Integrated geophysical analysis of the April 2017 Moiyabana intra-plate earthquake, Botswana

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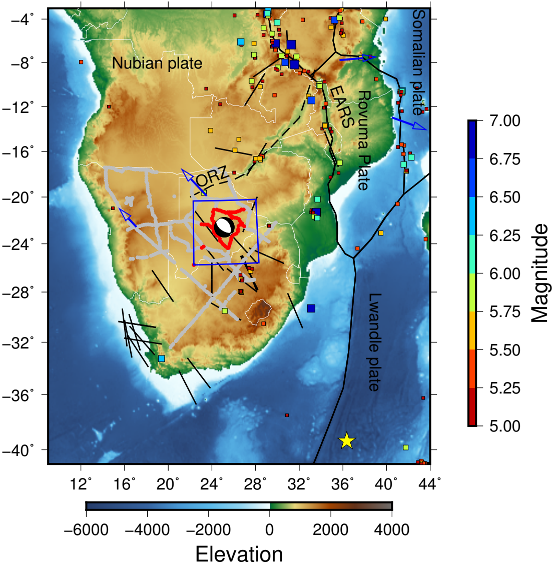
The 03/04/2017 Botswana event

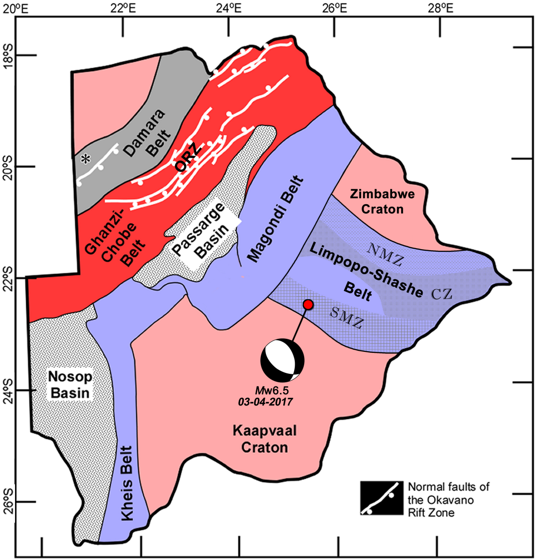


- Magnitude 6.5, ca. 200 km from Gabarone, 23-29 km depth
- Widely felt in Botswana, South Africa and other adjacent countries
- ca. 15 events with Magnitude > 6 in last 25 years
- All others associated with EAR
- South-western Africa shows no active tectonics

Some key questions

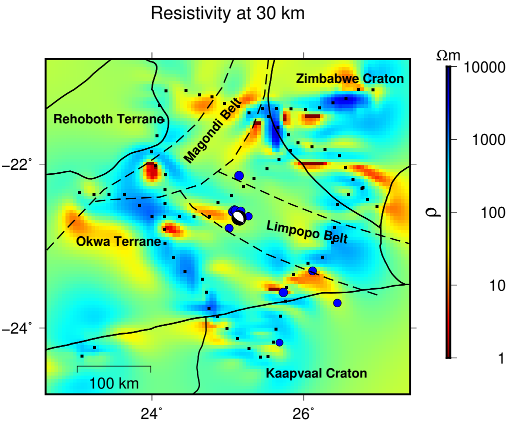
- Physical mechanisms of nucleation of intraplate events, transient loading vs. stress accumulation
- Importance of fault geometry and faulting mechanisms
- Impact of fluids: flooding/rain induced (unlikely); deep fluid migration (Gardonio 2018)
- Lithospheric and sub-lithospheric interaction, previous results suggest weak mantle (Moorkamp 2019)

Geological setting



- Occured in mobile belt between Kaapvaal, Rehoboth and Congo Craton
- Region of Proterozoic deformation
- Okavango rift zone (ORZ) suggested to the North

Previous results

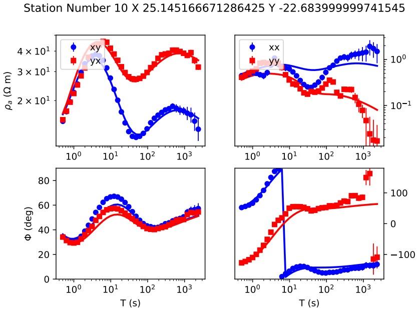


- Based on inversion of publicly available SAMTEX data
- Significant crustal variation
- Earthquake appears to occur at transition between more conductive and more resistive material
- Other smaller earthquakes suggest similar pattern

Moorkamp et al. 2019, EPSL

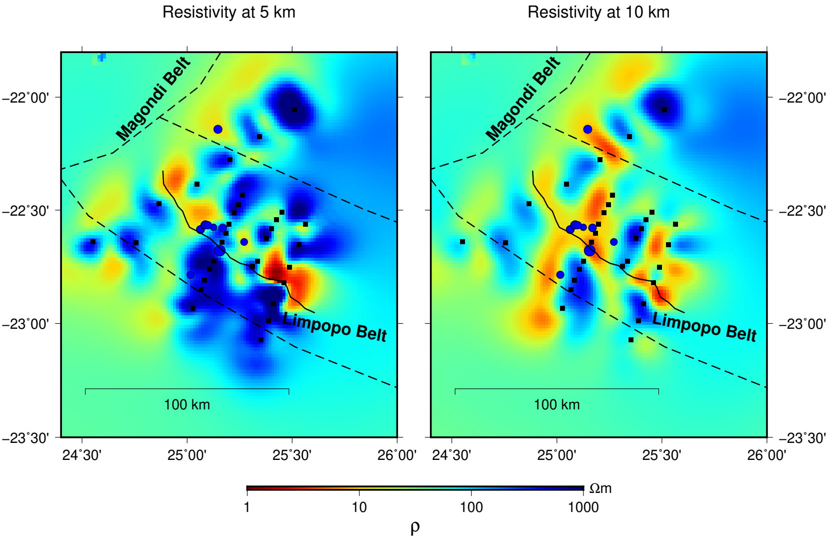
A high resolution study

New high-resolution data



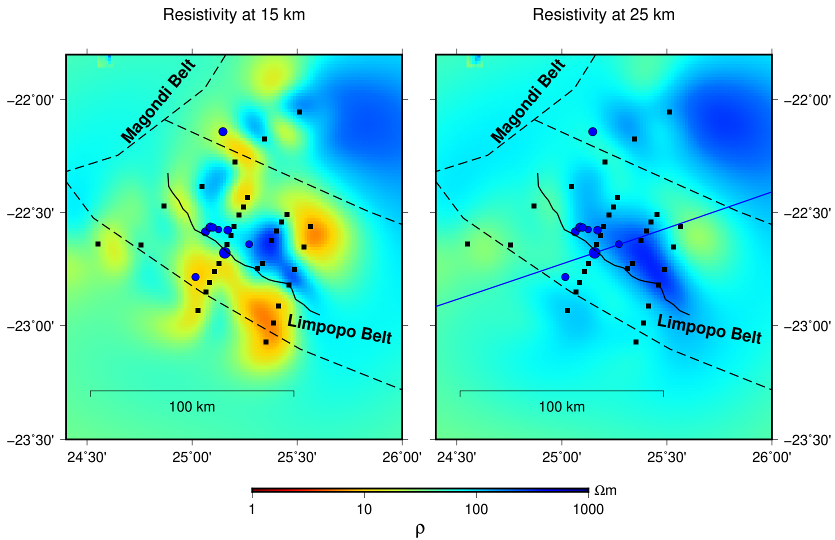
- 25 new magnetotelluric measurements across suspected fault location
- Period range 0.5 – 2800 s
- 3D Model 120 × 120 × 40 cells, 2 km hor. cell size, Depth 0 – 220 km
- Final RMS 2.0 for MT, assuming 2% noise on impedance

MT inversion 5-10 km



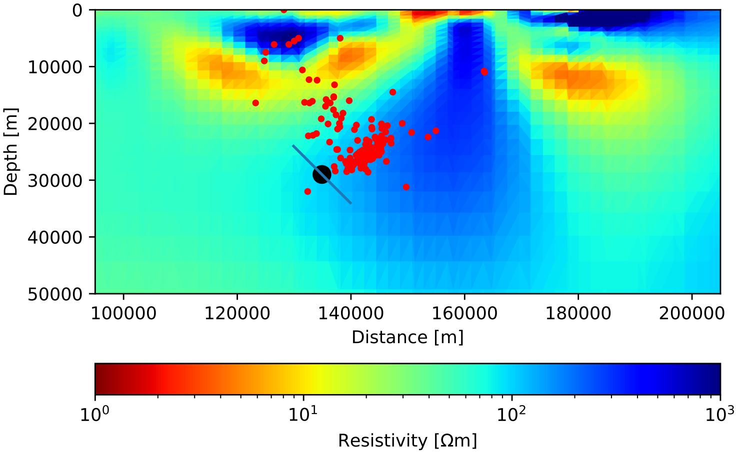
Can see strong resistivity contrast near the surface (black line)

MT inversion 15-30 km



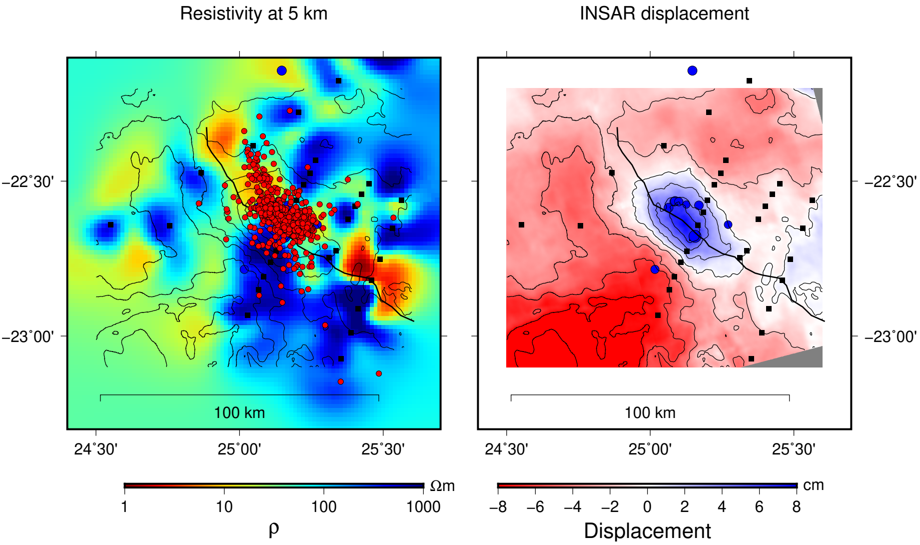
Contrast continues at depth, indication of fault trace (?)

Perpendicular cut



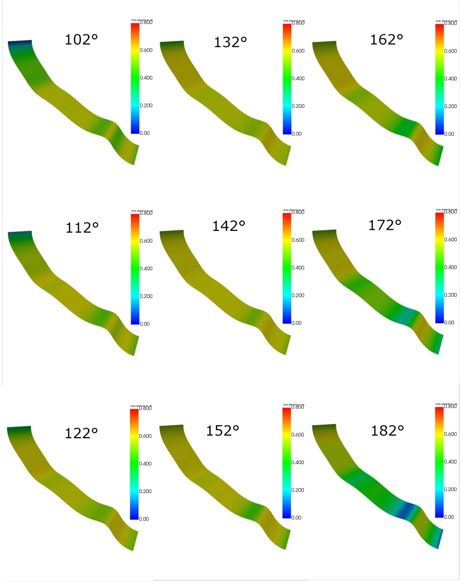
Aftershocks (red dots) from local recording, slightly displaced from main shock (black dot) from USGS catalog, hint of two active fault planes

InSAR



Map view of aftershocks (left) suggests different fault trace

Towards dynamic rupture modelling



- Currently performing initial parameter tests
- Principal stress direction from World Stress Map 145°
- Poor quality stress data, large uncertainty
- Angles > 162° will not rupture beyond southern bend

Conclusions

- 3D MT inversion reveals signature of ancient tectonic events in the area
- Event appears to be associated with reactivation of old reverse fault
- No clear signature of deep fluids
- Will use inferred fault location and geometry for dynamic rupture simulations