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Sedimentary records of past earthquakes in varved lake sediments

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Lacustrine paleoseismology, which focuses on sedimentary traces of past earthquakes in lakes, has gained increasing attention over the past two decades, even though on-fault trenching remains the most common technique in paleoseismology. This field primarily investigates Mass Wasting Deposits (MWD) and Soft Sediment Deformation Structures (SSDS) in lake sediments. Additionally, catchment response (CR), characterized by a temporary increase in erosion rates within catchments due to strong ground motions, is another significant trace of past earthquakes in lake sediments. In this study, past earthquake traces were analyzed in 19 gravity cores (98.880-138.70 cm in length) retrieved from the varved sediments of Köyceğiz Lake. High-resolution elemental profiles and optical images were obtained using ITRAX micro-XRF core scanner. ITRAX optical and XRF data along one core was used to generate varve chronology, and Ca/Ti profiles of the other cores were used to chronostratigraphically correlate 19 cores. Although the region experienced several notable earthquakes over the past 600 years, no MWDs were identified in Köyceğiz sediments; instead, SSDS and CR were observed. Distinct anomalies in Cr/Ti profiles related to the 1959 earthquake were evident in all cores. Conversely, CR associated with a mid-19th-century earthquake was detected only in the northern basin, which has significantly larger catchment than the southern basin. SSDS, including faults, intraclast breccias and laminae disturbances were identified in Köyceğiz sediments. While some of these SSDS correlate temporally with historical earthquakes, most do not correlate either with seismic events or with each other. This implies that, contrary to what has been thought so far, SSDS formation may not be limited to the water-sediment interface but could also occur in deeper parts of the sequence. Moreover, the study indicates that the formation of SSDS may be controlled not only by peak ground acceleration (PGA) but also by peak ground displacement (PGD) due to earthquakes.