THE FUTURE – NEW YORK'S REMAINING NATURAL GAS AND OIL RESOURCE POTENTIAL

New York is part of the Appalachian Basin, the largest, oldest, and most extensively drilled oil and natural gas producing basin in the United States. More than 75,000 wells have been drilled in New York alone and more than 8,700 oil and gas wells were reported active in 2005. These facts might suggest that New York's potential for future production is dim, if it were not also for the fact that after more than a century of oil and gas development, New York produced a record volume of natural gas in 2005. The hydrocarbon resource potential of both New York and the Appalachian Basin is far from depleted.

New York's Natural Gas and Oil Resource Potential

As of year-end 2005, New York's proved natural gas reserves were 349 Bcf, up from 324 Bcf of proved reserves at year-end 2004.[16] Proved reserves are replenished through exploration for and development of the State's estimated remaining resource base. Recent estimates of New York's remaining technically recoverable natural gas resources range from 6.2 to 7.1 trillion cubic feet (Tcf).[17, 18]

Undiscovered Natural Gas Resources A recent assessment of Trenton-Black River resources by an industry-government-academic consortium estimates a mean of 4.4 Tcf of undiscovered gas resources in the hydrothermal dolomite reservoirs of the Appalachian Basin. New York's share of this resource base is estimated to be 1.5 Tcf.[19] A previous assessment by the United States Geological Survey (USGS) of undiscovered conventional natural gas resources in the Appalachian Basin provides a mean estimate of 0.77 Tcf for New York, of which approximately 80 percent is contained in the Trenton-Black River hydrothermal dolomite play.

The Challenges of Estimating New York's Remaining Natural Gas Resources

Accurate and timely assessments of potential oil and gas resources are essential to ensure that public policy is based on sound information. The United States Geological Survey (USGS) conducts periodic national assessments of the potential undiscovered oil and gas resources of the United States. These oil and gas resources have not been discovered; rather, they represent a pool of ***potential*** *oil and gas resources which operators must find through exploration. The USGS assessments draw upon input from local industry experts, the latest oil and gas production information, and the most up-to-date geological and geophysical data available. The USGS National Assessment presents potential recoverable oil and gas resources as a range of estimated values, ranging from resources with a low probability of occurrence to a high probability of occurrence, as well as an estimated mean value.*

Oil and natural gas resource estimates evolve over time in response to production that has already occurred, advances in geologic knowledge, new exploration and recovery technology, and the economic conditions and public policies under which exploration and production are expected to occur. Resource assessments typically assume that oil and natural gas is "technically recoverable" using current technology or incremental foreseeable improvements on that technology. Throughout the history of oil and natural gas production in New York, technological leaps have helped industry to pursue resources previously thought to be unproductive, creating large and unexpected additions to estimated resources.

Unconventional Natural Gas Resources. The USGS estimates that unconventional reservoirs such as low permeability "tight" gas sandstones and fractured shale and siltstone reservoirs are the greatest source of undiscovered natural gas resources remaining in New York, potentially containing more than 5.4 Tcf of technically recoverable natural gas. Many of New York's unconventional gas reservoirs produce at low rates, but have long-producing lives. With modern drilling and production technologies and improving market conditions, New York's unconventional gas resources are increasingly attractive targets for exploration and for further development within established fields.

Remaining Oil Resources. New York State is currently estimated to have producible crude oil reserves of 1.2 million barrels. Some geoscientists believe that New York's oil potential remains "under-explored." An extensive 1980's geological study of the State's resource-base estimated original oil-in-place to be 1,118 million barrels. Cumulative oil production through 2005 has totaled approximately 245 million barrels, which would represent an estimated oil recovery rate of approximately 22 percent of original oil-in-place. Primary production can usually recover a maximum of 30 percent of oil-in-place with another 10 percent to 15 percent possible from enhanced oil recovery methods. Assuming a 40 percent to 45 percent maximum recovery factor, New York's total recoverable oil resources are estimated to range from 447 to 503 million barrels. If approximately 245 million barrels have already been produced in the State, the remaining recoverable crude oil potential ranges from approximately 200 million barrels to 250 million barrels.

Improved market conditions since 2004 have renewed interest in New York's remaining oil potential. Drilling permits and new oil well completions have increased significantly. Modern geologic concepts are currently being applied to study the oil-producing sandstone reservoirs of New York's Upper Devonian age Canadaway Group in an effort to identify potential untapped reservoir sandstones.

Also attracting exploration interest are hydrothermal dolomite reservoirs in the shallow Trenton-Black River formation in western New York, representing a possible extension of Trenton-Black River trends that produce oil in southwestern Ontario and Southern Michigan.

Several Natural Gas Plays are Attracting New Interest in New York

The natural gas reservoirs generating renewed interest in New York are in challenging geologic formations – including tight gas sands, gas shales and deep reservoirs. In 2005, six new Trenton-Black River fields were discovered, four in Steuben County, and two in Chemung County in south-central New York. Recent discoveries in the Oneida-Oswego and Theresa sandstone plays, as well as various gas shale discoveries, also contributed to the resurgence of gas production in New York. Several specific plays of interest are profiled in the following pages.

Definitions

Proved Reserves - *Proved reserves are demonstrated with reasonable certainty, based on geologic and engineering evidence, to be economically recoverable from known, accessible reservoirs.*

Probable or Inferred Reserves – *(also called "Reserves Growth") are assumed to be recoverable with additional development in discovered fields. Additional development includes drilling infill wells on tighter well spacing, testing new reservoir zones in established fields, and extending the field boundaries of discovered fields through drilling of extension wells.*

Undiscovered Conventional Resources – *are postulated to exist outside of known oil and/ or gas fields based on geologic information and theory. Conventional resources are contained in discrete accumulations by conventional hydrocarbon trapping mechanisms. Reservoir fluids (natural gas, oil and water) are generally segregated in the reservoir with water downdip from oil and gas. Although, oil and gas can be extracted using traditional exploration and development practices, conventional resources can still present significant technical challenges. The Trenton-Black River Formation and Oriskany Sandstone are important conventional resources in New York.*

Unconventional Resources - *Unconventional gas resources may occur as hydrocarbon accumulations over a broad geographic area, in which the accumulation does not appear to be controlled by conventional trapping mechanisms. Segregation of reservoir fluids may not be evident or may be atypical, such as gas occurring downdip from water. Unconventional resources may occur in reservoirs with low porosity and permeability and low flow rates, often requiring the presence of natural and induced fractures for economic production. Undiscovered unconventional oil and gas resources are found in reservoirs whose geologic characteristics generally require special technology or a unique approach for economic development. Successful development practices for unconventional resources have included horizontal drilling, hydraulic fracturing, multiple-zone completions, and reservoir desorption. Much of New York's current natural gas production and remaining undiscovered resource potential consists of unconventional resources such as low permeability or "tight" sandstone reservoirs and shale gas. Tight sandstones of the Medina Group comprise a major developed unconventional natural gas resource in New York. The State's extensive shale formations are estimated to contain a significant volume of undiscovered unconventional gas resources.*

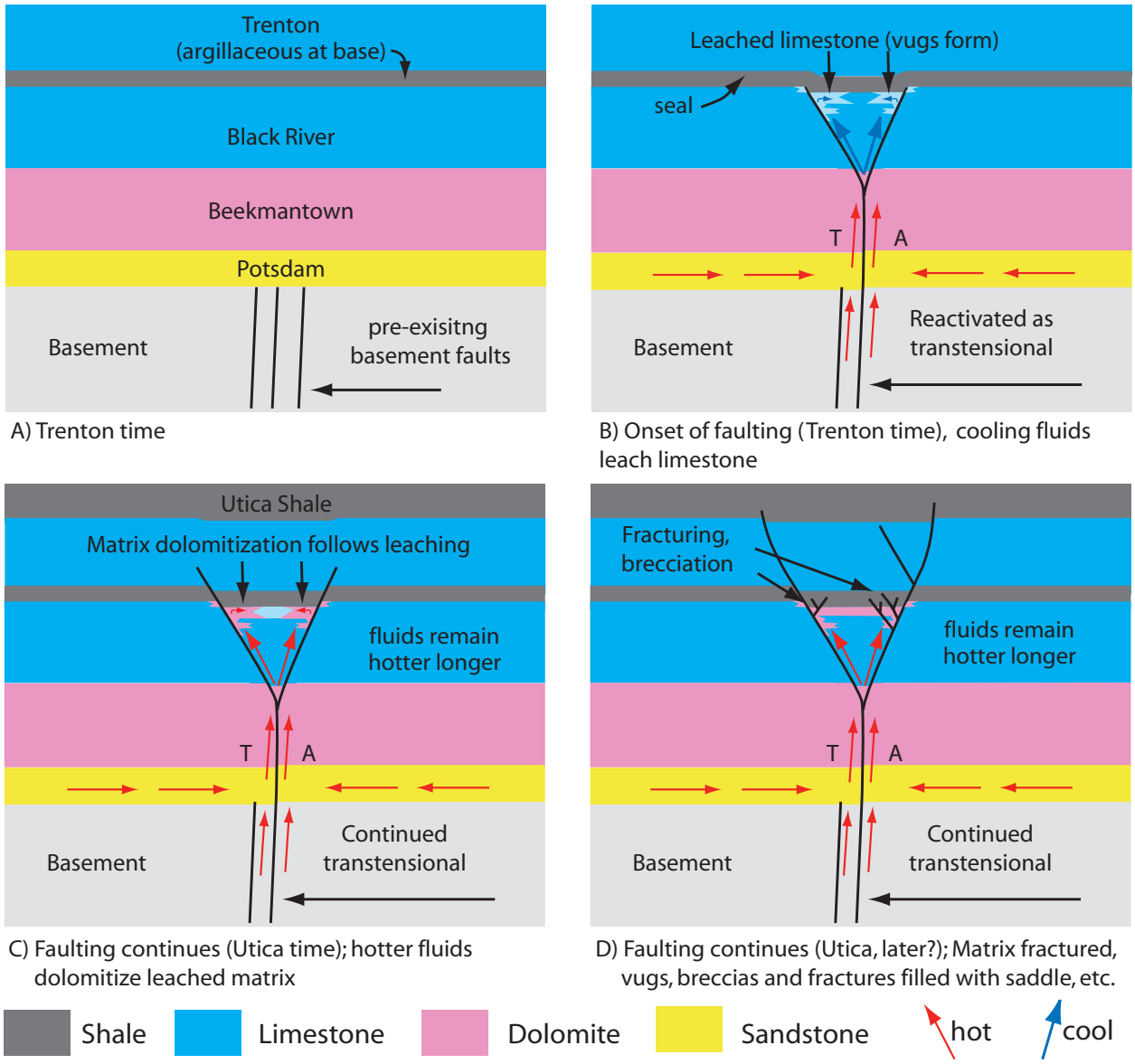
Geologic Play - *A geologic play is a set of known or postulated natural gas or oil accumulations sharing similar geologic, geographic and temporal properties such as hydrocarbon source, migration pathway and timing of hydrocarbon migration, trapping mechanism, and hydrocarbon type. The geologic play is the unit of assessment for estimating undiscovered oil and natural gas resources. In fact, the most recent U.S. Geological Survey resource assessments refer to geologic plays as "Assessment Units." The geologic play that is generating the greatest renewed interest in New York is the Trenton-Black River formation hydrothermal dolomite play.*

New York State Stratigraphic Column; Showing Oil and Gas Producing Formations

PERIOD (AGE)		GROUP	FORMATION	LITHOLOGY	THICKNESS (feet)	PRODUCTION
PENNSYLVANIAN		Pottsville	Olean	Sandstone	75-100	
MISSISSIPPIAN		Pocono	Knapp	Sandstone	5-100	
DEVONIAN	UPPER	Conewango	Riceville	Shale, Sandstone	70	
		Conneaut	Chadakoin	Shale, Sandstone	700	
		Canadaway	Undifferentiated	Shale, Sandstone	1100-1400	Oil, Gas
			Perrysburg-Dunkirk	Shale, Sandstone		Oil, Gas
				Shale		
		West Falls	Java	Shale, Sandstone	365-125	
			Nunda	Shale, Sandstone		Oil, Gas
			Rhinestreet	Shale		
		Sonyea	Middlesex	Shale	0-400	Gas
		Genesee	Genesee	Shale	0-450	Gas
	?		Tully	Limestone	0-50	Gas
	MIDDLE	Hamilton	Moscow	Shale	200-600	
			Ludlowville	Shale		
			Skaneateles	Shale		
			Marcellus	Shale		Gas
			Onondaga	Limestone	30-235	Gas, Oil
	LOWER	Tristates	Oriskany	Sandstone	0-40	Gas
		Helderberg	Manlius	Limestone	0-10	
			Rondout	Dolomite		
SILURIAN	UPPER		Akron	Dolomite	0-15	Gas
		Salina	Camillus	Shale, Gypsum	450-1850	
			Syracuse	Dolomite, Shale, Salt		
			Vernon	Shale		
		Lockport	Lockport	Dolomite	150-250	Gas
	LOWER	Clinton	Rochester Herkimer	Shale, Sandstone	125	Gas
			Irondequioit	Limestone		
			Sodus	Shale	75	Gas
			Reynales	Limestone		
			Thorold	Sandstone		
		Medina	Grimsby	Shale, Sandstone	75-150	Gas
			Whirlpool	Sandstone	0-25	Gas
ORDOVICIAN	UPPER		Queenston	Shale	1100-1500	Gas
			Oswego	Sandstone		Gas
			Lorraine	Shale		
			Utica	Shale	900-1000	
	MIDDLE	Trenton-Black River	Trenton	Limestone	425-625	Gas
			Black River	Limestone, Dolomite	225-550	Gas
	LOWER	Beekmantown Group	Tribes Hill-Chuctanunda	Limestone	0-550	Gas
CAMBRIAN	UPPER		Little Falls	Dolomite	0-350	
			Galway "Theresa"	Dolomite, Sandstone	575-1350	Gas
			Potsdam	Sandstone, Dolomite	75-500	Gas
PRECAMBRIAN				Gneiss, marble, quartzite		

Modified from 2002 NYSERDA Report, Fractured Gas Shale Potential in New York, prepared by TICORA Geosciences, Inc.

Fault-Related Hydrothermal Alteration Model for Black River Group Dolomite



Current evidence suggests that the limestone of the Black River Group and the overlying Trenton Limestone were hydrothermally altered to dolomite by high-pressure, high-temperature fluids moving up active faults during middle to late Ordovician time. This early dolomitization, which enhanced reservoir properties, was followed by further fracturing from later tectonic activity. A successful hydrothermal dolomite exploration model for the Trenton-Black River, based largely on New York, has found that the best reservoirs are in structures developed in association with basement faults, where subsequent faulting does not extend much into the overlying Utica Shale.

Courtesy of New York State Museum, from Geologic Playbook of Trenton-Black River Exploration in the Appalachian Basin.