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ABSTRACTS

Attributes analysis and optimum design of 3-D geometry. Yin Cheng, Lü Gong-he, Tian Ji-dong, Shang Ying-jun and Xu Jin-xi. *OGP*, 2005, 40(5): 495~498, 509

Attributes analysis and design of 3-D geometry are an important link of seismic data acquisition, among which the reasonableness of offsets distribution in attributes analysis of geometry is one of most important parameters. Common-used seismic data acquisition software don't provide distinguishing standard of quantitative analysis. For that reason, starting from the quantitatively distinguishing standard of offsets-distributing reasonableness and optimum design of geometry parameters, the paper presented that using the size of changing rate of adjacent offsets within a bin to judge the uniqueness of offsets distribution and minimizing the variance of offsets-changing rate for objective function of optimizing geometry parameters, which provided new method and tool for optimum design of geometry to a certain degree and in part links.

Key words: 3-D seismology, geometry, offset, optimum design

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Slide-sweeping harmonic analysis. Cao Wu-xiang and Zhang Mu-gang. *OGP*, 2005, 40(5): 499~503, 509

Shooting by vibroseis has important position in seismic exploration. The pattern of shooting by vibroseis has developed from former shooting in single shot-point to current shooting by multi-source. In order to improve the efficiency of multi-source shooting, it should use slide sweeping. The basic idea of slide sweeping is to use multi-group of vibroseis for slide sweeping without waiting, i. e. the other source has begun starting sweeping for shooting when the former source doesn't finish the process of sweeping for shooting, which inevitably produced harmonic interference. On the basis of briefly introduced slide sweeping technique, the paper analyzed the distributing feature of harmonic distortion, discussed the method greatly improving the efficiency of seismic operation by reasonable

setting sliding time and reducing the influence of harmonic distortion on seismic data quality and illustrated the results by real cases.

Key words: slide sweeping, harmonic distortion, sweeping length, sliding time, listening time

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Three-parameter velocity analysis of converted wave and NMO method. Liu Yang and Wei Xiu-cheng. *OGP*, 2005, 40(5): 504~509

The precision of converted wave time-distance equation directly affects the velocity analysis of converted wave and its NMO precision. Common-used converted wave time-distance equations include hyperbolic equation (single-parameter equation called in the paper), double-square-root equation (or called double-parameter equation) and high-order non-hyperbolic equation. Coming from the P-wave larger-offset equation and faced with the feature of converted wave propagation, the paper deduced converted wave three-parameter time-distance equation that can reflect the vertical inhomogeneity of media, among which the three parameters mean P-wave velocity, S-wave velocity and vertical inhomogeneity separately. On that basis, the methods for three-parameter velocity analysis and NMO of converted wave have been formed. In order to comparison among the single-parameter equation, double-parameter equation and three-parameter equation, we use these three equations to make syntheses data and process the real data, the results showed the converted wave three-parameter equation is superior to the other two equations in precision.

Key words: converted wave, inhomogeneity, time-distance equation, velocity analysis, NMO

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Analysis of velocity at common-converted-point. He Bing-shou and Zhang Hui-xing. *OGP*, 2005, 40(5): 510~514

The distance of common converted point (CCP) of converted wave relative to common mid

point (CMP) changes with such factors as ratio of P- and S-wave velocities, depths and offsets, which can't use fixed gathers to conduct analysis of converted wave velocity, whereas use different gathers to conduct velocity analysis when ratio of velocities and depths change. The paper presented a method of analysis of converted wave velocities that sorts traces dynamically along with the variation of ratio of velocities and depths of converted points, which realizes the correspondence of sweeping stack velocities and depths of converted points with common converted point gathers. It is shown by theoretical model and real seismic data that the method is effectiveness.

Key words: seismic exploration, converted wave, CCP gather, velocity analysis

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Seismic data interpolation based on signal hi-fi. Chen Shuang-quan, Wang Shang-xu and Ji Min. *OGP*, 2005, 40(5): 515~517

In a process of seismic data processing, it needs interpolation processing of seismic data when hi-fi static corrections and NMO processing are carried out, so how to select interpolation method adapted for hi-fi seismic signal is important. The paper uses Sinc function interpolation algorithm for interpolation of seismic data. The paper analyzes the superiority of Sinc function in seismic data interpolation and introduces the implementing method of Sinc function interpolation. It is shown by test and analysis of real model cases that using Sinc interpolation method can reduce the signal damage caused by interpolation and protect original seismic signal information.

Key words: signal hi-fi, Sinc function, interpolation, sampling

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Seismic trace reconstruction by trace equalization parabolic Radon transform. Wang Wei-hong, Gao Hong-wei and Liu Hong. *OGP*, 2005, 40(5): 518~522, 560

Based on the basic principle of seismic trace reconstruction by parabolic Radon transform (PRT) and basic nature of Fourier transform spectrum, the paper presented iteration plus trace e-

qualization parabolic Radon transform method that combines the trace equalization technique with band-limited PRT method, which not only greatly improves computational efficiency of interpolation reconstruction of missing seismic trace, but also is successfully used for anti-alias re-sampling processing in prestack seismic data. In comparison with traditional least square parabolic Radon transform, the method has equal computational precision but the efficiency increases by a factor of about 5. The theoretical model test and real seismic data processing showed that the method is characteristic of high precision and high efficiency.

Key words: parabolic Radon transform (PRT), iteration, trace equalization, seismic trace reconstruction, rapid algorithm

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Elastic wave equation inversion of seismic data in layered half-space. Zhang Fan-chang and Yin Xing-yao. *OGP*, 2005, 40(5): 523~529

Because prestack seismic data contain abundant both P-wave and S-wave information that are close relative to lithology, so more abundant and effective lithologic information can be obtained from inversion of prestack data in comparison with from ordinary poststack impedance inversion. Since propagating regularity of seismic wave in layered elastic half-space has condition simulating common AVO analysis, so a method based on elastic wave equation can be adopted to synthesize prestack records. The paper deduced the reflection formula formed by spherical wave in layered half-space that contains spreading effects of waveform, S-wave reflections in layered strata and reflections from free surface; taking the forward simulating algorithm as a basis, a set of prestack elastic wave equation inversion methods was built up, among which the solution of inversion problem was finished by genetic algorithm. The real implement of genetic algorithm was designed totally according to prestack inversion that is a certain optimized non-linear multi-parameters problem in order to effectively search optimum strata parameters. The P- and S-wave velocities and densities computed from prestack elastic wave inversion can be used to compute lithologic physical parameters such as Poisson ratio, elastic modulus etc., providing new tool for identifying fluid content in reservoir pores.

Key words: prestack inversion, elastic wave equation, prestack records, spherical wave, genetic algorithm, lithologic parameter

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Experimental results in partially saturated sandstone under condition of different pressure and their theoretical interpretation. Deng Ji-xin, Wang Shang-xu and Yu Jun. *OGP*, 2005, 40(5): 530~534

Under the experimental high-frequency condition, the velocity variation of elastic wave of sandstone samples in reservoir with saturation obtained by using common saturated method appears complex pattern, which is different from the theoretical results given by effective fluid model used in seismic exploration that is more apparent in lower confining pressure. Under the pressure-changed condition, the paper conducted systematically experimental research and quantitative analysis for the variation regularity of P- and S-wave velocities of partially saturated sandstone in reservoir. The study showed that under the experimental high-frequency condition, non-uniformity of fluid distribution in two different pore scales significantly affects the experimental results, that is also the main reason that differences exist between the experimental results and theoretical values of effective fluid model; the effect of unrelaxed action of saturated fluid in the fracture with smaller aspect of pores on elastic wave velocity exists under the high-frequency condition; the non-uniform patchy distribution of pore fluid in larger scale (including several pores) affects the P-wave velocity. It should consider the influences of these factors when analyzing elastic wave velocities either in laboratory condition or in practical seismic exploration.

Key words: elastic wave velocity, partially saturated sandstone, reservoir sandstone, distribution of pore fluid, high-frequency condition, fluid sandstone

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Quasi P-wave forward modeling in frequency-space domain in VTI media. Wu Guo-chen and Liang Kai. *OGP*, 2005, 40(5): 535~545

Coming from elastic wave equation in VTI me-

dia, by the aid of elastic parameters of VTI media and Thomsen parameters and combining with Kelvin-Christoffel equation, the paper deduced quasi P-wave equation in VTI media and implemented its forward simulation. During the process of forward simulation, in order to overcome the numeric dispersion in ordinary finite-difference operator, we adopted optimized 25 points finite-difference operator; differential format of quasi P-wave equation in frequency-space domain was created on the basis of optimum coefficients computed by way of optimization theory; in order to eliminate the reflections from the artificial boundary, the boundary conditions in different boundaries and corners for quasi P-wave equation in VTI media were constructed according to eigenvalue analysis and by using Kelvin-Christoffel equation; coming from the quasi P-wave equation and boundary conditions, the numeric forward simulations were conducted for the quasi P-wave propagation in homogeneous VTI medium, layered VTI medium and sag model separately by finite-difference algorithm in frequency-space domain. Single-frequency wavefields, time slices and common-shot-point records were obtained by forward simulation that provided a foundation for studying seismic imaging and inversion.

Key words: VTI media, forward simulation, optimum finite-difference operator, boundary condition, frequency-space domain

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Using uphole survey data to compensate high-frequency components of seismic data. Tian Gang, Shi Zhan-jie, Dong Shi-xue and Wang Zhe-jiang. *OGP*, 2005, 40(5): 546~549

The Low Velocity Layer zone (LVL) in desert area is main reason causing serious high-frequency attenuation of seismic data. For that reason, it should adopt direct wave data of uphole survey, use optimum Wiener filtering method and compute inverse filter for compensating absorption of LVL in different thickness to compensate the high-frequency components of seismic data. The paper briefly introduced the principle of inverse filter for compensating absorption and applied the inverse filter for compensating absorption to process the common stack data. The correlation between the pre- and post-processing data showed the spectral ener-

gy after the processing of compensating absorption can significantly broaden the bandwidth of dominant signal-to-noise of stack data in targets, increase relative energy of high-frequency components and improve the resolution of stack section. Meanwhile, the method can also protect the low-frequency components. Using the method to compensate the high-frequency attenuation of seismic signal is better and easier than inverse-Q filter.

Key words: desert area, uphole survey, compensating high frequency

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Frequency attributes characters of seismic traces in time domain and division of stratigraphic sequence. Xia Zhu, Liu Chao-ying, Wei Wen-bo, Ren Dun-zhan, Lang Ke-rang, Chen Geng-yi and Wang Yu-zhu. *OGP*, 2005, 40(5): 550~560

In high-resolution seismic exploration, apart from reflecting the underground sequential interfaces in different levels, seismic frequency attribute also includes sequence-internal structural information. Using time-frequency filtering technique to study the relationship between the frequency attribute character of seismic traces and sequence-internal structures can improve identified precision of sequence strata. The study showed that the frequency value in time domain, energy of frequency cluster, variation of time thickness of frequency branch and its branched structure, lateral spreading regularity and array pattern and formation of multi-periodic time-frequency sequences have obviously corresponding relationship with stratigraphic attributes and sedimentary cycle. Directly using the variety of characters of frequency attributes can more reasonably divide different kinds of multi-periodic and multi-cyclic time-frequency sequences at a different angle, which can more accurately identify lower levels of sequential details and realize high-precise prediction of thin beds.

Key words: frequency attribute character, branched structure, time-frequency sequence, division of stratigraphic sequence

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Study of near-shore underwater fans in Guanjiapu beach area and its exploration meaning. Li Ting-

hui, Liang Hui-lan, Hu Yong-jun, Chang De-shuang, Kong Fan-dong, Yao Yi-tai and Zhao Chun-duan. *OGP*, 2005, 40(5): 561~564

Guanjiapu beach area is located in slope zone that is transient zone from Qikou sag of Bohai Bay basin to Chengning uplift, where the Es is one of major exploration strata in the area. The Es is mainly lake basin margin facies deposition and developed near-shore underwater fans. Taking the coastline as a boundary, the Es sedimentary system in the area can be divided into following parts; the east sea area is underwater fans deposition with high content of feldspar and igneous grains; the west continent is underwater fans deposition with high content of carbonate grains. The east fans are characteristic of good reservoir quality and the west are bad. The paper finely described the spatial spreading feature of fans by identification of seismic facies, seismic attributes prediction, logging-constrained inversion, micro-facies analysis and frequency-division interpretation etc. It considered in combination with the analysis of reservoir-formed conditions that the near-shore underwater fans have the condition forming structural-lithologic reservoir and lithologic reservoir, the distribution of reservoirs has obviously controlling role to oil/gas accumulation and the favorable zones of expanded exploration areas should be along the main water channel where the fans were formed.

Key words: seismic facies, seismic attributes, near-shore underwater fans

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Geophysical feature of special low-positional geologic bodies in minor faulted lake basin: case of Miyang sag. Jiang Shu and Wang Hua. *OGP*, 2005, 40(5): 565~568, 584

Some low-positional fans in marine basins and large-scale of continental basins are often relative to oil/gas accumulation. In view of unclear feature of low-positional geologic bodies in sequence-stratigraphic framework of minor faulted lake basin, the authors introduced the conception of special low-positional geologic bodies in a process of studying minor faulted lake basin and found some special low-positional geologic bodies in sequence-stratigraphic framework on the basis of studying typical minor faulted lake basin—sequence-stratigraphic framework of Miyang sag. These special low-positional geologic bodies have distinct fea-

ture; the seismic reflections are characteristics of downlap structure in both direction; the self potential logging traces are box- or bell-shaped characteristics; the resistance logging traces are characteristics of fingers; there is significant difference between the mean-square-root amplitude volume and surrounding amplitudes; the impedance by logging-constrained inversion is significantly greater than surrounding data volume. These geophysical characters not only verify reliability special low-positional geologic bodies being looked for, but also are means and tools looking for special low-positional geologic bodies.

Key words: continent faulted lake basin, special low-positional geologic bodies, Miyang sag, sequential stratigraphy, subtle oil/gas reservoir

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Discussion about flexi-bin geometry. Chen Hao-lin, Liu Jun, Li Wen-jie and Zhang Rui-hua. OGP, 2005, 40(5): 569~575

Based on the result of 2-D field experiments, the paper analyzed and discussed 2-D ordinary geometry and flexi-bin geometry and further analyzed 3-D flexi-bin geometry, which got following conclusions: flexi-bin geometry may result in violently skipping variation in minimum offset, azimuth and even spatial wavefield of adjacent bins; the more the flexi-bins, the bigger the skip and the sudden change that have more significant influence on seismic data. The similar conclusions are also true for 3-D flexi-bin geometry, so that when designing the flexi-bin geometry, it should not only pay attention to the attributes of bin itself (including uniform distribution of offset and azimuth), but also consider the variation between adjacent bins and take relevant measures such as shorten of intervals of receiving lines and shot lines, which do our best to reduce the spatial variation. Generally, it had better do half-division for 2-D geometry and quarter-division for 3-D geometry.

Key words: 2-D/3-D, flexi-bin geometry, bin attributes, offset, azimuth

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Improving horizons-labeling method on seismic synthetic records. Zeng Zheng-ming. OGP, 2005, 40

(5): 576~578

Seismic horizons labeling is basis of structural interpretation of seismic data and study of seismic reservoir. There are many factors that affect the precise of horizons labeling. In order to eliminate the influence of time-distance relationship on seismic synthetic records, we suggest using time-scanning method to replace manual-shifting method. The time-scanning method can also be divided into integral-time-scanning method and local-time-scanning method. In order to eliminate the influence of the characters of used wavelet phases, we suggest using phase-scanning method to select optimum matched wavelet to make synthetic records on the basis of using time-scanning method to accurately determine the time-distance relationship, which can realize optimum seismic-horizons labeling.

Key words: synthetic record, horizons labeling, variance, time scanning, phase scanning, precision

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Recognition of subtle traps in SWD area. Li Yun, Ding Zheng-qing and Xu Jiang-qiao. OGP, 2005, 40(5): 579~584

The major prospecting target in SWD area is Jurassic Sangonghe Group Second Segment (J_1s_2) that is characteristics of south-inclined single-slope configuration, simple structure and undeveloped faults, and the exploration objects are subtle strata traps. The major prospecting objective sand body is meandering river delta front branching channel sand body that is characteristics of good reservation of fine-grained contents on the top part of channels, smaller grain grade, relatively undeveloped sand (gravel) stones and rapid variation of lithology on plane, which easily forms typical sandstone pinch-out reservoir that is difficult to identify and describe this kind of traps. The dominant frequencies of seismic data in the area are 45~55Hz and identified minimum thickness of strata is about 25m, which can provide more reliable data foundation for subtle reservoir exploration in the area. Coming from seismic and geologic feature in the area, the paper created seismic and geologic interpretation mode through stratigraphic-sequence division of major targets, fine horizons labeling and seismic forward and inversion studies; effectively identified and described subtle traps by using seis-

mic attributes analysis techniques to study sedimentary facies and distribution regularity of sand bodies and combining with logging-constrained inversion technique, among which $J_1s_2^1$ lithologic traps in S4 block has been proved by latter drilling results.

Key words: subtle trap, seismic and geologic feature, stratigraphic-sequence division, forward modeling and inversion, seismic attributes, sedimentary facies

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Using P-wave data in different angular domains for inversion of P- and S-wave velocities. Jiang Xiu-di, Wei Xiu-cheng, Huang Han-dong and Wang Jian. *OGP*, 2005, 40(5): 585~590

The ordinary seismic trace inversion based on the hypothesis of vertical incidence of reflected P-wave can't get reliable velocity or other lithologic information, but using prestack seismic data for stack by partial angular gathers can obtain many seismic sections with AVO characters, where the S/N ratio can also be greatly improved, so partial angular stack gathers can act as basic gathers of elastic impedance inversion or simultaneous inversion of P- and S-wave velocities. The inversion of partial stack sections in each angular scope can result in impedance or P- and S-wave velocities values in that angular scope, but relationship between the inverted results in different angular scopes and how to compute P- and S-wave velocities values in zero-incident angle are still difficult to be solved. For that reason, the paper presented the theory using variation of seismic propagating velocities with incident angles in anisotropic media and computation of P- and S-wave velocities values of seismic wave in zero-incident angle from inverted results of P- and S-wave velocities values in different angular scopes, which realized using prestack P-wave data for simultaneous inversion of P- and S-wave velocities and further can compute ratio of P- and S-wave velocities and Poisson section that can provide reliable foundation for lithologic and oil-bearing interpretation conducted by the interpreters.

Key words: P-wave velocity, S-wave velocity, seismic inversion, Hessian matrix, anisotropy

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Gravitational anomaly feature of reservoir in overlap zone of Songliao west slope. Zhang Yan, Yang Hui, Wen Bai-hong and Wu Xiao-zhou. *OGP*, 2005, 40(5): 591~593

The reservoirs in overlap zone of Songliao west slope are characteristic of shallow buried depth that generally is 300~600m and the lowest depth is 5~12m. On the basis of the conclusion studied by the predecessors that different type of reservoirs can produce relative negative gravitational anomaly, the paper studied in detail gravitational data of oil-sand mine drilled in Pu-36 well situated in Tumuji area. It is summarized that positive structural background can produce regional gravitational high and lithologic reservoir in that background also can produce local lower gravitational anomaly, which formed feature of "sag within uplift" on one-order gravitational derivative anomaly chart. The feature was predicted in the north area of Tu-9 well according to abovementioned analysis, which became oil/gas-predicted zone that has been preliminarily proved by geologic, self-potential and drilling data. Afterwards, using this idea to implement similar analysis for gravitational data in adjacent Jiang-37 well area, which discovered gravitational anomaly feature of "sag within uplift" in gravitational data of Jiang-37 well area.

Key words: Songliao west slope, one-order gravitational derivative, gravitational survey, oil/gas detection

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3-D physical model experiments of well-to-ground electrical survey. Wang Zhi-gang, He Zhan-xiang, Wei Wen-bo and Deng Ming. *OGP*, 2005, 40(5): 594~597

The paper uses tank simulation experiments to obtain electrical potential anomaly of single model, lateral and vertical array models. The experiment uses stainless steel pipe for simulating metal pipe, thin copper rod for power-supplied electrical pole, high-resistant isolated plate for oil horizon, red copper for water layer and network electrical potential recorder with 128 channels for recording. It can provide foundation for using well-to-ground electrical survey to study oil/gas reservoir or water-bearing layer through studying anomaly regu-

larity of electrical potential isopleths on the ground when high-resistant or low-resistant anomalous bodies exist in power-supplied steel-cased well. The simulated results showed that direct-current charge method, which is one of well-to-ground working mode that measures distribution of electrical field on the ground (or on the water surface) when supplying direct current to the oil well, can effectively eliminate the influence of non-uniform conductivity above on objective oil/gas reservoir, especially, the well-to-ground electrical survey can trap the distributed scope of different reservoirs when coexisting several sets of oil-water layers and certain distance exists among these layers. So, this method can play an important role in oilfield development and monitoring in waterflood stage as well as looking for the residual oil/gas distribution.

Key words: well-to-ground electrical survey, 3-D physical modeling, tank simulation experiment, oil-field development

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Using cosine transform for forward modeling and inversion of gravitational anomaly on density interface. Zhang Feng-xu, Zhang Feng-qin, Meng Ling-shun, Wu Yan-gang, Du Xiao-juan and Fan Meining. *OGP*, 2005, 40(5): 598~602

In accordance with the issue of improving precision of gravitational data processing, the paper presented using cosine transform to study the forward modeling and inversion of gravitational anomaly on density interface and theoretically deduced 2-D and 3-D forward formula for cosine transform spectrum of gravitational anomaly on density interface and inverted formula of interface depth. In order to discuss the inverted precision of the method, the Parker-Oldenberg method and cosine transform method were used separately for inversion of the depth of theoretical model with constant density and single interface and errors correlation was carried out. The maximum error and mean variation between using the Parker-Oldenberg method for inverting the depth of interface and the depth of theoretical model at computational point are 0.148km and 0.013km separately, while the maximum error and mean variation by using the cosine transform method are 0.041km and 0.003km separately and were reduced by 0.107km and 0.010km separately in comparison with the in-

verted results by the Parker-Oldenberg method, which illustrates that the inverted precision by cosine transform method are obviously higher than that by the Parker-Oldenberg method, which increased by 3 times or more.

Key words: cosine transform, interface inversion, the Parker-Oldenberg method, mean variation, precision

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New knowledge about seismic identifying capability. Yun Mei-hou and Ding Wei. *OGP*, 2005, 40(5): 603~608

Seismic resolution is always one of major studied problems. On the basis of expounding the difference between the seismic identifying capability and seismic resolution, the paper introduced the definition and criterion of seismic identifying capability, discussed the relationship and difference between seismic identifying capability and geologic interpretation ability and renewed the knowledge about relationship between noise and identifying capability. The study showed that seismic identifying capability is a subjective existence of seismic data that only depends on the nature of seismic wavelet and is independent to whether the noises exist or not in seismic sections. The only way to improve seismic identifying capability is to improve the nature of seismic wavelet. Improving the S/N ratio can only improve seismic-geologic interpretation ability and cannot improve identifying capability fundamentally. Under the condition of fixed seismic identifying capability, using special method (technique) can interpret the variation in thin beds that the thickness of strata is less than $\lambda/4$, but never means that the seismic identifying capability will be improved and only illustrates that the seismic-geologic interpretation ability will be strengthened.

Key words: seismic identifying capability, Rayleigh criterion, $1/4$ wavelength, S/N ratio, seismic-geologic interpretation ability

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New ideas improving capability of subtle oil/gas reservoir exploration. Xie Zhan-an and Zhou Jing-ming. *OGP*, 2005, 40(5): 609~615

Vast areas in China have entered the stage of subtle oil/gas reservoir exploration, along with the variation of prospecting objects, the seismic technology confronts with new serious challenge. The paper presented new ideals of subtle oil/gas reservoir prospecting; on the basis of 3-D "three high" (high S/N ratio, high resolution, hi-fi) fine processing and fine structural interpretation, through prestack and poststack (AVO and impedance) attributes parameters inversion and using high-resolution stratigraphic-sequence interpretation technique to closely combine the geophysical prospecting with geology; Through integrative working mode of processing and interpretation to realize organic combination of geology, seismic and logging information, which finished reservoir description and appreciation and presented favorable traps and suggestion on drilling-site deployment. The paper

also discussed the data processing and data interpretation techniques under the integrative mode of processing and interpretation and their importance. The paper considered using the integrative mode of processing and interpretation in whole process of data processing, structural interpretation, reservoir interpretation and oil/gas prediction both can promote development of seismic techniques and can improve prospecting benefits as well as reduce exploration risk.

Key words: seismic exploration, integration of processing and interpretation, new idea, exploration of subtle oil/gas reservoir, high S/N ratio, high resolution, hi-fi

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