EGU26-13994, updated on 11 Nov 2026
https://doi.org/10.5194/egusphere-egu26-13994
EGU General Assembly 2026
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Passive seismic resonance monitoring of a tailings dam at the Pyhäsalmi mine, Finland

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Tailings dams are critical infrastructures whose failure can cause severe human, economic, and environmental damage. However, their internal state is typically monitored using sparse point measurements, resulting in limited spatial resolution. In this study, we investigate the internal structure and temporal dynamics of a tailings dam at the Pyhäsalmi mine (Finland) using passive seismic HVSR methods. The dataset was acquired within the Horizon Europe Mine.io project over approximately one month using 470 three-component nodal sensors deployed from the crest to the toe of the dam. Our results reveal a clear dominant resonance frequency, which we interpret as being controlled by the water table within the dam. Time-lapse analysis shows systematic temporal variations primarily correlated with weather events, while spatial patterns reveal non-negligible lateral heterogeneity in the internal structure. These findings show that passive seismic methods based on resonance frequency measurements provide a robust, non-invasive, and spatially resolved way to image and monitor tailings dams, complementing conventional measurements and supporting geohazard assessment in the mining context.