ABSTRACTS

Wide frequency and wide azimuth 3D seismic acquisition in TJ area, Northeast Sichuan Basin. PAN Jiazhi[1], LIU Bin[1], HE Jingguo[1], LU Xiangpeng[1], and ZHANG Zaiwu[1]. Oil Geophysical Prospecting, 2020, 55(Supplement): 1-8.

The TJ area in the Northeast Sichuan Basin is rich in oil and gas resources, but the seismic and geological conditions are complex. The primary understand target has developed small fractures, making the fractured-porous reservoir very anisotropic. The near-surface interval is loose sandstone, so the seismic frequency band is narrow. The dense vegetation causes strong high-frequency noises. The matured "2W1H" seismic exploration technology (wide frequency and wide azimuth, high density) is used to design the recor-ding system to improve the image of the reservoir with small fractures and strong anisotropy. Finally, the comprehensive surface survey and shooting factor design technology is developed for loose sandstone, which can quantitatively analyze small array parameters for suppressing high-frequency noises. By expanding the effective bandwidth, the imaging effect of the seismic section is improved.

Keywords: mountains in Northeast Sichuan Basin, wide frequency and wide azimuth, loose sandstone, small array

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Research and application of real-time QC on marine towed cable acquisition. WANG Zengbo[1], HUANG Shaoqing[1], SHANG Minqiang[1], CHEN Jihong[1], ZHAO Jian[1], and SUN Xiaoping[1]. Oil Geophysical Prospecting, 2020, 55(Supplement): 9-14.

On-site QC is a necessary means to ensure the quality of marine towed cable seismic acquisition and improve production efficiency. Through timely acquisition of the status information of each system recorded in SEG-D or SEG-Y files, and displaying it in a flexible and intuitive way, the acquisition status and data quality can be monitored in real time. At the same time, in order to adapt to the characteristics of large amount of data and continuous marine towed cable seismic acquisition, the working status of the equipment such as cable and gun array is automatically monitored in real time, and various data are displayed in real time, including single shot record, near-trace section, stacked shot gather, stacked common cable data, near-field geophone, TB signal and RMS amplitude, to ensure the quality of seismic data and reduce costs. The practical application shows that this method can effectively monitor the air leakage, self excitation and pressure change of air gun, the noise development of cable, the quality of recorded seismic signals, and the abnormalities of seismic amplitude and frequency. Problems can be found in real time and solved quickly. This saves the working time of the fleet and improves the construction efficiency.

Keywords: marine towed cable, SEG-D, SEG-Y, real-time monitoring, CMP stacked section

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The quality control of navigation and positioning in OBN seismic exploration. LIU Dangwei[1], CAO Shuwei[2], QUAN Haiyan[1], QIN Xuebin[1], LUO Minxue[1], and DU Haitao[1]. Oil Geophysical Prospecting, 2020, 55(Supplement): 15-19, 32.

In recent years, OBN exploration has become an important operation mode and keeps developing. Real-time navigation and positioning is a basic and important part in OBN exploration. This paper firstly summarizes the process and accuracy requirement of real-time navigation and positioning in OBN exploration, then according to the specific process of OBN exploration, describes the quality control of real-time navigation and positioning in details from node vessel, positioning vessel and source vessel, and finally summarizes the quality control in data processing and management. The result provides a reference to improving the standardization of real-time navigation and positioning in OBN exploration, ensuring the reliability of navigation data and guaranteeing the quality of OBN data.

Keywords: OBN seismic exploration, real-time navigation, quality control, data management

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Research and application of the processing method for Carboniferous low-frequency signals, Junggar Basin. TUO Junjun[1], WANG Xiaotao[1], DOU Qiangfeng[1], YE Di[1], JIANG Li[1], TAN Jia[1]. Oil Geophysical Prospecting, 2020, 55 (Supplement): 20-24

Affected by noise and propagating distance, the effective signals of Carboniferous seismic reflection are almost at low frequency. How to im-

prove and protect lost low-frequency information is the key to improve the quality of carboniferous seismic data. This paper proposes a new method. To protect low-frequency information, the pre-stack matching technology based on a cross-domain FKK filtering is used to suppress noises in multiple domains. Compared with the conventional method, this multi-domain denoising method can effectively distinguish the low-frequency component of primary waves from low-frequency noises. While improving the signal-to-noise ratio of seismic data, effective low-frequency reflection information can be protected to the greatest extent. To enhance the processing of low-frequency component, based on the characteristics that the signal-to-noise ratio of the high-frequency component of deep seismic data is lower than that of the low-frequency component, a low-frequency energy enhancing factor is designed to compensate low-frequency seismic data. In particular, Carbonaceous energy clusters are more focused, and a fine velocity field can be established, thereby improving the accuracy of migration imaging. The new method has been applied to several seismic blocks in the Junggar Basin and obtained good effects. It can provide powerful technical support for the exploration of Carboniferous oil and gas.

Keywords: cross-domain, binary-space interpolation, low-frequency compensation, Carboniferous imaging

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The improved seismic data regularization method based on matching pursuit theory. LING Yue[1], LIU Weiming[1], XIAO Mingtu[1], and ZHANG Xiaomei[1]. Oil Geophysical Prospecting, 2020, 55(Supplement): 25-32.

The surface condition in the Yingxiongling area of the Qaidam Basin is complex with many cliffs, and different surveys have different acquisition parameters. This resulted in serious irregularities in traces, spatial samples and coverage, and consequently artifacts in seismic imaging results. To get accurate images of subsurface structures, data regularization is indispensable. Conventional MPFI (Matching Pursuit Fourier Interpolation) can "re-orthogonalize" the Fourier basis functions through iteratively subtracting the Fourier component with the maximum energy from original data to minimize the leakage from one frequency to another, but it suffers from aliasing. Improved MPFI can suppress alias at high frequency by using low frequency as a prior. In this paper, MPFI was applied to regularize the geometry of 3D land multi-survey recorded in the Yingxiongling area of the Qaidam Basin. The result shows that improved MPFI can provide a promising approach for reconstructing the missing data while preserving amplitude and removing noises, and improve the image of the fault crushed zone. It lays a foundation for subsequent reservoir prediction and evaluation.

Keywords: data regularization, matching pursuit, anti-aliasing, multi-survey joint processing

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The velocity model of converted wave VTI pre-stack time migration and its application in complex zones. YANG Zhe[1], WANG Xiaowei[1], SU Qin[1], BIAN Donghui[1], LIU Wei[1], and YANG Wei[1]. Oil Geophysical Prospecting, 2020, 55(Supplement): 33-40.

In VTI anisotropic media, multi-parameter analysis is an effective method for pre-stack time migration velocity modeling of converted waves. However, for converted wave from complex structures with serious anisotropy, low spectral accuracy and multiple solutions make it very difficult to directly perform multi-parameter spectrum analysis. This paper provides a method which simplifies the multi-parameter velocity modeling process. Through stratigraphic interpretation of P-wave and converted wave, the average velocity ratio of P-wave to converted waves(γ_0)can be obtained. The initial migration velocity of the converted wave (v_{C2}) and γ_0 are used to perform the isotropic pre-stack time migration of the converted wave, and the imaging gathers are used to iteratively optimize the v_{C2} with only finely tuning γ_0, so that the near-offset event is flattened. Then, the VTI four-parameter analysis of the converted wave is performed, in which v_{C2} and γ_0 is kept unchanged. The equivalent velocity ratio and the anisotropic parameter of the converted wave are sequentially iterated until the far-offset events are flattened. The application result shows that the method can effectively reduce the multiplicity of multi-parameter modeling of converted waves, improve the imaging quality, and lay a good data foundation for karst fracture prediction by using multi-wave data.

Keywords: converted wave, VTI, velocity modeling, multi-parameter analysis, multi-wave matching.

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Research on high-precision modeling and imaging with dual-complexity conditions: Taking the Kulongshan mountainous area of Jiuquan Basin as an example. XIAO Mingtu[1], SU Qin[1], YU Guoxiang[2], LI Fei[1], LING Yue[1], and SHAO Xichun[1]. Oil Geophysical Prospecting, 2020, 55 (Supplement): 41-48.

The Kulongshan mountainous area is rich in oil and gas resources in Jiuquan Basin. It is characterized by both complex in near-surface and overthrust subsurface structures, leading to great difficulties in subsurface accurate imaging. Conventional floating-datum-based prestack migration doesn't work well in such an area, so that problems such as insufficient static correction, inadequate adjustment of floating datum to severely undulating surface, and inaccurate shallow velocity models affecting the migration accuracy of deeper structures are presented, and the conventional method cannot satisfy the requirement for precise imaging of the overthrust structures. This paper proposes an integration strategy of static correction and depth imaging. Combining with the partitioned double-variable static correction, it can improve the accuracy of high-frequency near-surface static correction. The key technique integrates near-surface refraction inverted velocity with deep reflection inverted velocity reasonably to acquire a high-precision global velocity model, and uses prestack depth migration of true surface with small-scale surface smoothing parameters to enhance the deep imaging accuracy. Application of the high-precision depth modeling and imaging processing technique to raw data shows that the method can improve the imaging quality and accuracy of complex thrust structure effectively, proving the superiority and feasibility of the method for high-precision modeling and imaging in complex areas.

Keywords: true surface with small-scale surface smoothing parameter, double-variable static correction, dual-complexity conditions, fusion velocity modeling, prestack depth migration

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The velocity-depth modeling method of special lithologic bodies. ZHANG Tao[1], WANG Xiaowei[1], WANG Xiao[1], ZANG Shengtao[1], QIE Shuhai[1], and ZHANG Hao[2]. Oil Geophysical Prospecting, 2020, 50(Supplement): 49-55.

An accurate seismic velocity model is important for accurate seismic imaging. However, in some complex areas with special lithology, such as igneous rock, gypsum salt rock, conglomerate rock and so on, sharp changes in the composition of the special lithology cause sharp changes in seismic velocity, then complex seismic wave field, and consequently extremely difficult to get accurate modeling and imaging of the special lithology. A conventional layer-controlling velocity modeling method can't accurately deal with the violent lateral and internal velocity changes of the special geological body, so the underlying structure of the special geological body is unable to accurately image. Taking the special igneous rock in the L exploration area as a case, we use interpreted horizons to control the structure shape and extract VSP velocity to the special lithology and forward simulation to obtain an initial velocity model with reasonable spatial velocity distribution; then optimize the initial velocity model through three-dimensional grid tomography to improve the internal velocity accuracy. The velocity modeling method can not only restore the underlying structure of igneous rock in the middle and deep layers of the L exploration area and eliminate the underlying false faults, but also provide the more accurate image of the ultra-deep fracture-cave carbonate reservoir. The method is a reference to velocity-depth modeling and imaging of similar special geological bodies.

Keywords: middle-deep layer, igneous rock, carbonate rock, prior information, 3D grid tomography

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Processing workflow for improving shallow seismic image quality on GeoEast platform: A case study on Shaximiao Formation in central Sichuan Basin. GAN Dayong[1], GAO Xianwei[2], ZHU Dan[3], YANG Guangguang[1], LYU Yan[1], and HAN Song[1]. Oil Geophysical Prospecting, 2020, 55 (Supplement): 56-63.

The developed channel sandstone of the Shaximiao Formation in the central Sichuan Basin is a new target of oil exploration and development. To cope with problems and difficulties existing in the shallow seismic data of the central Sichuan Basin, GeoEast software was used to carry out fidelity and amplitude preservation to improve the resolution of the seismic data. After analyzing the original seismic data, difficulties in data processing were found out, then corresponding technical measures were taken, including processing experiments on static corrections, denoising while preserving prestack amplitude, prestack time migration and trace gather optimization, and finally the processing parameters and processes suitable for the characteristics of the study area were summarized for batch processing of all data. Based on the result, high-resolution seismic data were obtained with active characteristics of wave group, high signal-to-noise ratio, continuous shallow events and reasonable migration. They are the basic data for fine prediction of channel sandstone reservoirs and seismic detection of gas-bearing property.

Keywords: GeoEast, Sichuan Basin, Shaximiao Formation, processing workflow, static corrections

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High precision prediction and identification of high temperature and high-pressure gas reservoir in Yinggehai Basin. LIU Wei[1], LI Lei[1], MA Guangke[1]. Oil Geophysical Prospecting, 2020, 55 (Supplement): 64-71

The high temperature and high pressure gas reservoir in the Yinggehai Basin is an unclassical system of gravity flow deposits where the reservoir is very heterogenous, the contact between sand bodies is very complicated. Affected by shallow gas and diaper microfissures, the seismic resolution and SNR are low . There are fuzzy zones , and it is difficult to accurately distinguish the gas and water layers. The multiplicity of seismic attributes are not conducive to high precision reservoir and hydrocarbon identification. Taking the Huangliu formation in the Dongfang D gasfield as a case, a high precision reservoir and hydrocarbon identification technology for high temperature and high pressure complex gas reservoir is proposed. First, obtain high quality seismic data by high density seismic acquisition, then conduct seismic amplitude compensation and broadband geostatistical inversion by combining geostatistical inversion and broadband inversion, and finally identify the gas range by frequency tuning decomposition. The study result is useful for high precision reservoir and hydrocarbon identification at high temperature and high pressure conditions.

Keywords: high temperature and high pressure, complex gas reservoir, high density seismic, amplitude compensation, reservoir prediction, fluid detection

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Key technology and effect of prediction of tight sandstone gas based on seismic data. WANG Guanmei[1], ZHANG Wanfu[1], ZHANG Hongwei[1], LIU Liangqiong[1], LIU He[1] and ZHOU Shang[1]. Oil Geophysical Prospecting, 2020, 55(Supplement): 72-79

Tight sandstone gas is typical unconventional gas in the reservoir with low porosity and low permeability. The effective sandstone reservoir is thin and has a little difference in wave impedance from its surrounding rock after bearing gas, and its seismic response is weak. After analyzing the controlling factors including sandstone thickness, physical properties and gas-bearing property, the key technologies of seismic prediction were studied in the study area. Firstly, taking advantage of high vertical resolution of logging data and good lateral resolution of seismic data, geostatistical random simulation inversion was carried out to finely describe the sandstone distribution, then based on the mathematical relationship between the P-wave impedance and porosity of pure sandstone, two-step quantitative prediction of sandstone porosity and prediction of favorable reservoir distribution laws were carried out, and finally, based on fine petrophysical analysis, Poisson's ratio was selected as the sensitive elastic parameter to identify gas and water, and prestack elastic inversion was carried out based on fidelity and amplitude preserved seismic data to predict rich gas areas. The application of this method in the Sulige SX block has achieved very good exploration and development effect. Based on the structural background, and comprehensive evaluation of lithology, physical properties and gas bearing property, favorable target zones were selected, and well location were deployed.

Keywords: tight sandstone gas, seismic data, porosity, Poisson's ratio, prestack inversion

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Predicting deep reservoirs with "2W1H" seismic data. LI Hailiang[1], ZHANG Liping[1], WANG Hailong[1], GUI Jinyong[1], and ZHANG Yuangao[2]. Oil Geophysical Prospecting, 2020, 55 (Supplement): 80-84.

The Ordovician reservoirs at deeper than 6000 m in the Gucheng low uplift in the eastern Tarim

Basin are dolomite and limestone, which are taken as the typical deep to ultra-deep exploration targets. The quality of ultra-deep seismic data is affected by seismic acquisition, attenuation and processing, so that it is difficult to get expected results of reservoir prediction. In this study, based on the data with wide azimuth, the interpretation workflow for "2W1H " data was proposed, and then based on the information of broadband and azimuth, lithology prediction, zonal optimization and gas identification by dominant zones of deep karst reservoirs were carried out in the Gucheng low uplift. In order to improve the accuracy of reservoir prediction and determine the favorable exploration area in the study area, the distribution of dolomite was predicted by using the broadband of the seismic data, and the gas potential of the reservoir was detected by using the dominant azimuth of the seismic data. The results show that reservoir prediction based on the relationship between amplitude and frequency (AVF) is better than that of prestack seismic inversion. The wide azimuth seismic data has certain dominant azimuth of hydrocarbon response, and the anisotropy at such azimuth is less, and the hydrocarbon response characteristics are more obvious. This can better predict the distribution of favorable deep gas reservoirs.

Keywords: Gucheng low uplift in eastern Tarim Basin, deep reservoir, "2W1H", AVF relationship, dominant azimuth, reservoir prediction

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Permeability prediction of coal strata in block LB, Qinshui Basin. CHEN Longwei[1], WANG Guanmei[2], FENG Xiaoying[3], ZHANG Hongwei[2], DING Ruixia[3], and ZHANG Wanfu[2]. Oil Geophysical Prospecting, 2020, 55(Supplement): 85-91.

Permeability is an important parameter affecting the production of coalbed methane. There is a certain power exponential relationship between geostress and permeability. But the geostress prediction based on the curvature of seismic data can not accurately characterize the permeability distribution law of coal strata. In this study, taking coal strata in the Qinshui Basin as an example, the geostress was predicted by using the curvature of seismic data, and the fault development area was precisely predicted by using the intrinsic structural coherence technology; then the unreasonable areas of geostress prediction were eliminated by fusing geostress and coherent attribute volume; finally, the geostress was converted into permeability according to the power exponential relationship between permeability and geostress. The predicted results of this method are in good agreement with actual drilling data. They provide references to CBM exploration and development.

Keywords: coal strata, permeability, geostress, curvature, coherence, volume fusion

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Application of offshore 3.5D seismic survey for oilfield development at high water cut and high recovery stage. LI Xisheng[1], LIANG Wei[1], SONG Qianggong[2], XIA Xiaoyan[1], SHI Wenying[3], and YAN Haoyan[3]. Oil Geophysical Prospecting, 2020, 55 (Supplement): 92-97.

As development goes on, the Huizhou A oilfield in the South China Sea shows characteristics of extra- high water cut and extra- high recovery, so that the remaining oil is globally scattered and locally enriched. After conducting 3.5D and T-L seismic survey based on dual-azimuth high-quality 3D seismic technology, and carrying out rock physical analysis, prestack time-lapse data processing and spatial dynamic production information interpretation, the distribution of the remaining oil was investigated based on the relationship of seismic amplitude and dynamic information of reservoir production during the later development stage of the oilfield. The seismic result has been applied to update the pressure-depleting development plan in the Huizhou A oilfield. New wells show high recovery and help to produce the remaining oil.

Keywords: 3.5D seismic, offshore, oilfield development, remaining oil

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Research and implementation of geophysical cloud computing environment. SUN Xiaoping[1], CHEN Jihong[1], LUO Gang[1], ZHOU Kun[1], WEN Jiamin[1],

and DU Jiguo[1]. Oil Geophysical Prospecting, 2020, 55(Supplement): 98-104.

As a new technology with rapid development, the application scenarios of geophysical cloud computing has been more and more common. In geophysical field, seismic data processing and interpretation has also transferred from a traditional processing center to cloud computing (SaaS). This paper introduces the structure, composition and function of geophysical cloud computing environment of the latest GeoEast-iEco, the cloud computing management system on GeoEast. The cloud computing environment permits users to login with a web browser to use the applications and conduct collaborative work. The cloud computing environment manages all kinds of hardware and software resources, and through the unified management and coordinated operation of the global intelligent job scheduling system, it provides the best solution to seismic data processing and interpretation, and helps users realize the transformation from the traditional mode to the cloud computing mode.

Keywords: GeoEast-iEco, SaaS, centralized management, resource sharing, flexible scheduling, QoS

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