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Evidence for large Holocene earthquakes along the Denali fault in southwest Yukon Territory

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The Yukon-Alaska Highway corridor in southern Yukon Territory is subject to several geohazards, notably landslides and debris flows, floods, and earthquakes on faults in the St. Elias Mountains and Shakwak Valley. Here we report on one of these hazards; specifically we discuss the recent seismic history of the Denali fault, which is located at the east front of the St. Elias Mountains and is one of only a few known active faults on the Canadian landmass. Holocene faulting is indicated by scarps and mounds on late Pleistocene drift and by tectonically deformed Pleistocene and Holocene sediments. Trenches excavated across the scarp of the Denali fault near Duke River by the U.S. Geological Survey and Yukon Geological Survey in 2008, and re-examined by Simon Fraser University and the Geological Survey of Canada in 2013, reveal sediment disturbance related to several large earthquakes, which we have dated to about 300-1200, 2200, 3000, and 6000 years ago. Nearby Crescent Lake is ponded against the fault scarp. Sediment cores recovered from the lake reveal sediment and diatom changes, between 1900 and 1200 years ago, between 6000 and 2000 years ago, and at about 6000 and 6500-6800 years ago. At Duke River, the fault offsets sediments, including two White River tephra layers (ca. 1900 and 1200 years old). Thick, Late Pleisotcene stratified outwash gravel underlying the tephras has been tilted, and many stones within the gravel have been fractured and displaced by movement along the fault. The outwash gravel and overlying aeolian sediments at this site show in cross-section a positive flower structure indicative of postglacial contraction of the sediments by dextral strike-slip movement. The average horizontal slip-rate along the Yukon segment of the Denali fault over the Holocene is about 2 mm/yr.