ABSTRACTS

Infill shot point design for improving illumination uniformity of targets. Qin Long[1], Yin Cheng[1], Liu Wei[1], Zhao Hu[1], Li Zhong[2] and Shuai Pengyu[3]. OGP, 2016,51(4):639-646.

Many near surface scattering sources in piedmont fault zones, Western China cause low S/N seismic data and non-uniform reflection energy on target interfaces. So we propose a solution of infill shot point design for target illumination uniformity improvement. First we simulate seismic illumination of a regular geometry with two-way wave equation. Then, we simulate seismic shooting at shadow areas of target illumination. When first breaks arrive at the surface, we calculate the surface propagation direction with Poynting vector and the surface illumination energy. The main beam direction of source is determined by direction statistics. And infill source locations are determined by energy statistics. Models test show that our proposed method can greatly improve illumination energy of the shadow zones and target illumination uniformity, which may be very helpful for acquisition geometry optimization in complex subsurface areas.

Key words: source array, directional illumination, Poynting vector, infill shot point, wave equation

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Wide line seismic acquisition with over/under sources in the central uplift of South Yellow Sea Basin. Xiong Zhong[1], Gao Shunli[1], Zhang Minqiang[1], Xu Fa[1], Zhou Feng[1] and Hou Kaiwen[1]. OGP, 2016, 51(4):647-653.

It is believed that Mesozoic-Paleozoic marine sedimentary strata in the central uplift region of the South Yellow Sea Basin is extremely thick, and it bears enormous hydrocarbon potential. There are some disadvantageous factors about seismic geology conditions, such as strong shielding layers in shallow part, intense multiples, and intricate geological structures. We adopt a new seismic acquisition approach integrating wide line acquisition with over/under sources. To enhance the penetrability of artificial seismic wave field and broaden seismic frequency band, huge volume over/under sources with low frequency are applied. Dual-streamer wide line seismic geometry is used to increase folds and suppress various noise. Our seismic data acquisited with the proposed approach shows that both data S/N and seismic imaging are obviously improved, which contains much more imformation of Mesozoic-Paleozoic strata in South Yellow Sea.

Key words: South Yellow Sea, central uplift, Mesozoic-Paleozoic, over/under source, wide line acquisition, signal-to-noise ratio (S/N)

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A NMO stretch correction based on an amplitude-preserved matched filtering. Luo Xin[1,2], Chen Xuehua[1,2], Qi Yingkai[1,2], Song Lijuan[3] and Zhou Yuanmao[1,2]. OGP, 2016,51(4):654-660.

NMO correction is an important step in seismic data processing. However, conventional NMO correction leads to seismic wavelet stretch, especially for shallow far-offset seismic data in which wavelet shifts to lower frequency and amplitude gets larger. This NMO stretch damages seismic data resolution and affects AVO analysis. We propose in this paper an approach to NMO stretch correction based on an amplitude-preserved matched filtering algorithm. The proposed approach can enhance seismic event continuity, eliminate frequency shifts, and improve data resolution. Furthermore, it can preserve inherent amplitude variation in original data. This approach is suitable for any offset seismic data without knowing its wavelet.

Key words: matched filtering, NMO stretch correction, amplitude preservation, AVO analysis

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Source point deviation correction based on particle swarm optimization. Zhu Haiwei[1], Duan Wenchao[1], Cao Yongsheng[1] and Chen Jinhuan[1]. OGP, 2016, 51(4):661-664.

For seismic data acquisition in the field, source points deviate sometimes from their designed locations. In these conditions, the subsequent seismic data processing will be affected. To solve the problem, we propose to use the particle swarm optimization to correct source point devia-

tion in given the condition that the near surface velocity is constant. First, we calculate near surface velocity. And then we set up objective functions based on observed first arrivals and calculated first arrivals. Finally source point locations are obtained by objective function calculation with the particle swarm optimization. Compared with the grid searching method, the particle swarm optimization improves the computation efficiency while the calculation accuracy remains the same. The proposed method provides a reliable and high efficient way for quality control for seismic data acquisition.

Key words: source points deviation, particle swarm optimization, grid searching method, computing efficiency, quality control

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Multiple attenuation with anisotropic high-resolution Radon transform. Fan Jingwen[1], Li Zhenchun[1], Song Xiangyu[2], Zhang Kai[1] and Zhou Lihua[3]. OGP, 2016, 51(4): 665-669.

For VTI media, large offset reflection events in marine seismic cannot meet hyperbolic time distance relationship, and primary wave and multiple wave energy cannot well focus in the Radon domain, which leads poor multiple attenuation. We propose an approach to solve this problem. First we introduce the anisotropic parameters into the time distance relationship when we describe VTI medium and marine large offset seismic time-distance curve relationship, so that the primary wave and multiple wave energy can focus well in the Radon domain. Then based on L1 norm sparse constraint in the model space, we introduce anisotropic high-resolution Radon transform based on conjugate guided gradient (CGG) algorithm to improve the Radon transform resolution. Tests on model and real data show that the proposed approach can effectively attenuate multiples.

Key words: anisotropy, Radon transform, high resolution, multiple attenuation

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Seismic data resolution improvement based on mixed phase deconvolution with morphological filtering. Zhang Xiaolei[1], Wang Runqiu[2], Deng Xiaojuan[1], Liu Fang[3] and Xiong Zhuang[4]. OGP, 2016, 51(4): 670-676.

To solve the problems such as seismic low resolution and weak signals in middle-deep stratigraphic reservoirs, the article proposes a joint-application approach, a mixed phase deconvolution in connection with morphological filtering to improve data resolution and S/N. The article firstly discusses algorithm principle of the mixed phase deconvolution in connection with morphological filtering. Then multi-scale morphological filtering decomposes seismic data, S/N of various scales is analyzed to determine reconstruction coefficients, and multi-scale seismic data is reconstructed, and so seismic data noise is suppressed. Finally, the mixed phase deconvolution is used to process reconstructed seismic data. Some model data tests verified the feasibility of the proposed approach. Applications in the western front belt of Jilin Oilfield show that the proposed approach can not only improve data resolution in the shallow and deep layers, but also data S/N in deep parts, which may be beneficial to interbed prediction.

Key words: mixed phase deconvolution, morphological filtering, joint processing, high resolution, signal to noise ratio (S/N)

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Well-to-seismic integration to improve resolution based on ARX model. Xia Zhenhua[1,2,3], Gui Zhixian[2,3], Hu Ruiqing[2,3] and Li Yiqing[4]. OGP, 2016, 51(4): 677-684.

In this paper we discuss the system identification based on ARX model for seismic resolution improvement. Supposing seismic wave attenuation in formations is linear system, seismic data and logging data are respectively input and output, the reverse absorption system response can be evaluated based on ARX model. And then it can be used to recover attenuated high frequency component and improve seismic vertical resolution. Test results on model and real seismic data show that the proposed approach can significantly improve seismic vertical resolution and broaden its bandwidth about 15 Hz while the main features of the original seismic data remain the same.

Key words: ARX model, system identification, well-to-seismic integration, resolution, frequency expanding

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Seismic signal fractional local power spectrum estimation. Zheng Jia[1], Peng Zhenming[1], Wang Yuqing[1], Tian Lin[1], He Yanmin[1] and Li Yiqing[2]. OGP, 2016, 51(4): 685-690.

We propose in this paper a new method of fractional local power spectrum estimation by combining power spectrum estimation and fractional Fourier transform (FrFT). First, the maximum kurtosis in the fractional domain is found out to determine the optimal order for fractional power spectrum. Then the fractional 2-D distribution of fractional power spectrum in the optimal order is calculated. The time-frequency 2-D distribution of fractional power spectrum can be obtained with the rotation of fractional Fourier transform. Similarly, auto-regressive (AR) spectrum estimation can be used to calculate the time-frequency 2-D distribution of fractional power spectrum. The time-frequency properties obtained by these two methods are superior to that of the classic spectrogram. Tests on theoretical model and seismic signals show that the proposed method is efficient.

Key words: fractional Fourier transform (FrFT), power spectrum, seismic signal

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P-SV wave common receiver point stack algorithm with P-wave structure control. Tong Kailin[1], Li Rui[1] and Tang Jianming[2]. OGP, 2016, 51(4): 691-697.

In converted waves common receiver point (CRP) stack processing, conventional stack algorithms of P-wave structure control lead a few problems such as "unmatched structural horizons on P- and S-waves stacked sections", "inaccurate calculation of structural corrections of P-SV wave data", "converged local extremum", and "zero space" drift, especially in complex areas with low signal-to-noise ratio data. We analyzed in this paper the theoretical principle of these conventional algorithms and propose solutions to improving matched quality of P- and S-wave stack, and suppressing the "zero space". First structural horizons on P-wave CRP stack sections are used to match and control structural horizons on P-SV wave CRP stack sections. So structural horizons between P-wave CMP stack sections and P-SV wave ACCP stack sections are matched, and accurate structural corrections and v_P/v_S can be calculated. Absolute static corrections between CRP stack traces and flatted horizons of P-SV wave are estimated to overcome "zero space" drift. Applications to P-SV wave data indicate that this proposed approach can enhance residual static corrections of conventional CRP stack algorithms with P-wave structure control.

Key words: common reflection point (CRP) stack algorithms, residual static correction, v_P/v_S, "zero space" drift

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Numerical simulation of Lebedev grid for viscoelastic media with irregular free-surface. Yang Yu[1,2], Huang Jianping[3], Lei Jianshe[1], Li Zhenchun[3], Tian Kun[4] and Li Qingyang[3]. OGP, 2016, 51(4): 698-706.

Based on previous research, this paper adopts a Lebedev grid (LG) for viscoelastic media as a new kind of staggered grid scheme for finite-difference modeling. Compared to Virieux's standard staggered grid (SSG), this scheme can avoid numerical dispersion from the interpolate wavefield when dealing with equations in the curvilinear coordinates. First of all, we deduce viscoelastic media wave equations based on the generalized standard linear solid (GSLS) under the curved coordinate system. And in the process of implementation, Lebedev grid in anisotropy media is used to discretize the equations. The traction image method is used to implement free-surface conditions. And for other boundaries multi-axial convolution perfectly matched layer (MC-PML) technique is chosen to absorb waves. Based on numerical tests on synthetic data, influence of both viscosity and topography on wavefield is showed, and the MC-PML in this study is stable and can effectively absorb artificial boundary reflections. Test results show that the absorption in viscoelastic media reduces seismic energy and decreases the dominant frequency, and at the same time the velocity dispersion produces traveltime difference and waveform change.

Key words: viscoelastic media, Lebedev grid, irregular free-surface, multi-axial convolution perfectly matched layer (MC-PML), grid generation

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A novel time-domain viscoacoustic wave equation and its numerical simulation. Luo Wenshan[1,2], Chen Hanming[3], Wang Chengxiang[2], Zhou Hui[3] and Wang Shihu[2]. OGP, 2016,51(4):707-713.

We develop a fractional Laplacian viscoacoustic wave equation based on the dispersion relation of the constant-*Q* model, and formulate the wave equation into the first-order velocity-pressure system. Compared with the existing velocity-pressure-strain formulation, our formulation is more compact, and saves memory storage after discretization. The staggered-grid pseudo-spectral (SGPS) method is adopted to numerically solve our viscoacoustic wave equation. The convolutional perfectly matched layer (CPML) is applied to suppress artificial edge reflections in numerical simulation. Test results demonstrate that numerical simulation of our viscoacoustic wave can correctly describe seismic wave attenuation and dispersion. The SGPS approach combined with the CPML is verified to be an efficient numerical simulation scheme.

Key words: time domain, viscoacoustic wave equation, pseudo-spectral method, convolutional perfectly matched layer (CPML)

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Analysis of stochastic velocity field modeling uncertainty for variable-velocity mapping. Yue Youxi[1], Liu Chenxi[1], Wen Xue[2] and Zhang Xian[1]. OGP, 2016,51(4):714-720.

Deterministic methods used in velocity modeling and variable-velocity mapping cannot be used to characterize uncertainty of depth structure maps, and the reliability of these methods cannot be directly evaluated. Therefore, a stochastic velocity modeling method based on the theory of stochastic simulation is put forward to analyze probability field simulation and sequential Gauss simulation. Statistical analysis on the uncertainty of multiple realizations obtained by stochastic simulation is carried out. Application tests show that there is no velocity difference at conditional data points in the space, and velocity at non-conditional data points is uncertain. Velocity field uncertainty obtained by sequential Gauss simulation is smaller than that obtained by probability field simulation.

Key words: variable-velocity mapping, stochastic modeling, uncertainty analysis, probability field simulation, sequential Gaussian simulation

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Time-domain full waveform inversion based on least square filter. Bai Lu[1], Han Liguo[1], Zhang Pan[1] and Hu Yong[1]. OGP, 2016,51(4):721-729.

Conventional full waveform inversion often suffers from cycle skipping. In order to solve this problem, we propose a time-domain full waveform inversion based on least square filter. First we apply the least square filter in the preprocessing stage for full waveform inversion and construct a new objective function to make the inversion process toward global minimum point. This approach effectively avoids the problem so that the inversion process gets into local minima. Experimental results show that this full waveform inversion based on least square filter can better reconstruct velocity model, especially for deep layers and large offsets. The new objective function can stably descent and greatly reduces the possibility of suffering from cycle skipping.

Key words: full waveform inversion (FWI), least square filter, objective function, matrix fast forward modeling, steepest descent method, conjugate gradient method

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Acoustic full waveform inversion in the frequency domain based on fast conjugate gradient method. Zhang Guangzhi[1,2], Sun Changlu[3], Pan Xinpeng[1], Chen Hongliang[4], Jiang Lanjie[1] and Wen Tiemin[5]. OGP, 2016,51(4):730-737.

Hessian matrix in the full waveform inversion is huge and the convergence of the gradient method is slow. To solve the problem, we propose in this paper a new algorithm, fast conjugate gradient (FCG) method. The method introduces a new variable to transform the conjugate gradient method, which accelerates the convergence and makes convergence more stable. The method needs little more calculation of multiplication. The proposed method is applied to the acoustic full waveform inversion in the frequency domain and it is also tested in the simple depression model and the thinning complex Marmousi model. The tests show that the proposed method can accelerate convergence while the resolution of deep layer is better.

Key words: fast conjugate gradient (FCG), frequency domain, full waveform inversion

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Regularized least-squares reverse time migration with prior model. Li Zhenchun[1], Li Chuang[1], Huang Jianping[1] and Wang Rongrong[2]. OGP, 2016, 51(4): 738-744.

Least-squares reverse time migration (LSRTM) converges slowly, and sometimes drops into local extremum because of the ill-posedness of the inversion problem. On the other hand, the influence of irregular geometry and the absorption of underground layers result in some blank areas of illumination, in which the structures cannot be imaged by LSRTM. To solve these problems, the paper presents the theory of regularized least-squares reverse time migration (RLSRTM) with prior model. The prior model is constructed from logging data and incorporated into LSRTM as the regularization constraint. And dynamic regularization parameters and preconditioned regularization-term gradients are proposed to ensure better constraint. Based on numerical tests on a sparse Marmousi model, the following observation are obtained: ①LSRTM can suppress the migration artifacts and compensate energy in deep part compared with reverse time migration (RTM), but the compensation to uneven illumination is limited and the structures in blank illumination areas cannot be imaged; ②RLSRTM with preconditioned regularization-term gradient can further compensate energy of structures with poor illumination, produce more clear images of the boundary of anticlines and other layers in deep part, and even recover some information in blank illumination areas; ③RLSRTM without preconditioned regularization-term gradient produces images with some blurry boundaries and false structures. Therefore, RLSRTM with preconditioned regularization-term gradient can accelerate the convergence, improve the resolution and amplitude preservation of the images, ensure the stability of the inversion, and has reduced sensitivity to low signal-to-noise ratio shot data compared with LSRTM and RLSRTM without preconditioned regularization-term gradient.

Key words: least-squares reverse time migration, illumination, prior model, constraint, regularization

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A prestack depth migration method for walkaway VSP data. Wang Xin[1], Yin Xingyao[1] and Yang Jidong[1]. OGP, 2016, 51(4): 745-750.

From Helmholtz wave equation, we derive in this paper the Fourier finite difference operator of prestack depth migration for walkaway VSP data and built a corresponding processing flow. Both numerical model tests and real data processing results show that the proposed prestack depth migration method for walkaway VSP data is suitable not only for strong lateral velocity variation, but also can accurately image complex steep-dip structures.

Key words: Walkaway VSP, Fourier finite difference operator, prestack depth migration

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3D refraction traveltime inversion in common-receiver-bins. Jin Changkun[1,2] and Zhang Jianzhong[1,2,3]. OGP, 2016, 51(4): 751-759.

In this paper, an approach to 3D refraction traveltime inversion is proposed. First, work area is divided into common-receiver-bins (CRBs), and velocity of high-velocity layer for all bins is assumed to be constant. Velocity of the high-velocity layer for every CRB is calculated on instantaneous slopes of refraction time-distance curves. Then common azimuth gathers (CAG) are extracted from refraction data for a CRB based on traveltimes and offsets, and they are transformed into coordinate data based on their arithmetic mean values. After that, coordinate data in a CRB are fitted by least-square straight line and instantaneous slope of refraction time-distance curves is obtained. The reciprocal of this instantaneous slope is taken as velocity of high-velocity layer. After velocity for all CRBs is estimated, delay times for all source-receiver pairs can be calculated from refraction traveltime equations, which form a large linear equation. Finally delay times for each source and receiver are estimated by solving the equation set with smoothness constraint LSQR algorithm. Field data applications show that the proposed approach calculates accurately long-wavelength static corrections for 3D seismic data from a foothill belt in Xinjiang, West China.

Key words: refraction traveltime, common-receiver bin, common-azimuth gather, statics

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Seismic multi-scale inversion in the frequency domain based on smooth model constraint. Li Kun[1,2], Yin Xingyao[1,2] and Zong Zhaoyun[1,2]. OGP, 2016, 51(4):760-768.

Using partial frequency components of band-limited seismic data, an inversion in the frequency domain yields stratigraphic impedance information. In view of high resolution in the frequency domain inversion and band-limited characteristics of seismic signals, we consider jointly the frequency domain inversion theory and Bayesian framework, and propose a robust seismic multi-scale inversion method with smooth model constraint in the frequency domain. With smooth model constraint, this method not only enhances low frequency compensation, but also improves noise removal and lateral continuity of the inversion. Since decoupling different frequency component decoupling of seismic gathers can be realized in the frequency domain, successive iterations of different frequency components can obtain the optimal solution of the inverse problem. Tests on stationary, non-stationary models, and seismic data demonstrate the feasibility and stability of our proposed method.

Key words: inversion in the frequency domain, smooth model constraint, low-frequency compensation, multi-scale inversion, high resolution

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Seismic resolution improvement with bilateral matching pursuit. Liu Lanfeng[1], Wang Lu[2] and Li Lihua[3]. OGP, 2016, 51(4):769-773.

Based on conventional matching pursuit in the time domain, we put forward a matching pursuit in the time-frequency domain. Same as forward and inverse transform in signal processing, bilateral matching pursuit is implemented. In the time-frequency domain, an approach to seismic resolution improvement is achieved with this bilateral matching based on the theoretic framework of Gabor deconvolution. The approach workflow is shown as follows: First, seismic traces are decomposed into a series of wavelets using forward matching pursuit, and the time-frequency spectrum is obtained by wavelet spectrum accumulation; then, approximate reflection coefficient spectrum is calculated by the time-frequency spectrum smoothing; finally, the time-frequency spectrum is processed by inverse matching pursuit to get high-resolution wavelets and synthesis trace. Real seismic data applications show that the proposed approach extends seismic relative bandwidth and improves resolution.

Key words: matching pursuit, deconvolution, relative bandwidth, resolution

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An approach to seismic attributes fusion and reduction based on rough polarization sparse matrix. Liu Taoping[1], Liu Hongjie[2], Lou bing[2] and Gao xinfeng[2]. OGP, 2016, 51(4):774-781.

In the oil seismic exploration, seismic attributes are mainly adopted for oil and gas prediction. However, too many seismic attributes involved may not lead to a better prediction, and they may lower prediction accuracy instead. Therefore the selection of seismic attributes shall be optimized in accordance with the prediction object. As a result, research on seismic attributes reduction approaches has become a significant part. With the basis of the rough set theory and the polarization matrix, we propose an approach to seismic multi-attribute fusion in this paper. All the seismic attribute reductions are obtained by sparse polarization matrix combination. The feasibility of the proposed approach is further testified in the theory. It is a simple and easy way to access. Simulation tests and practical applications manifest that the proposed approach can not only decrease multiplicity and improve oil and gas prediction accuracy, but also improve prediction efficiency in practice.

Key words: rough set, polarization matrix, seismic attributes fusion, attribute reduction, oil and gas prediction

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Tight sandstone reservoir identification based on isochronal phase-controlled inversion. Chen Meiyi[1], Qin Yueshuang[2], Wang Jianmin[3], Chen Shoutian[3] and Fang Shi[4]. OGP, 2016, 51(4):782-791.

5 mid-term and 16 short-term cycles are recognized from Fuyu oil beds in the study area, and a high-frequency isochronal stratigraphic framework

and well-to-seismic framework are also built by horizon calibration and sub-bed correlation. On this basis, this paper analyzes log facies mode and sedimentary facies of each short-term cycle under the high-frequency isochronal stratigraphic framework in the area. It can be assumed that the sedimentary facies belongs to a river type between classical meandering rivers and anastomosing rivers. Then a phase-controlled sand shale model is also built under the high-frequency isochronal stratigraphic framework. A phase-controlled inversion on model-constrained prestack seismic data is carried out and reservoirs are predicted on results of phase-controlled prestack inversions. Tight sandstone reservoir seismic identification based on isochronal phase-controlled inversions is formed, which is very helpful for superposed sand body prediction in the area. Inversion sections show clear sandstone with the thickness more than 2m in posterior wells and sandstone responses with the thickness between 1～2m.

Key words: tight sandstone reservoir, seismic identification, isochronal phase-controlled inversion, superposed sand body, high resolution sequence framework

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Geophysical prediction of stress and stress desserts in unconventional reservoirs: an example in Bonan area. Liu Jianwei[1,2], Zhang Yunyin[1], Zeng Lianbo[2], Gao Qiuju[1] and Geng Xue[1]. OGP, 2016, 51(4): 792-800.

Unconventional reservoirs are very developed in Es3 of Bonan area, so geostress and stress dessert prediction is a key for the exploration and evaluation of this kind of reservoirs. We propose an ideal in this paper, which is combined with the previous research results to predict stress and stress desserts. The relationship can be established among rock-physical information from well logging data, stress data and seismic data through the analysis of rock mechanics parameters. Stress and Stress desserts can be predicted by inversion and multi-data calculation. Our researches show that the central and southern parts in Bonan are advantage areas for oil and gas accumulation. Type I and type II stress desserts are the main development zones of the mud-fractures, and they have the capacity of shale oil production. The proposed method has been verified by measured stress data and drilling results for unconventional oil reservoir exploration.

Key words: geostress, stress dessert, rock physical parameters, geophysical prediction, Bonan sag

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Conventional well logging data filtering with wavelet transformation and Hilbert-Huang transformation. Zhao Junlong[1] and Liu Jianjian[1]. OGP, 2016, 51(4): 801-808.

To make clear effect differences among wavelet transform (WT), wavelet package transform (WPT), and Hilbert-Huang transform (HHT) on logging data, we review fundamental idea and approach feature of WT filters, WPT filters, and HHT filters based on published documents. First gamma ray logging data with noise whose intensity is 10 times to Gauss white noise is filtered by WT filters, WPT filters, HHT reducing filters, and HHT-WT associating filters. Then HHT three dimensions spectrum characteristics, root-mean-square (rms) error, signal to noise ratio (S/N), and similar degree (SD) are analyzed on this filtered GR data. Finally the relation between filtering effect and noise intensity is studied. The following observations are found out based on our work: A. There is some difference of rms error, S/N, SD and HHT 3D spectrum features with the four filters; B. Filtering effects will be decreasing when noise intensity is high, filtering effect is similar when noise intensity is between 5 times and 17 times to Gauss white noise; C. WT filters should be the first choice when the noise intensity is relatively weak or strong; D. HHT-WT filters is better than HHT reducing filters.

Key words: wavelet transform (WT), Hilbert-Huang transform (HHT), conventional well logging data, filtering effect

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Forward and inverse modeling of the magnetotelluric field in 2D anisotropic media with an adaptive finite element method. Huang Yifan[1], Hu Xiangyun[1] and Han Bo[2]. OGP, 2016, 51(4): 809-820.

Electrical anisotropy, which widely exists in the crust and upper mantle, has shown great influence on the observation of the electromagnetic field in earth. This electrical anisotropy will affect on magnetotellurics sounding (MT), an electromagnetic geophysical method for inferring the earth subsurface electrical resistivity from measurements of natural geomagnetic and geoelectric field variation at the earth surface. We propose in the paper forward and inverse modeling of magnetotelluric

fields in 2D anisotropic media. MT governing equations of electromagnetic field in 2D medium with tri-axial anisotropy are derived, and solved with an adaptive finite element method based on unstructured grids. The unstructured triangle grids can easily simulate general models with not only bathymetry and topography, but also large-range scales and complex structures. The anisotropic inversion strategy employs the classical model space Occam method, so that the model searching is very stable and the reasonable inversion results can be achieved with a few iteration steps. This proposed method is tested on two models, a four-layer 1D model and a 2D anisotropic block model, which are respectively compared with the standard quasi-analytic solution and the standard finite difference solution. A complex 2D anisotropic seafloor model with bathymetry is also designed to test the inversion method. All the test results demonstrate the validity of the proposed algorithms.

Key words: magnetotelluric, 2D inversion, electrical anisotropy, adaptive finite element

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Transient electromagnetic response analysis for anisotropic media in shallow water. Zhou Jianmei[1], Li Xiu[1] and Qi Zhipeng[1]. OGP, 2016,51(4):821-830.

Transient electromagnetic (TEM) method in shallow water has drawn more and more attention in recent years, since it can identify thin resistive reservoirs in shallow water, and separate ocean bottom response from airwave. In this paper, we discuss TEM response in anisotropy layered media in shallow water. First, electromagnetic response in the frequency domain is obtained with TM and TE wave decomposition based on transmission line theory and dyadic Green function theory. Then using the sine and cosine digital filtering algorithm, we obtain the TEM response in anisotropic layered media in shallow water, and compare our results with open source code Dipole1D to verify the accuracy of the proposed algorithm. The following observations are obtained based on numerical tests results: ①TEM response in shallow water is predominantly sensitive to vertical resistivity, not to horizontal resistivity when they are thin and high-resistive reservoirs; TEM response is sensitive to both horizontal and vertical resistivity of overburden on top of reservoirs. ②In shallow water, impulse response curve can separate airwave response from stratum response; step response curves show some anomalies, but cannot separate airwave response from stratum response; in the middle-deep water, airwave and stratum responses are mixed, only some anomalies are showed in impulse and step responses. ③TEM response is sensitive to the thickness of overburdens and reservoirs; with the thickness increase, the anomaly response decreases, but a smaller reservoir thickness can still has anomaly. ④When distance between a reservoir and the basement is small, the basement will significantly reduce the anomaly response from reservoirs; when the distance is more than 1000m, the impact of the basement maybe ignored, because the basement will cause very little change of the anomaly.

Key words: marine controlled-source electromagnetic, transient electromagnetic method, anisotropic, Green function, digital filtering algorithm

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Backsliding structures in hanging walls of listric normal faults in Dongpu sag and their significance of hydrocarbon. Chen Shuping[1,2], Ji Hongying[1,2] and Li Wei[1,2]. OGP, 2016,51(4):831-840.

Structures formed by the overburden movement toward a master listric normal fault along a weak layer in the hanging wall are called backsliding structures. Backsliding structures were important deformation in the Dongpu sag. Based on seismic data interpretation, the characteristics of backsliding structures in the Dongpu sag, their role in trap formation, and their formation mechanisms are addressed. The backsliding structures occurred along the eastern limb of the central rise of the sag. The backsliding directions were either to the southeast or northwest depending on both the dip of master faults and the various detachment layers. Three types of backsliding were identified, including a single backsliding along one detachment, multi-layer backsliding along multi-level detachments, and an allying backsliding composed of two anti-directional backsliding. Backsliding occurred during Oligocene times. The detachment layers for the backslidings were the Carboniferous-Permian coal layers, the lower Eocene shale, and upper Eocene salt. Their low shear strength along with the overpressure caused by under-compaction and hydrocarbon generation enabled them to act as detachments. Backsliding structures formed potential hydrocarbon traps in the Dongpu sag.

Key words: rift sag, listric fault, backsliding structure, mechanism, trap

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