ACKER LAKE LANDSLIDE, MONROE COUNTY, MISSISSIPPI

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INFORMATION SERIES MGS-73-1

MISSISSIPPI GEOLOGICAL, ECONOMIC AND
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WILLIAM HALSELL MOORE
Director and State Geologist
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ACKNOWLEDGEMENTS

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While appreciation is expressed to each of these agencies and departments, the interpretation of data as presented in this report is the sole responsibility of the authors.

INTRODUCTION

Mass wasting in the Tombigbee Sand Member of the Eutaw Formation (Upper Cretaceous) is not an uncommon occurrence on steep bluffs developed on this unit in northeastern Mississippi. Reported, although unsubstantiated, landslides in this unit have occurred along the west wall of the Tombigbee River in Monroe County, Mississippi, in 1918, 1921, and 1926. Slide scars along the valley wall of Tombigbee River north of Aberdeen (Fig. 1) attest to the importance of mass wasting as a gradational process in the area.

At the time of this study the most recent documented slide occurred on Monday, April 27, 1970, in the vicinity of the small man-made Acker Lake, approximately five miles (8 kilometers) north of Aberdeen. Although no one appears to have observed the slide at the moment of its occurrence, the movement seems to have been sudden and accompanied by a loud noise. Workmen in the area have helped to fix the time of movement as late morning or early afternoon. There was at least one report of a noise that "sounded like someone was dynamiting fish in the river."

Through the courtesy of land owners in the area, and especially that of Mr. Bobby Smith of Smith Implement Co., Mr. Dave Houston, Attorney for Acker Lake Club, and Mr. Travis Robinson, Farm Manager of First American Farms, the authors have been able to study the slide and the surrounding area since April 1970. This report is a description of the slide and an interpretation by the authors of the factors involved in its development.

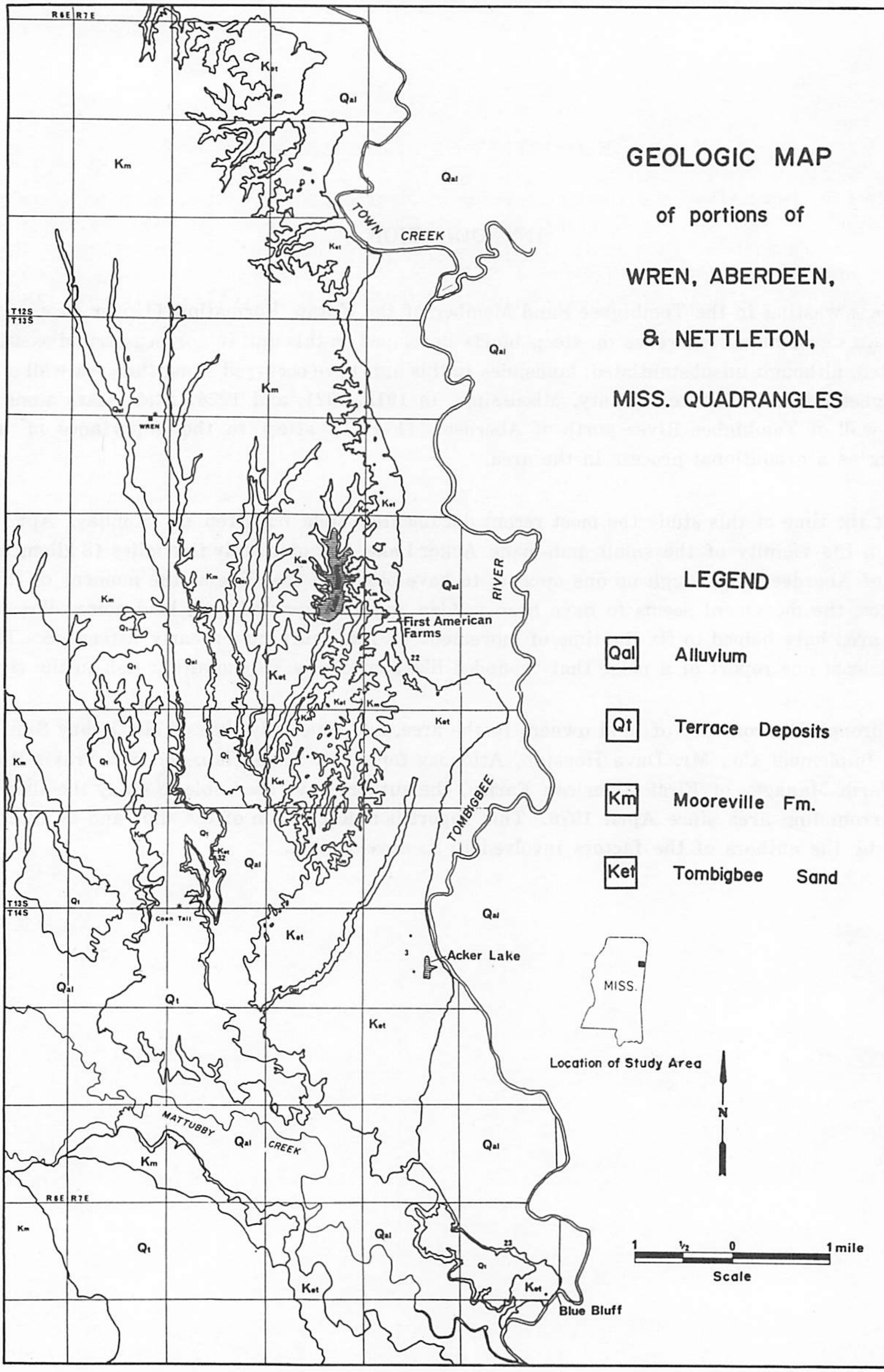

Fig. 1. Geologic map of a portion of Monroe County, Mississippi, showing location of Acker Lake.

DESCRIPTION OF SLIDE AREA

Most of the bluffs of the Tombigbee River in Monroe County tend to migrate laterally by the slumping of relatively small blocks, which are quickly eroded by the river leaving a steep freshly-exposed surface. Blue Bluff (Sec. 23, 14 S., R. 7 E.) is an excellent example. In the vicinity of Acker Lake (Sec. 3, T. 14 S., R. 7 E.) factors that normally contribute to slumping are present, and old slump features are common in the slopes below the bluff. However, the 1970 slide exhibits features not found in most other bluffs along the river, suggesting that addition al factors that affect slumping are present.

An aerial photograph of the slide area and a map of the major slump features are shown in Figures 2 and 3. The difference in elevation between Acker Lake and the Tombigbee River is about 90 feet (27.4 meters). The old surface adjacent to the bluffs, an old stream divide, rises approximately 15 feet (4.6 m.) between the two swampy areas at the ends of the lake. The inner edge of the slump is slightly more than 1,000 feet (304.8 m.) long and lies between 150 and 400 feet (45.7 and 121.9 m.) from the edge of the river. A striking feature, as observed in aerial view, is the close correspondence between the ends of the inner edge of the slump and the two arms of the lake. Graben-like features are located at both points (Fig. 2 and Fig. 3). The grabens, created by the April 27 movement, exhibit the unusual aspects of slumping for this area.

The northern graben area lies between a newly exposed bluff face and a long, thin block which was the edge of the bluff prior to the 1970 slide. The graben is about 600 feet (182.9 m.) long and is about 90 feet (27.4 m.) across at its widest point. Within the graben, blocks of Tombigbee Sand, most still preserving the old surface on their tops, dropped downward as much as 30 feet (9.1 m.) (Fig. 4). The prominent outer block bounding the graben is about 300 feet long and 30 feet across (91.4 x 9.1 m.) at its widest point, and its surface is nearly the same elevation as the bluff face side of the graben.

The southern graben is smaller, approximately 350 feet by 80 feet (106.7 x 24.4 m), but exhibits many of the features observed in the northern graben. There is no continuous outer block in the southern graben like the prominent block in the northern graben. There are, however, several smaller blocks that have separated from the bluff face (Figs. 5 and 6). In each graben the suddenness of slumping left trees and underbrush in a tangled mass not unlike that resulting from tornadic winds (Fig. 7).

Between the graben areas and the river are several features common to slide areas, so that an irregular, hummocky topography has resulted. This area includes small scaps, fractures, and pressure ridges that have developed, at least in part, during movements previous to the 1970 slide. Along the toe of the slide, near the present channel of the river, are banks of sand and blocks of silty, sandy clay (Fig. 8).

The slide is still active in several areas. In April 1972 small fractures, with separations amounting to approximately one inch (2.54 cm.), were observed parallel to the river bank above the south toe of the slide approximately 150 feet (45.7 m.) from the river and about 15 feet (4.6 m.) above normal water level. These fractures extended over a lateral area of approximately 40 feet (12.2 m.) and may reflect movement in the toe material.

During the preliminary investigation of the slump in 1970, the northern graben was mapped in detail by plane table. Continued checks, as late as March 30, 1973, do not indicate additional lateral movement in the northern graben. The heavy rains of mid-March 1973 have brought on adjustments in both the northern graben and the southern graben. The northern graben has been enlarged principally by erosion of the bluff face by water from swollen Acker Lake pouring

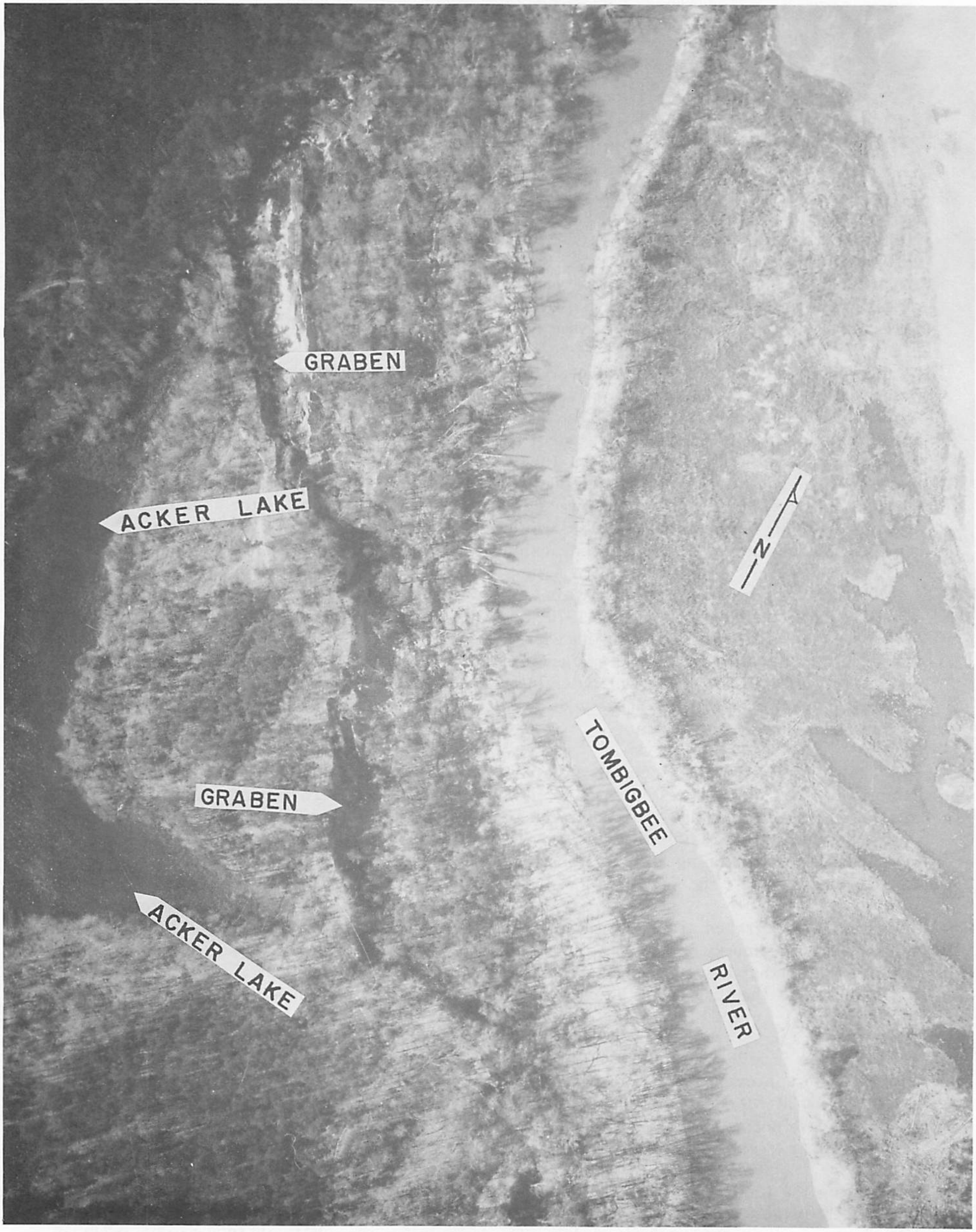

Fig. 2. Vertical aerial photograph of Acker Lake Landslide, April 1972. Courtesy Mississippi Air National Guard, Meridian, Mississippi.

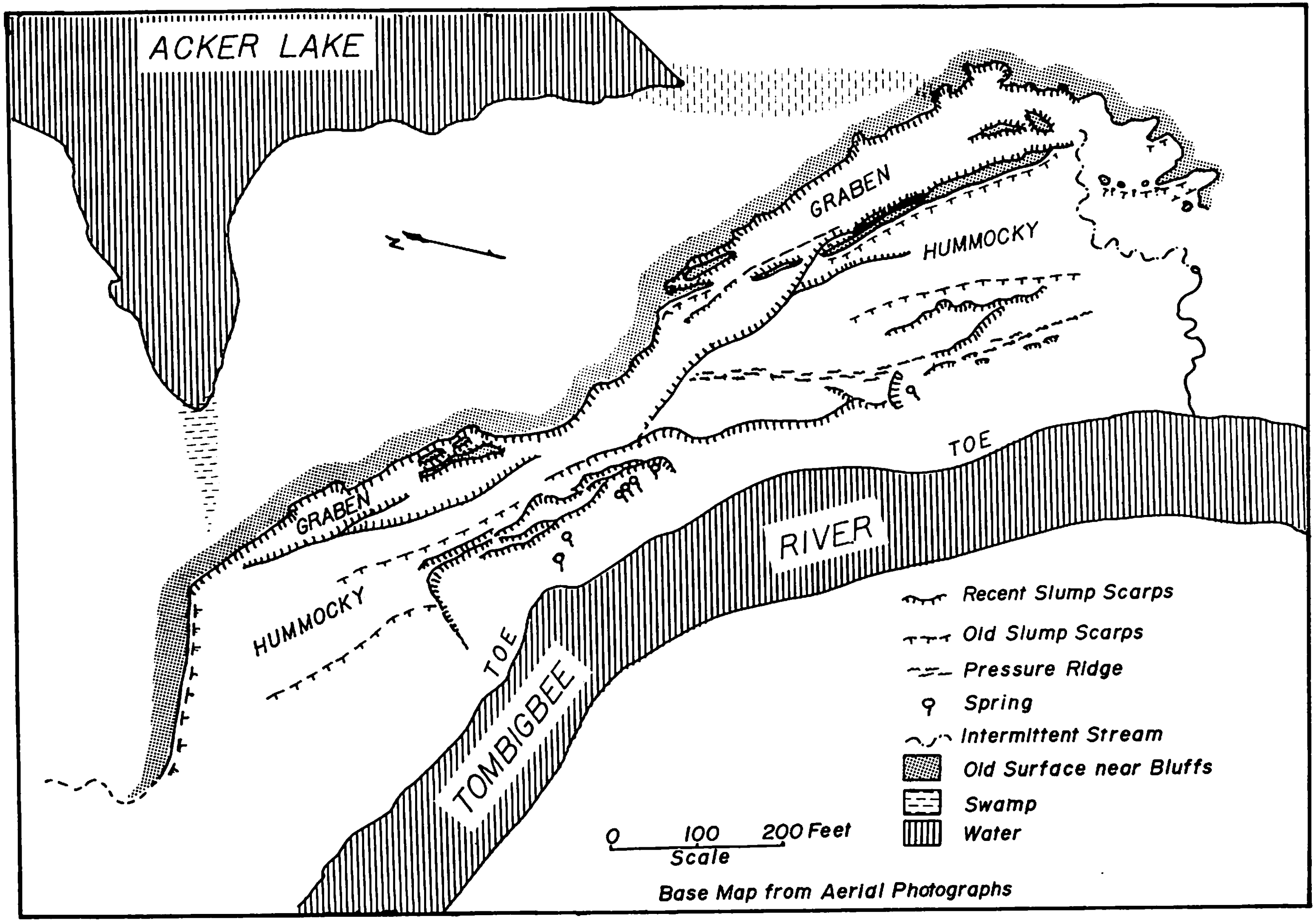

Fig. 3. Map of Acker Lake area showing major slump features.

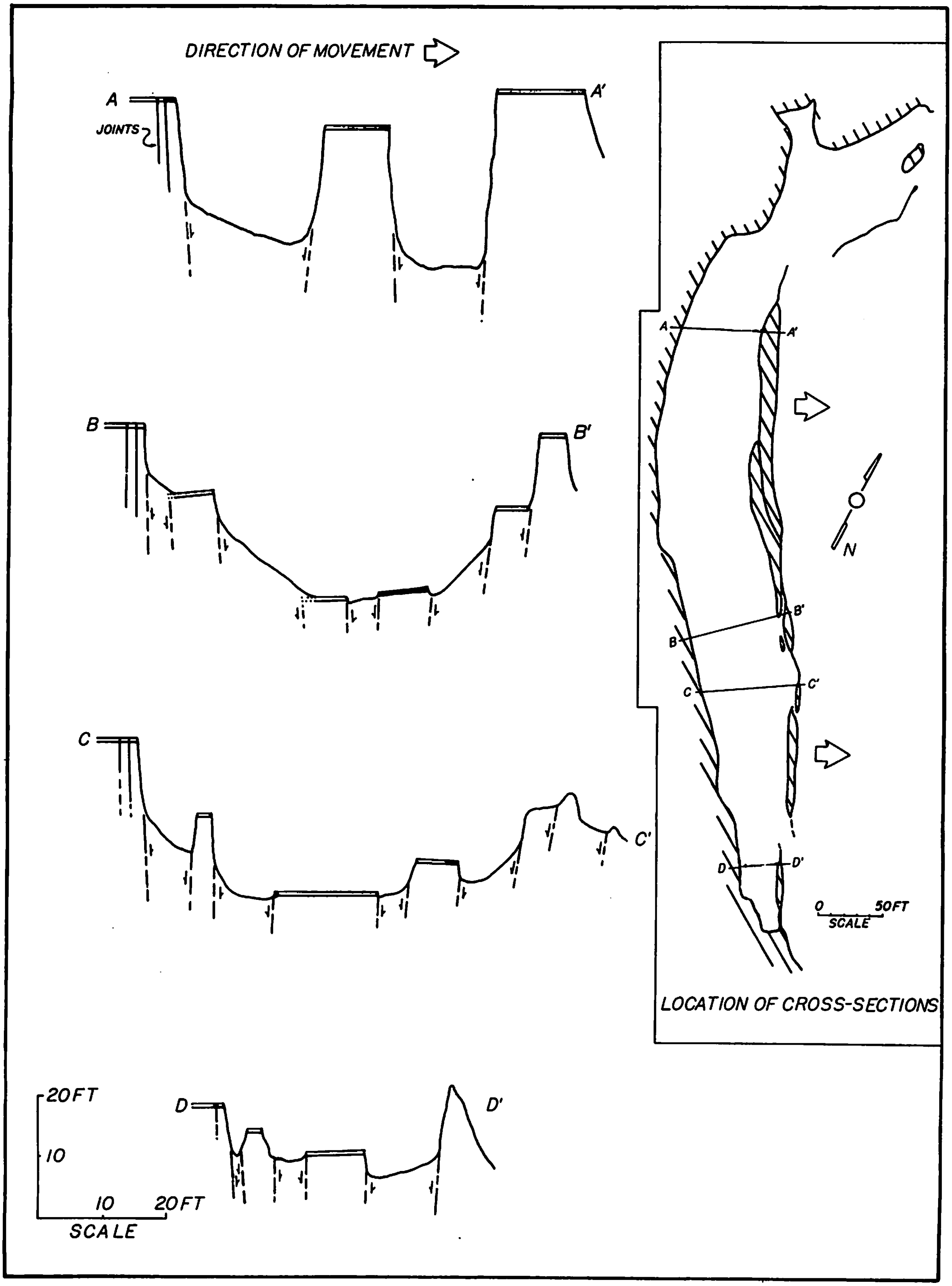

Fig. 4. Diagrammatic cross section showing surface profiles and major fractures in the northern graben area.

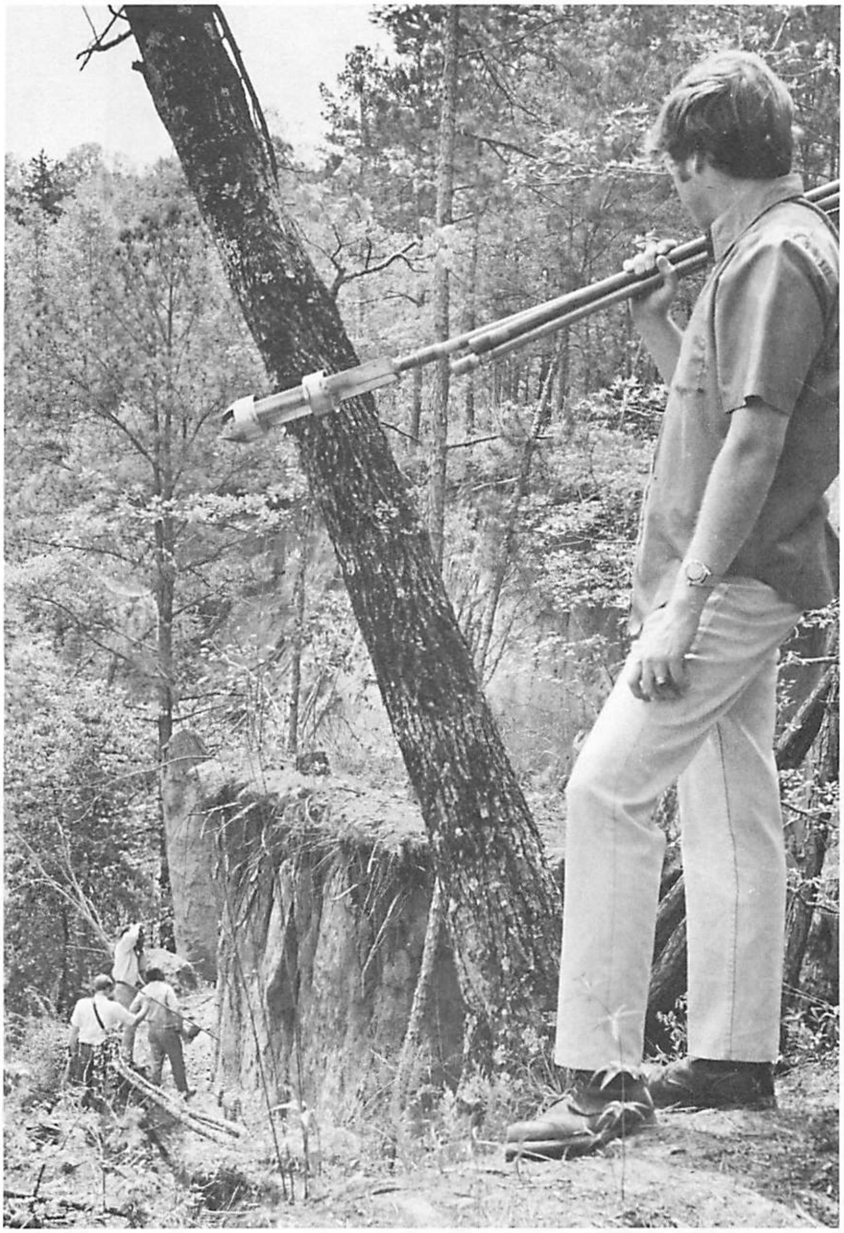

Fig. 5. Looking south along the bluff face of southern graben area. Mississippi State University photograph by Ronald Gunter.

Fig. 6. Blocks of jointed Tombigbee Sand in southern graben area.

Fig. 7. Looking north in northern graben area. Mississippi State University photograph by Ronald Gunter.

Fig. 8. Clay blocks along lower portion of toe of slide.

into the graben. The prominent outer block bounding the graben shows little if any effect from the heavy rains. Some of the isolated blocks of Tombigbee Sand in the southern graben have been reduced in size and the bluff face has migrated lakeward by a few feet. The Tombigbee River, still in flood stage in late March 1973, has probably moved material from the toe of the slide, and additional adjustments should be expected.

STRATIGRAPHY OF TOMBIGBEE SAND

The bluffs from north to south along the west wall of the Tombigbee River in Monroe County are developed progressively on the upper, middle, and lower parts of the Tombigbee Sand Member of the Eutaw Formation (Upper Cretaceous). Differences in lithology of these three divisions of the Tombigbee appear to have an effect on the type of bluff that forms where streams are actively cutting into the units.

Although a complete stratigraphic section of the Tombigbee Sand is not exposed in the county, gullies east of Lake Monroe at First American Farms and bluffs near Acker Lake and at Blue Bluff provide sufficient overlap to construct a composite stratigraphic section. Exposures in these areas, supplemented by test holes drilled near the bluffs and by electrical and gamma ray logs from test holes and from water wells in the area, permit the following description.

The characteristic lithology of the Tombigbee Sand is fine- to very fine-grained, glauconitic, micaceous sand, which in places contains large amounts of silt and clay. The sands are compact and massive and are generally coherent, depending on the silt and clay content. Many of the coherent beds are capable of fracturing and the independent blocks can maintain their integrity. Locally, the presence of calcium carbonate may produce indurated masses and beds.

The upper 80 feet (24.4 m.) of the Tombigbee Sand consists of 10-15 feet (3-4.6 m.) of calcareous, fossiliferous sand at the top, underlain by approximately 65 feet (19.8 m.) of noncalcareous glauconitic sand. In the interval below the upper 80 feet (24.4 m.) the sands are similar to those above but several significant clay beds are present. The thickness and stratigraphic positions of these clay beds is somewhat variable, but they can be correlated locally. None of the thicker beds was seen on the outcrop; however, blocks of clay were found in the slide area at Acker Lake (Fig. 8). Lignites associated with the clays become more common near the base of the interval.

The lower 30 feet (9.1 m.) of the Tombigbee Sand consists of calcareous, fossiliferous sand, and is exposed at the surface on Blue Bluff. Within this interval there are concretionary masses cemented by calcium carbonate. Shell material was noted in all test holes drilled through this interval. Beneath the calcareous zone is a coarser-grained, more permeable sand that ranges in thickness from 15-30 feet (4.6-9.1 m.). For mapping purposes, this sand was chosen as the base of the Tombigbee Sand. In places this sand is underlain by a clay bed that is from a few feet to as much as 15 feet thick (4.6 m.).

SIGNIFICANT PROPERTIES OF TOMBIGBEE SAND

Included on Figure 9 are the coefficients of permeability that were determined from Tombigbee Sand samples collected at the outcrop. Wasson and others (1965) reported that the average permeability of sand in the Eutaw Formation is about 100 gallons per day per square foot (meinzer units), but that the Tombigbee Sand Member is probably less permeable than the lower part of the Eutaw. The permeability values obtained in this study range from less than one to as much as 51.6 meinzers, which agree in magnitude with the findings of Wasson and others. It is well known that small samples used to determine permeability may yield unreliable results and that anomalous values should be expected. In most samples the permeability in the horizontal direction was greater than that in the vertical direction. Anomalous values could generally be attributed to features such as fractures, clay fragments, undetected root structures, and borings. These features that tend to increase permeability are common near the tops of bluffs. Joints are of particular importance, and are numerous at Acker Lake bluff (Fig. 10). Roots up to half inch in diameter were noted in joints.

The permeability of most of the Tombigbee Sand is low, on the order of 10 meinzers, based on the values that are considered to be fairly reliable. However, the higher values indicate that some beds are more permeable. In many of the auger holes it was found that thin permeable beds transmit water freely, but the adjacent beds yield no observable amounts of water.

Porosity values calculated for all samples were high (averaging about 40 per cent), as would be expected in fine-grained sediments. All samples show a high degree of water retention.

INFLUENCE OF SURFICIAL MATERIALS

One of the important factors in water movement in this area is the presence of extensive accumulations of alluvium and terrace deposits. Old alluvium floors the main valley in which Acker Lake lies. It is several feet thick in the vicinity where the lake drains, at high water stages, into the northern graben. It thins to a feather edge towards the valley walls. The basal few inches consists of coarse sand and a few scattered chert pebbles that grade upward into yellowish-orange clayey, silty, very fine-grained sand very similar to weathered Tombigbee Sand.

Alluvium in the valleys that form the two arms of the lake is saturated with water from Acker Lake to within a few inches of the surface depending upon the level of the lake. In high water stages the alluvium may be inundated so that water pours from the lake into the northern graben.

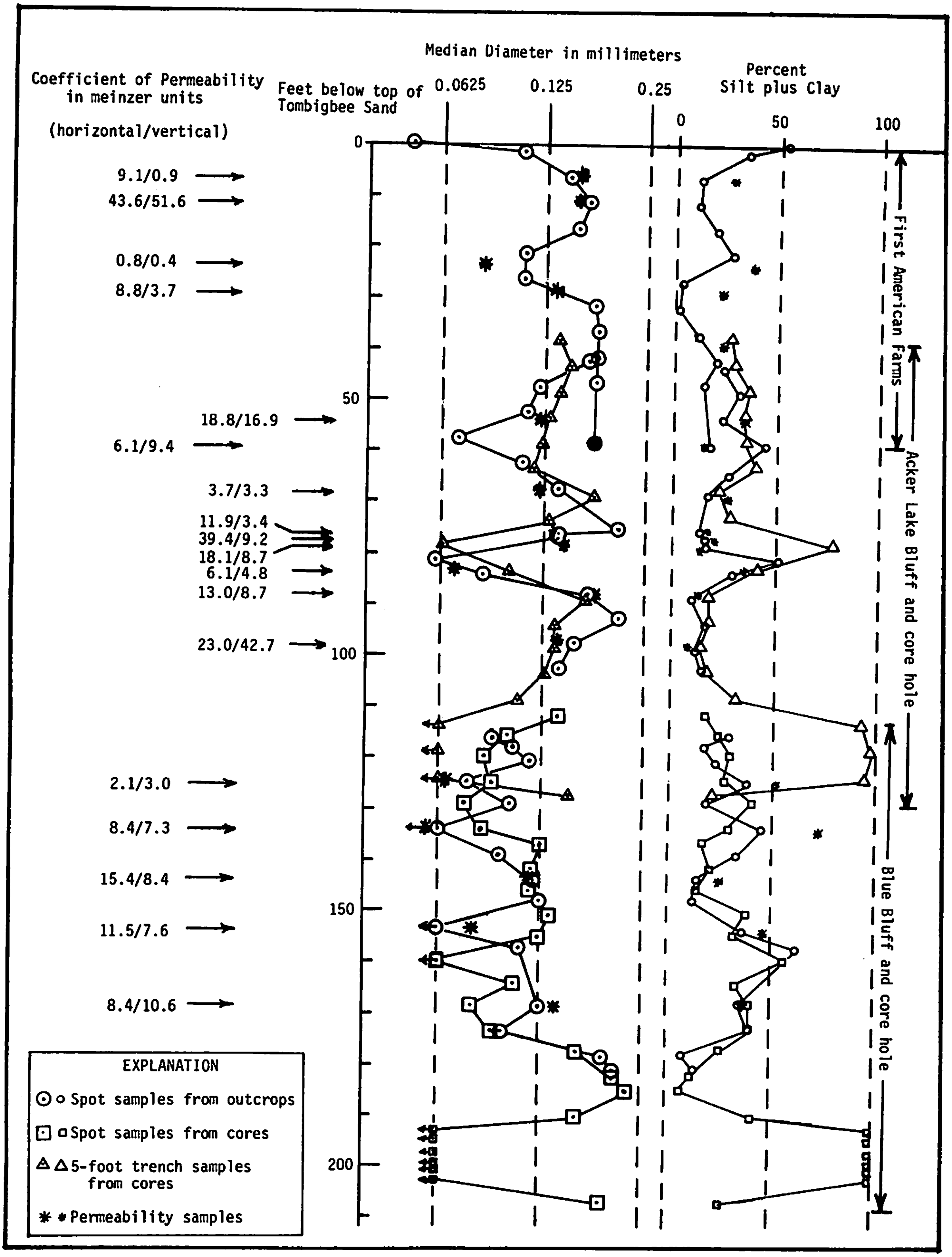

Fig. 9. Diagram showing value of sedimentary parameters and their projected positions on the composite stratigraphic section of the Tombigbee Sand.

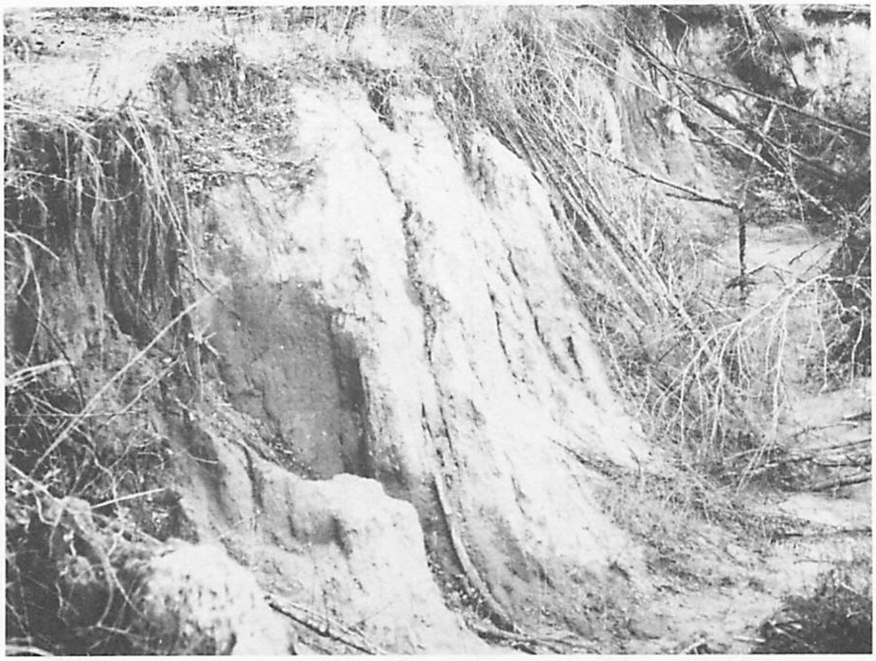

Fig. 10. Joints in Tombigbee Sand along inner scarp of northern graben.

ANALYSIS OF SLIDE

During the preliminary investigation of the slide in 1970, the hypothesis was advanced that perhaps water from Acker Lake had seeped into the Tombigbee Sand and had created a "sand run", which in turn caused a collapse forming the two grabens. However, no evidence was found to support this hypothesis. In fact, measurements on the old surface of the blocks in the northern graben indicated that the width of the graben is greater than could be accounted for by the down-dropped blocks. This would not be the case if the graben were a simple collapse feature.

To account for the discrepancies between the area of the old surfaces and the present area of the northern graben, the outer block would have to move as much as 40 feet (12.2 m.) toward the river. Slides of this type are well known in localities underlain by weak clay beds along which blocks may glide. The similarity of the Acker Lake slide to one in western Tennessee was brought to the attention of the authors by Dr. Richard G. Stearns of Vanderbilt University. In the Tennessee slide, however, a very thick clay bed was involved which was squeezed out at the toe of the slide, partially filling a small valley. In the early phases of the study no thick clay beds had been observed in place in the Acker Lake slide area. Blocks of silty, sandy clay, however, were noted in two places in the toe of the slide—at a spring in the gully at the north end of the slump area, and at a spring along the southern end of the slump. Subsequently, an examination of the electrical logs of water wells west of the slide area (Coon Tail Water Association TH #1, and Wren Water District Well, Fig. 11) indicated that clay beds are present in the Tombigbee Sand, and that if projected eastward, they could crop out in the slump area. Acker Lake Test Hole #1 (Fig. 11), located approximately 900 feet (274.3 m.) northwest of the slide, was cored to locate these clay beds. A clay bed 12 feet (3.7 m.) thick was penetrated at a depth of 92 feet (28.0 m.). The continuity of this clay bed was verified in Test Hole #2 (Fig. 11), located about 1,000 feet (304.8 m.) southwest of the slide, and in First American Farms Test Hole (Fig. 11), about three and one half miles (5.6 km.) north of the slide. It was noted in cores and cuttings from the two Acker Lake

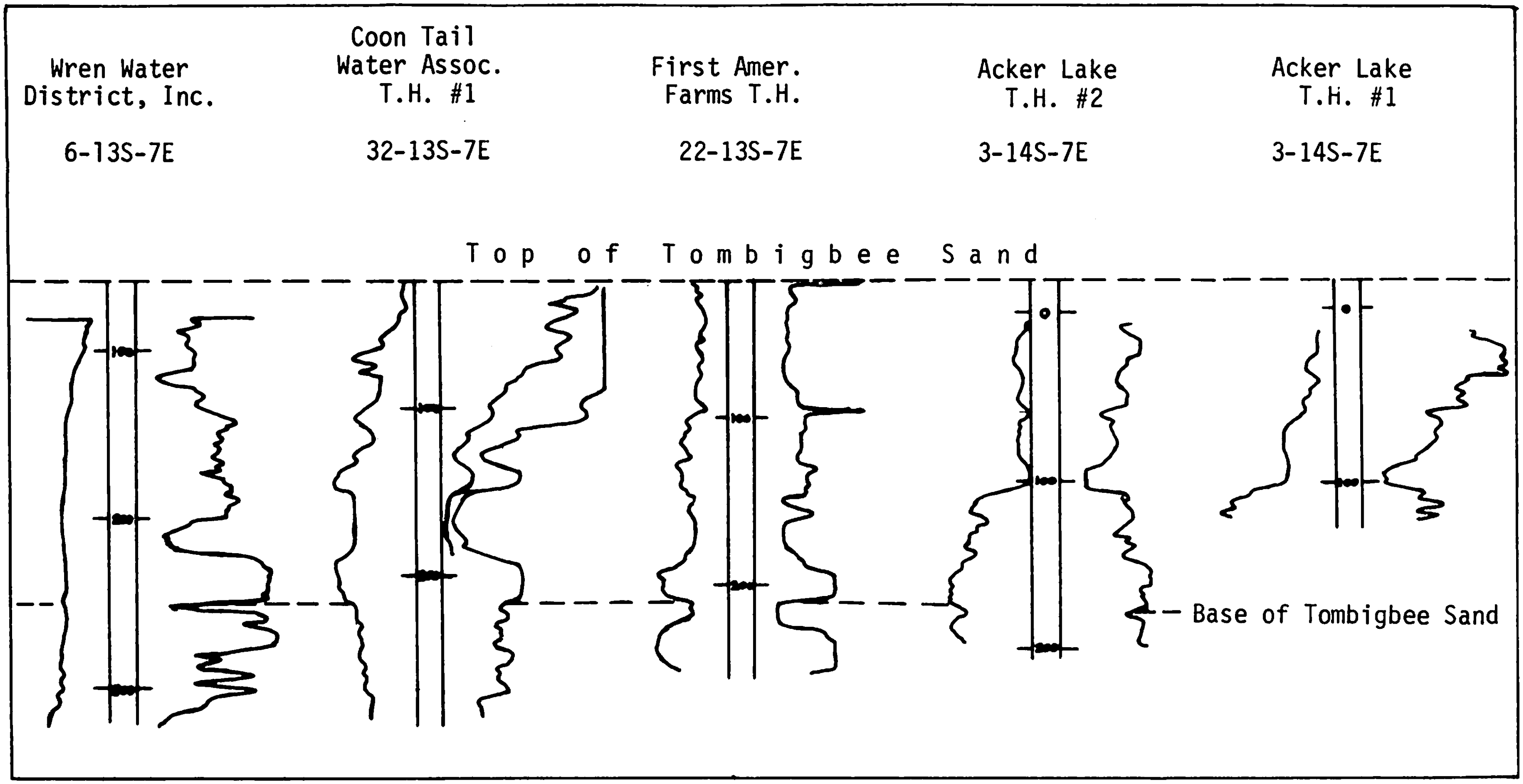

Fig. 11. Electrical log correlation of water wells and test holes in Acker Lake area, Monroe County, Mississippi—Logs from Mississippi Geological Survey.

test holes that oxidation effects on the sediments extended to a depth of about 60 feet (18.3 m.), and that a thin oxidized zone occurs beneath the clay. These observations suggest that the continuous ground water table is very low in the Acker Lake area.

Another important factor in the development of the graben part of the slump is the movement of water from Acker Lake into the joints near the edge of the bluff. The joints are probably a result of unloading along the bluff face, and are concentrated near the edge of the bluff. As previously noted, water seeps into the alluvium continually along joints, thus maintaining a high moisture content in these areas. This in turn probably increases the pore moisture and decreases the shearing strength of the sands; consequently, they collapse when support is removed.

Figure 12 shows, by diagrammatic cross section, the configuration of the northern part of the slump area after the slide of 1970, and a reconstruction of the same area as it probably appeared prior to this movement. This part of the area contains all of the slump features, and the following sequence of events is postulated.

Prior to the slide there were four rain storms, which were generally widespread, and the discharge of the Tombigbee River shows increases corresponding to the storms (see hydrographs on Fig. 13). In each instance the level of the river rose above 200 feet (61.0 m.) in elevation at the gage near Amory, Mississippi, and undoubtedly flooded the lower part of the slump area. Each flood eroded part of the toe of the slide, eventually removing support for the lowest slump block, which moved, removing support from the next higher block. This set up a chain reaction, and as support was removed each successively higher slump block moved. When the uppermost block moved away from the face of the bluff, a portion of the bluff moved downward and outward as a glide-block. Adjacent to the glide-block the sands, weakened by prolonged saturation from Acker Lake, collapsed, with apparent suddenness, into the space created. As the sand blocks collapsed into the space left by the glide-block they produced a graben, and probably forced the glide-block into lower slump blocks creating a pressure ridge between two of the blocks (Fig. 12). The inner edge of the graben was probably determined by the jointing. The newly formed inner edge intersected the old valley at a lower level, and could drain the lake to a level lower than it had maintained prior to the slumping.

Although the graben apparently formed rather rapidly, there is no way of determining the length of time for the entire sequence of events, but it was probably of very short duration. During 1972 small fresh scarplets were noted in the lower portion of the slump area, probably indicating movement of the lower slump blocks; but no evidence of movement was noted in the upper blocks. During periods when the level of Acker Lake is high, water drains directly into the graben, and as the lake level declines water can be observed seeping through the soil and alluvium and into the joints.

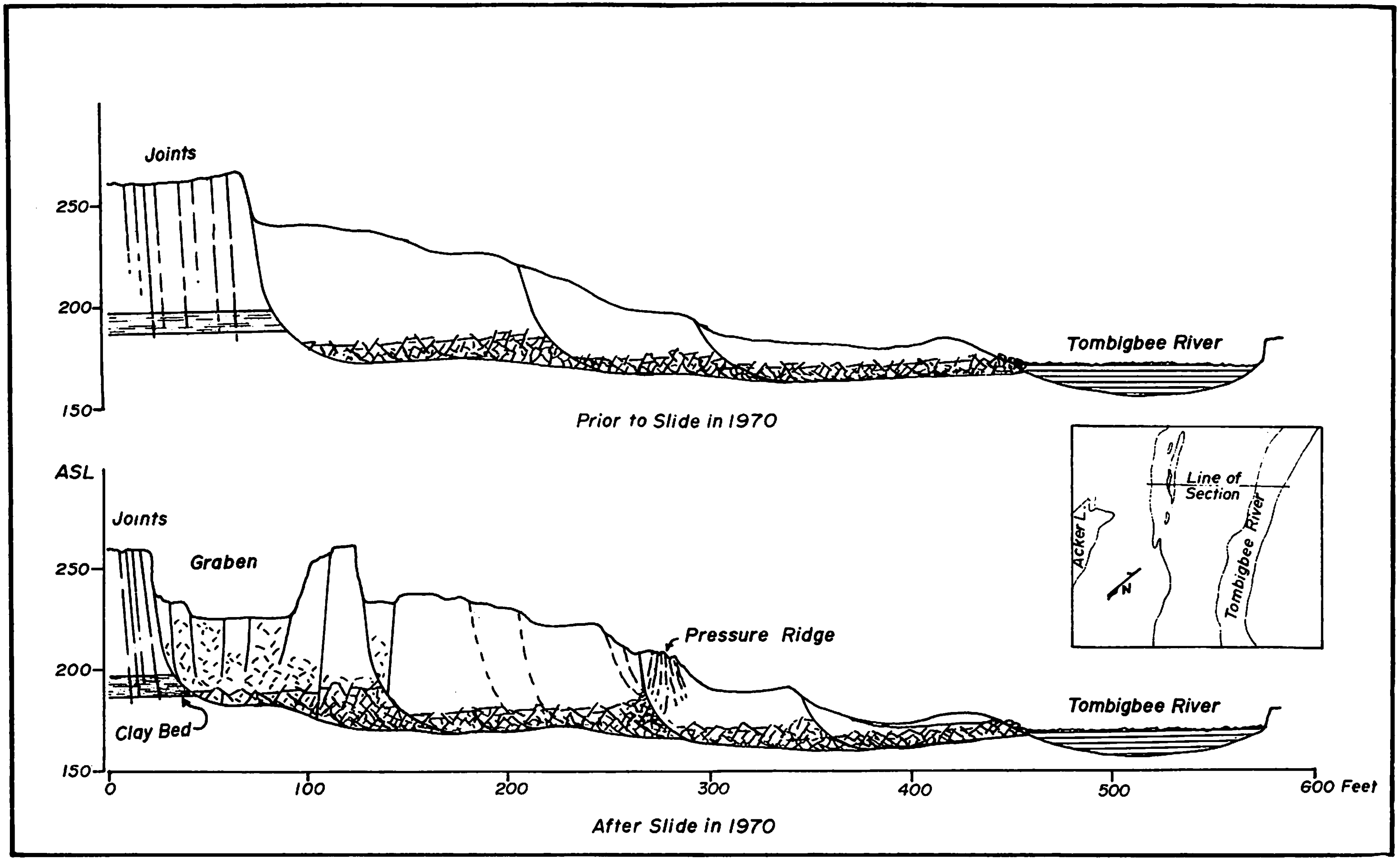

Fig. 12. Diagrammatic cross sections showing postulated conditions before and after 1970 slide.

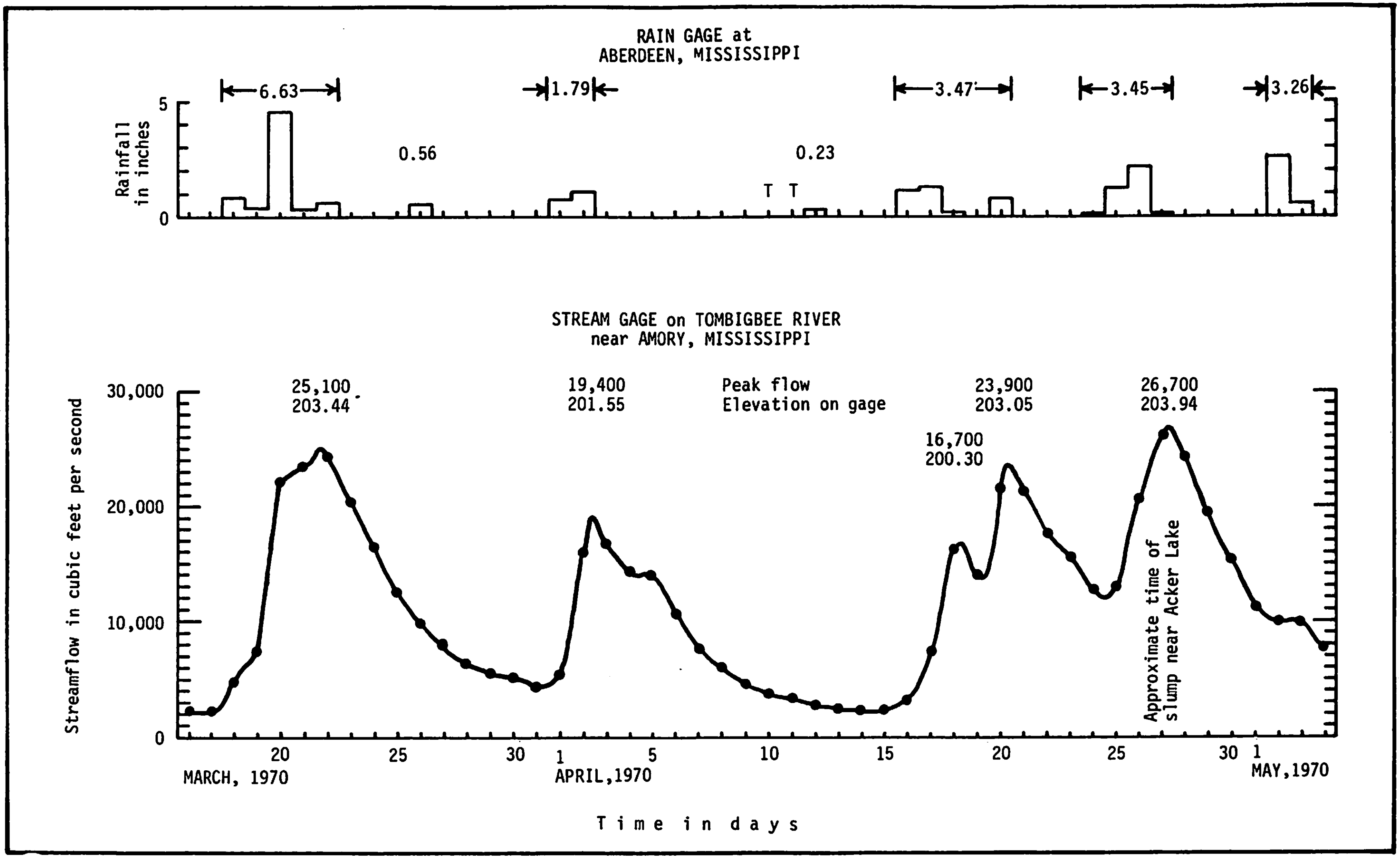

Fig. 13. Hydrographs of rainfall at Aberdeen, Mississippi, and discharge of Tombigbee River at Amory, Mississippi, from March 16 to May 4, 1970.

SUMMARY OF CONCLUSIONS

The 1970 Acker Lake landslide was not the result of a single factor, but was influenced by several variables. Inasmuch as the relative values of the different factors varied from place to place and from time to time, the order of listing below has no significance. Each factor is known to be an influence in the development of landslides in general, but it is believed that the 1970 landslide was the result of a complex series of events in a relatively small area at a given time.

1) Steep slopes — Bluffs along the western valley wall of the Tombigbee River are kept steep in the area of Acker Lake principally by the fact that the present channel of the river is against the west valley wall in the immediate area.

2) Saturation by water — Acker Lake furnishes a continuing supply of water thus maintaining a high moisture content, with accompanying weight increase in permeable beds. This high moisture content probably increases pore pressure and decreases shearing strength in the sands.

3) Presence of surficial material — Alluvium and terrace materials in the two arms of Acker Lake are especially susceptible to saturation by water from the lake.

4) Removal of toe — Heavy rainfall during March and April of 1970 brought an increase in stream energy thus enabling the Tombigbee River to remove material from the base of slides formed at an earlier period.

5) Presence of clay bed — A continuous clay bed at depth provided a surface along which initial lateral movement could occur.

6) Unindurated materials — Due to the general lack of cementing material, the Tombigbee Sand can be crumbled between the fingers. There is, however, sufficient coherence as to permit it to move as blocks.

7) Presence of fractures — Joints in Tombigbee Sand, prominent along the bluff face, probably provided passageway for more rapid movement of water than would have otherwise occurred.

8) Presence of root holes and borings — Although probably minor in influence, root holes and borings, like joints, provide passageways for relatively unrestricted movement of water.

Although in the final analysis a relatively small amount of water was probably involved in the slumping, its presence was an important factor in the unusual development of the slide, thus demonstrating that man's alterations of the water regimen in an area, no matter how insignficant they may seem to be, deserve consideration.

The conditions that led to the 1970 slide are essentially unchanged, therefore continued sliding of this type is a distinct possibility.

SELECTED REFERENCES

Beaty, C. B., 1972, The effect of moisture on slope stability: Jour. of Geology, Vol. 80, p. 362-366.

Boswell, E. H., 1963, Cretaceous aquifers of northeastern Mississippi: Miss. Board of Water Commissioners Bull. 63-10, 202 p.

Hansen, W. R., 1965, Effects of the earthquake of March 27, 1964 at Anchorage, Alaska: U. S. Geological Survey, Prof. Paper 542-A, 68 p.

Keady, D. M., and Russell, E. E., 1972, A case study of the hydrogeologic conditions in the outcrop area of an aquifer: Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi, 29 p.

Keady, D. M., Russell, E. E., and Laswell, T. J., 1971. Preliminary report on Acker Lake landslide (Monroe County, Mississippi) (Abst.): Jour. of the Miss. Acad. of Sci., Vol. 17, p. 62-63.

Morse, W. C., 1935, Geologic conditions governing sites of bridges and other structures. Miss. Geological Survey Bull. 27, 19 p.

Murphree, L. C., and others, 1966, Soil survey of Monroe County, Mississippi: U. S. Department of Agriculture Soil Survey Series 1961, No. 37, 123 p.

Stephenson, L. W., and Monroe, W. H., 1940, The Upper Cretaceous deposits: Miss. Geological Survey Bull. 40, 296 p.

Vestal, F. E., 1943, Monroe County mineral resources: Miss. Geological Survey Bull. 57, 218 p.

Wasson, B. E., and others, 1965, Water for industrial development in Clay, Lowndes, Monroe, and Oktibbeha Counties, Mississippi: Water Resources Division, U. S. Geological Survey and Miss. Research and Development Center, Jackson, MS., 39 p.

Zaruba, Q., and Mencl, V., 1969, Landslides and their control: American Elsevier Publ. Co., Inc., New York, N. Y., 202 p.