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Seismic Interferometry Monitoring for Tailings Storage Facilities

Camilla Rodrigues (Nanometrics), Benjamin Witten (Nanometrics)

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Introduction.

Tailings storage facilities (TSFs) are critical components of mining operations, and their monitoring is essential to ensure structural integrity and safety. However, catastrophic events such as the Brumadinho dam collapse have exposed limitations in conventional monitoring approaches, underscoring the need for more integrated and sensitive techniques.

Method and/or Theory

Seismic Interferometry (SI) has emerged as a promising tool for passive and continuous monitoring of TSFs. This technique originated from the potential to extract valuable information from ambient noise data. SI comprises two distinct processing methods: Seismic Ambient Noise Interferometry (SANI) and Coda-Wave Interferometry (CWI). The first method allows for the reconstruction of the wavefield that would be recorded at one receiver when a source is positioned at the other. These wavefields are estimated at regular time intervals and serve as a representation of the medium between pairs of stations. The CWI technique uses this data as input, measuring changes in phase and amplitude by comparing these wavefields. This comparison is conducted in the scattered waves, known as coda-wave, within the tail of the wavefield obtained by the SANI technique. The final output is velocity changes that are sensitive to variations in shear-wave velocity, often reflecting changes in the stiffness of the medium. This study presents results from real-world applications of SI in operational mining dams, ponds, and waste piles.

Results and Conclusions

Two general patterns of seismic velocity variation were identified: seasonal cyclic variations associated with climatic conditions, such as decreased velocity during the rainy season due to increased water content; and event-driven responses resulting from localized disturbances, including tailings removal during decommissioning, drainage operations, and minor landslides. Our results demonstrate that the ability to correlate these seismic responses with specific causes relies heavily on the expertise of the personnel responsible for the structures and the integration of data from complementary monitoring systems, such as rainfall records, visual inspections, and deformation monitoring. These findings highlight the complementary nature of Seismic Interferometry and its value in supporting a more comprehensive and data-informed understanding of TSF behavior.