Technology and Gas: Evolution of E&P in the Green River Basin

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Faster, Smarter, Cheaper… Evolution & Revolution

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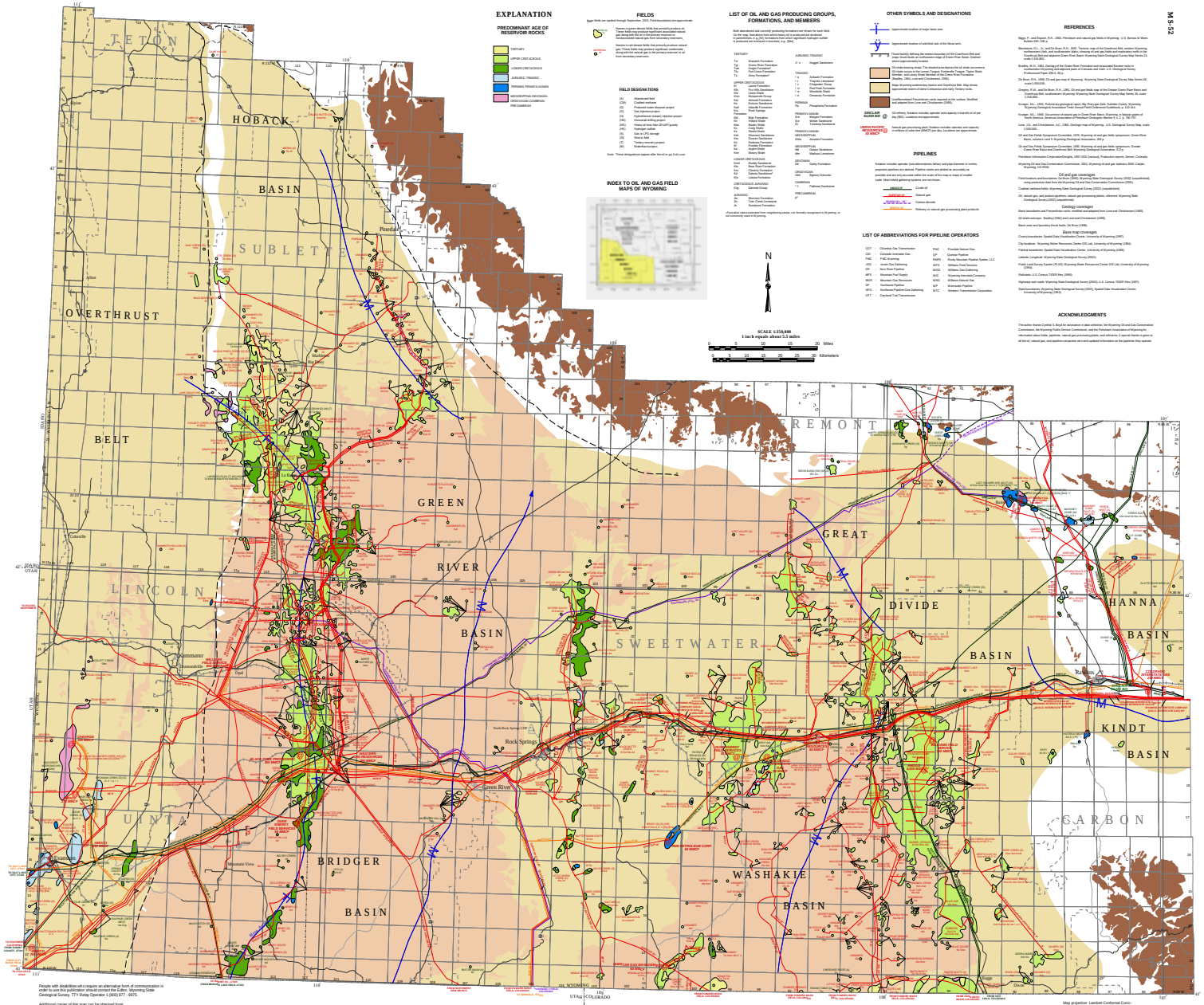
WYOMING STATE GEOLOGICAL SURVEY
Lance Cook, State Geologist
Laramie, Wyoming

MAP SERIES 52
Greater Green River Basin and Overthrust Belt oil and gas map

MS-52



EXPLANATION

PREDOMINANT AGE OF RESERVOIR ROCKS

- TERTIARY
- UPPER CRETACEOUS
- LOWER CRETACEOUS
- JURASSIC-TRIASSIC
- PERMIAN-PENNSYLVANIAN
- MESOZOIC/PALEOZOIC (MISSISSIPPIAN-CAMBRIAN)
- PRECAMBRIAN

FIELDS

Gas fields are spotted through September, 2001. Field boundaries are approximate.

Names in green denote fields that primarily produce oil. Some fields may produce small amounts of hydrocarbon gas along with the oil in the primary reservoir or in other reservoirs. Oil production is not included in this map.

Names in red denote fields that primarily produce natural gas. These fields may produce significant condensate along with the natural gas in the primary reservoir or oil from secondary reservoirs.

FIELD DESIGNATIONS

(A) Abandoned field
(CM) Coalbed methane
(D) Produced water disposal project
(G) Gas storage project
(H) Hydrokinetical (water) injection project
(HD) Horizontal drilling project
(HO) Heavy oil less than 20 API gravity
(HY) Hydrogen sulfide
(O) Oil or NGL storage
(S) Sour or Acid
(T) Tertiary recovery project
(W) Waterflood project

Note: These designations appear after the oil or gas field name.

INDEX TO OIL AND GAS FIELD MAPS OF WYOMING

LIST OF OIL AND GAS PRODUCING GROUPS, FORMATIONS, AND MEMBERS

Both abandoned and currently producing formations are shown for each field. Only the oldest and youngest formations are shown for fields with multiple reservoirs. In some areas, e.g. in [X] formations from which significant hydrogen sulfide is produced are restricted in baseline, e.g. [Mm].

TERTIARY
- Tw Wasatch Formation
- Tgr Green River Formation
- Tb Bridger Formation
- Tfu Fort Union Formation
- Tu Uinta Formation*

UPPER CRETACEOUS
- Kl Lance Formation
- Kfm Fox Hills Sandstone
- Klm Lewis Shale
- Kmv Mesaverde Group
- Kmc Mesaverde Coal
- Ke Ericson Sandstone
- Kwd Adaville Formation
- Kf Frontier Formation
- Mowry Formation
- Kbt Blue Tompson
- Kcd Cody Shale
- Kfrc Frontier Coal
- Kmy Muddy Sandstone
- Kt Thermopolis Shale
- Ka Cloverly Formation
- Kc Cedar Mountain
- Kmr Morrison Formation

LOWER CRETACEOUS
- Kmd Mowry Sandstone
- Kbr Bear River Sandstone
- Kcr Cloverly Formation
- Kfd Cedar Sandstone*
- Kmr Morrison Formation

CRETACEOUS-JURASSIC
- KJg Gannett Group

JURASSIC
- Jm Morrison Formation
- Jsr Sundance Formation
- Js Sundance Formation

JURASSIC-TRIASSIC
- JTr Nugget Sandstone

TRIASSIC
- T r Ankareh Formation
- T r Thaynes Limestone
- T r Chapel Creek Shale
- T r Dinwoody Formation
- T r Woodside Shale
- T r Dinwoody Formation

PERMIAN
- P Phosphoria Formation

PENNSYLVANIAN
- Pwr Weber Formation
- Ew Weber Sandstone
- Ec Tensleep Sandstone

PENNSYLVANIAN-MISSISSIPPIAN
- MM Amsden Formation

MISSISSIPPIAN
- Mm Madison Sandstone
- Mm Madison Limestone

DEVONIAN
- Dd Darby Formation

ORDOVICIAN
- Obh Bighorn Dolomite

CAMBRIAN
- T-Є Flathead Sandstone

PRECAMBRIAN
- p€

*Formation name extended from neighboring states, not formally recognized in Wyoming, or not commonly used in WI proving.

OTHER SYMBOLS AND DESIGNATIONS

- Approximate location of major basin axis.
- Approximate location of anticlinal axis of the Moxa arch.
- Thrust fault(s) defining the western boundary (of the Overthrust Belt and Hogsback Basin) and southeastern margin of Green River Basin. Dashed where inferred.
- Oil shale bearing strata. The shaded area depicts the oil shale occurrence in southwestern WI proving and adjacent parts of Colorado and Utah. U.S. Geological Survey Professional Paper 806-A, 90 p.
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UNION PACIFIC RESOURCES CO. 50 WELLS

PIPELINES

Notation includes operator (see abbreviations below) and pipe diameter in inches; proposed pipelines are dashed. Pipeline routes are plotted as accurately as possible and are only accurate within the scale of this map or maps of smaller scale. Most oilfield gathering systems are not shown.

- CRUDE OIL — Crude oil
- NATURAL GAS — Natural gas
- CARBON DIOXIDE — Carbon dioxide
- REFINERY GAS — Refinery or natural gas processing plant products

LIST OF ABBREVIATIONS FOR PIPELINE OPERATORS

CDT	Columbia Gas Transmission	PNG	Prestolite National Gas
CIG	Colorado Interstate Gas	QP	Questar Pipeline
FMC	FMC Wyoming	RMPS	Rocky Mountain Pipeline System, LLC.
JGG	Jonah Gas Gathering	WFS	Williams Field Services
KR	Kern River Pipeline	WGG	Williams Gas Gathering
MFS	Mountain Fuel Supply	WIC	Wyoming Interstate Company
MGR	Mountain Gas Resources	WNG	Williams Natural Gas
NP	Northwest Pipeline	WP	Wamsutter Pipeline
NPG	Southwest Pipeline Gas Gathering	WTC	Western Transmission Corporation
CTT	Overland Trail Transmission		

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Oil and gas coverages

Field boundaries and descriptions: Wyoming State Geological Survey (2002) [unpublished], using production data from the Wyoming Oil and Gas Conservation Commission (2001).

Coalbed methane fields: Wyoming State Geological Survey (2002) [unpublished].

Oil, natural gas, and product pipelines, natural gas processing plants, refineries: Wyoming State Geological Survey (2002) [unpublished].

Geology coverages

Basin boundaries and Precambrian rocks, modified and adapted from Love and Christiansen (1985).

Oil shale outcrops: Bradley (1961) and Love and Christiansen (1985).

Basin axes and laccolithic thrust faults: De Bruin (1998).

Base map coverages

County boundaries: Spatial Data Visualization Center, University of Wyoming (1997).

City locations: Wyoming Water Resources Center GIS Lab, University of Wyoming (1994).

Federal boundaries: Spatial Data Visualization Center, University of Wyoming (1999).

Latitude, Longitude: Wyoming State Geological Survey (2002).

Public Land Survey System (PLSS): Wyoming Water Resources Center GIS Lab, University of Wyoming (1994).

Railroads: U.S. Census TIGER files (1999).

Highways and roads: Wyoming State Geological Survey (2002); U.S. Census TIGER files (1997).

State boundaries: Wyoming State Geological Survey (2002); Spatial Data Visualization Center, University of Wyoming (1997).

ACKNOWLEDGMENTS

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People with disabilities who require an alternative form of communication in order to use this publication should contact the Editor, Wyoming State Geological Survey, TTY Relay Operator 1 (800) 877 - 9975.

Additional copies of this map can be obtained from:
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A digital version of this map is also available on CD - ROM.

OIL AND GAS FIELDS MAP OF THE GREATER GREEN RIVER BASIN AND OVERTHRUST BELT, SOUTHWESTERN WYOMING

by
Rodney H. De Bruin
2002

Map projection: Lambert Conformal Conic.
Horizontal datum: North American Datum of 1983.
Ellipsoid: Geodetic Reference System 80.
Digital cartography by Fred H. Porter, Phyllis A. Ranz, and Joseph M. Huss.

Data version: 09/18/2002

HOW MUCH GAS?

Resource (in place)

-5064 TCF in 1989

-3637 TCF in 2002

Recoverable

-364 TCF recoverable

Reserves

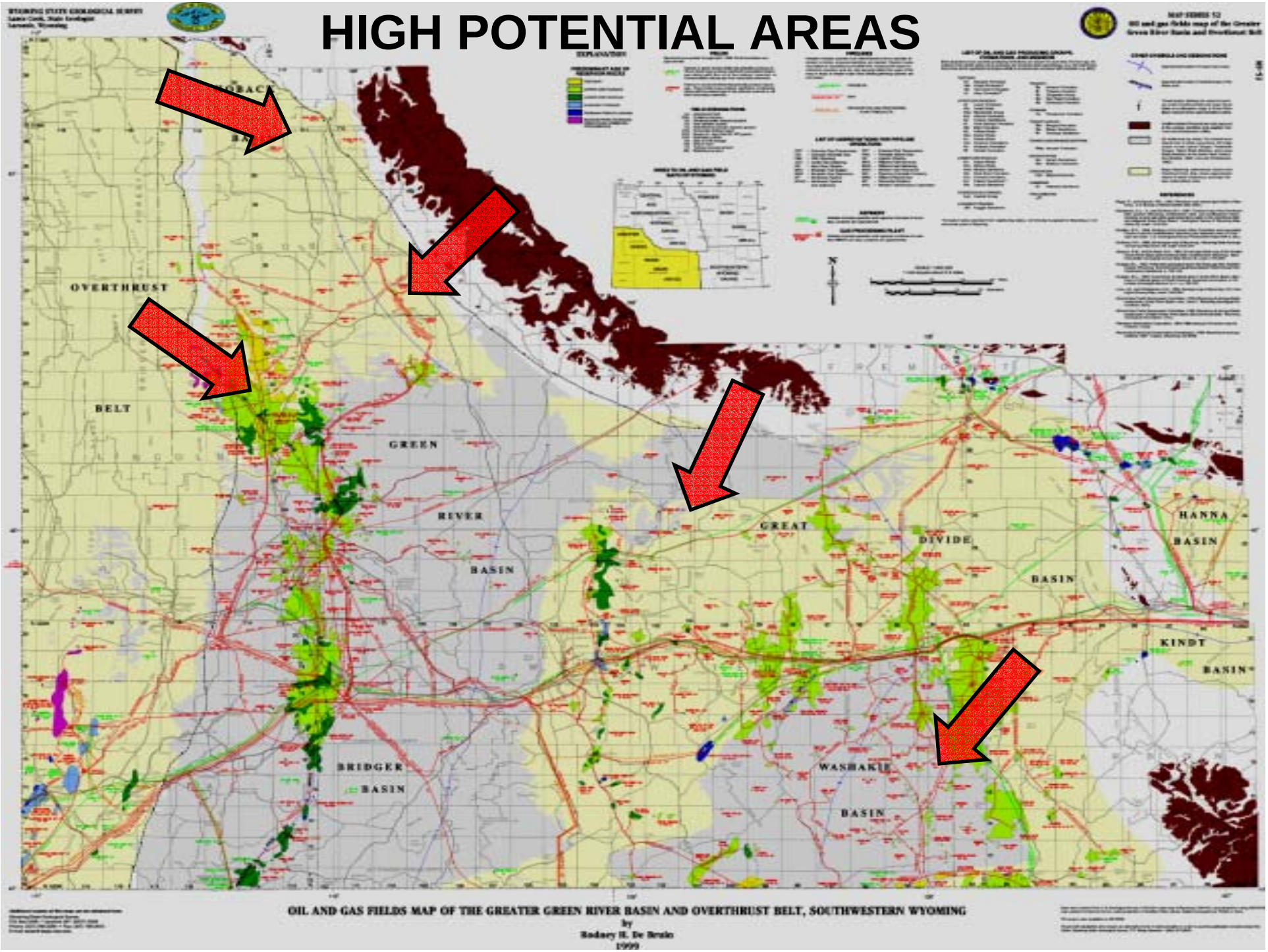
-10 TCF

Resource Classification System

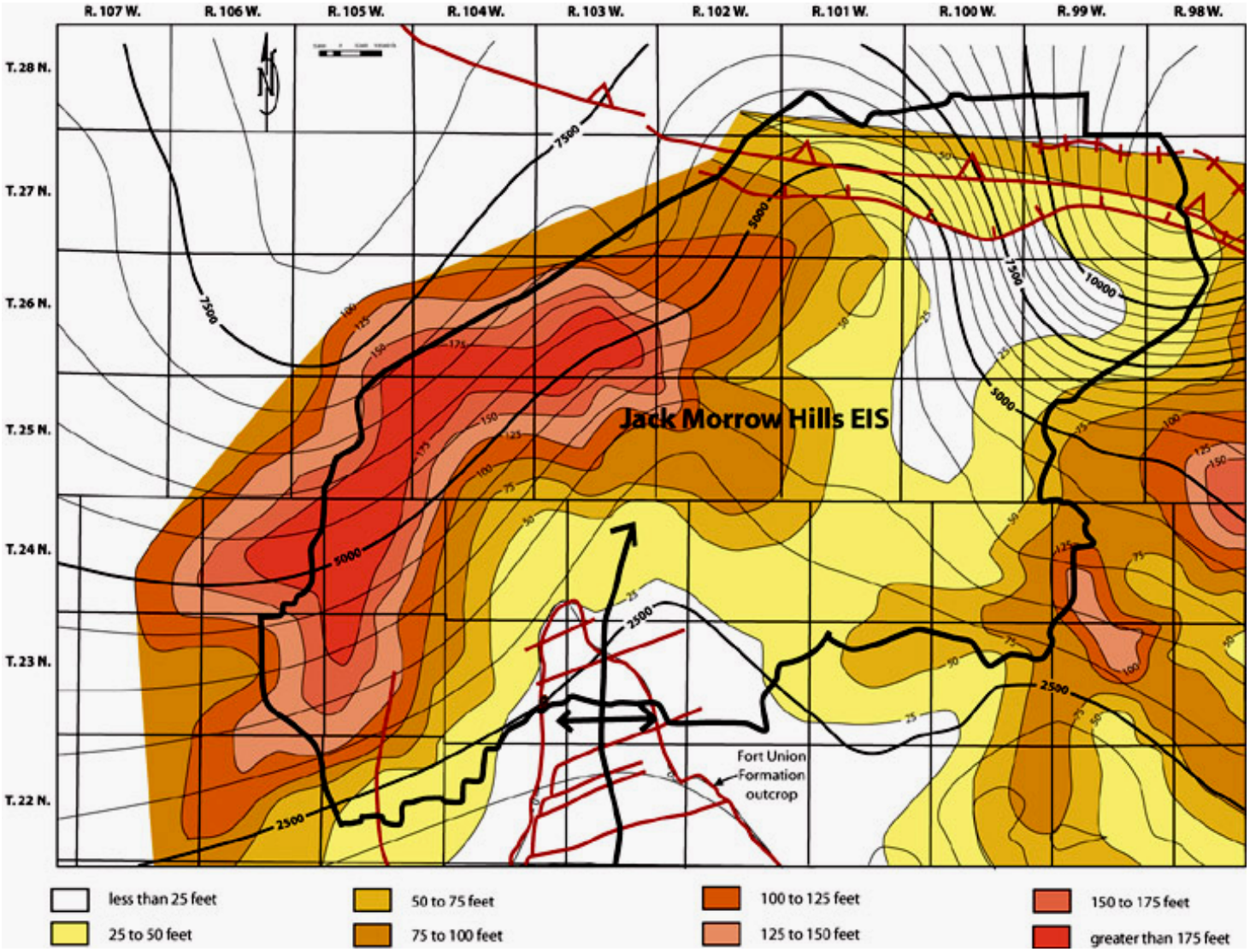
Total **Resource** In Place	Discovered Resources	Commercial	Production			Status	High risk----------Maturity----------Low Risk
			Reserves			Producing	
			Proved	Proved & Probable	Proved/ Probable/ Possible	Developing	
						Planned	
		Sub-commercial	Contingent Resources			Dev. Pending	
			Low Est.	Best Est.	High Est.	Dev. On Hold	
						Dev. Unviable	
			Unrecoverable				
	Undiscovered Resources		Prospective Resources			Prospect	
			Low Estimate	Best Estimate	High Estimate	Lead	
						Play	
			Unrecoverable				
			← Range of Uncertainty →				

Source: AAPG, SPE

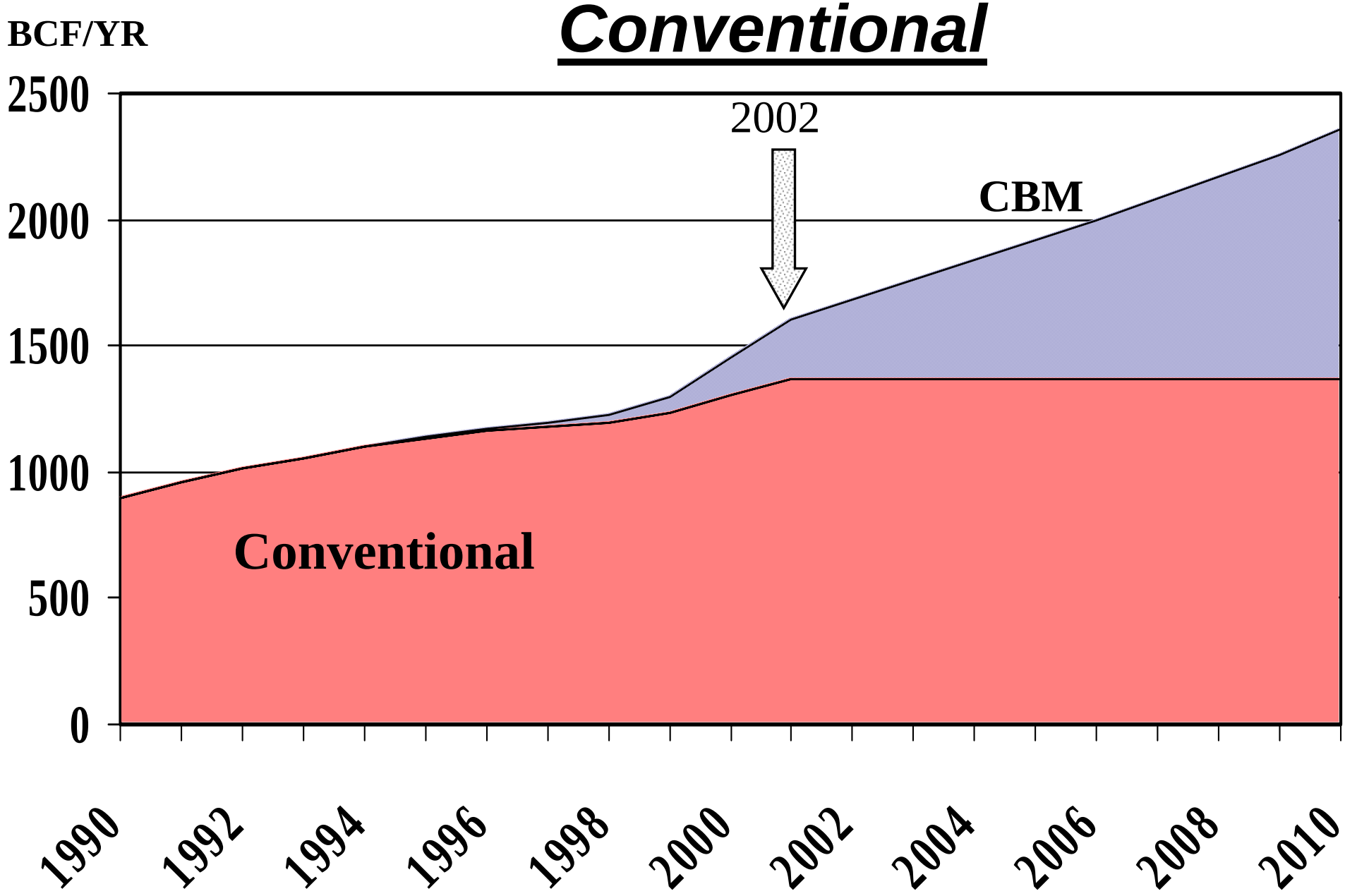
HIGH POTENTIAL AREAS



Jack Morrow Hills CBM
Red Desert Basin



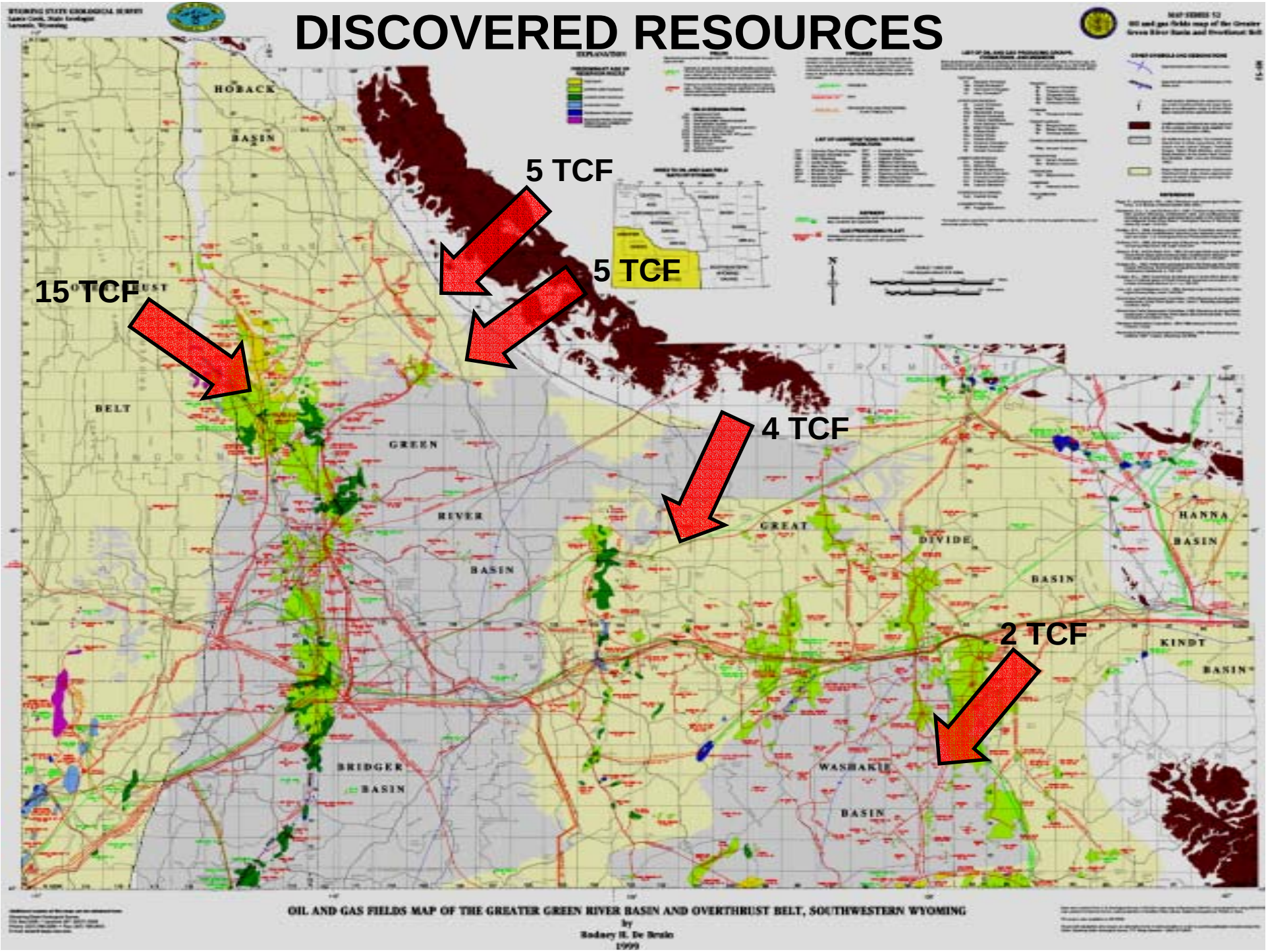
Gas Forecast: CBM Vs. Conventional



High Potential/High Conflict

- **Northern Hoback Basin**
- **Trona Resource Area**
- **Red Desert Basin/Jack Morrow Hills**
- **Southern Washakie Basin**

DISCOVERED RESOURCES



Faster

- Computerized log analysis
- Rotary drilling
- PDC bits
- Air drilling
- Computerized mapping and data management

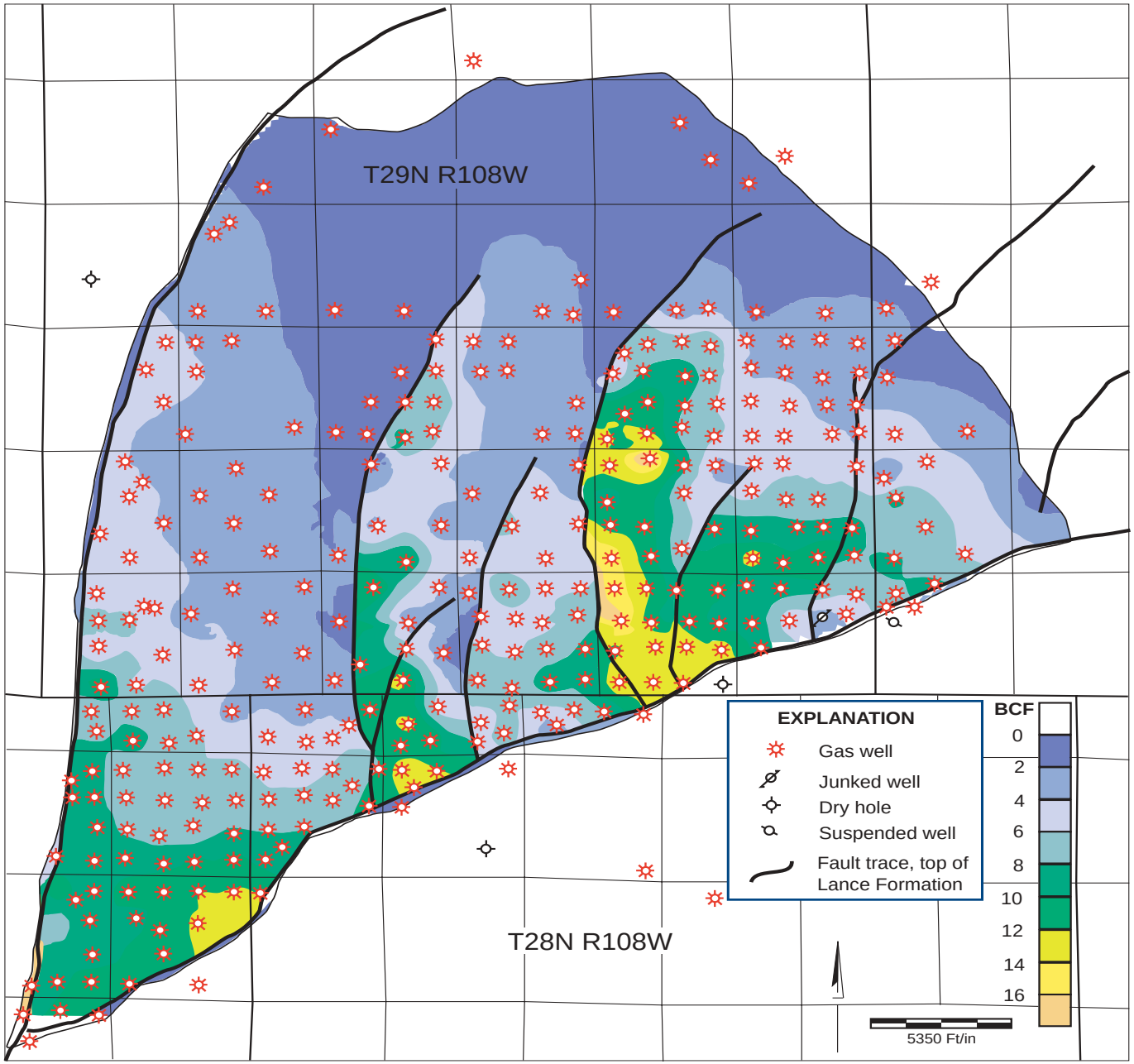
Smarter

- Multi-disciplinary teams
- Better Reservoir description
  - Better Reservoir modeling
    - Better Reservoir management
- Air drilling in tight formations
- 3-D seismic
- Horizontal Drilling in fractured reservoirs
- Better porosity logging tools
- Over/Under-balanced perforations
- “Green” completions

Cheaper

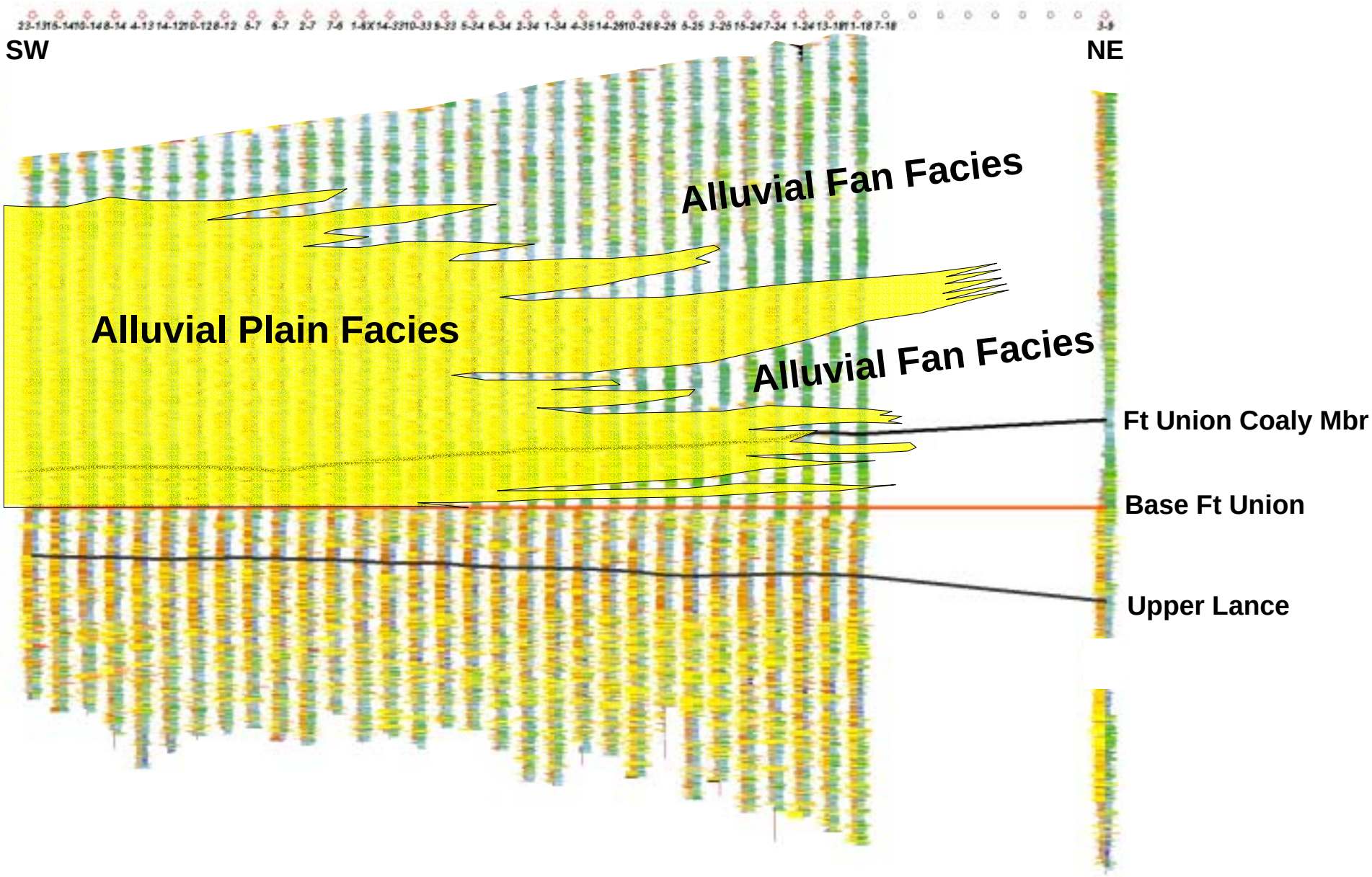
- Assembly line drilling
- Multi-stage fracs
- Under-balanced drilling
- Seismic costs have plummeted!

Jonah Field



Courtesy AEC

Jonah Reservoir Description

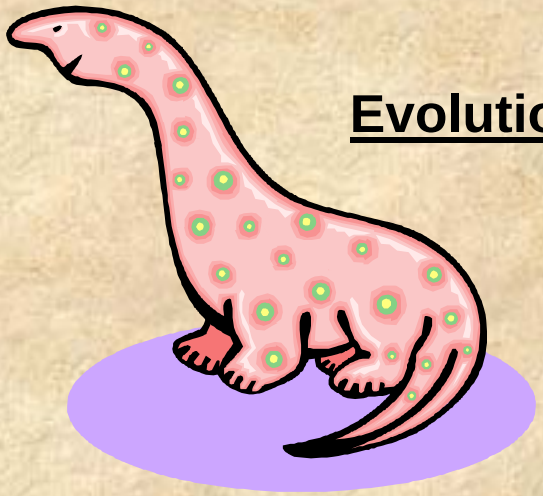


Stratigraphic Cross Section

Courtesy:EnCana

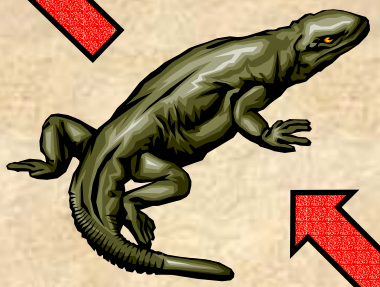
Future Technology

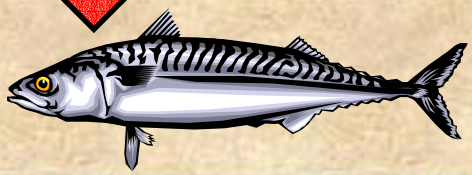
- Smart Casing
- Permeability measurements via wireline
- Improved market leverage / less volatility
- Direct detection of overpressured gas
- Pinnate drilling for deep CBM



Evolution is not a force but a process; not a cause but a law.
Viscount Morley John (1838-1923)

Necessity makes heroes of us all.
Mason Cooley (1927-)





If I have seen further than others, it is by standing upon the shoulders of giants.
Isaac Newton (1642-1727)