

## ABSTRACT

**Progress of research on 3-component (3-C) data acquisition technique on mountain area.** Tang Jianhou, Li Yalin, Zhang Xiaobin, Tang Xiaoxue, Zhang Lin and Chen Xiaochao. *OGP*, 2003, 38(1): 1~4, 16

Sichuan Basin belongs to hilly area, which is one of main gas-bearing basin and mainly fractured gas reservoir. In order to find out orientation, density and scope of fracture in the gas-bearing formation, we continuously study the 3-C data exploration method for many years.

We make 3-C data acquisition two times in same area of south-west of Sichuan Province within 10 years. The quality of acquired field 3-C data has been greatly improved (after estimation of quantitative signal-to-noise ratio), which benefit by the progress of acquisition equipment, technique and management. First is renewing the acquisition equipment; studying new-type, practical land 3-C geophone, which achieved the designing goals such as can be easily laid out, has good coupling to ground and without crosstalk, and using 360-cannel Telseis for receiving. Second is the progress of acquisition technique, including designing and optimization of acquisition parameters of system. Third is good operation management; carefully monitoring coupling of geophone to the ground, levelling survey, orientation of geophone and depth and position of shot, which reduce errors to minimum.

**Key words:** 3-component, converted wave, geophone, signal-to-noise ratio

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**A new method for seismic exploration of free arrangement.** Liu Taifeng, Ning Shunian and Kang Junjian. *OGP*, 2003, 38(1): 5~10

Limited by many factors and conditions such as apparatus, cables and field etc. in ordinary acquisition methods, the field operation has disadvantages of extreme difficulty, high cost and long production circle. The paper proposed a new design idea of seismic exploration that can be easily and flexibly operated and adapted to local conditions according to real field circumstances. The paper also briefly introduced field data acquisition system, setup, propagation theory of seismic wave, seismic

data processing and geologic interpretation that can support the realization of the idea.

**Key words:** seismic exploration, data acquisition, setup, theory

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**Seismic acquisition QC under complicated geologic condition.** Cui Xingbao. *OGP*, 2003, 38(1): 11~16

The complicated geologic conditions consist of two meaning: one is that surface seismic condition is complicated; the other is severe varying geologic structure. The key of controlling field acquisition quality of seismic exploration in complicated geologic condition is seizing of three factors: explosion of source, receiving of seismic wave and reasonable and scientific design of seismic setup.

**Key words:** complicated geologic condition, quality control, source explosion, seismic receiving, seismic setup

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**Discussion on reasonable application of seismic exploration technique in exploration and development of Yanqi basin.** Sun Yaohua. *OGP*, 2003, 38(1): 17~21

Application of seismic exploration technique can be divided into primary exploration phase mainly being study of structure by 2-D seismic prospecting, middle exploration phase mainly being seismic stratigraphy, high exploration phase mainly being static description of reservoir by 3-D seismic exploration, primary development seismic phase mainly being seismic reservoir study and high development seismic phase mainly being reservoir monitoring by 4-D seismic exploration. Aimed at the five different phases, selective use of reasonable seismic exploration technique is important way to effectively improve exploration and development benefit. The exploration and development in Yanqi basin reflect the train of thought mainly by using seismic exploration technique and pays attention to select reasonable seismic technology at different

exploration and development phase and aimed at different geologic targets in their exploration and development process, which gained good economic benefits in their early exploration and development.

**Key words:** seismic exploration, neural network, modular recognition, coherent analysis, seismic stratigraphy, 3-D prestack depth migration

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**Estimation of large residual statics in two steps.**  
**Jing Xili.** *OGP*, 2003, 38(1): 22~26

Analyzing the advantages and the shortcomings of linear and non-linear inversion methods, the paper presented a method in two steps for estimation of seismic automatic residual statics. After using non-linear method to obtain initial solution of linear inversion, the method uses linear method to obtain the final high-precision solution. The reduced statics model space has been adopted in non-linear inversion step, accelerating the convergence of non-linear inversion. Model and real data show that the method can better solve the contradiction between desired high-precision statics and poor computational efficiency and can be used for static correction processing of seismic data in the region with more complicated surface-geologic condition.

**Key words:** static correction, simulated annealing, model, inversion

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**3-D seismic trace interpolation in  $f$ - $k$  domain.**  
**Zhang Junhua, Tong Zhaoqi, He Chaoguan and Guan Yixian.** *OGP*, 2003, 38(1): 27~30

Seismic trace interpolation is an important work before migration. On the basis of theoretical study of models, the paper briefly analyzed the problems existed in 2-D interpolation in  $f$ - $x$  and  $f$ - $k$  domain and gave basic formula of 3-D seismic trace interpolation in  $f$ - $k$  domain based on extrapolation of 2-D  $f$ - $k$  spectrum. The used algorithm has been programmed by using corresponding serial modular and parallel routine based on high-performance language HPF. The program has been succeeded in realizing on PC group. The processing results of synthetic model and real data showed that the method can do 3-D wave-field interpolation

finely and rapidly.

**Key words:** 3-D wave-field, spectrum analysis, spatial aliasing, High Performance Fortran Language, seismic trace interpolation, migration

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**Absorbing boundary condition for acoustic wave equation by perfectly matched layer.** Wang Shoudong. *OGP*, 2003, 38(1): 31~34

Aimed at acoustic wave equation, the paper gave absorbing boundary condition by using perfectly matched layer. The basic ideal of the method is that absorbing layer is added on the boundary of interesting region, no reflection is produced when wave propagates from boundary of studied region to absorbing layer and wave attenuates exponentially with propagation distance. The paper also gave the basic principle of perfectly matched layer, introduced the control equation of perfectly matched layer for acoustic wave equation, and finally showed several satisfactory numerical modeling results.

**Key words:** forward, numeric simulation, perfectly matched layer, absorbing boundary condition

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**Knowledge of RG line and datum of time-depth conversion.** Lü Huantong, Zheng Hongming, Zhao Feng and Wei Jinlan. *OGP*, 2003, 38(1): 35~37, 57

The precondition of RG line being as datum of time-depth conversion is that the RG line is equivalent to the smooth line of surface elevation. The method was feasible in former exploration of looking for structural trap. The reasons are follows: ① the surface relief is simple in previous exploration area, RG line can approximately be as smooth line of surface, replacement of elevation of RG line by smooth line of surface makes little errors; ② the errors of reflection time are only a few ms or even scores ms, having no influence on discovery of anticline structure. Present seismic exploration puts high-resolution and high-precision as its object, so that can find out structural-lithological oil/gas reservoir, such as structure with lower amplitude, fault, fracture and sand body, which demands data (from processing and interpretation) coming to

some precision, so can ensure the reliability of interpretation of seismic section. In that cases, it is worth to consider whether the RG line is suitable for datum of interpretation of seismic section. The paper expounds in detail the relation between RG line and smooth line of surface. Its aims are showing the difference between RG line and smooth line of surface elevation, the negative influence on interpretation precision of subsurface structure if using RG line for datum of interpretation of seismic section and how to solve the datum of time-depth conversion.

**Key words:** datum, RG line, surface elevation, smooth, time-depth conversion

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**Prediction of superpressure stratum using inversion of seismic while drilling (SWD) data. Zhu Jian and Gao Shaoyan. *OGP*, 2003, 38(1): 38~43**

Studying the relation between seismic while drilling (SWD) and vertical seismic profile (VSP), the paper gave wave theory's model suitable for SWD. Using the convolution relation between directed wave and reflected wave, the inversion method of wave impedance, that is suitable for wavelet with any phase has an anti-multiple capability and can be used for prediction of ahead of bit, can be achieved. The examples of theoretic model and real data show that the inversion presented by the paper has a good practical value, is suitable for SWD data and can better predict the target position of ahead of bit, the depth of dangerous stratum under superpressure and its pressure, so that can improve purposefulness, security and accuracy of drilling.

**Key words:** seismic while drilling, inversion, prediction, superpressure stratum

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**Selection of first-break timing in using transmitting method for measuring sonic velocity. Shen Jianguo. *OGP*, 2003, 38(1): 44~47**

It is difficult to determine the first-break timing (or initial point) of P-wave or S-wave when using transmitting method for measuring sonic velocity of core or solid. The impact of errors on mea-

sured results is bigger when sonic frequency is lower. The paper uses phase analysis to study the problem of selecting the initial point. First, using good isotropic and homogeneous white marble for fabricating standard parts and measuring the sonic waveform from different propagation distance, then the propagation velocity can be got by using phase compensation method; second, using the propagation velocity, the first-break timing and the corresponding time-delay constant of measurement system can be determined from measured waveform at different distance; finally, the other position of waveform can be determined as time-delay constant corresponding to first-break timing; therefore, we select optimum first-break timing according to characters of practically measured waveform and get more precise sonic velocity by using corresponding time-delay constant.

The model test showed that different position of first-break timing may get different time-delay constant of measurement system, in other words, the time-delay constant of measurement system is corresponding to selection of first-break timing.

**Key words:** first-break timing, measurement of sonic velocity, phase, transmitting method, standard parts

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**Research on non-linear prediction of fracture of oil/gas reservoir and its application. Li Zhengwen and Li Qiong. *OGP*, 2003, 38(1): 48~52**

Based on non-linear character having in fractured system of reservoir, the paper presented non-linear prediction technique of fracture. The non-linear prediction technique of fracture consists of rebuilding of phase space, related dimension analysis of fracture and prediction technique by fractured mutation theory. Comparing with other fractured prediction technique, the method has clear advantage. The practical application showed the method can accurately determine the fractured development belt of reservoir and its space distribution, which provides a renewed knowledge for distinguishing the fractured system.

**Key words:** reservoir, fracture, non-linear prediction, study

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**Study of lithologic characteristic and layer-labeling technique in reservoir prediction.** Zhou Yubing, Dong Qiaoliang and Zhang Yubin. *OGP*, 2003, 38(1): 53~57

The multi-solution of inversion by single parameter and layer-labeling uncertainty are two difficult points that restricted the precision of reservoir prediction in complex fault block zone, which can be avoided to a certain degree by using multi-parameter integrated inversion. The paper studied carefully and fully the key technique of multi-parameter inversion-logging lithologic characteristic technique and summed up a set of methods for multi-informational and multi-leveling, precision layer-labeling. Finally, it is showed by a case that precision basic analytic works are the key to ensuring the reliability of inversion.

**Key words:** reservoir prediction, multi-parameter integrated inversion, layer-labeling, logging lithologic characteristic

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**Prediction of reservoir by laterally regional amplitude difference for fractured carbonate.** Long Jiandong, Xu Anna and Li Ming. *OGP*, 2003, 38(1): 58~61

It is showed from 3-D high-resolution and amplitude-preserved seismic data in Ordovician carbonate of Lunnan area, Tarim basin, that there exist a lot of desultory reflected energy forming "short event" in buried hill. According to seismic reflection theory and combining with the analysis and the study for core and logging data, it is considered that the reflected energy and "short event" in disordered level are a seismic response to carbonate reservoir in buried hill. The paper presented a simple and convenient method that can quantitatively describe the disordered reflected energy, mainly used to predict the plan distribution rule of fractured reservoir in carbonate, which is called for reservoir prediction by laterally regional amplitude difference. The practice of application in Lunnan area showed that the method has simple, convenient and practical characters and the feature of prediction with high-precision, having prominent applied effect in exploration of oil/gas reservoir in Ordovician fractured carbonate buried hill, Lunnan

area, and having a referential role in oil/gas exploration of carbonate in other platform and basin.

**Key words:** reservoir prediction, amplitude difference, fractured carbonate

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**Mechanism of contributing factor for Bohai Bay basin and appreciation of oil/gas.** Jia Zhibin, Tian Xinqi, Meng Xiangshun, Yu Jinying, Wang Xiaoshan, Gu Weicheng and Song Zhixia. *OGP*, 2003, 38(1): 62~66

Bohai Bay basin is a region which oil/gas exploration level is higher in China, but uneven in exploration is still existence in the region, and a large amount of area has lower level of exploration. Some of them are constrained by conditions and tools and others are limited by geological knowledge. Deepening the geological knowledge of the basin can accelerate effectively the process of oil/gas exploration in that basin. According to the change of crustal stress field during development of the basin, the paper analyzed and determined the property of the basin, divided 5 stress zones, analyzed mechanism of contributing factors and put forward appreciation of oil/gas for each stress zone combining with current condition of their oil/gas exploration.

**Key words:** Bohai Bay basin, strike-slip, stress, mechanism of contributing factor, appreciation of oil/gas

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**A few examples of lacustrine retrogradation reflection.** Pu Renhai, Du Jinhu, Cui Yongqian and Shen Janshi. *OGP*, 2003, 38(1): 67~71

Retrogradation reflection is a reflected phenomenon that reflects the thinning strata and truncated its top in toward basin center, which is different from that takes place generally in basin margin. The retrogradation reflection is rarely seen in continental basin and usually takes place in lacustrine deposition only when accommodation space greatly increases due to quick rise of lake level for a long period or gradual reducing and retreat of main solitary source supply from depression center. The retrogradation direction usually points to

the main source supply direction. In lacustrine sequence stratigraphy, the retrogradation reflection represents transgressive system tract with condensed section as its cap, which is overlaid by highstand system tract with progradation reflection or parallel reflection. The transgressive system tract with retrogradation reflection often happens in a fair large order cycle (4~10 Ma) of lake level rise-and-fall.

**Key words:** retrogradation reflection, lacustrine facies, seismic interpretation, sequence-stratigraphy  
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**Knowledge of several special representative features of normal fault on seismic section.** Dong Shuzheng, Lu Gangchen, Ma Jun, Li Zhenyong and Kong Fandong. *OGP*, 2003, 38(1): 72~76

The seismic interpretation of normal fault is very important because its obvious control role over Tertiary or even Pre-Tertiary hydrocarbon gathering and distribution. The normal fault has multiple features on seismic section, the people often considered: ① Thickness of strata in downthrow side must greater than or equal to that in uplifted side; ② The younger strata should appear in downthrow side of normal fault and older strata should appear in its uplifted side, which led to result in reluctant or mistaken interpretation. Combining with real examples, the paper explained the phenomenon why seismic two-way travel time in uplifted side of normal fault is great than that in downthrow side from several aspects such as cutting action of normal fault during different period, negative inverse of fault, strike-slip movement and intrusion of anomalous body as well as seismic velocity and differential compaction, and analyzed two types of fault that appear old strata in downthrow side.

**Key words:** normal fault, thickness, cutting action, strike-slip movement, anomalous body

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**Research on gas-bearing prediction using AVO in sandstone reservoir with low-impedance, Sulige gas field.** Shi Songqun and Zhao Yuhua. *OGP*, 2003, 38(1): 77~83

Sulige gas field is the biggest gas field of China found in Ordos Basin up-to-now, which main gas producing formation is sandstone reservoir of He 8 Member, near the bottom of Upper Paleozoic Lower Permian Lower Shihezi Formation, belonging to thin-interbedded reservoir of typical continental sedimentation. Appraisal well results based on large hole spacing (10~15km) show that the area is composite sandstone gas reservoir both gas-bearing with large area and typical heterogeneous. In nearly 10000km<sup>2</sup> exploration area, the maximum thickness of gas-bearing layer revealed by drilling is 15~20m, while minimum is only 1~2m; min-production of single well (non-resistant flow) is  $2 \times 10^4 \text{m}^3/\text{d}$  and maximum can reach to  $120 \times 10^4 \text{m}^3/\text{d}$ , varying in a large scope. Therefore, on the basis of prediction of reservoir thickness, qualitative or semi-quantitative gas-bearing prediction of sandstone reservoir is very important and necessary to effectively improve success rate of exploration well. On the basis of integrative analysis of logging and geologic data and through forward modeling, studying the AVO response of He 8 reservoir in seismic data and using petro-physical measuring results for inversion of hydrocarbon detection are major tools for gas bearing prediction of pre-drilling targets in the area, which gained better applied results in practice.

**Key words:** Sulige gas field, AVO technique, gas-bearing sandstone with lower-impedance, gas-bearing detection

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**Coding system of geophysical/geochemical survey line and cases.** Zhang Jiaodong, Liu Deliang, Yang Xiaoyong, Tan Ying, Cao Guobing, Zhang Xu and Gen Shaoyu. *OGP*, 2003, (38): 84~87

On the basis of line coding practice in Hefei Basin, the paper presented scientific and reasonable design principle for line coding system. According to the principle of coordinate transform, the paper discussed concrete design proposals for coding of line in south-north or east-west direction, oblique line, 3-D seismic line, gravimetric, magnetic survey line and geochemical survey line respectively and showed by real cases the meaning of scientific and reasonable design for line coding system and importance of creating a uniform coding coordinate in

whole basin.

**Key words:** line coding, coordinate transform, Hefei Basin

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**Discussion on seismic acquisition method and reservoir prediction technique.** Pan Zufu. *OGP*, 2003, 38(1): 88~90

Aimed at existing problems of current seismic acquisition in Sichuan Basin, the paper sought after more efficient, reliable and economic methods in order to obtain data with high quality and rich information that can be used for structure study and reservoir prediction. The practice showed that using downhole receiver to limit the spatial high-frequency random noise instead of linear or areal receiver-array can significantly improve S/N ratio, resolution and fidelity of raw data; adopting single 3-D geometry with fixing downhole areal receiving and moving shot in an area of gentle and uncomplicated structure can improve the precision of structure and to predict fracture-developed belt, meanwhile, using spectral difference curves for lateral prediction of oil-bearing fracture, improving successful opportunity of exploration and efficiency; after using 2-D multiple coverage for reconnaissance and detecting oil and gas, using previous single 3-D exploration with downhole receiving rather than 2-D multiple coverage for detail survey can greatly reduce acquisition cost; using 3-D acquisition with downhole receiving in full fold for exploration of key parts of complicated and steeply dipping structure can improve acquisition quality and for oil-gas prediction after processing of zero-offset section; using high-resolution VSP data and up-hole survey data and producing spectral difference curves can be used to predict the highest frequency and resolution reflected from the target, so that the decision whether the high-resolution acquisition will be done can be determined, achieving the goal of reasonably using equipment. Adopting above-mentioned tools can improve the success of exploration, reduce cost and speed up process of exploration.

**Key words:** seismic acquisition method, reservoir prediction, areal receiver-array, spectral difference curve

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**Application of singular value decomposition (SVD) in solution of  $T_2$  relaxation spectra from nuclear magnetic resonance (NMR) log data.** Wang Caizhi and Shang Weizhong. *OGP*, 2003, 38(1): 91~94

Due to the low signal-to-noise ratio of log data from NMR tool, reducing the influence of noise effectively is a key factor in transforming NMR logging data into  $T_2$  relaxation spectra. The paper introduced the SVD of solving eigenmatrix in solution of  $T_2$  relaxation spectra and the feasibility and the method that cuts-off the non-zero singular value in SVD in order to increase the stability of eigenmatrix. All these can ensure that the steady relaxation spectra can be obtained from low signal-to-noise NMR log data. This method has a good result in practice.

**Key words:** nuclear magnetic resonance log, singular value decomposition, solution of  $T_2$  relaxation spectra

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**Several questions need to pay attention to on balancing to GPS net.** Guo Haiyang. *OGP*, 2003, 38(1): 95~101

The paper introduced setting up control net using GPS relative positioning technique, including the design of GPS control net, its field observation, the calculation of GPS base-line vector net and the quality check of GPS base-line vector net etc. We focus our discussion on several questions that need to pay attention to in following topics: the optimized design of GPS net, the calculation of and the quality check of GPS base-line vector net.

**Key words:** design of GPS net, balancing calculation of GPS net, quality check of GPS net

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