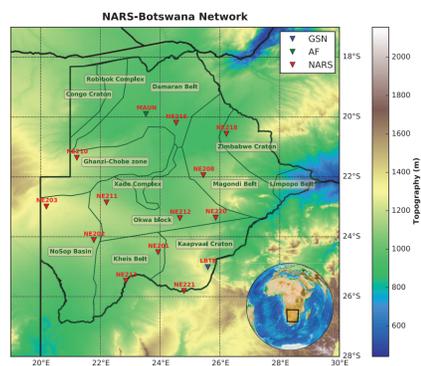


# Surface wave analysis of Botswana using ambient noise and two-station methods

## Introduction

NARS-Botswana is a temporary seismological network of 21 seismometers that is currently operational in Botswana. Its main aim is to explore the subsurface structure and the geodynamical framework of one of the least studied areas in Africa and the world. In this study we use surface wave analysis to obtain insight into the tectonic framework of the study area and we present preliminary results for data from 12 NARS-Botswana stations and an additional GSN station (LBTB).



## Tectonic setting:

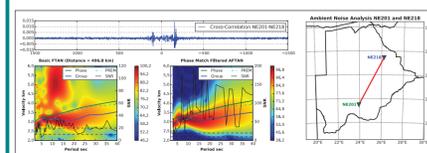
Botswana is one of the least studied areas in Africa. Although the area is rich in mineral resources and especially diamond (Schlüter, 2008), the 3D subsurface structure and the deep tectonic settings are poorly resolved.

The area is characterized by complex tectonics between the Kaapval Craton in the Southeast and the Congo Craton in the Northwest. It includes mobile fold belts of to Paleo-Proterozoic, Paleo-Meso-Proterozoic and Neo-Proterozoic ages, with ophiolites and main faults trending Northeast-Southwest, and a supposed buried micro-continent in the southwestern part (Begg et al., 2009). The dominant fold mobile belts in the study area were subject to several magmatic intrusions, metamorphic processes, and deformation and folding events that made the area highly complex.

## Ambient noise analysis:

Rayleigh wave dispersion curves between periods between 3 and 40 s were extracted for 3 months of data between March and June 2014. The methodology described by Poli et al., (2013) was used:

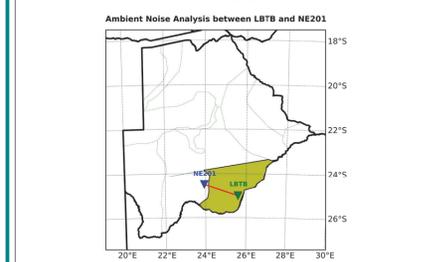
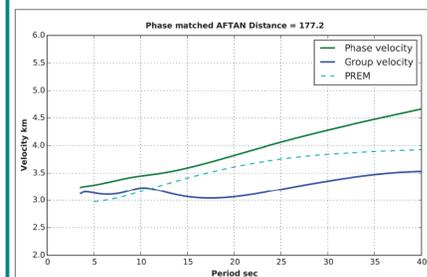
- 4-hour time windows.
- Exclude windows that contain amplitudes larger than 10 times standard deviation of the window data.
- Instrument correction.
- Decimation to 1 Hz.
- Spectral whitening.
- Cross-correlation.
- Automatic Frequency-time analysis (AFTAN) (Bensen et al., 2007).



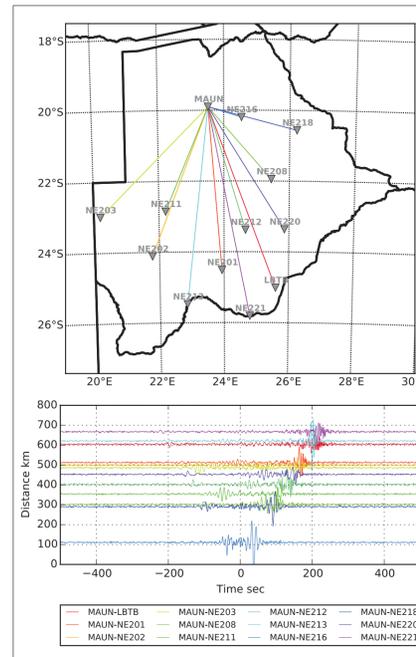
Example of the Frequency-Time analysis between NR.NE201 and NR.NE218

## Ambient noise results:

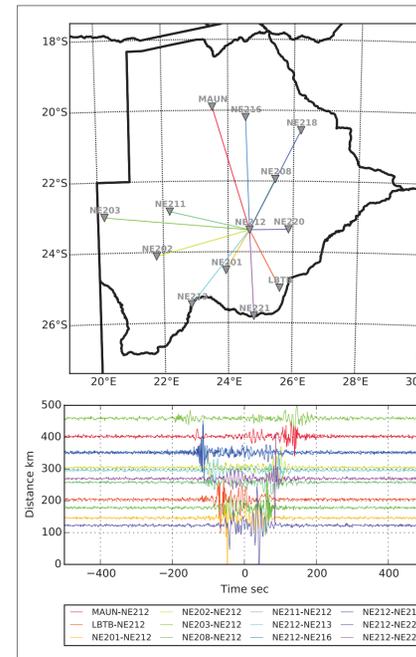
The dispersion curves show a striking correlation with the tectonic provinces of the study area. For example, the dispersion curves of interstation path GT.LBTB - NR.NE201 within the Kaapvaal Craton shows high velocities at short periods compared to the dispersion curves of NR.NE202 - NR.NE203 located within the NoSop Basin that is characterized by a thick layer of the Karoo Sediments group.



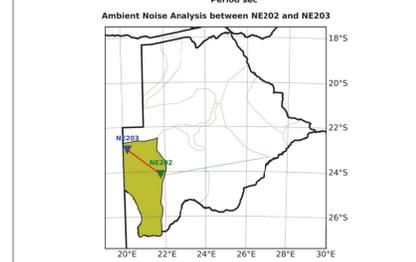
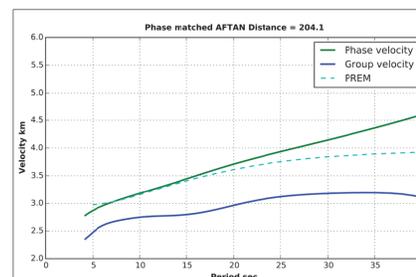
The dispersion curves between GT.LBTB and NR.NE201 represent the Kaapvaal Craton that is colored yellow.



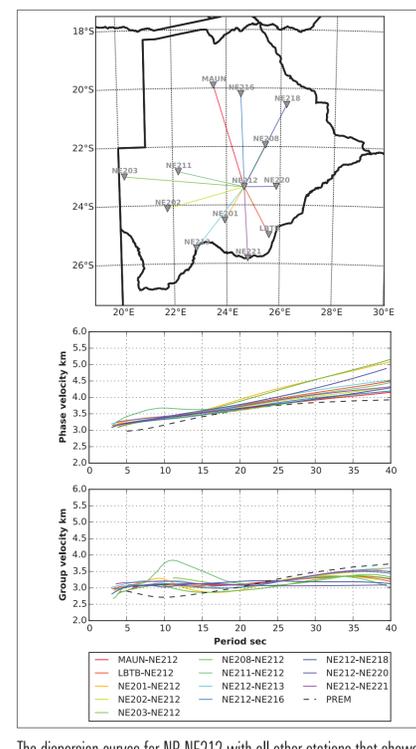
Example of the Green's functions between AF.MAUN and all other stations



Example of the Green's functions between NR.NE212 and all other stations



The dispersion curves between NR.NE202 and NR.NE203 within NoSop Basin that is colored yellow.



The dispersion curves for NR.NE212 with all other stations that shows the average variation of the group phase velocities Group phase velocities within the study area.

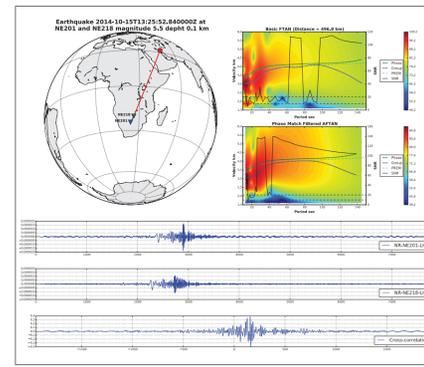
## Two-station analysis:

The methodology described by Knopoff, (1972) was used to extract phase velocity curves between 10 and 150 s.

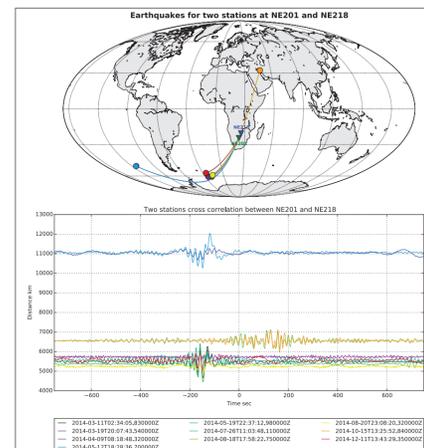
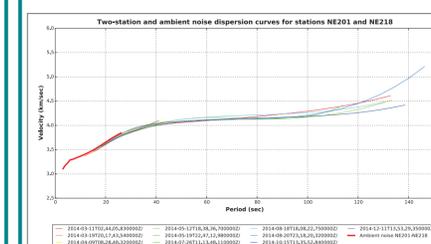
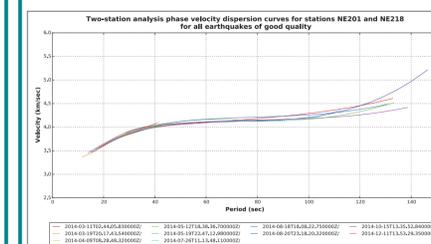
- Earthquakes within 7° azimuth difference with the station-pair azimuth were used.
- Epicentral distance between 5° and 120°.
- Instrument correction.
- Decimation to 1Hz.
- Cross-correlation.
- Automatic frequency time analysis (AFTAN).
- Visual check

## Combining the phase dispersion curves:

- After estimating the phase dispersion from both ambient noise analysis and from two-station analysis, they were visually checked.
- Curves that show unrealistic values were excluded or recalculated for a smaller period range in the AFTAN analysis.
- There is a good agreement between the ambient noise and two-station phase velocity curves.



Example of the of Earthquake analysis for two stations NR.NE201 and NR.NE218



Example of the all earthquakes cross-correlations for station pair NR.NE201-NR.NE218

## Conclusion:

**Ambient noise:** Interesting variations were found in the estimated group and phase velocity dispersion curves from ambient noise analysis. This makes us eager to improve the data quality by using longer time spans and to proceed to the next phase of the processing, that is to estimate the phase and group velocity maps and invert them into 3D tomographic images that reveal the subsurface structure of the study area.

**Two-station method:** Out of the 78 possible station pairs, 25 showed good dispersion curves matching the ambient noise results. Therefore, it is clear that more data is needed to improve the coverage and quality of the dispersion curves.

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## For more information

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