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EXPLORATION SCREENING PACKAGE FOR PENNSYLVANIA

In order to meet the needs of management and TTVS to rapidly evaluate any given area within the Appalachian, Illinois, or Michigan Basins for its Devonian shale exploration potential, the Prospect Development Group of the Eastern Gas Shales Project (EGSP) began conducting basin-wide Devonian shale exploration screening efforts. The attached represents the first in a series of states surveyed. All data utilized were collected and submitted as deliverables by the Pennsylvania Geologic Survey under EGSP Contract No. DE-AS21-76MC05198; the result is a summary, sketch synthesis, and some interpretation of the Pennsylvania deliverables. All maps developed are a consequence of three working sessions (May 4, May 30, and June 8), with the balance of time spent in drafting and editing.

Exploration Strategy

The basic exploration strategy of the Eastern Gas Shales Project envisions area-specific exploration rationale with application of specific techniques to credit or discredit it. An exploration rationale is a concept based on known or inferred geological circumstances that may combine to create a setting favorable to the accumulation of producible hydrocarbons. The ultimate objective of the exploration program is a set of site-specific prospects, well site recommendations presented with pertinent data, and assumptions and arguments; however, this requires a massive concentrated effort. Although this approach toward site-specific prospects optimizes our chances for success, efforts must be concentrated in a few or in small areas and the desire is for broader coverage. Presented in the attached Devonian Shale Gas Potential Map are areas in which the likelihood of encountering gas is greater than elsewhere. Within these areas, local geologic factors must be considered as they can dictate success or failure.

Devonian Shale in Pennsylvania

Three major and three minor Devonian organic-rich shale facies are found in Pennsylvania; as only the major units merit attention for gas potential, only these will be discussed. The three major facies are the Middle Devonian Marcellus shale member of the Hamilton Group, the Upper Devonian Rhinestreet member of the West Falls Formation, and Dunkirk member of the "Canadaway Group."

The total interval from the Mississippian-Devonian boundary to the base of the Marcellus member (top of the Onondaga Limestone) thickens southeastward. This pattern is reflected by most units within the interval. The radioactive shale, within the entire interval exhibits a linear pattern of alternating thick and thin areas which seem to be related to the general NE-SW strike of the Appalachian structures. This linear pattern is especially characteristic of the three major shale belts in Pennsylvania.[1]

Within the study area, east of a line extending from Greene to Potter Counties, the Marcellus is represented by a broad continuous area of 100 net feet or greater in the northeast and by isolated areas in the southeast of 100 net feet or less (see map of "Total Net Feet of Organic-Rich Shale in the Middle Devonian (Marcellus)). The Rhinestreet and Dunkirk belts are represented by northwest trends of 100 net feet or greater thickness, with the Dunkirk occupying the area along the margin of Lake Erie and the Rhinestreet belt lying to the southeast of it along a line extending from Beaver County to Warren County (see Map of Total Net Feet of Organic-Rich Shales in the Upper Devonian).

Explanation of Individual Maps

A. Concentration of Devonian Shale Gas Shows

In the area studied, three organic-rich units more commonly had shows or production of gas. The Dunkirk member of the "Canadaway Group" has production or shows in the Erie-Crawford Counties area while in the Beaver-Butler-Washington Counties area the Rhinestreet facies of the West Falls Formation is the Devonian shale from which production or shows occurs. To the east of a line extending from Greene County to Potter County, the Marcellus facies is the major unit of interest.

B. Total Net Feet of Organic-Rich Shale in the Middle Devonian (Marcellus)

In the middle Devonian, the thickest accumulations (greater than 100 net feet) of the Marcellus facies are located to the southeast of a line extending from Beaver and Lawrence Counties to Erie and Warren Counties.

C. Total Net Feet of Organic-Rich Shale in the Upper Devonian (Primarily Dunkirk and Rhinestreet)

Of the Upper Devonian Shales in Pennsylvania, the Dunkirk member and the Rhinestreet member more commonly have shows and/or production. The Rhinestreet member is best developed in a northeasterly striking belt extending from Beaver and Lawrence Counties to Warren and Erie Counties, confined to an area northwest of that line; the Dunkirk member is limited to northwestern Pennsylvania, with its greatest thickness restricted to Erie County paralleling the Lake Erie margin.

D. Maximum Drilling Depth (Average Depth to the Top of the Onondaga)

The maximum drilling depth in the case of the Devonian organic-rich shales is the top of the Onondaga Limestone which underlies the Marcellus member, the lowermost organic-rich shale unit in Pennsylvania. The drilling depth increases continuously and significantly from the northwest toward the central portion of the state to a maximum of 9000 feet subsea, a short distance west of the outcrop of Devonian shale along the Allegheny Front. This map was included to give some indication of the costs involved to drill to the Devonian shales in Pennsylvania. Five-thousand feet (subsea) was chosen as the cutoff between shallow and medium deep to deep wells, i.e., greater than 5000 feet subsea may be considered a major effort with costs increasing accordingly.

E. Devonian Shale Gas Potential Map

This map is self-explanatory; however, it should be emphasized that dual completion possibilities exist in areas labeled with high or moderate gas potential. For example, in the northwest portion of the study area, specifically Erie County, dual completion with the Medina Group (lower Silurian) may make a Devonian shale well appear more attractive to a prospective driller; while in the west central and northwest central portion, dual completion with the Oriskany Sandstone may make the Devonian shale a more attractive prospect. Toward the central part of the state, however, the Medina is too deep and too tight (and possibly water saturated) to be economically attractive. In the Oriskany Sandstone, dual completion is limited to those areas where the Oriskany is structurally high (e.g., the crests of anticlines); however, recent studes indicate that structural highs in the Oriskany may not be the most favorable structural setting for Devonian shale production. In a belt extending across the central portion of the study area in parts of Erie, Crawford, Venango, and Warren Counties, the Oriskany is absent.

Cautions

Due caution should be exercised in the use of these maps. Areas indicated as having high potential should not be considered as areas where shows/production are guaranteed; while areas rated as having low potential may include some excellent prospects. A purpose of the maps is to

suggest those general areas worthy of relatively greater consideration. Each offer of cooperation must be evaluated on its own merits with these maps used as a preliminary aid.

References

1. Piotrowski, Robert G and Harper, J. A.; 1979; Black Shale and Sandstone Facies of the Devonian "Catskill" Clastic Wedge in the Subsurface of Western Pennsylvania; In Press.

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1:YW:CD:br:302b

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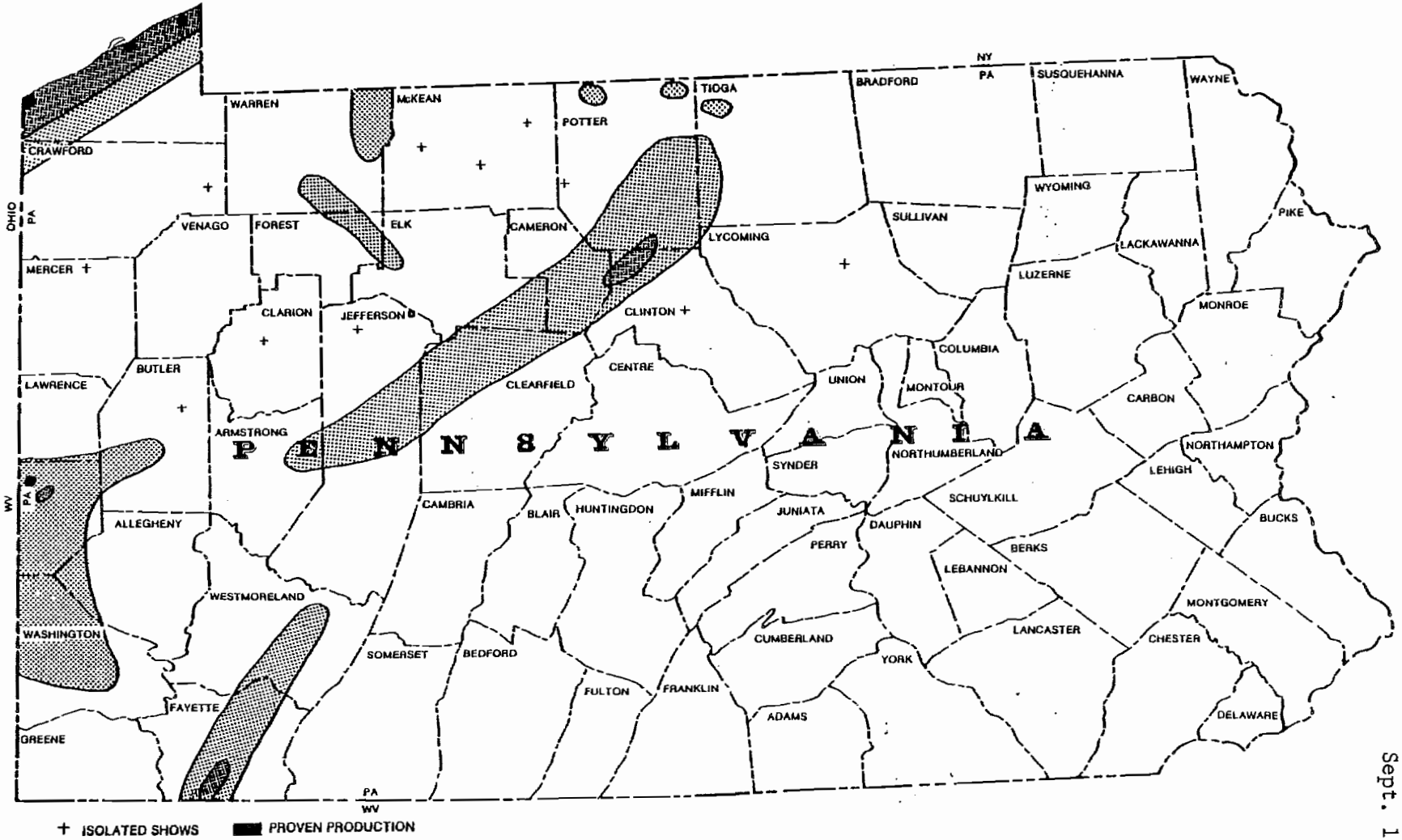
LASchrider
WKOverbey
RLWise
CAKomar
ABYost
CDLocke
CWByrer
GRSundheimer (Mound)
JCurtis (SAI)
GFingleton (SAI)



CONCENTRATION OF DEVONIAN SHALE GAS SHOWS

SCALE

5 0 5 10 15 20 25 MILES

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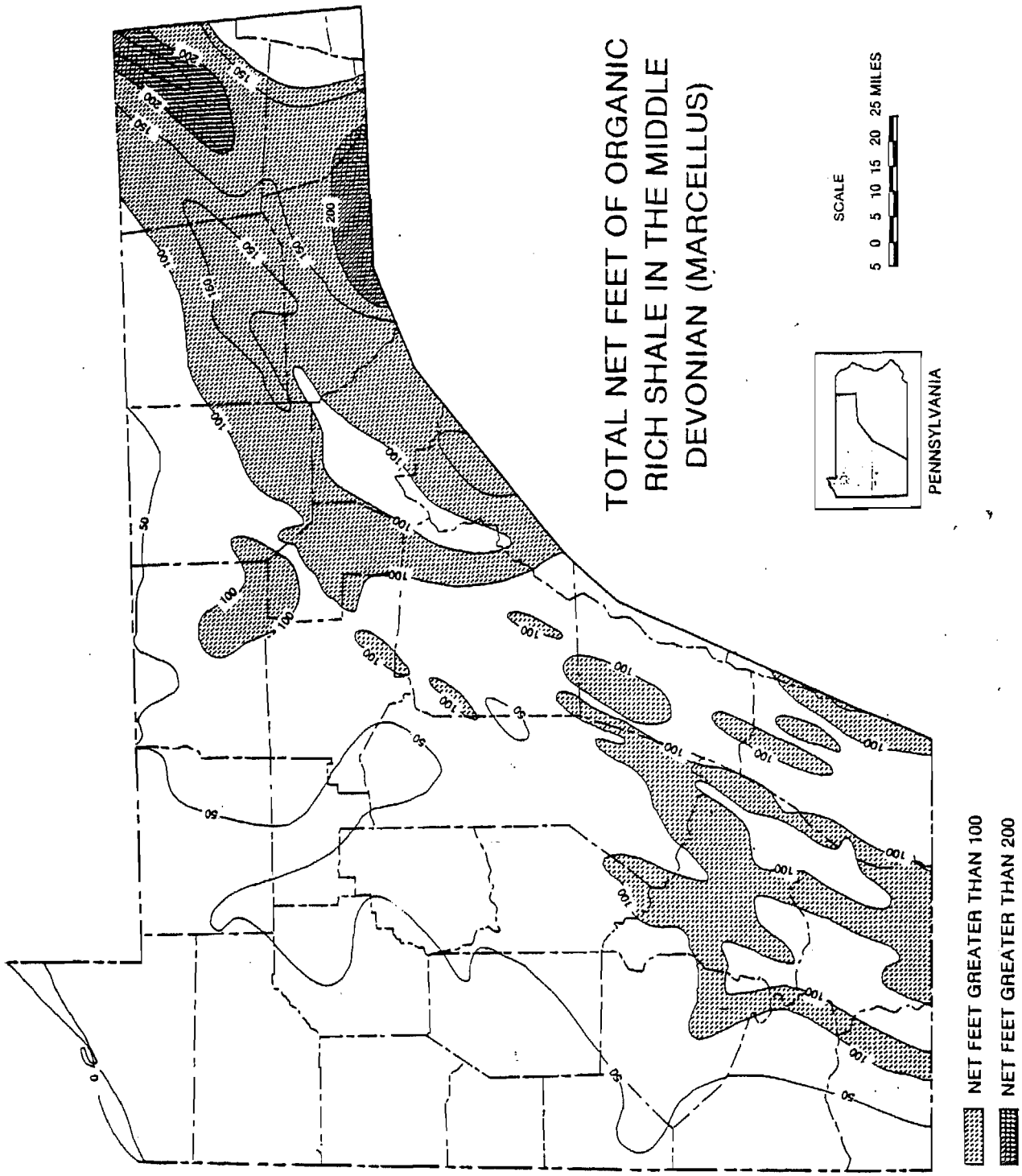

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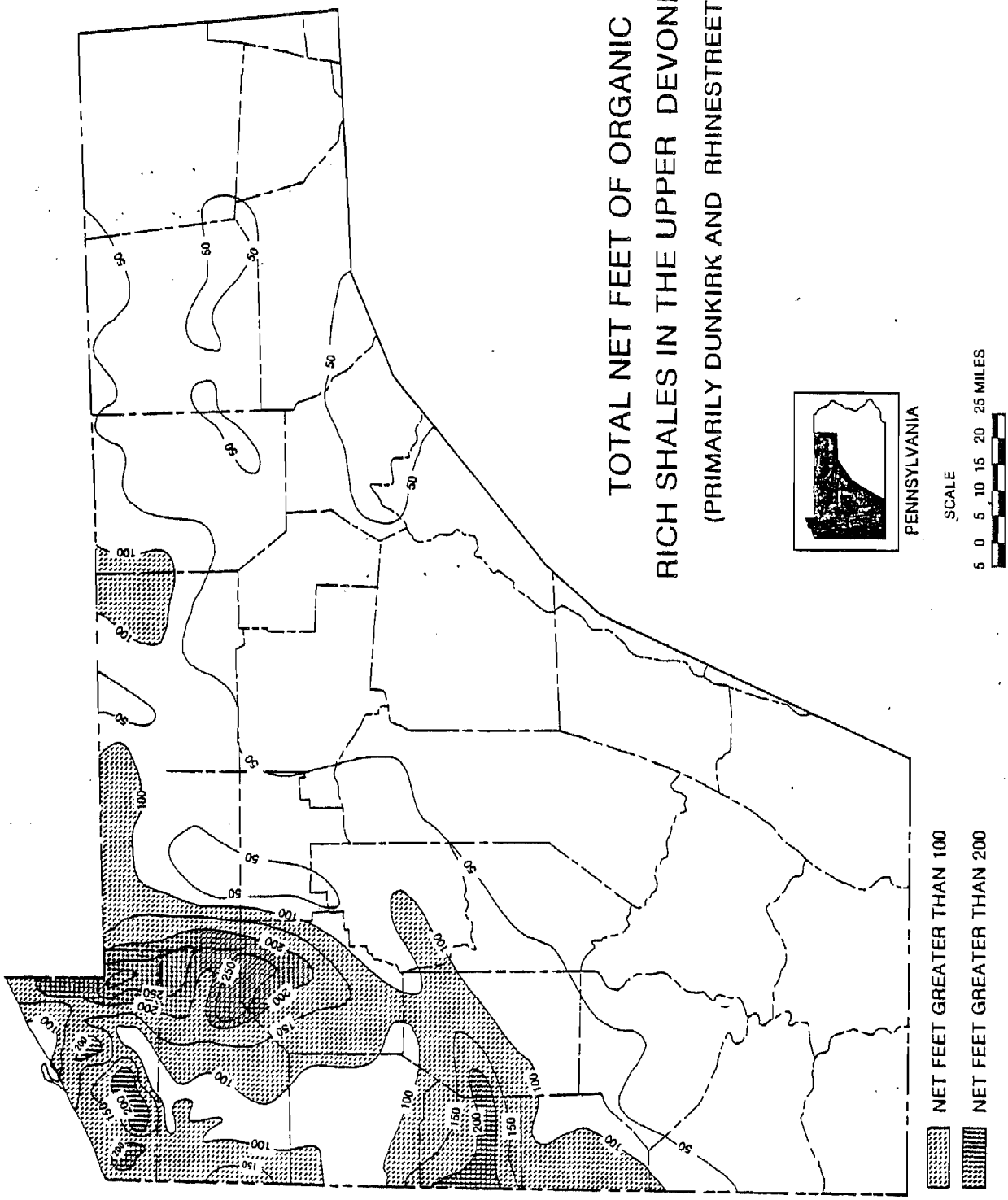

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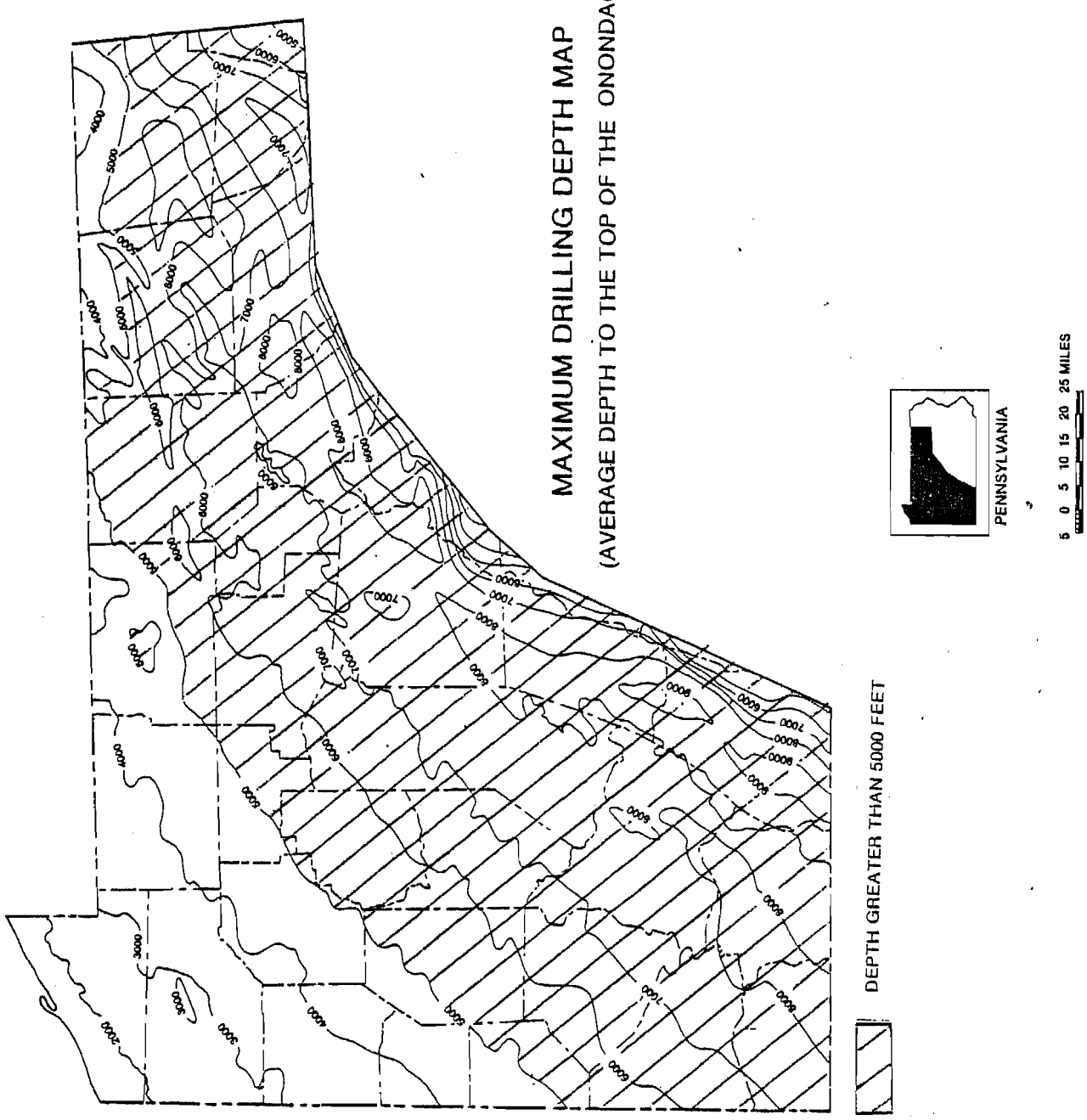

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