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Long-term and Short-term Earthquake Behavior Along The Dead Sea Fault (Jordan) From Geomorphology, Paleoseismology And Archeoseismology

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The recurrence of large and destructive earthquakes along major fault systems is key to understanding their driving mechanism and to infer future behaviour. For the Jordan Valley segment (JVF) of the ∼1000-km-long Dead Sea Fault, we provide evidence of episodic behaviour. We combine published historical data, re-appraised archaeological data and original geomorphic analyses and paleoseismic excavations to reveal the behaviour of the fault over the past 50 kyr, with an unprecedented high resolution of the rupture history for the past 14 kyr.

We document systematically offset drainages over three regions along the active fault trace. The mostly dendritic drainage pattern is inferred to form as a consequence of gully and streams incising into the soft Lisan lacustrine sediments. The drainages may be grouped into six distinct generations as a function of their incision depth. Assuming that each incision underwent a similar erosion/deposition process, the depth of each of the drainages is inferred to reflect its age. Consequently, the incisions may be sorted chronologically. Based on the history of past lake-level fluctuations and intense rainfall episodes, we identify six climatic events that are likely to have triggered the onset of gully incision episodes. We measured lateral offsets of individual drainages from analysis of aerial photographs combined with field control points and field measurements.

Paleoseismic trenches excavated across a pull-apart basin show at least two fault movements that can be associated with the major earthquakes (M>7) of A.D. 749 and A.D. 1033. At the archeological site of Tell Es-Saidiyeh, trenches show evidence for up to eight surface ruptures over the past 14 ka, of which the most recent may be correlated to the historical earthquake of A.D. 1033. A critical analysis of archeological observations from ten sites provides for a reinterpretation that 9 to 12 destruction events occurred after about 2900 B.C.

Our results indicate a long term average slip-rate of 4.9 mm/yr averaged over the last 48 kyr, with short-term rate varying between 3.5 and 11 mm/yr. We also document the occurrence of up to 14 Mw > 7 earthquakes for the past 14 ka with a recurrence interval ranging from 600 to 1000 years. In that the JVF has accumulated 3.5m to 5 m of slip since the most recent major surface rupture in AD 1033 earthquake, we propose that the JV segment may be mature for a large event.