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Earthquake-related microdeformations of the Lake Van sediments

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The Lake Van area is strongly affected by earthquakes that represent major natural hazards in Eastern Anatolia, a tectonically very active region (continental collision zone). Recent moderate earthquakes suggest ongoing subsidence yielding notable strike-slip motion. About 30 earthquakes with magnitude > 5.0 have occurred in the vicinity of Lake Van since 1900 and two semi-active volcanoes rise in the immediate vicinity of the lake (Nemrut Dag, Süphan Dag). Recurrence rates of strong earthquakes and past seismic activity are recorded in the sediment of Lake Van. A ~400,000 year old and 220 m long sedimentary sequence was recovered within the frame of the International Continental Scientific Drilling Program (ICDP) project PALEOVAN at the Ahlat Ridge site, a sedimentary ridge just of the deep main basin in Lake Van.

Facies analysis of this unique paleoclimate archive revealed that great changes of the depositional conditions occurred and hint to a fascinating evolution of the environment of the Quaternary climate evolution in the Near East. Moreover, a variety of microdeformations were observed, which are especially apparent in the finely laminated clayey silts. These are interpreted to have been caused by seismic shaking, occur throughout the entire record and consist of i) silt-filled vertical fractures, ii) microfaults with displacements at cm-scale, iii) microfolds, iv) liquefaction structures (mushroom, pseudonodules), iv) disturbed varve laminations and v) mixed layers. Other none-primary structures are few several cm-thick cemented blocks that often amalgamate different lithotypes. They are independent of lithology and occur in-between undisturbed soft-sediment intervals. As the correlative beds in parallel cores from the adjacent holes show no deformations, it is evident that these blocks are drilling artifacts. From 168 to 189 meters below the lake floor, a 21 m-thick unit of major irregularities and accumulation of deformations (deformed, tilted, overturned, repeated layers, and discrete unconformities) were identified. This deformed unit consists of beds of primary lacustrine and pyroclastic deposits with lithologies as the sediment above. This unit is sealed by a several meter-thick massive dark brown clayey silt, interpreted to be a megaturbidite. The entire unit is visible as acoustically chaotic layer in the seismic sections and can be mapped throughout the Tatvan Basin. This large-scale mega-event deposit is likely related to a seismic trigger mechanism coupled with seiche waves and cyclic water movement.

In order to identify seismic shaking events, microdeformations caused by drilling artifacts need to be excluded. Hence, we classified the deformation horizons by the concurrence of deformations in the correlative beds in one, two, or three adjacent holes, taking advantage of the fact that most sections were triple cored. If deformations occurs at least twice, drilling disturbances are excluded and the deformation event is assigned to seismic shaking related to fault movements or volcanic activity. Ongoing analysis of the earthquake-triggered microfaults or seismites and its correlation to the earthquake-triggered mass movements observed in the seismic data are used to deduce the first paleoseismic record documenting reoccurrence rates of past seismic activities for this tectonically active region.