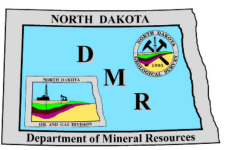


LANDSLIDE AREAS IN GOLDEN VALLEY COUNTY, NORTH DAKOTA



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LANDSLIDES IN GOLDEN VALLEY COUNTY

Landslides are masses of rocks and sediment that have tumbled or slid down a slope under their own weight. Landslides are one of the most common geologic hazards in North Dakota and can destroy buildings, roads, railroad tracks, pipelines, transmission lines, and other types of infrastructure. Landslides are generally characterized in the field by steep, near-vertical slopes (the scarp) that are upslope from a mound of displaced rock (the body). The body of the slide may be relatively intact, or it may be severely fragmented. Recent or relatively new landslides are generally characterized by a fresh (well-exposed rock) scarp and a sparsely vegetated body. Older slides are typically more difficult to identify in the field because the topography of the scarps and bodies may be smoother and more subdued due to weathering. Landslides are most readily identifiable from Light Detection and Ranging (LiDAR) data, supplemented with aerial imagery.

Landslides in Golden Valley County were mapped from LiDAR data collected from October to November 2021 along with NAIP digital imagery from 2016 to 2022 and a complete set of historical aerial photographs flown from July to August in 1958 at a scale of 1:20,000. The aerial photographs were taken when leaves were on the trees which is unfortunate because groves of leaf-bearing trees tend to obscure landslides, especially small ones. On the other hand, leaves can sometimes make it easier to identify these features as trees and bushes are often aligned within very distinct parallel-, transverse-, and/or semi-circular-depressions that generally occur within the body of the landslide. Using LiDAR elevation data allows us to see through most of the areas previously obscured by vegetation in the historical imagery and aerial photography and greatly increases our ability to identify additional landslide areas.

A total of 1,982 landslide areas were identified in Golden Valley County. Some of these slide areas are complexes, consisting of multiple landslides that formed from different events. Therefore, the number of individual landslides in this county is likely somewhat higher. Collectively, these landslide areas cover 11.8 square miles (7,533 acres) or approximately 1.8% of the county. Most of the landslides occur within the badlands of the Little Missouri River and Beaver Creek, in the western part of the county. Most of the larger slide areas are found along slopes in the Little Missouri River valley. These areas are landslide complexes consisting of several large, coalesced slides.

Most of the slides in Golden Valley County (54%) cover less than two acres (Figure 1). Landslides are commonly concentrated along drainages, ravines, and coulees, and within areas of high local topographical relief along the Little Missouri River and Beaver Creek badlands. All, or portions, of the head of a ravine typically fail, presumably because headward erosion causes these areas to undergo some of the fastest rates of erosion, oversteepening slopes.

Several historical abandoned mine lands (AMLs) are found in Golden Valley County, mostly in the southern western half. These small coal mines, commonly referred to as wagon mines, are found somewhat scattered across the Little Missouri badlands across western North Dakota. No collapse features from underground voids were visible on the surface in the county, but uncollapsed mine voids may occur in the subsurface beyond the boundaries of the known AML locations since a mine is reported to have existed at these locations, according to records compiled by the North Dakota Public Service Commission. It can be difficult to determine whether small surface irregularities along drainage slopes are old mines or slumps, further complicated as abandoned mines are susceptible to slope failure. Thus, some areas mapped as landslides may include the collapse of abandoned mine-headwalls.

Slopes fail for various reasons including the steepness or angle of the slope, rock type, bedding, and moisture content of the rocks. Most landslides in western North Dakota are rotational slumps that have a well-defined head and toe (Figure 2). Typically, the part of the slope that breaks apart slides down the slope as a single unit and the beds tilt back in the direction of the slope. The failed mass of rock is, however, never a cohesive unit; tension cracks generally cause the failed material to splinter into smaller portions. Successive landslides may occur at the same location. Over time, the accumulated material from multiple, adjacent landslides can cover an area that is much larger than a single landslide area.

The sedimentary bedrock geology of Golden Valley County consists of sandstone, siltstone, mudstone, claystone, and lignite deposited in rivers, floodplains, lakes, and swamps during the early and middle Tertiary (Paleocene). These rocks are included in the Slope (early Paleocene), Bullion Creek (middle Paleocene), and Sentinel Butte (late Paleocene) Formations, with the Sentinel Butte Formation comprising most of the surficial outcrops in the county. Large buttes in the southern half of the county (Bullion, Square, and Sentinel) are preserved by thick caprocks of cemented sandstone of the Golden Valley Formation (early Eocene). Claystone, limestone, and conglomerates of the Chadron Formation (late Eocene) can be found locally overlying these caprocks. Most of the landslides in Golden Valley County occur in the Bullion Creek Formation (81%) and Sentinel Butte Formations (13%). It is not uncommon for landslides to occur across multiple formations and displace several units.

Small landslides, 10 acres or less in size, are common throughout the rugged topography of western North Dakota. Many of these, as well as larger landslides, can be obscured by siltwash or colluvium. Layers or blankets of siltwash typically cover the lower portion of a slope and extend horizontally from its base. Thick smooth layers of siltwash can completely obscure the broken, jumbled beds of landslide material. In some areas, smaller landslides, or landslides that are very old and have been inactive for a long period of time, are only visible if siltwash is thin or absent, or the beds are sufficiently displaced to create subtle irregularities at the surface. An area with many landslides suggests that the slopes in that area may be predisposed to future slides (Figure 3). Even when landslides are not identified in these types of settings, these areas often remain vulnerable to slope failure and should be evaluated prior to the development of any civil works or energy infrastructure projects and, when possible, be avoided.

EXPLANATION

- Qs** Landslide Deposits
A mass of material that has moved downslope. Includes earth flows, slumps, and areas of soil creep.
- A** Abandoned Mine Lands (AML) location data maintained by the North Dakota Public Service Commission's Abandoned Mine Lands Program.

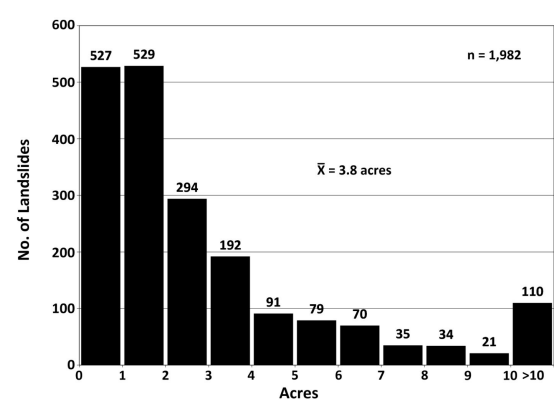


Figure 1. Distribution of landslides mapped in Golden Valley County. The majority of slides (54%) cover less than two acres. There are many slides (6%) that are over ten acres in size.

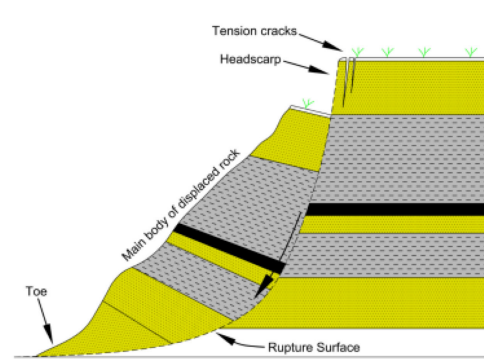
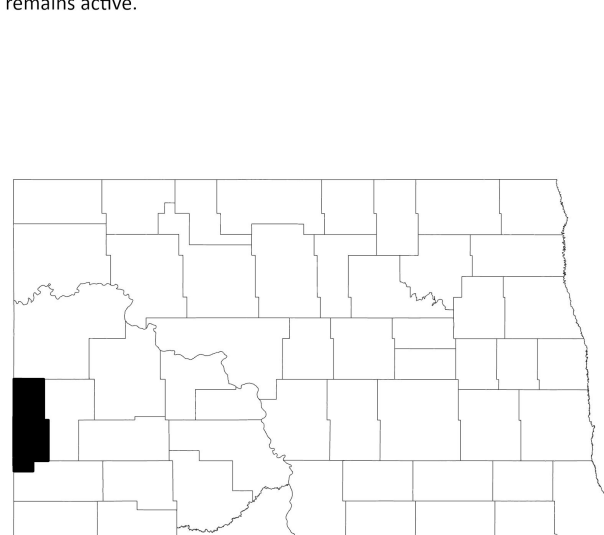


Figure 2. Generalized diagram of a rotational bedrock slump common to the badlands terrain of western North Dakota.



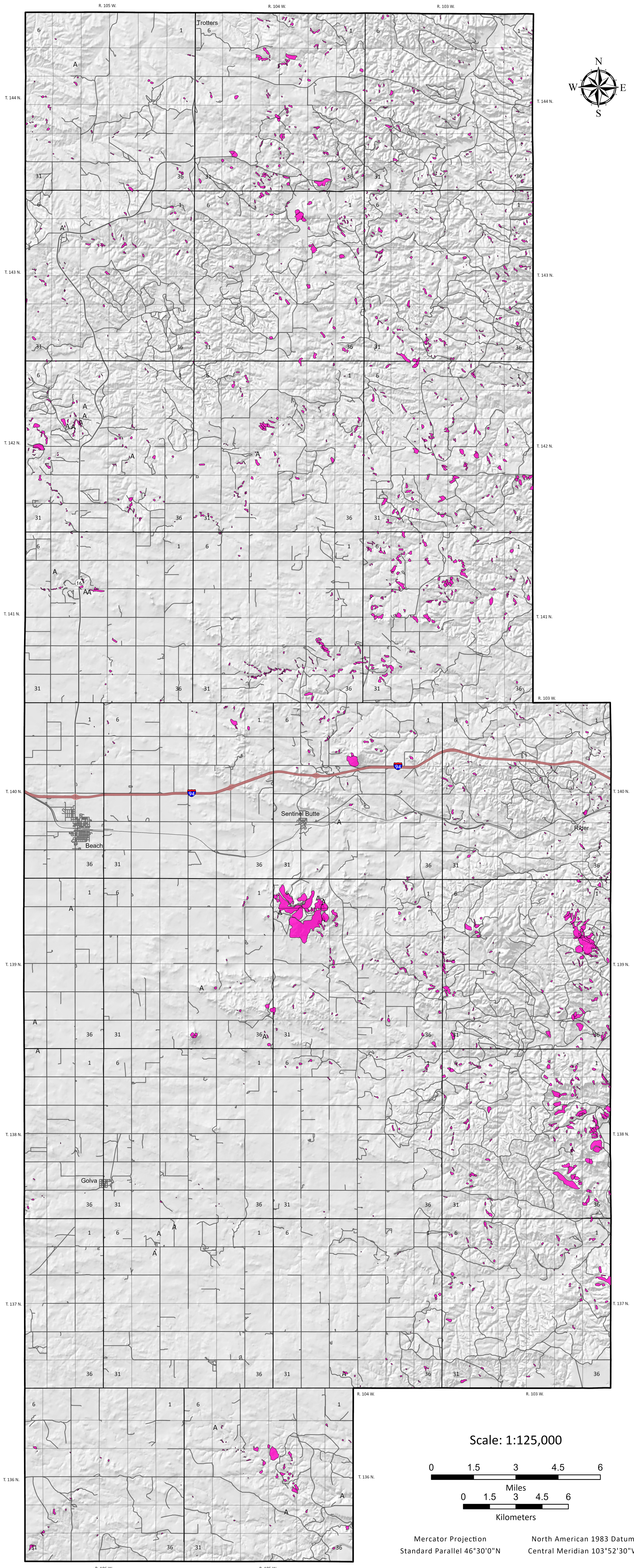
Figure 3. Example of a bedrock landslide in northeastern Golden Valley County along Beaver Creek (view is to the south). This landslide began in the western portion of the slide area ca. 2000 and progressed eastward with the failure of the upper scarp along a high bench within the slide area (a) prior to 2014. The upper bench continued to slump (b), covering the lower portion of the slide area with landslide deposits intruding into the channel of the creek in 2017. This landslide area remains active.

47°15'	Slope	Trotters	Sentinel Butte	Divide	47°15'
47°	Beaver Creek (NW)	Beaver Creek (W)	Beaver Creek (E)	Beaver Creek (SE)	47°
46°45'	Beaver Creek (SW)	Beaver Creek (S)	Beaver Creek (SE)	Beaver Creek (E)	46°45'
46°30'	Beaver Creek (SW)	Beaver Creek (S)	Beaver Creek (SE)	Beaver Creek (E)	46°30'



GOLDEN VALLEY COUNTY, NORTH DAKOTA

Index to 1:24,000 Quadrangles



Scale: 1:125,000

0 1.5 3 4.5 6
Miles

0 1.5 3 4.5 6
Kilometers

Mercator Projection
Standard Parallel 46°30'0"N

North American 1983 Datum
Central Meridian 103°52'30"W