A quantitative and qualitative analysis of the University of Brasília's Seismological Observatory's seismic catalog for the Carajás region from 2014 to 2025

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Introduction

The Carajás Mineral Province, located in the southeastern corner of the state of Pará, represents one of the most important mining regions in Brazil, characterized by intense extractivism. Despite it being part of the Amazonian Craton, a tectonically stable region, the Brazilian Seismographic Network (RSBR) maintains and operates a few seismographic stations throughout the state to monitor seismic activity, be it naturally occurring or man made. It is because of this intense mining activity, coupled with the sparsity of RSBR stations, that event analysis for the Carajás region presents itself as a challenge. Therefore, this work contains a preliminary study that wishes to verify the quality of the University of Brasília's Seismological Observatory's (SIS-UnB) catalog for the Carajás region in the period from 2014 to 2025 by employing quantitative and qualitative methods.

Method and/or Theory

The area of interest for this study was defined as a polygon comprised between the latitudes 6.87°S and 5.40°S and longitudes 51.26°W and 49.62°W, so as to include the entirety of the National Forest of Carajás and its surroundings, which contain the largest and most important mines in the region. The following analysis was based on the seismic catalog made publicly available by SIS-UnB on its website. From it, it was discovered that there were a total of 3675 events registered for the region from 2014 to 2025, with 89 events (2.42%) being classified as earthquakes and 3233 events (87.97%) being classified as explosions. For both event types, histograms for the magnitude, the associated magnitude uncertainty and the event time residual (also known as the root mean square, or RMS) were generated and compared. Yearly scatter plots were also generated for the magnitude uncertainty and RMS values, so as to observe the behavior of these parameters throughout the period of study. With the aim of categorizing catalog data quality, certain descriptive statistics were also calculated and compared.

Results and Conclusions

It was found that only 67.42% of earthquakes and 59.23% of explosions have the regional magnitude mR as the preferred magnitude, while 90.01% of the former event type and 94.65% of the latter have a calculated value for mR. The mR magnitude, as defined by Assumpção (1983) is the preferred magnitude for Brazilian catalogs. The mean uncertainties associated with the mR values were found to be 0.32 for earthquakes end 0.30 for explosions, and were considered to be satisfactory. In regards to the event time uncertainties, it was discovered that 90.91% of earthquakes and 83.02% of explosions have an RMS value < 1 second, while 98.88% of earthquakes and 99.16% of explosions have an RMS value < 2 seconds, indicating good event analysis. For the 2022 – 2024 triennium, it was found that RMS variability increased for both earthquakes and explosions alike, while the mean RMS values remained relatively constant for the former and had a tendency to increase for the latter. This suggests that the observed trend was caused by a few outlier events for earthquakes and a less rigorous event analysis for explosions. In general, the observed results lend themselves to the quality of the SIS-UnB catalog, indicating it as a reliable source for event data.