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A REVIEW OF SEISMIC ACTIVITIES IN NORTHERN NIGERIA AND THE GULF OF GUINEA

***[1]Oyibo David, [2]Omali Aurelius Ojaina and [1]Abdullahi Ayegba**

[1]National Space Research and Development Agency, Abuja, Nigeria,
[2]Kogi State University, Anyigba, Kogi State, Nigeria.

*Corresponding authors' email: davidoyibo08@gmail.com

ABSTRACT

Against the backdrop of Nigeria's seismic activity, which has been clearly scientifically proven to have increased over the past 35 years, seismic activity in northern Nigeria is becoming alarming. (Abuja 2018, Ifewara 2019, Mpape Abuja 2024, and Yola 1984-2005 all) demonstrate that Nigeria has entered a seismic zone. Northern Nigeria has had more than 17 events between 1990 and 2018, indicating an increase in seismicity. Over time, this has grown, reaching roughly 20 in 2024.The oceanic and continental fracture system and the NNE-SSW trending Ifewara - Zungeru fault zone are clearly linked by geophysical investigations of historical and instrumental seismicity in northern Nigeria. The study focusses on northern Nigeria's seismology and the active fault line that causes tremors in the region.

Keywords: Northern Nigeria, Seismic Activities, Gulf of Guinea

INTRODUCTION

Although previously thought to be inactive, the northern region of Nigeria is increasingly becoming more vulnerable to earth quake activity. Nigeria is thought to remain dormant due to its placement along the African belt, sandwiched between the Congo and West African cratons. The site of earth movement linked to the NE-SW trending fracture and zone of weakness that extends from the mid-Atlantic Ridge into the nation has been identified as the potential explanation for the earth tremor in Nigeria (fig. 1)(.1984's Ajakaiye). Geological and geophysical techniques have been used to identify a number of suture zones in the area; many of these look parallel to or correlate with identifiable paleo-rift and paleo-compressional zones within the West African craton (Onuoha 1989).

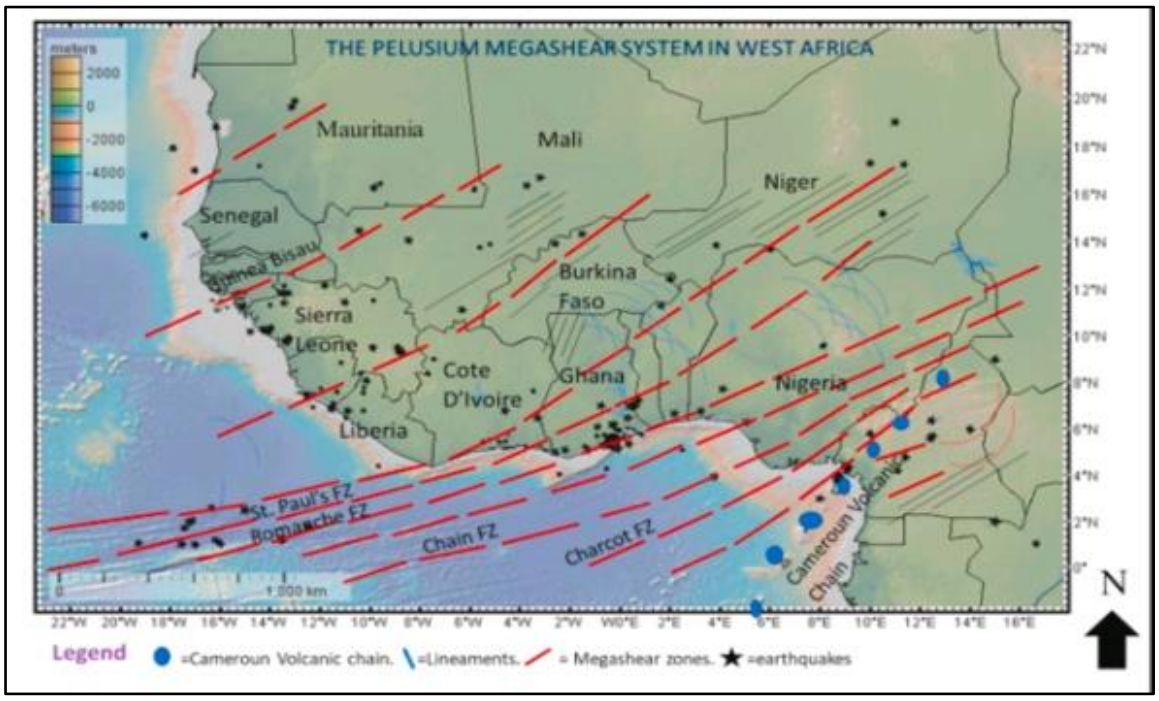

Figure 1: Tectonic map of West Africa (Akpan and Yakubu 2010)

Tectonic Setting in Gulf of Guinea and Tremors in Northern Nigeria

The location of the African orogeny, which was accompanied by significant deformation and metamorphism of 600 +/- 100, is confirmed by the geological framework of the Nigerian mobile belt. Mom Turner, 1971.Nigeria cannot completely avoid future seismic activity because the majority of fault lines are becoming active and extending from the Gulf of Guinea. Based on the analysis of calc-alkaline volcanic and basic/ultrabasic rocks in major transcurrent faulting in the Anka-maru belt of northwest Nigeria, MC Curry and Wright (1977) proposed the potential extension of a pan-African age suture zone in northwestern Nigeria. According to Fitton's 1980 research, the Cameroon volcanic line is made up of a chain of recent alkaline volcanoes that split into two arms, one of which runs northward into northeastern Nigeria, creating

Biu plateau, while the other arm run east-ward through Nagoundere plateau of eastern Cameroon. The opening of the equatorial Atlantic ocean (GOG) is characterized by initiation of oblique rifting on till the cretaceous period (120ma). This tectonic episode led to the segmentation of the Brazilian, West African craton and the Mid –Atlantic rifted margin which later became affected by several transform fault like the Romanchi Antoberehet al., (2009). Other researchers documented the seismic behavior of oceanic transform fault and their connection to the continental tectonic structures Franheteau and Le Pinchon 2003. Fractures/faulted lines, traversed through about twenty one states emanating from the Gulf of Guinea including federal capital territory and many northern parts of Nigeria (Fig) 2 (below).

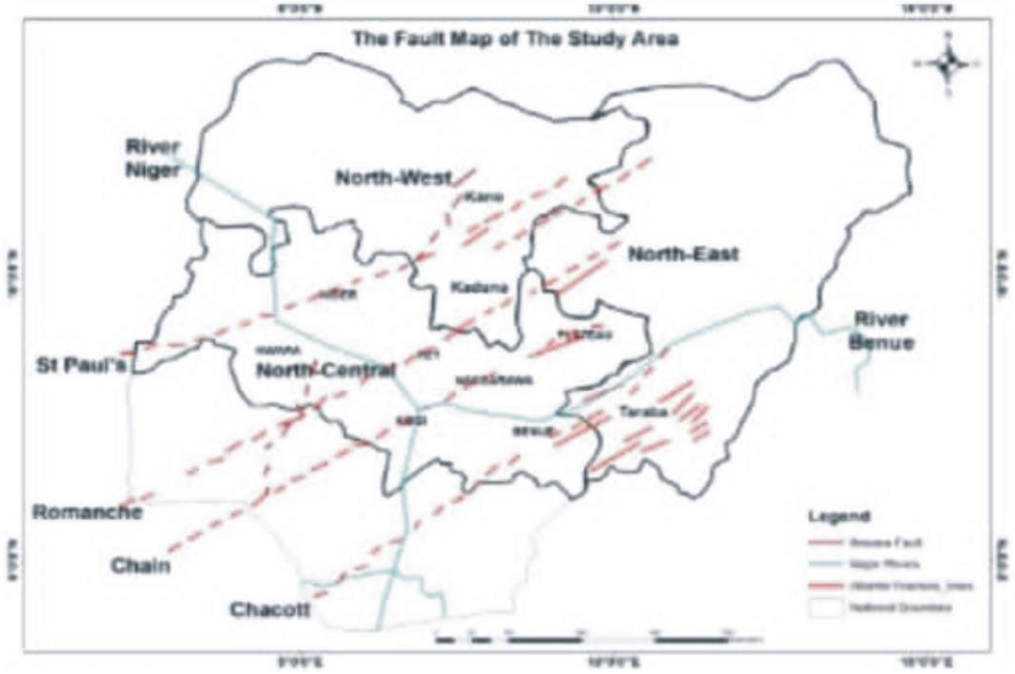

Figure 2: Map of Nigeria showing fault line traversing all the northern state that have experienced seismic activities

Seismic Activities in Northern Nigeria

Three major blocks of northern Nigeria have experienced various degree of earth tremors over the years.

The November 7, 1994, tremor in Dan Guibi, close to Gusaau, Zamfara state, northwest Nigeria, had a magnitude of roughly 4.2 on the Richter scale and happened at around 05:07:51:00 GMT. Three stations in Cote d'Ivoire reported experiencing severe vibration without any damage. Another was the Ikara tremor, which occurred on May 10, 2016, between Kano and Kaduna state in northwest Nigeria. It had a recorded magnitude of 3.5 on the Richter scale, and although no one was killed, the community was left with building fissures. Around three tremors were registered in Kwoi, Kaduna state, between September 5 and September 11, 2016. However, the reaction from the residents of the impacted villages showed obvious damage to buildings in Kwoi and a few others within the epicentre.

According to Ugoduluwa et al. (1986) and Ajakaiye et al. (1988), the Kambari Yaya incident occurred in Bauchi state table 2 in northeastern Nigeria. With a total length of 1.5 km to 2 m and a registered V on the modified Mercalli scale, the earthquakes occur at right angles to one another. On March 25, 2006, a tremor was reported in the isolated community of Lumpa, close to Niger State in north central Nigeria. According to eyewitnesses, people fled their various fields for safety when they heard a sudden, loud noise and vibration. Houses and rocks were broken, and the epi-central intensity of the tremor was III. Figure 4 and Table 1 illustrate the frequency and statistical distribution of seismic activity in Northern Nigeria.

Figure 3: Map of Nigeria showing few areas where earth tremors were felt (Akpan andYakubu 2010)

Table 1: List of historical and recent earth tremor in northern Nigeria

S/N	Date	Time	Felt Areas	State	Intensity	Probable epic center	Longitude/Latitude
1.	1977	--	Dangu gubiu	Zamfara	iv	---	---
2.	1975	--	Dambata	Kano	--	---	8° 31’ E 08° 22’N
3.	1990	--	Jere	Kaduna	v	---	---
4.	1982	--	Jalingo	Taraba	iii	Close to Cameroon	11°37’71’’E 8°89’29’’N
5.	1984	---	Yola	Adamawa	iii	Close to Cameroon volcanic line	12°47’82’’E 9°20’95’’N
6.	1985	21:00	Kambari Yaya	Bauchi	v	Kambari Yaya	11°0’E 10°02’N
7.	1986	10:45	Obi	Benue	iii	Close to Obi	8° 46”
8.	1987	--	Gembu	Taraba	v	Close to Cameroon	11°15’E 6°42’N
9.	1987	--	Akko	Gombe	iv	Close to Akko	10°57’E 10°17’N
10.	1987	--	Kurba	Bauchi	iii	Kurba	10°12’E 11°29’N
11.	1988	05:07:51	Oserurun hill	Gombe	--	---	11°10’02’’E 10°17’22’’N
12.	1994	--	Dan Guibi	Adamawa	iii	Dan Guibi	12°49’84’’E 95°26’5’’N
13.	2000	--	Jushi Kwari	Kaduna	iii	Close to Jushi Kwari	7°42’E 14° 03’ N
14.	2006	11:20	Lumpa	Niger	iii	Close to Ifewara	6°41’67’’E 9°28’33’’N
15.	2016	11:20	Sabang Daji	Kaduna	iii	Kwoi	8°89’5’’E 9°46’48’’N
16.	2016	2:28	Kwoi	Kaduna	iii	Kwoi	7°88’5’’E 9°8’25’’N
17.	2016	--	Ikara	Kano	iii	Ikara	---
18.	2018	5:11	Mpape	Abuja	iii	Mpape	7°50’E 9°15’N
19.	2020	01:46:20	Abaji	Abuja	iii	Abaji	6°47’E 8°49’N
20.	2024	01:14:50	Mpape	Abuja	iii	Mpape	7°58’4’’E 9°13’5’’N

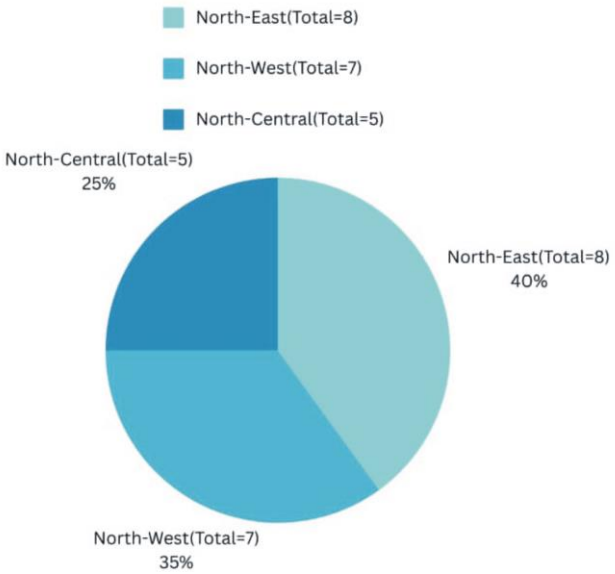

Figure 4: Pie Chart Showing seismic events spread by region within Northern Nigeria

MATERIALS AND METHODS

Data were obtained from the Global Centroid Moment Tensor (GCMT) and International seismological Center (ISC), the data catalogue revealed about four existing fracture zones of the Gulf of Guinea. Secondary data, report from previous studies based on seismological radar data provided information about seismicity in northern Nigeria and better understanding of the visibility of different fault zones in relation to the framework of the Gulf of Guinea.

RESULTS AND DISCUSSION

Kutu 2013 and Akpan etal., 2014 in their various studies stated that the recent siesmo-tectonics of the intraplate earthquake of west Africa has been linked to the adjoining area of the Gulf of Guinea province. The overall seismicity pattern shows a progression earthquakes from cluster zone in the Gulf of Guinea to sub-saharan African region with northern Nigeria. Eluyemi and Saurabh 2016 explained series of fracture and fault lines traversing over twenty states all through to three major zone of northern Nigeria including the federal capital territory (Abuja) emanating from the Gulf of Guinea, he further stated that the severity of the tectonics is in conformity with the Pan-African orogeny which account for persistent tremor all around the northern state of Nigeria. Kogbe CA, 2014 in his work on the evaluation of the September 11 2009 earthquake of southwestern Nigeria , he suggested that the event was a reactivation of buried fault in the precambian basement complex represented by the contemporary NE-SW trending regional horizontal compressive stress believed to be linked to the fracture zone in the Atlantic ocean . In another submission the interpretation of seismic reflection survey across the continental sheet south of Acccra. Kutu 2013. In seismic and tectonic correspondence of major earthquake region in southwestern Ghana, establish that the seismicity of the region have been linked to tectonic activities of St Paul and Romanchi transform fracture zone system of gulf of guinea to onshore . Blinks and Firhead 1992 in their plate tectonic setting for Mesozoic rift of west and central Africa concludedthe zone of extension increases in size (width) with depth. Bonatti et al., 1991 in their geological studies of the eastern part of the Romanchi transform zone concluded that Romanchi fracture zone can be traced across the equatorial Atlantic from an offset of the gulf of guinea continental shelf to east-western branch of the north Brazilian ridge on the American side, he also stated that the Romanchi fracture zone probably originated as a continent-continent transform zone at the time of initial rifting.There are numerous schools of thought on the causes of the seismic activities in Nigeria. Ajakaiye*et al.,* (1986), Ajakaiye*et al.,* (1987), Elueze 2003; Anifowose 2006; the earth tremor activities to earth movement associated with NE-SW trending fractures and zone of weakness extending from Atlantic Ocean into Nigeria. This Atlantic transform fractures zones include the St Paul, Romanche, Charcot and Chain fractures zones originate from the Gulf of Guinea and believed to form part of the Pelusium Megashear system that cuts across the continent of Africa from the West Africa Coast to the Nile basin in NE Africa (Neev and Hall, (1982). The presence of the fractures zones which prominently traverse the Western half of the country has been pointed out by Ajakaiye*et al.,* (1987); Odeyemi (1989) and Elueze (1990) Ofonime (2010) to be responsible for the seismic activities experienced in the areas. Burke (1972) suggested possible relationship between the epicenters of some of the West African earthquakes and continent-ward extensions of oceanic fracture zones. Onuoha (1988) attributed the tremors to partial reactivation of plate boundaries. The major fault systems in Nigeria as reported by Tsahla*et al.,* (2015) are the Ifewura-Zungeru, Yola-Dambata, Akka-Jushi, Warri-Ijebu Remo and theRomanche fault system.

Adepelumi*et al.*(2008) is the longest linear feature within the precambrian Basement Complex of Nigeria is about 250 km trending NE-SW mega structure. (Olujide, 1989), It stretches from East of Ijebu –ode in the South through Ifewara, Iwaraja, Okumesi to the Basin of River Niger, South of Lafiagi to Zungeru and beyond Kalangai in North – Western Nigeria . Anifowose*et al.*,2006 ,Ajakaiye 1987 reported that the many NW-SE trending faults along the Ijebu –ode -Ibadan – Oyo Axis could be where earthquakes originated and is linked to the Mid- Atlantic transform fractures zones in the Gulf of Guinea

Nwankwoala and Orji., (2018), Adepelum*et al.*,(2008); Ez*eet al.,* (2011) & Yusuf, (2016) proposed that tremors activities have most likely been caused by regional stress and zones of weakness in the crust or transfer of stress from plate boundaries since Nigerian Basement Complex rocks occur between the West African Craton, and Congo Craton. Murat (1988) inferred a principal stress acting WNW-ESE in the

basement rocks and they accredited this stress to major causes of tremor,these are in agreement with the regional stress models of Sykes, (1978) Iio and Kobayashi, (2002); Johnston and Kanter, (1990) and Zoback, (1992). Nwankwoala and Orji., (2018), Adepelumi*et al.,* (2008); Eze*et al.,* (2011)& Yusuf, (2016) also proposed the theory of zone of weakness stating that when a magmatic intrusion is present in stable rock the difference in geophysical properties can cause localized stress concentrations particularly when the intrusion is weaker than the surrounding rockshence leading to release 0f seismic energy.

Nwankwoala and Orji., (2018) also talked about the theory of stress transfer from plate boundaries, this is in agreement with Tsalha (2015) and Eze*et al.,* (2011) who argues that stresses that builds up around plate boundaries could travel towards the center of the plates triggering intraplate tremors especially in pre-existing faults. The zone of weakness model proposed by Sykes (1978) stated that intraplate seismicity occurs where the crust has been weakened by previous tectonic activity. The Abakaliki and Benue Troughs are regarded as examples of failed rift arms following the opening of the South Atlantic (Obaje, 2019; Nwajide, 2013) over geologic time, these zones were incorporated into mid-plate structure and became subject to tectonic compressive stresses (Short and Stauble, 1967).More localized study of the tremor areas around Mpape by Nigerian Geological Survey and Centre for Geodesy and Geodynamics attributed recent tremor activities to have resulted from possible human activities such as mining (blasting processes) and borehole water withdrawal and resettling of geologic formations. Goki *et al.,* (2020) who studies the activities within Kwoi agrees the theory of tectonic origin as all the epicenters plottedalong an extrapolated trend coincides with the Chain Fracture Zone of the Gulf of Guinea. The earliest tremor cases in Nigeria includes the Ijebu – Ode Earthquake, 1984 (Ajakaiye *et al.*1987 and Onouha, 1989), The Kombani Yaya Earthquake, 1985 (Ugodulunwa *etal.,* 1986 and Aje*et al.,* 1988) with intensity of V on the Modified Mercalli intensity scale and Ibadan Earthquake, 1990 & 2000 (Ananaba1991; Ojo, 1995 &Osagie, 2008) with epicenter at Ijebu-Ode. Recent tremor activities are at Kaduna (Kwoi) 2016 and Abuja (Mpape) 2018 and 2024.

CONCLUSION

Northern Nigeria is gradually transiting into active zone for earth tremor activities as against the earlier belief aboutthe region being aseismic. The review highlighted on the NE-SW trending fracture extending from the gulf of Guinea (GOG) south Atlantic ocean into Nigeria. The active Ifewara-Zungeru fault act as conduit intercepting all major regional fault line, it clearly associate with most epicenters of earth tremors in the zone. The frequency of seismic occurrences in the region over the years are clear indication of future earthquake in northern Nigeria.

REFERENCES

Ajakaiye D.E., Hall D.H. and Miller T. (1984). Interpretation of Aeromagnetic Data across the Central Crystalline Shield of Nigeria, in press.*Geophysical Journal*.

Ajakaiye DE Damiyan MA Ojo SB Onuoha KM 1987.The july 28 1984, southwestern Nigerian earthquake and its implication for the understanding of the tectonic structure of Nigeria .Journals of Geodynamics, 7,205:214.

Akpan, O.U. and Yakubu, T.A, (2010). A Review of Earthquake occurrences and observations in Nigeria Earthquake Sciences, 23, 289 – 294. doi.org/10.1007/s 11589 – 010-0725-7.

Anifowose Y.B., Odeyemi I.B. and Borode A.M. (2006).The Tectonic Significance of the Ifewara- Zungeru Mega -struture in Nigeria. Teme S C and Ezeigbo C U (Eds.), *Proceedings of the 1st International Workshop on Geodesy & Geodynamics* ,Centre of Geodesy & Geodynamics, Toro, Nigeria, pp. 17-28.

Burke K.C and Dewey J.F (1972) Orogeny in Africa. In: Dessauvagie TFJ, Whiteman AJ (eds), Africa geology. University of Ibadan Press, Ibadan, pp 583–608

Elueze, A.A, (2003). Elevation of the 7th March 2000 Earth Tremor in Ibadan Area, South-Western Nigerian. Journal of Mining and Geology, 39 79 – 83.

Eze C L, Sunday V N, Ugwu S A, Uko E D and Ngah S A (2011), "Mechanical Model for Nigeria Intraplate Earth Tremors. Articles, Disasters, Management Theme", Earth Observation, Port-Harcourt, IEEE Oceanic Engineering Society

Fitton JG, 1980.The Benue Trough and Cameroon line – A miTgrating Rift system in west Africa. Earthplansci 51, 132 – 138.

Franheteaus and Pinchion 2005; Incidence and importance of Tectonics and natural fluid migration on reservoir evaluation in foreland fold- and trust belts hgc:Oil and gas science and technology – RevIFP Vol.60 No 1 Pp67-105.

Johnston, A. C. and Kanter L. R. (1990). Earthquakes in stable continental crust, Scientific American, 262(3), 68 – 75 .Journals of Geophysical research solid earth volume 126 issue 1.

Kutu JM 2013. Seismic and tectonics correspondence of major earthquake region in southern Ghana with mid Atlantic transform-fractured zone Int, Geosci.1326- 1332.

Mc-curry and Wright JB 1977. Geochemistry of Cal- alkaline volcanics in northwestern Nigeriaand a possible Pan –African suture zone Earth planet. Sci, let 37,90-96.

Murat, (1988). Possible Mechanism for Nigerian Intra-plate Earth Tremor. Advanced in Science and Technology. 6 (2). 80 – 84.

NASRDA, (2018). Report of the Cabinet Committee to investigate the Earth Tremor in Abuja, Pp 4-14.

Neeve, D, Hall, J K,and Saul J M,. The PelusiumMegashear system across Africa and associated lineament swarms . Journal of Geophysical Research, 1982; 87,1015-1030.

Nwajide C.S, (2013). Geology of Nigeria Sedimentary Basin CBSS Bookshop Ltd Lagos, 1-1565.

Odeyemi I.B. (1989). Precambrian Crustal fractures as possible sites of SeismicActivityin Nigeria: Ifewara fault as a case example. AjakaiyeD.E; Ojo S.B; Daniyan M.A and Abatan A.O. Proceedings of the National Seminar on Earthquakes in Nigeria. *National Committee on Earthquake Phenomena*, Lagos, Nigeria.

Olujide P.O and Udoh A.N (1989). Preliminary Comments on the Fracture Systems of Nigeria in the Proceedings of the National Seminar on Earthquakes in Nigeria. Ajakaiye D E, Ojo S B and Daniyan M A (Eds.), pp. 97-109.

Onuoha K. (1989). Historical Perspective of Earthquakes in West Africa. Ajakaiye D.E., Ojo S.B, Daniyan M.A and Abatan A.O (Eds.), *Proceedings of the National Seminar on Earthquakes in Nigeria.Nnational technical committee on Earthquake Phenomena*, Lagos, Nigeria, pp. 129-141.

Ouoha KM 1989. Historical perspective of earthquakes in West Africa. Proceeding of the national seminar on earthquakes in Nigeria.National technical committee on earthquake phenomena, Lagos Nigeria,Pp 129 -141.

Shimaki K 1976. Intra – plate seismicity and intra – plate earthquake. Historical activities in southwestern Japan. Technopysics 33 – 42.

Short and Stauble, (1967). Geologic units of the Niger Delta.

Silva, A., Pires, A., Mccafferty, A., De Moraes , R., & Xia, H. (2003). Application of Airborne Geophysical Data to Mineral Exploration in the Uneven Exposed Terrains of the Rio Das Velhas Greenstone Belt.*Brasileira de Geociências*, *33*, 17-28.Singapore

Sykes, L. R. (1978). Intraplate Seismicity, Reactivation of Pre - existing Zones of Weakness, Alkaline Magmatism, And Other Tectonism Postdating Continental Fragmentation, Reviews of Geophysics and Space Physics, Vol. 16, No. 4, pp. 621-688

Tsalha M.S, Lar U.A., Yakubu T.A., Umar A.K. and Duncan D. (2015).The review of the historical and recent seismic activity in Nigeria. J Appl Geophysics 4:56–76

Turner RH 1971. Study of earthquake effect:Los Angeles and Sylmar ,1971(M174VI) US Department of Defense (1962).The effect on Nuclear Weapons ,Washington DC. Government printing office Pp 14.

Ugoduluwa FO, Ajakaiye DE, Guiraud M and Hossan MT (1986). The Pindiga and Obi fracture – possible earthquake site in Nigeria in: Geophysics and Geophysical Research in Africa. Faculty of Natural Science, University of Jos. Jos, Nigeria, 6.US Geological Survey (1997). National Earthquake information centre.

Yusuf, (2016). Study of Geomagnetic field Anomaly during Earthquakes in Indonesia Geophysical Instrumentation subdivision-Meteorolog https://doi.org/10.13140/RG.2.2.10133.17127.

Zoback, M. L (1992). Stress field constraints on intraplate seismicity in eastern North America, Journal of Geophysical Research 97(11), 761-782.