

# 南海北部油气成藏区带的划分与勘探前景

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**摘要** 南海北部大陆边缘整体勘探程度较低。为加强该区油气成藏特征的系统分析与对比, 根据构造、沉积特征的差异性, 将该区划分为4个油气成藏区带: 走滑拉分区(莺歌海盆地)、陆内裂陷区(北部湾盆地)、陆架浅水区(琼东南盆地北部裂陷带, 珠江口盆地北部裂陷带的珠一、珠三坳陷)、陆坡深水区(珠江口盆地珠二坳陷, 琼东南盆地中央裂陷带及南部裂陷带)。进而分析了各区带的油气成藏特征及勘探前景, 结论认为: ①走滑拉分区油气成藏主要受控于泥底辟构造活动, 应重点突破下含油气系统; ②陆内裂陷区断裂构造发育, 企西隆起东部是寻找大中型油田的有利区带; ③陆架浅水区“皮薄肉厚”, 油气勘探应以古近系陆相断陷沉积的储盖组合类型为主; ④陆坡深水区油气成藏要素配置良好, 是未来发现大型油气田、开创油气勘探新局面主战场。

**关键词** 南海北部 成藏区带 陆架浅水区 陆内裂陷区 陆坡深水区 油气藏形成 勘探前景

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南海北部大陆边缘发育多个新生代沉积盆地(本文以北部湾、莺歌海、琼东南、珠江口盆地为主要研究对象), 经过近半个世纪的勘探工作, 已发现50多个油气田, 但该区整体勘探程度仍较低, 特别是深水区油气勘探工作正处于起步阶段, 存在诸多悬而未决的问题<sup>[1-5]</sup>。因此, 加强该区油气成藏特征的系统分析与对比, 对于推进南海北部油气勘探与研究进程, 开辟深水领域油气资源战略接替新区, 具有重要的意义。

## 1 区域地质背景

南海是西太平洋最大的边缘海, 地处欧亚、印度—澳大利亚及太平洋3大板块交会处, 亦是古特提斯构造域与古太平洋构造域的混合叠置区, 地质构造复杂, 区域差异明显<sup>[6]</sup>。受南海演化及邻区构造事件的联合控制, 北部构造演化先后经历了中生代末的礼乐运动、始新世末的西卫运动、渐新世末的南海运动和中新世末的南沙运动。礼乐运动使南海北部张裂阶段开始并形成NE向裂陷; 西卫运动使裂陷作用进一步扩大; 南海运动使陆架盆地由断陷向坳陷转化; 南沙运动使南海北部以统一坳陷整体沉降, 并基本形成现今构造格局。

南海北部新生界发育基本齐全, 古新世沉积范围局限, 自始新世开始依次沉积了冲积—河湖相、滨海—沼泽相、三角洲—浅海相、滨浅海—台地相及浅海—半深海相地层, 形成不同时代、不同岩性的沉积体系在三维空间互相交叉、叠置的组合关系。

## 2 油气成藏区带的划分与勘探前景

### 2.1 成藏区带划分

根据南海北部边缘盆地构造、沉积特征的差异性, 将其划分为以下4种油气成藏区带(图1)。

#### 2.1.1 走滑拉分区

系指莺歌海盆地, 是受红河断裂控制的走滑拉分盆地, 呈北西向菱形长带状展布。具有断陷—坳陷双层结构, 但以新近纪巨厚海相坳陷沉积为主, 最大沉积厚度超过17 000 m。异常高温高压地层系统是莺歌海盆地的典型特征, 泥底辟构造十分发育, 热流体上侵活动频繁。莺歌海盆地断裂构造不发育, 除发育与泥底辟有关的小断距断层外几乎无其他深大断裂。

#### 2.1.2 陆内裂陷区

系指北部湾盆地, 位于华南板块南缘, 叠置于古生

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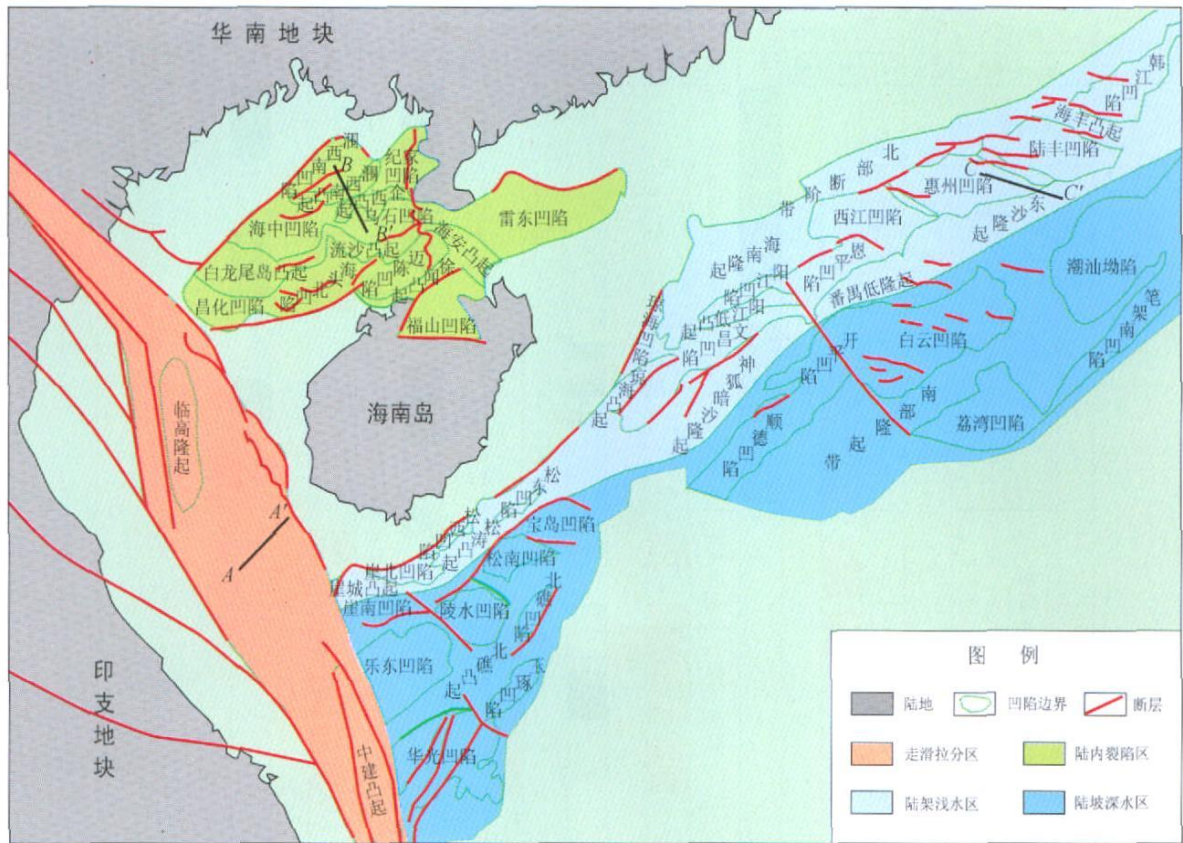


图1 南海北部油气成藏区带划分图

界粤桂隆起区和中生界海南隆起区基底之上。古近纪,在区域张应力作用下,产生一系列北东—南西向和近东西向的基底大断裂,形成众多半地堑、地堑和地垒构造;新近纪开始则产生裂后沉降,形成统一的中深边浅的整体海相坳陷沉积。以区域不整合面为界,划分为古近系陆相断陷和新近系裂后海相坳陷2大构造层系,以陆相沉积为主,其上披覆的海相层序较薄。

### 2.1.3 陆架浅水区

主要包括琼东南盆地北部裂陷带的崖北凹陷、松西及松东凹陷,珠江口盆地北部裂陷带的珠一坳陷、珠三坳陷。该区以古近纪裂谷期地层充填为主,新近纪裂后期地层为辅,形成“皮薄肉厚”的沉积充填特征。古近系陆相沉积厚度大(逾4 000 m),新近系及第四系海相沉积薄(一般为2 200 m左右)。

### 2.1.4 陆坡深水区

主要包括珠江口盆地南部珠二坳陷白云、荔湾、开平、顺德凹陷等,琼东南盆地中央裂陷带的宝岛、松南、陵水、乐东、崖南凹陷及琼东南盆地南部裂陷带的长昌、北礁及华光凹陷等<sup>[4]</sup>。古近纪裂谷期和新近纪裂后期地层均较发育,形成“皮厚肉也厚”沉积特征。盆地形成早期(古近纪),陆相断陷沉积较发育,沉积厚度

介于4 000~8 000 m;盆地形成中晚期(新近纪),沉积充填了大规模的新近系海相坳陷式沉积,并伴有区域大规模海侵,最大沉积厚度达6 000 m左右。

## 2.2 各区带油气成藏特征

### 2.2.1 走滑拉分区

中新统梅山、三亚组泥岩是莺歌海盆地主要烃源岩,目前仍处在有利的生、排气阶段。主要有以下2种储盖组合:①下中新统三亚组及其相邻层段的滨海、扇三角洲砂岩为储层,三亚组中上部及中中新统梅山组的浅海一半深海相泥岩为区域性盖层;②上中新统黄流组及其相邻层段的滨海、各种成因类型的三角洲、浊积砂为储层,上新统莺歌海组二段的浅海一半深海相泥岩为盖层(图2)。

走滑拉分区泥底辟活动是油气运聚成藏的主控因素。泥底辟上拱活动产生的大量垂向断层、裂缝是油气运移的主要通道。泥底辟活动形成众多泥底辟背斜、披覆背斜、断块等构造圈闭(图3)<sup>[7]</sup>。超压流体周期性聚压—泄压,促进油气幕式运移充注成藏。

### 2.2.2 陆内裂陷区

烃源岩主要为始新统流沙港组大套中深湖相暗色泥页岩,其次为渐新统涠洲组煤系地层。主要有以下

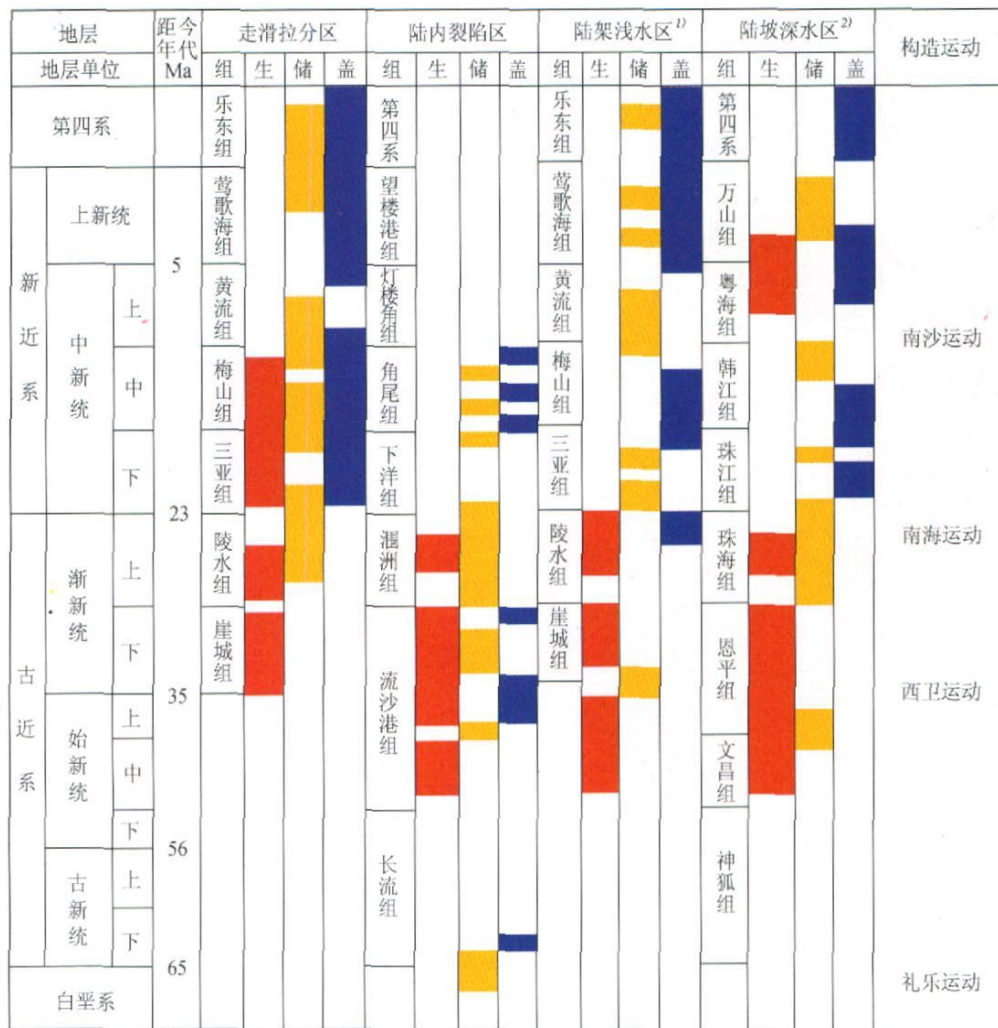


图2 南海北部生储盖组合特征与构造事件综合图  
注: 1) 以琼东南盆地浅水区为例; 2) 以白云凹陷为例

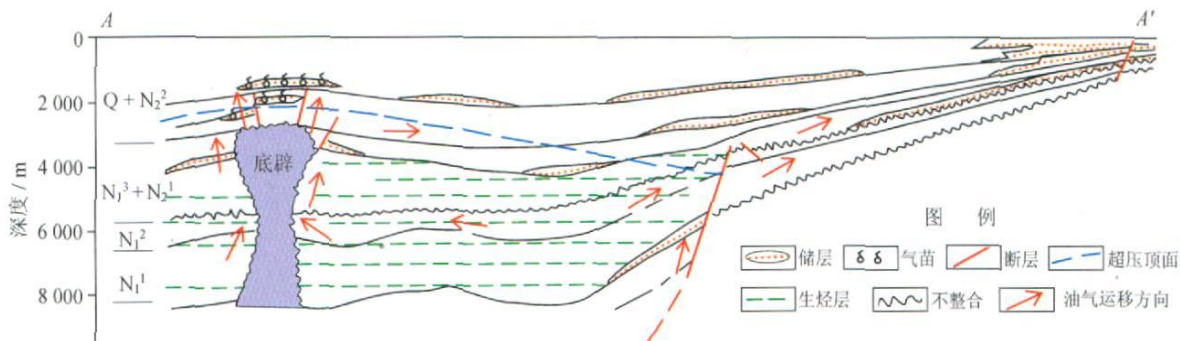


图3 走滑拉分区泥底辟构造带油气成藏模式图<sup>[1]</sup> (剖面位置见图1)

生储盖组合: ①自生自储型: 以流沙港组泥页岩为生油层及盖层, 其夹层砂岩为储层; ②古生新储型: 流沙港泥页岩为生油层, 渐新统涠洲组、中新统下洋组、角尾组砂岩为储层, 上覆泥岩为盖层; ③新生古储型: 流沙港组原油进入前新生界潜山石灰岩中储存, 盖层为石灰岩致密层段或上覆泥岩层(图2)。

陆内凹陷区断裂构造发育, 不仅为油气运移提供通道, 同时也形成诸多构造圈闭。迄今为止已发现8个油田和9个含油气构造, 油气藏类型主要有背斜型、断鼻—断块型、地层型、古潜山型等(图4)<sup>[8]</sup>。

### 2.2.3 陆架浅水区

以始新世、渐新世裂陷期中深湖相泥岩及部分滨

浅湖、河流沼泽相泥岩为主要烃源岩，以生油为主，生气为辅；裂后海相拗陷期中新统海相砂岩、碳酸盐台地礁滩灰岩、浅水三角洲砂岩等为主要储集层，储层物性好；中新统上部的海相泥岩为区域性盖层。含油气圈闭类型主要为披覆背斜、滚动背斜、断背斜、断块、古潜山和生物礁等。

珠江口盆地陆架浅水区油气自生烃凹陷多期多源沿主运移通道(构造脊砂体)主要向南侧的东沙隆起方向运聚成藏(图 5)<sup>[9]</sup>。琼东南盆地陆架浅水区总体沉积规模较小，为正常的地层压力系统，处于热演化正常成熟生烃的生油窗范围内<sup>[10]</sup>。

### 2.2.4 陆坡深水区

根据陆架浅水区钻探结果及油气地质综合分析研究，推测陆坡深水区可能主要发育 3 套烃源岩，以生气为主：①断陷裂谷期始新统一下渐新统湖相泥岩及河沼相含煤岩系；②断一拗过渡期上渐新统半封闭浅海相泥岩及滨海沼泽相含煤岩系；③拗陷期新近系中新统一上新统底部浅海一半深海相泥岩。同时，陆坡深水区至少有 3 套储层，即渐新统海陆过渡相砂岩、新近系海相砂岩及生物礁、始新统陆相砂岩。盖层发育广

泛，新近系海相泥岩和渐新统泥岩形成区域性盖层。

陆坡深水区圈闭数量较多，类型主要有披覆背斜、断层圈闭和深水扇体等。油气运移方式随时间和空间的不同变化很大，受新构造期断裂活动控制，琼东南盆地深水区以侧向运移为主；白云凹陷早期以侧向运移为主，晚期以垂向运移或断坡—断坪运移为主。深水区成藏单元有凸起、凹中次凸、断裂带和深水扇等。

### 2.3 各成藏区带油气勘探前景

#### 2.3.1 走滑拉分区

该区目前油气勘探主要集中在盆地中部中央泥底辟带浅层。泥底辟构造带存在上、下 2 套大的含油气系统。浅层气田的形成与泥底辟发育密切相关，尽管单个气田(藏)的天然气储量并非都是大型的，但气田在平面上成群成带分布，纵向上每个气田都存在多个气藏叠合，纵向叠合、横向连片仍可形成较大规模储量，采取中、小型气田联合开发可获较好的经济效益。

由于具有“近水楼台先得月”的优势，下部含油气系统比上部其成藏富集条件更优越，更具资源潜力。尽管目前勘探程度很低，几口探井资料已充分证明其勘探前景，加快研究和开拓该领域具有重要的意义。

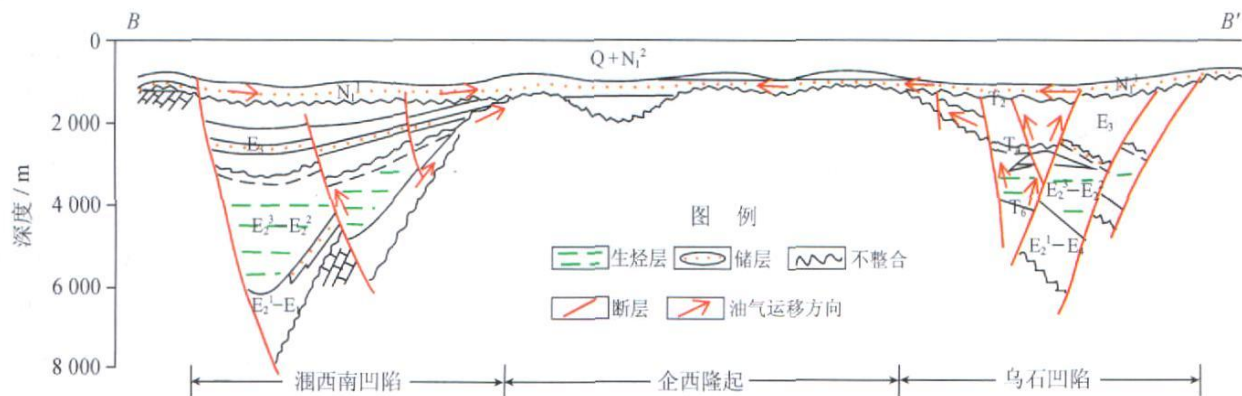


图 4 陆内裂陷区油气成藏模式图<sup>[2]</sup> (剖面位置见图 1)

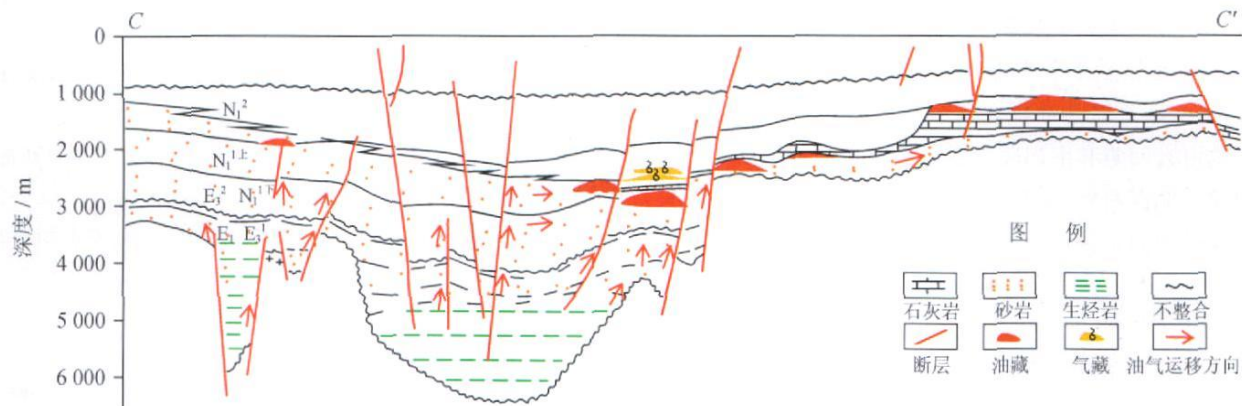


图 5 陆架浅水区油气成藏模式图<sup>[2]</sup> (剖面位置见图 1)

### 2.3.2 陆内裂陷区

该区7个凹陷中,除海头凹陷外,均见到良好的生油岩系,围绕烃源岩发育良好的储盖组合,具有较大的资源潜力。企西隆起东部发育有规模较大的披覆背斜,相邻的凹陷均能为其提供油源,是该区寻找大中型油田的有利区带。

断裂构造是陆内裂陷区主要的运移输导系统,处在油气运移通道附近的主要构造带应是油气运聚成藏的有利富集区带,具有较大的油气资源潜力及勘探前景。如涠西南凹陷1号断裂带和2号断裂带、涠西南凹陷南斜坡带、乌石凹陷16-1—乌石17-1构造带、迈陈凹陷乌石32-1—乌石29-1断裂背斜带、海中凹陷涠洲14-2背斜带及企西隆起东部凸起带等<sup>[4]</sup>。

### 2.3.3 陆架浅水区

琼东南盆地陆架浅水区裂后热沉降期构造运动不太活跃,其油气运聚通道和输导系统仅局限于古近系地层之中。因此,该区油气勘探应以古近系陆相断陷沉积的储盖组合类型为主,重点突破古近纪披覆构造。另外,位于崖城、松涛隆起倾没部位的披覆背斜及周缘的地层超覆尖灭圈闭,亦是今后应重视的勘探领域。

珠江口盆地陆架浅水区是目前我国南海北部重要的油气生产基地。珠一坳陷惠州、西江及陆丰油田群及其周缘和中深层古近系自生自储原生油气藏,具备优越的油气成藏条件,值得进一步深化勘探。珠三坳陷文昌A凹陷中央凸起带与珠三段南断裂下降盘东段油源断层发育,油气运聚输导系统配置优良,圈闭多且类型好,是下一步勘探的首选目标。

### 2.3.4 陆坡深水区

陆架浅水区油气勘探获得了重要发现,从区域上证实了陆坡深水区具备油气成藏基本地质条件。同时,深水区荔湾3-1-1井的重大突破直接证实了深水区具有形成大型油气聚集的条件<sup>[11]</sup>。

琼东南盆地南部裂陷带的北礁凸起成藏地质条件优越,可能是该区寻找大气田群的有利区带。珠江口盆地白云凹陷和南部隆起带具有巨大的油气资源潜力和油气勘探前景,将是未来发现大油气田、开创油气勘探新局面的主战场。

## 3 结论

1) 南海北部边缘盆地地质特征复杂,区域差异明显,可划分为以下4个油气成藏区带:走滑拉分区、陆

内裂陷区、陆架浅水区、陆坡深水区。

2) 走滑拉分区油气成藏主要受控于泥底辟构造活动,产生的大量垂向断层、裂缝是油气运移的主要通道,下部含油气系统比上部更具资源潜力;陆内裂陷区断裂构造发育,企西隆起东部邻近生烃凹陷,油气地质条件优越,是寻找大中型油田的有利区带;陆架浅水区“皮薄肉厚”,油气勘探应以古近系陆相断陷沉积的储盖组合类型为主,首选洼中隆及断裂活动区。

3) 科学研究及勘探实践表明,陆坡深水区油气成藏要素配置良好,具备形成大油气区的有利地质条件,将是未来发现大油气田、增储上产、开创油气勘探新局面的主战场。

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# ABSTRACTS AND AUTHORS

## **Subsalt structures and geological conditions for gas accumulation in western Qilitage, Kuqa foreland basin**

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**NATUR. GAS IND. VOLUME 30, ISSUE 8, pp. 1-3, 8/25/2010. (ISSN 1000-0976; In Chinese)**

**Abstract:** It is commonly accepted that the subsalt structure in the western Qilitage, Kuqa foreland basin, is a low uplift developed in a large monocline setting and no large-amplitude uplifting occurred in the center of this structural belt. However, an integrated analysis of the drilling, seismic, gravity, and electric survey data of the study area reveals the existence of a large subsalt anticline.

①It is more rational to interpret subsalt reflected wave groups with very strong continuity as strata dominated by sandstone and mudstone. ②The new structural interpretation model is similar to that of the adjacent Kelasu and eastern Qilitage-Dina structural zone. ③Both gravity and electric survey data reveal that a subsalt Mesozoic uplift exists in the core of the western Qilitage structural zone, verifying the existence of a large subsalt structure. The subsalt structure is large in scale and good in trap integrity. The drilling data of the adjacent area show that sandstone reservoirs of high quality occur in the Paleogene and Cretaceous. The sealing capacity of the Paleogene salt is large. The favorable conditions for hydrocarbon accumulation and preservation reveal the possibility of discovering a large uncompartimentalized gas field. It is proposed to strengthen exploration, process available seismic data, acquire high-density broadened cross lines in the central gobi area, delineate subsalt structural traps, and select the target of risk exploration.

**Key words:** Kuqa foreland basin, western Qilitage structural zone, salt structure, structural trap, seismic interpretation, electric survey data interpretation, gravity anomaly, large oil/gas field

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## **Plays division and exploration potentials in the northern South China Sea**

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**Abstract:** Exploration maturity is relatively low in the continental margin of the northern South China Sea. In order to strengthen systematic analysis and correlation of hydrocarbon pooling characteristics in the study area, we identify four plays according to the structural and sedimentary features, including a strike-slip pull-apart play (the Yinggehai Basin), an intra-continental faulted depression play (the Beibuwan Basin), a shallow-water shelf play (the northern faulted depression in the Qiongdongnan Basin, the Zhu-1 and Zhu-3 depressions in the northern faulted depression of the Pearl River Mouth Basin), and a deep-water slope play (the Zhu-2 depression in the Pearl River Mouth Basin, the central and southern faulted depressions in the Qiongdongnan Basin). The hydrocarbon pooling features and exploration potentials of each play are analyzed respectively. The strike-slip pull-apart play is mainly controlled by mud diapir structures, thus the lower petroleum system should be the major target. The intra-continental faulted depression play is intensively faulted and the eastern part of the Qixi uplift is favorable for the formation of large- and medium-oil reser-

voirs. Exploration in the shallow-water shelf play should focus on reservoir-seal combinations of the Palaeogene in the continental faulted depression. The deep-water slope play has favorable combinations of hydrocarbon pooling elements, thus it will be the major area to find large oil and gas fields in the future.

**Key words:** northern South China Sea, play, shallow-water shelf, intra-continental faulted depression, deep-water continental slope, hydrocarbon pooling, exploration potential

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## **An exploration breakthrough of subtle gas reservoirs in the Yuanba area of the northern Sichuan Basin and its significance**

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**Abstract:** A breakthrough has been made by the Sinopec South Exploration Company in the exploration of subtle oil and gas reservoirs in the deep Permian and Triassic of reef-bank facies. An analysis of this successful experience is of great significance for guiding the exploration of similar reservoirs in the Sichuan Basin. The following three measures have contributed to the discovery of the Yuanba subtle trap. ①The theory of sequence stratigraphy is used to guide the research of sedimentary facies; ②The theory of seismic sedimentology is used to guide the interpretation of sedimentary micro-facies; ③The conversion of seismic facies into sedimentary facies provides a robust basis for reservoir prediction. The hydrocarbon pooling characteristics of the lithologic traps of deep carbonates of reef-bank facies are studied, including good source rock conditions with favorable lateral barriers, good oil and gas combinations, as well as good migration and preservation conditions. The great significance of the exploration breakthrough of subtle gas reservoirs is also analyzed.

**Key words:** northern Sichuan Basin, Yuanba area, Changxing-Feixianguan formations, carbonates, reef-bank facies belt at platform margin, subtle oil/gas reservoir, sequence stratigraphy, seismic sedimentology

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## **Geochemical behaviors and distribution of natural gas in Zhongguai-5 and-8 blocks on the Junggar Basin**

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**NATUR. GAS IND. VOLUME 30, ISSUE 8, pp. 13-16, 8/25/2010. (ISSN 1000-0976; In Chinese)**

**Abstract:** The Zhongguai-5 and-8 blocks are the most important areas for gas exploration on the northwestern margin of the Junggar Basin. Gas chemical compositions, stable carbon isotopes and C<sub>7</sub> light hydrocarbon compound features are integrated to study the geochemical behaviors and distribution of gas in the Permian in the study area. According to the chemical compositions, natural gas can be divided into wet gas and dry gas both with a low nitrogen content. In contrast, according to their genesis, natural gas can be di-