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LANDSLIDES IN OHIO

Landslides are a significant problem in several areas of Ohio. The Cincinnati area has one of the highest per-capita costs due to landslide damage of any city in the United States. Many landslides in Ohio damage or destroy homes, businesses, and highways, resulting in annual costs of millions of dollars. Upon occasion, they can be a serious threat to personal safety. On Christmas Eve 1986, an individual traveling in an automobile was killed by falling rock along U.S. Route 52 in Lawrence County in southern Ohio. Although this is Ohio's only recorded landslide fatality, there have been numerous near misses.

TYPES OF LANDSLIDES

The term landslide is a general term for a variety of downslope movements of earth materials. Some slides are rapid, occurring in seconds, whereas others may take hours, weeks, or even longer to develop.

ROTATIONAL SLUMP

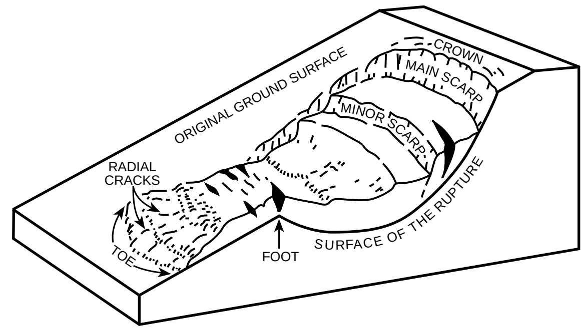
A rotational slump is characterized by the movement of a mass of weak rock or sediment as a block unit along a curved slip plane. These slumps are the largest type of landslide in Ohio, commonly involving hundreds of thousands of cubic yards of material and extending for hundreds of feet.

Rotational slumps have an easily recognized, characteristic form. The upper part (crown or head) consists of one or more transversely oriented zones of rupture (scarps) that form a stair-step pattern of displaced blocks. The upper surface of these blocks commonly is rotated backward (reverse slope), forming depressions along which water may accumulate to create small ponds or swampy areas. Trees on these rotated blocks may be inclined upslope, toward the top of the hill. The lower, downslope end (toe) of a rotational slump is a fan-shaped, bulging mass of material characterized by radial ridges and cracks. Trees on this portion of the landslide may be inclined at strange angles, giving rise to the descriptive terms "drunken" or "staggering" forest. Rotational slumps may develop comparatively slowly and commonly require several months or even years to reach stability; however, on occasion, they may move rapidly, achieving stability in only a few hours.

EARTHFLOW

Earthflows are perhaps the most common form of downslope movement in Ohio; many of them are comparatively small in size. Characteristically, an earthflow involves a weathered mass of rock or sediment that flows downslope as a jumbled mass, forming a hummocky topography of ridges and swales. Trees may be inclined at odd angles throughout the length of an earthflow. Earthflows are most common in weathered surface materials and do not necessarily indicate weak rock. They are also common in unconsolidated glacial sediments. The rate of movement of an earthflow is generally quite slow.

Landslide in westbound lanes of I-70 near New Concord, Muskingum County, 1986.



Major components of a rotational slump.

ROCKFALL

A rockfall is an extremely rapid, and potentially dangerous, downslope movement of earth materials. Large blocks of massive bedrock may suddenly become detached from a cliff or steep hillside and travel downslope in free fall and/or a rolling, bounding, or sliding manner until a position of stability is achieved.

Most rockfalls in Ohio involve massive beds of sandstone or limestone. Surface water seeps into joints or cracks in the rock, increasing the weight of the rock and causing expansion of joints when it freezes, thus prying blocks of rock away from the main cliff. Weak and easily eroded clay or shale beneath the massive bed is an important contributing factor to a rockfall; undercutting in this layer removes basal support.

CAUSES OF LANDSLIDES

Landslides are not random, totally unpredictable phenomena. Certain inherent geologic conditions are a prerequisite to the occurrence of a landslide in a particular area. The presence of one or more of the following conditions can serve as an alert to potential landslide problems.

1. **Steep slopes.** All landslides move downslope under the influence of gravity. Therefore, steep slopes, cliffs, or bluffs are required for development of a landslide, especially in conjunction with one or more of the conditions listed below.
2. **Jointed rocks.** Vertical joints (fractures) in rocks allow surface moisture to penetrate the rock and weaken it. During periods of cold weather, this moisture freezes and causes the rock masses to be pried apart along the joint.
3. **Fine-grained, permeable rock or sediment.** These materials are particularly susceptible to landslides because large amounts of moisture can easily enter them, causing an increase in weight, reduction of the bonding strength of individual grains, and dissolution of grain-cementing materials.
4. **Clay or shale units subject to lubrication.** Ground water penetrating these materials can lead to loss of binding strength between individual mineral grains and subsequent failure. Excess ground water in the area of contact between susceptible units and underlying materials can lubricate this contact and thus promote failure.

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5. **Large amounts of water.** Periods of heavy rainfall or excess snowmelt can saturate the zone above the normal water table and cause a landslide.

Although many areas of the state possess one or more of the above conditions, a landslide requires a triggering mechanism to initiate downslope movement. Events or circumstances that commonly trigger landslides in Ohio include:

1. **Vibrations.** Human-induced vibrations such as those from blasting, or even the passing of a heavy truck, in some circumstances, can trigger a landslide. Vibrations from earthquakes can trigger landslides, although no such occurrence has been documented in Ohio.
2. **Oversteepened slope.** Undercutting of a slope by stream or wave erosion or by human construction activities can disturb the equilibrium of a stable slope and cause it to fail. Addition of fill material to the upper portion of a slope can cause the angle of stability to be exceeded.
3. **Increased weight on a slope.** Addition of large amounts of fill, the construction of a building or other structure, or an unusual increase in precipitation, either from heavy rains or from artificial alteration of drainage patterns, can trigger a landslide.
4. **Removal of vegetation.** Cutting of trees and other vegetation on a landslide-prone slope can trigger failure. The roots tend to hold the rock or sediment in place and soak up excess moisture.

Areas of Ohio subject to severe slope failure.

LANDSLIDE-PRONE AREAS OF OHIO

Landslides are rare or nonexistent throughout much of Ohio because of a lack of steep slopes and/or lack of geologic units prone to failure. Several areas of the state, however, experience frequent and costly landslides.

Portions of eastern and southern Ohio are characterized by steep slopes and local relief of several hundred feet. In addition, bedrock of Mississippian, Pennsylvanian, and Permian ages, thick colluvium (deposits of broken and weathered bedrock fragments), and thick lake silts and outwash formed in association with Pleistocene glaciers make this area particularly prone to slope failures. The most slide-prone rocks in eastern Ohio are red mudstones ("red beds") of Pennsylvanian and Permian age. These rocks tend to lose strength when they become wet, forming rotational slumps or earthflows. About 85 percent of slope failures in this region are in red beds of the Pennsylvanian-age Conemaugh and Monongahela Groups.

Eastern Ohio also is subject to rockfalls. Thick, massive sandstones form steep cliffs in many areas of the region and, periodically, large blocks may suddenly fall or tumble downslope.

In the lower part of the Scioto River valley, thick colluvium developed on shales of Mississippian age, particularly the Bedford Shale, is prone to failure. Also prone to failure are lake clays and silts that accumulated in some valleys in this area when Pleistocene glaciers dammed the north-flowing preglacial Teays River system.

Portions of Cincinnati (Hamilton County) and surrounding counties where rocks of Ordovician age are exposed are prone to numerous and costly landslides in the form of rotational slumps and earthflows. The majority of bedrock slope failures are in the shale-dominated Kope Formation and to a lesser degree in the Miamitown Shale. Landslides tend to occur in the thick colluvium developed on these units when excessive hydrostatic pressure builds up in this zone.

The valley of the Cuyahoga River between Cleveland and Akron, in Cuyahoga and Summit Counties, is well known for rotational slumps in clays and silts deposited in lakes formed when glaciers of the Pleistocene Ice Age blocked various segments of the valley. The modern Cuyahoga River has cut through these deposits, leaving steep bluffs of unstable sediments along the valley walls. Many of these landslides tend to be concentrated on north-facing slopes where moisture retention is higher.

The eastern half of the Ohio portion of the Lake Erie shoreline, from Cleveland to Ashtabula, is characterized by unconsolidated glacial sediments such as till and lake clays and silts that are highly susceptible to wave erosion at the base of the bluff. Such erosion is accentuated during periods of high lake levels accompanied by large storms. The continual removal of slumped sediment by waves prevents natural achievement of stability of the slope. Many lakeshore homes, roads, and other structures have been destroyed in these areas, where bluff recession is as rapid as 7 feet per year.

HOW TO AVOID LANDSLIDES

Site selection for a home or other structure in a landslide-prone area of the state should include a determination of the underlying geologic materials and their susceptibility to failure. Geologic maps are a key resource for this. The presence of hummocky topography, steplike scarps, unusually inclined trees or fence posts, and seeps of water are all signs that the slope has undergone failure at some time in the past.

Precautions against slope failure include avoiding the following practices: excavating at the base of the slope, placing large quantities of fill on the upper part of the slope, removing vegetation, disrupting natural drainage patterns, and allowing water from downspouts or septic tanks to discharge onto a slope. In questionable areas, the services of a consulting geologist familiar with the problems of slope failure may be well worth the expense.

FURTHER READING

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• This GeoFacts compiled by Michael C. Hansen • September 1995 •

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