An overview of the 3 November, 2002, Mw 7.9 Denali Fault earthquake, Alaska

Peter J. Haeussler, U.S. Geological Survey, Anchorage, AK

The Mw 7.9 Denali fault earthquake on 3 November 2002 was the largest continental strike-slip earthquake in North America in almost 150 years, and was associated with 340 km of surface rupture. The relatively remote location of the fault resulted in little structural damage ($40+ million) and no loss of life. The Denali fault is part of a system of faults in southern Alaska that accommodate collision of the Yakutat terrane into the cusp of southern Alaska. The Mw 6.7 Nenana Mountain earthquake of 23 October preceded the 3 November 2002 Denali fault earthquake. It was located along the main trace of the Denali fault, has a right-lateral focal mechanism, but there was no surface rupture. The 3 November 2002 Mw 7.9 earthquake began as a Mw 7.2 south-directed thrust on the previously unrecognized Susitna Glacier fault, continued with Mw 7.8 right-lateral strike-slip rupture on the Denali fault, then took a right step and continued with right-lateral strike-slip on the Totschunda fault. Rupture on the Totschunda fault supports the hypothesis of Richter and Matson (1971) that it may eventually link up with the plate bounding Fairweather fault system. Two regions with the largest measured offsets correlate well with geophysically inferred areas of significant moment release. The largest measured offsets on the Denali fault were almost 9 meters in the region near Mentasta. The Totschunda fault had only 1-2 m of right-lateral slip, which is significantly less than the 5 m or so of the easternmost part of the Denali fault. The Mw 7.9 earthquake on the Denali fault was expected due to regional neotectonic studies that outlined the active faults, microplates, and zones of deformation in combination with rough estimates of rates of fault offsets. The Trans-Alaska Pipeline System was designed to accommodate a 20 foot right-lateral offset on the Denali fault, and is an example of the success of previous neotectonic investigations. The Denali fault earthquake stressed both ends of the fault system. A ~1250 yr. B.P. tephra is apparently undisturbed across the Totschunda fault trace about 20 km southeast of the southeasternmost surface rupture. This relationship suggests the southern Totschunda fault may have been brought significantly closer to failure

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