Preliminary analysis of the seismicity in Central-West Region, Brazil

Diogo Farrapo Albuquerque, George Sand França and Giuliano Sant'Anna Marotta

Abstract

We present a preliminary analysis of the data recorded by five seismic stations located in Mato Grosso and Mato Grosso do Sul (Brazil): FRNC1 (Corumbá-MS), NVXVB (Nova Xavantina-MT), PRNTB (Paranatinga-MT), COXMB (Coxim-MS) e RVMTB (Rio Negro-MS). An active seismic region was identified nearby the city of Nova Xavantina (MT) and others in Pantanal Basin and in the North of Goiás state, precisely in Mutunópolis (BARROS *et al.*, 2011), which is inside the Goiás-Tocantins Seismic Belt. Almost all the events were located using Hypo71 (LEE e LAHR, 1975) and Geotool LocSat (MILJANOVIC, 2007). Some of them were located using the single station method, when the polarity of P arrival was clear enough to analyze the particle motion.

Introduction

In 5th June 2009, a strong earthquake with 4.8 m_b magnitude struck Coxim, Mato Grosso (Brazil), which was felt by people in many cities such as Cuiabá, more than 300 km distant from the epicenter. For the purpose of studying the later seismicity, a five station temporary network was deployed: FRNC1 (Corumbá-MS), NVXVB (Nova Xavantina-MT), PRNTB (Paranatinga-MT), COXMB (Coxim-MS) e RVMTB (Rio Negro-MS), as presented in figure 1. The network stayed operational from July 2010 to March 2013.

Brazilian territory is located in the interior of a very stable tectonic region called South American Platform (ALMEIDA *et al.*, 2000), which has a very low seismicity compared to countries such as Chile, although some events with magnitude higher than 5.0 are not uncommon and may cause some damages in some fragile buildings.

One of the most important characteristics of Brazilian seismicity is that usually occurs in shallower depths (< 5 km). Figure 2 presents the seismicity occurred in Brazil from 1950 to 2014, extracted from Observatory catalogs, indicating five important active seismic zones.

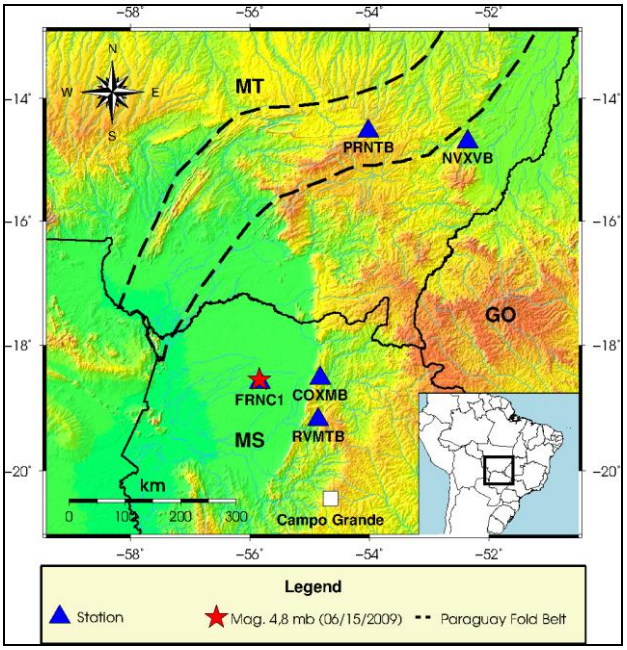

Figure 1 – *Location of the temporary stations. The red star represent the 4.8 m_b earthquake occurred in 06/15/2009, and the Paraguay Fold Belt is the black dotted line.*

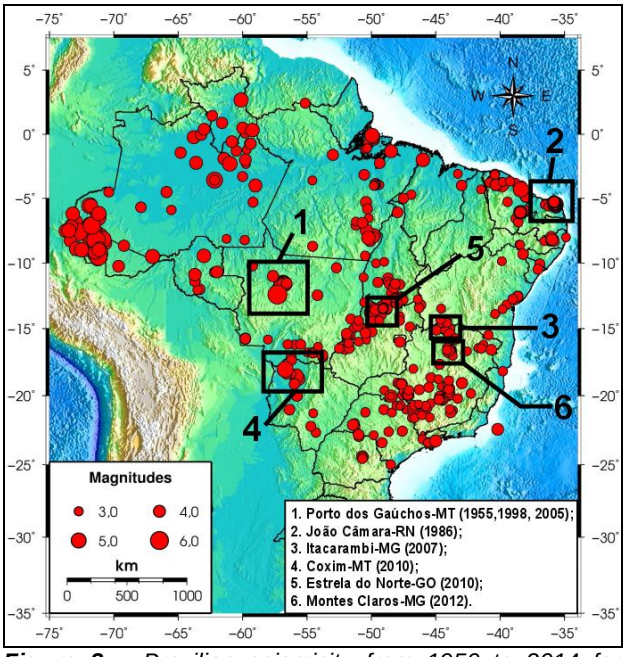

Figure 2 – *Brazilian seismicity from 1950 to 2014 for mag. > 3.0. The rectangle on the right presents some seismic zones.*

Method

Two location methods were used in order to compare the results: Geotool LocSat (MILJANOVIC, 2007) and Hypo71 (LEE e LAHR, 1975), each one applied to a specific velocity model. The first used IASP91 and the second used a regional model for Brazil (ASSUMPÇÃO *et al.*, 2010).

The magnitudes were calculated using two different equations: duration magnitude (m_d), for data with no calibration files, and regional magnitude (ASSUMPÇÃO *et al.*, 1983) for data with seismometer calibration values (Güralp files). Besides, m_d scale is more suitable for epicenters located less than 150 km and m_R is for epicenters ranging from 200 and 1.500 km distant.

Results

The temporary network registered a total of 79 natural events and 27 unreliable registers, which was not possible to tell if they are natural, chemical detonations or just noise. The lowest magnitude was 0.2 m_d, and the highest was 4.0 m_R, for two events: Estrela do Norte, Goiás state (10/08/2010), located in the Mutunópolis-Mara Rosa Seismogenic Zone (BARROS *et al.*, 2011), and Montes Claros, Minas Gerais state (05/19/2012).

Inside a radius of 30 km from the station NVXVB (Nova Xavantina-MT), 32 events were detected, with magnitudes ranging from 0.2 to 1.8 m_d. Unfortunately, it's not possible to register such microseisms with more distant stations, because of the energy dispersion and the background noise.

To study that seismicity, it is necessary to deploy a local network, with at least 4 stations and a good azimuth coverage. Figure 5 presents a map of the events locations.

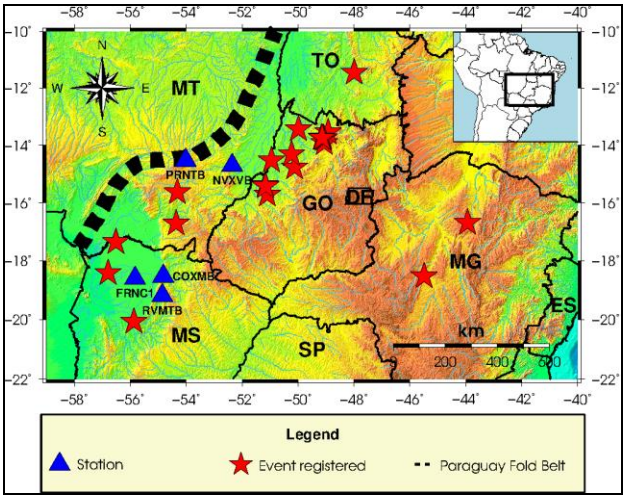

Figure 3 – *Natural events registered by the 5 temporary stations. State initials: MT (Mato Grosso), MS (Mato Grosso do Sul), GO (Goiás), DF (Distrito Federal), SP (São Paulo), MG (Minas Gerais), TO (Tocantins) and ES (Espírito Santo).*

It is important to point out that locating those events was possible only with additional data from stations belonging to the Institute of Astronomy, Geophysics and Atmospheric Sciences, University of São Paulo (IAG-USP).

The figures 4 and 5 show the seismograms of Montes Claros and Estrela do Norte events.

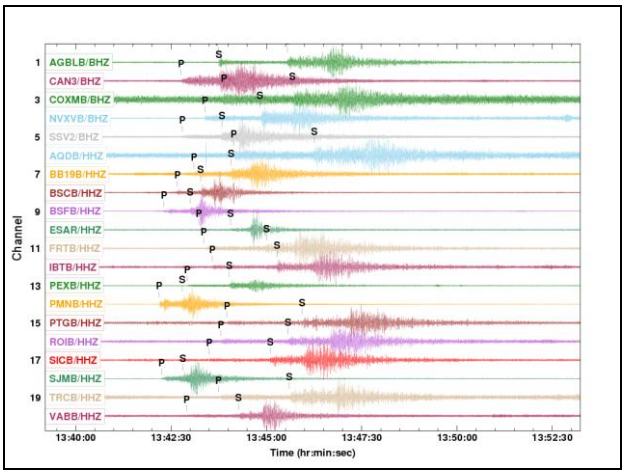

Figure 4 – *Geotool window with seismograms of the Montes Claros (MG) 4.0 m_R event. There are 20 stations (vertical channels).*

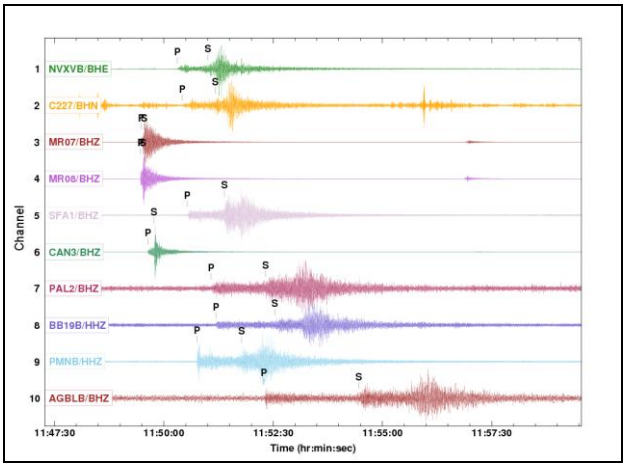

Figure 5 – *Geotool window with seismograms of the Estrela do Norte (GO) 4.0 m_R event. There are 10 stations (vertical channels).*

It is possible to notice that, for bigger events, the temporary network works fine, even in the presence of noise, which could be removed by band-pass filters.

The best locations in terms of residuals (less than 1 second) were obtained using Hypo71 with New BR model (ASSUMPÇÃO *et al.,* 2010).

Geotool LocSat is a very versatile tool, but the IASP91 model is not suitable for the geology and the crustal structure of Brazil.

Conclusions

The data used in this work are not good enough to determine important parameters such as epicenter or hypocenter and focal mechanism for the greatest part of

events. The data was too noisy, so it was necessary to use band-pass filters to improve the signal/noise ratio that, in some cases, could not be remove high frequency noise.

Most of events were not located because the network is very wide and only two stations, in the best scenario, were capable to register just some events simultaneously.

Nevertheless, a seismic zone was identified inside a 30 km ratio from station NVXVB (Nova Xavantina-MT). It is also possible to observe a line pattern that crosses Central-Brazil from Northeast to Southwest, which can be related to the reactivation of faults in Goiás-Tocantins Seismic Zone.

This work, although very preliminary, serves as an initial reference to deploy new stations in some of the seismogenic zones in Brazil, specially Pantanal Basin, Mato Grosso do Sul.

Acknowledgments

- Seismological Observatory, University of Brasília.

- Institute of Astronomy, Geophysics and Atmospheric Sciences, University of São Paulo.

References

ALMEIDA, F. F. M., BRITO NEVES, B. B. e DAL RÉ CARNEIRO, C. The origin and evolution of the South American Platform. Earth-Science Reviews, V. 50, p. 77-111, 2000.

ASSUMPÇÃO, M. A regional magnitude scale for Brazil. Bulletin of Seismological Society of America, V. 73(1), p. 237-246, 1983.

ASSUMPÇÃO, M., ARDITO, J. e BARBOSA, J. R. An improved velocity model for regional epicentre determination in Brazil. In: IV Simpósio Brasileiro de Geofísica, 2010.

BARROS, L. V., CHIMPLIGANOND, C. N., VON HUELSEN, M. G., FRANCA, G. S. L. A., CAIXETA, D. F., ALBUQUERQUE, D. F. The Mara Rosa 5.0 m_b Earthquake and aftershock activity. In: XII International Congress of the Brazilian Geophysical Society, Rio de Janeiro, 2011.

LEE, W.H.K., LAHR, J.C. HYPO71: a computer program for determining hypocenter, magnitude, and first motion pattern of local earthquakes. U.S. Geological Survey. Open-File Rep, p. 75-311, 1975.

MILJANOVIC, V. Geotool software user guide. Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). IDC/SA/SI, 217 p., 2007.