Waste Isolation Pilot Plant

Compliance Certification Application

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ORNL/SUB-4423/1

New Mexico Bureau of Mines and Mineral Resources

New Mexico Institute of Mining and Technology

OIL AND GAS POTENTIAL OF A PROPOSED SITE FOR THE DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE

Contract No. AT-(40-1)-4423
Oak Ridge National Laboratories
U. S. Atomic Energy Commission

MASTER

Open-file report
1974

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
DEPARTMENT OF ENERGY

ORNL/SUB-4423/1

OIL AND GAS POTENTIAL OF A PROPOSED SITE FOR THE DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE

by

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Oak Ridge National Laboratories

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1974

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INTRODUCTION

This study was in part funded by the Atomic Energy Commission under Contract No. AT-(40-1)-4423. Terms of this contract as they involve this particular study, are restated here so that reviewers may be aware of the basic aims of the project.

Project I - Evaluate the Petroleum Potential of the Proposed Radioactive Waste Disposal Site: Initial studies to be completed by February 15, 1973, will involve the development of pertinent information related to the location of a favorable site for coring of the Salado Formation and underlying rocks somewhere within Ts. 22-23 S., [Ts. 21-22 S.] , Rs. 31-32 E.

Evaluation of petroleum potential of the above-mentioned townships will include all rocks from the surface to the Pre-Cambrian [Precambrian] basement with emphasis on the deeper horizons. This study will include all wells in the area, and pertinent structural, lithologic and isopach data for the proposed disposal site. Necessary regional interpretation of these strata will be conducted and will include existing fields, wells, secondary recovery operations, areas of salt water disposal, production data, and pressures. In addition, the 1961 report by Foster and Stipp showing basement configuration in southeastern New Mexico will be revised.

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On or before February 15, 1973, the Contractor shall furnish a preliminary report addressed to Mr. Joseph A. Lenhard, Director, Research and Technical Support Division, U. S. Atomic Energy Commission, Oak Ridge, Tennessee 37830, which includes, but not restricted to, the following:

(i) information related to the location of a site for the coring of the Salado and overlying formations; and

(ii) a preliminary evaluation of the petroleum potential of the proposed waste disposal site. A final report regarding the petroleum potential of the area shall be furnished to the above-mentioned addressee on or before June 15, 1973. Such final report shall include necessary isopach, structural and facies maps of important formations from Permian to Pre-Cambrian [Precambrian] .

Project I shall be conducted under the direction of Mr. Ray [Roy] Foster or such other member of the Contractor's staff as may be mutually satisfactory to the parties.

The sections of the following report that are involved with the Atomic Energy Commission contract are stratigraphy, structure, geological evaluation of the oil and gas potential, petroleum exploration in the Pilot area, water injection and disposal wells, and that part of the section on conclusions involving geologic factors. Production data is given in the sections on exploration status, statistical oil and gas potential, and the tables in Appendix 1. The remainder of these sections involve reserve projections and potentials for each part of the geologic section and were generated primarily for the interests of the State of New Mexico. They were included here to give all interested parties some background information on the oil and gas producing potential of this part of New Mexico.

Because of limited oil and gas exploration in the four township contract area, named the Pilot area in this report, it was necessary to expand the investigation to include a sufficient number of wells for adequate evaluation of the oil and gas potential. The basic areas studied are shown in Figure 1. The Pilot area consists of T's. 21 and 22 S., R's. 31 and 32 E. The Study area covers T. 20 S., R's. 30 to 35 E., and T's. 21 to 26 S., R's. 29 to 34 E. and represents the area used in preparation of isopach and structural contour maps and stratigraphic sections used in evaluating the oil and gas potential from a geologic standpoint. Beyond this a much larger area was examined in less detail to support geologic conclusions, and to evaluate the producing potential of various parts of the geologic section. Naturally each part of this section requires somewhat different treatment and thus the area studied varies from one formation to the next. Finally, in keeping with terms of the contract, the contour map of the Precambrian surface as published by Foster and Stipp (1961) was completely revised for a large part of southeastern New Mexico.

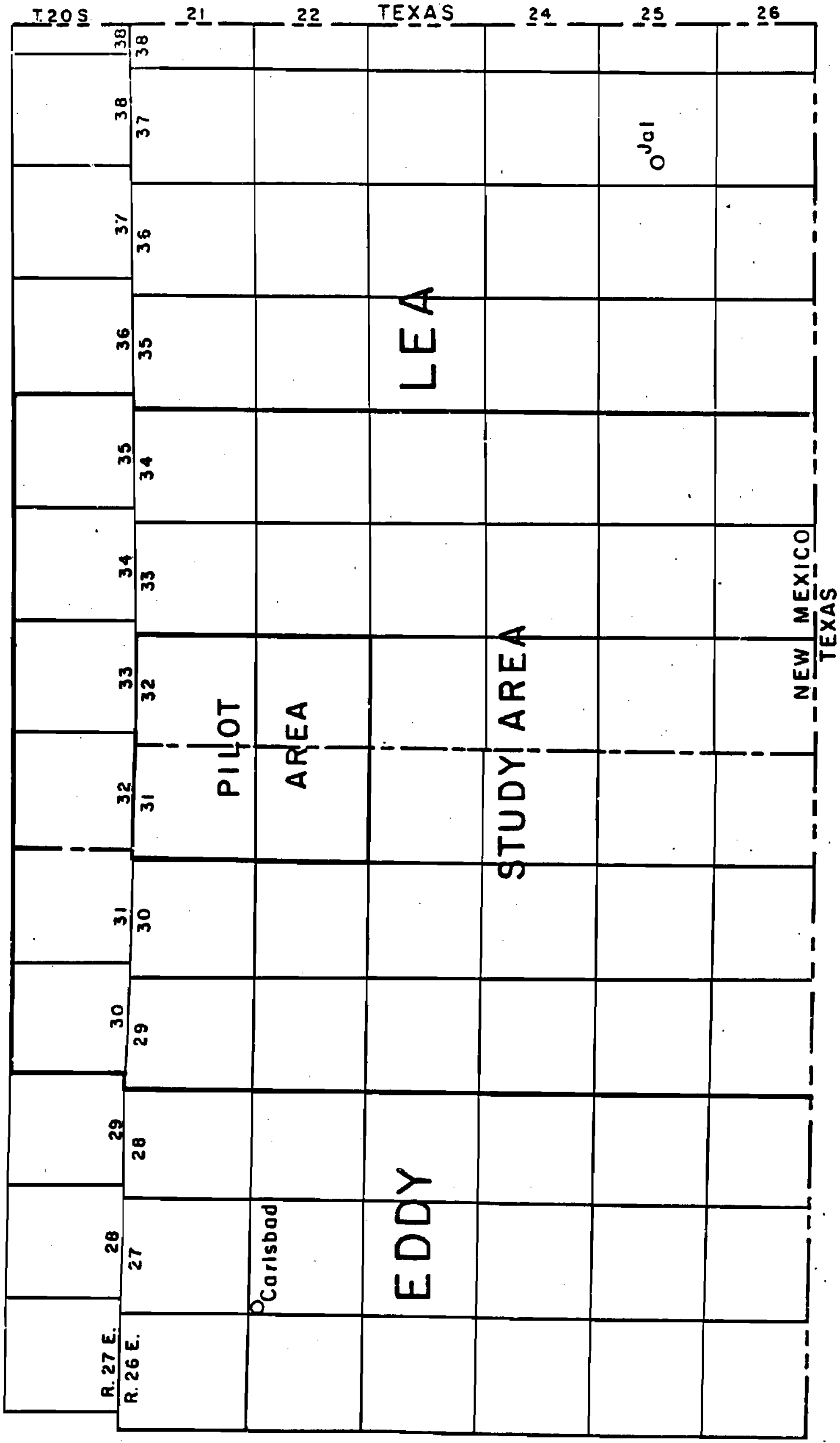

Fig. 1 Index map of report areas

STRATIGRAPHY

The stratigraphic section studied for this report includes rocks ranging in age from Precambrian to Permian (fig. 2). The sedimentary part of the sequence consists of, in simplest terms, dolomite, limestone, sandstone, and shale. Within this general classification are the complex variations in amounts of clay, silt, sand, dolomite, calcite, and organic remains that result in lateral and vertical variations typical of sedimentary rocks and that with tectonic events are of prime importance in exploration for oil and gas.

Near the center of the Pilot area of this report the thickness of sedimentary rocks present below the Permian Castile Formation, is approximately 13,500 feet. Of this slightly over 60 percent or 8,200 feet is attributable to strata of Permian age. Within this four township area rocks of Ordovician age range from 1,000 to 1,400 feet in thickness; Silurian and Devonian rocks from 1,200 to 1,700 feet; Mississippian from 600 to 800 feet; Pennsylvanian, 1,800 to 2,200 feet, and Permian, 6,700 to 8,800 feet.

To stratigraphers an important problem in the Delaware basin, as far as the subsurface rocks are concerned, is the lack of a formal rock-stratigraphic nomenclature for several parts of the stratigraphic section. For this report it was thought more advisable to utilize, where possible, the terminology developed by petroleum geologists and others engaged in the exploration for oil or gas in the basin. In part

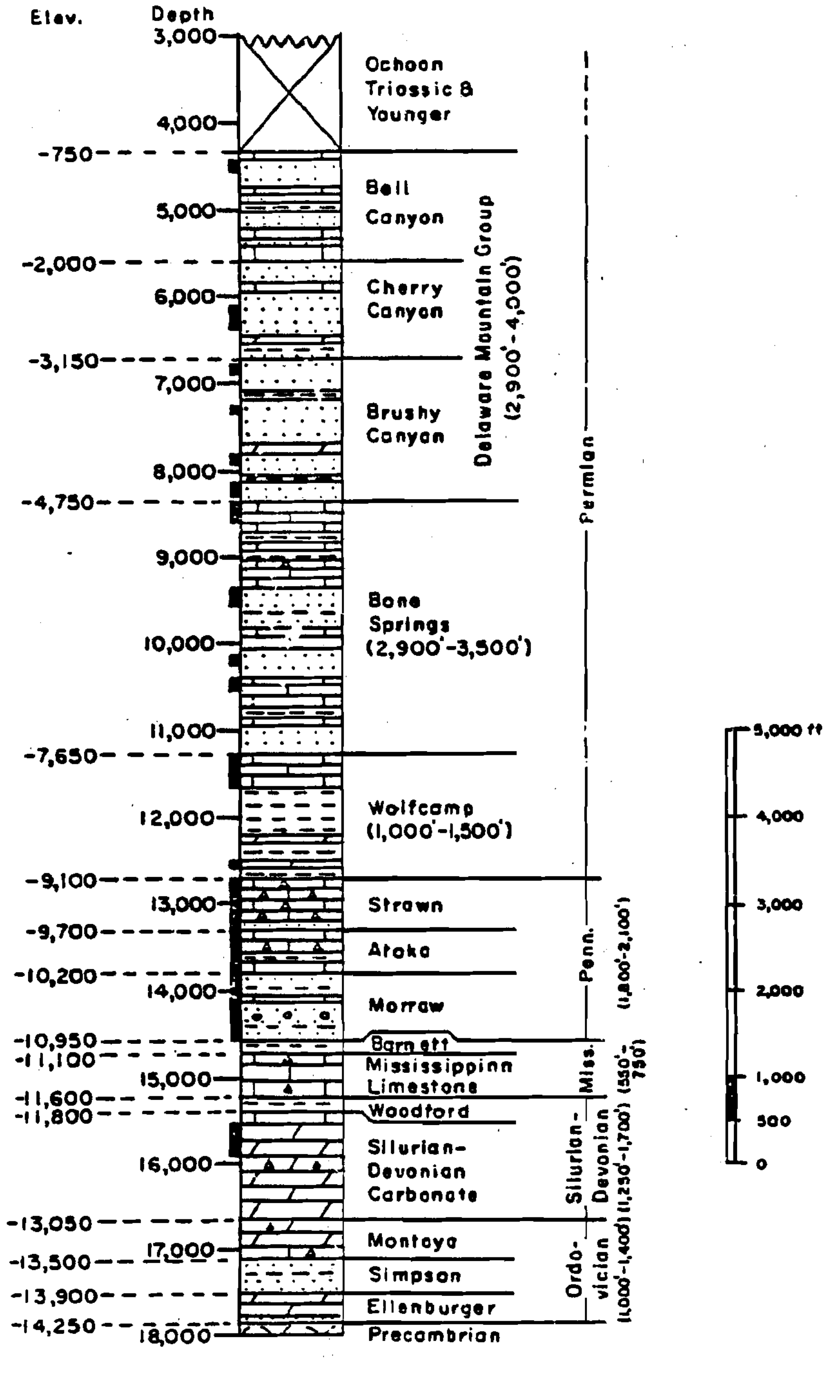

Fig. 2 Projected section: Center of Pilot area

▌ Potential pay zones

this follows formally accepted rock-stratigraphic names such as Ellenburger Group, Woodford Shale, and Bone Springs Formation. In other cases sufficient paleontological and/or lithological studies have not been made so that a formal classification can be used, or names have been applied to certain intervals of rocks that constitute pay zones in oil and gas wells. Thus we have Siluro/Devonian, Mississippian lime or Ramsey sand. These designate intervals that in areas of outcrop have either been subdivided into groups, formations, or members, or were not considered to be of significant stratigraphic variation to be given formal stratigraphic names. Rocks of Pennsylvanian age present a particular problem in that there is little consensus as to what constitutes a particular rock-stratigraphic interval. In addition, lack of formal names plus changes in stratigraphic designations have resulted in a rather loose application of time-stratigraphic and rock-stratigraphic names. The stratigraphic terms used for this as well as other parts of the section, along with their lithologic description, were designed to be generally recognizable by those familiar with the stratigraphy of the Delaware basin, and to relate these units to oil and/or gas-bearing zones.

Precambrian Rocks

Numerous wells have penetrated the upper part of the Precambrian on the Central Basin platform, but only a few have been drilled to rocks of this age elsewhere in southeastern New Mexico (fig. 3).

Flawn (1954, 1956) subdivided the Precambrian of Texas and southeast New Mexico by rock type and established various terranes. The regional area of this report is underlain for the most part by the Texas craton. This terrane is distinguished by granite and granodiorite, but as in most shield areas a complexity of detail is to be expected.

On the Central Basin platform, particularly in T. 19-20 S., R. 36-37 E. and T. 21-22 S., R. 37-38 E., the granitic rocks are fine grained and were considered microgranite and microgranodiorite by Flawn and Foster and Stipp (1961). Muehlberger (1964) noted that the texture of these rocks was definitely metamorphic, and based on tracing from unmetamorphosed rhyolite to slightly reconstituted rhyolite to an area of granofels, considered the rock to be probably metarhyolite. In the northern part of the Central Basin platform in New Mexico this rock type is associated with granite suggesting the possibility that they are cataclastically metamorphosed granite. Oil exploration has disclosed that similar rocks are present on the platform as far south as T. 25 S., R. 37 E. Unmetamorphosed rhyolite underlies a large part of northern Lea County and was named the Panhandle Volcanic terrane by Flawn (1956). Based on petrographic studies these rocks consist chiefly of rhyolite porphyry flows and associated tuffs. In addition to these rock types, wells drilled on the Central Basin platform have encountered diorite and olivine gabbro intrusives, and quartz-biotite schist. Cuttings from the well that penetrated the schist also included chips of rock of the microgranite type.

Three wells have been drilled to the Precambrian in the southeastern part of the Delaware basin in New Mexico. The rock type was reported to be granite, but in oil-field terminology this is commonly used to describe any igneous or metamorphic rock and thus is a synonym for basement or Precambrian. In T. 20 S., R's. 31 and 32 E. two wells encountered granite in the Precambrian. To the west, outside the Precambrian map area basement rocks consist of granite in T's. 18 and 19 S., R. 23 E. and in T. 23 S., R. 23 E. Between these two areas Flawn has shown a belt of metamorphic rocks extending east and north to Chaves County. Further to the west in eastern Otero County and southwestern Chaves County the Precambrian sequence includes unmetamorphosed shale, siltstone, sandstone, and dolomite, metasediments, andesite porphyry, and rhyolite porphyry (Foster, 1959). The sedimentary and metasedimentary rocks may extend into the northwestern part of the Precambrian map area and perhaps even further to the east. The aeromagnetic map of the Carlsbad area (U. S. Geological Survey, 1973) has a low magnetic intensity east of Carlsbad that may indicate an extension of this terrane. Elsewhere in the Delaware basin there is no magnetic indication of significant lithologic change in the Precambrian rocks and it is assumed that most of the basin in New Mexico is underlain by rocks of granitic composition.

Based on isotopic dating, Muehlberger (1964) considered the grouping of the Texas craton too broad and abandoned the use of this term. He introduced Central Basin platform terrane for an area including but not restricted to the structural Central Basin platform. Ages of Precambrian rocks in southeastern New Mexico vary considerably (Wasserburg, et. al., 1962, and Muehlberger, et. al., 1964, 1966, and 1967). The Panhandle Volcanic terrane has an age of approximately 1.14 by, and the Central Basin platform terrane, two distinct ages of 1.17 and 1.35 by. The older rocks are located primarily on the northwestern shelf and are similar in age to the intrusive events of central and northeastern New Mexico. The younger rocks dated from granite and a gneiss suggest an association with the Panhandle Volcanic terrane. The rhyolite to the west of the map area, although not dated, is similar to rhyolite of the Franklin Mountains and possibly Pump Station Hills. The Franklin Mountain rhyolite has a maximum age of about 0.97 by (Denison and Hetherington, 1969) somewhat younger than the Panhandle Volcanic terrane.

Ordovician System

Rocks of Cambrian age are not believed to be present in this area. The west-east transgressive overlap of Cambrian/Ordovician sediments onto the Precambrian surface has been well documented for many years. The Bliss Sandstone in the Franklin Mountains of west Texas, is in part of Cambrian age, but is thought to be entirely Early Ordovician in the Sacramento Mountains of New Mexico. Conglomerate and sandstone at the base of the Ordovician section in the subsurface of southeastern New Mexico are sometimes called Bliss Sandstone, particularly in the western part of the Delaware basin. These rocks probably correlate with the Ordovician part of the Bliss.

Barnes, et. al. (1959) have shown that the Gorman Formation of the Ellenburger Group overlies the Precambrian in the area of the Central Basin platform, and locally is as thin as 100 feet in parts of Lea County. Elsewhere in southeastern New Mexico the older Tanyard formation overlies Precambrian. This indicates a greater relief on the Precambrian surface on parts of the Central Basin platform. Areas suggestive of island chains consisting of Precambrian rocks, in the Early Ordovician seas have been noted in other parts of southern New Mexico and west Texas (Kottlowski, et. al., 1973).

The generalized section of Ordovician rocks in the vicinity of the Pilot area (fig. 4) is based on samples and a radioactivity log of the Texas 1 Richards well in sec. 25, T. 20 S., R. 32 E. In ascending order the section includes the Ellenburger Group, Simpson Group, and Montoya Group. The original reference to the Ellenburger was by Paige (1911) for Lower Ordovician rocks in the Llano region of central Texas. Cloud and Barnes (1948) noting inclusion of rocks of Late Cambrian age restricted the Ellenburger to the Lower Ordovician and published detailed type and standard sections including that of the Franklin Mountains.

In the reference well, above a basal sandstone-conglomerate interval, the Ellenburger Group consists of dolomite with some chert. Elsewhere in the Study area the sequence is quite similar, consisting

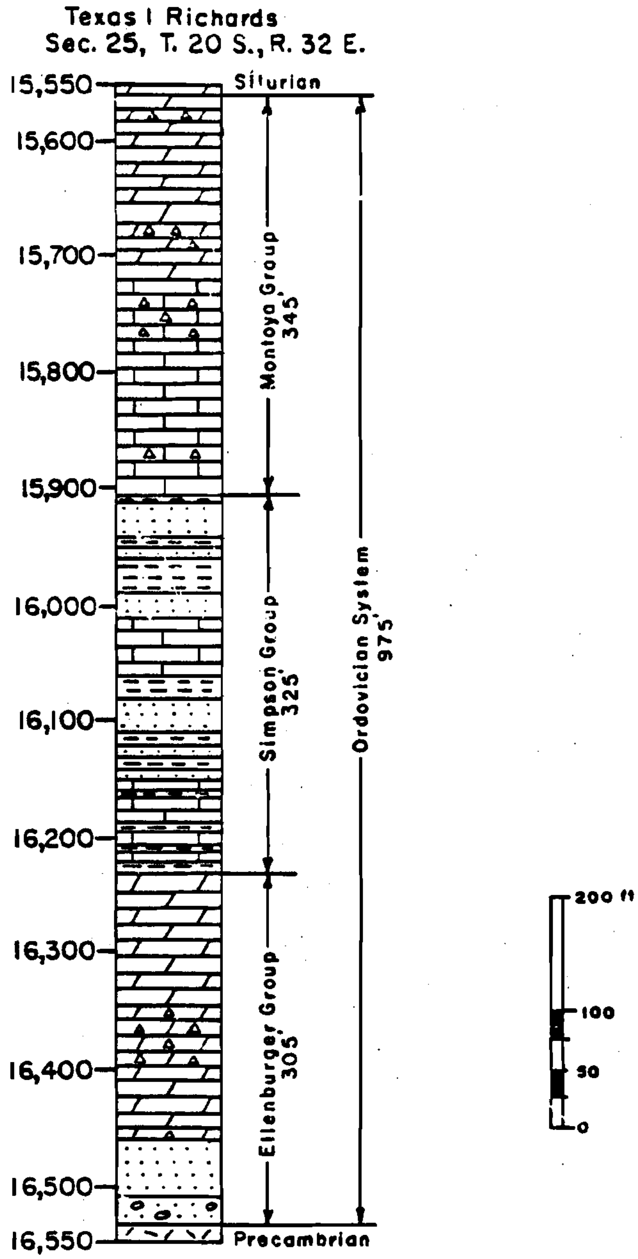

Fig.4 Ordovician reference section

of dolomite with appreciable chert in some beds and locally sandy dolomite in the lower part of the section. From the 300 feet present in the reference well the Ellenburger thickens to almost 600 feet in T. 25 S., R. 31 E., and to slightly over 1000 feet in T. 25 S., R. 33 E.

The Simpson Group was named by Taff (1902) for exposures in the Arbuckle Mountains of Oklahoma. Decker (1933) and Harris (1957) established several formations that are from oldest to youngest: Joins, Oil Creek, McLish, Tulip Creek, Bromide, and Corbin Ranch. Fossils indicate a Chazyan-Black River age for the Simpson. The Cable Canyon Sandstone of central New Mexico occupies a similar stratigraphic position to the Simpson in that it unconformably overlies the El Paso-Ellenburger Group. However, Flower (1961, 1969) and LeMone (1969) consider the Cable Canyon to be of Coburg-Eden age which would be younger than the Simpson. Flower (1961) has described a discontinuous sandstone sequence below the Cable Canyon in parts of southern New Mexico and suggested a Harding-Winnipeg age. In part this would be coeval with the Simpson. Another possibility would be that the Simpson-Cable Canyon rocks represent a transgressive clastic facies that overlaps to the west onto the El Paso-Ellenburger groups.

In the subsurface of west Texas the Simpson has been subdivided into A, B, C, and D zones. Ireland (1965) suggested correlation of Zone A with the Joins, B - Oil Creek, C - McLish, and Zone D with Tulip Creek and Bromide. In the Ordovician reference section the lower 65 feet of limestone and green shale is similar to the Joins, the next 55 feet of green shale, limestone, and sandstone may be an Oil Creek equivalent; the following 100 feet of limestone and green and gray shale suggesting the McLish; and the remaining 105 feet of sandstone and green shale, the Tulip Creek. Sandstone members of these formations contain oil on the Central Basin platform. If the subdivisions of the reference section do in fact correlate with Ireland's subdivisions, the Connell Member of the Oil Creek is not well developed in this area, but the Waddell Member at the base of the McLish Formation, and the McKee Member at the base of the Tulip Creel Formation would be present. Rocks similar to those of the Bromide Formation are present in the southern part of the Study area but do not appear to be present in the reference well. This could be the result of northward pre-Montoya erosional truncation.

As noted by Wright (1965) the Simpson is less than 1,000 feet thick on the Central Basin platform and thins to the north and west with less than 500 feet present in the vicinity of the Pilot area. In the reference well, the Simpson section is 325 feet thick. To the south in T. 25 S., R. 31 E. sedimentary rocks of this unit are almost 600 feet thick.

The Montoya Group, originally Montoya Limestone, was named by Richardson (1908) for exposures in the Franklin Mountains north of El Paso, Texas. Subsequent to this, geologists, notably Entwistle (1944), Kelley and Silver (1952), and Pray (1953, 1961) recognized various members and formations. From oldest to youngest the formational names most commonly used are Cable Canyon Sandstone, Upham Dolomite, and Alemar and Cutter formations. Howe (1959) considered the Upham to be Trenton, but did not rule out a Cincinnatian age; the Aleman to be Eden-Maysville-lower Richmond; and the Cutter as late Richmond. Flower (1969) refers the Upham to Coberg-Eden and possible late Trenton, and the Aleman-Cutter to be Richmond and possibly, in part late Maysville. Thus we have a general agreement as to a Late Ordovician age.

Howe established the presence of the above formations, except for the Cutter, in the Baylor and Beach Mountains north of Van Horn, Texas. Normally the formational names have not been used in subsurface rock classifications of southeastern New Mexico, although a routine examination of the section penetrated in wells in this area suggests possibilities of suitable correlations with outcrops of the Montoya Group to the west. In the reference section the upper part of the Montoya consists of dolomite, and the lower of limestone. Chert is fairly common, particularly in the middle part of the section and may indicate the Aleman. South of the Pilot area in T. 25 S., R. 31 E. the rock type is almost entirely limestone with some sandy limestone near the base possibly representing the Cable Canyon. The change south to limestone is similar to that observed in south-central New Mexico and west Texas. The Montoya thickens from 345 feet in the reference well to 450 feet in the well in T. 25 S., R. 31 E.

The isopach map of Ordovician rocks (fig. 5) is restricted to the four township Pilot area. There are no control points within this area, but two wells were drilled to the Precambrian in T. 20 S., and two points were available in T. 24 S., R. 34 E., and T. 25 S., R. 31 E. A gradual southeastern thickening is evident with about 1,000 feet in the north part of the Pilot area to slightly over 1,400 feet in the southeast corner of this area. The northward thinning of Ordovician strata has been discussed by Kelley and Silver (1952), Kottlowski, et al. (1956) and others. Kottlowski, et al., in particular demonstrated that the northward thinning was the result of a major period of erosion between Lower Ordovician rocks of Canadian age and Upper Ordovician, Cincinnatian-age rocks. In turn the upper part of the Ordovician is separated from Silurian rocks by an erosional unconformity and to the north Devonian and younger Paleozoic rocks rest on the Ordovician above an unconformity of a long and complex history. It is important to stress that northward thinning as far as can be determined is primarily the result of these erosional periods, and that depositional thinning or an approach to a shoreline facies cannot be demonstrated. Obviously there is depositional thickening to the south into the Ordovician Toboso basin, but the northward extent of this basin in New Mexico would appear to be much greater than previously indicated.

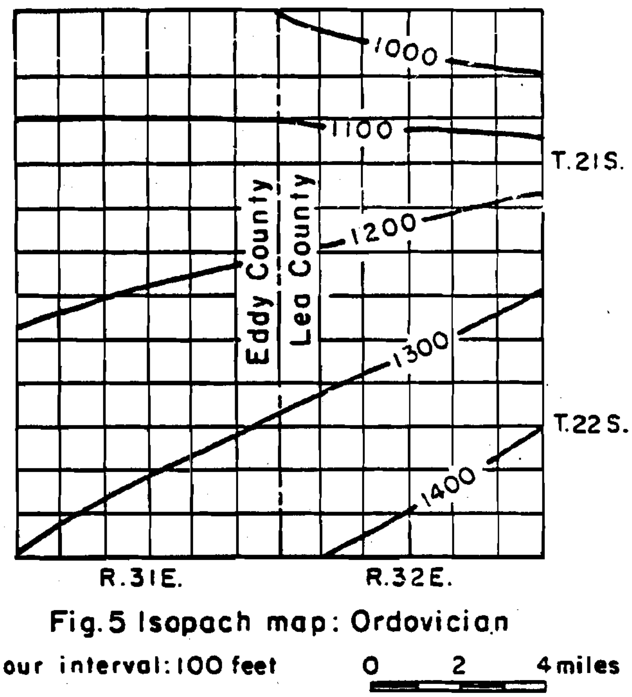

Fig. 5 Isopach map: Ordovician

Contour interval: 100 feet

Silurian/Devonian Systems

Rocks of Silurian and Devonian ages in southeastern New Mexico have been rather poorly defined. The standard usage includes the Woodford Shale and an underlying carbonate sequence referred to as Silurian, Devonian, or Siluro/Devonian. Locally rocks presumed to be of Silurian age have been separated into the Fusselman Dolomite and Upper Silurian. The difficulty in separating the carbonate sequence has been discussed by numerous geologists. Gibson (1965) used the term Hunton terrane for the carbonate sequence because of the varied terminology in the Permian basin. McGlasson (1967) suggested that the carbonate rocks in the Delaware basin of New Mexico are restricted to Fusselman and Upper Silurian with rocks of Devonian age found only at the southern end of the Central Basin platform in Lea County. Lacking any justification from the present work for specific formational designations for the carbonate sequence, the common oil-field usage of Siluro/Devonian is followed although modified to the more acceptable Silurian/Devonian. Included, however, is a brief description of the derivation of the Fusselman Formation.

The Fusselman Limestone was named by Richardson (1908) for exposures in the Franklin Mountains, Texas. Flower (1969) reviewed the available faunal data and concluded that the Fusselman was of Alexandrian and Niagaran ages, thus Early to Middle Silurian. Overlying the Fusselman Dolomite in the Sacramento Mountains are shale and siltstone of late Middle Devonian to early Late Devonian age (Flower, 1969). A suggested correlation of these beds with the Canutillo Formation of the Franklin Mountains was made by LeMone (1969). Of interest here is that the shaly beds overlying the Fusselman Dolomite are in part correlative in age with the Woodford Shale.

The type locality of the Woodford "Chert" is in Oklahoma and was originally referred to by Taff (1902). The age of the Woodford has been studied at some length and at times has been considered Devonian, Mississippian, or to include beds of both ages. McGlasson (1967) on the basis of fossils, suggested a Late Devonian age, except for the upper part which is probably Early Mississippian. He noted correlation with the Canutillo and overlying Percha formations in the Franklin Mountains. Wright (1963) divided the Woodford into lower, middle, and upper members and suggested correlation of the middle member with the Contadero Formation and Ready Pay Member of the Percha. The upper member was correlated with the Box Member of the Percha. Flower (1969) and others consider the Percha to be of Late Devonian age. LeMone (1969) observed a disconformable contact with the overlying Mississippian Las Cruces Limestone in the Franklin Mountains, and Pray (1961) a sharp disconformity between the Percha and Mississippian Caballero Formation in the Sacramento Mountains. In parts of the San Andres Mountains and in some wells in southeastern New Mexico, the contact appears gradational.

In the Silurian/Devonian reference section (fig. 6) the carbonate sequence consists of light-colored limestone, dolomite, and chert. There are two prominant intervals of limestone, the first, at the top of the section, is about 200 feet thick, and the second, near the middle, just under 100 feet thick. The remainder is dolomite. In the reference well carbonates are 1,260 feet in thickness, whereas in T. 25 S., R. 31 E. the thickness is 1,390 feet; in T. 25 S., R. 33 E., it is 1,680 feet; and in T. 26 S., R. 35 E., 1,675 feet. Closer to the Pilot area in T. 22 S., R. 30 E. this interval is 1,080 feet thick reflecting the regional westward thinning. Isopach lines in the Pilot area (fig. 7) show a rather uniform thinning from 1,500 feet in the east to 1,100 feet on the west. With all control points located outside the Pilot area no detail of local thinning or thickening is revealed.

The Woodford is typically dark gray to black and brown, pyritic shale. At the reference section it is 160 feet thick, and within the Study area has a minimum thickness of 80 feet in the northwest corner (fig. 8). The maximum thickness is about 250 feet in T. 24 S., R's. 33-34 E. and an estimated 260 feet in the southeast corner of the Study area. At the 10-foot contour interval used for the isopach map smaller features modify the regional southeastward thickening of the formation. These features are discussed further in the following section on structure.

Lack of control results in considerable spreading of the contours in the Pilot area. Available information would seem to indicate a thickness of from 170 to 180 feet in the center of the area. Slightly

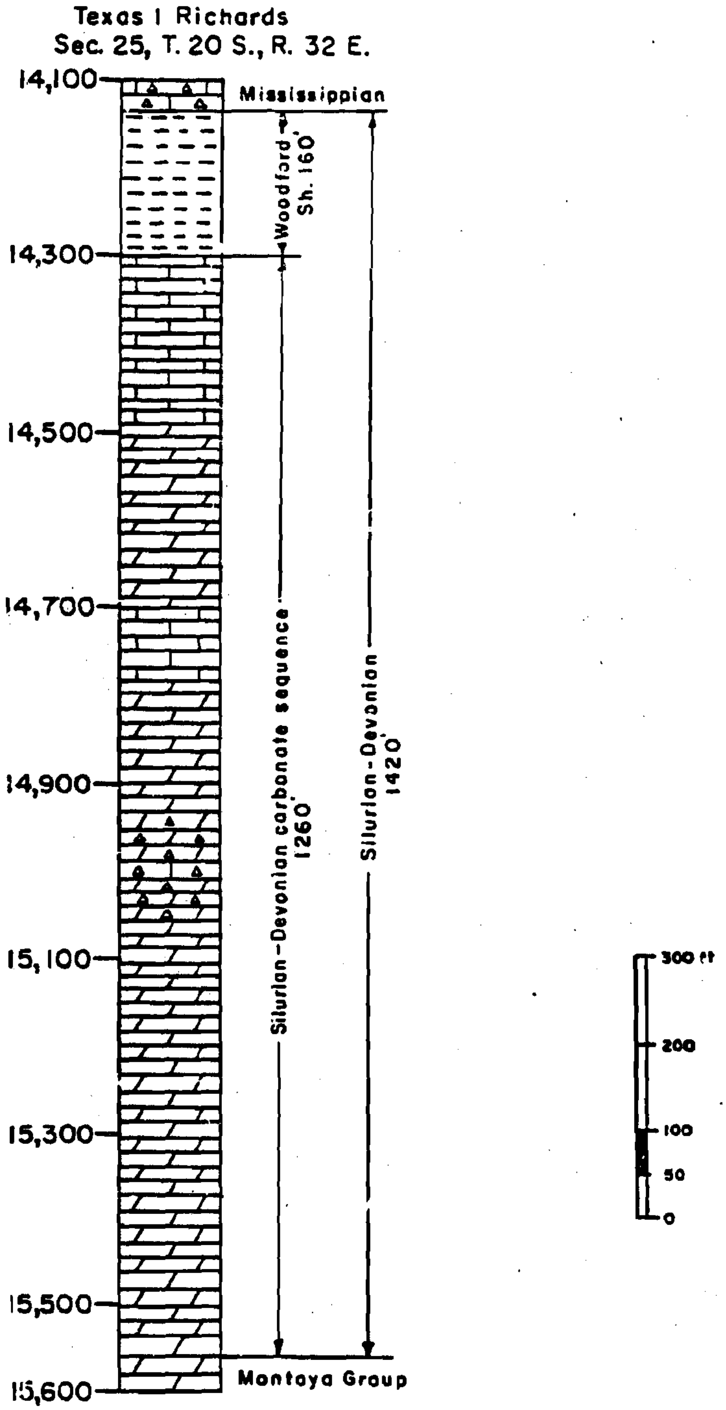

Fig.6 Silurian/ Devonian reference section

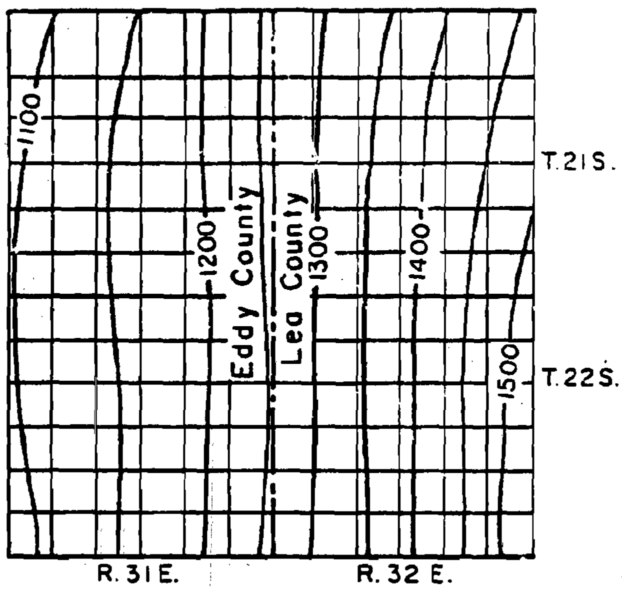

Fig.7 Isopach map: Silurian / Devonian carbonates
Contour interval: 50 feet 0 2 4 miles

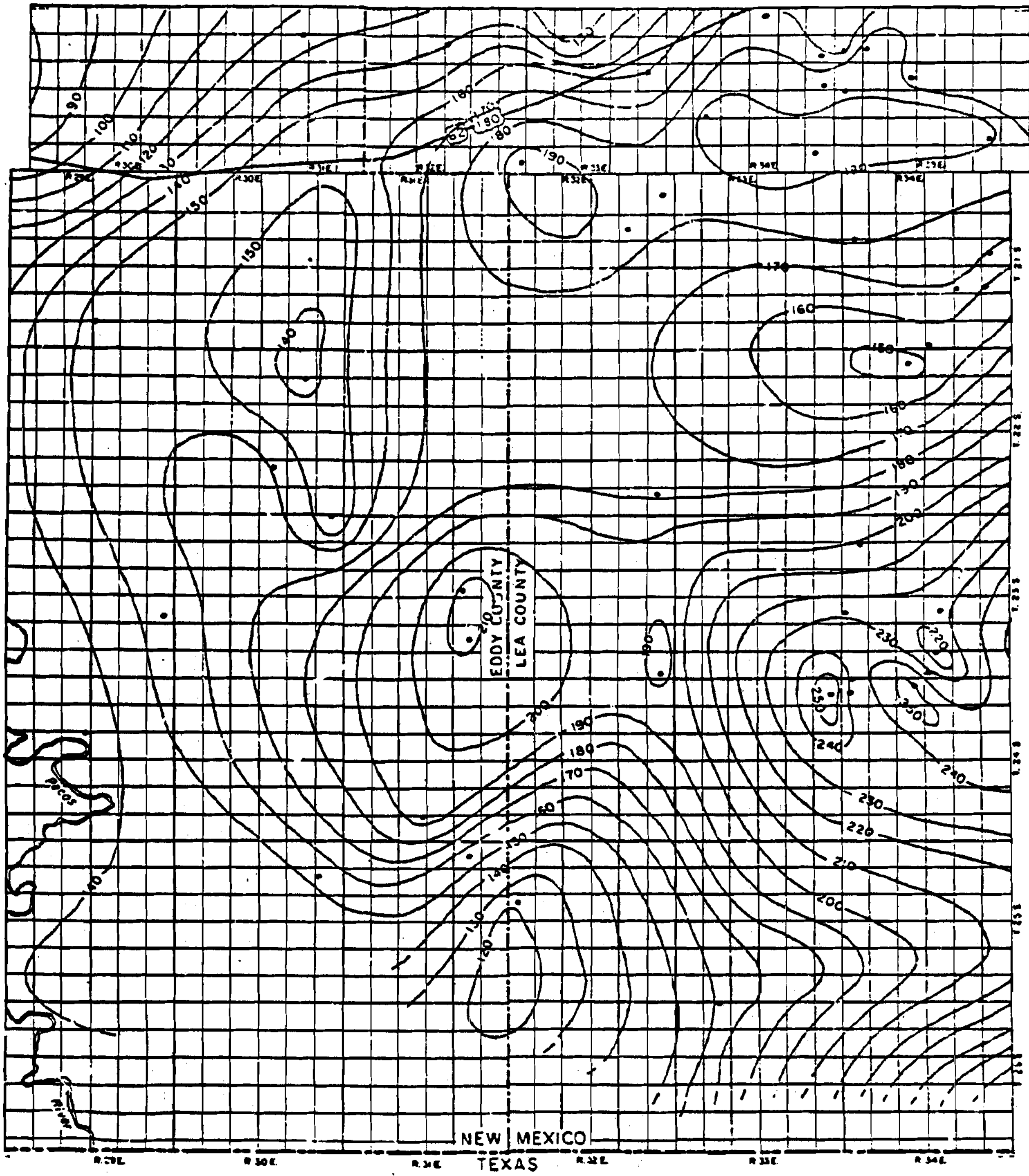

Fig. 8 Isopach map: Woodford Shale

Contour interval: 10 feet

0 5 10 miles

thicker Woodford Shale is present to the north and south with some thinning to the east and west.

Mississippian System

Rocks assigned to the Mississippian in this report include a series of limestone referred to simply as Mississippian limestone, and an overlying shaly interval called the Barnett Shale. This follows the general oil-field usage in southeastern New Mexico. The top and base of the Mississippian limestone can be easily recognized, in most cases, in well samples and from mechanical logs. Where some doubt might exist as to the top and base it becomes only a question of a few tens of feet. Because of this, reported scout tops usually are quite reliable. The contact between the Barnett Shale and overlying Pennsylvanian rocks is less reliable. For this report a distinctive "kick" on mechanical logs that could be traced throughout the Study area, was used as the base of the Pennsylvanian. From sample studies this kick seems to represent a thin sandstone. For most wells this top for the Barnett coincides with the consensus of data reported for southeastern New Mexico. Chester is sometimes used for the Barnett and an overlying section of shale and sandstone here included with the Pennsylvanian. Lower Mississippian also is used occasionally for the Mississippian limestone of this report.

One of the first references to ae Barnett Shale was by Moore and Plummer (1922). The interval was named for shale exposures near San Saba, Texas and originally included in the Bend Group of Pennsylvanian age, but with noted possible Mississippian affinities based on the faunal assemblage. Later work indicated a Meramec and possibly partly Chester age for an upper zone, and Osage for a lower zone. Therefore, at least in part the shales overlying the Barnett may be equivalent to the "Chester" shale of the Delaware-Val Verde basins.

No attempt has been made to project into the Delaware basin the formations established by Laudon and Bowsher (1941, 1949) or Pray (1961) in the Sacramento Mountains to the west. It would appear that the Barnett is equivalent to some degree with the Rancheria and Helms formations of Meramec and Chester age, and the underlying limestone with the Lake Valley Formation of Osage age.

At the reference section locality (fig. 9) the Mississippian includes 540 feet of light-yellowish brown limestone, locally containing fairly abundant chert, and minor gray shale. The barnett consists of 80 feet of brown, in part silty shale.

The thickest section of the limestone interval is in the northeast part of the Study area (fig. 10) where 680 feet were drilled. The limestone thins to less than 300 feet in southwestern Lea County and in parts of southeastern Eddy County. In the southern part of the Study area thinning appears to continue to the west but there is a slight thickening east towards the Central Basin platform. In the Pilot area thicknesses range from 420 feet in the southeast to 560 feet in the

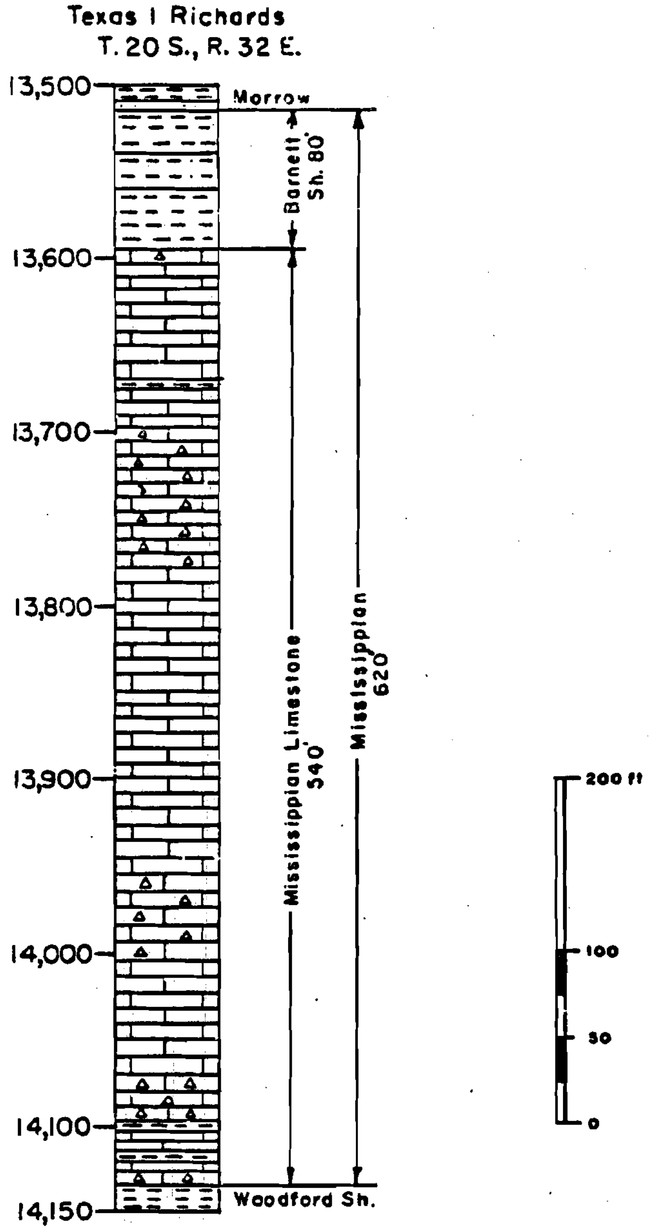

Fig. 9 Mississippian reference section

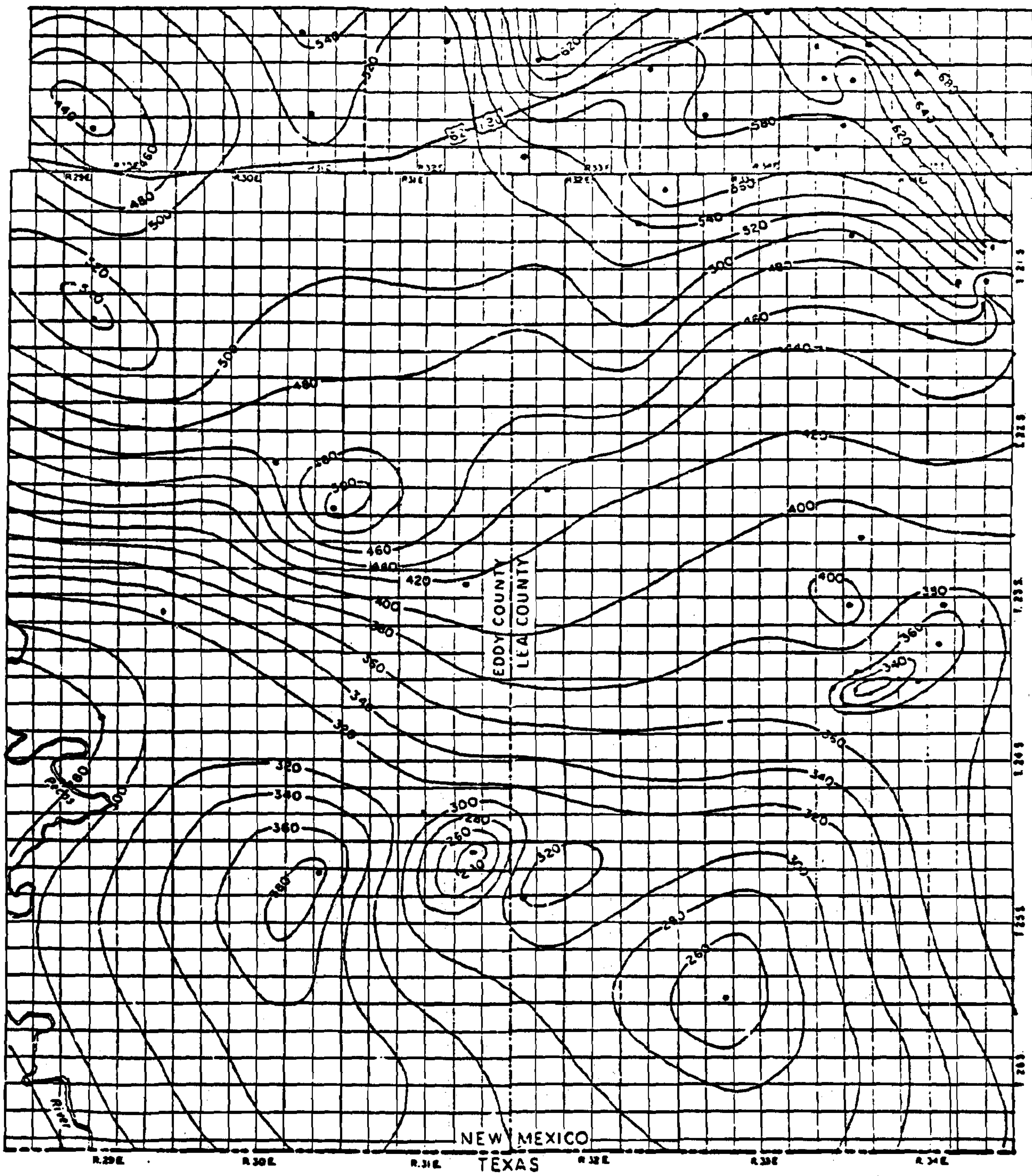

Fig.10 Isopach map: Mississippian carbonates
Contour interval: 200 feet
0 5 10 miles

northeast. No general depositional trend can be established for the Mississippian limestone in the Study area. Thicknesses vary considerably and do not follow patterns established for other parts of the stratigraphic section examined for this report.

The Barnett Shale maintains a fairly uniform thickness throughout much of the Study area of from 150 to 200 feet (fig. 11). It thickens locally to slightly over 300 feet in the eastern part of the area and there is a well defined trend toward a thicker Barnett interval to the southwest. Just outside the Study area in T. 25 S., R. 28 E. a well penetrated 540 feet of shale considered to be Barnett. In the Pilot area the unit is normally less than 200 feet thick and at the center of this area should measure about 175 feet. The thin interval in the reference section is unusual for this part of the Delaware basin.

Pennsylvanian System

In attempting to unravel the complex stratigraphy of the Pennsylvanian and arrive at a terminology suitable for use in this report it was necessary to establish correlative lithologic units within the Study area, and to relate these units to known producing zones. Three lithologic units were determined to fulfill these requirements and these are indicated in the reference section (fig. 12). All of the oil or gas discovered thus far in rocks of Pennsylvanian age in the Study area, with the possible exception of the Cabin Lake-Strawn Field occurs in these three zones.

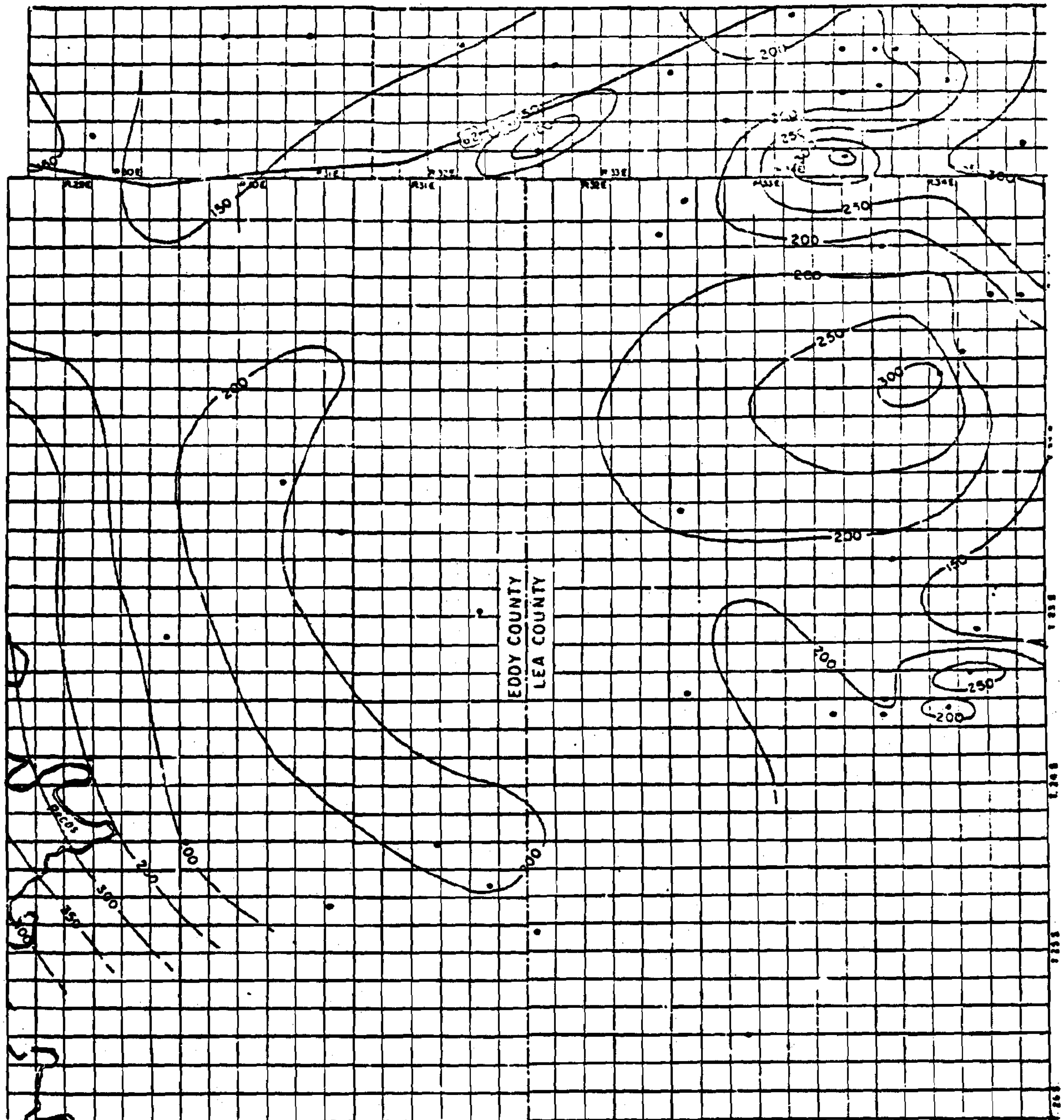

Fig.11 Isopach map: Barnett Shale
Contour interval: 50 feet
0 5 10 miles

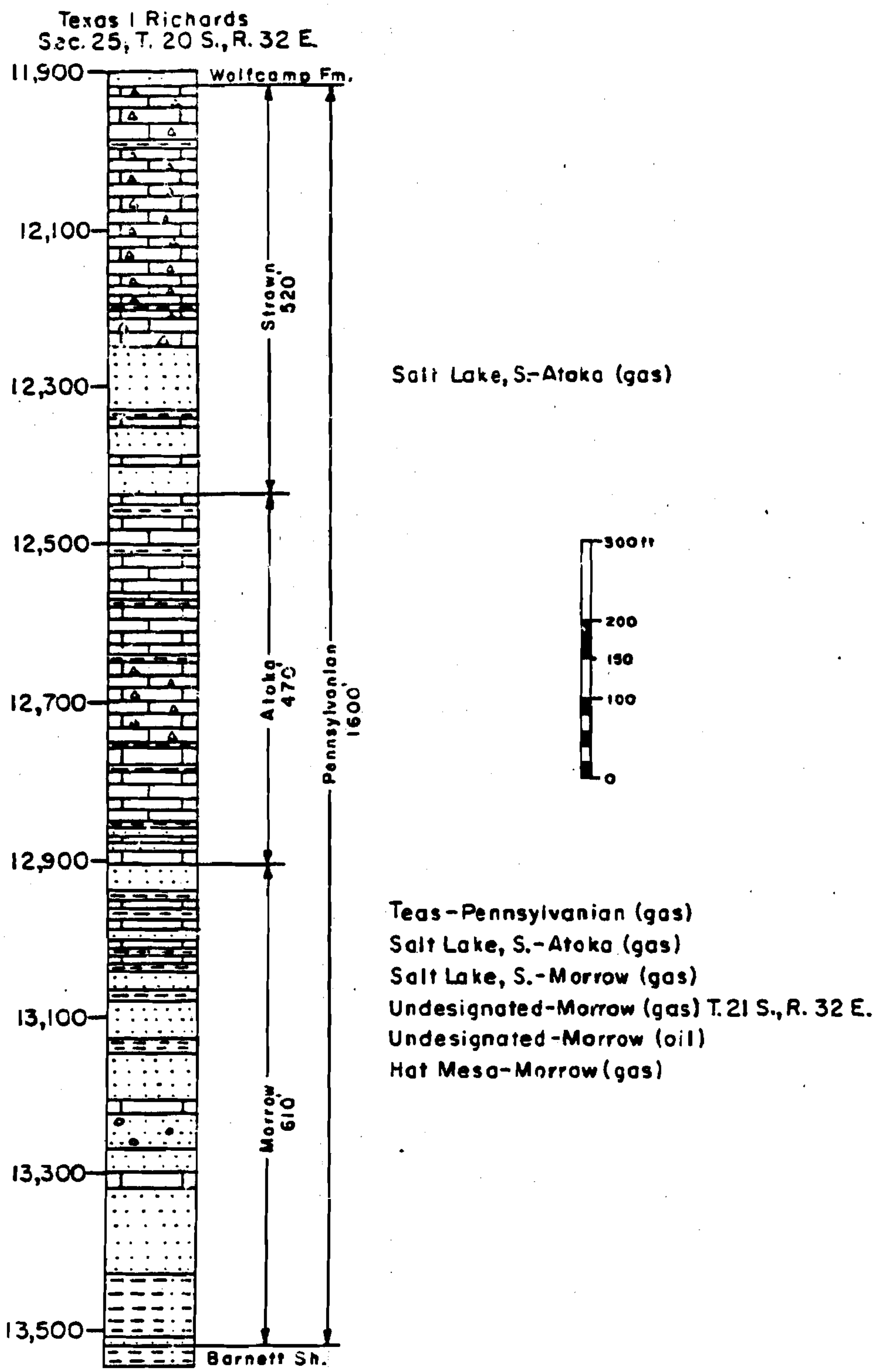

Fig. 12 Pennsylvanian reference section and type well for Area 2 oil and gas fields

Meyer (1966) used time-stratigraphic units for the Pennsylvanian System in southeastern New Mexico. From oldest to youngest the stages used were: Morrowan, Derryan, Desmoinesian, Missourian, and Virgilian. These names with the exception of Derryan represent the provincial series classification accepted for use by the U. S. Geological Survey. Although stratigraphic sections were not included in Meyer's paper it appears that the top of his Desmoinesian Stage is the same as the top of the Strawn of this report. The overlying rocks of Missourian, and Virgilian age are present throughout most of the Study area of this report, but following the common oil-field usage are included in the Wolfcamp sequence. The top of Meyer's Derryan (Atokan) interval would be at the base of the upper limestone of the Strawn and the top of the Morrowan at the top of the Atoka of this report.

Meyer's classification was not used in this report because most of these terms are not commonly used in the literature of southeastern New Mexico or in completion reports for specific wells. Above the Morrow oil-field usage is Atoka or sometimes Bend, Strawn, Canyon, and Cisco. Only in a few cases are attempts made to differentiate the Cisco and Canyon intervals; these, as in this report, being included in the Wolfcamp. Hills (1963), in contrast to the interpretation of Meyer, indicates Strawn underlying Wolfcamp in the Delaware basin of New Mexico. In well completion reports the top of the Strawn is picked fairly consistently. The Atoka may be picked at the top of the sandstone included here with the Strawn, at the top of the first sandstone in the Atoka of this report, or coinciding with the usage of this report. The Morrow top may be the same as used here or be as high as the uppermost sandstone in the Strawn interval.

In the reference well the Strawn consists of cherty limestone underlain by light-gray to white, medium-to coarse-grained sandstone. Thin beds of dark-gray and brown shale are present throughout the section. Elsewhere in the Study area chert is abundant except in the west where it is absent or of minor importance as indicated on the map of upper Strawn oil and gas fields (fig. 30). The lower sandstone interval is present except in the south where it grades into interbedded shale and thin limestone (fig. 31). Grain size of the sandstones ranges from very fine to coarse to conglomeratic, with coarser clastic material prominant in a west-east belt across the central part of the area. Thin beds of limestone, sometimes oolitic, occur in this part of the Strawn except in the north and locally in the south where they grade into shale. Sufficient data was not available to indicate the distribution of algal biostromes reported to be present in the upper limestone beds of the Strawn.

The upper part of the Atoka in the reference well also is mostly limestone but includes smaller amounts of chert. The limestone is underlain by alternating beds of medium-to dark-gray shale, medium- to coarse-grained sandstone, and limestone. This sequence is fairly uniform throughout the Study area with some fine-to medium-grained and locally conglomeratic sandstone in the upper part in the south, and oolitic limestone beds present in a large area south of the reference well (fig. 32).

Morrow rocks consist mostly of fine-to coarse-grained sandstone, commonly conglomeratic, and varying amounts of dark-gray shale. In some areas there is a thick shale section immediately above the Barnett. In addition, as indicated in the reference well, this zone also contains some, generally oolitic, limestone. Conglomerate occurs mostly in the northern part of the Study area, and in a relatively narrow band to the southeast (fig. 33). Some dolomite and dolomitic limestone is present locally within the Study area.

The isopach map of the Pennsylvanian shows the thickest sections in the southwest part of the area where over 2,700 feet of sedimentary rocks are assigned to this interval (fig. 13). Rather abrupt thinning occurs in T. 23 S., R. 31 E.; T. 24 S., R. 34 E.; and T. 21 S., R. 34 E. Thinning in the last two areas can be partly related to erosion preceding Wolfcamp deposition in the area of the Bell Lake and Central Basin platform fault systems. This eastward thinning also reflects depositional thinning in the Atoka and Morrow suggesting a pre-fault high to the east. The relatively thin area in T. 23 S., R. 31 E. is of considerable interest in that it may reflect the presence of a buried fault. This feature is not evident from the isopach map of the Wolfcamp nor from the Precambrian contour map. In the Pilot area Pennsylvanian strata range from 1,800 to 2,200 feet

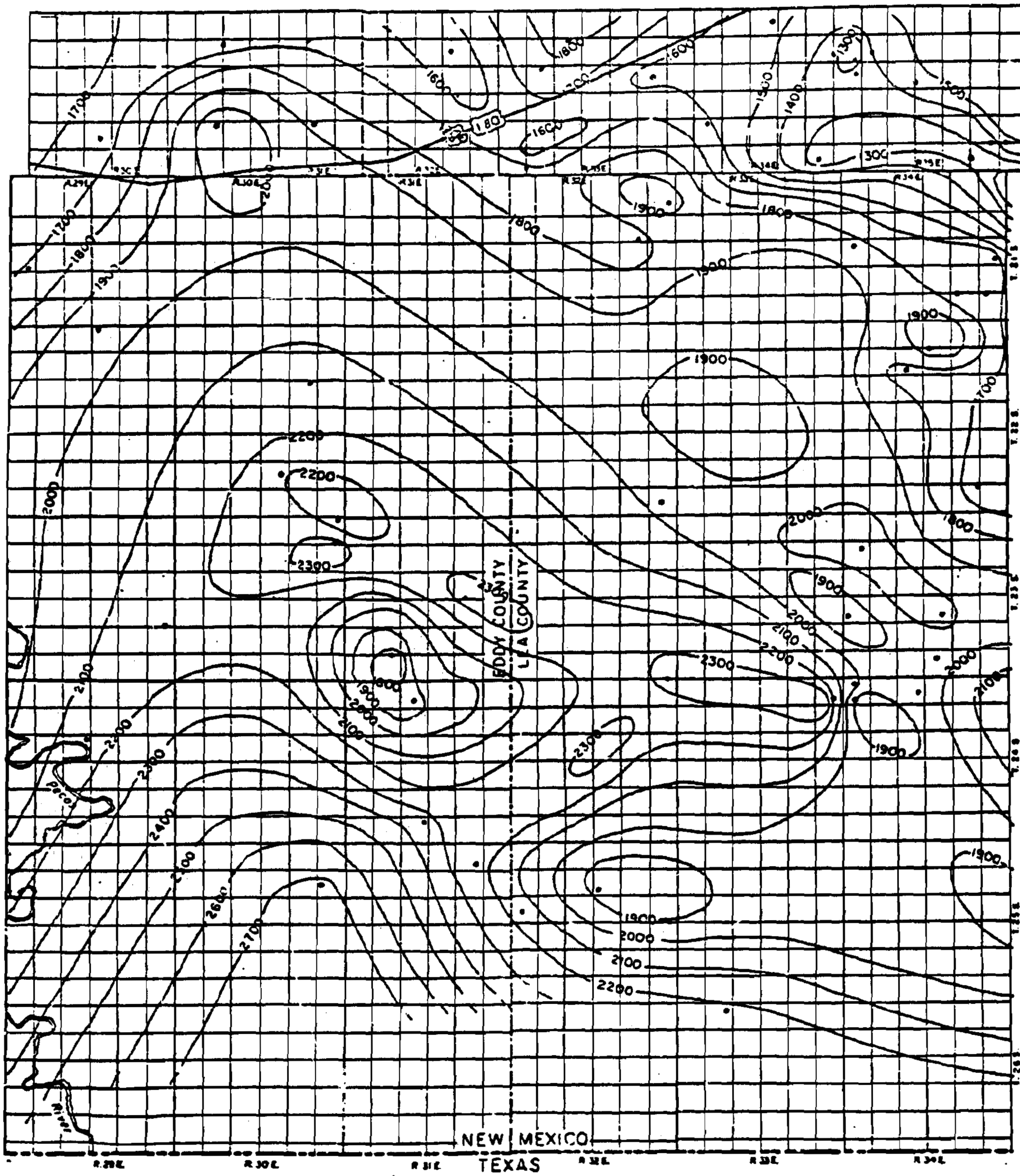

Fig.13 Isopach map: Pennsylvanian

Contour interval: 100 feet

0 10 miles

in thickness and the lithology should be similar to that discussed above.

Permian System

The Permian section in the Delaware basin, below the Castile Formation, includes rocks of Wolfcamp and Leonard age. Rocks of Wolfcamp age are referred to here, informally as Wolfcamp formation. Leonard rocks include the Bone Springs formation and overlying Delaware Mountain Group.

Wolfcamp Formation

The Wolfcamp formation was first described by Udden (1917) for exposures in the Glass Mountains of west Texas, and is now accepted as a provincial series term for rocks of the lower part of the Early Permian. West of the Delaware basin in New Mexico equivalent formations include from oldest to youngest the Powwow Conglomerate, Hueco Limestone, and Abo Formation. Abo is used on the Central Basin platform and Northwest shelf for rocks of lower Leonard age. The equivalent in the Delaware basin would be in the lower part of the Bone Springs Formation. Because of this Meyer (1966) suggested use of Wichita Formation for the Abo in the subsurface of southeastern New Mexico.

Silver and Todd (1969) have reported that the upper part of the Wolfcamp in the northern part of the Delaware basin is characterized by shale and micritic limestone. In general this lithologic description is adequate for the upper part of the Wolfcamp in the Study area of this report. In the reference section (fig. 14) the Wolfcamp consists of interbedded carbonate and shale including considerable dolomite and minor sandstone. To the south, where a much thicker section is present, the lower part consists mostly of shale. The increase in limestone to the north suggests approach to a shelf margin facies. Limestone and dolomite distribution and areas where carbonate thicknesses exceed that of shale or at least approach a 1:1 ratio can be defined approximately by the 1,400-foot contour line on the isopach map (fig. 15). North of this line the amount of carbonate increases; to the south clastic ratios (shale/limestone) are 2:1 to 5:1. Local variations occur particularly between the 800- and 1,200-foot contour lines in the northeast part of the area where most of the thickening to the west involves increase in shale content. This area is in line with the north-trending pre-Wolfcamp Bell Lake fault and indicates possible extension of this fault to the north. The thinnest sections are to the east on the upthrown side of this feature and its possible extension. In this area Wolfcamp strata locally are less than 400 feet thick. Sandstone deposits of any significance are restricted to this area and in particular in the northeast corner adjacent to the west-bounding fault system of the Central Basin platform. In this area some coarse to conglomeratic sandstone is present whereas elsewhere in the Study area the minor amounts of sandstone are very fine to fine-grained.

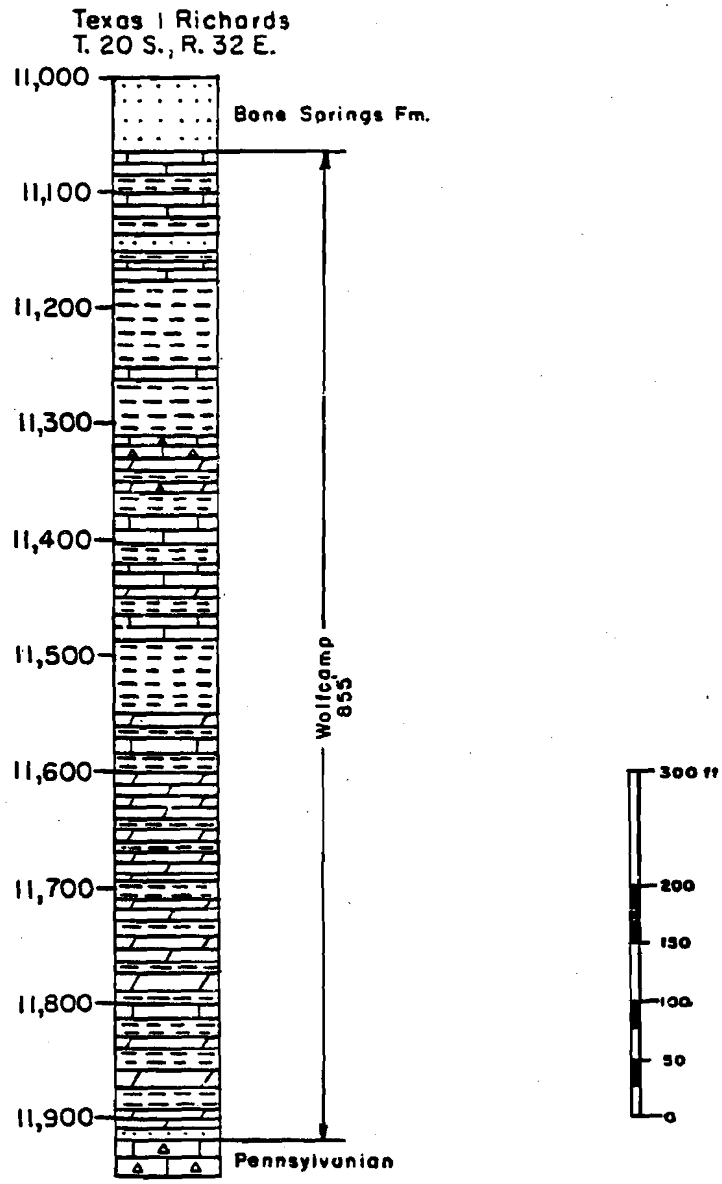

Fig. 14 Wolfcamp reference section

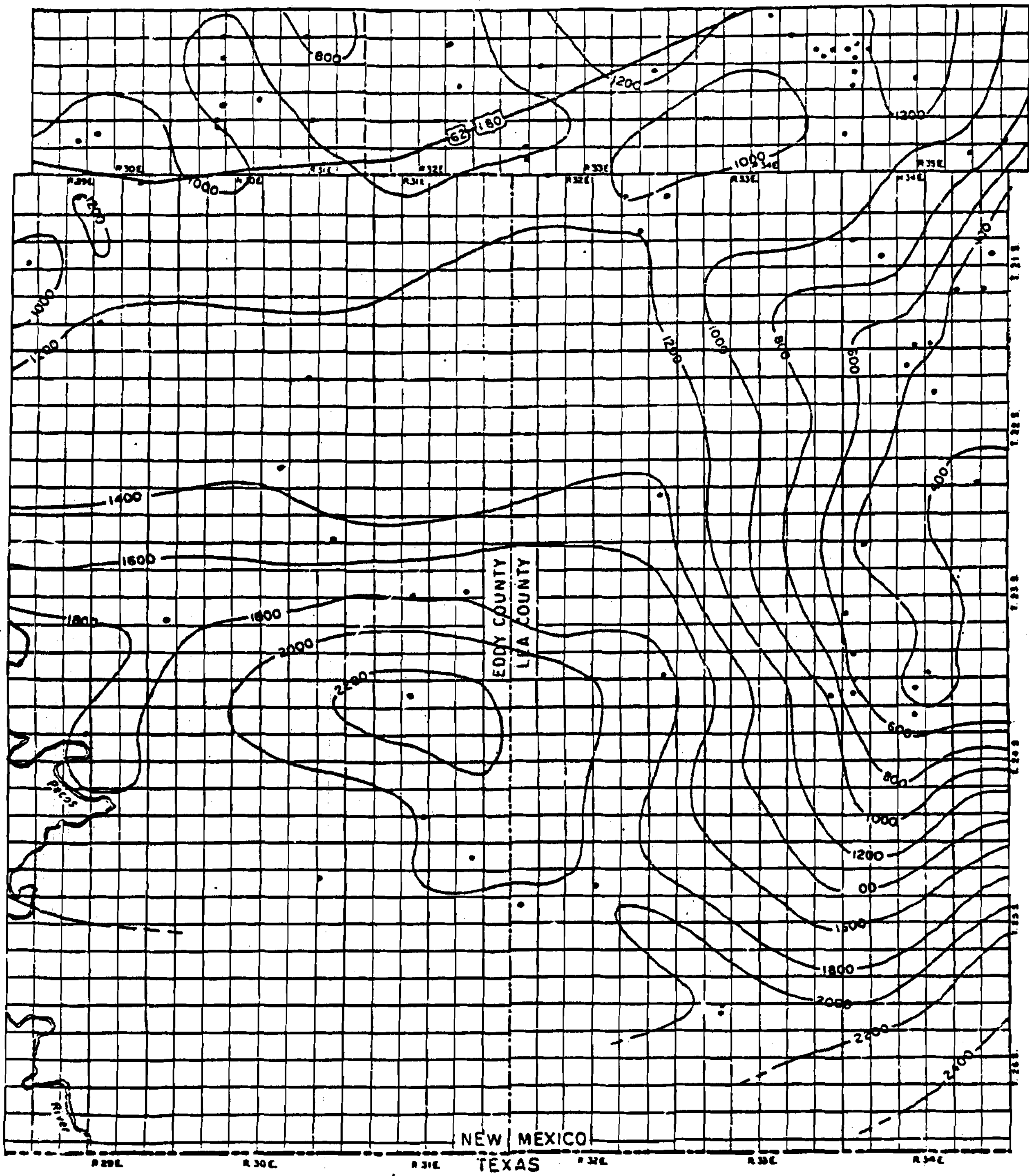

Fig.15 Isopach map: Wolfcamp

Contour interval: 200 feet

0 5 10 miles

The thickest sections of the Wolfcamp are in the southern part of the area where locally over 2,400 feet are present. In the Pilot area these beds range from 1,000 to 1,400 feet in thickness. Sedimentation during Wolfcamp time almost entirely smoothed over the considerable relief of the pre-Wolfcamp faulting along the eastern margin of the Delaware basin. The result of this in-filling is particularly evident on the isopach maps of the overlying Bone Springs Formation.

Bone Springs Formation

The Bone Springs was originally referred to by Blanchard and Davis (1929) and later defined by King (1942). At the type locality in the Delaware Mountains, West Texas, the unit consists mostly of limestone with a few members of shaly limestone and shale. Two members have been named; Victorio Peak Limestone and overlying Cutoff Shale. These intervals underlie the Brushy Canyon Formation of the Delaware Mountain Group. The Victorio Peak and Cutoff members crop out in the Guadalupe Mountains of New Mexico (Boyd, 1958).

As noted by King (1942) and Silver and Todd (1969) the Bone Spring facies of the Delaware basin is markedly different than in the outcrop sections to the west. A typical basinal section of the Bone Springs was drilled in the reference well (fig. 16). The interval consists of a thick, partly cherty, limestone at the top, underlain by alternating units of sandstone and limestone. The three very

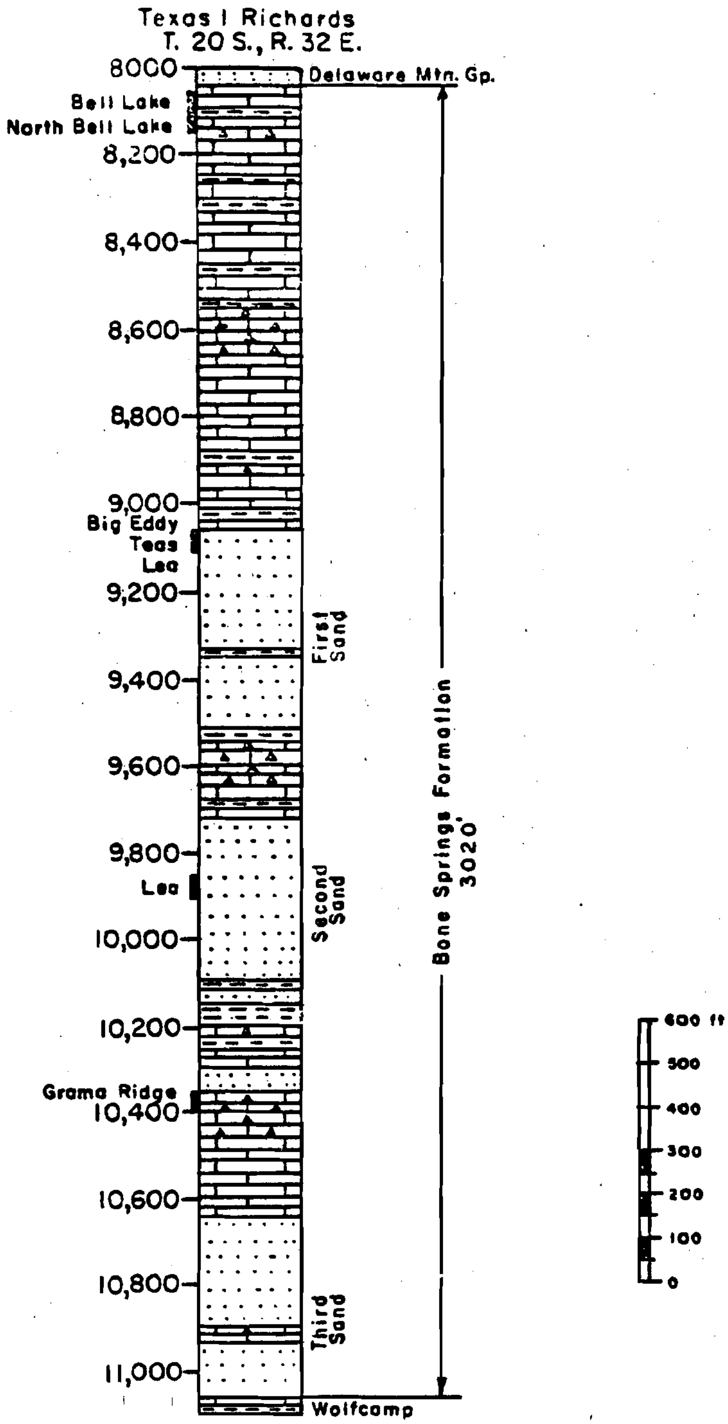

Fig.16 Bone Springs Formation reference section showing stratigraphic position of Study area fields.

fine-to-fine-grained sandstone intervals are referred to simply as the first, second, and third Bone Springs sands. The lower most "third sand" is also called the Dean sand. Shale is a minor constituent of the Bone Springs but limestone beds are commonly argillaceous. The lithologic sequence as shown in the reference well is quite uniform throughout the Study area with minor variations in thicknesses of members. The shelf-margin carbonates, consisting of reefs or banks that limit the areal extent of the Bone Springs basinal facies to the west, north, and east are not present in this area.

The thickest sections of the Bone Springs occur in the western part of the Study area (fig. 17). The interval, in the area of thickest accumulation of sediments ranges from 3,300 to 3,500 feet. At an angle to this north-south depositional axis there is a northeast trending area where 3,000 to 3,300 feet of sediments were deposited. This is an area where a comparatively thin section of Wolfcamp rocks is present although it follows the structural axis of the Delaware basin. The Bell Lake structure remains evident in rather abrupt thinning of the Bone Springs interval onto this pre-Wolfcamp formation high. In the Pilot area the Bone Springs Formation ranges from 2,900 feet to over 3,400 feet in thickness.

Delaware Mountain Group

The Delaware Mountain Group includes all rocks of Guadalupian (Early to Late Permian) age in the Delaware basin. Shelf correlatives

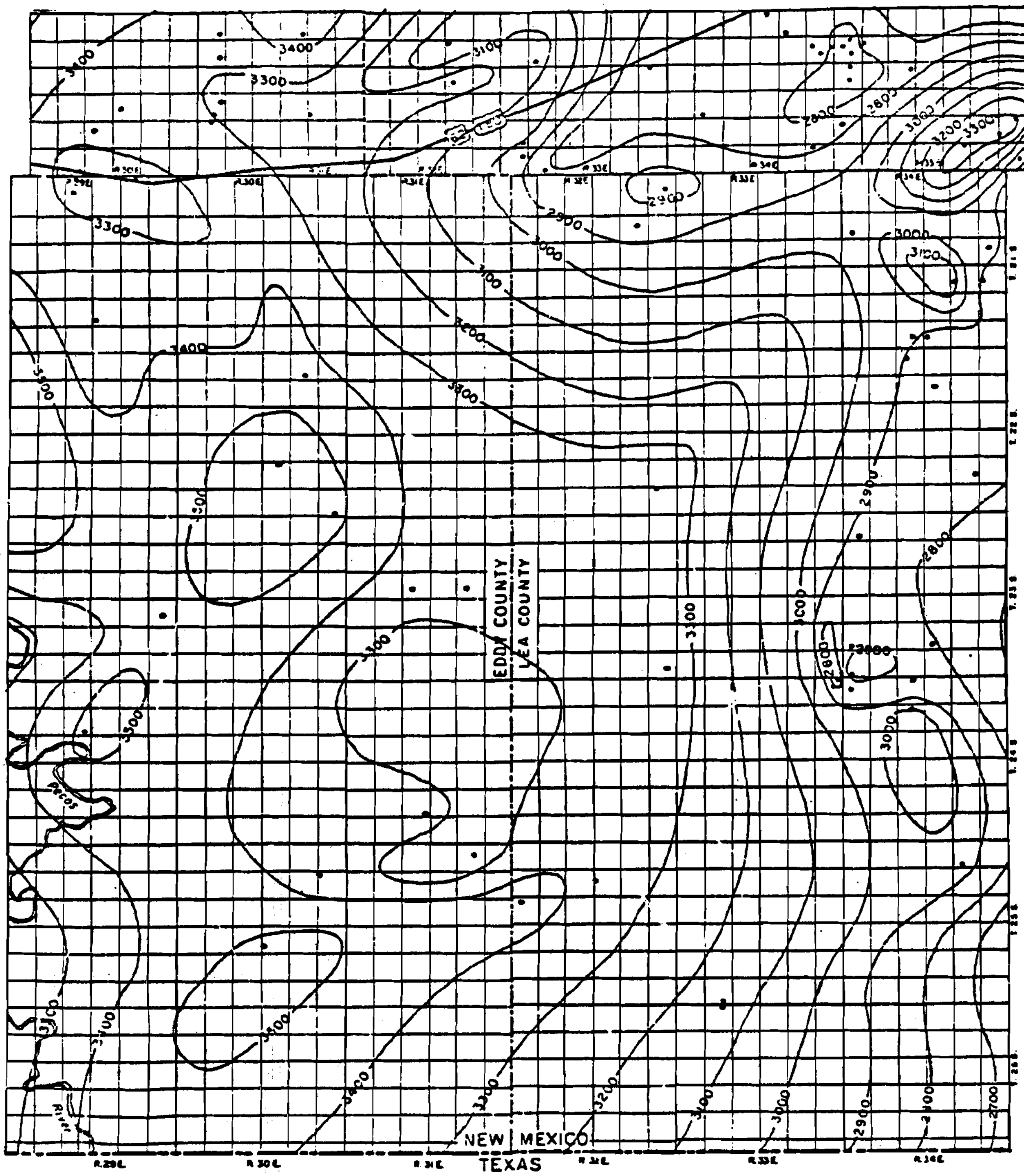

Fig.17 Isopach map: Bone Springs Formation

Contour interval. 100 feet

0 5 10 miles

to the north are the San Andres Formation and overlying Artesia Group. The predominantly sandstone facies of the Delaware Mountain terminates abruptly against various shelf-margin carbonates such as the Capitan and Goat Seep reefs, Getaway bank and other unnamed carbonate buildups. Successively older formations of the Delaware Mountain Group have greater areal extent beyond the Delaware basin as defined by the uppermost part of the Capitan reef.

The Delaware Mountain was named by Richardson (1904) for exposures at the south end of the Guadalupe Mountains. King (1942, 1948) raised the interval to group status and recognized in ascending order the Brushy Canyon, Cherry Canyon, and Bell Canyon formations. At the type locality in the Delaware Mountains the Brushy Canyon consists of about 1,000 feet of fine- to coarse-grained, in part shaly sandstone. The Cherry Canyon, also on the order of 1,000 feet in thickness contains interbedded very fine-grained sandstone and lenticular beds of limestone. Two limestone members in the lower part of the formation were named the Getaway and South Wells, and one in the upper part the Manzanita. No attempt has been made here to correlate the carbonate members in the basin with the outcrop sections. As with the limestones in the overlying Bell Canyon Formation these members are much more prominent in the margins of the basin where they are in proximity to bounding reefs. Silver and Todd (1969) feel that only the Manzanita Member of the Cherry Canyon Formation and the Lamar Member of the Bell Canyon Formation can be traced across the basin. In the area of the type locality in the bounding reefs. Silver and Todd (1969) feel that only the Manzanita Member of the Cherry Canyon Formation and the Lamar Member of the Bell Canyon Formation can be traced across the basin. In the area of the type locality in the Guadalupe Mountains the Bell Canyon Formation consists of 700 to 1,000 feet of very fine-grained sandstone interbedded with persistent limestone members. King (1948) named three of these in the lower fourth of the formation the Hegler, Pinery, and Rader. An upper limestone near or at the top of the Bell Canyon was named the Lamar. A fifth interval of flaggy limestone recognized by King between the Rader and Lamar was later named the McCombs by King and Newell (1956). King (1948) observed that in the Delaware Mountains the limestone members were each 10 to 25 feet thick, but that near the Capitan reef each member thickned to 50 to 100 feet. Exposures of the Delaware Mountain Group in New Mexico are restricted to a sandstone tongue of the Cherry Canyon Formation in the Guadalupe Mountains (Boyd, 1958).

Because of the absence of the upper part of the Bell Canyon Formation in the northern part of the Study area, the Shell I James Ranch test in T. 22 S., R. 30 E. was used for a reference section of the Delaware Mountain Group (fig. 18). Rarely is an attempt made to subdivide the Delaware Mountain Group in wells drilled in the Delaware basin; most oil fields being designated simply as Delaware. The formational contacts used in the reference well approximate oil-field

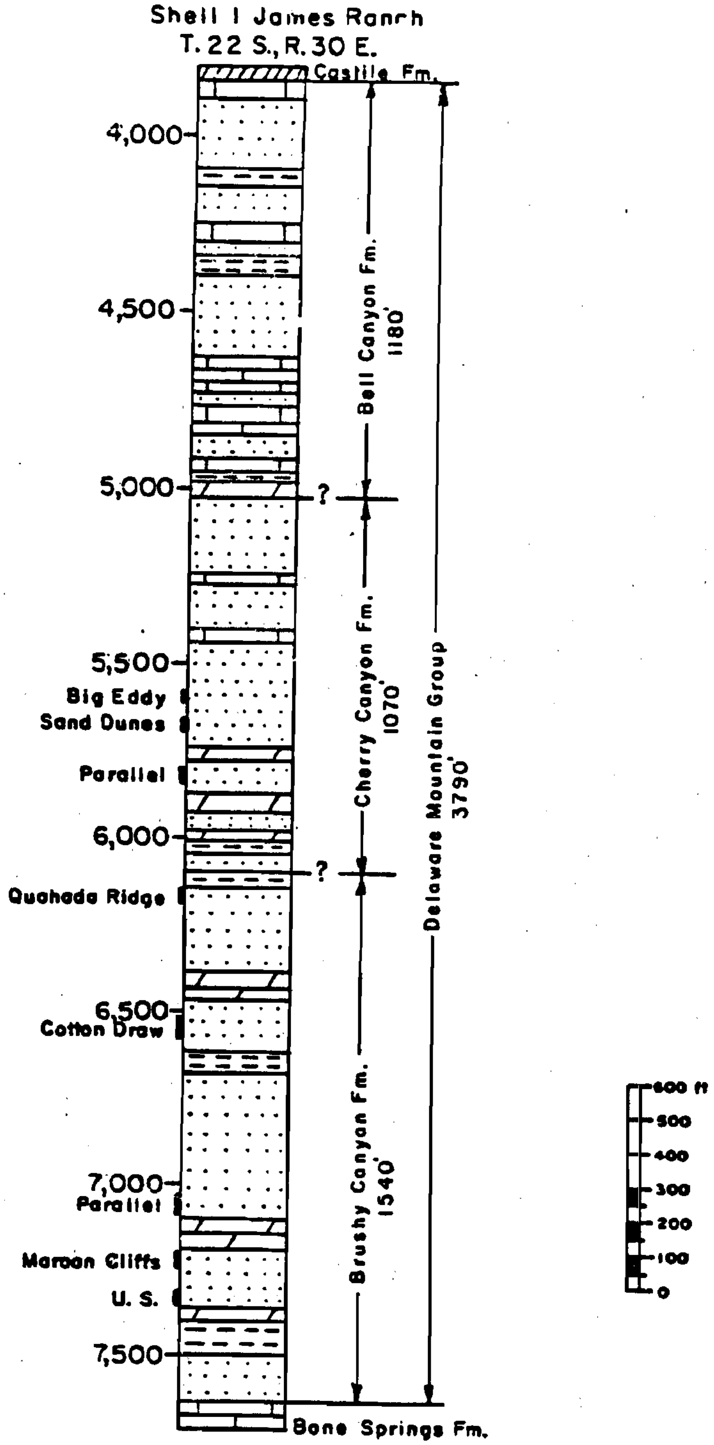

Fig. 18 Delaware Mountain Group reference section showing stratigraphic position of study area fields

usage where available, and some continuity was established for these contacts in the basin by use of mechanical logs. The primary purpose, of course, being to establish the stratigraphic position of oil wells completed in this interval.

In the reference well the Brushy Canyon Formation consists of 1,540 feet of mostly fine-grained, gray to brown sandstone with minor brown shale and dolomite. Shale is more abundant than indicated in the reference section but occurs in beds too thin to show at this scale. Better lithologic detail is given for portions of this interval and the overlying Cherry Canyon Formation in the section on oil and gas potential. The Cherry Canyon Formation consists of 1,070 feet of sandstone similar to that in the Brushy Canyon, interbedded with shale, dolomite, and some limestone. The 1,180 feet of the Bell Canyon Formation has a greater percentage of limestone, no doubt the result of closer proximity to the shelf-margin carbonates, but also consists mostly of fine-grained sandstone.

Because of the importance of the upper most part of the Delaware Mountain Group to the petroleum potential of the area some additional description of this part of the section is necessary. In the Study area the upper part of the Bell Canyon Formation includes the Lamar Limestone Member and an underlying sequence of rocks informally called the Ramsey sand, Ford Shale, and Olds sand. Marginal to the reef (fig. 19), limestone of the Lamar Member thickens rapidly. In T. 21 S. the Lamar is at least 75 to 80 feet thick and nearer to the

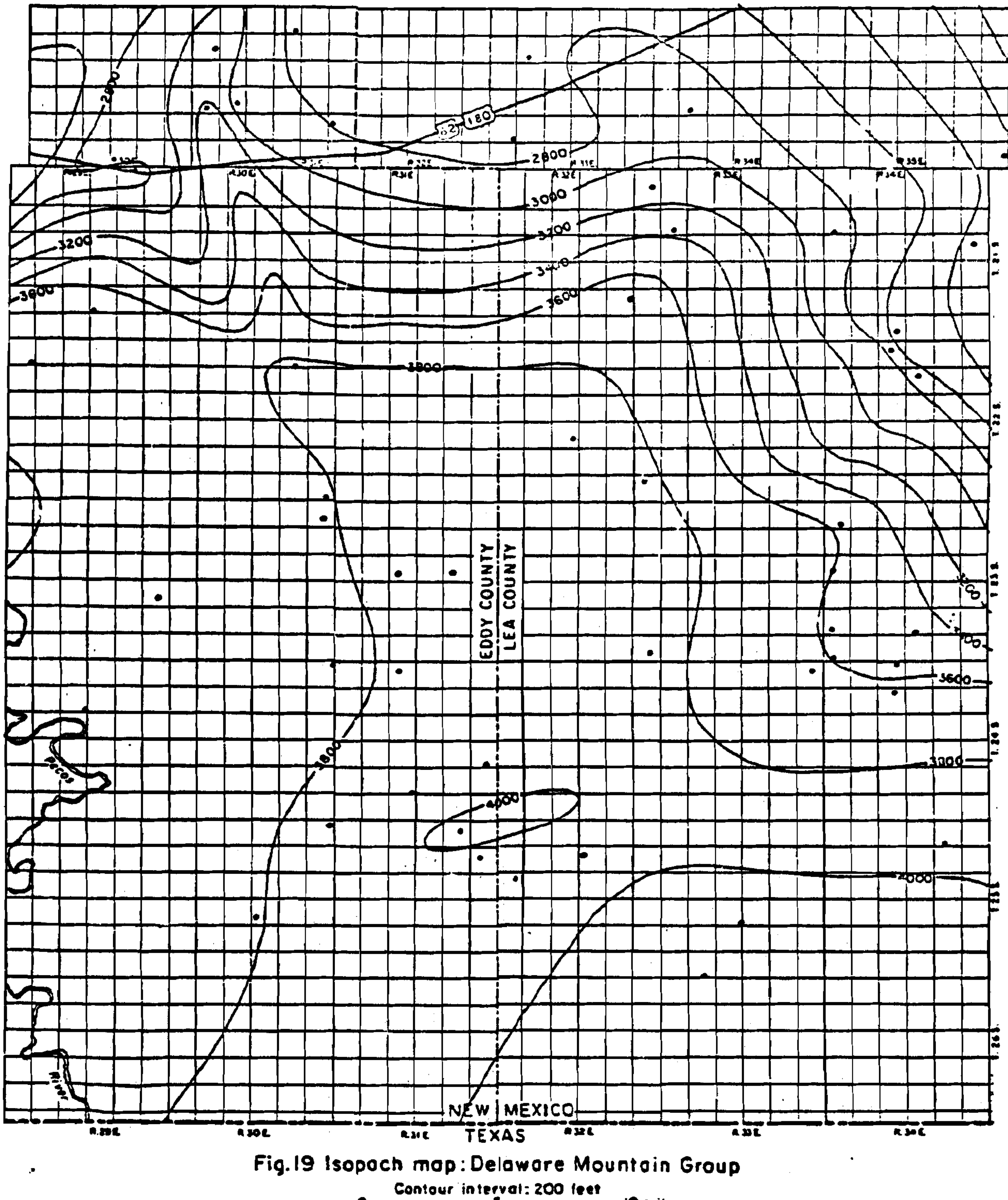

Fig. 19 Isopach map: Delaware Mountain Group

Contour interval: 200 feet

0 5 10 miles

reef may be as much as 200 to 700 feet thick. In T. 22 S. thicknesses of 40 to over 100 feet are present with the thinner sections located in the central portion of the basin. The Lamar continues to thin to the south in the Study area but eastward and westward thickening remains evident even where the reef front is beyond the limits of the area investigated. Near the New Mexico-Texas border maximum thicknesses are less than 40 feet and average less than 30 feet.

The Lamar, except in the vicinity of the Capitan reef, consists of interbedded gray to brown calcareous shale, white, gray, and brown, very fine- to fine-grained, silty to shaly sandstone, and brown limestone. Throughout much of the basin Lamar carbonates are shaly, silty, and sandy and in large areas grade into calcareous shale. Bordering the Capitan reef limestone is more prominent. Detailed sections of this interval are given in the section on oil and gas potential (fig. 43). The section nearest to the reef front is in T. 22 S., R. 32 E.

The base and top of the Ramsey sand are poorly defined. For convenience the top was selected at the base of the lowest limestone. Oil-field usage varies considerably from this definition. Some geologists choose the top of the first sandstone below the uppermost limestone in the Lamar and refer to this as top of Delaware sand. Others put the top of the Ramsey at the top of the pay zone in producing wells. This varies from field to field and within fields. In some areas the base of the Ramsey is chosen at a silty or shaly siltstone referred to as the Ford Shale. Lateral continuity has been inferred for the Ford

Shale throughout the Delaware basin.

The Ramsey and underlying beds in the upper part of the Bell Canyon consist of light-gray to white very fine- to fine-grained, silty sandstone, shaly sandstone, and silty shale. The clay-free sandstones are friable and appear to be well sorted, but may contain varying amounts of silt that could effect permeability. Locally near the reef front some medium-grained quarts is present.

The isopach map of the Delaware Mountain Group reflects a remarkable uniformity of thickness (fig. 19). The thinning to the northwest, north, and northeast is the result of the abrupt facies change to carbonates of the Capitan reef. Elsewhere the thickness is from 3,600 to 4,000 feet with the thickest sections in the southern part of the area. The section thins rapidly from south to north across the Pilot area and if more control were available the contour lines would probably be more closely spaced in the northern part of the area.

STRUCTURE

The larger structural features of the Permian basin have been reported on by numerous geologists. The area covered in this report is too limited to develop meaningful additions to the general knowledge of this area. Instead a series of contour maps on various surfaces have been prepared to show the major structural elements of the northern part of the Delaware basin, and in particular the structural features of the Study area of this report.

The development of a depositional basin in this area began following Canadian time when a broad sag formed in the west Texas, southeast New Mexico area. This sag was named the Tobosa basin by Galley (1958) and is supposedly bounded on the east by the Texas arch and on the west by the Diablo arch. Sedimentation in this basin until Late Mississippian time consisted mostly of shelf carbonates in New Mexico. Several periods of minor folding and perhaps faulting occurred in the Tobosa basin prior to Pennsylvanian time and there was some erosion of parts of the section. The most important event as far as oil and gas exploration is concerned is pre-Woodford uplift and erosion. The subsiding Tobosa basin covered a much larger area in Late Mississippian-Early Pennsylvanian time and the sag was split into two basins by a median ridge (Adams, 1965). The name Permian basin has been applied to this expanded basin; Central Basin platform to the median ridge; and Delaware and Midland basins to the segmented parts of the Tobosa basin. The Central Basin platform or Central Basin

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range as it has been called on pre-Permian tectonic maps appears to have been a high during Early Ordovician time, and may represent a zone of structural weakness along which movements took place periodically at least into Late Paleozoic time. The major period of structural adjustment as far as can be determined from maps prepared for this report, took place in Late Pennsylvanian-Early Permian time. Displacement appears to have been along high angle normal or reverse faults that according to Hills (1970) may have involved considerable lateral as well as vertical movement. The structural elements of this period of time dominate the contour maps for each datum preceding that of the Wolfcamp and are still evident in contour maps of the Permian.

Contour lines drawn on top of the Precambrian surface (fig. 3) show the major structural features of this part of southeastern New Mexico. The Central Basin platform and Delaware basin, previously were contoured by Flawn (1954, 1956), Foster and Stipp (1961) and Hills (1970). Because of the few wells that reach the Precambrian surface, other than on the Central Basin platform, an isopach map of the interval from the top of the Mississippian carbonate section to the top of the Precambrian was prepared, and depths to the Precambrian projected for wells that penetrated to the top of the Mississippian lime. By this method considerable control is added, particularly in the Delaware basin, and accuracy is considered quite high because of the uniformity of thickness trends for this combined part of the Paleozoic section. This sequence of rocks thickens gradually at the rate of about

30 feet per mile from about 1,800 feet in the northwestern part of the Precambrian map area to between 4,400 and 4,500 feet just west of the southern end of the Central Basin platform in New Mexico. The resulting contour map on the Precambrian gives some indication as to the complex fault systems that form the boundary between the Delaware basin and Central Basin platform. For discussion purposes names have been applied to some of these features.

On the structurally higher parts of the platform, the Hobbs and Eunice blocks, the Precambrian surface is at a depth of from 4,000 to 7,500 feet below sea level. In the Monument-Jal block depths are from 6,500 to 11,500 feet below sea level, and the Precambrian surface slopes toward the Delaware basin. Displacement along the fault system separating the Hobbs and Eunice blocks and the Monument-Jal block is about 1,000 feet in the north part of the area to possibly as much as 4,000 feet west of Eunice. The fault on the west side of the Monument-Jal block can be extended fairly reliably for a distance of approximately 50 miles and continues south into Texas. Inferred displacement is 1,500 feet at the north end to over 6,000 feet west of Jal. The south end of the East Delaware basin block appears to be only about three miles wide with displacement to the west on the order of 2,000 feet. The west bounding fault of this block is probably continuous with the fault to the north and this fault would appear to be a suitable boundary between the Central Basin platform and the Delaware basin. Hills (1970) indicated a fault in approximately this location and termed it the West Platform fault.

Faults and associated anticlinal closures are of considerable importance in exploration for oil and gas in rocks of pre-Permian age and in particular Ordovician and Silurian/Devonian strata. It thus becomes critical in determining the potential of this part of the section to establish the possibility of the presence of similar structural features in the Delaware basin. The aeromagnetic map of the Carlsbad area (U. S. Geological Survey, 1973) gives fairly good definition of the trend of the major features of the Central Basin platform. This is quite evident in the Eunice, Hobbs, and Monument-Jal blocks including a south-projecting nose of higher magnetic intensity in the Jal area. The locations of highest magnetic intensities roughly coincide with those shown on the Precambrian map as having the greatest displacements along suggested fault systems. The close spacing of the contour lines on the aeromagentic map and the northwest trend of these contour lines, although not sharply defining fault systems, do give adequate indication of the relief from the Eunice-Hobbs blocks west to the east edge of the Delaware basin. Along east-west sections perpendicular to the structural trend the maximum relief between the Central Basin platform and the Delaware basin is surprisingly uniform at about 9, 000 feet. As noted previously rocks of the Central Basin platform and probably the interior part at least of the Delaware basin, are fairly uniform in composition. This and the nature of the contour line spacing of the aeromagnetic map suggest that considerable sharp relief on the Precambrian surface is required before marked changes in line spacing can be expected from aeromagnetic surveys. Examination of the two maps seems to indicate that a minimum of 4,000 feet of relief is necessary for close definition of structural features of interest in oil and gas exploration of pre-Permian rocks. Except for the Bell Lake block projected control points cannot be used for location of intrabasin fault systems, and including Bell Lake, displacements obviously are not of equal magnitude to that of the Central Basin platform. The Bell Lake fault was recognized by Haigler (1962, 1972) and as shown on the Precambrian map has a displacement of about 500 feet. This is indicated as the Bell Lake block and there is evidence from projected control points of an east-bounding fault as shown by the dashed line. The graben to the east is substantiated by a north-trending area of lower magnetic intensity on the aeromagnetic map.

The possible presence of faults and/or anticlinal structures elsewhere in the Delaware basin can only be inferred by indirect methods. The isopach map of the Woodford Shale indicates several areas where the Woodford is slightly thinner and in part these areas coincide with known occurrences of petroleum in the underlying Silurian/Devonian sequence. This is true of the relatively thinner Woodford in the area of the Paduca and Antelope Ridge fields. This may reflect compaction in association with later structural events or pre-Woodford highs. In either case these areas could be favorable locations for exploration. A similar thinner Woodford section occurs just west of the Pilot area and it is of interest that contour lines on the aeromagnetic map trend northwest in this area. This, however, is not indicated on any of the structural contour maps and may simply reflect a change in basement rock type to the west.

The western margin of the Delaware basin cannot be defined from the area studied for this report. Based on projected well data a north-northwest trending fault is indicated in the southwest corner of the Precambrian map. Most published and service company maps show this feature as part of the Huapache fault but this cannot be demonstrated from well control on the Precambrian or from the surface expression of the Huapache structure as shown by Kelley (1971). On the aeromagnetic map a north-trending area of higher magnetic intensity is present in this general location. On this map as well, a possible continuation with the Huapache fault is not indicated.

The series of structural contour maps prepared for this report (figs. 20 to 25) are limited to the Study area. On the pre-Wolfcamp maps (figs. 20 to 22) the west-bounding fault of the Bell Lake block, and the north end of the proposed West Platform fault are shown. Also on these maps the structural axis of the Delaware basin is shown curving from northeast to southeast near the east edge of the Study area. The Pilot area is located on the west flank of the basin and is near the deepest part of the basin for this area.

Structural maps on top of the Wolfcamp and Bone Springs formations (figs. 23 and 24) differ considerably from the sharply defined structures on maps contoured on older formations. Much of this change is obviously the result of sedimentation during Wolfcamp time. The

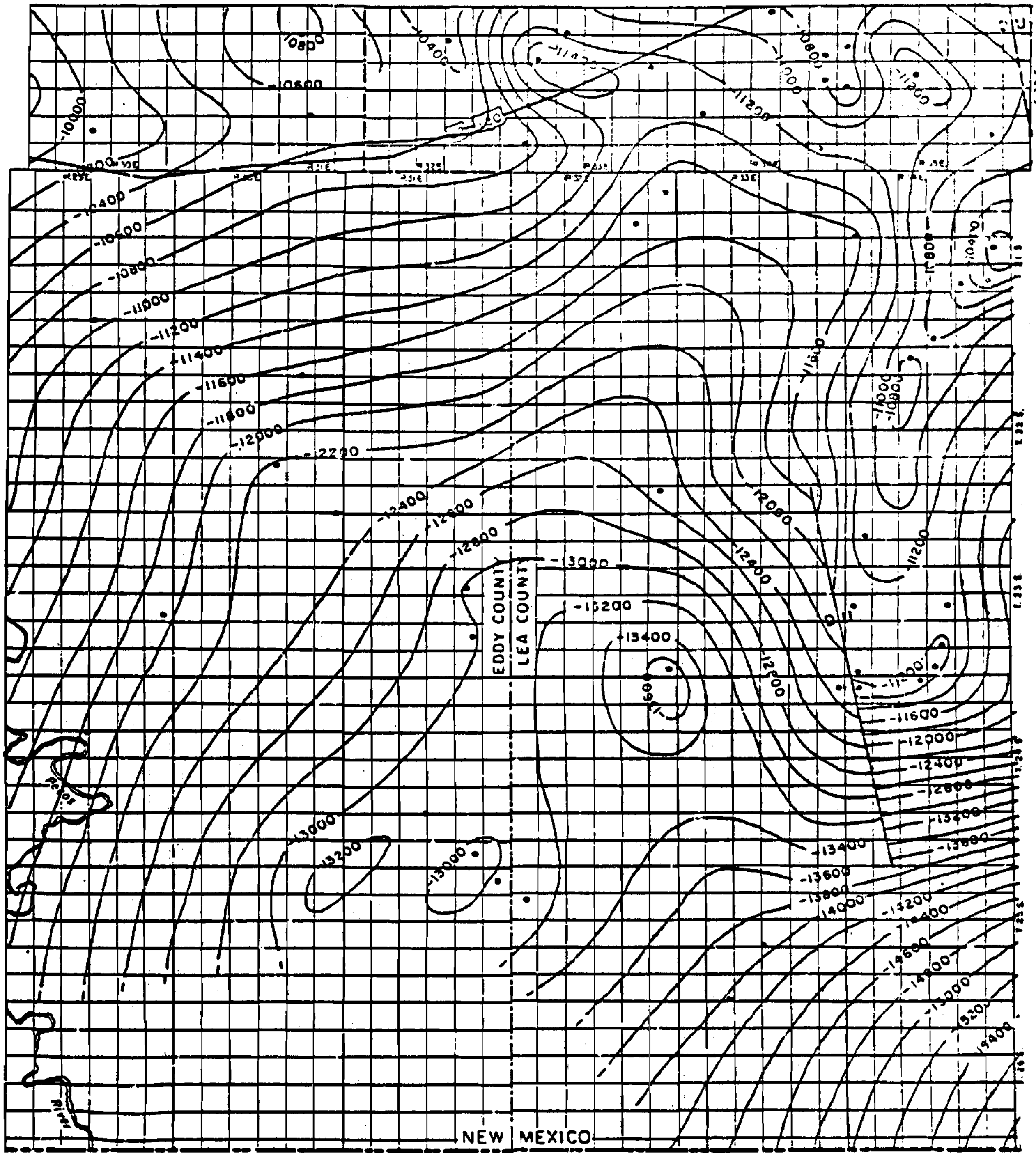

Fig. 20 Structure: Top of Silurian / Devonian carbonate

Contour interval: 200 feet

0 5 10 miles

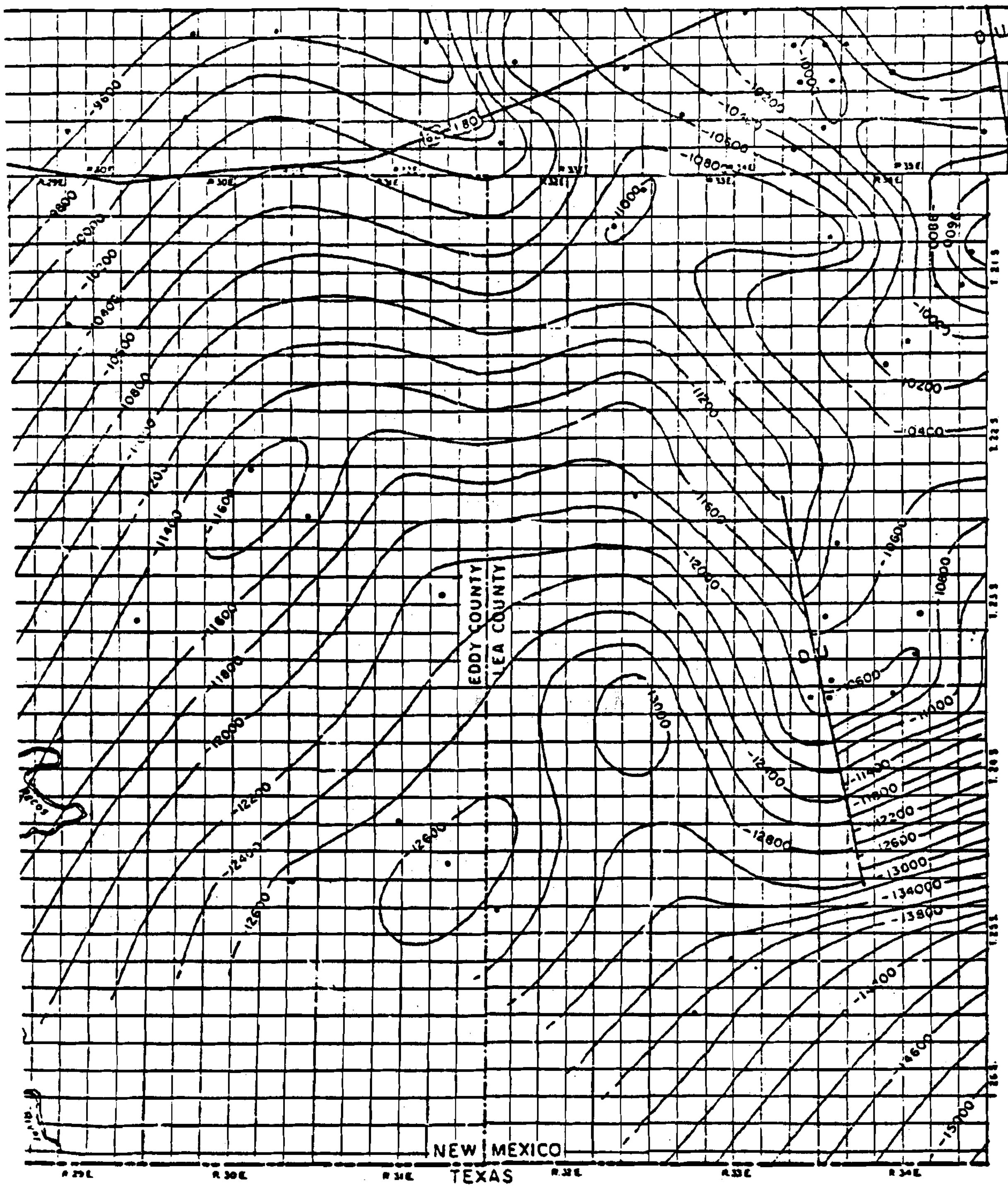

Fig. 21 Structure: Top of Mississippian carbonate
Contour interval: 200 feet
0 5 10 miles

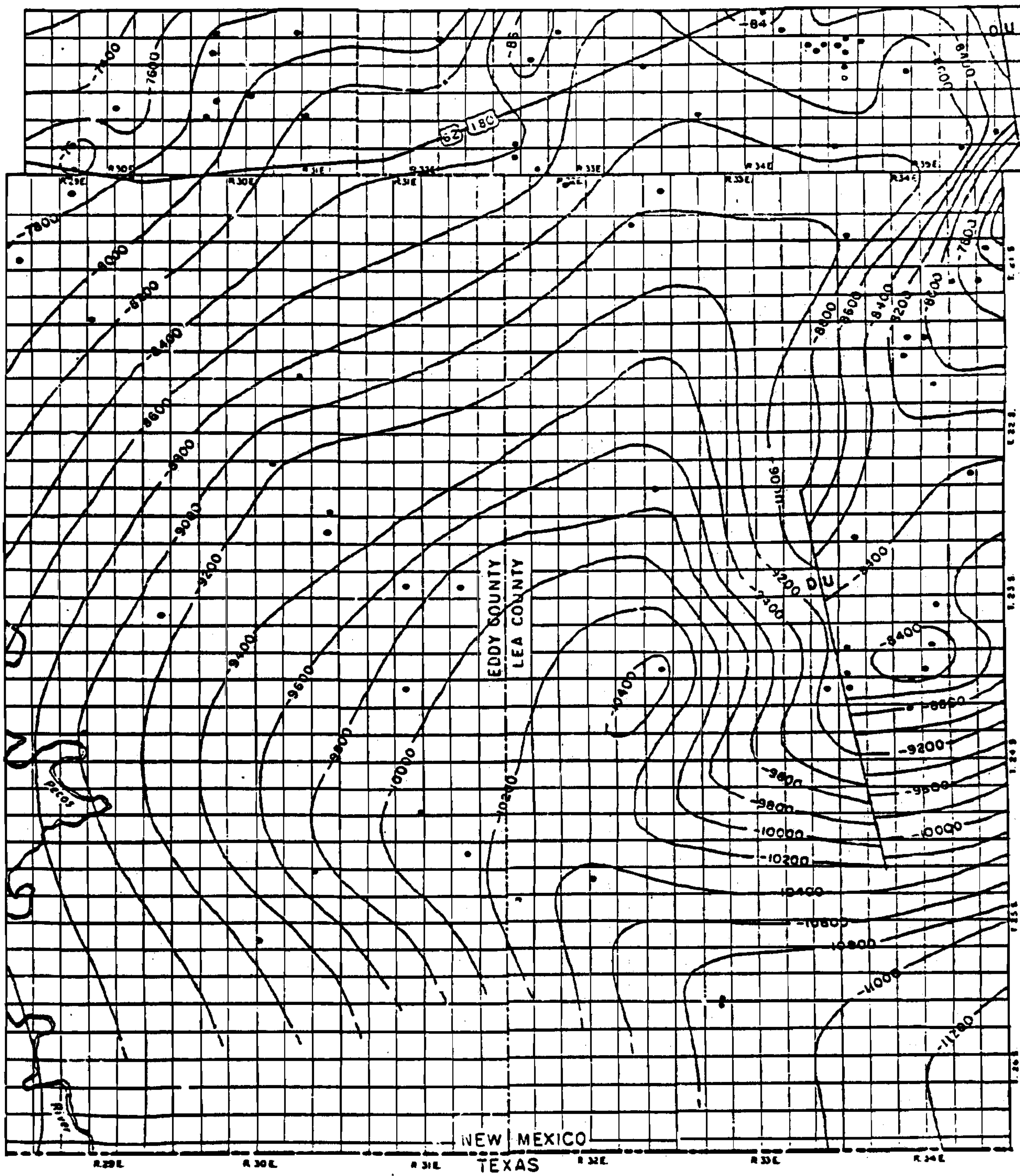

Fig.22 Structure: Top of Pennsylvanian System

Contour interval: 200 feet

0 5 10 miles

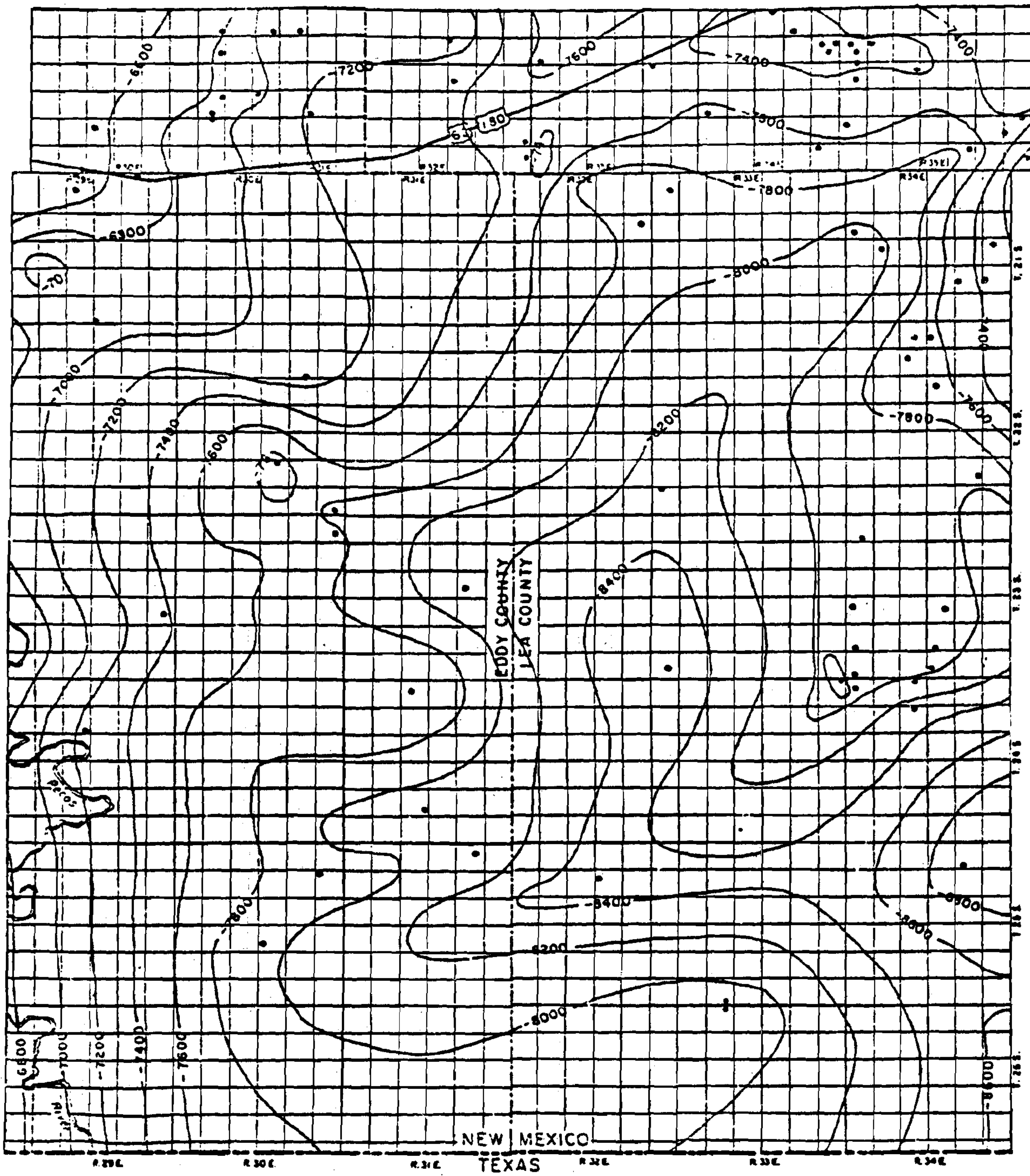

Fig.23 Structure: Top of Wolfcamp Formation

Contour interval: 200 feet

0 5 10 miles

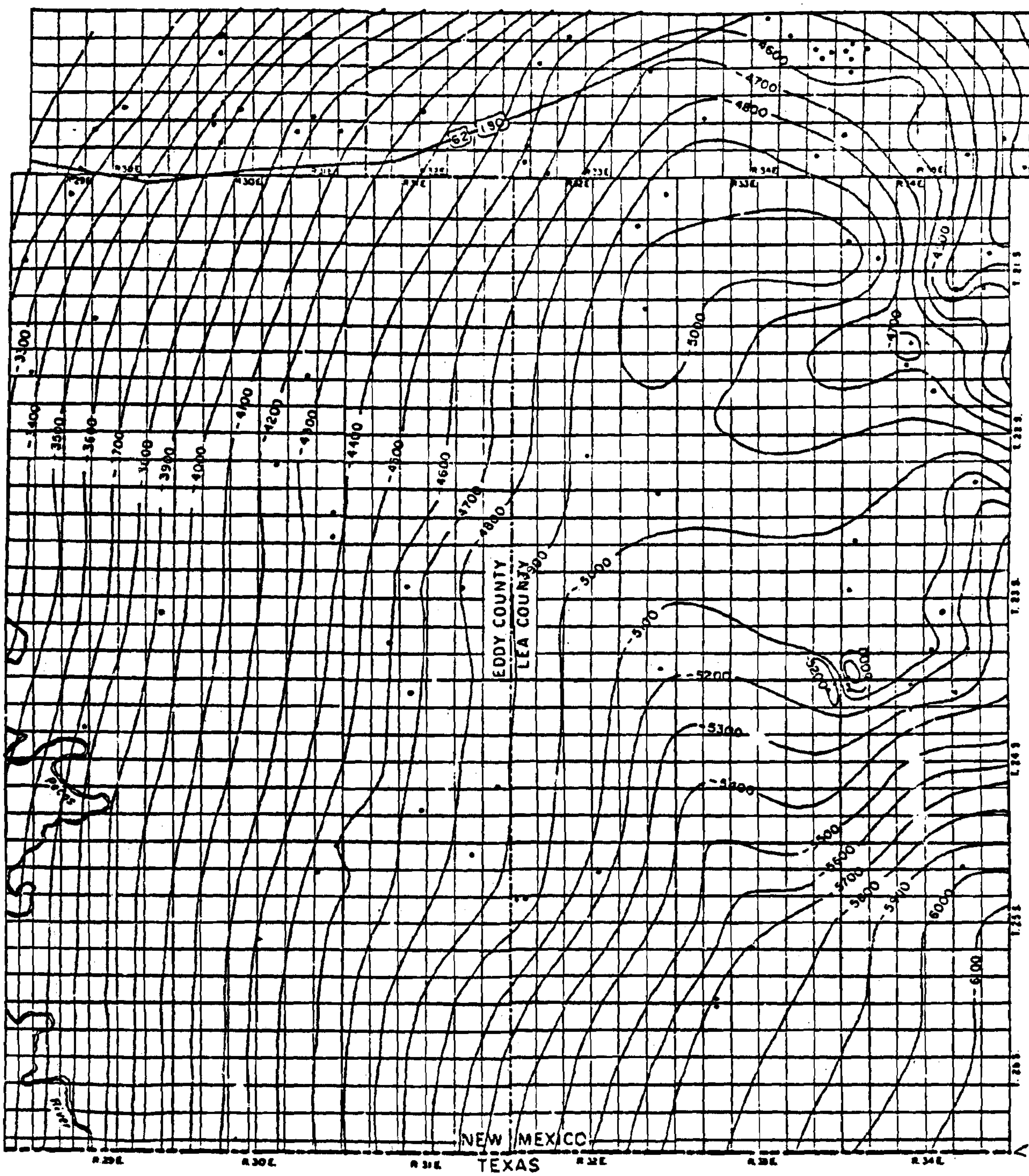

Fig. 24 Structure: Top of Bone Springs Formation

Contour interval: 100 feet

0 5 10 miles

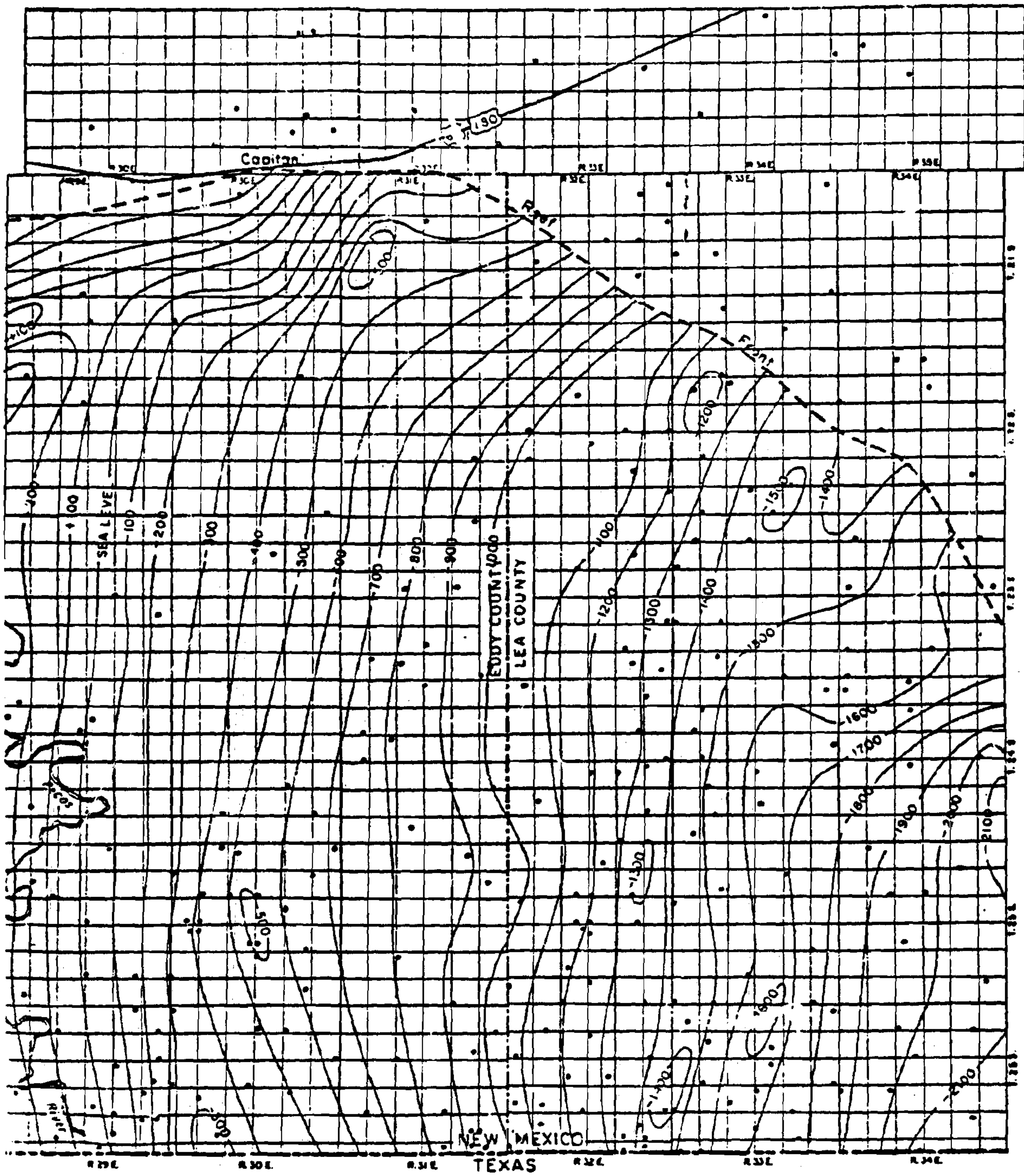

Fig.25 Structure: Top of Bell Canyon Formation

Contour interval: 100 feet

0 5 10 miles

general outline of the Late Pennsylvanian-Early Permian development of the basin is still fairly well defined particularly in the position of the structural axis of the basin. The Bell Lake structure appears on the Wolfcamp map as a north-south high with closure at the south end. Closure also is indicated on the Bone Springs map. Whether structural preservation of this feature is the result of continued movement of the Bell Lake fault system or a compacting effect is not known.

The structural contour map on top of the Bell Canyon Formation (fig. 25) is restricted on the north by the Capitan reef. The super position of the reef at an angle to the structural or depositional extent of the Delaware basin shows that the upper part of the Capitan reef neither defines the structural or depositional extent of the Delaware basin except from the standpoint of latest Guadalupian time.

GEOLOGICAL EVALUATION
OIL AND GAS POTENTIAL

In making a geologic evaluation of the oil and gas potential of an untested area the most logical approach is to search for factors that would have a negative affect on oil and/or gas accumulation. This can be best accomplished by a study of nearby areas that have proven petroleum reserves and occur in a geologically similar environment. Factors considered are reservoir and source rocks, trap types, number of potential pay zones, depth, and structure.

Ordovician System

In southeastern New Mexico oil and gas has been found in rocks of Ordovician age only on the Central Basin platform. However, exploration of these rocks is limited in the Delaware basin to only six wells that have penetrated the entire rock section. Not including fields that have been combined as development drilling indicated lateral continuity, there have been twenty-five fields discovered on the New Mexico portion of the Central Basin platform; six of these are now abandoned (fig. 26). Based on classification by the New Mexico Oil and Gas Conservation Commission twelve fields have been completed in the Ellenburger, eight in the Simpson, four in the Montoya, and one, the Monument gas field, is dually completed in the Simpson and Ellenburger. Most of these fields do, however, have stacked pay zones and share a common field name. As of January 1, 1973 oil produced from the Ellenburger amounted to

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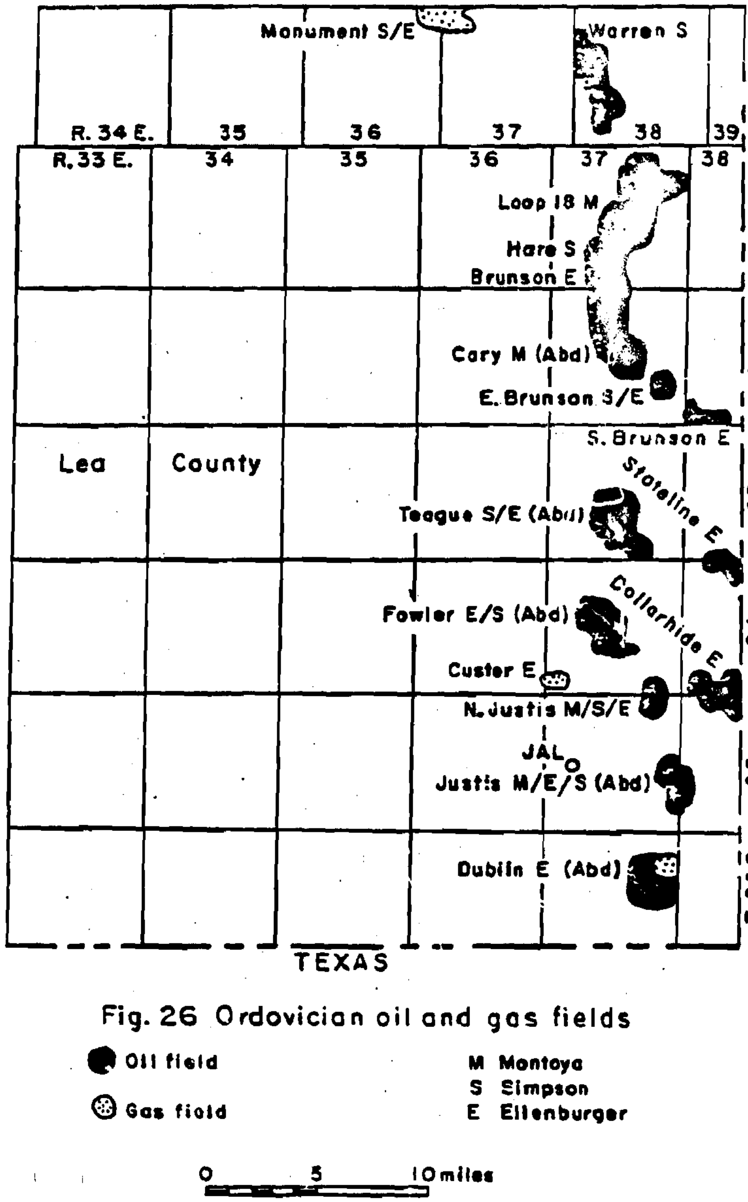


Fig. 26 Ordovician oil and gas fields

57, 147, 110 barrels; from the Simpson, 37, 858, 725; and from the Montoya, 3, 833, 153 barrels.

Data published by the Roswell Geological Society (1956, 1960) on seven Ellenburger fields indicates that oil is trapped in dolomite in anticlines or erosionally truncated anticlines. Suitable porosity is primarily controlled by fractures, with vugs and intragranular porosity contributing to the overall pay zone.

Gibson (1965) believes that there is a common paleoaquifer in the upper part of the Ellenburger that was developed by ground-water solution during the long period of subaerial erosion that preceded the deposition of the Simpson. He further suggests that the oil and gas in Ellenburger reservoirs entered after formation of the reservoir and deposition of the overlying sediments; any indigenous oil having escaped during the period of erosion. If such fields as Justis, Dublin, Fowler, Monument, and Teague are associated with a post-Ellenburger/pre-Simpson unconformity and structures are in part of Middle Ordovician age the potential for suitable reservoir conditions and traps not associated with the Central Basin platform would seem to be much better. According to Jones and Smith (1965) it appears that some Ellenburger and Simpson oils have a common origin, and that the source of these oils is from shales in the Simpson. Other oils appear to be similar to Devonian, Pennsylvanian, and Wolfcamp oils and on the higher parts of the Central Basin platform oil in the Ellenburger is Simpson oil diluted primarily with oil from the Pennsylvanian and Wolfcamp. From the foregoing, any oil or gas present in the Ellenburger in the Pilot area would either have to be indigenous or derived from the overlying Simpson. Further, the trapping mechanism would seem to require an anticlinal fold or possibly faulting. Although the tightly folded, high-closure structures of the Central Basin platform may not be necessary some structural displacement may be required to develop suitable fracture porosity. Other possible traps include favorable mound or reef structures surrounding Precambrian highs, selective dolomitization, and local unconformity traps beneath the Simpson.

Oil in the Simpson is in part thought to be indigenous and in part derived from shales of Woodford through Wolfcamp age (Jones and Smith, 1965). Simpson reservoirs are, according to Gibson (1965) of two types: sandstones confined by shales and truncated sand bodies unconformably overlain by a suitable caprock. In both cases traps are the result of anticlinal folding.

Most of the oil found in the Simpson Group in New Mexico occurs in the McKee Sandstone Member of the Tulip Creek Formation. Some oil has been produced from the Waddell Member of the McLish Formation at the abandoned North Justis-Waddell field, and from the Connell Sandstone of the Oil Creek Formation at Warren, Hare, and the abandoned Fowler field. All currently known fields are anticlinal, commonly faulted or truncated, and in the latter case unconformably overlain by rocks of Permian age.

The blanket-type sandstones of the Simpson would seem to require prominent structures to provide adequate traps. However, west of the Central Basin platform the Simpson thins beneath the pre-Montoya unconformity and where unfractured, Montoya limestone could be an effective caprock. Reservoir characteristics of Simpson sandstones should be favorable in the Pilot area although Wright (1965) feels they are not as favorable and become less so with distance from the Central Basin platform. A trapping mechanism is, as with the rest of the Ordovician, the vague parameter in evaluating the potential of this interval in the Delaware basin.

Based on past exploration the Montoya would seem to have the most limited potential of the Ordovician system. The Cary and Justis fields are truncated anticlines and suitable permeability appears to be closely related to fracturing. Wright (1963) stated that most seals consist of Permian rocks overlying truncated Montoya beds, but feels that there is a potential for stratigraphic traps where dolomite interfingers with limestone.

Very little information is available on the origin of oil in the Montoya. Jones and Smith (1965) suggest that it probably originated in shales of Woodford to Wolfcamp age.

According to Holmquest (1965) petroleum accumulations in Ordovician rocks in the deeper parts of the Delaware and Val Verde basins occur in anticlinal features associated with faulting. Holmquest also noted that oil derived from the Simpson disassociates into gas-condensate and gas below burial depths of 14,000 feet. There are, of course, exceptions to this theory, but whether on this basis or Gussow's (1954) concept of updip spilling of oil as it is displaced by gas, it would appear that the Ordovician potential in the Pilot area can be considered to be limited to gas and possibly condensate. Possibilities for suitable reservoir rocks and potential source beds are good for the Ellenburger and Simpson intervals. Presence of faults and associated anticlines such as on the Central Basin platform or the intrabasinal Bell Lake structure cannot be inferred from present drilling density.

Shows of gas and distillate in five of the six wells that penetrated the Ordovician section indicate a widespread distribution of gas in the Delaware basin. The Texas 1 Richards well in T. 20 S., R. 32 E. recovered on a drill-stem test from 16,200 to 16,280 feet (Simpson-Ellenburger) an estimated 179 MCF of gas plus distillate; from a second test at 16,280 to 16,330 feet (Ellenburger) 340 MCF of gas plus distillate; and in a third test of the Ellenburger from 16,330 to 16,409 feet, 344 MCF of gas. Southwest of the Pilot area in the Shell 1 James Ranch in T. 22 S., R. 30 E. a test of the Ellenburger and lower part of the Simpson from 17,378 to 17,555 feet yielded slightly gas-cut mud.

Silurian/Devonian Systems

An evaluation was made of fifty-nine Silurian/Devonian fields based on data published by the Roswell Geological Society (1956, 1960, and 1967). From this it can be determined that the typical field has an anticlinal or faulted anticlinal trap, the reservoir rock is dolomite with porosity and permeability controlled by fracturing and vugs, and the pay zone is immediately below the pre-Woodford unconformity or a thin limestone caprock. Exceptions to this are one field considered a fault trap; two stratigraphic in that Silurian/Devonian rocks are truncated updip beneath a seal of Permian rocks; the reservoir rock of one field, Reeves on the northwest shelf, is limestone; and the pay zone may be as much as 100 feet below the Woodford Shale, or a second pay zone may be present in the lower part of the interval. The necessity of an anticlinal trap has been noted by Salisbury (1968), Gibson (1965), Holmquest (1965), and Wright (1963), although Wright suggested the possibility of stratigraphic traps where there is a facies change from dolomite to limestone. Most of the productive anticlinal structures in New Mexico dip steeply away from the axis and have considerable closure.

As with the Ordovician the basic problem is in determining the potential of there being anticlinal traps associated with faulting in the Pilot area. The intrabasinal Bell Lake structure has been discussed previously; other fields within the Study area although not adequately drilled to establish size and trend appear to be structurally controlled. Hills (1968) has reported that the Red Hills field is an anticline and that the structure was located and drilled on the basis of seismic information. This field was completed in Pennsylvanian and Wolfcamp rocks, but a drill-stem test of the Silurian/Devonian yielded 478 MCF of gas, and following acidizing 10,400 MCF. Antelope Ridge field (fig. 27) is an anticline but is located on the Bell Lake block. It may, however, be associated with the east-bounding fault of this structure. Although

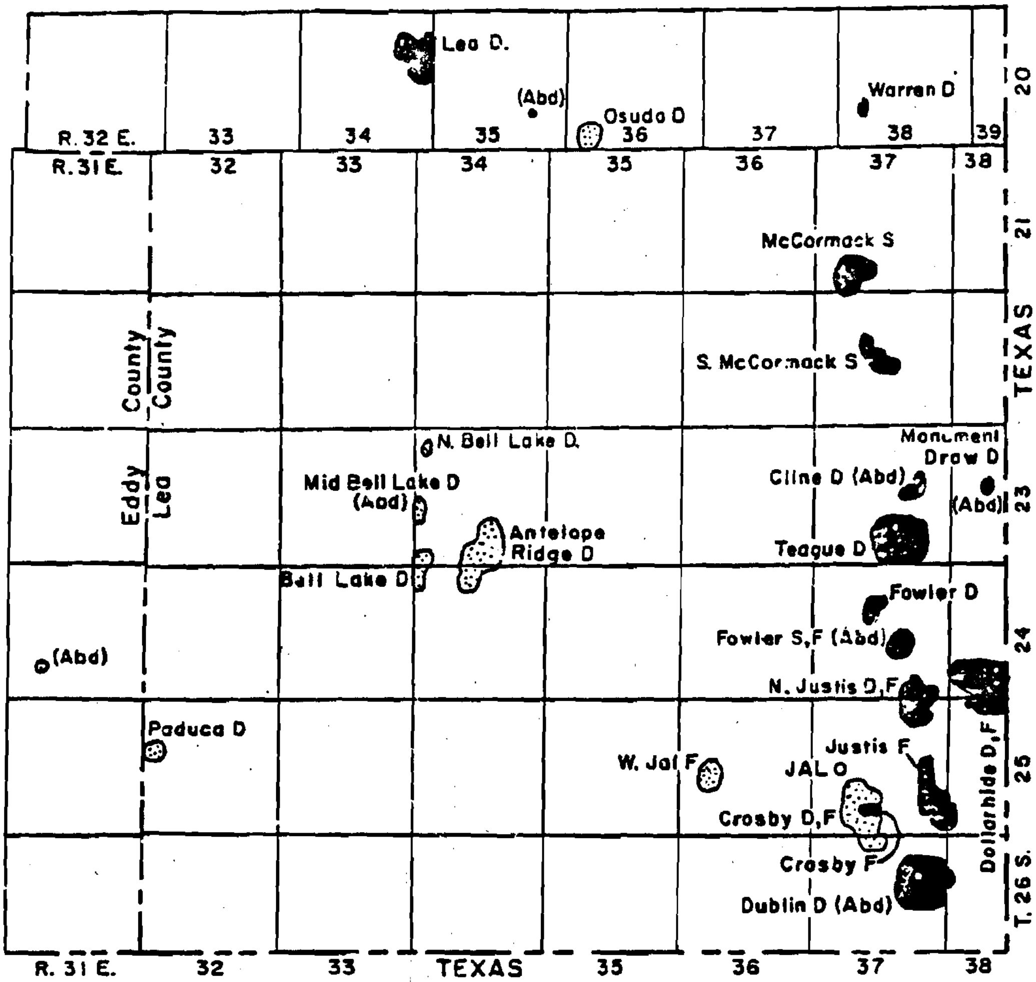


Fig. 27 Silurian / Devonian oil and gas fields

control is limited, the four wells in the area of the Paduca field show the presence of an anticline (fig. 20) and the Lea field also is a closed structure although the contour interval is too large for this feature to show on the structure map.

Based on the few Silurian/Devonian fields in the Study area the presence of suitable structural traps in rocks of Silurian/Devonian age is established, even though the frequency of such traps is not known. Structural traps in southeastern New Mexico commonly have stacked pay zones. Therefore, knowing that structures are present in the Delaware basin and that oil and gas is being produced from these structures, increases the potential for each part of the section known to contain suitable reservoir rocks.

Jones and Smith (1965) concluded that most oil in the Silurian/Devonian was probably derived from the Woodford and Pennsylvanian. In the Delaware basin the primary source would have to be from the Woodford. Holmquest (1965) noted disassociation of Woodford oil below burial depths of 13,000 feet. However, the Lea oil field is at a depth of over 14,000 feet below the present surface. The below surface depth in the northern part of the Pilot area is approximately the same as at the Lea field suggesting that the potential of finding oil cannot be overlooked. Weighted against this is the fact that reported shows surrounding the Pilot area are limited to gas. In addition Salisbury (1968) suggested that Silurian/Devonian gas had a different source than the oil and his dry gas area for this interval would include the Pilot area of this report.

Mississippian System

As noted by Gibson (1965) Mississippian limestones although overlain and underlain by potential source beds do not contain adequate reservoir rocks. The primary reason for this would appear to be lack of dolomitization and important tectonic movements and prolonged periods of erosion. The Bronco field in T. 13 S., R. 38 E. contains a dolomite facies from 80 to 100 feet below the top of the Mississippian and it is from this interval that oil has been recovered. Near the northern eroded limit of the Mississippian dolomitization may be common but it is doubtful for the Pilot area where the limestone sequence is overlain by the Barnett Shale. Although there are some reported gas shows in and around the Pilot area some of these have a questionable source in that the drill-stem tests also include the upper part of the Silurian/Devonian carbonate sequence.

Pennsylvanian System

Oil and gas field data published by the Roswell Geological Society and Meyer (1966) cannot be directly applied to this part of southeastern New Mexico. The fields examined in these reports were mostly oil fields north of the Delaware basin, whereas in the Delaware basin and immediately adjacent areas most discoveries have been gas (figs. 28 and 29). Field data included thirty-five limestone reservoirs, nineteen sandstone, and six in dolomite. Traps evaluated included forty-five stratigraphic or combination stratigraphic/structural, and fifteen anticlinal. In the Study area of this report, including singly designated fields that have

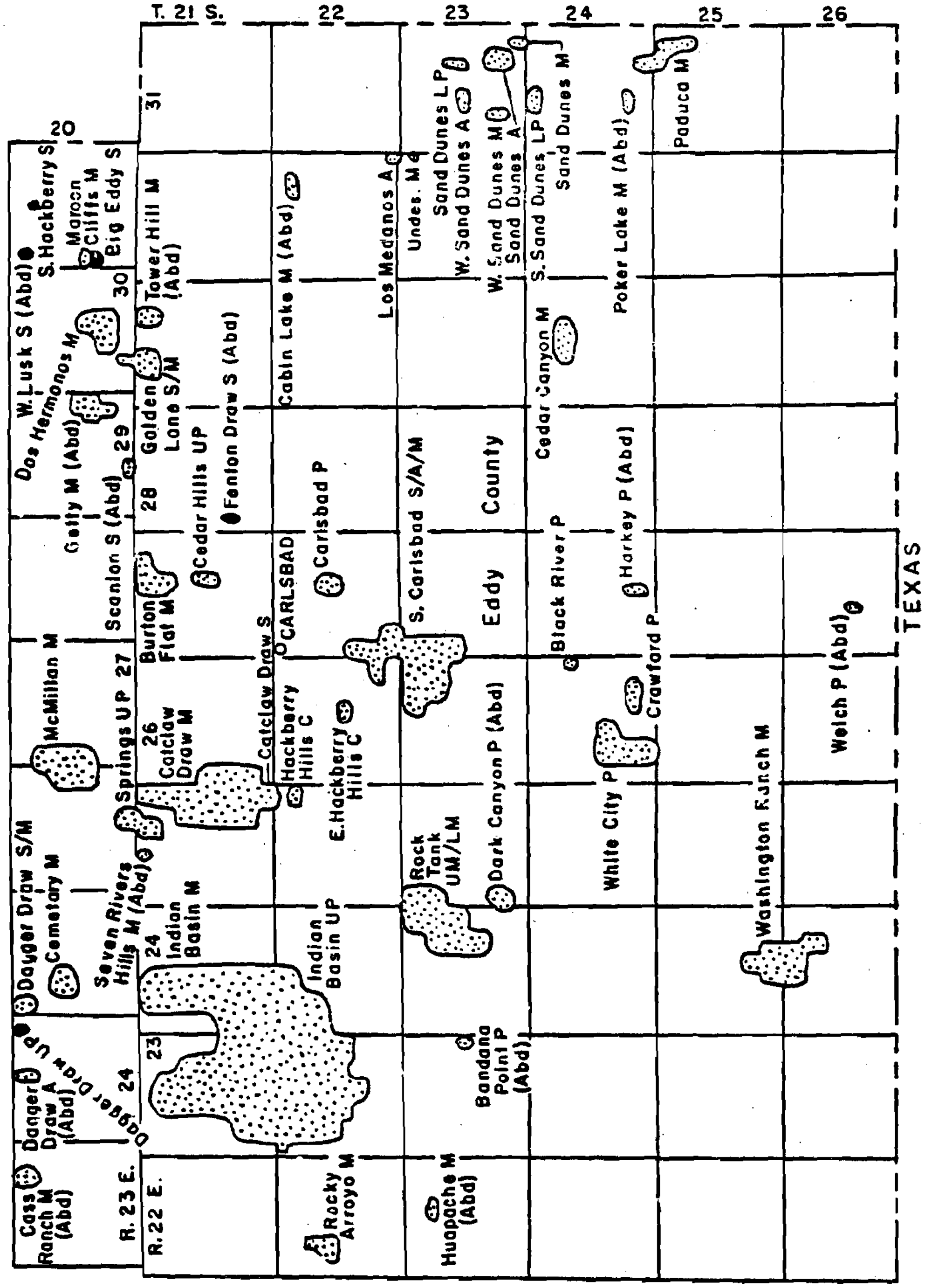


Fig 28 Pennsylvanian oil and gas fields: Southern Eddy County

Oil fields

Gas field

U - Upper
L - Lower
P - Pennsylvanian
C - Canyon
S - Strown
A - Atoka
M - Morrow

0 5 10 miles

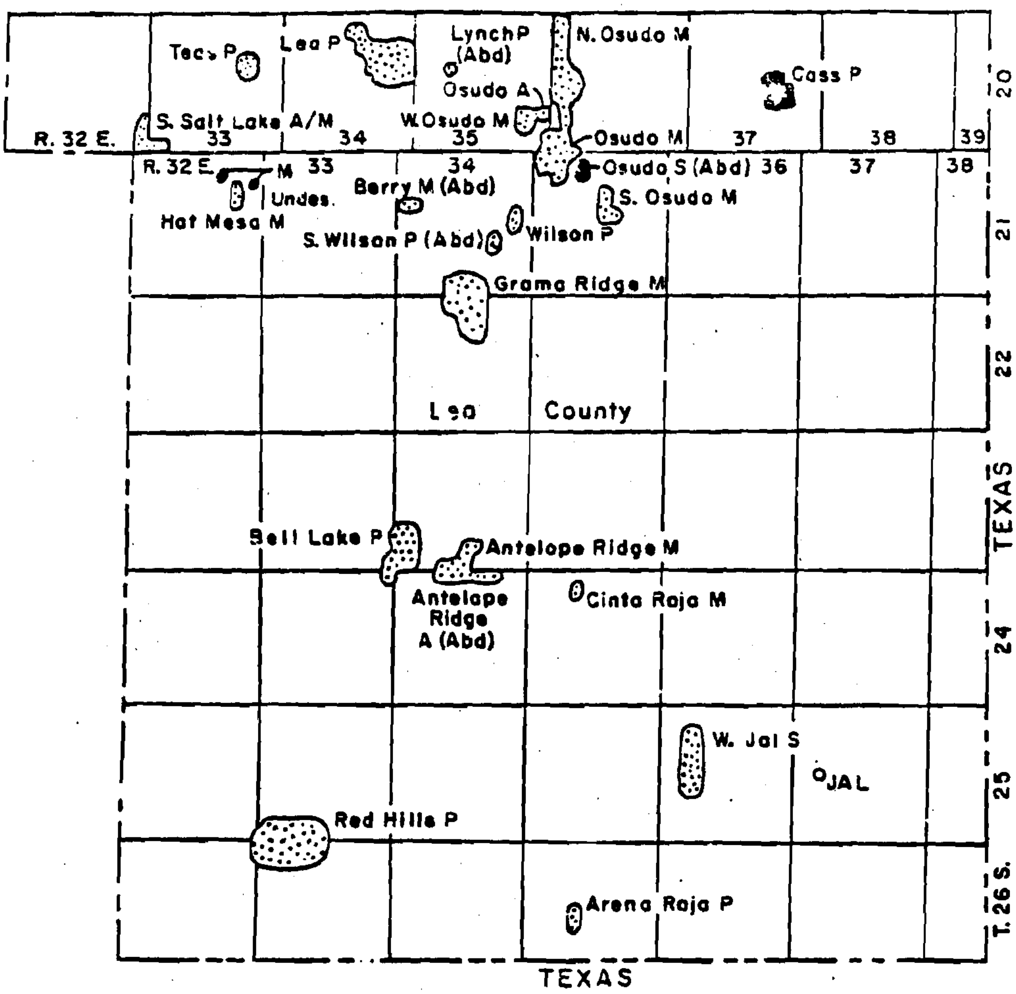


Fig. 29 Pennsylvanian oil and gas fields: Southern Lea County

Oil fields
Gas field

U - Upper
L - Lower
P - Pennsylvanian
C - Canyon
S - Strawn
A - Atoka
M - Morrow

0 5 10 miles

been determined to be producing from more than one part of the Pennsylvanian, there are four oil fields and eight gas fields completed in limestone reservoirs, and two undesignated oil wells and 29 gas fields completed in sandstone reservoirs. Most of these fields are stratigraphic or combination traps.

For discussion purposes five areas were established covering all of the producing fields in the Study area (fig. 48). For each of these areas a type well is used to show the stratigraphic position of each pay zone in that area. In addition the distribution of fields for the Strawn, Atoka, and Morrow intervals are shown on separate maps (figs. 30 to 33).

Area 1 in the northwest part of the Study area has five gas fields, three oil fields, and one undesignated oil well. The type well is the Pan American 1 Emperor; discovery well of the Dos Hermanos-Morrow gas field (fig. 34). Except for the Golden Lane-Morrow field, Morrow wells have multiple pay zones as follows: Dos Hermanos six sandstone pays, Tower Hill, four, and Maroon Cliffs at least three. The six gas-bearing sandstones at Dos Hermanos are distributed over a 400-foot section of the Morrow.

The Strawn fields are producing from limestone reservoirs that are probably algal reefs. According to Thornton and Gaston (1967), the Lusk field in T. 19 S., Rs. 31 and 32 E. is an algal reef that grew on a structural ridge that extends southeast into the Delaware basin. A possible extension of this ridge is indicated in the Pennsylvanian structure map (fig. 22) in T. 20 S., R. 32 E. If this is true this structural nose

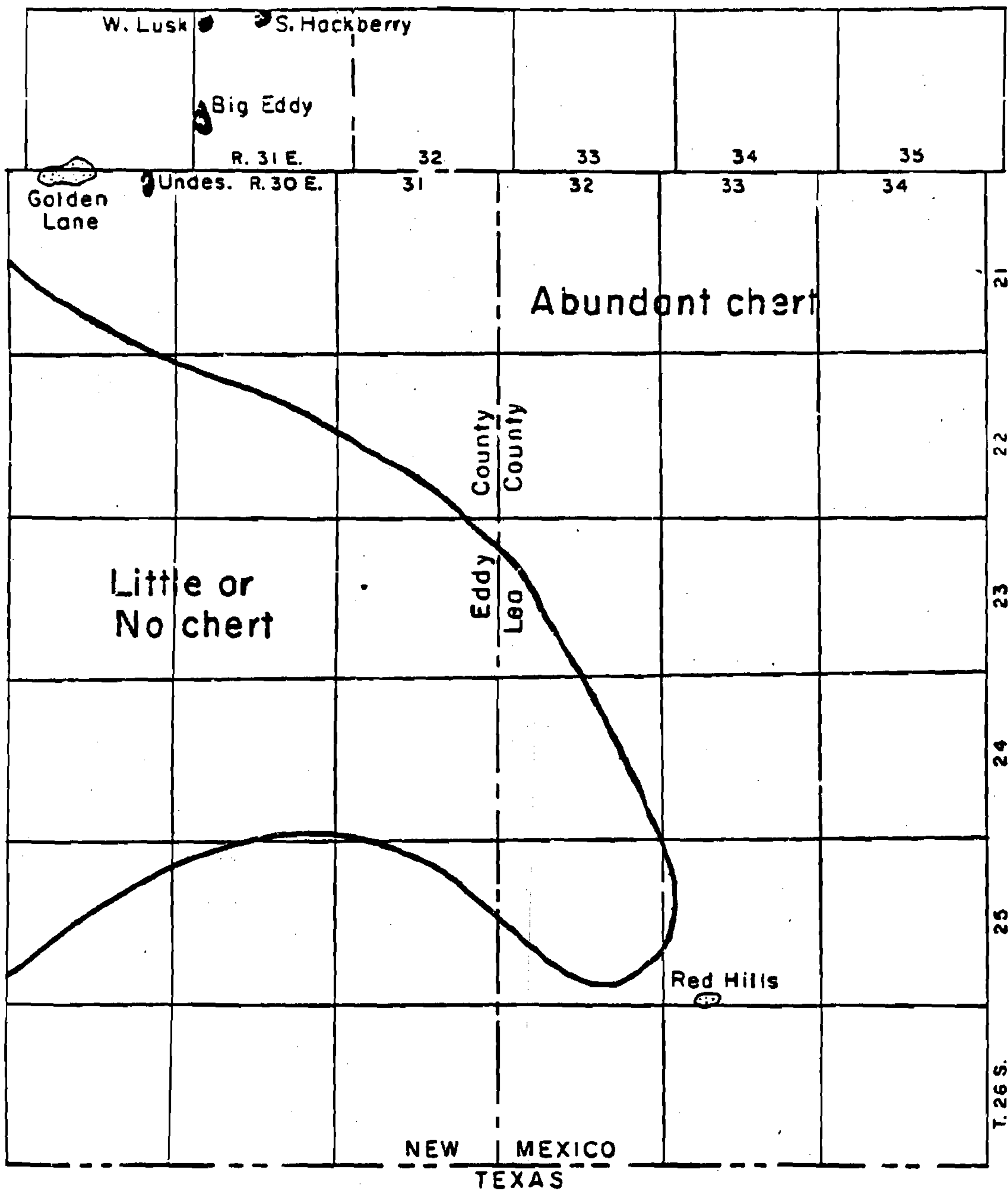


Fig. 30 Distribution of chert and upper Strawn oil and gas fields

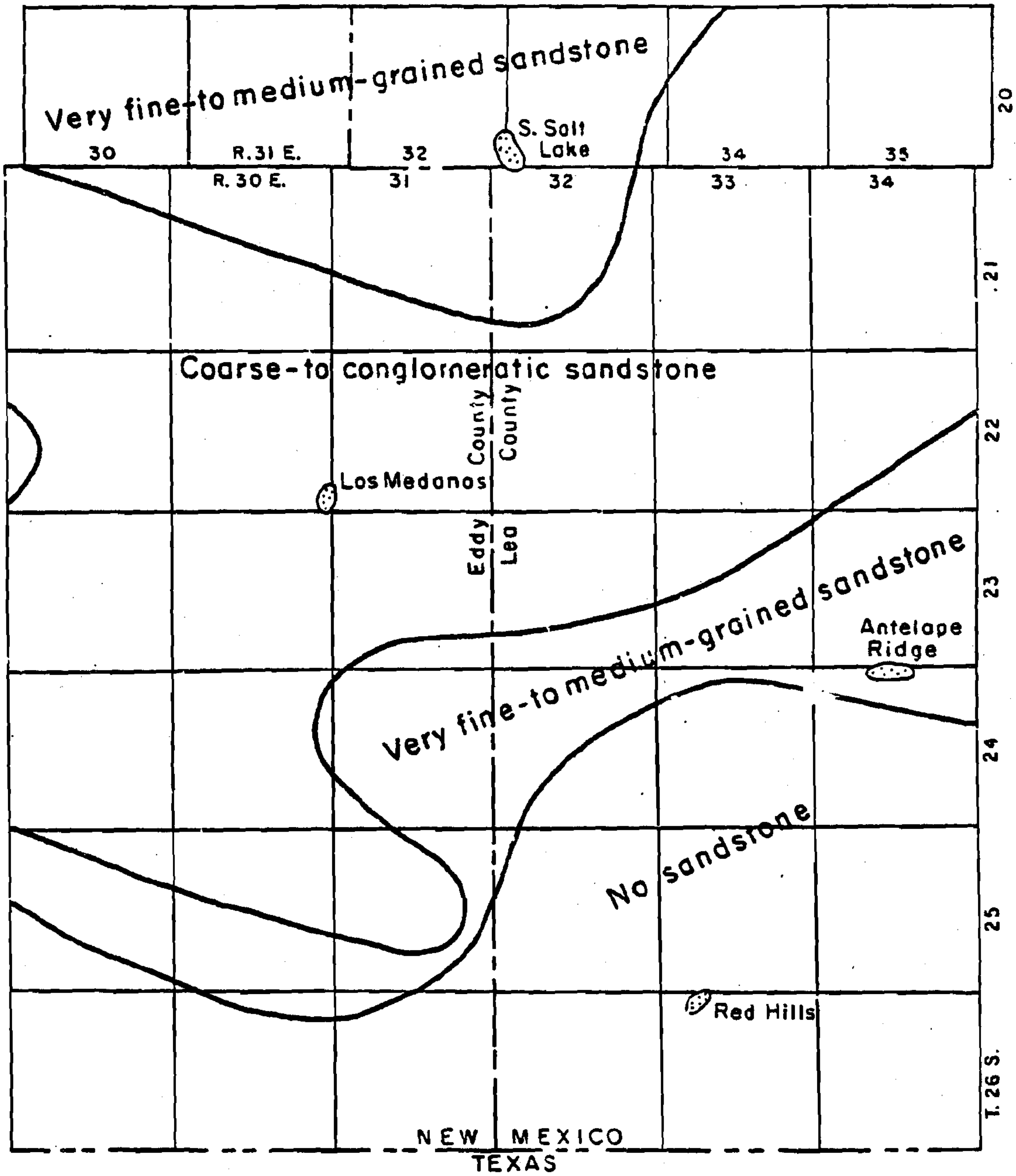


Fig. 31 Sandstone facies and lower Strawn gas fields

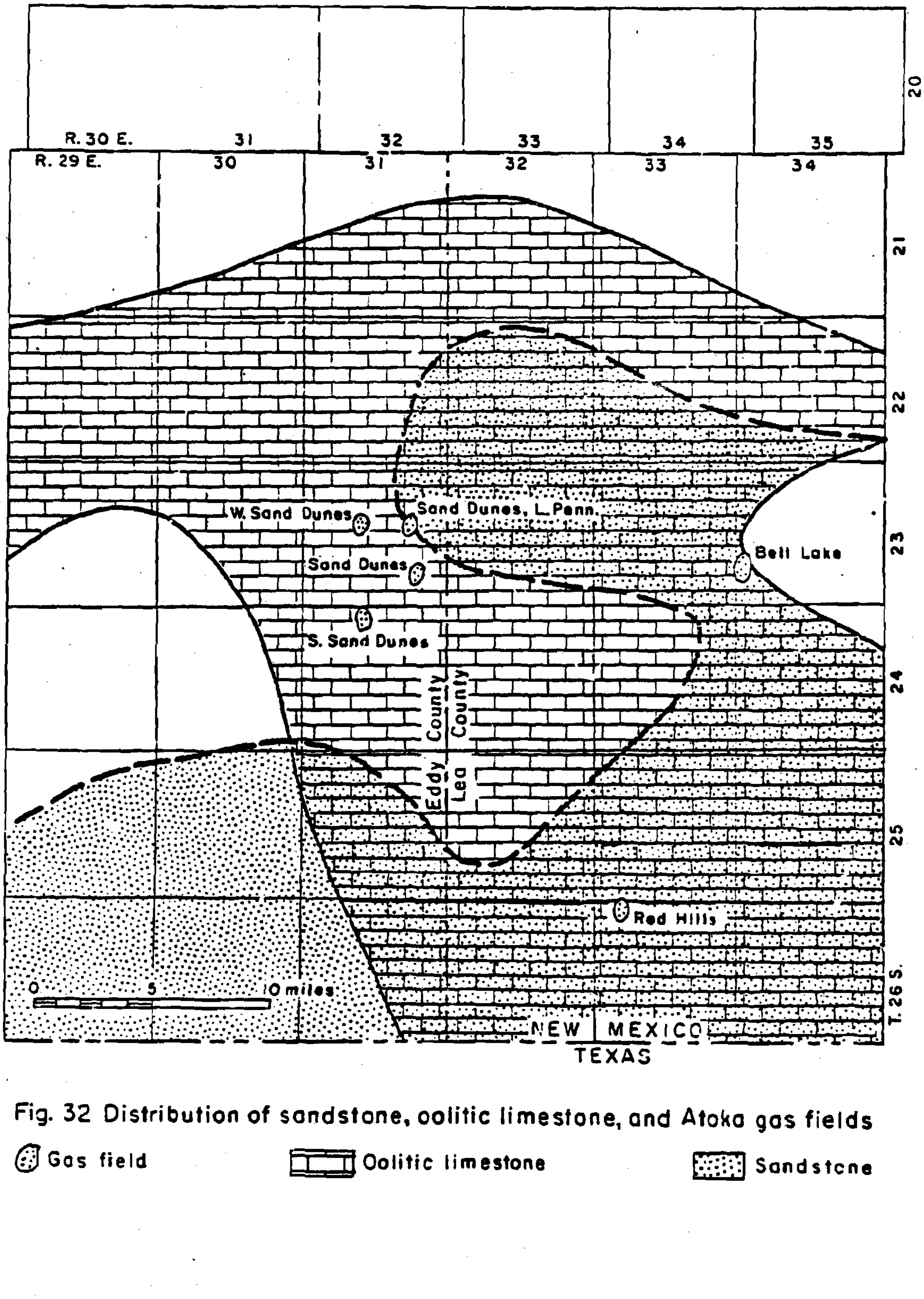


Fig. 32 Distribution of sandstone, oolitic limestone, and Atoka gas fields

Gas field — Oolitic limestone — Sandstone

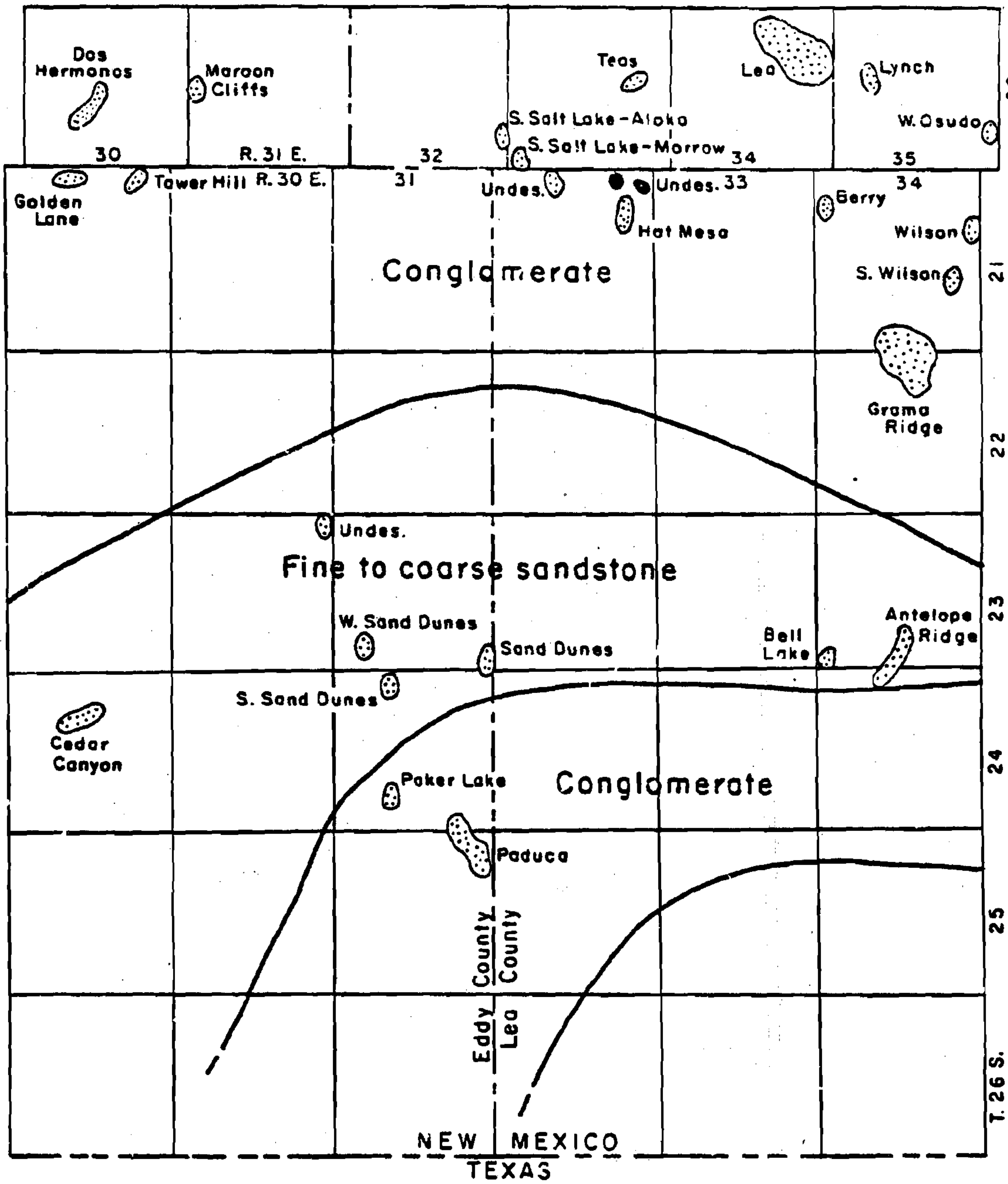


Fig. 33 Sandstone facies and Morrow oil and gas fields

● Oil field 0 5 10 miles Gas field

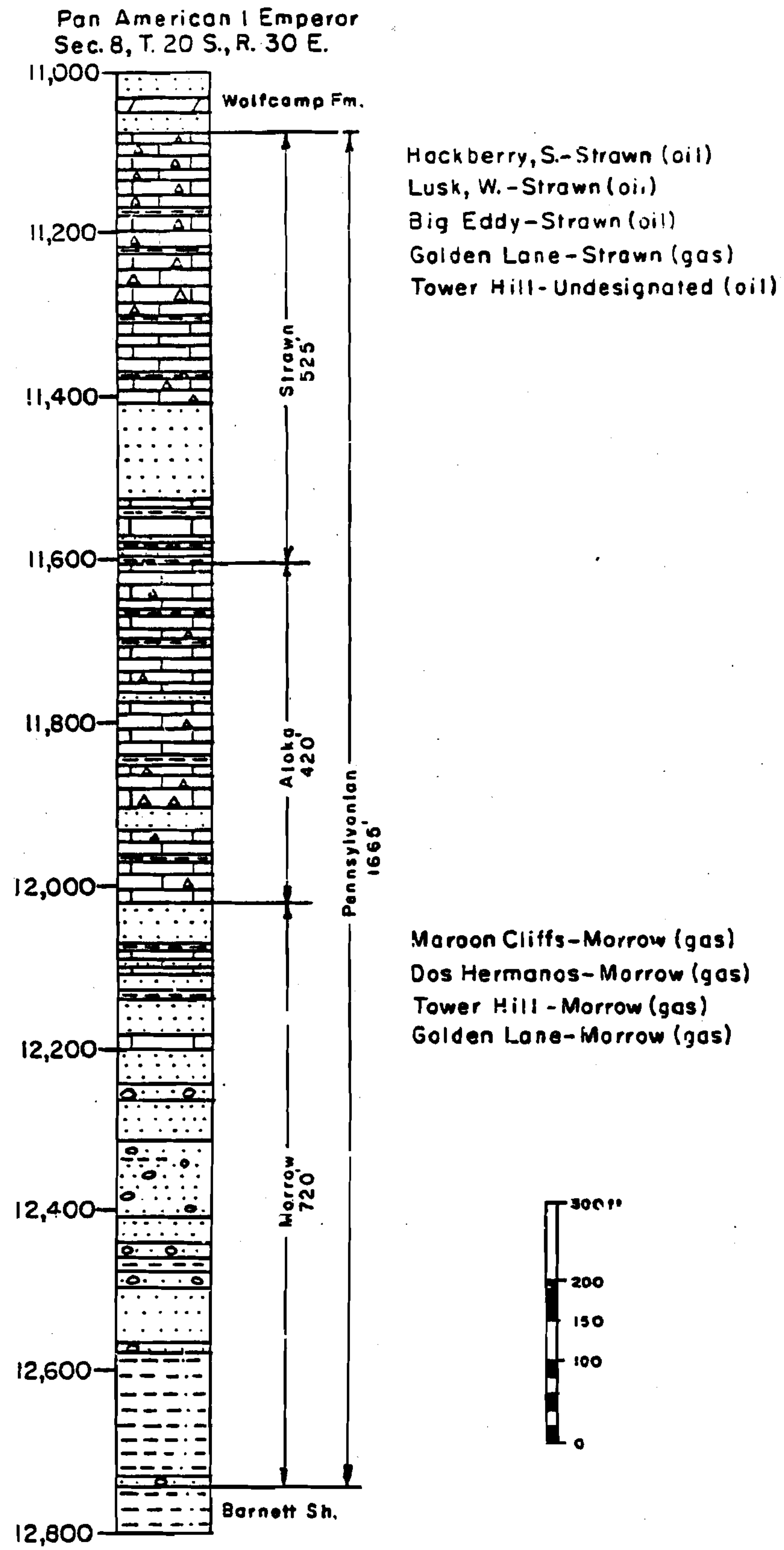


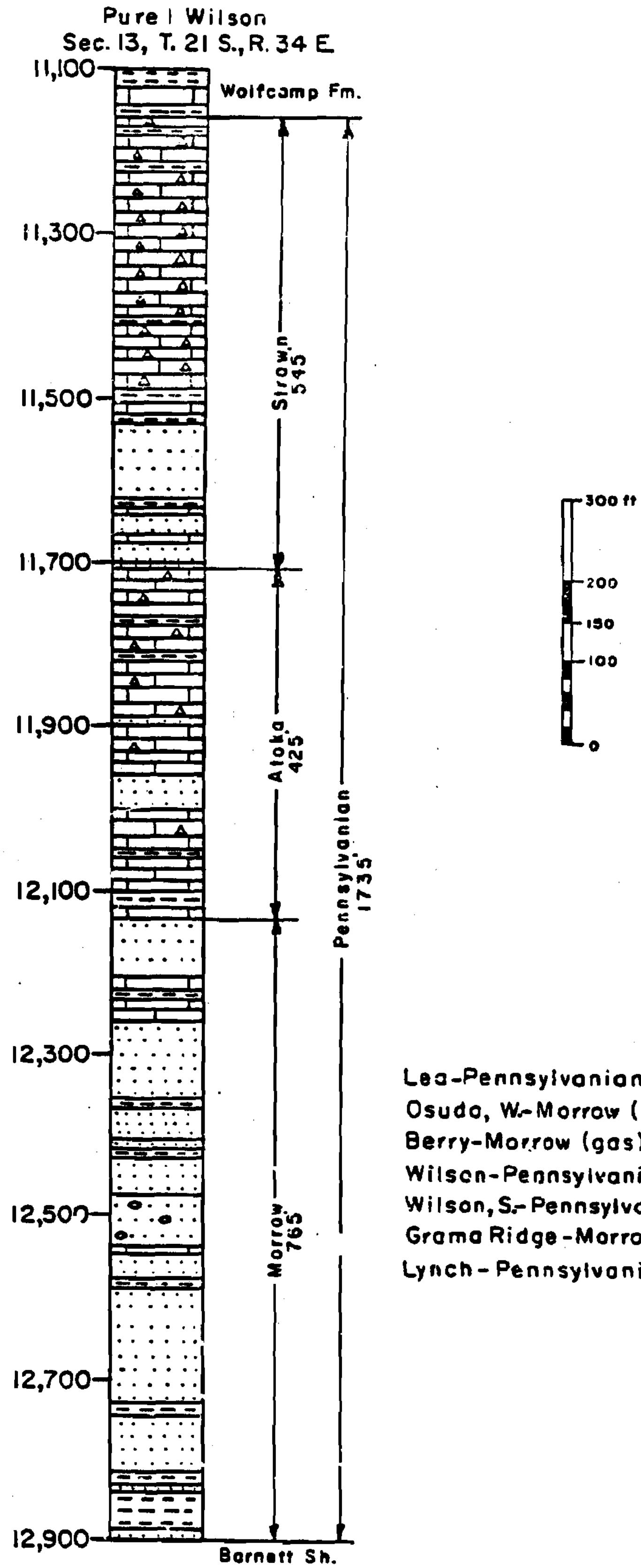
Fig. 34 Type well for Area I

was formed prior to Late Pennsylvanian-Early Permian time. Big Eddy, South Hackberry, and West Lusk may be related to this structure and corresponding control of reef growth but it would appear that reef development is much more widespread in Area 1 and not totally associated with structural ridges. Typical of platy or phylloidal algae reefs porosity development varies considerably. At Big Eddy the top of the pay zone differs in each of the four wells completed in this field, ranging from seven to 173 feet below the top of the Strawn. At South Hackberry and West Lusk the pay zone appears to be in the same stratigraphic position but exploration indicates that they do not represent a connected reservoir. To the south at Tower Hill and Golden Lane (Strawn) respectively the pay zone is 104 feet and 6 to 38 feet below the top of the Strawn.

The type well for Area 2 was the discovery well for the South Salt Lake-Atoka field (fig. 12). The pay zone in this well is the sandstone at the top of the Morrow while the pay zone of the well in sec. 36, attributed to the same field, is in sandstone in the lower part of the Strawn. The South Salt Lake-Morrow field was completed in sandstone near the top of the Morrow or approximately at the same stratigraphic position as the deeper pay zone in the South Salt Lake-Atoka field. The undesignated Morrow gas well in sec. 4, T. 21 S., R. 32 E. was completed in the Morrow but considerably below the pay zone of the South Salt Lake Morrow wells. It appears to be about at the same stratigraphic position as the well in the Teas field and both wells encountered four separate gas-bearing sandstones in this interval. The Hat Mesa field has two gas sands in the upper part of the Morrow. Although obviously producing from Morrow sufficient data was not available to evaluate the stratigraphic position of the pay zones in the two undesignated Morrow oil wells.

All of the wells in Area 3 were completed in the Morrow (fig. 35) but apparently from different sandstones, mostly in the upper one half of the interval. The number of gas-bearing sandstones in wells in the Lea field vary from one to six, and there are three at Wilson, six at West Osudo, three at Berry, six at South Wilson, and one to three at Grama Ridge. Gas production in the lower part of the Morrow is obtained from three sandstone beds at Lynch and from a single sandstone in one well in the Lea field. The upper half of the Morrow is on the order of 400 feet in thickness. It would appear that there is little continuity between gas-bearing sands from one well to the next, or that some may be continuous with nearby wells and others have graded into shales or shaly sandstones.

Area 4 takes in all of the south-central gas fields plus the Cedar Canyon field. The type well is the Pan American 36 Poker Lake-Morrow field (fig. 36). Gas production at Red Hills is from lower Strawn limestone in T. 25 S., and from limestones in the Atoka and upper part of the Strawn in T. 26 S. As noted previously sandstone is absent in the Strawn in this area. The Los Medanos field to the north is a sandstone reservoir in the lower part of the Strawn. Although data is limited for Atoka fields all appear to have limestone reservoirs perhaps of similar origin to the Strawn fields to the north.



Lea-Pennsylvanian (gas)
Osudo, W.-Morrow (gas)
Berry-Morrow (gas)
Wilson-Pennsylvanian (gas)
Wilson, S.-Pennsylvanian (gas)
Grama Ridge-Morrow (gas)
Lynch-Pennsylvanian (gas)

Fig. 35 Type well for Area 3 Pennsylvanian gas fields

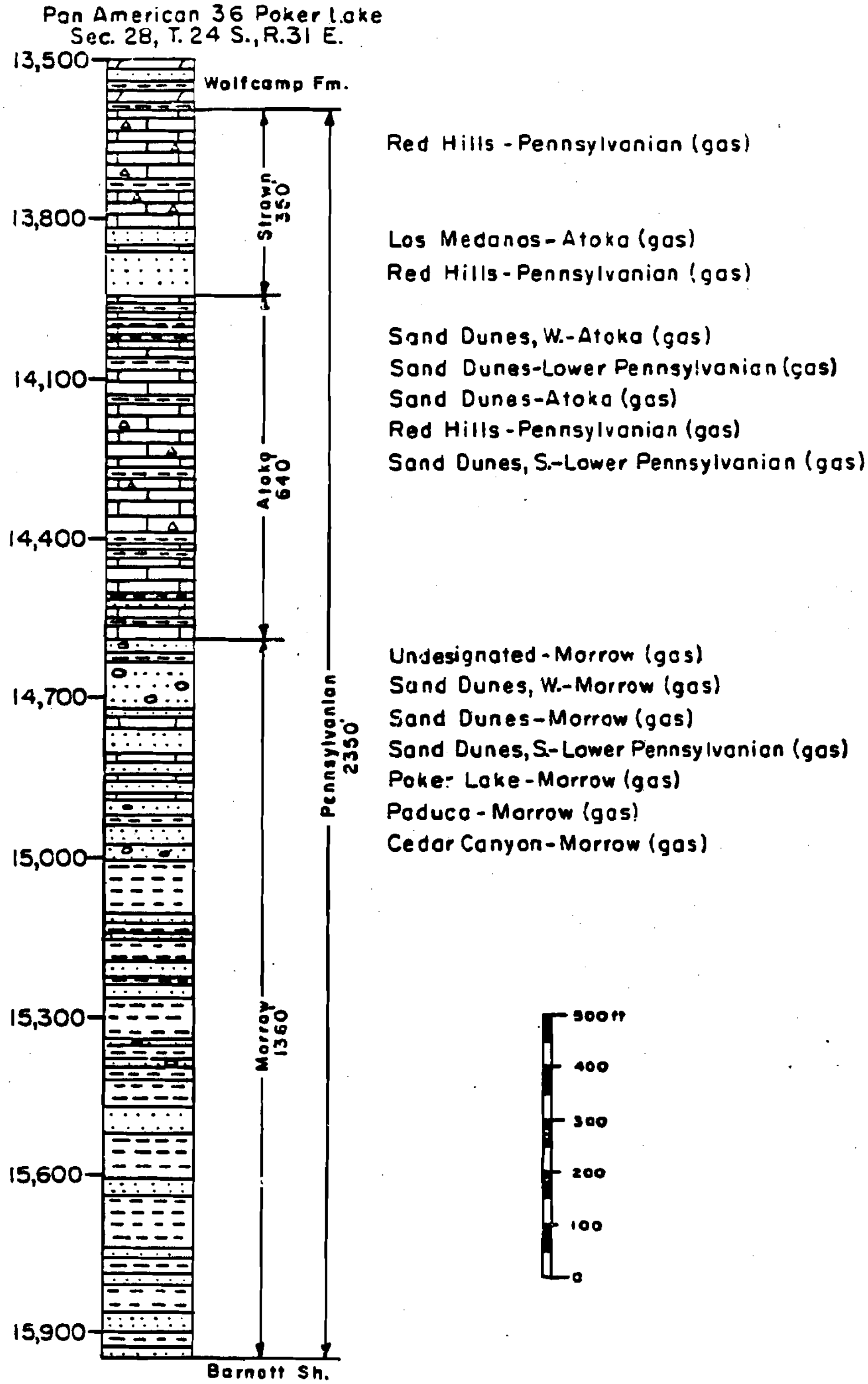


Fig. 36 Type well for Area 4 Pennsylvanian gas fields

Gas has been discovered in six fields and one undesignated well in the Morrow of Area 4. Adequate data was not available to determine the number of pay zones discovered for all the wells in this area. Reservoir rocks appear to be sandstones or conglomerates in the upper part of the Morrow. There are four thin gas sands occupying approximately the same stratigraphic position at the two Cedar Canyon wells and the Paduca wells in sec's. 2 and 12, T. 24 S., R. 31 E. There appears to be only one gas sand in the northernmost Paduca well. There are at least three gas sands at Poker Lake and in the undesignated Morrow well just south of the Los Medanos field. Sandstones in the lower part of the Morrow have not been productive in Area 4.

The type well for Area 5 is the Conoco 1A Bell Lake in sec. 31, T. 23 S., R. 34 E. (fig. 37). This well was completed in sandstone in the upper part of the Morrow. The well in sec. 30 of the same township discovered gas in cavernous limestone in the upper part of the Atoka and the well in sec. 1, T. 24 S., R. 33 E. on the downthrown side of the Bell Lake fault, from a sandstone near the middle of the Morrow, considerably below the pay zone in the sec. 31 well. The two wells in the Antelope Ridge-Atoka field appear to have a common reservoir in limestone in the lower part of the Strawn. The well in sec. 4 is recovering gas from four sandstone beds in the upper part of the Morrow and is included in the Antelope Ridge-Morrow field. The other well in this field in sec. 27, T. 23 S., R. 34 E. also has four gas sands but one or two of the sands is stratigraphically lower than in the well to the south.

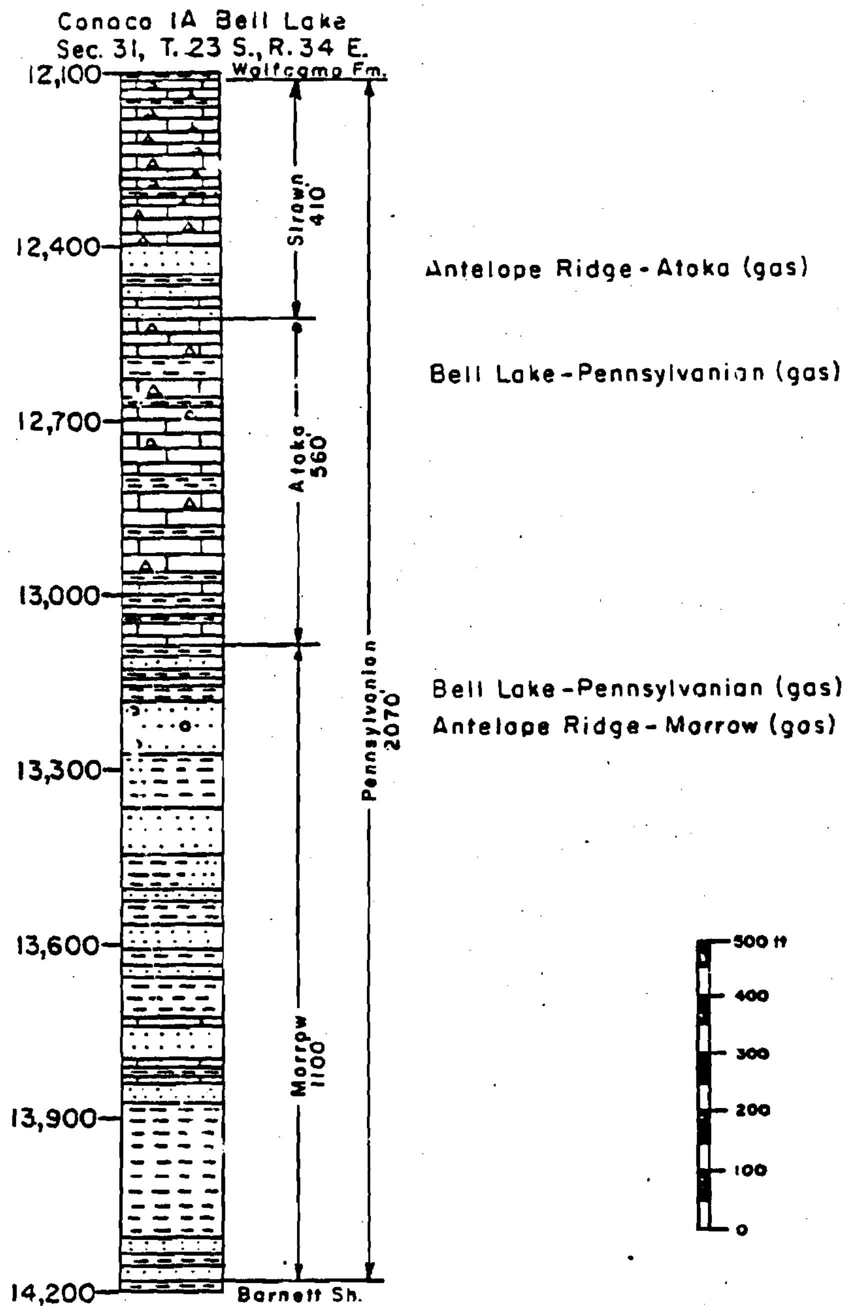


Fig. 37 Type well for Area 5 Pennsylvanian gas field

The Pennsylvanian rocks within the Study area have at least one limestone and one sandstone reservoir in the Strawn; possibly three limestone intervals in the Atoka; and at least six sandstones in the upper half and four in the lower half of the Morrow. Thus there is a minimum potential of 15 separate reservoirs. Coupled with the high rate of success of wildcat exploration the chances of one of these reservoir rocks being developed and containing oil or gas would seem quite high for any part of the Pilot area.

The source of Pennsylvanian oils is thought to be indigenous, derived from the dark shales present throughout the sequence (Jones and Smith, 1965). It would seem possible, however, that some of the Strawn oils might have their source in the overlying Wolfcamp. Holmquest (1965) has suggested that oils from Permian/Pennsylvanian shales diassociate at burial depths of 8,000 to 9,000 feet, and therefore future deep discoveries in the Delaware basin will be almost exclusively of this type. Oil fields within the Study area are all at depths exceeding 10,000 feet and the two recent Morrow oil discoveries occur at depths of over 14,000 feet. Phase segregation such as suggested by Silverman (1965) or Gussaw's (1954) updip spilling may account for the Morrow occurrence, but this implies reservoir continuity; highly questionable in the Morrow. In any event the potential presence of oil in any part of the Pennsylvanian in the Pilot area cannot be discounted.

Permian System

The source of oil and gas in the Permian of the Delaware basin is in general thought to be indigenous to the various formations. In particular the thick basinal Wolfcamp shales appear to be a prime source (Jones & Smith, 1965). The potential for intrabasinal migration in the Bone Springs and Delaware Mountain would appear to be good based on the apparent discontinuity of suitable caprocks and may in part explain the concentration of oil at the top of the Bell Canyon beneath the anhydrites of the Castile. Fields in the Delaware Mountain Group below the Ramsey "sand" in particular appear to have very limited areal extent. The most likely source of oil in the Leonardian and Guadalupian rocks would appear to be from the Bone Springs although shales and lime muds in the Delaware Mountain also may have contributed to the Guadalupian oils. As pointed out by Adams (1936) most oil in the upper part of the Delaware Mountain Group occurs on the west flank of the basin, but it also should be pointed out that basin asymmetry and the position of the Capitan reef favor west-flank accumulation. What contribution shelf oil might have made to the basin is questionable, particularly in view of the problems of migration. Holmquest (1965) has noted disassociation of Wolfcamp oil at depths of burial of from 8,000 to 9,000 feet and Meyer (1966) the shelfward migration of Wolfcamp oil.

Wolfcamp Formation

Based on an evaluation of field data from the symposiums of the Roswell Geological Society (1956, 1960, 1967) the majority of Wolfcamp fields are structural or combination traps with very few strictly stratigraphic traps. Fields analyzed more recently invariably indicate a combination trap consisting of porosity/permeability barriers associated with an anticlinal structure. Although reef conditions in the Wolfcamp were not generally recognized until quite recently some of the fields in the Study area may occur in porosity traps associated with biostromal deposits. All reported Wolfcamp reservoir rocks are limestone or in a few cases dolomite. These have intercrystalline, vuggy, and pinpoint porosity, and limited coring has indicated some fracture porosity in a few wells. Oil produced on the Central Basin platform occurs in carbonates of the Abo Formation of lower Leonard age and thus is not correlative with the Wolfcamp of the Delaware basin area even though Abo sediments to the west are in part coeval.

There are five fields known to be of Wolfcamp age in the Study area and one field designated as Pennsylvanian that is being produced from sediments included in this report with the Wolfcamp (figs. 14, 38, and 39). Gas at Big Eddy is being recovered from a massive fossiliferous limestone, the top of which is about 120 feet below the top of the Wolfcamp. This appears to be a reef complex that could have considerable extent in the northern part of the Study area. This limestone appears to be present but much thinner in T. 21 S., R. 32 E. Limestones at different positions within the Wolfcamp section are present in T. 22 S., R. 30 E., and T. 22 S., R. 32 E. The conclusion would seem to be that one or more limestone beds that could be potential reservoirs are present in the Pilot Area.

The Southeast Lea field in T. 20 S., R. 35 E. was a dual completion in Wolfcamp and Morrow. The top of the Wolfcamp pay zone is at 11,410

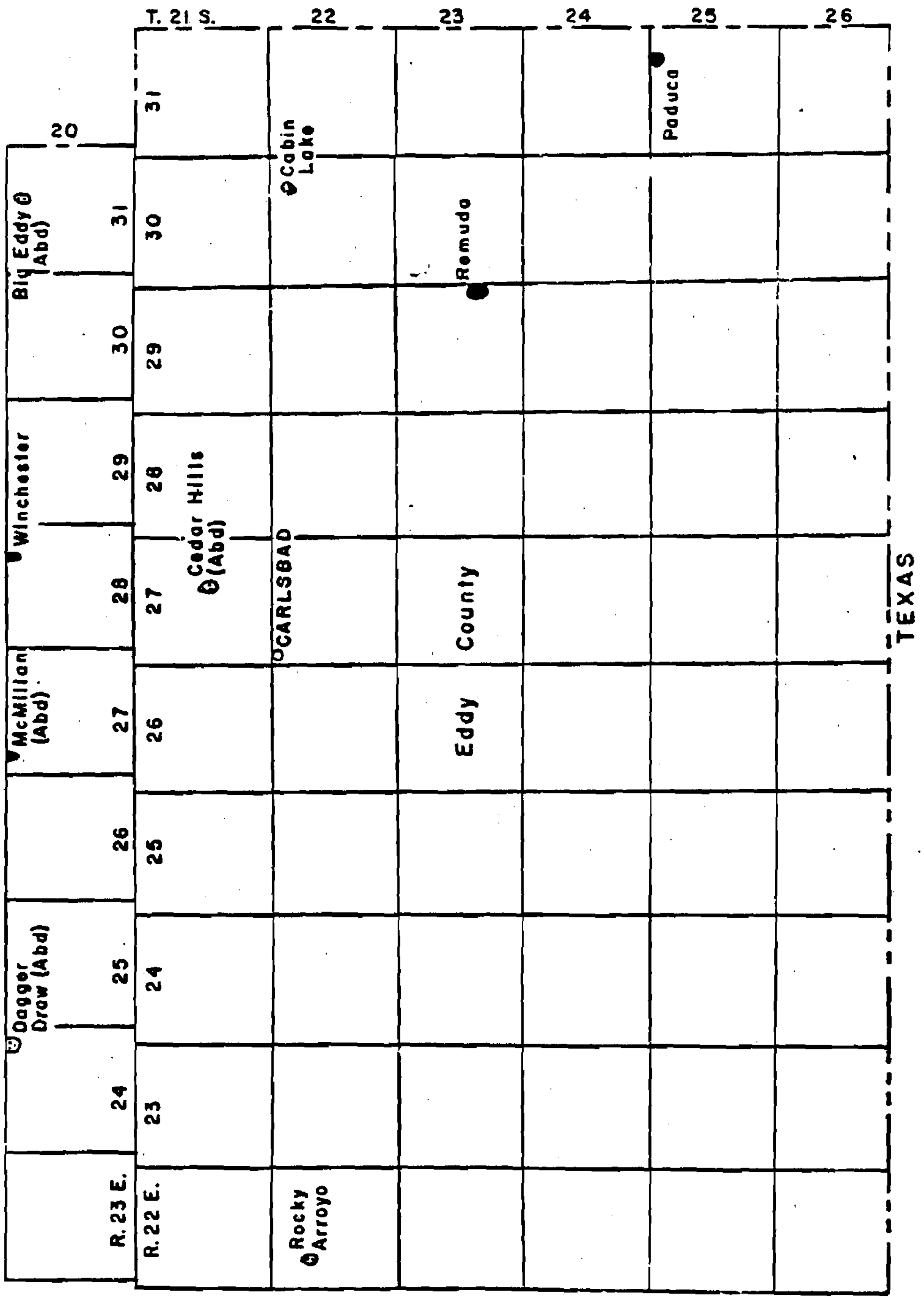


Fig. 38 Wolfcamp oil and gas fields: Southern Eddy County

Oil field 0 5 10 miles Gas field

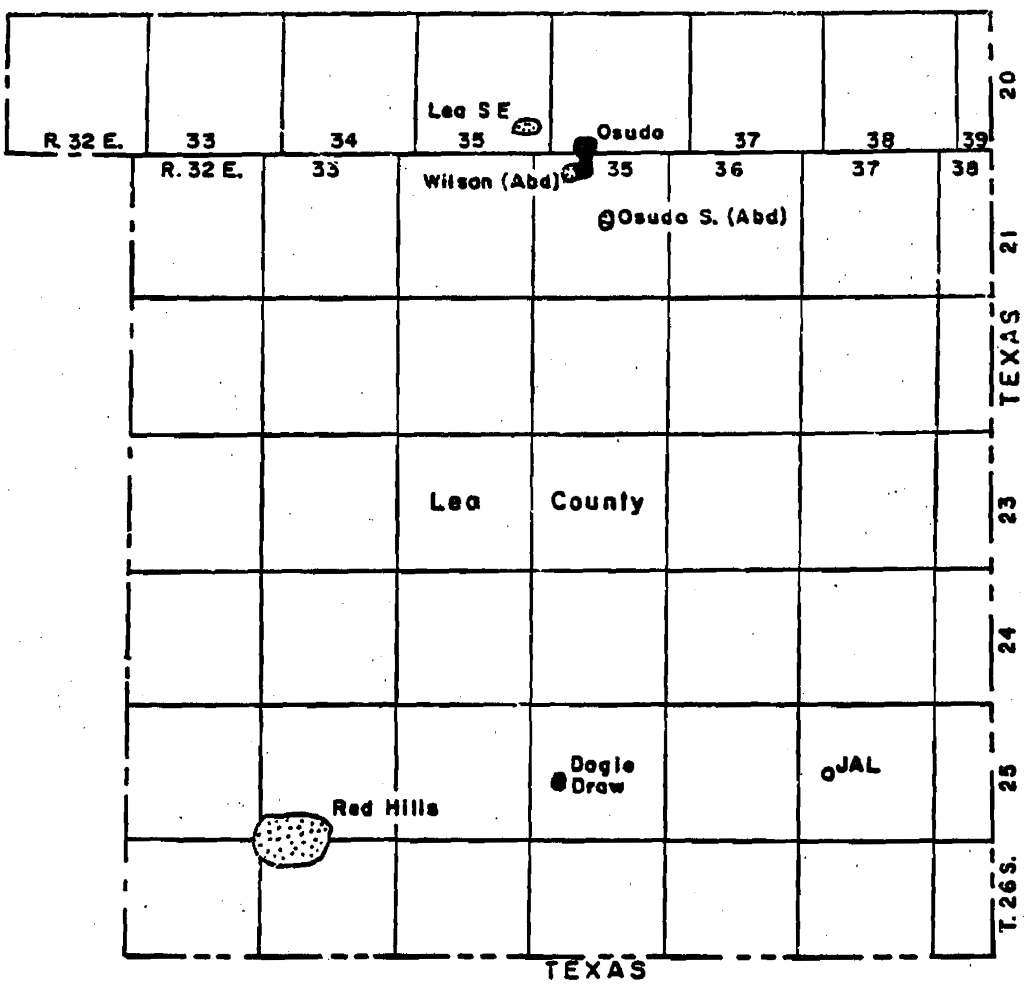


Fig. 39 Wolfcamp oil and gas fields: Southern Lea County

Oil field 0 5 10 miles Gas field

feet in a limestone occupying a similar position to the pay zone at Big Eddy. Gas is being produced from the same interval in the other well in this field in the SE$\frac{1}{4}$, sec. 26, T. 20 S., R. 35 E. The producing interval of the Cabin Lake-Strawn field may be Pennsylvanian but appears to be in limestone or dolomite just above the top of the Strawn. It therefore could be in the Canyon but this part of the section is included in the Wolfcamp in this report. The Remuda-Wolfcamp field to the southwest in T. 23 S., R. 29 E. has a limestone pay zone about 1,000 feet above the top of the Pennsylvanian. In this well as in the Cabin Lake well the Wolfcamp contains considerable limestone in the upper part of the section. Of interest of course is that Remuda and Cabin Lake are oil fields being produced at depths of from 11,000 to 12,000 feet. This certainly strengthens the oil potential of the Pilot Area where depths are approximately the same in the western part of the area and only slightly deeper in the east.

At Paduca gas is being produced from a limestone-dolomite sequence near the middle of the Wolfcamp. The carbonate section is overlain and underlain by thick shales. At Red Hills gas occurs in limestone stratigraphically lower than at Paduca but over 600 feet above the top of the Pennsylvanian.

It is obvious from the foregoing that limestone sections are the prime exploration target in the Wolfcamp. Suitable limestone reservoirs similar to those discovered in the Study area very likely underlie the Pilot area. Potential Wolfcamp reservoirs probably have not been carefully evaluated in many of the wells drilled in this part of the Delaware basin where the prime targets are in the underlying Pennsylvanian. The potential for discovery of oil and gas in this interval is considered good and in view of the prolific production of gas at Red Hills it is surprising that more tests of this interval are not being drilled.

Bone Springs Formation

Reservoir rocks in the Bone Springs Formation include limestone, dolomite, and sandstone. At Big Eddy and Teas oil is produced from the top of the first Bone Springs sand (fig. 16). Bone Springs oil occurs in limestone below the second sand at Grama Ridge and near the top of the upper limestone at Bell Lake and North Bell Lake. There are two pay zones in the Lea Field. The upper is in dolomite near the top of the first sand and the lower, also dolomite, near the middle of the second sand. There are, based on current knowledge, four pay zones in the Bone Springs and if it is considered that the dolomite in the first sand represents a separate possible reservoir there would be five pay zones.

Traps in the Bone Springs are normally thought to be stratigraphic or in part combination traps. Bell Lake obviously is primarily an anticlinal trap but apparently contains porosity/permeability barriers. Both the sandstones and carbonates in the Bone Springs have the characteristics to form permeability barriers and caprocks in that both contain varying amounts of argillaceous material. The potential for suitable traps including minor structural nosing would appear to be good on the west flank of the Delaware basin in the Pilot area. Rather

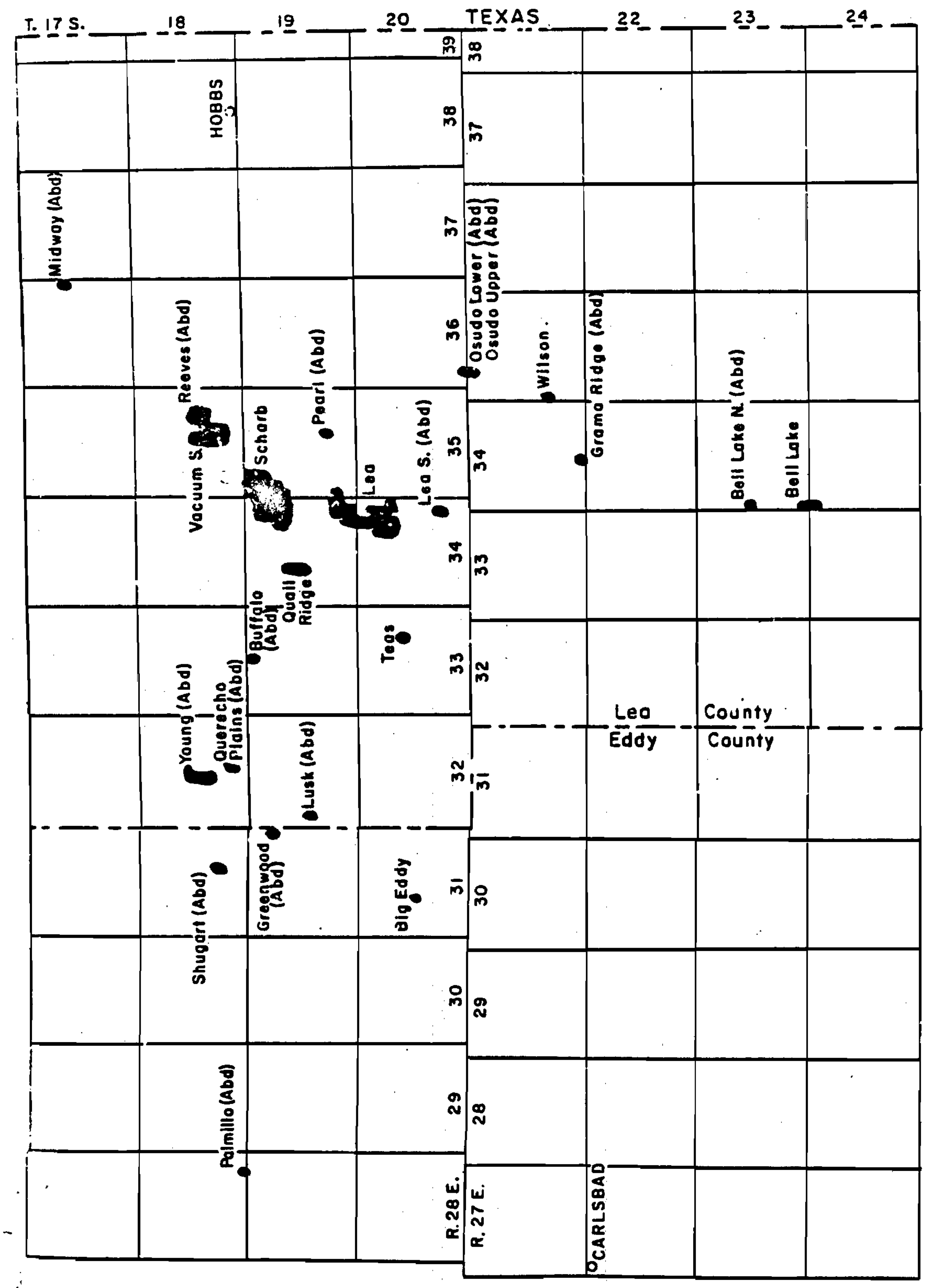


Fig. 40 Bone Sorings oil fields

● Oil field 0 5 10 miles

limited shows and the fact that all oil thus far produced from this interval lies to the north and east (fig. 40) are negative potential factors.

Delaware Mountain Group (Pre-Ramsey)

There are seven fields in the Study area that have been completed in the Delaware Mountain Group exclusive of the Upper Bell Canyon pay zone (fig. 41). The relative stratigraphic positions of these fields are shown on the reference section (fig. 18). As can be seen two reservoirs have been found in the Cherry Canyon Formation, Big Eddy and Sand Dunes; four in the Brushy Canyon Formation, Quahada Ridge, Cotton Draw, Maroon Cliffs, and U. S.; and the Parallel field consists of one well completed in the Cherry Canyon and one in the Brushy Canyon.

All the reservoir rocks are very fine-to medium-grained sandstone, with the oil confined by stratigraphic traps. Details of some of the pay zones are given in figure 42. Similar to the overlying Ramsey zone and underlying Bone Springs the traps may be difficult to distinguish, consisting of minor updip variations in grain size and sand "buildups" creating a depositional structural trap. Also similar to the Ramsey there is a good possibility of hydrodynamic traps in the Cherry Canyon and Brushy Canyon formations. The fields discovered thus far have a pronounced north-northwest trend and all are on the west flank of the Delaware basin. The only field outside this area, in this part of the Delaware Mountain Group is the Querecho Plains-Delaware (Brushy Canyon) in T. 18 S., R. 32 E. This also is in a sandstone reservoir but its position relative

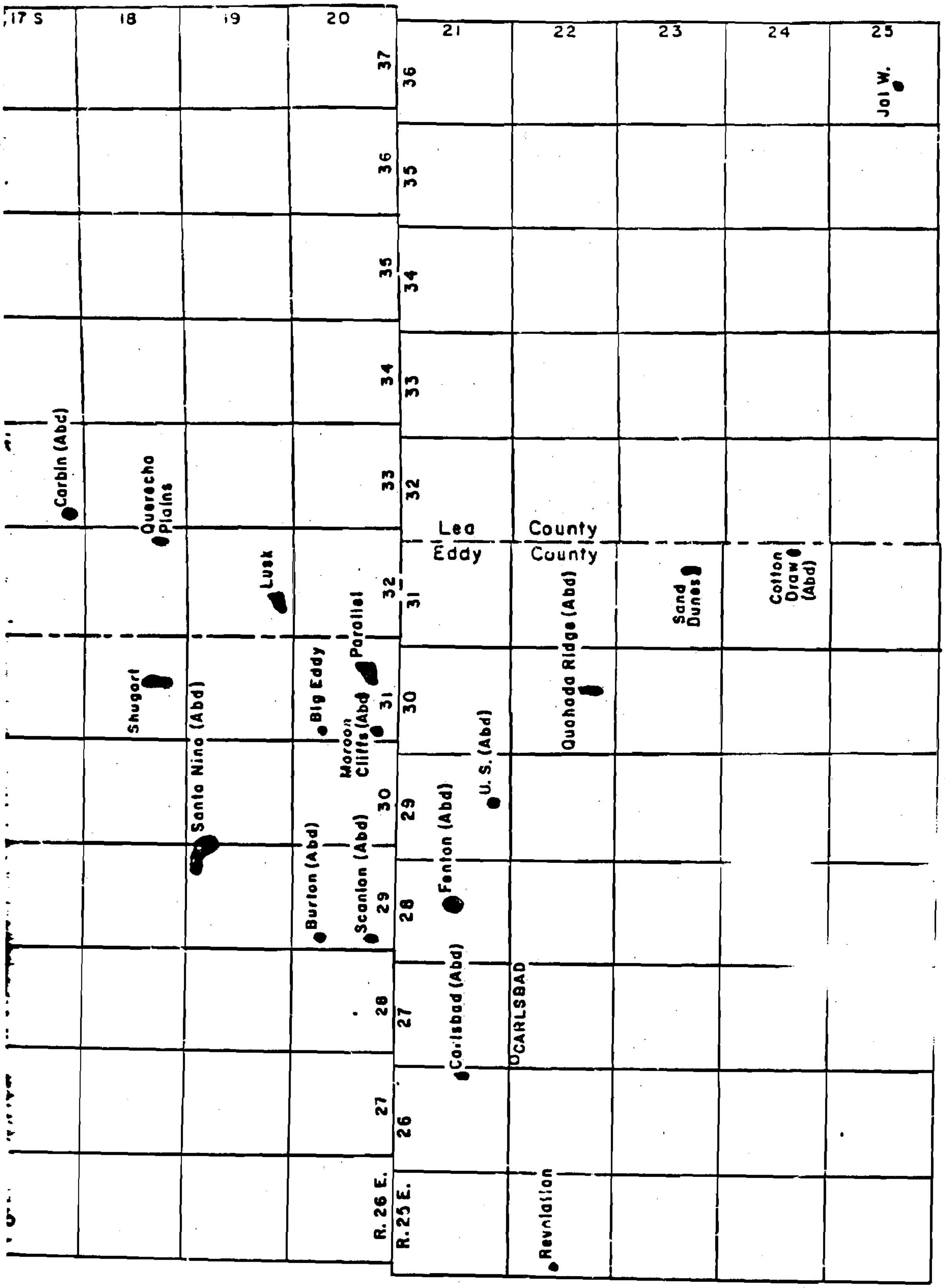


Fig. 41 Delaware Mountain Group oil fields

Gas field

0 5 10 miles

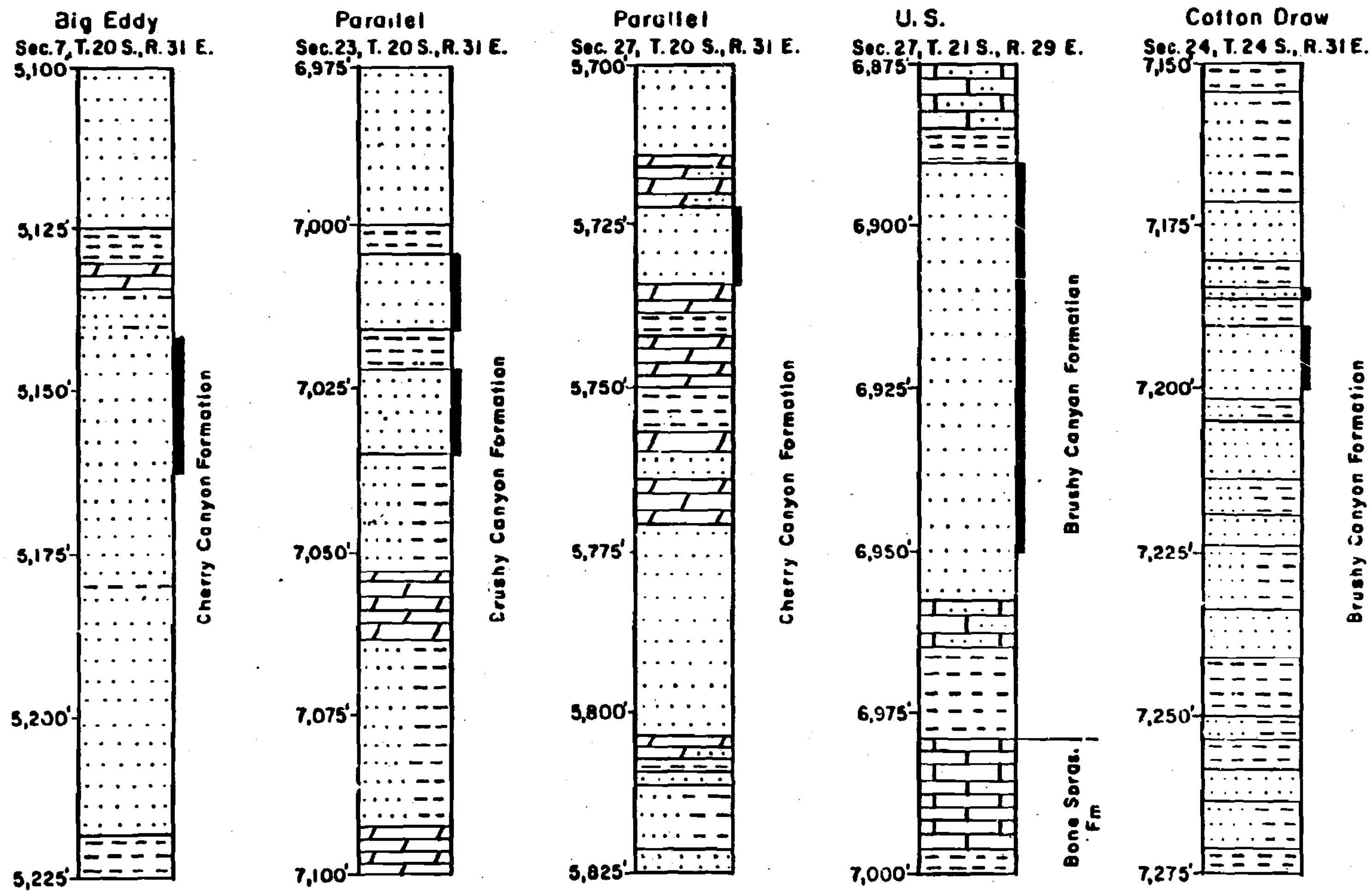


Fig. 42 Representative sections of pay zones in the Deleware Mountain Group

Pay interval

to the Delaware basin is not known. It may be very close to the shelf margin for the Brushy Canyon Formation.

Delaware Mountain Group (Ramsey Zone)

The upper part of the Bell Canyon Formation includes several informally named members. Units below the Lamar Limestone are in descending order; Trap member, Ramsey sandstone, Ford shale, Olds sandstone, and Hays sandstone. As pointed out by Grauten (1965) the Lamar Limestone in much of the interior of the Delaware basin consists of shale, shaly sandstone, and shaly limestone. Locally limestone is absent but highly calcareous shales give similar response on mechanical logs. An examination of sections of the upper part of the Bell Canyon Formation (fig. 43) gives some indication of the stratigraphic complexity in this sequence of rocks. The fact the oil is so widely distributed in this interval throughout the Delaware basin (petroleum distribution factor of 62 percent) suggests an interconnected hydrodynamic system, through which water, oil, and gas migrated rather freely. Where permeability barriers are present such as minor changes in clay and/or silt content, coupled with splitting of the permeable sands, traps occur to contain the oil and gas. This type of trap mechanism seems to be the dominant feature of the New Mexico fields although hydrodynamic trapping plays an important role in localization of oil in many of the fields. The Ford shale is considered by many geologists to be an effective, basin-wide permeability barrier. This requires that oil in the Ramsey be indigenous to the upper part of the Bell Canyon or derived from some unknown source

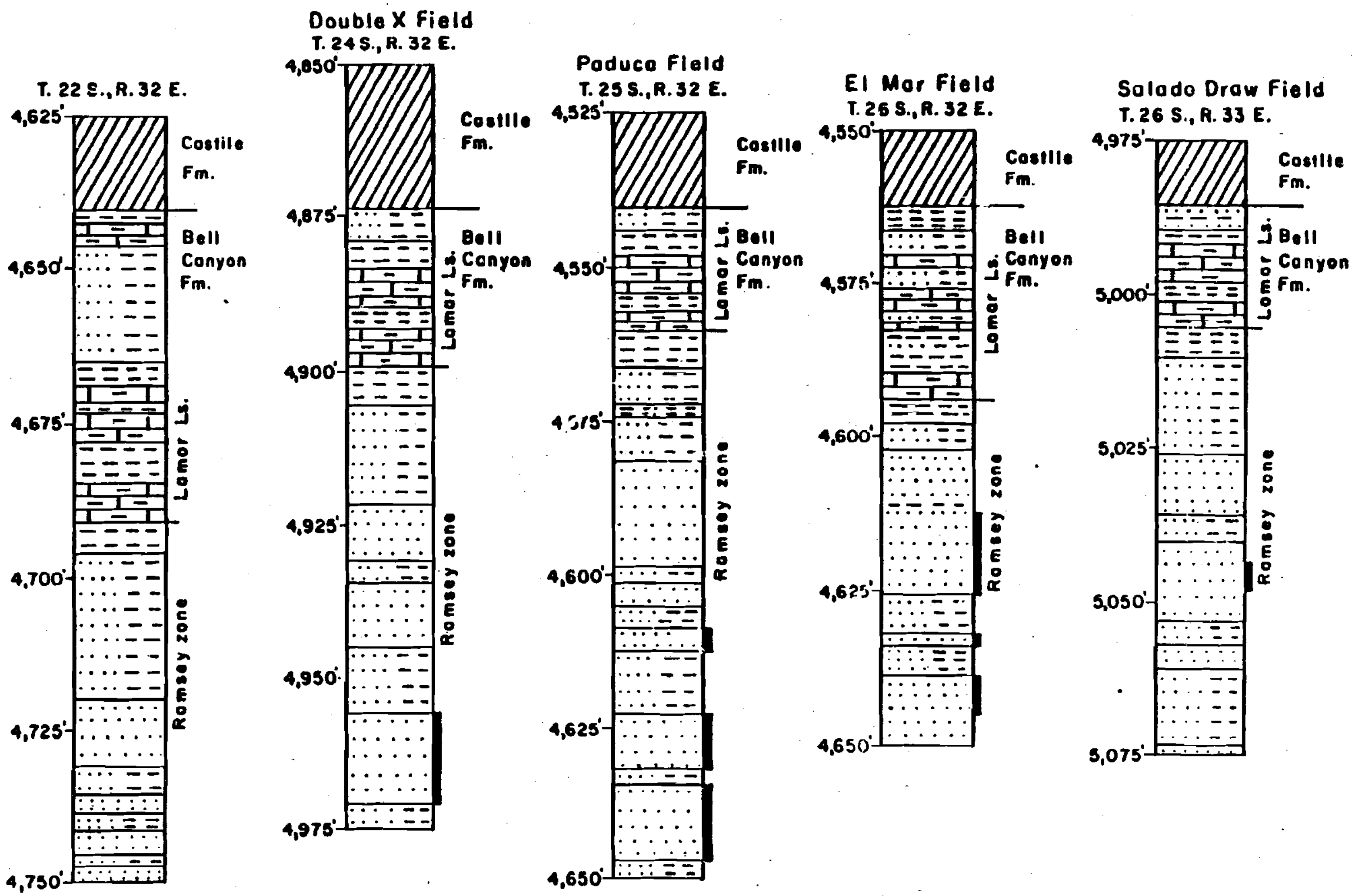


Fig. 43 Stratigraphic sections of upper part of Bell Canyon Formation

Pay interval

outside of the Delaware basin. In addition it would seem that if the Ford were such an effective permeability barrier, that it also would be an excellent caprock and considerable oil would be trapped below the Ford in the Olds sand.

Grauten shows an eastern anticlinal province that extends into Lea County. In this area the normal gas, oil, water relations exist whereas in the homoclinal province to the west these relationships are considerably mixed even between closely spaced wells. None of the New Mexico fields appear to be related to the anticlinal province. Fields such as Paduca, Cruz, and Salado Draw (fig. 44) have some structural nosing but this appears to be relatively unimportant in the entrapment of oil and gas.

The variable stratigraphic positions of oil occurrences in the upper Bell Canyon are shown in the examples in Figure 43. Depths below the Lamar interval are 56 feet at Double X; 47, 62, and 74 feet at Paduca; 17, 38 and 45 feet at El Mar; and 37 feet at Salado Draw. The important factor is that the differing depths of pay zones for these one-well field examples, are just as variable within each field. The noncommercial well in T. 22 S., R. 32 E. also contains fluids, presumably water with minor content of oil. If updip from this well the permeable sand at a depth of 4725 feet is split by a thin nonpermeable material oil may be concentrated in commercial amounts.

When it is considered that the depositional features of the upper part of the Bell Canyon suggest an almost infinite possibility for traps, of the tvpe discussed above, occuring in any given untested area, it must

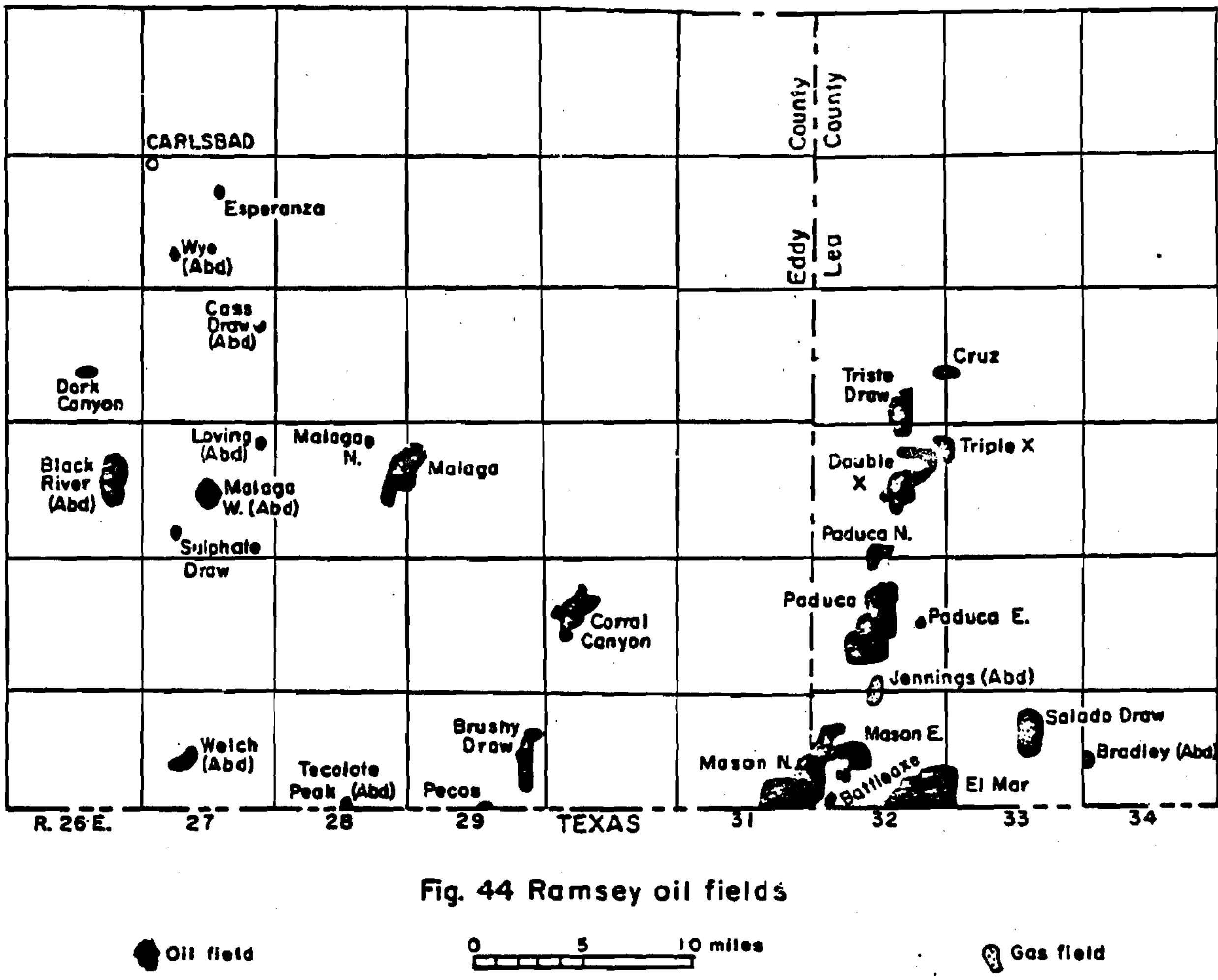


Fig. 44 Ramsey oil fields

be assumed that the petroleum potential for that area is good. Again, the important factors to consider are widespread distribution of petroleum, interconnecting fluid conduits, and rapid, small-scale variations in sand, silt, and clay content.

The Pilot Area is adjacent to the Capitan reef as shown in Figure 25. This proximity would appear to have no bearing on potential for the sand-shale facies of the Bell Canyon Formation. An added possibility for stratigraphic traps also exists in the reef detritus of the Lamar Limestone Member. Although no discoveries have been made in the Lamar, reef-detritus fields are present in the back-reef Yates Formation and occur in other parts of the Permian section adjacent to reef fronts. The Midway and Double A-Abo fields occur in Abo reef detritus in the Bone Springs Formation.

EXPLORATION STATUS AND ESTIMATED RESERVES

An evaluation was made for each well drilled to the Delaware Mountain Group or older rocks in the 42 township Study area. This involved cataloging 738 tests as to whether they were completed as producing oil or gas wells, had a "show" of oil, gas, or both, or had no reported occurrence of petroleum. Symbols indicating the appropriate status were used in plotting the maps showing the stage of exploratory development for each stratigraphic interval described in this report. Data was tabulated for all wells for which completion information was available as of November 1, 1973.

The reliability of some of the information used in compiling this data is questionable. Drill stem tests and core analyses provide good information for the interval examined. Reported shows of oil or gas, although positive in nature, are commonly difficult to evaluate in that they depend to some degree on the experience of the observer. At the other end of the spectrum is the test for which there is no reported presence of petroleum for a specific stratigraphic interval. If the exploration target is a deep pay zone, shallower, potentially productive intervals commonly are not tested or may not even be carefully examined through use of logs or samples. Wells shown as having no oil or gas for a particular interval, have the tendency, in the view of someone making a cursory evaluation of potential, to condemn that part of the section at that location. This is true even though in numerous cases the potential pay interval may not have been penetrated or adequately evaluated. To this is added the problem of historical sequence where many wells have been drilled prior to an awareness of various geologic parameters controlling accumulation, or engineering advances in drilling, testing, and completion of wells.

Success percentages for each interval were calculated using both the standard method of wildcat success versus failure, and from total productive acreage versus nonproductive tested acreage. In the latter case 40 acres is used for oil wells and 160 acres for gas wells with certain departures explained in the following discussions of each interval. Calculations based on productive acreage are considered more valid particularly where the occurrence of petroleum has a random distribution pattern indicative of widespread presence and stratigraphic control of accumulation with structural control of secondary importance. Validity of calculated yields of oil and gas is in part substantiated, although not used directly in calculations, by the incidence of petroleum for a particular interval. This is based on the percentage of wells producing or with recorded presence of oil or gas and the total number of wells drilled. There is a high incidence of petroleum in the upper part of the Delaware Mountain Group, Pennsylvanian, Silurian/Devonian, and Bone Springs Formation. Although petroleum incidence is high for the Ordovician the sample is considered to be too small to be significant and there is no petroleum being produced from this interval in the study area. Petroleum presence is low for the remainder of the Delaware Mountain Group, Wolfcamp Formation, and Mississippian rocks.

The total area used in arriving at the calculations of potential yield for an untested section, is approximately 979,200 acres for all intervals except the upper part of the Delaware Mountain Group (Ramsey pay zone) which underlies about 743,000 acres. Sedimentary rocks containing oil and/or gas within the Study area, but representing back-reef facies, are not included in this report.

Aside from geological factors the statistical analysis breaks down in part in that the probability of gas or oil accumulation is not taken into consideration. The depth of Silurian/Devonian oil in the north part of the area and recent oil discoveries in the Pennsylvanian at depths and in an area heretofor considered a natural gas province, negate to some extent any attempt to categorize production potential from this standpoint.

Another factor that might be considered in statistical evaluation of potential productive acreage is the density pattern of nonproductive wells. Even though only three percent of the total land area underlain by the Ramsey pay zone has been tested there is a relatively dense well distribution for much of the area such as in T. 22 S., R's. 32 to 33 E., and T. 23 S., R's. 31-33 E. (fig. 52). However, even within this area there are at least three untested blocks that could accommodate a field the size of Paduca.

The potential yields per section presented here and in the summary can be modified either up or down by application of the above factors, geologic conditions, or validity of projected per acre yields.

Ordovician System

Although there is no production of oil or gas from the Ordovician in the Study area, the incidence of occurrence of petroleum is a high 63 percent of the wells drilled. As with the Pennsylvanian and Silurian/Devonian this may in part reflect more careful attention to examination of a section requiring the drilling depths needed to reach the Ordovician. Some of the reported shows are of some interest in evaluating the potential from this interval (fig. 45). The well in sec. 32, T. 25 S., R. 33 E. had bleeding gas from a core taken between 20,890 and 20,936 feet. At the well in sec. 25, T. 20 S., R. 32 E., 340 MCF of gas and some oil were recovered during a drill stem test from 16,280 to 16,330 feet. The best results were obtained in the well drilled in sec. 4, T. 24 S., R. 34 E. where 950 MCF of gas was recovered from 17,432 to 17,843 feet.

The presence of petroleum in Ordovician rocks has been established for the Study area by the few tests drilled to date, involving only 0.03 percent of the land area. Whether or not there are commercial accumulations and if so under what type of geologic control can only be inferred by inadequate geologic data.

Silurian/Devonian Systems

There are six designated Devonian fields in the Study area, five gas and one oil (figs. 27 and 46). Gas fields are Paduca, Bell Lake, Middle Bell Lake, North Bell Lake, and Antelope Ridge; oil is produced at the Lea field. In addition there is one undesignated oil well and one undesignated gas well. Antelope Ridge, Bell Lake, and Lea contain more

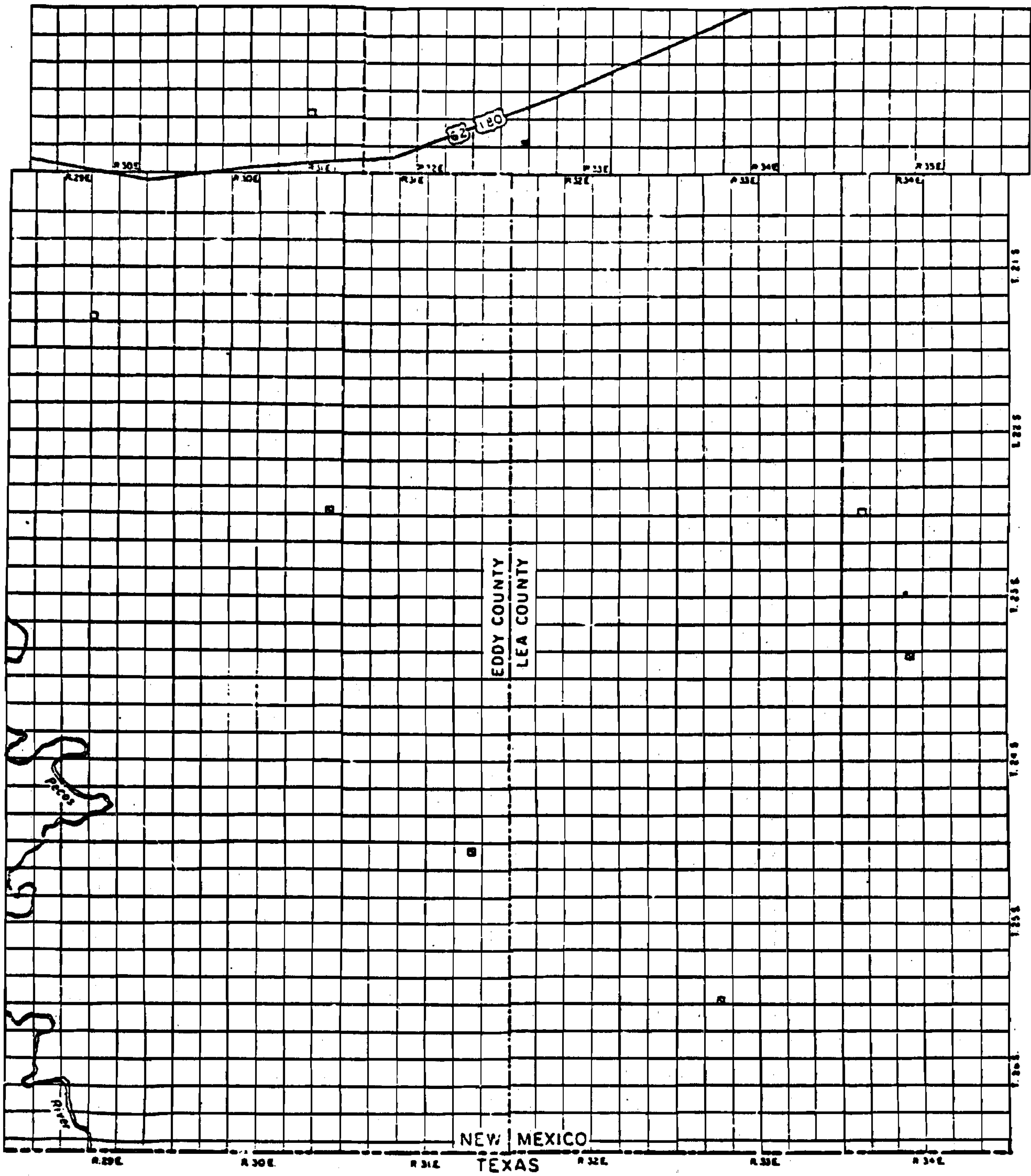


Fig. 45 Exploration status: Ordovician System

0 5 10 miles

■ Oil ■ Gas ▨ Show of oil ▧ Show of gas ▩ Show of oil and gas □ Dry hole

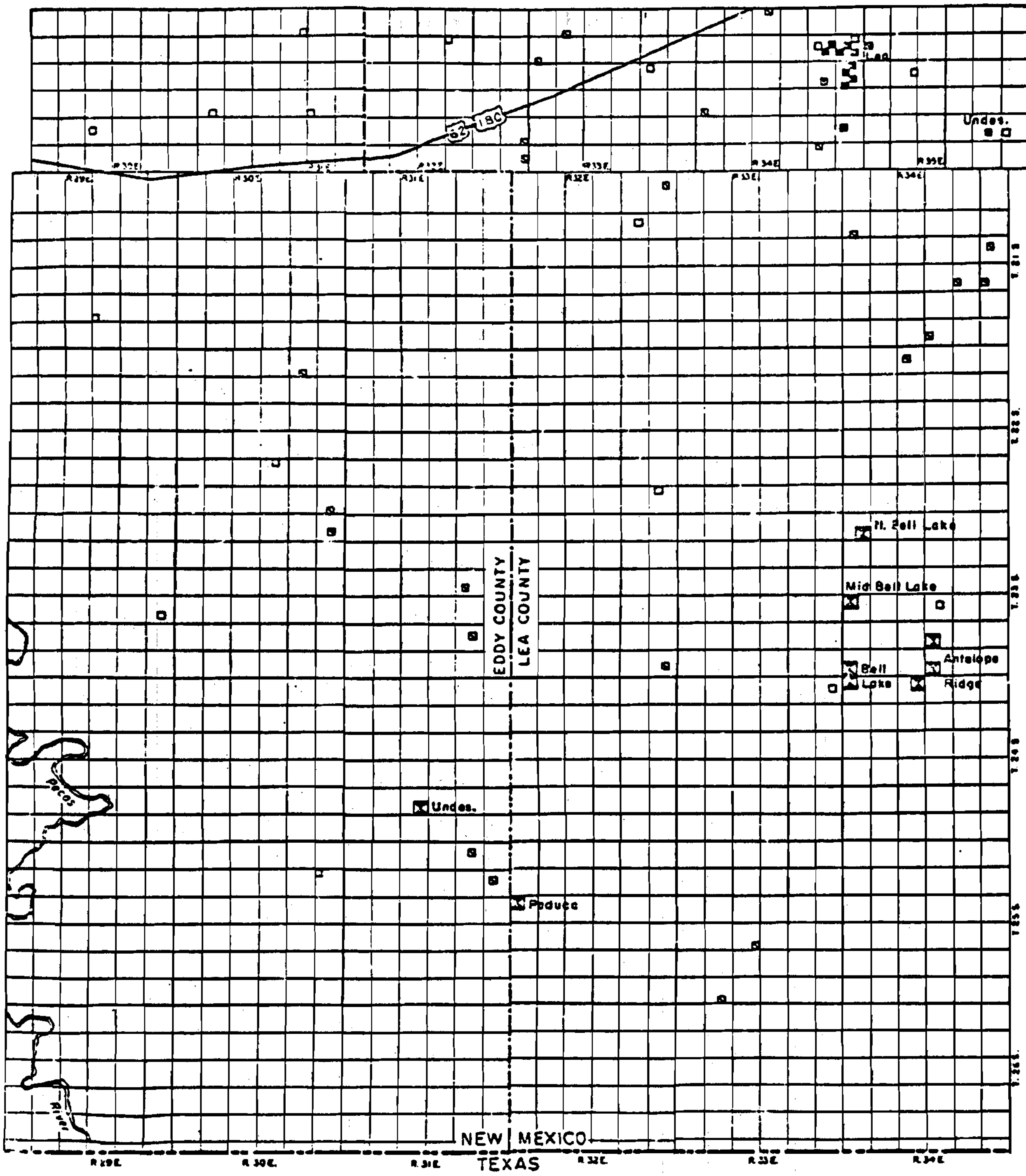


Fig. 46 Exploration status Silurian/Devonian Systems

0 5 10 miles

■Oil ▣Gas ▨Show of oil ▧Show of gas ▩Show of oil and gas □Dry hole than one producing well. Lea has nine producing wells and one dry hole plus three tests drilled to the Devonian in the immediate area. Two of the dry holes had shows of oil and gas in the Devonian and three of the wells not producing from this interval are Morrow gas wells including one well from which oil is produced from the Bone Springs Formation. Field limits are therefore quite poorly defined. At Bell Lake one development well has been completed and one offset to the west is producing from the Pennsylvanian with no reported shows of oil or gas in the Devonian. The northwest offset to the Paduca field also is producing from the Pennsylvanian but had good shows of gas from the Devonian, including 340 MCF for a drill stem test from 16,456 to 16,660 feet. To the northwest the undesignated gas well was completed in the Devonian in 1967 but later recompleted to the Pennsylvanian and is the discovery well for the Poker Lake-Morrow field. The undesignated oil well in sec. 26, T. 20 S., R. 35 E. is a dual completion in the Osudo-Morrow gas field. The offset to the east produces from Wolfcamp and Pennsylvanian and there were no reported shows in the Devonian. These are the only two wells that have been drilled to the Devonian in the immediate area. The gas well in sec. 4, T. 24 S., R. 34 E. in the Antelope Ridge field is of interest in that 56 barrels of oil were recovered on a drill stem test from 15,017 to 15,074 feet, and 52 barrels from 16,140 to 16,220 feet, both intervals within the Silurian/Devonian sequence.

Drilling density to the Devonian is one well for every 24 square miles, and one well for every 46 square miles south of T. 20 S. Seventeen townships have no tests and 11 have only one. The potential for this interval would appear to be high based on current production distribution. A possible random distribution is also indicated by the high incidence of petroleum occurrence compared with the number of wells drilled. For the Devonian this is 72 percent and is exceeded only by the Pennsylvanian.

Based on productive acreage there is a 16 percent success for oil and 14 percent for gas. Wildcat success is four percent for oil and 14 percent for gas. Statistically, using a productive area basis and data from the following part of this report, an untested section can be considered to be underlain by 1,368,330 barrels of oil; 36,720 barrels of distillate; 4,244,310 MCF of gas; and 656,676 MCF of associated gas. Using wildcat success ratios, average production per well, and number of potential well locations, the statistical potential would be: oil - 343,422 barrels; distillate - 36,562 barrels; gas - 4,225,491 MCF; and associated gas - 164,804 MCF. From reported shows and production the chance of finding gas instead of oil is seven to one in this area.

Mississippian System

There is no oil or gas production from Mississippian rocks in the Study area. A total of 69 wells have penetrated this part of the section primarily as tests of underlying Devonian sediments (fig. 47). Ten of the wells have encountered petroleum but some of the drill stem tests span the section into the Devonian and the shows may therefore be from

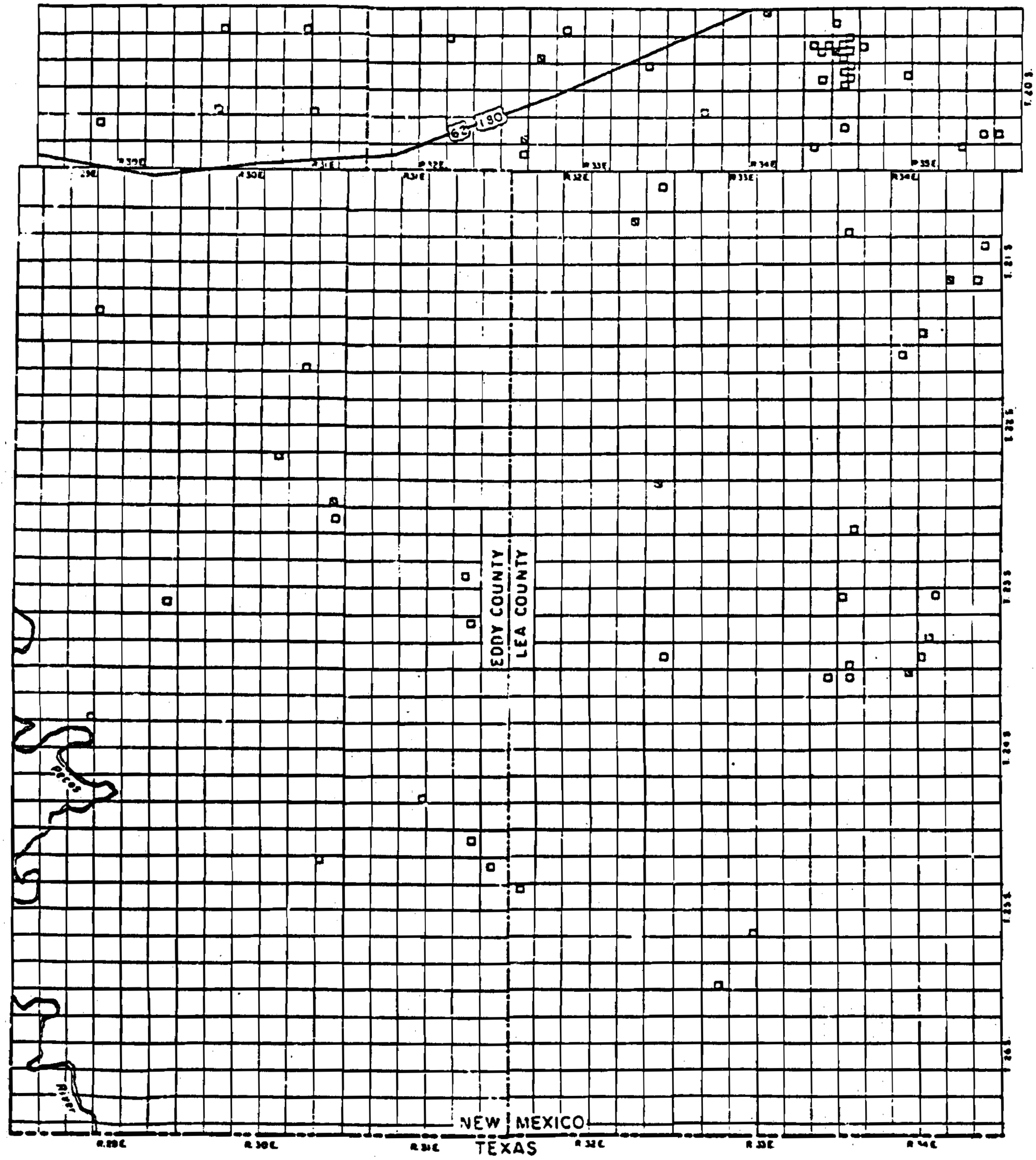


Fig. 47 Exploration status: Mississippian System

0 5 10 miles

■ Oil ■ Gas ▨ Show of oil ▧ Show of gas ⊠ Show of oil and gas □ Dry hole this interval. The drill stem test of the well in sec. 36, T. 22 S., R. 30 E. with a recovery of 2,850 MCF of gas was of this type. The producing interval given for the discovery well of the Paduca-Devonian field in sec. 12, T. 25 S., R. 32 E. includes the carbonate section of the Mississippian. An examination of logs from this well indicates that the gas is being produced from the Silurian/Devonian. The only significant occurrence that can fairly reliably be attributed to the Mississippian is the well in sec. 4, T. 20 S., R. 34 E. where 35 MCF of gas was recovered on a drill stem test of this interval.

The total area tested for the Mississippian, on a 40 acre per well basis is 2,760 acres or 0.3 percent of the study area. Inasmuch as there is no production, potential projected reserves per section are not given here. Projected yields per acre based on regional evaluations are given elsewhere in this report but no attempt has been made to calculate success ratios. These figures would be very low for southeastern New Mexico.

Pennsylvanian System

Exploration of Pennsylvanian age rocks has been quite recent in this area but results warrant extensive additional drilling. The incidence of petroleum occurrence in 88 percent of the wells drilled reflects the widespread distribution of oil and gas, the numerous potential pay zones, and in part the greater care in testing of Pennsylvanian rocks.

Based on 40-acre spacing for oil tests, 4,800 acres (0.5 percent of the total area) has been tested and eight percent has proven productive.

Because of reduction in the number of wells used in calculating wildcat success, nine percent of these tests resulted in discovery of new fields. Gas exploration figures show 19,040 acres or two percent of the land area tested and 10,400 acres productive for 55 percent success. Wildcat exploration for gas has resulted in 51 percent of this category being successfully completed. Using data based on productive acreage to determine the potential of each untested section statistical yields are: 265,455 barrels of oil; 105,952 barrels of distillate, 7,085,760 MCF of gas; and 1,580,286 MCF of associated gas. From wildcat success ratios predicted yields per section would be: 299,788 barrels of oil; 94,596 barrels of distillate; 6,441,672 MCF of gas; and 1,784,799 MCF of associated gas.

With the exception of the Big Eddy-Strawn oil field there have been only minor attempts to develop oil reserves in the Pennsylvanian (fig. 48). Two wells have been drilled in the vicinity of West Lusk-Strawn oil field and tested the pay zone in the upper part of the Pennsylvanian. The well to the south had a slight show of oil in core taken from 11,525 to 11,576 feet. At the South Hackberry-Strawn oil field, gas was recovered in drill stem tests of the upper Pennsylvanian pay zone as well as from other deeper intervals in the Pennsylvanian. The well to the east of South Hackberry was drilled prior to the discovery well and recovered some gas-cut mud from the South Hackberry pay zone. The undesignated oil field at Tower Hill in T. 21 S., R. 29 E. was recompleted as an oil well in the upper Pennsylvanian. Previously gas was produced from this well in the lower part of the Pennsylvanian. The test drilled in the next

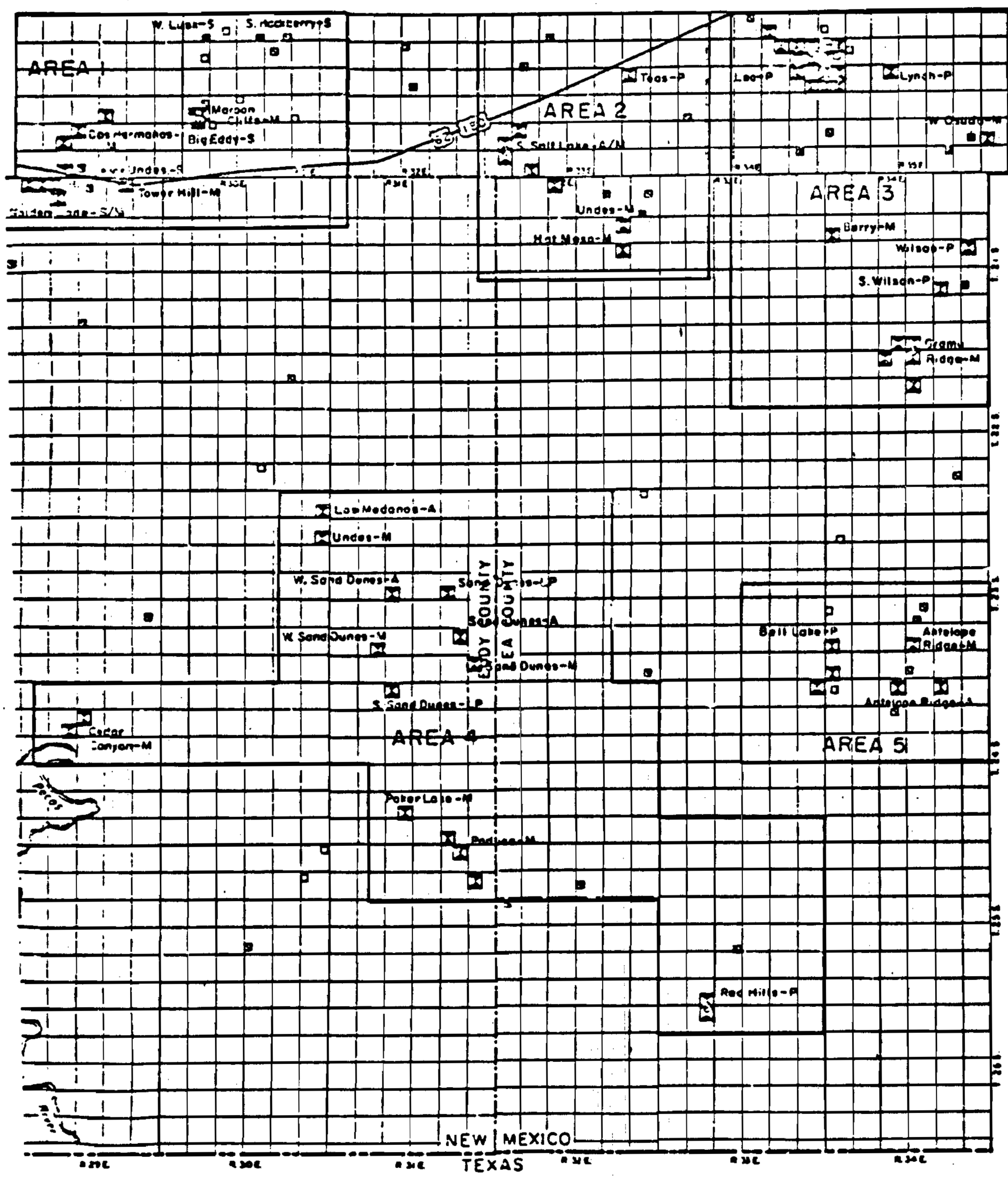


Fig. 48 Exploration status: Pennsylvanian System

0 5 10 miles

■Oil ■Gas ▨Show of oil ▨Show of gas ▨Show of oil and gas □Dry hole section west of Tower Hill recovered oil and gas in tests of the upper Pennsylvanian pay zone. The two undesignated oil wells in T. 21 S., R. 32 E. were completed in 1973. These wells are producing from the lower part of the Pennsylvanian and in addition to being the first oil wells completed in this zone, have the deepest Pennsylvanian oil production in the Study area. The well in sec. 1 had an initial potential of 288 barrels of oil per day from 13,791 to 14,075 feet. In sec. 2 the initial potential was 80 barrels of oil per day from 13,968 to 14,026 feet.

Offset wells have been drilled to 11 of the Pennsylvanian gas discoveries. Fields with at least one development well include Dos Hermanos, Golden Lane, South Salt Lake, Lea, Grama Ridge, Hat Mesa, Bell Lake, Antelope Ridge, Cedar Canyon, Paduca, and Red Hills. Although there are a number of wells drilled near the Maroon Cliffs field only one beside the discovery well has penetrated to this pay zone. Within the Lea field there are four wells shown as not producing from the Pennsylvanian. The wells in sec. 12 currently are producing oil from the Devonian and Bone Springs Formation. Two of these wells may be recompleted in the Pennsylvanian. The well in sec. 1, T. 20 S., R. 34 E. was completed as an oil well in the Bone Springs after negative testing in the Pennsylvanian. The well in sec. 4 northwest of Lea had shows of gas in the Pennsylvanian and gauged 1,250 MCF from the upper part of this sequence. The test near the discovery well of West Osudo produces from Wolfcamp and Devonian, and the test further to the west recovered 48 and 80 MCF from two zones in the Pennsylvanian. The well east of South Wilson was drilled prior to the discovery of the Wilson and South Wilson fields; several good shows of gas were tested in the Pennsylvanian. At Antelope Ridge the well in sec. 34, T. 23 S., R. 34 E. is currently producing from the Devonian. Drill stem tests of various parts of the Pennsylvanian recovered 40, 70, and 3,600 MCF of gas. The two wells just north of Antelope Ridge also had shows in the Pennsylvanian and one was not a complete test of this interval. The well near Bell Lake field in sec. 6, T. 24 S., R. 34 E. produces from the Devonian; there were no reported shows from the Pennsylvanian. The "dry hole" near the Paduca field also produces from the Devonian but encountered shows of gas in the Pennsylvanian.

It can be seen that many wells drilled in this area may be recompleted in the Pennsylvanian even though they are not currently producing from this part of the section. Even without additional discoveries this would significantly change the success ratio of Pennsylvanian exploration in the Study area. Production trends without intervening dry holes and the multiple producing zones support a conclusion that production from the Pennsylvanian may eventually cover a considerable part of this area. Significant as far as the Pilot area is concerned is the Paduca-Poker Lake-Sand Dunes-Los Medanos trend and potential for extension toward Hat Mesa. Drilling to date has not defined the horizontal or vertical limits of petroleum accumulations for any part of this area. When it is considered that there is only one test for every 13 square miles, sixteen of the 42 townships completely unexplored, and a high success ratio regardless of method used it would appear to be impossible to rule out a high potential for any specific untested location. Perhaps more than any other part of the stratigraphic section, statistical projection of reserves would appear to be quite valid for the Pennsylvanian sequence.

Wolfcamp Formation

Six gas wells and two oil wells have been completed out of the 125 tests that have penetrated all or part of the Wolfcamp Formation (fig. 49). Because both oil and gas wells occur in the Wolfcamp, 160 acres were assigned each well in calculating success ratios for gas, and 40 acres for each well for oil. This results in 19,680 acres having been tested for gas and 5,000 acres for oil. Of this 80 acres or two percent of the total acreage tested is oil productive and 960 acres or five percent has gas production. From a wildcat exploration standpoint two percent of the oil tests and three percent of the gas tests have been successful. Using statistical data based on percent of productive acres there is a potential for each untested section of 20,800 barrels of oil; 32,544 barrels of distillate; 633,984 MCF of gas; and 228,462 MCF of associated gas. From wildcat success ratios, the oil potential is 20,475 barrels; associated gas, 224,953 MCF; distillate, 19,530 barrels; and gas, 383,969 MCF.

The land area tested for oil amounts to 0.5 percent and for gas 2.0 percent. There are 15 townships without tests and five with one test. Drilling density is one well for every 12 square miles for the total area and one for every 20 square miles south of T. 20 S.

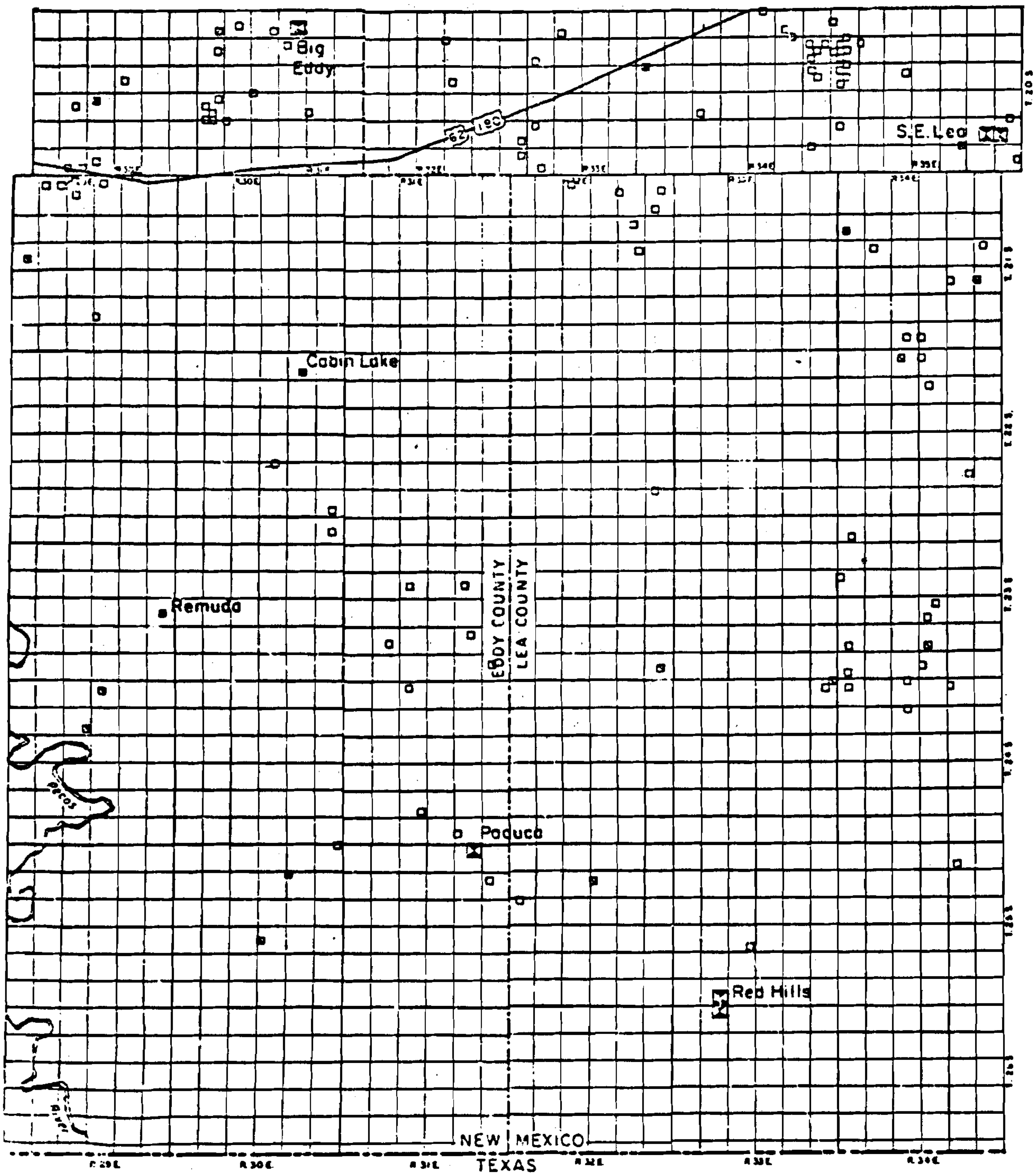


Fig.49 Exploration status: Wolfcamp Formation

0 5 10 miles

■Oil ⊞Gas ☒Show of oil ⊠Show of gas ⊞Show of oil and gas □Dry hole

Areas of more concentrated drilling are primarily where petroleum has been discovered in underlying rocks of Pennsylvanian age. With the exception of the second wells drilled at Red Hills and Southeast Lea there have been no development wells drilled in an attempt to extend Wolfcamp discoveries. The two wells near the Paduca field produce from the Pennsylvanian; no shows or tests were reported for the Wolfcamp interval. Big Eddy was discovered in 1962; the two wells drilled to the southwest were later Pennsylvanian tests apparently without testing the Wolfcamp pay zone. The well drilled about one mile southwest of the Southeast Lea field was drilled to the Mississippian. Tests of the Wolfcamp recovered heavily gas cut mud and a trace of oil.

Reported occurrences of noncommercial amounts of petroleum include two wells with oil, seven with gas, and 10 with gas and oil. Overall 23 percent of the wells that have tested the Wolfcamp have either been completed as oil or gas wells or have had shows. This is low compared with other parts of the stratigraphic sequence, but the wide spacing of oil and gas production in the Delaware basin, and recent discoveries to the west of the Study area indicate a regional occurrence of oil and gas.

Bone Springs Formation

Seven Bone Springs fields have been designated in the Study area: Big Eddy, Teas, Lea, South Lea, Grama Ridge, North Bell Lake, and Bell Lake (figs. 40 and 50). The Lea field which extends north into T. 19 S. consists of eight wells in the Study area, Bell Lake three and

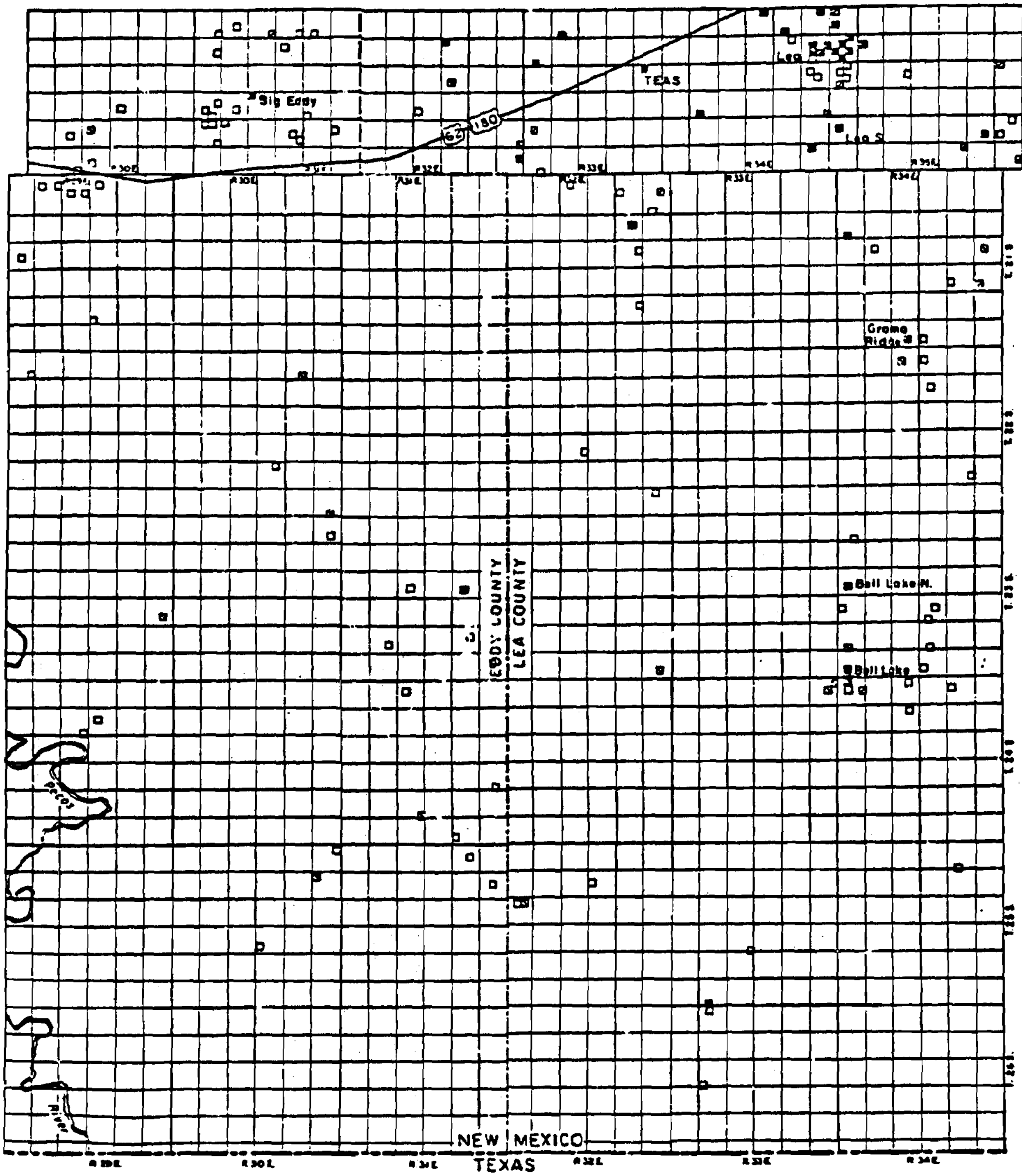


Fig. 50 Exploration status: Bone Springs Formation

0 5 10 miles

■ Oil ■ Gas ■ Show of oil ■ Show of gas ■ Show of oil and gas □ Dry hole the remainder of the fields, one well each. Many of the wells shown within the area of the Lea field as nonproductive in the Bone Springs are currently producing from the Pennsylvanian. The limits of the Bone Springs reservoir have not been defined and based on the significant shows of oil and/or gas it appears likely that several wells currently not producing from this interval will be recompleted to the Bone Springs when the deeper reservoir has been depleted. A number of wells have been drilled through the Bone Springs in the Bell Lake area to test Pennsylvanian and Devonian pay zones. Gas and some oil has been recovered during tests of various parts of the Bone Springs in this area. The nearest well drilled to the Big Eddy field, discovered in 1969, is to the southwest and was drilled in 1954. Although drilled to the Bone Springs this well did not reach the pay zone at Big Eddy. Grama Ridge was discovered in a test of the Morrow and after one year of production from the Bone Springs was recompleted in the Pennsylvanian. Other nearby wells also produce from Pennsylvanian age sediments. The offset well south of the North Bell Lake field apparently had no shows in the Bone Springs and only a small amount of oil was produced at North Bell Lake. There has been no attempt to develop the Teas field; somewhat surprising inasmuch as this has been a fairly good well.

Numerous wells drilled in the Study area have recovered some petroleum; included are eight for which oil was observed or recovered by testing, 15 with gas, and 20 with both oil and gas. Added to tests completed as oil wells, 39 percent of the wells drilled have encountered oil and/or gas. Drilling density is one well for every 10 square miles for the total area and with 46 percent of the wells drilled in T. 20 S., only one test every 17 square miles to the south. Fourteen townships have not had a test drilled to the Bone Springs Formation and five have had only one test. Based on 40 acres per well; 6,040 acres or 0.6 percent of the land area has been tested. Of this area 640 acres or 11 percent has been productive and wildcat success is five percent. From the calculated yield per acre for the Bone Springs in the Study area there is a statistical potential for each untested section of 193,952 barrels of oil and 379,738 MCF of associated gas. Based on the wildcat success ratio the estimate is 88,170 barrels of oil and 172,610 MCF of gas per section.

Delaware Mountain Group (Pre-Ramsey)

Fields producing from the Delaware Mountain Group within the Study area are shown in Figures 41 and 51. The fields are Big Eddy, Parallel, Maroon Cliffs, U.S., Quahada Ridge, Sand Dunes, and Cotton Draw. Only Sand Dunes and Parallel consist of more than one well, and Big Eddy, Sand Dunes, and Parallel are the only fields still under production. Attempts to develop the fields producing from this interval have been very limited as has exploration of this part of the geologic section. The fairly dense drilling in the northeast part of T. 20 S., R. 34 E. reflects exploration and development drilling to the Bone Springs and Wolfcamp formations and various parts of the Pennsylvanian section.

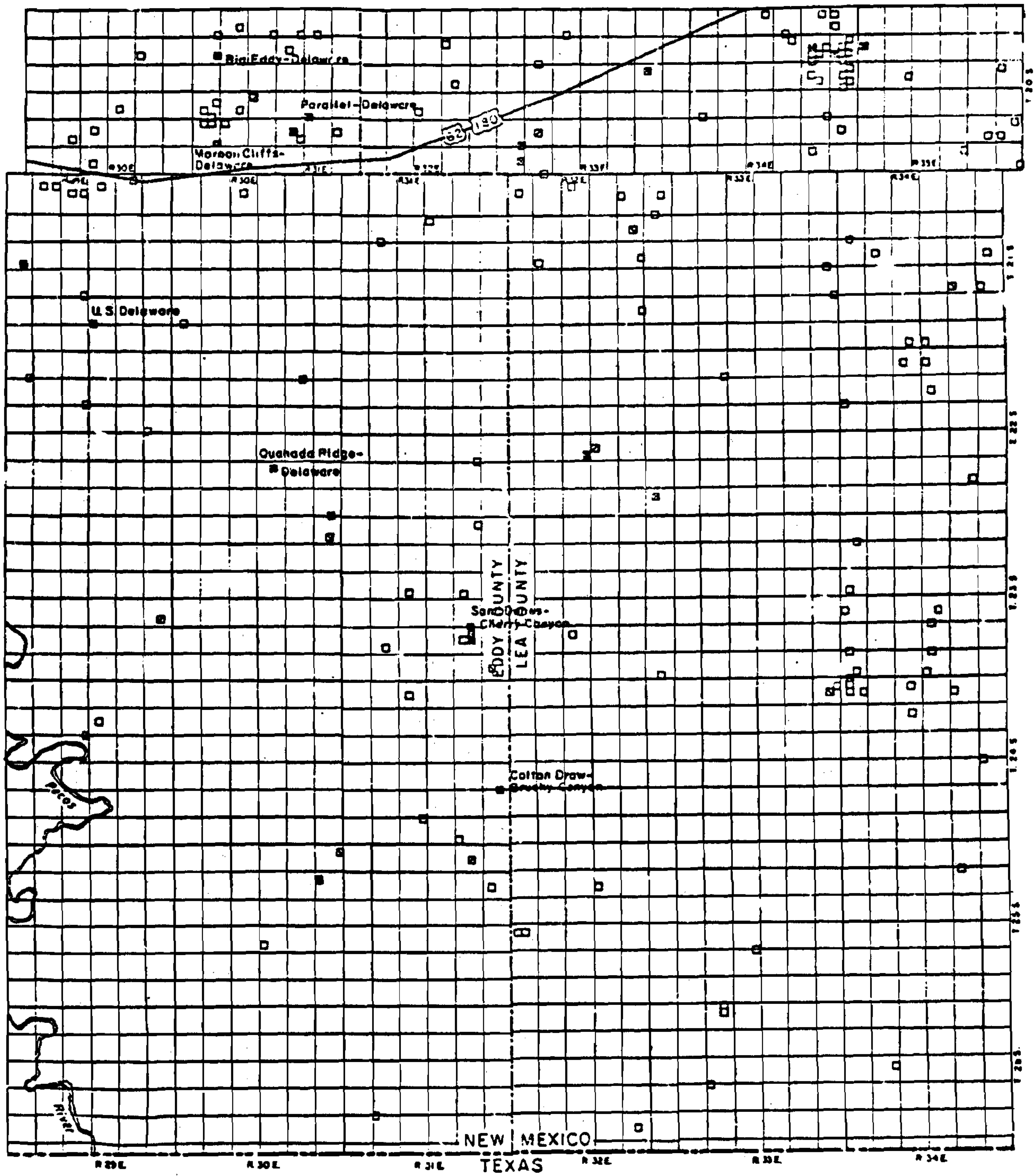


Fig. 51 Exploration status: Delaware Mountain Group

0 5 10 miles

Oil Gas Show of oil Show of gas Show of oil and gas Dry hole

The wells drilled northeast of Big Eddy field in T. 20 S., R. 31 E. are Pennsylvanian and Wolfcamp tests. Big Eddy was discovered in drilling a deeper primary objective; there have been no direct attempts at development. Maroon Cliffs was discovered by a test drilled into the upper part of the Bone Springs Formation. No attempts at development or, based on available records, even testing of this pay zone have been made in the wells drilled to the north. Parallel has two wells producing from different intervals separated by over 1,000 feet of section. Since discovery of the field two wells have been drilled into the Bone Springs presumably as tests of these pays, without any reported indications of petroleum. No development wells have been drilled in the immediate vicinity of U.S., Quahada Ridge, or Cotton Draw. Three extension wells have been drilled at Sand Dunes; the west offset was dry while two wells drilled to the north have been successful. Further development of this field is in progress.

Petroleum in amounts too small for commercial development have been reported for 26 wells. Most of these occurrences were minor consisting of oil and/or gas cut mud, but were based on drill stem tests. Two wells recovered measurable amounts of 10 and 22 MCF of gas. These wells are located in sec. 12, T. 20 S., R. 34 E., and sec. 36, T. 22 S., R. 32 E.

Through October 1973, 173 wells had been drilled into or through the Delaware Mountain Group below the Ramsey pay zone. Of these tests ten have been completed as oil wells resulting in 400 producing acres out of a total of 6, 920 acres tested. This is a six percent success based on productive acreage and four percent success for wildcat exploration. Only 0. 7 percent of the land area has been tested for a drilling density of one well for every nine square miles for the entire area and one well for every 13 square miles south of T. 20 S. An examination of Figure 51 shows six townships where no tests have been drilled and seven townships with only one test. The Delaware Mountain Group has a low incidence of petroleum occurrence of 21 percent of the tests drilled, and a per well yield for the study area of only 53, 847 barrels.

Based on current statistical data potential yields for an untested section amount to 51,686 barrels of oil and 19, 546 MCF of associated gas from acreage evaluations, and 34,462 barrels of oil and 13, 029 MCF of associated gas from wildcat success ratios.

Delaware Mountain Group (Ramsey Pay)

A total of 637 wells have penetrated the Ramsey pay zone in the Study area. Approximately 358 of these tests have been development wells in the twenty fields discovered thus far. The Ramsey unlike other parts of the stratigraphic section included in this report does not underlie the entire area. The interval is absent in T. 20 S., in several townships in the northeastern part of the area, and in the extreme northwest part of T. 21 S., R. 29 E. The horizontal limits of this part of the Delaware Mountain Group are defined by the presence of the buried Capitan reef and the rapid facies change to carbonates toward the reef in the upper part of the Bell Canyon Formation.

The density of Ramsey exploration drilling is greatest in the southeastern part of the area along the El Mar, North Mason, Paduca, Double X, and Triste Draw producing trend. The area underlain by the upper part of the Bell Canyon is approximately 1,160 square miles for a drilling density of one well every two square miles. Drilling density in the northwestern part of the area is much less, dropping to one well every nine square miles in the four township Pilot area exclusive of that part not underlain by the Ramsey pay zone. The lack of drilling in this area is in part due to the restricted potash district. Even with the apparent density of wells as shown in Figure 52, only three percent of the area has been tested on the basis of 40 acres per well. The few gas wells involved are included in the 40-acre designation because most occur within established oil fields and are subject to the standard oil field spacing pattern.

The northernmost production of oil from the Ramsey in the Study area is at the Cruz field in T. 23 S., R's 32 and 33 E. In the four township Pilot area there have been seven wells drilled that have had reported occurrences of petroleum; an incidence of 44 percent compared with 62 percent for the Study area. None of these "shows" appears to be significant.

For the Study area 44 percent of the area tested has proven production and seven percent of the wildcats drilled have resulted in new field discoveries. Based on statistical evaluations, expectable

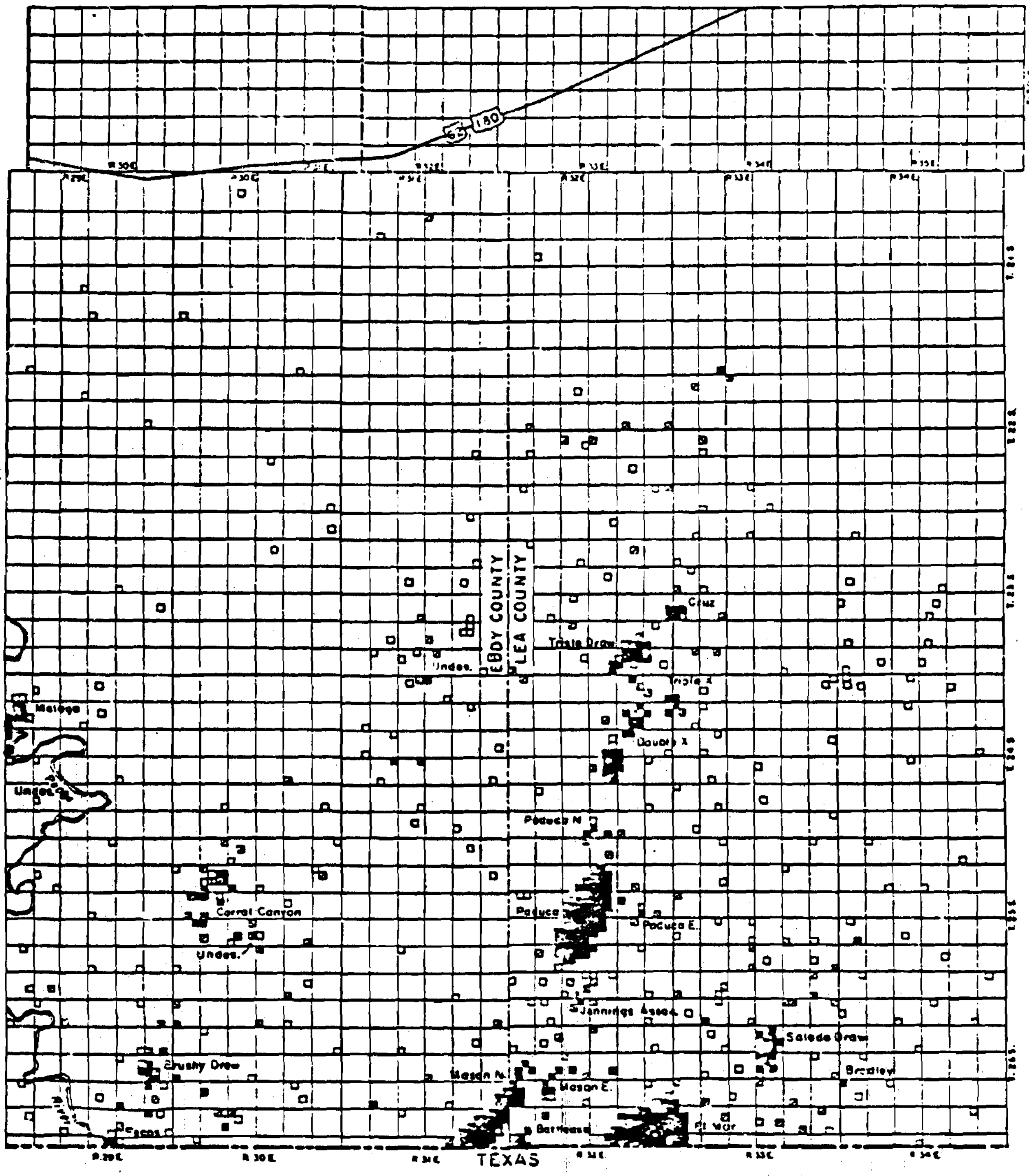


Fig. 52 Exploration status: Ramsey pay zone

0 5 10 miles

■ Oil ■ Gas ■ Show of oil ■ Show of gas ■ Show of oil and gas □ Dry hole recovery from an untested section using productive acreage would be: 472, 350 barrels of oil and 756, 324 MCF of associated gas. From wildcat success ratios potential petroleum reserves are: 75, 052 barrels of oil and 120, 141 MCF of associated gas.

STATISTICAL OIL AND GAS POTENTIAL

In evaluating the producing potential of the proposed high-level radioactive waste repository site, past and projected production from current and abandoned wells and fields was examined in a regional area encompassing approximately 115 townships from T. 20 S., south to the Texas line, and from R. 22 E., east to the Texas line. Included in this area are all of the Delaware basin as defined by the Capitan reef occurring in New Mexico, and parts of the Central Basin platform and northwestern shelf of the Permian basin. Site location is within the Delaware basin, thus oil and gas production from Permian back-reef sediments are not included in this report. Because of the stratigraphic and structural variations within the subsurface across the area, petroleum production within a 42 township block primarily within the Delaware basin was examined separately and is referred to as the Study area. Studies were made for each well and because of proximity to the site it is felt that evaluation figures for this area are more meaningful in projecting the site potential. It remains necessary, however, to present a broader spectrum of production analysis because of the limited exploration of deeper potential pay zones that underlie the Delaware basin.

Petroleum is produced from rocks of Permian, Pennsylvanian, Mississippian, Devonian, Silurian, and Ordovician ages in southeastern New Mexico. Various parts of this thick sequence of sediments warrants further subdivision and these have been studied separately for production purposes. Permian rocks are subdivided into the Delaware Mountain

Group, Bone Springs Formation and the Wolfcamp Formation. Most of the production from the Delaware Mountain Group is found in the upper part of this interval in the Ramsey pay zone of the Bell Canyon Formation. The remainder of the Bell Canyon and the Cherry Canyon and Brush Canyon formations are combined for analysis purposes. All fields producing from the Delaware Mountain Group were examined even though some occur as far north as T. 17 S. Production from the Bone Springs and Wolfcamp formations, although involving several different stratigraphic intervals within each unit are treated simply as Bone Springs or Wolfcamp without further subdivision. An analysis of all fields producing from the Bone Springs is included.

In view of its obvious importance in determining potential for this part of the Delaware basin, the Pennsylvanian sequence is treated in its entirety and also divided into three intervals that are readily traceable within the Study area and reasonably so elsewhere. The nomenclatural problems of the Pennsylvanian system are discussed in another part of this report, but it should be emphasized that the intervals used have not been examined to the extent necessary to establish equivalency with the Strawn, Atoka, or Morrow intervals commonly referred to in the literature, field nomenclature, or scout data for southeastern New Mexico. These sources of information indicate marked divergence in opinion as to what constitutes the formalized nomenclature for the Pennsylvanian.

Mississippian rocks are subdivided in the subsurface into the Barnett Shale and an underlying unnamed carbonate interval commonly referred to as Mississippian lime. There is no production from Mississippian rocks in the area covered by this report, and the potential yield per acre has been determined by examination of the few fields that produce from this interval in southeastern New Mexico. Sediments of Devonian and Silurian age are combined. Very few wells penetrate the entire interval and separation of the two is not practical with available information. Production within the Study area is entirely from the upper part of the carbonate sequence just beneath the Woodford Shale.

Ordovician rocks underlie all of the Delaware basin and that part of the northwestern shelf included in this report. These rocks like the rest of the Paleozoic section beneath the Wolfcamp interval are absent over part of the Central Basin platform. Ordovician oil and gas production is restricted to the platform and occurs in several parts of the Montoya, Simpson, and Ellenburger groups. The production is combined in projecting the petroleum potential for the Ordovician strata.

The production data used for this section is considered to be quite accurate. Information was obtained from yearly reports, dating back to 1946, of the New Mexico Oil and Gas Conservation Commission. Reserve projections were made with a computer program furnished by Thomas Plouf, a research metallurgist for the Bureau. The program involves a least squares, linear regression of data to predict ultimate recovery. Essentially it is similar to a straight-line fit, decline curve. This is not as satisfactory a method as volumetric procedures, but time was not available to compile all the data needed for this method of reserve calculations. In many cases, however, results should be fairly good because of increases in allowables since 1965, and in particular in 1969, followed by removal of allowables in 1972. This has presented an opportunity to evaluate production capacities of numerous wells. Data presented in the tables showing production summaries are conservative, but by using a large sample should approximate average yields per acre for each interval. Obviously there are many variables in production data for oil and gas wells. Allowables that were in effect until quite recently resulted in rather uniform production figures particularly for some wells. This is best seen in the well production data for the Paduca-Delaware field up to the period when secondary recovery operations began. Often gas wells were shut-in for extended periods of time and many wells undergo workover programs in any given year resulting in a decrease in production. Following increase in allowables in the middle of 1969 there was a sharp increase in production for one or two years followed by, in most cases an abrupt decline. Using the available program, declines of this type generally result in low estimates, whereas significant increases in production within the last two or three years gives an unreasonably high projection for recoverable reserves. The erratic nature of production from many wells is in general smoothed out in the field analysis if there are numerous producing wells. Fortunately in most cases declines appear to have developed a reliable pattern over the past few years and close examination of the producing history of individual wells and fields aids in evaluating the reliability of projected reserves recoverable under primary production methods. Where projections were deemed to high for a particular well or field based on examination of production data for that well or field, and comparison with other wells or fields producing from the same interval, the projected total primary production was not used in calculating the yield per acre. Instead production up to Jan. 1, 1973 was used and the result is a minimum yield figure. Projections that appeared to be low were utilized but again result in a conservative estimate of ultimate primary yield. An example of what would be considered to be a low estimate of recoverable oil is well ELMA29 in the El Mar-Delaware field (Table 41). Production up to the time secondary recovery operations began in this field amounted to 90,796 barrels of oil. Production for the three years preceding secondary recovery was 4,287, 4,901, and 4,115 barrels. Projecting only an additional 5,959 barrels under primary recovery does not seem justified after fairly stable production under the allowable program at that time. Where projections are considered high or low for reasons similar to those explained above a note to this effect is given in the tables.

Some seeming inconsistencies appear in the tables. For the Bone Springs-Lea field the projected production of 1,008,972 barrels is less than the actual production 2,080,111 barrels up to January 1,

1973. In this case projected production is based on wells completed prior to 1970 and involves only eight wells. Nine additional wells have been completed in that field and production from these wells is not considered in the projection of yield per acre. Assuming that the per acre yield figures arrived at by averaging all production data for a specific pay interval are reliable, additional wells will not change the potential estimate for a given tract of land or the production from a particular stratigraphic interval. Reliability naturally is better for those parts of the geologic section that have produced the most oil or gas. Where these figures are large appreciable changes in production are necessary in order to effect the average yield per acre or per well. Another problem encountered involved wells that were abandoned after secondary recovery began. The projected production for these wells may be higher than the actual production. However, these wells may have been converted to injection wells or have been shut-in as part of the secondary recovery program. The potential primary recovery may thus in fact have been greater.

In the tables covering projected yields per acre for fields and wells the second column gives cumulative production up to January 1, 1973 except where secondary recovery operations are involved. In these cases production is given up to the year these operations began. The projected production given in the third column is based only on those fields or wells where it was possible to establish a fairly reasonable decline or if the projection was low. In calculating yields per acre, 40 acres was used for oil wells and 160 acres for gas wells. With the exception of secondary recovery fields the number of wells given reflects the total number of producing wells completed in the field and the acreage involved reflects only the wells used in determining the projected yields.

Ordovician System

All of the Ordovician fields are located on or adjacent to the Central Basin platform. Production projections for producing fields and calculations for abandoned fields were made for 24 oil fields and three gas fields. Data pertaining to Ordovician fields is given in Tables 2 and 3 and is summarized in Table 1. As for the rest of the geologic section, projections of oil and gas yields for the Ordovician are considered low. For oil fields the projections are considered reasonable for five fields, high for one field, and low for 11 fields. Gas yields appear satisfactory for seven projections and low for nine.

The per acre recovery of oil ranges from 40 barrels for an abandoned one well field to 23,641 barrels at Fowler-Ellenburger. The average projected yield for all fields is 5,740 barrels per acre and production to January 1, 1973 was 5,415 barrels per acre. Estimated distillate recovery is from 123 to 651 barrels per acre and projected average is 406 barrels. An adequate projection of gas yield could not be made for the Custer-Ellenburger gas field but production from the single well up to January 1, 1973 had already been 81,618 MCF per acre with over 13,000,000 MCF of gas produced. The

TABLE 1 – Production summary: Ordovician System

Interval	Study Area					Regional Area				
Ordovician	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre	Producing Acres	Production to 1/1/73 *	Average Yield Per Acre to 1/1/73	Projected Production *	Projected Yield Per Acre
Gas (MCF)						1,920	49,730,611	25,901	62,859,008	32,739
Associated Gas (MCF)						17,800	244,914,313	13,759	258,640,479	14,530
Total Gas (MCF)						19,720	294,644,924	14,941	321,499,487	16,303
Oil (bbls)						17,800	96,388,026	5,415	102,164,913	5,740
Distillate (bbls)						1,920	680,101	354	779,921	406
Total Oil (bbls)						19,720	97,068,127	4,922	102,944,834	5,220

* Does not include production under secondary recovery for Teaque and Warren McKee Simpson fields.

TABLE 2 - Fields: Ordovician-Oil Production

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Brunson-Ellenburger	24,986,904	25,317,205	148	5920	4,277	P	Projection low
Brunson, East-Ellenburger	18,566	23,695	2	80	296	P	
Brunson, East-McKee	128,457	133,162	4	160	832	P	Projection low
Brunson, South-Ellenburger	412,473	423,877	4	160	2,649	P	Projection low
Cary-Montoya	263,302	263,302	3	120	2,194	A	
Custer-Ellenburger(Gas)	61,526	104,211	1	160	651	P	Projection high
Dollarhide-Ellenburger	4,138,154	4,330,595	8	320	13,533	P	Projection low
Dublin-Ellenburger(Gas)	39,460	39,460	2	320	123	A	
Dublin-Ellenburger	-	-	-	-	-	-	No production data
Fowler-Ellenburger	13,625,550	16,075,811	17	680	23,641	P	
Fowler-Connell	1,617	1,617	1	40	40	A	
Hare-Simpson	15,023,914	15,225,113	90	3600	4,229	P	Projection low
Hare, South-Simpson	192,373	192,373	3	120	1,603	A	

Field/Well	Cum. Prod. 1/1/73†	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Justis-Ellenburger	7,330,532	8,201,602	23	920	8,915	P	
Justis-Mckee	1,308,685	1,308,685	15	600	2,181	A	
Justis-Montoya	2,990,112	3,207,514	14	560	5,728	P	Projection low
Justis, North Ellenburger	598,149	622,006	8	320	1,944	P	Projection low
Justis, North-Mckee	652,208	682,791	11	440	1,552	P	Projection low
Justis, North-Montoya	572,490	581,808	6	240	2,424	P	Projection low
Justis, North-Waddell	70,234	70,234	3	120	585	A	
Loop 18-Montoya	7,249	7,299	1	40	182	P	Projection slightly low
Monument-Mckee Ellenburger(Gas)	579,115	636,250	9	1440	442	P	Includes Monument-Ellenbruger Projection low
Stateline-Ellenburger	3,464,784	3,834,937	11	440	8,716	P	Projection low
Teague-Ellenburger	2,471,012	2,471,012	10	400	6,178	A	
Teague-Simpson*	2,085,352	2,134,396	15	600	3,557	P	Primary projection low Secondary recovery, 1965

TABLE 2 - **Fields: Ordovician-Oil Production (Cont'd)**

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Warren-Connell	61,752	61,752	1	40	1,544	A	
Warren-McKee/Simpson*	15,984,157	16,994,317	47	1880	9,040	P	Includes Warren, North-Mckee Secondary recovery, 1966

* Secondary recovery
† Except secondary recovery production
P: Producing
A: Abandoned

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Brunson-Ellenburger	106,775,517	109,018,247	148	5920	18,415	P	
Brunson, East-Ellenburger	96,735	110,445	2	80	1,381	P	
Brunson, East-McKee	599,357	759,187	4	160	4,745	P	
Brunson, South-Ellenburger	1,533,382	1,783,092	4	160	11,144	P	Projection low
Cary-Montoya	1,690,748	1,690,748	3	120	14,090	A	
Custer-Ellenburger(Gas)	13,058,879	-	1	160	-	P	Data inadequate
Dollarhide-Ellenburger	1,918,121	1,931,276	8	320	6,035	P	Projection slightly low
Dublin-Ellenburger(Gas)	162,680	162,680	2	320	508	A	
Dublin-Ellenburger	-	-	-	-	-	-	No production data
Fowler-Ellenburger	11,401,049	15,441,899	17	680	22,709	P	
Fowler-Connell	518	518	1	40	13	A	
Hare-Simpson	67,428,358	67,698,098	90	3600	18,805	P	Projection low
Hare, South-Simpson	961,452	961,452	3	120	8,012	A	

TABLE 3 - Fields: Ordovician - Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Justis-Ellenburger	9,067,517	9,964,357	23	920	10,831	P	
Justis-McKee	4,409,974	4,409,974	15	600	7,350	A	
Justis-Montoya	4,596,100	5,000,700	14	560	8,930	P	Projection low
Justis, North-Ellenburger	767,057	819,867	8	320	2,562	P	Projection low
Justis, North-McKee	1,650,422	1,738,032	11	440	3,950	P	Projection low
Justis, North-Montoya	481,494	506,584	6	240	2,111	P	Projection low
Justis, North-Waddell	208,193	208,193	3	120	1,735	A	
Loop 18-Montoya	4,709	-	1	40	-	P	Data inadequate
Monument-McKee Ellenburger (Gas)	36,509.052	49.637.449	9	1440	34,470	P	Includes Monument-Ellenburger
Stateline-Ellenburger	1,035,454	1,075,584	11	440	2,445	P	Projection low
Teague-Ellenburger	2,533,879	2,533,879	10	400	6,335	A	
Teague-Simpson*	5,046,855	5,098,695	15	600	8,498	P	Primary projection low Secondary recovery, 1965
Warren-Connell	107,671	107,671	1	40	2,692	A	
Warren-McKee/Simpson*	22,599,751	27,781,981	47	1880	14,778	P	Includes Warren, North-McKee Secondary recovery, 1966

* Secondary recovery † Except secondary recovery production P: Producing A: Abandoned

other two gas fields have yields of 508 MCF at the abandoned Dublin area and 34,470 MCF at Monument. The range in yield per acre for associated gas is from 13 MCF for an abandoned well to 22,709 MCF for wells in the Fowler-Ellenburger field.

Average projected per well recovery for the Ordovician is as follows: Oil wells--229,584 barrels of oil and 581,214 MCF of associated gas; gas wells--5,238,250 MCF of gas and 64,993 barrels of distillate. Average gravity of crude oil produced from the Ordovician is 43°A. P. I. and that of distillate, 55°A. P. I.

Silurian/Devonian Systems

Within the Study area there have been five designated Devonian gas fields, one undesignated gas well, one designated oil field, and one undesignated oil well. In evaluating the producing potential for the combined Silurian/Devonian interval, production from 24 fields (including five single-well fields) and 16 wells were examined. Including abandoned fields and wells it was possible to determine an average yield per acre of gas production for 18 fields and 14 wells, and for oil production, 19 fields and 13 wells. Most of the oil production occurs on the Central Basin platform while most gas has been discovered in the Delaware basin area where Silurian/Devonian rocks are deeply buried.

The yield per acre estimate for oil and gas in both the study and regional areas, appears to be slightly low (Table 4). The only fields where estimated per acre yields might appear high are for oil production in the Fowler-Devonian and South McCormack-Silurian pools (Table 5). In the case of the South McCormack field this is brought about by increased production following completion of two wells in 1971. An analysis of individual wells might, at least in part, help to resolve this problem. The only fields with comparable oil yields are Lea-Devonian in the Study area, and Dollarhide-Fusselman. Many wells in the Lea field (Table 6) have yields per acre considerably higher than the field analysis of 14,943 barrels of the South McCormack field. If the projected production at South McCormack is eliminated from consideration the average projected yield per acre of oil would be 5,870 barrels compared with the 6,530 barrels given in Table 4. However, the higher yield figure must still be considered conservative because no projections were made for two fields where data was inadequate, and projections are obviously low for five other fields.

Within the Study area it was possible to determine distillate yield for the three wells in the Antelope Ridge-Devonian gas field and oil for the nine wells in the Lea-Devonian field. Indicated is a range in distillate yields of from 710 barrels per acre for an abandoned well to 1,594 barrels for the most productive well in the field. The average production based on decline curves for each well is the same as that for the field analysis. Oil yields from the Lea field range from a low of 230 barrels for an abandoned well to 21,978 barrels per acre. Average per acre yield from well decline curves suggests 15,833 barrels compared with the field decline curve of 14,850 barrels. Both estimates appear to be low.

Well analyses were made of gas wells in the Antelope Ridge- and Bell Lake-Devonian gas fields and Lea-Devonian oil field (Table 8). The average per acre yield for Antelope Ridge ranged from 31,714 MCF for the abandoned well to 81,283 MCF. The average expected yield based on field analysis of 56,626 MCF is essentially the same (Table 7) as for the well data average. Average yield for the Bell Lake field is expected to be 56,127 MCF almost the same as that based on well analyses. The estimated recovery per acre by well projections for the Lea field gives an average recovery of 6,468 MCF of associated gas compared with 7,087 MCF from the field decline curve. The range in yield per acre for this field is from 300 MCF for the single abandoned well to 8,916 MCF for well LEAD08. Comparison of projected total gas yield per acre is higher for the Study area than for the region. Although projected yields per acre for oil and distillate are higher in the Study area the average per acre recovery for all oil is lower because of the ratio of gas wells to oil wells and calculations based on 40 and 160 acre spacings.

The average per well production in the Study area to January 1, 1973 has been: 6,814,271 MCF of gas and 63,807 barrels of distillate for gas wells; and 513,850 barrels of crude oil and 223,669 MCF of associated gas for oil wells. Projected, the average recovery per gas and oil well will amount to at least 7,545,519 MCF of gas, 65,289 barrels of distillate, 536,596 barrels of oil, and 257,507 MCF of associated gas. Regionally the projected production per well is:

TABLE 4 – Production summary: *Silurian/Devonian Systems*

Interval	Study Area					Regional Area (includes study area)				
Silurian/Devonian	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre	Producing Acres	Production to 1/1/73 *	Average Yield Per Acre to 1/1/73	Projected Production*	Projected Yield Per Acre
Gas (MCF)	1,440	61,328,439	42,589	67,909,669	47,159	4,000	150,239,388	37,560	167,523,868	41,881
Associated Gas (MCF)	400	2,236,686	5,592	2,575,072	6,438	5,200	39,551,174	7,606	47,641,070	9,162
Total Gas (MCF)	1,840	63,565,125	34,546	70,484,741	38,307	9,200	189,790,562	20,629	215,164,938	23,387
Oil (bbls)	400	5,138,498	12,846	5,365,968	13,415	5,200	26,685,278	5,132	33,954,975	6,530
Distillate (bbls)	1,440	574,260	399	587,598	408	4,000	1,194,140	299	1,347,793	337
Total Oil (bbls)	1,840	5,712,758	3,105	5,953,566	3,236	9,200	27,879,4[illegible]	3,030	35,302,768	3,837

* Does not include production under secondary recovery for Dollarhide-Devonian field

TABLE 5 - Fields: Silurian/Devonian - Oil Production

Field/Well	Cum. Prod. 1/1/73 ↓	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Antelope Ridge-Devonian (Gas)*	535,581	543,841	3	480	1,133	P	Projection low
Bell Lake-Devonian (Gas)*	-	-	2	320	-	P	No distillate production
Bell Lake, Mid-Devonian (Gas)*	-	-	1	160	-	A	No distillate production
Bell Lake, North-Devonian (Gas)*	38,180	43,757	1	160	273	P	
Cline-Devonian	4,577	4,577	1	40	114	A	
Crosby-Devonian (Gas)	579,273	719,089	14	2240	321	P	
Crosby-Fusselman	16,129	-	1	40	-	P	Data inadequate
Dollanhide-Devonian**	2,581,308	2,655,108	18	720	3,702	P	Secondary recovery, 1962
Dollarhide-Fusselman	4,487,356	4,929,532	11	440	11,203	P	Projection does not include 1971-72 production
Dublin-Devonian	47,145	47,145	2	80	589	A	
Fowler-Devonian	990,332	1,832,570	5	200	9,163	P	Projection may be high
Fowler-Fusselman	586,935	586,935	5	200	2,935	A	

TABLE 5 - Fields: Silurian/Devonian - Oil Production (con't)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Fowler-Upper Silurain	48,481	48,481	2	80	606	A	
Justis-Fusselman	8,020,822	10,003,922	31	1240	8,086	P	
Justis, North-Devonian	400,471	365,246	11	440	830	P	Projection does not include 1971-72 production. Projection low
Justis, North-Fusselman	2,247,554	2,394,809	15	600	3,991	P	Projection low
Lea-Devonian*	5,118,494	5,345,964	9	360	14,850	P	Projection low
McCormack-Silurain	778,694	910,660	3	120	7,589	P	
McCormack, South-Silurain	749,490	4,183,913	7	280	14,943	P	Projection may be high
Monument Draw-Devonian	8,393	8,393	1	40	210	A	
Osudo-Devonian (Gas)	40,607	-	2	320	-	P	Data inadequate
Paduca-Devonian (Gas)*	499	499	1	160	3	P	
Teague-Devonian	499,153	511,647	5	200	2,558	P	
Warren-Devonian	79,940	-	2	80	-	P	Data inadequate
UNDES 1 (Gas)	-	-	1	160	-	A	No distillate production
UNDES 2	20,004	20,004	1	40	500	A	

*Study area fields **Secondary recovery ‡Except Dollarhide production under secondary recovery
P: Producing A: Abandoned

TABLE 6 - Wells: Silurian/Devonian (Study Area) - Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
ANRI 01 (Gas)	113,672	113,672	160	710	A	
ANRI 02 (Gas)	175,327	175,740	160	1098	P	Projection low
ANRI 03 (Gas)	246,250	255,100	160	1594	P	Projection probably low
LEAD 01	842,637	879,122	40	21,978	P	
LEAD 02	574,727	586,985	40	14,675	P	
LEAD 03	647,559	739,660	40	18,492	P	
LEAD 04	568,487	575,558	40	14,389	P	Projection low
LEAD 05	503,576	631,574	40	15,789	P	
LEAD 06	628,522	875,102	40	21,878	P	Projection may be slightly high
LEAD 07	582,212	619,058	40	15,476	P	
LEAD 08	761,567	783,438	40	19,586	P	
LEAD 09	9,207	9,207	40	230	A	

P: Producing

A: Abandoned

TABLE 7 - Fields: Silurian/Devonian - Gas Production

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Antelope Ridge-Devonian(Gas)*	24,433,274	27,180,704	3	480	56,626	P	
Bell Lake-Devonian(Gas)*	17,519,183	17,960,553	2	320	56,127	P	Projection low
Bell Lake, Mid-Devonian(Gas)*	745,986	745,986	1	160	4,662	A	
Bell Lake, North-Devonian(Gas)*	17,724,380	20,726,100	1	160	129,538	P	
Cline-Devonian	-	-	1	40	-	A	No gas production
Crosby-Devonian(Gas)	88,181,084	99,275,044	14	2240	44,319	P	
Crosby-Fusselman	229,350	-	1	40		P	Data inadequate
Dollarhide-Devonian**	10,919,764	11,419,844	18	720	15,86	P	Secondary recovery, 1962 Primary projection low
Dollarhide-Fusselman	3,491,324	3,549,174	11	440	8,066	P	Projection low
Dublin-Devonian	73,276	73,276	2	80	916	A	
Fowler-Devonian	5,167,910	6,973,530	5	200	34,868	P	
Fowler-Fusselman	393,709	393,709	5	200	1,969	A	
Fowler-Upper Silurian	211,900	211,900	2	80	2,649	A	

TABLE 7 - Fields: Silurian/Devonian - Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Justis-Fusselman	8,764,949	12,871,119	31	1240	10,380	P	
Justis, North-Devonian	1,716,502	-	11	440	-	P	Data inadequate
Justis, North-Fusselman	2,240,410	3,019,370	15	600	5,032	P	
Lea-Devonian*	2,213,104	2,551,490	9	360	7,087	P	Projection low
McCormack-Silurian	2,545,295	3,040,005	3	120	25,333	P	
McCormack, South-Silurian	851,484	-	7	280	-	P	Data inadequate
Monument Draw-Devonian	1,046	1,046	1	40	26	A	
Osudo-Devonian(Gas)	729,865	-	2	320	-	P	Data inadequate
Paduca-Devonian(Gas)*	900,618	1,291,328	1	160	8,071	P	Projection probably low
Teague-Devonian	601,673	609,793	5	200	3,049	P	
Warren-Devonian	105,896	-	2	80	-	P	Data inadequate
UNDES 1(Gas)	4,998	4,998	1	160	31	A	
UNDES 2	23,582	23,582	1	40	590	A	

* Study area fields ** Secondary recovery † Except Dollarhide production under secondary recovery
P: Producing A: Abandoned

TABLE 8 - Wells: Silurian/Devonian (Study Area) - Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
ANRI 01 (Gas)	5,074,270	5,074,270	160	31,714	A	
ANRI 02 (Gas)	8,281,590	9,129,340	160	57,058	P	
ANRI 03 (Gas)	11,011,807	13,005,297	160	81,283	P	
BLLK 01 (Gas)	4,048,020	4,048,020	160	25,300	A	
BLLK 03 (Gas)	13,473,163	13,914,533	160	86,966	P	Prcjection low
LEAD 01	266,395	287,181	40	7,180	P	
LEAD 02	323,927	340,107	40	8,503	P	
LEAD 03	207,946	256,546	40	6,414	P	
LEAD 04	155,941	177,271	40	4,432	P	
LEAD 05	280,784	298,174	40	7,454	P	
LEAD 06	285,829	-	40	-	P	Projection high; not used
LEAD 07	338,442	341,702	40	8,543	P	
LEAD 08	341,098	356,658	40	8,916	P	Projection low
LEAD 09	11,982	11,982	40	300	A	

P: Producing   A: Abandoned

TABLE 7 Discovery Well Data: Silurian/Devonian (Study Area)

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Antelope Ridge-Devonian (Gas)	Shell 1 Harris	N27-23S-34E	14,653-14,832	41,000 MCF GOR:43,041:1	56°	T:4503
Bell Lake Devonian (Gas)	Conoco 1A Bell Lake	N31-23S-34E	14,942-15,025	15,500 MCF GOR:14,820:1	—	T:5113
Bell Lake, Mid-Devonian (Gas)	Conoco 10 Bell Lake	E19-23S-34E	14,747-14,811	3200 MCF	—	—
Bell Lake, North-Devonian (Gas)	Conoco 6 Bell Lake	O6-23S-34E	14,568-14,829	30,500 MCF GOR:197,250:1	53°	T:5015
Lea-Devonian	Ohio 1 Lea	L12-20S-34E	14,337-14,489	516 bbls GOR:321:1	56°	T:1570
Paduca-Devonian (Gas)	Texaco 64 Cotton Draw	C18-25S-32E	16,218-16,537	90,000 MCF	—	—
Undesignated	American Trading 1 State	J26-20S-35E	14,560-14,644	210 bbls GOR:1570:1	53°	—
Undesignated	Pan Am 36 Poker Lake	P28-24S-31E	16,526-16,660	42,701 MCF	—	FSIP:7293

oil - 261,192 barrels; distillate--53,912 barrels; natural gas--6,700,956 MCF; and associated gas--366,470 MCF.

Producing depths, initial potential, oil gravity, and pressure are given in Table 9 for discovery wells of Silurian/Devonian fields in the Study area. Producing depths range from 14,337 to 16,660 feet with average net pay thickness of 160 feet. The reported initial potential of gas wells ranges from 15,500 to 90,000 MCF for an average I. P. of 36,472 MCF. Production up to January 1, 1973 for gas wells in the Study area shows a low yield of 4,998 MCF for an abandoned undesignated well to almost 18,000,000 MCF for the single well producing in the North Bell Lake field. Initial potential for oil wells ranges from 71 to 1,165 barrels of oil per day and an average I. P. of 541 barrels. Production range has been from 9,207 to 842,637 barrels for wells in the Lea field. Based on data from 12 wells the average gravity of oil and distillate is 56° A. P. I. with a range from 48 to 59°. The only shut-in pressure data available was 7,293 psi for the Poker Lake well. Average tubing pressure for gas wells is 4,877 psi.

Mississippian System

Rocks of Mississippian age include an upper shaley interval called the Barnett Shale, and a lower carbonate sequence referred to simply as Mississippian or Mississippian lime. Petroleum occurs in the lower carbonate sequence, but there is no oil or gas being produced within the area studied for this report. Only six designated fields exist in southeastern New Mexico (Tables 11 and 13) and four of these have been abandoned.

The nearest production is at the Austin-Mississippian gas field located in sec. 17, T. 14 S., R. 36 E. Production data for the Mississippian is presented in Table 10 for completeness, although it cannot be considered relevant to the area examined in this report.

Of the nine wells completed seven have been abandoned leaving one well in the Austin gas field and one at the Bronco field. An analysis of the four wells that have produced at Bronco is given in Tables 12 and 14. This indicates a per acre oil recovery of from 4 to 9, 844 barrels. Up to January 1, 1973 the remaining producing well had recovered 5, 804 barrels per acre and the projected recovery of 9, 844 barrels would appear to be high. Overall the projected recovery based on well interpretation, including the abandoned wells, is 3, 613 barrels per acre for the Bronco field. The field analysis indicates a recovery of 2, 669 barrels per acre and appears to be a more reasonable estimate of total primary recovery. Associated gas production at the Bronco field based on well analysis indicates a recovery of 2, 221 MCF per acre; approximately the same as that for the field analysis. Up to January 1, 1973 production had already amounted to 2, 188 MCF. It might appear therefore that the projection is low except for the marked decline in gas production since 1969. Gas production at the Austin field has been erratic since 1969 and the estimate of future potential from the single well in this field, as far as distillate production is concerned, appears to be low. The estimated gas yield is 3, 838, 565 MCF for a recovery of 23, 991 MCF per acre.

Per well recovery averages are 62, 013 barrels of crude oil and

TABLE 10 – Production summary: Mississippian System

Interval	Study Area					Southeastern New Mexico				
Mississippian	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre
Gas (MCF)						320	3,057,297	9,554	3,844,957	12,015
Associated Gas (MCF)						280	354,037	1,264	357,801	1,278
Total Gas (MCF)						600	3,411,334	5,686	4,202,758	7,005
Oil (bbls)						280	423,582	1,513	434,019	1,550
Distillate (bbls)						320	50,403	158	50,621	158
Total Oil (bbls)						600	473,985	790	484,640	808

TABLE II - Fields: Mississippian - Oil Production

Field/Well	Cum. Frod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Austin (Gas)	49,579	49,797	1	160	311	P	
Bronco	416,524	426,961	4	160	2,669	P	
Crossroads	1,631	1,631	1	40	41	A	
Denton	5,371	5,371	1	40	134	A	
Lone	56	56	1	40	1	A	
White Ranch (Gas)	824	824	1	160	5	A	

P: Producing A: Abandoned

TABLE 12 - Wells: Mississippian - Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
BRONC 1	55,108	55,108	40	1,378	A	
BRONC 2	232,173	393,767	40	9,844	P	
BRONC 3	129,081	129,081	40	3,227	A	
BRONC 4	162	162	40	4	A	

P: Producing A: Abandoned

TABLE 13 - Fields: Mississippian - Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Austin (Gas)	3,050,905	3,838,565	1	160	23,991	P	
Bronco	350,024	353,788	4	160	2,211	P	
Crossroads	984	984	1	40	25	A	
Denton	1,397	1,397	1	40	35	A	
Lone	1,632	1,632	1	40	41	A	
White Ranch (Gas)	6,392	6,392	1	160	40	A	

P: Producing A: Abandoned

TABLE 14 - Wells: Mississippian - Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
BRONC 1	86,388	86,388	40	2,160	A	
BRONC 2	226,479	226,483	40	5,662	P	
BRONC 3	42,297	42,297	40	1,057	A	
BRONC 4	173	173	40	4	A	

P: Producing A: Abandoned

51,114 MCF of associated gas for oil wells. Gas well yields are 1,922,479 MCF of gas and 25,311 barrels of distillate. Average gravity of crude oil is 43° A. P. I.

Pennsylvanian System

Data giving oil and gas yields per acre for the Pennsylvanian are given in Table 15. Because production from Pennsylvanian-age rocks is primarily gas, production has been quite erratic, and there are many recent discoveries, some additional evaluations are presented.

In determining the production potential of the Pennsylvanian, studies were made of 79 fields, 32 of them in the Study area, and 36 wells, from multi-well fields all in the Study area. A breakdown of the fields shows that 22, involving 62 wells, have been abandoned, no production data was available for five recently discovered fields, it was impossible to project gas yields for 24 fields and oil for 14 fields, and there were 15 fields without reported distillate production. In Table 25 all fields are considered in arriving at the average yield per acre. Thus even though there is no distillate production from a particular field the productive acreage involved in that field is used in calculating the overall yield of distillate for the Pennsylvanian. Based on the categories listed above it is possible to show a range in potential recovery per acre. For natural gas the range for the region is from 4,747 MCF per acre for abandoned fields to 56,690 MCF for fields where yields could be projected. For distillate the range is from 27 barrels for recent discoveries to 460 barrels for projected yields. By combining data for abandoned fields, fields where it was not possible to project yields, and projected yields, most Pennsylvanian fields are considered and a more realistic figure for average yield can be determined, although still considered to be a conservative estimate. The combined data gives a recovery figure of 44, 997 MCF per acre for gas and 375 barrels for distillate. The potential yield is therefore increased substantially from that given in Table 15 where recent discoveries and dry gas fields are included in the calculations.

Production average for a Pennsylvanian well is 3, 387, 486 MCF of gas recovered up to January 1, 1973. On a projected basis the per well recovery amounts to 5, 689, 028 MCF. By eliminating the 54 recently completed wells with an average production of 793, 965 MCF the projected recovery per well is 7, 199, 503 MCF. Projected distillate recovery, based on 160 wells, is 60, 009 barrels per well when recently completed wells and the 18 wells without distillate production are not considered.

Projected yields per acre for fields and wells are given in Tables 16 to 19. The range in gas yields is from 52 MCF per acre for the abandoned Dark Canyon-Pennsylvanian field to 102, 610 MCF for the projected yield in the Indian Basin-Upper Pennsylvanian field. Six fields exceed the average per acre yield of 35, 556 MCF. These are Antelope Ridge-Atoka, Antelope Ridge-Morrow, Los Medanos-Atoka, Paduca-Morrow, Sand Dune-Atoka, and Indian Basin-Upper Pennsylvanian. Five of these high yield gas fields are in the Study area and have an average projected yield per acre of 67,150 MCF and per well of 10,743,955 MCF.

In evaluating gas and distillate production from the Pennsylvanian similar analyses were made for the Study area. The projected yield per acre for all gas fields is 20,130 MCF, considerably lower than for the regional area. Recovery range is from 1,336 MCF per acre for seven recently completed wells to 51,750 MCF for fields where yields were projected. Distillate yields are slightly higher than for the region and excluding recent discoveries and wells with no distillate production averages 359 barrels per acre.

Oil production from the Pennsylvanian for the regional area is for the most part insignificant (Table 16). Only two fields have yields in excess of 1,000 barrels per acre. These are the Big Eddy-Strawn field with estimated recovery of 7,599 barrels and the Cass-Pennsylvanian field with 11,488 barrels. The Big Eddy field is in the Study area. The only appreciable gas produced with oil is at Big Eddy with a projected yield of 44,764 MCF per acre. Associated gas recovered with oil is less than 10,000 MCF per acre for most fields, but the average is 15,411 MCF for the region and 30,986 MCF for the Study area.

Analyses were made of oil and gas production in the Study area of wells in the Bell Lake-Pennsylvanian, Lea-Pennsylvanian, Paduca-Morrow, South Salt Lake-Atoka, and South Salt Lake-Morrow gas fields, and the Big Eddy-Strawn oil field (Tables 17 and 29). Based on three wells with production data in the Bell Lake field the projected yield per acre is 10,374 MCF of gas; about 2,000 MCF lower than the projected recovery for the fields. Seven of the 15 wells in the Lea field have been abandoned; for the remaining eight it was possible to project potential recovery. The estimated recovery based on wells is 12,406 MCF compared with 13,750 MCF for the field projection. Per well recovery by well analysis is 1,985,004 MCF and by field analysis 2,199,956 MCF. Projections for the three wells in the Paduca-Morrow field give an estimated recovery of 64,734 MCF per acre, slightly more than the field projection of 61,613 MCF. One well in this field had produced 22,885,062 MCF of gas up to January 1, 1973 with initial production reported in 1967. It is estimated that recovery from this well will be 26,008,222 MCF. The average yield per well for the Paduca field is 10,357,451 MCF. Production estimates based on well analyses for the other fields is approximately the same as that obtained by field projections. The average yield per well for the four wells involved in these fields is 2,885,720 MCF.

Distillate production based on well analyses of 21 wells with production data indicates an average yield per well of 56,011 barrels compared with the average, based on field projections, of 48,174 barrels for all wells in the Study area. The four wells with oil production in the Big Eddy oil field includes one well recompleted to the Morrow, one apparently almost depleted well, and one for which the projection is obviously low. Based on well analyses the recovery from current wells and the abandoned well amounts to 8,408 barrels per acre compared with the field projection of 7,599 barrels. Per well recovery for this field averages 336,337 barrels by well analysis, and 303,976 barrels from the field analysis.

TABLE 15 – Production summary: Pennsylvanian System

Interval	Study Area					Regional Area (includes study area)				
Pennsylvanian	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production*	Projected Yield Per Acre
Gas (MCF)	8,800	160,919,573	18,286	177,146,113	20,130	36,640	775,734,343	21,172	1,302,787,263	35,556
Associated Gas (MCF)	240	6,953,294	28,972	7,436,664	30,986	640	9,365,926	14,634	9,863,296	15,411
Total Gas (MCF)	9,040	167,872,867	18,570	184,582,777	20,418	37,280	785,100,269	21,060	1,312,650,559	35,211
Oil (bbls)	240	1,196,466	4,985	1,249,118	5,205	640	3,968,215	6,200	4,020,867	6,283
Distillate (bbls)	8,640	2,120,292	245	2,601,396	301	36,480	7,330,795	201	9,821,232	269
Total Oil (bbls)	8,880	3,316,758	374	3,850,135	434	37,120	11,299,010	304	13,841,720	373

* 1971-1972 gas production from White City field not used in projected recovery calculations.

TABLE 16 - Fields: Pennsylvanian-Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Antelope Ridge-Atoka (Gas)*	177,434	177,434	1	160	1109	A	
Antelope Ridge-Morrow (Gas)*	240,260	499,861	2	320	1562	P	
Arena Roja-Penn (Gas)	4,606	4,617	1	160	29	P	
Avalon, Mid-Morrow (Gas)	-	-	-	-	-	-	No production data
Bandana Point-Penn (Gas)	-	-	1	160	-	A	No distillate production
Bell Lake-Penn (Gas)*	17,343	17,343	3	480	36	P	No distillate production since 1965
Berry-Morrow (Gas)*	11,915	11,915	1	160	74	A	
Big Eddy-Strawn*	1,163,629	1,215,902	4	160	7599	P	Projection low
Black River-Penn (Gas)	-	-	1	160	-	P	No distillate production
Carlsbad, South-Atoka (Gas)	-	-	3	480	-	P	No distillate production
Carlsbad, South-Morrow (Gas)	14,883	-	20	3200	-	P	Data inadequate
Carlsbad, South Strawn (Gas)	176,629	-	5	800	-	P	Data inadequate

Field/Well	Cu. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Carlsbad-Permol Penn (Gas)	6,999	-	1	160	-	P	Data inadequate
Cass-Penn	2,757,112	2,757,112	6	240	11,488	P	Projection low
Cass Ranch Morrow (Gas)	300	300	1	160	2	A	
Catclaw Draw-Morrow (gas)	4,071	-	9	1440	-	P	Data inadequate
Catclaw Draw-Strawn (Gas)	1,407	-	1	160	-	P	Data inadequate
Catclaw Draw-East-Strawn	-	-	-	-	-	-	No production data
Cedar Canyon-Morrow (Gas)*	-	-	1	160	-	P	No distillate production
Cedar Hills-Upper Penn(Gas)	19,406	19,651	1	160	123	P	Projection low
Cemetary-Morrow(Gas)	296	296	2	320	0.9	P	Minor production
Cinta Roja-Morrow(Gas)	31,687	-	1	160	-	P	Data inadequate
Crawford-Penn (Gas)	-	-	2	320	-	P	No distillate production
Daggar Draw-Atoka (Gas)	-	-	1	160	-	A	No distillate production
Daggar Draw-Morrow (Gas)	2,378	2,433	1	160	15	P	Projection slightly low

Field/Well	Cum. Prod. 1.1.73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Daggar Draw-Upper Penn	33,715	12,113	4	80	303	P	New wells completed in 1971. No production from 1968-1971
Daggar Draw-Strawn(Gas)	251	251	1	160	1.6	P	No distillate production after 1971
Dark Canyon-Penn(Gas)	-	-	1	160	-	A	No distillate production
Dos Hermanos Morrow(Gas)*	34,136	-	1	160	-	P	Data inadequate
Fenton Draw-Strawn	47	47	1	40	1	A	
Getty-Morrow (Gas)	1,964	1,964	1	160	12	A	
Golden Eagle-Morrow(Gas)	1,582	1,582	1	160	10	A	
Golden Lane-Morrow(Gas)*	6,637	-	1	160	-	P	Data inadequate
Golden Lane-Strawn(Gas)*	228,959	225,012	3	320	703	P	Does not include 1972 production: New well
Grama Ridge-Morrow(Gas) *	82,340	84,750	5	800	106	P	Projection low
Hackberry, South-Strawn *	23,936	-	1	40	-	P	Data inadequate
Hackberry Hills-Canyon(Gas)	62,119	80,229	1	160	501	P	
Hackberry Hills, East Canyon(Gas)	2,482	2,651	1	160	17	P	

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Harkey-Penn (Gas)	-	-	1	160	-	A	No distillate production
Hat Mesa-Morrow(Gas)*	1,054	-	1	160	-	P	Data inadequate
Huapache-Morrow(Gas)	-	-	1	160	-	A	No distillate production
Indian Basin-Atoka (Gas)	-	-	-	-	-	-	No production data
Indian Basin-Morrow(Gas)	98,435	-	14	2240	-	P	Data inadequate
Indian Basin-Upper Penn (Gas)	3,716,440	5,676,680	56	8960	634	P	
Indian Hills, North-Morrow(Gas)	2,205	2,205	3	480	5	A	
Indian Hills-Upper Penn(Gas)	-	-	-	-	-	-	No production data
Jal, West-Strawn (Gas)	152,072	154,300	2	320	482	P	Projection low
Lea-Penn (Gas) *	927,151	944,314	15	2400	393	P	Projection low
Los Medanos-Atoka(Gas)*	149,151	296,350	1	160	1852	P	Projection slightly high
Lusk, West-Strawn *	8,901	8,901	1	40	223	A	
Lynch-Penn (Gas) *	27,925	27,925	1	160	175	A	

TABLE 16 - Fields: Pennsylvanian-Oil Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Maroon Cliffs-Morrow(Gas)*	7,281	-	1	160	-	P	Data inadequate
McMillan-Morrow(Gas)	40,897	41,172	5	800	51	P	Projection low
Osudo-Strawn	2,477	2,477	1	40	62	A	
Osudo, North-Morrow(Gas)	155,780	161,226	5	800	202	P	Projection low
Osudo, South-Morrow(Gas)	134,964	137,930	2	320	431	P	Projection low
Osudo, West-Morrow(Gas)*	2,397	12,532	1	160	78	P	Projection probably high
Paduca-Morrow (Gas)*	715	715	3	480	1	P	
Poker Lake-Morrow(Gas)*	-	-	1	160	-	A	No distillate production
Red Hills-Penn (Gas)*	146	146	1	160	0.9	A	
Rock Tank-Lower Morrow(Gas)	9,297	-	5	800	-	P	Data inadequate
Rock Tank-Upper Morrow(Gas)	950	975	2	320	3	P	
Salt Lake, South-Atoka (Gas)*	86,573	100,237	2	320	313	P	
Salt Lake, South-Morrow(Gas)*	83,198	85,647	2	320	268	P	Projection slightly low

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Sand Dunes-Atoka(Gas)*	-	-	1	160	-	P	No distillate production
Sand Dunes-Lower Penn (Gas) *	-	-	1	160	-	P	No distillate production
Sand Dunes-Morrow(Gas)*	-	-	-	-	-	-	No production data
Sand Dunes, South-Lower Penn(Gas)*	-	-	1	160	-	P	No distillate production
Sand Dunes, West-Atoka(Gas)*	-	-	1	160	-	P	No distillate production
Scanlon-Strawn (Gas)	3,072	3,072	1	160	19	A	
Seven Rivers Hills-Morrow(Gas)	55	55	1	160	0.3	A	
Springs-Upper Penn(Gas)	539,964	557,675	4	640	871	P	Projection low
Teas-Penn (Gas)*	13,471	13,755	1	160	86	P	Projection slightly low
Tower Hill-Morrow(Gas)*	1,455	1,455	1	160	9	A	
Washington Ranch-Morrow(Gas)	873	-	11	1760	-	P	Data inadequate
Welch-Penn(Gas)	-	-	1	160	-	A	No distillate production

TABLE 16 - Fields: Pennsylvanian-Oil Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
White City-Penn(Gas)	24,439	26,291	3	480	55	P	Projection may be low
Wilson-Penn (Gas) *	46,759	49,920	1	160	312	P	
Wilson, South-Penn(Gas) *	2,977	2,977	1	160	19	A	

*Study area fields
P: Producing
A: Abandoned

TABLE 17 - Wells: Pennsylvanian (Study Area) Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
BELP 01 (Gas)	-	-	160	-	P	No distillate production
BELP 02 (Gas)	-	-	160	-	-	No production data
BELP 03 (Gas)	14,892	14,892	160	93	A	
BELP 04 (Gas)	-	-	160	-	P	No distillate production
BELP 05 (Gas)	-	-	160	-	-	No production data
BEST 01	183,667	183,667	40	4592	A	
BEST 02	138,346	138,725	40	3459	P	Projection low
BEST 03	-	-	40	-	-	No production data
BEST 04	524,226	705,565	40	17,639	P	
BEST 05	317,390	317,390	40	7935	P	Almost depleted
LEAP 01 (Gas)	75,210	76,478	160	478	P	Projection low
LEAP 02 (Gas)	97,596	97,569	160	610	A	
LEAP 03 (Gas)	54,423	54,423	160	340	A	
LEAP 04 (Gas)	84,460	84,460	160	528	P	
LEAP 05 (Gas)	6,760	6,760	160	42	A	
LEAP 06 (Gas)	134,257	134,257	160	839	A	
LEAP 07 (Gas)	157,954	158,578	160	991	P	Projection low
LEAP 08 (Gas)	107,316	108,691	160	679	P	Projection slightly low
LEAP 09 (Gas)	10,288	10,288	160	64	A	
LEAP 10 (Gas)	16,574	16,574	160	104	A	

TABLE 17 - Wells: Pennsylvanian (Study Area) Oil Production(Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
LEAP 11 (Gas)	22,439	22,439	160	140	A	
LEAP 12 (Gas)	110,585	120,526	160	753	P	Projection low
LEAP 13 (Gas)	7,076	7,192	160	45	P	Projection slightly low
LEAP 14 (Gas)	22,062	22,064	160	138	P	Projection low
LEAP 15 (Gas)	20,156	20,587	160	129	P	Projection low
PAMR 01 (Gas)	-	-	160	-	P	No distillate production
PAMR 02 (Gas)	715	715	160	4	P	
PAMR 03 (Gas)	-	-	160	-	P	No distillate production
SLSA 01 (Gas)	71,705	86,549	160	541	P	Projection probably high
SLSA 02 (Gas)	44,868	47,532	160	297	P	
SLSM 01 (Gas)	17,129	17,129	160	107	A	
SLSM 02 (Gas)	66,069	68,518	160	428	P	Projection low
UNDG 01 (Gas)	-	-	160	-	P	No distillate production
UNDG 02 (Gas)	-	-	160	-	-	No production data
UNDG 03 (Gas)	-	-	160	-	-	No production data
UNDG 04	1,116	1,116	40	28	A	

P: Producing

A: Abandoned

TABLE 18 - Fields: Pennsylvanian-Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre +	Status	Remarks
Antelope Ridge-Atoka (Gas)*	9,373,215	9,373,215	1	160	58,583	A	
Antelope Ridge-Morrow (Gas)*	24,505,325	-	2	320	(76,579)	P	Data inadequate
Arena Roja-Penn (Gas)	966,908	1,169,868	1	160	7,312	P	
Avalon, Mid-Morrow (Gas)	-	-	-	-	-		No production data
Bandana Point-Penn (Gas)	23,817	23,817	1	160	149	A	
Bell Lake-Penn (Gas)*	5,434,538	5,963,318	3	480	12,425	P	Projection slightly low
Berry-Morrow (Gas)*	267,074	267,074	1	160	1,669	A	
Big Eddy-Strawn*	6,678,946	7,162,316	4	160	44,764	P	Projection low
Black River-Penn(Gas)	173,280	-	1	160	(1083)	P	Data inadequate
Carlsbad, South-Atoka(Gas)	2,332,651	3,232,591	3	480	6,735	P	
Carlsbad, South-Morrow (Gas)	19,027,302	-	20	3200	(5946)	P	Data inadequate
Carlsbad, South-Strawn (Gas)	6,233,809	-	5	800	(7792)	P	Data inadequate
Carlsbad, Permo/Penn (Gas)	109,165	-	1	160	(682)	P	Data inadequate

TABLE 18 - Fields: Pennsylvanian-Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre †	Status	Remarks
Cass-Penn	2,396,672	2,410,672	6	240	10,044	P	Projection low
Cass Ranch-Morrow(Gas)	234,087	234,087	1	160	1,463	A	
Catclaw Draw-Morrow(Gas)	5,161,244	-	9	1440	(3584)	P	Data inadequate
Catclaw Draw-Strawn(Gas)	44,515	-	1	160	(278)	P	Data inadequate
Catclaw Draw, East-Strawn	-	-	-	-	-	-	No production data
Cedar Canyon-Morrow(Gas)*	149,570	-	1	160	(935)	P	Data inadequate
Cedar Hills-Upper Penn(Gas)	344,091	370,981	1	160	2,319	P	Projection low
Cemetary-Morrow(Gas)	1,413,997	1,537,537	2	320	4,805	P	Projection slightly low
Cinta Roja-Morrow(Gas)	5,352,119	-	1	160	(33,451)	P	Data inadequate
Crawford-Penn(Gas)	8,881,630	10,261,370	2	320	32,067	P	
Daggar Draw-Atoka (Gas)	101,177	101,177	1	160	632	A	
Daggar Draw-Morrow(Gas)	1,906,128	2,015,838	1	160	12,599	P	Projection probably low
Daggar Draw-Upper Penn	10,107	10,107	4	80	126	P	New wells completed in 1971. No gas production from new wells.

TABLE 18 - Fields: Pennsylvanian-Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre †	Status	Remarks
Daggar Draw-Strawn(Gas)	85,192	85,442	1	160	534	P	Probably nearly depleted
Dark Canyon-Penn(Gas)	8,250	8,250	1	160	52	A	
Dos Hermanos-Morrow(Gas)*	4,666,629	-	1	160	(29,166)	P	Data inadequate
Fenton Draw-Strawn	350	350	1	40	9	A	
Getty-Morrow (Gas)	536,028	536,028	1	160	3,350	A	
Golden Eagle-Morrow(Gas)	2,620,941	2,620,941	1	160	16,381	A	
Golden Lane-Morrow(Gas)*	172,482	-	1	160	(1078)	P	Data inadequate
Golden Lane-Strawn(Gas)*	3,751,794	9,178,364	3	480	19,122	P	Projection high
Grama Ridge-Morrow(Gas)*	18,464,154	18,915,754	5	800	23,645	P	Projection low
Hackberry, South-Strawn*	235,600	-	1	40	-	P	Data inadequate
Hackberry Hills-Canyon(Gas)	2,305,812	-	1	160	(14,411)	P	Data inadequate
Hackberry Hills, East Canyon(Gas)	312,453	342,763	1	160	2,142	P	Projection low

TABLE 18 - Fields: Pennsylvanian-Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. [illegible] †	Status	Remarks
Harkey Penn (Gas)	78,544	78,544	1	160	491	A	
Hat Mesa-Morrow(Gas)*	265,485	-	1	160	(1659)	P	Data inadequate
Huapache-Morrow(Gas)	12,433	12,433	1	160	78	A	
Indian Basin-Atoka(Gas)	-	-	-	-	-	-	No production data
Indian Basin-Morrow(Gas)	35,318,403	-	14	2240	(15,767)	P	Data inadequate
Indian Basin-Upper Penn(Gas)	418,049,289	919,389,289	56	8960	102,610	P	Projection may be high
Indian Hills, North Morrow(Gas)	803,846	803,846	3	480	1,675	A	
Indian Hills-Upper Penn(Gas)	-	-	-	-	-	-	No production data
Jal, West Strawn (Gas)	8,740,904	9,668,854	2	320	30,215	P	Projection low
Lea-Penn * (Gas)	28,063,287	32,999,337	15	2400	13,750	P	Projection slightly low
Los Medanos-Atoka(Gas)*	12,155,366	-	1	160	(75,971)	P	Projection high; not used
Lusk, West-Strawn*	38,748	38,748	1	40	969	A	

TABLE 18 - Fields: Pennsylvanian-Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre +	Status	Remarks
Lynch-Penn (Gas)*	287,423	287,423	1	160	1,796	A	
Maroon Cliffs-Morrow(Gas)*	570,225	-	1	160	(3564)	P	Data inadequate
McMillan-Morrow(Gas)	9,897,362	11,258,292	5	800	14,073	P	Projection low
Osudo-Strawn	5,503	5,503	1	140	138	A	
Osudo, North-Morrow(Gas)	17,159,241	18,031,601	5	800	22,540	P	Projection low
Osudo, South-Morrow(Gas)	4,656,528	5,574,308	2	320	17,420	P	Projection low
Osudo, West-Morrow(Gas)*	72,357	-	1	160	(452)	P	Data inadequate
Paduca-Morrow (Gas)*	27,906,093	29,574,053	3	480	61,613	P	
Poker Lake-Morrow(Gas)*	251,999	251,999	1	160	1,575	A	
Red Hills-Penn(Gas)*	219,874	219,874	1	160	1,374	A	
Rock Tank-Lower Morrow(Gas)	22,953,926	-	5	800	(28,692)	P	Data inadequate
Rock Tank-Upper Morrow(Gas)	2,664,785	-	2	320	(8327)	P	Projection high; not used
Salt Lake, South Atoka(Gas)*	4,126,566	4,807,036	2	320	15,022	P	

TABLE 18 - Fields: Pennsylvanian-Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre †	Status	Remarks
Salt Lake, South Morrow(Gas)*	5,718,293	6,810,303	2	320	21,282	P	Projection low
San Dunes-Atoka(Gas)*	9,168,943	10,343,683	1	160	64,648	P	Projection low
Sand Dunes-Lower Penn(Gas)*	86,569	-	1	160	(541)	P	Data inadequate
Sand Dunes-Morrow(Gas)*	-	-	-	-	-	-	No production data
Sand Dunes, South-Lower Penn(Gas)*	63,123	-	1	160	(395)	P	Data inadequate
Sand Dunes, West-Atoka(Gas)*	189,265	-	1	160	(1183)	P	Data inadequate
Scanlon-Strawn (Gas)	30,000	30,000	1	160	188	A	
Seven Rivers Hills-Morrow(Gas)	72,757	72,757	1	160	455	A	
Springs-Upper Penn(Gas)	16,664,966	17,109,936	4	640	26,734	P	Projection low
Teas-Penn * (Gas)	1,072,843	1,172,173	1	160	7,326	P	
Tower Hill-Morrow(Gas)*	137,516	137,516	1	160	859	A	
Washington Ranch-Morrow (Gas)	10,805,337	-	11	1760	(6139)	P	Data inadequate

TABLE 18 - Fields: Pennsylvanian-Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre †	Status	Remarks
Welch-Penn (Gas)	774,378	774,378	1	160	4,840	A	
White City-Penn(Gas)	12,496,631	10,150,525	3	320	31,720	P	Projection does not include 1971-72 production
Wilson-Penn (Gas)*	3,661,445	3,829,975	1	160	23,937	P	Projection slightly low
Wilson, South-Penn(Gas)*	118,120	118,120	1	160	738	A	

† Production per acre in parentheses based on production to January 1, 1973
*Study area fields
P: Producing
A: Abandoned

TABLE 19 - Wells: Pennsylvanian (Study Area) Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
BELP 01 (Gas)	2,526,145	2,612,815	160	16,330	P	
BELP 02 (Gas)	-	-	160	-	-	No production data
BELP 03 (Gas)	164,080	164,080	160	1,026	A	
BELP 04 (Gas)	1,442,818	2,202,708	160	13,767	P	Projection slightly low
BELP 05 (Gas)	-	-	160	-	-	No production data
BEST 01	941,163	941,163	40	23,529	A	
BEST 02	819,172	831,422	40	20,786	P	
BEST 03	-	-	40	-	-	No production data
BEST 04	3,175,794	5,143,974	40	128,599	P	Projection may be high
BEST 05	1,742,817	1,744,787	40	43,620	P	
LEAP 01 (Gas)	1,971,198	1,989,198	160	12,432	P	Projection low
LEAP 02 (Gas)	4,469,569	4,469,569	160	27,935	A	
LEAP 03 (Gas)	1,326,322	1,326,322	160	8,290	A	
LEAP 04 (Gas)	1,516,758	1,517,078	160	9,482	P	Projection low
LEAP 05 (Gas)	120,867	120,867	160	755	A	
LEAP 06 (Gas)	3,015,306	3,015,306	160	18,846	A	
LEAP 07 (Gas)	5,068,708	5,224,758	160	32,655	P	Projection low
LEAP 08 (Gas)	4,035,992	4,228,252	160	26,427	P	Projection low
LEAP 09 (Gas)	245,203	245,203	160	1,533	A	
LEAP 10 (Gas)	617,363	617,363	160	3,859	A	
LEAP 11 (Gas)	1,283,150	1,283,150	160	8,020	A	

TABLE 19 - Wells: Pennsylvanian (Study Area) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
LEAP 12 (Gas)	2,451,100	2,964,550	160	18,528	P	
LEAP 13 (Gas)	719,121	720,321	160	4,502	P	
LEAP 14 (Gas)	435,208	436,768	160	2,730	P	
LEAP 15 (Gas)	787,422	1,616,362	160	10,102	P	
PAMR 01 (Gas)	4,699,115	4,731,965	160	29,575	P	Projection low
PAMR 02 (Gas)	22,885,062	26,008,222	160	162,551	P	Projection low
PAMR 03 (Gas)	321,916	332,166	160	2,076	P	
SLSA 01 (Gas)	1,648,506	1,708,276	160	10,677	P	Projection low
SLSA 02 (Gas)	2,378,770	3,017,530	160	18,860	P	
SLSM 01 (Gas)	452,140	452,140	160	2,826	A	
SLSM 02 (Gas)	5,266,153	6,364,933	160	39,781	P	
UNDG 01 (Gas)	216,680	-	160	-	P	Data inadequate
UNDG 02 (Gas)	-	-	160	-	-	No production data
UNDG 03 (Gas)	-	-	160	-	-	No production data
UNDG 04	-	-	40	-	A	No gas production

P: Producing

A: Abandoned

TABLE 20 - Discovery Well Data: Pennsylvanian (Study Area)

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Antelope Ridge-Atoka (Gas)	Shell 4 Antelope Ridge	B4-24S-34E	12,212-12,341	30,000 MCF	–	FTP:3717
Antelope Ridge-Morrow (Gas)	Shell 1 Federal	B4-24S-34E	12,898-13,151	38,000 MCF 342 bd	48°	–
Bell Lake-Pennsylvanian (Gas)	Conoco 2 Bell Lake	N30-23S-34E	12,635-12,665	13,100 MCF 140 bd	56°	SITP:4455
Berry-Morrow (Gas)	Texaco 1 Berry	N7-21S-34E	13,908-13,986	1,220 MCF 34 bd	57°	TP:4900
Big Eddy-Strawn	Pan Am 1 Big Eddy	O19-20S-31E	11,402-11,468	579 bbls GOR:3139/1	50°	TP:3450
Cedar Canyon-Morrow (Gas)	Skelly 1 Cedar Canyon	P9-24S-29E	13,062-13,374	32,868 MCF	–	FSIP:4257
Dos Hermanos-Morrow (Gas)	Pan Am 1 Emperor	F28-20S-30E	12,242-12,391	13,600 MCF	–	FSIP:4953

TABLE 20 - Discovery Well Data: Pennsylvanian (Study Area) Cont.

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Golden Lane-Morrow (Gas)	Westbrook 1 Cowden	K4-21S-29E	12,614-12,622	9,750 MCF	—	TP:3582
Golden Lane-Strawn (Gas)	Pennzoil 1 Hudson	C4-21S-29E	11,098-11,102	16,300 MCF GOR:33,571/1	55°	SITP:4100
Grama Ridge-Morrow (Gas)	Shell 1 Federal GR	F4-22S-34E	12,886-13,111	4,900 MCF	—	FSIP:7597
Hackberry, South-Strawn	Champlin 33 Big Eddy	P4-20S-31E	11,461-11,496	80 bbls GOR:2535/1	49°	TP:135
Hat Mesa-Morrow (Gas)	Phillips 1 Hat Mesa	G11-21S-32E	13,656-14,100	7,514 MCF	—	FSIP:6825
Lea-Penn (Gas)	U. S. Smelting 1 Federal	F11-20S-34E	13,034-13,054	1,922 MCF GOR:10,682/1	54°	FSIP:6750
Los Medanos-Atoka (Gas)	Shell 1 James Ranch	O36-22S-30E	12,920-12,929	9,000 MCF 104 bd	36°	TP:6600
Lusk, West-Strawn	Pan Am 3 Big Eddy	P6-20S-31E	11,316-11,354	47 bbls	45°	TP:120
Lynch-Penn (Gas)	Hamon 1 NE Lynch	H17-20S-35E	13,659-13,774	3,850 MCF	—	TP:3626

TABLE 20 - Discovery Well Data: Pennsylvanian (Study Area) Cont.

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Maroon Cliffs Morrow (Gas)	Bass 7 Big Eddy	O19-20S-31E	12,656-12,948	3,800 MCF 32 bd	54°	TP:2431
Osudo, West-Morrow (Gas)	Amer. Trad. 2 SE Lea	L25-20S-35E	12,856-13,033	42 MCF 2 bd	51°	FSIP:6021
Paduca-Morrow (Gas)	Texaco 65 Cotton Draw	G2-25S-31E	14,787-14,867	21,230 MCF	–	TP:6200
Poker Lake-Morrow (Gas)	Pan Am 36 Poker Lake	P28-24S-31E	14,950-15,010	2,200 MCF	–	TP:6358
Red Hills-Penn (Gas)	Pure 1 Red Hills Unit	O32-25S-33E	14,607-14,864	26,500 MCF	–	–
Salt Lake, South Atoka (Gas)	Texas 1 Richards	P25-20S-32E	12,909-12,916	1,794 MCF 48 bd	–	TP:1681
Salt Lake, South Morrow (Gas)	Texaco 1 State CH	H36-20S-32E	13,242-13,307	3,526 MCF 115 bd	53°	TP:500
Sand Dunes-Atoka (Gas)	Texas Amer. 1 Todd	G26-23S-31E	13,679-13,907	75,000 MCF	–	TP:7778
Sand Dunes-Lower Penn (Gas)	Texas Amer. 1-14 Todd	K14-23S-31E	14,051-14,076	6,700 MCF	–	TP:4320
Sand Dunes-Morrow (Gas)	Texas Amer. 1-36 Todd	F36-23S-31E	14,862-14,898	2,500 MCF	–	FSIP:7700

TABLE 20 - Discovery Well Data: Pennsylvanian (Study Area) Cont.

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Sand Dunes, So. - Lower Penn (Gas)	EPNG 1 Sundance	F4-24S-31E	13,691-14,379	3,376 MCF	—	FSIP:8640
Sand Dunes, West-Atoka (Gas)	EPNG 1 Arco	K16-23S-31E	13,880-13,890	3,826 MCF	—	FSIP:9121
Teas-Penn (Gas)	Sinclair 1 Mahaffey	C14-20S-33E	13,294-13,543	3,628 MCF GOR:30,167/1	—	TP:4403
Tower Hill-Morrow (Gas)	Cities Service 17 Big Eddy	B2-21S-29E	12,696-12,800	9,000 MCF 180 bd	—	—
Wilson-Penn (Gas)	Pure 1 Wilson	F13-21S-34E	?	20,200 MCF	—	—
Wilson, South-Penn (Gas)	Sinclair 1 South Wilson	L23-21S-34E	12,642-12,895	2,560 MCF 67 bd	54°	SITP:4567
Undesignated (Gas)	Belco 3 James Ranch	J1-23S-30E	13,862-14,266	6,500 MCF	—	—

In evaluating reserve projections from completed wells in Pennsylvanian gas fields the estimated recovery given in this report is considered low for 16 fields, and approximately correct for seven fields. Fields where the projection was considered to be unreasonably high were included with fields where data was inadequate to make a projection, and production figures are therefore limited to recovery as of January 1, 1973.

Discovery wells for Pennsylvanian fields within the Study area are listed in Table 2[illegible]. Producing depths range from 11,098 feet at the Golden Lane-Strawn field along the northern edge of the Delaware basin to over 15,000 feet at the Poker Lake-Morrow field in the central part of the Delaware basin in New Mexico. The average net pay thickness is 149 feet. Initial potential for discovery and development wells averages 10,036 MCF per day. The highest reported I.P. was 75,000 MCF for the discovery well of the Sand Dunes-Atoka field. This well, completed near the end of 1969, has already produced over 9,000,000 MCF of gas and estimated recovery is 10,343,683 MCF. The average gravity of distillate, based on 18 discovery and development wells, is 53° A.P.I.; for oil wells the average gravity is 48° A.P.I. Reported pressures are difficult to evaluate; times vary for final shut-in pressures, and only for recent completions are four-point pressure tests given. Shut-in pressures for gas discovery wells averages 6,874 psi.

Wolfcamp Formation

There are five designated Wolfcamp fields within the Study area: Big Eddy (gas), Southeast Lea (gas), Paduca (gas), Red Hills (gas) and

Remuda. Of these only the Big Eddy field is no longer in production. The Cabin Lake-Strawn field was completed in the Wolfcamp as defined in this report. Projections presented in Table 21 are based on per acre recovery of these six fields. An additional nine fields outside the Study area were evaluated to arrive at a per acre yield for this interval.

Of the 15 fields examined six have been abandoned involving a total of six wells. Although data from abandoned fields and wells represents the nearest approach to an absolute yield per acre, exploration of Wolfcamp rocks, particularly in the Delaware basin, is fairly recent and most abandoned wells were of marginal productive capacity. The production history, even of the shallow pay zones in the Delaware Mountain Group, is too short for most abandoned wells to be of value in analyzing producing potential of any interval. The one abandoned oil field in the Wolfcamp recovered 79 barrels per acre. By comparison the five still producing oil fields have averaged 1,169 barrels per acre based on production to January 1, 1973. Recovery from the five abandoned gas fields averaged 426 MCF per acre and 23,842 MCF had been recovered from the three fields producing at the end of 1972. Although abandoned wells are not representative of producing capacity for an interval, their inclusion is still necessary in calculating the average producing capacity.

Reserve projections for most of the oil and gas recovery as shown in Tables 22 to 25 appears to be fairly reliable although some projections, as indicated, are considered low. As an example per acre recovery of the Southeast Lea field appears to be low at 5,688 MCF. Studies of the two wells (Table 25) indicate a still lower recovery of 4,704 MCF per acre. Expected oil recovery for the Remuda and Cabin Lake fields may be slightly high but projections could not be improved because of fairly uniform production for the past several years. Peak gas production at Red Hills field occurred in 1971 and there appears to be no way to obtain a reliable field projection by the method used in this report. Up to January 1, 1973 recovery amounted to 48,798 MCF per acre. Evaluating production for the two wells in this field indicates a projected recovery of 69,216 MCF per acre for well REDHI1 and 41,154 MCF up to January 1, 1973 for well REDHI2. The two Red Hills wells are located on adjacent 40 acre tracts but six sections have been dedicated to this field. Recovery estimates are based on 160 acre spacing but it would appear that a much larger area is being drained.

Some fields where estimated reserves may appear low in the tables include the Dogie, Osudo, and Winchester oil fields, and the Paduca gas field. Examination of yearly production figures, particularly for the last few years, indicates that these reservoirs are approaching depletion under present circumstances, and at least insofar as current producing wells are concerned.

Average yields per acre of gas and associated gas to January 1, 1973 and for projected reserves are higher in the Study area than for the larger evaluation area. Total projected gas yields for the Study area are 19,812 MCF per acre compared with 11,676 MCF for all Wolfcamp fields. Estimated crude oil and distillate recovery for the Study area is 1,062 barrels per acre, somewhat higher than the regional estimate of 723 barrels. Up to January 1, 1973 the average production per well for the region amounted to 1,877,797 MCF of gas and 79,701 barrels of distillate for gas wells, and 41,925 barrels of oil and 263,379 MCF of associated gas for oil wells. Projected the per well recovery for the region is: gas wells - 1,941,464 MCF and 99,230 barrels; oil wells - 47,174 barrels and 385,678 MCF. In the Study area production per well to January 1, 1973 has been: Gas wells--3,093,633 MCF and 130,205 barrels; oil wells--42,489 barrels and 492,000 MCF. Projected well recovery is estimated to be: natural gas--3,199,745 MCF; distillate--162,754 barrels; oil--63,983 barrels; and associated gas--702,979 MCF.

Data covering the important details of discovery wells within the Study area are given in Table 26. Offset efforts of these discovery wells are limited to the Red Hills and Southeast Lea gas fields. The second Red Hills well located in sec. 5, T. 26 S., R. 33 E. had an initial potential (I.P.) of 13,600 MCF of dry gas per day. The offset to the Southeast Lea discovery well had an I.P. of 1,090 MCF of gas plus 30 barrels of 55° A.P.I. distillate. Depth to top of pay in the Wolfcamp ranges from 10,690 to 13,440 feet and average net pay thickness is 77 feet based on the discovery wells. A final shut-in pressure of 6,616 psi at 11,400 feet was given for the Southeast Lea discovery well. Average I.P. for gas wells is 12,842 MCF per day.

TABLE 21 – Production summary: Wolfcamp Formation

Interval	Study Area					Regional Area (includes study area)				
Wolfcamp/Abo	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre
Gas (MCF)	960	18,561,798	19,335	19,198,468	19,998	1,600	18,777,968	11,736	19,414,638	12,134
Associated Gas (MCF)	80	983,999	12,300	1,405,957	17,574	360	2,370,413	6,584	3,471,104	9,642
Total Gas (MCF)	1,040	19,545,797	18,794	20,604,425	19,812	1,960	21,148,381	10,790	22,885,742	11,676
Oil (bbls)	80	84,977	1,062	127,966	1,600	360	377,323	1,048	424,570	1,179
Distillate	960	781,228	814	976,526	1,017	1,600	797,006	498	992,304	620
Total Oil (bbls)	1,040	866,205	833	1,104,492	1,062	1,960	1,174,329	599	1,416,874	723

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Big Eddy* Wolfcamp (Gas)	3,518	3,518	1	160	22	A	
Cabin Lake "Strawn"*	[illegible]0,357	89,859	1	40	2,246	P	Projection may be high
Cedar Hills - Wolfcamp (Gas)	12,045	12,045	1	160	75	A	
Dagger Draw - Wolfcamp (Gas)	225	225	1	160	1	A	
Dogie Draw - Wolfcamp	39,998	43,626	1	40	1,091	P	
Lea, Southeast - Wolfcamp (Gas)*	236,891	293,395	2	320	917	P	
McMillan - Wolfcamp	3,143	3,143	1	40	79	A	
Osudo - Wolfcamp	161,921	162,092	4	160	1,013	P	
Osudo, South Wolfcamp (Gas)	173	173	1	160	1	A	
Paduca Wolfcamp (Gas)*	8,073	8,293	1	160	52	P	

TABLE 22 - Fields: Wolfcamp - Oil Production (con't)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Red Hills - Wolfcamp (Gas)*	532,746	671,320	2	320	2,098	P	
Remuda - Wolfcamp*	24,620	38,107	1	40	953	P	
Rocky Arroyo - Wolfcamp (Gas)	-	-	-	-	-	-	No production data
Wilson - Wolfcamp (Gas)	3,335	3,335	1	160	21	A	
Winchester - Wolfcamp	87,284	87,743	1	40	2,194	P	

*Study area fields P: Producing A: Abandoned

TABLE 23 - Wells: Wolfcamp (Study Area) Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
LEAS 01 (Gas)	226,216	282,721	160	1,767	P	
LEAS 02 (Gas)	10,573	12,276	160	77	P	
REDHI 1 (Gas)	346,967	383,068	160	2,394	P	
REDHI 2 (Gas)	185,779	250,068	160	1,563	P	

P: Producing

TABLE 24 - Fields: Wolfcamp - Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Big Eddy - Wolfcamp (Gas)*	124,605	124,605	1	160	779	A	
Cabin Lake - "Strawn"*	819,710	1,194,180	1	40	29,855	P	
Cedar Hills - Wolfcamp (Gas)	149,867	149,867	1	160	937	A	
Daggar Draw Wolfcamp (Gas)	45,452	45,452	1	160	284	A	
Dogie Draw - Wolfcamp	364,222	422,432	1	40	10,561	P	
Lea, Southeast Wolfcamp (Gas)*	1,351,792	1,820,062	2	320	5,688	P	
McMillan - Wolfcamp			1	40		A	No gas production
Osudo - Wolfcamp	530,808	531,321	4	160	3,321	P	
Osudo, South - Wolfcamp (Gas)	1,694	1,694	1	160	11	A	

TABLE [illegible] - Fields: Wolfcamp - Gas Production (con't)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Paduca - Wolfcamp (Gas)*	1,469,979	1,638,379	1	160	10,240	P	
Red Hills - Wolfcamp (Gas)*	15,615,422		2	320		P	Date inadequate
Remuda - Wolfcamp*	164,289	211,777	1	40	5,294	P	
Rocky Arroyo - Wolfcamp (Gas)							No production data
Wilson - Wolfcamp (Gas)	19,157	19,157	1	160	120	A	
Winchester - Wolfcamp	491,384	1,111,394	1	40	27,785	P	

*Study area fields   P: Producing   A: Abandoned

TABLE 25 - Wells: Wolfcamp (Study Area) Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
LEAS 01 (Gas)	1,216,681	1,356,481	160	8,478	P	
LEAS 02 (Gas)	135,111	148,708	160	929	P	
REDHI 1 (Gas)	9,030,763	11,074,493	160	69,216	P	
REDHI 2 (Gas)	6,584,659		160		P	Data inadequate

P: Producing

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Big Eddy (Gas)	Pan American 1 Big Eddy Unit	P3-20S-31E	10,690-10,710	10,500 MCF	65 D	2167:T
Cabin Lake "Strawn"	Phillips 1A James	O2-22S-30E	12,155-12,167	288 bbls	52	2100-2600:T
Lea, Southeast (Gas)	American Trading 1 NM State "26"	J26-20S-35E	11,400-11,470	15,557 MCF	—	6616:FSIP
Paduca (Gas)	Texaco 65 Cotton Draw Unit	G2-25S-31E	12,785-12,851	9592 MCF	—	—
Remuda	Texaco 1 Remuda Basin Unit	J24-23S-29E	11,111-11,180	72 bbls	47	50-100:T
Red Hills (Gas)	Pure 1 Red Hills Unit	O32-25S-33E	13,440-13,667	15,750 MCF	—	3125:T

Bone Springs Formation

Similar to the study of the Delaware Mountain Group all Bone Springs fields have been analyzed for this report. Involved are 23 oil fields, having 65 completed wells occurring as far north as T. 17 S. Production records could not be found for the Black River gas field listed in Table 28. Most of the oil and gas recovered from the Bone Springs thus far has been discovered on the shelf north of the Delaware basin and along the east flank of this basin. There are seven fields within the Study area and with the exception of the Lea field all consist of only one well. In addition to covering all of the Bone Springs fields analyses were made of 37 wells from multi-well fields.

Fifteen of the Bone Springs fields, including three in the Study area, have been abandoned (Tables 28 and 30). The average per acre yield for these abandoned fields amounts to 410 barrels of oil and 395 MCF of associated gas, and the average per well yields are 16,380 barrels of oil and 15,784 MCF of gas.

Yields per acre based on field analyses indicate a productive capacity for the Bone Springs ranging from 19 barrels of oil and 27 MCF of associated gas to 8,083 barrels of oil and 7,903 MCF of gas. The low yields are from abandoned one well fields. Analyses of individual wells indicates a high yield per acre of 19,237 barrels of oil from a well in the Scharb field,and 18,220 MCF of gas from an abandoned well in the Lea field (Tables 29 and 31).

For all Bone Springs fields, production to January 1, 1973 averaged 3,228 barrels of oil and 2,845 MCF of gas per acre. Projected the average primary recovery should amount to 4,338 barrels of oil and 3,622 MCF of gas per acre (Table 27). Within the Study area, 5,129 MCF of gas and 2,503 barrels of oil were recovered per acre up to January 1, 1973 and expected recovery is at least 5,394 of gas and 2,755 barrels of oil. Expected oil recovery is therefore considerably lower for the Study area and gas recovery quite a bit higher. Projected production per well averages 173,517 barrels of oil and 145,041 MCF of gas for all Bone Springs wells, and 110,213 barrels of oil and 215,762 MCF of gas per well in the Study area.

Fields for which projections are questionable are Big Eddy and Teas that may be somewhat high, and the Lea field where the projection is low. Eight wells were used in projecting per acre recovery for the Lea field. Nine additional wells have been completed in this field in the last three years but production has been too erratic to establish a reliable decline curve. Of the eight wells used seven have been abandoned after producing from four to ten years. Thus the per acre yield based on well analysis is essentially the same as the field analysis. Yields per acre of the nine wells completed since 1970 have already slightly exceeded the per acre yield determined for the older wells.

Well analyses for the four wells in the Quail Ridge field indicate a recovery of 6,893 barrels of oil and 5.168 MCF of gas per acre. The potential oil yield is considerably lower than that obtained by the field

TABLE 27 – Production summary: Bone Springs Formation

Interval	Study Area					Regional Area (includes study area)				
Bone Springs	Producing Acres	Production to 1/1/73 *	Average Yield Per Acre to 1/1/73	Projected Production *	Projected Yield Per Acre	Producing Acres	Production to 1/1/73 *	Average Yield Per Acre to 1/1/73	Projected Production *	Projected Yield Per Acre
Gas (MCF)	–	–	–	–	–	–	–	–	–	–
Associated Gas (MCF)	560	2,872,115	5,129	3,020,661	5,394	2,240	6,373,457	2,845	8,112,285	3,622
Total Gas (MCF)	–	–	–	–	–	–	–	–	–	–
Oil (bbls)	560	1,401,517	2,503	1,542,977	2755	2,240	7,230,977	3,228	9,716,954	4,338
Distillate (bbls)	–	–	–	–	–	–	–	–	–	–
Total Oil (bbls)	–	–	–	–	–	–	–	–	–	–

* Does not include 1972 production for new well in Bell Lake field or 1970-1972 production for new wells in Lea field.

TABLE 28 - Fields: Bone Springs - Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Bell Lake*	167,320	195,687	1	40	4892	P	
Bell Lake, North*	778	778	1	40	19	A	
Big Eddy*	12,430	46,393	1	40	1160	P	Projection may be high
Black River (Gas)	-	-	-	-	-	-	No production data
Buffalo	7,717	7,717	1	40	193	A	
Greenwood	12,218	12,218	1	40	305	A	
Grama Ridge*	17,053	17,053	1	40	426	A	
Lea*	2,080,111	1,088,972	17	320	3403	P	Projection low: based on 8 of 17 wells to 1970
Lea, South*	14,476	14,476	1	40	362	A	
Lusk	14,069	14,069	1	40	352	A	
Midway	8,194	8,194	1	40	205	A	
Osudo, Lower	978	978	1	40	24	A	
Osudo, Upper	7,282	7,282	1	40	182	A	
Palmillo	2,481	2,481	1	40	62	A	
Pearl	4,235	4,235	1	40	106	A	
Quail Ridge	973,405	1,282,938	4	160	8018	P	
Querecho Plains	40,524	40,524	1	40	1013	A	
Reeves	1,010	1,010	1	40	25	A	

TABLE 28 - Fields: Bone Springs - Oil Production (con't)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Scharb	4,453,599	6,466,609	20	800	8083	P	
Shugart	103,357	103,357	1	40	2584	A	
Teas*	101,064	179,618	1	40	4490	P	Projection may be slightly high
Vacuum, S.	178,671	199,296	5	200	996	P	
Wilson	10,389	11,738	1	40	293	P	
Young	11,331	11,331	1	40	283	A	

* Study area fields   P: Producing   A: Abandoned

TABLE 29 - Wells: Bone Springs (Study area) Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
LEAB 01	240,540	240,540	40	6,015	A	
LEAB 02	220,905	220,905	40	5,523	A	
LEAB 03	233,090	233,090	40	5,827	A	
LEAB 04	78,515	78,515	40	1,963	A	
LEAB 05	86,942	86,942	40	2,174	A	
LEAB 06	176,487	176,487	40	4,412	A	
LEAB 07	27,826	31,684	40	792	P	
LEAB 08	31,906	31,906	40	798	A	
QRBS 01	460,680	509,960	40	12,749	P	
QRBS 02	391,575	485,991	40	12,150	P	
QRBS 03	83,807	105,574	40	2,639	P	
QRBS 04	1,343	1,343	40	34	A	
SRBS 01	141,431	155,895	40	3,897	P	
SRBS 02	510,337	603,469	40	15,087	P	
SRBS 03	450,682	490,802	40	12,270	P	
SRBS 04	466,613	536,657	40	13,416	P	
SRBS 05	340,872	363,951	40	9,099	P	
SRBS 06	9,179	9,179	40	229	A	
SRBS 07	459,796	488,617	40	12,215	P	Projection low
SRBS 08	174,764	233,864	40	5,847	P	

TABLE 29 - Wells: Bone Springs - Oil (con't)

Field/Wells	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
SRBS 09	71,890	80,556	40	2,014	P	Projection may be low
SRBS 10	153,838	158,261	40	3,957	P	Projection may be low
SRBS 11	19,975	22,638	40	566	P	Projection low
SRBS 12	703,167	769,461	40	19,237	P	Projection low
SRBS 13	475,726	-	40	-	P	Data inadequate
SRBS 14	31,125	31,125	40	778	A	
SRBS 15	34,652	42,240	40	1,056	P	Projection low
SRBS 16	2,584	2,584	40	65	A	
SRBS 17	167,474	291,832	40	7,296	P	
SRBS 18	117,921	124,998	40	3,125	P	Projection low
SRBS 19	40,493	60,873	40	1,522	P	
SRBS 20	40,990	47,384	40	1,185	P	Projection probably low
SVBS 01	78,781	78,781	40	1,970	A	
SVBS 02	55,372	-	40	-	P	Data inadequate
SVBS 03	6,146	6,146	40	154	A	
SVBS 04	2,142	2,142	40	54	A	
SVBS 05	35,750	35,750	40	894	A	

P: Producing A: Abandoned

TABLE 30 - Fields: Bone Springs - Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Bell Lake*	204,477	239,854	1	40	5996	P	
Bell Lake, North*	1,712	1,712	1	40	43	A	
Big Eddy*	10,672	12,493	1	40	312	P	Projection may be low
Black River (Gas)	-	-	-	-	-	-	No production data
Buffalo	4,197	4,197	1	40	105	A	
Grama Ridge*	13,883	13,883	1	40	347	A	
Greenwood	10,787	10,787	1	40	270	A	
Lea*	4,030,569	2,528,922	17	320	7903	P	Projection based on 8 of 17 wells to 1970
Lea, South*	11,670	11,670	1	40	292	A	
Lusk	-	-	1	40	-	A	No gas production
Midway	1,591	1,591	1	40	40	A	
Osudo, Lower	1,082	1,082	1	40	27	A	
Osudo, Upper	3,175	3,175	1	40	79	A	
Palmillo	-	-	1	40	-	A	No gas production
Pearl	4,532	4,532	1	40	113	A	
Quail Ridge	686,686	-	4	160	-	P	Data inadequate
Querecho Plains	45,113	45,113	1	40	1128	A	

TABLE 30 - Bone Springs - Gas (con't)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Reeves	-	-	1	40	-	A	No gas production
Scharb	2,421,221	4,712,394	20	800	5890	P	
Shugart	80,563	80,563	1	40	2014	A	
Teas*	178,426	212,127	1	40	5303	P	
Vacuum, South	166,863	169,739	5	200	849	P	
Wilson	17,081	-	1	40	-	P	Data inadequate
Young	58,451	58,451	1	40	1461	A	

* Study area fields P: Producing A: Abandoned

TABLE 31 - Wells: Bone Springs (Study area) · Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
LEAB 01	336,629	336,629	40	8,416	A	
LEAB 02	344,170	344,170	40	8,604	A	
LEAB 03	417,733	417,733	40	10,443	A	
LEAB 04	66,871	66,871	40	1,672	A	
LEAB 05	728,809	728,809	40	18,220	A	
LEAB 06	219,971	219,971	40	5,499	A	
LEAB 07	89,913	90,836	40	2,271	P	
LEAB 08	209,487	209,487	40	5,237	A	
QRBS 01	288,812	324,455	40	8,111	P	
QRBS 02	289,483	391,184	40	9,780	P	
QRBS 03	107,963	111,174	40	2,779	P	Projection low
SRBS 01	74,458	80,071	40	2,002	P	
SRBS 02	323,525	359,958	40	8,999	P	
SRBS 03	204,382	275,797	40	6,895	P	
SRBS 04	266,640	307,316	40	7,683	P	
SRBS 05	216,694	362,357	40	9,059	P	
SRBS 06	178	178	40	4	A	
SRBS 07	224,561	258,753	40	6,469	P	
SRBS 08	102,221	182,113	40	4,553	P	Projection high

TABLE 31 - Wells: Bone Springs (Study area) Gas Production (con't)

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
SRBS 09	70,209	125,274	40	3,132	P	
SRBS 10	63,623	75,239	40	1,881	P	
SRBS 11	3,850	3,850	40	96	P	No gas production after 1966
SRBS 12	350,260	379,078	40	9,477	P	Projection low
SRBS 13	266,471				P	Data inadequate
SRBS 14	39,909	39,909	40	998	A	
SRBS 15	27,774	34,363	40	859	P	
SRBS 16	5,665	5,665	40	142	A	
SRBS 17	99,248	200,420	40	5,011	P	
SRBS 18	40,717	40,717	40	1,018	P	Projection low
SRBS 19	30,895	41,682	40	1,042	P	Projection probably low
SRBS 20	19,942	22,032	40	551	P	Projection low
SVBS 01	75,494	75,494	40	1,887	A	
SVBS 02	77,033	96,417	40	2,410	P	Projection slightly high
SVBS 03	1,552	1,552	40	39	A	
SVBS 04	1,815	1,815	40	45	A	
SVBS 05	10,989	10,989	40	275	A	

P: Producing A: Abandoned

TABLE 32 - Discovery Well Data: Bone Springs

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Bell Lake	Conoco 3 Bell Lake	C6-24S-34E	8,670-8,817	53 bbls GOR:1049	40	—
Bell Lake, North	Conoco 9 Bell Lake	K18-23S-34E	8,542-8,697	6 bbls	—	—
Big Eddy	Pennzoil 12 Big Eddy	D21-20S-31E	8,565-8,602	20 bbls GOR:1600	41	TP:50
Buffalo	Pan Amer. 1 Whelan	F3-19S-33E	10,314-10,328	38 bbls GOR:176	33	—
Grama Ridge	Shell 2 South Wilson	J33-21S-34E	10,675-10,711	285 bbls GOR:650	43	TP:450
Greenwood	Pan Amer. 7 Greenwood	H12-19S-31E	8,616-8,668	183 bbls GOR:787	41	TP:950
Lea	Ohio 1 Lea	L12-20S-34E	9,480-9,550	214 bbls GOR:1677	42	TP:100
Lea, South	Shell 1 Federal	F25-20S-34E	10,064-10,074	208 bbls GOR:965	37	TP:475
Lusk	E.P.N.G. 1 Lusk	A19-19S-32E	8,759-8,777	141 bbls GOR:1342	39	—
Midway	Sunray 1 State	H13-17S-36E	9,352-9,372	194 bbls GOR:940	34	TP:550

TABLE 32 - Discovery Well Data: Bone Springs (Cont.)

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Osudo, Lower	Brit. Amer. 1 North Wilson	O31-20S-36E	10,094-10,122	64 bbls GOR:1255	33	—
Osudo, Upper	Brit. Amer. 1 North Wilson	O31-20S-36E	7,888-7,901	238 bbls GOR:268	26	—
Palmillo	Redfern 1 Marathon	M36-18S-28E	6,422-6,428	132 bbls	—	TP:250
Pearl	Shell 1 Hooper	G27-19S-35E	8,198-8,272	120 bbls GOR:840	38	TP:50
Qual Ridge	E.P.N.G. 1 Mescalero Ridge	P21-19S-34E	10,118-10,134	933 bbls GOR:677	39	TP:563
Querecho Plains	Shell 2 Querecho Plains	N27-18S-32E	8,538-8,560	193 bbls GOR:780	39	TP:250
Reeves	Superior 1 McAlpin	F23-18S-35E	9,980-9,993	182 bbls GOR:760	42	TP:20
Scharb	Ohio 1 State	L6-19S-35E	?	?	?	?
Shugart	Pan Am. 3 Greenwood	H27-18S-31E	8,135-8,185	238 bbls GOR:755	41	TP:500
Teas	Sinclair 1 Mahaffey	C14-20S-33E	9,408-9,457	147 bbls GOR:1225	38	TP:200

TABLE 32 - Discovery Well Data: Bone Springs (Cont.)

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Vacuum, South	Sinclair 1 Lea	D22-18S-35E	8,504-8,514	478 bbls GOR:967	34	TP:100
Wilson	Leonard 1 East Wilson	K19-21S-35E	9,410-9,416	59 bbls GOR:1000	37	TP:100
Young	Internation 1 Linam	I21-18S-32E	8,708-8,716	213 bbls GOR:1222	37	TP:350

analysis. Data was not adequate to project a field analysis for gas. Of the 20 wells completed in the Scharb field all but three are still producing. Projections based on wells indicate an average per acre recovery of 6,238 barrels of oil and 3,827 MCF of gas. These estimates are well below the field projections on which the recovery figures are based in Table 27. Utilizing data obtained by well analyses the estimated per acre recovery for all Bone Springs completions is 3,589 barrels of oil and 3,261 MCF of associated gas compared with the field projections of 4,338 barrels of oil and 3,622 MCF of gas.

Bone Springs discovery wells are listed in Table 32. Data was not available for the discovery well of the Scharb field. Based on the other 19 wells in this field the average producing interval is from 10,109 to 10,174 feet in depth and average oil gravity is 38° A.P.I. Producing depths for the Bone Springs ranges from 6,422 feet for top of pay in the Palmillo field to 10,804 feet for bottom of pay zone for a well in the Scharb field. The Bone Springs Formation is quite thick and several pay zones have been discovered. Therefore depths do not necessarily reflect structural configuration. The average initial potential is 216 barrels of oil per day with an average gravity of 39° A.P.I. and an average pay interval of 39 feet.

Delaware Mountain Group (Pre-Ramsey)

There have been no successful completions in the Bell Canyon Formation below the Ramsey interval. Oil production has been obtained at 17 areas (Tables 34 and 36), designated as fields, from the Cherry

Canyon and Brushy Canyon formations; seven of these fields are within the Study area. Post-discovery development is limited as evidenced by the fact that there were as of January 1, 1973 only 29 producing wells completed in the 17 fields. Unsuccessful attempts at lateral extension of production is discussed in the section on exploration status.

Of the 17 fields, nine have been abandoned involving a total of 13 wells. Production from these wells amounted to 148,094 barrels of oil for an average yield per acre of 285 barrels and an average yield per well of 11,392 barrels. Data was not adequate to project production for the San Dunes field discovered in 1970. Production up to January 1, 1973 from two wells has amounted to 59,078 barrels for a yield per acre of 738 barrels and per well of 29,539 barrels. For the remaining seven fields with 14 wells the projected potential indicates a yield of 2,364 barrels per acre and 94,543 barrels per well. When all wells are taken into consideration the expected yield for this part of the Delaware Mountain Group is 1,320 barrels per acre (Table 33), and 52,785 barrels per well. Total primary recovery estimates are slightly higher for fields within the Study area. Four of these fields, all having one well, have been abandoned with total production of 107,429 barrels for a yield of 671 barrels per acre and 26,857 barrels per well. The two fields for which production was projected indicate a yield of 2,651 barrels per acre and 106,038 barrels per well. Projection for the Parallel field may be slightly high. However, the two producing wells in this field are not draining the same reservoir. Log interpretation indicates one is producing from the Cherry Canyon Formation and the other from the Brushy Canyon Formation. For the nine wells completed in the Study area average yields are estimated at 1,346 barrels per acre and 53,847 barrels per well.

Data concerning oil production for individual wells from multi-well fields are given in Table 35. Based on production estimates a well from the Shugart field, the largest of the pre-Ramsey fields, should produce 6,584 barrels per acre. This estimate appears to be low inasmuch as production up to January 1, 1973 has amounted to 232,221 barrels for a yield of 5,806 barrels per acre. Using projected recoveries for individual wells the yield per acre is only slightly lower than that based on the field analyses.

Based on field projections gas production from this part of the Delaware Mountain Group, indicates a recovery of 834 MCF per acre based on 40 acre spacing (Table 36), and 33,345 MCF per well. This includes eight wells for which there has been no reported gas production. If only currently producing wells are considered the primary recovery estimate averages 1,674 MCF per acre and 66,949 MCF per well. Projected recovery for the nine wells (seven fields) in the Study area is lower at 509 MCF per acre and 20,358 MCF per well. Eliminating the three abandoned wells, the well without reported gas production, and the two wells that could not be projected, recovery estimates are 800 MCF per acre and 32,005 MCF per well. Based on well analyses, (Table 37), the highest yield per acre 6,467 MCF is from the same well

TABLE 33 – Production summary: Delaware Mountain Group; Pre-Ramsey

Interval	Study Area					Regional Area (includes study area)				
Delaware Mountain Group (Pre-Ramsey)	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre	Producing Acres	Production to 1/1/73	Average Yield Per Acre to 1/1/73	Projected Production	Projected Yield Per Acre
Gas (MCF)	–	–	–	–	–	–	–	–	–	–
Associated Gas (MCF)	360	175,089	486	183,222	509	1,160	810,037	698	967,018	834
Total Gas (MCF)	–	–	–	–	–	–	–	–	–	–
Oil (bbls)	360	363,793	1,011	484,620	1,346	1,160	1,277,757	1,102	1,530,771	1,320
Distillate (bbls)	–	–	–	–	–	–	–	–	–	–
Total Oil (bbls)	–	–	–	–	–	–	–	–	–	–

TABLE 34 - Fields: Delaware Mountain Group (Pre-Ramsey) Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Big Eddy*	32,411	56,625	1	40	1416	P	
Burton	2,192	2,192	1	40	55	A	
Carlsbad	23,682	23,682	2	80	296	A	
Corbin	356	356	1	40	9	A	
Cotton Draw*	31,561	31,561	1	40	789	A	
Jal, West	20,501	27,495	1	40	687	P	
Lusk	109,231	146,962	3	120	1225	P	Projection low
Maroon Cliffs*	26,336	26,336	1	40	658	A	
Parallel*	164,875	261,488	2	80	3269	P	Projection may be high
Quahada Ridge*	24,939	24,939	1	40	623	A	
Querecho Plains	20,728	21,813	1	40	545	P	
Revelation	13,000	14,688	1	40	367	P	Projection low
Sand Dunes*	59,078	-	2	80	-	P	Data inadequate
Santo Nino	9,705	9,705	3	120	81	A	
Scanlon	4,730	4,730	2	80	59	A	
Shugart	709,839	794,528	5	200	3973	P	
U. S.*	24,593	24,593	1	40	615	A	

* Study Area Fields P: Producing A: Abandoned

TABLE 35 - Wells: Delaware Mountain Group (Pre-Ramsey) Oil Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
LUSK01	81,176	-	40	-	P	Projection too high; not used
LUSK02	24,974	25,212	40	630	P	Projection low
LUSK03	2,884	2,884	40	72	A	
PARAL1	88,589	-	40	-	P	Projection too high; not used
PARAL2	76,086	77,283	40	1932	P	Projection low
SADU01	48,380	137,645	40	3441	P	
SADU02	-	-	40	-	-	No production data
SADU03	10,698	-	40	-	P	Data inadequate
SANT01	7,270	7,270	40	182	A	
SANT02	764	764	40	19	A	
SANT03	1,671	1,671	40	42	A	
SHUGA1	218,407	238,636	40	5966	P	
SHUGA2	102,469	135,680	40	3392	P	
SHUGA3	20,477	20,477	40	512	A	
SHUGA4	232,221	263,365	40	6584	P	Projection probably low
SHUGA5	136,265	142,146	40	3554	P	Projection low

P: Producing A: Abandoned

TABLE 36 - Fields: Delaware Mountain Group (Pre-Ramsey) Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Big Eddy*	3,167	3,167	1	40	79	P	No gas production in 1973
Burton	-	-	1	40	-	A	No gas production
Carlsbad	-	-	2	80	-	A	No gas production
Corbin	-	-	1	40	-	A	No gas production
Cotton Draw*	32,770	32,770	1	40	819	A	
Jal, West	9,476	-	1	40	-	P	Data inadequate
Lusk	122,741	155,737	3	120	1298	P	Projection low
Maroon Cliffs*	-	-	1	40	-	A	No gas production
Parallel*	84,715	92,848	2	80	1161	P	Projection low
Quahada Ridge*	14,748	14,748	1	40	369	A	
Querecho Plains	2,106	2,106	1	40	53	P	No gas production since 1959
Revelation	5,944	5,965	1	40	149	P	Minor gas production
Sand Dunes*	23,052	-	2	80	-	P	Data inadequate
Santo Nino	-	-	3	120	-	A	No gas production
Scanlon	133	133	2	80	2	A	
Shugart	494,681	610,512	5	200	3053	P	
U. S.*	16,637	16,637	1	40	416	A	

* Study area fields P: Producing A: Abandoned

TABLE 37 - Wells: Delaware Mountain Group (Pre-Ramsey) Gas Production

Field/Well	Cum. Prod. 1/1/73	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
LUSK01	104,284	153,515	40	3838	P	Projection low
LUSK02	16,537	18,391	40	460	P	
LUSK03	2,896	2,896	40	72	A	
PARAL1	53,118	59,855	40	1496	P	Projection low
PARAL2	31,597	34,176	40	854	P	Projection low
SADU01	20,762	-	40	-	P	Data inadequate
SADU02	-	-	40	-	-	No production data
SADU03	2,290	-	40	-	P	Data inadequate
SANT01	-	-	40	-	A	No gas production
SANT02	-	-	40	-	A	No gas production
SANT03	-	-	40	-	A	No gas production
SHUGA1	181,761	214,486	40	5362	P	
SHUGA2	64,764	67,714	40	1693	P	Projection low
SHUGA3	4,389	4,389	40	110	A	
SHUGA4	188,337	258,680	40	6467	P	
SHUGA5	55,430	55,734	40	1393	P	Projection low

P: Producing   A: Abandoned

TABLE 38 - Discovery Well Data: Delaware Mountain Group (Pre-Ramsey/Study Area)

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Big Eddy	Amoco 11 Big Eddy	I7-20S-31E	5142-5165	61 bbls GOR:89/1	—	—
Cotton Draw	Texaco 1 Heflin	C24-24S-31E	7184-7200	25 bbls	36°	—
Maroon Cliffs	Shell 1 Big Eddy	P30-20S-31E	6796-6836	110 bbls GOR:573/1	33°	—
Parallel	Richardson 1 Cobb	M23-20S-31E	7003-7035	215 bbls GOR:676/1	41°	TP:75
Quahada Ridge	Richardson 1 Legg	B27-22S-30E	6112-6118	67 bbls GOR:639/1	43°	—
Sand Dunes	Texas Amer. 2 Todd	G26-23S-31E	6012-6036	173 bbls GOR:480/1	38°	—
U. S.	Richardson 1 Fidel	M27-21S-29E	6890-6950	175 bbls GOR:2131/1	40°	TP:200

in the Shugart field that had the highest expected oil recovery.

Discovery wells of fields in the Study area are given in Table 38. Depth to top of pay ranges from 5, 142 to 7, 184 feet, and to bottom of pay from 5, 165 to 7, 200 feet. The average pay interval thickness for the seven discovery wells is 29 feet. Other production data relating to this interval indicates an average gravity of 36° A.P.I., an average initial potential of 133 barrels of oil per day, and an average tubing pressure of 178 psi.

Delaware Mountain Group (Ramsey Pay)

There are 29 oil fields involving a total of 296 wells that are currently producing or have produced petroleum from the upper part of the Delaware Mountain Group. Most of these fields are located in the Study area. It was possible to arrive at what appears to be an adequate projection of reserves for most of the currently producing fields although a few projections appear to be low. The same, in general, is true for associated gas. Two fields, the East Paduca and Pecos, are shown as having projected gas reserves equal to cumulative production up to January 1, 1973. Reported gas production has been negligible from these fields in the last several years and cumulative production for the East Paduca field has amounted to only 73 MCF.

Oil production and projected recovery per acre for each field is given in Table 40 and production is summarized in Table 39. The average projected yield per acre for the Ramsey interval is 1,630 barrels of oil for all fields and 1.675 barrels for the Study area.

Additional studies were made of 294 wells from the 15 multi-well fields (Table 41) producing from this interval. Using projections for these wells the recovery per acre is reduced to 1,438 barrels. Much of this decrease is the result of projections, considered low, in the Battleaxe, Double X, East Mason, North Mason, and Paduca fields. The range in expected oil recovery per acre is from less than one to 7,661 barrels. The low figure is from an abandoned well in the Paduca field that produced only 35 barrels of oil. The high projection is for the one well Esperanza field completed in 1969, with projection based on production during the period from 1970 to 1973. This projection is probably high particularly when compared with the next highest yields per acre of 2,160 barrels for the Paduca field and 3,945 barrels for a well in the El Mar field. Recency of completion and changes in allowable factors add to the question of ultimate recovery from this well, but production capacity compared with other recently completed wells verifies that it is a high capacity well. The projected data for this well was not eliminated from consideration because of the minor change it would make in the projected yield per acre.

The average expected yield per well for all wells completed in the Ramsey interval is 64,998 barrels. This includes production from 18 abandoned wells that yielded an average of only 13,673 barrels. Within the Study area the average yield per well is 67,011 barrels. Production up to January 1, 1973 averaged 50,564 barrels per well.

Associated gas production from the Ramsey has not been very significant. Fields such as the Fenton, Dark Canyon, Loving, West Malaga, and Tecolote Peak have had no reported gas production and only minor amounts of gas has been produced from many other fields. The average per acre recovery of gas up to January 1, 1973 and projected is given in Table 42 for fields and Table 43 for wells from multi-well fields. This data is summarized in Table 39, based on 40 acre spacing. The highest primary recoveries are from the El Mar field where projected yields are 5,195 MCF per acre. The highest projected yield for a well, also from the El Mar field amounts to 12,888 MCF per acre. In evaluating the average per acre recovery for associated gas from all fields the yield of 2,522 MCF includes data from 13 abandoned wells with reported gas production, six wells with no reported gas production, and 74 wells for which data was not adequate to project recovery and thus only includes production up to January 1, 1973. The bulk of the nonprojected wells are in the Paduca field. The average projected recovery per well, based on all wells, is 100,866 MCF. The 13 abandoned wells recovered an average of 2,487 MCF per well, and nonprojected wells 97,506 MCF up to January 1, 1973. Eliminating these wells and those for which there has been no reported gas production, the average yield per well of 203 wells is 111,373 MCF.

Five wells have been completed as gas wells in the Ramsey but production has been reported for only three. These wells are located in the Double X, Paduca, and North Paduca fields. In Table 43, per acre recovery is based on 160 acre spacing and these, one of them now abandoned, have a projected potential of 1,128 MCF per acre. Using a 40 acre spacing, that in this case might be more appropriate, the yield would be 3,384 MCF.

Discovery wells for Ramsey completions drilled in the Study area are listed in Table 44. Based on these wells the net pay averages eight feet thick. From data available from producing wells in the Study area the average initial potential is 122 barrels of oil per day (average of 282 wells) with an average gravity of 40° A.P.I. (260 wells), at an average tubing pressure of 278 psi (147 wells). The range in initial potential is from 4 BOPD for a well in the Paduca field to 928 BOPD for a well in the North Mason field. The low yield well produced 612 barrels of oil before being shut-in. It was recompleted in 1971 and has produced over 8,000 barrels. The Paduca field has had a secondary recovery program since 1968. The well with the high initial potential in the North Mason field was completed in 1955 and had produced 90,204 barrels up to 1969 when secondary recovery operations were initiated. Production from this well has continued to decline and as of January 1, 1973 total production was 93,598 barrels. The gravity of oil from the Ramsey ranges from a reported low of 31° A.P.I. for a well in the Double X field and two wells in the Salado Draw field, to a high of 44° for a well in the Malaga field. Average gravities for these fields are 39° at Double X,

36^{o} at Salado Draw, and 42^{o} at Malaga. Reported tubing pressures indicate a low of 20 psi for wells in the Corral Canyon, Malaga, North Mason, and Paduca fields, and a high of 1,200 psi for a well in the Salado Draw field.

TABLE 39 — Production summary: Delaware Mountain Group; Ramsey Pay

Interval	Study Area					Regional Area (includes study area)				
Upper Delaware Mountain Group (Ramsey)	Producing Acres	Production to 1/1/73 *	Average Yield Per Acre to 1/1/73	Projected Production*	Projected Yield Per Acre	Producing Acres	Production to 1/1/73*	Average Yield Per Acre to 1/1/73	Projected Production*	Projected Yield Per Acre
Gas (MCF)	-	-	-	-	-	-	-	-	-	-
Associated Gas (MCF)	11,120	26,219,918	2,358	29,820,886	2,682	11,800	26,255,425	2,225	29,856,393	2,530
Total Gas (MCF)	-	-	-	-	-	-	-	-	-	-
Oil (bbls)	11,120	14,553,518	1,309	18,629,036	1,675	11,800	14,967,037	1,268	19,239,410	1,630
Distillate (bbls)	-	-	-	-	-	-	-	-	-	-
Total Oil (bbls)	-	-	-	-	-	-	-	-	-	-

* Does not include production under secondary recovery for El Mar, Malaga, Mason (North), and Paduca fields or 1970-1972 gas production for projection of recovery from Corral Canyon field.

TABLE 40 - Fields: Delaware Mountain Group (Ramsey) Oil Production

Field/Well	Cum. Prod. 1/1/73 ‡	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Battleaxe *	191,227	324,153	4	160	2026	P	
Black River	61,045	61,045	4	160	382	A	
Bradley *	11,329	11,329	1	40	283	A	
Brushy Draw *	211,594	290,445	8	320	908	P	
Cass Draw	16,897	16,897	1	40	422	A	
Corral Canyon *	196,165	259,556	10	320	811	P	
Cruz *	385,909	426,590	5	200	2133	P	Projection low
Dark Canyon	69,681	70,710	1	40	1768	P	
Double X *	601,553	1,127,027	20	800	1409	P	
El Mar * †	4,243,877	4,564,594	59	2360	1934	P	Secondary recovery, 1969 - primary projection low
Esperanza	110,623	306,449	1	40	7661	P	Projection high
Fenton	1,020	1,020	1	40	26	A	
Jennings *	1,575	1,575	1	40	39	A	
Loving	281	281	1	40	7	A	
Malaga * †	642,802	694,986	21	840	827	P	Secondary recovery, 1967
Malaga, North	14,663	14,663	1	40	367	A	
Malaga, West	363	363	1	40	9	A	

TABLE 40 - Fields: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ‡	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Mason, East *	235,201	503,518	7	280	1798	P	
Mason, North *†	2,614,077	3,330,966	40	1600	2082	P	Secondary recovery, 1969
Paduca *†	4,303,951	5,961,730	69	2760	2160	P	Secondary recovery, 1968
Paduca, East *	32,356	46,784	1	40	1170	P	
Paduca, North *	36,050	39,683	4	160	248	P	Projection low
Pecos *	30,843	35,917	2	80	449	P	Projection low
Salado Draw *	414,881	592,145	12	480	1234	P	Projection low
Sulphate Draw	4,469	4,469	1	40	112	A	
Tecolote Peak	3,293	3,293	1	40	82	A	
Triste Draw *	400,098	418,038	14	560	746	P	Projection low
Welch	129,468	129,468	4	160	809	A	
Wye	-	-	1	40	-	-	No production data

* Study area fields † - Secondary Recovery P - Producing A - Abandoned ‡ - Except for secondary recovery fields

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production

Field/Well	Cum. Prod. 1/1/73 ‡	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
BATTL 1	23,458	25,154	40	629	P	Projection low
BATTL 2	78,330	96,411	40	2410	P	
BATTL 3	73,745	95,193	40	2380	P	
BATTL 4	15,194	15,194	40	380	A	
BRUS 01	64,594	-	40		P	Projection too high; not used
BRUS 02	25,973	27,601	40	690	P	
BRUS 03	51,341	80,614	40	2015	P	Projection probably high
BRUS 04	50	50	40	1	A	
BRUS 05	2,806	2,806	40	70	A	
BRUS 06	8,002	9,217	40	230	P	Projection may be high
BRUS 07	66	66	40	2	A	
BRUS 08	24,864	59,822	40	1496	P	Projection probably high
BRUS 09	28,324	69,913	40	1748	P	Projection probably high
BRUS 10	37,603	-	40	-	P	Projection too high; not used
CORR 01	53,345	71,638	40	1791	P	Projection may be high
CORR 02	50,967	57,958	40	1449	P	
CORR 03	30,892	38,912	40	973	P	
CORR 04	24,525	32,053	40	801	P	
CORR 05	458	458	40	11	A	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 #	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
CORR 06	10,161	11,809	40	295	P	Projection may be high
CORR 07	8,594	10,792	40	270	P	
CORR 08	5,231	5,231	40	131	A	
CORR 09	6,066	6,911	40	173	P	
CORR 10	3,555	-	40		P	Data inadequate
CORR 11	3,201	-	40		P	Data inadequate
CRUZ 01	22,061	22,061	40	552	A	
CRUZ 02	60,784	64,111	40	1603	P	Projection low
CRUZ 03	75,183	80,123	40	2003	P	Projection low
CRUZ 04	86,820	92,899	40	2322	P	
CRUZ 05	-	-	40		-	No production data
CRUZ 06	123,529	154,139	40	3853	P	
DOUX 01	55,245	61,653	40	1541	P	
DOUX 02	42,854	55,830	40	1396	P	Projection may be high
DOUX 03	12,697	12,697	40	317	A	
DOUX 04	15,987	17,600	40	440	P	
DOUX 05	19,971	19,971	40	499	A	
DOUX 06	21,859	21,859	40	546	A	
DOUX 07	399	399	40	10	A	
DOUX 08	21,739	29,028	40	726	P	
DOUX 09	49,901	70,126	40	1753	P	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ‡	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
DOUX 10	131	131	40	3	A	
DOUX 11	75,117	80,532	40	2013	P	
DOUX 12	40,104	50,943	40	1274	P	Projection may be slightly high
DOUX 13	-	-	40		-	No production data
DOUX 14	32,089	45,730	40	1143	P	
DOUX 15	15,668	19,786	40	495	P	Projection probably high
DOUX 16	14,526	-	40		P	Data inadequate
DOUX 17	39,851	65,088	40	1627	P	
DOUX 18 (Gas)	-	-	160		P	No oil production
DOUX 19	19,081	-	40		P	Data inadequate
DOUX 20	22,802	-	40		P	Data inadequate
DOUX 21	11,045	11,045	40	276	A	
DOUX 22	837	837	40	21	A	
DOUX 23	52,269	69,818	40	1745	P	
ELMA 01*	77,069	82,308	40	2058	P	Projection low
ELMA 02*	86,769	87,418	40	2185	P	Projection low
ELMA 03*	70,267	72,452	40	1811	P	
ELMA 04*	50,071	50,071	40	1252	A	
ELMA 05*	78,789	79,289	40	1982	SA	Projection low

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ††	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
ELMA 06*	59,290	59,624	40	1491	SA	Projection low
ELMA 07*	89,416	90,425	40	2261	P	Projection low
ELMA 08*	60,736	66,834	40	1671	P	
ELMA 09*	59,432	-	40		P	Data inadequate
ELMA 10*	82,270	138,174	40	3454	P	Projection high
ELMA 11*	87,095	88,590	40	2215	P	Projection low
ELMA 12*	91,555	101,623	40	2541	P	
ELMA 13*	91,826	126,199	40	3155	P	Projection high
ELMA 14*	109,324	120,361	40	3009	P	Projection low
ELMA 15*	74,942	75,726	40	1893	P	Projection low
ELMA 16*	89,908	127,370	40	3184	P	
ELMA 17*	82,826	99,425	40	2486	P	
ELMA 18*	96,298	104,026	40	2601	P	
ELMA 19*	94,537	99,589	40	2490	P	Projection low
ELMA 20*	96,052	108,087	40	2702	P	
ELMA 21*	104,192	113,996	40	2850	P	Projection slightly low
ELMA 22*	92,447	157,810	40	3945	P	Projection slightly low
ELMA 23*	88,544	102,491	40	2562	P	
ELMA 24*	98,583	120,777	40	3019	P	

Field/Well	Cum. Prod. 1/1/73 ‡	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
ELMA 25*	86,327	94,874	40	2372	P	Projection low
ELMA 26*	5,904	5,904	40	148	A	
ELMA 27*	113,680	130,697	40	3267	P	
ELMA 28*	117,913	139,676	40	3492	P	
ELMA 29*	90,796	96,755	40	2419	P	Projection low
ELMA 30*	105,048	112,561	40	2814	P	Projection low
ELMA 31	84,646	89,403	40	2235	P	Projection low
ELMA 32	123,391	150,540	40	3764	P	Projection low
ELMA 33	14,700	14,700	40	368	A	
ELMA 34	60,725	61,354	40	1534	P	Projection low
ELMA 35	74,374	77,582	40	1940	SA	
ELMA 36	58,189	61,791	40	1545	P	Projection low
ELMA 37	70,454	78,263	40	1957	P	Projection low
ELMA 38	-	-	40		-	No production data
ELMA 39	99,446	123,013	40	3075	P	
ELMA 40	34,797	77,737	40	1943	P	Projection high
ELMA 41	64,961	66,743	40	1669	P	Projection low
ELMA 42	38,823	42,038	40	1051	P	Projection low
ELMA 43	35,612	35,612	40	890	A	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ††	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
ELMA 44	40,387	40,393	40	1010	A	
ELMA 45*	73,633	75,190	40	1880	P	Projection low
ELMA 46*	93,808	98,299	40	2457	P	Projection low
ELMA 47*	98,974	102,821	40	2571	P	Projection low
ELMA 48*	67,336	68,252	40	1706	P	Projection low
ELMA 49*	63,000	69,036	40	1726	SA	
ELMA 50*	63,031	66,240	40	1656	P	Projection slightly low
ELMA 51*	89,145	91,654	40	2291	P	Projection slightly low
ELMA 52*	42,757	42,897	40	1072	P	Projection low
ELMA 53*	24,992	24,992	40	625	A	
ELMA 54*	58,625	60,077	40	1502	P	Projection low
ELMA 55*	35,777	35,835	40	896	SA	
ELMA 56*	6,416	6,416	40	160	A	
ELMA 57*	66,594	66,720	40	1668	P	Projection low
ELMA 58*	44,149	50,001	40	1250	P	
ELMA 59*	80,451	86,812	40	2170	P	
ELMA 60*	15,912	24,629	40	616	SA	
MALA 01*	56,307	66,561	40	1664	SA	Projection high
MALA 02*	63,596	67,702	40	1693	SA	

Field/Well	Cum. Prod. 1/1/73 #	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
MALA 03*	30,838	37,396	40	935	SA	
MALA 04*	28,041	28,123	40	703	P	Projection slightly low
MALA 05*	18,672	18,785	40	470	SA	
MALA 06*	33,504	33,506	40	838	SA	
MALA 07*	28,981	29,088	40	727	P	
MALA 08*	17,791	18,088	40	452	SA	
MALA 09*	46,113	53,596	40	1340	P	Projection slightly high
MALA 10*	51,660	55,948	40	1399	SA	
MALA 11*	1,371	1,371	40	34	A	
MALA 12*	21,854	22,027	40	551	P	
MALA 13*	4,236	4,726	40	118	SA	
MALA 14*	-	-	40			No production data
MALA 15*	27,750	-	40		SA	Projection high; not used
MALA 16*	72,698	80,503	40	2013	P	
MALA 17*	355	355	40	9	A	
MALA 18*	836	836	40	21	A	
MALA 19*	17,631	18,335	40	458	SA	
MALA 20*	19,864	19,742	40	494	SA	
MALA 21*	18,651	19,718	40	493	P	
MALA 22*	8,171	8,612	40	215	SA	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 #	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
MALA 23*	43,146	-	40		P	Projection high; not used
MALA 24*	30,625	31,717	40	793	P	Projection slightly low
MALA 25*	1,244	2,814	40	70	P	Projection low
MASON 1	2,601	2,601	40	65	A	
MASON 2	55,617	-	40		P	Data inadequate
MASON 3	52,025	58,954	40	1474	P	Projection low
MASON 4	30,272	34,150	40	854	P	Projection low
MASON 5	39,219	-	40	-	P	Data inadequate
MASON 6	1,042	-	40	-	P	Data inadequate
MASON 7	45,137	-	40	-	P	Data inadequate
MASON 8	11,849	13,550	40	339	P	Projection low
NMAS 01*	110,995	112,565	40	2814	P	Projection low
NMAS 02*	112,360	-	40		P	Projection high; not used
NMAS 03*	97,635	-	40		P	Data inadequate
NMAS 04*	80,651	82,653	40	2066	P	Projection probably slightly low
NMAS 05*	99,389	-	40		P	Data inadequate
NMAS 06*	101,063	107,638	40	2691	P	
NMAS 07*	76,478	82,819	40	2070	P	Projection slightly high
NMAS 08*	68,730	68,730	40	1718	A	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ††	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
NMAS 09*	108,403	-	40		P	Projection high; not used
NMAS 10*	100,391	107,549	40	2689	P	Projection slightly high
NMAS 11*	114,909	117,256	40	2931	P	Projection slightly low
NMAS 12*	114,474	114,725	40	2868	P	Projection low
NMAS 13*	87,171	88,013	40	2200	SA	
NMAS 14*	49,942	49,942	40	1249	A	
NMAS 15*	110,311	141,375	40	3534	P	
NMAS 16*	1,376	1,376	40	34	A	
NMAS 17*	39,260	45,771	40	1144	SA	
NMAS 18*	90,204	91,821	40	2296	P	Projection slightly low
NMAS 19*	59,367	-	40		P	Projection high; not used
NMAS 20*	60,835	60,835	40	1521	A	
NMAS 21*	40,732	-	40		P	Projection high; not used
NMAS 22*	17,086	17,781	40	445	P	Projection low
NMAS 23*	29,886	-	40		P	Data inadequate
NMAS 24*	19,515	28,997	40	725	P	Projection slightly high
NMAS 25*	77,453	-	40		P	Data inadequate
NMAS 26*	24,421	24,421	40	611	A	
NMAS 27*	30,032	-	40		P	Projection high; not used

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ††	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
NMAS 28*	100,686	-	40		P	Projection high; not used
NMAS 29*	19,020	23,381	40	585	SA	
NMAS 30*	74,608	80,312	40	2008	P	Projection low
NMAS 31*	93,708	99,688	40	2492	P	Projection low
NMAS 32*	66,056	82,918	40	2073	P	Projection high
NMAS 33*	81,782	87,017	40	2175	P	Projection low
NMAS 34*	36,523	45,204	40	1130	P	
NMAS 35*	14,616	-	40		P	Data inadequate
NMAS 36*	72,864	78,054	40	1951	P	
NMAS 37*	18,951	19,548	40	489	P	Projection low
NMAS 38*	17,015	24,465	40	612	P	Projection slightly high
NMAS 39*	45,715	-	40		P	Projection high; not used
NMAS 40*	12,738	12,738	40	318	A	
NMAS 41*	2,601	2,601	40	65	A	
NMAS 42*	1,087	-	40		SA	Production following secondary recovery
PADU 01*	35	35	40	1	A	
PADU 02*	12,608	12,608	40	315	A	
PADU 03*	87,990	97,771	40	2444	SA	
PADU 04*	86,585	97,805	40	2445	SA	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 #	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
PADU 05*	85,804	94,522	40	2363	SA	
PADU 06*	81,159	94,487	40	2362	SA	
PADU 07*	2,195	2,195	40	55	A	
PADU 08*	91,565	107,781	40	2695	SA	
PADU 09*	84,265	93,320	40	2333	P	Projection low
PADU 10*	84,470	98,739	40	2468	P	Projection high
PADU 11*	87,603	104,963	40	2624	P	
PADU 12*	72,624	73,316	40	1833	P	Projection low
PADU 13*	72,442	76,946	40	1924	SA	
PADU 14*	71,565	72,119	40	1803	P	Projection low
PADU 15*	75,707	80,895	40	2022	P	
PADU 16*	88,420	90,595	40	2265	SA	
PADU 17*	86,279	-	40		P	Projection high; not used
PADU 18*	85,339	87,302	40	2183	P	Projection low
PADU 19*	88,847	-	40		SA	Projection high; not used
PADU 20*	83,454	85,566	40	2139	P	Projection low
PADU 21*	83,016	85,639	40	2141	P	
PADU 22*	83,851	-	40		SA	Data inadequate
PADU 23*	62,696	64,020	40	1601	P	Projection low
PADU 24*	91,289	-	40		P	Data inadequate
PADU 25*	76,872	78,360	40	1959	P	Projection low

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ##	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
PADU 26*	80,820	88,323	40	2208	P	Projection slightly high
PADU 27*	81,294	82,446	40	2061	P	Projection low
PADU 28*	85,060	85,973	40	2149	SA	
PADU 29*	83,728	85,362	40	2134	P	Projection slightly low
PADU 30*	78,154	79,002	40	1975	P	Projection low
PADU 31*	99,035	99,422	40	2486	P	Projection low
PADU 32*	84,311	-	40		P	Data inadequate
PADU 33*	82,482	84,064	40	2102	P	Projection low
PADU 34*	81,352	82,608	40	2065	P	Projection slightly low
PADU 35*	79,449	80,819	40	2020	P	Projection slightly low
PADU 36*	88,404	-	40		P	Projection high; not used
PADU 37*	96,878	-	40		P	Data inadequate
PADU 38*	77,938	84,723	40	2118	SA	
PADU 39*	86,990	-	40		P	Data inadequate
PADU 40*	82,275	84,661	40	2117	SA	
PADU 41*	79,059	84,210	40	2105	SA	
PADU 42*	77,779	85,260	40	2132	P	Projection high
PADU 43*	30,346	35,497	40	887	P	
PADU 44*	60,202	103,236	40	2581	P	Projection may be slightly high

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ††	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
PADU 45*	64,524	70,180	40	1755	P	Projection low
PADU 46*	73,843	94,297	40	2357	SA	
PADU 47*	32,904	34,022	40	851	P	Projection low
PADU 48*	70,163	72,253	40	1806	P	Projection low
PADU 49*	79,105	89,144	40	2229	P	Projection low
PADU 50*	43,293	-	40		P	Projection high; not used
PADU 51*	63,290	75,872	40	1897	P	
PADU 52*	59,523	60,666	40	1517	P	Projection low
PADU 53*	34,865	39,452	40	986	SA	
PADU 54*	64,285	72,249	40	1806	SA	
PADU 55*	61,730	72,807	40	1820	P	Projection low
PADU 56*	3,073	3,073	40	77	A	
PADU 57*	49,432	50,760	40	1269	SA	Projection low
PADU 58*	17,770	25,755	40	644	P	Projection slightly high
PADU 59*	10,173	11,487	40	287	SA	
PADU 60*	32,922	35,240	40	881	SA	
PADU 61*	19,732	27,979	40	699	P	
PADU 62*	8,920	8,920	40	223	A	
PADU 63*	7,759	7,799	40	195	SA	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 #	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
PADU 64*	18,988	21,173	40	529	SA	
PADU 65*	14,674	19,744	40	494	SA	
PADU 66*	5,114	5,114	40	128	A	
PADU 67*	6,940	6,940	40	174	A	
PADU 68*	612	612	40	15	SA	
PADU 69*	4,664	5,428	40	136	SA	
PADU 70*	45,021	60,883	40	1522	SA	Projection low
PADU 71*	41,251	-	40		SA	Data inadequate
PADU 72*	40,755	48,600	40	1215	SA	
PADU 73* (Gas)	-	-	160	-	A	No oil production
PADUN 1	1,471	1,471	40	37	A	
PADUN 2	23,644	27,617	40	690	P	Projection low
PADUN 3	11,838	12,866	40	322	P	Projection low
PADUN 4 (Gas)	-	-	160		P	No oil production
PECOS 1	17,180	17,180	40	430	A	
PECOS 2	13,663	17,210	40	430	P	
SALA 01	60,760	84,329	40	2108	P	
SALA 02	17,281	17,281	40	432	A	
SALA 03	4,052	4,052	40	101	A	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 #	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
SALA 04	48,739	-	40			Data inadequate
SALA 05	63,754	94,446	40	2361	P	Projection high
SALA 06	89,904	100,051	40	2501	P	
SALA 07	26,542	27,970	40	699	P	
SALA 08	5,937	5,937	40	148	A	
SALA 09	1,439	1,439	40	36	A	
SALA 10	26,367	26,367	40	659	A	
SALA 11	6,888	6,888	40	172	A	
SALA 12	41,316	86,812	40	2170	P	Projection high
SALA 13	13,056	-	40		P	Data inadequate
SALA 14	8,722	-	40		P	Data inadequate
TRIS 01		-	40		-	No production data
TRIS 02	23,965	23,965	40	599	A	
TRIS 03	47,190	47,204	40	1180	P	Projection slightly low
TRIS 04	8,578	8,578	40	214	A	
TRIS 05	3,525	3,525	40	88	A	
TRIS 06	67,359	80,358	40	2009	P	
TRIS 07	43,883	43,883	40	1097	A	
TRIS 08	51,086	55,566	40	1389	P	

TABLE 41 - Wells: Delaware Mountain Group (Ramsey) Oil Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ††	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
TRIS 09	-	-	40		-	No production data
TRIS 10	54,042	69,700	40	1743	P	Projection slightly high
TRIS 11	18,455	27,126	40	678	P	Projection slightly high
TRIS 12	-	-	40		-	No production data
TRIS 13	41,486	46,343	40	1159	P	Projection slightly high
TRIS 14	24,134	24,134	40	603	A	
TRIS 15	5,092	5,092	40	127	A	
TRIS 16	10,917	10,917	40	273	A	
TRIS 17	17,533	17,533	40	438	A	
WELCH 1	30,954	30,954	40	774	A	
WELCH 2	30,169	30,169	40	754	A	
WELCH 3	32,329	32,329	40	808	A	
WELCH 4	36,016	36,016	40	900	A	
UNDG 01	629	629	40	16	A	

P: Producing A: Abandoned SA: Abandoned following secondary recovery operations

* Secondary recovery ††Except for secondary recovery fields

TABLE 42 - Fields: Delaware Mountain Group (Ramsey) Gas Production

Field/Well	Cum. Prod. 1/1/73 ††	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Battleaxe *	274,326	-	4	160	-	P	Data inadequate
Black River	83	83	4	160	0.5	A	
Bradley *	17,579	17,579	1	40	439	A	
Brushy Draw *	197,852	206,751	8	320	646	P	
Cass Draw	25	25	1	40	0.6	A	
Corral Canyon *	48,717	36,089	10	320	113	P	Does not include 1970-1972 projected production. Projection low
Cruz *	561,401	593,517	5	200	2968	P	
Dark Canyon	-	-	1	40	-	P	No gas production
Double X *	1,635,088	1,770,778	20	800	2213	P	
El Mar * †	10,006,594	12,260,684	59	2360	5195	P	Secondary recovery, 1969
Esperanza	26,511	-	1	40		P	Data inadequate
Fenton	-	-	1	40	-	A	No gas production
Jennings*	5,761	5,761	1	40	144	A	
Loving	-	-	1	40	-	A	No gas production
Malaga * †	47,092	50,531	21	840	60	P	Secondary recovery, 1967 - primary projection low

TABLE 42 - Fields: Delaware Mountain Group (Ramsey) Gas Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 ††	Proj. Prod. Total	Prod. Wells	Acres	Proj. Prod. per acre	Status	Remarks
Malaga, North	4,616	4,616	1	40	115	A	
Malaga, West	-	-	1	40	-	A	No gas production
Mason, East *	279,745	324,153	7	280	1158	P	Projection low
Mason, North *†	4,900,276	5,899,266	40	1600	3687	P	Secondary recovery, 1969 - primary projection low
Paduca * †	6,914,585	-	69	2760	-	P	Secondary recovery, 1968 - Data inadequate
Paduca, East*	73	73	1	40	2	P	No gas production since 1968
Paduca, North *	333,774	348,604	4	160	2179	P	Projection low
Pecos *	39,626	39,626	2	80	495	P	No gas production since 1969
Salado Draw *	630,147	718,497	12	480	1497	P	
Sulphate Draw	2,022	2,022	1	40	51	A	
Tecolote Peak	-	-	1	40	-	A	No gas production
Triste Draw *	341,763	360,066	14	560	643	P	Projection low
Welch	2,250	2,250	4	160	14	A	
Wye	-	-	1	40	-	-	No production data

* Study area fields † Secondary recovery P: Producing A: Abandoned †† Except for secondary recovery fields

TABLE 45 - Wells: Delaware Mountain Group (Ramsey) Gas Production

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
BATTL 1	45,263	54,891	40	1372	P	
BATTL 2	96,125	-	40	-	P	Data inadequate
BATTL 3	122,975	-	40	-	P	Data inadequate
BATTLE 4	9,963	9,963	40	249	A	
BRUS 01	11,669	13,344	40	334	P	
BRUS 02	11,176	11,751	40	294	P	Projection low
BRUS 03	25,580	32,335	40	808	P	Projection high
BRUS 04	--	-	40		A	No gas production
BRUS 05	2,227	2,227	40	56	A	
BRUS 06	104,948	105,538	40	2638	P	
BRUS 07	41	41	40	1	A	
BRUS 08	15,087	16,583	40	415	P	
BRUS 09	12,213	14,376	40	359	P	
BRUS 10	15,034	-	40	-	P	Data inadequate
CORR 01	-	-	40	-	P	No gas production
CORR 02	-	-	40	-	P	No gas production
CORR 03	-	-	40	-	P	No gas production
CORR 04	28,069	-	40	-	P	Projection high; not used
CORR 05	206	206	40	5	A	
CORR 06	2,228	2,228	40	56	P	Almost depleted

TABLE 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
CORR 07	2,370	2,511	40	63	P	
CORR 08	1,690	1,690	40	42	A	
CORR 09	95	148	40	4	P	
CORR 10	3,379		40		P	Data inadequate
CORR 11	1,785	1,941	40	49	P	
CRUZ 01	22,032	22,032	40	551	A	
CRUZ 02	122,222	-	40		P	Projection high; not used
CRUZ 03	150,308	150,541	40	3764	P	Projection low
CRUZ 04	81,353	81,619	40	2040	P	Projection low
CRUZ 05	-	-	40		-	No production data
CRUZ 06	145,266	147,579	40	3689	P	Projection low
DOUX 01	53,736	54,937	40	1373	P	Projection low
DOUX 02	93,264	93,264	40	2332	P	
DOUX 03	12,690	12,690	40	317	P	
DOUX 04	16,480	16,480	40	412	P	
DOUX 05	12,396	12,396	40	310	A	
DOUX 06	48,052	48,052	40	1201	A	
DOUX 07	225	225	40	6	A	
DOUX 08	158,822	162,497	40	4062	P	Projection low
DOUX 09	36,003	-	40		P	Data inadequate
DOUX 10	183	183	40	5	A	

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
DOUX 11	89,420	89,420	40	2236	P	
DOUX 12	55,114	57,792	40	1445	P	
DOUX 13	-	-	40			No production data
DOUX 14	87,231	87,399	40	2185	P	Projection low
DOUX 15	50,217	50,475	40	1262	P	Projection low
DOUX 16	166,460	167,225	40	4181	P	Projection low
DOUX 17	144,253	-	40		P	Projection high; not used
DOUX 18 (Gas)	378,560	379,274	160	2370	P	Projection low
DOUX 19	27,743	-	40		P	Data inadequate
DOUX 20	137,514	-	40		P	Data inadequate
DOUX 21	21,779	21,779	40	544	A	
DOUX 22	168	168	40	4	A	
DOUX 23	92,759	-	40		P	Data inadequate
ELMA 01*	120,755	129,457	40	3236	P	Projection low
ELMA 02*	350,830	350,861	40	8772	P	Projection low
ELMA 03*	330,662	337,765	40	8444	P	
ELMA 04*	90,381	90,381	40	2260	A	
ELMA 05*	179,508	185,668	40	4642	SA	
ELMA 06*	204,030	215,144	40	5379	SA	Projection low
ELMA 07*	227,322	232,195	40	5805	P	Projection low
ELMA 08*	136,248	-	40		P	Data inadequate
ELMA 09*	86,766	-	40		P	Data inadequate

TABLE 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
ELMA 10*	316,999	364,537	40	9113	P	Projection low
ELMA 11*	221,079	261,700	40	6543	P	
ELMA 12*	153,391	190,958	40	4774	P	
ELMA 13*	164,921	204,696	40	5117	P	
ELMA 14*	365,553	-	40		P	Projection high; not used
ELMA 15*	136,406	-	40		P	Projection high; not used
ELMA 16*	252,985	316,930	40	7923	P	
ELMA 17*	132,062	134,749	40	3369	P	Projection low
ELMA 18*	260,404	294,754	40	7369	P	Projection low
ELMA 19*	244,658	318,440	40	7961	P	
ELMA 20*	173,697	204,789	40	5120	P	Projection slightly high
ELMA 21*	176,390	181,298	40	4532	P	Projection low
ELMA 22*	149,565	-	40		P	Data inadequate
ELMA 23*	118,841	267,430	40	6686	P	Projection may be high
ELMA 24*	338,883	515,526	40	12,888	P	
ELMA 25*	243,926	-	40		P	Data inadequate
ELMA 26*	754	754	40	19	A	
ELMA 27*	232,739	313,243	40	7831	P	
ELMA 28*	225,335	-	40	-	P	Projection high, not used
ELMA 29*	158,517	172,868	40	4322	P	Projection low
ELMA 30*	202,281	251,738	40	6293	P	

TABLE 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
ELMA 31*	155,704	179,780	40	4495	P	Projection low
ELMA 32*	220,365	298,678	40	7467	P	Projection low
ELMA 33*	9,269	9,269	40	232	A	
ELMA 34*	227,918	284,058	40	7101	P	
ELMA 35*	213,112	226,425	40	5661	SA	
ELMA 36*	93,266	96,500	40	2413	P	Projection low
ELMA 37*	33,992	41,469	40	1037	P	Projection low
ELMA 38*	-	--	40	-	-	No production data
ELMA 39*	138,530	139,191	40	3480	P	Projection low
ELMA 40*	32,218	-	40		P	Data inadequate
ELMA 41*	72,499	73,528	40	1838	P	Projection low
ELMA 42*	46,842	53,913	40	1348	P	Projection low
ELMA 43*	71,599	71,599	40	1790	A	
ELMA 44*	41,232	41,232	40	1031	A	
ELMA 45*	344,862	454,207	40	11,355	P	
ELMA 46*	228,786	313,859	40	7846	P	Projection low
ELMA 47*	342,122	475,263	40	11,882	P	
ELMA 48*	239,131	248,668	40	6217	P	Projection low
ELMA 49*	261,481	287,856	40	7196	SA	Projection low
ELMA 50*	111,344	-	40		P	Data inadequate
ELMA 51*	377,918	472,734	40	11,818	P	Projection slightly low

TABLE 43 - Wells: Delaware Mountain Group (-Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remar's
ELMA 52*	100,233	100,597	40	2515	P	
ELMA 53*	89,550	89,550	40	2239	A	
ELMA 54*	90,049	90,065	40	2252	P	Projection low
ELMA 55*	58,028	58,028	40	1451	SA	
ELMA 56*	24,895	24,895	40	622	A	
ELMA 57*	142,269	-	40		P	Data inadequate
ELMA 58*	70,864	-	40		P	Data inadequate
ELMA 59*	91,997	94,993	40	2375	P	Projection low
ELMA 60*	-	-	40	-	P	No gas production
MALA 01*	955	983	40	25	SA	
MALA 02*	904	973	40	24	SA	
MALA 03*	730	815	40	20	SA	
MALA 04*	-	-	40		P	No gas production
MALA 05*	-	-	40		SA	No gas production
MALA 06*	-	-	40		SA	No gas production
MALA 07*	-	-	40		P	No gas production
MALA 08*	-	-	40		SA	No gas production
MALA 09*	-	-	40		P	No gas production
MALA 10*	-	-	40		SA	No gas production
MALA 11*	-	-	40		A	No gas production
MALA 12*	676	736	40	18	SA	

TABLE 43- Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont.)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
MALA 13*	478	478	40	12	SA	
MALA 14*	--	-	40			No production data
MALA 15*	801	1,126	40	28	SA	
MALA 16*	8,867	-	40		P	Data inadequate
MALA 17*	-	-	40		A	No gas production
MALA 18*	-	-	40		A	No gas production
MALA 19*	823	-	40		SA	Not run
MALA 20*	-	-	40		SA	No gas production
MALA 21*	-	-	40		P	No gas production
MALA 22*	-	-	40		SA	No gas production
MALA 23*	-	-	40		P	No gas production
MALA 24*	3,102	-	40			No run
MALA 25*	-	-	40		P	No gas production prior to secondary recovery
MASON 1	-	-	40		A	No gas production
MASON 2	30,764	32,219	40	805	P	Projection low
MASON 3	30,203	30,232	40	756	P	Projection low
MASON 4	11,796	12,185	40	305	P	Projection low
MASON 5	15,617	-	40		P	Data inadequate
MASON 6	151,733	177,106	40	4428	P	
MASON 7	34,184	70,050	40	1751	P	
MASON 8	5,453	10,632	40	266	P	

TABLE 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
NMAS 01*	206,409	209,121	40	5,228	P	Projection low
NMAS 02*	382,754	385,443	40	9,636	P	Projection low
NMAS 03*	197,430	-	40		P	Data inadequate
NMAS 04*	88,564	88,748	40	2,219	P	Projection low
NMAS 05*	141,094	146,155	40	3,654	P	Projection low
NMAS 06*	212,529	215,838	40	5,396	P	Projection low
NMAS 07*	128,028	141,796	40	3,545	P	
NMAS 08*	87,711	87,711	40	2,193	A	
NMAS 09*	306,629	322,859	40	8,071	P	
NMAS 10*	233,390	234,862	40	5,872	P	Projection low
NMAS 11*	84,529	103,887	40	2,597	P	
NMAS 12*	208,342	209,884	40	5,247	P	Projection low
NMAS 13*	161,449	161,713	40	4,043	SA	Projection low
NMAS 14*	39,783	39,783	40	995	A	
NMAS 15*	250,652	-	40	-	P	Data inadequate
NMAS 16*	-	-	40		A	No gas production
NMAS 17*	51,626	51,991	40	1,300	SA	
NMAS 18*	171,045	171,084	40	4,277	P	Projection low
NMAS 19*	56,732	-	40	-	P	Data inadequate
NMAS 20*	81,466	81,466	40	2,037	A	
NMAS 21*	23,929	-	40		P	Data inadequate
NMAS 22*	9,737	-	40		P	Data inadequate

TABLE 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
NMAS 23*	17,250	21,349	40	534	P	Projection low
NMAS 24*	13,673	-	40		P	Data inadequate
NMAS 25*	44,136	-	40		P	Data inadequate
NMAS 26*	26,330	26,330	40	658	A	
NMAS 27*	26,102	28,390	40	710	P	Projection low
NMAS 28*	191,699	-	40		P	Data inadequate
NMAS 29*	21,107	21,375	40	534	SA	Projection low
NMAS 30*	64,298	79,913	40	1,998	P	Projection low
NMAS 31*	93,536	161,858	40	4,046	P	Projection high
NMAS 32*	76,034	82,021	40	2,051	P	Projection low
NMAS 33*	82,794	-	40		P	Projection high; not used
NMAS 34*	39,639	44,728	40	1,118	P	Projection low
NMAS 35*	12,882	-	40		P	Data inadequate
NMAS 36*	81,842	-	40		P	Data inadequate
NMAS 37*	12,541	18,455	40	461	P	Projection low
NMAS 38*	14,863	-	40		P	Data inadequate
NMAS 39*	25,191	-	40	-	P	Data inadequate
NMAS 40*	51,094	51,094	40	1,277	A	
NMAS 41*	-	-	40		A	No gas production
NMAS 42*	-	-	40	-	P	Production after secondary recovery

TABLE 43- Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
PADU 01*	-	-	40		A	No gas production
PADU 02*	18,754	18,754	40	469	A	
PADU 03*	198,796	-	40		SA	Data inadequate
PADU 04*	149,876	-	40		SA	Data inadequate
PADU 05*	161,327	-	40		SA	Data inadequate
PADU 06*	99,106	-	40		SA	Data inadequate
PADU 07*	575	575	40	14	A	
PADU 08*	129,074	-	40		SA	Data inadequate
PADU 09*	168,990	-	40		P	Data inadequate
PADU 10*	169,794	-	40		P	Data inadequate
PADU 11*	172,989		40		P	Data inadequate
PADU 12*	146,633		40		P	Data inadequate
PADU 13*	122,218		40		SA	Data inadequate
PADU 14*	159,819	-	40		P	Data inadequate
PADU 15*	157,570	-	40		P	Data inadequate
PADU 16*	140,388	-	40		SA	Data inadequate
PADU 17*	175,348	-	40		P	Data inadequate
PADU 18*	154,666	-	40		P	Data inadequate
PADU 19*	116,483		40		SA	Data inadequate
PADU 20*	105,907		40		P	Data inadequate
PADU 21*	164,004		40		P	Data inadequate
PADU 22*	116,051		40		SA	Data inadequate

TABLE 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
PADU 23*	66,109	67,874	40	1697	P	Projection low
PADU 24*	137,616		40		P	Data inadequate
PADU 25*	185,630		40		P	Data inadequate
PADU 26*	129,362		40		P	Data inadequate
PADU 27*	152,646		40		P	Data inadequate
PADU 28*	106,218		40		SA	Data inadequate
PADU 29*	100,275		40		P	Data inadequate
PADU 30*	154,915		40		P	Data inadequate
PADU 31*	109,978		40		P	Data inadequate
PADU 32*	160,498		40		P	Data inadequate
PADU 33*	134,276		40		P	Data inadequate
PADU 34*	151,238		40		P	Data inadequate
PADU 35*	152,808		40		P	Data inadequate
PADU 36*	172,914		40		P	Data inadequate
PADU 37*	125,224		40		P	Data inadequate
PADU 38*	172,068		40		SA	Data inadequate
PADU 39*	134,018		40		P	Data inadequate
PADU 40*	152,760		40		SA	Data inadequate
PADU 41*	98,253	149,871	40	3747	SA	
PADU 42*	108,614		40		P	Data inadequate
PADU 43*	38,075	69,970	40	1749	P	Projection probably high

TABLE 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
PADU 44*	59,242	63,288	40	1582	P	Projection low
PADU 45*	64,524	67,166	40	1679	P	Projection low
PADU 46*	98,452	175,885	40	4397	SA	Projection low
PADU 47*	25,913	27,442	40	686	P	Projection low
PADU 48*	61,098	61,827	40	1546	P	Projection low
PADU 49*	117,930	-	40		P	Data inadequate
PADU 50*	29,044	-	40		P	Data inadequate
PADU 51*	90,274	96,103	40	2403	P	Projection low
PADU 52*	98,169	100,219	40	2505	P	Projection low
PADU 53*	41,223	42,074	40	1052	SA	
PADU 54*	63,307	64,359	40	1609	SA	Projection low
PADU 55*	65,164		40		P	Data inadequate
PADU 56*	-	-	40		A	No gas production
PADU 57*	30,382	-	40		SA	Data inadequate
PADU 58*	9,946	-	40		P	Data inadequate
PADU 59*	6,594		40		SA	Data inadequate
PADU 60*	11,968		40		SA	
PADU 61*	5,703	6,900	40	173	P	Projection low
PADU 62*	7,768	7,768	40	194	A	
PADU 63*	4,036	5,657	40	141	SA	
PADU 64*	17,781	22,990	40	575	SA	
PADU 65*	12,454	14,645	40	366	SA	Projection low

TABLE 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
PADU 66*	138	138	40	3	A	
PADU 67*	402	402	40	10	A	
PADU 68*	105	-	40		SA	Small production before secondary recovery
PADU 69*	3,690		40		SA	Data inadequate
PADU 70*	135,954	-	40		SA	Data inadequate
PADU 71*	138,181	-	40		SA	Data inadequate
PADU 72*	126,018	-	40		SA	Data inadequate
PADU 73* (Gas)	6,097	6,097	160	38	A	
PADUN 1	23,788	23,788	40	595	A	
PADUN 2	52,673	62,090	40	1552	P	Projection low
PADUN 3	105,410	107,491	40	2687	P	Projection low
PADUN 4 (Gas)	150,440	156,144	160	976	P	Projection low
PECOS 1	11,536	11,535	40	288	A	
PECOS 2	28,090	28,090	40	702	P	
SALA 01	22,416	28,344	40	709	P	Projection low
SALA 02	4,246	4,246	40	106	A	
SALA 03	-	-	40		A	No gas production
SALA 04	19,384	-	40		P	Data inadequate
SALA 05	24,071	42,165	40	1054	P	Projection may be high

Table 43 - Wells: Delaware Mountain Group (Ramsey) Gas Production (Cont'd)

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
SALA 06	135, 208	155, 402	40	3885	P	
SALA 07	33, 547	33, 992	40	850	P	Projection slightly low
SALA 08	6, 120	[illegible], 120	40	153	A	
SALA 09	105, 350	105, 350	40	2634	A	
SALA 10	35, 069	35, 069	40	877	A	
SALA 11	20, 089	20, 089	40	502	A	
SALA 12	208, 100	213, 213	40	5330	P	Projection low
SALA 13	10, 999	-	40		P	Data inadequate
SALA 14	5, 548	-	40		P	Data inadequate
TRIS 01	-	-	40		-	No production data
TRIS 02	6, 530	6, 530	40	163	A	
TRIS 03	27, 644	-	40		P	Data inadequate
TRIS 04	4, 780	4, 780	40	120	A	
TRIS 05	2, 782	2, 782	40	70	A	
TRIS 06	74, 134	-	40	-	P	Data inadequate
TRIS 07	55, 067	55, 067	40	1377	A	
TRIS 08	52, 307	52, 307	40	1308	P	
TRIS 09	-	-	40		-	No production data
TRIS 10	60, 369	97, 413	40	2435	P	Projection high
TRIS 11	23, 945	33, 429	40	836	P	
TRIS 12	-	-	40		-	No production data

Field/Well	Cum. Prod. 1/1/73 †	Proj. Prod. Total	Acres	Proj. Prod. per acre	Status	Remarks
TRIS 13	19,653	-	40		P	Data inadequate
TRIS 14	9,021	9,021	40	226	A	
TRIS 15			40		P	No gas production
TRIS 16	4,177	4,177	40	104	A	
TRIS 17	40,220	40,220	40	1006	A	
WELCH 1	-	-	40		A	No gas production
WELCH 2	-	-	40		A	No gas production
WELCH 3	-	-	40		A	No gas production
WELCH 4	-	-	40		A	No gas production
UNDG 01	-	-	40		A	No gas production

* Secondary recovery
P: Producing
A: Abandoned
SA: Abandoned following secondary recovery
† : Except secondary recovery fields

TABLE 44 - Discovery Well Data - Ramsey (Study Area)

Field	Discovery Well	Location	Producn Interv.	Initial Potential/Day	Gravity	Pressure
Battleaxe	Conoco 1 Russell	030-26S-32E	4221-4231	42 bbls GOR:345/1	40°	–
Bradley	Conoco 1 Bradley	D19-26S-34E	5302-5308	38 bbls GOR:292/1	39°	–
Brushy Draw	Hankamer 1 Gulf	N13-26S-29E	3210-3216	37 bbls	37°	TP:200
Corral Canyon	Lowe 1 R & B	A18-25S-30E	3643-3649	68 bbls	42°	TP:50
Cruz	Conoco 1 Marshall	M19-23S-33E	5095-5099	271 bbls GOR:627/1	40°	TP:150
Double X	Tenneco 1 U. S. Smelting	B22-24S-32E	4914-4919	44 bbls	40°	–
El Mar	Hill & Meeker 1 State	D36-26S-32E	4609-4619	192 bbls GOR:414/1	–	TP:600
Jennings	Westates 1 Jennings	I33-25S-32E	4609- ?	34 bbls GOR:1870/1	41°	–
Malaga	Southern Calif. 1 Valleyland	F7-24S-29E	2774-2779	30 bbls	42°	TP:200
Mason, East	Enfield 1 Ohio	K16-26S-32E	4443- ?	8 bbls	39°	–

TABLE 44 - Discovery Well Data - Ramsey (Study Area) Cont.

Field	Discovery Well	Location	Producing Interval	Initial Potential/Day	Gravity	Pressure
Mason, North	Ibex 1 Hanson	M25-26S-31E	4139- ?	44 bbls	42°	—
Paduca	Tenneco 1 Jordan	M15-25S-32E	4673-4689	171 bbls GOR:1500/1	41°	TP:100
Paduca, East	O'Neill 1 Fed.	P14-25S-32E	4851-4855	85 bbls	42°	TP:100
Paduca, North	Texaco 69 Cotton Draw	K34-24S-32E	4975-4800	23 bbls GOR:3310/1	40°	—
Pecos	Hankamer 1 Gulf	P34-26S-29E	2898-2905	27 bbls	38°	TP:150
Salado Draw	Coastal States 1 Conoco	C15-26S-33E	5005-5009	34 bbls	—	TP:150
Triste Draw	Palmer 1 James	A35-23S-32E	5062-5066	58 bbls	41°	TP:80

SECONDARY RECOVERY PROJECTIONS

Limited to that part of the geologic section considered in this report there are seven fields where secondary recovery operations have been initiated. These fields are El Mar, Malaga, North Mason, and Paduca producing from the Ramsey interval of the Delaware Mountain Group; Dollarhide from the Devonian; and Teague-Simpson and Warren-McKee/Simpson from the Ordovician. The four Delaware Mountain Group fields are in the Study area. In determining the effect of secondary recovery on yield per acre, field projections were made on six of these pools. Production at North Mason increased markedly in 1972 and it was impossible to obtain an adequate projection from the time secondary recovery operations began in 1969. Production up to 1969 had been 2,614,077 barrels for an average yield per acre of 1,634 barrels and per well of 65,352 barrels. Projected yield based on wells that had produced up to 1969 indicated an additional 716,889 barrels could be produced under primary recovery. This would give a yield of 2,082 barrels per acre and 83,274 barrels per well. Production declined during the first three years of secondary recovery operations with total production amounting to 264,365 barrels from a maximum of 35 wells, for an average per acre yield of 189 barrels and a per well yield of 7,553 barrels. Total production up to January 1, 1973 has been 2,878,442 barrels for an average yield for all wells of 71,961 barrels and a per acre yield of 1,799 barrels. This is considerably below the projected primary recovery but additional data is needed to determine the effect on ultimate recovery in this field.

Projection of primary recovery at the El Mar field was 4,564,594 barrels for an average yield per acre of 1,934 barrels, and per well of 77,366 barrels. The projection is considered low based on the rate of production up to 1969 when secondary recovery operations began. Production from 1969 to 1973 amounted to 535,420 barrels, well above the additional 320,717 barrels projected under primary recovery. Added production projected under secondary recovery is 239,580 barrels resulting in a total increase over primary recovery of 454,283 barrels. Under current conditions net recovery would be 5,018,877 barrels for a yield of 2,127 barrels per acre, and 85,066 barrels per well. The increase over primary production for the field is therefore only nine percent.

Based on projections of primary and secondary recovery the net indicated increase in production at Malaga is only seven percent. Projected primary production was estimated to be 694,986 barrels for a yield of 827 barrels per acre and 33,095 barrels per well. Analyses of the production data indicate that net yields for this field will be 894 barrels per acre and 35,748 barrels per well. The various aspects of the project at Malaga are not known, but based on recent production figures the estimates given here would appear to be fairly reliable.

Paduca is the largest of the Delaware Mountain Group fields. Secondary recovery operations began in 1968 and from recovery estimates determined here the program would seem to be quite successful. Production up to 1968 amounted to 4,303,951 barrels of oil, and a projected recovery of an additional 1,657,779 barrels. The estimated primary production of 5,961,730 barrels for an average yield per acre of 2,160 barrels and per well of 86,402 barrels appeared to be reasonable. Production to January 1, 1973 amounted to 7,372,208 barrels for a net increase over estimated primary production of 1,410,478 barrels. Projected recovery under the present program is estimated to be an additional 1,840,750 barrels for a net recovery of 9,212,958 barrels. This would be a yield of 3,338 barrels per acre and 133,521 barrels per well, for an increase in production of 35 percent. Evaluation of recent production data suggests that the recovery will be higher than this estimate.

A secondary recovery program was initiated at the Dollarhide-Devonian field in 1962. Up to this time production had amounted to 2,581,308 barrels of oil. Projected from 1962 the primary recovery was estimated at 2,665,108 barrels for a per acre yield of 3,702 barrels and a per well yield of 148,062 barrels. Examination of the production history suggests this estimate is low. It was not possible to project the potential secondary recovery yield at Dollarhide because of the steady yearly increase in production plus a considerable increase in 1972. Production to January 1, 1973 was 4,178,920 barrels, an increase of 1,513,812 barrels over the projected primary recovery. Yield up to 1973 was 5,224 barrels per acre and 208,946 barrels per well. The net gain over projected primary recovery is 36 percent up to January 1, 1973.

The Teague-Simpson field has had a secondary recovery program since 1965. The projected increase in production over that of the primary recovery projection is 19 percent. This is based on a primary production estimated at 2,134,396 barrels and a projected total recovery of 2,638,955 barrels. Primary yield was projected at 3,557 barrels per acre and 142,293 barrels per well. Total recovery is indicated to be 4,398 barrels per acre and 175,930 barrels per well.

Warren-McKee/Simpson is one of the larger fields producing from the Ordovician. Production up to the time secondary recovery operations began in 1966 amounted to 15,984,157 barrels of oil. Projected primary yield studies suggested a recovery of 16,994,317 barrels for a per acre yield of 9,040 barrels and a per well yield of 361,581 barrels. Production since secondary recovery operations began has been 1,827,143 barrels, an increase of 816,983 barrels over the projected primary recovery for this period. Projected ultimate recovery at the current stage of development is 18,175,870 barrels for a yield of 9,668 barrels per acre, 386,721 barrels per well, and an increase in production over the primary projection of seven percent.

In evaluating the effect of these secondary recovery programs on the ultimate yield for a given field many other factors are no doubt involved. Time for full development of the program would vary just as would pressure and injection rates. Each formation would have to be treated in a different way, and of course the overall economics of the program would have to be considered. From the data presented here it is not possible to determine just what the ultimate increase in production might be. For the six fields examined the average increase is estimated to be 19 percent.

At Dollarhide there was a substantial decrease in production for the first several years after secondary recovery injections began. Yearly production then increased from 38,953 barrels in 1965 to 467,246 barrels in 1972. The recency of recovery programs in the Delaware Mountain Group might explain the projected low additional recoveries if there were a lag between initiation of operations and substantial increase in production. However, at Paduca production decreased for only one year and reached a peak in the third year of the program. Production at Malaga was greatest during the first year of operation and has had a fairly uniform decline since. As noted, production at North Mason declined for the first three years and then increased sharply in 1972. At El Mar production has declined steadily for the four years the program has been in operation. The Teague field has been in operation slightly longer than the Delaware Mountain Group fields. Here production increased with the exception of one year, for the first six years but declined rapidly in 1971 and 1972. Production at Warren averaged 888,009 barrels per year preceding the secondary recovery program of 1966 and has averaged 261,020 barrels since. In

1965 production was 448,199 barrels, declining to 391,049 barrels in 1966 and 189,242 barrels in 1972.

PETROLEUM EXPLORATION IN PILOT AREA

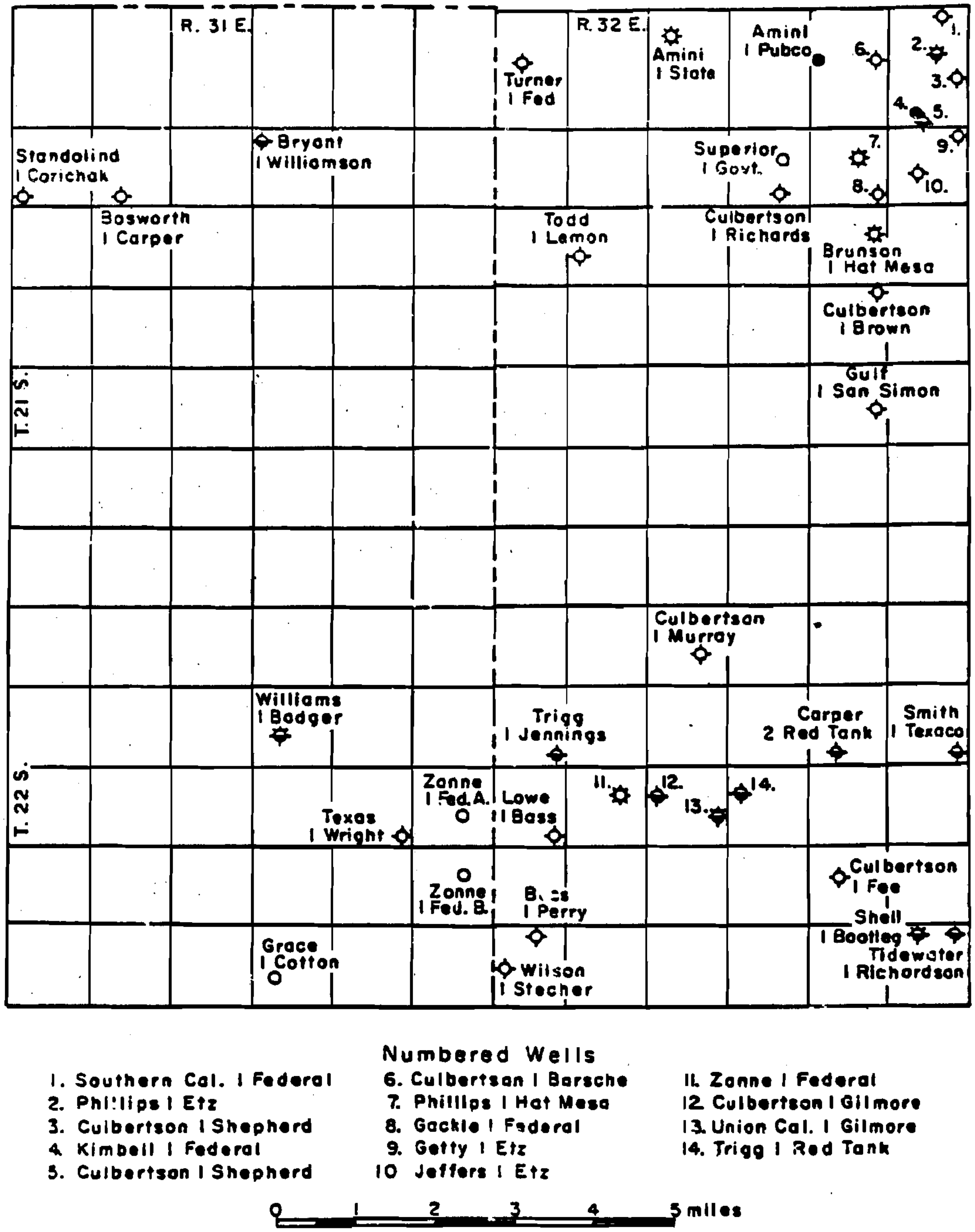
From records of the New Mexico Bureau of Mines and Mineral Resources there have been 37 wells drilled in exploring for oil or gas in the four township Pilot area (Table 45 and fig. 53). As of January 1, 1974 four additional tests were being drilled in this area. Exploration began in 1935 and up to 1954, 15 shallow wells had been drilled to the upper part of the Delaware Mountain Group and the Yates and Seven Rivers formations on the shelf. None of these wells found commercial amounts of oil or gas. The first relatively deep well was drilled in 1954 to the Bone Springs Formation, and this test was followed in 1956 with the deepest well drilled in the Pilot area; a 16,396 foot test of Silurian/Devonian. Both of these wells although having fairly good shows of oil and gas were plugged and abandoned. Through 1963 another 10 wells were drilled, mostly to the Yates/Seven Rivers and upper part of the Delaware Mountain Group. One test of the Bone Springs and one of the lower part of the Delaware Mountain Group were drilled in 1962. Results for all these tests were negative other than shows of oil or gas. In 1964, in addition to a shallow test of the Delaware Mountain, the second pre-Permian test was drilled. This well also was drilled to the Silurian/Devonian and also had significant shows of oil and gas. No tests were drilled in the area from 1965 to 1968 when the third well to the Silurian/Devonian was completed. This test, drilled by Phillips resulted in the discovery of gas in the Morrow interval. Initial production

TABLE 45. Oil and gas tests drilled in Pilot area.

Well	Location S–T–R	Completed	Total Depth	Top Pay	Producing Formation	Initial Production Gas MCF/day	Initial Production Oil Bbls/day	Initial Production Water Bbls/day	Field	Lowest Formation Tested
Stanolind 1 Corichak	M 7–21S–31E	9–17–39	1,980	P & A						Salado
Bosworth 1 Carper	N 8–21S–31E	10–3–49	4,505	P & A						Delaware
Bryant 1 Williamson	D10–21S–31E	5–15–45	4,287	P & A						Delaware
Culbertson 1 Shepherd	P 1–21S–32E	6–11–42	3,496	P & A						Yates-Seven Rivers
Culbertson 1 Shepherd	V 1–21S–32E	8–20–47	3,445	P & A						Yates-Seven Rivers
Kimball 1 Federal	V 1–21S–32E	6–9–73	14,495	13,791	Morrow		288	96	undesignated	Morrow
Phillips 1 Etz	J 1–21S–32E	7–3–56	16,396	P & A						Silurian/Devonian
Southern Cal. 1 Federal	B 1–21S–32E	1–18–54	3,508	P & A						Yates-Seven Rivers
Amini 1 Pubco	L 2–21S–32E	6–16–73	14,400	13,968	Morrow		80		undesignated	Morrow
Culbertson 1 Borsche	I 2–21S–32E	8–10–37	3,500	P & A						Yates-Seven Rivers
Amini 1 New Mexico	F 4–21S–32E	4–27–73	14,000	13,640	Morrow	16,200			S. Salt Lake	Mississippian
Turner 1 Federal	K 6–21S–32E	6–6–51	5,083	P & A						Delaware
Culbertson 1 Richards	O10–21S–32E	10–1–35	3,872	P & A						Delaware
Superior 1 Government	G10–21S–32E	Drilling								
Gackle 1 Federal	P11–21S–32E	12–10–61	3,671	P & A						Yates-Seven Rivers
Phillips 1 Hat Mesa	G11–21S–32E	6–28–68	15,721	13,656	Morrow	7,514			Hat Mesa	Silurian/Devonian
Getty 1 Etz	A12–21S–32E	2–23–37	3,517	P & A						Yates-Seven Rivers
Jeffers 1 Etz	K12–21S–32E	7–19–35	3,594	P & A						Yates-Seven Rivers
Brunson 1 Hat Mesa	H14–21S–32E	7–25–73	14,476	13,838	Morrow	3,401			Hat Mesa	Mississippian
Todd 1 Lemon	L17–21S–32E	5–5–36	4,608	P & A						Delaware
Culbertson 1 Brown	A23–21S–32E	[illegible]–24–35	3,602	P & A						Yates-Seven Rivers
Gulf 1 San Simon	H26–21S–32E	3–2–62	9,000	P & A						Bone Springs
Williams 1 Badger	K15–22S–31E	9–17–73	15,225	P & A						Mississippian
Texas Crude 1 Wright	P23–22S–31E	4–25–62	4,767	P & A						Delaware
Zonne 1 Federal A	J24–22S–31E	Drilling								
Zonne 1 Federal B	G25–22S–31E	Drilling								
Grace 1 Cotton Baby	K34–22S–31E	Drilling								

TABLE 45. Oil and gas tests drilled in Pilot area (cont'd).

Well	Location S–T–R	Completed	Total Depth	Top Pay	Producing Formation	Initial Production Gas MCF/day	Initial Production Oil Bbls/day	Initial Production Water Bbls/day	Field	Lowest Formation Tested
Culbertson 1 Murray	J 9–22S–32E	2–24–48	5,035	P & A						Delaware
Smith 1 Texaco	P 13–22S–32E	12–3–61	5,070	P & A						Delaware
Carper 2 Red Tank	N 14–22S–32E	12–12–62	5,030	P & A						Delaware
Trigg 1 Jennings	P 18–22S–32E	5–3–61	4,896	P & A						Delaware
Lowe 1 Bass	P 19–22S–32E	6–9–64	4,802	P & A						Delaware
Zonne 1 Federal	G 20–22S–32E	11–8–73	14,855	14,556	Morrow	4,945				Morrow
Culbertson 1 Gilmore	E 21–22S–32E	8–1–50	4,846	P & A						Delaware
Union Cal. 1 Gilmore	I 21–22S–32E	7–16–54	8,770	P & A						Bone Springs
Trigg 1 Red Tank	E 22–22S–32E	5–10–62	7,313	P & A						Delaware
Culbertson 1 Fee	G 26–22S–32E	4–17–45	4,977	P & A						Delaware
Bass 1 Perry	B 31–22S–32E	3–7–63	4,777	P & A						Delaware
Wilson 1 Stecher	L 31–22S–32E	3–7–63	266	P & A						Santa Rosa
Shell 1 Bootleg Ridge	C 36–22S–32E	8–24–64	16,300	P & A						Silurian/Devonian
Tidewater 1 Richardson	A 36–22S–32E	8–6–62	5,068	P & A						Delaware



Numbered Wells

1. Southern Cal. I Federal
2. Phillips I Etz
3. Culbertson I Shepherd
4. Kimbell I Federal
5. Culbertson I Shepherd
6. Culbertson I Barsche
7. Phillips I Hat Mesa
8. Gackle I Federal
9. Getty I Etz
10. Jeffers I Etz
11. Zonne I Federal
12. Culbertson I Gilmore
13. Union Cal. I Gilmore
14. Trigg I Red Tank

Fig. 53 Oil and gas tests drilled in Pilot area

- Oil well
- Gas well
- Show of oil
- Show of oil and gas
- Plugged and abandoned
- Drilling well

from this well was 7.5 million cubic feet per day. No further tests were drilled in the area until 1973 when six wells were completed. Three were drilled to the Mississippian and three to the Morrow, resulting in two oil well completions and three gas well completions, all from the Morrow interval.

Exploration of pre-Permian rocks in the Pilot area involves nine wells with two completed as oil wells and four as gas wells for a wildcat success of 63 percent (excluding the South Salt Lake extension well). Oil and/or gas has been observed in 49 percent of the tests drilled, exclusive of the Yates/Seven Rivers wells in the northeast part of the area. Very little of this area has been tested thus far with 117 of the 144 sections involved having had no wells drilled to explore for oil or gas.

WATER INJECTION AND DISPOSAL WELLS

Based on data obtained from the New Mexico Oil and Gas Commission there were 30 water injection wells and 32 salt water disposal wells active in the Study area as of January 1, 1974 (fig. 54). The only injection wells near the Pilot area are in the Teas-Yates/ Seven Rivers field in T. 20 S., R. 33 E. Water in these wells is injected at relatively shallow depths in back reef deposits. The total amount of water injected up to 1974 amounted to 965,551 barrels at an average injection pressure of 1,835 p.s.i. The other secondary recovery operations in the Study area are all in the upper part of the Delaware Mountain Group at Malaga, Paduca, North Mason, and El Mar. The largest of these operations is the Paduca pressure maintenance program with 13,463,943 barrels of fluid injected at 985 p.s.i.

All disposal wells in the Delaware basin are injecting water into the Delaware Mountain Group, in most cases into the upper part of this interval. Water produced with oil at the Brushy Draw, North Mason, Salado Draw, Triple X, Pecos, Triste Draw, and Bradley fields is being disposed of either in the Ramsey pay zone or the underlying Olds sand. Over 460,000 barrels of salt water at an injection pressure of 650 p.s.i. has been disposed of in the northern Triste Draw well. The only other wells with appreciable amounts of injected water are in the Bradley field and one of the North Mason disposal wells.

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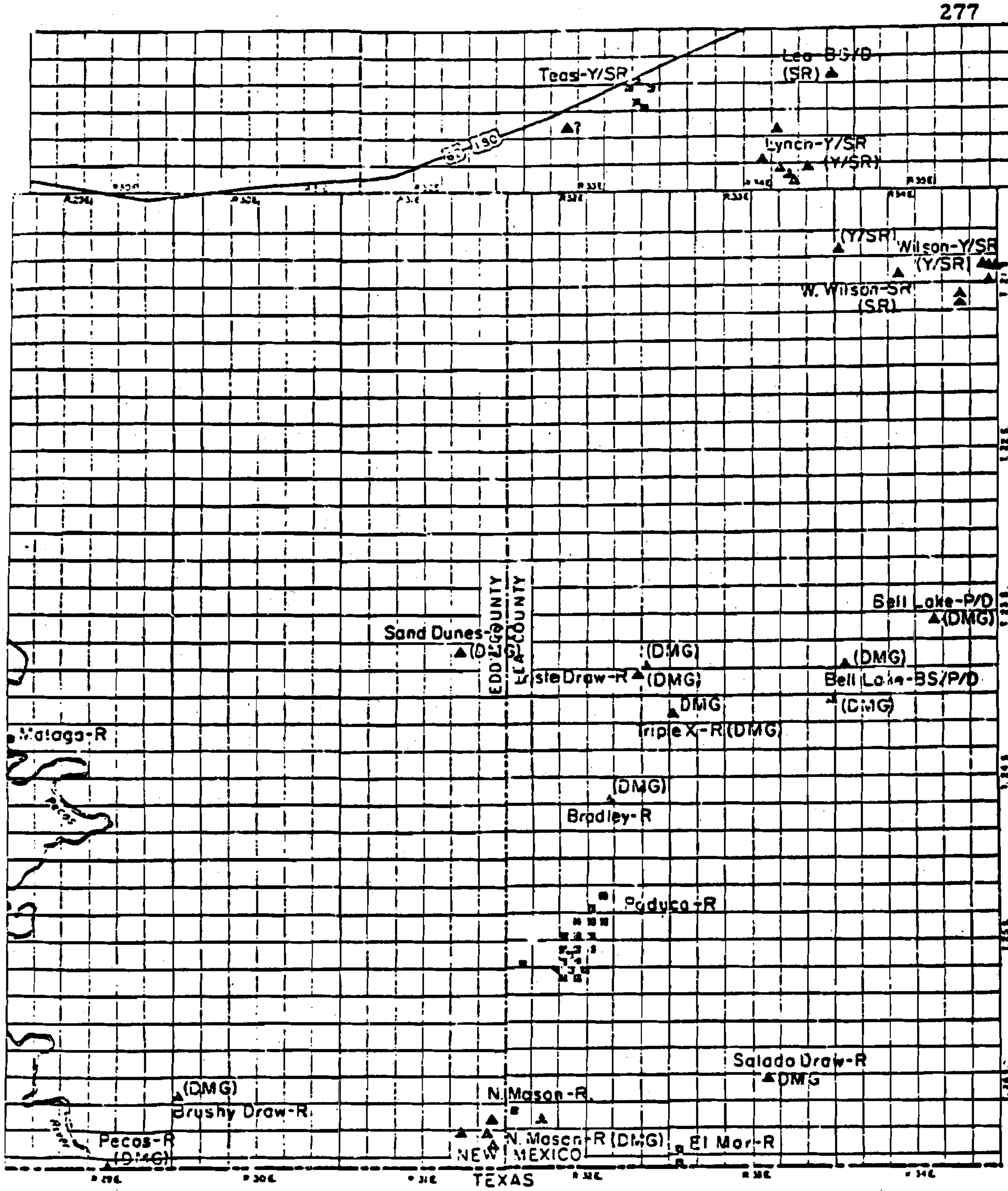

Fig. 54 Study area salt water disposal and injection wells as of January 1, 1974

0 5 10 miles

■ Injection well ▲ Salt water disposal well

(SR) Disposal interval
Y Yates
SR Seven Rivers
R Ramsey
CC Cherry Canyon
DMG Delaware Mountain Group
BS Bone Springs
P Pennsylvanian
D Devonian

Water at Sand Dunes is produced from the Cherry Canyon and is disposed of in the Delaware Mountain Group in the interval from 4,390 to 6,048 feet or possibly, limited to the interval from 5,700 to 5,800 feet. Water at Bell Lake is produced from the Bone Springs, Pennsylvanian, and Devonian and is disposed of in the Delaware Mountain Group. Disposal depths are from 5,018 to 7,530 feet. Total water injected as of January 1, 1974 was 4,666,567 barrels at an average pressure of 1,080 psi.

Disposal wells in the northeast part of the area are utilizing sandstones or reef limestones of the Yates/Seven Rivers intervals to dispose of water produced primarily from the same intervals. The exception is the disposal well in the Lea field where water is produced from the Bone Springs and Devonian intervals. Over 17 million barrels have been disposed of in the Lea well. No data could be found regarding disposal interval for the well in T. 20 S., R. 33 E. and there is no record of a well having been drilled at this location.

CONCLUSIONS

The potential oil and gas reserves for an untested section in the Pilot area are based on geological and statistical evaluations of each part of the geologic section known to contain commercial accumulations of petroleum (Table B). Geological evaluations in particular are subject to varying interpretations. In this report consideration was given to such parameters as the occurrence and number of suitable reservoir and source rocks; the type of trap most commonly associated with accumulations in a specific part of the section; the potential for this type of trap being present in the Pilot area and distribution of known occurrences of oil and/or gas primarily within the Study area. Potential for suitable traps, and particularly structural traps, was the most difficult parameter to evaluate. Seismic data would be invaluable in making a more exact determination for petroleum potential in the pre-Permian rocks, especially the Ordovician and Silurian/Devonian intervals.

Statistical evaluations were based primarily on productive acreage compared with total acreage tested, and wildcat success ratios. Other factors considered were the occurrence of petroleum, whether commercial or not, the number of oil wells versus the number of gas wells completed for each interval, average production per well, and oil/associated gas and gas/distillate ratios for each interval.

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The projected stratigraphic section underlying the center of the Pilot area (fig. 2) is limited to that part of the section considered to have some petroleum potential. Thicknesses and depths are based on the isopach and structural contour maps presented elsewhere in this report. At the center of the Pilot area an exploratory test of the entire sedimentary rock section having a potential for oil and/or gas accumulations would require drilling to a depth of approximately 18,000 feet. The shallowest possible occurrence of oil would be in the upper part of the Bell Canyon Formation at a depth of over 4,000 feet, and to penetrate rocks with the highest potential for gas in the Pennsylvanian and Silurian/Devonian would require drilling from 13,000 to 16,000 feet. As shown in Figure 2 the potential oil and/or gas zones, based on oil and gas wells in the Delaware basin, includes all of the sedimentary rock section except for those of Ordovician or Mississippian ages. In addition, within each of these intervals there is more than one potential pay zone.

Although nonproductive in the Study area, petroleum has been found apparently in noncommercial amounts in 63 percent of the few tests drilled into Ordovician rocks. In addition, these are suitable appearing source and reservoir rocks, a possibility of stratigraphic traps, and because of the known presence of faulted anticlinal structures in the deeper parts of the Delaware basin, a potential for similar features being present in the Pilot area. The potential for oil is considered very low, in part because of the depth of these rocks, but also the fact that shows are limited to gas, and gas and distillate. The gas potential was considered moderate from a statistical standpoint (Table 46) and given the same adjusted rating although no attempt was made to give possible reserves per section for the Pilot area. For comparative purposes the average production of an Ordovician gas well on the Central Basin platform is 5.2 billion cubic feet.

The statistical potential for the discovery of oil in rocks of Silurian/Devonian age is very good in the Study area based on success ratios. Average well yields are at least twice as great for this interval compared with any other part of the sedimentary rock section. Geologically, potential source and reservoir rocks are present, depth does not appear to be a limiting factor, and there is a possibility of suitable structural conditions. The apparent restriction on petroleum accumulation in structural traps does limit both the oil and gas potential for this interval. The adjusted rating for oil is low because of the concentration of oil wells in the northeast part of the area, absence of oil shows in the rest of the Study area, and the rather low distillate yield for gas wells of 9.4 barrels per million cubic feet. The latter point suggests almost complete disassociation of the oil and probable migration shelfward by updip spilling from gas-filled structures.

Geologically the gas potential of the Silurian/Devonian is favorable from the standpoint of source and reservoir rocks, but

	Rating					Production Estimate Section								Adjusted Rating		Adjusted Production Estimate Section							
	Geological		Statistical		P.O.F.	Acreage				Wildcat						Acreage				Wildcat			
	Oil	Gas	Oil	Gas		Oil (bbls)	Assoc. Gas (MCF)	Dist. (bbls)	Gas (MCF)	Oil (bbls)	Assoc. Gas (MCF)	Dist. (bbls)	Gas (MCF)	Oil	Gas	Oil (bbls)	Assoc. Gas (MCF)	Dist. (bbls)	Gas (MCF)	Oil (bbls)	Assoc. Gas (MCF)	Dist. (bbls)	Gas (MCF)
y	IV		V		62	472,350	756,324			75,052	120,141			IV		472,350	756,324			75,052	120,141		
are ip.	II		II		21	51,686	19,546			34,462	13,029			II		25,843	9,773			17,231	6,515		
s	III		IV		39	193,952	379,738			88,170	172,610			III		145,464	284,804			66,128	129,458		
	III	III	II	II	23	20,800	228,462	32,544	633,984	20,475	224,953	19,530	383,969	III	III	15,600	171,[illegible]17	24,408	475,488	15,356	168,715	14,648	287,977
l-	III	V	III	V	88	265,455	7,085,760	105,952	1,58[illegible],286	299,788	1,784,799	94,596	6,441,672	IV	~~IV~~ V	265,455	1,580,826	132,440	8,857,200	299,788	1,784,799	118,245	8,052,090
ip-	I	I	I	I	14																		
n/ an	III	III	IV	IV	72	1,368,330	656,676	36,720	4,244,310	343,422	164,804	36,562	4,225,491	I	IV	342,083	164,169	36,720	4,244,310	85,856	41,201	36,562	4,225,491
.	I	II	I	III	63										III								
															Totals	1,266,795	2,967,243	193,568	13,576,998	559,411	2,250,829	169,455	12,565,558

Ratings	Calculated %
Very low	25
Low	50
Moderate	75
High	100
Very high	125

TABLE 46. Calculated reserves for untested Pilot area section.

limited by lack of data supporting presence of suitable structures within the Pilot area. Gas occurs on both the east and west flanks of the Delaware basin indicating good distribution in the basin. Statistically, the gas potential is not as high as for Pennsylvanian rocks, but with a 14 percent success ratio from both acreage and wildcat wells it is considered high. Although distillate production is low per million cubic feet the average production of a Silurian/Devonian gas well in the Study area is over 7.5 billion cubic feet resulting in considerable production of distillate.

There is no oil or gas being produced from rocks of Mississippian age in the area of this report, and very few fields in other parts of southeastern New Mexico. From a geological standpoint the possibility of suitable reservoir rocks is considered remote and there is a low occurrence of reported oil or gas shows. The potential is therefore given a very low rating and no adjusted rating is given for the Pilot area. It can be argued that some potential production should be given. Certainly there are suitable source rocks both above and below this interval, and a possibility for porosity and permeability development through fracturing. However, similar to the Ordovician, distance from producing fields precludes using projected reserve figures in this area.

Based on average production per well, and acreage and wildcat success ratios, Pennsylvanian rocks have a high statistical potential for oil in the Study area. However, this is not verified from a regional standpoint or completion data which shows only one oil well completed for every seven gas wells. Geologically the oil potential is considered moderate because of suitable reservoir rocks, particularly in the Strawn interval, and possible presence of both stratigraphic and structural traps. The recent Morrow oil discoveries within the Pilot area add considerably to the potential, and are the reason for the higher adjusted rating.

The gas potential for the Pennsylvanian is rated very high from both a geological and statistical evaluation. The multiplicity of possible reservoir rocks, the occurrence of gas in both stratigraphic and structural traps, the numerous potential source rocks, and the widespread geographic distribution, combined with a high petroleum occurrence in 88 percent of the wells drilled, 55 percent of the tested acreage having proven production, and 51 percent of all wildcat tests successfully completed, all support the very high rating given this interval. Distillate production averages 13.2 barrels per million cubic feet of gas adding to the value of a gas well and increasing the possibility of exploration and discovery in the Pilot area. Although the projected potential reserves per section for the Pilot area are based on 125 percent of the projected average recovery, the estimate is considered conservative. Much of the development in the Study area is so recent that reserve projections were not possible by methods employed here and average projected yields in many instances were based on production to January 1, 1973. Because of this, average recovery per well for the

Study area was only 3.2 billion cubic feet compared with 5.8 billion cubic feet for all wells evaluated.

Statistically Wolfcamp rocks rank last in both oil and gas potential for productive intervals in the Study area. The occurrence of petroleum is a low 23 percent of the wells tested, and average oil and gas yields per successful completion are below the average for the area. Adequate testing of the interval however, is considered questionable even for wells that have penetrated to the potential Wolfcamp pay zones. Geologically the section is somewhat limited,as far as possible reservoir rocks are concerned, to a few carbonate beds. However, these favorable reservoir rocks are fairly widespread geographically, and the known fields have a good distribution pattern with many occurring on the west flank of the basin. There would appear to be no valid geological reason for rating the gas potential of these rocks higher than the oil potential.

In adjusting the ratio for Wolfcamp potential another factor that was considered was potential value of a Wolfcamp well. Within the Study area the average distillate production at 42 barrels per million cubic feet is more than three times that for gas wells producing from other parts of the section, and associated gas amounts to 11.6 MCF per barrel of oil, also the highest for the Study area.

Although trap conditions are not fully understood for the Bone Springs Formation they would appear to be in part structurally controlled. Suitable cap, source, and reservoir rocks occur throughout the interval, ıd vertical distribution of oil increases the overall potential. atistically the wildcat and acreage success ratios are fairly good r the Study area, but current field distribution indicates commercial cumulations of oil concentrated on the east and northeast flank of the elaware basin. The occurrence of oil is below average for the udy area, at 39 percent of the wells drilled into this interval, but r well production averages are exceeded only by those completed Pennsylvanian and Silurian/Devonian rocks. Gas potential is not ted but would have to be considered low inasmuch as there are no gas ells completed in this interval and associated gas amounts to only 0 MCF per barrel of oil. The adjusted rating gives a moderate tential for the discovery of oil, and projected reserves for the Pilot rea are based on 75 percent of the projected average recovery of l for an untested section.

Of oil and gas bearing stratigraphic units in the S area the elaware Mountain Group, statistically ranks just ahead lfcamp and has the lowest per well oil yield. Geologically e terval is not considered very favorable because of the appa sence of large traps and possibly a vertically interconnected drodynamic system that favors oil accumulation in the upper part the Bell Canyon Formation. The Delaware Mountain Group has a v ratio of associated gas with yields of 0.5 MCF per barrel of oil, o possibly suggesting lack of suitable traps. The occurrence of troleum is 21 percent compared with the average for the Study area 48 percent.

Geologically the Pilot area is considered favorable for oil accumulation in the Ramsey pay zone. Primarily this is because of the type of stratigraphic trap controlling accumulation of oil in this interval, and the potential for similar trap development anywhere in the depositional area of the upper part of the Bell Canyon Formation. The occurrence of petroleum is a high 62 percent and the Ramsey has the highest amount of successful acreage versus acres tested, and is second in wildcat success ratios. The average oil production per well, however, is lower than that of the Bone Springs, Pennsylvanian, and Silurian/Devonian intervals. The adjusted oil rating is high and reserve projections for the Pilot area are based on 100 percent of the projected yield per section.

Gas produced with oil averages 1.8 MCF per barrel based on production data to January 1, 1973. The adjusted reserves for the Pilot area are based on the average of all wells producing from the Ramsey interval. Although there are a few gas wells in the Study area only one gas well is completed for every 40 oil wells. No estimate was attempted for gas and distillate reserves.

The total projected reserves given in Table B indicate a range of from 559,411 to 1,266,795 barrels of oil; 2,250,829 to 2,967,243 MCF of associated gas; 169,455 to 193,568 barrels of distillate; and 12,565,558 to 13,576,988 MCF of gas. At first these calculations might appear high, but it must be considered that an entire section is being included with a potential of 16 · 1 well locations and two to four gas well locations. The highest figure used in determining reserves based on wildcat success ratios was 1.44 oil wells and 2.0 gas wells per section. For comparison 16 oil wells completed in the Ramsey would, based on average well production, recover over 1,000,000 barrels of oil, and two Silurian/Devonian gas wells over 15,000,000 MCF of gas. Where only part of a section might be withdrawn potential reserves might be prorated, but it is important to be aware that most fields in the Study area have stacked pay zones and no particular stratigraphic unit could be eliminated from consideration.

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