Summary: WIT report 2009

IMAGING

Baykulov and Gajewski performed partial 3D CRS stacks to enhance the quality and regularity of prestack 3D seismic data. Results of the automatic CRS parameter search are used to perform a simple and robust weighted summation. The method is verified on 2D and 3D synthetic data and applied to field 3D data. Improved prestack gathers have higher S/N ratio and show better coherence of reflections.

Costa and Schleicher apply the idea of double path-integral migration velocity analysis to a real data set to show that the method yields quantitative information about the migration velocity model. Migrated images using interpolations with different regularisations of the extracted velocities demonstrate the high quality of the resulting velocity information.

Dell and Gajewski demonstrate a new application of the CRS attributes for time migration velocity analysis. They show how the attributes can be used to effectively separate reflected and diffracted energy. Then, they introduce and apply a new technique for poststack time migration velocity analysis on the diffracted wavefield. As a result, they obtain highly-focused time migrated images in addition to the velocities.

Dell et al. propose a new method to map common midpoint (CMP) gathers into common scatterpoint (CSP) gathers. The CSP data mapping is based on the parameterization of the migration operator with the apex time. Then, they apply a migration velocity analysis to CSP gathers and perform an automatic Common Reflection Surface (CRS) stack for this gathers. As a result, they obtain more accurate velocity spectra and highly-focused time migrated images.

Dümmong and Gajewski add geological constraints into the search procedure of CRS attributes. These constraints are linked to the stacking velocity and the geological dip of the structures under investigation. Field data examples illustrate the effect of the constraints on the determined CRS attributes and the final stack.

Kang revisits the fundamentals of the normal-incidence point (NIP) wave tomography. Inverting for picked kinematic wavefield attributes otained from the 3D CRS stack, this approach offers an efficient way to generate a kinematically consistent smooth 3D velocity model along with the reconstructed NIPs in the subsurface.

Köhn et. al. discuss the influence of parametrization in elastic full waveform tomography of synthetic multicomponent reflection seismic data. Starting from a long wavelength model for the elastic material parameters the waveform tomography result can resolve details below the seismic wavelength. The influence of different parameterizations on resolution and ambiguity are investigated using a simple test problem. Afterwards the resolution for a geological realistic model will be discussed.

Lima et al. present results of a consistent workflow for processing and imaging applied to marine seismic data. The data set was collected in the Southern Atlantic offshore Brazil. Searching for techniques to increase the data resolution, fundamental steps of signal processing together with imaging methods based on the data-driven CRS technology, such as CRS-stack-based residual static correction and pre-stack data enhancement, were applied and proved to be successful. The final aim of the data processing and imaging sequence was to obtain sections ready to be submitted to geological interpretation. The latter was conducted on the final stacked and CRS time-migrated sections.

Macedo et al. propose to use smearing instead of stacking when constructing velocity spectra in CMP velocity analysis. They describe, discuss, and test two methodologies in a very simple model. Smearing the total amplitude leads to conventional velocity spectra, with possible advantages because of its potential for parallel computing. Using the amplitude density gives rise to a slightly different coherency measure. Numerical experiments indicate that this measure might be able to improve the focussing of the velocity peaks in the velocity spectra.

Oliveira et al. discuss the dependence of single-stack redatuming constructed from migration-demigration chainging on the velocity model. For this purpose, they demonstrate the application of single-stack redatuming to synthetic seismic data for media with two or many flat layers and in models with lateral velocity variations. Our examples demonstrate the quality of the redatumed data both kinematically and dynamically.

Silva Neto et al. show that reverse time migration (RTM) in 2.5D offers an alternative to improve resolution and amplitude when imaging 2D seismic data. They implement a truly parallel finite-difference modelling algorithm in the mixed time-space/wavenumber domain. Numerical experiments using synthetic data demonstrate the better resolution and amplitude recovery of 2.5D RTM relative to 2D reverse time migration.

Valente et al. review three time-to-depth conversion techniques, discuss their algorithmic procedures and show their differences by applying them to a 2D synthetic data set. In particular, they demonstrate that the different procedures react differently to different kinds of regularization. Although the image-ray trajectories and the resulting depth velocity models depend on the regularization employed, the final depth images corresponding to these different models are very similar.

MODELING

Gelius et al. provide a simple framework of understanding and analyzing both diffraction-limited imaging as well as super-resolution. By utilizing the null-space solutions of the wave problem, super-resolution is apparently obtained since such solutions can give an extremely well localization of the point-source target.

Kaschwich et al. present a comparison between different ray-based modeling techniques, such as standard ray tracing, Kirchhoff-Helmholtz forward modeling and modeling by demigration. Furthermore, we propose a modified modeling by demigraion approach by using an alternative PSDM simulator.

Tessmer discusses that modelling algorithms based on the so-called pseudo-acoustic wave equations for TTI media are unstable if variations of symmetry axes tilt are present. By numerical examples he shows that an algorithm based on the anisotropic equations of motion yields stable results.

OTHER TOPICS

Aleixo et al. extend Alkhalifah's two-step procedure for extracting the NMO velocity and the nonhyperbolicity from seismic travaltimes. For this purpose, they use a more accurate nonhyperbolicity term in the traveltime approximation, which allows to predict the bias in the NMO velocity estimate, thus providing a means of correcting both the estimated NMO velocity and the resulting anisotropy parameter value. By means of a numerical example, they demonstrate that the estimation of both traveltime parameters is improved considerably.

Coimbra et al. relate offset-continuation (OCO) rays to the kinematic properties of OCO image waves that describe the continuous transformation of the common-offset reflection event from one offset to another. By applying the method of characteristics to the OCO image-wave equation, they obtain a ray-tracing-like procedure that allows to construct OCO trajectories describing the position of the OCO output point under varying offset. The endpoints of these OCO trajectories for a single input point and different values of the RMS velocity form then the OCO rays. A numerical example demonstrates that the developed ray-tracing procedure leads to reliable OCO rays, which in turn provide high-quality RMS velocities.

Freitas presents a case study for a 3D land data from Mexico illustrating how applications of the CRS attributes may contribute to important steps of the conventional workflow of depth processing.

Garabito et al. discuss the results of the application of two CRS stack implementations (multi-step and one-step search strategies) in a low-fold real land dataset, without using any constraints in the determination of the CRS parameters and using the stacking velocity model as an information known "a priori" in the optimization process.

Leite and Vieira investigate the relationship between sensitivity analysis, based on the Miller-Murray model, **S**, of the CRS operator with respect to the parameters v_0, R_{NIP}, R_N and α_0, and compare with the attributes search strategies that is based on physical-mathematical considerations of the stack operator.

Perroud et al. propose an algorithm for an (approximate) Inverse CRS transformation, namely one that (approximately) transforms the CRS attributes back to data space. The CRS transform pair established in this way may find a number of applications in seismic imaging and data processing, in the same way as other well-known transformations, e.g., Fourier, Radon, tau-p, etc.

Santos and Schleicher show that the complete set of CRS parameters can be extracted from seismic data by an application of modern local-slope-extraction techniques. The necessary information about the CRS parameters is contained in the slopes of the common-midpoint and common-offset sections. Here, they improve the previous extraction technique, eliminating the need for slope derivatives.

Tygel et al. provide an interpretation of the CRS coefficients of time-migrated reflections. The interpretation is done in terms of the ability of such coefficients to determine dip and curvature of the reflectors in depth.