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ABSTRACTS

Discussion of high-precision seismic prospecting acquisition technology. Lù Gong-he. *OGP*, 2005, 40(3):261~266

Faced with the currently existed problems in high-precision seismic exploration acquisition, the discussion and analysis are mainly focused on such issues as shot, receiver, noises and folds and the following knowledge and suggestions are presented: ① it should not emphasize the explosive speed of dynamite too much in shot coupling issue and it should analyze the property of surrounding rocks; ② it should change the method determining the depth of shot-hole from qualitative to quantitative methods; ③ the geophone having higher natural frequency should be carefully used, because it lost seismic signal with lower frequencies basically and does not improve the high-frequency signals at the same time, on contrary, it greatly reforms the seismic signals; ④ the method of receiving in geophone-hole makes the receiver environment and wavefield complex, it's better to firmly plant the geophone into near-surface; ⑤ the method concentrating the geophones in an array together at single point for receiving decreases harmonica frequency of coupling and lost a noise-eliminated opportunity, which is neither improvement of resolution nor improvement of S/N ratio; ⑥ the small areal array can purposefully suppress the noises in high frequencies and expand superior band; ⑦ it should consider both S/N ratio and resolution in the issue of selection of folds and also consider the economic benefits at the same time, it should strike a balance amount these three aspects.

Key words: high precision, seismic data acquisition, source coupling, high-frequency geophone, noise, folds

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Finite-difference numeric modeling of wavelet adaptive network of seismic scalar equation. Pei Zheng-lin. *OGP*, 2005, 40(3):267~272

The current seismic numeric modeling algorithm can't adaptively adjust the size of special network, so a great amount of storage space and computation time are needed for computing the

wavefield and the precision of local simulated wavefield is not higher at the same time. The paper presented an adaptive network algorithm on the basis of average interpolation wavelet and gave the wavelet adaptive numeric algorithm of 2-D one-order pressure—velocity scalar equation in non-homogeneous medium. The method operates the issue of seismic wave propagation in the general boundary condition in the interpolation space of wavelet and the non-uniform change of wavefield responses adaptively, which has greatly improved the simulated precision and computational efficiency. The results of numeric modeling showed that the method is correctness and effectiveness.

Key words: non-homogeneous medium, scalar wave equation, average interpolation wavelet, adaptive network, finite-difference

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Multi-scale inversion of wave equation. Li Qing-ren, Zhang Xiang-jun, Yi Wei-qi, Hui Shan and Qian Feng-zhang. *OGP*, 2005, 40(3):273~276

Based on the multi-scale idea, the paper presented a method of multi-scale inversion of wave equation. The basic ideas of the method are as follows: multi-scale decomposition of inverted objective function and inversion is conducted by using normalization method under each scale, which overcome the ill-posedness of inversion problem, acquired global optimum solution and improved resolution and hi-fi of inverted results. The paper uses wavelet transform to conduct multi-scale inversion. The better estimation of parameters is acquired first by inversion in large scale, then the estimated values are taken as initial values in smaller scale to invert until the global optimum solution is obtained. The application cases showed that the method has advantages of low dependence on initial model, rapid convergent speed and stable inverted results.

Key words: wave equation, multi-scale, normalization, inversion

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Noise-eliminated method by morphologic filtering in seismic data processing. Wang Run-qiu, Zheng Gui-juan, Fu Hong-zhou and Li Qing. *OGP*, 2005, 40(3): 277~282

The application of digital filtering method has to be limited when the signals and noises are difficult to be separated. For that reason, the paper tried to use the difference in shape of seismic wave and morphologic filtering method developed on the basis of mathematic morphology to suppress the accident pulse noises on the seismic records. The basic theory of morphologic filtering method was mainly discussed in the paper, the size of structural elements and effect of shape on the processing results were also probed. The test processing of real seismic data was conducted, which achieved good application effects. In view of that using mathematical morphology for seismic data processing is new application realm, we hope that there are more persons can joint the studying ranks.

Key words: mathematical morphology, erosion, dilation, open operation, close operation, structural element

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Seismic data processing technology of low-amplitude buried-hill in Liaohe depression. Liu Shi-guang, Cui Xiao-juan and Gao Yuan. *OGP*, 2005, 40(3): 283~288

The seismic data with low-amplitude buried-hill in Liaohe depression are characterized by low S/N ratio, complex diffractions of faults, unidentified feature of buried-hill configuration and interior reflections. For that reason, it has to improve the S/N ratio of seismic data and imaging precision. We used such data processing techniques as sub-azimuth velocity analysis and stack, surface consistence, 3-D map filtering noise-elimination, anisotropic DMO, sweeping of migrated velocity fields and interval velocity smoothing and prestack time migration and detailed introduced the principles and application effects of each technique. We considered after study that the former three techniques could effectively suppress the interference, improve the precision of residual statics and improve the S/N ratio of data in low-amplitude buried-hill in a precondition of preserving the fea-

ture of useful seismic signals; the later three techniques can strongly guarantee the precision of images in complex structures of low-amplitude buried-hill. A set of data processing techniques series aimed at the feature of seismic data in Liaohe low-amplitude buried hill areas are preliminarily formed, which gives a reference and practical value to seismic data processing in low-amplitude buried-hill areas.

Key words: sub-azimuth NMO and stack, map filtering, anisotropy, prestack time migration

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Finite-difference wavefield simulation of full P-wave equation. Sun Cheng-yu and Zhang Ji-hui. *OGP*, 2005, 40(3): 289~294

Generally, when the variation of density of medium is smaller than that of velocity, it can approximately take the density as constant and using acoustic equations and velocity functions to describe wave is feasible; but when the variation of density of medium is equivalent to or greater than the variation of velocity, the variation of density can't be neglected, the acoustic equations do not reflect the influence of density function on wavefield. Starting from the basic equations of elastic dynamics, the paper deduced full P-wave equations in non-homogeneous medium and its finite-difference format. The right items of full P-wave equations include spatial variation item of pressure field and spatial variation item of density and completely describe the role of two factors---velocity and density during waving. The numeric computation showed that the simulated results by full P-wave equations could more accurately describe the feature of wavefield when studying reflection and transmission in non-homogeneous geologic body and on interface of beds. The analyses of relevant simulated results were conducted in combining with analytic solution of reflection and transmission issues in the paper, which pointed out that it should use the conception of impedance or impedance rate in reflection issue when there is distinct difference of density on both sides of interface.

Key words: wave equation, full P-wave equation, finite-difference, seismic simulation, reflection and transmission

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Improvement of static corrections technique using continuous velocity model for inversion. Zu Yun-fei, Li Pei-ming, Yang Bao-jun and Xu Zhao-long. *OGP*, 2005, 40(3): 295~299

In the west of China, there are areas of giant-thick loess, deserts with unstable water table and giant-thick-gravel-piled piedmont, which is characterized by continuous near-surface velocity that using common method of controlling points of near-surface survey and first breaks refraction method to control the distributed regularity of near-surface velocity and density is very difficult. For that reason, on the basis of former "static corrections technique using continuous velocity model for inversion", the paper conducts inversion using continuous velocity model through fully and reasonably using near-surface survey data during the inversion and in combining with inflexion wave and refractions of first breaks on the shot records, which can accurately solve the structural parameters of near-surface and then compute final statics by integration. The analysis of real cases showed that the method described in the paper can better solve the static corrections in the west of China where the near-surface velocity continuously changed vertically.

Key words: near-surface structure, static corrections, inversion using continuous velocity model, time-distance curve, delay time

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Azimuth travel time forward modeling in arbitrary anisotropic media. Xiong Jin-liang, Liu Yang and Hou Bo-gang. *OGP*, 2005, 40(3): 300~304

Faced at gas-bearing fractured model and oil-bearing fractured model, the paper presented ray-tracing computational method in anisotropic media when studying travel time forward modeling method in arbitrary anisotropic media. The computed results showed that ①in a scenario of vertical fracture, P-wave reflected times changed with offsets and azimuths and the azimuth difference and difference of offsets of P-wave reflected times in gas-bearing fractures are more distinct; ②in a condition of equal offsets, the travel times of reflections is approximately elliptic change with azimuths and the azimuth difference of reflected

times in gas-bearing fractures is more distinct than in water-bearing fractures; ③in a scenario of different dips of fractured planes, the azimuth difference of travel times of reflections is the most distinct when the fractured planes is vertical and decreases with decreasing the dip of fractured plane and becomes azimuth isotropic media when the fractured planes is horizontal; ④on the lines with different orientation, the biggest time difference of P-wave reflections between the lines vertical and parallel to the fractured orientation exists.

Key words: anisotropic medium, forward modeling, azimuth, phase velocity, group velocity

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Analysis and appreciation of wide/narrow azimuth exploration cases (I). Ling Yun, Gao Jun, Sun De-sheng and Wu Lin. *OGP*, 2005, 40(3): 305~308, 317

In recent years, the people has gradually had comprehensive knowledge of superiority of implementing wide azimuth survey but flinched from more expensive acquisition cost because of higher folds and smaller bin size for wide azimuth survey. For that reason, through wide azimuth seismic data practically acquired in Junggar basin of the west China and taking the lithologic reservoirs as the explored targets, the paper conducted the correlation and analysis of wide/narrow azimuth surveying effects. In studyings, we adopted processing techniques improving resolution in which the amplitude is strictly relative preserved and appreciated the ability of wide/narrow azimuth in exploring lithologic reservoirs on the basis of the difference of seismic attributes along the reservoirs. The studied results showed that in view of lithologic seismic exploration, the wide azimuth (aspect is greater than 0.5) has better spatial imaging resolution than narrow azimuth while is unnecessary to keep high folds that are 60~80 folds being enough to meet exploration demand on lithologic exploration in conditions of the areas having flat beds (hinterland of basin) and seismic data having certain S/N ratio.

Key words: wide azimuth, narrow azimuth, spatial imaging resolution, amplitude attribute, attribute of coherent data volume

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Multi-scale edge detection of wavelet and application in fracture prediction. Gou Liang and Peng Zhen-ming. *OGP*, 2005, 40(3): 309~313

On the basis of expounding the basic principle using 2-D wavelet transform for seismic attributes data, the paper built up the effective flow used for multi-scale edge detection of image. According to the characters of 2-D image formed by seismic horizons data, the effective basic function and scale function of wavelet were constructed, which improved the precision of image edge detection and image partition. In order to improve the computational efficiency, the optimum designs of algorithm and wavelet filter were implemented and application of the method to study the distribution of fracture, providing foundation for the prediction of oil/gas reserve. It is proved by the processing of real data in studied areas and in comparison with threshold method and Sobel method that the method is effectiveness and feasibility.

Key words: fracture prediction, multi-scale edge detection, wavelet transform, image processing, seismic attributes data

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Fine interpretation and description of river facies reservoir. Yang Guo-quan, Gao Rong-tao, Lei Ling, Zhang Jun-hua, Wang Yong-gang, Wang Xue-jun, Lin Hong-mei and Zhang Jia-zhen. *OGP*, 2005, 40(3): 314~317

River facies reservoir is one of major targets in oil exploration in China, which is characterized by good porosity and permeability, shallow buried depth, high production and wide spread, but on the other hand, the rapid changed channels and unstable facies led to have difficulty in fine interpretation. For that reason, the paper made concentrated studies for fine interpretation and description of river facies reservoir and achieved a certain geologic effects. First, making 3-D theoretical model of river facies reservoir and studying the basic feature of the reservoir; on that basis and taking LHK practical data as an example, analyzing band distribution of river facies reservoir in the region and picking up frequency-division data volume of 20 Hz reflected the feature of frequency of targets and conducting frequency-division interpretation of palaeochannel; using the third generation of coherent data volume characterized by anti-noise and

good resolution for interpretation of multiple channel sand bodies; exploring the possibility using composite attributes to study geologic bodies and presenting a new attribute—series attribute, i. e. on the basis of seismic attributes taken from raw data volume, the new relative seismic attribute is picked up from it that is of benefit to improve the showing effects.

Key words: channel, frequency-division interpretation, third generation of coherent data volume, composite attribute, series attribute

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Seismic prediction of Kongdian Group source rock in Jiyang depression. Yu Jian-guo, Han Wen-gong, Yu Zheng-jun, Lu Shen-qiang and Wang Jin-duo. *OGP*, 2005, 40(3): 318~321, 338

The study of distribution of source rock and computation of hydrocarbon-produced capacity are the important contents of exploration of hydrocarbon-bearing basins. It is very difficult to study its distribution and even to compute the hydrocarbon-produced capacity in a situation of without directly drilling into source rock. Using seismic data and through analysis of feature of seismic facies and seismic velocity, the paper correctly predicted the potential source rock in Kongdian Group second Segment of Dongying sag, presented a conception of resource factor and computed the hydrocarbon-produced capacity of the set of source rock. The predicted results have been proved by following drilling results, which illustrated that using seismic data to predict source rock is feasibility and effectiveness, thus the source issue that had troubled the deep exploration of Jiyang depression for some dozens of years has been preliminary solved, which proved that the deep of Jiyang depression has also the large potential of exploration. The method can be used in the areas without drilling and lower exploration degree, having higher popularized value.

Key words: source rock, seismic facies, seismic velocity, resource factor, Kongdian Group

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Seismic prediction of mid-shallow gas reservoirs in Jiyang depression. Wang Xing-mou. *OGP*, 2005, 40(3): 322~327

The gas reservoirs in Jiyang depression mainly accumulate in Tertiary and mid and upper parts of Paleogene, where the buried depths are 800m~1800m. The reservoirs are characters of a large number, thin thickness and small area. The gas-enriched characters in mid and shallow layers and changed petrophysical property of reservoirs before and after gas-bearing provided conditions for using seismic methods for detection and description. Because the gas reservoirs exist in a large set of mud rocks, the gas-bearing formation has bright feature; the mid gas reservoirs are more complex than the shallow ones, mainly are structural gas reservoirs, generally existing gas/oil or gas/water interfaces, which mainly have the flatten spot feature for reflections. The velocities and densities of mid and shallow gas reservoirs are all greater than the surrounding beds, thus the distinct AVO effect exists. Using abovementioned reflections feature, the gas reservoirs have been successfully predicted.

Key words: gas reservoir, seismic prediction, bright spot, flatten spot, 3-D AVO

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Feasibility of time-lapse seismic monitoring in long-period water-drive continental facies clastic rock reservoir. Shi Yu-mei, Yao Feng-chang and Liu Wen-lin. *OGP*, 2005, 40(3): 328~333

Studying the feasibility of time-lapse seismic prospecting is important to effectively carry out the seismic reservoir monitoring. In accordance with the feature of geological conditions and long-period water drive in the east oilfields of China and based on Kuster-Toksoz petrophysical model and Biot wave theory in fluid-saturated porous medium, the paper discussed the conditions implementing seismic monitoring in the east long-period water-drive reservoirs from such aspects as reservoir thickness, porosity and seismic data quality etc. The studied results showed that it needs meet the following conditions for conducting seismic monitoring in the east of China: ①the thickness of reservoir should be greater than one-twelfth of seismic wavelength; ②the porosity is greater than 20%; ③the lateral stretched scope of reservoir is greater than one-fifth of radius of Fresnel zone and spatial sampling interval is small enough; ④the reservoirs should be high-velocity and low-velocity reservoirs (in relation to surrounding beds); ⑤the S/N ratio

of seismic data should be above 2; ⑥the errors of nonrepeatability of seismic data should be less than 20%.

Key words: continental facies, clastic rock, reservoir, long-period water drive, time-lapse seismic exploration, feasibility

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Effects of fractures of rock on elastic property of rock and velocity-porosity relation. Zhou Wei and Yang Hong-xia. *OGP*, 2005, 40(3): 334~338

A lot of sedimentary rocks have long and thin pores and fractures. According to Berryman scattering model method, using ellipsoidal pores to simulate the fractures of rocks and through changing the aspect of ellipsoidal pores, the shapes of fractures can be modeled. In combination with Gassmann equations and Walsh formulas, the studying the effects of aspect of pores on elastic property, P- and S-wave velocities and fluid-replacement is conducted. The computational results showed that for the rocks having similar mineral components and porosity, the volumetric modulus of rock, elastic modulus of pores, P- and S-wave velocities and Poisson ratio have distinct difference because of difference of shape of fractures (aspect of ellipsoidal pores). Along with increasing the aspect of pores, the volumetric modulus and elastic modulus of pores approximately linearly increase, Poisson ratio decrease non-linearly, P- and S-wave velocity increase and influence of fluid on petrophysical property also decreases, vice versa.

Key words: aspect of pores, fluid replacement, elastic property, composite medium, equivalent modulus, P- and S-wave velocity

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Study of prestack joint inversion of P-wave impedance and S-wave impedance and its application. Yuan Shu-jin, Dong Ning and Yu Chang-qing. *OGP*, 2005, 40(3): 339~342

Exploration of subtle oil/gas reservoirs is paid more and more attention of industry and the analysis and application of prestack data of seismic data are becoming hot point. On the basis of AVO analysis and study of inversion of seismic wave impedance, the paper analyzed the principle of Fat-

ti-AVO equations and sparse spike inversion and the joint constraint sparse spike inversion was conducted for the data volume of multiple prestack angle-gathers, from which the three data volumes of P-wave impedance, S wave impedance and density could simultaneously acquired. In comparison with the P-wave impedance, the S-wave impedance can more reflect the lithology and fluid. The picked elastic combining attributes parameters of rocks on that basis are jointly used for fine description of reservoir in combination with AVO attributes parameters, which can improve the precision of identification of lithology and fluid. The practical use in Ordos areas showed that the method can provide a powerful technical support to identify the subtle lithologic oil/gas reservoirs.

Key words: AVO angle gather, joint inversion, P-wave impedance, S-wave impedance, elastic attributes of lithology, reservoir description

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Using wavelet parameters for detection of distribution of sand body. Fu Zhi-guo, Yi Cheng, Zhang Bai-lin, Zhao Wei, Liu Zhi-bin and Zhang Jin-miao. *OGP*, 2005, 40(3): 343~348

Since the sand body reservoir have influence on seismic reflected signals in time and frequency and wavelet transform can just reflect the time and frequency components of signals, therefore, the paper uses wavelet transform to analyze the time-frequency feature of seismic records. In view of the capability of locally analyzing the signals and providing multi-scale wavelet coefficients that the wavelet transform has, so the wavelet transform can finely be used for reservoir prediction. The wavelet coefficients can be taken as measuring the time-frequency feature of signals that could be further demonstrated by tests of the theoretical models. The paper presented the wavelet parameters of seismic signals being taken as a new kind of seismic attributes, i. e. wavelet attributes. The map of seismic attributes of the targets can be acquired in practice where the lateral variation of reflected feature of targets is known and distribution of reservoirs is detected. The paper considered that like other seismic attributes parameters, the wavelet attributes belong to multi-attributes analysis.

Key words: time-frequency feature, wavelet transform, Mallat algorithm, wavelet coefficient, seismic

attributes

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Seismic signal compression based on wavelet transform. Wu Wen-bo, Yang Zhi-gao and Qing Qian-qing. *OGP*, 2005, 40(3): 349~352

Compression of seismic data is a key technique for solving a great amount of transportation and storage of seismic data. Aimed at the feature of signals and noises in seismic data, the paper selected the compressed method of seismic data based on wavelet transform. The method includes: ① 2-D wavelet transform of seismic signals; ② using correlation between the coefficients to reorganize the transformed coefficients by zero-tree coding method; ③ threshold-operational and quantitative processing of coefficients; ④ using adaptive arithmetic code for entropy coding of quantitative coefficients without loss. The method can implement hi-fi compression with high rate of seismic signals. The compressed results of typical seismic signals showed that there would be no distinct loss of information after decompression when the compressed ratios are above 50:1.

Key words: wavelet transform, QMF compression, soft threshold, arithmetic coding

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Using 2-D inversion for interpretation of 3-D MT data. Hu Zu-zhi, Hu Xiang-yun and He Zhan-xiang. *OGP*, 2005, 40(3): 353~359

In view of premature inversion method for 3-D MT data, it is necessary to probe improving the method using 2-D inversion method for interpretation of 3-D MT data. The paper gave the 2-D inverted results of two models: 3D/1D and 3D/2D. It is discovered through the comparing the responses of MT apparent resistivity and phase of 3-D geologic prism conductor model with 2-D geologic rectangle conductor model that the response of 2-D TM mode is close to that of 3-D YX mode and the existed position of conductor could be determined by the inversion of single TM mode but inverted the resistivity is greater than the real value; the response of 2-D TE mode is large different to that of 3-D XY mode at low frequency and the resistivity of conductor could be reflected by the inversion of

TE mode but the phenomenon of stretched conductor exists in vertical direction. The results of joint inversion of TE and TM combine the advantages of inversion of TE with TM mode, which can better invert the existed position and resistivity. The results of 2-D inversion are difficult in reflection of real 3-D structure along with the increasing buried depth of good conductor; using 2-D inversion can still effectively reflect the exist of 3 D anomalous body if increasing the oriental length and scale of 3-D anomalous body.

Key words: MT, 3-D, 2-D, inversion, REBOCC

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Renewing knowledge of deep structures of Dongying depression. Yang Hui, Cheng Jun and Wang Yi-chang. *OGP*, 2005, 40(3): 360~365

Using high-resolution filtering method of gravity-magnetic anomalous apparent-velocity for implementing apparent velocities filtering processing of Bouguer gravitational anomaly in Dongying depression, the horizontal slices from the shallow to the deep are acquired. It is discovered that the shallow (1~5km) anomaly mainly reflects the E_{s_3} - E_d shallow structures; the deep (6~10km) anomaly mainly reflects the E_{s_1} - E_k structures. 11 larger faults are preliminarily determined, among which there are 2 faults that have significant influence on the whole areas, i. e. 110km long and NNW orientated Hui-Dong big fault and NNW-oriented Chen-Dong subtle fault. Meanwhile, 10 hidden low-amplitude rises are interpreted, which provided a foundation for knowing the deep structures in the areas and pointed out the targets of following oil/gas exploration.

Key words: Dongying depression, deep structure, gravitational anomaly, CEMP, apparent velocity filtering

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Development of seismic exploration promoting new discovery of oil/gas exploration — taking 40 years' history of seismic exploration in Shengli Oilfield as an example. Qu Shou-li. *OGP*, 2005, 40(3): 366~370

The seismic exploration has become an ordinary exploration method since 1927 and seismic exploration techniques have always been continuously developed. Especially in recent 20 years, along with the rapid development of relevant disciplines such as electronics, computer and information science, seismic exploration techniques have developed from analogue to numeric, from original 1-D to 3-D even to 4-D, from 1-C to multiple component, from ground exploration to stereo exploration, from simple structural exploration to explore subtle lithologic reservoir. The current seismic exploration methods are not only used for prospecting of reservoirs in complex areas, but also used for infiltrating and expanding toward the new oil/gas development realm. Taking the 40 years' history of seismic exploration in Shengli Oilfield as clues, the paper expounded the relationship between development of seismic exploration techniques and reserve increasing of oilfields and emphasized that it has to further devote major efforts to develop seismic exploration techniques in order to adapt the daily complex situation of explored targets and promote continuously increasing of oil/gas reserves.

Key words: seismic technology, oil/gas exploration, exploration history, oil/gas reserve, structural exploration, subtle reservoir, exploration precision

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