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Sackungen record four major Holocene earthquakes on the Reelfoot fault, New Madrid seismic zone, U.S.A.

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One of the best studied faults in the stable-continental Central and Eastern United States is the Reelfoot reverse fault, a major structure within the New Madrid seismic zone. The Reelfoot fault was involved in the historic 1811-1812 CE earthquake sequence and has been the subject of extensive paleoseismic trenching, paleoliquefaction investigations, and fluvial geomorphic analyses. The paleoearthquake record on the Reelfoot fault only extends back to the mid-Holocene. In this investigation, we extend the paleoearthquake record on this fault via a paleoseismic investigation of ridge-top gravitational failure features, interpreted as sackungen. In the region, sackungen occur along the bluffs above the eastern margin of the Mississippi River floodplain and are concentrated in the hanging wall of the southwest-dipping Reelfoot reverse fault. A paleoseismic trench excavated across sackungen at the Paw Paw site exposed four packages of colluvial sediment that postdate 30-11 ka Peoria loess. We interpret the colluvial packages to have been deposited following episodic failure of the sackungen as a result of strong ground motions. Radiocarbon and luminescence dating, along with 210Pb and 137Cs concentrations, constrain the ages of the colluvial packages and indicate the following sequence of earthquakes: event 4, 1640 $\pm$ 1730 BCE; event 3, 270 $\pm$ 670 CE; event 2, 1430 $\pm$ 380 CE; and event 1, 1810 $\pm$ 50 CE (2-sigma). Event timing corresponds to previously documented earthquakes and represents the longest archive of paleoearthquakes on the Reelfoot fault. If the trenched sackungen record all major Reelfoot fault earthquakes, our observations in combination with prior investigations indicate a period of quiescence from at least 11 – 4.7 ka, followed by four major seismic events culminating in the 1811-1812 CE sequence. This clustered earthquake recurrence pattern helps place bounds on seismic-hazard and geodynamic models in the New Madrid seismic zone.