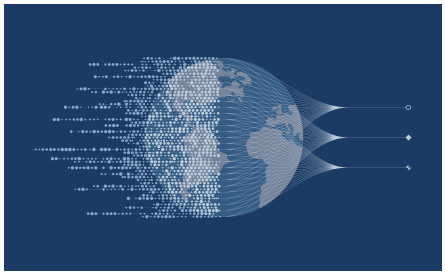

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2D Seismic Reflection Method for Identifying Caverns Generated by Underground Nuclear Explosions in Synthetic Data

Underground nuclear explosions create cavities and zones of fractured rock, which can be detected using seismic reflection and inversion techniques. This study focuses on using seismic methods in accordance with the Comprehensive Nuclear Test-Ban Treaty (CTBT) protocols to improve the accuracy of cavity detection. Simulations of wave propagation using the Spectral Element Method (SEM) through subsurface structures, including cavities and their surrounding fractured zones, generate synthetic seismic data. Advanced data processing techniques, such as time migration and the addition of precise lithology to the models, based on previous nuclear test sites, are used to analyze seismic reflections and delineate subsurface anomalies. The results demonstrate that the proposed methods can effectively identify cavity dimensions and locations, even in complex geological settings. We also investigated whether it can be determined when an underground cavity is caused by a nuclear test or not. This work highlights the importance of seismic technologies in supporting global efforts to monitor compliance with nuclear test bans and ensure the effectiveness of CTBT verification measures.

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