Paleotectonic Investigations of the Pennsylvanian System in the United States

Part II. Interpretive Summary and Special Features of the Pennsylvanian System

GEOLOGICAL SURVEY PROFESSIONAL PAPER 853

PART II OF III

Paleotectonic Investigations of the Pennsylvanian System in the United States

Part II. Interpretive Summary and Special Features of the Pennsylvanian System

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GEOLOGICAL SURVEY PROFESSIONAL PAPER 853

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1975

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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Library of Congress Cataloging in Publication Data
Main entry under title:
Paleotectonic investigations of the Pennsylvanian System in the United States.
(Geological Survey Professional Paper 853)
Bibliography: v. p.
Includes indexes.
CONTENTS: pt. 1. Introduction and regional analyses of the Pennsylvanian System.—pt. 2. Interpretive summary and special features of the Pennsylvanian System. pt. 3. Plates.
Supt. of Docs. no.: I 19.16:853
1. Geology, Stratigraphic—Pennsylvanian. 2. Geology—United States.
I. McKee, Edwin Dinwiddie, 1906- II. Crosby, Eleanor J. III. Series: United States Geological Survey Professional Paper 853
QE673.P34 551.7'52'0973 75-619122

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402
Stock Number 024-001-02725-9

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PALEOTECTONIC INVESTIGATIONS OF THE PENNSYLVANIAN SYSTEM IN THE UNITED STATES, PART II: INTERPRETIVE SUMMARY AND SPECIAL FEATURES OF THE PENNSYLVANIAN SYSTEM

INTERPRETATION OF PENNSYLVANIAN HISTORY

Compiled by EDWIN D. MCKEE

INTRODUCTION

An interpretive summary of paleotectonic events of the Pennsylvanian Period has been compiled from data supplied by the geologists who prepared the regional chapters in Part I of this publication. The contributing geologists were:

George O. Bachman	Ernest E. Glick	Edwin D. McKee
Kenneth G. Bell	William P. Irwin	George E. Prichard
Eleanor J. Crosby	William W. Mallory	Gary F. Stewart
George H. Dixon	William J. Mapel	Harold R. Wanless
Sherwood E. Frezon	Edwin K. Maughan	Richard F. Wilson

Interpretation of the paleotectonic history of the Pennsylvanian System is represented on two sets of maps, one referred to as *interpretive isopach maps* and the other as *interpretive paleotectonic maps* (pl. 15*A*–*C*). Each set includes five maps, one for each interval of the Pennsylvanian. All maps of both sets were prepared at the same scale (1:5,000,000) and are published at a scale of 1:10,000,000. Therefore direct comparisons can readily be made.

The interpretive isopach maps are derived from the isopach maps of present rock thickness (pls. 3, 6, 7, 8, and 9) as determined from outcrops and boreholes. The areas of present Pennsylvanian rock distribution, both surface and subsurface, are shown on the interpretive isopach maps in green. Estimates of the original thicknesses of strata for each interval are shown by restored isopachs superimposed on the areas of present extent, and estimated original margins of depositional areas are indicated by zero isopachs. Because all these data are estimates, no question marks or broken lines are used to indicate uncertainty — the maps are interpretations and are intermediate in subjective character between the isopach maps showing present distribution and thickness and the interpretive paleotectonic maps.

On the interpretive isopach maps, the principal positive and negative areas as determined from reconstructed isopachs are indicated. Positive elements are labeled as "low" or "high" according to deductions based largely on characteristics of the detrital sediments derived from them. Negative elements are classified as geosynclines, basins, troughs, shelves, and platforms, largely on the basis of shape and depth of fill as illustrated by the reconstructed isopachs. The criteria used in applying this classification are shown in figure 1. Miogeosynclines are distinguished from eugeosynclines largely by the kinds of contained sedimentary rocks. Directions of sediment transport determined from crossbedding and other current vectors or from grain-size distribution, and the relative amounts of transported sediment, are shown by arrows. Thick arrows indicate coarse sediment; thin arrows, fine; long arrows indicate much sediment; short arrows, little.

Paleotectonic maps are derived from the interpretive isopach maps. They are designed to emphasize structural activity and trends within the conterminous United States during deposition of each of the five intervals of the Pennsylvanian System. The axes of features having linear configuration, such as geosynclines, troughs, arches, and certain other uplifts or positive elements, and the centers of more nearly equidimensional features, such as basins and most small positive elements, as determined from thickness relations and trends, are shown. Positive areas that underwent considerable uplift (estimated at more than 1,000 feet) are in brown; those that underwent little or no uplift (estimated at less than 1,000 feet) are yellow. Similarly, negative areas are in different shades of blue according to the amount of subsidence. Other structural features of Pennsylvanian age, indicated by appropriate symbols, are zones of overthrusting, belts of slight deformation, and belts of severe deformation; areas of volcanic deposits also are represented. Thus, the structural pattern of the continent is portrayed in broad terms that permit generalizations regarding its history.

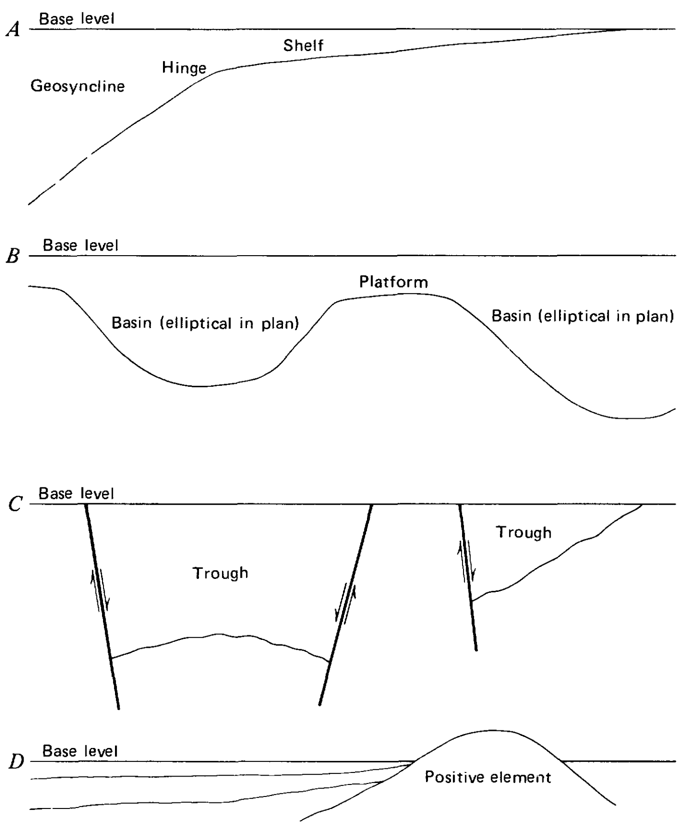

FIGURE 1. — Terms for structural features as used in this paper.

STRUCTURAL FRAMEWORK

The structural framework of interval A of the Pennsylvanian System was to a considerable extent inherited from earlier Paleozoic time and included many major structural features already established. As shown on plate 15*A*, figure 2, the major structures have axes oriented in one of two principal directions, northeast or northwest. Those with a northeast trend include the Appalachian positive element and bordering geosyncline, the southwestern part of the Ouachita geosyncline in eastern Texas, and both northern and southwestern ends of the Cordilleran geosyncline. A northwest trend controlled the La Salle anticline, the Frontrange positive element and the Central Colorado trough, the Oquirrh basin, and parts of the Cordilleran geosyncline.

Trends of some simple structural features, largely in the north-central part of the United States, differ from those of the two main sets by having a north-south orientation. Such structures include the Nemaha anticline, the Mississippi River arch, and the Duquoin monocline, among others.

Some compound structural belts had anomalous trends in certain segments. Among these are the Arkansas part of the Ouachita geosyncline, which trends east; the Nashville-Cincinnati-Kankakee structure in which the middle part extends north; and the Central Kansas uplift-Cambridge arch, which also trends north in its central part. Some compound structures bifurcate, and the resulting branches parallel two different major structural trends. An example is the branching north end of the Cincinnati arch.

Although axes having a northwest trend are about equal in number to those having a northeast trend, the northwest series is largely in the western half of the continent and the other series largely in the eastern half. North-trending axes are mostly in between. This almost fan-shaped pattern possibly is related to compression from the continental margins, which are approximately parallel to the adjacent major structural axes. No readily apparent explanation has been found for the compound cross-structure trends.

The overall symmetry is perhaps related to a midcontinent gravity high (American Geophysical Union and U.S. Geological Survey, 1964; King and Zietz, 1969) that today extends from western Lake Superior through Abilene, Kans., to a point west of Wichita, Kans. This belt of high gravity contains the Precambrian Keweenawan mafic igneous rocks and includes the Duluth Gabbro Complex. Uplift in Pennsylvanian time of the Applachian positive element, the Antler positive element where relief was less, and also probably the Frontrange and Uncompahgre positive elements may have resulted from compression of the continental margins against the Precambrian core of the craton, which served as the ultimate stable element.

INTERPRETATION OF INTERVAL A

STRUCTURAL FEATURES

The dominant structural features along the eastern margin of the continent during the time of interval A were the Appalachian geosyncline and an accompanying positive element or landmass to the east. Conclusions about the geosyncline are fairly trustworthy because parts of the geosyncline are still preserved. Conclusions about the landmass are necessarily much less certain; they are inferred from characteristics of the sediments derived from the land. In the present coastal region, still farther east, information about Pennsylvanian rocks and about tectonic events and features is completely lacking. For this reason, the easternmost part of the continent is shown blank on the maps. According to modern concepts of earth history, the North American and European continents were probably joined in Pennsylvanian time, and orogenic belts in the northeastern United States were continuous with those of western Europe. Reconstructions of a eugeosyncline or of an ocean basin off the present coast of the United States in Pennsylvanian time were once thought likely but are now generally considered wrong.

The Appalachian geosyncline in interval A time was a linear feature that extended from Pennsylvania south to Alabama and Mississippi. Localized elliptical basins formed in at least two parts of the larger downwarped belt, as shown by thickened deposits of sediment. One of these basins was in eastern Pennsylvania, and the other, Black Warrior basin, was in central Alabama and Mississippi (pl. 15*A*). In the southern basin, the amplitude of downwarping was particularly great — more than 9,000 feet.

No sedimentary record of interval A has survived in the Appalachian geosyncline of south-central Pennsylvania, south of the present-day Southern Anthracite basin, although a thin covering of sediment, probably derived from a region of low relief to the southeast, may once have been there. Farther south, from West Virginia through Tennessee to northern Alabama and Georgia, strata representing the latter part of interval A and including much sandstone with pebbles of vein quartz are present, but nowhere are these deposits very thick (pl. 15*A*), and downwarping was probably slight.

West of the northern part of the Appalachian geosyncline, several shallow basins that received small amounts of sediment apparently were partly isolated from one another by low positive elements. One of these basins that developed in Ohio and western Pennsylvania was roughly elliptical in outline, and it was largely filled with alluvial and deltaic deposits. Another was the circular Michigan basin where downwarping began after mid-Mississippian time and a narrow trough apparently formed a connection with a marine shelf to the northwest. A third was the Illinois basin which began to form in southern Illinois at the upper end of an ancestral Mississippi embayment. Although some of these basins, and some of the positive elements between them, trend northeast or northwest, parallel to major structural features of adjoining areas, the trends of minor features in this region seem inconsistent.

A major structural belt commonly referred to as the Ouachita geosyncline extended in a broad arc from the south end of the Appalachian geosyncline northwestward, westward, and finally southwestward. During the time of interval A, it was an elongated trough, 70-100 miles wide, having a shelf on each side in Alabama, Arkansas, and Oklahoma. Although sediments of interval A generally are somewhat thinner in the Ouachita geosyncline than in the adjacent southern part of the Appalachian geosyncline, they are, nevertheless, more than 6,000 feet thick in parts of Arkansas. The southwest-trending segment of the Ouachita geosyncline in Oklahoma and Texas was a major structural feature of that region, but far less sediment accumulated in it than in the more easterly areas. Major branches of the system conform to either the northeast or to the northwest major trends of the continent and are the Ardmore and Anadarko basins that extended northwest in Oklahoma, and the ancestral Mississippi embayment that extended northeastward in Arkansas, Tennessee, and Kentucky to connect with the Illinois basin.

Among the most active structural features during deposition of interval A were the Ardmore basin and its continuation, the Anadarko basin in Oklahoma. Downwarping of at least 5,000 feet took place locally along these structural axes. Uplift of comparable magnitude accompanied by normal faulting took place in the narrow Amarillo-Wichita uplift to the south, as partly indicated by the volume of coarse sediments that were shed both north and south of the uplift. The Palo Duro basin to the south and the Dalhart basin to the northwest of the Amarillo-Wichita uplift apparently were only moderately active, as indicated by relatively thin accumulations of shallow-water sediment in the basin.

An extensive, mildly positive lowland lay north of the Ouachita geosyncline and Anadarko basin during interval A. It is commonly referred to as the Siouxia landmass. This emergent area corresponded closely to a present-day midcontinent gravity high (American Geophysical Union and U.S. Geological Survey, 1964). A few major structural features such as the Mississippi River arch, Nemaha anticline, central Kansas uplift, and Cambridge arch are inferred to have been locally active within this positive area. These structural features are known to have been forming earlier in the Paleozoic, and evidence of activity is clear in later Pennsylvanian time. The central part of Texas, partly enclosed by the Ouachita geosyncline, was mostly a stable, slightly emergent platform, probably with slight relief. A region south of the Delaware basin and north of the Marathon salient of the Ouachita geosyncline may have been more strongly uplifted than the surrounding areas.

A mildly downwarped belt extended along the west side of the great interior landmass of Siouxia (pl. 15*A*, fig. 2) from Canada southeastward to connect with the tectonically active Anadarko basin of Oklahoma. Thin deposits of shelf-type sediment of interval A accumulated throughout this belt in contrast to deposits as much as 5,000 feet thick that accumulated in parts of Oklahoma at the same time. Traces of the Hugoton embayment where deposits of interval A attain a thickness of 500 feet can be detected in the southern part of this negative area at the northwest end of the Anadarko basin in western Kansas and southeastern Colorado. The northern part of this mildly negative area forms a broad reentrant in North and South Dakota in the area of the shallow, northwesterly trending Williston basin. Strata of interval A are 250 feet thick in the center of this embayment. Farther west, in north-central Montana, a better defined, similarly trending basin contains more than 1,000 feet of sediment of interval A. In southeastern Montana, discontinuities in the isopachs define the Cedar Creek structure and other linear structures that are probably northwest-striking faults, believed to have been active at this time.

Downwarping occurred across trans-Pecos Texas and parts of southern New Mexico and Arizona, allowing a shallow sea to cover this area west of the interior lowland of Texas. An incipient Delaware basin, the Orogrande basin, and northern end of the Sonoran geosyncline can be distinguished in the region bordering Mexico.

Structural elements in the central Rocky Mountain region display definite northwest trends in interval A, including the Frontrange and Uncompahgre positive elements, and the Central Colorado trough. Uplift of the ancestral Frontrange is indicated by fine detrital sediment in the Colorado Springs area. The amount of uplift of the central Rocky Mountain structures probably was small compared with that during succeeding intervals, for the maximum thickness of strata trapped in the Central Colorado trough did not greatly exceed 500 feet during interval A. In northwestern Wyoming and southeastern Idaho a low unnamed landmass was separated from the Frontrange uplift by the Sweetwater trough. In northern Idaho another positive element, probably anticlinal with a northwest-trending axis, was also active.

The elongate, northwest-alined Oquirrh basin in northern Utah and southern Idaho sank rapidly during the time of interval A, and more than 1,000 feet of carbonate rock accumulated there. Farther west and south in Nevada, the Bird Spring-Ely basin, trending southward roughly parallel to the Oquirrh basin, likewise received sediment to a thickness of more than 1,000 feet. A broad, shallow embayment or trough that branched from the Bird Spring-Ely basin toward the southeast may have connected this basin with the Sonoran geosyncline of southeastern Arizona.

A large, indefinitely defined positive element extended across central Nevada and southwestern Idaho. This feature, called here the Antler positive element, coincided closely with the Late Devonian-Early Mississippian Antler orogenic belt. It separated a eugeosyncline farther west from the Oquirrh and Bird Spring-Ely basins to the northeast and southeast, respectively. Little is known about the eugeosyncline, as only fragmentary and isolated remains of rocks deposited in it are preserved in a wide area that includes northwestern Nevada, California, Oregon, and Washington. Limited petrographic and stratigraphic information from these exposures suggests a mobile downwarped belt that locally included positive elements, volcanic islands, island arcs, and continental rises. The mobile belt is thought to have merged westward into the deep ocean.

INFERRED MARGINS OF DEPOSITION

Regions in which the inferred margins of deposition of interval A extend considerably beyond the present limits are readily apparent on the interpretive isopach map (pl. 15*A*, fig. 1).

In the Appalachian region of the Eastern United States a great thickness of interval A is believed to have been removed all along the geosynclinal belt east of the present area of interval A outcrop. Thickness trends suggest that sediment once accumulated to a thickness of as much as 2,000 feet in the northeastern part of the geosyncline, 2,000 feet in the central part, and more than 9,000 feet in the southeastern part.

Strata of interval A west of the geosyncline in northern Pennsylvania, Ohio, and Illinois probably never extended far beyond their present limits. In contrast, strata of interval A in the Michigan basin are thought to have originally been much more extensive (pl. 15*A*, fig. 1).

Two areas in the Midwest in which sediments of interval A probably accumulated more extensively than represented today are in the area of ancestral Mississippi embayment, which connected the Illinois basin and the Ouachita geosyncline, and in the southern part of the Ouachita geosyncline. The Mississippi embayment may once have contained sediment of interval A to a thickness of between 1,000 and 2,000 feet; parts of the geosyncline in Arkansas and Oklahoma may have contained strata exceeding 15,000 feet in thickness.

In the Texas Panhandle-Oklahoma region, margins of deposition during interval A seem to have been about the same as the present-day margins (pl. 3*A*) except near the south end of the Nemaha anticline. This area was probably buried during interval A time. Farther west, in the central Rocky Mountain region and in the Cordilleran miogeosynclinal belt, isopachs (pl. 15*A*, fig. 1) likewise are restored to show the original thickness and extent of interval A, which are only slightly different from the present-day thicknesses and extent. Notable exceptions are on the Apishapa uplift in southeastern Colorado, at the southern end of the Central Colorado trough (Rowe-Mora basin) about which little is known, and in the northern Arizona shelf where intra-Pennsylvanian erosion removed part of the record.

In parts of the northern Rocky Mountain and northern Plains areas, the outer limit of deposition of interval A, as inferred from the eastward rate of thinning and the facies relations, was 50-100 miles east of the present truncated edge of the interval in eastern North Dakota and northwestern Montana. A shoreline facies in interval A rocks along the southern margin of Williston basin in South Dakota indicates that the depositional edge of interval A nearly coincided with the present-day zero isopach in the area.

The eugeosyncline at the far western margin of the continent is poorly known and its boundaries are largely speculative. The eastern boundary is believed to have been determined by the north-trending Antler positive element in central Nevada and eastern Idaho, but few data are available for locating a margin of deposition. Even more speculative is the western boundary that presumably was subparallel to the eastern boundary and that may have merged with the deep area west of the present Sierra Nevada.

SOURCE AREAS

Interval A in the Appalachian geosyncline had four principal source areas as determined by the thickness and facies relations of the detritus that accumulated.

Coarse gravels in the northeast section of the Appalachian region, principally in the Anthracite coal field of Pennsylvania, indicate that a highland source area lay to the south or southeast, near the present site of Philadelphia. The absence of any interval A strata in south-central Pennsylvania suggests that sediments, if ever present, were thin. Their probable source was to the southeast and probably was an area of relatively low relief. Interval A in the central Appalachian area of West Virginia, Virginia, Kentucky, and Tennessee contains much pebbly sandstone including abundant pebbles of quartz which indicate an origin in a greatly uplifted terrane of vein-bearing crystalline schists like that found in the Piedmont to the southeast. A high area south of the Cahaba coal field in the southern Appalachian highlands was the source for an extreme thickness of interval A in central Alabama.

The currently recognized abrupt south termination of the geosyncline in Alabama and Louisiana may be the result of major faulting, for south of the area in question Jurassic rocks rest on Lower Ordovician. Whether Pennsylvanian strata once extended farther south than east-central Louisiana is not known. No marked increase in coarseness of sediment is noticeable along the present southern margin of the geosyncline that would indicate land to the southwest.

Strata of interval A filling an elongate basin in northern Pennsylvania and Ohio apparently accumulated as alluvial and deltaic deposits, including much pebbly sand that apparently was transported from a northern source. Many of the pebbles were derived from Devonian chert similar to that in the area of western New York and probably came from either New York State or farther north. South of this basin, in southern Pennsylvania and central Ohio, a positive element formed a barrier of southward-dipping Mississippian limestone. This barrier was a low divide separating sediments derived from northern and southeastern sources.

The source of sediment of interval A in the Michigan basin seems to have been to the northeast and north, the largest volume entering through the present site of Saginaw Bay (pl. 15*A*). A wedge of sand and mud about 300 feet thick accumulated near this entrance to the basin. Much of the sediment was stream-transported quartz sand, derived from sedimentary strata of middle and early Paleozoic age. A marine limestone within the basin indicates a former sea connection; the record of its location, however, has been destroyed by subsequent erosion. Probably the sea transgressed from the northwest, for the lithology of interval A to the southeast, south, and west in areas beyond the basin precludes the likelihood of a marine advance from those directions.

In the Illinois basin, sediment entered largely from the northeast. Fifteen main stream channels have been recognized in Indiana. Their orientation suggests that sediment from southern Quebec, Ontario, and part of northern New York was transported southward along a corridor in Ohio southeast of the Michigan basin and northwest of the Appalachian region. Much sediment continued south through the Illinois area because of differential downwarp along the Duquoin monocline. Additional sediment was transported into this area from the highlands of Virginia and North Carolina, passing through a saddle between the Cincinnati arch and Nashville dome. Final deposition for much of the sediment was in the downwarped area of Arkansas, far to the south.

Interval A deposits in a small area of northwestern Illinois and in adjacent Iowa probably were introduced by streams from the northwest. Possibly these deposits were originally continuous with those in the rest of the Illinois basin to the southeast, but as yet no evidence has been found to demonstrate such a connection. The extensive midcontinent region west and north of this basin seems to have been a low landmass during the time of interval A, as indicated by the fineness of sediment derived from it. Continental deposits of Morrow age not yet recognized may have accumulated in parts of western Iowa and Kansas that are shown as a land area.

Detrital sediment of interval A in the most active part of the Ouachita geosyncline — in Arkansas and in northern Louisiana — is calculated to have had a volume of 30,000 cubic miles, and an equal or greater volume of sediment possibly was transported west and southwest across the area during this time. Much of the sediment seems to have been deposited by turbidity currents. This vast amount of sediment apparently had two major sources: (1) The region of northern New York and eastern Canada, from which mature to semimature detritus was transported along the route of the present

Ohio and middle Mississippi Rivers. Sediments from this region included little feldspar and few heavy minerals other than tourmaline and zircon; quartz granules and pebbles were locally common. (2) The southern Appalachians furnished, partly in the form of turbidites, much detritus from a metamorphic terrane. A large percentage of feldspar and various heavy minerals was characteristic; quartz granules and pebbles were common.

Sediments in the east Texas segment of the Ouachita geosyncline contain directional indicators that suggest transportation by turbidity currents southwestward along the structural axis. Farther west, in the Marathon salient of the geosyncline, much of the sediment apparently was furnished from land to the south, as indicated by trends in thickness and in facies, and by current indicators. Some sediment, including conglomerate, apparently came from the northwest.

Interval A on both flanks of the Amarillo uplift contain moderate to large amounts of sandstone, probably reflecting nearness to a mountainous area of considerable relief. Other land areas in the region provided detritus, but only fine sediment including much carbonate sediment is adjacent to most of the land areas, suggesting that they were low. The Delaware basin in southwestern Texas probably received most of its sediment from surrounding low-lying land, as suggested by facies relations and by remoteness from other possible sources.

The Williston basin in the Dakotas apparently received some sand and much finer sediment largely from the extensive lowland called Siouxia to the east and southeast. A broad river valley trending northwest across Siouxia may have occupied a synclinal extension of the Williston basin. In any event, a dominance of mudstone in the basin center early in the interval and a gradation upward, later into increasingly calcareous sediment reflect the expansion of Early Pennsylvanian seas across areas of low relief.

In the Colorado Rocky Mountain region, a restriction of coarse detrital sediment of interval A to a few places on the east flank of the present-day Front Range indicates that uplift of the Frontrange positive element was very local and minor at that time. Farther north in Montana terrigenous source areas of moderate size, but not of great height, probably existed in Idaho and western Wyoming from where fine sediments were carried to the east and north, respectively.

Pennsylvanian sediment of interval A preserved in the few scattered areas of outcrop in the far western part of the United States probably had its sources at least partly in the Antler landmass and partly in local islands within the eugeosyncline west of the Antler region in Nevada; data are insufficient, however, to locate the sources specifically. Volcanic materials are estimated to make up 18-24 percent of the Pennsylvanian rocks in the El Paso Mountains (loc. 143) and in the Calico Mountains (loc. 206) in the western Mojave Desert of California (Dibblee, 1952, p. 15-19; McCulloh, 1954, p. 15). In the El Paso Mountains, 42 percent of the rock is chert (Dibblee, 1952, p. 15).

CHEMICAL SEDIMENTS

A negligible amount of chemical sediments accumulated in the Eastern United States during the time of interval A. Sediment in the Appalachian geosyncline, the Michigan and Illinois basins, and other less extensive areas was dominantly terrigenous in all but a few very small and local areas. This is partly because the sea did not at this time cover large parts of the region and partly because the large percentage of terrigenous sediment from adjacent areas tended to mask the presence of carbonate deposits throughout the region.

Bioclastic and oolitic carbonate sediments are well represented in interval A west of the Mississippi River within and flanking the Ouachita geosyncline. In shelf areas, north of the very thick accumulation of sediment in Arkansas and Oklahoma, strata are locally more than 50 percent carbonate rock and were probably deposited in a shallow-water and shoaling sea.

Bioclastic limestone is extensive west of the Ouachita geosyncline in north-central Texas suggesting conditions of shallow, clear water. Even in places where downwarping was continuous, as east of the Ardmore basin, on the north side of the Ouachita geosyncline of Oklahoma, much muddy limestone was deposited, but in these areas its presence is largely obscured by vastly greater amounts of detrital sediment.

In west Texas, extensive beds of limestone were deposited during interval A time in what probably were shallow waters in and near the Delaware basin. Much carbonate sediment also accumulated in the north end of the Sonoran geosyncline in Arizona and New Mexico.

The most widespread carbonate seas in the United States during interval A time occupied a broad region west of the present-day Colorado Rocky Mountains. Much carbonate mud was combined with terrigenous mud along the shore areas in western Utah, eastern Nevada, and northwestern Arizona, especially to the south. The Sweetwater trough in southern Wyoming and the Eagle basin in the northern part of the Central Colorado trough in Colorado also were areas of calcium carbonate accumulation.

In the northern Rocky Mountain region, marine limestone is widespread only in the upper part of interval A. Calcium carbonate formed earliest in the axial parts of the troughs and basins, but was deposited virtually throughout the region by the end of interval A time. In North and South Dakota, carbonate rock grades eastward and southeastward into mudstone, indicating land sources in those directions.

Only minor deposits of calcium or magnesium carbonate are recorded in the sparse remnants of marine strata in far western United States. Interbedded chert and argillite and some greenstone are the principal rock types in the western Nevada deposits.

CLIMATE

Widespread and numerous coal swamps developed in many parts of the United States during the time of interval A and are strong evidence that a humid, probably warm climate prevailed at that time. Coal beds that constitute this record occur in both lower and upper parts of the interval in the Anthracite field of Pennsylvania, in the central and southern Appalachians, and in the northern part of the Ouachita geosyncline. Coals are in only the upper part of the interval in western Pennsylvania and in the Illinois and Michigan basins. Thin, local coals occur farther west in Iowa. Coal swamps apparently became more widespread and better established with time. Presumably, a climate favorable to the forming of coal also became more widespread.

Compilations prepared by H. R. Wanless (pl. 16) of coal thickness and of the total number of coal beds in interval A for each of several principal regions show that frequent and cyclic recurrence of coal-forming conditions was typical of much of the Eastern United States and parts of Western United States. For instance, deposits of coal at least 60 feet in cumulative thickness and including more than 30 beds are represented in the southern Appalachian region in interval A. In other parts of the geosyncline or in other basins, the number of coal beds ranges from 5 to 20, and the cumulative thickness of deposits ranges from 5 to 40 feet.

Further evidence elucidating climatic conditions is furnished by karst surfaces covered by residual red soils. Deposition of interval A began on such surfaces in numerous areas. These relations are compatible with a warm and humid climate such as is also inferred from the distribution and abundance of coal. Regions in which karst surfaces and residual red soils are well developed are the Ozark Mountains of Missouri, parts of the central and west-central Texas region, the area of the Molas Formation in southwestern Colorado, and large parts of central and northern Arizona.

Locally within the United States, climatic conditions may have differed considerably from the norm as just described. In the northwestern part of the Michigan basin, some gypsum was formed during interval A, possibly because part of the basin was cut off by distributary deposits of sand at a time when the climate was dry enough to cause marked evaporation (H. R. Wanless, writen commun., 1969). In Montana and North and South Dakota, existence of a reducing environment in early interval A time, represented by deposits that are carbonaceous and that contain a tree-fern flora, was followed in late interval A time (interval A_2) by widespread deposits of red beds, indicating change to an oxidizing environment (E. K. Maughan, written commun., 1968). In northwestern Arizona, extensive deltaic deposits of late Morrow age also include a considerable number of red beds.

Evidence that temperatures of extensive water bodies fluctuated between warm and cold is available for the Ouachita geosyncline and adjacent shelf area in Arkansas. Times of shoal water on the shelf when oolitic calcium carbonate was accumulating and coal swamps flourished nearby were characterized by warm water; in contrast, at times when the sea level was higher, currents of cold water welled up from the adjacent depths to the south and circulated across the shelf area under the influence of high-energy waves. How much these changes in water temperature affected the climate of the land is not known, but such changes may have had a noticeable impact in that region.

INTERPRETATION OF INTERVAL B

STRUCTURAL FEATURES

The overall structural framework, with dominantly northeast and northwest trends in interval B, was generally like that of interval A. A few new structural features appeared in interval B and, in some areas, uplift or downwarping seems to have been rejuvenated. Most areas of deposition were enlarged — the result of a broad negative tendency of the continent as a whole with resulting transgression of the sea (pl. 15*A*). Lowlands that were considerably reduced in area during this interval include the southern Appalachian region, Siouxia, central Texas, and much of Arizona, New Mexico, and Utah.

The region east of the Appalachian positive element, which includes much of the present Atlantic margin of the United States, apparently was not eugeosynclinal and probably was positive during interval B of the Pennsylvanian. This concept is supported by comparative data from the Old World. Structural trends of this age in parts of eastern America, formed prior to continental drift in Mesozoic time, correspond to trends of the Hercynian belt in Europe and Africa (Zwart, 1967). These structures contrast with those of the earlier Caledonian eugeosynclinal-miogeosynclinal couples of western Europe and have a different trend.

The New England region of Eastern United States includes, in a few areas in its southeastern part, Pennsylvanian deposits similar to those in maritime Canada. Thicknesses range from approximately 1,000 to 12,000 feet. Whether these deposits were connected to each other or to the main body of Pennsylvanian rocks in the Appalachian belt is not known; possibly, they were separated in Pennsylvanian time from deposits in the Appalachian region by land along an earlier (Acadian) orogenic axis. These New England rocks are shown only on the maps of interval B (objective map, pl. 6; interpretive map, pl. 15*A*), even though they may have been deposited through much of Pennsylvanian time. Dating of Pennsylvanian rocks in this area is so poor that interval assignment must be arbitrary.

The Appalachian geosynclinal belt of eastern America at the time of interval B was in a late stage of filling, as indicated by types of rock in the coal basins of West Virginia and Pennsylvania and possibly those of the Maritime provinces. Coal basins in the Eastern United States seem comparable in size to the Upper Carboniferous coal basins of the English Midlands and the Ruhr of Germany. The basins in these several regions would form part of a continuous linear belt if restoration were made of the North American and European continents to their configuration during Pennsylvanian time as suggested by Zwart (1967).

A comparison of paleotectonic maps of intervals A and B for the United States (pl. 15*A*, figs. 2, 4) shows that during interval B some new structural features, both uplifts and downwarps, began to form in widely separated regions. The Forest City basin of Iowa, Nebraska, and Kansas began to form in what earlier had been a part of the great interior lowland or landmass of Siouxia. In the central Texas part of the Ouachita geosyncline, the Fort Worth basin or embayment in the north and the Kerr basin farther south attained their characteristic forms as a result of moderate sinking, although the beginnings of their development may date back to interval A time. In west Texas a Midland basin appeared for the first time, though with indefinite form, leaving the low Central Basin platform between it and the Delaware basin farther west. In the northern part of Texas, the Muenster and Red River arches began to rise as positive elements along the south side of the Amarillo-Wichita uplift at the Oklahoma border.

Other developments first recognized during the time of interval B include uplift of the Uncompahgre, the southern Frontrange, and the Apishapa positive elements in Colorado, and the beginnings of the Pathfinder uplift in Wyoming. Downwarping of the Paradox basin in Utah and adjoining areas also was initiated. Farther north, in Montana, regional warping late in interval B time produced low anticlinally arched areas having axial trends both to the northeast and to the northwest. Most conspicuous of those folds was the Cedar Creek structure, a northwestward-trending, slightly en echelon anticlinal extension of the Cambridge arch of Nebraska. This tectonism locally and briefly interrupted sedimentation in Montana and North and South Dakota.

In the far western United States, the northeast-trending Antler positive element was much less continuous than during interval A, and the amount of its uplift probably much less (pl. 15*A*). A broad trough formed across it in northern Nevada connecting the eugeosyncline on the west and the Cordilleran miogeosyncline on the east. A positive element in northern Idaho, postulated for interval A, apparently no longer existed as land. Also noteworthy is the probability that the southern end of the Cordilleran miogeosyncline was no longer blocked by a positive area across southern California but was open toward the southwest.

In most regions the negative elements of interval B were more extensive than corresponding ones of interval A. Examples are in the northern Appalachian region; across large parts of Siouxia or the interior lowlands, especially north and west of the Illinois basin and bordering the Forest City basin; along parts of the margin of the Ouachita geosyncline; across much of the Texas interior lowland; and throughout extensive areas in Wyoming, Idaho, and a few other western states.

With the expansion of negative areas and accompanying broader transgressions of the seaways many positive elements became more clearly defined and appear on the map (pl. 15*A*) as isolated islands surrounded by areas of deposition. Especially notable in this connection are the greatly restricted Cincinnati arch, Nashville dome, and Ozark dome in Eastern United States. On the Ozark dome, extensive cavern and sinkhole development took place. In Western United States the Uncompahgre, Frontrange, Apishapa, Sierra Grande, and Pathfinder uplifts became islandlike elements and the landmass in western Wyoming and adjacent Idaho and Utah was greatly reduced in size.

INFERRED MARGINS OF DEPOSITION

Deposits of interval B in the Appalachian geosyncline were once thicker and far more extensive than they are today. Scattered remnants in the Anthracite field of eastern Pennsylvania, the projection of thickness trends, and the pattern of lithofacies all suggest that the original margins of the depositional area probably extended north into central New York State and east as far as New Jersey. In the central and the southern parts of the Appalachian geosyncline, the area of deposition apparently once extended an indefinite but not a great distance southeastward of the present margins as indicated by abundant detrital sediment at the eastern edge of the geosyncline. All along the eastern margin of the geosyncline, sediment probably accumulated to an estimated thickness of 3,000 to 4,000 feet, but in many places all or nearly all the interval was subsequently removed by erosion. The Appalachian positive area then probably was moderate to high.

The greatest accumulation of sediment in the United States during the time of interval B seems to have been along the axis of the Ouachita geosyncline. In Arkansas, deposits 15,000 feet thick are recorded, and in the Kerr basin of south-central Texas, the deposits may exceed 5,000 feet. Southward and eastward from this axis, however, the record is very poorly preserved and, in many places, is nonexistent. Correlation of the interval is based on generalized lithologic comparisons, and restored thicknesses are necessarily based on such correlations.

A positive element is postulated southeast of the Ouachita geosyncline in south Texas, largely because a landmass in this location seems necessary to explain the source of sediment in the geosyncline. Land is not postulated farther to the northeast, south of the Arkansas part of the geosyncline. In this area direct evidence of a positive element is lacking, and adequate sources of sediment are recognized to the east and the northeast.

In the Eastern Interior region where the Nashville, Cincinnati, and Ozark positive elements dominated the terrane, strata of interval B seem in most places to be eroded back appreciably from their original margins. The exact positions of these margins, of course, can no longer be accurately determined, but they are shown (pl. 15*A*, fig. 3) at what seem, on the basis of facies relations and rates of thinning, to be reasonable locations. Relatively little detritus (all fine-grained) was derived from these positive elements at this time but the Ozark area was sufficiently high to permit much karst development.

Original margins of deposition bordering the Anadarko basin in Oklahoma, the Central Colorado trough in Colorado, and the Paradox basin in Utah and adjoining States, and in parts of west Texas probably were very close to present zero isopachs. Both north and south of this region, however, erosion has removed interval B over wide areas, and original margins of deposition seem to have been far removed from present margins. In the eastern part of the Williston basin area, in parts of southern and northwestern Montana, and in parts of Idaho the interval has been restored to a considerable extent. To the south, a large part of southwestern New Mexico and southern Arizona contains only scattered remnants of interval B preserved in basin-ranges that probably are well inside the original limits of deposition for this interval.

In the far western United States, the Cordilleran miogeosynclinal margins are moderately well defined. In the eugeosynclinal belt of western Nevada and the Pacific Coastal States, however, the record of interval B is so poor that the outer boundaries are impossible to determine and as a result even approximate lines cannot be justified.

SOURCE AREAS

In the Appalachian geosyncline the amount of introduced detrital sediment was much the same in interval B as in interval A (pl. 15*A*, fig. 3). Virtually all the sediment seems to have been derived from the postulated linear land mass or positive element that paralleled the geosyncline along its southeastern margin, except in New York State where moderate amounts of fine sediment are believed to have come from farther north. The quantity and coarseness of sediment differed greatly from place to place along the geosyncline.

In the Appalachian region detritus of interval A and that of interval B seem to differ in coarseness. During the time of interval A fairly coarse sediments, implying elevated sources, were furnished to the Anthracite field in the northern part of the goesyncline, to eastern Tennessee in the central part and, most notably, to the Black Warrior basin of Alabama and central Mississippi in the southern part. In contrast, only fine-grained sediments were introduced into the geosyncline during the time of interval B, although the quantity of detritus remained great.

The Nashville, Cincinnati, and Ozark positive elements were land areas that provided the surrounding basins with some detritus, but apparently these areas were not high, inasmuch as only fine-grained material seems to have been derived from them. The Ozark area was sufficiently high to permit an extensive development of caves and sinkholes.

The Ouachita geosyncline continued to receive sediments from two principal sources during the time of interval B, as before. A very large volume of detritus — mostly very fine grained sand, silt, and clay — moved westward from the largely metamorphic terrane in the southern Appalachian region. Much of this sediment was transported by turbidity currents into the deep and rapidly sinking area of central Arkansas; a considerable amount of it may have been released to parts of the Ouachita belt farther to the southwest.

A second important source of sediment for the Ouachita geosyncline is believed to have been the northern and middle Appalachians. Mature to semimature detritus, containing little feldspar and including mostly zircon and tourmaline among the heavy minerals, is believed to have been introduced through the ancestral Mississippi embayment by way of the Illinois basin to the north and a passage between the Nashville and Cincinnati positive elements to the northeast. A very large amount of fine detritus apparently came in by both routes.

A major source of sediment to the southeast is indicated in the southern segment of the Ouachita geosyncline in east Texas by the facies distribution and thickness trends. A positive element postulated in that direction probably consisted of moderately high land as suggested by thick accumulations of sand in the Fort Worth and Kerr basins. Significant but much smaller sources of sediment in Texas are the Muenster and Red River arches on the north. Material from both southeastern and northern sources was dominantly fine grained, as shown by directional arrows on the interpretive map (pl. 15*A*); however, gravel accumulations are locally common, suggesting moderate uplift.

Source areas for sediment in the Anadarko basin of Oklahoma presumably were the bordering positive elements. The Amarillo-Wichita-Criner uplift along the south side of the basin and the southern part of a landmass to the northeast both seem to have contributed fine material.

The Michigan basin of the Eastern Interior region continued to receive sediment from the northeast, as in interval A, but apparently the basin sank more slowly and less sediment (<200 feet) accumulated than in interval A. A little sand, much dark mud, and some lenticular coals were deposited. Either the source areas were more distant or their relief was much less than during the time of interval A.

In the Illinois basin, sediment continued to enter from the northeast along a corridor between the Michigan basin and the Cincinnati arch. Sand-sized detritus contained a much lower percentage of quartz than in interval A, however, suggesting that in the source area much of the mantle of sedimentary rocks had been removed and the crystalline basement furnished a considerable part of the sediment.

In the Forest City basin of western Iowa, eastern Kansas, and southeastern Nebraska most of the detritus of interval B is fine grained, indicating that surrounding land areas probably were low. Presumably, streams entering the basin drained an extensive flat terrain (Siouxia) to the north, and the sources of much of the sediment must have been distant. Other probable sources were along the Nemaha anticline to the west, which apparently was a lowland at that time.

In contrast to most other positive elements in the Rocky Mountain region, the Pathfinder uplift in southeastern Wyoming and the northern part of the Frontrange to the south apparently were greatly elevated during the time of interval B. Evidence is furnished by large quantities of sandstone and feldspathic conglomerate adjacent to these positive elements. Elsewhere in the Rocky Mountain region, however, land elevation generally remained low or moderate as shown by a lack of coarse materials in the flanking areas.

In Montana and North and South Dakota, mudstones merge southwestward into carbonate rocks of the basin interiors (pl. 6*B*), suggesting that main sources of detritus were northeastward in the Canadian Shield. Other possible sources may have been to the north and west of this region, but if so, the evidence has been largely eradicated by erosion.

Deposits in the Cordilleran miogeosyncline probably were derived from land on both sides. Terrigenous material did not enter in great volume and was mostly fine grained except in north-central Nevada where the north end of the Antler positive element shed abundant gravel now preserved in the Battle and Ely Formation. In the eugeosyncline farther west large amounts of detritus, mostly fine grained, apparently were derived from the Antler positive element, from smaller tectonic islands within the geosyncline, and from volcanic eruptions, either subaerial or submarine.

CHEMICAL SEDIMENTS

Although marine waters entered the southern Appalachian region along the axis of the geosyncline and periodically spread north as far as northern Ohio and Pennsylvania during the time of interval B, very little carbonate rock was formed in the geosyncline. Likewise, marine waters covered the southern part of the Illinois basin and other parts of the eastern interior, but the percentage of carbonate rock of interval B is negligible in this region. The many dark mudstone strata and abundant iron carbonate nodules suggest poorly ventilated waters and reducing bottom conditions across large parts of the interior region; lack of evaporites suggests a low rate of evaporation or fairly active circulation in the sea and periodic exchange and freshening of the surface waters.

The Ouachita geosyncline in Arkansas, like the Appalachian geosyncline, contains very little limestone in interval B. Farther southwest in Texas carbonate deposits locally form 20 percent or more of the interval. Among the shelf deposits of the Fort Worth basin in northern Texas, bioclastic limestone predominates; in the area immediately north of Kerr basin, appreciable amounts of carbonate sediment accumulated; and in the Marathon salient of the geosyncline, the Dimple Limestone constitutes a considerable contribution of carbonate rock. Textures and structural features in the Dimple suggest that turbidity currents were active during its deposition.

In the Western United States, carbonate sediments accumulated across wide areas during interval B time. They were extensively deposited in the shallow seaway east of the Frontrange, in the Paradox basin of Colorado and Utah where they formed a broad band flanked by terrigenous sediment, and in many parts of the Cordilleran miogeosyncline. Except along margins of land masses, carbonates covered much of southern Wyoming and northwestern Colorado, and they apparently extended across much of Montana, grading laterally into mudstone shoreward.

CLIMATE

During the time in interval B, widespread deposits of coal formed in Tennessee, Kentucky, West Virginia, and western Virginia, and less extensive coal beds formed in the northern Appalachian, Michigan, Illinois, and Forest City basins. These deposits indicate that a humid and, probably, a mild climate prevailed throughout Eastern and Central United States. Lack of evaporites throughout this region, in contrast to some areas in Western United States during interval C time, is in agreement with the postulate of high humidity.

A warm, moist climate is postulated for the region of the Ouachita geosyncline. In the early part of interval B time the central or axial part of the trough in Arkansas probably was sufficiently deep to contain cool water at the bottom. As the geosyncline filled, the sea presumably became shallower and warmer and coal swamps developed along its margins. On land areas in both the Ozark region to the north and the central Texas region to the south, karst topography continued to develop, indicating a continuation there of the humid climate of interval A.

The extensive carbonates deposited throughout most parts of Western United States, like the widespread coal beds of the east, suggest a warm climate. No change from the warm humid environmental conditions postulated for interval A is apparent.

INTERPRETATION OF INTERVAL C

STRUCTURAL FEATURES AND THICKNESS TRENDS

The structural features of interval C closely resemble those of interval B. Axial trends were broadly similar and most negative and positive elements that were active in interval B continued to be active in interval C. As in interval B, an original connection of extreme eastern America with western Europe and Africa is inferred on the basis of structure trends in New England similar to those of the Hercynian belt.

Major differences between intervals C and B are: (1) A deep basin at the south end of the Appalachian geosyncline in interval B became positive in interval C; (2) the rate of sinking along the Ouachita geosyncline became progressively slower and in the late stages of interval C parts of the geosyncline were compressed to become the sites of extensive thrusting and uplift; (3) the interior of the continent became slightly negative, allowing the seas to transgress widely. Landmasses between the Appalachian positive element on the east and the Antler positive element on the west in general shrank, although some parts continued to be elevated (pl. 15*B*, figs. 1, 2).

The northern and central parts of the Appalachian geosyncline continued to be active in interval C. The axis trended northeastward, probably parallel to the western border of a landmass postulated for the area farther to the east. Approximately 1,000 feet of sediment accumulated in the axial part of this geosyncline. In the Anthracite field of eastern Pennsylvania the thickness of sediment deposited in interval C was considerably more than the thickness of sediment deposited in interval B. Farther south — in western Virginia, southern West Virginia, and southeastern Kentucky — strata of interval C have only moderate thickness; the maximum is about 800 feet, which is considerably less than that of interval B. Only the lower part of interval C remains in this area, however, which makes restoration of the original thickness uncertain.

The thickness determined for interval C in the Virginia-Kentucky area is questionable because of uncertainty in dating; strata of this interval may have thinned northward to extinction in Virginia and Kentucky through offlap against a thick wedge of interval B sediment (J. C. Ferm, oral commun., 1967). Alternatively, interval C may pinch out farther south in Tennessee (Harold Wanless, oral commun., 1967). If the latter interpretation is correct, the Cincinnati arch stood as a small island in the eastern interior seaway, and the Nashville dome was a broad peninsula projecting northward from a landmass in the position of the Black Warrior basin of earlier Pennsylvanian time in Tennessee and northern Alabama. Thus, the structure pattern of the Appalachian geosyncline developed significant changes during the time of interval C.

Westward from the Appalachian region, a broad but weakly negative area extended from the Appalachian region to the Frontrange uplift of the Rocky Mountains during the time of interval C. The Michigan, Illinois, and Forest City basins were not independently active, being parts of a single continuous depositional surface. Remnants of the Ozark dome, the Nemaha anticline, and the Cambridge arch may have stood slightly above sea level in the central part of this region, and possibly were very weakly positive.

In the middle part of Southern United States, notable structural changes are recorded in interval C. The Ouachita geosyncline of northern Arkansas was downwarped sufficiently during the early part of interval C time for several thousands of feet of sediment to accumulate, as judged from the thickest remnants preserved. The total thickness, however, was considerably less than that of either interval A or interval B deposits. By about the middle of interval C time, downwarping in this region ceased; and by the end of the interval, though possibly much later, uplift began.

In the central Texas part of the Ouachita geosyncline, downwarping continued early in interval C time, especially in those areas opposite the Fort Worth and Kerr basins. Uplift, compression, and thrusting occurred east of the Fort Worth basin during the last half of the interval. The remnant Marathon salient of the geosyncline in southwestern Texas continued to sink during all of interval C time, and its margins were locally faulted. Its northern margin evolved into the Val Verde basin during late stages of the interval.

Other active structural features of the Texas interior region were the Midland and Delaware basins; the Diablo uplift, farther west, which locally was mildly positive; and the Muenster and Red River arches to the north, which apparently rose early in the interval but which stabilized before the end. The Red River arch was quickly submerged and is not shown on plate 15*B*, figure 2. Other interbasin areas apparently were stable or changed elevation only slightly.

In Oklahoma and the Texas Panhandle, structural features active in interval B continued to be active at the start of interval C time. By about the middle of interval C, the Arbuckle positive element began to rise, possibly contemporaneously with uplift and folding in the Ouachita structural belt to the east (pl. 15*B*, fig. 2). The Amarillo-Wichita element reached a greater elevation in interval C than before, although the area involved was more restricted. The adjacent basins were enlarged and deepened, and the area of the Nemaha anticline to the north became almost totally submerged.

In the Rocky Mountain region, as in most parts of the United States, interval C represents the time of maximum expansion of the seas for the Pennsylvanian Period. Not only was the sea more widespread, but a climax in tectonism was reached. The Uncompahgre, Frontrange, and Apishapa uplifts attained their greatest elevations, and adjacent basins attained their maximum depths. These complementary movements resulted in the production and entrapment of exceptionally thick deposits of sediment. At least 5,000 feet of sediment accumulated in the central part of the Paradox basin, and perhaps a comparable amount accumulated locally in the smaller Eagle basin, indicating a minimum measure of subsidence.

The mode of uplift of the ancestral Rocky Mountains in Colorado and Wyoming is not entirely clear, but both arching and block faulting probably contributed. The rectilinear, conjugate pattern of structural elements typical of interval C throughout the United States is especially conspicuous in this region. The Freezeout Creek fault along the eastern margin of the Apishapa uplift is a well-documented fault that probably was active during interval C time. Normal faulting on a large scale occurred along the southwestern margin of the Uncompahgre where probable deepwater deposits, such as the black mudstone interbedded with halite in the adjoining Paradox basin, lie close to the basin margin. Possibly, a hinge along the southwest side of this basin accounts for its shape, shown by isopachs (pl. 15*B*, fig. 1); clearly the great thickness of sediment that filled it reflects a major mountain source to the northeast that furnished detritus throughout the time of this interval.

The Piute positive element in southwestern Utah was stable or slightly uplifted during the time of interval C, but the land was more restricted than just before interval C, inasmuch as a greatly expanded depositional basin occupied most of Arizona to the south. Although no evidence of major elevation in the Piute landmass is known, this positive element apparently furnished the fine-grained material of deltaic deposits in much of northern Arizona. Mississippian limestones were exposed to subaerial erosion, but were not deeply dissected or removed.

In central Wyoming, the Pathfinder uplift was tectonically passive during the time of interval C. The sinking of adjoining areas, as indicated by the sand deposits of shallow seas that encroached upon the uplift from several directions, however, greatly reduced its size. The contrast in tectonic activity between this stable area and the highly unstable areas to the south in Colorado was considerable.

Most of the northern Rocky Mountain and Plains region from Idaho and Montana eastward into North and South Dakota was negative and continued receiving sediments, though in fairly small amounts, during the time of interval C. The major tectonic change in this region was the reappearance of a northwest-trending positive area in northern Idaho. A prong of the Cordilleran geosyncline, east of and parallel to the landmass, began to sink appreciably.

In east-central Idaho, the geosynclinal axis took a sharp curve southwestward at right angle to the northern section. Farther east in that area, a second southwest-trending axis of downsinking developed with a northern termination at the edge of the shelf in western Montana. This axis occupied the same position and probably represented a rejuvenation of the structure formed there in Late Mississippian and interval A times.

In the far western part of the conterminous United States, the Cordilleran geosyncline extended from southern California generally northward into Washington and Idaho. Its overall configuration in interval C was much like that in interval B, with the Antler positive element separating a wide eugeosynclinal area to the west from a series of basins in the miogeosyncline to the east. Negative elements crossed or bounded the Antler positive element at its lower end in southern California, possibly in northern Nevada, and at its north end in central Idaho.

The general rectilinear structure pattern of the Cordilleran geosyncline in both interval B and interval C is apparent on plates 15*A* and *B*. It is conspicuously displayed in southern and central Nevada by the northeast trend of basins within the miogeosyncline and in Idaho and adjacent areas by the northwest trend of major structural features.

INFERRED MARGINS OF DEPOSITION

As is true for earlier intervals of the Pennsylvanian System, a very large part of interval C originally deposited in Eastern United States probably has been removed by erosion. In the Appalachian geosyncline, the maximum thickness of strata probably was deposited in a belt along the eastern margin of the geosyncline, adjoining the postulated ancient highlands that formed a principal source of sediment. Because the thick deposits in this belt have been completely or almost completely removed, their former extent has been estimated by projecting the thickness trends from remnants farther west.

In the Ouachita geosyncline a very imperfect record remains. Across northern Mississippi, Arkansas, and eastern Oklahoma less than half of the original very thick depositional blanket remains. Deposits in the southern and eastern parts of the region, including some of the thickest deposits, are completely removed by erosion. In the Ouachita structural belt of Texas, drilling gives only sparse information about the type and amount of sediment that apparently filled the Ouachita geosyncline of this area.

The Eastern Interior region is believed to have once contained interval C throughout a considerably more extensive area than at present. Strata that today are restricted to the Michigan, Illinois, and other basins once formed a continuous blanket across the region, as indicated by comparable faunas and lithic facies of the remnants. The area between the Michigan and western Appalachian basins which currently is devoid of interval C probably was once occupied by sediment in transport to the Illinois basin, as indicated by trends in current direction within that basin. In brief, the negative areas in which sediment accumulated probably were more extensive during interval C time than in any other part of the Pennsylvanian Period.

SOURCE AREAS

During the time of interval C, as during that of intervals A and B, the northeastern part of the Appalachian geosyncline received sediment largely from a source to the southeast. The coarsest detritus, consisting of cobbles as much as 5 inches in diameter, accumulated as widespread basal deposits of the interval in the Southern Anthracite field of eastern Pennsylvania. Higher in the interval in this area, coal deposits formed that are thicker individually and cumulatively than in any other area of Pennsylvanian rocks in the United States. Thus, although initially detritus probably accumulated rapidly from nearby highlands, relatively slow deposition and a coal-swamp environment dominated the later stages of interval C time.

In the central and southern parts of the Appalachian geosyncline, interval C sediments came largely from source areas in North Carolina and Virginia. Other source areas in northern New York, Ontario, and Quebec supplied sediment to the Appalachian region of western Pennsylvania and Ohio. The sea repeatedly transgressed and regressed across Ohio and Indiana north of the remnant Cincinnati arch in Kentucky, forming a series of extensive intertonguing sediment wedges that provide the finest records of cyclic sedimentation in the American Pennsylvanian. Although sources of sediment in that region seem initially to have been to the northeast, toward the end of interval C they probably were more northerly, suggesting an increased contribution from the Wisconsin arch. Trends of current indicators show that most sediment in the Illinois basin was transported southwestward across the area between the Michigan and western Appalachian basins.

The Arkansas, Oklahoma, and east Texas parts of the Ouachita geosyncline apparently derived most of their extensive load of sediment — estimated as about 15,000 cubic miles in Arkansas — from a major stream system coinciding at its lower end with the course of the present Mississippi River. Source lands were probably to the northeast and east in the region of the northern Appalachians. Some sediment, however, presumably was derived from the southern Appalachians and was transported westward along the axis of the geosyncline. Farther south, in southern Texas, the source area for sediment deposited in the Ouachita geosyncline was a region south of the Marathon area, as indicated by facies relations within the geosynclinal rocks. In west Texas the Diablo positive element was a local source and, during early stages of interval C, the Muenster and Red River arches of north Texas furnished sediment to nearby areas as indicated by fringing deposits of coarse detritus.

In Oklahoma and northeastern New Mexico extensive arkose deposits bordering various positive elements indicate that granitic basement rock was exposed in the uplifts during the time of interval C. Coarse arkoses on both the north and the south flanks of the Amarillo-Wichita uplift, around the Bravo dome, and east of the Sierra Grande uplift, suggest vigorous erosion of nearby sources within these positive areas. In central Texas, much sediment was derived late in the interval from the rising Ouachita structural belt.

In the great interior lowland of the Central United States — the region of the present-day Great Plains — sediments accumulated more widely during the time of interval C than during any other part of the Pennsylvanian Period (pl. 15*B*, fig. 2). Only a few fairly small land areas stood high enough within the depositional area to furnish sediments locally. The northern end of the

Nemaha anticline, for example, apparently developed into a hilly region, raised by faulting as well as by folding along the monoclinal front, as shown by a large quantity of arkose and coarse sand deposited directly east of the fault escarpment. The Cambridge arch, a remnant of the Siouxia landmass of earlier Pennaylvanian time, likewise was a source of sediment, and the much restricted mainland of low relief to the northeast probably supplied detrital material from that direction.

The middle Rocky Mountain region apparently consisted of high ranges in interval C time that furnished large quantities of coarse detritus to adjacent lowland areas or bordering seas. These deposits are well preserved along the eastern margin of the Frontrange and the northeastern end of the Apishapa uplifts. They consist of poorly sorted cobble conglomerates in central Colorado and are thick and extensive in many places bordering the Uncompahgre uplift. Abundant trough crossbedding and other sedimentary features of these deposits suggest that they are largely alluvial fans.

In northern Idaho and westernmost Montana an inferred geanticlinal landmass is believed to have been the principal source of quartzose terrigenous sediments in the adjacent region to the east, although much sediment may also have been transported southeastward along the axis of the geosyncline from areas far to the north. Farther east in Montana, North and South Dakota, and Nebraska fine-grained terrigenous sediment probably came mostly from a shield area, greatly reduced in size from the Siouxia of earlier Pennsylvanian time, that lay to the northeast.

In northern Arizona, a broad sheet of continental red beds of the Supai Formation, considered in part to represent interval C, must have come largely from the Piute positive element in southwestern Utah as shown by current-direction indicators, especially crossbedding. Some detritus may have been furnished by the Defiance-Zuni positive element, but land in the vicinity of that element was restricted in size at the time and direct evidence of current movement of sediments from it is not available.

The Cordilleran miogeosyncline apparently continued to derive sediment from the Antler positive element on the west as in intervals A and B. How much additional detritus may have been introduced from the sources to the east or southeast is not known, but a large volume of fine-grained sediment that accumulated near the Arizona-Nevada boundary may have had a source or sources in those directions as indicated by lithofacies patterns. In the eugeosyncline, farther west, rocks similar in composition to those of intervals A and B were formed; presumably sediment was received from the Antler landmass, and also from tectonic islands to the west. Subaerial and submarine volcanic eruptions also contributed to the record. Absence of Pennsylvanian rocks from the Sierra Nevada region possibly indicates that a source occupied that part of California.

CHEMICAL SEDIMENTS

The eastern part of the United States is nearly devoid of carbonate deposits in rocks of interval C. Sediment in the Appalachian geosyncline, except for some freshwater limestones in the northern part, is nearly all terrigenous. Farther west, from Ohio southwestward through Missouri, wedges of deltaic sandstone and mudstone interfinger with marine mudstone and limestone in an intricate cyclic sequence produced by many transgressions and regressions of the sea. In the Michigan and Illinois basins terrigenous sediments are dominant, but marine carbonate rocks are proportionately more abundant toward the west. In the Forest City basin of Nebraska, Iowa, and Missouri, carbonate rocks constitute a very appreciable percentage of interval C, for marine conditions apparently prevailed there almost continuously.

In the Ouachita geosyncline, carbonate rock occurs very sparsely in interval C, for although shallow seas probably covered southern Arkansas and Louisiana at this time, these areas were continuously flooded by terrigenous detritus which prevented the accumulation of an appreciable percentage of purely chemical sediment. In shoreward areas of northern Arkansas much clay-ironstone formed in thin layers and lenses. In the Texas areas bordering the geosynclinal belt on the west, bioclastic limestone was formed widely in early parts of the interval, but later, carbonate deposition was mainly restricted to reefs, such as those forming the Horseshoe atoll, fringing the Central Basin platform and the eastern margin of the Midland basin.

In the region of Oklahoma, Kansas, and eastern Colorado, a shallow-water marine environment seems to have prevailed during much of interval C time; calcium carbonate accumulated in considerable amounts, alternating with mudstone and sandstone in characteristic cyclothems. The percentage of limestone is much greater than was formed farther east. Meanwhile, in Nebraska and adjoining areas to the north, chemical sediments were restricted in distribution. They included dolomite and some anhydrite.

Elevation and erosion of landmasses in the middle Rocky Mountain region produced large accumulations of detritus adjacent to uplifts and correspondingly little chemical rock. In the central part of the trough between the Frontrange and the Uncompahgre uplifts was an evaporite basin (Eagle), however, and a still larger basin (Paradox) lay west of the Uncompahgre highlands where salt was concentrated to a great thickness. Farther north, in Montana, considerable dolomite and small amounts of gypsum, believed to have been primary or penecontemporaneous deposits, suggest that the shelf there was covered by hypersaline waters much of the time. The area of distribution of chemical sediments in Montana became steadily more restricted as a sheet of quartz sand from the northwest spread progressively southward.

West and south of the Rocky Mountain region in Colorado, carbonate sediment was widespread and dominant among deposits of interval C. In southern Arizona it constituted the major component in strata of the Sonoran geosyncline. In areas of northern Arizona bordering the Supai delta and in the Cordilleran miogeosyncline of Nevada, it also contributed greatly to the volume of sediment. Cyclothems are conspicuously developed in interval C rocks of this region, but the rocks are largely marine and the cyclothems record changes of sea level rather than oscillations of the shoreline as do most cyclothems of the East and Middle West.

CLIMATE

Climatic conditions during the time of interval C probably did not change greatly from the conditions during earlier parts of the Pennsylvanian Period, although the evidence is more pronounced. Coal swamps had a greater extent than during any other time. One coal, representing the deposit in a single swamp in the lower middle part of the interval, extended from Oklahoma to Pennsylvania. Such widespread coals are the basis for postulating a humid, mild climate in Eastern and Southern United States. In Oklahoma and Texas, marine waters supported abundant corals and crinoids suggesting warm, clear seas throughout that region. In the Ouachita area of Arkansas and along the eastern margin of the geosyncline in Texas, however, regional uplift during a late stage of the interval may have altered climates considerably. Air-circulation patterns were probably changed by a rising mountain chain in this region. Withdrawal of the sea from large areas as a result of the Ouachita orogeny may have reduced the ameliorating effects of the marine waters.

In some parts of Western United States, evaporite deposits indicate local concentration of salines and imply semiarid to arid conditions at least locally during the time of interval C. The greatest and most noteworthy of these deposits is in the Paradox basin of western Colorado and eastern Utah, where salt formed extensively, but also fairly widespread are evaporite deposits of the Central Colorado trough. Presumably the environment in these areas was controlled by great mountain uplifts of the Frontrange and Uncompahgre which dominated air-circulation patterns and the related ocean currents. The clay mineralogy of the Minturn Formation in Colorado (Raup, 1966, p. 267), the absence of carbonaceous material, and the scarcity of plant fossils furnish additional evidence of semiaridity.

Evaporite deposits in Nebraska and Montana suggest a climate more arid than in earlier parts of the Pennsylvanian in those regions. The deposits include much dolomite and some gypsum.

INTERPRETATION OF INTERVAL D

STRUCTURAL FEATURES

The restored isopach map of interval D (pl. 15*B*, fig. 3) suggests that the major structural features of the Eastern United States that became active early in the Pennsylvanian Period and continued to be active through intervals B and C still exerted an important influence on sedimentation during interval D. As with preceding intervals, the few remnants of Pennsylvanian rocks in eastern New England and their possible correlatives in maritime Canada probably once connected with rocks in the Hercynian belt of western Europe. Thus, prior to the time of continental separation, the Appalachian positive element shown on plate 15 may have extended to the northeast, seaward of the present Atlantic coastline. The Appalachian positive element continued to rise, and basins in the northern and central parts of the geosyncline to the west continued to sink with much the same configuration as during interval C. In Georgia and Alabama at the extreme southern end of the Appalachian positive element, the amount of uplift and the area of folding decreased notably as compared to interval C.

The areas formerly occupied by the Cincinnati arch and the Nashville dome in the eastern interior are believed to have been slightly negative and were probably covered by a blanket of sediment, and the Ozark dome, farther west, was probably stable or only very mildly positive. No residues of interval D are today near enough to these ancient features to give positive evidence of their structural history. A last remnant of the Nemaha anticline was buried by the middle of the interval, and the Cambridge arch probably was inactive throughout the interval.

The area of deposition in the eastern half of the United States possibly was about as large during the time of interval D as during C; however, the record has been largely removed over wide areas. Evidence is not available to show whether the Michigan, Illinois, and Forest City basins continued to sink as separate structural entities, as in earlier Pennsylvanian time, or were merely parts of a very widespread negative region that was covered by a relatively uniform blanket of sediment.

The structural pattern of the South-Central United States, unlike regions to the north and east, changed appreciably during interval D. Arkansas and northern Louisiana were positive areas, and uplift may have been rapid along the Ouachita structural belt at that time. An area north of the Marathon salient of the structural belt continued to sink and constituted the only remaining part of the former Ouachita geosyncline. The Muenster and Red River arches were quiescent or negative, and the broad central part of Texas continued to sink slowly and intermittently. In Oklahoma, uplift continued in the Arbuckle uplift and the Amarillo-Wichita uplift, but otherwise structural movements were similar to those of interval C.

Farther west, in the Rocky Mountain region, structural features of interval D were basically the same ones that were active during the preceding interval, but the amount of movement of the uplifts and basins apparently was much less. The Frontrange uplift to the north and the Apishapa and Sierra Grande uplifts to the south were still the dominant positive areas, but the linear trough north of the Apishapa uplift and the Hugoton embayment were no longer recognizable structural elements. In general, deposits tended to assume a blanket form, rather than a wedge shape as before. Along the northern margin of the Frontrange uplift and in much of western Wyoming the former shelf was positive and emergent as indicated by the beveling and redistribution of sand that had accumulated during the time of interval C. Meanwhile, the Eagle and Paradox basins subsided a little, perhaps only 500 feet, and were almost indistinguishable structurally from adjacent shelf areas. Uplift of the Frontrange and Uncompahgre elements probably also diminished greatly as compared to their movement in interval C. Apparently these elements were no longer extremely high, for in the Central Colorado trough, those parts of the Maroon and Sangre de Cristo Formations assigned to interval D are generally thinner and contain less coarse material than those parts deposited during the time of interval C.

In the northern Rocky Mountain region, the original extent and thickness of interval D rocks can be inferred only in a general way because the strata involved are largely removed by erosion. Scattered remnants suggest that the structural framework probably was much like that of the preceding interval. Much of Montana is believed to have remained a stable shelf on which thin deposits of sediment accumulated; a remnant of the geosyncline persisted in the extreme western part of the State; and the northern Idaho positive element is inferred to have continued as an active structural element and a source of sand deposits.

Southwestern United States, especially Arizona, seems to have been the site of radical changes in depositional pattern although the structural elements were nearly the same as during interval C. Much of that region was positive and withdrawal of the sea resulted. The shape of the Antler positive element may have been modified by two northeastward-trending prongs with a trough between them as shown on plate 15*B*, figures 3 and 4. On the other hand, the prongs may be features resulting from postinterval D uplift and erosion rather than from folding during interval D.

The record of interval D in the eugeosynclinal region west of the Antler positive element is scant, but presumably sparse sedimentation and submarine or subaerial volcanic eruptions continued throughout a wide area. Turbidites in the Jory Member of the Havallah Formation and the high sand content of the Havallah indicate possible uplift of the Antler region.

INFERRED MARGINS OF DEPOSITION

In the eastern half of the United States, interval D probably has been removed by erosion from an area larger than that still containing it (pl. 15B, fig. 3). Within the Appalachian region, for example, interval D probably was widely distributed in Virginia and Tennessee, and possibly extended into Georgia, Alabama, and Mississippi although the original boundaries are now unknown. Parts of these areas probably were low coastal plains, and possibly, deposits extended beyond the limits restored on plate 15*B*. Farther west, the former Cincinnati arch and Nashville dome possibly no longer stood as islands; in any case, even though no rocks of interval D are present within these areas, the areas are considered to have been within the depositional region. In contrast, the Ozark dome in Missouri has been interpreted as a low hilly area that continued to be eroded though reduced in size. This conclusion, however, cannot be verified.

A former, greatly expanded area of deposition has been postulated for the Illinois basin and other parts of the Midwest on the basis of certain constituents in the rocks. In north-central Illinois, for example, erratic blocks and pebbles of quartzite and crystalline rock in limestone (Savage and Griffin, 1928), apparently of Precambrian origin and transported by rafts of vegetation, suggest shorelines at least as far north as the Wisconsin arch.[1] The original southern limits of interval D in this region likewise probably were far beyond present remnants.

In Texas, inferred margins of deposition were about the same during interval D as they were late in interval C. The various shore facies of interval D that presumably once occupied a narrow band between the elevated Ouachita structural belt and the still-preserved parts of the interval have been removed by erosion. In west Texas, especially near the Diablo positive element and the Central Basin platform, interval D has been removed in numerous places.

[1]Results of a recent investigation by Jansa and Carozzi (1970) suggest that these gravels were not rafted into their present place of burial but were first transported by rivers and then distributed in the carbonate basin by submarine mudflows.

SOURCE AREAS

In the Appalachian geosyncline, most of the detritus that accumulated to form interval D, like the detritus of earlier Pennsylvanian deposits, came from a southeasterly direction. The sediment formed a generally westward-thinning wedge, containing abundant mudstone in the northern part of the region and including some pebbly sandstone farther south in West Virginia. The northern part of the geosyncline also received substantial volumes of sediment from sources in New York, Ontario, and Quebec.

In the Illinois region, terrigenous sediments apparently came largely from the northeast as shown by the orientation of deltaic deposits at several places along the northern margin of the part of the interval remaining in Illinois. Likewise, deposits in Iowa probably came mostly from the north, but those in northern Missouri were generally derived from the region of the Ouachita uplift to the south. In parts of Missouri, channel sandstones in the lower part of interval D indicate northern sources, whereas those higher in the interval contain detritus from uplands in Arkansas and Oklahoma to the south. The Nemaha anticline of Kansas was much reduced in size and nearly buried in detritus by the time of interval D; thus, its importance as a source area was negligible.

In east Texas and in the Marathon region of south Texas, principal source areas of sediment during interval D continued to be hilly to mountainous areas along the Ouachita structural belt from which much detritus seems to have been transported westward and northward. Other sources were land areas along the Amarillo uplift in Oklahoma and the Diablo positive element in west Texas. Evidence for these being source areas consists of an increase in coarseness of detritus near each of the areas. In Oklahoma, the low hills in the region of the Amarillo-Wichita uplift and of the combined Ouachita and Arbuckle uplifts were chief sources of sediments. Except for some conglomerate around the Arbuckle uplift and some coarse detritus north of the Wichita uplift little evidence of high relief is recognized.

In the Rocky Mountain region continued uplift of the principal positive elements seems to have produced highlands that assured a source of considerable detritus for surrounding areas of deposition. Although the volume was large and included some coarse detritus, deposits of this interval were far less and, in general, much finer than those of interval C; this suggests that the time of maximum uplift and erosion in the Colorado Rockies was prior to interval D. The Apishapa and Frontrange uplifts clearly were the most important source areas in central Colorado as indicated by facies in the Sangre de Cristo and Maroon Formations.

In the southern and southwestern parts of the Rocky Mountain region the timing of uplift, as reflected in accumulated sediment of surrounding areas, seems to have been different from that in Colorado. The regions of the Pedernal uplift and the southern part of the Uncompahgre uplift in New Mexico, which apparently had been relatively low landmasses surrounded by dominantly lime-forming seas during the time of interval C, were elevated in Late Pennsylvanian time. Coarse detrital material, including much arkose, increased markedly in volume in surrounding basins during interval D time, indicating that Precambrian rocks forming the cores of adjacent land areas were being progressively more exposed. Scattered grains of fresh feldspar were transported into areas of dominantly lime-mud accumulation. At this time Precambrian rocks on the crests of the Sierra Grande, Defiance-Zuni, and other positive elements may also have been exposed, but those areas did not contribute much coarse arkosic sediment as did the Uncompahgre and Pedernal areas.

Source areas for interval D in the northern Rocky Mountain region are not clearly indicated in the facies and thickness relations. Probably this is because landmasses were low and far from the areas of deposition. A possible source was the northeastern part of the northern Frontrange uplift from which fairly coarse arkosic sediment apparently was carried eastward as far as Nebraska. In extreme southwestern Montana, terrigenous sands are believed to have come southward from a landmass inferred in northern Idaho; this sand body extended farther south than the deposits of interval C. Elsewhere in the northern tier of States, terrigenous detritus presumably came southwestward from the Canadian Shield, but direct evidence in those areas is very sparse.

In the far western United States, sources of sediment for interval D were landmasses probably of low relief along the Antler positive element in Nevada and within the Piute positive element in Utah, then much larger than during the time of interval C. Other land areas contributing detritus may have been in or west of the Cordilleran eugeosyncline; however, little evidence is available concerning the position of any such areas. Coarse material that might suggest nearby mountainous regions is lacking, although sandstones in northern Nevada adjacent to the north end of the Antler positive element, and in the Havallah Formation to the west, indicate that a considerable volume of older rocks was being eroded in nearby areas.

CHEMICAL SEDIMENTS

In the Eastern and Midwestern United States, carbonate deposits of interval D were accumulated during a series of eastward marine transgressions and westward regressions of widely differing magnitude. Of the principal transgressions and corresponding regressions, each containing a limestone unit, about 15 are represented in Missouri, 11 in Illinois, 7 in Ohio, and only 1 in the Northern Anthracite field of Pennsylvania. In the Northern Anthracite field the single marine limestone represents the easternmost spread of Pennsylvanian seas in the United States. Thus, because individual limestone and dolomite units mostly are thin, and commonly are very extensive, it is difficult to combine them into meaningful composite entities on lithofacies maps.

In Texas, limestone is the principal component of interval D in the Horseshoe atoll, on and near the Central Basin platform, and in El Paso and western Hudspeth Counties in the extreme western part of the State. It makes up reefs and bioherms in these areas and indicates locally shallow, agitated water; the thicker limestone deposits generally formed rims around deeper water areas of the major basins. Farther west, in New Mexico, calcium carbonate was deposited across broad areas during interval D time, but deposition of the carbonates was interrupted frequently by influxes of debris from uplifted areas. The most notable limestone accumulations were adjacent to uplifts and probably represent shoals.

Because in the Rocky Mountain region much of the land had considerable relief during the time of interval D, detrital sediments were dominant in most nearshore areas. Away from the uplifts, however, especially in areas of eastern Colorado, along the eastern part of the Wyoming shelf, and in parts of Nebraska, calcium carbonate was the dominant deposit. In southwestern South Dakota, in the Eagle basin of northwestern Colorado, and along the western margin of the Paradox basin in Utah, moderate amounts of gypsum and dolomite accumulated by evaporation of sea water. Throughout the central part of the Paradox basin in Colorado and Utah, where great volumes of evaporites formed earlier, mostly marine limestones were deposited during interval D time. In the far western United States at the southern end of the Cordilleran miogeosyncline (Bird Spring-Ely basin of southern Nevada) and at the northern end of the Antler positive element in Idaho, interval D is represented by carbonate rocks, principally limestone. Rocks in the eugeosyncline of southeastern California and northwestern Nevada consist predominantly of sandstone, rather than volcanic material and siliceous shale — the main rocks of intervals A, B, and C; carbonate rocks are absent from interval D of that region.

CLIMATE

Climate in the Eastern United States during the time of interval D probably was mild and the sea warm as suggested by abundant fossils in marine strata. Coal deposits were considerably less extensive than in interval C, but this may reflect less extensive regions of coastal swamps rather than any important differences in climate. In general, intermittent deposition of coal in many parts of the region suggests a persistently humid climate and temperature fluctuations within rather narrow limits. On the other hand, alternation of coal deposits with strata that are dominantly detrital might be explained as the result of climatic cyclicity.

In much of the Rocky Mountain region, the relatively high relief of many uplifted areas doubtless made climatic conditions less stable and less monotonous than in most parts of the east. This seems especially likely near the mountains of the Ouachita structural belt, in the vicinity of the Pedernal uplift, and near the already elevated Frontrange and Uncompahgre areas. Local evaporitic deposits in South Dakota, Colorado, and Utah suggest local semiarid climates, and perhaps the beginning of a more widespread change to the arid climate of the Permian.

INTERPRETATION OF INTERVAL E

STRUCTURAL FEATURES

Throughout most of the continental United States, few differences between structural features of intervals D and E can be shown. The lack of significant change may be the cause in many areas of problems concerning the boundary between these intervals. Absence of notable differences in lithology commonly require that a separation of interval D from interval E be based on the position of faunal or floral elements or on the projection of key beds from areas of established contacts.

In Eastern United States, the Appalachian geosyncline and the inferred positive element bordering it to the southeast seem to have been much as they were during the time of interval D, although the remnants of sedimentary rocks that constitute interval E are even more restricted than those of interval D. Linear belts, in which the interval is thin, correspond with the axes of anticlines that were active during deposition of interval E in Pennsylvania, Maryland, and West Virginia (pl. 15*C*, fig. 2). The anticlinal structures, which first appeared in interval C, seem to have been uplifted intermittently during both D and E, but accurate dating of their movements is very difficult.

West of the Appalachian region, the ancient positive elements referred to as the Cincinnati arch and Nashville and Ozark domes (pl. 15*B*, fig. 2) presumably were buried by Pennsylvanian sediment during the time of interval E, although this cannot be proved because remnants of interval E are lacking near the uplifts. Slight differential sinking in the Illinois basin, along the Moorman syncline of western Kentucky, and along the axis of the Forest City basin in Missouri and eastern

Kansas can be shown by the thickness relations of rocks still preserved. In general, however, the entire midcontinent region west as far as the Frontrange uplift of the Rocky Mountains was a broad negative region which sank rather uniformly a small amount.

The structural framework in Southern United States was about the same during the time of interval E as in interval D. The Ouachita region of Arkansas was greatly elevated, the Arbuckle uplift in Oklahoma was active tectonically, and the several basins in Texas were deepened. Principal new activity involved normal faulting on the north side of the Arbuckle uplift, possible thrusting in the western part of the Ouachita structural belt, and probable rejuvenation of the west end of the Matador arch.

In the southern part of the Rocky Mountain region, the Sierra Grande, southern Uncompahgre, and Pedernal uplifts and the Florida Island positive element all were sharply defined and all were probably still active at this time. A zone of faulting along the western margin of the Pedernal uplift is suggested by closely spaced isopachs in that area (pl. 9*A*). The Rowe-Mora and Orogrande basins continued to sink, forming prominent but narrow, north- and northwest-trending features, respectively. Structural activity in this part of the Rocky Mountain region apparently reached a peak later than it did in Colorado, where the major uplift is believed to have occurred well before interval E.

In the Rocky Mountain region of Colorado and northern New Mexico, important positive elements during the time of interval E were the Frontrange, Apishipa-Sierra Grande, and Uncompahgre uplifts. The uplifts did not furnish the tremendous amounts of arkosic sediment that had been characteristic of interval C and, therefore, were probably rising less rapidly than before. Faulting on the west flank of the Apishapa uplift ceased during interval E time so that strata of that interval were deposited west of the uplift directly on rocks of interval A. The Eagle basin, the Paradox basin, especially its central trough, and other basins in Colorado and New Mexico deepened. Farther north, in western Wyoming, a large part of the former shelf remained slightly positive and emergent as it was during deposition of interval D.

From all of Montana, except the extreme southwestern part, rocks representing interval E are absent. Reconstruction of tectonic events is uncertain; however, the region was most likely a relatively stable or slightly negative shelf until the end of Pennsylvanian time. Uplift that caused the seas to withdraw from northern Montana occurred late in the interval and resulted in a beveling of strata down to the Upper Mississippian. Coarse sand in Lower Permian strata of North and South Dakota and adjacent parts of Wyoming and Montana probably came from the Mississippian Kibbey Sandstone in northern Montana, suggesting uplift of that area in Late Pennsylvanian time; however, erosion may have begun earlier and been relatively ineffectual because of low elevation.

Far western United States was considerably affected by tectonic changes during late stages of the Pennsylvanian. In Arizona, a broad lowland area that extended south from the Piute positive element in the time of interval D apparently was downwarped during the time of interval E. A slight deepening occurred at the north end of the Sonoran geosyncline, which was thereby again connected with the Cordilleran geosyncline to the northwest. The north and south prongs of the Antler positive element may have continued as active positive features, but carbonate rocks deposited adjacent to the prongs suggest that structural movements more likely were post-Pennsylvanian. Thus, the prongs probably resulted from later uplift and erosion.

INFERRED MARGINS OF DEPOSITION

In much of the Appalachian region of the Eastern United States large parts of the record of interval E have been destroyed by erosion. Probably only about the lower one-third has survived in the Southern Anthracite field, and all the record has been removed in adjacent areas to the north and south. The basin of deposition had about the same configuration as before, except that it probably was slightly more constricted, as compared to interval D. Margins of deposition on the south, east, and north are more limited than those postulated for interval D on the restored isopach map, plate 15*B*.

In the Eastern Interior States and as far west as the Forest City basin in Missouri and Kansas, interval E has been largely removed by erosion except for a large area in southeastern and central Illinois, and in the Moorman syncline of western Kentucky. South from the Forest City basin to south-central Texas, the margin of deposition was everywhere west of that postulated for interval D. In numerous areas farther west in Texas, rocks of this interval were removed in latest Pennsylvanian or earliest Permian time. Around the Amarillo-Wichita uplift, however, interval E extends today almost, if not fully, as far as at the time of deposition and is about as widespread as interval D.

In southeastern Colorado, interval E seems to be preserved almost as it was originally deposited, but it is progressively more eroded toward the north and has been removed completely in northern Colorado by post-interval E erosion along the eastern margin of the Frontrange uplift. In western New Mexico and Arizona, interval E is now largely absent across a wide area where small scattered remnants indicate that it was formerly present. In Montana and adjacent States, it is entirely lacking, but facies trends in the rocks of Wyoming and North and South Dakota suggest that it probably was once widely distributed in the Montana region.

In the eugeosynclinal area of the Far West, the record of interval E, like that of other Pennsylvanian intervals, is sparse and uncertain and no reconstruction is attempted. For much of California and western Nevada, it seems impossible to determine whether the region at that time was one of nondeposition or whether it contained strata of interval E that have since been destroyed.

SOURCE AREAS

Throughout most of the United States, sources of sediment during the time of interval E were virtually the same as during interval D. Furthermore, environments of deposition persisted almost unchanged from interval D as indicated by the sedimentary record.

The Appalachian positive element was still sufficiently high to furnish large quantities of sand, silt, and clay, especially in the northwest part of the geosyncline. Lesser amounts of sediment apparently were carried southward from the Canadian Shield and spread across the Eastern Interior States. Little coarse detritus was deposited.

In the southwestern part of the Appalachian region, interval E consists of fluviatile and deltaic red sandstone and mudstone and contains only a little coal or limestone. Thickness and facies relations indicate land sources to the southeast. In contrast, strata toward the northwest are thinner and grayer, and coals are fairly numerous and locally thick enough to be of economic interest.

Mountains along the Ouachita structural belt of Arkansas and its southwestward extension in Texas, and a hilly region in the Amarillo-Wichita belt of Oklahoma continued to supply mostly fine material to adjacent depositional areas. Smaller positive elements such as the Cincinnati arch and Nashville and Ozark domes, which were prominent topographic features early in the Pennsylvanian, probably were buried; no evidence is known that any of them was a source of sediment during the time of interval E.

In New Mexico, at the southern end of the Rocky Mountain region, the Pedernal and southern Uncompahgre uplifts apparently contributed large volumes of detritus to nearby basins. Boulders, cobbles, coarse sand, and arkose from these sources accumulated in the Orogrande and Rowe-Mora basins; some tree trunks and macerated plant debris from the Pedernal uplift were rafted far out to sea in the Orogrande basin. Farther north in the Paradox basin of Colorado and Utah, the sea became shallow and in late Virgil and in earliest Permian time terrigenous sediments accumulated, rather than carbonates or evaporites as in earlier Pennsylvanian time. In most of the Colorado Rockies, deposits of interval E continued to include much coarse detritus although the total volume of sediment was far less than that of earlier intervals.

Sources of sediment in the western part of the northern Rocky Mountain region, as interpreted from the scant evidence available, were virtually the same as in the time of interval D. An inferred positive element in northern Idaho and western Montana may have continued to furnish detritus, although the elevation of any such land must have been much diminished. Farther east, however, major changes probably occurred. Northern Montana was uplifted and its surface beveled by erosion down to the Upper Mississippian rocks; the resulting detritus was transported southward during interval E or early in Permian time.

As during earlier parts of the Pennsylvanian, the Antler positive element in Nevada was an important source of sediment that accumulated in the Cordilleran geosyncline. Some coarse detritus was deposited on both the east and the west sides, implying high elevations locally. East of the geosynclinal belt the Piute positive element furnished fine detrital sediment westward into basins of the miogeosyncline and southward across Arizona. Transport southward has been determined through current directions indicated by crossbedding. Sand forming a belt along the southeastern margin of Nevada may also have been derived from the Piute positive element or from land inferred to have been in southwestern Arizona and adjacent California.

CHEMICAL SEDIMENTS

During the time of interval E only nonmarine sediments accumulated in the Appalachian region, whereas to the west, in Illinois, fine-grained marine terrigenous sediments alternated with wedges of deltaic detritus. In the region of Missouri, still farther west, marine carbonates and muds were the dominant sediments. As in preceding times, numerous and widespread transgressions and regressions were characteristic, but in interval E the resulting cyclothems were largely restricted to the midcontinent region, perhaps because a slight but general uplift farther east restricted the eastward spread of the seas.

In Texas and adjoining areas the distribution of chemical sediments was almost the same as in interval D. Thickest accumulations were in reefs and banks. Farther west, in New Mexico and Arizona, deposition of calcium carbonate was notably widespread at this time, and it suggests shoal conditions. The limestone is in lenticular beds, interbedded with terrigenous units. In the southern part of the Orogrande basin some gypsum was also deposited.

The lithofacies map of interval E (pl. 9*B*) shows that in the Rocky Mountain region terrigenous sediment everywhere dominates deposits in areas bordering the major uplifts, but carbonate sediments are dominant elsewhere, as for example, in areas north and east of the Frontrange uplift in the present-day Great Plains of eastern Colorado and Nebraska, and in the Paradox basin west of the Uncompahgre uplift. Most of the carbonate rock of interval E in the Great Plains region is dolomite; in the Paradox basin it is partly limestone and partly dolomite, although in the upper part of the interval terrestrial deposits — largely red beds — constitute much of the rock. Along the western margins of the Paradox basin, gypsum occurs in this interval, presumably formed in partly landlocked areas where normal circulation of the sea was impeded and evaporation was high.

In much of the Cordilleran miogeosyncline, carbonate deposits accumulated during the time of interval E, especially in western Utah and northeastern Nevada and in southern Nevada and adjacent parts of California and Arizona. The latter area was a seaway apparently directly connected across Arizona with the Sonoran geosyncline, in which much carbonate sediment likewise was accumulated.

CLIMATE

A survey of data upon which inferences concerning climatic conditions during the time of interval E can be based permits relatively few positive statements.

Continued widespread development of coal in the east and extensive marine carbonate deposits in the west suggest that, in general, the climate remained warm and equable. In the northern part of the Appalachian region at least five major widespread coal beds formed in the upper part of interval E. These included the *Pittsburg coal*, which is the thickest widespread coal in the United States. Because no major tectonism is recorded in either the Appalachian or the midcontinent region, marked or sudden change of environment during interval E in these regions seems unlikely and climatic conditions established earlier in the Pennsylvanian presumably continued into the Permian.

Possible indicators that a less humid, perhaps semiarid environment, such as apparently characterized the Permian in the west, was beginning to develop in some regions, especially in the southwest, are: (1) evaporites in the southern part of the Orogrande basin, New Mexico; (2) fewer coal deposits in the basins of Oklahoma and surrounding area than earlier in the Pennsylvanian; (3) gypsum along the western margin of the Paradox basin; (4) red beds in Arizona, Utah, Wyoming, and other areas.

REFERENCES

American Geophysical Union and U.S. Geological Survey, 1964, Bouguer gravity anomaly map of the United States (exclusive of Alaska and Hawaii): Washington, D.C., U.S. Geol. Survey, scale 1:2,500,000, 2 sheets.

Dibblee, T. W., Jr., 1952, Geology of the Saltdale quadrangle, California: California Dept. Nat. Resources, Div. Mines Bull. 160, p. 7-43.

Jansa, L. F., and Carozzi, A. V., 1970, Exotic pebbles in LaSalle Limestone (Upper Pennsylvanian), LaSalle, Illinois: Jour. Sed. Petrology, v. 40, no. 2, p. 688-694.

King, E. R., and Zietz, Isidore, 1969, The midcontinent gravity high — Keweenawan tectonics and a possible ancestral global rift system [abs.]: Geol. Soc. America Abs. with Programs 1969, pt. 7, p. 125-126.

McCulloh, T. H., 1954, 1. Problems of the metamorphic and igneous rocks of the Mojave Desert, [Pt.] 2 *in* Chap. 7 of Jahns, R. H., ed., Geology of southern California: California Dept. Nat. Resources, Div. Mines Bull. 170, p. 13-24.

Raup, O. B., 1966, Clay mineralogy of Pennsylvanian redbeds and associated rocks flanking Ancestral Front Range of central Colorado: Am. Assoc. Petroleum Geologists Bull., v. 50, no. 2, p. 251-268.

Savage, T. E., and Griffin, J. R., 1928, Significance of crystalline boulders in Pennsylvanian limestone in Illinois: Geol. Soc. America Bull., v. 39, no. 2, p. 421-428.

Zwart, H. J., 1967, The duality of orogenic belts: Geologie en Mijnbouw, v. 46, no. 8, p. 283-309.

PALEOTECTONIC INVESTIGATIONS OF THE PENNSYLVANIAN SYSTEM IN THE UNITED STATES, PART II: INTERPRETIVE SUMMARY AND SPECIAL FEATURES OF THE PENNSYLVANIAN SYSTEM

PENNSYLVANIAN CLIMATE IN THE UNITED STATES

By JAMES M. SCHOPF

INTRODUCTION

The climate during the Pennsylvanian Period in continental United States was milder than the climate at present. Probably much of the country was mostly tropical or subtropical which implies that, year around, it was usually entirely free of frost. Most regions of sediment deposition probably were near sea level. Intermittently during the Pennsylvanian, much of the interior of the United States was occupied by vast swamps; at other times, the interior was flooded by shallow seas. The presence of these seas and swamps and the kinds of vegetation growing in the swamps all suggest a humid atmosphere, and possibly seasonally fluctuating rainfall. Other evidence also indicates that the climate was warm and humid, depending at various places on direction and proximity to the sea.

Factors that determine seasonal climate or even daily weather are complex. Consequently, an interpretation of climate during the Pennsylvanian Period, 300 million years ago, involves much speculation. The disposition of land and sea, the positions of the equator and poles and hence the incidence of the sun's rays, and atmospheric circulation all greatly influenced the climate. Probably, within broad limits, the best climatic indicators are fossil plants, but consideration of the tectonic aspects of earth history during the Pennsylvanian is also necessary in reconstructing the climate and the climatic changes during the period.

In an area as large as that part of the conterminous United States that was continental during the Pennsylvanian Period, the climatic regime probably was not uniform. Nevertheless, there are few indications of marked climatic diversity. Most indications of climatic differences discernible among the plants are either ambiguous or quantitative only. The preservations of *Walchia* and of *Callipteris,* for instance, in a channel-fill deposit of Virgil age in southeastern Kansas can be readily interpreted either as the result of topographic zonation and transport or as the result of climatic control at the site of deposition.

The effects of climate on erosion and on transportation and deposition of sediments have been discussed by Barrell (1908), who cited many examples from older literature. Four general types of climate as noted by Barrell can be distinguished on the basis of geologic evidence: warm and rainy, warm and arid, cold and rainy, and cold and arid.

The paleoclimatic material first treated by Barrell has recently been discussed in greater detail by Strakhov (1962, 1967, 1969, 1970). Strakhov provided small-scale paleoclimatic maps that differentiate (1) tropical-moist, (2) southern- and northern-arid, (3) north and south temperate-moist, and (4), on some maps, polar zones of climate. Most important, his work indicates the ranges of climates and the trends of climatic variation that may have prevailed in the past.

THEORIES OF CLIMATE CONTROL

Essentially three opposing theories regarding ancient climate have been advanced. According to the first of these, the climate of most early periods was genial and warm, zonation from pole to pole was slight (for example, Lyell, 1892), and the relative positions of continents and ocean basins were established very early in the earth's history, to remain virtually unaltered. Under this theory the present zonal climate is considered abnormal; it was established in late Tertiary time and was responsible for Pleistocene glaciation. Periods of exceptional climate other than Pleistocene supposedly occurred at times of other glacial episodes as during the Early Permian and the late Precambrian. Advocates of this theory claim that the distribution of ancient fossils shows little basis for believing that a strong climatic zonation, comparable with that of the present regime, existed in the distant past.

A second theory to explain climatic changes of the past postulates, as does the first, that continents have been fixed in position since early geologic time. According to this theory the control of climates has been mainly solar and zonal, and according to its principal advocates (Berry, 1930; Chaney, 1940; Brooks, 1949) the extent of climatic zones may have varied widely. Furthermore, some types of tropical plants may have formerly possessed hardiness to frost (Berry, 1930).

That the upper Carboniferous "with its apparently tropical forests in temperate latitudes accompanied by an enormous glaciation near the present equator, is a meteorological paradox" was recognized by Brooks (1949, p. 209). To explain this paradox, which is made even more striking by recent discoveries of tropical plants in Antarctica, he was forced to postulate land bridges in the Atlantic and Indian Oceans (for which modern oceanography provides no support) and an opening of the Tethys and Volga Seas for diversion northward of the entire equatorial current.

The Carboniferous was considered by Brooks to be a period of extensive mountain making, during which continents were elevated and Gondwanaland extended southward from the present position of India. A cold southern ocean apparently encircled Antarctica, which was excluded from Gondwanaland, and Brooks postulated that quantities of dust produced by extensive volcanism caused a general atmospheric cooling.

The extent of the modifications of present-day climatic controls that are necessary to solve the paradox of Pennsylvanian climate seems one of the strongest reasons for questioning a "fixed continent" approach to explanation of ancient environments. Thus, a third theory — one that involves changes in position of landmasses — was evolved.

The third theory of climatic control considers that throughout time terrestrial climate has been zonal, as it is at present. Maximum insolation always has been near the equator and minimum insolation near the poles. The climatic zones were altered locally in the past, as at present, by oceanic and atmospheric currents. However, the zones of Pennsylvanian time are not in their former positions because of changes in the relative positions and elevations of continents since the Pennsylvanian.

According to this theory, the present high-latitude positions of certain ancient fossil indicators of warm and genial climates have been determined by post-Pennsylvanian displacement of continental masses, and the climatic significance of the fossil indicators can be assessed only relative to mobility of the earth's crust.

Much disagreement prevails about specific rearrangements of crustal elements; however, strong geophysical and oceanographic evidence has been presented, especially during the last 20 years (Hess, 1962; Runcorn, 1962; Irving, 1964; Takeuchi and others, 1967), which seems to support and be consistent with displacement of continents during the course of geologic time. Results of study of Antarctic fossil plants, for instance (Schopf, 1972), are inconsistent with the interpretation that Antarctica occupied a polar position at the time these plants were growing. Continental displacement thus is invoked to explain the apparent climatic anomalies.

Each of the climatic control theories has certain uniformitarian aspects. The first considers the fixed location of continents a very important principle and suggests that fossil animals and plants flourished in the same climates as their modern counterparts. The second theory is intended to be conservatively uniformitarian; it requires periodically higher temperatures near the poles, whether the polar areas are land or sea, and it requires extended tolerances in certain fossil plants that are now located anomalously. However, the extent of physical and biological adjustment that seems to be required according to this theory is difficult to accept. The third theory regards the continents as geologically mobile, but accepts as uniformitarian principles both the solar control of climate and the indication of past climate by fossils.

Conceivably, climatic changes result from sporadic variations in the solar constant. Although, in our experience, solar radiation seems remarkably uniform, the sun might actually be a variable star. If, on occasion, the sun emitted a notably greater amount of radiant energy than at present, the increased terrestrial input probably would cause greater equatorial heating, accelerated circulation of atmosphere and ocean currents, increased climatic contrasts from poles to equator, and displacement of storm tracks. However, the differences of insolation would not be greatly altered, and extremes of weather would still be about the same.

Polar land areas that in the past had climates other than distinctly frigid are difficult to envision. No evidence is available that plants have ever grown naturally near the poles and no indication is known of a period in the earth's history when equatorial temperatures were significantly greater than they are now. For these reasons, it does not seem necessary to account for past variations in climate by differences in the amount of solar radiation.

An attempt will be made in this paper to interpret climate of the Pennsylvanian Period according to the concepts of a constant solar input and displaced continents.

Continent displacement alone cannot, of course, completely explain the Pennsylvanian climate. Factors such as elevation of land, albedo differences, and precession must have had their effects. Many of these factors will produce only a nominal variation in climate, but, as Milankovic (1941) and others have pointed out, if several of them work in conjunction, they may have appreciable effect. The point for emphasis is that whatever effects may have resulted from continent displacement, they are in addition to the effects contributed by all other causes; they cannot be regarded independently.

Arguments against the displacement of continents — Brooks (1949), Berry (1930), Chaney (1940), Simpson (1947), Meyerhoff (1970a, b), and, formerly, Axelrod (1952) — have so rationalized and compromised geological evidence on paleoclimates that studies of the literature on this subject are of little value now in discussing displacement. Although paleoclimates have been nearly ignored in recent discussions of sea-floor spreading, a valid reconstruction model must provide a reasonable interpretation of the distribution of fossil plants and animals.

Three broad areas of the earth are marked by climatic extremes induced by solar radiation — the two polar regions and the region around the equator. Under present conditions, the polar areas are complementary, the south polar area illustrating the extreme in a continental area, the north polar area illustrating the extreme at sea. The equatorial area is broken into different-sized segments of land and sea. Reconstructing the paleoclimate for any past period requires consideration of evidence for location of poles and equator and determination of paleogeographic gradients which may suggest orientation of climatic zones or belts.

GEOGRAPHIC SETTING

THE PENNSYLVANIAN EQUATOR

The luxuriant Pennsylvanian flora of the coal measures in the Appalachian region is an impressive record of plant growth in a warm, humid climate. Most geologists and botanists have agreed on this climatic interpretation. Discovery, about 70 years ago, that many of the fernlike plants were actually seed-bearing led to the suggestion that perhaps the presence of this group of plants did not necessarily imply a climate such as that favored by present-day ferns. Today this suggestion seems unlikely. These seed ferns display all the anatomical features characteristic of rapid growth in a warm and humid climate, and their anatomical features are considered to take precedence over taxonomic affiliation in interpreting ecological significance.

Evidence that the climate indicated by the Pennsylvanian coal flora was indeed tropical or subtropical was presented by White (1913, 1932) and Potonié (1911). Reliance on much the same lines of evidence is shown in recent U.S.S.R. studies of paleoclimatology (Meyen, 1969, 1970), which emphasize that the conclusions reached by Potonié and White were essentially correct (Schopf, 1972). A summary of such evidence, compiled chiefly from the work of White and Potonié, follows:

General luxuriance, size, and abundance of vegetation.
Succulent nature of many plants, as in *Medulossa* and *Psaronius*.
Tissues with large cells, thin walls, such as the calamite cortex.
Organs with large intercellular spaces and abundant lacunar tissue.
General absence of growth rings in all plants showing secondary wood.
Large size of fronds of bushy plants, as in *Neuropteris*.
Delicate foliage of climbers, as in sphenophylls and some sphenopterids.
Presence of aphlebiae in ferns and pteridosperms.
Large size and texture of leaves such as *Megalopteris*, *Psygmophyllum*, and others.
Occurrence of stomata in grooves, as in leaves of arborescent lycopsids.
Presence of hydathodes to discharge excess water in certain sphenopterids and sphenopsids.
Profusion of large drooping fronds and pendant branches to shed rain.
Indications of delayed fertilization and adaptations for seed flotation.
Prevalence of the free-sporing habit and dependence on fluid moisture in reproduction.
Inflorescences borne on central stems (cauliflory), as in calamites and sigillarians.
Presence of subaerial roots in pteridosperms and ferns.
Smoothness and thickness of bark, as in *Bothrodendron* and other lepidophytes.
Occurrences of pneumatophores in *Sigillaria* and some cordaites.
Dilation of tree bases as in large calamites, sigillarians, and others.
Presence of close relatives of modern types of tropical plants.

Areas within the Appalachian coal field and the northern European coal fields appear to represent the warmest and most humid climates of which a record is available. If North America and Europe lay adjacent during Pennsylvanian time, a line drawn lengthwise through these coal fields might mark the axis of a tropical zone now displaced northward. This postulate was first made by Köppen and Wegener (1924) and it still seems valid. The Carboniferous equator as they drew it is shown on the map, figure 2. If any area more tropical than the zone shown on this map existed on the earth during Pennsylvanian time, its record is extremely scant. Although not all the reconstructions of latitude shown on the map may be correct, the great Appalachian coal field in the United States seems clearly to lie upon the Carboniferous equator.

The equator shown on the map corresponds to the present site of the Appalachian coal field, suggesting that most of the United States may have been within the tropical or subtropical zone north of the equator during Pennsylvanian time. The maximum distance from the equator would have been about 2,000 miles or roughly the distance that southern Florida or Texas now is north of the equator. The postulated geographic relationships are sketched in figure 3.

The presence during the Pennsylvanian of sub-equatorial types of plants in parts of the United States

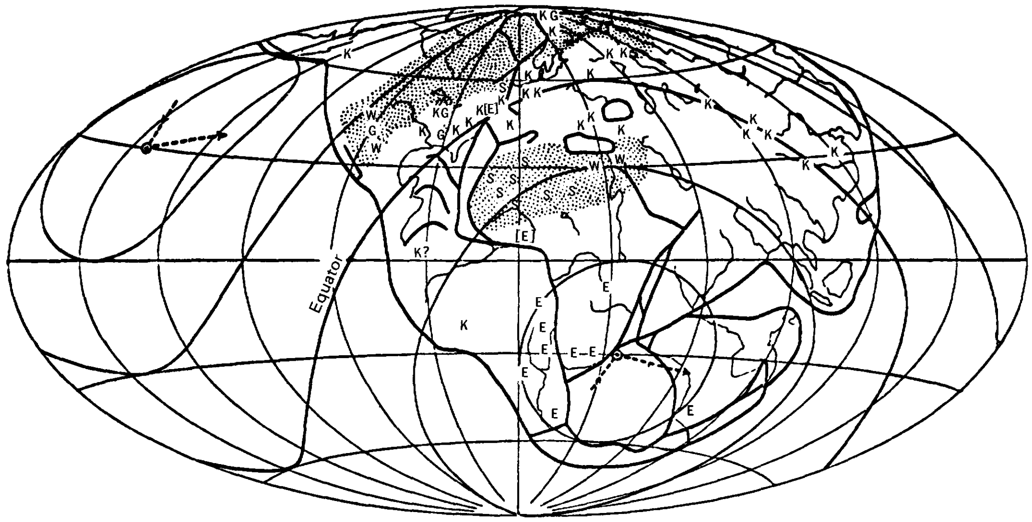

FIGURE 2. — Reconstruction of continents during the Carboniferous according to Köppen and Wegener (1924, p. 22). E, glacial deposits; K, coal; S, rock salt; G, gypsum; W, eolian sandstone; dotted area, arid regions. Nonglacial explanations are now generally accepted for local deposits of diamictite in Oklahoma and Massachusetts. Reproduced from Wegener (1966, fig. 35) with the permission of Dover Publications, Inc.

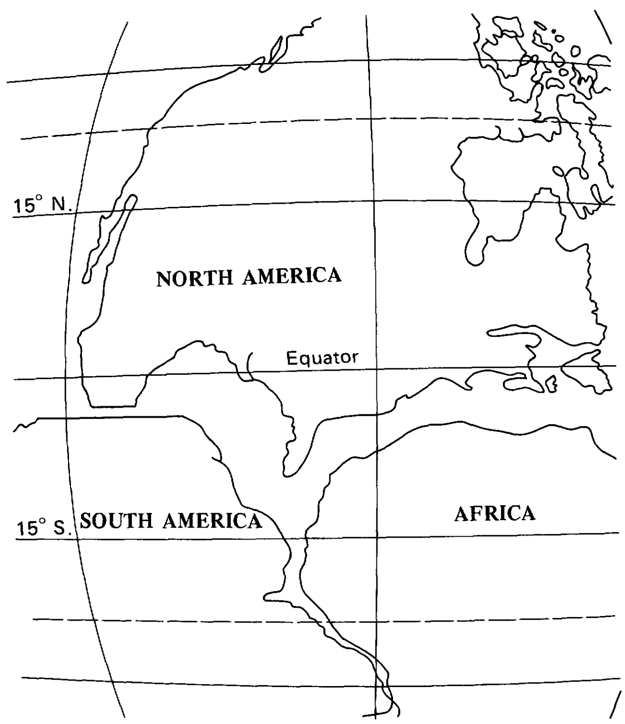

FIGURE 3. — Approximate position of equator in relation to North America, South America, and Africa during the Pennsylvanian Period.

that are now temperate seems to indicate that the equatorial and subequatorial zones were no broader than those zones are today, and that the differences between climatic zones were probably not greater than today.

LANDS OF PENNSYLVANIAN TIME

The landmasses of North America, Europe, and northern Africa included extensive epicontinental seas which doubtless were bordered by many barrier bars, estuaries, and tidal flats. The seas likewise probably were bordered by vast areas of interior swamp at elevations little more than a few feet above tide level. Apparently no deep Atlantic Ocean separated North America from Europe and Africa at this time, though shallow seas existed. The European and North American continents were close together if not part of the same landmass. In part, low highlands inherited from orogenies of the Devonian and Mississippian Periods occupied positions along the present coasts and shelves of both continents, perhaps with some intervening continental selvage, much of which has since disappeared.

The western border of North America during the Pennsylvanian Period is poorly defined. The continental area may have been less extensive than now, but regardless of its extent, it bordered on an ancient Pacific Sea. The continent of North America must have been oriented in such a way that the Appalachian coal field had an approximately east-west alinement, if our postulate about the coal field being an equatorial zone is reasonably correct.

The relative positions of North and South America during Pennsylvanian time are uncertain. If one attempts a reconstruction of Pennsylvanian paleogeography, an excess of sea area and continental islands is evident in the region between the two continents. Much new sea floor has been formed since late Paleozoic time.

Nowhere in the United States south of the Black Warrior basin in Alabama and the Ouachita structural belt in Arkansas, Oklahoma, and Texas (pl. 3*A*) do we have represented a late Paleozoic terrestrial facies containing fossil land plants, on which climatic inferences mainly depend. Permian marine deposits that are present in Honduras, and Pennsylvanian and Permian marine limestones in Peru and Bolivia presumably represent vestiges of epicontinental seas or shelves of that region. Still farther south, in the Parana basin of southern Brazil and Uruguay, continental deposits occur which may be of Late Pennsylvanian age. These rocks probably are the oldest of the Lower Gondwana continental deposits, facies of which differ from those of most of the North American terrestrial Pennsylvanian. They include an assemblage of fossil plants which is completely different from any found in the Pennsylvanian of North America and which probably grew in a temperate climate.

No record of the Pennsylvanian is preserved in the Canadian Shield area in northeastern Canada. North of the Shield, marine sedimentation occurred in the Franklin geosyncline of the Arctic region. No Pennsylvanian coal deposits formed in the extreme north, and the Pennsylvanian floral representation is relatively sparse.

Coal deposits, particularly characteristic of Pennsylvanian land areas, indicate the presence of intermittent swamps, many of which were more extensive than any peat-forming areas are at present. Thin coal beds occur in the Pennsylvanian, from eastern Pennsylvania as far west as Colorado (pl. 16; figs. 8, 9, 11, 15, 16), and a coal-measures flora is present in southern Oregon. Minable coal is absent west of eastern Kansas but is present in increasing amounts eastward to the Anthracite region of eastern Pennsylvania. Coal is present in small quantity in the Naragansett basin of Rhode Island and Massachusetts.

Northeasterly from New England, coal occurs in the Minto basin of New Brunswick and the Canso basin and other relatively small, but deep, basins in Nova Scotia. The partly submarine Sydney basin in Nova Scotia may have been contiguous with the South Wales coal field in Great Britain. A virtually continuous coal swamp area must have followed the Hercynian trend across southern England, through western Europe and North Africa to Asia Minor and the Donetz basin in the U.S.S.R., ending in the Trans-Caspian area of central Asia. Through all this vast area, the well-known and characteristic Pennsylvanian type of coal flora is abundantly represented.

PHYSIOGRAPHY

The physiographic setting must be considered an important influence on the climate of the Pennsylvanian. This factor has been reviewed by White (1913, p. 52–84), who concluded that the coal swamps were of a magnitude unparalleled in the world today. Such conclusions have been documented by later detailed studies of Wanless ([1961], 1969a, b), Wanless, Tubb, Gednetz, and Weiner (1963), and Wanless, Baroffio, and Trescott (1969). The broad extent of low-lying swampland and epicontinental seas must have had a great effect on atmospheric humidity, thermal regime, and climate in general.

Epicontinental seas of the Pennsylvanian were subject to unusually broad fluctuations. Large areas of the American coal swamps were repeatedly inundated by the sea as indicated in Wanless' studies. During each inundation, previously deposited coals were covered by a thin layer of marine sediments. When the shallow seas retreated, the land surfaces became revegetated and reconverted into coal swamps. This cycle of events was repeated many times and intervals between invasions ranged from several tens of thousands to a few hundred thousand years. Such broad fluctuations of the strandline also must have had an ancillary effect on rainfall and other climatic factors.

The causes of the repeated and widespread oceanic transgressions during the Pennsylvanian have been much discussed (Weller, 1930, 1931, 1956; Wanless and Weller, 1932; Westoll, 1968). Diastrophic control is emphasized by most authors, although climatic control is also considered. Withdrawal of water from the oceans to form continental ice sheets would have lowered sea level and caused regressions of the strandline. Such eustatic changes, attributed to the waxing and waning of late Paleozoic (Gondwana) ice sheets, were suggested by Wanless and Shepard (1936).

Many aspects of southern glaciation have been reviewed by Wanless (1960) and Wanless and Cannon (1966). Whether each of the transgressions and regressions of the Pennsylvanian seas in North America corresponded with advances and retreats of Gondwana glaciers in the Southern Hemisphere (Wanless, 1960) may be questioned (Weller, 1937). Whether, in fact, the glacial episode of the Southern Hemisphere was contemporary with most of the cyclothemic deposition in the north is also debatable.

Eustatic causes of strandline variability are consistent with the concept of plate tectonics and are not necessarily the result of changing of water level by glaciation. The location of the strand reflects the volume of ocean basins. The chief variables in ocean basins consist of midocean ridges (or rises) and crustal trenches; both represent a considerable volume displacement, the amount depending on whether ridges are high or low and whether the trenches are deep. Both ridges and trenches are active seismically and are presumed to be active tectonically. If the trenches operate as crustal sumps, troughs would become deeper when the spreading rate is increased, and a more rapid movement of oceanic crust would result in lowering of the average heights of ridges. Both effects would result in an increased ocean basin volume. A period of relatively rapid spreading might readily account for eustatic withdrawal of the sea.

Major Pennsylvanian transgressive-regressive cycles were probably due to eustatic causes according to Wanless and others (1970), whereas lesser cycles had climatic causes. Of course, similar effects might be produced by other causes such as tectonic uplift and related subsidence either on land or in the oceanic basins, rapid but intermittent compaction, or sudden breaching of a barrier to the sea. Certainly the extensive shallow flooding of any broad embayment comparable in size to the interior basins of North America would be accompanied by changes in rainfall and probably in rates of erosion. Even though the primary causes of fluctuation of the sea are obscure, climatic factors must be recognized as continuously changing forces that exert an influence on the marine environment.

Some recent attempts to account for cyclothemic deposition, particularly that of the Dunkard Group, including beds that may be of Late Pennsylvanian age, are described by Beerbower (1961). He considers these repetitive types of deposits, which are almost completely nonmarine, to reflect climatic, rather than tectonic or eustatic, cycles. The relationships of deposition to erosional base level also are believed significant. All other variables must be considered within the dynamic context of secular variation in continental climate (Beerbower, 1961). Which of these possible, largely independent factors were governing, either separately or in conjuction, in any particular part of the Pennsylvanian is difficult to determine.

ELEVATION AND OCEAN CURRENTS

Elevation plays an important part in manifestations of climate. Any Pennsylvanian mountainous areas in the United States would be expected to show much the same type of climatic zonation that exists in tropical mountain areas today; however, few indications of mountain flora are preserved in the fossil record of the Pennsylvanian. Indications of a walchian forest are recognized in parts of Western United States (Florin, 1940; Read and Mamay, 1964) and these may, in part, reflect variations in climate due to elevation during orogenic episodes. Because Pennsylvanian deposits were largely marine in these areas, mountainous terrain probably was relatively limited and small in comparison with the mountains of today. Belts of coarse sediment show that some strongly elevated areas did occur during this period.

The present Appalachian Mountains did not exist during the Pennsylvanian, though highlands almost surely existed farther to the southeast (pl. 15). A general conclusion is that much of the North American continent was then lower and closer to sea level than at present. Any general lessening in elevation would tend to lessen climatic gradients and result in a generally more equable climate than at present. Zones of tropical and subtropical climate probably were wider than today.

The efficiency of ocean currents in modifying climate is well known and must have had an important influence in Pennsylvanian time. The effects of oceanic circulation have been evaluated by Frakes and Crowell (1970). They placed the poles where evidence of glaciation is strongest; glaciers, however, merely indicate a climate that was cool and temperate. These two writers have not attempted a reconstruction for the Northern Hemisphere.

The lush growth of Pennsylvanian plants seems to indicate that the United States, particularly the eastern part, had abundant rainfall, and that the temperature was higher than at present. This is scarcely sufficient information, however, on which to postulate the existence and courses of warm sea currents. Within the United States, evidence of cold sea currents is lacking.

PENNSYLVANIAN CLIMATIC REGIONS

EASTERN REGION

Climates of coal-forming periods, especially those of Pennsylvanian age in Eastern United States, were thoroughly reviewed in 1913 by David White. His study more than any other is the basis for assigning the coal measures of the Appalachian trough to a near-equatorial position in reconstructing Pennsylvanian paleogeography, even though White himself did not make such an assignment. Instead, he regarded the tropical flora as evidence of widespread climatic equability. Probably the first to interpret the eastern coal measures flora in terms of an actualistic, zonal climate were Köppen and Wegener (1924). White's conclusions about the climate are valid, however, regardless of any paleogeographic interpretation that is derived from them.

The "climate of the principal coal-forming intervals of the Pennsylvanian was mild, probably near-tropical or subtropical, generally humid and equable," according to White (1913, p. 74). Mindful of the geographic discrepancy between the tropics and present location of the eastern coal fields, he was careful to point out that the climate may nowhere have been "torrid." In spite of this disclaimer, the eastern coal-measures flora is recognized as the most tropical of any plant assemblage that existed during the Pennsylvanian and corresponds fully with the requirements of a tropical rain forest (Richards, 1966).

The Pennsylvanian flora was developed largely from that of the Mississippian, which White (1913, p. 74) regarded as "impoverished, restricted and seemingly stunted." The very rapid expansion and differentiation of new types of plants during Pottsville (Early Pennsylvanian) time is taken as unmistakable evidence of climatic amelioration, the most uniform climate being in the late Pottsville. This was perhaps the time of greatest and most evenly distributed rainfall. Plants of later, Allegheny age are regarded as having somewhat less lush foliage and, in fact, represent a transition to climatic conditions of Conemaugh time during which, White thought, the flora showed evidence of considerably less rainfall. Ferns of the family Marattiaceae were well represented, however, and this family is now exclusively tropical in distribution as noted by White. Red beds, which first appeared during the Pennsylvanian in the eastern region in the Conemaugh, may indicate actual aridity, but are not an infallible indication. Fossil plants in red deposits differ little from those found elsewhere in the Conemaugh.

The climate during the interval of time represented by Upper Pennsylvanian Monongahela deposits appears to have been favorable to lush growth, and represents a reversion to the climate of Allegheny time. The climate was mild, probably subtropical, marked by short periods of dryness but not of frost. The flora of the overlying Dunkard, mostly of Permian age, on the other hand, is indicative of a colder climate. The Dunkard deposits were considered by White to be contemporary with those formed in the Southern Hemisphere and India during the period of glaciation.

INTERIOR REGION

The climate of the interior region was specifically considered by David White in 1931 and little can be added to statements he made then. A summary of the conclusions reached by White (1931, p. 271) follows: "In considering the climatic conditions prevailing during Pennsylvanian time in the region of the continent now embracing Illinois, we have to do with an ancient geological epoch and a land pattern very different in size and configuration from that of the present day." Plants of the Chester (Late Mississippian) "suggest either that the climate was characterized by severe drouths or that the soil was, perhaps, overdrained during dry seasons" (White, 1931, p. 275)." On the whole, the evidence points rather definitely, though not with certainty, to slightly less favorable conditions for plant growth in Southern Illinois and Indiana during Sharon time [middle Pottsville] than in the Appalachian Trough." White inferred that during the Sharon interval the climate of the Eastern Interior region of North America was slightly less humid than in the Appalachian trough. "Although the Carbondale [Middle Pennsylvanian] climate was very mild, almost certainly without frost in Illinois, it is likely that the rainfall, while abundant, varied seasonally * * *."

During the later part of Pennsylvanian (Conemaugh) time, less coal was deposited in Illinois than in the Appalachian trough; the difference resulted either from less rainfall in the Illinois-Indiana region than farther east or less even distribution of precipitation throughout the year, according to White. Differences in rainfall between the interior and the Appalachian regions during the Pennsylvanian probably were of the same order of magnitude as today, that is, rainfall was about a third greater in the Appalachian region. "Both the far greater rainfall and the very much greater equability of the mild climate, which approached subtropical in the Eastern Interior region, should have and undoubtedly did result from [altered] land and sea patterns of Pennsylvanian time" (White, 1931, p. 279).

WESTERN REGION

With regard to Western United States, the climatic trends interpreted by White for Illinois have been applied with little modification by Read and Mamay (1964, p. 16). They wrote:

> The plant associations in the oldest parts of the Pennsylvanian sequences in the western areas [Rocky Mountain and Pacific Coast regions] are similar to those of the [Eastern] coal measures, but the relative rarity of Lycopodiales suggests drier habitats than those indicated by the approximately contemporaneous floras in the eastern coal basins. The younger Pennsylvanian floras in the western United States, however, are striking departures from the plant associations of the same general ages in the eastern part of the country, as inferred from index forms and independent stratigraphic data. The plants in the western area occur in suites of sediments that were deposited during a period of widespread orogeny in parts of the Rocky Mountain region. Many geological data indicate that the lowlands were restricted and the upland habitats or areas were expanded during this period of mountain building. The floral modifications include the presence of abundant conifers and appear to be in the direction of mesophytic associations. The term "Cordilleran flora" has been used for the modifications that occur in the Rocky Mountains (Read, 1947).

A MODEL FOR PALEOCLIMATIC INTERPRETATION

The use of models helps in reconstructing the paleoclimate. The roughly triangular or acute-obovate figures of Köppen (1931, p. 137-138) have been oriented meridionally by Axelrod (1952) and by Camp (1956) to approximate the most common generalized shapes of continents. This model theoretically eliminates differential effects of local relief on climate, and makes possible an analysis of conditions imposed by normal insolation and rotation of the globe. Such models show the expected distribution of the climatic zones so that deviations can be evaluated. The model selected assumes a very simplified shape for the continental mass and assumes that the interiors of continents were not occupied by epicontinental seas. Atmospheric circulation would remain basically unchanged, however, if models incorporating these features were used.

In figure 4 the outline of North America (omitting Alaska) is superimposed on one of Camp's theoretical diagrams of a triangular supercontinent of minimum relief. Moderate or high relief would, of course, introduce much greater climatic differentiation than shown, and would modify the climatic patterns. Climates that White (1913) described on the basis of fossil plants seem to correspond very well with the theoretical model produced by Camp, including a superhumid equable climate in the Appalachian (equatorial) region, a humid zone of more seasonal rainfall in the interior region, and a zone approaching semiaridity in the extreme western United States.

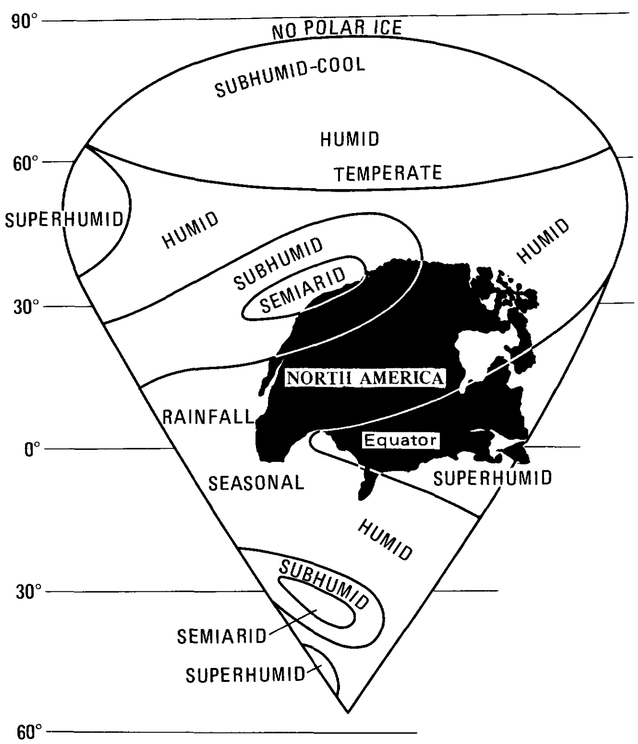

FIGURE 4. — Theoretical model showing climate of a supercontinent having very low relief and triangulate outline (modified from Camp, 1956), with North American outline map (omitting Alaska) of similar latitudinal scale superimposed; Appalachian area paralleling the equator. Used with permission of the American Geographical Society.

REFERENCES

Axelrod, D. I., 1952, Variables affecting the probabilities of dispersal in geologic time, *in* Mayr, Ernst, ed., The problem of land connections across the South Atlantic with special reference to the Mesozoic, Art. 3: Am. Mus. Nat. History Bull., v. 99, p. 177-188.

Barrell, Joseph, 1908, Studies for students — Relations between climate and terrestrial deposits: Jour. Geology, v. 16, no. 2, p. 159-190; no. 3, p. 255-295; no. 4, p. 363-384.

Beerbower, J. R., 1961, Origin of cyclothems of the Dunkard group (upper Pennsylvanian-lower Permian) in Pennsylvania, West Virginia, and Ohio: Geol. Soc. America Bull., v. 72, no. 7, p. 1029-1050.

Berry, E. W., 1930, The past climate of the north polar region: Smithsonian Misc. Colln., v. 82, no. 6, 29p.

Brooks, C. E. P., 1949, Climate through the ages — a study of the climatic factors and their variations, [2d ed., rev.]: New York, McGraw Hill Book Co., 395 p.

Camp, W. H., 1956, The forests of the past and present, Chapter 2, *in* Haden-Guest, Stephen, and others, eds., A world geography of forest resources: Am. Geog. Soc. Spec. Pub. 33, p. 13-47.

Chaney, R. W., 1940, Tertiary forests and continental history: Geol. Soc. America Bull., v. 51, no. 3, p. 469–488.

Florin, Rudolf, 1940, Verzeichnis über die Fundorte und die an ihnen gefundenen Koniferen, [chap.] 6, *in* Die Koniferen des Oberkarbons und des unteren Perms: Palaeontographica, v. 85, pt. B, no. 5, ch. 6, p. 337–353.

Frakes, L. A., and Crowell, J. C., 1970, Glaciation and associated circulation effects resulting from late Paleozoic drift of Gondwanaland, *in* Internat. Union Geol. Sci. Symposium, 2d, South Africa 1970, Proc. and Papers — Gondwana stratigraphy and palaeontology: Marshalltown, Transvaal, South Africa, Geol. Soc. South Africa, p. 99-109.

Hess, H. H., 1962, History of ocean basins, *in* Petrologic studies — A volume in honor of A. F. Buddington: Geol. Soc. America, p. 599–620.

Irving, E., 1964, Paleomagnetism and its application to geological and geophysical problems: New York, John Wiley and Sons, Inc., 399 p.

Köppen, W. P., 1931, Grundriss der Klimakunde: Berlin and Leipzig, 388 p.

Köppen, W. P., and Wegener, A. L., 1924, Die Klimate der geologischen Vorzeit: Berlin, Verlag von Gebrüder Borntraeger, 256 p.

Lyell, Sir Charles, 1872, Principles of geology [11th rev. ed.]: New York, D. Appleton and Co., v. 1, 671 p.

Meyen, S. V., 1969, The continental drift hypothesis in the light of Carboniferous and Permian paleoflora: Geotectonics, no. 5, p. 289–295.

——1970, On the origin and relationship of the main Carboniferous and Permian floras and their bearing on the general paleogeography of this period of time, *in* Internat. Union Geol. Sci. Symposium, 2d, South Africa 1970, Proc. and Papers — Gondwana stratigraphy and palaeontology: Marshalltown, Transvaal, South Africa, Geol. Soc. South Africa, p. 551-555.

Meyerhoff, A. A., 1970a, Continental drift: Implications of paleomagnetic studies, meteorology, physical oceanography, and climatology: Jour. Geology, v. 78, no. 1, p. 1–51.

——1970b, Continental drift, [Pt.] 2 — High-latitude evaporite deposits and geologic history of Arctic and North Atlantic Oceans: Jour. Geology, v. 78, no. 4, p. 406–444.

Milankovic, Mikalin, 1941, Canon of isolation and the Ice-age problem: Royal Serbian Acad. Spec. Pub., v. 132, Math. and Nat. Sci. Soc., v. 33, 484 p.; available only from U.S. Dept. Commerce, Natl. Tech. Inf. Service, Springfield, Va. 22151, as Rept. IPST 1793.

Potonié, H., 1911, Die Tropen-Sumpfflachmoor-Natur der Moore des Produktiven Carbons, *in* Kgl. Preuss. geol. Landesanstalt, Berlin, Jahrb. 1909: v. 30, pt. 1, p. 389–443.

Read, C. B., 1947, Pennsylvanian floral zones and floral provinces, *in* Wanless, H. R., Symposium on Pennsylvanian problems: Jour. Geology, v. 55, no. 3, pt. 2, p. 271–279.

Read, C. B., and Mamay, S. H., 1964, Upper Paleozoic floral zones and floral provinces of the United States, *with a* Glossary of stratigraphic terms, by G. C. Keroher: U.S. Geol. Survey Prof. Paper 454-K, p. K1-K35.

Richards, P. W., 1966, The tropical rain forest: Cambridge Univ. Press, 450 p.

Runcorn, S. K., ed., 1962, Continental drift: New York and London, Academic Press, 338 p.

Schopf, J. M., 1972, Coal, climate and global tectonics, *in* Continental drift, sea-floor spreading, and plate tectonics — Implications for the earth sciences: NATO Advanced Advisory Study Inst., Univ. Newcastle upon Tyne, England 1972, Book of Abstracts, [Paper] 13-15.

Simpson, G. G., 1947, Holarctic mammalian faunas and continental relationships during the Cenozoic: Geol. Soc. America Bull., v. 58, no. 7, p. 613-687.

Strakhov, N. M., 1962, Osnovy teorii litogeneza [in Russian]: Akad. Nauk SSSR Geol. Inst., v. 1, 212 p; v. 2, 574 p.

———1967, 1969, 1970, Principles of lithogenesis: New York, Consultants Bur., and Edinburgh and London, Oliver & Boyd, 1967, v. 1, 245 p.; 1969, v. 2, 609 p.; 1970, v. 3, 577 p. [Translation].

Takeuchi, Hitoshi, Uyeda, Seiya, and Kanamori, Hiroo, 1967, Debate about the Earth — Approach to geophysics through analysis of continental drift: San Francisco, Calif., Freeman, Cooper and Co., 253 p.

Wanless, H. R., 1960, Evidences of multiple late Paleozoic glaciation in Australia: Internat. Geol. Cong., 21st, Copenhagen 1960, Rept., pt. 12, p. 104-110.

———[1961], Depositional basins of some widespread Pennsylvanian coal beds in the United States, *in* The origin and constitution of coal, 3d Conf., Crystal Cliffs, Nova Scotia, 1956: Halifax, Nova Scotia Dept. Mines, p. 94-128.

———1969a, Eustatic shifts in sea level during deposition of Late Paleozoic sediments in the central United States, *in* Cyclic sedimentation in the Permian Basin — Symposium, Midland, Tex., Oct. 19-20, 1967: West Texas Geol. Soc. Pub. 69-56, p. 41-54, 12 figs., 1 table.

———1969b, Marine and non-marine facies of the upper Carboniferous of North America, *in* Internat. Cong. Stratigraphie et Geologie du Carbonifere, 6th Sheffield, England, 1967, Compte Rendu, V. 1: Maastricht, Netherlands, Ernest Van Aelst Publishing Co., p. 293-336.

Wanless, H. R., Baroffio, J. R., Gamble, J. C., Horne, J. C., Orlopp, D. R., Rocha-Campos, Antonio, Souter, J. E., Trescott, P. C., Vail, R. S., and Wright, C. R., 1970, Late Paleozoic deltas in the central and eastern United States, *in* Morgan, J. P., ed., Deltaic sedimentation; modern and ancient: Soc. Econ. Paleontologists and Mineralogists Spec. Pub. 15, p. 215-245.

Wanless, H. R., Baroffio, J. R., and Trescott, P. C., 1969, Conditions of deposition of Pennsylvanian coal beds, *in* Dapples, E. C., and Hopkins, M. E., eds., Environments of coal deposition: Geol. Soc. America Spec. Paper 114, p. 105-142.

Wanless, H. R., and Cannon, J. R., 1966, Late Paleozoic glaciation: Earth-Sci. Rev., v. 1, no. 4, p. 247-286.

Wanless, H. R., Tubb, J. B., Jr., Gednetz, D. E., and Weiner, J. L., 1963, Mapping sedimentary environments of Pennsylvanian cycles: Geol. Soc. America Bull., v. 74, no. 4, p. 437-486.

Wanless, H. R., and Shepard, F. P., 1936, Sea level and climatic changes related to late Paleozoic cycles: Geol. Soc. America Bull., v. 47, no. 8, p. 1177-1206.

Wanless, H. R., and Weller, J. M., 1932, Correlation and extent of Pennsylvanian cyclothems: Geol. Soc. America Bull., v. 43, no. 4, p. 1008-1016.

Wegener, Alfred, 1966, The origin of continents and oceans (translated from German by John Biram): New York, Dover Pubs., Inc., 246 p.; (originally pub. in German 1929; revised 1962).

Weller, J. M., 1930, Cyclical sedimentation of the Pennsylvanian period and its significance: Jour. Geology, v. 38, no. 2, p. 97-135.

———1931, The conception of cyclical sedimentation during the Pennsylvanian period: Illinois Geol. Survey Bull. 60, p. 163-177.

———1937, Comment on "Sea level and climatic changes related to late Paleozoic cycles," by H. R. Wanless and F. P. Shepard, *in* Discussion of papers in volume 47: Geol. Soc. America Bull., v. 47, p. 2011-2013.

———1956, Argument for diastrophic control of late Paleozoic cyclothems: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 1, p. 17-50.

Westoll, T. S., 1968, Sedimentary rhythms in coal-bearing strata, *in* Murchison, Duncan, and Westoll, T. S., eds., Coal and coal-bearing strata: New York, Am. Elsevier Publishing Co., Inc., p. 71-103.

White, David, 1913, Physiographic conditions attending the formation of coal, *in* White, David, and Thiessen, Reinhardt, The origin of coal, with a chapter on the formation of peat, by C. A. Davis: U.S. Bur. Mines Bull. 38, p. 52-84.

———1931, Climatic implications of Pennsylvanian flora: Illinois Geol. Survey Bull. 60, p. 271-281.

———1932, The carbonaceous sediments, *in* Twenhofel, W. H., and others, Treatise on sedimentation [2d ed., rev.]: Baltimore, Williams & Wilkins, p. 351-430.

PALEOTECTONIC INVESTIGATIONS OF THE PENNSYLVANIAN SYSTEM IN THE UNITED STATES, PART II: INTERPRETIVE SUMMARY AND SPECIAL FEATURES OF THE PENNSYLVANIAN SYSTEM

DISTRIBUTION OF PENNSYLVANIAN COAL IN THE UNITED STATES

By HAROLD R. WANLESS[1]

INTRODUCTION

Rocks of Pennsylvanian age contain substantial resources of bituminous coal and anthracite. This coal occurs principally in the eastern half of the United States (fig. 5), but thin discontinuous beds of coal occur in Pennsylvanian rocks as far west as Colorado and New Mexico.

Coal occurs in each of the mapped intervals in this publication, as shown in the following tabulation.

Interval or subinterval	Approximate stratigraphic equivalents	Plate No.	Figure Nos.
A_1(oldest)	Chester-lower Morrow (Springer)	16–*A*	---
A_2	Upper Morrow	16–*B*	9
B	Atoka	16–*C*	7, 8, 9
C	Des Moines	16–*D*	6, 10, 12
D	Missouri	16–*E*	13, 14, 15
E (youngest)	Virgil	16–*F*	16

Coal fields of the Appalachian region are divided into the Anthracite fields of eastern Pennsylvania and the Appalachian bituminous coal fields, which extend from western Pennsylvania and eastern Ohio to Alabama. For brevity, these two coal-bearing areas are designated in this article as the Anthracite fields and the Appalachian basin.

CONDITIONS OF COAL ACCUMULATION

As the precursor of coal, peat requires very special climatic and topographic conditions for its accumulation. The climate must be sufficiently humid to support a rich growth of vegetation, and the water table must be high enough to allow prolonged accumulation of plant detritus in a reducing environment. If the water table is too low, the plant detritus is destroyed by oxidation.

In cold regions, the evaporation of surface water and the oxidation of organic matter are retarded, and some plants that grow in such regions, particularly *Sphagnum,* or peat moss, have the capacity to hold much water, even on a slope. In Canada, Alaska, and northern Eurasia, therefore, peat accumulates on slopes as well as in flat marshes. An upland peat area of this type is called a high moor.

In warmer regions, where rates of evaporation and oxidation are higher, marsh vegetation and peat accumulation require a nearly level water table. This type of peat-forming marsh, exemplified by the Everglades of Florida and other coastal marshes and large delta plains like those of the lower Mississippi valley, is called a low moor.

It is generally believed that the peat-forming marshes of Pennsylvanian time were of the low-moor type, developed on nearly flat plains saturated with freshwater. The substantial thickness and broad areal extent of many Pennsylvanian coal beds suggest that low-moor marshes characterized by luxuriant plant growth were far more extensive in Pennsylvanian time than they are today.

Most large peat-forming areas of today are bordered on the landward side by areas in which the water table is too low and the rate of oxidation too high for accumulation of plant debris, and on the seaward side by areas in which the water is too deep or too saline for growth and accumulation of plants. At many places in sequences of coal-bearing rock, a carbonaceous film or "smut" streak a fraction of an inch thick may be underlain by an underclay with many root impressions, and overlain by a sequence of shale, mudstone, or sandstone containing either marine or nonmarine fossils. Such a stratigraphic record indicates that plant growth was prevalent in the area at the time marked by the carbonaceous film, but that the water table was low and most of the plant detritus was destroyed by oxidation prior to submergence of the land and deposition of the overlying

[1]Deceased June 3, 1970.

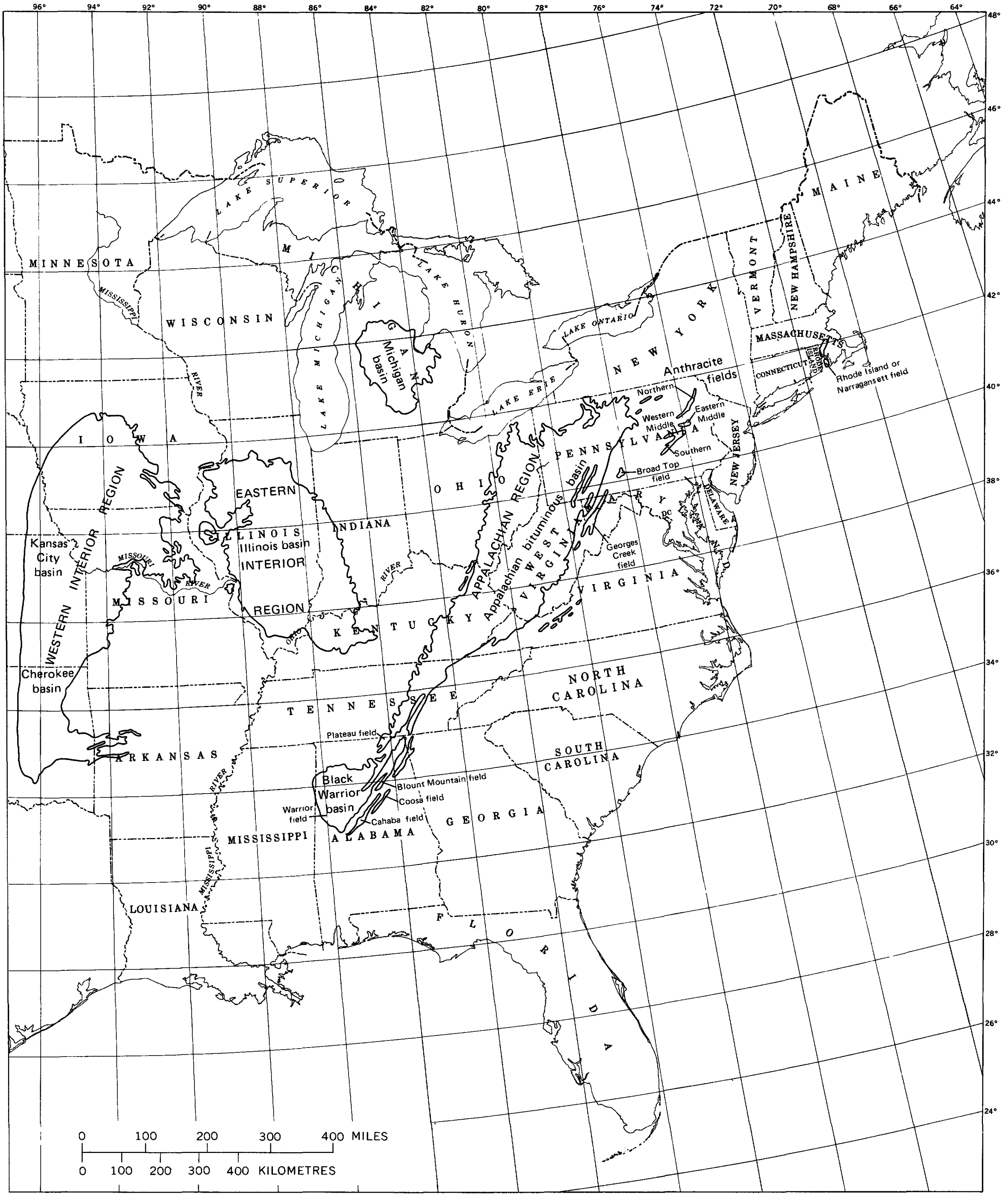

FIGURE 5. — Pennsylvanian coal fields in the Eastern United States (For coal-bearing basins and other structural features mentioned in text, but not shown on this map or other text figures in this article, see index maps of Pennsylvanian tectonic features in chapters of Part I; this map includes some terms used only in chapter C of Part I.)

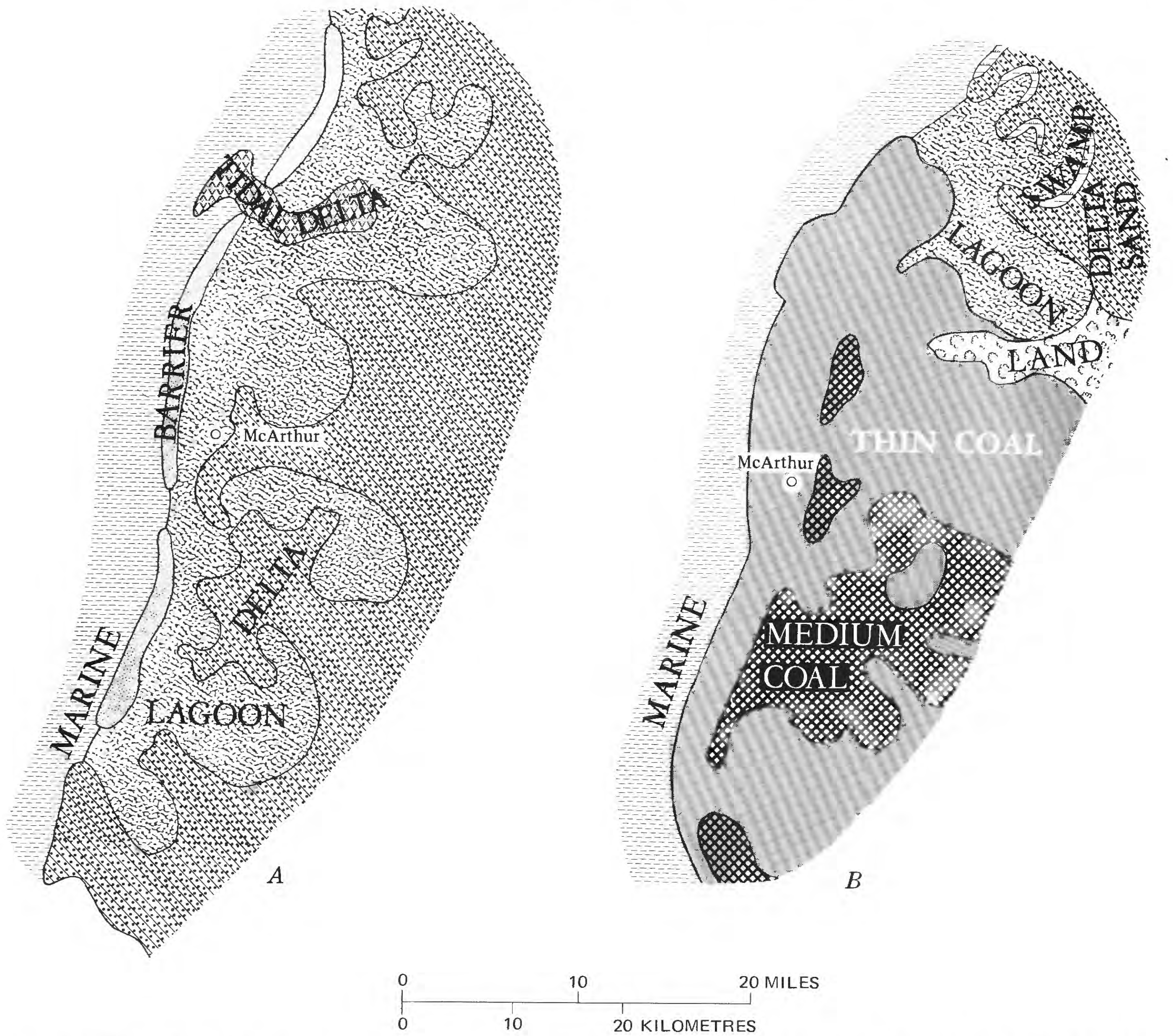

FIGURE 6. — Distribution and depositional environments of *Clarion Sandstone* and overlying *Clarion coal* (lower part of interval C) in a small area in southern Ohio (from Baroffio, 1964).

sedimentary material. At other places, the lateral correlative of a coal bed is a thin marine limestone or mudstone. This transition records the seaward margin of a former peat-forming swamp. In large parts of the Eastern and Central United States, however, the original borders of Pennsylvanian coal swamps have been destroyed by erosion, and the coal that remains was formed well within the limits of swamp areas.

Pennsylvanian coals typically were deposited on the surface of a large delta, on small coalescing deltas, or on widespread low-lying coastal plains in areas of gentle downwarping marginal to the sea. Other places favorable to the forming of coal included estuaries, coastal lagoons (fig. 6), and abandoned stream meanders. From time to time downwarping may have permitted a transgression of the sea. The water table would have risen in land areas bordering the sea, producing conditions conducive to the formation of peat. At a slow, optimum rate of subsidence and sea encroachment, the zone of peat deposition would have moved slowly up slope and, at times, extended into the contributory stream valleys. Thus, under nearly ideal conditions of deposition, a continuous layer of coal would have been oldest on the seaward margin, and progressively younger up slope.

If land subsidence and sea transgression took place rapidly, as probably was the situation in the Ouachita trough (pl. 15) during late Morrow and Atoka time and in the Delaware and Midland basins (pl. 15) of New Mexico and Texas during Missouri and Virgil time, the low-lying plains and other potential areas of peat accumulation would have been drowned, and no peat would have remained to mark the transgression.

Plants that grew during a regression of the sea and a concomitant lowering of the water table would have tended to become oxidized and would rarely have been preserved as coal in a stratigraphic sequence.

COAL MAPS

Generalized coal maps prepared for each of the six intervals or subintervals cited previously show the number of coal beds in the unit, and the cumulative thickness of coal in these beds (pls. 16*A*, *B*, *C*, *D*, *E*, and *F*, in case). The maps also show the present extent of all rocks included in the interval. The data used to prepare the coal maps were obtained from geologic reports, measured sections, and logs of drill holes, including descriptive, electric, and drilling-time logs.

INTERVAL A, ROCKS OF LATEST CHESTER AND MORROW AGES

SUBINTERVAL A_1 ROCKS OF LATE CHESTER AND EARLY MORROW AGES

The rocks included in subinterval A_1 were deposited during the latest part of Mississippian and the earliest part of Pennsylvanian time. The sites of deposition were limited to border geosynclines such as the Appalacian in the east and the Ouachita in the south (pl. 15*A*).

In the Southern Anthracite field of eastern Pennsylvania (fig. 5), subinterval A_1 is represented by piedmont fan deposits derived from highlands to the southeast. These piedmont fans were built rapidly and to such a height that plant detritus was largely destroyed by oxidation; however, several films of carbonaceous material in the sequence may be time equivalents of coal beds formed elsewhere.

At the extreme southwest end of the Southern Anthracite field a sequence of beds, termed the Tumbling Run Member of the Pottsville Formation, records a time and place on the southwest flank of the piedmont fans where deposition was slower, detrital material was finer grained, and downwarping was of less amplitude than elsewhere nearby. In this area, three to six coal beds with a cumulative thickness of a little more than 20 feet were formed. At Pennsylvania locality 397, the cumulative thickness of coal is 41 feet, but this may be a local phenomenon due to later folding. Outside this area of relatively thick coal, the cumulative thickness ranges from 4 to 16 feet.

In the central part of the Appalachian basin — southern West Virginia, Virginia, and extreme eastern Kentucky — interval A_1 is represented by the Pocahontas Formation and equivalents, which contain substantial amounts of coal in the southeastern part of its area of occurrence. In the Pocahontas field of Tazewell County, Va., and McDowell County, W. Va., 10–17 coal beds have a maximum cumulative thickness of 26 feet. The number of beds and the cumulative thickness decrease to zero in a fan-shaped pattern northeast, north, northwest, west, and southwest of Pocahontas, Va. These coals probably formed on a broad alluvial plain as suggested in (1) the patterns produced by isopachs of the number and thickness of coal beds, and (2) the fact that the sedimentary rocks associated with the coal are finer grained than those in the Southern Anthracite field. A marine bed containing *Lingula*, which lies above one of the Pocahontas coals, suggests that this coal and possibly all the coals were formed during transgressive cycles.

In Alabama, subinterval A_1 is represented by a sequence of beds designated the Pottsville (lower part) and Parkwood Formations. The number and cumulative thickness of coal beds in these units is greatest in the Blount Mountain, Coosa, and Cahaba fields on the southeast side of the area of outcrop. These fields, which are small, contain 4–15 coals having a maximum cumulative thickness of 15–19 feet. Both the number and thickness of the beds decrease to the west and northwest. In the Warrior and Plateau fields, the cumulative thickness of coal is at least 4 feet throughout large areas.

The average thickness of coal beds in Alabama is markedly less than the average thickness in the Pocahontas field of Virginia, but the environments of coal deposition were similar.

In Orange County, southwestern Indiana, a laminated siltstone, the *Hindostan Whetstone Beds,*[2] contains a flora indicative of subinterval A_1. The *Hindostan Whetstone Beds* are underlain by a single coal bed less than a foot thick. The *Hindostan Whetstone Beds* and the associated coal seemingly formed in a freshwater lake at least 20 miles long from north to south, probably not connected with the sea.

In northern Arkansas, rocks assigned to subinterval A_1 contain a single coal bed 4–6 inches thick that has been mined locally. This isolated occurrence of coal is on the northernmost edge of a very thick succession of noncoal bearing geosynclinal sedimentary rocks made up largely of sandstone and siltstone. Most of these rocks accumulated in deep water in a rapidly subsiding trough (Cline, 1960) where the environment was unfavorable for coal accumulation.

[2]Stratigraphic names that have not been adopted by the U.S. Geological Survey and those that have not occasioned any official action are shown in italic type.

SUBINTERVAL A_2, ROCKS OF LATE MORROW AGE

Rocks included in subinterval A_2 cover a much larger area in Eastern and Central United States than those assigned to subinterval A_1. In the Southern Anthracite field of eastern Pennsylvania, subinterval A_2 contains three to nine coal beds having a cumulative coal thickness ranging from 9 to 21 feet. Near the north edge of the Appalachian basin in northern Ohio and Pennsylvania, and along the southern border of New York, many elongated discontinuous bodies of rock assigned to subinterval A_2 consist of sandstone that filled channels cut into the underlying pre-Pennsylvanian rocks. In northern Ohio and Pennsylvania, subinterval A_2 contains a discontinuous coal bed known as the *Sharon coal* and, locally, a second, unnamed coal.

South of the belt of channel sandstone deposits is a large area that contains no strata representative of subinterval A_2. This area was a low-lying, west-trending landmass that was not covered by sediments until the time of interval B.

South of the land area of southern Pennsylvania and central Ohio, subinterval A_2 reappears and is coal bearing across the entire central and southern parts of the Appalachian basin. In general, both the number of beds and the cumulative coal thicknesses are greatest on the southeast side of this area. In an area north of the Tennessee-Kentucky line, subinterval A_2 contains 20 coal beds, having a cumulative thickness of 41 feet. Surrounding this area is a narrow, northeast-trending belt in which the cumulative coal thickness is 10–20 feet, and farther northwest is a wide belt in which the cumulative coal thickness is 5–10 feet.

In Tennessee, the pattern of coal distribution is much the same as outlined for Kentucky, but the maximum cumulative coal thickness is 20 feet.

In Alabama, as in the northern part of the Appalachian basin, subinterval A_2 contains on the southeast side of its area of occurrence the maximum number of coal beds and the maximum cumulative coal thickness. The Coosa field contains 42 coals having a maximum cumulative thickness of 49 feet, and the Cahaba field contains 21 coals having a maximum cumulative thickness of more than 50 feet. The cumulative coal thickness decreases gradually in a westward direction across the Warrior field and is only about 5 feet at the Alabama-Mississippi line.

Information on subinterval A_2 is more sparse for Mississippi than for areas farther east, but logs of oil and gas wells suggest that some coal is present. A sample log of a well at locality 103 (Cropp, 1960) shows 24 beds that have a cumulative coal thickness of 39 feet, but this well may not be typical.

In the Michigan basin, coal beds in subinterval A_2 are discontinuous. Alluvial fans that were accumulating along the eastern side of the basin apparently did not coalesce, so no uninterrupted relatively level surfaces developed on which widespread coals could accumulate. The *Saginaw bed,* the most extensive coal in subinterval A_2 in the Michigan basin, occurs principally on the eastern side of the basin. Three beds having a maximum cumulative coal thickness of 10 feet are recorded in available records. No coal is reported from the western third of the basin.

In the Illinois basin, deposition of strata included in subinterval A_2 began in areas where relief on the underlying rocks was locally as much as 300 feet. Although this relief was greatly reduced by valley fill by the later part of subinterval A_2, coals of the Caseyville Formation (Illinois and Kentucky) and the Mansfield Formation (Indiana) are nearly all local in distribution. Subinterval A_2 in the Illinois basin contains a maximum of five coals having a cumulative thickness of 5 feet.

Subinterval A_2 is absent in Iowa, Missouri, Nebraska, and Kansas, but it is present in Arkansas and Oklahoma. In those two States, much of the subinterval is marine. The interval contains one thin coal, known as the *Baldwin bed,* which crops out locally in the Bloyd Shale of Washington County, northwest Arkansas, and in adjoining parts of Oklahoma. This bed is probably not continuous, and it is generally less than 1 foot thick.

In the Texas and Oklahoma Panhandles, subinterval A_2 is deeply buried, but cuttings from wells in those areas indicate that it contains a few, probably thin coal beds. The total thickness, number, and continuity of the coal beds are unknown.

Near Colorado Springs, Colo., the Glen Eyrie Member of the Fountain Formation, which is included in subinterval A_2, contains a coal bed less than 1 foot thick (localities 1 and 2, fig. 9). No coal beds are known in rocks assigned to subinterval A_2 west of the Rocky Mountains. In western Utah, Idaho, and eastern Nevada, most strata included in this subinterval are marine.

INTERVAL B, ROCKS OF ATOKA AGE

Rocks assigned to interval B are widespread and contain coal on a large scale in many parts of Eastern and Central United States.

In the Pennsylvania Anthracite fields, rocks assigned to interval B occur in the Northern, Eastern and Western Middle, and Southern fields, but most of the coal in the interval is in the Eastern Middle and Southern fields. In the Eastern Middle field, the cumulative coal thickness is 35 feet; in two beds in the Southern field, it is 10-13 feet.

Interval B attains its greatest thickness and has both the largest number of coal beds and the largest cumulative thickness of coal in the Appalachian basin. Near the common corner of Kentucky, Tennessee, and

Virginia the interval contains as many as 50 coals, having a total thickness of 50 feet. The interval is thinner, the coals are fewer, and the cumulative thickness of coal is less to the northeast. In northern West Virginia, the interval is only 200 feet thick and contains 10 or fewer coal beds, having a cumulative coal thickness generally in the range of 5-10 feet. A decline in number and thickness of coal beds continues northward into Pennsylvania and Ohio, where the average thickness of several widespread coal beds is only about 1 foot. In these States the number of coals in interval B is generally less than five, and the cumulative thickness is 5 feet or less. In Ohio, most of the coal beds are overlain by marine rocks.

Interval B is absent in southern Tennessee, Georgia, and northern Alabama, but it is represented in the Cahaba field, Alabama, and in the deeply buried part of the Warrior field in the Black Warrior basin on both sides of the Alabama-Mississippi line. In a small part of the Cahaba field, six or more coal beds are present in the unit. In the Black Warrior basin 34 or more coal beds having a possible maximum cumulative coal thickness of 48 feet may be present in a drill hole at locality 103, Mississippi (Cropp, 1960). However, the samples from this well are reported to be mixed, so the number of coal beds and the cumulative thickness of coal may be substantially less than reported. No comparable thickness of coal is suggested by data from other drill holes in Mississippi.

In the eastern part of the Michigan basin, interval B is reported to contain a maximum of six thin beds in one small area, and a maximum cumulative coal thickness of 5–6 feet in two nearby small areas. One thin bed, the *Verne coal,* is overlain by marine limestone. No appreciable amount of coal is recorded in samples from drill holes in interval B in the western part of the basin.

In the Illinois basin, interval B is present everywhere except on the axis of the La Salle anticline (pl. 15*A*) of northern Illinois and on the eastern flank of the Mississippi River arch (pl. 15*A*). In the deepest part of the basin in southwestern Illinois and adjoining parts of Indiana and western Kentucky, interval B typically contains 5–10 coal beds having a cumulative coal thickness of 10–20 feet. The number of coal beds and the cumulative coal thickness decrease in the northwest part of the basin. In central Illinois the interval typically contains three beds that have a cumulative coal thickness of 7 feet; in western Illinois, only one coal, the *Rock Island* (*No. 1*) in the Spoon Formation, is thick enough to be mined. This coal probably accumulated in an estuary, for the coal is locally as much as 5 feet thick but thins to disappearance within a few yards of what apparently were the borders of an estuary (fig. 7). The coal is generally overlain by marine limestone, which suggests that the coal was formed during a time of marine transgression. In the same areas, a thin coal suggestive of

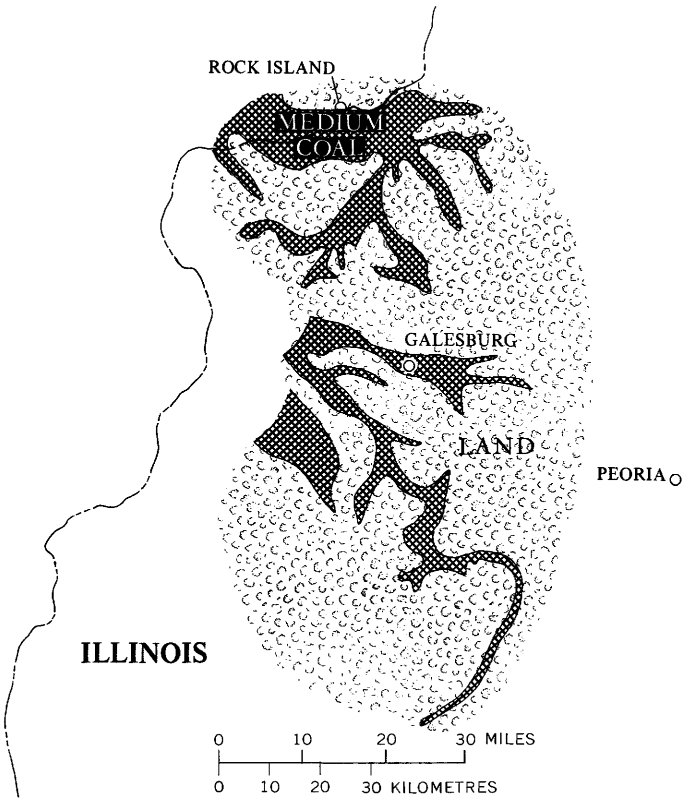

FIGURE 7. — Distribution of the *Rock Island (No. 1) coal* (near top of interval B) in estuaries in northwestern Illinois (from Baroffio, 1964).

the regressive phase occurs locally a short distance above the limestone.

In south-central Missouri, interval B is represented by many small almost cylindrical coal deposits formed in sinkholes and caves. Some of the thicker deposits are 45–80 feet thick (Hinds, 1912; Bretz, 1950). In most deposits, bedding planes of the coal slope inward and downward, which suggests that the sinkholes continued to be enlarged as plant detritus accumulated. Deposits of coal in sinkholes of south-central Missouri are the finest examples of such deposits in the United States.

In the northern part of the Forest City basin (pl. 15*A*) of northwest Missouri, southwest Iowa, northeast Kansas, and extreme southeast Nebraska, strata assigned to interval B (Searight and Howe, 1961, p. 80) locally contain three coal beds having a cumulative coal thickness of about 5 feet.

In both the Arkoma basin (fig. 41, ch. J) and, farther south, the Ouachita structural belt (pl. 15*A*) of Arkansas and Oklahoma, interval B is several thousand feet thick but contains very little coal. The rocks of these areas were deposited in a dominantly marine environment. Probably the basins of deposition were downwarped rapidly, and even during periods of rapid sedimentation the water was too deep for swamp vegetation to grow.

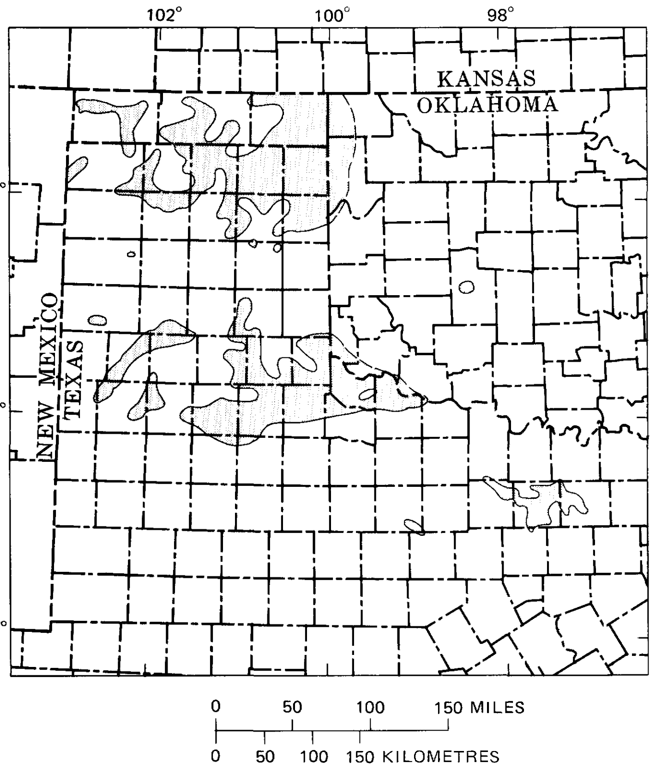

FIGURE 8. — Distribution of coal in interval B in northern Texas and western Oklahoma (modified from Mapel, 1967, and G. H. Dixon, unpub. data).

On the northwest flank of the Fort Worth basin (pl. 15*A*), mainly in Jack, Wise, and Denton Counties of north-central Texas, interval B of the subsurface is well known through studies of well cuttings (fig. 8). Strata of this interval include a few thin coal beds.

Interval B is present in the subsurface on the north and south flanks of the Amarillo-Wichita uplift (pl. 15*A*) of west Texas and Oklahoma. The north flank was located in the northern counties of the Texas Panhandle, the Oklahoma Panhandle, and, presumably, adjoining parts of Kansas. The southern flank extended across the southern counties of the Texas Panhandle and adjoining counties in western Oklahoma (fig. 8). Interval B, including some coal, was deposited on piedmont surfaces or on discontinuous alluvial fans on the two flanks of the uplift; however, little is known about the number or thickness of coals in the two areas.

In central and western Colorado and in north-central New Mexico (fig. 9), coal occurs locally in interval B as thin discontinuous beds but does not extend farther west.

INTERVAL C, ROCKS OF DES MOINES AGE

By Des Moines time, most of the eastern and central parts of the United States had been converted to a low-lying, nearly level plain by filling of pre-Pennsylvanian

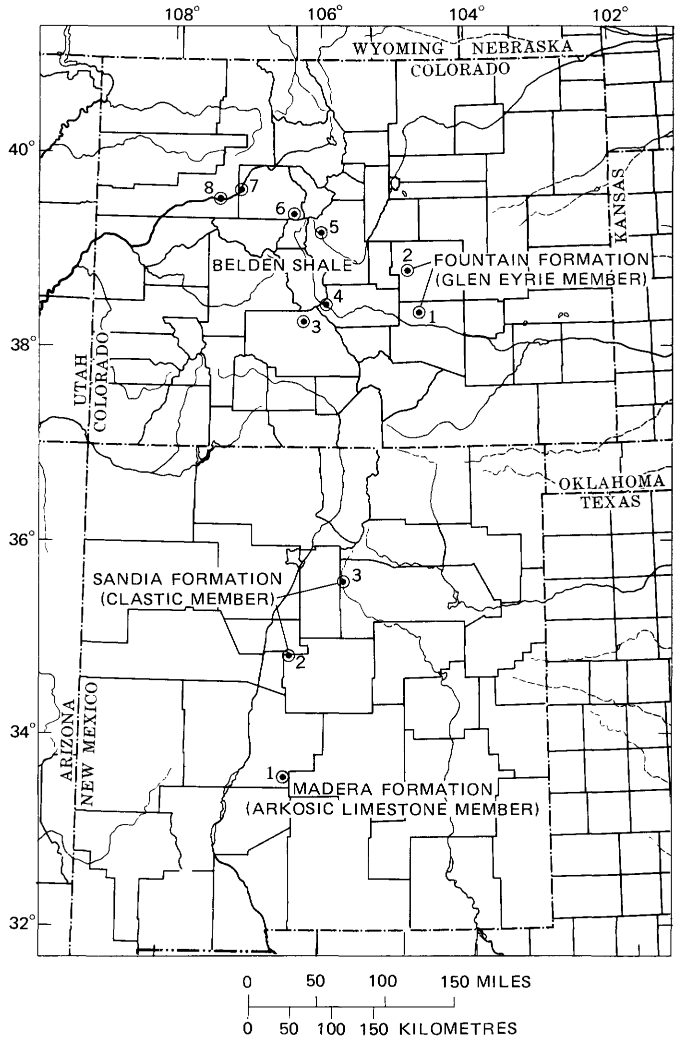

FIGURE 9. — Coal localities in the Pennsylvanian of Colorado and New Mexico. Colorado: 1, Continental 1 Young drill hole; 2, near Colorado Springs; 3, Bonanza; 4, Wellsville; 5, western South Park; 6, Gilman; 7, Dotsero; 8, Glenwood Springs. New Mexico: 1, Burro Mountains; 2, Manzano Mountains and adjacent areas; 3, Pecos Valley.

stream valleys, sinkholes, and other surface irregularities. Strandlines shifted hundreds of miles north and east when the sea level rose, or south and west when the sea level fell. Many cycles of transgression and regression of the sea permitted periodic accumulation of layers of peat, intercalated among layers of sediment, across many thousands of square miles. The floor of most interval C coals, like that of many other Pennsylvanian coals, is underclay that contains abundant root impressions; the roof commonly is marine mudstone or limestone. These relations are diagnostic of coals deposited during marine transgressions. In Indiana, some coal beds are underlain by marine strata and overlain by nonmarine strata (Murray, 1958). These relations are diagnostic of coals deposited during regressions.

In Pennsylvania, West Virginia, and Virginia, many interval C coals contain partings of mudstone or sandstone, which generally increase in number, thickness, and coarseness southeastward. These partings record periods when swollen streams from the Appalachian highlands flowed into the landward sides of peat swamps (fig. 10). In coal fields of the Midwest, the coal beds do not exhibit such partings, because those coals formed in areas remote from upland sources of detrital material.

More coal occurs in interval C of the Anthracite fields in eastern Pennsylvania than in any other interval. At the eastern end of the Southern field, the interval contains a maximum of 14 coal beds having a maximum cumulative thickness of 137 feet. The *Mammoth bed* alone, where not split by partings, is 50 feet thick; this is the maximum thickness recorded for any single bed of Pennsylvanian coal in the United States. The maximum thickness for an individual coal bed in the Western and Eastern Middle and Northern Anthracite fields is about 45 feet.

Interval C is present in many places in the Appalachian basin, north of the Kentucky-Tennessee line, but it is absent south of that line. In southern West Virginia, where the interval is thickest, it contains a maximum of 10–13 coals that have a cumulative total thickness of 25 feet; some of these coals contain detrital

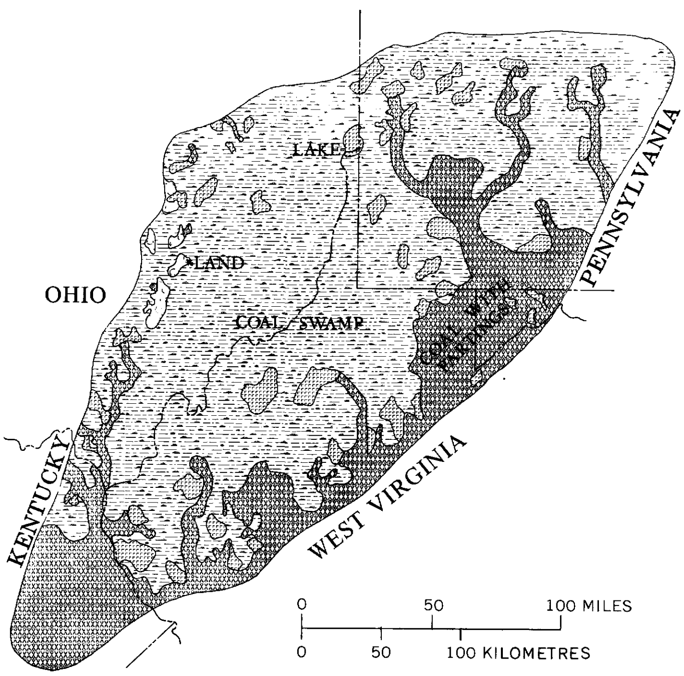

FIGURE 10. — Distribution and depositional environment of the *Brookville coal* (lower part of interval C) in the northern Appalachian basin (from Baroffio, 1964).

partings. In Ohio the coals are thinner and fewer but contain a smaller number of partings. In this area, interval C contains 5–10 coals having a typical cumulative thickness of about 10 feet, except in areas where interval C is thinner than normal as a result of postdepositional erosion of the uppermost beds. The *Middle Kittanning coal,* which is the thickest individual coal of interval C in the Appalachian basin, locally is 15 feet thick in southern Ohio.

In the Michigan basin, interval C was eroded shortly after deposition, and only the lowermost part is preserved, forming isolated and irregular remnants. Most of these remnants contain no coal, but at one locality in the southeastern part of the basin two thin coal beds occur that have a cumulative total thickness of 3 feet.

Nearly all coal mined in the Illinois basin is from interval C. The number and cumulative thickness of coals are greatest in the southeast part of the basin and tend to decrease to the northwest. In southern Illinois, western Kentucky, and southwestern Indiana, 15–18 beds, having a cumulative total thickness of about 30 feet, are present; whereas in northwestern Illinois only about eight beds having a cummulative thickness of 10 feet are present.

The *Herrin (No. 6) coal* of southwestern Illinois, locally as much as 14 feet thick, and *coal V* of Indiana, locally as much as 11 feet thick, are the most important coals in the Illinois basin.

Most of the extensive coals of interval C in the Illinois basin formed on delta and prodelta surfaces that sloped gently southeastward. Each of these surfaces came to an apex, generally on the northwest margin of the basin. The *Herrin (No. 6) coal,* which is typical of the group, is thickest to the southeast and thins to a mere layer of smut on its northwestern edge, near the highest part of the delta surface. Presumably oxidation took place in the high area during most of the time that plants accumulated to the southeast. At places on the west side of the delta surface, the *Herrin (No. 6) coal* rests directly on marine strata. The *Herrin (No. 6) coal* generally is overlain by transgressive marine mudstone or limestone. Thus, this coal and others exhibiting similar features must have started to accumulate during regression of the sea and continued to accumulate throughout the regression and a subsequent transgression.

Coals overlain by marine mudstone or limestone generally are high in sulfur, perhaps because of deposition of iron sulfide (FeS_2) in the peat when saturated by marine waters. In parts of the Illinois basin, several of the major coals in interval C, which generally are relatively low in sulfur, are directly overlain by nonmarine gray mudstone as much as 50 feet thick. These nonmarine mudstones, which lie between the coals and stratigraphically higher marine mudstones and limestones, are detrital wedges that thicken in the direction of the source and are considered to be prodelta deposits.

The most extensive and perhaps most distinctive coal in interval C is a bed that is known as the *Colchester (No. 2)* in Illinois, *coal IIIa* in Indiana and the *Croweburg* in Iowa, Missouri, Kansas, and Oklahoma, and may correlate with the *Schultztown* in western Kentucky. Paleontologic evidence suggests that this bed is a correlative of the *Lower Kittanning coal* of the northern Appalachian basin. The original distribution of this coal is approximately shown in figure D on plate 17. Although the *Colchester (No. 2) coal* and its many correlatives are not perfectly synchronous, the bed provides very convincing evidence of a period of widespread and unusually low relief. It is the most widespread coal bed in the United States, and possibly in the world.

In the Western Interior region, particularly in the Forest City basin (pl. 15*B*) in eastern Kansas and the Cherokee basin in northeastern Oklahoma, most of the coal beds in interval C are correlatives of those in the Illinois basin, but they differ from those in the Illinois basin by being generally thinner, ranging in thickness from less than 1 foot to about 3 feet, and are more commonly overlain by marine mudstone or limestone.

In southern Iowa and northwestern Missouri, interval C contains about seven coal beds having a cumulative thickness of about 13 feet, whereas in extreme southeastern Kansas and northeastern Oklahoma the cumulative thickness attains a maximum of 11 feet and, more typically, is in the 5- to 10-foot range.

Westward and downdip from the coal outcrops and toward the axes of the Forest City and Cherokee basins, interval C has been penetrated by many oil-test borings, for which sample logs are available. Most of these sample logs are poor sources of coal data, but some mention coals, mostly single beds. In contrast, very reliable records from five holes and shafts, located considerable distances downdip from the outcrops, provide data as follows: Missouri, two holes, 10–11 coals having a cumulative thickness of 13–19 feet; Kansas, two holes, four to five coals having a cumulative thickness of 7-9 feet; and Oklahoma, one hole, four coals having a cumulative thickness of 4 feet. These records suggest that many of the coals in interval C in the midcontinent region persist 50–80 miles downdip from the outcrops.

Farther west, in the deeper parts of the Forest City basin (pl. 15*B*), coal is rarely mentioned in drill records and probably is absent. The center of the basin may have been too far offshore for plant debris to accumulate. Still farther west near the Nemaha anticline (pl. 15*B*), which forms the western boundary of the Forest City basin, a coal believed to be a correlative of the *Croweburg* has been noted in a sample log.

In the deep Arkoma basin (fig. 41, ch. J) of western

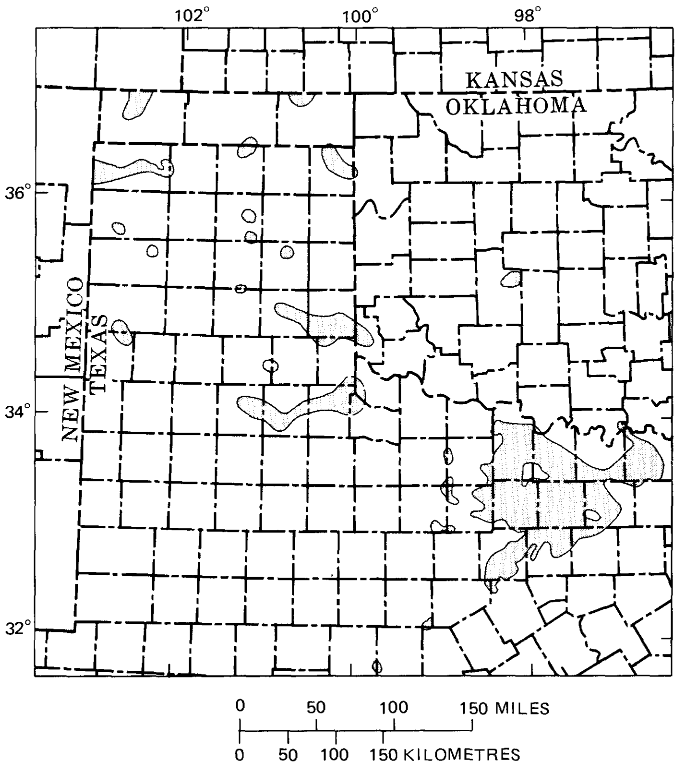

FIGURE 11. — Distribution of coal in interval C in northern Texas and western Oklahoma (modified from Mapel, 1967, and G. H. Dixon, unpub. data).

Arkansas and eastern Oklahoma, coal occurs in the Hartshorne, McAlester, Savanna, and Boggy Formations of early Des Moines age. Strata younger than the Boggy Formation are barren. The interval C coals of the Arkoma basin are, therefore, older than most interval C coals in the Cherokee and Forest City basins to the north. The several coal-bearing formations of the Arkoma basin contain about five named and several unnamed thin coals having a cumulative thickness of 10–15 feet. The coal-bearing formations and the contained coal beds are preserved largely in synclinal folds that exhibit moderately steep dips.

The principal coal-bearing area of north-central Texas is in Wise, Jack, Young, Parker, and Palo Pinto Counties. This area is underlain by two to four coals having a cumulative thickness of about 10 feet (fig. 11). The *Thurber coal,* the thickest outcropping coal in north-central Texas, attains a maximum thickness of 28 inches. The distribution pattern of the coals in north-central Texas suggests that the coals were formed on alluvial or deltaic platforms built westward from the newly elevated Ouachita uplift (pl. 15*B*) that lay to the northeast.

In the Texas Panhandle, and to a minor extent in the Oklahoma Panhandle, strata assigned to interval C contain a few small sporadic and deeply buried coal beds, as

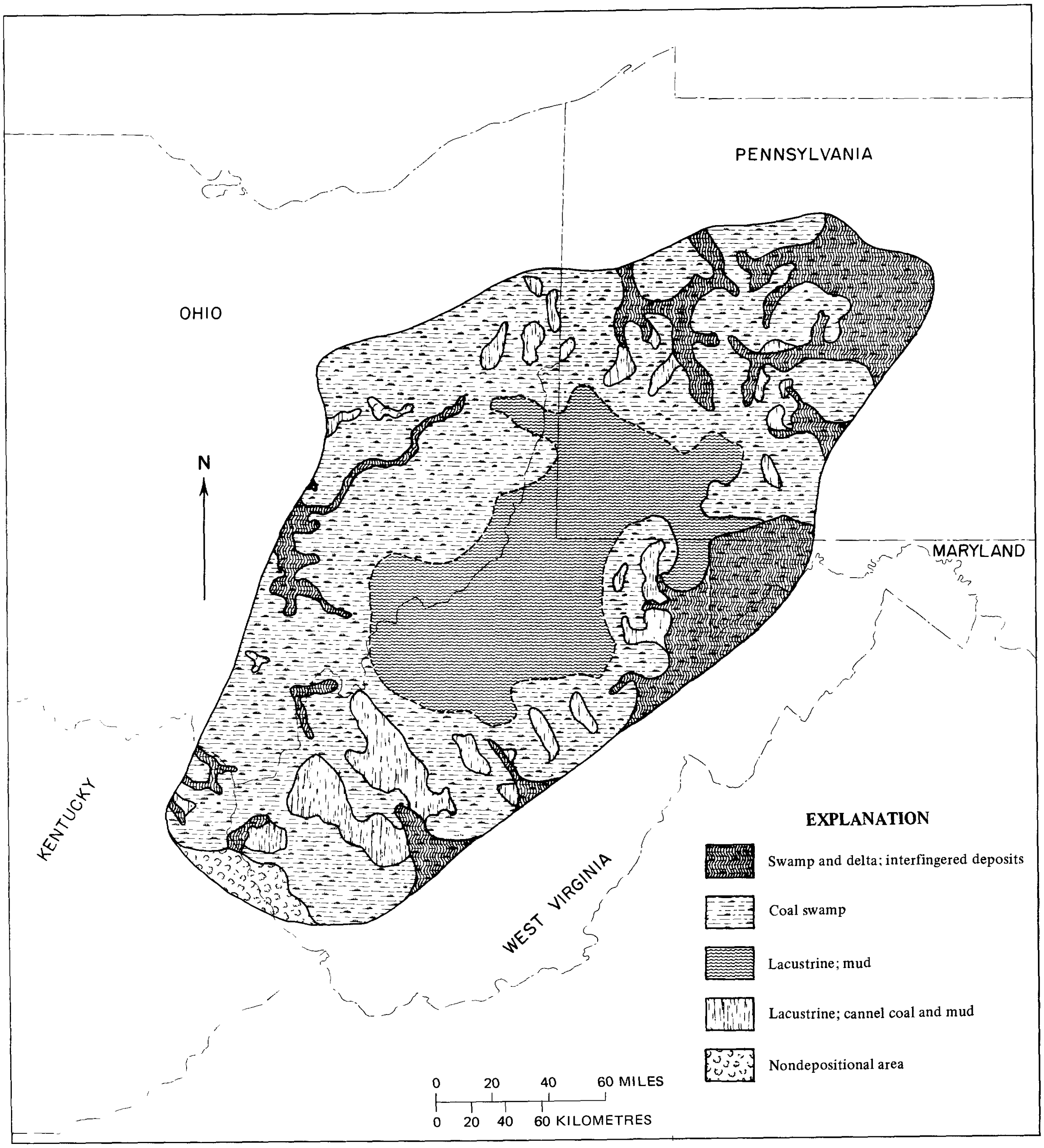

FIGURE 12. — Distribution and depositional environment of the *Middle Kittanning coal* (upper part of interval C) in the northern Appalachian basin (from Baroffio, 1964).

shown in figure 11. No detailed information is available as to their number or thickness. The distribution pattern suggests that they formed in deltaic or alluvial environments marginal to uplands along the Wichita uplift (pl. 15*B*) of southwest Oklahoma.

No coal of Des Moines age is known west of the areas shown in figure 11.

INTERVAL D, ROCKS OF MISSOURI AGE

Interval D contains many coal beds but, except in the Anthracite fields, most are too thin to mine and have not been recorded in detail.

In the Northern Anthracite field of Pennsylvania, interval D contains a maximum of 10 beds having a

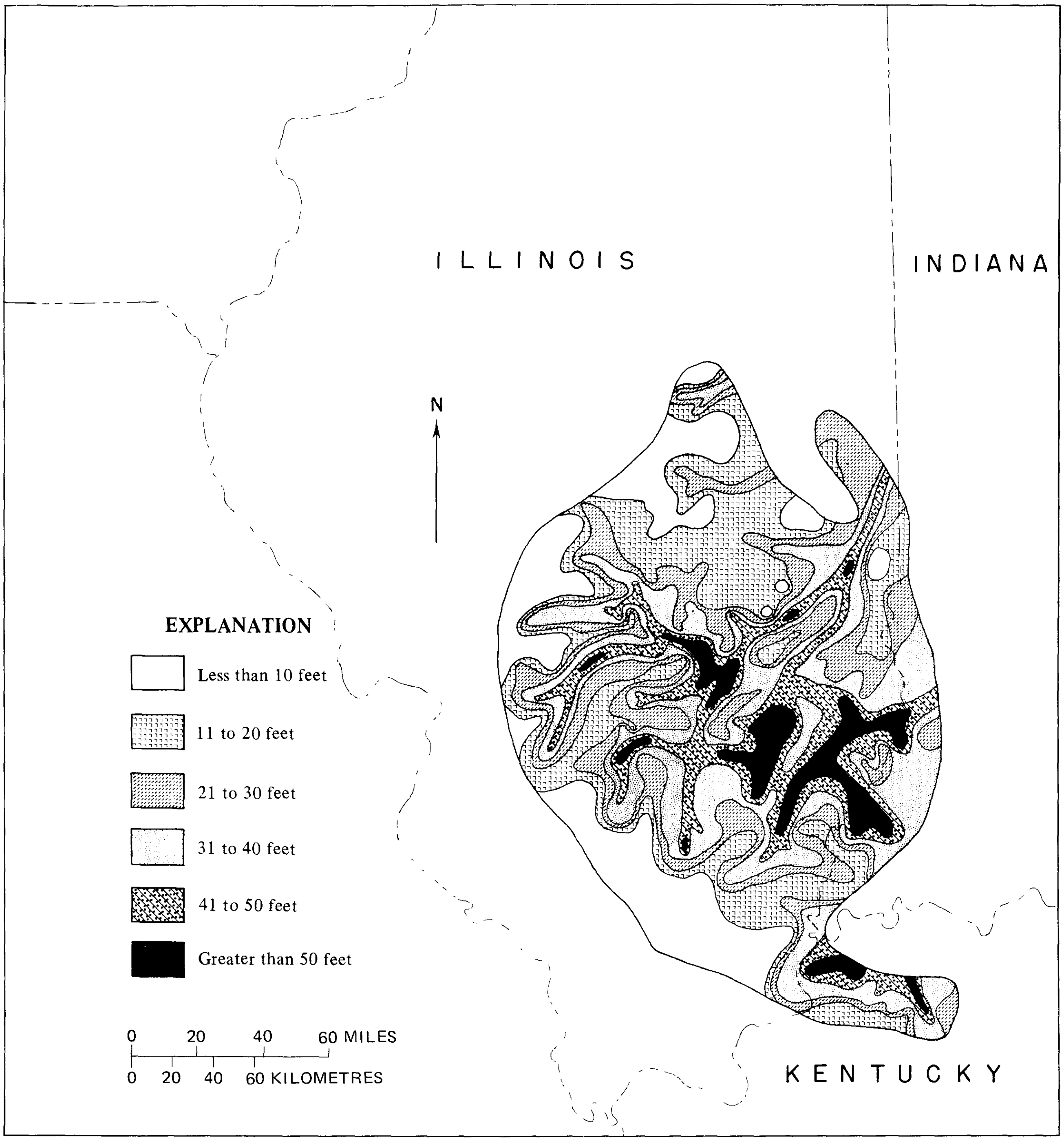

FIGURE 13.— Thickness of delta and prodelta formed during the *Sorento cyclothem* (middle part of interval D) in the southeastern part of the Illinois basin (from Horne, 1965).

cumulative thickness of 44 feet; in the middle fields, the interval contains a maximum of 12 beds, having maximum cumulative thicknesses ranging from 30 feet in the Eastern Middle field to 53 feet in the Western Middle field; in the Southern field interval D contains 26 beds that have a maximum cumulative thickness of 79 feet. Several of the anthracite beds are locally as much as 10 feet thick, far exceeding the maximum thickness for a single coal in interval D in other parts of the United States.

In the Appalachian basin, interval D contains a maximum of eight coal beds, but the number typically is less than five. The maximum cumulative thickness in parts of Maryland is as much as 16 feet but generally is on the

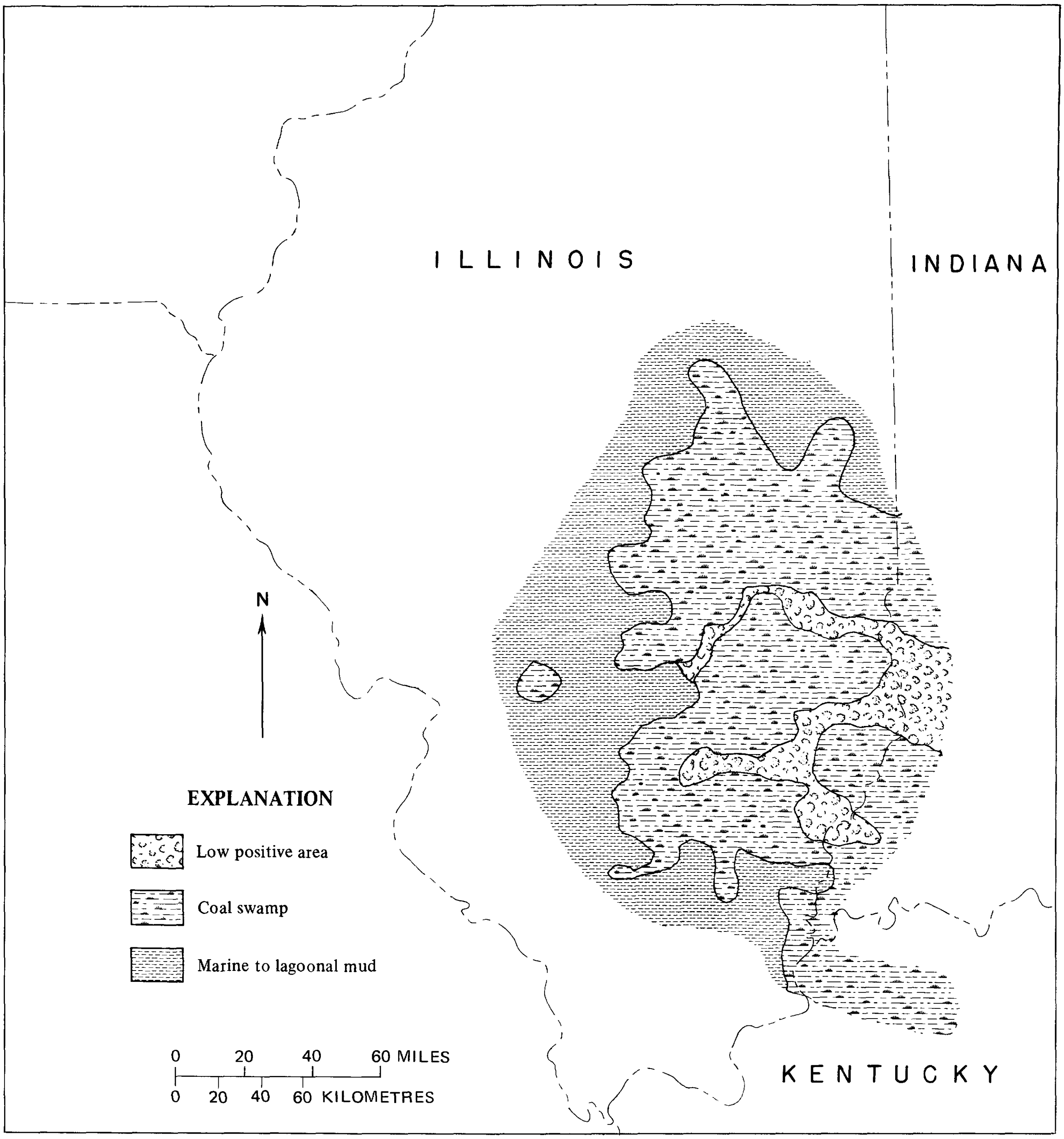

FIGURE 14. — Distribution and depositonal environment of coal formed during the *Sorento cyclothem* (middle part of interval D) in the southeastern part of the Illinois basin (from Horne, 1965).

order of 5 feet. Many individual coals average no more than 1 foot in thickness, and in places they thin to carbonaceous films a millimeter or so thick. Because of its negligible coal content, the Conemaugh Formation, which comprises all of interval D and the lower part of interval E, was called the *Lower Barren Measures* in early studies of Pennsylvanian stratigraphy.

A series of maps by Morris (1967) showing individual coal beds, beginning with the *Middle Kittanning coal* of late Des Moines age, suggests that coal deposition in the uppermost Allegheny Formation and lower part of the Conemaugh Formation took place along the margins of a central lake or bay, open to the sea on the west and bordered by a highland on the east (fig. 12). The basin occupied by the central lake or bay was intermittently downwarped and flooded with fresh or salt water (Baroffio, 1964). This unstable environment was conducive to the formation of many coal beds but not to the formation of a single thick coal.

Interval D of the Illinois basin is represented everywhere in Illinois except in the northern and northwestern parts. The number of coal beds in the interval ranges from a maximum of 14 in south-central Illinois to less than 5 in north-central Illinois. The cumulative coal thicknesses show a range from 15 to 18 feet in south-central Illinois, but are 5 feet or less in north-central Illinois. Most of the individual coals are too thin to be mined, except locally where the coal is used for household purposes.

The principal coal beds in interval D rest on and are coextensive with underlying deltaic platforms built up by streams flowing from the south or southeast (Horne, 1965, 1968) (figs. 13 and 14).

In the Western Interior region, interval D contains three fairly widespread thin coal beds — the *Ovid bed*, largely in Missouri (Glover, 1964); the *Dawson bed* in Oklahoma; and the *Thayer bed* in Kansas (Horne, 1965). Each of these beds is locally as much as 18 inches thick, but the average thickness is generally less. The cumulative thickness of the three beds rarely exceeds 3

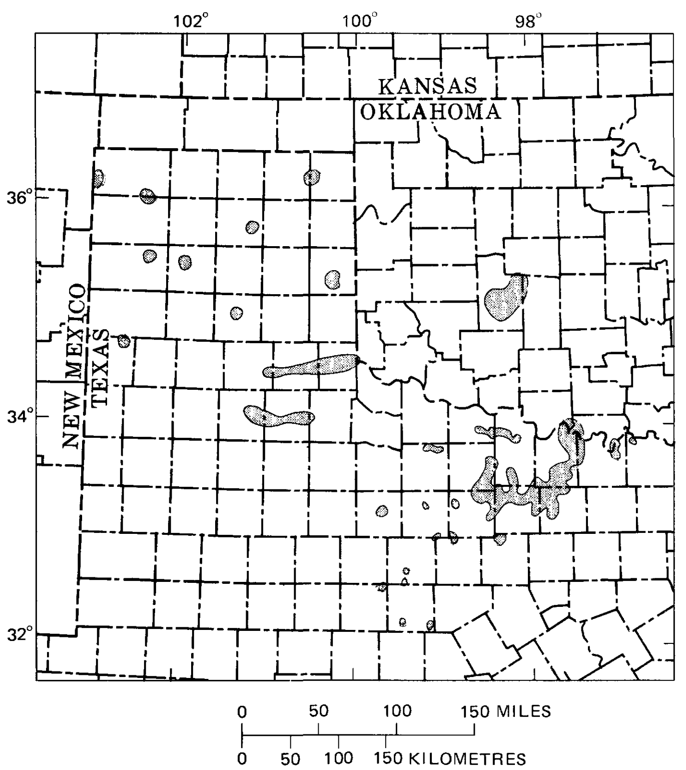

FIGURE 15. — Distribution of coal in interval D in northern Texas and western Oklahoma (modified from Mapel, 1967, and G. H. Dixon, unpub.).

feet. Each coal bed is approximately coextensive with a subjacent delta platform.

In the Ardmore basin (fig. 41, ch. J) of southern Oklahoma, at one locality a 2-foot coal bed has been reported in interval D.

In north-central Texas, coal deposits of interval D (fig. 15) occur in about the same area as the older coal of interval C. The cumulative thickness of the interval D coal is probably not more than 5 feet. The only part of the interval D coal that has been mined is the *Bridgeport coal* of Wise County; the *Bridgeport coal* has a maximum reported thickness of 22 inches. All these coals, like those of the underlying interval C, were formed on deltaic or alluvial platforms built up by sediment derived from the Ouachita Uplift (pl. 15*B*) to the northeast.

In parts of the Texas Panhandle, and in southwestern Oklahoma, just north of the Wichita uplift (pl. 15*B*), interval D contains coal, as shown by cuttings from deep wells. No information is available about the number or thickness of these coals, but they are probably few and thin as most of the associated rocks are of marine origin. The coals must have formed on deltaic or alluvial plains that extended both north and south of the Amarillo-Wichita uplift (pl. 15*B*).

INTERVAL E, ROCKS OF VIRGIL AGE

In the Appalachian basin, interval E comprises the upper part of the Conemaugh Formation, which contains only a few thin coal beds, and the Monongahela Formation, which contains many thick coals. The *Pittsburgh coal*, at the base of the Monongahela Formation, is of minable thickness throughout an area of 6,000 square miles in Maryland, West Virginia, Pennsylvania, and Ohio. It attains a maximum thickness of 22 feet in western Maryland but thins gradually in all directions from this area. It is 8–14 feet thick in southwestern Pennsylvania and in northern West Virginia, and 4–6 feet thick in easternmost Ohio and in southern West Virginia (Cross, 1952). This coal bed has produced more coal than any other bed in the United States. Above the *Pittsburgh coal* are the *Redstone, Sewickley, Uniontown,* and *Waynesburg coals,* all of which are locally of minable thickness.

In western Maryland, interval E contains a maximum of 12 coal beds having a cumulative thickness of 42 feet. In the West Virginia Panhandle and adjoining parts of Pennsylvania and Ohio, the interval contains 5 to 10 coal beds that have cumulative thicknesses ranging from 10 to 32 feet. Southwest of this general area, an abrupt facies change is marked by an appreciable thinning of the coal beds; some coals thin to carbonaceous films. Associated sandstone and mudstone beds are generally red. In this area there are as many as five coal beds, and their cumulative thickness is as much as 10 feet, but mostly it is 5–7 feet. The greatest amount of coal was accumulated in the most deeply depressed parts of the Appalachian basin, continuing a pattern shown by coals of intervals C and D. Interbedded with interval E coals are several thin but persistent freshwater (lacustrine) limestone beds that are useful stratigraphic markers. The thick coal beds of interval E probably formed on deltas built forward into gradually deepening water.

In the Illinois basin in east-central Illinois and in the Moorman syncline of western Kentucky, interval E is very thin. It contains about five coal beds in each area. In east-central Illinois, the cumulative coal thickness is more than 10 feet in a very small area but is 5–10 feet throughout a much larger area. In western Kentucky, the maximum cumulative coal thickness is 8 feet.

In southwestern Iowa and northwestern Missouri, interval E was partly eroded before the deposition of overlying beds. Its full thickness is preserved, however, farther west in Kansas and Nebraska, and farther south in Oklahoma. In those areas, interval E consists of a basal unit, the *Douglas Group*, which consists primarily of detrital rocks; a middle unit, the *Shawnee Group*, which contains much limestone; and an upper unit, the *Wabaunsee Group*, which consists of a sequence of intercalated limestones and detrital rocks. Three coal beds occur in the *Douglas Group* (Bowsher and Jewett, 1943),

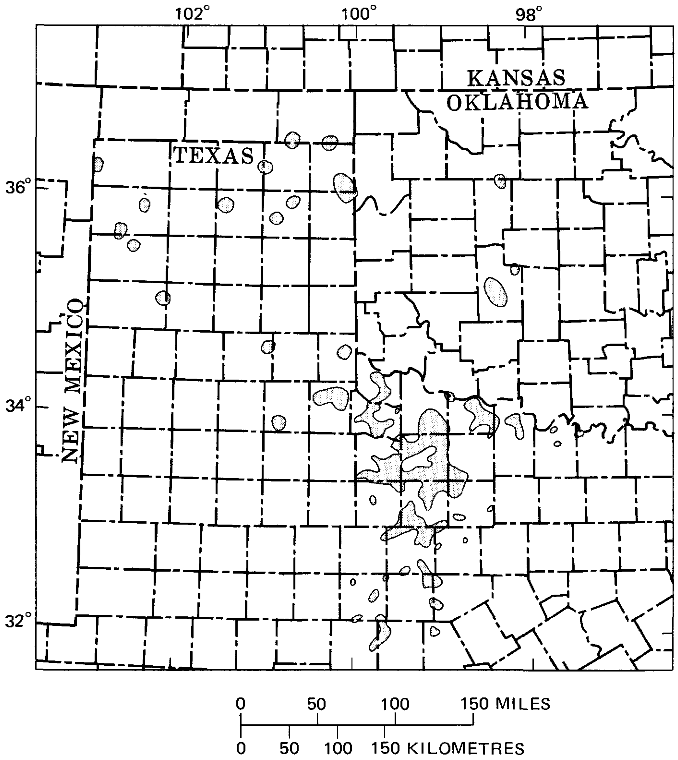

FIGURE 16. — Distribution of coal in interval E in northern Texas and western Oklahoma (modified from Mapel, 1967, and G. H. Dixon, unpub. data).

and 10 in the *Wabaunsee Group* (Schoewe, 1946). Each of these coals averages less than 1 foot in thickness, but most are widespread. All the coals probably formed on deltaic or alluvial plains, and several are directly overlain by limestone beds, which suggests that they formed during periods of marine transgression.

In north-central Texas, interval E comprises the Graham and Thrifty Formations of the Cisco Group (fig. 16). Coal in the Graham Formation occurs in small widely spaced areas, but that in the Thrifty Formation is more continuous. The *Chaffin coal* in the Thrifty Formation is 20 inches thick locally in McCulloch County where it once was mined. However, most of the interval E coals are deeply buried and information concerning them is based on oil-well cuttings and records.

In the Texas Panhandle and in western Oklahoma, interval E coal has been observed in well cuttings in small widely spaced, deeply buried areas.

COAL OF PENNSYLVANIAN AGE IN NEW ENGLAND

In the Narragansett basin of eastern Rhode Island and southeastern Massachusetts, coal-bearing rocks of Pennsylvanian age are assigned to the Rhode Island Formation. This formation has been folded and faulted, and most of the beds are steeply dipping. Sections measured at outcrops, or cored in search of coal, represent only a small part of the entire sequence. The formation is estimated, on the basis of incomplete data, to be 12,000 feet thick. Coal in the Rhode Island Formation is of meta-anthracite rank and is somewhat graphitic; it seems to occur near the base of the formation and is probably of Early or Middle Pennsylvanian age. This formation cannot yet be divided into the intervals used in discussion of Pennsylvanian rocks throughout this report.

Coal in the Rhode Island Formation is associated entirely with detrital nonmarine rocks; individual beds form discontinuous lens-shaped pods. Coals commonly thin abruptly from as much as 25 feet to 5 feet or less. Correlation has not yet been made between many of the coals in different parts of the basin.

Two published logs of cored drill holes in the Rhode Island Formation provide quantitative information on its coal. One, from Portsmouth, Aquidneck Island, R. I., records 485 feet of rock, including 15 coal beds having a cumulative thickness of 24 feet. The second, from Seekonk, Mass., records 900 feet of rock, including 13 coals that have a cumulative thickness of 21 feet. Neither hole was drilled perpendicular to the bedding, so the reported coal thicknesses are probably overstated.

The Rhode Island meta-anthracite was mined sporadically and intermittently on a small scale in the days of early settlement, but most operations have been abandoned for many years. The steeply dipping and discontinuous beds are difficult to mine, and the coal is generally too graphitic to burn effectively as fuel (Ashley, 1915; Toenges and others, 1948).

SUMMARY OF PENNSYLVANIAN PALEOGEOGRAPHY AND COAL DEPOSITION

In the Eastern United States, deposition of Pennsylvanian sediments continued from Late Mississippian time into Early Pennsylvanian time in both the Appalachian and Ouachita geosynclines. The oldest coals in these geosynclines formed on leveled depositional surfaces of earliest Pennsylvanian age. In adjacent shelf areas, relief of pre-Pennsylvanian and Early Pennsylvanian time was reduced by the filling of stream valleys and sinkholes; in those areas, the somewhat younger coals formed mainly in river valleys, estuaries, and sinkholes.

By late Morrow time (interval A_2), widespread coal beds formed in the Black Warrior basin of Alabama, in southern Tennessee, and in northwestern Georgia. By Atoka time (interval B), still more widespread coals formed in central and southern West Virginia, Virginia, and eastern Kentucky.

Most of the pre-Pennsylvanian and Early Pennsylvanian land surfaces had been buried by sediment by middle Des Moines time (interval C), and a low, nearly uniform, gently dipping depositional plain extended from Kansas and Oklahoma to Pennsylvania and West Virginia. High places on this plain included the Ozark area, the Nemaha anticline, and the Central Kansas uplift. In this setting, slight changes in the relative elevations of land and sea produced extensive transgressions and regressions of the Pennsylvanian sea across an area of thousands of square miles. These slow changes were conducive to the formation of the many widespread coal beds of uniform thickness that characterize interval C.

By Missouri and Virgil time (intervals D and E), newly elevated areas appeared on the periphery of the Des Moines (interval C) depositional plain and were gradually eroded. The debris from these areas formed deltas, many of them composite, and they tended to segment the Des Moines (interval C) depositional plain. The coals, which are coextensive with the deltas, or nearly so, are markedly less widespread than older Pennsylvanian coals.

Throughout Pennsylvanian time, coal accumulation was concentrated in the easternmost part of the United States, particularly in the eastern part of the Appalachian basin, and in the Anthracite fields of Pennsylvania. This concentration is probably the result of three factors working in combination: (1) the areas of thick coal accumulation were in a gently subsiding geosyncline that permitted many repetitions of a nearshore swamp environment favorable for coal formation, (2) marine transgressions all came from the west, and areas farther west were covered by the sea much of the time, and (3) the climate was more humid to the east than in western America, and the vegetation more luxuriant.

REFERENCES

Ashley, G. H., 1915, Rhode Island coal: U.S. Geol. Survey Bull. 615, 62 p.

Baroffio, J. R., 1964, Environmental mapping of the lower Allegheny series of the Appalachian Basin: Illinois Univ. Ph.D. thesis, 100 p.

Bowsher, A. L. and Jewett, J. M., 1943, Coal resources of the Douglas group in east-central Kansas: Kansas Univ. Geol. Survey Bull. 46, 94 p.

Bretz, J. H., 1950, Origin of the filled sink-structures and circle deposits of Missouri: Geol. Soc. America Bull., v. 61, p. 789-833.

Cline, L. M., 1960, Stratigraphy of the late Paleozoic rocks of the Ouachita Mountains, Okalhoma: Oklahoma Geol. Survey Bull. 85, 113 p.

Cropp, F. W., 3d, 1960, Pennsylvanian spore floras from the Warrior Basin, Mississippi and Alabama: Jour. Paleontology, v. 34, p. 359-367.

Cross, A. T., 1952, The geology of the Pittsburgh coal [Appalachian basin], *in* Nova Scotia Dept. Mines, Conf., Origin and Constitution of Coal, 2d, June 1952, p. 32-111.

Glover, A. D., 1964, Environmental maps of the Trivoli and Carlinville cyclothems, Pennsylvanian, and their equivalents: Illinois Univ. M.S. thesis, 31 p.

Hinds, Henry, 1912, The coal deposits of Missouri: Missouri Bur. Geology and Mines, v. 11, 503 p.

Horne, J. C., 1965, Environmental study of the Bond Formation of the Illinois basin and the Kansas City Group (Upper Pennsylvanian) of the northern and central mid-continent: Illinois Univ. M.S. thesis, 101 p.

——1968, Detailed correlation and environmental study of some Late Pennsylvanian units of the Illinois basin: Illinois Univ. Ph.D. thesis, 49 p.

Mapel, W. J., 1967, Bituminous coal resources of Texas: U.S. Geol. Survey Bull. 1242–D, 28 p.

Morris, D. A., 1967, Lower Conemaugh (Pennsylvanian) depositional environments and paleogeography in the Appalachian Coal basin: Kansas Univ. Ph.D. thesis, v. 1, 800 p.; v. 2, plates.

Murray, H. H., 1958, Transgressions and regressions of early Allegheny (Pennsylvanian) seas in Indiana [abs.]: Indiana Acad. Sci. Proc. 1957, v. 67, p. 205-211.

Schoewe, W. H., 1946, Coal resources of the Wabaunsee group in eastern Kansas: Kansas Geol. Survey Bull. 63, 144 p.

Searight, W. V., and Howe, W. B., 1961, Pennsylvanian system, *in* The stratigraphic succession in Missouri: Missouri Div. Geol. Survey and Water Resources [Rept.], v. 40, 2d ser., p. 78-122.

Toenges, A. L., and others, 1948, Investigation of meta-anthracite in Newport and Providence Counties, Rhode Island; petrography, chemical characteristics, and geology of deposits: U.S. Bur. Mines Rept. Inv. 4276, 37 p.

RED BEDS IN THE WESTERN INTERIOR OF THE UNITED STATES

By THEODORE R. WALKER[1]

INTRODUCTION

The late Paleozoic and early Mesozoic were times when environmental conditions throughout the western interior of the United States were favorable for the formation of red beds. These conditions became widespread at about the beginning of deposition of interval C (rocks of Des Moines age) in Pennsylvanian time, and by Middle Jurassic time they had resulted in the accumulation of a sequence of red beds that covered hundreds of thousands of square miles and had a maximum thickness in excess of 8,000 feet. All these red beds, regardless of age, probably had a common origin, as shown by the facts that the sequence is physically continuous and the characteristics of the pigment are similar throughout the deposits.

The conditions that formed the red beds, especially as they relate to the origin of the red pigment, are controversial. Some writers (Krynine, 1949; Van Houten, 1961; Wahlstrom, 1948; Walker, 1959; Hubert, 1960) have concluded that the pigment is detrital and derived from red lateritic soils in moist or seasonally moist tropical regions. Others (Robb, 1949; DeVoto, 1965; Walker 1967a) believe it is authigenic and derived from in situ alteration of iron-bearing detrital grains in sediments that were deposited in arid basins. The two hypotheses have strikingly different implications: the first emphasizes the source area and contends that special conditions of surface weathering were essential; the second emphasizes the depositional basin and contends that special conditions of intrastratal alteration were essential. Prior to the mid-1960's most geologists believed that the pigment was detrital, but since that time evidence has been acquired that strongly indicates that the pigment is authigenic.

In the following discussion the major characteristics of the red beds that pertain to the origin of the pigment are described and are applied to an evaluation of the two hypotheses.

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CHARACTERISTICS OF THE RED BEDS

The red beds are composed dominantly of first-cycle arkosic detritus that reflects derivation of sediments from the crystalline highlands exposed by orogenies that began in Early Pennsylvanian time. Many depositional environments are represented; coarse fanglomerates representing high-energy fluvial conditions flank the highland source areas and interfinger basinward with sandstones, siltstones, mudstones, carbonates, and evaporites that represent diverse lower-energy conditions such as low-gradient alluvial plains, tidal flats, various shallow open-marine and restricted-marine environments, salinas, and probably playas. Grain size in the red beds generally decreases upward through the sequence, reflecting the progressive denudation of the highlands and gradual filling of the basins.

The pigment in the red beds is ferric oxide, presumably mainly hematite, which stains both framework grains and interstitial matrix clays. The pigment characteristically is concentrated in fine-grained beds and in the interstitial matrix of sandstones and conglomerates. Some red sandstones and conglomerates contain interstitial cement instead of matrix clay, and in these rocks the red pigment occurs as irregular, commonly plumose, coatings on the framework grains. Significantly, the red coatings show no evidence of abrasion.

At many localities the red beds contain layers of nonred sediments which typically are coarser and more permeable than the associated red sediments. Crossbedding, particularly in the fanglomerates, commonly is accentuated by the alternation of red and nonred cross-laminae, and in such beds the red color characteristically follows finer grained laminae. In many places the color relationships indicate that some of the nonred layers or laminae have resulted from bleaching of sediments that previously had been red.

The continental facies on the flanks of the highlands are dominantly red, whereas the marine facies in the basins are dominantly nonred. The differences in color, however, cannot be used to distinguish marine from nonmarine deposits; fossiliferous marine beds in places are bright red (Walker, 1959), and continental beds in places are not red.

Red shales in the sequence generally contain more iron than do shales of other colors, and all shales, regardless of color, contain much more iron than do associated coarser grained sediments (table 1). Shales throughout the sequence also contain concentrations of biotite which account for local high iron content.

In petrographic thin section, the red arkoses show evidence of intrastratal alteration which clearly has modified both the minerals and texture of the original sediment. Some feldspar grains are fresh, but many have been extensively replaced by clay (fig. 17). The alteration has changed the original mineralogy by reducing the

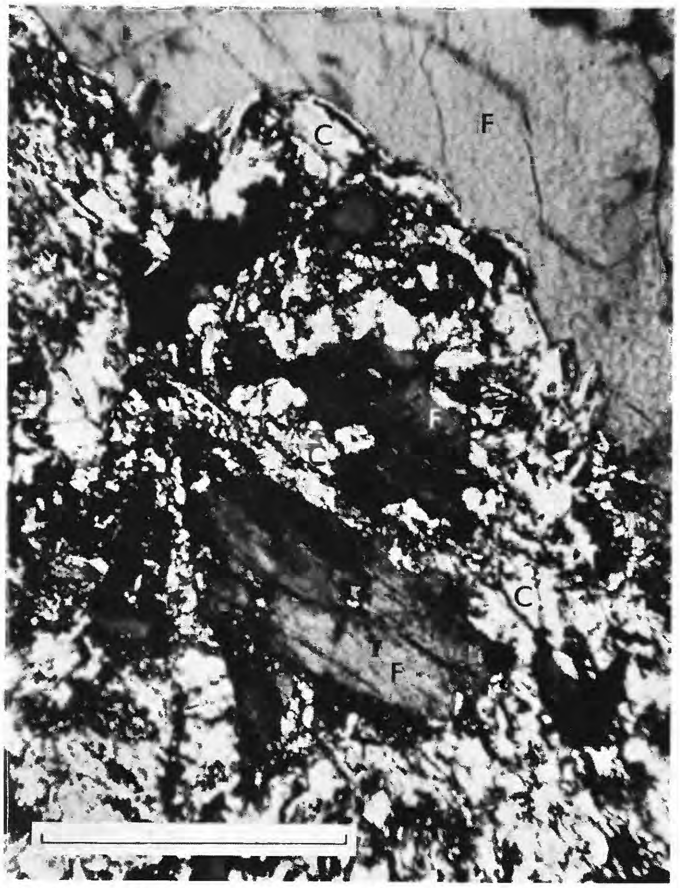

FIGURE 17. — Detrital feldspar grain (F) which has been extensively replaced by authigenic clay (C). Sample RMA-1127OB, from core of Fountain Formation at depth of 11,270 feet in well at Rocky Mountain Arsenal, near Denver, Colo. Length of bar represents 0.25 mm. Crossed nicols.

TABLE 1. – *Iron analyses of Minturn Formation, McCoy area, Colorado*

Sample No.	Iron, in percent		
	Total	Combined	Extractable
Red shale			
512-67-2	3.9	1.9	2.0
3	5.5	5.3	.2
4	3.4	3.4	.0
5	5.1	4.8	.3
6	5.0	4.8	.2
7	4.6	4.2	.4
11a	7.0	6.9	.1
12a	4.0	4.0	.0
13a	7.1	6.7	.4
15	4.8	4.3	.5
28	5.0	4.5	.5
34	6.1	5.8	.3
35	5.2	4.9	.3
Average	5.1	4.7	0.4
Green shale			
512-67-116	4.9	4.7	0.2
12b	2.3	2.4	.0
13b	4.7	4.8	.0
16	1.4	1.4	.0
21	3.8	3.9	.0
33	3.8	3.7	.1
36	4.7	4.7	.0
Average	3.7	3.7	0.0
Brown shale			
512-67-17	4.7	4.1	0.6
23	3.5	2.9	.6
24	3.2	3.2	.0
26	4.8	2.9	1.9
27	4.2	3.4	.8
Average	4.1	3.3	0.8
Gray-black shale			
512-67-1	5.7	5.6	0.1
18	4.8	3.4	1.4
19	4.2	2.8	1.4
22	5.0	2.8	2.2
25	3.0	2.2	.8
31	3.4	2.5	.9
32	3.6	3.4	.2
Average	4.2	3.2	1.0
Red arkose			
512-67-8a	1.2	1.1	0.1
9a	2.4	2.1	.3
10a	1.4	1.3	.1
14a	2.9	3.0	.0
20a	1.5	1.4	.1
29a	.7	.64	.1
Average	1.7	1.6	0.1
White arkose			
512-67-86	1.0	1.0	0.0
9b	1.0	.99	.0
10b	1.1	1.1	.0
14b	1.7	1.7	.0
20b	1.0	1.0	.0
29b	.49	.44	.05
30	.33	.31	.02
Average	0.9	0.9	0.0

amount of unstable minerals; it has changed the texture by increasing the amount of interstitial matrix clay. In addition, biotite has been leached and reddened, and ends of biotite grains commonly are splayed, owing to concentrations of authigenic hematite between the cleavage lamellae. In places biotite grains are surrounded by halos or aureoles of red iron oxide stain which in some places contain euhedral crystals of hematite.

The clay minerals, both in the fine-grained beds and in the interstitial matrix of coarse-grained beds, are composed mainly of illite, mixed-layer illite-montmorillonite, and chlorite (Raup, 1966; author's unpub. data). Kaolinite is common at some outcrop localities but it is absent from all analyzed samples that have been collected from the subsurface (Raup, 1966; author's unpub. data). Thin sections show that the kaolinite occurring in the outcrop samples has formed by in situ alteration of both framework grains (fig. 18) and interstitial matrix clay (fig. 19). The kaolinite is not red.

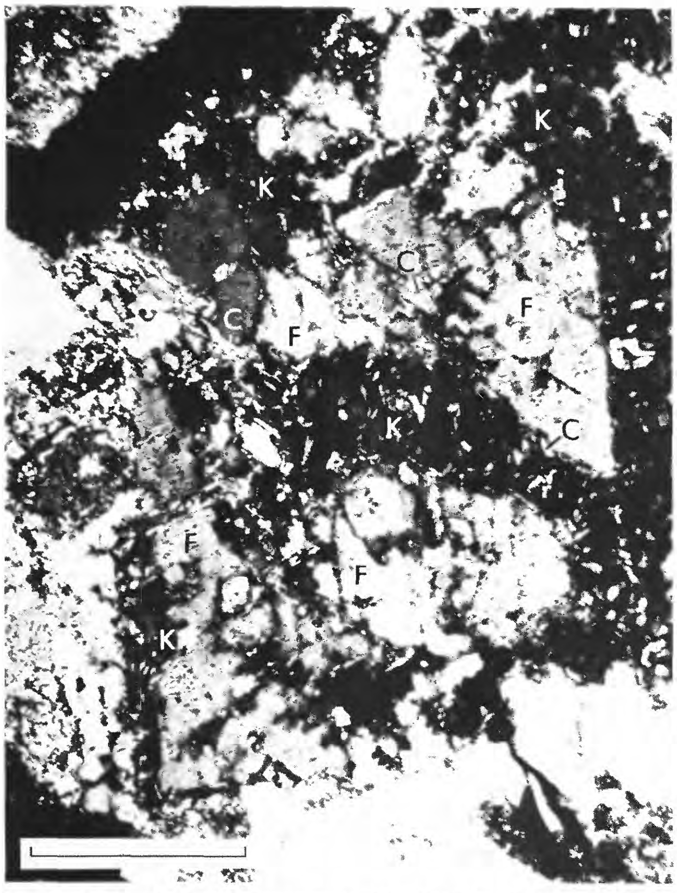

FIGURE 18. — Detrital feldspar grain (F) which has been extensively replaced by authigenic kaolinite (K). Remnants also remain of more highly birefringent clay (C), which replaced the feldspar prior to replacement by kaolinite. Sample Mc-1-S-292, from Minturn Formation near McCoy, Colo. Length of bar represents 0.25 mm. Crossed nicols.

FIGURE 19. — Vermiform books of authingenic kaolinite (K) replacing matrix clay (C) having higher birefringence than kaolinite. Sample Mc-1-S-292, from Minturn Formation near McCoy, Colo. Length of bar represents 0.25 mm. Crossed nicols.

Sediments throughout the sequence, regardless of their color or texture, contain a stable suite of detrital, nonopaque, heavy minerals, mainly zircon and apatite (Hubert, 1960; author's unpub. data). The main opaque heavy mineral is hematite which has pseudomorphically replaced magnetite.

In places, carbonate beds which are interbedded with the red beds contain jasperized fossils such as brachiopods, gastropods, corals, and crinoidal debris.

DETRITAL PIGMENT

Certain of the preceding characteristics have led many geologists (for instance, Krynine, 1949; Hubert, 1960) to conclude that the highland source areas were warm and moist and deeply dissected, and that interfluve areas were covered by red, deeply weathered lateritic soils which upon erosion provided the pigment in the red beds. These conclusions are based upon the following reasoning: The common association of both altered and unaltered feldspars in the same thin section and the equally common association of hematite-stained and kaolinite-bearing matrix clay with unaltered feldspar grains are interpreted to indicate two loci of origin of the sediments. The altered feldspars and matrix clays are believed to be the derivatives of the weathered material from interfluve areas, whereas the fresh feldspars are the products of erosion in canyons cut into unaltered crystalline bedrock. The kaolinite is cited as evidence of intense weathering that required abundant rainfall, and the hematite is cited as evidence that the soils were lateritic. The great intensity of staining and the relatively high concentration of iron in the fine-grained beds are explained by mechanical separation at the site of deposition of the hematite-rich, soil-derived, fine fraction from the unstained, canyon-derived, coarse fraction. The interstitial, red, kaolinitic, matrix clay in the sandstones and conglomerates is interpreted to be the result of entrapment of the soil-derived clays within coarser deposits during sedimentation. The stable heavy mineral suite is believed to reflect the destruction of the less stable minerals in the source areas, and is interpreted as further evidence that the highlands were moist regions where weathering was intense.

These interpretations, however, do not explain some major characteristics of the red beds. For example, some of the Pennsylvanian evaporite deposits, such as those of interval C in the Paradox basin, cover thousands of square miles and in places are thousands of feet thick (Hite, 1961). They also contain some of the world's most economically important deposits of potash salts (Hite, 1961). Such thick and widespread evaporites almost certainly reflect an intensely arid climate which, by about the beginning of interval C time, must have extended throughout the western interior. It seems unreasonable, therefore, to assume that the highlands were locally moist, tropical areas in the midst of what must have been a regional desert. As Hubert (1960, p. 222) has pointed out, it also is unsatisfactory to postulate as an alternative explanation that red soils which were produced by weathering in pre-Pennsylvanian time survived the change from a moist to an arid climate, and were stripped from the highlands during Pennsylvanian time, because the volume of red detritus available for removál would be insufficient to explain the large amount of red clayey material in the Pennsylvanian red beds — to say nothing about the pigment in the thick sequence of red beds that overlies the Pennsylvanian rocks. It also is unreasonable to assume that lateritic soils continued to form in the highlands during Pennsylvanian time, because the processes by which lateritic soils are formed are incompatible with the occurrence of thick evaporite deposits of the same age in the adjacent basins. Moreover, the interpretation that the pigment is derived from soils in the source areas is not supported by present knowledge of the color of detritus eroded from modern moist tropical regions. Modern sediments in such regions are characterized by gray and brownish, not reddish, colors, despite the occurrence of red soils in the source areas (Van Houten, 1964, p. 653; Walker, 1967b).

The occurrence of kaolinite in the red beds cannot be accepted as evidence that kaolinite-bearing red soils covered the source areas at the time the Pennsylvanian sediments were being deposited, because kaolinite is present only locally in the red beds, and thin sections show that at these localities the kaolinite is authigenic (figs. 18 and 19) and it is not red. The fact that kaolinite has not been found in subsurface samples suggests that it formed subsequent to uplift of the Pennsylvanian rocks during the Laramide orogeny. The petrographic evidence for in situ replacement of feldspars by clay is so widespread that it seems likely that much and perhaps nearly all of the interstitial matrix clay in the sandstones and conglomerates is authigenic, not detrital. The mineral composition of the clay, therefore, probably reflects chemical conditions of intrastratal alteration, not chemical conditions of weathering in the source areas.

Finally, to interpret the pigment as detrital does not explain many other important characteristics of the red beds, such as the hematite-stained halos adjacent to biotite grains, hematite in the splayed ends of biotite grains, the irregular unabraded nature of the hematite coatings on framework grains, or the hematite in the jasperized fossils. These characteristics are better explained if the hematite is interpreted as authigenic.

AUTHIGENIC PIGMENT

The lithologies and facies relationships in the Pennsylvanian red beds are strikingly similar to those in red beds that are forming today in the Sonoran Desert of northwestern Mexico and Southwestern United States (Walker, 1967a), and, in my opinion, the Pennsylvanian red beds are ancient counterparts of the Sonoran red beds. Using the Sonoran deposits as a model, the following discussion outlines my interpretation of the regional setting and environmental conditions that existed in the western interior during Pennsylvanian time after the beginning of interval C, and explains how these conditions led to the formation of the red pigment after the sediments were deposited.

The widespread occurrence of evaporites in interval C indicates that by the time these sediments were deposited, land areas in the western interior had become a vast desert. An increase in coarseness and thickness of the fanglomerates deposited in interval C compared to earlier fanglomerates indicates that the highlands, which in previous intervals had low to moderate relief, now were mountain ranges that stood a few thousand feet above the surrounding basins. Erosion had already removed Paleozoic sediments from most of the highlands by the time of interval C, and plutonic crystalline rocks which formed the cores of the mountains now predominated among rock types cropping out in the

FIGURE 20. — Typical landscape in the Sonoran Desert. Crystalline highlands are devoid of soil, but weak desert-type soils containing iron-bearing clay minerals are developed on the flat interfluves of the dissected bajadas. Unstable silicate minerals are unaltered when eroded from these highland source areas. Coastal plain about 2 miles north of San Felipe, Baja California, Mexico.

watersheds. Soils probably were sparse or absent on the crystalline rocks in the mountains, in part because of the unfavorable weathering conditions created by the low rainfall, and in part because slopes were very steep and vegetation was too scarce to prevent removal of the small amount of weathered material almost as it formed. However, soils presumably were weakly developed on the flat interfluve surfaces of dissected bajadas at the base of the crystalline highlands and these soils, like soils in a comparable position in the modern Sonoran Desert (Walker and Honea, 1969), probably contained iron-bearing clay minerals consisting mainly of illite and montmorillonite. The general landscape probably resembled that of the Sonoran Desert today (fig. 20), and the granitic detritus eroded from the highlands, like that in the modern Sonoran Desert, probably was gray, not red, when deposited. This detritus doubtless contained abundant unstable silicate minerals because the climate in the source areas almost certainly was too dry, and the time the minerals were exposed to weathering too short, for them to be destroyed prior to transportation.

All available evidence indicates that unstable iron-bearing silicates such as hornblende and biotite were at least as abundant in the Pennsylvanian arkoses at the time they were deposited as they are in modern sediments derived from crystalline rocks of the present Front Range in Colorado. The Pennsylvanian red beds were derived mainly from the same crystalline rock types as are the modern sediments under climatic conditions that must have been much drier than those now existing in the Front Range. Weathering in the highlands, therefore, presumably was no more intense, and it may have been much less intense, than it is in the Front Range today. The amount of hornblende originally present, therefore, can be estimated from the work of Hall (1966), who reported that the modern alluvium along the Front Range in northern Colorado contains an average of about 10 percent by weight of heavy minerals and that hornblende constitutes about 50 percent of the grains. That biotite was also an abundant original constituent of the sediments is obvious from its present abundance in the red beds. Hence, although the arkoses were not red when deposited, they contained enough unstable iron-bearing minerals to easily account for all the iron that now exists in the red pigment.

The detrital silicate grains were chemically unstable, to varying degrees, in the interstitial environments of all facies in the depositional basins, as is indicated by the widespread evidence of in situ alteration of silicate minerals such as feldspars, many of which still remain in the sediments. The silicates were altered by chemical hydrolysis, a reaction which can be expected to have occurred wherever the silicate minerals were in contact with migrating interstitial water both above and below the water table. The rate of alteration probably varied with the amount of water available, and therefore it probably was most rapid below the water table. Presumably, as basin subsidence continued, hydrolysis of the silicate grains ultimately occurred throughout the sediments and gradually removed the more unstable minerals. I believe that the paucity of unstable silicate minerals such as hornblende in the heavy-mineral fraction of the Pennsylvanian arkoses is best explained by the removal of these grains in this manner.

These diagenetic alterations produced authigenic clay, which became interstitial matrix, and yielded material in solution, such as calcium, magnesium, sodium, potassium, alumina, silica, and iron, which either migrated with the interstitial waters or was precipitated as cement or, in the case of iron, as pigment. The behavior of the iron, which is of prime concern here, depended on the Eh and pH of the interstitial water. Wherever the Eh and pH were such that the interstitial environment was in the stability field of ferric hydroxide (fig. 21), the iron precipitated as amorphous oxide which, being metastable (Berner, 1969), ultimately was converted to hematite, at which time the sediments became reddened. Elsewhere the iron either remained in solution as ferrous ions or was precipitated in authigenic ferrous minerals and such sediments were not reddened.

The interstitial environment probably was in the stability field for ferric hydroxide throughout the time of deposition of much of the sedimentary sequence and for an indefinite time thereafter, particularly the interstitial environment in the continental sediments, because of a combination of two factors. The detritus in the sediments was derived from desert source areas and therefore it initially contained little organic matter; hence, the interstitial environment was either oxidizing or only weakly reducing even below the water table. Intrastratal hydrolysis of the silicates tended to create an interstitial environment having high pH (Krauskopf, 1967, p. 113-116). Accordingly, the resulting interstitial environment lay somewhere to the right of the ferric hydroxide fence shown in figure 21. The iron released by the alteration of the silicate minerals was precipitated as irregular coatings of ferric oxide on whatever surfaces were present, which included the surfaces of both the framework grains and the matrix clay. Upon aging, the sediments gradually became reddened, just as analogous sediments are becoming reddened today in the Sonoran Desert.

The fine-grained sediments, including both shales and siltstones, originally contained more iron and, assuming

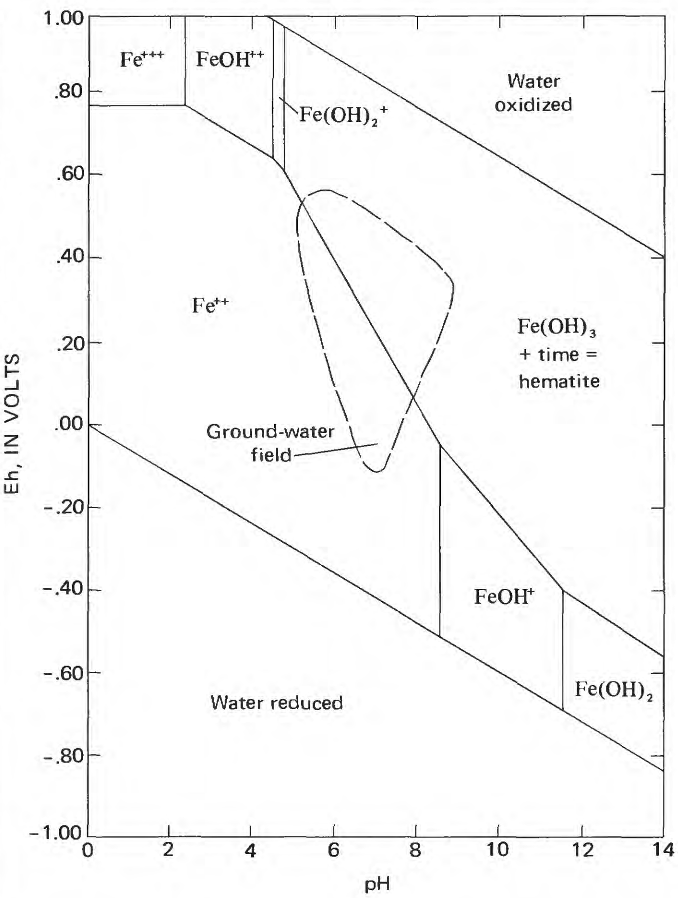

FIGURE 21. — Stability field diagram for aqueous ferric-ferrous system. (Modified from Hem and Cropper, 1959; limits for ground water from Baas Becking and others, 1960.)

that the interstitial Eh-pH environment was favorable for precipitation of ferric oxide, they ultimately became redder than associated sandstones and conglomerates. This is because the fine-grained sediments had the advantage of containing concentrates of both fresh biotite derived from the crystalline source rocks and iron-bearing clay minerals derived from the weakly developed desert soils. The pigment, in addition to being concentrated in the shales and siltstones, became concentrated in the interstitial matrix of the sandstones and conglomerates. This is because most of the clay in the matrix probably was formed authigenically, and much of it, particularly that which formed from alteration of iron silicates such as hornblende, probably was iron bearing. Evidence obtained from studies of Pliocene red beds in the Sonoran Desert indicates that such clays are important sources of iron for diagenetic pigment (Walker and others, 1967; Walker and Honea, 1969).

The interstitial environments in some sediments, especially the marine types and those deposited in coastal swamps or in inland oases, were not in the stability field of ferric hydroxide because these environments were rich in organic matter and consequently the interstitial environment was strongly reducing. The iron released by hydrolysis of silicate grains in these sediments either remained in solution or was precipitated as ferrous compounds, and there was no reddening of the deposits. Locally, however, either because of the initial occurrence of a smaller amount of organic matter in the sediments, higher pH, or because postdepositional oxidation removed the organic matter, some marine sediments were not sufficiently reducing to prevent ultimate precipitation of ferric oxides, and in time these sediments also became reddened (Walker, 1959)[2].

During the course of becoming reddened diagenetically, the Pennsylvanian sediments apparently became more uniformly red than they are at present; the existing color relationships in the red beds indicate that the colors of many of the nonred rocks have resulted from bleaching of sediments that previously were red. It should be emphasized that these color relationships do not imply that the sediments were red when deposited; they merely indicate that red pigment predates the bleaching in some beds. The bleaching apparently reflects subsequent changes in ground-water chemistry that resulted in reduction of the previously formed iron oxide pigment. The reason for the chemical change is unknown, but the postdepositional history of these sediments involves about 250 million years, and during this time two important events occurred, either one of which could have affected the chemistry of the interstitial water and caused partial removal of the red pigment. These events were: (1) the deposition of strongly reducing marine geosynclinal sediments of Mesozoic age above the red beds, and (2) the occurrence of a moist continental environment subsequent to uplift of the red beds during the Laramide orogeny in early Tertiary time. During this late-stage bleaching, the coarser, more permeable beds were affected most, and in places the red pigment was completely removed from some of the beds. The red pigment in other beds was only partly removed. In some of these, crossbedding patterns have been accentuated by selective removal of the pigment from the more permeable laminae. In others, irregularly shaped bleached areas have been formed. The bleaching has resulted in the development of alternating fine-grained red and coarse-grained nonred beds that now characterize the red bed sequence at many places.

SUMMARY

The main conditions which, in my opinion, contributed to the formation of pigment in the Pennsylvanian red beds of the western interior can be summarized as follows.

Regional aridity inhibited weathering in the source area and allowed unstable silicate minerals to survive alteration until after the arkosic sediments were deposited in the basins. The arid climate also inhibited the growth of plants, and therefore the sediments, when originally deposited, contained little organic matter. As a result the Eh of the interstitial water in the deposited sediments commonly was oxidizing or only weakly reducing.

The detrital silicate minerals, particularly the iron-bearing silicates, were unstable wherever water migrated through the sediments and they were slowly altered by hydrolysis. This reaction removed the more unstable grains such as hornblende; it released iron, and created an alkaline pH. Owing in part to the initial low content of organic matter and in part to the development of alkaline conditions, the interstitial Eh-pH environment commonly was in the stability field for iron hydroxide, and wherever these conditions prevailed the iron released by intrastratal alteration was precipitated as iron-oxide pigment. The pigment probably was initially precipitated as amorphous ferric oxide, but upon aging it converted to hematite, and the sediments involved were reddened.

Exceptions to the conditions of reddening occurred in sediments that were deposited in marine environments or in coastal swamps or inland oases where more abundant organic matter created strongly reducing conditions that prevented precipitation of iron oxide, despite the occurrence of alkaline interstitial water. Such sediments generally were not reddened.

[2]When the 1959 paper was written. I interpreted the pigment in these deposits to be detrital. I no longer accept that interpretation.

REFERENCES

Baas Becking, L. G. M., Kaplan, I. R., and Moore, Derek, 1960, Limits of the natural environment in terms of pH and oxidation-reduction potentials: Jour. Geology, v. 68, no. 3, p. 243–284.

Berner, R. A., 1969, Goethite stability and the origin of red beds: Geochim. et Cosmochim. Acta, v. 33, no. 2, p. 267–273.

DeVoto, R. H., 1965, Pennsylvanian and Permian stratigraphy of central Colorado: Mtn. Geologist, v. 2, no. 4, p. 209–228.

Hall, R. D., 1966, Heavy minerals in Recent alluvium along the eastern flank of the Front Range, Golden to the Colorado-Wyoming line: Colorado Univ. M. S. thesis.

Hem, J. D., and Cropper, W. H., 1959, Survey of ferrous-ferric chemical equilibria and redox potentials: U.S. Geol. Survey Water-Supply Paper 1459-A, p. 1–31.

Hite, R. J., 1961, Potash-bearing evaporite cycles in the salt anticlines of the Paradox basin, Colorado and Utah, *in* Short papers in the geologic and hydrologic sciences: U.S. Geol. Survey Prof. Paper 424-D, p. D135–D138.

Hubert, J. F., 1960, Petrology of the Fountain and Lyons Formations, Front Range, Colorado: Colorado School Mines Quart., v. 55, no. 1, 242 p.

Krauskopf, K. B., 1967, Introduction to geochemistry: New York, McGraw-Hill Book Co. (Internat. Ser. Earth and Planetary Sci.), 721 p.

Krynine, P. D., 1949, The origin of red beds: New York Acad. Sci. Trans., ser. 2, v. 11, no. 3, p. 60–68.

Raup, O. B., 1966, Clay mineralogy of Pennsylvanian redbeds and associated rocks flanking Ancestral Front Range of central Colorado: Am. Assoc. Petroleum Geologists Bull., v. 50, no. 2, p. 251–268.

Robb, G. L., 1949, Red bed coloration: Jour. Sed. Petrology, v. 19, no. 3, p. 99–103.

Van Houten, F. B., 1961, Climatic significance of red beds, Chap. 5 *in* Descriptive paleoclimatology: New York, Interscience Pub., Inc., p. 89–139.

——1964, Origin of red beds — some unsolved problems, *in* Nairn, A. E. M., ed., Problems in paleoclimatology, NATO Paleoclimates Conf. Proc. 1963: New York, Interscience Pub., Inc., p. 647–661.

Wahlstrom, E. E., 1948, Pre-Fountain and Recent weathering on Flagstaff Mountain near Boulder, Colorado: Geol. Soc. America Bull., v. 59, no. 12, p. 1173–1189.

Walker, T. R., 1959, Fossiliferous marine redbeds in Minturn formation (Des Moines) near McCoy, Colorado: Am. Assoc. Petroleum Geologists Bull., v. 43, no. 5, p. 1069–1071.

——1967a, Formation of red beds in modern and ancient deserts: Geol. Soc. America Bull., v. 78, no. 3, p. 353–368.

——1967b, Color of Recent sediments in tropical Mexico — A contribution to the origin of red beds: Geol. Soc. America Bull., v. 78, no. 7, p. 917–919.

Walker, T. R., and Honea, R. M., 1969, Iron content of modern deposits in the Sonoran desert — A contribution to the origin of red beds: Geol. Soc. America Bull., v. 80, no. 3, p. 535–543.

Walker, T. R., Ribbe, P. H., and Honea, R. M., 1967, Geochemistry of hornblende alteration in Pliocene red beds, Baja California, Mexico: Geol. Soc. America Bull., v. 78, no. 8, p. 1055–1060.

PENNSYLVANIAN CYCLOTHEMS OF THE APPALACHIAN PLATEAU, A RETROSPECTIVE VIEW

By John C. Ferm[1]

INTRODUCTION

The concept of the cyclothem as a product of cyclic sedimentation in coal-bearing Pennsylvanian sedimentary rocks in the United States is among the major ideas that have captured the attention and imagination of American geologists of the last century. It is, of course, part of the more general idea of cyclicity in natural processes but has special appeal in that it has specific application to a group of rocks that are widespread and have been intensely studied. Furthermore, it has proved to be especially attractive to stratigraphers inasmuch as it has provided a means for organizing a group of strata consisting of greatly diverse rock types that previously seemed to lack any consistent interrelationships. Thus Ashley (1931), after years of experience in the coal measures, agreed that coal beds generally overlay seat rocks or underclays but could recognize no vertical or horizontal pattern beyond this. As a result of the widespread popularity of cyclothems, the literature dealing specifically with them is voluminous, including a very large number of titles dealing directly with the subject and an even larger number in which this topic is a major adjunct.

Weller, who can be said to be the father of the cyclothem concept, brought together many of the major thought trends up to 1964. More recently, Duff, Hallam, and Walton (1967) treated the concept as a major part of their summary volume on cyclic sedimentation.

Despite all this effort and enthusiasm, or perhaps because of it, many basic problems of cyclothemic deposits are apparently unresolved. There seems to be no general agreement as to what exact sequence should make up a cyclothem in a specific area or at what particular point a cyclothem is to begin or end. Likewise, the question of origin remains unresolved.

In addition, one may reasonably question the functional value of the cyclothem concept. It now seems clear that cyclothems do not constitute a basis for stratigraphic classification (Kosanke and others, 1960), and if the stress should be placed on environmental interpretation, as Doty and Hubert (1962) suggested, the notion of a specific sequence or of several specific sequences of beds may not be the most fruitful approach.

One of the major advances in the description of cyclothemic sequences is that of their quantification (Pearn, 1964; Potter and Blakely, 1968; Preston and Henderson, 1964). Unlike previous approaches, which dealt with "idealized" or "complete" cycles, this approach describes exactly the rock units of which a cyclothemic sequence consists and associated a mathematical probability with each sequence. Such an approach has a high level of objectivity and provides an excellent predictive device for dealing with vertical sequences. The method, however, is applicable to any vertical sequence, and some question arises as to whether it is really dealing with the cyclothem as a unique phenomenon, as originally proposed.

Although interest in the subject of cyclothems continues, it may be waning, as suggested by the fact that fewer formal papers deal with the subject than heretofore, and informal discussion also has apparently diminished, but has not ended. One notable recent treatment of the cyclothem concept is given in the group of papers in Kansas Geological Survey Bulletin 169 (Merriam, 1964). The present essay is intended to provide a retrospective view of some of the major ideas associated with cyclic coal measure sedimentation and to indicate the direction in which they are evolving.

A regional summary treatment seems inappropriate

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while the excellent synthesis by Duff, Hallan, and Walton (1967) is available. An attempt is made, however, to trace the initiation and growth of the concept in the Illinois basin, to show how the ideas developed there were tested in the coal measures of the Appalachian Plateau, and to demonstrate how this testing, in turn, led to the development of new lithogenetic models in that region. Thus, this treatment is restricted to the experiences of a few people in a limited geographic area. It provides an example of hypothesis generation and testing in the context of nonquantitative geologic thought and so may have general relevance at this time.

THE INNOVATION IN ILLINOIS

If Weller can be said to be the father of the American cyclothem concept, then Udden can certainly be regarded as the grandfather. Udden's ideas expressed in a U.S. Geological Survey report (Udden, 1912) on the Peoria quadrangle in northwestern Illinois centered on the tendency for repetition of sequences of rock units among Pennsylvanian strata above the Number 5 coal bed. These sequences, in vertical order, consisted of underclay and coal overlain by marine limestone and (or) shale which was in turn overlain by another seat rock and coal. He further recognized that all such sequences (which he called cycles of sedimentation) were not identical. In some cycles the coal, underclay, or limestone was much thinner than in others, and in some places one or more members were absent. Enough of the members were present at each place, however, to clearly show the pattern.

Udden (1912) further believed that each sequence represented a repeated pattern of sedimentation commencing with the development of a peat and underlying soil (coal and seat rock). This was followed by subsidence of the swamp surface and concomitant marine inundation now represented by marine limestone and shale. Deposits of clay, silt, and sand filled the basin to a level that would allow swamps to form again. These observations and inferences were similar to those of later workers on British Carboniferous rocks (see Duff and others, 1967, p. 117-141); moreover, the British "idealized" or "standard" cycle is very similar to that of Udden.

Because of its publication in a quadrangle report and its necessarily local implications, Udden's idea of coal-measure cyclothemic sedimentation might have quietly expired except for the innovative paper by Weller (1930). His paper had a galvanic effect and even now a reader can be impressed by its breadth and by the sweeping nature of its conclusions. Today there is little question that many of his inferences and even some of his data were projected beyond available evidence, but such lapses are forgivable in the face of the overall result.

Weller's cyclic sequence, later designated a cyclothem (Wanless and Weller, 1932) and slightly modified to include a few additional members (Weller and others, 1942), is shown by Krumbein and Sloss, (1963, fig. 13-10). This sequence consists of the following 10 members, from base to top: 1, sandstone with plant remains; 2, gray sandy shale; 3, freshwater limestone; 4, underclay; 5, coal; 6, gray shale, sparse marine fossils; 7, marine limestone; 8, marine black shale; 9, marine limestone; 10, gray shale, marine fossils in lower part.

One of the most obvious differences between the cycle of Udden and the cyclothem of Weller and Wanless (1932) is the greater precision in the latter's lithologic descriptions. Weller, for example, pointed out that the basal sandstone member, which is the coarsest grained member of the cyclothem, is overlain with gradational contact by siltstone and this, in turn, is overlain by an even finer grained underclay which may or may not contain freshwater limestone. Further, Weller distinguished between different types of shale above the coal beds, he recognized at least two different types of marine limestone, and he described the position of sideritic ironstone.

Lateral variability, as important as the detailed descriptions and the discrimination between rock types, was not stressed by Weller (1930) — in fact he made a point of emphasizing lateral continuity of some rock units — but lateral variability is implied in his statement that all members are not necessarily present in any one place. He stated, however, that as the cyclothem is traced laterally, members not present in one area occur in another at the expected place in the sequence. Thus, from the beginning the cyclothem was a laterally predictive device. Reger (1931) attempted to define this complete sequence, including all known members, as a "phantom" cycle, but the term "phantom" mistakenly became associated with units that were not actually present. To geologists who were having enough trouble mapping real coal beds, the notion of mapping phantoms was simply too much.

Equally unfortunate with respect to development of the idea that a cyclothem is the product of sedimentary processes was the notion of the "incomplete" cyclothem in which some members were said to be missing. This notion, perhaps arising from the practice of numbering the rock units in the cycle, gives the impression that a cyclothem in which some numbered units are not present at a specific place reflects an incomplete sedimentary record. Elementary knowledge of sedimentation should show the fallacy of such an idea. For any particular area the record was complete, but that area may have lacked conditions or processes necessary for the development of a lithologic unit that is present in adjoining areas.

Many difficulties caused by variation from the ideal Illinois sequence became immediately apparent in a conference held at Urbana, Ill., in 1930 at which representatives from Pennsylvania, West Virginia, Ohio, Kansas, and Texas outlined the characteristics of Pennsylvanian successions in their respective regions (Illinois Geological Survey, 1931). It became clear that repeated sequences in other areas, although vaguely reminiscent of those in Illinois, were different from them in major aspects. These differences, after they were studied by many people, were summarized by Wanless (1950), who accounted for variation from one region to another by differences in tectonic background and attendant depositional environment (fig. 22).

Cycles in the Appalachian region were mainly nonmarine, dominated by clastic deposition and by frequent splitting of coal beds, whereas those of the Western Interior basin were characterized by a complete sequence of marine carbonates and by relatively little coal. Implicit in this synthesis, however, as in Weller's original paper (1930), was the notion that at least some beds of the cyclothem are extremely widespread, covering distances halfway across the continent. Weller, in making this assumption (and it is an assumption, as there exists no proof for it), concluded that the cyclothem should properly be called a formation and thus constitute a basis for stratigraphic classification and mapping. This idea, coupled with a suggestion that each member of the cyclothem should everywhere bear the same stratigraphic name, was greeted enthusiastically by many geologists, if only to simplify the oppressive practice of Pennsylvanian stratigraphers of giving every shale, coal, limestone, ironstone, and sandstone a different stratigraphic name. The cyclothem

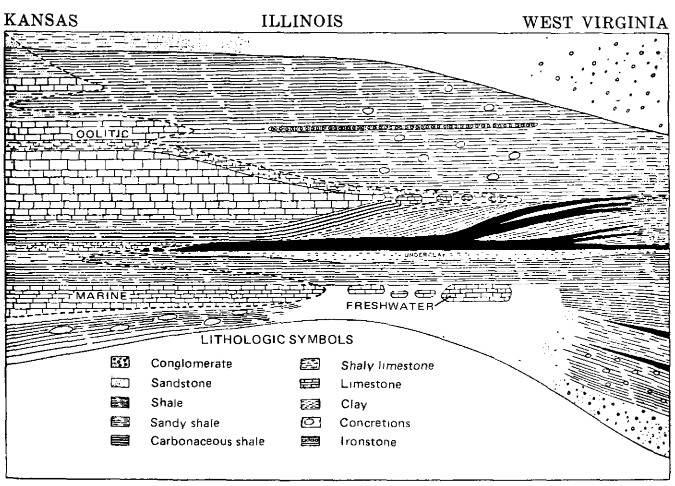

FIGURE 22. — Model of lateral variation of cyclothemic deposits (from Wanless, 1950, p. 21).

as a basin element of stratigraphic classification was adopted in various States; now, however, it has been abandoned in some of these States, notably Illinois (Kosanke and others, 1960).

The probable origin of cyclothems was also discussed by Weller (1930). The cyclothems he described were composed of units which were bounded at base and top by regional unconformities and which contained a lower segment that was indicative of marine environments. Pursuing a logical argument requiring that regional events arise from regional causes, Weller proposed a tectonic origin, beginning with an episode of uplift which generated the regional unconformity; this episode was followed by initial stages of subsidence or perhaps reduction of the source area by erosion, which permitted accumulation of sands and silts on the eroded surface. Further subsidence and (or) erosion of the source reduced the amount of detritus, permitting first the development of coal swamps and later a marine inundation, represented by marine shale and limestone. Uplift and erosion began the next cycle. This explanation came under fire quickly on the grounds that the large number of cyclothems represented in many areas would require an unreasonably large number of uplifts and downwarps — a kind of springboard tectonism that would in itself be difficult to explain. Wanless and Shepard (1936), calling upon more conventional causes, associated late Paleozoic glaciation in the southern hemisphere with cyclothemic deposits, correlating periods of glaciation with lowering of sea level and resulting erosion, and waning ice sheets with the rise of sea level. This hypothesis, although in many ways more attractive than the tectonic explanation, would require matching of cyclothems in the northern hemisphere with a known number of glacial stages in the southern hemisphere. But the number of late Paleozoic glaciations had not been carefully worked out (and still has not been); thus, the theory has not been verified. The origin of the cyclothems remains one of the intriguing questions of American geology.

APPALACHIAN TRIALS AND AN "ALLEGHENY DUCK"

During the two decades following the widespread application of the cyclothem concept in the Middle West, several workers, including E. G. Williams and me, attempted to test the idea in the coal-bearing strata of the Appalachian Plateau. Williams and I were concerned with the Middle Pennsylvanian Allegheny Group in western Pennsylvania. Our experience led us first to tentative acceptance of the cyclothem concept, but later to rejection of it, and finally to development of a new model.

At first the Weller cyclothem concept, modified by

Wanless' regional variation model, seemed applicable. Many open-pit coal mines clearly showed sequences very similar to the upper half of Weller's cyclothem, consisting in vertical succession of underclay, coal, dark shale, thin calcareous shale and limestone containing marine fossils, and gray shale which became silty upward. Absence of the two limestones and the black fissile shale of the Weller model could be attributed to a generally more landward position of Appalachian Plateau rocks. Other exposures showed similar sequences except that the limy components were still further reduced or absent and faunas consisted only of phosphatic brachiopods and pelecypods, presumably of brackish-water or freshwater origin. These rocks, in addition to showing strong similarities to a part of the Illinois cyclothem, also demonstrated that zones of marine fossils, formerly known only in Ohio, also extended eastward into central Pennsylvania.

Major problems centered upon the basal sandstone of the cycle and the unconformity upon which it rested. Such problems were especially important because the scoured surface at the base of the sandstone had been defined as the lower boundary of the Weller cyclothem and had been considered to be a feature of regional importance. In accord with the Illinois model, many exposures of strata between two coal beds showed sandstones on the order of 30–40 feet thick lying with an erosional contact on the underlying coal or roof shale and grading upward into siltstone and finally into underclay and coal. But in other coal-to-coal intervals where the sandstone was thin, the sandstone was near the top of the interval and was overlain by underclay, but it graded downward into siltstone and shale. There was not the slightest evidence of an unconformity beneath these thin sandstones and thus no boundary for the cyclothem.

Still other strip-mine exposures, which showed both types of sequence and their lateral relationships, provided a partial solution. In these cuts, from a place where the sandstone was thick and obviously disconformable, the erosional base of the sandstone rose laterally from the coal or roof shale and, as the sandstone thinned, passed into the underclay of an overlying coal bed. Thus the unconformity at the base of the sandstone and the underclay into which it laterally graded were manifestations of the same event; the underclay represented an interfluve surface and the sandstone with its scoured base reflected an adjoining area of alluvial scour and fill. The observation clarified an active debate between those who favored a boundary at either the base or the top of the coal bed and followers of Weller who advocated a boundary at the base of the sandstone.

At still other places, the problem of the position of the unconformity and basal sandstone could not easily be resolved. In some exposures, sandstones 30–40 feet thick, with an erosional base similar to those previously described, intertongued laterally into dark shales containing marine fossils; the underlying unconformable surface at the base of the sandstone changed laterally to a sharp but nonscoured contact and finally disappeared as the overlying coarse sediment pinched out. No regional unconformity could be recognized here, nor was there channeling as would be expected in a channel-interfluve situation.

In some exposures where the sandstone was thin (2–10 ft thick), the problem was even more difficult. These sandstones graded downward through siltstone into shale but were separated from an overlying shale by a very sharp contact, the reverse sequence of that in the Weller cyclothem.

In still other localities, the lateral continuity claimed for the Illinois cyclothem could not be demonstrated. Wanless noted similar occurrences in the Appalachian basin, but explained them partially through the mechanism of coal-bed splitting, in which a bed of coal is divided into two or more units with intervening strata developed between them as a full cyclic sequence of a sort. This seemed to be clearly the situation in some places, but in many others a sequence of underclay, coal, shale, sandstone, underclay, and coal wedged out completely in both directions in the cut face of a single strip mine and could not be found in adjoining exposures. Such cyclothems obviously had no significant lateral continuity.

Because of the many exceptions cited, the Weller ideal cyclothem seemed to be unacceptable and a new model was required. Strongly influenced by the lectures of P. D. Krynine (1947-55), Williams and I concluded that in a sequence such as the Allegheny Group, composed dominantly of detrital rocks, the most suitable boundaries or punctuation points in the sedimentary record should represent those periods of minimum detrital influx. In the Appalachian rocks these would be the coal beds, composed primarily of vegetable matter and very little detritus. Also included were the underclays which, although composed mainly of detrital material, had been strongly modified by the indigenous process of plant growth. This boundary was in accord with the ideas of Udden (1912)), Stout (1931), and others, and, as shown previously, it was not far from that of Weller.

The concept of minimum detrital influx and the generation of indigenous sediments was further extended, however, to bedded sideritic ironstone and limestone; these rocks, too, required a depositional setting relatively free of detrital sediments in order that the carbonates could be precipitated by biochemical or physiochemical processes. As in the Illinois cyclothem, the ironstones and limestones were recognized to be, for the most part, of marine or brackish-water origin and the coal beds and underclays were primarily of freshwater origin, but their genesis as nondetrital deposits was emphasized. Furthermore, it could be shown that at some places marine limestones graded laterally into bedded ironstones and finally into coal and underclay (Ferm and Williams, 1965). All these rocks represented nondetrital sites of deposition but in different environmental settings.

Among detrital (or clastic) rocks, the principal basis of classification is grain-size variation in a vertical sequence. Experience has shown that Weller's simple sequences — sandstone grading upward through siltstone to claystone beneath coal beds and shale and becoming coarser grained upward above the coal — did not adequately describe the complex detrital sequences in the Appalachian area. In fact, sequences of detrital rocks between two nondetrital rocks contain virtually every combination of local rock types. Thus, as shown in figure 23, the sandstone was at the base in sequence *A*, at the top in sequence *B*, in the middle in sequence *C*, and at both top and bottom in sequence *D*. In sequence *A* the scoured surface was at the base of the sandstone; in *D* the basal contact of the lower sandstone was sharp but clearly not erosional in some sections, whereas in others it was clearly erosional; in *B* the top contact of the sandstone was sharp; and in *C* both bottom and top contacts of the sandstone were gradational.

As in nondetrital rocks—coal, limestone, and ironstone—these foregoing detrital sequences could be related to a marine-nonmarine dichotomy. Thus, in some type *B* sequences, marine or brackish-water faunas occurred throughout the sequence and nondetrital rocks lying directly above and below were limestone or ironstone that also contained marine fossils. Type *C* sequences in some, but not all, places contained marine fossils in the shaly lower part; type *D* sequences in a few

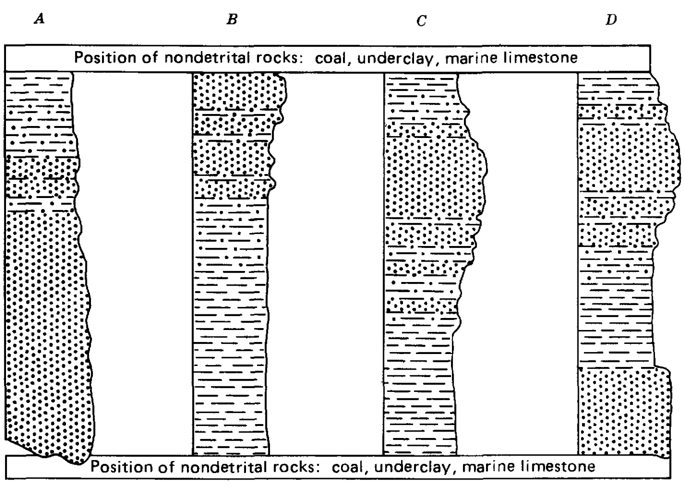

FIGURE 23. — Sequential arrangement of sandstone, siltstone, and shale between nondetrital rocks in the Northern Appalachian Plateau. Sandstone, dots; shale or mudstone, dashes; sandy shale or mudstone, dashes and dots.

places contained marine fossils at the top of the lower sandstone. Marine fossils were not found in any type *A* sequences. In all sequences marine or brackish-water fossils were less common in sandstones than in finer grained rocks, but the fact that they occurred in certain kinds of sandstone but not in others suggested that the presence or absence of fossils could be used as an environmental criterion.

Obviously all the complex sequences and rock types described above could not be represented in a single cyclothemic column, especially because different sequences and rock types were shown to grade laterally into one another. Furthermore, a vertical marine-nonmarine dichotomy would be useless inasmuch as marine rocks were shown to grade laterally into nonmarine strata. Thus a model should be two, or better, three dimensional showing all manner of lateral relationships. Such a model is shown in figure 24 with its lateral terminations based on the observation that nondetrital units—underclays and coals and marine limestones—tended to be more widespread than detrital rocks and locally converged into single units.

Initially, we had planned to designate this model a cyclothem, but the draftsman, observing the pattern in a slightly different way, thought that it looked more like a duck in flight. The name "Allegheny duck," although not exactly in accord with the original intent and certainly not very erudite, was easy to remember and therefore was retained. Although shown in two dimensions, the duck was visualized as a lens-shaped, three-dimensional body; the enclosing nondetrital sediments converged outward in all directions and the associated detrital sediments diminished in the fashion shown in figure 24, sandstone wedging out first, then siltstone, and finally shale. Further, not all "ducks" had a marine "tail"—some were entirely enclosed in coal and seat rocks and consisted wholly of detrital sequences similar to those shown on the right side of the drawing. Likewise a "duck" of detrital rocks surrounded entirely by limestone or ironstone like the part shown on the left side of the model could be hypothesized, but none like this was ever observed. Actually, the most common arrangement among those which included both marine and nonmarine components was the one shown in the figure, in which coal and underclay extended across the top and limestone and ironstone along the bottom. And, of course, cross sections through different parts of a single three-dimensional body could yield a variety of combinations.

Observed thicknesses of "ducks" ranged from 10 to 100 feet but most were about 50 feet. Horizontal distances ranged from about 100 miles for a complete coal-to-limestone "duck" to only a few hundred yards where only coal and seat rock were the enclosing members.

The origin of the "Allegheny duck" could not be

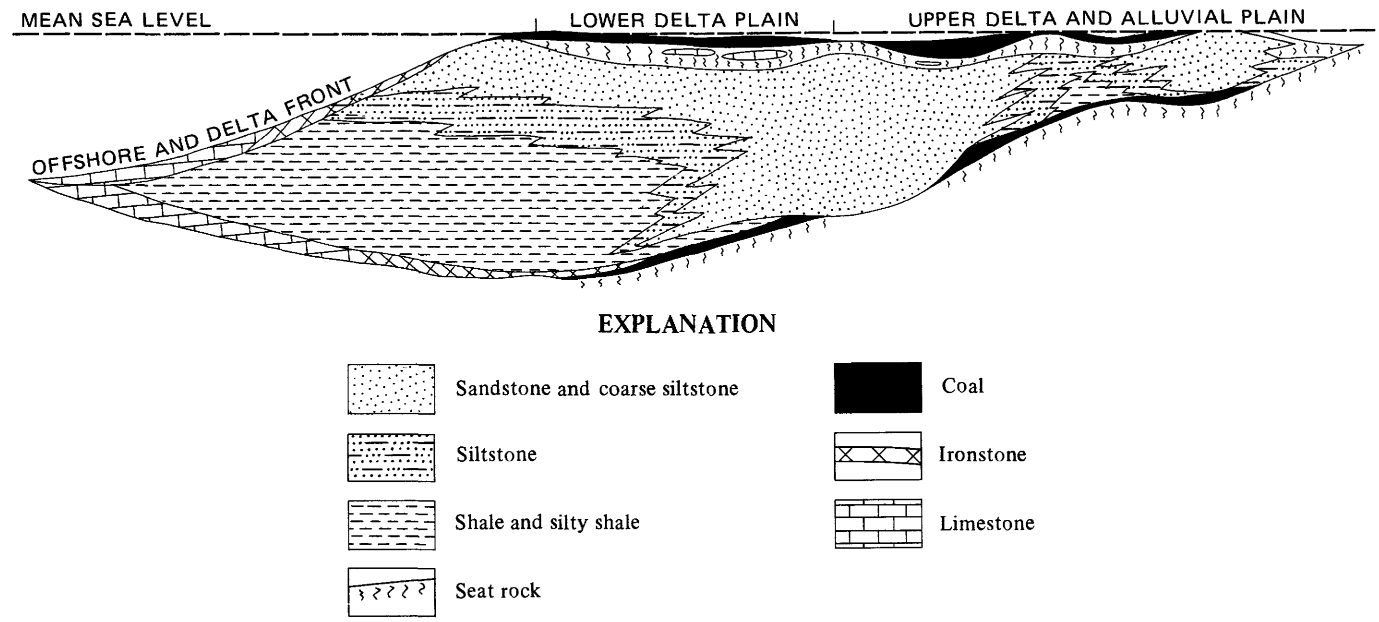

FIGURE 24. — The "Allegheny duck" model of lithologic variation in the Northern Appalachian Plateau, showing relation to modern depositional environments. Slightly modified from Ferm and Cavaroc (1969, p. 4). Earlier version is shown in Ferm and Williams (1963) and Williams and others (1964, p. 6).

dependent on a cycle of transgressive and regressive events. Some "ducks" in which coal was on top and limestone was below were produced during regression, others in which limestone or ironstone was on top and coal was below were produced during transgression; still others, however, were neither clearly transgressive nor regressive in origin. The only basic requirements for formation of a "duck" were pulsating influxes of detrital sediments punctuated by episodes of nondetrital deposition. The underlying cause could not be regional tectonism, as suggested for cyclothems in the Middle Western States, because some of the resulting products were not regional in extent. For a similar reason, glacial control of sea level seemed unlikely.

The overall shape of the model was similar to that of deltas and was not dissimilar to the Devonian Catskill delta in New York, except for scale and some rock types; therefore, some sort of deltaic origin appeared to be reasonable. Sandstones on the right (landward) side of the "duck" seemed to fit what had been described in alluvial point bars (Gwinn, 1964), and associated sequences of shale and siltstone that are progressively coarser upward and that contain well-preserved plants and freshwater faunas could reasonably be interpreted as lacustrine deposits. Likewise, the type *D* sequences that occur farther seaward seemed analogous to those of distributary mouth bars as described by Coleman, Ferm, and Gagliano (1969), and the thick type *B* and *C* sequences that are progressively coarser upward were very similar to those sections for modern delta fronts described by others (for example, Scruton, 1960).

The underlying mechanism for deposition of a "ducklike" deposit was and remains in doubt. After working on the deformed east edge of the Allegheny Plateau in Pennsylvania, Williams (Williams and others, 1964) was impressed by the control of sedimentation exerted by small tectonic subblocks. I (Ferm, 1970), having examined the Mississippi delta processes in Louisiana, favored regional subsidence, together with deltaic progradation, retreat, and lateral shifting as the causal mechanism for "duck"morphology. Regardless of the causes, explanations of rock types and patterns of variation were shifted from a simple transgressive-regressive mechanism to processes associated with modern depositional complexes.

AN AILING "DUCK" AND SOME CONCLUSIONS

Although the "duck" model, with its high degree of flexibility, proved to be generally applicable in the Allegheny Group and in some older and younger Pennsylvanian rocks of western Pennsylvania and Ohio, significant difficulties were encountered in relating it to other coal measure rocks of the Appalachian Plateau. Thus Cavaroc (1963) and later Ferm and Cavaroc (1968) described for upper deltaic and fluvial sediments in upper strata of the Kanawha Formation and Allegheny Group in south-central West Virginia a lithogenetic model that was substantially different from the Allegheny "duck." Figure 25, which is a graphic portrayal of this model, could be interpreted as a cross section perpendicular to the landward end (see fig. 24) of

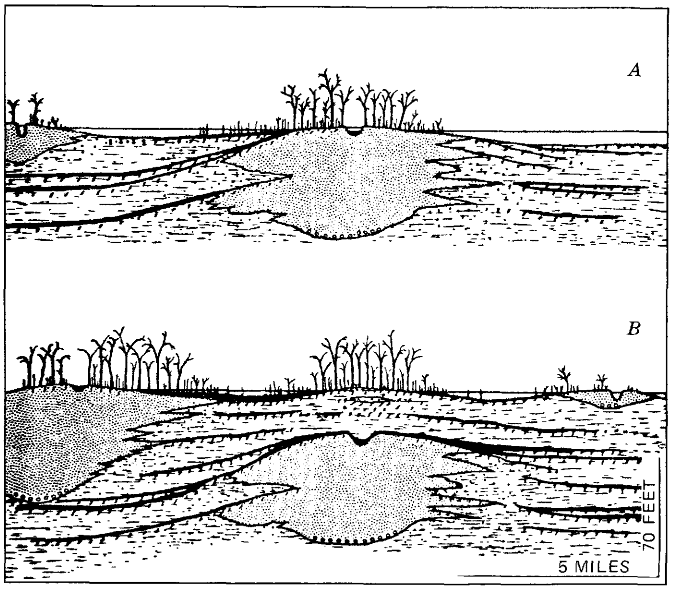

FIGURE 25. — A model for upper deltaic and alluvial sediments in the Allegheny Group in West Virginia (from Ferm and Cavaroc, 1968, p. 11). Published with permission of Geological Society of America.

the "duck," but the coarser grained components were thicker and consisted of repeated sequences, fining upward, of sandstone and siltstone. Likewise, the coarsening-upward sequences between coal beds in West Virginia appeared similar to those of lacustrine Allegheny sediments, except that such sequences were stacked one upon the other and that such groups graded laterally into a single thick sandstone unit.

In the Black Warrior basin of Alabama, Ehrlich (1965) and Ferm, Ehrlich, and Neathery (1967) found between successive coal units sequences which were similar, in both kind and proportion, to those on the landward side of the "Allegheny duck." Those parts of the Black Warrior basin section that contained marine or brackish-water fossils, however, were much thicker (250 ft) and lacked both the well-developed, upward-coarsening attribute and the distinct nondetrital limestone or ironstone breaks described in the Allegheny model.

Even greater differences occurred in the Lower Pennsylvanian strata of northern Alabama, Tennessee, and Georgia described by Hobday (1969). Among the finer grained rocks of this area, sequences that became coarser upward could clearly be related to the seaward end of the "duck," but the relationships of the finer sediments to the sandstones and the internal and external characteristics of the sandstones themselves were clearly so different from those known in the Allegheny that a wholly new model was required.

The sum of these and other experiments with the "Allegheny duck" seemed to indicate that its most broadly applicable aspects were those that related some specific rock type, sequence of rock types, or pattern of lateral variation to a known depositional setting in which rock properties could be related to environmental processes. Obviously, tectonic, climatic, or other factors can and do modify lithic patterns within depositional environments; such modifications, once patterns are known, provide a way to recognize the effects of these factors.

The relations described in the preceding paragraphs seen to have little or no application to any specific type of cyclothem, and there seems to be little point in perpetuating the notion of a classical sequence or any suggested modification of it. Rather, what now seems to be needed is a set of environmental lithic models, derived from and directly applicable to a given group of rocks. Such lithogenetic models and recent depositional products of known processes could then be compared.

If it is concluded that the original notion of a cyclothem now offers little to advance current Carboniferous research, it must also be recognized that this idea provided a critical starting point for much of our present thought not only in work on Pennsylvanian rocks but also in the general area of sedimentary geology. In preparing this retrospective view, I have attempted to provide most of the evolutionary steps, but in so doing, recognition of the major contributions to the thought pattern tends to become obscured in the process of questioning certain aspects of these ideas. Thus, in questioning an "idealized" sequence, widespread unconformity, and tectonic origin of the Illinois cyclothem, one should not forget that the cyclothem theory was one of the first attempts at geological modeling of sedimentary rocks at the outcrop scale and, as such, was a major innovation in geologic thought. Models of larger scale features—geosynclines, deltas, and even continents—had previously been proposed, but the cyclothem was a pioneer attempt to synthesize directly the patterns of sedimentary rock variation observable in the field.

Equally important, the model required greater precision of observation than was commonly practiced at that time. Descriptions such as "50 feet of sandstone and shale" were no longer adequate. Unconformities had to be examined and recorded in detail; also thin beds of limestone, shale, and ironstone that had previously been overlooked or ignored took on greater significance. Observation of important details led to the recognition of different kinds of rock types and sequences in different geographic areas which, in turn, suggested very precise models describing how one particular rock type or sequence graded laterally into another. Such descriptions were much more precise than the traditional zigzag type of facies line. These trends toward greater precision in documenting both vertical and lateral relationships of rock types and rock sequences permitted abandonment of simple explanations of marine transgression and regression and made possible direct comparison with process models developed in recent depositional environments. Such an approach was long ago advocated by Hutton and is known to every novice geologist, but Hutton, unfortunately, did not spell out the way precisely and it remained for others to pass through those intermediate steps.

REFERENCES

Ashley, G. H., 1931, Pennsylvanian cycles in Pennsylvania: Illinois Geol. Survey Bull. 60, p. 241-245.

Cavaroc, V. V., Jr., 1963, "Allegheny" (Pennsylvanian) stratigraphy of southern West Virginia: Louisiana State Univ. M.S. thesis, 71 p.

Coleman, J. M., Ferm, J. C., and Gagliano, S. M., 1969, Recent and ancient deltaic sediments—a comparison: Louisiana State Univ. Coastal Studies Inst., 205 p.

Doty, R. W., and Hubert, J. F., 1962, Petrology and paleogeography of the Warrensburg channel sandstone, western Missouri: Sedimentology, v. 1, no. 1, p. 7-39.

Duff, P. M. D., Hallan, A., and Walton, E. K., 1967, Cyclic sedimentation, [v.] 10 *of* Developments in sedimentology: Amsterdam and New York, Elsevier Publishing Co., 280 p.

Ehrlich, Robert, 1965, The geologic evolution of the Black Warrior detrital basin: Louisiana State Univ. Ph. D. dissert., 64 p.; available from University Microfilms, Inc., Ann Arbor, Mich., 77 p.

Ferm, J. C., 1970, Allegheny deltaic deposits, *in* Morgan, J. P., ed., Deltaic sedimentation, modern and ancient: Soc. Econ. Paleontologists and Mineralogists Spec. Pub. 15, p. 246-255.

Ferm, J. C., and Cavaroc, V. V., Jr., 1968, A nonmarine sedimentary model for the Allegheny rocks of West Virginia, *in* Late Paleozoic and Mesozoic continental sedimentation, northeastern North America—A symposium: Geol. Soc. America Spec. Paper 106, p. 1-19.

——1969, A field guide to Allegheny deltaic deposits in the upper Ohio Valley, with a commentary on deltaic aspects of Carboniferous rocks in the Northern Appalachian Plateau [1969 spring field trip]: Ohio Geol. Soc. and Pittsburgh Geol. Soc., 21 p.

Ferm, J. C., Ehrlich, Robert, and Neathery, T. L., 1967, A field guide to Carboniferous detrital rocks in northern Alabama—Geol. Soc. America, Coal Div., 1967 Field Trip: Alabama Univ., Alabama Geol. Soc., 101 p.

Ferm, J. C., and Williams, E. G., 1963, Model for cyclic sedimentation in the Appalachian Pennsylvanian [abs.]: Am. Assoc. Petroleum Geologists Bull., v. 47, no. 2, p. 356-357.

——1965, Characteristics of a Carboniferous marine invasion in western Pennsylvania: Jour. Sed. Petrology, v. 35, no. 2, p. 319-330.

Gwinn, V. E., 1964, Deduction of flow regime from bedding character in conglomerates and sandstones: Jour. Sed. Petrology, v. 34, no. 4, p. 656-658.

Hobday, D. K., 1969, Upper Carboniferous shorelines systems in northern Alabama: Louisiana State Univ., Agr. and Mech. Coll., Ph. D. dissert., 75 p.

Illinois Geological Survey, 1931, Studies relating to the order and conditions of accumulation of the coal measures, *in* Papers presented at the quarter centennial celebration of the Illinois State Geological Survey: Illinois Geol. Survey Bull. 60, pt. 5, p. 161-289.

Kosanke, R. M., Simon, J. A., Wanless, H. R., and Willman, H. B., 1960, Classification of the Pennsylvanian strata of Illinois: Illinois Geol. Survey Rept. Inv. 214, 84 p.

Krumbein, W. C., and Sloss, L. L., 1963, Stratigraphy and sedimentation, [2d ed.]: San Francisco, W. H. Freeman, 660 p.

Merriam, D. F., ed., 1964, Symposium on cyclic sedimentation: Kansas Geol. Survey Bull. 169, v. 1, 2, 636 p.

Pearn, W. C., 1964, Finding the ideal cyclothem, *in* Merriam, D. F., ed., Symposium on cyclic sedimentation: Kansas Geol. Survey Bull. 169, v. 2, p. 399-413.

Potter, P. E., and Blakely, R. F., 1968, Random processes and lithologic transitions: Jour. Geology, v. 76, no. 2, p. 154-170.

Preston, F. W., and Henderson, J. H., 1964, Fourier series characterization of cyclic sediments for stratigraphic correlation, *in* Merriam, D. F., ed., Symposium on cyclic sedimentation: Kansas Geol. Survey Bull. 169, v. 2, p. 415-425.

Reger, D. B., 1931, Pennsylvanian cycles in West Virginia: Illinois Geol. Survey Bull. 60, p. 217-239.

Scruton, P. C., 1960, Delta building and the deltaic sequence, *in* Shepard, F. P., Phleger, F. B., and vanAndel, T. H., eds., Recent sediments, northwest Gulf of Mexico: Tulsa, Oklahoma, Am. Assoc. Petroleum Geologists, p. 82-102.

Stout, W. E., 1931, Pennsylvanian cycles in Ohio: Illinois Geol. Survey Bull. 60, p. 195-216.

Udden, J. A., 1912, Geology and mineral resources of the Peoria quadrangle, Illinois: U.S. Geol. Survey Bull. 506, 103 p.

Wanless, H. R., 1950, Late Paleozoic cycles of sedimentation in the United States: Internat. Geol. Cong., 18th, Great Britain, 1948, Rept., pt. 4, p. 17-28.

Wanless, H. R., and Shepard, F. P., 1936, Sea level and climatic changes related to late Paleozoic cycles: Geol. Soc. America Bull., v. 47, no. 8, p. 1177-1206.

Wanless, H. R., and Weller, J. M., 1932, Correlation and extent of Pennsylvanian cyclothems: Geol. Soc. America Bull., v. 43, no. 4, p. 1003-1016.

Weller, J. M., 1930, Cyclical sedimentation of the Pennsylvanian Period and its significance: Jour. Geology, v. 38, no. 2, p. 97-135.

——1964, Development of the concept and interpretation of cyclic sedimentation, *in* Merriam, D. F., ed., Symposium on cyclic sedimentation: Kansas Geol. Survey Bull. 169, v. 2, p. 607-621.

Weller, J. M., Henbest, L. G., and Dunbar, C. O., 1942, Stratigraphy of the fusuline-bearing beds of Illinois: Illinois Geol. Survey Bull. 67, p. 9-34 [1943].

Williams, E. G., Ferm, J. C., Guber, A. L., and Bergenback, R. E., 1964, Cyclic sedimentation in the Carboniferous of western Pennsylvania: State College, Pennsylvania Geologists Guidebook 29th Conf., 35 p.

REFRACTORY CLAY IN THE LOWER PART OF THE PENNSYLVANIAN SYSTEM

By WALTER D. KELLER[1]

ABSTRACT

Refractory-clay deposits are widespread in rocks of the lower part of the Pennsylvanian System in much of the Appalachian and midcontinent regions. Characteristically, they contain kaolin minerals having, in flint clays, a well-ordered form and, in the more plastic clays, the b-axis disordered form. Generally the deposits are irregular in thickness, ranging from a film to more than 100 feet. Where they are more than a few feet thick, the deposits generally fill sinkholes or other topographic depressions in pre-Pennsylvanian carbonate rocks.

The refractory clays are multiple-cycle sedimentary deposits. A long period of subaerial exposure and erosion in Late Mississippian and Early Pennsylvanian time produced a considerable insoluble residue from pre-Pennsylvanian carbonate rocks. Clays from this residue accumulated and were reworked in freshwater or brackish-water swampy areas under humid to tropical conditions. The chelating effects of organic acids during diagenesis resulted in desilication of the reworked clay minerals with accompanying concentration of Al^{+3}; leaching depleted the clays of the fluxing ions Na^{+1}, Ca^{+2}, Mg^{+2}, Fe^{+2}, and K^{+1}.

On the Ozark dome in Missouri the clay deposits are zoned. High-alumina clays occur near the crest of the dome, and flint, semiflint, and semiplastic varieties are at successively lower structural positions on the northwest side of the dome.

INTRODUCTION

Certain claystones that are distinctive in lithology and that presumably indicate distinctive geologic and geochemical environments occur at or a few feet above the base of the Pennsylvanian System throughout much of the Appalachian and midcontinent regions. Among the more economically important of these are the *Cheltenham Clay*[2] of Missouri and Illinois, the Mercer Shale Member of the Pottsville Formation of Pennsylvania, the *Olive Hill Clay Bed* of the Lee Formation of Kentucky, and the *Mount Savage Clay* of the *Mount Savage coal group* of Maryland, which is placed in the Allegheny Formation by Waagé (1950). The *Sciotoville* and *Oak Hill Clays* of the *Pottsville Group* of Ohio may be extensions northward across the Ohio River of the *Olive Hill Clay Bed,* or the western extensions of deposits in Pennsylvania. They have been described as a flint-clay facies (Keller, 1968), and they range in composition (in the order of increasing alumina) from shale (?) through plastic, semiplastic, semiflint, and flint varieties to high-alumina (diaspore or boehmite) clays. Although the Lower Pennsylvanian refractory clays are widespread and occur in considerable volume, no unique descriptive rock name indicating their geologic or petrologic derivation has been coined to designate them. Lacking such name, they are best called "refractory clays," which signifies their most important use. Some names that have been coined are bone, block, burnt, burley, nodule, diaspore, boehmite, and other local or trade-generated names.

In the structural setting of the Ozark dome in Missouri, the *Cheltenham Clay* shows a regional facies pattern grading from relatively high-silica and high-K illitic clays low on the flank of the dome, progressing southeastward through lower silica and lower-K plastic, semiflint, and clays to low-silica diaspore clay high on the dome (fig. 26; Keller, 1968). A similar facies pattern seems to occur in the Mercer clay in Pennsylvania (W. A. Bragonier, written commun., 1970), although it has not been described in as much detail as the pattern in Missouri.

Refractory clay is believed to characterize a particular geologic environment that was widely prevalent in the Eastern United States during Early Pennsylvanian time; refractory clays are worldwide, however, and were deposited at intervals throughout geologic history. Presumably, similar environmental conditions were repeated in Cretaceous time in the Canon City, Colo., refractory-clay district (Waagé, 1953), and at Olliers in southern France (Halm, 1952), and also in Early Triassic time in Israel (Bentor, 1966).

A refractory clay, or "fire clay," is defined as one that resists fusion or heat deformation below the arbitrarily defined Pyrometric Cone Equivalent 28—customarily

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[2]Stratigraphic names that have not been adopted by the U.S. Geological Survey and those that have not occasioned any official action are shown in italic type.

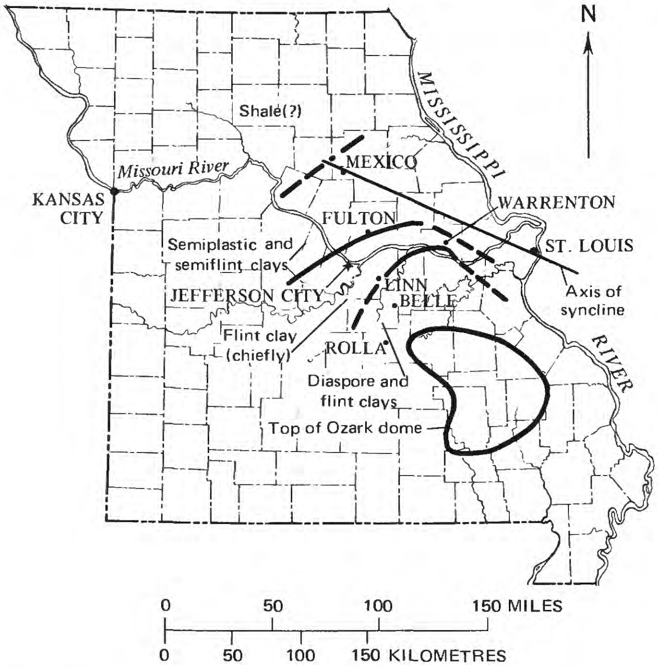

FIGURE 26. — Distribution of zones of high-alumina clays, flint clays, plastic clays, and shale of Pennsylvanian age in progressively down-structure position on the Ozark dome. This is a relatively complete development of the flint-clay facies.

written PCE 28 (about 1615°C under specified conditions of heating). Some of the Pennsylvanian clays go to PCE 34 or higher, whereas others fuse below PCE 28 if the fluxing elements Na, K, Ca, Mg, and Fe are sufficiently abundant to render the clay nonrefractory.

Distinctive properties of Pennsylvanian refractory clays and geologic associations of the deposits that have environmental significance are as follows:

Distinctive properties

1. Nonfissile.
2. Composed largely of interlocking hypidiomorphic kaolinite crystals, giving a homogeneous texture and fabric.
3. Composed mostly of high-alumina minerals — notably clays from Missouri and Pennsylvania.
4. Content of fluxing elements.
5. Resistant to slaking.

Geologic associations

1. Deposits rest on a widespread erosion surface.
2. Basins of deposition were on a land surface at or near sea level.
3. Deposits commonly are overlain by coal or carbonaceous shale.

Characteristically, Pennsylvanian refractory clays contain kaolin minerals ranging from well-ordered kaolinites in "hard" flint clays to the b-axis disordered kaolinite, formerly called the "fire clay" mineral, which is abundant in the more plastic varieties. Illite, especially the low-K, high-H type, possibly interlayered with an expanding clay mineral, is common in plastic, semiplastic, and semiflint clays. Chlorite having a 14A basal spacing, most probably Al-chlorite, has been recorded from Kentucky and Missouri refractory clays (Patterson and Hosterman, 1962; Hahn, 1954, cited *in* Keller, 1968).

Claylike varieties of diaspore and (or) boehmite, which are polymorphic forms of $Al_2O_3{\cdot}H_2O$, occur in some of these clays. Not being silicates, diaspore and boehmite are not clay minerals in a strict sense; however, they are earthy, fine grained, refractory, and claylike in physical properties. In these sedimentary occurrences, they are normal components of clay rocks.

Depending on one's definition of underclays, some or most of the Pennsylvanian refractory clays are underclays. Many of them occur beneath coal beds and, in Missouri, most of them are associated with minor coal lenses, coal films, or beds of shale containing plant remains. Certainly not all underclays are refractory.

The refractory clays to be discussed are parts of otherwise more extensive mudstones in the lower part of the Pennsylvanian. They are not shale because they are not fissile. They are notably lower in silica, iron, and alkali-alkaline earth metals than most shale, and they are more refractory and more restricted in distribution than most shale. They typically have the characteristics of paludal or nonmarine rocks, but grade laterally at places into marine shale, which is the marine end member of the flint-clay facies.

LITHOLOGY AND FABRIC OF THE CLAYS

In outcrop, hand specimen, and thin section, the refractory clays are strikingly isotropic (nondirectional) in structure and in texture. Although they are composed primarily of platy phyllosilicate minerals, they are characteristically not fissile (Keller, 1946; fig. 27). They

FIGURE 27. — Face of semiplastic refractory clay in an open pit, showing absence of bedding. A. P. Green Refractories Co., Mexico, Mo.

break typically with conchoidal fracture into irregular, angular, blocky fragments or chips having smooth surfaces (fig. 28). Fragments of the more plastic varieties commonly are cut by many randomly oriented, slickensided surfaces a few inches across. Flint clay and the high-alumina varieties resist slaking for perhaps a year, or longer, in a humid, temperate climate.

Wafers cut at different angles from flint clay and many other plastic clays typically show no preferred orientation of mineral crystals when X-rayed; neither do thin sections of kaolin-rich clays observed between crossed polars. In plastic clays containing illite, tiny birefringent areas having various orientations are randomly distributed (Keller, 1946). Replicas of fractured surfaces of flint clay show under the electron microscope an interlocking pattern of kaolinite crystals (Keller, 1968). Scan electron micrographs of the freshly fractured surface of semiplastic refractory clay containing illite and kaolinite show a flow-petal fabric that is characteristic of illite (Borst and Keller, 1969). Such distinctively uniform and nondirectional crystalline fabric probably is significant in interpreting the origin of the deposits.

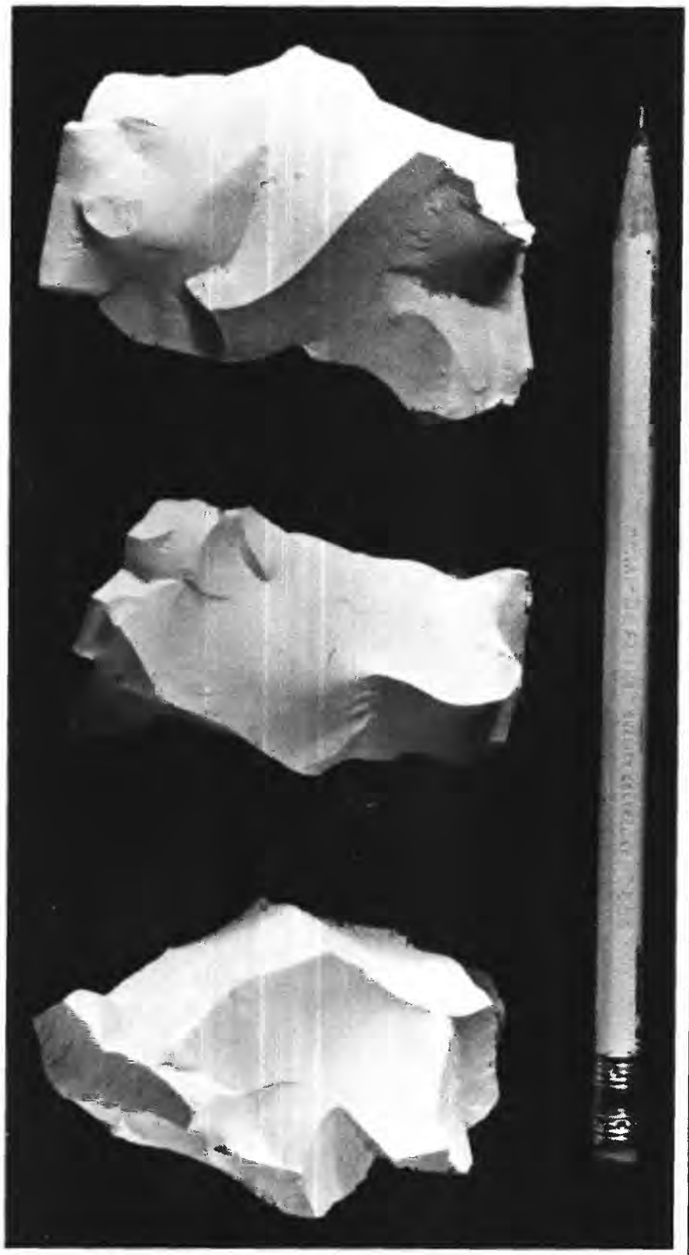

FIGURE 28. — Hand specimens of Missouri flint clay, showing very fine grained nondirectional texture and conchoidal fracture that are characteristic of flint clay. From Bueker Clay Pit, north of Owensville, Mo.

MODE OF OCCURRENCE OF THE REFRACTORY CLAYS

Economic deposits of the Pennsylvanian clays occur as convex-downward, lens-shaped bodies which taper to thin films or pinch out within short distances. The thin films or seams of clay are far more extensive than the workable deposits. Thus, the environment of deposition was notably more widespread than the extent of the lensing bodies preserved in individual clay mines would suggest.

Flint and nodule clay composing the Mercer clay of Pennsylvania averages approximately 6 feet in thickness, but ranges in thickness from less than 1 foot to 20 feet (Foose, 1944, p. 568). The *Mount Savage clay* in Maryland was studied by Waagé (1950, p. 66), who stated: "The thickest section of flint clay recorded in Maryland occurs in a narrow 'rib' that occupies the entire 12-foot underclay zone. Elsewhere in the stripping the flint clay is from 4 to 6 feet thick and is overlain by a weathered plastic clay * * * ."

The *Olive Hill Clay Bed* in Kentucky "consists of irregular lenses that rest on an undulating surface * * * . The maximum thickness of most lenses is less than 10 feet, but in one old mine, now inaccessible, the bed is reported to be 25 feet thick" (Patterson and Hosterman, 1962, p. F51).

The *Cheltenham Clay* of Missouri, north of the Missouri River, was deposited on an undulating probable karst surface. The maximum thickness that I have observed is 65 feet in a funnel depression; this deposit pinched to a thin film within 500 feet laterally (fig. 29). Flint and diaspore clay fillings in sinkhole deposits south of the Missouri River locally are more than 100 feet thick.

ENVIRONMENT OF DEPOSITION

Pennsylvanian-age refractory clays were deposited on a surface of pronounced erosion or on a residual sandstone, locally conglomeratic, that unconformably mantles a surface of erosion.

The *Cheltenham Clay* in Missouri typically was deposited on the *Warner Formation* (earlier named the

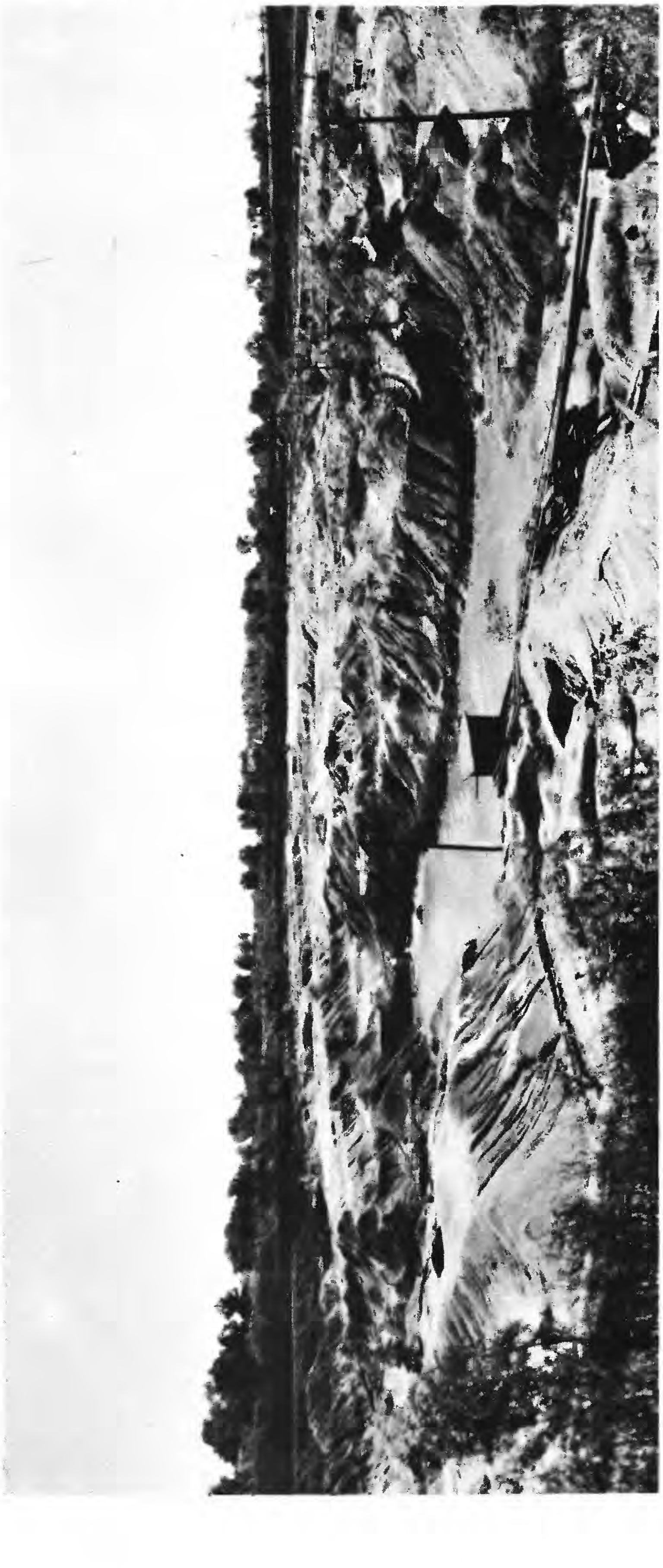

FIGURE 29. — An exhumed surface that existed in Pennsylvanian time in central Missouri during deposition of the *Cheltenham Clay*, a refractory clay. This surface was exposed by removing the clay that had been deposited in valleys and solution pits eroded in the underlying Mississippian Burlington Limestone. The clay was removed down nearly to the sandstone that thinly mantles the limestone beneath. The upper surface of the clay was nearly flat at the top of the pit rim. Overburden on the clay was Pleistocene glacial drift which eroded to the slopes around the top of the pit. The sump in the foreground contained refractory clay to a depth of 65 feet. This pit area has been reclaimed, in part by backfill, and in part as a recreational lake. Photograph courtesy of A. P. Green Refractories Co., Mexico, Mo.

Graydon Formation), which "overlaps formations ranging from probably the Potosi of Ozarkian age to the Warsaw of Mississippian age" (McQueen, 1943, p. 69). The *Warner (Graydon)* and its geologic relations were described by McQueen (1943, p. 37, 204) as follows:

The contact of the Graydon formation and the underlying formations marks one of the great unconformities of the Paleozoic group and one of the great unconformities of wide-spread distribution. * * * The Graydon was deposited upon a truncated or bevelled surface of great magnitude and areal complexity. This surface was developed in the long period of erosion which followed the close of the deposition of the limestones of Mississippian age. * * * [After removal of the *Graydon* by erosion in some places] the lower member of the Cheltenham was deposited * * * in shallow, quiet bodies of water over a wide area. The water was probably brackish for coal was also being formed, which indicates a warm, humid climate, sub-tropical at least, and one favorable for the development of the rank vegetation that was characteristic of this part of the Pennsylvanian period. Abundant rainfall, perhaps periodic in nature, is also suggested. These environmental conditions no doubt were instrumental in inaugurating the period of alteration which these deposits have undergone, and in bringing about some of the changes in the residual clay material derived from the sources previously described.

The *Olive Hill Clay Bed* in Kentucky rests on an undulating surface that has a local relief of as much as 40 feet, according to Patterson and Hosterman (1962, p. F51), who stated (p. F80):

The shapes of the irregular lenses of clay, the relation of lithologic units within the bed, the presence of fossil roots, the absence of a soil profile, the lack of bedding, overlying coal, and marine or brackish-water fossils in the dark shale above the clay — all point toward an origin of the clay in coastal swamps * * * A sparse fauna, chiefly small *Lingula*, in the shale a short distance above the clay suggest that only slight subsidence was required to lower the clay below sea level.

In Pennsylvania, the Mercer Shale Member of the Pottsville Formation overlies an erosional surface cut on the Connoquenessing Sandstone Member of the Pottsville Formation, which is the basal unit of the Pottsville (Foose, 1944, p. 562). A hypothesis that "the high-alumina deposits were formed in a region of low-lying coastal swamps, probably in the interfluvial areas which were topographic highs, but were only slightly elevated relative to the stream channels," has been advanced by Erickson (1963) to explain the Mercer clay.

The *Mount Savage* and other refractory clays of Maryland were interpreted by Waagé (1950, p. 47) as parts of cyclothems. Initiation of the cyclothems "resulted in some erosion that was followed by the deposition of sands in a continental environment. The finer sediments of the underclay zone were deposited next under relatively stable conditions probably in shallow bodies of fresh water."

That the refractory clays were deposited in fresh to brackish water in shallow, low-lying, irregularly connected basins was the opinion of Greaves-Walker (1939), after a comprehensive survey of these clays in the United States. The climate was humid, probably subtropical to tropical, and vegetation apparently was luxuriant.

SOURCES OF REFRACTORY-PRODUCING SEDIMENTS

The main source of sediments giving rise both to the *Cheltenham Clay* of Missouri and to the underlying cherty conglomeratic sandstone was insoluble residue of Paleozoic limestone and dolomite. The chert in the conglomerate is similar to that weathering from the Paleozoic carbonate rocks today (McQueen, 1943, p. 35). Much of the sand is similar to that in the Ordovician St. Peter Sandstone which was beveled during development of the unconformity beneath the Pennsylvanian rocks. That the clays could have come from the residuum of nearby chemically weathered carbonate rocks was shown by Robbins and Keller (1952); they found illite, accompanied by minor amounts of kaolinite, to be the main clay mineral in the Paleozoic carbonate rocks of Missouri.

The high-alumina clay of the Mercer clay in Pennsylvania was inferred by Williams (1960) to be equivalent in age, at least in part, to the upper part of the Connoquenessing which, in turn, was probably derived from the southeast where chemical weathering was not very intense. As a result, chlorite and biotite and large amounts of illite were preserved. The environment in the source area of the lower part of the Connoquenessing, in contrast, probably was conducive to intense chemical weathering that "reduced the source rocks to quartz, kaolinite, lesser amounts of illite, and stable heavy minerals such as tourmaline, zircon, and rutile" (Williams, 1960, p. 1301). The high-alumina clay probably was forming on topographic highs, while sand and gravel were being deposited in adjacent lows, as suggested by Williams.

The source of the clay minerals in the *Olive Hill Clay Bed* is not identified by Patterson and Hosterman (1962, p. F30), although they discuss the source of sandstone in the Lee Formation, of which the *Olive Hill* is a part. They suggest that the source of the sand was a considerable distance away and that perhaps the sand came from the erosion of older sediments.

GENESIS OF THE REFRACTORY CLAYS

Extensive erosion preceded clay deposition. Where the country rock was carbonate rock (including dolomite), sinkholes and solution basins formed, and in many places deepening of these solution features continued during deposition. Upon the erosion surface, sand or cherty gravelly sand was either (1) deposited after some transport, or (2) especially in Missouri, concentrated directly as a residual mantle.

The refractory clays, or more probably their precursors, were deposited in shallow topographic basins on the erosion surface. In Missouri, the irregular bottom surface of the clay was determined by the underlying karst topography; the top surface formed a mudflat. In Kentucky and Pennsylvania, the relief was less because of a subduing effect of locally thick sandstones that partly filled depressions. In these areas, more nearly continuous beds and lenses of clay give an impression of more uniform sedimentation than do the pocketlike lenses in Missouri.

The clay apparently was transported various distances; but so far as can be discerned, the source was, without exception, clay residue from preexisting sedimentary rocks. A source in sedimentary rocks is, in my opinion, critically important for the formation of refractory clays of the flint-clay facies. The parent material must have been clay that had gone through a previous "sedimentary cycle." The direct weathering of feldspars or other primary minerals yields so-called "kaolins," which possess physical properties different from those of the flint-clay facies.

The refractory clays in Missouri are believed to have formed from chemically weathered limestones in nearby areas. The clay-mineral composition of the limestone residue was probably disordered kaolinite and high-H (low-K) illite — possibly accompanied by aluminous and siliceous gels, inasmuch as disordered kaolinite and illite comprise the least altered refractory clays. With higher intensity of alteration, illite disappeared and kaolinite in the clay became better ordered, presumably through recrystallization that occurred during the deposition-lithification stages of the refractory clay.

For a clay sediment to undergo recrystallization and "purification" of kaolinite to refractory clay in a near-surface environment, the clay probably had to be preconditioned in a regimen like that of a residual soil. Whether this is absolutely necessary has not been proved, but the energy expended in pedologic weathering possibly satisfies the need for activation energy for later kaolinization. If the sediment lacks the preconditioning stage as a soil, it may resist the chemical change necessary for recrystallization as kaolinite.

The effect of prior weathering is illustrated near Stanford, Ky. Here, a kaolinite-illite residuum from Silurian Brassfield Limestone is undergoing endellitization (transformation to a hydrated kaolin mineral), but the illitic shale underlying it is resisting change (Keller and others, 1966). Oxidizing rainwater, reacting with iron sulfide in the Devonian New Albany Shale which overlies the residuum, generates acid solutions which percolate downward through the Brassfield residuum and well into the Ordovician *Richmond Shale.* The residuum is altering to clean, white, fairly pure endellite. The residuum presumably was made more susceptible to recrystallization and "purification" because of its prior weathering as a soil. The typical *Richmond Shale* below is strongly modified in color by the acid solutions, but is not appreciably recrystallized or kaolinized.

After and during deposition the clay mud underwent chemical digestion, "purification," and "refinement" toward kaolinite and in places to high-alumina minerals. No doubt reactions between clays and both inorganic and highly complexing organic solutions occurred in the clay-digestion basin. During this alteration, fluxing ions, such as Na^{+1}, Ca^{+2}, Mg^{+2}, Fe^{+2}, and the more strongly held K^{+1} that is basic to illite, were leached away; simultaneously, desilication with accompanying concentration of aluminum took place.

Ion removal, caused by leaching, may occur through the Donnan effect (Keller, 1957, 1968). A crystal of illite may lose K^{+1} to the solution in exchange for H^{+1} by dialysis. With each. individual clay particle, the relatively insoluble Al-silicate ionic framework acts as if it were a semipermeable membrane that permits the more highly soluble cations to move through — provided, of course, that the requisite chemical energies are available. Statistical evidence is furnished by Keeling (1961) that such dialysis has occurred and that K^{+1} declines and H^{+1} is progressively and reciprocally substituted for K^{+1} in the mineral sequence mica, illite, disordered kaolinite, and well-ordered kaolinite.

Certain organic compounds possessing strongly complexing, or chelating, properties must also have been active in the kaolinization process. Complexing or chelating solvents seize and hold tightly ions such as Al^{+3} and Si^{+4} in a dissolved but relatively inactive state. They may thus enhance the solubility of otherwise low-solubility ions. Complexing organic acids like those in humic acid, namely, 0.01M salicylic, tartaric, citric, and tannic acids, dissolve 60–100 times more Al in clays, such as the precursors of the Missouri flint clays, than does distilled water. Furthermore, they take into solution more Al in relation to Si than is present in relation to Si in the clay mineral. This means that in strongly complexing organic acids, Al may be preferentially removed in solution, leaving Si. Alternatively, Al may be reprecipitated as a hydrated alumina mineral or be recombined with Si as an Al-rich clay mineral, such as kaolinite. Strongly complexing organic acids may, therefore, cause silicate minerals to weather in an order inverse to that in which they hydrolyze in distilled water.

Fluxing ions that were dissolved from clay minerals were probably flushed away by water flowing through the basins. Such flushing by water seems more likely than a downward leaching of the ions because most of the basins were probably near ground-water level and were clay sealed in their bottoms. Field studies of the *Cheltenham Clay* show that the more refractory, higher kaolinitic, and lower flux clays occur in the bottoms of the deeper pits. The opposite relation would be found if downward leaching had predominated — in that situation, the top layers would have been leached most and would be most refractory; the fluxing ions and silica would have been carried to the bottom layers and concentrated there.

The original sediment that accumulated in the clay basins is envisioned as a colloid gel having the composition of kaolinite, illite-kaolinite intermediates, and (or) hydrated oxides (hydroxides) of Al and Si, and organic substances. This Al-rich Al-Si gel might be called a low-temperature "magma." From it, kaolinite crystals grew in a random orientation to yield homogeneous plastic or flint clay possessing an interlocking-crystalline isotropic fabric and uniform nondirectional physical properties (fig. 30). This mechanism contrasts with the simple accumulation of mineral grains by which a shale, or even other "kaolins," are formed. A high-temperature parallel is an Al-rich Al-Si syenite magma from which feldspar crystallized in an interlocking nondirectional crystal fabric. A gel stage seems to be both a necessary and a sufficient precursor to explain the distinctive fabric of the refractory clays.

FIGURE 30. — Replica of a fractured surface of flint clay from Bueker pit, showing interlocking crystals of kaolinite in random orientation, which yields a compact, relatively nonporous clay rock. This clay is inferred to have crystallized directly from a gel. Charles B. Roth, microscopist.

REFERENCES

Bentor, Y. K., 1966, The clays of Israel — guidebook to the excursions [*of* The International Clay Conference, Jerusalem, Israel, 1966]. Jerusalem, Israel Program for Scientific Translations, 121 p.

Borst, R. L., and Keller, W. D., 1969, Scanning electron micrographs of API reference clay minerals and other selected samples: Jerusalem, Israel Univ. Press, Internat. Clay Conf., Tokyo Proc., v. 1, sec. 6, p. 871-901.

Erickson, E. S., Jr., 1963, Mineralogical, petrographic, and geochemical relationships in some high-alumina and associated claystones from the Clearfield Basin, Pennsylvania: Pennsylvania State Univ. Ph.D. thesis, 190 p.

Foose, R. M., 1944, High-alumina clays of Pennsylvania: Econ. Geology, v. 39, no. 8, p. 557-577.

Greaves-Walker, A. F., 1939, The origin, mineralogy and distribution of the refractory clays of the United States: North Carolina Univ. Eng. Experiment Sta. Bull. 19, 87 p.

Halm, Louise, 1952, Comparative study of American and French flint clays [abs.]: Am. Ceramic Soc. Jour., v. 31, no. 3, p. 79-84.

Keeling, P. S., 1961, Geochemistry of the clay minerals: British Ceramic Soc. Trans., v. 60, p. 678-689.

Keller, W. D., 1946, Evidence of texture on the origin of the Cheltenham fireclay of Missouri and associated shales: Jour. Sed. Petrology, v. 16, no. 2, p. 63-71.

——1957, The principles of chemical weathering, revised ed.: Columbia, Mo., Lucas Bros., 111 p.

——1968, Flint clay and a flint-clay facies: Clays and Clay Minerals, v. 16, no. 2, p. 113-128.

Keller, W. D., McGrain, Preston, Reesman, A. L., and Saum, N. M., 1966, Observations on the origin of endellite in Kentucky, and their extension to "indianaite," *in* Clays and clay minerals — Clays and Clay Minerals 13th Conf., Madison, Wis., 1964, Proc.: Pergamon Press (Internat. Ser. Mons. Earth Sci., v. 25), p. 107-120.

McQueen, H. S., 1943, Geology of the fire clay districts of east central Missouri: Missouri Geol. Survey and Water Res., 2d Ser., v. 28, 250 p.

Patterson, S. H., and Hosterman, J. W., 1962, Geology and refractory clay deposits of the Haldeman and Wrigley quadrangles, Kentucky: U.S. Geol. Survey Bull. 1122-F, p. F1-F113.

Robbins, C. R., and Keller, W. D., 1952, Clay and other noncarbonate minerals in some limestones: Jour. Sed. Petrology, v. 22, no. 3, p. 146-152.

Waagé, K. M., 1950, Refractory clays of the Maryland coal measures: Maryland Dept. Geology, Mines, and Water Resources Bull. 9, 182 p.

——1953, Refractory clay deposits of south-central Colorado: U.S. Geol. Survey Bull. 993, 104 p.

Williams, E. G., 1960, Relationships between the stratigraphy and petrography of Pottsville sandstones and the occurrence of high-alumina Mercer clay: Econ. Geology, v. 55, no. 6, p. 1291-1302.

ENVIRONMENTS WITHIN A TYPICAL PENNSYLVANIAN CYCLOTHEM

By CYNTHIA ROSEMAN WRIGHT[1]

PURPOSE OF STUDY

The present study is one of a series made under the direction of the late Prof. H. R. Wanless to determine the sequence of environments represented by Pennsylvanian rocks in the Eastern Interior basin, the northern Appalachian coal basin and the northern midcontinent region during different parts of the Pennsylvanian Period. The purpose of these investigations was to determine the lateral extent of the variations within successive lithologic units, to examine the factors which determined the distribution pattern and caused variations in the units and, finally, to draw conclusions about the environment in which the units were deposited. The region and the time represented by this particular report are considered representative of a typical cyclothem in the Pennsylvanian System.

REGION OF STUDY

This investigation consisted largely of the preparation of a series of environmental maps illustrating Middle Pennsylvanian [interval C of this publication] beds in the Spoon and Carbondale Formations of Illinois and western Kentucky that make up the *Liverpool cyclothem*[2] (*Tonica* and *Lowell cyclothems* of Kosanke and others, 1960), and equivalent rocks in the upper part of the Linton Formation of Indiana and the *Croweburg, Verdigris, Bevier,* and *Lagonda Formations* (or members of the Cabaniss and Senora Formations) of the northern midcontinent region. Southwestern Iowa, Missouri, southeastern Nebraska, eastern and central Kansas, and northeastern Oklahoma are represented on the maps. Both formally named and informal or unnamed stratigraphic units within the mapped sequences are shown in table 2.

[1]Beloit College, Beloit, Wis.

[2]Stratigraphic names that have not been adopted by the U.S. Geological Survey and those that have not occasioned any official action are shown in italic type.

PROCEDURE

Approximately 2,500 stratigraphic sections, both published and unpublished, containing the cyclothem under consideration were assembled for the region. The location of each section was plotted on a base map (pl. 17, fig. *A*). Using the coal beds as datum planes, sections were correlated and lithologic and paleontologic data were recorded for each unit on a preliminary map.

After the objective information on the preliminary maps had been examined and the distribution pattern of the rock types had been determined, the preliminary maps were interpreted in terms of the environment of deposition of each rock type. The final maps illustrate the geographical distribution of environments believed present during the time of accumulation of a particular stratum. It is assumed that the thin, rock-stratigraphic units of the Pennsylvanian are equivalent to time-stratigraphic units.

The completed maps of the units in the cyclothem were examined in sequential order to interpret the depositional history of the cyclothem. Emphasis was given not only to the data on individual maps but also to the relationships between underlying and overlying maps.

INTERPRETING ENVIRONMENTS OF DEPOSITION

Because sandstone, limestone, or shale may develop under any of several depositional environments, criteria for recognizing each of these environments had to be determined. On the basis of these criteria the various environments were assigned to the maps.

Sandstones were considered to have originated in channels if they were lenticular in cross section and more than 20 feet thick. Whether the channels were fluvial or deltaic was determined on the basis of their areal dis-

TABLE 2. — *Rock units in the* Liverpool cyclothem *and equivalent units in the Illinois basin and eastern midcontinent region*

		Kansas, Oklahoma, and Nebraska				Missouri and Iowa				Illinois and Kentucky				Indiana		
System	Series	Group	Formation	Member	Units	Group	Subgroup	Formation	Units	Group	Formation	Cyclothem	Units	Series	Formation	Units
Pennsylvanian (Middle, part)	Des Moines (part)	*Cherokee* (part, Kansas-Nebraska); Cabaniss (part, Oklahoma)	Cabaniss (part, Kansas); Senora (part, Oklahoma)	*Lagonda Sandstone*	Sandstone	*Cherokee* (part)	*Cabaniss* (part)	*Lagonda*	Sandstone	Kewanee (part)	Carbondale (part)	*Summum*	*Pleasantview Sandstone Member*	*Allegheny*	*Petersburg* (part)	
					Shale				Shale				*Purington Shale Member*			Shale
								Bevier	*Bevier coal* of Missouri			*Liverpool*	*Lowell (2A) coal*		Linton	*Indiana IV coal*
									Shale and sandstone				Sandstone and shale			Sandstone and shale
									Desmoinesia-bearing limestone				*Desmoinesia*-bearing limestone			*Desmoinesia*-bearing limestone
									Dark shale				Dark shale			Dark shale
				Bevier	*Bevier coal* of Kansas			*Verdigris*	*Wheeler coal*				Absent			Absent
					Underclay				Underclay							
					Sandstone and shale				Sandstone and shale (local)							
				Verdigris Limestone	Limestone beds				*Ardmore Limestone Member*				Basal limestone of *Oak Grove beds*			
					Black shale				Black shale				Black shale			*Mecca Quarry Shale Member*
					Sandstone and shale (local)				Sandstone and shale (local)				*Francis Creek Shale Member*			Gray shale (local)
				Croweburg	*Croweburg coal*			*Croweburg*	*Croweburg coal*				*Colchester (No. 2) (Schultztown?) coal*			*Indiana IIIa coal (Velpen)*
					Underclay				Underclay				Underclay and local limestone			Underclay
					Shale and limestone											
					Shale, sandstone, and limestone				Shale and sandstone		Spoon (part)		*Browning Sandstone Member*			Sandstone and shale

tribution. Channels forming tributaries that merged downstream into trunk streams were considered fluvial; those forming distributaries leading away downstream from major channels were considered deltaic. Sandstones less than 20 feet thick and sheetlike in distribution were believed to have originated in interdistributary areas, especially if they were adjacent to distributary channels. If they were adjacent to fluvial channels, they were referred to as flood-plain deposits.

Shales associated with fluvial deposits were considered to have originated on flood plains, and those associated with deltaic sandstone were considered to have originated in either interdistributary areas or channels. Deltaic shales not associated with coarse detrital materials were termed prodelta deposits and supposedly originated either (1) earlier than deltaic distributaries that carried the coarse detritus, or (2) at the distal end of a delta after well-developed distributaries had formed. Delta and prodelta shale bodies were distinguished by their wedgelike form in cross section, which is the form of the frontal parts of modern deltas. Shales that showed no pronounced thickening toward a source area and which were associated with marine limestones were considered nondeltaic marine.

STRUCTURAL SETTING FOR *LIVERPOOL CYCLOTHEM*

The general structural setting in which units of the *Liverpool cyclothem* and its equivalents were deposited is illustrated in figure 31. As shown there, the northern midcontinent area was a surface on which broad upwarpings (the Nemaha anticline and the Central Kansas uplift), shallow basins (the Salina and Sedgwick), moderately deep basins (the Cherokee and Forest City), and deep basins (the Anadarko and Arkoma) were located.

The Nemaha anticline and the Central Kansas uplift,

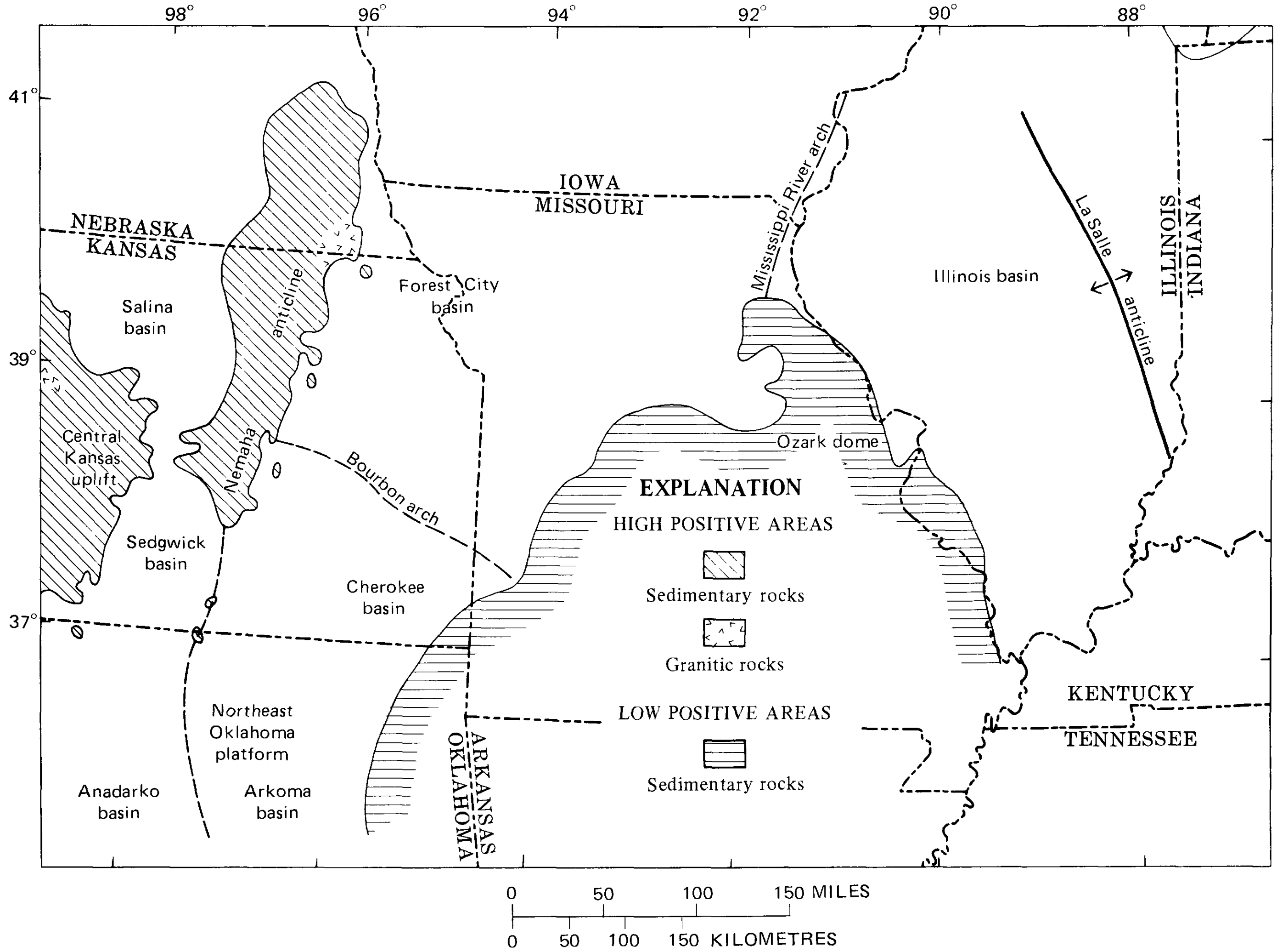

FIGURE 31. — Middle Pennsylvanian structural features and land areas in the midcontinent region.

which are post-Mississippian structures, were land areas during the time of deposition of the Cabaniss Formation, Group, or *Subgroup* of Middle Pennsylvanian age. The outline of the land is shown for both areas in figure 31 as they were at the time of deposition of the *Croweburg coal.* During this time Precambrian granite cropped out along the northeastern part of the Nemaha anticline; on the remainder, lower Paleozoic rocks were exposed. A Precambrian core of the Central Kansas uplift was flanked by lower Paleozoic rocks and only a small amount of granite was exposed on the central high portion of the uplift.

Both the Nemaha anticline and the Central Kansas uplift were source areas for sediments deposited in adjacent basinal areas. Sediment shed from the eastern flank of the Nemaha anticline accumulated in the Cherokee and Forest City basins, and sediments from both the Nemaha anticline and the Central Kansas uplfit were deposited in the Salina and Sedgwick basins. The Wichita, Arbuckle, and Ouachita Mountains of southern Oklahoma, south of the area of figure 31, also served as sources for large volumes of sediment in the Arkoma and Anadarko basins.

Many positive structural features in the midcontinent region were buried before the time of deposition of the Cabaniss Formation. Because of differential compaction of the sediments on their flanks, an uneven subsea topography was produced and the structural features continued to affect sedimentation after burial. The largest of these buried structural highs were the Bourbon arch and the Northeast Oklahoma platform.

In Illinois, western Indiana, and western Kentucky, sediments were deposited in the shallow, subsiding Illinois basin, bounded on the north by the Wisconsin arch portion of the Canadian Shield, on the east by the Cincinnati arch, on the southeast by the Nashville dome (pl. 15*B*, fig. 2), and on the southwest by the Ozark dome (fig. 31), which served as a barrier between the basin and the midcontinent region. The Mississippi River arch (fig. 31), and the La Salle anticline in northern Illinois (pl. 15*B*, fig. 2) sank more slowly than nearby basinal areas; rocks under study are relatively thin over these structures.

SUMMARY OF EVENTS DURING DEPOSITION OF *LIVERPOOL CYCLOTHEM*

The basal beds of *Liverpool cyclothem* and equivalent rocks were deposited on a nearly level surface from which pre-Pennsylvanian topographic irregularities had been almost eliminated. By the time of deposition of the *Colchester (No. 2), Croweburg,* and equivalent coals (table 2), the whole area from eastern Kansas to western Indiana was a vast flat, vegetated plain. On this plain, a coal swamp developed in which was deposited one of the most widespread coals on the North American continent. The sea then repeatedly transgressed and regressed across this flat region. During the transgressive phases the following widespread marine units were deposited: (1) the *Mecca Quarry Shale Member* of the Linton Formation and equivalent black shale, (2) the *Ardmore Limestone Member,* (3) the dark shale above the *Wheeler coal* (*Bevier coal* of Kansas), and (4) the *Desmoinesia*-bearing limestone.

Deposition of the widespread marine units was interrupted by the deposition of local, lithologically variable detrital wedges, in part nonmarine. Such wedges of detritus, composed of prodelta muds or delta sands and (or) muds formed (1) the *Francis Creek Shale Member* of the Carbondale Formation and equivalent shales, (2) the sandstone and underclay beneath the *Wheeler coal* (*Bevier coal* of Kansas), (3) the shale between the *Desmoinesia*-bearing limestone and the *Bevier coal* of Missouri, (4) the sandstone beneath the *Lowell (2A)* and equivalent coals, and (5) the *Purington Shale Member* of the Carbondale in western Indiana, western Kentucky, Illinois, eastern Iowa, and eastern Missouri.

Throughout the time of deposition of units of the *Liverpool cyclothem,* sediment sources within the area mapped were (1) the Nemaha anticline, composed of Precambrian granites that were almost completely covered by lower Paleozoic rocks, (2) the Central Kansas uplift, which was also composed of a Precambrian core flanked by lower Paleozoic rocks, and (3) the Ozark dome, a low positive area on which older Paleozoic rocks, primarily cherty limestone and dolomite, were exposed. Coarse detritus was shed from the small exposed granitic portions of the Nemaha anticline and the Central Kansas uplift, and variegated muds, predominantly red and locally sandy, were shed from the sedimentary portions of the ridges. If the Ozark dome was providing sediment, it was primarily mud which originated from the insoluble residues of the weathering limestone and dolomite.

The areas that provided the largest volumes of sediment to the Illinois basin and the northern midcontinent lay outside the area mapped. The source of much of the material transported into the Illinois basin was somewhere in the northern Appalachian Mountains, although the Canadian Shield also provided sediment both to the Illinois and to the Forest City basins. The sources of large volumes of detrital sediments transported into the northern midcontinent region were the Wichita, Arbuckle, and Ouachita Mountains to the south.

ENVIRONMENTS OF *LIVERPOOL CYCLOTHEM*

BROWNING SANDSTONE MEMBER OF THE SPOON FORMATION AND EQUIVALENT STRATA

(pl. 17, fig. *B*)

The initial deposits of the *Liverpool cyclothem* were spread over most of the region in the form of delta complexes, but in the northwestern part of the Illinois basin, they filled alluvial channels and covered flood plains.

The delta complex in southeastern Illinois, southwestern Kentucky, and western Indiana was developed from sands and muds derived from an eastern source and brought into the Illinois basin to be deposited in channels and interdistributary areas. The pattern of the complex has been determined through the work of H. R. Wanless and Julia R. Cannon, who studied more than 1,000 subsurface records in the southwestern part of the Illinois basin in order to ascertain the distribution of channel sandstones. Wanless noted several large channels that extend through the outcrop area in Indiana and Kentucky. The northernmost of these channels, the Coxville channel, is exposed in Parke County, Ind., and the largest channel, the Rockport channel, is exposed near the Indiana-Kentucky line. Through these and other channels, coarse detritus was carried into the Illinois basin, while finer detritus was washed into and deposited in interdistributary areas.

Two elongate sandstone bodies in southwestern Illinois which trend northwest appear to be offshore bars. These sandstone bodies, which are transverse to the drainage of the area, indicate the position of the northeastern shoreline of the Ozark dome at the time of deposition of the *Browning Sandstone Member* of the Spoon Formation and equivalent units.

In northern Illinois, tributary stream channels, extending southward, joined and formed the Browning channel. Sandstones as much as 100 feet thick are present at Wildcat Den State Park east of Muscatine, Iowa, and at other places, but lack of good control in eastern Iowa and northwestern Illinois prevented detailed mapping of these channels. The *Browning Sandstone Member* is believed to consist of channel sandstones and associated siltstones and shales which originated on flood plains. An abundant flora grew on the flood plains as evidenced by the large number of specimens assignable to *Neuropteris, Pecopteris, Annularia,* and *Cordaites* in the shaly beds of the Browning channel (Jongmans and Gothan, 1934).

Sandstone beds believed to have originated in a delta complex are present in northwestern Missouri. These beds are thin, averaging less than 10 feet. The Ozark dome was a low positive area probably incapable of furnishing large quantities of detritus, but the sand may have been derived, in part at least, from the dome. North-central Iowa received sand from a northern source, and sandstone beds as much as 20 feet thick are found in that area.

In the midcontinent region the rising Arbuckle and Ouachita mountains contributed large volumes of sediment to the Arkoma basin, the northern fringe of which is shown on plate 17, figure *B*. A wedge of detrital sediment, developed in northern Oklahoma as coarse-grained sediment, filled channels leading from the highlands and sheets of sand and mud were laid down in interdistributary areas. The finer deltaic sediments were carried northward and deposited on the distal edges of the delta. The channel sandstones range in thickness from about 30 feet in northern Oklahoma to 80 feet in the southernmost part of the region. Sands deposited in interdistributary areas are sheetlike in character and much thinner than channel types—ranging from 4 to 8 feet in thickness in northeastern Oklahoma and southeastern Kansas and from 10 to 15 feet in east-central Oklahoma.

The basinal areas to the east of the Nemaha anticline also received deltaic sediments. Delta channels apparently led off the flanks of the Nemaha ridge, and sand was deposited both in these channels and in interdistributary areas. Mud shed from the ridge coalesced with the mud moving northward from the highlands farther south.

Marine conditions existed in areas west of the delta complexes of the midcontinent, and gray marine mud accumulated in north-central Oklahoma.

In most of the Sedgwick basin interbedded gray muds and thin units of calcium carbonate were deposited, but some variegated muds shed from the Nemaha anticline and the Central Kansas uplift accumulated in the central part of the basin. These muds, predominantly red, may have been deposited in shallow, well-circulated waters where the iron contained in them remained in an oxidated state; possibly, however, the oxidation occurred at a later time.

Variegated marine muds were deposited over a large area in the Salina basin. Marine muds and thin units of calcium carbonate accumulated in the deeper western part of the basin, and a small amount of detritus was deposited adjacent to the northern border of the Central Kansas uplift.

The Nemaha anticline and the Central Kansas uplift were almost joined during the time of deposition of the *Browning Sandstone Member* and equivalent units. Coalescing detrital sediments shed from both uplifts formed a partial barrier between the Sedgwick and Salina basins, although some circulation must have occurred between the basins. The presence of thin limestone layers in the deeper part of the Salina basin indicates that marine waters were able to move between the ridges even though the passageway was partially blocked.

UNDERCLAY BENEATH THE *COLCHESTER (NO. 2), CROWEBURG,* AND EQUIVALENT COALS

(pl. 17, fig. C)

Thin sheets of clay and silt were spread over most of the midcontinent region east of the Nemaha anticline and in south-central Iowa, northern Missouri, central Illinois, western Indiana, and western Kentucky during the final stages of deltaic sedimentation. The clay and silt accumulated initially over the interdistributary areas of the deltas and then in the distributary channels themselves. Isolated patches of sandstone in southeastern Illinois, northern Oklahoma, and eastern Kansas are considered to be areas where coarse deltaic sedimentation continued while finer sediments were being deposited elsewhere.

As the delta deposits were accumulating, large areas were above or nearly above water level and a varied flora developed. Evidence of this flora consists of root structures which are preserved in the underclay of outcrop sections in both the Illinois basin and the midcontinent region.

In northwestern Illinois and eastern Iowa, clay and silt were spread over the flood-plain areas and filled the channels of streams. Leaves preserved in the fine-grained rock found at the top of Browning channel (pl. 17, fig. *B*) in northwestern Illinois indicate that vegetation flourished there.

The origin of the underclay of the *Colchester (No. 2), Croweburg,* and equivalent coals is still a subject of debate. A sedimentary origin and derivation from an eastern low-lying source area were postulated by W. E. Parham (written commun., 1958) after a petrographic study of underclay in the Eastern Interior basin. The presence of a stable, heavy-mineral assemblage in the underclay indicates that the silts of which it is composed were reworked many times. No vertical variation in sediment size was noted by Parham; such a variation should have been evident if the underclay had originated as a soil. Other evidence that the underclay is depositional in origin is the gradational rather than erosional contact between the underclay and local underlying sandstone or shale.

The underclay is refractory in western Indiana, where it is believed to have originated on the apical part of a delta and in parts of northwestern Illinois where it developed in alluvial valleys. The underclay probably became refractory in these areas because here its environment of deposition permitted a period of exposure to the atmosphere, during which time alkalies, alkaline earths, and iron were leached (Wanless and others, 1969). The underclay is not refractory elsewhere, probably because the remainder of the area in which it accumulated was not sufficiently above ground-water level to allow any appreciable amount of leaching.

Calcium carbonate accumulated in small areas in the Illinois basin and in the Cherokee and Forest City basins where good circulation was maintained. The petrography of the underclay limestone of the *Colchester (No. 2) coal* in the Illinois basin was studied by E. K. Norman (written commun., 1959), who found it to be mostly an arenaceous limestone, composed of freshwater algal remains and angular quartz grains. The association of the algal colonies with quartz grains in the limestones suggests that the colonies grew on sandy lake or pond bottoms. The calcium carbonate that accumulated in the Forest City basin probably originated under conditions similar to those attributed to the Illinois basin. The calcium carbonate in the Cherokee basin, however, is associated with marine sediments and probably is marine in origin.

In the Sedgwick basin variegated marine mud, interbedded with thin units of calcium carbonate, was deposited in well-circulated, marine waters. Apparently no coarse detritus was coming from the Nemaha anticline at this time, and only a small amount of coarse detrital material was being shed from the Central Kansas uplift.

A barrier of coarse detrital sediment between the Nemaha anticline and the central Kansas uplift partly restricted circulation between the Sedgwick and Salina basins. Marine waters were present in the Salina basin, however, and were deep enough to allow thin beds of calcium carbonate to accumulate within the gray muds being deposited in the central part of the basin. Adjacent to the Nemaha anticline and the Central Kansas uplift, variegated muds, predominantly red, accumulated in the Salina basin in shallow, well-circulated, marine waters.

COLCHESTER (NO. 2), CROWEBURG, AND EQUIVALENT COALS

(pl. 17, fig. *D*)

When the deposition of the clays and silts that now make up the underclay had terminated, the flat vegetated plain subsided sufficiently to allow development of a vast coal swamp in which one of the most widespread coal deposits on the North American continent was formed. The coal is designated the *Colchester (No. 2)* in Illinois, the *Whitebreast coal* in Iowa, the *Croweburg coal* in Kansas, Oklahoma, and Missouri, the *Illa coal* in Indiana, and the *Lower Kittanning coal* in the Appalachian Mountains, and it is tentatively correlated with the *Schultztown coal* in Kentucky. This was the first extensive Pennsylvanian coal to develop on the North American continent, and owes its wide distribution to the fact that the sediments underlying it had formed a broad platform on which the swamp could develop under favorable climatic conditions. In earlier Pennsylvanian time, prior to deposition of the detrital units in the lower part of the *Liverpool cyclothem* and equivalent strata, pre-Pennsylvanian topographic irregularities had not been eliminated, and even under favorable climatic conditions coals could accumulate only locally.

The *Colchester (No. 2) coal* ranges in thickness from 21 to 39 inches in western and northern Illinois. In Missouri, the *Croweburg coal* ranges in thickness from 22 inches in Randolph County in the north-central part of the State to a thin smut streak in Lincoln County to the southeast. In Kansas the *Croweburg coal* averages about 15 inches in thickness. It probably thins southward and westward into the deeper parts of the basinal areas of Kansas and northern Oklahoma, but the thickness could not be determined with any accuracy south or west of the outcrop belt.

Spores from the *Colchester (No. 2)* coal in Illinois have been studied by Kosanke (1950) and those from the *Croweburg coal* in Oklahoma by Wilson (Wilson and Hoffmeister, 1956). The spore successions in the two areas are very similar. The Oklahoma spore succession indicates that the Croweburg swamp flora consisted of ferns, lycopods, calamarians, and gymnosperms. In places in the midcontinent, the coal grades into a thin shale unit which originated in brackish-water lagoons.

West of the coal swamps marine sedimentation persisted. The Sedgwick basin was the site of deposition of variegated marine muds and discontinuous calcium carbonate beds. In the Salina basin, variegated muds, predominantly red, were deposited adjacent to the Nemaha anticline and the Central Kansas uplift. In the deeper part of the basin, marine muds were interbedded with thin layers of calcium carbonate.

FRANCIS CREEK SHALE MEMBER OF THE CARBONDALE FORMATION AND EQUIVALENT STRATA

(pl. 17, fig. *E*)

Following deposition of the coal, fine deltaic sediments were deposited in northern Illinois and eastern Missouri, and coarser deltaic sediments were laid down in northern Oklahoma. The silt, mud, and small amount of sand brought into the Illinois basin formed the *Francis Creek Shale Member* of the Carbondale.

The *Francis Creek Shale Member* is as much as 60 feet thick in Marshall County, Ill., and 39 feet thick in Fulton County, Ill. The shale is absent in parts of west-central Illinois. In eastern Missouri, a thin gray shale bed, generally less than a foot thick, occupies the same stratigraphic position as does the *Francis Creek* in Illinois. It probably represents the southernmost extension of the prodelta sediments deposited in the Illinois basin.

The *Francis Creek* contains well-preserved plant fossils including those found in ironstone concretions along Mazon Creek in northern Illinois. Associated with the plants that grew on the delta plain were amphibians and reptiles, described by Gregory (1950), and invertebrates. In an examination of the insects found in concretions in the *Francis Creek*, Richardson (1956) noted a scarcity of roaches. Because roaches today prefer a dense, moist forest habitat, he interpreted their scarcity in the *Francis Creek* to mean that the delta plain supported a drier, more open forest where vegetation was sparser than in a typical coal swamp. The scarcity of roaches, plus the presence of the flora and fauna mentioned above, suggests that the plain formed by the delta deposits was probably built high enough to stand above sea level.

In western Indiana and western Kentucky, gray muds were deposited in isolated areas. The source of these deposits probably lay far to the east.

Muds originating from a northwestern source area accumulated in northern Iowa, and those muds probably originating from the Ozark dome were deposited in southwestern Missouri.

A large amount of detrital sediment was shed from the Arbuckle and Ouachita Mountains on delta complexes extending as far north as southern Kansas. In northern Oklahoma, deposits attained a thickness of 90 feet in places, including sands deposited in channels, and both sands and muds spread over interdistributary areas in sheetlike masses. Finer deltaic sediments were carried farther north into Kansas and deposited as prodelta muds.

Thin sheets of sand and mud were deposited in a small area in the northern part of the Cherokee basin. The source area for these deposits was the Nemaha anticline to the northwest. A small amount of gray mud deposited in the Sedgwick basin farther west probably also was derived from the Nemaha.

During the time of deposition of the *Francis Creek Shale Member* and equivalent strata, a large part of the region under study received no sediments and was probably submerged. Evidence for submergence of the Illinois basin is found in places where the *Francis Creek Shale Member* was not deposited. There, the contact between the *Colchester (No. 2) coal* (pl. 17, fig. *D*) and the overlying shale, equivalent to the *Mecca Quarry Shale Member* of the Linton Formation in Indiana (pl. 17, fig. *F*), shows no evidence of subaerial erosion.

MECCA QUARRY SHALE MEMBER OF THE LINTON FORMATION AND EQUIVALENT SHALES

(pl. 17, fig. *F*)

After accumulation of the *Colchester (No. 2) coal* and the *Francis Creek Shale Member* and equivalents, marine waters spread from the midcontinent region into the Illinois basin, and vegetation of the coal swamp was inundated. In these waters a dark mud from northern Oklahoma was deposited across the central part of the United States as far east as western Indiana and Kentucky. Dark muds were also deposited in central parts of the Salina and Sedgwick basins, but shoreward they graded into variegated muds from the Nemaha anticline and the Central Kansas uplift.

The dark mud is now a black, fissile, thinly laminated, fossiliferous shale which contains limestone and phosphatic concretions. The limestone concretions are of two types: small, oval, flattened concretions around which the shale laminae bend, giving bedding surfaces a pimply appearance; and large sinuous or flattened spheroid concretions composed of black limestone (Wanless, 1957). Many of the phosphatic nodules in the *Mecca Quarry* and equivalent shales have nuclei consisting of coprolitic masses composed of fragmentary phosphatic material, principally fish scales (Howe, 1956).

This black fissile shale is unnamed in the midcontinent and in Illinois, but it is designated the *Mecca Quarry Shale Member* of the Linton Formation in Indiana (Zangerl and Richardson, 1963). Because the shale is the initial deposit of marine transgressive waters, it is almost surely a shallow-water deposit. This belief is supported by the fact that the shale does not overlie the thickest accumulations of the *Francis Creek Shale Member* of the Carbondale. An index to water depth is the thickness of the *Francis Creek* (James Schopf, written commun., 1965) over which the *Mecca Quarry* was deposited. In Schuyler County, Ill., the black shale overlies 18 feet of *Francis Creek* in T. 2 N., R. 1 W., but is not present in T. 3 N., R. 3 W., where the *Francis Creek* is 24 feet thick. In northern Oklahoma, however, the black shale overrides even the thickest of the underlying deltaic sediments, suggesting that the water in which the black shale originated was somewhat deeper in the midcontinent region than in the Illinois basin.

The environmental conditions—physical, chemical, and biological—in which the *Mecca Quarry Shale Member* originated have been reconstructed by Zangerl and Richardson (1963), who conducted a lamina-by-lamina study on blocks of the *Mecca Quarry* excavated from Parke County, Ind. Several stratigraphic levels in the black shale were noted in which different lithologies and different faunal elements occurred. On this basis the environment was postulated to have changed during initial marine transgression from brackish water to water of normal marine salinity. The conclusion was that the muds had accumulated under quiet conditions, and throughout the time of accumulation a mat of floating vegetation, perhaps an algal "flotant," covered the water. An algal "flotant" would provide the quantity of oxygen necessary to aerate the surface waters where aquatic organisms were able to live (Zangerl and Richardson, 1963), and it would prevent disturbance of the bottom by wind and waves even in shallow water, thus allowing for the preservation of fine laminae characteristic of the shale at Mecca Quarry.

This shale and its equivalents have not been studied at other places to determine specific conditions under which they were deposited. However, because attributes of the shale are generally the same throughout an area extending from Oklahoma to Indiana, conditions of deposition postulated by Zangerl and Richardson for the Parke County, Ind., outcrop may be fairly representative.

UPPER UNIT OF *VERDIGRIS LIMESTONE MEMBER* OF THE CABANISS FORMATION AND EQUIVALENTS

(pl. 17, fig. *G*)

Marine waters apparently deepened and became clearer after *Mecca Quarry* time; in these waters the most persistent limestone of the *Liverpool cyclothem* originated. In most of the midcontinent region the upper unit of the *Verdigris Limestone Member* of the Cabaniss Formation (Kansas; see table 2 for equivalents in adjacent areas) consists of three limestone beds and intervening shale beds, as illustrated in the southeastern Kansas outcrop belt (Howe, 1956). Although none of the three limestone beds in that area can be traced through the entire Kansas-Oklahoma outcrop belt, the three beds are persistent enough to be distinguished from one another, and the characteristic lithologies and faunas of each give an indication of changing environmental conditions. The following descriptions of the limestone beds of the *Verdigris* in Kansas and adjacent areas are those of Howe (1956) except where otherwise indicated.

The basal limestone bed of the upper unit of the *Verdigris* consists of dark-gray to black limestone concretions, most of which have pyritic rinds. These concretions probably formed in places of restricted circulation, in shallow stagnant marine water under conditions similar to those in which the underlying black shale was deposited. This basal concretion zone in Kansas may correspond to a zone of large black limestone concretions at the top of the black shale in the *Verdigris Formation* (Howe, 1956) in southwestern Missouri (Wanless, oral commun., 1965).

Overlying the discontinuous basal limestone bed of the upper unit of the *Verdigris* is a sequence of black and gray shale on top of which is the middle limestone bed, a dark-gray to black limestone which grades laterally in some places to an almost continuous layer of dark-gray to black limestone concretions. Marine waters must have been somewhat clearer and deeper where the continuous limestone bed occurs, and relatively shallow where the concretionary limestone originated.

Another sequence of black and gray shales separates the middle limestone bed from the upper limestone, which is the thickest and most prominent of the three *Verdigris* limestone beds. In Cherokee and Crawford Counties, eastern Kansas, the upper limestone is mottled dark and light gray and averages about 2 feet in thickness. This bed probably was deposited in clear, relatively deep water; it contains abundant marine fossils.

In the outcrop area in eastern Missouri a basal, dense, argillaceous, light-gray limestone is present, overlain by a series of marine shales and limestones (Searight, 1959). The uppermost limestone bed is nodular and resembles the upper *Verdigris* limestone bed of Kansas and Oklahoma, which suggests that open-circulation conditions probably extended from Kansas into eastern Missouri. Such conditions apparently did not exist in western Illinois, however, for a discontinuous, dark-blue-gray siliceous limestone representing what may have been an estuarine environment was deposited. This bed, which is the basal unit in the *Oak Grove beds* of Wanless (1931), is generally very thin, but reaches a thickness of 10 feet at Mill Creek in Schuyler County, Ill. There, the siliceous limestone contains crinoid stems and also a variety of marine brachiopods which may have been washed into the area.

Fairly shallow marine waters were probably present in the Illinois basin at this time. The sea possibly entered the basin through a corridor extending from eastern Missouri to western Illinois. The water may initially have spread northeastward, but later was prevented from extending in that direction by a wedge of the *Francis Creek Shale Member* of the Carbondale in northwestern Illinois. The water then may have been diverted southeastward by this wedge, perhaps into a shallow estuary, into southern Illinois, where about 1 foot of dark-gray to black argillaceous limestone was deposited. This limestone bed, which is thin and discontinuous, represents the easternmost extension of the sea in the midcontinent region in which an appreciable thickness of mud and calcium carbonate was deposited.

In relatively shallow water, where open circulation was maintained, gray muds were deposited locally in Oklahoma, Kansas, Iowa, and Missouri.

In the Sedgwick basin, water was deep enough to allow widespread deposition of calcium carbonate, but in the Salina basin to the north the water apparently was shallower in places, for gray muds were deposited throughout a large part of the area. In places where deeper water was present, calcium carbonate was deposited.

A tongue of coarse detritus separated the Sedgwick and Salina basins, but it was relatively thin, and water circulated freely between the two basins.

SANDSTONE BENEATH THE *WHEELER COAL* (*BEVIER COAL* OF KANSAS)

(pl. 17, fig. *H*)

Following deposition of the upper unit of the *Verdigris Limestone Member* and its equivalents, marine waters apparently withdrew from Missouri and Iowa, and deltaic sediments spread into southwestern Iowa, northwestern Missouri, and northeastern Oklahoma. Delta sands entered Iowa from a northeastern source and were deposited in thin sheets, but in Missouri they were derived from the southeast. The Ozark dome, which was an area of very low relief during deposition of the beds of the *Liverpool cyclothem* and equivalent strata, could scarcely have shed large quantities of detrital material into Missouri, but it may have yielded some sand at this time.

In Missouri the sandstone underlying the *Wheeler coal* generally ranges in thickness from 1 to 12 feet but is 20 feet thick at one locality. In Iowa it is somewhat thinner, ranging in thickness from 1 to 9 feet.

In the *Bevier Member* in northeastern Oklahoma and in eastern Labette County, Kans., a fine-grained sandstone ranging in thickness from 1 to 8 feet overlies the *Verdigris* succession of limestones and shales. The sandstone probably was formed by streams that carried detritus northward from the Ouachita and Arbuckle Mountains into delta complexes.

Associated with the delta sands of this age in Oklahoma, Iowa, and Missouri were thin sheets of delta mud. These sands and muds formed a platform on which underclay of the *Wheeler coal* (*Bevier coal* of Kansas) was deposited.

UNDERCLAY BENEATH THE *WHEELER COAL* (*BEVIER COAL* OF KANSAS)

(pl. 17, fig. *I*)

Deltaic sedimentation continued in Iowa, Missouri, eastern Kansas, and eastern Oklahoma, and silts accumulated in these areas. Subsequently the silts were exposed to weathering, and an abundant flora developed on them as shown by rootlets and carbonized plant material preserved in the underclay of the *Wheeler coal* (*Bevier coal* of Kansas).

In areas where underlying coarse deltaic sediments were not deposited (eastern Missouri and southeastern Kansas), underclay rests directly on the *Verdigris* limestone and shale sequence. Some coarse deltaic sediments continued to accumulate in northeastern Oklahoma during the time of deposition of exclusively fine sediments farther north.

Gray mud accumulated in north-central Oklahoma, eastern Kansas, southeastern Nebraska, and southwestern Iowa; variegated mud was deposited in the Sedgwick and Salina basins.

WHEELER COAL (BEVIER COAL) OF KANSAS)

(pl. 17, fig. *J*)

The deltaic platform of which underclay accumulated later subsided and a widespread coal swamp developed in Missouri, Iowa, eastern Kansas, and northeastern Oklahoma. In Missouri the coal formed in this swamp is the *Wheeler* and is the upper member of the *Verdigris Formation* (Searight and others, 1953); in Kansas the equivalent is the *Bevier coal* at the top of the Bevier Member (not equivalent to the *Bevier coal* of Missouri). These coals are correlated because both are overlain by a limestone containing large numbers of the brachiopod *Desmoinesia muricatina* (H. R. Wanless, oral commun., 1964).

In the outcrop belt in Missouri, the *Wheeler coal* ranges in thickness from 4 to 16 inches, thickening to the west (Searight, 1959). In Kansas, the *Bevier coal* ranges from 15 to 24 inches in Cherokee, Crawford, and Bourbon Counties, but thins southward, and in Craig County, Okla., it is only a thin smut streak. The coal disappears farther south, where detrital deltaic sedimentation continued throughout the time of deposition of the coal.

West of the coal swamp, gray mud accumulated in central Oklahoma and in Kansas, Nebraska, and Iowa. Conditions under which this mud was deposited were, for the most part, marine, but the water probably became brackish adjacent to the freshwater coal swamp.

In the Sedgwick basin, marine water probably was relatively deep and interbedded layers of calcium carbonate and gray mud were deposited in the deep parts of the basin. Variegated mud derived from the Nemaha anticline and the Central Kansas uplift was deposited in the central part of the basin.

While deltaic detrital sediments were being transported into northeastern Oklahoma, southeastern Kansas, Iowa, and Missouri, open-circulation marine conditions persisted in central Kansas and north-central Oklahoma. Gray mud was deposited in a corridor extending from north-central Oklahoma into Kansas, east of the Nemaha anticline. Variegated, predominantly red mud was carried from the eastern border of the Nemaha anticline into northern Kansas and southern Nebraska, and coarser detritus was accumulating along the eastern border of the anticline.

Marine water moved from the Sedgwick basin into the Salina basin through an open channel that had been eroded along the southwestern border of the Nemaha anticline. Two islands remained in the area between the

Nemaha anticline and the Central Kansas uplift, and these islands, as well as the Central Kansas uplift, furnished detritus to the adjacent basinal areas. The Sedgwick and Salina basins at this time were sites of deposition for variegated marine muds which accumulated in fairly shallow, well-circulated water.

No rock units at the stratigraphic level of the beds described above can be traced into the Illinois basin; the assumption is made, therefore, that the time during which detrital units accumulated in Iowa, Missouri, and Kansas was one of nondeposition in the Illinois basin. No representatives of the overlying underclay and coal are in the Illinois basin either, indicating that the period of nondeposition included the time of deposition of these units.

The connection between the Sedgwick and Salina basins persisted during the time of coal formation, and deep water was present in a small area in the Salina basin where gray mud and discontinuous calcium carbonate strata were deposited. The remainder of the Salina basin received variegated mud and some sand, which were shed from the Nemaha anticline and the Central Kansas uplift.

DARK SHALE ABOVE THE *WHEELER COAL* (*BEVIER COAL* OF KANSAS)

(pl. 17, fig. *K*)

The sea transgressed from the west across the coal swamp in which the *Wheeler coal* (*Bevier coal* of Kansas) was deposited, killing the vegetation and inundating not only western Missouri and Iowa, but also northeastern Iowa, northwestern Illinois, and a part of eastern Indiana. In these marine waters dark-gray to black mud and interbedded thin layers of calcium carbonate were deposited. The resulting shale and limestone sequence is fossiliferous, the most abundant fossil being the brachiopod *Desmoinesia muricatina,* which is also abundantly preserved in the overlying limestone.

In the Kansas outcrop belt a thin layer of pyrite containing many fossils directly overlies the *Bevier coal,* indicating that initially the sea that inundated the coal swamp must have been very shallow and circulation in it restricted (Howe, 1956).

During the time of deposition of the lower dark-shale units, the sea margin advanced along a route immediately north of the Ozark dome. However, the water spread somewhat north of its previous path, perhaps because the wedge of detrital sediments that elsewhere underlies the *Wheeler coal* was thickest in the area of no coal deposition immediately adjacent to the north and west flanks of the Ozark dome, and in that area it may have blocked the sea's advance.

In Illinois the marine transgression is represented by a few feet of dark-gray, fossiliferous shale resting on the basal limestone of the *Oak Grove beds* (the equivalent, in the Illinois basin, of the upper unit of the *Verdigris Limestone Member* of the Cabaniss). In some places the dark shale contains very thin, fossiliferous limestone layers, but these layers are not nearly as numerous or as widespread as they are in the midcontinent region. A similar thin shale unit is present in west-central Indiana, but there it rests on the *Mecca Quarry Shale Member* of the Linton Formation because the marine waters in which the upper limestone unit of the *Verdigris* was deposited did not extend that far east. The reduction in the number of limestone layers in the shale in the Illinois basin suggests that the waters there may have been somewhat shallower than in the midcontinent.

West of the Nemaha anticline interbedded dark-gray mud and thin layers of calcium carbonate were deposited in isolated areas in Sedgwick and Salina basins. Lighter gray marine mud, calcium carbonate, and variegated mud shed from the Nemaha anticline and the Central Kansas uplift were also being deposited in both basins.

DESMOINESIA-BEARING LIMESTONE

(pl. 17, fig. *L*)

The sea probably became clearer and somewhat deeper, as shown by calcium carbonate that was deposited in eastern Kansas and Oklahoma, Iowa, Missouri, Illinois, and western Indiana. The limestone formed at this time contains abundant specimens of *Desmoinesia muricatina,* and in some places forms a coquina of this species. The *Desmoinesia*-bearing limestone is persistent but thin, ranging from only a few inches to 1 foot in thickness in western Illinois (Wanless, 1957). It forms the cap of the *Wheeler coal* in parts of Missouri and Iowa where the dark shale unit (pl. 17, fig. *K*) is absent and is correlated with the persistent gray, septarian limestone of the *Oak Grove beds* in Illinois, which also contains large numbers of *Desmoinesia muricatina.* Transgressive waters in which this calcium carbonate was deposited most likely inundated the whole Illinois basin, including southern Illinois and southeastern Indiana, which had not been covered by marine water when the underlying shale was deposited.

In northern Oklahoma, the western part of the Cherokee basin in Kansas, and western Iowa, gray marine mud accumulated. Coarse detritus was deposited adjacent to the eastern flanks of the Nemaha anticline, and variegated mud, predominantly red, was deposited farther east.

Marine water filled the Salina basin to a considerable depth; gray mud interbedded with thin layers of calcium carbonate was deposited throughout its extent. Marine water also circulated through the connection between the Salina and Sedgwick basins. The Sedgwick basin apparently was deeper than the Salina basin, for the sediments deposited in the Sedgwick were mostly variegated muds, predominantly red.

WEDGE OF DETRITUS BETWEEN THE *DESMOINESIA*-BEARING LIMESTONE AND *BEVIER COAL* OF MISSOURI

(pl. 17, fig. *M*)

Following deposition of widespread units of calcium carbonate, the sea withdrew from Indiana, Illinois, and most of Iowa and Missouri where the remainder of the *Liverpool cyclothem* was marked by the deposition of detrital material and the development of coal swamps. Local swamps developed on platforms of detrital sediment. In Kansas and Oklahoma deposition was predominantly marine.

Stratigraphic relationships between detrital units and the resulting coals have not been definitely established for the *Liverpool cyclothem;* for this reason they are placed on separate maps (pl. 17, figs. *M–Q*). Stratigraphic relationships of coals with the *Lagonda Sandstone Member* of the Cabaniss Formation, which overlies the *Bevier coal* of Kansas (table 2), also have not been established, but probably the coal swamps developed during the time of deposition of the lower shale unit of the *Lagonda* in the midcontinent region and the *Purington Shale Member* of the Carbondale Formation to the east (pl. 17, fig. *R*); the detrital wedge in southern Iowa and northern Missouri is correlated with the lower part of the shale of the *Lagonda.*

In Iowa and Missouri detrital sediments were introduced from a southeastern source during a retreat of the marine waters in which the *Desmoinesia*-bearing limestone originated. An isopach map of these sediments (pl. 17, fig. *M*) illustrates that they formed a wedge, which lies between the *Wheeler coal* or overlying limestone and the *Bevier coal* of Missouri. Only a thin clay parting separates the two coals in eastern Missouri, but westward the parting thickens in a short distance to a maximum of 79 feet. The wedge is composed primarily of fine detritus — shale and some sandstone. It thickens to the southwest, indicating that the source area was in that direction. Sediments composing the wedge may have come from the Ouachita Mountains to the south, but evidence is not conclusive, because the thickness of the wedge cannot be determined farther south than northeastern Kansas, where the overlying *Bevier coal* of Missouri disappears.

BEVIER COAL OF MISSOURI

(pl. 17, fig. *N*)

After detrital sediments had accumulated in Iowa and Missouri, coal-swamp conditions developed on the resulting platform, and the *Bevier coal* of Missouri was deposited. This coal was once correlated with the *Bevier coal* of Kansas, now believed to be older than the *Bevier coal* of Missouri (table 2). The *Wheeler coal* of Missouri is now correlated with the *Bevier coal* of Kansas. The correlative in eastern Kansas of the *Bevier coal* of Missouri is unnamed.

The *Bevier coal* of Missouri was deposited in swamps in extreme northeastern Kansas, northern Missouri, and south-central Iowa. The western boundary of the coal is somewhat tenuous and may have been farther west than shown on plate 17, figure *N*. The coal is fairly thick in Missouri, attaining a thickness of more than 3 feet in places (Searight, 1959).

West of the coal-swamp area, marine conditions predominated. A full description of depositional conditions in Kansas and Oklahoma is in the text description of the *Purington Shale Member* of the Carbondale and the equivalent *Lagonda.*

Conditions east of the *Bevier coal* swamp area cannot be precisely determined because correlation problems exist between the *Bevier coal* of Missouri and a possible equivalent coal in Illinois. The *Lowell (2A) coal* of Illinois may be equivalent, but the caprocks of these two coals have not been thoroughly studied and until this is done they cannot be correlated with any degree of confidence.

SANDSTONE BENEATH THE *LOWELL (2A) COAL* AND EQUIVALENT COALS

(pl. 17, fig. *O*)

Sometime after the regression of the sea in which the *Desmoinesia*-bearing limestone originated, sediments were transported into the southeastern part of the Illinois basin from the east and were deposited both in delta channels and in interdistributary areas. These deltaic sands and muds formed a platform in the southeastern part of the Illinois basin, on which the *Lowell* and equivalent coals accumulated.

Detrital sediments derived from a northwestern source also entered the Illinois basin at this time and were deposited in alluvial channels and, during times of high water, on adjacent flood plains. These alluvial sediments formed the northwestern part of the platform on which the *Lowell (2A) coal* was deposited.

UNDERCLAY BENEATH THE *LOWELL (2A) COAL* AND EQUIVALENT COALS

(pl. 17, fig. *P*)

In the southeastern part of the Illinois basin, silts were deposited over interdistributary areas and in most of the delta channels. Some coarse sediments were still being transported, however, and were being deposited in the larger channels.

Streams flowing from the northwest carried only fine sediments at this time. Silts were spread out on flood plains adjacent to the tributary channels and in channels, eventually filling them. Exposure or partial exposure of large areas of delta and flood plain then took place and a varied flora developed on the mud and sand surfaces. This flora continued to flourish in the *Lowell (2A) coal* swamp area.

LOWELL (2A) COAL AND EQUIVALENT COALS

(pl. 17, fig. Q)

Shallow fresh water covered the low plain formed by the delta and alluvial flats, and a coal swamp formed in which the *Lowell* and *2A* coals of Illinois and the *Indiana IV coal* were deposited. These coals are all directly underlain by a stigmarian root zone in the underlying sandstone or siltstone (William H. Smith, written commun., 1965), which aids in their correlation.

In LaSalle County, Ill., the coal is shaly and reaches a thickness of 10 inches, but at other exposures in northern Illinois it is 2–3 feet thick (Willman and others, 1942).

PURINGTON SHALE MEMBER OF CARBONDALE FORMATION AND EQUIVALENTS

(pl. 17, fig. *R*)

After deposition of the *Bevier coal* of Missouri and the *Lowell (2A),* and *Indiana IV coals* of the Illinois basin, the sea transgressed from the midcontinent region eastward, and marine shales were deposited from central Kansas as far eastward as western Indiana. In the Kansas outcrop belt the shale averages about 50 feet in thickness. It thickens markedly to the southwest and reaches a thickness of more than 100 feet in Okfuskee County, Okla., along the northern fringe of the Arkoma basin. At least the upper part of the *Purington Shale Member* of the Carbondale Formation in the Illinois basin is a freshwater deposit, but shale of the *Lagonda Formation* (*Lagonda Sandstone Member* of Cabaniss or Senora Formation) is most likely completely marine in the midcontinent region.

Evidence supporting the freshwater origin of the upper part of the *Purington Shale Member* in Illinois is the presence of plant fossils preserved in concretions in the upper part of the unit in western Illinois (Wanless, 1957). Where the shale is not truncated by the channel phase of the overlying *Pleasantview Sandstone Member* of the Carbondale, it is as much as 50 feet thick in the Illinois basin. The shale thickens in northern and western Illinois, and also in southeastern Illinois and adjoining parts of Kentucky and Indiana. This suggests that both a northern source and a southeastern source were contributing sediments to the basin at this time.

Because the *Purington* in the Illinois basin and perhaps even farther to the west is nonmarine in part, whereas shale of the *Lagonda* in Kansas, Oklahoma, and Nebraska is completely marine, an arbitrary dividing line was drawn in western Missouri and Iowa; the shale east of the line probably originated primarily in delta complexes and the shale west of the line in open marine waters.

In the Sedgwick basin fairly deep, well-circulated waters probably were present, for interbedded gray muds and thin layers of calcium carbonate accumulated. In the eastern and southern parts of the Salina basin to the north, interbedded gray muds and carbonates were deposited. The remainder of the basin was filled with variegated muds, predominantly red, which were supplied from the Nemaha anticline. The eastern flanks of both the Central Kansas uplift and the Nemaha anticline continued to shed coarse detritus which formed piedmont areas adjacent to these elevated ridges.

This transgressive episode brought the *Liverpool cyclothem* to an end.

REFERENCES

Gregory, J. T., 1950, Tetrapods of the Pennsylvanian nodules from Mazon Creek, Illinois: Am. Jour. Sci., v. 248, p. 833-873.

Howe, W. B., 1956, Stratigraphy of pre-Marmaton Desmoinesian (Cherokee) rocks in southeastern Kansas: Kansas Geol. Survey Bull. 123, 132 p.

Jongmans, W. J., and Gothan, W. U. E. F., 1934, Florenfolge und vergleichende Stratigraphie des Karbons der östlichen Staaten Nord-Amerika's Vergleich mit West-Europe: Geol. Bur. Nederlandsche Mijngebied Heerlen, Jaarverslag 1933, p. 17-44.

Kosanke, R. M., 1950, Pennsylvanian spores of Illinois and their use in correlation: Illinois Geol. Survey Bull. 74, 128 p.

Kosanke, R. M., Simon, J. A., Wanless, H. R., and Willman, H. B., 1960, Classification of the Pennsylvanian strata of Illinois: Illinois Geol. Survey Rept. Inv. 214, 84 p.

Richardson, E. S., Jr., 1956, Pennsylvanian invertebrates of the Mazon Creek area, Illinois—Introduction; Insects; Marine fauna: Fieldiana—Geology, v. 12, no. 1, p. 3-12.

Searight, T. K., 1959, Post-Cheltenham Pennsylvanian stratigraphy of the Columbia-Hannibal region, Missouri: Illinois Univ. Ph. D. thesis, 256 p.

Searight, W. V., Howe, W. B., Moore, R. C., Jewett, J. M., Condra, G. E., Oakes, M. C., and Branson, C. C., 1953, Classification of the Desmoinesian (Pennsylvanian) of northern Mid-Continent: Am. Assoc. Petroleum Geologists Bull., v. 37, no. 12, p. 2747-2749.

Wanless, H. R., 1931, Pennsylvanian cycles in western Illinois: Illinois Geol. Survey Bull. 60, p. 179-193.

______1957, Geology and mineral resources of Beardstown, Glasford, Havana, and Vermont quadrangles: Illinois Geol. Survey Bull. 82, 233 p.

Wanless, H. R., Baroffio, J. R., and Trescott, P. C., 1969, Conditions of deposition of Pennsylvanian coal beds, *in* Environments of coal deposition—Geol. Soc. America, Coal Geology Div., Ann. Mtg., 1964, Symposium: Geol. Soc. America Spec. Paper 114, p. 105-142.

Willman, H. B., and others, 1942, Geology and mineral resources of the Marseilles, Ottawa, and Streator quandrangles [Ill.]: Illinois Geol. Survey Bull. 66, 388 p.

Wilson, L. R., and Hoffmeister, W. S., 1956, Pennsylvanian plant microfossils of the Croweburg coal in Oklahoma: Oklahoma Geol. Survey Circ. 32, 57 p.

Zangerl, Rainer, and Richardson, E. S., Jr., 1963, The paleoecological history of two Pennsylvanian black shales: Fieldiana—Geology Mem., v. 4, 352 p.

INDEX TO LOCALITIES AND SOURCES (PL. 1)

[Complete bibliographic information for each region is listed in the "References" at the end of each chapter]

Citations of sources of data used in compilation of the maps fall into six categories. An asterisk (*) denotes that the source of data is the files of an individual or organization and, therefore, is not listed. Data references for a few localities were given in confidence and are so listed. An independent series of index numbers has been assigned to each State; not all numbers for any one State have been used for the published maps.

1. Published data and theses. Shown as: author's name; year of publication (or completion of thesis); page, plate, or figure, with section number or name, if necessary.
2. Unpublished reports. Shown as: asterisk, author's name, affiliation, and date. Location: section, township, and range, or specific locality.
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4. Unpublished well logs. Shown as: name of company drilling; well number; farm name. Location: coordinate location, specific locality, or county (in Texas). Asterisk, name of person and (or) organization that prepared log; year samples were examined (if known).
5. Written and oral communications. Shown as: asterisk, name, affiliation, date, form (oral or written). Location: section, township, and range, or specific locality.
6. Confidential sources. Shown as: well name, location, and confid. or only as confid.

Abbreviations used in the index include the following:

Agr.	Agriculture
AmStrat.	American Stratigraphic Company
ASLS	Abilene Sample Log Service
Assoc.	Associated
AT and SF	Atchinson, Topeka and Santa Fe Railroad
Bros.	Brothers
Bur.	Bureau
Cen.	Central
cen.	center
Chem.	Chemical
Co.	Company
col., cols.	column, columns
Comm.	Commission
commun.	communication
Confid.	Confidential
Const.	Construction
Corp.	Corporation
Dept.	Department
Devel.	Development
Dist.	District
Div.	Division
Drlg.	Drilling
DSL	Denver Sample Log
E.	east
Est.	Estate
Explor.	Exploration
fig.	figure
Found.	Foundation
gen.	general
Geol.	Geologic(al), geologist(s)
Govt.	Government
GS	Geological Services, Inc.
Inc.	Incorporated
Ins.	Insurance
KSLS	Kansas Sample Log Service
Lab.	Laboratory
Libr.	Library
loc.	locality
Ltd.	Limited
*MCGS	Mid-Continent Geological Services
*MCGS (AmStrat)	AmStrat log now owned by Mid-Continent Geological Services
*MCGS (DSL)	Denver Sample Log now owned by Mid-Continent Geological Services
*MCGS (Ellison)	Ellison sample log now owned by Mid-Continent Geological Services
Mfg.	Manufacturing
Min.	Mining, Mineral
Mtn., Mtns.	Mountain, Mountains
Mus.	Museum
New Mexico BMMR	New Mexico Bureau of Mines and Mineral Resources
N.	north
Nat.	Natural
Natl.	National
NE.	northeast
NPRR	Northern Pacific Railroad
NTSLS	North Texas Sample Log Service
NW.	northwest

NWGS	Northwest Geological Service
Okla. Geol. Surv. (Shell)	Shell Oil Company log in files of Oklahoma Geological Survey
p.	Page
PBSL	Permian Basin Sample Log
Pet.	Petroleum
PI	Petroleum Information
PL	Paleontological Laboratory
pl.	Plate
prep.	preparation
Prod.	Producing, Production
quad.	Quadrangle
Res.	Resources
Ref.	Refining
rept.	report
RR	Railroad
S.	south
SE.	southeast
sec., secs.	section, sections
Serv.	Service
Soc.	Society
Strat.	Stratigraphic
subsurf.	subsurface
surf.	surface
Surv.	Survey
SW.	southwest
Synd.	Syndicate
TPSLS	Texas Panhandle Sample Log Service
Tr.	Trustee
Trans.	Transmission
Twp.	Township
Univ.	University
unpub.	unpublished
UPRR	Union Pacific Railroad
USGS	U.S. Geological Survey
W.	west
WCTSLS	West Central Texas Sample Log Service
W. & K.	Ware and Kapner Sample Log Service

ALABAMA

19. Applin, 1951, p. 22.
25. Applin and Applin, 1947, fig. 10.
    E. C. Johnston 1 H. D. Peteet.
27. McCalley, 1891, p. 54–55. Crutcher, Short Creek, and Mine Branch secs.
28. Metzger, 1965, p. 46–48.
29. David E. Brooks 1 U.S.A.; 26-7S-8W. *Alabama Geol. Surv., 1959.
30. McCalley, 1891, p. 71. 28-7S-9W.
32. Coulter, 1947, p. 42 (log FP-12).
34. Metzger, 1965, p. 48–49.
35. McCalley, 1891, p. 64. 11-8S-1W.
36. McCalley, 1891, p. 65. 33-8S-3W.
37. Metzger, 1965, p. 54–56.
39. McCalley, 1891, p. 69 (32-8S-9W), p. 70 (15-8S-9W).
41. James L. Duffy and others 3 M. C. Hester and Carolyn N. White; 11-8S-11W. *Alabama Geol. Surv., 1959.
43. Warrior Basin Oil 1 A. L. Childers; 23-8S-14W. *Alabama Geol. Surv., 1958.
44. McCalley, 1891, p. 57. 25-9S-2E.
46. Metzger, 1965, p. 52–54.
47. McGlamery, 1955, p. 465–476.
48. Warrior Basin Oil 1 Miller-Childers Unit; 12-9S-15W. *Alabama Geol. Surv.

ALABAMA—Continued

49. McCalley, 1891, p. 74. 8-10S-6E.
55. Metzger, 1965, p. 57.
    Hugh Morrow, Lewis Odess, & Assoc. 1 First Natl. Bank of Birmingham; 22-11S-10W. *Alabama Geol. Surv., 1959.
57. Frank J. Sharp 1 First Natl. Bank of Birmingham, Tr.; 36-11S-12W. *Alabama Geol. Surv.
58. McGlamery, 1955, p. 320–331.
60. McGlamery, 1955, p. 313–320.
61. Gibson, 1891, p. 118–119, 126–129, 131. 12S-3E.
62. Metzger, 1965, p. 59. 22-12S-4W.
65. Texala Drlg. and Joe L. Moore, unit 8, well 1 First Natl. Bank of Birmingham; 23-12S-8W. *Alabama Geol. Surv., 1956.
68. McCalley, 1900, p. 294. 33-12S-12W.
69. Metzger, 1965, p. 60–62.
70. McGlamery, 1955, p. 443–456.
74. McGlamery, 1955, p. 390–415.
80. McCalley, 1900, p. 277–278.
81. *Confid.
82. Metzger, 1965, p. 68–69.
83. McGlamery, 1955, p. 166–176.
86. U.S. Bur. Mines, 1949, p. 65–67, 67–68.
    Prouty, 1912, map 3, 10-15S-4E.
    Rothrock, 1949, figs. 2, 3.
87. McCalley, 1900, p. 268. 1-15S-3W.
88. Metzger, 1965, p. 64 (sec. 24).
90. McCalley, 1900, p. 274 (25-15S-9W), p. 275–276.
91. McGlamery, 1955, p. 66–79.
95. Rothrock, 1949, p. 104–107, 136–141, fig. 2.
96. Butts, 1907, pl. 6 (sec. 1). Black Creek.
97. McCalley, 1900, p. 261–264.
101. McGlamery, 1955, p. 61–66.
102. McGlamery, 1955, p. 54–61.
103. Squire and McCalley, 1890, Cahaba coal field map (6, 8-17S-1E and Henryellen basin sec.).
    Butts, 1927, columnar sec. sheet (Cahaba Valley and Coosa coal field sec.).
104. Butts, 1910a, columnar sec. sheet (Cahaba coal field gen. sec.).
105. Butts, 1910a, columnar sec. sheet (Warrior coal field gen. sec.).
107. McCalley, 1900, p. 270–271.
109. Prouty, 1912. 4, 9-18S-1E, sec. I-J.
110. Butts, 1907, pl. 6 (sec. 7).
111. Butts, 1927, columnar sec. sheet (Birmingham Valley and Warrior coal field sec.).
113. McCalley, 1900, p. 249. 33-18S-8W.
114. McGlamery, 1955, p. 380–389.
115. Prouty, 1923, p. 39–44.
116. Butts, 1907, pl. 6 (sec. 9).
117. Metzger, 1965, p. 75–76.
118. Metzger, 1965, p. 79–80. 17-19S-7W.
120. Prouty, 1912. 11, 14, 24-20S-2W, sec. C-D. Yellowleaf basin.
    Butts, 1927, columnar sec. sheet (Coosa coal field).
123. McCalley, 1900, p. 247–248.
124. Butts, 1940, gen. sec.
127. McCalley, 1900, p. 243–245.
129. McCalley, 1900, p. 251–252, 253.
130. Squire and McCalley, 1890, Cahaba coal field map: (1, 2, 11-24N-11E).
131. Butts, 1911, p. 91–93, pl. 4 (gen. sec.). 5, 6, 7, 8-24N-10E.
    Squire and McCalley, 1890, Cahaba coal field map (Blocton basin).

ALABAMA—Continued

132. Sonat 1 J. G. Lee; 26-24N-3W. *USGS.
133. George G. Marett, II, well; 34-20N-2W. *Alabama Geol. Surv., 1954.
134. Harry Elliott 1 Pete Perolio; 29-18N-1E. *USGS, 1948.
135. *H. R. Wanless, Illinois Univ., 1939. 13-1S-8E.
136. Metzger, 1965, p. 35-37.
137. Metzger, 1965, p. 39-40.
138. McCalley, 1891, p. 30, 33-2S-3E..
139. Metzger, 1965, p. 40.
140. McCalley, 1891, p. 48. 4-4S-8E.
141. McCalley, 1891, p. 32.
142. Metzger, 1965, p. 41.
143. McCalley, 1891, p. 49. 12-5S-6E.
145. Coulter, 1947, p. 43-44.
146. Metzger, 1965, p. 43.
147. McCalley, 1891, p. 60 (Paint Rock Bluff sec.).
148. Metzger, 1965, p. 45.
149. Coulter, 1947, p. 35-36.
*H. R. Wanless, Illinois Univ., 1939. 33-7S-10E.
151. McCalley, 1891, p. 38. 14-3S-6E.
158. Southern Nat. Gas 1 Phelan-Shepherd and others; 35-17N-9W. *USGS, 1956.
159. Sonat and Geochemical Surveys 1 J. J. Hagerman; 9-23N-3W. *USGS, 1960.
160. Gulf Ref. 1 A. Sellers; 13-11N-7E. *USGS.
180. Shreveport Geol. Soc., 1946, pl. 3. Johnston 1 Willis; 11-20N-1E.

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56. Sinclair and Phillips 1 Navajo; 28-37N-14E. *AmStrat.
64. General Pet. 14 Creager-State; 6-19N-23E. *AmStrat.
96. Amerada and Stanolind 1 Navajo-Black Mtn.; 26-32N-23E. *AmStrat.
157. Huddle and Dobrovolny, 1945, sec. 25. 22-15N-29E.
170. El Paso Nat. Gas 1 Bita Peak; 19-41N-31E. *AmStrat.
172. *H. R. Wanless, Illinois Univ., 1949. 29, 30-20S-14E.
174. *H. R. Wanless, Illinois Univ., 1949. 7-18S-17E.
177. Tyrrell, 1957. 32, 33-18S-19E.
179. *H. R. Wanless, Illinois Univ., 1949. 26-20S-22 E.
180. Gilluly, Cooper, and Williams, 1954, p. 7. 16S-23E.
181. *H. R. Wanless, Illinois Univ., 1949. 26, 35-23S-23E.
184. Epis, 1956, p. 94. 22-20S-29E.
192. McNair, 1951, p. 530. 21N-5W.
193. Hughes, 1952, p. 644. 19-21N-4W.
194. Hughes, 1952, p. 645. 15-20N-3W.
195. Hughes, 1952, p. 645. 26-19N-2W.
196. *E. D. McKee, USGS, in prep. 32N-8W.
198. Welsh, 1959. 9, 10-35N-16W.
202. *E. D. McKee, USGS, in prep. 26 N, 27N-9W, 10W.
203. Huddle and Dobrovolny, 1945, sec. 24. 15-14N-26E.
204. Huddle and Dobrovolny, 1945, sec. 20. 34-15N-19E.
205. Huddle and Dobrovolny, 1945, sec. 19. 19-15N-18E.
207. Huddle and Dobrovolny, 1945, sec. 3. 24-12N-9E.
208. Huddle and Dobrovolny, 1945, sec. 8. *H. R. Wanless, Illinois Univ., 1949. 25-9N-15½E, 31-9N-16E.
209. Huddle and Dobrovolny, 1945, sec. 11. 22-7N-19E.
213. *E. D. McKee, USGS, in prep. Kanab Canyon.
214. *E. D. McKee, USGS, in prep. Toroweap Valley.
218. *E. D. McKee, USGS, in prep. South Kaibab trail.
219. *E. D. McKee, USGS, in prep. Hermit trail.
220. *E. D. McKee, USGS, in prep. Tanner trail.
222. *E. D. McKee, USGS, in prep. Bass trail.
223. *E. D. McKee, USGS, in prep. Havasu Canyon.

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238. Hancock Oil 1 Dinne-Federal; 29-41N-27E. *AmStrat.
255. *E. D. McKee, USGS, in prep. 32N-9W.
260. McKee, *in* Huddle and Dobrovolny, 1945, sec. 1. 9-18N-6E.
269. Sabins, 1957. 23-15S-30E.
Sabins and Ross, 1963. 23-15S-30E.
272. *H. R. Wanless, Illinois Univ., 1949. 22, 23-17S-31E.
273. Sabins, 1957. 21-17S-31E.
281. Lockhart 1 Aztec Land and Cattle; 33-14N-20E. *AmStrat.
282. Lockhart 1 Babbitt; 21-27N-9E. *AmStrat.
283. Collins 1 Navajo; 4-34N-8E. *AmStrat.
284. Falcon-Seaboard 1 Govt.; 28-40N-8W. *AmStrat.
285. Sinclair 1 Santa Fe-Pacific; 35-28N-1W. *AmStrat.
286. Texas, Sinclair, and Skelly 1a Navajo; 34-42N-18E. *AmStrat.
287. Shell 1 Navajo; 6-41N-29E. *AmStrat.
288. Franco Western 1 Navajo; 22-41N-28E. *AmStrat.
289. Humble 1 Navajo Tribal; 4-41N-28E. *AmStrat.
322. Huddle and Dobrovolny, 1945, sec. 21. 21-17N-20E.
356. McClymonds, 1957. 25-12S-8E.
Ruff, 1951. 12S-8E, 9E.
364. Tyrrell, 1957. 27-19S-19E.
365. Tyrrell, 1957. 1, 11-18S-18E.
367. Gulf 1 Walker Creek-Navajo; 28-41N-26E. *Texas Pacific Coal and Oil.
368. Superior 2 Navajo "H"; 16-41N-30E. *AmStrat.
369. Texas Pacific Coal and Oil 1 Navajo 138; 11-40N-28E. *Texas Pacific Coal and Oil.
370. Pan American 1 Tohlacon-Navajo; 11-40N-25E. *Texas Pacific Coal and Oil.
371. Pan American B-1 New Mexico and Arizona Land; 25-12N-23E. *AmStrat.
372. Kerr-McGee 1 Hortenstein; 23-18N-25E. *AmStrat.
373. Lion Oil 1 Cabin Wash; 30-14N-14E. *AmStrat.
374. Pan American 1 Aztec Land and Cattle; 5-16N-20E. *AmStrat.
375. Pan American B-1 Aztec Land and Cattle; 9-16N-18E. *AmStrat.
376. Western Drlg. and Valen Oil and Minerals 1 Govt.; 31-38N-5W. *AmStrat.
378. Texas Pacific Coal and Oil 1 Navajo Tract 190; 20-40N-26E. *AmStrat.
379. La Rue 1 Navajo; 18-40N-28E. *AmStrat.
380. Tennessee Gas & Oil 1 USA-Schreiber; 35-39N-13W. *AmStrat.
382. Midwest Pet. 1 Navajo; 7-41N-23E. *AmStrat.
383. Gilluly, Cooper, and Williams, 1954, p. 9. 16-14S-21E.
Nations, 1961. 14S-21E.
384. Loring, 1947. 20S-27E.
386. Kerns, 1958. 16S-16E, 17E.
387. Papke, 1952. 16S, 17S-30E.
388. Gilluly, Cooper, and Williams, 1954, p. 8. 4-16S-23E.
389. Brown, 1939, p. 712. 26-12S-11E.
390. Krieger, 1968 b. 5S-6S, 16E-17E.
*H. R. Wanless, Illinois Univ., 1949. 22-5S-16E.
391. Darton, 1925, p. 264. 10S-2E.
392. Lindgren, 1905. 2S-29E.
393. Huddle and Dobrovolny, 1950, pl. 12, p. 108. 36-1S-12E.
394. *E. D. McKee, USGS, in prep. Hidden Canyon.
395. *E. D. McKee, USGS, in prep. Andrus Canyon.
396. Huddle and Dobrovolny, 1945, sec. 2. 12-12N-7E.
*H. R. Wanless, Illinois Univ., 1949. 12-12N-7E.
397. *E. D. McKee, USGS, in prep. Blue Springs.
398. *E. D. McKee, USGS, in prep. Grandview trail.

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399. *E. D. McKee, USGS, in prep. North Kaibab trail.
400. *E. D. McKee, USGS, in prep. Twin Springs Canyon.
401. *E. D. McKee, USGS, in prep. Shinumo trail.
402. *E. D. McKee, USGS, in prep. Thunder River.
403. *E. D. McKee, USGS, in prep. S. B. Canyon.
404. *E. D. McKee, USGS, in prep. Tuckup Canyon.
405. *E. D. McKee, USGS, in prep. 30N-14W.
406. *E. D. McKee, USGS, in prep. 32N-16W.
407. *E. D. McKee, USGS, in prep. Snap Canyon.
408. *E. D. McKee, USGS, in prep. 33N, 34N-14W.
410. Sorauf, 1962, Cane Springs Pocket.
411. Huddle and Dobrovolny, 1945, sec. 10. 8-7N-16E.
412. Huddle and Dobrovolny, 1945, sec. 12. 29-5N-18E. *H. R. Wanless, Illinois Univ., 1949. 29-5N-18E.
413. *H. R. Wanless, Illinois Univ., 1949. 11-4N-20E.
414. *H. R. Wanless, Illinois Univ., 1949. White River Canyon.
415. Pan American 1 New Mexico and Arizona Land "A"; 12-13N-25E. *AmStrat.
416. British-American 1 Navajo "C"; 5-40N-30E. *AmStrat.
418. *E. D. McKee, USGS, in prep. 36N-5E.
427. Gilluly, Cooper, and Williams, 1954, p. 6, 7. 22-20S-22E. Armstrong, 1962, columnar sec. 22-20S-22E.
429. *H. R. Wanless, Illinois Univ., 1949. 6, 7-11N-10E.
432. *H. R. Wanless, Illinois Univ., 1949. 16-11N-12E.
472. Nations, 1963, p. 1254. 9-15S-22E.
476. Epis, 1956. 22, 23-21S-29E.
477. Richard F. Harless 1 Federal; 4-17N-4E. *AmStrat.
478. Roy Owen 12-1 Diablo Amarillo; 12-20N-11E. *AmStrat.
516. R. Pickett 1 Padre Canyon-State; 26-20N-10E. *AmStrat.
517. E. B. LaRue, Jr., 1 Dinne; 23-41N-26E. *AmStrat.
518. Gulf 1 Navajo-Garnet Ridge; 16-41N-24E. *AmStrat.
519. Marathon 1 Navajo; 18-40N-29E. *AmStrat.
520. Occidental Pet. 1 Texaco-Navajo; 6-40N-27E. *AmStrat.
521. Underwood 1-32 Jacob Lake; 32-39N-2E. *AmStrat.
522. Ross, 1969, p. 1405-1422. H. R. Wanless Illinois Univ., 1949. 2S, 3S-18E.
524. *P. T. Hayes, USGS, 1964. 33-22S-23E.
525. *P. T. Hayes, USGS, 1964. 25-23S-24E.
526. *Frank Simons, USGS, written commun., 1964. 23S-16E.
527. *Frank Simons, USGS, written commun., 1964. 5S-19E.
529. Sabins, 1957, pl. 7. 10-16S-31E.
534. Brew, 1965. 31-10N-16E.
535. Brew, 1965. 4-7N-16E.
536. Brew, 1965. 6, 7-6N-20E.
537. Atlantic and British-American 1 Hopi-9; 9-28N-15E. *AmStrat, 1966.
538. Krieger, 1968a. 6S-17E.
539. Willden, 1964. 4S-5S, 16E-17E.

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101. Sheldon, 1954, p. 17-19. R. S. Lee 1 W. S. King; 24-18N-22W. *E. E. Glick, USGS, 1952.
102. *H. J. Hyden, USGS, 1958. 32-16N-21W.
103. *H. J. Hyden, USGS, 1958. 33-16N-22W.
104. Chisholm, 1959, p. 7-9. *W. A. Chisholm, USGS, 1954. 28-16N-23W.
    Chisholm, 1959, p. 10-13. *W. A. Chisholm, USGS, 1954. 22-16N-23W.
105. Sheldon, 1954, p. 120-122. J. V. McAllister 1 J. Sizemore; 10-15N-27W.
    *R. J. Lantz, USGS, 1950.
106. Henbest, 1953, p. 1948, loc. 19. 32-16N-29W.
107. Henbest, 1953. p. 1948, locs. 17, 18. 24, 25-16N-31W.

ARKANSAS—Continued

108. Chisholm, 1959, p. 46-50. *W. A. Chisholm, 1954. 36-15N-19W.
109. *W. A. Chisholm, USGS, 1953. 16-14N-19W.
110. Chisholm, 1959, p. 21-25. *W. A. Chisholm, USGS, 1954. 33-14N-20W. *H. J. Hyden, USGS, 1959. 19-14N-20W.
111. *H. J. Hyden, USGS, 1958. 10-14N-21W.
    Chisholm, 1959, p. 14-16. *W. A. Chisholm, USGS, 1954. 33-15N-21W.
    Chisholm, 1959, p. 17-20. *W. A. Chisholm, USGS, 1954. 33-15N-21W.
114. Phillips 1 B. Skinner; 11-14N-28W. *Confid.
115. Henbest, 1953, p. 1948, locs. 8-15. 4, 9, 16-14N-30W.
116. Giles and Brewster, 1930. 7-13N-32W.
117. Henbest, 1953, p. 1948, locs. 1, 2. 26, 35-13N-33W.
119. Sheldon, 1954, p. 177-178. H. H. Taylor and others 1 C. E. Rummey; 1-13N-29W. *E. E. Glick, USGS.
121. Chisholm, 1959, p. 39-45. *W. A. Chisholm, USGS, 1954. 8-13N-21W.
122. Phillips 1 Sand Gap; 8-12N-19W. *E. E. Glick, USGS, 1964.
123. *E. E. Glick, USGS, 1954. 12-13N-19W.
124. Chisholm, 1959, p. 30-33. *W. A. Chisholm, USGS, 1954. 7-13N-17W.
    Chisholm, 1959, p. 34-38. *W. A. Chisholm, USGS, 1954. 3-13N-17W.
125. Phillips 1 S. T. Copeland; 28-12N-15W. *E. E. Glick, USGS, 1964.
127. *E. E. Glick, USGS, 1961. 15-13N-13W.
128. Sheldon, 1954, p. 93-96. Hinckle and Fitzpatrick 1 W. W. Pryor; 32-13N-6W. *R. J. Lantz, USGS.
129. Tennark 1 R. Martin and others; 35-14N-3E. *R. J. Lantz, USGS.
130. Sheldon, 1954, p. 209-215. Deep Rock Oil 1 Sample; 4-10N-6W. *S. E. Frezon, USGS.
131. Stephens, Inc., 1 Albert Est. and others; 29-10N-7W. *E. E. Glick, USGS, 1964.
132. Sheldon, 1954, p. 32-35. Donnelly and others 1 Donaphan Lumber; 33-11N-9W. *E. E. Glick, USGS.
133. Sheldon, 1954, p. 171-176. Lion Oil 1 Griggs; 23-10N-13W. *R. J. Lantz, USGS.
134. Pecos Explor. 1 Charles Hurley; 25-11N-14W. *E. E. Glick, USGS, 1961.
135. Phillips 1 N. E. Cleveland; 29-10N-16W. *E. E. Glick, USGS, 1965.
137. Bert Wheeler 1 U.S. Govt.; 36-10N-18W. *E. E. Glick, USGS, 1960.
139. Sheldon, 1954, p. 143-148. Arkansas Louisiana Gas 1 J. C. Millsappe; 23-10N-21W. *R. J. Lantz, USGS.
140. Sheldon, 1954, p. 138-142. Stanolind 1 U.S. Govt.-Fred Brinkman; 6-10N-20W. *R. J. Lantz, USGS. *USGS surf. data.
141. Phillips 1 Indian Creek; 4-11N-20W. *E. E. Glick, USGS, 1961
142. Republic Nat. Gas 1 Watson; 12-10N-22W. *E. E. Glick, USGS, 1961.
143. Stephens, Inc., 1 L. Landthrip; 22-10N-23W. *E. E. Glick, USGS, 1960. *USGS surf. data.
144. Phillips 1 South Low Gap Unit; 31-11N-23W. *E. E. Glick, USGS, 1961.
145. LeFlore County Gas & Electric and Pure 4-A Low Gap Unit; 6-11N-23W. *E. E. Glick, USGS, 1960.
146. Pure 2 Low Gap Unit; 33-12N-24W. *S. E. Frezon, USGS.
147. Sheldon, 1954, p. 102-109. Pure 1 Low Gap Unit; 17-11N-24W. *R. J. Lantz and J. C. Maher, USGS.
149. Phillips 1 S. Clarksville; 27-10N-24W. *E. A. Merewether, USGS, 1964.

ARKANSAS—Continued

Carter 1 Boyer Heirs; 18-10N-24W. *B. R. Haley, USGS.
151. Sheldon, 1954, p. 82-84. Ozark Nat. Gas 1 Edna Self; 31-10N-26W. *S. E. Frezon, USGS.
152. Carter 1 U.S. Govt.; 12-11N-26W. *E. E. Glick, USGS, 1960.
154. Ambassador Oil 1 U.S. Govt.; 6-11N-27W. *Schlumberger, 1961.
155. Croneis, 1930, p. 239-241. 19-11N-27W.
156. Arkansas Western Gas 1 Stapp Est.; 4-10N-28W. *Rinehart, 1962.
158. Sheldon, 1954, p. 85-90. Arkansas Western Gas 1 H. T. Peters; 34-11N-29W. *S. E. Frezon, USGS.
159. Arkansas Louisiana Gas 1 O. J. Kirksey; 30-10N-29W. *Schlumberger, 1962.
161. Arkansas Oklahoma Gas 1-A Carney; 20-10N-31W. *S. E. Frezon, USGS.
162. Stephens Prod. 1 C. D. Huckleberry; 11-10N-32W. *Rinehart, 1955.
163. Sheldon, 1954, p. 60-63. Donald Trumbo 1 Craddock Est.; 3-11N-30W. *E. E. Glick, USGS.
164. Cities Service 1 W. R. Bruce; 4-11N-32W. *E. E. Glick, USGS.
165. Stephens Prod. 1 Free Ferry Est.; 13-8N-32W. *Schlumberger, 1963.
Stephens Prod. 1 W. W. Ward; 1-8N-32W. *Schlumberger, 1962.
166. Sheldon, 1954, p. 53-56. Citizens Gas 1 Greenstreet; 18-9N-32W. *S. E. Frezon, USGS.
F. E. Sagely 1 J. S. Richmond; 15-9N-32W. *B. R. Haley, USGS, 1965.
168. Gulf 1 Titsworth; 24-9N-31W. *B. R. Haley, USGS, 1965.
169. Ambassador Oil 1 F. E. Shearer Unit; 9-9N-30W. *B. R. Haley, USGS, 1965.
170. Sheldon, 1954, p. 44-47. Industrial Oil & Gas 3 G. W. Williams; 6-8N-30W. *R. J. Lantz, USGS.
171. Huber 1 Nixon; 33-8N-29W. *B. R. Haley, USGS, 1965.
174. Lantz, 1950, 26p. Arkansas Louisiana Gas 1 Ralph S. Barton; 27-9N-28W. *R. J. Lantz, USGS.
179. Haley, 1961c, p. 30-40. Gulf 1 Raymond Hembree; 13-8N-26W. *B. R. Haley, USGS, 1958.
180. Murphy Corp. 1 Altus Gas Unit; 14-9N-26W. *E. A. Merewether, USGS, 1963.
Arkansas Western Gas 1 T. Moody; 9-9N-26W. *E. E. Glick, USGS, 1965.
183. Huber 1 Mabry; 6-8N-24W. *B. R. Haley, USGS, 1962. *USGS subsurf. data.
184. Gulf 1 A. W. McElroy; 32-8N-24W. *B. R. Haley, USGS.
187. Gulf 1 Arkansas Real Estate; 32-9N-23W. *E. E. Glick, USGS.
Gulf 1 Excelsior; 30-9N-23W. *E. A. Merewether, USGS.
Gulf 1 Spadra Bottoms; 22-9N-23W. *E. A. Merewether, USGS.
189. Gulf 1 J. J. Bauman; 13-9N-22W. *E. A. Merewether, USGS, 1959. *USGS subsurf. data.
190. Merewether and Haley, 1961, p. 25-30. Gulf 1 Joe Roberts; 33-8N-22W. *B. R. Haley, USGS, 1958.
191. Merewether and Haley, 1961, p. 18-25. Gulf 1 W. H. Tackett; 2-8N-22W. *B. R. Haley, USGS, 1958.
193. Gulf 1 Ida Jones; 18-9N-20W. *Lane Wells, 1961. *USGS subsurf. data.
195. Sheldon, 1954, p. 131-137. Cosden Oil 1 Shackleford; 13-9N-19W. *J. C. Maher, USGS.
196. Sinclair 1 Richard Hogan; 8-9N-18W. *E. E. Glick, USGS, 1964.
197. Murphy Corp. 1 R. L. Barton; 10-8N-19W. *E. E. Glick, USGS.
199. Carter 1 Morrilton Lumber; 33-9N-17W. *E. E. Glick, USGS, 1964.

ARKANSAS—Continued

200. Arkansas Louisiana Gas 1 J. E. Merryman; 8-8N-16W. *Schlumberger, 1957.
202. Sheldon, 1954, p. 39-43. Carter 1 C. L. Williams; 1-9N-16W. *W. A. Chisholm, USGS.
203. Arkansas Louisiana Gas 1 H. A. McGowan; 16-9N-14W. *E. E. Glick, USGS, 1964.
204. Carter 1 G. L. Bahner; 12-8N-14W. *E. E. Glick, USGS, 1964.
205. Western Nat. Gas 1 Lucy Chapman; 14-9N-12W. *E. E. Glick, USGS.
206. Stephens Prod. 1 S. A. Hovis; 30-8N-12W. *E. E. Glick, USGS, 1964.
207. Stephens Prod. 1 W. G. Ward; 13-8N-12W. *E. E. Glick, USGS, 1964.
208. Beard Oil 1 R. A. Evans; 32-9N-11W. *E. E. Glick, USGS, 1964.
209. Sheldon, 1954, p. 29-31. Cosden Oil 1 Donaphan Lumber; 19-9N-10W. *E. R. Applin, USGS.
210. Pure 1 M. L. McCollum; 13-9N-8W. *E. E. Glick, USGS, 1961.
211. Starr Oil & Gas 1 W. A. Horn; 1-8N-8W. *E. E. Glick, USGS, 1964.
212. Sheldon, 1954, p. 199-204. Lion Oil 1 Nalley; 33-8N-7W. *R. J. Lantz, USGS.
213. Sunray Mid-Continent 1 Edgar Wright; 16-8N-6W. *E. E. Glick, USGS, 1964.
214. Sheldon, 1954, p. 205-208. Killam and McMillan 1 J. S. Curl; 10-9N-5W. *R. J. Lantz, USGS.
215. Magnolia 1 Roy Sturgis; 30-9N-3W. *E. E. Glick, USGS, 1958.
216. Manning & Martin, Inc., 1 Cartwright; 16-7N-8E. *R. J. Lantz, USGS.
217. Manning & Martin, Inc., 1 Park-Grieseck; 4-6N-5E. *R. J. Lantz, USGS.
219. Manning & Martin, Inc., 1 R. C. Gregg; 20-5N-5E. *R. J. Lantz, USGS.
220. Bimet Bros. 1 J. A. Stribling; 14-6N-8W. *E. E. Glick, USGS, 1964.
221. States Oil 1 J. T. La Ferney; 25-6N-8W. *E. E. Glick, USGS.
223. Sinclair 1 J. E. Carmichael; 11-7N-10W. *E. E. Glick, USGS, 1964.
224. Shell 1 C. Stewart; 23-6N-14W. *E. E. Glick, USGS, 1965.
225. Carter 1 J. H. Jones; 8-6N-15W. *E. E. Glick, USGS.
227. Blackwell Oil & Gas 1 G. A. Scroggin; 14-7N-16W. *E. E. Glick, USGS.
228. Humble 1 Kaufman Unit; 12-7N-17W. *E. E. Glick, USGS, 1964.
229. B. & G. Oil, Inc., 1 F. T. Wilcutt; 29-7N-18W. *E. E. Glick, USGS.
230. C. E. Plummer 1 Nora Rorex; 10-6N-17W. *Schlumberger, 1959.
232. Stephens, Inc., 2 Clifton Andrews; 3-7N-20W. *Schlumberger, 1962. *USGS surf. data.
233. Shell 1 T. V. Jones and others; 19-7N-21W. *B. R. Haley, USGS, 1960. *USGS surf. data.
234. Sinclair 1 Federal-Smith; 24-7N-24W. *B. R. Haley, USGS, 1963. *USGS surf. data.
236. Haley, 1961, p. 24-30. Carter 1 Hugh B. McVay; 22-7N-27W. *B. R. Haley, USGS, 1958. *USGS surf. data.
238. Arkansas Louisiana Gas 1 T. Price; 10-7N-28W. *Schlumberger, 1963.
241. Gulf 1 F. R. Borum; 18-6N-28W. *B. R. Haley, USGS, 1958. *USGS surf. and subsurf. data.
243. Western Nat. Gas 1 W. B. Bergkamp; 1-7N-30W. *E. E. Glick, USGS.
245. Sheldon, 1954, p. 163-167. Arkansas Oklahoma Gas 1 George Bicker; 2-7N-32W. *E. E. Glick, USGS.

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246. Shell 1 Western Coal & Min.; 36-7N-32W. *B. R. Haley and S. E. Frezon, 1965.
247. Reynolds Min. 1 E. C. Tomlin; 33-6N-30W. B. R. Haley, USGS, 1958, *USGS surf. data.
248. Midwest Oil 1 Sebastion County Coal & Min.; 15-5N-32W. *Rinehart, 1965.
Wheeler & Ryan, Inc., 1 Sebastion County Coal & Min.; 14-5N-32W. *B. R. Haley, USGS, 1962.
250. Sheldon, 1954, p. 149-154. Residue Co. 1 Mansfield Gas; 6-4N-30W. *S. E. Frezon, USGS. *USGS surf. data.
251. El Paso Nat. Gas 1 Cheesman; 22-3N-28W. *B. R. Haley, USGS.
252. Sheldon, 1954, p. 216-218. B. & G. Oil, Inc., and Carter 1 J. E. Mitchell; 16-5N-24W. *E. E. Glick, USGS.
253. Wheeler & Ryan, Inc., 1 Campbell; 14-5N-21W. *Schlumberger, 1962.
255. Danilchik and Haley, 1964. *E. E. Glick, USGS, 1957. 7, 18, 19-5S-18W.
260. Sheldon, 1954, p. 97-98. Arkansas Oil Ventures 1 Doggett; 31-10N-3W. *S. E. Frezon, USGS.
264. Sheldon, 1954, p. 110-111. Arkansas Oklahoma Gas 1 S. B. Wall; 29-5N-27W. *S. E. Frezon, USGS. *USGS surf. data.
286. Caplan, 1964, p. 75. 21-2N-10W.
287. Sinclair 1 W. Rockefeller; 8-5N-17W. *B. R. Haley, USGS, 1965.
289. Pan American A-1 U.S. Govt.; 15-12N-22W. *E. E. Glick, USGS, 1964.
291. Pan American 1 Hart; 4-2N-1W. *E. E. Glick, USGS, 1965.
292. Pan American 1 Bosnick Operating Unit; 1-2N-1E. *E. E. Glick, USGS, 1965.
293. Wheeler & Ryan, Inc., 1 U.S. Govt.; 18-5N-26W. *Rinehart, 1963.
294. Sunray DX 1 G. L. Morris; 12-7N-2W. *E. E. Glick, USGS, 1965.
299. Continental 1 W. J. Sorrels; 28-8N-18W. *E. E. Glick, USGS, 1964.
300. Texaco 1 U. S. Govt.; 33-13N-28W. *E. E. Glick, USGS, 1965.
301. E. J. Longyear S-10 Peyton Creek; 12-13N-15W. *E. E. Glick, USGS, 1964.
302. Ambassador Oil 1 Craig; 19-4N-31W. *B. R. Haley, USGS, 1964.
304. Haley, 1960, pl. 63. 25-5N-19W.
305. Haley, 1960, pl. 63. 5-4N-32W.
306. Miser and Purdue, 1929, p. 77. 16-7S-24W.
307. Reinemund and Danilchik, 1957. 12-1N-31W.
309. Caplan, 1954, pl. 6. 6-6N-3W.
310. Caplan, 1954, pl. 5. 36-2N-6W.
311. Caplan, 1954, pl. 5. 10-1N-5W.
312. Caplan, 1954, pl. 5. 24-2S-5W.
313. Caplan, 1954, pl. 8. 24-4S-2W.
314. Caplan, 1954, pl. 8. 23-5S-3W.
317. Caplan, 1964, p. 76. 18-1S-9W.
318. Caplan, 1964, p. 76. 22-1S-4W.
319. Caplan, 1954, pl. 7. Caplan, 1964, p. 76. 22-8N-7E.
320. Caplan, 1964, p. 75. 16-4S-7W.
321. Caplan, 1964, p. 75. 11-3S-4E.
323. Branner, 1896, 3-4N-14W.
324. Stone, 1963. 3N-16W.
325. Caplan, 1954, p. 13-14, pl. 8, well 6.
Flawn and others, 1961, p. 349, well 19.
326. Renfroe, 1949, p. 17-18.
Flawn and others, 1961, p. 349, well 15.
327. Caplan, 1954, p. 13.
Flawn and others, 1961, p. 358, well 69. 33-5S-4W.

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328. Flawn and others, 1961, p. 349, well 18.
329. Flawn and others, 1961, p. 350, well 20.
330. Weeks, 1938, p. 962.
Flawn and others, 1961, p. 354. 25-9S-19W.
331. Imlay, 1940, sec. C-C.
Flawn and others, 1961, p. 354. 27-9S-17W.
332. Spooner, 1935, p. 296-298, well 10.
Flawn and others, 1961, p. 359. 4-9S-11W.
333. Weeks, 1938, p. 962.
Flawn and others, 1961, p. 354. 36-10S-11W.
334. Weeks, 1938, p. 962.
Swain, 1944, p. 589, fig. 7.
Flawn and others, 1961, p. 354, well 43. 28-11S-27W.
335. Hazzard and others, 1947, sec. *B-B'*.
Flawn and others, 1961, p. 354, well 44. 7-11S-14W.
336. Hazzard and others, 1947, sec. *A-A'*.
Flawn and others, 1961, p. 354, well 42. 18-12S-29W.
337. Imlay, 1940, sec. *E-E'*.
Flawn and others, 1961, p. 359, well 75. 27-15S-15W.
338. Imlay, 1940, p. 10.
Hazzard and others, 1947, p. 486-487, sec. *B-B'*.
Flawn and others, 1961, p. 359, well 74. 5-16S-16W.
341. Seely, 1963, pl. 2. 1S-32W.
342. Reinemund and Danilchik, 1957, Poteau Mtn. 29-4N-30W.
343. Carter 1 Royston; 31-10S-24W. *R. F. Faull, Chevron Research Co., 1966, written commun.

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140. Thompson, Wheeler, and Hazzard, 1946, p. 38-39. 24-10N-13E.
Gordon, 1964, p. A22. 10N-13E.
143. Dibblee, 1952, p. 15-19.
Roberts, 1964, p. A44, A49. N½ 29S-39E.
148. Hopper, 1947, p. 410-412. NE¼ 19S-41E.
150. Hazzard, 1954, p. 881-885. 9-23N-8E.
161. Evans, 1958, p. 38-42. 35-16N-13E.
163. Merriam and Hall, 1957, p. 4-7.
Merriam, 1963, p. 24-25, 117°45'W, 36°31' N.
171. Rinehart, Ross, and Huber, 1959, p. 941-944. SW¼ 4S-28E.
174. Skinner and Wilde, 1966. SE¼ 31-36N-3W. NE¼ 36-36N-4W.
201. Hall and MacKevett, 1958, p. 9-10. 1, 2-19S-40E.
202. Johnson, 1957, p. 384. NW¼ 17S-46E.
203. Bowen, 1954, p. 23-34. 33, 34, 35-7N-6W.
206. McCulloh, 1954, p. 15, 17. SE¼ 11N-1W.
207. Dobbs, 1961, p. 51-56. 28, 33-17N-13E.
208. Clary, 1959, p. 30-36. SW¼ 18N-14E.
209. Haskell, 1959, p. 33-42. NW¼ 13N-16E.

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2. I.T.I.O. and Carter 1 Vorce; 28-1S-49W. *AmStrat.
16. Texaco 1 Govt.-Davis; 12-28S-52W. *AmStrat.
28. Sohio 1 Baughman; 29-28S-41W. *AmStrat.
33. L. M. Thompson 1 F. M. Peterson; 27-29S-48W. *AmStrat.
44. D. D. Harrington 1 Homsher "A"; 27-31S-46W. *AmStrat.
45. California 1 J. A. Spikes; 13-31S-48W. *AmStrat.
54. Provincial Oil Corp. 1 State; 36-32S-43W. *AmStrat.
58. A. R. Jones Operating Co. 1 Boyce Cattle Co.; 22-34S-42W. *J. C. Maher, USGS.
72. Maher and Collins, 1952, sheet 1. 2-21S-48W.
74. Maher and Collins, 1952, sheet 16. 23-29S-56W.
79. Maughan and Wilson, 1960, p. 38-39. 12-9N-70W.
98. Pure 1 Adolph Frank; 32-26S-45W. *AmStrat.
103. Continental 1 Colo. State; 4-18S-67W. *J. C. Maher, USGS.

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114. Anderson-Prichard 1 Blanchard; 11-6N-55W. *AmStrat.
122. Chicago Corp. and Republic Nat. 1 A. E. Sheetz; 11-3S-51W. *AmStrat.
129. Gulf 1 U. P. Smith; 19-15S-53W. *AmStrat.
132. Union Oil 1 UPRR; 17-17S-48W. *J. C. Maher, USGS.
133. Maher, 1946. 1-17S-50W.
140. Gulf and Colorado Fuel & Iron 1 Unit; 6-18S-64W. *AmStrat.
141. Continental 1 Paige; 34-18S-66W. *AmStrat.
143. British-American 1 Colorado Sch. Mines; 11-19S-65W. *AmStrat.
144. Continental 1 Young; 11-19S-65W. *J. C. Maher, USGS; AmStrat.
148. Stanolind 1 E. Snell; 7-20S-41W. *AmStrat.
149. Maher, 1946. 6-20S-46W.
150. J. B. Stoddard and Colorado Fuel & Iron 1 Wright; 11-20S-58W. *J. C. Maher, USGS.
156. Maher and Collins, 1952, sheet 1. 31-21S-44W.
157. Maher and Collins, 1952, sheet 1. 27-21S-46W.
158. Shell 1 State; 3-21S-50W. *AmStrat.
160. Skelly 1 M. E. Lutin; 30-21S-65W. *AmStrat.
162. California 1 Luster; 10-22S-47W. *AmStrat.
166. Maher, 1947. 15-23S-46W.
169. Maher, 1947. 32-24S-41W.
173. Pacific Western and Frontier 1 Smith-Govt.; 12-26S-50W. *AmStrat.
174. Carter 1 Strat. hole; 30-26S-57W. *AmStrat.
175. Skelly 1 Weiland; 19-26S-62W. *AmStrat.
176. Skelly 1 Busch; 30-26S-63W. *AmStrat.
177. Skelly 1 Niebuhr; 6-26S-64W. *AmStrat.
178. Skelly 1 Shafer; 32-26S-64W. *AmStrat.
180. Ohio 1 Eldridge; 25-27S-46W. *J. C. Maher, USGS.
181. Marland Prod. Co. 1 Pipe Springs; 27-27S-49W. *J. C. Maher, USGS.
184. Skelly 1 Jolly-U.S.; 30-27S-61W. *AmStrat.
189. Huber and Frontier Ref. 1 Ingle; 27-29S-50W. *AmStrat.
192. Skelly 1 Hawes; 31-30S-44W. *AmStrat.
197. Skelly 1 Glassor; 22-33S-44W. *J. C. Maher, USGS.
203. Stanolind 1 Colorado Fuel & Iron; 31-34S-63W. *AmStrat.
207. Sunray 1-A Hotaling; 27-9N-43W. *AmStrat.
208. Shell 16 Green-A; 30-9N-53W. *AmStrat.
211. Sherrod & Apperson 8 Miles-Don Gillette; 9-9N-61W. *AmStrat.
214. British-American 18 Yenter "B"; 3-8N-54W. *AmStrat.
216. California 1 Meyer; 19-8N-68W. *AmStrat.
218. Brown Drlg. 1 William Pyle; 21-4N-45W. *AmStrat.
219. Ohio 1 Brophy; 31-4N-46W. *AmStrat.
223. Carter 1 Glade Stansfield; 35-3N-50W. *AmStrat.
224. Superior 45-32 Weiss; 32-3N-55W. *AmStrat.
226. Lion Oil 1 Chrismer; 2-2N-48W. *AmStrat.
227. Carter and Mtn. States Drlg. 1 Ed Henik; 8-1N-48W. *AmStrat.
228. Skiles Oil 1 Bower; 34-1N-49W. *AmStrat.
231. Texas 1 Black; 19-1S-47W. *AmStrat.
232. Amerada 1 Corbus J. Heyen; 7-2S-52W. *AmStrat.
236. Continental 1 Powell; 34-8S-45W. *AmStrat.
237. Continental 1 Leoffer; 33-8S-46W. *AmStrat.
238. Superior 1 State; 16-18S-46W. *AmStrat.
239. Continental 1 State-Fergus; 36-18S-48W. *AmStrat.
240. Continental and Strake 1 State; 16-18S-52W. *AmStrat.
241. Continental 1 White; 20-19S-45W. *AmStrat.
243. Imperial Prod. 1 State; 13-22S-55W. *J. C. Maher, USGS.
244. C. A. Wallace 1 Witte; 12-24S-44W. *J. C. Maher, USGS.
246. Baker and Taylor Drlg. 1 LeSage; 2-33S-60W. *AmStrat.

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248. Canada Southern Oil 1 Doyle Nieman; 10-5N-46W. *Chem. and Geol. Lab.
250. Deep Rock Oil 1 W. F. Ernst; 6-5S-49W. *AmStrat.
251. Deep Rock Oil 1 R. L. Edmondson; 33-6S-44W. *AmStrat.
252. Southwestern Explor. 1 State; 16-30S-42W. *AmStrat.
255. Southwestern Explor. 1 Rutherford; 6-29S-45W. *AmStrat.
262. Gulf 1 U. P. Larson; 13-13S-49W. *AmStrat.
264. Huber 1 H. J. Abrams; 24-20S-49W. *AmStrat.
265. Deep Rock Oil and others 1 State; 16-21S-49W. *AmStrat.
266. Maher and Collins, 1952, sheet 2. 8-30S-50W.
267. Skelly 1 Joe Hakins; 34-33S-44W. *AmStrat.
269. Ohio 1 Gall; 23-7N-46W. *AmStrat.
275. Huber and Frontier Ref. 1 Hientz; 22-28S-50W. *AmStrat.
276. Huber and Frontier Ref. 1 McCarroll; 11-28S-50W. *AmStrat.
278. Continental 1 Gente; 32-20S-46W. *J. C. Maher, USGS.
281. P. Livermore 1 I. Green; 8-2S-43W. *AmStrat.
293. Superior 65-23 Weisenberger; 23-19S-49W. *AmStrat.
298. Pure 1 E. K. Warren; 13-23S-68W. *J. C. Maher, USGS.
306. Amerada and Western Nat. Gas 1 O. H. Vail; 19-29S-41W. *AmStrat.
307. Amerada 1 F. L. Crook; 8-24S-47W. *AmStrat.
309. Taylor and Sullivan 1 Mock; 29-34S-59W. *AmStrat.
310. Terminal Facilities, Inc. (Cities Service) 1 Holt "A"; 6-26S-43W. *AmStrat.
311. N. B. Hunt 1 Town of Fowler and others; 33-21S-59W. *AmStrat.
317. Falcon-Seaboard 1 Edmund; 28-7S-47W. *AmStrat.
318. Shell 2 State "B"; 16-8N-53W. *AmStrat.
334. Maughan and Wilson, 1960. 2-11N-70W.
335. Carter 1 Schweitzer; 9-31S-4W. *AmStrat.
336. Pure 1 Henry Teeter; 26-30S-44W. *AmStrat.
350. Boswell and Frates 1 Govt.; 2-35S-52W. *AmStrat.
351. Superior 44-6 Stalford; 6-35S-41W. *AmStrat.
352. Stanolind 1 Bolton-Lamberson; 7-20S-52W. *AmStrat.
353. Sid Katz 1 L. W. Bailey; 30-19S-57W. *AmStrat.
354. British-American 1 Wise; 19-8N-61W. *AmStrat.
355. Megra Oil 1 Stites; 6-14S-44W. *AmStrat.
356. Standard and British-American 1 Morrow; 31-6S-42W. *AmStrat.
357. Phillips 1 Stwalley; 4-24S-43W. *AmStrat.
358. Texas Pacific Coal and Oil 1 Immer; 19-20S-45W. *AmStrat.
359. Katz Oil 1 Einspahr; 23-9S-47W. *AmStrat.
360. W. H. Gaddis 1 G. H. Kamla; 17-3S-42W. *AmStrat.
361. Cree Drlg. Co. 1 Etter; 18-23S-41W. *AmStrat.
362. Amerada 1 C. C. Dillon; 17-27S-51W. *AmStrat.
363. Continental 1 Wellman; 1-25S-50W. *AmStrat.
364. Continental 1 Hasser; 28-25S-49W. *AmStrat.
365. Skelly 1 McMillan; 21-23S-45W. *AmStrat.
366. Cosden Pet. 1 State; 16-22S-45W. *AmStrat.
367. D. D. Harrington 1-A Wagner; 31-23S-49W. *AmStrat.
368. D. D. Harrington 1-A A. B. Harn; 5-22S-50W. *AmStrat.
370. D. D. Harrington 1-A Carl D. Earl; 5-22S-49W. *AmStrat.
373. Shell 1 Federal 4728; 18-10N-56W. *AmStrat.
374. Shell 1 Schmidt; 27-21S-45W. *AmStrat.
375. Seaboard Oil 1 Govt.; 14-26S-53W. *AmStrat.
376. Southwest Explor. 1 Schrader; 20-33S-45W. *AmStrat.
377. Shell 1 Kennie; 1-4N-43W. *AmStrat.
378. Shell 1 Klinginsmith; 1-11N-59W. *AmStrat.
379. M. P. Gilbert 1 Prihbeno; 4-9S-57W. *AmStrat.
381. Amerada 1 State "A"; 36-33S-42W. *AmStrat.
382. Amerada 1 C. A. Newman; 12-32S-42W. *W. L. Adkison, USGS.
383. Davis Oil 1 Rutledge; 28-2S-47W. *AmStrat.

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384. B. F. Allison 1 LeMay; 9-15S-55W. *AmStrat.
385. Shell 1 Colo. Natl. Bank; 12-8N-60W. *AmStrat.
386. Shannon Oil 1 State; 15-21S-52W. *AmStrat.
387. Jones and Arwell 1 Wright-Griffin; 21-22S-52W. *AmStrat.
388. M. J. Le Bsack 1-A Watmore; 30-5S-48W. *AmStrat.
389. Davis Oil 1 Galbreath; 3-4S-50W. *AmStrat.
391. Davis Oil 1 Antholz; 21-6S-48W. *AmStrat.
392. Utah Southern 1 Sheridan-Worm; 4-18S-57W. *AmStrat.
398. Lion Oil (Monsanto) 1 Clair; 23-19S-54W. *AmStrat.
399. Shell 1 Lasher; 5-2N-44W. *AmStrat.
403. Read and others, 1949. 28-36N-4W.
406. Wirt Franklin 1 Hirsch; 28-35N-2W. *Phillips Pet.
407. Phillips 1 Crowley; 1-32N-1E. *Phillips Pet.
409. Stanolind 1 Scott; 20-1N-93W. *AmStrat.
410. Texas and California 20 Unit; 34-3N-94W. *AmStrat.
416. Texas 70-32 UPRR; 32-2N-102W. *AmStrat.
417. Superior 1 Douglas Creek; 5-3S-101W. *AmStrat.
418. Superior 1 Fee; 12-4S-102W. *AmStrat.
421. *M. L. Thompson, Phillips Pet. 36-10N-101W.
463. Pure 1 Unit; 24-46N-14W. *AmStrat.
481. Allison and Prestridge 1 Long; 9-42N-19W. *AmStrat.
496. Stanolind 1 Schmidt; 24-36N-18W. *AmStrat.
498. Slick Moorman 1 Weaver; 1-35N-14W. *AmStrat.
499. Byrd-Frost and Western Nat. 1-A Driscoll; 3-38N-19W. *AmStrat.
527. Great Western Drlg. 1 Ft. Lewis School Land; 3-34N-11W. *AmStrat.
542. Gulf 1 Fulks; 27-37N-17W. *AmStrat.
565. Stanolind 1 Blue; 35-6N-96W. *AmStrat.
566. Stanolind 1 Madison; 22-4N-92W. *AmStrat.
567. Union Oil 1 Crawford; 32-4N-89W. *AmStrat.
568. Texas 1 Colvert; 7-6N-86W. *AmStrat.
570. Phillips 1 Unit; 10-2N-88W. *AmStrat.
Benedum-Trees Oil 1 Govt.-Dougherty; 7-1N-88W. *AmStrat.
590. Luedke and Burbank, 1962. 31-44N-7W.
593. Weir 1 Fee; 33-50N-10W. *AmStrat.
594. Continental 1 Unit; 18-47N-14W. *AmStrat.
595. Pure 1 Unit; 14-46N-13W. *AmStrat.
596. Chicago Corp. 1 Ayers; 31-47N-18W. *AmStrat.
597. Byrd-Frost and Western Nat. 1-A Uhl-Govt.; 26-41N-17W. *AmStrat.
600. Hathaway 1 Lyon-Federal; 11-37N-20W. *AmStrat.
601. Delhi 2 Barker; 3-32N-14W. *AmStrat.
603. Robinson 1 Kagie; 29-4N-87W. *AmStrat.
613. Kerr-McGee 1 Gar Mesa; 8-8S-102W. *AmStrat.
616. Gardner 1 Chura; 4-7N-86W. *AmStrat.
618. General Pet. 1 Schulte; 15-6S-103W. *AmStrat.
620. Greenbriar 1 Federal; 24-5S-102W. *AmStrat.
627. Stanolind B6 Ute Indian; 17-33N-7W. *AmStrat.
630. Histco 1 Eldridge; 19-4N-101W. *AmStrat.
639. Wilson, 1957, p. 54-58, section 11. 29-7N-98W.
640. Gould, 1935, p. 976. 15-13S-77W.
642. Amerada 1 Unit; 14-9S-101W. *AmStrat.
645. California 1 Benton; 14-3S-85W. *AmStrat.
651. Skelly 1 Benton; 15-33N-13W. *AmStrat.
672. Florence 1 Newton; 5-33N-2W. *Phillips Pet.
677. Texaco 1 King Mtn. Unit-Govt.; 2-1S-85W. *AmStrat.
682. Bass and Northrop, 1963, pl. 2. 25-4S-91W.
683. Buford 1 Wyman-Govt.; 16-1N-91W. *AmStrat.
688. Phillips 1 Hell's Hole Canyon; 12-2S-104W. *AmStrat.
711. Pure 1 Unit; 15-15S-104W. *AmStrat.
723. Frontier 1 Unit; 17-2N-97W. *AmStrat.
724. Champlin 1 Black; 4-5S-84W. *AmStrat.

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732. Phillips 1 Mannel; 27-1N-95W. *AmStrat.
737. Dinger 1 Fee; 34-2S-2E. *Phillips Pet.
743. Texaco 2 Govt.-Cheney; 30-3N-86W. *AmStrat.
751. Patrick Doheny 1 Mittlestadt; 23-10N-53W. *AmStrat.
752. *R. F. Wilson, USGS, 12-7N-70W.
753. *R. F. Wilson, USGS, 21, 22-6N-70W.
754. *R. F. Wilson, USGS, 33, 34, and SW¼ 27-5N-70W.
755. *R. F. Wilson, USGS, 27-7N-70W.
756. *R. F. Wilson, USGS, 10-5N-70W.
757. *R. F. Wilson, USGS, 1-3N-71W.
758. *R. F. Wilson and J. D. Wells, USGS, 12-1S-71W.
759. Monsanto Chem. 1 Pointon; 22-21S-51W. *AmStrat.
760. *R. F. Wilson, USGS, 3, 5, 8-6S-69W.
761. *R. F. Wilson, USGS, 11-16S-67W.
762. *R. F. Wilson, USGS, 11, 14-17S-68W.
763. *R. F. Wilson, USGS, 19, 20, 29, 30-18S-70W.
764. *R. F. Wilson, USGS, 9, 11-22S-68W.
765. *R. F. Wilson, USGS, 23, 26-2N-71W.
766. Maughan and Wilson, 1960, p. 38, column 9. 9, 12-10N-70W.
767. McLaughlin, 1947, p. 1944. 28-13S-67W.
768. Colorado Pet. Co. 1 L. V. Hart; 17-17S-67W. *J. C. Maher, USGS.
769. Maher, 1950, p. 3. 11-22S-69W.
770. Maher, 1950, p. 5. 32-19S-70W.
771. Maher, 1950, p. 9. 32-17S-69W.
772. Maher, 1950, p. 11. 19-17S-68W.
773. Maher, 1950, p. 11. 19-17S-70W.
774. Maher, 1950, p. 17. 34-10S-69W.
775. Maher, 1950, p. 19. 2-10S-68W.
776. Maher, 1950, p. 2. 4-23S-68W.
777. Lion Oil 1 Thim; 23-25S-50W. *AmStrat.
778. Pan American 1 Ingram; 4-20S-67W. *AmStrat.
779. Sterling Drlg. 1 Walz; 3-4S-43W. *AmStrat.
780. Honolulu 1 Virgil Glunt; 2-11S-48W. *AmStrat.
781. J. W. Murchison 1 Colo. State; 14-22S-56W. *AmStrat.
782. Phillips 1 Cody; 34, 51-2S-42W. *AmStrat.
784. Kinney Coastal Oil and Ohio 1 Rockwell; 18-1S-45W. *AmStrat.
785. Tennessee Gas & Oil 1-A Nickles; 17-2S-42W. *AmStrat.
786. California 1 UPRR-Ferch; 27-8N-66W. *AmStrat.
787. Creslenn Oil 1 Wilkins; 6-10S-43W. *AmStrat.
788. Davis Oil 1 J. F. Elliston; 3-6S-52W. *AmStrat.
789. Davis Oil 1 Smith 8-4S-48W. *AmStrat.
790. Katz Oil 1 Dieckman; 31-3S-44W. *AmStrat.
791. Van Grisso-Northern 1 State; 16-18S-42W. *AmStrat.
792. Gulf 1 Kakavas; 23-18S-56W. *AmStrat.
793. Ambassador Oil 1 Childers; 25-19S-51W. *AmStrat.
794. Skelly 1-B State; 22-21S-54W. *AmStrat.
795. Phillips 1 Johnson "A"; 25-24S-61W. *AmStrat.
796. Vaughey and Vaughey 1 W. S. Sidney; 3-24S-59W. *AmStrat.
797. Inland Drlg. and L. H. Smith 1 Lash; 35-24S-49W. *AmStrat.
798. William Snee and Robert and Orville Eberly 1 Verhoeff; 34-22S-43W. *AmStrat.
799. Pan American 1 Herd Operating Unit; 22-25S-51W. *AmStrat.
800. Shell 1 Olsen; 21-4N-48W. *AmStrat.
802. Shell 1 Federal Land Bank; 31-34S-44W. *AmStrat.
804. Honolulu 1 McConnell; 20-10S-47W. *AmStrat.
805. Amerada 1 Colo. State C; 17-20S-56W. *AmStrat.
806. Sierra Pet. 1 Hasser; 14-27S-47W. *AmStrat.
807. Excelsior Oil and Hanaker Davis 1 Hoffman; 26-25S-45W. *AmStrat.
808. Pure 1 Byther; 14-25S-48W. *AmStrat.
810. D. D. Harrington 1-A Roy Curtis; 28-28S-49W. *AmStrat.

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811. Clayton Oil 1 Grover-Swift; 13-25S-52W. *AmStrat.
812. Pure 1 Craighead; 24-25S-56W. *AmStrat.
813. Clayton Oil 1 Etchart; 15-26S-52W. *AmStrat.
814. D. D. Harrington 1-A Eagon; 15-28S-49W. *AmStrat.
815. Hamilton Oil & Gas 1 State; 16-28S-48W. *AmStrat.
816. Moran Bros. 1 Homsher; 30-28S-47W. *AmStrat.
817. Kerr-McGee 1 Nation; 15-28S-43W. *AmStrat.
819. Snee and Eberly 1 Davis; 32-22S-44W. *AmStrat.
820. Chandler Musgrove, Inc., 1 State "B"; 15-19S-47W. *AmStrat.
821. Shell 1 Govt. 5374; 2-35S-44W. *AmStrat.
822. Sierra Pet. 1 Caldwalder; 12-35S-46W. *AmStrat.
823. Southwestern Explor. 1 Fugate; 12-32S-45W. *AmStrat.
824. Frankfort Oil 1 Trostel; 36-22S-50W. *AmStrat.
825. R. W. Lange 1 Govt.; 10-29S-62W. *AmStrat.
826. Amerada 1-D State; 16-30S-41W. *AmStrat.
827. Frankfort Oil 1 Rutherford; 25-30S-45W. *AmStrat.
828. Isern Bros. 1 Burnes; 20-13S-43W. *AmStrat.
829. Frankfort Oil 1 Cimmaron; 22-34S-48W. *AmStrat.
830. Petroleum Explor. Texas 1-10 Baughman; 10-28S-42W. *AmStrat.
831. Keith Rising 1 F. J. Wagner; 35-23S-46W. *AmStrat.
832. Amerada 1 Oblander; 30-23S-44W. *AmStrat.
833. Davis Oil 1 Blomstrom; 9-1S-47W. *AmStrat.
834. Shell 1 Clevenger; 2-35S-42W. *AmStrat.
835. Keener Oil 1 Nelson; 6-26S-51W. *AmStrat.
836. D. D. Harrington 1 Baughman Farms "A"; 19-20S-47W. *AmStrat.
837. Samuel Gany 1 Kirby; 20-18S-47W. *AmStrat.
838. Frankfort Oil 1-16 State; 16-20S-48W. *AmStrat.
839. Amerada 1 Colo. "E"; 16-29S-43W. *AmStrat.
840. Frankfort Oil 1 Lanterman; 7-31S-45W. *AmStrat.
841. U.S. Smelting, Ref. and Mining 1-1 Stulp; 1-1N-47W. *AmStrat.
842. Texota 1 Hansen; 30-8N-43W. *AmStrat.
843. Creslenn Oil 1 UPRR-Hoff; 5-13S-42W. *AmStrat.
845. Delhi-Taylor Oil 1-16 State; 16-18S-69W. *AmStrat.
847. Germany Invest. 1 Vaugh-Etter; 18-23S-42W. *AmStrat.
848. Frankfort Oil 1 Kern; 5-23S-47W. *AmStrat.
849. Germany Invest. 1 Lackay; 27-31S-47W. *AmStrat.
850. Moran Bros. 1 Rice; 12-32S-49W. *AmStrat.
851. Moran Bros. 1 Cramer; 12-33S-50W. *AmStrat.
852. Moran Bros. 1 Singer; 3-35S-50W. *AmStrat.
853. Scopel, 1964, p. 39-40. 26-2S-67W.
854. McLaughlin, 1947, p. 1948-1949. 3, 4, 5, 10-14S-67W.
855. Shannon Oil and Fremont Pet. 1 Govt.-Sapp; 24-23S-51W. *AmStrat.
856. Sands Oil 1 Hunter-Welch; 13-34S-49W. *AmStrat.
857. Sullivan and Parley 1 Doughtery; 15-32S-56W. *AmStrat.
858. J. K. Wadley 1 Fee; 23-32S-54W. *AmStrat.
859. Sands Oil 1 Wear; 14-20S-51W. *AmStrat.
860. Pan American 1 Thompson; 24-31S-44W. *AmStrat.
861. Sands Oil 1 State; 15-21S-47W. *AmStrat.
862. Snee and Eberly 1 Bothwell; 31-20S-42W. *AmStrat.
863. D. D. Harrington 1-A Schneider; 9-22S-48W. *AmStrat.
864. McDannald Oil 1 Young; 21-5S-47W. *AmStrat.
865. Shawnee Oil and others 1 Rodman-State; 1-7N-52W. *AmStrat.
866. Champlin 1 Dodge; 9-26S-44W. *AmStrat.
867. Keith Rising 1 Baughman; 30-18S-50W. *AmStrat.
868. British-American 4 K. E. Segel; 26-11N-53W. *AmStrat.
869. Sharples Oil 1 Jacobson, 28-29S-50W. *AmStrat.
880. Thompson, 1945, 31-6N-102W.
881. Bissell and Childs, 1958. 19-6N-99W.
882. Thompson, 1945, figs. 5, 9, 18-6N-94W.
884. Amerada 1 Unit; 9-5N-94W. *AmStrat.
885. Stuart McLaughlin 1 Myer-State; 36-4N-103W. *AmStrat.
886. Thompson, 1945, fig. 2. 2-3S-88W.
887. Murray, 1958, pl. 7. 29-4S-86W.
888. Cameron 1 Bowen; 20-4S-93W. *AmStrat.
889. Pan American 1 Tully; 30-6S-85W. *AmStrat.
890. Murray, 1958, pl. 7. 1-6S-81W.
890. *T. G. Lovering, USGS, 1965, written commun.; Mackenzie Gordon, USGS, 1966, written commun. 1-6S-81W.
891. Forest 1 Govt.; 2-7S-104W. *AmStrat.
892. Shannon 1 Rose; 12-7S-89W. *AmStrat.
*W. W. Mallory, USGS, in prep. Cattle Creek section.
893. *U.S. Bur. Reclamation, Meredith core hole. 8-8S-84W.
894. *R. L. Langenheim, 1956, written commun. 29-9S-88W.
895. Vanderwilt, 1937, p. 22-24. 28-11S-87W.
896. Mallory, 1957, p. 50-53, section 10. 36-13S-85W.
897. Mid-Colorado 1 Mower; 14-14S-95W. *Phillips Pet.
898. Sterling 1 Reagan; 6-14S-91W. *Phillips Pet.
899. Williamson 1 Peters; 15-15S-95W. *Phillips Pet.
900. Wengerd and Matheny, 1958, fig. 4. 26-37N-9W.
902. *W. W. Mallory, USGS, in prep. 12-2S-93W. Miller Creek section.
903. *W. W. Mallory, USGS, in prep. 14-4S-92W. East Rifle Creek section.
904. Karig, 1963, fig. 4. 9-24S-73W.
905. Lynch, 1957, p. 38, section 7. 24-49N-9E.
906. McGehee, 1957, p. 35-37, section 6. 33S-69W.
907. Chronic, 1957, p. 39-45, section 8. 33-1S-84W.
908. *D. L. Baars and others, Shell Oil, 1955, written commun. 29-40N-8W.
909. Tennessee Gas Trans. 1-B State; 14-41N-7E. *AmStrat.
911. Patton and others, 1912, p. 56. 8-9S-77W.
912. Burbank, 1932, pl. 5. 27-46N-8E.
913. Brill, 1952, pl. 1. 5-26S-71W.
914. Intex 1 Halls; 35-45N-8W. *AmStrat.
915. Kerr-McGee 1 Placerville Unit; 11-43N-11W. *AmStrat.
916. Parker and McCune 1 Ferris Trail; 16-39N-16W. *AmStrat.
918. Penrose and Tatum 5 Scott; 2-45N-12W. *AmStrat.
919. De Barard Cattle 1 State; 27-4N-81W. *AmStrat.

CONNECTICUT

8. Krynine, 1950, p. 49-51.
*R. J. Ross, Jr., USGS, 1950.

GEORGIA

17. *H. R. Wanless, Illinois Univ., 1939. Near Davis School; White Oak Gap, Sand Mountain.
19. Troxell, 1946, p. 9, col. 1. U.S. Bur. Mines diamond drill hole 1. *H. R. Wanless, Illinois Univ., 1939. Round Knob, Nickajack Gap.
21. *H. R. Wanless, Illinois Univ., 1939. Steven Gap, Lookout Mountain.
26. *H. R. Wanless, Illinois Univ., 1939. Cloudland Park, Lookout Mountain.
28. Hayes, 1902, p. 4. Rocky Mountain.
29. *Confid.

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16. Phillips 1 Horseshoe Unit; 28-5N-44E. *AmStrat.
63. *V. McKelvey, USGS, 1963, written commun. 24-6S-42E.

IDAHO—Continued

82. *E. R. Cressman, M. A. Warner, and F. S. Honkala, USGS, 1963, written commun. 33-9S-45E.
100. *Harold Bissell, Utah Univ., 1963, written commun. 18-14S-34E.
103. Ross, 1962, p. 58.
104. *L. Mannion, Stauffer Chem., 1962, written commun. 9-13S-44E.
105. *Louis Gardner, UGSG, 36-3S-44E.
106. *D. A. Jobin, USGS, 1962, written commun. 25-1N-45E.
107. *M. H. Staatz and H. F. Albee, USGS, 1962, written commun. 12-4N-43E.
108. *Harold Bissell, Utah Univ., 1963, written commun. 12-12S-29E.
109. Shannon, 1961, fig. 2. 16, 21-6N-30E.
110. Thomasson, 1959, pl. 37c. 15-2N-23E.
111. *E. T. Ruppel, USGS, 1964, written commun. 6, 7-16N-27E.

ILLINOIS

1. *H. R. Wanless, Illinois Univ., 1934. 12-21N-4E.
4. Frank Stultz Insurance well; 25-20N-8E. *Illinois Geol. Surv.
5. E. Stevenson 1 James M. Rahn; 1-19N-9E. *Illinois Geol. Surv.
8. Whitebreast Fuel C hole; 36-18N-10E. *Illinois Geol. Surv.
9. F. E. Webb 1 Abraham; 24-18N-8E. *Illinois Geol. Surv.
10. Amboy Oil and Gas 1 Kidder; 22-18N-7E. *Illinois Geol. Surv.
11. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv., 15-18N-3E.
13. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv., 15, 24-18N-1E.
14. *H. R. Wanless, (09N36-09N25), Illinois Univ., 1930; 25, 36-17N-4W.
15. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv., 29, 32-17N-3W.
16. C. F. Teeple Milan Packing well; 17-17N-2W. *Illinois Geol. Surv.
18. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv., 21-17N-1E.
    Larson and Swanson Mrs. Sylvia Seys well; 22-17N-1E. *Confid.
19. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv., 28, 34-17N-2E.
    Larson and Swanson 1 Lucille Young; 14-17N-2E. *Confid.
25. Whitebreast Fuel coal test; 20-17N-11E. *Illinois Geol. Surv.
    Whitebreast Fuel 21 hole; 24-17N-11E. *Illinois Geol. Surv.
    Whitebreast Fuel 11 hole; 16-17N-11E. *Illinois Geol. Surv.
26. John Bolliger and Sons 1 Mark Setchell; 19-35N-2E. *Illinois Geol. Surv.
27. C. R. Johnson John Krug well; 35-35N-3E. *Illinois Geol. Surv.
28. Commonwealth Edison 21 Powers; 25-34N-8E. *Illinois Geol. Surv.
30. T. T. Anderson Hoge School well; 26-34N-6E. *Illinois Geol. Surv.
32. Willman and Payne, 1942, p. 288-289. Charles F. Woodruff 1 W. A. Bradford; 31-34N-4E. *Illinois Geol. Surv.
41. AnnaWan Creamery well; 3-16N-5E. *Illinois Geol. Surv.
47. D. E. Edwards-Walter Fuhr well; 17-16N-3W. *Illinois Geol. Surv.
51. Coal Valley Min. 18 hole; 18-15N-4W. *Illinois Geol. Surv.
53. Coal Valley Min. 8 hole; 34-15N-2W. *Illinois Geol. Surv.

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    Jones and Schmeiser 1 (?) Village of Matherville; 27-15N-2W. *Illinois Geol. Surv.
54. Coal Valley Min. 3 hole; 8-15N-1W. *Illinois Geol. Surv.
    Coal Valley Min. 4 hole; 6-15N-1W. Illinois Geol. Surv.
    Ken Schmeiser 1 (?) Village of Sherrard; 4-15N-1W. *Illinois Geol. Surv.
55. Kewanee Coal Co. test; 10-15N-1E. *Illinois Geol. Surv.
    Peerless Service Russell Lindquist well; 12-15N-1E. *Illinois Geol. Surv.
60. Peerless Service 1 City of Neponset; 10-15N-6E. *Illinois Geol. Surv.
61. *Illinois Geol. Surv. 13, 14, 23-15N-8E.
65. Whitebreast Fuel 3 hole; 30-33N-1W. *Illinois Geol. Surv.
68. *Illinois Geol. Surv., 30-33N-3E. Truax-Traer Coal 4A hole; 30-33N-3E. *Illinois Geol. Surv.
72. Peabody Coal 7 hole; 29-33N-7E. *Confid.
73. Star Coal 1; 32-33N-8E. *Illinois Geol. Surv. EJ and ERR 1 (?) Coal City; 34-33N-8E. *Illinois Geol. Surv.
74. Chicago 1 Wilmington Coal Co.; 3-33N-9E. *Illinois Geol. Surv.
    Northern Illinois Coal Co. 323 hole; 34-33N-9E. *Illinois Geol. Surv.
76. Willman and Payne, 1942, p. 322. Wilmington Star Min. bore hole; 17-32N-8E.
79. Jim Gordon Farm well; 30-32N-5E. *Illinois Geol. Surv.
83. Willman and Payne, 1942, p. 322-323.
86. R. J. Fogerty 1 Magoon Kane; 9-14N-9E. *Illinois Geol. Surv.
91. Galva Coal test; 35-14N-4E. *Illinois Geol. Surv. Midwest Drlg. Defense Plant Corp. well; 35-14N-4E. *Illinois Geol. Surv.
96. Alden Coal 6 coal test; 17-14N-2W. *Illinois Geol. Surv.
    Hydraulic Press Brick 9 hole; 8-14N-2W. *Illinois Geol. Surv.
100. Wanless, 1929, p. 61-67, p. 77 (19-13N-2W), p. 172 (1-13N-2W).
111. St. Paul and Braceville Coal Co. coal test; 5-31N-1E. *Illinois Geol. Surv.
112. Willman and Payne, 1942, p. 317. Chicago, Wilmington, and Vermilion Coal 1 shaft; 10-31N-3E.
118. Athy, 1928, p. 100-101. Diamond drill holes; 6, 7, 8-30N-9E.
120. C and A RR round house depot well; 8-30N-7E. *Illinois Geol. Surv.
122. Frank Ellison 1 Mooney; 16-30N-8E. *Illinois Geol. Surv.
123. Willman and Payne, 1942, p. 320-321.
    Lamar, 1929, p. 10. 6-30N-4E.
124. C. S. Cumming 1 James Daugherty; 6-30N-3E. *Illinois Geol. Surv.
125. Willman and Payne, 1942, p. 325-326.
126. Willman and Payne, 1942, p. 326. Cherry Option Synd. 6 coal test; J. P. Miller Artesian Well 1 Village of Varna; 28-30N-11W. *Illinois Geol. Surv. 9-30N-11W.
131. Varner Drlg. 2 Wyoming City; 1-12N-6E. *Illinois Geol. Surv.
132. Watson, Egbert, and others 1 hole; 22-12N-5E. *Illinois Geol. Surv.
133. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 30-12N-4E. R. P. Ringle 1 W. T. Boehringer; 27-12N-4E. *Illinois Geol. Surv.
135. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 13, 24-12N-2E. Peerless Service 1 Village of Wataga; 16-12N-2E. *Illinois Geol. Surv.
139. John Acheson 1 E. R. Hawkins and son; 33-12N-3W. *Illinois Geol. Surv.
140. Ellis Jones Fred Pattee well; 18-11N-3W. *Illinois Geol. Surv.
142. *Illinois Geol. Surv., 20-11N-1W. Johnson Coal test; 6-11N-1W. E. E. St. George Coal test; 33-11N-1W.

ILLINOIS—Continued

147. H. R. Miller and Sinclair 1 Cudahy Pipeline; 22-11N-5E. *Illinois Geol. Surv.
149. *H. R. Wanless, Illinois Univ., 1929. 5-11N-7E. *Illinois Geol. Surv., 7-11N-7E. C. W. Holmes 2 Z. M. Holmes; 13-11N-7E.
152. Willman and Payne, 1942, p. 327-328. Cady, 1915, p. 136-137.
156. Layne Western 9 City of Odell; 3-29N-6E. J. Bolliger 1 Thomas Curtis; 16-29N-6E. *Illinois Geol. Surv.
161. G. Berns 1 Flos. O'Connor; 14-24N-14W. *Illinois Geol. Surv.
162. Old coal test boring; 27-29N-13W. *Illinois Geol. Surv.
167. A. Adams Meriotte well; 4-28N-13W. *Illinois Geol. Surv.
170. Lowell French 1 Kempton Village; 6-28N-9E. *Illinois Geol. Surv.
172. Bennett Reeder 2 well; 15-28N-7E. *Illinois Geol. Surv. Saunemin city well; 15-28N-7E. *Illinois Geol. Surv.
173. Pontiac coal shaft; 23-28N-5E. Illinois Police Headquarters well; 33-28N-5E. *Illinois Geol. Surv.
174. Ben Weichman well; 8-28N-3E. *Illinois Geol. Surv.
175. Minouk shaft; 7-28N-2E. *Illinois Geol. Surv.
176. John Deitrick and others 1 Banta; 26-28N-2W. *Illinois Geol. Surv.
177. Peerless Service Alta School Dist. 303 well; 31-10N-8E. *Illinois Geol. Surv.
178. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 30, 31-10N-7E.
187. W. C. Swallow 1 Watson; 33-10N-3W. *Illinois Geol. Surv.
192. *Illinois Geol. Surv.; 15, 31, 35, 36-9N-1E.
194. Truax-Traer Coal R15 hole; 33-9N-3E. Larson and Swanson 1 Margaret Bloomer; 16-9N-3E. *Illinois Geol. Surv. *H. R. Wanless, Illinois Univ., 1929. Illinois Geol. Surv.; 27, 29-9N-3E.
198. Udden, 1912, p. 23-24, 28-41. 29, 30, 31, 36-9N-7E.
201. J. Bolliger and Sons 1 Elsie Wahls; 33-27N-5E. *Illinois Geol. Surv.
204. ICRR well; 31-27N-14W. *Illinois Geol. Surv.
210. *Illinois Geol. Surv.; 14-26N-17W.
211. Charles Cummings well (?), 21-26N-13W. *Illinois Geol. Surv.
213. Herndon Drlg. 1 W. J. Fecht; 33-26N-9E. *Illinois Geol. Surv.
216. *H. L. Marsh-Fairbury shaft; Illinois Geol. Surv. 4-26N-6E.
220. Paul H. Martin 1 Joseph Zuercher; 29-26N-3W. *Illinois Geol. Surv.
221. Cedar St. bridge test; 30-26N-4W. *Illinois Geol. Surv. Peoria Mineral 1 Lee Haut; 23-26N-4W. *Illinois Geol. Surv.
225. *H. R. Wanless, Illinois Univ., 1929; 3, 5-8N-5E. A. C. Steinberg 3 coal test; 4-8N-5E. *Illinois Geol. Surv. Algoma Oil 1 Charles Cramer; 27-8N-5E. *Illinois Geol. Surv.
227. *Illinois Geol. Surv.; H. R. Wanless, Illinois Univ., 1929. 20, 21, 28, 34-8N-3E. Star Coal 1 Parrville; 30-8N-3E. *Illinois Geol. Surv.
228. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 26-8N-2E. Star Coal Co. Frederick test; 28-8N-2E. Willis Peterson E. A. Brokaw well; 24-8N-2E. *Illinois Geol. Surv.
230. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 24-8N-1W. Brettini Oil & Gas 1 Clayburg; 14-8N-1W. *Illinois Geol. Surv.
231. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 16-8N-2W. J. Simpson 1 Stanfield; 17-8N-2W. Hy Staat well; 27-8N-2W. *Illinois Geol. Surv.
233. Northern Ordnance 1 Willis Adams; 28-8N-4W. *Illinois Geol. Surv.
234. J. N. Lovitt L. E. Lovitt well; 17-8N-5W. *Illinois Geol. Surv.

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235. O. C. Peck Farm well; 23-7N-6W. *Illinois Geol. Surv.
239. Savage and Nebel, 1923, p. 44. Walnut Grove Township well; 9-7N-2W.
240. Old Prairie City coal test; 1-7N-1W. *Illinois Geol. Surv.
243. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 32-7N-3W.
Star Coal 4 hole; 29-7N-3E. R. McAllister 1 Truax-Traer Coal; 33-7N-3E. *Illinois Geol. Surv.
247. Crescent Min. 43 hole; 6-7N-7E. Crescent Min. 31 hole; 7-7N-7E. Acme Harvester coal test; 25-8N-7E. *Illinois Geol. Surv.
252. Earnest Zink 1 Watson; 33-25N-7E. *Illinois Geol. Surv.
254. Milford Coal test; 14-25N-12W. *Illinois Geol. Surv.
256. Earnest Zink 1 H. Sibley; 1-24N-7E. *Illinois Geol. Surv.
257. Minnesota Prod. 1 J. McGowan; 33-24N-5E. *Illinois Geol. Surv.
258. H. V. House 1 W. H. Greening; 28-24N-2W. *Illinois Geol. Surv.
259. Turner Hudnut Co. Elm Grove saltwell; 20-24N-6W. *Illinois Geol. Surv.
265. *H. R. Wanless, Illinois Univ., 1929. 21, 23-6N-1E.
268. *Illinois Geol. Surv.; H. R. Wanless, Illinois Univ., 1929. 23, 26-6N-3W.
270. Savage and Nebel, 1923, p. 40 (3-6N-5W), p. 41 (7-6N-5W).
271. H. Mourning 1 Wm. Miller; 24-5N-8W. *Illinois Geol. Surv.
272. Plymouth Well 1 Broadhead; 14-5N-5W. *Illinois Geol. Surv.
278. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 19-5N-2E.
280. *H. R. Wanless, Illinois Univ., 1927; Illinois Geol. Surv. 1-5N-4E. 17, 20-5N-4E.
Darrell Bowton and others 1 P. J. McNally; 19-5N-4E.
284. McLean County Coal shaft; 5-23N-2E. *Illinois Geol. Surv.
287. D. K. Roth 1 Glenn Reynolds; 31-23N-8E. *Illinois Geol. Surv.
292. A. L. Stice Rossville Packing well; 12-22N-12W. *Illinois Geol. Surv.
295. Heyworth city well; 27-22N-2E. *Illinois Geol. Surv.
297. *Illinois Geol. Surv. 19-22N-6W.
300. *H. R. Wanless, Illinois Univ., 1927; Illinois Geol. Surv. 27, 34-4N-2E.
W. B. Lagers and F. E. Webb 1 Claude E. Cleer; 28-4N-2E. *Illinois Geol. Surv.
303. *Illinois Geol. Surv. 30-4N-2W. H. R. Wanless, Illinois Univ., 1929.
Bur-Kan Pet. 1 Katie Chapman; 23-4N-2W. *Illinois Geol. Surv.
304. Hinds, 1919, p. 5-6 (25-4N-3W). *H. R. Wanless, Illinois Univ., 1929. 20-4N-3W.
308. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 26, 27, 34-3N-5W.
310. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv. 10, 13, 14-3N-3W.
311. *W. C. Morse, 1916(?); Illinois Geol. Surv. 13-3N-2W.
C. E. Hites 1 Miller; 13-3N-2W. *Illinois Geol. Surv.
314. *H. R. Wanless, Illinois Univ., 1929. 3, 13-3N-2E. Astoria Oil & Gas Devel. 1 Salisbury; 24-3N-2E.
318. F. Strickland 1 Cook; 25-21N-4E. *Illinois Univ. microfilm, reel 183.
319. Coal test bore; 21-21N-5E. *Illinois Geol. Surv. Farmer City diamond drill hole; 8-21N-5E. *Illinois Geol. Surv.
320. E. V. Richardson 1 Wisegarver; 22-21N-7E. *Illinois Geol. Surv.
325. Kay and White, 1915, p. 17-19.

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327. Barber and Seivers 1 Teap; 20-20N-10E. *Illinois Univ. microfilm, reel 83.
328. Barber and Seivers 1 Lindsey; 20-20N-8E. *Illinois Geol. Surv.
330. Paul Doran 1 Arbogast; 10-20N-4E. *Illinois Univ. microfilm, reel 83.
332. Old coal test; 10-20N-2E. *Illinois Geol. Surv.
334. Citizens Coal & Min. coal test; 32-20N-2W. Bay Oil 1 Grace M. Lake; 11-20N-2W. *Illinois Geol. Surv.
335. A. M. Park 4 hole; 31-20N-3W. *Illinois Geol. Surv.
338. *H. R. Wanless, Illinois Univ., 1929. 26, 36-2N-1W.
342. W. A. Schuster 1 City of Golden well and Henry Schuster W. L. Bruns well; 31-2N-5W. *Illinois Geol. Surv.
344. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv. 36-2N-6W.
345. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv. 16-1N-6W. Guy Gabel 1 Marion G. Jackson; 24-1N-6W. Illinois Geol. Surv.
346. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv. 12, 13-1N-5W. Harry E. Miller 1 Miller; 12-1N-5W. *Illinois Geol. Surv.
348. *H. R. Wanless, Illinois Univ., 1929; Illinois Geol. Surv., 23, 32, 34-1N-3W.
355. Bruder and others 1 Stilt; 16-19N-4W. *Illinois Geol. Surv.
357. Logan Devel. 1 Foley; 3-19N-2W. *Illinois Geol. Surv.
360. J. S. Young, Jr., 1 Roy Shinneman; 11-14N-4E. *Illinois Geol. Surv.
362. J. W. Stipes and E. M. Burr Power Plant; 12-19N-8E. *Illinois Geol. Surv.
367. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv. 21, 27-19N-11W.
   Old core tests, Fairmount, 16-18N-13W. *Illinois Geol. Surv.
369. C. L. English Nesbitt Farm well; 10-18N-12W. Jet Oil 1 Henry C. Finley; 9-18N-12W. *Illinois Geol. Surv.
370. *Illinois Geol. Surv. 20-18N-13W. R. N. Sylvester 1 Trisler; 30-18N-13W.
371. A. M. Meyers and others 1 Newt Foreman; 3-18N-14W. *Illinois Geol. Surv.
372. Sydney coal shaft, 16-18N-10E. *Illinois Geol. Surv.
378. Coal Test; 2-18N-2E. *Illinois Geol. Surv.
380. Mt. Pulaski Coal Co., shaft; 27-18N-2W. Mrs. Mayer 1 well; 22-18N-2W. *Illinois Geol. Surv.
382 Lee Werner 1 Britin; 22-18N-4W. *Illinois Geol. Surv.
388. Culver, 1925, p. 66. *H. R. Wanless, Illinois Univ., 1927. 11, 14-18N-11W.
390. *W. C. Morse, 1916(?), Illinois Geol. Surv. 6-15N-2W.
393. Concord Drlg. 1 Jefferson ;10-1S-5W. *Illinois Geol. Surv.
396. *Ben Cox, note 140 (field note 105, 36-25N-7W), note 137 (field note 105, 22-25N-7W), Illinois Geol. Surv.
399. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv. 8-25N-4W.
402. Cass. Com. Oil 1 (?) J. Maslin; 2-17N-10W. *Illinois Geol. Surv.
405. Lloyd Coal mine shaft; 23-17N-7W. Earnest Zink 1 Epling; 8-17N-7W. *Illinois Geol. Surv.
407. Peabody Coal 1 hole; 36-17N-5W. George W. Spence 1 Oscar Elliot; 21-17N-5W. *Illinois Geol. Surv.
410. Sun 1 Robert Knap; 27-17N-1W. *Illinois Geol. Surv.
413. Breeze and Bayless 1 Hiser; 27-17N-3E. *Illinois Univ. Microfilm, reel 183.
414. H. G. Kuns 1 (?) well; 35-17N-4E. Theo. Myers 1 Wagoner Est.; 24-17N-4E. *Illinois Geol. Surv.
426. Carter 1 Lydia Busby; 5-16N-11W. *Illinois Univ. microfilm, reel 115.

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427. Coal test; 32-16N-12W. *Confid. Burkett 1 (?) Schnitker; 30-16N-11W. *Illinois Geol. Surv.
431. C. H. Lewis 1 Gilloughly coal test; 36-16N-9E. *Illinois Geol. Surv.
433. Joy Drlg. 1 Natl. Petrochemical; 36-16N-7E. T. M. Courcy Drlg. 1 Collins; 35-16N-7E. *Illinois Geol. Surv.
435. Natl. Assoc. Pet. 1 H. Reed; 6-16N-5E. *Illinois Univ. microfilm, reel 83.
440. Niantic coal shaft; 12-16N-1W. *Illinois Geol. Surv.
441. Sullivan Machinery 1 Bullard; 26-16N-3W. Edgar White 1 Alvie Pryor; 21-16N-3W. *Illinois Geol. Surv.
444. Peabody Coal 2 hole; 1-16N-6W. *Illinois Geol. Surv.
449. *Illinois Geol. Surv.; H. R. Wanless, Illinois Univ., 1930. 2-16N-12W. R. R. Long André; 9-16N-12W. *Illinois Geol. Surv.
450. *Illinois Geol. Surv. 8-35N-4W.
453. *H. R. Wanless, Illinois Univ., 1930; Illinois Geol. Surv. 10, 15-4S-5W.
456. *Illinois Geol. Surv. 25-15N-13W. *H. R. Wanless, Illinois Univ., 1930.
   19-15N-12W, 23-15N-13W. *Illinois Geol. Surv.
460. Frank Byrns and others 1 Mrs. Katie Byrns; 21-15N-9W. *Illinois Geol. Surv.
463. Peabody Coal 3 hole; 12-15N-6W. Peabody Coal 2 hole; 13-15N-6W. *Illinois Geol. Surv.
467. Mid-Illinois Pet. 2 Ralph; 27-15N-2W. *Illinois Geol. Surv., control well 115.
470. Columbus Explor. 1 Hogan; 21-15N-2E. *Illinois Univ. microfilm, reel 83.
474. *Confid. 13-15N-6E.
475. H. C. Sanders 1 Huckaba; 25-15N-7E. *Illinois Univ. microfilm, reel 83.
478. C. E. Freeman W. E. Brown well; 35-15N-10E. *Illinois Geol. Surv.
480. Louillo Oil 5 J. Congdon core test; 6-15N-13W. *Illinois Geol. Surv.
485. J. R. Heinnen 1 J. B. Suddeth; 31-14N-12W. *Illinois Geol. Surv.
489. W. L. Topk 1 T. D. Basler; 26-14N-9E. *Illinois Geol. Surv.
490. J. L. Schaefer 1 Thompson; 29-14N-8E. *Illinois Geol. Surv.
492. F. K. Frederick 1 McDonald; 2-14N-6E. *Illinois Univ. microfilm, reel 83.
493. H. C. Sanders 1 Brewer; 5-14N-5E. *Illinois Univ. microfilm.
495. Harry R. Lippitt 1 Virgil Pasley; 34-14N-3E. *Illinois Geol. Surv.
500. Peabody Coal 72 hole; 26-14N-3W. *Confid.
505. *H. R. Wanless, Illinois Univ., 1930. 31-14N-8W. Apple Creek Co. coal test; 36-14N-9W. *Illinois Geol. Surv.
506. Coal test; 9-14N-10W. *Illinois Geol. Surv. Allan J. Coe 1 Carl Robinson; 29-14N-10W. *Illinois Geol. Surv.
508. T. F. James well; 23-5S-4W. *Illinois Geol. Surv.
509. *Illinois Geol. Surv.; H. R. Wanless, Illinois Univ., 1930. 14-13N-12W.
516. Madison Coal 6 hole; 21-13N-5W. *Illinois Geol. Surv.
527. Duncan 1 Cobb; 10-13N-7E. *Illinois Geol. Surv., control well 214.
529. Merle P. Steward and Son 1 Humphries; 35-13N-9E. *Illinois Geol. Surv.
530. Yellowhammer Oil 1 Flynn; 10-13N-10E. *Illinois Univ. microfilm, reel 83.
531. H. C. Sanders 1 Childress; 30-13N-11E. *Illinois Univ. microfilm, reel 83.

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534. J. W. Rudy 1 Stanfield; 24-13N-12W. *Illinois Univ. microfilm, reel 115.
536. Universal G hole; 7-13N-10W. *Confid.
539. F. L. Strickland 1 Joe Staub; 30-12N-12W. *Illinois Univ. microfilm, reel 115.
545. A. E. Keating 1 F. Upholf; 25-12N-7E. *Illinois Geol. Surv.
546. Paul Doran 1 Edwards; 11-12N-6E. *Illinois Univ. microfilm, reel 81.
549. M. H. Richardson 1 H. Moore; 4-12N-3E. *Illinois Univ. microfilm, reel 81.
551. Kay, 1915, p. 74-77.
554. Collingwood, 1924, p. 22-23.
555. Peabody Coal 47 hole; 24-12N-4W. *Confid.
556. Kay, 1915, p. 142-144, 144-146.
558. Ball, 1952, p. 106-107.
559. Payne, 1942, pl. 3, col. 4. *H. R. Wanless, Illinois Univ., 1930. 1, 12-12N-9W, 15-12N-8W, Scottville.
560. *Illinois Geol. Surv. 7, 12, 18-12N-9W. James Castle 1 Glen Butcher; 17-12N-9W.
564. Lamar, 1931, p. 40-43.
568. Ball, 1952, p. 103-104.
570. Ball, 1952, p. 101-102.
573. Peabody Coal 48 hole; 6-11N-3W. *Confid. Sun Oil 1 Mundheuke; 5-11N-3W. *Illinois Geol. Surv.
575. Donk Coal 27 hole; 26-11N-1W. Gulf 1 R. B. Sieger; 26-11N-1W. *Illinois Geol. Surv.
578. Sims 1 Bauer; 21-11N-3E. *Illinois Geol. Surv., control well 73.
579. Shelby Coal & Nat. Gas coal test; 18-11N-4E. Oil Securities 1 Kensil; 22-11N-4E. *Illinois Geol. Surv.
580. Paul Doran 1 York; 13-11N-5E. *Illinois Univ. microfilm, reel 81.
583. E. C. Reeves 1 Miller; 6-11N-8E. *Illinois Univ. microfilm, reel 81.
586. Natl. Assoc. Pet. 1 Spelbring; 8-11N-14W. *Illinois Univ. microfilm, reel 114.
587. M. M. Strickler and R. Hurst 1 Joe Fitzgerald; 10-11N-13W. *Illinois Geol. Surv.
589. Texas 1 Coldren; 4-11N-11W. *Illinois Geol. Surv., control well 198.
592. Henry R. Smith 1 Higginbottom; 34-10N-12W. *Illinois Geol. Surv.
595. B. H. Nation 1 Strong; 9-10N-10E. *Illinois Univ. microfilm, reel 80.
596. M. Ritchie 1 Greeson; 4-10N-9E. Sohio 1 Moses; 28-10N-9E. *Illinois Geol. Surv.
600. R. A. Hose 1 Falk; 15-10N-5E. *Illinois Univ. microfilm, reel 80.
603. Paul Doran 1 Whitlock; 16-10N-2E. *Illinois Geol. Surv., control well 240.
608. David Claypool 1 J. Held; 8-10N-4W. *Illinois Geol. Surv. E. L. Wirth 2 Poggenpohl; 10-10N-4W. *Illinois Geol. Surv.
609. Gulf 1 Lucin More; 12-10N-5W. *Illinois Geol. Surv.
610. Kay, 1915, p. 92, 94. 34-10N-6W. Payne, J. N., 1942, pl. 3, column 5. 9-10N-6W. *H. R. Wanless, Illinois Univ., 1930. 34, 35-10N-6W.
611. Ball, 1952, p. 100-101. Calvert Drlg. 1 Oscar McLin; 20-10N-7W. *Illinois Geol. Surv.
614. B. W. Quick 1 Charles W. Meng; 9-10N-10W. *Illinois Geol. Surv.
616. *H. R. Wanless, Illinois Univ., 1930. Illinois Geol. Surv. 11, 12-10N-12W.
617. Lamar, 1931, p. 23-29.
619. Chesterfield well; 31-10N-9W. *Illinois Geol. Surv.
622. Ball, 1952, p. 97. Fuller and Turner 1 Chamness.
625. Sullivan Machinery Co. well and Pentecost and Wellman 1 G. Pope; 28-9N-3W. *Illinois Geol. Surv.
630. Troop-Larson 1 Larrimore; 25-9N-3E. *Illinois Univ. microfilm, reel 180.
632. Natl. Assoc. Pet. 1 Shumard; 3-9N-5E. *Illinois Geol. Surv., control well 238.
635. J. M. Miller 1 Floyd Connor; 22-9N-8E. *Illinois Univ. microfilm, reel 80.
636. Lloyd 1 Stephenson; 8-9N-9E. Reznick 1 E. Butler; 20-9N-9E. *Illinois Geol. Surv.
637. K. R. Wilson 1 Rue; 27-9N-10E. *Illinois Univ. microfilm, reel 80.
638. Frodermann and Connally 1 F. E. Bennet; 13-9N-14W. *Illinois Univ. microfilm, reel 113.
641. J. W. Merrill 1 E. P. Daley; 27-9N-11W. *Illinois Univ. microfilm, reel 113.
644. G. F. Moulton 1 Lamb; 26-8N-13W. *Illinois Geol. Surv.
645. Hooker 1 Freeland; 15-8N-14W. *Illinois Geol. Surv. Pierce 1 Cramer; 22-8N-14W. *Illinois Geol. Surv.
647. Tidewater 1 Eubanks; 5-8N-9E. *Illinois Geol. Surv.
648. Rinehart and Fruehauf 1 Lux; 28-8N-8E. *Illinois Geol. Surv.
649. *Illinois Geol. Surv. 10-8N-7E.
651. H. H. Weinert 1 Berry; 34-8N-5E. *Illinois Geol. Surv.
652. Carter Oil 1 Claggett; 6-8N-4E. *Illinois Geol. Surv., control well 405.
655. Kay, 1915, p. 85-87.
661. Madison Coal 15 hole; 35-8N-6W. *Illinois Geol. Surv.
662. *Illinois Geol. Surv. 13-8N-7W. Henry W. Knoche 1 Knoche; 32-8N-7W.
665. *H. R. Wanless, Illinois Univ., 1930. 25-8N-10W.
667. Missouri Oil Enterprises 1 Tatman; 16-7N-11W. *Illinois Geol. Surv.
670. R. W. Hunt & Co. D-1 hole; 12-7N-8W. William Pfeffer 1 Wadsworth; 24-7N-8W. *Illinois Geol. Surv.
674. Kay, 1915, p. 46. 26-7N-4W.
675. Peabody Coal 2 hole; 32-7N-3W. *Confid.
682. Ohio 1 Vogt; 1-7N-5E. *Illinois Geol. Surv., control well 27.
686. Big Chief Drlg. 1 Ross; 35-7N-9E. *Illinois Geol. Surv., control well 181.
687. Texas 1 Wiyatt; 6-7N-10E. *Illinois Geol. Surv., control well 217.
691. Peabody Coal 1 W. Werner; 18-7N-11W. *Illinois Geol. Surv. F. T. Ellison 1 Titsworth; 18-7N-11W. *Illinois Geol. Surv.
694. George and Wrather 1 Coen; 27-6N-12W. *Illinois Univ. microfilm, reel 112.
695. A. W. Waymire 1 Buck; 4-6N-13W. *Illinois Geol. Surv.
697. Pure 1 Armistead; 17-6N-10E. *Illinois Geol. Surv., control well 59.
698. Gulf 1 Heap; 28-6N-9E. *Illinois Geol. Surv., control well 169.
700. Kingwood Oil 1 Wendt; 21-6N-7E. *Illinois Geol. Surv., control well 79.
702. Tidewater Oil 1 Dauks; 29-6N-5E. *Illinois Geol. Surv., control well 153.
Homer Luttrell 1 See; 34-6N-5E. *Illinois Geol. Surv., control well 21.
703. Gulf 1 Siegman; 4-6N-4E. *Illinois Geol. Surv., control well 234.
706. Bassett coal test; 16-6N-1E. *Illinois Geol. Surv.
Paul Darah 1 Whitman; 9-6N-1E. *Illinois Univ. microfilm, reel 71.

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707. A. R. Byrd 1 (?)Dolly coal test; 15-6N-1W. Kingwood Oil 1 Dayton; 14-6N-1W. *Illinois Geol. Surv.
708. Leo Horton 1 C. Rea; 16-6N-2W. *Illinois Geol. Surv., control well 223.
711. Simon, 1946, p. 28-31. T. T. Eason 1 Mohme, 14-6N-5W. *Illinois Geol. Surv., control well 201.
713. Interstate Coal and Min. coal test; 24-6N-7W. R. A. Lane and C. E. Stout 1 Boebel; 7-6N-7W. *Illinois Geol. Surv.
716. *Illinois Geol. Surv. 35-6N-10W.
718. *H. R. Wanless, Illinois Univ., 1930. 1-14S-7W.
719. *H. R. Wanless, Illinois Univ., 1930. 14, 15-5N-9W.
723. Texas 1 H. A. Hoste; 18-5N-5W. *Illinois Geol. Surv., control well 236. Mount Olive and Staunton coal 112 hole; 5-5N-5W. *Confid.
725. B. C. White 1 hole; 29-5N-3W. *Illinois Geol. Surv.
Natl. Assoc. Pet. 1 L. Potthast; 32-5N-3W. *Illinois Geol. Surv.
727. Mark Twain Oil 1 F. Sparks; 22-5N-1W. *Illinois Geol. Surv.
728. Magnolia 1 Wamuth; 24-5N-1E. *Illinois Univ. microfilm, reel 68.
730. Mid-Continent 1 Meyers; 29-5N-3E. *Illinois Geol. Surv., control well 134.
734. Texas 1 Hardin; 20-5N-7E. *Illinois Geol. Surv., control well 90.
Ohio 3 Webster; 3-5N-7E. *Illinois Geol. Surv., control well 200.
735. Sinclair-Wyoming 1 Cook; 4-5N-8E. *Illinois Geol. Surv., control well 38.
736. Kingwood 1 Volk; 20-5N-9E. *Illinois Geol. Surv., control well 210.
739. W. C. Meredith 1 Wagner; 20-5N-13W. *Illinois Geol. Surv.
J. S. Young 1 Ridgeway; 18-5N-13W. *Illinois Geol. Surv.
743. J. W. Everhart 1 Goodwin; 5-4N-10W. *Illinois Univ. microfilm, reel 111.
745. Ohio 2 Johnson; 32-4N-12W. *Illinois Geol. Surv., control well 237.
748. Texas 1 Haslinger; 22-4N-10E. *Illinois Geol. Surv., control well 39.
753. Krohn 1 Smith; 10-4N-5E. *Illinois Geol. Surv., control well 191.
755. Kinmundy Coal test; 23-4N-3E. *Illinois Geol. Surv.
Papoose Oil 1 Snelling; 35-4N-3E. *Illinois Geol. Surv., control well 64.
760. Nickerson 1 Armer and Rhodes; 33-4N-3W. *Illinois Geol. Surv., sample set 20740.
763. Obering 4 Grimm Comm.; 9-4N-6W. *Illinois Geol. Surv., control well 180.
764. Donk Bros. Coal and Coke 3 hole; 30-4N-7W. *Illinois Geol. Surv. Sohio 2 R. F. Imbs; 10-4N-7W. *Illinois Geol. Surv.
765. Madison Coal 4 Mike; 26-4N-8W. *Illinois Geol. Surv.
766. Joseph Kesl, Jr., 1 S. Gargac; 12-3N-9W. *Illinois Geol. Surv.
768. Lumaghi Coal 1 hole; 18-3N-7W. *Confid.
Lumaghi Coal 2 mine; 32-3N-7W. *Illinois Geol. Surv.
Coal shaft at Troy; 8-3N-7W. *Illinois Geol. Surv.
770. F. L. Strickland 1 Plocher; 10-3N-5W. *Illinois Geol. Surv.
771. Schierman 1 Trimmerman; 34-3N-4W. *Illinois Geol. Surv., control well 182.
773. Texas 1C Schaefer; 26-3N-2W; *Illinois Geol. Surv., Coal Div., control well 214.
776. Diamond Oil Explor. 1 Hopkins; 22-3N-2E. *Illinois Univ. microfilm, reel 61.
781. Bell Bros. 1 Crickman; 15-3N-7E. *Illinois Geol. Surv.
783. Pure 1 Myers; 31-3N-9E. *Illinois Geol. Surv., control well 135.

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790. J. E. Bauer 1 Akin; 5-2N-11W. *Illinois Geol. Surv., control well 186.
792. J. S. Young 1 Lewis; 17-2N-13W. *Illinois Geol. Surv.
794. *Illinois Geol. Surv., sample set 10252. 35-2N-10E.
796. Pure 1 Mosely; 3-2N-8E. *Illinois Geol. Surv.
Pure 1 Patterson; 21-2N-8E. *Illinois Geol. Surv., control well 103.
797. Pure 1 Baylor; 10-2N-7E. *Illinois Geol. Surv., control well 54.
Amber Oil & Gas 1 Curry; 16-2N-7E. *Illinois Geol. Surv.
799. Carter Oil 1 Ida Walker; 4-2N-5E. *Illinois Geol. Surv., control well 18.
800. Gilliam Drlg. 1 Ebe; 14-2N-4E. *Illinois Univ. microfilm, reel 46.
801. Nash Redwine 1 James; 22-2N-3E. *Illinois Univ. microfilm, reel 58.
802. Coal shaft at Salem; 13-2N-2E. *Illinois Geol. Surv.
Texas 11 Shanafelt; 16-2N-2E. *Illinois Geol. Surv., control well 141.
804. C. R. Winn and Treffert 1 Curdt Comm.; 15-2N-1W. *Illinois Geol. Surv.
805. Dunnill 1 Huntley; 8-2N-2W. *Illinois Geol. Surv.
807. Cooperative Coal, coal test. *Illinois Geol. Surv. 23-2N-4W. Nat. Assoc. Pet. and Breese-Trenton Min. 1 Haar; 25-2N-4W. *Illinois Geol. Surv.
808. Trenton Coal 1 hole; 29-2N-5W. *Illinois Geol. Surv.
817. Reserve Oil 1 B. J. Frohn; 9-1N-5W. *Illinois Geol. Surv.
821. Kay, 1915, p. 183-184. B. R. Williams 1 Spreke; 6-1N-1W. *Illinois Univ. microfilm, reel 43.
822. Kay, 1915, p. 116-119. R. Powers 1 City of Centralia airport; 21-1N-1E. *Illinois Univ. microfilm, reel 50.
823. Texas 1 Frickey; 16-1N-2E. *Illinois Geol. Surv., control well 35. Texas NCT-1 Frickey; 16-1N-2E. *Illinois Geol. Surv.
824. Benoist and Finn 1 Finn; 6-1N-3E. *Illinois Geol. Surv.
826. Kingwood Oil 1 Melton; 20-1N-5E. *Illinois Geol. Surv., control well 233.
831. Mid States 1 McKinley; 18-1N-10E. *Illinois Geol. Surv., control well 151.
832. Sinclair-Wyoming 1 Bichhaus; 6-1N-14W. *Illinois Geol. Surv., control well 30.
Magnolia 1 Matthes; 10-1N-14W. *Illinois Geol. Surv. control well 156.
838. Superior 4 Lipper; 28-1S-14W. *Illinois Geol. Surv., control well 177.
839. Magnolia 1 Gould; 7-1S-11E. *Illinois Geol. Surv., well 33.
840. Stanolind 1 Alvin Reid; 16-1S-10E. *Illinois Geol. Surv., control well 118.
Globe Oil and Ref. 1 J. McKinzie; 16-1S-10E. *Illinois Geol. Surv.
842. Deep Rock Oil 1 S. L. Cantley; 7-1S-8E. *Illinois Geol. Surv., control well 97.
845. Gulf 1 Melton; 1-1S-5E. *Illinois Geol. Surv., control well 66.
848. Cameron Oil 1 J. C. Bizott; 30-1S-2E. *Illinois Geol. Surv., control well 192.
849. Crevat Coal Co. hole; 21-1S-1E. *Illinois Geol. Surv.
John Dorlan 1 CB and QRR; 21-1S-1E. *Illinois Geol. Surv.
852. Texas 1 Doelling; 30-1S-3W. *Illinois Geol. Surv., control well 207.
854. Truax-Traer Coal Co. 4 hole; 25-15S-5W. *Confid.
J. E. Mulligan 1 Ostendorf; 26-1S-5W. *Illinois Geol. Surv.
856. Union Colliery 58 hole; 8-1S-7W.
N. W. Bordensi Wise well; 10-1S-7W.

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Braun Drlg. 1 American Legion; 15-1S-7W. *Illinois Geol. Surv.
859. Midwest Radiant Fuel 424 hole; 33-1S-10W. *Illinois Geol. Surv.
861. J. C. Mays 1 G. Scheifler; 5-2S-9W. *Illinois Geol. Surv.
862. *H. R. Wanless, Illinois Univ., 1932; Illinois Geol. Surv. 9-2S-8W.
865. Internation Coal P-3 hole; 1-2S-5W. Nash Redwine 1 Marguard; 2-2S-5W. *Illinois Geol. Surv.
867. Werner Bros. 1 Mueller; 3-2S-3W. *Illinois Geol. Surv., control well 175.
869. Kay, 1915, p. 182-183. J. W. Russell and others 1 Pevely Dairy; 27-2S-1W. *Illinois Geol. Surv.
871. Walter C. Wellman 1 Wilson; 21-2S-2E. *Illinois Univ. microfilm, reel 89.
877. Watkins Drlg. 1 Sutherland; 4-2S-8E. *Illinois Geol. Surv., control well 10.
879. Nelson Devel. 1 Bunting; 8-2S-10E. *Illinois Geol. Surv., control well 123.
Lewis Prod. 1A Ina Dunk; 36-2S-10E. *Illinois Geol. Surv., control well 171.
880. Kingwood 1 Cowling; 20-2S-14W. *Illinois Geol. Surv., control well 162.
881. H. C. Ames 6 Akin; 27-2S-13W. *Illinois Geol. Surv.
885. Cherry and Kidd 1 Seifert; 1-3S-9E. *Illinois Geol. Surv., control well 81.
888. Texas 1 Butler; 8-3S-6E. *Illinois Geol. Surv., control well 46.
889. Seaboard 1 Kiefer; 30-3S-5E. *Illinois Geol. Surv., control well 8.
891. Lewis Prod. 1 State Game Farm; 21-3S-3E. *Illinois Geol. Surv., control well 13.
892. Inland Steel 4 hole; 26-3S-2E. *Illinois Geol. Surv.
Armstrong and Bay 1 Scott; 23-3S-2E. *Illinois Geol. Surv.
893. Interstate Coal 12J hole; 33-3S-1E. *Confid.
Skelly Oil 1 Interstate J.F.P.; 33-3S-1E. *Illinois Geol. Surv.
896. Magnolia 10 Gill Est.; 26-3S-3W. *Illinois Geol. Surv., control well 122.
899. Rotramel 1 (?) hole; 27-3S-6W. *Illinois Geol. Surv.
Consolidated Coal 1 hole; 27-3S-6W. *Illinois Geol. Surv.
900. Midwest Radiant Coal 31 hole; 12-3S-7E. *Illinois Geol. Surv.
Midwest Radiant Coal 16-D hole; 1-3S-7E. *Illinois Geol. Surv.
Carter 1 H. P. Dinges; 35-3S-7E. *Illinois Geol. Surv.
901. *H. R. Wanless, Illinois Univ., 1932; Illinois Geol. Surv. 1, 22, 25-3S-8W.
904. M. W. Borders 1 hole; 14-4S-5W. *Illinois Geol. Surv.
Unnamed well; 31-4S-5W. *Illinois Geol. Surv., Sample Sed. 3901.
906. Winn and Beck 1 McKinstry; 10-4S-3W. *Illinois Geol. Surv.
907. Pyramid Coal 2 hole; 10-4S-2W. *Illinois Geol. Surv.
P. Townes 1 F. Zelasko; 2-4S-2W. *Illinois Geol. Surv.
908. Worthen, 1868, p. 88. 31-4S-1W. Texas 1 T. M. Effiert; 31-4S-1W. *Illinois Geol. Surv.
909. Deep Rock Oil 1 Interstate Coal; 4-4S-1E. *Illinois Geol. Surv., control well 199.
C. W. & F. Coal 3 hole; 12-4S-1E, and Sohio F core hole; 10-4S-1E. *Confid.
911. Deep Rock Oil 1 I. H. Cox; 36-4S-3E. *Illinois Geol. Surv., control well 136.
912. George Echols 1 Aydt; 1-4S-4E. *Illinois Geol. Surv., control well 102.
913. Delafield Coal Co. core hole; 25-4S-5E. *Illinois Geol. Surv.

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Texas 1 R. Rawles; 1-4S-5E. *Illinois Geol. Surv., control well 130.
915. Ohio 2 E. D. York; 26-4S-8E. *Illinois Geol. Surv., control well 183.
916. Carter 1 Crebs; 13-4S-8E. *Illinois Geol. Surv., control well 216.
923. Pure A-1 E. J. Storey; 36-5S-8E. *Illinois Geol. Surv., control well 218.
924. Natl. Assoc. Pet. 1 Rubenacker; 15-5S-7E. *Illinois Geol. Surv., control well 194.
925. American Coke and Chem. 12 hole; 27-5S-6E. *Illinois Geol. Surv.
Texas 1 Mildred Meadorth; 23-5S-6E. *Illinois Geol. Surv.
933. Atlas Powder 1 hole; 9-5S-3W. T. D. Rotramel Co. 1 C. Brants; 29-5S-3W. J. W. Rudy 1 Bandison; 24-5S-3W. *Illinois Geol. Surv.
936. Moffat Coal 1 hole; 13-5S-6W. Hampton Oil 1 Huey Comm.; 12-5S-6W. *Illinois Geol. Surv.
939. United Electric Coal 559 hole; 1-6S-5W. L. W. Gwin 1 Southwest Illinois Coal; 2-6S-5W. *Illinois Geol. Surv.
942. Union Colliery 253 hole; 26-6S-2W. Magnolia Pet. 1 Hahn Est.; 34-6S-2W. *Illinois Geol. Surv.
943. Forester 1 well; 5-6S-1W. *Illinois Geol. Surv.
944. Old Ben Coal 19 and 19A holes; 16-6S-1E. *Illinois Geol. Surv.
947. Stewart Oil 6 U.S. Coal and Coke; 23-6S-4E. *Illinois Univ. microfilm, reel 29.
955. Taylor and Boyd drill core; 18-7S-10E. *Illinois Geol. Surv.
957. Sinclair-Wyoming 1 Cox; 24-7S-8E. *Illinois Geol. Surv., control well 22.
959. American Coke and Chem. 20 hole; 4-7S-6E. *Illinois Geol. Surv.
George and Wrather 1 W. F. Rodgers; 11-7S-6E. *Illinois Univ. microfilm, reel 34.
966. Union Colliery 222 hole; 1-7S-2W. Holliday Est. 21 hole and Eason Oil 1 Bowlin; 12-7S-2W. *Illinois Geol. Surv.
967. Truax-Traer 74 hole; 14-7S-3W. Stevens Oil 1 Speith Heirs; 6-7S-3W. *Illinois Geol. Surv.
970. *H. R. Wanless, Illinois Univ., 1932; Illinois Geol. Surv. 1-7S-6W.
972. Mid-Egypt Co. 5 hole; 24-8S-3W. Magnolia 1 Smith Heirs; 9-8S-3W. *Illinois Geol. Surv.
974. Watson Coal Min. 4 hole; 1-8S-1W. Holliday Est. 30 hole; 5-8S-1W. Coal test; 8-8S-1W. Calvert 1 Shirley; 10-8S-1W. *Illinois Geol. Surv.
975. A. S. Fee 6 hole; 1-8S-1E. Madison Coal 56 hole; 21-8S-1E. E. E. Rehn 2-B Old Ben Coal; 11-8S-1E. *Illinois Geol. Surv.
979. Peabody Coal 40-4 and 40-4A holes; 31-8S-5E. *Confid.
Kingwood Oil 1 Gullett; 31-8S-5E. *Illinois Univ. microfilm, reel 38.
981. Dering Coal 16 hole; 7-8S-7E. Dering Coal 15 hole; 5-8S-7E. *Confid.
Sam Garfield 1 Kittinger; 8-8S-7E. *Illinois Univ. Microfilm, reel 38.
986. Union Colliery 3 hole; 4-9S-10E. *Confid.
Magnolia Pet. 1 Logsdon; 1-9S-10E. *Illinois Geol. Surv., control well 146.
988. Bransford Min. 6 hole; 12-9S-8E. Union Colliery 28 hole; 23-9S-9E. Stonefort 46 hole; 33-9S-8E. *Confid.
S. L. Dedman 1 Hamilton; 10-9S-8E. *Illinois Univ. microfilm, reel 41.
991. Peabody Coal 43-56 hole; 6-9S-5E. Saline County 5 hole; 1-9S-5E. *Confid.

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C. E. Brehm 1 J. Lewis; 11-9S-5E. *Illinois Univ. microfilm, reel 110.

992. Cady, 1916, p. 22-25. Delta Collieries 21 hole; 5-9S-4E. *Illinois Geol. Surv.
J. C. Starr 1 Carney; 21-9S-4E. *Illinois Univ. microfilm, reel 110.
994. Peabody Coal 3 hole; 1-9S-2E. *Illinois Geol. Surv.
998. *H. R. Wanless, Illinois Univ., 1932. Illinois Geol. Surv. 14-9S-3W.
1000. *H. R. Wanless, Illinois Univ., 1932. Illinois Geol. Surv. 13-10S-4W, 18-10S-3W.
1003. Austin Oil 1 A. B. Neiber; 12-10S-1E. *Illinois Geol. Surv.
1004. Ge-Lo Oil 1 Scott; 4-10S-2E. *Illinois Geol. Surv.
1008. Saline Gas and Coal 24 coal test; 4-10S-6E. J. E. Bauer 1 Gersbacher; 2-10S-6E. *Illinois Geol. Surv.
1010. Byrd-Pittsburgh 5 hole; 8-10S-8E. F. K. Taylor 13 hole; 15-10S-8E. Dillon and others 1 Frohock; 4-10S-8E. *Illinois Geol. Surv.
1011. Taylor-Byrd 19 hole; 13-10S-9E. Taylor-Byrd 15 hole; 20-10S-9E. Peak Drlg. 1 Reade Ellis; 36-10S-9E. *Illinois Geol. Surv.
1019. Tunnel Hill Oil 1 J. Boner; 30-11S-3E. *Illinois Geol. Surv.
1021. Nation Oil 1 Gray; 2-11S-1E. *Illinois Geol. Surv.
1022. Erie Drlg. 4 Giant City Park; 2-11S-1W. *Illinois Geol. Surv.
1024. *H. R. Wanless, Illinois Univ., 1933. Illinois Geol. Surv. 3, 10, 16-12S-3E.
1025. *H. R. Wanless, Illinois Univ., 1933. Illinois Geol. Surv. 13-12S-4E.
1027. Aluminum Co. 1 Shawnee Nat. Forest; 2-12S-6E. *Confid.
1028. *H. R. Wanless, Illinois Univ., 1933. Illinois Geol. Surv. 6-12S-7E.
1029. Interstate Fluorspar 1 hole; 17-12S-8E. *Illinois Geol. Surv.
1031. *H. R. Wanless, Illinois Univ., 1933. Illinois Geol. Surv.; 12, 14-13S-5E.

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1. *Confid.
3. Ashley, 1899, p. 184. 3-26N-9W.
6. Ashley, 1899, p. 199-200. Hopkins, 1896, p. 300. 33-23N-8W.
7. Ashley, 1899, p. 197. 32-23N-6W.
8. Hopkins, 1896, p. 290. 30-22N-6W.
11. Ashley, 1899, p. 216-217. Logan, W. N., 1931, p. 774. Old Oak Oil 1 Farden.
12. Ashley, 1899, p. 203-208.
13. Ashley, 1899, p. 239-240.
20. Ashley, 1899, p. 238. 16-19N-6W. Jesse Brant well; 8-19N-6W.
22. Ashley, 1899, p. 263-265. E. A. Riggs and W. Dice 1 Perigo; 4-18N-8W. *Illinois Geol. Surv.
23. Ashley, 1899, p. 269 (34-18N-9W), p. 272 (36-18N-9W), p. 273-274.
24. Peabody Coal 1 Hall; 30-18N-10W. *Illinois Geol. Surv.
28. Ashley, 1899, p. 311. 9-17N-7W.
29. Esarey, Bieberman, and Bieberman, 1950, p. 7. 7-17N-6W.
30. Esarey, Bieberman, and Bieberman, 1950, p. 15. 25-16N-5W.
31. Hopkins, 1896, p. 254. 22-16N-6W.
32. Ashley, 1899, p. 322. 27-16N-7W. F. B. Cling 1 Timberlake; 7-16N-7W. *Illinois Univ. microfilm, reel 115.
36. Paul Weir Co. 2 St. Bernice; 15-15N-10W. U.S. Coal and Coke 8 Wakefield-Hazlett; 35-15N-10W. *Confid.

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42. Ashley, 1899, p. 287. 28-14N-4W.
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50. Snowhill Coal 1 Talleydale Mine; 20-13N-9W. *Confid.
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52. Carter well; 31-13N-7W. *Illinois Univ. microfilm, reel 115. *H. R. Wanless, Illinois Univ., 1935. 7, 8, 9-13N-7W.
54. Ashley, 1899, p. 294. 32-13N-5W.
55. Esarey, Bieberman, and Bieberman, 1950, p. 9. 18-13N-4W.
63. Dresser Mike 15W drill hole; 10-11N-10W. *Confid.
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65. Snowhill Coal Corp. 3 Jones Farm; 7-11N-8W. *Confid.
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67. Ashley, 1899, p. 611 (5-11N-6W), p. 613 (3-11N-6W). Lucht and Simpson 1 J. C. Fischer; 23-11N-6W. *Illinois Univ. microfilm, reel 174.
69. Ashley, 1899, p. 477. 11-11N-4W.
72. Ashley, 1899, p. 627 (33-10N-6W), p. 637 (33-10N-6W). Allen Lucht and John Simpson 1 Otis Francis; 9-10N-6W. *Illinois Univ. microfilm, reel 174.
73. Ashley, 1899, p. 675. 20-10N-7W. W. G. Burrage 1 Maggie Harris; 20-10N-7W. *Illinois Geol. Surv.
75. Great Lakes Carbon 3 United States; 3-10N-9W. *Illinois Geol. Surv.
76. Julia McClanahan coal test; 26-10N-10W. *Illinois Geol. Surv.
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80. Ayrshire Patoka Collieries 133 Edmund Jewell; 15-9N-9W. *Confid.
85. Ashley, 1899, p. 476. 20-9N-4W.
86. Malott, 1952, p. 51. 19-9N-2W.
87. Malott, 1952, p. 66. Ashley, 1899, p. 775. 30-8N-3W.
90. Ashley, 1899, p. 798. 12-8N-6W.
93. Ayrshire Patoka Collieries 1 Jim Riggs; 5-8N-9W. *Confid.
94. Ashley, 1899, p. 909-910. Ohio Oil 1 Chas. Riggs; 3-8N-10W. *Illinois Geol. Surv.
95. A. J. Slagter, Jr., and Frank Strickland 1 Kelly; 11-8N-11W. *Illinois Univ. microfilm, reel 113.
97. Walter Bledsoe 3 Payton; 34-7N-9W. *Illinois Geol. Surv.
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99. Ashley, 1899, p. 819 (19-7N-7W), p. 820 (11-7N-7W). George and Wrather 1 Greenwood; 10-7N-7W. *Illinois Univ. microfilm, reel 112.
100. Ashley, 1899, p. 804. 33-7N-6W. Winmar Oil 1 Allen; 22-7N-6W. *Illinois Univ. microfilm, reel 112.
104. Beede, 1915, p. 225-226.
105. Ashley, 1899, p. 772. 15, 23-6N-3W.
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116. Ashley, 1899, p. 1052 (7-5N-7W), p. 1053 (3-5N-7W). Sun 1 H. Weaver; 5-5N-7W. *Illinois Geol. Surv.
117. Edison and Gwaltney 1 C. O. Bean; 10-5N-6W. *Illinois Univ. microfilm, reel 112.
119. Ashley, 1899, p. 932, 934. 31-5N-3W.
120. Malott, 1945, p. 96-101.
122. Ashley, 1899, p. 915. 11-4N-3W.
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134. Ashley, 1899, p. 1005-1006. Ryan Oil 1 Carl C. Keith; 7-3N-6W. *Illinois Univ. microfilm, reel 110.
135. Ashley, 1899, p. 996. 29-3N-5W. George E. Nelson and others 1 Ethel Burress; 25-3N-5W. *Illinois Geol. Surv.
138. Franklin, 1939, p. 4. 26-3N-2W. Kindle, 1896, p. 353. 26-3N-2W.
139. Ashley, 1899, p. 1082. 32-2N-2W.
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153. Ashley, 1899, p. 1200, 1204. 22-1N-8W. Ohio Oil 15 Gladish; 31-1N-8W. *Illinois Geol. Surv.
154. *H. R. Wanless, Illinois Univ., 1935. 7-1N-7W. Ashley, 1899, p. 1205. 27-1N-8W. Skiles Oil 1 Lester Sievers; 27-1N-7W. *Illinois Univ. microfilm, reel 43.
156. Ashley, 1899, p. 1020. 18-1N-5W. *H. R. Wanless, Illinois Univ., 1935, 18-1N-5W. Natl. Assoc. Pet. 1 Harder; 11-1N-5W. *Illinois Univ. microfilm, reel 43.
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160. Kindle, 1896, p. 333. 20-1N-1W.
162. Ashley, 1899, p. 1087. 7-1S-2W.
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174. Lima Oil 1 E. K. Brady; 14-2S-12W. *Illinois Geol. Surv.
176. Ashley, 1899, p. 1237-1240. Messmer, Dickerson, and Lieberknecht 1 Crecelius; 5-2S-10W. *Illinois Geol. Surv.
177. *H. R. Wanless, Illinois Univ., 1935. 33, 34-2S-9W. Ashley, 1899, p. 1235. 13-2S-9W. E. J. Cunningham 1 Guy Loften; 17-2S-9W. *Illinois Geol. Surv.
179. *H. R. Wanless, Illinois Univ., 1935. 22-2S-7W. W. O. Allen Jr., 1 Electric Shovel Coal; 18-2S-7W. *Illinois Geol. Surv.
184. Gray and others, 1957, p. 28 (15-2S-2W), p. 29 (26-2S-2W).
186. Malott, 1950, p. 242-243. 36-2S-1E.
191. *H. R. Wanless, Illinois Univ., 1935. 19-3S-5W. Texas 1 S. C. Feldmeyer; 21-3S-5W. *Illinois Geol. Surv.
192. Ashley, 1899, p. 1151. 23-3S-6W. R. L. Tilton 1 Oliver Werremeyer; 1-3S-6W. *Illinois Univ. microfilm, reel 178.
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211. Ashley, 1899, p. 1304. 12-4S-4W. Ohio Oil 1 Holtzman; 27-4S-4W. *Illinois Geol. Surv.
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217. Ashley, 1899, p. 1310. 28-5S-4W. Joe Bander 1 Wittman; 30-5S-4W. *Illinois Univ. microfilm, reel 164.
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15. Olie well; 21-90N-26W. *Iowa Geol. Surv.
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21. Dr. John T. Reynolds well; 26-90N-36W. *Iowa Geol. Surv.
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41. Norton, 1928, p. 326-329.
43. Owasa 5 city well; 17-88N-20W. *Iowa Geol. Surv.
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91. John Halroyd well; 31-85N-18W. *Iowa Geol. Surv.
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124. Savage, 1903, p. 229. 9-83N-16W.
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149. J. C. Barkey well; 8-82N-24W. *Iowa Geol. Surv.
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172. Clyde E. Robinson well; 31-81N-29W. *Iowa Geol. Surv.
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191. Clyde Collins well; 35-80N-27W. *Iowa Geol. Surv.
192. Jenkins Bros. 2 well; 17-80N-28W. *Iowa Geol. Surv.
195. Hooper Farm well; 12-80N-31W. *Iowa Geol. Surv.
197. Audubon 1 city well; 21-80N-35W. *Iowa Geol. Surv.
198. Calvin, 1897, p. 82-83.

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199. Mrs. Schleseman well; 23-79N-13W. *Iowa Geol. Surv.
202. John Will Van Wyke well; 29-79N-17W. *Iowa Geol. Surv.
203. Walter Kingery well; 4-79N-19W. *Iowa Geol. Surv.
210. W. E. Hufford and F. J. Atkins 3 well; 9-79N-25W. *Iowa Geol. Surv.
213. Northern Nat. Gas 28 Neff; 19-79N-28W. *Iowa Geol. Surv.
214. Northern Nat. Gas 27 Kipping; 26-79N-29W. *Iowa Geol. Surv.
215. Stuart town well; 31-79N-30W. *Iowa Geol. Surv.
217. Harlan 2 city well; 19-79N-38W. *Iowa Geol. Surv.
218. Norton and others, 1912b, p. 1133-1135. Wood, 1939, p. 145-146. St. John, 1870, p. 180. 24-79N-43W.
219. Hinds, 1909, p. 353. 5-78N-5E.
221. Marvin Eflin 1 well; 2-78N-15W. *Iowa Geol. Surv.
225. John Kinart well; 32-78N-19W. *Iowa Geol. Surv.
227. Joe S. Pachaske well; 33-78N-21W. *Iowa Geol. Surv.
229. M. B. Zeiler well; 30-78N-23W. *Iowa Geol. Surv.
233. B. E. Wilson well; 3-78N-27W. *Iowa Geol. Surv.
234. Hunt 1 Macklin; 17-78N-28W. *Iowa Geol. Surv.
235. Northern Nat. Gas 33; 8-78N-29W. *Iowa Geol. Surv.
236. Dale core test; 6-78N-30W. *Iowa Geol. Surv.
    Hunt 1 H. D. McConnell; 11-78N-30W. *Iowa Geol. Surv.
239. Norton, 1899, p. 466-469. Frank Smith well; 9-77N-2E. *Iowa Geol. Surv.
240. *H. R. Wanless, Illinois Univ., 1930. 13-77N-1E.
    *H. R. Wanless, Illinois Univ., 1930. 34-77N-1W.
241. Udden, 1899, p. 324, well 60. *Neil O'Brien, Illinois Geol. Surv., 1961.
244. Keokuk County test well; 15-77N-12W. *Iowa Geol. Surv.
245. Galbraith well; 32-77N-13W. *Iowa Geol. Surv.
249. H. N. Van Zee well; 27-77N-17W. *Iowa Geol. Surv.
253. Mrs. Dodge well; 3-77N-21W. *Iowa Geol. Surv.
254. Harley Carpenter well; 25-77N-22W. *Iowa Geol. Surv.
257. Dr. Kelly well; 13-77N-25W. *Iowa Geol. Surv.
258. Hepburn 1 Ingham well; 5-77N-26W. *Iowa Geol. Surv.
259. Earlham city 1 well; 6-77N-28W. *Iowa Geol. Surv.
260. Fred S. Whittam Farm well; 23-77N-31W. *Iowa Geol. Surv.
261. Adair city well; 4-77N-33W. *Iowa Geol. Surv.
263. Bain, 1896a, p. 151. 21-76N-7W.
264. Paul Bousloguen well; 5-76N-10W. *Iowa Geol. Surv.
266. Ambrose Wehr well; 3-76N-12W. *Iowa Geol. Surv.
268. Bacon Farm well; 31-76N-14W. *Iowa Geol. Surv.
269. Andrew Heslinga well; 6-76N-15W. *Iowa Geol. Surv.
274. H. E. Jennings well; 13-76N-20W. *Iowa Geol. Surv.
279. Earle Bros. coal test; 9-76N-24W. *Iowa Geol. Surv.
    Earl Jones Farm well; 12-76N-24W. *Iowa Geol. Surv.
280. J. S. Johnson well; 8-76N-25W. *Iowa Geol. Surv.
    Doyle Ports well; 7-76N-25W. *Iowa Geol. Surv.
281. Herrick Farm well; 14-76N-26W. *Iowa Geol. Surv.
283. Jesse Stevenson well; 9-76N-30W. *Iowa Geol. Surv.
288. Ralph J. Tinnes well; 15-75N-10W. *Iowa Geol. Surv.
292. Vanzee quarry 1 Fremont; 34-75N-14W. *Iowa Geol. Surv.
295. Boyd Adair well; 21-75N-17W. *Iowa Geol. Surv.
298. Rolf Shirers 2 well; 6-75N-20W. *Iowa Geol. Surv.
301. E. C. Harlan well; 9-75N-24W. *Iowa Geol. Surv.
305. Stanzel, Inc., well; 11-75N-30W. *Iowa Geol. Surv.
306. Greenfield city well; 7-75N-31W. *Iowa Geol. Surv.
308. Harris, 1947, p. 233-246.
309. Bain, 1896a, p. 129. 5-74N-8W.
310. W. C. Sky well; 25-74N-10W. *Iowa Geol. Surv.
313. Hedrick well; 36-74N-13W. *Iowa Geol. Surv.
319. Floyd Fortner 1 well; 2-74N-20W. *Iowa Geol. Surv.
322. Tilton, 1896, p. 330 (sec. 12), p. 331 (sec. 13), p. 340-341.
323. Barker Est. well; 30-74N-25W. *Iowa Geol. Surv.

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324. Roy Keating well; 2(?)-74N-27W. *Iowa Geol. Surv.
P. E. Beeler well; 2-74N-27W. *Iowa Geol. Surv.
326. Council Bluff School for Deaf 3 well; 8-74N-43W. *Iowa Geol. Surv.
327. Dale Piers well; 4-73N-8W. *Iowa Geol. Surv.
328. Hinds, 1909, p. 315. 32-73N-9W.
331. Ottumwa 1 Gypsum test; 33-73N-13W. *Iowa Geol. Surv.
335. Lovilia city well; 10-73N-18W. *Iowa Geol. Surv.
336. Lora Weller community well; 31-73N-19W. *Iowa Geol. Surv.
337. Lugn, 1927, p. 146 (10-73N-20W), p. 147 (17-73N-20W), p. 149 (22-73N-20W), p. 223 (26-73N-20W). *H. R. Wanless, Illinois Univ., 1932.
339. Lugn, 1927, p. 141 (12-73N-22W), p. 161 (33-73N-22W), *H. R. Wanless, Illinois Univ., 1932.
341. Kenneth Calkins well; 34-73N-35W. *Iowa Geol. Surv.
342. Lonsdale, 1895, p. 403-408.
344. F. O. Akin 1 Harry Paul; 15-73N-40W. *Iowa Geol. Surv.
348. Hinds, 1909, p. 295. 12-72N-12W.
351. Hocking Coal Co. test 1; 7-71N-16W. *Iowa Geol. Surv.
J. H. Bicker well; 9-72N-16W. *Iowa Geol. Surv.
355. Lugn, 1927, p. 162-163, p. 163-164, p. 231-232, p. 232 (25-72N-22W). *H. R. Wanless, Illinois Univ., 1932.
356. Lugn, 1927, p. 232-233.
357. Murray Independent School well; 15-72N-27W. *Iowa Geol. Surv.
358. K. Dugger well; 32-72N-27W. *Iowa Geol. Surv.
359. Thayer Consol. School well; 15-72N-28W. *Iowa Geol. Surv.
360. R. F. Fitch coal test; 26-72N-29W. *Iowa Geol. Surv.
362. By-Products Co. well; 35-72N-34W. *Iowa Geol. Surv.
363. Ohio 1 C. Ratliff; 15-72N-38W. *Confid.
364. Glenwood city well; 11-72N-43W. *Iowa Geol. Surv.
367. *H. R. Wanless, Illinois Univ., 1932. 3-71N-10W.
369. Hinds, 1909, p. 305-306. *H. R. Wanless, Illinois Univ., 1932. 21-71N-12W.
370. A. E. Anderson well; 2-71N-13W. *Iowa Geol. Surv.
371. Jack McClure well; 71N-16W. *Iowa Geol. Surv.
372. White Breast Fuel Co. of Illinois; 10-71N-17W. *Iowa Geol. Surv.
Farm Security Admin. 4 well; 6-71N-17W. *Iowa Geol. Surv.
374. Lugn, 1927, p. 158. 12-71N-21W.
376. Frank Mannequist; 35-71N-38W. *Iowa Geol. Surv.
379. Keyes, 1895a, p. 484. 22-70N-4W.
380. Stock Port city well; 19-70N-8W. *Iowa Geol. Surv.
382. Frank Cox well; 24-70N-10W. *Iowa Geol. Surv.
386. Lake Wapello State Park well; 34-70N-15W. *Iowa Geol. Surv.
389. W. M. Cook well; 25-70N-20W. *Iowa Geol. Surv.
390. Garden Grove town well; 33-70N-24W. *Iowa Geol. Surv.
392. Lenox City well; 8-70N-32W. *Iowa Geol. Surv.
396. Condra, 1933, p. 7. 23-70N-43W.
Fremont Oil 1 Schroeder; 28-70N-43W. *Iowa Geol. Surv.
397. Glenn Smith well; 15-64N-5W. *Iowa Geol. Surv.
399. James E. Pieper well; 12-69N-7W. *Iowa Geol. Surv.
404. Bloomfield city well; 25-69N-14W. *Iowa Geol. Surv.
406. Bain, 1896b, p. 405, 435. Norton and others, 1912a, p. 937. 36-69N-18W. Cline, 1941, p. 66-68; 1, 16, 19, 26, 36-69N-18W.
409. Taylor County Home; 27-69N-33W. *Iowa Geol. Surv.
410. New Market Coal Co. coal test; 33-69N-35W. *Iowa Geol. Surv.
W. O. Smythe and others 2 Hooks; 18-69N-35W. *Iowa Geol. Surv.
413. Shenandoah 2 city test; 19-69N-39W. *Iowa Geol. Surv.
414. John Fletcher well; 21-68N-6W. *Iowa Geol. Surv.
416. Carroll Renaburger well (?); 68N-8W. *Iowa Geol. Surv.
418. Clyde H. Brewster well; 24-68N-10W. *Iowa Geol. Surv.
420. J. C. Wisdom 1 well; 10-68N-14W. *Iowa Geol. Surv.
423. Scandinavian Coal Co. coal test; 1-68N-18W. *Iowa Geol. Surv.
424. Seymour diamond drill hole; 14-68N-20W. *Iowa Geol. Surv.
427. Kellerton City Park well; 2-68N-28W. *Iowa Geol. Surv.
428. Pryor and Lockhart 1(?) Crumin; 32-68N-33W. *Iowa Geol. Surv.
431. Iowa Devel. Co. 1 Wilson; 24-68N-37W. *Iowa Geol. Surv.
433. Ohio 1 Gruber; 19-68N-40W. *Iowa Geol. Surv.
434. Skelly core tests, 30, 33-68N-41W. Ohio 1 Wisham; 23-68N-41W. *Confid.
436. Verle de Rosean well; 5-67N-8W. *Iowa Geol. Surv.
440. Cline, 1941, p. 62-63.
441. Cincinnati well; 3-67N-18W. *Iowa Geol. Surv.
443. Lamoni city well; 3-67N-27W. *Iowa Geol. Surv.
444. Stanolind 1 W. P. Turner; 8-67N-29W. *Iowa Geol. Surv.
449. Thorpe Drlg. 1 Gruber; 8-67N-40W. *Iowa Geol. Surv.
450. Skelly core holes; 22, 26-67N-41W. *Iowa Geol. Surv.
451. Skelly core tests; 19, 27-67N-42W. Spicer Farm well; 3-67N-42W. *Iowa Geol. Surv.
452. Hinds, 1909, p. 338. 27-65N-5W.

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26. Stanolind 1 Patterson; 23-22S-38W. *Schlumberger.
46. Wilcox Oil 1 Parker; 9-11S-40W. *Schlumberger.
55. F. C. Cullum 1 Smith; 11-17S-25W. *Schlumberger.
84. Ben F. Brack 2 Judy; 35-1S-39W. *Schlumberger, KSLS.
85. Deep Rock Oil 1 Clark; 23-1S-42W. *Schlumberger.
89. C. H. Bigsby 1 Hill; 36-11S-42W. *Schlumberger.
91. Superior 1A Tucker; 4-29S-42W. *Schlumberger, KSLS.
92. Texas 1 Walz; 3-5S-42W. *Schlumberger, KSLS.
108. Texas 1 Dougherty; 23-6S-33W. *Schlumberger.
115. Texas 1 Federal Land; 7-8S-35W. *Schlumberger.
116. Texas 1 McArthur; 18-8S-36W. *Schlumberger.
119. Sinclair-Prairie 1 Mercer; 28-10S-40W. *Schlumberger, KSLS.
124. Texas 1 Smith; 30-11S-36W. *Schlumberger.
126. Sinclair-Prairie 2 Wallace Inv.; 28-11S-39W. *Schlumberger, Kansas Geol. Surv.
129. Helmerich & Payne, Inc., 1 Sauvage; 3-1S-27W. *Schlumberger.
130. Stanolind 1 Cahoj; 20-1S-34W. *Schlumberger.
136. Sinclair 1 Bremer; 28-4S-28W. *Schlumberger.
137. Stanolind 1 Mullen; 14-4S-35W. *Schlumberger.
139. Harry Gore 1 Sheetz; 5-5S-25W. *Schlumberger, KSLS.
147. Sinclair 1 Cogswell; 20-10S-38W. *Schlumberger, KSLS.
152. Amerada 1 Melchert; 33-17S-32W. *Schlumberger.
155. Shell 1 Scott; 28-22S-43W. *Schlumberger.
156. Sinclair-Prairie 1 Frye; 25-6S-17W. *Schlumberger.
160. Empire Drlg. 1 Atens; 6-1S-22W. *Schlumberger, KSLS.
161. Texas 1 Baynes; 8-2S-19W. *Schlumberger, KSLS.
162. Strain and Hall 1 Odle; 14-2S-26W. *Schlumberger, KSLS.
164. Musgrove Pet. 1 Mines; 11-2S-30W. *Schlumberger, KSLS.
166. Anderson-Prichard 1 Brooks; 17-3S-25W. *Schlumberger, KSLS.
168. Anderson-Prichard 1 Nitsch; 3-3S-29W. *Schlumberger, KSLS.
170. Harry Gore 1 Nauer; 27-4S-26W. *Schlumberger, KSLS.
172. Herndon Drlg. 1 Bader; 20-5S-26W. *Schlumberger, KSLS.
173. Wood River Oil & Ref. 1 Oliver; 24-6S-23W. *Schlumberger, KSLS.
174. Empire Drlg. 1 Ward; 13-6S-26W. *Schlumberger, KSLS.

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175. J. G. Brown & Assoc. 1 Reed; 21-6S-30W. *Schlumberger, KSLS.
176. Keating Drlg. 1 Ridgley; 6-7S-21W. *Lane Wells, KSLS.
177. Empire Drlg. 1 Goddard; 21-7S-24W. *Schlumberger, KSLS.
178. Graham-Messman-Rinehart 1 Emigh; 4-7S-29W. *Schlumberger, KSLS.
180. Don Pratt 1 Cooper; 25-8S-29W. *Schlumberger, KSLS.
182. Ashland Oil & Ref. 1 Misner; 33-8S-32W. *Schlumberger, KSLS.
184. Anschutz Drlg. 1 Bollig; 28-9S-25W. *Schlumberger, KSLS.
185. Phillips 1A Keller; 19-9S-32W. *Schlumberger, KSLS.
187. Heathman-Seeligson Drlg. 1 Stites; 1-10S-23W. *Halliburton, KSLS.
188. Prime Drlg. 1 Fallow; 19-10S-27W. *Schlumberger, KSLS.
189. H. K. Riddle 1 Albers; 26-10S-32W. *Schlumberger, KSLS.
190. D. R. Lauk Oil 1 Stover; 29-10S-35W. *Schlumberger, KSLS.
195. Deep Rock Oil 1 Nicholson; 29-13S-22W. *Schlumberger, KSLS.
196. E. K. Carey Drlg. 1 Burkhead; 21-13S-33W. *Schlumberger, KSLS.
199. Flynn Oil 1 Pearce; 4-14S-38W. *Halliburton, KSLS.
200. Herndon Drlg. 1 Jasper; 30-15S-29W. *Schlumberger, KSLS.
201. Rooney-Siegfried-Thomas 1 Dumler; 10-17S-26W. *Atlas, KSLS.
202. Woodward & Co. 1 Bruner; 17-17S-30W. *Schlumberger, KSLS.
204. Duncan Drlg. 1 Sell; 20-18S-42W. *Schlumberger, KSLS.
205. Herndon Drlg. 1 Kirk; 14-19S-32W. *Schlumberger, KSLS.
206. Woodward & Co. 1 Alexander; 4-20S-35W. *Schlumberger, KSLS.
207. Woodward & Co. 1 Lehner; 6-20S-36W. *Schlumberger, KSLS.
208. B & R Drlg. 1 Darbro; 32-20S-38W. *Schlumberger, KSLS.
209. Alpine and Berwick 1 Landgraf; 27-21S-32W. *Schlumberger, KSLS.
210. Trans-Era Pet. 1 Miller; 23-22S-37W. *Schlumberger, KSLS.
211. Woodward & Co. 1 Buck; 15-23S-39W. *Schlumberger, KSLS.
218. Texas 1 Keenan; 25-4S-27W. *Schlumberger, KSLS.
221. Natl. Coop. Ref. Assoc. 1 Teagarden; 10-7S-26W. *Halliburton, KSLS.
226. Cities Service 1 Sells; 9-18S-40W. *Schlumberger, KSLS.
227. Rooney-Siegfried-Thomas 1 Smith; 22-20S-36W. *Atlas, KSLS.
228. Carter 1 Overton; 24-24S-41W. *Schlumberger, KSLS.
229. W. J. Coppinger 1 Beyer; 24-26S-33W. *Schlumberger, KSLS.
230. J. M. Huber Corp. 1 Walkemeyer; 22-28S-42W. *Schlumberger, KSLS.
231. J. M. Huber Corp. 1 Sparks; 34-30S-42W. *Schlumberger, KSLS.
232. Cities Service 1A Boehm; 11-33S-42W. *Schlumberger, KSLS.
234. Flynn Oil 1 Willis; 8-4S-16W. *Schlumberger.
241. Anderson-Prichard 1 Delaney; 29-6S-15W. *Schlumberger, KSLS.
246. Natl. Coop. Ref. Assoc. 1 Hardesty; 20-6S-26W. *Schlumberger, KSLS.
248. W. J. Coppinger 1 Kritzmire; 24-26S-40W. *Schlumberger, KSLS.
310. Herndon Drlg. 1 Eitel; 18-18S-30W. *Schlumberger, KSLS.
311. Texas 1 Russell; 7-20S-16W. *Schlumberger, KSLS.
313. Natl. Coop. Ref. Assoc. 1 Newell; 7-25S-11W. *Schlumberger, KSLS.
314. United Prod. 1 McCrary; 35-31S-18W. *Schlumberger, KSLS.
316. Champlin Oil & Ref. 1 Nurse; 23-31S-13W. *Schlumberger, KSLS.
317. United Prod. 1 Helfrich; 6-25S-42W. *Schlumberger, KSLS.

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318. Musgrove Pet. 1 Bray; 26-25S-41W. *Schlumberger, KSLS.
319. Natl. Coop. Ref. Assoc. 1 Carr; 35-19S-20W. *Schlumberger, KSLS.
320. Eason Oil 1 O'Connell; 10-35S-17W. *Schlumberger, KSLS.
323. Helmerich & Payne, Inc., 23 Jones; 4-27S-34W. *Lane Wells, KSLS.
328. J. M. Huber Corp. 1 Kilgore; 5-30S-42W. *Schlumberger, KSLS.
330. J. M. Huber Corp. 1 Denton; 35-31S-24W. *Schlumberger, KSLS.
331. Shamrock Oil & Gas 1 Stevens; 10-32S-21W. *Schlumberger, KSLS.
332. Stanolind 1 Perry; 33-32S-22W. *Schlumberger, KSLS.
334. J. M. Huber Corp. 1 Neff; 2-35S-32W. *Schlumberger, KSLS.
335. Beardmore Drlg. 1 Straub; 20-18S-11W. *Schlumberger, KSLS.
336. Continental 1 Wade; 3-29S-28W. *Schlumberger, KSLS.
337. Cities Service 1 Coberly; 15-14S-29W. *Schlumberger, KSLS.
338. Lafayette Oil 1 Nichols; 21-15S-31W. *Lane Wells, KSLS.
339. Texas 1 Casner; 33-29S-4W. *Schlumberger, KSLS.
343. Stanolind 2 Adams; 9-35S-30W. *Schlumberger, KSLS.
344. Falcon-Seaboard Drlg. 1 Alexander; 5-35S-20W. *Schlumberger, KSLS.
345. Chicago Corp. 1 Davis Ranch; 11-35S-15W. *Schlumberger, KSLS.
346. Ohio 1 Bond; 32-33S-30W. *Schlumberger, KSLS.
349. R. W. Shields 1 Smith; 27-4S-21W. *Schlumberger, KSLS.
350. United Prod. 1 Rector; 23-25S-40W. *Schlumberger, KSLS.
351. Morrison Drlg. 1 Harper; 4-20S-18W. *Lane Wells, KSLS.
352. J. M. Huber Corp. 1 Cockreman; 12-28S-43W. *Schlumberger, KSLS.
358. Sun 1 Fruend; 23-30S-3W. *Schlumberger, KSLS.
360. Barnett Oil 1 Bader; 36-20S-22W. *Schlumberger, KSLS.
361. Texas 1 Parsons; 30-29S-2W. *Schlumberger, KSLS.
362. Cities Service 1 Risse; 14-20S-20W. *Schlumberger, KSLS.
363. Continental 1 Christy; 34-14S-32W. *Schlumberger, KSLS.
364. J. M. Huber Corp. 1 Blucher; 13-35S-31W. *Schlumberger, KSLS.
365. Cities Service 1 Sullivan; 26-5S-23W. *Schlumberger, KSLS.
368. Anderson-Prichard 1 Stephenson; 32-7S-15W. *Schlumberger, KSLS.
369. Gulf 1 Manhart; 28-9S-29W. *Schlumberger, KSLS.
370. Anderson-Prichard 1A Ruggles; 23-10S-15W. *Schlumberger, KSLS.
375. Northern Nat. Gas 1 Bierwagen; 10-26S-21W. *Schlumberger, KSLS.
377. Anderson-Prichard 1 Beisner; 5-9S-15W. *Schlumberger, KSLS.
378. Northern Nat. Gas 1 Collingwood; 8-32S-27W. *Schlumberger, KSLS.
379. Northern Nat. Gas 1 Jones; 9-32S-32W. *Schlumberger, KSLS.
380. Texas 1 Hochman; 31-14S-9W. *Schlumberger, KSLS.
381. Twin Oil 1 Bogered; 10-24S-18W. *Schlumberger, KSLS.
383. United Prod. 1 Owens; 7-23S-42W. *Schlumberger, KSLS.
385. Gulf 1 Abell Ranch; 21-31S-23W. *Schlumberger, KSLS.
386. Gulf 1 Rife; 31-33S-6W. *Schlumberger, KSLS.
387. Columbian Fuel 1B Keeting; 13-34S-31W. *Schlumberger, KSLS.
388. Deep Rock Oil 1 Adams; 16-35S-29W. *Lane Wells, KSLS.
389. Aurora Gasoline 1 Thompson; 4-28S-17W. *Halliburton, KSLS.
390. Superior 1 Wade; 30-29S-41W. *Schlumberger, KSLS.
391. Musgrove Pet. 1 Schartz; 20-22S-16W. *Schlumberger, KSLS.

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392. Texas 1 Dumler; 26-15S-15W. *Schlumberger, KSLS.
394. Beardmore Drlg. 1 Allen; 22-32S-9W. *Schlumberger, KSLS.
396. Colorado Oil & Gas 1 Hills; 22-7S-34W. *Schlumberger, KSLS.
399. Texas 1 Laughlin; 35-17S-19W. *Schlumberger, KSLS.
400. Derby Oil 1 Nickel; 16-6S-35W. *Schlumberger, KSLS.
401. Stearns Drlg. 1 Fink; 8-12S-14W. *Schlumberger, KSLS.
405. Sinclair 1 Smith; 17-28S-13W. *Schlumberger, KSLS.
406. Barnsdall Oil 1 Hare; 13-31S-3W. *Schlumberger.
407. Davis Bros. Oil 1 Mermis; 10-13S-19W. *Schlumberger, KSLS.
408. Great Lakes Carbon 1 Minshall; 35-1S-23W. *Schlumberger, KSLS.
409. Herndon Drlg. 1 Blair; 3-29S-12W. *Schlumberger, KSLS.
411. Murfin Drlg. 1 Bahl; 32-12S-19W. *Schlumberger, KSLS.
413. Atlantic 1 Sankey; 22-22S-10W. *Schlumberger, KSLS.
415. W. L. Hartman 1 Stoops; 5-32S-42W. *Schlumberger, KSLS.
416. Champlin Oil & Ref. 1 Shinkle; 31-25S-12W. *Schlumberger, KSLS.
418. Lewis Drlg. 1 Penny; 31-14S-17W. *Schlumberger, KSLS.
422. Anschutz Drlg. 1 Liddeke; 27-29S-5W. *Halliburton, KSLS.
424. Atlantic 1 Hoeffner; 2-14S-2W. *Schlumberger, KSLS.
429. United Prod. 1 Lane; 25-27S-41W. *Schlumberger, KSLS.
430. Bay Pet. 1 Anschutz; 12-14S-12W. *Schlumberger, KSLS.
432. Champlin Oil & Ref. 1 Brungardt; 35-10S-17W. *Schlumberger, KSLS.
433. M. B. Armer 1 Taylor; 14-16S-16W. *Schlumberger, KSLS.
434. Herndon Drlg. 1 Davis; 24-11S-20W. *Schlumberger, KSLS.
436. Northern Nat. Gas. 1 Weaver; 33-30S-29W. *Schlumberger, KSLS.
438. Natl. Coop. Ref. Assoc. 1 Becker; 29-4S-20W. *Schlumberger, KSLS.
439. Chas. A. Lasky 1A Habiger; 34-2S-11W. *Schlumberger, KSLS.
440. Derby Oil 1 Kistler; 34-9S-34W. *Schlumberger, KSLS.
442. Empire Drlg. 1 Knoll; 16-10S-25W. *Schlumberger, KSLS.
444. Atlantic 1 Mooney; 20-22S-21W. *Schlumberger, KSLS.
445. Natl. Assoc. Pet. 1 Dirksen; 13-20S-1W. *Schlumberger, KSLS.
447. Stanolind 1 Rickers; 27-32S-29W. *Schlumberger, KSLS.
Sinclair 1 Angell; 30-32S-29W. *Schlumberger, KSLS.
449. Amerada 1 Ohnmacht; 5-20S-29W. *Schlumberger, KSLS.
451. Atlantic 1 Short; 14-23S-8W. *Schlumberger, KSLS.
452. Tatlock Oil 1 Curtis; 21-26S-15W. *Schlumberger, KSLS.
453. Cities Service 1 Murphy; 16-20S-28W. *Schlumberger, KSLS.
454. Franco-Central Oil Bonjour; 13-31S-1W. *Schlumberger, KSLS.
455. Continental 1 Northrup; 16-24S-23W. *Schlumberger, KSLS.
458. Gulf 1 Saterlee; 31-24S-14W. *Schlumberger, KSLS.
460. Bishop Oil 1 Burns; 25-33S-11W. *Schlumberger.
463. United Prod. 1 Wheeler; 21-17S-41W. *Schlumberger, KSLS.
464. Cities Service 1 Wokaty; 25-25S-17W. *Schlumberger, KSLS.
467. Shell 1 Baumann; 4-22S-29W. *Schlumberger, KSLS.
470. Tatlock Oil 1 Rudiger; 30-19S-14W. *Schlumberger, KSLS.
471. Barbara Oil 1 Schrader; 18-19S-17W. *Schlumberger, KSLS.
472. Isern Bros. 1 Haynes; 22-25S-15W. *Welex, KSLS.
473. Harry Gore 1 Bruntz; 15-19S-21W. *Schlumberger, KSLS.
475. Natl. Coop. Ref. Assoc. 1 McCune; 8-25S-12W. *Schlumberger, KSLS.
476. Phillips 1A Newsom; 13-26S-17W. *Schlumberger, KSLS.
477. United Prod. 1 Leese; 34-27S-28W. *Schlumberger, KSLS.
479. Gulf 1 Pyle; 16-29S-16W. *Schlumberger, KSLS.
480. Continental 1 Laird; 15-26S-30W. *Schlumberger, KSLS.
481. Deep Rock Oil 1 Kinkaid; 34-26S-26W. *Schlumberger, KSLS.
482. Falcon-Seaboard Drlg. 1 Zweygardt; 1-3S-41W. *Schlumberger, KSLS.

KANSAS—Continued

483. Great Lakes Carbon 1 Muir; 12-3S-23W. *Schlumberger, KSLS.
487. Sun 1 Prose; 13-20S-27W. *Schlumberger, KSLS.
488. Atlantic 1 Hall; 36-23S-22W. *Schlumberger, KSLS.
489. Sun 1 Matthews; 5-30S-1W. *Schlumberger, KSLS.
490. M. B. Armer 1 Helmers; 25-28S-21W. *Schlumberger, KSLS.
491. Texas Pacific Coal & Oil 1 Gasper; 31-7S-10W. *Schlumberger, KSLS.
492. Palmer Oil 1 Ryan; 23-16S-21W. *Halliburton, KSLS.
493. Texas 1 Urbanek; 15-16S-10W. *Schlumberger, KSLS.
494. Texas 1 Staab; 28-12S-21W. *Schlumberger, KSLS.
495. Carl Todd Drlg. 1 Kuhn; 24-13S-17W. *Schlumberger, KSLS.
497. Morrison Drlg. 1 Eichel; 23-17S-17W. *Lane Wells, KSLS.
501. Shell 1 Statton; 12-30S-25W. *Schlumberger, KSLS.
503. Orville H. Parker 1 Franklin; 3-18S-34W. *Schlumberger, KSLS.
507. Texas 1 Moore; 25-31S-22W. *Schlumberger, KSLS.
510. E. H. Adair Oil 1 Allen; 4-33S-14W. *Schlumberger, KSLS.
511. Wycoff Drlg. 1 Priefer; 13-13S-29W. *Schlumberger, KSLS.
514. Carter 1 Antrim Campbell; 25-31S-9W. *Schlumberger, KSLS.
515. Natl. Assoc. Pet. 1A Madden; 13-26S-18W. *Schlumberger, KSLS.
517. Carter 1 Russell; 22-22S-31W. *Schlumberger, KSLS.
518. Coop. Ref. Assoc. 1A Schaffer; 13-12S-33W. *Schlumberger, KSLS.
519. Phil Han Oil 1 Bailey; 17-15S-1W. *Halliburton.
527. Wolf Creek Oil 1 Schrag; 5-22S-2W. *Schlumberger.
536. Deep Rock Oil 1 Whitmer; 10-30S-9W. *Schlumberger.
538. Helmerich & Payne, Inc., 1 Winters; 16-32S-10W. *Schlumberger.
543. Glickman Oil 1 Mynatt; 8-13S-1W. *Welex, KSLS.
546. Northern Ordnance 1 Warner; 10-15S-3W. *Schlumberger.
554. Northern Ordnance 1 Burr; 35-8S-9W. *Schlumberger.
557. Carter 1 Neuschwanger; 15-8S-14W. *Schlumberger.
558. Lario Oil & Gas 1 Cress; 13-11S-17W. *Schlumberger.
559. Sohio 1 Schneider; 9-16S-18W. *Schlumberger.
560. Wolf Creek Oil 1 Thalheim; 1-19S-20W. *Schlumberger.
567. Stanolind 1 Turpin; 16-19S-31W. *Schlumberger.
568. Phillips 1 Kees; 3-19S-30W. *Schlumberger.
573. Champlin Oil & Ref. 1 Becker; 34-28S-29W. *Schlumberger.
575. Cities Service 1 Victory Life; 36-13S-30W. *Halliburton.
576. Guy F. Atkinson 1 Albin; 18-13S-27W. *Schlumberger, KSLS.
578. Phillips 1 Folkers; 31-13S-23W. *Schlumberger.
580. Maher and Collins, 1952, log 22. Stanolind 1 Trussell; 28-26S-39W.
591. Lion Oil 1 Penner; 17-20S-2E. *Schlumberger, Kansas Geol. Surv.
608. Natl. Assoc. Pet. 1 Roe; 19-1S-7W. *Schlumberger.
610. Empire Drlg. 1 Brooks; 19-2S-22W. *Schlumberger, KSLS.
611. E. K. Carey Drlg. 1 Monaghan; 15-2S-27W. *Schlumberger, KSLS.
614. Cities Service 1 Blake; 8-8S-4W. *Schlumberger.
617. Central Commercial 1 Locker; 12-14S-22W. *Schlumberger.
620. Trans-Era Pet. 1 Trouble; 20-4S-22W. *Schlumberger, KSLS.
621. Harry Gore 1 Hershiser; 34-3S-23W. *Schlumberger.
624. Anderson-Prichard 1 Esau; 27-19S-1E. *Schlumberger.
626. Texas 1 Blackford; 24-25S-2E. *Schlumberger.
629. Stickle Drlg. 1 Farber; 32-29S-2E. *Schlumberger, KSLS.
632. E. S. Adkins 1 Stephens; 26-33S-3E. *Schlumberger.
635. Cities Service 1B James; 7-8S-28W. *Schlumberger, KSLS.
637. Champlin Oil & Ref. 1 Lauterbach; 21-32S-2W. *Schlumberger, KSLS.
639. Stanolind 1 Cornell; 26-16S-10E. *Schlumberger.

KANSAS—Continued

641. Huber, Anderson, and Haworth 1 Ball; 23-18S-10E. *Schlumberger.
645. J. W. McKnab 1 Babbinger; 23-21S-10E. *Schlumberger.
655. Sinclair-Prairie 1 Young; 34-27S-21W. *Lane Wells, KSLS.
659. Republic Nat. Gas 1 Hawkinson; 25-16S-5W. *Schlumberger, KSLS.
661. Pure 1 Meyer; 4-35S-6W. *Halliburton.
673. Rooney and Siegfried 1 Ward; 12-27S-15W. *Welex, KSLS.
674. Davon Oil 1 Schaeffer; 20-1S-6E. *Schlumberger, Kansas Geol. Surv.
675. Gulf 1 Baker; 1-1S-2E. *Schlumberger.
679. Stanolind 1 Duggan; 12-12S-1W. *Schlumberger, Kansas Geol. Surv.
680. Vickers Pet. 1 Bozart; 3-16S-1E. *Schlumberger, Kansas Geol. Surv.
681. Phillips 1 Bernhard; 24-21S-1E. *Schlumberger.
683. Atlantic 1 University; 6-25S-2W. *Schlumberger.
684. British-American 1 Petrie; 36-26S-1W. *Schlumberger.
685. Aladdin Pet. 1 Woolf; 7-28S-1W. *Schlumberger.
687. Stickle Drlg. 1 Bolay; 34-33S-1W. *Schlumberger, USGS.
689. Vickers Pet. 1 Alexander; 14-33S-32W. *Schlumberger, KSLS.
690. Panhandle Devel. 1A Wheatley; 23-33S-31W. *Schlumberger, KSLS.
691. J. M. Huber Corp. 1 Misak; 21-34S-5W. *Schlumberger.
693. Harbar Drlg. 1 Knorp; 27-34S-10W. *Schlumberger, USGS.
695. Superior 1 Ott; 6-34S-13W. *Schlumberger.
696. Bishop Oil 1 Davis; 6-34S-14W. *Schlumberger.
697. Lion Oil 1 De Geer; 2-33S-15W. *Schlumberger.
700. Sinclair-Prairie and Olson 1 Central Life; 23-32S-24W. *Schlumberger.
707. L. B. Jackson 1 Petro; 7-34S-19W. *Schlumberger.
712. Westgate-Greenland Oil 1 Benson; 6-14S-30W. *Schlumberger, KSLS.
719. Auto Ordnance 1 Gelker; 20-12S-2W. *Schlumberger.
721. Skelly 1 Theis; 5-34S-25W. *Schlumberger, KSLS.
723. Southwest Explor. 1 Collins; 16-32S-31W. *Schlumberger, KSLS.
725. Shell 1 Case: 7-21S-30W. *Schlumberger, KSLS.
726. Shell 1 Springer; 24-22S-24W. *Schlumberger, KSLS.
728. Midstates Oil 1 McCreight; 10-20S-23W. *Schlumberger, KSLS.
732. Superior 1 Norris; 9-22S-20W. *Schlumberger, KSLS.
733. Davon Oil 1 Stout; 28-19S-26W. *Schlumberger, KSLS.
734. Jones, Shelburne & Farmer, Inc., 1 Baker; 21-8S-33W. *Schlumberger.
735. J. M. Huber Corp. 1 Berryman; 12-31S-21W. *Schlumberger, KSLS.
736. Rine Drlg. 1 Lorimor; 20-30S-20W. *Schlumberger, KSLS.
743. Texas 1 Barngrover; 35-27S-24W. *Schlumberger, KSLS.
744. Skelly 1 Slocum; 2-28S-27W. *Schlumberger, KSLS.
747. A. G. Hill 1 Wolleridge; 35-27S-8W. *Schlumberger, KSLS.
748. Gulf 1 Calista-State; 35-27S-9W. *Schlumberger, KSLS.
749. Plains Explor. 1 Swander; 20-28S-9W. *Schlumberger, KSLS.
750. W. C. McBride, Inc., E. K. Carey Drlg. Co., and Derby Ref. 1 McBride; 27-27S-14W. *Schlumberger, KSLS.
751. Phil Han Oil and Gulf 1 Albritton; 6-29S-10W. *Schlumberger, KSLS.
755. Cities Service 1F Smith; 24-30S-13W. *Schlumberger, KSLS.
756. Gulf 1 Dent; 21-32S-7W. *Schlumberger, KSLS.
757. Carter 1 Cochran; 11-33S-1W. *Schlumberger, KSLS.
759. Lion Oil 1 Reed; 3-33S-8W. *Schlumberger, KSLS.
761. Republic Nat. Gas 1 Hille; 13-15S-24W. *Schlumberger, KSLS.

KANSAS—Continued

762. Sohio 1 Pfaff; 14-15S-23W. *Schlumberger, KSLS.
764. J. M. Huber Corp. 1 Cook; 8-34S-12W. *Schlumberger, KSLS.
767. Texas 1 Hobbisiefkin; 3-35S-3W. *Schlumberger, KSLS.
769. Beardmore Drlg. 1 Rice; 5-22S-5W. *Schlumberger, KSLS.
770. Atlantic 1 Beitler; 27-22S-8W. *Schlumberger, KSLS.
773. Cities Service 1 Zimmerman; 21-25S-6W. *Schlumberger, KSLS.
775. Stearns Drlg. 1 Brown; 36-33S-5E. *Schlumberger, KSLS.
777. Texas 1 White; 7-34S-2E. *Schlumberger, KSLS.
778. Texas Pacific Coal & Oil 1 Gabrielson; 33-17S-2W. *Schlumberger, KSLS.
779. Phillips 1 Newkirk; 11-18S-7W. *Halliburton.
781. Shawver-Armour, Inc., 1 O'Dette; 5-6S-4W. *Schlumberger, KSLS.
782. Shawver-Armour, Inc., 1 Daniels; 32-6S-5W. *Schlumberger, KSLS.
783. Shawver-Armour, Inc., 1 Hall; 18-7S-3W. *Schlumberger, KSLS.
784. Shawver-Armour, Inc., 1 Blosser; 8-6S-3W. *Schlumberger, KSLS.
787. Northern Ordnance 1 Vandament; 3-9S-13W. *Schlumberger.
788. Carter 2 Exploration; 20-9S-7W. *Schlumberger.
789. Carter 5 Exploration; 5-5S-10W. *Schlumberger.
795. George Johnston 1 Brown; 21-4S-7E. *Schlumberger, KSLS.
796. Ohio 1 Kratochvil; 30-5S-7E. *Schlumberger, KSLS.
797. Ohio 1 Osterkamp; 27-5S-6E. *Schlumberger, KSLS.
802. Carter 1 Lindgren; 18-15S-8E. *Schlumberger.
805. Carter 8 Exploration; 21-11S-8W. *Halliburton.
806. Brack Oil 1 Letsch; 15-13S-12W. *Schlumberger.
807. Northern Ordnance 1 Colliver; 29-12S-12W. *Schlumberger.
808. Northern Ordnance 1 Beverly; 11-11S-14W. *Schlumberger.
810. Woods Oil & Gas 1 Munzer; 13-13S-9E. *Schlumberger, KSLS.
812. Carter 1 Woodburg; 11-15S-10E. *Schlumberger, KSLS.
815. Morrison Drlg. Co. 1 Norton; 36-20S-8E. *Lane Wells, KSLS.
818. Birmingham & Bartlett Drlg. 1 Ralston; 6-28S-4E. *Schlumberger, KSLS.
819. Champlin Oil & Ref. 1 Bevis; 13-30S-3E. *Schlumberger, KSLS.
820. Earl Wakefield 1 Snyder; 25-32S-7E. *Schlumberger, KSLS.
821. Carter 1 Taylor; 12-33S-6E. *Schlumberger, KSLS.
823. Natl. Coop. Ref. Assoc. 1 Wright; 34-7S-36W. *Schlumberger, KSLS.
824. Sun 1 Ficken; 31-20S-23W. *Schlumberger, KSLS.
825. Van-Grisso Oil 1 Watson; 8-20S-39W. *Lane Wells, KSLS.
826. Aurora Gasoline 1A Tupps; 26-23S-21W. *Halliburton, KSLS.
827. Van-Grisso Oil 1 Frazier Farms; 15-15S-39W. *Schlumberger, KSLS.
828. Natl. Coop. Ref. Assoc. 1 Brown; 13-11S-25W. *Halliburton, KSLS.
829. Wm. Gruenerwald 1 Muehlnekamp; 26-11S-32W. *Schlumberger, KSLS.
831. Musgrove Pet. 1 Langly; 12-17S-38W. *Schlumberger, KSLS.
832. Musgrove Pet. 1 Mantel; 33-18S-36W. *Schlumberger, KSLS.
833. Caulkins Oil 1 Fankhauser; 21-18S-39W. *Schlumberger, KSLS.
834. Ben F. Brack Oil 1 Stutz-Bradley; 1-15S-26W. *Halliburton, KSLS.
835. Van-Grisso Oil 1 Wilson; 11-27S-43W. *Schlumberger, KSLS.
836. Hilton Drlg. 1 Schaben; 9-19S-24W. *Halliburton, KSLS.
837. Chicago Corp. 1B Davis Ranch; 9-34S-15W. *Schlumberger, KSLS.
839. Van-Grisso Oil 1 Clift; 9-19S-40W. *Schlumberger, KSLS.
840. United Prod. 1 Staerkel; 14-22S-41W. *Schlumberger, KSLS.

KANSAS—Continued

841. Jocelyn and Varn 1 Linn; 27-23S-2W. *Schlumberger, KSLS.
842. Aurora Gasoline 1 Schultz; 21-26S-16W. *Halliburton, KSLS.
843. Natl. Coop. Ref. Assoc. 1 Lovette; 17-24S-17W. *Schlumberger, KSLS.
844. Manhart, Millison, and Beebe 1 Hinshaw; 17-24S-9W. *Halliburton, KSLS.
845. F. Kirk Johnson 1 Kisner; 21-24S-31W. *Schlumberger, KSLS.
846. Amerada 1 Thomas; 6-32S-22W. *Schlumberger, KSLS.
847. Skelly 1 Harvey; 31-33S-24W. *Schlumberger, KSLS.
850. Colorado Oil & Gas 1 Bartell; 29-32S-27W. *Schlumberger, KSLS.
851. Lion Oil 1 Tate; 17-24S-42W. *Schlumberger, KSLS.
853. Sinclair 1 Good; 35-34S-12W. *Schlumberger, KSLS.
854. Northern Nat. Gas. 1A Stout; 9-32S-36W. *Schlumberger, KSLS.
855. Coop. Ref. Assoc. 1A Steward; 6-23S-30W. *Schlumberger, KSLS.
859. Pure and Ohio 1 Konde; 11-27S-22W. *Halliburton, KSLS.
860. J. M. Huber Corp. 1 Einsel; 11-33S-17W. *Schlumberger, KSLS.
862. Armer and Natl. Coop. Ref. Assoc. 1 McKinley; 11-28S-20W. *Schlumberger, KSLS.
863. J. M. Huber Corp. 1 Weirauch; 23-28S-31W. *Schlumberger, KSLS.
866. Champlin Oil & Ref. 4 Garden City; 18-23S-34W. *Schlumberger, KSLS.
867. Kansas-Nebraska Nat. Gas 1 Wilcox; 36-23S-39W. *Schlumberger, KSLS.
868. Falcon-Seaboard Drlg. 1 Randall; 23-34S-22W. *Schlumberger, KSLS.
869. United Prod. 1 Fitzgerald; 13-14S-42W. *Schlumberger, KSLS.
870. Trans-Era Pet. 1 Bell; 13-9S-28W. *Schlumberger, KSLS.
871. Shell 1 Harden; 24-6S-40W. *Schlumberger, KSLS.
872. Van-Grisso Oil 1 Golden; 24-10S-42W. *Schlumberger, KSLS.
874. Pure 1 Griffiths; 3-9S-4E. *Schlumberger, KSLS.
875. Aurora Gasoline 1 Voth; 17-21S-1E. *Schlumberger, KSLS.
876. Cities Service 1 Gibson; 17-22S-7E. *Schlumberger, KSLS.
877. Aurora Gasoline 1 Burns; 30-23S-26W. *Halliburton, KSLS.
878. H. E. and E. E. Ogden 1 Herrman; 32-24S-19W. *Halliburton, KSLS.
879. A. G. Hill Oil 1 Miller; 17-25S-19W. *Schlumberger, KSLS.
880. Nat. Gas and Oil 1 Craft; 15-26S-19W. *Schlumberger, KSLS.
881. Natl. Coop. Ref. Assoc. 1 Milford; 7-28S-8W. *Schlumberger, KSLS.
882. Big X Drlg. 1 Taylor; 21-30S-23W. *Schlumberger, KSLS.
883. W. Gruenerwald 1 Bain; 15-30S-24W. *Schlumberger, KSLS.
885. Shell 1 Miller; 24-34S-18W. *Schlumberger, KSLS.
886. Shell 4 Theis; 5-35S-24W. *Schlumberger, KSLS.
887. Musgrove Pet. 1 Van Donge; 31-9S-38W. *Schlumberger, KSLS.
889. Natl. Coop. Ref. Assoc. 1 Burnett; 4-22S-38W. *Schlumberger, KSLS.
890. Gulf 1 Wells; 27-22S-19W. *Schlumberger, KSLS.
891. Musgrove Pet. 1 Nelson; 16-17S-37W. *Schlumberger, KSLS.
892. A. D. McKelvey 1 Deal; 23-21S-30W. *Schlumberger, KSLS.
893. Gene Goff 1 Chennell; 22-21S-28W. *Schlumberger, KSLS.
894. Don Pratt 1 North; 21-15S-20W. *Halliburton, KSLS.
895. Panhandle-Eastern Pipeline 1-21 Grose; 21-18S-22W. *Schlumberger, KSLS.
896. Musgrove Pet. 1 Richardson; 25-18S-36W. *Schlumberger, KSLS.
897. Leben Drlg. 1A Buckbee; 3-20S-22W. *Halliburton, KSLS.

KANSAS—Continued

899. Nat. Gas and Oil 1 Larrison; 26-29S-13W. *Schlumberger, KSLS.
900. Graham Devel Synd. 1 Rathbun; 35-10S-7W. *Halliburton, KSLS.
901. Kewanee Oil 1 Hartley; 36-21S-25W. *Halliburton, KSLS.
902. Durbin-Bond and Sierra Pet. 1 Edwards; 18-31S-27W. *Schlumberger, KSLS.
903. Miami Pet. 1 Bear; 18-7S-37W. *Schlumberger, KSLS.
905. Van-Grisso Oil 1 Touslee; 11-9S-35W. *Schlumberger, KSLS.
906. Jackson, Shear, and Parker 1Eggers; 23-5S-37W. *Schlumberger, KSLS.
907. Jackson, Shear, and Parker 1 Grover; 32-5S-33W. *Schlumberger, KSLS.
908. J. S. Carter 1 Henry; 27-5S-34W. *Welex, KSLS.
909. Petroleum, Inc., 1 Falconer; 6-5S-36W. *Schlumberger, KSLS.
910. D. E. Dunne 1 Gonder; 2-23S-26W. *Welex, KSLS.
911. K & E Drlg. 1 Sinclair; 28-22S-25W. *Welex, KSLS.
912. Gulf and Pan American 1 Lewis; 33-19S-27W. *Welex, KSLS.
913. Virginia Drlg. 1 Janne; 1-13S-34W. *Schlumberger, KSLS.
914. J. S. Carter 1 Ross; 36-13S-34W. *Schlumberger, KSLS.
915. Northern Nat. Gas. 1EE Brown; 21-25S-34W. *Schlumberger, KSLS.
917. Amerada 1 Yanda; 12-11S-26W. *Schlumberger, KSLS.
918. Imperial Oil of Kansas 1 Houser; 14-11S-29W. *Schlumberger, KSLS.
919. Westheimer-Neustadt Corp. 1 Glasco; 10-1S-38W. *Schlumberger, KSLS.
920. R. G. Lawton 1 Rueb; 13-3S-42W. *Schlumberger, KSLS.
921. Atomic Drlg. & Service 1 Mundhenke; 18-4S-39W. *Welex, KSLS.
922. Phillips 1 Wilkins; 16-2S-37W. *Schlumberger, KSLS.
923. Jackson, Shear, and Parker 1 Ruda; 14-4S-33W. *Welex, KSLS.
924. Jackson, Shear, and Parker 1 Bowles; 24-4S-34W. *Welex, KSLS.
925. Kewanee Oil 1 Rahmeier; 8-13S-9W. *Schlumberger, KSLS.
926. Westheimer-Neustadt Corp. and Shear 1 Cahoj; 6-30S-14W. *Schlumberger, KSLS.
928. Natl. Coop. Ref. Assoc. and Murfin Drlg. 1 Weede; 6-30S-14W. *Schlumberger, KSLS.
929. J. M. Huber Corp. 1 Dreyer; 17-32S-43W. *Schlumberger, KSLS.
930. Miami Pet. 1A Dawes; 24-7S-37W. *Schlumberger, KSLS.
931. J. S. Carter 1 Foster; 6-7S-31W. *Schlumberger, KSLS.
933. Jackson, Shear, and Parker 1 Foster; 14-6S-32W. *Schlumberger, KSLS.
936. Miami Pet. 1 Stewart; 28-7S-33W. *Schlumberger, KSLS.
937. Miami Pet. 1A Ackerman; 30-6S-37W. *Schlumberger, KSLS.
939. R. G. Lawton 1 Blair; 20-6S-41W. *Schlumberger, KSLS.
940. Wm. Gruenerwald 1 Guthrie; 11-18S-8E. *Welex, KSLS.
941. Glickman Oil 1 Royal; 24-13S-2W. *Welex, KSLS.
942. Pickrell Drlg. 1 Hamill; 11-21S-27W. *Schlumberger, KSLS.
944. Virginia Drlg. 1 Hanson; 28-13S-36W. *Welex, KSLS.
945. Gulf and Natl. Coop. Ref. Assoc. 1 Weide; 29-28S-18W. *Schlumberger, KSLS.
947. Iron Drlg. and others 1 Brack; 21-22S-26W. *Schlumberger, KSLS.
948. Kewanee Oil 1 Herman; 7-21S-24W. *Schlumberger, KSLS.
949. Colorado Oil & Gas 1 Nau; 25-26S-23W. *Schlumberger, KSLS.
951. Rupp-Ferguson Oil 1 Hume; 26-30S-43W. *Schlumberger, KSLS.
952. Skelly 1 Potter; 8-26S-42W. *Schlumberger, KSLS.

KANSAS—Continued

953. Producers Pipe & Supply 1 Renn; 14-31S-2W. *Welex, KSLS.
954. Aurora Gasoline and Natl. Coop. Ref. Assoc. 1 Locke; 12-30S-7W. *Welex, KSLS.
955. D. G. Hansen 1 Thompson; 28-1S-24W. *Welex, KSLS.
956. Natl. Coop. Ref. Assoc. 1 Kruse; 6-29S-17W. *Welex, KSLS.
957. Cities Service 1C Salley; 16-34S-33W. *Halliburton, KSLS.
959. Cities Service 1 Lockhart; 19-14S-11E. *Schlumberger, KSLS.
960. Cities Service 1 Cobb; 6-17S-10E. *Schlumberger, KSLS.
961. Nat. Gas and Oil 1 Alexander; 4-17S-8E. *Schlumberger, KSLS.
962. Stelbar Oil Corp. 1B Blood; 29-29S-4E. *Schlumberger, KSLS.
964. Cities Service 1 Huber; 27-22S-9E. *Schlumberger, KSLS.
965. Sun 1 Grose; 9-33S-5E. *Schlumberger, KSLS.
966. Pure 1 Holdridge; 26-24S-7E. *Schlumberger, KSLS.
967. Big Chief Drlg. 1 Seyfrit; 27-33S-18W. *Schlumberger, KSLS.
968. Gulf 1 Moberly; 31-30S-17W. *Schlumberger, KSLS.
1000. Miami Pet. 1A Brumm; 7-2S-36W. *Schlumberger, KSLS.
1001. James H. Snowden 1 Lull; 5-3S-11W. *Schlumberger, KSLS.
1002. Helmerich & Payne, Inc., 1 Meyer; 10-5S-11W. *Schlumberger.
1003. Stanolind 1 Campbell; 26-6S-2W. *Schlumberger.
1004. H & T Drlg. 1 Harold; 11-6S-28W. *Schlumberger.
1006. Harry Koplin 1 Tatman; 23-7S-18W. *Schlumberger, KSLS.
1007. Davis and Childs Motor Co. 1 Scott; 7-7S-22W. *Schlumberger.
1008. Roland L. Pelt & Co. 1 Renners; 14-7S-31W. *Schlumberger, KSLS.
1009. Rupp-Ferguson Oil 1 Larson; 21-8S-2W. *Halliburton, KSLS.
1010. Olson Drlg. 1 Palen; 26-8S-10W. *Schlumberger.
1011. Westgate-Greenland Oil and Carter 1 Dean; 5-8S-14W. *Schlumberger.
1012. Cities Service 1 Post; 3-8S-16W. *Schlumberger.
1013. B & R Drlg. 1 Roy; 14-8S-20W. *Schlumberger.
1014. Union 1 Pratt; 23-8S-26W. *Schlumberger.
1015. Derby Oil 1 Schielke; 17-8S-34W. *Schlumberger, KSLS.
1016. Westgate-Greenland Oil 1 Foote; 29-9S-1W. *Schlumberger.
1017. Continental 11 Trexler; 15-9S-21W. *Schlumberger.
1018. Westgate-Greenland Oil 1 Schlotz; 22-10S-2W. *Schlumberger.
1019. Harbar Oil & Gas 1 Rasmussen; 29-10S-9W. *Schlumberger.
1020. Birmingham-Bartlett Drlg. 1 Marcotte; 18-10S-19W. *Schlumberger.
1021. B & R Drlg. 1 Carder; 2-10S-26W. *Schlumberger.
1022. Anschutz Drlg. 1 Gassman; 28-10S-29W. *Schlumberger, ger, KSLS.
1023. J. O. Farmer and Texas Crude Oil 1 Bertrand; 24-10S-34W. *Welex, KSLS.
1024. Excelsior Oil and Falcon-Seaboard Drlg. 1 Marshall; 17-10S-36W. *Schlumberger, KSLS.
1025. Rupp-Ferguson Oil 1 Metz; 33-11S-7W. *Halliburton, KSLS.
1026. Virginia Drlg. 1 Schimkowitch; 36-11S-25W. *Schlumberger, KSLS.
1027. Newmont and GMR 1 Lamoreaux; 8-12S-29W. *Schlumberger, KSLS.
1028. Texas 1 Federal Farm & Mortgage; 17-12S-30W. *Schlumberger.
1029. Superior 38 Pinney; 32-13S-21W. *Schlumberger.
1030. Skiles Oil 1 Pierand; 27-13S-27W. *Schlumberger, KSLS.
1031. Skelly 1 Sexson; 19-13S-42W. *Schlumberger, KSLS.
1032. Coop. Ref. Assoc. 1B Goodrich; 9-14S-42W. *Schlumberger, KSLS.
1033. Phillips 1 Rathbun; 31-16S-8W. *Halliburton, KSLS.
1034. Helmerich & Payne, Inc. 1 Broughton; 10-16S-27W. *Schlumberger, KSLS.

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1035. Virginia Drlg. 1 Harper; 26-16S-30W. *Schlumberger.
1036. Phillips 1 Holcomb; 28-17S-1W. *Halliburton.
1037. Anschutz Drlg. 1 Kratzer; 14-17S-8W. *Schlumberger.
1038. W. C. McBride, Inc., 2 Schultz; 35-18S-1W. *Schlumberger.
1039. Eldorado Ref. 1 Wohlford; 31-18S-8W. *Halliburton, KSLS.
1040. Bay Pet. 2 Everett; 7-18S-25W. *Schlumberger.
1041. Imperial Oil of Kansas 1 Carpenter; 11-18S-32W. *Welex, KSLS.
1042. Amerada 1 Grube; 24-18S-32W. *Schlumberger, KSLS.
1043. Rex and Morris Drlg. 1 Reikowsky; 34-19S-1W. *Schlumberger, KSLS.
1044. Skelly 1 SWD Conway; 30-19S-4W. *Schlumberger, KSLS.
1045. L. B. Jackson 1 Ramage; 16-19S-6W. *Schlumberger, KSLS.
1046. Flynn Oil 1 Gray; 17-19S-8W. *Schlumberger, KSLS.
1047. Aladdin Pet. 1 Isern; 19-19S-11W. *Schlumberger.
D. R. Lauck 1 Johnson; 6-19S-11W. *KSLS.
1048. Lohmann and Johnson Drlg. 1 Button; 13-19S-13W. *Schlumberger.
1049. Tatlock Oil 1 Peterson; 36-19S-16W. *Schlumberger, KSLS.
1050. Skelly 1 Pechaneco; 2-19S-17W. *Schlumberger, KSLS.
1051. Musgrove Pet. 1 Shiney; 12-19S-19W. *Schlumberger, KSLS.
1052. Helmerich & Payne, Inc., 3 Dirks; 32-20S-12W. *Schlumberger.
1053. Atlantic 1D Mark; 7-20S-33W. *Schlumberger.
Imperial Oil of Kansas 1 Rothfelder; 7-20S-33W. *Halliburton, KSLS.
1054. Atlantic 1A McHugh; 23-21S-34W. *Schlumberger.
1055. K & E Drlg. 1 Belden; 20-23S-10W. *Schlumberger.
1056. Leben Drlg. 1 Webster; 15-24S-2W. *Schlumberger, KSLS.
1057. Bay Pet. 1C Buhrle; 4-26S-41W. *Schlumberger.
1058. Lion Oil 1 Mico; 30-29S-11W. *Schlumberger, KSLS.
1059. Orville H. Parker 1 Chain; 21-31S-11W. *Schlumberger, KSLS.
1060. M. B. Armer 1 Lorimer; 36-31S-20W. *Schlumberger.
1061. Beardmore and Barbara Drlg. 1 Schnelle; 22-32S-11W. *Schlumberger, KSLS.
1062. Cities Service 1B Holt; 28-32S-34W. *Schlumberger, KSLS.
1063. Stanolind 1 Bear; 17-32S-40W. *Schlumberger.
1064. J. M. Huber Corp. 1 Cather; 16-34S-7W. *Schlumberger, KSLS.
1065. W. Gruenerwald 1 East; 23-34S-9W. *Schlumberger, KSLS.
1066. Rupp-Ferguson Oil 1 Koontz; 11-34S-11W. *Schlumberger, KSLS.
1067. Pure 1 Beals; 5-34S-17W. *Schlumberger.
1068. Sunray 1 Harper; 21-34S-21W. *Schlumberger, KSLS.
1069. Colorado Oil & Gas 1 Central Life; 34-34S-42W. *Schlumberger, KSLS.
1070. Cities Service 1B Interstate; 7-34S-43W. *Schlumberger, KSLS.
1071. Skelly 1 Dunne; 4-35S-23W. *Schlumberger, KSLS.
1072. Ohio 1 Husted; 3-1S-15E. *Schlumberger.
1074. Texas 1 Murdock; 16-2S-13E. *Schlumberger.
1075. Ohio 1 Lamparter; 3-2S-14E. *Schlumberger.
1076. Five Nations Drlg. 1 Seematter; 24-3S-8E. *Schlumberger, KSLS.
1077. Shawver-Armour, Inc., 1 Sedlacek; 31-4S-8E. *Welex.
1078. Carter 4 Exploration; 24-4S-16E. *Schlumberger.
1079. Woods Oil & Gas 1 Whaley; 34-4S-13E. *Schlumberger.
1080. Cities Service 1 O'Connor; 21-6S-9E. *Schlumberger, KSLS.
1081. Kaiser-Francis Oil & Gas 1 Biggart; 20-6S-14E. *Welex, KSLS.
1082. Kewanee Oil 1 Bloom; 14-7S-2E. *Schlumberger.
1083. Vickers Pet. 1 Lutz; 10-7S-7E. *Schlumberger, KSLS.

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1189. Cities Service 2 Yaege; 25-11S-8E. *Schlumberger, KSLS.
1190. Skelly 1 Thoewe; 2-13S-10E. *Schlumberger.
1191. Gold Oil 1 Nelson; 6-15S-7E. *Schlumberger.
1192. McDonald 1 Lee; 16-16S-23E. *Kansas Geol. Surv.
1193. Westgate-Greenland Oil 1 Myers; 23-17S-7E. *Schlumberger.
1194. Anderson-Prichard 1 Jost; 22-19S-2E. *Schlumberger.
1195. Phillips 1 Clark; 15-22S-4E. *Halliburton.
1196. Phillips 6S D & S Unit; 12-22S-10E. *Schlumberger.
1197. Raymond Oil 2 Classen; 18-24S-4E. *Schlumberger, KSLS.
1198. Cities Service 1S Pierpont; 33-25S-5E. *Schlumberger.
1199. Kewanee Oil 4A Schramm; 34-26S-1E. *Schlumberger.
1200. Gulf 58 Schumway; 11-26S-4E. *Schlumberger.
1201. Morris Sitrin and others 1B Bates; 10-27S-4E. *Lane Wells.
1202. Rex and Morris 1 Mann; 6-29S-4E. *Lane Wells.
1203. Shell 8 Taton; 36-31S-2E. *Schlumberger.
1204. McNeish Oil 3 Wenrich; 23-32S-2E. *Schlumberger.
1205. Frankfort Oil 1 Carter; 23-32S-14E. *Schlumberger.
1206. Frankfort Oil 1 Merdith; 15-34S-17E. *Schlumberger.
1208. Murfin Drlg. 1B Niemuth; 1-2S-32W. *Schlumberger, KSLS.
1209. Russell Cobb, Jr., Inc., 1 Jacobs; 16-3S-20W. *Schlumberger, KSLS.
1210. M. J. Lebsack 1 Unger; 3-3S-30W. *Welex, KSLS.
1211. J. O. Farmer, Inc., 1 Fikan; 11-3S-33W. *Schlumberger, KSLS.
1212. Murfin Drlg. and Roy Northern 1 Cahoj; 28-3S-36W. *Schlumberger, KSLS.
1213. Saffa, Brauer & McDevitt 1 Weaver; 13-4S-38W. *Welex, KSLS.
1214. Cities Service 1 Higby; 29-5S-18W. *Schlumberger, KSLS.
1215. Derby Oil 1 Skiles; 17-5S-30W. *Schlumberger, KSLS.
1216. J. O. Farmer, Inc., 1 Neitzel; 3-5S-39W. *Welex, KSLS.
1217. Natl. Assoc. Pet. 1 Probst; 18-6S-19W. *Schlumberger, KSLS.
1218. Anschutz Drlg. 1 Dally; 10-8S-30W. *Schlumberger, KSLS.
1219. Musgrove Pet. 1 Trachel; 23-8S-39W. *Welex, KSLS.
1220. E. J. Athens 1 Ziebig; 10-8S-42W. *Schlumberger, KSLS.
1221. Empire Drlg. 1 Moellering; 28-9S-30W. *Schlumberger, KSLS.
1222. Peel-Hardman Oil 1 Osborn; 7-11S-21W. *Schlumberger, KSLS.
1223. Texas Crude Oil and John Farmer 1 Unrich; 17-12S-35W. *Welex, KSLS.
1224. Wycoff Bros. Drlg. 1 Bretz; 5-12S-37W. *Schlumberger, KSLS.
1225. General Crude Oil 1 Adams; 15-12S-39W. *Schlumberger, KSLS.
1226. Toto Gas 1 Stover; 7-12S-40W. *Schlumberger, KSLS.
1227. Rupp-Ferguson Oil 1 Craig; 20-13S-3W. *Halliburton, KSLS.
1228. A. F. Schmidt 1 McKune; 17-13S-15W. *Lane Wells, KSLS.
1229. Toto Gas 1 Eaton; 24-13S-32W. *Schlumberger, KSLS.
1230. Target Drlg. 1 Fankhauser; 31-13S-39W. *Welex, KSLS.
1231. Leben Drlg. 1 Rohr; 19-14S-18W. *Schlumberger, KSLS.
1232. Rupp-Ferguson Oil 1 Farrington; 15-15S-6W. *Halliburton, KSLS.
1233. Cherry Drlg. 1 Brown; 3-15S-8W. *Welex, KSLS.
1234. Bennett and Roberts 1 Berrick; 13-15S-13W. *Schlumberger, KSLS.
1235. Petroleum, Inc., 1 Garvey; 11-15S-27W. *Schlumberger, KSLS.
1236. Toto Gas 1 Wood; 10-15S-34W. *Schlumberger, KSLS.
1237. Pickrell Drlg. 1 Montgomery; 5-16S-24W. *Schlumberger, KSLS.
1238. Texas 1 Dahlsten; 21-17S-4W. *Schlumberger, KSLS.
1239. John Hawley 1 Schreiber; 33-17S-15W. *Schlumberger, KSLS.

1240. Earl F. Wakefield 1 Hartman; 26-17S-28W. *Schlumberger, KSLS.
1241. Toto Gas 1 Eichenberger; 2-17S-35W. *Schlumberger, KSLS.
1242. Whitehall Oil 1 Trigg; 8-17S-39W. *Schlumberger, KSLS.
1243. Time Pet. 1 Berggaren; 27-18S-3W. *Welex, KSLS.
1224. D. R. Lauck Oil 1 Trester; 33-18S-14W. *Lane Wells, KSLS.
1245. Trans-Era Pet. 1 Antenan; 9-18S-23W. *Schlumberger, KSLS.
1246. Petroleum Explor. 1 Patton; 20-19S-33W. *Welex, KSLS.
1247. Honaker-Davis Drlg. 1 Pearson; 17-19S-41W. *Schlumberger, KSLS.
1248. Petroleum, Inc., 1C Malone; 25-20S-10W. *Atlas, KSLS.
1249. Pickrell Drlg. 1 Brown; 20-21S-22W. *Schlumberger, KSLS.
1250. Pure 1 Campbell; 9-21S-35W. *Welex, KSLS.
1251. Jones, Shelburne and Farmer, Inc., 1 Grilliot; 17-21S-40W. *Schlumberger, KSLS.
1253. Transit Corp. and Lion Oil 1 Krankenburg; 19-22S-12W. *Halliburton, KSLS.
1255. Horizon Oil & Gas 1 Barrett; 20-22S-34W. *Schlumberger, KSLS.
1256. Union Texas Nat. Gas. 1 Hill; 27-23S-4W. *Schlumberger, KSLS.
1257. Westgate-Greenland Oil 1 Copeland; 2-23S-14W. *Schlumberger, KSLS.
1258. M. B. Armer 1 Garvin; 30-23S-15W. *Schlumberger, KSLS.
1259. D. G. Hamilton 1 Maxwell; 32-23S-29W. *Welex, KSLS.
1260. M & L Oil 1 Trekell; 6-23S-31W. *Schlumberger, KSLS.
1261. Mack Oil 1 Harms; 27-24S-25W. *Welex, KSLS.
1262. Artnell Co. 1 Stegman; 2-25S-21W. *Welex, KSLS.
1263. Mack Oil 1 Cobb; 27-25S-24W. *Schlumberger, KSLS.
1264. Pan American 1B Beaty; 8-25S-38W. *Schlumberger, KSLS.
1265. Morris Mizel 1 Knoblauch; 26-26S-5W. *Schlumberger, KSLS.
1266. Aylward Drlg. 1 Hay; 25-26S-8W. *Schlumberger, KSLS.
1267. Bennett and Roberts 1 Hayes; 21-26S-10W. *Halliburton, KSLS.
1268. D. R. Lauck Oil 1 Schrack; 15-26S-13W. *Schlumberger, KSLS.
1269. Continental 1 Klaysteuber; 29-26S-31W. *Schlumberger, KSLS.
1270. Bankoff Oil 1 Rosenhagen; 21-27S-4W. *Schlumberger, KSLS.
1271. S & S Drlg. 1 Wimer; 25-27S-6W. *Welex, KSLS.
1272. Coop. Ref. Assoc. 1 Montgomery; 1-27S-12W. *Schlumberger, KSLS.
1273. M. B. Armer and others 1 Reeder; 22-27S-16W. *Halliburton, KSLS.
1274. Gulf 1 Rice; 30-27S-18W. *Schlumberger, KSLS.
1275. Champlin Oil & Ref. 1 Thompson; 21-27S-32W. *Schlumberger, KSLS.
1276. Pleasant Prairie Oil 1 Polly-Anna; 36-27S-35W. *Schlumberger, KSLS.
1277. Shawver-Armour, Inc., 1 Turner; 23-28S-5W. *Halliburton, KSLS.
1278. Beardmore Drlg. 1 Blumenhourst; 29-28S-6W. *Schlumberger, KSLS.
1279. D. R. Lauck 1 Seyfert; 14-28S-15W. *Welex, KSLS.
1280. Walter Kuhn 1 Masoner; 30-28S-32W. *Schlumberger, KSLS.
1281. W. J. Coppinger 1 Reimer; 35-28S-34W. *Welex, KSLS.
1282. Pan American 1 Pinegar; 7-28S-38W. *Schlumberger, KSLS.
1283. W. E. Green 1 Brand; 16-29S-7W. *Schlumberger, KSLS.
1284. Falcon-Seaboard Drlg. 1 McColm; 18-29S-21W. *Schlumberger, KSLS.
1285. Braden Drlg. 1 Groth; 31-29S-33W. *Schlumberger, KSLS.

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1286. Hugoton Prod. 1 Eichenberger; 27-29S-37W. *Schlumberger, KSLS.
1287. Pan American 1 Watkins; 20-30S-32W. *Schlumberger, KSLS.
1288. Walter Kuhn 1 Bryant; 20-30S-34W. *Schlumberger, KSLS.
1289. United Prod. 2 Curtis; 21-30S-36W. *Schlumberger, KSLS.
1290. Hugoton Prod. 2 Schmidt; 22-30S-38W. *Schlumberger, KSLS.
1291. Aladdin Pet. 1 Johns; 34-31S-4W. *Halliburton, KSLS.
1292. Gene Goff 1 Moritz; 30-31S-5W. *Schlumberger, KSLS.
1293. Coop. Ref. Assoc. 1 Rutledge; 8-31S-7W. *Welex, KSLS.
1294. Cities Service 1E Adams; 18-31S-33W. *Halliburton, KSLS.
1295. Mobil 1 Anderson Trust; 27-31S-35W. *Schlumberger, KSLS.
1296. Hugoton Prod. 2 Grubbs; 29-31S-37W. *Schlumberger, KSLS.
1297. Pan American 1D Cooper; 21-31S-39W. *Schlumberger, KSLS.
1298. Sohio 1 Ayers; 16-32S-5W. *Schlumberger, KSLS.
1299. Leftwich Co. 1 DuVall; 36-32S-25W. *Schlumberger, KSLS.
1300. Herndon Drlg. 1 Schmidt; 30-33S-2W. *Schlumberger, KSLS.
1301. E. H. Adair Oil 1 Shobe; 29-33S-4W. *Schlumberger, KSLS.
1302. Shamrock Oil & Gas 1J Dennis; 1-33S-26W. *Schlumberger, KSLS.
1303. Skelly 1 Borchers; 21-33S-28W. *Schlumberger, KSLS.
1304. Panhandle Eastern Pipeline 2-20 Shuck; 20-33S-34W. *Schlumberger, KSLS.
1305. Republic Nat. Gas. 1 Toole; 13-33S-37W. *Schlumberger, KSLS.
1306. United Prod. 5 Christopher; 14-33S-39W. *Schlumberger, KSLS.
1307. Westhoma Oil 1 Dowdy; 31-34S-34W. *Schlumberger, KSLS.
1308. Anadarko Prod. 1B Kelly; 15-34S-38W. *Schlumberger, KSLS.
1309. Anadarko Prod. 1 Kendall; 33-34S-39W. *Schlumberger, KSLS.
1310. Aurora Gasoline 1 Zellers; 10-35S-8W. *Halliburton, KSLS.
1311. Gulf 1 Higinbotham; 2-35S-26W. *Schlumberger, KSLS.
1312. Musgrove Pet. 1 Jones; 11-35S-43W. *Schlumberger, KSLS.
1313. Kiska Oil 1 Kraus; 36-1S-7E. *Schlumberger, KSLS.
1314. Kaiser-Francis Oil & Gas 1 Atwater; 14-5S-15E. *Schlumberger, KSLS.
1315. Cities Service 1 Wunder; 16-8S-17E. *Schlumberger, KSLS.
1316. Brunson-Spines 1 Fevurley; 25-8S-17E. *Welex, KSLS.
1317. Cities Service 1 Schmidling; 15-8S-21E. *Schlumberger, KSLS.
1318. Olin Oil & Gas 1 Duenney; 36-11S-6E. *Schlumberger, KSLS.
1319. Olin Oil & Gas 1 Ritter; 5-12S-5E. *Schlumberger, KSLS.
1320. F. G. Holl 1 McArthur; 6-13S-8E. *Welex, KSLS.
1321. Kaiser-Francis Oil & Gas 1 McKnight; 17-13S-12E. *Schlumberger, KSLS.
1322. Smart and Griffith 1 Messer; 27-14S-19E. *Schlumberger, KSLS.
1323. Waco Oil 1 Volgast; 17-15S-18E. *Schlumberger, KSLS.
1324. Schermerhorn Oil 1 Johanning; 17-15S-19E. *Schlumberger, KSLS.
1325. White and Ellis Drlg. 1 Miller; 1-16S-12E. *Schlumberger, KSLS.
1326. Messman-Rinehart 1 Woodward; 23-16S-16E. *Schlumberger, KSLS.
1327. Lance Hill and others 1 Bowman; 17-16S-18E. *Welex, KSLS.

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1328. Rex and Morris Drlg. 1 Pankratz; 21-17S-3E. *Schlumberger, KSLS.
1329. Cities Service 1 Mounkes; 27-18S-13E. *Schlumberger, KSLS.
1330. Anderson-Prichard 1 Church; 24-19S-5E. *Schlumberger, KSLS.
1331. Stanolind 1 Kline; 10-19S-7E. *Schlumberger, KSLS.
1332. E. H. Adair 1 Wallace; 6-22S-3E. *Schlumberger, KSLS.
1333. Kewanee Oil 1 Bitler; 27-24S-13E. *Schlumberger, KSLS.
1334. Cities Service 1 Thacker; 27-26S-3E. *Schlumberger, KSLS.
1335. G. R. Jones 1 LaRue; 26-26S-13E. *Schlumberger, KSLS.
1336. Kewanee Oil 1 Worley; 2-27S-9E. *Schlumberger, KSLS.
1337. Delta Oil 1 Oakes; 30-27S-12E. *Elgin, KSLS.
1338. Delta Oil 1 Eck; 16-27S-13E. *Elgin, KSLS.
1339. Hamilton and Dunn Drlg. 1 Doggett; 10-29S-11E. *Elgin, KSLS.
1340. J. P. Gaty and others 1 Lawless; 14-31S-1E. *Schlumberger, KSLS.
1341. K & E Drlg. 1 Nelson; 6-31S-13E. *Schlumberger, KSLS.
1342. Pure 1 Jarboe; 12-32S-8E. *Schlumberger, KSLS.
1343. Magnolia 1 Burns; 33-11S-20E. *Kansas Geol. Surv.
1344. Allen Gas 2 Ramsey; 31-18S-23E. *Kansas Geol. Surv.
1345. 1 Kippler well; 9-19S-19E. *Kansas Geol. Surv.
1346. 1 Church well; 20-22S-20E. *Kansas Geol. Surv.
1347. Oklahoma Nat. Gas. 1 Nevitt; 6-24S-21E. *Kansas Geol. Surv.
Oklahoma Nat. Gas. 2 Nevitt; 6-24S-21E. *Kansas Geol. Surv.
1348. Depew well; 1-22S-24E. *Kansas Geol. Surv.
1349. Bryant and Sarber 3 Dickerson; 33-26S-18E. *Kansas Geol. Surv.
1350. Beitton 1 Miner; 21-26S-21E. *Kansas Geol. Surv.
1351. LaSalle 1 Gobl; 20-28S-25E. *Kansas Geol. Surv.
1352. Wise and Jackson 3 Lant; 21-31S-18E. *Kansas Geol. Surv.
1353. Olathe Gas & Oil Devel. 1 Miller; 2-13S-23E. *Kansas Geol. Surv.
1354. Roth and Faurot 1 Brandt; 2-32S-19E. *Kansas Geol. Surv.
1355. Stover Oil & Gas 1 Bryant; 23-33S-20E. *Kansas Geol. Surv.
1356. Eagle-Picher 2 Reese; 1-34S-23E. *Kansas Geol. Surv.
Eagle-Picher 1 E. Davis; 11-34S-23E. *Kansas Geol. Surv.
1357. Ockerman, 1935, p. 47. Valley 1 Mann.
1358. Ockerman, 1935, p. 41-43. Well at Atchison.
1359. Ockerman, 1935, p. 52-53. Northern Oil and Gas 1 Winchester.
1360. Ockerman, 1935, p. 59-63. Well at Topeka.
1361. Ockerman, 1935, pl. 1, no. 3, Twist 1 Well.
1362. Ockerman, 1935, p. 56, Universal Oil 1 Harrington.
1363. Ockerman, 1935, p. 55, Higgins and others 1 Harrison.
1364. Charles, 1927, pl. 2, no. 8, 1 Spencer well.
1365. Charles, 1927, pl. 1, no. 1, Eskin and others 1 Drybread.
1366. Charles, 1927, pl. 1, no. 8, Peerless Oil 1 Barnes.
1367. Abernathy, 1943, p. 77-112, Jayhawk Ordnance Works water well.
1368. Cramm 1 Allen; 13-21S-15E. *Kansas Geol. Surv.
1369. Bundred 1 Louk disposal; 2-21S-19E. *Kansas Geol. Surv.
1371. Musgrove Pet. 1 Jackson; 21-1S-16W. *Schlumberger, KSLS.
1372. Anschutz Drlg. 1 Cannon; 17-2S-17W. *Schlumberger, KSLS.
1373. Atchison, Buchan, and Cornell and others 1 Resco; 24-5S-1W. *Schlumberger, KSLS.
1374. R. C. Halbert 1 Rank; 12-5S-6W. *Schlumberger.
1375. Continental 1 Thon; 26-16S-31W. *Schlumberger, KSLS.
1377. United Prod. 1 Hiebert; 5-17S-42W. *Schlumberger, KSLS.

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1378. Aylward Drlg. 1 Ward; 8-18S-26W. *Schlumberger, KSLS.
1379. Welch and Olsson Drlg. 1 Bryant; 11-21S-20W. *Schlumberger, KSLS.
1381. Midstates Oil 1 Westfahl; 16-25S-8W. *Schlumberger, KSLS.
1382. Skiles Oil 1 Wright; 17-25S-9W. *Schlumberger, KSLS.
1383. Barbara Oil 1 Simon; 20-26S-2W. *Schlumberger, KSLS.
1384. Champlin Oil & Ref. 1 Peltzer; 15-26S-3W. *Schlumberger, KSLS.
1385. Drillers Prod. 1 Martin; 22-27S-2W. *Welex, KSLS.
1386. K & E Drlg. and Bradley Bros. 1 Focke; 16-2S-34W. *Schlumberger, Kansas Geol. Surv.
1387. Phillips and Westgate-Greenland Oil 1 Vernon; 32-3S-28W. *Lane Wells.
1388. Carter 1 Jackson; 20-4S-18W. *Schlumberger.
1389. Stanolind 1 Brennecke; 2-4S-19W. *Schlumberger.
1390. Continental 1 Gillespie; 34-5S-27W. *Schlumberger.
1391. Shell 9 Krug; 19-8S-17W. *Schlumberger.
1392. Sohio 1 Brault; 20-8S-21W. *Schlumberger, Kansas Geol. Surv.
1393. Phillips 2 Nettie; 34-9S-17W. *Halliburton.
1394. Sinclair 4 Baldwin; 5-10S-20W. *Schlumberger.
1395. Midstates Oil 6B Wasinger; 21-11S-18W. *Lane Wells.
1396. J. J. Lynn 1 Warner; 5-13S-17E. *Schlumberger, KSLS.
1397. Helmerich & Payne, Inc., 1 Davis; 32-16S-14W. *Halliburton.
1398. Auto Ordnance 1 Melander; 9-17S-3W. *Schlumberger.
1399. Imperial Oil of Kansas 1 Seuser; 5-18S-17W. *Schlumberger.
1400. Brunson Prod. & Explor. 1E Stucky; 33-20S-3W. *Schlumberger.
1401. Gulf 1 Bell; 34-21S-16W. *Schlumberger.
1402. Phillips 1 Bordewick; 1-22S-14W. *Schlumberger.
1403. Derby Oil 1 House; 7-25S-4W. *Schlumberger, KSLS.
1404. Rex and Morris Drlg. 1 Kohlmeyer; 9-3S-3E. *Schlumberger.
1405. Rex and Morris Drlg. 1 Beikmann; 30-3S-3E. *Schlumberger.
1406. Kewanee Oil 1 Carlson; 25-4S-1E. *Schlumberger.
1407. Kewanee Oil 1 Strawberry; 2-5S-1E. *Schlumberger.
1408. Kewanee Oil 1 Sherman; 13-5S-3E. *Schlumberger.
1410. C & G Drlg. 1 McPherson; 4-9S-23W. *Schlumberger.
1411. Great Basins Pet. 1 Commercial Bank of Nelson; 23-1S-28W. *Schlumberger.
1412. Gulf 1 Butler; 16-1S-25W. *Schlumberger.
1413. Kaufman and others 1 Smith; 22-1S-11E. *KSLS.
1414. Woods Oil & Gas 1 Turner; 7-1S-15E. *Schlumberger, KSLS.
1415. Amerada 1 Enlow; 4-11S-10E. *Schlumberger.
1416. Anschutz Drlg. 1 Lang; 36-13S-17W. *Schlumberger, KSLS.
1417. Bundred 1 Bowman Disposal; 6-21S-20E. *Kansas Geol. Surv.
1418. Wilcox Oil 1 Harter; 28-30S-21W. *Schlumberger, KSLS.
1419. Falcon-Seaboard Drlg. 1 Berryman; 14-31S-21W. *Schlumberger, KSLS.
1420. E. J. Athens 1 Rath; 11-2S-41W. *Schlumberger, KSLS.
1421. Mull Drlg. 1 Van Epps; 23-3S-17E. *KSLS.
1422. Carter 3 Exploration; 10-6S-19E. *Schlumberger.
1423. Ockerman, 1935, p. 50-51, Garvin and others 1 Lutz.
1424. Ockerman, 1935, p. 51, Goens and others 1 Wabense.
1425. Ockerman, 1935, p. 58, well at Leavenworth.
1426. National Drlg. 1 Zemke; 11-9S-10W. *Welex, KSLS.
1427. Advance Oil & Ref. 1 Shawnee; Ockerman, 1935, p. 63.
1428. Clint Murchison 1 Federal Land Bank; 28-10S-15E. *USGS.
1429. Ockerman, 1935, p. 53, Anderson Drlg. 1 Gramse.
1430. Ockerman, 1935, p. 59, Forrester and others 1 Yazel.
1431. Columbian Fuel 2A Kennedy; 17-28S-35W. *Schlumberger.
1432. United Prod. 1 Knoeber; 19-29S-27W. *Schlumberger, KSLS.
1433. Pan American 1 Goertzen; 5-29S-38W. *Schlumberger, KSLS.
1434. Sinclair 1 Lemert; 21-32S-33W. *Schlumberger, KSLS.
1435. McNeish and Gralapp 1B Jarvis; 25-33S-7E. *Schlumberger, KSLS.
1436. J. M. Huber Corp. 1 Merkel; 23-34S-27W. *Schlumberger, KSLS.
1437. Thomas and Brewer 1 H. G. Adams; 30-34S-29W. *Schlumberger.
1438. Cities Service 1B Price; 31-34S-40W. *Schlumberger, KSLS.
1439. Humble 3 Krey; 13-35S-42W. *Schlumberger.

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1. Shell 1 Pogue; 3-F-30. *Illinois Univ. microfilm.
2. George A. Hoffman 1 E. Robinson; 1-G-23. *Illinois Univ. microfilm, reel 183.
4. George A. Hoffman 1 Lucian Lee; 16-G-27. *Illinois Univ. microfilm, reel 219.
8. Crider, 1915, p. 76-78.
10. Ryan Oil 3 Fowler; 19-H-22. *Kentucky Geol. Surv.
16. *H. R. Wanless, Illinois Univ., 1935. 17-H-25.
    Shell 1 B. G. Dixon; 9-H-25. *Illinois Univ. microfilm, reel 214.
18. Truman Drake 1 E. Wells; 16-H-27. *Illinois Univ. microfilm, reel 200.
20. Ryan Oil 1 C. Saddler; 10-H-29. *Illinois Univ. microfilm, reel 219.
22. Stouder Drlg. 1 Kirkpatrick Bros. 4-H-31. *Illinois Univ. microfilm, reel 239.
23. Crider, 1915, p. 130. 18-H-32.
26. *H. R. Wanless, Illinois Univ., 1936. 11-I-22.
    C. B. Small, Jr., 1 V. Dixon; 10-I-22. *Illinois Univ. microfilm, reel 128.
29. Crider, 1915, p. 18 (Nortonville quad.), p. 59 (Nortonville well).
    Ashby Bros. Drlg. 1 O'Bryant; 3-I-25. *Illinois Univ. microfilm, reel 128.
30. Crider, 1915, p. 47. 3-I-26.
    J. C. Miller Oil-West Kentucky Coal Co.; 20-I-26. *Illinois Univ. microfilm, reel 128.
31. Basin Drlg. 1 Wm. Glow; 6-I-27. *Illinois Univ. microfilm, reel 167.
32. Basin Drlg. 1 Eunice Kelly; 15-I-28. *Illinois Univ. microfilm, reel 212.
36. Crider, 1915, p. 126-127, 143. Dunmore quad. 7-I-32.
    Cox Drlg. 2 Barbee; 18-I-32. *Illinois Univ. microfilm, reel 219.
37. Yewell and Hildebrand 1 Willis; 8-I-33. *Kentucky Geol. Surv.
39. Crider, 1915, p. 165-166, 171 (7-I-35).
40. Ohio Oil 1 Sheperd; 3-I-36. *Kentucky Geol. Surv.
42. Smith and Barnett 1 Sam N. Tartar; I-38. *Kentucky Geol. Surv.
43. Freeman, 1951, p. 537-540.
44. Weller, 1927, p. 80. 4-J-16.
45. Weller, 1927, p. 79-80.
46. *H. R. Wanless, Illinois Univ., 1953. 20-J-19.
47. *H. R. Wanless, Illinois Univ., 1955. 13-J-20.
    S. R. Stanley 1 Stone; 12-J-20. *Kentucky Geol. Surv.
49. Crider, 1914, p. 82-84, 101.
    Continental 1 Baker Est.; 12-J-22. *Illinois Univ. microfilm, reel 128.
    *H. R. Wanless, Illinois Univ., 1936. 19-J-22.
51. Crider, 1914, p. 137, 143 (12-J-24).

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143. Peabody Coal 99 hole; 20-N-19. *Confid.
Bander 1 Stodghill; 20-N-19. *Illinois Geol. Surv.
146. Joe Reznik 1 Chandler; 22-N-22. *Illinois Univ. microfilm, reel 129.
147. Bayer Pet. 1 Allen; 15-N-23. *Illinois Univ. microfilm, reel 130.
150. Sohio and Hupp 1 J. C. Brown; 15-N-26. *Illinois Univ. microfilm, reel 130.
151. Bowen, 1952, p. 10. W. E. Hupp 1 Elizabeth Leet; 20-N-27. *Illinois Univ. microfilm, reel 130.
152. *H. R. Wanless, 1936, Illinois Univ. 2-N-28.
Maggard and Frawe Ford 1 well; 22-N-28. *Illinois Univ. microfilm, reel 131.
155. Alvin T. Roth 1 Howard; 5-N-31. *Illinois Univ. microfilm, reel 131.
156. Jillson, 1930, p. 364-365.
157. *H. R. Wanless, Illinois Univ., 1936. 10-N-33.
Nomo Pet. 7M Rhodes; 8-N-33. *Illinois Univ. microfilm, reel 168.
159. Jillson, 1930, p. 582-584.
161. Flamingo Drlg. 1 McKinney; 10-O-18. *Confid.
Truax-Traer Coal hole 53; 11-O-18. *Illinois Univ. microfilm, reel 131.
162. Truax-Traer Coal hole 10; 16-O-19. *Confid.
Trans-Texas 1 Newman; 18-O-19. *Illinois Univ. microfilm, reel 131.
163. Dave Shock 1 Hancock; 8-O-20. *Illinois Univ. microfilm, reel 132.
165. Ashland Oil & Ref. 1 King; 1-O-22. *Illinois Univ. microfilm, reel 132.
166. Atlas Drlg. 1 Cuttingham; 17-O-23. *Illinois Univ. microfilm, reel 133.
167. Ashland Oil & Ref. and Basin Drlg. 1 Holliday; 20-O-24. *Illinois Univ. microfilm, reel 133.
168. A. J. Slagter 1 Gish; 6-O-25. *Illinois Univ. microfilm, reel 133.
170. C. E. Skiles 1 Twentieth Century Coal; 20-O-27. *Illinois Univ. microfilm, reel 133.
171. Ohio and Basin Drlg. 1 St. Raphaels Church; 15-O-28. *Illinois Univ. microfilm, reel 133.
173. Felmont Oil and Coleman Johnson 1 Hardy; 13-O-30. *Illinois Univ. microfilm, reel 271.
175. Schoonmaker 10 Neal; 1-O-32. *Illinois Univ. microfilm, reel 271.
176. Nomo Pet. 2-W Bailey; 4-O-33. *Illinois Univ. microfilm, reel 185.
180. Kirk D. Holland 1 Pollard; 25-P-19. *Illinois Univ. microfilm, reel 134.
182. Carter Oil 1 Culver; 25-P-21. *Illinois Univ. microfilm, reel 136. Section; 25-P-21. *Confid.
184. Ashland and Basin 2 H. H. Farmer; 8-P-23. *Illinois Univ. microfilm, reel 135.
186. W. C. Reynolds 1 F. W. Cosby; 21-P-25. *Illinois Univ. microfilm, reel 136.
187. Natl. Assoc. Pet. 1 Dempewolf; 1-P-26. *Illinois Univ. microfilm, reel 136.
190. Cathey, 1955, p. 11, pl. 4. Newburg quad.
*H. R. Wanless, Illinois Univ., 1936. 14-P-29.
W. M. Angle and G. B. Crain 1 Waltman; 6-P-29. *Illinois Univ. microfilm, reel 137.
191. Jillson, 1930, p. 69-70.
192. Jillson, 1930, p. 131-132.
195. L. T. Stinnett 1 Hudson and Bobo; 25-P-34. *Kentucky Geol. Surv.

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197. J. E. Ellis 1 Fee; 5-Q-20. *Illinois Univ. microfilm, reel 137.
198. Delta Drlg. 1 Wickliffe; 15-Q-21. *Illinois Univ. microfilm, reel 137.
199. George S. Engle 1 J. E. Bower; 15-Q-22. *Illinois Univ. microfilm, reel 137.
201. Canterbury and Balderson 1 Barrett Heirs; 16-Q-24. *Illinois Univ. microfilm, reel 137.
202. Cathey, 1955, pl. 4.
Kingwood Oil 1 Rash; 16-Q-25. *Illinois Univ. microfilm, reel 137.
206. *H. R. Wanless, Illinois Univ., 1936. 7-Q-31.
Charlie Gordon Oil 1 Thomas; 17-Q-31. *Illinois Univ. microfilm, reel 138.
209. Jillson, 1930, p. 155-156.
*H. R. Wanless, Illinois Univ., 1936. 7-Q-34.
213. Barron Kidd and Cherry 1 Smith; 24-R-26. *Illinois Univ. microfilm, reel 138.
216. Crider, 1913a, p. 304. Tell City quad.
Natl. Assoc. Pet. 1 Williams; 25-R-33. *Illinois Univ. microfilm, reel 138.
218. Core; B-61. ½ mile W. of Round Top School. *USGS.
220. Jillson, 1922, p. 712-715.
221. *H. R. Wanless, Illinois Univ., 1935. Road at head of Big Patterson Creek, B-66.
222. Ashley and Glenn, 1906, p. 85-86.
224. *H. R. Wanless, Illinois Univ., 1938. U.S. Highway 25E, NW. from Cumberland Gap.
*USGS Yellow Hill Church Road section, B-70.
226. Huffakers Bros. 2 A. W. Campbell Heirs; 25-C-57. *Kentucky Geol. Surv.
227. Superior 4 A. and G. W. Burnett; 24, 25-C-58. *Kentucky Geol. Surv.
229. Stearns Coal & Lumber 4 hole; C-61. *USGS.
230. *H. R. Wanless, Illinois Univ., 1938. U.S. Forest Service road E. of Marsh Creek, C-62.
231. Jillson, 1922, p. 707-708.
*H. R. Wanless, Illinois Univ., 1936. C-14, Kentucky Route 92, Paint Creek to Jellico Creek.
234. Merle B. Piper 1 Milton Lawson; 7-C-67. *Kentucky Geol. Surv.
*H. R. Wanless, Illinois Univ., 1936. Oatliff, C-67.
235. Crandall and Sullivan, 1912, p. 114. Head of Greasy Creek, C-68.
237. *H. R. Wanless, Illinois Univ., 1938. U.S. Highway 25E near Moss Chapel School.
Benedum-Trees 1 Linnie B. Hurst; 21-C-70. *Kentucky Geol. Surv.
239. Ashley and Glenn, 1906, p. 121. Hance Ridge, C-72.
241. *H. R. Wanless, Illinois Univ., 1938. Chucklick Knob firetower, C-74.
243. *H. R. Wanless, Illinois Univ., 1935. D-57.
245. *H. R. Wanless, Illinois Univ., 1936. D-64.
246. *H. R. Wanless, Illinois Univ., 1936. D-65.
Valerius Royalty and others 1 W. R. Mounce; 16-D-65. *Kentucky Geol. Surv.
247. Albert Roskopf 1 Elmer Lovitt; 19-D-66. *Kentucky Geol. Surv.
248. *H. R. Wanless, Illinois Univ., 1938. D-68.
249. *H. R. Wanless, Illinois Univ., 1938. D-69.
Bell-Knox Pipeline 1 J. Winkler; 2-D-69. *Kentucky Geol. Surv.
250. Freeman, 1951, p. 294-295.
251. North American Pet. well; D-71, 1 mile from mouth of Kettle Island Creek. *USGS.

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252. *H. R. Wanless, Illinois Univ., 1938. D-72.
254. Columbian Fuel Corp. 1 Mary Bailey and others, 3-D-74. *Kentucky Geol. Surv.
Ashley and Glenn, 1906, p. 148-150, pl. 22. P-74.
255. Ashley and Glenn, 1906, p. 174-175.
256. Rex Carpenter and others 1 Cawood; 15-D-76. *Kentucky Geol. Surv.
*H. R. Wanless, Illinois Univ., 1938. D-76.
257. Jillson, 1922, p. 702-703.
258. Seymour Pollack 1 D. Bassett; 23-E-58. *Kentucky Geol. Surv.
259. *H. R. Wanless, Illinois Univ. State Highway 90, E-60.
261. Jillson, 1922, p. 708-709.
*H. R. Wanless, Illinois Univ., 1935. E-63.
262. Jillson, 1922, p. 709-710.
264. Jillson, 1922, p. 234-236.
266. Jillson and Hodge, 1919, p. 17-18.
*H. R. Wanless, Illinois Univ., 1935. E-68.
268. Freeman, 1951, p. 439-441.
*H. R. Wanless, Illinois Univ., 1935. E-70.
269. Graham Michaels Drlg. 5 Asher; 20-E-71. *Kentucky Geol. Surv.
*H. R. Wanless, Illinois Univ., 1938. Head of East Fork of Straight Creek, E-71.
274. *H. R. Wanless, Illinois Univ., 1938. Little Black Mtn. Firetower, E-76.
276. Hodge, 1912, p. 91, 101. Breeding Creek, Bucklick Branch, E-78.
278. Hodge, 1912, p. 123, 125, 127, 130. Razor Fork section, E-80.
280. Freeman, 1951, p. 285-287.
281. James F. Patrick 1 U.S. Government; 12-F-62. *Kentucky Geol. Surv.
282. Jillson and Hodge, 1919, p. 26-27.
283. *H. R. Wanless, Illinois Univ., 1938. Richland Creek, F-67.
284. McDaniel Jaynes 1 Albert Gander; 21-F-68. *Kentucky Geol. Surv.
*H. R. Wanless, Illinois Univ., 1936. F-68, Kentucky Route 234.
286. Jillson, 1922, p. 233-234.
287. Baumgarden Lumber hole; F-71. *USGS.
289. United Fuel Gas 10 Fordson Coal; 5-F-73. *Kentucky Geol. Surv. 4-P Coal test; Rocky Point of Phillips Creek, F-73. *USGS.
290. United Fuel Gas 17 Fordson Coal; 18-F-74. *Kentucky Geol. Surv.
Black Star Coal 19 hole; Rocky Hollow, F-74. *USGS.
Intermountain Coal and Lumber 9 hole; Upper Double Creek, F-74. *USGS.
291. Lowry and others 2 Intermountain Coal and Lumber; 24-F-75. *Kentucky Geol. Surv.
Blacks Coal Co. 21 hole and two other coal tests; F-75. *USGS.
292. Lowry and others 1 Intermountain Coal and Lumber; 3-F-76. *Kentucky Geol. Surv.
293. Hodge, 1912, p. 146, fig. 165. F-77.
294. Hodge, 1912, p. 166, fig. 165. Meadow Branch of Poor Fork, F-78.
295. Hodge, 1912, p. 181, fig. 165. Slick Rock Branch of Big Looney Creek, F-79. Route 229, near Laurel River, F-79. *USGS.
296. *H. R. Wanless, Illinois Univ., 1938. F-80.
297. C. G. Stanley 1 Fred Lucas and Cloyd; 8-G-66. *Kentucky Geol. Surv.
298. Freeman, 1951, p. 295-297.

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300. United Fuel Gas 7 Fordson Coal; 2-G-72. *Kentucky Geol. Surv.
*USGS. Big Branch of Katies Creek of Red Bird Creek Section, G-72. 4-T hole; Red Bird River near Bowen Creek, G-72.
301. United Fuel Gas 12 Fordson Coal; 14-G-73. *Kentucky Geol. Surv.
Fordson Coal 8E hole; G-73. *USGS.
Ford Motor 7S hole; G-73. *USGS.
302. United Fuel Gas 16 Fordson Coal; 14-G-74. *Kentucky Geol. Surv.
Kentucky River Coal core; Deadening Fork of Lower Bad Creek, G-74. *USGS.
303. United Fuel Gas 11 Fordson Coal; 17-G-75. *Kentucky Geol. Surv.
Kentucky River Coal 83 hole; G-75. *USGS.
306. Howe Oil & Gas 21 Swift Coal Co.; 20-G-78. *Kentucky Geol. Surv.
*USGS. Shibley Branch and Trace Fork section, G-78.
Drill Core; Blair Fork, G-78.
308. Crider, 1916, p. 46. Collier Creek, G-80. Left Fork of Joe Day Branch. ½ mile above Joe Day Branch.
*H. R. Wanless, Illinois Univ., 1938. U.S. Highway 119. Poor Fork, near School 7. G-80.
309. *H. R. Wanless, Illinois Univ., 1938. G-81. Little Fork, Franks Creek. West Eolia, Oven Fork, and Pine Mtn. sections.
312. Freeman, 1951, p. 92-94.
313. *H. R. Wanless, Illinois Univ., 1935. East of Acton mine section. U.S. Highway 80. 3 miles W. of London, H-65.
314. Freeman, 1951, p. 85-92.
316. E. W. Herchenroeder 2 Liley House Heirs; 22-H-69. *Kentucky Geol. Surv.
317. Jillson, 1922, p. 93-94.
*USGS. Firetower, head of Hector Branch, H-70.
319. Hodge, 1918, p. 138.
United Fuel Gas 6 Fordson Coal. 12-H-72. *Kentucky Geol. Surv.
320. United Fuel Gas 1 Fordson Coal; 9-H-73. *Kentucky Geol. Surv.
Ford Motors 1 hole; Woolery Fork of Cane Fork, H-73. 12P drill core; Left Fork Elisha Creek, H-73. *USGS.
322. *H. R. Wanless, Illinois Univ., 1936. Kentucky Route 80, Road Gaps, H-75.
25 Core; Dans Creek of Catskin Creek, H-75. *USGS.
323. Howe Oil & Gas 1 D. W. Browning; H-76. *USGS.
324. Johnston, Stafford, and Welch, 1955, Map C22, Sheet 1, Column 4.
Kentucky-West Virginia Gas 3 Horn Eversole; 24-H-77. *Kentucky Geol. Surv.
325. Hodge, 1910, p. 132. H-78.
USGS 11 Core; 4-H-78. *USGS.
326. Colony Oil & Gas (Howe Oil & Gas, Oper.); 24-H-79. *Kentucky Geol. Surv.
Crider, 1916, p. 109-110, p. 134 (H-79).
327. Crider, 1916, p. 142, 146, 151. H-80.
329. Crider, 1916, p. 173. H-82.
332. Ferguson and Bosworth 1 Geneva Sargent; 22-I-64. *Kentucky Geol. Surv.
335. Petroleum Explor. (Paul Ensetiss) 1-918 Frank Scott; 3-I-69. *Kentucky Geol. Surv.
339. Diamond drill hole 16-P; Ford Motor hole; Petroleum Explor. 1 Lucy A. Vield; I-73. *USGS.
341. *H. R. Wanless, Illinois Univ. I-75. Preston Branch to Wooton

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344. Johnston, Stafford, and Welch, 1955, Map C-22, sheet 1, column 5.
Kentucky-West Virginia Gas 6710 W. R. Combs; 6-I-78. *Kentucky Geol. Surv.
Kentucky River Coal 2 hole; Yellow Creek, I-78. *USGS. Stacy Branch section, I-78.
346. Crider, 1916, p. 121, 128. I-80.
Kentucky-West Virginia 1 E. J. Hammonds; 5-I-80. *Kentucky Geol. Surv.
347. Jillson, 1931, p. 487-489.
Crider, 1916, p. 126, 129, 167. I-81.
349. Kentucky-West Virginia Gas 6362 Owen Mullins; 2-I-83. *Kentucky Geol. Surv.
Crider, 1916, p. 192-193, 197. USGS 6 hole; Tom Biggs Branch, I-83. *USGS.
351. Miller, 1910a, pl. A, fig. 5. J-63.
353. Freeman, 1951, p. 269-270.
*H. R. Wanless, Illinois Univ. U.S. Highway 125, E. of Rock Castle River, J-65.
354. Perpetual Oil 1 Walker McQueen; 10-J-66. *Kentucky Geol. Surv.
357. Freeman, 1951, p. 362-364. 24-J-69.
359. Freeman, 1951, p. 361-362. 25-J-71.
360. Petroleum Explor. 1 F. F. Chesbrough; 25-J-72. *Kentucky Geol. Surv.
361. Kentucky-West Virginia Gas 1 Ferris Bagley; J-74. *USGS. Gays Creek and Eversole Creek.
362. *USGS. Kentucky Route 80 and Busy Road, J-75.
364. Jillson, 1931, p. 571-573.
Hardy-Bingham Min., 3 hole; J-77. Kentucky River Coal 1 hole; J-77. *USGS.
365. Hardy Burlingame Min., 2 holes; J-78. Inland Gas 275 H. R. Smith; J-78. USGS 3 hole; Sassafras Creek of Car Fork, J-78. *USGS.
367. United Fuel Gas 6858 G. C. Amburgey; 25-J-80. *Kentucky Geol. Surv.
Kentucky-West Virginia oil hole; 25-J-80. *USGS.
368. Jillson, 1931, p. 441-442. USGS 9 hole; J-81. *USGS.
371. Diamond drill hole; J-84, 37° 7′ N, 82° 32′ W. *USGS.
Kentucky-West Virginia Gas 6094 Miles Smallwood; Dorton Creek, J-84. *USGS.
372. United Fuel Gas 6609 Shelby Creek Corp. 8-J-84. *Kentucky Geol. Surv.
Drill core; Flatwood, J-84. *USGS.
373. Kentucky-West Virginia Gas 6244 J. E. Ratliff; 4-J-85. *Kentucky Geol. Surv.
Hunt and others, 1937, pls. 34, 35, 37. J-85.
375. Hunt and others, 1937, pls. 33, 47. J-87.
376. Miller, 1910, pl. A, fig. 6. Old Brush Creek Mines, K-63.
377. Planet Pet. 1 Martha Pond; 10-K-66. *Kentucky Geol. Surv.
378. Miller, 1910, pl. B, fig. 9. K-67.
379. Freeman, 1951, p. 379-380.
380. N. S. Brewer 2 Fee; 20-K-69. *Kentucky Geol. Surv.
381. Hi Knob Oil 1 Arch Bell; 2-K-70. *Kentucky Geol. Surv.
383. Diamond drill hole; Buckhorn, K-73. *USGS.
384. Well 1; 22-K-74. *Kentucky Geol. Surv.
385. *USGS. Cockerell Fork, K-75.
386. Jillson, 1931, p. 567-568.
Kentucky River Coal 4 and 5 holes, K-76. *USGS.
Middle Fork of Toms Creek, K-76.
387. Jillson, 1931, p. 437-439.
Calvin 1 hole; K-77. *USGS.
388. *USGS. Ogden Branch, K-78.

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Evans and Dixon 1 Evans; K-78. *USGS.
Inland Gas 265 Virginia-Kentucky Coal; K-78. *USGS.
390. Jillson, 1931, p. 424-426.
*H. R. Wanless, Illinois Univ., 1935. K-80.
M-41 hole; Jones Fork, K-80. *USGS.
391. Jillson, 1922, p. 232-233.
M-16 hole; Roaring Branch, K-81. *USGS.
392. Jillson, 1931, p. 250-251.
393. Joseph Reynolds 1 (Kentucky-West Virginia Gas); 6-K-83. *Kentucky Geol. Surv.
USGS 4 hole; Abner Mtn., K-83. USGS.
394. Jillson, 1931, p. 591-592.
Shelby Creek Coal core; Carney Creek, K-84. 37° 21′ N., 82° 32′ W. *USGS.
395. United Carbon 4 Republic Steel Corp.; 7-K-85. *Kentucky Geol. Surv.
Hunt and others, 1937, pls. 32, 37, 38, 47. K-85.
397. Kentucky-West Virginia Gas 1 A. J. Arshire; 7-K-87. *Kentucky Geol. Surv.
USGS 7 hole; Beaver Knob; K-87. *USGS.
Hunt and others, 1937, pls. 27, 30, 32, 33, 47.
403. Kentucky-West Virginia Gas 1 Isom Moore; 6-L-72. *Kentucky Geol. Surv.
407. Kentucky-West Virginia Gas United Fuel Gas well; 6-L-76. Kentucky Geol. Surv.
*H. R. Wanless, Illinois Univ., 1935. Fugate Fork, L-76.
410. Jillson, 1931, p. 455-461.
411. Jillson, 1931, p. 211-213.
M-27 hole; Plummer Creek and M-56 hole; Salt Lick Creek, L-80. *USGS.
412. Jillson, 1931, p. 168-169.
Drill hole; head of Mill Creek and 39 drill hole, left head of Mill Creek, L-81. *USGS.
416. Crandall, 1905, pl. B. Hendricks well, L-85.
USGS 2 hole; L-85. *USGS.
419. Hunt and others, 1937, pls. 11, 12, 28, 29, 47.
Columbian Fuel 22 Chesapeake Min.; 15-L-88. *Kentucky Geol. Surv.
USGS 10 hole; Dicks Knob, L-88. *USGS.
420. United Fuel Gas 150 Kentland Coal and Coke; 7-L-89. *Kentucky Geol. Surv.
421. United Fuel Gas 67 Kentland Coal and Coke; 4-L-90. *Kentucky Geol. Surv.
422. Miller, 1910, pl. B, fig. 10. M-67.
424. Miller, 1910, pl. C, fig. 11. M-69.
426. Cecil Kincaid 1 Cecil Fox; 15-M-71. *Kentucky Geol. Surv.
429. Forman, Hunt, and Miller 1 Tom Chapman; 1-M-74. *Kentucky Geol. Surv.
*USGS. Kentucky Route 15 NE of Jackson, M-74.
430. Fohs, 1912, p. 17-18, 37. M-75.
John T. McMinn 1 Gopp heirs; 25-M-75. *Kentucky Geol. Surv.
431. Fohs, 1912, p. 26-27.
Petroleum Explor. 1 Continental Realty; 10-M-76. *Kentucky Geol. Surv.
433. Jillson, 1931, p. 464-465. M-78.
BBR Drlg. 44 hole; M-78. *USGS.
434. Jillson, 1931, p. 26-28. Pruicers Elkhorn Coal 15 hole and Beaver Creek Consol. Coal 44a hole; M-79. *USGS.
437. Jillson, 1931, p. 192-194.
439. Jillson, 1931, p. 586-588.
USGS 8 hole; M-84. *USGS.
441. Columbian Fuel 13 Smith heirs, 11-M-86. *Kentucky Geol. Surv.

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Tierney Land 1 hole; M-86. *USGS.
443. United Fuel Gas 64 Kentland Coal and Coke; 21-M-88. *Kentucky Geol. Surv.
Ford Eastern Coal 17 and 18 holes; M-88. *USGS.
447. Miller, 1910, pl. B. N-67.
448. Freeman, 1951, p. 342-343.
449. Flahaven 17 well; 10-N-69. *Kentucky Geol. Surv.
451. Freeman, 1951, p. 275-277.
453. Panboo Oil 1 Jim Oaks; 12-N-73. *Kentucky Geol. Surv.
454. Cities Gas 11 William Northrup; 10-N-74. *Kentucky Geol. Surv.
457. Bergin, 1956, column 6. N-77.
Kentucky and Ohio Gas 1 Allen Sherman; 11-N-77. *Kentucky Geol. Surv.
458. *USGS. Hogtown Knob, N-78. E. J. Evans Oil 16 Well; N-78.
459. Estell Smith well; 13-N-79. *Kentucky Geol. Surv.
460. Kentucky-West Virginia Gas 1 J. M. Richardson; 10-N-80. *Kentucky Geol. Surv.
M-1-B hole; Rough and Tough, N-80. *USGS.
Magoffin County line to David, N-80.
462. Jillson, 1931, p. 243-245.
Beaver Creek south of Allen, N-82. *USGS.
463. Kentucky-West Virginia Gas 1 J. H. and Benjamin Sellards; 8-N-83. *Kentucky Geol. Surv.
*USGS. Lancer Pass Road, N-83.
464. *USGS. Broad bottom Pass Road, N-84.
Kentucky-West Virginia Gas 922 Bonnie Stephens; N-84. *USGS.
465. *USGS. Brushy Fork, N-85.
Diamond drill hole 1626; N-85. *USGS.
United Fuel Gas 57 Federal Oil, Gas, and Coal well; N-85. *USGS.
467. Jillson, 1931, p. 606-609.
Leckie Collieries hole, N-87. *USGS.
Heads of Turkey and Long Branches, N-87. *USGS.
469. Ernest Calhoun 1 United Fuel Gas; 24-N-89. *Kentucky Geol. Surv.
471. Miller, 1910, pl. C, fig. 12. O-69.
474. Jillson, 1922, p. 730. O-72.
475. Robinson and Heath 1 Smallie Banks; 16-O-73. *Kentucky Geol. Surv.
*H. R. Wanless, Illinois Univ., 1935. Malaga, O-73.
476. L. C. Young 2 Merida Brewer; 16-O-74. *Kentucky Geol. Surv.
*H. R. Wanless, Illinois Univ., 1935, Kentucky Route 15, O-74. *USGS.
478. Jillson, 1922, p. 469. O-76.
Bergin, 1956, 37° 43′ N., 83° 12′ W.
480. Lewis Marshall 1 Fee; O-78. *USGS.
482. *USGS. State Road Fork, O-80.
Kentucky-West Virginia Gas 1005 H. H. Hornsby; O-80. *USGS.
483. Jillson, 1931, p. 283-284.
Big Sandy Coal & Coke 1 hole; Little Paint Creek, O-81. *USGS.
*H. R. Wanless, Illinois Univ., 1935. N. of Cliff station, O-81.
485. Pocahontas Land well 20; O-83. *USGS.
Kentucky-West Virginia Gas 891 J. M. Taylor; O-83. *USGS.
486. W. H. May 4 Burbank; 12-O-84. *Kentucky Geol. Surv.
Pocahontas Land 13 hole; O-84. *USGS.
487. Pocahontas Land well 8; O-85. *USGS.
United Fuel Gas 5845-53 Federal; O-85. *USGS.

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489. Ashland Oil & Ref. 1 Slater Unit; 17-O-87. *Kentucky Geol. Surv.
Borderland Coal drill hole; O-87. *USGS.
490. Arch Carpenter 2 Jim Smith; 18-P-68. *Kentucky Geol. Surv.
492. Miller, 1910, pl. C, fig. 15. Chimney Top Creek, P-71.
494. Matt Schuster and others 1 Charles Sample; P-73. *USGS.
496. Englund, 1955, pl. 2, columns 5, 7. P-75.
George Finch and others well; P-75. *USGS.
497. Wilpolt and Marden, 1959, pl. 28, columns 5, 9. P-76.
Jillson, 1922, p. 556-557.
498. Adkison, 1957, pl. 2, column 6.
Bed Rock Pet. 1 Carl May; 21-P-77. *Kentucky Geol. Surv.
Bend Branch Licking river, P-77 *USGS.
499. *USGS, P-78. United Carbon 2 Nora Clark; P-78.
501. Jillson, 1922, p. 205-207.
503. Kentucky-West Virginia Gas 1 R. N. Akers; 16-P-82. *Kentucky Geol. Surv.
*H. R. Wanless, Illinois Univ., 1935. 2 miles E. of Paintsville, P-82.
504. United Fuel Gas 1 M. S. Agassiz; 17-P-83. *Kentucky Geol. Surv.
Pocahontas Land 21 hole; P-83. *USGS.
505. Jillson, 1931, p. 507-509.
Pocahontas Land 19 hole;P-84.*USGS.
506. Pocahontas Land 17 hole and W. E. Brewer 1 R. L. Hale; P-85. *USGS.
507. *USGS. Emily Branch of Mossy Creek, P-86.
E. Smith F 5347 Lewis Dempsey; P-86. *USGS.
508. Crandall, 1910, pl. 4.
512. Englund, 1955, pl. 2, column 1.
Wayne United Gas 1 John Fugate; Q-74. *USGS.
514. Adkison, 1957, pl. 2, columns 3, 7.
Raymond Long and others 1 O. C. Day; 7-Q-76. *Kentucky Geol. Surv.
*USGS. U.S. Route 460, 1.25 miles SE. of West Liberty, Q-76.
522. Jillson, 1922, p. 488-490.
*H. R. Wanless, Illinois Univ., 1935. 1½ miles W. of Inez, Q-84.
524. *USGS, R-70.
530. *USGS, R-77. Swiss Oil 1 Alonzo Pilfrey; R-77.
531. *USGS, R-78. May Drlg. 1 J. Wells; R-78.
532. Hauser, 1953, p. 27. Redbush, R-79.
Ashland Oil & Ref. 8 Wallace Williams; 19-R-79. *USGS.
534. Kentucky-West Virginia Gas 1 Mary Ball; 1-R-81. *Kentucky Geol. Surv.
Hauser, 1953, p. 25-26.
535. Kentucky-West Virginia Gas 1212 Calvin Moore; 5-R-82. *Kentucky Geol. Surv.
536. Crandall, 1905, p. 25. R-83.
Warfield Nat. Gas 1 J. R. Fairchild; 22-R-83. *Kentucky Geol. Surv.
539. *USGS. Wrigley, S-75.
Crandall, 1880, pl. 1 (sec. 2). Crandall, 1910, pl. 1 (sec. 2).
540. *USGS. Wells Creek, S-76.
*USGS. Doctors Knob, S-76.
542. Bell and Gault 1 F. E. Branham; 16-S-78. *Kentucky Geol. Surv.
*USGS. General section, S. ½ Isonville quad.
543. Inland Gas 343 Lonie F. Boggs and others; 1-S-79. *Kentucky Geol. Surv.
546. Jillson, 1922, p. 294-295.
547. Crandall, 1905, pl. A.

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Phalen, 1912, p. 3 (Levisa Fork sec.).
*H. R. Wanless, Illinois Univ., 1935. U.S. Highway 23 N. of Levisa Fork, S-83.
549. Kentucky Geol. Soc., 1955, p. 14 (fig. 5).
551. Washington Oil 1 Dr. Wallace Brown; 19-T-76. *Kentucky Geol. Surv.
553. E. C. Ware and Rainbow Prod. 1 Diak; 13-T-78. *Kentucky Geol. Surv.
555. *USGS. Caney Fork Falls, T-80.
*USGS. Cherokee Creek, T-80.
556. Jillson, 1922, p. 261-262.
557. Jillson, 1922, p. 263-264.
*USGS. Muddy Branch and Blaine Creek secs. T-82.
559. Ray Fraley well; U-75. *Kentucky Geol. Surv.
560. Harbison Walker Refractories 884 hole; U-76. *USGS.
561. Day and Mobry Oil 3 F. A. Smith; 19-U-77. *Kentucky Geol. Surv.
562. Phalen, 1912, p. 4. U-79.
563. J. M. and Kelly Koch 1 Arden; 1-U-80. *Kentucky Geol. Surv.
564. W. S. Perry 1 P. W. Young; 10-U-81. *Kentucky Geol. Surv.
*USGS. E. Fork of Little Sandy River and Thompson Fork sections, U-81.
566. Crandall, 1905, pl. A. Horsford well; U-83.
*H. R. Wanless, Illinois Univ., 1935. U. S. Highway 23, U-83.
567. P. Bannom Pipe 1503-238 I. E. Eden; V-75. *USGS.
569. Crider, 1913b, p. 623-632 (sections near Olive Hill).
Crandall, 1877, p. 35-37, pl. 5 (sec. 15).
570. General Refractories hole 1087; V-78. *USGS.
571. Jillson, 1922, p. 79. New Domain Oil & Gas 1 L. C. Glaney.
572. USGS hole 11A; V-80. *USGS.
574. Jillson, 1922, p. 63-64.
575. Krebs and Teets, 1913, p. 79. Kavanaugh well.
Drill core; Upper Hatton Branch, V-83. *USGS.
576. Olive Hill Clay Products 1060-305 hole; W-76. *USGS.
578. Diamond drill hole and Potato Knob sections; W-78. *USGS.
581. Inland Gas 6051 fee; 11-W-81. *Kentucky Geol. Surv.
Diamond drill hole 142 and High Knob section; W-81. *USGS.
582. Big Run 3 Serial; 6-W-82. *Kentucky Geol. Surv.
USGS Diamond drill core. 0.08 miles E. of Boyd County High School and USGS diamond drill core 69; W-82. *USGS.
583. Fontana Oil & Gas 2 L. C. Caldwell; 16-W-83. *Kentucky Geol. Surv.
*USGS. Barbecue Branch. W-83.
585. *USGS. Tygart Creek, Pipeline Road, and Head of Hurricane Branch sections. X-78.
586. Core hole 1 and outcrop; X-79. *USGS.
587. USGS 2 drill core; X-80. *Kentucky Geol. Surv.
588. S. P. Allen and others 1 Kelly Spears; 13-X-81. *Kentucky Geol. Surv.
*USGS. Danleyton, X-81.
589. Jillson, 1922, p. 64--66.
590. Kentucky Fuel Gas K-92 Armco; 17-X-83. *Kentucky Geol. Surv.
*USGS. Sec. N. of Highway 68 and USGS drill hole C-1; X-83.
594. Drill holes 133-B, AGE-143, AGE-141; Y-81. *USGS.
595. *H. R. Wanless, Illinois Univ., 1935. Y-82.
Worthington Sand & Gravel shaft and drill core; Y-82. *USGS.
596. Crandall, 1877, pl. 4 (sec. 12), pl. 29 (secs. 2, 4, 5).
597. *USGS. Z-80.
598. Crider, 1913b, p. 660. AA-79.

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610. Freeman, 1951, p. 157. 19-I-7.
611. Freeman, 1951, p. 455-456.
612. Freeman, 1951, p. 144-146.
613. Freeman, 1951, p. 139-144. Freeman, 1954.
614. Walker, 1956, p. 17.

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9. Hoffmeister and Staplin, 1954, p. 158-159. 8-22N-4E.

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8. Toenges and others, 1949, p. 64 (U.S. Bur. Mines hole 15-GC), p. 65-67.
9. Toenges and others, 1949, p. 76-80.
10. Toenges and others, 1952, p. 30-32.
11. Toenges and others, 1952, p. 56-57, 79-80.
12. Toenges and others, 1949, p. 39-40.
13. Toenges and others, 1952, p. 35-41; 68-69.
14. Toenges and others, 1949, p. 38-40.
15. O'Harra, 1900, p. 127-128. Toenges and others, 1952, p. 41-42.
18. Toenges and others, 1949, p. 45-47. O'Harra, 1900, p. 114, ½ mile NE. of Westernport.
19. Reger, 1924, p. 160 (Bloomington, Md.), p. 161-162, 163-164.
20. Toenges and others, 1952, p. 86-87, 89-90.
21. Martin, 1902, p. 103 (Swallow Falls, Youghiogheny River), p. 117 (4 miles NW. of Oakland).
22. Martin, 1902, p. 128 (Blaine).
Toenges and others, 1952, p. 85-87.
24. Reger, 1924, p. 439-440.
25. Reger, 1924, p. 179-181, 441-443.
26. Swartz, 1922, p. 117-119. Martin, 1902, p. 108, 112-113. Henry bore hole.

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3. Balk, 1956a. Emerson, 1917, p. 98. Segerstrom, 1956, 1 mile N. of W. Deerfield.
5. Balk, 1956b. Emerson, 1917, p. 99.
6. Emerson, 1917, p. 99.
13. LaForge, 1932, p. 43-44.
14. LaForge, 1932, p. 37-43.
15. Dott, 1961, p. 1298. Squantum Head.
16. Dott, 1961, p. 1298. Dorchester.
18. Billings and others, 1939, p. 1878. Hingham, northern anticline.
19. Billings and others, 1939, p. 1878. Hingham, southern anticline.
20. Emerson, 1917, p. 59-61.
21. Mansfield, 1906, p. 219-229.
22. Chute, 1950, map text. Brockton sec.
23. Woodworth, 1899, p. 180-181.
24. Woodworth, 1899, p. 196. Norton.
25. Woodworth, 1899, p. 149. South Attleboro.
26. Woodworth, 1899, p. 198-199.
27. Woodworth, 1899, p. 170-172.

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1. Cohee, Macha, and Holk, 1951.
2. C. W. Teater 1 Fee; 31-23N-5W. *Michigan Univ.
3. Moser Oil 1 B. Schetenhelm; 36-23N-7W. *Michigan Univ.
4. Gordon Oil 1-A State-Caldwell; 31-23N-8W. *Michigan Univ.

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153. Freeman Oil 1 A. Reynolds; 24-13N-7W. *Michigan Univ.
155. Mercer Oil 1 Howe; 26-13N-9W. *Michigan Univ.
156. Chapman Oil 1 C. D. Clark; 25-13N-1W. *Michigan Univ.
158. Butler Synd. 1 Douglass; 26-13N-12W. *Michigan Univ.
159. Daily Crude Oil 1 L. and E. J. Ridderman; 18-13N-13W. *Michigan Univ.
160. Frank Norton 1 C. Voorhees; 8-12N-11E. *Michigan Univ.
162. Caro test well; 3-12N-9E. *Michigan Univ.
163. W. R. Wiechers 1 Glenn H. Gray; 8-12N-8E. *Michigan Univ.
165. Jack Nall Co. 1 Leonard Elbers; 5-12N-6E. *Michigan Univ.
168. Darke Bros. 1 L. R. and A. Bell; 31-12N-3E. *Michigan Univ.
169. F. W. Stork 1 Hemlock Poultry Farm; 33-12N-2E. *Michigan Univ.
172. E. D. Swearen 1 W. Alexander; 8-12N-2W. *Michigan Univ.
173. Michigan Chem. 9 Fee; 24-12N-3W. *Michigan Univ.
174. Shell 1 J. Covel; 15-12N-4W. *Michigan Univ.
176. Socony Vacuum 1 Chris Hansen; 22-12N-6W. *Michigan Univ.
178. Bale, Hickey, and Snyder Bros. 1 Ernest Snyder; 20-12N-8W. *Michigan Univ.
182. H. E. Walton 1 Sophia Schumaker; 21-12N-12W. *Michigan Univ.
183. Sun 2 Richard M. Vile; 10-12N-13W. *Michigan Univ.
187. Weber Oil 1 B. Uebler; 9-11N-6W. *Michigan Univ.
188. Consolidated Coal; 24-11N-5E. *Michigan Univ.
189. Mercer Oil 1 Otto Trinklein; 20-11N-4E. *Michigan Univ.
190. Darke Bros. 1 J. Rockwell; 5-11N-3E. *Michigan Univ.
192. C. W. Teater 1 A. Sweeney; 1-11N-1E. *Michigan Univ.
193. Russell L. Standard 1 M. Soule; 9-11N-2W. *Michigan Univ.
195. Texas 1 A. C. Johnson; 22-11N-4W. *Michigan Univ.
197. Roy F. Tobe, Jr., 1 Peter Mortenson; 11N-6W. *Michigan Univ.
203. Don Rayburn 1 Watchhorn and Wells; 5-10N-9E. *Michigan Univ.
207. T. F. Caldwell, Inc., 1 McDonagh; 19-10N-5E. *Michigan Univ.
211. Brant Marion Prospecting 1 Ward; 12-10N-1E. *Michigan Univ.
213. Shell 1 A. Mellinger; 9-10N-2W. *Michigan Univ.
220. Kenmon Oil & Gas 1 Bertha Garbow; 3-10N-9W. *Michigan Univ.
222. P. E. Broughton 1 Beryle Austin; 11-10N-11W. *Michigan Univ.
223. Atlas Supply 3 Groenke and others; 15-10N-12W. *Michigan Univ.
224. Hugh H. Heinig 1 Dan McCarty; 11-9N-8E. *Michigan Univ.
228. Del Forthey 1 Machilina Yurek; 21-9N-3E. *Michigan Univ.
232. Van Core 1 G. H. and E. L. Oberlin; 36-9N-2W. *Michigan Univ.
233. Perrinton Village well; 9-9N-3W. *Michigan Univ.
236. Michigan Gas & Oil 1 W. F. Young; 1-9N-6W. *Michigan Univ.
237. Leonard Oil, Fred UHL, 1 Franklin Rand and Chester W. Johnson; 7-9N-7W. *Michigan Univ.
239. Socony Vacuum 1 L. and M. Pennington; 9-9N-11W. *Michigan Univ.
241. Universal Oil 1 Bruner; 8-8N-7E. *Michigan Univ.
243. John F. Hurley, Tr., and Owasso Oil 1 Van Pelt; 34-8N-2E. *Michigan Univ.
244. Monroe Marks 1 H. Litchfield; 4-8N-1E. *Michigan Univ.
245. Custer 1 Curtis; 12-8N-1W. *Michigan Univ.
246. Van Core 1 Ed Fleagle; 15-18N-2W. *Michigan Univ.
248. Prima Oil 1 Fitzpatrick; 10-8N-4W. *Michigan Univ.
251. A. F. Holliday 1 Wm. Abbey; 36-8N-7W. *Michigan Univ.

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255. Clarence H. Crawford 1 Heft and Klahn; 4-8N-12W. *Michigan Univ.
258. Diamond drill hole; 23-7N-3E. *Michigan Univ.
260. C. W. Teater 1 C. Walker; 8-7N-1W. *Michigan Univ.
262. Coal test; 4-7N-3W. Michigan Univ.
263. Wolverine Nat. Gas 1 A. F. Spitzley; 21-7N-4W. *Michigan Univ.
265. Miller Bros. 1 Breanan and Lower; 3-7N-6W. *Michigan Univ.
268. W. H. Thourlby 1 Doyle; 6-7N-9W. *Michigan Univ.
269. Copman 1 Tody; 25-6N-8E. *Michigan Univ.
270. R. B. Tamblyn and M. W. McGillivray 1 J. J. Minter; 14-6N-7E. *Michigan Univ.
271. Lewis Barr 1 A. C. Hermann; 13-6N-5E. *Michigan Univ.
274. Lima Oil 1 Glenn H. Gladden; 35-6N-2E. *Michigan Univ.
275. H. E. Bell 1 L. D. Arthur; 29-6N-1W. *Michigan Univ.
276. E. L. Bennight and C. S. McCutcheon 1 Eleanor Culp; 17-6N-2W. *Michigan Univ.
280. Terry-Dale-Michigan Corp. 1 E. A. Tow; 12-6N-7W. *Michigan Univ.
281. C. W. Ramsey 1 Fred Nummer; 6-6N-8W. *Michigan Univ.
282. Rowmor Corp. 1 George Gillespie; 3-5N-5E. *Michigan Univ.
285. Panhandle Eastern Pipeline 1 Nemcik; 23-5N-2E. *Michigan Univ.
287. O. A. Daniels 1 Crawford; 1-5N-1E. *Michigan Univ.
288. Petroleum Explor. 1 N. Jenison; 6-5N-1W. *Michigan Univ.
290. Seba Oil & Devel. 1 R. T. Zischkett; 14-5N-3W. *Michigan Univ.
291. Herman J. Schrauben 1 Creyton Est.; 4-5N-6W. *Michigan Univ.
292. Arctic Dairy Prod. well; 34-5N-7W. *Michigan Univ.
293. McClure Oil 1 Emanuel Trayer; 28-5N-8W. *Michigan Univ.
294. Hilmer Oil 1 C. Earlon; 28-4N-3E. *Michigan Univ.
295. Leasia Farm coal test; 33-4N-2E. *Michigan Univ.
296. Three Lakes Oil & Gas 1 M. B. Clark; 2-4N-1E. *Michigan Univ.
297. Voorhees Drlg. 1 Kirkpatrick; 22-4N-1W. *Michigan Univ.
298. Lansing city well 13; 14-4N-2W. *Michigan Univ.
300. W. T. Bernie 1 H. A. and H. P. Woodwarth; 5-3N-4W. *Michigan Univ.
305. Petroleum Explor. 1 Burgess; 12-3N-1W. *Michigan Univ.
308. Michigan Oil 1 Elmer Tennis; 22-3N-6W. *Michigan Univ.
309. Norris-Montgomery 1 J. M. Bradley; 21-2N-3E. *Michigan Univ.
310. E. Chapman 1 Orla Stoew; 24-2N-2E. *Michigan Univ.
312. Burke Bros. 1 A. O. Sullivan; 28-2N-1W. *Michigan Univ.
313. Barris and Keeler 1 James Moon; 11-2N-4W. *Michigan Univ.
314. Norris and Smith 1 Kruzen; 28-2N-5E. *Michigan Univ.
315. Ralph Fletcher 1 David Basore; 13-1N-2E. *Michigan Univ.
317. *Confid.
318. Wittmer Oil & Gas 1 Alpha Portland Cement; 28-1N-6W. *Michigan Univ.
319. Herrietta well; 18-1S-1E. *Michigan Univ.
320. Kent Drlg. 1 V. H. and Ida Easton; 26-1S-1W. *Michigan Univ.
321. Bell and Gault Drlg. 1 Harold J. Pritchard; 11-1S-3W. *Michigan Univ.
323. Otterbine, Dailey, and McClure 1 Midlam; 12-1S-5W. *Michigan Univ.
324. Eastern Michigan Power; 34-2S-1W. *Michigan Univ.
326. Petromas Corp. 1 Hartung; 9-2S-3W. *Michigan Univ.
327. Columbia Oil & Gas 1 F. Andrews Comm.; 25-3S-1E. *Michigan Univ.
345. Associated Pet. 1 Plain; 29-9N-10W. *Michigan Univ.

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348. E. M. Treat Oil & Gas 1 Chapman Bros.; 17-8N-2E. *Michigan Univ.
352. Gordon Oil 1 W. C. Taylor; 35-11N-5W. *Michigan Univ.
360. Murphy Oil 1 Adam Butler; 33-11N-11E. *Michigan Univ.
361. Muskegon Devel. 1 T. J. Carey; 35-14N-11W. *Michigan Univ.
363. Daily Crude Oil 1 F. Thrush; 25-16N-7W. *Michigan Univ.
366. Leonard Drlg. and Rowmor Corp. 1 (?) M. and G. Whitney; 20-13N-3W. *Michigan Univ.
369. N. Y. Pet. Corp. 1 Marthey; 19-15N-3W. *Michigan Univ.
372. Thomas E. Currie 1 Mackenzie; 34-16N-4W. *Michigan Univ.
375. Theodore Oil 1 Durkia; 5-14N-2W. *Michigan Univ.
378. Chapman Oil 1 Castlebar; 29-17N-11W. *Michigan Univ.
380. C. C. Maguire 1 State-E. Watson; 1-17N-9W. *Michigan Univ.
382. Leon B. Ayers Trust 1 D. and M. Bretz; 21-18N-7W. *Michigan Univ.
386. Gulf 1 Ben Streib; 11-17N-5W. *Michigan Univ.
391. Mammoth Prod. & Ref. 1 A. Mellinger; 35-18N-2W. *Michigan Univ.
398. Freeman Oil D-1 State; 14-21N-3W. *Michigan Univ.
420. *Confid.
421. *Confid.
422. *Confid.

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44. Pure Oil 1 J. D. Jones; 19-11N-13E. *USGS, 1951.
45. Magnolia 1 Culpepper; 4-8N-14E. *Pan American Oil, 1941.
46. Harry W. Elliot and others 1 Mrs. Laura Oakes; 36-11N-13E. *USGS, 1950.
47. Southern Nat. Gas 1 F. W. Smith; 1-9N-11E. *USGS, 1943.
48. Slick Oil and Plains Prod. 1 J. D. Breazle; 28-12N-10E. *USGS.
52. Southeastern Drlg. 1 Lucy Eley; 19-8N-8E. *USGS, 1952.
54. Carter 1 Denkman; 31-11N-7E. *USGS, 1952.
58. Sun 1 Citizens Natl. Bank; 23-5N-13E. *USGS.
65. Continental 1 H. R. Fortenberry; 13-12N-10E. *USGS, 1952.
72. Adams Oil & Gas 1 Lewellen; 9-10S-1W. *USGS, 1939.
73. Ogg and Clark 1 Burhalter; 27-26N-3E. *USGS, 1945.
74. L. E. Salmon 1 Rex Patterson; 12-11S-1E. *USGS, 1953.
75. K. A. Ellison 1 W. H. Neely; 28-11S-5E. *USGS, 1953.
76. J. F. Michael 1 Temple-Harmon Unit; 8-11S-7E. *USGS, 1950.
77. Ogg and Clark 1 Bardwell; 5-25N-3E. *USGS, 1945.
78. Gulf 1 Reid; 26-12S-1E. *USGS, 1960.
79. Justis Mears A-1 J. W. Clarke; 19-12S-2E. *USGS, 1952.
81. Vaughey 1 Vaughey; 9-12S-4E. *USGS, 1953.
83. Pure Oil 1 E. L. Murphree; 28-12S-6E. *USGS, 1956.
84. J. R. McLean and A. G. Hill 1 Brasfield-Boyd Unit; 31-13S-17W. *USGS, 1959.
86. Pan American 1 Lee Roy Murphree; 30-13S-6E. *USGS, 1956.
88. Shell Oil Unit 1 J. E. McCain and others; 8-13S-2E. *USGS, 1960.
89. Seaboard Oil 1 J. L. Williams; 35-13S-1E. *USGS, 1954.
90. Phillips "C" 1 Crawford; 33-14S-2E. *USGS, 1957.
91. Carter 1 Minnie S. Pulliam; 4-14S-4E. *USGS.
92. Carter 1 Clem Baskin Heirs; 19-14S-5E. *USGS, 1953.
93. Shell Oil and W. C. Feazel 1 Watkins Unit A; 26-14S-6E. *USGS, 1955.
95. J. R. McLean and A. G. Hill 1 Murphree; 17-14S-7E. *USGS, 1959.
96. Shell 1 Dalrymple; 1-14S-19W. *USGS, 1957.
97. Vaughey & Vaughey 1 Monroe County; 16-14S-17W. *USGS, 1954.

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98. B. B. Orr 1 Mrs. R. A. Kilburn and others; 14-15S-17W. *USGS, 1958.
99. Atlantic 1 Margaret Myers; 31-15S-18W. *USGS, 1951.
100. Union Prod. 1 Nancy Watson; 31-15S-7E. *USGS, 1952.
101. Union Prod. 1 Neal; 21-15S-6E. *USGS, 1952.
102. L. G. McMillan 1 Bessie Brownlee; 22-15S-5E. *USGS, 1957.
103. Union Prod. and Marshall R. Young 1 J. N. Henderson; 22-15S-4E. *USGS, 1953.
104. J. R. Lockhart 1 Fite; 25-22N-6E. *USGS, 1946.
106. Frederick F. Mellen 1 Mrs. A. G. Williams; 31-22N-3E. *USGS, 1957.
107. Carter 1 Mattie B. McFadden; 36-16S-5E. *USGS, 1953.
109. Atlantic 1 R. G. Dunning; 12-18S-16E. *USGS, 1947.
110. McAlester Fuel A-1 W. P. Sudduth; 6-19N-15E. *USGS, 1959.
111. John Allen 1 W. C. Nowell; 2-19N-13E. *USGS, 1942.
112. Hope and Thompson 1 Donohoo; 25-16N-17E. *USGS, 1940.
113. A. P. Flannes and J. C. Steinmetz 1 D. L. Fair Lumber Co.; 27-15N-14E. *USGS, 1952.
114. Homer Price 1 W. H. Cooper Est.; 21-15N-19E. *USGS, 1949.
116. Harvey Schmidt 1 Pete Flora; 12-13N-16E. *USGS, 1950.
119. Pure 1 H. W. Henry; 15-12N-15E. *USGS, 1962.
125. C. L. Higgason and L. L. Chapman 1 Malone Thigpen; 2-6N-16E. *USGS.
127. Sinclair 1 E. E. Moore; 9-6S-9W. *USGS, 1962.
128. Mrs. Wm. H. Pine 1 Poynter well; 11-7S-7W. *USGS, 1956.
129. Price and Voss 1 A. J. Hadaway; 18-15N-19E. *USGS, 1950.
130. Ryan and Anderson 1 Swope; 3-19S-18W. *USGS, 1939.
131. Airmont Devel. and Acme Holding 1 Boyle; 33-25N-7E. *USGS.
132. Honolulu Oil 2 D. R. Davis; 27-12S-1E. *USGS, 1954.
134. G. L. Grasty 1 Kentucky Lumber; 7-10S-10E. *USGS, 1956.
150. Caplan, 1954, pl. 5, well 8. Flawn and others, 1961, p. 350, well 24. Beikman and Drakoulis, 1958, p. 14. 2-24N-7W.
151. Flawn and others, 1961, p. 358, well 70. Beikman and Drakoulis, 1958, p. 14. 18-24N-7W.

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1. Hinds, [1912?], p. 149-150.
3. Grohskopf, Hinchey, and Greene, 1939, p. 131. 35-67N-18W.
5. Hinds, [1912?], p. 150. 23-66N-7W.
8. *Confid.
12. Grohskopf, Hinchey, and Greene, 1939, p. 119-120.
13. T. J. Frisbie 1 well; 16-66N-25W. *Missouri Geol. Surv.
14. McQueen and Greene, 1938, p. 166-167, 167-169.
16. Elmo School Board 1 Elmo School well; 20-66N-37W. *Missouri Geol. Surv.
19. Jackson and Rust 1 June Hayes; 22-66N-42W. *Missouri Geol. Surv.
23. Grohskopf, Hinchey, and Greene, 1939, p. 144. 5-65N-11W.
25. Morrow and Rogers 1 Mrs. J. O. Seamster; 6-65N-13W. *Missouri Geol. Surv.
26. Grohskopf, Hinchey, and Greene, 1939, p. 139. 19-65N-15W.
27. Grohskopf, Hinchey, and Greene, 1939, p. 125-126.
29. Edward Slater 1 E. S. Sayer; 14-65N-18W. *Missouri Geol. Surv.
30. Dan McLaughlin 1 Harvey Johnson; 13-65N-21W. *Missouri Geol. Surv.
32. Hinds, [1912?], p. 172-174. 13-65N-26W.
33. Stanolind 4B well; 14-65N-30W. *Missouri Geol. Surv.
34. McQueen and Greene, 1938, p. 203-204.
35. Palensky and others 1 O. O. Wallace; 1-65N-36W. *Missouri Geol. Surv.

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36. Cities Service 1 Glen Gray; 29-65N-39W. *Missouri Geol. Surv.
38. McQueen and Greene, 1938, p. 115-117.
42. Morrow and Rodgers 1 J. A. Cooley; 33-64N-17W. *Missouri Geol. Surv.
43. Hinds and Greene, 1915, p. 86. 34-64N-18W.
45. Van Horn 1 Watson; 26-64N-21W. *Missouri Geol. Surv.
46. Grohskopf, Hinchey, and Greene, 1939, p. 116-118.
49. Palensky and others 1 Slagle; 13-64N-33W. *Missouri Geol. Surv.
51. McQueen and Greene, 1938, p. 182-185.
52. Claude McQueen and others 1 A. Patterson; 14-64N-38W. *Missouri Geol. Surv.
55. Bell Invest. Co. 1 C. Hunter; 16-64N-41W. *Missouri Geol. Surv.
56. Grohskopf, Hinchey, and Greene, 1939, p. 56. 6-63N-12W.
57. Mayson Oil 1 McGonigle; 20-63N-13W. *Missouri Geol. Surv.
58. J. W. Eddington 1 and 2 H. W. Clark; 8-63N-14W. *Missouri Geol. Surv.
59. U.S. Corps of Engineers 1 well; 4-63N-15W. *Missouri Geol. Surv.
63. New Hampton Coal Min. 1 Johnson Bros.; 17-63N-29W. *Missouri Geol. Surv.
64. Stanolind 1 McDonald; 30-63N-34W. *Missouri Geol. Surv.
66. D. McClintock Farm well; 10-63N-40W. *Missouri Geol. Surv.
67. Hinds, [1912?], p. 253. 27-62N-9W.
70. Hinds and Greene, 1915, p. 87. 27-62N-16W.
71. Grohskopf, Hinchey, and Greene, 1939, p. 38. 10-62N-17W.
72. H. V. Elwell 1 Taylor; 12-62N-21W. *Missouri Geol. Surv.
73. Mrs. Bertha Rogers Farm well; 22-62N-22W. *Missouri Geol. Surv.
74. Greene, 1945, p. 94-99. 3-62N-26W.
75. R. Burdick Farm well; 36-62N-31W. *Missouri Geol. Surv.
76. Stanolind structure test; 12-62N-32W. *Missouri Geol. Surv.
78. General Drlg. 2 Dwight-Meyer and others; 27-62N-39W. *Missouri Geol. Surv.
80. Hinds, [1912?], p. 252-253. 5-61N-7W.
81. Hinds, [1912?], p. 55. 20-61N-15W.
    H, L & L Devel. 1 Malinda Lackey; 8-61N-15W. *Missouri Geol. Surv.
82. Grohskopf, Hinchey, and Greene, 1939, p. 33. 20-61N-17W.
83. Grohskopf, Hinchey, and Greene, 1939, p. 149. 15-61N-19W.
84. Grohskopf, Hinchey, and Greene, 1939, p. 150-151.
85. Grohskopf, Hinchey, and Greene, 1939, p. 47-49.
86. Grohskopf, Hinchey, and Greene, 1939, p. 50-51.
88. King City Community 1 F. Howitt; 9-61N-32W. *Missouri Geol. Surv.
89. Greene, 1945, p. 108-114.
91. Grohskopf, Hinchey, and Greene, 1939, p. 106-107.
92. Grohskopf, Hinchey, and Greene, 1939, p. 52-53.
93. Grohskopf, Hinchey, and Greene, 1939, p. 46-47.
94. Newton Robinson 1 well; 8-60N-25W. *Missouri Geol. Surv.
95. Messler Gas 1 S. E. Arnold; 27-60N-26W. *Missouri Geol. Surv.
96. W. S. Cline 2 Glasson; 11-60N-29W. *Missouri Geol. Surv.
101. Grohskopf, Hinchey, and Greene, 1939, p. 104. 6, 10-59N-14W.
105. Grohskopf, Hinchey, and Greene, 1939, p. 80. 29-59N-20W.
107. Greene, 1945, p. 130-132.
109. Greene, 1945, p. 87-94.
111. McQueen and Greene, 1938, p. 105-107.

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112. Miller and Harper 1 Moss; 4-59N-37W. *Missouri Geol. Surv.
113. McQueen and Greene, 1938, p. 169-176.
114. C. A. Hanley 1 Fee; 29-58N-8W. *Missouri Geol. Surv.
115. Grohskopf, Hinchey, and Greene, 1939, p. 103. 29-58N-13W.
117. Hinds, [1912?], p. 278. 19-58N-17W.
121. Thomas Stevenson well; 3-58N-21W. *Missouri Geol. Surv.
124. Hinds and Greene, 1915, p. 82. 21-58N-24W.
125. John Willman 1 Gould; 3-58N-29W. *Missouri Geol. Surv.
126. Walter Cherault 1 Glen Dice; 2-58N-30W. *Missouri Geol. Surv.
127. Grohskopf, Hinchey, and Greene, 1939, p. 81-87.
128. Ohio 1 A. J. Schneider; 30-58N-31W. *Missouri Geol. Surv.
131. V. G. Lewellyn 1 Fee; 31-57N-9W. *Missouri Geol. Surv.
132. Hinds, [1912?], p. 402. 16-57N-10W.
133. A. Brogden well; 15-57N-12W. *Missouri Geol. Surv.
135. Grohskopf, Hinchey, and Greene, 1939, p. 93-94.
    Grohskopf, Hinchey, and Greene, 1939, p. 94-95.
136. Grohskopf, Hinchey, and Greene, 1939, p. 100-101.
145. H. R. Benson 1 Fee; 22-57N-25W. *Missouri Geol. Surv.
146. McQueen and Greene, 1938, p. 131-133.
147. Hinds, [1912?], p. 109.
    Creek Coal Mine main shaft; 26-57N-28W. *Missouri Geol. Surv.
148. Cameron Min. 1 J. B. Russell; 20-57N-29W. *Missouri Geol. Surv.
150. Greene, 1945, p. 76-80.
152. McQueen and Greene, 1938, p. 120-124.
153. Moore, 1936, p. 32. 31-57N-35W.
    Greene, 1945, p. 39-45.
154. Grohskopf, Hinchey, and Greene, 1939, p. 123. 13-56N-8W.
156. Grohskopf, Hinchey, and Greene, 1939, p. 89-90.
159. Miles Pontius 1 Fee; 22-56N-16W. *Missouri Geol. Surv.
160. Hinds, [1912?], p. 138. 18-56N-16W.
163. Hinds, [1912?], p. 147. 8-56N-20W.
164. Greene, 1945, p. 122-126. 15-56N-23W.
165. Grohskopf, Hinchey, and Greene, 1939, p. 82. 19-56N-24W.
166. Hinds, [1912?], p. 110-111.
168. Fall and others 1 Harper-Whitaker; 28-56N-30W. *Missouri Geol. Surv.
171. McQueen and Greene, 1938, p. 117-119.
172. Tortle Est. 1 Hallstater; 32-56N-36W. *Missouri Geol. Surv.
173. McQueen, 1943, p. 26. 28-55N-9W.
174. Searight, 1959, p. 222-223. 32-55N-10W.
179. Hinds, [1912?], p. 354. 2-55N-15W.
180. Hinds, [1912?], p. 139.
    Prairie Hill School well; 32-55N-16W. *Missouri Geol. Surv.
182. Tina School well; 10-55N-23W. *Missouri Geol. Surv.
183. Blue Hill Oil 1 W. O'Roark; 21-55N-24W. *Missouri Geol. Surv.
187. Levring and others 1 Albright; 32-55N-28W. *Missouri Geol. Surv.
188. Ruby Newcomer 1 W. H. Zirkie; 27-55N-29W. *Missouri Geol. Surv.
191. Greene, 1945, p. 64-69.
194. Carter 1 McQueen; 2-55N-34W. *Missouri Geol. Surv.
198. Hinds and Greene, 1915, p. 98. McQueen, 1943, p. 53-54. 3-54N-9W. Searight, 1959, p. 226-227. 3-54N-9W.
199. Monroe County Home 2 Fee; 13-54N-10W. *Missouri Geol. Surv.
200. John Ownby 1 Fee; 33-54N-12W. *Missouri Geol. Surv.
202. Hinds, [1912?], p. 356-357.
207. Travelers Ins. 1 Wheeler; 17-54N-18W. *Missouri Geol. Surv.
208. Grohskopf, Hinchey, and Greene, 1939, p. 30. 29-54N-20W.
209. Donald Gross well; 9-54N-27W. *Missouri Geol. Surv.

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404. Van Horn, 1905, p. 58-68.
406. Bretz, 1950, p. 804-805.
408. J. W. Spicker Est. well; 28-45N-23W. *Missouri Geol. Surv.
412. Joe Burden well; 33-45N-27W. *Missouri Geol. Surv.
415. B. C. W. Hyde, Jr., 1 Noyes; 26-45N-30W. *Missouri Geol. Surv.
417. Cities Service 1 Snead; 16-45N-32W. *Missouri Geol. Surv.
419. *H. R. Wanless, Illinois Univ., 1932. 11-44N-5E.
420. Hinds, [1912?], p. 158. 2-44N-13W.
421. Van Horn, 1905, p. 61. 7-44N-15W.
422. Van Horn, 1905, p. 64-66.
424. Hinds, [1912?], p. 231. 21-44N-24W. Phillips 1 A. R. Carson; 6-44N-24W. *Missouri Geol. Surv.
431. A. P. McBride 1 Conger; 4-44N-31W. *Missouri Geol. Surv.
432. R. A. Foster 1 A. A. Whitsett; 3-44N-32W.
    A. J. Anderson 1 well; 26-44N-32W. *Missouri Geol. Surv.
433. E. E. Willis 2 Virgil Hern; 5-44N-33W.
    Beaumont Pet. 1 Wm. Schulz; 4-44N-33W. *Missouri Geol. Surv.
434. Bretz, 1950, p. 805-806.
435. K. J. Dingley well; 29-43N-1W. *Missouri Geol. Surv.
436. McQueen, 1943, p. 134, 140-141.
    Searight, 1959, p. 256. 30-43N-5W.
438. Hinds, [1912?], p. 307-308.
439. Marbut, 1908, p. 82-83.
440. Mrs. Minnie Meyer well; 35-43N-21W. *Missouri Geol. Surv.
445. City of Blairstown well; 36-43N-28W. *Missouri Geol. Surv.
446. Frank Flynn old Lloyd Wooler well; 18-43N-29W. *Missouri Geol. Surv.
448. Cline and Greene, 1950, p. 66-67. 21-43N-31W.
450. Interstate Pipeline 1 Henry Hearson; 30-43N-33W. *Missouri Geol. Surv.
452. McQueen, 1943, p. 43. 3-42N-3W.
453. Rosebud town well; 17-42N-4W. *Missouri Geol. Surv.
456. Ball and Smith, 1903, p. 92-93.
457. Ball and Smith, 1903, p. 113-114.
458. Marbut, 1908, p. 84-85.
459. August Micke well; 22-42N-24W. *Missouri Geol. Surv.
460. Hinds, [1912?], p. 190-191.
466. Hinds, [1912?], p. 77-78.
468. Bretz, 1950, p. 796-797.
469. Bretz, 1950, p. 813-815.
470. James Anderson well; 22-41N-3W. *Missouri Geol. Surv.
471. Fannie J. Mattox well; 19-41N-4W. *Missouri Geol. Surv.
473. International Shoe 2 Bland; 7-41N-6W. *Missouri Geol. Surv.
474. McQueen, 1943, pl. 25. 26-41N-7W.
475. McQueen, 1943, p. 179. 17-41N-7W.
477. Ball and Smith, 1903, p. 94. 27-41N-12W.
478. Ball and Smith, 1903, p. 106-107.
480. Winslow, 1891, p. 168-169.
481. Marbut, 1908, p. 80-81.
482. Marbut, 1908, p. 53. 18-41N-17W.
489. Richard Morris 1 well; 25-41N-32W. George Hand 1 Fee; 5-41N-32W. *Missouri Geol. Surv.
490. Interstate Pipeline 1 Maggie Crews; 21-42N-33W. Henry Denhart 2; 28-42N-33W. *Missouri Geol. Surv.
491. Merwin well; 5-41N-33W. Kaw Oil & Gas 2 Nutt; 33-41N-33W. *Missouri Geol. Surv.
493. Sewell 2 well; 36-40N-6W. *Missouri Geol. Surv.
495. Ball and Smith, 1903, p. 99-100.
496. A. J. Vannahme well; 8-40N-24W. *Missouri Geol. Surv.
498. Henry Finks, Jr., well; 20-40N-26W. *Missouri Geol. Surv.
501. Clarence Varn well; 34-40N-29W. J. E. Pyeatt 1 Fee; 33-40N-29W. *Missouri Geol. Surv.

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503. J. B. Armstrong and others 1 well; 22-40N-31W. Roy Wheatley well; 29-40N-31W. *Missouri Geol. Surv.
505. Hinds, [1912?], p. 80-81.
506. R. A. Pokorski well; 5-39N-4W. *Missouri Geol. Surv.
507. Jessie A. Cromwell well; 36-39N-5W. *Missouri Geol. Surv.
508. G. E. Morrison 1 Well; 15-39N-6W. *Missouri Geol. Surv.
509. U.S. Govt. Vichy Airport; 2-39N-8W. *Missouri Geol. Surv.
510. Ball and Smith, 1903, p. 94. 2-39N-12W.
512. Johnie Baner well; 26-39N-26W. *Missouri Geol. Surv.
520. Jessie Lorts 1 well; 8-38N-6W. *Missouri Geol. Surv.
521. James Lewis; 19-38N-7W. *Missouri Geol. Surv.
523. Ball and Smith, 1903, p. 94-95.
527. June Gragg well; 6-38N-28W. *Missouri Geol. Surv.
528. H. L. Alexander well and John Eger 1 Midkiff; 11-38N-29W. *Missorui Geol. Surv.
532. Hume 1 town well; 8-38N-33W. *Missouri Geol. Surv.
533. Bretz, 1950, p. 817-819.
535. James H. Henderson; 10-37N-26W. *Missouri Geol. Surv.
538. Henry E. Rapp well; 3-38N-30W. *Missouri Geol. Surv.
540. Kellett, 1932, cross section.
    Nevada Oil & Gas 1 Henshaw; 31-37N-32W.
542. Hendricks, 1954, p. 49-50, p. 73-74.
543. Bretz, 1950, p. 815-817.
544. Bretz, 1950, p. 800-801.
545. J. Gregory Graves well; 10-36N-26W. *Missouri Geol. Surv.
547. Kellett, 1932, cross section.
    Eldorado Springs town well; 21-36N-28W.
549. Hinds, [1912?], p. 418. 8-36N-30W.
    McJohnson well; 16-36N-30W. *Missouri Geol. Surv.
552. Greene and Pond, 1926, p. 106. 28-36N-33W.
    *H. R. Wanless, Illinois Univ., 1931. 2-36N-33W.
553. Dake, 1930, p. 168-172.
555. Hinds, [1912?], p. 135. 13-35N-26W.
    J. R. Schroyer 1 Fee; 13-35N-26W. *Missouri Geol. Surv.
560. Bretz, 1950, p. 819-820.
561. Bretz, 1950, p. 812-813. 5-34N-18W.
563. Hinds, [1912?], p. 418-419. 16-34N-31W.
    Greene and Pond, 1926, p. 43. 16-34N-31W.
564. Searight, 1955, p. 22-33.
    Hinds and Greene, 1915, p. 43. General sec. Barton and southern Vernon Counties.
565. Unnamed well and F. C. Burns and others 1 Caldwell; 6-34N-33W. *Missouri Geol. Surv.
569. Winslow, 1894, p. 424. 9-30N-19W.
570. Mrs. Perkins well; 3-32N-25W. *Missouri Geol. Surv.
571. Hinds, [1912?], p. 162. 16-32N-28W.
575. Hinds and Greene, 1915, p. 43. 2-32N-33W.
576. L. H. Sawell 2 well; 33-31N-31W. *Missouri Geol. Surv.
578. Ellsworth Karver Construction 1 Fee; 7-31N-33W. *Missouri Geol. Surv.
580. Hinds, [1912?], p. 214-215.
581. Shell Pipeline 1 Emmet 2 Station well; 6-29N-25W. *Missouri Geol. Surv.
582. American Zinc and Lead 2 Fox; 27-29N-32W. *Missouri Geol. Surv.
583. Searight, 1955, p. 11. 23-29N-33W.
585. Searight and Palmer, 1957, p. 2129. 20-28N-32W.
589. Bridge, 1930, p. 131-132.
590. Winslow, 1894, p. 423. 25N-25W.
591. Winslow, 1894, p. 424. 10-27N-24W.
592. Shepard, 1898, p. 124-127.
593. Winslow, 1894, p. 423. 36-32N-23W.
603. Grohskopf, 1955, p. 72. 31-26N-13E.

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604. Grohskopf, 1955, p. 108. 23-26N-10E.
605. Grohskopf, 1955, p. 63. 34-23N-9E.
606. Grohskopf, 1955, p. 75. 33-23N-14E.
607. Grohskopf, 1955, p. 76. 29-22N-11E.
608. Grohskopf, 1955, p. 58. 27-22N-6E.
609. Grohskopf, 1955, p. 81. 24-19N-11E.
610. Clark, 1952, p. 58. 7-21N-28W.
1370. Callison and McKenry 1 Kirk; 15-53N-36W. *USGS.

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7. *A. E. Roberts, USGS, 1961. 19-2S-7E.
13. Easton, 1962, p. 121-123. 31, 32-11N-21E.
19. Walton, 1946, fig. 2. Easton, 1962, p. 114. 14-17N-6E.
23. Robinson, 1963, p. 132-133. Gardner and others, 1946, p. 14-18. 34-1N-1W.
36. McMannis, 1952. 15-2N-6E.
37. Gardner and others, 1946, p. 30-33. 6-7N-8E.
46. Walton, 1946, p. 1296-1297, fig. 2. 9-16N-8E.
47. Walton, 1946, fig. 2. 8-16N-9E.
48. Walton, 1946, fig. 2. 10-16N-10E.
49. Walton, 1946, fig. 2. 29-15N-11E.
51. Walton, 1946, fig. 2. 24-13N-17E.
52. Scott, 1935, p. 1024. Easton, 1962, p. 116-117. 6-12N-20E.
53. Easton, 1962, p. 118. 5, 8-13N-21E.
54. Reeves, 1931, p. 141. Walton, 1946, fig. 2. 13, 14-12N-22E.
62. Pacific Western 1 Todd; 32-17N-14E. *AmStrat; NWGS, 1958.
65. Pet. Prod. 11 Crow Tribal; 27-6S-32E. *AmStrat.
66. Tidewater 1-A Crow Tribal; 29-7S-33E. *AmStrat.
71. Gardner and others, 1946, p. 12-14. 13, 24-1N-3W.
73. Gustafson, 1951. 27-1S-6E.
74. Gardner and others, 1946, p. 36-39. 5, 8-10N-13E.
78. Gardner and others, 1946, p. 68-69. 27-4S-4E.
80. Gardner and others, 1946, p. 82-85. 17, 18, 33, 35-6S-26E.
82. California 1 Crowley; 35-5N-7E. *NWGS.
87. Northern Ordnance 1 Morris; 15-9N-26E. *NWGS, 1957.
88. Stanolind 1 Rostad; 16-2S-13E. *AmStrat, 1960.
93. Carter 1 Yellowstone; 2-6N-32E. *AmStrat; NWGS.
    Miles Jackson 1 Canadian-Grierson; 30-7N-33E. *AmStrat, 1959.
99. Farmers Union 1 Tribal; 34-3S-31E. *AmStrat; NWGS.
100. Carter 1 Crow Tribal; 17-2S-29E. *AmStrat, 1960.
110. Brever and Curran 1 Snyder; 3-6S-18E. *AmStrat, 1959.
125. Texas 1 Eggen; 33-5S-17E. *NWGS.
126. Union Oil 1 A. L. 1490; 3-6S-35E. *AmStrat.
127. Gulf 1 Boyle; 4-8S-52E. *AmStrat.
129. Cities Service 1 McFarland; 6-1N-24E. *AmStrat, 1956.
130. Carter 1 Liscom Creek; 15-1N-45E. *AmStrat.
132. Carter 1 NPRR; 23-3N-40E. *AmStrat, 1955.
133. McDonald Hydraulic 1 Tucker; 19-3N-59E. *AmStrat, 1956.
134. Flank Oil 1 Gjerde; 24-5N-8E. *NWGS, 1955.
135. Cities Service 1 Nelson; 25-5N-24E. *AmStrat.
136. Carter 1 Max Schenk; 20-5N-40E. *AmStrat, 1955.
137. Carter 1 Perry; 23-5N-42E. *AmStrat.
146. Delta and Williston Oil & Gas 1 Trangmoe; 6-14N-55E. *AmStrat.
152. Union Oil 1 Nuhring; 32-35N-47E. *AmStrat.
155. Hunt Oil 1 Hagan; 7-34N-52E. *AmStrat; NWGS, 1954.
166. Continental 1 Fast; 14-30N-46E. *AmStrat.
167. Gulf 1 R. L. Cornwell; 14-30N-38E. *AmStrat; NWGS, 1953.
168. Deep Rock Oil 1 Picard; 6-29N-58E. *AmStrat.
173. Shell 22-29 Etzel; 29-26N-51E. *AmStrat; NWGS, 1953.
174. California 1 Govt.; 33-26N-34E. *AmStrat.

MONTANA—Continued

177. Williston Basin Oil Explor. 1 Thunderbird; 4-23N-30E. *AmStrat.
182. Texas 1 Maciorski; 23-16N-50E. *AmStrat.
183. Cities Service 1 Kathryn Huffine; 27-17N-15E. *AmStrat; NWGS, 1956.
191. Hunt and Gulf 1 J. J. Loberg; 26-30N-36E. *AmStrat; NWGS, 1953.
192. Amerada 1 Washburn; 31-5S-57E. *AmStrat; NWGS, 1954.
193. Amerada 1 Corral Creek Unit; 15-4S-57E. *AmStrat, 1958.
194. Stanolind 1 NPRR; 27-2S-50E. *AmStrat; NWGS.
196. California Explor. 1 Pierce; 13-4S-24E. *AmStrat; NWGS.
197. Mule Creek Oil 1 Melchoir; 30-9S-25E. *NWGS.
198. General Pet. 5-25-P Freedom Dome Unit; 25-16N-38E. *AmStrat; NWGS, 1954.
202. Sloss and Moritz, 1951, p. 2163. 1-15S-2W.
204. Cities Service 1 Cremer; 17-4N-17E. *AmStrat, 1956.
205. Amerada 1 Molvig; 13-29N-37E. *NWGS.
206. Texas 1 Govt.; 11-34N-31E. *AmStrat; NWGS.
207. Texas 1-822 Bowdoin Unit; 8-32N-32E. *NWGS, 1954.
208. Texas 2-3424 Bowdoin Unit; 34-32N-34E. *AmStrat; NWGS.
209. Phillips 1 Alice Dome Unit; 9-13N-34E. *AmStrat; NWGS.
216. Texas Pacific Coal and Oil 1 NPRR; 11-7N-27E. *AmStrat.
217. McCarty 2 Kendrick Cattle; 26-3N-35E. *AmStrat, 1956.
220. Champlin Oil & Ref. and Republic Nat. Gas 1-13 NPRR; 13-11N-27E. *AmStrat, 1958.
221. Cities Service 1 Buyse; 27-4N-33E. *AmStrat, 1956; NWGS, 1956.
222. Rock Creek Bench 1 Nessen; 36-14N-16E. *NWGS.
227. Sun and Phillips 1 Dynneson; 32-24N-58E. *AmStrat.
233. Amerada and British-American 1 Burke; 25-17N-24E. *AmStrat.
234. Shell 1 Crow; 36-9S-37E. *AmStrat; NWGS.
237. Socony-Vacuum F-11-6 Rhodes; 6-33N-47E. *AmStrat; NWGS.
238. Zach Brooks 1 Cowell; 17-20N-25E. *AmStrat.
239. Amerada and Stanolind 1 State; 36-18N-49E. *AmStrat; NWGS, 1956.
240. Carter 1 Traweek; 6-2N-61E. *NWGS, 1956.
241. Richfield 1 Newton; 7-17N-53E. *AmStrat.
243. Gulf 1 Govt.; 31-37N-34E. *AmStrat.
246. Stanolind and Amerada 1 NPRR; 5-20N-45E. *AmStrat.
252. Texas 1 NPRR "F"; 11-9N-22E. *AmStrat, 1957.
254. Shelbourne 1 Govt.; 34-3S-24E. *NWGS.
255. Anton Koerber 1 Metzger; 8-3S-25E. *NWGS.
257. Crowe 1 Snyder; 23-1S-32E. *NWGS.
259. Hanlon and Moncana 1 NPRR; 9-10N-22E. NWGS.
260. Amerada 1 NPRR "B"; 1-14N-32E. *AmStrat, 1956.
263. Amerada 1 Lester Pestol; 17-18N-24E. *AmStrat.
269. Quintana 1 NPRR; 29-10N-41E. *AmStrat.
270. Texas Pacific Coal and Oil and Pure 1 Cox; 23-3N-61E. *NWGS.
277. Shell 11-3-"C" NPRR-Richey; 3-22N-49E. *AmStrat, 1956.
278. Shell 22-9 Knudson; 9-23N-50E. *AmStrat.
279. Oceanic Oil 1 Casterline; 4-22N-50E. *AmStrat.
282. Ajax 1 McGowan; 10-29N-50E. *AmStrat.
285. George Greer, Trust, 1 Ottun; 32-1N-34E. *AmStrat.
294. Hanlon 1 Woodworth; 32-14N-24E. *NWGS.
297. B. & L. Drlg. 1 N-Bar Ranch; 9-21N-23E. *NWGS.
    B. & L. Drlg. 1 Nelson; 21-12N-23E. *NWGS.
298. Texas 1-D NPRR; 31-5N-20E. *AmStrat.
299. Walton, 1946, fig. 2. 7-12N-17E.
306. Gardner and others, 1946, p. 33-36. 14-9N-10E.
    Mundt, 1955, p. 203-204. 11-9N-10E.
    Easton, 1962, p. 114-115. 14-9N-10E.

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307. *A. E. Roberts, USGS, 1957. 35-2S-9E.
Gardner and others, 1946, p. 69-73. 26, 35, 36-2S-9E.
Mundt, 1955, p. 205. 35-2S-9E.
318. Murphy Corp. 1 Firemoon; 12-30N-41E. *AmStrat; NWGS, 1954.
319. Deep Rock Oil 1 Charles LePage; 14-28N-59E. *AmStrat.
320. Amerada 1 Lander; 21-37N-52E. *AmStrat.
321. F. H. Anderson 1 Bohle; 20-7N-57E. *NWGS, 1954.
322. Warren Pet. 1 Curry; 20-1S-60E. *AmStrat; NWGS.
325. Shell 21-15 NPRR Iron Bluff Unit; 15-13N-56E. *AmStrat.
326. Mobil Prod. F-33-23P Demm; 23-29N-54E. *AmStrat, 1957; NWGS, 1956.
327. Shell 14-34 Williamson; 34-16N-42E. *AmStrat; NWGS.
329. Phillips and others 1 Harmon; 29-27N-58E. *AmStrat, 1956; NWGS, 1956.
333. Texas 1 M. N. Guelff; 4-15N-54E. *AmStrat, 1959.
335. Shell 33X-21 Gas City Unit; 21-14N-55E. *AmStrat.
336. Phillips, Amerada, and NPRR 1 NPRR; 33-12N-53E. *AmStrat; NWGS, 1955.
337. Forest Oil 12-1 Alderson; 12-1N-37E. *AmStrat, 1955.
339. Shell 32-30 Pine Unit 1; 30-12N-57E. *AmStrat, 1959.
341. Stanolind 1 NPRR "E"; 21-20N-52E. *AmStrat; NWGS, 1955.
342. Hancock Oil 1 Kilien; 26-12N-40E. *AmStrat, 1957.
344. Richfield 1 Madoc; 31-37N-49E. *NWGS, 1955.
346. Burt Fields 1 Figmaka; 14-27N-39E. *AmStrat.
348. Coden 1 Nefsy-Thompson; 34-11N-42E. *AmStrat; NWGS, 1954.
349. Ohio 1 NPRR; 9-10N-39E. *AmStrat; NWGS.
350. Gulf, Sinclair, and Carter 1 Lentzner; 9-32N-42E. *AmStrat; NWGS, 1958.
351. Shell 22X-36 State (Pennel); 36-8N-59E. *AmStrat, 1955.
352. Shell 1 Little Beaver; 13-4N-61E. *AmStrat.
353. California 1 Pennel Unit; 15-10N-56E. *AmStrat; NWGS, 1957.
354. J. Ray McDermott 1 Kelly; 34-4N-34E. *AmStrat.
357. British-American 1 N. P. Fuller; 21-9N-39E. *NWGS, 1957.
358. Seaboard Oil 1 Rickter Unit; 18-32N-38E. *AmStrat.
360. D. E. L. Byers 1 Jerome; 8-27N-51E. *AmStrat, 1956; NWGS, 1956.
361. Zach Brooks 1 Larson; 2-32N-55E. *AmStrat, 1955; NWGS, 1954.
362. Carter 1 C. E. Danielson; 12-36N-47E. *AmStrat.
365. Carter 1 R. W. Lowe; 13-28N-50E. *AmStrat, 1959.
367. Phillips 1-A Sethrie; 20-30N-48E. *AmStrat, 1960.
Sinclair 1 Ironbear; 14-30N-49E. *AmStrat, 1957; NWGS.
373. McAlester Fuel Co. 1-A NPRR; 19-7N-61E. *NWGS, 1955.
374. Brady and Wampler 1 F. Smith Est.; 34-7N-37E. *AmStrat; NWGS.
376. Superior 71-22 Copulos; 22-2N-21E. *AmStrat.
378. Lion Oil 1 Knight; 29-14N-60E. *AmStrat; NWGS, 1954.
379. Shell 32-33 "B" NPRR-J. W. Richey; 33-22N-48E. *AmStrat.
380. Amerada 1 Rock Creek Unit; 10-22N-44E. *AmStrat; NWGS, 1955.
381. Eramont and others 1 NPRR; 21-23N-54E. *AmStrat, 1956; NWGS, 1954.
383. Socony-Vacuum F-11-20P Waller; 20-21N-46E. *AmStrat, 1960; NWGS, 1957.
384. E. M. Cranston 1 Govt.; 26-27N-52E. *AmStrat.
385. Continental and others 1 George Good; 21-26N-49E. *AmStrat, 1956; NWGS, 1957.
386. Sun 1 Beagle Land and Livestock; 17-23N-59E. *NWGS, 1956.
387. Stanolind 1 NPRR "F"; 29-18N-43E. *AmStrat, 1958.
388. Shell 14-5 NPRR; 5-22N-48E. *AmStrat.

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389. W. M. and A. P. Fuller 1 NPRR; 29-5N-60E. *AmStrat.
391. Amerada 1 Belzer; 29-29N-40E. *AmStrat, 1956.
393. Stanolind 1 Crow Tribal Unit 3; 30-3S-30E. *AmStrat; NWGS.
396. Zach Brooks 1 State; 18-36N-44E. *AmStrat.
414. Gealy, 1953, p. 127-130. 23, 24, 25-10S-4W.
434. Hall, 1961, p. 195-198. 13-8S-3E.
Gardner and others, 1946, p. 67-68. 4-8S-4E.
Mundt, 1955, p. 207-208. 5-8S-4E.
437. *G. D. Robinson, USGS, 1964. 5-4N-3E.
Klemme, 1949. 7-4N-3E.
446. Klepper, Weeks, and Ruppel, 1957, p. 20-21. 29-6N-1E.
498. Superior 22-25 Windsor; *Schlumberger, 1963. 25-1S-11E.
499. Sweeney, 1955. 25, 35, 36-37N-23W.
500. U. S. Smelting, Ref. and Min. and Voss 1 Pelton; 13-1N-19E. *AmStrat, 1959.
502. Murphy Corp. 1 McIntosh; 21-1N-50E. *AmStrat; NWGS, 1957.
504. Amerada 1 U.S.A.-Hoefle; 2-1S-16E. *AmStrat.
505. Theodosis, 1956. 18-2S-10W.
506. Theodosis, 1956. 7-2S-9W.
507. Guttormsen, 1952. 1S-10W. Big Hole River near Wise River.
508. Amerada 1 (?) Hedrick; 11-3S-16E. *AmStrat, 1960.
509. Shoreline Pet. 1 Federal 90-278; 29-3S-16E. *AmStrat, 1960.
510. Sloss and Moritz, 1951, p. 2163. N½ 3S-10W.
511. Gardner and others, 1946, p. 74-75. 20-4S-15E.
515. Loma 1 Barber; 6-5S-25E. *NWGS, 1956.
517. Gardner and others, 1946, p. 75-76. 17-5S-16E.
Gardner and others, 1946, p. 76-79. 16-5S-16E.
Mundt, 1955, p. 211-213. 16-5S-16E.
518. Sloss and Moritz, 1951, p. 2163. 15-6S-10W.
520. Ohio 18 NPRR; 3-7S-21E. *AmStrat.
521. Deep Rock Oil 1 Rukavina; 1-6S-24E. *NWGS.
522. Knappen and Moulton, 1930, p. 12-13. 7-6S-25E.
Gardner and others, 1946, p. 79-82. 35, 36-5S, 6S-24E.
523. Gardner and others, 1946, p. 85-89. 28, 33-6S-31E.
Mundt, 1955, p. 215. 33 (?)-6S-31E, Limekiln Gulch.
526. Electron Oil & Gas 2 Govt.; 31-7S-24E. *AmStrat, 1960.
528. Gardner and others, 1946, p. 63-66. 20, 22-8S-2E.
529. Mundt, 1955, p. 213-214. 25-8S-25E.
530. Sahl, 1952. 12-7S-31E.
532. E. M. Davis 1 Govt.; 9-8S-62E. *AmStrat, 1960.
533. Continental 1 Govt.; 17-9S-61E. *AmStrat, 1957.
534. Union Oil 1 Govt.-Newton; 23-9S-59E. *AmStrat, 1958.
536. Richards, 1955, p. 28, 31-32. 34, 35-9S-28E.
537. British-American 1 State; 16-9S-22E. *AmStrat, 1958.
538. Hall, 1961, p. 203-207. 21, 22-8S-4E.
Gardner and others, 1946, p. 66-67. 2-9S-4E.
Austin and Stoever, 1950. (Approx.) 10-9S-4E.
Mundt, 1955, p. 208. 23 (?)-8S-4E, 320 Ranch, Gallatin River Canyon, Elkhorn Ranch, Gallatin River Canyon 2-9S-4E.
539. Phillips 1 Carrot Basin Unit; 11-10S-3E. *AmStrat. 1960.
540. LeVan and McLean, 1951. Probably 11S-4E, Red Canyon (?), near Grayling Post Office. *Irving Witkind, USGS. 12-11S-4E.
541. Brasher, 1950. 4-12S-5W.
542. Sloss and Moritz, 1951, p. 2163. 7-12S-1W.
543. Honkala, 1949, p. 42-43. 23, 27-12S-2W.
544. Sloss and Moritz, 1951, p. 2163. 21-13S-7W.
545. Krusekopf, 1948. 36-13S-10W.
546. Sloss and Moritz, 1951, p. 2162. 34-14S-12W.
547. Skelly 1 Bergen; 14-7S-56E. *AmStrat, 1957.
548. Gulf 1 Bales; 11-9S-45E. *AmStrat.
549. *E. K. Maughan, USGS, 1964. 32-9S-33E.

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708. Atlantic 1 Horton Est.; 18-7N-32E. *AmStrat; NWGS.
714. F. R. Anderson 1 Govt.; 2-12N-40E. *AmStrat; NWGS.
716. Continental 1 Begger; 34-12N-60E. *AmStrat; NWGS, 1955.
722. Hodge and Hodge 1 Eggebrecht; 3-23N-49E. *AmStrat.
724. Mobil Prod. F-43-3 NPRR; 3-4S-44E. *AmStrat; NWGS, 1957.
727. Union Oil 1 Govt.-Lowe; 1-8S-56E. *AmStrat; NWGS.
729. Sinclair Wyoming 1 Wilkins; 28-9S-23E. *AmStrat.
730. Shell 12-12 H. Schmitt; 12-1S-18E. *AmStrat, 1959.
731. Mobil T-44-10-"1"; 10-1S-36E. *AmStrat.
732. Ohio 1 Govt.; 4-1S-62E. *NWGS, 1956.
733. Montana Oil Drlg. 1 Triangle 7; 28-2S-11E. *AmStrat, 1959.
734. Continental 1 Govt.; 33-2S-19E. *AmStrat; NWGS, 1957.
735. Tidewater 1 Crow Tribal; 3-3S-37E. *AmStrat.
737. Mobil Prod. F-13-18-G Govt.; 18-8S-58E. *AmStrat, 1959.
739. Union Oil 1 Govt.-Catron; 29-9S-58E. *AmStrat; NWGS, 1956.
740. Lion Oil 1 Hereford; 1-1N-28E. *AmStrat.
741. Cities Service 1 State; 16-2N-25E. *NWGS, 1956.
742. Cherry, Kidd, and Greer 1 Weinberg; 35-2N-33E. *AmStrat, 1957; NWGS, 1955.
743. Renwar 1 Kelly; 15-2N-34E. *AmStrat, 1957.
745. Moncana 1 Murray; 24-3N-22E. *NWGS.
748. Continental 1 P. Eller Est.; 10-4N-23E. *AmStrat.
749. DeKalb and Northern 1 Forguer; 25-4N-24E. *AmStrat, 1957.
750. Cities Service 1 M. H. Cleveland; 11-4N-25E. *AmStrat.
751. Gulf 1 Mackey Ranch; 27-4N-27E. *AmStrat, 1958.
752. Plymouth 1-14 Crow Tribal; 14-4N-37E. *AmStrat, 1958.
753. Aries Oil 1 Spidel; 12-5N-23E. *AmStrat.
754. Anschutz 1 Waco Land & Cattle Co.; 9-5N-31E. *AmStrat.
755. Ohio 1 Ole Roget; 19-5N-59E. *AmStrat, 1956.
756. Amerada 1 Ethel Jones (2); 7-6N-30E. *AmStrat, 1958.
757. Shell 41-3 NPRR Corral Creek Unit; 3-6N-60E. *AmStrat, 1958.
758. Amerada 1 NPRR "J" Tract 1; 17-7N-29E. *AmStrat, 1958.
759. American Metal Climax, Inc. 1 Erickson; 3-7N-38E. *NWGS, 1955.
762. Champlin Oil and Ref. 1 NPRR-149; 33-8N-36E. *AmStrat, 1958.
764. E. C. Johnson 1 NPRR; 19-8N-61E. *AmStrat, 1958.
772. Richfield 1 Hunnes; 31-10N-37E. *AmStrat, 1957.
775. Shell 24-21 Roberts; 21-11N-43E. *AmStrat, 1950; NWGS, 1957.
776. Manning and Midwest Oil 1 NPRR; 27-11N-44E. *AmStrat, 1958.
777. Shell 43-22A Pine Unit; 22-11N-57E. *AmStrat, 1959.
780. Mobil Prod. F-44-34P; 34-16N-57E. *AmStrat, 1959.
782. Shell 44-2 Frady; 2-18N-43E. *AmStrat, 1959.
783. Shell 1 Kubesh 41-26; 26-18N-53E. *AmStrat, 1959.
784. Pan American 1 NPRR "P"; 31-19N-51E. *AmStrat, 1958.
786. Shell 12-29 "C" NPRR Richey; 29-22N-49E. *AmStrat, 1958.
787. Shell and others 23-9 Govt.; 9-24N-48E. *AmStrat, 1956.
788. J. D. Sprecher 1 George Nick; 7-27N-52E. *AmStrat, 1958.
789. Ohio 1 G. L. Jacobs; 27-25N-48E. *AmStrat, 1958.
791. Murphy Corp., Sohio, and D'Orsey 1 Tribal; 15-29N-51E. *AmStrat, 1958.
793. California 1 Grimm; 13-32N-49E. *AmStrat, 1955; NWGS, 1955.
794. Wilcox Oil 1 Moe; 2-29N-52E. *AmStrat.
797. Mobil F-44-20P Mueller; 20-32N-59E. *AmStrat, 1960.
800. Sun 1 E. Hansen; 10-37N-57E. *AmStrat, 1959.
801. Carter 1 Margaret Nelson; 4-37N-53E. *AmStrat, 1960.
802. Signal Drlg. & Explor. 1 Govt.; 27-37N-38E. *AmStrat, 1960.
803. Signal Drlg. & Explor. 1 Govt.; 30-36N-37E. *AmStrat, 1960.
804. Gibralter Oil 1 Larson; 28-36N-41E. *AmStrat, 1957.

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805. Amerada 1 Grant; 2-36N-51E. *NWGS, 1957.
806. Amerada 1 Loucks; 35-36N-52E. *AmStrat, 1960; NWGS, 1957.
807. Gulf 1 (?) Paulson; 15-36N-53E. *AmStrat, 1958.
810. Texota Oil 1 Nyquist; 14-35N-48E. *AmStrat, 1957.
811. Signal Drlg. & Explor. 1 Govt.-East Fork; 24-35N-38E. *AmStrat, 1960.
813. Chicago Oil and Republic Nat. Gas 1 Govt.-U.S. Smelting, Ref. and Min.; 31-35N-31E. *AmStrat; NWGS, 1954.
815. Pan American 1 L. Anderson; 14-34N-48E. *AmStrat, 1960.
817. Texaco 1 L. Marsh; 14-34N-54E. *AmStrat, 1960.
821. Texas and Mobil 1 Brekke; 5-33N-56E. *AmStrat, 1957.
822. Calvert and others 1 Carl Tong; 28-33N-49E. *AmStrat, 1958.
823. Pan American 1 E. H. Godden; 5-33N-49E. *AmStrat, 1957.
825. Texas 1 McGowan; 2-32N-50E. *AmStrat, 1958.
826. Carter 1 Sioux Tribal; 8-32N-52E. *AmStrat, 1959.
827. Juniper 1 Masters; 19-31N-54E. *AmStrat, 1959.
830. H. Cox 1 Eggum; 13-31N-46E. *AmStrat.
831. Phillips and others 1 Unruh; 23-31N-45E. *AmStrat, 1957.
834. Amerada 1 State 1; 16-31N-37E. *AmStrat, 1960.
835. Shell 13-26 Govt.; 26-31N-33E. *AmStrat, 1958.
837. Amerada 1 State H; 16-30N-37E. *AmStrat, 1960.
838. Phillips and others 1-A Schutz; 24-30N-45E. *AmStrat.
840. Richfield 1 Stanolind-Govt.; 21-30N-51E. *AmStrat, 1958.
843. Amerada 1 Nyquist; 11-29N-40E. *AmStrat, 1957.
844. DeKalb and Northern 1 Gjersing; 12-29N-31E. *AmStrat.
846. Plymouth Oil 1 Govt.; 20-26N-39E. *AmStrat.
850. Harrison and Abercrombie 2 Govt.; 19-25N-35E. *NWGS, 1954.
851. DeKalb and Northern 1 Govt.; 2-23N-31E. *AmStrat.
853. M. R. Waggoner and Assoc. 1 Allen; 12-19N-14E. *AmStrat.
854. *E. K. Maughan, USGS, 1961. 12-20N-1E
855. Anaconda 1 Bloom; 29-20N-3W. *NWGS.
856. Anaconda 1 Moss; 33-20N-4W. *NWGS.
857. Pan American and Gulf 1 Gelsinger; 32-20N-7W. *AmStrat.
858. Walton, 1946, fig. 2, p. 1296-1297. 25-19N-4E.
859. Seaboard Oil 1 Dunphy; 17-19N-14E. *AmStrat.
861. Fuller Bros. and Lion Oil 1 Hendriksen; 25-19N-23E. *AmStrat.
862. Murphy Corp. 1 Rivenes; 10-19N-37E. *Schlumberger, 1957.
863. Anaconda 1 Swan; 17-18N-2W. *AmStrat.
865. Carl Yanat and Melford Colony; 13-18N-5W. *AmStrat.
866. Riverdale Oil 1 Murphy; 8-17N-2E. *AmStrat.
867. DeKalb and Northern 1 Melton; 7-17N-14E. *AmStrat.
868. Sohio 1 Hortens Campbell; 6-17N-15E. *AmStrat, 1958.
870. Texas 1 B. J. M. Elpel; 35-17N-53E. *AmStrat, 1957.
871. Ralph Lowe 1 Sandquist; 28-16N-36E. *AmStrat; NWGS.
873. Phillips 1 Ostler "A", 23-16N-26E. *AmStrat, 1957.
874. Youngblood 1 Shannon Cross; 7-16N-22E. *AmStrat; NWGS.
876. DeKalb 1 Kesselheim; 5-15N-15E. *AmStrat, 1959.
877. Mundt, 1955, p. 185. 24-16N-9E.
880. DeKalb and Northern 1 Cecile; 14-15N-15E. *AmStrat; NWGS.
881. Flank Oil 1 Ryan; 22-15N-23E. *NWGS, 1957.
883. DeKalb and Northern 24-28 State; 28-15N-25E. *AmStrat, 1956.
884. Flank Oil 1 Eva Guenon; 14-15N-27E. *AmStrat, 1959.
886. California 1 Peterson; 13-15N-30E. *AmStrat.
887. Murphy Corp. 1 NPRR; 23-15N-34E. *AmStrat.
888. Atlantic 1 NPRR-33; 33-15N-37E. *AmStrat, 1960.
Murphy Corp. 1 Govt.; 22-15N-37E. *AmStrat, 1957; NWGS.
890. Richfield 1 NPRR; 7-14N-31E. *AmStrat, 1956.
891. Flank Oil 1 Hansen; 29-14N-29E. *AmStrat, 1959.

MONTANA—Continued

893. Continental 1 Teigen; 5-14N-26E. *AmStrat, 1959.
894. Continental 1 Olsen-Federal Land Bank; 3-13N-25E. *AmStrat, 1958.
897. Mundt, 1955, p. 182-184. 4(?)-13N-12E. Red Hill, northeast Little Belt Mtns.
898. Cities Service 1 State "B"; 12-13N-15E. *AmStrat, 1958.
899. Walton, 1946, fig. 2. 10-14N-19E.
900. Amerada 1 Wilden; 27-13N-23E. *AmStrat.
901. Ike Taylor Drlg. 1 Hughes; 26-13N-24E. *NWGS.
902. Ike Taylor Drlg. 1 McGlenn; 3-13N-26E. *AmStrat, 1959.
903. McAlester Fuel Co. A-1 Clauson; 27-13N-28E. *NWGS, 1957.
904. Amerada 1 Amerada-Warren-NPRR; 1-13N-32E. *AmStrat, 1957.
905. Amerada 1 Michelfelder; 9-13N-35E. *AmStrat, 1959.
906. Roden and McRae 1 Govt.; 2-13N-37E. *AmStrat; NWGS.
907. Amerada 1 State "E"; 16-13N-38E. *AmStrat, 1959.
908. Amerada 1 Cherry Creek Sheep Co.; 35-13N-39E. *AmStrat, 1956.
909. Ohio 1 (?) Govt.-Cranston; 33-12N-49E. *AmStrat, 1960.
910. Deiss, 1943, p. 233-234. SW¼ 1-20N-9W.
911. Continental 1 South Zortman Unit; 29-23N-26E. *AmStrat, 1956.
912. Miles Jackson 1 NPRR Cherry Creek; 27-12N-38E. *AmStrat, 1960.
913. Global Enterprises 1 NPRR; 3-12N-36E. *AmStrat, 1960.
914. Seaboard Oil 1 Indian Creek; 1-12N-35E. *AmStrat, 1956; NWGS, 1954.
915. Porter and others 1 Savage "D"; 1-12N-33E. *AmStrat, 1958.
916. D. E. L. Byers 1 Kincheloe; 23-12N-32E. *AmStrat, 1956.
917. Flank Oil 2 Goffens; 14-12N-28E. *AmStrat, 1957.
918. *E. K. Maughan, USGS, 1963. 22-11N-12W.
919. Miller, 1959. 11-16N-17E.
920. Easton, 1962, p. 119-120. 24-12N-22E and 18, 19-12N-23E.
921. Pure 1 Dover; 19-12N-14E. *NWGS, 1959.
922. Walton, 1946, fig. 2. 6(?)-11N-15E.
923. Doswell 1 Dalgan; 12-11N-15E. *NWGS.
924. Douglass, 1954. 7-11N-18E.
925. Continental 1 Govt.; 18-11N-23E. *AmStrat, 1958.
926. H. M. Cox and Ajax 1 Govt.; 11-11N-26E. *AmStrat, 1959.
927. Carter 1 Bedlan; 8-11N-29E. *NWGS, 1956.
928. Texas 1 Manion; 5-11N-30E. *AmStrat; NWGS, 1956.
929. Honolulu Oil 11-9 Stensvad; 11-11N-31E. *AmStrat, 1959.
930. D. E. L. Byers 1 Ottman-O'Neil; 25-11N-32E. *AmStrat, 1956.
931. Sohio 1 Howard; 35-11N-33E. *AmStrat, 1958.
932. Porter Sesnon and others 1-B Savage Bros.; 10-11N-34E. *AmStrat, 1960.
933. *F. S. Honkala, Montana Univ., 1963. 18-10N-9W.
*T. H. Rosenkrantz, Washington State College, 1914. 10N-9W. Warm Springs Creek, Garnet Range.
934. Richfield 1 Cherry Creek Sheep Co.; 32-11N-36E. *AmStrat.
935. Mundt, 1955, p. 206. 22(?)-8S-2W. Morgan Gulch, Gravelly Range.
936. Shell and NPRR 21-17 Cabin Creek Unit; 17-10N-58E. *Am Strat, 1960.
937. Pure 1 Hopf; 35-10N-32E. *AmStrat, 1960.
938. Continental 1 NPRR; 29-10N-32E. *AmStrat, 1959; NWGS, 1957.
939. American Metal Climax, Inc., and L. Barker 1 Stensvad; 11-10N-30E. *AmStrat, 1960.
940. Lawrence Barker, Jr., 1 Cooley; 31-10N-30E. *AmStrat, 1957; *NWGS, 1957.
941. Texas and Amerada 1 Unit; 2-10N-28E. *AmStrat.
942. Amerada 1 Gunderson; 10-10N-27E. *AmStrat, 1957; NWGS, 1957.

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943. Trigood Oil 1 Hendrex; 24-10N-26E. *AmStrat.
944. Richfield A-1 NPRR; 5-10N-25E. *AmStrat, 1960.
945. Mobil Prod. F-41-36S; 36-10N-24E. *AmStrat, 1958; NWGS, 1957.
946. Hall, 1961, p. 208. 23, 24-9S-2E.
947. Stone, 1952. 1-10N-7W.
Stone and Bonine, 1915, p. 375. 20-10N-6W.
948. Continental 1 NPRR; 9-9N-17E. *AmStrat.
949. Heep Oil 1 Reed; 23-9N-19E. *AmStrat.
950. Evans 1 Crocker; 15-9N-20E. *NWGS, 1957.
951. Shell 21-19 NPRR; 19-9N-21E. *AmStrat, 1958.
952. *E. K. Maughan, USGS, 1964. About 13, 24-6S-30E, Yellowtail Dam.
953. Flank 1 Cartwright; 22-9N-30E. *AmStrat; NWGS, 1955.
954. Texas 1 "E" NPRR; 5-9N-34E. *NWGS.
955. American Metal Climax, Inc., 1 Barker; 17-9N-35E. *Amstrat, 1956.
956. Pure 1 A. D. Chase; 14-9N-43E. *AmStrat, 1960.
957. Mann, 1954. 26, 36-10S-2W.
958. *J. B. Hadley, USGS, 1964. 26, 27, 35-7S-3W.
959. Denison Drlg. 1 Lusk; 3-8N-33E. *AmStrat, 1959.
960. Atlantic 1 C. A. Johnson; 33-8N-32E. *AmStrat.
961. Atlantic 1 Harvey; 7-8N-30E. *AmStrat, 1960.
962. Warren Pet. 1 Waggner-Wallin; 13-8N-28E. *AmStrat, 1958.
963. *G. D. Robinson, USGS, 1964. 12N-2W, 3W. Near Hauser Dam.
964. Continental 1 R. Lind; 5-8N-26E. *AmStrat, 1958.
965. H. and H. Crocker 1; 15-8N-21E. *NWGS.
966. Ashland and Zach Brooks 1 NPRR; 29-8N-21E. *AmStrat.
967. Amerada 1 NPRR "A", 1-8N-20E. *NWGS.
968. Amerada 1 Russell; 1-8N-13E. *AmStrat, 1956.
969. Lyons, 1944, p. 450. Center 15N-3W. Missouri River, Craig.
970. Mon-O-Co Oil 1 NPRR; 19-7N-19E. *AmStrat.
971. Phillips 1-A Jensen; 27-7N-22E. *AmStrat, 1960.
972. Barnett, 1916, p. 218-220. 34-17N-3E.
973. *W. B. Myers, USGS, 1964. Center 14N-2W. Cottonwood Creek.
974. Anschutz Drlg. 1 Blum; 21-7N-48E. *NWGS, 1957.
975. Texas 1 Horsky; 23-6N-33E. *NWGS.
976. Pure 1 Bilden; 27-6N-22E. *NWGS, 1957.
977. Texaco 1 Griffith; 12-6N-17E. *AmStrat, 1963.
Seaboard Oil 44-22 State; 22-6N-18E. *NWGS.
978. Barker 1 Barker-State; 2-6N-15E. *NWGS.
979. Naftzger and Barker 1 Glennie; 20-6N-14E. *NWGS.
980. Mertie and others, 1951, p. 28. 36-10N-1W.
981. Sloss and Moritz, 1951, p. 2163. 7-9S-8W.
982. Mahorney, 1956. 34-5N-12W.
983. Gardner and others, 1946, p. 28-30. 26-5N-5E.
984. Montana Power and Hadley 1 Gugler; 9-5N-18E. *AmStrat, 1958.
985. DeKalb and Northern 88-23 NPRR; 23-5N-19E. *AmStrat, 1957.
986. Carter 1 State; 16-5N-33E. *NWGS.
987. Wilson, 1934, p. 373. 8S-8E. Cinnabar Mtn.
988. McMannis, 1952, p. 22a. 19-3N-6E.
989. Sohio 1 Kimball; 7-3N-19E. *NWGS, 1957; *AmStrat, 1958.
990. Shamrock Oil & Gas Corp. 1-22 Federal; 22-9N-55E. *NWGS, 1962.
991. L. Barker, Jr., 1 Govt.-Stovall; 4-3N-31E. *AmStrat.
992. Amerada 1 G. VanCleve; 13-3N-33E. *AmStrat.
993. Shannon Oil 1 Govt.-Pure; 35-1S-56E. *NWGS, 1962.
994. Garfield and Pasternak 1 Govt; 20-2N-52E. *NWGS, 1957.
995. Pure 1 State; 36-2N-51E. *AmStrat.
996. Robert Jordan 1 State; 16-2N-46E. *AmStrat, 1959.

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997. J. W. Brown 1 Binion Ranch; 21-20N-39E. *Schlumberger, 1957.
998. Robinson, 1963, p. 129-130, sec. B. 32-3N-1E.
999. McMannis, 1952. 36-1N-6E.

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2. Fisher & Ward 1 Dusenberry; 23-1N-22W. *Nebraska Geol. Surv. 1953.
   Falcon Seaboard Drlg. 1 Einspahr; 10-1N-22W. *Nebraska Geol. Surv., 1957.
4. Superior 72-36 State; 36-2N-29W. *Nebraska Geol. Surv., 1951.
   Rothmeier 1 Thompson; 32-2N-29W. *AmStrat, 1960.
5. Deep Rock Oil 1 Baney; 6-3N-37W. *AmStrat, 1952. *E. C. Reed, Nebraska Geol. Surv., 1955.
6. Deep Rock Oil 1-A Nichols; 6-3N-40W. *AmStrat, 1952; Nebraska Geol. Surv., 1952.
7. Indianola Oil 1 Anderson; 14-4N-28W. *Nebraska Geol. Surv., 1953.
8. Superior 28-12 Little; 12-5N-31W. *AmStrat, 1951.
   Superior 88-1 Schneider; 1-5N-31W. *Nebraska Geol. Surv., 1953.
10. Victor Anderson 1 Herman; 9-6N-27W. *Nebraska Geol. Surv. 1953.
11. C. J. Westlund 1 Schultz; 34-6N-41W. *Nebraska Geol. Surv., 1952; AmStrat, 1952.
12. Shell 1 Madison; 33-7N-23W. *Nebraska Geol. Surv., 1953.
13. K. & E. Drlg. 1 Swanson; 32-8N-16W. *Nebraska Geol. Surv., 1953.
14. Northern Nat. Gas 1 Baldwin; 24-8N-38W. *Nebraska Geol. Surv., 1953; E. C. Reed, Nebraska Geol. Surv., 1955.
    W. F. Newton 1 Eberhardt; 21-8N-38W. *Nebraska Geol. Surv., 1961.
15. Roden, Darden & McRay 1 Jessen; 2-11N-22W. *Nebraska Geol. Surv., 1952.
17. Oil Hunters, Inc., 1 Steck; 8-12N-34W. *Nebraska Geol. Surv., 1952; AmStrat, 1952.
19. Rock Hill Oil 1 Ables; 21-14N-37W. *Nebraska Geol. Surv., 1952; AmStrat, 1952.
20. Momper, 1963, p. 49 (fig. 5, log 5). Hoyt, 1963, p. 72 (fig. 5, log 15).
21. Momper, 1963, p. 49 (fig. 5, log 4).
22. W. C. O'Ferall Co. 1 Mildale Ranch; 13-18N-27W. *Nebraska Geol. Surv., 1953.
23. Cosden Pet. 1 Baskin; 1-18N-23W. *Nebraska Geol. Surv., 1952.
24. Stanolind 3 Lovercheck; 21-18N-55W. *Nebraska Geol. Surv., 1952; AmStrat, 1952.
26. Shell 1 Valla; 6-19N-16W. *Nebraska Geol. Surv., 1953.
28. Momper, 1963, p. 51 (fig. 6, log 7).
29. Ohio 1 Machlan; 5-23N-31W. *Nebraska Geol. Surv., 1952.
33. Momper, 1963, p. 51 (fig. 6, log 6).
37. Champlin Ref. 1 Vinton; 13-30N-39W. *Nebraska Geol. Surv., 1952; AmStrat, 1952.
38. Hassie Hunt Oil 1 Peterson; 14-30N-45W. *Nebraska Geol. Surv., 1951.
39. Momper, 1963, p. 52 (fig. 7, log 3). Hoyt, 1963, p. 71 (fig. 4, log 4).
40. British-American 1 Leach; 23-31N-38W. *Nebraska Geol. Surv., 1952; AmStrat, 1952.
41. S. D. Johnson 3 State; 16-32N-45W. *AmStrat, 1951; Nebraska Geol. Surv., 1951.
42. Sand Hills Drlg. 1 Borman Cattle Co.; 5-33N-27W. *AmStrat, 1952; Nebraska Geol. Surv., 1952.

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43. Perl Smith Drlg. 1 Krell; 19-33N-40W. *Nebraska Geol. Surv., 1952.
44. Hunt Oil 1 Pilster; 17-33N-51W. *AmStrat, 1951.
    Wondra-Mickelson 1 Guse; 12-33N-52W. *Schlumberger, 1951.
45. R. C. Gangwer 1 Roseberry; 28-28N-28W. *AmStrat, 1952; Nebraska Geol. Surv., 1952.
46. Ashland Oil & Ref. 1 Hanna; 28-28N-30W. *Nebraska Geol. Surv., 1952.
48. Momper, 1963, p. 51 (fig. 6, log 5).
49. Rocky Mountain Association of Geologists, 1963, sec. A-B, log 11.
51. Condra and Reed, 1943, fig. 10. Byrd-Frost 1 Abbott; 22-24N-38W. *AmStrat, 1950; Nebraska Geol. Surv., 1937.
52. Sohio 1 Dove; 1-21N-49W. *AmStrat, 1951; Nebraska Geol. Surv., 1951.
54. Deep Rock Oil 1 Refining; 20-2N-37W. *AmStrat, 1952; Nebraska Geol. Surv., 1952.
55. Skelly 1 Kilpatrick; 15-8N-39W. *Nebraska Geol. Surv., 1950; AmStrat, 1950.
57. Ohio 1 Sejkora; 23-10N-39W. *Nebraska Geol. Surv., 1951.
59. Momper, 1963, p. 49 (fig. 5, log 7).
60. Momper, 1963, p. 49 (fig. 5, log 6).
61. Pure 1 Blanchard; 32-16N-43W. *Nebraska Geol. Surv., 1952; AmStrat, 1952.
62. Sinclair-Prairie 1 Monahan; 23-25N-35W. *Nebraska Geol. Surv., 1942; AmStrat.
63. Momper, 1963, p. 52 (fig. 7, log 2).
64. Culham Pet. 1 Bachelor Ranch; 25-30N-33W. *Nebraska Geol. Surv., 1951; AmStrat, 1952.
65. Condra and Reed, 1943, fig. 10. C. L. Price and others 1 Platt; 3-1N-11W. *Nebraska Geol. Surv., 1931.
    Jones, Shelburne & Farmer 1 Merrill; 25-1N-11W. *Nebraska Geol. Surv., 1956.
66. Bell Oil & Gas 1 Roulier; 10-1N-19W. *Nebraska Geol. Surv., 1945.
    Sauvage & Dunn 1 Porter; 16-1N-19W. *Nebraska Geol. Surv., 1956.
67. Barnsdall and Helmerich & Payne 1 Erickson; 8-1N-23W. *Nebraska Geol. Surv., 1963.
68. Helmerich & Payne 1 Hamilton; 31-1N-24W. *Nebraska Geol. Surv.
    British-American 1 McClintic; 29-1N-24W. *Nebraska Geol. Surv., 1961.
69. Sunray Mid-Continent 1 Anderson; 28-1N-39W. *Nebraska Geol. Surv., 1961; AmStrat, 1961.
70. Condra and Reed, 1943, fig. 10. Hudson & Veeder 1 Battin; 15-2N-18W. *Nebraska Geol. Surv., 1941.
71. Gilbreath Pet. & Devel. 1 Edwards; 13-2N-22W. *Nebraska Geol. Surv., 1963.
72. Sinclair-Prairie 1 Landbank; 11-2N-28W. *Nebraska Geol. Surv., 1942.
    Frontier Ref. 1 Reiners; 14-2N-28W. *AmStrat, 1959.
73. J. M. Huber Corp. 1 Myers; 18-2N-30W. *AmStrat, 1961.
74. C. L. Price and others 1 Carter; 35-2N-32W. *Nebraska Geol. Surv., 1939.
    Skelly 1 Brown; 33-2N-32W. *Nebraska Geol. Surv., 1960.
75. Texas 1 Redmer; 35-2N-33W. *Nebraska Geol. Surv., 1945; E. C. Reed, Nebraska Geol. Surv., 1955.
76. Texas 1 Taunton; 22-2N-35W. *Nebraska Geol. Surv., 1960; AmStrat, 1955.
77. U.S. Drlg. 1 Brunke; 2-3N-13W. *Nebraska Geol. Surv., 1940.
78. Juilfs, 1953, fig. 2. Helmerich & Payne and Skelly 1 Leising; 14-3N-23W. *Nebraska Geol. Surv., 1945.

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79. Juilfs, 1953, fig. 2. Stanolind 1 Harding; 31-3N-25W. *Nebraska Geol. Surv., 1943; E. C. Reed, Nebraska Geol. Surv., 1955.
82. Ohio 1 Bauder; 35-5N-9W. *Nebraska Geol. Surv., 1945; E. C. Reed, Nebraska Geol. Surv., 1955.
83. Red Willow Oil & Gas 1 Watkins; 13-5N-26W. *Nebraska Geol. Surv., 1940.
    Lewis, Kirk & Jones 1 Allen; 22-5N-26W. *Nebraska Geol. Surv., 1961.
84. Juilfs, 1953, fig. 2. Sinclair-Prairie 1 Brown; 21-5N-29W. *Nebraska Geol. Surv., 1960.
85. Stanolind 1 Bailey; 27-5N-38W. *Nebraska Geol. Surv., 1953; AmStrat, 1945; E. C. Reed, Nebraska Geol. Surv., 1955.
87. Condra and Reed, 1943, fig. 10. Trees Pet. 1 Bergman; 23-6N-19W. *Nebraska Geol. Surv.
88. Chase Pet. 1 Ingold; 24-6N-38W. *Nebraska Geol. Surv., 1960.
89. Howard, 1941, p. 11. Prunty Prod. 1 Katzberg; 26-7N-10W. *Nebraska Geol. Surv., 1960.
91. Juilfs, 1953, fig. 2. Texon Royalty 1 State; 16-9N-33W. *Nebraska Geol. Surv., 1960.
92. Midwest Oil 1 Bernert; 34-10N-16W. *Nebraska Geol. Surv., 1953.
93. Carter 2 Exploration; 33-10N-17W. *Nebraska Geol. Surv., 1960.
94. Bell Oil & Gas 1 Nickel; 27-10N-18W. *Nebraska Geol. Surv., 1960.
    F. Frawley 1 Hild; 17-10N-18W. *Nebraska Geol. Surv., 1962.
95. Phillips 1 Simmons; 21-10N-22W. *Nebraska Geol. Surv., 1964.
97. Bell Oil & Gas 1 Harse; 3-12N-18W. *Nebraska Geol. Surv., 1945.
98. Parker Drlg. and others 1 State; 16-12N-26W. *Nebraska Geol. Surv., 1960.
99. Carter 1 Stocker; 21-13N-13W. *Nebraska Geol. Surv., 1960.
100. Sinclair-Prairie 1 Wiebe; 13-13N-20W. *Nebraska Geol. Surv., 1960.
    Arrowhead Explor. 1 Horn; 21-13N-20W. *AmStrat, 1962.
102. Carter 4 Exploration; 19-15N-14W. *Nebraska Geol. Surv., 1963.
105. Bredthauer & Taylor 1 Williams; 29-18N-13W. *Nebraska Geol. Surv., 1963.
106. S. D. Johnson 1 Abbott; 12-23N-41W. *Nebraska Geol. Surv., 1955; AmStrat, 1952.
107. C. L. Price and others 1 Hall; 10-23N-49W. *Nebraska Geol. Surv., 1945.
    Ryan Consol. Pet. 1 Hall; 27-23N-49W. *AmStrat, 1962.
108. Cave & Baxter Drlg. 1 Taylor; 31-25N-6W. *Nebraska Geol. Surv., 1963.
112. Ohio 1 Demmer; 22-31N-46W. *AmStrat, 1962; Nebraska Geol. Surv.
113. Valentine Oil 1 Murphy; 5-34N-46W. *AmStrat, 1954.
114. Nebraska Oil 1 Duthie; 33-35N-47W. *Nebraska Geol. Surv., 1939.
    Wm. Clary 1 Christenson; 4-34N-47W. *Nebraska Geol. Surv., 1955.
117. Peters and Knauss 1 Atchison; 28-10N-23W. *Nebraska Geol. Surv., 1960.
119. Carter 6 Exploration; 11-18N-17W. *Nebraska Geol. Surv., 1960.
120. Sinclair-Prairie 1 Delatour; 33-19N-42W. *Nebraska Geol. Surv., 1945; AmStrat, 1945.

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122. P. O. Lynch 1 Miller; 10-22N-21W. *Nebraska Geol. Surv., 1960.
123. P. O. Lynch 2 Campbell; 13-26N-22W. *Nebraska Geol. Surv., 1960.
130. Momper, 1963, p. 54 (fig. 8, log 6). Hoyt, 1963, p. 72 (fig. 5, log 12).
131. Momper, 1963, p. 51 (fig. 6, log 4).
134. Paul B. Johnson 1 Hite; 25-12N-30W. *Nebraska Geol. Surv., 1966.
135. Reed, 1938, p. 5-7. Midland Oil 1 Forster; 5-16N-8E. *Nebraska Geol. Surv., 1960.
136. Oil & Gas Journal, 1941, Arab Kerlyn Oil 1 Ogle; 9-1N-14E. *Nebraska Geol. Surv., 1940.
137. Ferguson Oil 1 Stalder; 14-1N-13E. *Nebraska Geol. Surv., 1961.
138. Condra and Reed, 1943, fig. 10. Ohio 1 Avery; 30-1N-13W. *Nebraska Geol. Surv., 1940.
    Sun 1 Kugler; 22-1N-13W. *Nebraska Geol. Surv., 1961.
139. Boyle-Grossman Drlg. 1 Bonham; 31-1N-1E. *Nebraska Geol. Surv., 1965.
140. Leon Wondra 1 Stanoscheck; 14-1N-6E. *Nebraska Geol. Surv., 1960.
143. Momper, 1963, p. 52 (fig. 7, log 4).
    Rocky Mountain Association of Geologists, 1963, sec. A-B, log 9.
145. Lubar Oil and Strain Drlg. 1 Sutton; 3-21N-41W. *AmStrat, 1954.
146. Vernon M. Mann 1 Whipple; 20-7N-27W. *AmStrat, 1955; Nebraska Geol. Surv., 1963.
147. Superior 17-24 Murray; 24-32N-46W. *AmStrat, 1950.
148. Frank McHale 2 Monahan Ranch; 12-24N-37W. *AmStrat, 1955; Nebraska Geol. Surv., 1965.
150. Momper, 1963, p. 52 (fig. 7, log 7).
151. Gage Co. Devel. 1 Hurtz; 27-2N-7E. *Nebraska Geol. Surv., 1945.
153. Cass Pet. 1 Shrine Club; 26-10N-7E. *Nebraska Geol. Surv., 1960.
154. State of Nebraska 1 Capitol Beach; 21-10N-6E. *Nebraska Geol. Surv., 1960.
155. General Explor. 1 Trautner; 35-9N-8E. *Nebraska Geol. Surv., 1960.
156. F. C. Gish and others 1 Mooberry; 25-7N-2E. *Nebraska Geol. Surv., 1955.
157. Wm. Ebke 1 Mathies; 22-5N-1W. *Nebraska Geol. Surv., 1960.
158. Parker Pet. 1 Sunflower; 3-7N-9E. *Nebraska Geol. Surv., 1960.
159. Veeder Supply & Devel. 1 State; 16-4N-19W. *Nebraska Geol. Surv., 1964.
160. American Plains Oil 1 Schluntz; 35-2N-17W. *Nebraska Geol. Surv., 1960.
161. Imperial Pet. 1 Peschel; 23-1N-20W. *Nebraska Geol. Surv., 1960.
162. Jones, Shelburne & Farmer, Inc., 1 Fritz; 35-3N-31W. *Nebraska Geol. Surv., 1963; AmStrat, 1956.
163. G. P. Vye 1 Lenneman; 13-2N-19W. *Nebraska Geol. Surv., 1961.
164. Juilfs, 1953, fig. 2. United Prod. 1 Asche; 27-3N-17W. *Nebraska Geol. Surv., 1958.
165. United Prod. 1 Arehart; 35-4N-17W. *Nebraska Geol. Surv., 1964.
167. Stanolind 1 Schact; 6-6N-12E. *Nebraska Geol. Surv., 1960.
168. Krueger and Assoc. 1 Roe; 5-7N-7E. *Nebraska Geol. Surv., 1960.

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169. Mudge and Yochelson, 1962, p. 196-197. Jackson Rust and others 1 Shaffer; 19-4N-16E. *Nebraska Geol. Surv., 1960.
170. *M. R. Mudge and E. L. Yochelson, USGS, 1962, sec. 354. 19-5N-16E.
171. Jones, Shelburne & Farmer, Inc., 1 Harris; 33-7N-19W. *Nebraska Geol. Surv., 1960.
172. Pure 1 Kline; 13-6N-18W. *Nebraska Geol. Surv., 1962.
173. Jones, Shelburne & Farmer, Inc., 1 Urwiller; 8-11N-13W. *Nebraska Geol. Surv., 1962.
175. Juilfs, 1953, fig. 2. E. E. Evans and others 1 Poore; 6-3N-27W.
176. Juilfs, 1953, fig. 2. C. E. McCaughey 1 Lambrecht; 25-3N-12W. *Nebraska Geol. Surv., 1960.
177. Shell 18 Travis; 15-16N-54W. *AmStrat, 1956.
178. Ohio 1 Dunse; 1-10N-19W. *Nebraska Geol. Surv., 1961.
179. Ohio 1 Stear; 13-9N-19W. *Nebraska Geol. Surv., 1963. Miami Pet. 1-A Mitchell; 10-9N-19W. *AmStrat, 1961.
180. Kirby Oil 1 Bartlett; 21-3N-5E. *Nebraska Geol. Surv., 1964.
181. Blaser and McClure 1 Allen; 16-1N-10E. *Nebraska Geol. Surv., 1960.
182. Juilfs, 1953, fig. 2. Stanolind 1 Bruntz; 25-4N-21W. *Nebraska Geol. Surv., 1960.
183. Superior 11-24 Dewey; 24-12N-20W. *Nebraska Geol. Surv., 1960.
184. Midwestern Contractors 1 Edson; 32-12N-25W. *Nebraska Geol. Surv., 1963.
185. Kingwood Oil 1 Spencer; 22-24N-21W. *Nebraska Geol. Surv., 1963.
186. Kingwood Oil 1 Schneidereit; 23-24N-23W. *Nebraska Geol. Surv., 1964.
187. Carter 11 Exploration; 9-8N-18W. *Nebraska Geol. Surv., 1964.
188. Lewis Drlg. 1 Robinson; 8-8N-16W. *Nebraska Geol. Surv., 1964.
189. Carter 9 Exploration; 27-9N-13W. *Nebraska Geol. Surv., 1964.
190. Carter 3 Exploration; 13-10N-15W. *Nebraska Geol. Surv., 1964.
191. Ohio 1 Taylor; 21-11N-18W. *Nebraska Geol. Surv., 1964.
192. Gled Oil 1 Swenson; 26-12N-17W. *Nebraska Geol. Surv., 1964.
193. Bellwood Synd. 1 Nichols; 29-16N-2E. *Nebraska Geol. Surv., 1961.
194. Ohio 1 Wiggins; 18-25N-29W. *Nebraska Geol. Surv., 1956.
195. Fillmore Devel. 1 Wernimont; 3-5N-2W. *Nebraska Geol. Surv., 1961.
196. Bay Pet. 1 Malick; 17-1N-15W. *Nebraska Geol. Surv., 1961.
199. Nelson Bros. 1 Ideus; 5-3N-7E. *Nebraska Geol. Surv., 1961.
200. S. F. Miller and others 1 Pethoud; 2-4N-6E. *Nebraska Geol. Surv., 1961.
201. Liberty and Phillips 1 Dawson; 2-5N-22W. *Nebraska Geol. Surv., 1963.
203. Brethauer and others 1 Brethauer; 28-17N-12W. *Nebraska Geol. Surv., 1961.
204. Carter 5 Exploration; 26-18N-10W. *Nebraska Geol. Surv., 1961.
205. Al Ward 1 Ditfield; 32-9N-11W. *Nebraska Geol. Surv., 1961.
206. Wyoming Oil 1 Dennison; 11-12N-11W. *Nebraska Geol. Surv., 1961.
207. W. L. Hartman and others 1 Ralston; 32-1N-17W. *Nebraska Geol. Surv., 1950.
208. Veeder Devel. 1 Alter; 15-1N-18W. *Nebraska Geol. Surv. 1961.

NEBRASKA—Continued

209. Cope and Smith 1 Perry; 36-18N-28W. *Nebraska Geol. Surv., 1964.
210. Ohio 1 Doyle; 21-18N-32W. *Nebraska Geol. Surv., 1964; AmStrat, 1953.
211. Engles and others 1 Wheeler; 9-4N-14E. *Nebraska Geol. Surv., 1961.
O. A. Sutton 1 Hopkins; 20-4N-14E. *Nebraska Geol. Surv., 1963.
212. Phillips 1 Niel; 24-4N-14E. *Nebraska Geol. Surv., 1963.
213. Black Gold Oper. and others 1 Allen; 16-4N-15E. *Nebraska Geol. Surv., 1961.
214. Skelly 1 Morehead; 35-4N-16E. *Nebraska Geol. Surv., 1961.
215. Kees and Leiker 1 Keichel; 4-5N-13E. *Nebraska Geol. Surv., 1961.
216. Black Gold Oper. 1 Ord; 8-5N-14E. *Nebraska Geol. Surv., 1961.
217. Bow & Arrow Oil 1 Schreifer; 20-5N-14E. *Nebraska Geol. Surv., 1961.
218. Isaacs and others 1 Magor; 15-5N-15E. *Nebraska Geol. Surv., 1961.
219. Short and others 1 Gauchot; 23-6N-13E. *Nebraska Geol. Surv., 1961.
221. J. M. Conner 1 Ritter; 25-7N-12E. *Nebraska Geol. Surv., 1961.
222. Pieper and others 1 Pesek; 13-1N-12E. *Nebraska Geol. Surv., 1961.
223. Carmody and others, 1941, log 1. Droge and others 1 Small; 34-2N-10E. *Nebraska Geol. Surv., 1961.
224. Black Gold Oper. 1 Bernadt; 31-3N-11E. *Nebraska Geol. Surv., 1961.
225. Carter 10 Exploration; 15-7N-20W. *Nebraska Geol. Surv., 1960.
226. C. A. Aldrich and others 1 Kersenbrock; 32-9N-3E. *Nebraska Geol. Surv., 1961.
227. Nebraska Drlg. 1 Markle; 23-9N-4E. *Nebraska Geol. Surv., 1961.
228. Jones, Shelburne & Farmer, Inc., 1 Britton; 18-19N-26W. *Nebraska Geol. Surv., 1964; AmStrat, 1956.
229. Carmody and others, 1941, log 8. Western Central Pet. 1 Bucholz; 34-3N-16E. *Nebraska Geol. Surv., 1961.
230. Carmody and others, 1941, log 7. R. L. McIntyre 1 Hough-Hill; 6-1N-16E. *Nebraska Geol. Surv., 1960.
231. Carmody and others, 1941, log 6. Pawnee Royalty 1 Meyers; 24-1N-15E. *Nebraska Geol. Surv., 1960.
232. Carmody and others, 1941, log 5. Sparks and Campbell 1 Horton; 5-1N-15E. *Nebraska Geol. Surv., 1960.
233. American Plains Oil 1 Seigel; 29-1N-16W. *Nebraska Geol. Surv., 1961; E. C. Reed, Nebraska Geol. Surv., 1955.
234. Moore, 1932, p. 72. 9-1N-13E.
235. Carmody and others, 1941, log 2. Stevens and Uhri 1 Harlow; 32-1N-13E. *Nebraska Geol. Surv., 1960.
236. Ohio 1 Maloley; 30-10N-19W. *Nebraska Geol. Surv., 1960.
237. M. P. Gilbert 1 Barger; 6-4N-30W. *Nebraska Geol. Surv., 1960; AmStrat, 1956.
239. Jones, Shelburne & Farmer, Inc., 1 Schneider; 9-5N-31W. *AmStrat, 1955; Nebraska Geol. Surv., 1963.
240. Momper, 1963, p. 51 (fig. 6, log 8).
241. Jones, Shelburne & Farmer, Inc., 1-A School Land; 36-4N-34W. *AmStrat, 1956; Nebraska Geol. Surv., 1963.
242. Momper, 1963, p. 52 (fig. 7, log 5).
243. Hoyt, 1963, p. 72. (fig. 5, log 14).
244. Nebraska Drillers 1 Dudek; 17-5N-36W. *AmStrat, 1956; Nebraska Geol. Surv., 1963.

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245. Lion Oil 1 Earl; 1-4N-41W. *AmStrat, 1958; Nebraska Geol. Surv., 1963.
247. Jones, Shelburne & Farmer, Inc., 1 Kanost; 21-6N-36W. *AmStrat, 1956; Nebraska Geol. Surv., 1964.
248. Ohio 1 Hanes; 28-2N-18W. *Nebraska Geol. Surv., 1960.
249. R. L. Gilmore 1 Shriver; 31-2N-17W. *Nebraska Geol. Surv., 1960.
    Superior 32-17 Dixon; 17-2N-17W. *AmStrat, 1960.
250. Bell Oil & Gas 1 Flamang; 25-2N-20W. *Nebraska Geol. Surv., 1945.
    Superior 44-34 Ohlund; 34-2N-20W. *AmStrat, 1951.
251. Jones, Shelburne & Farmer, Inc., 1 Breder; 33-12N-37W. *AmStrat, 1956; Nebraska Geol. Surv., 1964.
253. Ohio 1 Pettett; 20-9N-18W. *Nebraska Geol. Surv., 1964.
254. Central Plains Oil 1 Olson; 29-18N-18W. *Nebraska Geol. Surv., 1964.
255. Stanolind 1 Schoen; 34-5N-21W. *Nebraska Geol. Surv., 1964.
256. Jones, Shelburne & Farmer, Inc., 1 St. John; 4-2N-29W. *Nebraska Geol. Surv., 1964.
257. Kottmeyer 1 Barta Bros.; 30-2N-10W. *Nebraska Geol. Surv., 1964.
258. York Devel. 1 Roehr; 11-12N-2W. *Nebraska Geol. Surv., 1964.
259. Dan Kees and others 1 Terry; 27-5N-6E. *Nebraska Geol. Surv., 1964.
260. F. H. Schultze 1 Gronwohl; 4-4N-7E. *Nebraska Geol. Surv., 1963.
261. F. H. Schultze 1 Schultze; 26-2N-8E. *Nebraska Geol. Surv., 1963.
262. Gage County Devel. 1 Stanoschek; 24-1N-6E. *Nebraska Geol. Surv., 1964.
263. Herndon Drlg. 1 Shald; 30-32N-39W. *Nebraska Geol. Surv., 1963.
264. Herndon Drlg. 1 Churn; 1-31N-36W. *Nebraska Geol. Surv., 1966.
265. Jones, Shelburne & Farmer, Inc., 1 Robertson; 24-8N-37W. *Nebraska Geol. Surv., 1964; AmStrat, 1956.
266. Ohio 1 Bremer; 5-7N-39W. *Nebraska Geol. Surv., 1963; AmStrat, 1955.
267. General Resources 1 Browning; 2-5N-40W. *Nebraska Geol. Surv., 1964; AmStrat, 1956.
268. Chapman and Knight 1 Turner; 23-22N-21W. *Nebraska Geol. Surv., 1955.
269. Hunt 1 Pinkerton; 25-19N-33W. *AmStrat, 1954; Nebraska Geol. Surv., 1964.
270. J. O. Denton and others 1 Boyle; 28-15N-32W. *Nebraska Geol. Surv., 1955.
    Reco Oil & Gas 1 Bartner; 23-15N-32W. *Nebraska Geol. Surv., 1964.
271. Northern Drlg. 1 Hanson; 36-15N-31W. *Nebraska Geol. Surv., 1955.
    V. L. Baker 1 Haase-Halligan; 15-15N-31W. *Nebraska Geol. Surv., 1964.
272. F. M. McHale 3 Monahan; 21-24N-34W. *Nebraska Geol. Surv., 1960.
273. Jones, Shelburne & Farmer, Inc., 1 Carter; 23-4N-33W. *Nebraska Geol. Surv., 1964.
274. Jones, Shelburne & Farmer, Inc., 1-B State; 16-4N-32W. *Nebraska Geol. Surv., 1964.
275. Jones, Shelburne & Farmer, Inc., 1-C State; 16-4N-31W. *Nebraska Geol. Surv., 1964; AmStrat, 1956.
276. Jones, Shelburne & Farmer, Inc., 1 Habben; 10-2N-31W. *Nebraska Geol. Surv., 1964.

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278. Rothmeier and Betts 1 Harris; 23-2N-30W. *Nebraska Geol. Surv., 1963.
279. Ohio 1 State; 16-10N-39W. *Nebraska Geol. Surv., 1964; AmStrat, 1950; E. C. Reed, Nebraska Geol. Surv., 1955.
280. Kay Oil 1 Moyer; 33-1N-27W. *Nebraska Geol. Surv., 1964.
281. Sauvage & Dunn Drlg. 1 Crudden; 14-2N-24W. *Nebraska Geol. Surv., 1964.
282. Sheffer Drlg. 1 Johnson; 8-3N-14W. *Nebraska Geol. Surv., 1961.
283. American Plains Oil 1 Baverle; 6-1N-16W. *Nebraska Geol. Surv., 1961.
284. Jones, Shelburne & Farmer, Inc., 1 Malone; 15-5N-34W. *Nebraska Geol. Surv., 1963.
285. Al Ward 1 State; 36-9N-12W. *Nebraska Geol. Surv., 1961.
286. Bedrock Oil & Gas 1 Havekost; 34-19N-8E. *Nebraska Geol. Surv., 1962.
287. Franklin Explor. 1 Zahn; 4-20N-9W. *Nebraska Geol. Surv., 1952.
288. Amerada 1 Shoeder; 26-11N-12E. *Nebraska Geol. Surv., 1961.
289. Carter 7 Strat. test; 23-22N-7W. *Nebraska Geol. Surv., 1961.
290. Twibell 1 Asher; 9-28N-9W. *Nebraska Geol. Surv., 1961.
291. W & M Oil 1 Brigham; 36-16N-1W. *Nebraska Geol. Surv., 1962.
292. Stanolind 1 Stout; 3-9N-12E. *Nebraska Geol. Surv., 1962.
293. Stanolind 1 Schutz; 7-9N-12E. *Nebraska Geol. Surv., 1966.
294. Stanolind 1 Reitsch; 1-8N-10E. *Nebraska Geol. Surv., 1962.
295. Ingersoll Bros. 1 Brickplant; 10-8N-14E. *Nebraska Geol. Surv., 1962.
296. Phelps Oil 1 Roddy; 31-9N-14E. *Nebraska Geol. Surv., 1966.
297. John A. Nixon 1 Gibbs; 3-21N-12W. *Nebraska Geol. Surv., 1964.
298. British-American 1 Cole; 12-33N-37W. *Nebraska Geol. Surv.
300. Tucker Drlg. and O. N. Beer 1 Augustine; 27-33N-47W. *Nebraska Geol. Surv.
302. Serl Hutton 1 Copple; 24-31N-18W. *Nebraska Geol. Surv.
303. Tucker Drlg. and O. N. Beer 1 Wolvington; 7-31N-47W. *Nebraska Geol. Surv.
304. Momper, 1963, p. 51 (fig. 6, log 3). Rocky Mountain Association of Geologists, 1963, sec. A-B, log 10.
309. Time Pet. 1 Froelich; 13-29N-13W. *Nebraska Geol. Surv.
310. Motex Oil 1 Saultz; 12-29N-37W. *Nebraska Geol. Surv.
311. Champlin Oil & Ref. 1 Hull; 11-29N-40W. *Nebraska Geol. Surv.
314. Hunt Oil 1 Dobrovolny; 23-28N-15W. *Nebraska Geol. Surv.
315. Time Pet. 1 Schaffer; 34-28N-13W. *Nebraska Geol. Surv.
316. Hunt Oil 1 Gotschall; 8-27N-15W. *Nebraska Geol. Surv.
317. Hunt Oil 1 Brooman; 15-27N-16W. *Nebraska Geol. Surv.
318. Hunt Oil 1 Brown; 26-27N-19W. *Nebraska Geol. Surv.
321. Rocky Mountain Association of Geologists, 1963, sec. A-B (log 7).
322. Hoyt, 1963, p. 71 (fig. 4, log 8).
323. Belco Pet. 1 Starr; 34-26N-32W. *AmStrat.
324. Thomas Prod. 1 Egan; 8-22N-36W. *Nebraska Geol. Surv.
325. Hunt Oil 1 Saar; 22-26N-18W. *AmStrat.
326. Hunt Oil 1 Beck; 9-25N-16W. *Nebraska Geol. Surv.
327. Hunt Oil 1 Jordan; 9-25N-17W. *Nebraska Geol. Surv.
    Hunt Oil 1 Gurney; 22-25N-17W. *Nebraska Geol. Surv.
328. Hunt Oil 1 Buell Est.; 14-25N-19W. *Nebraska Geol. Surv.
330. Muir-Thompson 1 Beckhoff; 13-24N-28W. *Nebraska Geol. Surv.
332. Davidor & Davidor 1 Myers Land & Cattle Co.; 35-20N-40W. *Nebraska Geol. Surv.
333. Hunt Oil 1 Satterfield; 26-24N-19W. *Nebraska Geol. Surv.

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334. Hunt Oil 1 Snyder; 8-24N-18W. *Nebraska Geol. Surv.
335. Thomas Prod. 1 Vinton; 12-21N-37W. *Nebraska Geol. Surv.
336. Platte Valley Oil 1 Dames; 14-20N-6E. *Nebraska Geol. Surv.
337. Trans-Era Pet. 1 Collin; 9-23N-1E. *Nebraska Geol. Surv.
338. Atlas Explor. 1 Malmstem; 14-23N-14W. *Nebraska Geol. Surv.
339. Hunt Oil 1 Wallace; 5-23N-16W. *Nebraska Geol. Surv.
Hunt Oil 1 Burwell Invest.; 25-23N-16W. *AmStrat.
340. Hunt Oil 1 Schrup; 29-23N-17W. *Nebraska Geol. Surv.
341. Hunt Oil 1 Goos Ranch; 14-23N-19W. *Nebraska Geol. Surv.
342. Belco Pet. 1 Cooley; 26-23N-33W. *AmStrat.
Thomas Prod. 1 Vinton; 27-22N-34W. *Nebraska Geol. Surv.
343. Texas-Seaboard, Inc., 1 Lower; 1-23N-38W. *Nebraska Geol. Surv.
344. Hunt Oil 1 Hawthorne; 26-22N-19W. *Nebraska Geol. Surv.
345. Hunt Oil 1 Peterson; 32-22N-17W. *Nebraska Geol. Surv.
346. Hunt Oil 1 Lakin; 21-22N-16W. *Nebraska Geol. Surv.
347. Superior 41-32 Johnson; 32-22N-15W. *Nebraska Geol. Surv.
348. Central Nebraska Oil Synd., Ltd. 1 Parks, 26-22N-12W. *Nebraska Geol. Surv.
349. Wheeler County Resources Devel. 1 Pflugge; 20-22N-11W. *Nebraska Geol. Surv.
350. Omaha Drlg. 1 Erickson; 25-21N-9E. *Nebraska Geol. Surv.
L. D. Burt 1 Erickson; 13-21N-9E. *Nebraska Geol. Surv.
351. Watkins Oil 1 Reif; 11-21N-6E. *Nebraska Geol. Surv.
352. W & M Oil 1 Hunt; 12-21N-1E. *Nebraska Geol. Surv.
353. Ned Biffle (Oil Interest) 1 Justus; 15-21N-9W. *Nebraska Geol. Surv.
354. J. E. Jones 1 Senn; 7-21N-10W. *Nebraska Geol. Surv.
Ned Biffle 1 Swiatek; 12-21N-10W. *Nebraska Geol. Surv.
355. Nebraska State Oil Co. 1 Casteel; 29-21N-23W. *AmStrat.
356. Oil Hunters, Inc., 1 Farrar; 9-21N-38W. *Nebraska Geol. Surv.
357. Placid Oil 1 Lowe; 9-21N-39W. *Nebraska Geol. Surv.
358. Thomas Prod. 1 Minor; 5-22N-39W. *Nebraska Geol. Surv.
359. D. G. Hamilton 1 State; 36-20N-39W. *Nebraska Geol. Surv.
360. Volentine and Sharp 1 Mildale; 33-20N-36W. *AmStrat.
361. Placid Oil 1 Huffman; 17-20N-33W. *Nebraska Geol. Surv.
362. Reliance Tr. 1 Neal; 12-20N-32W. *Nebraska Geol. Surv.
363. Time Pet. 1 Anderson; 22-20N-25W. *Nebraska Geol. Surv.
364. P. E. Newell 1 Brooks; 35-19N-11E. *Nebraska Geol. Surv.
365. Superior 41-33 Barnes; 33-19N-11W. *Nebraska Geol. Surv.
366. Superior 14-11 Predmore; 11-19N-19W. *Nebraska Geol. Surv.
367. Placid Oil 1 Lanka; 15-19N-28W. *Nebraska Geol. Surv.
368. Placid Oil 1 Kramer; 33-19N-29W. *Nebraska Geol. Surv.
369. Placid Oil 1 Connell; 15-19N-31W. *Nebraska Geol. Surv.
370. Placid Oil 1 Huffman; 13-19N-34W. *AmStrat.
372. Thomas Prod. 1 Marland; 13-21N-33W. *Nebraska Geol. Surv.
373. Hoyt, 1963, p. 72 (fig. 5, log 13).
377. British-American 1 T-Lazy-T Ranch; 17-18N-34W. *Nebraska Geol. Surv.
378. Placid Oil 1 Star; 15-18N-33W. *Nebraska Geol. Surv.
379. Placid Oil 1 Winters; 5-18N-30W. *Nebraska Geol. Surv.
380. *R. R. Burchett, Nebraska Geol. Surv. 28-17N-13E.
381. *R. R. Burchett, Nebraska Geol. Surv. 1-17N-12E.
382. Blair Oil 1 Wilkinson; 1-17N-11E. *Nebraska Geol. Surv.
383. W & M Oil 1 Marshal; 22-17N-10E. *Nebraska Geol. Surv.
384. Superior 11-7 Lauvetz; 7-17N-3E. *Nebraska Geol. Surv.
385. Thomas Prod. 1 Vinton; 27-22N-34W. *Nebraska Geol. Surv.
386. D. G. Hamilton 1 Nagel; 27-17N-17W. *Nebraska Geol. Surv.
387. D. G. Hamilton 1 Hogaboom; 29-17N-21W. *Nebraska Geol. Surv.

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388. D. G. Hamilton 1 Bartak; 21-17N-23W. *Nebraska Geol. Surv.
389. D. G. Hamilton 1 Wells; 26-17N-28W. *Nebraska Geol. Surv.
390. D. G. Hamilton 1 Barner; 8-17N-29W. *Nebraska Geol. Surv.
391. Momper, 1963, fig. 5 (p. 49, log 2).
392. Volentine and Sharp 1 Pierson; 33-17N-33W. *Nebraska Geol. Surv.
Placid Oil 2 Ellery; 5-17N-33W. *Nebraska Geol. Surv.
393. Placid Oil 1 Ellery; 14-17N-34W. *Nebraska Geol. Surv.
394. D. G. Hamilton 1 McClain; 20-17N-35W. *Nebraska Geol. Surv.
395. D. G. Hamilton 1 Packard; 13-17N-37W. *Nebraska Geol. Surv.
396. Rocky Mountain Association of Geologists, 1963, sec. A-B, log 5.
U. S. Smelting Ref. & Min. 1-35 Wilson; 35-17N-40W. *AmStrat.
398. Superior 21-36 Travis-State; 36-16N-53W. *AmStrat.
399. D. G. Hamilton 1 McGinley; 15-16N-38W. *Nebraska Geol. Surv.
400. Osborn Oil 1 White Tail Creek Ranch; 31-16N-37W. *Nebraska Geol. Surv.
401. D. G. Hamilton 1 Studley; 29-16N-31W. *Nebraska Geol. Surv.
402. D. G. Hamilton 1 Peterson; 2-16N-30W. *Nebraska Geol. Surv.
403. Placid Oil 1 Bayne; 28-16N-29W. *Nebraska Geol. Surv.
404. D. G. Hamilton 1 Pearce; 26-16N-27W. *Nebraska Geol. Surv.
405. Placid Oil 1 Lucas; 14-16N-26W. *Nebraska Geol. Surv.
406. D. G. Hamilton 1 Arnold; 26-16N-24W. *Nebraska Geol. Surv.
407. D. G. Hamilton 1 Lichtenberger; 18-16N-22W. *Nebraska Geol. Surv.
408. Arrowhead Explor. 1 Willis; 34-16N-21W. *AmStrat.
409. Superior 11-7 Spotanski; 7-16N-13W. *Nebraska Geol. Surv.
410. W. F. Prochaska 1 Kment; 10-16N-12W. *Nebraska Geol. Surv.
411. Ohio 1 Kravenek; 35-16N-4E. *Nebraska Geol. Surv.
412. L. J. Staska 1 Prochaska; 29-16N-5E. *Nebraska Geol. Surv.
413. Ohio 1 Roberts; 9-16N-6E. *Nebraska Geol. Surv.
414. Great Western Oil 1 Smith; 25-16N-9E. *Nebraska Geol. Surv.
415. *Confid. 32-16-12E.
416. J. P. Miller 1 Miller Park; 33-16N-13E. *Nebraska Geol. Surv.
417. Fairmont Creamery 3 water well; 22-15N-13E. *Nebraska Geol. Surv.
418. Layne-Western water well; 36-15N-12E. *Nebraska Geol. Surv.
419. Union Pacific Railroad 1 Lane Station; 27-15N-11E. *Nebraska Geol. Surv.
420. Superior 44-33 Nygren; 33-15N-8E. *Nebraska Geol. Surv.
421. Todd Valley Devel. 1 Koutney; 11-15N-7E. *Nebraska Geol. Surv.
422. Ohio 1 EGR; 24-15N-5E. *Nebraska Geol. Surv.
423. Ohio 4 Fiala; 29-15N-4E. *Nebraska Geol. Surv.
424. J. E. Palensky 1 Pullen; 11-15N-6W. *Nebraska Geol. Surv.
425. Superior 22-26 Weber; 26-15N-10W. *Nebraska Geol. Surv.
426. D. G. Hamilton 1 Wilson; 27-15N-19W. *Nebraska Geol. Surv.
427. Volentine and Murfin Drlg. 2 Gibbons; 30-15N-20W. *Nebraska Geol. Surv.
428. Volentine and Murfin Drlg. 1 Horn; 33-15N-21W. *Nebraska Geol. Surv.
429. D. G. Hamilton 1 Peterson; 18-15N-24W. *Nebraska Geol. Surv.

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430. Indiana Farm Bur. Coop. Assoc. 1 Bailey; 26-15N-28W. *Nebraska Geol. Surv.
431. Miami Oil Prod. 1 "C" Meyer Ranch; 28-15N-29W. *Nebraska Geol. Surv.
432. T. N. Berry and Mast Drlg. 1 Pedersen; 1-15N-33W. *Nebraska Geol. Surv.
433. W. B. Osborn 1 McGinley; 9-15N-36W. *Nebraska Geol. Surv.
435. Pan American 1 Humphrey; 26-14N-35W. *Nebraska Geol. Surv.
436. Placid Oil 1 Binegar; 28-14N-34W. *Nebraska Geol. Surv.
437. Wallace Enter. 1 Hoatson; 5-14N-32W. *Nebraska Geol. Surv.
438. Miami Oil Prod. 1 "A" Bergstrom; 32-14N-26W. *Nebraska Geol. Surv.
439. D. G. Hamilton 1 Ostergard; 12-14N-25W. *Nebraska Geol. Surv.
440. D. G. Hamilton 1 Schuster; 4-14N-23W. *Nebraska Geol. Surv.
441. D. G. Hamilton 1 Hendricks; 29-14N-22W. *Nebraska Geol. Surv.
442. D. G. Hamilton 1 Young; 9-14N-17W. *Nebraska Geol. Surv.
443. Ohio 1 Petrazilka; 22-14N-4E. *Nebraska Geol. Surv.
444. Palensky and Thege 1 Ohnoutka; 34-14N-5E. *Nebraska Geol. Surv.
445. Ohio 1 Holoubek; 12-14N-6E. *Nebraska Geol. Surv.
446. Northern Nat. Gas 18 Schnack; 33-14N-10E. *Nebraska Geol. Surv.
447. Northern Nat. Gas 8 Glasshoff; 9-14N-11E. *Nebraska Geol. Surv.
448. Victor I. Jeep 1 Rahn; 23-14N-12E. *Nebraska Geol. Surv.
449. Union Stockyards 1 water well; 3-14N-13E. *Nebraska Geol. Surv.
450. Nebraska Geol. Surv., test well; 11-13N-13E. *Confid.
451. L. K. Hough 1 Timm: 15-13N-12E. *Nebraska Geol. Surv.
452. Northern Nat. Gas 10 Glesman; 14-13N-11E. *Nebraska Geol. Surv.
Northern Nat. Gas 2 Fay; 36-14N-11E. *Nebraska Geol. Surv.
453. Northern Nat. Gas 16 Wainwright; 15-13N-10E. *Nebraska Geol. Surv.
454. Northern Nat. Gas 25 Ballow; 15-13N-9E. *Nebraska Geol. Surv.
455. C. Williams 1 Radensleben; 28-13N-8E. *Nebraska Geol. Surv.
456. Pyramid Oil 1 Johnson; 33-13N-7E. *Nebraska Geol. Surv.
457. Superior 22-9 Sundberg; 9-13N-3W. *Nebraska Geol. Surv.
458. Superior 21-25 Kroeger; 25-13N-11W. *Nebraska Geol. Surv.
459. Gower Oil 1 Wood; 21-13N-19W. *Nebraska Geol. Surv.
460. D. G. Hamilton 1 Brown; 23-13N-22W. *Nebraska Geol. Surv.
461. Placid Oil 1 Mundell; 28-13N-23W. *Nebraska Geol. Surv.
462. Miami Oil 1B Koster; 18-13N-24W. *Nebraska Geol. Surv.
463. D. G. Hamilton 1 Bergstrom; 11-13N-26W. *Nebraska Geol. Surv.
464. Miami Oil 1B Brestel; 13-13N-27W. *Nebraska Geol. Surv.
465. D. G. Hamilton 1 Carpenter; 26-13N-31W. *Nebraska Geol. Surv.
466. E L K Oil 1 Thompson; 26-13N-32W. *Nebraska Geol. Surv.
467. D. G. Hamilton 1 Koch; 2-13N-33W. *Nebraska Geol. Surv.
468. Placid Oil 1 Anderson; 15-13N-35W. *Nebraska Geol. Surv.
469. Rocky Mountain Association of Geologists; 1963, sec. A-B (log 4).
470. J. C. Mann, Jr., 1 Southwell; 11-12N-35W. *Nebraska Geol. Surv.
471. D. G. Hamilton 1 White; 13-12N-33W. *Nebraska Geol. Surv.
472. Baker Drlg. 1 Diener; 7-12N-29W. *Nebraska Geol. Surv.

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473. D. G. Hamilton 1 Anderson; 21-12N-23W. *Nebraska Geol. Surv.
474. D. G. Hamilton 1 Kopf; 11-12N-22W. *Nebraska Geol. Surv.
475. Sterling Drlg. 1 Wiley; 34-12N-21W. *Nebraska Geol. Surv.
476. Superior 11-14 Scudder; 14-12N-19W. *Nebraska Geol. Surv.
477. Phillip C. Dixon 1 Stoeger; 11-12N-13W. *Nebraska Geol. Surv.
478. Northern Nat. Gas 20 Penke; 11-12N-10E. *Nebraska Geol. Surv.
479. Northern Nat. Gas 7 test; 23-12N-11E. *Nebraska Geol. Surv.
480. Northern Nat. Gas 6 test; 9-12N-12E. *Nebraska Geol. Surv.
481. Nebraska Geol. Surv. test well and measured section; 17-12N-14E. *Nebraska Geol. Surv.
482. Cass Oil 1 Sporer; 8-11N-13E. *Nebraska Geol. Surv.
483. Schleifort 1 water well; 7-11N-11E. *Nebraska Geol. Surv.
484. Nebraska Geol. Surv. water test well; 6-11N-8E. *Nebraska Geol. Surv.
485. Frawley Drlg. 1 Abels; 30-11N-17W. *Nebraska Geol. Surv.
486. Western Drlg. 1 Johnson; 27-11N-19W. *AmStrat.
487. Placid Oil 1 Kittenbrink; 26-11N-25W. *AmStrat.
488. M. W. Volentine 1 Middleton; 29-11N-26W. *Nebraska Geol. Surv.
489. James R. Sharp 1 Trimble; 22-11N-27W. *Nebraska Geol. Surv.
490. M. W. Volentine 1 96 Ranches; 13-11N-28W. *Nebraska Geol. Surv.
494. D. G. Hamilton 1 Law; 12-11N-35W. *Nebraska Geol. Surv.
495. Pan American 1 Nichols; 22-11N-39W. *Nebraska Geol. Surv.
D. G. Hamilton 1 Nichols; 28-11N-39W. *Nebraska Geol. Surv.
497. Pan American 1 Sellers; 23-10N-35W. *AmStrat.
Phillips 5 Madrid; 7-10N-35W. *Nebraska Geol. Surv.
498. Rocky Mountain Association of Geologists, 1963, sec. A-B, log 3.
500. Sun 1 Ballard; 20-10N-32W. *Nebraska Geol. Surv.
501. Wentworth Oil & Devel. 1 McDermott; 32-10N-31W.
502. Burch Drlg. 1 Votaw; 20-10N-29W. *Nebraska Geol. Surv.
503. D. G. Hamilton 1 Sundstrom; 7-10N-27W. *Nebraska Geol. Surv.
M. W. Volentine 1 Stebbins; 13-10N-27W. *Nebraska Geol. Surv.
504. J. R. Sharp 1 Aden; 12-10N-26W. *Nebraska Geol. Surv.
505. D. G. Hamilton 1 Kauffman; 29-10N-24W. *Nebraska Geol. Surv.
506. D. G. Hamilton 1 Hock; 27-10N-21W. *Nebraska Geol. Surv.
507. Miami Pet. 1 Hervert; 3-10N-14W. *Nebraska Geol. Surv.
508. Superior 24-20 Lewis; 20-10N-12W. *Nebraska Geol. Surv.
509. Superior 22-14 Idhe; 14-10N-4E. *Nebraska Geol. Surv.
510. Nebraska Geol. Surv. 1 Thorn; 12-10N-11E. *Nebraska Geol. Surv.
511. Northern Nat. Gas 11 test; 28-10N-12E. *Nebraska Geol. Surv.
512. Baker and Pollack 1 Larsh; 21-10N-14E. *Nebraska Geol. Surv.
513. Shar-Alan Oil 1 Krueger; 28-9N-6E. *Nebraska Geol. Surv.
514. Shar-Alan Oil 1 Cobb; 28-9N-5E. *Nebraska Geol. Surv.
515. Miami Pet. 1 Gofobed; 11-9N-15W. *Nebraska Geol. Surv.
B & R Drlg. 1 Huffstutter; 8-9N-15W. *Nebraska Geol. Surv.
516. Miami Pet. 1 Burkey; 26-9N-20W. *AmStrat.
517. D. G. Hamilton 1 Oberhauser; 22-9N-23W. *Nebraska Geol. Surv.
518. Interstate Nat. Gas & Oil 1 Yeutter; 36-9N-24W. *Nebraska Geol. Surv.

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519. D. G. Hamilton 1 Schurr; 25-9N-25W. *Nebraska Geol. Surv.
520. D. G. Hamilton 1 McNickle; 24-9N-26W. *Nebraska Geol. Surv.
521. M. W. Volentine 1 Hill; 8-9N-27W. *Nebraska Geol. Surv.
522. M. W. Volentine 1 Wolfe; 24-9N-29W. *Nebraska Geol. Surv.
523. Burch Drlg. 1 Hasenauer; 9-9N-30W. *Nebraska Geol. Surv.
524. W. C. Poole and Mast Drlg. 1 State; 36-9N-34W. *AmStrat.
525. Phillips 3 Madrid; 5-9N-35W. *Nebraska Geol. Surv.
526. Phillips 4 Madrid; 6-9N-36W. *Nebraska Geol. Surv.
527. Phillips 1 Madrid; 28-9N-37W. *Nebraska Geol. Surv.
528. Aladdin Pet. 1 O'Neil; 15-8N-36W. *Nebraska Geol. Surv.
    Donnell Drlg. and Christensen & Mollerstuen 1 O'Neil; 35-8N-36W. *Nebraska Geol. Surv.
529. Donnell Drlg. 1 Schumer; 2-8N-35W. *Nebraska Geol. Surv.
    Cities Service 1 Leu; 17-8N-34W. *AmStrat.
530. Cities Service 1 Clark; 23-8N-34W. *AmStrat.
531. Murfin Drlg. 1 Scott; 14-8N-33W. *AmStrat.
532. Leben Drlg. 1 Fisher; 13-8N-32W. *Nebraska Geol. Surv.
    Leben Drlg. 1 Leu; 8-8N-31W. *Nebraska Geol. Surv.
533. M. W. Volentine 1 Schmitz; 7-8N-30W. *Nebraska Geol. Surv.
534. M. W. Volentine 1 Thompson; 14-8N-29W. *Nebraska Geol. Surv.
535. Shaake, Patrick & Koepke 1 Lenz; 13-8N-28W. *Nebraska Geol. Surv.
    Interstate Nat. Gas & Oil 1 Waltemath; 18-8N-27W. *Nebraska Geol. Surv.
536. Panhandle Eastern Pipeline 1 Broekmeier; 13-8N-26W. *Nebraska Geol. Surv.
537. Miami Oil 1B Lehman; 32-8N-25W. *Nebraska Geol. Surv.
538. Panhandle Eastern Pipeline 1-26 Toberer; 26-8N-24W. *Nebraska Geol. Surv.
    Interstate Nat. Gas & Oil 1 Umberger; 8-7N-23W. *Nebraska Geol. Surv.
539. Murfin Drlg. 2 Whaley; 6-8N-21W. *Nebraska Geol. Surv.
540. Bond Oil 1 Cedarblade; 17-8N-19W. *AmStrat.
541. Superior 43-28 Jackson; 28-8N-13W. *Nebraska Geol. Surv.
542. T. G. Kleinholz 1 Arnold; 35-8N-2E. *Nebraska Geol. Surv.
543. Shar-Alan Oil 1 Petersen; 14-8N-6E. *Nebraska Geol. Surv.
544. General Explor. 1 Maahs; 7-8N-9E. *Nebraska Geol. Surv.
545. Ingersoll Bros. 1 Hanks; 3-7N-14E. *Nebraska Geol. Surv.
546. Stanolind 2 Hopp; 22-7N-11E. *Nebraska Geol. Surv.
    H. H. Meyer 1 Grundman; 21-7N-11E. *Nebraska Geol. Surv.
547. Stanolind 1 Cameron; 11-7N-10E. *Nebraska Geol. Surv.
548. Texas Crude Oil and J. O. Farmer 1 Claassen; 6-7N-12W. *Nebraska Geol. Surv.
549. Frank Frawley 1 Just; 15-7N-17W. *Nebraska Geol. Surv.
550. Weston Drlg. 1 Krohm; 16-7N-18W. *Nebraska Geol. Surv.
551. Heart Mountain Oil 1 Fox; 30-7N-21W. *AmStrat.
552. Brinkerhoff Drlg. 1 Whaley; 22-7N-22W. *Nebraska Geol. Surv.
553. Panhandle Eastern Pipeline 1-13 Oldenburg; 13-7N-25W. *Nebraska Geol. Surv.
554. L. C. Knight 1 Nickerson; 29-7N-26W. *Nebraska Geol. Surv.
555. W. P. Simmons Oil 1 Jorgensen; 3-7N-28W. *Nebraska Geol. Surv.
556. Tipps Drlg. 1 Schultz; 7-7N-29W. *AmStrat.
557. Tipps Drlg. 1 Prindle; 15-7N-30W. *AmStrat.
558. R. Kirk-Rockhill 1 Beebe; 20-7N-31W. *AmStrat.
559. S. G. Harrison 1 Wilson; 17-7N-32W. *Nebraska Geol. Surv.
560. Mound Co. 1 Lawson; 21-7N-33W. *Nebraska Geol. Surv.
561. Plains Explor. 1 Cochran; 32-7N-34W. *Nebraska Geol. Surv.
562. W. C. Poole III and Mast Drlg. 1 Voda; 3-7N-35W. *Nebraska Geol. Surv.

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563. Prize and Kee Pet. 1 Fanning; 26-7N-36W. *Nebraska Geol. Surv.
    F. W. Gage 1 Maddux; 15-7N-37W. *Nebraska Geol. Surv.
565. W. F. Newton 1 Raker; 12-7N-38W. *Nebraska Geol. Surv.
566. Huber 1 Colson; 10-7N-41W. *AmStrat.
567. W. F. Newton 1 Mathews; 10-6N-39W. *Nebraska Geol. Surv.
    W. F. Newton 1 Teply; 24-6N-39W. *Nebraska Geol. Surv.
568. Carter 1 Smith; 9-6N-37W. *AmStrat.
    Brinkerhoff 1 Fanning; 12-6N-37W. *AmStrat.
569. Bedrock Oil & Gas 1 Irvine; 23-6N-35W. *Nebraska Geol. Surv.
570. Plains Explor. 1 Fortkamp; 21-6N-33W. *Nebraska Geol. Surv.
571. Mast Drlg. 1 State; 36-6N-32W. *Nebraska Geol. Surv.
    M. W. Volentine and Murfin Drlg. 1 Broz; 20-6N-31W. *Nebraska Geol. Surv.
572. Blair & Assoc. and Murfin Drlg. 1 Zimmer; 33-6N-30W. AmStrat.
    Excelsior and M. W. Volentine 3 Ruppert Est.; 2-6N-30W. *Nebraska Geol. Surv.
573. M. W. Volentine 1 Peterson; 2-6N-29W. *Nebraska Geol. Surv.
574. Murfin Drlg. and Rains-Williamson 1 Brush; 20-6N-28W. *Nebraska Geol. Surv.
575. Miami Pet. 1E Druse; 14-6N-26W. *Nebraska Geol. Surv.
576. Murfin Drlg. and Lewis & Jones 1 Farr; 34-6N-25W. *AmStrat.
    Shell 1 Sayer; 17-6N-25W. *Nebraska Geol. Surv.
577. Murfin Drlg. and Lewis & Jones 1 Romatzke; 5-6N-24W. *Nebraska Geol. Surv.
578. M. W. Volentine 1 Moeller; 17-6N-23W. *Nebraska Geol. Surv.
579. Allardyce Pet. 1 Tootle-Johnson; 26-6N-20W. *Nebraska Geol. Surv.
580. Bedrock Oil & Gas 1 Blomenkamp; 8-6N-9W. *Nebraska Geol. Surv.
581. Bedrock Oil & Gas 1 McPherson; 25-6N-7E. *Nebraska Geol. Surv.
582. Bow & Arrow Oil 1 Wrightsmann; 36-6N-14E. *Nebraska Geol. Surv.
583. Gulf 1 Snyder; 34-6N-15E. *Nebraska Geol. Surv.
584. Stanolind 8 Hertz; 8-5N-12E. *Nebraska Geol. Surv.
    Phillips 1 Broady-Johnson; 10-5N-12E. *Nebraska Geol. Surv.
585. Jones Drlg. 1 Deckinger; 13-1N-16E. *Nebraska Geol. Surv.
586. Robinson and others 1 Paben; 19-5N-9E. *Nebraska Geol. Surv.
    Paben and Fisher 1 Buss; 4-4N-9E. *Nebraska Geol. Surv.
587. White and Fry 1 Parde; 14-5N-8E. *Nebraska Geol. Surv.
588. Wesley Hancock 1 Skalka; 28-5N-7W. *Nebraska Geol. Surv.
589. G. F. Atkinson 1 Meyer; 33-5N-10W. *Nebraska Geol. Surv.
590. Superior 33-5 Ehlers; 5-5N-20W. *AmStrat.
591. Murfin Drlg. 1 Huxoll; 31-5N-23W. *AmStrat.
592. Exeter and others 1 Phelps; 14-5N-25W. *AmStrat.
593. Lewis & Lewis and Jones 1 Fritzer; 25-5N-27W. *Nebraska Geol. Surv.
    Kay Oil 1 Crawford; 1-5N-27W. *Nebraska Geol. Surv.
594. Superior 31-18 Sliger; 18-5N-28W. *AmStrat.
    Murfin Drlg. and Kirk & Jones 1 Teel; 23-5N-28W. *Nebraska Geol. Surv.
595. Excelsior and others 1 Ruppert; 11-5N-30W. *AmStrat.
596. Pan American 1 Altman; 13-5N-32W. *AmStrat.
    E. F. Wakefield 1 State; 16-5N-32W. *Nebraska Geol. Surv.

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597. W. F. Newton 1 Pribbeno; 29-5N-37W. *Nebraska Geol. Surv.
598. Tennessee Gas & Trans. 1-A Nichols; 32-4N-41W. *AmStrat.
599. W. F. Newton 1 Watts; 1-4N-40W. *Nebraska Geol. Surv.
600. W. F. Newton 1 Frazier; 20-4N-38W. *Nebraska Geol. Surv.
601. Texas 1 Egle; 29-4N-35W. *Nebraska Geol. Surv.
Donnell and others 1 Keiser; 1-3N-36W. *AmStrat.
602. Lewis & Alpine Oil 1 Potthoff; 35-4N-29W. *AmStrat.
Mast Drlg. 1 Murphy; 31-4N-29W. *Nebraska Geol. Surv.
603. Kimbark and others 1 Mihm; 35-4N-28W. *AmStrat.
604. Miami Pet. 1B Rosier; 15-4N-27W. *Nebraska Geol. Surv.
605. Texaco 1 Weir; 3-4N-26W. *AmStrat.
Volentine and Murfin Drlg. 1 Beda; 16-4N-26W. *Nebraska Geol. Surv.
606. J. A. Lewis and Shannon Oil 1 Sexton; 23-4N-25W. *Nebraska Geol. Surv.
607. B. F. Allison 1 Ten Bensel; 27-4N-24W. *Nebraska Geol. Surv.
608. Beaird and McCullum 1 Kropf; 1-4N-23W. *Nebraska Geol. Surv.
609. Sharples Oil 1 Chapman; 1-4N-22W. *Nebraska Geol. Surv.
610. Miami Pet. 1 Fletcher; 11-4N-21W. *Nebraska Geol. Surv.
611. Mercury Pet. 1 Lueking; 36-4N-20W. *Nebraska Geol. Surv.
612. T. W. Eason 1 Ashley; 27-4N-18W. *Nebraska Geol. Surv.
613. H. G. Kramer 1 Pullman; 24-4N-15W. *Nebraska Geol. Surv.
Foree and Fields 1 Quadhammer; 29-4N-15W. *Nebraska Geol. Surv.
614. Sunray Mid-Continent 1B State; 36-3N-38W. *Nebraska Geol. Surv.
615. Guy F. Atkinson 1 Schmidt; 20-4N-10W. *Nebraska Geol. Surv.
616. Shar-Alan Oil 1 Newman; 4-4N-5E. *Nebraska Geol. Surv.
617. Musgrove Drlg. 1 Remmers; 15-4N-8E. *Nebraska Geol. Surv.
Musgrove Drlg. 1 Andrew; 4-4N-8E. *Nebraska Geol. Surv.
618. Cities Service 1 Baum; 23-4N-10E. *Nebraska Geol. Surv.
619. Stanolind 6 Broody; 4-4N-12E. *Nebraska Geol. Surv.
620. Peters Oil 1 Wiltze; 17-3N-17E. *Nebraska Geol. Surv.
621. Phillips 3 Shubert (Lewis); 4-3N-16E. *Nebraska Geol. Surv.
622. Phillips 2 Shubert; 11-3N-15E. *Nebraska Geol. Surv.
623. O. A. Sutton 1 Schmidt; 11-3N-14E. *Nebraska Geol. Surv.
624. O. A. Sutton 1 Boomgaarn; 28-3N-13E. *Nebraska Geol. Surv.
625. Palensky and others 1 Dahike; 14-3N-12E. *Nebraska Geol. Surv.
626. Cities Service 1 Schuster; 13-3N-9E. *Nebraska Geol. Surv.
627. Henzel and Robinson 1 Henzel; 12-3N-8E. *Nebraska Geol. Surv.
Musgrove Drlg. 1 Martin; 30-3N-8E. *Nebraska Geol. Surv.
628. Carter and Bauman 1 Williams and Naiman; 33-3N-1W. *Nebraska Geol. Surv.
629. Condra, 1935, p. 9-15. B. F. Morgan 1 Albin; 26-1N-14E.
630. R. M. Hart and others 1 Flesner; 17-3N-16W. *Nebraska Geol. Surv.
631. Superior 32-29 Specht; 29-3N-19W. *Nebraska Geol. Surv.
632. Inter-Continental Oil 1 Bose; 32-3N-20W.
D. H. Peaker 1 Cowan; 24-3N-21W. *Nebraska Geol. Surv.
633. Falcon Seaboard Drlg. 1 Escher; 28-3N-22W. *Nebraska Geol. Surv.
Falcon Seaboard Drlg. 1 Gentry; 1-2N-23W. *Nebraska Geol. Surv.
634. B. F. Allison 1 Phillips; 6-3N-24W. *AmStrat.
Lewis, Lewis, and Jones 1 Warner; 10-3N-24W. *Nebraska Geol. Surv.
635. Rutledge and Kenfield 1 Noll; 6-3N-26W. *AmStrat.

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637. M. W. Volentine 1 Gettman; 33-3N-28W. *Nebraska Geol. Surv.
638. M. W. Volentine 1 Potthoff; 22-3N-29W. *Nebraska Geol. Surv.
639. Geochemical Surv. 1 Sutton; 35-3N-30W. *AmStrat.
M. P. Gilbert 1 Olson; 22-3N-30W. *Nebraska Geol. Surv.
640. Citizens Oil and Mast Drlg. 1 Perkins; 12-3N-32W. *Nebraska Geol. Surv.
641. Murfin Drlg. and Thomas Prod. 1 Baker; 18-3N-33W. *Nebraska Geol. Surv.
642. J. K. Wadley 1 State; 16-3N-35W. *Nebraska Geol. Surv.
643. E. A. Obering 1 Foster; 27-3N-36W. *AmStrat.
644. Rocky Mountain Association of Geologists, 1963, sec. A-C, log 28.
J. K. Wadley 1 Clegg; 29-3N-40W. *AmStrat.
645. Woody, Keil, & Burns 1 Huey; 17-2N-41W. *Nebraska Geol. Surv.
646. J. K. Wadley 1 Peck; 11-2N-40W. *AmStrat.
647. E. A. Obering 1 Vanderfecht; 10-2N-36W. *AmStrat.
648. Mast Drlg. 1 Morgan; 31-2N-27W. *AmStrat.
649. Murfin Drlg. 1 Hagg; 21-2N-26W. *Nebraska Geol. Surv.
Burch Drlg. 1 Nokes; 13-2N-27W. *Nebraska Geol. Surv.
Pubco Pet. 29-14 Kerst; 29-3N-26W. *AmStrat.
650. Exeter Drlg. 1 Palmer; 17-2N-25W. *AmStrat.
651. Dickenson & Larkin and Sterling Drlg. 1 Hewett; 18-2N-21W. *Nebraska Geol. Surv.
652. W. Ebke 1 Meyer; 20-2N-2E. *Nebraska Geol. Surv.
653. F. O. Hawn 1 Doyle; 3-2N-6E. *Nebraska Geol. Surv.
Shar-Alan Oil 1 Paben; 11-2N-6E. *Nebraska Geol. Surv.
654. E. A. Emal 1 Blecha; 15-2N-12E. *Nebraska Geol. Surv.
655. O. A. Sutton 1 Heim; 15-2N-14E. *Nebraska Geol. Surv.
O. A. Sutton 1 Kotouc; 24-2N-13E. *Nebraska Geol. Surv.
656. Skelly 1 Maddox; 27-2N-16E. *Nebraska Geol. Surv.
657. Cabot Corp. 1 Boose; 35-2N-17E. *Nebraska Geol. Surv.
658. Cities Service 1 Boose; 28-1N-18E. *Nebraska Geol. Surv.
659. Ferguson and Towle 1 Tiehen; 24-1N-17E. *Nebraska Geol. Surv.
660. Chieftain Pet. 1 Eilts; 29-1N-2E. *Nebraska Geol. Surv.
661. M. P. Gilbert 1 Taylor; 28-1N-9W. *Nebraska Geol. Surv.
662. W. H. Gaddis 1 Johnson; 21-1N-21W. *Nebraska Geol. Surv.
663. A. J. Hickerson 1 Orvis; 19-1N-25W. *AmStrat.
K & E Drlg. 1 Palmer; 9-1N-25W. *Nebraska Geol. Surv.
664. C. R. Bale 1 Haag; 6-1N-26W. *AmStrat.
665. Alpine and J. O. Farmer 1 Ashton; 26-1N-28W. *AmStrat.
666. M. P. Gilbert 1 Campbell; 14-1N-29W. *Nebraska Geol. Surv.
667. Volentine and Rothmeier 1 Leitner; 21-1N-30W. *Nebraska Geol. Surv.
Stickelman and Betts 1 Bobinmyer; 25-1N-31W. *Nebraska Geol. Surv.
668. D. R. Claussen 1 Roose; 29-1N-32W. *AmStrat.
Skelly 1 Reiher; 28-1N-32W. *AmStrat.
669. Rocky Mountain Association of Geologists, 1963, sec. A-C (log 29).
D. R. Claussen 1 Wagner; 29-1N-33W. *AmStrat.
670. Brack Drlg. 1 Hudson; 1-1N-34W. *Nebraska Geol. Surv.
671. Franco-Central Oil 1 Bedford; 11-1N-35W. *Nebraska Geol. Surv.
672. Obering and Dow & McHugh 1 Gottschalk; 10-1N-36W. *AmStrat.
673. James M. Cline Oil 1 Jones; 21-1N-37W. *Nebraska Geol. Surv.
674. Tipps Drlg. 1 Shrader; 11-1N-38W. *AmStrat.
675. Dow and McHugh 1 Hansen; 1-1N-39W. *AmStrat.
676. Donnell Drlg. 1 Daniels; 27-3N-41W. *Nebraska Geol. Surv.

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9. Ferguson, Muller, and Cathcart, 1954. N. line of 3N-34E, 35E.
17. Welsh, 1959, p. A206-A215. 4, 5, 9-24S-58E.
27. Ferguson, Muller, and Cathcart, 1953. 3N-37E.
29. Ferguson and Cathcart, 1954. 10N-42E.
66. Bissell, 1964, p. 570-572, 578. 17N-58E, 59E.
86. Berge, 1960, pl. 3. 16, 21-30N-69E.
Slade, 1961, p. 55-92. 21-30N-69E.
93. Longwell and Dunbar, 1936, p. 1198-1207. SW¼ 19S-56E.
116. Bissell, 1964, p. 580, sec. 14. 33N-53E.
117. Riva, 1957, pls. 1, 2. 29-22N-55E.
118. Bissell, 1964, p. 582, sec. 28. 17-23N-55E.
127. Bissell, 1964, p. 582, sec. 25. 26N, 27N-63E.
Steele, 1959, p. 62-63. 1, 12-26N-63E.
130. Barr, 1957, p. 74-82.
Langenheim and others, 1960, 36-15N-62E.
Coogan, 1964, fig. 2, col. 2. 31-15N-62E.
131. Nolan, Merriam, and Williams, 1956, p. 64, fig. 1. 30, 31-18N-54E.
Bissell, 1962, p. 1092. 31-18N-54E.
132. Nolan, Merriam, and Williams, 1956, fig. 1. 21, 22-22N-52E.
136. Rich, 1956, p. 52-56. NW¼ 17N-56E.
162. Johnson and Hibbard, 1957, p. 360-363. 37° 1′N-37° 4′N, 116°10′W.
168. Robinson, 1961, p. 100-103. 34-34N-65E.
174. Dott, 1955, figs. 13, 16, 17. 11, 12-24N-54E.
182. Nahama, 1961, p. 20-23. NW¼ 15N-59E.
183. Steele, 1959, loc. 65. 21-9N-60E.
184. Rich, 1959; 1963, p. 1660. S½ 17S-57E.
185. Welsh, 1959, p. A160-A166. 2, 3-21S-57E.
189. Steele, 1959, loc. 61. 31-14N-66E.
192. Steele, 1959, loc. 62. 2-14N-68E.
230. Kellogg, 1960, p. 193. NE¼ 8N-62E.
Bissell, 1964, p. 594.
Coogan, 1964, fig. 2, col. 4. 8N-62E.
231. Nolan, Merriam, and Williams, 1956, p. 61-63, fig. 1. 1-19N-54E.
Brew, 1964, p. 275-279. 7, 8-20N-55E.
232. Lane, 1961, 5-19S-63E.
233. Dott, 1955, p. 2273. 21-20N-54E.
234. Dott, 1955, p. 2293-2301. 25, 33, 35-33N-54E.
235. Dott, 1955, figs. 13, 16, 17. 24-25N-54E.
236. Dott, 1955, fig. 18. E½ 14N-46E.
237. Fritz, 1960, p. 74-78. 26, 30-22N-62E.
238. Douglass, 1960, p. 181. 33-20N-59E.
Bissell, 1964, p. 579. 33-20N-59E.
240. Welsh, 1959, p. A13-A21. 36-14S-70E.
241. Welsh, 1959, p. A35-A42. 17-16S-66E.
242. Welsh, 1959, p. A22-A34. 35, 36-12S-67E.
243. Welsh, 1959, p. A46-A53. 29, 32-17S-66E.
244. Welsh, 1959, p. A54-A61. 24-20S-62E.
245. Welsh, 1959, p. A62-A66. 22, 23-23S-60E.
246. Welsh, 1959, p. A74-A78. 31-23S-59E.
247. Welsh, 1959, p. A85-A106. 11, 12-14S-64E.
248. Welsh, 1959, p. A107-A121. 10, 11-19S-63E.
249. Welsh, 1959, p. A122-A131. 21, 22, 27-18S-63E.
250. Welsh, 1959, p. A132-A157. 1, 2, 12, 14, 23-18S-61E.
251. Welsh, 1959, p. A194-A201. 15, 16-23S-57E.
252. Welsh, 1959, p. A179-A193. 13-22S-57E.
253. Muffler, 1964, p. 86-88.
Roberts, Hotz, Gilluly, and Ferguson, 1958, p. 2841. SE¼ 28N-49E.
254. Bortz, 1959, p. 29-30. 22-16N-49E.
255. Lehner, Tagg, Bell, and Roberts, 1961. 35-19N-49E.

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256. Lehner, Tagg, Bell, and Roberts, 1961. 9-24N-49E.
257. Gordon and Duncan, 1961, p. C233-C234. 11-29N-52E.
258. Lehner, Tagg, Bell, and Roberts, 1961. SW¼ 24N-52E.
259. Steele, 1959, loc. 21. 16, 22-37N-61E..
260. Steele, 1959, loc. 4. 2-41N-64E.
261. Steele, 1959, loc. 7. 6-42N-62E.
262. Brill, 1963, pl. 1, col. 14. 36-8N-64E.
263. Steele, 1959, loc. 17. 18-37N-66E.
264. Steele, 1959, loc. 75. 9-12N-68E.
265. Steele, 1959, loc. 8. 22-42N-61E.
266. Steele, 1959, loc. 14. 27-38N-68E.
267. Humphrey, 1960, p. 37-40. N½ 16N-58E.
268. Reso, 1960, p. 328-342, 606-612; 1963, p. 912-913.
Coogan, 1962, fig. 18. 23, 24-5S-59E.
269. Kay and Crawford, 1964, p. 442. N½ 13N-46E.
270. Greene, 1953, p. 30-34. 1-11N-48E.
271. Coogan, 1962, p. 50-53, pl. 2. 15-16S-63E.
272. Coogan, 1964, fig. 2, col. 5. 12-13S-64E.
273. Coogan, 1962, fig. 16. 33-9S-64E.
274. Coogan, 1964, fig. 2, col. 1. 32-17N-58E.
275. Roberts, 1964, p. A34. 21, 22, 27, 28-32N-44E.
276. Roberts, 1964, p. A29, A33. 3, 4-31N-43E.
277. Ferguson, Muller, and Roberts, 1952. S½ 31N-40E.
278. Brill, 1963, pl. 1, col. 13. 16, 20, 21-16N-62E.
279. Brill, 1963, figs. 3-8. 10-18S-70E.
280. Brill, 1963, figs. 3-5. 32-4N-65E.
281. Brill, 1963, figs. 3-8. 34-11S-69E.
282. Bissell, 1964, p. 580, sec. 8. 37N, 38N-65E.
283. Bissell, 1964, p. 582, sec. 2. 27N-70E.
284. Bissell, 1964, p. 583, sec. 45. W½ 12N-55E.
285. Bissell, 1964, p. 583, sec. 37. SE¼ 17N-61E.
286. Bissell, 1964, p. 573, SW¼ 28N-69E.
287. Bissell, 1964, p. 573, 575. 18-28N-70E.
288. Bissell, 1964, p. 575. SW¼ 32N-65E. Steele, 1959, loc. 34. 21, 22-32N-65E.
289. Bissell, 1964, p. 575. NE¼ 26N-63E.
290. Bissell, 1964, p. 582, col. 30, 32, 33. NE¼ 20N-60E.
291. Bissell, 1964, p. 579. 23N-59E.
292. Bissell, 1964, p. 579-580, 591. 26, 27-14N-63E.
293. Bissell, 1964, p. 581, 592, 604. 12N-65E.
294. Bissell, 1964, p. 584. 36-12N-62E.
296. Steele, 1959, loc. 27. 33-34N-54E.
297. Steele, 1959, loc. 29. 17-32N-58E.
298. Steele, 1959, loc. 39. 18-29N-58E.
299. Steele, 1959, loc. 22. 19-35N-56E.
300. Steele, 1959, loc. 45. 16, 17-17N-53E.
301. Steele, 1959, loc. 49. 14-22N-57E.
302. Steele, 1959, loc. 68. 27-4S-65E.
303. Steele, 1959, loc. 31. 16, 17-31N-62E.
304. Steele, 1959, loc. 20. 31-37N-63E.
305. Fagan, 1962; Churkin and Kay, 1967. 29, 30-42N-53E.
306. Hotz and Willden, 1964, p. 33-36. 22-39N-42E.
307. Hotz and Willden, 1964, pl. 1. 8-36N-41E.
308. Hotz and Willden, 1964, pl. 1. 17-37N-41E.
309. Hotz and Willden, 1964, p. 29, 30, pl. 1. 34-37N-41E.
310. Hotz and Willden, 1964, p. 29. 26-38N-41E.
311. Roberts, 1964, p. A34. 9-33N-39E.
312. Roberts, 1964, p. A46. 7, 18-31N-43E.
313. *R. C. Speed, Northwestern Univ., 1970. T. 5 N., R. 34 E.
314. *R. C. Speed, Northwestern Univ., 1970. T. 6 N., R. 36 E.
315. *R. C. Speed, Northwestern Univ., 1970. T. 6 N., R. 38 E.
316. *R. C. Speed, Northwestern Univ., 1970. T. 5 N., R. 39 E.
317. *R. C. Speed, Northwestern Univ., 1970. T. 11 N., R. 41 E.
318. *R. C. Speed, Northwestern Univ., 1970. T. 13 N., R. 42 E.

NEVADA—Continued

319. *F. J. Kleinhampl and J. I. Ziony, 1967, USGS. Northeastern part, T. 11 N., R. 48 E.
320. *E. H. McKee, USGS, 1972. T. 17 N., R. 43 E.
321. Stewart and McKee, 1970. Eastern part, T. 20 N., R. 41 E.
322. *J. R. MacMillan, Northwestern Univ., 1970. Sec. 33, T. 21 N., R. 41 E.
323. E. H. McKee, 1968. Sec. 32, T. 22 N., R. 48 E.
324. Stewart and McKee, 1970. Sec. 9, T. 23 N., R. 45 E.
325. Stewart and McKee, 1970. Sec. 3, T. 23 N., R. 45 E.
326. *J. H. Stewart, USGS, 1971. Sec. 3, T. 23 N., R. 43 E.
327. Stewart and McKee, 1970. Secs. 21, 22, and 31, T. 24 N., R. 44 E.
328. *J. H. Stewart, USGS, 1971. Sec. 17, T. 25 N., R. 44 E.
329. *J. H. Stewart, USGS, 1971. Sec. 19, T. 26 N., R. 44 E.
330. Stewart and McKee, 1970. Eastern part, T. 27 N., R. 40 E.
331. *J. H. Stewart, USGS, 1971. Sec. 6, T. 27 N., R. 46 E.
332. Gilluly and Gates 1965. Northern part, T. 29 N., and southern part, T. 30 N., R. 45 E.
333. Willden, 1964, pl. 1. T. 35 N., R. 41 E.
334. Stewart and McKee, 1970. T. 21 N., R. 40 E.
335. Coats, 1971. Secs. 1 and 12 (unsurveyed), T. 45 N., R. 52 E.
336. Coats, 1971. Sec. 22, T. 46 N., R. 53 E.
337. Bushnell, 1967, p. 5–8, pl. 1. Sec. 36, T. 45 N., R. 55 E.
338. *F. J. Kleinhampl and J. I. Ziony, USGS, 1972. Secs. 4 and 11, T. 9 N., R. 42 E.
339. *Roger Hope, USGS, 1969. Sec. 34 (not surveyed), T. 41 N., R. 68 E., and Sec. 3, T. 40 N., R. 68 E.
340. *Roger Hope, USGS, 1968. Sec. 2, T. 32 N., R. 63 E., and Sec. 10, T. 31 N., R. 63 E.
341. Gardner, 1968. Sec. 27, T. 43 N., R. 60 E.
343. Riva, 1970, p. 2699–2700; fig. 4.

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21. Darton, 1922, p. 265. 13N–10E.
70. Stanolind 13 U.S. Gov't; 19–29N–16W. *DSL, 1952.
71. Texas 1-A Navajo; 34–31N–17W. *DSL, 1952.
72. Phillips 1 Navajo; 5–30N–17W. *DSL, 1952.
73. Continental 1 S. Dulce; 6–28N–2W. *DSL.
74. Derby Drlg. 1 Jicarilla Apache; 33–28N–1E. *New Mexico BMMR.
77. Dillard 1 State; 2–23N–33E. *New Mexico BMMR, *TPSLS, 1952.
91. Kates and Sidwell 1A Sauble; 35–27N–24E. *New Mexico BMMR.
92. Wood, Northrop, and Griggs, 1953. 10–29N–24E.
98. Southwest Drlg. 1 Conchas Devel.; 34–17N–21E. *New Mexico BMMR.
102. Pure 2 Federal Land Bank; 6–30N–37E. *TPSLS, 1953.
114. Humble 2 Navajo "R"; 31–30N–16W. *PBSL, 1960.
115. Continental 139 Rattlesnake; 2–29N–19W. *AmStrat, 1962.
119. Southern Union 1 Navajo; 1–21N–14W. *AmStrat, 1952.
154. Pure 1 Wiggins; 13–31N–36E. *TPSLS, 1951.
156. Johnson, 1929, p. 4–9. Colfax County.
168. Wood, Northrop, and Cowan, 1946. 25–21N–1W.
174. Mitchell 1 Red Lake; 2–3N–8W. *R. W. Foster, New Mexico BMMR, 1963.
187. Humble 1 Navajo; 27–20N–20W. *AmStrat, 1948.
202. Amerada 1-LC State; 1–17S–36E. *PL, 1960.
206. Amerada 3 Phillips "A"; 31–19S–37E. *PL, 1948.
208. Stanolind 1 Fuller; 25–8N–30E. *New Mexico BMMR.
212. Gulf 1 Navajo; 28–25N–16W. *AmStrat, 1955.
216. Humble B-1 Navajo; 29–32N–20W. *AmStrat, 1956.

NEW MEXICO—Continued

217. Humble 1 Navajo "H"; 4–31N–18W. *Rinehart, 1960.
220. J. S. Abercrombie and Lloyd Hawkins "X" 1 J. L. Nappier; 22–5N–26E. *PL.
222. Gulf 1 Federal-Hinkle; 21–13S–30E. *PL.
224. Republic and Seaboard 1 White Ranch; 34–11S–29E. *R. F. Meyer, 1963.
225. Continental 1 L. T. White et al. "27"; 27–9S–28E. *PL, 1956.
228. Lawton 1 Simpson; 3–13S–37E. *PL, 1953.
229. Blackwood & Nichols Co. 1 Woodward; 24–14S–35E. *PL, 1954; *R. F. Meyer, 1963.
230. Goldston 1 Lamberth-State; 36–5S–32E. *R. F. Meyer, 1963; *PBSL, PL.
231. H. L. Brown, Jr., and Clem E. George 1 H. P. Saunders Est.; 5–8S–37E. *PL.
237. Pure 1 Pure; 31–3N–28E. *Shell Oil; TPSLS, 1953.
243. Shamrock 1 McArthur; 12–19N–21E. *TPSLS, 1953.
249. Continental 1 Shoemaker Reed; 28–17N–18E. *TPSLS, 1954.
264. Gulf 1-A Federal-Kelley; 30–26S–25E. *R. F. Meyer, 1963.
266. Quaker State 1 Zurich; 2–21N–34E. *New Mexico BMMR.
274. Hartwell and Perry 1 Monsimer; 26–12N–23E. *New Mexico BMMR.
288. Union Oil 2 Baker-State; 6–31N–33E. *New Mexico BMMR.
289. Skelly 1 Goesling; 27–3N–21W. *New Mexico BMMR. 1951–1952.
322. Hassie Hunt Tr. Est. 1 State "C"; 16–11S–31E. *PL.
328. Standard of Texas 1-1 Lillian Coll; 10–16S–31E. *Pl, 1959.
332. Pure 1 Federal "C"; 4–20S–34E. *R. F. Meyer, 1963.
343. Dane, 1948. 34–28N–2E.
394. Wood, Northrop, and Cowan, 1946. 2–19N–1E.
401. Continental 1 Bielabito; 13–30N–21W. *AmStrat.
406. Gartland 1 Drew Mathews; 8–12S–4W. *PBSL, 1952.
407. Summit Explor. 1-A Mims; 2–13S–4W. *PBSL, 1954.
408. Union Oil 1 J. W. McMillan; 9–25S–13E. *PBSL, 1946.
410. Sun 1 T. J. Pearson; 35–20S–10E. *PL; R. F. Meyer, 1963.
411. Plymouth 1 Federal; 15–20S–9E. Pray, 1961, fig. 4. *R. F. Meyer, 1963, 1966.
412. Southern Prod. 1 Cloudcroft; 5–17S–12E. *R. F. Meyer, 1963.
414. Vincent and Welch 1 Cassidy-Federal; 27–14S–27E. *PL; R. F. Meyer, 1963.
418. Standard of Texas 1 Federal-Heard; 33–6S–9E. *R. F. Meyer, 1963.
419. Barnsdall 1 State "A"; 23–8S–32E. *New Mexico BMMR; R. F. Meyer, 1963.
420. Texas Prod. 1 State; 29–17S–18E. *R. F. Meyer, 1963.
426. Union Oil and DeKalb Agr. Assoc. 1 State; 27–11S–27E. *T. F. Stipp, USGS.
440. Huckleberry 1 Federal; 11–2N–16W. *R. W. Foster, New Mexico BMMR.
442. Gillerman, 1958, p. 119–125.
452. Southern Union 17 Barker Dome; 27–32N–14W. *AmStrat, 1946.
454. Continental 24 Table Mesa; 4–27N–17W. *AmStrat, 1962. Continental 17 Table Mesa; 3–27N–17W. *AmStrat, 1951.
455. Humble 1D Navajo; 30–26N–19W. *AmStrat, 1957.
460. Shell 113-17 Carson Unit; 17–25N–11W. *G. O. Bachman USGS, 1959.
504. Sharples 1 Alston; 17–13S–35E. *PL, 1951; R. F. Meyer, 1963.
505. Ada 1 Coalson; 12–15S–35E. *PL, 1956.
507. Richardson and Bass 1 J. N. Fidel-Federal; 27–21S–29E. *PL, 1953.
508. Shell 1 James Ranch Unit; 36–22S–30E. *PL, 1958.
509. El Paso Nat. Gas 1-X Welch Unit; 21–26S–27E. *R. F. Meyer, 1963.

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510. Texas Pacific Coal and Oil 1 Lane Mill; 32-15S-32E. *PL, 1953.
511. Phillips 6 Leamex; 23-17S-33E. *PL, 1956; R. F. Meyer, 1963.
514. San Juan Drlg. 1 San Juan Drlg.-State; 28-17S-28E. *PBSL, 1954.
518. Makin Drlg. 1 Boller-Kincaid-Watson; 29-16S-28E. *PL, 1954.
522. Ohio 1 Federal-Trigg; 20-13S-33E. *G. O. Bachman, USGS, 1963.
528. Magnolia 1 Burro Hills Unit; 16-21S-22E. *PL, 1948.
531. Humble 2 Huapache Unit; 23-23S-22E. *R. F. Meyer, 1963.
532. Pan American 1 Greenwood Federal Unit; 27-18S-31E. *PL, 1957; *R. F. Meyer, 1963.
534. Magnolia 1 Tres Ranchos Unit; 10-19S-23E. *PL, 1957; R. F. Meyer; 1963.
538. Richardson and Bass 1 J. F. Harrison-Federal; 12-25S-30E. *PL, 1954; R. F. Meyer, 1963.
542. Stanolind 1 State of New Mexico "AD"; 10-19S-28E. *R. F. Meyer, 1963.
543. Richardson and Bass 1 Geo. H. Cobb-Federal; 23-20S-31E. *R. F. Meyer, 1963; *G. O. Bachman, 1965.
544. El Paso Nat. Gas 1 Mescalero Ridge Unit; 21-19S-34E. *PL, 1961.
546. Union Oil 1-31 Federal-Wiggs; 31-24S-27E. *PL, 1963; *R. F. Meyer, 1963.
547. Magnolia 1 Four Lakes; 15-10S-34E. *R. F. Meyer, 1963.
554. Phillips 1 Shipp; 20-18S-37E. *PL; R. F. Meyer, 1963.
556. G-M-K Oil 1 Lowe-State; 1-9S-32E. *PL, 1960.
557. Magnolia 2 Betanbaugh "B"; 14-9S-35E. *PL, 1951; R. F. Meyer, 1963.
559. J. L. Hamon 1 Landreth-Federal; 29-10S-38E. *PL, 1955.
564. James H. Snowden and others 1 Santa Fe RR "27"; 27-11S-36E. *PL, 1953.
570. Skelly 1 West Tatum; 26-12S-35E. *PL, 1956.
571. Sinclair 1 Anderson; 17-12S-35E. *PL, 1956; *R. F. Meyer, 1963.
572. Max Pray 1 Lealan Craig; 27-12S-37E. *Rinehart, 1960.
574. Union Oil 1 Duncan; 6-13S-36E. *PL, 1957.
575. Texas 1 State "AU"; 29-14S-32E. *PL, 1951.
576. Texas 2 State "AU"; 10-14S-33E. *PL, 1954.
577. Phillips 1 Austin; 17-14S-36E. *PL, 1957.
578. Humble 1 O. A. Pearson; 2-16S-25E. *PL, 1950.
579. Bogle 1 Bogle Farms; 15-16S-26E. *PL.
584. Shell 1 State "CA"; 23-16S-36E. *PL, 1952.
587. Humble 1 State "AC"; 22-17S-35E. *R. F. Meyer, 1963.
589. Southern Union Prod. 1 Elleott Federal; 24-18S-23E. *R. F. Meyer, 1963.
590. Standard of Texas 1 J. H. Everest; 4-18S-26E. *PL, 1958; R. F. Meyer, 1963.
594. Ralph Lowe 1 Yates-Federal; 24-18S-32E. *PL, 1961.
596. Continental 1 Tonto Deep Unit; 22-18S-34E. *R. F. Meyer, 1963.
598. Sinclair 1 Charlesia-Taylor; 14-18S-38E. *PL, 1952.
599. McAlester Fuel 1-A Steve Taylor; 7-18S-39E. *PL, 1953; PBSL.
600. Stanolind 1 Lakewood Unit; 34-19S-25E. *PL, 1953; *R. F. Meyer, 1963.
604. El Paso Nat. Gas 2 Lusk Deep Unit; 18-19S-32E. *PL, 1962.
607. John M. Kelley 1 Lake McMillan Unit; 36-20S-26E. *PL, 1954; *R. F. Meyer, 1963.
609. Sunray Mid-Continent 1-Q New Mexico State; 32-19S-29E. *PL, 1960; *R. F. Meyer, 1963.
610. Sinclair 1 Mahaffey-Federal "ARC"; 14-20S-33E. *PL, 1963.
613. Continental 1 Saunderson "B-9"; 9-20S-36E. *R. F. Meyer, 1963.

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614. Continental 5-B-23 J. M. Skaggs; 23-20S-37E. *PL, 1947.
621. Continental 1 Bass-Federal; 5-22S-21E. *R. F. Meyer, 1963; PL, 1953.
624. Northern Nat. Gas Prod. 1 McKittrick Hills; 23-22S-24E. *PL, 1957.
635. Skelly 7 R. R. Sims; 3-23S-37E. *PL, 1948.
643. Sun 1 Harper-Federal; 26-25S-35E. *PBSL; PL, 1951.
647. Union Oil 1 Federal-White; 17-24S-22E. *R. F. Meyer, 1963.
651. Continental 21 Navajo; 21-32N-19W. *PI, 1960.
652. Texaco 1 Navajo-AJ; 35-32N-18W. *PI, 1964.
653. California 1 Hunav-Navajo; 1-31N-21W. *PI, 1961.
El Paso Nat. Gas 2 Bita Peak; 26-32N-21W. *AmStrat, 1956.
654. British-American 1 Navajo E; 15-31N-20W. *PI, 1961.
655. Continental 1 St. Louis, Rocky Mtn. & Pacific; 13-30N-22E. *AmStrat, 1954.
666. Amerada 1 Navajo; 24-30N-20W. *PI, 1960.
669. Amerada 1 Navajo Tract 20; 31-29N-17W. *PI, 1963.
670. El Paso Nat. Gas 50 San Juan Unit 29-5; 7-29N-5W. *PI.
672. Texaco 1-G Cruz NCT-1; 14-29N-36E. *PI, 1964.
674. Continental 1 Maxwell Land Grant; 11-28N-22E. *E. H. Baltz, Jr., USGS; *AmStrat.
680. Wood, Northrop, and Cowan 1946, p. 1, 2. 12-20N-1E.
683. Shell 41-26 Wright; 26-17N-3W. *PI, 1961.
685. Read and others, 1944, graphic sec. 20. 26-17N-11E.
687. Wood, Northrop, and Cowan 1946, strat. sec. 9. 20-16N-1E.
688. Read and others, 1944, graphic sec. 19. 9-16N-11E.
689. Read and others, 1944, graphic sec. 21. 5-16N-12E.
690. Read and others, 1944, graphic sec. 22. 7, 18-16N-13E.
691. Continental 1 Leatherwood-Reed; 15-16N-17E. *E. H. Baltz, USGS.
693. Read and others, 1944, graphic sec. 18. 1-15N-10E.
694. Read and others, 1944, strat. sec. 26. Bernal Creek.
695. Phillips 1 Leatherwood; 2-15N-18E. *New Mexico BMMR.
698. Read and others, 1944, graphic sec. 23. 14N-15E.
699. Dane and Bachman, 1965. 13N-16W.
702. Shell 1 Bluitt; 14-8S-37E. *PL.
703. Pan American 1 South Hope; 23-7S-33E. *PL, 1962.
704. Lion Oil 1 Slack-Federal; 30-6S-33E. *PL.
732. Smith, 1957, p. 72-73. 16-9N-12E.
745. Smith, 1957, p. 141. 26-8N-9E.
749. Bates and others, 1947, p. 17. 32-3N-5E.
751. Superior 28-31 Blackwell; 31-6N-11E. *TPSLS, 1954.
755. Lubar Oil 1 Gonzales; 29-12N-14E. *TPSLS, 1956.
756. Baker and Taylor 1 Smith; 15-7N-22E. *TPSLS, 1952.
757. Cities Prod. 1 Hobson; 12-1S-27E. *R. F. Meyer, 1963.
759. Frazier 1 Frazier; 12-2N-13E. *USGS, 1944.
761. Matador 1 State-Woods; 6-4N-20E. *New Mexico BMMR; PL.
762. Forty Eight Pet. 1 Greenfield; 17-9N-8E. *New Mexico BMMR, 1943.
763. Sanders 1 State; 32-10N-12E. *New Mexico BMMR.
766. Darton, 1922, p. 195-196. 30-11N-19E.
767. Miami 1 Bell Ranch; 34-15N-26E. *TPSLS, 1958.
768. Miami 1 Hoover Ranch; 14-12N-28E. *TPSLS, 1958.
772. Gardner Pet. 1 E. Kidwell; 21-6N-10E. *PBSL.
774. Tidewater 1 Best; 27-2S-29E. *R. F. Meyer, 1963.
775. Signal Oil and Gas and Makin 1 Bell-Federal; 33-3S-33E. *R. F. Meyer, 1963; PL.
776. Mid-Continent 1 Strickland; 9-4S-35E. *R. F. Meyer, 1963.
781. Skelly 1 Van Pelt; 9-28N-35E. *TPSLS, 1959.
784. Tidewater 1 Pat Boone; 7-5S-30E. *PL.
787. Shell 1 Harwood; 27-7S-35E. *R. F. Meyer, 1963; New Mexico BMMR, 1943.
789. Magnolia 1 Vallie-Whitehead; 32-6S-34E. *PBSL.
790. Magnolia 1 Jacobs-Federal; 18-8S-35E. *PL.

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791. Gulf 1 Clifford-Stevenson; 22-4S-31E. *PL; PBSL.
792. Austral 1 Sadler; 29-4S-32E. *R. F. Meyer, 1963.
793. Amerada 1 Federal "C"; 10-7S-32E. *R. F. Meyer, 1963.
795. Consolidated Gas and Equipment 2 Cash Ramey; 13-3N-32E. *PBSL.
805. Cities Service 1 Driggers; 22-11N-21E. *New Mexico BMMR; TPSLS, 1959.
807. Continental 1 Mares-Duran; 14-23N-17E. *TPSLS, 1958.
809. Sunray Mid-Continent 1 Briscoe; 31-10N-30E. *TPSLS, 1959.
817. Oil Exploration 1-X Irvin; 24-21N-36E. *TPSLS, 1957.
818. Continental 2 Federal Land Bank; 2-24N-36E. *TPSLS, 1957.
820. Trend 1 Brown; 29-32N-31E. *TPSLS, 1957.
830. Bellevue Synd. 1 McMullen; 24-5N-16E. *Stanolind, 1943.
833. Danube (Underwood) 1 Sanders; 22-14N-33E. *New Mexico BMMR.
839. Sunray 1 State "N"; 16-14N-32E. *TPSLS, 1959.
840. General Crude Oil 1-14 Wilkie; 14-10N-24E. *TPSLS, 1959.
841. General Crude Oil 1-1 State; 2-8N-23E. *TPSLS, 1958.
843. Petrol Oil 1 State; 1-6N-13E. *New Mexico BMMR, 1943.
845. Brice 1 Garland; 32-7N-7E. *New Mexico BMMR, 1948.
853. Miami 1-A Hoover Ranch "C"; 2-10N-27E. *TPSLS, 1960.
854. Miami Pet. 2 Hoover Ranch; 18-12N-29E. *TPSLS, 1958.
855. Miami Pet. 2 Bell Ranch; 12-14N-27E. *TPSLS, 1959.
897. Read and others, 1944, graphic sec. 17. 22-15N-10E.
909. Stanolind 1 Picacho Unit; 10-12S-18E. *New Mexico BMMR, 1958.
911. Turner 1 Everett; 34-22S-13E. *R. F. Meyer, 1963.
914. Standard of Texas 1 Scarp Unit; 18-21S-18E. *R. F. Meyer, 1963.
915. Sun 1 Bingham-State; 23-5S-5E. *R. F. Meyer, 1963; *G. O. Bachman, USGS, 1963.
931. Kottlowski, 1960, p. 64-65; 26S-7W.
939. Intex 1-24 Magnolia-Federal; 24-7S-29E. *PL.
941. Magnolia 1 Turney-Federal; 23-14S-22E. *R. F. Meyer, 1963.
950. Lockhart 1 Lockhart; 28-4S-6E. *R. W. Foster; New Mexico BMMR, 1962.
961. Black Drlg. 1 Shildneck; 24-16S-20E. *New Mexico BMMR, 1963; PL; R. F. Meyer, 1963.
965. Sinclair 1 State 119; 17-8S-27E. *PL.
966. DeKalb and Los Nietos 1-X White; 30-9S-29E. *R. F. Meyer, 1963.
DeKalb Agr. Assoc. 1 J. P. White; 7-10S-29E. *PL.
970. Humble 1 Gibson State; 12-12S-27E. *PL.
973. Humble 1 Railroad Mtn. Unit; 8-8S-31E. *R. F. Meyer, 1963.
977. Kerr-McGee 1 State "A"; 32-13S-29E. *R. F. Meyer, 1963.
978. Kewanee Oil 1 Four Mile Unit; 26-18S-18E. *R. F. Meyer, 1963.
979. Magnolia 1 Brown; 27-14S-26E. *PL.
981. Magnolia 1 Lightcap Land Co.; 6-8S-30E. *PL.
985. Sanders 1 Federal; 25-5S-24E. *R. F. Meyer, 1963.
986. Sinclair 1 State-Chaves 129; 2-8S-27E. *R. F. Meyer, 1963.
987. Spartan 1 State "25"; 25-5S-29E. *PL, 1963.
988. Stanolind 1 Polecat Unit (1-Z State); 34-10S-31E. *USGS.
989. Gulf 1 Caprock; 34-14S-31E. *PL.
990. Westcoast Hydrocarbons, Inc., 1 Black Hills Unit-Federal; 28-17S-20E. *PL; G. O. Bachman, USGS, 1963; R. F. Meyer, 1963.
991. Richfield 1 Comanche; 13-11S-26E. *New Mexico BMMR.
992. Seaboard 1 Trigg-Federal; 18-26S-11E. *R. F. Meyer, 1963.
999. Cosden Pet. 1-A Federal; 34-10S-30E. *PL, 1959.
1005. Gulf 1 Chaves "U"; 10-18S-16E. *R. F. Meyer, 1963.
1006. Sun 1 Pinon Unit; 19-19S-17E. *R. F. Meyer, 1963.
1009. W. Stewart Boyle 1 Welch Federal; 11-9S-20E. *Rinehart, 1955.

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1012. DeKalb 1 Lewis; 13-10S-25E. *R. F. Meyer, 1963.
1014. British-American 1 Honolulu; 27-14S-29E. *PL, 1959; R. F. Meyer, 1963.
1034. Flynn, Welch, and Yates 1 Donahue Permit; 28-24S-15E. *R. F. Meyer, 1963.
1035. Turner 1 Evans; 22-24S-12E. *R. F. Meyer, 1963.
1037. Skelly 1 Goddard; 22-2S-4E. *R. F. Meyer, 1963.
1039. Acme Devel. 1 Camp; 27-7N-4W. *New Mexico BMMR, 1943.
1041. Humble 1 State "N"; 35-14S-17E. *R. F. Meyer, 1963.
1046. Stella Dysart 1 Federal; 14-14N-10W. *PI, 1959.
1056. Spanel-Heinze 1-G Santa Fe; 17-4N-5W. *R. W. Foster, New Mexico BMMR.
1057. Sun 1 Pueblo of Acoma; 2-7N-7W. *R. W. Foster, New Mexico BMMR, 1960.
1058. Spanel-Heinze 1M Santa Fe Pacific; 5-5N-7W. *R. W. Foster, New Mexico BMMR, 1959.
1059. Spanel-Heinze 1 Santa Fe Pacific-Unit "H"; 27-4N-11W. *PI, 1959; Rinehart.
1060. Coral Oil and Gas 1 Warren; 19-23S-18E. *PI, 1960.
1062. Dane and Bachman, 1965. Valencia County. Eastern Zuni Mtns.
1064. Southland Royalty 1-14 Federal Lucero; 14-6N-11W. *PI, 1960.
1068. J. P. Stewart 1 Harry Lemmons; 3-3N-12E. *New Mexico BMMR.
1069. Pure 1 Overton-Federal; 20-2N-22E. *PL.
1070. *R. F. Meyer, 1963. 23-1N-1E.
1072. Nearburg and Ingram 1 Milton; 28-1S-25E. *PL, 1960; R. F. Meyer, 1963.
1074. Nearburg and Ingram 1 Murray; 23-3S-24E. *PL, 1960.
1076. Olson 1 Noble Tr.; 18-4S-27E. *R. F. Meyer, 1963.
1077. Skelly 1 Pat Boone; 26-4S-30E. *PL, 1960.
1080. McBee Oil 1-14 Warren-Federal; 14-5S-26E. *PL, 1960; *Rinehart, 1960.
1081. Samedan 1 Chatten Ranch; 11-6S-27E. *R. F. Meyer, 1963.
1082. Lion 1 Haire; 12-6S-30E. *R. F. Meyer, 1963.
1083. Gulf 1 Elida Unit; 10-6S-32E. *R. F. Meyer, 1963.
1084. Wilpolt and Wanek, 1951. 18-6S-6E. *R. F. Meyer, 1963.
1085. *G. O. Bachman, USGS, field notes. 6-7S-6E.
1086. Magnolia 1 Brown; 6-7S-34E. *PL; *R. F. Meyer, 1951.
1087. Tennessee Gas Trans. 1 State-Sunray Mid-Continent; 16-7S-37E. *PL, 1961.
1089. *G. O. Bachman, USGS, 1962. 22-8S-5E.
1090. DeKalb 1 Duke; 14-8S-26E. *PL; R. F. Meyer, 1963.
1091. Jake L. Hamon 1 North Salisbury; 6-8S-29E. *Rinehart, 1959.
1092. *G. O. Bachman, USGS, 1960. 16-9S-6E.
1095. Lone Star 1 Warren Davis; 19-9S-37E. *PL, 1952; R. F. Meyer, 1963.
1096. Warren Pet. 1 J. E. Simmons; 7-9S-38E. *PL, 1955.
1097. Kottlowski, 1960, p. 61. Sierra County.
1098. Bachman, 1965, p. 3, col. secs.
1099. Sinclair 1 State-Chaves "180"; 31-10S-27E. *PL.
1100. British-American 1 White Ranch; 19-10S-28E. *PL.
1101. Haskins and Knickerbocker 1 Love Ranch; 4-10S-33E. *R. F. Meyer, 1963.
1102. Humble 1 W. D. Peveler; 33-10S-35E. *PL, 1962.
1103. Texas Pacific Coal and Oil 1 Cross Roads; 10-10S-36E. *PL, 1955.
1104. Union Oil 1-22 State; 22-10S-37E. *PL, 1962.
1105. Republic and Seaboard 1 White; 9-11S-28E. *R. F. Meyer, 1963.
1106. Amerada 1 State "MB"; 11-11S-32E. *PL, 1952; Rinehart.

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1107. Texas Pacific Coal and Oil 1 J. P. Collier; 10-11S-33E. *PL.
1108. Sinclair 1 State-Lea "840"; 1-11S-34E. *PL.
1109. Lawton Oil 1-A Brady M. Lowe; 25-11S-37E. *PL, 1954.
1111. Franklin, Aston, and Fair 1 Orchard Park; 22-12S-25E. *PL; R. F. Meyer, 1963.
1112. Richfield 1 White; 6-12S-29E. *New Mexico BMMR; PL.
1113. Sohio 1 Monterey-Federal; 27-12S-30E. *PL, 1959.
1114. Humble 2 S. Four Lakes; 2-12S-34E. *G. O. Bachman, USGS, 1962.
1116. Kottlowski and others, 1956, pl. 1. 12-13S-2E. *R. F. Meyer, 1963.
1117. Bachman, 1960, p. B239-B241. 13S-11E.
1118. Delta Drlg. 1 Clayton; 8-13S-25E. *Rinehart, 1962.
1119. Intex 1-11 Gulf State; 11-13S-28E. *PL, 1960.
1120. Amerada 1 State Caprock "B"; 3-13S-32E. *PL, 1962.
1121. Gulf 1 Betanbaugh; 20-13S-34E. *PL, 1956.
1125. Pan American 1 East Saunders; 12-14S-33E. *PL, 1959; R. F. Meyer, 1963.
1126. Texas Pacific Coal and Oil 1 Simmons-Schenck; 12-14S-37E. *PL, 1960.
1127. Kelley and Silver, 1952, p. 253-256. 10-15S-4W.
1128. Sunray Mid-Continent 1 Federal "M"; 23-15S-2W. *PL, 1959.
1129. Magnolia 1 Pearson; 23-15S-25E. *PL.
1130. Ken Blackford and others 1 Rudolph Roberts; 10-15S-26E. *PL.
1131. Ralph Lowe 1 Moots-Fee; 31-15S-27E. *PL, 1963.
1132. Texaco 1 Cone-Federal; 23-15S-29E. *PL, 1962.
1133. Amerada 5 State "SD"; 3-15S-33E. *PL, 1957.
1134. Hunt Tr. 1 State; 14-15S-34E. *PL, 1954.
1135. Magnolia 1 J. D. Black; 9-15S-36E. *PL, 1952.
1137. Atlantic 1-A Dickenson; 13-15S-37E. *PL, 1949.
1139. Kottlowski and others, 1956, pl. 1. 7-16S-3E.
1140. Pray, 1961, p. 70-90. Otero County.
1143. Shell 1 Henshaw Deep; 24-16S-30E. *R. F. Meyer, 1963.
1144. Continental 1 West Anderson Ranch; 6-16S-32E. *PL; R. F. Meyer, 1963.
1145. Shell 1 Williams Unit; 8-16S-34E. *PL.
1146. American Liberty 1 State; 12-16S-35E. *R. F. Meyer, 1963.
1147. Shell 1 State "CA"; 23-16S-36E. *R. F. Meyer, 1963; PL. Union Oil 1-30 George Spires; 30-16S-36E. *PL.
1148. Stanolind of Texas 1-B State 1527; 15-16S-37E. *PL.
1149. Gehrig, 1958, p. 3. 32-17S-4W.
1150. Pray, 1961, p. 76-77. 15-17S-10E.
1151. Ralph Lowe 1 Berry-Federal; 23-17S-27E. *PL, 1962.
1155. Sinclair 27 H. W. West "B"; 4-17S-31E. *PL, 1961.
1156. Buffalo Oil 25 Baish; 21-17S-32E. *PL, 1954.
1157. Socony Mobil 95 State; 26-17S-34E. *PL, 1962.
1159. Jake L. Hamon 1 Federal-Davis; 13-17S-38E. *PL, 1954.
1160. Elston, 1960. Hidalgo County.
1161. *G. O. Bachman, USGS. 19-18S-4E.
1162. Pray, 1961, p. 70-90. 13, 14-18S-10E.
1163. Gulf 1 Eddy-State "AC"; 36-18S-25E. *PL, 1957.
1164. Gulf 1 State "CI"; 25-18S-27E. *PL, 1960; R. F. Meyer, 1960.
1165. John H. Trigg 1-20 Federal-Sively-Wright; 20-18S-29E. *PL, 1960.
1168. Pray, 1961, p. 74, fig. 21. 6, 7-19S-11E.
1172. Jicha, 1954, p. 21-24. Cook Peak, 20S-9W.
1173. Standard of Texas 1 Federal-Cass Ranch Unit; 3-20S-24E. *PL, 1953; R. F. Meyer, 1963.
1174. Signal Oil and Gas 1 Fred Turner, Jr.; 6-20S-38E. *PL, 1955.
1175. *R. F. Meyer, 1963. 35-21S-1W.

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1176. J. C. Williamson 1 Standard-Federal; 19-21S-23E. *PL, 1962.
1177. Phillips 1 Seven Rivers Unit; 5-21S-25E. *R. F. Meyer, 1963.
1178. Humble 1 Cedar Hills Unit; 15-21S-27E. *PL, 1962.
1180. Phillips 1 Etz; 1-21S-32E. *R. F. Meyer, 1963; *PL, 1956.
1181. Ohio 1 Ohio-Wilson State "A-24"; 24-21S-34E. *PL, 1961.
1183. Shell 10-A Argo; 22-21S-37E. *Rinehart, 1963.
1184. Sinclair 1-18 Dona Ana-Federal; 27-22S-1W. *PL, 1962.
1185. Honolulu 1 McKittrick Canyon Unit; 25-22S-25E. *PL.
1186. W. R. Weaver 1 Thompson; 9-23S-19E. *Rinehart, 1962.
1187. Sun 1 Weaver-Federal; 6-22S-23E. *PL, 1963.
1188. Humble 2 Bandana Point Unit; 2-23S-23E. *PL, 1961.
1189. Gulf 1 North Caverns Unit; 11-23S-24E. *PL, 1960; R. F. Meyer, 1963.
1190. Texaco 1 Remuda Basin; 24-23S-29E. *PL, 1961; R. F. Meyer, 1963.
1192. Coral Oil and Gas 1 Spanel; 9-24S-14E. *Rinehart, 1961.
1193. Gulf 2 Federal-Estill "AD"; 20-24S-26E. *PL, 1960.
1195. Shell 1 Shell-State "B-36"; 36-24S-36E. *PL, 1960; R. F. Meyer, 1963.
1196. Hunt 1 McMillan and Turner; 5-26S-16E. *R. F. Meyer, 1963.
1198. Skelly 1 West Jal Unit; 20-25S-36E. *PL, 1963.
1199. Gulf 10-F Arnott Ramsey; 36-25S-37E. *Rinehart, 1961.
1203. Forest Oil 1 Federal-Lowe; 7-26S-38E. *PL, 1960.
1204. Zeller, 1965, p. 33-41, 85-88, pl. 3. Big Hatchet Mtns.
1205. Humble 1 New Mexico State "BA"; 25-32S-16W. *PL, 1948.
1206. Socony Mobil 1 State "AA"; 25-10S-32E. *PL.
1207. Pan American 1 Pagosa Jicarilla; 23-32N-3W. *AmStrat.
1208. Kern County Land and Shell 1-21 Navajo; 21-29N-18W. *PI, 1963.
1209. Skelly 1 Navajo-O; 34-26N-14W. *PI, 1962.
1210. Magnolia 1A Jicarilla; 18-23N-2W. *G. O. Bachman, USGS, 1965.
1211. Wood, Northrop, and Cowan, 1946, sec. 7. 29-22N-1E.
1212. Pure 1 Coyote Canyon; 29-19N-17W. *R. W. Foster, New Mexico BMMR; G. O. Bachman, USGS.
1213. Hutchinson and Magnolia 1 Federal; 14-19N-3W. *Schlumberger, 1953.
1214. Great Western Drlg. 1 Hospah; 1-17N-9W. *R. W. Foster, New Mexico BMMR.
1215. Wood, Northrop, and Cowan, 1946, sec. 4. 17N-2E.
1216. Marshall 1 Beal-Miller; 3-15N-19W. *R. W. Foster, New Mexico BMMR, 1963.
1217. Tidewater 1 Mariano; 8-15N-13W. *R. W. Foster, New Mexico BMMR.
1218. Richfield 1 Drought-Booth; 4-15N-6W. *New Mexico BMMR.
1219. Avila Oil Co. 1 Odlum Federal; 15-15N-1W. *AmStrat, 1953.
1220. Superior 1 San Mateo; 14-14N-8W. *R. W. Foster, New Mexico BMMR.
1221. Continental 1 L-Bar; 2-13N-4W. *R. W. Foster, New Mexico BMMR.
1222. Cities Service 1 Zuni A; 5-9N-18W. *G. O. Bachman, USGS, 1963; R. W. Foster, New Mexico BMMR.
1223. Larrazolo 1 Gottlieb; 21-10N-9W. *R. W. Foster, New Mexico BMMR, 1963.
1224. King 1 Wilson Heirs; 14-7N-3W. *R. W. Foster, New Mexico BMMR, 1963.
1225. Kelley and Wood, 1946, sec. 2. 4-5N-3, 4W.
1226. Kelley and Wood, 1946, sec. 4. Gray Mesa.
1227. Kelley and Wood, 1946, sec. 1. 3N-3W.
1228. *R. F. Meyer, 1963. 28-1N-3E.
1229. *R. F. Meyer, 1963. 8-1N-4E.
1230. *R. F. Meyer, 1963. 28-1N-13E.

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1231. Katy 1 Field; 13-1N-22E. *R. F. Meyer, 1963.
1232. Smith, 1957, p. 122. 23-5N-12E.
1233. Smith, 1957, p. 122. 12-5N-11E.
1234. Smith, 1957, p. 129. 2-6N-12E.
1235. Smith, 1957, p. 137. 30-7N-12E.
1236. Sunray 1-A State-Federal; 5-8N-19E. *TPSLS, 1955.
1238. Adkins 1 Bashor; 23-12N-11E. *New Mexico BMMR, 1945.
1239. Richfield 2 Lee; 14-14N-11E. *New Mexico BMMR.
1240. *E. H. Baltz, Jr., USGS; 17N-14E.
1241. Bachman, 1953. 21N-14E.
1242. Sierra Grande Oil 1 J. J. Rogers; 4-29N-29E. *New Mexico BMMR.
1243. Wayne Freeman 1 Ferrol L. Smith; 22-29N-32E. *New Mexico BMMR.
1246. Union Oil 1 and 2 Bartlett; 23-31N-18E. *New Mexico BMMR.
1247. Kottlowski, 1960, p. 55-56. 35-2S-1E.
1248. *R. F. Meyer, 1963. 9-3S-1W.
1249. *R. F. Meyer, 1963. 28-5S-1W.
1250. Kottlowski, 1960, p. 60-61. *R. F. Meyer, 1963. 5-7S-1E.
1251. Talbert 1 Andree; 20-2S-22E. *R. F. Meyer, 1963.
1252. Transcontinental 1 McWhorter; 6-3S-22E. *R. F. Meyer, 1963; G. O. Bachman, USGS, 1963.
1253. Sun 1 Victorio Land and Cattle Co.; 25-10S-1W. *R. F. Meyer, 1963.
1254. DeKalb and Los Nietos 1 White "Y"; 30-9S-29E. *R. F. Meyer, 1963.
1257. Malco 1 Waller; 35-12S-28E. *R. F. Meyer, 1963.
1258. Texas Crude Oil 1-16 State; 34-14S-31E. *PL.
1259. Honolulu 1 Malco-Fed.; 15-14S-28E. *PL.
1260. *R. F. Meyer, 1963. 33, 35-15S-11E.
1261. Humble 1 Federal-Gorman; 30-15S-22E. *New Mexico BMMR; *G. O. Bachman, USGS, 1963; R. F. Meyer, 1963.
1262. Humble 1 Daughtry; 32-15S-36E. *PL, 1956; R. F. Meyer, 1963.
1264. *G. O. Bachman, USGS, 1961. 23-19S-4E.
1265. *G. O. Bachman, USGS, 1961. 20S-4E.
1266. *W. Seager, New Mexico Univ., 1961. 9, 10, 11-21S-8E.
1267. Otero 1 McGregor; 5-22S-10E. *R. F. Meyer, 1963.
1268. *R. F. Meyer, 1963. 26-24S-3E.
1269. *R. F. Meyer, 1963. 23-26S-9E.
1270. Continental 19 Meyer-Federal (B-4); 4-21S-36E. *PL, 1962.
1271. Penrose 2 Jones; 6-22S-38E. *R. F. Meyer, 1963.
1272. Continental 1 East Gladiola; 34-11S-38E. *Rinehart, 1960.
1274. Ohio 1 J. A. Keller Est.; 21-7S-38E. *PL, 1960.
1275. Zapata 1 Federal "14"; 14-20S-14E. *USGS, 1958, R. F. Meyer, 1963.
1276. Magnolia 1 Cox-Federal; 1-9S-36E. *PL, 1949.
1277. *R. B. O'Sullivan and R. C. Douglas, USGS, written commun., 1959. 8-12N-10W.
1278. Ernest 1 Located Land Co.; 20-25S-7E. *R. F. Meyer, 1963.

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1. Paige, 1956, p. 391-394.
2. Brewer, 1933, p. 9-10.
3. Glenn, 1903, pl. 2, sec. E.
5. Glenn, 1903, p. 984 (Olean).
6. Glenn, 1903, pl. 2, sec. A.

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5. Ajax 1 Bell; 28-158N-72W. *AmStrat.
6. Barnett 1 Gaier Bros.; 11-141N-67W. *AmStrat.
7. Hunt 1 J. Wold; 23-155N-81W. *AmStrat.

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8. Kelly and Plymouth 1 Leutz; 28-142N-89W. *AmStrat.
9. Wannette 1 Lee; 24-156N-85W. *AmStrat.
12. Stanolind 1 McLean County; 28-150N-80W. *AmStrat, 1955.
13. General Atlas 1 Ketterling; 15-131N-73W. *AmStrat, 1956.
14. Continental 1 Lueth; 27-146N-73W. *AmStrat, 1957.
15. Deep Rock Oil 1 Brusich; 8-135N-98W. *AmStrat.
20. Continental and Pure 1 McCay; 32-137N-76W. *AmStrat, 1956.
21. Evans 1 Bailey; 26-145N-62W. *AmStrat; NWGS, 1954.
23. Hunt 1 Lenertz; 17-153N-77W. *AmStrat.
31. Roeser and Pendleton 1 Weber; 35-133N-76W. *AmStrat, 1955.
36. General Atlas 1 Floyd Barthel; 15-142N-65W. *AmStrat.
42. Continental and Pure 1 Dronen; 9-140N-75W. *AmStrat, 1957.
43. Hunt Oil 1 Emma Kleven; 18-140N-80W. *AmStrat, 1956.
45. Carter 1 State; 16-143N-71W. *AmStrat, 1956.
46. Williston Oil & Gas 1 Boeckel and others; 10-144N-88W. *AmStrat, 1956; NWGS, 1954.
47. Evans 1 Erickson; 24-145N-64W. *AmStrat; NWGS, 1954.
50. Pure 1 Carr; 15-146N-66W. *AmStrat.
53. Calvert Explor. 1 State; 16-150N-67W. *AmStrat.
56. Amerada 1 George Wollan; 15-152N-96W. *AmStrat.
58. Stanolind 1 W. Waswick; 2-153N-85W. *AmStrat.
59. Carter 1 MacDiarmid; 16-154N-65W. *AmStrat.
60. Calvert and others 1 Joe Bachmeier; 23-154N-76W. *AmStrat, 1957.
62. Calvert and Don Traders 1 Payne; 34-156N-76W. *AmStrat.
68. Sohio 1 J. Nelson; 34-158N-81W. *AmStrat, 1956.
69. O. W. R. Oil and Whitson 1 Johnberg; 15-158N-93W. *AmStrat; NWGS, 1957.
71. Ellison 1 State; 16-159N-96W. *AmStrat.
86. Phillips 1 Saude; 19-158N-74W. *AmStrat.
87. General Atlas 1 Alex Peplinski; 21-142N-63W. *AmStrat.
88. Deep Rock Oil 1 H. Johnson "A"; 30-139N-86W. *AmStrat, 1956.
89. Stanolind 1 Woodrow-Star Tribal; 21-152N-94W. *AmStrat.
90. Youngblood and Youngblood 1 Kelstrom; 26-133N-83W. *AmStrat, 1956.
93. Peak Drlg. (T. & O. Oil) 1 Ohlhauser; 8-132N-78W. *AmStrat, 1956.
95. Pure 1 Gunderson; 11-160N-98W. *AmStrat.
98. Deep Rock Oil 1 Gangel "A"; 11-135N-82W. *AmStrat; NWGS, 1955.
102. Socony-Vacuum F-42-6P Dvorak; 6-141N-94W. *AmStrat; NWGS, 1954.
103. Ohio 1 Standing Rock Sioux; 29-131N-80W. *AmStrat; NWGS, 1954.
104. Socony-Vacuum F-14-24 Jacobs; 24-134N-96W. *AmStrat; NWGS, 1954.
107. Blackwood and Nichols 1 Gilman; 15-140N-105W. *AmStrat.
112. Hunt and Zach Brooks 1 State; 16-129N-104W. *AmStrat.
114. Hunt 1 Dunham; 24-155N-90W. *AmStrat.
115. W. H. Hunt 1 Newmann; 33-152N-82W. *AmStrat, 1960.
116. Hunt 1 Horne; 14-156N-92W. *AmStrat; NWGS, 1955.
117. Western Nat. Gas 1 Truax-Traer; 13-132N-102W. *AmStrat.
123. Continental 1 Duemeland; 3-140N-77W. *AmStrat, 1957.
131. Youngblood and Youngblood 1 Wachter; 3-141N-81W. *AmStrat, 1957; NWGS, 1956.
135. Zach Brooks 1 Jaugen; 11-163N-80W. *AmStrat, 1959.
139. Quintana 1 Chris Linnertz; 33-156N-83W. *AmStrat.
140. Natl. Bulk Carriers 1 Miller; 20-136N-80W. *AmStrat.
145. Calvert and Don Traders 1 Voller; 22-154N-74W. *AmStrat, 1960.

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147. Carter 1 Lockwood; 5-147N-93W. *AmStrat.
148. Phillips 1 Hoehn; 13-152N-102W. *AmStrat; NWGS, 1955.
149. Hunt 1 Anderson; 25-157N-89W. *AmStrat.
152. Wilson, Germany, and Cardinal 1 Bohnmiller; 26-145N-72W. *AmStrat.
153. Hunt 1 Waltz; 15-148N-76W. *AmStrat.
155. Hunt 1 Sauter; 32-142N-74W. *AmStrat.
158. Northwest Oil 1 Hamann; 8-141N-91W. *ÅmStrat, 1956; NWGS, 1956.
159. R. Hunt Est. 1 Soder, Inc.; 31-142N-76W. *AmStrat, 1960; NWGS, 1955.
160. Stanolind 1 Northwestern Improvement; 17-143N-100W. *AmStrat, 1956.
161. Hunt 1 Paul Ryberg; 23-140N-79W. *AmStrat, 1960.
164. Hunt 1 Guy Almy; 13-155N-82W. *AmStrat.
166. Mobil Prod. F-32-24-P Kennedy; 24-149N-93W. *AmStrat, 1955.
179. Sohio 1 Marcil; 13-163N-84W. *AmStrat.
183. Amerada 1 Clarence Iverson; 6-155N-95W. *AmStrat.
187. Sun 1 Wayne; 20-162N-69W. *AmStrat.
189. Calvert 1 Petra Stangeland; 29-162N-86W. *AmStrat, 1956.
194. Argo Oil 1 Larson; 19-144N-94W. *AmStrat, 1955.
196. Hunt 1 Schlaback-State; 36-139N-76W. *AmStrat; NWGS, 1955.
197. Hunt 1 Board of Univ. Lands; 36-144N-75W. *AmStrat.
199. Stanolind 1 Hans Creek Unit; 11-146N-91W. *AmStrat, 1956.
208. Cities Service 1 Clark; 17-145N-91W. *AmStrat.
209. Hunt 1 Bauer; 19-146N-76W. *AmStrat; NWGS, 1955.
211. Owen and Hyde 1 Hager; 6-152N-73W. *AmStrat.
214. Magnolia 1 State "A"; 36-141N-73W. *AmStrat, 1956.
216. Southern Prod. and Texota Oil 1 Wanner; 9-137N-97W. *AmStrat, 1957.
218. Hunt 1 Kudrna; 20-139N-97W. *AmStrat; NWGS, 1954.
222. Sinclair 1 Bill P. Heidecker; 23-143N-93W. *AmStrat, 1958.
223. Mobil Prod. F-22-22-1 Bird Bear; 22-149N-91W. *AmStrat, 1956.
224. Carter 1 Lewis-Allen Johnson; 9-129N-196W. *AmStrat, 1958.
226. Calvert 1 Bender; 19-130N-69W. *AmStrat.
Calvert 1-X Max Wishek; 33-130N-69W. *AmStrat.
227. J. H. Snowden and others 1 Morrison; 34-130N-103W. *AmStrat.
230. Skelly 1 Bismarck "A"; 16-135N-100W. *AmStrat, 1958.
232. Amerada 1 R. Grosz; 35-136N-93W. *AmStrat, 1958.
234. Caroline Hunt Trust 1 Nicholson; 32-137N-77W. *AmStrat, 1957; NWGS, 1956.
235. Northern Pump 1 C. Braun; 15-137N-99W. *AmStrat, 1958.
236. Northern Pump 1 Lucy Fritz; 15-137N-100W. *AmStrat, 1957; NWGS, 1957.
237. Skelly 1 Paul Stieg; 9-138N-92W. *AmStrat, 1959.
238. Texota Oil 1 J. A. Kubishta; 6-138N-95W. *AmStrat, 1958.
239. Stanolind 1 Alfred Schwartz; 34-138N-100W. *AmStrat, 1958; NWGS, 1955.
243. Pan American 1 Raymond Velter; 27-139N-90W. *AmStrat, 1958.
244. Amerada 1 Scoria Unit; 10-139N-101W. *AmStrat, 1958.
245. Shell 41-35 NPRR; 35-139N-103W. *AmStrat, 1958.
246. Leach Oil and others 1 Wm. Kalanek; 32-140N-96W. *AmStrat, 1957.
247. Skelly 1 Merrill; 33-140N-98W. *AmStrat, 1959.
248. Amerada 1 R. E. Newton; 31-140N-99W. *AmStrat, 1957; NWGS, 1957.
249. Gulf and NPRR 1 Govt.-Dorough; 24-143N-103W. *AmStrat.

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250. Hunt 1 Anton Novy; 14-144N-77W. *AmStrat, 1960; NWGS, 1955.
251. General Crude Oil 1 McElvain; 18-145N-75W. *AmStrat, 1960.
252. Hunt Oil 1 Theodore Darwin; 35-145N-96W. *AmStrat.
255. Herman Hanson 1 Ellen Samuelson; 32-146N-82W. *AmStrat, 1958.
257. Hunt 1 Matz; 1-147N-75W. *AmStrat.
259. California 1 Danielson-Bank of N. Dak.; 20-148N-97W. *AmStrat, 1957.
California 1 Rough Creek; 13-148N-98W. *AmStrat.
260. Gulf and Sun 1 Bennie Pierre-Federal; 28-148N-104W. *AmStrat, 1958.
261. Amerada 1 Bear Den Unit; 25-149N-96W. *AmStrat, 1958.
262. Texas 1 C. Lovaas; 6-150N-95W. *AmStrat, 1957.
267. Investors Oil 1 Ida and Edna Shaide; 8-151N-103W. *AmStrat, 1959.
268. Amerada 1 Lacey Norby; 1-152N-95W. *NWGS, 1956.
269. Davis Oil 1 Allen Peterson; 28-153N-86W. *AmStrat, 1959.
271. Pure 1 Reuben Esterby; 11-159N-100W. *AmStrat, 1957.
272. Texas 1 Joseph Donahue; 23-154N-100W. *AmStrat, 1959.
273. Texota Oil 1 W. F. Bauer; 27-156N-88W. *AmStrat, 1958; NWGS, 1957.
274. Williamson 1 Bernard Pederson; 6-156N-86W. *AmStrat, 1959.
275. W. H. Hunt 1 Weyrauch; 27-156N-97W. *AmStrat, 1957.
277. Hanlon Oil 1 Knudtsen; 7-157N-87W. *AmStrat; NWGS, 1957.
278. Williamson and Calvert 1 Salo; 19-157N-90W. *AmStrat, 1957.
279. Sinclair 1 Joseph Muecke; 29-140N-94W. *AmStrat.
280. Calvert Drlg. 1 Wolf; 5-149N-90W. *AmStrat, 1960.
281. Anschutz Drlg. 1 Matthews; 20-150N-94W. *AmStrat, 1960.
282. Stanolind 1 Kenneth Drags Wolf; 10-151N-94W. *AmStrat, 1959.
284. Amerada 1 Mogen; 10-153N-96W. *AmStrat, 1960.
286. Anschutz Drlg. 1 A. F. Lehman; 10-158N-91W. *AmStrat, 1959.
300. Lion Oil and Calvert 1 Wilmer; 34-164N-78W. *AmStrat, 1957.
301. Cardinal 1 Mary Koester; 36-164N-81W. *AmStrat, 1959.
302. North Central Oil 1 L. Ferguson; 33-164N-86W. *AmStrat, 1960.
303. Texota Oil 1 Wolfkenhauer; 33-164N-90W. *AmStrat, 1958.
304. J. R. Padon and Mar-Win Devel. 1 J. R. Ruppert; 34-164N-92W. *AmStrat, 1959.
305. Northwest Oil 1 Durrick Bros.; 31-164N-93W. *AmStrat.
306. Carter 1 Dallas Moore; 7-163N-102W. *AmStrat, 1959.
307. Kerr-McGee 1 Wifslad Unit; 13-163N-95W. *AmStrat.
309. Northern Pump 1 A. G. Bauer; 31-163N-88W. *AmStrat, 1957.
310. Sohio 1 Ritter; 23-163N-86W. *AmStrat, 1958.
314. Lion Oil 1 Larson; 7-163N-74W. *AmStrat, 1956.
317. Lion Oil 1 Wallace; 14-162N-76W. *AmStrat, 1956.
321. Carter and Phillips 1 Oscar Fossum; 31-162N-81W. *AmStrat, 1956.
323. L. J. Williamson 1 Nordmark; 9-162N-84W. *AmStrat, 1958.
325. Texota Oil 1 John Koch; 6-162N-89W. *AmStrat, 1959.
327. Northwest Oil 1 Ed Bunting; 5-162N-91W. *AmStrat, 1957.
328. Utah Southern 1 State; 16-162N-92W. *AmStrat, 1959.
329. Davis Oil 1 Leroy Bonsaess; 22-162N-93W. *AmStrat, 1959.
330. Phillips and Ballard 1 Phil Braathen; 29-162N-95W. *AmStrat, 1957.
331. Signal Drlg. & Explor. 1 Elmar; 11-162N-96W. *AmStrat, 1960.

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332. Dakamont Explor. 1 Jacobson; 6-162N-96W. *AmStrat, 1958.
333. Signal Drlg. & Explor. 1 Knute Unhjem; 5-162N-98W. *AmStrat, 1959.
334. Skelly 1 O. M. Olson; 33-162N-100W. *AmStrat, 1957.
335. Kerr-McGee and Argo Oil 1 Johnson Est.; 34-162N-101W. *AmStrat, 1958.
336. Signal Drlg. & Explor. 1 Joyce; 13-161N-98W. *AmStrat, 1960.
337. Calvert and others 1 Joraanstad; 26-161N-95W. *AmStrat, 1960.
338. DeKalb-Northern 1 J. Berg; 3-161N-94W. *AmStrat, 1958.
339. Wilhite and Northwest Oil 1 Rudin; 15-161N-93W. *AmStrat, 1958.
340. Vern O. Lund 1 Gullickson; 8-161N-91W. *AmStrat, 1959.
341. Calvert 1 Carl Jepson; 30-161N-90W. *AmStrat, 1958.
343. Texota Oil 1 Stefonowilz; 11-161N-89W. *AmStrat, 1957.
345. Gulf 1 Ray D. Hoke; 32-161N-84W. *AmStrat, 1959.
347. Cardinal, Great Plains, and Daufman 1 Johnson; 20-161N-78W. *AmStrat, 1959.
350. Cardinal 1 Joseph Andrieux; 2-161N-74W. *AmStrat, 1957.
355. Winona Oil 1 Anderson; 23-160N-80W. *AmStrat, 1956.
357. Carter 1 George Blowers; 20-160N-83W. *AmStrat, 1959.
358. Anschutz Drlg. 1 Lynn May; 27-160N-84W. *AmStrat; NWGS, 1957.
359. Northwest Oil 1 Roy Ladd; 13-160N-87W. *AmStrat, 1957.
360. Northern Pump 1 C. J. Johnson; 5-160N-88W. *AmStrat, 1957.
361. Pet. Corp. America and Jordan 1 Smith; 1-160N-92W. *AmStrat, 1958.
362. Pet. Corp. America 1 Jensen; 8-160N-92W. *AmStrat, 1960.
363. Stewart Pet. 1 Olson; 3-160N-94W. *AmStrat, 1959.
364. Calvert 1 M. Skarphol; 11-160N-95W. *AmStrat, 1960.
365. Hunt 1 Strombeck; 28-159N-95W. *AmStrat.
366. Calvert and others 1 State; 16-159N-94W. *AmStrat, 1957.
367. Williamson and Calvert 1 Ray Brant; 29-159N-90W. *AmStrat, 1957.
368. Anschutz Drlg. and Rudman 1 State-H. Sinclair; 32-159N-88W. *AmStrat, 1959.
370. Anschutz Drlg. 1 Amerada-Heath; 31-159N-83W. *AmStrat, 1957.
371. Winona Oil 1 Sherman Welsled; 28-159N-80W. *AmStrat, 1956.
372. Davis Oil 1 W. S. Klebe; 15-159N-76W. *AmStrat, 1957.
373. Amerada 1 Keller; 15-158N-77W. *AmStrat, 1959.
374. Davis Oil 1 P. H. Torr; 12-158N-78W. *AmStrat, 1957.
375. Anschutz Drlg. 1 Einer Christensen; 7-158N-81W. *AmStrat, 1958.
376. Explor. Drlg. and Sam Gary 1 Cryder; 22-158N-87W. *AmStrat, 1958.
377. Calvert and Williamson 1 E. Bratlien; 9-158N-92W. *AmStrat, 1957.
378. Hunt 1 Odegarrd; 21-157N-95W. *AmStrat, 1960.
379. Amerada 1 Lokken; 2-157N-94W. *AmStrat, 1960.
380. Harrison 1 Anderson and others; 21-157N-85W. *NWGS, 1955.
381. Farmers Union and others 1 Wiltse; 21-157N-80W. *AmStrat, 1956.
382. Amerada 1 P. J. Nermoe; 5-157N-78W. *AmStrat, 1959.
383. Davis Oil 1 A. Tagestad; 28-157N-75W. *AmStrat, 1960.
386. Lion Oil 1 Ed; 26-156N-77W. *AmStrat.
387. Anschutz Drlg. 1 Seck; 1-156N-82W. *AmStrat, 1959.
388. Champlin Oil & Ref. 1 Tank; 7-156N-96W. *AmStrat, 1956.
390. Natl. Bulk Carriers and others 1 Stadum; 31-154N-70W. *AmStrat, 1956.
391. Calvert Drlg. 1 Wright; 14-154N-78W. *AmStrat, 1956.
392. Amerada 1 Henry Norby; 20-153N-95W. *AmStrat, 1957.
393. Calvert Drlg. 1 Gilbert Jacobson; 30-153N-84W. *AmStrat, 1957; NWGS, 1956.
394. Cardinal and Great American 1 Bassel; 33-152N-72W. *AmStrat, 1960.
395. Texas 1 Koeser NCT-1; 35-151N-97W. *AmStrat, 1960.
396. Juniper and Brinkerhoff Drlg. 1 Alfred Elton; 2-151N-95W. *AmStrat, 1959.
398. Hunt Trust 1 Obed Larson; 32-150N-70W. *AmStrat, 1960.
399. General Crude Oil 1 State; 36-150N-74W. *AmStrat, 1957.
401. Amerada 1 H. H. Shelrik; 35-150N-97W. *AmStrat, 1958.
402. Wetch, Zac, and Disney 1 Blasky; 9-148N-62W. *AmStrat, 1960.
403. Hunt 1 Leitner; 14-148N-71W. *AmStrat.
404. Germany and Cardinal 1 L. Fallon; 22-148N-74W. *AmStrat, 1957; NWGS, 1953.
405. Amerada 1 U.S.A.-Reed; 18-148N-95W. *AmStrat, 1960.
406. Hunt 1 Thormadsgaard; 31-147N-71W. *AmStrat.
408. Cardinal 1 J. M. Anderson; 10-146N-67W. *AmStrat.
409. Calvert Drlg. 1 Zwinger; 8-146N-68W. *AmStrat, 1960.
410. Hunt 1 Pfeiffer; 16-146N-74W. *AmStrat.
411. Herman Hanson 1 N. D. Hanson; 2-146N-81W. *AmStrat, 1960.
412. Continental 1 State; 36-147N-96W. *AmStrat, 1959.
413. Shell 32-15 NPRR; 15-145N-101W. *AmStrat, 1960.
414. Continental and Pure 1 J. Miller; 30-143N-75W. *AmStrat.
415. Shell and NPRR 42-21 NPRR; 21-141N-100W. *AmStrat, 1959.
416. Signal Drlg. & Explor. 1 Paul Bueligen; 34-141N-85W. *AmStrat, 1959.
417. Tennessee Gas 1 State-Duletski; 16-139N-99W. *AmStrat, 1959.
418. Signal Drlg. & Explor. 1 Adam F. Boehm; 11-139N-82W. *AmStrat, 1959.
419. Calvert 1 Rau; 35-139N-68W. *AmStrat.
420. Calvert Explor. 1 Wanzek; 12-139N-67W. *AmStrat, 1960.
422. Skelly 1 Weigum; 25-138N-99W. *AmStrat.
423. California 1 Govt.; 20-137N-102W. *AmStrat, 1959.
424. Calvert 1 Craig; 25-136N-71W. *AmStrat, 1960.
425. Hunt and others 1 Fuller; 6-136N-73W. *AmStrat, 1960.
426. Shell 41-23A Govt. Unit; 23-130N-107W. *AmStrat, 1960.
427. Snowden and Sheehan 1 Gibson; 34-130N-63W. *AmStrat.
429. Mobil F-22-30-P Kruse; 9-134N-75W. *AmStrat, 1960.
430. Herman Hanson 1 B. A. and T. Welder; 20-133N-72W. *AmStrat, 1959.
431. Calvert, Leach, International, and Western 1 Jensen; 6-134N-71W. *NWGS, 1958.
432. Shell and NPRR 41-24-1 Brown; 24-142N-103W. *AmStrat.
433. Amerada 1 Ulven Unit; 34-156N-96W. *AmStrat.

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4. *Ohio Div. Geol. Surv.; 1, 7, 27-4N-12W.
8. Sturgeon and others, 1958, p. 413. 11-5N-12W.
   W. L. Cromwell 2 Myrtle Schwartz; 36-5N-12W. *Ohio Div. Geol. Surv.
12. Sturgeon and others, 1958, p. 488-490, 495-496.
   Montgomery Oil and Gas 1 Ora Fensterwald; 9-6N-12W.
   Yeoman and Ross 8 J. R. Winner; 28-6N-12W. *Ohio Div. Geol. Surv.
14. *Ohio Div. Geol. Surv.; 23-7N-12W. Joe Hollow Oil 25 Armadale Coal; 7-7N-12W. Ohio Fuel Gas 2 Gertrude L. Shrunk; 9-7N-12W.

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18. Stout, 1954, pt. 2, p. 19-24.
Ohio Fuel 2 C. Mendenhall; 35-8N-12W. *Ohio Div. Geol. Surv.
20. Morrow 1 L. F. Murrey; 12-6N-10W. *Ohio Div. Geol. Surv.
22. Magbee and Alkire, 1954, p. 51-52.
23. Ohio Oil 1 C. W. Edgar; 24-2N-9W. *Ohio Div. Geol. Surv.
24. *Ohio Div. Geol. Surv.; 27-3N-9W. J. T. Shearer 1 J. F. Farley; 27-3N-9W.
26. Ohio Oil 1 C. W. Edgar; 24-3N-9W. *Ohio Div. Geol. Surv.
27. G. S. Lacknott 1 J. W. Dutton; 1-4N-9W. *USGS.
30. John T. Galey 1 J. Ullman Heirs; 21-5N-7W. *USGS.
31. E. W. Cline 1 John Mills and others; 21-5N-8W. *USGS.
39. Sinclair-Prairie 1 Rosanna Hill; 25-3N-7W. *Ohio Div. Geol. Surv.
43. Pure Oil 1 J. G. Semmler; 16-2N-6W. *USGS.
44. Milton D. Schramm 1 J. F. Wagner and others; 27-3N-8W. *USGS.
46. Pleasant Ridge Oil 1 J. E. Shaffer; 15-4N-6W. *USGS.
49. Pure Oil 25 Nathaniel S. Moffatt; 21-4N-5W. *Ohio Div. Geol. Surv.
50. Robert Lewis 1 John Allen; 28-4N-5W. *USGS.
51. Lucas and Thornburn 2 M. I. Nanson; 3-6N-7W. *USGS.
54. Lucas and Thomberg 9 J. W. Bandi; 34-3N-4W. *USGS.
59. Stout, 1954, pt. 1, p. 122 (28-6N-6W), p. 254-255 (24-6N-6W).
J. Griffith 1 well; 30-6N-6W. *Ohio Div. Geol. Surv.
67. Wesley A. Moffatt 1 Feisley; 25-2N-3W. *USGS.
69. George and Charles Beck 1 G. Christman; 27-5N-6W. *USGS.
72. Mott Core Drlg. coal test; 20-7N-6W. Belmont Drlg. 1 J. McLaughlin; 26-7N-6W. *Ohio Div. Geol. Surv.
73. Republic Coal & Coke 1 W. Trach; 36-5N-5W. St. Clair Oil 1 H. W. Stidd; 6-5N-5W. *Ohio Div. Geol. Surv.
76. Borden and Creighton 1 Clarence K. Bey; 34-3N-3W. *USGS.
85. Nat. Gas of West Virginia 1 Crawford Neff; 1-6N-4W. *USGS.
89. Stout, 1954, pt. 1, p. 90 (6-7N-5W), p. 367 (23-7N-5W).
Barnesville Devel. 1 Thornberry Heirs; 33-7N-5W. *Ohio Div. Geol. Surv.
90. Stout, 1954, pt. 1, p. 193-194 (26-8N-5W), p. 232 (4-8N-5W).
St. Clair Oil 1 Gus Maistros; 9-8N-5W. *Ohio Div. Geol. Surv.
91. Stout, 1954, pt. 1, p. 103 (Captina Creek core hole), p. 372 (10-6N-5W). p. 413-414.
C. W. Paine 1 Alvin Kinney; 14-6N-5W. *Ohio Div. Geol. Surv.
92. Mott Core Drlg. coal test; 20-7N-6W. *Ohio Div. Geol. Surv.
Belmont Drlg. 1 J. McLaughlin; 26-7N-6W. *Ohio Div. Geol Surv.
93. Stout, 1954, pt. 1, p. 59-60, 188-189.
Union Gas and Oil 5 A. Smelko; 26-6N-3W. *USGS.
98. St. Clair Oil 2 John Hayes; 2-9N-5W. *USGS.
99. Stout, 1954, pt. 1, p. 351-352.
Dunn and Gillingham B-2 W. T. Caldwell; 32-8N-4W. *Ohio Div. Geol. Surv.
106. *Ohio Div. Geol. Surv.; 33-13N-4W, 14-13N-4W.
George S. Locknett 1 Frank and Helen Lafferty; 4-13N-4W.
107. J. Renkle 1 W. F. Snoderly; 14-14N-5W. *USGS.
108. *Ohio Div. Geol. Surv.; 2, 9, 19, 27-15N-6W.
109. *Ohio Div. Geol. Surv.; 24, 29-16N-7W. Magnolia Natl. Fireproofing mine; 29-16N-7W. Whitacre-Green Fireproofing mine; 36-16N-7W. East Ohio Gas and Wooster Drlg. 1 G. and C. Aston; 26-16N-7W.
111. Lamborn, 1956, p. 30 (12-10N-2W), p. 98 (1-10N-2W), p. 136 (5-10N-2W), p. 146 (18-10N-2W), p. 173 (24-10N-2W).

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Sample study log; 10N-2W. *Ohio Div. Geol. Surv.
112. Lamborn, 1956, p. 30 (4-10N-3W), p. 36 (NW part Lawrence Twp.), p. 135 (1-10N-3W), p. 143-144.
William, Emma, Charles, and Margaret Aul 1 William Aul; 20-10N-3W. *Ohio Div. Geol. Surv.
113. White, 1949, p. 290-292. 10N-4W.
118. White, 1949, p. 60, 91-92. 1, 2, 4, 8, and 33-16N-14W.
120. Read, 1878, p. 523; Hanover Twp., Ashland County.
122. Lamborn, 1930, p. 25 (4-8N-2W), p. 26 (32-8N-2W), p. 52 (35-8N-2W), p. 85 (6-8N-2W), p. 101-102, p. 223 (9-8N-2W), p. 275 (A. C. McCullough 1 well; 20-8N-2W).
123. Lamborn, 1930, p. 22-23 (12-11N-3W), p. 94 (23-11N-3W), p. 101-102, p. 145 (31-11N-3W).
George Oil & Gas 1 Emmet Williams; 32-11N-3W. *Ohio Div. Geol. Surv.
124. Lamborn, 1930, p. 24 (10, 11-12N-4W), p. 28-29.
M. F. Gerstenschlager 1 Thomas Carson; 23-12N-4W. *Ohio Div. Geol. Surv.
127. *Ohio Div. Geol. Surv., 7-15N-7W. W. M. Lytle 1 A. C. Weaver; 23-15N-7W.
132. White, 1949, p. 317-327. 1, 7, 13, 16, 19, 23, 25-9N-5W.
Ohio Fuel Gas 1 Hushbarger; 4-9N-5W. *Ohio Div. Geol. Surv.
134. White, 1949, p. 64-66, 305-314. 9N-7W.
136. White, 1949, p. 297-301. 9N-9W.
138. Lamborn, 1930, p. 26 (5-7N-2W), p. 146 (13-7N-2W), p. 190 (21-7N-2W), p. 278 (10 Morrow, 22-7N-2W).
140. O. Monaco farm well; 14-11N-4W. Emanuel Tedron coal test; 14-11N-4W. Cecil Sanders 1 Charles C. Cline; 2-11N-4E. *Ohio Div. Geol. Surv.
141. Condit, 1912, p. 191. 33-12N-5W.
Kiel 7 W. C. Shearer; 12-12N-5W. *Ohio Div. Geol. Surv.
143. Condit, 1912, p. 192-193.
145. Lamborn, 1956, p. 91, 142 (9-8N-2W), p. 165 (14-8N-2W).
10 David Anderson; 13-8N-2W. *Ohio Div. Geol. Surv.
146. Willis Blackstone 1 James B. Shee; 8-8N-3W. *Ohio Div. Geol. Surv.
147. White, 1949, p. 333-334. 17, 21, 24, and 25-8N-4W.
Seneca Gas & Oil 1 Thayer; 16-8N-4W. *Ohio Div. Geol. Surv.
149. White, 1949, p. 335-337, 341, 343-344. 1, 4, 13-8N-6W.
151. White, 1949, p. 345-346, 351-352. 1, 4, 5, 18, 23, 24-8N-8W.
155. Samuel J. Brendel Oil & Gas 1 Michael Boltz; Lot 18, 2d quarter-7N-3W. *Ohio Div. Geol. Surv.
156. Lamborn, 1956, p. 40 (16-7N-4W), p. 51 (2-7N-4W), p. 86 (11-7N-4W), p. 103 (5-7N-4W).
158. Lamborn, 1954, p. 69, 86, 100, 112-113, 125, 154. 5, 8, 18, 22, 23-7N-6W.
159. Lamborn, 1954, p. 31, 36-38, 68, 99, 123, 166. 21, 22, 23, 25-7N-8W.
160. Lamborn, 1954, p. 31, 36-37, 38, 79, 119, 139, 154. 8, 19, 23-7N-8W.
161. Lamborn, 1954, p. 30-37, p. 32 (15-7N-9W), p. 90-91.
162. Lamborn, 1930, p. 26-27, p. 198 (28-2N-1W).
163. Lamborn, 1930, p. 29-30, p. 169 (4-6N-2W).
Test hole D-2; 32-6N-2W. *Ohio Div. Geol. Surv.
164. Lamborn, 1930, p. 101-102, p. 133 (12-9N-3W), p. 190 (33-9N-3W), p. 282-283.
165. Columbian Carbon 1 G. D. Miller; 23-10N-4W. *Ohio Div. Geol. Surv.
166. *Ohio Div. Geol. Surv.; 10, 32-11N-5W. Coal test 34 Isabella Matten; 8-11N-5W. Gaily Myers and others 1 Cora Devore; 2-11N-5W. Texas Co. 1 E. A. Mizer; 32-11N-5W.

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171. Lamborn, 1956, p. 101-102, 107, 181 (Belden Brick Co. pit), p. 185 (20-6N-2W).
C. D. Croup and others 3 A. B. Perry; 7-5N-2W. *Ohio Div. Geol. Surv.
172. S. M. Ebersbach and W. N. Blackstone 1 Paul Schwab; 1-6N-3W. *Ohio Div. Geol. Surv.
175. Lamborn, 1954, p. 100, 106, 113, 126, 143, 157-158. 1, 10, 14, 20, 24-6N-6W.
176. Lamborn, 1954, p. 47, 58, 67, 77, 98, 141, 167. 2, 8, 10, 11, 13, 20, 25-6N-7W.
177. Lamborn, 1954, p. 40, 49-50, 80-81, 94-95, 110, 122, 138, 148. 1, 3, 10, 16, 17, 19, 20, 23, 25-6N-8W.
178. Lamborn, 1954, p. 42-43, 51, 91, 133. 3, 7, 12, 21-6N-9W.
180. Lamborn, 1930, p. 30 (35-5N-2W), p. 33-34, p. 171 (8-5N-2W).
Ohio Oil 2 H. Gerke; 25-5N-2W. *Ohio Div. Geol. Surv.
181. Lamborn, 1930, p. 32-33, p. 285 (1 Runyon; 17-8N-3W).
184. Condit, 1912, p. 195. 26-11N-6W.
St. Clair Oil 1 John L. Knight; 6-11N-6W. *Ohio Div. Geol. Surv.
185. Ohio Oil 2 H. W. Blackwell; 2-12N-7W. *Ohio Div. Geol. Surv.
186. Lamborn, 1956, p. 205-206, p. 220 (3-5N-1W), p. 222 (29-5N-1W), p. 227 (20-5N-1W).
S. P. McCracken and O. D. Calbraith 1 McCracken; 17-5N-1W. *Ohio Div. Geol. Surv.
188. Lamborn, 1956, p. 38 (4-5N-3W), p. 67 (Tuscarawas County, general section), p. 100 (24-5N-3W), p. 152 (15-5N-3W), p. 193 (24-5N-3W).
Harry B. England 1 Ira Tittle; 21-5N-3W. *Ohio Div. Geol. Surv.
190. Lamborn, 1954, p. 70, 114, 127, 150, 174. 6, 15, 17-5N-5W
B. H. Miller 1 Irwin and Nettie Evans; 1-5N-5W. *Ohio Div. Geol. Surv.
192. Lamborn, 1954, p. 65, 85, 97, 108, 155, 182-183, 187. 1, 8, 13, 14, 15, 17, 19-5N-7W.
Lamborn, 1954, p. 119. Coshocton County, general sec.
South Penn Nat. Gas 1 Zebbie McVay; 18-5N-7W. *Ohio Div. Geol. Surv.
194. Lamborn, 1956, p. 40, 44, 53, 56, 62, 94-95, 104, 109-110, 120, 121, 137, 149, 184. 4, 7, 8, 16, 21, 24, 25-5N-9W.
195. *Ohio Div. Geol. Surv. 11-5N-10W.
198. Ohio Oil 2 L. B. Clark; 13-7N-3W; *USGS.
199. *Ohio Div. Geol. Surv. 16-9N-8W.
200. *Ohio Div. Geol. Surv. 6N-1W, 4.5 miles S. of Kinsman.
201. *Ohio Div. Geol. Surv. 7, 14-10N-6W. Craig Milliken coal test; 32-10N-6W.
Frank Stranger 1 B. B. Barcklay; 29-10N-6W.
202. Condit, 1912, p. 171 (11-11N-7W), p. 171-172 (13-11N-7W).
*Ohio Div. Geol. Surv. 1, 13, 18-11N-7W.
203. *Ohio Div. Geol. Surv. 16-4N-1W. Lewis Gas 1 L. E. Lewis; 14-4N-1W.
204. Ohio Div. Geol. Surv. 16-4N-2W. Monroe Oil & Gas and George Kernodle 2 C. Gillespie; 15-4N-2W. *Ohio Div. Geol. Surv.
205. Zanesville Tool and Supply 1 J. W. Lowler; 10-4N-3W. *Ohio Div. Geol. Surv.
206. Ohio Fuel Gas 2 Marsh Lumber Co.; 20-4N-4W. *Ohio Div. Geol. Surv.
207. Lamborn, 1954, p. 71, 87, 107, 130, 193. 2, 5, 11, 19, 25-4N-5W.
208. Lamborn, 1954, p. 87, 126, 179-180.
Ohio Fuel Gas 1 Cornelia Ballory; 17-4N-6W. *Ohio Div. Geol. Surv.
212. Ohio Div. Geol. Surv. 13, 14-4N-10W.

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217. Stout, 1954, pt. 1, p. 233 (20-9N-6W), p. 233-234 (31-9N-6W), p. 234 (32-9N-6W), p. 358-359.
Condit, 1912, p. 183. 9N-6W, general sec., Kirkwood Township.
Bradfield and Harobird 1 A. D. Campbell; 2-9N-6W. *Ohio Div. Geol. Surv.
219. *Ohio Div. Geol. Surv. 21-3N-1W.
D. T. Orndorff 1 Lenore Stewart; 14-3N-1W.
220. *Ohio Div. Geol. Surv. 7-3N-2W. George Jewell and others 1 Don P. Kennedy; 4-3N-2W.
221. *Ohio Div. Geol. Surv. 16, 20, 23, 33-3N-3W. George Jewell and others 1 Howard S. McCalley; 14-3N-3W.
223. Stout, 1918, p. 232-233, p. 237 (19-3N-5W).
Thomas W. Evans 12 Ona and Frank Moore; 12-3N-5W. *Ohio Div. Geol. Surv.
224. Whittmer Oil 1 C. A. Klein; 11-3N-6W. *Ohio Div. Geol. Surv.
226. Stout, 1918, p. 48, table 1 (Muskingum County, general sec.), p. 108 (12-3N-8W), p. 157 (25-3N-8W), p. 176 (13-3N-8W), p. 194 (12-3N-8W), pl. 3, column 15.
Mutual Oil and Gas 1 E. R. Johnson; Cass Township, Muskingum County. *Ohio Div. Geol. Surv.
227. Stout, 1918, table 1, p. 48 (Muskingum County, general sec.), p. 57-58, p. 100 (21-3N-9W).
228. Stout, 1954, p. 170-171, p. 235 (31-2N-1W), p. 327-328.
229. *Ohio Div. Geol. Surv. 7, 8, 13, 23-6N-9W.
230. Fuller, 1955, p. 161. SE Cuyahoga County.
231. A. J. West 9 W. S. and B. Crossby; 35-6N-4W. *USGS.
232. *Ohio Div. Geol. Surv.; 5N-1W. SE part.
233. Stout, 1954, pt. 1, p. 197 (21-8N-8W), p. 244 (1-8N-6W).
Barnesville Devel. 1 L. P. Bailey; 3-8N-6W. *Ohio Div. Geol. Surv.
234. Stout, 1954, pt. 1, p. 177-178, p. 260 (13-9N-7W).
Condit, 1912, p. 168-169.
F. Sheppard well; 12-9N-7W. Barnesville Devel. 2 Henderson; 29-9N-7W. *Ohio Div. Geol. Surv.
236. *Ohio Div. Geol. Surv. 14-2N-2W. Ohio Oil 1 Pearl Fitzgerald; 2-2N-2W.
237. Condit, 1912, p. 174. 25-2N-3W.
*Ohio Div. Geol. Surv. 25-2N-3W. George Kernodle and others 1 K. K. Dean; 1½ miles SE of Cambridge.
238. Ohio Oil 1 R. H. Marshall; 16-2N-4W. *Ohio Div. Geol. Surv.
239. Stout, 1918, p. 251. 9-2N-5W.
Chartiers Oil 1 Elbert E. Williams; 19-2N-5W. *Ohio Div. Geol. Surv.
241. Stout, 1918, p. 141 (24-2N-7W), p. 158 (4-2N-7W), p. 315 (Taylor 1 Stotts; 19-2N-7W).
Morningstar, 1922, p. 33. 4-2N-7W.
242. Stout, 1918, p. 155-156. 1-2N-8W.
Morningstar, 1922, p. 42. 20-2N-8W.
*H. R. Wanless, Illinois Univ., 1928. 20-2N-8W.
245. *Ohio Div. Geol. Surv. 22-1N-2W. B. R. Strater and others 1 Michael Sherby; 17-1N-2W.
248. Condit, 1912, p. 149. 4-1N-5W.
Oxford Oil 3 Jacob Morrison; 15-1N-5W. *Ohio Div. Geol. Surv.
249. Condit, 1912, p. 150-151.
Stout, 1918, p. 215 and 223 (5-1N-6W), p. 230, table 2 (Muskingum County, general sec.).
Ohio Fuel Gas 1 E. W. McDonald; 8-1N-6W. *Ohio Div. Geol. Surv.
251. Stout, 1918, p. 38 (5-1N-8W), p. 62-63, p. 85 (19-1N-8W), p. 126 (Muskingum County, general sec.), p. 155 (5-1N-8W), p. 175 (20-1N-8W).

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252. Stout, 1918, p. 144 (G. L. Porter mine), p. 153 (14-1N-9W), p. 179 (17-1N-9W).
Morningstar, 1922, p. 30-31. 12, 19-1N-9W.
253. Read, 1878, p. 353. 1N-1W. Hopewell Township, general sec.
Morningstar, 1922, p. 73, 75, 100. 1N-1W.
255. *John D. Winslow, USGS, 1957; 33-5N-7W.
256. Kondik 1 Thomas; 27-5N-8W. Thomas 1 Patterson; 17-5N-8W. *John D. Winslow, USGS., 1957.
258. Stout, 1954, pt. 1, p. 168 (9-8N-7W), p. 262 (16-8N-7W).
Ohio Fuel Gas 1 Israel Harris; 5-8N-7W. *Ohio Div. Geol. Surv.
259. Stout, 1954, pt. 1, p. 147 (33-8N-8W), p. 315 (34-8N-8W), p. 401 (33-8N-8W).
Ohio Fuel Gas 1 O. S. Johnson; 27-8N-8W. *Ohio Div. Geol. Surv.
260. Coal test; 7-8N-9W. *Ohio Div. Geol. Surv.
Tristate Oil and Gas 1 E. O. Bond; 29-8N-9W. *Ohio Div. Geol. Surv.
262. Stout, 1954, pt. 2, p. 97 (11-13N-11W), p. 146 (33-13N-11W).
Condit, 1912, p. 151. 6-13N-11W.
H. K. Porter 1 C. A. Richey; 29-13N-11W. *Ohio Div. Geol. Surv.
263. Ohio Fuel Gas 1 Geneva H. Young; 8-13N-12W. *Ohio Div. Geol. Surv.
266. Stout, 1918, p. 94, 151-152; 13-18N-15W.
Oxford Oil 1 J. W. Dissett; 4-18N-15W. *Ohio Div. Geol. Surv.
267. Stout, 1918, p. 174 (11-11N-13W), p. 211-212, p. 232 (18-11N-13W).
Wasson 2 Albert Morgan; 29-11N-13W. *Ohio Div. Geol. Surv.
268. Stout, 1918, p. 66, 91, and 104 (20-15N-14W), p. 116 (20, 33-15N-14W), p. 130 (34-15N-14W), p. 209 (34-15N-14W), p. 213 (14-15N-14W).
270. Flint, 1951, p. 166-167.
271. *Ohio Div. Geol. Surv. 15-4N-1W.
276. Stout, 1918, pt. 1, p. 336-337.
Condit, 1912, p. 157. Noble County, general sec.
Hope Nat. Gas well; 25-7N-8W. *Ohio Div. Geol. Surv.
277. *Ohio Div. Geol. Surv.; 24-7N-9W.
Hope Nat. Gas and E. P. Sheridan 1 Homer Guiler; 25-7N-9W.
278. Ferguson and McCulloch 1; 11-8N-10W. *Ohio Div. Geol. Surv.
282. Norling, 1958, pl. 7, columns 8053 and 8054.
Stout, 1918, p. 232. 18-10N-13W.
Ohio Fuel Gas 1 Bertha E. Mercer; 26-10N-13W. *Ohio Div. Geol. Surv.
284. Flint, 1951, p. 210-211, p. 213-214, p. 216-217.
Ohio Oil 1 Callie McDugin; 32-16N-15W. *Ohio Div. Geol. Surv.
285. Flint, 1951, p. 159-160, p. 164 (34-16N-16W), p. 206-207.
286. Andrews, 1874, p. 593-594.
287. M. D. Hart well; 17-4N-9W. Eastwood 1 Willmer; 15-4N-9W. *John D. Winslow, USGS., 1957.
289. *Ohio Div. Geol. Surv. 21-3N-3W.
290. *J. Winslow, USGS. Two drillers logs, 3N-6W.
293. H. D. Clymer 1 Francis Thompson; 26-6N-8W. *USGS.
294. Ohio Fuel Gas 1 L. Davis; 13-6N-9W. *USGS.
295. Stout, 1954, p. 287. 30-7N-10W.
Norling, 1958, fig. 11, column 6994.
John F. Morrow and Wittmer Oil and Gas 1 Margaret D. and F. Foster Dye; 30-7N-10W. *Ohio Div. Geol. Surv.
296. Stout, 1954, pt. 2, p. 6 (10-11N-11W), p. 152 (13-11N-11W), p. 241 (23-11N-11W).
Norling, 1958, fig. 9, column 7780.
Wittmer Oil and Gas 1 W. Wortman; 24-11N-11W. *Ohio Div. Geol. Surv.
298. *Ohio Div. Geol. Surv.; 1, 10, 33-9N-13W. Roy Gordon 2 Wiseman; 14-9N-13W.
299. Flint, 1951, p. 162-163, p. 178-179.
Ohio Fuel Gas 1 Clara B. Williams; 11-13N-14W. *Ohio Div. Geol. Surv.
300. Flint, 1951, p. 156-157, 200-201, 203-204.
Pettet, Kimball, and Strawn 1 R. H. and Blanche D. Denison; 9-15N-15W. *Ohio Div. Geol. Surv.
301. Flint, 1951, p. 156 (Junction City Sewer Pipe Co. pit; 3-15N-16W), p. 161-162, 198-199, 199-200, table 1 (Perry County, general sec.).
302. Kent State Univ. well; 3N-9W. *J. Winslow, USGS.
305. Great Lakes Carbon 1 Herman Pabst; 15-5N-7W. *Ohio Div. Geol. Surv.
306. *Ohio Div. Geol. Surv. 23-3N-11W.
307. *Ohio Div. Geol. Surv. 10-3N-14W.
308. Costadon Oil and Gas 19 C. B. Ogle; 12-5N-9W. *Ohio Div. Geol. Surv.
309. *Ohio Div. Geol. Surv. 6-2N-1W.
311. *Ohio Div. Geol. Surv. 24-10N-12W. G. Gordon 1 P. Massey; 24-10N-12W.
312. Stout, 1954, pt. 2, p. 17-18, 98-99.
Ohio Fuel Gas 1-A A. W. Embree; 16-9N-12W. *Ohio Div. Geol. Surv.
313. Stout, 1954, pt. 2, p. 18 (2-8N-13W), p. 207-208 (21-8N-13W).
Norling, 1958, pl. 6, column 5654.
Condit, 1912, p. 139. 20-8N-13W.
Wm. F. Pfeiffer 1 George E. Van Horn; 19-8N-13W. *Ohio Div. Geol. Surv.
316. Flint, 1951, p. 138-140, 151-152.
317. *Ohio Div. Geol. Surv. 24-15N-17W.
318. Jim Run Oil and Gas 1 J. H. Petty; 11-2N-5W. *USGS.
319. *Ohio Div. Geol. Surv. 11-2N-4W.
320. Irwin Hendershott 1 De Puy Bros.; 22-4N-7W. *USGS.
322. Southeast High School well; 17-2N-6W. R. I. Schambach well; 19-2N-6W. *John D. Winslow, USGS. 1957.
324. Stout, 1954, pt. 2, p. 243-244, 267-268.
Stone Springs Oil and Gas 2 J. W. Van Fossen; Lot 1056-9N-11W.
330. *Ohio Div. Geol. Surv. 2-1N-1W.
334. Stout, 1954, pt. 2, p. 168. 16-7N-13W.
Norling, 1958, fig. 6, column 7868.
P. T. Orndorff 2 G. M. Lowell; 1-7N-13W. *Ohio Div. Geol. Surv.
335. Sturgeon and others, 1958, p. 506-507, 512 (34-11N-14W), p. 513 (33-11N-14W).
Joseph McAlester 5 well; 3-11N-14W. *Ohio Div. Geol. Surv.
336. *Ohio Div. Geol. Surv. 34-13N-15W, 36-13N-15W, 33-13N-15W.
Preston Oil 239-1945 Sunday Creek Coal Co.; 10-13N-15W.
337. *Ohio Div. Geol. Surv. 22-13N-16W., 15-13N-16W, 6-13N-16W, 22-13N-16W.
338. *Ohio Div. Geol. Surv. 26-14N-17W.
340. H. F. McTaggart and others 3 Davis Turner; 8-3N-10W. *Ohio Div. Geol. Surv.
341. Stout, 1954, pt. 2, p. 287. 23-7N-11W.
*Ohio Div. Geol. Surv. 6-7N-11W. Wetoga Oil 1 Lydia A. Root; 13-7N-11W.
342. Sturgeon and others, 1958, p. 317-319, 337 (12-6N-13W).

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Choquill Gas 1 J. G. and Anna Hixon; 26-6N-13W. *Ohio Div. Geol. Surv.

344. Sturgeon and others, 1958, p. 558-560, 564-565, 581-583.
345. *Ohio Div. Geol. Surv. 1, 10, 29, 30, 35-12N-16W. Preston Oil 16 J. W. and E. Hamilton; 22-12N-16W.
348. *Ohio Div. Geol. Surv. 35-11N-19W.
349. Unnamed well; 29-2N-10W. *Ohio Div. Geol. Surv., sample set 577.
350. Stout, 1954, pt. 2, p. 288-289.
Old core test; 21-6N-11W. E. N. Calhoun and J. N. Williams 1 A. Z. Penrose; 29-6N-11W. *Ohio Div. Geol. Surv.
351. Sturgeon and others, 1958, p. 392-393, 400-401, 406-407.
Ross, Weimer, and Ross 1 Ann Mansfield; Fraction B, 14-6N-12W. *Ohio Div. Geol. Surv.
352. Sturgeon and others, 1958, p. 355-357, 366-367.
E. J. Omara 3 Cincinnati Min. Co.; Lot 172 near Luhrig. *Ohio Div. Geol. Surv.
353. Sturgeon and others, 1958, p. 525-527, 532 (32-11N-15W), p. 537 (25-11N-15W), p. 551-552.
S. Parks 1 Eva Lysey and Martin Knowles; 12-11N-15W. *Ohio Div. Geol. Surv.
354. Stout, 1927, p. 66-67, p. 105 (29-11N-16W), p. 176-177, p. 359-360, p. 385-386.
Unnamed well; 36-11N-16W. *Ohio Div. Geol. Surv., sample set 540.
*H. R. Wanless, Illinois Univ., 1936. 32-11N-16W.
359. Sturgeon, 1958, p. 463 (9-4N-13W), p. 467-468, p. 477-478.
A. D. Townsend 2 Arthur Konkoskia Est.; 11-4N-13W. *Ohio Div. Geol. Surv.
361. Sturgeon and others, 1958, p. 456-457, p. 460 (1-10N-15W).
Albany Gas 2 Ora Sanborn; 14-10N-15W. *Ohio Div. Geol. Surv.
362. Stout, 1927, p. 89 (Vinton Furnace shaft), p. 336-337, p. 360-361, p. 364 (6-10N-16W), p. 387 (Preston Oil 12 E. W. Strong).
364. Stout, 1927, p. 72-73, p. 78 (26-9N-18W), p. 94 (30-9N-18W), p. 116-117, p. 127 (1-9N-18W).
365. Stout, 1927, p. 67 (Vinton County, general sec.), p. 74 (35-9N-19W), p. 79 (26-9N-19W), p. 95 (26-9N-19W).
366. Stout, 1954, pt. 2, p. 83 (36-3N-13W), p. 86-87.
Ohio Fuel Gas 1 Edith W. Whaley; Fraction 18, 3N-13W, 1 mile N. of Millersburg. *Ohio Div. Geol. Surv.
367. Stout, 1954, pt. 2, p. 258. 1-7N-14W.
*Ohio Div. Geol. Surv. 8-7N-14W, 23-7N-14W. Petroleum Drlg. 1 Allie French; 8-7N-14W.
372. Stout, 1916, p. 451. 2-7N-20W.
373. O. D. Jones 1 S. Middleswart; 13-3N-11W. *Ohio Div. Geol. Surv.
374. Mammoth Prod. 1 Clifford Morris; 3-3N-12W. *Ohio Div. Geol. Surv.
375. C. N. Williams and others 2 Rose Hill Coal; 1-2N-13W. *Ohio Div. Geol. Surv.
N. Rohrkasta 1 R. T. Burdett; 22-2N-13W. *Ohio Div. Geol. Surv.
376. Stout, 1954, pt. 2, p. 110. 3-6N-14W.
Condit, 1912, p. 92. Meigs County, general sec.
*Ohio Div. Geol. Surv. 35-6N-14W. Ohio Fuel Gas 1 Frank Giles; 5-6N-14W.
378. Stout, 1927, p. 209 (24-8N-16W), p. 345-346, p. 353 (15-8N-16W), p. 356 (29-8N-16W), p. 392 (Ohio Fuel Gas 2 J. A. Newsom).
379. Stout, 1916, p. 107 (Superior Colliery coal test; 13-9N-17W), p. 168-169, p. 243 (11-9N-17W), p. 273 (2-9N-17W).

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Kewanee Oil 1 Frank C. Morrow; 29-9N-17W. *Ohio Div. Geol. Surv.

380. Stout, 1916, p. 60 (7-7N-18W), p. 101-102, p. 103-104, p. 136 (23-7N-18W), p. 145-146.
382. Stout, 1916, p. 444. 2-6N-20W.
383. Ohio Fuel Supply 1 E. J. Henderson; 24-2N-11W. *Ohio Div. Geol. Surv.
384. *Ohio Div. Geol. Surv. 16, 21, 22-5N-14W. Cady 1 Rufus W. Grover; 13-5N-14W.
385. Stout, 1916, p. 653 (33-7N-15W), p. 655 (34-7N-15W).
*Ohio Div. Geol. Surv. 3-7N-15W. Ohio Fuel Gas 3 T. Logue and others; 23-7N-15W.
386. *Ohio Div. Geol. Surv. 34-7N-16W.
Stout, 1916, p. 623 (7-7N-18W), p. 647 (18-7N-16W).
387. Stout, 1916, p. 26-28, p. 158 (8-8N-17W), p. 201 (32-8N-17W), p. 236 (28-8N-17W), p. 272 (7-7N-16W).
Edwards well; 8N-17W. *Ohio Div. Geol. Surv.
388. Stout, 1916, p. 135 (5-6N-18W), p. 163 (8-6N-18W), p. 164 (3-6N-18W), p. 200 (36-6N-18W).
Ohio Fuel Gas 2 Belle M. Buckley. *Ohio Div. Geol. Surv.
389. Stout, 1916, p. 30 (6-6N-19W), p. 79 (26-6N-19W), p. 143-144.
390. Stout, 1916, p. 449. 29-5N-20W.
391. Stout, 1916, p. 444. 19-4N-21W.
393. Jones and Laughlin Steel core; 15-4N-14W. *Ohio Div. Geol. Surv.
396. Stout, 1916, p. 197-198, p. 231 (6-7N-17W), p. 265-266.
D. W. Williams well; 2-7N-17W. *Ohio Div. Geol. Surv.
397. Stout, 1916, p. 162 (27-5N-18W), p. 162-163 (11-5N-18W), p. 229-230.
Ohio Fuel Gas 1 Myers; 27-5N-18W. *Ohio Div. Geol. Surv.
398. Stout, 1916, p. 117 (24-5N-19W), p. 143 (36-5N-19W).
399. Stout, 1916, p. 487 (13-4N-20W), p. 490-491.
400. Stout, 1916, p. 492; 22-3N-21W.
402. Condit, 1912, p. 86. 13-5N-15W.
Stout, 1916, p. 704 (Mills Station well).
403. *Ohio Div. Geol. Surv. 17-5N-16W.
Arnold Oil 1 Wendell Reese; 16-5N-16W. *Ohio Div. Geol. Surv.
405. Stout, 1916, p. 365 (36-4N-18W), p. 386 (11-4N-18W), p. 392 (1-4N-18W), p. 527 (32-4N-18W Brandt 1A core drill), p. 578 (19-4N-18W), p. 582 (5-4N-18W).
Pfeffer 1 Cambria Clay Prod.; 13-4N-18W. *Ohio Div. Geol. Surv.
408. *Ohio Div. Geol. Surv. 32, 35-2N-14W. Twenty Grand Oil and Gas 1 C. W. Baker; SE part of 2N-14W.
410. Condit, 1912, p. 87 (4-4N-16W), p. 89 (36-4N-16W).
Stout, 1916, p. 623-624 (12, west-4N-16W), p. 639 (1, west-4N-16W), p. 645 (19-4N-16W).
Ralph Bros. 1 O. Russell; 23-4N-16W. *Ohio Div. Geol. Surv.
411. Ohio Fuel Gas 1 well; 30-5N-17W. *Ohio Div. Geol. Surv.
412. Stout, 1916, p. 413 (Lawrence County, general section), p. 421 (1-3N-18W), p. 692 (Freehold Oil & Gas 1 H. Moulton; 27-3N-18W).
*H. R. Wanless, Illinois Univ., 1935. 27, 33-3N-18W.
414. Stout, 1916, p. 553-554.
417. *Ohio Div. Geol. Surv. 9-3N-15W. B. H. Putnam 1 John and Nellie McClure; 12-3N-15W.
Stout, 1916, p. 82 (29-3N-15W).
418. Condit, 1912, p. 66 (9-3N-16W), p. 67 (19-3N-16W), p. 415 (9-3N-16W).
Scott W. Wilson 3 T. Doester; 2-3N-16W. *Ohio Div. Geol. Surv.
419. Condit, 1912, p. 63 (Lawrence County, general section), p. 68 (36-4N-17W), p. 70 (33-4N-17W).

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85. Cities Service 1 Stonebreaker "Y"; 9-2N-12ECM. *TPSLS, 1953.
89. Panhandle Eastern Pipeline 2-25 Fletcher; 25-3N-17ECM. *TPSLS, 1956.
92. Cities Service 1-A Stelzer; 11-4N-14ECM. *TPSLS, 1958.
96. Panhandle Eastern Pipeline 2-2 Tucker; 2-5N-12ECM. *TPSLS, 1957.
98. Republic Nat. Gas 3 Ewing; 20-6N-14ECM. *TPSLS, 1958.
112 A. R. Jones and others 1 Johle; 6-28N-2W. *MCGS (Ellison), 1948.
123. Superior 1 Mowdy; 13-6N-5W. *W. & K., 1955.
133. Adkison and Sheldon, 1963, p. 83. 30-13N-9W.
136. Mack Oil 1 Freeman; 18-7N-17W. *W. & K., 1956.
139. Phillips 1 Oleta; 34-2N-3W. *W. & K., 1955.
Hamon 1 McGee; 24-2N-3W. *W. & K., 1954.
142. Sun 1 Christie; 28-24N-7W. *MCGS (Ellison), 1946.
144. Adkison and Sheldon, 1963, p. 26-31. 12-24N-11W.
148. Coline Oil 1 Sessums; 25-4N-10W. *W. & K., 1951.
151. Republic Nat. Gas 1 Osage; 9-24N-5E. *MCGS (DSL).
165. W. T. Sherry 1 Staggers; 4-25N-3W. *MCGS (Ellison), 1946.
176. Sun 1 Perryman; 21-3N-22W. *W.&K., 1952.
214. Union Oil 1 Hoffman; 30-29N-19W. *MCGS (DSL), 1953.
216. Adkison and Sheldon, 1963, p. 21-25. 9-28N-10W.
220. Keating Drlg. 1 Dunn; 22-28N-26W. *MCGS, 1956.
222. Cities Service 1 Lehrling; 19-28N-3W. *MCGS (AmStrat).
223. Sunray Mid-Continent 1 Vanderpool; 21-28N-23W. *MCGS (AmStrat), 1955.
226. Huber 1 Maxwell; 17-28N-12W. *MCGS, 1956.
230. Mohawk Drlg. 1 Schmaltz; 24-21N-2E. *MCGS (Ellison), 1948.
236. Davis & Wharton Drlg. 1 Bohan; 21-27N-4W. *MCGS (AmStrat).
240. Ashland Oil & Ref. 1 Albright; 31-27N-7W. *MCGS (DSL).
241. T. G. Wylie 1 Young; 18-27N-5W. *MCGS (Ellison), 1950.
255. G. W. Peel 1 Warren; 32-29N-4E. *MCGS (Ellison), 1948.
267. Sun 1 Holmes; 30-26N-24W. *MCGS (AmStrat), 1955.
270. H. S. Marston and others 1 Biggs; 8-26N-5W. *MCGS (Ellison), 1950.
275. Texas 1 Pritchard; 4-2S-4W. *W.&K., 1956.
282. George Deck and others 1 Morris; 27-25N-9W. *MCGS (DSL), 1950.
283. Jernigan and Morgan 1 Leeper; 16-25N-12W. *MCGS, 1961.
286. Shell 1-30 Munson; 30-25N-19W. *MCGS, 1959.
289. Continental 1 Manny; 8-24N-1W. *MCGS (AmStrat).
290. Republic Nat. Gas 1 Armstrong; 35-24N-2W. *MCGS (DSL).
291. Wolfe Drlg. and F. T. Haddock 1 Ensminger; 12-24N-3W. *MCGS (Ellison), 1950.
292. Derby Oil 1 Venselious; 27-25N-1E. *MCGS (Ellison), 1949.
293. Falcon Seaboard Drlg. 1 Clark; 22-24N-5W. *MCGS (DSL).
294. Champlin Oil & Ref. 1 Coburn; 33-25N-8W. *MCGS (Ellison), 1950.
295. Amerada 1 Farris; 21-24N-13W. *MCGS (AmStrat), 1955.
300. Pan American 1 Polin Unit; 34-24N-26W. *MCGS, 1961.
301. British-American 1 Rehom; 34-24N-4W. *MCGS (AmStrat).
304. Adkison and Sheldon, 1963, p. 32-37. 22-23N-10W.
318. Anderson-Prichard 1 Kroel; 2-22N-4W. *MCGS (DSL).
321. Superior 1 (27-18) Law; 18-22N-11W. *MCGS (DSL), 1951.
324. Adkison and Sheldon, 1963, p. 38-44. 27-22N-10W.
330. Adkison and Sheldon, 1963, p. 45-49. 30-21N-10W.
332. Mid-Continent 1 Lowenhaupt; 14-21N-8W. *MCGS (DSL).
338. Stephens Pet. 1 Kieser; 7-20N-3W. *MCGS (Ellison), 1946.
339. Sinclair-Prairie 1 Weber; 28-20N-4W. *MCGS (Ellison), 1945.
340. Deardorf Oil 1 Gengell; 11-20N-8W. *MCGS (Ellison), 1950.
341. Hunt and Altus 1 Munkers; 16-20N-9W. *MCGS (DSL), 1953.

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346. Barnsdall Oil (Sunray) 1 Hanan; 1-19N-24W. *MCGS (DSL), 1950.
349. Adkison and Sheldon, 1963, p. 59. 22-18N-9W.
351. Adkison and Sheldon, 1963, p. 50-53. 17-19N-10W.
355. Woods Drlg. 1 Brase; 10-19N-2W. *MCGS (DSL).
358. Allied Material and December Drlg. 1 Hobbs; 30-18N-7W. *MCGS (DSL).
359. Amerada 1 Altmanns; 23-18N-5W. *MCGS (Ellison), 1947.
360. Walter Duncan and others 1 Shircliff; 17-18N-3W. *MCGS (Ellison), 1950.
361. Eason Oil 1 Gooch; 18-17N-2W. *MCGS (Ellison), 1949.
363. Ashland Oil & Ref. 1 Adams; 29-17N-4W. *MCGS (Ellison), 1950.
364. L. C. Turner and others 1 Dodd; 6-17N-4W. *MCGS (Ellison), 1948.
371. Ashland Oil & Ref. 1 Goffney; 27-16N-2W. *MCGS (DSL).
372. Portable Drlg. 1 Dunham; 27-16N-1W. *MCGS (Ellison), 1946.
373. Eason Oil 1 School land; 16-15N-1W. *MCGS (Ellison), 1947.
374. Ptak Pet. 1 Luckinbill; 12-15N-3W. *MCGS (Ellison), 1947.
376. N. B. Hunt 1 Boyd Miller; 22-15N-16W. *MCGS (DSL), 1953.
378. Stanolind 1 Macklin; 1-13N-1W. *MCGS (Ellison), 1946.
379. F. Ptak 1 Kennard; 17-14N-1W. *MCGS (Ellison), 1947.
380. Stanolind 1 Rinehart; 30-13N-2W. *MCGS (Ellison), 1948.
381. Continental 1 Suenram; 10-13N-3W. *MCGS (Ellison), 1947.
382. Phillips and others 1 Piedmont; 2-13N-6W. *MCGS (Ellison), 1948.
383. J. E. Trigg 1 Tennery; 22-13N-7W. *MCGS (Ellison), 1945.
384. Gulf and others 1 Sprowls; 28-13N-23W. *MCGS (DSL), 1952.
385. Carter 1 Hartley; 34-14N-26W. *TPSLS, 1953.
390. Sinclair 1 Huchteman; 14-12N-7W. *MCGS (Ellison).
391. Adkison and Sheldon, 1963, p. 90. 18-11N-8W.
392. Amerada 1 Whitehead; 3-11N-1W. *MCGS (Ellison), 1948.
394. Gulf 1 B. W. Fletcher; 34-11N-16W. *MCGS (DSL), 1954.
396. Howell & Howell 1 Flynn; 27-11N-23W. *MCGS (DSL), 1952.
397. Carter 1 Garrett; 32-11N-25W. *MCGS (DSL), 1951.
404. Adkison and Sheldon, 1963, p. 97-109. 16-10N-9W.
405. Adkison and Sheldon, 1963, p. 110-117. 33-10N-10W.
412. Olson Drlg. 1 Theimer; 6-10N-5W. *MCGS (DSL).
413. Continental 1 Maruska; 16-10N-4W. *MCGS (Ellison), 1948.
415. Taylor 1 Fisher; 27-7N-25W. *MCGS (DSL).
417. Magnolia 1 Bolin; 15-7N-22W. *W.&K., 1956.
418. Eddie Fisher and others 1 Wittum; 22-29N-2W. *MCGS (Ellison), 1949.
420. Adkison and Sheldon, 1963, p. 118-128. 11-8N-12W.
421. Adkison and Sheldon, 1963, p. 77. 16-14N-9W.
426. Carter 1 State-Taylor; 31-9N-21W. *MCGS (DSL), 1951.
427. Pure 1 Bohanon; 10-9N-23W. *MCGS (DSL), 1954.
428. Deep Rock Oil 1 Scott; 22-9N-14W. *MCGS (DSL), 1951.
430. Adkison and Sheldon, 1963, p. 72. 14-15N-8W.
431. Adkison and Sheldon, 1963, p. 67. 6-16N-7W.
434. Adkison and Sheldon, 1963, p. 137-139. 24-6N-13W.
435. Adkison and Sheldon, 1963, p. 129-136. 1-6N-13W.
436. Carter 2 Galloway; 22-8N-18W. *MCGS (DSL), 1951.
440. Shell 1 Gardner; 2-8N-20W. *MCGS (AmStrat), 1951.
444. Carter 1 Hastings; 29-7N-3W. *W.&K., 1946.
447. Cities Service 1 Tah-Ko-Poodle; 17-7N-14W. *W.&K., 1957.
448. Stanolind 1 Stuckey; 5-7N-15W. *W.&K., 1952.
449. Huffman and Malloy 1 Patton; 4-7N-16W. *MCGS (AmStrat), 1954.
457. Gulf 1 Dyer; 20-6N-3W. *W.&K., 1956.
458. Plymouth Oil 1 Powell; 25-5N-1W. *W.&K., 1948.
459. Stephens Pet. 1 Big Chief; 24-5N-2W. *W.&K., 1946.
460. Weimer and Fitzhugh 1 Hanley; 5-5N-3W. *W.&K., 1956.

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462. Wrather Pet. 1 Lance; 12-5N-6W. *W.&K., 1955.
463. Frankfort Oil 1 Mutz; 24-5N-7W. *W.&K., 1955.
476. McCasland 1 Yernipcut; 11-3S-12W. *W.&K., 1946.
484. Anson Pet. 1 Ware; 30-4N-22W. *W.&K., 1952.
488. Kewanee Oil 1 Blanton; 11-3N-1W. *W.&K., 1950.
489. British-American 1 Guthrie; 7-3N-2W. *W.&K., 1946.
494. Sunray Mid-Continent, Shell, and Sinclair 1 Cline; 21-3N-10W. *W.&K., 1958.
497. Amerada 1 Moore; 8-3N-25W. *W.&K., 1957.
500. Coronado Pet. 1 Humphrey; 11-3N-2E. *W.&K., 1950.
501. C. L. Carlock 1 Nickelson; 27-3N-3E. *W.&K., 1949.
504. Amerada 1 Hale Est.; 19-2N-3E. *W.&K., 1956.
505. J. T. Hines 1 Headnor; 10-2N-2E. *W.&K.
506. Helmerich & Payne 1 Cooper; 25-2N-1E. *W.&K., 1948.
508. Carter 1 Helvey; 25-2N-2W. *W.&K., 1947.
516. Stanolind 1 Murry "A"; 33-2N-22W. *W.&K., 1952.
522. Mack Oil 1 McPherson; 14-1N-21W. *W.&K., 1955.
531. Texas Pacific C. and O. 1 Derdyn; 18-1N-3W. *W.&K.
542. California 1 Waller; 26-1S-9W. *W.&K.
544. Champion 1 Crofton; 31-1S-11W. *W.&K., 1946.
545. Continental 1 Smith; 6-2S-16W. *W.&K., 1954.
546. Mack Oil 1 Steincke; 23-1S-17W. *W.&K., 1958.
548. Sunray 1 Mock; 28-1S-20W. *W.&K., 1955.
554. Mack Oil 1 Humphreys; 34-2S-5W. *W.&K., 1951.
565. Campbell 1 Sargent; 34-2S-19W. *W.&K., 1955.
570. Fain-Porter Drlg. 1 Gray; 12-3S-3W. *W.&K., 1953.
571. Richardson 1 Byrum; 26-3S-4W. *W.&K., 1950.
575. Phillips 1 Price; 21-3S-7W. *W.&K., 1948.
583. Sinclair 1 Harris; 33-4S-1E. *W.&K., 1952.
584. Carter 1 Goddard; 20-4S-1W. *W.&K., 1954.
585. Franklin 1 Davis; 6-5S-2W. *W.&K., 1947.
586. Jocelyn Verne Oil 1 Smalley; 18-4S-3W. *W.&K., 1956.
593. Frankfort Oil 1 Montgomery; 21-4S-13W. *W.&K., 1955.
596. Falcon Seaboard Drlg. 1 McClure; 7-4S-17W. *W.&K., 1957.
598. Gibson 1 Arnold; 27-5S-1W. *W.&K., 1952.
599. Olson Drlg. 1 Murphy; 12-5S-5W. *W.&K., 1948.
600. Lario Oil & Gas 1-C Seay; 34-5S-6W. *W.&K., 1950.
601. McMillan 1 Stanley; 30-5S-8W. *W.&K., 1955.
602. Sunray 1 Suiter; 3-5S-15W. *W.&K., 1955.
605. Sun Drlg. 1 Samuels; 20-6S-5W. *W.&K., 1950.
606. Texas 1 Howard; 14-6S-4W. *W.&K., 1951.
610. Carter 1 Calleton; 30-6S-1E. *W.&K., 1948.
616. British-American 1 Brannon-Reid; 10-7S-2E. *W.&K., 1956.
617. Sinclair 1 Taylor; 33-7S-2W. *W.&K., 1951.
620. Mack Oil 1 Scheer; 35-7S-6W. *W.&K., 1954.
622. Texas 1 Jackson; 8-8S-2W. *W.&K., 1951.
623. Sun Drlg. 1 Kirby; 17-8S-6W. *W.&K., 1950.
638. Miles Jackson Drlg. 1 Haigler; 26-18N-13W. *MCGS, 1958.
654. Continental 1 Durham; 27-2N-26W. *W.&K., 1959.
655. Skelly and Tidewater 1 Baldwin; 10-9N-25W. *MCGS (Ellison), 1945.
657. Mobil 1 M. V. Weathers; 8-12N-11W. *MCGS, 1960.
665. Sinclair 1 Kunc; 11-17N-18W. *MCGS, 1956.
685. Gas and Oil Indes. 1 Hankens; 24-4N-2E. *W.&K.
688. Weimer and Fitzhugh 1 Newbern; 15-5N-2E. *W.&K., 1956.
689. Harper-Turner Oil 1 Johnston; 33-5N-3E. *W.&K.
690. Ohio 1 Housen; 14-6N-1E. *W.&K., 1952.
691. Algord 1 Petty; 19-6N-4E. *W.&K., 1947.
692. Brown 1 Witt; 6-7N-1E. *W.&K., 1955.
693. Continental 1 Rosebush; 19-8N-2E. *MCGS(Ellison), 1947.
694. J. F. Smith 1 School land; 36-8N-3E. *W.&K., 1948.
695. Gutowsky 1 Eaves; 10-10N-2E. *MCGS (Ellison), 1946.

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696. Mid-Continent 1 School land; 36-12N-4E. *MCGS (Ellison), 1947.
697. Danciger Oil & Ref. 1 Pantlick; 15-12N-5E. *MCGS(Ellison), 1946.
698. Continental 1 Dewitt; 13-13N-3E. *MCGS (Ellison), 1946.
699. Eason Oil 1 Lough; 21-14N-1E. *MCGS (DSL).
700. Anderson-Prichard 1 Cunningham; 22-14N-4E. *MCGS (Ellison), 1948.
701. Creekmore and Rooney 1 Hodges; 24-14N-5E. *MCGS (Ellison), 1946.
   Amerada 1 Tipton; 13-14N-5E. *MCGS (Ellison), 1948.
702. Gulf 1 Zimmerman; 12-28N-18W. *MCGS (DSL), 1954.
704. Birmingham & Bartlett 1 Walker; 9-16N-1E. *MCGS (Ellison), 1950.
705. J. E. Trigg 1 State; 36-18N-3E. *MCGS (Ellison), 1946.
706. Kingwood Oil 1 Downey; 22-18N-1E. *MCGS (Ellison), 1947.
707. Flynn and others 1 School land; 33-20N-2E. *MCGS (Ellison), 1949.
708. F. L. Bishop and Lynn Drlg. 1 Cress; 4-21N-1E. *MCGS (AmStrat).
709. Herndon Drlg. 1 Kelly; 24-22N-4E. *MCGS (Ellison), 1947.
710. Stanolind 1 Sanders; 17-23N-1E. *MCGS (Ellison), 1947.
711. Huber 1 Allen; 2-23N-5E. *MCGS (Ellison), 1946.
712. Arnold 1 Young; 7-23N-2E. *MCGS (Ellison), 1949.
714. Continental 1 Wolfe; 10-26N-1E. *MCGS (Ellison), 1950.
723. Magnolia 1 Love; 4-5N-2W. *W.&K., 1953.
725. Ohio 1 Anderson; 19-7N-1W. *W.&K., 1948.
726. Carter 1 Johnson; 30-8N-2W. *MCGS (DSL).
727. Livermore Drlg. 1 Giles; 35-8N-5W. *MCGS (Ellison), 1946.
728. Cities Service 1 Amberg; 5-8N-5W. *MCGS (DSL).
729. Dearing, Inc., 1 Rockstool Est.; 10-9N-1E. *MCGS (Ellison), 1947.
731. Shell 1 Wantland; 6-9N-2W. *MCGS (Ellison), 1945.
732. Sinclair-Prairie 1 White; 20-9N-3W. *MCGS (Ellison), 1948.
734. Gulf 1 Wilson; 27-10N-1E. *MCGS (Ellison), 1950.
736. Anderson-Prichard 1 Replogle; 18-11N-5W. *MCGS (Ellison).
738. Vierson & Renso 1 Beresford; 1-14N-4W. *MCGS (Ellison), 1945.
739. Falcon Seaboard Drlg. 1 Mitchell; 23-19N-7W. *MCGS (DSL).
   Jones and Pellow 1 Louise; 36-19N-7W. *MCGS.
740. Sun 1 Donahue; 11-19N-3W. *MCGS (Ellison), 1946.
741. Skelly 1 Smith; 14-19N-3E. *MCGS (Ellison), 1947.
744. Anderson-Prichard 1 Buschmeyer; 20-22N-2W. *MCGS (DSL).
746. Swanson and others 1 Sheets; 24-25N-1W. *MCGS (Ellison), 1949.
747. Calvert Drlg. 1 Herbig; 15-25N-2W. *MCGS (AmStrat).
748. Sinclair 1 Mulkey; 7-25N-4W. *MCGS (DSL).
749. Ace Gutowsky 1 Smith; 36-25N-6W. *MCGS (Ellison), 1947.
802. Sun 1 Getz; 22-1N-24ECM. *TPSLS, 1958.
805. Lynn Drlg. 1 Hendricks; 17-1N-27ECM. *TPSLS, 1953.
815. Garr-Woolley 1 Laws; 21-3N-22ECM. *TPSLS, 1954.
826. Carter 1 Dorman; 29-5N-22ECM. *TPSLS, 1952.
840. J. T. Grimmett 1 Hennigh; 11-6N-28ECM. *TPSLS, 1952.
846. Phillips 2 Edith; 29-1N-17ECM. *TPSLS, 1959.
853. Bay 1 Crauder; 17-3N-8ECM. *MCGS (DSL), 1951.
854. Cities Service 1 Ferguson "C"; 35-5N-9ECM. *TPSLS, 1953.
855. Colorado Interstate Gas 1 Whisennand; 8-5N-8ECM. *TPSLS, 1953.
856. United Carbon 1 F. T. Kelly; 2-4N-10ECM. *TPSLS, 1953.
858. Peerless Oil & Gas and Jake Hamon 1 Elmore; 28-5N-18ECM. *TPSLS, 1959.
859. Oceanic Oil 1-A Swinger; 5-5N-16ECM. *TPSLS, 1954.
860. Sun 1 Carter-Haywood; 4-1N-21ECM. *TPSLS, 1953.

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861. Deep Rock Oil 1 Shadden "A"; 25-3N-24ECM. *TPSLS, 1952.
862. Service Drlg. 1 Sizelove; 12-3N-27ECM. *TPSLS, 1954.
863. Carter and Stanolind 1 Kinnamon; 23-5N-23ECM. *TPSLS, 1953.
864. Ammeco Tool Co. 1 Davis; 17-5N-26ECM. *TPSLS, 1954.
865. Aladdin Pet. 1 Cobb; 16-6N-20ECM. *TPSLS, 1953.
866. Huber 1 Wallace; 15-6N-21ECM. *TPSLS, 1951.
867. R. E. Adams and Alpine Oil & Royalty 1 XIT Ranch; 19-6N-25ECM. *TPSLS, 1952.
868. Harbour 1 Wilson; 19-1N-9W. *W.&K., 1957.
869. Mack Oil 1 Perkins; 26-1N-19W. *W.&K., 1958.
870. Continental 1 Smith; 8-4N-11W. *W.&K., 1958.
871. Cities Service 1 Kerbo; 15-4N-24W. *W.&K., 1950.
872. Deep South 1 Cement Townsite; 3-5N-9W. *W.&K., 1952.
873. Summar 1 Mindeman; 18-5N-11W. *W.&K., 1959.
874. Texas 1 Mahsett; 26-5N-11W. *W.&K.
875. Shell 1 Phariss; 31-6N-11W. *W.&K., 1956.
876. Cities Service 1 Weidenmaier; 16-6N-12W. *W.&K., 1958.
877. Atlantic 1 Hobbs; 15-7N-11W. *W.&K., 1958.
878. Wegener 1 Bretch; 5-7N-18W. *W.&K.
880. Howell, Ellison, and others 1 Anadarko Basin; 4-9N-12W. *MCGS, 1959.
881. Rogers Fain 4 Windle; 31-9N-23W. *MCGS (DSL), 1953.
883. Magnolia 1 Troy Smith; 12-11N-11W. *MCGS, 1959.
884. Gulf 1 Burgtorf; 6-13N-15W. *MCGS, 1959.
885. Sunray Mid-Continent 1 Baker; 36-14N-13W. *MCGS, 1959.
886. Texaco 1 Ruth; 34-15N-12W. *MCGS, 1961.
887. Texaco 1 Woodruff; 4-15N-13W. *MCGS, 1960.
888. Mobil and Phillips 1 Young; 3-15N-24W. *MCGS, 1960.
889. Union Oil 1 Fortner; 25-16N-18W. *MCGS, 1960.
890. Gulf and Coyle 1 Clester; 15-18N-10W. *MCGS, 1958.
891. Clavert Drlg. 1 Addis; 29-18N-15W. *MCGS, 1959.
892. Poor Boy Oil and Shell 1 Poor Boy; 34-18N-22W. *MCGS, 1958.
893. Pan American 1 Buck Unit; 28-19N-19W. *MCGS, 1961.
894. Mobil 1 Akers; 22-19N-26W. *MCGS, 1961.
895. Pan American 1 Nichols Unit; 35-20N-12W. *MCGS, 1961.
896. Cabeen Explor. Corp. 1 Classen; 10-20N-14W. *MCGS, 1960.
897. Pan American 1 Davis Unit; 11-20N-22W. *MCGS, 1959.
898. Ashland Oil & Ref. 1 Shoreline; 34-21N-17W. *MCGS, 1959.
899. King-Stevenson 1 Adams; 26-21N-20W. *MCGS, 1959.
900. Champlin Oil & Ref. 1 Bymaster; 33-22N-9W. *MCGS, 1958.
901. Pan American 1 Hutchinson Unit "B"; 32-22N-15W. *MCGS, 1958.
902. Sunray Mid-Continent 1 Peinhardt; 16-22N-18W. *MCGS, 1960.
903. Champlin Oil & Ref. 1 McDonald; 1-22N-21W. *MCGS, 1957.
904. Pan American 1 Sutter; 19-22N-23W. *MCGS, 1958.
905. Pan American and others 1 Emerson Unit; 27-22N-25W. *MCGS, 1961.
906. Aladdin Pet. 1 Pecha; 9-23N-9W. *MCGS, 1961.
907. Amerada 1 Rexroat; 14-23N-11W. *MCGS, 1957.
908. Texoma Prod. 1 Bur. of Land; 22-24N-16W. *MCGS.
909. Pan American 1 Phillips; 15-24N-24W. *MCGS, 1959.
910. Pan American 1 Cooper Unit; 26-25N-22W. *MCGS, 1959.
911. Viersen Drlg. 1 Collins; 21-26N-11W. *MCGS, 1960.
912. Goff-Leeper 1 Bonner; 34-26N-13W. *MCGS, 1961.
913. Panhandle Devel. 1 Urban; 35-26N-17W. *MCGS, 1960.
914. Sinclair 1 Ethel Boasen; 8-26N-22W. *MCGS, 1959.
915. Apache Oil 1 Clark; 17-27N-9W. *MCGS, 1958.
916. Halliburton Oil Prod. 1 Kletke; 17-27N-15W. *MCGS, 1957.
917. Davon Drlg. 1 Nixon; 5-26N-19W. *MCGS, 1960.
918. Ohio 1 R. B. Yank; 27-28N-21W. *MCGS (AmStrat), 1954.
919. Dudley and Heath 1 Roth; 29-29N-11W. *MCGS, 1957.

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920. Bachus Oil 1 Achenback; 28-29N-14W. *MCGS, 1959.
921. Republic Nat. Gas 1 McNett; 18-29N-16W. *MCGS, 1958.
922. Sinclair 1 Browning; 26-29N-22W. *MCGS, 1958.
923. Big Chief and others 1 Painter; 22-29N-24W. *MCGS, 1958.
924. Midstates 1 Faubion; 16-1S-18W. *W.&K., 1958.
925. Mack Oil 1 Hallbusch; 25-2S-15W. *W.&K., 1958.
926. Continental 1 Kunc; 34-2S-17W. *W.&K., 1958.
927. Zephy Oil 1 Fry; 13-3S-19W. *W.&K., 1956.
928. Continental 1 Hooper; 24-4S-10W. *W.&K., 1957.
929. Pyramid Pet. 1 Polk; 13-4S-16W. *W.&K., 1957.
930. Falcon Seaboard Drlg. 1 Wilson; 16-29N-7W. *MCGS.
931. Russell Cobb, Jr., 1 Stewart; 25-29N-4W. *MCGS.
932. Boren Oil and others 1 Oklahoma School Lands; 33-29N-1W. *MCGS.
933. Union Oil 1 Stalnaker; 20-29N-2E. *Atlantic.
934. Strickler 1 Treat; 20-29N-3E. *MCGS (Ellison), 1947.
935. Devonian 1 Lohman (Osage); 28-29N-7E. *Atlantic.
936. Garr-Woolley 1 Potter; 24-29N-10E. *Atlantic.
937. Gross 1 Bacastion; 28-28N-3E. *Atlantic.
938. Texas 1 Kahle; 18-28N-2E. *Atlantic.
939. H. J. Conheim and others 1 Killian; 17-28N-5W. *MCGS (Ellison), 1949.
940. Gulf 1 Rixse; 9-28N-7W. *MCGS.
941. Jones Shelburne, Inc., and Texas Crude Oil 1 Clark; 24-27N-7W. *MCGS (AmStrat).
942. Raymond 1 Steffen; 7-27N-2W. *MCGS.
943. Texas 1 Shepherd; 24-27N-2W. *MCGS (DSL).
944. Siler 1 Whitmore; 15-27N-2E. *MCGS (Ellison), 1947.
945. Mobil and Deep Rock Oil 1 Farnsworth; 6-27N-5E. *Atlantic.
946. Kewanee Oil 1 Ross; 26-27N-6E. *Atlantic.
947. Albert 1 Osage; 24-27N-8E. *Atlantic.
948. Atlantic 1 Osage D; 12-26N-6E. *Atlantic.
949. Olson Drlg. 1 Osage; 23-26N-4E. *Okla. Geol. Surv. (Shell).
950. Pure 1 Pollard; 34-19N-5W. *MCGS (DSL).
951. Amerada 1 Tindle; 21-26N-3E. *MCGS (DSL).
952. Aberdeen Pet. 1 Burk; 27-26N-2W. *MCGS (DSL).
953. Foundation Oil 1 Hamburg; 21-26N-3W. *MCGS (Ellison), 1949.
954. Cummings-McIntyre 1 Combs; 6-25N-5W. *MCGS (DSL).
955. Continental 4 Hall; 18-25N-2E. *Atlantic.
956. A. G. Oliphant 1 Secrest; 19-25N-3E. *Atlantic.
957. Phillips 1 Bean; 15-25N-6E. *Atlantic.
958. Texas 1 Pearson; 13-25N-7E. *Atlantic.
959. Ohio 87 Osage; 20-25N-11E. *Atlantic.
960. Bingham 1 Smittle; 19-24N-15E. *Atlantic.
961. Helms and Reynolds 1 Little; 32-24N-14E. *Atlantic.
962. Rinehardt and Donovan 1 Able; 27-24N-13E. *Atlantic.
963. Davon Oil & Gas 1 Buffalo Head; 7-24N-4E. *MCGS (Ellison), 1946.
964. Mazda Oil 1 Marshall; 27-24N-1E. *MCGS (DSL).
965. Glenn, 1963, p. 67. 7-25N-14E.
966. Benson Montin Construction 1 Schultz; 16-23N-7W. *MCGS.
967. Champlin Oil & Ref. 1 Johnson; 29-23N-5W. *MCGS.
968. Deep Rock Oil 1 Dunn; 15-23N-3W. *MCGS (DSL).
969. Eason Oil 1 Kubala; 3-23N-1W. *MCGS (Ellison), 1948.
970. Baker 1 Schultz; 34-23N-2E. *Atlantic.
971. Crosbie 1 Doyle; 36-23N-3E. *Atlantic.
972. Wolf 1 Turner; 32-23N-6E. *Atlantic.
973. Texas 1 Bennet; 1-23N-7E. *Atlantic.
974. Buell, Inc., 1A Osage; 29-23N-9E. *Atlantic.
975. Silurian 59 Lot 73; 18-23N-12E. *Atlantic.
976. Day 1 Mayberry; 20-23N-15E. *Atlantic.
977. Huffman, 1958, p. 265, locality 158. 21-22N-20E.
978. Huffman, 1958, p. 262, locality 153. 5, 6-22N-20E.

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979. Berry and others 1 Mayes Est.; 8-22N-17E. *Atlantic.
980. McGee 2 Green; 19-22N-16E. *Atlantic.
981. Silurian 1 Pier; 27-22N-13E. *Atlantic.
982. Ohio 2 Dickenson; 12-22N-11E. *Atlantic.
983. Norbla Oil 1 Carson; 30-22N-8E. *M. S. Kirk, 1956.
984. Deep Rock Oil 1 Garett; 20-22N-6E. *Atlantic.
985. Dorrance 1 Gilbert; 32-22N-3E. *Atlantic.
986. Kingwood Oil 1 Sykora; 24-22N-1W. *MCGS (Ellison), 1947.
987. Frankfort Oil 1 Dulick; 32-22N-6W. *MCGS.
988. Sunray Mid-Continent 1 Hime; 30-28N-8W. *MCGS.
989. Little 1 Groom; 10-21N-4W. *MCGS.
990. Fleet and Richardson 1 Wagner; 25-21N-2W. *MCGS (DSL).
991. Kelly and others 1 Montgomery; 11-21N-17E. *Atlantic.
992. Guffey and Gillespie 1; 9-22N-10E. *Okla. Geol. Surv. (Shell).
993. Strong, 1961, p. 177. 35-20N-16E.
994. McIntyre 1 Anderson; 21-20N-15E. *Atlantic.
995. Miller and others 3 Nichols; 3-20N-14E. *Atlantic.
996. Brant, 1954. 31-20N-13E.
997. Echo Oil 1 Scott; 28-20N-10E. *Atlantic.
998. Dunbar 2 Taylor; 20-20N-9E. *Atlantic.
999. Mid-Continent 1 Johnson; 6-20N-6E. *MCGS (Ellison), 1947. Turner and others 1 Summers; 34-21N-3E. *MCGS (Ellison), 1946.
1000. Howell & Howell 1 Human; 5-20N-3E. *MCGS (DSL).
1001. Wilcox Oil 1 Johnson; 3-20N-1E. *MCGS (DSL).
1002. Magnolia 1 Dvorak; 22-20N-1W. *MCGS.
1003. Greer and others 1 Hammer; 2-20N-5W. *MCGS (DSL).
1004. Midwest Oil Corp. 1 Linehart; 20-20N-6W. *MCGS (Ellison).
1005. Atlantic 1 Choat Unit; 26-19N-9W. *B. R. Haley, USGS.
1006. King-Stevenson 1 Tutt; 26-19N-8W. *MCGS.
1007. Sherry 1 Keith; 22-19N-1E. *MCGS (Ellison), 1946.
1008. Amerada 1 Penny; 25-19N-4E. *Atlantic.
1009. Pure 26 Richards; 33-19N-7E. *Atlantic.
1010. Cobb 1 Doolin; 6-19N-8E. *Atlantic.
1011. Holms and others 1 Hasley; 28-19N-9E. *Atlantic.
1012. Superior 1A Woods; 18-19N-12E. *Atlantic.
1013. McIntire 1 Maudlin; 10-19N-14E. *Atlantic.
1014. Huffman, 1958, p. 253-254, section 36. 13-19N-19E.
1015. Moore, 1947, p. 149-150, section 92. 6-18N-20E.
1016. Brown 1 Sissney; 24-18N-16E. *Atlantic.
1017. Murphy and others 6 Letterman; 19-18N-16E. *Atlantic.
1018. Harris 1 Harris; 9-18N-13E. *Atlantic.
1019. Sooner Oil 1 Lee; 17-18N-12E. *Atlantic.
1020. Pepis 1 Whitman; 14-18N-10E. *M. S. Kirk, 1956.
1021. Elson 1 Posey; 22-18N-9E. *Atlantic.
1022. Coronado 1 Foster; 26-18N-6E. *MCGS (Ellison), 1950.
1023. Carter 1 Tank; 7-18N-6E. *MCGS (DSL).
1024. Smith 1 Tiger; 25-14N-9E. *Okla. Geol. Surv. (Shell).
1025. Republic Nat. Gas 1 Howland; 26-18N-2W. *MCGS (Ellison), 1950.
1026. Abbott 1 Wrobble; 5-18N-2W. *MCGS (AmStrat).
1027. Amerada 1 Galligan; 31-17N-8W. *MCGS.
1028. Superior 1 Long; 16-17N-7W. *MCGS (Ellison), 1948.
1030. Cities Service 1 Koehn; 8-17N-1W. *MCGS (Ellison), 1950.
1031. Gulf 1 Bliss; 26-17N-1E. *MCGS (Ellison), 1947.
1032. Texas 1 Carter; 25-17H-2E. *MCGS (Ellison), 1947.
1033. Anderson 1 Derrick; 9-17N-5E. *MCGS (Ellison), 1948.
1034. Carter 1 Hales; 28-17N-9E. *Atlantic.
1035. Mid-Continent 1 Beets; 1-16N-10E. *Louise Jordan, Okla. Geol. Surv.; 1955.
1036. Archer 1 King; 22-17N-11E. *Atlantic.
1037. Bright and Compton 1 Childers; 11-17N-14E. *Atlantic.
1038. Sewell 1 Darnell; 30-17N-17E. *Atlantic.
1039. Gardner Pet. 1 Nelson (?); 7-17N-19E. *Atlantic.

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1040. Keener Oil 1 Rogers; 33-17N-19E. *Atlantic.
1041. Huffman, 1958, p. 238-240. 6-17N-20E, 31-18N-20E.
1042. Huffman, 1958, p. 222. 5, 6-17N-21E.
1043. Moore, 1947, p. 141-143. 11, 14, 23-16N-26E.
1044. Huffman, 1958, p. 206-207. 2-16N-24E.
1045. Huffman, 1958, p. 203. 28-16N-23E.
1046. Huffman, 1958, p. 195-196. 27, 28-16N-22E.
1047. Huffman, 1958, p. 193. 15-16N-21E.
1048. Moore, 1947, p. 130-131. 10-16N-20E.
1049. Moore, 1947, p. 129-130. 25-16N-19E.
1050. Petty Oil 1 Steil; 10-16N-18E. *Atlantic.
1051. Dunbar 2 Spencer; 3-16N-16E. *Atlantic.
1052. Lambert 2 Call; 24-16N-14E. *Atlantic.
1053. Miller and others 2A Hutchinson; 34-16N-13E. *Atlantic.
1054. Kirk, 1957, pl. 2. 18-16N-8E.
1055. Fleet Oil and R. Maguire 1 Teegarden; 24-16N-3E. *MCGS (Ellison), 1948.
1056. Herndon 1 Griffith; 17-16N-2E. *MCGS (DSL).
1057. Sinclair 1 Rundell; 18-16N-3W. *MCGS (DSL).
1058. Phillips 1 Jirick; 26-16N-5W. *MCGS (Ellison), 1945.
1059. Natl. Assoc. Pet. 1 Stephens; 15-16N-6W. *MCGS (DSL).
1060. Slats Honeymon Drlg. 1 Oppell; 30-16N-9W. *MCGS.
1061. Apache Oil 1 Snow Unit; 5-15N-7W. *MCGS.
1062. Payne and Blaik 1 Francis; 14-15N-7W. *MCGS.
1063. Gulf 1 Triplett; 8-15N-5W. *MCGS (Ellison), 1945.
1064. MacMillan and Blackwood & Nichols Co. 1 Krout; 14-15N-4W. *MCGS (DSL).
1065. Zephyr Pet. and Alpha Pet. 1 Tilbury; 26-15N-2W. *MCGS (DSL).
1066. Fleet Drlg. and others 1 Coleman; 12-15N-1E. *MCGS (Ellison), 1949.
1067. Kingwood Oil 1 Betow; 10-15N-3E. *MCGS (Ellison), 1948.
1068. Vickers Pet. and Eason Oil 1 Thompson; 17-15N-4E. *MCGS (Ellison), 1947.
1069. F. A. Gillespie & Sons 1 Kinder; 5-15N-5E. *MCGS (Ellison), 1945.
1070. Hubbell & Webb 1 Bukaty; 19-15N-6E. *MCGS (Ellison), 1946.
1071. Silurian 1 Ireland; 25-15N-9E. *Atlantic.
1072. 1 Thompson well; 18-15N-11E. *Atlantic.
1073. Berry 1 Wilson; 32-15N-14E. *Atlantic.
1074. Bryan and Emery 1 Lowery; 9-15N-15E. *Atlantic.
1075. Godfrey 1 Davis; 13-15N-17E. *Atlantic.
1076. Moore, 1947, p. 98-99. 32-15N-20E.
1077. Moore, 1947, p. 103-104. 28-15N-22E.
1078. Moore, 1947, p. 104-105. 28, 33-15N-23E.
1079. Moore, 1947, p. 107-108. 9-15N-24E.
1080. Huffman, 1958, p. 176-178. 1, 2-15N-25E.
1081. Huffman, 1958, p. 186-187. 35, 36-15N-26E.
1082. Moore, 1947, p. 89-90. 18-14N-24E.
1083. Moore, 1947, p. 85-86. 29-14N-23E.
1084. Moore, 1947, p. 83. 30-14N-21E.
1085. Curran 1 Harris; 35-14N-18E. *Atlantic.
1086. Crank 1 Siebolt; 1-14N-17E. *Atlantic.
1087. Armstrong & McLeod Co. 1 Huse; 15-14N-16E. *Atlantic.
1088. Atlantic 9 Chatman; 13-14N-14E. *Atlantic.
1089. Selby Oil and Gas 1 Jenkins; 23-14N-10E. *Atlantic.
1090. Shamblin and others 1 Lumm; 8-14N-8E. *Okla. Geol. Surv. (Shell).
1091. Mid-Continent 1 Bear; 3-14N-7E. *Okla. Geol. Surv. (Shell).
1092. McBride 1 Seaton; 21-15N-7E. *Okla. Geol. Surv. (Shell).
1093. Williams Bros. and others 1 Chandler; 27-14N-3E. *MCGS (Ellison), 1946.

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1094. Hodges and others 1 Pettit; 32-14N-2E. *MCGS (Ellison), 1949.
1095. Harper-Turner Oil 1 Mitchell; 2-14N-3W. *MCGS (Ellison), 1947.
1096. Sinclair 1 Treece; 24-14N-6W. *MCGS.
1097. Pan American 1 Kau-Bee Invest.; 23-13N-5W. *MCGS.
1098. Hall-Miller Drlg. 1 Ecker; 31-13N-2E. *MCGS (Ellison), 1948.
1099. Nye 1 Richardson; 23-13N-4E. *MCGS (DSL).
1100. Sun 1 Kalda; 13-13N-5E. *MCGS (Ellison), 1948.
1101. Alma Oil 1 Martin; 4-12N-7E. *Okla. Geol. Surv. (Shell).
1102. Bay 1 Follansbee; 16-13N-8E. *MCGS (Ellison), 1947.
1103. Josaline Prod. 1 Truut; 14-13N-9E. *MCGS (Ellison), 1947.
1104. Gled Oil 9 Baker; 28-13N-14E. *Atlantic.
1105. D. & D. Drlg. and others 1 Pence; 11-13N-15E. *Atlantic.
1106. Tulsa Geological Society, 1961, pl. 5. 23-13N-19E.
1107. Moore, 1947, p. 73-74. 28-13N-20E.
1108. Huffman, 1958, p. 118-119. 10-13N-21E.
1109. Huffman, 1958, p. 145-151. 21, 22-13N-23E.
1110. Harren 1 Cheek; 19-12N-25E. *MCGS.
1111. Cook 1 Fee; 8-12N-24E. *MCGS (AmStrat).
1112. U. S. Smelting, Ref. and Mining 1 Williams; 11-12N-19E. *Atlantic.
1113. Bridgeview Coal 1 Williamson; 2-12N-18E. *Atlantic.
1114. Oklahoma Oil 1 Wolfe; 35-12N-17E. *Okla. Geol. Surv. (Shell).
1115. Tulsa Geological Society, 1961, pl. 7. 14-12N-16E.
1116. Phillips 1 Bozarth; 12-12N-15E. *Atlantic.
1117. Carter 1 Yarhola (Van Pelt); 9-12N-11E. *Okla. Geol. Surv. (Shell).
1118. Wilcox Oil 1 Lewis; 24-12N-9E. *MCGS (Ellison), 1946.
1119. Monahan 1 Replogle; 15-12N-8E. *MCGS (DSL).
1120. Summitt Oil and others 1 Gafford; 26-12N-7E. *MCGS (Ellison), 1947.
1121. Carter 1 Walker; 22-12N-6E. *MCGS (Ellison), 1947.
1122. Hayes 1 Bolen; 25-12N-3E. *MCGS (Ellison), 1946.
1123. Eason Oil 1 Horse She Lake; 26-12N-1E. *MCGS (DSL).
1124. Peppers Ref. 1 Wegener; 23-12N-2W. *MCGS (DSL).
1125. Double R Drlg. 1 Lincoln Park; 13-12N-3W. *MCGS, 1948.
1126. Phillips 1 Airport; 8-12N-4W. *MCGS (Ellison), 1945.
1127. Carlock 1 Kirschner; 15-12N-5W. *MCGS (DSL).
1128. Cities Service 1 Porter B; 5-12N-8W. *MCGS.
1129. Sun 1 Litton; 30-12N-9W. *MCGS.
1130. Ashland Oil & Ref. 1 Zurline; 16-11N-4W. *MCGS (DSL).
1131. Star Oil 1 Socher; 31-11N-3W. *MCGS (Ellison), 1948.
1132. Cities Service 5 Farley; 19-11N-2W. *MCGS (Ellison), 1947.
1133. Deardorf Oil 1 Tickle; 28-11N-1E. *MCGS (Ellison), 1948.
1134. Stanolind 1 Logan; 20-11N-3E. *MCGS (Ellison), 1946.
1135. Droppleman 1 Yahola; 15-11N-10E. *Atlantic.
1136. Atlantic 4 Jefferson; 16-11N-11E. *Atlantic.
1137. Harper Oil 1 Rosendahlt; 7-11N-15E. *Atlantic.
1138. Tulsa Geological Society, 1961, pl. 18. 26-11N-15E.
1139. Western Oil & Gas 1 Brandon; 17-11N-16E. *W.&K., 1959.
1140. Tidewater 1 Sizemore-Winkle; 25-11N-17E. *MCGS.
1141. Frezon, 1962, pl. 1. 31-11N-19E.
1142. Tulsa Geological Society, 1961, pl. 16. 36-11N-19E.
1143. Harris 1 Standifer; 5-11N-20E. *MCGS.
1144. Frezon, 1962, pl. 1. 5-11N-23E.
1145. Sunray Mid-Continent 1 Woodward; 11-10N-23E. *W.&K.
1146. Frezon, 1962, pl. 1. 3-10N-21E.
1147. Intex Oil 1 McKee; 18-10N-18E. *MCGS (DSL).
1148. Frezon, 1962, pl. 1. 30-10N-16E.
1149. Chapman and Poland 1 Schrimsher; 19-10N-15E. *W.&K., 1960.

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1150. Gypsy Oil 1 E. E. Klein; 17-10N-14E. *Atlantic.
1151. Phillips 1 Wood; 31-11N-13E. *Okla. Geol. Surv. (Shell).
1152. Hillcrest Oil 1 Lasley; 25-10N-10E. *Atlantic.
1153. Hall Pet. 1 Morris; 29-10N-9E. *Atlantic.
1154. Culham Pet. and others 1 Whitmey; 32-10N-8E. *MCGS (Ellison), 1946.
1155. Gulf 1 Remaklus; 17-10N-7E. *MCGS (Ellison), 1946.
1156. Wise and others 1 Meneely; 8-10N-5E. *MCGS (Ellison), 1946.
1157. Globe Oil & Ref. 1 Romberg; 23-10N-4E. *MCGS (Ellison), 1946.
1158. Danciger Oil & Ref. and others 1 Bolan; 34-10N-3E. *MCGS (Ellison), 1947.
1159. Humble 1 Harris; 7-9N-5W. *MCGS.
1160. Gulf 1 Kaplin; 35-9N-2E. *MCGS (Ellison), 1948.
1161. Olson Drlg. 1 Coffman; 24-9N-7E. *MCGS (DSL).
1162. Mid-Continent 1 Rogers; 26-9N-8E. *MCGS (Ellison), 1946.
1163. Frezon, 1962, pl. 1. 12-9N-13E.
1164. Frezon, 1962, pl. 1. 18-9N-15E.
1165. Pure 1 Bauman Unit; 29-9N-16E. *W.&K., 1959.
1166. Tooter Guthrie Oil 1 Griffin; 21-9N-18E. *Atlantic.
1167. Apache Oil 1 Webster; 14-9N-19E. *W.&K., 1959.
1168. Tulsa Geological Society, 1961, pl. 17. 31-9N-20E.
1169. Phillips 1 Sammons; 22-9N-21E. *S. E. Frezon, USGS.
1170. Humble 1 Nelson; 18-9N-24E. *W.&K. 1961.
1171. Pan American 1 King; 31-9N-25E. *Atlantic.
1172. Le Flore County Gas & Electric 1 Parnell; 18-9N-27E. *MCGS (AmStrat).
1173. Midwest Oil Corp. 1 Morris; 12-8N-26E. *S. E. Frezon, USGS.
1174. Superior 1 Allred; 18-8N-20E. *S. E. Frezon, USGS.
1175. Phillips 1 Parsons; 24-8N-16E. *Okla. Geol. Surv. (Shell).
1176. Mobil 1 Tate; 15-8N-15E. *W.&K., 1959.
1177. Bradshaw Drlg. 1 Cole; 36-8N-12E. *W.&K., 1959.
1178. Frezon, 1962, pl. 1. 18-8N-12E.
1179. Tulsa Geological Society, 1961, pl. 1. 32-8N-8E.
1180. Prairie 1 Maxey; 1-8N-6E. *Okla. Geol. Surv. (Shell).
1181. Goff and Eason Oil 1 Richter; 4-8N-1W. *W.&K., 1958.
1182. Sinclair 1 Lamar; 15-8N-3W. *W.&K., 1961.
1183. Jordan Pet. 1 Hall; 8-8N-6W. *MCGS (DSL).
1184. Rotary Devel. 1 Coleman-Davis; 20-8N-7W. *MCGS (AmStrat).
1185. Goff and Leeper 1 Holmes; 29-7N-8W. *W.&K., 1959.
1186. Universal 1 Moore; 20-7N-4W. *W.&K., 1947.
1187. Slick Oil 1 Marcum; 32-7N-2W. *W.&K., 1956.
1188. Texas 1 Stine; 1-7N-2E. *W.&K., 1957.
1189. Cities Service 1 Douglas; 31-7N-3E. *W.&K., 1947.
1190. Tulsa Geological Society, 1961, pl. 2. 1-7N-9E.
1191. Deep Rock Oil 1 Eckles; 12-7N-11E. *W.&K.
1192. Tulsa Geological Society, 1961, pl. 10. 12-7N-14E.
1193. Olson and All 1 Coleman-Riddle; 10-7N-18E. *W.&K.
1194. Mobil 1 Veazey; 28-7N-27E. *B. R. Haley, USGS.
1195. Tulsa Geological Society, 1961, pl. 19. 18-6N-22E.
1196. Tulsa Geological Society, 1961, pl. 11. 28-6N-17E.
1197. Pure 1 Derrick "A"; 32-6N-11E. *W.&K., 1948.
1198. Frezon, 1962, pl. 1. 1-6N-10E.
1199. Atlantic 1 Stephenson; 15-6N-9E. *W.&K., 1949.
1200. Huffman, 1958, p. 260, locality 149. 31-21N-20E.
1201. Magnolia 1 Anneler; 26-6N-1W. *MCGS (Ellison), 1945.
1202. Blackwood & Nichols Co. 1 Hendrix; 4-6N-6W. *W.&K., 1955.
1203. Gulf and Tidewater 1 Wood; 29-6N-8W. *W.&K., 1961.

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1204. Gulf 1 Mainka; 12-5N-5W. *W.&K., 1948.
1205. Sinclair 1 Sparkman; 36-5N-3W. *W.&K., 1947.
1206. Sohio 1 Wilfong; 34-5N-5E. *W.&K., 1948.
1207. Frezon, 1962, pl. 1. 12-5N-9E.
1208. Bell Oil & Gas 1 Lackey; 27-5N-11E. *W.&K., 1959.
1209. Tulsa Geological Society, 1961, pl. 12. 7-5N-14E.
1210. D. & D. Drlg. 1 McDonnell; 12-4N-9E. *W.&K., 1958.
1211. Frezon, 1962, pl. 1. 12-4N-8E.
1212. Kollsman 1 Brumley; 18-4N-8E. *W.&K., 1951.
1213. Deep Rock Oil 1 Bond; 23-4N-4E. *W.&K., 1946.
1214. Sherin 1 Dulin; 19-4N-1E. *W.&K., 1960.
1215. Woods Pet. 1 Flippo; 10-4N-2W. *W.&K., 1961.
1216. Musgrove Drlg. 1 Godfrey "B"; 4-4N-5W. *W.&K., 1961.
1217. British-American 1 Sizemore-Phipps; 1-3N-6W. *W.&K., 1959.
1218. Lewis & Mucher 1 Nix; 21-3N-1E. *W.&K., 1957.
1219. Pure 1 Burkhart; 13-3N-4E. *W.&K., 1959.
1220. Gilmore 1 Rollow; 2-3N-5E. *W.&K., 1957.
1221. Boyd 1 Smith; 9-3N-6E. *W.&K., 1957.
1222. Stanolind 1 Allison; 6-3N-8E. *W.&K., 1956.
1223. Stanolind 1 Aetna Life; 29-3N-10E. *W.&K., 1947.
1224. Cox & Hamon 1 Reynolds; 26-12N-13E. *Louise Jordan, Okla. Geol. Surv., 1962.
1225. Welch and Lugan 1 Chully; 14-13N-12E. *Louise Jordan, Okla. Geol. Surv., 1962.
1226. Texaco 19 Fee NTC 2; 11-14N-11E. *Louise Jordan, Okla. Geol. Surv., 1961.
1227. Gulf 1 Chapel; 33-19N-8E. *Louise Jordan, Okla. Geol. Surv., 1955.
1228. Mid-Continent 1 Shaupp; 24-5N-6E. *Okla. Geol. Surv. (Shell).
1229. Amerada 1 Mitchell; 3-6N-4E. *Okla. Geol. Surv. (Shell).
1230. Superior 1 Little; 34-3N-12E. *W.&K., 1953.
1231. Delhi Oil 1 Mawdy; 10-2N-11E. *W.&K., 1953.
1232. Knechtel, 1937, p. 109-122. 34-2N-9E.
1233. Carter 1 Morgan; 3-2N-9E. *W.&K., 1953.
1234. Texas-New Mexico Devel. 1 Polk; 8-2N-8E. *W.&K., 1953.
1235. Gulf 1 McKinney; 24-2N-5W. *W.&K., 1958.
1236. Smith and Scott 1 Scroggins; 4-6N-6E. *Okla. Geol. Surv. (Shell).
1237. McCasland 1 Callaway; 33-1N-8W. *W.&K., 1952.
1238. Eason Oil 1 Pinson; 30-1N-7W. *W.&K., 1957.
1239. Stanolind 1 Burkhart; 27-1N-5W. *W.&K., 1953.
1240. Carter 1 Crawford; 29-1N-2E. *W.&K., 1955.
1241. Palmer 1 Truitt; 10-1N-7E. *W.&K., 1948.
1242 Frezon, 1962, pl. 1. 35-1N-8E.
1243. Ohio 1 Carson; 27-1N-10E. *W.&K., 1959.
1244. Tulsa Geological Society, 1961, pl. 6. 26-1N-11E.
1245. Shelburne, 1960, p. 36, 41. Boktukola syncline, Ouachita Mtns.
1246. Pure 1 Bates; 13-6N-7E. *Okla. Geol. Surv. (Shell).
1247. Porter 1 Hudson; 28-1S-9E. *W.&K., 1956.
1248. Intex Oil 1 Carter-Vaden Unit; 34-1S-8E. *W.&K., 1955.
1249. Van Grisso Oil 1 Russell; 33-1S-3E. *W.&K., 1958.
1250. Frankfort Oil 1 Hale; 4-1S-1E. *W.&K., 1955.
1251. Samedan Oil 1 Hook; 12-1S-3W. *W.&K., 1954.
1252. Magnolia 7 Bumpass; 33-1S-3W. *W.&K., 1950.
1253. Amerada 1 Britton; 15-1S-5W. *W.&K., 1953.
1254. Stephens Pet. 1 Grooms; 16-1S-6W. *W.&K., 1947.
1255. Perkins 1 Stanley; 34-1S-7W. *W.&K., 1951.
1256. Falcon Co. 1 Pruitt; 11-2S-6W. *W.&K.
1257. Skelly 1 Pierce "D"; 8-2S-2W. *W.&K., 1954.
1258. Drlg. and Explor. Co. 1 Backaus; 13-2S-7E. *W.&K., 1956.
1259. Turner 1 Coe; 7-2S-9E. *W.&K., 1957.

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1260. Shelburne, 1960, p. 36, 41. Harris Creek syncline, Ouachita Mtns.
1261. Gulf 1 Butler; 21-3S-10E. *W.&K., 1954.
1262. Huber 1 Oliver; 9-3S-2E. *W.&K., 1960.
1263. Pure 1 Fitzgerald; 27-3S-1E. *W.&K., 1946.
1264. Sunray 1-B Fitzgerald; 12-3S-1W. *W.&K., 1955.
1265. Pan American 1 Oklahoma Nat. Bank; 27-3S-2W. *W.&K., 1960.
1266. Magnolia 1 Gulf Fee; 27-3S-5W. *W.&K., 1959.
1267. Falcon Co. 1 Beavers; 27-3S-6W. *W.&K., 1948.
1268. Youngblood 1 Bennett; 13-4S-6W. *W.&K., 1949.
1269. Buffalo Pet. 1 Poland; 14-4S-3E. *W.&K., 1955.
1270. Pan American 1 Chapman; 36-4S-4E. *W.&K., 1957.
1271. Continental 1 Rutherford; 31-4S-6E. *W.&K., 1958.
1272. Buffalo Pet. 1 Lee; 1-4S-10E. *W.&K.
1273. Phillips 1 Matoy; 24-5S-11E. *W.&K., 1955.
1274. Honeymoon Drlg. 1 Townsend; 30-5S-8E. *W.&K., 1962.
1275. Tolliver and others 1 Ransbottom; 13-5S-6E. *W.&K., 1960.
1276. Godfrey 1 Underhill; 31-5S-6E. *W.&K., 1959.
1277. Sinclair 1 Griffen; 16-5S-5E. *W.&K., 1954.
1278. Gulf 1 Scott; 31-5S-2E. *W.&K., 1956.
1279. Nelson and Spain 1 Buck; 32-5S-1E. *W.&K., 1959.
1280. Sinclair 1 Bond; 33-5S-2W. *W.&K.
1281. Stanolind and Amerada 1 Aldridge; 2-5N-7E. *Okla. Geol. Surv. (Shell).
1282. Bolin Oil 1 Gaines; 24-5S-6W. *W.&K., 1957.
1283. Texas 1 Worrell; 10-6S-7W. *W.&K., 1950.
1284. Sinclair 2 Peabody; 26-6S-2W. *W.&K., 1951.
1285. Sinclair 1 Tucker; 17-6S-2E. *W.&K., 1957.
1286. Sinclair 1 Tucker; 32-6S-3E. *W.&K., 1958.
1287. Parker Pet. 1 McKenzie; 26-6S-4E. *W.&K., 1958.
1288. Union Oil 1-C Woody; 6-6S-5E. *W.&K.
1289. Jake Hamon 1 Haden Unit; 22-6S-7E. *W.&K., 1961.
1290. Pasotex Pet. 1 Griffin; 25-6S-8E. *W.&K., 1955.
1291. Flawn and others, 1961, p. 340-341. 21-7S-10E.
1292. Sinclair 1 House; 3-7S-9E. *W.&K., 1959.
1293. Phillips 1-A Hodge; 21-7S-8E. *W.&K., 1956.
1294. Superior and Fleetborne Oil 1 Harden; 30-2N-7E. *Okla. Geol. Surv. (Shell).
1295. Pasotex Pet. 1 Brannon and others Unit; 32-7S-3E. *W.&K., 1959.
1296. Tennessee Gas Trans. 1 Baker; 9-7S-1W. *W.&K., 1959.
1297. Nelson and Spain 1 Black; 25-7S-4W. *W.&K., 1958.
1298. Cities Service 1 Linton; 7-7S-6W. *W.&K., 1947.
1299. Sinclair 1 McClure; 1-8S-1E. *W.&K., 1961.
1300. Daube 1 Tidwell; 30-8S-2E. *W.&K., 1961.
1301. Shell 1 Halkins B; 15-8S-5E. *W.&K., 1959.
1302. Britton 1 Scott; 14-9S-1E. *W.&K., 1961.
1303. Britton 1 Leeper; 29-9S-2E. *W.&K., 1959.
1304. S. D. Johnson 1 Robinson; 17-1N-23W. *W.&K., 1951.
1305. Atkinson 1 Coody; 21-2N-9W. *W.&K.
1306. Frezon, 1962, pl. 1. 23-11N-25E.
1307. Strong, 1961, pl. 5. 5-18N-18E.
1308. Strong, 1961, pl. 5. 27-19N-17E.
1309. Strong, 1961, pl. 4. 36-20N-18E.
1310. Strong, 1961, pl. 5. 16-21N-18E.
1311. Strong, 1961, pl. 5. 33-22N-18E.
1312. Strong, 1961, pl. 3. 17-23N-17E.
1313. Strong, 1961, pl. 3. 19-23N-18E.
1314. Strong, 1961, pl. 3. 17-23N-19E.
1315. Strong, 1961, pl. 2. 25-25N-16E.
1316. Strong, 1961, pl. 2. 12-25N-19E.
1317. Strong, 1961, pl. 6. 12-26N-21E.
1318. Strong, 1961, pl. 2. 20-26N-19E.

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1319. Strong, 1961, pl. 2. 27-26N-18E.
1320. Strong, 1961, pl. 5. 14-27N-18E.
1321. Strong, 1961, pl. 1. 24-28N-22E.
1322. Strong, 1961, pl. 1. 21-28N-21E.
1323. Strong, 1961, pl. 1. 31-28N-20E.
1324. Strong, 1961, pl. 1. 19-28N-19E.
1325. Strong, 1961, pl. 1. 24-28N-17E.
1326. Shell 1 L. J. Counts; 29-9N-20W. *MCGS (DSL), 1953.
1331. Sunray Mid-Continent 1 Allen; 17-1S-22W. *MCGS, 1964.
1332. Garvin Drlg. 1 Fink; 32-1S-10W. *Confid.
1333. Magnolia 1 Amyx; 17-3S-16W. *Confid.
1334. Humble 1 Henry; 13-1N-21W. *MCGS, 1964.
1335. Tidewater 1 Johnson; 19-3N-23W. *Confid.
1336. Kingwood Oil 1 Darden; 20-4N-23W. *Confid.
1337. Frankfort Oil 1 Black Bear; 9-5N-10W. *Confid.
1338. Unknown; 14-6N-9W. *Confid.
1339. Vickers Pet. 1 Tonekeahbo; 8-7N-14W. *Confid.
1340. Texas 1 Warden; 17-8N-10W. *Confid.
1341. Buttram 1 Smith; 34-8N-16W. *Confid.
1342. Helmerich & Payne 1 Britton; 28-9N-17W. *Confid.
1343. Continental and others 1 North Corn Unit; 19-11N-14W. *MCGS, 1961.
1344. Parker (V. A. Brill) 1 Newcomb; 10-12N-16W. *Confid.
1345. United Carbon and others 1 Clark Unit; 32-12N-21W. *Confid.
1346. Sunray Mid-Continent 1 Hatcher; 1-14N-18W. *MCGS, 1961.
1347. Texaco 1 Morgan; 3-16N-11W. *MCGS, 1963.
1348. Oklahoma Nat. Gas 1 Oakwood Unit; 6-17N-14W. *Confid.
1349. Ashland Oil and Ref. 1 Boggess; 22-17N-16W. *MCGS, 1962.
1350. Tenneco 1 Patterson; 16-17N-20W. *MCGS, 1963.
1351. Continental 1 Berryman; 15-17N-23W. *Confid.
1352. El Paso Nat. Gas 1 Eggleston; 11-17N-26W. *MCGS, 1961.
1353. King-Stevenson 1 Kirkham; 14-19N-14W. *MCGS, 1960.
1354. Shell 1-22 Louthan; 22-20N-16W. *MCGS, 1959.
1355. Magnolia 1-A J. C. Borden; 20-20N-20W. *Confid.
1356. Pan American 1 Elmore; 17-20N-24W. *MCGS, 1962.
1357. Gulf 1 Wichert; 14-21N-13W. *MCGS, 1960.
1358. Magnolia and others 1 James Unit; 8-21N-23W. *MCGS, 1959.
1359. Magnolia 1 H. J. Schoennals; 24-21N-26W. *Confid.
1360. Calvert Explor. and others 1 McBride; 24-23N-14W. *MCGS, 1963.
1361. Pan American 1 Burr Unit; 19-23N-16W. *MCGS, 1960.
1362. Sinclair and others 1 O. Z. Morrow; 6-23N-19W. *Confid.
1363. Pan American 1 Snyder; 7-23N-24W. *MCGS, 1961.
1364. Pan American 1 Cooper Unit "B"; 25-24N-22W. *MCGS, 1960.
1365. L. B. Jackson 1 McNally; 35-25N-15W. *MCGS (DSL), 1951.
1366. Pan American 1 O'Hair; 27-25N-26W. *MCGS, 1962.
1367. Jones and Pellow 1 Prewett "B"; 8-27N-11W. *MCGS, 1962.
1368. Warren Explor. 1 Moorefield; 9-27N-13W. *MCGS, 1960.
1369. Tooter Guthrie Oil 1 De Geer; 8-27N-17W. *MCGS, 1962.
1371. Shell 1-8 Fisher; 8-3N-16ECM. *TPSLS, 1961.
1372. Hamilton Bros. 1-28 Buzzard; 28-4N-12ECM. *TPSLS, 1961.
1373. Shell 5 Rumberger; 16-10N-21W. *Rinehart's Oil Repts., August 13, 1959.
1374. Texas 1 Cook; 27-1N-19ECM. *TPSLS, 1953.
1380. Colton and Phillips 1-A Wilson; 10-12N-12E. *Okla. Geol. Surv. (Shell).
1381. Scruggs 1 Laning; 19-12N-15E. *Okla. Geol. Surv. (Shell).
1382. Thompson 1 Ruby; 30-12N-22E. *Okla. Geol. Surv. (Shell).
1383. Stanolind 1 Hamilton; 33-4N-9E. *W.&K., 1952.
1384. Lion Oil 1 Murray; 29-10N-27E. *B. R. Haley, USGS, 1965.
1385. Arkansas Oklahoma Gas 1 Phillips Unit; 14-8N-23E. *W.&K., 1951.
1386. Dana, 1954, fig. 7. Bay 1 Hoover; 14-29N-3W.
1387. Dana, 1954, fig. 8. Stauffer 1 Hall; 9-25N-7W.
1388. Dana, 1954, fig. 9. Ace Gutowski 1 Shipley; 33-27N-3W.
1389. Smith, 1955, fig. 3. Glickman 1 Heagy; 22-27N-3E.
1390. Berryhill, 1961, pl. 2. Woods Drlg. 1 Hajek; 22-21N-6E.
1391. Berryhill, 1961, pl. 1 Harris and Suppes 1 Speed; 22-21N-7E.
1392. Berryhill, 1961, pl. 2. Kroy American Oils 5 State; 16-20N-7E.
1393. Berryhill, 1961, pl. 1. Ambassador Oil 2 Frick; 32-20N-6E.
1394. Blumenthal, 1956, pl. 4. S & K Oil Fielden; 11-13N-6E.
1395. Cline, 1960, p. 86. Lynn Mtn. syncline, Ouachita Mtns.
1396. Flawn and others, 1961, p. 343. 16-2N-14E.
1397. Flawn and others, 1961, p. 343. 30-3S-15E.
1398. Hill and others 1 Marshall; 25-6S-15E. *Rinehart's Oil Repts., Sept. 20, 1962.
1399. Hoxsey Oil 1 Brinkley; 10-7S-24E. *Rinehart's Oil Repts., April 9, 1959. 10-7S-24E.
1400. Wocco and Woosley 1 Wilson; 4-8S-23E. *Rinehart's Oil Repts., April 4, 1963.
1401. Calvert 1 Quaid; 22-8S-9E. *Rinehart's Oil Repts., Jan. 28, 1960.
1402. Flawn and others, 1961, p. 339. 16-8S-8E.
1403. Flawn and others, 1961, p. 343. 7-7S-6E.
1404. Cline and Moretti, 1956, p. 4. Indian Service Road, Ouachita Mtns.
1405. Cline and Moretti, 1956, p. 14. Kiamichi Mtn., Ouachita Mtns.
1406. Blackwell Oil & Gas 1 Mount; 13-4N-6E. *Okla. Geol. Surv. (Shell).
1407. Hall 1 Stockton; 2-6N-5E. *Okla. Geol. Surv. (Shell).

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25. Mamay and Read, 1956, p. 212-213. 18S-25E.

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48. Fettke, 1961, p. 185 (South Penn Oil 4 Warrant 3416).
50. South Penn Oil D-92 Bingham West; 1 mile NE. of Davis. *Pennsylvania Geol. Surv.
51. Fuller and Alden, 1903, p. 3 (head of Painter Run).
52. Butts, 1910b, p. 6, fig. 9 (N. of Morrison Run).
55. Minard Run Oil G-13 Dent-Whitney; 1.5 miles NW. of Irishtown. *Pennsylvania Geol. Surv.
56. Fettke, 1938, p. 18 (Kinzua viaduct), pl. 3 (sec. L16).
57. Platt, 1880, p. 74-76.
58. Platt, 1878, p. 226 (2 miles N. of Gaines).
59. Fuller and Alden, 1903, p. 3 (head of Big Asaph Run).
60. Fuller, Irving, and Butts, 1903, geologic map and structure section, Elkland quad. (head of Canada Creek).
63. South Penn Oil 208 Upper Farm; 1.3 miles W. of Mt. Jewett. *Pennsylvania Geol. Surv.
64. Platt, 1880, p. 36 (Whittemore Run).
65. Platt, 1878, p. 163 (Blossburg).
66. Platt, 1878, p. 166 (Fall Brook mines).
67. White, 1881, p. 168-169, 172 (NE. of Meadville).
68. White, 1881, p. 186 (Hydetown).
69. Ashburner, 1880, pl. 11 (Kane-Lodlow and Kane secs.).
70. Ashburner, 1885, p. 68-69.
71. Ashburner, 1885, p. 84 (fig. 7), p. 87-88.
72. Ashburner, 1885, pl. 7 (sec. 5).

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73. d'Invilliers, 1895, pl. 430 (opposite p. 2268). Arnot.
74. Lesley and others, 1878, p. 125, 127 (Barclay basin).
75. Lesley, d'Invilliers, and Smith, 1895, p. 1954 (1 mile W. of Forest City).
76. White, 1881, p. 146 (Millers Knob).
77. Lesley, d'Invilliers, and Smith, 1895, p. 1752 (pl. 255, sec. 2).
78. White, 1881, p. 122-123.
79. Quaker State Oil Ref. 10 August; Oil Creek Township. *Pennsylvania Geol. Surv.
80. W. F. Clinger 104 Warrant 5110; ridge between Fourmile and Guiton Runs of Salmon Creek, Jenks. *Pennsylvania Geol. Surv.
81. Fettke, 1961, p. 263-276.
83. Hanley and Bird 1231 Armstrong Forest Co.; SW. slope of Spencer Run. *Pennsylvania Geol. Surv.
84. Ashburner, 1885, p. 104 (fig. 19), p. 106.
85. Sheafer, 1885, p. 18 (E. Shippen sec.).
86. Platt, 1880, p. 69-70.
88. Sherwood and Platt, 1880, p. 121-122, 124-125.
89. Ashburner and others, 1883-1889a, pt. 5, columnar sec. sheet 15, logs 7, 14, 31.
90. White, 1880, p. 199. Snodgrass quarry, NE. of Jamestown.
91. P. M. Bortz and Assoc. 1 F. B. and Mary Lena McCracken; NW. of Mill Creek School, Mill Creek. *Pennsylvania Geol. Surv.
92. Gale P. Oakes 1 Wilbur and Henry Moore; 1 mile N. of Younk Hill School. *Pennsylvania Geol. Surv.
93. Marienville Devel. 4-MD Wagner and Wilson; 1.5 miles SE. of Marienville. *Pennsylvania Geol. Surv.
95. Chance, 1880, p. 142-143.
98. Chance, 1880, p. 141-142.
99. Lee A. Minter 1 Fletcher Coleman heirs; Shippen. *Pennsylvania Geol. Surv.
100. Lesley, d'Invilliers, and Smith, 1895, p. 1740 (pl. 249).
101. Sherwood and Platt, 1880, p. 93. Little Pine Creek basin.
102. Sherwood and Platt, 1880, p. 124-125.
103. Sherwood and Platt, 1880, p. 221. S. of Forksville.
105. Sherwood and Platt, 1880, p. 178-199.
106. Lesley, d'Invilliers, and Smith, 1895, p. 2013-2015.
107. Ashburner and others, 1883-1889a, pt. 5, columnar sec. sheet 13 (logs 2, 12). (Log 1 on sheet 14 same as log 12 on sheet 13).
109. White, 1880, p. 158 (Morris Coal Co. shaft), p. 160 (Living Stone Furnace).
110. White, 1880, p. 50 (Madge Farm 5 coal test), p. 57 (Meyer's quarry).
111. White, 1880, p. 174 (Bromley land), p. 168 (Mercer Iron and Coal 1 bore hole).
112. White, 1880, p. 182. Maple Grove Coal Co.
113. Sherrill and Matteson, 1941, p. 6-8.
114. B. J. Owczycowsky and James A. Boyer 2 Owczycowsky; Salina, Cranberry. *Pennsylvania Geol. Surv.
115. United Nat. Gas 3784 well; W. of Centerville. *Pennsylvania Geol. Surv.
116. Dickey, Sherrill, and Matteson, 1943, p. 141-144.
119. Ashburner, 1885, p. 306 (fig. 90), p. 307 (Jenks sec.).
120. Ashburner, 1885, pl. 6 (Spring Creek well, 2 miles E. of Hallton).
121. Ashburner, 1885, p. 184-186.
122. New York State Nat. Gas 1 Merle I. St. John; SW. of West Branch Hicks Run. *Pennsylvania Geol. Surv.
123. Sheafer, 1885, pl. 5. Sterling
124. Sheafer, 1885, p. 41-42.
125. Chance, 1880, p. 78. Karthaus Coal & Lumber coal test.
127. Lesley, d'Invilliers, and Smith, 1895, pl. 312 (opposite, p. 1948, Scranton log), pl. 318 (opposite p. 1968, Manville Colliery log), pl. 319 (opposite p. 1970, Brisbin Colliery log).
128. White, 1880, p. 163. D. Moyer Farm 2 miles above Big Bend.
131. Chance, 1880, p. 149 (Snydersburg well). Lesley, d'Invilliers, and Smith, 1895, p. 1654, (pl. 240, Loyalsock Creek sec.).
133. James A. Mays 48 James A. Mays; 2 miles NE. of Sigel. *Pennsylvania Geol. Surv.
134. Williams, 1960, p. 914, fig. 3 (sec. 4).
135. Ashburner, 1885, p. 207 (SW. of Kyler's Corners), p. 214 (SW. of Kyler's Corners).
136. Ashburner, 1885, p. 244-246.
138. Chance, 1880, p. 135-136.
139. Chance, 1880, p. 134-135.
140. Chance, 1880, p. 74, 77. Renovo coal basin, N. bluff, W. Branch, Susquehanna River, between Drury and Shintown Runs.
141. Ebright, 1952, p. 26. W. Fork, Susquehanna River, across from Glen Union.
142. Ashburner and others, 1883-1889a, pt. 2, columnar sec. sheet 6 (logs 1, 12).
143. *G. H. Wood, Jr., USGS, 1971, written commun.
145. Carswell and Bennett, 1963, fig. 5 (wells 126, 369).
146. Carswell and Bennett, 1963, fig. 6 (wells MR 963, MR 1273).
147. Poth, 1963, well 1183.
148. Poth, 1963, log 930, 1.25 miles WNW. of Grove City.
149. Shaw and Munn, 1911a, pl. 6 (sec. 1), pl. 8 (secs. 2, 3).
151. Shaw, Lines, and Munn, 1911, p. 6-7. Foxburg quad. sec.
152. Shaw, Lines, and Munn, 1911, p. 7 (sec. 1 mile SW. of Shippensville).
154. Corsica Drlg. 1 Walter Clark; 1 mile SW. of Watterson. *Pennsylvania Geol. Surv.
156. Hudson D. Smith 2 Leonard J. Smith; Roseville. *Pennsylvania Geol. Surv.
157. F. C. Deemer 2 Brookville Girl Scouts; Redlick Run, Eldred. *Pennsylvania Geol. Surv.
159. Ashburner, 1885, pl. 7 (sec. 9).
160. Felmont Oil and Deemer 2 Green Glen Corp.; Sandy. *Pennsylvania Geol. Surv.
162. New York State Gas 1 George J. Baummer; Huston. *Pennsylvania Geol. Surv.
163. Parsons Bros. 1 State of Pennsylvania, tract 42; Goshen. *Pennsylvania Geol. Surv.
164. Chance, 1880, p. 129-130.
165. Ashburner and others, 1883-1889b, v. 1, pt. 2, columnar sec. sheet 5 (log 12).
166. Lesley, d'Invilliers, and Smith, 1895, pl. 325 (opposite p. 1992).
167. Ashburner and others, 1883-1889a, pt. 2, columnar sec. sheet 5, sec. 21.
168. Chance, 1879, p. 210. Pulaski.
169. Carswell and Bennett, 1963, well 838.
170. Poth, 1963, well MR 69.
172. Fettke, 1961, p. 37-39.
173. Hill Oil and Gas 1 Mary Becker, 2 miles NE. of Branchton. *Pennsylvania Geol. Surv.
174. Shaw and Munn, 1911a, pl. 8 (sec. 5).
176. Manufacturers Light and Heat 2 Isabelle McKee; 0.5 mile SW. of Sligo, Toby Township. *Pennsylvania Geol. Surv.
179. Goal Drlg. 32 E. P. Cyphert; 1.4 miles N. 75° W. of Crates, Limestone Township. *Pennsylvania Geol. Surv.

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182. Graeber and Foose, 1942, pl. 10 (sec. 8), p. 22 (W. of Brookville), p. 23 (Tunnel Hill).
185. Sylvania Corp. 1 C. H. Prescott and others; 1 mile S. of Dubois, Sandy Township. *Pennsylvania Geol. Surv.
188. F. C. Deemer 6 Baker Run Reserve; State Game Lands, Huston Township. *Pennsylvania Geol. Surv.
189. Williams, 1957, secs. 1 mile NW. of Bald Hill and 1 mile NE. of Surveyor.
    New York Nat. Gas 1 Clearfield Trust Co., 1.5 miles S. of Gillingham, Girard Township. *Pennsylvania Geol. Surv.
191. Chance, 1880, p. 69. Upper Branch of Three Runs, sec. and shaft log.
192. Williams and Nickelsen, 1958, pl. 2, sec. 1.
193. Chance, 1880, p. 166 (Tanggascootac coal basin).
195. Ashburner and others, 1883-1889a, pt. 2, columnar sec. sheet 5 (logs 3, 4, 6).
197. Carswell and Bennett, 1963, fig. 8 (wells La889, La864, and La861).
199. Poth, 1963, well 150.
201. Poth, 1963, Slippery Rock sec. and well BT-17.
204. Shaw, Lines, and Munn, 1911, p. 6 (southern Foxburg quad., gen. sec.), p. 8 (2 miles SE. of Petrolia), deep well sec. 1.
205. Shaw, Lines, and Munn, 1911, p. 6 (southern Foxburg quad., gen. sec.), p. 8 (Queenstown), deep well sec. 6.
210. Williams, 1960, p. 914, fig. 3 (sec. 5).
    Graeber and Foose, 1942, p. 57 (Patton Station).
211. Shaffner, 1946, fig. 33, (log 153).
    Graeber and Foose, 1942, pl. 10 (log 6).
212. Graeber and Foose, 1942, sec. 7. (Ramsaytown).
213. Manufacturers Light and Heat 1 Andrews Real Estate Co.; Camp Run, Sandy Lick Creek. *Pennsylvania Geol. Surv.
214. New York State Gas 1 Helen G. Rhines; Sykesville. *Pennsylvania Geol. Surv.
216. Williams and Nickelsen, 1958, pl. 4 (sec. 40).
217. New York Nat. Gas 1 O. W. McNaul; Pine Township. *Pennsylvania Geol. Surv.
220. Williams, 1957. Sec. 1 mile W. of Shiloh.
    Susquehanna Oil & Gas 1 John Woolridge Est.; Shiloh. *Pennsylvania Geol. Surv.
222. Ashburner and others, 1883-1889a, v. 2, pt. 2, sheet 4, columns 1, 14.
223. DeWolf, 1929, pl. 8 (secs. 50, 51).
226. James H. Duff and others 1 J. Scott Munnell; 2 miles E. of Gibsondale. *Pennsylvania Geol. Surv.
228. Richardson, 1936, p. 76 (drill core, NW. Zelionople quad.), p. 85 (John Smith well).
229. Richardson, 1936, p. 84. Adam Dumbaugh well.
234. Hanley and Bird 1 Kenneth Treece; 1.5 miles E. of Templeton. *Pennsylvania Geol. Surv.
235. Paul E. Shaffer 1 Lloyd Shilling; Oakland. *Pennsylvania Geol. Surv.
236. Butts, 1905a, p. 8 (fig. 5). Drill hole; 1 mile SE. of S. Bethlehem. *Pennsylvania Geol. Surv.
237. Shaffner, 1946, pl. 4 (sec. 1).
    Peoples Nat. Gas 1 Charles W. Ellenburger; McGregory. *Pennsylvania Geol. Surv.
238. Shaffner, 1946, pl. 4 (sec. 2).
    Peoples Nat. Gas 1 George A. Stockdale; E. of Sunrise. *Pennsylvania Geol. Surv.
240. Shaffner, 1946, fig. 10 (log 2), fig. 33 (log 158), fig. 38 (log 172).
    T. W. Phillips Gas and Oil 1 Rochester & Pittsburgh Coal Co.; N. of Wallston. *Pennsylvania Geol. Surv.

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242. Ashley, 1926, pl. 4 (sec. 8).
    F. C. Demmer 2 B. W. Irvin; Bell Township. *Pennsylvania Geol. Surv.
245. Ashley and others, 1940, p. 31, pl. 2 (sec. 7).
    Williams and Nickelsen, 1958, pl. 3 (sec. 19).
247. Williams and Nickelsen, 1958, p. 43-44 (sec. 31).
248. Williams and Nickelsen, 1958, pl. 3 (sec. 21), pl. 4 (sec. 24).
249. Chance, 1884, p. 60-61.
252. Ashburner and others, 1883-1889b, pt. 3, columnar sec. sheet 7 (sec. 25).
254. Ashburner and others, 1883, v. 2, pt. 3, columnar sec. sheet 6 (logs 21, 22).
255. Ashburner, 1883, p. 232-233.
    Lesley, d'Invilliers, and Smith, 1895 (opposite p. 2026, Harleigh sec.), pl. 336.
256. Ashburner and others, 1883-1889b, pt. 2, columnar sec. sheet 5, log 11.
257. DeWolf, 1929, pl. 9 (secs. 72, 74), pl. 10 (sec. 25).
259. DeWolf, 1929, pl. 7 (sec. 16), pl. 10 (sec. 6).
260. Richardson, 1936, p. 14 (2 miles W. of Mountville Church), p. 88 (Chew well).
261. Quaker State Oil 1 F. E. Miller-Yellow Creek; cen., Zelienople quad. *Pennsylvania Geol. Surv.
262. Wittmer Oil and Gas and T. W. Phillips Oil & Gas 1 Perry S. Davis; 1 mile N. of Whitestown. *Pennsylvania Geol. Surv.
263. E. C. Burton and others 1 W. Bunger; Center Township. *Pennsylvania Geol. Surv.
264. Richardson, 1936, p. 80, two drill cores, central rectangle Butler quad.
265. Richardson, 1936, p. 79 (core, E. cen. Butler quad.), p. 82 (Robert Thompson well).
267. T. W. Phillips and others 1 T. Beidenbach; 79° 42′ N., 40° 53′ W. *Pennsylvania Geol. Surv.
268. Peoples Nat. Gas 2 Margaret B. Leason; 1.5 miles NW. of Ewing. *Pennsylvania Geol. Surv.
269. Haws Refractories 1 Lee C. and Flora Zellefrow; West Mosgrove. *Pennsylvania Geol. Surv.
271. Butts, 1905a, well sec. 17.
272. Shaffner, 1946, pl. 4 (secs. 1, 10) (Red Bank Township, gen. sec.).
    Bittinger Drlg. 1 John D. Stiteler; Smicksburg. *Pennsylvania Geol. Surv.
274. Shaffner, 1946, pl. 4 (sec. 7), fig. 34 (log 16).
    T. W. Phillips Gas and Oil 2 Sidney Neale; 0.5 mile N. of Trade City. *Pennsylvania Geol. Surv.
277. Ashley and others, 1940, p. 30 (near Mahaffey), pl. 3, sec. 1.
278. Williams, 1957. 1 mile N. of Kerrmore.
    Ashley and others, 1940, pl. 2 (sec. 4).
279. Williams, 1957, secs. SE. and NE. of New Millport.
    Ashley, 1940, pl. 2 (sec. 21).
281. Williams and Nickelsen, 1958, pl. 2 (sec. 17). *V. C. Shepps, 1960?, Pennsylvania Geol. Surv., 3 miles N. of Madera.
283. Williams and Nickelsen, 1958, pl. 2 (sec. 8).
    Chance, 1884, p. 84 (Log near Phillipsburg).
286. Ashburner and others, 1883-1889b, pt. 2, columnar sec. sheet 5 (log 2).
288. Ashburner, 1883, p. 44-45, p. 49 (Tunnel 1), p. 50 (Rhume Run Gap sec.).
289. DeWolf, 1929, pl. 9 (secs. 62, 68), pl. 10 (sec. 23).
291. DeWolf, 1929, pl. 7 (secs. 3, 6), pl. 8 (sec. 37).
294. Richardson, 1936, p. 77, p. 78 (SE. Zelienople quad.), p. 87 (Ida Graham well).
298. Butts, 1904, well sec. 6.

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299. Pittsburgh Plate Glass 2 Mary A. McGinley; Nicholson Run, S. Buffalo Township. *Pennsylvania Geol. Surv.
301. Butts, 1905a, well sec. 10.
302. Butts, 1905a, well sec. 7.
304. Shaffner, 1946, pl. 4 (sec. 13).
307. Ashley, 1926, pl. 4 (sec. 14).
H. P. McEvoy 1 J. Cloid Rinn; Gorge of Little Mahoning Creek, Canoe Township. *Pennsylvania Geol. Surv.
308. Ashley, 1926, pl. 4 (sec. 15).
T. W. Phillips Gas & Oil 1 Winifred P. Clark; 1.3 miles SW. of Glen Campbell. *Pennsylvania Geol. Surv.
312. Ashley and others, 1940, pl. 2 (secs. 18, 21).
314. Williams and Nickelsen, 1958, pl. 2 (sec. 12).
*V. C. Shepps, Pennsylvania Geol. Surv., 1960, 2 miles SE. of Houtzdale. 2.5 miles SE. of Houtzdale. 3 miles E. of Houtzdale.
315. Ashburner and others, 1883-1889c, pt. 2, columnar sec. sheet 1 (sec. 1).
316. Ashburner and others, 1883-1889c, pt. 2, columnar sec. sheet 1 (sec. 2).
317. Danilchik, Arndt, and Wood, 1962, sheet 2 (secs. 1-3).
318. *G. H. Wood, Jr., USGS, 1971, written commun.
319. Ashburner and others, 1883-1889c, pt. 2, columnar sec. sheet 3 (sec. 14).
321. Danilchik, Rothrock, and Wagner, 1955, Map C-21, sheet 2. Mine tunnel sec., Mahanoy Basin.
322. Maxwell and Rothrock, 1955, Map C-25, sheet 2, Mahanoy Basin.
324. *G. H. Wood, Jr., USGS, 1971, written commun.
325. James H. Duff and John T. Galey 1 Eliza Allen; 2 miles N. of Blackhawk. *Pennsylvania Geol. Surv.
326. Woolsey, 1905, Detailed sec. sheet (well 27, sec. B).
Sisler, 1926, p. 59, log 14.
328. Munn, 1911b, columnar sec. sheet (surface secs. 3, 4).
Woolsey, 1905, log 33.
331. Purvis and Borland 1 Skraber; Adams Township. *Pennsylvania Geol. Surv.
333. Hughes, 1933, p. 182, sec. 17 (Kerr Coal Co.).
White, 1891, p. 111 (Freeport).
Carll, 1890, p. 193 (Philadelphia Gas Co. Friendly well).
334. Hughes, 1933, p. 50 (fig. 24), p. 52 (fig. 25, sec. 28), p. 178 (sec. 3), p. 181 (sec. 13), p. 264, pl. 8 (secs. 2, 3).
335. Hughes, 1933, p. 38 (fig. 15, secs. 17, 18), pl. 8.
Platt, 1880, p. 57 (Crooked Creek).
White, 1891, p. 109 (Allegheny River below Crooked Creek).
336. Pittsburgh Plate Glass 2 Wayne R. Schaeffer; 1 mile NE. of Brick Church. *Pennsylvania Geol. Surv.
338. Peoples Nat. Gas 2 E. Marie Kimmel; Gastown. *Pennsylvania Geol. Surv.
340. Richardson, 1904, columnar sec. sheets 1 (log A), 2 (log 6).
342. Campbell, Clapp, and Butts, 1913, p. 4, fig. 5 (secs. A, B).
343. Campbell, Clapp, and Butts, 1913, p. 4, fig. 5 (sec. K).
Platt and Platt, 1877a, p. 179. Cherry Tree core.
344. Campbell, Clapp, and Butts, 1913, p. 4, fig. 5 (sec. L).
346. Platt and Platt, 1877a, p. 89. Muddy Run.
347. Wood, Trexler, and Kehn, 1969, pl. 1 (cols. 24, 25), pl. 2 (col. 37).
348. Wood, 1972.
349. Ashburner and others, 1883-1889d, pt. 4, columnar sec. sheet 4 (secs. 10, 12).
352. Woolsey, 1905, detailed sec. sheet (well 31).
353. Munn, 1911b, columnar sec. sheet (surface secs. 6, 7, deep well sec. 2).

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Natl. Supply 1 Spang-Chalfin and Div.; 1.3 miles N. of Ambridge. *Pennsylvania Geol. Surv.
355. Munn, 1911b, columnar sec. sheet (surface secs. 11, 12).
Munn, 1910, p. 43-44.
357. South Penn Oil 5 Fred Backus; Cedar Run, West Deer Township. *Pennsylvania Geol. Surv.
358. Hughes, 1933, p. 27 (Freeport quad., sec.), p. 54 (col. 34), p. 182 (col. 18), pl. 8 (col. 5).
360. Hughes, 1933, pl. 15 (sec. 19).
Peoples Nat. Gas 1 Effie J. Heckman; 1 mile S. of Parkville. *Pennsylvania Geol. Surv.
361. Pittsburgh Plate Glass 1 C. E. Davis; 1 mile SW. of Cochran Mills. *Pennsylvania Geol. Surv.
364. Peoples Nat. Gas 1 Ralph E. Greene; 2 miles N. of Coleman Hill. *Pennsylvania Geol. Surv.
365. Richardson, 1904, columnar sec. sheet 1 (logs C, E, 12).
366. Delta Drlg. 1-D J. S. Ralston; east of Lick Creek, Cherryhill Township. *Pennsylvania Geol. Surv.
367. Campbell, Clapp, and Butts, 1913, p. 4, fig. 5 (secs. C, E).
368. Campbell, Clapp, and Butts, 1913, p. 4, fig. 5 (secs. D, H).
369. Campbell, Clapp, and Butts, 1913, p. 4, fig. 5 (secs. I, J).
371. Campbell, Clapp, and Butts, 1913, p. 4 fig. 5 (secs. P, Q).
372. Campbell, Clapp, and Butts, 1913, p. 4, fig. 5 (sec. S).
373. Wood, Trexler, and Kehn, 1969, pl. 1 (col. 5).
375. Wood, Trexler, and Kehn, 1969, pl. 1 (col. 14).
377. Woolsey, 1905, detailed sec. sheet (well 28).
379. Munn, 1910, p. 31 (Carnot), p. 40-41.
White, 1891, p. 73. Cockran Flemings core.
380. Munn, 1910, p. 42-43.
381. Munn, 1911b, columnar sec. sheet (surface sec. 10, well sec. 13).
383. Richardson, 1932, pl. 5, cols. 1, 2.
385. Richards Drlg. 1 Merle A. McCutcheon; 1 mile W. North Washington. *Pennsylvania Geol. Surv.
387. General Refractories 1 Brick Plant; Salina, near Kiskiminetas River. *Pennsylvania Geol. Surv.
388. Stone, 1905, p. 5 (between Blacklegs Creek and Long Run), p. 6 (Elders Ridge).
T. W. Phillips Gas and Oil 1 E. A. Dean; Young Township. *Pennsylvania Geol. Surv.
390. Peoples Nat. Gas 1 J. M. Johnston, 40° 34′ N., 79° 13′ W. *Pennsylvania Geol. Surv.
391. J. C. Walker 1 H. C. Griffith; 2.5 miles NE. of Homer. *Pennsylvania Geol. Surv.
393. Felmont Oil 1 Charles A. Ferrier; 1.5 miles W. of Blaides. *Pennsylvania Geol. Surv.
394. Campbell, Clapp, and Butts, 1913, p. 4, fig. 5 (sec. R).
396. Dutcher, Ferm, Flint, and Williams, 1959, fig. 18, sec. 1 mile E. of Coupon.
397. Wood, Trexler, and Kehn, 1969, pl. 1 (col. 3).
398. Wood, Trexler, and Kehn, 1969, pl. 1 (col. 4).
399. Wood, Trexler, and Kehn, 1969, pl. 3 (col. 38).
401. Woolsey, 1905, detailed sec. sheet (well 29).
402. Texas 1 A. S. Kraba; Robinson Township. *Pennsylvania Geol. Surv.
403. Munn, 1911a, p. 24; pl. 2 (log 102).
405. Munn, 1911a, p. 11-12.
407. Johnson, 1929, p. 48 (sec. 1 mile SE. of Wilkinsburg), p. 53 (sec. 58), p. 114 (log 4), p. 183 (0.5 mile N. of Wilkinsburg).
408. Johnson, 1929, p. 22-23, 41 (3 miles NW. of Clugston).
Universal Atlas Cement Co. core; Universal. *H. L. Rader, 1951.

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409. Johnson, 1925, p. 43-44, p. 44 (drill hole SE. of New Texas), p. 140 (R. G. Sharp well).
410. Johnson, 1925, p. 36 (sec. 1 mile N. of Export), p. 46 (5 miles N. of Export), p. 69 (core, Export), pl. 10, log 7.
411. Johnson, 1925, p. 47 (log 3 miles NW. of Sloan), p. 152-153, pl. 2 (log 4).
413. Peoples Nat. Gas 1 Brice H. Fitzgerald; 2.5 miles NE. of Tunnelton, Conemaugh Township. *Pennsylvania Geol. Surv.
415. Shaffner, 1958, pl. 2 (secs. 1, 3).
416. Shaffner, 1958, pl. 3 (log Ba4), pl. 13 (sec. 9).
417. Shaffner, 1958, p. 34 and 39, pl. 2 (log 23), pl. 4 (log 18).
418. Shaffner, 1958, pl. 2 (log 20).
420. Peoples Nat. Gas 1 G. W. Mumford, 40° 26′ N., 78° 45′ W. *Pennsylvania Geol. Surv.
421. Peoples Nat. Gas 1 Wm. A. Krempasky; 40° 26′ N., 78° 43′ W. *Pennsylvania Geol. Surv.
422. Platt and Platt, 1877a, p. 30. Drill hole, Cresson.
423. Butts, 1905b, p. 3 (figs. 3, 4), p. 4 (fig. 6), columnar sec. sheet (gen. sec.).
425. Johnson, 1929, p. 37c (NW. of Willock), p. 39 (W. of Willock), p. 213-214, pl. 31 (log 8).
426. Johnson, 1929, p. 36 (col. 3), p. 38b (Dravosburg to Thompson Run), p. 47b (1 mile E. of Dravosburg), p. 114, p. 215b (log 2), p. 216a (log 1), pl. 21 (log 10).
428. Johnson, 1925, p. 23-24, 41-42, 68-69.
429. Johnson, 1925, p. 24 (S. of Export), p. 45-46, 69-70, 143-144.
430. Johnson, 1925, p. 56 (1 mile S. of Delmont), p. 151-152.
431. Mid-Atlantic Oil and Gas 1 Andrew Perach; near Crabtree. *Pennsylvania Geol. Surv.
433. Peoples Nat. Gas 2 Lucille Bertoncine; 2.5 miles SW. of Blairsville. *Pennsylvania Geol. Surv.
434. Shaffner, 1958, p. 28 and 36 (Torrance), pl. 2 (log 15).
435. Shaffner, 1958, p. 20 (core at West Fairfield, Lockport sec., and C. N. Gross 1 R. A. Ross), pl. 5 (sec. 3).
438. Phalen and Martin, 1911, p. 47. E. Conemaugh.
439. Phalen, 1910, p. 4 (Johnstown quad. sec.), p. 6 (Wilmore basin logs).
440. Butts, 1905b, columnar sec. sheet, gen. sec.
442. Weir Walker 1 Patterson; 1 mile S. of Woodrow. *Pennsylvania Geol. Surv.
443. Shaw and Munn, 1911b, columnar sec.
Martens, 1939, p. 54-64.
444. Munn, 1911a, pl. 3 (log 206).
445. Johnson, 1929, p. 37 (sec. f), p. 40 (sec. c), p. 45 (sec. i), pl. 22 (log 16).
446. Johnson, 1929, p. 36 (sec. 5), p. 45 (sec. 7), p. 186 (Union Sewer Pipe quarry), p. 228 (log c), pl. 22 (log 19).
449. Johnson, 1925, p. 47-48, p. 148 (American Nat. Gas 1 C. H. Roose).
450. Johnson, 1925, p. 24-25, 150-151.
451. Johnson, 1925, p. 48-49.
Peoples Nat. Gas 1 Unity Cemetery Assoc.; N. of Carney. *Pennsylvania Geol. Surv.
452. Sayman Salt well; Sayman Run, near Latrobe. W. H. Haupt 1 Alex and Albert Hoza; 1 mile NW. of Latrobe. *Pennsylvania Geol. Surv.
453. Shaffner, 1958. T. W. P. Co. 1 J. B. Phillips; SW. New Florence quad.
454. Shaffner, 1958, pl. 4 (log 25), pl. 5 (sec. 4).
455. Shaffner, 1958, pl. 2 (log 24).
456. Phalen, 1910, p. 4 (near Johnstown; Kring Station), p. 13 (hill E. of Johnstown).

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457. Butts, 1946, p. 14 (Great Trough Creek sec., Wrays Hill and Rocky Ridge sec.).
458. Taylorstown Nat. Gas 2 Grace Mahaffy and Mary M. Kerr; 2 miles SE. of Acheson. *Pennsylvania Geol. Surv.
459. Munn, 1912, Deep well sheet (well 18).
460. Munn, 1912, p. 4, 15 (log 12).
461. Fettke and Stephenson, 1946, p. 3-7.
463. Manufacturers Light and Heat 1 Mike Furda; 1 mile NE. of Denningsville. *Pennsylvania Geol. Surv.
465. Campbell, 1903, p. 18. American Window Glass 1 Stephen Applegate.
466. Peoples Nat. Gas 2 John Lenar; 1.5 miles SW. of West Newton. *Pennsylvania Geol. Surv.
467. James Drlg. 1 Austin Book; 1.5 miles north of Armbrust. *Pennsylvania Geol. Surv.
469. Stevenson, 1878, p. 129 (near Ligonier), p. 135 (Laurel Run).
470. Platt and Platt, 1877b, p. 223. Forwardstown.
471. Phalen and Martin, 1911, p. 92. Scalp Level.
472. Gardner, 1913, p. 28-29.
474. Munn, 1912, deep well sec. 17.
478. Campbell, 1903, p. 18. T. L. Daly 3 Gibson.
480. Hickock and Moyer, 1940, p. 62. Jacob Creek sec. W. flank Fayette anticline.
Lloyd E. Miller 1 Ross M. Kolley; 1.5 miles SE. of Centerville. *Pennsylvania Geol. Surv.
481. Hickock and Moyer, 1940, p. 110 (Standard 2 shaft), p. 186 (log 3b).
482. Hickock and Moyer, 1940, p. 56. W. side Chestnut Ridge sec.
484. Peoples Nat. Gas 1 Blanche G. Clark; 0.5 mile N. of Laurel Summit. *Pennsylvania Geol. Surv.
485. Felmont Oil 1 Clarence W. Friedline; W. of Sipesville. *Pennsylvania Geol. Surv.
486. Felmont Oil 1 Robert F. Henninger; W. of California School, Quemahoning Township. *Pennsylvania Geol. Surv.
487. Peoples Nat. Gas 1 R. F. Grove; 2 miles SE. of Stoyestown. *Pennsylvania Geol. Surv.
488. Gardner, 1913, p. 26, 33-34. Sandy Run.
489. Gardner, 1913, p. 25-26.
490. Gardner, 1913, p. 35. Shaft log near Woodvale.
492. Manufacturers Light and Heat 1 W. H. Ealy; East Finley Township. *Pennsylvania Geol. Surv.
493. Dunn-Mar Oil and Gas 1 M. M. and Pearl Hupp; 0.5 mile E. of Condit Crossing, Amwell Township. *Pennsylvania Geol. Surv.
494. Manufacturers Light and Heat 1 George F. Bird; 2 miles NE. of Tenmile. *Pennsylvania Geol. Surv.
495. Manufacturers Light and Heat 5 W. M. Evans; Amwell Township. *Pennsylvania Geol. Surv.
496. McCormick Drlg. 1 McCarty; 0.5 mile N. of Riverville, East Bethlehem Township. *Pennsylvania Geol. Surv.
498. G. A. Bargly, Jr., 1 Mark and Leona Williams; 1 mile SE. of Redstone. *Pennsylvania Geol. Surv.
499. Manufacturers Light and Heat 1 St. Basil the Great; 2 miles NW. of Dawson, Youghiogheny River. *Pennsylvania Geol. Surv.
502. Hickock and Moyer, 1940, p. 331, log 8.
Shaffner, 1963, logs 12, 15, SW. Donegal quad.
503. Shaffner, 1963, logs 8, 10. S. Cen. Donegal quad.
504. Peoples Nat. Gas 3 Pennsylvania Dept. Forests and Waters, tract 75; 1.5 miles S. of Harrison School. *Pennsylvania Geol. Surv.

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507. Peoples Nat. Gas 1 Wm. H. Shaver; 40° 3′ N., 78° 59′ W. *Pennsylvania Geol. Surv.
509. Clapp, 1907, columnar sec. sheet (well 8).
511. Martens, 1945, p. 849-856.
512. Peoples Nat. Gas well 3541; Morgan Township. *Pennsylvania Geol. Surv.
513. Stone, 1905, p. 5. Rices Landing.
   Equitable 1-3597 Effie Bonnell; 1.9 miles E. 10° S. of Jefferson.
   Peoples 1-3562 W. M. King; 1.3 miles S. 25° E. of Jefferson. *USGS.
515. Hickock and Moyer, 1940, p. 106. Filbert hoisting shaft.
516. Hickock and Moyer, 1940, p. 78 (Fayette County Sec.), p. 105 (H. C. Frick Coal & Coke, Brier Hill shaft).
   Campbell, 1902, p. 18. Hugh Thompson 1 well.
518. Hickock and Moyer, 1940, p. 85 (Dunbar Creek), p. 111 (Leisenring 1 shaft), p. 286 (columnar secs. 4, 5).
520. Hickock and Moyer, 1940, p. 57 (George Kern Farm log), p. 67 (Martin Minor Farm), p. 68 (George Kern Farm log), p. 331 (log 3).
521. Kuhn, 1952, p. 63-72 (1.75 miles NW. of Berlin, 1 mile W. of Berlin, and 1.5 miles SW. of Brotherton).
524. Clapp, 1907, columnar sec. sheet (well 6).
526. Martens, 1945, p. 847-848.
527. Texas Eastern Gas Trans. core 1; 39° 54′ N., 80° 12′ W. *Pennsylvania Geol. Surv.
   M. C. Brumage & Sons 1 T. William and Mary L. Barnes; 1 mile SE. of Oak Forest. *Pennsylvania Geol. Surv.
528. Carnegie 734 Ingraham; 2.5 miles N. of Cummins. *USGS.
530. Campbell, 1902, columnar sec. sheet 2 (Gates mine shaft).
531. Peoples Nat. Gas 1 Frank J. Martin; German Township. Pennsylvania Geol. Surv.
532. Gerthoffer and Jones 1 S. H. Powers; Footdale. *Pennsylvania Geol. Surv.
533. Campbell, 1902, columnar sec. sheet 2 (Leith mine shaft).
   Hickock and Moyer, 1940, p. 63, 84, 267 (secs. near Hopwood).
534. Hickock and Moyer, 1940, p. 66 (Cucumber Falls).
   Peoples Nat. Gas 1 Melvin Spruell; Stewart Township. *Pennsylvania Geol. Surv.
535. Hickock and Moyer, 1940, p. 56 (near Ohiopyle), p. 65 (1 mile N. of Ohiopyle).
536. Platt and Platt, 1877b, p. 194-195, 202-203.
538. Flint, 1965, p. 262-267.
   Kuhn, 1952, p. 63-72 (secs. 0.25 mile NE. of Goodtown, 1 mile N. of Berkeleys Mill, on Buffalo Creek N. of Goodtown, 0.75 mile SE. of Berlin, and 0.75 mile SE. of shaft at Sales Mines).
539. Clapp, 1907, columnar sec. sheet (well 2).
540. Peoples Nat. Gas 3283 R. L. Wise; Jackson Township. *Pennsylvania Geol. Surv.
542. Equitable Gas 1454 Hiram Gordon; 1.3 miles NW. of Gump. *USGS.
545. Campbell, 1902, p. 19 (David Gans well).
546. Campbell, 1902, p. 19 (E. L. Geer 1 Smithfield).
549. Hickock and Moyer, 1940, p. 80 (2 miles W. of Somerfield).
550. Hickock and Moyer, 1940, p. 80 (0.5 mile N. of Somerfield).
552. New York State Nat. Gas 1 Pennsylvania Dept. Forests and Waters, tract 64; E. slope of Mt. Davis, Negro Mtn. anticline. *Pennsylvania Geol. Surv.
553. Kuhn, 1952, p. 63-72 (secs. 1 mile E. of Meyersdale, and along railroad cut through Allegheny Mtn. along Flaugherty Creek).
554. Hennen and Reger, 1913, p. 422-423.
555. Hickock and Moyer, 1940, p. 64 (Springhill Furnace), p. 78 (Fayette County sec.), p. 84 (0.5 mile S. of Gans), p. 244 (sec. 8).
556. Hickock and Moyer, 1940, p. 81 (O'Neil Farm log), p. 343 (sec. 3).
558. Lesley, 1885, p. 230-232.
559. Big Bend Dam. *Pennsylvania Geol. Surv.

RHODE ISLAND

2. Quinn, Ray, and Seymour, 1948. Pawtucket quad.
3. Richmond, 1952, Georgiaville quad.
4. Woodworth, 1899, p. 161. Old well log, Providence.
5. Quinn and Springer, 1954. Bristol quad.
6. Quinn, 1952. East Greenwich quad.
7. Foerste, 1899, p. 322-325.
8. Foerste, 1899, p. 352-369.
9. Foerste, 1899, p. 333-336.
10. Nichols, 1956. Narragansett Pier quad. Quinn and Oliver, 1962.

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5. Baker, 1947 (rev. 1953), p. 37-40. 13-2N-8E.
9. Baker, 1951, p. 8-11. 12-8N-5E.
10. Agnew and Lange, 1961, map 6. 98N-64W.
11. Baker, 1951, p. 16-20. 25-4S-7E.
12. Rocky Mountain Association of Geologists 1963, cross section A-B, log 12. Baker, 1951, p. 25-30.
13. Weller and Bush 1 Weisman; 30-7N-4E. *AmStrat.
14. Baker, 1951, p. 44-46. 6-104N-74W.
15. Baker, 1951, p. 47-55. 19-3N-7E.
17. Baker, 1948, p. 3-4. 36-111N-62W.
18. Baker, 1948, p. 5. 123-63W, 64W.
21. Baker, 1947, p. 8-10. 35-111N-79W.
22. Baker, 1947, p. 11-12. 26-5N-28E.
23. Baker, 1947 (rev. 1953), p. 16-21. 16-6N-27E.
24. Carter 2 South Dakota; 12-9N-27E. *AmStrat.
25. Carter 1 South Dakota Explor.; 34-118N-78W.
26. Gypsy 1 Hunter; 28-3N-16E. *AmStrat.
29. Baker, 1947, p. 82-86. Amerada 1 Moody; 8-12S-6E. *AmStrat, 1946.
30. Baker, 1947, p. 87-93. 25-36N-48W.
31. Baker, 1947, p. 94-102. Amerada 1 Voorhees; 25-10S-8E. *AmStrat, 1946.
34. Dakota-Texas Oil 1 Williams-Thompson; 27-119N-78W. *NWGS, 1953.
35. Max Pray 1 Kranzler; 14-121N-77W. *AmStrat, 1955.
37. J. P. Evans 1 Querbes-Capp; 9-13N-16E. *AmStrat.
38. Kerr-McGee 1 Brammer; 20-13N-20E. *AmStrat.
39. Kerr-McGee 1 Wallace Cook; 32-13N-22E. *AmStrat, 1956.
40. Hunt Oil 1 Paul Peterson; 7-20N-3E. *AmStrat, 1959.
42. Sidney A. Martin 1 Eucks; 20-36N-41W. *AmStrat, 1952. *A. F. Agnew, South Dakota Geol. Surv., 1961.
43. Amerada 1 State; 4-14N-4E. *AmStrat, 1956.
44. Shell 1 Veal; 7-17N-15E. *AmStrat.
45. Shell 1 J. T. Homme; 13-20N-12E. *AmStrat.
46. Youngblood and Youngblood 1 Galvin; 25-16N-22E. *AmStrat, 1956.
47. Shell 1 J. K. Winter; 11-22N-19E. *AmStrat, 1956.
49. Peppers Ref. 1 Fee; 36-123N-76W. *AmStrat, 1957.
51. N. B. Hunt 1 Gutenkauf; 20-118N-72W. *NWGS.
52. Carter 1 J. W. Danielson; 5-3N-22E. *AmStrat, 1955.
53. N. B. Hunt 2 Lakota; 24-116N-73W. *NWGS.

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54. Kerr-McGee 1 Fred Chute; 33-3N-19E. *AmStrat; NWGS, 1957.
55. Ward Dayton 1 Olson; 35-12N-20E. *AmStrat.
56. S. E. Pohle Enterprises 1 State; 16-4N-18E. *AmStrat.
58. Shell 1 State "A"; 9-21N-4E. *AmStrat; NWGS, 1954.
62. Baker, 1947, p. 13-15. 36-5N-27E.
67. Youngblood and Youngblood 1 MacHeel; 8-21N-19E. *AmStrat, 1955.
68. Richfield 1 State; 16-17N-4E. *AmStrat, 1959.
71. Shamrock 1 Barrick; 29-8N-27E. *AmStrat.
73. Youngblood and Youngblood 1 Anderson; 26-21N-14E. *AmStrat, 1956.
74. Youngblood and Youngblood 1 Draskovich; 20-23N-22E. *AmStrat.
76. Stanolind 1 Clark; 11-22N-2E. *AmStrat, 1957.
79. McCarty and Coleman 1 Shull; 3-1S-14E. *AmStrat, 1955; *South Dakota Geol. Surv., 1960.
80. Hunt and Zach Brooks 1 Federal; 8-22N-11E. *AmStrat, 1958.
83. Bates, 1955, p. 1992-1993, p. 1994 (fig. 4, sec. E). 29, 30, 32-5S-6E. Jennings, 1959, p. 986-1000, fig. 1 (Beaver Creek sec.).
84. Petsch, 1949, p. 19-20. 12-5N-4E. Jennings, 1959, p. 992 (fig. 1, Bear Butte Creek sec.).
85. Shell 2 Herman; 3-1N-29E. *AmStrat.
86. Shell 1 Wilbur Olson and others; 8-2N-26E. *AmStrat.
87. Shell 1 McCrone; 23-3N-25E. *AmStrat.
88. Lion Oil 1 Govt.-Libertin; 9-4N-11E. *AmStrat; NWGS, 1954.
89. Independent Drlg. 1 Charles Hinckley; 7-120N-75W. *AmStrat, 1955.
90. Momper, 1963, p. 51 (fig. 6, log 1).
91. Ohio 1 Paul O. Evenson; 28-21N-1E. *AmStrat, 1957; *NWGS, 1957.
92. Atlantic 1 Knoll-State; 16-2N-16E. *AmStrat, 1959.
93. Jack Campbell 1 Dale; 1-1S-22E. *AmStrat, 1958; South Dakota Geol. Surv., 1960.
95. Superior 1-33 Indian Creek Unit; 33-13N-2E. *AmStrat, 1958.
96. Condra, 1940, p. 34 (fig. 15). 15, 16-7S-5E. Condra and Reed, 1940, p. 37-41. Jennings, 1959, p. 986-1000. Hot Brook Canyon.
97. *Continental Oil, 1953. 7-1N-7E.
102. Thompson and Kirby, 1940, p. 146 (pl. 16, sec. 24), 29-2S-7E.
107. Brobst and Epstein, 1963, p. 360-362. 9-3S-1E.
111. Mobil Prod. F-21-9-G Govt.; 9-22N-1E. *AmStrat, 1958; NWGS, 1957.
112. Shell 14-4 Johnson; 4-21N-8E. *AmStrat, 1957.
113. Shell 11-23 Govt.; 23-19N-18E. *AmStrat, 1957.
114. Shamrock 3 Barrick; 23-7N-26E. *AmStrat, 1957; NWGS, 1955.
116. General Crude Oil 1 Straka; 22-105N-72W. *AmStrat, 1960, NWGS, 1957.
117. General Crude Oil 1 Vogt; 25-99N-79W. *AmStrat, 1958; *South Dakota Geol. Surv., 1960.
118. General Crude Oil 1 Shippy; 5-96N-75W. *AmStrat, 1960.
119. General Crude Oil 1 Rural Credit Board; 33-95N-77W. *AmStrat, 1958.
123. Youngblood and Youngblood 1 Wheiner; 7-19N-17E. *Amstrat, 1959.
124. Shell 22-12 Everidge; 12-18N-19E. *AmStrat, 1957; NWGS, 1957.
125. Shell 41-23 State; 23-18N-8E. *AmStrat, 1957.

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126. Hunt Oil 1 School Land; 23-18N-1E. *NWGS, 1956.
127. Herndon Drlg. 1 Merkle; 27-17N-27E. *AmStrat, 1957; NWGS, 1956.
128. Amerada 1 U.S.A.-Ellis; 24-17N-1E. *NWGS, 1957.
129. Herndon Drlg. 1 Young; 1-16N-20E. *AmStrat, 1956; NWGS, 1957.
130. Shell 1 Bastian; 7-15N-16E. *AmStrat, 1957.
131. Herndon Drlg. 1 O'Leary; 13-15N-23E. *NWGS, 1956.
132. Herndon Drlg. 1 Butler; 21-12N-19E. *NWGS, 1957.
133. Shell 1(?) W. Johnson 23-23; 23-10N-1E. *AmStrat, 1956; NWGS, 1957.
134. Herndon Drlg. 1(?) Shinost; 26-8N-13E. *AmStrat, 1957.
137. Jennings, 1959, p. 986-1000. 6S-4E.
138. Condra and Reed, 1950, p. 37-41. 34-5S-4E. Jennings, 1959, (Loring Siding).
139. Herndon Drlg. 1(?) Price; 15-9N-13E. *AmStrat, 1956.
141. Herndon Drlg. 1(?) Agnes Oakland; 20-10N-17E. *AmStrat, 1956.
145. Shell 14-18 Dreis and others; 18-17N-18E. *AmStrat, 1958.
150. Braddock, 1963, pl. 21. Wagner 1 Govt.; 26-5S-1E. *South Dakota Geol. Surv., 1960.
152. Kuchera 1 Bartels; 23-100N-77W. *AmStrat, 1960; *South Dakota Geol. Surv., 1960.
153. General Crude Oil 1 Assman Ranch; 22-98N-78W. *AmStrat, 1958; *South Dakota Geol. Surv., 1960.
155. Thompson and Kirby, 1940, p. 146 (pl. 16, sec. 21).
156. *E. K. Maughan, USGS, 1965. 4-2S-23E.
157. *E. K. Maughan, USGS, 1965. 17-2S-25E.
165. Cardinal 1 John Travers; 17-22N-5E. *AmStrat, 1960.
166. Shell 32-31 Nieme "B"; 31-20N-5E. *AmStrat, 1959.
167. Shell 12-3B Brown; 3-20N-5E. *AmStrat, 1960.
168. Signal Drlg. & Explor. and Gulf 1 Olson; 23-20N-7E. *AmStrat, 1960.
171. Mule Creek 41-33 State; 33-13N-10E. *AmStrat, 1960.
172. Herndon Drlg. 1 S. Dak. State; 34-13N-24E. *AmStrat, 1956.
173. Baker, 1948, p. 29. 18-114N-62W.
174. Ohio 1 Reinschmidt; 27-112N-76W. *NWGS, 1957; AmStrat, 1958.
175. Cities Service 1 Wagner; 13-5N-29E. *Schlumberger.

TENNESSEE

1. Wanless, 1946, pl. 37 (sec. 6).
2. Ashley and Glenn, 1906, p. 56. Glenn, 1925, p. 224. Bryson Mtn. and Bennett Fork. *H. R. Wanless, Illinois Univ., 1938. A-67E.
3. Milhous, 1959, p. 488. Superior 1 Reed.
4. Milhous, 1959, p. 447-448.
5. *H. R. Wanless, Illinois Univ., 1938. A-59E.
7. *H. R. Wanless, Illinois Univ., 1938. B-59E.
8. Wanless, 1946, pl. 34 (sec. 13).
10. *H. R. Wanless, Illinois Univ., 1938. B-64E.
11. Wanless, 1946, pl. 31 (sec. 6), pl. 36 (sec. 5).
12. Wanless, 1946, pl. 36 (sec. 6).
13. Wanless, 1946, pl. 33 (sec. 8). Milhous, 1959, p. 12-13.
15. Glenn, 1925, p. 411. Helenwood 1 well.
16. Wanless, 1946, pl. 30 (sec. 6).
17. Wanless, 1946, pl. 24 (sec. 17).
18. Glenn, 1925, p. 266 (log A). *H. R. Wanless, Illinois Univ., 1938. 2S-55E.
19. *H. R. Wanless, Illinois Univ., 1938. 2S-56E.
22. Wanless, 1946, pl. 34 (sec. 9).
23. *H. R. Wanless, Illinois Univ., 1938. 2S-61E.
25. Wanless, 1946, pl. 31 (sec. 7).
27. Wanless, 1946, pl. 32 (sec. 6).

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28. Milhous, 1959, p. 18-20. Columbian Carbon E. Tennessee Iron & Coal.
Tennessee Min. & Mfg. core test; 4-3S-63E. *Tennessee Div. Geol.
29. Milhous, 1959, p. 450-451.
31. Wanless, 1946, pl. 34 (sec. 8). Milhous, 1959, p. 309-310.
32. Milhous, 1959, p. 323-326.
33. Milhous, 1959, p. 149-150.
34. Wanless, 1946, pl. 29 (sec. 5).
36. Glenn, 1925, p. 365-366.
37. Wanless, 1946, pl. 24 (sec. 14).
39. *H. R. Wanless, Illinois Univ., 1938. 4S-57E.
40. Wanless, 1946, pl. 34 (sec. 7). Milhous, 1959, p. 317-320.
41. Wanless, 1946, pl. 32 (sec. 4). Milhous, 1959, p. 2-3.
42. Milhous, 1959, p. 4-5.
44. Wanless, 1946, pl. 32 (sec. 1). Milhous, 1959, p. 5-7.
45. Wanless, 1946, pl. 33 (sec. 2). Glenn, 1925, p. 300-301.
46. Wanless, 1946, pl. 34 (sec. 6).
52. Nelson, 1925, p. 164-165. *H. R. Wanless, Illinois Univ., 1938. 5S-51E.
53. Wanless, 1946, pl. 24 (sec. 11).
54. *H. R. Wanless, Illinois Univ., 1938. Stearns core 1 and sec. 6S-55E.
55. Stearns, 1954, pl. 2 (loc. 8).
56. *H. R. Wanless, Illinois Univ., 1938. 6S-57E.
57. Wanless, 1946, pl. 35 (sec. 1).
58. Wanless, 1946, pl. 33 (sec. 1).
59. Wanless, 1946, pl. 35 (sec. 5).
60. Glenn, 1925, p. 301-302.
61. Wanless, 1946, pl. 35 (sec. 6).
63. Wanless, 1946, pl. 21 (sec. 24).
64. Milhous, 1959, p. 66. 7S-59E.
65. Wanless, 1946, pl. 28 (sec. 4).
66. Wanless, 1946, pl. 24 (sec. 10).
67. *R. G. Stearns, Vanderbilt Univ., 17-8S-43E.
70. Wanless, 1946, pl. 28 (sec. 6).
73. Stearns, 1954, pl. 3 (loc. 9). *H. R. Wanless, Illinois Univ., 1938. 8S-55E.
75. Wanless, 1946, pl. 28 (sec. 8).
76. Wanless, 1946, pl. 21 (sec. 23).
79. Wanless, 1946, pl. 23 (sec. 16). Wanless, 1946, pl. 23, (sec. 17).
80. Glenn, 1925, p. 198. 9S-51E.
81. Wanless, 1946, pl. 27 (sec. 2).
82. Wanless, 1946, pl. 27 (sec. 3).
85. Nelson, 1925, p. 170 (Duskin Creek, Grand View). Wanless, 1946, pl. 21 (sec. 21).
86. *H. R. Wanless, Illinois Univ., 1938. 11S-55E.
87. Wanless, 1946, pl. 22 (sec. 6).
89. *H. R. Wanless, Illinois Univ., 1938. 11S-50E.
90. Wanless, 1946, pl. 24 (sec. 6).
92. *H. R. Wanless, Illinois Univ., 1938. 11S-48E.
93. Wanless, 1946, pl. 24 (sec. 5).
94. Milhous, 1959, p. 559-560.
95. Wanless, 1946, pl. 23 (secs. 11, 12).
98. Wanless, 1946, pl. 21 (sec. 19).
99. Wanless, 1946, pl. 21 (sec. 16).
101. Wanless, 1946, pl. 23 (sec. 8).
102. Wanless, 1946, pl. 24 (sec. 4).
104. Wanless, 1946, pl. 26 (sec. 1).
107. Milhous, 1959, p. 178, Sequatchie Gas 1 Sewanee Fuel and Iron.
109. Wanless, 1946, pl. 26 (sec. 4).
112. Wanless, 1946, pl. 22 (sec. 4).

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115. Wanless, 1946, pl. 21 (sec. 12).
118. *H. R. Wanless, Illinois Univ., 1939. 18S-46E.
122. Wanless, 1946, pl. 25 (sec. 3).
123. *H. R. Wanless, Illinois Univ., 1939. 16S-46E.
125. Wanless, 1946, pl. 23 (sec. 6).
126. *H. R. Wanless, Illinois Univ., 1938, 16S-49E.
127. *H. R. Wanless, Illinois Univ., 1939. 16S-51E.
128. Wanless, 1946, pl. 21 (sec. 10).
129. Wanless, 1946, pl. 21 (sec. 7).
130. Wanless, 1946, pl. 21 (sec. 6).
134. *H. R. Wanless, Illinois Univ., 1939. 17S-45E.
135. Wanless, 1946, pl. 25 (sec. 4).
138. Wanless, 1946, pl. 25 (sec. 7).
140. *H. R. Wanless, Illinois Univ., 1939. 19S-50E.
151. Milhous, 1959, p. 113-115.
152. Milhous, 1959, p. 47-52.
153. Milhous, 1959, p. 284-299.

TEXAS

110. Stanolind 1 O. V. Beck; Hartley. *TPSLS, 1953.
112. I.T.I.O. (Cities Service) 1 S. J. Calvirid; Sherman. *TPSLS, 1955.
300. Anderson-Prichard 1 Gettys; Lamb. *TPSLS, 1952.
301. Stanolind 1 Hopping; Lamb. *TPSLS, 1950.
302. Woodley 1 Bird; Lamb. *TPSLS, 1954.
303. Humble 1 Jackson; Lamb. *TPSLS, 1951.
307. Honolulu and Signal 1 Ellwood Est.; Hockley. *PBSL, 1948.
313. Stanolind 15 American Warehouse Co.; Gaines. *PBSL; PL, 1951.
314. Seaboard Oil 1 M. S. Doss; Gaines. *PBSL; PL, 1949.
Monsanto Chem. 1 Birge; Gaines. PL, 1960.
315. Magnolia W. C. Hicks; Gaines. *PBSL; PL, 1960.
332. Davis and others, 1953. Phillips 1 Schnee (Schneeman); Crockett. *PBSL.
339. Jones and others, 1949. Magnolia 1-D Walton; Winkler.
341. Jones and others, 1949. Stanolind 1-D Taylor; Winkler.
343. Magnolia 1 H. A. Wheeler; Winkler. *PBSL.
345. Phillips 1-A-E Phillips-TXL; Ector. *PBSL.
346. Cities Service 1 J. E. Parker; Ector. *PBSL.
364. Humble 1 F. O. Masten; Cochran. *PBSL, 1949.
372. Stanolind 1 W. T. Stiles; Andrews. *PBSL.
373. Humble 1 Hugh W. Ferguson; Andrews. *PBSL.
376. Stanolind 1-D Univ.; Andrews. *PBSL.
377. Van den Bark, 1957, p. 232-233. Stanolind 1 J. M. Williamson.
378. Scobey and others, 1951. Sinclair 1 Williamson; Ector.
379. Humble 1 Earl Vest; Ector. *PBSL.
383. Scobey and others, 1951. Gulf 1-E J. T. Muir; Crane. *PBSL.
385. Phillips 1 Price; Pecos. *PBSL; PL, 1962.
386. Scobey and others, 1951. Stanolind 1 Hinyard Land & Cattle Co.; Pecos. *PBSL.
393. Ada Oil 1 Walter Cowden Est.; Ector. *PBSL; PL, 1956.
414. Whittenburg 1 Whittenburg-Masterson; Potter. *TPSLS, 1955.
415. Standard of Texas 1 Bush Est.; Potter. *TPSLS, 1952.
416. Sinclair-Prairie 1 Bush "A"; Potter. *TPSLS, 1952.
417. Gulf 1-A Keliehor; Parmer. *TPSLS, 1953.
418. Stanolind 1 Jarrell; Parmer. *TPSLS, 1950.
420. Stanolind 1 Green; Oldham. *TPSLS, 1953.
423. Humble 1-B Matador; Motley. *TPSLS, 1951.
427. Honolulu 1 Halsell; Lamb. *TPSLS, 1950.
428. Stanolind 1 G. F. Buzzard; Hartley. *TPSLS, 1955.
431. Kerr-McGee 2 Berneta; Hartley. *TPSLS, 1952.
432. Shamrock 1 Dammier; Hartley. *TPSLS, 1954.
434. Texas Gulf 1 Matador; Hartley. *TPSLS, 1953.

TEXAS—Continued

435. Standard of Texas 1 Keliehor; Hale. *TPSLS, 1952.
437. N. B. Hunt 1 Overstreet; Deaf Smith. *TPSLS, 1952.
439. Humble 1 Hyslop; Deaf Smith. *TPSLS, 1951.
441. R. H. Fulton and Baker Taylor 1 Evans; Hansford. *TPSLS, 1954.
444. Houston Oil 1 J. S. Lackey; Floyd. *TPSLS, 1951.
445. Sinclair 1 Savage; Swisher. *TPSLS, 1955.
448. V. A. Brill 1 Haley; Hutchinson. *TPSLS, 1954.
461. Texas 1 Capital Syndicate; Dallam. *TPSLS, 1951.
462. Sun 1 A. L. Haberer; Castro. *TPSLS, 1952.
463. Standard of Texas and others 1 W. H. Steakley; Castro. *TPSLS, 1954.
465. Shell 1 W. E. Nichols; Bailey. *TPSLS, 1951.
466. Burdell 1 McGehee; Armstrong. *TPSLS, 1954.
467. Phillips 1 Bivins "Q"; Sherman. *TPSLS, 1951.
468. Phillips 1 Cattle "A"; Hartley. *TPSLS, 1955.
469. D. D. Harrington 1 Brown & Tovrea "A"; Dallam. *TPSLS, 1955.
470. Continental 1 Willis; Dallam. *TPSLS, 1955.
471. Humble 1 Bagwell; Lamb. *TPSLS, 1955.
472. W. H. Taylor and others 1 W. H. Taylor "H"; Hartley. *TPSLS, 1955.
475. Clark Drlg. 1 W. C. Martin; Hartley. *TPSLS, 1955.
512. Pure 1 Wanda Hanks "A"; Upton. *PBSL.
519. Gulf 1 Dean; Dawson. *PBSL; PL, 1947.
521. Standard 1 T. L. Griffin 6; Borden. *PBSL; PL, 1951.
522. Sinclair 1 Sterling Williams; Borden. *PBSL; PL, 1949.
534. Amerada 1 Stribling; Lubbock. *PBSL, 1948.
537. Humble 1 R. N. Irvin and others; Crosby. *PBSL, 1953.
557. Standard of Texas 1 Johnson; Hartley. *TPSLS, 1956.
559. *P. B. King, USGS; Hudspeth. Bass Canyon section.
566. *P. B. King, and J. B. Knight, USGS; Hudspeth. McAdoo section.
567. *P. B. King, and J. B. Knight, USGS; Hudspeth. Circle Ranch section.
580 King, 1949. Hudspeth.
586. Rowan Oil and others 1 Willie L. Grimes; Cochran. *PBSL, 1952.
588. Stanolind 1 D. C. Reed "D"; Cochran. *PBSL, 1954.
589. Texàs 2 L. and C. Mallet "G"; Cochran. *PBSL, 1953.
590. Texas Pacific C. and O. 1 Silvey Thompson; Cochran. *PBSL, 1951.
592. Big Chief Drlg. 1 DeLoache; Hockley. *PBSL, 1950.
599. Honolulu 1-A A. L. Lockett; Hockley. *PBSL, 1953.
601. Sohio 1 Ellwood Est.; Hockley. *PBSL, 1953.
603. Stanolind 1 J. E. Bowman; Hockley. *PBSL, 1953.
620. Continental 1 W. L. Rodgers; Yoakum. *PBSL.
622. R. H. Fulton and others 1 J. C. Keller; Yoakum. *PBSL.
623. General American Oil and others 1 W. J. Richmond; Yoakum. *PBSL.
624. Oceanic Oil and Ashmun & Hilliard 1 Allie S. Graham; Yoakum. *PBSL.
626. Star Oil 1 Taylor Heirs "A"; Yoakum. *PBSL.
627. Texas 1-A Roy Fitzgerald; Yoakum. *PBSL.
628. Murchison and Fikes 1 Mattie Neely; Yoakum. *PBSL.
630. Amerada 1 L. B. Tannehill; Yoakum. *PBSL; PL, 1957.
631. J. S. Abercrombie and others 1 J. C. Rogers; Yoakum. *PBSL; PL, 1957.
632. Amerada 1 L. R. Weems; Yoakum. *PBSL.
633. Plymouth Oil 1 R. A. Cox and others; Yoakum. *PBSL; PL, 1957.
   Jake L. Hamon and others 1 W. D. Carter; Yoakum. *PL, 1960.

TEXAS—Continued

634. Signal Oil and Gas 1 Signal-So. Cal.-Webb; Yoakum. *PBSL; PL, 1960.
   Williamson, Hamon, and U.S. Smelting, Ref. and Mining 1 Brown; Yoakum. *PL, 1960.
635. Stanolind 1 M. E. Lott; Yoakum. *PBSL; PL, 1956.
637. Stanolind 1 E. Albert Williams; Yoakum. *PBSL.
638. Colin Oil 1 N. W. Willard "881"; Yoakum. *PBSL; PL, 1956.
639. Shell 1 C. E. Granger; Yoakum. *PBSL; PL, 1959.
640. Texas 1 Tom Cobb; Yoakum. *PBSL.
641. Stanolind 1 Ida Mae and others; Yoakum. *PBSL.
644. Honolulu 1 H. T. Fillingim; Yoakum. *PBSL.
   Brinkerhoff Drlg. 1 Robison; Yoakum. *PL, 1956.
646. Anderson-Prichard and others 1 Oil Devel. Co. of Texas; Terry. *PBSL; PL, 1954.
647. Anderson-Prichard 1 Rich; Terry. *PBSL; PL, 1956.
648. Humble 1 G. F. Bell and others; Terry. *PBSL; PL, 1952.
649. Honolulu and others 19 F. M. Ellington "B"; Terry. *PBSL; PL, 1955.
650. Socony Mobil 1 Mary Hope Pusey; Terry. *GS; PL, 1961.
652. Seaboard Oil 1 Cravens; Lubbock. *PBSL, 1948.
655. Humble 1 C. L. Parr and others; Lubbock. *PBSL, 1953.
656. Humble 1 V. J. Farris; Lubbock. *PBSL, 1951.
657. Bankline Oil, Wilshire Oil, and Basin Oil 1-A Earl E. Elliott "A"; Lubbock. *PBSL, 1951.
659. G. P. Livermore and M. A. Sanders 1 Bettie Lindsey; Lubbock. *PBSL, 1950.
670. Natl. Assoc. Pet. 1 L. M. Abel; Crosby. *PBSL, 1951.
671. Ohio 2 Morgan Jones; Crosby. *PBSL, 1954.
679. G. P. Livermore 1 Bird; Dickens. *PBSL, 1945.
681. Union Oil 1 W. J. Eliot; Dickens. *PBSL, 1949.
682. Union Oil 1 W. J. Eliot; Dickens. *PBSL, 1949.
692. Shell 3-A S. B. Burnett Est.; King. *PBSL, 1954.
694. Shell 1 Burnett "F"; King. *NTSLS, 1954.
695. Shell 1 Burnett "H"; King. *NTSLS, 1954.
696. Humble 43 Bateman Est.; King. *NTSLS, 1948.
697. Youngblood and Youngblood 1 Mary Martin; King. *NTSLS, 1955.
698. Humble 1 Mary A. Martin; King. *NTSLS, 1957.
699. Shamrock and Lone Star 1 R. B. Masterson; King. *NTSLS, 1950.
701. J. Kimberlin 1 Norton; Hardeman. *NTSLS.
702. Magnolia 1 S. E. Malone; Hardeman. *NTSLS.
703. Ard Drlg. and Ray Oil 1 E. G. Ross; Hardeman. *NTSLS.
704. Ard Drlg. and Ray Oil 1 V. E. Hafner; Hardeman. *NTSLS.
705. Russel Maguire 1 E. E. Grimes; Hardeman. *NTSLS.
706. Sun 1 S. H. Sorenson; Hardeman. *NTSLS.
707. Grace and Ford Drlg. 1 H. M. Reinhardt; Hardeman. *NTSLS.
708. Tom B. Medders 1 C. H. Higgins; Wilbarger. *NTSLS.
709. Henry Grace 1 Hubbard Colley; Wilbarger. *NTSLS.
710. Amerada 1 Alexander; Wilbarger. *NTSLS.
711. Blackwood & Nichols Co. 1 C. Ayres; Wilbarger. *NTSLS.
712. Grace and Ford 1 R. B. Arnold; Wilbarger. *NTSLS.
713. Cities Service 1 Lawson-Waggoner "AL"; Wilbarger. *NTSLS.
714. Continental 1 Waggoner "39"; Wilbarger. *NTSLS.
715. Continental 1 W. T. Waggoner "52"; Wilbarger. *NTSLS.
716. Star Oil A-1 Waggoner; Wilbarger. *NTSLS.
717. G. E. Kadane & Sons B-1 W. T. Waggoner; Wilbarger.*NTSLS.
718. J. R. and Adam Seitz 1 Jack E. Robb; Wichita. *NTSLS.
719. F. Wood 8 E. D. Heiserman "A"; Wichita. *NTSLS.
721. Continental and Phillips 1 R. L. Jackson; Wichita. *NTSLS.
722. Continental 1 K. Emmert; Wichita. *NTSLS.
723. Continental 1 S. Cunningham; Wichita. *NTSLS.

TEXAS—Continued

724. Shaw Oil 1 J. P. Boddy; Clay. *NTSLS.
725. A. Goldsmith 1 W. R. Lyon; Clay. *NTSLS.
726. Ohio 1 P. P. Langford, Jr.; Clay. *NTSLS.
727. Ada Oil 1 Troy Douthitt; Clay. *NTSLS.
728. F. Wood and others 1 C. T. Maddox; Clay. *NTSLS.
729. E. A. Smith 1 J. W. Moser; Clay. *NTSLS.
730. Stephens Pet. 1 B. Edwards; Clay. *NTSLS.
731. Gulf 1-A Fields; Clay. *NTSLS.
732. S. D. Johnson 1 E. Childs; Clay. *NTSLS.
733. Standard of Texas and Reno Oil 1 Cato Heirs; Montague. *NTSLS.
734. R. Caraway 2 Crow; Montague. *NTSLS.
735. Continental 1 J. T. Garrett; Montague. *NTSLS.
736. Continental 1 J. G. Free; Foard. *NTSLS.
737. G. E. Kadane & Sons 1 R. S. Carroll, Sr.; Foard. *NTSLS.
738. Cities Service 1 Johnson "J"; Foard. *NTSLS.
739. Humphrey 1 C. C. Ribble; Foard. *NTSLS.
741. Oxford and Stasney 1 G. Halbert; Foard. *NTSLS.
742. American Liberty Oil 1 D. B. Traweek; Foard. *NTSLS.
743. G. E. Kadane & Sons 1-B J. H. Minnick; Foard. *NTSLS.
744. Humble 3 Waggoner "S"; Foard. *NTSLS.
745. S. D. Johnson and others 1 M. L. Hughston; Foard. *NTSLS.
746. Sunray 1 Big Four Ranch; Knox. *NTSLS.
747. Sun 1 I. Ellis; Knox. *NTSLS.
748. Katz and Venable 1 McFadden Est.; Knox. *NTSLS.
749. Tennessee Gas Trans. 1 L. D. Beavers; Knox. *NTSLS.
750. Standard of Texas 1 D. McGuire; Knox. *NTSLS.
751. Texas 1 Hamilton "NCT-3"; Knox. *NTSLS.
753. Continental 1 R. C. Hamilton; Knox. *NTSLS.
754. Skelly 1 H. J. Michels; Knox. *NTSLS.
755. Stanolind 1 M. F. Baker; Knox. *NTSLS.
756. Pure 1 W. T. Waggoner "B"; Baylor. *NTSLS.
757. Pure D-1 W. T. Waggoner; Baylor. *NTSLS.
758. Humble 4-S Waggoner Est.; Baylor. *NTSLS.
759. Texas 1-A Waggoner; Baylor. *NTSLS.
760. Harper and Turner 1 Arledge; Baylor. *NTSLS.
762. J. J. Lynn B-1 C. Cowan; Baylor. *NTSLS.
763. Southern Pet. Explor. 1 F. B. Ranger; Baylor. *NTSLS.
764. Deep Rock Oil 1 A. F. Wirz; Baylor. *NTSLS.
766. Continental 1 J. H. Thomas; Baylor. *NTSLS.
767. Robinson-Puckett, Inc., 1 L. L. Stout; Baylor. *NTSLS.
768. G. E. Kadane & Sons 1 W. C. Frey "E"; Archer. *NTSLS.
769. Bay Pet. 1 W. M. McGreagor; Archer. *NTSLS.
770. White Eagle Oil 1 Sebring; Archer. *NTSLS.
771. Tom D. Medders 1-C Petrex "C"; Archer. *NTSLS.
772. Russell Maguire 1 Prescher; Archer. *NTSLS.
773. T. F. Hunter 1 T. B. Wilson; Archer. *NTSLS.
774. Austral Oil 1-B Parkey Ranch; Archer. *NTSLS.
775. Deep Rock Oil 1 L. T. Key; Archer. *NTSLS.
776. Tennessee Gas Trans. 1 E. E. Treet; Archer. *NTSLS.
777. D. D. Feldman 1 Turbeville; Archer. *NTSLS.
778. Honolulu 1 W. B. King; Lynn. *PBSL; PL, 1947.
779. Sunray 1 Sunray-Sohio-Ernest; Lynn. *PBSL.
780. Humble 1 Jarrell Q. Cox; Lynn. *PBSL; PL, 1952.
781. Great Western Drlg. 1 Bryan Williams; Lynn. *PBSL; PL, 1962.
782. Shell 1 Southland Royalty Co. and others; Lynn. *PBSL; PL, 1952.
783. Barnsdall Oil 1 Billie Williams; Lynn. *PBSL; PL, 1949.
784. Dan and Jack Auld 1 John Thomas; Lynn. *PBSL; PL, 1960.
786. Humble 1 Launa Thomas and others; Lynn. *PBSL; PL, 1963.
787. Cities Service 1 Gregory; Lynn. *PBSL; PL, 1952.
788. Coffield 1 Schneider; Garza. *PBSL.

TEXAS—Continued

789. Continental 1 Ralph Welch; Garza. *PBSL.
790. Honolulu 1 B. Altman; Garza. *PBSL; PL, 1945.
792. Jim Lee Drlg. 1 Bryan Williams; Garza. *PBSL.
793. Cities Service 1 Stoker; Garza. *PBSL.
794. Stanolind 1 D. C. Hill, Jr., "A"; Garza. *PBSL.
796. Plymouth Oil 1 V. B. Sims; Garza. *PBSL; PL, 1949.
797. Big Chief Drlg. 1 Big Chief, Glasco, Constantin, and Lowe; Kent. *PBSL.
798. Stanolind 1 J. J. Emery "A"; Kent. *PBSL.
799. Addison Warner 1 B. F. Spradling; Kent. *PBSL.
802. H. L. Hunt 4 Ritchie; Armstrong. *TPSLS, 1952.
806. Hassie Hunt Trust 1 M. Helms; Armstrong. *TPSLS, 1952.
809. Standard of Texas A-1 A. L. Palm; Armstrong. *TPSLS, 1952.
810. Stanolind 1 Corbin; Armstrong. *TPSLS, 1952.
811. El Paso Nat. Gas 1 W. Texas Mortgage; Bailey. *PBSL, 1945.
813. Phillips 1 Stephens "A"; Bailey, *TPSLS, 1951.
814. Amerada 1 J. C. Hamilton; Briscoe. *TPSLS, 1951.
816. Gulf 1 Rodgers "D"; Briscoe. *TPSLS, 1956.
817. H. L. Hunt 9 Ritchie; Briscoe. *TPSLS, 1952.
818. H. L. Hunt 3 Ritchie; Briscoe. *TPSLS, 1952.
819. H. L. Hunt 10 Ritchie; Briscoe. *TPSLS, 1952.
822. Hassie Hunt and Standard of Texas 1 W. D. Owens; Briscoe. *TPSLS, 1952.
823. Midstates 1 Hickok & Reynolds Royalty Co.; Briscoe. *TPSLS, 1951.
829. Cities Service 4-F Burnett; Carson. *TPSLS, 1959.
830. Phillips 1 Ardis; Carson. *TPSLS, 1953.
832. Roark, Hooker, Hill, and Clark 1 Rohan; Carson. *TPSLS, 1954.
835. Stanolind 1 Griffin; Carson. *TPSLS, 1953.
837. C. C. Whittenburg 1 W. J. Morris; Carson. *TPSLS, 1953.
840. Stephens 1 Little; Castro. *TPSLS, 1957.
842. Sun 1 Herring; Castro. *TPSLS, 1954.
849. Placid Oil 1 K. M. Waters; Childress. *NTSLS, 1948?
851. Sinclair 1 W. Mullins; Childress. *TPSLS, 1951.
852. Skelly 1 H. A. Painter; Childress. *TPSLS, 1955.
855. Stanolind 1 Owens; Childress. *TPSLS, 1950.
856. Texas 1 P. B. Smith; Childress. *TPSLS, 1953.
857. Texas 1 S. B. W. Hughes; Childress. *TPSLS, 1951.
861. Herbert Oil 1 Coleman-Hess; Collingsworth. *TPSLS, 1956.
862. Humble 1 Scruggs; Collingsworth. *TPSLS, 1950.
865. Tatum, Bennett, and Depauw 1 A. F. Wischkaemper, Jr.; Collingsworth. *TPSLS, 1953.
866. Union Prod. 1 B. Glenn; Collingsworth. *NTSLS, 1947.
869. Humble J-1 Matador; Cottle. *TPSLS, 1951.
874. Ohio 1 Yarbrough; Cottle. *TPSLS, 1950.
881. Sun 1 Hughes; Cottle. *TPSLS, 1951.
883. Texas 1 A. A. Payne; Cottle. *TPSLS, 1950.
884. J. P. Bay 1 Heiskell; Dallam. *TPSLS, 1958.
887. Panoma Corp. 1 Hill "A"; Dallam. *TPSLS, 1954.
888. Panoma Corp. 1 E. S. Pritchard; Dallam. *TPSLS, 1954.
889. Pure 1 A. C. Cleavinger; Dallam. *TPSLS, 1958.
890. Shamrock 1 Brown; Dallam. *TPSLS, 1957.
891. Shamrock 1 Swift; Dallam. *TPSLS, 1956.
892. Shell 1 Price; Dallam. *TPSLS, 1958.
893. Skelly 1 Dixon; Dallam. *TPSLS, 1959.
894. Standard of Texas 1 Adolph Hill; Dallam. *TPSLS, 1958.
895. Frankfort Oil 1 Allison-Hayes; Deaf Smith. *TPSLS, 1957.
896. Honolulu 1 Ponder; Deaf Smith. *TPSLS, 1951.
897. Alan Drlg. 1 Sharrett Meyers; Donley. *TPSLS, 1952.
898. Clark 1 Gentry; Donley. *TPSLS, 1956.
899. Doswell and others 1 McMurtry; Donley. *TPSLS, 1950.

TEXAS—Continued

901. Humble 1 Roach; Donley. *TPSLS, 1954.
902. H. L. Hunt 5 Ritchie; Donley. *TPSLS, 1952.
904. Miami 1 Lazy RG Ranch; Donley. *TPSLS, 1959.
906. Placid Oil 1 W. R. Kelly; Donley. *TPSLS, 1952.
909. Stanolind 1 Lewis; Donley. *TPSLS, 1952.
911. Livermore 1 Krause; Floyd. *TPSLS, 1951.
912. Sinclair 1 J. M. Massie; Floyd. *TPSLS, 1953.
914. Standard of Texas 1 Minnie Adams; Floyd. *TPSLS, 1952.
916. Clayton-Dwyer Drlg. 1 J. E. Williams; Gray. *TPSLS, 1956.
918. Gulf 1 E. A. Shackleton; Gray. *TPSLS, 1953.
920. Russell Maquire 1 Franklin; Gray. *TPSLS, 1954.
921. Panoma Corp. 1 J. S. Hohnson; Gray. *TPSLS, 1953.
922. Shamrock 1 Byrum; Gray. *TPSLS, 1955.
923. Phillips 1 Jackson "C"; Gray. *TPSLS, 1954.
927. Foster Oil and Marvin Oil 1 Harrell; Hale. *TPSLS, 1950.
929. Honolulu and others 1 Clements; Hale. *TPSLS, 1951.
931. Stanolind 1 Hegi; Hale. *PBSL, 1947.
934. Amerada 1 L. Hughes; Hall. *TPSLS, 1951.
935. Constantin 1 Wilson; Hall. *TPSLS, 1952.
936. Humble 1 Weaver; Hall. *TPSLS, 1955.
937. Phillips 1 Hughes; Hall. *TPSLS, 1950.
938. J. P. Revier 1 Lewis; Hall. *TPSLS, 1954.
941. Coats Drlg. 1 S. P. Miller Est.; Hansford. *TPSLS, 1955.
942. Colorado Oil and Gas and Fulton 1 Steel; Hansford. *TPSLS, 1954.
943. Fulton 1 Alexander; Hansford. *TPSLS, 1954.
945. Gulf 1 C. Gamertsfelder; Hansford. *TPSLS, 1951.
952. Phillips 1 Cator; Hansford. *TPSLS, 1951.
953. Phillips 1 Hiram; Hansford. *TPSLS, 1951.
954. Phillips 1 Keffer; Hansford. *TPSLS, 1951.
956. Roark, Hooker, Hill, and Clark 1 Cavin; Hansford. *TPSLS, 1954.
966. H. L. Hunt 1 O. H. Finch; Hartley. *TPSLS, 1952.
967. Pure 1 Lankford; Hartley. *TPSLS, 1951.
968. Sinclair 1 Bivins Est.; Hartley. *TPSLS, 1951.
969. Skelly 1 Castleberry; Hartley. *TPSLS, 1958.
970. Standard of Texas 1 Lathem; Hartley. *TPSLS, 1957.
971. Whitehall 1 Reynolds Cattle; Hartley. *TPSLS, 1959.
973. Cities Service 1 Humphrey; Hemphill. *TPSLS, 1957.
978. Sinclair 1 Isaacs; Hemphill. *TPSLS, 1952.
979. Sun 1 Nix; Hemphill. *TPSLS, 1955.
983. Huber 1 Weatherly; Hutchinson. *TPSLS, 1954.
984. Huber 2 C. H. Jasper; Hutchinson. *TPSLS, 1951.
985. Magna Oil 5 Belle Wisdom "A"; Hutchinson. *TPSLS, 1956.
987. Phillips 12 Elva; Hutchinson. *TPSLS, 1955.
988. Phillips 1 Amethyst; Hutchinson. *TPSLS, 1954.
989. Phillips 1 Price "F"; Hutchinson. *TPSLS, 1956.
992. Skelly 17 Armstrong; Hutchinson. *TPSLS, 1956.
993. Texas 1 Holt; Hutchinson. *TPSLS, 1952.
996. H. L. Hunt 1 C. B. Robertson; Lamb. *TPSLS, 1951.
1001. Seaboard Oil 1 Jackson; Lamb. *TPSLS, 1955.
1007. El Paso Nat. Gas 1 Kellen; Lipscomb. *TPSLS, 1958.
1011. Humble 1 Doyle; Lipscomb. *TPSLS, 1957.
1012. Humble 1 Cowan; Lipscomb. *TPSLS, 1957.
1014. Keating 1 Gadberry; Lipscomb. *TPSLS, 1959.
1016. L. H. Puckett 1-733 Perry; Lipscomb. *TPSLS, 1958.
1023. Sun 1 Mason; Lipscomb. *TPSLS, 1956.
1027. Texas 1 Jones; Lipscomb. *TPSLS, 1958.
1029. Magnolia 1 Pool; Moore. *TPSLS, 1956.
1030. Shamrock 1 Burnett "A"; Moore. *TPSLS, 1955.
1031. Shamrock 2 Taylor; Moore. *TPSLS, 1956.
1035. Texas 1 Lacy Meek; Moore. *TPSLS, 1957.
1037. Amerada 1 Birnie; Motley. *TPSLS, 1951.
1041. Humble 1 Matador "H"; Motley. *TPSLS, 1950.

TEXAS—Continued

1042. Humble 1-K Matador; Motley. *TPSLS, 1953.
1043. Lion Oil 1 Shoenail; Motley. *TPSLS, 1953.
1046. Pan American 1 Brandon; Motley. *TPSLS, 1957.
1047. Skelly 1 Windham; Motley. *TPSLS, 1954.
1048. West Central 1 Ross; Motley. *TPSLS, 1957.
1055. Honolulu 1 Chunn; Ochiltree. *TPSLS, 1956.
1059. Magnolia 1 Ellis; Ochiltree. *TPSLS, 1956.
1061. Magnolia 1 J. W. Parnell; Ochiltree. *TPSLS, 1956.
1068. Sinclair 1 Schultz; Ochiltree. *TPSLS, 1957.
1069. Skelly 1 McGarraugh; Ochiltree. *TPSLS, 1956.
1074. Superior 1 Tevis Unit; Ochiltree. *TPSLS, 1955.
1083. Albaugh 2 Matador; Oldham. *TPSLS, 1953.
1085. Hooper & Duke, Joe Kelly, and Superior 1 Howard; Oldham. *TPSLS, 1952.
1087. Livermore 1 Moser; Oldham. *TPSLS, 1951.
1088. Shell 1 Alamosa Ranch "C"; Oldham. *TPSLS, 1958.
1090. Shell 1 L. S. Ranch; Oldham. *TPSLS, 1957.
1093. Superior 1 Matador; Oldham. *TPSLS, 1952.
1094. Superior L-C 6 Matador; Oldham. *TPSLS, 1952.
1095. Oil Well Drlg. 1 Tharp; Parmer. *TPSLS, 1953.
1096. Sunray 1 Kimbrough; Parmer. *TPSLS, 1954.
1097. U.S. Smelting, Ref. and Min. 1 Sloan-Osborn "A"; Parmer. *TPSLS, 1952.
1101. Sinclair 4 Masterson; Potter. *TPSLS, 1958.
1102. Sinclair 13 Bivins Est.; Potter. *TPSLS, 1958.
1105. Frankfort Oil 1 Stinnett; Randall. *TPSLS, 1959.
1106. Frankfort Oil 1 Hix; Randall. *TPSLS, 1957.
1107. Placid Oil 1 Greeley; Randall. *TPSLS, 1951.
1115. Gulf 1-A Byrum; Roberts. *TPSLS, 1958.
1118. Keating 1 Payne; Roberts. *TPSLS, 1957.
1121. Marsh 1 Martin; Roberts. *TPSLS, 1954.
1123. Phillips 1 Jenkie; Roberts. *TPSLS, 1962.
1124. Red River Gas 1 Red River Gas-Sinclair-Lips; Roberts. *TPSLS, 1953.
1126. Sinclair 8-H Lips; Roberts. *TPSLS, 1952.
1129. Texas 1 Ledrick "A"; Roberts. *TPSLS, 1962.
1130. U.S. Smelting, Ref. and Min. 1 Morrison; Roberts. *TPSLS, 1957.
1134. T. M. Evans and Phillips 1-A Freeman; Sherman. *TPSLS, 1956.
1135. Phillips 1 Shirk; Sherman. *TPSLS, 1950.
1138. Skelly 1 E. E. Ott; Sherman. *TPSLS, 1951.
1139. H. L. Hunt 1 J. A. Bivens; Swisher. *TPSLS, 1952.
1140. Frankfort Oil 1 Sweatt; Swisher. *TPSLS, 1958.
1142. Humble 1 Nanny; Swisher, *TPSLS, 1954.
1143. L. B. Newman 1 M. A. Patton; Swisher. *TPSLS, 1956.
1144. Standard of Texas 1 Johnson; Swisher. *TPSLS, 1952.
1145. Gulf 1 J. L. Bailey "A"; Wheeler. *TPSLS, 1953.
1146. Max Pray 1 Mills; Wheeler. *TPSLS, 1958.
1147. E. and H. Phillips 1 M. D. Ware; Wheeler. *TPSLS, 1955.
1149. Shamrock 5 McAdams; Wheeler. *TPSLS, 1955.
1151. Sinclair-Prairie 1 Henderson; Wheeler. *TPSLS, 1945.
1152. Sunray Mid-Continent 1 Britt; Wheeler. *TPSLS, 1956.
1154. Phillips 2 Wilson; Moore. *TPSLS, 1953.
1162. Humble 1 Howard Ranch; Briscoe. *TPSLS, 1959.
1164. Amarillo Oil 1 Veigel; Castro. *TPSLS, 1959.
1169. Frankfort Oil 1 Muse; Deaf Smith. *TPSLS, 1959.
1174. Shell 1 Thompson; Hartley. *TPSLS, 1959.
1177. Baker and Taylor 1 Hobart Ranch; Hemphill. *TPSLS, 1959.
1182. Shell 1 Alamosa Ranch "B"; Oldham. *TPSLS, 1957.
1185. Humble 1-B Binford; Oldham. *TPSLS, 1959.
1186. Shell 1A-84 Fulton; Oldham. *TPSLS, 1959.
1188. Shell 4-58 L. S. Ranch; Oldham. *TPSLS, 1959.

TEXAS—Continued

1193. Amarillo Oil 1 Price A; Roberts. *TPSLS, 1959.
1194. Shamrock 37 Price and others "D"; Sherman. *TPSLS,. 1959.
1200. Shell 1-2 Simms Unit; Dallam. *TPSLS, 1959.
1201. New Seven Falls 1 Wiggins; Dallam. *TPSLS, 1959.
1202. Humble 1 J. E. Crabtree and others; Dallam. *TPSLS, 1955.
1203. Humble 1 Hannah Morris; Sherman. *TPSLS, 1954.
1204. Phillips 1-A Kathryn; Sherman. *TPSLS, 1951.
1206. Roy Furr 1 Hart; Hansford. *TPSLS, 1957.
1207. Phillips 1-B Meeks; Hansford. *TPSLS, 1957.
1208. Sun 1 Sam Hill; Ochiltree. *TPSLS, 1957.
1209. Pan American 1 L. C. Clements; Ochiltree. *TPSPS, 1958.
1210. Texas 1 A. E. McGarraugh; Ochiltree. *TPSLS, 1951.
1211. Humble 1 Flowers; Ochiltree. *TPSLS, 1958.
1212. Texas 1 Frass; Lipscomb. *TPSLS, 1958.
1214. Humble 1-E Schultz; Lipscomb. *TPSLS, 1958.
1215. Standard of Texas 1-36 Walker; Hartley. *TPSLS, 1956.
1216. Union 1-384 W. B. Wooster; Moore. *TPSLS, 1959.
1217. Sun 1 Kirk; Hutchinson. *TPSLS, 1958.
1219. Sun 1 Parsell Est.; Roberts. *TPSLS, 1957.
1221. Morganhead 1 Morrison Ranch; Roberts. *TPSLS, 1953.
1222. Shamrock 1 Maddox; Roberts. *TPSLS, 1953.
1223. Magnolia 1 Feldman; Hemphill. *TPSLS, 1957.
1225. Superior 3 Matador; Oldham. *TPSLS, 1952.
1226. Sinclair 11 Bivins; Potter. *TPSLS, 1957.
1227. Skelly 214 Schaffer; Carson. *TPSLS, 1953.
1228. Texas Gulf Prod. 1 Horn; Carson. *TPSLS, 1958.
1230. Amarillo Oil 1 Bryant Edwards "B"; Briscoe. *TPSLS, 1958.
1231. E. Nepple 1 Hutchins; Hall. *TPSLS, 1958.
1232. Honolulu 1 Jones; Hale. *TPSLS, 1961.
1233. Russell Maguire 1 L. C. Wheeler; Hale. *TPSLS, 1953.
1234. Humble 2-D Matador; Motley. *TPSLS, 1958.
1235. General Crude Oil 33-1 Swenson "C"; Cottle. *TPSLS, 1954.
1236. Hamilton 1 Richards; Cottle. *TPSLS, 1950.
1237. Gulf 1 C. D. Shamberger; Cottle. *TPSLS, 1953.
1240. Honolulu 1 Ozier; Donley. *TPSLS, 1953.
1241. Placid Oil 1 Matheson; Armstrong. *TPSLS, 1954.
1242. Ashmun & Hilliard 1 Merritt; Castro. *TPSLS, 1962.
1243. Pan American 1 Robbins-Castro; Castro. *TPSLS, 1960.
1244. Texas 1 F. & M. Trust; Childress. *TPSLS, 1953.
1245. Shell 1-13 Cook; Collingsworth. *TPSLS, 1964.
1246. Sun 1 Bagot; Dallam. *TPSLS, 1960.
1247. Ashmun & Hilliard 1 Oppenheim; Deaf Smith. *TPSLS, 1961.
1248. Sun 1 Spears; Hall. *TPSLS, 1960.
1249. Gulf 1 Gowers "F"; Hemphill. *TPSLS, 1960.
1250. Humble 1 Campbell; Hemphill. *TPSLS, 1964.
1251. Humble 1 Gill; Hemphill. *TPSLS, 1963.
1252. Shamrock 1 Weinett; Lipscomb. *TPSLS, 1961.
1253. Humble 2-C Matador; Motley. *TPSLS, 1962.
1254. Ashmun & Hilliard 1 London; Parmer. *TPSLS, 1961.
1255. Texaco 1 Bivins; Potter. *TPSLS, 1964.
1256. Frankfort Oil 1 Erwin; Randall. *TPSLS, 1961.
1257. Frankfort Oil 1 White; Randall. *TPSLS, 1957.
1258. Phillips 1 Lee "C"; Wheeler. *TPSLS, 1964.
1259. Sun 1 McMurty; Wheeler. *TPSLS, 1964.
1260. Standard of Texas 1 Harris; Wheeler. *TPSLS, 1961.
1261. Superior 1 Cameron Est.; Cochran. *Confid.
1263. McGarr, Trusler, and Moskovitz 1 Beck; Crosby. *GS, 1962.
1264. M. R. Antweil 1 E-A; Crosby. *Confid.
1265. Long Pet. 1 Wiley; Dickens. *Confid.
1266. Natl. Assoc. Pet. 1 Blackwell; Dickens. *Confid.

TEXAS—Continued

1267. Norsworthy 1 Burleson; Dickens. *Confid.
1268. Tidewater 1 Pitchfork Ranch; Dickens. *Confid.
1269. Great Western Drlg. 1 Broome; Hockley. *Confid.
1270. Burdell Oil 1 Long; Lubbock. *Confid.
1271. Honolulu 1 Rhoads; Lubbock. *Confid.
1272. Magnolia 1 Johnson; Lubbock. *Confid.
1273. Sunray Mid-Continent 1 Starnes; Cochran. *PBSL, 1959.
1274. Honolulu 25 Frazier; Hockley. *PBSL, 1960.
1275. Cities Service 1 Gillespie; Hockley. *PBSL.
1276. Shell 1 Sherrod; Hockley. *PBSL.
1401. General Crude Oil and others 1 Percy Jones; Kent. *ASLS.
1402. Warren Oil 1 P. R. Chisum; Kent. *PBSL.
1409. Mid-Continent 1 Bilby Wallace Tract 3; Kent. *PBSL; PL.
1410. Continental 1 Springer; Stonewall. *ASLS.
1412. Woodley Pet. and Kirby Pet. 1 Godfrey; Stonewall. *ASLS.
1413. Champlin Oil & Ref. 1 C. H. Byrd; Stonewall. *PBSL.
1415. G. E. Kadane & Sons 1 Peacock; Stonewall. *ASLS.
1416. Norsworthy 1 Herbst; Stonewall. *ASLS.
1417. Moss and others 1-A Pumphrey; Stonewall. *ASLS.
1418. Honolulu 1 Sam Baugh; Stonewall. *PBSL; PL.
1419. Seaboard Oil 1 J. D. Smith; Stonewall. *PBSL; PL.
1420. General Crude Oil 1 J. W. Kennedy; Stonewall. *ASLS; PL.
1421. Gene Goff and others 1 Beulah Branch and others; Stonewall. *PBSL.
1425. Geochemical Surveys and Intex Oil 1 M. Cornelius; Haskell. *ASLS.
1429. Phillips 1 R. W. Herren; Haskell. *NTSLS.
1430. K. & H. Operating Co. 1 C. A. Frierson; Haskell. *ASLS.
1431. T. D. Humphrey 1 J. M. Collins; Haskell. *ASLS.
1437. Mid-Continent 1 M. Waldrop; Haskell. *NTSLS.
1438. Warren Oil 1 H. Allen; Throckmorton. *NTSLS.
1439. Deep Rock Oil 1 T. W. Forman; Throckmorton. *NTSLS.
1440. Cities Service 1-41 Swenson; Throckmorton. *NTSLS.
1441. Cities Service 1-210 Swenson; Throckmorton. *NTSLS.
1442. K. J. Rich 1 Boyd; Throckmorton. *NTSLS.
1443. Sky-Hi Oil 1 P. G. Speth and others; Throckmorton. *NTSLS.
1444. Texon and others 1 G. R. Davis; Throckmorton. *NTSLS.
1445. Warren Oil 1 J. T. Davis; Throckmorton. *NTSLS.
1447. Cities Service 1 Matthews Ranch; Throckmorton. *NTSLS.
1449. Pan American Prod. 2 W. R. Matthews; Throckmorton. *NTSLS.
1450. Woodley Pet. 1 Dickie; Throckmorton. *ASLS.
1451. Hanlon-Boyle, Inc., 1 K. Beaty and others; Throckmorton. *NTSLS.
1454. Amerada 1 D. L. Adcock; Dawson. *PBSL; PL, 1951.
1455. Seaboard Oil 1 Mart Barrow; Dawson. *PBSL, 1949; PL, 1960.
1459. Seaboard Oil 6-A J. H. Robinson; Dawson. *PBSL, 1948; PL, 1949.
1460. Magnolia 1 J. H. Foster; Dawson. *PBSL, 1954; PL, 1955.
1461. Double U Oil 1 G. E. Spinnler "A"; Borden. *PBSL.
1468. McElroy Ranch 1 J. L. Higginbotham; Borden. *PBSL.
1470. Ohio 1-C J. W. Neal Est.; Scurry. *PBSL; PL.
1474. C. L. Norsworthy, Jr., 1 D. D. Feldman and others; Scurry. *PBSL; PL.
1476. Amerada 1 Jap Beck; Scurry. *PBSL.
1477. Empire Drlg. 1 Maggie Bacot; Fisher. *PBSL.
1478. Lion Oil 1 Huddleston; Fisher. *ASLS.
1480. General Crude Oil 1 Belle Sumrall; Fisher. *ASLS.
1481. Kerr-McGee 1 Deram; Fisher. *PBSL.
1482. Texas 7 D. W. Stevens; Fisher. *PBSL.
1483. Union Oil 1 Lila Nash; Fisher. *PBSL.

TEXAS—Continued

1484. Exploration Drlg. 1 Newman; Fisher. *ASLS.
1485. Humble B-1 Jeanette Nickless; Fisher. *PBSL.
1486. American Republics Corp. 1 Bryan; Fisher. *ASLS.
1487. General Crude Oil 1 Huddleston; Fisher. *ASLS.
1488. H. H. Coffield 1 G. C. Carpenter; Fisher. *PBSL.
1489. Snowden 1 McGee; Fisher. *ASLS.
1495. Fain & McGaha 1 Hoehn; Jones. *ASLS.
1497. Crown Central Pet. 1 Callier; Jones. *ASLS.
1499. Hunter and Hunter 1 Steele; Jones. *ASLS.
1502. Ungren & Frazier and others 1 Amy Sears; Jones. *ASLS.
1503. Sojourner Drlg. 1-H T. G. Hendrick; Shackelford. *ASLS.
1504. Big West Drlg. 1 J. H. Nail; Shackelford. *ASLS.
1505. Deep Rock Oil 1 Dawson-Conway; Shackelford. *ASLS.
1506. Humble 1 Diller Est.; Shackelford. *ASLS.
1508. Roeser and Pendleton 1 J. P. Morris Est.; Shackelford. *ASLS.
1509. Oil Well Drlg. 1 W. P. Newell; Shackelford. *ASLS.
1510. McElroy Ranch Co. 1 J. H. Sedwick; Shackelford. *ASLS.
1511. A. R. Dillard 1 L. Ackers; Shackelford. *ASLS.
1512. Phillips 1 Roark; Shackelford. *ASLS.
1513. Danciger and Intex Oil 1 Edwards Heirs; Shackelford. *ASLS.
1514. Humble 1 H. O. West; Shackelford. *ASLS.
1515. Starr Oil & Gas 1 J. D. Windham; Shackelford. *ASLS.
1516. M. J. Mitchell 1 T. C. Partney; Shackelford. *ASLS.
1519. S. O. Herring Drlg. 1 A. H. Cox; Stephens. *ASLS.
1521. Oxford Drlg. 1 McMahon-Doss; Stephens. *ASLS.
1522. E. H. R. Sabens and others 2 R. E. Elliott and others; Stephens. *ASLS.
1524. Stanolind 1 J. E. Mabee; Martin. *PBSL; PL, 1960.
Pan American 1 F. D. Breedlove and others; Martin. *PBSL.
1527. Phillips 1 Scharbauer "C"; Martin. *PBSL; PL, 1954.
1528. Callery and Hurt 1 Earl B. Powell; Martin. *PBSL; PL, 1951.
1529. Stanolind 1 Gladys H. Cowden; Martin. *PBSL; PL, 1952.
1531. Tidewater 1 E. B. Dickinson; Martin. *PBSL; PL, 1951.
1532. Texas Pacific Coal and Oil 1 Tom Spencer "A"; Howard. *PBSL; PL, 1954.
1535. Deep Rock Oil 1 J. O. McCrary; Howard. *PBSL; PL, 1951.
Monsanto Chem. 1 Rosa Harper; Howard. *PL, 1959.
1536. Stanolind 1-A Susie Snyder; Howard. *PBSL.
1537. Cosden Pet. 1 D. D. Crawford; Howard. *PBSL, 1953; PL, 1954.
1539. Stanolind 1 T. H. Gaskins; Howard. *PBSL; PL, 1947.
1541. Brinkerhoff Drlg. 1 E. Jones and others; Howard. *PBSL; PL, 1951.
Roden, Darden & McRae, Ltd., 1 Milton Gaskins; Howard. PL, 1959.
1542. Standard Oil of Texas 1 B. F. Dunn and others; Mitchell. *PBSL; PL.
1543. Humble 1 A. C. Pratt; Mitchell. *PBSL; PL.
1544. Magnolia 22 Foster; Mitchell. *PBSL; PL.
1545. S. F. Hurlbut and Olson Drlg. 1-A U. D. Wulfjen; Mitchell. *PBSL.
1547. S. F. Hurlbut and G. P. Livermore 2 Ellwood; Mitchell. *PBSL.
1548. S. F. Hurlbut and others 1 B. L. Wulfjen; Mitchell. *PBSL.
1550. Amerada 1 J. F. McCabe; Mitchell. *PBSL.
1551. Ohio 1 City of Sweetwater; Nolan. *PBSL; PL.
1552. Skelly 1 E. A. Ater; Nolan. *PBSL.
1553. Union Oil and Sun 1 Pete Starnes "B"; Nolan. *PBSL.
1554. Skelly 1 Bradberry; Nolan. *ASLS.
1555. Deep Rock Oil 1-A Georgia Inst. Tech.; Nolan. *ASLS.

TEXAS—Continued

1556. C. L. Norsworthy, Jr., 1 N. M. Brooks; Nolan. *PBSL.
1557. R. S. Lytle 1 W. A. Elliott; Nolan. *ASLS.
1558. Wilshire Oil of Texas and British-American 24-182 R. L. Spires; Nolan. *PBSL; PL.
1559. Harper and Huffman 1 May Sears; Nolan. *PBSL.
1561. Seaboard Oil 1 B. Hanks; Nolan. *ASLS.
1562. C. L. Norsworthy, Jr., 1 R. H. Jordan; Nolan. *ASLS.
1575. Magnolia 1 Elma Jackson; Callahan. *ASLS.
1577. Star Oil 1-B H. W. Ross; Callahan. *ASLS.
1578. W. G. King, Jr., 1 L. C. Ray; Callahan. *ASLS.
1579. Star Oil 1 Ella Taylor; Callahan. *ASLS.
1580. C. W. Scott and others 1 G. A. Chrane; Callahan. *ASLS.
1581. Humble 1 L. J. McFarlane; Callahan. *ASLS.
1582. Oil Well Drlg. 1 A. Hickman; Callahan. *ASLS.
1584. Sunray 1 Aspin; Callahan. *ASLS.
1585. Bay Pet. 1 Windham; Callahan. *ASLS.
1586. Anzac Oil 1 F. Cutbirth; Callahan. *ASLS.
1587. Groebl 1 Gary; Callahan. *ASLS.
1588. Skelly 1 A. L. Thomas; Eastland. *ASLS.
1589. Senate Oil 1 Speegle; Eastland. *ASLS.
1590. Algord Oil 1 O. P. Wheeler; Eastland. *ASLS.
1594. Magnolia 2 Roy Parks; Midland. *PBSL.
1600. Plymouth Oil 1-38 Midkiff and others; Midland. *PBSL.
1602. C. L. Norsworthy, Jr., 1 L. S. McDowell; Glasscock. *PBSL.
1603. Ralph Lowe 1 Neal-Ballinger; Glasscock. *PBSL.
1605. R. R. Herrell 1 Marshall Cook; Glasscock. *PBSL.
1612. Cities Service 1 Collins; Sterling. *PBSL.
1613. Progress Oil and Ray Albaugh 1 N. C. Paramore; Sterling. *PBSL; PL.
1614. Humble 1 W. L. Foster, Jr., and others; Sterling. *PBSL.
1618. Humble 1 R. T. Foster "B"; Sterling. *PBSL; PL.
1620. Humble 1 L. C. Harris and others; Sterling. *PBSL.
1621. Humble 1 J. W. Arledge, Jr., Coke. *WCTSLS, PL.
1623. Mar-Tex Realization Corp. 1 Gee; Coke. *ASLS.
1624. Fortune Drlg. and Cosden Pet. 1 W. D. Markham; Coke. *PBSL.
1625. Cameron Oil 1 Butner; Coke. *ASLS, PL.
1627. Harper and Huffman 1 Mrs. A. S. Eubanks; Coke. *PBSL.
1628. Norsworthy 1 Mims; Coke. *PBSL; PL.
1629. Seaboard Oil 1 Counts; Coke. *ASLS; PL.
1630. Shamrock 1 Wendland; Coke. *ASLS; PL.
1631. Saxon Explor. 1 Hill; Coke. *ASLS.
1632. Amerada 1 March Ranch; Coke. *ASLS; PL.
1633. LaGloria Oil & Gas and Dykes Drlg. 1 M. C. Reed; Coke. *PBSL.
1635. Gulf 2 Inez Smith; Runnels. *ASLS.
1636. Standard of Texas 1 Lilly Est.; Runnels. *ASLS.
1637. Robinson-Puckett, Inc., 1 Roberts; Runnels. *ASLS.
1638. F. K. Johnson 1 C. B. Spill; Runnels. *ASLS.
1639. Hickok & Reynolds Royalty Co. 1 R. G. Erwin; Runnels. *ASLS.
1640. Youngblood and Foree 1 H. Byler; Runnels. *ASLS.
1642. Creslenn Oil 1 Lange; Runnels. *ASLS.
1644. N. B. Hunt 1 Gulley; Runnels. *ASLS.
1646. E. K. Burt and E. M. Woods 1 Wilson; Runnels. *ASLS.
1647. Frank Love & Co. 2 Willike; Runnels. *ASLS.
1648. Superior 1 McDowell; Runnels. *ASLS.
1649. Sunray 1 H. Arendal; Runnels. *ASLS.
1658. Mid-Continent 1-A M. Horne; Coleman. *ASLS.
1659. Eastland Oil and others 1 J. T. Padgett; Coleman. *ASLS.
1665. Seaboard Oil and others 1 Julia Meiners; Upton. *PBSL.
1668. Wilshire Oil of Texas 1 McElroy; Upton. *PBSL; PL, 1957.
1670. Hunt Oil 1 W. T. Amacker; Upton. *PBSL.
1671. Richardson and Bass 1 H. F. and A. D. Neal; Upton. *PBSL.

TEXAS—Continued

1674. Phillips 1 Univ. "H"; Upton. *PBSL.
Pure 1 Univ. "G"; Upton. *PBSL.
Texaco 1 State of Texas "DZ"; Upton. *GS; PL, 1961.
1678. Humble 1 Sawyer Cattle Co. "K"; Reagan. *PBSL.
1679. Amerada 1 Georgia O. Mitchell; Reagan. *PBSL.
1689. Atlantic 1 Univ. 48 "C"; Reagan. *PBSL.
1691. M. J. and M & M Consol. 1-A Calvin H. Sugg; Irion. *PBSL.
1692. Russell Maguire 1 Sugg; Irion. *PBSL.
1693. Standard 6-1 M. D. Bryant; Irion. *PBSL.
1694. Amerada 1 I. P. Van Keuren; Irion. *PBSL.
1696. Wilshire Oil of Texas B. F. Phillips-M. L. Beam; Irion. *PBSL.
1697. Humble 1-F Sawyer Cattle Co. "F"; Irion. *PBSL.
1700. Morgan-Aikman Co. 1 Sol Mayer; Irion. *PBSL.
1701. Shell 2 Tankersley; Irion. *PBSL.
1704. Strake Oil 1 Smith Land & Cattle Co.; Concho. *ASLS.
1708. El Tex, Ltd., 1 Mellinger; Concho. *PBSL.
1712. Guy Mabee Drlg. 1 A. H. Dennis; Concho. *PBSL.
1718. Fain & McGaha 1 Williams; Callahan. *ASLS.
1719. Midwest Oil 1 A. L. Forehand; Coke. *PBSL.
1720. Ohio 1 F. H. Demera and others; Coke. *PBSL; PL.
1721. Sun 1 F. F. Jameson; Coke. *ASLS; PL.
1722. Davis Drlg. 1 Hendry; Coke. *ASLS.
1724. Hubbard 1 Campbell; Coleman. *ASLS.
1725. Stanolind 1 M. A. Glass; Fisher. *ASLS.
1726. Skelly B-3 D. O. Huddleston; Fisher. *ASLS.
1728. Cities Service 1 Cross "B"; Glasscock. *PBSL.
1729. Humble 10 Sears; Jones. *ASLS.
1730. Danciger 2 Stephenson; Jones. *ASLS.
1733. Gulf Plains Corp. 1 W. C. Leavitt; Jones. *ASLS.
1734. Arnold H. Bruner & Co. 1 E. E. York; Kent. *PBSL.
1739. J. Ray McDermott & Co. 1 P. K. Mackey; Mitchell. *PBSL.
1740. Great Western Drlg. 1 C. W. Baumann; Mitchell. *PBSL.
1741. Continental 1 I. L. Ellwood; Mitchell. *PBSL; PL.
1742. R. S. Brennand, Jr., 1 TXL; Mitchell. *PBSL.
1743. Hanley Co. 1 A. L. Jaggers; Nolan. *ASLS.
1744. Cities Service 1-B B. Etheridge; Nolan. *ASLS.
1746. Thos. D. Humphrey & Sons, Ltd., 2 Chitwood; Nolan. *ASLS.
1747. Sun 1 E. Parramore; Nolan. *PBSL.
1748. Cities Service and Skelly 1 Cooper; Nolan. *PBSL.
1750. Texas Pacific Coal and Oil 1 P. S. Fincher; Shackelford. *ASLS.
1751. Big West Drlg. 1 T. G. Hendricks; Shackelford. *ASLS.
1752. Continental 1 Flowers; Stonewall. *ASLS.
1753. Paul Steed 1 J. O. Barrett; Taylor. *ASLS.
1754. Robinson-Puckett, Inc., 1 E. T. Calvert; Taylor. *ASLS.
1755. Katz and Venable 1 L. Fletcher; Taylor. *ASLS.
1756. Columbian Fuel 1 Elm Cattle Co.; Taylor. *ASLS.
1757. Tex-Harvey Oil 1 F. Antilley; Taylor. *ASLS.
1760. Stanolind 1-G J. Willis Johnson; Tom Green. *PBSL.
1761. Republic Nat. Gas 1 Hair; Tom Green. *PBSL.
1762. Honolulu and E. M. Wahlenmaier 1 C. R. Norsworthy; Tom Green. *PBSL.
1763. Standard of Texas 1 B. W. Moore and others; Tom Green. *PBSL.
1764. Gray Wolfe Co. 1 J. W. Field; Tom Green. *PBSL.
1765. Ohio 1-A J. W. Turner and others; Tom Green. *PBSL.
1766. Bridwell, Perkins, and Prothro 1 Julia Farr Kennemer and others; Tom Green. *PBSL.
1767. Skelly 1 Ethelwyn Turner; Tom Green. *PBSL.
1768. Seaboard Oil 1 Robert T. Neill and others; Tom Green. *PBSL.
1769. American Republics Corp. 1 Alice C. Hennig and others; Tom Green. *PBSL.
1770. Republic Nat. Gas 1 H. Willis Johnson; Tom Green. *PBSL.
1771. C. L. Norsworthy, Jr., 1 J. D. Robertson; Tom Green. *PBSL.
1772. C. L. Norsworthy, Jr., 1-X J. W. Duff; Tom Green. *PBSL.
1773. American Republics Corp. 1 Eugene E. Foster; Tom Green. *PBSL.
1775. H. B. Poff 1 L. V. Braden; Tom Green. *ASLS.
1777. Cosden Pet. 1 Sealy; Borden. *PBSL.
Gulf 1 Alice Askins "A"; Borden. *PBSL; PL, 1961.
1778. Phillips 1 Dennis "A"; Borden. Burnside, 1959, p. 23-24. *PBSL; PL, 1952.
1785. Sun 2 Elwood Est.; Mitchell. *PBSL.
1788. Kerr-McGee 1 Slaughter "A"; Garza. *PBSL.
1793. Stanolind 1 F. E. Mulkey "A"; Martin. *PBSL; PL, 1951.
1795. Shell 1 Elona L. Slaughter; Martin. *PBSL.
J. C. Barnes and Pierce & Davis 1 Slaughter; Martin. *PBSL; PL, 1962.
1809. Texas 1 F. M. Covert "A"; Lynn. *PBSL.
1811. Shell 2 TXL; Glasscock. *PBSL; PL, 1957.
1813. British-American 1 Noelke; Irion. *PBSL; PL, 1956.
1815. J. Ray McDermott & Co. 1 O. C. Schlinke; Irion. *PBSL.
1816. British-American 1 Cargile "B"; Irion. *PBSL.
1820. Humble 1 Edward R. Jones; Tom Green. *PBSL.
1835. Ross Brunner 1 Univ. "12"; Reagan. *PBSL; PL, 1957.
1836. Blackwood & Nichols Co. 1 O'Daniel; Reagan. *PBSL; PL, 1956.
1837. Cosden Pet. 1 Ricker Ranch; Reagan. *PBSL; PL, 1957.
1838. Phillips 1 Phillips-Southland Royalty Co.-Zullette; Reagan. *PBSL; PL, 1956.
1839. Texas 1 Nannie C. Becton; Reagan. *PBSL; PL, 1956.
1843. Ultra Oil 1 Calvin H. Sugg; Sterling. *PBSL; PL.
1845. Wayne Babb 1 H. B. Bailey; Sterling. *PBSL; PL.
1846. Union Oil 1 T. Elkin; Midland. *PBSL.
1848. Sinclair 2 June Tippett "Tr. B"; Midland. *PBSL.
1850. Husky Oil 1 Inez Fasken; Midland. *PBSL; PL, 1956.
1852. Gulf 1 State "ER"; Upton. *PBSL; PL, 1956.
1853. Texas Pacific Coal and Oil 1 Anna M. Egolf; Upton. *PBSL.
1854. Sunray Mid-Continent 1 Hazel Neal; Upton. *PBSL; PL, 1956.
1855. W. H. Hunt 1 E. E. Windham; Upton. *PBSL.
Odessa Nat. Gas, E. G. Rodman, and W. D. Noel 1 Wier; Upton. *PL, 1961.
1859. Pure 1 TXL; Upton. *PBSL; PL, 1957.
1860. Monsanto Chem. 1 Kay; Upton. *PBSL; PL, 1956.
1862. Wilshire Oil of Texas 43-31 J. F. Peck; Upton. *PBSL; 1956.
1903. Seaboard Oil 1 E. M. Hinson; Terry. *PBSL; PL, 1950.
1905. Texas 1 A. H. Herring and others; Terry. *PBSL; PL, 1955.
1906. Humble 1 J. D. Beasley; Terry. *GS; PL, 1961.
1907. J. C. Williamson, Bill Roden, and Texas Pacific Coal and Oil 1-A Coline; Terry. *PBSL.
Fred Turner, Jr., and L. D. Durham 1 Luther Bohanon and others; Terry. *PL, 1956.
R. N. Fulton and others 1 C. E. Eubank; Terry. *PBSL; PL, 1954.
1909. Honolulu 1 Ella Covington "B"; Terry. *PBSL; PL, 1955.
1914. Texas 1 L. D. Spradling; Terry. *PBSL; PL, 1955.
1917. O. D. Alsabrook 1 Mrs. W. B. Dunn; Gaines. *PBSL; PL, 1955.
1920. Blackwood & Nichols Co. 1-7 Granberry; Gaines. *PBSL; PL, 1956.
1921. Delhi Oil Corp. 1 Oil Devel. Co. of Texas; Gaines. *PBSL; PL, 1953.

TEXAS—Continued

1922. Forest Oil 1 Parmer County "B"; Gaines. *PBSL, 1951; PL, 1960.
1923. Jake L. Hamon 1 L. M. Estes; Gaines. *PBSL; PL, 1955.
1925. Honolulu, Gulf, and Atlantic 1-A T. S. Riley Est.; Gaines. *PBSL, 1952.
1928. Placid Oil 1 Terry CSL; Gaines. *PBSL; PL, 1955.
1932. Texas 2 Tobe Foster and others NCT-1; Gaines. *PBSL, 1954; PL, 1956.
1933. Texas 1 Sam C. Jenkins and others; Gaines. *PBSL; PL, 1948.
1934. Union Oil 1 J. E. Stanley; Gaines. *PBSL, 1954; PL, 1955.
1935. Sinclair 1 Luther Lee; Gaines. *PBSL; PL, 1953.
1937. Stanolind 1 Oil Devel. Co. of Texas "D"; Gaines. *PBSL; PL, 1956.
1938. Texas 1 Eva Hudson; Gaines. *PBSL; PL, 1957.
1941. Amerada 1 Riley Est.; Gaines. *PBSL; PL, 1957.
1942. Husky Oil 1 Wimberly; Gaines. *PBSL; PL, 1956.
1944. Shell 1 E. H. Jones; Gaines. *PBSL, 1956.
1945. Magnolia 1 E. H. Jones Est. "B"; Gaines. *PBSL; PL, 1957.
1947. Signal Oil and Gas 1 Ford; Gaines. *PBSL; PL, 1957.
1948. Anderson-Prichard and Stanolind 1 Fasken "H2"; Andrews. *PBSL; PL, 1956.
1951. Forest Oil and Monterey Explor. 1 Univ. "C"; Andrews. *PBSL; PL, 1954.
1952. Gulf 1 H. C. McQuatters; Andrews. *PBSL; PL, 1952.
1958. Stanolind 1 Univ. Texas "BN"; Andrews. *PBSL; PL, 1954.
1959. Texas 1 J. E. Mabee "B"; Andrews. *PBSL; PL, 1959.
1961. Texas 1-AX State; Andrews. *PBSL; PL, 1955.
1964. Wilshire Oil of Texas 33-16 Cox; Andrews. *PBSL; PL, 1953.
1965. Continental 1 J. T. Lindley; Andrews. *PBSL; PL, 1957.
1968. Forest Oil 1 E. Linebery and others; Andrews. *PBSL; PL, 1956.
1969. Fullerton Oil 1 Univ.; Andrews. *PBSL; PL, 1953.
1970. Gulf 1 Texas "LLL"; Andrews. *PBSL; PL, 1952.
1971. Humble 1 Eliz. Armstrong "B"; Andrews. *PBSL.
Humble 1 Eliz. Armstrong; Andrews. *PL, 1957.
1973. Magnolia 1 Univ. Texas 36994; Andrews. *PBSL; PL, 1952.
1975. Stanolind 1 Emma Cowden; Andrews. *PBSL; PL, 1957.
1976. Phillips 4 Embar "B"; Andrews. *PBSL; PL, 1956.
1978. Phillips 1 Texas Univ. "JJ"; Andrews. *PBSL; PL, 1953.
1979. Shell and Cities Service 8 E. F. King; Andrews. *PBSL; PL, 1956.
1980. Sinclair 1 John Stevenson; Andrews. *PBSL; PL, 1949.
1981. Signal Oil and Gas 1 T. R. Parker; Andrews. *PBSL; PL, 1955.
1982. Skelly 1 Frank Orson; Andrews. *PBSL; PL, 1955.
1983. Frank Waters Oil 1 W. A. Farmer; Andrews. *PBSL; PL, 1957.
1985. Richardson and Bass and others 1 S. M. Kyle; Loving. *PBSL; PL, 1956.
2000. J. C. Barnes and C. V. Lyman 1 Kerr; Winkler. *PBSL.
2001. Amon G. Carter 1 Fee; Winkler. *PBSL.
Superior 1 G. P. Mitchell; Winkler. *PL, 1962.
Pan American 1 Etta L. Milmo; Winkler. *PL, 1961.
2002. Amon G. Carter 1 S. B. Wight; Winkler. *PBSL.
Lone Star Prod. 1-A C. A. Mitchell; Winkler. *PL, 1961.
2004. Humble 1 R. M. Evans; Winkler. *PBSL; PL, 1959.
2006. Stanolind 20-A Sealy-Smith Foundation; Winkler. *PBSL.
Chambers, Kennedy, and Gulf 1 Sealy-Smith Foundation; Winkler. *PBSL; PL, 1960.
2010. Pan American 1-B Ida Hendrick; Winkler. *GS; PL, 1959.
Pan American 1-G Hendrick Operating Area; Winkler. *PL, 1962.
2011. Richardson and Bass and Southland Royalty Co. 1 Joe Wallace and others; Winkler. *PBSL.
2014. Phillips 1 R. F. Waddell and others; Winkler. *PBSL.
2016. Shell 1 Univ. "17-A"; Winkler. *PBSL; PL, 1956.
2019. V. A. Brill 1 David Fasken "A"; Ector. *PBSL.
2021. Forest Oil 1-L TXL; Ector. *PBSL.
2022. Humble 1-B R. L. York; Ector. *PBSL.
2023. W. D. McBee and others 1 TXL; Ector. *PBSL.
2025. Stanolind and Cities Service 2 E. F. Cowden "D"; Ector. *PBSL.
2026. Texas 1 Texas-Magnolia-Sallie W. Ratliff; Ector. *PBSL.
Sinclair 11 Marcus Gist; Ector. PL, 1960.
2028. Felmont Oil 1 Millard Eidson; Ector. *PBSL.
2029. Sinclair 42 J. L. Johnson "B"; Ector. *PBSL; PL, 1960.
2032. Texas Pacific Coal and Oil and Eastland Oil 1 J. Lee Johnson; Ector. *PBSL; PL, 1961.
2033. Gulf 1 O. W. Pool "B"; Ector. *PBSL; PL, 1957.
2035. Stanolind 1 Midland Farms "AJ"; Ector. *PBSL; PL, 1956.
2036. Texas Gulf Prod. 1 Headlee; Ector. *PBSL.
2046. Phillips 1-B Texas Univ.; Ward. *PBSL.
2050. Shell 1 Sealy-Smith "A"; Ward. *PBSL.
2053. Gulf 1 Sealy-Smith Foundation; Ward. *PBSL.
2054. Gulf 166 E. W. Estes; Ward. *PBSL.
2055. Cities Service 1 Brandenberg "B"; Ward. *PBSL.
2056. British-American 1 J. B. Tubb; Ward. *PBSL.
2060. Gulf 319 G. W. O'Brien and others; Ward. *PBSL.
2061. Standard 1-X Durgin; Ward. *PBSL; PL, 1962.
2062. Gulf 44 W. A. Estes; Ward. *PBSL; PL, 1959.
2064. Atlantic 1 Univ. "LL"; Crane. *PBSL.
2065. Atlantic 1-A Univ.; Crane. *PBSL.
2068. Humble 5 Jax M. Cowden and others; Crane. *PBSL.
2069. Humble 1 Jax M. Cowden and others; Crane. *PBSL.
2071. Sinclair-Prairie 1 McKnight; Crane. *PBSL; PL, 1945.
2073. Gulf 1-E Hattie Connell "A"; Crane. *PBSL.
2074. Gulf 54-E M. F. Henderson; Crane. *PBSL, 1949.
2078. Seaboard Oil 1 TXL "D"; Crane. *PBSL, 1956; PL, 1957.
2081. Forest Oil 1 Univ. "B"; Crane. *PBSL, 1952; PL, 1960.
Gulf 1 State-McElroy; Crane. *GS, 1960.
2082. Gulf 221 W. N. Waddell; Crane. *PBSL, 1954.
2083. Gulf 589 W. N. Waddell; Crane. *PBSL, 1958.
2084. Humble 1 G. H. Cowden "D"; Crane. *PBSL, 1951; PL, 1956.
2085. Seaboard Oil 1 J. H. McFarlane; Crane. *PBSL.
2086. TXL 1 Reeves-State; Reeves. *PBSL.
2087. Standard 2 Balmorrhea Ranches "1"; Reeves. *PBSL.
2090. Gulf 1 P. G. Northrup and others; Reeves. *PBSL.
2092. Gulf 1 Mrs. V. I. Shurtleff; Reeves. *PBSL.
2094. Miami Operating Co. 1 Balmorrhea Ranches, Inc.; Reeves. *PBSL.
2125. Pure 1 Hunter; Culberson. *PBSL.
2132. Cosden Pet. 1 C. R. Cockrell; Culberson. *PBSL.
2141. El Paso Nat. Gas 1 J. M. Montgomery-State "1"; Culberson. *PBSL.
2142. Gulf 1 M. A. Grisham; Culberson. *PBSL.
2143. Continental 1 E. E. Pokorny "18"; Culberson. *PBSL.
2144. El Paso Nat. Gas 1 Grisham-Hunter-State "L"; Culberson. *PBSL.
2146. Magnolia 1 Homer Cowden "A"; Culberson. *PBSL.
2147. Phillips 1 Crews; Culberson. *PBSL.
2152. King, 1948, p. 12, pl. 8. N. B. Updike 1 Williamson.
2155. King, 1948, pl. 8, sec. 48. Anderson-Prichard 1 Borders.
2161. Magnolia 1 U-Tex 39881; Hudspeth. *PBSL.
2162. General Crude Oil 1 Merrill & Voyles and others; Hudspeth. *PBSL; PL, 1960.
2163. Seaboard Oil and Shamrock 1-C Univ.; Hudspeth. *PBSL.

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2165. J. P. Hurndall and R. A. Gray 1 J. C. Reed; Hudspeth. *PBSL.
2166. J. P. Hurndall and R. A. Gray 1 J. S. Pierce; Hudspeth. *PBSL.
2170. Stanolind 1 W. M. McCutcheon "A"; Jeff Davis. *PBSL.
2171. Continental 1 McCutcheon Est.; Jeff Davis. *PBSL.
2172. Plymouth Oil 1 H. L. Kokernot, Jr.; Jeff Davis. *PBSL.
2174. Gulf 1 W. L. Kingston and others "A"; Jeff Davis. *PBSL.
2176. West Texas Geol. Soc., 1951, p. 47-49. Humble 1 Reynolds Cattle Co.; Culberson.
2181. King and others, 1945, sec. K, sheet 2; Hudspeth. Hueco Canyon.
2184. West Texas Geol. Soc., 1953, p. 82. California 1 Univ.-Theissen.
2189. Albritton and Smith, 1965, p. 120-121.
2190. Keener, 1957, p. 88. Humble 13 E. P. Cowden.
2191. Stanolind 1 Midland Farms "AE"; Andrews. *PBSL; PL, 1953.
Stanolind 1-AE Fasken; Andrews. *PL, 1962.
2192. TXL 1-K-T Reeves Fee; Reeves. *PL, 1960.
2203. N. B. Hunt 1 Toodle (Presidio Trust); Presidio. *PBSL.
2204. L. W. Welch 1 Joe Espy; Presidio. *PBSL.
2205. Welch 1 Brite; Presidio. *Confid.
2207. Gulf 1 Mitchell Bros.; Presidio. *PBSL.
2210. W. B. Hinton (Dodson) 1 Texas American Syndicate; Brewster. *PBSL; PL, 1959.
Texas-New Mexico Devel. Co. 14-66 State; Brewster. *PBSL; PL, 1959.
2216. Hull, 1957. Slick-Urschel Oil 1 Mary Decie-Sinclair; Brewster. *PBSL.
2217. Pure 1 Massie West; Brewster. *PBSL.
2220. Flawn and others, 1961, p. 236. Sun 1 Nellie Mae McElroy; Brewster. *PBSL.
2221. Flawn and others, 1961, p. 235-236. Albert Plummer and Dick Schwab 1 Bud Roark; Brewster. *PBSL.
2222. Atlantic 1 Harold L. Lowry; Pecos. *PBSL; PL, 1959.
2226. Hiawatha 1 J. C. Trees Est.; Pecos. *PBSL.
2228. Richardson and Bass 1 Texas Cotton Ind.; Pecos. *PBSL.
W. A. and E. R. Hudson 1 Charles T. Hart; Pecos. *PBSL.
2232. Jergins Oil 1 H. J. Eaton; Pecos. *PBSL.
2235. Continental 1 E. E. Bonebrake; Pecos. *PBSL; PL, 1959.
2237. C. L. Hay, Trustee for Wm. Stoll, 1 Alexander; Pecos. *PBSL.
2238. N. G. Penrose and McDaniel & Beecherl Drlg. 1 Cordova Union; Pecos. *PBSL.
2241. Midwest Oil 1 J. P. O'Neill; Pecos. *PBSL.
2245. Standard 1 Tri-State Assoc. Credit Men; Pecos. *PBSL.
2246. Humble 2 San Pedro Ranch; Pecos. *PBSL.
2249. Humble 1 O. L. Barnes-State "B"; Pecos. *PBSL.
2250. Brown & Thorp Drlg. and La Gloria Corp. 1 A. A. Sullivan "F"; Pecos. *PBSL.
2254. Phillips 1 Univ. "EE"; Pecos. *PBSL.
2255. Santiago Oil & Gas 1 Hinyard Land & Cattle Co.; Pecos. *PBSL; PL, 1959.
2257. Shell 1 J. A. McDonald; Pecos. *PBSL.
2258. G. B. Putnam and others 1 McDonald and State; Pecos. *PBSL.
2265. British-American 1 White & Baker; Pecos. *PBSL, PL, 1957.
Forest Oil 1 White & Baker and others; Pecos. *PBSL.
2266. Gulf 1 G. Yates 231; Pecos. *PBSL; PL, 1959.
2267. Superior 1 J. L. Nutt "4"; Pecos. *PBSL.
2269. Stanolind 9 Univ. Texas "B"; Pecos. *PBSL.
2270. Tidewater 1 White & Baker Ranch "A"; Pecos. *PBSL; PL, 1957.

TEXAS—Continued

2273. Humble 1 L. W. Stone; Pecos. *PBSL; PL, 1959.
2276. Pan American 1 Univ. "CS"; Pecos. *PBSL, 1957.
2282. Standard 1 Frank A. Perry "30"; Pecos. *PBSL; PL, 1956.
2285. Standard 1 C. C. Cannon and others; Pecos. *PBSL.
2287. Texas 1 John L. Monroe "A"; Pecos. *PBSL; PL, 1957.
2292. Hunt Oil 47 Elsinore Royalty Co.; Pecos. *PBSL.
2293. Hunt Oil 51 Elsinore Royalty Co.; Pecos. *PBSL; PL, 1958.
2294. Phillips-Sinclair 1-A Montgomery; Pecos. *PBSL.
2296. Hunt Oil 48 Elsinore Royalty Co.; Pecos. *PBSL; PL, 1956.
2297. Gulf 6E Jerusha Robbins and others "A"; Pecos. *Confid.
2302. Standard 1 Hellon Hokit "2"; Pecos. *PBSL.
2304. Phillips 1 Puckett "G"; Pecos. *PBSL.
2306. Phillips 1 Odom "A"; Pecos. *PBSL; PL, 1953.
2308. Phillips 1 Haral "B"; Pecos. *PBSL.
2309. Continental 1 Mrs. Kennie Noelke; Pecos. *PBSL; PL, 1956.
2310. Humble 1 W. M. Edwards; Pecos. *PBSL; PL, 1957.
2316. Pan American 1 Ethel Corder; Terrell. *PBSL; PL, 1959.
2318. Flawn and others, 1961, p. 306; Hull, 1957, p. 88-90. Humble 1 N. D. Blackstone and others; Terrell. *PBSL.
2320. Gulf 1 H. B. Allison; Terrell. *PL, 1959.
2322. Texas Pacific Coal and Oil 1 W. C. Dunlap "A"; Terrell. *PBSL.
2326. Hunt Oil 1 Busten Cannon; Terrell. *PBSL.
2330. Magnolia 1 State-Brown; Terrell. *PL, 1959.
2331. Flawn and others, 1961, p. 307. Milham Oil 1 Bassett; Terrell.
2333. Duncan, Hamm, O'Brien, and Cox 1 Tippett; Crockett. *PBSL; PL, 1959.
2335. Atlantic 1 B. C. Mann and others; Crockett. *PBSL.
2336. Texas Pacific Coal and Oil 1 Univ. "G"; Crockett. *PBSL; PL, 1957.
2339. Shell 1-5 Univ.; Crockett. *PBSL.
2340. Continental 1 Harris "B"; Crockett. *PBSL; PL, 1956.
2343. Continental 1 C. T. Harris "E"; Crockett. *PBSL; PL, 1956.
2346. Pan American 1 Univ. "DL"; Crockett. *PBSL; PL, 1959.
2348. Texas 12 State of Texas "CY"; Crockett. *PBSL.
Forest Oil 1 Univ. "M"; Crockett. *PBSL; PL, 1957.
2350. Continental 1-A-13 Univ.; Crockett. *PBSL.
2352. C. U. Bay and Vickers Pet. 1-39 Univ.; Crockett. *PBSL.
2354. Watchorn 1 Thompson; Crockett. *PBSL.
2355. Duquesne Oil 2 Shannon Est.; Crockett. *PBSL.
2358. Magnolia 1 Shannon-Hospital; Crockett. *PBSL; PL, 1957.
2359. Texas Gulf Prod. 1 Univ. "Q"; Crockett. *PBSL; PL, 1955.
2360. Chambers and Kennedy 1 Hugh Andrews; Crockett. *PBSL.
2361. Amerada 1 Univ. C-T-A; Crockett. *PBSL; PL, 1947.
2364. Humble 1 E. C. Mitcham; Crockett. *PBSL.
2365. Ohio 2 Halff and Bivens; Crockett. *Schlumberger.
2368. Forest Oil 1 J. S. Todd; Crockett. *PBSL.
2369. Southland Royalty Co. and others 1-14 J. S. Todd; Crockett. *PBSL.
Monsanto Chem. 1 Todd; Crockett. *PL, 1961.
2372. Richfield 1 Bean; Crockett. *PBSL; Schlumberger.
2373. La Gorce Oil and Garlitz-Howell 1 Jack and Nettie Holt; Crockett. *PBSL.
2374. Texas Pacific Coal and Oil 1 H. L. Bair "A"; Crockett. *PBSL.
2377. Sinclair-Prairie 1 Univ. "94"; Crockett. *PBSL.
2379. Continental 1 Univ. "31-36"; Crockett. *PBSL.
2381. Continental 1 Univ. "32-13"; Crockett. *PBSL.
2383. Shell 1 Friend; Crockett. *PBSL.
2385. T. W. Loffland and J. M. Loffland, Jr., 1 V. B. Cox; Crockett. *PBSL.
2387. Humble 1 Charles E. Davidson, Jr.; Crockett. *PBSL.
2388. Sinclair 1 M. S. Jones; Crockett. *PBSL.

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2390. Magnolia 1 J. W. Henderson; Crockett. *PBSL.
2392. Sinclair 1 Frank F. Friend; Crockett. *PBSL.
L. R. French, Jr., 1 Friend; Crockett. *PL, 1962.
2393. Sun 1 Myrtle Mitchell; Crockett. *PBSL.
2395. Texas 1 Victor L. Pierce; Crockett. *PBSL; PL, 1961.
Texas 2 Victor L. Pierce; Crockett. *PBSL.
2396. Continental 1 D. A. Friend; Crockett. *PBSL.
2398. Flawn and others, 1961, p. 323. Humble 1 Mills Minerals Tr.; Val Verde. *PBSL; PL, 1957.
2399. Flawn and others, 1961, p. 326. Magnolia 1 L. M. Morrison; Val Verde. *PBSL; PL, 1956.
2400. Flawn and others, 1961, p. 330. Stanolind 1 Wayne W. West; Val Verde. *PBSL; PL, 1957.
2402. Flawn and others, 1961, p. 328. Phillips 1-A Guinn; Val Verde. *PBSL; PL, 1957.
2403. Pure 1 T. L. Drisdale; Val Verde. *PBSL; PL, 1957.
2404. Flawn and others, 1961, p. 320. Phillips 1 B. E. Wilson; Val Verde. *PBSL; PL, 1961.
2406. Flawn and others, 1961, p. 323. Humble 1 Emma Wardlaw; Val Verde. *PBSL; PL, 1959.
2409. S. F. Hurlbut and others 1 Bluff Creek Ranch; Val Verde. *PBSL.
2410. Flawn and others, 1961, p. 331. D. H. Werblow and others 1 Maud Newton; Val Verde. *PBSL.
2411. Flawn and others, 1961, p. 319-320. R. J. Carraway 1 Guida Rose; Val Verde. *PBSL.
2412. R. W. Fair 1 Univ. "53"; Schleicher. *PBSL.
2414. Humble 1 R. L. Henderson and others; Schleicher. *PBSL.
2415. Stanolind 1 R. S. Williams; Schleicher. *PBSL.
2416. R. W. Berry and others 1 A. B. Thomerson and others; Schleicher. *PBSL; PL, 1954.
2417. A. C. Hope 1 Upton and Upton; Schleicher. *PBSL; PL, 1957.
2419. Fryer & Hanson Drlg. 1 D. E. DeLong; Schleicher. *PBSL.
2421. Ashland Oil & Ref. 1 Brown; Schleicher. *PBSL.
Warton Drlg. 1 R. Wilbur Brown, Sr., and others; Schleicher. *PBSL.
2423. Sinclair-Prairie 1 Mary F. McClatchy; Schleicher. *PBSL.
2424. Argo Oil 1 T. C. Meador; Schleicher. *PBSL.
Texas Crude Oil 1-15 T. C. Meador; Schleicher. *PBSL.
White Eagle Oil 1 T. H. Wilton; Schleicher. *PBSL.
2426. Panuco Oil Leases, Inc., 1 Henry C. Moore and others; Schleicher. *PBSL.
Miami Operating Co. 1 Paul Klatt; Schleicher. *PL, 1957.
2427. Texas Crude Oil and B. L. McFarland, Inc., 1-8 N. Daughdrill; Schleicher. *PBSL.
2428. Ohio 1 A. L. Baugh and others; Schleicher. *PBSL.
2429. J. D. Wrather, Jr., 1 Williams Est.; Schleicher. *PBSL; PL, 1956.
2430. Sinclair 2 Catherine Martin; Schleicher. *PBSL; PL, 1959.
2431. C. E. Marsh II and others 1 Willoughby; Schleicher. *PBSL.
2432. C. E. Marsh II 1 Davis; Schleicher. *PBSL.
2435. Skelly 1 J. T. Jackson; Schleicher. *PBSL.
Stanolind 1 Augusta West; Schleicher. *PBSL.
2437. Atlantic 1 W. B. Roberts; Schleicher. *PBSL.
American Trading & Prod. Co. 1 Otto Sauer; Schleicher. *PBSL.
Atlantic 1 Oliver Teele; Schleicher. *PBSL; PL, 1959.
Caroline Hunt Trust Est. 1 R. J. Nixon; Schleicher. *PBSL; PL, 1959.
2438. Sorrels Oil 1 Mary Tisdale and others; Schleicher. *PBSL.
2439. Humble 1 Sol Mayer "B"; Schleicher. *PBSL; PL, 1959.
2441. F. A. Callery 1 S. E. Jones; Schleicher. *PBSL.
2444. Honolulu 1 George Kothmann; Menard. *PBSL; PL, 1959.

TEXAS—Continued

2445. Tucker Drlg. 1 L. F. Callan; Menard. *PBSL.
2446. Deep Rock Oil 1 W. P. Bevens; Menard. *PBSL.
2449. Continental and others 1 Sol Mayer; Sutton. *PBSL.
2450. Lisman, 1957, C. L. Norsworthy, Jr., and Lone Star Prod. 1 R. M. Thompson; Sutton. *PBSL.
2451. Bluebonnet Oil & Gas 1 H. Walker Est.; Sutton. *PBSL.
Texaco 1-C Allison NCT-1; Sutton. *PBSL; PL, 1960.
2454. Placid Oil 1 E. S. Mayer; Sutton. *PBSL.
2455. C. L. Norsworthy 1 Barton Heirs; Sutton. *PBSL.
2457. C. L. Norsworthy, Jr., 1 R. A. Halbert; Sutton. *PBSL.
2458. Ada Oil 1 Rip Ward; Sutton. *PBSL.
2459. Ada Oil 1 John D. Fields; Sutton. *PBSL.
2460. C. L. Norsworthy, Jr., 1 Alfred Schweining; Sutton. *PBSL.
C. L. Norsworthy, Jr., 1 Sam Allison; Sutton. *PBSL.
2461. Sinclair 1 Ray Hudspeth; Sutton. *PL, 1957.
2462. Shell 1 Aldwell; Sutton. *PBSL.
Union Oil 1-22 Aldwell Bros.; Sutton. *GS; PL, 1959.
2463. C. L. Norsworthy, Jr., 1 E. E. Sawyer; Sutton. *PBSL.
2465. C. L. Norsworthy, Jr., 1 M. S. Clarkson; Sutton. *PBSL.
2467. C. L. Norsworthy, Jr., 1 Mrs. Harold Friess; Sutton. *PBSL.
Parnell and Coleman and Fortune Drlg. Corp. 1 Bryan Hunt; Sutton. *PL.
2469. Humble 1 D. J. Harrison; Sutton. *PBSL; PL, 1960.
2473. Texas Pacific Coal and Oil 1 Murr; Kimble. *PBSL; WCTSLS.
2474. Aztec Oil and others 1 J. F. Farmer; Kimble. *PBSL.
2477. Skelly 1 M. P. Rieck; Kimble. *PBSL.
2478. Taylor Oil & Gas 1 Holman; Edwards. *WCTSLS.
2479. Flawn and others, 1961, p. 251. Shell 1 Elsie 1 Honeycutt; Edwards. *PBSL; WCTSLS.
2480. Slagter Prod. 1 Whittenburg; Edwards. *PBSL; WCTSLS.
2481. Flawn and others, 1961, p. 250. Humble 1 O. D. Collins; Edwards. *PBSL; WCTSLS.
2482. Flawn and others, 1961, p. 251. Phillips 1 Carson "A"; Edwards. *PBSL; WCTSLS.
2483. Flawn and others, 1961, p. 283. Fish Prod. Co. 1 Henderson; Kinney. *WCTSLS.
2484. Flawn and others, 1961, p. 283. Fish Prod. Co. 1 Postell; Kinney. *WCTSLS.
2485. J. I. Moore and Dan Auld 1 Claude Haby; Real. *PBSL.
2486. Flawn and others, 1961, p. 299. Stanolind 1 C. O. Knippa; Real. *PL, 1959.
2491. Skinner, 1940, p. 183, 185.
2497. Jack Woodward and Dan Auld 1 Hal and Charlie Peterson; Edwards. *PBSL; PL.
2500. Shell 1 C. A. Bird; Garza. *GS; PL, 1961.
2502. Atlantic 1 Swenson; Garza. *PBSL.
2504. Continental 2 Swenson Land & Cattle; Garza *PBSL.
2505. Guy Mabee Drlg. and Morris Mizel 1 Justice Est.; Garza. *PBSL.
R. L. York and others 1 Justice Heirs; Garza. *PBSL.
2506. Anderson-Prichard 1 G. W. Connell "A"; Garza. *PBSL; PL, 1959.
2508. Shell 1 Coleman and others; Lynn. *PBSL; PL, 1960.
2509. Texas 1 H. A. Macha; Lynn. *PBSL; PL, 1960.
2510. Sinclair-Prairie 1 George C. Lindley; Lynn. *PBSL; PL, 1949.
2511. Wilshire Oil of Texas 1 Augusta Brownfield; Terry. *PBSL; PL, 1962.
2512. Amerada 1 M. D. Green; Terry. *PBSL; PL, 1957.
2513. Texas 1 Jack W. Frost; Yoakum. *PBSL; PL, 1960.
2514. Texaco 17-B Mrs. Annie Miller "B"; Yoakum. *PBSL.
2515. Murphy H. Baxter 1-A Katherine Mayo; Gaines. *GS; PL, 1961.

TEXAS—Continued

2516. Tennessee Gas Trans. 1 P. G. Northrup "A"; Gaines. *PBSL; PL, 1960.
2517. Pan American 1 R. C. Blanchard "A"; Gaines. *PL, 1957.
2518. Continental 1 Stonecipher; Gaines. *GS; PL, 1961.
2519. Sinclair 1 A. M. Lane; Gaines. *PBSL; PL, 1959.
2520. Humble 1 Humble-Atlantic; Gaines. *PBSL; PL, 1962.
2521. Tennessee Gas & Oil and Husky Oil 1-A Dupree; Dawson. *PBSL; PL, 1960.
2522. Texas Crude Oil 1-30 H. A. Hunt; Dawson. *GS; PL, 1961.
2523. Pan American 1 Lindsey Operating Area; Dawson. *GS; PL, 1961.
2524. Superior 1 Barnes-McBrayer and others; Dawson. *PBSL; PL, 1956.
2525. Pure 1 L. Hester; Borden. *GS; PL, 1961.
2526. Rowan Drlg. 1 Frank Miller; Borden. *PBSL; GS; PL, 1960.
2527. Shell 1 Clayton-Johnson; Borden. *PBSL.
2528. Continental 1 W. D. Johnson; Borden. *PBSL; PL, 1957.
2529. Texaco 1 J. T. Johnson NCT-1; Borden. *PBSL; PL, 1960.
2530. Amerada 1 J. R. Canning; Borden. *PBSL; PL, 1954.
2531. Phillips 1 Satterwhite; Howard. *PBSL; PL, 1956.
2532. Ralph Lowe 1 Florence Read; Howard. *GS; PL, 1961.
2533. Tennessee Gas Trans. 1 Paul B. Adams "A"; Howard. *PBSL; PL, 1960.
2534. Seaboard Oil 2 Tora Campbell; Howard. *PL, 1961.
2535. Stanolind 1 C. W. Burton; Howard. *PL, 1950.
2536. Sunray Mid-Continent 1 F. W. Henson; Martin. *PBSL; PL, 1962.
2537. Hunt 1 C. C. Griffin; Martin. *GS; PL, 1961.
2538. Husky Oil and others 1 Knox; Martin. *PBSL; PL, 1959.
2539. Husky Oil 1-A Hill; Martin. *GS; PL, 1961.
2540. Humble 295 J. S. Means; Andrews. *GS; PL, 1961.
2541. Union Oil 11-B Logsdon; Andrews. *GS; PL, 1960.
2542. Skelly 167 S. M. Halley; Winkler. *PBSL; PL, 1960.
2543. Superior 1-D Sealy-Smith; Winkler. *PL, 1962.
2545. Socony Mobil 1 George Sealy "56"; Ward. *PL, 1959.
2546. Shell 88 Sealy-Smith; Ward. *PBSL; PL, 1960.
2547. Gulf 1 Jane Dean Miller and others; Ward. *PL, 1960.
2548. White Eagle Oil and Freeport Sulphur Co. 1-32 Edwards Ranch; Ector. *PL, 1956.
2549. Gulf 1-E W. Bryant; Midland. *PBSL; PL, 1959.
2550. M. H. Baxter 1 N. L. Heidelberg; Midland. *PBSL; PL, 1957.
2551. A. N. Hendrickson 1 Floyd; Midland. *PBSL; PL, 1957.
2552. Texaco 5-D C. Scharbauer; Midland. *PL, 1962.
2553. TXL 1 TXL "41"; Glasscock. *GS; PL, 1960.
2554. Shell 1 E. Chriesman; Glasscock. *GS; PL, 1961.
2555. Standard 1 Viola Scherz and others; Glasscock. *PBSL; PL, 1959.
2556. TXL 1 L. C. Clark; Glasscock. *GS; PL, 1961.
2557. Humble 1 Mrs. Z. Oswalt and others; Upton. *PBSL; PL, 1959.
2558. Texaco 1 State of Texas "DG"; Upton. *PBSL; PL, 1960.
2559. Sinclair 1 Houser and Southland Royalty Co.; Upton. *PBSL; 1961.
2560. Shell 1 Shirk "B"; Upton. *PL, 1960.
2561. Pan American 6 Leonard Proctor "B"; Reagan. *PBSL; PL, 1960.
2562. Sunray Mid-Continent 1 Ella C. Sugg; Irion. *PBSL; PL, 1956.
2563. Lyda Hunt and Herbert Trust 1 M. M. Williams; Irion. *PBSL; PL, 1960.
2564. Jones 1 Mowery; Hudspeth. *PBSL.
2565. Socony Mobil 1 State-Barrett; Culberson. *PBSL; PL, 1960.
2566. TXL 1 Culberson "C"; Culberson. *GS; PBSL; PL, 1961.
2567. TXL 1-BT Culberson; Culberson. *GS; PBSL; PL, 1961.

TEXAS—Continued

2568. Humble 1 M. C. Sibley; Culberson. *GS; PL, 1961.
2569. Tidewater 1 Delaware Basin Prop., Inc.; Culberson. *GS; PL, 1961.
2570. TXL 1 Harry Goode; Culberson. *GS; PL, 1960.
2571. Continental 1 Charlotte Montgomery; Reeves. *PBSL; PL, 1960.
2572. El Paso Nat. Gas and Odessa Nat. Gas 1 Hoefs; Reeves. *PBSL; PL, 1962.
2573. Gulf 2 R. Cleveland and others; Reeves *GS; PL, 1961.
2574. Texas Pacific Coal and Oil 1 Ollie P. Anderson; Reeves. *PBSL; PL, 1962.
2575. Socony Mobil 1 Fred Schlosser; Pecos. *PBSL; PL, 1961.
2576. Felmont Oil 1 White & Baker; Pecos. *PL, 1959.
North Central Oil and others 1 Lowery and Wilson; Pecos. *GS; PL, 1960.
2577. Pure Oil 1 State School; Pecos. *PL, 1962.
2578. Hassie Hunt Trust 2 H. A. Wimberly; Pecos. *GS; PL, 1961.
2579. Southern Minerals Corp. 1-A Jasper CSL; Pecos. *GS; PL, 1961.
2580. Tidewater 1 Mary McKenzie Carter; Pecos. *PL, 1961.
2581. Pan American (Rowan Drlg. and others) 1 Douglas Oil; Pecos. *PBSL; PL, 1960.
2582. Southern Minerals Corp. and others 1 J. N. Thigpin; Pecos. *GS; PL, 1961.
2583. Humble 1 Carolyn H. Harral; Pecos. *GS; PL, 1961.
2584. Neville G. Penrose, Inc., 1 Rashap; Pecos. *GS; PL, 1961.
2585. Atlantic 1 Lucas-State; Pecos. *GS; PL, 1961.
2586. Sinclair 1 Popham Land & Cattle Co.; Pecos. *PL, 1962.
2587. TXL 1 Pecos Fee; Pecos. *PL, 1962.
2588. King, P. B., 1937, p. 74-75; Pecos.
Forest Oil and Lone Star Prod. 1 Jo Ann Moore; Pecos. *GS; PL, 1961.
2589. Pure 1 J. F. Lane; Presidio. *PL, 1961.
2590. Gulf 1 H. J. Hubbard; Presidio. *PL, 1961.
2591. Socony Mobil 1 J. M. Corder; Terrell. *PBSL; PL, 1960.
2592. Sinclair 1 Alma H. Poulter; Terrell. *PL, 1960.
2593. Shell and Gulf 1-X Robert J. Cauthorn; Val Verde. *PL, 1962.
2594. Sinclair 1 J. H. Herd; Val Verde. *GS; PL, 1961.
2596. Monterey Oil 23-40 Harris; Crockett. *PL, 1960.
2597. Gulf 1-A Shannon Hospital; Crockett. *GS; PL, 1961.
2598. Sun 1 Univ.; Crockett. *GS; PL, 1961.
2599. Cities Service 1 Bean "B"; Crockett. *GS; PL, 1961.
2600. Honolulu 1 Emma Lou Adams; Crockett. *GS; PL, 1961.
2601. Sinclair 1 Univ.-Crockett 154; Crockett. *GS; PL, 1960.
2602. Humble 1 D. M. Boyd; Schleicher. *GS; PL, 1961.
2603. Magnolia 1 Mary Ball; Schleicher. *PBSL; PL, 1960.
2604. TXL 1 Mrs. C. R. Judkins; Schleicher. *GS; PL, 1961.
2605. T. A. Kirk and H. L. Neeb 1 B. B. Dunbar; Sutton. *PL, 1962.
2606. Amerada 1 Dilla Rode; Sutton. *GS; PL, 1961.
2607. Delfern Oil 1 Allison; Sutton. *PBSL.
2608. Monterey Oil 1 Anderson; Sutton. *GS; PL, 1960.
2609. Tucker Drlg. 1 Holman Est.; Sutton. *PBSL; PL, 1960.
2610. Wayne Allison 1 Fritz Volkmann; Menard. *PBSL; PL, 1960.
2611. Cities Service 1 Nelson "B"; Kimble. *PBSL; PL, 1960.
2612. Skelly 1 Gully Cowsert; Kimble. *GS; PL, 1961.
2613. Sunray Mid-Continent 1 R. R. Spiller; Kimble. *PBSL; PL, 1962.
2614. Sinclair 1 W. L. Miers; Edwards. *PBSL; WCTSLS; PL, 1961.
Humble 1 W. L. Miers; Edwards. *WCTSLS; PL, 1960.

TEXAS—Continued

2615. Gulf 1 Anderson-Dunham; Edwards. *PL, 1962.
2616. Dan Auld and others 1 Rigsby; Edwards. *PL, 1960.
2617. J. Dalglish and others 1 Peterson; Edwards. *PL, 1960.
2618. Val Verde Ventures 1 J. H. Harding; Edwards. *PL, 1961.
2619. Shell 1 J. H. Brown; Edwards. *WCTSLS; PL, 1960.
2620. Humble 1 J. L. Greer; Edwards. *PBSL; PL; 1961.
2621. H. M. Naylor Oil 1 Lloyd Mitchell; Edwards. *WCTSLS.
2622. Plateau Oil 1 Hatch; Edwards. *WCTSLS.
2623. Flawn and others, 1961, p. 250–251. H. L. Hunt 1 Allison; Edwards. *WCTSLS.
2624. Spencer Chem. 1 Earwood; Edwards. *WCTSLS.
2625. Texas 1 J. E. Phillips; Edwards. *WCTSLS.
2626. Lewis Mabee Co. 1 Wheat-Bradford; Edwards. *WCTSLS.
2627. Tucker Drlg. 1 Wardlaw Bros.; Edwards. *WCTSLS.
2628. General Crude Oil 1-1 Joe Wilhelm; Menard. *WCTSLS.
2629. Wilcox Oil 1 Spiller; Kimble. *WCTSLS.
2630. Humble 1 Bolt; Kimble. *WCTSLS.
2631. Tucker Drlg. 1 C. M. Brown Est.; Real. *WCTSLS.
2632. Flawn and others, 1961, p. 285. Magnolia 1 Wardlaw; Kinney. *WCTSLS.
2634. Flawn and others, 1961, p. 317. Humble 1 Anderson; Uvalde. *WCTSLS.
2635. Flawn and others, 1961, p. 317. B. Einstoss 1 Wardlaw; Uvalde. *WCTSLS.
2636. Flawn and others, 1961, p. 319. Universal Pet. 1 Mountain Eagle Ranch; Uvalde. *WCTSLS.
2637. Auld and Woodward 1 William Auld; Kerr. *WCTSLS.
Continental 1 G. F. Schreiner; Kerr. *WCTSLS.
Evans and Gant 2 Love; Kerr. *WCTSLS.
Flawn and others, 1961, p. 282. Evans and others 2 Love.
2638. G. L. Rowsey 2 R. B. Nowlin; Kerr. *WCTSLS: PL, 1960.
2639. Phillips 1 C. O. Whitworth; Kerr. *WCTSLS.
2640. Fields and Schmidt 1 H. Real; Kerr. *WCTSLS.
2641. Tucker Drlg. 1 Roy O. Perkins; Kerr. *WCTSLS.
2642. Ohio 1 Charles Robinson; Kerr. *WCTSLS.
Flawn and others, 1961, p. 282. Ohio 1 J. H. Soul (Saul?).
2644. Flawn and others, 1961, p. 211. General Crude Oil 1 S. H. Anderson; Bandera. *WCTSLS.
2645. Flawn and others, 1961, p. 225. Hickok & Reynolds Royalty Co. 1 Ewert; Bexar. *WCTSLS.
2646. Flawn and others, 1961, p. 226. Pagenkopf 1 Max Blum; Bexar. *WCTSLS.
2647. Flawn and others, 1961, p. 223–224. Bur-Kan Pet. Co. and Stanolind 1 Lee Hubbard; Bexar. *WCTSLS.
2648. Flawn and others, 1961, p. 223. Anderson-Prichard 1 E. H. Yturri; Bexar. *WCTSLS.
2649. Ralph Fair, Inc., and others 1 Pauline Lyro; Bexar. *WCTSLS.
2650. Flawn and others, 1961, p. 278–279.
2651. Flawn and others, 1961, p. 271–272. Shell 1 J. L. Harwell; Hays. *WCTSLS.
2652. Flawn and others, 1961, p. 272. Woodward & Co. 1 David Schubert; Hays. *WCTSLS.
2653. Flawn and others, 1961, p. 238. E. A. Dunham and Hensman Drlg. 1 W. F. Day; Burnet. *WCTSLS.
2654. Flawn and others, 1961, p. 239. Twin Cities Oil & Gas 1 Taylor.
2655. Flawn and others, 1961, p. 238. Al Belanger 1 Nella T. Evans.
2656. Flawn and others, 1961, p. 337–338. Shell and Sinclair 1 Purcell; Williamson. *WCTSLS.
2657. Flawn and others, 1961, p. 337. Jesse Russell 1 A. B. McGill.
2658. Flawn and others, 1961, p. 230. D. J. Meeks 1 E. W. Walker.
2659. Flawn and others, 1961, p. 230. E. L. Nixon 3 C. E. Crist.

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2660. Flawn and others, 1961, p. 230. E. L. Nixon 2 Hohenberger.
2661. Flawn and others, 1961, p. 228. R. K. Blumberg 1 Wagner.
2662. Flawn and others, 1961, p. 229. Johnson (R. A. Rodson and others) 1 Glasscock.
2663. Flawn and others, 1961, p. 281. P. B. Sterling and others 1 McCracklin.
2664. Flawn and others, 1961, p. 279–280.
2665. Flawn and others, 1961, p. 212. Mikton 1 Stelzer.
2666. Flawn and others, 1961, p. 318. Phantom Oil 1 M. D. Cloudt.
2667. Flawn and others, 1961, p. 318. Texas 1 Mitchell; Uvalde. *WCTSLS.
2668. Flawn and others, 1961, p. 258. Magnolia 1 McKinley.
2669. Flawn and others, 1961, p. 307. Magnolia and Western Nat. Gas. 1 Brown and Bassett.
2670. Wilson, 1954, p. 2460; Flawn and others, 1961, p. 61.
2671. Monk and Rodan, 1952.
2672. Ellison, 1957, p. 249. Cooper Gas 5-A-32 Bert Page.
2673. Humble 1 W. J. Burrus; Schleicher. *PL, 1963.
2674. Mississippi River Fuel 1-A J. C. Trees Est.; Pecos. *PL, 1963.
2675. Socony Mobil 1-B Effie Potts Sibley; Pecos. *PL, 1963.
Socony Mobil 1 Athey Unit; Pecos. *PL, 1963.
Socony Mobil 1 Effie Potts Sibley; Pecos. *PL, 1963.
2676. King, 1965, p. 43. Culberson.
2677. King and others, 1945; El Paso.
2678. Nelson, 1958, p. 20, 22.
2679. King, 1937, p. 60, 63, 75–76, 80–82.
2680. King, 1937, p. 56–57, 61–63, 65–68.
2681. Flawn and others, 1961, p. 305. R. E. Freeman 1 Barksdale.
2682. Flawn and others, 1961, p. 311. Williams, Calvert, and Brown 1 George M. Snowden.
2683. Flawn and others, 1961, p. 309. Southwest Texas Oil & Gas 1 A. T. Folsom.
2684. Flawn and others, 1961, p. 320–321.
2685. Flawn and others, 1961, p. 327. C. A. Maurer 1 John W. Ingram.
2686. Flawn and others, 1961, p. 290. Humble 1 Bandera CSL.
2687. Flawn and others, 1961, p. 296–297.
2688. Flawn and others, 1961, p. 295. Humble 1 E. E. Wilson.
2689. Flawn and others, 1961, p. 243. Roland Blumberg 1 D. C. Knibbe.
2690. Flawn and others, 1961, p. 271. Mann 1 Reeder.
2691. Plummer, 1950, pl. 1; Menard.
2692. Plummer, 1950, p. 57–59.
2693. Plummer, 1950, p. 59–60, pls. 9, 16; Mason. Honey Creek.
2694. Plummer, 1950, p. 50–52, 56.
2695. Plummer, 1950, p. 49–50.
2696. Humble 1 Univ. "CK"; Reagan. *PL, 1963.
2697. Gulf 1-J Burner-State "B"; Hudspeth. *PL, 1963.
2699. Plummer, 1950, p. 48, pl. 1. South fork of Honey Creek.
2801. Reynolds, Kirk, and Neeb 1 W. F. Williams; Hardeman. *NTSLS.
2802. R. H. Fulton and Amarillo Oil 1 Certainteed Prod.; Hardeman. *NTSLS.
2803. Gennett and Gilchrist 1 W. I. Tabor; Hardeman. *NTSLS.
2804. L. Grace Drlg. 1 W. C. Landers; Hardeman. *NTSLS.
2805. Shell 5 C. G. Conley; Hardeman. *NTSLS.
2806. W. H. Hudson 1 J. Hurst; Hardeman. *NTSLS.
2807. J. C. Maxwell 1 Emerson-Huie-Cox; Hardeman. *NTSLS.
2808. J. L. Patton 1 F. L. Moffett "A"; Hardeman. *NTSLS.
2809. Burk Royalty 1 Riddle; Wilbarger. *NTSLS.
2810. Sunray Mid-Continent 2 C. F. Mock; Wilbarger. *NTSLS.
2811. E. B. Clark and others 1 F. H. Coburn; Wilbarger. *NTSLS.

TEXAS—Continued

2812. A. R. Dillard (Rycade) 1 Bill Bond; Wilbarger. *NTSLS.
2813. Fain & McGaha 1 Streit; Wilbarger. *NTSLS.
2814. Socony Mobil 1 Waggoner Est. "A"; Wilbarger. *NTSLS.
2815. Woodson Oil 1 J. B. Johnson; Wilbarger. *NTSLS.
2816. Cities Service 19-S Gussman-Waggoner "N"; Wilbarger. *NTSLS.
2817. Hunter Bros. 1 B. Lee; Wichita. *NTSLS.
2818. C. E. Morrison 1 Krohn; Wichita. *NTSLS.
2819. Akin & Dimock 1 Beulah May; Wichita. *NTSLS.
2820. A. Goldsmith and others 1 R. L. Kempner; Wichita. *NTSLS.
2821. E. B. Clark and others 1 M. C. Brannon; Clay. *NTSLS.
2822. G. S. Hammonds 1-A A. B. Edwards; Clay. *NTSLS.
2823. Bridwell Oil 1 Tom Watson; Clay. *NTSLS.
2824. S. O. Johnson and Acme Die and Machinery 1 Fred Wines; Clay. *NTSLS.
2825. G. H. Vaughn 1-A Hapgood; Clay. *NTSLS.
2826. Continental 1 C. P. Miller; Montague. *NTSLS.
2827. Stephens Pet. 1 Chandler; Montague. *NTSLS.
2828. Ambassador Oil 1 W. R. Hodges; Montague. *NTSLS.
2829. Magnolia 1 Carminati; Montague. *NTSLS.
2830. Texas and others 1 D. B. Benson; Montague. *NTSLS.
2831. Texas 1 P. E. Boedecker; Montague. *NTSLS.
2832. Russell Maguire 1 Whitehead; Montague. *NTSLS.
2833. Continental 1 J. B. Williams; Montague. *NTSLS.
2834. W. B. Omohundro 1 Shoemaker; Montague. *NTSLS.
2835. Wrather Pet. 1 C. D. Meadow and others; Montague. *NTSLS.
2836. J. Grace Prod. 1 J. K. Seibold and others; Montague. *NTSLS.
2837. Seitz, Comegys, & Seitz 1 R. W. Harris; Montague. *NTSLS.
2838. Mid-Continent 1 L. Orrell; Montague. *NTSLS.
2839. Continental 1 H. M. Berry; Cooke. *NTSLS.
2840. Continental 1 C. G. Whaley; Cooke. *NTSLS.
2841. Northern Pump 1 F. B. Mitchell; Cooke. *NTSLS.
2842. Sun 1 D. C. Monroe; Cooke. *NTSLS.
2843. Paul B. Scott 1 L. C. Brittain; Cooke. *NTSLS.
2844. Howell and Holloway 1 D. Hudspeth; Cooke. *NTSLS.
2845. Broday Drlg. 1 Scott-Potter; Cooke. *NTSLS.
2846. P. G. Lake, Inc., 1 Pace Bros.; Cooke. *NTSLS.
2847. A. R. Dillard 1 Addle Ware; Cooke. *NTSLS.
2848. V. Taylor and others 1 C. Pendleton; Cooke. *NTSLS.
2849. Kay Kimbell 1 A. L. Williams; Cooke. *NTSLS.
2850. J. R. and A. Seitz 1 R. A. Richie; Cooke. *NTSLS.
2851. Kay Kimbell 1 Univ.; Cooke. *NTSLS.
2852. Humble 1 M. Williams; Grayson. *NTSLS.
2853. Texas 1 Marshall; Grayson. *NTSLS.
2854. R. P. Karll 1 E. Gattis; Grayson. *NTSLS.
2855. G. W. Humphrey 1 Barnes Heirs; Grayson. *NTSLS.
2856. Ashland Oil & Ref. 1 J. N. Crow; Grayson. *NTSLS.
2857. Sinclair 1 G. L. Croakham; Grayson. *NTSLS.
2858. J. R. and Adam Seitz 1 A. E. Hutton; Grayson. *NTSLS.
2859. S. A. Winfrey and others 1 A. Roark; Grayson. *NTSLS.
2860. Amis and Starr and Vernon Howell 1 Lady Myra Fuller; Grayson. *NTSLS.
2861. Oil and Gas Ventures 1 Circle "F" Ranch; Grayson. *NTSLS.
2862. Kerr-McGee 1 A. Weiss; Grayson. *NTSLS.
2863. Superior 1 S. L. Privette; Grayson. *NTSLS.
2864. A. R. Dillard and others 1 W. B. McMillan; Grayson. *NTSLS.
2865. Lone Star Prod. 1 C. O'Hagan; Grayson. *NTSLS.
2866. Lean-Tex (Star Oil) 1 Heironimus; Grayson. *NTSLS.
2867. Continental 1 B. F. Armstrong; Grayson. *NTSLS.

TEXAS—Continued

2868. R. M. Laurence 1 O. W. Kinnard; Grayson. *NTSLS.
2869. Phillips 1 Aldine "A"; Grayson. *NTSLS.
2870. Star Oil and General American Oil 1 G. Hodgin; Grayson. *NTSLS.
2871. Pan American Prod. 1 J. Umphress; Grayson. *NTSLS.
2872. F. A. Callery 1 R. G. Robinson; Fannin. *NTSLS.
2873. Deep Rock Oil 1 Shirley; Collin. *NTSLS.
2874. Walter Crocker 1 J. Murray; Collin. *NTSLS.
2875. Hill and Hill 1 Levi Carruth; Collin. *NTSLS.
2876. Humble 1 Miller; Collin. *NTSLS.
2877. Standard Oil of Kansas 1 E. F. McEntyre; Collin. *NTSLS.
2878. Burk Royalty (Northern Ordnance) 1 D. W. Light, Jr., and others; Denton. *NTSLS.
2879. L. A. Stemmons, Jr., 1 J. B. Thomas; Denton. *NTSLS.
2880. Holliman Drlg. and J. R. McLean 1 C. K. Justus; Denton. *NTSLS.
2881. 1 W. T. Evers; Denton. *NTSLS.
2882. Trentman, Jr., and others 1 R. M. King; Denton. *NTSLS.
2883. Texas 1 Ada Trietsch; Denton. *NTSLS.
2884. Howell and Holloway 1 B. Lewter; Denton. *NTSLS.
2885. Maguire 1 E. R. Wade; Denton. *NTSLS.
2886. Hunt Oil 1 Jones; Denton. *NTSLS.
2887. Hall and Glasco 1 Carroll; Denton. *NTSLS.
2888. A. Carter 1 Allen; Denton. *NTSLS.
2889. Carter-Gifford Oil 1 M. A. Knox; Denton. *NTSLS.
2891. Christie, Mitchell & Mitchell Co. 1 J. V. Hampton; Wise. *NTSLS.
2892. Texas and Mid-Continent 1 G. C. Young; Wise. *NTSLS.
2893. Miles Prod. and Christie, Mitchell & Mitchell Co. 1 Florida and others; Wise. *NTSLS.
2894. Cities Service 1 E. B. Monk; Wise. *NTSLS.
2895. A. R. Dillard 1 M. P. Younger; Wise. *NTSLS.
2896. Cities Service 1 B. O. Manning. Wise. *NTSLS.
2897. Christie, Mitchell & Mitchell Co. and Trio Drlg. 1 N. Kirk; Wise. *NTSLS.
2898. Mid-Continent and J. V. Howell 1 G. S. Kaker; Wise. *NTSLS.
2899. Champlin 1 Stanfield; Wise. *NTSLS.
2900. Cities Service 1 E. T. McKissick; Wise. *NTSLS.
2901. Texzona Prod. 1 Birdwell; Wise. *NTSLS.
2902. Signal Oil and Gas and others 1 Dr. J. Daly; Wise. *NTSLS.
2903. Christie, Mitchell & Mitchell Co. 1 D. W. Newsome; Wise. *NTSLS.
2904. Davon Oil 1 W. J. Dees; Jack. *NTSLS.
2905. Russell Maguire 1 H. L. Roper; Jack. *NTSLS.
2906. J. J. Lynn 1 A. L. Crawford; Jack. *NTSLS.
2907. Continental 1 M. Copeland; Jack. *NTSLS.
2908. W. T. Waggoner Est. 1 R. H. Thompson; Jack. *NTSLS.
2909. Russell Maguire 1 T. H. Chebryhomes; Jack. *NTSLS.
2910. Mid-Continent 1 T. E. Davis; Jack. *NTSLS.
2911. W. T. Waggoner Est. 1 J. F. Lewis; Jack. *NTSLS.
2912. Texas 1 A. T. Hicks; Jack. *NTSLS.
2913. Texas 1 J. E. Lemons; Jack. *NTSLS.
2914. Mid-Continent 1 B. Zuber; Jack. *NTSLS.
2915. Sorrells 1 A. D. Campsey; Jack. *NTSLS.
2916. Wilcox and Warren 1 Voyles; Jack. *NTSLS.
2917. Hanlon-Boyle, Inc.; 1 I. L. Dodson; Jack. *NTSLS.
2918. Hanlon-Boyle, Inc., 1 J. H. Tucker; Jack. *NTSLS.
2919. Humble 1 Richards; Jack. *NTSLS.
2920. Superior 1 A. C. Deats and others; Young. *NTSLS.
2921. R. F. Ratliff 1 N. D. Stovall; Young. *NTSLS.
2922. Gulf 1 Norton Prop. "E"; Young. *NTSLS.
2923. Texas 1 Irene McPherson; Young. *NTSLS.
2924. Ne-Tex Oil 1 G. A. Welch; Young. *NTSLS.

TEXAS—Continued

2925. Woods and Cox Drlg. 1-C H. Shanafelt; Young. *NTSLS.
2926. Texaco 1 F. V. Hinson; Young. *NTSLS.
2927. Pure 1 J. K. Jeffery; Young. *NTSLS.
2928. C. O. Pollard 1 Bloodworth "A"; Young. *NTSLS.
2929. Humble 1 Daws and others "B"; Young. *NTSLS.
2930. Anderson Oil 1 N. D. Stovall "E"; Young. *NTSLS.
2931. Texas 1 T. G. Price; Young. *NTSLS.
2932. J. K. Bailey and others 1-B Graham "B"; Young. *NTSLS.
2933. L. T. Burns 1 F. Brezina; Archer. *NTSLS.
2934. Perkins & Cullum 1-D Titken; Archer. *NTSLS.
2935. C. Sztykgold 1 Peyson; Archer. *NTSLS.
2936. Texas 1 J. B. Ferguson; Archer. *NTSLS.
2937. Pure 1-BB W. T. Waggoner; Baylor. *NTSLS.
2938. Burk Royalty 1 Fayette CSL "A"; Baylor. *NTSLS.
2939. Rycade Oil 1 J. H. Jenkins; Baylor. *NTSLS.
2940. Deep Rock Oil 1 N. Wright; Throckmorton. *NTSLS.
2941. Woodley Pet. 1 H. S. Bryson; Throckmorton. *ASLS.
2942. Pan American 1 J. R. Coody; Haskell. *NTSLS.
2943. Thos. D. Humphry & Sons 1-A Mable Jean Wood; Haskell. *ASLS.
2944. Texas Crude Oil 1 Strommell; Haskell. *ASLS.
2945. Sojourner Drlg. 1 Clark; Haskell. *ASLS.
2946. Clark & Cowder Prod. 1 Burton-Dotson; Haskell. *ASLS.
2947. Roark, Hooker, and Hill 1 C. B. Long; Haskell. *ASLS.
2948. Gilliam Drlg. 1 R. J. Rainey; Haskell. *ASLS.
2949. Fain & McGaha and Sohio 1 J. W. Goode; Haskell. *ASLS.
2950. Katz Oil 1 W. P. Russell; Haskell. *ASLS.
2951. Humphrey and Humble 1 B. B. Armstrong; Haskell. *ASLS.
2952. Sid Katz and A. C. Hope 1 D. Helton and others; Haskell. *ASLS.
2953. Republic Nat. Gas 1 Allie May; Haskell. *ASLS.
2954. Miami Pet. 1-K Swenson Land & Cattle; Stonewall. *ASLS.
2955. Rowan Oil 1 W. Z. Rutherford; Stonewall. *ASLS.
2956. Katz Oil and General American Oil of Texas 1 W. M. Barrett; Stonewall. *ASLS.
2957. R. K. Stoker 1 M. Wilson; Stonewall. *ASLS.
2960. Sinclair 1 W. A. Mays; Kent. *WCTSLS; PL.
2961. Stafford, 1959, Scurry and Kent.
2962. Louisiana Land and Explor. 1 E. L. Howell; Scurry. *PBSL; PL.
2963. Sunray Mid-Continent and Lauderdale & Straughan Drlg. 1-126 J. M. Davenport; Fisher. *ASLS.
2964. Lennert Erickson and others 1 Mrs. L. B. Darden; Fisher. *ASLS.
2965. Crown Central Pet. 1 J. H. Withers; Fisher. *ASLS.
2966. B. A. Duffy 1 M. Alexander; Jones. *ASLS.
2967. R. L. Wheelock, Jr., and others 1 J. Young; Jones. *ASLS.
2968. A. J. Slagter 1 R. L. Milstead; Jones. *ASLS.
2970. Texas 1 W. W. Mayfield; Jones. *ASLS.
2971. Humble 19 J. W. Hollums; Jones. *ASLS.
2972. Humble 1 Pittard; Jones *ASLS.
2973. A. J. Frazier and others 2-A Dorsey; Jones. *ASLS.
2974. Allison and Prestridge 1 H. S. Nease; Jones. *ASLS.
2975. Barron and Griffith 1 A. E. Harvey; Jones. *ASLS.
2976. J. W. King, Jr., and others 1 C. B. Snyder; Shackelford. *ASLS.
2977. Dean Bros. 1 J. P. Strickland; Shackelford. *ASLS.
2978. W. M. Jarrell and others 1 L. E. Turner; Stephens. *WCTSLS.
2979. Texas Pacific Coal and Oil 1 C. L. Trammell; Stephens. *WCTSLS.
2980. McElroy Ranch Co. 2 J. Barker and others; Stephens. *WCTSLS.
2981. Ada Oil 1 A. Walker; Stephens. *WCTSLS.

TEXAS—Continued

2982. Tennessee Gas & Oil 1 S. P. Robertson; Stephens. *WCTSLS.
2983. I. A. Stephens and General Crude Oil 1 B. Burgess; Stephens. *WCTSLS.
2984. McElroy Ranch Co. 1 M. W. Kendricks; Stephens. *ASLS.
2985. Texas Pacific Coal and Oil 1 S. L. Harris; Stephens. *WCTSLS.
2986. Abilene Geol. Soc., 1949, McCulloch County to Young County section, well 17.
2987. Abilene Geol. Soc., 1949, Scurry County to Parker County section, well 32.
2988. Texas Pacific Coal and Oil 1 Stuart; Palo Pinto. *WCTSLS.
2989. Hoblitzelle and others 1 Hudspeth; Palo Pinto. *WCTSLS.
2990. J. C. Wynne 1 C. H. Belding; Palo Pinto. *WCTSLS.
2991. A. J. Frazier 1-E Seaman; Palo Pinto. *WCTSLS.
2992. Ambassador Oil 1 Johns; Palo Pinto. *WCTSLS.
2993. J. J. Lynn 1-B J. K. Weldon; Palo Pinto. *WCTSLS.
2994. Trans-Gulf Corp. 1 Stanolind-McClure; Palo Pinto. *WCTSLS.
2995. Allison and Prestridge 1 Yeager-Mitchell; Palo Pinto. *WCTSLS.
2996. American Drlg. 1 Kendrick; Palo Pinto. *WCTSLS.
2997. G. E. Kadane & Sons 1 L. C. Taylor; Palo Pinto. *WCTSLS.
2998. Woods Trucking Co. 1 Roy Hittson, Sr.; Palo Pinto. *WCTSLS.
2999. Pan American 1-B Long; Palo Pinto. *WCTSLS.
3000. Abilene Geol. Soc., 1949, Scurry County to Parker County section, well 36.
3001. Pan American 1 C. B. Long; Palo Pinto. *WCTSLS.
3002. Pan American 1 Quante; Palo Pinto. *WCTSLS.
3003. Fletcher Oil & Gas Drlg. 1 A. R. Chestnut; Palo Pinto. *WCTSLS.
3004. Signal Oil and Gas 1 L. B. Carpenter; Palo Pinto. *WCTSLS.
3005. Burk and Brown 1 S. Jackson Heirs; Parker. *WCTSLS.
3006. Humble 1 J. H. Doss; Parker. *WCTSLS.
3007. Crader Oil 1 O. V. Sneed; Parker. *WCTSLS.
3008. Continental 1 C. P. Johnson; Parker. *WCTSLS.
3009. B. J. Taylor 1 H. D. Durham; Parker. *WCTSLS.
3010. G. E. Kadane & Sons 1 R. T. Land; Parker. *WCTSLS.
3011. Humble 1 C. H. Tompkins; Parker. *WCTSLS.
3012. Rowan Oil and others 1 J. E. Carter; Parker. *WCTSLS.
3013. Cities Service 1 Glenn; Parker. *WCTSLS.
3014. R. B. Owings 1 T. B. Saunders; Parker. *WCTSLS.
3015. Sunray 1 B. F. Fletcher; Parker. *WCTSLS.
3016. Devonian Oil 1 Raymond Buck; Parker. *WCTSLS.
3017. G. E. Kadane & Sons 1 Winston; Parker. *NTSLS.
3018. Rowan Oil and others 1 B. L. Marcum; Tarrant. *WCTSLS.
3019. Bruce Sullivan 1 L. and N. C. Putnam; Tarrant. *WCTSLS.
3020. A. G. Carter 1 T. R. Hinton; Tarrant. *NTSLS.
3021. C. Andrade III 1 R. B. Sharpless; Tarrant. *WCTSLS.
3022. I. D. Campbell and others 1 S. Cannon; Tarrant. *NTSLS.
3023. Magnolia 1 Trigg Est.; Dallas. *WCTSLS.
3024. J. Mitchell 1 J. L. Rush; Ellis. *WCTSLS.
3025. Christie and others 1 Nick Peikoff; Johnson. *WCTSLS.
3026. Humble 1 Haskell Dean; Johnson. *WCTSLS.
3028. Austral Oil 1 R. C. Gage; Johnson. *WCTSLS.
3030. Humble 1 Ella Freeman; Hill. *WCTSLS.
3031. J. A. Humphrey 1 J. E. Osborne; Hill. *WCTSLS.
3032. Phillips 1-A Posey; Hill. *WCTSLS.
3033. Southland Oil and others 1 R. T. Greenwade; Bosque. *WCTSLS.
3034. American Liberty Oil 1 Reichert; Bosque. *WCTSLS.
3035. C. M. Buie and others 1 A. M. Anderson; Bosque. *WCTSLS.

TEXAS—Continued

3036. American Republics Corp. 1 F. T. Shaffer; Bosque. *WCTSLS.
3037. McKinzie 1 Fee; Bosque. *WCTSLS.
3038. H. C. Plumley 1 Lynch; Bosque. *WCTSLS.
3039. Ernest Closuit 1 "Fee"; Bosque. *WCTSLS.
3040. M. E. Davis 1 T. H. Cousins; Somervell. *WCTSLS.
3041. DeSoto Oil 1 B. W. Wann; Hood. *WCTSLS.
3042. Mid-Continent 1 Squaw Creek Cattle Co.; Hood. *WCTSLS.
3043. C. J. Davidson 1 G. V. Matthews; Hood. *NTSLS.
3044. Sunray 1 H. B. Little; Hood. *WCTSLS.
3045. Sunray 1 J. R. Black; Hood. *WCTSLS.
3046. Signal Oil and Gas and others 1 Dennis Jones; Hood. *WCTSLS.
3047. Connally and Jackson 1 A. McPherson; Erath. *WCTSLS.
3048. Cities Service 1 Parkey "D"; Erath. *NTSLS.
3049. J. B. Collier, Jr., 1 Diamond C Ranch; Erath. *WCTSLS.
3050. McCarthy Oil & Gas 1 W. C. Hedrick; Erath. *WCTSLS.
3051. E. C. Burks and others 1 Lackey; Erath. *WCTSLS.
3052. American Liberty Oil 1 D. A. Fellers; Erath. *WCTSLS.
3053. J. D. Monk and others 1 O. N. McPherson; Erath. *WCTSLS.
3054. Finley and Hamilton 1 Medford; Erath. *WCTSLS.
3055. Lewis Mahan 1-A Noah Grimes; Erath. *WCTSLS.
3056. Continental 1 John Wiley; Erath. *WCTSLS.
3057. Texaco 1 Claude Irons; Erath. *NTSLS.
3058. J. B. Collier, Jr., 1 Stewart; Erath. *WCTSLS.
3059. Sun 1 Fambrough; Erath. *WCTSLS.
3060. B. N. Fitzgerald 1 Wilcoxson; Erath. *WCTSLS.
3061. Lubbock Machinery Co. 1 N. E. Whitfield; Erath. *WCTSLS.
3062. Coats and Foster 1 C. A. Scott; Comanche. *WCTSLS.
3063. Texas 1 O. D. Brinson; Comanche. *WCTSLS.
3064. H. O. Newman 1 T. J. Kelly, Jr.; Comanche. *WCTSLS.
3065. Humble 1 E. R. Hayes; Comanche. *WCTSLS.
3066. Humble 1 J. A. Mercer; Comanche. *WCTSLS.
3067. Murray and White 1 W. S. Lawrence; Comanche. *WCTSLS.
3068. Humble 1 Foreman; Comanche. *WCTSLS.
3069. W. H. Bryant Co. 2 E. D. Ward; Comanche. *WCTSLS.
3070. O. L. Johnson 1 T. L. Hutchinson; Comanche. *WCTSLS.
3071. Continental 1 M. W. Helm; Comanche. *WCTSLS.
3072. Sohio 1 M. Tate; Comanche. *WCTSLS.
3073. Continental 1 N. L. Box; Comanche. *WCTSLS.
3074. Sohio 1 Byrl Frasier; Comanche. *WCTSLS.
3075. Frank Wood 1 P. D. Patton; Comanche. *WCTSLS.
3076. Bankline Oil 2 Callaway; Comanche. *WCTSLS.
3077. G. E. Kadane & Sons 1 E. A. Whiteside; Eastland. *WCTSLS.
3078. C. H. Murphy & Co. 1 R. M. Day; Eastland. *WCTSLS.
3079. Capital Investment Co. 1 C. E. Allen; Eastland. *WCTSLS.
3080. Deep Rock Oil 1 J. J. Hawkins; Eastland. *WCTSLS.
3081. Texas Pacific Coal and Oil 30 J. E. Butler; Eastland. *WCTSLS.
3082. Signal Oil and Gas 1 C. U. Connellee; Eastland. *WCTSLS.
3083. British-American 1 J. W. Courtney; Eastland. *WCTSLS.
3084. McElroy Ranch Co. 1 M. E. Robinson; Eastland. *WCTSLS.
3085. Lone Star Prod. 1-E G. P. Mitcham; Eastland. *WCTSLS.
3086. Globe and Shive Drlg. 1 Lee Leiske; Eastland. *WCTSLS.
3087. Abilene Geol. Soc., 1949, McCulloch County to Young County section, well 11.
3088. Standard Oil of Kansas 1 R. L. Murphy; Callahan. *ASLS.
3089. Producers Devel. 1-B J. D. Eisenhower; Callahan. *ASLS.
3090. Rhodes Drlg. 1-H A. E. Dyer; Callahan. *ASLS.
3091. Eastland Drlg. 1 J. J. Lehew; Callahan. *ASLS.
3092. Hovgard 2 H. H. and M. T. Ramsey; Taylor. *ASLS.

TEXAS—Continued

3093. Hickock & Reynolds, Inc., 1 J. Armstrong; Taylor. *ASLS.
3094. Lester & Duffield, Inc., and others 1 G. C. Stewart; Taylor. *ASLS.
3095. Delta Oil 1 Marshall; Taylor. *ASLS
3096. Little and Crawford 1 A. P. Head; Taylor. *ASLS.
3097. Continental 1G-43 F. S. Shelton; Taylor. *ASLS.
3098. Sojourner Drlg. and others 1 Emma Hankins; Taylor. *ASLS.
3099. West Central Drlg. 1 J. W. Seymore; Taylor. *ASLS.
3100. Sojourner Drlg. 1 H. McCoy; Taylor. *ASLS.
3101. Roark, Hooker, and Roark 1 J. C. Hamner; Taylor. *ASLS.
3102. A. W. Cherry and others 1 J. H. Christian; Taylor. *ASLS.
3103. Sun and Seaboard Oil 18 B. K. Stone; Nolan. *ASLS.
3104. Standard Oil of Texas 1 J. Dell; Mitchell. *PBSL; PL.
3105. H. L. Hunt 1 C. J. Copeland; Sterling. *PBSL.
3106. Sunray Mid-Continent 1 G. H. McEntire; Sterling. *PBSL; PL.
3108. Fletcher Oil & Gas Drlg. 1 E. C. Sugg; Tom Green. *PBSL; PL.
3109. British-American 1 Cargile and others; Tom Green. *PBSL; PL.
3110. L. L. Lookabough, Jr., 1 J. Y. Rust Est.; Tom Green. *ASLS.
3111. C. L. Norsworthy, Jr., 1-A J. J. Smith; Coke. *ASLS; PL.
3112. J. B. Randle 1 King Est; Coke. *ASLS.
3113. Miami Operating Co. 1-A S. C. Sayner; Coke. *ASLS.
3114. Skelly 1 A. M. Underwood; Runnels. *ASLS.
3115. Humble 1 J. A. Broadstreet; Runnels. *ASLS.
3117. Pan American Prod. 1 J. W. Barr; Runnels. *ASLS.
3118. Paine Drlg. 1 Herring; Runnels. *ASLS.
3119. Cherry Bros. 1 W. A. Schumann; Runnels. *ASLS.
3120. Blanco Oil 1 Sims; Concho. *WCTSLS.
3121. West Central Drlg. 1 Brosig; Concho. *WCTSLS.
3122. Gulfshore 1 Trail; Concho. *WCTSLS.
3123. Progress Pet. 1 M. Samson; Concho. *WCTSLS.
3124. Brown and Stone 1 H. L. Mosley; Concho. *WCTSLS.
3125. Skelly 1 McCulloch; Concho. *WCTSLS.
3126. Texas 1 Mrs. A. Rainwater; Concho. *WCTSLS.
3127. Dobbs and Bradshaw 1 J. W. Welty; Concho. *WCTSLS.
3128. Homer Easterwood 1 Kate-N. C. Johnson; McCulloch. *WCTSLS.
3129. A. G. Hill 1 Smith; McCulloch. *WCTSLS.
3130. New Seven Falls Co. 1 Mitchell; McCulloch. *WCTSLS.
3131. N. G. Weatherford (Northwest Oil) 1 P. S. Pumphrey; McCulloch. *WCTSLS.
3132. I. E. Clark and others 1 J. B. Lively; McCulloch. *WCTSLS.
3133. Abilene Geol. Soc., 1949, McCulloch County to Young County section, well 3.
3134. McMillen and Rominger 1 Jordt (Randal); McCulloch. *WCTSLS.
3135. D. M. Cashin 1 Smith Est.; McCulloch. *WCTSLS.
3136. P. M. Durbin and others 1 C. H. Wiess; Coleman. *ASLS.
3137. Abilene Geol. Soc., 1949, McCulloch County to Young County section, well 6.
3138. Addison Warner 1 Brehm; Coleman. *ASLS.
3139. Abilene Geol. Soc., 1949, Coke County to Hamilton County section, well 11.
3140. Wildcats, Inc., 1 V. M. Close; Coleman. *ASLS.
3141. B. F. Phillips, Jr., 1 A. A. Purcell; Coleman. *ASLS.
3142. E. K. and E. M. Burt and others 1 G. E. Kemp; Coleman. *ASLS.
3143. Anderson & Word and others 1 Stephens; Coleman. *ASLS.
3144. W. T. Waggoner 1 Wethered; Coleman. *ASLS.
3145. Tex-Harvey Oil 1 E. W. Webb; Coleman. *ASLS.
3146. Westates Pet. of Texas 1 R. Jameson; Coleman. *ASLS.

TEXAS—Continued

3148. Saxon Explor. 1 W. J. McClure; Coleman. *ASLS.
3149. Abilene Geol. Soc., 1949, Coke County to Hamilton County section, well 14.
3150. Abilene Geol. Soc., 1949, McCulloch County to Young County section, well 9.
3151. Lone Star Prod. 1 Ella M. Snyder; Brown. *WCTSLS.
3152. Lydia Johnson 1 G. C. Goss; Brown. *WCTSLS.
3153. Lone Star Prod. 1 R. N. Smith; Brown. *WCTSLS.
3154. T. E. Edgell 1 W. J. Richmond; Brown. *WCTSLS.
3155. Lone Star Prod. 1 John Shannon Heirs; Brown. *WCTSLS.
3156. J. M. Johnson 1 Billy Barr; Brown. *WCTSLS.
3157. H. O. Newman 1 Mrs. Mary L. Weldon; San Saba. *WCTSLS.
3158. Norman and others 1 Gibbons; San Saba. *WCTSLS.
3159. Three Widows 1 Minnie E. Ballard; San Saba. *WCTSLS.
3160. Pure 1 W. A. Triplitt; Mills. *WCTSLS.
3161. Abilene Geol. Soc., 1950, Coke County to Lampasas County section, well 23.
3162. Trigger Mtn. Oil 1 J. F. Burdett; Mills. *WCTSLS.
3163. M. M. Miller and others 1 George Nieman; Mills. *WCTSLS.
3164. R. K. Stoker 1 Grelle; Mills. *WCTSLS.
3165. Fisher and Stoker 1 Leonard; Mills. *WCTSLS.
3166. Deep Well Oil 1 Segelquist Bros.; Mills. *WCTSLS.
3167. Robertson and Smith 1 Smith; Lampasas. *WCTSLS.
3168. Skelly 1 Earl Price; Hamilton. *WCTSLS.
3169. American Mfg. 1 T. W. Winters; Hamilton. *WCTSLS.
3170. Lone Star Gas 1 E. L. Riewe; Hamilton. *WCTSLS.
3171. E. C. Johnston 1 H. Costen; Hamilton. *WCTSLS.
3172. Falls Ref. (Wallace and Vickers) 2 Lund; Hamilton. *WCTSLS.
3173. Amerada 1 Alice D. Cowling; Hamilton. *WCTSLS.
3174. Seaboard Oil 1 T. B. Fuqua, Jr.; Hamilton. *WCTSLS.
3175. Amerada 1 L. S. Barney and others; Hamilton. *WCTSLS.
3176. Amerada 1 John Briscoe; Hamilton. *WCTSLS.
3177. Luling Oil & Gas and others 1 Ernest Phillips; Hamilton. *WCTSLS.
3178. Amerada 1 S. R. Campbell; Hamilton. *WCTSLS.
3179. American Liberty 1 Bywaters and others; Hamilton. *WCTSLS.
3180. Walter H. Grant 1 S. P. Drake; Hamilton. *WCTSLS.
3181. Phillips 1-A Townson; Hamilton. *WCTSLS.
3182. Amerada 1 N. F. Tate; Coryell. *WCTSLS.
3183. Flawn and others, 1961, p. 247. New York Synd. 1 Charles Gotcher.
3184. Leonard F. Gehrig 1 Mrs. W. B. Duncan; Coryell. *WCTSLS.
3185. Buckeye and Mid-Texas Oil 1 Strickland Ranch; Coryell. *WCTSLS.
3186. Flawn and others, 1961, p. 247. Keystone Texas Oil 1 J. S. Clark.
3187. Cockburn 1 Kearney; Coryell. *WCTSLS.
3188. General Crude Oil 1 Ernest Day; Coryell. *WCTSLS.
3189. Falcon Oil 1 H. Mattlage; McLennan. *WCTSLS.
3190. Dunham 1 Hunt; Bell. *WCTSLS.
3191. Shell 1 Massie; Bell. *WCTSLS.
3192. G. E. Kadane & Sons 1 C. D. Shamburger, Jr.; Foard. *NTSLS.
3193. Shell 1 H. Allison; Foard. *NTSLS.
3194. B. B. Burke 1 Cato; Foard. *NTSLS.
3195. Kewanee Oil 1 Sandifer; Foard. *NTSLS.
3196. Socony Mobil 1 Halsell; Foard. *NTSLS.
3197. Plymouth Oil 2 A. N. Miller; Concho. *PBSL.
3198. Bell, 1957, p. 25-30, Conner Ranch section. San Saba.
3199. Bell, 1957, p. 15-19, Rough Creek section. San Saba.
3200. Flawn and others, 1961, p. 255. Elkay Oil and Gas 1 Wilson Lane.
3201. Flawn and others, 1961, p. 287. Clark and Ogg 1 Smiley.
3202. Flawn and others, 1961, p. 287. Cosden Pet. 1 W. T. Adams.
3203. Flawn and others, 1961, p. 301. Johnston Pet. Synd. 1 Lady Alice.
3204. Flawn and others, 1961, p. 302. Magnolia 1 Henry.
3205. Flawn and others, 1961, p. 302-303.
3206. Flawn and others, 1961, p. 232-233.
3207. Flawn and others, 1961, p. 276. Humble 1 E. M. Anderson.
3208. Flawn and others, 1961, p. 276-277.
3209. Flawn and others, 1961, p. 248. City of Dallas 45 water well.
3210. Flawn and others, 1961, p. 248-249.
3211. Flawn and others, 1961, p. 252. Lesco 1 Lesage.
3212. Flawn and others, 1961, p. 253. Triangle Corp. 1 Hale.
3213. Flawn and others, 1961, p. 253. J. B. Stoddard 1 W. E. Smith.
3214. Flawn and others, 1961, p. 273. Hill-Texas Oil 1 C. Weatherby.
3215. Flawn and others, 1961, p. 274. A. P. Meeritt 1 Henry Nors.
3216. Flawn and others, 1961, p. 273. Humble 1 M. Holderman.
3217. Flawn and others, 1961, p. 298. H. L. Hunt 1 E. E. Hamilton.
3218. Flawn and others, 1961, p. 298. Falcon Drlg. 1 J. C. Keitt.
3219. Flawn and others, 1961, p. 289-290.
3220. Flawn and others, 1961, p. 289. Farrell Drlg. 1 J. R. Gillam.
3221. Flawn and others, 1961, p. 293-294.
3222. Flawn and others, 1961, p. 293. St. Louis Oil Pool Co. 1 E. V. Stuart.
3223. Flawn and others, 1961, p. 218. A. B. Johnson 1 F. C. Howard.
3224. Flawn and others, 1961, p. 220-221.
3225. Flawn and others, 1961, p. 253-254.
3226. Flawn and others, 1961, p. 297-298.
3227. Flawn and others, 1961, p. 297. J. B. Coffee 1 Nelson Davis.
3228. Flawn and others, 1961, p. 288-289.

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99. Mountain Fuel Supply 6W Murphy; 22-3N-24E. *AmStrat.
100. Western Nat. 1 Redd; 23-34S-25E. *AmStrat.
144. Reid, 1954, pl. 4. 33-15S-12E.
148. Frontier and Stanolind 1 Crittenden; 12-17S-25E. *AmStrat.
149. Equity and Pacific Western 1 Unit; 33-21S-21E. *AmStrat.
150. General Pet. 45-5-G; 5-24S-15E. *AmStrat.
152. Delhi 1 Russell; 34-25S-12E. *AmStrat.
153. Heylmun, 1958, fig. 4. 18-26S-7E.
158. Heylmun, 1958, fig. 4. 12-36S-1E.
160. Byrd-Frost and Western Nat. 1 English-Tribal; 22-43S-22E. *AmStrat.
162. Hathaway and Glasco 1-B Federal; 5-39S-25E. *AmStrat.
164. Reid, 1954, pl. 4. 15-17S-8E.
174. Reid, 1954, pl. 4. 12-18S-12E.
270. Reid, 1954, pl. 4. 27-23S-11E.
376. Skelly 1-A Nokai; 27-40S-12E. *AmStrat.
385. Huddle and McCann, 1947. 15-1N-8W.
399. Bissell, 1962. 15-7S-19W.
408. Phillips 1 Two-Waters; 22-14S-25E. *AmStrat.
412. Tidewater 74-11 Unit; 11-26S-19E. *AmStrat.
413. Carter 1 Bluff Bench Unit; 29-39S-22E. *AmStrat.
415. Hawkins 1 Butler Wash; 13-38S-21E. *AmStrat.
420. Carter 1 White Mesa; 1-42S-24E. *AmStrat.
423. Ohio 1 Navajo; 10-43S-21E. *AmStrat.
427. *Harold Bissell, Utah Univ., 1962, written commun. 15-4N-3E.
464. Stanolind 1 U.S.A.; 23-5S-22E. *AmStrat.
471. Gulf 1 Ute-Federal; 12-4S-22E. *AmStrat.

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602. Tidewater 6-25 Unit; 25-26S-13E. *AmStrat.
603. Amerada 1 Unit; 2-22S-16E. *AmStrat.
608. Phillips 1 Schick; 16-27S-16E. *AmStrat.
610. Wengerd and Matheny, 1958, fig. 10. 30-34S-19E.
614. Heylmun, 1958, fig. 4. 17-30S-6E.
623. Great Western Drlg. 1 Fish Creek; 22-38S-20E. *AmStrat.
633. Heylmun, 1958, fig. 4. 34-42S-2W.
635. California 1 Unit; 22-35S-2W. *AmStrat.
639. Hubbard 1 Govt.; 12-24S-23E. *AmStrat.
647. Equity 1 Govt.; 28-22S-15E. *AmStrat.
649. California 1 Muley Creek Unit; 18-36S-10E. *AmStrat.
650. Heylmun, 1958, fig. 4. 29-28S-8E.
665. Amerada 1 Blue Mesa; 8-29S-10E. *AmStrat.
673. Brill, 1963, fig. 9. 10-42S-18W.
691. Carter 1 Minton-State; 32-14S-20E. *AmStrat.
692. Equity 1 Govt.; 20-21S-23E. *AmStrat.
697. Texas Pacific Coal and Oil 1 Govt. A; 33-32S-15E. *AmStrat.
702. Sinclair 1 Govt.; 26-16S-25E. *Phillips Pet.
706. Continental, Union, and Mountain Fuel Supply 1 Unit; 23-20S-21E. *AmStrat.
709. Brill, 1963, pl. 1. 15-25S-6W.
710. Brill, 1963, pl. 1. 24-28S-12W.
711. Brill, 1963, pl. 1. 18-29S-9W.
713. Brill, 1963, pl. 1. 15-14S-17W.
714. Brill, 1963, pl. 1. 10-23S-18W.
717. Gulf 1 Hart Point Unit; 8-31S-22E. *AmStrat.
734. Phillips 1 Watson B; 34-9S-25E. *AmStrat.
739. McRae Oil & Gas 1 McRae-Federal; 10-25S-18E. *AmStrat.
760. Utah Southern 1 Cisco; 26-21S-23E. *Phillips Pet.
761. Wengerd and Matheny, 1958, fig. 13. 35-29S-20E.
762. Wengerd and Matheny, 1958, fig. 10. 1-37S-18E.
763. Carter 1 Cedar Mesa; 15-39S-18E. *AmStrat.
764. Shell 1 Bluff Unit; 32-39S-23E. *AmStrat.
765. Uinta Oil Ref. and Utah Southern 1 Nobel; 28-40S-18E. *AmStrat.
766. Wengerd and Matheny, 1958, fig. 9. 32-40S-20E.
767. Wengerd and Matheny, 1958, fig. 5. 15-40S-16E.
768. Wengerd and Matheny, 1958, fig. 5. 33-41S-19E.
769. Wengerd and Matheny, 1958, fig. 5. 29-41S-18E.
770. Shell 1 Desert Creek; 2-42S-23E. *AmStrat.
772. Heylmun, 1958, fig. 2. 2-43S-8W.
773. Bissell and Childs, 1958, pl. 1. 15-3S-7E.
774. Thompson, 1945, fig. 4. 19-4S-24E.
775. Kinney, 1951. 13-2N-1W.
776. Tidewater 58-7 Pine Ridge; 7-3S-20E. *AmStrat.
777. Bissell and Childs, 1958, pl. 1. 31-1S-22E.
778. Bissell and Childs, 1958, pl. 1. 23-3S-25E.
779. Verville and Momper, 1960, pl. 1. 24-5S-25E.
780. Bissell and Childs, 1958, pl. 1. 29-4S-25E.
781. Texaco 1 Fence Canyon; 36-15S-22E. *AmStrat.
782. *G. G. Anderman and Walter Sadlick, 1962, written commun. 24-2N-19E.
783. Bissell and Childs, 1958, pl. 1. 15-2N-4W.
784. *Harold Bissell, Utah Univ., 1962, written commun. 18-5S-4E.
785. Huddle and others, 1951. 27-2N-5W.
786. Bissell and Childs, 1958, pl. 1. 32-2N-6W.
787. Shell 1 Unit; 21-22S-4W. *AmStrat.
788. Brill, 1963, figs. 3-8. 35-18S-17W.
789. Brill, 1963, figs. 5, 10. 11-28S-4W.
790. Brill, 1963, pl. 1. 15-13S-2W.
791. Bissell, 1959, p. 95-124. 10-5S-3W.

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792. *Harold Bissell, Utah Univ., 1962, written commun. 15-1S-7E.
793. *Harold Bissell, Utah Univ., 1962, written commun. 18-4S-10W.
794. *Harold Bissell, Utah Univ., 1962, written commun. 15-1S-9W.
795. *Harold Bissell, Utah Univ., 1962, written commun. 15-11N-2W.
799. N. B. Hunt 1 Circle Cliffs; 24-34S-7E. *AmStrat.
800. Reynolds Mining 1 Cedar Mtn. Unit; 29-19S-12E. *AmStrat.
801. Paradox Prod. 1 Govt.; 34-30S-13E. *AmStrat.
802. Pure 1 Spiller Canyon-State; 16-30S-25E. *AmStrat.
803. Continental 1 Salt Valley Unit; 22-22S-19E. *AmStrat.
804. Sinclair 1 McLane-Federal; 25-36S-16E. *AmStrat.
805. Kern County Land 1-X Moqui-Federal; 33-37S-15E. *AmStrat.
806. Pacific Nat. and Southern Union 1-27 Range Creek; 27-17S-16E. *AmStrat.
807. Skelly 1 Emery Unit; 34-22S-5E. *AmStrat.
808. Paddock, 1956. 5N-14W.
809. Anderson, 1957. 2-4N-17W.

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34. Hinds, 1918, p. 51. Junction of Sulphur and Knox Creeks. United Fuel Gas 8415-T Natl. Shawmut Bank of Boston; 37° 29′ N., 82° 01′ W. *Virginia Dept. Min. Res.
35. United Fuel Gas 8295-T Kentland Coal & Coke; 37° 25′ N., 82° 06′ W. *Virginia Dept. Min. Res.
36. Hinds, 1918, p. 49-50 (Right Fork of Knox Creek, Right Fork of Guess Fork). United Fuel Gas 5810 Natl. Shawmut Bank; 37° 23′ N., 81° 57′ W. *Virginia Dept. Min. Res. well.
37. Hinds, 1918, p. 48 (Left Fork of Lester Fork, Elkins Gap), p. 48-49 (Knox Creek SE. of Hurley). Pipeline Const. and Drlg. 2-A F. H. Curtis; 37° 20′ N., 82° 02′ W. *Virginia Dept. Min. Res. well 5.
39. Hinds, 1918, p. 45-46, 46-47.
40. Harnsberger, 1919, p. 34-35.
43. Hinds, 1918, p. 43. Slate Creek, Bee Branch. United Prod. 14-2694 Lon B. Rogers and others; 37° 19′ N., 81° 54′ W. *Virginia Dept. Min. Res.
46. Hinds, 1918, pl. V and p. 16 (Buchanan County sec.), p. 30 (Duty Branch, Poplar Creek), p. 42 (Little Prater Creek). Pipeline Const. and Drlg. 1-B F. H. Curtis and others, 37° 15′ N., 82° 07′ W. *Virginia Dept. Min. Res.
49. Harnsberger, 1919, p. 24, Upper Horsepen Creek.
51. Harnsberger, 1919, p. 18, fig. 2C.
52. Union Prod. 1-1784 Pocahontas Min.; 37° 15′ N., 81° 45′ W. *Virginia Dept. Min. Res.
53. Hinds, 1918, p. 13-16, 40-41. United Fuel Gas 6705 Consolidated Coal; 37° 13′ N., 81° 45′ W. *Virginia Dept. Min. Res.
54. Hinds, 1918, p. 37 (Mill and Grapevine Branches, Dismal Creek), p. 38 (Dismal Creek to Bill Young Gap), p. 39 (Laurel Creek, Whitewood). Pipeline Const. and Drlg. 1 L. M. Fugate; 37° 13′ N., 81° 55′ W. *Virginia Dept. Min. Res.
56. Hinds, 1918, p. 33-34, 36-37. United Prod. 1-1454 Yukon-Pocahontas Coal; 37° 14′ N., 82° 03′ W. *Virginia Dept. Nat. Res.
57. Hinds, 1918, p. 27 (Russell Prater Creek to Poplar Creek Gap). United Prod. 1-2177 Combs, Pabst, and others; 37° 13′ N., 82° 07′ W. *Virginia Dept. Min. Res.

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58. Hinds, 1918, p. 27 (Russell Prater Creek). Giles, 1921, p. 45 (area Cc). Clinchfield Coal 113 T. K. Colley; 37° 12′ N., 82° 37′ W. *Virginia Dept. Nat. Res.
60. Giles, 1921, p. 34 (Cranesnest River to Davis School), pl. 9 (log S 32). Clinchfield Coal 205 Isaac Cochran; 37° 10′ N., 82° 20′ W. *Virginia Dept. Min. Res.
62. Giles, 1921, p. 20 (Camp Creek of Pound River); p. 36 (NW. Dickenson County). Clinchfield Coal Corp. 197 Wm. McFall; 37° 10′ N., 82° 30′ W. *Virginia Dept. Min. Res.
66. Hinds, 1918, pl. V and p. 16 (SE. Buchanan County), p. 35 (Pistol Gap to Pistol Branch). United Fuel Gas 6431 Hugh McRae; 37° 09′ N., 81° 58′ W. *Virginia Dept. Min Res.
67. Hinds, 1918, p. 24–25, p. 34 (Whitt Fork of Garden Creek). United Prod. 2-1466 Yukon-Pocahontas Coal Co.; 37° 10′ N., 82° 02′ W. *Virginia Dept. Min. Res.
68. Hinds, 1918, p. 25 (Fox Creek east of Left Fork), p. 26 (Rockhouse Branch of Hurricane Creek). Clinchfield Coal C62 hole; 37° 07′ N., 82° 10′ W. *Virginia Dept. Min. Res.
69. Hinds, 1918, p. 26 (Russell Fork, mouth of Fox Creek). Clinchfield Coal 102 Andrew Thomas; 37° 09′ N., 82° 11′ W. *Virginia Dept. Min. Res.
70. Giles, 1921, p. 30–31, p. 32 (Lick Creek of Russell Fork). Clinchfield Coal 133 E. S. Counts; 37° 06′ N., 82° 18′ W. *Virginia Dept. Min. Res.
72. Giles, 1921, p. 19 (Cranesnest River, Clintwood), p. 22 (Cranesnest River to Hibbitts Gap). Clinchfield Coal Corp. 203 R. G. Baker; 37° 07′ N., 82° 26′ W. *Virginia Dept. Min. Res.
77. Giles, 1921, p. 27–28, pl. 9 (log C10). Clinchfield Coal 193 J. M. Kiser; 37° 01′ N., 82° 15′ W. *Virginia Dept. Min. Res.
78. Giles, 1921, p. 27 (Mouth of Roaring Fork). Clinchfield Coal 211 E. J. Long; 37° 02′ N., 82° 20′ W. *Virginia Dept. Min. Res.
79. Giles, 1921, p. 23 (Rockhouse Branch). Clinchfield Coal Corp. 178 Samuel Bise; 37° 01′ N., 82° 24′ W. *Virginia Dept. Min. Res.
81. Eby, 1923, pl. 3, logs 56, 58.
82. Eby, 1923, pl. 3, log 53. *H. R. Wanless, Illinois Univ., 1938 (Indian Gap). Virginia Oil & Gas 1 Kaufman; 37° N., 82° 09′ W. *Virginia Dept. Min. Res.
84. Eby, 1923, p. 97 (Dunbar to Pardee to top of Big Black Mtn.).
85. Wentworth, 1922, pl. 3 (loc. 100).
86. Wentworth, 1922, p. 27 (Hazel to Chaney Fork School), pl. 3 (loc. 61). Clinchfield Corp. 175 Elijah La Force; 36° 59′ N., 82° 14′ W. *Virginia Dept. Min. Res.
87. Wentworth, 1922, p. 25 (Dante to Austin Gap), p. 26–27. Clinchfield Coal 179 Standard Banner Coal Corp.; 36° 59′ N., 82° 18′ W. *Virginia Dept. Min. Res.
90. *Confid.
91. Eby, 1923, p. 62 (Wise County sec.), p. 99–100 (Little Stone Gap), pl. 3, logs 34, 35.
93. Eby, 1923, p. 92–93, p. 94–95, p. 110–111. Clinchfield Coal 195 Virginia Coal and Iron; 36° 57′ N., 82° 47′ W. *Virginia Dept. Min. Res.
94. Eby, 1923, p. 65 (Wise County sec.), p. 109 (Appalachia). Wanless, 1946, pl. 21, sec. 29 (Big Stone Gap). *H. R. Wanless, Illinois Univ. (Virginia Route 160, The Doubles to Inman).
97. Eby, 1923, p. 466, 478–479 (Chimney Rock Fork).
99. Giles, 1925, p. 35 (Jones Creek to Kentucky line), p. 36 (Little Bundy Creek).

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101. Eby, 1923, p. 466, fig. 49 (Stony Creek drainage).
102. Eby, 1923, p. 466 (Stock Creek), p. 472 (Stock Creek near Mabe), p. 472–473 (Stock Creek near Walling mine).
103. Giles, 1925, p. 22 (Lee County sec.), p. 30 (Puckett Creek N. to Big Branch), p. 33 (Summers Creek E. of Benedict Branch), p. 34. *H. R. Wanless, Illinois Univ., 1936. Sandlick Branch, Pennington Gap.

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10. Danner, 1966, p. 250–253. 4-40N-6E.
12. Danner, 1966, p. 66. 23-36N-4W.
21. Danner, 1966, p. 66. 30-37N-2W.
24. Misch, 1952, p. 8. 40N-9E.
25. Danner, 1966, p. 67. 36N-8E.
26. Danner, 1966, p. 66; Misch, 1952, p. 8. 2-35N-8E.
28. Danner, 1966, p. 337. 13-31N-11E.
29. Little, 1960, p. 45–51. 3-40N-38E.
30. Enbysk, 1956, p. 1766. 27-30N-40E.
31. *W. R. Danner, British Columbia Univ., written commun., 1970. N½ 10 and S½ 3-37N-7E.

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2. Grimsley, 1907, p. 81. 1 mile E. of Elm Grove.
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12. J. T. McIntyre 1 W. C. Steger; Long Run near Woodstock. *USGS.
14. Hennen, 1909, p. 266–267, 395 (Wheeling Nat. Gas 1 Isaac Crow).
16. Hennen, 1909, p. 85 (Panama Coal Co. shaft, 1 mile S. of Moundsville), p. 86–87.
17. Hennen, 1909, p. 263–264, 380 (Carter 1 Lem Leach).
18. Hennen, 1909, p. 80–81.
21. Hennen, 1909, p. 271–272, 273–274.
22. Martens, 1945, p. 642–646.
Hennen, 1909, p. 433. Wheeling Nat. Gas 1 Hugh Cosgray.
23. Martens, 1945, p. 635–638.
29. Hennen, 1912, p. 308. Philadelphia 1 Luther E. Kyle.
39. Hennen, 1909, p. 114–115.
41. Hennen, 1909, p. 118–119.
42. Hennen, 1909, p. 120–121.
43. K. M. Widert and others 1 W. J. Bell; 2 miles E. of Bens Run. *USGS.
44. Martens, 1945, p. 442–447.
50. Hennen and Reger, 1913, p. 126–127.
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55. Hennen, 1912, p. 77–78. Sec. 1 mile NW. of Long Run and South Penn Oil 1 J. D. Crabtree.
57. Hennen, 1912, p. 80–82.
59. Hennen and Reger, 1913, p. 96–97, 464–465.
32. Hennen and Reger, 1913, p. 553–554, 564–565.
66. Hennen and Reger, 1913, p. 140–141, 268–269, 272 (Fairmont sec.), p. 610–611.
69. Grimsley, 1910, p. 74 (Zimri Flannagan bore hole), 201–202.
72. Martens, 1945, p. 532–533.
74. South Penn Nat. Gas Chas. Shattuck well; Walker Dist. 1 mile W. of Dallison, *USGS.
78. Martens, 1945, p. 159–162.
81. Hennen, 1911, p. 361–362.
83. Hennen, 1911, p. 356–357.
84. Hennen, 1911, p. 339. Julius K. Monroe 1 F. M. Simmons.
86. Hennen, 1911, p. 48–49.

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242. Reger, 1923, p. 139–140.
243. Reger, 1931b, p. 196–197.
244. Reger and Teets, 1918, p. 112 (Belington), 113 (Valley Coal & Coke 3 Blackman Wilmoth).
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247. Reger and Teets, 1918, p. 118–119, 119–120, 123–125.
249. Reger, 1916, p. 64–66.
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254. Martens, 1945, p. 538–540.
255. Martens, 1945, p. 534–537.
256. Hennen, 1911, p. 315. A. B. Wilson 1 well.
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257. Hennen, 1911, p. 63 (Munday Post Office), 317 (South Penn Oil 3 L. R. Roberts).
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262. Krebs, 1911, p. 130. Spilman sec.
265. Reger, 1931b, p. 188–190.
266. Reger, 1931b, p. 475–476, p. 651 (Lloyd Lanta prospect).
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271. Reger and Teets, 1918, p. 128–129, 351–353.
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272. Reger, 1916, p. 66–67, 419–420.
274. Reger, 1916, p. 350–351.
275. Reger, 1916, p. 474–475, 508 (Reuben Dyer 1 coal test).
276. Reger, 1916, p. 85–87.
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281. Martens, 1945, p. 289–292.
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286. Reger, 1931b, p. 642–643.
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293. Reger and Teets, 1918, p. 134–136.
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307. Reger, 1931b, p. 655. Thompson Coal Co. mine, S. of Montes.
308. Reger, 1931b, p. 159–162.

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310. Reger and Teets, 1918, p. 146 (Hemlock), 159–160, 264–266.
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316. Hennen, 1917, p. 53 (sec. 1.6 miles N. of Napier), 462 (Chas. Singleton 1 coal test), 463–464.
318. Martens, 1945, p. 222–224.
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324. Martens, 1939, p. 125–132.
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326. Krebs, 1911, p. 216–217.
328. Reger, 1931b, p. 213. Spruce Knob sec.
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334. Reger and Teets, 1918, p. 180 (Arvondale Junction), 387 (Mayton Lumber 4903 well).
337. Hennen, 1917, p. 55–56, 93 (High Knob), 99 (sec. 0.8 mile SW. of Holly), 99–100, 100 (Marpleton).
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341. Hennen, 1917, p. 63–64, 333–334.
342. Hennen, 1917, p. 76–77, 77–79.
343. Hennen, 1911, p. 119–120.
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344. Hennen, 1911, p. 118. Sec. 1 mile E. of Minnora on Sears Run and South Penn Oil 1 E. C. Knotts well.
346. Hennen, 1911, p. 78–79, 83–84.
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350. Martens, 1945, p. 306–311.
352. Krebs, 1911, p. 89–90.
353. Martens, 1945, p. 307–308.
355. Reger, 1931b, p. 478–479.
356. Reger, 1931b, p. 490–492.
357. Reger, 1920, p. 80. Big Run.
358. Reger, 1920, p. 91–92.
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366. Hennen, 1911, p. 90–91.
368. Hennen, 1911, p. 184. Sec. 1 mile SE. of Walton.
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370. Krebs, 1911, p. 129. Sec. 0.5 mile S. of Jackson County line and Dr. Jones well.
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376. Price, 1929, p. 119. West Virginia Pulp and Paper 1 coal test.
377. Reger, 1931b, p. 170–174.
378. Reger, 1920, p. 100 (2 miles SE. of Waneta), p. 103 (1.2 miles SE. of Whitaker Falls).

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500. Krebs and Teets, 1915, p. 60 (Brounland), 61–62.
501. Krebs and Teets, 1913, p. 64 (Cobbs Creek), 93 (Sugar Camp Knob), 333 (Seaboard Fuel 2 well).
502. Krebs and Teets, 1913, p. 49–50, 52 (Porter Creek), 144–145.
503. Krebs and Teets, 1913, p. 57 (Stowers Knob), 60–61 (Bernie sec. and South Penn Oil Lincoln Land Assoc. well).
505. Krebs and Teets, 1913, p. 58 (Mid Kiff), 153 (Pound Fork), 359–360.
506. Krebs and Teets, 1913, p. 70–71.
Martens, 1945, p. 597–600.
507. Krebs and Teets, 1913, p. 153–154.
Tucker, 1936, p. 480–481.
508. Krebs and Teets, 1913, p. 116–117. *H. R. Wanless, Illinois Univ., Wayne.
Martens, 1945, p. 607–611.
509. Tucker, 1936, p. 483–485.
511. Price and Heck, 1939, p. 183–184.
513. Price and Heck, 1939, p. 171 (Gauley Land Co. 30 coal test), 398–399.
519. Hennen and Teets, 1919, p. 170–172, 402 (Gauley Mtn. Coal test bore 6).
520. Hennen and Teets, 1919, p. 128–129, 150 (Head of Wilson Branch of Laurel Creek), 347–348, 396 (Kanawha and Hocking Coal & Coke 1 well).
521. Hennen and Teets, 1919, p. 149 (sec. 0.4 mile W. of Deepwater), 153–154, 158–160 (Powellton sec. and well 14).
522. Hennen and Teets, 1919, p. 145–146.
Krebs and Teets, 1914, p. 236 (Detroit), 238–239, 242–243.
524. Krebs and Teets, 1914, p. 247. Sec. 2 miles S. of Winifrede. *H. R. Wanless, Illinois Univ. Mouth of South Hollow, Fields Creek.
Krebs and Teets, 1915, p. 150–151.
527. Krebs and Teets, 1915, p. 77–79.
Martens, 1945, p. 80–81.
528. Krebs and Teets, 1915, p. 70–71, p. 72–73.
531. Krebs and Teets, 1913, p. 152. (Ranger).
Tucker, 1936, p. 263–264.
532. Krebs and Teets, 1913, p. 115–116, 155 (Lick Creek).
533. Krebs and Teets, 1913, p. 143–144 (East Lynn sec. and East Lynn Coal core hole), 377–378.
536. Krebs and Teets, 1913, p. 76. Fort Gay. *H. R. Wanless, Illinois Univ.
537. Price and Heck, 1939, p. 406–407.
539. Price and Heck, 1939, p. 167–168, 169–170, 174–176, 393–394.
541. Hennen and Teets, 1919, p. 110–111, 176–177, p. 201 (1 mile N. of Corliss).
542. Hennen and Teets, 1919, p. 177–178.
Price and Heck, 1939, p. 353–355, 403 (Brackens Creek Coal and Land 5 coal test), 435–436.
544. Hennen and Teets, 1919, p. xxvi–xxviii, 186–187.
545. Hennen and Teets, 1919, p. 398–399, 410–411.
547. Krebs and Teets, 1914, p. 226–227, 234–235.
Hennen and Teets, 1919, p. 353, (Gallego well).
548. Krebs and Teets, 1914, p. 223 (SE. of Acme), p. 228 (S. of Wevaco), 392–393.
549. Krebs and Teets, 1915, p. 194 (4 miles W. of Lee Wood), 245 (5 miles W. of Red Warrior Post Office), 250 (3.3 miles E. of Orange).
551. Krebs and Teets, 1915, p. 158–159, 190 (4 miles NE. of Gordon).
552. Krebs and Teets, 1915, p. 82 (Workman Knob and Crofts and Stalling coal test), 170 (1.2 miles SE. of Madison), 556 (D. M. Arbogast 1 well).
554. Krebs and Teets, 1915, p. 88 (sec. 1 mile NW. of Logan), 89 (sec. 1 mile NW. of Estep Post Office), 90 (sec. 3 miles W. of Estep Post Office).
Tucker, 1936, p. 29–30.
556. Krebs and Teets, 1913, p. 226–227 (Harts Station), 369 (Lincoln Land Assoc. 6 well).
559. Krebs and Teets, 1913, p. 74. (Hooker Knob).
560. Krebs and Teets, 1913, p. 72–73, 151–152, 154–155.
561. Krebs and Teets, 1913, p. 75 (Glenhayes sec. and South Penn Oil Glenhayes), 160 (Powder Mill Branch), 161 (Saltpetre).
563. Price and Heck, 1939, p. 166. (Big Clear Creek Mtn.)
565. Hennen and Teets, 1919, p. 203–204.
Price and Heck, 1939, p. 440–441.
568. Hennen and Teets, 1919, p. 189–190.
White, 1908, p. 41. Plum Orchard Land 1 drill hole.
570. Krebs and Teets, 1914, p. 229–232.
571. Krebs and Teets, 1916, p. 51–55.
575. Krebs and Teets, 1915, p. 99–102.
Martens, 1945, p. 95–97.
578. Hennen and Reger, 1914b, p. 49, 106, 193 (Stone Branch).
579. Hennen and Reger, 1914b, p. 107 (Whirlwind sec.), 196 (Shively sec.).
Martens, 1945, p. 392–396 (Hope Nat. Gas 1 J. Albright).
580. Hennen and Reger, 1914b, p. 46 (sec. at corner of Logan, Mingo, and Lincoln Counties).
581. Krebs and Teets, 1913, p. 227–228.
Tucker, 1936, p. 471–472.
582. Krebs and Teets, 1913, p. 73–74. Arkansas Branch section and A. W. Wilson well. *H. R. Wanless, Illinois Univ., 1936. Bull Creek.
Martens, 1945, p. 613–617.
583. Krebs and Teets, 1913, p. 160–161.
584. Price and Heck, 1939, p. 464–465.
585. Price and Heck, 1939, p. 456–457, 461–463.
Hennen and Teets, 1919, p. 215–216.
586. Hennen and Teets, 1919, p. 208 (Royal sec.).
588. Hennen and Teets, 1919, p. 425–426.
Krebs and Teets, 1916, p. 313–315.
589. Krebs and Teets, 1916, p. 66–68, 120–121, 216–217.
Tucker, 1936, p. 391 (Godfrey Cabot 1 McKinley Land Co.).
590. Krebs and Teets, 1916, p. 108 (1.2 miles E. of Pond Knob), 111 (2 miles NW. of Dameron).
593. Krebs and Teets, 1915, p. 182–184, 184–186, 198–200.
596. *H. R. Wanless, Illinois Univ., 1936. Blair Mtn. U.S. Highway 52.
Hennen and Reger, 1914b, p. 298 (Boone County Coal Corp. coal test 6).
Martens, 1945, p. 399 (Boone Coal Corp. 15 well).
597. Hennen and Reger, 1914b, p. 55–57, 110 (Hughey sec.).
599. Hennen and Reger, 1914b, p. 64–65, 66 (Hale).
600. Hennen and Reger, 1914b, p. 67–69.
Martens, 1945, p. 438–441.
602. Reger and Price, 1926, p. 239–242.
604. Krebs and Teets, 1916, p. 296–297, 299–300.
608. Krebs and Teets, 1916, p. 64–65, 272–273, 333–334.
609. Krebs and Teets, 1916, p. 63 (1 mile NW. of Bolt), 198–200.
611. Krebs and Teets, 1915, p. 188–189.
Krebs and Teets, 1916, p. 105–106.
614. Hennen and Reger, 1914b, p. 121–122, 122–123, 124–125.
616. Hennen and Reger, 1914b, p. 314 (John A. Shepard and others 1 coal test), 314–315, 317 (John A. Shepard and others 3 coal test).
621. Hennen and Reger, 1914b, p. 70–72, 279–280, 330 (M. H. Waldron 3 coal test).

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622. Reger and Price, 1926, p. 256-259.
623. Reger and Price, 1926, p. 289 (sec. 0.9 mile NW. of Judson).
624. Krebs and Teets, 1916, p. 75-76.
Reger and Price, 1926, p. 246-248.
627. Krebs and Teets, 1916, p. 164 (Shady Spring), p. 293-294, 334 (Raleigh County, gen. sec.).
628. Krebs and Teets, 1916, p. 149 (Sullivan), p. 150-151, 161 (Crab Orchard), p. 334 (Raleigh County, gen. sec.).
629. Krebs and Teets, 1916, p. 78-79.
Martens, 1945, p. 512-514.
630. Krebs and Teets, 1916, p. 290-291.
Hennen and Gawthrop, 1915, p. 69-70.
632. Martens, 1945, p. 717-719.
Hennen and Gawthrop, 1915, p. 269-271.
633. Hennen and Gawthrop, 1915, p. 61 (Oceana), p. 62 (3 miles S. of Oceana).
Tucker, 1936, p. 517-518.
634. Hennen and Reger, 1914b, p. 58-60.
636. Hennen and Reger, 1914b, p. 73-74. United Thacker Coal 1 coal test and Ragland sec.
637. *H. R. Wanless, Illinois Univ., 1935. Secs. at head of Buffalo Creek, Cinderella, and Delbarton.
639. Krebs and Teets, 1916, p. 168 (1 mile NW. of Jumping Branch Post Office).
640. Krebs and Teets, 1916, p. 184 (2 miles E. of Flattop Post Office).
641. Krebs and Teets, 1916, p. 154-155, 155-156, 334 (Raleigh County sec.).
644. White, 1908, p. 95-97 (W. H. Page 6 coal test).
646. Hennen and Gawthrop, 1915, p. 66 (Baileysville).
655. Hennen and Gawthrop, 1915, p. 59-60, 80-81.
656. Hennen and Gawthrop, 1915, p. 77-79.
657. Hennen and Gawthrop, 1915, p. 59-60, 286 (U.S. Coal and Coke 47 H. N. Eavenson).
658. Hennen and Gawthrop, 1915, p. 283-284, 300-330.
Martens, 1945, p. 700-703.
659. Hennen and Gawthrop, 1915, p. 299-300.
660. Hennen and Gawthrop, 1915, p. 134-135.
*H. R. Wanless, Illinois Univ., 1936. (Indian Ridge Gap.)
Martens, 1945, p. 711-712.
661. Hennen and Gawthrop, 1915, p. 86-87, 135-136.
662. Hennen and Reger, 1914b, p. 88-89.
Hennen and Gawthrop, 1915, p. 85 (Wyoming Station).
664. Hennen and Reger, 1914b, p. 86-87.
665. Krebs and Teets, 1916, p. 375 (Griffith 1 coal test, 1¼ miles E. of Spanishburg).
666. Krebs and Teets, 1916, p. 83 (4 miles NE. of Springton), p. 177-178.
668. Hennen and Gawthrop, 1915, p. 51-60, 82-83.
669. Hennen and Gawthrop, 1915, p. 51-60, 81-82.
670. Hennen and Gawthrop, 1915, p. 107. 8 miles E. of Welch SW. to Keystone Station.
671. Hennen and Gawthrop, 1915, p. 101-104, 301-303.
676. Krebs and Teets, 1916, p. 181-182 (secs. 1 mile NW. and 1 mile SE. of Goodwill).
677. Krebs and Teets, 1916, p. 179 (1.5 miles N. of Coaldale), 186-187, 234 (Mercer County sec.).
679. Hennen and Gawthrop, 1915, p. 59-60, 372-373.
681. Hennen and Gawthrop, 1915, p. 59-60, 311-313 (H. N. Eavenson and G. J. Cooper coal tests), 315-316.
684. Krebs and Teets, 1916, p. 187-188, 334 (Mercer County sec).
685. Hennen and Gawthrop 1915, p. 122-123.
686. Hennen and Gawthrop, 1915, p. 115 (sec. 1 mile NW. of Squire Jim), 362 (U.S. Coal & Coke 52 H. N. Eavenson).

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690. Hennen and Gawthrop, 1915, p. 59-60, 121-122.
691. Hennen and Gawthrop, 1915, p. 59-60, 346-347.
692. Hennen and Gawthrop, 1915, p. 59-60, 119-121.

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4. Seaboard Oil 53-NP Silvertip; 33-58N-100W. *AmStrat.
25. Pacific Western 1 Kirby Creek; 21-43N-92W. *Love, USGS, 1956, written commun.
37. Sinclair and Wyoming 9 Unit; 14-32N-95W. *AmStrat.
45. Kirk and Pacific Western 5 Connagham; 29-51N-100W. *AmStrat.
56. Pure 1 Unit; 34 and 56½N-69W. *AmStrat.
57. Kerr-McGee and Phillips 1 Unit; 2-50N-92W. *AmStrat.
62. Love, 1954. 9-33N-76W.
65. Texas 3 Unit; 13-49N-102W. *AmStrat.
79. Verville and Momper, 1960, pl. 1. 21-16N-104W.
88. Love, 1954. 36-39N-109W.
110. Trigood Oil 10 Govt.; 3-37N-85W. *AmStrat.
114. Cities Service 1 Sprecher; 22-36N-82W. *AmStrat.
115. Pure 1 Unit; 36-37N-82W. *AmStrat.
117. Morton 1-A Johnson; 20-33N-80W. *AmStrat.
121. Stanolind 1-A Unit; 22-28N-81W. *AmStrat.
125. Ritzma, 1951, p. 66. 20-14N-87W.
133. Hoyt, 1963, p. 69 (fig. 2, log 20). Rocky Mountain Association of Geologists, 1963, section B-D, log 19.
140. Berg, 1956, column 88. 35-20N-78W.
143. Wasatch 1-25 Swan; 25-24N-76W. *AmStrat.
146. Texas 1 Unit; 14-20N-81W. *AmStrat.
147. Sinclair 1 Unit; 28-21N-86W. *AmStrat.
149. Ritzma, 1951, p. 66. 2-9N-88W.
160. Sun and others 1 Govt.-Hintze; 24-26N-89W. *AmStrat.
161. Berg, 1956, column 89. 18-17N-76W.
163. Continental 42-T Unit; 23-44N-95W. *AmStrat.
165. Husky Ref. 5 Unit; 12-44N-97W. *AmStrat.
169. Stanolind 2 Unit; 34-48N-100W. *Love, USGS, 1959, written commun.
170. Continental 1 Skelton Unit; 26-45N-100W. *AmStrat.
171. Ohio and Stanolind 1 L U Sheep; 25-46N-100W. *AmStrat.
173. G & G Drlg. 1 Unit; 19-45N-92W. *AmStrat.
175. General Pet. 43-26-G; 26-46N-91W. *Love, USGS, 1956, written commun.
179. Ohio 6 G. Easton Unit; 28-56N-97W. *AmStrat.
180. General Pet. 2 Badura; 7-57N-101W. *AmStrat.
181. Texas 1 Unit; 2-52N-72W. *AmStrat.
193. Krampert, 1940b, p. 158. Clascock and Cosden 1 State; 36-42N-61W. *AmStrat, 1956.
198. Wilson, 1954. 25-52N-84W.
232. *J. D. Love, USGS, 1959, written commun. 33-7N-6E.
249. Kemmerer and Kemmerer 1 State; 16-32N-81W. *AmStrat.
255. Stanolind 2 Orchard Unit; 24-51N-93W. *AmStrat.
271. Superior 1 Unit; 31-52N-101W. *AmStrat.
274. Love, 1954, sheet 1 (sec. 4) 28-29N-67W. Hoyt, 1963, p. 69 (fig. 2 Hartville uplift sec.). Bates, 1955, p. 1985 (fig. 3, sec. D), p. 1987-1991. 28-29N-67W.
280. Momper, 1963, p. 54 (fig. 8, log 4). Hoyt, 1963, p. 72 (fig. 5, log 11).
293. California 1 Hodges; 26-22N-78W. *AmStrat.
303. Momper, 1963, p. 52 (fig. 7, log 1). Hoyt, 1963, p. 71 (fig. 4, log 3).
307. Love, 1954. 24-31N-81W.
310. Carter 1 Neiman; 13-33N-69W. *AmStrat.
323. Stanolind 1 Govt.-Mains; 19-44N-81W. *AmStrat.

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324. Williams, 1949, 19 p. Sioux Oil 1 Sioux; 29-45N-61W. *AmStrat, 1960.
330. General Pet. 1 Renner; 28-47N-100W. *Love, USGS, 1959, written commun.
331. Carter 3 Rider; 17-48N-82W. *AmStrat.
348. California 1 Unit; 27-53N-100W. *AmStrat.
351. Mule Creek Oil and Atlantic 2 Unit; 11-54N-95W. *AmStrat.
355. Hiawatha 1-31 Govt.; 31-43N-89W. *AmStrat.
356. Farmers Union 1 Shad; 6-43N-91W. *AmStrat.
362. Shell 1 Demple; 22-55N-85W. *AmStrat.
366. Trigood 2 Unit; 33-53N-70W. *AmStrat.
367. Canada Southern Oil 1 Tribal; 6-8N-3E. *AmStrat.
370. Skelly 1 Wallway-Govt.; 10-34N-82W. *AmStrat.
377. Lynn 1 Burk; 15-26N-78W. *AmStrat.
381. Carter 1 Unit; 17-13N-89W. *AmStrat.
383. Mohawk 1 Govt.; 34-58N-96W. *AmStrat.
384. Shell 1 Buszkieswic; 30-58N-84W. *AmStrat.
387. Continental 1 Govt.; 8-57N-98W. *AmStrat.
388. Shell 1 Clear Creek; 11-57N-78W. *AmStrat.
392. Texas 1 Community; 12-56N-96W. *AmStrat.
393. Hunt Oil 1 Govt.-Miller; 14-56N-61W. *AmStrat.
394. Stanolind 1 J. E. Pepper; 26-55N-97W. *AmStrat.
400. Texas 4 Unit; 14-53N-72W. *AmStrat.
403. Osborne 1 Krueger; 20-52N-93W. *AmStrat.
406. Davis 1 Govt.; 33-51N-90W. *AmStrat.
407. Gulf 1 C. H. Davis; 34-51N-72W. *AmStrat.
408. Continental 1 Unit; 25-50N-105W. *AmStrat.
409. Richfield 1 Unit; 6-50N-101W. *AmStrat.
410. Sohio 1 Simmons-Govt.; 13-50N-100W. *AmStrat.
417. George Nolan 1 Govt.; 19-49N-89W. *AmStrat.
419. California 1 Rawhide; 4-48N-101W. *AmStrat.
421. Gulf 1 Mills-Federal; 31-48N-89W. *AmStrat.
433. Stanolind 1 Brock; 24-45N-83W. *AmStrat.
446. Shell 1 Unit; 2-42N-96W. *AmStrat.
448. Chicago Corp. and Republic Nat. 1 Harlan; 4-42N-83W. *AmStrat.
452. Sohio 1 Govt.-Evans; 18-39N-83W. *AmStrat.
465. Amerada 1 Unit; 4-36N-81W. *AmStrat.
470. Momper, 1963, p. 54 (fig. 8, log 1).
473. Momper, 1963, p. 54 (fig. 8, log 2).
484. W. A. Barber and others 1 Govt.; 4-31N-98W. *AmStrat.
490. Tidewater 81-22 Lawn Creek; 22-29N-80W. *AmStrat.
493. Hoyt, 1963, p. 72 (fig. 5, log 10).
494. Amerada and Sohio 1 Sullivan; 17-26N-80W. *AmStrat.
500. Cities Service 1 UPRR; 35-19N-102W. *AmStrat.
502. Shell 1 Rawlins; 27-17N-88W. *AmStrat.
504. Mississippi River Fuel 1 State; 36-16N-75W. *AmStrat.
703. Hoyt, 1963, p. 69 (fig. 2, log 2), p. 71 (fig. 4, log 2). Natl. Assoc. Pet. 1 Govt.; 2-30N-67W. *J. D. Love, USGS, 1959, written commun.
715. Hensley, 1956. 24-20N-73W.
717. Thomas, Thompson, and Harrison, 1953, pl. 9. 4-14N-72W.
721. Wilson, 1954, p. 352-359. 26-52N-61W.
733. Agatston, 1954, p. 569. 35-55N-86W.
756. Love, 1954. 22-32N-78W.
765. Sohio 1 Picard; 27-41N-91W. *AmStrat.
773. Maughan and Wilson, 1960, fig. 2. 14, 18-15N-72W.
776. Thomas, Thompson, and Harrison, 1953, pl. 9. 6-18N-72W.
778. Thomas, Thompson, and Harrison, 1953, pl. 9. 29-23N-73W.
780. Love, 1954. 26-32N-77W.
781. Love, 1954. 6-32N-74W.
782. Hoyt, 1963, p. 69 (fig. 2, Deadhead Basin sec.). Thomas, Thompson, and Harrison, 1953, pl. 9. 19-20N-68W.

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784. Hoyt, 1963, p. 71 (fig. 4, log 1). California 1 Nylen-Gillespie; 20-31N-69W. *AmStrat.
786. Rocky Mountain Association of Geologists, 1963, section B-D, log 14.
791. Gulf 1 Little Missouri; 9-55N-67W. *AmStrat.
793. Aurora and Kingwood 1 Unit; 31-17N-85W. *AmStrat.
794. Wasatch 1 Govt.-Unit; 3-17N-89W. *AmStrat.
797. Maughan and Wilson, 1960, fig. 2. 8-13N-73W.
803. Natl. Assoc. Pet. 1 UPRR; 13-24N-80W. *AmStrat.
804. Sinclair 1 Unit; 4-27N-86W. *AmStrat.
806. Atlantic 1 Foster Unit; 9-31N-84W. *AmStrat.
814. Mississippi River Fuel 1 Unit; 25-25N-84W. *AmStrat.
815. Coulston and Harrel 1 Schmidt; 15-13N-76W. *AmStrat.
823. McCulloch 1 Govt.-Macson; 34-23N-78W. *AmStrat.
838. Agatston, 1954, p. 530 (Bridge Creek log).
840. Momper, 1963, p. 54 (fig. 8, log 5).
847. True B-19 Burrows; 5-49N-68W. *AmStrat.
853. Williams, 1949, 19 p. 6-44N-60W.
854. Foster, 1958, fig. 5. 5-46N-81W.
863. Coronado Pet. 1 Betts-Govt.; 15-51N-67W. *AmStrat.
864. Continental 1 Govt.; 15-55N-92W. *AmStrat.
870. Shell 1 Unit; 31-40N-80W. *AmStrat.
872. Rocky Mountain Association of Geologists, 1963, section B-D, log 18. 31-17N-68W.
879. Maughan and Wilson, 1960, fig. 2. 15-14N-73W.
885. Condra and Reed, 1935 (p. 10-37), 1950 (p. 26-35). Hoyt, 1963, p. 72 (fig. 5, Hartville uplift sec.).
906. Coronado 1 Govt.-Tuttle; 10-37N-62W. *AmStrat, 1956.
916. Phillips 1 Unit; 27-46N-96W. *AmStrat.
919. Atlantic and Fremont 3 Unit; 34-25N-86W. *AmStrat.
920. Hoyt, 1963, p. 69 (fig. 2, log 17). Rocky Mountain Association of Geologists, 1963, section B-D, log 16. Seaboard Oil 1 Wilson; 29-25N-65W. *AmStrat.
922. Continental 1 Unit; 10-16N-84W. *AmStrat.
930. Momper, 1963, p. 54 (fig. 8, sec. 3).
932. Maughan and Wilson, 1960, fig. 2. 23, 24-12N-75W.
933. Thomas, Thompson, and Harrison, 1953, pl. 9. 5-17N-72W.
934. Thomas, Thompson, and Harrison, 1953, pl. 9. 11-24N-74W.
935. Thomas, Thompson, and Harrison, 1953, pl. 9. 31-19N-70W.
936. *W. W. Mallory, USGS. 17-14N-77W.
937. U.S. Smelting, Ref. and Mining 1-9 Unit 19-76; 9-19N-76W. *AmStrat.
938. Shell 1 Govt.; 2-49N-91W. *AmStrat.
939. *J. D. Love, USGS, 1959, written commun. 24-50N-89W.
940. Texas 1 Linderman; 10-52N-92W. *AmStrat.
941. *J. D. Love, USGS, 1959, written commun. 16-53N-90W.
943. Agatston, 1954, p. 571. 6-56N-93W.
944. Sohio and Barnsdall Oil 2 Dorothy Fox; 7-57N-97W. *AmStrat.
945. Bauer, 1951. 32-19N-79W.
946. Ashley, 1947. 10-17N-82W.
947. Allphin 1 Peterson; 23-14N-83W. *Phillips Pet.
948. Continental 2 Unit; 24-16N-84W. *Phillips Pet.
949. Wilson, 1954. 36-25N-82W.
950. Thomas, Thompson, and Harrison, 1953, pl. 9. 21-29N-77W.
951. Love, 1954. 13-32N-74W.
952. Love, 1954. 33-32N-72W.
953. Wilson, 1954. 23-29N-72W.
954. Stanolind 9-"A" Tribal; 19-2N-1W. *AmStrat.
955. Love, 1954. 10-33N-96W.
956. Burk, 1956 column 22. 5-3N-1W.
957. Shaw and Bell, 1955, p. 334. 19-31N-99W.
959. Carter 1 Shoshone-Madden; 30-7N-1E. *AmStrat.
960. Agatston, 1957, fig. 1. 36-1S-4E.

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961. Stanolind 3 Terry; 19-2S-2E. *AmStrat.
962. Love, 1954. 1-33N-92W.
963. California 1 Langguth; 6-42N-107W. *AmStrat.
964. Continental 2 Sage Creek; 27-1N-1W. *AmStrat.
965. Love, 1954. 23-32N-94W.
966. British-American 1 Govt.; 5-31N-94W. *AmStrat.
967. Carter 1 Yellowstone Sheep Co.; 20-29N-96W. *AmStrat.
968. California 3 Unit; 2-28N-94W. *AmStrat.
969. Agatston, 1957, p. 30. 18-27N-95W.
970. California 1 Govt.; 14-30N-95W. *AmStrat.
971. *J. D. Love, USGS, 1959, written commun. 7-42N-105W.
972. Love, 1954. 15-41N-197W.
973. Love, 1954. 5-33N-101W.
974. *John Murphy, USGS, 1962, written commun. 6-4N-5W.
975. Love, 1954. 18-32N-100W.
976. Love, 1954. 33-1S-2W.
977. *J. D. Love, USGS, 1959, written commun. 1-6N-4W.
978. Continental 20 Chatterton; 15-6N-2W. *J. D. Love, USGS, 1959, written commun.
979. Biggs, 1951. 28-1N-3W.
980. Murphy, Privrasky, and Moerlein, 1956. 2-2N-4W.
981. *J. D. Love, USGS, 1959, written commun. 28-43N-93W.
982. Texas 1 Govt.-Walton; 25-46N-98W. *AmStrat.
983. Agatston, 1954, p. 568. 36-46N-83W.
984. Agatston, 1954, p. 568. 20-42N-84W.
985. Agatston, 1954, p. 568. 2-47N-83W.
986. Pure 1 Unit; 20-48N-76W. *AmStrat.
987. Wilson, 1954. 49-50N-83W.
988. *J. D. Love, USGS, 1959, written commun. 28-38N-116W.
989. Love, 1954. 22-38N-118W.
990. Love, 1954. 17-30N-83W.
991. Thomas, Thompson, and Harrison, 1953, pl. 9. 30-30N-78W.
992. Thomas, Thompson, and Harrison, 1953, pl. 9. 30N-79W.
993. Love, 1954. 9-32N-79W.
994. Love, 1954. 24-33N-88W.
995. Love, 1954. 23-33N-89W.

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996. Socony-Vacuum 32-X-21G; 21-35N-77W. *AmStrat.
997. Agatston, 1954, p. 568. 40N-85W.
998. Stanolind 1 Govt.; 35-40N-79W. *J. D. Love, USGS, 1959, written commun.
999. Agatston, 1954, p. 574. 31-48N-103W.
1000. Continental 1 Govt.; 20-47N-102W. *AmStrat.
1001. Love, 1954. 18-28N-70W.
1002. Wilson, 1954. 23-56N-87W.
1003. *W. W. Mallory, USGS. 33-57N-87W.
1004. Agatston, 1954, p. 569. 6-58N-89W.
1006. Condit, 1919, p. 117-118; Scott, 1935; Thompson and Scott, 1941. Bannock Peak and Quadrant Mtn.
1007. *J. D. Love, USGS, 1959, written commun. 3-38N-115W.
1008. Love, 1954. 16-40N-116W.
1009. Love, 1954. 28-40N-112W and 12-40N-113W.
1010. Love, 1954. 2-42N-115W.
1011. Love, 1954. 34-42N-113W.
1012. Carter 1 Treglown; 1-42N-114W. *AmStrat.
1013. California 1 Unit; 25-44N-111W. *AmStrat.
1014. Verville and Momper, 1960, pl. 1. 32-16N-117W.
1015. *W. W. Mallory, USGS. 1-47N-88W.
1016. Agatston, 1954, p. 570. 5-41N-88W.
1017. Agatston, 1954, p. 570. 2-42N-88W.
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1019. Stanolind 1 Unit; 8-55N-100W. *AmStrat.
1020. U. S. Navy 1-G-10 Naval Pet. Reserve 3; 10-38N-78W. *AmStrat.
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1027. Mobil 22-19 Tip Top Unit; 19-28N-113W. *AmStrat.
1028. Shell 1 Unit; 16-30N-118W. *AmStrat.
1034. MacLachlan and Bieber, 1963, p. 84-94. Raymond Oil 1 Christiansen; 29-34N-60W. *AmStrat, 1963.

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