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Slip rate determination along the Southern Dead Sea fault: optically stimulated luminescence, 10Be cosmogenic radionuclide, and 14C ages brought face to face

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Active tectonics studies are often limited by difficulties in accurately and precisely dating Late Quaternary alluvial deposits that commonly lack organic matter or date beyond the 14C dating limit. This is illustrated at a site called Fidan, in arid southern Jordan, where a series of alluvial fans are laterally offset by the southern Dead Sea fault. Geodetic, geomorphic and geologic studies converge to a fault slip rate of 5 $\pm$ 2 mm/a. Yet, Late Pleistocene slip rate at Fidan cover a wide range due to the dispersion of 10Be cosmogenic radionuclide (CRN) ages. The maximum slip rate since $\sim$100 ka is up to a value of 11 mm/a, possibly suggesting significant variations in fault activity with time. In order to reduce the uncertainty on the Late Pleistocene slip rate and draw further conclusions regarding the fault seismic behavior, we implement complementary dating using optically stimulated luminescence (OSL) techniques on both quartz and K-feldspar minerals and using 14C when possible. OSL measurements include a newly developed technique called post-infra-red infra-red stimulated luminescence at 290˚C (pIR290). We extensively sampled surface levels F2 and F4, digging $\sim$50-cm deep pits into the geomorphic surfaces. Annual dose rates were determined in the laboratory from both geochemical analysis of the sediment and gamma-ray spectrometry. Due to sediment heterogeneity, we consider gamma-ray spectrometry as more reliable because it is based on a larger volume of sediment. Quartz OSL ages and preliminary pIR290 results on K-feldspars give consistent Early Holocene ages of 9-14 ka for F2, also in agreement with a 14C age of 13 ka from a landsnail shell. 10Be CRN exposure ages on F2 were significantly older, with 37 $\pm$ 4 ka, probably due to inheritance. On F4, 10Be CRN exposure ages showed a scattered distribution, from $\sim$50 ka to $\sim$120 ka, with most samples comprised in the mean interval of 87 $\pm$ 26 ka. Quartz OSL ages from 5 locations on F4 are comprised between 32 $\pm$ 3 ka and 37 $\pm$ 4 ka, with one older age at 50 $\pm$ 6 ka. All ages are younger than the average 10Be exposure age. Because OSL growth curves of quartz suggested that the minerals may be saturated, quartz ages could be under-estimated. IRSL at 50˚C on K-feldspars yielded high fading rates (= loss of luminescence signal with time) with g-values of 9% per decade and more, considered too high to provide reliable fading correction. On-going pIR290 measurements on K-feldspars, for which fading is expected to be negligible, should help resolve the age discrepancy on F4.