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LANDSLIDES ALONG THE ILLINOIS RIVER VALLEY SOUTH AND WEST OF LA SALLE AND PERU, ILLINOIS

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ILLINOIS STATE GEOLOGICAL SURVEY

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INTRODUCTION

In 1931 at the Illinois Academy of Science, Dr. George E. Ekblaw, engineering geologist with the State Geological Survey, observed:

> As most people associate landslides with mountainous, hilly, or rugged country, and as most of them also seem to be imbued with the misconception that Illinois is nothing but a flat, monotonous prairie, the statement that in this State landslides are very common generally occasions some surprise. Only those who through bitter experience have learned otherwise and those who have actually studied landslides appreciate fully the true situation. Despite the fact that landslides are common and do frequently present troublesome problems, they are not serious and possess no great potential dangers in Illinois. However, the prevalent false idea that they are non-existent engenders utter disregard, and this in turn does pave the way for preventable disasters.

The Illinois River bluff near La Salle and Peru (fig. 1) is an area in Illinois where landslides are common. Because the Illinois River barge system provides low-cost transportation for the region, industrial growth is accelerating along this river corridor. With the construction of a major steel plant at Hennepin and its associated service industries, the accompanying population growth is requiring a greater number of home sites (McComas, 1968).

Because many home builders desire a site with a view, they have tended to concentrate thus far on the Illinois River bluffs. An excellent view of both the river and nearby cities is provided from the top of the bluff, which rises nearly 100 feet above the river floodplain.

Heavy rainfall during the spring and summer of 1970 triggered slumping and earth flowage of portions of the Illinois River bluff south of La Salle and Peru, causing serious construction problems. The Illinois State Geological Survey was requested by several home owners in the area to make an investigation. Road reconnaissance and field observations in the region indicated unstable slope conditions along the Illinois River bluffs from Oglesby to a section about 10 miles west, near Allforks Creek (fig. 2). Subsequently, an aerial inspection with low-altitude, oblique photography demonstrated the extent and type of slumping and sliding in the area. Samples of geologic materials were taken at one locality and tested for both geologic and engineering properties.

This report outlines the general landslide hazard of the area for the general public, particularly for people engaged in planning a construction project on or near existing or potential landslide areas. It describes some of the slide areas in detail, shows how the areas of sliding are directly related to the geology, and discusses possible causes of the slides.

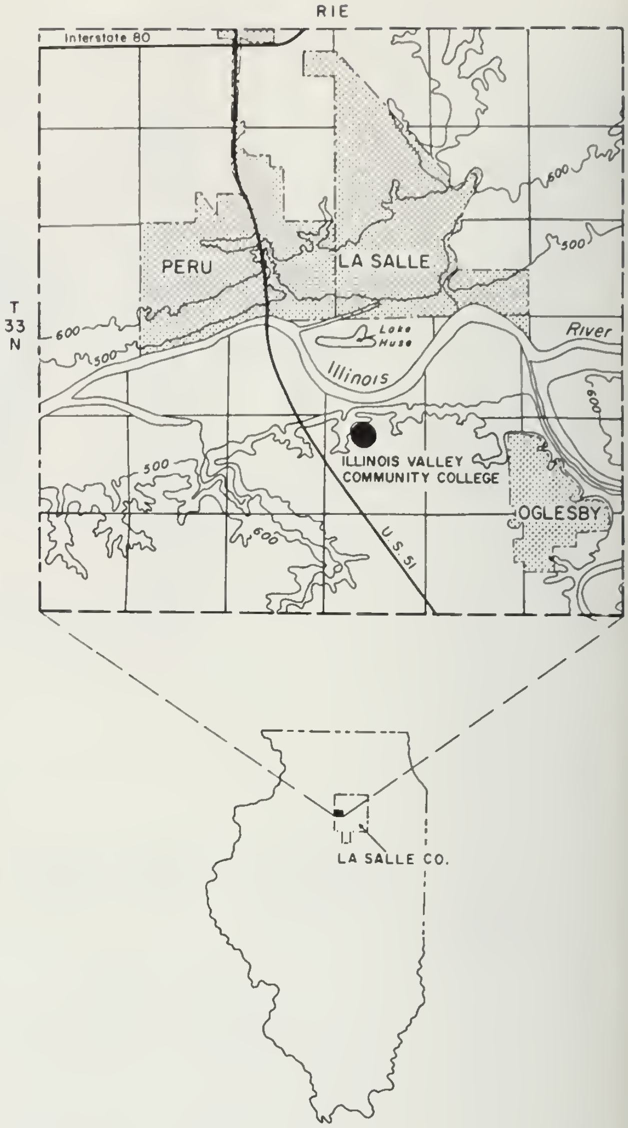

Fig. 1 - Index map and township (6 miles by 6 miles) showing study area and location of Illinois Valley Community College.

Acknowledgments

James C. Gamble, University of Illinois, made the slake durability and Atterberg limits tests on our samples. Dr. Robert K. Morse, Consulting Engineer, El Paso, Illinois, provided information about the subsurface of the area and helpful discussion of problems caused by the unstable slopes. Ross D. Brower, Illinois State Geological Survey, photographed locations 5C and 5D (fig. 5) and discussed the geologic problems with some of the land owners.

GENERAL AERIAL SURVEY

A series of low-altitude, oblique photographs were taken along the Illinois River bluff from Oglesby to Allforks Creek, at points shown on figure 2

Fig. 2 - Topographic map of the area from Allforks Creek to Oglesby, showing line of shale outcrop (modified from Cady, 1919) and locations of landslide areas discussed in this report.

Location 1 - Terracettes formed by slumping alon small tributary of the Illinois River.

Location 2 - Bluff slope showing recent cracks caused by slumping.

Location 3 - Large well developed landslide abov buildings on the slope of a tributary valley.

Location 4 - Bluff slope of the Illinois River. Arrow indicates a recent small slide. Shadows show positions of older landslides.

Location 5 - New home constructed along the bluf Recent landslide obstructs road. Fracturing an slumping are visible above and to left of hous

Fig. 3 - Oblique aerial photographs of landslides in five locations along the south bluff slopes of the Illinois River.

The unstable slope condition was observed principally in the region where the Bond Formation, a shale of Pennsylvanian age, crops out as shown on the figure. Selected photographs taken at five locations (fig. 3) show the type and lateral extent of slumping. All the photographs are views looking south toward the bluff slope.

At location 1 (fig. 3), a tributary creek flows north toward the Illinois River, truncating the bluff slope. A series of slump blocks have developed terracettes on both sides of the valley. An attempt is being made to stabilize the slope below the home on the right, or west, side of the valley through the use of sealing, draining, and cribbing. Construction on the homesite in the foreground on the left side of the valley was discontinued when cracks appeared in the immediate area of the foundation.

The photograph of location 2 (fig. 3) shows a farm at the mouth of a tributary creek. Slumping and associated cracks can be seen along the slopes to the left of the farm and extending some distance up the slope. The steep banks along the road resulted when slumped material was removed from the road surface.

The photograph taken at location 3 (fig. 3) shows a major slump developed on the slope above the home at center left in the picture. Materials that periodically flow are encroaching on the back yard. Slump cracks are evident along the north-facing slopes as well as on the east-facing slopes.

At location 4 (fig. 3), a small scarp and landslide have recently developed on the slope shown in the lower left corner of the picture. Many larger scarp shadows from old slides are visible in the wooded area. These slumps cause road maintenance problems. A scarp is a natural exposure of fresh earth and rock material uncovered by slumping activity.

The picture at location 5 (fig. 3) shows the bluff slope about 2 miles east of the mouth of Allforks Creek. Numerous scarps are visible in the left half of the photograph. The newly constructed house is situated in the central part of the slope. Active slumping is taking place both above and below the lot. The slide to the left of the house buried the road below. The one-lane section of road, opened when part of the slide was cleared, is offset 20 feet from the original road.

RECOGNITION OF LANDSLIDES (SLUMPS)

Large landslides are readily seen from an airplane, but they are more difficult to recognize when viewed from the ground, particularly during months when foliage is dense. We have suspected that slides might occur on steeper slopes in most of the area where shales are exposed, although there are some areas with apparently stable slopes in this region. It is, therefore, important to recognize the typical characteristics of unstable slopes.

The landslides associated with failure of the shales in this area are called successive rotational, or slump, slides. As defined by Sharpe (1938), a slump is "the downward slipping of a mass of rock or unconsolidated material

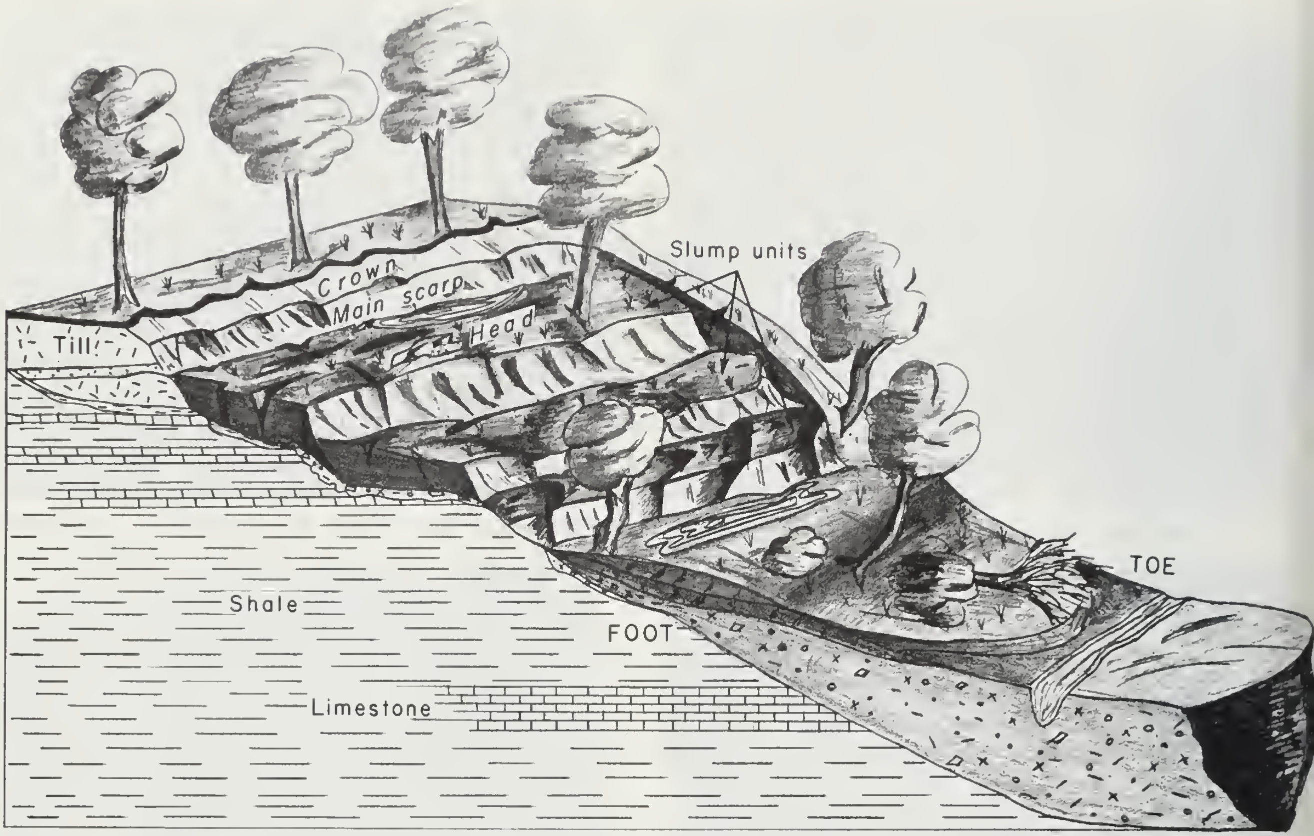

Fig. 4 - Schematic drawing of progression of landslide (modified from Fairbridge, 1968, p. 699)

of any size, moving as a unit or as several subsidiary units, usually with backward rotation on a more or less horizontal axis parallel to the cliff or slope from which it descends." Figure 4 depicts this type of slumping, which is common in the La Salle region.

Downward movement of the uppermost unit from the crown area may occur relatively rapidly, causing a sharp cliff (the main scarp) several feet in height to appear in a matter of hours or weeks. If such movement takes place in a wooded, unpopulated area, such as that shown in figure 5A, it goes essentially unnoticed. On the other hand, movements affecting structures, such as the road shown in figure 5B, are noticed very quickly.

Poor drainage is a conspicuous feature associated with large slump structures. The slumping of the units causes cracks and depressions near the scarp faces and frequently disrupts normal surface run-off of rainfall and ground-water flow (fig. 5C). As the cracks fill with mud and water, ponds and marshes may form. Trees in this part of the slump usually die because of root damage or drowning.

Another recognizable feature of unstable slopes is the presence of trees tilted at various angles (figs. 5A and 5C). This phenomenon has been referred to as "staggering forest." Some trees, particularly large oaks, may ride a slump block down the slope. These trees may, in part, control the size of the slump unit by holding together large masses of sliding material.

The units generally do not move continuously down the slope, and, as is shown in figure 5D, some blocks may become relatively stable. Within a few years the slope may look inviting for development. However, it is practically impossible to predict how long the unit will remain stationary. Action of the natural forces that cause erosion of the landscape will eventually cause renewed movement.

As units move downslope, they tend to break up and form a tongue of flowing mixture of rock and soil, as is shown in the toe of the illustration modified from Fairbridge (fig. 4). If these areas of mudflows are active, they are often devoid of standing trees. As shown in figure 5E, the toe may flow onto the floodplain of the adjacent stream. During spring floods, these slide and mudflow materials are easily eroded or water-soaked, which rejuvenates creep. Roadbeds in the paths of these flowing materials are often buried. In figure 5F the ditch along such a road is being re-excavated to maintain proper drainage for the road. As the toe of the slide is removed, the balance or the stability of the slope is disturbed, and the cycle of landslide erosion is repeated.

SLIDES NEAR ILLINOIS VALLEY COMMUNITY COLLEGE

The site of the Illinois Valley Community College was chosen for detailed study because landslide activity was evident from aerial and ground reconnaissance observations, because the rate of creep has been monitored through the surveying of stations by the resident engineer during the past year, and because engineering test-boring data were available from Dr. Robert K. Morse, Foundation Engineer and Engineering Geologist from El Paso, Illinois. Dr. Morse recognized the problem of the unstable slopes and conducted a testing program to develop for the campus an engineering plan that would stabilize the slopes and prevent future damage to the structures. The treatment includes an engineering design for reconstruction of parts of the slopes and control of surface water run-off to prevent erosion and overloading of the slopes.

Aerial Survey

The new facilities of the Illinois Valley Community College are located east of U. S. Route 51 near the south bluff slope of the Illinois River, south of La Salle (fig. 2). An aerial view (fig. 6A) of the campus area looking west shows the temporary buildings in the center, the Illinois River and bluff to the right or north, and the new construction to the west.

Figure 6B shows the new buildings and their proximity to the adjacent tributary valley of the Illinois River. The site is bounded on three sides by tributary valleys with steep gradients. The absence of vegetation, and the presence of exposures of the shale bedrock are due to sliding. The prominent bench (white arrow, fig. 6B) along the lower part of the slope is a surface reflection of the more resistant beds of the La Salle Limestone Member. The limestone is the lowermost unit of the Bond Formation (fig. 7).

EXPLANATION OF FIGURE 5

A. Slump slide in a wooded area. Note arcuate scarp (light colored outcrop) below the crown of the slide.

B. A road damaged by slumping activity and now abandoned.

C. The crown and main scarp (center and right) viewed after a rain. Ponding and poor drainage can be seen along the back slope of the first unit (center and left).

D. Top of a stabilized slump unit, seen here as a nearly level terrace, appears inviting for development.

E. Material slumping and flow (left to right) onto the valley alluvium.

F. Piles of creep and flow material along the road that were dug from the borrow ditch. Note crooked fence line and hummocky slope to right caused by slides.

The larger scarps at this locality are about 15 to 20 feet high, and were formed by slumping blocks of soil and rock. The slump blocks extend laterally along the slope for 100 to 800 feet and form step-like benches, generally 20 to 25 feet wide. Continuity of the units is lost as the material moves downslope, which results in an earth-creep or mudflow. Material creeping down the slope of the small valley south of the structure has completely filled the bed of the stream (fig. 6C).

The proximity of the college buildings to the unstable slopes is shown in the plan view photograph (fig. 6D). To prevent further slumping, the slopes are being kept as dry as possible. A maintenance road will circle the complex as part of the water control program for the college grounds. A stormwater system designed to intercept the downward movement of surface water will collect this water at a location east of the campus and conduct it in conduits to the valleys to the west. To prevent erosion of the slope, the drainage conduits will be extended below the limits of the outcrop of the La Salle Limestone Member at an elevation of 520 feet above mean sea level. The unstable valley slopes will be recut into benches, reconstructed at lower angles of repose, and compacted to develop a more stable grade.

GEOLOGY AND ENGINEERING CHARACTERISTICS OF THE SLOPES

The geologic column and generalized cross section (fig. 7) summarize the lithologies as they occur at the Illinois Valley Community College. Capping the sequence of sediments of the Modesto and Bond Formations of the Pennsylvanian System is a section of Pleistocene glacial deposits. Coarse sands and gravels and scattered boulder beds commonly occur in the lower portion of the glacial section. A series of till units, in some places separated by beds

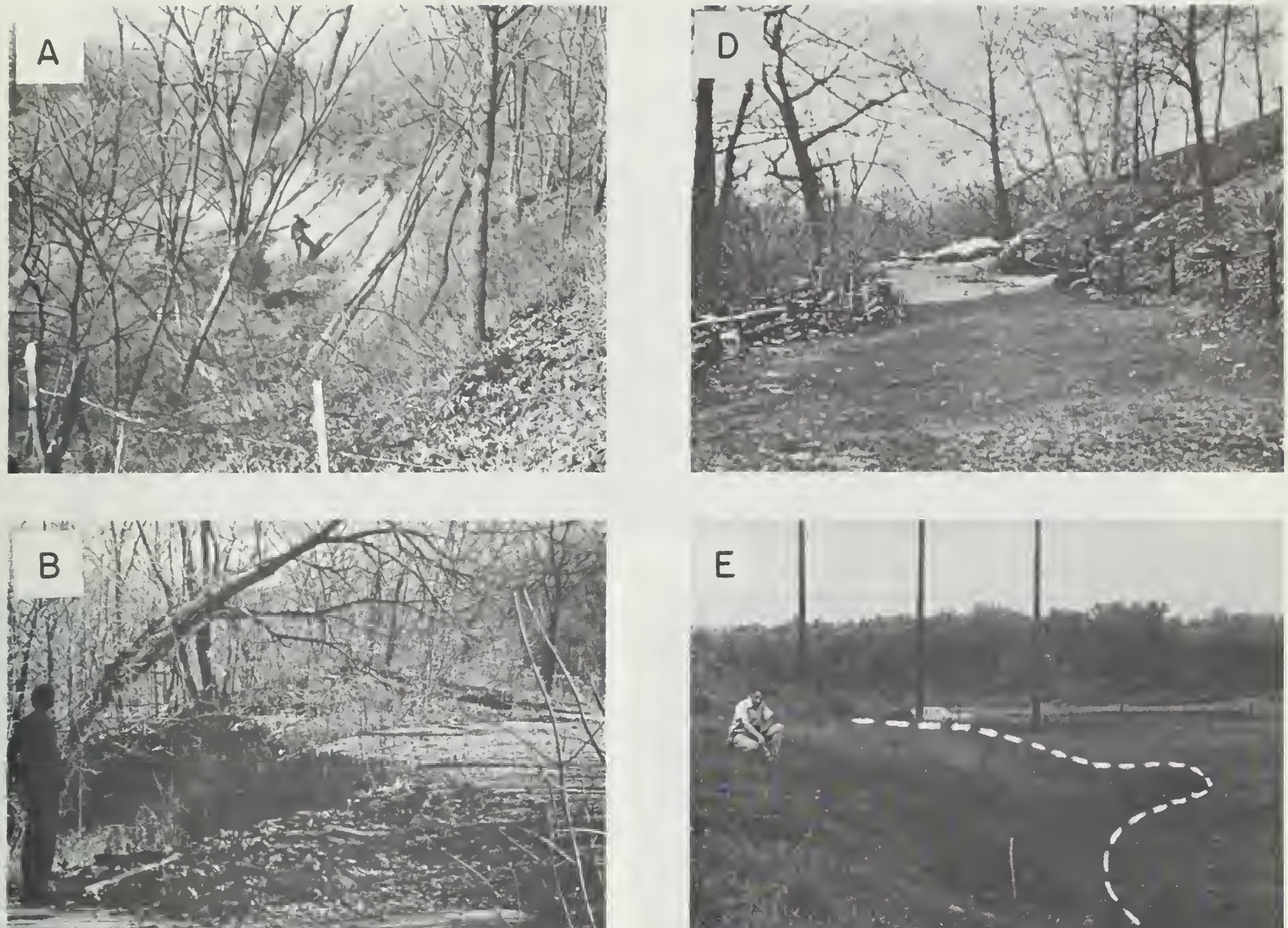

Fig. 5 - Examples of landslide activity in the La Salle-Peru area.

EXPLANATION OF FIGURE 6

A. Illinois Valley Community College campus on the south bluff of the Illinois River Valley. Arrow points to new building construction.

B. Construction site from the northwest is bounded on three sides by steep tributary valleys. Arrow points to shadow caused by outcrop of the La Salle Limestone Member.

C. Construction site from the southwest. Scarps, slump blocks, and slides appear as irregular shapes and arcuate lines on the 2:1 slope. The large slide encroaches on the short tributary stream (arrow) south of the structure.

D. Construction site from east-southeast showing series of slump blocks and slides southwest of the structure.

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of silt, rest on the basal deposits. Loess and soil 2 to 4 feet thick cap the bluff slopes.

The valley profile shown in figure 7 has a vertical exaggeration of two; the true angle of slope is about 25 degrees. The slope failure pattern is schematically drawn to indicate the kinds of materials incorporated in the landslides. As observed in the field, the thin limestone units, except for the La Salle Limestone Member, are generally unable to prevent slumping. Pronounced jointing causes blocks of bedrock to loosen and slide downslope. Ground water seeps from a series of springs located at several horizons along the slopes, and springs occur along permeable bedding planes that lie above less permeable beds.

Laboratory analyses of shale samples from bedrock exposures of the Bond Formation in the La Salle region indicate that usually more than 50 percent of the clay present consists of the expandable type of clay minerals. Physical tests of the shale samples show that they are weakened by freezing and thawing and/or wetting and drying. Approximately 50 percent of the unweathered shale consists of clay-size (less than 0.002 millimeters) particles, and weathered shale contains more than 70 percent clay-size particles. The weathered shales tend to take up water more readily than unweathered shales. When the clays do take up water, weight is added to the slope, and the lubrication characteristics of the materials are increased. Our tests indicate this change is primarily a mechanical rather than a chemical alteration of the shale. These data strongly suggest that the weathered shales are more prone to sliding and slumping than the unweathered shales and that in many of the slope failures only the weathered materials are affected.

EFFECTS OF CLIMATE AND WEATHERING

Heavy rainfall during high-intensity storms and freeze-thaw conditions during winter prevail in most landslide areas and provide the weathering

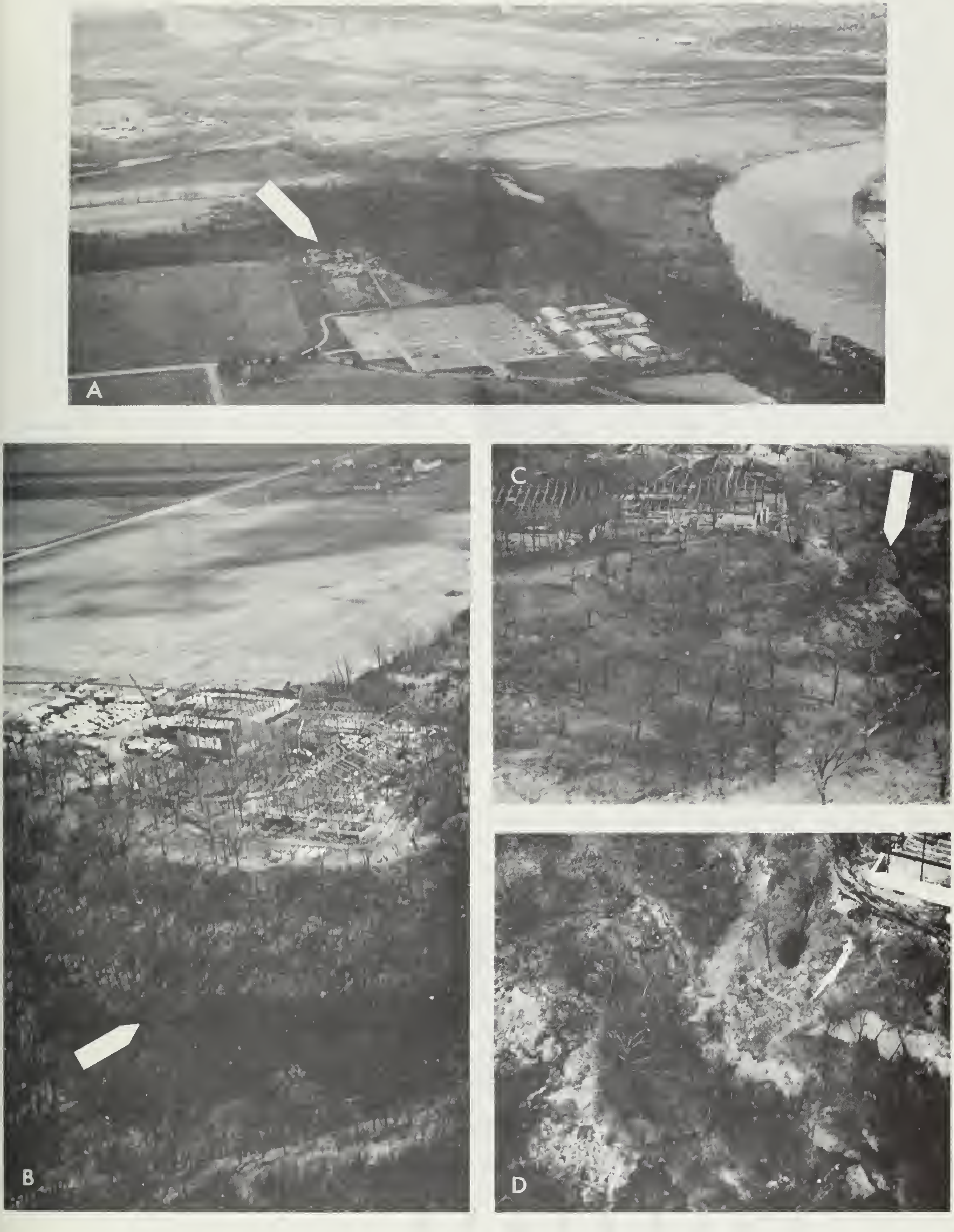

Fig. 6 - Oblique aerial photographs of landslides near Illinois Valley Community College.

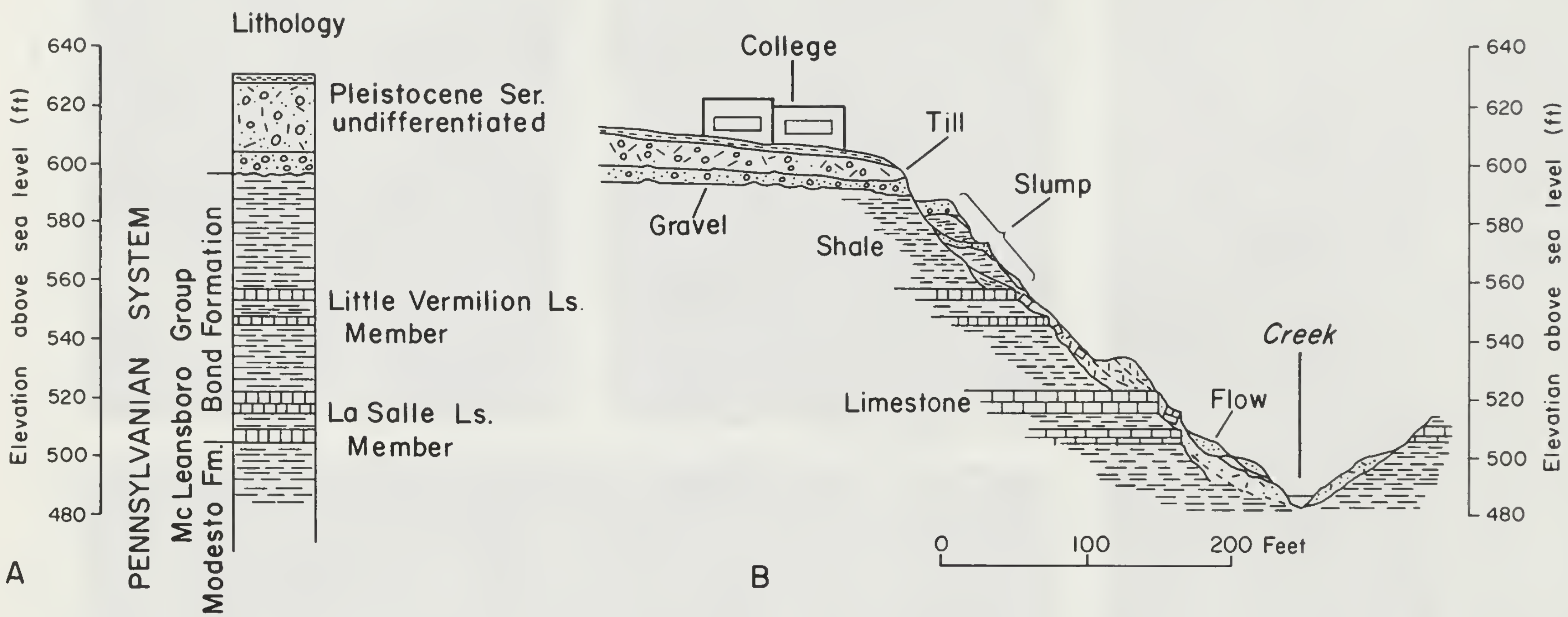

Fig. 7 - (A) Geologic column and (B) cross section of landslide in tributary valley adjacent to the Illinois Valley Community College campus. (Modified from Cady, 1919, and Willman and Payne, 1942.)

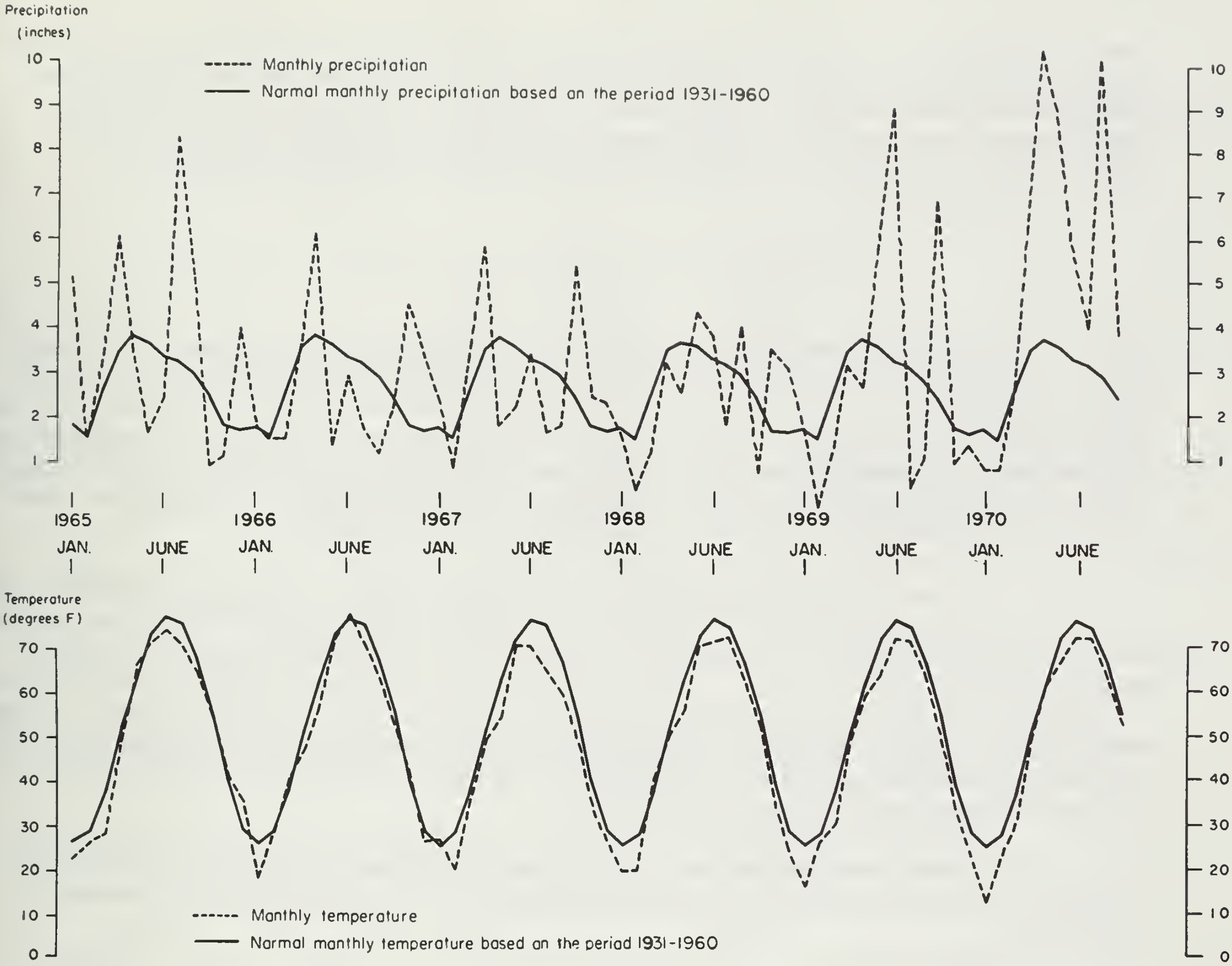

Fig. 8 - Climatological data from Peru Sewage Plant (U. S. Department of Commerce, National Oceanic and Atmospheric Administration).

mechanism to alter the surficial sediments, the water for active erosion, and the excess water to trigger the movement. Extreme temperature and precipitation conditions are common in Illinois.

Temperature and precipitation records for the past 5 years from the nearby Peru sewage treatment plant are shown in figure 8. The solid lines in both graphs represent the monthly "normal" temperature and precipitation for the plant. "Normal" is based on records collected for the 30-year period from 1931 to 1960. The dashed lines represent the actual monthly recorded average temperature and precipitation at the plant.

The temperature records show that near-normal or slightly cooler than normal temperatures prevailed during the past 5 years and the slopes were subjected to freezing and thawing. The precipitation records indicate high-intensity storms followed by dry periods generally have a frequency interval of less than a month. This pattern of precipitation subjects the bluff slopes to intermittent wetting and drying. In addition to this pattern, in some years these regions have periods of very heavy precipitation. Precipitation occurring as a series of high-intensity rainfalls deluged the region during the spring and summer of 1970. More than 45 inches of rain fell during the 6-month period, and more than 10 inches fell during both May and September. These rains contributed to the triggering of the landslide activity.

CONCLUSIONS

Slopes in the La Salle-Peru region are unstable because of a combination of physical factors: (1) the slopes consist of a particular type of clay-rich shale; (2) the slopes are generally steeper than 20 degrees; (3) the climate of the area typically includes periods of heavy rainfall. Abnormally high amounts of rainfall help to cause rapid erosion of the toe of the slopes, increase the bearing weight on the underlying formations, and lubricate the materials in the slope, causing them to flow or fracture.

Because the type of rock is one of the major factors determining the occurrence and distribution of these landslides, a study of the geology of the area is essential before plans are made for construction on or near a slope developed in clay-rich shale. Both ground and air reconnaissance are helpful in determining and evaluating the extent of landslides. Geologic field studies reveal that sliding will recur naturally. When the critical balance of these slopes is upset by improper construction activity, the process of sliding is accelerated and damage may be extensive.

If the existing or potential hazard of these slopes is recognized, unplanned expansion of urban construction can be discouraged and disasters prevented.

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