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Advancing Dam Safety through Seismic Interferometry: Towards More Detailed Data Interpretation

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Introduction

Tailings dam monitoring is fundamental for detecting structural changes in several stages, protecting the structure's integrity, the safety of surrounding communities, and the environment's preservation. By utilising ambient noise, seismic interferometry allows for monitoring variations in seismic wave velocity, associated with changes in the internal stiffness and saturation of the massif. Despite its potential, the technique faces ambiguities, such as the influence of variable noise sources and environmental conditions. In industrial practice, it complements traditional methods, helping to identify infiltration and instability zones. To ensure less ambiguous results, it is essential to guarantee data acquisition quality, maintain continuous processing, integrate different monitoring technologies, and invest in improving computational tools that support the interpretation of seismic velocity variations. This abstract will address factors that can introduce ambiguities in interpreting data obtained by seismic interferometry, emphasising the use of ambient noise. The main challenges associated with natural variations that affect the shear wave velocity (V_S) will be discussed, and methodological strategies to mitigate these influences will be presented, aiming for a more robust and reliable interpretation in the context of dam monitoring.

Method and/or Theory

Seismic interferometry using ambient noise is based on estimating seismic responses between virtual sources through the cross-correlation of seismic noise recorded at multiple points. This approach allows for the reconstruction of information about wave propagation without the need for artificial seismic sources. The methodology may involve two main steps: obtaining the cross-correlation between pairs of signals collected at different sensors and stacking the cross-correlations to improve the signal-to-noise ratio. This operation allows for the precise estimation of differential travel times of seismic waves between sensor pairs, enabling detailed analyses of the elastic properties of the medium, which are essential for the structural monitoring of dams.

Results and Conclusions

Given the presented parameters, this work proposes constructing synthetic models that simulate variations in shear wave velocity (V_S) in response to extreme climatic events, such as intense rainfall, to provide a framework to develop an early warning system for affected dams. From these models, it would be possible to calibrate and validate approaches applied to real ambient noise seismic interferometry data to improve the sensitivity in detecting early structural changes. The proposal emphasises the importance of integrating passive interferometric data with petrophysical and saturation information to mitigate the risks associated with rapid changes in the massif's conditions. This will contribute to the safety of dams in increasingly challenging and extreme climatic scenarios.