ABSTRACTS

Analysis of seismic energy produced by shock wave of vertical stack source. Song Yu-long, Lü Gong-he, Wang Xin-hong, Xu De-hui and Fang Shi-xin. *OGP*, 2004, 39(4): 371~374

According to explosive theory, the paper analyzed the relation of energy transformed from shock wave into seismic wave when explosion by spherical charge, studied the principle of seismic energy stacked by using multilevel small-charge-sized and vertically delayed sources, which suggested that two-level vertically-delayed time depends on the interval of two-level spherical charges and it must consider the radius of broken zone formed by explosion of one-level spherical charge and the explosion-save distance. Under the condition of reasonable controlling on time of ignition of two-level or multilevel spherical charge, the downgoing energy of seismic wave can be improved and the vibration of surface can be reduced. The experiment of vertically delayed stack source has been implemented by using the results of the theoretical analysis. The results showed that the vertically delayed stack source can increase the frequency of seismic wave in a precondition of ensuring a certain S/N ratio, that is ideal explosive source for high-precision seismic exploration.

Key words: source, seismic exploration, shock wave, seismic wave, energy

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3-D seismic geometry design based on seismic data processing — Case of 3-D seismic geometry design in south steep slope of Miyang Depression. Liu Xue-wei, Yi Jun-jie, Wang De-zhi and Jia Lie-ming. *OGP*, 2004, 39(4): 375~380, 387

In order to clarify the position of large boundary fault and inner-structure of faulted zone within south steep slope of Miyang depression and starting from the demand of four key processing links (static correction, velocity analysis, 3-D DMO and migration) on raw seismic data, the paper designed 3-D seismic geometry. After the balance between various processing demands and work efficiency, the numbers of line in each patch, the length of line for full-fold, bin-size, folds both in in-line and cross-line direction and the pattern of spread are defined. The results of application showed that the quality of seismic data acquired from using above-mentioned methods are greatly improved in comparison with the legacy data: distinguished position of fault imaging, reliable feature of events on the targets and above and improvement of resolution and S/N ratio, basically reached the predicted effects.

Key words: geometry design, 3-D seismology, exploration of faulted zone

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Characteristics of wavefield in 2-D viscoelastic random medium. Xi Xian and Yao Yao. *OGP*, 2004, 39(4): 381~387

Non-coherent disturbances are often treated as "noise" in high-resolution seismic data, which actually partially resulted from inhomogeneity of medium in a small-scale, that made one can make inversion of inhomogeneity of medium in small scale in statistical meaning (for instance, spatial autocorrelation function, average anomalous scale and standard deviation etc.). By using staggered finite-difference grads forward modeling for wave equation, the paper modeled seismic propagation in 2-D viscoelastic random medium and self-shooting and self-receiving records; studied characteristics of wavefield, arrival travel-time in maximum amplitude and amplitude attenuation in viscoelastic random medium and gained some conclusions. It is showed by forward modeling that the complex characteristics of wavefield such as scattering wave, amplitude attenuation, traveltime disturbance and seismic tails etc. existed in seismic records associated with viscoelastic random medium model; the scattering form of wave strongly depends on statistical characters of medium such as autocorrelation, variance and absorption coefficient; the variation of autocorrelation length in medium has a little influence on amplitude of wavefront.

Key words: random medium model, staggered finite-difference grids, viscoelastic medium, wavefield modeling

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Analytic velocity analysis in prestack time migration. Xu Ji-xiang and Cui Hua-juan. *OGP*, 2004, 39(4):388~393,405

Common poststack seismic velocity analysis is on the basis of three hypotheses: uniform lateral velocity, small offset and horizontal reflector, which is inconsistent with the feature of geologic sedimentary structure in China. Therefore, the paper presented the method of analytic velocity analysis in prestack time migration. By studying the rule of variation of event depth versus offset on common-imaging-point gathers, the method can result in following conclusions: ①the depth-ditance curves of events are hyperbolic; ②the errors of event depth are directly related to relative errors of velocity; ③the errors of event depth are inversely related to true depth; ④imaging velocities are true velocities when events are flat. The main implementing steps are: using moveout of events on third-order prestack time-migrated gathers to analytically compute the velocities when the moveout (or called as delay)is zero, which are needed imaging velocities; then using these velocities for prestack time migration. The method is used for practical data processing, it's seen from the results that the method is simple and practical and effects are evident.

Key words: prestack time migration, analytic velocity analysis, depth-distance curves

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Analysis of wavelet package and prestack noise-suppressed method in singular value decomposition (SVD). Zhan Yi and Zhou Xiang-xi. *OGP*, 2004, 39(4):394~397

The wavelet analysis is mostly used to suppress the surface wave and singular value decomposition is mostly used to suppress coherent interference, but if strong coherent interference coexisted with surface wave in seismic records, only using a single noise-suppressed method is difficult to achieve success. Therefore, the paper combined the wavelet package analysis with singular value decomposition that can solve the noise-suppressed issue which can't be successfully treated only by a single noise-suppressed method. The method first uses the wavelet package for frequency-shared processing, then uses automatic events-tracing method to find out the direction of events of interference and surface wave on frequency-shared records, next uses singular value decomposition (SVD) method to restore the wavefields of coherent interference and surface wave, finally minus of the results from the original seismic records resulted in noise-suppressed seismic records. It is shown by evaluation of practical data that the effects of the computational method are evident.

Key words: noise suppression, wavelet package analysis, singular value decomposition, automatic trace, coherent interference, surface wave

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Analysis of applied factors for using parabolic Radon transform to remove multiple. Zhang Junhua, Lü Ning, Lei Ling, Tian Lian-yu and Guo Jian-le. *OGP*, 2004, 39(4):398~405

Parabolic Radon transform is one of the effective methods for removing multiple abroad, but unfortunately is less used at home. One of the important reasons is lack of enough knowledge about the key problems such as physical meaning of parabolic Radon transform, its adaptive conditions, algorithm and selection of parameters etc. On the basis of model study and through theoretical model test, the paper separately discussed the characters and existed problems of Radon transform in time domain, different realizing ways and applied effects of Radon transform in frequency domain, alias of Radon domain, solution of complex coefficient matrix equation and selection of white coefficient, mute and truncation effects of multiple in Radon domain and self-adaptive filtering mute etc., acquired some useful conclusions: ①PRT in time-domain can't be directly used; ②the least-square method of forward transform in frequency domain is of benefit to removing multiple; ③the parameter values in Radon domain should meet the sampling theorem; ④the selected white coefficient of solving complex coefficient equation is in a region of 0.1~1.0; ⑤to add a gain function similar to Butterworth filter can realize self-adaptive filtering of multiple. Using the method presented in the paper for practical data processing achieved a good applied results.

Key words: parabolic Radon transform, multiple,

seismic data processing, alias, white coefficient, self-adaptive mute

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Putting 3-D seismic data together based on wavelet transform. Cheng Jin-xing, Zhu Li-hua, Yang Chang-chun and Chen Jun. *OGP*, 2004, 39(4): 406~408

The processing of joining new-acquired 3-D seismic data with legacy data has merging problem because of different shooting and receiving parameters. The merging of 3-D seismic data can be looked as the issue of optimum in different scale space mathematically, the key is how to realize the time-variant merging. Using Mallat factor in wavelet analysis and carrying out the multi-resolution decomposition for two stack data at merging position; using least-square algorithm to compute optimum match filter in different scale space and applying each match filter to one of 3-D prestack data after multi-resolution decomposition separately, the merging goal is arched. The method can realize time-variant merging automatically, result in simultaneous corrections both for phase and amplitude and avoid the influence of noise. The real application showed that the data merging method by wavelet transform has good effects.

Key words: 3-D seismic data merging, wavelet transform, multi-resolution decomposition, match filter

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PRONY filtering method and application. Li Lai-yun, Jiang Jia-yu and Yang Bao-quan. *OGP*, 2004, 39(4): 409~414

There has been long period of time that studying the absorptivity of reservoir was generally to uses Fourier transform that decomposes the signal into harmonic wave and computes the relative average absorptivity of targets by linear form, which constrained the predicting accuracy of reservoir and popularization of the method. The paper used PRONY filtering method that decomposes the signal by damping filtering, implements non-linear filtering and directly computes the absorbing coefficient. The method has good decomposing ability for a single wave, can provide three kinds of shows such as amplitude spectrum, energy curves and PRONY filtered sections, having a strong QC tools. In Zizhou-Jiaxiang area of Changqing gasfield, using the method to predict the Upper Paleozoic reservoirs made good results, the knowledge of relation between absorbing coefficient and gas production is as follows: if it's high gas producing rate, more high-frequency components are absent on section that characterized by weaker energy, evident absorbing zone and being weaker and blind reflection; on the contrary, if it's lower gas producing rate, less high-frequency components are absent on the section that characterized by stronger energy, fuzzy absorbing zone and being middle-strong reflection.

Key words: PRONY transform, signal processing, reservoir prediction, non-linear filtering

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Theoretical solution of seismic reflections from fault plane. Xiao Jian-hua. *OGP*, 2004, 39(4): 415~418, 423

According to fractural condition and infilling material condition and based on theoretical mechanics, the paper studied the reflection and transmission of wavelet from fault plane. The used wavelet is approximation of dominant wavelet frequency in time domain. It is considered by analysis that the fault plane reflection relies on the mechanical attributes of infilling materials and is characteristics of band-pass filter when infilling materials are fluids. The transmitted coefficient contains the information of the filter and evaluation of wave impedance of fluids in broken zone of fault can be measured by decreasing ratio of dominant frequency of transmitted wave, thus the ratio between dominant frequencies of transmitted wave and incident wave can act as studying hydrocarbon-bearing indicative parameter of fault and further be used for detection of fault screen.

Key words: fault attributes, fault plane reflection, seismic exploration, elastic mechanics

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Application of integrative seismic exploration techniques to Kongquehe slope area. Liang Yun-ji, Jia Quan-gen, Jia Lie-min. 2004, 39(4): 419~423

Kongquehe slope is situates in the northeast of Tarim basin, which has good oil/gas exploration

prospect, but it has complex seismic and geologic conditions which resulted in unsuccessful explorations many times in the past. In a new round of exploration, we adopted integrative exploration techniques such as geologic targets-oriented acquisition scheme design, interactive seismic data processing and integrative interpretation of seismic and geologic data to improve exploration accuracy. After first round of integrative seismic exploration, 20 traps have been found and determined and Kongque-1 well in Weima-2 faulted anticline has been drilled, the commercial oil/gas stream has been gained in well test, achieved in good scenario that the exploration provided benefits the same year it was finished.

Key words: Tarim basin, Kongquehe slope, integration, seismic exploration

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Cross-equilibration technique in time-lapse seismic data processing. Li Rong and Hu Tian-yue, *OGP*, 2004, 39(4): 424～427

In recent years, time-lapse seismic reservoir monitoring technique has rapidly developed. The inconsistent factors always existed in practical time-lapse seismic production, mainly are four aspects as time delay of signal, energy difference of signal, bandwidth difference of signal and phase difference. In order to remove or reduce the inconsistent factors, there are four cross-equilibration techniques in time-lapse seismic data processing: ① time shift of data; ②mean-square-root (msr) energy compensation (amplitude equilibration); ③ bandwidth equilibration; and④phase equilibration. The paper introduced the four equilibration techniques and used them for data processing combining with time-lapse seismic data in Bohai area, resulted in good effects.

Key words: time-lapse seismic, cross-equilibration, matched filtering, differential section

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Development of study on detection of Luojia fractured-shale. Ji Yu-xin, Wang Xiu-ling, Qu Shou-li and Liu Yu-zhen. *OGP*, 2004, 39(4): 428～434

In order to examine the capacity using variation of impedance versus azimuth (IPVA) to detect the fracture and showing the author's development in an aspect of fracture detection, the paper detected the distribution of fracture in Luo-42 well zone of Shengli Oilfield. It is shown by drilling data in the region that the fracture-concentrated segment of S3 shale situated in the fourth oil shale of S3 shale. There are many fractural types and the proportion of structural fracture is maximum. Using simultaneously the IPVA method and structural fracture-predicted forward and inversion techniques to predict the distribution of fractures in the well zone, the predicted results of both methods are basically coincident and matched the analytic results of drilling data. It is further demonstrated by above results that the both methods have strong ability of fractural detection and four favorable targets are trapped, providing a benefit basis for exploration of fractured reservoir in the region.

Key words: fractural detection, P-wave in full-azimuth, method of variation of impedance versus azimuth, structural forward and inversion, stress strain

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Study of seismic resolution limit. Ling Yun Research Group. *OGP*, 2004, 39(4): 435～442

Seismic resolution is always the key issue in thin-reservoir and lithologic seismic exploration and is also one of the main problem that is a trouble to geophysical development. Seismic resolution is divided into vertical (time) and lateral (space) resolution. Generally, the 1/4 wavelength of seismic wave is defined as the limit of seismic resolution in notebooks and related literatures, even if according to the Fresnel radius to define the limit of spatial seismic resolution, it is also 1/4 seismic wavelength. It can compute the seismic resolution limit in time and space (1/4 wavelength) according to seismic apparent dominant frequency and the velocity of targets. It is difficult to obtain the geologic information less than 1/4 wavelength by using seismic interpretation according to ordinary resolution theory. If you want to obtain the reservoir information less than 1/4 wavelength, it must raise the dominant frequency of seismic imaging. Because the vertical (time) resolution is affected by attenuation by earth absorption and high S/N ration for practical seismic data, the seismic resolution is limitation and is difficult to meet the needs of geologic interpretation, especially for continental thin reser-

voirs in China. But can the seismic exploration breakthrough the 1/4 wavelength of resolution limit ? Faced with the problem, it is showed by study of many blocks of 3-D seismic data processing that in a processing condition of relatively preserved-amplitude, frequency and phase and combining with reasonable drilling information labeling and seismic attributes detection, the paper considered that the seismic exploration can breakthrough the 1/4 wavelength of seismic resolution limit, which provided an important theoretical basis for seismic exploration of continental thin reservoir in China.

Key words: seismic resolution, thin reservoir, wavelength, relatively preserved-amplitude, seismic attributes detection

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Structural feature of Lujing depression and analysis of oil/gas prospect. Li Gang. *OGP*, 2004, 39(4): 443～449

Late in the 1980's, Lujing depression (also called Mamuwusu depression) became a target of oil/gas exploration. In 1995, the industrial oil/gas stream was first gained at well Er-1, which proved that the depression has the conditions of oil/gas generation and accumulation. But the succeeding drillings (Er-2 and Er-3) have lost. In order to explore the next exploration direction in the region, starting with the structural and sedimentary evolution of the depression, the paper centered on study of characteristics of oil-generated strata, sedimentary facies of reservoir and favorable oil/gas accumulation area. Early-Middle Jurassic Dashankou Group and Cretaceous Mamuwusu Group are main oil-generated rock formation; Early Cretaceous Erjina Group is good reservoir; Early and Middle Yanshan-Movement-formed various local structural traps are capable of being oil/gas accumulated sites; Taoxi lower swell, Ma No. 2 and Ma No. 3 structural belts are favorable oil/gas accumulation zones. The paper suggested that the region has good oil/gas prospect.

Key words: structural evolution, sedimentary facies zone, sedimentary environment, oil-gas-bearing prospect, Lujing depression

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High-resolution seismic data interpretation in Qian northwest area. Li Jian-xiong, Zhang Yan-qing, Cui Quan-zhang, Wu Qing-long and Pan Hong-wei. *OGP*, 2004, 39(4): 450～456

The oil/gas in Qian northwest area of Jilin Province is mainly concentrated on thin sand body with delta front facies. The trap types are mainly lithologic trap and lithologic-structural composite trap. On a basis of 3-D high-resolution seismic data acquisition and processing and through integrative use of coherent volume with optimum frequency band, integrative detection of dips and fault edges, analysis of sedimentary microfacies and seismic inversion etc. , the paper gained the following major results: the rule of spatial distribution of faults is known, total 135 faults are interpreted (only 29 faults in 2-D data); the corresponding relation between sedimentary facies and logging response is built up, the characters of sedimentary microfacies such as underwater distributary channel, river mouth bar, distant sand bar and sheet sand on natural potential logging and resistivity logging are given separately; the scopes of distribution of reservoirs and oil/gas are defined. The good results are obtained by drilling, played a good role in improvement of exploration effects in Jilin prospecting area.

Key words: high-resolution seismic data, optimum frequency band, coherent data volume, sedimentary microfacies, lithologic oil/gas reservoir

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Distinguishing of gas from water in carbonate reservoir of Sichuan basin. Dai Yong, Li Zhen-wen, Cai Qi-hong. *OGP*, 2004, 39(4): 457～460

The seismic and geologic characters of carbonate reservoir in Sichuan basin are: ①the Poison ratio of gas-bearing strata is greatly lower than that of non-reservoir and the Poison ratio of gas-bearing strata is greatly lower than that of water-bearing strata; ② the reflected amplitude associated with gas-bearing reservoir increased with incident angle and the reflected amplitude associated with water-bearing reservoir has no significant variance with incident angle; ③ the absolute value of reflected amplitude associated with gas-bearing reservoir increased with incident angle and the polarity has no reverse. On the basis of above-mentioned seismic and geologic characters of carbonate reservoir, the paper pointed out that we should use

prestack time migration to transform the common-midpoint gathers to common-reflection-point gathers in AVO preprocessing; we should study continuous spectrum analysis besides ordinary AVO attributes analysis and inversion of elastic impedance in AVO attributes analyses. Application of AVO technical series in the paper to distinguish the gas from water in many sets of carbonate reservoirs, that was examined by the results of testing of well in tens exploration wells.

Key words: carbonate rock, distinguishing gas from water, AVO, prestack time migration, spectrum analysis

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Gradually-geometry-changed design principle and application. Li Gui-lin, Liang Yung-ji, Wang Dezhi, Jiang Chun-ming, Lei Xun-yi and Su Jing. *OGP*, 2004, 39(4): 461～464

According to the characteristics of complex structures in Kongquehe area of Tarim basin, the paper presented a designing thought of gradually changed geometry: designing the acquisition parameters (maximum offset, group interval, geophone separation, folds etc.) point by point and segment by segment according to the trend of geologic structural variation and buried depth of targets, among which the NMO stretching, the accuracy of velocity analysis, separation of useful wave from interference, stable reflectivity and effective multiple suppression etc. are considered in selection of maximum offset, designed gradually-changed geometry can meet the needs of NMO stretching, accuracy of velocity analysis and reflectivity at the physical points with different layers. Different spread patterns are used for seismic lines in N-S and E-W directions separately. Acquired seismic single-shot records are characteristics of stable quality, high S/N ratio and reduced shallow multiple and refraction after using designed gradually-changed geometry, better solved the problems existed in data processing such as velocity analysis, NMO stretching, static corrections, stack and migration imaging and achieved good effects.

Key words: gradually-changed geometry, geologic structure, buried depth of strata, seismic-geologic condition

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Application of AVO attributes to wave impedance inversion processing. Song Zong-ping. *OGP*, 2004, 39(4): 465～467

Traditional wave impedance inversion processing and interpretation is on the basis of poststack migrated data, which can't meet the hypothetic conditions of wave impedance inversion. The paper uses AVO attributes parameters to detect the P-wave section and S-wave section, then implements wave impedance inversion separately. The paper discussed such key processing steps as how to do well the low-frequency component processing of wave impedance, compute the deconveltion factor and compute high-frequency component of wave impedance etc. This technique is used for real data processing and achieved evident effects.

Key words: wave impedance, AVO analysis, reservoir prediction

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Joint layer-stripped inversion of 3-D gravity and seismic data. Yang Hui, Dai Shi-kun and Mu Yong-guang. *OGP*, 2004, 39(4): 468～471

Based on the model of 3-D structural map interpreted by seismic data, the 3-D forward gravity modeling is used to model the gravitational effect produced by stripped basement and interfaces above base, then inversion for separated anomaly of base rock is implemented to evaluate the basement density. As concerns the concrete algorithms of joint inversion, the DLSQR method widely-used for seismic tomographic imaging is introduced in potential inversion, that not only improved the stability of joint inversion results, but also increased the inversion speed. The results of test of theoretical models and inversion of real data showed that both have similar isoplethal map of density contract, the relative errors between minimum and maximum density contract is less than 4%.

Key words: 3-D, gravity, seismic, joint inversion, layer-strapped inversion, density contract

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Effects of stratigraphy-sequential interface in prediction of lithologic traps in Fandong area. Fang

Yong, Deng Hong-wen, Dang Zi-jun, Shi Shi-ge and Chen Di. *OGP*, 2004, 39(4): 472～477

In sequence-stratigraphic analysis, the identification of stratigraphy-sequential interfaces and definition of the nature of interfaces are more important. In continental basin, the sequential interface are usually formed in transitional position between rising and falling of datum, that is the position of minimum ratio between capable space and sedimentary supply. In that period, the source supply was abundant, sand body was development and the causes of forming sand body and distribution of sand body are changed around the interfaces, so that the accumulation conditions and types of different sandy bodies are very different. Faced with more than tens meters of sand rock developed in Paleogene S3 Zmiddle Segment in Fandong area, Dongying depression, the sequential interface is determined by using the ratio between capable space and sedimentary supply, it's considered that delta front slum turbidite sand bodies are developed under the interface, above the interface, the basin-floor fan sand bodies caused by turbidite current and slope fan sand bodies caused by gravity flow-traction current are developed.

Key words: accommodation space, sedimentary supply, lithologic trap, datum, sequential-stratigraphy, Dongying depression

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Integrative structural-sedimentary analysis method based on seismic data: a new method for restoring denuded thickness. Hu Shao-hua. *OGP*, 2004, 39(4): 478～483

Triassic is one of the valuable formations for exploration in Tarim basin, thus the restore of denuded thickness and study of raw basin can further clarify the following problems such as distribution of Triassic sedimentary zone, framework of basin and prediction of exploration prospect, that are significant to exploration in Tarim basin. The paper presented a method for integrative structural-sedimentary analysis based on seismic data in order to restore the denuded thickness. The restoring the denuded Triassic thickness in Tarim basin is carried out by analysis of a majority of seismic data and drilling data. It's considered that Taxinan area in Tarim basin had thicker Triassic sediments, the raw Triassic basin were two foreland basins formed from the press of Beikunlun and Nantianshan in opposite direction, that were Kuche foreland basin and North foreland basin.

Key words: Tarim basin, restore of denuded thickness, raw basin, foreland basin, Triassic

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Relation of structural highs between overburden of salt and subsalt layers in Kelasu tectonic zone and petroleum geologic significance. Zhang Jun-jie and Chen Shu-ping. *OGP*, 2004, 39(4): 484～487

Kumgeliemu Groupe, lower part of Tertiary in Kuche depression, is a set of huge thickness of gypsum salt that caused inconsistent deformation between overburden of salt and subsalt layers, which is evident in Kelasu tectonic zone. It's proved by seismic sections and drilling practice that the structural highs of overburden of salt and subsalt layers exit two corresponding relations, that is structural highs (anticlines) in overburden of salt are corresponding to the synclines in subsalt layers and anticlinal flanks of overburden are corresponding to anticlinal highs in subsalt layers. These corresponding relation of highs is related to contacting relation between Kuche foreland fill and Tianshan orogenic wedge. The highs (anticlines) of overburden of salt corresponds to front-flank of subsalt anticlines and back-flank of overburden to subsalt highs when the foreland fill thrusted beneath the Tianshan orogenic wedge; on the contrary, the structural highs of overburden of salt corresponds to subsalt synclines and synclines of overburden to subsalt anticlines. From the respect of petroleum exploration, the former is of benefit to preservation of oil that is favorable zone of oil prospecting.

Key words: Kuche depression, Kelasu tectonic zone, salt structure, structural high

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