10.4: Examples of Landslides

Figure \(\PageIndex{1}\): Scar of the Gros Ventre landslide in the background with landslide deposits in the foreground.

**1925, Gros Ventre, Wyoming:** On June 23, 1925, a 38 million cubic meter (50 million cu yd) translational rock slide occurred next to the Gros Ventre River (pronounced “grow vont”) near Jackson Hole, Wyoming. Large boulders dammed the Gros Ventre River and ran up the opposite side of the valley several hundred vertical feet. The dammed river created Slide Lake, and two years later in 1927, lake levels rose high enough to destabilize the dam. The dam failed and caused a catastrophic flood that killed six people in the small downstream community of Kelly, Wyoming [5].
A combination of three factors caused the rock slide: 1) heavy rains and rapidly melting snow saturated the Tensleep Sandstone causing the underlying shale of the Amsden Formation to lose its shear strength, 2) the Gros Ventre River cut through the sandstone creating an oversteepened slope, and 3) soil on top of the mountain became saturated with water due to poor drainage [6]. The cross-section diagram shows how the parallel bedding planes between the Tensleep Sandstone and Amsden Formation offered little friction against the slope surface as the river undercut the sandstone. Lastly, the rockslide may have been triggered by an earthquake.

1959, Madison Canyon, Montana: In 1959, the largest earthquake in Rocky Mountain recorded history, magnitude 7.5, struck the Hebgen Lake, Montana area. The earthquake caused a rock avalanche that dammed the Madison River and ran up the other side of the valley hundreds of vertical feet. Today, there are still house-sized boulders visible on the slope opposite their starting point. The slide moved at a velocity of up to 160.9 kph (100 mph), creating an incredible air blast that swept through the Rock Creek Campground. The slide killed 28 people, most of whom were in the campground and remain buried there [5]. In a manner like the Gros Ventre slide, foliation planes of weakness in metamorphic rock outcrops were parallel with the surface, compromising shear strength.

1980, Mount Saint Helens, Washington: On May 18, 1980, a 5.1-magnitude earthquake triggered the largest landslide observed in the historical record. This landslide was followed by the lateral eruption of Mount Saint Helens volcano, and the eruption was followed by volcanic debris flows known as lahars. The volume of material moved by the landslide was 2.8 cubic kilometers (0.67 mi³) [7].

1995 and 2005, La Conchita, California: On March 4, 1995, a fast-moving earthflow damaged nine houses in the southern
California coastal community of La Conchita. A week later, debris flow in the same location damaged five more houses. Surface-tension cracks at the top of the slide gave early warning signs in the summer of 1994. During the rainy winter season of 1994/1995, the cracks grew larger. The likely trigger of the 1995 event was unusually heavy rainfall during the winter of 1994/1995 and rising groundwater levels. Ten years later, in 2005, a rapid-debris flow occurred at the end of a 15-day period of near-record rainfall in southern California. Vegetation remained relatively intact as it was rafted on the surface of the rapid flow, indicating that much of the landslide mass simply was being carried on a presumably much more saturated and fluidized layer beneath. The 2005 slide damaged 36 houses and killed 10 people [8].

Figure 1: Oblique LIDAR image of La Conchita after the 2005 landslide. Outline of 1995 (blue) and 2005 (yellow) landslides shown; arrows show examples of other landslides in the area; red line outlines main scarp of an ancient landslide for the entire bluff. Source: Todd Stennett, Airborne 1 Corp., El Segundo. Public domain

Figure 2: 1995 La Conchita slide. Source: USGS.

La Conchita Landslide
2014, Oso Landslide, Washington: On March 22, 2014, a landslide of approximately 18 million tons (10 million yd$^3$) traveled at 64 kph (40 mph), extended for nearly a 1.6 km (1 m), and dammed the North Fork of the Stillaguamish River. The landslide covered 40 homes and killed 43 people in the Steelhead Haven community near Oso, Washington. It produced a volume of material equivalent to 600 football fields covered in material 3 m (10 ft) deep. The winter of 2013-2014 was unusually wet with almost double the average amount of precipitation. The landslide occurred in an area of the Stillaguamish River Valley historically active with many landslides, but previous events had been small [11].

Yosemite National Park Rock Falls: The steep cliffs of Yosemite National Park cause frequent rockfalls. Fractures created to tectonic stresses and exfoliation and expanded by frost wedging can cause house-sized blocks of granite to detach from the cliff-faces of Yosemite National Park. The park models potential runout, the distance landslide material travels, to better assess the risk posed to the millions of park visitors.
Utah Landslides

Figure \(\PageIndex{1}\): Approximate extent of Markagunt Gravity slide.

**Markagunt Gravity Slide**: About 21–22 million years ago, one of the biggest land-based landslides yet discovered in the geologic record displaced more than 1,700 cu km (408 cu mi) of material in one relatively fast event. Evidence for this slide includes breccia conglomerates (see Chapter 5), glassy pseudotachylyte, (see Chapter 6), slip surfaces (similar to faults) see Chapter 9), and dikes (see Chapter 7). The landslide is estimated to encompass an area the size of Rhode Island and to extend from near Cedar City, Utah to Panguitch, Utah. This landslide was likely the result of material released from the side of a growing laccolith (a type of igneous intrusion) see Chapter 4), after being triggered by an eruption-related earthquake.

Figure \(\PageIndex{1}\): The 1983 Thistle landslide (foreground) dammed the Spanish Fork river creating a lake.

**1983, Thistle Slide**: Starting in April of 1983 and continuing into May of that year, a slow-moving landslide traveled 305 m (1,000 ft) downhill and blocked Spanish Fork Canyon with an earthflow dam 61 m (200 ft) high. This caused disastrous flooding upstream in the Soldier Creek and Thistle Creek valleys, submerging the town of Thistle. As part of the emergency response, a spillway was constructed to prevent the newly formed lake from breaching the dam. Later, a tunnel was constructed to drain the lake, and currently, the river continues to flow through this tunnel. The rail line and US-6 highway had to be relocated at a cost of more than $200 million [13].
2013, Rockville Rock Fall: Rockville, Utah is a small community near the entrance to Zion National Park. In December of 2013, a 2,700 ton (1,400 yd$^3$) block of Shinarump Conglomerate fell from the Rockville Bench cliff, landed on the steep 35-degree slope below, and shattered into several large pieces that continued downslope at a high speed. These boulders completely destroyed a house located 375 feet below the cliff (see the before and after photographs) and killed two people inside the home. The topographic map shows other rockfalls in the area prior to this catastrophic event [14].

2014, North Salt Lake Slide: In August 2014 after a particularly wet period, a slow-moving rotational landslide destroyed one home and damaged nearby tennis courts.
Figure 1: Scarp and displaced material from the North Salt Lake (Parkview) slide of 2014.

Reports from residents suggested that ground cracks had been seen near the top of the slope at least a year prior to the catastrophic movement. The presence of easily-drained sands and gravels overlying more impermeable clays weathered from volcanic ash, along with recent regrading of the slope, may have been contributing causes of this slide. Local heavy rains seem to have provided the trigger. In the two years after the landslide, the slope has been partially regraded to increase its stability. Unfortunately, in January 2017, parts of the slope have shown reactivation movement. Similarly, in 1996 residents in a nearby subdivision started reporting distress to their homes. This distress continued until 2012 when 18 homes became uninhabitable due to extensive damage and were removed. A geologic park was constructed in the now vacant area.

North Salt Lake Landslide

2013, Bingham Canyon Copper Mine Landslide, Utah: At 9:30 pm on April 10, 2013, more than 65 million cubic meters of steep terraced mine wall slid down into the engineered pit of Bingham Canyon mine, making it one of the largest historic landslides not associated with volcanoes. Radar systems maintained by the mine operator warned of movement of the wall, preventing the loss of life and limiting the loss of property.
References


