



Introduction

The area under study is located at the northern tip of the Malawi Rift System. Historical and instrumental data indicate Karonga as seismically active area; mostly experiencing low-to-moderate earthquakes (figure 1). Based on ongoing seismicity, there is need for mapping the lineaments/ faults which could be responsible for current seismicity experienced in the area. Previous studies done in the area aimed at identifying active faults and the triggering mechanism for earthquakes in the area (Macheyeki et al., 2015, Shillington, 2010), not much has been done on mapping potential active source zones within the area.

This study was aimed at mapping active lineaments within Karonga area; to achieve this, we used lineament extraction methods on both topographic data and magnetic data. Since the study area is a shear zone; we used 3D Euler deconvolution in order to understand subsurface structures/ lineaments in order to quantify them as possible seismicogenic lineaments.

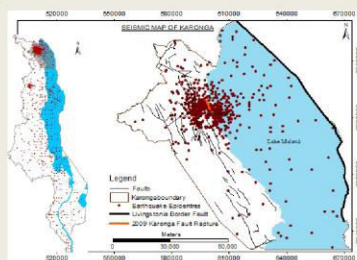


Figure 1: Seismicity of Malawi & Karonga

Methodology

- Automatic lineament extraction from multidirectional hill shaded SRTM DEM (figure 4).
- Lineament extraction using LINE Module algorithm in PCI Geomatica. LINE module parameter settings by Mdala (Mdala, 2015) were adopted.
- Fault dip angle of 45° (Biggs et al., 2010) and earthquake hypocenter depth of 5 Km were considered for the calculation of a buffer zone (figure 5A)
- Extracted lineaments were then exported in Arc GIS 10.0 where integration with seismic data (figure 5B) for the area was done in order to delineate and identify active lineaments.
- 3D subsurface linear feature extraction was done by Euler deconvolution and lineaments at a depth of 10 km were extracted (figure 6A).

Data sets

Mostly two data sets have been used in this study i.e. satellite data which include SRTM DEM and geophysical data which include geophysical and seismic data (figure 2 & 3)

Figure 2A & 2B: Satellite data – (A) SRTM DEM & (B) hill shaded SRTM DEM

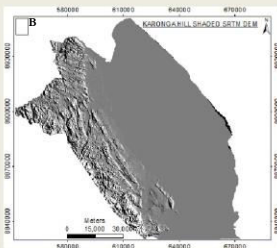
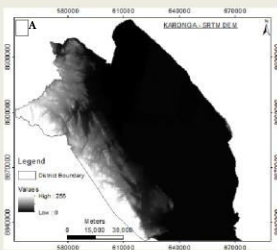
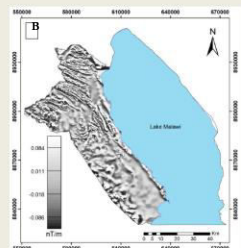
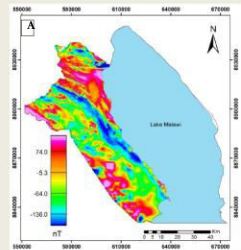


Figure 3A & 3B: Geophysical data – (A) Total magnetic intensity & (B) Vertical derivative



Lineament extraction

Lineaments were extracted from hill shaded SRTM DEM (figure 3A) using LINE Module algorithm in PCI Geomatica. A total 350 lineaments were extracted with varying lengths from 0.13 km to 31 km. On magnetic data lineaments were extracted on vertical derivative image (figure 3B)

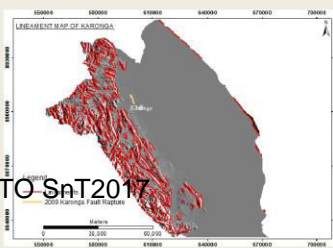


Figure 4: Lineament extracted from multidirectional hill shaded SRTM DEM

Active lineament mapping

Active lineament mapping involved defining a ~10 km buffer zone around seismic epicenters / hypocenters (distance Y in figure 5A). Fault dip angle of 45° (Biggs et al., 2010) and depth of 5Km were considered for the calculation of a buffer zone (figure 5A). The assumption in this article is that there is a high degree of fracturing / faulting happening within area Y (buffer zone) hence any lineament originating or crossing the buffer zone (figure 5B) was mapped as active lineament (“fault”).

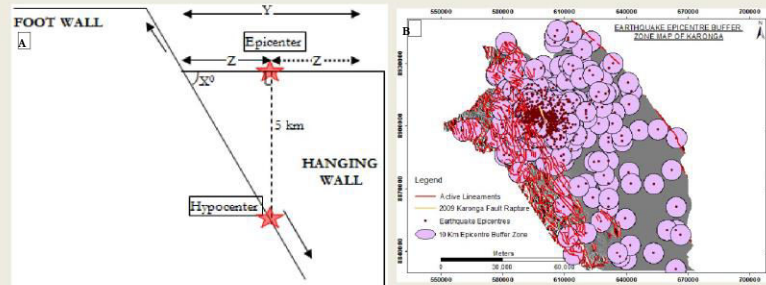


Figure 5: (A) Calculation of buffer zone & (B) Mapping of active lineaments - integration of lineaments and earthquake epicenter buffer zone

Results

The northern part of the study area is highly faulted with very few earthquakes occurrences. The orientations of lineaments / faults in the northern part is NW-SE while in the southern part of the study area, it is almost NNW and SSE oriented. Between these two trending directions, earthquake frequency increases; this implies geodynamic activities between two directional moving crusts.

Observed similarities in the orientation direction for the active lineaments from hill shaded SRTM DEM (figure 6B), Aeromagnetic data (figure 6A) and the 2009 Karonga fault rupture (St. Mary's Fault) superimposed on figure 6B offers an excellent setting for investigating interactions and continuity between the St. Mary's Fault and the extracted lineaments.

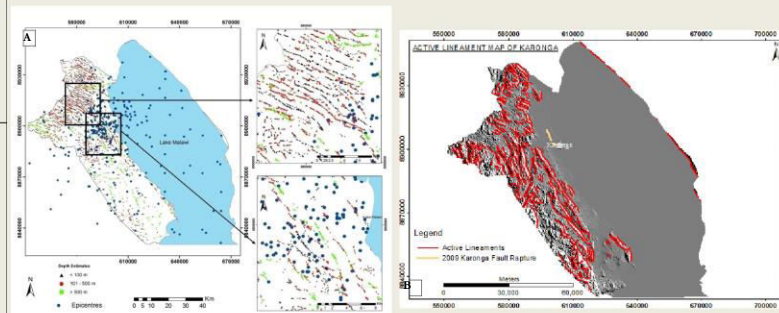


Figure 6: (A) Lineaments / faults picked at a 10 km depth using 3D Euler deconvolution & (B) Active Lineament Map of Karonga

Conclusion

The existing geological, geophysical data and seismicity correlated with the mapped lineaments could be used for improved seismic hazard assessment in future. This study has revealed possible active sources from observed active lineaments largely populated in the central and northern parts of Karonga; this implies that the current seismicity is influenced by movement along some of the mapped lineaments or sub-surface structures. It has to be noted that not all the extracted active lineaments are a result of rifting activities, some are a result of basement fracturing during the orogenic period. These orogenic associated lineaments may have been reactivated during the rifting episode thereby causing seismic activities within the area.

Seismic activity of Karonga area though moderate, presents great hazard in future due to the increasing population and a great number of structures that are seismically non-resilient. We conclude that future seismic hazard assessment and planning should consider these active lineaments as potential structures representing weak zones capable of generating earthquakes that could lead to severe damage to property and loss of life.

References.

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