Evidence for Prehistoric Earthquakes on the Southern Fairweather Fault in Trenches across the 1958 Surface Rupture, Glacier Bay National Park, Alaska

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The Fairweather Fault in southeast Alaska accommodates ~46 mm/yr of dextral slip (>90% of relative Pacific–North America Plate motion) where the Yakutat terrane collides obliquely with North America. In 1958, the Fairweather Fault ruptured over 260 km from near Cross Sound northward toward Yakutat Bay during the M 7.8 Lituya Bay earthquake. We acquired lidar along parts of the 1958 fault rupture not covered by water or ice to aid fault mapping and identify sites that might record prehistoric earthquakes. We selected a site at the north end of Crillon Lake where post-1958 earthquake surveys measured ~6.5 m dextral and >1 m vertical offsets, but coarse sediment and shallow groundwater prevented trenching across uphill-facing scarps here. West of the primary fault scarp, we discovered a second scarp with 1 m dextral and 0.5 m vertical offsets; tilted and fallen trees along the scarp imply slip in 1958.

Lidar-derived terrain models helped select a second trench site, 3 km southeast of the Crillon Lake site, where an alluvial fan filled a closed depression present in 1958 photos. On the west, the fan is bounded by a fault scarp along the base of a ridge of sandy and gravelly till; the 1958 rupture shattered the ridge. Fan deposits abutting the ridge consist of 0.5–3.3 m of laminated fine sand and silt that bury a possibly pre-earthquake soil. Trenches across the scarp provide evidence for past earthquakes. Trench A exposed tilted deposits of till and fan alluvium, and fault zones and fissures that terminate within successively younger deposits. The faulted strata and fissures provide evidence for at least three earthquakes, likely including 1958. Trench D exposed till, scarp-derived colluvial wedges, and tilted organic-rich layers that provide evidence for three earthquakes. Massive till in trench D obscures faulting, but stratigraphic relationships suggest an oblique-reverse sense of motion. Ongoing 14C analyses will anchor estimates of earthquake timing.