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Tailings Dam Monitoring Using Geophysical Methods: Ambient Noise Seismic Interferometry and Electrical Resistivity – B1B4 Dam, Araxá (MG)

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Introduction

The expansion of mining activities in Brazil, driven by the growing demand for strategic minerals, has increased the need for more rigorous care in tailings management and in ensuring the safety of containment dams. These structures, due to their specific construction and operational characteristics, tend to show vulnerability to instabilities when compared to conventional dams. This evidence shows the importance of continuous monitoring combined with complementary strategies to assess their structural condition over time.

In this context, this study aims to apply and analyze the integration of the geophysical methods of ambient noise seismic interferometry and electrical resistivity in monitoring the physical properties of the B1B4 Dam, located in Araxá (Minas Gerais, Brazil), with the purpose of enhancing early warning systems and supporting the technical management of such structures.

Methods

In this study, the ambient noise seismic interferometry and electrical resistivity methods were employed. Ambient noise seismic interferometry is based on the extraction of the Green's function through the cross-correlation of seismic signals recorded by pairs of geophones, allowing the estimation of variations in the propagation velocity of S-waves, which are associated with the stiffness of the embankment. For this purpose, eight geophones were installed along the dam, including four uniaxial sensors positioned on the embankment and two triaxial sensors on the abutments. Monitoring was carried out continuously, with real-time data acquisition, from July 2020 to February 2024.

The electrical resistivity method is based on determining the electrical resistivity of the subsurface. The survey was conducted between July and September 2020, with the acquisition of 21 geophysical sections using the dipole-dipole array. These sections were distributed along the crest, the dam body, and the beach area, with line spacing ranging from 15 to 130 meters and orientations both parallel and perpendicular to the dam axis.

Results and Conclusions

During the monitoring period, ambient noise seismic interferometry data indicated cyclic behavior in S-wave velocity (Vs), with decreases during rainy months (October to February) and recovery in drier periods.

Electrical resistivity sections indicated conductive zones (<56 ohm·m), mainly in the tailings beach, drainage blanket and toe drain. However, between July and September 2020, a drop in Vs coincided with low resistivity values in the left abutment.

The integration of seismic interferometry data from ambient noise with electrical resistivity measurements provided a comprehensive approach to monitoring variations in the dam's physical properties.

This study reinforces the importance of continuous geophysical monitoring as a complementary tool to conventional methods, contributing to the preventive assessment of the dam and the management of associated geotechnical risks.