

The background of the slide is a collage of four images arranged in a large 'X' shape. The top-left image shows an offshore oil rig in the ocean. The top-right image shows an onshore drilling site in a green field. The bottom-left image shows a geological cross-section with various colored layers and drilling paths. The bottom-right image is a solid red triangle containing the Halliburton logo.

HALLIBURTON

Unconventional Pulse in China: 非常规脉搏在中国跳动

**Play Concepts in China's Unconventional
Reservoirs and Challenges**
中国非常规储层开发现状及所遇挑战

Joe Dumesnil

乔·杜麦尼尔

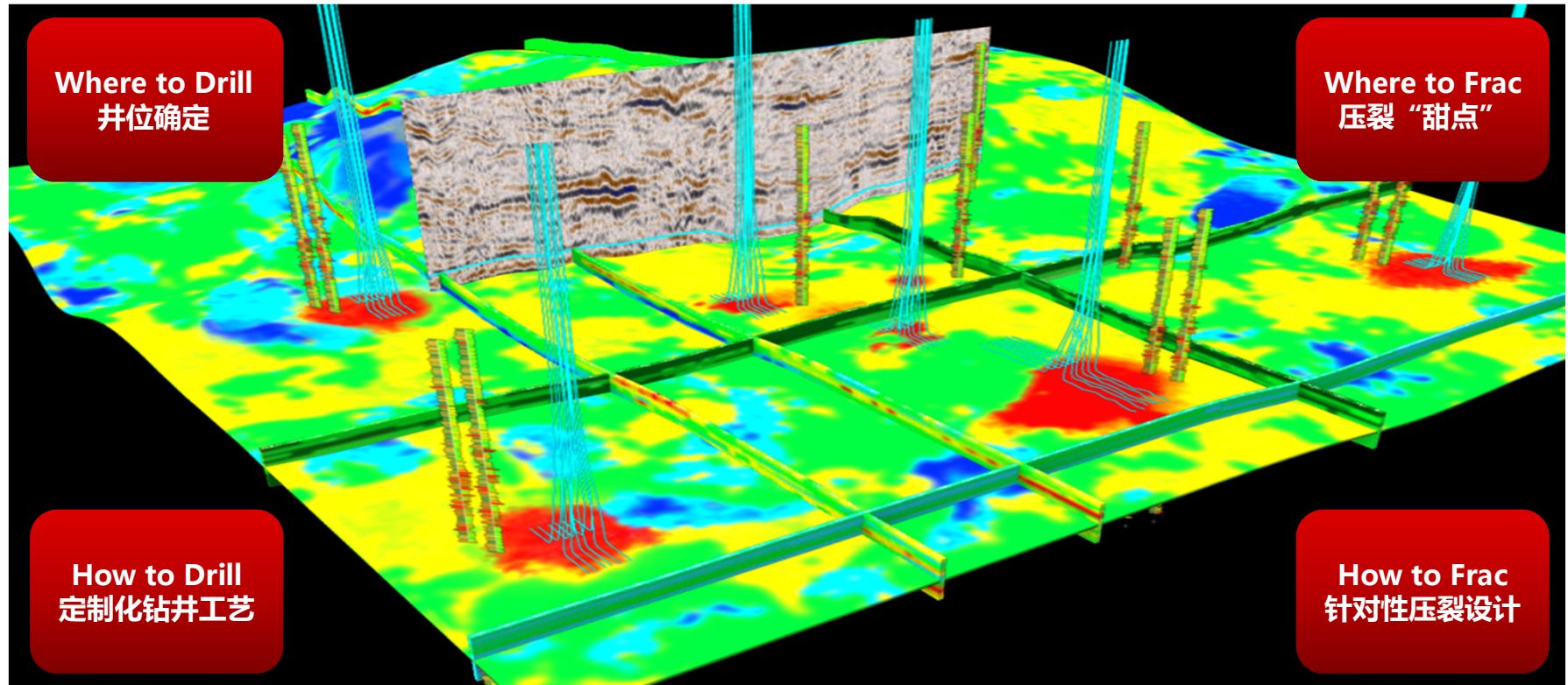
China Unconventional Tech Team Leader

中国非常规技术团队主管

Solving challenges.™

CYPHERSM Seismic-to-Stimulation Service

CYPHERSM从地震到增产一体化服务



CYPHERSM Service

- Common data platform, multi-user capability | 常规数据集成平台，提供多用户操作接口
- All reservoir and well information located in a single environment | 所有储层信息和井数据落于一个单独处理环境
- Links data to drilling to fracturing to production for best performance for the basin or individual well | 关联整个盆地或任意单井的钻井、压裂和生产数据，最大程度挖掘储层潜力
- Collaborative environment | 协同化的操作环境
- Continuous learning and optimization | 可持续学习和优化的平台

West China

中国西部

Tarim Basin 塔里木盆地

- Structurally Complicated Sub Salt, Deep, High Pressure Tight Gas
构造复杂：盐下、埋深、高压、致密气藏
- Analog: Deep Madden Formation Wyoming and Saudi
类似储层：美国怀俄明州的曼登储层和沙特的深层气井
- Under explored shales
处在勘探阶段的页岩储层

Junggar Basin 准格尔盆地

- Shallow Heavy Oil with recovery factor challenges
采收率较低、埋深较浅的致密油储层

Turpin Hami and Sangtanghu Basin 特平哈密和三塘湖盆地

- Tight Oil with thin bedding
薄互层发育的致密油

China Success Story (Tight Gas)

中国成功案例（致密气）

CHALLENGE 挑战:

Wells drilled in complicated onshore low permeability massive sand had highly variant results. The geology was complicated by natural fractures, multiple thrust sheets, 1000m of salt and target intervals greater than 6000m TVD
超深、低渗、天然裂缝发育、多逆冲断层存在、储层厚且非均质性强

SOLUTION 解决方案:

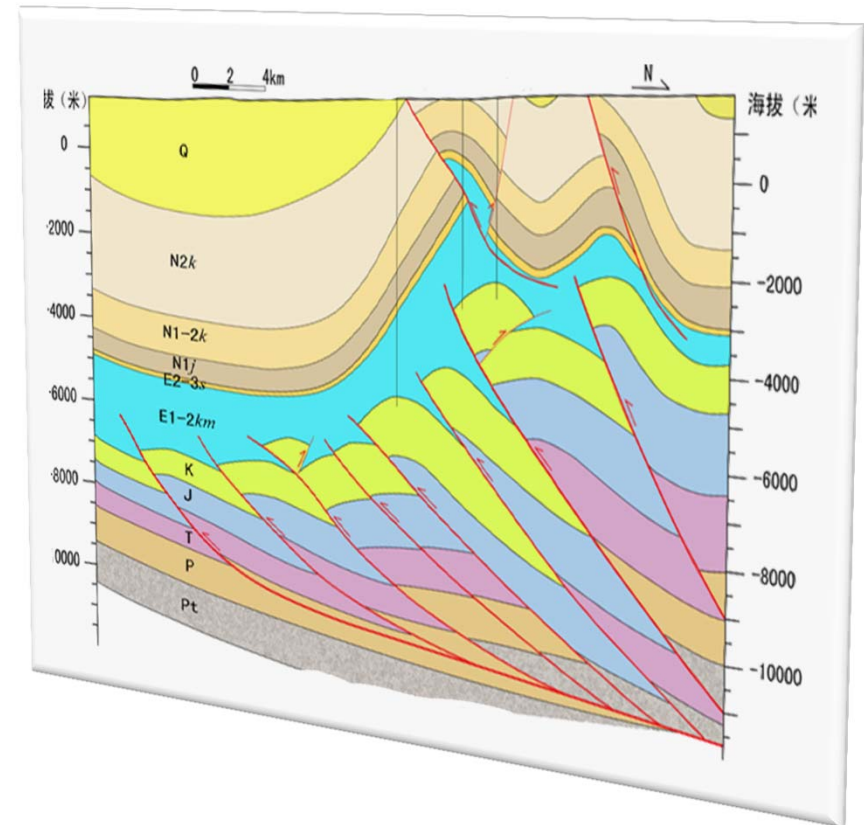
Front End Loading and CYPHER to reinterpret existing data and start from clear baseline productivity.

采用前沿技术和CYPHER研究手段，从基础数据入手，重新分析已有资料，提出增产为核心的解决方案

RESULT 结果:

First new well recently completed and producing. New baseline understanding of the geologic complications and the resultant production.

第一口采用新技术的井刚刚完工，对储层有了新的认识，同时对未来产量预测有了新的拟合依据



PE, HCT and C&PM

增产、井下工具和项目咨询管理

Tight Sand Reservoir Analysis

致密砂岩储层分析

Sichuan Basin and Upper Yangtze Platform

四川盆地和上扬子地块

Source Rock Reservoirs

源岩储层

- 4 of the oldest SRR's tried to date
迄今已尝试开发的4个最古老源岩
- Analogs to Woodford and Barnett Formations (PR/YM)
杨氏模量/泊松比与伍德福特和巴奈特储层类似
- Not laterally extensive from a completion perspective – not a “resource play”?
从完井的角度看，储层没有很好横向展布—不是源岩？
- Preservation Issues
保存问题
- Tectonic Stress causing Drilling and Completion challenges driving up costs
构造应力给钻井和完井带来很多挑战，作业成本也大幅增加

Tight Gas

致密气

- Massive Sands that are Naturally Fractured
天然裂缝发育的巨厚砂岩
- Analog: East TX and Cozzette & Corcoran in CO
与东德州和科罗拉多Cozzette & Corcoran类似
- Basin Centered but degassed in some areas due to natural fracturing, again preservation issues
盆地集中但由于天然裂缝发育，有些地方保存条件差
- Shallow Low Pressure Gas Play/Daanzhai Formation
低压力梯度的气层/大安寨

China Success Story (Shale Gas)

中国成功案例（页岩气）

CHALLENGE 挑战:

Changning field is the first shale gas field in China. This field has undergone very complex tectonic movement since deposition, forming very complex geological structures, and still suffers from high horizontal stress. So where is the optimal (cost and benefit) place to land a wellbore in the target interval?

长宁是中国第一个页岩气开发区块，该区块历史上经历了特别频繁的构造运动，造成现在复杂埋藏和地质环境，迄今依然遭受高水平应力影响。如何有效地在目的层钻进？

SOLUTION 解决方案:

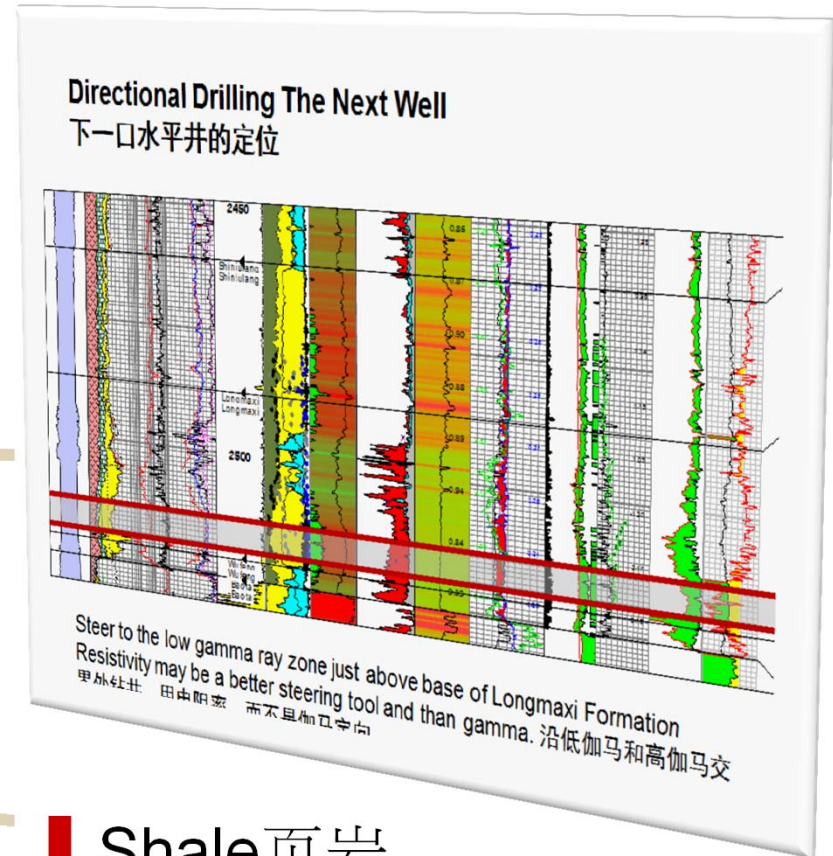
We analogued the well to our experience in North America and looked at the modeled production forecasts that led us to suggest steering for a deeper interval of the target formation with a different log signature.

类比北美近似储层，结合产量预测模型，决定在储层底部，测井显示不同的地方钻进

RESULT 结果:

Production results on future wells continue to improve in the field and number of drilling days continues to decline. Both Cost and Benefit are improved using Halliburton experience and Halliburton modeling.

产量逐步提高，投入持续下降。哈里伯顿的经验和所建模型使客户在成本和收益上都得到优化。



Shale页岩

Sperry DD定向井

Cypher®

Ordos–TGS and CBM 鄂尔多斯–致密气和煤层气

Tight Gas Sand Exploration and Well Spotting for small IOC

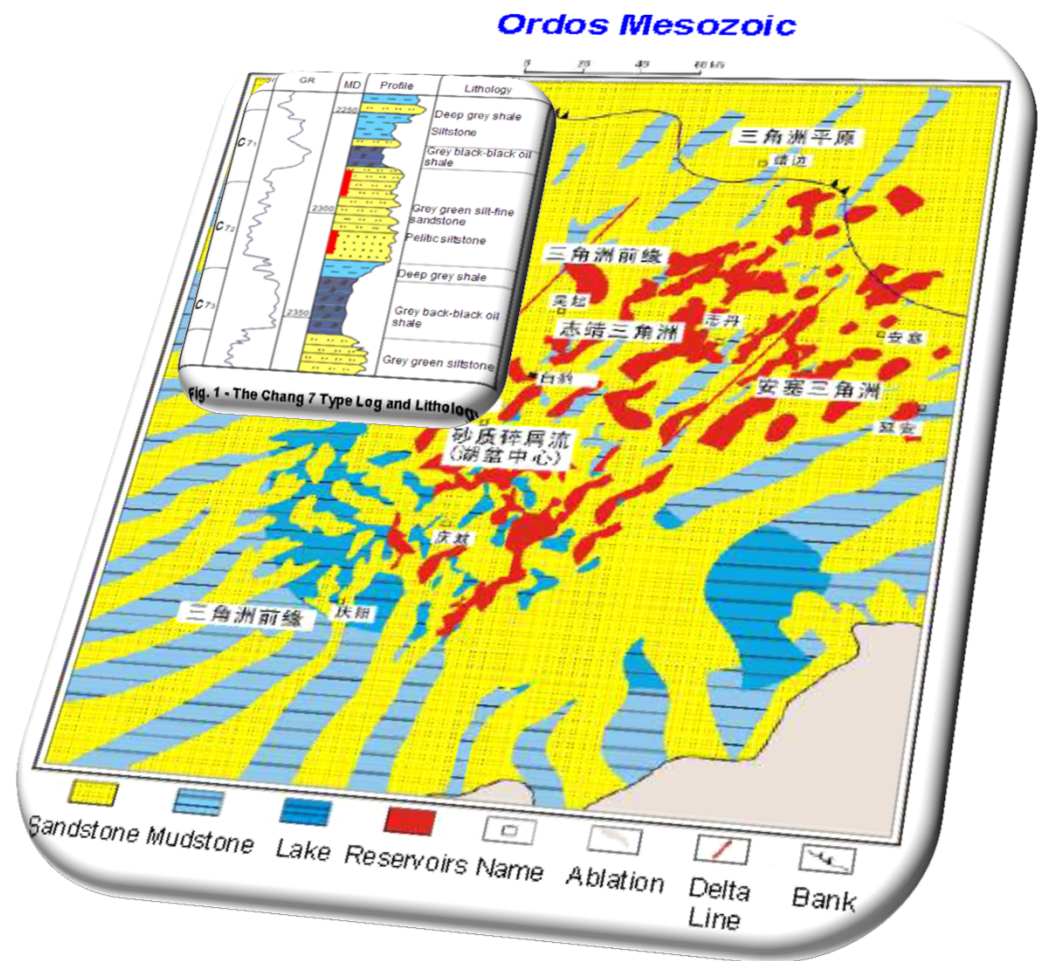
为国外油公司提供致密砂岩气
勘探和井位部署服务

CBM Fracture Design and Microseismic for IOCs and NOCs

煤层气压裂设计和裂缝监测

Tight Gas Reservoir Characterization for Field Design

致密气油藏描述



Ref. Zou Cianeng and PetroChina RIPED

Bohai-Mature Fields, Low Perm Bypassed Pay and Heavy Oil 渤海-成熟油田，之前未考虑的低渗层和稠油

Tight Gas Sand Play Qualification and Target Identification

致密气储层评估和目的层识别

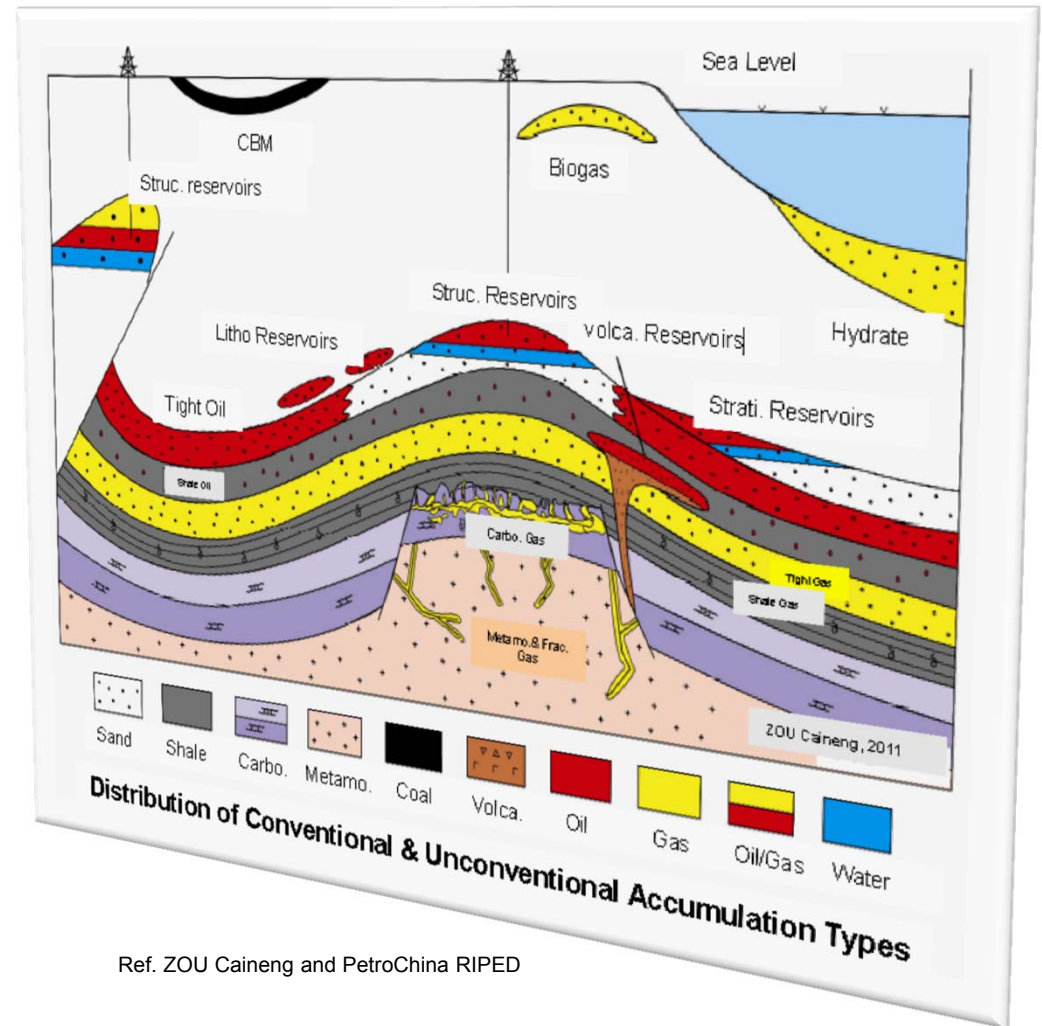
Tight Oil Exploration and Qualification

致密油勘探和储层评估

Stratigraphic Continuity of Play Across a Block

储层展布整个区块

Basins	Formation	Ro(%)	Pressure Coefficient	Crude Density (g/cm ³)	Notes
Williston	Upper Devonian	0.6~1.0	1.35~1.58	0.81~0.83	Bakken
S. Texas	Cretaceous	0.5~2.0	1.35~1.80	0.82~0.87	Eagle Ford
Bohai Bay	Shahejie	0.5~2.0	1.30~1.80	0.67~0.85	Liaohs Sag
Bohai Bay	Shahejie	0.5~2.0	1.53~1.80	0.68~0.78	Jiyang Sag



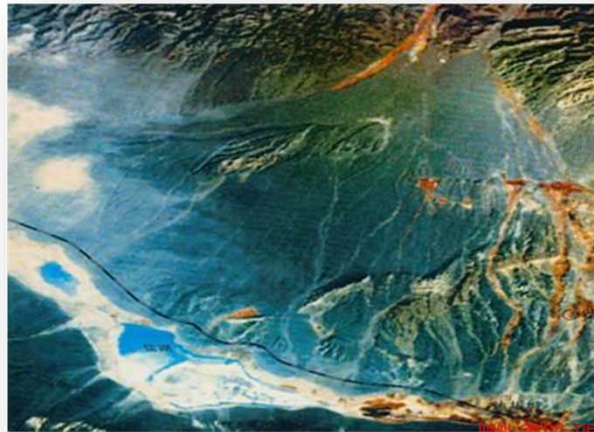
Ref. ZOU Caineng and PetroChina RIPED

Songliao and Northern China–Tight Oil and Mature Fields

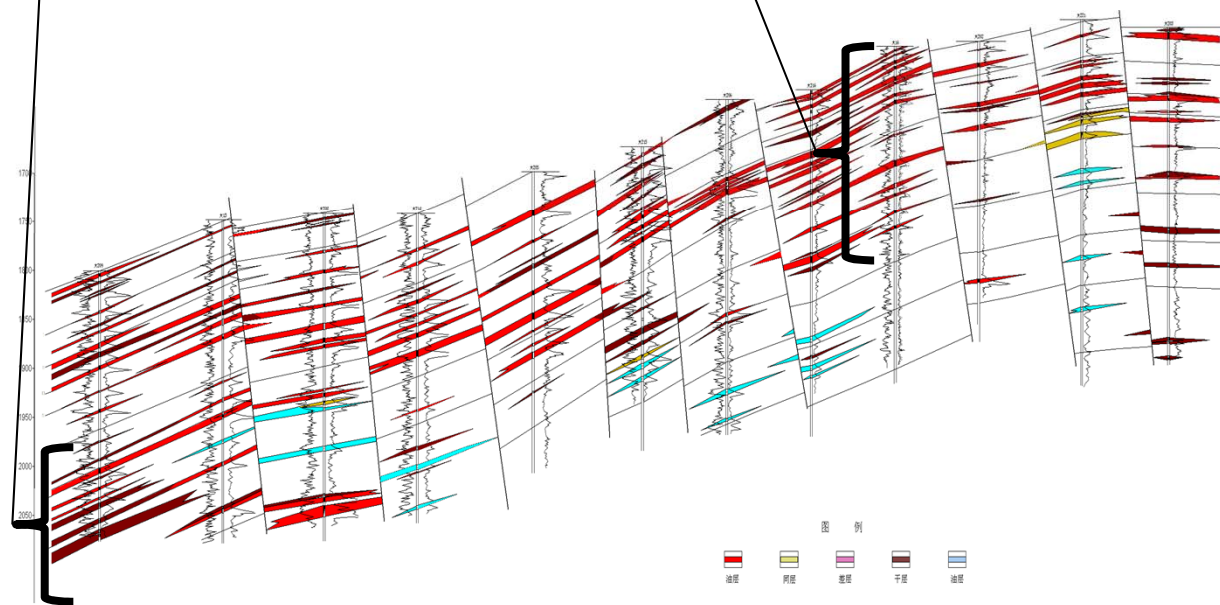
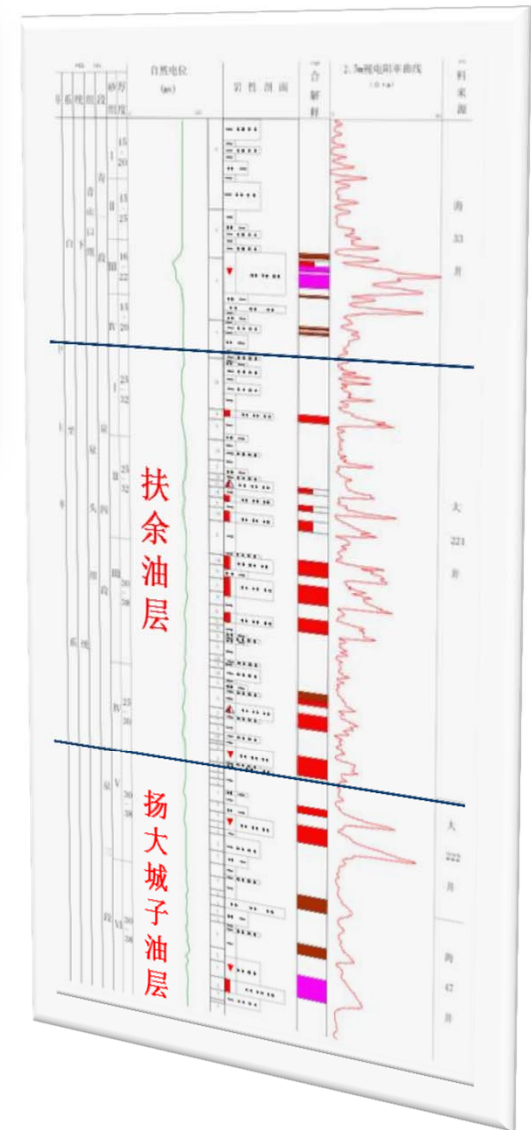
松辽盆地和中国–北部致密油和成熟油气



Birds Foot Delta
鸟足状三角洲

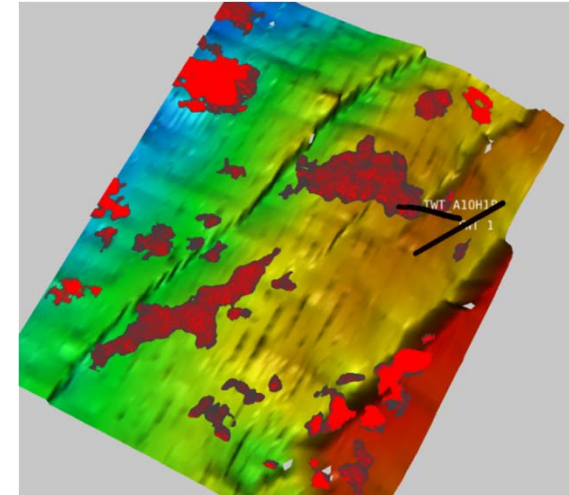


Alluvial Fan
冲积扇



East China Sea–Offshore TGS 中国东海–海上致密砂岩

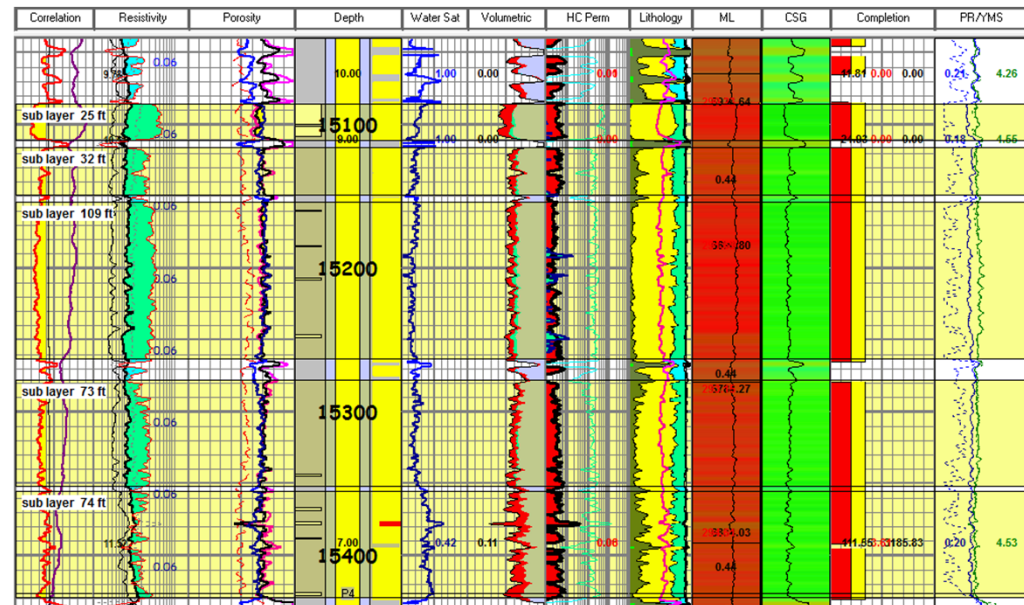
3D Geophysical Mapping of TGS ECS 三维地球物理模型



Full field Integration
and Mapping to solve:
整个区块的一体化研究,
以便确定:

- ❖ Where to drill
在哪里钻井?
- ❖ How to frac
如何压裂?

StimLOG in an East China Sea Tight Gas Sand 石油物理StimLOG模型-中国东海致密砂岩



Challenges To Code Cracking in China

中国非常规开发面临的挑战

- Single well mentality and not enough activity to make real headway
 - 离散的单井服务，没有足够的工作量来总结和优化技术开发方案
- Opaque or Superficial Collaboration between operator and service comps
 - 油公司和服务公司间不透明或是浅层次的合作
- Data Quality and Data Deficiency
 - 数据质量和数据不足
- Geologic Compartmentalization & Preservation Issues
 - 地质模块区分和保存条件
- Active Tectonic Basins and Significant Mechanical Risk
 - 盆地地质构造活跃，存在显著的地质力学风险
- No Benchmarking Happening or Establishment of Best Practices
 - 缺乏已有的参考基准和最佳实践
- Politics and Commoditization Stopping Technology Importation & Complications Free Execution
 - 政策和商业方面阻碍新技术引进和应用
- Compromises on Data Acquisition, Equipment, Experience
 - 数据采集、设备和经验上的不足
- Misconceptions, Unreal Expectations and Analysis Paralysis
 - 概念错误，不切实际的期望和分析偏差
- Very Few Unconventional, Experienced, Full Service, Trusted Partners
 - 可提供整体服务且有经验的服务商非常少

Two Key Technologies Made Unconventionals Work

非常规开发中两个关键技术

Ability to Drill Long Horizontal Wells Cost Effectively

经济的长水平井钻井能力

- Directional Drilling & Accurate Subsurface Locations
定向钻井&精确着陆
- LWD Tools (Ability to Stay In-Zone)
随钻测井工具（在目的层钻进）
- Bit, Mud & Cementing Technologies
钻头、泥浆和固井技术

Ability to Perform Multiple Hydraulic Fractures for Flow Capacity Enhancement

多段水力压裂，提高导流能力

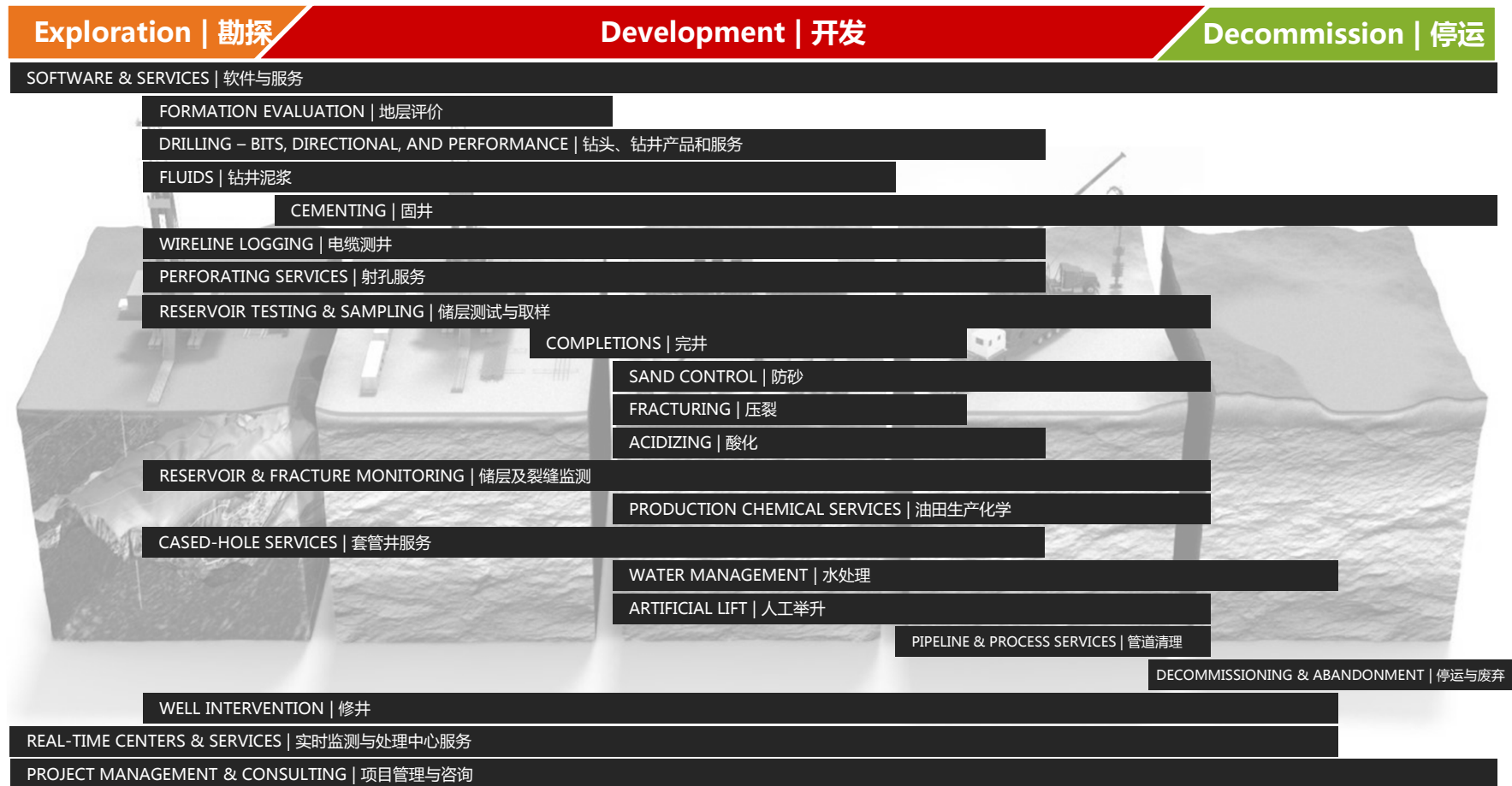
- Downhole Tools 井下工具
- Surface Facilities 地面设施

3 E's : Experience + Economies of Scale = Cost Reducing Efficiency

3E : 经验 + 规模经济 = 有效降本

Capabilities for Customer Challenges

解决客户挑战的能力



The background of the slide is a collage of four images arranged in a triangular pattern around a central red triangle. The top-left image shows an offshore oil rig in the ocean. The top-right image shows an onshore drilling site in a green field. The bottom-left image shows a 3D seismic scan of a geological formation. The bottom-right image shows a 3D seismic scan of a geological formation. The word "HALLIBURTON" is written in white capital letters on the red triangle.

HALLIBURTON

谢谢 - *Thanks*

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