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ABSTRACTS

1 **Geochemical and Palaeo-climate Significance of Om₅ in Well SJ1 of Ordovician Salt Basin in Northern Shaanxi**

Gong Wenqiang, Zhang Yongsheng, Tang Youjun, Zhang Yuyin, Gao Wei, Han Jiasheng (First Author's Address: Institute of Mineral Resources, CAGS, Beijing 100037, China; The Fifth Detachment of Gold Force, CAPF, Xi'an 710100, Shaanxi, China)

Abstract: According to the test results of X-ray diffraction, trace and major elements about mudstone interlayer samples from Well SJ1, clay mineral assemblage in the studied area included illite and chlorite, both were complementary in composition. From bottom to top, the mass concentrations of Mn, Sr, P, Cu, Rb/Sr, Sr/Cu, Fe/Mn, (Fe+Al) / (Ca+Mg), V / (V+Ni), Cu/Zn were regular. In the upper and middle cycles, five and four sub-cycles could be identified respectively. The analysis on clay minerals and chemical elements reveal that the paleoclimate of Om₅ is between semi-arid and arid with reducing deeper water. The upper cycle is more arid than that of the central one, but the secondary wet-arid change is less frequently induced.

Key words: Salt Basin in Northern Shaanxi; Om₅; Clay mineral; elemental analysis; paleoclimate

6 **Provenance Analysis on the Middle Jurassic Shaximiao Formation in the Middle of West Sichuan Depression**

Wang Chaoping, Liu Tiantian, Xiong Ting (First Author's Address: School of Geosciences, Yangtze University, Wuhan 430100, Hubei, China)

Abstract: Through the data of drilling and thin section identification, by adopting the light and heavy minerals, imaging logging data, the characteristics of conglomerate distribution and lithologic distribution of sandstone, combined with the reflection characteristics of seismic section, paleogeomorphological features and ancient flow measurement of peripheral field section of Jurassic Shaximiao Formation in the western Sichuan, the provenance of sediment of Jurassic Shaximiao Formation and its direction in the western Sichuan depression were analyzed. The J₂s deposits in Shaximiao Formation were mainly from the west Longmenshan short axis provenance and the east Micang-Daba Mountain long axis provenance. This new understanding plays an important guiding role for the further exploration and development of gas reservoirs of J₂s deposits in the middle Jurassic Shaximiao Formation of the middle western Sichuan Depression.

Key words: western Sichuan Depression; Shaximiao Formation; provenance analysis; light mineral; heavy mineral

10 **Discovery of Gastropoda Fossil and Its Geological Significance in Jurassic Yangqu Formation of Xinghai Basin in Qinghai Province**

Li yang, Zhang Kexin, Pan huazhang, Xu Zenglian, Wei yi, Zou yarui (First Author's Address: Faculty of Earth Sciences, China University of Geosciences, Wuhan 430074, Hubei, China)

Abstract: The Jurassic continental strata were developed in Yangqu Formation of Xinghai Basin, which was an intermountain basin, Yangqu Formation was a standard profile in the studied area, it was divided into 2 lithologic sections; the low lithology included variegated siltstone, mudstone, fine coal line and glutenite with mauve fluval-lake facies, the upper section included variegated sandstone, glutenite, mudstone and conglumarite in mauve fluval-alluvial fan, in which abundant

gastropoda fossils were found out in the siltstone, they belonged to marine gastropoda. In this paper, 10 gastropoda species (including 2 indetermined species) belonging to 4 genera are described. An assemblage, that is the *Amplivatvata antiqua*-*Pseudamnicola acuta*-*Amnicola kushuixianensis*, is established, it is an important basis for stratigraphic division and study of stratigraphic sequence, which indicates the late middle Jurassic epoch-the early late Jurassic age, and also shows the environmental changes and climatic variation.

Key words: Qinghai; Jurassic; Yangqu Formation; gastropoda

15 Identifying Minor Faults Based on Well-seismic Integration and Its Application

Bai Xue (Author's Address: Research Institute of Exploration and Development, Daqing Oilfield Co. Ltd., PetroChina, Daqing 163712, Heilongjiang, China)

Abstract: In Daqing Changyuan Oilfield, intersection relations were complex between faults, especially the minor faults were more developed. Traditional fault interpretation method was difficult for effectively and quickly identifying the complex structures and low order small faults. In order to accurately characterize the spatial distribution of faults, a technical study for identifying minor faults was carried out by well-seismic integration, through the comprehensive utilization of the key technologies such as well breakpoint guidance technology, forward model guidance, frequency division interpretation, seismic attribute three-dimensional visualization identification, the methods for identifying minor faults and lithologic changes were initially established. the method is used for improving the accuracy of minor fault interpretation, deepening identification of fault structural characteristics, it provides the technical basis for tapping the potential of adjustment of oilfield exploration in time.

Key words: well-seismic; integration; minor fault; seismic attribute

19 The Effective Reserves Forecasting Method Used in Complex Fault Block Reservoir in Block Li 7 of Lijin Oilfield

Wu Jihui (Author's Address: Binman Oil Production Plant, Shengli Oilfield Company, SINOPEC, Binzhou 257439, Shandong, China)

Abstract: In allusion to the problems of reservoir forecasting in complex fault blocks, Block Li 7 in Lijin Oilfield was taken as an object of study. First, by analyzing core data, log data and test data, it was indicated that $Es_2^{\frac{1}{2}}$ in Block Li 7 was a delta front subfacies sedimentary, where distributary channel, sand sheet and so on were mainly developed. On the base of the feasibility analysis of multi-attributes, such as seismic amplitude frequency, phase and energy, a forward modeling was carried out by using different sand shale combination models in Es_2 of Block Li 7, it indicated that it was hard to distinguish the different combinations by only using the amplitude and frequency attributes. Therefore arc length seismic attribute was introduced for effective reservoir prediction. By extracting the arc length seismic attribute in the studied area and by the comparison with sedimentary facies and reservoir distribution map it is indicated that they have good correlations, thus the prediction of effective reservoirs is realized in complex fault block by using arc length attribution.

Key words: complex fault block; reservoir forecasting; arc length attribute; the second member of the Shahejie Formation; Lijin Oilfield

24 Application of the Technology of High Density and Full Azimuth Seismic Data Processing

Yang Limin (Author's Address: Department of Exploration, Liaohe Oilfield Company, PetroChina, Panjin 124010, Liaoning, China)

Abstract: Tight oil exploration has been the focus target of oil and gas exploration at the present stage. To improve research cognition and technical storage, in 2013, Liaohe Oilfield preferably selected Leijia Area in the western sag for "wide azimuth wide frequency and high density" single geophone seismic acquisition and processing for the purpose of increasing the quality of seismic data and

satisfying the demands of tight oil reservoir exploration. The original seismic data are high density and full azimuth data in the studied area, the processing is based on the geologic goal of the Paleogene Es₄ tight oil and gas reservoirs in Leijia Area. The characters of original seismic data are analyzed intensively and the advanced and applicable flow process is determined. A set of matching processing technologies are established including amplitude-preserved processing of high resolution and OVT domain processing. The final result is satisfactory.

Key words: single geophone; wide azimuth wide frequency and high density; OVT domain processing; high density; full azimuth

29 A New Method for Determining Residual Oil Saturation in Oil-water Relative Permeability Experiments

—Application of Zhang's Widely-Applicable Water Flooding Curve

Liu Xinguang, Tian Ji, Zhu Guojin, Tan Xianhong, Ding Zupeng, Zhang Xiaoliang, Peng Shiqiang, Li Zhuolin (First Author's Address: General Research Institute, CNOOC, Beijing 100028, China)

Abstract: In this paper, a new method was proposed to calculate residual oil saturation S_{or} by extrapolated exponential expression the residual oil in core was calculated by Zhang's Widely-Applicable Water Flooding Curve and extrapolated exponential expression was used to calculate relative water permeability in residual oil to get a higher accuracy S_{or} , which was compared to the cutback method in traditional industry standard. Then $K_{ow}(S_{or})$ is extrapolated by the exponential expression of relative permeability curve. This method is proved to be clear in principle and simple in flow process and the calculation error is within 1%.

Key words: relative permeability curve; residual oil saturation; Zhang's Widely-Applicable Water Flooding Curve

34 Research and Application of Support Vector Machine in Water Plugging Decision of Fractured-cavity Carbonate Reservoirs

Wu Yahong, Tian Xishan, Wang Li, Li Boyuan, Lin Xin (First Author's Address: College of Petroleum Engineering, China University of Petroleum, Beijing 102249, China)

Abstract: Tahe Oilfield was a typical fractured-cavity carbonate reservoir, where heterogeneity was strong, oil-water contact was unclear with high water production and poor water plugging effect, it needed a technological integration. Based on the characteristics of fractured-cavity carbonate reservoirs, a conceptual model was established for water plugging wells, eleven factors influencing the water plugging effect were summarized from three aspects of reservoir geological factor, reservoir development status and engineering and technology. Then major factors influencing the water plugging effect were optimized through calculating mean value and mean square deviation of the eleven factors. The support vector machine method was adopted to establish the Tahe Ordovician reservoir model for predicting water plugging effect. The model is used to forecast the plugging effect of eight wells the consistence rate of 87%. For the limited sample sizes of water plugging wells in Tahe Oilfield, the model built with support vector machine method has higher precision, which can be used to guide the selection of wells and layers for water plugging in Tahe Oilfield.

Key words: fractured-cavity reservoir; carbonate reservoir; water plugging; support vector machine; well selection; layer selection; Tahe Oilfield

38 Analysis of Factors Influencing Commingled and Fractured Vertical Wells Production Capacity in Sulige Tight Gas Field

Zhang Mingyang, Li Juhua, Wei Yunsheng (First Author's Address: Key Laboratory of Exploration Technologies for Oil and Gas Resources (Yangtze University), Ministry of Education; School of Petroleum Engineering, Yangtze University, Wuhan 430100, Hubei, China)

Abstract: Multi-layer commingled and fracturing were an effective technical means for improving sin-

gle well production of vertical wells and for oil and gas production at a large scale in Sulige Tight Gas Field. Due to the differences in the reservoir and fluid properties, with the variation of yield contribution in each layer, production rate in the fractured vertical well was varied. In consideration of the non-Darcy and pressure-sensitive numerical simulation method, by taking Sulige Gas Field as an example, a typical geological model with interlayer cross flow in three layers was established. The impact multi-layer fractured vertical wells was the impact multi-layer fractured vertical wells was evaluated from the aspects of high, medium and low permeability reservoir reserves distributions, permeability contrast and fracture half-length respectively, and by using univariate and multivariate orthogonal analysis method. By introducing the dimensionless characterization, the variation rule of dimensionless in each layer was presented. The results show that there exist different permeability ratios and different reserves productions in each layer, oil recovery difference was bigger. With the increase of reserves ratio, the difference has been reduced gradually. The percolation channel was improved by fracturing. The influence of fractured half-length on recovery ratio was not obvious because of the limitation of fracturing. By analyzing these three factors' influence on recovery ratio, it indicates that the permeability contrast has the maximum influence on the recovery percent, fracture half-length is the second and reserves ratio is the least influence. The method has a positive significance for multi-layer commingled vertical well productivity in tight gas reservoirs.

Key words: tight gas reservoir; multilayer; numerical simulation; yield contribution; fractured vertical wells

43 **Application of A Model of Multi-segment Fractured Horizontal Wells in Low Permeability Gas Reservoirs**

Xia Yu, Luo Yong, Gao Zhibin, Li Min (First Author's Address: Geophysical Exploration Division of China Offshore Oilfield Services Limited, Tianjin 300452, China)

Abstract: To accurately describe the fluid percolation characters or pressure distribution in near wellbore of horizontal wells, the grid refinement was performed in the near well area of horizontal well, but it was limited in conventional refinement of angle-point grids, it was hard to obtain fracture width of millimeter level. This paper generally introduced the fundamental theory and method of PEBI grid which was used to describe the model of multi-segment fractured horizontal wells. By taking the low permeability gas reservoir in Daniudi Area for example, horizontal wells in the low permeability gas reservoir were modeled by using PEBI grid. The PEBI models were capable to describe the horizontal well length, hydraulic fracture numbers, fracture width, and fractured conductivity etc. The production history in the trial production period was historically matched, the effects of working system for given gas production rate, calculated wellhead pressure matching with observed historical matching value were obtained. On the basis of more reliable historical matching, the optimal allocation production rate was studied, the allocation schemes of open flow capacity 1/3, 1/4, 1/5 and 1/6 were calculated respectively. The predicted results of each scheme indicate that allocation is established based on scheme of 1/4~1/5, 3~5 years of stable production can be obtained. It can meet the requirement of stable production of gas field development with higher predicted and accumulated production and reasonable production velocity.

Key words: horizontal well; multi-segment fracturing; PEBI grid; reasonable yield; stable production in gas well

47 **Technical Study on Improving the Thermal Recovery Effect of Heavy Oil Reservoirs in Bamianhe Oilfield and Its Application**

Mi Fulin (Author's Address: Qinghe Oil Production Plant, Jiangnan Oilfield Company, SINOPEC, Shouguang 262714, Shandong, China)

Abstract: In consideration of the problem of poor effect in heavy oil thermal recovery wells of Bamianhe Oilfield, a technical study was carried out for improving the development effect of thermal recovery wells. Through mathematical modeling, the value setting range of steam injection in thin reservoirs of Bamianhe Oilfield was determined. The OQK-03 high temperature foam profile control sys-

tem was chosen. By using a nitrogen-assisted steam soaking, the well type, the technology of perforation and sand control was optimized. The results showed that the high temperature foaming agent should be used in the wells with reservoir thickness greater than 5m. Nitrogen-assisted stimulation should be used in the thermal recovery wells with oil permeability greater than 300mD and crude oil viscosity less than 5000mPa · s. For the extra-thin reservoir with its thickness less than 3m, better effect could be obtained by using horizontal well. The poorer the geological condition was, the more obvious advantages could be obtained in the horizontal wells. For horizontal wells, optimized perforation and shortening the segments of horizontal wells could enhance the intension of steam injection and reduce thermal loss. The technology is used for testing in a high production injection well in the 1st member of Es₃ in Block Mian 120, it is used for 24 times with accumulated oil increment of 1.5 × 10⁴t, good result is obtained in testing.

Key words: heavy oil thermal recovery; development effect; high yield injection well; Bamianhe Oilfield

51 Development of A New Sand Control Screen and Its Performance Evaluation

Gao Bin, Wang Yao, Zhang Chunsheng, Zhang Jishuang, Liu Peng, Luo Jianwei, Dong Jia (First Author's Address: CNOOC Ener-Tech Drilling&Production Co., Tianjin 300452, China)

Abstract: The hole opening foam metal was a new gas-solid composite material, its natural property was in accordance with the requirement of sand block medium in sand control completion. First the pore structure characteristics of foam metal and aperture size distribution were quantitatively described. Based on the mechanical property test, the matching relationship was established between the foam metal materials with different pore throats and different formation sands of the main offshore production zones. Then a new screen is made from foam metal as sand block medium, the sand block property, its plugging capacity and abrasive resistance are systematically evaluated and tested. It is demonstrated that the foam metal has optimal performance, it has better prospects in oil and gas well completion and it can be popularized in oilfields.

Key words: foam metal; stand-alone synthesized screen; sand control; well completion evaluation

55 Research and Application of Prepacking Sand Control Technology

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Abstract: In recent years, restricted by the environment, the number of one-platform and high-angle wells has been raised in Gudao Oilfield year by year. There existed high risk of gravel packing in high-angle wells, which was characterized as low liquid, short production cycle, etc. In order to improve sand control effect of the high-angle wells, based on prepacking screen technology and wire wrapped screen gravel packing technology, a prepacking sand control technology is researched and applied. The technology is mainly used in high-angle and serious sand production wells. It is determined as one of the dominant sand control technology in Gudao Oilfield. Since 2011, the technology has been used in 48 wells and it is effective in 46 wells, the effective rate is 95.8%, good effect is obtained.

Key words: Gudao Oilfield; high-angle wells; prepacking sand control technology

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