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# What triggered Mass Movement Deposits in the maar Lake Issarlès (Ardèche, France)?

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## Résumé

Maar Lake Issarlès (Ardèche, France) is partly filled by Mass Movement Deposits (MMD) visible in seismic reflection data and sediment cores. What triggered such deposits? Lake level fluctuations, floods, earthquakes, sediment overload? Here are preliminary results from a multiproxy study that investigate their origins. Since 1954, Lake Issarlès experienced decametric lake level changes due to EDF water management. It was already hypothesized in several endoreic and maar lakes that water level fluctuations increase the recurrence of MMDs due to steep slopes. Derived from a geophysical survey using a 4 kHz Chirp system from Knudsen in June 2019 (five months before the Teil earthquake; see details below) a coring campaign in 2020 was conducted from an anchored platform in the central deep basin, together with a new seismic reflection survey using high-resolution sub-bottom profiler Echoes 10 000. Acoustic sub-bottom data highlight several MMDs in the central basin and at the bottom of slopes, and a recent thin reflector close to the water-sediment interface. 7 meters deep into the sediment, a thick MMD prevents deeper acoustic penetration. The 7 meter-long composite sequence consists of laminated sediments interrupted by rapidly deposited layers such as clayey layers, MMDs, slumps and turbidites. Sedimentary analyses (radiography, geochemistry, radionuclides and "varves" counting) suggest that fine laminations in the first decimeters are related to the finest sedimentation settling of turbidites derived from those MMDs. The first event could be linked to the recent damaging Mw 4.9 (MLv 5.4) earthquake that occurred on November 11th, 2019 in Teil, 60 km east from Lake Issarlès. Another event (dated  $1944 \pm 7$  years) is contemporaneous with underground pipes' installation of between 1947 and 1953 by EDF, and a third event (dated  $1929 \pm 7$  years) could be synchronous with a similar regional earthquake occurred at Tricastin in 1934 (20 km south of Teil). The sequence reaches back to 3000 years and delivers minimum ten events. This study suggests that lake-level fluctuations and earthquakes are potential triggers for landslides that characterize the pre-1950 sequence. Future investigation and additional radiocarbon dating will help to better constrain the origin and refine seismic risk in this region.

**Mots-Clés:** Maar Lake Issarlès, Mass Movement Deposit, Earthquake, Lake Level Fluctuations, Seismic Reflection

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