Summary: WIT report 2005

IMAGING

Camargo and Santos present an efficient algorithm for the uniform resampling problem, using Shannon Sampling Theorem (Sinc function) and the aproximation of the pseudo-inverse of a matrix. To illustrate the approach, we apply the algorithm to resample a seismogram and to recover a corrupted two-dimensional image.

Cruz et al. identify first-order interbed symmetric multiple reflections. For this, they compare parameters of hypothetical NIP and N wavefronts obtained by forward modeling and Kirchhoff migration. This comparison is verified also with the NMO velocity.

Müller presents a technique for correcting traveltimes and wavefield attributes obtained by means of coherence analyses. Search aperture dependent "best fit" quantities are extrapolated to zero-aperture in order to obtain the desired attributes as well as a corrected stack section.

Spinner presents an CRS-based approach for minimum aperture Kirchhoff migration in the time domain. The main focus of the method lies on the migration amplitudes and the resulting improvments in AVO/AVA analysis.

Klüver presents a new technique for migration based velocity model update. It is based on the same model parameterization as CRS-based tomography but partially overcomes the limitation to second order of that method.

Novais et al. present a stable implementation of image-wave remigration in the time domain, demonstrating the computational efficiency of the algorithm. An example using ground-penetrating-radar (GPR) data demonstrates how image-wave remigration can be used to estimate a model of the medium velocity.

Schleicher and Aleixo derive image-wave equations, that is partial differential equations that describe the dislocation of a reflector image as a function of the velocity model, for time and depth remigration in elliptically anisotropic media, under variation of migration velocity and medium ellipticity. A numerical example demonstrates the validity of the theory.

Kashtan, Tessmer and Gajewski show that the commonly used acoustic 2D one-way wave equation needs to be modified in order to yield correct amplitudes. In order to yield correct results amplitudes from the one-way and the two-way wave equations need to be the same in the direction into which energy is propagated. They theoretically explain artifacts when using the one-way wave equation.

Buske et al. describe an extension of Kirchhoff prestack depth migration. The so-called Fresnel-Volume-Migration restricts the migration operator to the physically relevant part of the subsurface using the concept of Fresnel-Volumes and the emergence angle determined at the receiver from a local slowness analysis. The application to a synthetic model as well as to a real data set over a salt pillow demonstrates the benefits of this method, e.g. enhanced image quality and resolution.

Ferreira and Cruz extend that KGB-PSDM algorithm to the case of a depth-dependent velocity medium. A sensibility analysis is made in order to test for possible errors in velocity models.

Santos and Tygel propose an algorithm to invert elastic-parameter contrasts from Amplitude-versus-Ray Parameter curves using the reflection impedance approximation of the PP-reflection coefficient. First results shown on synthetic data indicate that the procedure may offer a promising alternative to existing methods of inverting reservoir attributes from AVO/AVA curves

Kashtan, Gajewski, Tessmer, and Vanelle explain and verify by numerical studies that the localization of seismic events by reverse modeling or other back-projection methods possess inherent errors. The location and timing of the events by these methods are systematically shifted toward the receiver network and to earlier hypocentral times. The errors depend on the acquisition geometry and the length of the recorded signal.

Yoon et al. applied the CRS stack method to crustal reflection data from the North German basin which were recently released by the industry. The data were acquired and processed in the early 80ies with the focus on the sedimentary fill of the basins. The focus of the reprocessing was moved to imaging of the deeper structures within the basin. The new results yielded improved images of structures in the lower and middle crust. Also, the visibility of the Moho was significantly enhanced. This example shows a first succesful application of the CRS stack method to real crustal reflection data.

Heilmann et al. are giving attention to the seismic processing and interpretation of a land data set from the Takutu basin, Brazil. The presented extension of CRS-stack-based time-to-depth imaging supports arbitrary top-surface topography and is well suited to the specific problems of land data processing, namely, sparse data, complex geological structures, and complicated near surface conditions. The following processing steps were carried out: CRS stack, residual static correction, determination of a macrovelocity model via tomographic inversion, and Kirchhoff pre- and poststack depth migration.

ROCK PHYSICS AND WAVES IN RANDOM MEDIA

Gerner et al. investigate P-wave attenuation in vertical direction caused by interlayer flow and scattering in poroelastic media. Numerical and analytical results indicate that interlayer flow may be a significant attenuation mechanism in highly permeable sediments. Especially in the lower seismic frequency range poroelastic modeling yields attenuation values that are comparable to field observations.

Zanoth et al. consider the leaky mode, a possible attenuation phenomenon of seismic waves in a gas-hydrate-bearing sediment layer. This attenuation mechanism in horizontal direction occurs when a high-velocity layer is embedded in a low velocity zone. This is a typical situation for gas hydrate occurrences. We will demonstrate that the leaky mode is a significant attenuation mechanism which cannot be neglected.

Ciz et al. perform numerical simulations using the rotated staggered grid for an idealized porous medium, namely a periodic system of alternating solid and viscous fluid layers. The simulation results show excellent agreement with the theoretical predictions. Specifically the simulations agree with the prediction of Biot's theory of poroelasticity at lower viscosities and with the viscoelastic dissipation at higher viscosities.

Saenger et al. consider viscous fluid effects on wave propagation. They implement an accurate approximation of a Newtonian fluid into a finite-difference approach. Biot-type effects can be observed in numerical experiments on a micro-scale, i.e from first principles.

Saenger et al. model a Biot slow wave on microscale. Since the theory of dynamic poroelasticity was developed by Biot (1956), the existence of the type II or Biot's slow compressional wave (SCW) remains the most controversial of its predictions. To our knowledge this is the first time that the slow wave is simulated on first principles.

Davolio et al. make a review of impedance-type approximations for the P–P reflection coefficient and introduce the corresponding approximation for the P–S reflection coefficient. They also describe how to estimate the ratios of some elastic parameters, directly from the data, using the concept of the impedance function. Some illustrative examples for a well-log data are presented.

Müller analyzes effective properties of diffusion waves in randomly inhomogeneous poroelastic solids.

Brajanovski et al. analyze characteristic frequencies of seismic wave attenuation due to wave-induced flow in fractured porous rocks.

MODELING

Bohlen and Saenger consider the accuracy of different finite-difference approaches for modeling Rayleigh waves. The conventional standard staggered-grid (SSG) and the rotated staggered grid (RSG) is investigated. For an irregular interface the RSG scheme is more accurate than the SSG scheme. The RSG scheme, however, requires 60 grid points per minimum wavelength to achieve good accuracy for all dip angles.

Silva Neto et al. describe a velocity-stress formulation for elastic finite-difference modeling of elastic wavefields in 2.5 dimensions. The approach is appealing due reduced storage and computing time when compared to full 3D finite difference elastic modeling. Numerical experiments show the accuracy of the scheme.

Lima et al. give a theoretical revision about 3-D CRS Stack. They make a comparison of the CRS traveltime approximation for reflection and diffraction events with respect to true traveltimes. Although the 3-D ZO CRS operator have a better fit then the 3-D ZO CDS operator, the last also can be used for 3-D Stacking.

OTHER TOPICS

Schleicher and Biloti discuss a frequency criterion on how to choose the number of nodes for a smoothing by optimal cubic splines. They also compare smoothing results to those obtained by filtering using a moving average and a lowpass.

Tygel and Ursin examine the power series representation of traveltime as a function of offset for multiply transmitted and reflected wave in VTI media. They show that there is convergence for sufficiently small offsets, except in the case of a vanishing NMO-velocity. This can happen for qSV propagation in some layer. The situation of on-axis triplication, which occurs when the squared NMO-velocity becomes negative is also discussed.

Vanelle and Gajewski suggest a method to determine the vertical slowness in a weakly anisotropic medium, if only the horizontal slowness components are known. The main applications for the method are the reflection-transmission problem between two anisotropic media, and the traveltime-based determination of geometrical spreading and true-amplitude migration weight functions for anisotropic media.

Netzeband, Hübscher, and Gajewski have shown that in the initial stages of salt movement in the Levantine Basin very little lateral evaporite movement has taken place in the past 5 Ma, the direction of this movement is controlled by the sediment load of the Nile River. Five sub-units of evaporite deposition have been found, which have been deformed syn-depositionally.