



## Motivation: Rifting in the Kalahari?

The Okavango delta composes of upstream panhandle and the downstream mega-fan situated in the middle of the Kalahari Basin. The Okavango Delta Region (ODR) has been observed to have elevated occurrence of seismic events compared with other regions in Botswana. A number of previous studies argue that the region sits on an incipient arm associated with the East African Rift System (EARS), which explains the continuous seismicity and expected occurrence of earthquakes in the ODR (Scholz, 1975). Prior to 2000, seismic events in this region were detected by distant seismic stations at regional distances (beyond 300 Km from the epicenters), and this resulted in relatively poor location determinations. In the present study, we present results based on seismic stations of the Network of Autonomously Recording Stations-Botswana (NARS-Botswana) Project.. The project consisted of 21 broadband seismic stations deployed across Botswana with the aim of studying the earth structure beneath the country and to obtain a better understanding of its complex tectonics. The network coverage allow for a better computation of magnitude, focal mechanism and understanding the nature of causative faults for seismic events located in the region.

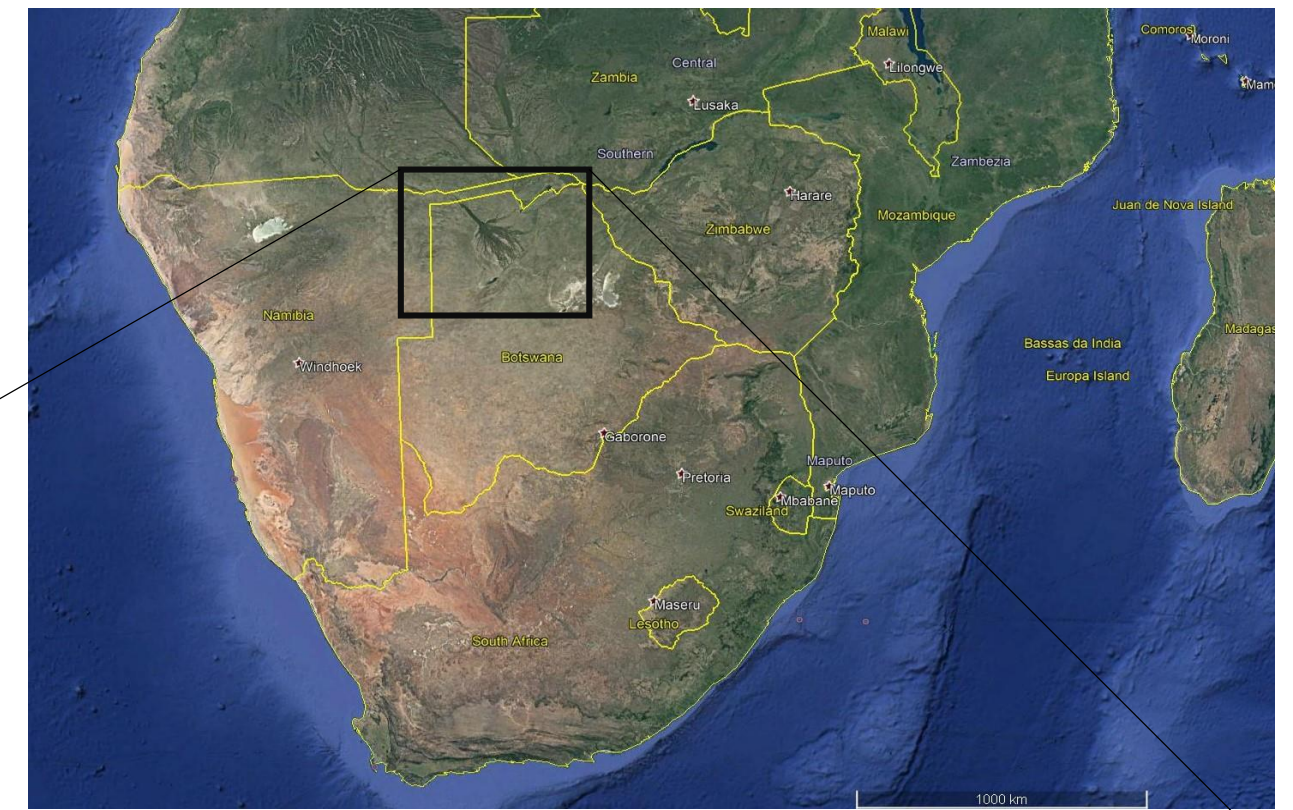
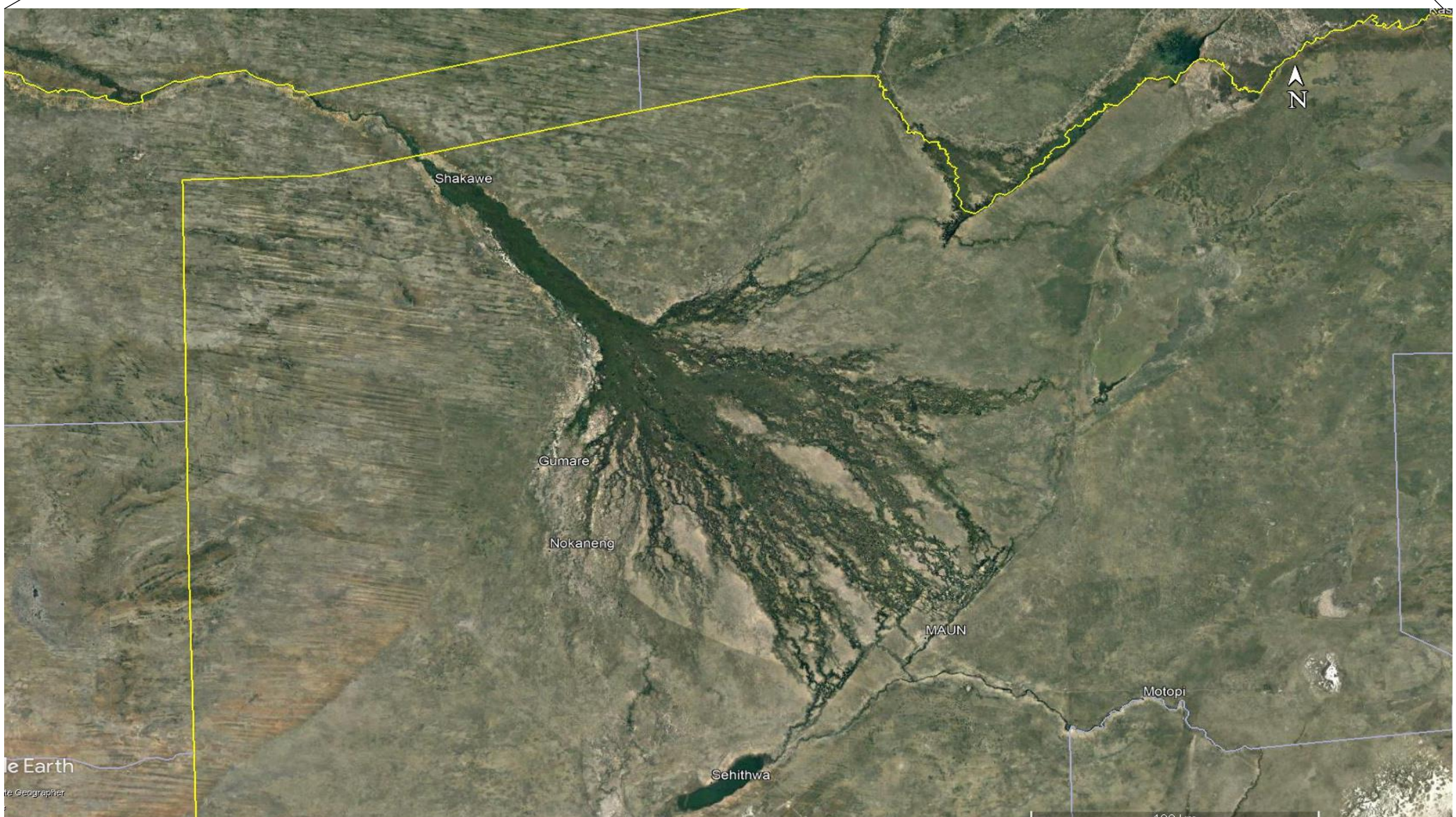


Figure 1: The location map of the Okavango Delta Region (ODR) in Botswana.



## Location and Tectonic Setting

- In northwestern Botswana lies the famous alluvial Okavango delta (Figure 1), which is one of the world's largest inland water systems. The delta's headwaters initiate in the western highlands of Angola, with numerous tributaries interconnecting to form the Cubango river.
- Tectonic activity and faulting interrupted the flow of the river and caused it to backup and form what is now the Okavango delta.
- The Okavango Delta is hosted within the North-Eastern trending Neoproterozoic Pan African orogenic known as the Damara Belt. The region sits between two cratons joined by a series of Paleo to Neoproterozoic belts (Figure 2).
- Below the Okavango Delta, there are extensional tectonic movements that created a topographic low region referred to as the Okavango Rift Zone or ORZ (Shemang and Molwalefhe, 2011).
- The tectonic activity has led to high incidence of earthquakes in the area (Reeves, 1972; Hutchins et al., 1975 and Scholz 1975).
- The ORZ is described as a large graben structure transecting the course of the Okavango river (Shemang and Molwalefhe, 2011) with the main faults in this area being the Gumare, Thamalakane and Kunyere faults all trending North East – South West (Figure 6).

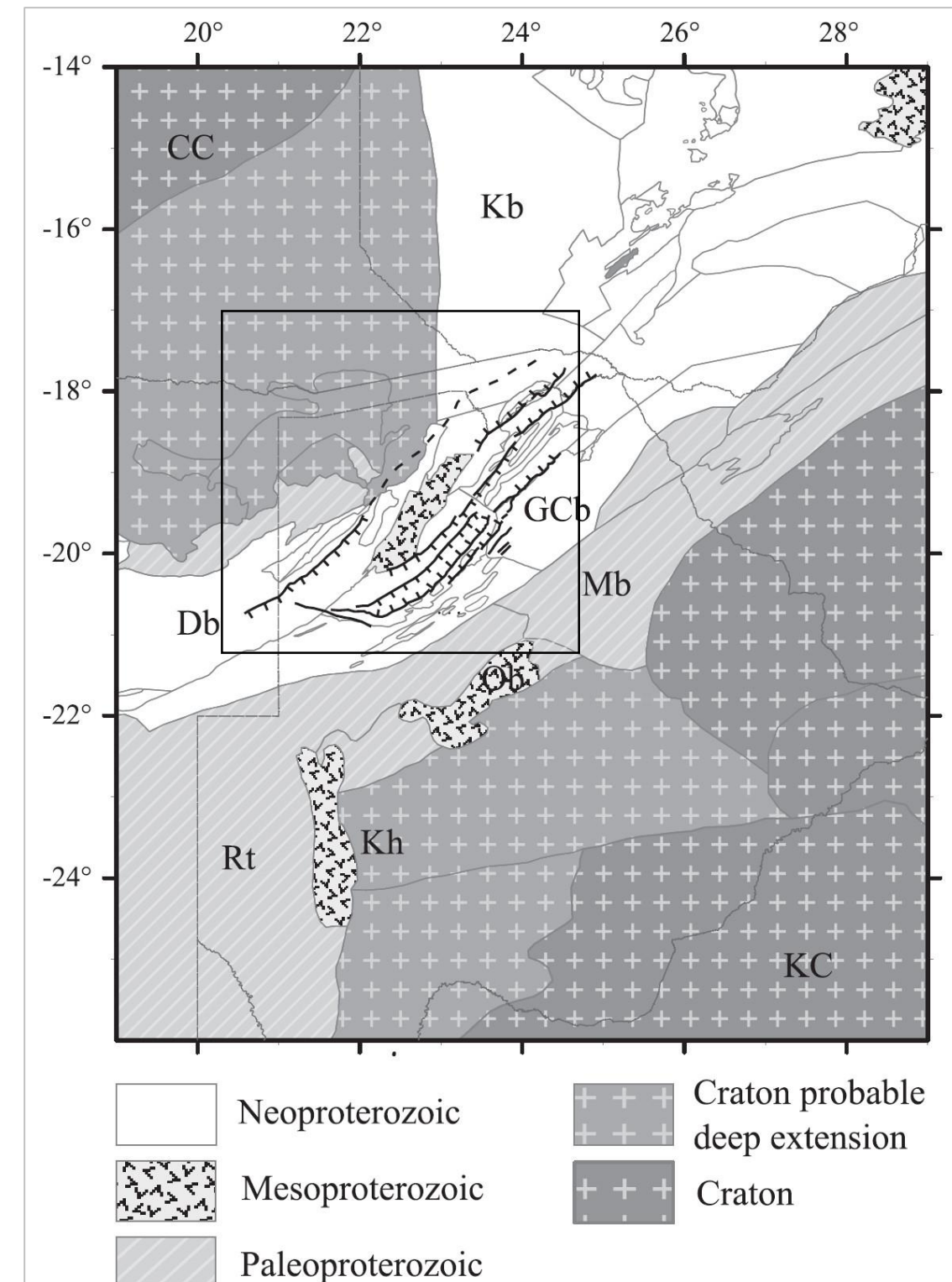


Figure 2: The structural crust model showing the ODR

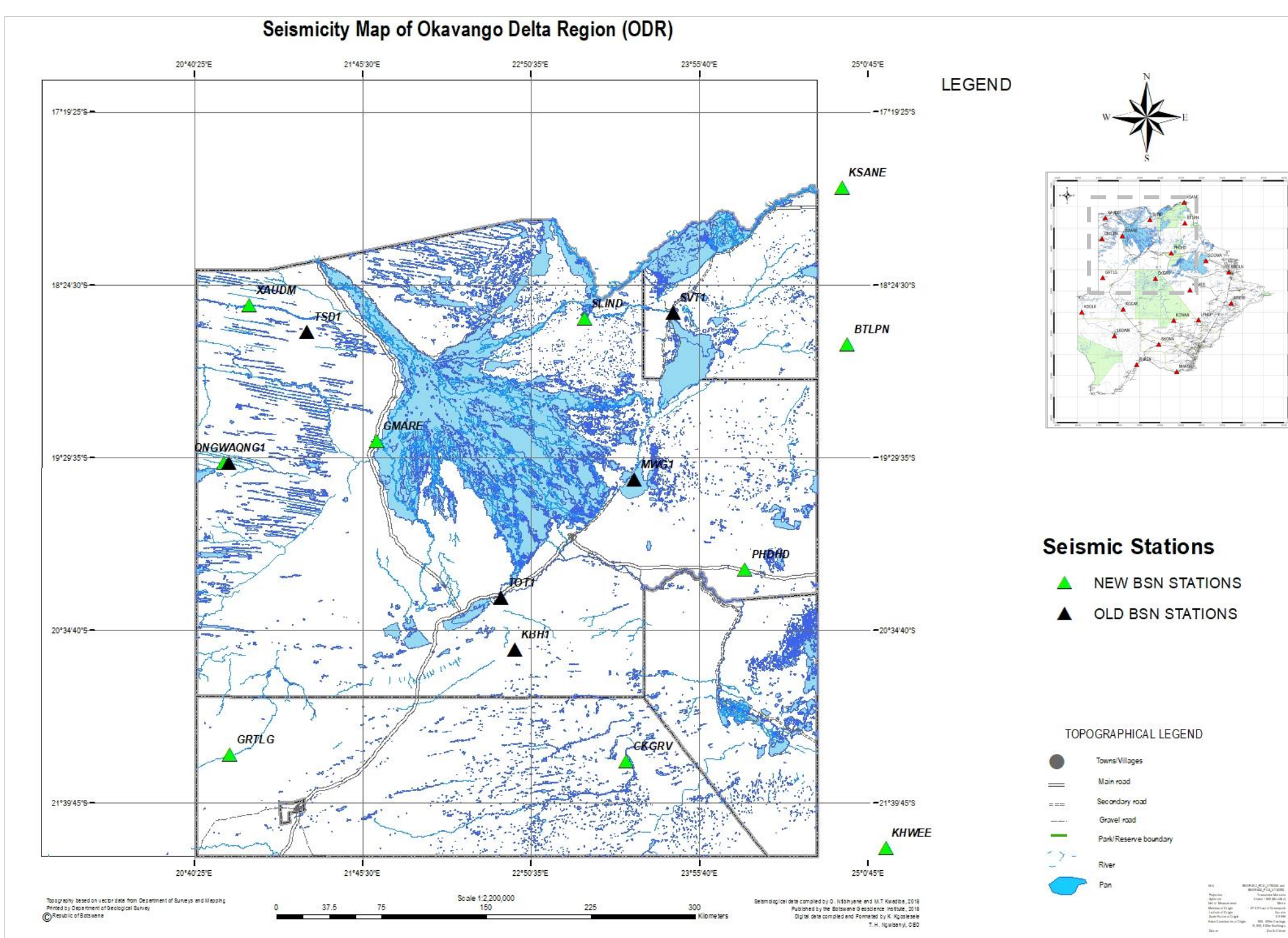


Figure 3: Location of NARS-BW/BSN stations

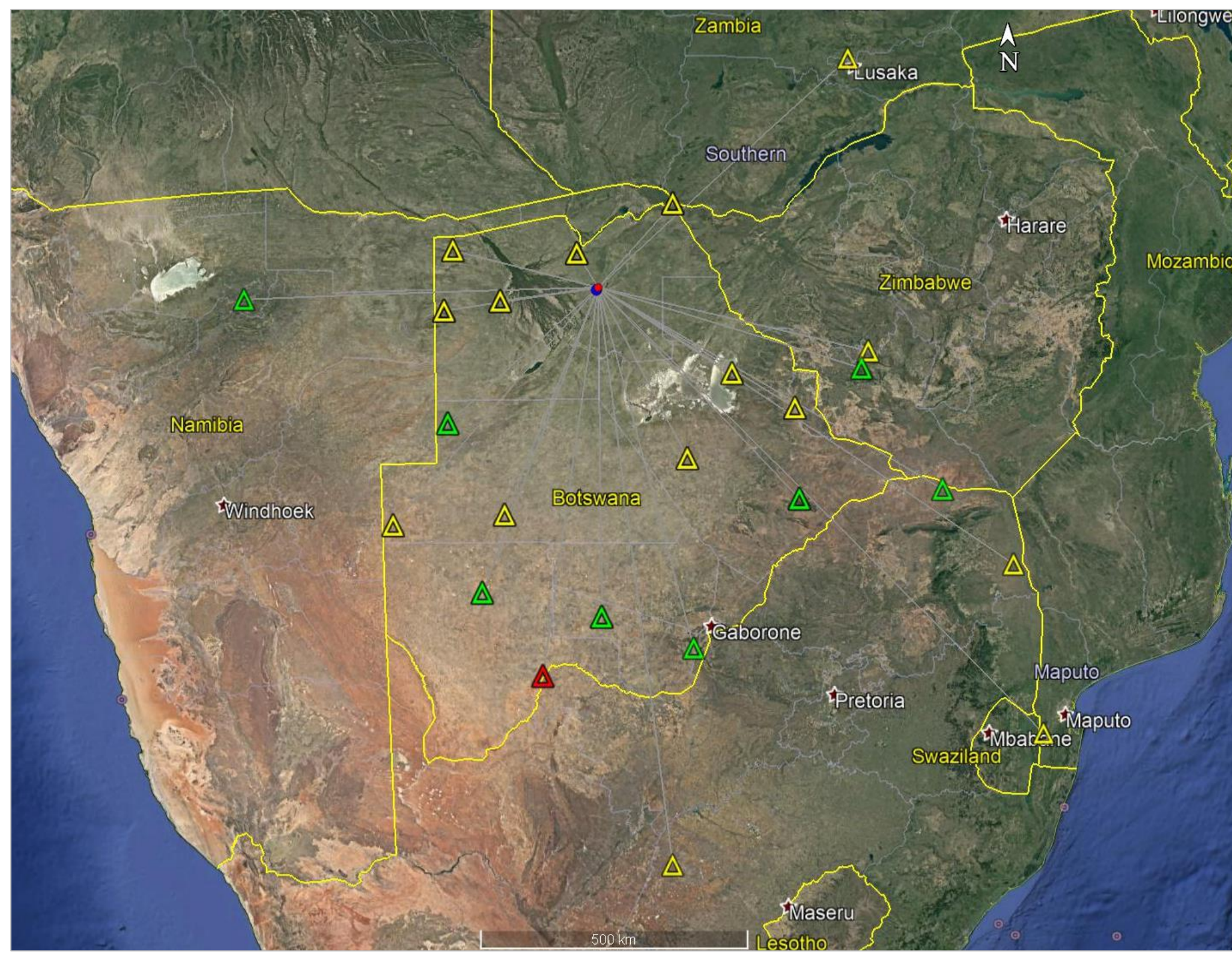
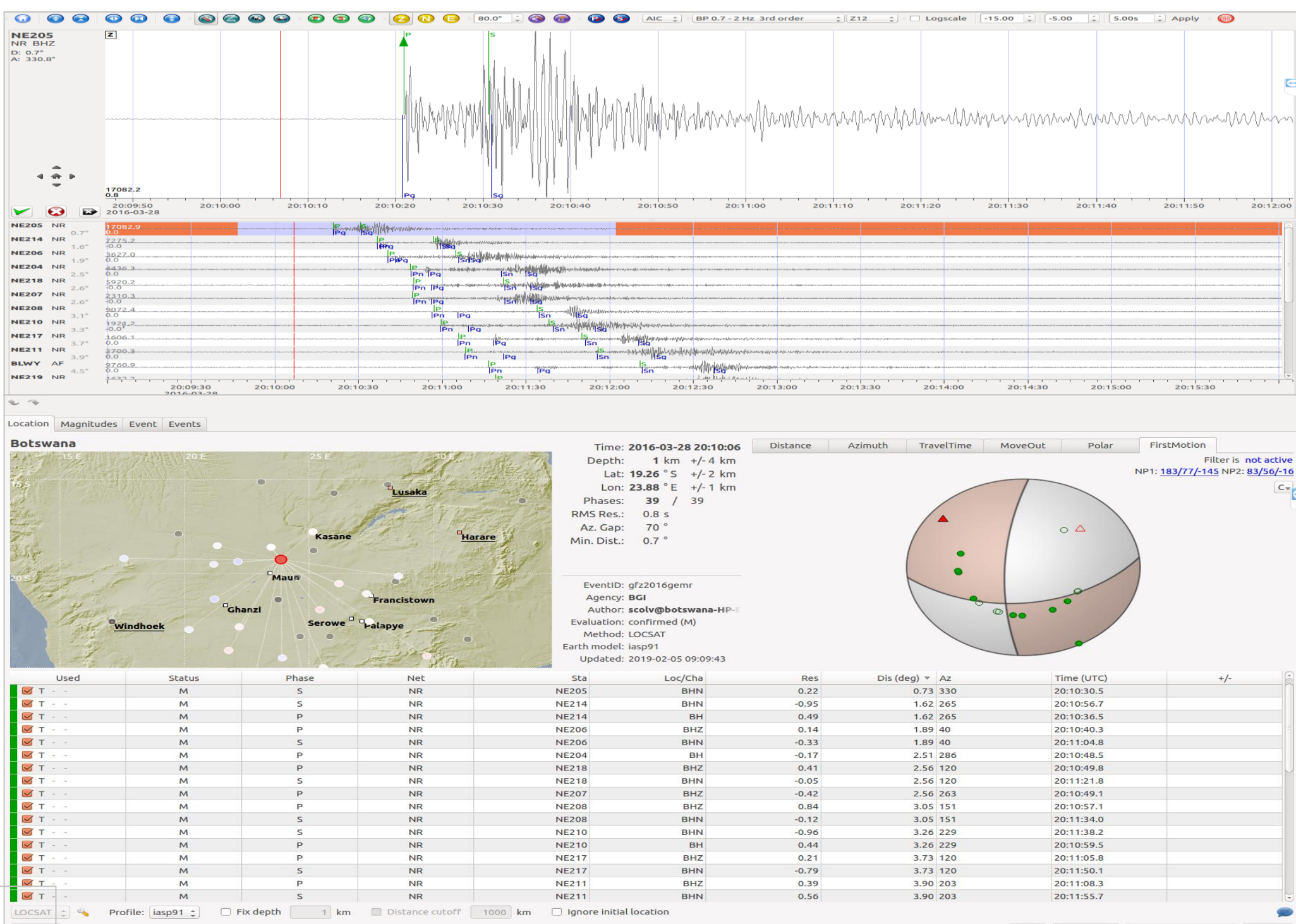


Figure 4: The 3.8 ML March 28<sup>th</sup>, Khwai village Seismic event as located by the NARS-BW Stations, IMS and Africa Array Stations.



## Seismological Networks and Stations

- The NARS-BW temporary project was deployed for the period of five years (2013 – 2018) to image the crustal and the upper mantle structure beneath Botswana.
- The 21 broadband seismic stations network was distributed country-wide. Events such as those in the ODR were detected by the array.
- The network now forms part of the Botswana Seismological Network (BSN) in addition to the Lobatse (LBTB) stations which is part of the IMS networks.

## Results

- A total of 20 events were recorded by both the NARS – Botswana and the new BSN between the period 2014 and 2018 in the ODR.
- Series of events were recorded and reported in the months of January and March 2016
- The highest magnitude event located near Khwai village in the South-Eastern limb of the Okavango delta, the 3.8 ML 28<sup>th</sup> March 2016 figure 4.
- Data analysis carried out done using SEISAN and SeisComp3 scolv picker (figure 5).
- The NE205 was the closest station to the epicenter at approximately 70 Km
- The furthest station that recorded the event clearly was at CNG, Africa Array station in Southern Zimbabwe.
- IMS stations of LBTB, LSZ, TSUM, BOSA and MATP were used as compute the preliminary epicenter
- Other event, the 3.1 ML 20<sup>th</sup> January 2016 event was reported by residents near Maun.
- Due to some noise associated with poor coupling for the NARS-BW stations, some P-wave polarities were not clear

Figure 5: Phase Picking, Polarity detection, magnitude computation and First motion estimation using Seiscomp3

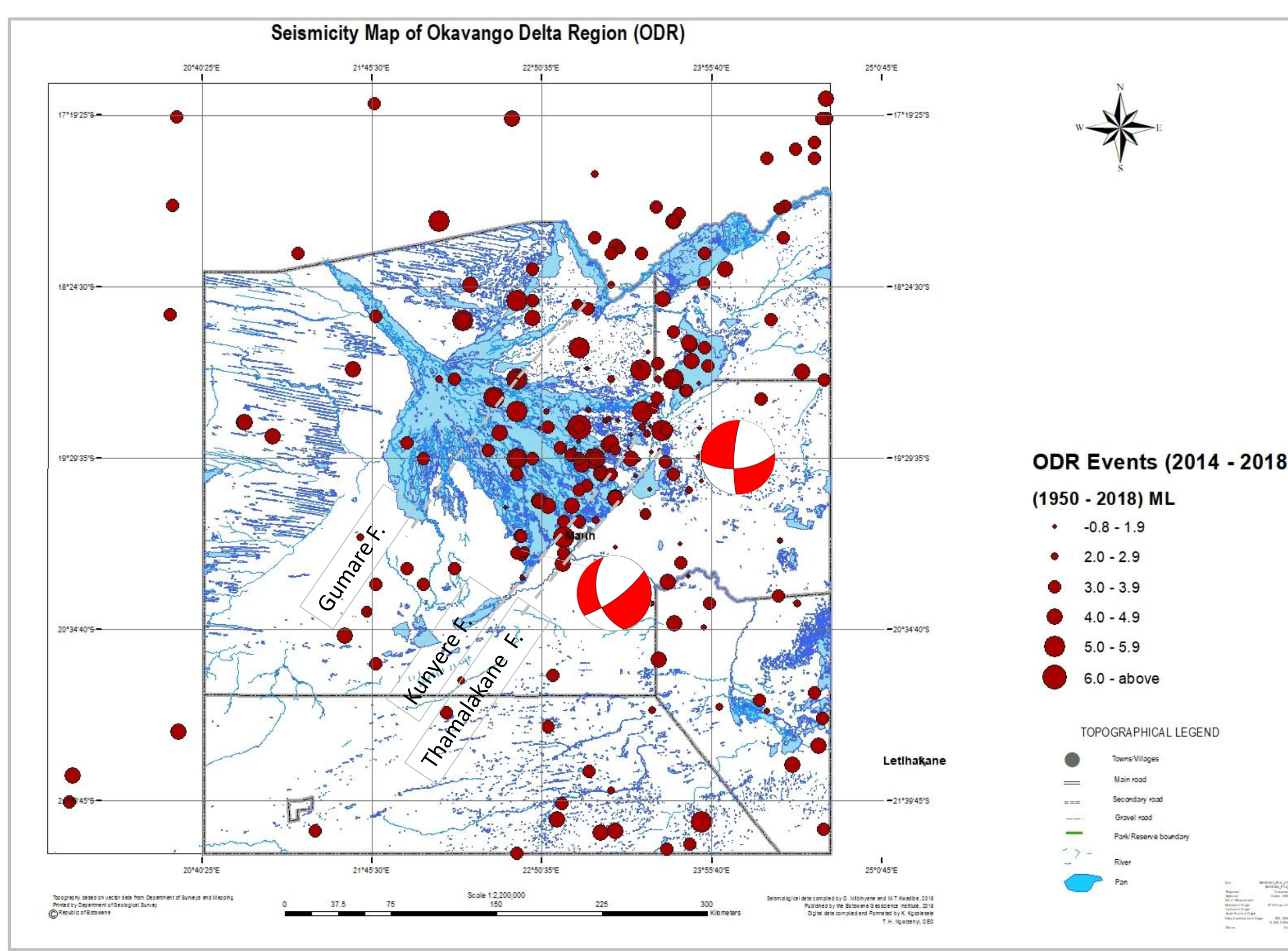


Figure 6: Seismicity map of the ODR, location of faults associated with tectonic activity and Fault plane solution of two (2) 2016 events.

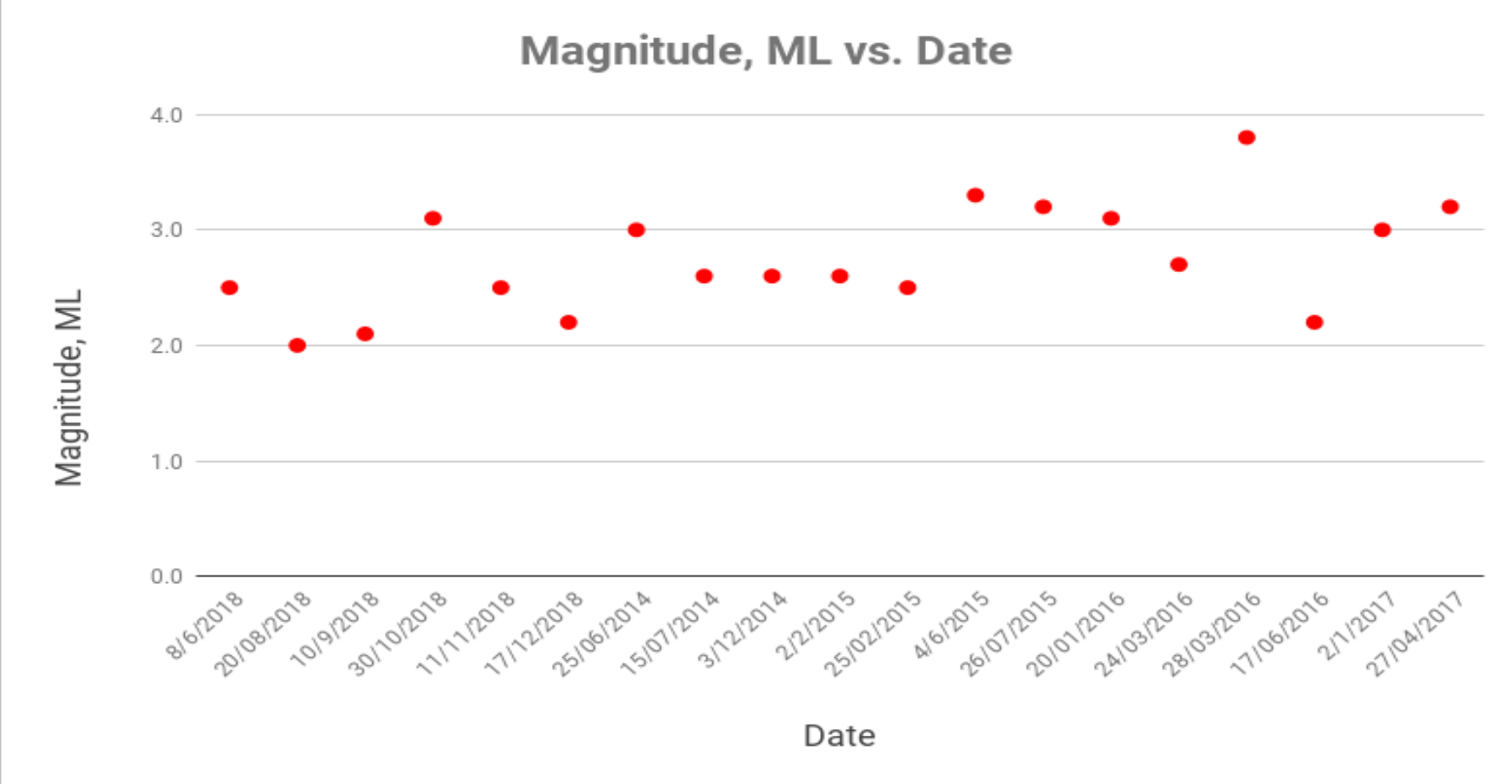


Figure 7: Events detected by the NARS-BW and the new BSN station for the period 2014 – 2018.

## Summary

- The events in this period are consistent with previous studies that observed higher seismicity in Maun – Mababe depression area along the Thamalakane and Kunyere faults (Hutchins et al., 1975 and Scholz 1975).
- Focal mechanisms indicates an oblique strike-slip fault source mechanism indicating a possibility of a trans-tensional structure not a purely rift zone as proposed by early scholars.
- Currently, the new BSN stations operate at 40 Hz and 1Hz sampling rates for primary and secondary channels respectively.
- The is a need to either
  - Introduce a high sample rate of the secondary channel to better detect local events, or
  - Deploy additional stations to monitor seismicity in the ODR to complement the new BSN stations in providing a good opportunity to detect seismic activities more accurately.

## References

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