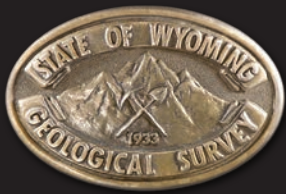


Wyoming's Geologic Hazards Summary Report

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Overview

Geologic conditions that represent a risk to people, property, and infrastructure are known as geologic hazards. Numerous types of geologic hazards exist in the state, including landslides, earthquakes, expansive soils, windblown deposits, radon, karst, and volcanic eruptions. Because of the rural nature of Wyoming, many of the geologic hazards in the state occur without danger to the public. However, when they occur near people or infrastructure – roads, railways, pipelines – they can cause damage. The two most frequent and costly geologic hazards in Wyoming are earthquakes and landslides.

The mission of the Wyoming State Geological Survey (WSGS) includes “helping protect the public from geologic hazards.” This is accomplished by survey geologists monitoring, investigating, and reporting on the geologic hazards in the state.

The WSGS monitors earthquakes, investigates landslides, maps the characteristics and locations of quaternary faults, and tracks the status of slower moving hazards such as expansive soils and windblown deposits. This information is then distributed to the public. The WSGS is also a member of the Yellowstone Volcano Observatory, a multi-agency group tasked with understanding and distributing data about the Yellowstone volcanic system.

Earthquakes

In Wyoming, most earthquakes occur within the Yellowstone region and the western portion of the state. However, earthquakes have occurred in almost every county of the state. Based on U.S. Geological Survey (USGS) data, there have been more than 45,000 earthquakes in Wyoming (since record keeping began). The largest was a magnitude 6.5 in 1959, located in Yellowstone National Park (YNP).

In 2014, there were 49 earthquakes with magnitudes greater than 2.5 in Wyoming (fig. 1). Twenty of those earthquakes had magnitudes greater than 3.0, of these, 17 occurred in YNP.

The WSGS continually monitors earthquake activity across the state by incorporating USGS Advanced National Seismic System (ANSS) data into the agency's Earthquake Database Internet Map Service, online at www.wsgs.wyo.gov/Research/hazards/Earthquakes.aspx. The agency also provides this information to the public through its outreach program and email listserve.

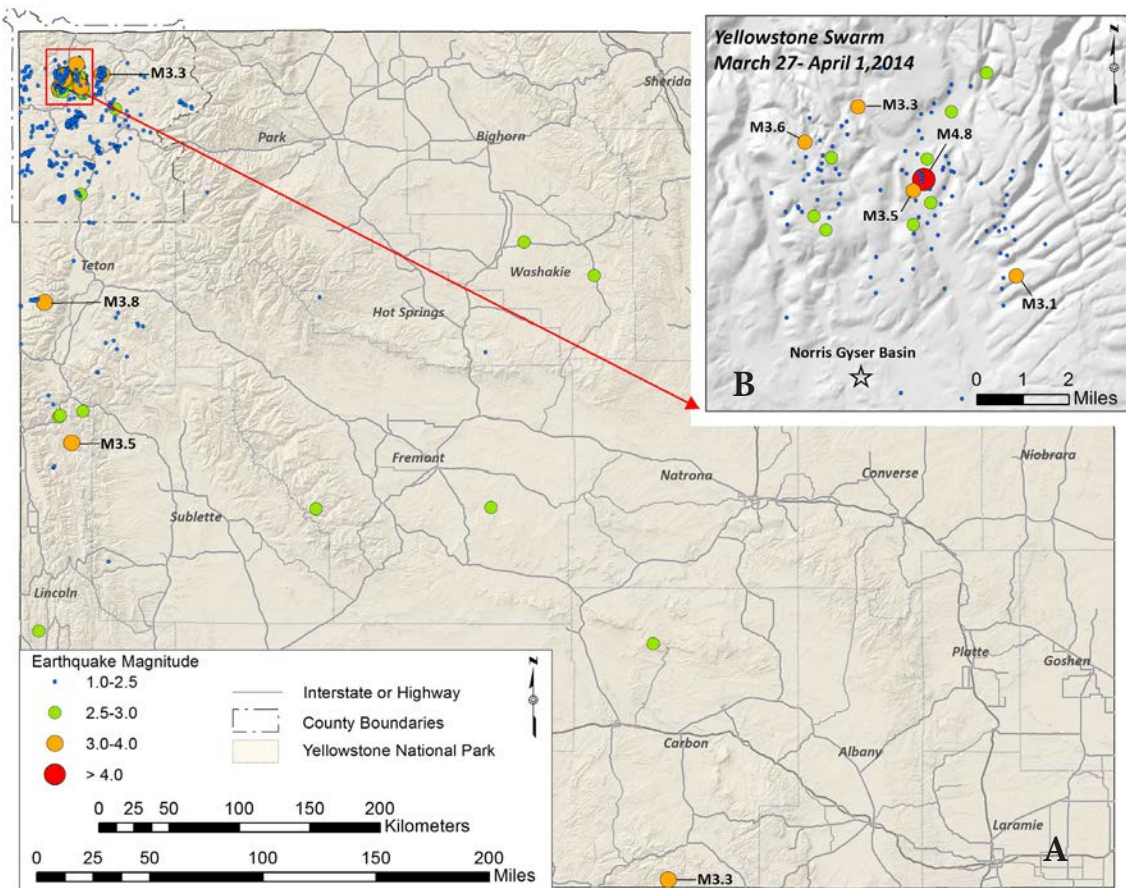


Figure 1A. Location of earthquakes with magnitude >2.5 in Wyoming. **B.** Location of the March 30th 4.8 magnitude earthquake and March 27-April 1 earthquake swarms that occurred in YNP.

Yellowstone National Park significant seismicity during 2014

The most notable and largest earthquake in 2014 occurred on March 30th in YNP with a magnitude of 4.8. The epicenter was located 4 miles north-northeast of Norris Geyser Basin and was part of the Norris Geyser Basin earthquake swarm. The swarm began on March 27th and continued into early April and consisted of 144 earthquakes with magnitudes ranging from less than 1.0 to 4.8. The swarm of earthquakes included approximately 113 earthquakes with magnitudes greater than 1.0 that followed the main shock of magnitude 4.8. The

magnitude 4.8 event was reportedly felt in the park as well as in the towns of West Yellowstone and Gardiner, Montana. This event, to date, was the largest earthquake in Yellowstone since a magnitude 4.3 earthquake occurred on February 20, 1980. Other significant earthquakes (>2.5) and earthquake swarms that occurred in YNP are indicated in the sidebar above.

Significant earthquakes with magnitude greater than 3.0 outside of YNP in 2014

On Aug. 30, 2014, a magnitude 3.8 earthquake occurred in Teton County, approximately 28 miles north of Jackson (fig. 1A). This earthquake occurred at a depth of 3.10 miles. More than 20 residents within the area of Alta, Wyoming reported feeling this earthquake.

A magnitude 3.5 earthquake occurred on Sept. 30, 2014, just 12 miles south-southeast of Hoback in Lincoln County (fig 1A.). The earthquake recorded a depth of 1.18 miles and was reported by nearby residents in Etna and Freedom, Wyoming.

Yellowstone 2014 Seismicity

February

- 243 earthquakes; cluster of 153 near Norris Geyser Basin; largest a magnitude M3.5.

March/April

- Norris swarm (144 earthquakes), largest a M4.8.

May

- 135 earthquakes; largest a M3.5 near Mammoth.
- Small series (11) earthquakes occurred near West Thumb (NE), with a second series of 14 quakes near the SW West Thumb.
- A swarm of 26 earthquakes occurred near Old Faithful.

September

- 71 earthquakes; largest a M3.2 near Mammoth.

November

- 98 earthquakes; one small swarm occurred near Lewis Lake with the largest a M2.7.

The USGS “**Did You Feel It**” is a program for the public to report if they felt ground motions or experienced possible damage related to an earthquake.

(www.earthquake.usgs.gov/earthquakes/dyfi/).



Figure 2A. View from the Jackson Walgreens parking lot, looking directly upslope toward the body of the landslide. **B.** The movement or motion of the landslide caused the asphalt to buckle and deform in the parking lot. *Photo by Martin Larsen, WSGS, April 16, 2014.*

An area approximately 29 miles south of Saratoga (Carbon County) near the Wyoming and Colorado border experienced a magnitude 3.3 earthquake that occurred on Nov. 15, 2014 (fig. 1A). The earthquake occurred at a depth of 1.65 miles. There were no reports that the public felt this earthquake.

Recent Earthquake Investigation

Other WSGS monitoring efforts in 2014 included a study to determine whether industry injection and disposal well activities have contributed to earthquakes in the past. Geologists found no direct link with the exception of one site near Bairoil, Wyoming. Further research on this site is necessary to determine if there is a direct correlation with injection and disposal well activities and seismicity. The WSGS continues to monitor and map injection and disposal well activity with any earthquakes that occur in those areas. For the report, log on to www.wsgs.wyo.gov/Research/hazards/earthquakes-wells.aspx.

Landslides

The majority of the landslides in Wyoming are located in remote rugged areas of the state and typically do not cause damage or economic impacts. The ones that have caused significant damage and economic impacts in the state have historically occurred along major highways or interstates. In 2014, there were two landslides that posed a threat to the public (Budge and Cook Lake landslides) and a few minor landslides along transportation corridors, as reported by the Wyoming Department of Transportation.

The WSGS has a **Report a Landslide** program for the public to help the agency track slides around the state. Log on at www.wsgs.wyo.gov/Research/hazards/Report-Landslide.aspx.



Budge Landslide – Jackson, Wyoming

One landslide that made national media attention in 2014 was the Budge Drive landslide, located in Jackson, Wyoming. This landslide is located on the south-facing slope of the East Gros Ventre Butte near Broadway Ave. and Budge Dr. Significant cracks, fissures, and asphalt buckling in the Walgreens parking lot was observed on April 16, 2014. Directly upslope of the parking lot is a headscarp with visible lateral scarps. Crown fissures and cracks were observed in a resident's driveway and garage directly above the headscarp. The residence overlapped the headscarp, which caused a portion of the house to collapse within the main body of the landslide.

The landslide also caused significant damage to the retaining walls, pavement and curbs along Budge Dr., and to a commercial property. An estimated cost in work and repairs could range from \$8 to \$30 million, according to news reports. For additional information and a slideshow on this landslide, visit the Town of Jackson's website.

Cook Lake Recreational Area

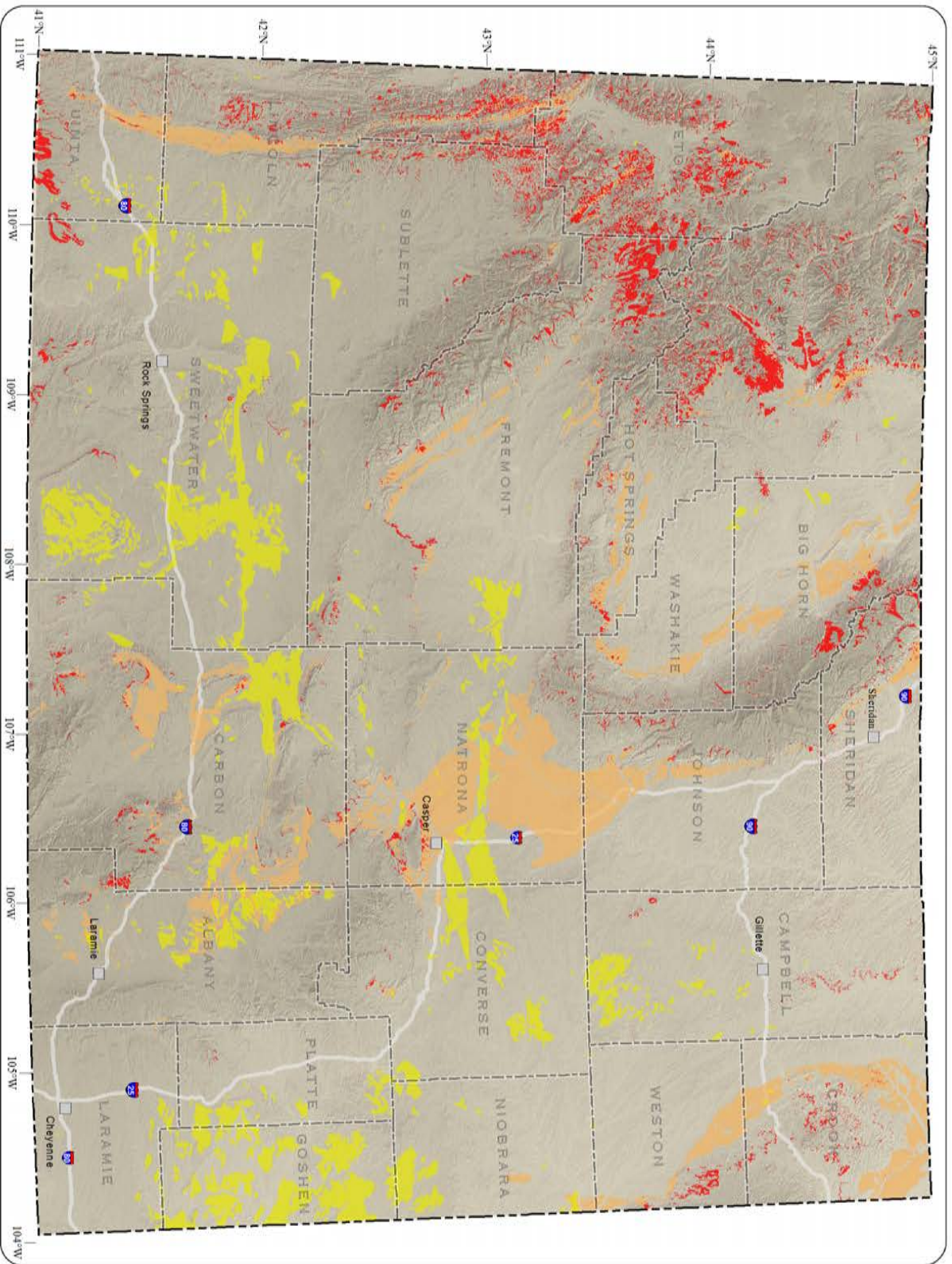
The U.S. Forest Service closed the Cook Lake Recreational area on May 9th, 2014 due to potential landslide activity as a result of saturated soils from heavy spring rain and snow melt. Because of historical landslides in the area, coupled with the slope conditions, Forest Service officials were concerned of possible landslide activity on the western slopes and took the necessary actions to ensure public safety. The Forest Service continues to monitor the area for potential slope activity. The Cook Lake Recreational Area remains closed due to unstable slope conditions.

Current information on Wyoming's geologic hazards, at
www.wsgs.wyo.gov/research/hazards



Interpreting the past, providing for the future

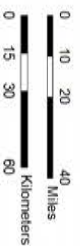
WYOMING STATE GEOLOGICAL SURVEY
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EXPLANATION

- Landslides
- Potential windblown deposits
- Potential expansive soils

- City or town
- Interstate highway
- County boundary



Wyoming Geologic Hazards