Relocating aftershocks of the 2017 Moiyabana, Botswana earthquake

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**INTRODUCTION**

Botswana has been known for its low historical seismic activity. On April 3, 2017 a magnitude 6.5 earthquake occurred in southeast Botswana. Because the 2017 Moiyabana earthquake occurred more than 300 km away from the East African Rift System, the event has been classified as an intraplate seismic event. Large intraplate earthquakes can cause severe damage to buildings and infrastructure, but their seismic hazard is hard to assess.

A sequence of 79 aftershocks was recorded with magnitudes between 2.5 and 5.0. The majority of these earthquakes occurred in the Paleoproterozoic Limpopo-Shashe (LS) orogenic belt, whereas two aftershocks are located in the Kaapvaal Craton.

The LS belt was formed during collision between the Kaapvaal Craton and Zimbabwe Craton, resulting in northeast dipping thrust faults in the southern part of the belt. A 30 - 120 meter thick layer of Kalahari sand challenges the investigation on the structures that slipped during the earthquake sequence. Relocations of the aftershocks give insight in the geometries of these structures and how they relate to the local geology.

**DATA & METHODS**

**Data**

The earthquakes used for the relocation occurred between April 3, 2017 and November 9, 2017. The arrival time picks are from station LBTT and stations of the NARS Botswana seismic network.

**HypoDD**

HypoDD\(^{(1)}\) is used to determine the relocations. Double-difference residuals are calculated by taking the differences in travel times between pairs of events.

When the distance between two events is small compared to the event-station distance, then the travel time difference between the events can be attributed to the spatial offset.

**RESULTS**

After relocation:

- The hypocenters are located closer together
- The events in the large cluster are located along a plane with NW-SE strike, dipping towards the northeast
- The depth of the aftershocks decreases towards the northwest
- The depth range is from 0.1 ± 0.6 km to 18.4 ± 0.7 km

**CONCLUSION**

The strike and dip, along which the hypocenters are located, are consistent with the interpreted fault structures\(^{(2)}\) and the focal mechanisms of the main event and several aftershocks. A few smaller aftershocks align along a southwest dipping structure. These events may have occurred on an anticlinal fault.

Comparing our results with the cross-section of aeromagnetic data with interpreted fault structures\(^{(3)}\) shows that our relocated hypocenters align well with the interpreted Moiyabana Fault.

The earthquake locations and focal mechanisms are consistent with the stress field in Botswana\(^{(4)}\), \(S_n\).

**References**