Geology of the Lost River Rock Slide, West Virginia

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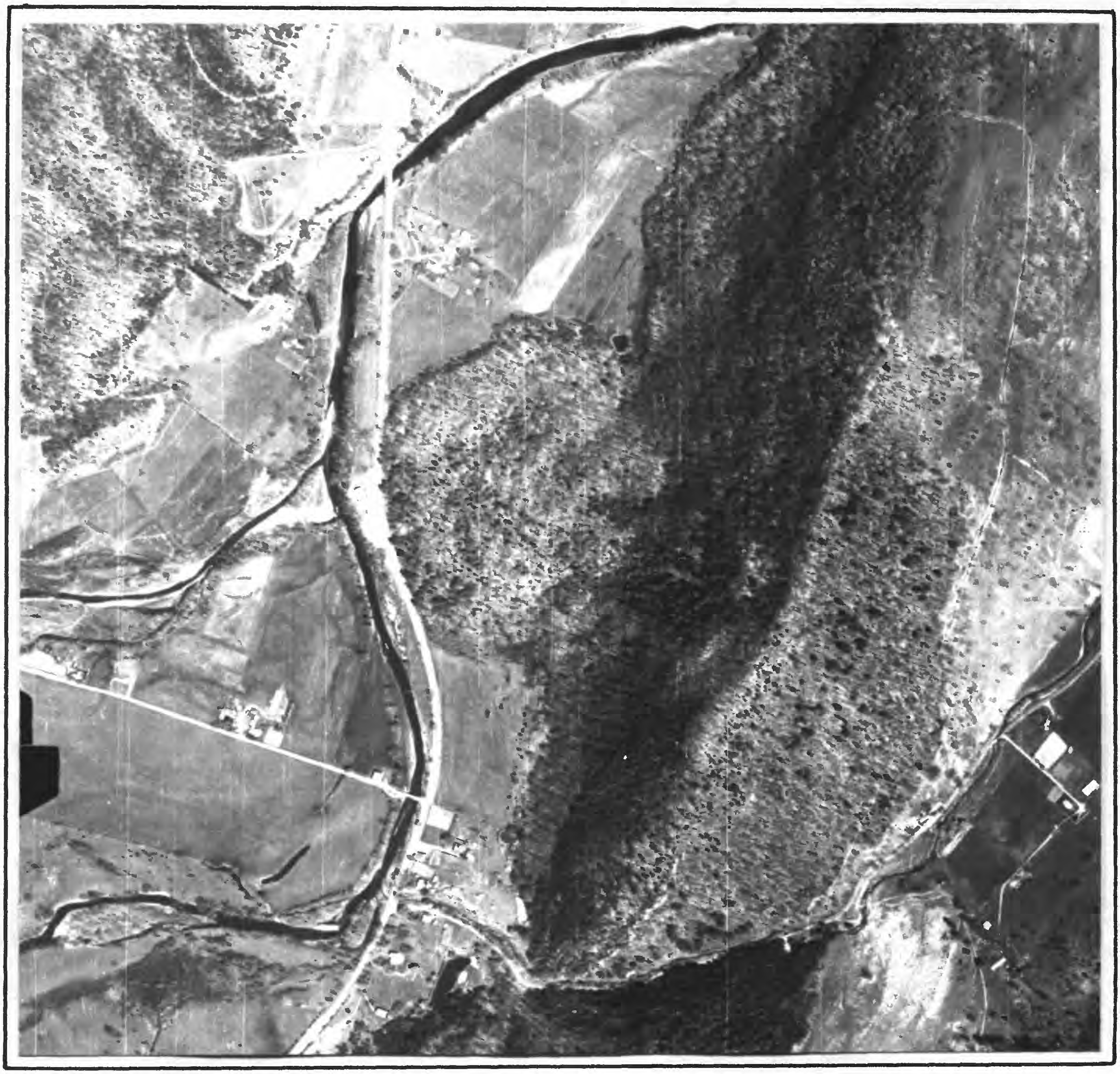

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Abstract

Geologic field mapping and analysis of aerial photographs reveal a rock slide of Oriskany Sandstone of Devonian age in the Quaternary alluvial valley of Lost River, West Virginia. Approximately 3 x 10^6 m^3 of sandstone became detached along a bedding surface dipping 30° northwest within a calcareous sandstone and cherty limestone. Undercutting by Lost River at the base of the slope is inferred to have caused the gravity failure. Devonian shale preserved at the toe, distinct levels of rock slide deposit, and stratigraphic relationships determined from auger holes suggest that alluvium was deposited partially on and around the rock slide. Future excavation may reveal the contact and provide organic matter to date the rock slide event and terrace formation.

Introduction

Geologic field mapping and analysis of aerial photographs reveal a rock slide near Lost River, W.Va. (figure 1). No similar rock slide has yet been recognized in a valley of Quaternary alluvium in the Central Appalachians of the Virginias and Maryland. Although slide scars have been recognized adjacent to valleys, the rock slide deposits were apparently long since removed by fluvial erosion (Southworth and Schultz, 1986). At Lost River, W.Va., the rock slide appears to rest <u>on</u> the adjacent flood plain. This investigation provides data that suggests a more complex geologic history.

The Lost River rock slide may have been a translational bedrock landslide where the dominant type of movement was planar sliding along bedding on the dip slope (figure 2). Failure of the bedrock slab may have occurred as multiple events or as a single event which disaggregated upon impact with the valley bottom.

Regional Geology

The Lost River rock slide is located in the Valley and Ridge province of the Central Appalachians in east central West Virginia (figure 1). The rock slide involves Oriskany Sandstone of Devonian age on the northwest limb of the Hanging Rock Anticline near a zone of fold interference with the Adams Run Anticline (figure 3). These anticlines are the product of compressional tectonics of the Alleghenian Orogeny. In this region, anticlines may be the result of at least two stages of deformation: broad folding due to deformation in the footwall of the North Mountain fault to the east, and later, increased folding by blind thrust faults splaying from the underlying duplex structures of Cambrian - Ordovician carbonate rocks (Kulander and Dean, 1986).

Extensive erosion since the Alleghenian Orogeny has exposed resistant sandstone and quartzite on the fold limbs. Adjacent to these ridges, the removal of less resistant shale and siltstone by fluvial erosion results in the classic topography of the Valley and Ridge province. Existing small-scale geologic maps (Tilton, 1926; Cardwell and others, 1968) do not identify the rock slide.

Local Geologic Setting

Field mapping and analysis of aerial photographs provide new data on the bedrock and surficial geology (figure 3). Structurally, the rock slide occurs on the northwest limb of Hanging Rock Anticline approximately 1 km north of where the fold becomes the northwest limb of Adams Run Anticline. The ridge here is held up by the resistant Oriskany Sandstone of Early Devonian age and attains the highest elevation where the bedrock dip flattens near the axial trace of the plunging fold. Six out of fifteen bedrock landslides currently under investigation (Southworth and Schultz, 1986) have this characteristic structural setting; all but one have rivers at the base of the slope. This relationship between the bedrock attitude, structure, and topography is best illustrated by a side-looking airborne radar (SLAR) image which shows the largest backslope shadow along the longitudinal ridge at the rock slide (figure 4).

The rock slide appears to have failed onto the surface of the alluvial valley (figure 5). The present flood plain consists of approximately 2 meters of alluvial sand, silt, and gravel deposited on shale bedrock. The bedrock has been planed by the northeast-flowing Lost River. The contact of the rock slide toe and the flood plain alluvium appears to be sharp. Colluvium mantles the contact of the rock slide and the ridge. This "mountain slope colluvium" is formed by long term accumulation of rock debris weathering from the ridge. The colluvium conceals the contact of Needmore Shale and Oriskany Sandstone. South of the rock slide, extensive mountain slope colluvium is present. Paired fluvial terrace remnants over 100 m above the present flood plain are also preserved.

The Rock Slide

An approximately 350-m long, 200-m wide, and 50-m thick volume of Oriskany Sandstone became detached and slid on a ~30°-dipping bedding surface over 500 m into the valley. Topographic relief of 180 m and well preserved lateral and head scarps provide the basis for these measurements (figures 5 and 6). Scree of Oriskany Sandstone (figures 6 and 7) and rock trenches high on the slope (figure 5) provide evidence of detachment within the Oriskany Sandstone. Detachment was within the lower calcareous sandstone beds near the Shriver Chert of the Helderberg Group. Here, bedding surfaces are well etched, often open, and dissolution of calcium carbonate may have contributed to the instability of the overlying massive sandstone (figure 9). Lateral scarps are obvious but bedrock is covered. The head scarp appears intact, although, ridge crest valleys suggests gravitational spreading.

The rock slide consists of a jumbled mass of subangular boulders, and blocks of Oriskany Sandstone (figure 9). Blocks of Oriskany Sandstone are as large as 7 m^3. Two distinctive levels are apparent with the higher level above the 1400'contour interval. The existence of at least 2 topographic levels of rock slide may indicate more than one event or erosional modification of a single rock slide. Due to the lack of accurate topographic data, a morphologic interpretation (figure 10) was produced from stereoscopic analysis of aerial photographs (figure 5). The micro- and macro-topography of depressions and knolls is not yet fully understood. Possible mechanisms include subsidence due to groundwater sapping and decomposition of buried flora, sorting due to surface drainage, periglacial modification, and human work. It is unlikely that the mounds are depositional in origin. Shale saprolite and shale fragments exposed near the toe of the rock slide (figure 11) suggests that the rock slide may not have been deposited on top of the present alluvium.

Sixteen, 3" diameter holes were augered in the substrate to various depths. Eight cores on the rock slide and 8 cores on the alluvial valley near the toe were logged (figure 12). A generalized stratigraphic correlation derived from these data is shown in figure 13 and are incorporated into the geologic/topographic cross sections in figure 14. Although surface datum elevations are presently lacking, some qualitative observations are pertinent. Rock slide cobbles of Oriskany Sandstone are underlain by shale saprolite and shale bedrock around the toe of the rock slide. Large rocks are as deep as 2 m on the alluvial flood plain and as much as 20 m away from the "sharp contact" with the rock slide. Depth to these rocks increases with distance away from the rock slide. Sandy alluvial loam and rounded pebbles of shale and sandstone (other than Oriskany Sandstone) were found ~1 m below the surface of the rock slide; this horizon is ~3 m above the alluvial valley.

Discussion

Geologic field data suggest that alluviation by Lost River has modified the rock slide; the margins may have been buried by deposition of alluvium and the toe reworked during high-water conditions. The present alluvial valley fill was deposited around a previously larger rock slide, rather than the rock slide deposited on top of the flood plain. The existence of Devonian shale bedrock at the toe suggests that the rock slide buried a preexisting rock-cut terrace. This rock-cut terrace would be intermediate in elevation between the high alluvial terraces above 1400' and the present rock-cut terrace at the base level of Lost River (figure 3).

These terrace landforms are due to a process of "cut and fill" where laterally migrating rivers cut bedrock and deposit alluvium. Terraces at elevations above base level are remnants of fluvial valleys prior to steady downcutting or climatic and/or tectonic events.

The shale bedrock at the toe of the rock slide is interpreted to be a rock-cut terrace when the channel of Lost River was near the mountain slope. Downcutting at the base of the sandstone beds would have created instability resulting in gravity failure (figure 15).

The rock slide was deposited on the flood plain which included the channel and rock-cut terrace. Lost River was then diverted around the toe of the rock slide. Alluvium was deposited around the rock slide by slack water; periods of high water flooded the rock slide margin. The mound-like, hummocky topography and distinctive, lower level of the rock slide may owe their origin to subsequent erosional modification. Erosion by Lost River isolated the shale at the toe as a topographic knoll; the shale was preserved due to an armoring effect by the colluvium. Using an erosion rate of 40 mm per 1000 years (Hack, 1980) and an elevation difference 11.5 m of (38'), incision at the toe has been active for 289,000 years (Early Illinoian Glaciation of Middle Pleistocene). Since these average erosion rates are applied to an actively incised region, the relative age estimates may be considered as maximum. Indian projectile points found on the surface of the rock slide supports a prehistoric age.

If the proposed model is correct, flora and fauna of (Mid?) Pleistocene-time may have been buried by the rock slide thus providing a time capsule. Trenching by backhoe at the margin of the rock slide and present alluvial valley may expose these relationships. ^{14}C radiometric dating of buried organic material could provide constraining ages on two very significant processes in the Valley and Ridge province: rock slide/colluviation and fluvial terrace formation.

A geologic interpretation of stereo aerial photographs of Lost River from the headwaters to its exit from the longitudinal valley support the rivers lateral migration and undercutting of ridges (figure 16). Mountain slope colluvium extends from the Oriskany Sandstone ridges to the valley floor where Lost River meanders to the rock defended berm of the west side of the valley. Lost River is diverted westward around a prograding alluvial fan to the south of and resumes a longitudinal course along the bedrock berm. A smaller alluvial fan draining into Lost River creates a diversion of the channel toward the rock slide. Here, the river flows around the toe. Then Lost River regains a longitudinal course against the dip slope of the Oriskany Sandstone. A key here is the markedly decreasing width and extent of mountain slope colluvium north of the largest alluvial fan. Specifically at the Lost River rock slide, the change in outcrop width of mountain slope colluvium decreases by more than 50%. Where the river currently flows along the Oriskany-defended-dip slope to the north, virtually all mountain slope colluvium has been removed.

The Saidmarreh landslip in the Zagros Mountains of Iran (figure 17) is an analog to the Lost River rock slide. Although the Zagros rock slide involves different lithologies and is far greater in size, river undercutting at the base seems to have caused the failure; lake sediments from the dammed river yielded a date of 10,370 ±120 years before present (Watson and Wright, 1968).

Acknowledgements

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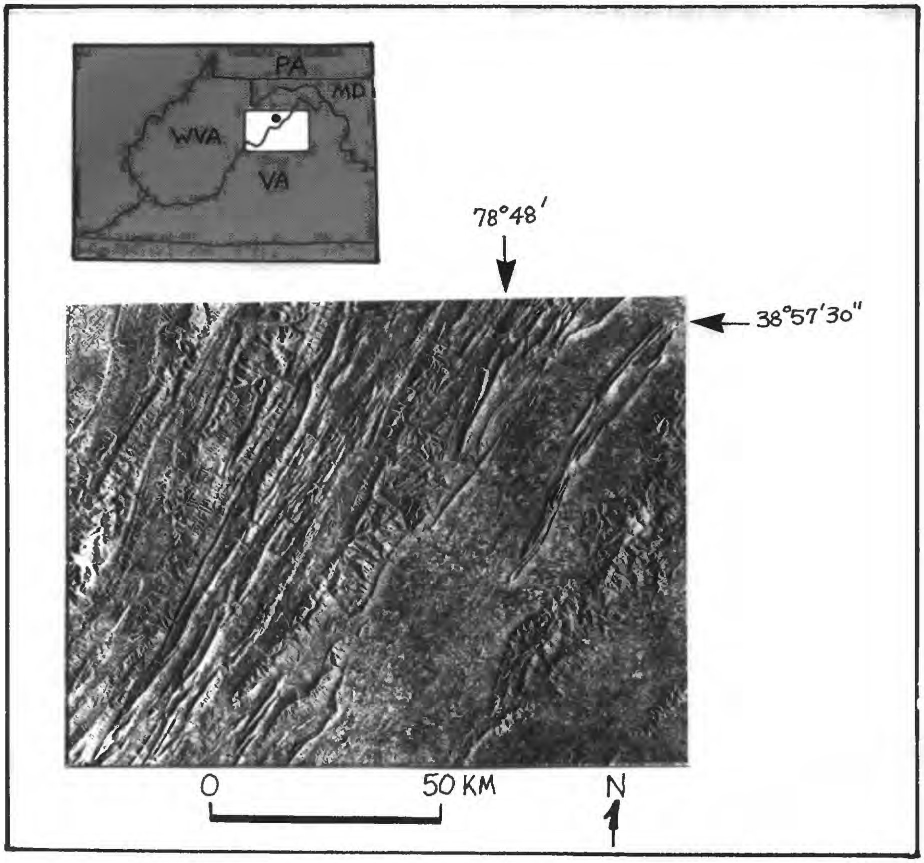

Figure 1. - Index map showing Lost River rock slide located within the Charlottesville 1° x 2° quadrangle SLAR image mosaic.

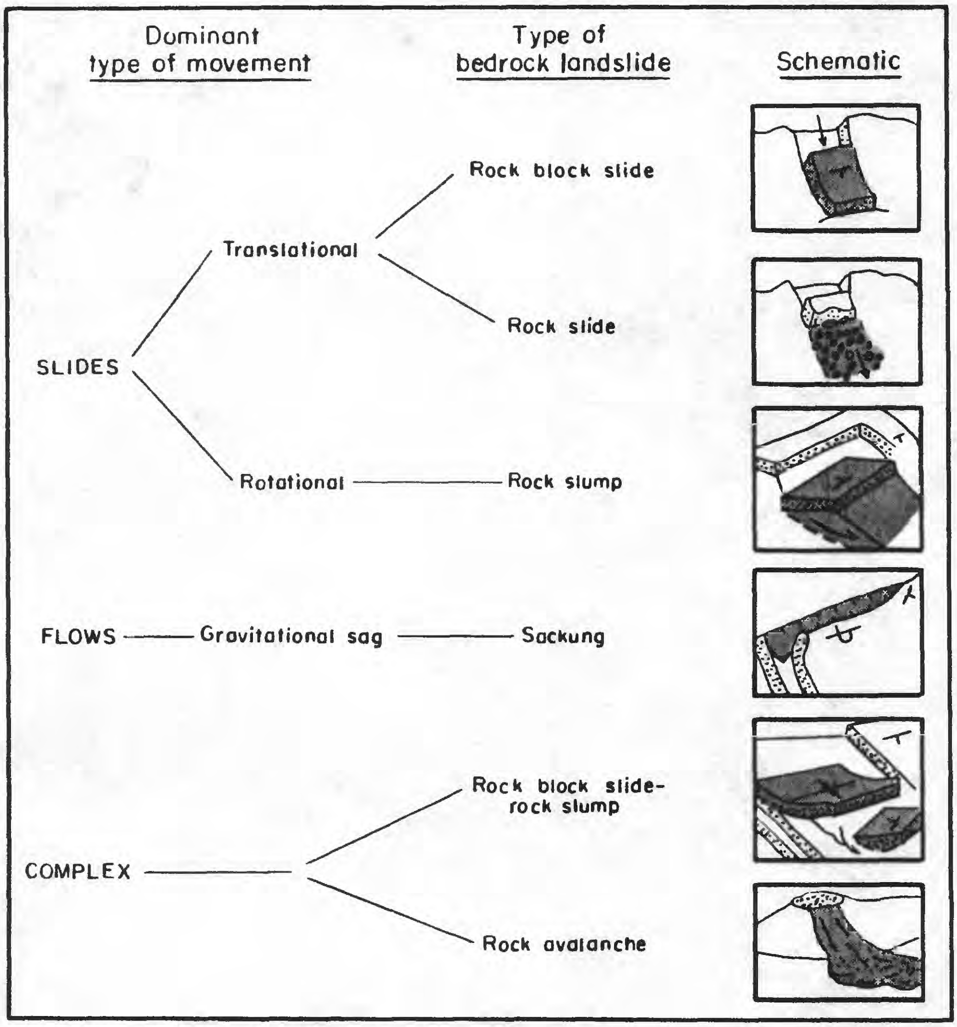

Figure 2. - Types of bedrock landslides in the Appalachian Valley and Ridge province. The feature at Lost River is interpreted to be a rock slide although it could have originated as a rock block slide.

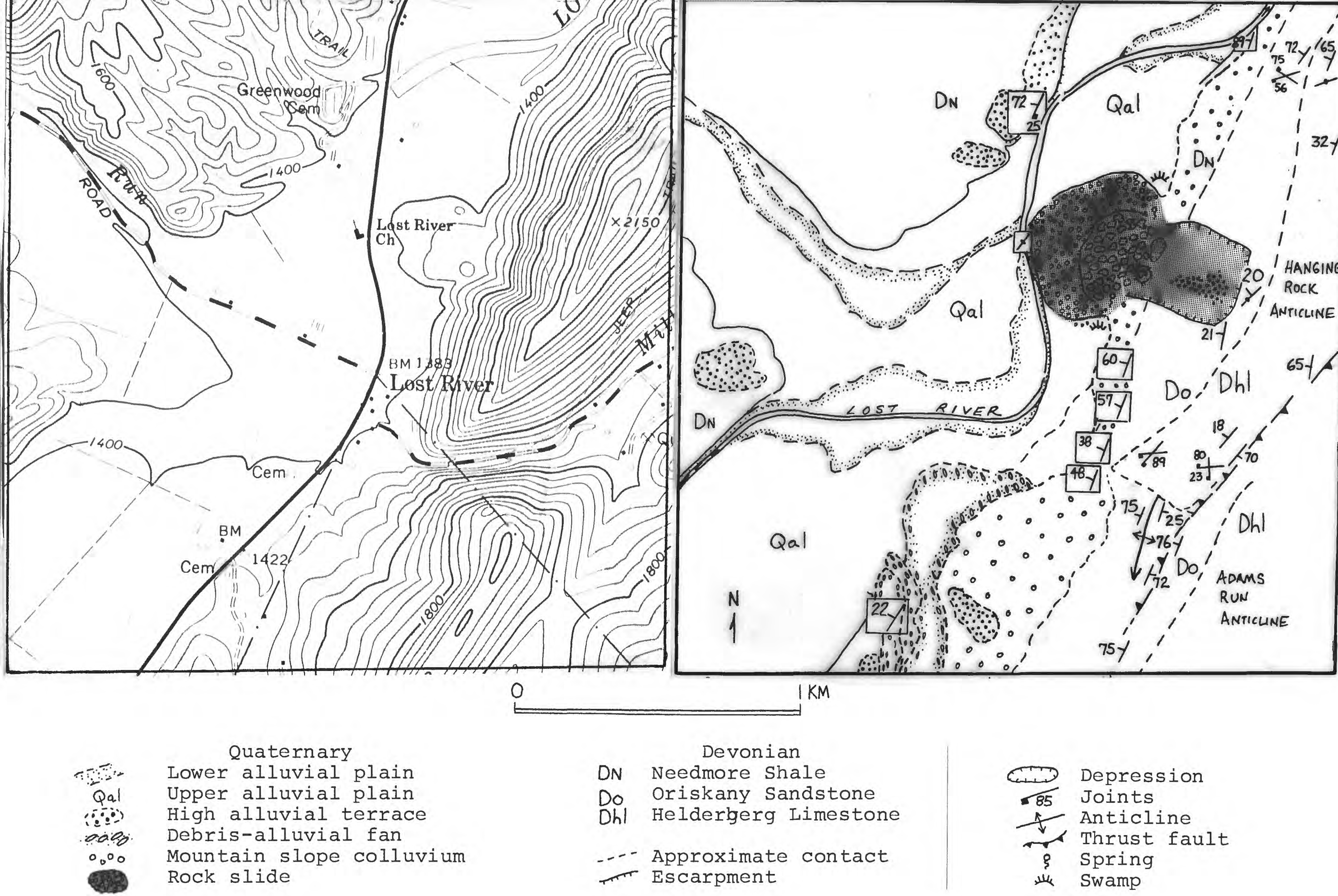

Figure 3. - Topographic and geologic map of Lost River, W.Va. region.

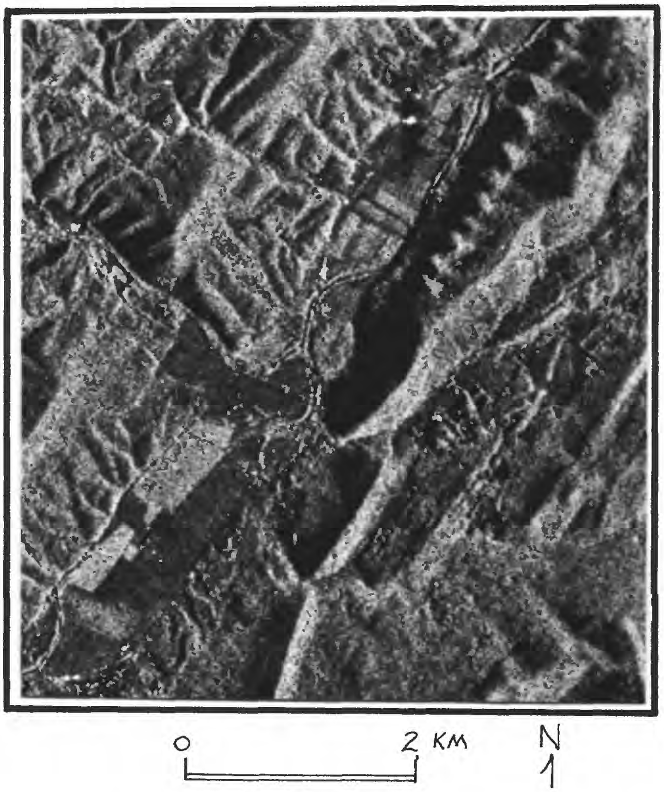

Figure 4. - Side-looking airborne radar (SLAR) image of the rock slide. The anomalous semi-circular radar return of the deposit is due to diffuse return of deciduous tree canopies adjacent to grass covered alluvial valley. The increased topography of the ridge due to closure of the anticline is evidenced by increased shadowing in the radar backslope.

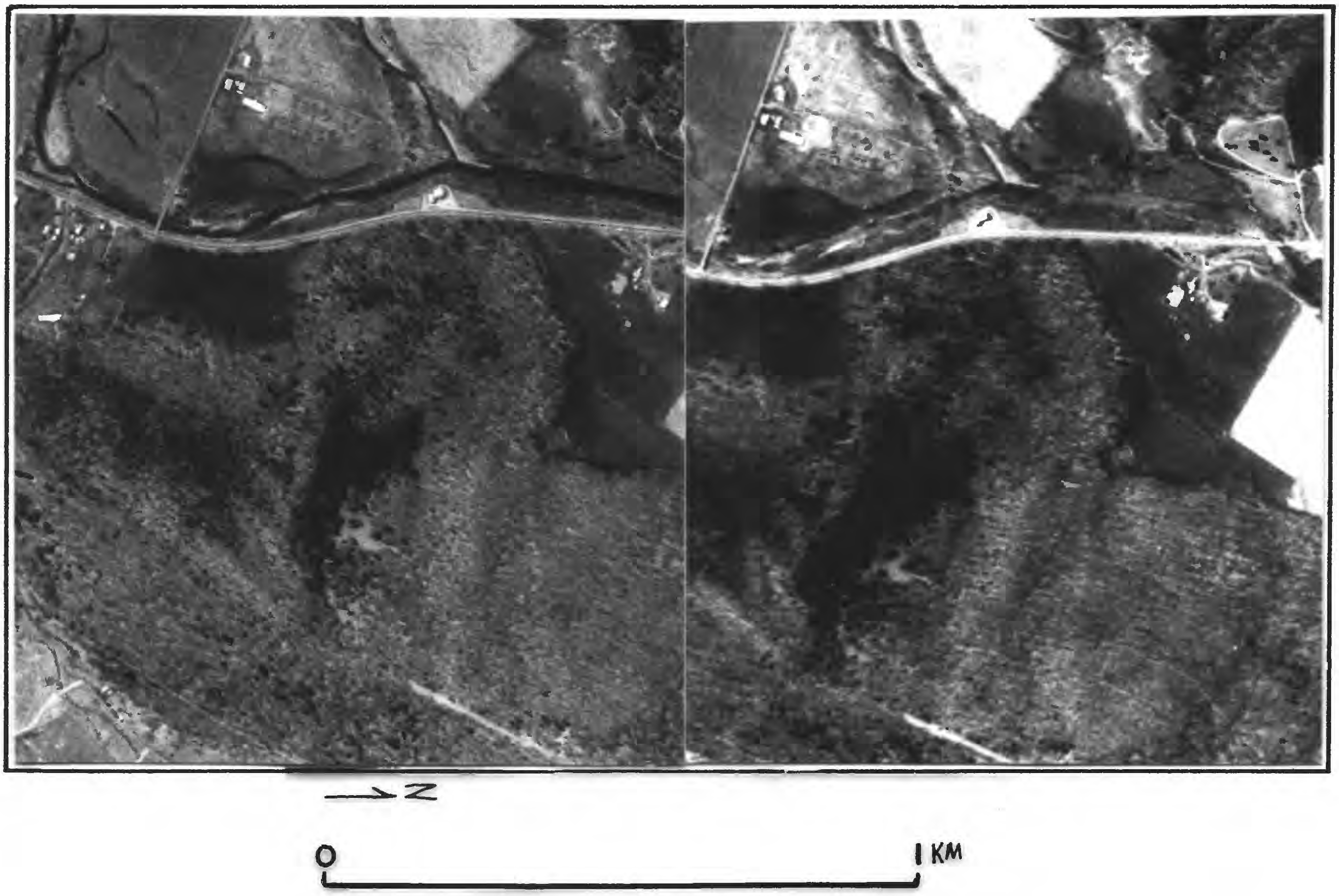

Figure 5. - Stereopair of aerial photographs acquired April, 1982 of the Lost River rock slide.

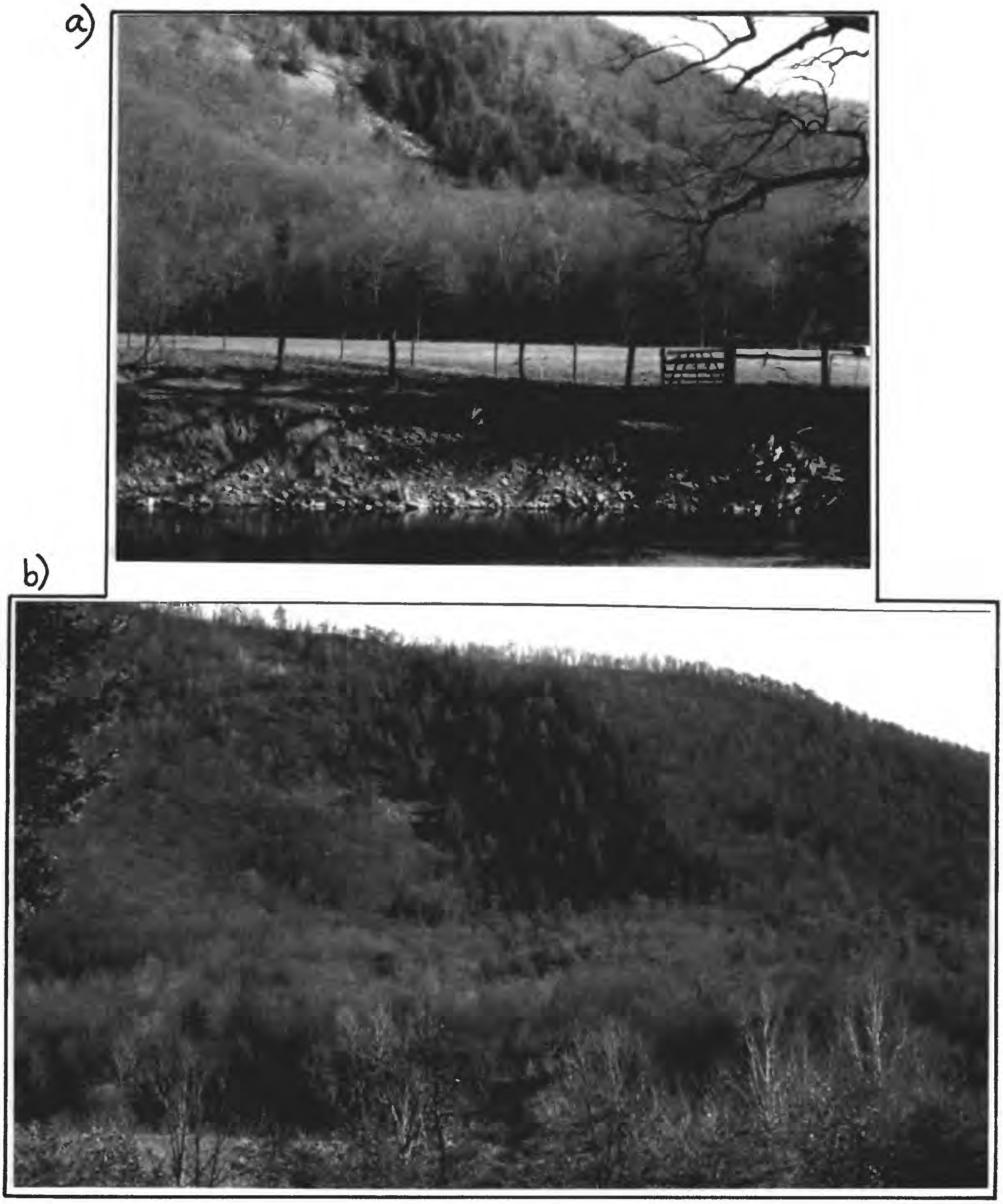

Figure 6. - Ground-based photographs of the rock slide taken from a) present flood plain (Qal) and, b) elevated fluvial terrace (see figure 3, Greenwood Cemetary).

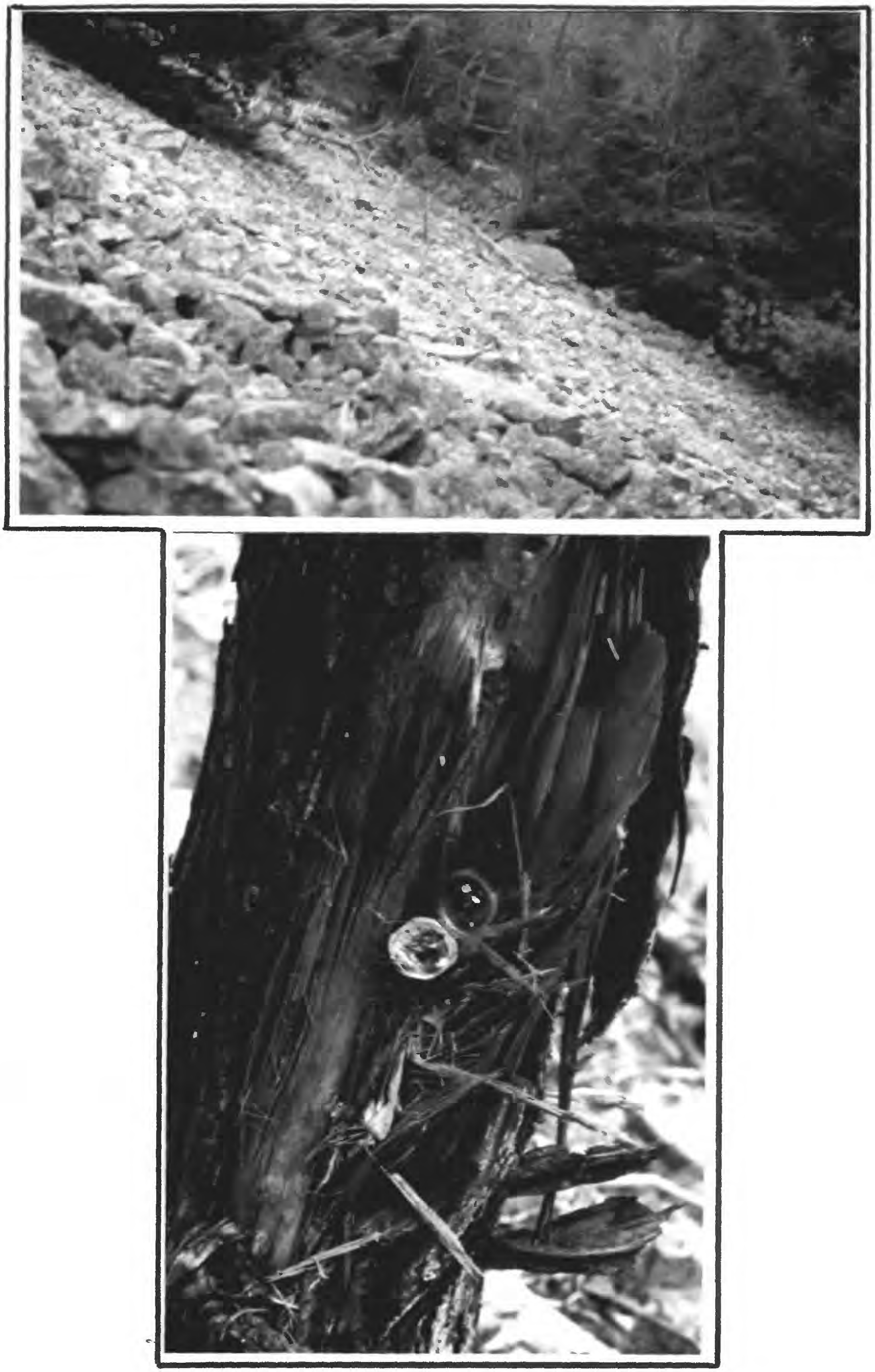

Figure 7. - Active scree slope of Oriskany Sandstone at angle of repose. Tree blast is evidence of active rock fall. Scree slope is also proof that the rock slide involved part of the Oriskany section since sandstone colluvium is still being generated by the ridge.

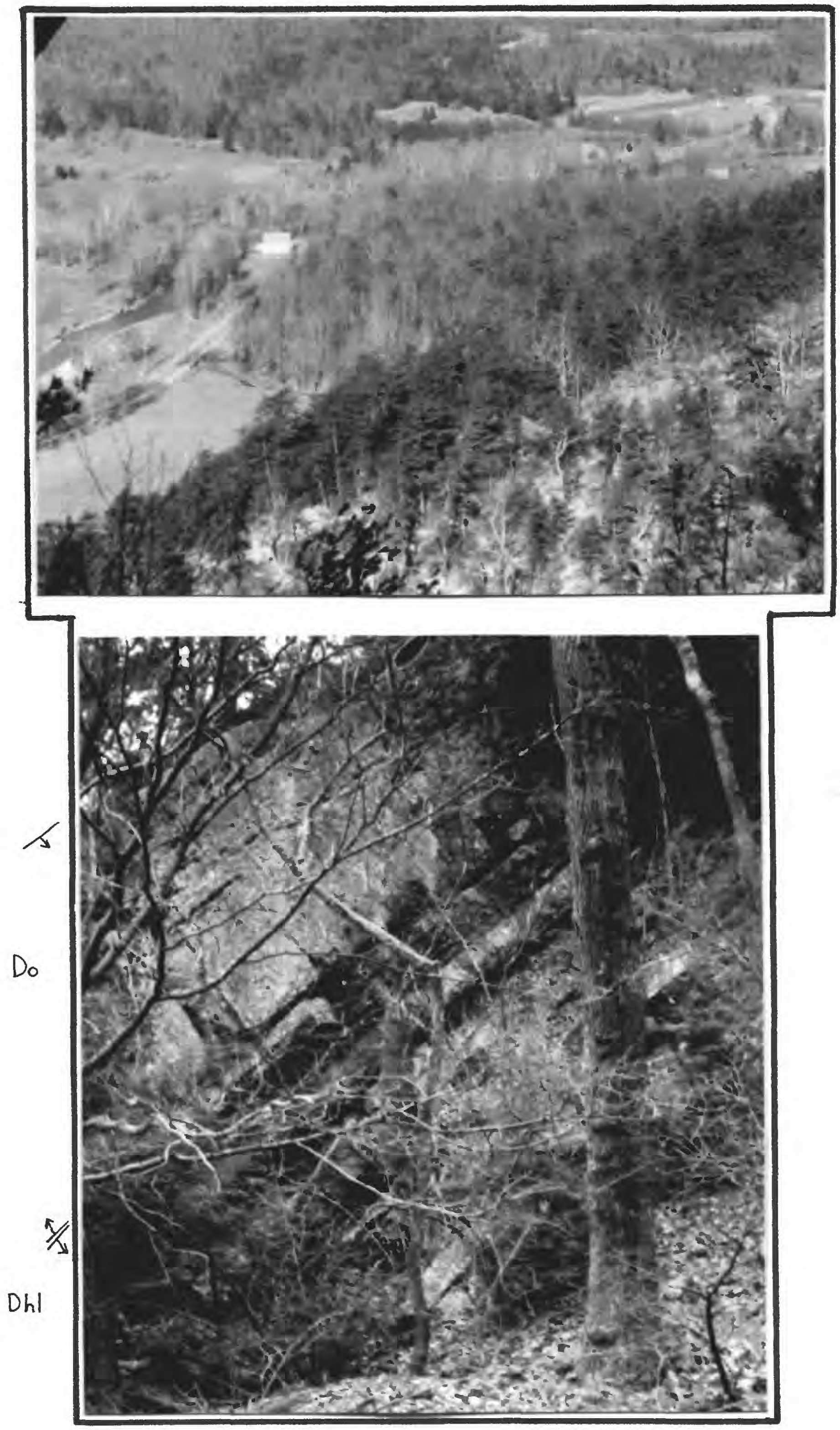

Figure 8. - Oblique photograph showing cross section through the water gap exposing ~30° dipping Oriskany Sandstone and Helderberg Group contact. Thin-bedded calcareous sandstone with shale and chert stringers is exposed below the massive sandstone beds.

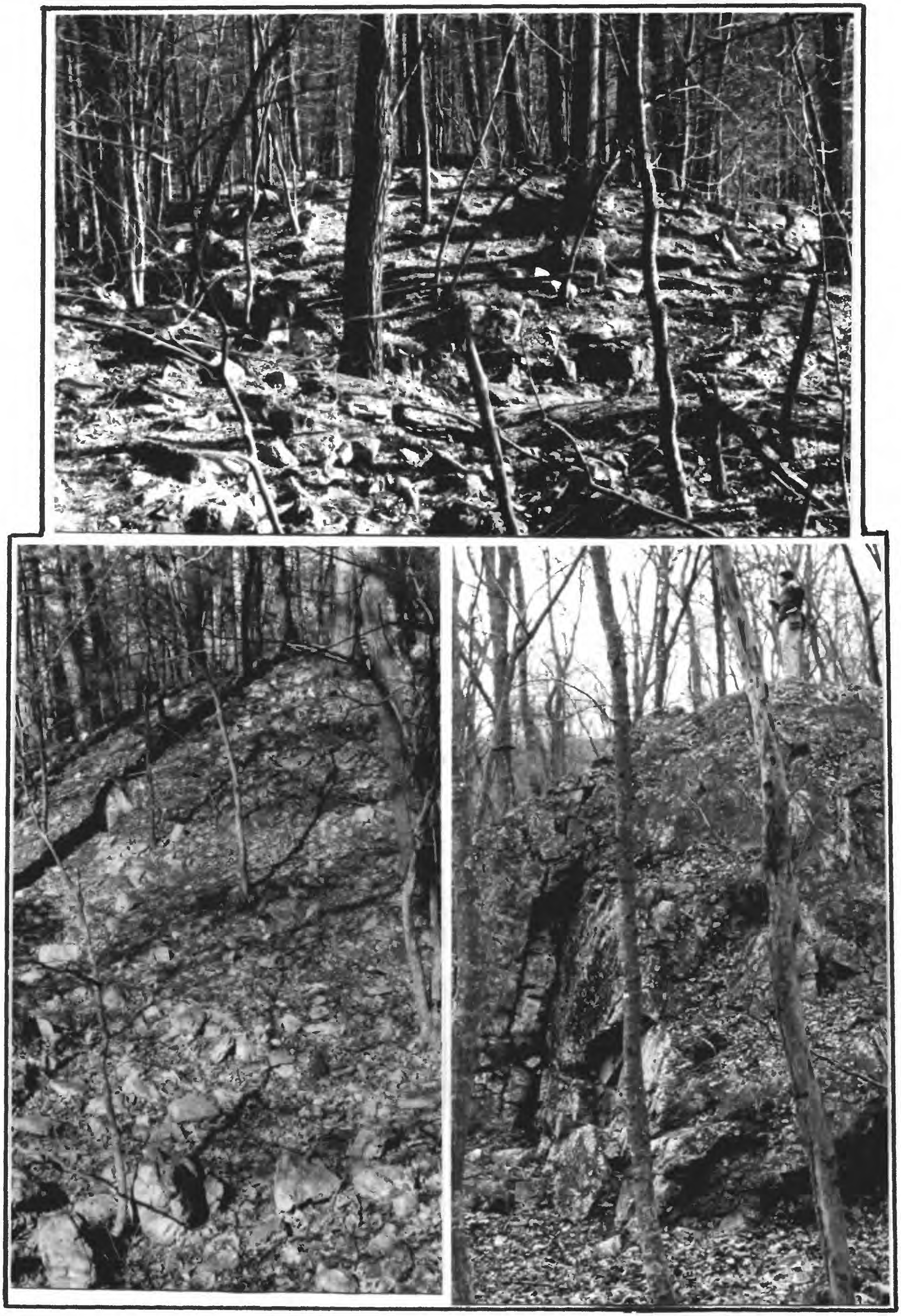

Figure 9. - Conical shaped mounds at the toe of the rock slide are not fully understood. Large blocks of Oriskany Sandstone are highly fractured.

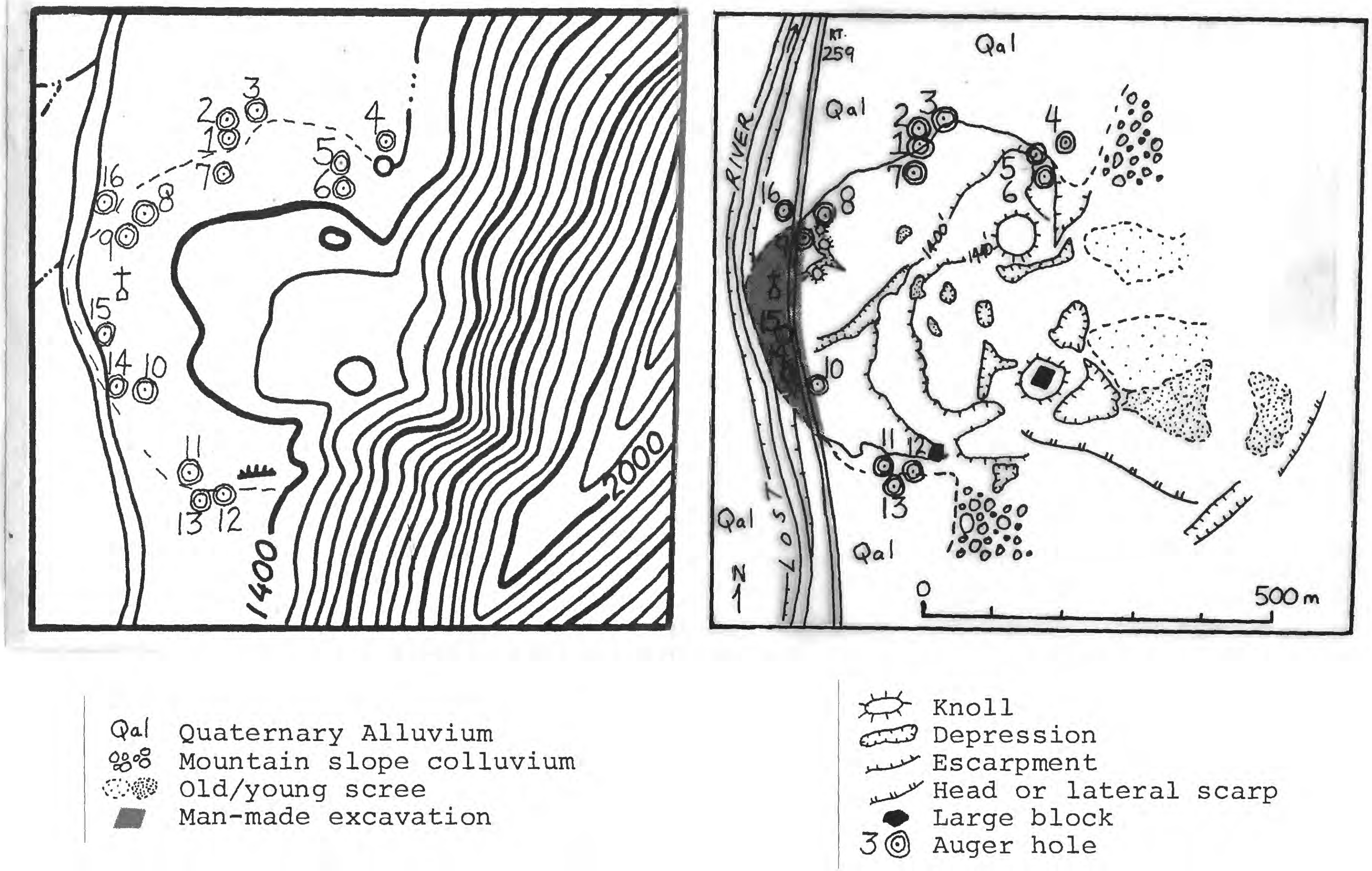

Figure 10. - Topographic and morphologic map of the rock slide.

Figure 11. - Topographic knoll mantled with rock slide and underlain by shale bedrock at the toe of the slide. Approximately 1 m of colluvium is exposed on top of shale saprolite in the adjacent road cut.

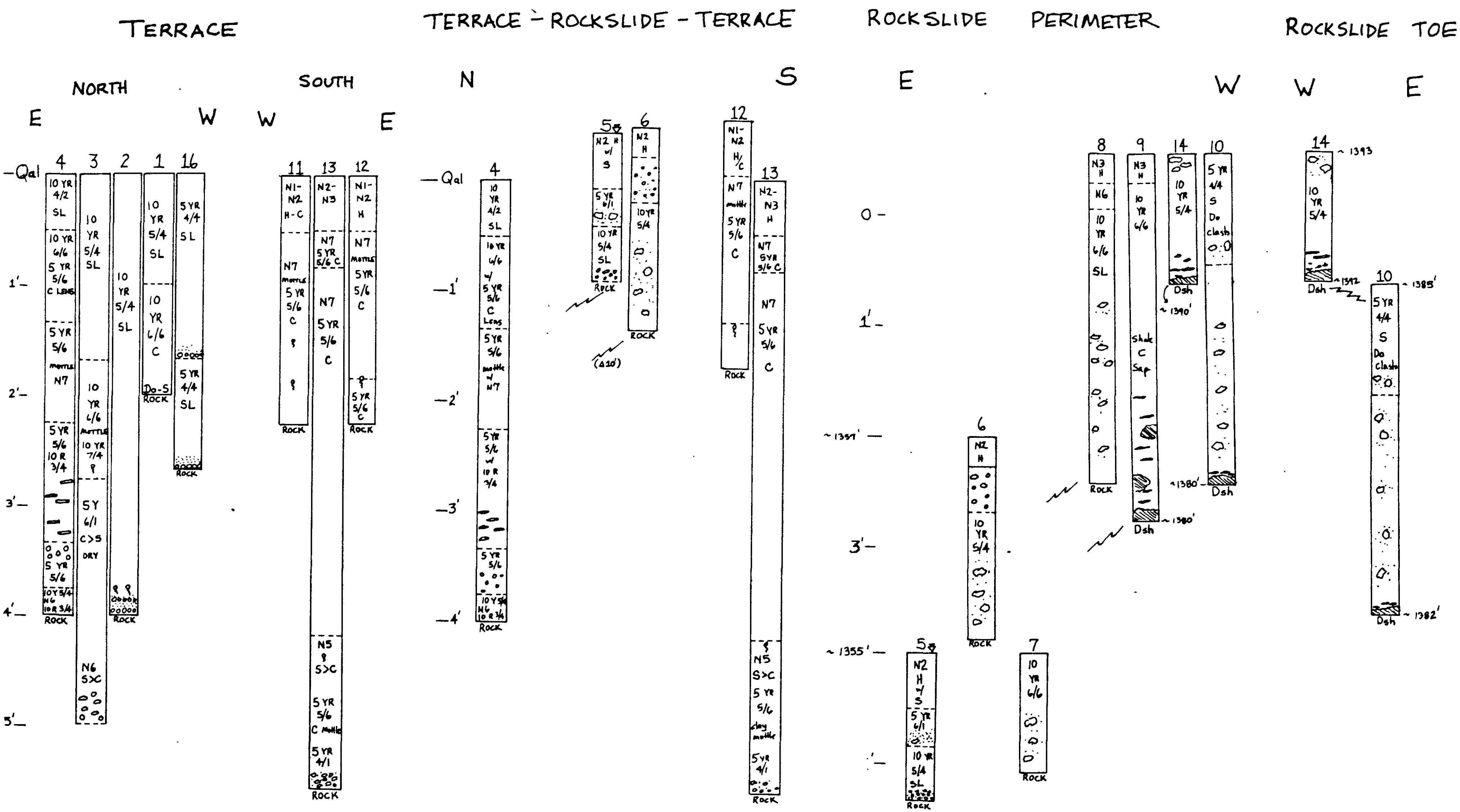

Figure 12. - Stratigraphic logs of auger holes.

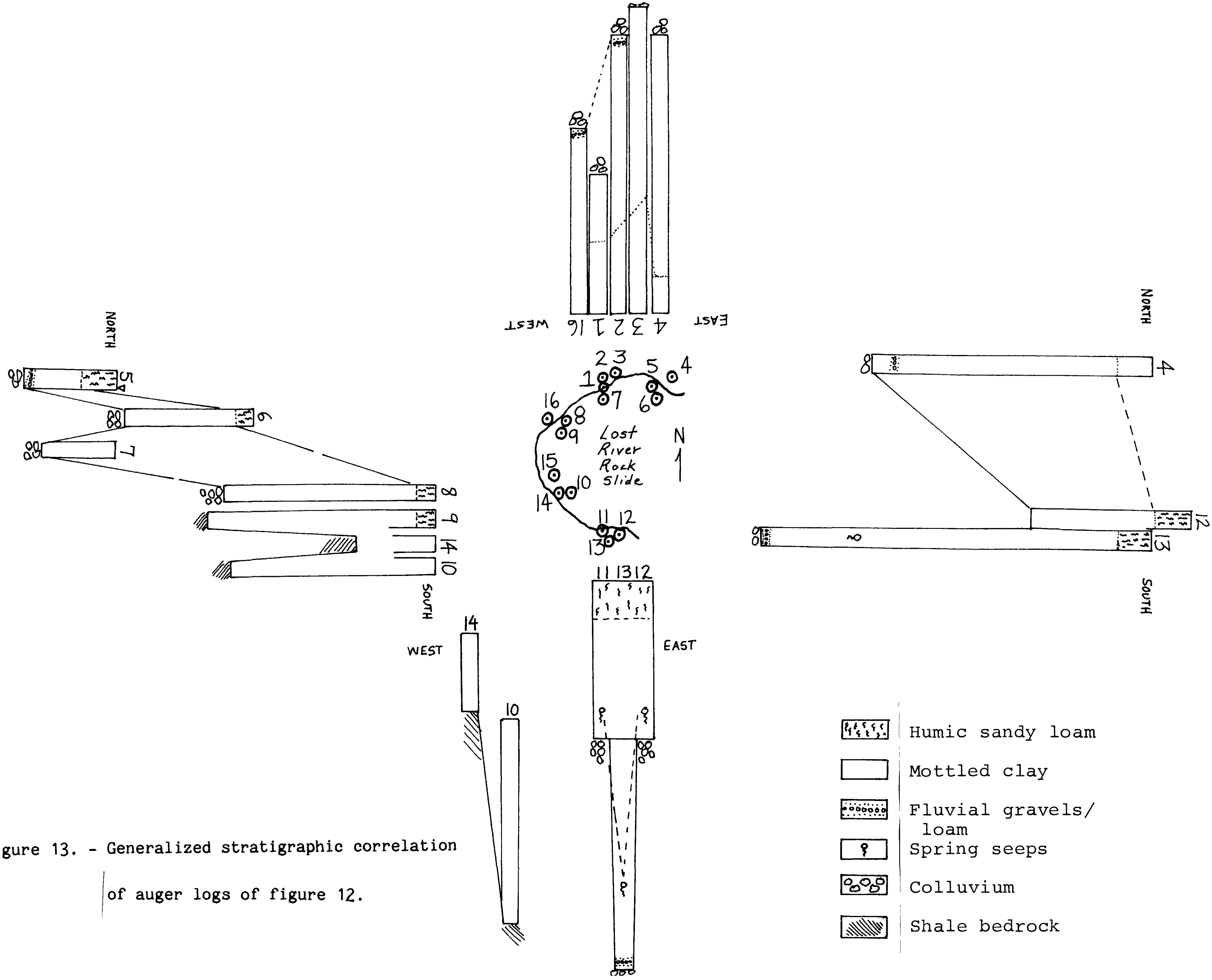

Figure 13. - Generalized stratigraphic correlation of auger logs of figure 12.

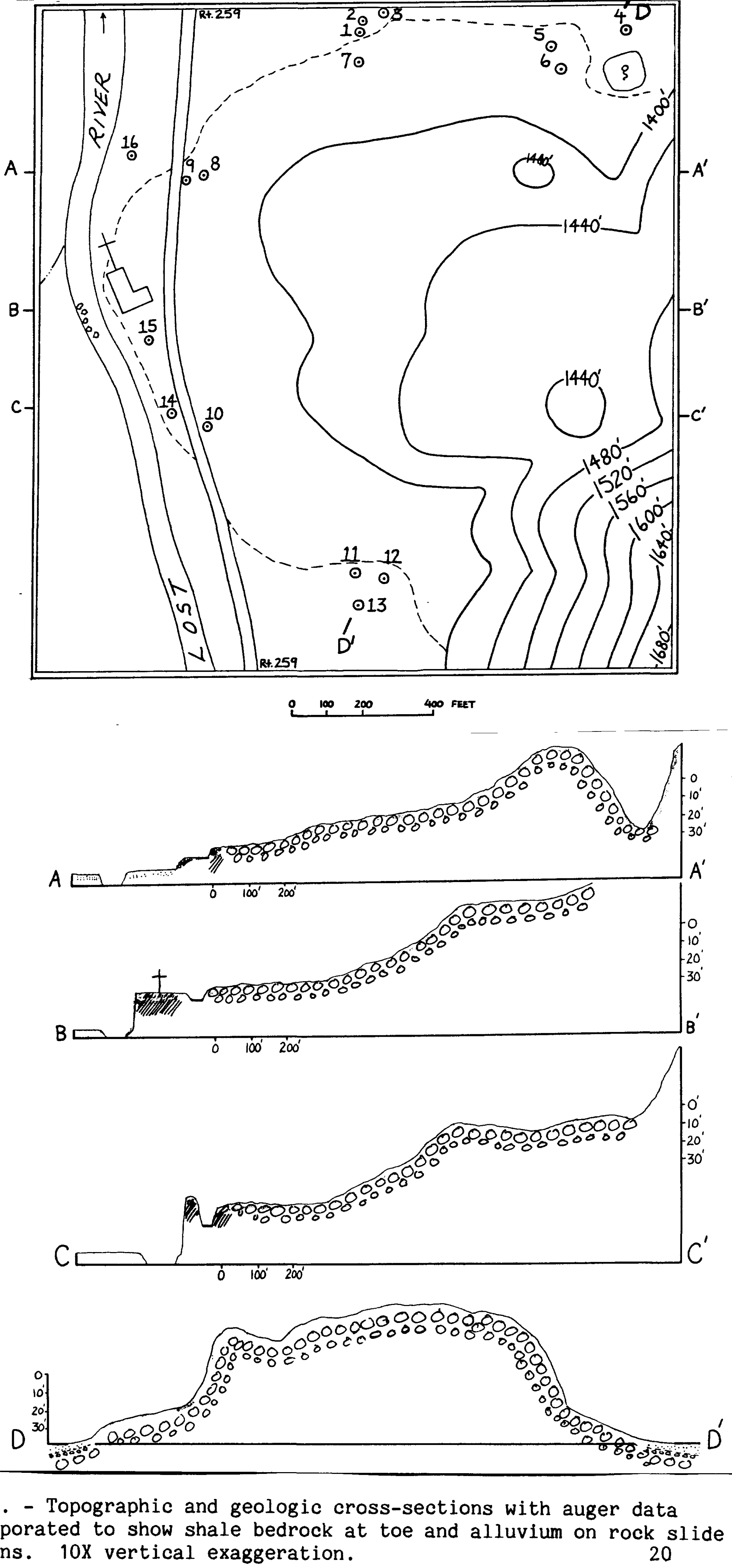

Figure 14. - Topographic and geologic cross-sections with auger data incorporated to show shale bedrock at toe and alluvium on rock slide at the margins. 10X vertical exaggeration.

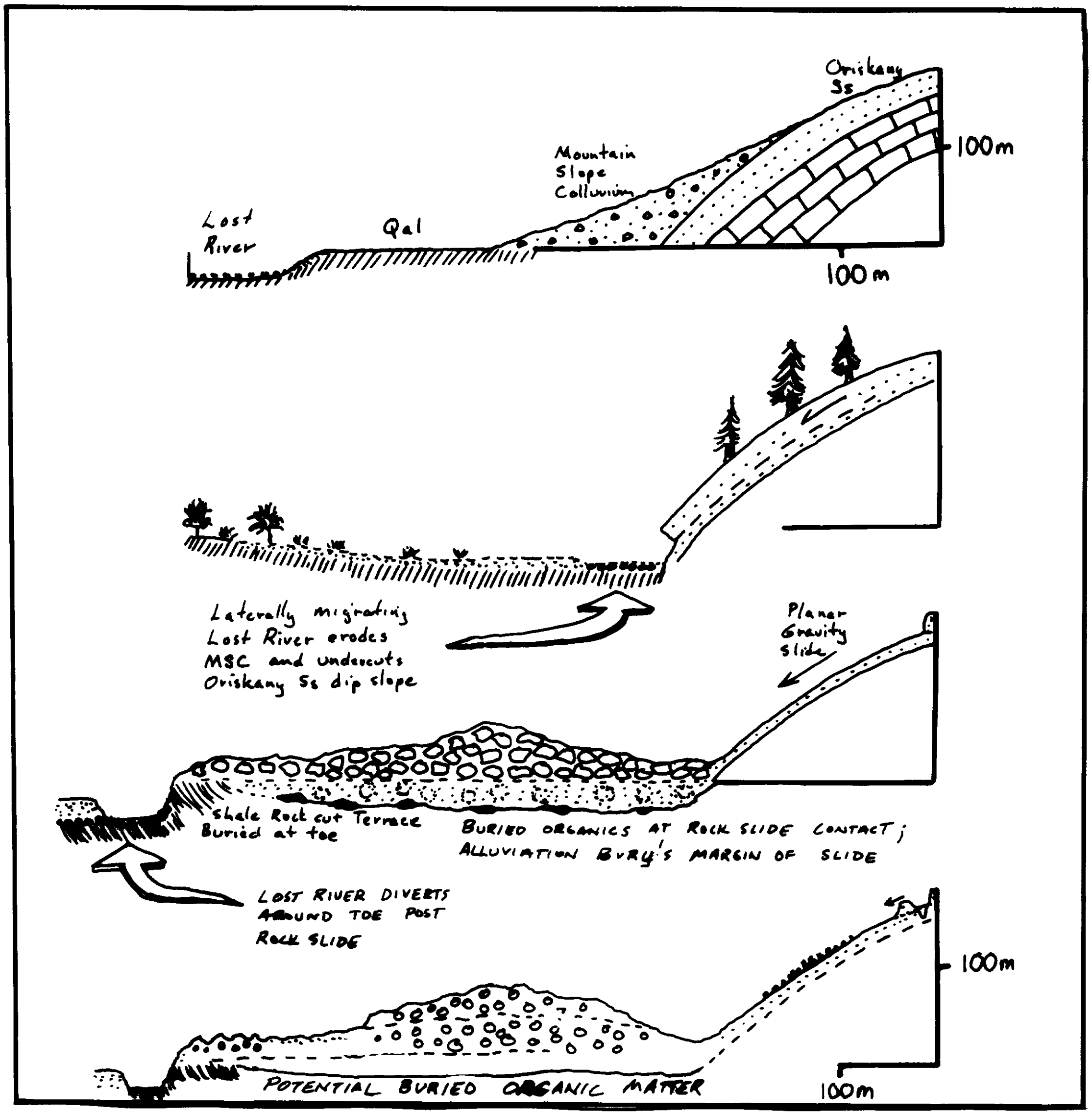

Figure 15. - Schematic diagram of interpreted model of the rock slide.

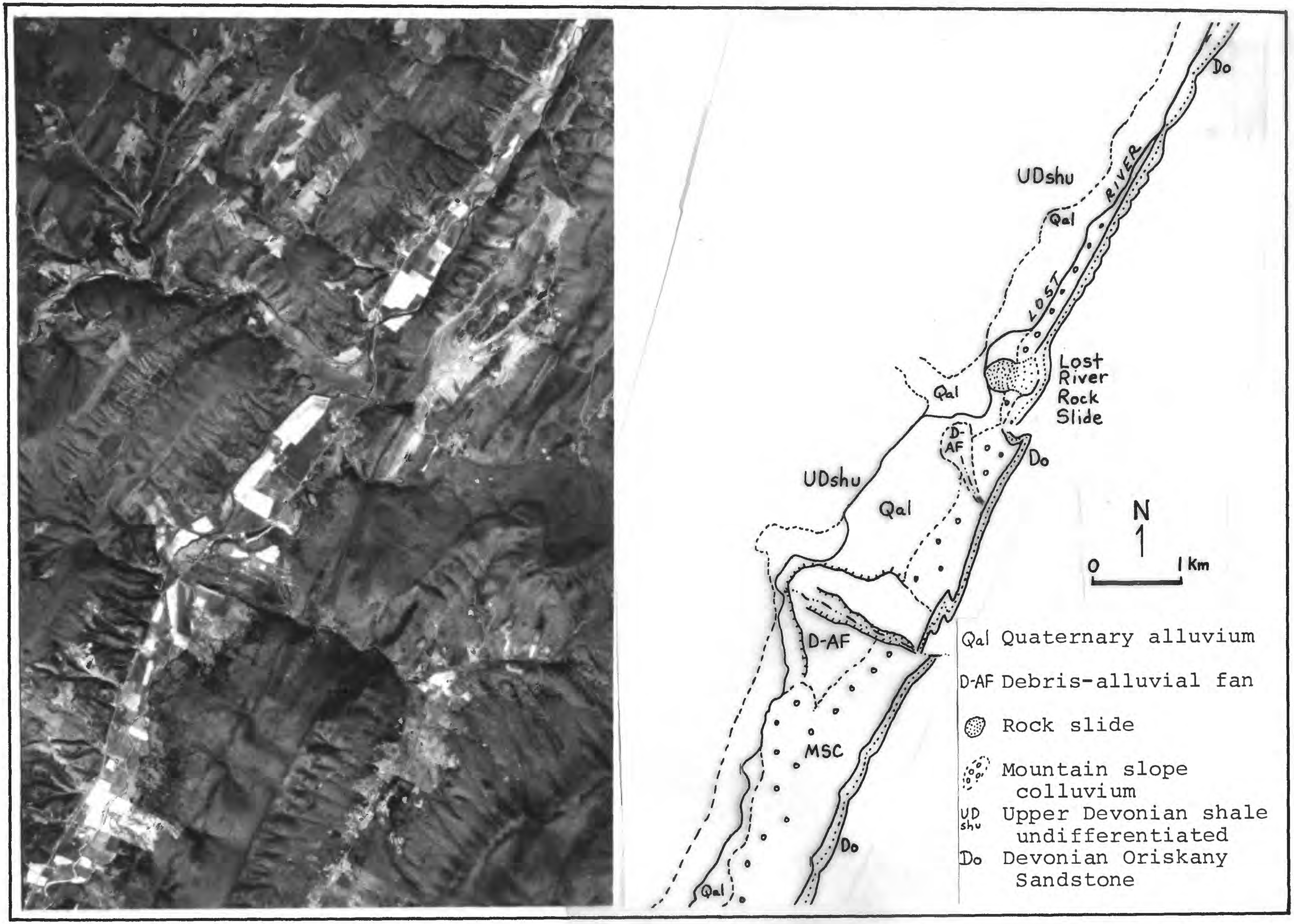

Figure 16. - Airphoto interpretation of fluvial erosion of mountain slope colluvium by laterally migrating river to expose slopes underlain by Oriskany Sandstone.

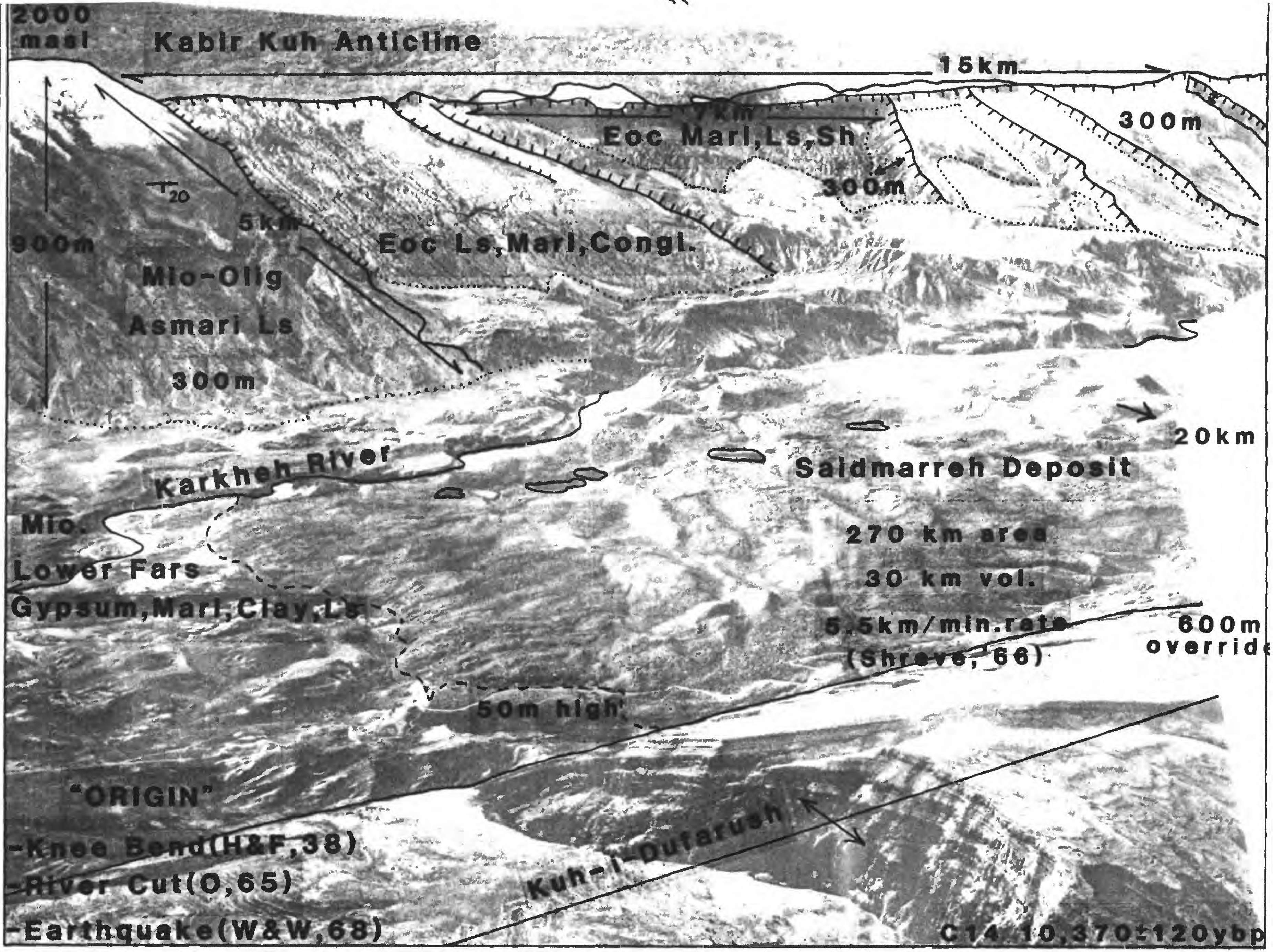

Figure 17. - Oblique aerial photograph of the Saidmarreh landslip in the Zagros Mountains of Iran - an analogous slope failure to the Lost River rock slide.