More Efficient in Oil & Gas Extraction

Challenges in Shale Gas Development in China

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KERUI-University of Calgary, Canada

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USA vs China Shale Gas Plays

	Item	China	USA
Geology	Structure depositional	Heterogeneous, easily frangible Marine, lacustrine and transitional	Homogeneous, very thick Marine
	TOC	Mostly 1% - 5%	5% - 10%
	Gas content	Average 1 - 3 m^3/t	3 - 6 m^3/t
	R_0	Marine - R_0>2% Lacustrine - R_0<1.3%	R_0: 1.1% - 2.0% -
Development	Depth	>3500 m (mostly)	1500 - 3500 m
	Surface	Mountain areas, limited water	Flat plain，good water resources
	Pipelines	Limited	Good network

Challenges in Shale Gas Development in China

1、Limited evaluation of geological resources and reserves;

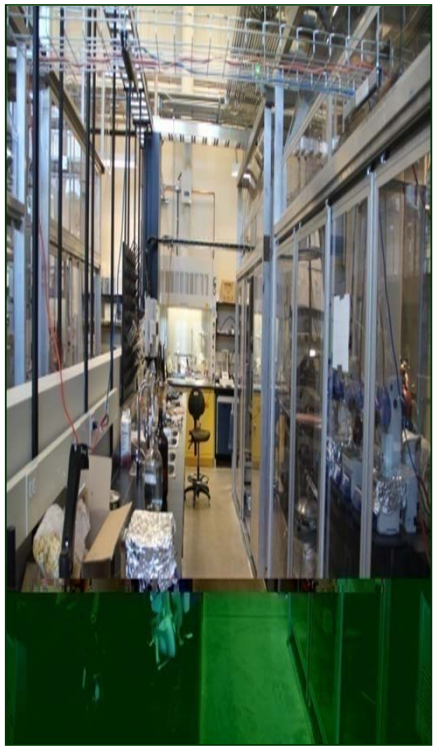
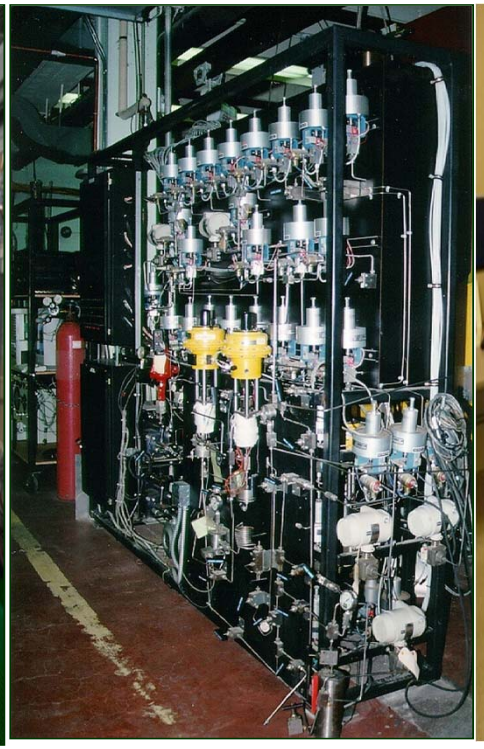
2、Key development and production remains breakthrough;

3、Surface facilities are not established;

4、Environmental, safety and water supply issues.

Technology Advances in North America

R&D Initiatives started in the 1970s in North America

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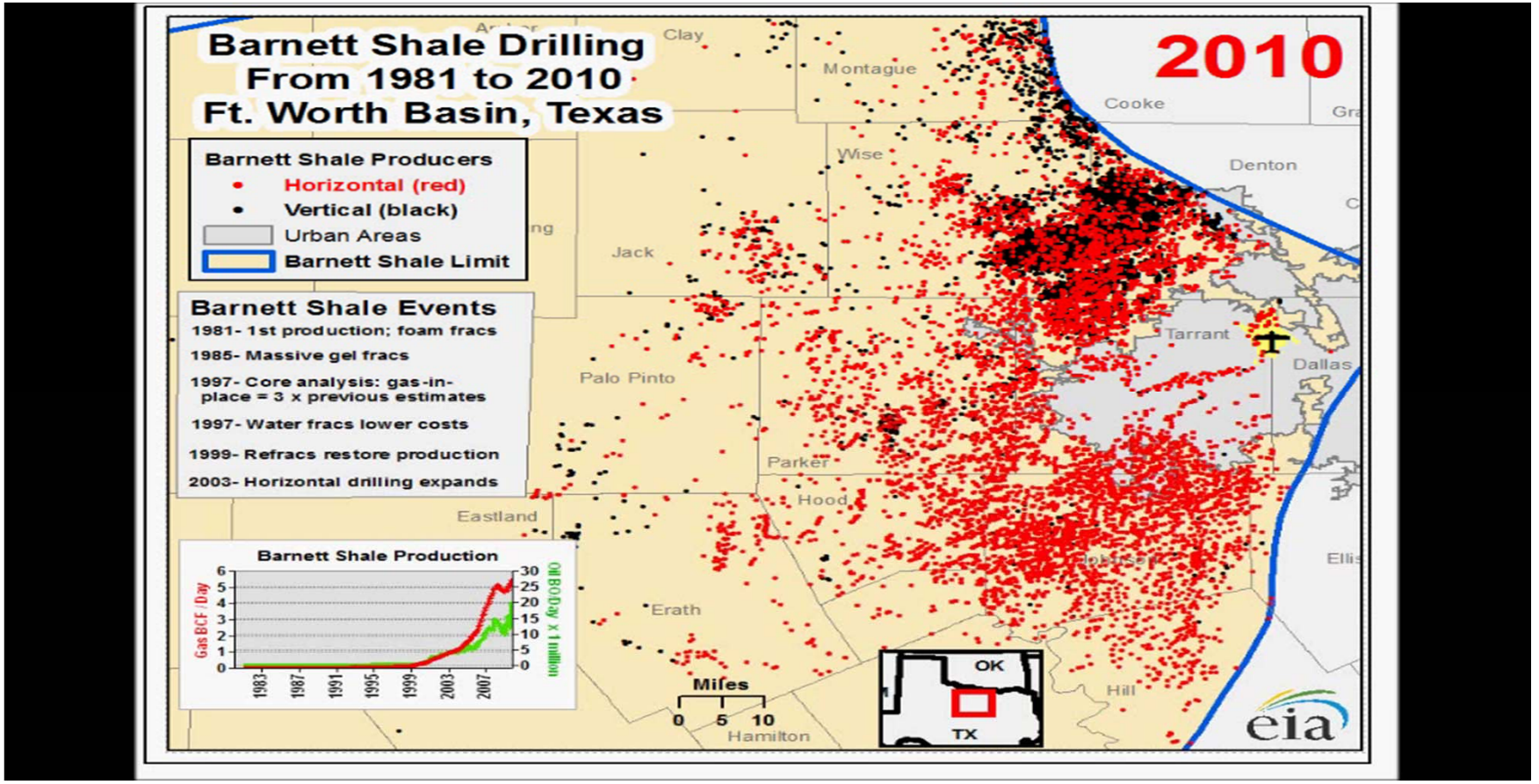
Barnett Shale Gas Development



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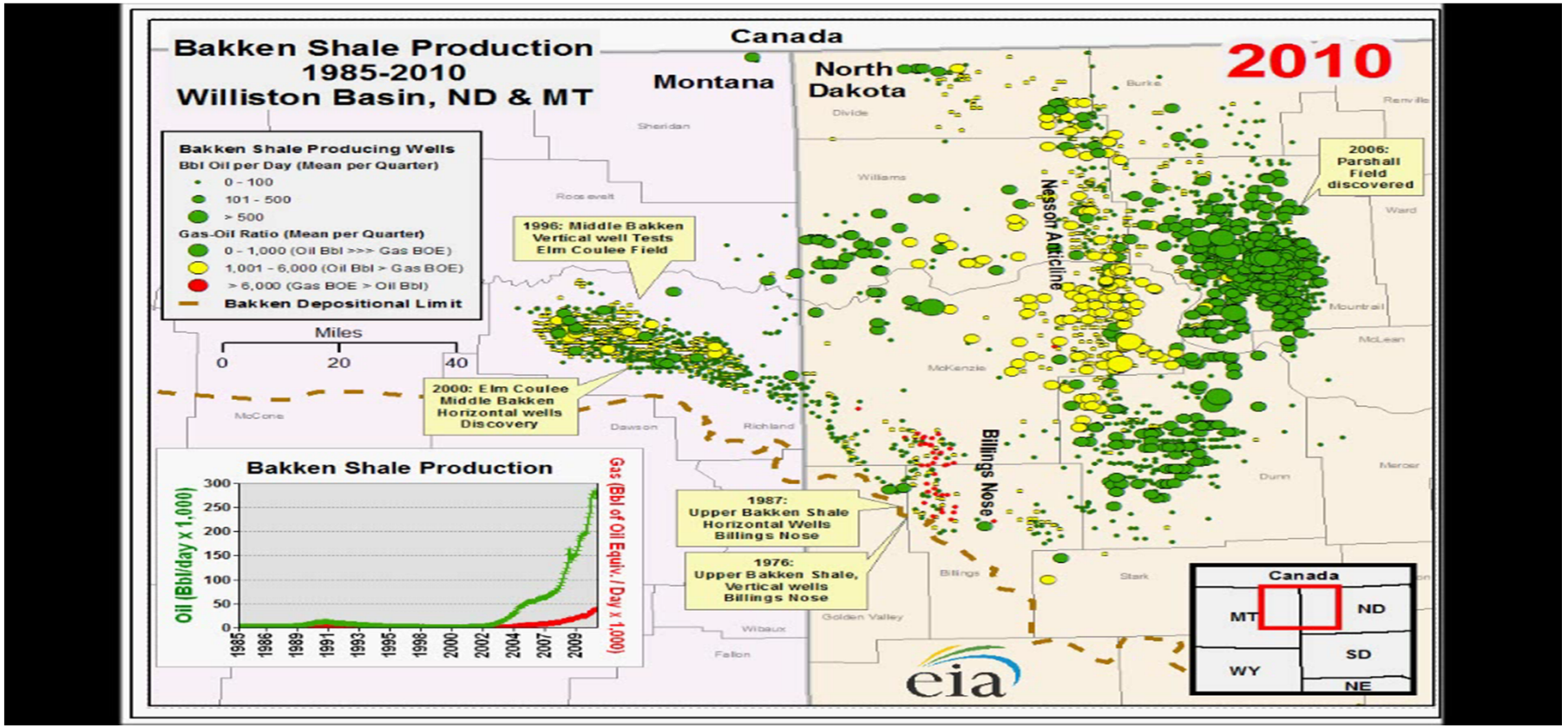
Bakken Tight/Shale Oil Development



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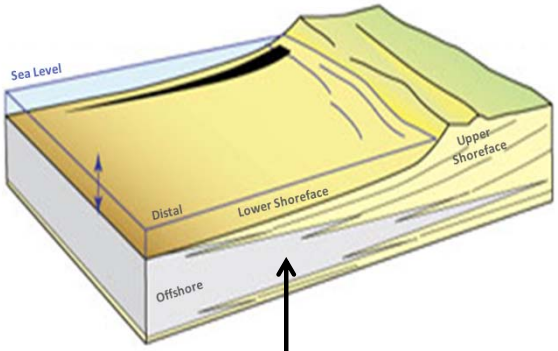
What are Really Lacked?



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Geology

R&D

Production

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Unconventional Oil and Gas Research Center

Global Initiative for Research in Unconventional Oil & Gas:

The Beijing Site, University of Calgary, Alberta, Canada

Shandong Kerui Group

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Opening Ceremony for the Beijing Site

Research Summit for Unconventional Oil & Gas

October 23 and 24, 2014

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Lab Facilities in Unconventional Oil and Gas

Petrohysics

Geochemistry

Imaging

Formation stimulation

Rock mechanics

Reservoir simulation

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Lab Personnel

Trailblazers

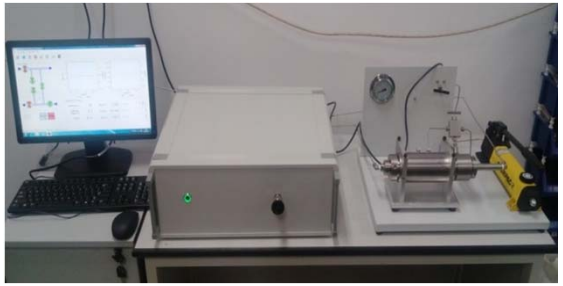
Roberto Aguilera (SSE), John Chen (SSE), Chris Clarkson (Science), Mingzhe Dong (SSE), David Eaton (Science), Ian Gates (SSE), Stephen R. Larter (Science), Larry Lines (Science), Brij Maini (SSE), Frank Maurer (Science), Sudarshan (Raj) A. Mehta (SSE), Gordon Moore (SSE), Pedro Pereira (SSE), Mario Costa Sousa (Science), and Uttandaraman (U.T.) Sundararaj (SSE)

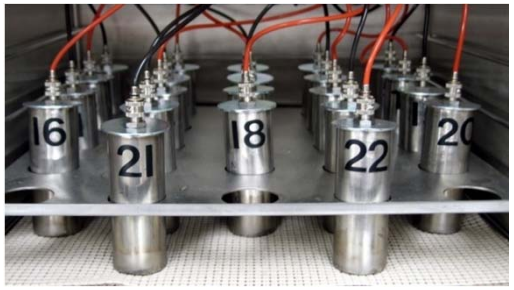
Perpetuators

Usman Alim (Science), Nancy Chen (SSE), Hassan Hassanzadeh (SSE), Hossein Hejazi (SSE), Stephen Hubbard (Science), Haiping Huang (Science), Per Pedersen (Science), and Xin Wang (SSE)

Lab Facilities

1 Geophysics





- **Lithology analysis** including porosity, absolute permeability, oil and water saturations, capillary pressure curves, relative permeability curves;
- Analysis for **fluid properties** including density and viscosity and their variation with temperature, surface and interfacial tension, and rheology;
- **Special lithology** analysis including reservoir sensitivity, shale gas adsorption, desorption, diffusion, rock pore throat structure analysis and evaluation of unconventional oil and gas reserves.

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Lab Facilities

2 Geochemistry

- Geochemical lab analyzes **hydrocarbon source rocks** and oil, gas and water chemical **composition** and **properties**.
- Source rock study aimed to determine **organic matter** abundance, type and maturity.
- Oil analysis studies the **physical properties** of crude oil (density, viscosity, sulfur content, wax content, freezing point, etc.), **composition**, **sources** of crude oil, **maturity** and **oil possession** of various secondary changes.
- Gas analysis is based on natural gas **composition** and isotopic to determine its **origin** (biogas vs thermogenic gas, and source rock pyrolysis gas vs oil cracking gas), hydrocarbon dynamics and occurrence (**adsorbed hydrocarbons** and **free hydrocarbons**).

Lab Facilities

3 Imaging

- By GAMA scanning, one acquires the composition of clay content of an entire core segment and an overall understanding of a reservoir interval.
- Through micro-nano and CT scanning, scanning electron microscope, polarizing microscope thin sections, X diffraction analysis and other testing means, one studies shale layers foliations, pore structure and mineral composition to obtain a comprehensive understanding of the microscopic structure of a reservoir.
- Simulation of fluid flows at micro scales.

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Lab Facilities

4 Rock mechanics

- Performing **stress analysis**, **triaxial compression**, and pure **shear** lab simulation;
- Through the core segments of different layers, simulating the actual geological conditions underground and performing **rock mechanics** experiments.

Lab Facilities

5 Formation stimulation

Combining reservoir physics, chemistry, micro-structure and geomechanics lab analyses, one studies fracturing fluids and proppants and promotes their field applications.

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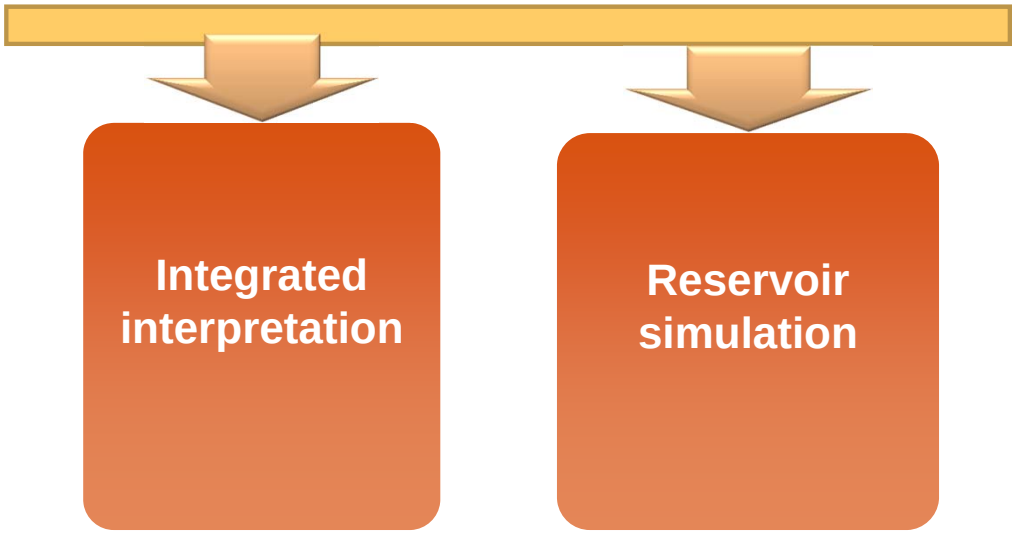
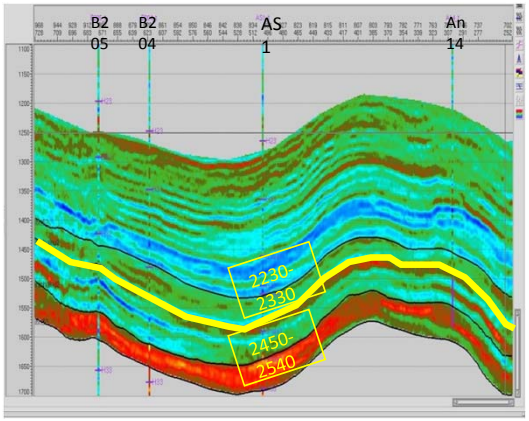
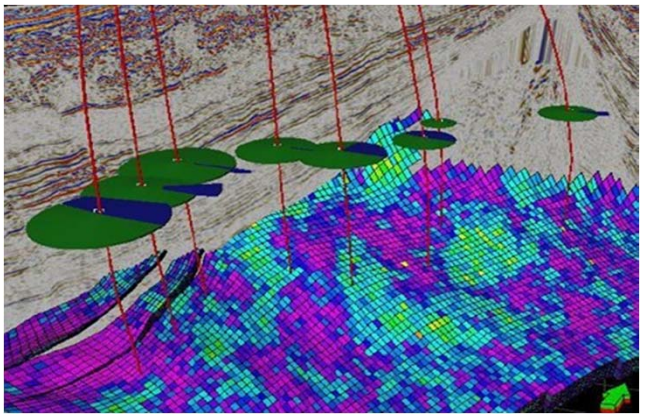
Modeling and Simulation Research Lab



Modeling and Simulation Research Lab

6 Integrated Interpretation





- For exploration of unconventional oil and gas reservoirs, seismic data is processed and interpreted, combined with comprehensive geological studies;
- Integrated projects of reservoir development and production engineering are designed.

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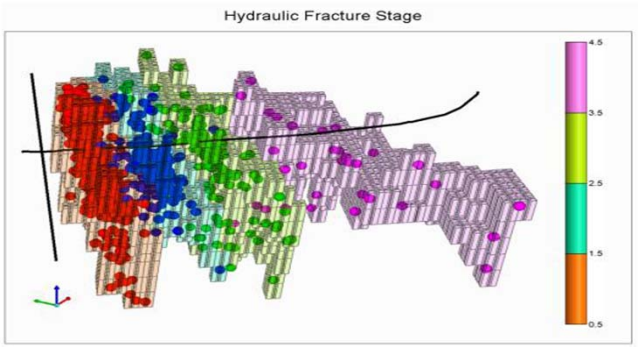
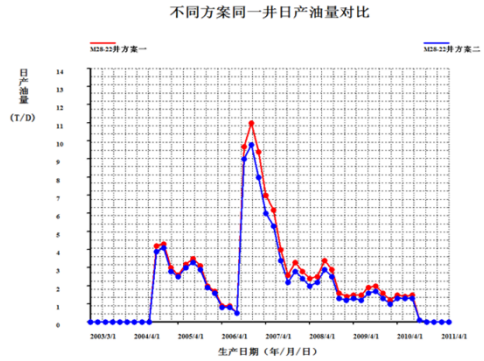
Modeling and Simulation Research Lab

7 Reservoir Simulation





- According to the experimental results, all data are integrated and used in numerical simulation;
- Based on geological models, hydraulic fracturing model, and production models, a full range of numerical simulators are established to guide ultimately on-site hydraulic fracturing jobs and design and optimize development and production.

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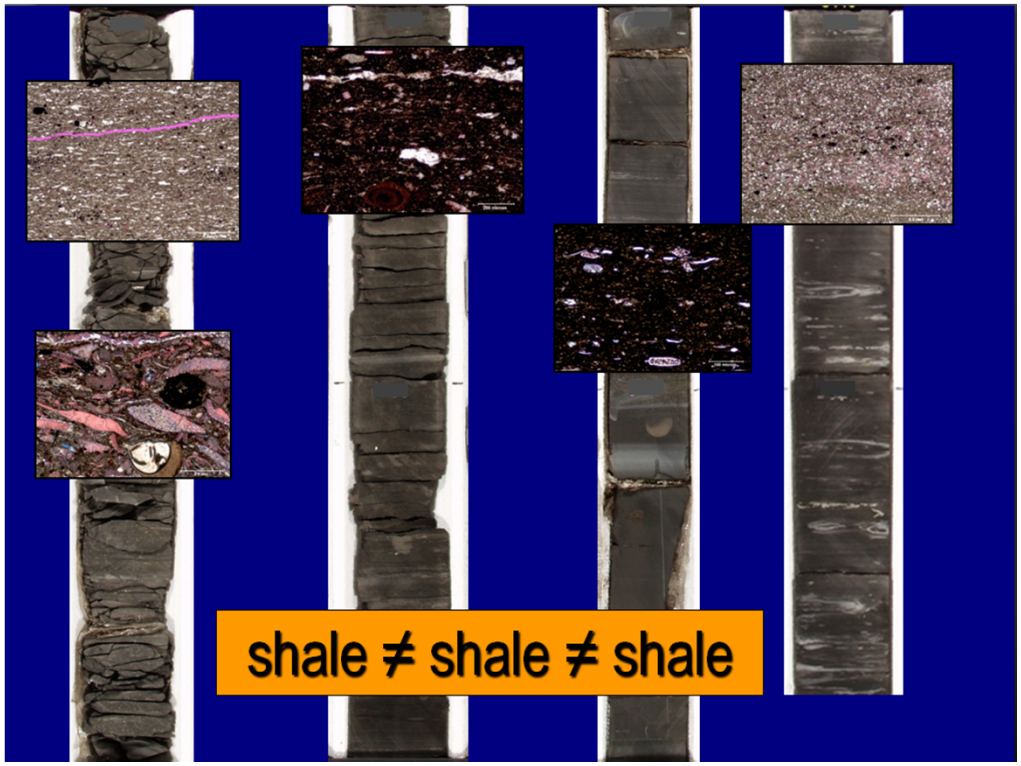
Comments

1、Conventional vs unconventional oil and gas： Reservoir generation and preservation, fluid flow, development and production theory, design, and scheme, reservoir management and associated technologies significantly differ.

2、US vs China：China shale gas plays vary significantly, much challenging to explore, develop and produce.

3、Based on past 30+ years R&D programs.



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