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National Cooperative Geologic Mapping Program, in collaboration with the National Park Service

Assessing Geohazards to the Denali National Park Road with Geologic Mapping

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Denali National Park Road—An Economic Lifeline in Alaska

Denali National Park (DENA), located in Alaska, is home to iconic and breathtaking landscapes surrounding the tallest mountain range in North America. DENA has about 6 million acres of wild land that provides opportunities for recreation, subsistence hunting and gathering, preservation of cultural resources, and scientific research. In 2017, DENA received more than 600,000 visitors, resulting in $632 million in visitor spending in the park and nearby communities; 8,150 jobs; and $924 million in general economic output (Denali National Park and Preserve, 2018). As a result, DENA represents a major economic engine for the State of Alaska.

Despite its size and popularity, DENA has only one road—the 92-mile Denali National Park Road (hereafter referred to as the Park Road; fig. 1). The Park Road is mostly gravel; only 16 percent is paved. It is the only access for most DENA infrastructure, including visitor centers, staff facilities, campgrounds, and businesses. The success of DENA as a visitor destination, an economic engine, and a safe environment for visitors, residents, and staff relies on the resilience of the Park Road, making it a major transportation lifeline for the region.

Figure 2. *A*, Pretty Rocks landslide (dashed outline) and location of scarp photograph. *B*, 2-meter landslide scarp (outlined in white) in Park Road caused by slump at the head of Pretty Rocks landslide (Photographs from Denny Capps, National Park Service).

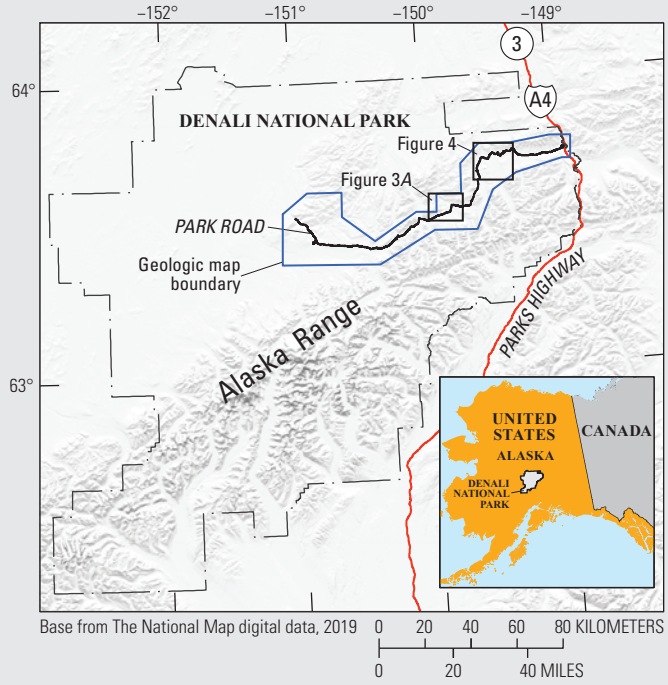

Figure 1. Denali National Park (DENA), geologic mapping boundary, and course of the Park Road. Inset shows DENA park boundary in Alaska.

U.S. Geological Survey Surficial Geologic Mapping—Identifying Geohazards in the Park Road Corridor

The Park Road crosses a steep, constantly changing landscape, shaped by the rapid uplift of the Earth's crust along the central part of the Alaska Range, by glacier and meltwater erosion, and by permafrost heaving. Geologic hazards (geohazards) such as rockfall, flooding, and landsliding (fig. 2) cause significant damage to the Park Road every year, requiring periodic closure, and costing millions of dollars in repair and maintenance. In addition, DENA is situated along a major fault system and experiences numerous earthquakes every year. Most are too weak to be felt, but a 7.9 magnitude earthquake shook the region in 2002, and at least one major landslide, which formed Bergh Lake along the Park Road corridor, was caused by seismic shaking in 1953 (Capps and others, 2017).

In response to the threat posed by geohazards, the U.S. Geological Survey (USGS) and the National Park Service (NPS) have partnered to produce a new, high-resolution surficial geologic map to help identify unstable slopes, active faults, and hazardous geologic substrates in the Park Road corridor to better inform infrastructure planners. This new USGS map augments previous broad scale, bedrock-focused maps and uses detailed Interferometric Synthetic Aperture Radar elevation data for Alaska (Carswell, 2013) to do high-resolution mapping along the Park Road corridor (fig. 1). The map defines a spatial geologic history for Holocene and Pleistocene (more than 2.6 million years old) sediments deposited by glaciers, braided rivers, alluvial fans, and landslides, and active fault displacements that cut across these young deposits.

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Park Road Reroute Planning near Polychrome Overlook

The Park Road crosses steep topography in the area surrounding the Polychrome Overlook. This section is the most immediate infrastructure concern because it crosses several active landslides (figs. 2 and 3). Maintaining the current (2020) road course is costly and poses a high risk to DENA staff and visitors. However, closing the road to vehicle traffic would greatly restrict visitor access and negatively affect tour businesses operating within the park.

Thus, NPS is considering options for rerouting the road, either to the north or southeast of its current path (fig. 3*A*). New surficial geologic mapping in this region will help identify potential geohazards and define geologic substrates in the areas of rerouting (fig. 3*B*). This will help road engineers ensure safe, cost-efficient, and resilient road infrastructure can be built and maintained for the long term.

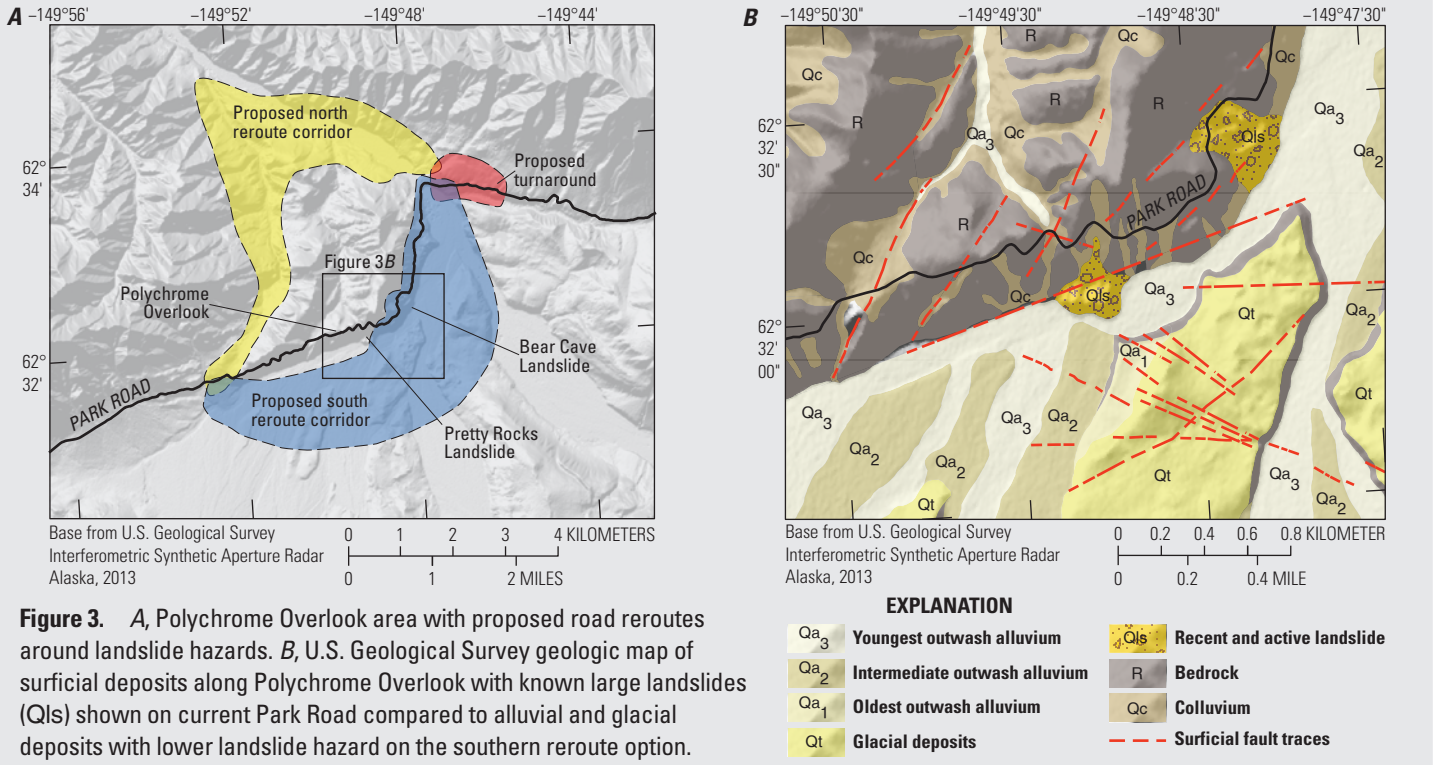

Figure 3. *A*, Polychrome Overlook area with proposed road reroutes around landslide hazards. *B*, U.S. Geological Survey geologic map of surficial deposits along Polychrome Overlook with known large landslides (Qls) shown on current Park Road compared to alluvial and glacial deposits with lower landslide hazard on the southern reroute option.

Collaborative Research—Active Faults and Glaciation

The USGS and the NPS are collaborating with colleagues at Purdue University to date glacial sediments using cosmogenic nuclide exposure methods. Multiple generations of Pleistocene glaciers have crossed the Sanctuary River valley south of the Park Road. The glacial sediments left behind are all crosscut by active faults (fig. 4). In general, the oldest sediments show the most surface offset along faults, whereas modern streams show the least. Dating of the glacial deposits, therefore, constrains (1) the history of glaciation in the central Alaska Range and (2) rates of fault slip posing earthquake hazards to NPS infrastructure. This scientific research contributes to both geohazard assessment and furthering understanding of the geologic history of Denali National Park.

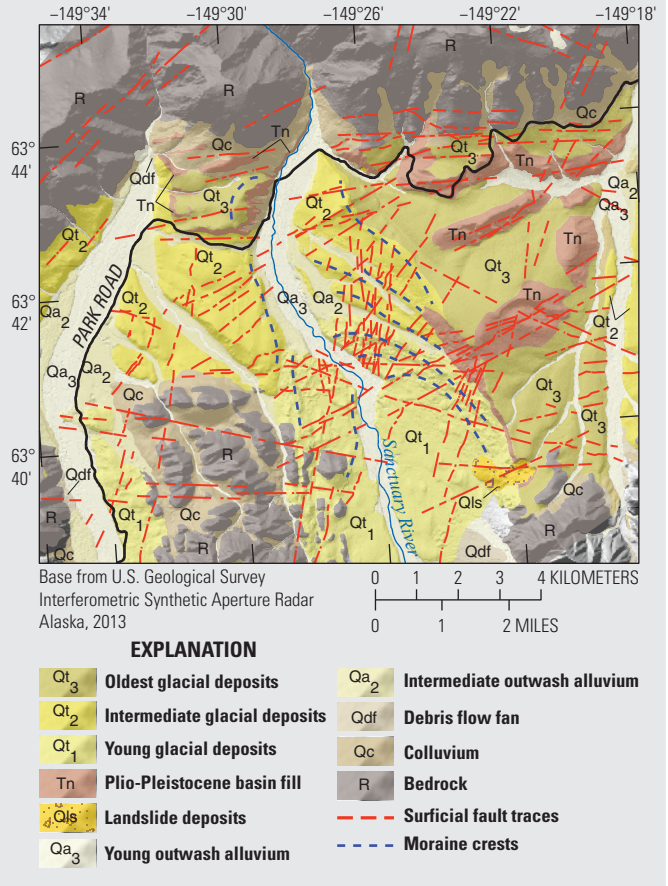

Figure 4. Pleistocene glacial deposits, Neogene sediments, and surficial fault traces near Sanctuary River, Park Road corridor.

Acknowledgments

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References Cited

Capps, D.M., Rosenberg, R., Collins, A., Anderson, D.A., Hooper, S., Rogers, H., Collins, B., and Bilderback, E., 2017, Geohazards risk assessment of the Denali National Park Road, *in* Proceedings North American Symposium on Landslides, Roanoke, Va., Association of Environmental & Engineering Geologists.

Carswell, W.J., Jr., 2013, The 3D elevation program: Summary for Alaska: U.S. Geological Survey Fact Sheet, 2013–3083, 2 p. https://doi.org/10.3133/fs20133083.

National Park Service, 2018, Denali National Park & Preserve, 2018 park statistics: National Park Service, accessed August 8, 2019, at https://www.nps.gov/dena/learn/management/statistics.htm.