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Is the Carmel Fault, a major branch of the Dead Sea Transform, active?

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Haifa, a metropolitan area, with about one million people, is situated near and along the Carmel Fault (CF), a major branch of the Dead Sea Transform. The fault has been considered potentially active, adding to the threat to city and its industry by the nearby Dead Sea Transform. Several geological, geomorphological, geodetic, seismic, and paleoseismic studies were recently conducted in order to determine the state of current activity along the fault, which has important implications for seismic hazard in this highly populated area.

The CF offsets Upper Cretaceous sedimentary rocks vertically by about 1000m and Tertiary structures sinistrally by about 1500m. Pleistocene stream channels are offset sinistrally by up to 300m. The steep slopes of Mt. Carmel along the trace of the fault, the displaced alluvial fans and stream channels, and the formation of shutter ridges and morphological scarps along the fault trace, all indicate significant vertical and horizontal movements during the Quaternary.

Deep seismic profiles along the CF, as well as shallow high resolution reflection profiles across several fault scarps, show normal and reverse fault offsets that almost reach the surface. One high resolution seismic line in the Haifa harbor crossed a major CF segment. Dating of undisturbed sediments suggests that this segment has not been active over the last hundred thousand years.

In a paleoseismic study across one fault scarp of the main fault strand, a zone of

deformation was observed overlying a reverse fault identified by seismic reflection, but evidence for surface rupture was not found. The deformed units were dated to about 15 ky. A paleoseismic study along the Nesher Fault, a branch of the Carmel Fault, shows tilting, possibly related to normal faulting prior to 20 ky BP. The paleoseismic observations suggest that if any earthquake occurred along the Carmel Fault in the last fifteen thousand years, it did not cause any surface rupture, thus limiting its magnitude to a maximum value of M$\sim$6.

A geodetic study, using the PSInSAR technique shows no detectable relative motion across the fault (at a resolution of $\pm$1 mm/y) for the last 10 years. Double difference relative location of earthquakes epicenters of magnitudes M=2-5.3 of the last 20 years, does not show focused lineation of epicenters along the trace of the CF, although diffuse seismicity is clearly occurring along the $\sim$10km broad Carmel-Gilboa fault zone. Thus, current deformation along the CF does not reflect the paleoseismic evidence for Quaternary activity.

Combining all the accumulated information to date, we cannot define the Carmel Fault *senso-stricto* as currently active. However, we cannot exclude the possibilities of a blind fault that did not rupture the surface or a long pause in faulting activity which may resume in the future.