T5.4-P16

MALAWI SEISMICITY AND SEISMIC NETWORK FROM 1900-2016

Felix C.D. Mphepo

Geological Survey Department, P.O. Box 27, Zomba, Malawi

CTBT: SCIENCE AND TECHNOLOGY 2017 CONFERENCE

Introduction

Instrumental seismological observation in Malawi commenced in 1962 with two single Z-component seismographs at Mzuzu Airport (MZM) and Chileka Airport (CLK). The stations remained operational until when replaced with new analogue seismographs in 1989 where also two other stations were installed in Zomba and Lilongwe respectively. Currently, the network has expanded to 11 broadband stations where two of them belong to AfricaArray Project network and are co-located with GPS and weather stations.

Geology and Tectonics

The Malawi Basement Complex consists of crystalline rocks of Precambrian to lower Paleozoic age. At various localities, these rocks are overlain unconformably by sedimentary and subordinate volcanic rocks which range in age from Permo-Triassic to Quaternary (Fig.1). The basement complex was subjected to a prolonged structural and metamorphic history that was associated with epeirogenic movements, faulting and formation of the Malawi Rift Valley (Carter, 1973).

The Malawi rift was initiated in the late Tertiary (Crossley and Crow, 1981) and extends ~800km from the Rungwe volcanic region (South Tanzania) through Lake Malawi into Mozambique. In Malawi, it is largely dominated by a linear trough forming Lake Malawi which is characterised by a series of half grabens with complex fault geometries and mostly infilled with thick sediments which have been intruded by dyke like structures (Fig. 2)(Scholz C.A., 1989)

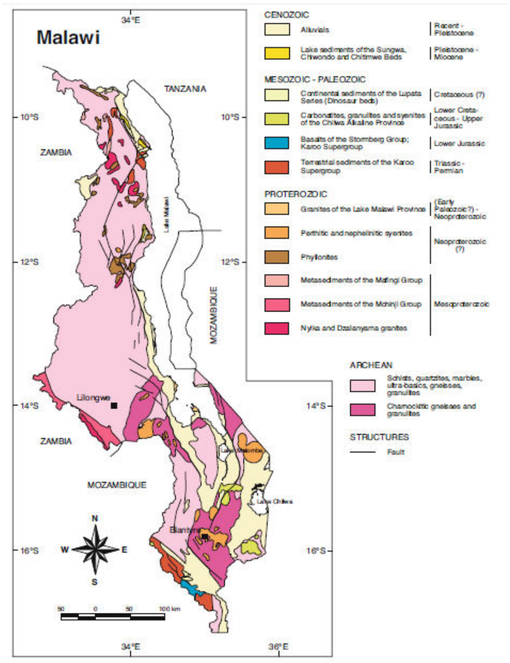

Figure 1: Geological Map of Malawi (www.eisourcebook.org)

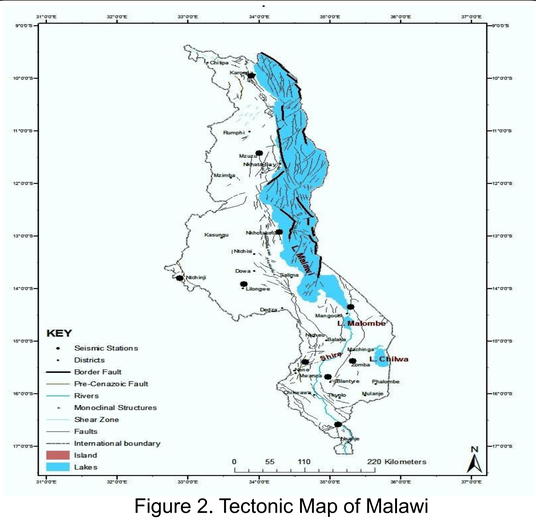

Figure 2. Tectonic Map of Malawi

Seismicity of Malawi

The available catalogue has events from 1900 which has records of some strong earthquakes such as the Rukwa earthquake (Ms 7.4) on December 13, 1910 south of Tanzania. The catalogue presents 144 earthquakes of between Ms 4.5 to 7.4, with the Rukwa event of 1910 being the largest during the pre-instrumental observation period (1900-1962). In the post-instrumental period, the catalogue has 686 earthquakes of magnitude 4.0 to 6.2, with the Salima event of 1989 (Ms 6.2) and the Karonga event of 2009 (Ms 6.0) being the largest events. The larger events fall within the northern part of the country where highest seismicity is also concentrated.

In Malawi, small-to-moderate earthquakes both from within the country and from neighbouring countries are felt which makes it vulnerable to seismic hazards. The spatial distribution shows northern Malawi as highly active followed by the Centre, whereas the South is sparsely distributed (Fig. 3)

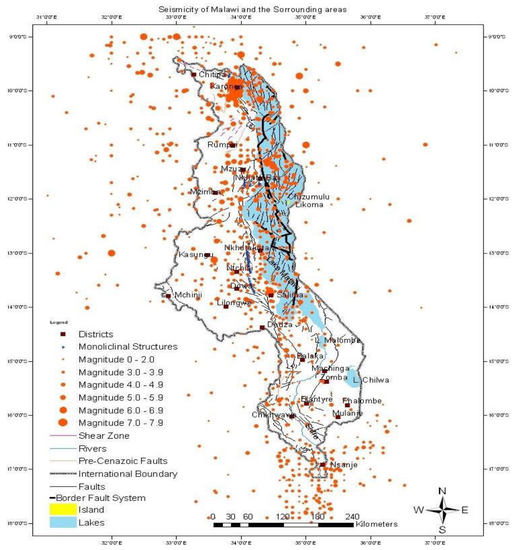

Figure 3. Seismicity of Malawi and surrounding areas (1900-2016)

Seismic Network of Malawi

Instrumental seismological observation in Malawi dates back to 1962. Currently, Geological Survey Department of Malawi (GSDM) operates 11 broadband seismic stations throughout the country (Fig. 4). Two of the stations belong to AfricaArray Project (Pennsylvania State University, USA) in Zomba and Mzuzu, co-located with GPS and weather Stations. The data is in reftek format (Fig. 5) and is analyzed using compass software.

Additionally, Malawi has a CBS Work Station installed by the CTBTO in Zomba that provides access to International Monitoring System (IMS) data and products that are useful in regional event locating and characterization by integrating with the national data.

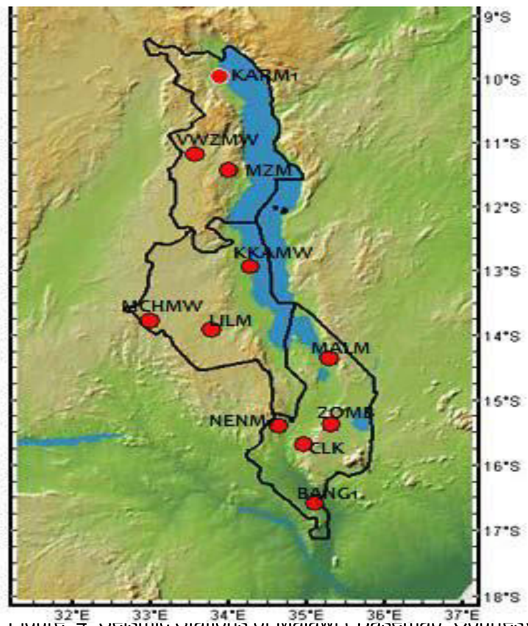

Figure 4: Seismic Stations of Malawi (Basemap: Courtesy of GeoMapApp, Ryan et. al., 2009, Http://www.geomapapp.org)

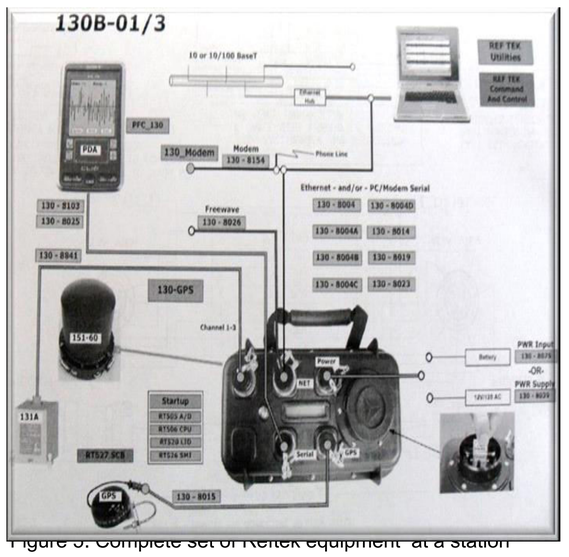

Figure 5: Complete set of Reftek equipment at a station

Conclusion

Malawi as a country that lies in the region undergoing extensional rifting, is likely to continue experiencing earthquakes as evidenced by the instrumental observation. The integration of IMS data from the CTBTO with our national data provides a unique regional event location and characterization whether natural or manmade. Generally, The northern part of Malawi is the most seismically active region.

Despite the efforts made in managing the seismic network, there is lack of capacity building to the personnel working in the network.

References

- **Castaing, C. 1991:** Post—Pan African tectonic evolution of South Malawi in relation to the Karroo and Recent East African Rift System. Tectonophysics, 191, 55-73.
- **Chapola, L.S. 1991:** Seismicity and source mechanisms of the Malawi Rift and adjacent areas, from 1900 to 1990. Individual Studies. IISEE, Tsukuba, Japan, Vol.27 49-67.
- **Crossley, R.C. and Crow, M.C. 1981:** The Malawi Rift in: Geodynamic Evolution of the Afro—Arabian Rift System. Accad. Naz. del Lincei, 47, P77—87. I
- **Crow, M.C. and Crossley R.C. 1980:** Seismicity and Tectonics of Malawi area. National Atlas of Malawi. P32. Published by Malawi Surveys Dept., Blantyre.
- **Geological survey of Malawi 1999-2003:** Earthquake and Seismological Files. Geol. Survey Malawi, Z0mba.
- **Jackson, J. and Blenkinsop, T. 1993:** The Malawi 10th March, 1989: Deep faulting within the East African Rift System. Unpubl. report, *Bullard Lab. Cambridge,* U.K.
- **International Seismological Centre (ISC) 1966_1990:** Seismological Bulletins. UK.
- **Ray, G.E. 1975:** The Geology of the Chitipa-Karonga Area. Geological Survey. Malawi, Bull. 42, P25-27.
- **Ray G.E. 1974:** The structural and metamorphic geology of northern Malawi. J. Geol. Soc. London 130:427-440.
- **Scholz, C.A. et al 1989:** Seismic Atlas of Lake Malawi (Nyasa). East Africa Pub. by Project PROBE, Duke University.
- **Shudofsky, G.N. 1985:** Source Mechanisms focal depths of East African earthquakes and body wave modelling. Geophy. J.R. astr. soc. 83, 563-614.