Geologic Relationships Of Slope Movement in Northern Alabama

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By JOHN S. POMEROY and ROGER E. THOMAS

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By John S. Pomeroy *and* Roger E. Thomas

Abstract

Slope-stability problems in northern Alabama result from slope movement that takes place within all major physiographic sections which include the Cumberland Plateau, Highland Rim, and Eastern Gulf Coastal Plain. Slope movements, commonly debris slides, slumps, earthflows, and complex forms, take place in the colluvium or at the contact between the colluvium and the underlying weathered mudstone or shale in the Cumberland Plateau. Slopes underlain by the Pennington Formation and/or the upper part of the Bangor Limestone of Late Mississippian age are the most susceptible to movement. Toppling failures, involving the overlying subhorizontal sandstone caprock of the Pottsville Formation of Pennsylvanian age, are largely controlled by separation along the vertical joint faces and by undermining caused by rapid weathering of the underlying incompetent mudstones and shales of Mississippian age. Old slope movements as long as 0.9 km have been documented near Huntsville. Road construction in that area reactivated a small part of one old slope movement. In the extreme western part of the Cumberland Plateau, colluvium derived from shale and mudstone of the Parkwood Formation of Late Mississippian and Early Pennsylvanian age is prone to sliding.

Slopes underlain by the Pride Mountain Formation of Late Mississippian age in the Highland Rim section show evidence of present and past instability. Recent sliding has taken place in colluvium derived from mostly grayish-green shale. Two large prehistoric bedrock slumps (0.5 and 1.3 km wide) have displaced the overlying Hartselle Sandstone in a northwest-trending, joint-controlled valley southwest of Tuscumbia.

Sand, gravel, and less abundant clay of the Tuscaloosa Group of Late Cretaceous age mantle the Eastern Gulf Coastal Plain in northern Alabama. Highway construction in this unit, near Hamilton, has caused major slope movements whose failure surfaces can be traced to thin clay seams.

INTRODUCTION

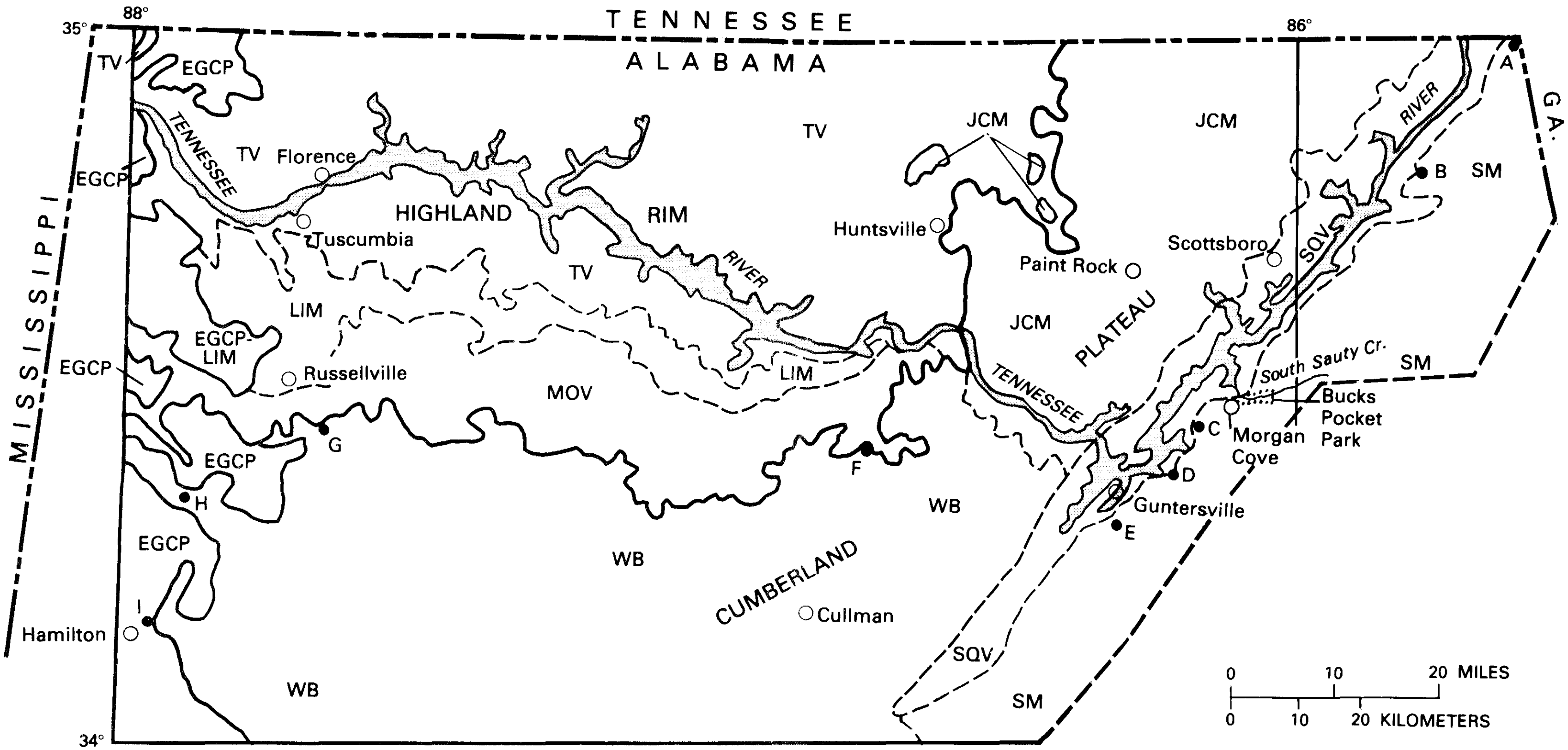
A large part of northern Alabama was examined in 1979–1981 for slope stability (Pomeroy, 1982b; Thomas, 1979, 1982) as part of a comprehensive investigation involving the Appalachian Plateau Province. Adjoining areas of the Interior Low Plateaus and Coastal Plain Provinces to the north and west were also examined. This area is bordered by Sand Mountain in the east and by longitude 88° in the west. The State boundary and latitude 34° border the area in the north and south, respectively (fig. 1).

Aerial photography at scales of 1:20,000 (1971, 1972), 1:40,000 (1977–1979), and 1:80,000 (1977) was used in the study. Photo interpretation was followed by reconnaissance from vehicles and selected foot traverses. Included in the inventory were identification of recently active and historic landslides, prehistoric landslides, and the outlining of zones considered by the investigator to be most susceptible to slope failure on the basis of landslide incidence, rock and soil textures, and topography. Pomeroy was responsible for the inventory west of longitude 86°. Thomas investigated the Appalachian Plateau Province east of longitude 86° (fig. 1).

In this report, we have adopted the term *slope movement* rather than *landslide* as a general, inclusive term except for movements that involve only sliding. *Landslide* has been widely used as an all-inclusive term for almost all types of slope movement including some that involve little or no sliding (Varnes, 1978, p. 11). The popular geomorphic term, *mass movement*, is synonymous with *slope movement* and is not used in this report.

Five types of slope movement (Varnes, 1978, fig. 2.1) are present in northern Alabama. They include falls (rockfalls), topples, slides (earth slumps, debris slides), flows (debris and earth flows, debris avalanches), and complex movements (slump-earthflows, debris slide-earthflows).

Rock falls are extremely rapid free falls of bedrock. Alternating competent and incompetent lithologies, in addition to closely spaced vertical joints parallel to the major drainages, are contributing factors to the process. Topples are rock blocks that have



EXPLANATION

A	Locality discussed in text
———	Boundary between physiographic sections
– – –	Boundary between physiographic districts
	Physiographic unit boundaries are slightly modified from Sapp and Emplaincourt, 1975

EGCP, East Gulf Coastal Plain
JCM, Jackson County Mountains
LIM, Little Mountain
MOV, Moulton Valley
SM, Sand Mountain
SQV, Sequatchie Valley
TV, Tennessee Valley
WB, Warrior Basin

Figure 1. Map showing area investigated for slope-stability study and physiographic regions in northern Alabama.

rotated forward. Slides are either earth slumps involving rotational movement with an upward curving rupture surface or are debris slides which take place along planar or mildly undulatory surfaces and are called translational movements. Both types of slide movements can be very slow to rapid. Flows in northern Alabama are of three types, ranging in movement patterns from extremely rapid (debris avalanche) to very rapid (debris flow) to rapid to very slow (earth flows). Flows in surficial materials show movement resembling that found in the flows of viscous fluids.

A debris avalanche has a long and relatively narrow track along a steep mountain or hill slope and is usually preceded by copious precipitation. A debris flow, similar to a debris avalanche, is commonly a wider and less viscous movement. An earthflow commonly shows shear surfaces along the flanks and basal surface even though the distribution of velocities within the displaced material may indicate plastic flow (Varnes, 1978, fig. 2.1). Indeed, most slope movements are complex in that features of two or more basic slope movements are represented, as in slump-earthflows, debris slide-earthflows, and so on. Complex movements involve an upper zone of depletion (slump, debris slide) and a lower zone of accumulation or deposition (flow).

Rocks exposed in the area range from Ordovician to Cretaceous in age. The relatively simple structure is made up of subhorizontal strata except for the Sequatchie Valley west of Sand Mountain (fig. 1). The physiographic sections include the Cumberland Plateau (Appalachian Plateaus Province), Highland Rim (Interior Low Plateaus Province), and the East Gulf Coastal Plain (Coastal Plain Province). Slope stability is discussed by physiographic region.

CUMBERLAND PLATEAU

The Pottsville Formation (table 1), which caps the Cumberland Plateau, is the most widespread and conspicuous stratigraphic unit in northern Alabama. The revised stratigraphic nomenclature of the Mississippian units in northern Alabama indicated that the Pennington Formation (table 1) is areally restricted to the northeast part of the region (Thomas, 1972, p. 84). The Pennington Formation grades westward into the upper part of the Bangor Limestone (table 1), which includes light-green and maroon shale and mudstone interbeds in its upper part. The Parkwood Formation (table 1) in the western part of the Cumberland Plateau lies between the Bangor Limestone and the Pottsville Formation.

The Cumberland Plateau section in divided into several physiographic districts (Sapp and Emplaincourt, 1975). The districts applicable to this discussion are Sand Mountain, Jackson County Mountains, and the Warrior Basin (fig. 1).

Sand Mountain

Sand Mountain is a submaturely dissected synclinal plateau of moderate relief capped by the Pottsville Formation. The boundaries are distinct except at the southwest end where Sand Mountain subtly merges with the Warrior Basin. The sandstone escarpment along both sides of Sand Mountain ranges in relief from 122 m (400 ft) at the south end to 305 m (1,000 ft) at the (north end). Slope movements are common only along the flanks of the plateau.

That part of the east side of Sand Mountain that was inventoried for slope movements is largely covered by colluvium within which small ($<$30 m wide) debris slides, slumps, and complex forms are found above and below roads.

The west side of Sand Mountain has greater relief than the east side. The slope is largely covered by colluvium and is generally slide-prone. All recent slope movements have been induced by man and are largely slump-earthflows or debris slide-earthflows.

For example, along Alabama 73 less than 1 km southwest of the tri-State intersection (AL-TN-GA), colluvial movements are restricted to the upper part of the slope underlain by the Pennington Formation (fig. 1, locality A). A more extensive area within which the movements are larger is on the upper side of Alabama Route 117, 25 km northeast of Scottsboro (fig. 1, locality B). Parent materials are the upper part of the Bangor Limestone and the Pennington Formation. Slope movements in the spoil banks of strip mines are 8 km south of locality B (fig. 1).

Most slope movements noted at Bucks Pocket Tri-County Park (fig. 1) originated during or after road construction and took place in colluvium masking Bangor Limestone. One such movement, a 38-m-wide slump-earthflow, was triggered midway up the south-facing slope above South Sauty Creek adjacent to the upper side of the road. Thin soil ($<$1 m thick) masks reddish-purple mudstone. Several slumps, as wide as 45 m, are present above an improved road at nearby Morgan Cove (fig. 1) and incorporate red soil and weathered red mudstone of the Bangor Limestone.

A well-defined prehistoric (?) example of a rock-toppling failure (fig. 2*A*) is found along the same slope and involves an area of about 20,000 m^2. The

Table 1. Stratigraphic units whose derivative soils are moderately to highly susceptible to movement

[Asterisk (*) indicates the most susceptible units]

Geologic unit	Lithology	Physiographic section
Tuscaloosa Group*	Sand, gravel, clay	Eastern Gulf Coastal Plain.
Pottsville Formation	Sandstone, shale, claystone, conglomerate.	Cumberland Plateau.
Parkwood Formation	Shale, mudstone, claystone, sandstone.	Cumberland Plateau.
Pennington Formation*	Shale, mudstone, claystone, limestone, sand stone.	Cumberland Plateau.
Bangor Limestone*	Limestone, mudstone, claystone.	Cumberland Plateau.
Pride Mountain Formation*.	Shale, mudstone, claystone, limestone, sandstone.	Highland Rim.

subhorizontal sandstone caprock of the Pottsville Formation is largely shattered and broken by separation along vertical joint faces. The toppled blocks dip 15–20° downslope, at distances of about 8 m from the caprock, and are increasingly rotated and disoriented at larger distances from the point of separation. Sandstone-boulder scree is more prevalent at the base of the slope. The bedrock beneath these failures includes both the Bangor Limestone and the Pennington Formation.

The toppling movement is believed to have been caused by initial horizontal slip along bedding in the weathered mudstone (or claystone) in the upper part of the Pennington Formation followed by outward rotation of the blocks. The slope movement is classified, at least in part therefore, as a secondary toppling failure (Evans, 1981).

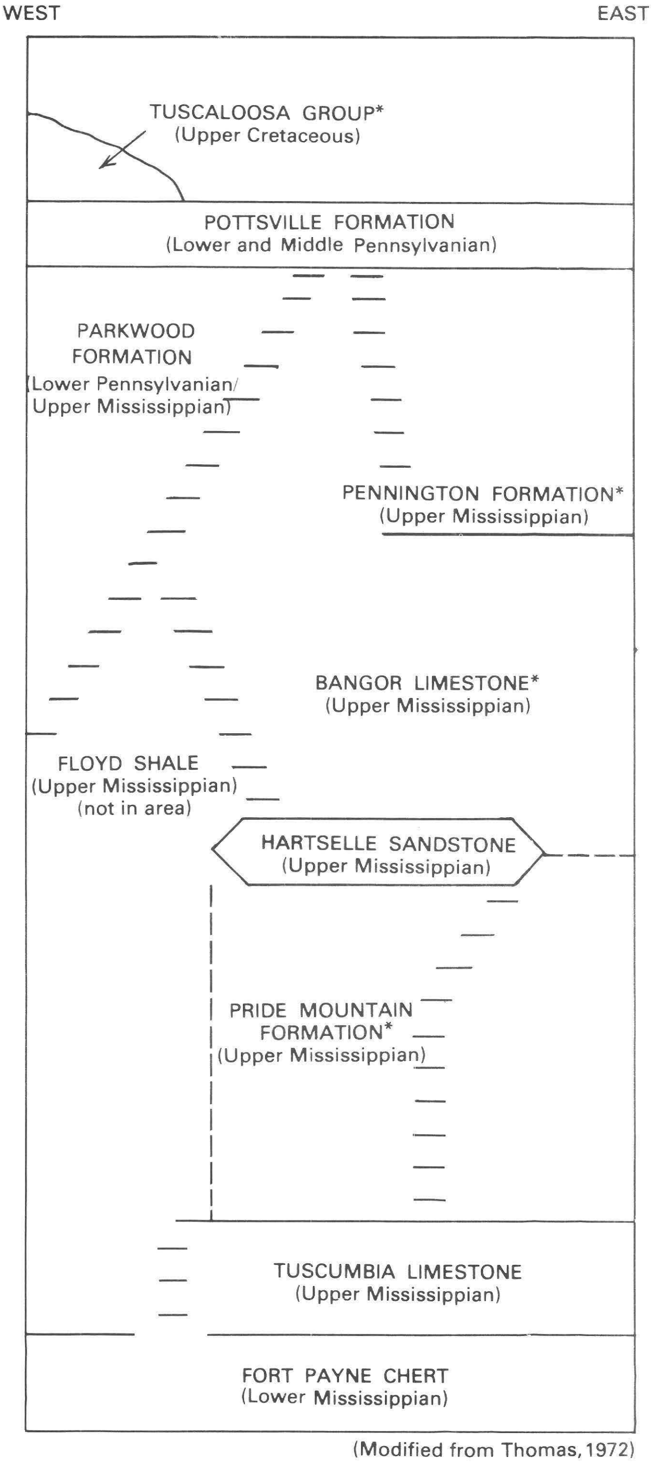
Above the newly constructed Alabama 227, east of Gunterville Lake, are several sizable slope movements (figs. 1, locality C; 3*A*). The highway cuts across the lower part of an extensive colluvial slope and is oriented roughly parallel to the major subvertical joint direction (N. 75° W.). In a steeply dipping roadcut (83°) at locality A (fig. 3*A*), light-green and red mudstone beds of the Pennington Formation(?) or upper Bangor Limestone(?) overlie a cliff-forming limestone at the lower edge of the cut. At locality B the surface of the landslide area has been modified by man, but several large, fresh, discontinuous scarps along a 21° (39 percent) slope indicate very recent movement. Movements have taken place in both the colluvium that overlies mudstone and at the colluvium-weathered mudstone interface. The prominent joint trend is the same as at locality A. Springs were noted at the contact of the base of the cliff-forming sandstone. Upslope from the new road cut, a 6-m-high exposure of boulder colluvium consists of older toppled blocks of sandstone that were undermined by rapid weathering of the less competent mudstones of the Pennington Formation. Two previous sinuous highway routes (fig. 3*A*) avoided major cut-and-fill operations, and only minimal slope-movement problems occurred.

A road cut with a slope greater than 20° above Alabama 227, 12 km southwest of locality C (fig. 1) may have been a factor in the genesis of a 45-m-wide slump in forested colluvium above the road (fig. 1, locality D). The slope is 9° (16 percent) at the head of the slump and increases downslope to 17° (32 percent). The head, which is 50 m upslope from the road, is within the upper 35–40 m of the Bangor Limestone, which locally consists of interbedded limestone and mudstone. Slope movements 2 km southwest along the same road and above U.S. 431 south of Guntersville (fig. 1, locality E) took place in colluvium derived from rocks at about the same stratigraphic horizon.

Jackson County Mountains

The Jackson County Mountains (fig. 1) is a submaturely dissected plateau which has relief ranging from 274 m (900 ft) to 335 m (1,100 ft). The region is characterized by mesas capped by Pottsville Formation within which valleys are cut into limestone of Mississippian age.

Whereas most of the slopes along the east and west sides of Sand Mountain are largely colluvial and can be classified as generally unstable, slopes in the Jackson County Mountains, even though of greater relief on the average, are only partially unstable.



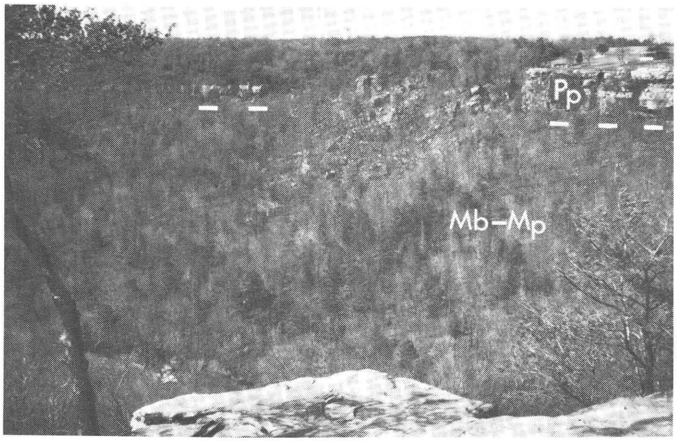
Generally, the only slope movement-prone rock zone is about 60 m thick and stratigraphically occupies the upper Bangor Limestone interval and the position of the Pennington Formation, which forms the upper part of most slopes in the area. More resistant limestone of Mississippian age commonly crops out along the lower and middle parts of the slopes. In the eastern part of the region, where several small slope movements were identified, a colluvial mantle commonly was found to extend to the base of a slope. In contrast, in the western part of the Jackson County Mountains in the Huntsville area, the lower and middle slopes are almost always ribbed by bedrock (fig. 2*C*). Thus, extensive debris avalanches apparently do not exist in the western part because a supply of colluvium is absent a short distance downslope from the head area. For example, one debris avalanche 8.0 km north of Paint Rock (fig. 1) terminated as soon as the colluvial movement encountered limestone ledges.

All but two observed recently active slope movements in the areas southwest, west, northwest, and north of Scottsboro (fig. 1) and in the Huntsville area took place in the regolith overlying upper Bangor Limestone and Pennington Formation. Nearly one half of all roads traversing colluvium that overlie these formations have been affected by slippage and/or flowage. The slope movements are largely slump-earthflows showing an upper zone of depletion and a lower zone of accumulation (Varnes, 1978).

A large 0.2-km-long recently active colluvial slope movement (fig. 3*B*), best defined as a slump-earthflow, took place along an east-facing forested slope 8 km north of Paint Rock (fig. 1). The head, about 90 m wide with an irregular outline and subsidiary scarps, lies on a 13° (24 percent) slope. Above the head scarp is a 30-m-wide, nearly flat bench where water ponds from springs located along the Pennington and Pottsville contact further upslope. Levees on both sides are well developed downslope. The toe stands 2.0–2.5 m in relief along a 14° (27 percent) slope. Adjacent to the foot of the slump-earthflow are limestone outcrops. Below the foot, a considerably steeper slope with abundant ledges and scant colluvium extends to the base of the slope.

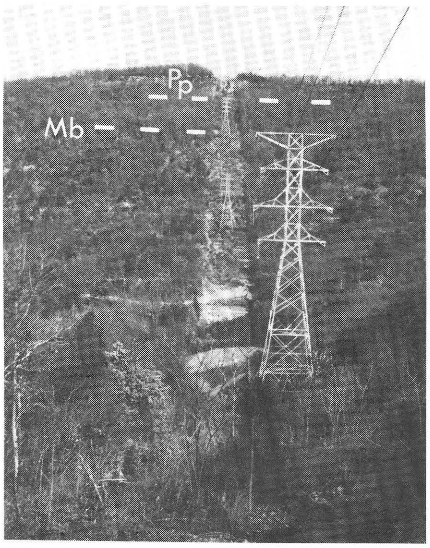
An old slope movement, perhaps a debris flow, was identified nearly 1 km west of the recently active slump-earthflow (fig. 3*B*). The 0.5-km-long movement has hummocky topography and is capped with boulders of Pottsville Formation. Limestone ledges are adjacent to the prominent gulch east of the movement (fig. 2*D*). In the foot area, the surface of the old flow is 7.5–9.0 m above the drainage.

Other old slope movements, including probable debris flows, were identified along both sides of Green Mountain southeast of Huntsville (fig. 3*C*) and in the Guntersville Lake area (fig. 3*D*). In each case, the slope movement appeared to originate at or below the Bangor Limestone and Pottsville contact resulting in tilted (slumped) benches in the colluvium overlying the Bangor Limestone and possibly in detached blocks of rock.

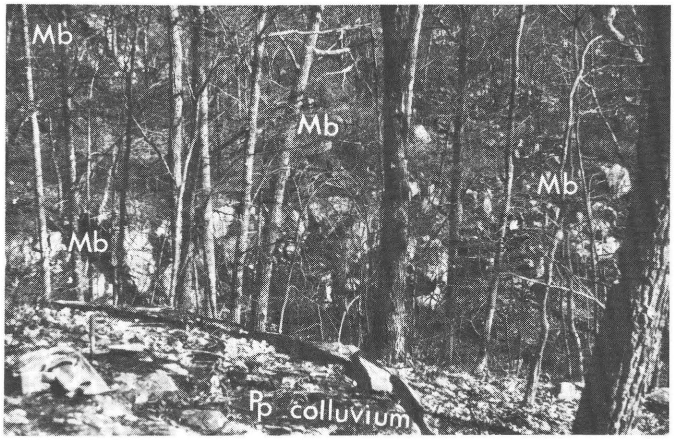


A

B



C



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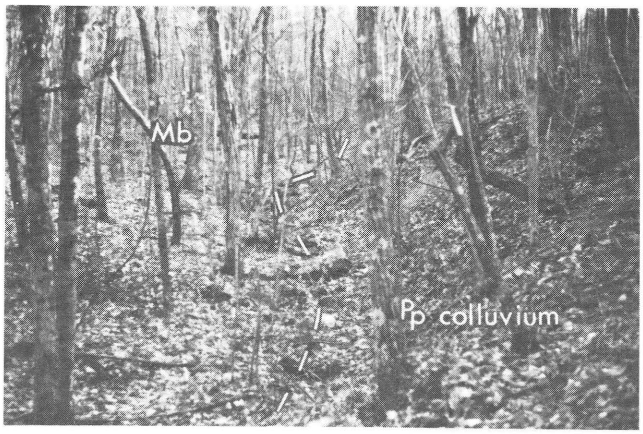

E

F

G

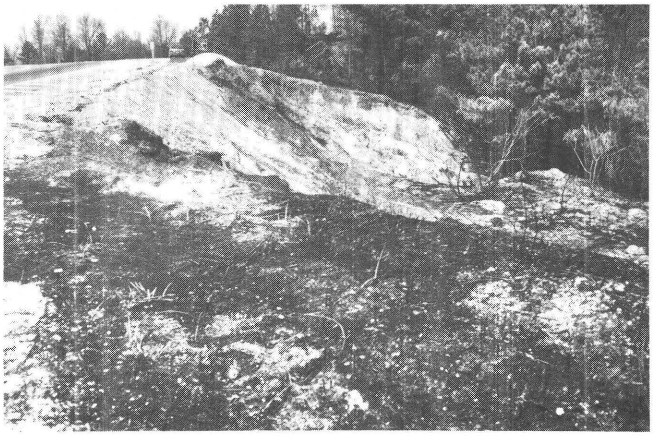

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Figure 2. Photographs showing recent and older slope movements, northern Alabama. Mb, Bangor Limestone; Mp, Pennington Formation; Pp, Pottsville Formation.
A. Prehistoric(?) toppled blocks from Pottsville Formation as seen from caprock at Point Rock. Bucks Pocket Tri-County Park 28 km northeast of Guntersville; Grove Oak 7 1/2-minute quadrangle.
B. Prehistoric(?) toppled blocks of Pottsville Formation downslope from outcrop at far left of figure 2*A*. Unstable colluvium and weathered rock of Pennington Formation in foreground was recently active (see locality B on fig. 3*A*). Alabama 227, 18 km northeast of Guntersville. Columbia City 7 1/2-minute quadrangle.
C. Interval (60 m thick) susceptible to slope movement in upper part of Bangor Limestone (Mb) denoted by dashed lines. Note excellent outcrops of Mb and older limestone units beneath weak zone. West edge of Cumberland Escarpment 12 km south-southeast of Huntsville. Huntsville 7 1/2-minute quadrangle.
D. View laterally across east side of probable debris flow (Pp colluvium) to Bangor Limestone (Mb) ledges (see fig. 3*B*). Cumberland Plateau 24 km east of Huntsville. Paint Rock 7 1/2-minute quadrangle.
E. View up lateral margin (dashed line) of prehistoric probable debris flow (see fig. 3*E*). Cumberland Plateau escarpment 16 km southeast of Russellville. Newburg 7 1/2-minute quadrangle.
F. Head of translational (planar) slide in woodland above road. Weathered mudstone from Bangor Limestone underlies head. Cumberland Plateau escarpment 38 km south-southwest of Huntsville. Center Grove 7 1/2-minute quadrangle.
G. Colluvial slope failure above U.S. 43. Grayish-green weathered shale and soil of Pride Mountain Formation. Little Mountain section 13 km northeast of Russellville. Russellville 7 1/2-minute quadrangle.
H. Head of slope failure in Tuscaloosa Group along U.S. 43, 8 km south of Hamilton. Eastern Gulf Coastal Plain section. Hamilton SW 7 1/2-minute quadrangle.

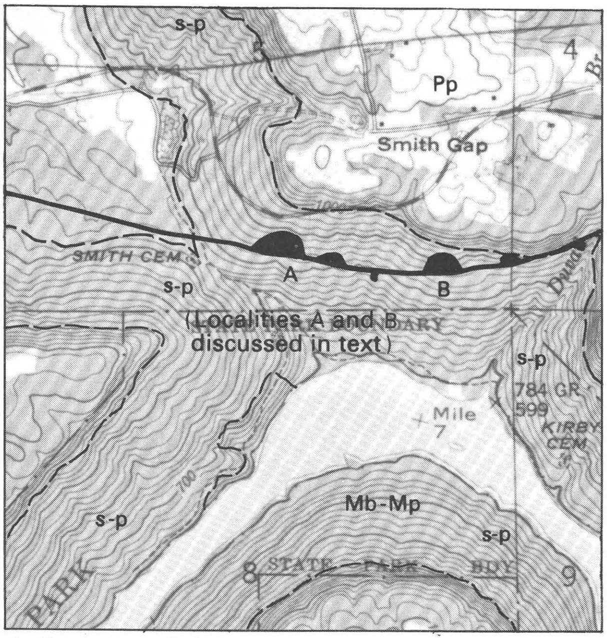
Recent slope movement took place along the lower slope at Weatherly Cove adjacent to the southeast part of Huntsville (fig. 1). This 40-m-long, 40-m-wide colluvial movement is part of a larger (0.9 km by 0.5 km) old movement. Road construction along the base of the slope was a factor triggering the movement.

Warrior Basin

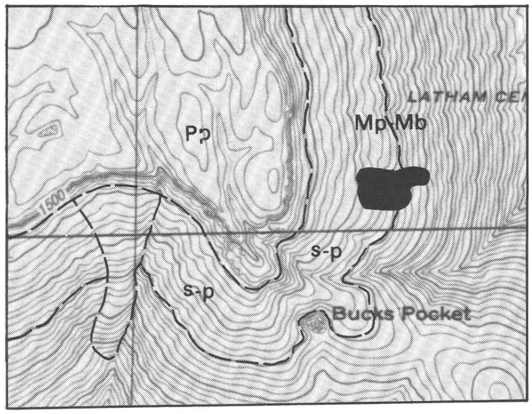
The Warrior Basin (fig. 1) is a synclinal, submaturely to maturely dissected plateau developed upon the Pottsville Formation. The north-facing sandstone-capped escarpment at the northern edge of the basin has relief ranging from 61 m (200 ft) in the western part to 183 m (600 ft) in the eastern part. In the inventoried area, the Basin slopes gently southward and has relatively shallow incised drainages.

Slope movements occur frequently in colluvium overlying the upper part of the Bangor Limestone from Cullman northeastward to the Tennessee River (fig. 1). As the northern rim of the Warrior Basin is of relatively low relief northwest of Cullman, the incidence of slope movement is less common there (figs. 2*E* and 3*E*). Although the upland surface shows moderate incisement in the Pottsville Formation west and southwest of Cullman, the slopes are generally stable. However, some instability was documented along the slopes underlain by the Pottsville Formation bordering Interstate 65, 16 km south of Cullman (fig. 1). Spoil-bank failures from strip-mining operations are numerous 3 km east of the Interstate.

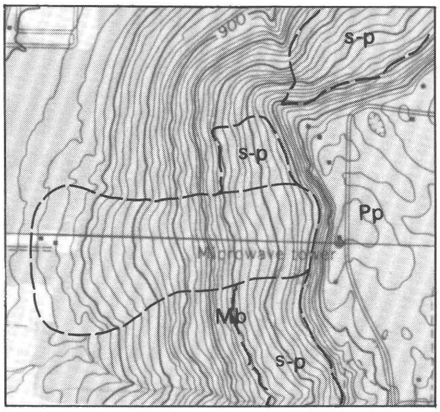
The incidence of recently active slope movements in the northeastern part of the Warrior Basin is greater than that in the Jackson County Mountains because of higher population density with more roads



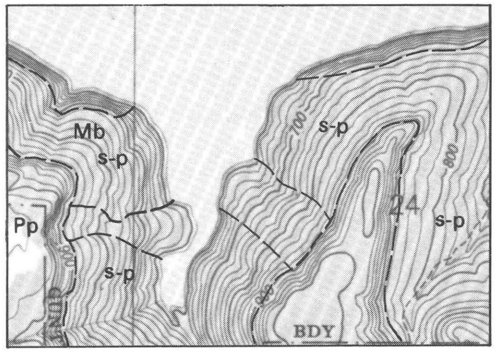
A. Recent man-induced slope movement 18 km northeast of Guntersville (see fig. 2*B*). Cumberland Plateau. Columbia City 7½-minute quadrangle.



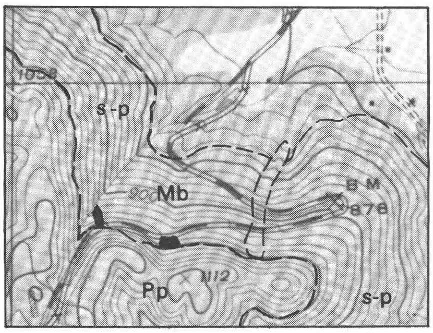
B. Prehistoric and recent slope movement 24 km east of Huntsville (see fig. 2*D*). Cumberland Plateau. Paint Rock 7½-minute quadrangle.



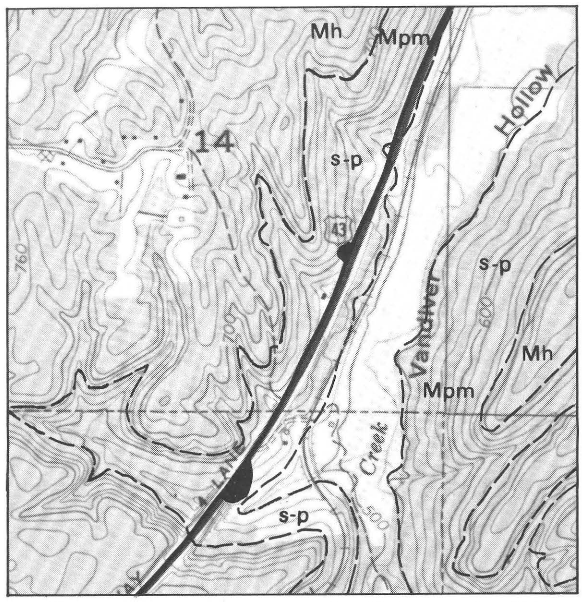
C. Prehistoric slope movement 15 km southeast of Huntsville. Flow stands 2.0–2.5 m in relief near base. Cumberland Plateau. Farley 7½-minute quadrangle.



D. Prehistoric slope movement above Guntersville Lake 1 km southeast of Dam. Cumberland Plateau. Guntersville Dam 7½-minute quadrangle.

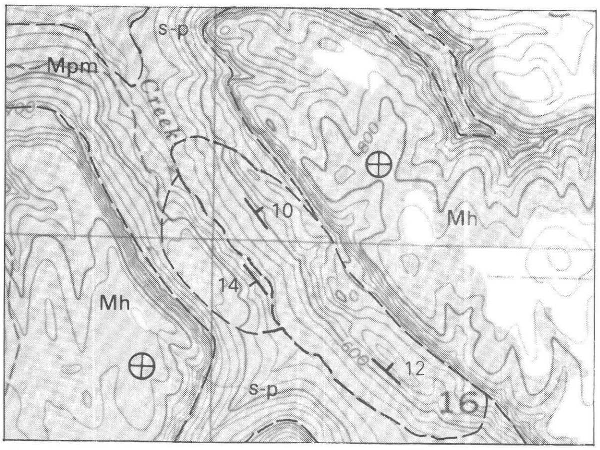


E. Prehistoric and recently active slope movements 16 km southeast of Russellville (see fig. 2*E*). Cumberland Plateau. Newburg 7½-minute quadrangle.

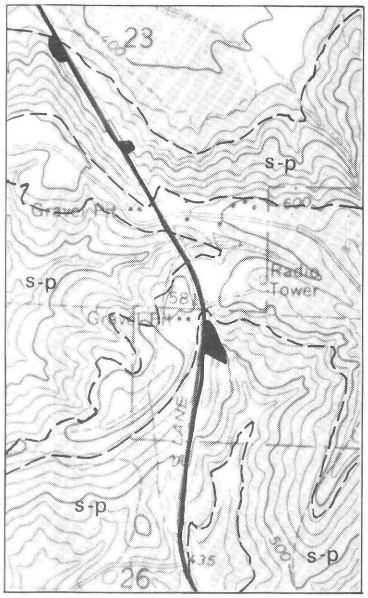


F. Slope movement-prone terrain 15 km south of Tuscumbia. Highland Rim. Russellville 7½-minute quadrangle.

Figure 3. Maps showing recent and older slope movements and slope movement-prone (s-p) terrain, northern Alabama. Mb, Bangor Limestone; Mp, Pennington Formation; Pp, Pottsville Formation; Mpm, Pride Mountain Formation; Mh, Hartselle Sandstone



G. Prehistoric bedrock slump blocks 15 km southeast of Tuscumbia. Highland Rim. Pride 7½-minute quadrangle.
Horizontal beds, ⊕. Strike and dip of beds, ⊥10.



H. Slope movement-prone terrain 7 km south of Hamilton. East Gulf Coastal Plain. Hamilton SW 7½-minute quadrangle.

EXPLANATION

Recent slope movements — Older slope movements — s-p Slope movement-prone terrain

0 — 1 MILE

0 — 1 KILOMETER

CONTOUR INTERVAL 20 FEET

traversing the slopes of low relief. Most slope movements take place above roads. Several zones of red and green mudstone interbedded with limestone are observed in highway cuts along the northern rim. Commonly, the green mudstone is more clay-rich than the reddish to reddish-purple siltier mudstone and shale.

Most of the slope movements are 9–15 m wide. One of the larger debris slides (figs. 1, locality F; 2*F*), is more than 30 m wide, has well-defined lateral borders, and is at least 10 years old based on vegetation. The debris slide originated along a 22° (41 percent) wet slope a few meters below the contact of Bangor Limestone and Pottsville Formation and shows translational (planar) movement.

An extensive zone of movements is found along Alabama 243, 10 km southeast of Russellville (fig. 1, locality G). Highway fill has slumped, but colluvium derived from the Parkwood Formation (table 1) also is unstable adjacent to the highway fill. At the base of the slope, slumped limestone ledges are underlain by weathered red mudstone of the Bangor Limestone. Stress relief along joints in the limestone parallel to the road has dislodged the thick-bedded limestone and has surcharged the already unstable slope extending to the highway. According to the nearest landowner, the 1970 highway construction caused the movements which have now been largely stabilized. The original slope prior to highway construction was about 17° (30 percent) but is now 35° (70 percent).

Not all slope movements take place in colluvium derived from Mississippian rocks. Small slope movements have been mapped within the lower 10 m of the Pottsville Formation. For example, water penetration down the joint plane in sandstone to an impermeable blue-gray clay caused the slippage of an area 60–75 m wide above Alabama 187, 24 km southwest of Russellville near the western extremity of the Warrior Basin (fig.1, locality H).

Samples from the upper part of the Bangor Limestone and the Pennington Formation in the Cumberland Plateau were studied to determine their clay mineralogy. Illite is the principal clay mineral identified in all samples. The (003)/(001) ratio is less than one indicating that the illite is deficient in potassium (Gloria Hunsburger, written commun., 1981). Fisher and others (1968, p. 79) in Ohio concluded that "simultaneous deposition of ferric iron with degraded illitic clay prevented reabsorption of the bonding potassium ion in the depositional environment. The continued presence of iron has greatly inhibited the reconstitution of the clay throughout diagenesis and later geologic time." They indicated that degraded illites are similar to montmorillonite in the presence of water except that expandability is not as great. Unstable potassium-deficient illitic soils derived from mudstones and shales are characteristic over much of western Pennsylvania (Pomeroy, 1982a) and southeastern Ohio (Fisher and others, 1968).

HIGHLAND RIM

The Little Mountain district (fig. 1) of the Highland Rim section is a submaturely dissected southward-dipping sandstone ridge with as much as 134 m (440 ft) of relief. The Hartselle Sandstone caps the less competent Pride Mountain Formation both of which are of Late Mississippian age.

All observed slope movements in the Highland Rim have taken place in areas underlain by the Pride Mountain Formation (table 1). The Pride Mountain Formation consists of thick shale units including mudstone interbedded with thin beds of limestone and sandstone. Recent sliding and flowage have taken place in highly plastic when wetted soil derived from mostly grayish-green shale. Major localities include slopes along U.S. 43 between Russellville and Tuscumbia (figs. 2*G*, 3*F*) and Alabama 247 west and southwest of Tuscumbia.

Movements 100–120 m wide were documented along slopes as gentle as 9° (16 percent) next to recently widened roads. Cut slopes at grades as much as 100 percent show movement wherever colluvial pockets are found above the road. Filling operations frequently appear to have overloaded already inherently unstable slopes (fig. 3*F*). Although slopes in the Little Mountain area south, southwest, and west of Tuscumbia have been largely undeveloped, some homes have been endangered by slides (C. D. Bowen, U.S. Soil Conservation Service, written commun., 1981).

Two large prehistoric bedrock slumps (0.5 and 1.3 km wide) have displaced the overlying Hartselle Sandstone in a northwest-trending, joint-controlled valley, 16 km southwest of Tuscumbia (fig. 3*G*). Outcrops within the two rotated blocks of Hartselle Sandstone dip towards the slope (fig. 3*G*) in contrast to the regional structure. Slumping is probably attributable to penetration of water along northwest-trending joint planes in the caprock downward to an impermeable stratum which acted as a failure plane in the Pride Mountain Formation. A minimum rotational displacement of 42 m is inferred. At the smaller bedrock block west of the drainage a broad gently sloping (6–9°) surface above the outcrops reflects the rotational nature of the movement (fig. 3*G*).

The decreased incidence of slope movements in the Little Mountain area to the east is related to a more subtle topography with less relief and facies changes from shale to limestone.

Slopes north of the Tennessee River involving colluvium derived from the Chattanooga Shale of Late Devonian age and the Fort Payne Chert of Early Mississippian age did not show obvious evidence of movement.

EAST GULF COASTAL PLAIN

The East Gulf Coastal Plain (fig. 1) is a dissected upland with a few broad, flat ridges (Sapp and Emplaincourt, 1975) of unconsolidated sediments which mask the adjacent physiographic sections to the east.

The Cumberland Plateau and Highland Rim of extreme northwestern Alabama are covered by sand, gravel, and minor clay of the Tuscaloosa Group of Late Cretaceous age (table 1). Highway construction in this stratigraphic unit in the Hamilton area (fig. 1) has caused major slides whose failure surfaces can be traced to clay seams. Harris and Causey (1973) have divided the Tuscaloosa Group into the Coker and Gordo Formations. All of the slope movements seem to take place within the older Coker Formation.

Slope movements have taken place both above and below U.S. 43, 78, and 278, 8 km south of Hamilton (figs. 2*H*, 3*H*). At the locality south of elevation x581 (figs. 2*H*, 3*H*) successive earthflow lobes indicate many periods of flowage. The most recent movement is at the northeast edge whereas the oldest and most extensive earthflow took place along the southernmost part where 15- to 20-year-old trees are growing on the foot of the flow. A variegated red and light-gray clay, containing little silt, lies beneath some of the older lobes and probably acted as a slippage surface.

Most observed slope movements showed evidence of rotation (slumping) and flowage. Slump-earthflows as wide as 60 m were observed along slopes cut by secondary roads south and southeast of Hamilton. All movements are in the Smithdale-Luverne soils which have a American Association of State Highway Officials rating of A-7 and a plasticity index of 10–30 (Cotton, 1979) signifying moderate to high susceptibility to sliding.

Large slope movements greater than 60 m in width took place during and after construction of a new segment of U.S. 43, 3 km northeast of Hamilton (fig. 1, locality I). Benching of the slope above the east side of the highway has not completely solved the problem of active slope movement. A massive slope movement on the west side of the highway shows perfectly formed 1.5-to 2.5-m-wide "mini" slump-earthflows within the larger disturbance. Blue-gray clay is commonly exposed in the "floor" of each head area and acts as the slippage surface.

In the Coastal Plain areas southwest, west, and northwest of Russellville (fig. 1) reddish and greenish-gray clay is visible in the head areas of all slump-earthflows.

The incidence of slope movements in the Tuscaloosa Group(?)[1] north of the Tennessee River is slight. Nearly vertical highway cuts are found beneath 60-percent-grade slopes without any discernable slope movement. An examination of the exposures in this area failed to reveal any clay within beds of highly ferruginous well-cemented gravel.

SUMMARY

Stratigraphic units in northern Alabama, whose derivative colluvial soils are highly susceptible to slope movements, include the Pride Mountain Formation, the Bangor Limestone and the Pennington Formation all of Late Mississippian age and the Tuscaloosa Group of Late Cretaceous age. Derivative soils formed from the Parkwood (Upper Mississippian and Lower Pennsylvanian) and Pottsville Formations (Lower and Middle Pennsylvanian) are moderately to highly susceptible to slope movements. Slope movement-prone areas are shown on figure 4.

Illite deficient in potassium is the major clay mineral found in slope movement-prone soils derived from the upper part of the Bangor Limestone and the Pennington Formation on the Cumberland Plateau. Commonly, the green mudstone in these units is more clay-rich than the reddish to reddish-purple siltier mudstone and shale, and thus more susceptible to slope movement. Movements take place either in the colluvium or at the contact of the colluvium and weathered mudstone or shale. Slump-earthflows, debris slides, debris flows, earthflows, debris slide-earthflows, rock topples, and rock falls are the principal types of slope movement. Debris avalanches are not abundant, in part because of limited quantities of colluvium along the lower and middle parts of many slopes, especially in the western part of the Jackson County Mountains. Road widening and new highway relocations have triggered large numbers of slope movements along the west side of Sand Mountain. One new highway (Alabama 227) cuts across the lower part of an extensive colluvial slope in a direction roughly parallel to the prevalent orientation of nearly vertical joints. Above the highway cut, slumping and flowage at or near the base of colluvium overlying the Pennington Formation has been compounded by the dislodging of the thick-bedded sandstone bedrock of the Pottsville Formation, largely as a result of stress release. The fallen blocks have surcharged the already unstable slope. Springs emanating at the contact of permeable and impermeable bedrock contribute to the initiation of slope movement.

In the Highland Rim section of northern Alabama, the movement-prone slopes are underlain by the Pride Mountain Formation of Late Mississippian age. The most susceptible material is plastic colluvial soil derived from grayish-green shale. Recent colluvial movements more than 100 m wide along gentle slopes, and prehistoric bedrock slumping along a northwest-trending joint-controlled valley attest to the long-term instability.

Slope movements in the East Gulf Coastal Plain can be traced to failure surfaces in blue-gray and red to light-gray clay of the Tuscaloosa Group of Late Cretaceous age. Large slope movements northwest of Hamilton took place during and after construction of a major highway (U.S. 43).

[1]M. Szabo (Alabama Geological Survey) believes that these sediments are not the Tuscaloosa Group but a younger sequence.

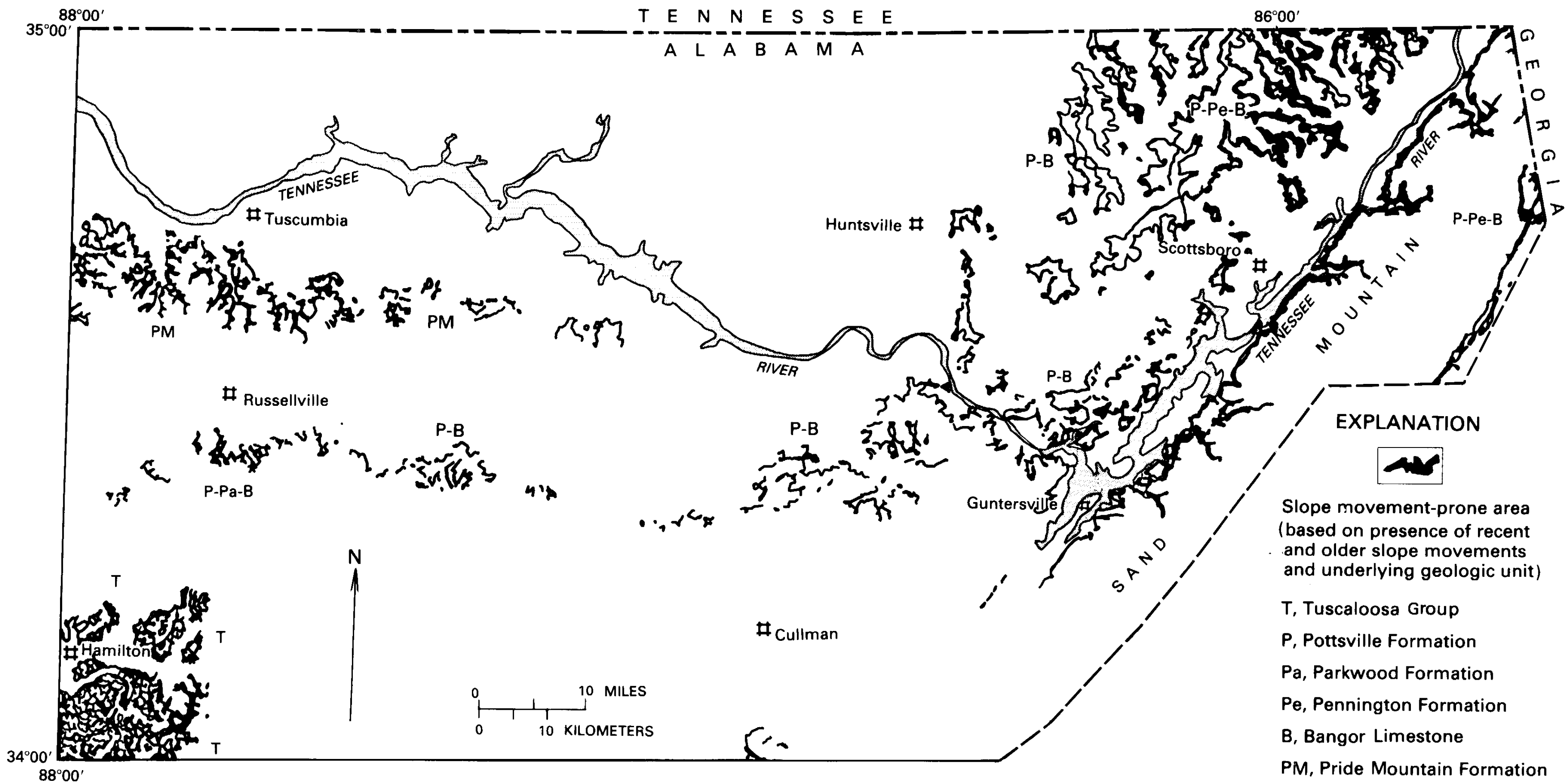


Figure 4. Map showing slope movement-prone areas, northern Alabama. Modified from Pomeroy, 1982b; Thomas, 1979, 1982.

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