# 济阳坳陷车 15 井区浊积扇沉积及油气勘探意义

彭勇民[1] 宋传春[2] 王登稳[2] 罗 群[3] 黄捍东[3]

(1.中国石化石油勘探开发研究院, 北京 100083; 2.中国石化胜利油田分公司物探研究院, 山东 东营 257022;
3.中国石油大学, 北京 102200)

**提要**:根据岩心、地震、测录井资料,在济阳坳陷车镇凹陷车 15 井区的沙三下砂砾体中识别出滑塌浊积扇和深水浊积扇。其中,车古 25 井以具水道补给的(有根的)滑塌浊积扇为特色;内扇及水道最发育,为碎屑流夹浊流的巨砾岩、中细砾岩(厚 10~20 m)与砾质砂岩夹薄层深灰、灰色泥岩;崩塌成因的巨砾(大小 1.06 m)反映了陡的斜坡;地震上呈楔状外形,内扇为弱反射,中扇与外扇为发散、亚平行的连续反射。车 57 井以粒度偏细且有根的深水浊积扇与深湖相互层为特色;中扇发育,为厚(5~11 m) 的水道碎屑流细砾岩与砾质砂岩,夹深灰色泥岩;水道沉积表现为钟型测井曲线。顺水道方向滑塌浊积扇由北而南产生进积,向盆出现深水浊积扇;2 类扇体沿主构造线串珠状排列,包裹于大片的深湖相中,呈现"深湖包扇"的沉积格局。不同类型浊积扇的识别及其边界的确定,对于该区隐蔽圈闭勘探具有重要意义。

**关 键 词**:深水浊积扇;滑塌浊积扇;碎屑流;隐蔽圈闭;济阳坳陷

**中图分类号**:P531 **文献标志码**:A **文章编号**:1100-3657(2011)05-1289-09

湖底扇或浊积扇在地理位置上可处于湖泊陡岸、缓岸, 也可处在深水平原;其成因机制可以是洪水重力流直接注入深水区而成,也可以是三角洲、扇三角洲或水下冲积扇前缘沉积物顺坡滑塌快速堆积而成[1];多数学者将前者称之为深水浊积扇,后者称之为滑塌浊积扇[2]。但在济阳坳陷的油气勘探实践中,按照构造背景将浊积体系分为陡坡近源浊积扇、缓坡远源浊积扇和洼陷中心滑塌浊积扇 3 种类型[3-7]。

近 40 年来,位于济阳坳陷车镇凹陷的北部陡坡带成熟勘探区[7-10]的砂砾岩体被一致认为是重力流形成的[3,5-6,11-16],但究竟是深水浊积扇还是滑塌浊积扇的分歧较大,有坚持深水浊积扇或低位扇的[4,12-17],有主张滑塌浊积扇[12-15],以及斜坡扇或扇三角洲的[12]。

车 15 井区砂砾岩体业已成为济阳坳陷隐蔽圈闭勘探的重点区[11,14,17-19],因此,识别浊积扇类型及预测其边界,对于该区油气勘探十分重要。

## 1 地质背景

车镇凹陷位于济阳坳陷西北部, 是一个北断南超、南高北低、近东西向延伸的"S"形箕状陆相断陷湖盆(图 1),面积约 2 400 km$^2$;由北而南沉积相分布从冲积扇或扇三角洲→水下扇→浊积扇→深湖相变化,水体向盆中心加深;物源来自北部的埕子口凸起。

## 2 不同类型浊积扇的识别

利用"三相"(地震相、测井相、岩心相)分析方法, 通过地球物理与地质的标志识别出了不同类型的浊积扇。该区见到滑塌浊积扇与深水浊积扇等 2 种类型。

其中,车古 25 井以滑塌浊积扇夹深湖相为特色(表 1,图 2)。内扇及其水道最发育,主要为碎屑流沉积的巨砾岩、中细砾岩(厚 10~20 m)与砾质砂岩夹薄

**收稿日期**:2010-12-23;**改回日期**:2011-05-03

**基金项目**:国家 973 项目 (2006CB202306)、中国石化重大科技攻关项目(P0105)资助。

**作者简介**:彭勇民,男,1965 年生,博士,研究员,从事层序地层学及隐蔽油气藏研究工作;E-mail:pengyongmin2005@163.com。

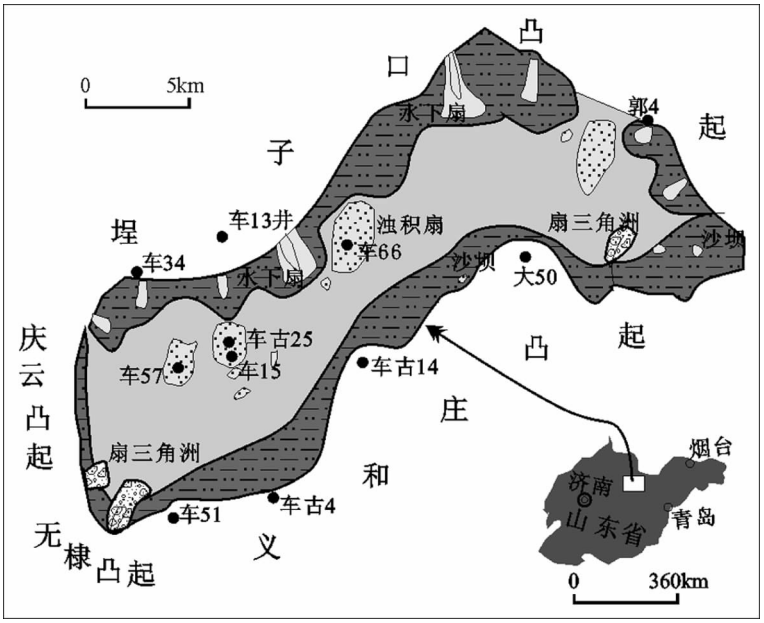


图 1 车 15 井区地质背景图

Fig.1 Geological setting of Well Che 15

层深灰、灰色泥岩。中扇次之,为厚 5~11 m 水道碎屑流细砾岩与砾质砂岩,夹深灰泥岩。外扇更次之,为深灰色深水背景泥岩夹厚至较薄层席状碎屑流、浊流含砾砂岩,类似于片流。深湖相为背景沉积的深灰色深水泥岩。车古 25 井于 4 170.3 m 处见到中扇亚相中砾岩, 测井曲线类型为箱型(表 1);颗粒呈双峰分布(细砾与砂级),无定向、无粒序、无层理,见直立滴落状细砾;细砾呈漂浮状,局部呈颗粒支撑,整体上具基质支撑结构,为碎屑流沉积(图 2-A)。类似于车 66 井区所见到的[14]。而在 4 489~4 490.5 m 处为荧光巨砾岩,砾石成分为灰岩与白云岩,与济阳坳陷的车镇凹陷与东营砾凹陷的角砾成分一致[1,8,12]。这里的砾石大小呈多峰分布,一般 5~15 cm,大者为 106 cm 的巨砾;具有灰泥或泥岩基质支撑;无粒序、无层理、无定向组构; 这些特征反映了内扇亚相的典型碎屑流沉积(相当于水上的泥石流)[1-2,5,8-9,12,14]。尤其是,该位置巨砾的出现反映了非常陡的沉积斜坡上的崩塌或滑塌产物。

**表 1 滑塌浊积扇与深水浊积扇特征的对比**

**Table 1 Comparisons between slided turbidity fans and deep-water turbidity fans**

| 内容 | 滑塌浊积扇 | 深水浊积扇 |
|---|---|---|
| 岩性组合 | 以砾岩为主。厚块状的巨砾岩、中砾岩夹少量细砾岩、砂岩与薄泥岩，以中砾岩为主；测井曲线类型为箱型、少量钟型，属水道沉积 | 以砂岩为主、粒度变细。砂岩与泥岩互层夹厚块状的细砾岩，以含砾砂岩、细砂岩为主；测井曲线类型为钟型，多属水道浊流沉积 |
| 砂砾岩比例 | 砾岩高，为碎屑流；砂岩少(15%)，为鲍玛序列的浊积岩 | 砾岩低(5%～8%)，厚块状细砾岩为碎屑流；含砾砂岩、薄层细砾岩多为浊积岩 |
| 泥岩含量 | 非常低，只占 5%～8%，为深灰、灰褐色油/泥岩 | 非常高，占 40%～60%，为深灰、灰褐色油/泥岩 |
| 重力流类型 | 碎屑流多，浊流少，具岩崩现象 | 碎屑流少，浊流多，见液化与滑动柔皱 |
| 空间位置 | 紧邻近岸水下扇，位于其前缘的相对陡的斜坡带，如车古 25 井 | 与近岸水下扇相隔一定距离，处于其前缘的相对缓的斜坡带，如车 57 井 |

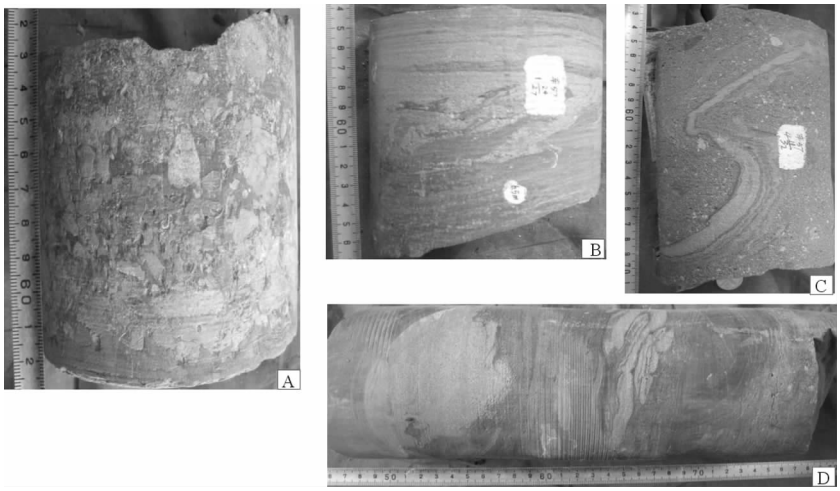


图 2　车 15 井区岩心特征与重力流沉积

Fig.2　Gravity flow of cores in Well Che15 area

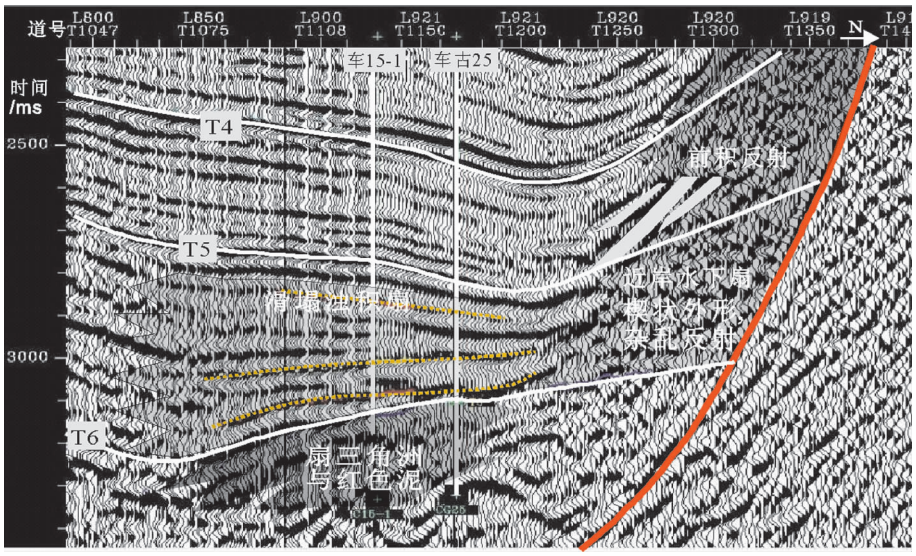


图 3　车 15 井区沙三下地震相分析

Fig.3 Seismic facies of lower 3rd Member of Shahejie Formation in Well Che15 area

值得指出的是,车古 25 井靠北部的主边界断裂附近发育近岸水下扇,由于没入水下,所以无红色泥岩出现。但是,在车古 25 井沙三下底部以下,即沙四段沉积末期,这里却发育扇三角洲,最特色的是出现了红色泥岩与大量的泥石流。这区别于近岸水下扇,因为扇三角洲的平原亚相常常出现干旱环境下的红层[7]或潮湿环境下的沼泽泥炭或煤层;红色泥岩反映了沉积物暴露于空气中所引起的氧化现象。

这里的滑塌浊积扇特征与其他地区的一样,具有特征的粒序层理、液化包卷层理、滑动截切和变形构造、小型同生断层、槽模、沟模和重荷模等浊流沉积相标志[7,14,23-24];其形成的基本条件是触发机制、地形坡度等[24-26]。

与此同时,进行了地震相分析。在南北向地震剖面上,于图 3 右侧阴影处可见到近岸水下扇,呈楔状外形(图中的 T4 代表 $Es^3$ 上亚段、T5 为 $Es^3$ 中亚段、T6 为 $Es^3$ 底),内部反射结构随着近岸水下扇亚相的不同而不同;其中,内扇为杂乱反射,中扇与外扇为前积反射(图 3)、连续性较好。紧邻近岸水下扇向南,由于滑塌、碎屑流与浊流作用导致形成了滑塌浊

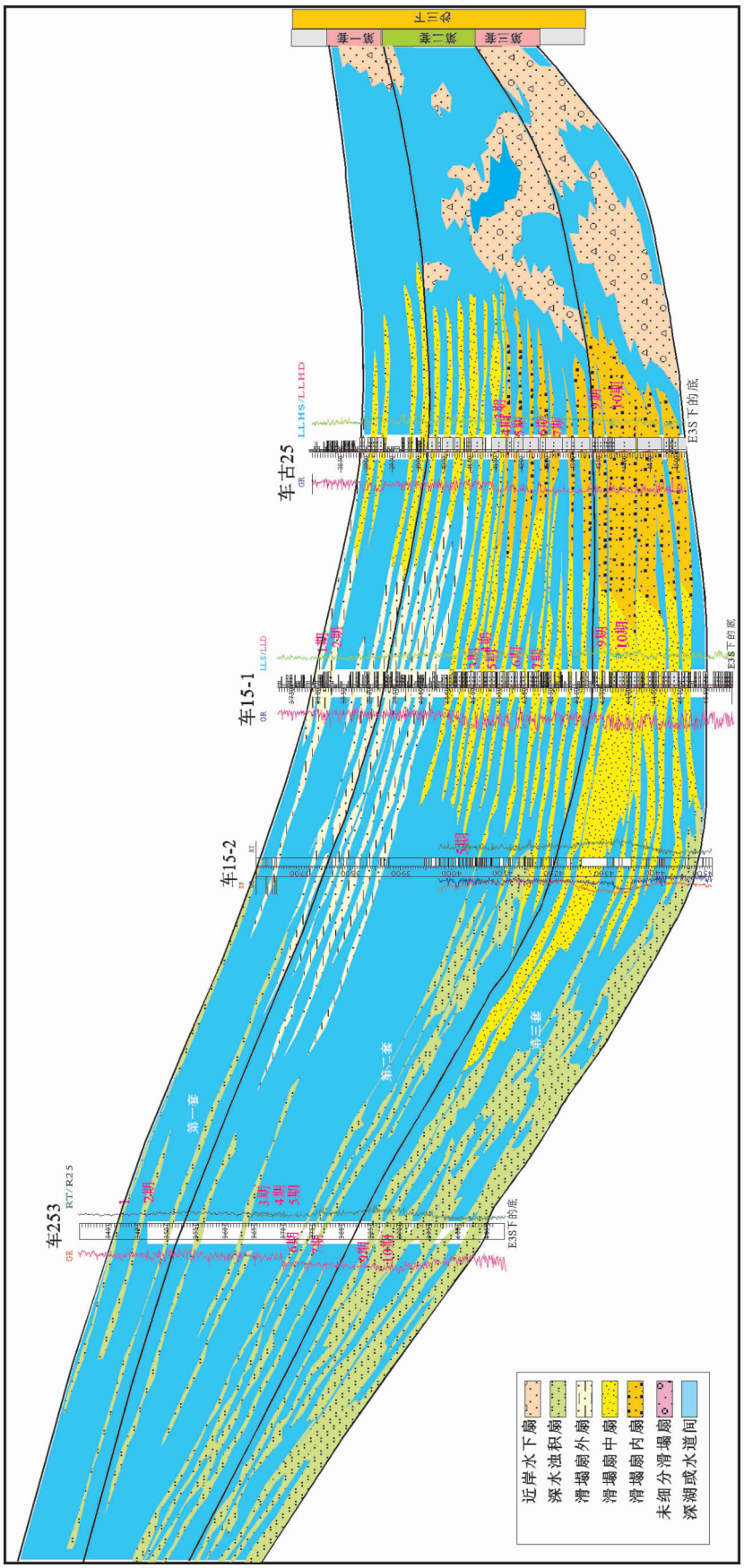


图 4 近南北向的车 253—车古 25 井沉积相

Fig.4 Sedimentary facies of nearly NS-trending profile from Well Che253 to Chegu25

积扇,后者呈发散状外形(图 3 左侧阴影);其中,滑塌浊积扇的内扇为弱或空白或块状反射, 中扇与外扇为相对粗的发散、亚平行连续反射同相轴;这些反射特征也见于济阳坳陷的其他凹陷[6-7,20,22]。而在过车 15-1 井的东西向地震剖面中, 滑塌浊积扇呈丘状外形,内部同相轴增厚并向两侧减薄。

与车古 25 井不同,车 57 井区的测井相/岩心相表明该处发育粒度相对偏细的深水浊积扇(表 1,图 2-B、C、D)。在车 57 的井深 3 051.9 m 处,可见到具鲍玛序列 DE 段浊流沉积, 其中 D 段的下部为厚 3 cm 细粉砂岩,见液化并陷入下伏 E 段泥岩,上部 D 段厚 4~5 cm 的 D 段粉砂岩具平行层理 (图 2-B);同时,3 292.5 m 井段发现顶部 1 cm 厚的鲍玛序列 A 段具正粒序且含泥质条带发生了滑动与柔皱 (图 2C), 以及 3 658.9 m 处的 C 段浊流砂岩具有液化变形(图 2-D)。在 4 041~4 080 m 处为油浸厚块状细砾岩,砾石成分为灰岩与白云岩,砾石大小呈双峰分布,一般 2~8 mm,大者达 3 cm;灰泥或泥岩基质支撑;具有无粒序、无层理、无定向组构,测井曲线类型为箱型;属碎屑流沉积。

在过车 57 井的南北向地震剖面上, 车 57 井深水浊积扇的反射呈透镜状外形; 它与近岸水下扇有深湖泥岩带相隔, 泥岩带分开了靠北的近岸水下扇与靠南的深水浊积扇。其中,深水浊积扇的内扇为弱反射,中扇与外扇为相对细的发散、亚平行连续反射同相轴。在东西向地震剖面上,也呈透镜状外形,内部杂乱反射。

## 3　浊积扇展布特征

图 4 示出了南北向沉积相连井剖面, 该图是结合反演剖面与实钻分析得到的。它代表了顺水道方向的剖面,展示了连井剖面的不同成因砂的分布、富集与变化特征。在车古 25 井—车 15-1 井一带发育滑塌浊积扇,车古 25 井主要为内扇,表现为厚的水

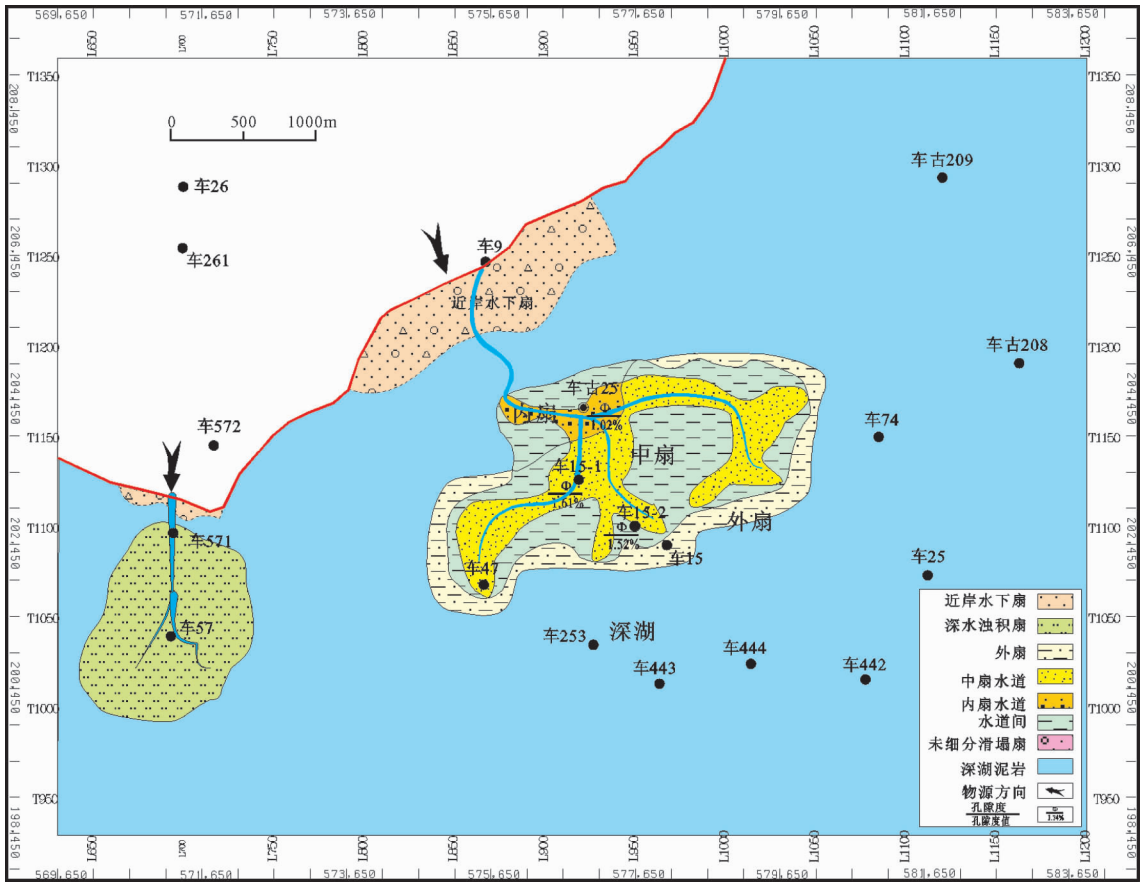


图 5　第 7 号砂砾岩层的沉积相平面图

Fig.5　Sedimentary facies map of No. 7 sandstone and conglomerate layers

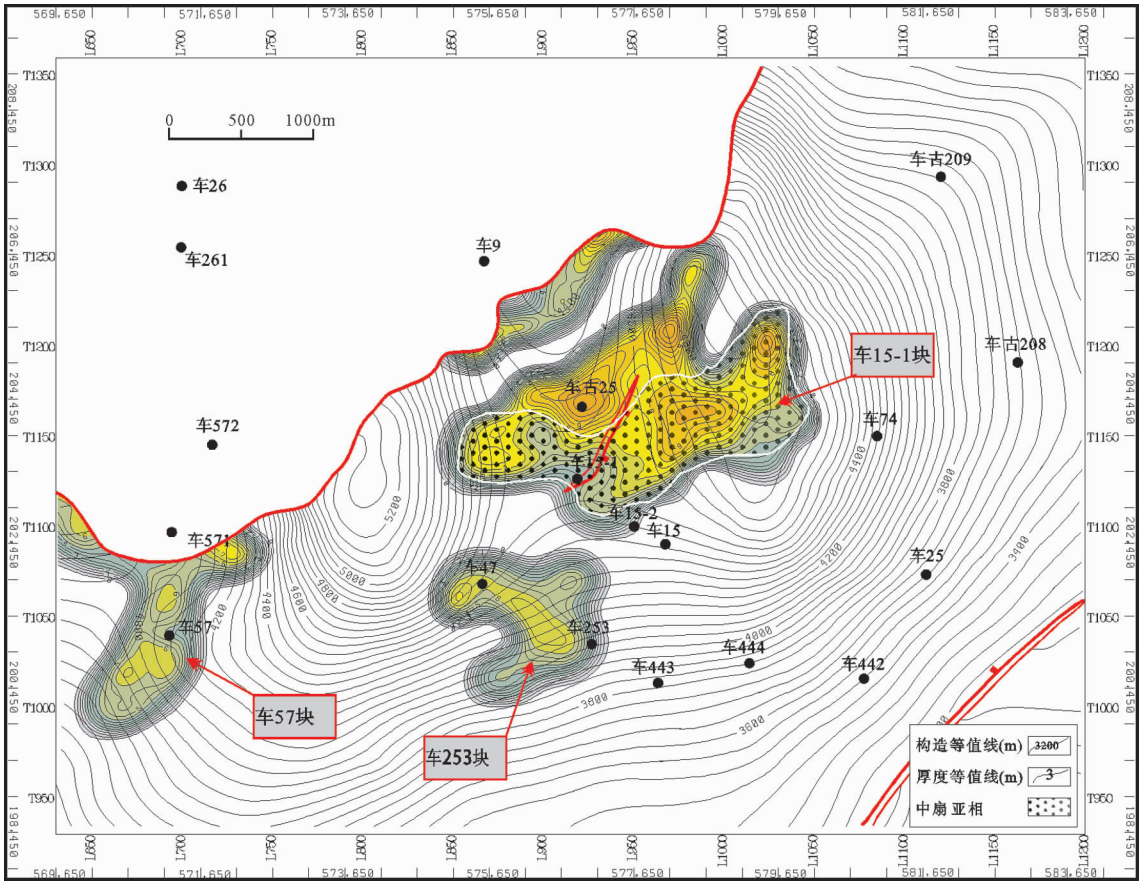


图 6 第 9 期(层)砂砾体潜力评价图

Fig.6 Evaluation of hydrocarbon potential of No. 9 sandstone and conglomerate layers

道砂砾岩夹薄泥;车 15-1 井为中扇,出现砂砾夹泥、砂砾泥互层;在车 253 井则演变为深水浊积扇,粒度更细,呈现“泥包砂”特征。这两类扇为深湖相泥岩隔开。由北向南,从车古 25 到车 253 井,自北而南沉积相由近岸水下扇演变为滑塌浊积扇;并且滑塌浊积扇向湖心推进,产生进积;这暗示物源来自北部。

纵向上,湖水加深导致退积沉积,如车 15-1 井由下而上自老至新从中扇→外扇→深湖相变化,产生退积(图 4)。

图 5 是车 15 井区沙三下亚段第 7 期砂砾岩体(层序见图 4)的沉积相图。该砂砾体堆积时的沉积格局表现为“深湖包扇”特征,主要为滑塌浊积扇与深水浊积扇, 以及靠近主断层边界或陆源区的近岸水下扇;物源从北方向进入工区。在西部的车 57 井发育深水浊积扇;在中部的车 15-1—车古 25 井一线产生较大的滑塌浊积扇; 此外, 在东部的车 74、车古 209、车古 208 井也见到小规模的滑塌浊积扇; 在南部,车 253—车 444—车 25 一线砂体不发育,为偏泥的深湖亚相。而车 15-1 井的滑塌浊积扇可细分内扇水道、中扇水道与水道间,以及外扇亚相,水道呈网状化并见 3 支。从图中可看出,滑塌浊积扇具有水道补给的(有根的),而深水浊积扇也有水道补给的。

## 4 浊积扇的油气勘探

湖泊中的浊流沉积、浊积扇砂体与油气勘探有着极其密切的关系[14,21,26,27],已被国内外很多油田证实[3,5,24]。

近 10 年来,在济阳坳陷东营凹陷各大油田中,浊积岩岩性油藏找到了近 3 亿 t 的石油地质储量[22]。车 15 井区发育二种类型的浊积扇砂砾岩体,勘探潜力各不相同。目前来看,车古 25 井滑塌浊积扇的勘探潜力要好。

这里针对第 9 号砂砾岩体潜力作一简要分析,层号见图 4。从图 6 中可以看出,车 15-1 圈闭为岩

性圈闭。该圈闭落实可靠,面积较大(3.92 $km^2$),储层厚度中等(5.5 m),储量较大、77.62 万 t;见 2 口高产油井,油源充分,中扇亚相较发育、孔隙度相对较高 1.61%~1.52%;它是最有利的勘探目标。该圈闭目标内的车 15-1 井在 4 350.5~4 354.5 m 井段电测解释 4 m/1 层为油层, 经试油 4 349.6~4 420.6 m 的 25 m/7 层,日产油 13.4 t,结论为油层。车古 25 在 4 344~4 348 m 井段电测解释 4 m/1 层为差油层,经试油 4 337~4 375 m 的 24 m/4 层,日产油 22 t,结论为油层。分类评价为Ⅰ类圈闭,综合评价属"好"级。

在车 15-1 圈闭中,选择砂层厚度适中、水道发育、相带有利、构造位置相对高的部位,作为有利的勘探目标进行井位部署;最终提出了 2 口建议井井位。

## 参考文献(References):


[1] 刘家铎, 吴富强, 田景春. 胜利油区渤南洼陷沙四上段沉积环境分析[J]. 矿物岩石, 2001, 21(3):8-15.
Liu Jiaduo, Wu Fuqiang, Tian Jingchun. The sedimentary environment analysis of the upper part of the Shasi Member in Bonan Subsag[J]. Journal of Mineralogy and Petrology, 2001, 21(3): 8-15 (in Chinese with English abstract).

[2] 范振峰. 车西洼陷北带湖底扇成因机制及其勘探意义 [J]. 新疆石油地质, 2007, 28(1):48-50.
Fan Zhenfeng. The origin of sublacustrine fan and its significance for exploration in Northern Chexi Sub-Sag,Jiyang Depression [J]. Xinjiang Petroleum Geology, 2007, 28 (1):48-50 (in Chinese with English abstract).

[3] 郑和荣, 林会喜, 王永诗. 埕岛油田勘探实践与认识[J]. 石油勘探与开发, 2000, 27(6):1-3.
Zheng Herong, Lin Huixi, Wang Yongshi. Practice and knowledge of exploration on Chengdao oil field [J]. Petroleum Exploration and Development, 2000, 27(6):1-3 (in Chinese with English abstract).

[4] 孟万斌, 张善文, 田波, 等. 沾化凹陷五号桩地区沙河街组三段浊流沉积特征及储集性能[J]. 石油与天然气地质, 2007, 28(4):504-510.
Meng Wanbin, Zhang Shanwen, Tian Bo, et al. Depositional characteristics and reservoir properties of turbidites in the 3~(rd) member of Shahejie Formation in Wuhaozhuang area,eastern Zhanhua depression [J]. Oil & Gas Geology, 2007, 28 (4):504-510 (in Chinese with English abstract).

[5] Li Pilong, Zhang Shanwen, Xiao Huanqin, et al. Exploration of subtle trap in Jiyang Depression [J]. Petroleum Science, 2004, 1(2): 13-21.

[6] 刘传虎. 砂砾岩扇体发育特征及地震描述技术 [J]. 石油物探, 2001, 40(1) :64-72.
Liu Chuanhu. Features and seismic description of glutenite segment [J]. Geophysical Prospecting for Petroleum, 2001, 40 (1):64-72 (in Chinese with English abstract).

[7] 袁静. 济阳坳陷南部古近系洪水—漫湖沉积 [J]. 中国地质, 2005, 32 (4):655-662.
Yuan Jing. Paleogene flooded lake sediments in the southern part of the Jiyang depression[J]. Geology in China, 2005, 32(4):655-662 (in Chinese with English abstract).

[8] 吴崇筠. 湖盆砂体类型[J]. 沉积学报, 1986, 4 (4) : 1-24.
Wu Chongjun. Sand-body types of lacustrine basin [J]. Acta Sedimentologica Sinica, 1986, 4 (4):1-24 (in Chinese with English abstract).

[9] 韦东晓, 田景春, 倪新锋. 湖相浊积砂体沉积特征及油气勘探意义[J]. 油气地质与采收率, 2006, 13(5):15-17.
Wei Dongxiao, Tian Jingchun, Ni Xinfeng. Sedimengtary characteristics of lacustrine turbidite sand body and its significances on petroleum exploration [J]. Petroleum Geology and Recovery Efficiency, 2006, 13(5):15-17 (in Chinese with English abstract).

[10] 张萌, 田景春. "近岸水下扇"的命名、特征及其储集性[J]. 岩相古地理, 1999, 19 (4):42-52.
Zhang Meng, Tian Jingchu. The nomenclature, sedimentary characteristics and Reservoir potential of nearshore subaqueous fan [J].Sedimentary Facies and Palaeogeography, 1999, 19 (4):42-52(in Chinese with English abstract).

[11] 李丕龙, 张善文, 宋国奇, 等. 济阳成熟探区非构造油气藏深化勘探[J]. 石油学报, 2003, 24(5):10-15.
Li Pilong, Zhang Shanwen, Song Guoqi, et al. Exploration potential of nonstructural pools in the matured acreage of Jiyang District [J]. Acta Petrolei Sinica, 2003, 24 (5):10-15 (in Chinese with English abstract).

[12] 王永诗, 鲜本忠. 车镇凹陷北部陡坡带断裂结构及其对沉积和成藏的控制[J]. 油气地质与采收率, 2006. 13(6):5-8.
Wang Yongshi, Xiang Benzhong. Fault structures of northern steep belts and their influences on sedimentation and reservoir formation in Chezhen Sag [J]. Petroleum Geology and Recovery Efficiency, 2006. 13(6):5-8(in Chinese with English abstract).

[13] 张善文, 隋风贵, 王永诗. 济阳坳陷下第三系陡岸沉积模式[J]. 沉积学报, 2001, 19(2):219-223.
Zhang Shanwen, Sui Fenggui, Wang Yongshi. Sedimentary models on the steep slope of Paleogene, Jiyang basin [J]. Acta Sedimentologica Sinica, 2001, 19 (2):219-223 (in Chinese with English abstract).

[14] 彭勇民, 黄捍东, 罗群. 济阳坳陷车镇凹陷车 66 块沙三下段精细沉积相分析[J]. 现代地质, 2007, 27(4):18-23.
Peng Yongmin, Huang Handong, Luo Qun. Fine analysis of sedimentary facies in the Lower Third Member of Shahejie Formation from Block Che 66 in Chezhen Sag,Jiyang Depression [J]. Geoscience, 2007, 27 (4):18-23 (in Chinese with English abstract)

[15] 张俊, 庞雄奇, 陈冬霞, 等. 牛庄洼陷砂岩透镜体成藏特征及主控因素剖析[J]. 石油与天然气地质, 2003, 24(3):233-237.
Zhang Jun, Pang Xiongqi, Chen Dongxia, et al. Petroleum accumulation mechanism and its main controlling factors of sand

lens in Niuzhuang Subsag [J]. Oil & Gas Geology, 2003, 24(3): 233-237.

[16] 肖焕钦, 王宝言, 陈宝宁, 等. 济阳坳陷陡坡带断裂控砂模式[J]. 油气地质与采收率, 2002, 9(5):20-22.
Xiao Huanqin, Wang Baoyan, Chen Baoning, et al. Fracture sand control pattern in actic region of Jiyang depression [J]. Petroleum Geology and Recovery Efficiency, 2002, 9(5):20-22 (in Chinese with English abstract).

[17] 施振生, 朱筱敏, 胡斌, 等. 济阳坳陷车镇凹陷古近系沙河街组遗迹化石 Maca ronichnus ( 通心粉管迹) 及其沉积环境[J]. 古地理学报, 2004, 16(12):207-215.
Shi Zhensheng, Zhu Xiaomin, Hu Bin, et al. Sedimentary environments of Maca ronichnus of the Shahejie Formation of Paleogene of Chezhen Sag in Jiyang Depression [J]. Journal of Palaeogeography, 2004, 16 (12):207-215 (in Chinese with English abstract).

[18] 张家震, 毕彩芹, 王新峰, 等. 车镇凹陷石油地质特征及勘探远景[J]. 海洋石油, 2005, 26(3):6-10.
Zhang Jiazhen, Bi Caiqin, Wang Xinfeng, et al. Petroleum and oil geology and exploratory prospect of Chezhen Sag [J]. Ocean Geology,2005, 26(3):6-10 (in Chinese with English abstract).

[19] 朱光有, 金强, 张水昌, 等. 车镇凹陷下第三系沙河街组生烃系统研究[J]. 天然气工业, 2006, 26 (3):19-22.
Zhu Guangyou, Jin Qiang, Zhang Shuichang, et al. Hydrocarbon generating system of Eogene Shahejie Fm in Chezhen sag [J]. Natural Gas in Dustry, 2006, 26 (3):19-22 (in Chinese with English abstract).

[20] 陈清华, 王秀玲. 陆相断陷盆地"五扇一沟"的地震响应特征[J]. 特种油气藏, 2007, 14(1):15-19.
Chen Qinghua, Wang Xiuling. Seismic characteristics of "five-fan one-channel turbidite"in continental rift basin[J]. Special Oil and Gas Reservoirs, 2007, 14(1):15-19 (in Chinese with English abstract).

[21] 刘宪斌, 万晓樵, 林金逞, 等. 陆相浊流沉积体系与油气[J]. 地球学报, 2003, 24 (1):61-66.
Liu Xianbin, Wan Xiaoqiao, Lin Jincheng, et al. Continental turbidite deposition system and hydrocarbon [J]. Acta Geosicientia Sinica, 2003 ,24 (1):61-66(in Chinese with English abstract).

[22] 牛富玲. 现河地区滑塌浊积岩油藏勘探技术 [J]. 断块油气田, 2005, 12(1):16-18.
Niu Fuling. Exploration technology of slump turbidite reservoir in Xianhe Zone[J]. Fault Block Oil & Gas Field, 2005, 12(1):16-18 (in Chinese with English abstract)

[23] 王居峰, 郑和荣, 苏法卿. 东营凹陷中带沙河街组三段浊积体储层特征类型与成因[J]. 石油与天然气地质, 2004, 25(5):528-532.
Wang Jufeng, Zheng Herong, Su Faqing. Reservoir characteristics and genesis of turbidite fans in the 3rd Member of Shahejie Formation in central Dongying depression [J]. Oil & Gas Geology, 2004, 25 (5):528-532 (in Chinese with English abstract).

[24] 郑荣才, 文华国, 韩永林, 等. 鄂尔多斯盆地白豹地区长 6 油层组湖底滑塌浊积扇沉积特征及其研究意义 [J]. 成都理工学院学报,2006, 33(6):566-575.
Zheng Rongcai, Wen Huaguo, Han Yonglin,etal. Discovery and significance of sublacustrine slump turbidite fans in Chang 6 oil-bearing formation of Baibao region in Ordos Basin, China [J]. Journal of Chengdu University of Technology, 2006, 33 (6):566-575 (in Chinese with English abstract).

[25] 饶孟余, 钟建华, 王海侨, 等. 山东东营牛庄洼陷沙三中亚段浊积砂体储层特征及影响因素[J]. 现代地质, 2004, 18(2):256-262.
Rao Mengyu, Zhong Jianhua, Wang Haqiao, et al. Reservoir characteristics and influence factors of the turbidite sandbody Shasan intermediate Member in the Niuzhuang Sag, Dongying depression, Shandong Province [J]. Geosience, 2004, 18 (2): 256-262 (in Chinese with English abstract)

[26] 张关龙, 陈世悦, 鄢继华. 三角洲前缘滑塌浊积体形成过程模拟[J]. 沉积学报, 2006, 24 (1):50 -55.
Zhang Guanlong, Chen Shiyue, Yan Jihua. Simulation of Luxoturbidite in Front of Delta [J]. Acta Sedimentologica Sinica, 2006, 24(1):50-55(in Chinese with English abstract).

[27] 姜慧超, 张勇, 任凤楼, 等. 济阳、临清坳陷及鲁西地区中新生代构造演化对比分析[J]. 中国地质, 2008, 35(5):963-974.
Jiang Huichao, Zhang Yong, Ren Fenglou, et al. Comparative analysis of Meso-Cenozoic tectonic evolutions of the Jiyang and Linqing depressions and Luxi area [J]. Geology in China, 2008, 35 (5): 963-974 (in Chinese with English abstract).

[28] 夏景生, 王成明, 王志坤, 等. 山东东营凹陷东部深层浊积扇储层的微观特征及影响因素[J]. 中国地质, 2008, 35(5):975-983.
Xia Jingsheng, Wang Chengming, Wang Zhikun, et al. Micro-properties and influence factors of deep turbidite fan reservoirs in the eastern Dongying subbasin, Shandong [J]. Geology in China, 2008, 35(5):975-983(in Chinese with English abstract).

# Turbidity fans and hydrocarbon prospecting of lower 3rd Member of Shahejie Formation from well Che15, Jiyang depression

PENG Yong-min[1], SONG Chuan-chun[2],
WANG Deng-wen[2], LUO Qun[3], HUANG Han-dong[3]

(1. *Research Institute of Petroleum Exploration and Production, Beijing* 100083*, China;* 2. *Geophysical Research Institute of Shengli Oilfield Branch Company, Sinopec, Dongying* 257022*, Shandong, China;* 3. *China University of Petroleum, Beijing* 102200*, China*)

**Abstract**: Based on seismic, well-logging and core data, the authors recognized the deep-water turbidity fans and slide turbidity fans developed in the lower 3rd Member of Shahejie Formation from the well block Che 15 in Chezhen sag, Jiyang depression. Well Chegu 25 is characterized by the slide turbidity fans with supplied or rooted channels, where the inner fan and its channels are especially developed, and are composed of debris-flow and a few turbidity-flow boulder-, cobble- and pebble-conglomerates with thickness of 10 to 20 m and gravel sandstones bedded with thin-layer dark grey or grey mudstones; the conglomerates of falling-boulder 1.06m in size reflect steep slope topography. On the seismic profiles, the fans assume wedge form, where the inner-fan is weakly reflected, and the middle- and outer-fans are of divergently and subparallelly continuous seismic reflection configuration. Well Che 57 of fine-grained sediments is characterized by the deep-water turbidity fans with rooted channels and deep lacustrine facies, where the middle-fans are especially developed, and are composed of debris-flow pebbly-conglomerates with thickness of 5 to 11m and gravel sandstones interlayered with dark grey mudstones; the well-logging curve pattern of channel sediments is bell-shaped. it is concluded that the slide turbidity fans experienced progradation along the channels from north to south, and the deep-water turbidity fans occurred in the central lake; two types of fans were disposed in the pinch-and-swell form along the main tectonic orientation, and were wrapped in extensively-distributed deep lake facies, assuming the sedimentary framework of "fans packaged in deep-lake". The recognition and confirmation of boundaries of the turbidity fans is of great significance for hydrocarbon prospecting of the subtle traps.

**Key words**: deep-water turbidity fan; slide turbidity fan; debris flow; subtle trap; Jiyang depression

---

**About the first author**: PENG Yong-min, male, born in 1965, Doctor, senior researcher, engages in the study of sequence stratigraphy and subtle-trap oil and gas reservoirs; E-mail: pengyongmin2005@ 163.com.