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The Itajobi/SP Earthquake of April 16, 2025

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Abstract

In the early hours of April 16, 2025, at 04:14 AM (Brasília time), a seismic event with a magnitude of 3.4 mR was recorded in Itajobi, São Paulo, Brazil. The tremor, perceived by the local population, was detected by 22 stations of the Brazilian Seismographic Network (RSBR). The primary objective of this study is to relocate the event using regional models and analyze the local seismotectonic context. The initial hypocentral location was determined using the SeisComP3 software with the global velocity model IASPEI91, indicating a depth of 3 km and a magnitude of 3.4 mR, with an average residual of 1.2 seconds. The relocation using Seisan software, through the Hypocenter program and the regional velocity model NEWBR, confirmed the epicenter's proximity to the urban area of Itajobi, situated on sedimentary rocks of the Bauru Group in the Paraná Basin. This study reinforces the importance of regional models for accurate intraplate event localization and contributes to the understanding of seismicity in tectonically stable regions of Brazil.

Introduction

Although Brazil is considered a region of low seismicity (Assumpção et al., 2004), intraplate events such as the one recorded in Itajobi (SP) in 2025 highlight the geological complexity of ancient sedimentary basins. The Paraná Basin, where the event occurred, is an intracratonic basin with limited historical records of seismic activity, generally associated with the reactivation of pre-existing faults and induced seismicity events (Assumpção et al., 2004).

Itajobi (SP) is located in the east-central portion of the Paraná Basin, a sedimentary intracratonic basin formed during the Paleozoic and Mesozoic, with sedimentary rocks reaching thicknesses of up to 7,000 meters (Milani et al., 2007). Over the Precambrian crystalline basement, sedimentary rocks of the Upper Cretaceous Bauru Group predominate, composed of sandstones from the Adamantina Formation and siltstones from the Marília Formation, shown in Figure 1, deposited in a desert continental environment (Riccomini, 1995). The region is characterized by crustal lineaments trending NE-SW and NW-SE, inherited from tectonic events of the Brasiliano Cycle (Almeida, 1980), which may be reactivated under current crustal stresses, such as those generated by Andean convergence (Assumpção et al., 2008).

Intraplate seismicity in Brazil is frequently associated with the reactivation of ancient faults or lithological heterogeneities in sedimentary basins. In the state of São Paulo, historical records include the 1922 Mogi-Guaçu earthquake, with an approximate magnitude of 5.1 mR, associated with faults at the interface between the Paraná Basin and the crystalline basement (Berrocal et al., 1984), and smaller events (< 3.0 mR) recorded near Presidente Prudente between 2008 and 2010 (Pirchiner et al., 2011), as shown in Figure 2A. In Itajobi, the absence of previous significant seismic activity makes the 2025 event relevant for seismotectonic studies, suggesting that its

origin is linked to localized reactivation of shallow structures within the Bauru Group, possibly influenced by residual crustal stresses from the Andes.

The Itajobi earthquake, with a magnitude of 3.4 mR and an estimated depth of 3 km, stands out for its occurrence in an area without prior seismic records. This study analyzes the event using data from the Brazilian Seismographic Network, combining global and regional models to discuss the local seismotectonic context.

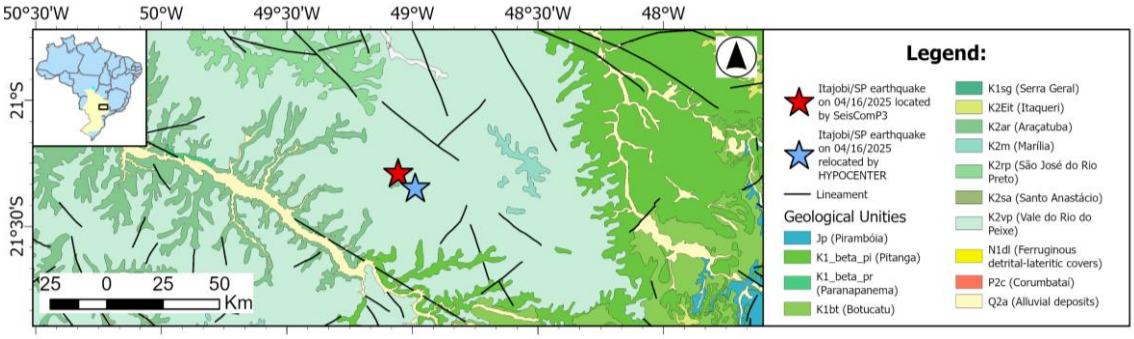

Figure 1: *Geological map of Itajobi (SP) region, showing lineaments and geological unities nearby. The map of Brazil shows the Paraná Basin in yelllow.*

Method and/or Theory

The data used in this study were collected from 22 stations of the Brazilian Seismographic Network (RSBR), located at distances ranging from 66.7 km to 1,200 km from the epicenter. The initial event location was performed using the locator LOCSAT from SeisComP3 software (Hanka et al., 2010), shown in Figure 2B, which applies the global velocity model IASPEI91 (Kennett & Engdahl, 1991). A total of 21 P phases and 5 S phases were manually identified, resulting in a local magnitude of 3.4 mR, a depth of 3 km, and a root mean square residual of 1.2 seconds, with coordinates –21.287 S; -49.056 W.

For the relocation, the Seisan software (Havskov & Ottemöller, 1999) was used, via the HYPOCENTER program (Lienert et al., 1986), with the regional velocity model NEWBR (Assumpção et al., 2010), specifically developed for the expected structure of the Brazilian continental crust.

Results

The initial location of the event, performed using SeisComP3 and the global IASPEI91 model, resulted in a magnitude of 3.4 mR, a depth of 3 km, and a root mean square residual of 1.2 seconds, based on 21 P phases and 5 S phases identified at 22 stations.

The relocation using Seisan software and the regional NEWBR model maintained the magnitude and depth values but altered the original event location, shifting it by 9.5 km relative to the initial SeisComP3 result. The azimuthal gap between stations was 65°, with the nearest station to the epicenter (BB19B) at 66.7 km from the source and the farthest (ITQB) at 1,200 km. The final root mean square residual was 1.2 seconds, assuming a Vp/Vs ratio of 1.72. The result after using HYPOCENTER provided a new event location at -21.345 S; –48.987 W.

Additionally, it was possible to observe regions in the vicinity of the Itajobi event that exhibit significant seismic activity, while others appear aseismic or present only a few recorded events. This supports the hypothesis proposed by Assumpção et al. (2004) that the Paraná Basin is heterogeneous and, in certain areas, concentrates greater tectonic stress or experiences more occurrences of induced seismicity, which may result in zones with a higher concentration of seismic events compared to surrounding areas.

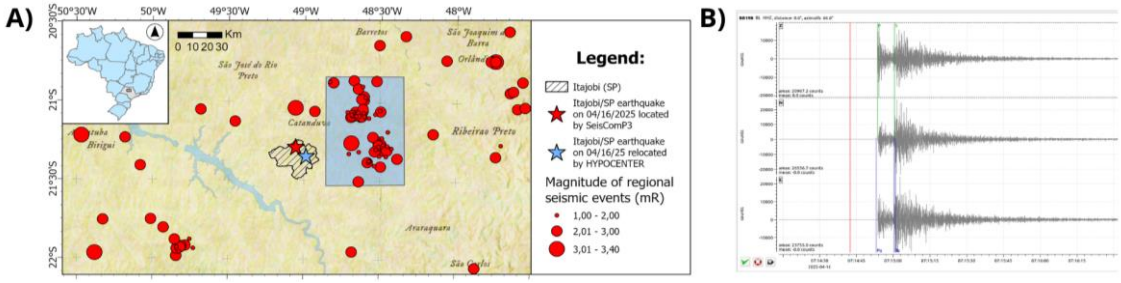

Figure 2: *Results obtained from the relocation of the Itajobi earthquake on April 16, 2025, and event analysis using SeisComP3.* ***A)*** *Map of regional seismicity near the municipality of Itajobi (SP). The blue rectangle highlights a region with a high concentration of seismic events within the state of São Paulo, while surrounding areas exhibit more scattered events.* ***B)*** *Seismic record of the Itajobi event captured by station BB19B (SP) within SeisComP3.*

Conclusions

The Itajobi/SP earthquake, which occurred on April 16, 2025, underscores the importance of using regional velocity models to improve the hypocentral location of intraplate events in Brazil. The relocation using the NEWBR model demonstrated a significant variation compared to the initial location determined with the global IASPEI91 model, emphasizing the need for regional adjustments for events occurring in sedimentary basins such as the Paraná Basin. The absence of historical seismicity in the municipality of Itajobi renders this event significant for future tectonic analyses in southeastern Brazil.

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