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Outstanding imprints of c. 200 million year old earthquakes in seafloor sediments

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Large earthquakes may trigger catastrophic and irreversible events, such as tsunamis, submarine landsides and intense in situ deformation of unlithified sediments. Historic to Recent earthquakes have produced similar phenomena, however, certain identification of sudden tectonic movements from the geological record and especially, detailed recording of their impact are limited. This study focuses on soft sediment deformation (SSD) in the largely-marine Triassic–Jurassic boundary strata of southwest Britain. The studied section is located at Pinhay Bay, in Devon, UK and the rocks represent deposition during a tectonically and climatically intriguing time. The freshwater to brackish and shallow marine deposits of the Penarth Group (Rhaetian – earliest Hettangian, Triassic–Jurassic) are exposed along the coastal cliffs and overlain by the deeper marine, shelf facies of the Lias Group (Hettangian and younger, Early Jurassic). Evidence of re-sedimentation and spectacular SSD exists at various levels in the section. It includes two networks of brittle normal faults, up to two metres long, within two specific units affected by fluidization. At some places, the fluidization is pronounced and only decameter- to metre-scale balls or lenses of the precursor sedimentary deposit (micritic limestone) remain in the center part of the unit. They are observed "floating" in a sedimentary breccia that postdates the re-transportation of the sedimentary particles. Convolute bedding, slumps, drops, small injective peaks and decimeter- to decameter-scale domes are also widespread. Within the defined 13 lithological units, a selection of the SSD deserved specific geometric measurements and thin sections for analysis at a microscopic scale. Our analyses demonstrated a genetic relation between the various SSD types. They can be explained to result from a series of earthquakes along neighboring N–S oriented faults, which bordered the sub-basins accumulating sediment during the Triassic – Early Jurassic. Based on this outstanding example, we proposed a sequential model for the deformation and disturbance of the seafloor subsurface sediments triggered by an earthquake. The sequence of deformation includes brittle failure, fluidization of the failed unit, plastic deformation, and sediment flow at designated places (e.g. close to the fault tips). We also discuss the roles of contrasting stiffness, shear strength, and thickness of the units on the sediment destabilization of freshly deposited sediments that are characterized by a prominent mechanical layering.