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CIRCUMFERENTIAL FAULTING AROUND WELLS CREEK BASIN, HOUSTON AND STEWART COUNTIES, TENNESSEE — A MANUSCRIPT BY J. M. SAFFORD AND W. T. LANDER, CIRCA 1895

CHARLES W. WILSON, JR., AND RICHARD G. STEARNS
Vanderbilt University, Nashville, Tennessee

INTRODUCTION

Safford's first Biennial Report as State Geologist, which was presented to the Thirty-First General Assembly of Tennessee in December, 1855, was accompanied by a geological map of Tennessee. As this map did not show the structure around Wells Creek Basin between Erin and Cumberland City, it is assumed that Safford was unaware of the existence of this structure at that time. However, the structure was shown on the geologic map of Tennessee that accompanied his "Geology of Tennessee" published in 1869 and was described in the text (pp. 147-148, 220, and 257). A more detailed geologic map of the structure was presented in the corner of this geologic map. All that we can infer from this is that Safford became acquainted with the structure at some time between 1855 and 1869.

In 1874 Safford (with J. B. Killebrew) described the geology of the central portion of the Wells Creek structure. This central portion, which is about 2 miles in diameter, was then believed to be the entire structure (1874, pp. 761-762):

> A very interesting geological phenomenon occurs in this county, in the Wells' Creek basin. This is an area, nearly circular, containing six or seven square miles, and touching the Cumberland River. Wells' Creek runs through it, the rocks in the basin dip at a very great angle, and in some places are nearly vertical. There are evidences of a terrible subterranean convulsion at one time. To explain to the unscientific reader, we will premise that the crust of the earth consists of layers which were originally deposited or formed in regular order, one above the other. Sometimes there are lapses or failures of certain formations, but a lower formation is never seen superimposed on a higher one without showing signs of great disturbance. Now, to illustrate the peculiarity of the Wells' Creek basin, we will suppose that layers of flour dough, of different colors, are placed one above another, and that from beneath, the mass is forced up in the center, so as to form a cone. Now, suppose this cone to be cut off horizontally, and on a level with the surface of the undisturbed portion, the various colors of dough would be seen in concentric rings, the lowest layer on a level with the highest. This is precisely the case with Wells' Creek basin. The center of the basin has been elevated by subterranean forces, and the elevation or cone swept away by abrasion. The surrounding rocks belong to the silicious group of the lower carboniferous formation; the other formations—the Black Shale of the Devonian, the lower Helderberg, and the limestone of the upper Silurian; the Nashville and Trenton limestones, and lastly, the Knoxville limestones of the lower Silurian, all appear in regular succession until the center of the basin is reached. Walking across the valley, all the formations are passed over twice, except the lowest—the Knoxville.

Later, while a Professor at Vanderbilt University, Safford and W. T. Lander,[1] a Graduate Fellow and assistant in natural history and geology at Vanderbilt, mapped the structure in some detail. Their field work was begun by 1889 and continued until at least 1893—dates obtained from nine field notebooks used by both men. The notebook records show that their survey was at least partly supported by the U. S. Geological Survey. These notebooks were found in the storeroom of the Tennessee Division of Geology in about 1955. They have since been collated by Richard G. Stearns and Phyllis S. Marsh of Vanderbilt University.

During the course of this project the full size of the structure was first recognized. The culmination of their field work was the preparation of a manuscript, signed by Lander, and apparently edited by Safford. The manuscript was accompanied by a geologic map and cross sections, the style and workmanship of which suggest the work of Safford but also may have been drawn by Lander. The manuscript and drawings probably were stored in Washington where, during the years of World War II, they were discovered by Josiah Bridge of the U. S. Geological Survey, who forwarded them in about 1950 to Herman W. Ferguson, then State Geologist of Tennessee. Ferguson presented them to C. W. Wilson, Jr., who at that time was working on the manuscript for his report on the geology of the Indian Mound Eocene deposits and their relationship to the structure at Wells Creek (Wilson, 1953).

This long-lost manuscript with its map and drawings is probably the first detailed geologic report on a crypto-explosive (perhaps meteor impact) structure in the United States. As such, it should have been published many years ago, and we feel strongly that it is better that it be published late than never.

The Geology Department of Vanderbilt University is currently conducting an investigation of this same area with the support of the National Aeronautics and Space Administration (Grant NsG-465). The present writers are principal investigators for this project and wish to acknowledge the information already obtained by Safford and Lander, believing that modern scientists will be interested in this example of past field research.

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[1] William Tertius Lander received his Bachelor's degree from Wofford College, Spartanburg, S. C. At age 26 he went to Vanderbilt University for graduate work, where he was Graduate Fellow and Assistant in Natural History and Geology. He attended Vanderbilt during the school years of 1887-88 and 1888-89. From at least June 1889 until August 1890 he worked as Safford's assistant in studying the faulting of Wells Creek Basin. At the close of the field work on this project, Lander apparently wrote the manuscript that is the subject of this article. So far parently wrote the manuscript that is the subject of this article. So far
as is known he did not receive an advanced degree from Vanderbilt.

From 1890 to 1907 Lander was Vice President of Williamston Female College, Williamston, South Carolina. In 1910 he received the degree of Doctor of Medicine from the Medical College of South Carolina. He was engaged in the practice of medicine in Williamston from 1910 until his death in 1950.

We present the unchanged manuscript on the circumferential faulting around Wells Creek Basin by Safford and Lander. The manuscript is an "old time" field guidebook, reminiscent of the late 1800's. The author leads the reader, as a traveler, around the structure twice.

Nomenclature of the formations has changed considerably in the last 70 years. Changes in terminology are summarized in Fig. 1, which shows the rock column with their terminology on the right side in contrast with current terminology on the left side.

Because of more detailed recent investigations the geologic pattern is changed to some degree. Fig. 2 shows the fault pattern as presently understood.

Geography known to them in 1890, necessary for the modern reader to understand their comments, is shown on Fig. 3.

Manuscript on The Faults of the Well's Creek Basin

by

J. M. Safford and W. T. Lander

Formations [1]

The formations of the Well's Creek Basin are, in ascending order, (1) the Knox dolomite, (2) the Trenton limestone, (3) Franklin limestone, (4) Niagara limestone, (5) Lower Helderberg limestone, (6) Baker black shale, (7) Harpeth shale, (8) Erin burry limestone, (9) Arlington limestone, and (10) St. Louis limestone. The first five of these formations are confined to the central area of the Basin. The other five (6 to 10 inclusive) lie around and outside of this area and it is in the strata of these ouside ones that we find the greater, or at least the most striking, of the faults of the region. We call them for convenience the faulted formations, and it is to be noted that, excepting the Baker shale, they are all of lower carboniferous age.

Investigation and Main Fault Pattern

In the exploration and study of the faults, there is generally little difficulty in determining the formation to which the rocks belong. The tracing out of the lines of the faults, however, is no easy thing, and cannot always be done. The line is, as a rule, obscure or covered, and there are but few faults in which the hade can be seen with satisfaction.

Very early in the survey, we had found so many exposures of the Baker black shale on the rim of the Basin as virtually to make a continuous outcrop, evidently produced by the general Basin erosion. While trying accurately to locate this outcrop, our enquiries about black shale elicited information with regard to exposures other than we had expected. Far removed from this circle, we learned of exposures in Tan Trough Hollow, near Erin; in the Willson neighborhood, across the river from Cumberland City; and on Elk Creek. These reports we found to be true; and, at each of the last two places, we found two exposures of Baker shale more than a mile apart. On locating these exposures, on the map, it was suggested that they were likely produced by a roughly circular fault surrounding the Basin. As the work continued, many observations and facts appeared to favor this view. But faults were found which could not be placed in this circle; so that it became manifest that, if there were one circle of faults, there must be two other concentric circles also. On the map, the three circles proposed are indicated, no fault being laid down except such as were carefully located. The fault circles are longer North and South than East and West, the direction of the long diameter being about N.N.E. and S.S.W. The dimensions of the inner circle are about 5½ miles by 2¼ miles; of the middle circle, about 6½ miles by 5½ miles; of the outer circle about 7½ miles, by 6½ miles. From this it is seen that the space between the middle and the outer circle is very much less than that between the middle and the inner circle. Indeed, sometimes the former space will be found to be less than a hundred yards.

In defense of the proposition that there are three concentric circles of faults around the Basin, we not only offer a description of the faults found, but add that the position of most of them was predicted with satisfactory accuracy before they were visited; and furthermore, that no prediction as to the position of a fault was unverified, except in a few cases where no rocks were exposed to indicate the lay of the formations.

Inner Fault Circle

Taking first the inner circle let us begin at Cumberland City, taking up the individual faults in the order of the hands of a watch. At the ferry on the River, St. Louis rocks are seen well characterized. They are much disturbed, suggesting the proximity to a fault; and, on going down stream we find the St. Louis succeeded by clay and mud for two hundred yards until Harpeth is met. The disintegrating of this shale seems to have made this mud flat. The Arlington and the Erin, which otherwise would be in this space (supposing there were sufficient room for them), would hardly have weathered so extensively to clay; and at least the Erin, from its spongy, flintly fragments, would have made a soil readily distinguishable from a soil of any other origin. A fault may safely be placed just beyond the West end of the St. Louis rocks of the ferry.

From here the line of faults seems to have run up the valley West of Cumberland City Church. The distance up this valley is about 700 yards, S.35°E. The ridge on the right shows a great deal of Harpeth shale debris, from its top down on its West side; and, from a careful examination, it was concluded that the whole ridge was Harpeth shale. The ridge on the left shows St. Louis debris wherever any is to be seen; and, on the East side, was found a ledge of St. Louis rocks.

The next evidence of the fault is back of Mrs. Bishop's. Here, under the County road, red earth from the disintegrating Niagara attracts one's attention. Beyond, two hundred yards from the road, careful observation will show grey earth from the disintegrated Baker shale; sixty yards further up the valley, by the spring, several heavy chert ledges of the Harpeth shale

[1] Headings have been added by the present writers.

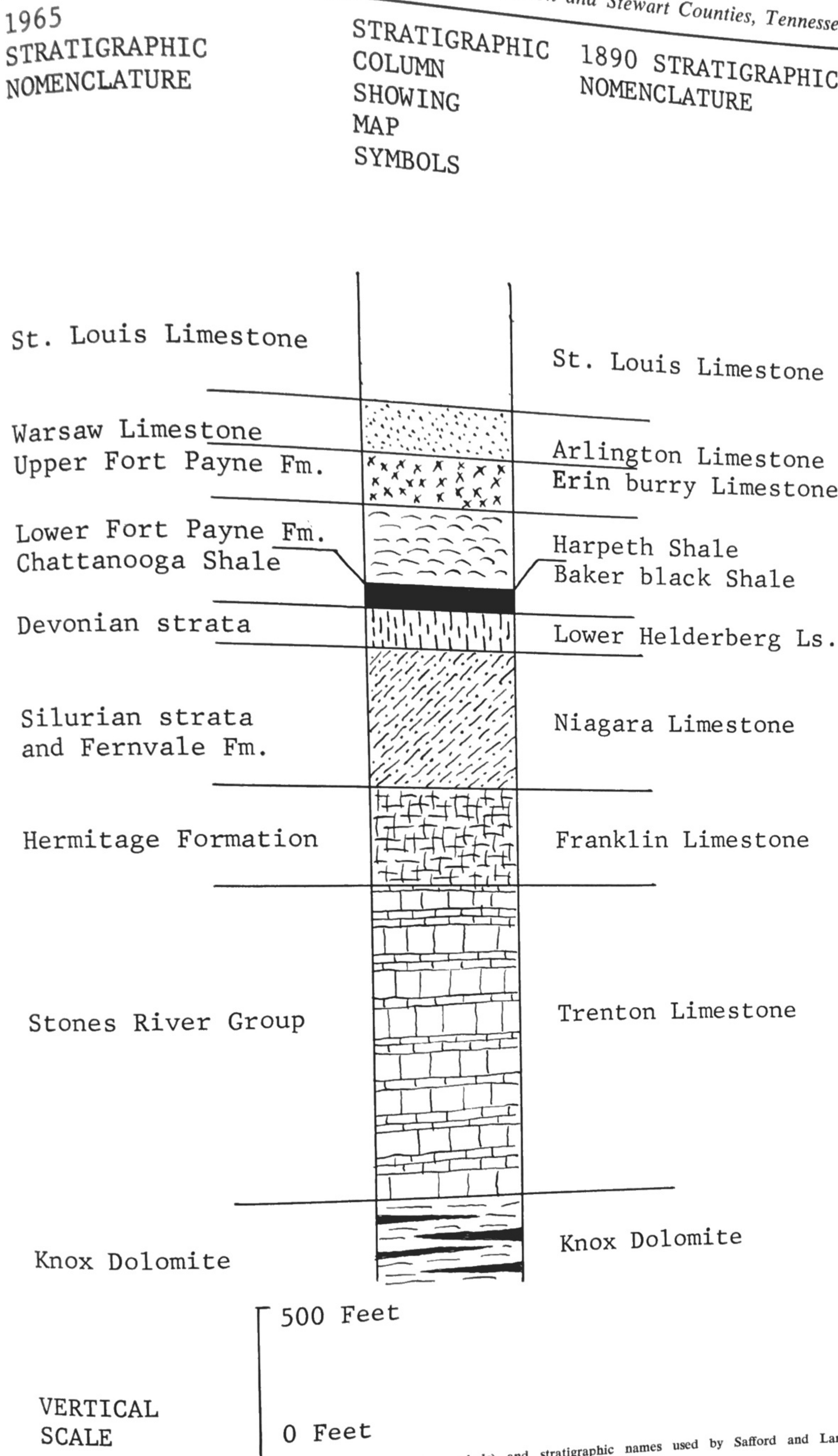

Fig. 1. Stratigraphic section showing lithologic column (with lithologic symbols) and stratigraphic names used by Safford and Lander, compared with names used in 1965.

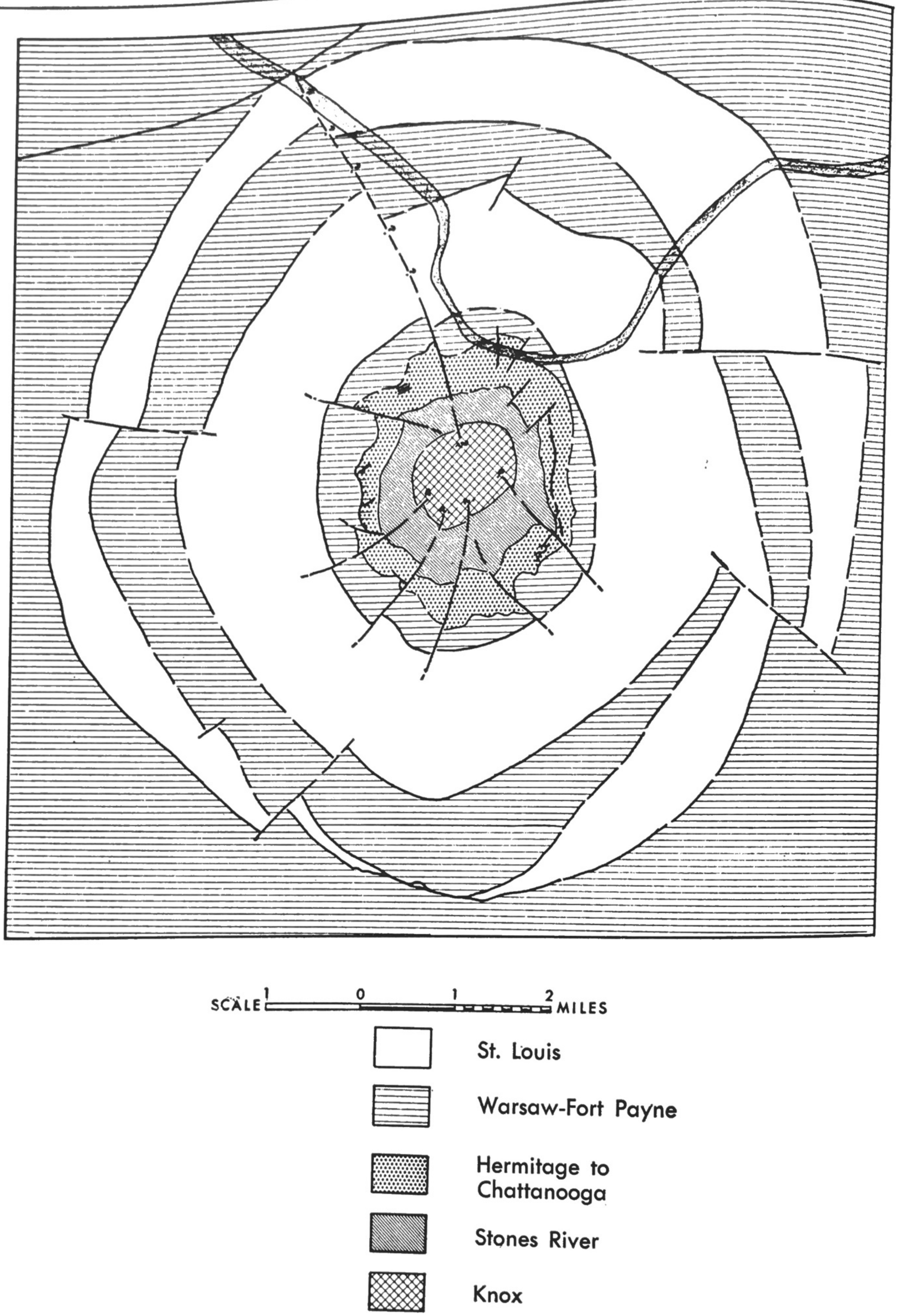

Fig. 2. Geologic map of Wells Creek Basin showing the fault pattern as presently understood (after Tiedemann, Marsh, and Stearns, 1965).

are to be found, with a dip of 80°. The normal dip would be about 25°. One hundred yards further, a side valley extends towards the North. The Harpeth shale seems to continue to this, while the ridge beyond, here and throughout its further length, gives evidence only of St. Louis. This side valley may therefore indicate the position of the fault line.

After an interval of 1½ miles we have the fault exposed to us in the lower part of West's Hollow. Here, after passing the Niagara marble, we leave the road going Easterly up the valley, and cross to the South side. Here we come upon a good exposure of Baker black shale dipping 15°, S.50°E. This is succeeded toward the East by Harpeth shale until, after two hundred yards, we meet a fault between the Harpeth and the Erin. The hade is about 45° Southeasterly.

Back of Mr. Bis. Lockhart's the fault seems to continue where the "well spring" is found in St. Louis 400 yards from the railroad. The strata here takes the form of an inverted canoe pointing Easterly, of which half can very well be seen.

At Widow Marable's and the Blue Spring, we next see the fault. To the North from the house extends a bluff of St. Louis rocks for several hundred yards. Just East of the house is found Harpeth shale, which continues for a mile along the Easterly road. Between these two formations, but covered entirely, is the continuation of the inner fault circle, which here has begun to bend very much toward the West. It continues to the East end of the Blue Spring exposure. At this end is St. Louis, which represents a continuation of the Marable St. Louis ridge. The St. Louis at the Blue Spring is only a small mass joined to the side of the hill; the fault dividing it, but not separating it, from the Baker shale and the Harpeth shale which here makes up the greater part of the hill. The line of fault is covered by debris from the easily decomposable shales.

By this time, the direction of the fault line has become almost due West; and so it continues 1½ miles to Borings, then it turns towards the North, penetrating the ridge along which the road runs; showing St. Louis on the inner or Eastern side, and Erin burry limestone on the outer or Western side. The fault passes very near the fine spring, if not through it; and the spring very likely depends upon this breaking of the strata for its outlet.

Continuing West of North, the line crosses Roy or Brigham's Branch, half a mile North of Dr. Brigham's. The fault lies across the valley West of North, where horizontal Erin was found to lie at a greater altitude than neighboring St. Louis, for the most part horizontal.

West of Byron Forge six hundred yards on the North side of the valley, lies the next fault of the line. On the inner or East side is the Erin, on the outer or West side is St. Louis. The dip of the Erin 18°, S.70°W., the dip of the St. Louis 23°, S.40°W. From a study of the rocks projecting through the earth covering of the hill, the strike of the fault is judged to be N.20°E.; and from the same, together with the view of the fault meagerly exposed at the base of the hill, the hade seems to be North Westerly about 25°.

Near the mouth of Plum Orchard Hollow, and on the South side, the fault again is shown. Here, as at Byron Forge, Erin is on the inner side, and St. Louis on the outer. The exposure of the rocks is not sufficient for the determination of more details with regard to the fault.

Four hundred yards above Well's Creek Bridge, is next to be seen a very good exposure of the fault. Here on the left bank is a bluff of sixty feet altitude from the mean water level. A dry valley cuts the bluff in two; and the fault is to be seen in either part. The more Southern of these faults we take up first. The Arlington limestone has become very thin, if it has not disappeared; and the St. Louis lies above Erin. Where the fault is best seen, the succession as we go up the hill is Erin, St. Louis, the fault, Erin. The strike of the fault, N.25°E., is but little different from the direction of the face of the bluff. A swell exposure of the line of junction between the faulted rocks gives a hade of 20°, S. 30°E. Crossing the dry valley we find that a similar arrangement of strata seems to exist, through here the fault line is not so easily made out. On account of the general Northerly dip, the Erin of the inside lies below the general surface; and the succession is St. Louis, fault, Erin. An interesting semi-arch, made specially of the outer Erin, makes up the North end of this bluff. Radiating cleavage planes are well shown.

The disturbance in the Devil's Face and Eyes is the next point of interest in the circle. This bluff consists of a low St. Louis arch of one hundred and fifty yards span, the axis of which lies in the direction of the faults. Beyond this, and separated by a mud flat, rises prominently two narrow St. Louis cliffs which project into the river. The first of these is full of chert layers, and shows a Northwesterly dip of 80°. Accordingly, this cliff seems to be a part of the just mentioned arch. The second cliff is very different in character and shows no stratification. The fault most likely lies between these two cliffs. From here by a natural course, the fault line returns to the starting place.

In six out of eleven of these individual faults, the inner side is seen to rise; in the remaining five, the inner side sinks. The great general rise shows that the sinking at these faults must be looked upon as local. The hade can be made out satisfactorily in one case where the inner side rises, and in two cases where it falls. It is interesting to notice that, in these three cases, the hade is normal.

Middle and Outer Fault Circles

The middle and the outer circle are best considered together. We begin 1½ miles E.N.E. of our starting point for the inner circle. This point is on the railroad, near the house of W. B. Lewis.

All the way from the ferry at Cumberland City, has been on St. Louis limestone, until after crossing Guice's Creek. Here we strike the Erin almost horizontal. The bed of the Creek may be recognized as indicating the position of the middle fault circle. For about three miles up its course, the bed of the creek approximates the position of this fault. The fault of the outer circle we did

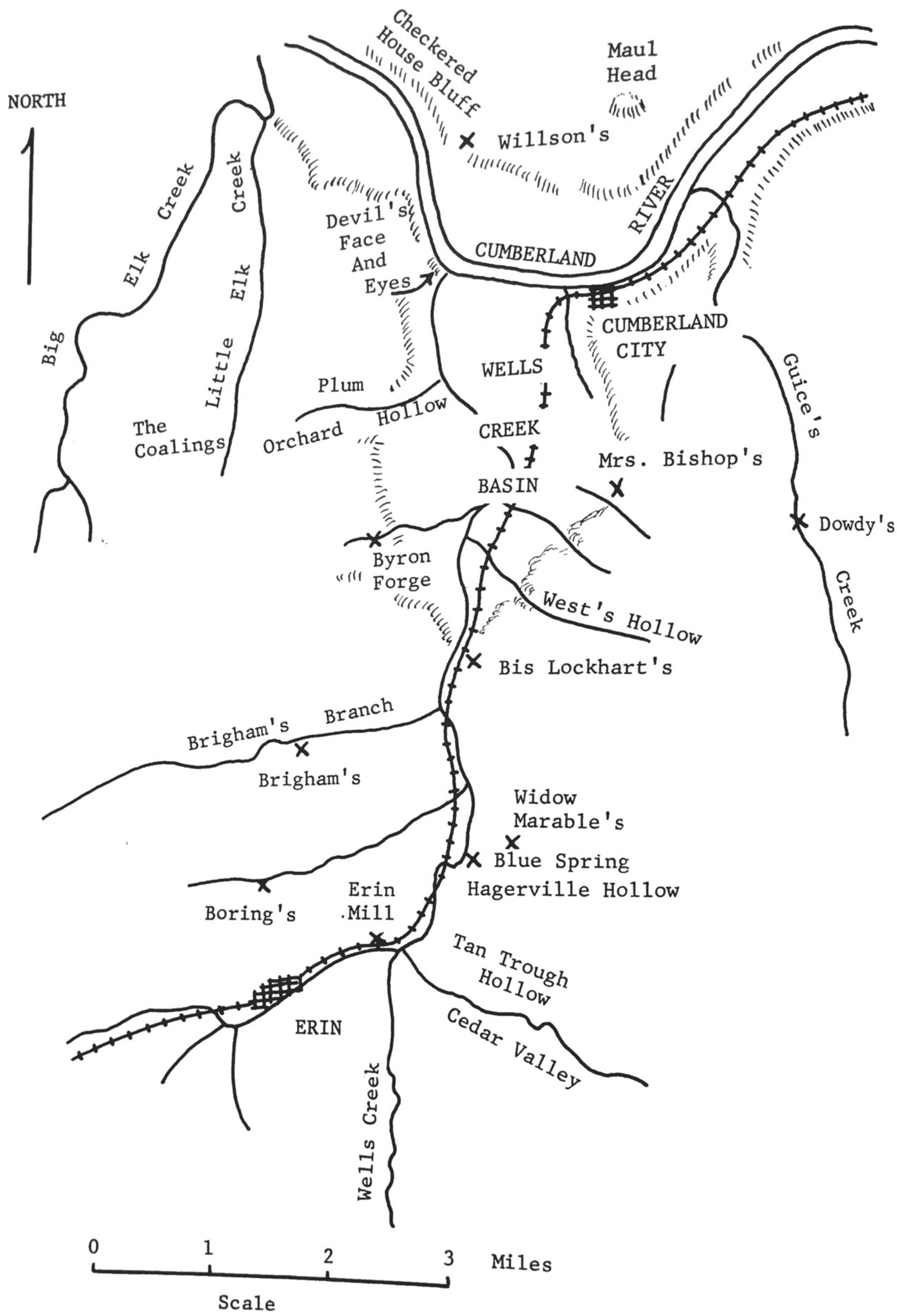

Fig. 3. Geographic map showing the location of features referred to by Safford and Lander.

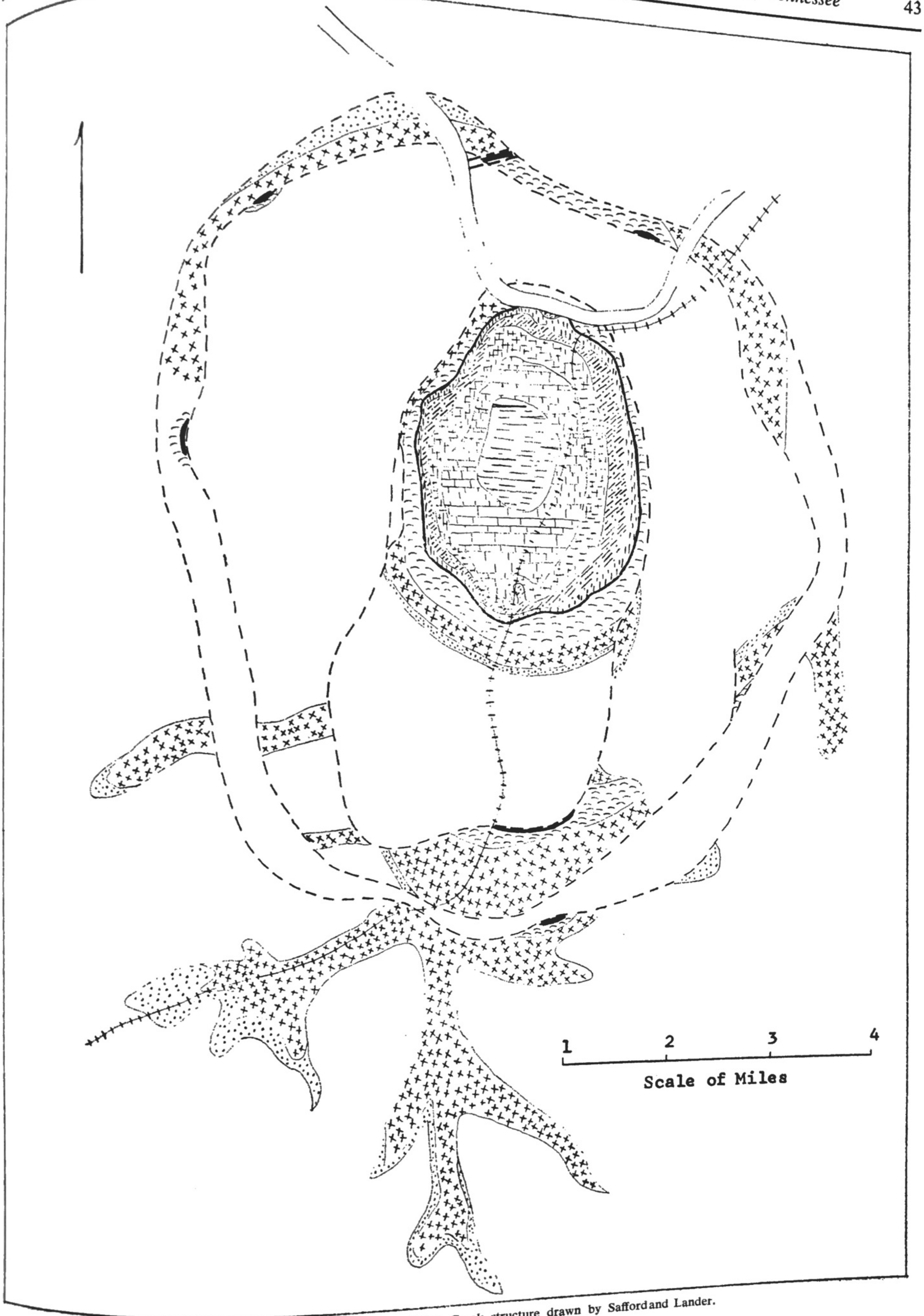

Fig. A. Geologic map of the Wells Creek structure drawn by Safford and Lander.

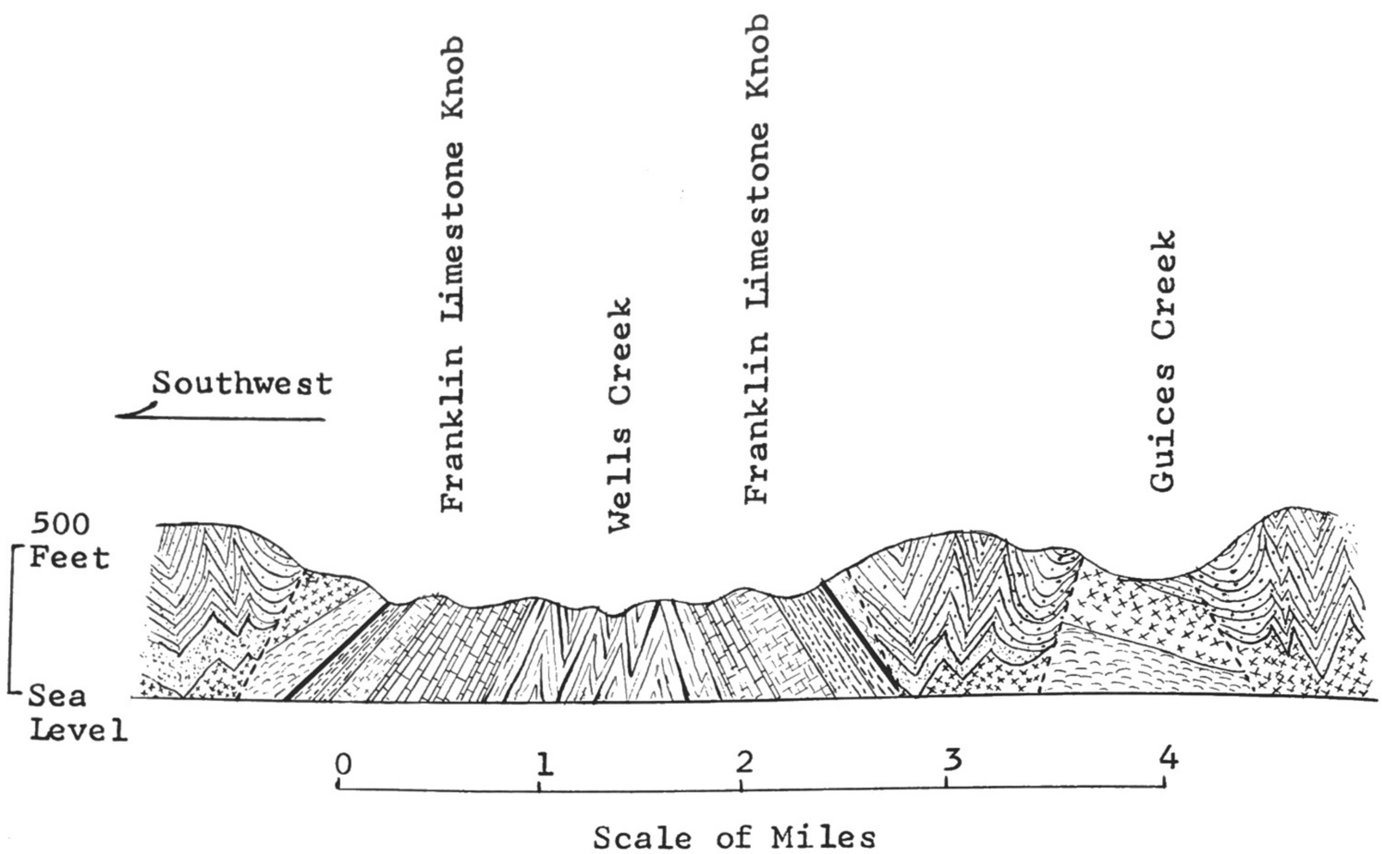

Fig. B. Section from beyond Byron to Guices Creek near PalmyraRoad.

not have opportunity of looking for along the railroad. We judge, however, that it is about ¾ mile further on, beyond which the St. Louis is found indefinitely.

On the Palmyra road we next meet the pair of faults. At the ford of Guice's Creek, we find St. Louis limestone. A few yards further, the Erin is found almost horizontal. The Erin belt is here about 1200 yards broad. The outside fault circle has St. Louis beyond.

From the Palmyra road, we continue up Guice's Creek by the settlement road that lies just to the East of the creek. Until we come to W. T. Dowdy's, we find in the road St. Louis rocks only; though in the first part of the way, we find good indication of the Erin just to the East. For a mile up the creek from Dowdy's, the formations are very interestingly disposed. Where the road crosses the creek, the valley is narrow; but it rapidly widens as we ascend; within a mile, becoming more than ¼ mile broad. The rocks are well displayed on either side. Beginning with St. Louis at the road, we meet with the Arlington and the Erin in quick succession. The general dip is towards the North; and, while varying, is generally considerable, becoming even as much as 45°. On the East side of the valley, the fault of the middle circle is met in ½ mile; on the West side it is nearly ¾ mile, before we find the same. The direction from the first exhibition to the second is S.S.W. Beyond this line of faults, lies the St. Louis. On the East side, the St. Louis shows an interesting arch, the axis of which lies in the general direction of the fault line. Continuing up the creek it requires ⅓ mile to pass through the St. Louis belt.

We then strike Erin burry limestone, which is almost horizontal from the first. The direction from one of these faults to the other is essentially the same as in the pair just mentioned. The West fault of this second pair is deserving of mention. We have been going along the base of an uninterrupted St. Louis bluff and have come to a considerable cross valley that brings it to an abrupt end. No Erin has yet been seen; and it is only on turning up this valley a few yards, that we meet it. Here the face of the St. Louis is plastered with some patches of Erin only a foot or two in thickness. The hade of the fault seems to be 15° S.E. There is, however, so little Erin left that this is not conclusive. This side valley continues in the direction of fault, and its formation may be associated with it.

Hagersville valley gives the next exhibition of this set of faults. In ascending this valley, after leaving Well's Creek five hundred yards, the Erin is found by the roadside, and continues for a full mile, the dip never being over 20° and generally nearly 0°. The middle fault occurs two hundred and fifty yards before coming to the Hagersville Spring. On the inside is the Erin about horizontal; on the outer side is the St. Louis, dipping 10° E.S.E. The hade may fairly well be made to be Easterly, 45°. Some of this St. Louis resembles the Arlington considerably, in its light color and in its metallic ring. It is truly St. Louis however. This

Arlington is oolitic. For 1250 yards Southeasterly up the valley St. Louis is found at frequent intervals. Its general dip is S.E., averaging about 30°. Suddenly the Arlington, well characterized, displaces it. The place of contact is covered, so that the elements of the fault cannot be obtained.

Tan Trough Hollow, which lies parallel to Cedar Valley and just North of it, is the next place of interest. Perhaps no part of the field is more interesting than this. This Hollow extends from Well's Creek in a general direction slightly South of East. It is irregular in width, but in no part is it wide. From it extend side valleys, specially on the North. Nothing of interest is to be seen in the North valleys. No rocks but Erin are found in them; and it is all horizontal, or nearly so. The two outer fault circles enter the valley about a mile from its mouth; and, continuing down the valley for 1000 yards, they cut through the ridge on the South, and emerge into Cedar valley at its lower end. A large part of the Tan Trough Hollow is accordingly made by the erosion of the belt between these two lines of fault. This erosion is so complete that the St. Louis remaining on the side of the valley could be carted away in a few hours. The bottom of the valley is covered, except at one place; where the St. Louis is seen.

At the Erin mill, we find the faults next. Near the middle of the railroad quadrant, on the North side, an angular cliff of Erin burry limestone serves as a reckoning point. This limestone continues toward Erin for one hundred and fifty yards, when it is suddenly displaced by the St. Louis. The line of fault is well seen here, and gives a hade of 30°, S.30°W. The St. Louis is exposed here for an altitude of 80 feet and is so abundant in Syringopora aulopora that we generally call it the Syringopora exposure. For four hundred yards the St. Louis continues until near the Erin mill fault. At the Erin mill, the rocks are in such confusion as is often to be found at a fault. The fault is a clear line between the Erin burry limestone on the outer side and upper Arlington on the inner. The exposure of the rocks at the fault is too nearly horizontal to allow the hade to be determined. The fault outcrop is N.84° W. This leads one to inspect a drain one hundred and twenty-five yards beyond. Going Northerly up this for eighty yards the crossing of the fault is found; the Erin lying on the outside, the St. Louis on the inside.

At the beginning of the railroad curve East of Erin, a narrow valley extends toward the North. Near the head of the left branch of this valley, the outer fault line crosses. For four hundred and seventy-five yards from the mouth, horizontal Erin is found almost continuously, but here it is displaced by the St. Louis. The valley dwindles out before the inner fault line is met.

The Erin hotel fault is next in order. Here too we have only the outer circle represented. Back of the hotel, the strata continues N.W. into an open valley. At a distance of seven hundred yards from the hotel the fault is met. The outer rocks are the Erin burry limestone about horizontal; the inner are St. Louis, considerably disturbed. The fault line cannot be seen, but its position can very accurately be judged. The St. Louis is exposed in a shallow wash where the dips indicate that the wash crosses the axis of an arch. The axis is directed N. E.—the direction of the fault line, and very likely coincides with the fault. The hade cannot very materially miss 30° N.W.

At Borings seems to be the middle fault corresponding to this last. The distance by the almost straight road is about ⅔ mile; but this is a diagonal line across the belt, which is here hardly ½ mile broad. At Borings, continuing toward the West from the fault of the first circle, there is Erin limestone for several hundred yards: after a vacant space St. Louis cherts are found in great abundance; making up a hill and extending to the bot-

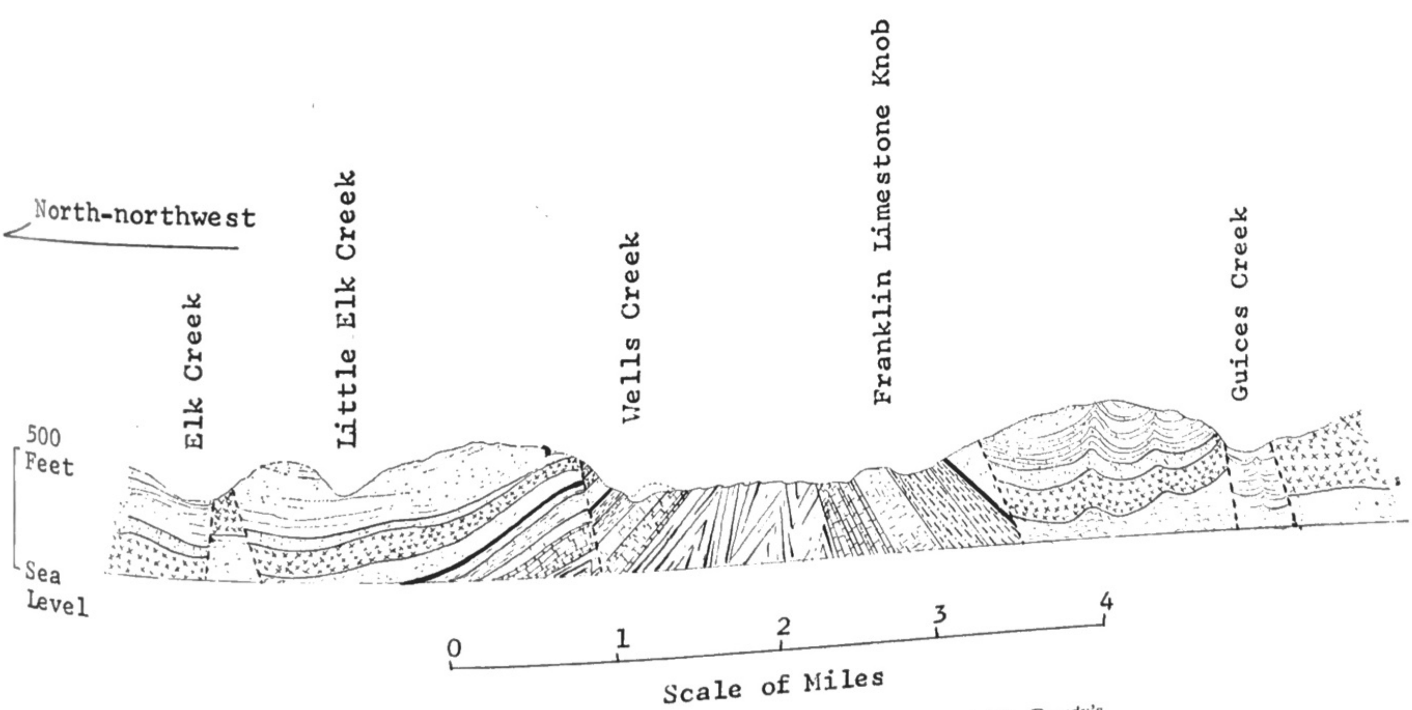

Fig. C. Section from Elk Creek near Weaks's to Guices Creek near Mr. Dowdy's.

tom of a fifteen foot well in the valley. No Erin debris is here to be found. The inner fault circle seems surely to pass here.

The Frazier neighborhood [locality unknown in 1965] is the next of interest. At the Cross Roads near Frazier's, the middle fault circle passes with Erin on the inside, the St. Louis on the outside. The hade was not satisfactorily made out in either case.

In the "coalings", 1¼ miles S.W. of Trinkles', is the next evidence of the faults. Here over a small area among the hills, Baker black shale is shown. The faults are not to be seen, though they are very surely East and West of the exposure.

On the road connecting the head waters of the branches of the Elk is the next evidence of the faults. For ¼ mile from the main branch, St. Louis is found. The outer fault then introduces horizontal Erin, which continues for ½ mile; after which, the middle fault brings in St. Louis.

The valley of Big Elk seems to be secant to both the outer circles; for following it down from the intersection of the road just mentioned these circles are each met twice. About ⅓ mile down, the outer fault separates the St. Louis on the outside from the Erin. About the same distance further, the inner fault introduces St. Louis. As the St. Louis approaches the fault, it dips increasingly toward the N. E. The hade of the fault is 15° E. After another interval of ⅓ mile, the middle fault cuts into the hill side, bringing up the Erin beyond. This Erin continues for nearly ½ mile; when the outer fault is met with, introducing St. Louis.

The Checkered House bluff, ending above and below in St. Louis is intersected by the inner and outer fault circles. The part of the bluff between the faults is Erin and Arlington. In the upper end of this bluff are two secondary faults; which are of importance, since they cross the fault belt and bring up Baker black shale and Harpeth shale to displace the Arlington and the Erin. This bluff ends in two slightly disconnected arches; and, though both arches are St. Louis, they are very different. The upper arch is of compact gray, crystalline limestone. The other has very steep flanks, with chert layers, inside of which is a mass of light colored limestone, much resembling the Arlington. The axis of these arches have the same direction, crossing the fault belt very obliquely as they go toward the N. E. The inner fault circle passes between these arches and the general bluff. The secondary fault passes on either side of the upper arch.

Back of this end of Checkered House bluff, a narrow valley extends seven hundred yards toward the N. E. On account of several exposures of the Baker black shale here, we have called this the Black Shale Valley. In this valley the fault belt is crossed by the secondary faults just referred to. The result is that after having the Baker black shale brought up, in the upper part of the valley, the fault belt becomes Harpeth shale, with St. Louis on either side. For seven hundred yards further, the fault circles are traced until they have passed Mr. W. G. Willson's house; the inner circle one hundred and fifty yards North of the house; the outer one a hundred and fifty yards further to the North. There is no change in the relation of the formations, except that, two hundred and fifty yards West of Mr. Willson's, a little Erin limestone is found; introduced apparently by a subsidiary fault, between the St. Louis and the Harpeth shale.

On Maul Head, one mile North of Cumberland City, Baker black shale is again found uplifted, and lies in the belt between the faults.

The bluff on North side of the Cumberland River Valley is St. Louis from the ferry for fifteen hundred yards, up stream when the middle fault brings up Erin. This Erin is found only at the top of the slope, and seems, from the debris below, to lie in place upon Harpeth shale. After two hundred yards more, the St. Louis is restored by the outer fault. The rocks of this bluff are much disturbed, and two minor faults are to be seen, beside evidence of the likely presence of two others. The uplift of Maul Head is continuous with the Erin with which we began.

Only four hades could be made out satisfactorily. All these were normal. The hade proposed at Mr. Dowdy's would give a perverse fault; but the evidence of this hade is not entirely satisfactory.

Interpretation and Conclusion

Representing the middle and outer fault circles by ellipses, which they approximate, we have the following diagram: [Fig. D.]

From this it is seen that the formations may naturally be divided by a line running approximately from Mr. Dowdy's to Mr. Frazier's, the line not being perpendicular to the axis of the ellipses but an angle of about 60°. This line constitutes an axis of oscillation. On the North of it, the formations on either side of the belt under consideration are the same, the more recent St. Louis, or its representative. South of this line, the corresponding formations are the older Erin, or its representative, Arlington. In the belt itself also is oscillation manifest. North of the line, Erin, or its representative, is found. South of the line, St. Louis is found. Accordingly, on the North there must have been a sinking, raising, sinking, of the strata: whereas, on the South, there was a raising, sinking, raising, of the strata.

It is apparent that the outer faults circles contributed very little net rise to the Well's Creek uplift.

Some other faults are to be met with in this region; but they lie almost altogether outside of the circles here laid down. These faults are to be noticed specially at Mr. W. G. Willson's and between Sailors Rest and Palmyra.

W. Tertius Lander

Critical Comments on the Manuscript

Having the luxury of 70 years of hindsight and 3 years of current investigation of this same structure, the present authors may perhaps be excused by the reader for having the temerity to venture to criticize research by J. M. Safford. We begin by stating that the geology set forth is amazingly accurate, as anyone familiar with Safford's work would readily believe.

The main addition that later work contributes is the

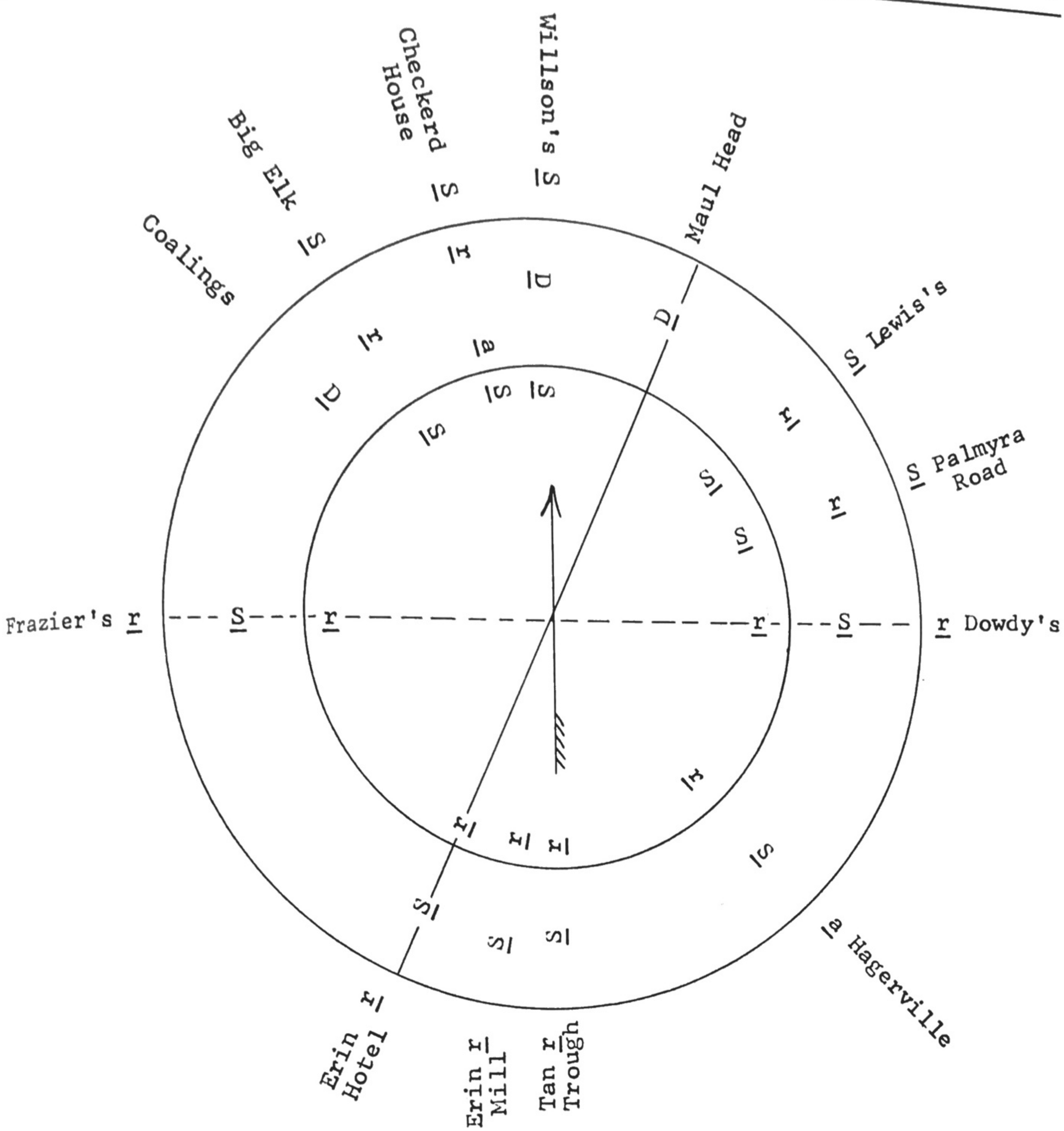

Fig. D. Diagram showing interpretation of the movement along the ring faults as drawn by Safford and Lander.

presence of another main fault around the structure. Figure 2 is a generalized geologic map which shows the fault pattern as presently known. Safford and Lander found three faults everywhere around the structure. Unfortunately, they did not find the same three faults all the way around. They did not find the outermost fault in the northern portion of the structure, along which very high St. Louis is faulted against uppermost Warsaw limestones; cherts weathering from these zones, though they are about 200 feet apart stratigraphically, are similar enough to make the fault difficult to see. In the southern part of the structure, they did not find the innermost fault, mainly because of unfavorable exposures.

They connected the three faults known to them (through areas of scant exposure on the east and west sides of the structure) in such a manner that each fault on the north side was connected with a fault of opposite vertical movement on the south side. This is the origin of their "oscillation" structure shown on Figure D.

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NEWS OF TENNESSEE SCIENCE

(Continued from Page 36)

Six of the health protection staff at AEC's Oak Ridge Operations, Research and Development Division, have recently received Group Superior Performance Citations and Awards from the Manager, Oak Ridge. These are Joseph A. Lenhard, Howard V. Heacker, Raymond L. Hervin, and William T. Thornton, health physicists, and nuclear safety specialists Wiley A. Johnson and William A. Pryor. The recipients are members of the Biology Branch of the Division, which has administrative responsibilities in the fields of biomedical research and in applied health physics, industrial hygiene, nuclear safety and occupational medicine.

The University of Tennessee is working with the U. S. Atomic Energy Commission's Oak Ridge National Laboratory to establish a new Graduate School of Biomedical Sciences in Oak Ridge, Tennessee. According to Dr. Herman E. Spivey, academic vice president of the University, the new school will perform four related functions: advance the frontiers of knowledge in the health-related sciences through basic biological research; educate college and university teachers of biology; educate prospective professors for medical colleges; prepare scientists for full-time careers of research in biomedical sciences.

The University's Board of Trustees has approved the opening of the new school, which was initiated by the Atomic Energy Commission and the National Institutes of Health. The school is scheduled to open in September 1966.

Dr. John W. Barrett, head of the forestry department at the University of Tennessee, has been elected as a member of the Council of the Society of American Foresters. The 11-man council is the governing body of the society. Dr. Barrett was elected for a two-year term for the period 1966-67. He has been a member of the 15,500 member society since 1937.

The Helene Fuld Health Foundation of Trenton, New Jersey, recently announced that $100,000 had been awarded to Vanderbilt University. The funds are being used toward the construction of the Vanderbilt University Student Health Center and Helene Fuld Clinic for Student Nurses. Construction of the building has begun and completion is expected by March 1967.

The Winfield Baird Foundation of New York City has pledged 4 percent of its assets to Vanderbilt University toward the construction of a new center for medical research. The grant has been added to an initial gift of $100,000 announced earlier by the foundation's president, David G. Baird.

The 17th Annual Fisk University Infrared Spectroscopy and Gas Chromatography Institute will be held at Fisk University, Nashville, Tennessee, 23 August - 2 September 1966, under the direction of Nelson Fuson, Ernest A. Jones and James R. Lawson. The Institute includes two infrared sessions and one gas chromatography session. The First or Basic Infrared Session and the Basic GC Session will run concurrently in order that those attending one of the sessions can audit certain general lectures of the other session if they wish. These two sessions are scheduled for Tuesday through Saturday, 23-27 August 1966.

The Second Infrared Session, Monday through Friday, 29 August - 2 September 1966, gives a concentrated training in the interpretation of infrared spectra of a wide range of compounds, and an insight into the latest developments, techniques and applications of infrared spectroscopy. The First Infrared Session and the Gas Chromatography Session are limited to 50 persons each, the Second Infrared Session to 60 persons. The Institute registration fee is $10.00; the tuition fee for each session is $150.00.

The most recent commercial infrared spectrophotometers and gas chromatographs, as well as GC and IR accessories, will be exhibited at all these sessions. These instruments will be available for use by Institute participants during the afternoon laboratory programs under the guidance of the Institute faculty instrument company engineers.

For further information write the Director, Fisk Infrared Institute, Box 8, Fisk University, Nashville, Tennessee, 37203.

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