

Seismic Observation and Seismicity of Uganda

1. Seismic observation in Uganda

In 1989, UNESCO and the International Programs in Physical Sciences (IPPS) donated four (4) Micro-earthquake (MEQ) 800 analogue paper seismographs. This made the Department Geological Survey and Mines through Uganda Seismological Network to revive earthquake monitoring after it was destroyed during political instabilities in 1979, and in 1990 three (3) of seismographs were installed at Entebbe, Hoima, and Kilembe. The stations form a rectangular network occupying the southern part of the country as shown in the Figure 1. In 1995, the Norwegian Seismic Array (NORSAR) donated and installed a fourth station at Dundu few kilometres from Entebbe.

In 1996, a memorandum of understanding was signed between the government of Uganda and the University of California San Diego to install an IRIS global station at Kyahi-Mbarara. In 1999, the IPPS purchased three Orion Nanometrics digital seismograph stations to strengthen the MEQ-800 analogue paper stations at Entebbe, Hoima and Kilembe.

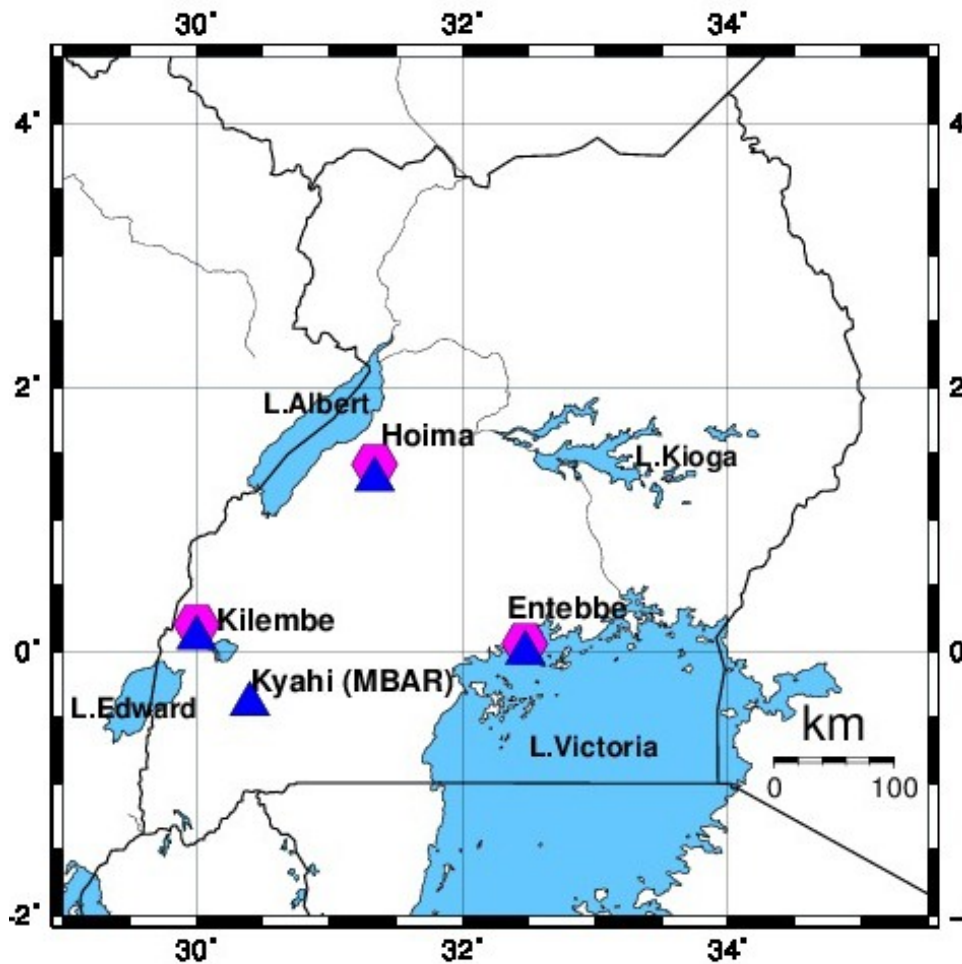


Figure 1. A map showing distribution of Uganda seismological stations
Blue triangle: Broadband seismic stations
Pink hexagon: Short period seismic stations

2. Monitoring equipment installed

Micro-earthquake (MEQ) 800 analogue seismograph

This is portable and wide range seismic recording equipment. At the station, the seismograph is connected to L-C4 short period vertical component seismometer for generating the seismic signal. The seismograph receives the signal from the sensor, amplifies and records it on paper wrapped on a rotating drum. The system is specifically designed for site location with an internal timing system that tags the time marks onto the signal. The seismograph is manually operated and the output paper record (seismogram) is interpreted and data retrieved is stored in the computer for further analysis.

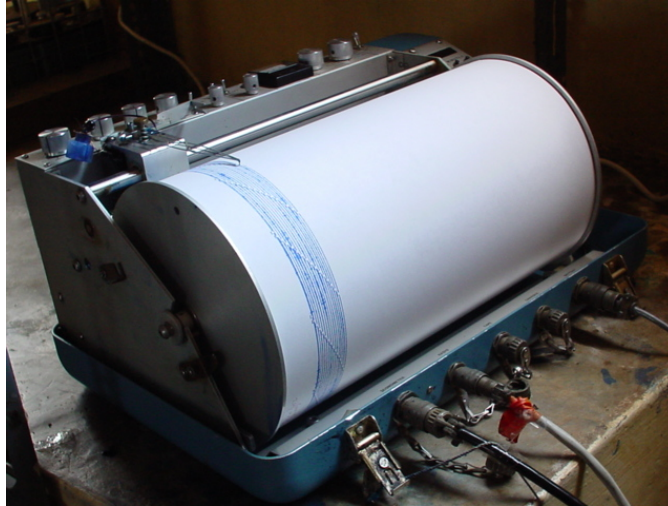


Photo 1. Micro-earthquake (MEQ) 800 analogue paper seismograph

Orion digital seismograph

This seismograph is a modern portable field seismic data logger from Nanometrics Inc., having 3 to 6 input channels. At each station, the seismograph is connected to an L4-3D three component short period seismometer which detects ground motion and records the signals it onto data cartridge. This seismograph has inbuilt GPS clock for providing time and it is capable of operating on different settings depending on the needs of the user. It can also be set according to suitable data acquisition modes either continuous or event detector trigger mode.



Photo 2. Orion Nanometrics digital seismograph and seismometer

Kyahi global seismographic equipment

The equipment installed consists of a Quanterra, Q330 model digitizer, 3-component broadband, 3-component short period, and 3-component strong motion accelerometers installed in a

borehole. It has a high resolution data acquisition recording system (DAS) designed to acquire data with minimal routine checkup. The DAS receives the analogue output from sensors and converts it to digital form. Workstation processor (computer) under the Solaris platform a version of UNIX operating system was installed to control the recording. The processor is connected to V-sat antenna for easy access of the data by Automatic data request manager at the University of California SanDiago (UCSD). The processor also monitors the state of health of the system and is capable of unpacking and copying data to magnetic tapes that are changed weekly and brought to Entebbe NDC.

Dundu seislog recording system

This a broadband station used to operate in near real time system, equipped with a CMG-40T three component broadband seismometer. It has a wide dynamic range recording system and the seismic signals from sensors are passed through a 24 bit digital seismic modulator and further transmitted by radio link to Seislog desktop receiving computer at the Entebbe National Data Centre. The radio link consists of a transmitter at Dundu and a receiver at the Entebbe NDC operating in Ultra High frequency band using a Yagi antenna.



Photo 3. Seismometer installation at Dundu site.

Table 1. Summary of the monitoring equipment installed.

Station/Code	Equipment (seismograph) type	Data storage format	Year of installation
Entebbe: ENT ENTT	MEQ-800 analogue	Paper seismogram	1991
	Orion Nanometrics digital	Data disc/cartridge	1999
Hoima: HOI HOID	MEQ-800 analogue	Paper seismogram	1992
	Orion Nanometrics digital	Data disc/cartridge	1999
Kilembe: KIL KILD	MEQ-800 analogue	Paper seismogram	1992
	Orion Nanometrics digital	Data disc/cartridge	1999
Dundu: ENTD	CMG-40T broadband seismometer and Seislog Data acquisition system (DAS).	Telemetry transmission to data center.	1995
Kyahi MBAR AS103	- High resolution digitizer (Quanterra, Q330). - 3 types of seismometers namely; 3-component broadband sensor, 3-component short period sensor, 3-	Magnetic data tapes, Pen drives and internet transmission	1999

	component strong motion accelerometer.		
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3. Seismicity and Devastating Earthquake Events in Uganda

In Uganda, history of big earthquakes felt is associated with magnitudes in the range between 5.0 and 6.8. For construction and safety purposes, one should design earthquakes resistant structures for magnitude 7.0 and above and peak ground acceleration of 0.352g for the return period of 950 years. Uganda has severely experienced devastating earthquakes in the past as presented in the table below.

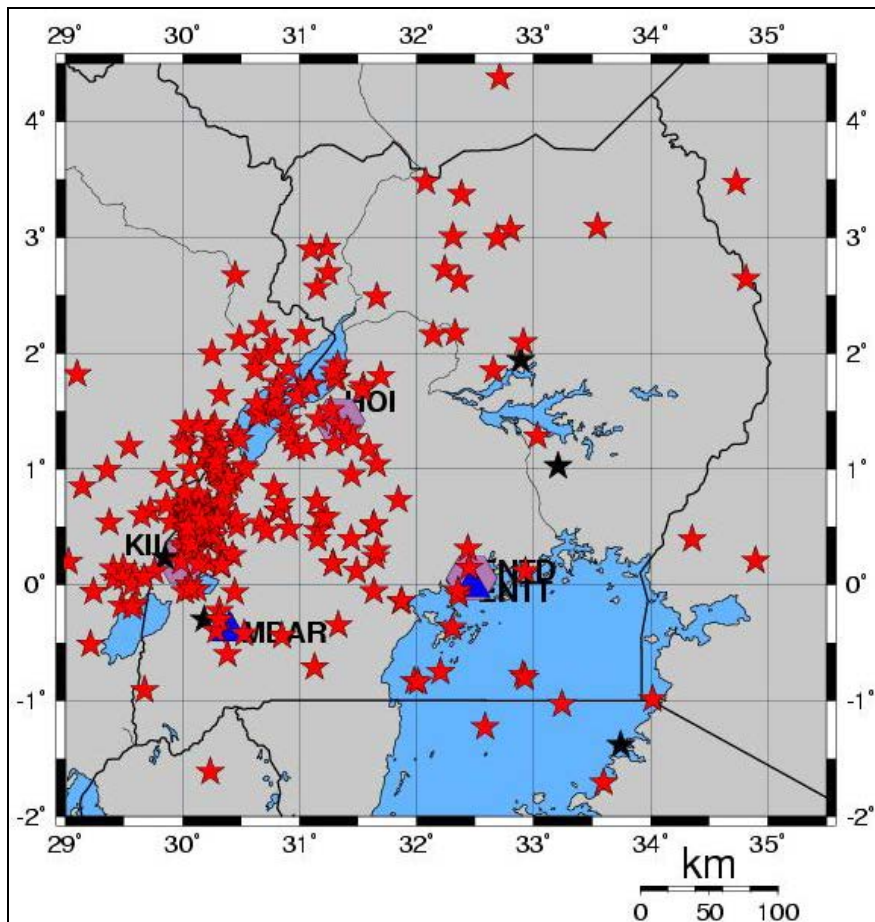


Figure 1. Map showing seismicity of Uganda and vicinity in period 2000 – 2010

Red star: Location of earthquake epicenters during the period 2000-2009

Black star: Location of earthquake epicenters in only 2010

Blue triangle: Broadband seismic stations

Pink hexagon: Short period seismic stations

Table 2. Summary of destructive earthquakes events in Uganda.

Date	Epicentre location	Magnitude (Richter Scale)	Effects
9 th July 1912	Kitgum close to Aswa shear zone.	6.0	Partial destruction of buildings in northern and northwestern Uganda
2 nd October 1929	Toro, Western Uganda.	5.9	Change of water color in the hot springs and earthquake induced landslides (Simmons 1930).
18 th March 1945	Sembabule (40 km north of Masaka town).	6.0	Entebbe seismograph put out of order, 5 people dead and destruction of some buildings (Bisset 1945; Gutenberg and Richter, 1949).
29 th March 1966	Toro, Western Uganda.	6.6	150 people dead and over 1,300 injured as well as property loss worth millions of dollars. (Loupekine 1966; Sykes 1967).
7 th September 1990	Lake Victoria close to Kampala.	5.0	Destroyed semi-permanent buildings around Kampala.
9 th October 1991	Butiaba on Lake Albert.	5.3	Destroyed semi-permanent buildings.
5 th February 1994	Kisomoro, Western Uganda.	6.2	8 people dead and destruction of property worth US\$ 61 in the western districts of Kasese, Bundibugyo and Kabarole. The hottest hot spring in Buranga (Sempaya) geothermal field (98°C) emerged.