Journal of African Earth Sciences 89 (2014) 72–78

Contents lists available at ScienceDirect

Journal of African Earth Sciences

journal homepage: www.elsevier.com/locate/jafrearsci

The seismicity in Kenya (East Africa) for the period 1906–2010: A review

J.K. Mulwa [a,b,*], F. Kimata [b], S. Suzuki [c], Z.N. Kuria [a]

[a] University of Nairobi, Department of Geology, P.O. Box 30197-00100, Nairobi, Kenya
[b] Research Center for Seismology, Volcanology and Disaster Mitigation (RSVD), Graduate School of Science, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan
[c] Tono Geoscience Center, 959-31, Jorinji, Izumicho, Toki-shi, Gifu 509-5102, Japan

ARTICLE INFO

Article history:
Received 15 February 2012
Received in revised form 18 September 2013
Accepted 18 October 2013
Available online 26 October 2013

Keywords:
Review
Seismicity
Historical records
Kenya

ABSTRACT

Kenya has had a seismic station since 1963 as part of the World Wide Standardized Seismograph Network (WWSSN). In 1990, the University of Nairobi in collaboration with GeoForschungsZentrum (GFZ) started to build up a local seismological network, the Kenya National Seismic Network (KNSN), which operated for about ten years between 1993–2002. This, however, experienced a myriad of problems ranging from equipment breakdown, vandalism and lack of spares. Kenya is seismically active since the Kenya rift valley traverses through the country from north to south bisecting the country into eastern and western regions. In the central part, the Kenya rift branches to form the NW-SE trending Kavirondo (Nyanza) rift. The Kenya rift valley and the Kavirondo (Nyanza) rift are the most seismically active where earthquakes of local magnitude (M_l) in the order of $\leqslant$2.0–5.0 occur. Furthermore, historical records show that earthquakes of magnitudes of the order of $M_l \geqslant 6.0$ have occurred in Kenya. Such large magnitude earthquakes include the January 6, 1928 Subukia earthquake (M_l 7.1) and an aftershock (M_l 6.2) four days later, as well as the 1913 Turkana region earthquake (M_l 6.2). Since early 1970's, numerous seismic investigations have been undertaken in Kenya in order to understand the formation and structure of the Kenyan part of the East African rift valley. Earthquake data from these studies is, however, rather disorganized and individual datasets, including that acquired during the period 1993–2002, cannot furnish us with comprehensive information on the seismicity of Kenya for the past ~100 years. The purpose of this paper is, therefore, to review the seismicity in Kenya for the period 1906–2010 by utilizing data and results from different sources. The general seismicity of Kenya has been evaluated using historical data, data recorded by local seismic networks, the United States Geological Survey catalogue as well as earthquake data from the numerous seismic investigations by different individuals and research groups. On the basis of earthquake data from these sources, the entire N–S trending Kenya rift valley and the NW-SE trending Nyanza (Kavirondo) rift are characterized by a high rate of seismicity, and the USGS network has been effective in detecting local $M > 3.0$ earthquakes. A peculiar trend is exhibited by earthquakes of $M_l \geqslant 5.1$ in that these occur along the N-S and NW-SE trending Kenya rift valley and the Kavirondo (Nyanza) rift zone respectively. Earthquake data from the various sources for the period 1906–2010 is complete for $M_l \geqslant 4.4$ earthquakes with a b-value of 0.79 which is characteristic of tectonic active regions like rifts. There is need to revive and extend the KNSN for a greater coverage and effective seismic monitoring in Kenya.

1. Introduction

Kenya is located on the eastern part of African continent and borders Ethiopia to the north, Republic of Somalia to the east and northeast, Indian Ocean to the southeast, Tanzania to the southwest, Uganda to the west and the Republic of Southern Sudan to the northwest (Fig. 1).

Earthquake monitoring in Kenya dates from 1963 when the first seismic station was installed at the University of Nairobi's Chiromo campus at coordinate location 1°16′22″S and 36°80′4″E by United States Geological Survey (USGS) as part of the World Wide Standardized Seismograph Network (WWSSN). The WWSSN seismic station at the University of Nairobi's Chiromo campus was the first and major seismic station in Kenya. The seismic station consisted of a 3 component short period (SP) recording system (Benioff Seismometers with a period of 1 s) and a 3 component long period system (Sprengnether seismometers with a period of 15 s). The sensors were "founded" on volcanic tuffs which, in Nairobi region, constitute part of 122 m thickness of volcanics which unconformably overlie metamorphic rocks of the Mozambique Belt. This seismic station initially operated by Mines and Geology Department of the Ministry of Environment and Natural Resources was handed

* Corresponding author at: University of Nairobi, Department of Geology, P.O. Box 30197-00100, Nairobi, Kenya. Tel.: +254 20 4445896; fax: +254 20 4449539.
E-mail address: josphat_mulwa@yahoo.com (J.K. Mulwa).

1464-343X/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jafrearsci.2013.10.008

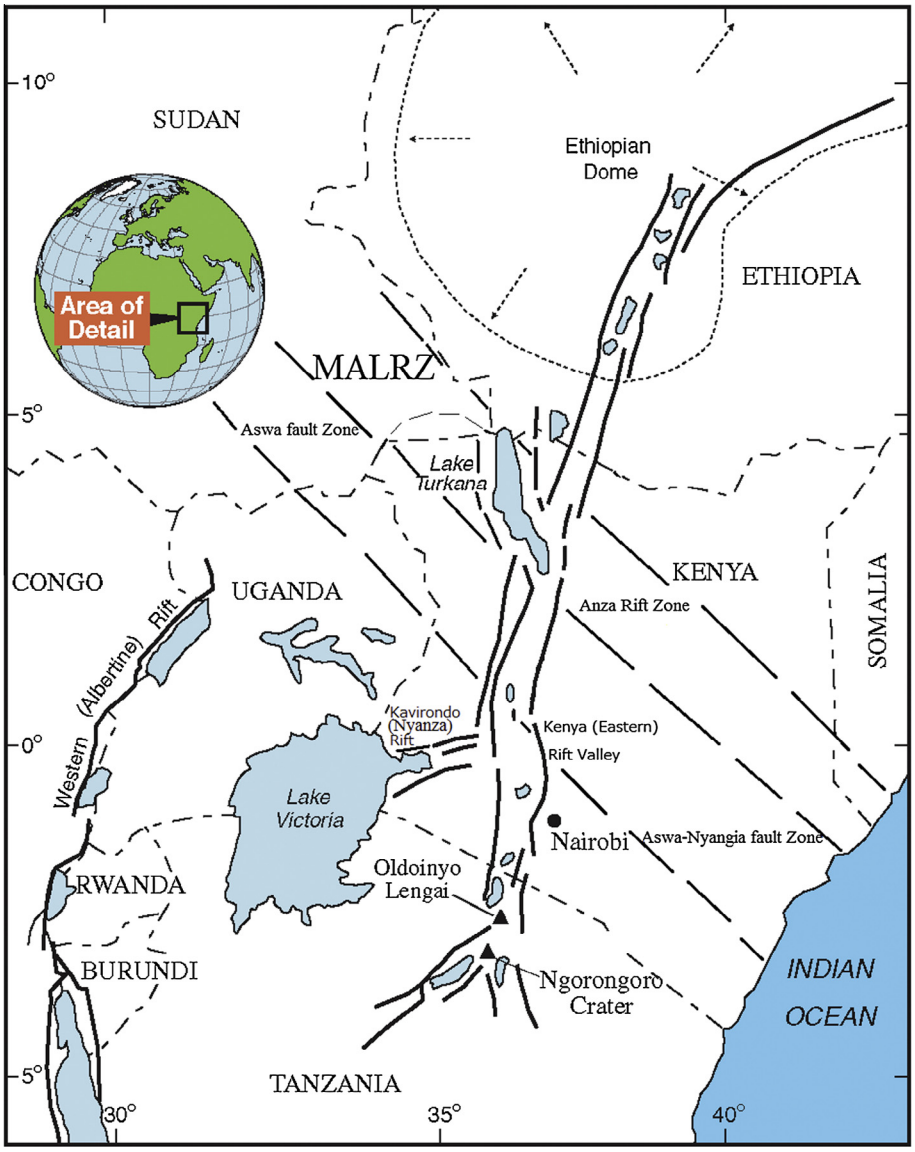

Fig. 1. Map of Kenya showing the NNE–SSW Kenya rift valley and NW–SE trending fault zones; MALRZ – Muglad Anza Lamu Rift Zone (Modified after Ashley et al., 2004).

over to Geology Department of the University of Nairobi in 1964. Since its installation in 1963, analogue data was recorded on photographic paper up to 1990. Between 1990 and 1995, analogue data from the station was recorded using a hot stylus system on heat sensitive paper. In September 1995 the WWSSN analogue station was upgraded to an IRIS digital seismic station with broadband seismometers and moved to Kilimambogo hill (coordinates 1.127°S and 37.252°E) about 70 km to the east of Nairobi city. For close to 30 years when it was first installed, this seismic station was the only permanent station in Kenya. Thousands of local and regional earthquakes were recorded by this station but they could not be properly located as no recordings from other stations were available for most of these events. In 1990, the University of Nairobi in collaboration with and funding from GeoForschungsZentrum (GFZ) started to build up a local seismological network, the Kenya National Seismic Network (KNSN) consisting of five short period seismic stations, which operated for about ten years between 1993 and 2002. This seismic network, however, experienced a myriad of problems ranging from equipment breakdown, vandalism and lack of spares especially after the funding organization (GFZ) pulled out.

Table 1 and Fig. 2 show the seismic stations distribution and the current setup of the Kenya National Seismic Network (KNSN). It is evident from Fig. 2 that the station configuration for the KNSN is rather skewed omitting much of the northeastern, central and western parts of the country. This therefore implies that the magnitude threshold of $M_l \leqslant 3.0$ is only detectable at distances of up to 350 km from the center of the network.

2. Tectonic setting

The East African Rift System (EARS), which is a classical example of an active intra-continental ridge system comprising an axial rift zone dissects Kenya longitudinally into almost two halves. The eastern arm of EARS (Figs. 1 and 2) extends from Afar Triangle in the north through Djibouti, Ethiopia, Kenya, and Tanzania to Mozambique in the south. The eastern arm of EARS is variously referred to as Eastern, Gregory (Gregory, 1921; Sikes, 1926; Saggerson, 1991) or the Kenya rift valley, and its central and southern parts form a 50 to 80 km wide rift valley with high escarpments on one side and en echelon fault steps on the opposite (Ibs-von Seht et al., 2008).