University of Kansas
State Geological Survey of Kansas

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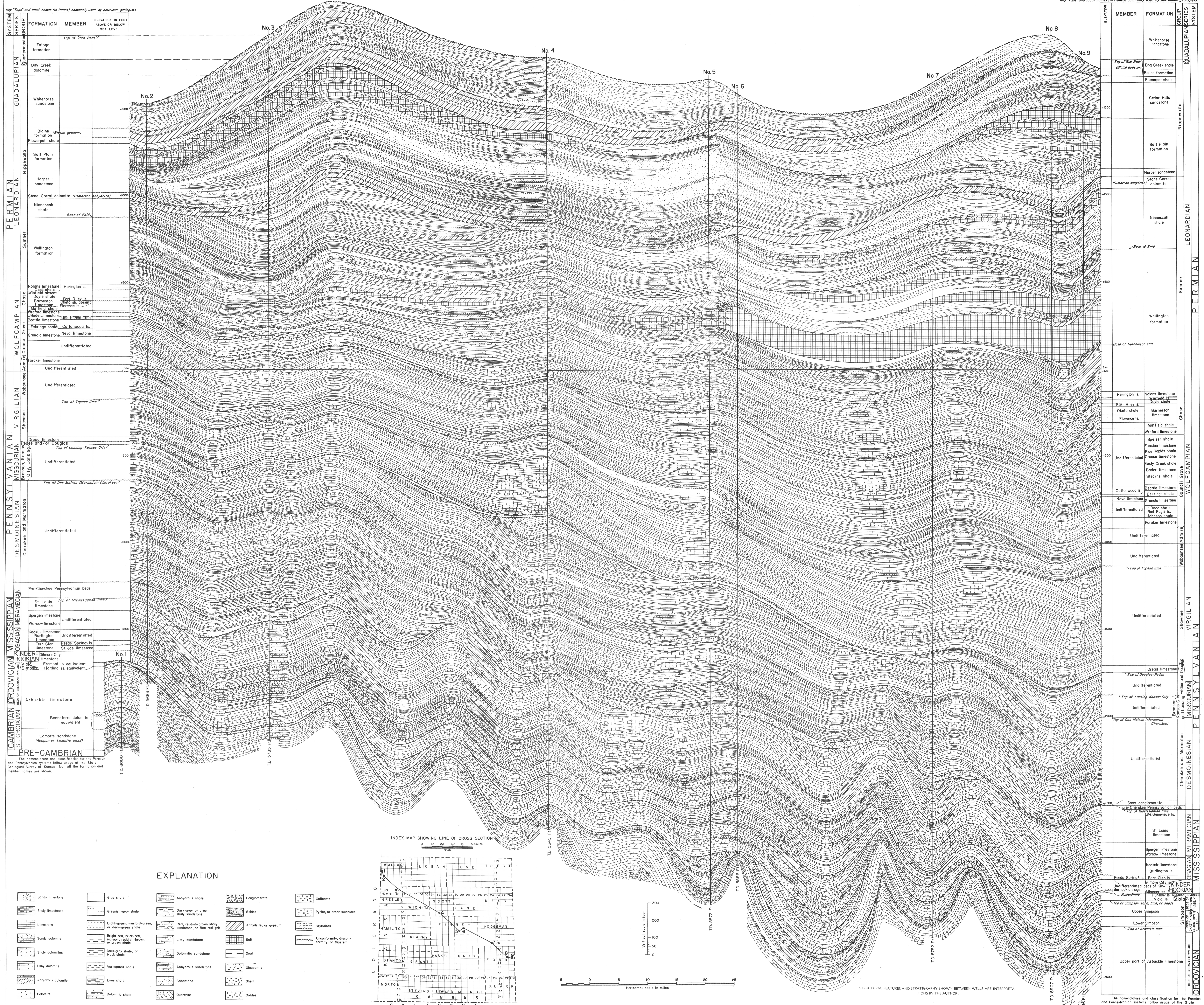
Oil and Gas Investigations
Preliminary Cross Section No. 1



SUBSURFACE GEOLOGIC CROSS SECTION FROM FORD COUNTY TO WALLACE COUNTY, KANSAS

By Fanny Carter Edson

INTRODUCTION

A subsurface investigation of far western Kansas, eastern Colorado, and parts of Oklahoma and Nebraska was undertaken in 1943 by the Geological Survey, U. S. Department of the Interior, in cooperation with the State Geological Survey of Kansas. The purposes of the investigation are (1) correlation of subsurface beds of the oil fields of central-western Kansas with beds penetrated by dry holes in far western Kansas, eastern Colorado, and parts of Oklahoma and Nebraska, and (2) preparation of cross sections and maps of the region showing the subsurface distribution of several formations believed to be prospectively valuable as reservoirs for oil and gas.

The accompanying cross section is the first of a series of cross sections giving some of the results of the investigation. The preparation of the cross section was begun in the oil fields of central-western Kansas where many wells have been drilled. The subsurface stratigraphic subdivisions in this area are well known to petroleum geologists through many years of microscopic study of well samples. These geologists have identified in the subsurface many subdivisions of the Permian and Pennsylvanian systems described by geologists of the State and Federal Geological Surveys from outcrops in central and eastern Kansas, and they have identified most principal subdivisions of the Mississippian, Devonian, Ordovician, and Cambrian systems described by the State and Federal Geological Surveys from outcrops mainly in Missouri and partly in Oklahoma. The subsurface subdivisions generally agreed upon and used by Kansas petroleum geologists for the oil fields in central-western Kansas were accepted as a basis for correlations shown in the cross sections.

The correlations were carried westward from well to well by microscopic examination of well samples. Each of the geologists assigned to the project selected a cross section and carried his investigation westward independently but conferred frequently with other geologists on the project and with geologists engaged in similar investigations for oil companies. Each cross section thus prepared includes wells selected as nearly as possible along straight courses and as many wells as possible spaced only a few miles apart. In parts of the area few wells have been drilled and it was necessary to use wells spaced many miles apart.

ACKNOWLEDGMENTS

An investigation such as this is not possible without the cooperation of geologists and oil companies who operate in the region. The writer is glad of this opportunity to express her appreciation of the aid of many oil companies, petroleum geologists, and of the State Geological Survey of Kansas for the loan of well samples. A. J. Crowley contributed stratigraphic criteria for establishing lithologic subdivisions of the Mississippian system. L. G. Henbest and other paleontologists of the Federal Geological Survey identified the microfossils.

LOCATION

Cross section No. 1 extends from the Sinclair Prairie Oil Company F. B. Young No. 1 well, in the center of the south line of the SE¼ sec. 34, T. 27 S., R. 21 W., eastern Ford county, Kansas, northwestward to the Sinclair Prairie Oil Company Glad Brock No. 1 well, in the SE¼ NW¼ NE¼ sec. 19, T. 13 S., R. 42 W., Wallace county, Kansas. It includes nine wells, numbered from northwest to southeast. The line of the section and the wells are shown on the index map.

METHOD OF WORK

In the preparation of this cross section the well logs were aligned on sea-level datum. Although the vertical scale is exaggerated 160 times over the horizontal scale, it was necessary to omit from the cross section many details upon which correlations have been based because even at this exaggerated scale it was impossible to show them adequately.

All wells except No. 7 used in this cross section were drilled with rotary tools. Each sample obtained from rotary drilling consists of fragments of many different kinds of rock, most of which caved from beds above those at the indicated depth at which the sample was collected. Accordingly, the type of rock actually penetrated by the drill at any given depth usually constitutes only a small part of the sample obtained from that depth. The cross section was prepared from detailed interpreted sample logs which were made by the writer from an examination of the well samples by use of a binocular microscope. An interpreted log, such as those shown on the cross section, is made by recording for a given interval only that type of rock which has not appeared in the samples at shallower depths. The well logs prepared from rotary samples are much influenced by the personal equation of the geologist, and no two experienced geologists will record a set of rotary samples exactly alike.

The correlations shown are based on all information available from the samples. The main items noted in the examination of samples for the well logs shown on the cross section are the kinds of rock, their color, grain, crystallinity, hardness, chemical and mineral composition, bond or cementing material; type of included chert, its texture, color and degree of alteration; oolites or oolicasts and stylolites; composition of sandstone, including size, shape and texture of grains, and degree of abrasion and sorting; microfossils, glauconite, and pyrite. In Kansas many very thin recognizable beds persist for great distances. In the correlation of wells shown on the cross section enough persistent beds were identified to serve as key beds for the less persistent beds associated with them; thus the identification of a sequence of beds served to correlate groups of strata from well to well.

GEOLOGY

This cross section traverses an area in western Kansas whose surface is formed on rocks of Quaternary, Tertiary, and Upper Cretaceous age. Beds of Lower Cretaceous age underlie Upper Cretaceous beds and in turn are underlain by rocks of Jurassic (?), Permian, Pennsylvanian, Mississippian, Devonian (?), Ordovician, and Cambrian age. The total thickness of the sedimentary rocks is greater than 6,000 feet. These beds overlie a basement complex composed mainly of granite and schist of pre-Cambrian age. Beds younger than Permian were not a part of this investigation and are not shown on the cross section. The part of each well shown on the section, therefore, starts at the top of Permian rocks, which was encountered at depths ranging from about 500 feet at the southeast end to about 2,300 feet at the northwest end of the cross section.

PERMIAN SYSTEM

Guadalupian Series

The Guadalupian series is represented by the Taloga formation, the Day Creek dolomite, and the Whitehorse sandstone. In the wells in the cross section the lower part of the Taloga formation and the Day Creek dolomite are present only in well No. 3 and the Whitehorse sandstone is present in all wells except No. 9. The Taloga formation is composed of sandy anhydrous shale, and the Day Creek dolomite consists of a bed of white crystalline anhydrite, 35 feet thick. The Whitehorse sandstone consists dominantly of very fine red grit containing stringers of fibrous gypsum and bright-red shale.

Leonardian Series

Nippewalla group.—The Nippewalla group of the Leonardian series includes six formations, several of which are identified on the cross section. The Dog Creek shale may or may not be present and distinguishable from the Blaine formation. The Blaine interval is occupied by beds of white and pink crystalline anhydrite separated by one or two thin beds of dark-red or reddish-brown argillite.

The Flowerpot shale, Cedar Hills sandstone, and Salt Plain formation constitute a sequence of red argillites, stringers of anhydrite, fibrous gypsum, buff sucrose dolomite, calcareous or maroon sandstone, and beds of salt.

Two thick sandstone beds, separated by bright-red shale containing some fibrous gypsum and a thin, medium-grained, white, calcareous sandstone, are present in the upper part of the Harper sandstone. The middle Harper interval contains soft, yellowish-gray, dolomitic argillite; fine, dolomitic red sandstone; soft, calcareous, light-gray shale; and thin stringers of fibrous gypsum. The lower Harper beds are predominantly soft, medium- and frosted-grained sandstone. The Harper sandstone differs greatly in thickness from place to place, seemingly because of the addition of beds at the base.

Sumner group.—The Stone Corral dolomite, Ninnescah shale, and Wellington formation form the Sumner group. The Stone Corral dolomite consists predominantly of white crystalline anhydrite in the subsurface and is there called by many geologists the Cimarron anhydrite. A thin bed of dense, reddish-brown, dolomitic argillite occurs in places at its top; one or two thin stringers of finely granular grayish-buff dolomite are present locally.

The Ninnescah shale consists of red, reddish-brown, and maroon argillites, thin beds of fibrous gypsum, and dolomitic argillites. Light-buff dolomitic sandstones are present in some places.

Greenish-gray and maroon dolomitic argillites occur in places at the top of the Wellington formation; these are underlain by very fine, angular, brown and green argillaceous sandstone, which, in turn, is underlain by a sequence of light-gray and cream-colored anhydrite beds interlaminated with light-gray, gritty, dolomitic argillites. The thickness of the Hutchinson salt varies greatly. In places it is absent or partly represented by anhydrite and green shales. The Wellington formation thins westward, owing mainly to lensing out of the thick salt beds.

Wolfcampian Series

Chase group.—The Chase group consists of several formations. The group maintains a fairly uniform thickness except near the Kansas-Colorado State line, where it it somewhat thinner owing to the absence of the Winfield and Florence limestones. In places the Herington limestone has grayish-buff, finely and profusely oolicastic dolomite intercalated with fine-grained micaceous sandstone at the top. These beds are underlain by buff to tan, more coarsely sucrose dolomite containing a minor amount of pink and white, opaque, mottled chert. The Herington limestone changes in facies toward the Kansas-Colorado State line and its interval is occupied by a 10-food bed of red coarsely crystalline dolomite underlain by 10 feet of cream-colored, angular, very fine-grained dolomitic sandstone. A reddish-brown shale and, toward the west, a red coarsely crystalline dolomite occur just below the Herington interval.

The Winfield limestone in its subsurface expression is cream-colored to buff sucrose dolomite containing abundant gray, subvitreous chert. The Winfield also undergoes a facies change westward by first losing its chert, then becoming shaly, and finally disappearing east of the Colorado State line. Greenish-gray and maroon shales, which become very sandy toward the Kansas-Colorado State line, underlie the Winfield limestone.

The upper part of the Fort Riley limestone is buff to brown sucrose dolomite or cream-colored dolomitic limestone. Minor amounts of chert generally are present; the chert is white translucent, white opaque, or gray vitreous opaque. A reddish-brown, finely gritty shale, 1 to 2 feet thick, occurs about 20 feet below the top of the Fort Riley and is underlain by fossiliferous calcareous dolomite which, in places, is porous and profusely oolicastic. Westward, this interval is occupied by red or reddish-brown dolomitic shales. A sandy zone (dolomitic, micaceous sandstone or dolomitic, red and green, gritty sandstone) about 15 feet thick occurs in many places just above the Florence limestone.

The Florence limestone in west-central Kansas is light-gray, chalky, calcareous dolomite containing abundant gray, vitreous, mottled chert. Westward, it loses its dolomitic character and becomes the uppermost true limestone encountered in wells. The Florence in northwestern Kansas is gray, chalky, mottled, algal limestone; its chert is white, light gray, dark gray, buff, or brown, and in many places is mottled or speckled. In Greeley county the Fort Riley limestone rests directly on a thin remnant of the Florence limestone; the Florence limestone is absent in wells examined in Wallace county. A widespread, persistent bed of reddish-brown shale, 5 to 10 feet thick, occurs at the base of the Florence interval.

The Wreford limestone is cream-buff to tan dolomitic limestone. In western-central Kansas it contains white to dark-brown fossiliferous chert which disappears northwestward. In Wallace county the Wreford limestone is locally absent or is represented by a bed of pinkish-cream, finely crystalline dolomite, 15 feet thick, underlain by greenish-buff, finely granular to dense calcareous dolomite.

Council Grove group.—Several formations of the Council Grove group are differentiated on the cross section. The upper part of the group consists of cream-colored and white, dense to chalky limestones and cream-colored dolomitic limestones interbedded with reddish-brown and green shales. At the base of the group is a persistent, widespread bed of reddish-brown gritty shale, 5 to 10 feet thick. The group thins northwestward because of the absence of some of its upper members.

The Cottonwood limestone is the only member of the Beattie limestone differentiated in well cuttings. As encountered in wells the Cottonwood limestone is cream-colored and chalky or light-gray, dense, fossiliferous limestone. Its distinguishing characteristic is the presence of weathered fusulinids which "drill free" and can be found in samples from nearly all wells examined. Dark-gray, maroon, and purple shale is found in most wells at the base of the Cottonwood.

The Neva limestone is cream-colored, chalky, dense or finely granular and, in many places, is finely oolicastic. It contains beds of gray, calcareous, fossiliferous shale; a red or maroon shale occurs at its base. Brachiopods, ostracods, gastropods, and fusulinids are present in several wells. Dark and light-gray marly limestones; cream-colored dense to finely sucrose dolomitic limestones; cream-colored to light-gray, chalky to finely sucrose algal limestones; and red, reddish-brown and, in Wallace county, maroon shales occur beneath the Neva limestone.

The upper Foraker limestone consists of greenish-gray, granular marl with abundant mottled buff and white fossiliferous chert containing fusulinids northwestward from Ford county to Scott county; the chert is absent northwest of Scott county.

Admire group.—The Admire group consists of cream-colored to grayish-white, chalky to finely crystalline, fusulinid-bearing limestones interbedded with greenish-gray shale and a few beds of reddish-brown shale. The uppermost limestone is glauconitic in Scott county. The shales decrease in thickness and number westward; their color changes from greenish-gray to predominantly maroon, purple, and reddish-brown. In places thin glauconitic and pyritic sandstone marks the base of the Admire, and in other places its base is marked by a red or reddish-brown shale of the type that occurs in both the Admire and Wabaunsee groups. The Admire group is fairly uniform in thickness from southeast to northwest.

PENNSYLVANIAN SYSTEM

Virgilian Series

Wabaunsee group.—The Wabaunsee group is composed of a series of thin, grayish-buff, finely crystalline, algal, fossiliferous, locally oolitic limestones; thin greenish-gray, some reddish-brown shales; and thin, micaceous, typical Pennsylvanian sandstones. Fusulinids, ramose foraminifera, brachiopods, ostracods, and bryozoans are common. Pyritic shales occur near the base of the group in many places. The thickness of the Wabaunsee group is fairly uniform along the cross section.

Shawnee group.—The Shawnee group consists of a series of thick, cherty, commonly dolomitic limestones interbedded with thin, grayish-green and dark-gray shales, many of which become reddish-brown and maroon northwestward. The Shawnee group thins northwestward because of truncation of its upper beds; near the southeast end of the cross section the group rests with an angular unconformity on the underlying beds. The uppermost formation of the Shawnee group is the Topeka limestone which, where present, is a cream- or buff-colored, finely sucrose, fusulinid-bearing limestone; white vitreous to opaque and tripolitic chert containing fusulinids is commonly present. The Oread limestone, the lowest formation of the Shawnee group, can be distinguished in nearly all wells as cream-colored, dolomitic, generally oolitic or oolicastic limestone. In western-central Kansas white chalcedonic or opaque chert containing fusulinids is present, and northwestward the chert gradually lessens in amount until it is absent and the Oread limestone itself is less dolomitic and thinner. In some wells the Oread limestone is difficult to distinguish and may be absent.

Missourian and Virgilian Series

Douglas group (Virgilian) and Pedee group (Missourian).—In Ford county about 150 feet of dark-colored earthy limestones and gray and reddish-brown shales are assigned to the Douglas and/or Pedee groups, which are indistinguishable one from the other in well samples. These beds thin rapidly northwestward; northwest of Ford county the Douglas and Pedee beds may be absent or may be represented by a 10-foot zone of heterogeneous material including variegated shales, pyrite, and sand.

Missourian Series

Lansing, Kansas City, and Bronson groups.—The Lansing, Kansas City, and Bronson groups are treated as a unit in well-sample examinations because few, if any, beds of these groups are distinguishable as individual units capable of being correlated from well to well. The limestones and cherts generally are whiter and more dense than those above the Lansing group. One zone of oolitic or oolicastic dolomitic limestone persists through several wells. Shales, generally gray, greenish-gray, or rarely reddish-brown, are thin and inconspicuous. The sequence thickens northwestward from Ford county to Scott county by the addition of beds at the top; it thins northwestward from Scott county to Wallace county because of the absence of these upper beds.

Desmoinesian Series

The Desmoinesian series includes the Marmaton group and the Cherokee shale. As encountered in wells, the rocks in these units are so similar that it is difficult to separate the Marmaton from the Cherokee; for convenience, no differentiation was attempted and they are treated as a whole. The Desmoinesian series is somewhat variable in thickness from southeast to northwest, owing to overlap at the base and truncation at the top. The distinguishing characteristic of the Desmoinesian beds is their dark color. The shales are dark gray or black; the limestones are dark buff or dark gray; the cherts are dark gray or black; thin coal seams are present in places. In central-western Kansas approximately half the Desmoinesian interval is occupied by limestone; near Finney county the limestone beds thin appreciably and the series becomes a sequence of shales and thin beds of limestone. Northwest of Finney county the Desmoinesian series thickens because of the addition at the top of about 200 feet of a predominantly limestone sequence, upper Marmaton in age. Sandstones are conspicuously absent from the Marmaton and the Cherokee.

Sooy conglomerate.—On the Central Kansas uplift and its flanks and throughout much of western Kansas a detrital conglomerate, probably a terrestrial sediment, was deposited on the truncated edges of pre-Cherokee beds. The conglomerate is overlain by beds ranging in age from Cherokee to Kansas City. This detrital zone is called Sooy conglomerate by petroleum geologists and yields oil in some places. On the line of this cross section the Sooy conglomerate is present at the base of the Cherokee formation from Ford county northwestward to Scott county, but it is absent in Greeley and Wallace counties unless represented there by about 20 feet of mustard-green shales and calcareous and pyritic sandstones in the basal part of the Cherokee shale.

Pre-Cherokee Beds

In well 7, Ford county, and in wells 2 and 3, Greeley and Wallace counties, beds are present which seem to be older than the Cherokee shale and younger than the underlying beds of known Mississippian age. These beds are designated as pre-Cherokee Pennsylvanian on the cross section. In Ford county they are cream-colored to white coarsely crystalline limestone, dolomitic and cherty near the top and including one or two thin beds of greenish-white flaky shale; in Greeley county the beds are black and gray pyritic shales and a few thin limestones; in Wallace county they are dark-buff, coarsely crystalline, glauconitic limestones, separated by dark-gray and greenish-gray shales and one or two thin, calcareous, glauconitic sandstones. Beds recently named Kearny formation by Thompson[1] are, at least in part, equivalent in age to these pre-Cherokee Pennsylvanian beds.

MISSISSIPPIAN SYSTEM

Meramecian Series

The Ste. Genevieve, St. Louis, and Spergen and Warsaw limestones of the Meramecian series were tentatively identified on the cross section. The Ste. Genevieve limestone, uppermost formation of the Meramecian series, is present in the structurally lower parts of the region traversed by the cross section; it is absent in the higher parts probably because of pre-Pennsylvanian erosion. The Ste. Genevieve consists of buff-colored, fine to medium crystalline, nearly everywhere finely oolitic and glauconitic limestone; some beds are locally both oolitic and sandy; chert rarely is present.

The St. Louis limestone is less oolitic than the Ste. Genevieve and, in places, contains beds of buff or brown finely granular dolomite, buff granular dolomitic limestone, and buff finely granular porous glauconitic dolomite; bluish-gray semitranslucent chert is present near the base of the formation in most places.

The proper correlation of the limestones assigned to the Spergen and Warsaw interval is not known; they may be Spergen or Warsaw in age or may partly represent both formations. These beds are called Spergen by some Kansas geologists. These so-called Spergen beds are variable in character. Buff or dark-gray limestones or dolomitic limestones are common; some of the beds are glauconitic or oolitic; buff and white, finely mottled or spicular chert may be present toward the base. Quartzose chert is present nearly everywhere at or just above the base. The foraminifer Endothyra is present in many wells.

Osagian Series

It has not been practicable in the preparation of the cross section to differentiate all formations of the Osagian series. It is common practice among subsurface geologists in Kansas to treat the Keokuk and Burlington limestones as a unit and call it "Osage", "Boone", or "Mississippi lime" because in eastern and central Kansas these two formations are the only limestones of Osagian age present. Lithologically the "Osage" (Burlington and Keokuk) beds are more distinctive than any other Mississippian limestones in that they are everywhere dolomitic or composed of beds of buff or cream-colored finely granular dolomite, interlaminated with dolomitic limestone. Both dolomites and dolomitic limestones contain abundant gray to white tripolitic chert. This weathered tripolitic chert is universally present, especially at the top of the "Osage" beds, whether they are overlain by younger Mississippian or by Pennsylvanian beds.

In several wells a sequence from 30 to 90 feet thick of lithologically radically dissimilar limestones occurs immediately below the typical tripolitic dolomites of the "Osage" beds. The uppermost bed in this sequence is dense, dark-buff, lithographic "birdseye" limestone which is underlain in some places by buff, porous, oolitic limestone, or by buff, earthy, glauconitic limestone. These limestones are underlain by gray and buff, mottled, fine to medium crystalline limestone containing white vitreous chert. The lowest bed in this zone is sandy in most places. Because these beds differ so radically from the typical "Osage" beds and because they seem to constitute a separate, traceable subsurface unit, the writer believes that they probably do not belong to the Keokuk and Burlington limestones and has tentatively assigned them to the Fern Glen limestone, which at its outcrops in Missouri includes the Reeds Spring and St. Joe limestones. The Reeds Spring and St. Joe limestones were tentatively identified only in the northwestern part of the area.

Kinderhookian Series

The Gilmore City limestone of the Kinderhookian series is buff, finely sucrose, coarsely oolitic to pisolitic limestone; it is only very rarely dolomitic or cherty. The Gilmore City limestone is absent in well 9 at the southeast end of this cross section, but present in all other wells.

Some wells contain a sequence of limestones with interlaminated grayish-green pyritic shales which seem not to belong to the overlying Mississippian limestones. These lower Mississippian beds have tentatively been assigned to the Kinderhookian series and may possibly correlate with some part of the Sedalia limestone, Northview shale, and Compton limestone of southwestern Missouri.

The typical tripolitic dolomites of the Burlington and Keokuk limestones do not directly overlie pre-Mississippian beds in any well on the cross section. Beneath the Burlington and Keokuk in wells at the southeastern end of the section, the so-called Fern Glen and Kinderhookian beds are found; the Gilmore City limestone is absent. In Finney and Scott counties the Burlington and Keokuk rest on the Gilmore City which, in turn, is underlain by undifferentiated Kinderhookian beds; the Fern Glen is absent. In Greeley and Wallace counties, at the northwestern end of the cross section, Burlington and Keokuk beds are underlain by Fern Glen and Gilmore City beds, and undifferentiated Kinderhookian beds are absent. One or all of the beds here called Fern Glen and undifferentiated Kinderhookian could represent facies changes of the Gilmore City limestone or of each other, except that typical oolitic Gilmore City beds overlie the undifferentiated Kinderhookian beds in wells in Finney and Scott counties, and that typical oolitic Gilmore City beds underlie Fern Glen beds at the northwestern end of the section. It, therefore, becomes difficult, if not impossible, to decide which sequence, Fern Glen, Gilmore City, or undifferentiated Kinderhookian, is a facies change of which other sequence. The writer believes that the beds here called Fern Glen, Gilmore City, and undifferentiated Kinderhookian are three formations separated from each other and from the Burlington and Keokuk limestones by disconformities.

In well 8 in Ford county and in wells 5 and 6 in Finney county, sandstone tentatively identified as the Misener sandstone is present at the base of the Kinderhookian beds. In Ford county the sandstone is very fine-grained, calcareous, tightly cemented and quartzitic. In Finney county a cream-colored or grayish-buff, coarsely sucrose dolomite containing abundant embedded coarse sand grains is present in wells 5 and 6; this bed has been called Misener sandstone (Mississippian) by some geologists and Hunton limestone (Devonian and Silurian) by others.

DEVONIAN AND SILURIAN SYSTEMS

A bed of dolomite found in wells 5 and 6 in Finney county may represent the Hunton limestone. This bed is described in the preceding paragraph. As indicated there this bed is called Misener sandstone by some geologists.

ORDOVICIAN SYSTEM

Rocks of Trenton Age

Viola limestone.—The first formation encountered beneath Mississippian beds in the wells on this cross section has been called Viola limestone by many Kansas geologists and Galena limestone by others. The Viola interval is occupied by beds of light-colored dolomite in which the degree of crystallinity is variable from bed to bed and from place to place. All of the dolomite beds are very cherty, and the color and kind of chert are as variable as the crystallinity of the dolomites. The writer believes (1) that these beds may be, in part, post-Trenton in age, possibly equivalent to the Fremont limestone[2] of the Sawatch Range, Colorado, (2) that they may be, in part, upper Trenton in age, equivalent to the Dubuque formation and Stewartville members of the Galena limestone in the Upper Mississippi Valley, (3) that they are not equivalent to any part of the Viola limestone that crops out in the Arbuckle Mountains in Oklahoma, and (4) that they perhaps are equivalent to beds called Viola in the Ardmore and Anadarko basins of Oklahoma.

Rocks of Black River and Chazyan Age

Simpson rocks.—Several widely different types of beds underlying the Viola limestone have been called Simpson and are believed to correlate with some parts of the Simpson group which crops out in the Arbuckle Mountains of Oklahoma. The subsurface beds in western Kansas assigned to the Simpson may be buff to brown, finely crystalline, earthy to dense lithographic limestones; buff, coarsely crystalline to coarsely sucrose dolomites; sandy and dolomitic or green plastic shales; cherty, sandy, and shaly dolomites; and dolomitic limestones. These beds do not occur in a persistent sequence and no individual bed can be traced for any great distance. Their exact correlation with any of the named formations of the Simpson group and their precise age are unknown. The writer believes that beds (including the Harding sandstone) of Chazyan and Black River age are probably represented.

ORDOVICIAN AND CAMBRIAN SYSTEMS

Rocks of Beekmantown and St. Croixian Age

Arbuckle limestone.—The Lower Ordovician dolomites encountered in wells drilled in the Mid-Continent region are cream-colored and coarsely rhombic; tripolitic chert commonly is present at the top of the sequence; other types of chert are present lower in the sequence. Drusy dolomite is locally present. These dolomites are called Arbuckle limestone in Kansas, but their exact age and correlation with various named upper formations of the Arbuckle group at its outcrops in the Arbuckle Mountains of Oklahoma are unknown to the writer.

In Scott county and northwestward therefrom, the dolomites of the Arbuckle are red and very coarsely crystalline in places. Glauconitic dolomites are common, and sandy dolomites and sandy cherts are present. The character of these dolomites suggests that they may be older than those encountered at the southeastern end of the cross section; it is possible that they may be of Upper Cambrian age and equivalent to some part of the Manitou limestone of the Front Range of Colorado or to some of the Upper Cambrian formations of the Arbuckle group of the Arbuckle Mountains of Oklahoma. Well 1 at the northwest end of the cross section completely penetrated the Arbuckle limestone which at that place is 350 feet thick. Most of it may be of Upper Cambrian age. The lowermost 90 feet of the Arbuckle limestone in this well is very glauconitic and has been correlated by some geologists with the Bonneterre dolomite of Missouri.

Lamotte sandstone.—The basal Paleozoic beds in the Mid-Continent region form a sandstone formation called Lamotte, Reagan, or Sawatch. It was reached only by well 1 in Wallace county where it is composed of glauconitic dolomitic sandstone and shaly sandstone and some glauconitic dolomite.

IMPORTANT UNCONFORMITIES

Following are the important unconformities shown on the cross section.

Top of the Permian system.—Any one of several formations of Permian age may be encountered at the top of the Permian system.

Top of the Shawnee group.—Because of truncation of the Shawnee group, beds lying 400 feet below the top of the group in Ford county are the topmost beds in Greeley county. It is suggested that further drilling may find an erosional remnant of channel sandstone at the top of the Shawnee.

Top of Lansing group.—Erosion in post-Lansing time cut far down into the Lansing-Kansas City-Bronson sequence.

Top of Desmoinesian series.—Post-Desmoinesian erosion truncated the Marmaton-Cherokee sequence.

Base of Desmoinesian series.—The Sooy conglomerate marks a period of erosion which truncated the underlying beds.

Top of Mississippian beds.—Pennsylvanian deposition began everywhere in the Mid-Continent region after a prolonged but variable period of uplift and erosion. This orogenic period is represented in Kansas by the regionally angular unconformity between the Mississippian and the Pennsylvanian systems. In some places on the line of the cross section this stratigraphic break represents upper Meramecian time, all of Chesterian time, and probably most of Morrowan time.

Base of Mississippian beds.—In the part of Kansas represented by the cross section, except for a possible remnant in Finney county, the Devonian and Silurian periods are not represented by sediments. Also Upper Ordovician (above the Trenton) time is not represented.

Top of Arbuckle limestone.—The Arbuckle limestone is truncated throughout the region, including the areas where it is overlain by Simpson rocks.

Base of Paleozoic rocks.—No beds of Lower and Middle Cambrian age are present in western Kansas, and it is probable that in places Upper Cambrian time is not represented by sediments because the so-called lower Paleozoic sandstone (Lamotte sandstone) is probably not everywhere the same bed or of the same age.

Minor unconformities.—In addition to the major unconformities listed above there are many minor unconformities, disconformities, and diastems, some of which are shown on the cross section. Both the major and minor unconformities are represented by the same symbol on the section. The unconformity between the Pennsylvanian and Permian systems is classified as minor by the writer because along the line of the cross section there seems not to have been more than 50 feet of truncation and/or overlap at this systemic boundary.

STRUCTURAL FEATURES

Anticlinal structures, greatly exaggerated by the scale used, have been drawn on the cross section between wells 7 and 8, 6 and 7, 4 and 5, and 3 and 4. The reasons for inserting these anticlines are stratigraphic; but because the parts of the cross section between wells are inferential, the anticlinal structures shown are hypothetical.

OIL AND GAS

Oil and/or gas have been produced in western Kansas from the following rocks: Lamotte sandstone, Arbuckle limestone, Simpson rocks, Viola limestone, St. Louis limestone, a sand in the Cherokee shale called the "Patterson sand," the Sooy conglomerate, the so-called "Oswald lime" in the Lansing-Kansas City-Bronson sequence, the so-called "Topeka lime" which is not everywhere the true Topeka limestone of the Shawnee group, and the Fort Riley limestone and other dolomites in the Chase and Sumner groups of the Permian system.

The most favorable reservoir rocks for oil and gas are sandstones, but only four of the oil- or gas-bearing formations listed above are sandstones or sandy rocks. The cross section discloses that massive sandstones which could serve as reservoirs for petroleum are conspicuous by their absence. Of the four sandy zones that produce oil in western Kansas, the Lamotte sandstone, reached only by well 1, is dolomitic and quartzitic; the Simpson beds are shaly and dolomitic and very thin in the northwestern part of the area; and the Sooy conglomerate seemingly does not extend northwestward beyond Scott county. It is, therefore, probable that sandstone reservoirs will not be frequent sources of any future oil production that may be found in the area of this cross section. Limestones, dolomitic limestones, and dolomites have, to date, served as reservoir rocks for oil and gas in most places in central-western Kansas; accordingly, future production from this region probably will come mainly from these types of reservoir rocks.

The cross section suggests that stratigraphic traps caused by erosion and truncation and subsequent deposition of younger strata are common at several of the major and minor unconformities, notably at the top of each of the following units or sequences: Arbuckle limestone, Simpson rocks, Viola limestone, Kinderhookian series, Mississippian limestones, Bronson-Kansas City-Lansing sequence, Shawnee group, and Chase group. Such stratigraphic traps may also lie at the base of the Stone Corral dolomite and at the base of the Blaine formation.

Stratigraphic traps caused by the lensing out of beds or a change of facies occur less commonly than those associated with unconformities. The writer thus believes that a search for this type of petroleum trap along the line of the cross section will not be as profitable as a search for the types associated with unconformities.

Oil or gas occur on anticlinal folds at three places on the line of this cross section: (1) oil in the St. Louis limestone in the center of the south line of the NE¼ sec. 34, T. 27 S., R. 21 W., Ford county; (2) the Shallow Water oil pool in the St. Louis limestone in secs. 14 and 15, T. 20 S., R. 33 W., Scott county; and (3) show of gas at 2,460 feet in beds of dolomite in the upper part of the Permian rocks in the SE¼ NW¼ NE¼ sec. 19, T. 13 S., R. 42 W., Wallace county.

If the anticlinal folds which have been postulated from stratigraphic evidence along the line of this cross section should actually be present, petroleum might be found somewhere within the following areas: (1) the NW¼ T. 26 S., R. 23 W., Ford county, (2) the SW¼ T. 24 S., R. 25 W., Hodgeman county, (3) the N½ T. 22 S., R. 31 W., Finney county, (4) the S½ T. 18 S., R. 35 W., and/or the N½ T. 19 S., R. 35 W., Wichita county, and (5) the N½ T. 17 S., R. 38 W., Wichita county.

[1] Thompson, M. L., Pennsylvanian Morrowan rocks and fusulinids of Kansas: Kansas Geol. Survey, Bull. 52, pt. 7, p. 411, Dec. 30, 1944.

[2] Johnson, J. H., Paleozoic stratigraphy of the Sawatch Range, Colorado: Geol. Soc. America Bull., vol. 55, no. 3, p. 324, 1944.

LIST OF WELLS

	Company	Farm name	Well no.	Location	Elev. in ft. above sea level	Remarks
1	Sinclair Prairie	Glad Brock	1	SE¼ NW¼ NE¼ sec. 19, T. 13 S., R. 42 W., Wallace county	3,808	Gas show in dolomite in upper part of Permian.
2	Broderick & Gordon	Goodrich	1	Cen. NE¼ sec. 9, T. 14 S., R. 42 W., Wallace county	3,844	Dry hole.
3	Helmerick & Payne	McCormack	1	Cen. NW¼ NE¼ sec. 23, T. 16 S., R. 40 W., Greeley county	3,641	Dry hole.
4	Atlantic Refining	C. Mark	1-C	Cen. NE¼ SE¼ sec. 15, T. 20 S., R. 33 W., Scott county	2,958	Oil in St. Louis limestone in Shallow Water pool.
5	National Refining	Frank Wells	1	Cen. SW¼ sec. 13, T. 23 S., R. 30 W., Finney county	2,783	Dry hole.
6	Olson Drilling	Ely	1	NW¼ NW¼ SE¼ sec. 34, T. 22 S., R. 29 W., Finney county	2,703	Dry hole.
7	Swain et al.	Taylor	1	Cen. NW¼ sec. 21, T. 25 S., R. 24 W., Ford county	2,503	Dry hole.
8	Olson Drilling	S. E. Fowler	1	Cen. SW¼ sec. 26, T. 27 S., R. 22 W., Ford county	2,419	Dry hole.
9	Sinclair Prairie	F. B. Young	1	Cen. SL SE¼ sec. 34, T. 27 S., R. 21 W., Ford county	2,330	Oil in St. Louis limestone.

Drafting of cross section by H. Russell Cooley
Lettering and arrangement by Eileen Martin

SUBSURFACE GEOLOGIC CROSS SECTION FROM FORD COUNTY TO WALLACE COUNTY, KANSAS

JULY 1945 — BY FANNY CARTER EDSON — DATUM—SEA LEVEL