STRATIGRAPHIC COLUMN

WEST TEXAS-SOUTHEAST NEW MEXICO

SYSTEM	SERIES	GROUP	NORTHWEST SHELF	
QUATERNARY	RECENT		ALLUVIUM	
	PLEISTOCENE			
TERTIARY	PLIOCENE-EOCENE		OGALALLA	
CRETACEOUS	GULF			
	COMANCHEAN			
TRIASSIC	UPPER	DOCKUM	CHINLE	
			SANTA ROSA	
			TECOVAS	
PERMIAN	OCHOA		DEWEY LAKE	
			RUSTLER	
			SALADO	
	GUADALUPE	WHITEHORSE	TANSILL	CAPITAN
			YATES	
			SEVEN RIVERS	
			QUEEN	
			GRAYBURG	
		WORD	SAN ANDRES	GOAT SEEP
			GLORIETA	
	LEONARD		YESO	
			ABO	
	WOLFCAMP		WOLFCAMP	
PENNSYLVANIAN	VIRGIL		CISCO	
	MISSOURI		CANYON	
	DES MOINES		STRAWN	
	ATOKA		ATOKA	
	MORROW		MORROW	
MISSISSIPPIAN	CHESTER		BARNETT SH.	
	MERAMEC-OSAGE		MISSISSIPPIAN LM.	
	KINDERHOOK		KINDERHOOK	
DEVONIAN	UPPER		WOODFORD	
	MIDDLE			
	LOWER		DEVONIAN	
SILURIAN	U/NIAGARAN		U/SILURIAN	
	L/NIAGARAN		FUSSELMAN	
	ALEXANDRIAN			
ORDOVICIAN	CINCINNATIAN		MONTOYA	
	MOHAWKIAN	SIMPSON GR.	BROMIDE	
	CHAZYAN		McKEE	
			WADDELL	
			CONNELL	
			JOINS	
	CANADIAN		ELLENBURGER	
	OZARKIAN			
CAMBRIAN	UPPER			
PRECAMBRIAN				

Figure 1. Stratigraphic column for west Texas and southeast New Mexico. From Geomap Executive Reference Map No. 306, 1981 Edition. Reproduced with permission of Geomap, Inc

TYPE LOG
SOUTHLAND ROY.
PARKWAY ST. No.1
15-19S-29E

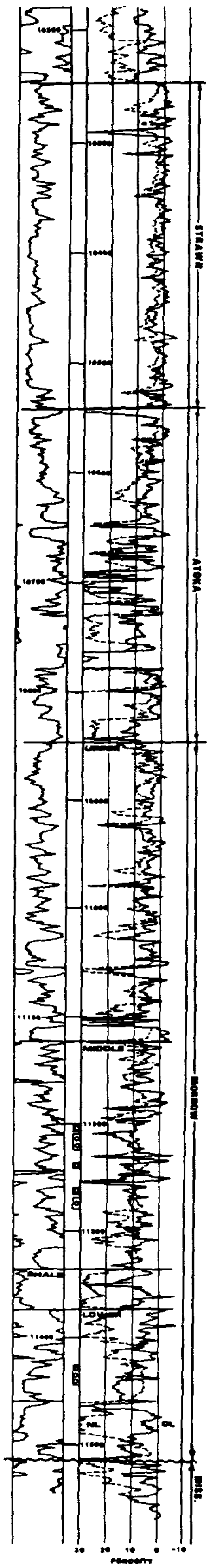

Figure 2. Compensated density-neutron log from the Southland Royalty Company Parkway State No. 1.

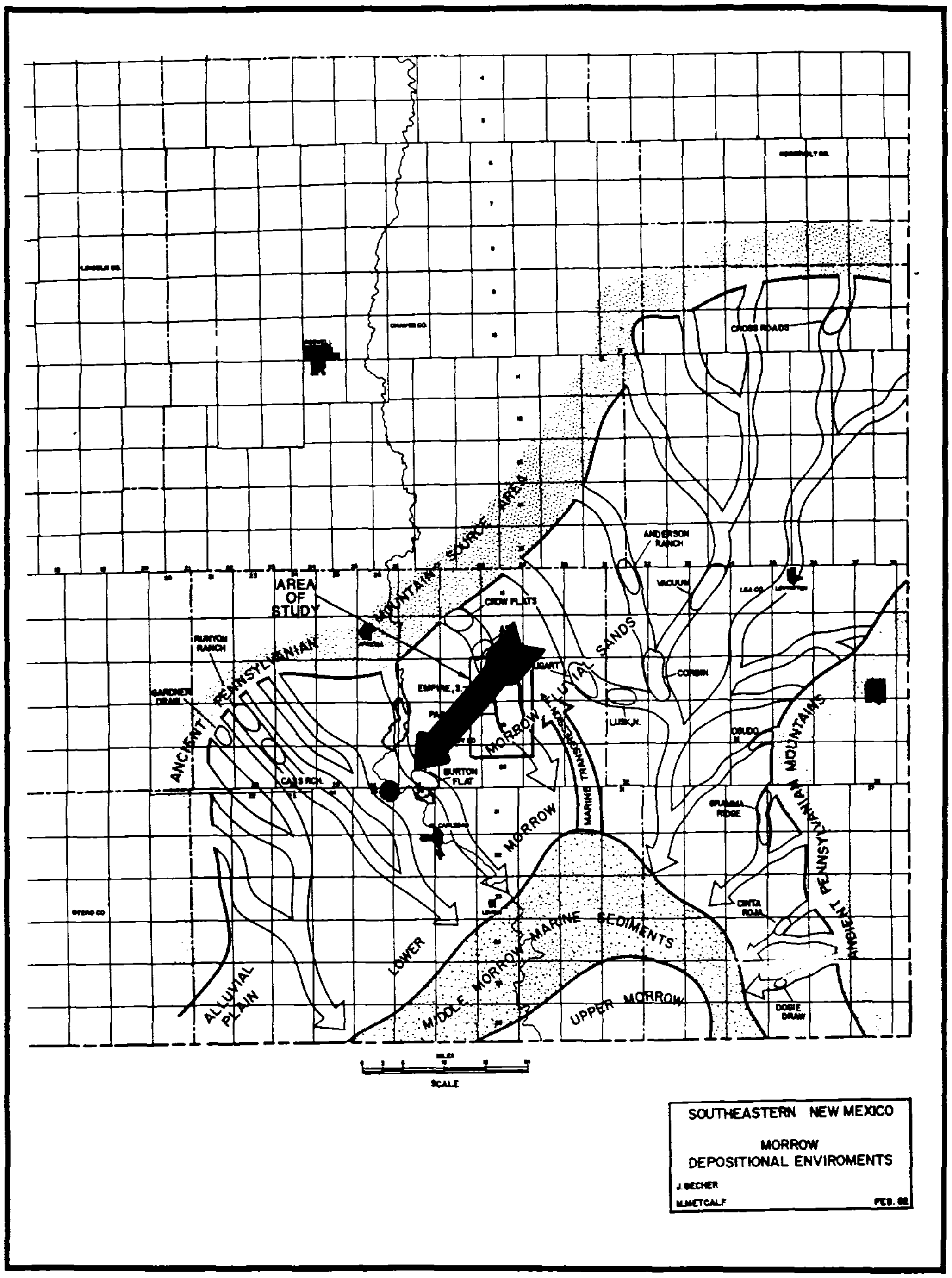

Figure 3. Map of interpreted depositional environments in southeast New Mexico during early Morrowan. Study area is outlined.

unit consists of light gray limestone with interbedded marine shales and occasional marine sandstones. The upper portion of this carbonate unit is probably Atoka in age. No easy wireline log correlation pick can separate the Morrow from the Atoka in this area. For simplicity, the entire carbonate unit is generally designated as upper Morrow.

Figure 3 is a depositional environment map for southeast New Mexico during early Morrow time. At this time, sands and shales from the Pedernal Highlands were being deposited in the Parkway-Empire South areas in fluvial-deltaic systems of channels, point bars, and stream-mouth bars. The sea level was static, and these sediments prograded from northwest to southeast into the basin. Resting on top of the lower Morrow sediments is the Morrow shale which occurs over a large part of the Northwest Shelf. It is dark gray and can contain coal. This shale represents the transition from fluvial-deltaic to marine conditions. Transgression continued generally through Strawn time.

The middle Morrow sediments contain marine sandstones which were probably deposited in migrating beaches or perhaps submarine bars. These sands trend northeast and were deposited near and parallel to the ancient shoreline. Water depth may have been 15 to 50 feet. These sandstones are occasionally glauconitic and can have up to 100 API units of gamma ray response, making them incorrectly appear to be shaley.

Upper Morrow carbonates and shales were deposited on a shallow shelf. During early Morrow time, these sediments were being deposited south of the study area as shown on Figure 3.

A structure map was prepared on the base of the Morrow shale,

Figure 4. The Morrow shale occurs between 11,336 and 11,374 feet on the type log (Fig. 2). The Morrow shale structure map shows 150 feet per mile of regional dip with a northeast strike. This present-day dip and strike are probably similar to the dip and strike of the depositional slope during Morrow deposition. This map, in a very generalized fashion, tends to reflect the underlying main depositional channels for the lower Morrow. Arrows have been drawn on the map showing the channel patterns. These reflected patterns may be caused by differential compaction of the shales underneath the sands. They indicate that the main channels may have existed into the early part of the middle Morrow sequence, and influenced early deposition of the middle Morrow marine sandstones.

Stratigraphic traps are formed in the lower Morrow sandstones by variations in the depositional patterns and cementation of the sands. These traps are small, with reservoirs only 200 to 400 acres in areal extent. These small reservoirs can be defined by using the close subsurface control, production data, and test data. The method used to define the traps was to prepare a lower Morrow net sand isopach, Figure 5, which was then used as a contouring guide to prepare a net effective porosity isopach, Figure 6. The porosity isopach was overlaid with the Morrow shale structure map. Mapping was fitted to account for test data, water saturation calculations, and production to define the discrete reservoirs and productive areas. The hachured areas show the proven and probable gas producing areas and the clear areas show the water legs of the reservoirs. Salt water production commonly occurs in the lower Morrow sands throughout the Northwest Shelf.

Log curve shapes, typical for point bars, channels, and distributary mouth bars, can be seen on the wireline logs in the study area. Figure 7 shows several examples of these log responses and gives their interpreted environments.

Figure 7 also shows one example of the middle Morrow marine sands (the Hondo Union "Tx" St. No. 1). Production is found in the middle Morrow sandstones in stratigraphic traps created by the presence of effective porosity and permeability. These traps can be variable in size and shape. Predicting the occurrence of reservoir-quality porosity and permeability is difficult, but in general the thicker sandstones tend to have the better preserved porosity and permeability. To define middle Morrow reservoirs, a net sand isopach, Figure 8, and a net effective porosity isopach, Figure 9, were prepared.

Gas production in the middle Morrow sands is not related to structure, but to porosity development. Areas with approximately 10 or more net feet of effective porosity should be productive. Producing wells in both the lower and middle Morrow sandstones have porosities ranging between 8% and 14%. In contrast to the lower Morrow sandstones, water production rarely occurs in the middle Morrow sands.

Fluvial channels are also present near the base of the middle Morrow section. They represent a fluvial-deltaic system that was largely destroyed during transgression of the seas during middle Morrowan time. Two such channels occur in the mapped area and account for large volumes of gas production. These channels are shown in Figure 9. One channel is located to the northwest in Sections 6, 5, and 4 of T18S, R29E, and the other channel is present in Sections 2 and 12 of T20S, R28E.

Morrow production in the mapped area was 93.2 BCFG and 1,161 MBC on December 31, 1982. The lower Morrow production has a cumulative of 52.1 BCFG and 608 MBC from 46 wells and the middle Morrow has a cumulative of 41.1 BCFG and 553 MBC from 53 wells.

Figures 10 and 11 are southwest-northeast stratigraphic cross sections in the study area of the Morrow and Atoka sediments. These cross sections were constructed with a datum at the base of the Morrow shale to best show the cut and fill depositional relationships of the lower Morrow sandstones. The cross sections are normal to the depositional trend of the lower Morrow sandstones and parallel to the depositional trend of the middle Morrow and Atoka sandstones.

ATOKA STRATIGRAPHY

Shallow-marine limestone deposition was predominant in late Morrowan and early Atokan time. Renewed uplift during Atokan caused an influx of clastics which were deposited in a shallow-marine environment. These sandstones are interpreted to be a prograded system of beaches and bars. The Atoka sandstones were deposited along northeast trends parallel to the ancient Atokan shorelines. The sand trends migrated with the shorelines into the basin during Atokan time.

Figure 12 shows the regional environmental interpretation for the Atoka. The Atoka marine sands were derived from fluvial systems bringing in sediments from the northwest. The Buffalo Valley Field, located about 20 miles north of the study area, is productive from such a fluvial system. South of the study area, an extensive Atoka bank developed along a slope break on the Atoka shelf. Gas production occurs within this bank, associated with local buildups and later structural uplift.

The most significant Atoka gas production on the Northwest Shelf occurs from the Atoka marine sandstones. Two attractive Atoka sandstone trends are found in the mapped area. One trend occurs in the Parkway area in Sections 10, 11, 14, and 15, T19S, R29E, and the other is present in the Empire South area in Sections 22 and 27, T18S, R29E (Fig. 14). Cumulative Atoka production was 8.4 BCFG and 68 MBC on December 31, 1982, from 12 wells in the Parkway–Empire South area.

Figure 13 is a density-neutron log of the Atoka section in the Southland Royalty Company Empire "A" Federal No. 1. This well has 28 feet of Atoka sand pay with porosities ranging from 9% to 12%. This well, which is located in the NW/4 Section 27, T18S, R29E, was completed on July 7, 1980, from this Atoka sandstone for a CAOF of 2,514 MCFGPD. It had cumulative production of 1.41 BCFG on December 31, 1982, when it was flowing at an average rate of 1.3 MMCFGPD for the month of December. An isopach of this sand, which has been called the "B" sand by Metcalf, is shown on Figure 14. Production for each well is noted on the map. Note the attractive production from the two mentioned areas. Atoka sands only 5 to 8 feet thick can be prolific gas producers. This suggests that good drainage can occur along the long and lenticular reservoirs.

As shown on the cross sections, Figures 10 and 11, three or more Atoka sandstones occur in this area. The lowermost of these sands is the mapped Atoka "B" sand, which accounts for the significant gas production. Significant production has not been documented in the other Atoka sandstones.

STRAWN STRATIGRAPHY

Strawn limestones were deposited on the Northwest Shelf on a broad ramp as shown in Figure 15, the regional Strawn environment map. In the mapped area, northeast-trending localized thicks developed. These thicks are interpreted to be phylloid algal mounds formed primarily from carbonate mud. Porosity ranges from 4% to 10% in the productive Strawn zones. Net clean carbonate and net porosity isopachs, Figures 16 and 17, were prepared to define the reservoirs. Cumulative production from this zone was 7.7 BCFG and 333 MBC from 10 wells on December 31, 1982.

SUMMARY

The Parkway area is an attractive multi-pay area. Typical completions in the Morrow and Atoka zones yield 1 to 2 BCFG and 10 MBC. Initial producing rates are generally about 1,500 MCFGPD with an 8 to 12 year life. The Strawn recoveries vary greatly but contain considerably

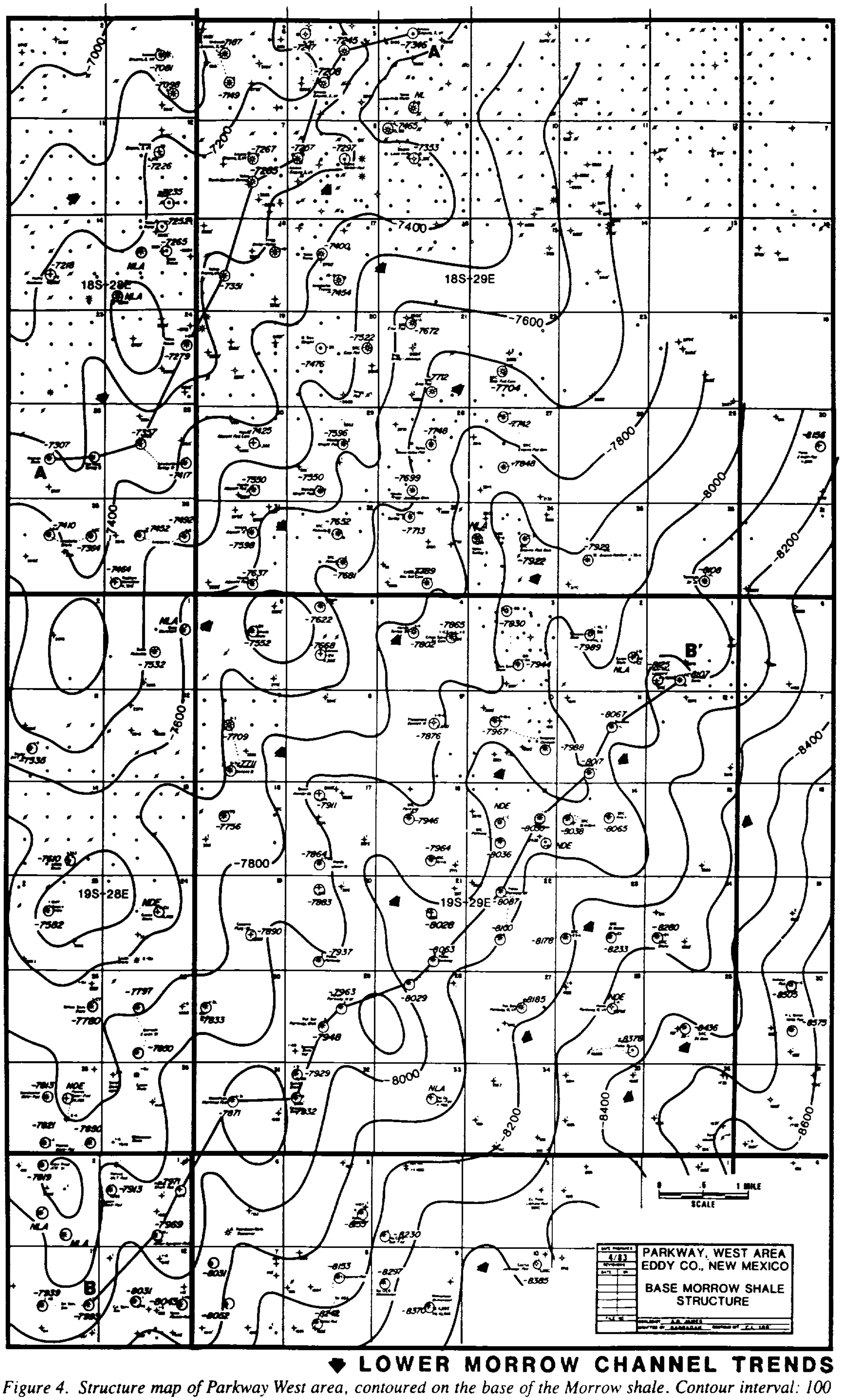

Figure 4. Structure map of Parkway West area, contoured on the base of the Morrow shale. Contour interval: 100 feet. Lines of cross section for Figures 10 (AA') and 11 (BB') are shown.

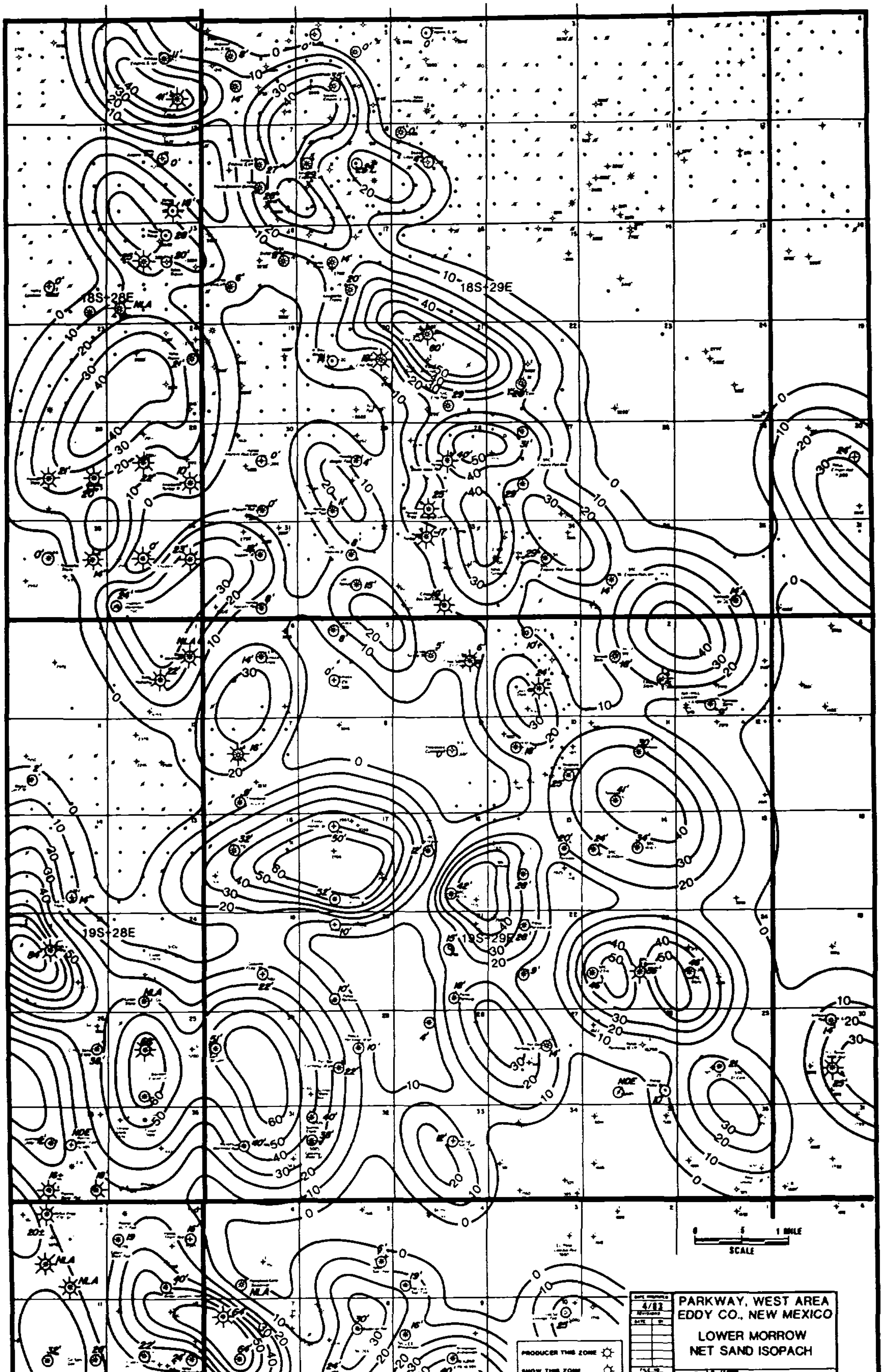

Figure 5. Isopach map of net lower Morrow sand thickness, Parkway West area. Contour interval: 10 feet.

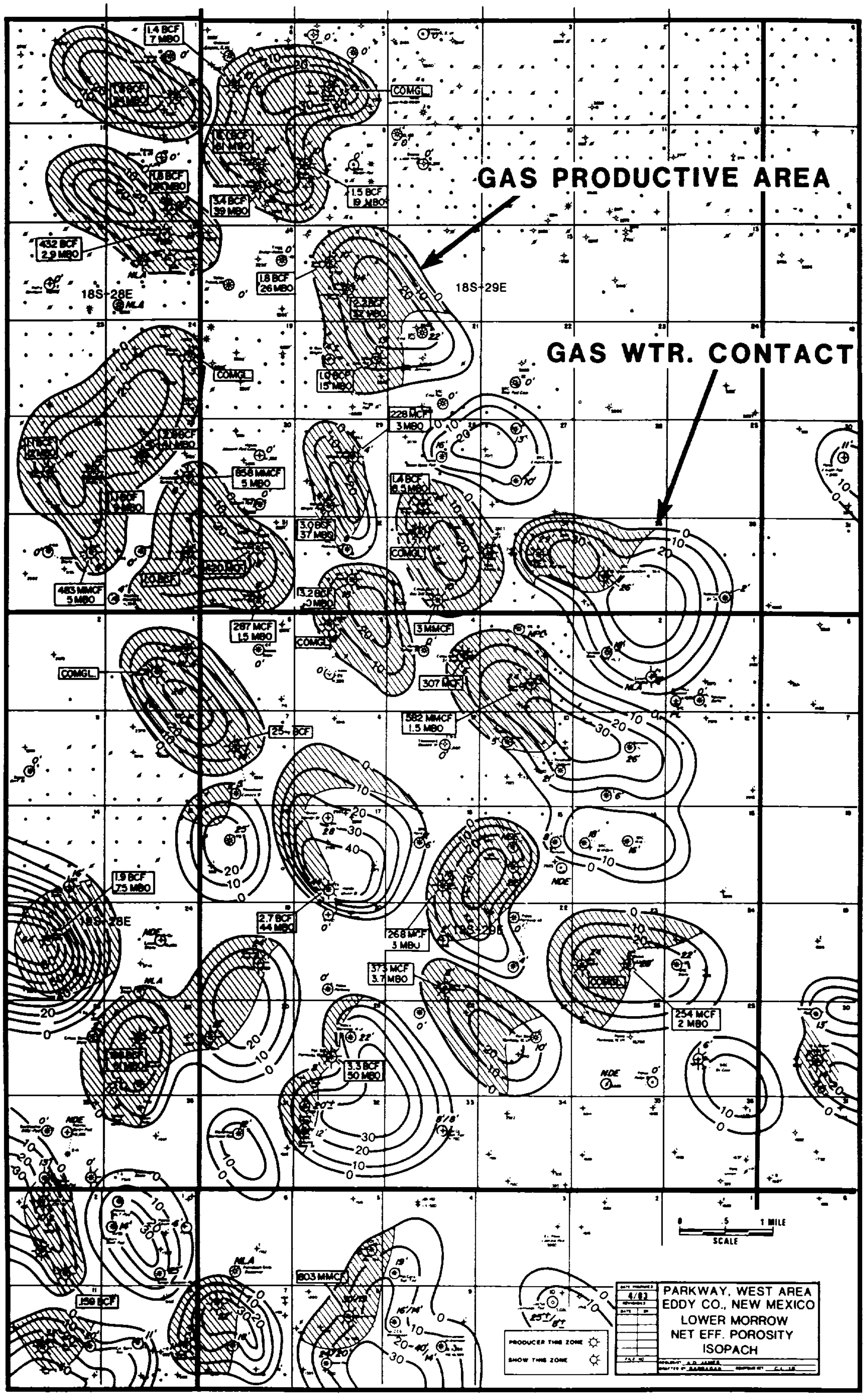

Figure 6. Isopach map of net effective porosity in the lower Morrow sands, Parkway West area. Contour interval: 10 feet. Hachured areas show proven or probable productive areas.

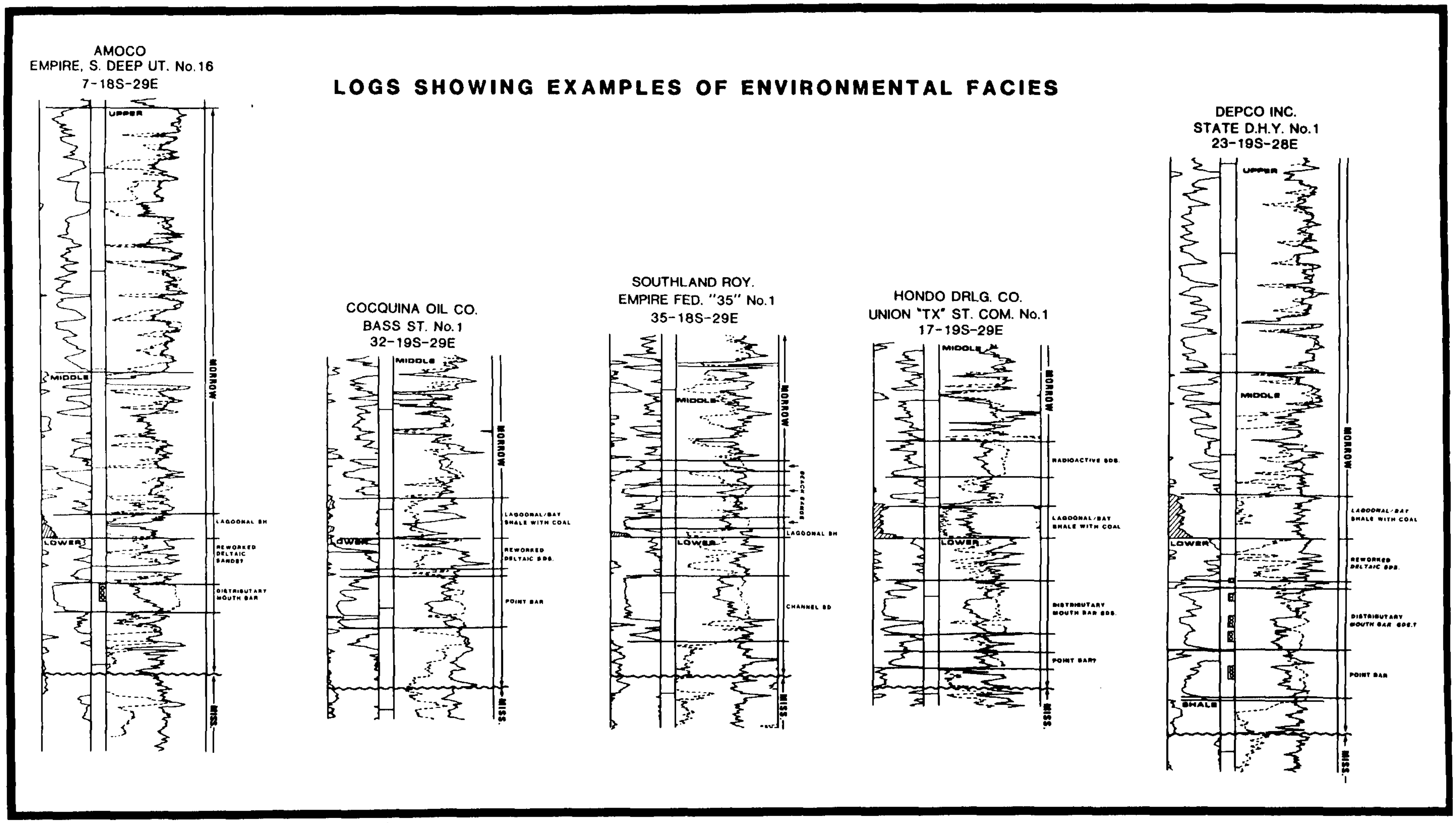

Figure 7. Log comparison showing examples of Morrow sands, their log responses, and their interpreted environments of deposition.

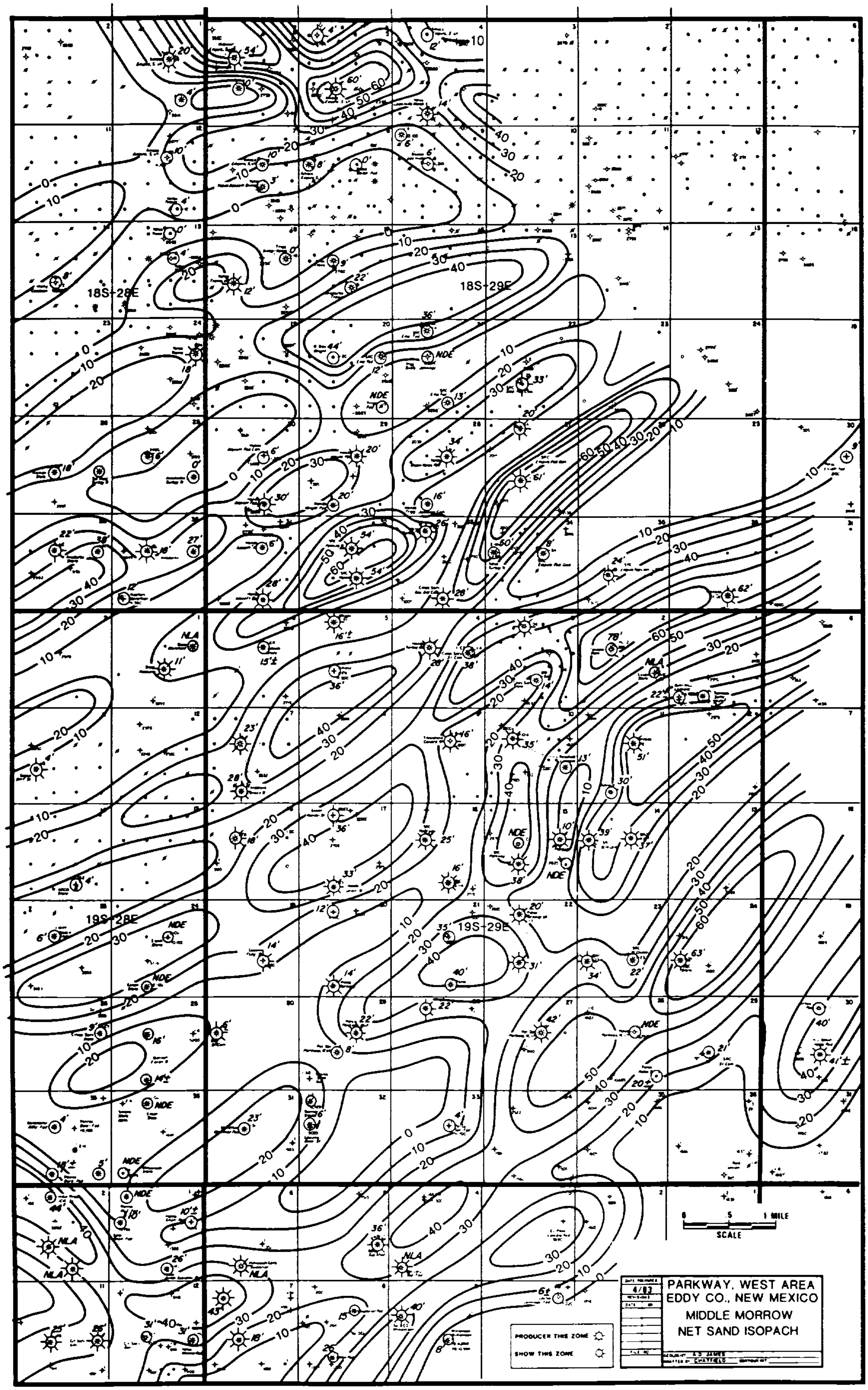

Figure 8. Isopach map of net middle Morrow sand thickness, Parkway West area. Contour interval: 10 feet.

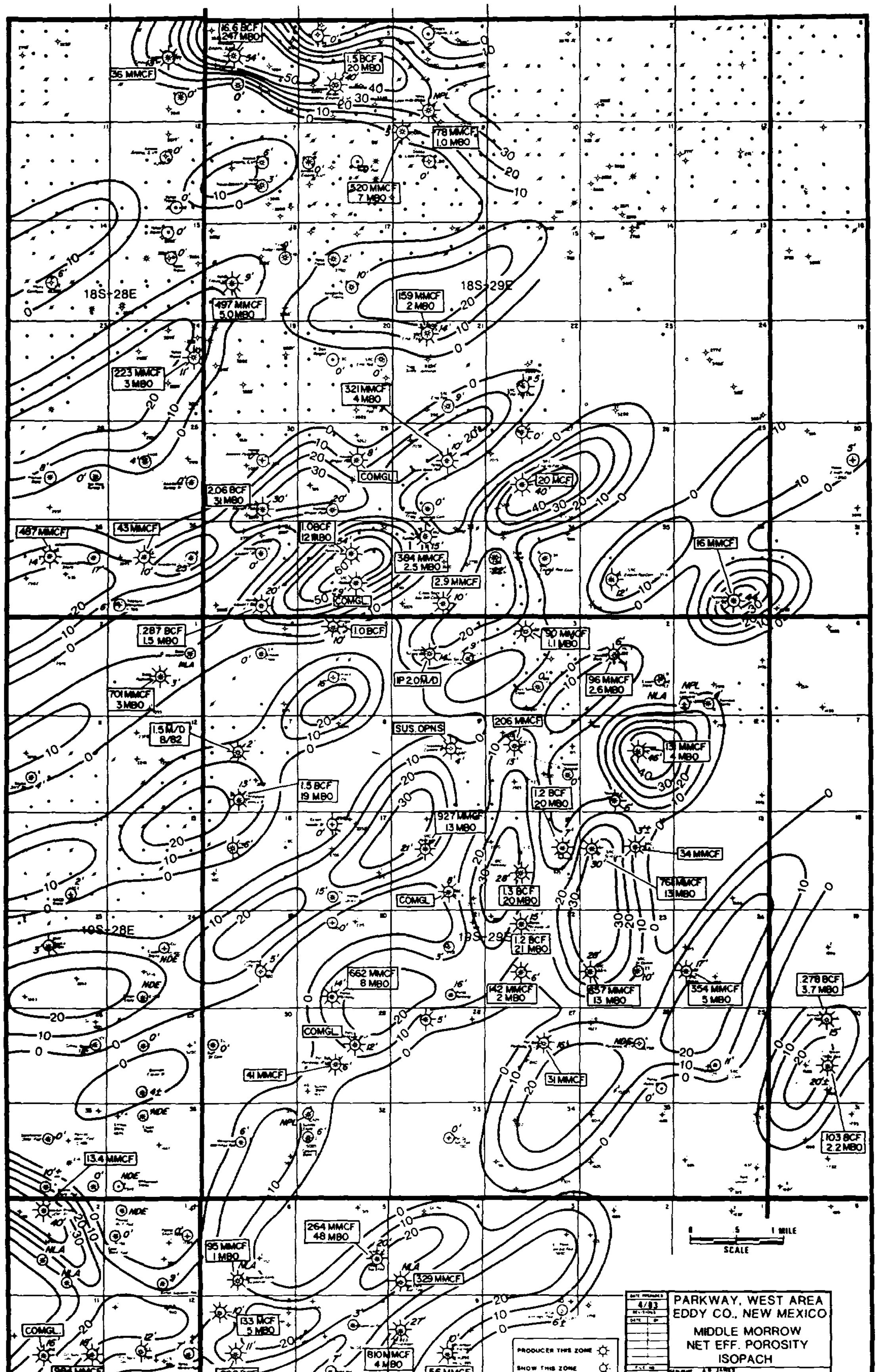

Figure 9. Isopach of net effective porosity in the middle Morrow sands, Parkway West area. Contour interval: 10 feet.

more liquid hydrocarbons than the other Pennsylvanian reservoirs. Typical ultimate recoveries for this zone are 800 MMCFG and 50 MBC with a life of about 10 years. Approximately half the wells in this area have more than one potentially productive zone, which greatly increases the attractiveness of the play.

Predicting the presence of the producing zones is difficult because the reservoirs are relatively small and complex, but having multiple prospective zones increases the success probability, making up for this prediction difficulty. These reservoirs have been developed on 320-acre proration units which will not, in many areas, allow all the gas to be produced. Selected infill drilling will likely be needed to ensure complete drainage.

ACKNOWLEDGMENTS

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