

油气储层岩溶研究

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摘要: 详细介绍了岩溶和古岩溶的概念, 按岩溶发生时间、深度、岩石介质、发生环境和成因机制对岩溶进行分类; 根据岩溶水动力学特征, 岩溶纵向上大致分为风化壳、垂直渗流带、季节变动带、水平潜流带和深部缓流带。综合前人的研究成果, 论述了油气储层古岩溶发育相关的10个地质因素, 列举了7种岩溶发育机理, 并总结分析了岩溶研究的进展及其发展趋势。

关键词: 岩溶; 古岩溶; 地质条件; 发育机理; 研究进展; 发展趋势

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岩溶研究由来已久, 古岩溶的研究已成为油气储层研究的热点之一。自1985年由P.N.Choquette和N.J.James召集和组织召开了题为“古岩溶系统及不整合面特征和意义”的学术研讨会以来, 国内外岩溶研究进入了一个高峰期, 碳酸盐岩储层古岩溶研究日益深入, 取得了令人鼓舞的成绩。本文较深入地讨论了与油气储层形成、改造紧密相关的古岩溶发育地质条件、发育机理等问题。

1 岩溶及古岩溶的概念

岩溶原称喀斯特(Karst), 为一种成岩相, 是碳酸盐岩体暴露于大气水成岩环境中, 由含 CO_2 的地表水和地下水对可溶性岩石的溶解、淋滤、侵蚀、搬运和沉积等一系列地质作用的综合。它既包括这一地质作用的物理、化学作用过程, 又包括这一地质作用的结果; 它既包括所有的微观和宏观的地表和地下成岩形态, 又包括地表沉淀物(石灰华)、地下的洞穴沉淀物、坍塌角砾岩和洞穴中机械沉积的“内部沉积物”及微孔孔隙中的机械充填物^[1]。后来它的涵义几乎是溶蚀作用的同义词, 一直到表示岩溶发育的全部过程。现在一般认为, 地下水和地表水对可溶性岩石的破坏和改造过程及由此产生的地表及地下地质现象的总和称为岩溶。

古岩溶(Paleokarst)是地质历史时期而非现代营力环境下形成的岩溶, 通常认为它在第四纪之前形成, 常被年轻的沉积物或较老的沉积岩所覆盖, 是地质历史中碳酸盐岩体曾暴露于大气水成岩环境中, 受岩溶作用改造的一种印迹, 多呈残存状态发育, 即地质历史时期碳酸盐岩序列中残存的岩溶痕迹^[2]。

2 岩溶分类

不同分类依据有不同的方案: 可按时间分类: 如印支—海西期岩溶等; 按深度分类: 表层岩溶带、浅部岩溶、深部岩溶; 按岩石介质分类: 碎屑岩型、灰岩型、白云岩型; 按岩溶发生的环境分类: 同生期岩溶、风化壳岩溶(不整合面岩溶)、埋藏岩溶(深部岩溶); 按成因机制分类: 沉积(层间)岩溶、侵蚀期岩溶、缝洞系岩溶和地下水循环岩溶等。

3 岩溶分带

侵蚀面岩溶自上而下, 大致可以分为5个带(图1): 风化壳(地表岩溶)、垂直渗流带、季节变动带、水平潜流带和深部缓流带, 它在垂向上的发育深度与古地貌、构造、岩性、古水文条件等因素有关, 因地制宜, 但一般在侵蚀面之下200~300m之内^[3]。

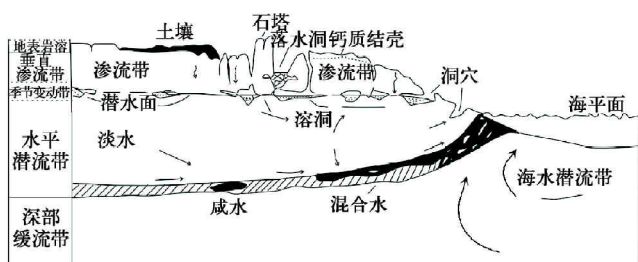


图1 岩溶水动力学特征分带 (据 Choquette 等, 略改)

Fig.1 Karst zone division according to hydrodynamic characteristics
(from Choquette, with some modification)

3.1 风化壳 (地表岩溶)

位于岩溶剖面顶部的地表岩溶,一般位于侵蚀面或不整合面附近,厚度在0~60m。有些井由于后期改造看不到地表岩溶。

3.2 垂直渗流带

该带位于侵蚀面与最高潜水面之间,岩溶作用以垂直方向为主,常形成一些垂向溶孔、溶缝、侵蚀沟和孤立的落水洞等。该带的最大特点是发育各种裂缝,尤其是风化缝和构造缝,而且这些缝隙常被溶蚀。

3.3 季节变动带

由于潜水面随季节而升降,因此在垂直渗流带与水平潜流带之间存在一个过渡带即季节变动带,在这个过渡带中,地下水的水平流动和垂直流动呈间歇性交替,因此,裂缝和孔洞在两个方向都很发育。这些溶缝、溶孔和溶洞虽然常被多期充填和胶结,但由于地下水多期活动,仍能保留大量的有效空间。因此,该带也可能成为重要的油气储集空间。

3.4 水平潜流带

水平潜流带位于枯水期的最低潜水面之下,距侵蚀面一般30~200m,其厚度与补给区高程有关。该带以发育大量的溶洞和溶孔为主,当然也有一些溶缝,但远不及垂直渗流带发育。

3.5 深部缓流带

该带位于水平潜流带下,最大底界深度是岩溶作用的下限,一般可达侵蚀面下300m左右,该带仅见一些小型的溶孔和零星溶缝,与普遍未发生岩溶作用的层段差别不大,胶结作用在该带较明显。

4 岩溶发育的地质条件及有利因素

综观国内外岩溶研究成果,与风化壳古岩溶相关的地质因素可归结为以下几个方面:气候;地下水的化学作用能力;矿物学;出露地表的时间长短;先存的孔洞网络;沉积相和地层特征;水文系统;出露区的规模和地形特征;基准面的改变;构造沉降特征。

4.1 气候 (降雨量)

Wagoner 等提出气候,特别是大量的降雨,很大程度上控制了地表水系统的溶解能力,溶解能力随着年降雨量的增加而显著增强。因为岩溶形成条件之一是相对围岩来说,流体应是未饱和的^[4],大气降水正好具备此条件。降雨量的大小还直接控制地下水量,从而对大型洞穴形成过程中的地下暗河的机械冲刷能力起控制作用。

4.2 地下水的化学作用能力

淡水和海水的混合能使地下水更具侵蚀性,水中 CO_2 的增加也会增加水的溶解能力。对于风化壳岩溶带,处于一个开放的大气水系统中,地下水中 CO_2 丰富,溶蚀能力强。

4.3 矿物学 (岩石的可溶性)

地下必须具备可溶性岩石,其成分和结构分别控制着岩溶的发育程度,一般来讲,质纯厚层的石灰岩岩溶规模较大。另外,岩石还必须具备较好的透水性,水流才能通畅。

4.4 出露地表的时间长短

对于孔洞系统在地表出露期间的演化,出露地表的持续时间和方式是至关重要的 (Myroie 和 Carew, 1995)。地表出露的短暂时间(10000~40000a)可能对于基质孔隙的发育更为有利。较长的地表出露(1~40Ma)可能减少基质孔隙,但是可能增加裂缝和洞穴孔隙;同时也会更大程度地改变渗透率,因为高渗透率及与此有关的喀斯特通道能够很快地形成并保留数百万年。

●代宗仰,王振宇等,塔中古岩溶研究,2002,内部资料。

4.5 先存的孔洞网络

先存的孔洞网络决定了淡水的流向及由此决定溶解和胶结的位置。在具有水流通道的含水层中,成岩作用主要发育在邻近水道的岩石中,而其他部位的岩石,即使是非常多孔的部位,受淡水改变作用较弱。

4.6 沉积相和地层特征

在出露地表以后,基质孔隙仍然与沉积相和地层特征密切相关^[5],从而产生了不同强度的岩溶作用。一般地,颗粒碳酸盐岩通常具有最大的孔隙度和渗透率,如颗粒白云岩、石灰岩通常先存的孔隙度和渗透率较高,岩溶作用强,易形成优质储层。

4.7 水文系统

水文系统的性质、大小和结构通常决定孔洞系统改变的方式和部位。溶解作用和胶结作用的系统变化引起上层淡水潜流带孔隙度的降低,而渗流带与混合带的孔隙度增加。在封闭性的含水层中成岩作用相当微弱。

4.8 出露区的规模和地形特征

碳酸盐岩可溶蚀地层暴露区的大小和地形特征影响水文系统的类型。出露区的范围越大,能够汇集的地下水量规模越大。在更大的系统中,淡水流量和地下水的流动由诸如裂缝、裂隙、洞穴的通道所支配。

4.9 基准面的改变

基准面通常是海平面的改变将决定地表出露发生的时间和地点,以及相关的潜水面的位置。大幅度的海平面波动能够引起周期性的地表出露带和淡水成岩作用。

4.10 构造沉降特征

构造沉降通常是决定上述因素的最终控制作用。在构造运动活跃的地区,地表出露、侵蚀和沉积也能够构造低部位产生与不整合相关的储层。

此外,地带性也是其影响因素,地球上不同气候带的水热条件不同,岩溶强度不同,以湿热气候区最强烈。

5 岩溶机理研究

5.1 表生期的大气水淋滤

构造抬升会使地层遭受普遍而广泛的风化剥蚀,

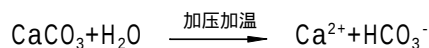
对于有岩溶基础的地层,在大气水淋滤作用下,就会使颗粒溶蚀和早期胶结物溶蚀,甚至产生溶蚀缝洞。川东石炭系储层中多数溶蚀缝、洞、孔均主要在这一阶段形成^[6]。

5.2 压实水溶蚀

泥岩在埋藏压实过程中,会排出大量的孔隙水进入储层,这些具侵蚀性的水对储层造成溶蚀。

5.3 压溶

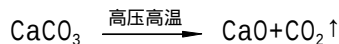
碳酸盐岩体中存在缝合线是一种普遍的特性,主要是由压溶作用形成,并提供大量的胶结物,使缝洞体积大量减小。压溶作用主要在高水平地应力区形成,原缝洞系中垂直于局部主应力方向的张裂缝闭合,流体排出过程中,在裂缝两侧壁接触处优先压溶。即:



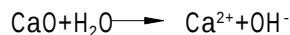
压溶作用产生大量的 Ca^{2+} 、 HCO_3^- 离子,在与最大主应力平行的张裂缝带沉淀,使缝洞空间减小。

5.4 热分解—溶解

碳酸盐岩体在水平挤压应力作用下, CaCO_3 晶体被压剪碎裂,存在一很小的位移,即超显微断裂或断层。在此过程中,因断面两侧压性位错摩擦生热造成断面局部高温, CaCO_3 热分解^[7]。



它给缝洞系统增加了 CO_2 量,有利于提高 CO_2 浓度,也提供了比 CaCO_3 更易遭溶解的 CaO 。



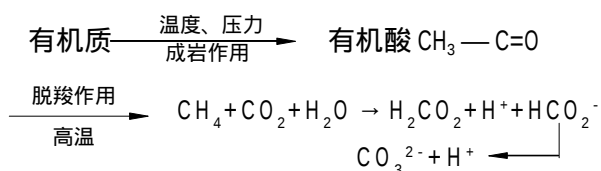
$\text{Ca}^{2+} + \text{OH}^-$ 离子在水平挤压应力驱使下随地层水转移到平行于最大主应力方向上的张裂缝带中,仍以离子存在或结晶沉淀。这在高水平挤压应力区地层中广泛存在。

5.5 有机酸溶蚀

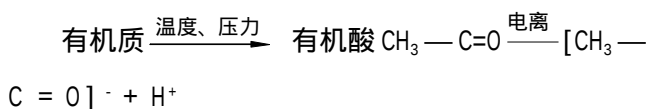
碳酸盐岩的有机溶蚀过程与有机质的成岩作用有密切关系。在有机质热演化过程中,首先是热稳定性较差的双官能团羧酸由岩体脱出进入地下水,然后是单官能团羧酸脱出,使地下水变成富含有机质的流体^[8]。

据 Indu 等研究^[9],有机成岩作用产生 H^+ 有两种途

径,第一是有机质的脱羧作用,其模型为:



第二是有机质的电离作用,其模型为:



模型中C表示同位素较轻的有机碳,有机作用所产生的H⁺的活性在化学计量上对碳酸盐的溶解作用比碳酸溶解作用更有效。有机溶解能力与有机酸含羧基量的多少呈正向递变关系。

有机溶蚀之所以比较强烈,除上述机理外,还有如下因素:一是有机溶蚀过程中产生新的CO₂,增加溶蚀营力;此外,在有机沉积的深成阶段,沉积物中的微生物,以有机质为能源从潜伏状态转为活跃状态,分解和改造有机质,又生成大量CO₂。

5.6 热水溶蚀

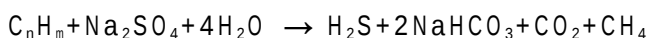
热水来源与地热源,是热水岩溶发育的基础,热水来源具多样性,既有岩浆或变质作用释放出的水,又有埋藏加热的封存水;既有构造运动加热的深循环水,又有深部原生水和回注的海水等。其热能除地热梯度加热,构造运动加热外,还有放射性物质的蜕变热^[10]。

热水岩溶除了有充足的热源外,还要求热水具有侵蚀性。一般认为,只要水中源源不断有侵蚀性CO₂的补充,其侵蚀性可以长盛不衰。特别是当含一定量SO₄²⁻的岩溶水在流经碳酸盐岩地层时,将大大提高其溶蚀、溶解能力,尤其是提高其中镁的溶解、迁移能力。

深部岩溶系统中CO₂的来源主要有如下几个方面^[11]:

(1) 如前所述的有机质在热化学生油期间,由于脱羧降解作用产生大量的CO₂和H₂S。

(2) 在脱硫细菌作用下,油田水中硫酸盐与烃类反应产生CO₂和H₂S。



(3) 深部如有两种以上浓度或温度不同的碳酸钙饱和溶液混合释出CO₂。

(4) 深部碳酸盐岩受高温、高压分解产生CO₂。

5.7 复合岩溶机理

复合岩溶是指对含碳酸盐岩和硫酸盐岩地层的溶蚀。它与可溶岩层序关系密切,对碳酸盐岩—硫酸盐岩地层,发生两种可溶岩的溶解作用,碳酸盐岩溶解通过增大溶液离子力,使硫酸盐岩溶解度增大;对硫酸盐岩—碳酸盐岩地层,除硫酸盐岩(石膏和半水石膏)溶解外,还有由其促使的去白云化作用。这些作用之间相互促进,导致复合岩溶较单一可溶岩的岩溶更发育^[12]。

硫酸盐岩成因通过影响其中矿物成分含量,对复合岩溶产生影响。溶解度大的半水石膏含量越高,硫酸盐岩溶解越多,去白云化作用更强烈,最终导致岩溶发育。复合岩溶的发育还受溶液的pH值和环境温度的影响,溶液pH值降低,环境温度升高有利于复合岩溶发育,热液环境更易发育复合岩溶。

此外,还有水的机械侵蚀与真空侵蚀作用,以及重力滑塌和充水过程中被压缩气体的气压增加形成的气爆等,都会导致岩溶及岩溶塌陷的产生^[13]。

6 岩溶研究进展及发展趋势

6.1 岩溶研究进展

近年来,随着人们对古岩溶作用地质意义的深刻认识,“古岩溶与油气储层”引起了一些国内外学者的重视,并取得了以下几方面的研究进展:

(1) 从地层、地貌、岩石矿物、地球化学等方面提出了古岩溶的宏观和微观鉴别标志;

(2) 借鉴现代岩溶学的理论,开展了古岩溶作用过程与机理的探讨性研究,讨论了岩溶形成的内外地质因素;

(3) 研究了古生代以来的一些岩溶实例,总结了地表和地下岩溶的发育特征,对岩溶在垂向剖面上的分带性和洞穴充填物的分带特征有了较详细的论述;

(4) 应用碳酸盐沉积学、储层成岩作用、地球化学等基础理论和实验分析手段,开展了洞穴物理、化学等充填物的研究,提出了大气水成岩作用体系的地球化学、胶结物地层学和水动力学模式,建立了一些实例性的古岩溶发育综合模式;

(5) 认识到了古岩溶对决定大型储渗空间、碳酸盐岩储集体形成和分布的控制作用及地质意义,识别到世界上许多大储量、高产油气田的形成多与地质历史

时期中的古岩溶作用有关,并从地质、钻井、录井、测井、开发动态等方面对岩溶型储层的特征进行了表征性的描述。

6.2 存在的问题和发展趋势

总体来说,目前对古岩溶与油气储层的研究还不够重视,对古岩溶的大气水成岩作用、岩溶期后成岩作用的改造、岩溶孔洞的保存条件和深埋地下的古岩溶发育特征、规律还知道或研究得很少,对岩溶及岩溶型储层的预测还缺乏必要的手段和技术。其发展趋势主要表现在以下几个方面:

- (1) 研究与古岩溶有关的充填物和充填作用;
- (2) 研究叠加型或继承型的古岩溶;
- (3) 研究岩溶对储层的控制作用;
- (4) 研究岩溶期后的埋藏成岩作用、溶蚀—充填物质平衡、物质—空间再分配过程;
- (5) 应用新的技术与手段,恢复岩溶古地貌,预测岩溶的区域分布,识别岩溶地下形态,探索区域上岩溶发育规律;
- (6) 研究各种岩溶型储集体的识别特征,建立相应的地质模型及地震响应模型,预测岩溶型储层的区域分布规律。

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ABSTRACT

Features and Exploration Potential of Lithologic Oil Reservoirs in Southern Songliao Basin // Mao Chaolin^{1,2}, Zhao Zhanyin^{1,2}, Ma Yutian^{1,2}, Song Lizhong¹ and Liu Ke¹ / 1 China University of Geosciences, Beijing 100083; 2 PetroChina Jilin Oilfield Company, Songyuan City, Jilin Province 138001

Abstract: On the basis of analyzing the forming conditions of lithologic oil reservoirs in the south of Songliao Basin, the types and distributing features of lithologic oil reservoirs have been summarized. There are 6 types of lithologic oil reservoirs such as updip sandstone pinchout oil reservoir, lenticular sandstone oil reservoir, structural-lithologic oil reservoir, fault-lithologic oil reservoir, hydrodynamic trap oil reservoir and mud fractured oil reservoir. By researching and summarizing, it is thought that there would be 5 forming regularities of lithologic oil reservoirs and approximately 1 billion tons oil resources potential in the southern Songliao Basin. Meanwhile, it is put forward that next target areas should be the frontal zones of the western, westsouth and eastsouth deposition systems.

Key words: southern Songliao Basin, lithologic oil reservoir, distribution regularity, exploration potential, depositional system

Exploration Thinking and Mapping Suggestion for Lithologic-stratigraphic Oil Traps // Yao Chao¹, Jiao Guihao², Lu Yousheng³ and Zheng Lianghe³ / 1 PetroChina Exploration & Production Company, Beijing 100011; 2 Langfang Branch, PetroChina Research Institute of Petroleum Exploration and Development, Langfang City, Hebei Province 065000; 3 CNPC BGP Inc., Zhuozhou City, Hebei Province 072751

Abstract: The formation and distribution of lithologic-stratigraphic traps are dependent on the geological structural background, space distribution of strata, special deposition environment of the basin, and the effect of later structure events. With the theory of sequence stratigraphy and seismic stratigraphy, it analyses the various types of lithologic-stratigraphic traps, their occurrence conditions and the exploration difficulty, and also proposes the exploration thinking that builds in the basement of finding out "three surfaces and one line" (i.e. maximum flooding surface, initial flooding surface, unconformable surface and pinchout line) in oil-rich sags and the suggestions that include mapping for lithologic-stratigraphic traps and checking the interpretation quality in the term of lithologic-stratigraphic traps. The suggestion is not only helpful for mapping standardization of lithologic-stratigraphic trap, but also to promote deepening the interpretation of lithologic-stratigraphic traps and discover more promising lithologic-stratigraphic oil reservoirs.

Key words: lithologic-stratigraphic trap, exploration difficulty, exploration thinking, three surfaces and one line, interpretation technique, industry mapping, quality checking

Oil-gas Transfer Station Model of Oil-gas Migration Formed by Fault-sandbody // Deng Yunhua / CNOOC Tianjin Company, Tianjin 300452

Abstract: Oil-gas migration is regarded as the weakest link in petroleum geology research in the world and is the most frontier science as well, and is the core of the dynamic research of oil-gas accumulation and migration. Although fault is the important pathway for oil-gas migration in the faulted-depression basin, the contact plane of the hydrocarbon source rock is small, which cannot absorb a mass of oil and gas. However, in the downthrow block of the major fault, the subsea fan sandbody has large contact plane with the hydrocarbon source rock, which could absorb the most of oil and gas produced in the hydrocarbon rock. While reaching the certain saturation of oil and gas, the temperature and pressure will rise and along with the episodic movement of the fault, oil and gas will migrate upwards in the transfer station of the sandbody along the fault, accumulate, and the reservoir will then be formed. Both the success and the failure practice in exploration proved that the way of model "Oil-gas Transfer Station" of the fault-sandbody is correct, furthermore, it will guide the research and exploration for the oil-gas migration in the future.

Key words: fault, sandbody, transfer station, oil and gas migration, model

Application of Chemical Kinetic Theory in Resource Evaluation of Immature to Low-mature Oil in Huanghua Depression // Lu Shuangfang¹, Guo Chunping¹, Shen Jianian¹, Wang Feng¹, Liao Qianjin² and Yu Junli² / 1 Daqing Petroleum Institute, Daqing City, Heilongjiang Province 163318; 2 Research Institute of Exploration and Development, PetroChina Dagang Oilfield Company, Tianjin 300280

Abstract: The application of chemical kinetic models in Huanghua Depression indicates that the botryococcus, organic matter (OM) reworked by microbe and soluble OM (non-hydrocarbon and asphaltene) in the research region do begin to generate hydrocarbons in large amount at shallower buried depth relative to the normal threshold of oil generation. Combined with the distribution, thickness, and buried history of source rocks as well as their geochemical characteristics and feature of residue hydrocarbon, the quantitative evaluation shows that the amounts of hydrocarbon generation and expulsion for the 2nd member of Kongdian Formation are 3.45 billion tons and 3.19 billion tons respectively in the south region of Kongdian, and that for the 1st member of Shahejie Formation are 1.34 and 0.94 billion tons respectively, the amounts of oil resource (including mature oil) of the 2nd member are 0.71 and 0.28 billion tons respectively. This means that the 2nd member of Kongdian Formation in south Kongdian will result the enrichment of oil accumulation of immature to low-mature oil, and the exploration potential related to the 1st member of Shahejie Formation is not negligible. These also suggest that it is both reliable and workable to evaluate the amount of generation and expulsion as well as the resource of immature to low-mature oil from the chemical kinetic theory.

Key words: Huanghua Depression, immature oil, low-mature oil, resource evaluation, chemical kinetics

Karstification Study on Gas-oil Reservoirs // Liu Shanhua, Dai Zongyang and Wu Changjiang / Southwest Petroleum Institute, Chengdu City, Sichuan Province 610500

Abstract: According to karstification time, depth, rocks medium, producing environment and mechanisms, karst can be classified into karst and paleokarst, and in vertical it also be divided into five belts including weathered layer, vertical seepage belt, seasonal changed belt, horizontal seepage belt and deep sluggish belt based on the features of karst's hydrodynamics. After summing up the former researchers' results, it is discussed that 10 geological factors are related to develop the paleokarst of oil-gas reservoirs and 7 kinds of karst developing mechanism, and is concluded the progress and the development tendency of karst research in the future.

Key words: karst, paleokarst, geological condition, development mechanism, research progress, development tendency

Non-seismic Technique for Direct Oil-gas Detection and Its Exploration Practice // Zhao Bangliu¹, He Zhanxiang² and Wen Baihong³
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Abstract: It is well known that general seismic method has been playing an important role in exploration and development of oil and gas. Nevertheless, with the increase of exploration and development difficulties for structural and stratigraphic traps in complex mountainous regions and thrusting belts in forelands and lithologic-stratigraphic oil-gas reservoirs, sole P-wave seismic method barely meets these needs. By contrasting, studies and applications of non-seismic direct oil-gas detection methods show their superiority to reduce the exploration risk and cost. As a result of technical progresses and based on multi-attribute characteristics of oil-gas reservoirs, a non-seismic oil-gas detection strategy is formulated and the application prerequisites of non-seismic methods are studied with exploration cases. So that arouses attentions and reconsiderations from experts and administrators in exploration and development sector of oil and gas industry.

Key words: non-seismic methods, direct oil-gas detection, application prerequisites, exploration cases

Exploration Status and Technical Development Suggestion of Seismic Exploration in PetroChina Exploration Area in Bohai Bay Basin // Zhang Ying / PetroChina Research Institute of Petroleum Exploration and Development, Beijing 100083

Abstract: On the basis of analysis of seismic exploration history and extent in PetroChina exploration area in Bohai Bay Basin, it evaluated mainly the quality of 3D seismic data in the area. Combined with the geophysical characteristics and geological features in the key targets to be explored in Bohai Bay exploration area in the future, it is discussed that oil and gas exploration needs the suitable seismic exploration techniques, and then put forward that the suggestions will be considered for technique development of seismic exploration in Bohai Bay Basin in the future.

Key words: seismic exploration extent, data quality, evaluation, exploration status, technical demand, development suggestion

Application of Fine Demarcation with Synthetic Seismic Record for Stratigraphic Unit // Hong Yugang, Chen Jingshan, Dai Zongyang and Li Lingfeng / Department of Resources and Environment, Southwest Petroleum Institute, Chengdu City, Sichuan Province 610500

Abstract: By analyzing general methods used in compiling synthetic record, taking consideration of the seismic and geological data of the study area, a useful optimal method, which emphasized the wavelet extraction method and the deviation caused by wavelet phase, was presented to make synthetic seismic records. With the application of this method to Xinkai-Dongjiagang area, Liaohe Oilfield, where the quality of seismic data was relatively poor, making the accuracy of stratigraphic unit demarcation highly increase compared with general methods.

Key words: stratigraphic unit demarcation, synthetic seismic record, wavelet extraction

Kirchhoff Prestack Time Migration Technology and Its Application // Yang Chunmei¹, Yan Jun¹ and Chen Tianzhu² / 1 Geophysical Research Institute of Zhongyuan Oilfield Company, Sinopec, Puyang City, Henan Province 457001; 2 Geological Survey Department, Zhongyuan Oilfield Company, Sinopec, Puyang City, Henan Province 457001

Abstract: The geological structure is complex in Zhongyuan area, and there are a lot of small fault-blocks in this area, at the same time original seismic data are severely dominated by linear noise and multiple waves. According to the characteristic of original seismic data in this area, firstly linear noise and multiple are removed, then Kirchhoff prestack time migration (KPSTM) is carried out on the data, whilst aperture and frequency limits are tested. The final processing effect is obvious, and velocity picking conflict problem in crossing strata is effectively resolved.

Key words: Kirchhoff prestack time migration (KPSTM), multiple wave; linear noise; migration aperture, frequency

High-pressure and Low-permeability Reservoir Reconstruction Technology and Its Application in Deep Permian in Xiazijie Region, Junggar Basin / Jin Jun^{1,2}, Kuang Lichun² and Song Guiyou² // 1 College of Earth Resources and Information, China University of Petroleum, Beijing 102249; 2 PetroChina Xinjiang Oilfield Company, Karamay City, Xinjiang 834000

Abstract: The core problem of low-permeability oil & gas reservoirs' exploration and exploitation is to heighten the output of single well, so as to declining the production cost. Recently, with the continuous improvement of reservoir reconstruction technology and further research on Xiazijie region in northwestern Junggar Basin, it is tackled the key problems focusing mainly on reconstruction technology for high-pressure and low-permeability reservoirs in this area, and on the basis of analysis the early fractured effect of neighbor wells, starting with the content of clay minerals in reservoirs, the reconstruction technique such as fracture fluid mixing,