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# Rockslides in Masada: thermally induced "ratchet" mechanism vs. response to seismic loading

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Annual temperature fluctuations are responsible for generating irreversible displacements of removable rock blocks that are separated from the rock mass by the intersections of pre-existing discontinuities in the rock mass. A new mechanism, referred to as "ratchet" model, is proposed to explain how cyclic thermal oscillations induce intermittent expansion and contraction of the tension crack, thus causing seasonal translations of rock blocks. New evidence for thermally induced block displacements is presented using both climate and displacement data from a carefully monitored rock block in the West face of the Masada Mountain, a UNESCO World Heritage site, along with re-visited and re-analyzed monitoring data from the East face of mountain. The monitored deformation is explained here in terms of a weather-induced wedging failure that essentially operates as a "ratchet" mechanism involving the rock mass, tension crack, sliding block, and sliding surface. In order to validate the proposed mechanism the discrete element, numerical Discontinuous Deformation Analysis (DDA) method is employed to analyze the proposed "ratchet" model and to simulate the monitored block displacements in the field. The numerical analysis results provide a comparison between the thermal and the seismic driving mechanisms for a mapped block in the East slope of Masada, which climatically is situated in the Eastern part of the arid Judean Desert, and seismically is located on the western margins of the Dead Sea rift (DSR) valley. Based on the long-term climatic conditions and the seismic hazard assessment for the region, including topographical site effect on the mountain top, it is found that the thermal effect is the more dominant mechanism that drives the displacement of the analyzed block over time. Therefore, understanding the mechanism of the “ratchet” model, and identifying its potential in the field, can help mitigate rock slope stability risks in rock masses that are prone to such a failure mechanism, and provides some new rules in rate assessment of bedrock erosion.