A 14-kyr-long history of surface ruptures for the Jordan Valley segment of the Dead Sea fault

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The Dead Sea fault is one of the major active strike-slip faults in the world. The Jordan Valley segment, defined by the Sea of Galilee to the north and the Dead Sea to the south is capable of producing large and destructive earthquakes (Mw > 7.2), the most recent having occurred in AD 1033. From the detailed analysis of topography, aerial photographs, satellite images and field observations, we mapped the active fault trace in its complexity. At the scale of the fault system, the Jordan Valley segment is bounded by major pull-apart basins: the Sea of Galilee and the Dead Sea. At a lower scale, we identified 5 sub-segments limited by pressure ridges at tell Arba'een, tell Al-Qarn, Karameh and Ghor Al-Mendessa. Their length ranges from 16 km to 25 km, a value similar to the thickness of the brittle crust. This suggests sub-segments are actually fault patches. At the km-scale, sub-segments exhibit small (a few hundred meters long) and well-expressed pull-apart basins. From the limited extent of the various stepping zones we identified, it appears a strong enough event initiating on any of the sub-segments would likely propagate along the full length of the segment into a 110-km-long rupture. We combined historical, archeological and paleoseismic data from two trench sites to build a unique composite catalogue of such large past earthquakes. On that basis, we show evidence for surface rupture during the AD 749 and AD 1033 earthquakes. Overall, we identified 8 surface-rupturing events for the last 14 kyr and 9 to 12 destructive events since ~2900 BC. A temporal analysis displays clusters of seismicity as well as quiescence periods as well as a 600- to 1000-yr-long recurrence interval for large earthquakes in the last 14 kyr.