ABSTRACTS

Analysis of cross-hole seismic data attributes and transformation of reservoir parameters. Xing Zheng-yan, Liu Lei, Wang Yong-gang, Yue You-xi and Song Jian-guo. OGP, 2004, 39(2): 127~132

Considering the speciality presented by depth domain in cross-hole seismic data, currently-detected seismic attributes mainly includes special parameters such as amplitude, waveform and coherent function as well as "three instantaneous" sections of cross-hole seismic data. On the basis of analyzing standard of cross-hole seismic attributes and coherence between seismic attributes, using ordinary cluster analysis method to complete the optimum processing of seismic attributes; selecting neural network analysis method and non-parameter regression analysis method, the transformation from optimized seismic attributes in main targets to reservoir parameters section has been realized. The application of real data showed that some relative techniques being suitable for surface seismic data can also be used for cross-hole seismic section when considering the speciality of cross-hole seismic data, the precision and effects are more better than that in surface seismic prospecting.

Key words: cross-hole seismology, attributes analysis and optimization, cluster analysis, instantaneous section, reservoir parameter

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Impact of hyperbolic time-distance equation on seismic data processing. Liu Yang. OGP, 2004, 39(2): 133~138

Traditional seismic data processing is on the basis of hyperbolic time-distance theory. The paper studied the impact of velocity analysis and NMO correction based on hyperbolic equation on stack velocity and t_0 time and presented improvement method. First, it is theoretically proved that the correction velocity based on the hyperbolic equation increased along with the increased offset in horizontal layered medium and then the case of horizontal layered medium is analyzed. The results showed that hyperbolic velocity analysis can lead calculated stack velocity to become bigger and is also the same for the corrected t_0 time; the larger the used offset of reflected wave is, the bigger the errors of calculated stack velocity and t_0 time are. Using non-hyperbolic time-distance equation can reduce the calculated errors.

Key words: reflected wave, hyperbolic time-distance equation, velocity analysis, NMO correction, non-hyperbolic time-distance equation

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Series deconvolution by resolution into factors. Xiong Ding-yu and Yu Shou-peng. OGP, 2004, 39(2): 139~143, 157

Currently more used minimum phase deconvolution method supposed that the wavelet is minimum phase, which is unsuitable for real seismic wavelet with non-minimum phase, limited the improvement of resolution in seismic data processing. Even though the real seismic wavelet is minimum phase, using minimum phase deconvolution method can also introduce more noise with high frequency, reducing S/N ratio. The method for series deconvolution by resolution into factors presented by this paper avoids the supposition that the wavelet is minimum phase. The possible factors of wavelet are obtained through resolution into factors by self-correlation, then the operator of deconvolution corresponding to each resolved factor of wavelet can be calculated separately and selection is carried out according to maximum or minimum phases, finally the try and judgment for each factor series resulted in deconvolution with non-minimum phase wavelet. The application of theoretical and real data showed that the method for series deconvolution by resolution into factors can significantly improve the resolution and S/N ratio in some degree, the effect is prior to currently-used minimum phase deconvolution method even if the wavelet is minimum phase.

Key words: deconvolution, minimum phase wavelet, non-minimum phase wavelet, resolution into factors, series

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Moveout analysis of P-wave reflection in VTI medium. Xue Gang, Guan Lu-ping, Wang Liang-

shu and Yang Zi-xing. *OGP*,2004,39(2):144~148

The precision of stack velocity and interval velocity provided by common NMO correction processing method can't meet the need of predicting the pre-drilling press. The key reason is that the method supposed that the seismic wave traveled in isotropic layered medium and the practical layer has anisotropic feature on the contrary. Therefore, taking VTI medium as underground layer model, the paper uses P-wave forward modeling, expounds Alkhalifah method, 4-order moveout analysis method containing useful anisotropic parameters and parallel-shifted hyperbolic moveout analysis technique, using these methods to correct the P-wave non-hyperbolic moveout separately; meanwhile, the comparison of above mentioned results with the results of 4-order moveout correction and parallel-shifted hyperbolic moveout correction based on isotropic medium model; The correction for real data is carried out by using useful isotropic parameters of real rock samples presented by Mr. Thmen (1986). The results showed that the moveout analysis method of VTI medium is also suitable for isotropic medium and can provide precise seismic velocity; using useful anisotropic parameter of VTI medium η can also describe isotropic horizontal layered medium; when the useful anisotropic parameter η is taken as less than 0.1, the characters of weak anisotropic layer can be better reflected, which the errors of trace correction in near and middle offset are only 1 sample interval. Finally, the paper gave two practical methods for calculating useful NMO velocity and useful anisotropic parameter η.

Key words: moveout analysis, VTI medium, P-wave, forward, useful anisotropic parameter

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Technique of S-wave splitting detection by orthonormal basis rotation. Huang Zhong-yu and Zhao Jin-zhou. *OGP*,2004,39(2):149~152

The parameters of orientation and density of stratum fracture development can be evaluated based on the character and information of S-wave splitting. These two parameters have important meaning in increasing recovery factor of oil & gas in fractured reservoir. When using converted wave data of 2-D single source to evaluate the fracture parameters, we usually supposed that a certain relation of time difference and amplitude might exist

between the fast and slow S-waves which often do not exist in reality, especially the relation of time difference can not be certain. Therefore, on the basis of polarization of fast and slow S-wave being orthonormal polarization, the paper presented an orthonormal basis rotation method, deduced an analytic expression of the angle between geometry co-ordinate and natural co-ordinate, which finished the separation of fast and slow S-waves and evaluated the developed orientation of stratum fracture. The synthetic records and real cases showed that the method has both feasibility and practicality for evaluation of main orientation of fracture.

Key words: S-wave splitting, fracture, orthonormal basis

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Residual static correction by self-adaptive mixed inversion. Jing Xi-li, Li Li and Chen Shu-mei. *OGP*,2004,39(2):153~157

In view of the non-linear character of residual static correction, the paper analyzed the advantages and disadvantages of currently-used linear and non-linear inversion methods and presented a new mixed inversion method having high computational efficiency and searching global optimum solution on that basis, that is: in the process of solving the problem the linear optimization is used to look for local optimum solution for each disturbance and simulated annealing method is used for random searching in each iteration, resulted in global optimum solution by lesser iterative number. The paper also presented the selective method for inversion parameters, making the method have self-adaptive character. The theoretical analysis and numeric calculation showed that the method not only solved the non-linear global optimum problem of larger residual static corrections, but also improved the efficiency, being a feasible self-adaptive residual static correction method.

Key words: linear inversion, non-linear inversion, simulated annealing, self-adaptive, residual static correction

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Automatic identification of seismic facies and application. Duan Yu-shun and Li Fang. *OGP*, 2004, 39(2):158~162

The purpose of studying seismic facies lies on reconstruct the sedimentary history and structural history of basin. The analysis of seismic facies means identification and mapping for seismic facies unit on the basis of seismic attributes. Using manual neural network analysis technique to automatically identify and classify seismic waveform of channels and its reflected geologic feature in the paper, the seismic map is obtained and correlation and synthetic analysis with known drilling data and regional geologic data is carried out, resulted in sedimentary facies corresponding to seismic facies and identified wanted geologic targets. The real cases further proved that automatic identification of seismic facies has clear priority in description of such geologic bodies as delta, turbidite sandstone and palaeo-eroded geomorphology, the paper also introduced automatic identification method of seismic facies for 2-D lines.

Key words: seismic facies, self-organized manual neural network, analysis of seismic facies, automatic identification, seismic attributes, geologic body

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Meaning of second 3-D seismic exploration in east maturing region and effects. Chen Fa-liang, Du Jin-song, You Hong-wen, Yang Xiao-bo, Zhang Shu-hai and Wang Rui-xiang. *OGP*, 2004, 39 (2): 163~167

3-D seismic exploration has basically been carried out in whole area of Zhongyuan Oilfield, among which the 3-D seismic data in Baimiao area was acquired in 1987. Because of the characteristic of complex sub-surface conditions, developed underground minor faults, rapid-changed lithology and deep-buried targets in this area, the oil/gas accumulation rule was not clearly defined although the data was repeatedly processed many times. Therefore, a 3-D seismic exploration was again carried out in a period from winter of 2001 to spring of 2002. Using 3-D geometry with changeable bin for field acquisition, adopting hi-fi processing modules in data processing and using such advanced interpretation techniques as high-precise synthetic layer-labeling, seismic forward analysis, coherent data volume analysis and visualization in interpretation of seismic data, so that the resolution and S/N ratio of seismic data have been greatly improved, providing condition for lithol:gic inversion, attributes analysis and reservoir prediction. The second 3-D seismic exploration in Baimiao area had characteristic of instantly becoming effective and short investment period, which can provide a shortcut for increasing resource potential and production capacity in maturing oilfield.

Key words: 3-D seismic exploration, fine interpretation, geometry with changeable bin, hi-fi seismic data processing, reservoir description

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3-D reflector tracing. Zhang Er-hua, Ma Ren-an, Zhao Chun-xia and Yang Jing-yu. *OGP*, 2004, 39 (2): 168~172

Recently common-used visualization of 3-D seismic data volume (for example, slice visualization) has obvious trace that uses 2-D interpretation method to interpret 3-D seismic data. The paper considers that in order to completely avoid the limit that uses 2-D interpretation method to interpret 3-D seismic data, the visualization of 3-D seismic data volume has to show each reflector, then to show the fault surface according to the displacement and discontinue of the reflectors so that the relief of these reflectors, space configuration of fault surface and contact relation between the reflector and fault surface can be known and then the beneficial position of oil/gas trap can be determined. Therefore, the paper presented a conception that the wavelet element of same reflector can be stacked into isophase in 3-D space and expounded the thought that directly transform 3-D connected domain (isophase) into 3-D reflectors after refinement of the former. On that basis, the paper presented a new method for 3-D reflector tracing— the ordered cross algorithm of 3-D connected domain. The results of real cases showed the effectiveness of the method.

Key words: 3-D, 2-D interpretation, seed point, connected domain

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Application of logging data to synthetic study of buried-hill oil reservoir. Xing Yu-zhong, Zhang Ji-chang, Zhang Ya-zhong, Wang Tao, Wang Ming-feng and Liu Chen-li. *OGP*, 2004, 39 (2): 173~176

The key of development of fractured-carbonate reservoir is to know in detail the space distributed rule of useful reservoir. Taking Protozoic carbonate buried-hill reservoir in Shen 299 well of Liaohe Oilfield as an example, the paper uses 3700 series logging and imaging logging data to separately study the attitude of formation, identifying and dividing the reservoir rock and identifying and predicting the fracture, which showed that the dolomitite, sandstone (main reservoir) and mudstone in that area have clear feature on 3700 logging trace that can act as main identification mark; the formation dip of buried-hill is generally around 30°; the orientation of the fracture in that area mainly is NE and nearly NW. Using neural network technique to identify vertical feature of fracture and using 3D move and Stress software to model space distribution condition of fracture. The developed zone of useful reservoir and reasonable perforated zone are presented on the basis of this study, achieved good results.

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Impact of gypsum layer on seismic reflection feature of subsalt layer in Tahe area.

Wang Shi-min, Qi Li-xin, Hu Peng-fei and Gu Han-ming. *OGP*, 2004, 39(2): 177～180

Taking the real model of gypsum layer obtained from the interpretation of seismic section crossing Xiang 1 well in Tahe area as a seismic-geologic model of salt body and using ray-tracing forward modeling and the relation of energy distribution of seismic wave in elastic interface, the paper analyzed the kinematical and dynamic feature of seismic wave in subsalt reflector and its impact on imaging precision of subsalt layer. The analytic results showed that the reflected folds and reflected energy do not abruptly change when seismic wave traveled through the gypsum layer and its margins of Tahe area; the produced upward time shift is less than 4.2 ms when the thickness of gypsum layer is less than 200m. In view of this, the impact of salt body on imaging precision of subsalt layer is minimum in Tahe area, in other words, the subsalt seismic structural image has high confidence level in Tahe area. The studied results in this paper are of benefit to study the subsalt AVO feature and seismic imaging of complicated salt bodies in Tahe area.

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Discussion on feasibility of using Rayleigh wave to investigate near-surface structure.

Zhou Xi-xiang and Wang Zhen-guo. *OGP*, 2004, 39(2): 181～186

The surface wave is treated as interference wave in oil seismic prospecting, however, the Rayleigh wave, like the refraction and reflection waves, contains the information of underground medium. The purpose of the paper is to discuss the feasibility of using the available surface wave in seismic prospecting for investigation of near-surface structure. The main thoughts of the method are: ①separate Rayleigh wave from seismic data by using 2-D f-k transform or wavelet package transform; ②calculate the dispersive curves from separated Rayleigh wave; ③ solve the near-surface structure from the dispersive curves. The results of theoretical analysis of two-layer model and real cases showed that using Rayleigh wave to investigate the near-surface structure is feasible. It is possible to provide a new tool for studying the near-surface structure by making full use of the Rayleigh wave information.

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Study of model well test for acoustic log.

Li Shan-sheng and Shen Jian-guo. *OGP*, 2004, 39(2): 187～190, 197

Through the model well test of acoustic log, the paper discussed the affect of outer radius of model well on acoustic waveform. There are a lot of mode wave patterns near P-wave velocity line in 2-D spectrum, which have dense special distribution and large amplitude when the radial thickness of model well is thicker ; the space distribution of mode wave is sparse when the radial thickness of model well is thinner. The experiments and numeric calculation showed that the Stoneley wave with lower frequency basically coincides with primary wave having smaller amplitude in two groups of measured waveform and the waveform has larger

difference between primary wave and Stoneley wave when the radial thickness of both different model wells is greater than one wavelength. The result of numeric calculation is consistent with experiments result. Combining with 2-D spectrum of acoustic waveform of model well and numeric results of mode wave, the paper discussed the relation between detecting depth of acoustic log and waveform configuration, providing a certain experimental basis for further studying the data processing method for waveform of acoustic wavetrain log.

Key words: acoustic log, model well, experiment, waveform

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Quality appreciation of carbon - oxygen ratio spectral logging curves. Song Yan-jie, Liu Xian-wei and Zhang Qing-guo. *OGP*, 2004, 39(2): 191~197

The quality of carbon - oxygen ratio spectral logging curves not only depends on the characters and technical level of logging instrumentation itself, but also depends on the element contents of borehole and stratum as well as the impact of such factors as logging environment, logging speed and sample interval et al. Using the time series analysis method presented by Mr. Kerford and Georgi, the indexes (repeatability, S/N ratio and vertical resolution) of each ratio curve of real-tested carbon - oxygen ratio spectral log can be estimated quantitatively by using coherent technique. The practical application showed that carbon - oxygen ratio, silicon - calcium ratio, porosity indicator ratio, iron indicator ratio and salinity indicator ratio of carbon - oxygen ratio spectral log measured by single detector have good quality and can be used for practical interpretation, but lithology indicator ratio and calcium - silicon have bad repeatability and can't be used for practical interpretation; carbon - oxygen ratio, silicon - calcium ratio, porosity indicator ratio and salinity indicator ratio measured by double detector have better quality than that by single detector, among which the quality of carbon - oxygen ratio spectral logging curves measured by far detector is better than that by near detector, the quality of capture curves is better than that of non-elastic dispesive curves.

Key words: carbon - oxygen ratio spectral log, single detector, double detector, repeatability, S/N ratio, vertical resolution, spectrum analysis

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Coincidence of seismic data with drilling data to improve fine interpretation level. Lu Gang-chen, Kong Fan-dong, Ding Xue-yin, Lu Yan-xia and Yao Yi-tai. *OGP*, 2004, 39(2): 198~204

In order to more objectively and accurately reflect the underground geologic scenario, it must use combination of seismic data with drilling data to do seismic data interpretation, that is more important to known oil/gas region. Therefore, the paper considered that it must better make such combination in following aspects: seismic horizons being finely labeled; adjusting seismic interpretation schedule, discovering and describing the concealed faults mainly according to drilling-showed formation; using reservoir relation to find minor faults; qualitatively describing laterally plugging faults, fully using dipmeter synthetic curves to aide structural interpretation and interpret the special scenario on the sections. Some practical cases were listed in the paper in order to detailed description of common combination forms of seismic data with drilling data in reservoir exploration of maturing region. Interpreted cases showed the goal of fine structural interpretation can be achieved only by fully using abundant drilling information and making it maximum combination with seismic data.

Key words: fine structural interpretation, drilling data, seismic horizon labeling, concealed fault, synthetic interpretation, laterally plugged fault

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Study of velocity and attenuation for gas-bearing hydrate formation. Zhang Yu-wen, Liu Xue-wei and Jin Yu-jie. *OGP*, 2004, 39(2): 205~214

Based on Biot two-phase medium theory and three kinds of hydrate deposition mode (that is hydrate is a part of liquid, hydrate is a part of solid frame and hydrate cement is on the contacted face of solid grain), the paper studied the changing law of velocities of fast P-wave, slow P-wave, S-wave and attenuation with frequency for hydrate-bearing formation under the conditions of dissipation and non-dissipation, compared the calculated results for above-mentioned three models with that of the formation without hydrate and pointed out that the third model has significant different characters

from other two models in variation of velocity and attenuation with frequency, mainly showing as the reliance on frequency. We can qualitatively divided the third model from the other two models according to the character.

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Using seismic data to identify gas in Tainan gas field. Wang Gong-huai, He Bi-zhu and Liu Ya-cun. OGP, 2004, 39(2): 215~217

Tainan gas field is Quaternary biogenetic gas, having characters of shallow buried depth, thicker gas-bearing bed and simple structure, which is of benefit to use seismic data to identify gas reservoir. Because the former seismic data in that area are common-processed seismic sections that have lower S/N ratio and poorer event continuity and any feature of gas-bearing bed has not been seen on the sections. Therefore, the processing tests have been carried out on a seismic line that crosses the gas field. The results showed that using 20 Hz in frequency to carry out target-oriented processing can best reflect the seismic response to the gas-bearing bed, such as dim spot, plat spot, event downwarping, low-frequency effect and polarity reversal etc. The planar distribution of gas reservoir in separate layers can be predicted according to these characters, that meets the need for development of gas field.

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Division of oil/gas-bearing system of Jiannan buried-hill, Huanghua Depression and prospecting direction. Li Ting-hui, Li Zhen-yong, Wang Jin, Liang Hui-lan and Kong Fan-dong. OGP, 2004, 39 (2): 218~221

According to the characters of source rock and structural relation in Jiannan buried-hill area, Huanghua Depression, the paper divided the area into two oil/gas-bearing systems: Beitang oil/gas-bearing system and Nanpu oil/gas-bearing system.

The key period of accumulation of Beitang oil/gas-bearing system is the latter of Ed, the main hydrocarbon-bearing interval is Paleogene Es_3, forming Es self-producing and self-reserving primary reservoir. The key period of accumulation of Nanpu oil/gas-bearing system mainly is the latter of Nm (2Ma), the main hydrocarbon-bearing interval is Es_1 and Ed_3 source rock, forming Ed self-producing and self-reserving primary reservoir and Teriary secondary reservoir. The west structures on the side of downthrow of Jianxi fault belong to Beitang oil/gas-bearing system after analysis, so the prospecting in this area is to take Es_3 interval as main target; The east structures on the side of upper side of Jianxi fault belong to Nanpu oil/gas-bearing system, so the prospecting in this area is to take Ed interval and Teriary system as main targets.

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Structural character of frontland thrust belt of Jiuquan Basin South Margin and oil/gas exploration direction. Zhao Xian-zheng, Xia Yi-ping, Pan Liang-yun and Xie Jie-lai. OGP, 2004, 39(2): 222~227

Because of thrust action of Qilian Fold Belt from south to north in Cenozoic, the complex foreland basin was formed laterally in Jiuquan Basin, having following structures successfully: South-Margin frontland thrust belt, South foreland depression, foreland slope, Heishan-Helishan frontal uplift and Huahai-Jinta post-uplift depression; vertically there is characteristic of double-layer structure that the Cenozoic foreland structural layer was stacked on Mesozoic strengthening structural layer. Mainly through the synthetic study of seismic sections and outcrop, the analysis in the paper centers on the characters of geologic structures and structural deformation in Jiuquan Basin since Neogene and the next oil/gas exploration direction, in which the following acknowledge is gained: the structural deformation of South-Margin frontland thrust belt is characteristic of the lateral stack of multiple thrust belts and structural deformation and structures are characterized by clear east-west segmentation because of the divide action of adjust-

ing fault, the strength of structural deformation is generally showed as strong in west and weak in east and trust block is widely thrust above the Lower Cretaceous; oil geologic condition is superiority in South-Margin foreland thrust belt that is most important oil/gas accumulation zone in that basin, among which the thrust structure on the side of down-thrown of thrust block is main targets of next oil/gas exploration.

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Selective-inverted characters of faults in Liaohe Depression. Zheng Meng-lin, Wu Tie-sheng, Wang Gui-liang, Gao Qing-sheng and Deng Xiu-chun. OGP, 2004, 39(2): 228~231

The developed inverted faults in Liaohe Depression have various form of expression, such as the lower-normal and upper-reverted fault, the reverse fault with inverted fault plane and inverted fault with flower-structural character. The inverted faults of Liaohe Depression are distributed in the east faulted depression, west faulted depression and Damintun faulted depression of second structural unit. Most of them are born in main fault parts having NE and NNE directions that controlled the deposition of faulted depression. Only some of faults were inverted in the same fault system controlling the development of faulted depression and only some segments were inverted in same fault. The characters of coexistence of normal and thrust faults in depression and combination of normal segment and reverse segment in same fault are formed. The inverted faults in Liaohe Depression belongs local inversion, being of benefit to oil/gas accumulation.

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Soft region and hard block. Hao Wei-san. OGP, 2004, 39(2): 232~236

Because of different softness and hardness in crystalline basement of different structural units, the difference reflected on Bouguer gravimetric anomaly map and magnetic anomaly map is significant. The Bouguer map for hard block is characterized by regionally open and flat gravitational high and its magnetic map is characteristic of wide and flat magnetic high or normal magnetic response; gravitational low having clear trend and close isoanomalic contour is characteristic of Bouguer map of soft region and magnetic field of this region on magnetic map is characteristic of changed or significantly changed area. The reasons resulted in abovementioned phenomena lie in that most of the hard blocks were old uplift-new depression, the basement of soft region was softer, which is easy to produce lateral compression and vertical increase under the action of horizontal extrusion, forming severe fold belt.

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Talk about effectiveness for a given period of time of paper published in Oil Geophysical Prospecting. Zhang Ya-zhong, Zhu Han-dong, Ren Dun-zhan and Li Zao. OGP, 2004, 39(2): 244~247

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