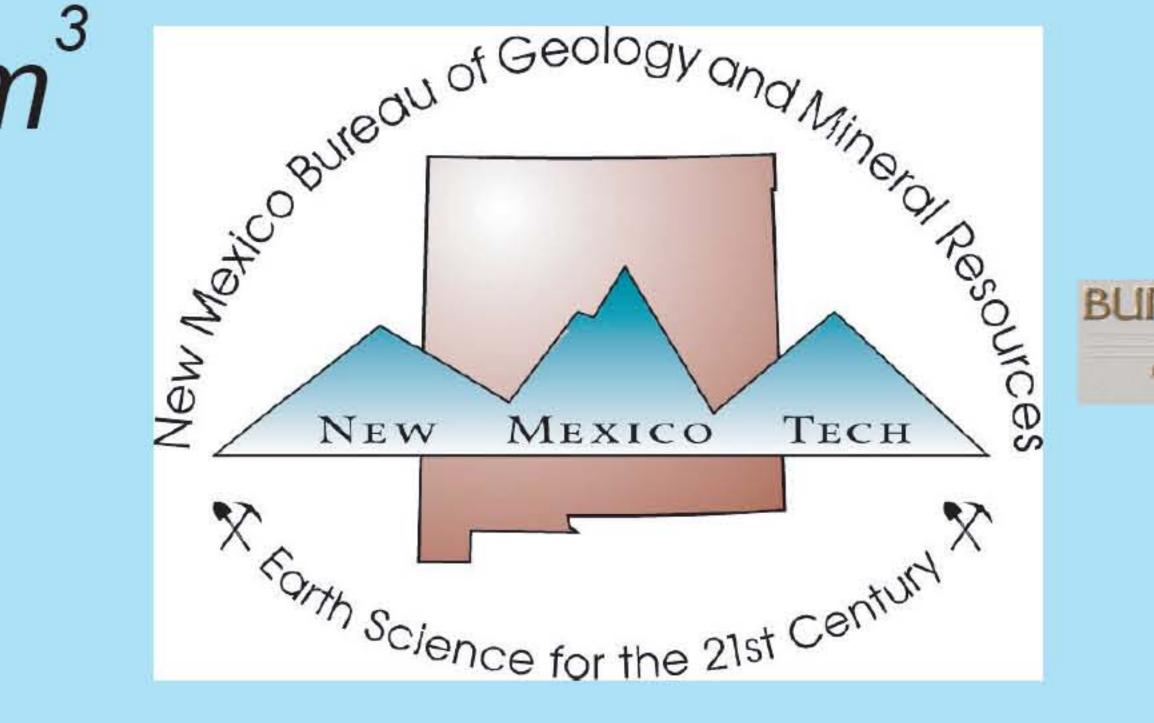
Play Analysis and Digital Portfolio of Major Oil Reservoirs in the Permian Basin: New Mexico

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Abstract

oproximately 300 reservoirs in the New Mexico part of the Permian Basin have cumulative production of more than 1 MMBO, with a combined production of 4.5 billion bbls oil as of 2000. Reservoirs with 1 MMBO cumulative production have been grouped into 17 plays based on geologic parameters, including reservoir stratigraphy, lithology, depositional environment, tectonic setting, and trapping mechanism. The 10 Permian plays have a cumulative production of 3501 MMBO. The two Pennsylvanian plays have a cumulative production of 424 MMBO. Three Siluro-Devonian plays have a cumulative production of 440 MMBO. The two Ordovician plays have a cumulative production of 86 MMBO. Four New Mexico plays are selected for detailed discussion based on favorable production trends, potential for significant bypassed pay, possibilities for enhanced production, or rethinking of exploration concepts that may result in rethinking of exploration, development, and production

The Delaware Mountain Group Basinal Sandstone Play has 155 reservoirs in New Mexico, 33 with more than 1 MMBO cumulative production. These 33 reservoirs have produced a cumulative total of 112 MMBO. Production from the New Mexico part of this play peaked in the mid-1990's at more than 7 MMBO per year. Reservoirs are deep-water submarine fan sandstones. Primary production via solution gas drive declines quickly as reservoir pressure is depleted. Pressure maintenance, and water flooding in selected cases, may prevent premature abandonment and increase ultimate recovery by more than 50 percent.

The Upper San Andres and Grayburg Platform Artesia Vacuum Trend Play contains 13 reservoirs with more than 1 MMBO production. These 13 reservoirs have produced a cumulative total of 796 MMBO. Although much of this production has historically been from vugular porosity in carbonates of the upper San Andres Formation, significant reserves remain that may be produced by horizontal drilling to tap underproduced reservoir compartments in established San Andres reservoirs as well as targeting bypassed, behind-pipe pay within the less permeable sandstone of the Grayburg Formation.

The Leonard Restricted Platform Carbonate Play has 34 reservoirs with production exceeding 1 MMBO. Cumulative production from these reservoirs is 431 MMBO. Reservoirs consist of limestones and dolostones deposited on a restricted carbonate platform; associated platform sandstones are also productive. Traps are formed by wide, low-relief anticlines. Uneven pay distribution across structures and strata-limited fracture systems have compartmentailzed reservoirs and resulted in bypassed pay that may be tapped through horizontal drilling.

The Northwest Shelf Upper Pennsylvanian Carbonate Play has been productive from 197 reservoirs, 34 of which have produced more than 1 MMBO. These 34 reservoirs have produced a combined 354 MMBO. Reservoirs consist of algal mounds and associated carbonate sands. Trapping mechanisms are largely stratigraphic. Historically, the largest reservoirs in this play yielded significant production (>10 MMBO cumulative) only decades after initial discovery. Initial development was often predicated on the presumption of structural entrapment of oil. Redevelopment proved entrapment is stratigraphic, resulting in an increase in the productive area and production rates, turning seemingly minor reservoirs into major ones. Rediscovery of the Dagger Draw reservoir in the 1990's increased production by more than one-hundredfold and resulted in an annual production rate of more than 10 MMBO during 1996.

About the Project

This poster summarizes the New Mexico part of our work developing a play portfolio of major oil-productive reservoirs in the Permian Basin. Data from reservoirs with more than 1 MMBO cumulative production in the Permian Basin were mapped and compiled in a Geographic Information System (GIS). In addition to the 299 reservoirs identified in New Mexico, approximately 1000 reservoirs with more than 1 MMBO cumulative production have been identified in the Texas part of the Permian Basin. 33 plays are defined by this project, 17 of which are partially or wholly in New Mexico. The New Mexico Bureau of Geology and Mineral Resources at New Mexico Tech and the Bureau of Economic Geology at the University of Texas at Austin have jointly undertaken this Preferred Upstream Management Practices (PUMP) initiative funded by the U.S. Department of Energy under contract DE-FC26-02NT15131. The objectives of this *PUMP* project are to: 1) develop an up-to-date portfolio of oil plays in the Permian Basin of west Texas and southeast New Mexico; 2) study key reservoirs of some of the largest or most active plays to incorporate information on improved practices in reservoir management or development; and 3) widely disseminate the play portfolio via CD-ROM, the internet, and other media.

Α	ge		Strata	Oil Plays
Triassic		Chinle		
		Santa Rosa		
	Ochoan	Dewey Lake Rustler		
Permian		Sa	alado	
	Guadalupian	Tansill Yates		
		-	Yates	Artesia Platform Sandstone
		Artesia	Seven Rivers	
		ď	Queen Grayburg	
e O		_	Grayburg	Upper San Andres and Grayburg Platform - Artesia Vacuum Trend
_		San Andres		Upper San Andres and Grayburg Platform - Central Basin Platform Trend
	Leonardian	Glorieta		
		Yeso	Paddock Blinebry	Leonardian Restricted Platform Carbonate
		¥	Tubb	
			Drinkard	
	Malformanian	Abo Hueco ("Wolfcamp")		Abo Platform Carbonate
	Wolfcampian			Wolfcamp Platform Carbonate
Pennsylvanian	Virgilian	Bough		Northwest Shelf Upper Pennsylvanian Carbonate
	Missourian	Canyon		
	Des Moinesian	Strawn		Northwest Shelf Strawn Patch Reef
	Atokan	Atoka		
	Morrowan	Morrow		
Miss.		undivided		
Dev.	Upper	Woodford		1
	Middle			
	Lower		Thirtyone	Devonian Thirtyone Deepwater Chert
Sil.	Upper		Wristen	Wristen Buildups and Platform Carbona
	Middle			
	Lower		Fusselman	Fusselman Shallow Platform Carbonate
~	Upper	NAME OF THE OWNER.		The second of th
Ord.	- 111	Montoya		Simpon Costonio Condet
	Middle	Simpson		Simpson Cratonic Sandstone Ellenburger Karst-Modified
	Lower		Ellenburger	Restricted Ramp Carbonate
Can	nbrian			
	ambrian	Torrier or	ous, metamorphics	

	DE	Δ	WARE BA	SIN	
Age			Strata	Oil Plays	
			hinle	On Flaye	
Triassic		Santa Rosa			
Permian	Ochoan	Dewey Lake Rustler			
		Salado			
		Castile			
	Guadalupian	in Group	Bell Canyon	Delaware Mountain Group Basinal Sandstone	
		Delaware Mountain	Cherry Canyon		
			Brushy Canyon		
	Leonardian		Bone Spring	Bone Spring Basinal Sandstone and Carbonate	
	Wolfcampian	Hueco ("Wolfcamp")		Wolfcamp/Leonard Basinal Carbonate	
Pennsylvanian	Virgilian	Cisco			
	Missourian	Canyon			
	Des Moinesian	Strawn			
	Atokan	Atoka			
Ь	Morrowan	Morrow			
Miss.		Barnett			
		undivided limestones			
Dev.	Upper		Woodford		
	Middle		AND LOCATION OF THE PARTY OF TH		
	Lower		Thirtyone	Devonian Thirtyone Deepwater Chert	
Cil	Upper		Wristen	Wristen Buildups and Platform Carbonate	
Sil.	Middle				
	Lower	Fusselman		Fusselman Shallow Platform Carbonate	
Ord.	Upper	Montoya			
Oru.	Middle		Simpson	Simpson Cratonic Sandstone	
	Lower	Ellenburger		Ellenburger Karst-Modified Restricted Ramp Carbonate	
Cambrian			Bliss		
The second secon			ous, metamorphics		
Precambrian		volcanics			

Guadalupian (Upper Permian) Plays

Artesia Platform Sandstone Play (586 MMBO cumulative production from 38 reservoirs with > 1 MMBO production) Delaware Mountain Group Basinal Sandstone Play (112 MMBO cumulative production from 33 reservoirs with > 1 MMBO production) Upper San Andres & Grayburg Platform Mixed - Artesia Vacuum Trend Play (796 MMBO cumulative production from 13 reservoirs with > 1 MMBO production) Upper San Andres & Grayburg Platform Mixed - Central Basin Platform Trend Play (809 MMBO cumulative production from 8 reservoirs with > 1 MMBO production) Northwest Shelf San Andres Platform Carbonate Play (95 MMBO cumulative production from 13 reservoirs with > 1 MMBO production)

Wolfcampian and Leonardian (Lower Permian) Plays

Bone Spring Basinal Sandstone and Carbonate Play (71 MMBO cumulative production from 16 reservoirs with > 1 MMBO production) Leonard Restricted Platform Carbonate Play (429 MMBO cumulative production from 34 reservoirs with > 1 MMBO production) Abo Platform Carbonate Play (455 MMBO cumulative production from 14 reservoirs with > 1 MMBO production) Wolfcamp/Leonard Slope and Basinal Carbonate Play (32 MMBO cumulative production from 9 reservoirs with > 1 MMBO production) Wolfcamp Platform Carbonate Play (116 MMBO cumulative production from 16 reservoirs with > 1 MMBO production)

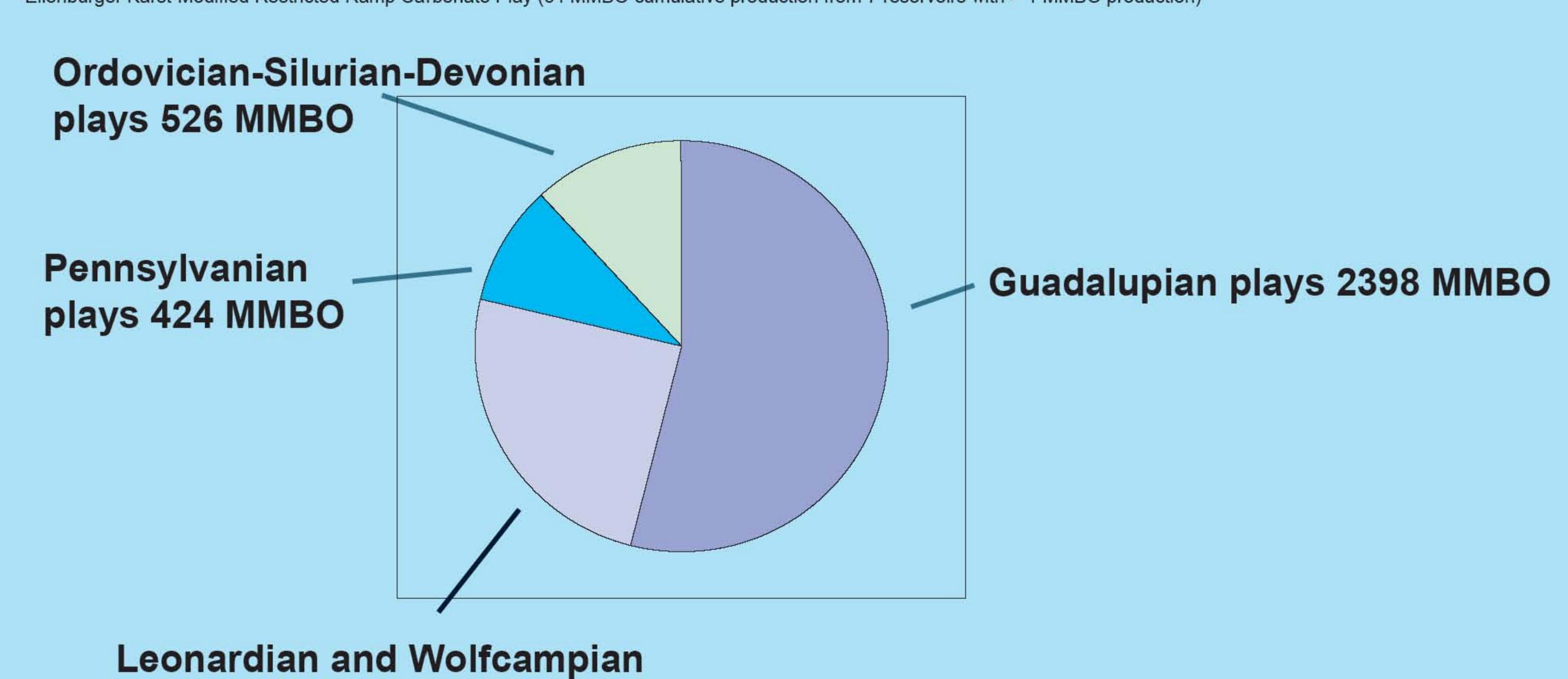
Pennsylvanian Plays

plays 1103 MMBO

Northwest Shelf Upper Pennsylvanian Carbonate Play (354 MMBO cumulative production from 34 reservoirs with > 1 MMBO production) Northwest Shelf Strawn Patch Reef Play (70 MMBO cumulative production from 13 reservoirs with > 1 MMBO production)

Ordovician, Silurian and Devonian Plays

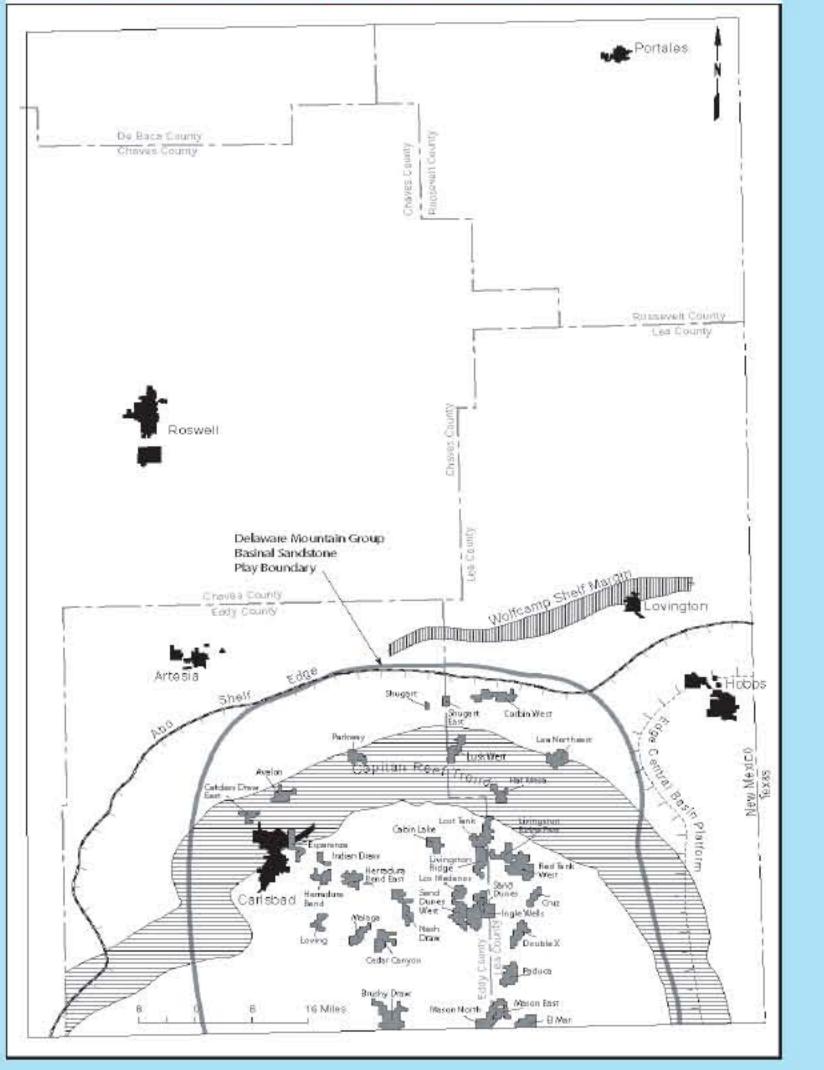
Devonian Thirtyone Deepwater Chert Play (9 MMBO cumulative production from 1 reservoir with > 1 MMBO production) Wristen Buildups and Platform Carbonate Play (369 MMBO cumulative production from 36 reservoirs with > 1 MMBO production) Fusselman Shallow Platform Carbonate Play (62 MMBO cumulative production from 11 reservoirs with > 1 MMBO production) Simpson Cratonic Sandstone Play (22 MMBO cumulative production from 3 reservoirs with > 1 MMBO production) Ellenburger Karst-Modified Restricted Ramp Carbonate Play (64 MMBO cumulative production from 7 reservoirs with > 1 MMBO production)



Emphasized Plays

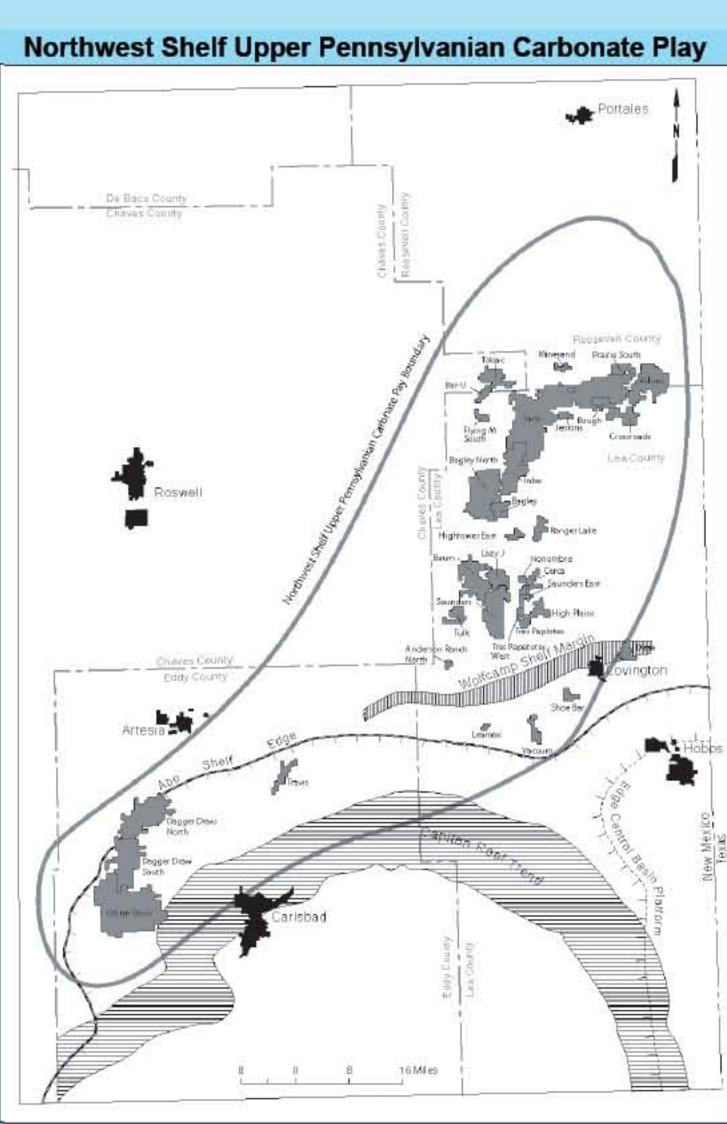
Four New Mexico plays have been selected for in-depth discussion and analysis in this poster: Delaware Mountain Group Basinal Sandstone Play, Upper San Andres and Grayburg Platform Artesia Vacuum Trend Play, Leonard Restricted Platform Carbonate Play, and Northwest Shelf Upper Pennsylvanian Carbonate Play. These plays were selected based on favorable production trends, potential for significant future growth through either new or improved primary or secondary production, or newly applied geologic and/or engineering concepts that may result in rethinking of exploration, development, and production strategies.

Delaware Mountain Group Basinal Sandstone Play



San Andreas/Grayburg Artesia Vacuum Trend Play

Leonard Restricted Platform Carbonate Play De Baca County Chaves County



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References

Broadhead, R.F., Luo, F., and Speer, S.W., 1998, Oil and gas resources at the Waste Isolation Pilot Plant (WIPP) site, Eddy County, New Mexico: New Mexico Bureau of Mines and rnham, D.E., 1991, Depositional environments and facies distribution of the Permian Paddock

Lower Permian carbonate margins, slopes and basinal sandstones: West Texas Geological Cys., J.M., 1986, Lower Permian grainstone reservoirs, southern Tatum Basin, southeastern

New Mexico, in Ahlen, J.L., and Hanson, M.E., eds., Southwest Section of AAPG Transactions and guidebook of 1986 convention, Ruidoso, New Mexico: New Mexico Bureau

carbonate and continental to shoreface siliciclastic facies, San Andres - Grayburg Formations, Eddy County, New Mexico, in Martin, R.L., ed., Permian Basin oil and gas fields:keys to success that unlock future reserves: West Texas Geological Society,

Hovorka, S.D., Nance, H.S., and Kerans, C., 1993, Parasequence geometry as a control on

permeability evolution: examples from the San Andres and Grayburg Formations in the Guadalupe Mountains, New Mexico, in Loucks, R.G., and Sarg, J.F., Carbonate sequence stratigraphy: American Association of Petreolum Geologists, Memoir 57, p. 493-514 of southeastern New Mexico, 1977 supplement: Roswell Geological Society, p. 142-143

Martin, R.L., and Hickey, K.F., 2002, Horizontal drilling at Vacuum Glorieta West unit, Lea County preserving our past - securing our future: West Texas Geological Society, Publication 02-111,

May, B.A., 1996, Geology and development history of the Livingston Ridge and Lost Tank Delaware pools, southeastern New Mexico, in DeMis, W.D., and Cole, A.G., eds., The Brushy Canyon play in outcrop and subsurface: concepts and examples: Permian Basin

Section SEPM, Publication 96-38, p. 113-118. (Upper Pennsylvanian) on the Northwest shelf, southeastern New Mexico, in DeMis, W.D. and Nelis, M.K., eds., The search continues into the 21st century: West Texas Geological

Modica, C.J., and Dorobek, S.L., 1996, High frequency sequence framework and effects of exposure events on porosity evolution and reservoir heterogeneity: Maljamar field, Lea County, southeast New Mexico, in Martin, R.L., ed., Permian Basin oil and gas fields: keys to success that unlock future reserves: West Texas Geological Society, Publication 96-101

Pranter, M.J., Hurley, N.F., Davis, T.L., Raines, M.A., and Wehner, S.C., 2004, Dual-lateral Vacuum field, New Mexico: American Association of Petroleum Geologists, Bulletin,

Permian Basin: Permian Basin Section SEPM, Publication 86-26, p. 49-53

A symposium of oil and gas fields of southeastern New Mexico: Roswell Geological Society,

New Mexico Bureau of Mines and Mineral Resources, p. 154-156.

Stoudt, E.L., and Raines, M.A., 2001, Reservoir compartmentalization in the San Andres Formation of Vacuum field, Lea County, New Mexico - peritidal deposits and karst overprints create vertical and lateral barriers to fluid flow on carbonate platform dolopackstones and dolograinstones (abstract): American Association of Petroleum Geologists, Bulletin, v. 85, p. 390.

New Mexico, 1995 supplement: Roswell Geological Society, p. 210-215.

