极地永冻区与海洋环境天然气水合物形成模式差异

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[摘要] 极地永冻区与海洋是两种完全不同的自然环境，因而两种环境中天然气水合物成藏模式必然有本质的差异。成藏模式不同，水合物形成方式不同，决定着勘探思维和方法也不同。从两种不同环境中天然气水合物形成模式的基本条件出发，讨论了海洋环境和永冻区天然气水合物形成模式的差异。分析认为，极地永冻区天然气水合物的主要成藏模式是深部热解甲烷模式，而海洋环境天然气水合物的形成除了有生物甲烷气模式以外，热解甲烷气模式也是其成藏的重要模式之一。

[关键词] 天然气水合物；形成模式；永冻区；海洋区
[中图分类号] TE132.2 [文献标识码] A [文章编号] 1000-9752 (2010) 06-0057-05

天然气水合物主要存在于极地永冻区和海洋水深大于300～500m的地层中[1]，全世界已直接或间接发现了116处，其中海洋85处[2]。据估算[3,4]，极地冻土带中天然气水合物约有10^{13}～$10^{16}m^3$，而海洋中约为10^{15}～$10^{18}m^3$储量，即约98%天然气水合物产在近海，仅2%产在极地永冻带中[5]。

与常规油气成藏一样，天然气水合物的成藏涉及成藏过程中的方方面面. 笔者就上述两种环境中甲烷气的成因、气体运移通道、相态及动力、储层和盖层以及温压条件等方面进行对比分析。

1 甲烷气成因

甲烷气来源不同，形成天然气水合物的模式也不同。一般认为天然气水合物中的气体主要有热解和微生物两种成因，并可用甲烷$\delta^{13}C$值和烃类湿度比值（$C_1/(C_2+C_3)$）来区分[6]。这两种成因的甲烷气都与有机质密切相关，均涉及到生物及其数量，包括生物死亡后成为可保存有机质的丰度和产甲烷菌量两方面。

1.1 海洋和冻土区有机质丰度差别

极地永冻区常年处于低温、缺氧等极端环境，不利于生物生长和繁殖。在北极、加拿大、阿拉斯加、南极等地冻土中发现有活的微生物群落[7～9]。青藏高原多年冻土中微生物种类少、生长缓慢，多为耐冷性或嗜冷性生物[10]，且随冻土深度增加而显著递减[11～13]。冻土微生物观测表明，南极最少，北极最多，青藏高原处于二者之间[11,12,14]。

Rowe等[15]对陆坡和陆隆总生物进行了估计，认为这里生物相当发育，丰度仅次于大陆架，为中等丰度，根据0.42或0.5mm筛析档板从沉积物中分离的数据，大陆坡的大无脊椎内生动物的变化范围为1000～10000个/km^2；虽然生物群落随水深的增加有所变小，但大多数鱼类中的较大和较老的个体生活在较深的水中。由于较为适宜的温压条件和大量动植物的存在，微生物在此大量繁殖，并极为活跃。同时，三角洲地区条件更为优越，河流带来大量的陆源物质，有机质类型更为丰富，富含大量易于形成甲

[收稿日期] 2010-05-10
[基金项目] 国家科技攻关项目（GZH200202-1）。
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烷气的混合型和腐殖型有机质。

1.2 海洋和冻土区产甲烷菌量的差异

多数产甲烷菌的最适温度是 30~40℃，最佳温度为 35℃[16]，温度过低，会限制产甲烷菌以及与甲烷发酵有关的其他微生物的活性；温度过高（>75℃[17]），甲烷菌大量死亡，均不利于甲烷气的大量生成。青藏高原多年冻土层年均地温 -4~0℃[18]，冻土底板温度为 0℃[19]，一般只有嗜冷产甲烷菌才能生存，而嗜冷产甲烷菌在自然界中分布很少，且活性不高，这样就会在很大程度上影响甲烷气的生成；海洋环境比极地冻土区条件要优越得多，温度不像永冻区那样低，也有细菌大量繁殖发育所需要的养料，因此产甲烷菌的种群、数量及其活性都比冻土区高出很多。因此，海洋环境更有利于生物甲烷气的形成。

可见，极地永冻区无论是在生物数量、有机质丰度，还是产甲烷菌的量等方面都与海洋区的相去甚远，这必然会对极地永冻区和海洋区的天然气水合物形成模式及其储量的大小造成影响。

2 运移通道

海洋区天然气水合物形成过程中，浅部生物甲烷气等轻烃流体因其自身的重力和密度而形成的势能差和浮力及流体本身的自由扩散作用[20]，可以通过还没有固结的软泥或松散的沉积物进入气体水合物稳定带；深部甲烷气可以通过断裂、不整合以及泥火山等运移通道快速进入浅部或水合物稳定带；极地永冻区和海洋环境不同，天然气水合物成藏的运移通道也应存在差异。极地永冻区天然气水合物气源以深部热解气为主，主要是通过断层、裂隙、不整合面或储层作横向或垂向运移。

3 运移相态和动力

无论是生物成因甲烷气，还是热解成因甲烷气，都要经过运移才能够在温压条件适宜的地方形成天然气水合物，甲烷气在运移的过程中都要呈一定的相态运移。一般运移相态与其成因模式及形成环境密切相关。生物成因甲烷气，一样遵从有机质成熟演化规律，在埋深小于 1500m，温度 10~60℃时，生物甲烷气可以大量溶解在水中。据研究[21]，当压力为 2.76×10^6 Pa 时，天然气在水中的溶解度为 $0.71m^3/m^3$，以海水比值为 $1.03\times10^3kg/m^3$，那么在水深 300~500m 的水底压力（未计算沉积物上覆压力）为 $(2.94\sim5.05)\times10^6$ Pa，溶解度应该高于此值，应该有较多的天然气溶解于水中运移；同时，由于生物甲烷气的生成与压实的初期和稳定压实阶段一致，这些游离气和水溶气依靠压实力为动力而进行运移。相对而言，热解成因的甲烷（或遭到破坏的气藏）气体较为集中、数量较大，孔隙水的数量远远无法溶解如此多的甲烷气，这时甲烷气的运移相态应以游离相为主。

4 储层和盖层条件差异

从天然气水合物作为一种“累赘”发现于输气管内[22]来看，储盖层对它的形成似乎关系不大，但有利储盖层会更利于天然气水合物的形成，因为甲烷气沿一定的通道运移到温度、压力适宜的储盖层，就地聚集，不至于逸散，并形成天然气水合物而得以保存。

目前大多数海洋区的天然气水合物存在于中新世以来沉积的颗粒较粗的沉积地层中，这些沉积地层还处于未固结、半固结状态，岩性比较疏松[23]，一般为粉砂质泥岩、泥质粉砂岩、粉砂岩、砂岩及砂砾岩[24]，具有良好的孔渗性能，孔隙度一般为 20%~35%，渗透率为 $(150\sim1750)\times10^{-3}\mu m^2$[25]，为天然气水合物的发育和赋存提供了空间。

相对而言，冻土带的水合物更倾向于储集在粗粒的沉积物中。加拿大 Mackenzie 三角洲冻土带中的天然气水合物主要充填于砂/砾孔隙中，淤泥和粘土不含天然气水合物或含量很低。例如，在 Mallik 5L-38 水合物开发井中，砂层中的水合物饱和度可达 80%，而粉砂岩和泥岩水合物饱和度则较低[20]。

海域产甲烷菌活动的范围涵盖水合物的稳定带，与形成生物气藏不同的是，疏松地层中微生物成因的甲烷可以先形成天然气水合物而毋须良好的封盖条件[25]。多年冻土区，常年低温，冻土厚度大，一方面抑制甲烷的生成，另一方面可使甲烷在永久冻土带成为水合物，阻止甲烷散逸，成为良好的盖层，从而形成生物气藏和天然气水合物矿藏[26]。

5　温压条件

天然气水合物一般在低温、高压的环境下形成，在一定的范围内，温度的不足可用增加压力来弥补，同样压力的不足也可以用降低温度来补充。

永冻区天然气水合物深度的上限为 150m，地表温度低于 0℃；在海洋沉积区，天然气水合物产于海底温度约为 0℃，水深在 300m 以下[27]；青藏高原多年冻土层年平均温度－0.5～－3℃[28]，冻土层地温梯度 11～33℃/km，冻土层之下沉积层地温梯度为 28～51℃/km，多年冻土厚度 25～200m，天然气水合物最浅的顶界埋深可能为 74m 左右[29]，最深的底界埋深有可能达到上千米。

海洋区与冻土区则不同，多年冻土温度一般低于 0℃，因此无需太高的压力，而海洋区水深多在 300m 以上，压力相对较大，所以形成天然气水合物的温度可以适当放宽。从天然气水合物形成的相界条件可知，在温度 0～20℃、水深 300～3000m 范围内，海底沉积物中容易形成天然气水合物[30]。

6　形成模式

通过极地永冻区和海洋环境的生物（包括甲烷菌）发育情况、有机质丰度、储盖层、运移通道、运移相态与动力以及温压条件等多方面的综合研究，认为天然气水合物的形成模式主要有生物甲烷成因模式、热解甲烷成因模式，但由于环境存在差异，其中天然气水合物的主要成因模式也存在差异。

6.1　生物甲烷成因模式

该类成因模式的共同特点是甲烷气为生物成因，只是形成时间有早晚之分[31～33]。根据有机质是否位于天然气水合物稳定带内，将其进一步划分为浅部生物甲烷气模式和深部生物甲烷气模式两种。

1) *浅部生物甲烷气模式*　该模式假定甲烷是气水合物稳定带内的有机质经生物作用形成的[31]，气水合物的生成与沉积作用同时发生，甲烷气在有机质形成的同一地层中生成并保存。

2) *深部生物甲烷气模式*　该模式假定气水合物的甲烷是深部来源的，即是由上升流体从深部进入气水合物稳定带时分离出来的甲烷形成的[32]。

6.2　热解甲烷成因模式

这种模式认为甲烷是有机质经热解形成的，可以根据形成天然气水合物时是否需要运移分成气藏速冻式和缓慢冷冻式两种，前者不需要运移，后者则需要运移。

1) *气藏速冻式*　该模式假设原来的气藏，由于气候条件的变化（由间冰期到冰期），温度下降，当温度压力达到气水合物形成条件时形成的，或是由于构造运动使其上升剥蚀温度降低，而形成天然气水合物，可以认为它是极地气水合物的形成模式。

2) *缓慢冷冻式*　这种模式是深部热解甲烷气，运移到气水合物带或适合于形成气水合物的海底或极地永冻区，边运移边成藏而形成气水合物矿藏。这种模式可以为海域和极地气水合物的共同模式。

7　结　　论

1) 极地永冻区，微生物量及沉积地层中的有机质保存量相对较少，生物成因甲烷对天然气水合物矿藏贡献有限，而热解甲烷气沿一定的通道向上运移或原先业已存在的气藏受剥蚀接近地表，在温压适中的地方，可以形成天然气水合物。因此气藏速冻式和缓慢冷冻式是极地永冻区天然气水合物形成的主要模式。

2) 海洋环境, 生物大量发育, 丰富的有机质在产甲烷菌的作用下生成数量可观的甲烷气, 这些甲烷气以溶解态或游离相态, 在压实力的作用下运移, 由深部向浅部运移, 当温压适中时, 可以形成天然气水合物。因而深部和浅部生物甲烷气是海洋的天然气水合物形成模式; 此外由于海底同样具备低温和高压环境, 如果热解甲烷气沿一定的通道向上运移, 而且温度压力适中, 一样可以形成天然气水合物, 因而缓慢冷冻式也是海洋环境天然气水合物的形成模式之一。

3) 按照模式理论, 地史过程中, 良好的烃源岩和储盖层发育, 有一定程度的构造运动, 裂隙、断层等运移通道发育, 同时经历过冰期气候, 温压条件适宜的极地永冻区是有利的天然气水合物赋存区; 而海洋环境, 只要生物发育, 死亡后有机质得以保存, 在甲烷菌的作用下, 就可以形成大量天然气, 储盖层发育, 并且温压适宜的沉积区是天然气水合物赋存区; 除此之外, 即使在生物不太发育的海洋区, 如果海底断层或裂缝发育, 当天然气运移到合适的温压环境, 也可以形成天然气水合物, 所以这些地区也是天然气水合物赋存的地区。

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4 结　论

1) 西峰油田长 8 储层主要成岩作用有压实作用、胶结作用、交代作用、溶蚀作用 4 种, 其中压实作用以中等~ 强压实为主, 胶结作用以中等~ 强胶结为主, 交代作用以中等~ 强胶结为主。溶蚀作用以长石和方解石胶结物的溶蚀为主, 溶蚀强度以中等溶蚀为主。

2) 西峰油田长 8 油层组成岩储集相分为 3 类: ①不稳定组分溶蚀次生孔隙成岩储集相; ②中等压实弱-中胶结混合孔隙成岩储集相; ③强压实强胶结残余粒间孔成岩储集相。其中不稳定组分溶蚀次生孔隙成岩储集相为最有利于油气储集的成岩储集相类型。

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ples or the similarity between the phase variables, it was classified step by step. By taking Wellblock Xi259 in Chenghao Oilfield for example, Q-hierarchical clustering method of cluster analysis was used to study the type of $C3_2$ reservoir, and samples were classified, by which the law of spatial distribution of reservoirs was obtained. The results show that the method for reservoir evaluation is feasible with high rationality.
Key words: reservoir evaluation; cluster analysis; Q-type hierarchical clustering method; Chenghao Oilfield

27 **Analysis on Structural Evolution of Northern Jiangsu-South Yellow Sea Basin**
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Abstract: By analysis of extension-ratio and subside ratio of northern Jiangsu- South Yellow Sea Basin, tectonic evolution of the basin was divided into three periods. The period of deposition of Taizhou- Funing Formation was a prosperous period of the basin development, in which the extensional ratio and deposition ratio of the basin were maximum. The erosion intensity of Wubao Event was stronger in the east and weaker in the west. The period of the deposition of Dainan-Sanduo Formation was a typical development period of a rift basin, of which extensional ratios and depositional ratios were lower than that of the previous period. For the effect of the Sanduo event, from the analysis of its preservation state, integrated strata were preserved in the depression and they were less preserved in humped and slope areas, and it was less eroded in the south depression and more in the north depression. After Sanduo event, the basin is turned from rift basin to depression basin, the earlier separated sediment of the rift basin is turned to a unified sediment of depression deposit.
Key words: extensional ratio analysis; subside ratio analysis; tectonic evolution; northern Jiangsu-South Yellow Sea Basin

32 **Characteristics of Light Hydrocarbon Inclusions and Reservoir Formation Stages of Xia'ermen Oilfield in Biyang Depression**
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Abstract: : Core samples were collected from the third member of Hetaoyuan Formation of Xiaermen Oilfield in Biyang Depression, in which inclusions were studied by petrology analysis, fluoroscopy analysis and uniformity temperature measurement. The results indicate there are three stages of hydrocarbon inclusions, which corresponds to three formation stages of reservoir resulted from basin- history analysis and thermal-history analysis. Hydrocarbon inclusions analysis provides evidence for determining main reservoir forming stages, which indicates that the late Oligocene Stage is a less hydrocarbon formation stage, and Miocene-Pliocene uplift Stage (the end of Liaozhuang Formation) is a main primary hydrocarbon formation stage, The third stage (Before Quaternary Period) mainly produces secondary hydrocarbon reservoir. It is recognized that it would be more reliable to synthesize the results of hydrocarbon inclusions analysis, basin-history analysis and thermal-history analysis.
Key words: hydrocarbon inclusion; formation stage of reservoir; hydrocarbon accumulation; Biyang Depression; Xiaermen Oilfield

37 **Carboniferous Volcanic Rock Geological Characteristics in Xinjiang Sanbao Depression**
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Abstract: To study the carboniferous oil and gas in Sanbao Depression of Xinjiang Area, based on the data of field outcrops, heavy magneto-electric detection and data collected from seism and drilling in recent operations, the conditions of oil-gas geology of the carboniferous volcanic rocks in Sanbao Depression were preliminarily studied. It is demonstrated that it has the condition of hydrocarbon accumulation with good prospects of oil and gas exploration. It is pointed out that Huanglugang Structure is the favorable exploration zone of Carboniferous oil and gas in Sanbao Depression, where the No. 1 Trap in Huanglugang Structure is the first selection of carboniferous oil and gas exploration.
Key words: Sanbao Depression; carboniferous; volcanic rock; geologic characteristics; favorable exploration zone

41 **Study on Eq_3 Sedimentary Microfacies and Its Oil-bearing Property in the South of Daqingzijing Oilfield**
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Abstract: Eq_3 in the south of Daqingzijing Oilfield was one of the main target zones for oilfield exploration. Therefore it was of great significance for oilfield exploration and development by correctly restoring the type of sedimentary microfacies and its areal distribution and studying the relationship between the sedimentary microfacies and oil-gas distribution. The sedimentary facies signs used for study includes rock colour, lithology, particle size, rock structure, sedimentary tectonics and log facies, the study reveals that Eq_3 in the studied area is a delta plain subfacies, and 4 sedimentary microfacies such as distributary channel, crevasse splays, river overflows shore sand body and distributary bay are further identified and plain distribution rules of the sedimentary microfacies in each layer are restored on the basis stated above, the control of sedimentary microfacies on oil and gas accumulation is analyzed.
Key words: south of Daqingzijing Oilfield; Eq_3; sedimentary microfacies; oil-bearing sand bodies

45 **Geochemical Characteristics and Comprehensive Evaluation of Source Rocks of Yingcheng Formation in Lishu Fault Depression of Southern Songliao Basin**
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Abstract: The data of regional geological survey and organic geochemical measurement from Lishu Fault Depression of southern Songliao Basin were used to comprehensively evaluate the source rocks from the aspects of organic matter abundance, its types and maturity. The results show that source rocks of Yingcheng Formation are mainly developed in Shiwu, Gujiazi and Siwujiazi Areas, their maximum thickness are more than 500 m; the source rocks have high organic matter abundance, they belong to med-good rank source rocks; the organic matter type is dominated by kerogen of Type II1, the nest is kerogen of Type III; maturity of organic matter are greatly different in various regions, source rocks of Xiaochengzi, Gujiazi and Shiwu areas are highly matured, they are at over mature stage those of the gentle slope belt are at mature and high mature stages in the southwest of the fault depression. In addition, source rocks from Shuanglong Area in the northeast of the fault depression are at low-mature stage. Seeing from the source rock conditions, it reveals that source rocks of Yingcheng Formation provide enormous material storage conditions for deep or shallow hydrocarbon accumulation in Lishu Fault Depression in the southern Songliao Basin.
Key words: source rock evaluation; hydrocarbon genesis potential; Yingcheng Formation; Lishu Fault Depression

49 **Differences between Gas Hydrate Formation Patterns in Arctic Permafrost Region and Marine Environment**
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Abstract: The natural environment in arctic permafrost region and marine environment were completely different, therefore the reservoir formation patterns of gas hydrate in these two environments should be essentially different. Because of different reservoir forming patterns and different hydrate forming modes, therefore the thinkings and methods for looking for it were different. Based on the formation patterns and basic conditions in two different environments, the differences between the patterns of gas hydrate formation in two different environments were discussed. It is considered by analysis that deep pyrolysis methane gas is the main formation pattern in permafrost re-

gion, and the bio-methane gas is the main formation in marine environment, while pyrolysis methane gas is also holding an important position.

Key words: gas hydrate; arctic permafrost region; marine environment; formation model

54 **Es_4 Heavy Oil Reservoir Characteristics and Control Factors of Block Cao4 in Le'an Oilfield**

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Abstract: The trap assemblies of the slow slope zone at the basin's edge were closely related to their special areal structural characters, where overlap, unconformity heavy oil reservoirs were usually developed. By taking the typical stratigraphic unconformity heavy oil reservoir - Le'an Oilfield in the southern gentle slope zone of Dongying Depression as an example, the reservoir characteristics and primary control factors were analyzed by applying seismic, core, drilling and logging data. It was of great importance to scientific and effective development of similar special oil and gas reservoirs. The results show that in Es_4 reservoir in Block Cao4 of Le'an Oilfield two sequences are developed. The rock types are mainly of carbonaceous or muddy, seriate and pebbled debris-feldspar sandstones. Stronger reservoir sensitivity is induced by higher silt and carbonate contents. The source of sediments is mostly derived from the Guangrao up-lift in the south-east and it has the sedimentary character of mid-subfacies of underwater alluvial fan. It is the reservoir with high porosity and middle permeability. Oil viscosity is lower in the high structure than that in the low structure of a reservoir; and thickens vertically from the bottom to top of the formation, The factors, including sediment characters, unconformity, big basement fault, volcano activity and shallow burial, comprehensively control the reservoir characters and oil property.

Key words: gentle slope zone; heavy oil; reservoir characteristics; control factor

58 **Heterogeneous Genesis of Carbonate Reservoirs in Yaha-Yingmaili Area**

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Abstract: The weathering crust karst reservoirs, inner karst reservoirs and tectonic fractured reservoirs were grown in Palaeozoic era of Yaha-Yingmaili Area; each type of reservoir had very strong heterogeneity. The differences of the hardness, brittleness, rock structures, way of weathering caused two types of reservoir heterogeneities in limestone and dolomite rocks. By comparing the reservoirs with limestone as parent rock with the one using dolomite rock as parent rock, the former had strong heterogeneity, so it was hard to be predicted in vertical or horizontal direction. And for a certain type of reservoir, the heterogeneity of carbonate karst weathering crust reservoir was related to the vertical karst zones and location of the ancient landscape; but for insider karst or fracture structural reservoir, its growth was closely related with crack open or close of carbonate reservoirs. Because chemical property of the carbonate rocks were unstable, when the reservoirs were influenced by the deep thermal fluid, goos reservoir property often induced. However, as the role of randomness hydrothermal activity and the area of influence is hard to be predicted, so it is hard to be evaluated in the vertical or horizontal direction, it is also an important factor influencing the reservoir heterogeneity.

Key words: carbonate reservoir; heterogeneity; hydrocarbon distribution

62 **Application of Stratal Slicing in Lithofacies Identification of Complex Exploration Area**

WANG Jiang, LIN Dong-cheng, LI Peng, YANG Wei (*First Author's Address: School of Energy Resources, China University of Geosciences, Beijing* 100083, *China; Research Institute of Petroleum Exploration and Development, Daqing Oilfield Co. Ltd., CNPC, Daqing* 163712, *Heilongjiang, China*)

Abstract: Fault depression basin generally had characteristics of fracture breaking, complicated structures, proximal sources, the thickness of sedimentary strata changed rapidly in horizontal direction, thus seismic reflection characteristics changed rapidly, it resulted in great difficulty for seismic data interpretation. How to extract the simultaneous seismic data reflecting the changes of lithology based on sequence stratigraphic framework was increasingly important. Based on the analysis of application of time slicing and slice layer in fault depression basin, a new method of extracting the simultaneous seismic information——stratal slicing was discussed, which was used in the sedimentary strata of 3D seismic data that the thickness changed rapidly in the horizontal direction. It is used for recognizing channel and fan body in Damoguaihe Formation of Beixibei Area of Hailar Basin and good effect is obtained.

Key words: 3D seismic data; lithologic interpretation; stratal slicing

66 **Application of Pre-stack Seismic Attribute in Prediction of Turbidite Reservoir**
——By Taking the Lower Member of Shahejie Formation in Xinglongtai-Majuanzi Region for Example

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Abstract: Exploration results indicated that the turbidite reservoirs were developed in the mid-lower member of Es_3 in Xinglongtai-Majuanzi Region, where oil and gas was apparently controlled by their distribution, and had a strong hidden nature. The arrangement of exploration was seriously restricted because of unclear recognition of favorable reservoir distribution. Therefore, the logging lithologic information and sensitive curves of SP, GR were comprehensively analyzed first and the lithology-indicated curve was established for reflecting the lithologic variations. Then, the pre-stack AVO process was carried out to obtain multiple attribute volumes, including intercept (P), gradient (G), $P*G$, far angle low frequency (FLF) and $\mu\rho$, $\lambda\rho$ to extract seismic attributes including amplitude, frequency and phase. Finally, by taking the lithology-indicated curve as the target curve, the pre-stack seismic attributes with high sensitivity were optimized as inversion parameters, neural network inversion was used to identify and describe the turbidite reservoirs in Xinglongtai-Majuanzi Region. The result is consistent with that of drilled wells and geological recognitions.

Key words: turbidite; lithology-indicated curve; pre-stack seismic attribute; neural network inversion

70 **Seismic Facies and Characteristics of Sand-body Distribution of Shahejie Formation in Beitang Sag of Huanghua Depression**

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Abstract: Local exploration showed that Shahejie Formation was one of the important layers of oil and gas exploration in Beitang Sag. A few wells were drilled in large areas, especially in deep depressions, therefore it was very necessary to analyze the seismic facies. Based on the reliable seismic reflection marks, such as internal seismic reflection structure and external shape of Shahejie Formation in Beitang Sag, and in combination with its reflection parameters including amplitude, continuity, frequency and so on, the seismic facies was analyzed, and six seismic facies were identified, including mat-shaped facies, moundy facies, down-cutting filling facies, lenticular facies, wedge-shaped and foreset facies. In combination with the regional drilling data and structural background, the areal distribution characteristics of seismic facies were analyzed, the seismic facies was transfered into sedimentary one. The result shows that three sedimentary facies are developed in the area, which include lacustrine, fan delta and turbidite facies. It provides an important basis for studying the distribution of sand bodies.

Key words: Beitang Sag; Shahejie Formation; seismic facies; sedimentary facies; sand body

77 **Experimental Analysis and Application of Permian Rock Sample NMR in Ordos Basin**

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