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Integrated Microseismic and Seismic Reflection Analysis in a Salt-Solution Mining-Induced Subsidence Zone in NE Brazil

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Introduction

Maceió, located in Northeast Brazil, has experienced significant ground deformation due to long-term salt-solution mining beneath its urban area. This phenomenon gained national attention following a felt earthquake of magnitude 2.1 Mw in March 2018, which was followed by progressive subsidence, affecting approximately 5.5% of the city's territory and leading to the evacuation of thousands of residents. Given the scale of the damage and the potential for further instability, understanding the geophysical processes responsible for these events is critical for improving monitoring strategies and ensuring public safety.

Method and/or Theory

We integrated data from passive and active seismic methods to investigate the subsurface dynamics associated with the 2018 event and subsequent deformation. A temporary microseismic monitoring network was deployed across the affected area, operating at high sampling rates from January to December 2019. The data were visually inspected and processed to locate seismic events and generate a local earthquake catalogue. In parallel, nineteen 2D seismic lines were processed with workflows, including time and depth migration and meta-attribute enhancement. These seismic images were interpreted to identify structural discontinuities, stratigraphic horizons, and potential cavity zones.

Results and Conclusions

A total of 39 seismic events were located, primarily concentrated along a NW–SE alignment near the margin of the Mundaú Lagoon. Hypocentral depths range from 0.5 to 1.5 km, with a notable clustering around 1 km. Seismic reflection profiles reveal angular unconformities, normal faults dipping to the NNW, and zones of chaotic seismic facies interpreted as collapsed or dissolution-affected layers. By overlaying earthquake locations onto seismic sections, we identified a spatial correlation between microseismicity and major structural features, including fault zones and possible collapse areas. In particular, five events were aligned along a main normal fault, suggesting neotectonic reactivation, while one event occurred within a chaotic zone consistent with roof collapse. These results indicate that vertical structural connectivity plays a key role in fluid migration and stress redistribution, ultimately driving subsidence.