MISSISSIPPI
STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph.D.
Director

BULLETIN 69

STATUS OF FEARN SPRINGS FORMATION

By

FREDERIC FRANCIS MELLEN, M.S.

UNIVERSITY, MISSISSIPPI

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LETTER OF TRANSMITTAL

Office of the Mississippi Geological Survey
University, Mississippi
May 31, 1950

To His Excellency,
Governor Fielding L. Wright, Chairman, and
Members of the Geological Commission

Gentlemen:

Herewith is Bulletin 69, Status of the Fearn Springs formation by Frederic Francis Mellen—a paper clarifying the stratigraphic sequence of the beds in Mississippi.

In 1949 Mississippi produced 37,885,120 barrels of oil, about 15 percent of it from Wilcox formations of Adams County. At the present time this percentage is increasing, due to discovery of additional Wilcox oil reserves, mostly in Adams County, to a lack of recent discoveries in Mesozoic formations, and to a normal rate of depletion of existing Mesozoic reserves.

Wilcox oil has accummulated, mostly in lenticular sands, usually associated with slight structural folding. The extension of the Wilcox oil province into Mississippi in recent years has brought to light the fact that strata deeper and deeper within the Wilcox are producing oil. Oil within these Wilcox strata, as the wild-catter well knows, is difficult to discover. There are, however, definite zones that are more prolific than the rest of the Wilcox, and because of this condition, the subdivision or the zonation of Wilcox sediments is highly desirable.

Although no oil is obtained at present from the Fearn Springs formation, no good reason exists why such a condition should continue. Because of its marine deposition in South Mississippi, its thick upper shale member, and the development of good sands of lenticular character, there appears to be no basic geologic reason why the lower Wilcox Fearn Springs formation will not produce commercial oil.

The present paper is an approach to the division of the subsurface Wilcox strata into recognizable units, and the correlation of them. The problem is a difficult one, and several approaches are being made at this time. The present paper is, in part, a summary of the stratigraphic and economic work on Wilcox sediments in their outcrop belt through North-central Mississippi, where the Mississippi Geological Survey has undertaken detailed surveys to study, to subdivide, and to map the Wilcox units; and it is in part an extension of that work to correlate it with the subsurface in the hope that the work will contribute to the understanding of the Wilcox in the areas in which these beds produce oil.

Very truly yours,

William Clifford Morse,
Director and State Geologist

ILLUSTRATIONS

FIGURES

STATUS OF FEARN SPRINGS FORMATION

Frederic F. Mellen

Jackson, Mississippi

The objectives of this paper are three-fold: (1 to correct any misconception of what is included in Fearn Springs formation;[1] (2 to illustrate the cyclical deposition that has been observed in the Southeastern States in beds ranging in age from Pennsylvanian or earlier to Miocene; (3 and to present a provincial argument that these depositional cycles, in being genetic units, individually represent a complete geologic process, the sediments of which, irrespective of their heterogeneity, comprise a fundamental rock unit, the formation. These three objectives are necessitated by the conditions under which the name Fearn Springs has been employed in the literature by some writers. No attempt is made here to pass on the definitions, the correlations, or on the validity of the Midway and Wilcox names outside of Mississippi.

A review of the lower Tertiary stratigraphy shows cyclic sedimentation to prevail. Lateral gradation is common in the shallower water deposits, and in many places in the subsurface the boundaries between the Wilcox cycles are obscure. A normal cycle consists of a basal transgressive sand member, a median clay or shale member of the inundated phase, and a superior regressive silt or fine sand member, all composing a more or less orderly depositional sequence as outlined by Bornhauser[2].

The Midway cycle is composed of the basal transgressive Clayton limestone or sandstone, made up in part of reworked Cretaceous chalk and fossils and containing some coarse pebbly sand; the Porters Creek clay member, marine throughout, constituting the inundated phase; and the regressive Naheola micaceous silty marine clays. The Betheden formation may be added more properly as a member of the Midway, in which this sub-aerially lixiviated residuum of kaolin and bauxite and their associated lignite would be a fourth phase terminal member. This usage, first employed by Priddy[3], is recommended. Bramlette[4] regarded a period of emergence of 1,000,000 years as being necessary for the production by weathering of the bauxite-kaolin deposits of Arkansas, which are at this stratigraphic horizon. For this reason, the erosional unconformity at this position is considered to be of greater magnitude than that at the top of the Fearn Springs, so that the Midway-Wilcox contact is placed at the top of the Betheden residuum or at the top of the Naheola where the residuum has been eroded.

The oldest Wilcox cycle, Fearn Springs formation, consists usually of a thin basal sand which may be lignitic and may contain reworked kaolin and bauxite, and a succeeding thicker sequence of nonmarine clays, silts, lignites and fine sands which are essentially Wil-

Figure 1.—Fearn Springs formation at the type exposure (NE. 1/4, Sec. 3, T. 13 N., R. 14 E.) 0.25 mile west of Fearn Springs; the paper marks the unconformity between the Fearn Springs below and the Ackerman above.—October 22, 1938 (M. S. G. S., Bull. 38, Fig. 10).

cox in character. The anauxitic clays useful for ceramic purposes distinguish it from younger Wilcox clays and from the older montmorillonitic clays of the Midway. In many localities a basal sand has not been preserved, but contact of Fearn Springs clays on Midway clays can usually be determined without doubt by close examination. This type of contact in an electrically logged hole might be impossible to pick[5]. The local presence of high-grade bentonite in the Fearn Springs was first discovered by the U. S. Bureau of Mines in Union County and has since been observed by the present writer from well

Series	Formation-Member		Description
Claiborne	Tallahatta Winona (?) Basic Meridian	175	Ferruginous sandstone; light-colored siltstone; siliceous sedimentary clays; masonry sand
Disconformity			
	Hatchetigbee	175	Lignite; siliceous underclays; lignitic clays; ferruginous sandstone; masonry sand
	Disconformity		
	Holly Springs	250	Lignite; siliceous underclays; lignitic clays; ferruginous sandstone; masonry sand
	Disconformity		
Wilcox	Ackerman	400	Lignite; siliceous underclays; lignitic clays; ferruginous sandstone; masonry sand
	Disconformity		
	Fearn Springs	50	Ball clay; stoneware clay; lignite
Disconformity			
	Betheden	25	Kaolinitic clay; bauxitic clay; lignite
	Conformity		
Midway	Porters Creek	500	Clay, marine carbonaceous montmorillonitic; sandy and micaceous toward top; sandy calcareous toward base

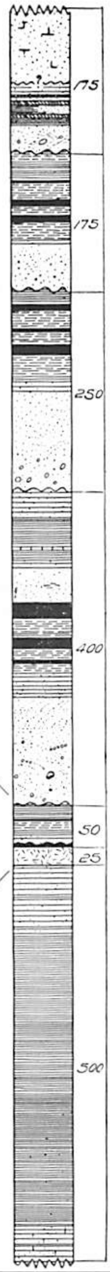

Figure 2.—Generalized section of rocks of Winston County showing thickness in feet. (M. S. G. S., Bull. 38, Fig. 7).

cuttings from Webster, Attala, Holmes, Yazoo, and Hinds Counties. This bentonite, the source of which is unknown, may be evidence of crustal disturbance and volcanic activity. The fresh water deposition of much of the Fearn Springs is attested by the presence of fresh-water mussels reported by Priddy[6] from the clays in Pontotoc County. Down-dip and in Alabama marine glauconitic and fossiliferous horizons are developed in the formation.

Figure 3.—Interbedded sand and shale in upper member of Fearn Springs formation. Highway cut on U. S. 45, 0.5 mile north of the Lauderdale-Kemper County line. V. M. Foster, Photo. October 10, 1938. (M. S. G. S., *Bull. 41*, Fig. 7).

The second cycle of the Wilcox, Ackerman formation, is the most conspicuously developed cycle in the lower Tertiary. In addition to normal evidences of epeirogenic warping, its basal sand exhibits evidence of great orogenic developments in the region by the coarseness of its grains, the sporadic presence of pebbles, cobbles and boulders (up to 905 pounds) of quartz and quartzite, the local concentration of large muscovite flakes, its thickness (up to 475 feet in the subsurface, Jasper County), and its widespread lateral extent. For this basal sand the writer reserved the name Noxubee with Miss Wilmarth, Secretary to the Committee on Geologic Names of the U. S. Geological Survey; the name was not used because of the decision against naming members until the larger subdivisions were more widely recognized. In the Memphis area the basal Ackerman sand is one of the more prolific fresh water reservoirs[7]. The basal sand is succeeded by several hundred feet of silts, clays and lignites, and by a superior regressive fine sand or silt.

The third Wilcox cycle is similar to the Ackerman except that its basal sand is finer and exhibits a greater tendency to lateral gradation into argillaceous beds. Its average thickness is not as great as the average of the Ackerman, and its subsurface limits are commonly not

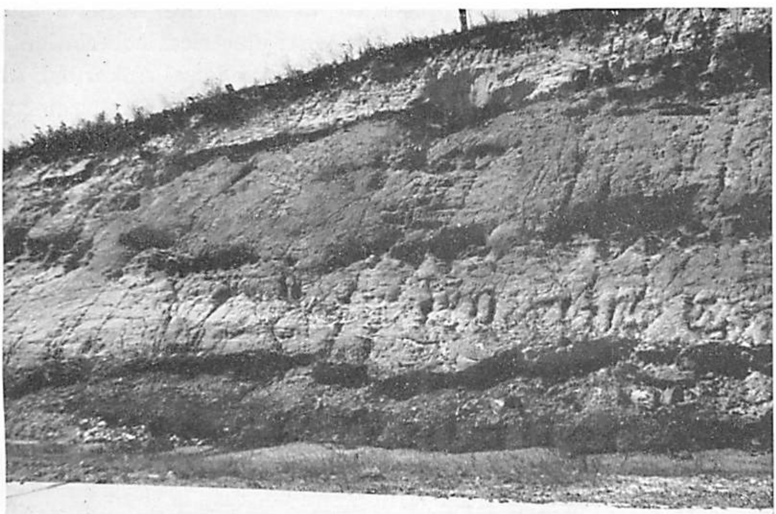

Figure 4.—Fearn Springs-Ackerman unconformity, the basal Ackerman sand directly overlying and truncating the Fearn Springs lignite. Highway cut on U. S. 45, 2.0 miles north of the Lauderdale-Kemper County line. V. M. Foster, photo. October 10, 1938. (M. S. G. S., Bull. 41, Fig. 8).

clear on electrical logs. The name "Holly Springs" in quotation marks is used, although it is now recognized generally that the name is invalid: the outcrops at the type locality are of up-dip Claiborne instead of Wilcox.

The fourth Wilcox cycle is the Hatchetigbee formation, similar in many respects to the Ackerman and to the "Holly Springs." It is typically known by its inundated phase, the dark-gray, laminated, carbonaceous marine clays of Lauderdale County and southwestern Alabama. These beds are underlain by the Bashi fossiliferous glauconitic sand-marl member and an underlying loose non-glauconitic basal sand. The marine clays are overlain by lignitic clays, silts, lignite, and fine sands of regressive character.

The Meridian sand is regarded as a basal transgressive sand of the Tallahatta formation lying unconformably upon the Wilcox. In subsurface mapping the top of this sand is much more useful and is called "top of Wilcox." The Tallahatta is the first of a series of depositional cycles in the Claiborne and later Tertiary on which Stenzel[8] has recently done much meticulous work.

Two cross-sections are presented to show the writer's interpretation of lower Tertiary deposition from electrical correlation. In the dip section the invasion of fresh water in the basal Ackerman sand to depths around 3500 feet is indicative of its "blanket" character and high permeability. In the stratigraphic section this basal Ackerman sand appears to be equivalent to the Nanafalia-Salt Mountain of Alabama. The writer has found fossiliferous glauconitic marl at the top of the Ackerman basal sand in well cuttings from Webster County Oil Development Trust No. 1 State of Mississippi (Sec. 15, T. 21 N., R. 8 E., Webster County), C. L. Higgason No. 1 Long-Bell (Sec. 10, T. 3 N., R. 16 E., Clarke County), and other wells in the area. Though these correlations can be supported by numerous other logs and some sample work, there is an inadequacy of lithologic analysis. The drilling penetration rate through these beds is commonly 100 feet per hour, about 50 percent of which time is consumed in making connections. Because of the softness of these strata, and because of their unpromising petroliferous outlook above 4000 feet, samples, if collected at all, are poor and unfit for critical study.

The seeming inability to distinguish stratigraphic units of the Wilcox in the deep subsurface from electrical logs and from our present incomplete sampling techniques does not affect the validity of names applied to surface units and extended into the shallower subsurface. After all, electrical logging is a measurement of physicochemical response of formation fluids, and not an absolute measurement of lithology. The Tertiary unconformities are perhaps co-extensive with the outcrop belt in the Gulf Coastal Plain; whether they extend far basinward has not been determined, and may not be determined until electric log control is closer, and until the section is cored continuously in critical areas. The shale resistivity technique of Claudet[5] offers definite promise of aid in this direction. It is still true that closer examination of depositional arrangement and of stratigraphic values can be made from the numerous large outcrops than from 9-inch well bores.

Knowledge of periodicity in sedimentation offers the possibility of needed reform in stratigraphic interpretation. The formation is a basic stratigraphic term, yet we find ourselves in constant disagreement as to definition. Many workers require a formation to be "a mappable lithologic unit." Individual definitions of "mappability" range to such extreme degrees as to be absurd. It is not clear whether "lithologic" implies a single rock type or a combination of rock types related in genesis. The Committee on Stratigraphic Nomenclature

Figure 5.—Gully exposure of Fearn Springs silts and silty clays (NW. 1/4, SW. 1/4, SW 1/4, Sec. 26, T. 8 S, R. 1 E., Pontotoc County), 1 mile west of Esperanza (Hurricane) School. R. R. Priddy photo. November 8, 1941. (M. S. G. S., Bull. 54, Fig. 11).

reported *"Uniform procedure is essential in dealing with the taxonomy of rock units."*[9] Also, "The discrimination of sedimentary formations is based on the local sequence of rocks, lines of separation being drawn at points in the stratigraphic column where lithologic characters change or *where there are significant breaks in the continuity of sedimentation or other evidences of important geologic events.* As thus conceived, *the formation is a genetic unit* * * * *."[10] "In determining this unity of constitution, *all available lines of evidence, including lithologic constitution, fossil content, structural relations, and unconformities, shall be considered.*"[11] Sedimentary periodicity was found by Wanless and Weller[12] to be valuable in stratigraphic delineation; the cyclothems of the Pennsylvanian are formational in rank. Sedimentary periodicity is no less valuable as a gauge of stratigraphic values in Mesozoic and Tertiary deposits. More and more workers in the Gulf Coastal Plain are referring to sedimentary cycles discovered by them in their work. Thomas described in detail the processes by which the Claiborne cycles were developed in Mississippi.[13] Brown, in addition to the workers mentioned in the following paragraph, found the cyclic pattern in his work on ground-water.[14] Why, then, if these depositional sequences can be demonstrated, would they not meet the objectives of stratigraphic nomenclature by applying *uniform procedure* in defining these *genetic units* as formations?

Figure 6.—Roadcut showing Porters Creek, Betheden, and Fearn Springs formations, east valley wall of a small creek near Calhoun County line (SW. 1/4, NE. 1/4, SW. 1/4, Sec. 18, T. 11 S., R. 1 E., Pontotoc County), 2.5 miles northeast of Robbs. Figure at left points to Porters Creek-Fearn Springs contact. Figure at right indicates a thin wedge of bauxite representing the Betheden formation. R. R. Priddy photo. November 3, 1941. (M. S. G. S., Bull. 54, Fig. 9).

The original definition of Fearn Springs[15] stated that in the complete section the Fearn Springs formation lies disconformably on the lignite of the Betheden formation and is disconformably overlain by the grit-bearing arkosic (?) sand of the Ackerman formation. It contains ball-type clays, good stoneware clays, silty clays, silt, sand, lignite, and siderite. In the northern part of Mississippi siderite is highly developed in Tippah and Benton Counties. The stoneware clays are exposed in places in Tippah, Benton, Union, Pontotoc, Choctaw, Winston, and Lauderdale Counties and are probably present in the intervening ones. The sand, present chiefly in the base of the

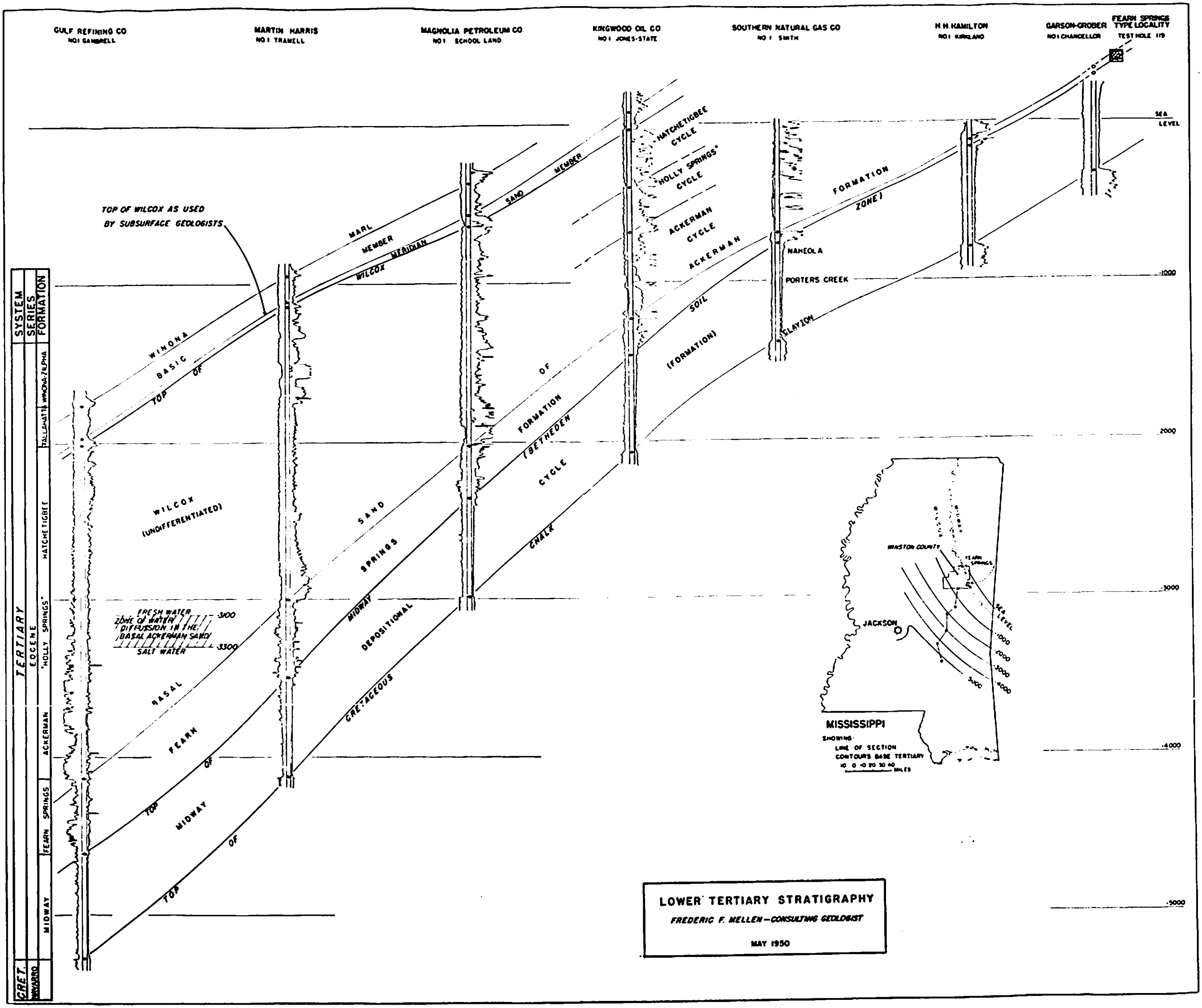

Figure 7.—Lower Tertiary stratigraphy.

formation, is normally fine-grained, less micaceous than the older Naheola, in places cross-bedded, and in places contains reworked or redeveloped pisolites (pseudopisolites); locally, however, the basal member contains coarse sand and small quartz pebbles. The thickness of the Fearn Springs formation in the outcrop ranges from a feather edge to more than 50 feet; in the subsurface it develops a thickness up to 600 feet or more. Its type locality is at Fearn Springs, Winston County, Mississippi (SE 1/4 of NE 1/4, Sec. 3, T. 13 N., R. 14 E.). This concept of Fearn Springs was followed in subsequent work of the Mississippi Geological Survey by Foster[16], Conant[17], [18], Vestal[19], and Priddy[20], all of which work, as well as the work preceding these county surveys, were under the direction and with the counsel of Dr. W. C. Morse and Prof. F. E. Vestal.

It is proposed that the section of Fearn Springs clays at Flat Rock Church (old Hurley School) be regarded as an alternate locality of the formation. This locality (near the center of Sec. 9, T. 5 S., R. 2 E.) in Benton County, is about 1/2 mile west of the Tippah County line. Here, the basal Ackerman gritty sand which caps the ridge, overlies the stoneware clays of the Fearn Springs formation, at the top of which is a fossil leaf-bearing ironstone. About 300 yards to the west Betheden kaolin is well exposed in a stream channel. A few hundred yards to the south of the church the silty micaceous gray clays of the Naheola member of the Midway are exposed. Conant reckons the thickness of Fearn Springs at this locality about 90 feet. In the Tippah County work Conant found it impracticable to auger the entire thickness of the Fearn Springs.

E. H. Rainwater recently called attention to existing confusion in the usage of Fearn Springs as a stratigraphic term in the subsurface of South Alabama and Western Florida. A review of its published usage since Fearn Springs formation[21] was introduced reveals that the misconception probably originated in a paper by Murray and Thomas[22] in which they presented a correlation chart showing the "Fearn Springs (sand) member" in the base of the "Wilcox group (undifferentiated)." The modified usages of the Fearn Springs and Betheden of F. Stearns MacNeil[23] probably endanger the validity of these two useful stratigraphic terms. Subsequent to the writer's surface work in Winston County, Mississippi, and elsewhere in these strata, extensive oil exploratory drilling has yielded samples and electrical logs which substantiate in large measure the conclusions reached in the Winston County report.

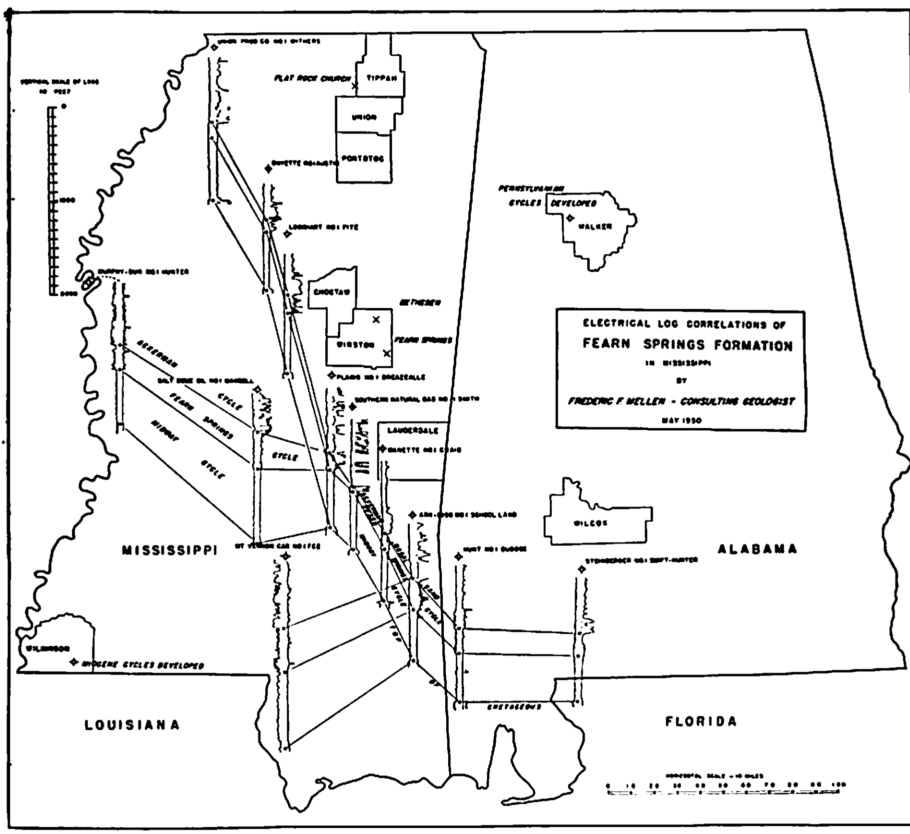

Figure 8.—Electrical log correlation of Fearn Springs formation.

The nomenclatural confusion has possibly resulted from attempted redefinition of Betheden to include channel and other water-laid deposits in addition to the residuum, and partly from probable local mis-correlation of basal Ackerman sand as Fearn Springs. A cursory examination of MacNeil's report and chart seems to give the impression that he is transposing Betheden for Fearn Springs and Fearn Springs for basal Ackerman sand. The Fearn Springs is dominantly argillaceous or silty, but his references to the Fearn Springs gives the impression that it is dominantly arenaceous: "The greatest thickness, about 100 feet, and very coarse throughout, was found in northern Lauderdale and southern Kemper Counties" (p. 19). It is not unlikely that the sand referred to is basal Ackerman. The writer has pointed out, as have other workers, that the Fearn Springs clays are locally overlapped or removed by channelling at the surface. However, MacNeil apparently intended to follow the original definitions for he stated: "The Fearn Springs formation of the Mississippi Geological Survey is recognized in this report as the basal member of the Wilcox formation in Mississippi."[24] "The Betheden formation, as used by the Mississippi Geological Survey is here adopted."[25]

MacNeil's action in reducing the entire Wilcox to the rank of formation in Mississippi (reducing Fearn Springs to rank of member) while retaining formational names and the rank of "group" for the Wilcox in Alabama is retrogressive and inconsistent. Certainly "Wilcox group—undifferentiated" would have served his purpose better. Though there is an intervening political boundary there is no justification in grouping the four Wilcox formations recognized by him in Alabama as one formation in Mississippi. The stratigraphic boundaries do not respect state boundaries. The criteria for subdivision in Alabama also exist, with modifications, in Mississippi. When once subdivisions have been established, it is certainly a step backwards to ignore their use.

The Fearn Springs as originally defined is a valuable formation in many ways. Its siderite and its anauxitic clays have been used for many years for paint pigment and for stoneware. Further development of these mineral substances, and perhaps lignite, might be expected in the future. The high ratio of shale to sand, and its marine character down-dip, suggest that it may yield oil or gas under proper conditions. As a fairly distinctive stratigraphic unit which can be locally zoned, it is commonly used by petroleum geologists as a stratigraphic guide in determining the position of fault planes in the oil and gas fields of southeastern Mississippi.

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The writer wishes to thank Mr. E. H. Rainwater of the Shell Oil Company, Dr. H. B. Stenzel of the Bureau of Economic Geology of Texas, Dr. R. R. Priddy of the Geology Department of Millsaps College, Dr. Glen F. Brown of the U. S. Geological Survey, and Mr. Frank Kokesh of Schlumberger Well Surveying Corporation, for many helpful suggestions which followed their readings of the manuscript. The writer is particularly thankful to Dr. F. T. Holden of the Carter Oil Company, and to Mr. Ellis Denning of the Continental Oil Company for technical suggestions and assistance during preparation of the manuscript.

It would be greatly amiss not to acknowledge with deep appreciation the earlier assistance and inspiration of Prof. F. E. Vestal under whom the writer received his first field experience, much of which was in the lower Wilcox and Midway areas of northern Mississippi; and of Dr. W. C. Morse under whom the writer received most of his classroom instruction in geology. Dr. Morse's demand for geological accuracy and precision throughout the years has had a great influence on the economic growth of Mississippi, and whatever of value that may develop from this or from other work that I have done is due in no small measure to his professional standards.

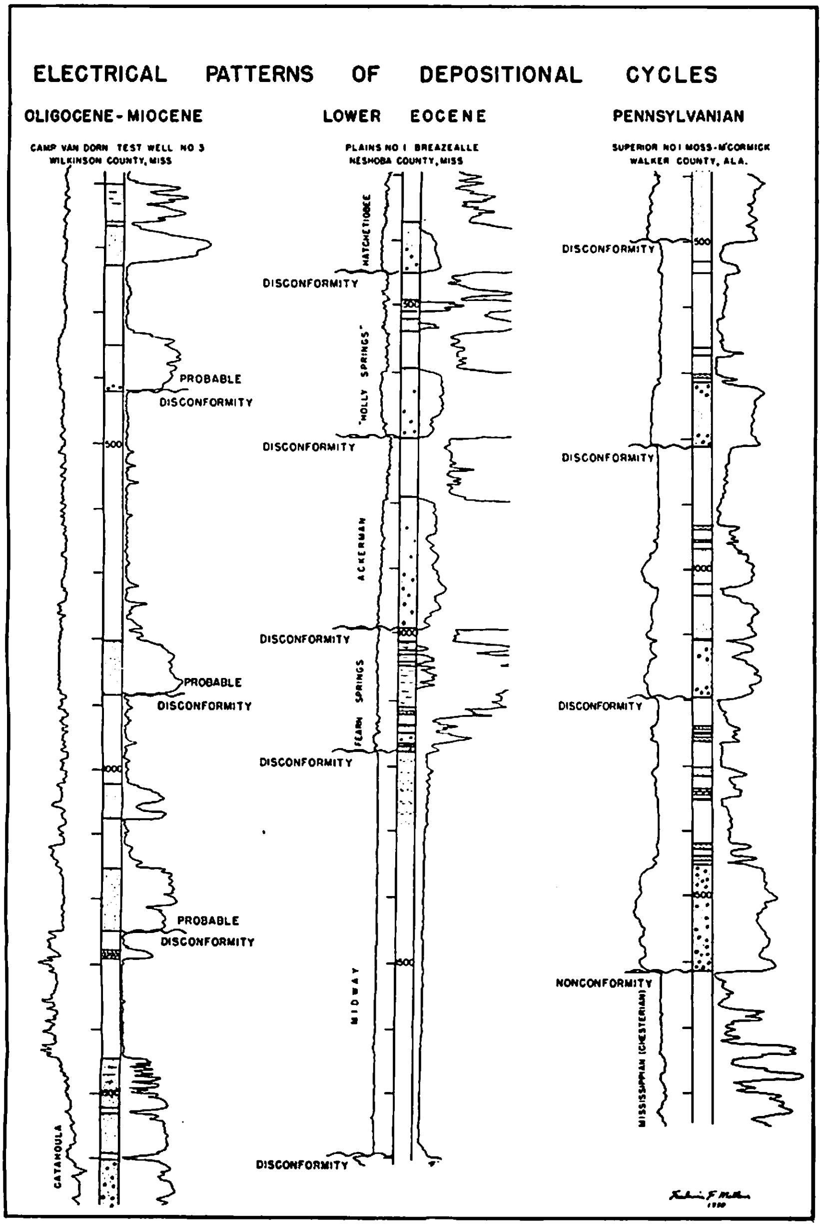

Figure 9.—Electrical patterns of depositional cycles.

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