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# 新疆吐谷鲁背斜构造建模与分析<sup>\*</sup>

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**摘要:** 吐谷鲁背斜位于新疆准噶尔盆地南缘西部山前霍玛吐构造带。立足于现代构造地质学理论新进展对山前复杂构造带的构造解释, 主要运用断层相关褶皱理论根据地震资料进行构造建模, 推断吐谷鲁背斜构造的主要构造样式为早期深部构造楔与后期突破推覆构造的叠加组合。最终运用三维可视化成图软件形成直观的构造解释三维图, 方便进一步分析。

**关键词:** 断层相关褶皱; 构造楔; 三维成图

**中图分类号:** TE121

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## 引 言

断层相关褶皱理论作为现代构造地质学近几十年发展起来的重要理论, 已经广泛并且有效地应用于对山前复杂构造带的研究和构造解释当中。自 Rich<sup>[1]</sup> (1934) 提出断层转折褶皱的几何学概念, Suppe<sup>[2]</sup> (1983) 首次将其定量化, 建立了褶皱形态与断层形态和断层滑动之间的定量关系, 奠定了断层相关褶皱理论的基本类型。20 多年来, 不但建立了断层传播褶皱、断层滑脱褶皱等基本端员类型的几何学与运动学模型, 也建立并完善了断层相关褶皱叠加样式的几何学与运动学模型, 例如叠瓦构造、构造楔<sup>[3]</sup>等。本次研究就是在前人研究的基础之上, 结合地表地质与地下地震资料解释北天山山前带中吐谷鲁背斜的构造特点, 从而落实构造模型。并利用三维可视化软件成图。

## 1 区域地质概况

吐谷鲁背斜位于新疆准噶尔盆地南缘北天山山前褶皱—冲断带的凹中背斜, 即第二排背斜带霍玛吐滑脱片的东端。构造呈长条线性状 (图 1), 走向近东西, 褶皱核部出露  $E_{2-3a}$ 。吐谷鲁构造表现为—逆冲推覆背斜, 老第三系通过断层直接与下盘的  $N_1-2$  接触<sup>[4]</sup>。其背斜形态在地表被冲断而受破坏, 形成浅部倾角陡直的南倾单斜。在冲断滑脱面以

下, 其构造形态与上部不协调,  $E_{2-3a}$  以下地层为完整的背斜构造, 而在侏罗系以下则表现为台阶状断层、双重构造及断层相关褶皱。这表明该构造在燕山期已初具雏形, 后来受喜山期挤压应力作用, 山前推举带的位移部分通过下第三系地层传递到第二排构造带形成滑脱片。该构造地表未见油气显示, 表明断层具有较好的封闭性。

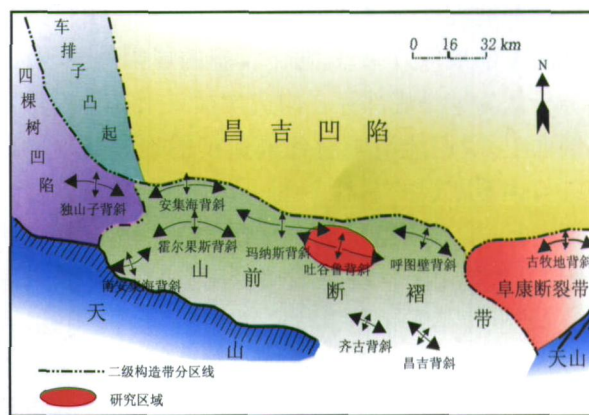


图 1 准噶尔盆地南缘西部构造纲要图

## 2 构造建模

目前, 国内外越来越重视山前带的油气勘探, 运用于山前带油气勘探的断层相关褶皱及其组合叠加形态特征也逐步为人们所认识。运用断层相关褶皱理论进行的构造建模和构造解释近几年越来越多地

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被钻井证实。通过前人的努力和对地震资料的分析,我们认为吐谷鲁背斜主要由以下两个构造组合而成:

### 2.1 吐谷鲁逆冲推覆断层

在所有的地震剖面上,此逆冲断层均清晰可见(如图2)。断层由第三系安集海河组泥岩层段内部呈近水平席状滑覆并最终向上推覆,直至地表,破坏了表皮构造的完整性。断层在吐谷鲁背斜东段位移量逐渐传递给玛纳斯断层。二者可看成霍玛吐大型逆冲推覆断层的分支断层。

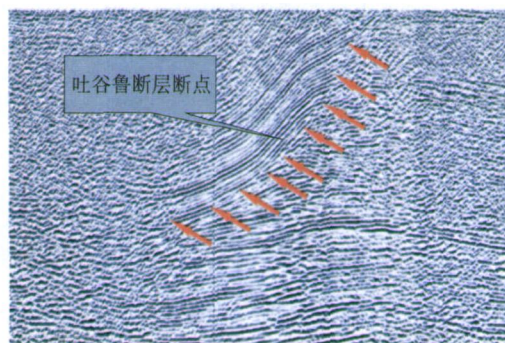


图2 侧线 tg9633上显示的吐谷鲁逆冲断层

### 2.2 吐谷鲁构造楔

在吐谷鲁断层的下盘,有一明显的背斜构造。背斜轴部地震反射比较清晰,高点明确,但由于两翼和背斜下部成像效果差,对于背斜的成因争论较大。经分析认为这是底部存在构造楔插入所造成。从很多剖面上,我们能清晰看到构造楔的地震反射。在吐谷鲁推覆断层的下盘存在一个反向的阶梯状逆冲断层:(1)第三系与下伏白垩系的变形幅度存在明显的差异,呈上陡下缓变形,表明反向逆冲断面的存在;(2)上覆第三系与下伏白垩系不能连续追踪,存在断点,可勾画出对应的断面形态(图3);(3)深部褶皱的南翼出现收敛状三角形反射,是断层转折褶皱前翼的典型反射特征。由于吐谷鲁背斜深部  $J_{2x}$  煤层向上出现分叉并可与反向断层相连,因此由  $J_{2x} \sim E_{2-3a}$  组成的构造楔沿  $J_{2x}$  滑动并向上转入  $K_2$  底部插入,导致吐谷鲁推覆断层下盘背斜的形成<sup>[5]</sup>。

构造楔向前插入时前方受阻形成正向和反向冲断层,反向冲断层上下盘地层产状明显不一致,在构造楔的顶部可以看到同相轴的收敛;正向冲断层上盘,地层被动爬升,地层产状变陡。从这张剖面可以看出正反向冲断层上盘均表现为断层转折褶皱。所以构造楔可以简单地看成断层转折褶皱的叠加组合形式。

构造楔在全球各地的前陆冲断带内广泛发育,并且和油气聚集关系密切。过去人们将靠近山前的楔冲带看作是无法预测的地带,或者认为是基底的隆起。因此,认为该带是油气勘探的贫区,但近年来的勘探成果表明,该带是完全可以预测的并且在阿尔伯特地区找到了油气,引起普遍的重视。

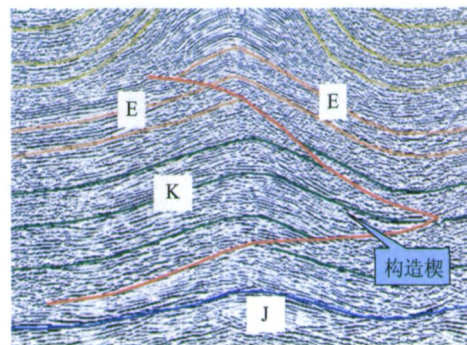


图3 吐谷鲁地震剖面上的构造楔形态

## 3 三维构造分析

图4是可视化成图软件形成的构造模型,展示了吐谷鲁逆冲推覆断层和底部构造楔在吐谷鲁背斜稳定发育。

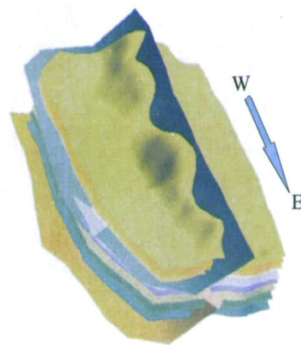


图4 吐谷鲁构造模型三维成果图

空间上,由西向东,吐谷鲁逆冲断层的位移量逐渐减小,底部构造楔幅度减弱。区域大背景下可知,吐谷鲁逆冲推覆断层和三角构造楔向西都将消失于底部的侏罗系煤层滑脱面。吐谷鲁背斜东段,深部的吐谷鲁构造逐渐减弱,构造幅度降低,在区域构造中可知北部的玛纳斯构造逐渐加强,构造抬升增加。吐谷鲁和玛纳斯三角构造楔的底部正向滑脱面皆位于  $J_{2x}$  煤层内。这表明,吐谷鲁深部的三角构造楔向西插入量逐渐减小,其衰减量分配至正向滑脱面向前陆方滑移,并在玛纳斯处形成三角构造楔,造成由

吐谷鲁构造向西其深部构造楔逐渐消失,而前陆方的玛纳斯深部构造楔逐渐增强。

图 5也可以显示出吐谷鲁逆冲推覆断层的发展变化趋势。向东西两个方向推覆的位移量都要比中部的小,说明吐谷鲁断层向东西两边都有变弱的趋势。



图 5 吐谷鲁逆冲推覆断层的三维网格化成图

图 6是底部三角构造楔的网格化成图。我们可以清楚地看到反冲断层的上盘是断层转折褶皱的形态。这也是吐谷鲁断层下盘褶皱隆起的原因。在三个切片中,我们还可以发现中间的断层转折褶皱位移量最大,这也是构造建模中,构造楔向两边逐渐消失的又一个证据。

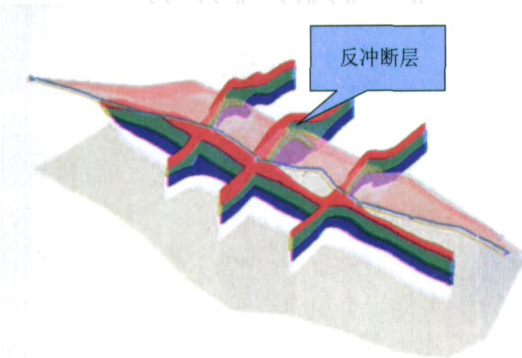


图 6 构造楔三维网格化成果图

## 4 结 论

(1) 吐谷鲁背斜主要由两个大型的构造类型组成。其构造类型为浅层的吐谷鲁推覆构造和深部的断层转折褶皱的构造叠加组合——三角构造楔共同作用。由于构造楔的发育,造成吐谷鲁断裂下盘出现上陡下缓的褶皱形态。

(2) 吐谷鲁背斜位于霍玛吐构造带的东端,横向上,构造向东发展位移量逐渐减小,最终消失在侏罗系煤层滑脱层面。构造向西发展,位移量逐渐传递给玛纳斯构造。

目前,人们对构造楔有了较深的认识,也肯定了其中含有油气的可能性。而且吐谷鲁地表没有油气显示,说明断层具有较好的封闭性。所以,对于吐谷鲁背斜的勘探,可以将重点放在构造楔发育的部位。

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## [ ABSTRACT ]

### APPLYING ROUGH SET THEORY TO OPTIMIZE SEISMIC ATTRIBUTES

GU Fa-ming (Southwest Petroleum University, Chengdu Sichuan 610500, China), YIN Cheng, DING Feng  
*JOURNAL OF SOUTHWEST PETROLEUM UNIVERSITY*, VOL. 29, 2007 - 11, 1 - 4 (ISSN 1000 - 2634, IN CHINESE)

**Abstract:** Along with the development of seismic attributes technology, using seismic attributes to predict reservoir has become a very effective method. The seismic attributes have many types and uncertain factors, and the choice of seismic attributes has a direct impact on pattern recognition, so it is very necessary to optimize seismic multi-attributes. In the paper, seismic attributes are optimized by the Rough Set theory and the Discernibility Matrix Attributes Frequency Reduction Algorithm, which can retain the knowledge information, delete redundant attributes and reduce data. This method can be relatively easy to find the attributes core, obtain seismic attributes reduction results and decrease the reduction difficulty.

**Key words:** rough set theory; seismic attribute; seismic attribute quantification; seismic attribute optimization

### THE FEATURE ANALYSIS OF EARLY CRATACEOUS FAULTS IN THE EAST AREA OF JIERGALANGTU SAG

ZHANG Lin-lin (Southwest Petroleum University, Chengdu Sichuan 610500, China), ZHOU Lu, ZHANG Yi-ming, et al *JOURNAL OF SOUTHWEST PETROLEUM UNIVERSITY*, VOL. 29, 2007 - 11, 5 - 8 (ISSN 1000 - 2634, IN CHINESE)

**Abstract:** Jiergalantu sag is a type of fault-controlled half graben-like basin. In this area, faults are very complex. There are a series of normal faults whose trends are northeast and north-northeast, the faults are almost growth faults, and the main period when they acted were Late Jurassic and Early Cretaceous. The main faults of northeast trend control the pattern of structure and sedimentation in this area, and divide this area into three parts: Baofeng structural zone, Bade structural zone and sag zone. Under the control of these faults, the sag zone became the center of sedimentation. The other faults are the derivation of the main faults. The faults cut each other, make the structure units more complex and form a series of fault traps or fault structure that are different in size. The matching of fault-trap developing time and oil active time makes the fault-traps around the sag zone more suitable for the oil accumulation.

**Key words:** Erlian basin; Jiergalantu sag; fault feature; formation and evolution; structure feature

### STRUCTURE MODELING AND STRUCTURE ANALYSIS OF XINGJIAN TUGULU ANTICLINE

HAO Jin-jin (Southwest Petroleum University, Chengdu Sichuan 610500, China), CHEN Wei *JOURNAL OF*

*SOUTHWEST PETROLEUM UNIVERSITY, VOL. 29, 2007 - 11, 9 - 11 (ISSN 1000 - 2634, IN CHINESE)*

**Abstract:** Tugulu anticline is located at the complicated foreland structure zone in the south margin of Junggar Basin, Xinjiang province. This study is aimed at a better structure elucidation with the help of modern tectonics in complicated foreland zone. fault-related theories are mainly used in dealing with seismic data to carry on structure modeling. Finally, the conclusion that the structure pattern of Tugulu anticline is composed by an earlier deep duplex tectonic wedge and a latter broke out thrust overlaying. There will be some 3D visualized pictures of tectonics interpretation made by 3D visualized restitution software which can help us to do some more analyses.

**Key words:** fault-related folds; tectonic wedge; 3D visualized restitution

### THE CONTROL OF LITHO FACIES PALEOGEOGRAPHY TO JIALINGJIANG FORMATION RESERVOIR IN ZIGONG AREA

CHANG Yan (Southwest Petroleum University, Chengdu Sichuan 610500, China), TAN Xiu-cheng, DU Ben-qiang, et al *JOURNAL OF SOUTHWEST PETROLEUM UNIVERSITY, VOL. 29, 2007 - 11, 12 - 15 (ISSN 1000 - 2634, IN CHINESE)*

**Abstract:** Through the analysis of depositional setting and Characteristics of Jialingjiang period, early Triassic in Zigong area of Sichuan Basin, it is recognized that most sedimentary cycles with difference steps have been developed by the affect of sea level fluctuation change. It is the best development time of Jialingjiang Formation reservoir only in the period of ordered configuration which is between the late increased to early decrease of every sea level change cycle and early-middle time of every sea salinity cycle. The reservoir mainly develops on the Jia21 Sub-member, Jia41 Sub-member, Jia43 Sub-member and Jia51 Sub-member. The favorite reservoir microfacies is the sand-size intraclast shoal and dolomite flat microfacies in the whole Jialingjiang Formation, its average porosity is quite high, over 5%, followed by dolomite lagoon microfacies, which shows that the development of the bedded reservoir distribution is controlled by sedimentary microfacies. The complexity of microrelief in bottom determine that the plane distribution of microfacies has variegated differentiation. And it leads to the reservoir which is determined by microfacies has obvious macroscopic heterogeneity at the early time.

**Key words:** sea-level fluctuation change; salinity cycle; sedimentary facies; microtopography; reservoir; Jialingjiang Formation; Zigong Area

### FRACTURE RECOGNITION AND THE PARAMETER CALCULATION IN SHIZIGOU AREA

ZHANG Feng-sheng (Southwest Petroleum University, Chengdu Sichuan 610500, China), SIMA Li-qiang, ZHAO Hui *JOURNAL OF SOUTHWEST PETROLEUM UNIVERSITY, VOL. 29, 2007 - 11, 16 - 19 (ISSN 1000 - 2634, IN CHINESE)*

**Abstract:** Development of fractures can lead to good secondary porous reservoirs and important flow pathways, in tight carbonate rock formations, searching for fracture is the key to find reservoirs, but the identification of fracture is quite difficult. This research chiefly uses the method of field data analysis and theoretical analysis, investigates the method of recognizing and evaluating fracture reservoir and application of conventional logging and image logging. On the basis of qualitative recognition and comprehensive analysis, core calibration logging establishment of fractured carbonate reservoir parameters calculation model is used in Shizigou area, which improves well logging in-