Bureau of Economic Geology

Unconventional Energy Research

Overview for CEE meeting
December, 2011

BUREAU OF ECONOMIC GEOLOGY

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- **Oldest research unit of The University of Texas at Austin**
- **Geological Survey of Texas**

Bureau of Economic Geology

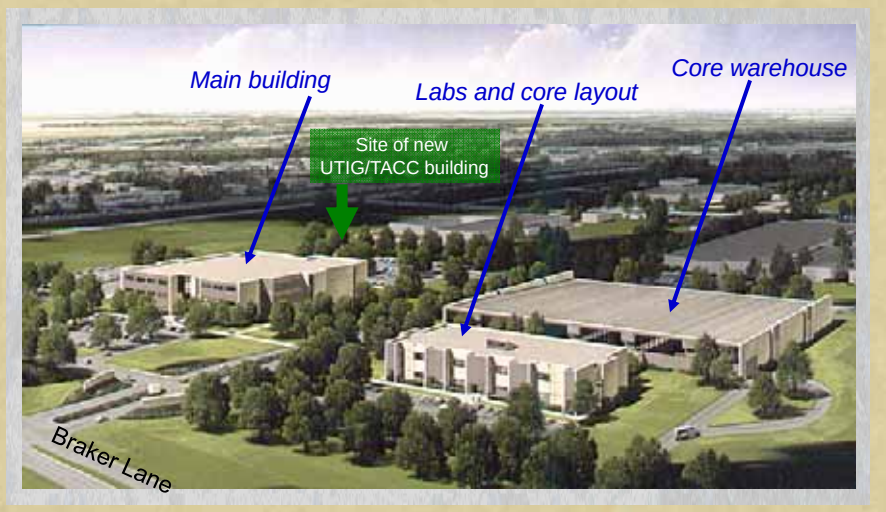
- **Conducts basic and applied research**
  - **Energy**
  - **Environmental Geoscience**
- **Provides extensive advisory, technical, and informational services**
- **Budget: ~$30 million annually**
  - **Industry**
  - **Federal Government**
  - **State of Texas**

Assets

- One of three components of Jackson School of Geoscience
  - $300 million endowment
  - Largest university-based geoscience program in US
- Largest core collection in US (1500 miles of core)
- One million electric-logs – official repository
- Ample space for offices, labs
- Well-equipped laboratories
- Strong IT support and infrastructure
- Capable graduate student assistants (50 currently)
- Support from 70 companies

Bureau Facilities

Austin, Texas

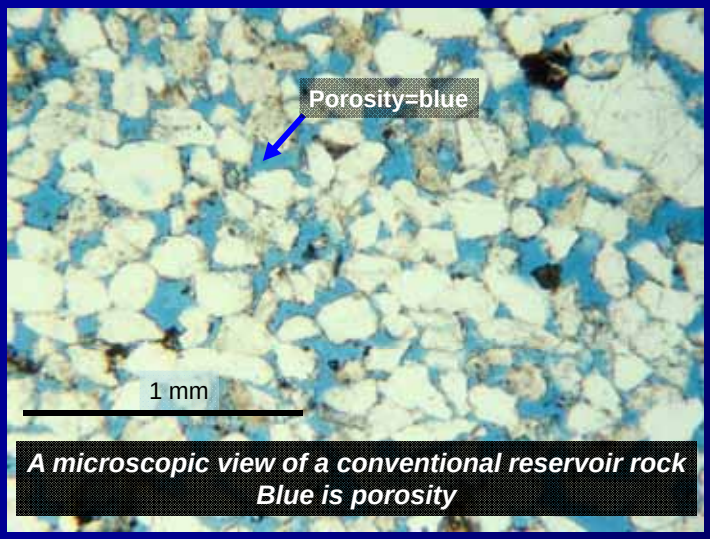


Bureau Staff

Unconventional O&G

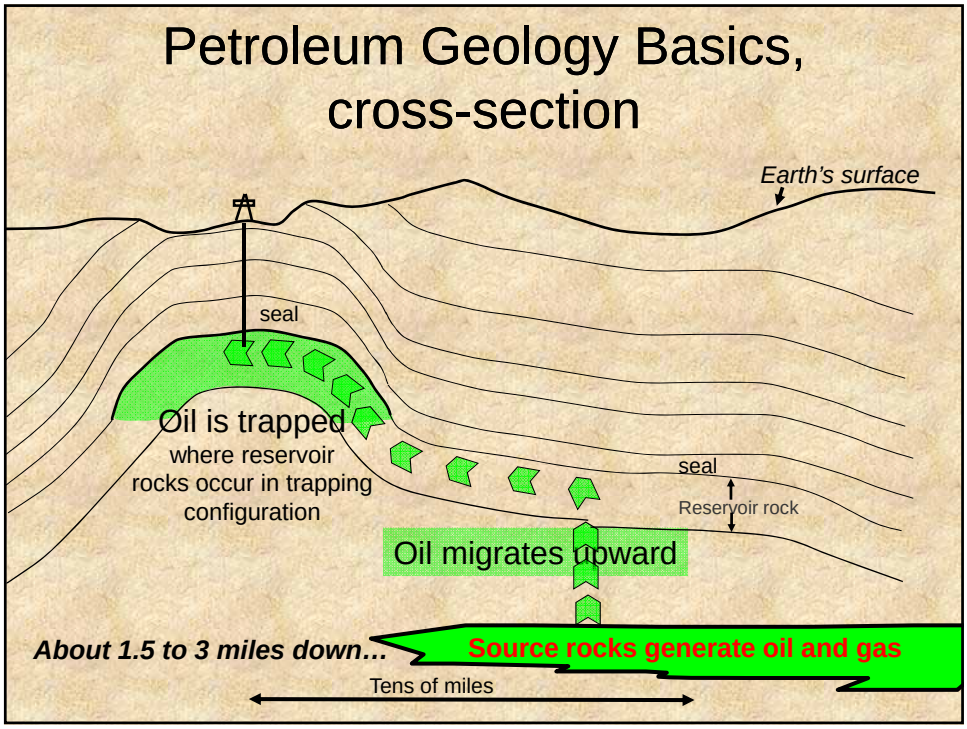
- = needs to be frac'd
- Compare to conventional…

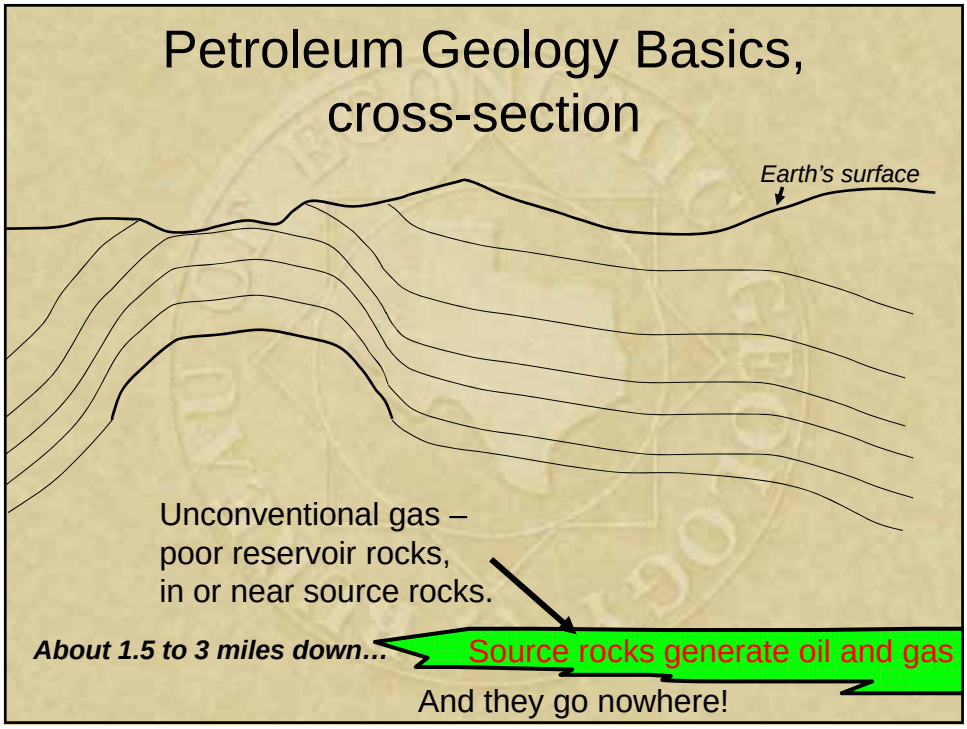
Conventional reservoir rock (sandstone)



A microscopic view of a conventional reservoir rock Blue is porosity

Porosity 35%; permeability >1 darcy


Petroleum Geology Basics,
cross-section
Earth's surface
seal
Oil is trapped
where reservoir
rocks occur in trapping
configuration
seal
Reservoir rock
Oil migrates upward
About 1.5 to 3 miles down…
Source rocks generate oil and gas
Tens of miles


Petroleum Geology Basics,
cross-section
Earth's surface
Unconventional gas –
poor reservoir rocks,
in or near source rocks.
About 1.5 to 3 miles down…
Source rocks generate oil and gas
And they go nowhere!

Eagle Ford Pores

Hay #1 well, 13818', Eagle Ford Fm., DeWitt Co. Texas, R_o ~ 1.5%

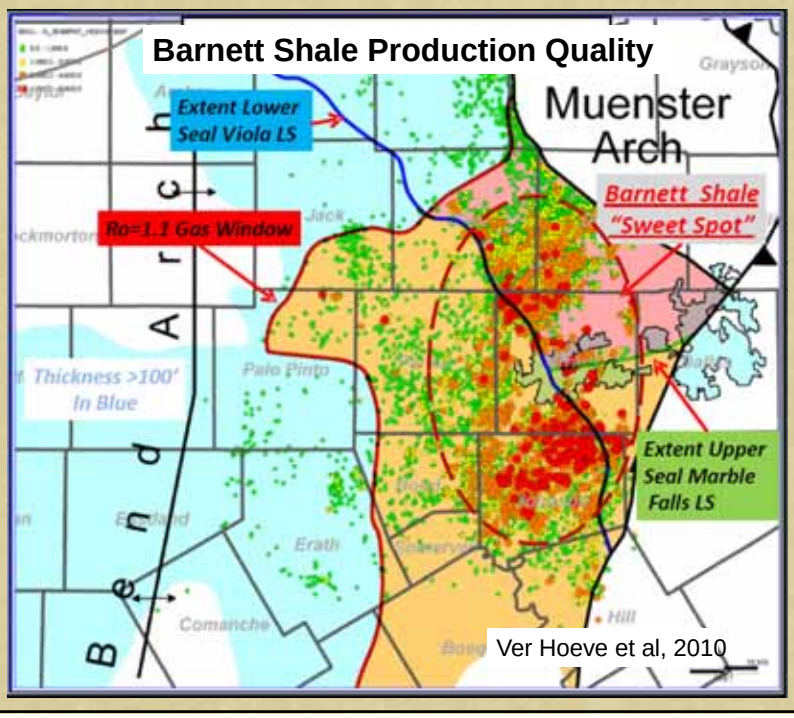
BEG resources for unconventional research

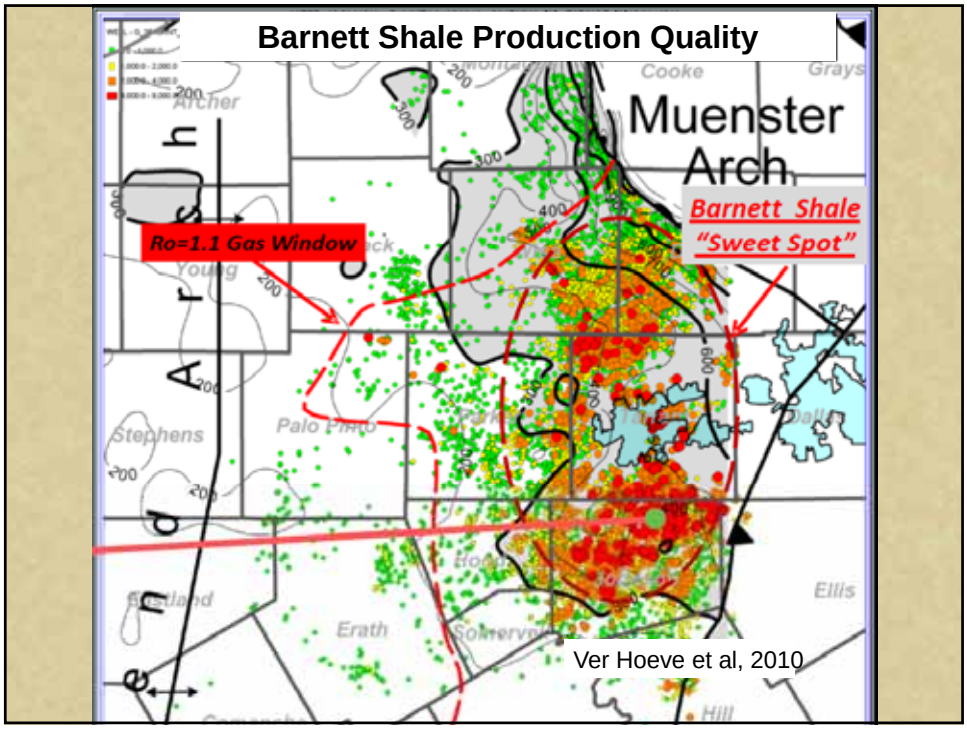
- >$5 million per year in funding
- 35 full time researchers (Energy & Envir)
- Core repositories
- Lab instrumentation investments >$5 mm
- Collaboration with Petroleum Engr Dept
- Interactions with >70 companies
- CEE

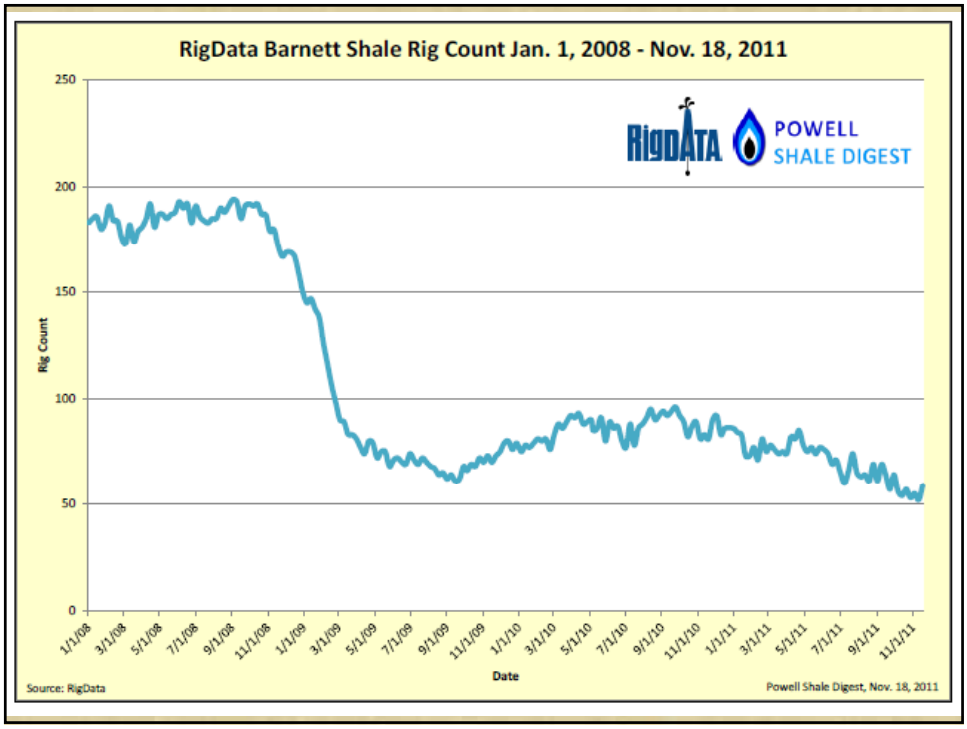
BEG
Unconventional O&G Research

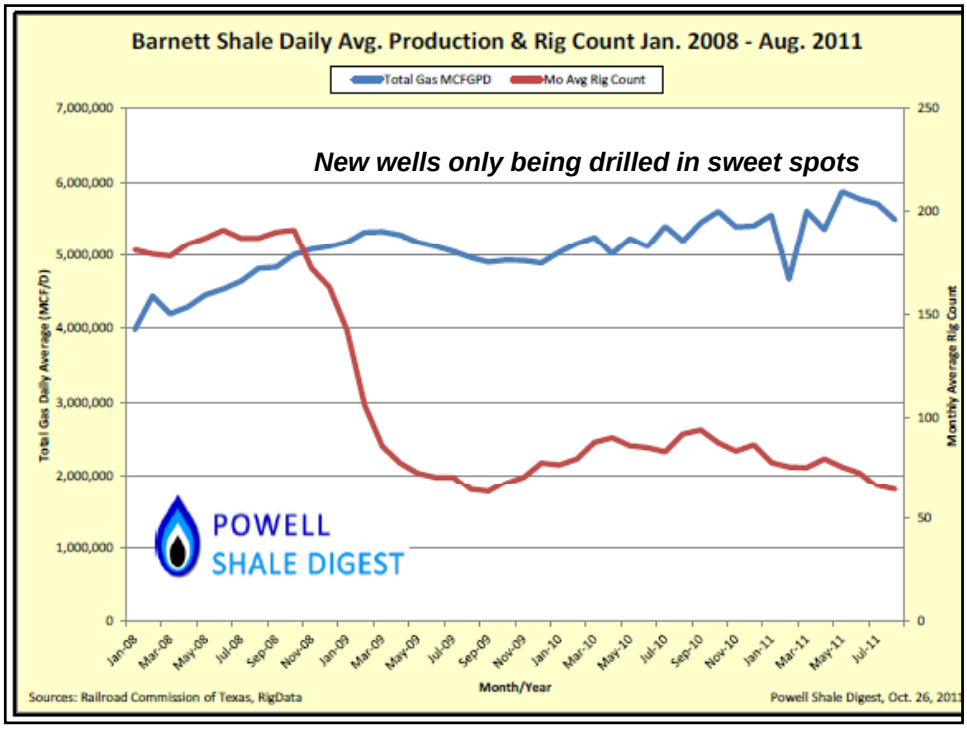
- Mudstone systems (MSRL)
- Natural fractures (FRAC)
- Multicomponent seismic applications (EGL)
- Deep Shelf Gas reservoir quality project
- ExxonMobil Tight Sands/Gas Shales project
- STARR program – shale, TGS plays in Texas
- Deepwater hydrates - geophysics
- RPSEA diffraction imaging of fractures
- RPSEA Marcellus (fracture and multicomponent projects)
- Tight carbonates – RCRL program
- PetroChina/CUP - Daqing Basin tight sands
- Energy Economics (CEE)
- Sloan Foundation grant: US gas shale growth scenarios
- Water supply and disposition
- Frac/groundwater issues

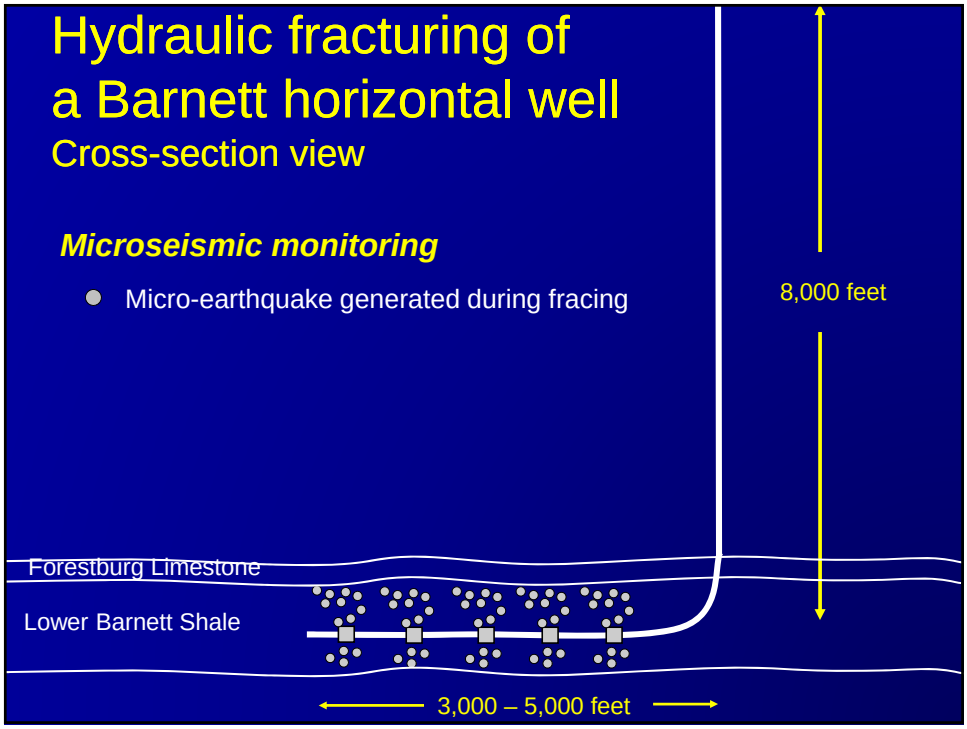
Mostly rock-based research on fundamental processes and linkages




Barnett Shale Production Quality
Muenster Arch
Barnett Shale "Sweet Spot"
Ro=1.1 Gas Window
Fort Worth Basin
Archer
Cooke
Grays
Young
Stephens
Palo Pinto
Ellis
Erath
Hill
Ver Hoeve et al, 2010


RigData Barnett Shale Rig Count Jan. 1, 2008 - Nov. 18, 2011
RIGDATA
POWELL SHALE DIGEST
Rig Count
250
200
150
100
50
0
1/1/08
3/1/08
5/1/08
7/1/08
9/1/08
11/1/08
1/1/09
3/1/09
5/1/09
7/1/09
9/1/09
11/1/09
1/1/10
3/1/10
5/1/10
7/1/10
9/1/10
11/1/10
1/1/11
3/1/11
5/1/11
7/1/11
9/1/11
11/1/11
Date
Source: RigData
Powell Shale Digest, Nov. 18, 2011


Barnett Shale Daily Avg. Production & Rig Count Jan. 2008 - Aug. 2011
Total Gas MCFGPD
Mo Avg Rig Count
New wells only being drilled in sweet spots
Total Gas Daily Average (MCF/D)
Monthly Average Rig Count
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
250
200
150
100
50
0
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Month/Year
POWELL
SHALE DIGEST
Sources: Railroad Commission of Texas, RigData
Powell Shale Digest, Oct. 26, 2011


Hydraulic fracturing of
a Barnett horizontal well
Cross-section view
Microseismic monitoring
Micro-earthquake generated during fracing
8,000 feet
Forestburg Limestone
Lower Barnett Shale
3,000 – 5,000 feet

Three main types of research funding

- Sponsored research projects
  - Proprietary projects for single companies
  - Government grants
- Industrial Associates Programs (research consortia)
  - Each program has multiple company sponsors, ~$50,000 per year
- STARR program directly funded by TX Legislature

FY12 STARR program increase

- Was $1.5 million per year; now $4.5
- Increased budget for O&G component
- Funding additional initiatives in TX, including
  - Energy Economics
  - Environmental Economics

Discussion

Major Research Areas

- Unconventional oil and gas resources
- Carbon sequestration
- Natural fractures
- Deep tight gas, U.S. Gulf of Mexico
- Mudrocks research
- Exploration geophysics research (multicomponent seismic)
- Reservoir characterization – carbonates, clastics
- Salt tectonics
- Sustainable groundwater resources
- Energy Economics

BEG Energy Research

- Salt tectonics (AGL)
- Carbonate reservoirs (RCRL)
- Natural fractures (FRAC)
- Mudstone systems (MSRL)
- Multicomponent seismic applications (EGL)
- Computational geophysics
- Quantitative clastics (QCL)
- Energy Economics (CEE)
- Nanotechnology in subsurface (AEC)
- STARR program
- Deep Shelf Gas reservoir quality project
- Permian Basin Synthesis
- Links to BEG's Carbon Sequestration and Geothermal programs
- International projects:
  - Petrobras carbonate reservoir characterization
  - Aramco Ghawar Field
  - BG Trinidad offshore
  - Central American hydrates
  - BGP China karst reservoirs

Proprietary projects in progress

- Petrochina/BGP – karst reservoirs, Tarim Basin outcrop/subsurface
- Petrochina/CUP – seismic geomorphology, Daqing nonmarine reservoirs
- ExxonMobil – unconventional reservoirs
- Shell – shale gas and light tight oil
- Petrobras – fractured carbonate reservoir characterization