EGU22-3728
https://doi.org/10.5194/egusphere-egu22-3728
EGU General Assembly 2022

Detecting earthen dam defects using seismic interferometry monitoring on Distributed Acoustic Sensing data

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Earthen dams and embankments are prone to internal erosion, their most significant source of failure. Standard monitoring techniques often measure erosion effects when they appear at the surface, reducing the potential response time to address the problem before failure. Through their integrative sensitivity along their propagation, seismic signals are well suited to assess mechanical changes in the bulk of a dam. Moreover, seismic velocities are strongly sensitive to porosity, pore pressure, and water saturation, physical properties that vary the most for internal erosion. Here, we used fiber optics and a Distributed Acoustic Sensing (DAS) array installed on an experimental dam with built-in defects to record the ambient seismic wavefield for one month while the dam reservoir is gradually filled up. The position and nature of the dam defects are unknown to us, to allow an actual blind-detection experiment. We computed cross-correlations between equidistant channels along the dam every 15 minutes and monitored the relative seismic velocity changes at each location for the whole month. The results show a strong correlation of the velocity changes with the water level in the reservoir at all locations along the dam. We also observe systematic deviations from the average velocity change trend. We interpret these anomalies as the effects of the built-in defects placed at different positions in the bulk of the dam. The careful analysis of the residual velocity changes allows us to hypothesize on the position and nature of the defects.