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Paleoseismology and Fault Interactions of the Pajarito Fault System, Rio Grande Rift, New Mexico

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American Geophysical Union, Fall Meeting 2006, abstract #S31A-0185

Published in Dec 2006

The Pajarito fault system is the local active boundary fault of the Rio Grande rift in the vicinity of Los Alamos, New Mexico. Detailed geologic and geomorphic mapping, and displacement-length profiles, reveal a complex pattern of structural deformation that suggests interaction and connective growth among the principal faults in the system (Pajarito, Rendija Canyon, Guaje Mountain, and Santa Clara faults, totaling ~55 km in length). At the surface, the Pajarito fault is not a single shear surface but a complex zone of deformation with considerable lateral variation in structural style from south to north. In the area of detailed mapping, the Pajarito fault is a broad zone of distributed deformation: at the southwest corner of the area, structure is dominated by a large monocline, but small faults and monoclines span a breadth of about 2 km with about 125 m of displacement in the last 1.2 million years; at the west central part of the area, the Pajarito fault is expressed as mainly a large normal fault with smaller faults spread across about 1 km with about 80 m of displacement in the last 1.2 million years; and, in the northwestern part of the area, structure is again dominated by a large monocline with normal faulting in a zone about 1.5 km wide with about 65 m of displacement in the last 1.2 million years. These along-strike variations in the deformation of the Pajarito fault suggest that in most places the tip of the
master fault does not break the surface; instead, most of what can be observed is subsidiary structure. The implication of the complex structure and styles of deformation in the fault is that it severely complicates paleoseismic exploration for hazard analyses because different subsidiary structures rupture in different seismic events; no individual structure can be identified with even a near-complete paleoseismic record. Additionally, surface rupture hazards must be associated with broad zones instead of individual faults. Seven paleoseismic trenches and one borehole, drilled into a faulted fissure, provide constraints on the timing of the three most recent surface rupturing earthquakes, all of which occurred in the Holocene, in the fault system: 1.4 to 2.2 cal ka; 4.2 to 6.5 cal ka; and, 9 to 10.9 cal ka. Each of these events has been identified at more than one location. Three Holocene earthquakes suggest a higher rate of activity, in terms of both slip rate and recurrence interval, than was previously believed. Prior to the Holocene events, a surface rupturing earthquake occurred at about 39 ka, implying the most recent events represent a cluster.