

Montana Bureau of Mines and Geology  
Open-File Report 632  
**Landslide Map of the Big Sky Area**  
Madison and Gallatin Counties, Montana

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2013

This reconnaissance overview map of areas where landslides have occurred and where rock glaciers are present is based on their landform expression observed on a hillshade base, recent field mapping in the Lone Mountain and Gallatin Peak 7.5' quadrangles (Vuke, 2013), and previous mapping (Gooley, 1972; Florentine, 2011; Kellogg and Williams, 2000; and Tysdal, 1990).

The LIDAR base map is from the National Center for Airborne Laser Mapping (NCALM), obtained through the National Science Foundation-supported NCALM Data Distribution Center: <http://calm.geo.berkeley.edu/ncalmddc.html>.

**Landslide Warning Signs**

- Springs, seeps, or saturated ground in areas that are not typically wet.
- New cracks or unusual bulges in the ground, street pavement, or sidewalks.
- Soil moving away from foundations.
- Ancillary structures such as decks and patios tilting and/or moving relative to the primary structure.
- Tilting or cracking of concrete floors and foundations.
- Broken water lines or other underground utilities.
- Leaning telephone poles, trees, retaining walls, or fences.
- Offset fence lines.
- Sunken or down-dropped road beds.
- Rapid increase in creek water levels possibly accompanied by increased turbidity (soil content).
- Sudden decrease in creek water levels although rain is still falling or just recently stopped.
- Sticking doors or windows, or visible open spaces indicating jams and frames out of plumb.
- A faint rumbling sound that increases in volume as the landslide nears.
- Unusual sounds, such as trees cracking or boulders knocking together that might indicate moving debris.

**Areas generally prone to landslide hazards**

- Existing landslides
- On or at the base of slopes.
- Within or at the base of minor drainage hollows.
- At the base or top of old fill slopes.
- At the base or top of steep-cut slopes.
- Hillside where septic system drain fields are used.

**Areas typically considered safe from landslides**

- Hard, non-jointed bedrock that has not moved previously.
- Relatively flat-lying areas away from sudden changes in slope.
- At the top or along ridges set back from the tops of slopes.

Modified from Landslide Warning Signs (U.S. Geological Survey Landslide Hazards Program): <http://landslides.usgs.gov/learn/wps/signs/>

**TYPES OF LANDSLIDES INCLUDED ON MAP**

The following are included on the map under the general term **landslide**.

**Rotational landslide (Figure 6).**

A type of mass movement in which the mass (sediment or rock) moved along a curved, concave-upward rupture surface. The main body of the slide rotated toward the up-slope part of the rupture surface, and the toe moved beyond the rupture surface. There are numerous rotational landslides in the Big Sky area.



Figure 6. Rotational landslide

**Translational landslide (Figure 7).**

A type of mass movement in which unconsolidated sediment or rock moved downslope without rotation along a planar or undulating surface. A rockslide is a type of translational landslide that involves a bedrock unit that has moved downslope as a relatively coherent mass along a rock bedding plane or other planar surface. The bedrock mass may have broken into smaller pieces as the slide moved downslope. Local areas where rock bedding dips downslope have been prone to translational landslides in the Big Sky area.

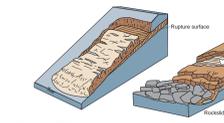


Figure 7. Translational landslides

**Debris flow (Figure 8).**

A water-saturated slurry of soil, rock, and organic matter that moved downslope rapidly. Debris flows may be dense enough to transport large boulders and trees.

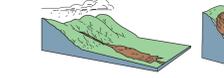


Figure 8. Debris flows

**Earthflow (Figure 9).**

Fine-grained, generally clay-bearing material that liquefied with addition of water, and flowed downslope.



Figure 9. Earthflow

**Rock glaciers, shown on the map, also move materials down-slope, if active.**

**Rock glacier (Figure 10).**

A mass of angular boulders, cobbles, and fine-grained sediment cored by or partly cemented by ice. A rock glacier has the general morphology and slow downslope movement (if active) of a small valley glacier.

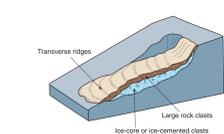


Figure 10. Rock glacier

**OTHER TYPES OF GRAVITATIONAL MASS MOVEMENT IN THE BIG SKY AREA**

**Creep (Figure 11).**

The imperceptibly slow, steady, downslope movement of slope-forming soil or rock that produces soil ripples or ridges, curved tree trunks, and tilted or out-of-alignment fences, poles, or retaining walls. Creep is extensive and on-going in much of the Big Sky area.



Figure 11. Creep

**Rockfall (Figure 12).**

A mass of rock that detached from a cliff face along a discontinuity such as a fracture, and fell freely with near-vertical motion.



Figure 12. Rockfall

**Topple (Figure 13).**

A mass of rock that fell rapidly as a result of forward rotation. In the high peaks of the Big Sky area, rock topples have occurred where an overhang of resistant rock broke free and rotated downward.



Figure 13. Topple

Landslide graphics modified from Highland (2004).

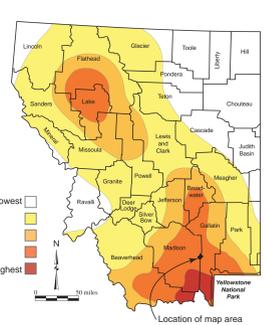


Figure 1. Relative earthquake hazard map, western Montana (modified from Slickney and others, 2000). Earthquakes can trigger landslides. The map area is within Montana's next to highest, and close to its highest earthquake hazard zone.



Figure 2. Sign indicating landslide area along Highway 64, Big Sky.

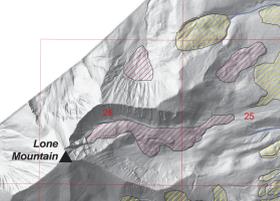


Figure 3. Bentonitic mudstone along Highway 64, Big Sky. Bentonite is slippery when wet, contributing to landslide development.

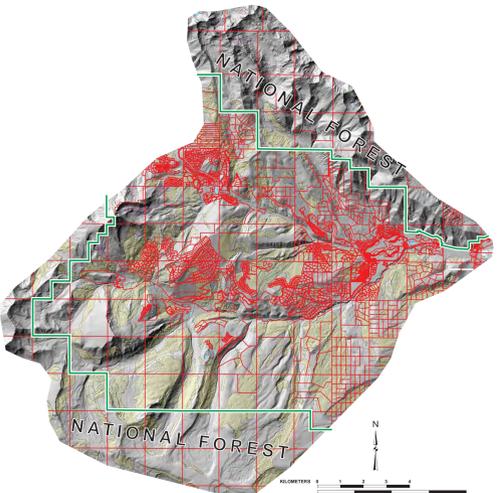
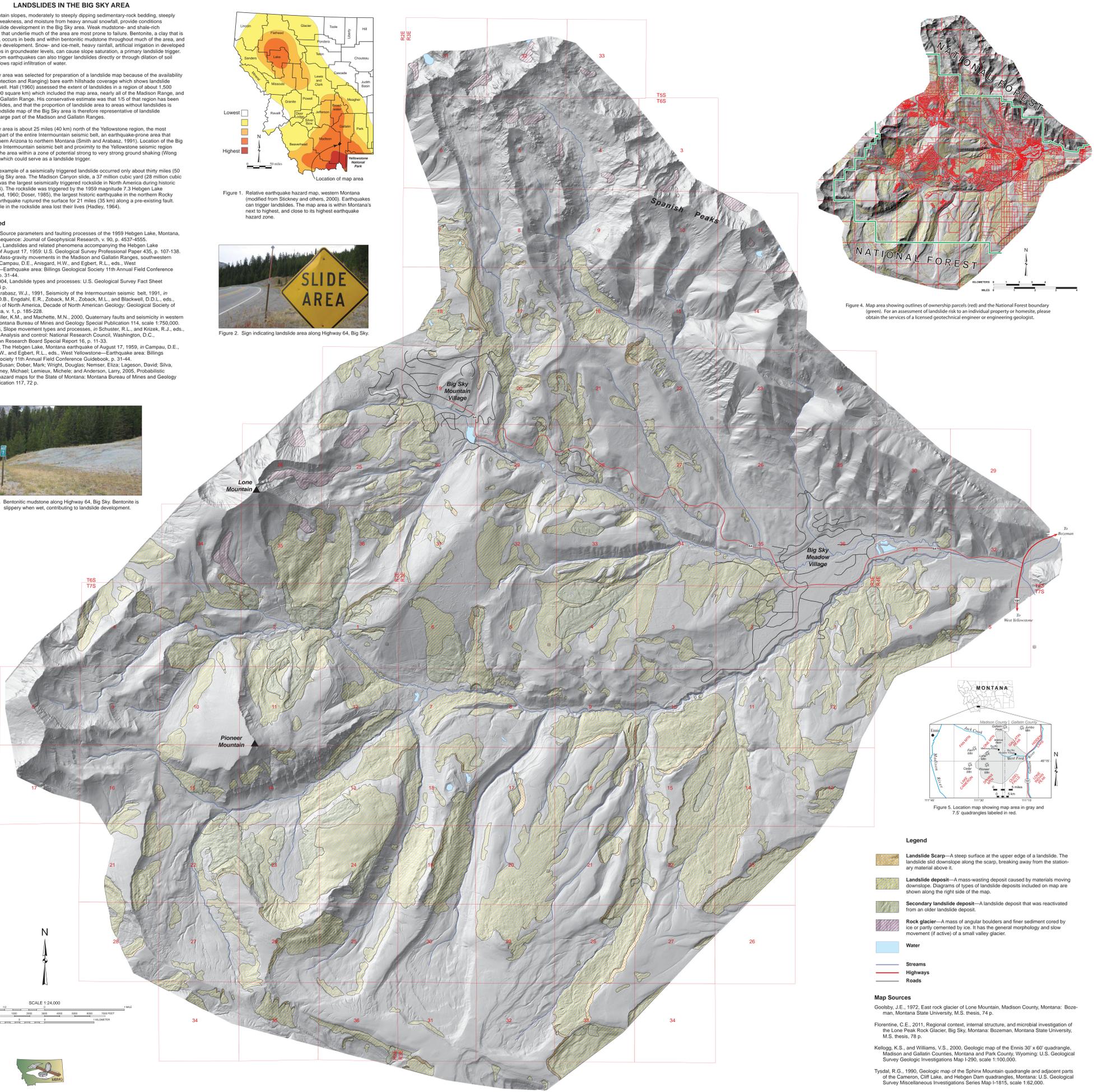


Figure 4. Map area showing outlines of ownership parcels (red) and the National Forest boundary (green). For an assessment of landslide risk to an individual property or homestead, please obtain the services of a licensed geotechnical engineer or engineering geologist.



**References cited**

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Maps may be obtained from:  
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