tijmen Jan Moser (Zeehelden Geoservices, ´s-Gravenhage, Netherlands) visited us during the period June, 2010 — May, 2011.

Ivan Pšenčík is a member of the technical committee preparing the 15th International Workshop on Seismic Anisotropy in Bahrain in 2012, and serves as the editor of the special issue of Studia Geophysica et Geodaetica (No. 1/2012) with the proceedings from international workshop "Seismic waves in laterally inhomogeneous media VII" held at the Teplá Premonstratensian Monastery in Czech Republic on June 21–26, 2010. The special issue will be distributed to the Consortium members early in 2012.

Research **Report 21** contains mostly the papers related to seismic anisotropy (8 of 11 papers). Report 21 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.

In paper "Constructing model P1I for reflection studies", P. Bulant and N. Martakis smooth given P–wave and S–wave propagation velocities in order to obtain a smooth 2–D velocity model suitable for ray tracing. They also smooth given positions of structural interfaces and construct a 2–D velocity model with interfaces by smoothing the same given P–wave and S–wave velocities separately in individual blocks. In the constructed model with interfaces, they calculate synthetic seismograms which simulate a reflection measurement in the modelled locality.

Paper "Resolution of prestack depth migration" by L. Klimeš represents a considerably revised and corrected version of the paper of Report 6 (1997). It is demonstrated that, for a given source, the migrated section is the convolution of the reflectivity function with the corresponding local resolution function, or the convolution of the spatial

distribution of the weak–contrast displacement reflection–transmission coefficient with the corresponding local resolution function.

In paper "Kirchhoff prestack depth migration in 3–D models: Comparison of triclinic anisotropy with simpler anisotropies", V. Bucha demonstrates the behaviour of the 3–D Kirchhoff prestack depth migration in the presence of triclinic anisotropy. V. Bucha then studies the effects of simplified or incorrectly estimated anisotropy upon the migrated image. Note that the calculation of one common–shot prestack depth vertical section on a PC takes 5 seconds on average. The total of 19 440 stacked common–shot depth sections then takes 27 hours on a PC.

Paper "Estimativa de anisotropia local de dados de onda P em experimentos de VSP multiazimutal" by A.C.R. Barreto, R. de N.A. Macambira, E.N.S. Gomes and I. Pšenčík represents the expanded abstract submitted to the 11th International Congress of Brazilian Geophysical Society (August 2011). The expanded abstract is related to the study of stability and sensitivity of local determination of anisotropy from P–wave vertical components of slowness vectors and of polarization vectors. The authors use synthetic data to study the dependence of the quality of the inversion on the number and distribution of profiles with sources, on used waves (direct and/or reflected) and on the level of noise.

The second part, **Ray–based Born approximation**, is devoted to the first–order Born approximation.

L. Šachl tests the behaviour and accuracy of the ray–based first–order Born approximation for simple perturbations of a homogeneous background model in paper "2D and 3D computations of 3D synthetic seismograms using the ray–based Born approximation in simple models", and of a heterogeneous background model in paper "2D computations of 3D synthetic seismograms using the ray–based Born approximation in heterogenous model P1". He also derives and applies the correction enabling to calculate 3–D seismograms by the 2–D Born approximation in a 2–D configuration.

The third part, **Ray methods in anisotropic elastic media**, addresses the general theoretical problems of ray theory.

In the only paper of this part, L. Klimeš simplifies the derivation of the "Zero–order ray–theory Green tensor in a heterogeneous anisotropic medium". His paper has thus educational rather than research character, but we feel that the derivations of already known results are worth to be simplified.

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

Paper "Approximate seismic–wave traveltimes in laterally varying, layered, weakly anisotropic media" by I. Pšenčík, V. Farra and E. Tessmer represents the expanded abstract submitted to the 11th International Congress of Brazilian Geophysical Society (August 2011). The expanded abstract is related to the problem of calculating P– and S–wave FORT (first–order ray tracing) travel times in layered, weakly anisotropic media. The FORT formulae for travel–time computations in smooth media are supplemented by the procedure for computing the FORT approximation of slowness vectors of waves generated at interfaces.

I. Pšenčík, V. Farra and E. Tessmer concentrate in their paper "Comparison of the FORT approximation of the coupling ray theory with the Fourier pseudospectral

method" on the study of accuracy of the FORT (first–order ray tracing) approximation of coupling ray theory in inhomogeneous weakly anisotropic media and in the S–wave singular regions such as intersection, kiss or conical singularities. Comparison with the Fourier pseudospectral method indicates surprising accuracy of coupling ray theory and its superiority over standard ray theory.

In paper "Comparison of the anisotropic–common–ray approximation of the coupling ray theory for S waves with the Fourier pseudo–spectral method in weakly anisotropic models", P. Bulant, I. Pšenčík, V. Farra and E. Tessmer compare three different approximations of the coupling ray theory for S waves with the very accurate synthetic seismograms calculated by the Fourier pseudo–spectral method. The comparison is performed in six velocity models considerably differing in their anisotropy. The significantly shortened expanded abstract of this paper has been submitted to the 11th International Congress of Brazilian Geophysical Society (August 2011).

The fifth part, **Waves in anisotropic attenuating media**, is devoted to waves propagating in anisotropic attenuating media and described by the complex–valued travel time.

In paper "Componental specification of plane waves in isotropic and anisotropic viscoelastic media", V. Červený and I. Pšenčík investigate time–harmonic, homogeneous and inhomogeneous plane waves by the componental specification of their slowness vectors. In the componental specification, the plane wave is specified at an arbitrarily chosen plane Σ by a known projection $\mathbf{p}^{\Sigma}$ of its slowness vector on Σ. Analogously to the mixed specification of slowness vectors of plane waves, the componental specification leads to the solution of an algebraic equation of the sixth degree with complex–valued coefficients. Some special cases are discussed in a greater detail, in which the algebraic equation factorizes and allows analytical solution. The componental specification plays an important role in the problem of reflection and transmission of plane waves on a plane interface between the viscoelastic halfspaces.

The sixth and final part, **DVD–ROM with SW3D software, data and papers**, contains the DVD–R compact disk SW3D–CD–15.

Compact disk SW3D–CD–15, edited by V. Bucha and P. Bulant, contains the revised and updated versions of the software developed within the Consortium research project, together with input data related to the papers published in the Consortium research reports. A more detailed description can be found directly on the compact disk. Compact disk SW3D–CD–15 also contains over 400 complete papers from journals and previous reports in PostScript, PDF, GIF or HTML, and 3 books by V. Červený in PDF. Refer to the copy of the Consortium WWW pages on the compact disk. Compact disk SW3D–CD–15 is included in Report 21 in two versions, as the UNIX disk and DOS disk. The versions differ just by the form of ASCII files.

This Introduction is followed by the list of members of the SW3D Consortium during the eighteenth year of the project.

The Research Programme for the current, eighteenth year of the Consortium project comes after the list of members. The Research Programme for the next year will be prepared after the discussion at the Consortium meeting, May 30–31, 2011. More detailed information regarding the SW3D Consortium Project is available online at "http://sw3d.cz".

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