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Seismological Characterization of the 2018 Maceió Earthquake and Its Association with Ground Subsidence

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Introduction

Naturally occurring or induced by human activity, ground subsidence represents a serious hazard for urban areas worldwide. In Maceió, Brazil, a Mw 2.1 earthquake on March 3, 2018, coincided with growing evidence of land deformation, the emergence of sinkholes, and widespread infrastructure damage. The earthquake's proximity to an area of long-term salt-solution mining raised concerns about the role of anthropogenic processes in triggering seismic events and exacerbating subsidence. This study aims to provide a detailed seismological characterisation of the mainshock and investigate its potential links to subsurface cavity collapse.

Method and/or Theory

We analysed seismic records from the Brazilian Seismographic Network stations 58–289 km from the epicentral area. After applying Wiener deconvolution and a 4–8 Hz band-pass filter, we picked P- and S-wave arrivals and estimated the earthquake's hypocenter. We then performed two complementary source mechanism analyses: first, we inverted P-wave polarities and amplitude ratios from four regional stations, obtaining focal mechanism solutions. Next, we performed a full moment tensor inversion, considering waveform data from three stations with high-quality surface wave recordings.

Results and Conclusions

The earthquake hypocenter was located at approximately 1 km depth near the Mundaú Lagoon, a site where over 2 meters of vertical ground deformation had been previously recorded. Uncertainties in epicentral and depth estimates were 3 km and 4 km, respectively. The focal mechanism solutions obtained from FOCMEC indicate predominantly normal faulting on NE-striking planes. The moment tensor inversion also supports a normal faulting regime at shallow depth (0.7 km), but with a strong non-double-couple component: CLVD = –66.2%, and isotropic component (VOL) = –29.1%, with only 4.7% double-couple energy. These results suggest that the March 2018 event was likely non-tectonic in origin, associated with the collapse of subsurface voids formed by decades of salt extraction. The high CLVD and isotropic components reinforce the interpretation of volumetric collapse as the primary source mechanism.