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U. S. Top Plays and Trends…… Leaving no stone unturned

Interstate Oil & Gas Compact Commission
Energy Resources, Research & Technology Committee
Santa Fe, November 18, 2008

IHS
Stephen Trammel
Sr.Product Manager—Activity Products

The Playing Field

Key U.S. onshore unconventional oil and gas plays and the Gulf of Mexico, especially the ultra deepwater, Lower Tertiary Trend, continue to attract high bids for acreage.

Industry is evaluating potential shale gas reservoirs across the country, geographically and throughout the stratigraphic column--leaving no stone unturned, so to speak.

With some notable exceptions for oil, discussed below, in the U.S., the industry is focusing on gas.

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The Playing Field

Current Situation:

- •Higher natural gas prices stimulated increased drilling
- • Gas production only has reached an undulating plateau.
- • Shift to lower volume unconventional gas implies increasing drilling to sustain production

Complications:

- •Rising capital costs
- •Uncertainties about regulatory climate, price of gas, manpower/rig shortages and periodic transportation bottlenecks.
- •Energy security needs and growing anti-hydrocarbon sentiments and policies in support of climate change targets could result in access restricted or denied to future oil and unconventional gas developments!

Concern:

What are the implications of these trends on North America gas supplies? Impact on major decisions such as base load power generation, LNG facilities and Alaska pipeline.

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Unconventional Resource--Making it Pay

The Technology List:

- 3D Seismic and microseismic
- Pad Drilling-increase density
- Fit for Purpose Rigs
- Horizontal and extended reach lateral drilling
- Palm/Pinnate
- Frac Big, Frac Often
- Micro manage the production

The Knowledge List:

- Leverage existing infrastructure
- Understand the rocks and how they respond
- Gather Best Drilling and Completion Practices and Reservoir Analogs
- Manage developments/reclamation with local community concerns
- Control the Supply Chain

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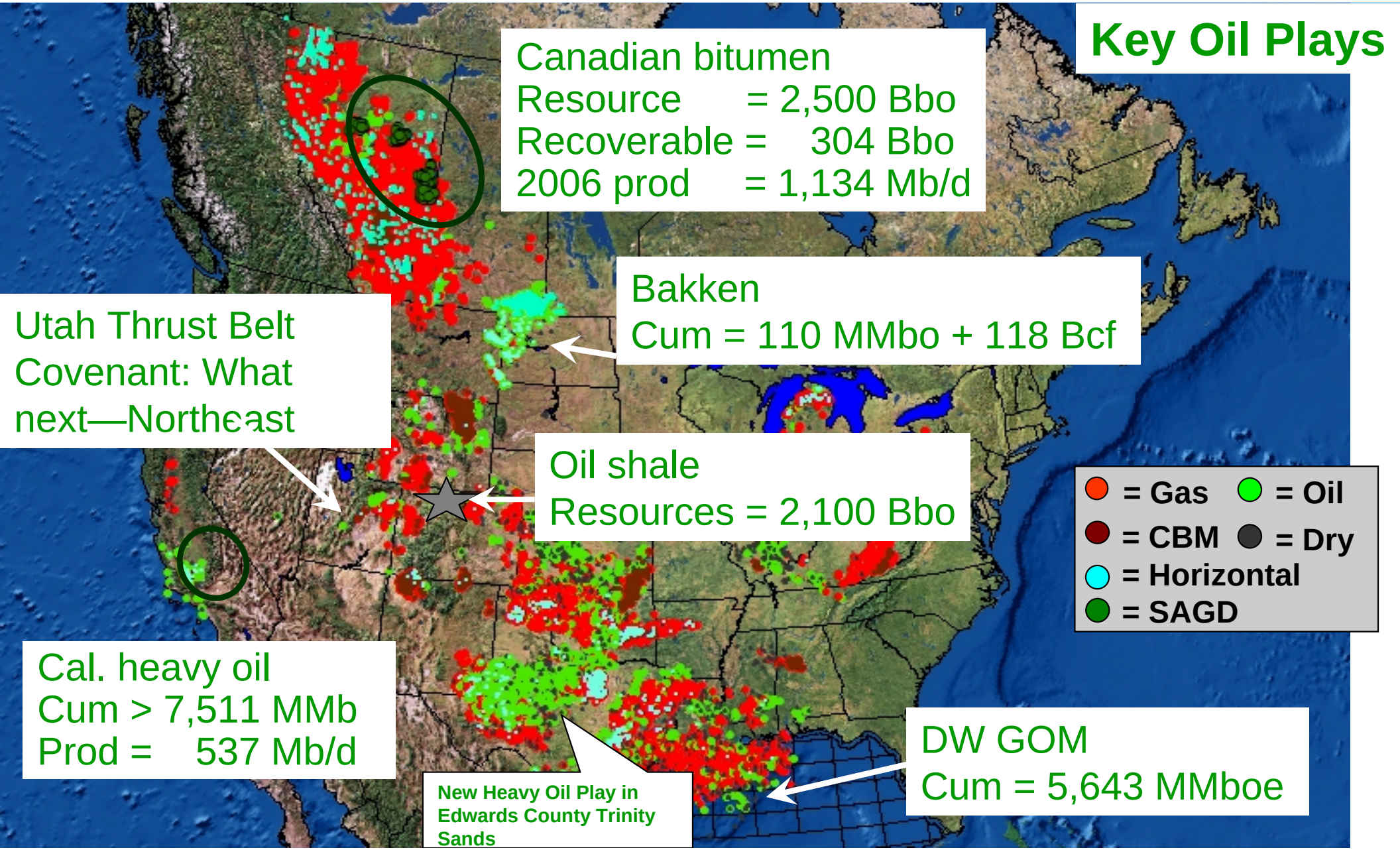
North America Key Oil Plays
U.S. Lower 48 States and Canada



Unconventional Liquids Issues

- Economics
  - high capital cost; cost overruns, labor scarcity
  - long lead times
  - supply / cost of natural gas (hydrogen, steam)
  - supply / cost of condensate (diluent)
- Infrastructure
  - pipeline / refinery (high aromatics) limitations
- Environment
  - energy intensive: high GHG emissions
  - forest fragmentation, tailings disposal
  - water supply / disposal
  - C, SO_2, NOx, H_2S, CO, ozone, particulates
- Resource Competition
  - gas over bitumen

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THE MISSING SLIDE

Enhanced Oil Recovery—the 11 percent factor

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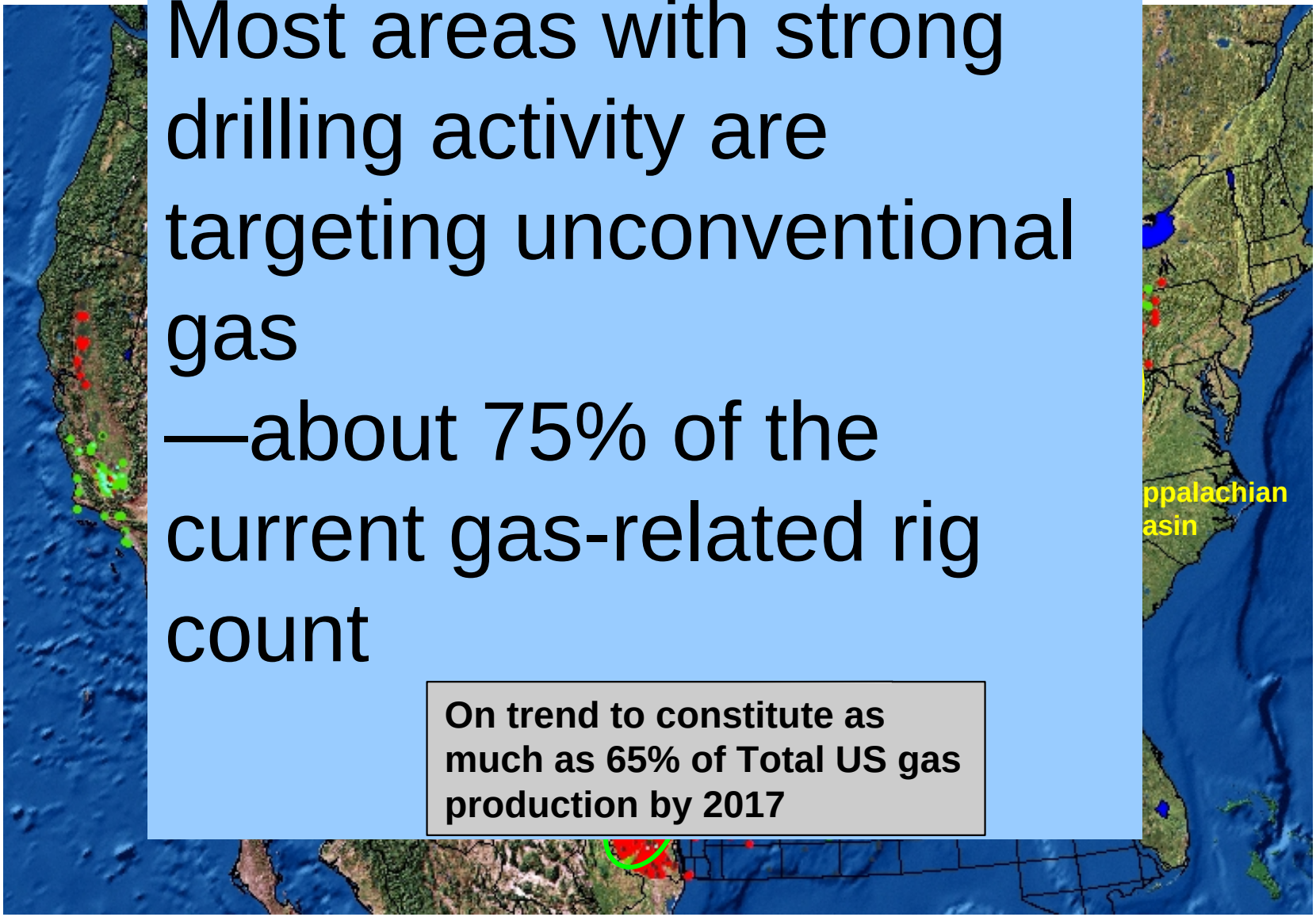
North American Gas
Where the Plays and Trends Are ?

Most areas with strong drilling activity are targeting unconventional gas
—about 75% of the current gas-related rig count

On trend to constitute as much as 65% of Total US gas production by 2017



CBM

Tight Sands

Shale

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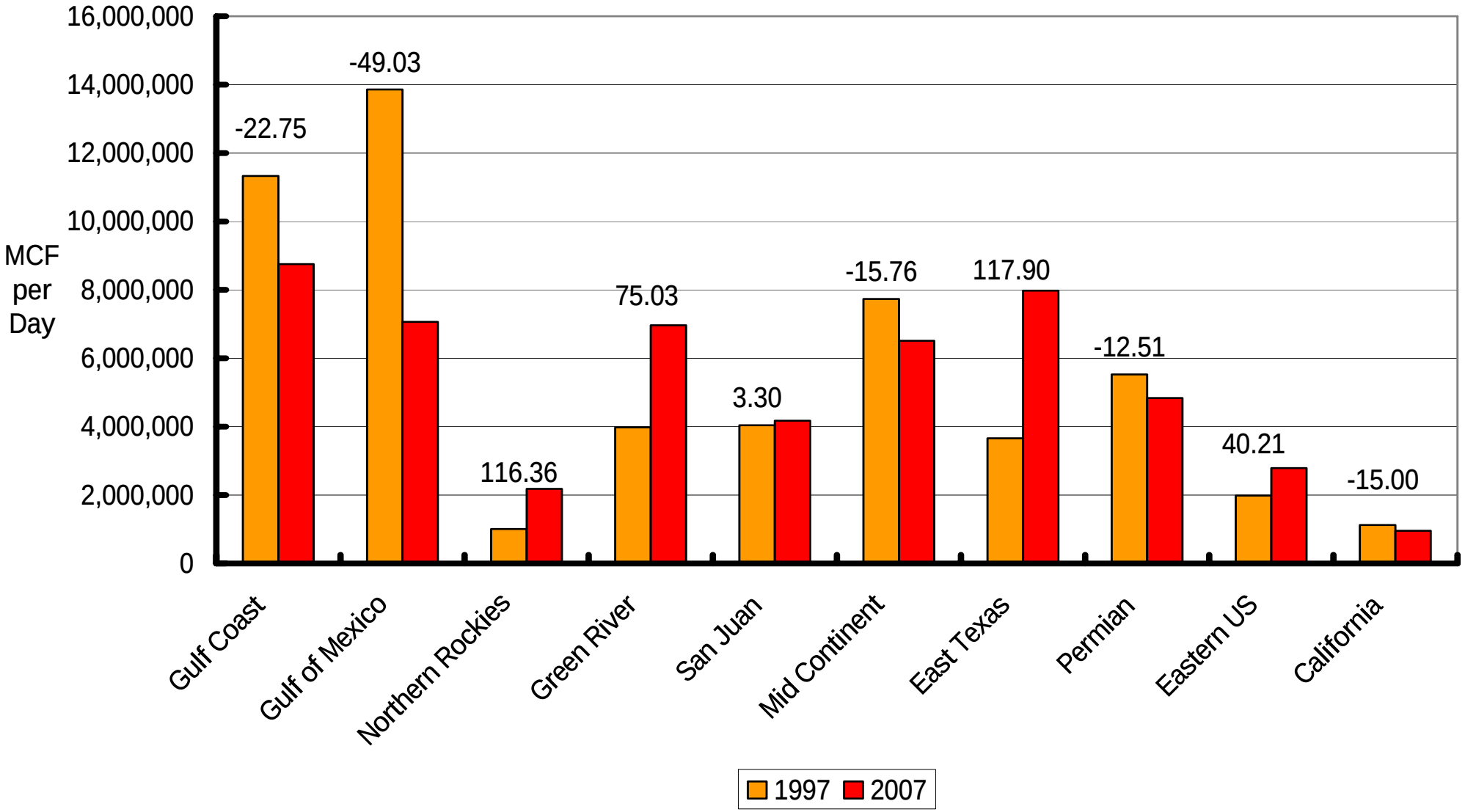
Regional U.S. Lower 48 Gas Production 2007 vs 1997



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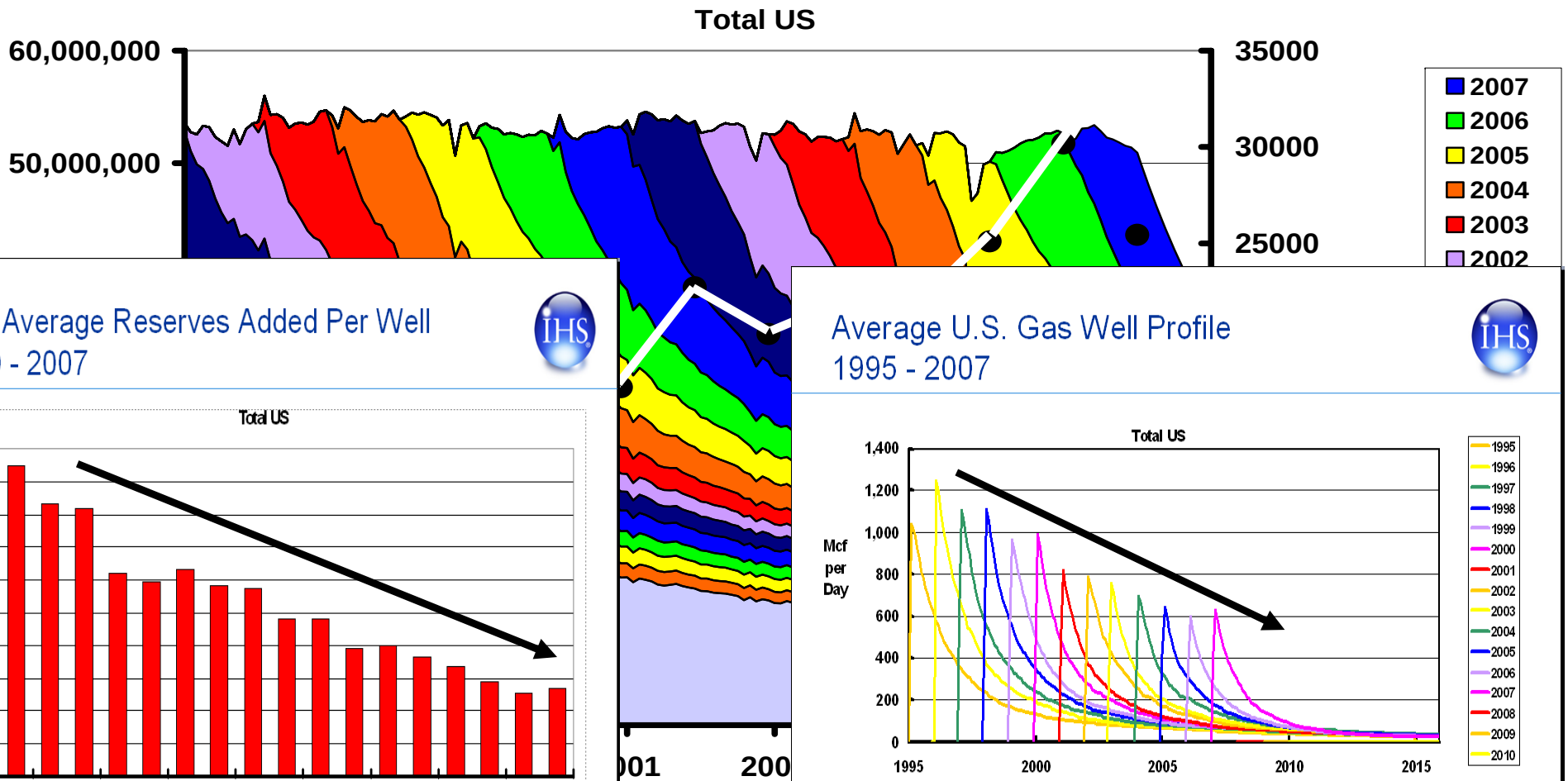
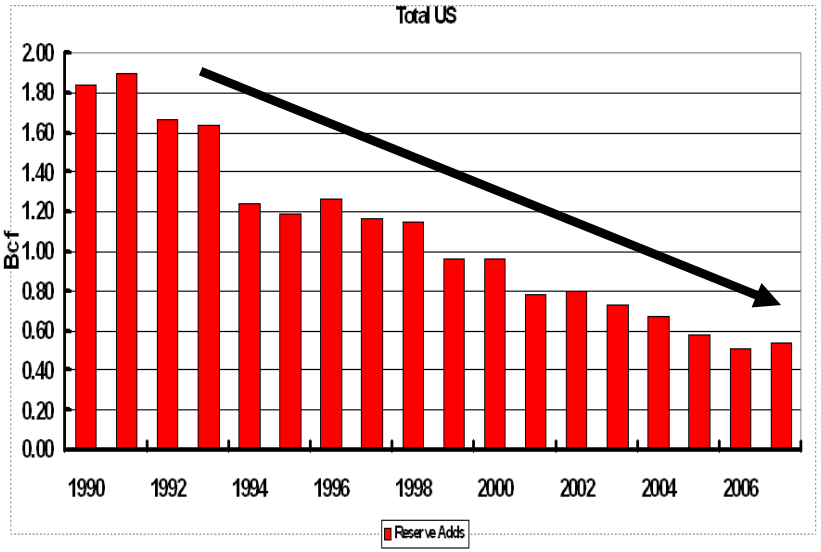
U.S. Vintaged Gas Production With Annual Gas Well Completions



U.S. Average Reserves Added Per Well 1990 - 2007



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Average U.S. Gas Well Profile 1995 - 2007

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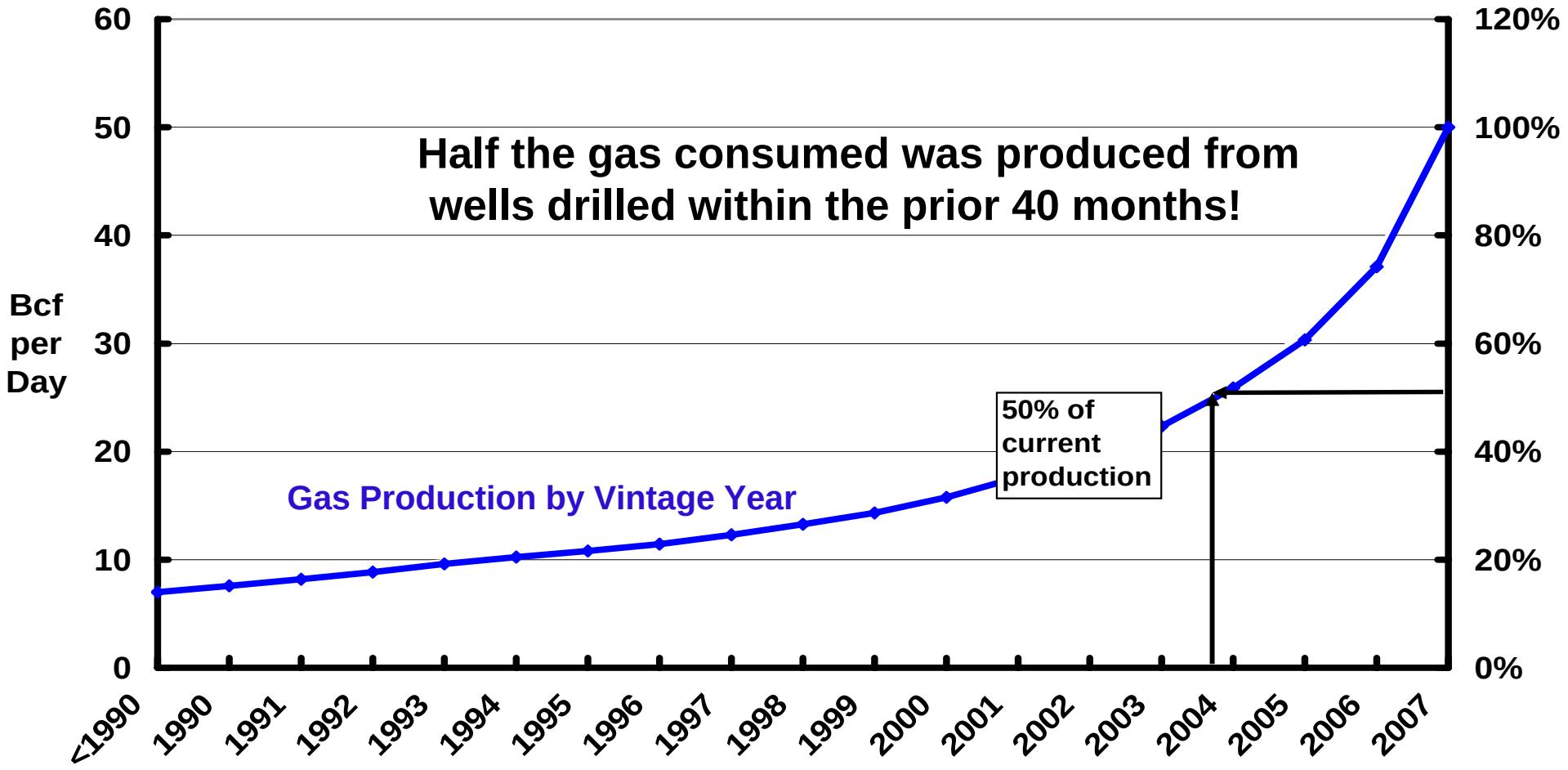
US Vintage Daily Gas Production Contribution to December 2007 Volume



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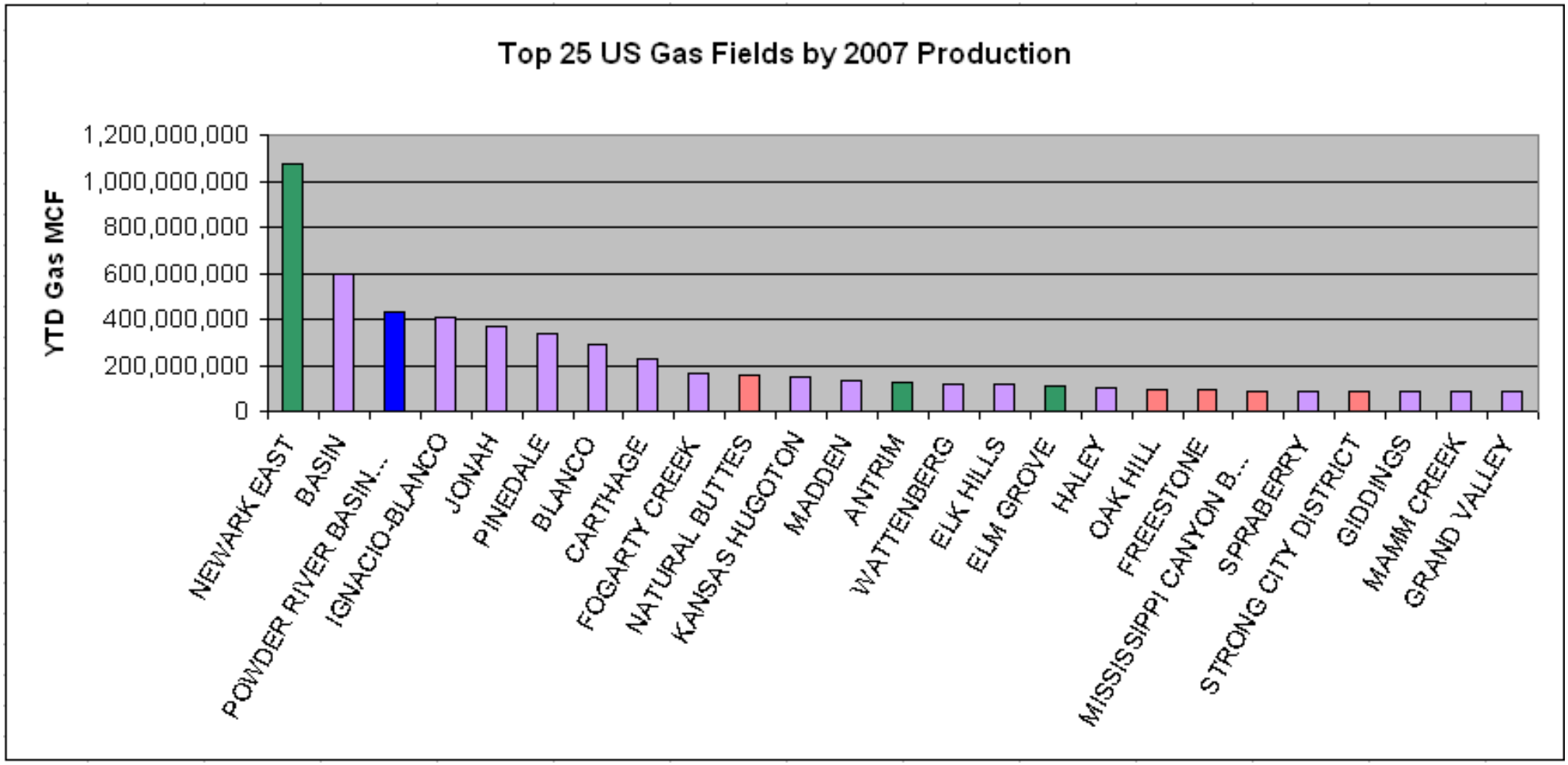
TOP 25 US Gas Fields by 2007 Production



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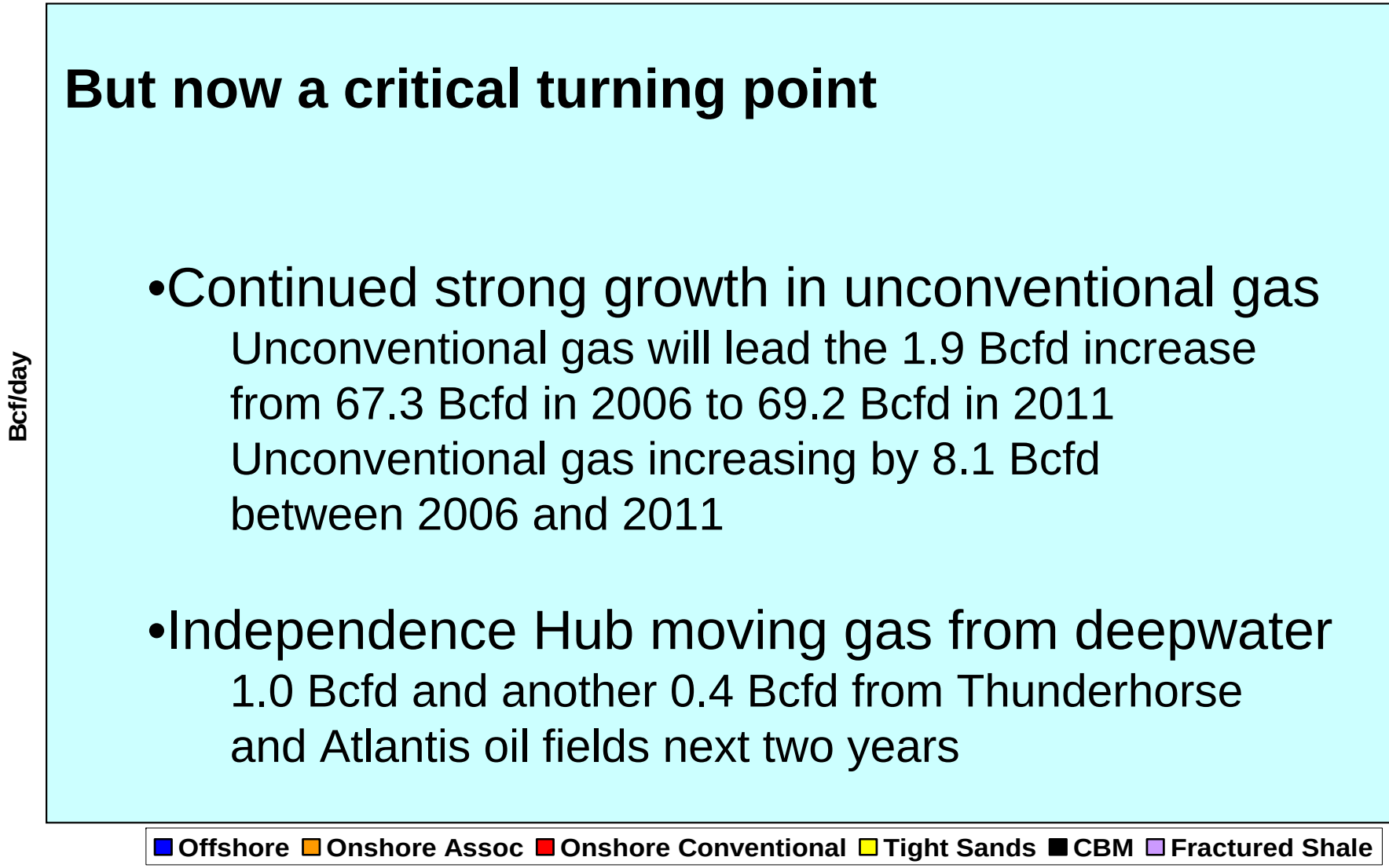
U.S. Daily Gas Production by Source 1995-2006

But now a critical turning point

- Continued strong growth in unconventional gas
  - Unconventional gas will lead the 1.9 Bcfd increase from 67.3 Bcfd in 2006 to 69.2 Bcfd in 2011
  - Unconventional gas increasing by 8.1 Bcfd between 2006 and 2011
- Independence Hub moving gas from deepwater
  - 1.0 Bcfd and another 0.4 Bcfd from Thunderhorse and Atlantis oil fields next two years



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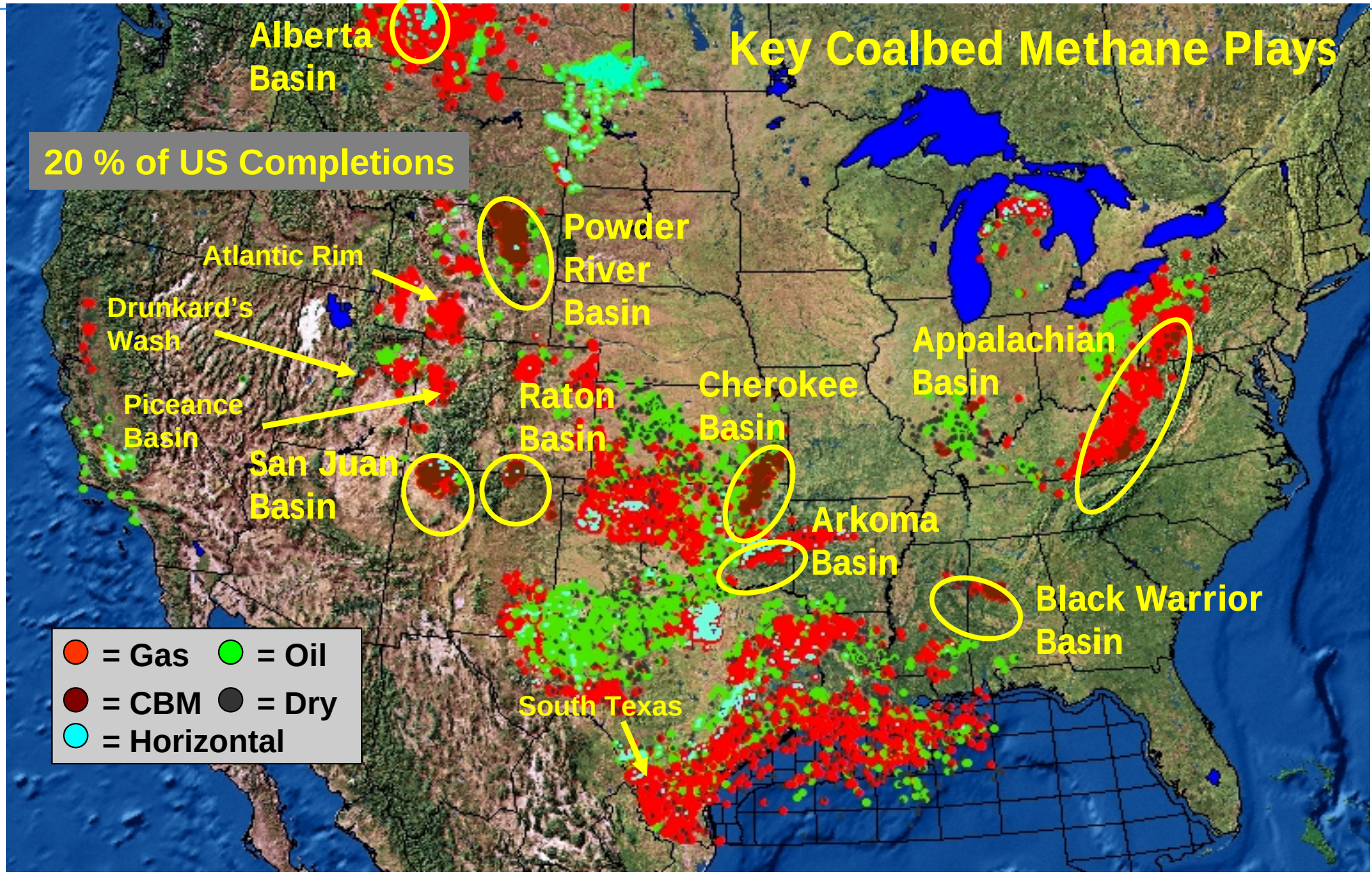
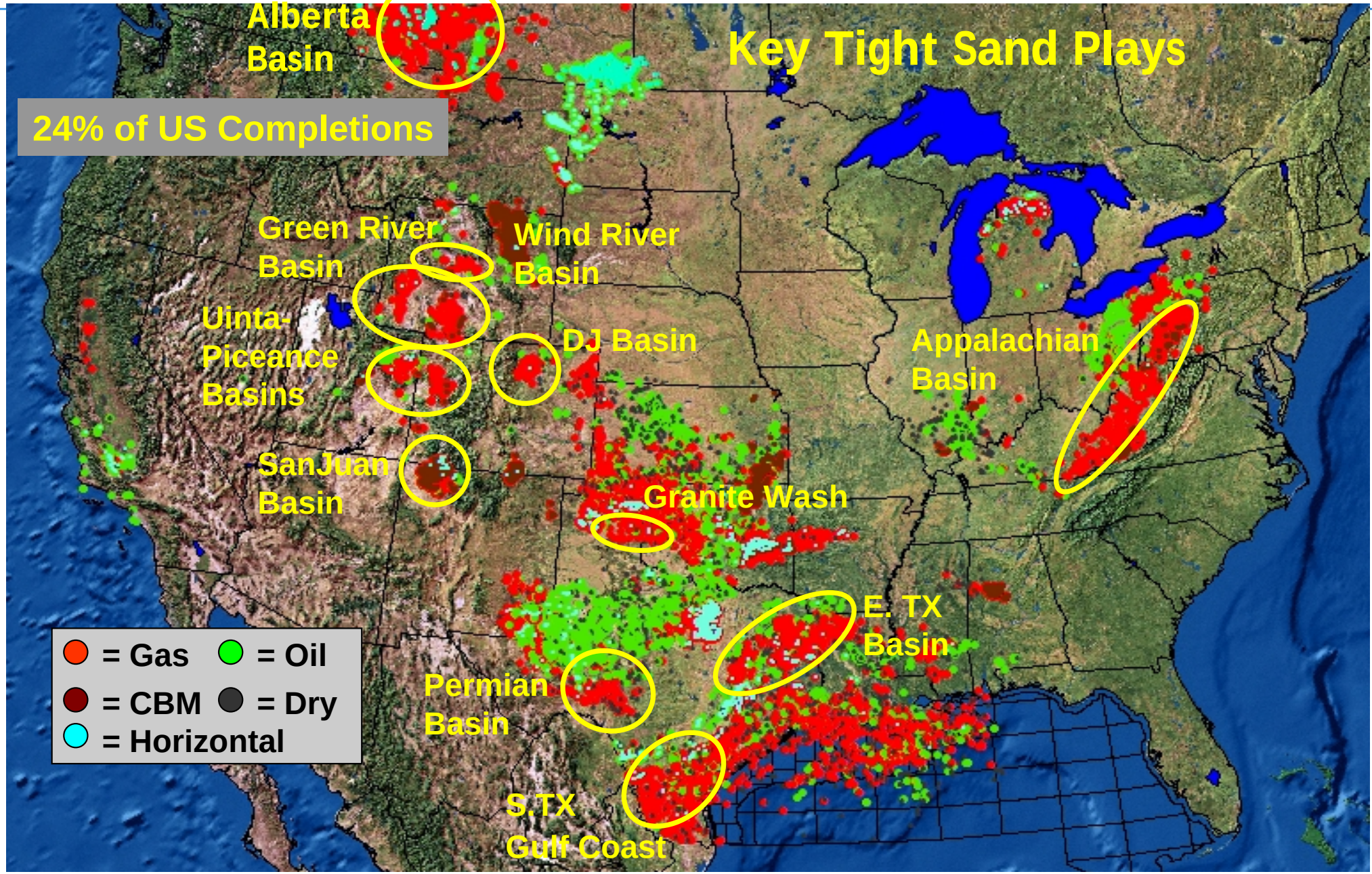
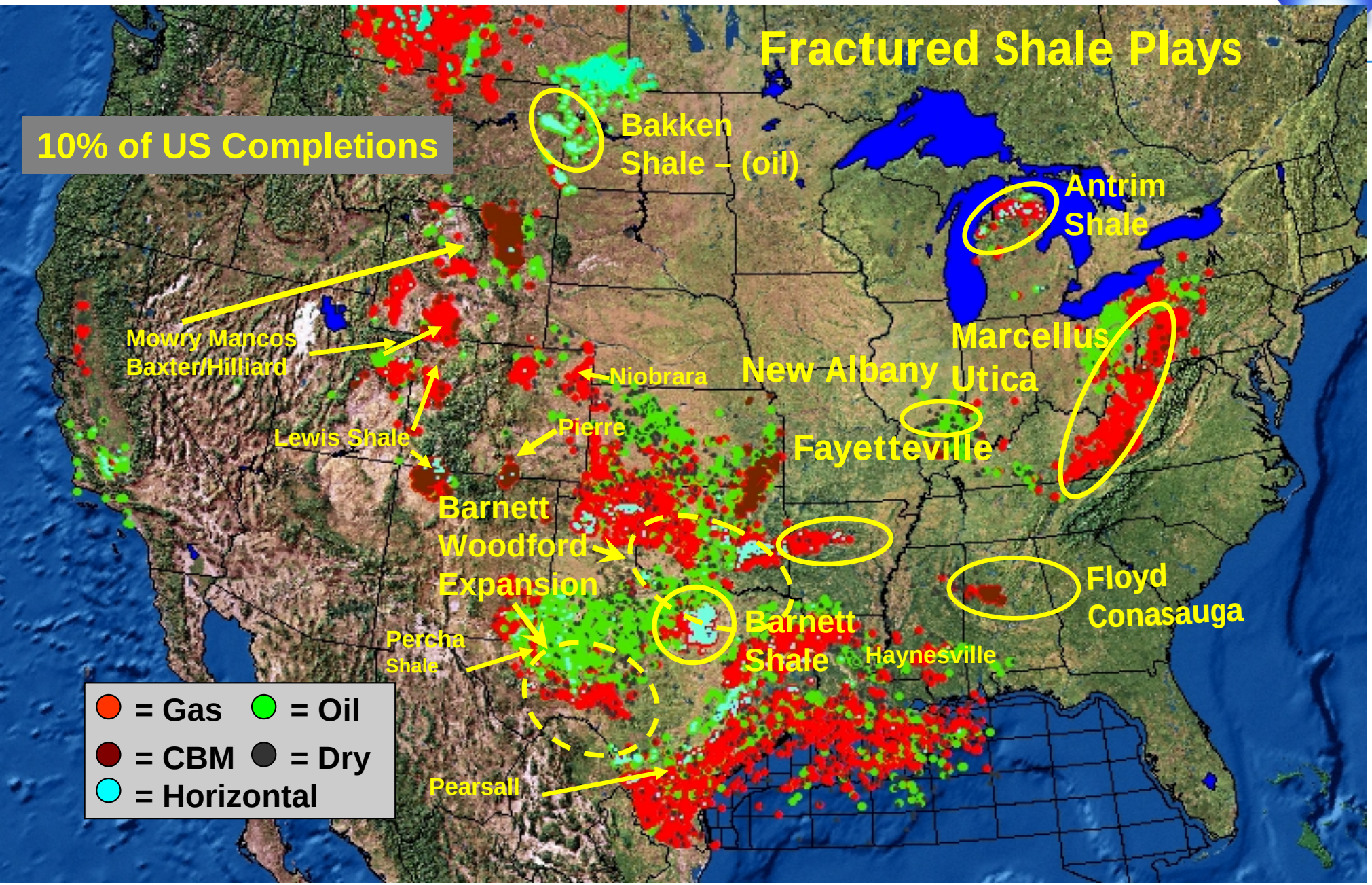
US. Drilling Coalbed Methane



US Drilling Tight Gas



US Drilling Shale



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Regional Maps

Selected Play Details

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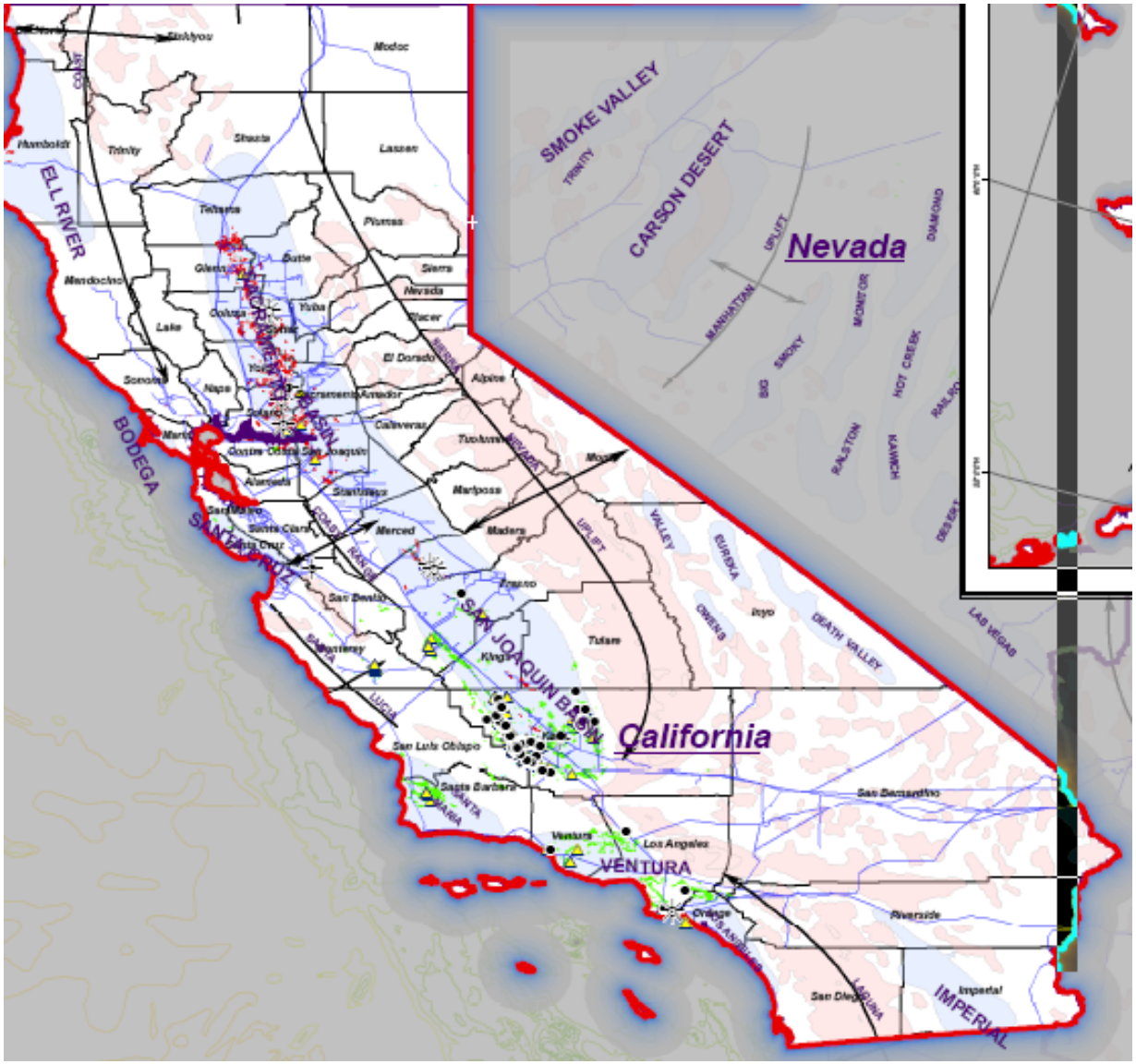
California



Development drilling in established fields and more drilling in some recently quieter areas due to commodity prices.

California may serve as a model for heavy oil development in other parts of the U.S.

Cum > 7.5 Bbo

Annual Production still >1Bbo

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Pacific Northwest

Some potential for future CBM development

Several exploratory wells planned in Columbia River Basin tight sands with sub-Basalt gas targets in the Eocene Roslyn and some Oligocene zones.

May be some sandstone reservoir potential for gas in Tertiary zones

These play ideas seem to bubble up and then subside every few years

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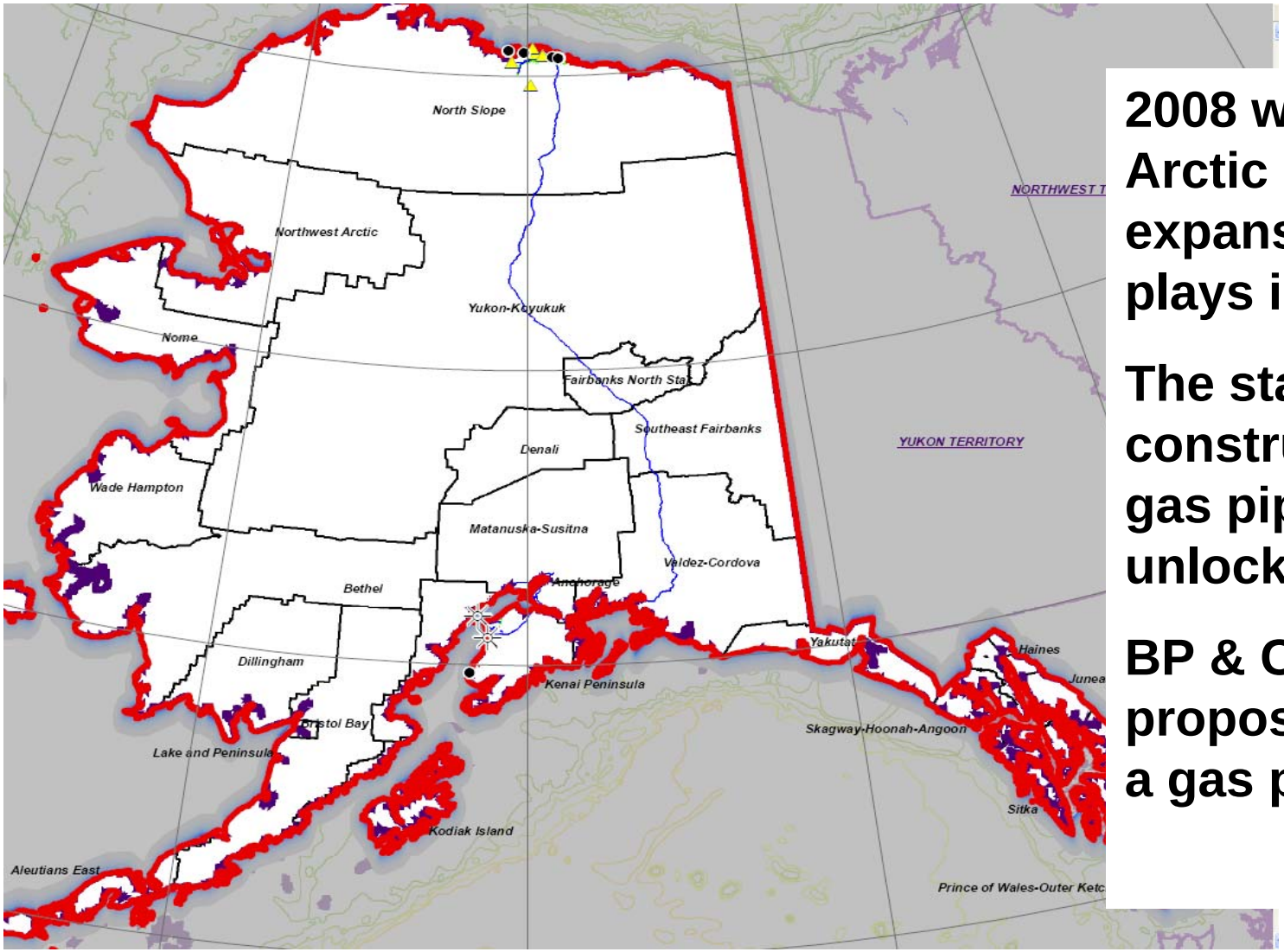
Alaska



2008 will be pivotal for Arctic gas and continued expansion of high impact plays in the Arctic

The state's tender for construction of the Alaska gas pipeline should help unlock the huge reserves

BP & ConocoPhillips also proposing their version of a gas pipeline

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Alaska

Chukchi Sea one of the last frontiers in North America

MMS estimates perhaps 15 Bbo recoverable

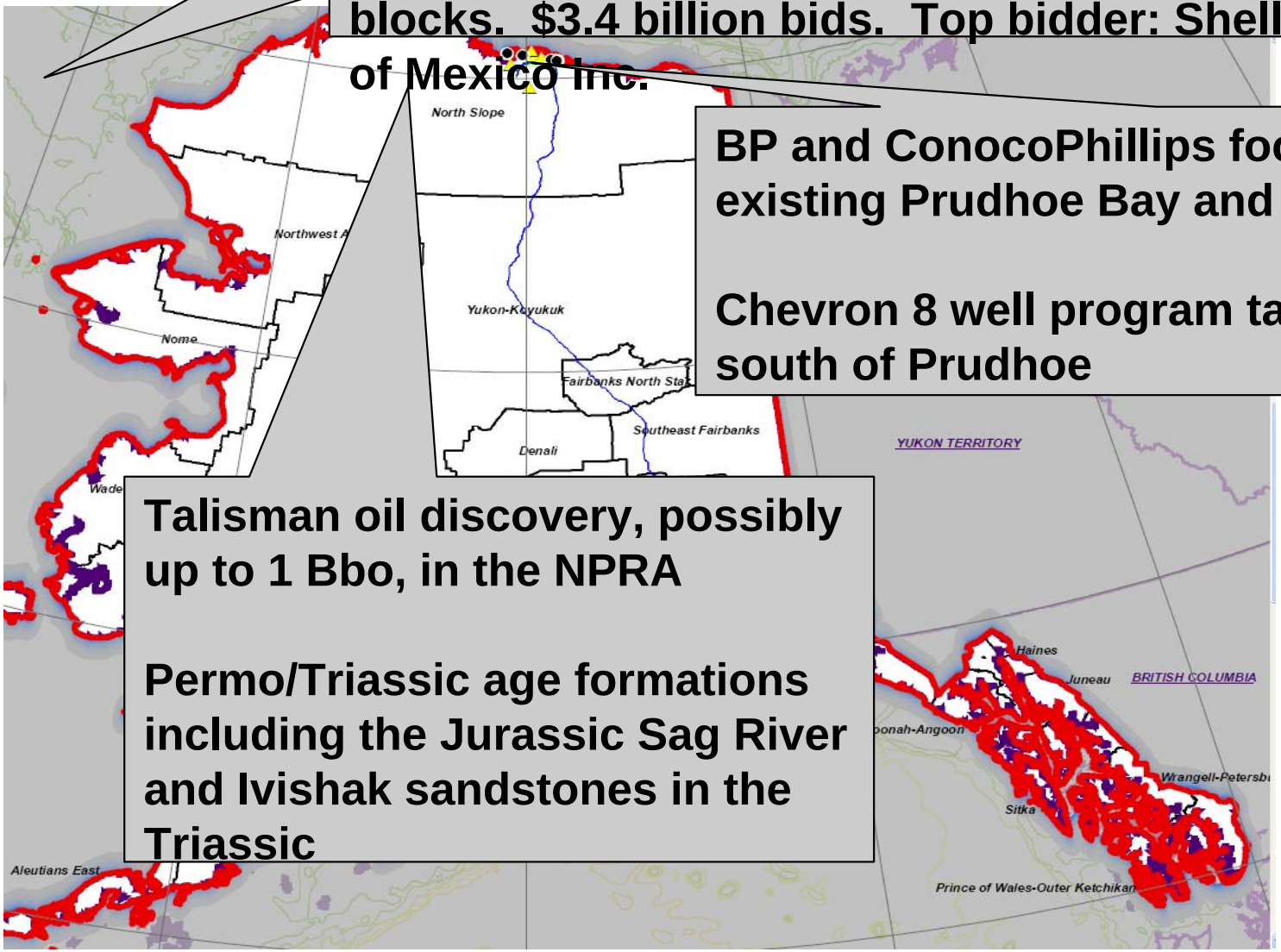
1st Lease sale since 1991—667 bids on 488 blocks. $3.4 billion bids. Top bidder: Shell Gulf of Mexico Inc.

BP and ConocoPhillips focus on heavy oil in existing Prudhoe Bay and Kuparuk River fields

Chevron 8 well program targeting heavy oil south of Prudhoe

Talisman oil discovery, possibly up to 1 Bbo, in the NPRA

Permo/Triassic age formations including the Jurassic Sag River and Ivishak sandstones in the Triassic



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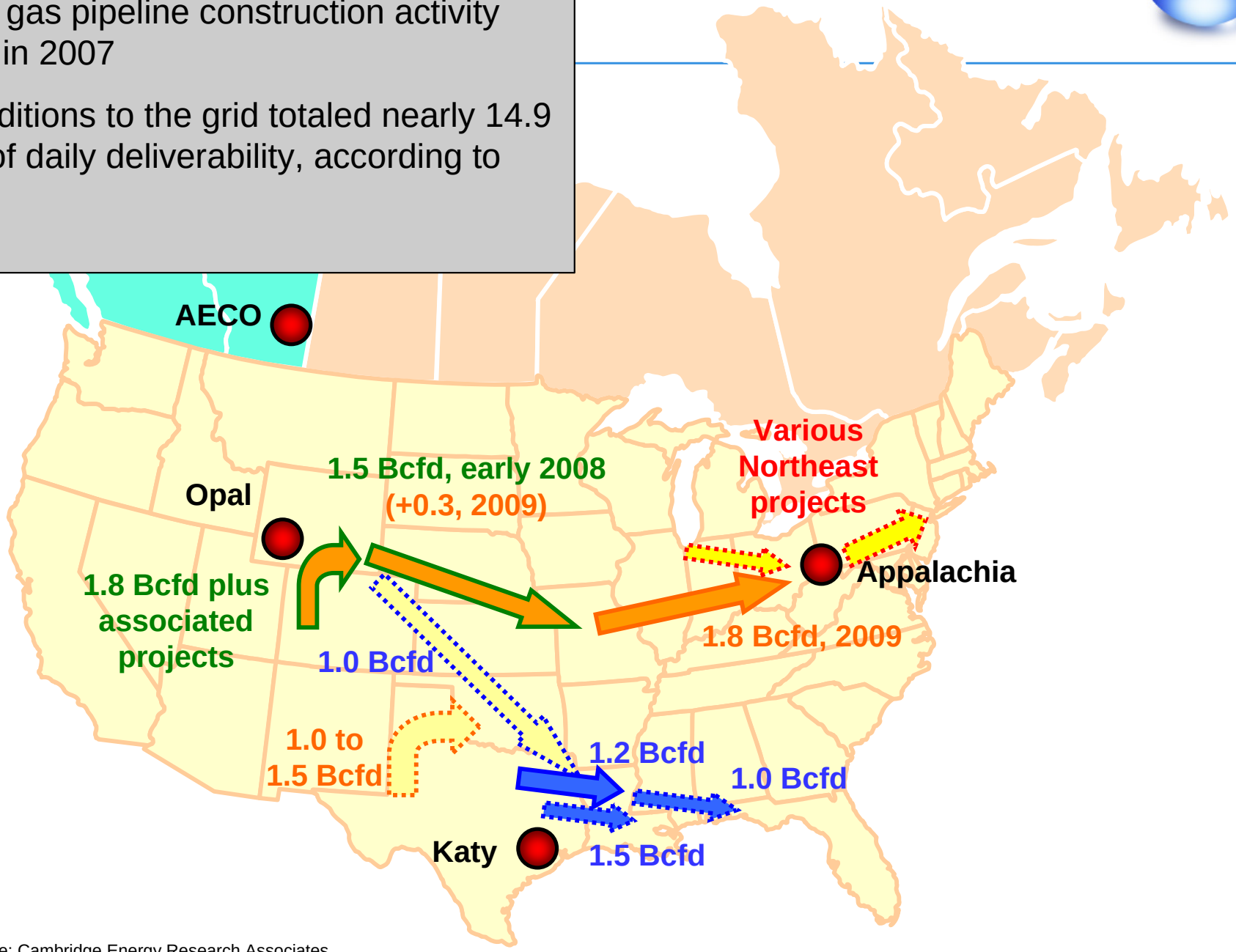
New Gas Pipelines: Bridging the Divide

U.S. natural gas pipeline construction activity accelerated in 2007

Capacity additions to the grid totaled nearly 14.9 billion cu ft of daily deliverability, according to EIA



Source: Cambridge Energy Research Associates.

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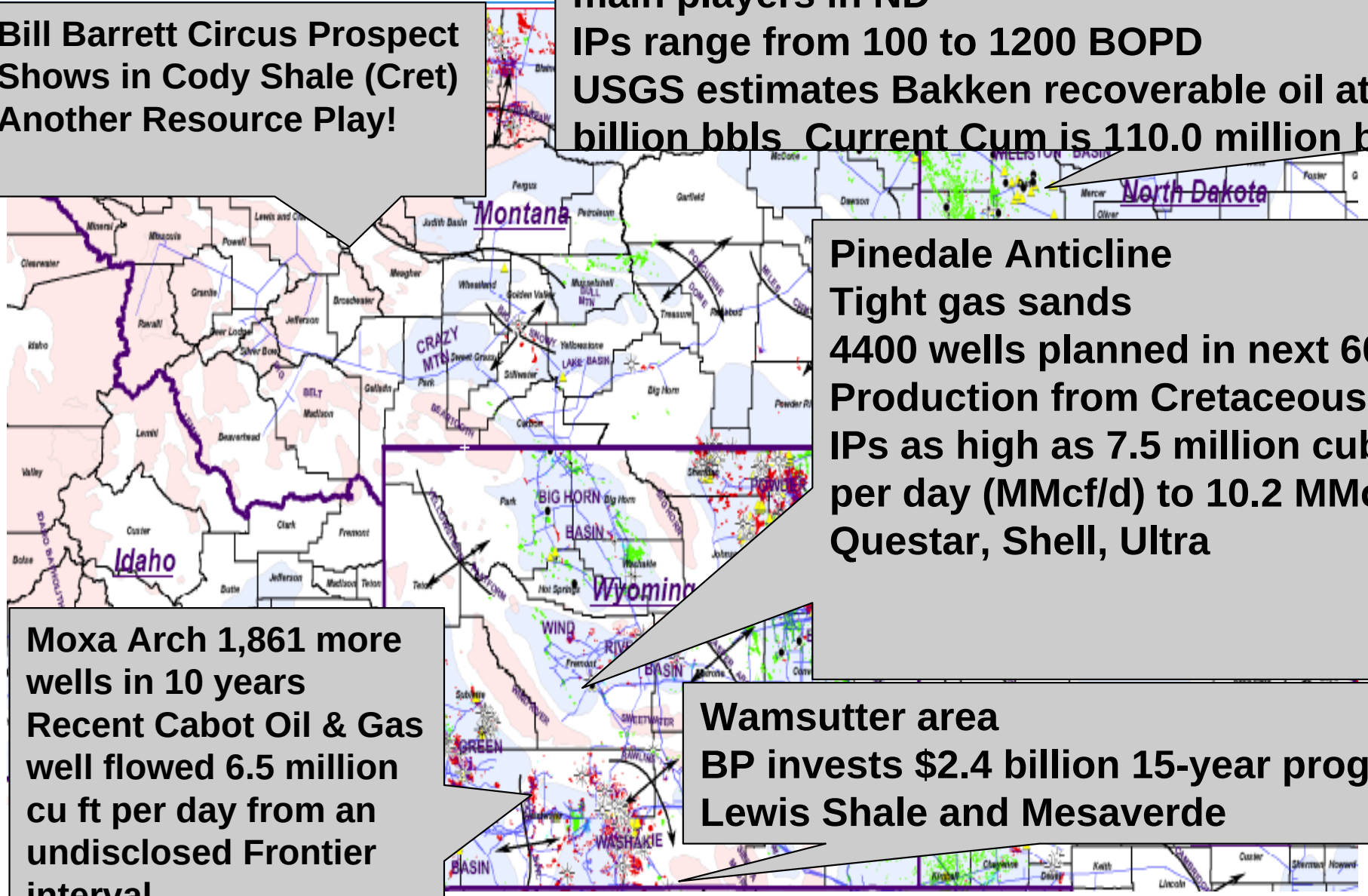
Northern Rockies

Bakken oil play—easily the dominant oil play in the Rockies
Expansion into North Dakota
Hess, EOG, Continental Res, ConocoPhillips are main players in ND
IPs range from 100 to 1200 BOPD
USGS estimates Bakken recoverable oil at 3.0-4.3 billion bbls. Current Cum is 110.0 million bbls

Bill Barrett Circus Prospect
Shows in Cody Shale (Cret)
Another Resource Play!



Pinedale Anticline
Tight gas sands
4400 wells planned in next 60 years
Production from Cretaceous Lance
IPs as high as 7.5 million cubic feet per day (MMcf/d) to 10.2 MMcf/d
Questar, Shell, Ultra

Moxa Arch 1,861 more wells in 10 years
Recent Cabot Oil & Gas well flowed 6.5 million cu ft per day from an undisclosed Frontier interval

Wamsutter area
BP invests $2.4 billion 15-year program
Lewis Shale and Mesaverde

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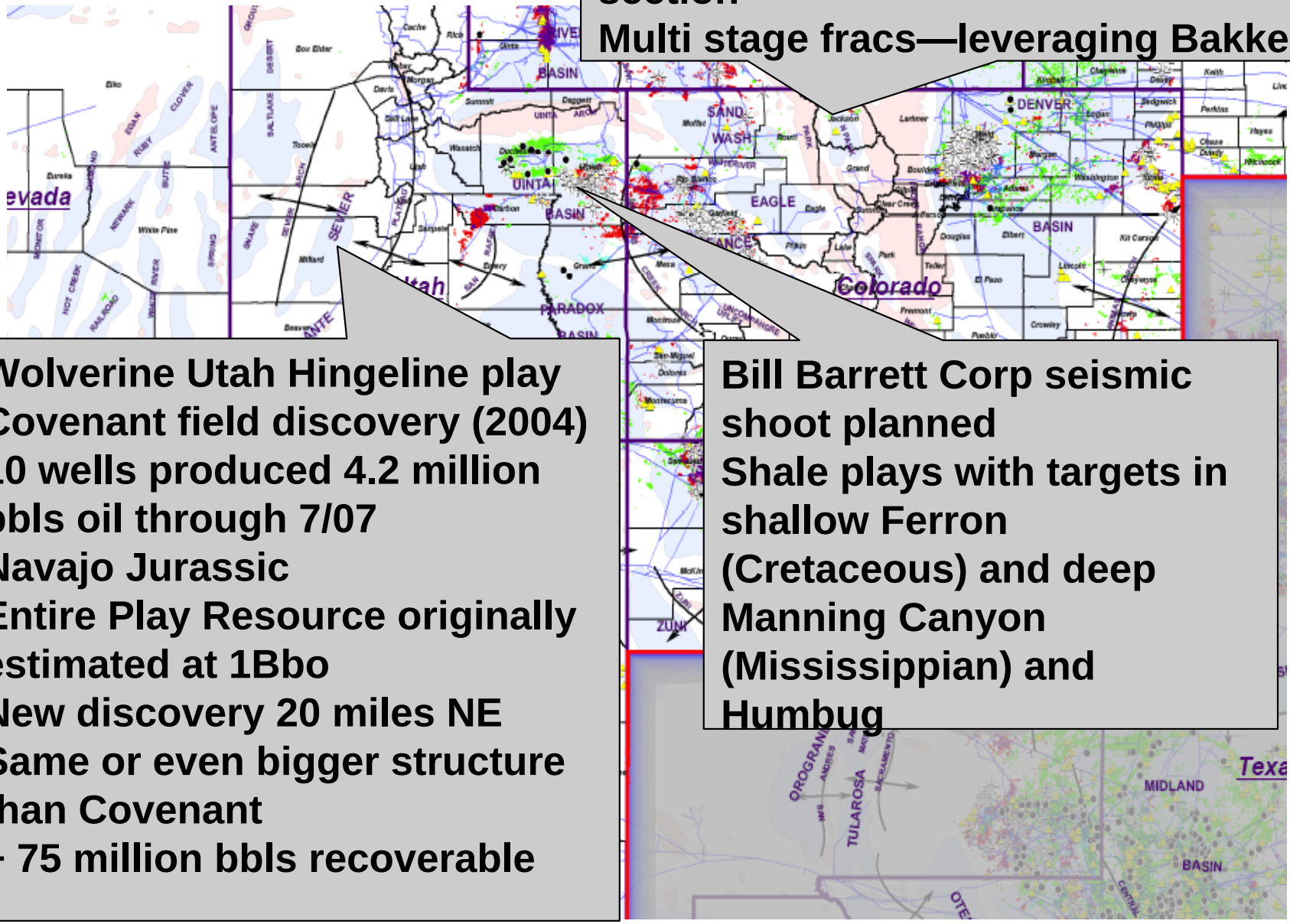
Southern Rockies

Potential new play in Colorado's North Park Basin
EOG horizontal wildcat IPs at 550 bopd
Upper Cretaceous Niobrara
EOG estimates OOIP at 10-40 million bbls per section
Multi stage fracs—leveraging Bakken experience



Wolverine Utah Hingeline play
Covenant field discovery (2004)
10 wells produced 4.2 million bbls oil through 7/07
Navajo Jurassic
Entire Play Resource originally estimated at 1Bbo
New discovery 20 miles NE
Same or even bigger structure than Covenant
+ 75 million bbls recoverable

Bill Barrett Corp seismic shoot planned
Shale plays with targets in shallow Ferron (Cretaceous) and deep Manning Canyon (Mississippian) and Humbug

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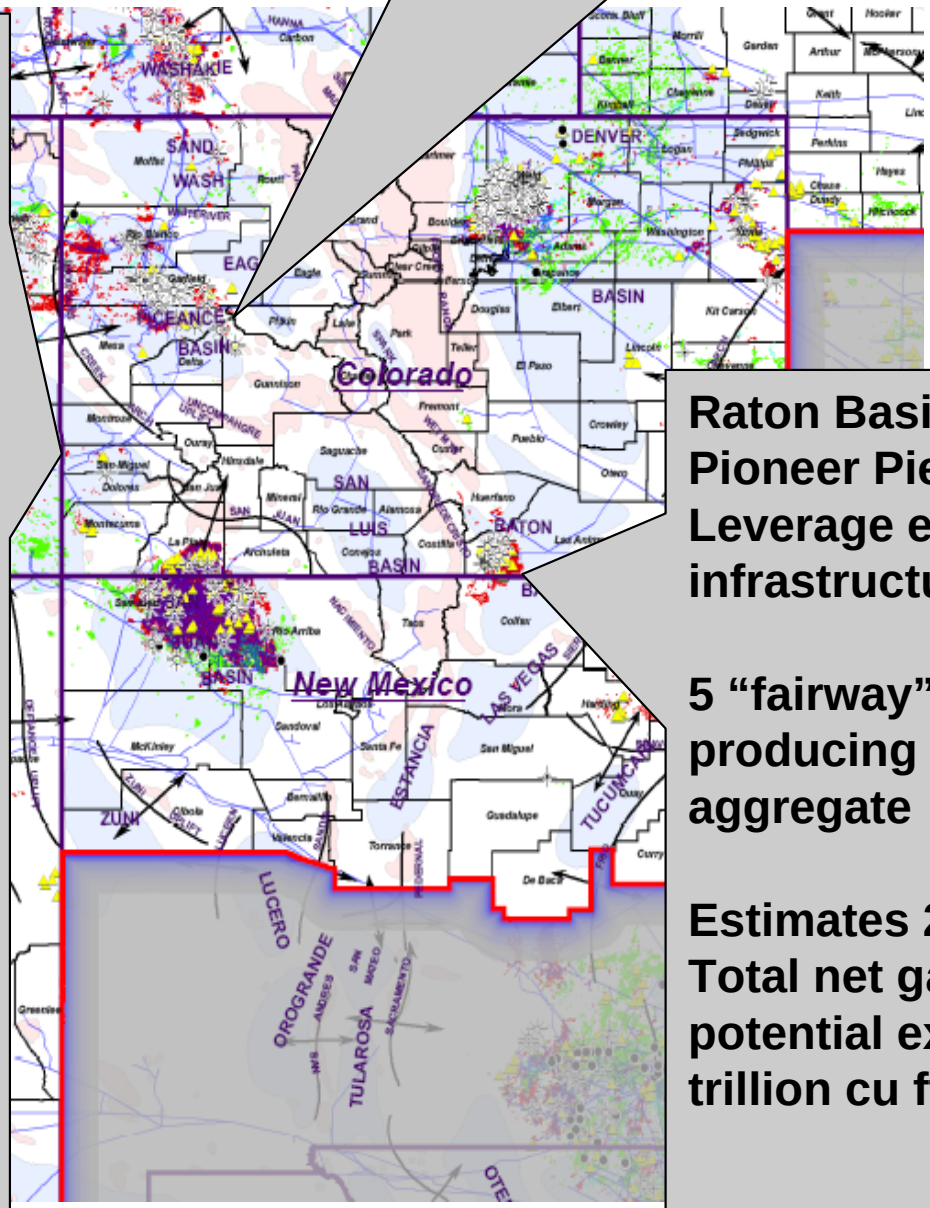
Southern Rockies

Oil shale R&D for years
Resources = 2,100 Bbo
Shell ICE

Delta's Paradox "O" clastic gas play south of Green River, boosted by $684 million infusion of capital from Kirk Kerkorian's Tracinda Corp--wells flow 1.2 to 4.5 MMcfgpd BHPs at 8000psi

Bill Barrett Gothic Shale Discovery at sustained rates of over 500,000 cu ft of gas per day – also targeting Hermosa zones

Encana three resource plays and conventional prospects in the fold and fault belt of the northern Paradox Basin
Program includes 16 wells, acquiring 200 square miles of new 3-D seismic and leasing additional acreage
Targets are Cutler, Hermosa, Ismay, Cane Creek Clastic



Raton Basin
Pioneer Pierre Shale Play
Leverage existing CBM infrastructure

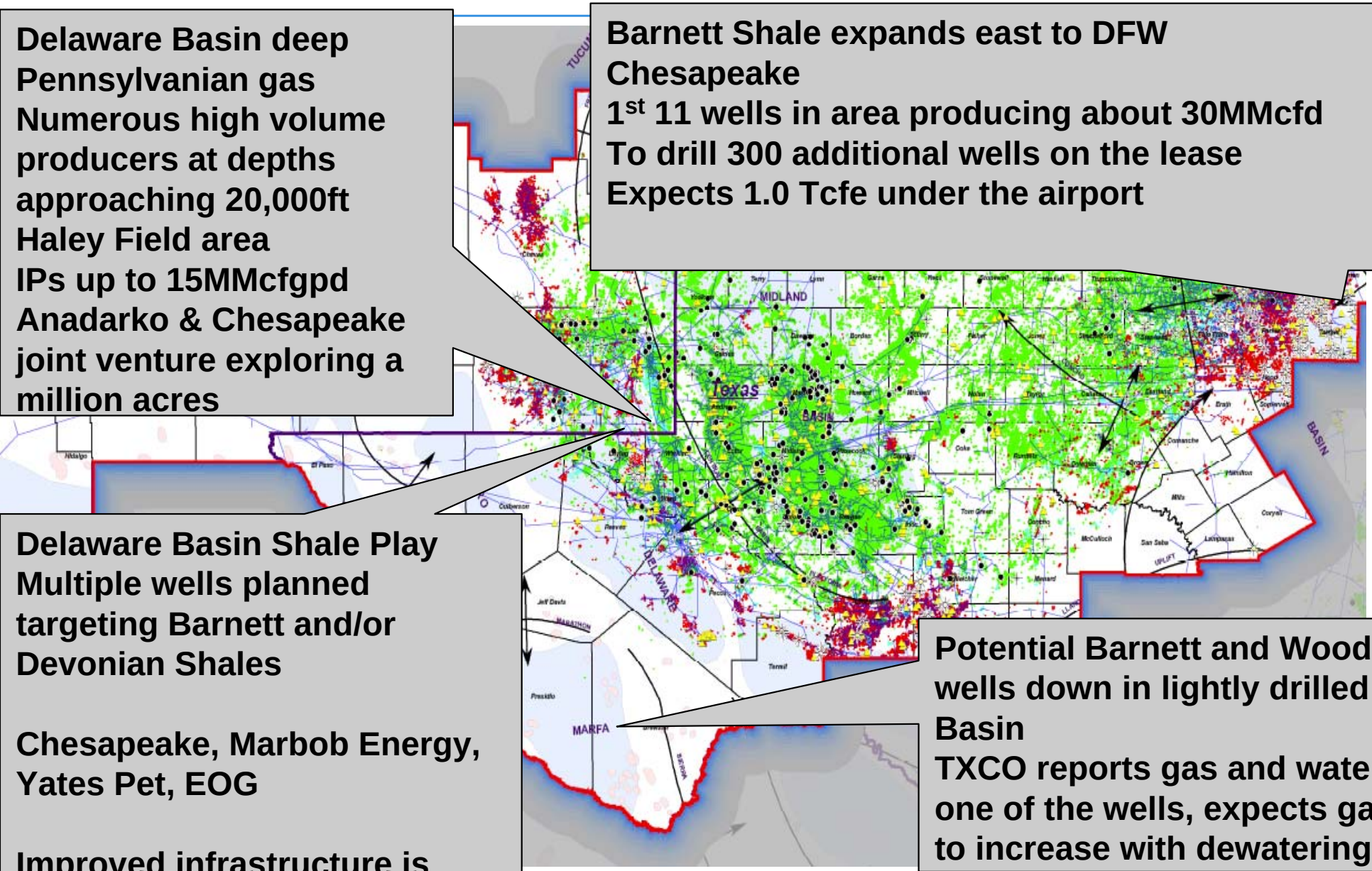
5 "fairway" wells producing 2 MMcfgpd in aggregate

Estimates 21 Tcf in place
Total net gas resource potential exceeds 2.0 trillion cu ft

SE New Mexico/West Texas

Delaware Basin deep Pennsylvanian gas
Numerous high volume producers at depths approaching 20,000ft
Haley Field area
IPs up to 15MMcfgpd
Anadarko & Chesapeake joint venture exploring a million acres

Barnett Shale expands east to DFW
Chesapeake
1st 11 wells in area producing about 30MMcfd
To drill 300 additional wells on the lease
Expects 1.0 Tcfe under the airport



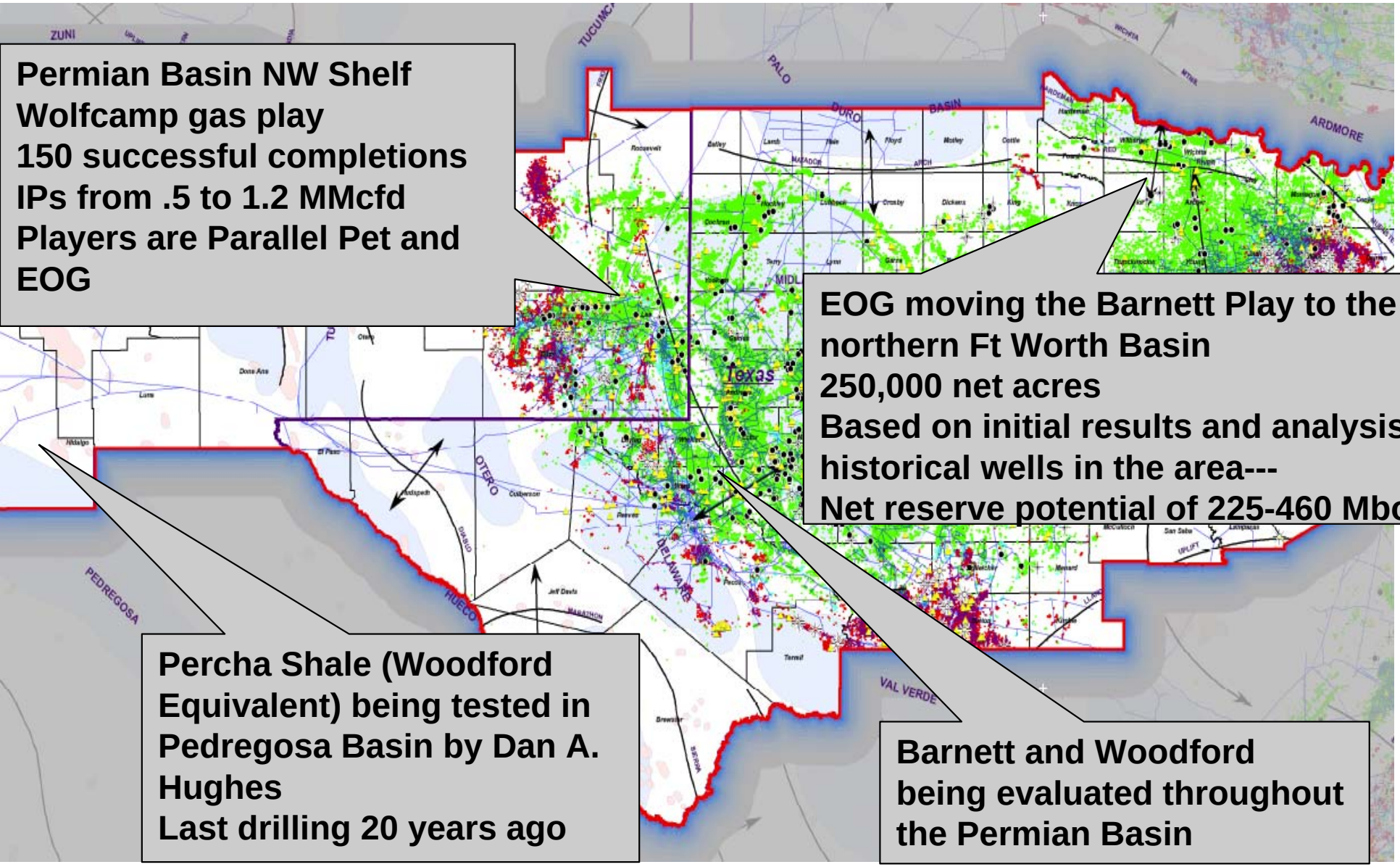
Delaware Basin Shale Play
Multiple wells planned targeting Barnett and/or Devonian Shales

Chesapeake, Marbob Energy, Yates Pet, EOG

Improved infrastructure is allowing this play to expand

Potential Barnett and Woodford wells down in lightly drilled Marfa Basin
TXCO reports gas and water from one of the wells, expects gas rate to increase with dewatering

SE New Mexico/West Texas



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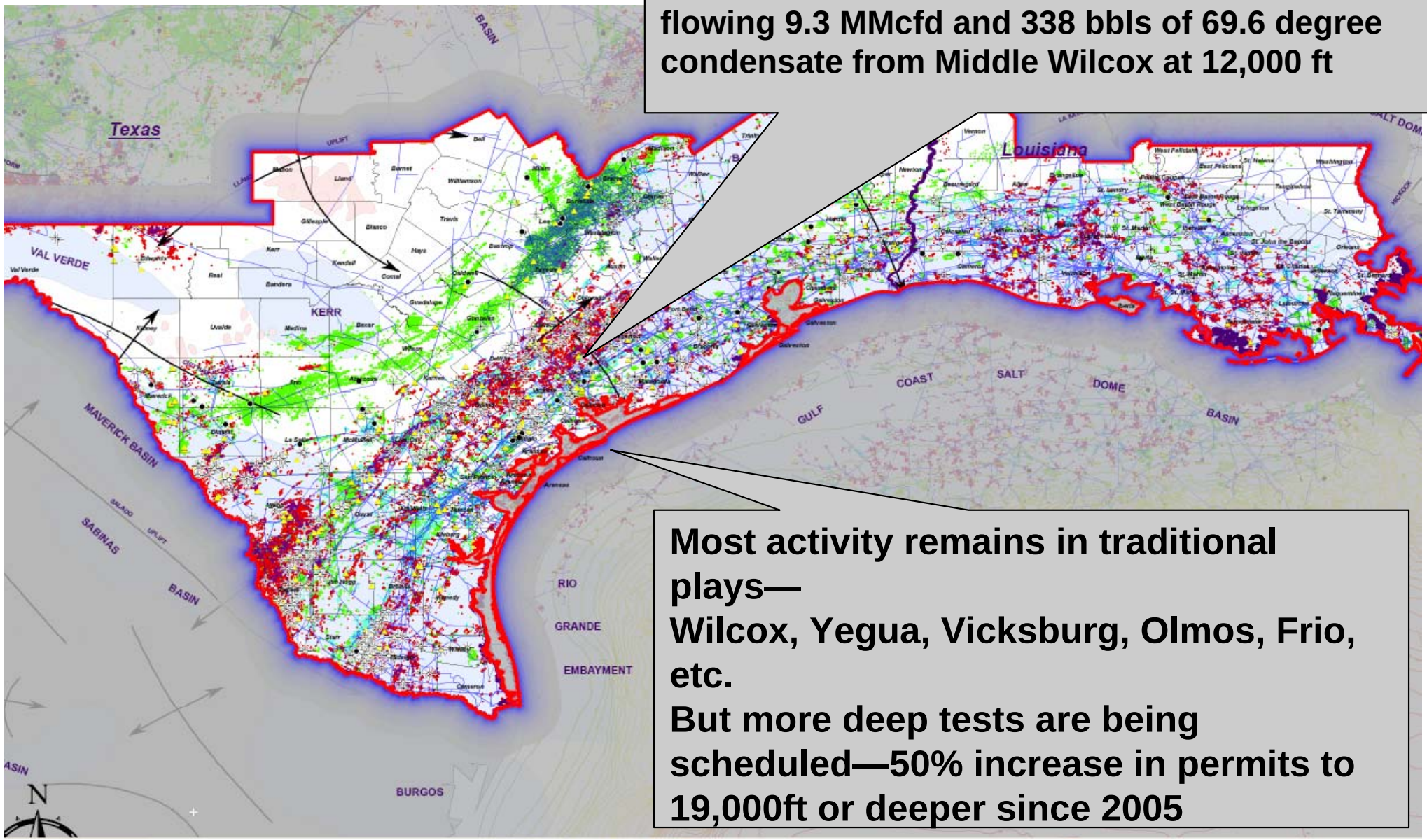
Gulf Coast

Notable Wilcox wells include El Paso's Lavaca county 15,000 to 17,000ft TDs, IPs up to 15.2 MMcfd

Devon also active in the same area with a Wilcox flowing 9.3 MMcfd and 338 bbls of 69.6 degree condensate from Middle Wilcox at 12,000 ft



Most activity remains in traditional plays—
Wilcox, Yegua, Vicksburg, Olmos, Frio, etc.
But more deep tests are being scheduled—50% increase in permits to 19,000ft or deeper since 2005

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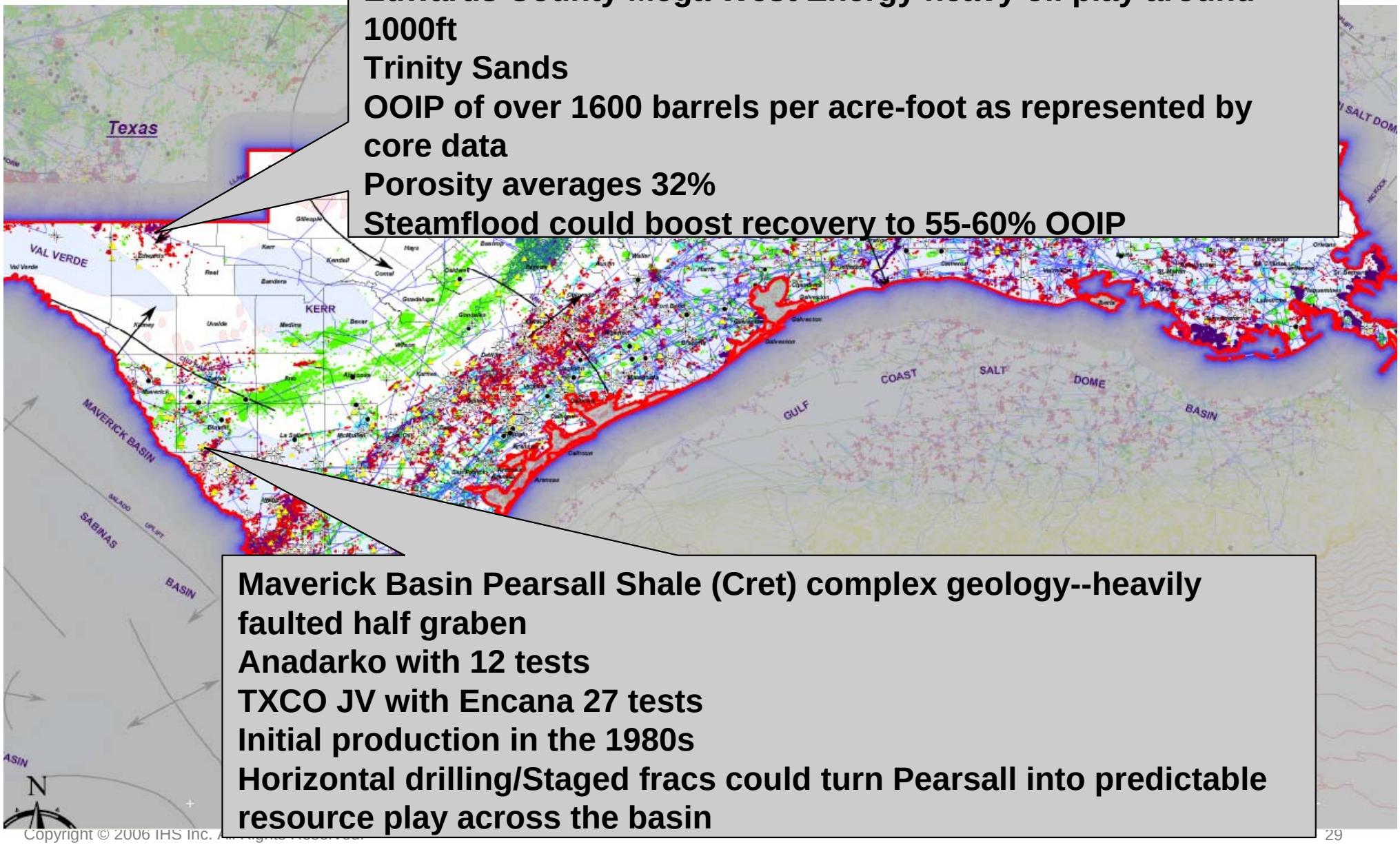
Gulf Coast



Edwards County Mega West Energy heavy oil play around 1000ft
Trinity Sands
OOIP of over 1600 barrels per acre-foot as represented by core data
Porosity averages 32%
Steamflood could boost recovery to 55-60% OOIP

Maverick Basin Pearsall Shale (Cret) complex geology--heavily faulted half graben
Anadarko with 12 tests
TXCO JV with Encana 27 tests
Initial production in the 1980s
Horizontal drilling/Staged fracs could turn Pearsall into predictable resource play across the basin

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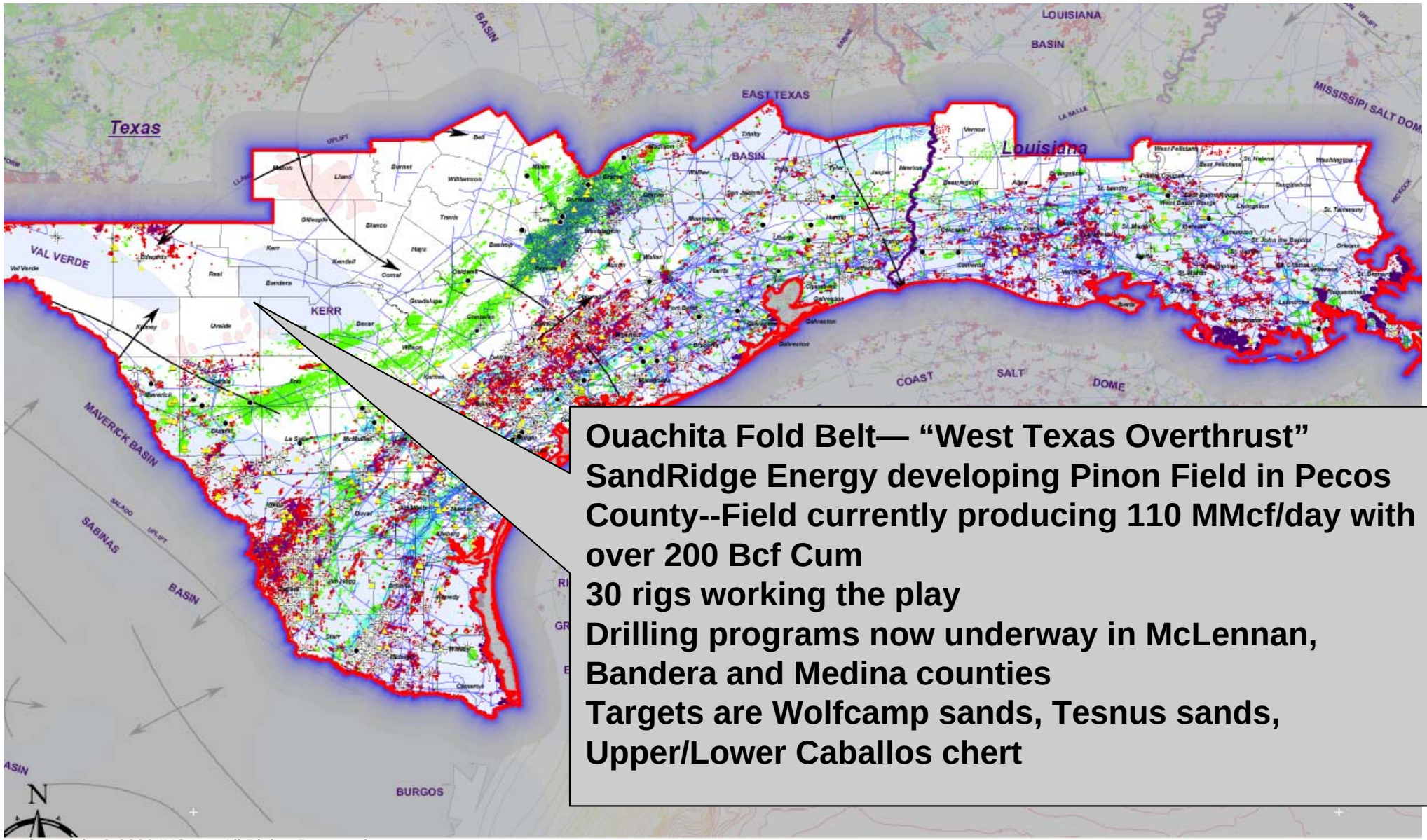
Gulf Coast



Ouachita Fold Belt— "West Texas Overthrust"
SandRidge Energy developing Pinon Field in Pecos County--Field currently producing 110 MMcf/day with over 200 Bcf Cum
30 rigs working the play
Drilling programs now underway in McLennan, Bandera and Medina counties
Targets are Wolfcamp sands, Tesnus sands, Upper/Lower Caballos chert

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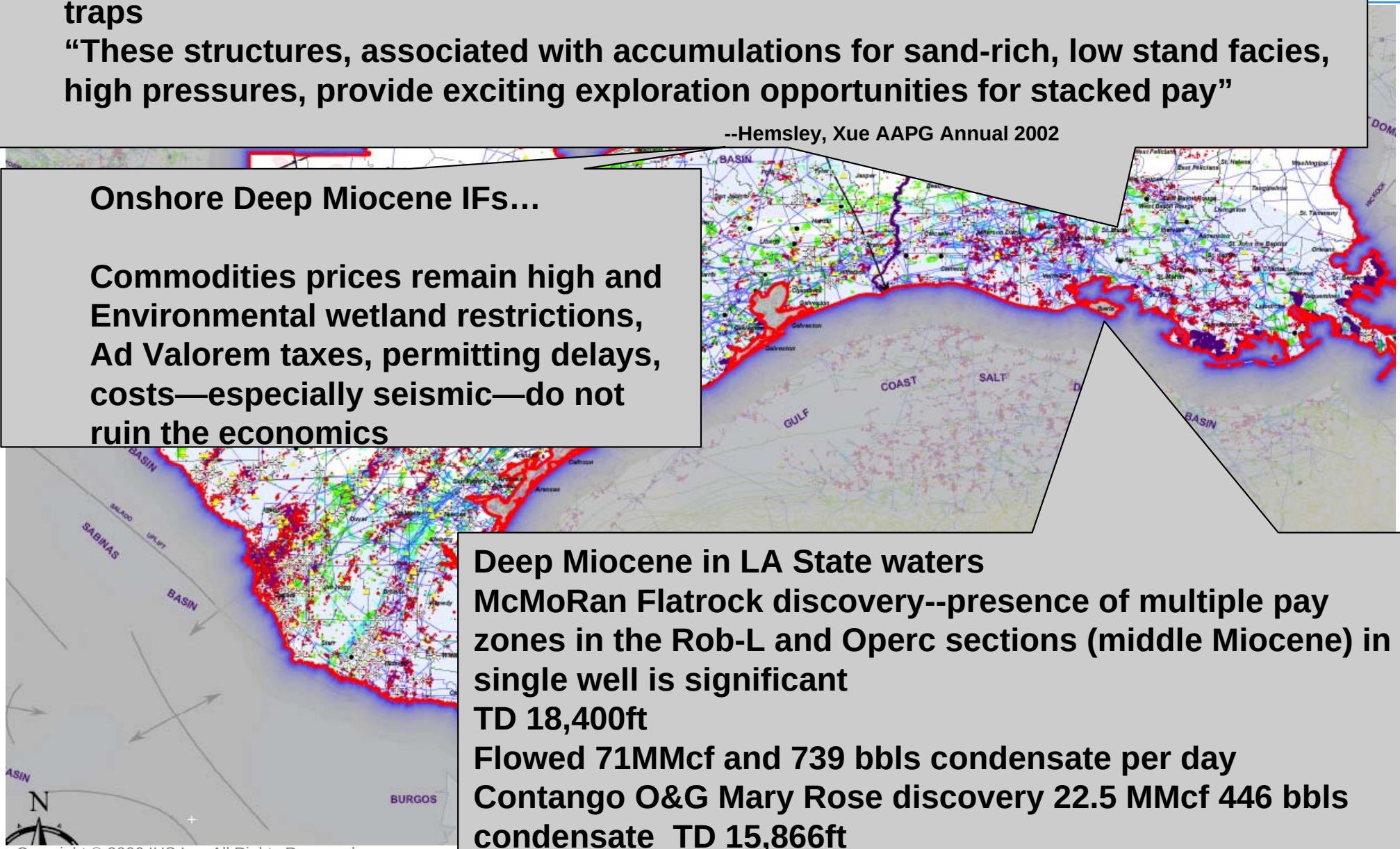
South Louisiana Miocene in slow decline but…
Recent offshore "deep shelf" successes point to deep Miocene onshore
Below 15,000 ft several thousand feet of unexploited section underlying the current production zone in most areas
High res seismic reveals extensive salt movement and associated growth-faulting traps
"These structures, associated with accumulations for sand-rich, low stand facies, high pressures, provide exciting exploration opportunities for stacked pay"

--Hemsley, Xue AAPG Annual 2002

Onshore Deep Miocene IFs…

Commodities prices remain high and Environmental wetland restrictions, Ad Valorem taxes, permitting delays, costs—especially seismic—do not ruin the economics



Deep Miocene in LA State waters
McMoRan Flatrock discovery--presence of multiple pay zones in the Rob-L and Operc sections (middle Miocene) in a single well is significant
TD 18,400ft
Flowed 71MMcf and 739 bbls condensate per day
Contango O&G Mary Rose discovery 22.5 MMcf 446 bbls condensate TD 15,866ft

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Southeast Ark La Tex

Development of the Hosston (Travis Peak) Bossier/Cotton Valley tight gas sand play continues with expansion into north LA

Bossier pay extended into RRC 3 10 miles south of established production in Hilltop Resort field. Chesapeake IP'd the 1 Theiss at 200 Mcfd from 17,794-17,848ft

Travis Peak, Cotton Valley and shallow Bossier average wells produce 1.5 to 2 Bcf over their life while the top 10% produce an average of 5 to 6 Bcf

Anadarko thinks Cotton Valley play could extend into MS

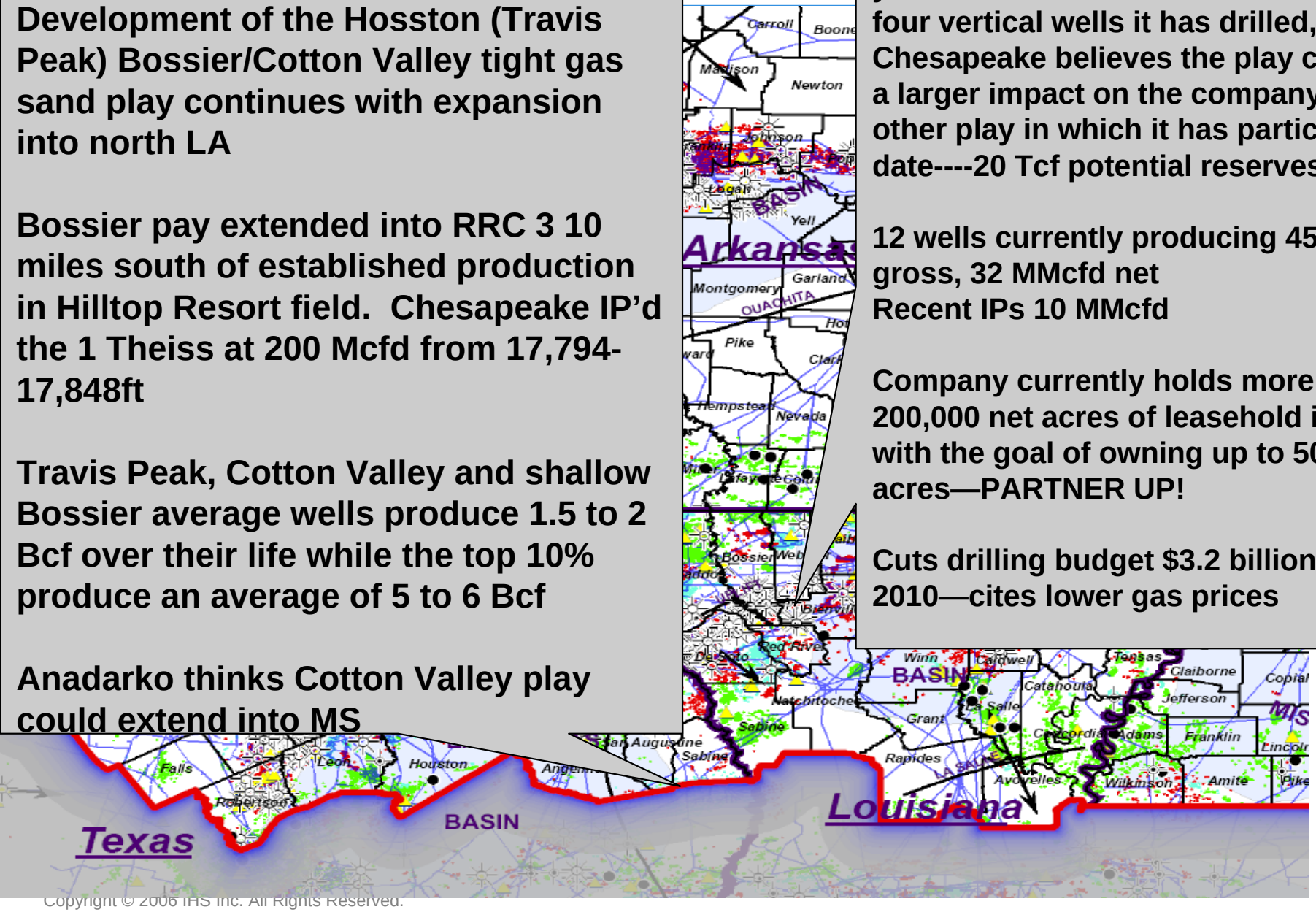
Chesapeake announces an undisclosed Haynesville Shale discovery in North Louisiana 10,500-13,000ft

Based on research during the past two years and results of three horizontal and four vertical wells it has drilled, Chesapeake believes the play could have a larger impact on the company than any other play in which it has participated to date----20 Tcf potential reserves????

12 wells currently producing 45 MMcfd gross, 32 MMcfd net
Recent IPs 10 MMcfd

Company currently holds more than 200,000 net acres of leasehold in the play with the goal of owning up to 500,000 net acres—PARTNER UP!

Cuts drilling budget $3.2 billion through 2010—cites lower gas prices



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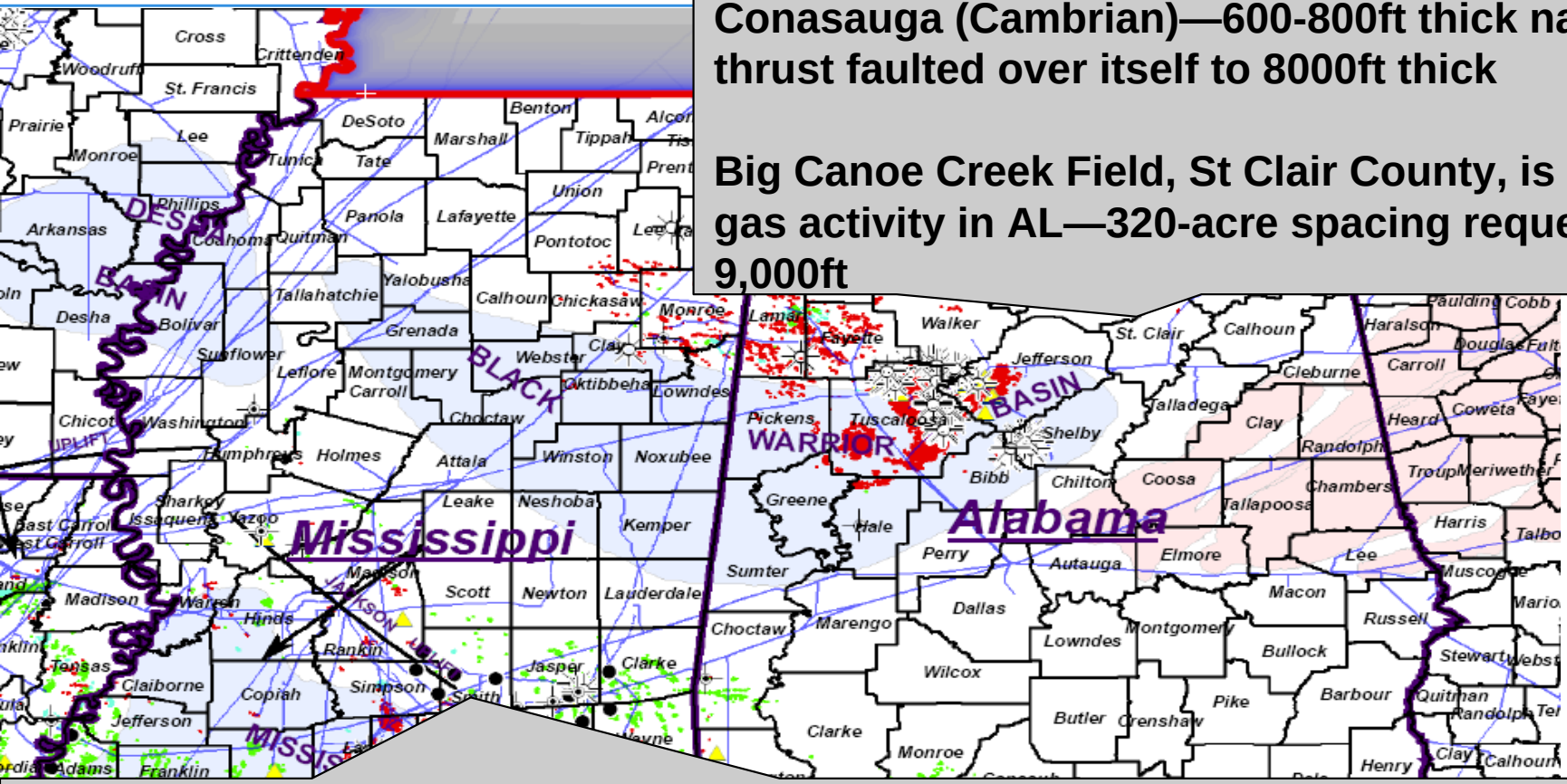
Southeast MS AL

Shale Plays Aggressive lease play
Tests in non-producing counties throughout the Black Warrior Basin

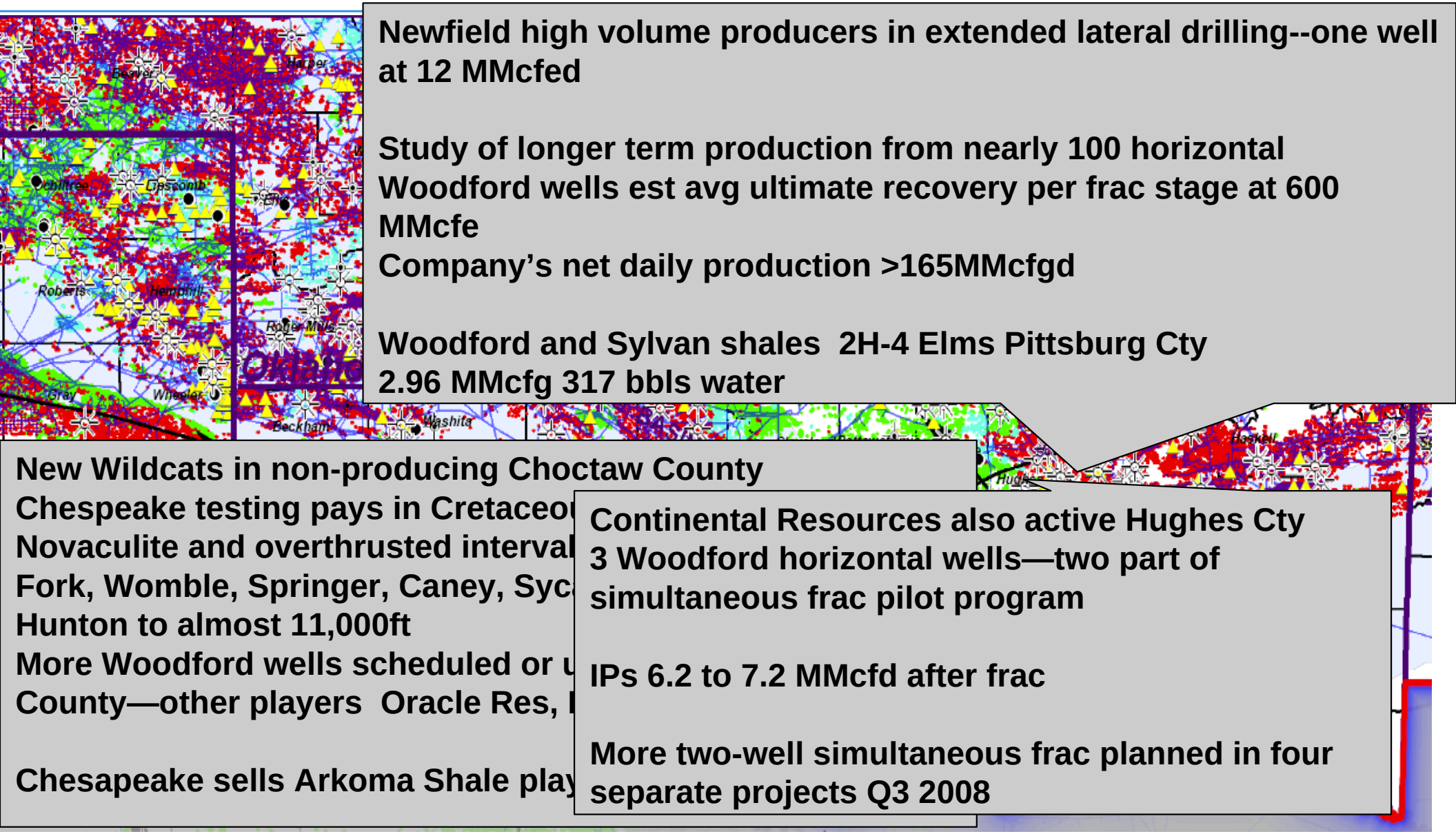
Targets are the Floyd (Devonian)—80-180ft thick
Conasauga (Cambrian)—600-800ft thick naturally but thrust faulted over itself to 8000ft thick

Big Canoe Creek Field, St Clair County, is focus of shale gas activity in AL—320-acre spacing request 2,000-9,000ft



Tellus Operating new Cotton Valley discovery in Smith County
IP 305 bopd 180 mcfgpd
Perfs 15,061-15,132ft
Several wells being drilled
Traditional plays still a focus in MS—Selma Chalk, Tuscaloosa, Frio, Hosston in the south. Lewis and Carter in the northeast.
In AL, Smackover, Lewis and Carter reserves

Oklahoma Woodford East



Newfield high volume producers in extended lateral drilling--one well at 12 MMcfed

Study of longer term production from nearly 100 horizontal Woodford wells est avg ultimate recovery per frac stage at 600 MMcfe
Company's net daily production >165MMcfgd

Woodford and Sylvan shales 2H-4 Elms Pittsburg Cty
2.96 MMcfg 317 bbls water

New Wildcats in non-producing Choctaw County
Chespeake testing pays in Cretaceou
Novaculite and overthrusted interval
Fork, Womble, Springer, Caney, Syc
Hunton to almost 11,000ft
More Woodford wells scheduled or u
County—other players Oracle Res, I

Chesapeake sells Arkoma Shale play

Continental Resources also active Hughes Cty
3 Woodford horizontal wells—two part of simultaneous frac pilot program

IPs 6.2 to 7.2 MMcfd after frac

More two-well simultaneous frac planned in four separate projects Q3 2008

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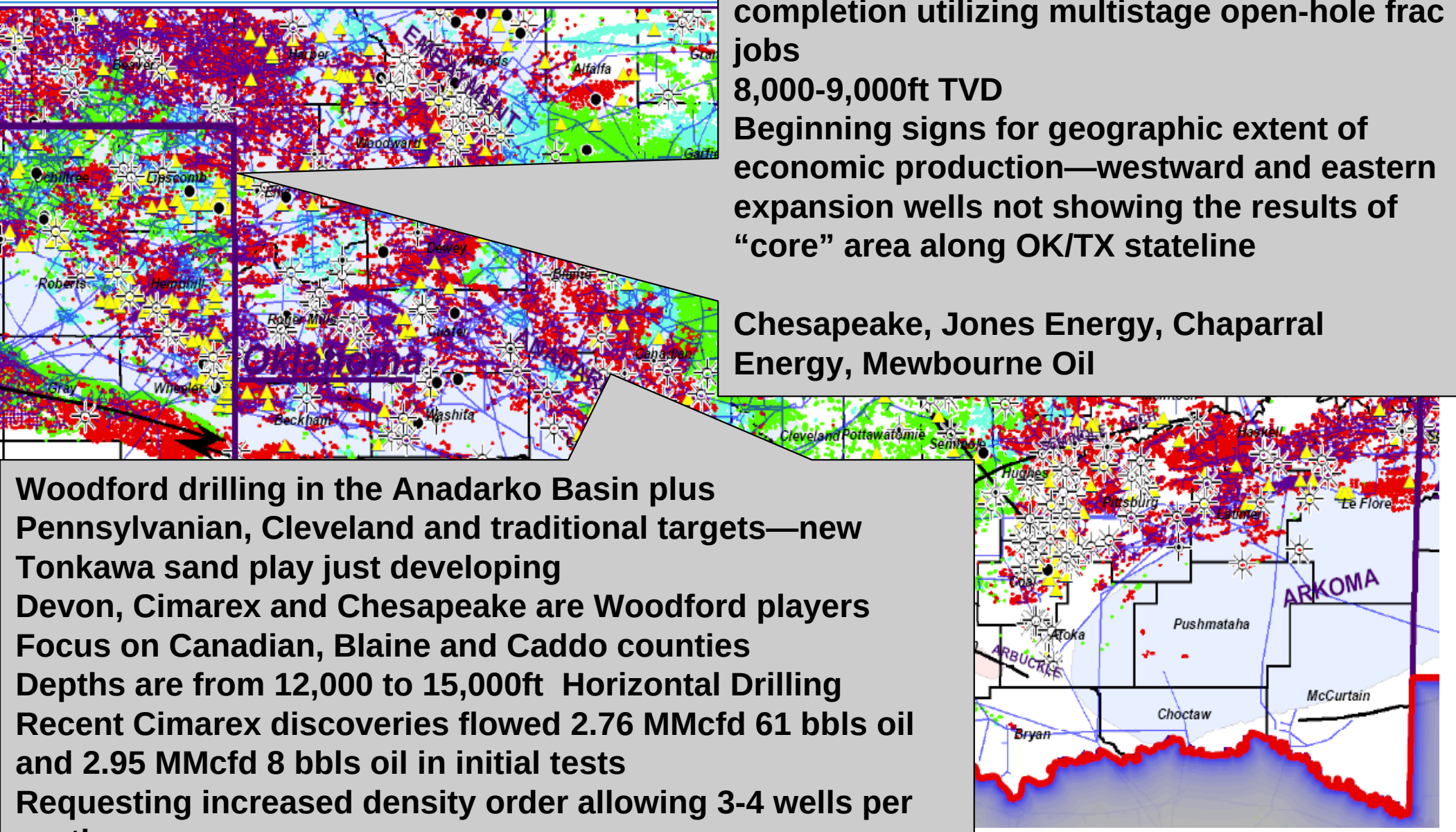
Oklahoma Woodford We

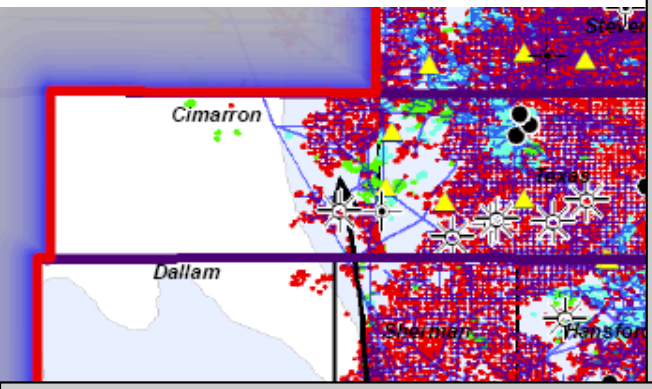


Cleveland tight gas sand (Upper Penn)
Redevelopment using horizontal drilling (coiled tbg)
EURs est 1.5 bcf per well, following completion utilizing multistage open-hole frac jobs
8,000-9,000ft TVD
Beginning signs for geographic extent of economic production—westward and eastern expansion wells not showing the results of "core" area along OK/TX stateline

Chesapeake, Jones Energy, Chaparral Energy, Mewbourne Oil

Woodford drilling in the Anadarko Basin plus Pennsylvanian, Cleveland and traditional targets—new Tonkawa sand play just developing
Devon, Cimarex and Chesapeake are Woodford players
Focus on Canadian, Blaine and Caddo counties
Depths are from 12,000 to 15,000ft Horizontal Drilling
Recent Cimarex discoveries flowed 2.76 MMcfd 61 bbls oil and 2.95 MMcfd 8 bbls oil in initial tests
Requesting increased density order allowing 3-4 wells per section

Texas Panhandle Western Oklahoma



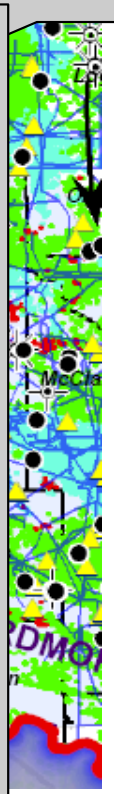
Chesapeake Colony Granite Wash play producing 40 MMcfge daily net to the company (55 MMcfge per day gross) from 12 net (18 gross) horizontal wells

Currently using four rigs to further develop approx 60,000 net acres in the play
May drill 250 additional net horizontal wells.

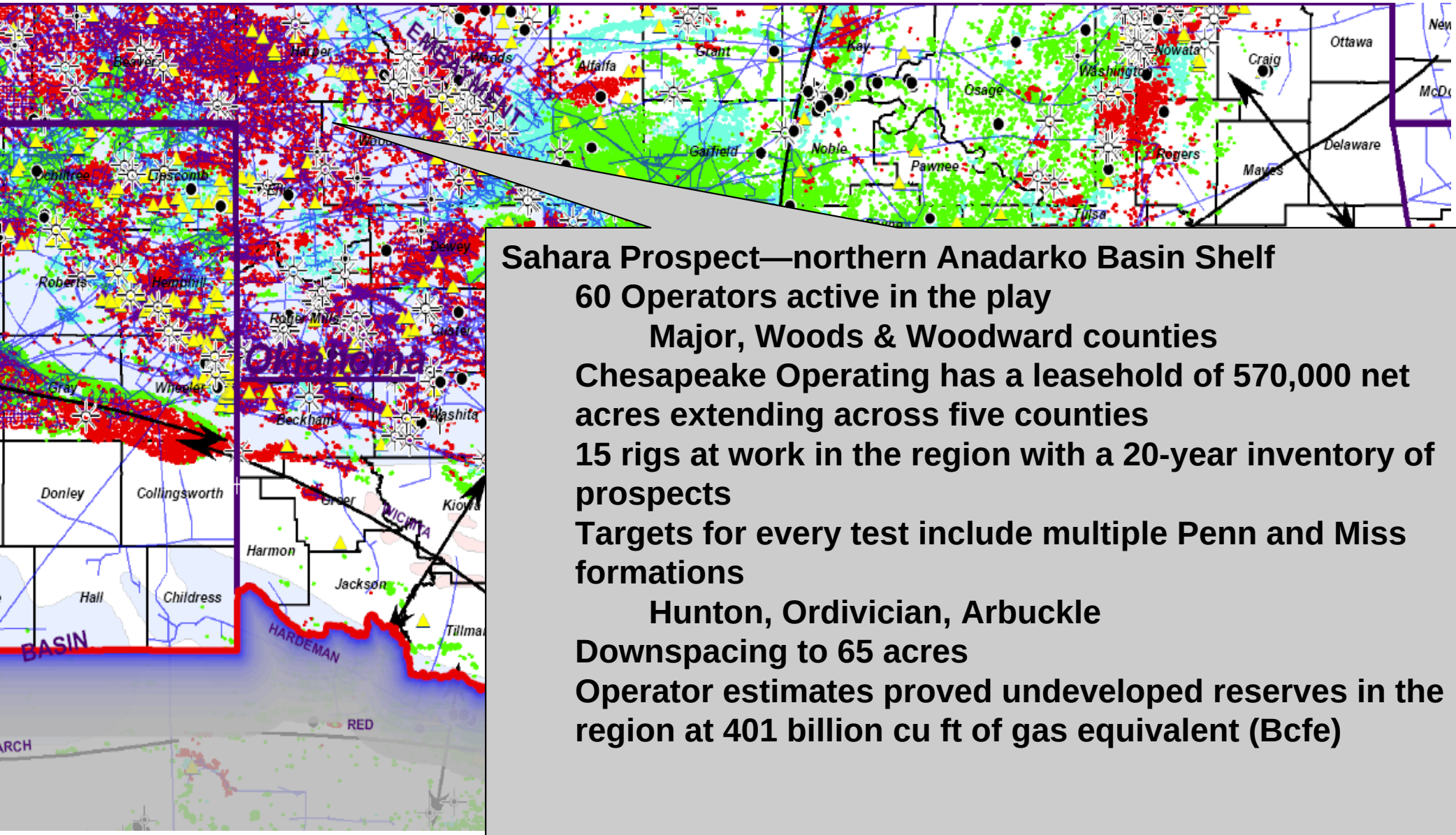
Granite Wash (Penn) play expansion
Depths from 10,000-15,000ft
Began in Buffalo Wallow Field, Hemphill county
Complex sediments highly variable, little continuity-- low-perm sandstones drain limited areas

Wheeler County's Stiles Ranch and Britt Ranch fields are in the "heart" of play
Est. Stiles recoverable reserves est at 2.5-3 Bcfe per well
Recent IPs: 3.5 MMcfd, 34 bbls cond, 1,000 bbls water
Devon West Park field area well 14.9 MMcfd 147 bbls cond, 1,899 bbls water

Newfield in Wheeler County
Nov 07 prod 35.7 MMcf 250 bbls cond
Dec 07 173.9 MMcf 2,795 bbls cond
Avg 5.6 MMcfd 90 bbls cond



Oklahoma



Sahara Prospect—northern Anadarko Basin Shelf

- **60 Operators active in the play**
  - **Major, Woods & Woodward counties**
- **Chesapeake Operating has a leasehold of 570,000 net acres extending across five counties**
- **15 rigs at work in the region with a 20-year inventory of prospects**
- **Targets for every test include multiple Penn and Miss formations**
  - **Hunton, Ordivician, Arbuckle**
- **Downspacing to 65 acres**
- **Operator estimates proved undeveloped reserves in the region at 401 billion cu ft of gas equivalent (Bcfe)**

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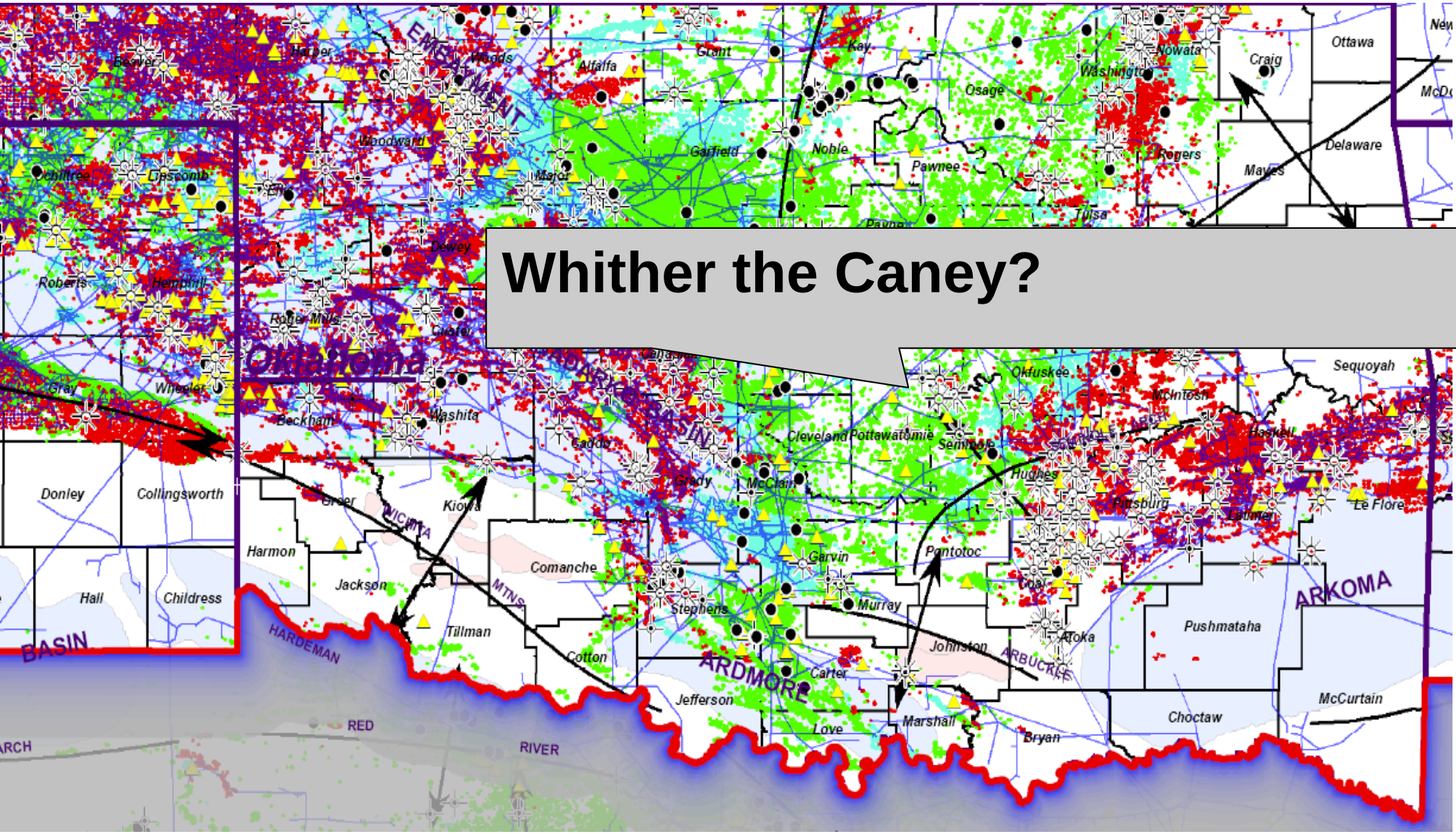
Oklahoma A Tale of Two Shales



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Arkoma

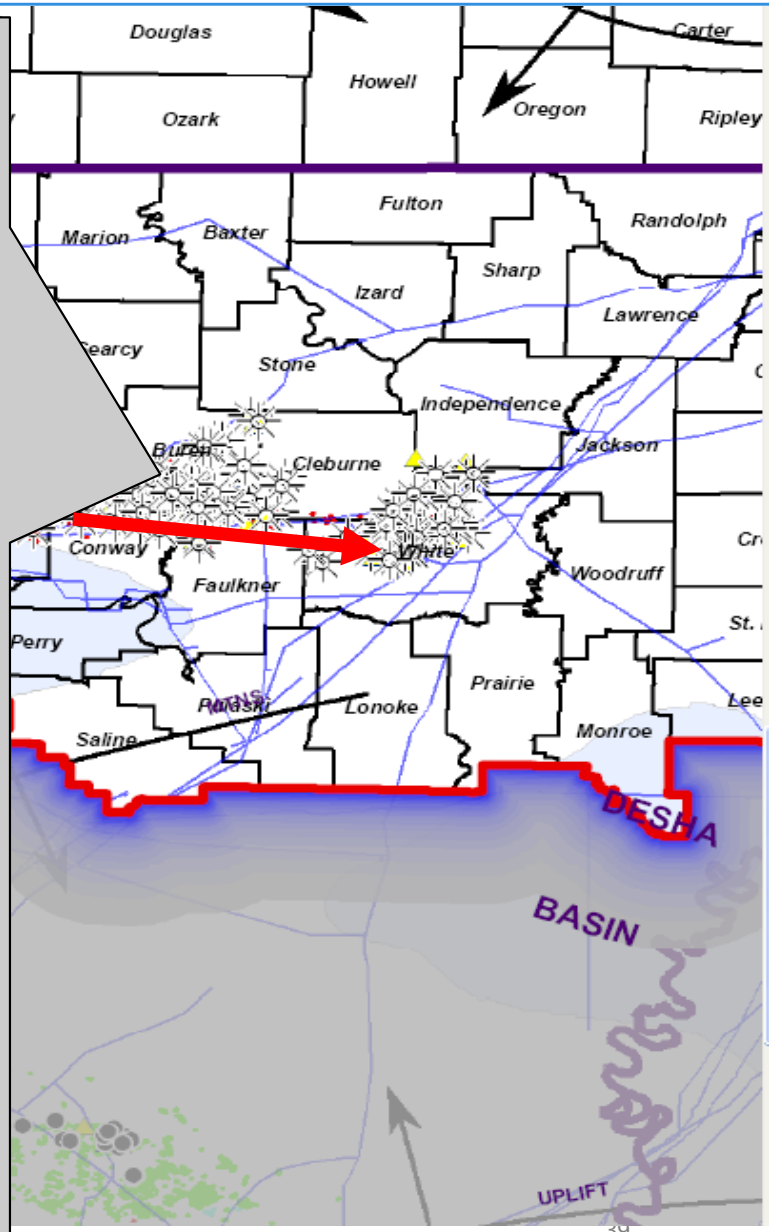
Fayetteville Shale only "brand new" play in the Mid-continent in years—needs gathering system infrastructure

Most active operator is Southwestern Energy (SEECO) 19 rigs running on its 900,000 acres
Horizontal drilling laterals over 3,000ft, multi-well pads, New White County IPs >5 MMcfd

Serendipitous Pennsylvanian discoveries and production Includes Penn Hale 7500ft drilling in deeper, eastern part of Arkoma

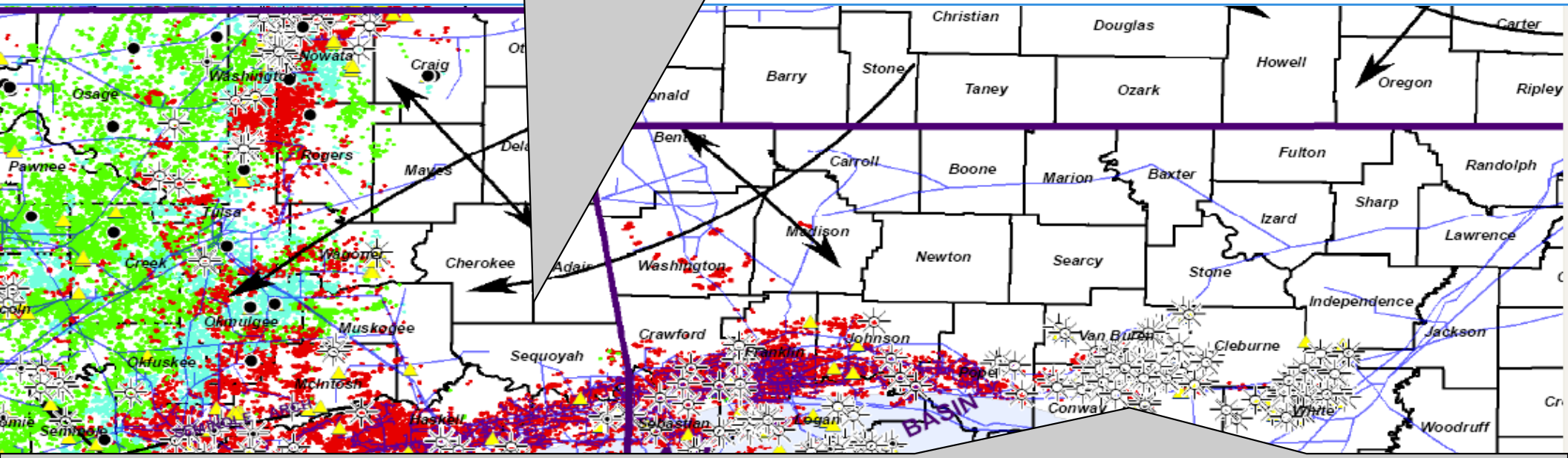
Southwestern reported its gross operated production from Fayetteville shale play area recently exceeded 300 MMcfd, up from 84 MMcfd one year ago
Year-end 2008 production from the region could approximate 450 MMcfd

Chesapeake had 11 rigs drilling on its 420,000 acres at the play's core-- BP pays Chesapeake $1.9 billion for Arkansas JV
Others: XTO, PetroHawk



Arkoma

Hartshorne CBM Play going strong
Of the approximately 1500 horizontal coalbed wells, 115 completed in ’98-’01 with the rest since 2002



The Eastern States Office BLM April 24 oil and gas lease sale:
Eleven Arkansas leases encompassing 2,394.73 acres (7 percent of the leased acres) attracted an average of $5,135.02 per acre

SEECO Inc recently completed four horizontal Fayetteville producers in township 9n-15w with initial flowing potentials ranging from 4.42 million to 5.43 million cu ft of gas per day. Those ventures are three to four miles from lands covered by the new Catawba lease

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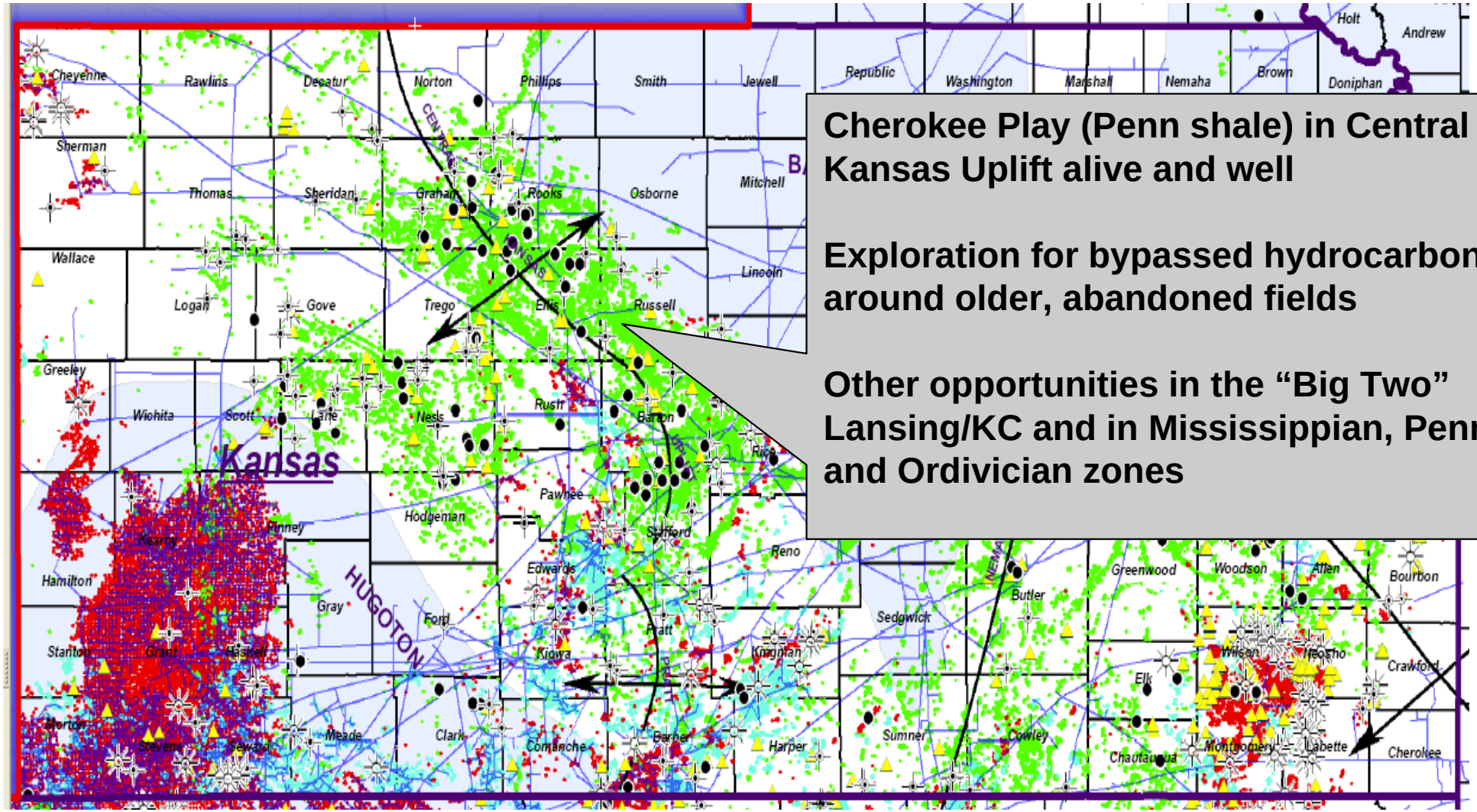
Kansas Current Activity



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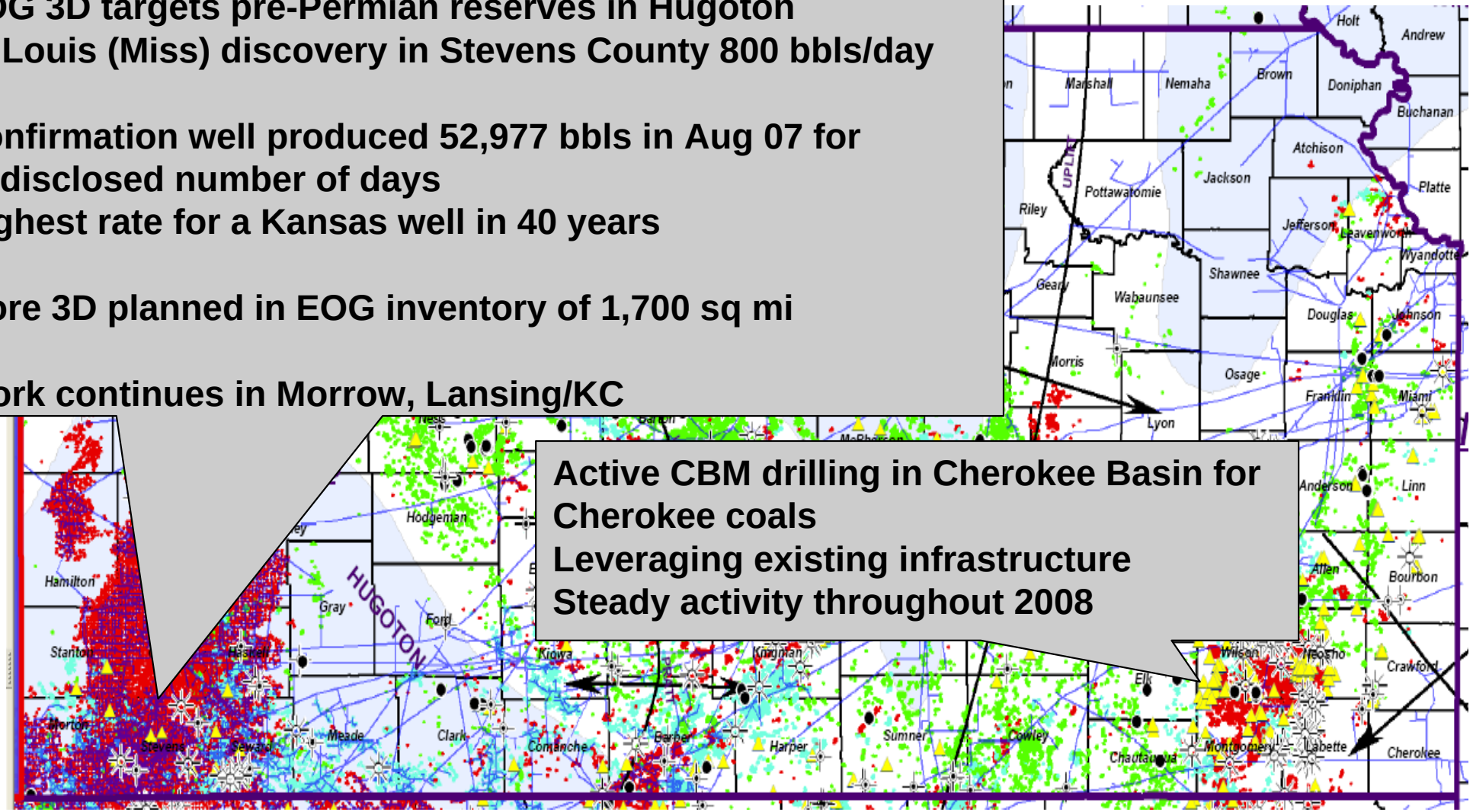
Kansas Current Activity

EOG 3D targets pre-Permian reserves in Hugoton
St Louis (Miss) discovery in Stevens County 800 bbls/day

Confirmation well produced 52,977 bbls in Aug 07 for undisclosed number of days
Highest rate for a Kansas well in 40 years

More 3D planned in EOG inventory of 1,700 sq mi

Work continues in Morrow, Lansing/KC



Active CBM drilling in Cherokee Basin for Cherokee coals
Leveraging existing infrastructure
Steady activity throughout 2008

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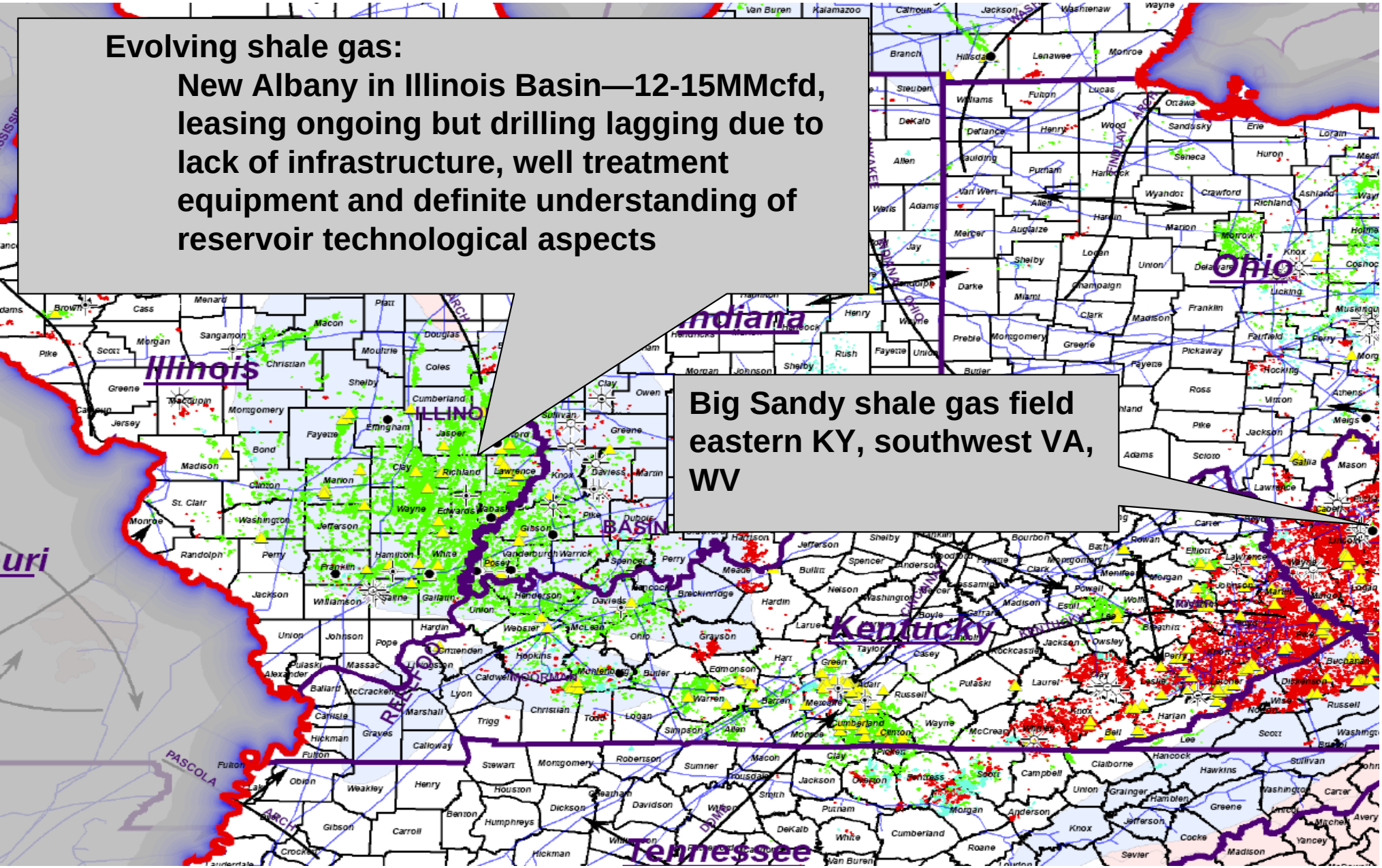
Northeast

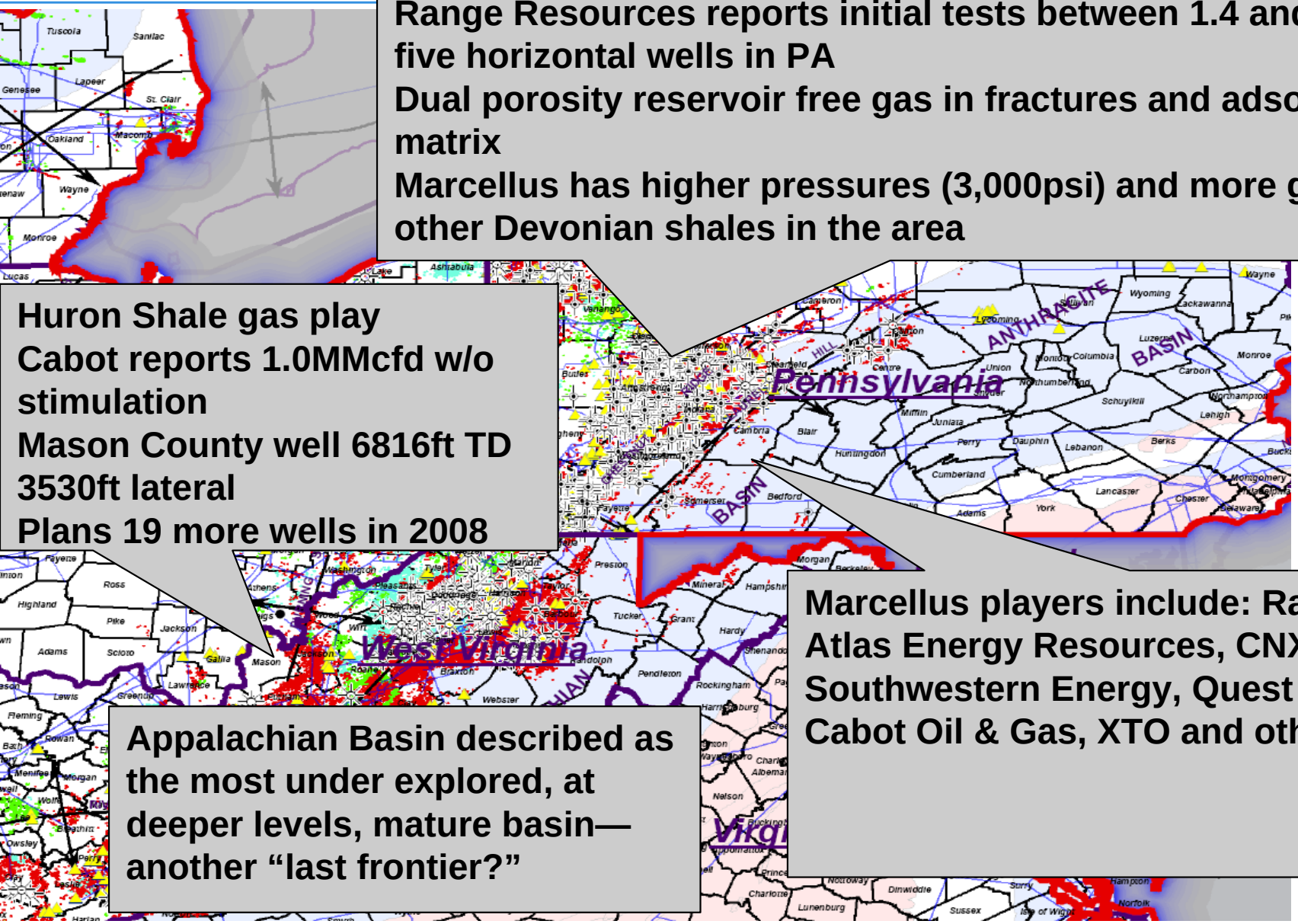
Evolving shale gas:

- **New Albany in Illinois Basin—12-15MMcfd, leasing ongoing but drilling lagging due to lack of infrastructure, well treatment equipment and definite understanding of reservoir technological aspects**



Northeast

Inspired by the Barnett, Marcellus Devonian Shale Play attracts Texas accents to western PA
600 miles or more in extent from WV to NY and continuous
Depths around 8,000ft 120-150ft thick
Probable resource 50 Tcf to 200 Tcf Recovery factor ~10%
Range Resources reports initial tests between 1.4 and 4.7 MMcfd for five horizontal wells in PA
Dual porosity reservoir free gas in fractures and adsorbed gas in matrix
Marcellus has higher pressures (3,000psi) and more gas-in-place than other Devonian shales in the area



Huron Shale gas play
Cabot reports 1.0MMcfd w/o stimulation
Mason County well 6816ft TD 3530ft lateral
Plans 19 more wells in 2008

Marcellus players include: Range Resources, Atlas Energy Resources, CNX Gas, Southwestern Energy, Quest Resources, Cabot Oil & Gas, XTO and others

Appalachian Basin described as the most under explored, at deeper levels, mature basin—another “last frontier?”

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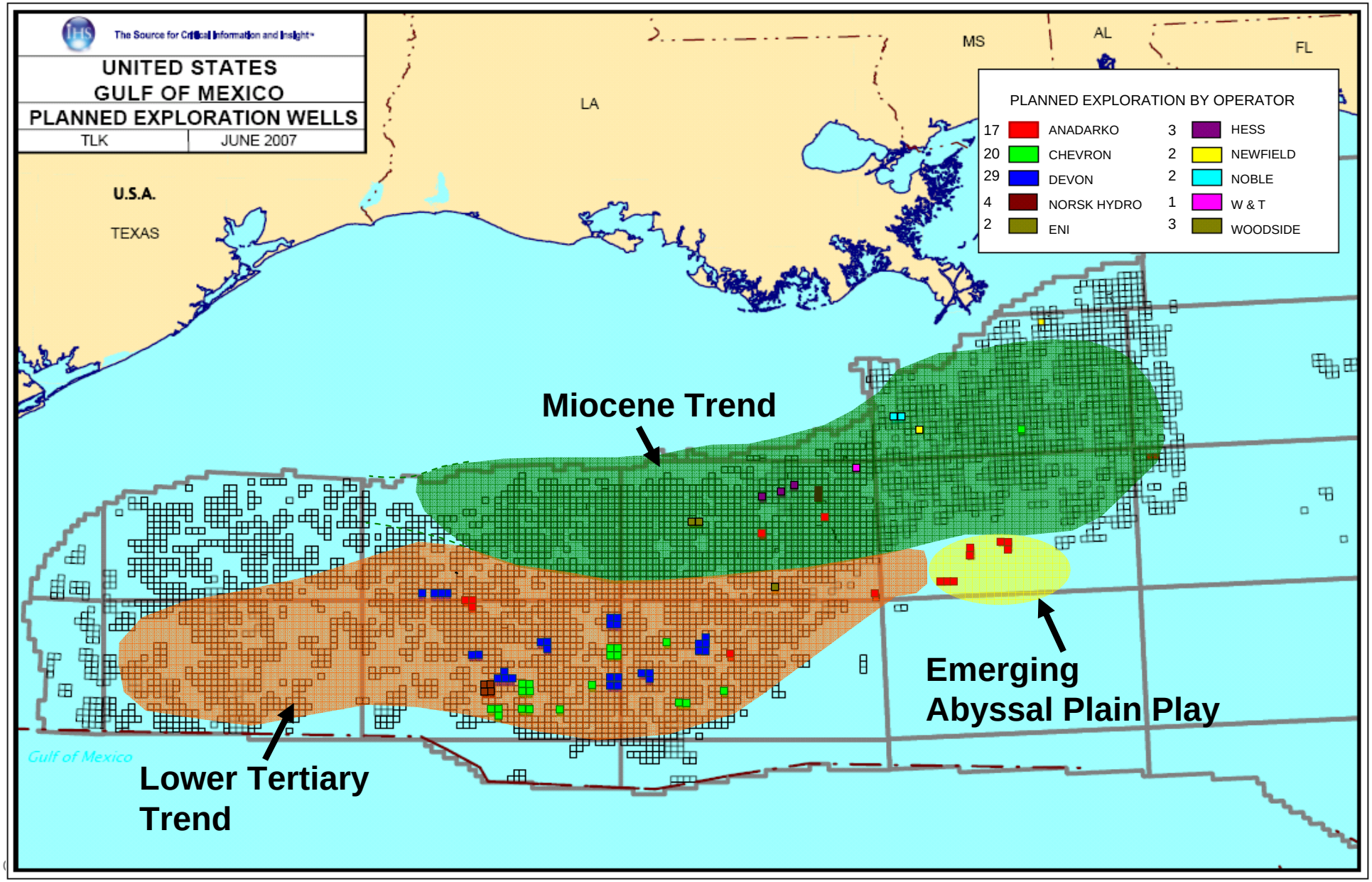
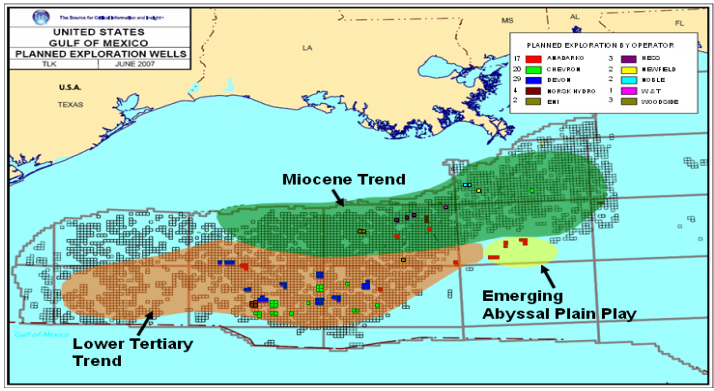
Gulf of Mexico – Deepwater Trends



The Deepwater Future

Existing Trends

- Flexure trend;
- Mini-basins;
- Sub-salt;
- Fold belts (Perdido fold belt, Subsalt fold belt, Mississippi fan fold belt);
- Paleogene (Lower Tertiary)



- There are still large areas of GOM yet to be explored and more light to be shed on emerging plays by these opportunities
  - Offshore Florida, Yucatan platform, Sierra de Chiapas, & Mexican and Cuban sectors of the deepwater.
- And in the more explored areas, new plays may emerge in a variety of areas and age intervals. These potentially include:
  - The Triassic-Mid-Jurassic syn-rift section;
  - The Oxfordian (Upper Jurassic) age on the US and Mexican sides;
  - Upper Cretaceous;
  - Mid-Upper Eocene and Oligocene submarine fans in the western deepwater;
  - K/T boundary mass-transport breccias throughout the Gulf;
  - Unconventional resource plays such as gas hydrates and shale gas trends.

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What information is needed by the industry to continue the growth and development of unconventional resources?

- Tight Gas Sands
  - Pad drilling
  - Perf breakdowns, fracs and treatments, all stages, fluids, proppant , pressures, including fracture success/extent
  - Production tests before and after treatment stages
  - Permeability and porosity
  - Core description/analysis
- Coalbed Methane
  - Coal type
  - Water gauges/water disposal
  - Barefoot completions
  - Cavitation
  - Palm/pinnate lateral leg IDs
  - Coal Thickness, Grade and Gas Content
- Shale Gas (and oil from Shale)
  - Total Organic Content (TOC) and content percentage
  - Thermal maturity/vitrinite reflectance
  - Rock properties—e.g. brittleness, permeability/porosity, water saturation
  - Kerogen type
  - Gas sample analyses, (all from core analysis, any available geochem?)
  - Fracture matrices including orientation and density (microseismic mapping)

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Closing Comments

- Unconventional resources will have an increasing share of U.S. gas supplies
- Well productivity and reserves per well tend to decrease as plays expand and well density increases
- If productivity trends continue, substantial increase in drilling will be required to sustain U.S. gas production volumes.
- Volatile prices and basis differential will continue to challenge profitability unconventional gas plays
- **Manage the entire supply chain –**
  - **Counter Soaring costs by leveraging existing infrastructure**
  - **Shortages of equipment, services and personnel**
  - **Understand the technology imperative—improve recoveries & efficiencies spanning the supply chain**

- **Innovation** and new technologies critical to sustain growth

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U. S. Top Plays and Trends…… Leaving no stone unturned

Interstate Oil & Gas Compact Commission
Energy Resources, Research & Technology Committee
Santa Fe, November 18, 2008

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