

ABSTRACTS

Research status and development trends for seismic migration technology. Li Zhenchun¹. *OGP*, 2014, 49(1):1-21.

Based on a mathematical and physical model (acoustic medium, elastic medium and so on), seismic migration imaging is a process which applies appropriate geophysical theory to back-propagate the multiple coverage data observed on the ground and eliminates the propagation effects of seismic waves in order to obtain the subsurface model image. Firstly, we do briefly comment on the seismic migration in the different categories, describe several types of pre-stack depth migration method widely used today, analyze the constraint factors of the migration imaging, such as computational efficiency, imaging accuracy, amplitude preservation, undulating surface and the complexity of media, and so on. Then we point out that specific issues, assumptions and applicability needed to be analyzed when selecting migration methods. Finally, based on recent SEG/EAGE conferences and publications about seismic migration imaging, we summarize development trends as follows: ①Pre-stack depth migration has become mainstream in studies of seismic migration; ②RTM is gradually developing from theory research into the industrial application; ③Seismic migration application shifts from two-dimensional to three-dimensional; ④Migration for undulating surface attracts more and more attention; ⑤Migration in TI, VTI and TTI media becomes a hot topic; ⑥Inversion migration has emerged as a new favorite of seismic migration fields.

Keywords: migration, pre-stack depth migration, research status, development trends

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Research progress of fluid discrimination with pre-stack seismic inversion. Yin Xinyao¹, Cao Daping¹, Wang Baoli¹ and Zong Zhaoyun¹. *OGP*, 2014, 49(1):22-34, 46.

Seismic fluid discrimination describes the distribution of oil and gas reservoirs underground with seismic data, which is one of the important goals in oil and gas exploration. Pre-stack seismic inversion plays an important role in oil and gas reservoir discrimination and evaluation. Based on the review of development of pre-stack seismic inversion methods, we stress in this paper the necessity of the construction of reservoir or fluid sensitive

parameters, and review some methods of fluid sensitive parameters construction and evaluation. Furthermore, we discuss the fluid discrimination methods based on model-driven and data-driven strategy respectively. Finally, theory and real data tests demonstrate that we should combine the rock physics, fluid sensitive parameters evaluation and seismic inversion technology together to ensure that the fluid type can be discriminated effectively.

Keywords: pre-stack seismic inversion, fluid factor, rock physics, elastic impedance, sensitivity evaluation

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Research progress on time-space domain finite-difference numerical solution and absorption boundary conditions of wave equation. Liu Yang^{1,2}. *OGP*, 2014, 49(1):35-46.

Numerical solution of the wave equation is one of core technologies for wave equation forward modeling, reverse time migration and full waveform inversion. In this paper, I review finite difference for numerical solution of wave equation and absorption boundary conditions, and discuss the hybrid absorption boundary conditions and different finite difference methods such as the time-space domain dispersion-relation-based finite difference, the adaptive variable-length spatial finite difference, the optimized finite difference. The paper introduces applications and progresses of these methods in reverse time migration and waveform inversion.

Keywords: wave equation, time-space domain finite difference, absorption boundary condition, research progress

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A method for vibroseis data harmonic filtering. Wu Jian¹, Wang Runqiu¹, Wei Jiaming², Zhang Xiaolei³, Yu Junqing¹, Sun Lipeng¹ and Jiang Yongyong¹. *OGP*, 2014, 49(1):47-52.

We analyze in this paper the causes of harmonics generated in vibroseis slip-sweep, and point out that the high order harmonics are the most se-

rious noise. We discuss the slip-sweep through the theory analysis and numerical experiments. Based on the linearity between the energy of high order harmonics and reference signals in every frequency band, we build a mathematical model for harmonic filtering. We utilize reference signal multiplication to generate every order harmonics, and estimate the energy ratio between every order harmonics. Application results on seismic data show that this harmonic filtering method can not only effectively remove harmonics, but also achieve fast calculations.

Keywords: vibroseis, harmonic distortion, seismic data acquisition, slip-sweep, high order harmonic filtering

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Surface wave joint suppression based on Shearlet transformation and time-time transformation. Wang Deying¹, Li Zhenchun¹ and Dong Lieqian¹. *OGP*, 2014, 49(1):53-60.

The surface wave suppression is one of the most important steps in seismic data processing. However, many surface wave suppression methods damage inevitably the signal because they only consider certain different properties between signal and surface wave. Therefore, a method surface wave joint suppression method based on Shearlet transform and time-time (TT) transform is proposed in this paper. First, effective reflection wave and surface wave distributed mainly in low frequency and high wavenumber are separated by the excellent localized property and the property of directional representation of the high-scale Shearlet basis function. Then, using the excellent identification capability of TT transform, most of surface wave component of low frequency and low wavenumber are suppressed by the filtering in TT domain. After that, according to the more accurate signal extracted by the Shearlet transform, an adaptive time-variant and space-variant filter is designed to remove the residual surface wave. Finally, we transform the data back to time domain without surface wave. Applications on synthetic and real field data show that the proposed method in this paper suppresses surface wave and maintains amplitude and phase information of reflection wave.

Keywords: Shearlet transformation, time-time transform, surface wave suppression, adaptive, time-space variant filter

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Layer related interbed multiple elimination. Liu Zhen^{1,2}, Zhang Junhua¹, Han Shuang¹, Wu Tao¹ and Huang Guangtan¹. *OGP*, 2014, 49(1):61-67.

Nowadays, most of interbed multiple suppressing methods focus on layer related interbed multiples which are generated under a specific interface. Through theoretical derivation and modeling, we expand upon the concept of layer related interbed multiples and propose the concept of interbed multiples which are generated by interaction of a reflector and upper interfaces. And we name such internal multiple as lower layer related interbed multiple (LLRIM). In addition, we redefine the formula of the data-driven interbed multiple elimination method and propose the expression for predicting LLRIM. Test results on synthetic data prove the validity of the method.

Keywords: interbed multiple, layer related, prediction

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A band-limited and robust inverse Q filtering algorithm. Chen Zengbao^{1,2}, Chen Xiaohong^{1,2}, Li Jingye^{1,2}, Wang Benfeng^{1,2} and Ma Sha³. *OGP*, 2014, 49(1):68-75.

Inverse Q filtering in Gabor domain makes use of Gabor spectrum instead of the downward wavefield. It performs stabilized inverse Q filtering in 2-D time-frequency spectrum, and reconstructs seismic traces in the time-domain. Compared with the layered implementation of inverse Q filtering, this algorithm may use a more accurate earth Q model without 2D amplitude compensation operator approximation. So its efficiency and accuracy are much higher. In order to improve the compensation effect without boosting the ambient noise, we perform inverse Q filtering in Gabor domain by incorporating a time-variant passband filter. The high-cut frequency of this passband filter follows a hyperbolic trajectory of a seismic signal travel time at a specified point as the signal bandwidth varies in media due to the attenuation. Test results on theoretical and real data demonstrate that the inverse Q filtering algorithm incorporating a time-va-

riant passband filter is robust and effective for seismic noisy data, and improves seismic resolution with no S/N degradation.

Keywords: inverse Q filtering, time-variant passband filter, attenuation compensation, high-resolution, Gabor transform

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Iterative parabolic Radon transform for primary and multiple separations. Xie Junfa¹, Sun Chengyu¹ and Han Wengong². *OGP*, 2014, 49(1):76-81.

Radon transform is commonly used in the separation of the primary from multiples. After least square parabolic Radon transform in frequency domain, the data in $t-x$ domain is transformed into Radon domain. The Radon transform image reveals spatial truncation effect and the linear events cross-hatching the image. So it is difficult to completely separate the primary from multiples by the conventional method. Therefore we propose iterative parabolic Radon transform in this paper. Selecting data in a small area near the focus of the primary in Radon domain as initial data, we can get new Radon field data after inverse Radon transform and forward Radon transform. Then we conduct iterations in the area of the initial data, and finally obtain primaries with well-preserved amplitude and no multiples. With this method, we can also get multiples without primaries. The correctness and effectiveness of the method is proved by tests on theory model and real data.

Keywords: Radon transform, iteration method, primary, multiple, wave-field separation

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High-resolution seismic processing based on generalized S transform. Huang Handong^{1,2}, Feng Na^{2,3}, Wang Yanchao¹ and Cai Yanjie⁴. *OGP*, 2014, 49(1):82-88.

Generalized S transform (GST) can flexibly adjust the change trend of the fundamental window function according to the frequency distribution characteristics and the time-frequency emphasis of seismic data. This transform can also quicken or

slow the time-bandwidth change along with the frequency to make the amplitude of the fundamental window function present various nonlinear changes. This will be very helpful for adapting to signal analysis and processing. We introduce window function database, sin (cosin) function database and IFFT in the GST method, the calculation of which is simple, convenient and effective. Then we redistribute the energy of the time-frequency spectrum, and reconstruct signals to obtain the high-resolution seismic data. Test results on model and real seismic data indicate that this method can availably improve seismic signal resolution both in time and frequency domain, and make structural and the lithologic characteristics on seismic sections much clearer.

Keywords: time-frequency analysis, generalized S transform (GST), high resolution processing

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Influence of offset-related absorption on AVO analysis and its compensation. Li Guofa¹, Zhang Xiaoming¹, Peng Gengxin², Yin Jinyin³ and Cui Yongfu². *OGP*, 2014, 49(1):89-94.

Dynamic characteristics of seismic reflection are seriously distorted due to viscoelastic media absorption influence. For pre-stack seismic data, this influence consists of two parts. One is related with reflection depth, and the other is related with offset. And this offset-related absorption has dominant influence on AVO analysis. The offset-related absorption can be compensated by calculating the absorption differences between nonzero-offset and zero-offset records in CRP gather. In this way, lateral variations of reflection characteristic resulted from media absorption are eliminated, and the precision of AVO analysis and prestack inversion are improved.

Keywords: absorption, dispersion, offset-related, AVO analysis, CRP gather

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Seismic data reconstruction based on high order high resolution Radon transform. Xue Yaru¹, Tang Huanhuan^{1,2} and Chen Xiaohong¹. *OGP*, 2014, 49(1): 95-100, 131.

Missing seismic data will affect seismic data processing and interpretation. Considering the reflection wave amplitude lateral continuity along events, we propose a high order high resolution Radon transform for seismic data reconstruction. Radon transform is only summation along events, and our method incorporates it with orthogonal polynomial transform and gets the gradient and curvature information of events. The high order high resolution Radon transform takes advantage of both velocity distinction of Radon transform and preserves AVO information of orthogonal polynomial transform. Tests on model data and real seismic data show that this method can achieve anti-aliasing, data reconstruction, and AVO information preservation.

Keywords: high order high resolution Radon transform, orthogonal polynomial transform, AVO, seismic data reconstruction

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Reverse time migration with Gaussian beams based on the Green function. Huang Jianping¹, Zhanqing², Zhangkai¹, Li Zhenchun¹, Yue Yubo³ and Yuan Maolin¹. *OGP*, 2014, 49(1):101-106.

We base on Kirchhoff integral for propagated wavefields to realize migration, and rely on the calculation of the Green functions for the classical wave equation by performing a summation of Gaussian beams for the direct and back propagated wavefield. The subsurface image is obtained by calculating the coherence between the direct and back-propagated wavefields. The model calculation and the real data verify that our method combines the advantages of the high computational speed of ray-based migration with the high accuracy of reverse-time wave-equation migration, which can overcome problems with caustics, yield good images of steep dips, and be readily extendible to target-oriented implementation.

Keywords: Gaussian beam, Green function, reverse-time migration, Kirchhoff integral, summation

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Least square reverse time migration in high resolution imaging of near surface. Huang Jianping¹, Cao Xiaoli¹, Li Zhenchun¹, Sun Yunsong¹, Li Chuang¹ and Gao Guochao¹. *OGP*, 2014, 49(1):107-112.

Near surface high resolution imaging in seismic data processing is attracting great attention. Reverse time migration (RTM) from two way wave equation is considered a good way to image the steep structure. However low frequency noise generated during the RTM imaging process is relatively high, which affects high resolution imaging of near surface. To challenge this problem, we propose in this paper a least square reverse time migration (LSRTM) method. Test results on a complex near surface velocity model indicate that LSRTM is much better than RTM for structure high resolution imaging and energy preservation.

Keywords: near surface, reverse time migration, steep structure, low frequency noise, least square reverse time migration

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True-amplitude imaging based on least-squares reverse time migration. Guo Zhenbo¹ and Li Zhenchun¹. *OGP*, 2014, 49(1):113-120.

Conventional reverse time migration (RTM) has disadvantages such as low frequency imaging, heavy noise, high requirements for acquisition, lack of compensating transmission losses and etc. In this paper, we propose a method for true-amplitude imaging based on least-squares reverse time migration. We treat the true-amplitude imaging as a linear inversion problem. Firstly, we derive the linearized wave propagation operator which is also called de-migration operator, and then we do some theoretical derivation on least-squares reverse time migration (LSRTM). Numerical tests on a multi-layer model and Marmousi model prove that LSRTM obtains true-amplitude imaging with higher imaging resolution than conventional reverse time migration, and the noise was also well suppressed.

Keywords: reverse time migration, true-amplitude, least-squares migration, linear inversion

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Numerical simulation with coupling Lebedev and standard staggered grid schemes for complex anisotropic media. Li Na¹, Li Zhenchun¹, Huang Jianping¹, Guo Zhenbo¹, Tian Kun¹ and Li Qingyang¹. *OGP*, 2014, 49(1):121-131.

This paper adopts the finite-difference (FD) forward modeling algorithm with coupled Lebedev and standard staggered grid schemes for complex anisotropic media, which means that the Lebedev grid is used only inside the media with lower symmetry (such as TI media with tilted symmetry axis, monoclinic anisotropy), while the standard staggered grid is used in other regions. This algorithm avoids the errors introduced by wavefield interpolation of standard staggered grid scheme and reduces the consuming on memory and computation of Lebedev scheme. On this basis, we present the high-order FD relations in the transitional region of the coupled scheme and a new method for interpolating variables. This high-order coupled scheme could efficiently control the reflection error and overall error produced by different types of wave incident to the coupling interface even with big space sampling interval. At the same time, it provides a geometric savings in memory and the computation time decreases as well, thereby simulating the peculiarities of the wavefield in heterogeneous anisotropic media with high efficiency and accuracy.

Keywords: coupling scheme, high-order finite-difference, anisotropy, Lebedev grid

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Characteristics of wave propagation in anisotropic two-phase media. Liu Xinxin¹, Yin Xingyao¹, Zhang Feng² and Zhang Xiuqi³. *OGP*, 2014, 49(1):132-142.

Fractured hydrocarbon reservoirs show anisotropic and two-phase characteristics. To reasonably describe the propagation of seismic waves in this kind of media, the equivalent anisotropic parameters are calculated based on rock physics theory; and then the anisotropic two-phase theoretical model is established combined with anisotropic BISQ theory. From the elastic wave propagation equations, the Christoffel equation of plane wave is derived. The wave-number equation for qP_1 , qP_2 , qSV and qSH waves in 3D totally anisotropic two-phase elastic media are obtained by solving this equation. Then the phase velocity and attenuation factors of these kinds of waves can be calculated.

Finally, for the two-phase media of elastic reservoir with anisotropy induced by horizontal fractures, the changes of wave phase velocities and attenuation factors with clay content, crack density and shape, porosity, water saturation, viscosity, permeability and different propagation azimuth are analyzed, which can provide theoretical support for the pore and fracture structure analysis and for the prediction of oil or gas-bearing reservoirs.

Keywords: rock physics, fractured media, two-phase media, anisotropy, phase velocity, attenuation

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Multi-axial convolution perfectly matched layer absorption boundary condition. Tian Kun¹, Huang Jianping¹, Li Zhenchun¹, Cao Xiaoli¹, Li Qingyang¹ and Lu Ping². *OGP*, 2014, 49(1):143-152.

The perfectly matched layer (PML) absorption boundary condition is widely used in numerical forward modeling of elastic wave equation since it has been proved to have a superior absorption performance than other absorption boundary condition method. But this PML absorption boundary condition also has some defects. For example, unsplit convolution perfectly matched layer (C-PML) absorption boundary is not stable in some media, and the split multi-axial perfectly matched layer (M-PML) absorption boundary is not efficient. Therefore we propose multi-axial convolution PML (MC-PML) based on the combination of C-PML and M-PML. The MC-PML can enhance the stability of C-PML as well as improve the absorption effect of M-PML. And the computational expense is lower because of the unsplit implementation method. Test results on a numerical forward modeling show that MC-PML obtains both higher stability and better absorption.

Keywords: PML, convolution perfectly matched layer (C-PML), multi-axial perfectly matched layer (M-PML), multi-axial convolution perfectly matched layer (MC-PML), absorption boundary condition, numerical modeling, stability, absorption effect

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Seismic wave simulation in attenuation medium based on FFD operator. He Binghong¹, Wu Guochen¹ and Xu Chong². *OGP*, 2014, 49(1):153-160.

We propose the FFD operator for seismic one-way wave propagation in attenuation medium to achieve seismic wavefield numeral simulation in attenuation medium by transformation between space-time domain and the wavenumber-frequency domain. Since the numeral simulation of offset data in wavefield downward is not efficient, we apply Green's function integral solution of scattered wave to improve the computation efficiency. Results of numerical simulation of seismic wave propagation in attenuation medium indicate that the FFD operator is more accurate than the SSF operator, especially for steep dip layers. As we know, when seismic wave travels through gas reservoir, reflection delays occur. In this paper, we prove the contribution of stratigraphic absorption to the delay through the simulation based on the models built by seismic and well data. At the same time, we provide the mechanism of low-frequency shadow phenomenon.

Keywords: FFD operator, stratigraphic absorption, reflection downshift, low-frequency shadow

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Seismic Q estimation with logarithmic spectrum equation root. Cao Siyuan^{1,2}, Tan Jia², Gao Ming², Yuan Dian¹, Yang Jinhao¹ and Zhang Haoran¹. *OGP*, 2014, 49(1):161-166.

Quality factor Q is an important parameter, one of characteristics of subsurface medium absorption of seismic wave. Q describes internal essential characteristics of the media, and is also an indication factor of oil and gas recognition. Therefore the accurate determination of seismic Q has certain significance to reservoir prediction. In general, it is stable to extract Q in the frequency domain, and the commonly used methods include spectral ratio and centroid frequency shift. Although the spectral ratio method has a higher theoretical precision, but it is vulnerable by the influence of SNR and has lack of stability. On the contrary, the centroid frequency shift method has higher robustness. But this method needs to do theoretical approximations, and it is difficult to do error analysis. So we present in this paper an inversion method based on statistical combination of

logarithmic spectrum to calculate Q according to natural logarithmic spectrum of the wavelet amplitude attenuation law in the strata. Based on this combination method of statistical properties, we propose logarithmic spectrum equation root method by integral for frequency. According to computations on model data, the combination of statistical properties has higher theoretical precision, and avoids the assumption of source spectrum using in the centroid frequency method; the logarithmic spectrum equation root method combines the advantages of the spectral ratio method and the centroid frequency method; and the accuracy and denoise are much higher than spectral ratio and centroid frequency.

Keywords: quality factor Q , combination of statistic, equation root, noise immunity

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Problems and countermeasures in seismic interpretation of beach bar sandstone reservoirs. Zhang Junhua¹, Liu Peijin¹, Zhu Bohua¹, Liu Xiantai², Yang Yong², Wang Jun² and Liu Lei². *OGP*, 2014, 49(1):167-175.

Beach bar sandstone reservoir belongs to a special class of low permeability and thin interbed reservoir. This kind of deeply buried reservoir shows low vertical resolution and fast lateral variation on seismic sections. So it is difficult to do fine interpretation with conventional methods. We analyze difficulties in seismic interpretation of beach bar sandstone reservoir, and put forward four countermeasures, i.e. HHT (Hilbert-Huang transform) extended frequency, three-parameter wavelet detection, energy half time attribute prediction, fusion display of ancient landform and seismic attributes. HHT extended frequency can extend the frequency of the targets and enhance weak signal energy of beach bar sandstone. The three-parameter wavelet can well describe the internal structure of beach bar sandstone. The energy half time attribute is the best seismic attribute to describe the entire beach bar sandstone reservoir. As a kind of attributes, the ancient landform information can be used in fusion display.

Keywords: beach bar sandstone, seismic attribute,

HHT (Hilbert-Huang transform), three-parameter wavelet, energy half time, attribute fusion

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Bayesian stochastic inversion constrained by seismic data. Zhang Fanchang¹, Xiao Zhangbo² and Yin Xingyao¹. *OGP*, 2014, 49(1):176-182.

Due to the band limitation of seismic data, conventional inversion method inevitably has the shortcomings of low resolution. In this paper, we present seismic-constrained stochastic inversion based on Bayesian theory and geological statistics. This method uses well-logging information as a condition data and is constrained by seismic data. Then it integrates information from seismic, well logs, and geostatistics into a posterior probability density function of subsurface models. The perturbed simulation based on Markov chain is used to effectively sample the posterior distribution function, and the subsurface model characteristics can be inferred by analyzing a set of the posterior samples. Test results on model and real data show that this method improves the inversion precision and is very helpful for reservoir fine description.

Keywords: Bayesian theory, Markov chain, perturbed simulation, stochastic inversion

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Bayesian facies identification based on Markov-chain prior model. Wang Fangfang^{1,2}, Li Jingye^{1,2} and Chen Xiaohong^{1,2}. *OGP*, 2014, 49(1):183-189.

According to Bayesian classification theory, we propose in this paper a workflow for facies identification based on Markov-chain prior model. First we choose the key well logs and define different facies based on the log data and core data. Then we extend log data as training data through rock physics modeling, synthesize seismic attributes, and estimate facies-dependent conditional probability density function. After that, we up-scale seismic attributes by Backus average model. Finally we obtain posterior probability density functions by Bayesian classification on the basis of a Markov-chain prior model, and obtain the solution of the maximum posterior probability. We have tested this method on model data and marine seismic data with entropy and Bayesian confusion

matrix. Test results prove that this method provides very good facies prediction.

Keywords: facies identification, Bayesian classification, Markov-chain, entropy, confusion matrix

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Seismic data edge detection using multichannel local complex-valued correlation. Wang Jingbo^{1,2}, Wang Shangxu^{1,2}, Yuan Sanyi^{1,2} and Xiao Mengxiang^{1,2}. *OGP*, 2014, 49(1):190-196.

The edge detection of seismic data is an effective technique to identify the feature and edge of seismic stratigraphy. Currently, it is mainly performed with coherence algorithm. Different from the conventional coherent algorithms based on real-valued signals, the first step of local complex-valued correlation is to transform a real trace into a normalized complex trace, and then the complex-valued correlation of two adjacent ones at zero lag is performed in a sliding time window. The calculation is simple without the semblance scanning, dip scanning or iteration solution which is necessary for conventional coherence algorithms. The local complex-valued correlation can provide both correlation coefficient attributes used for coherence analysis and phase shift attributes related to the apparent dip, which leads to identify the seismic-geology edge more effectively. And the comparison analysis of correlation coefficient attributes and phase shift attributes can improve the accuracy of seismic edge detection. Furthermore, since the edge anomalies shown by correlation coefficient attributes are not highlighted and the anti-noise ability is weak for local complex-valued correlation using single channel, we proposed an improved multi-channel technique called multi-channel complex-valued correlation to enhance the ability of detecting seismic edge anomalies and anti-noise property. And the proposed multi-channel technique is applied to 3D seismic data as an extension. Test results on synthetic data and field data show the validity of the proposed method.

Keywords: local complex-valued correlation, multi-channel, seismic data, edge detection, correlation coefficient attributes, phase shift attributes

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Oil-gas prediction with multi-attributes fusion based on fuzzy logic. Li Fang^{1,2}, Wang Shoudong^{1,2}, Chen Xiaohong^{1,2}, Liu Guochang^{1,2} and Zheng Qiang³. *OGP*, 2014, 49(1): 197-204.

There is no strictly corresponding relationship between seismic attributes and reservoir parameters, which inevitably gives rise to uncertainty of reservoir characterization when only a single attribute is used. During the process of reservoir prediction, there is no distinctive boundary between whether single or integral attributes are capable of indicating oil and gas or not because of ambiguity. Therefore we propose in this paper a multi-attributes fusion method based on fuzzy logic. We apply fuzzy theory to attributes fusion, quantify the fuzzy problem with the help of membership function, calculate weight factor through fuzzy nearness matrix, and eventually obtain a quantitative comprehensive result. During the process of fusion, the calculation of weight factor of each attribute is completely data driven which could reduce the subjectivity. This method has been tested on synthetic and real data in order to prove its feasibility and effectiveness. Results of the tests demonstrate that the fusion results match very well with well data. Consequently, the proposed multi-attributes fusion method based on fuzzy logic used for oil and gas prediction is effective and available.

Keywords: oil-gas prediction, attribute fusion, fuzzy logic, membership function, fuzzy nearness

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Automatic matching of seismic and logging data. Luo Weiping¹, Li Hongqi¹, Zhu Liping¹, Qiao Yuedong², Shi Ning¹ and Yu Fei¹. *OGP*, 2014, 49(1): 205-212.

We propose in the paper an automatic matching method of seismic and logging data in viscoelastic media for high accuracy time-depth curve in seismic calibration with logging data. In the view of the differences between logging and seismic observations, we analyze factors which affect matching synthetic seismogram and near-well seismic traces, and propose a method for automatically matching seismic and logging data in viscoelastic

media. It includes the process of rough frequency matching, as well as fine frequency matching between them. This method can obtain precise phase velocity of seismic wave. Applications of the method in Kenly area, Shengli Oilfield prove its validity with good results.

Keywords: velocity dispersion correction, rough matching, subtle matching, resonance Q model

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Application of the cross-hole electromagnetic method (CHEM) in hydrocarbon reservoir monitoring. Shen Jinsong^{1,2,3}, Wang Zhigang⁴, Ma Chao¹, Wang Ningsheng⁵ and Jia Yaozhong⁵. *OGP*, 2014, 49(1): 213-224.

Developed in recent years, the cross-hole electromagnetic method (CHEM) is one of the new technologies applied to hydrocarbon reservoir evaluation and monitoring. It can directly provide information of resistivity distribution of an inter-well area, and therefore it can provide fluid distribution mapping at the inter-well scale. It can be used for identifying bypassed hydrocarbon resulted from the heterogeneity, monitoring the macroscopic sweep efficiency, planning optimum infill drilling and improving effectiveness of reservoir simulation. Based on the analysis of the publications related to the cross-hole electromagnetic method, we review in this paper its fundamental principle, development history, the techniques of data acquisition, processing and interpretation. We also discuss the challenges in the present applications and the development trend in the future.

Keywords: cross-hole electromagnetic method (CHEM), numerical simulation of EM response, data acquisition planning, processing and interpretation, hydrocarbon reservoir monitoring

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