OnLine Journal of Earth Sciences 1 (3): 136-138, 2007
ISSN: 1991-7708

Variation of Global Seismicity Across the Equator

[1]O.I. Popoola and [2]O.S. Hammed
[1]Department of Physics, University of Ibadan, Ibadan, Nigeria
[2]Department of Physical Sciences, Bells University of Technology, Ota, Nigeria

Abstract: A study of the trend of global seismicity across the equator was carried out in this research. The aim was to see if any notable change in the earthquake occurrence existed from Northern latitudes to the Southern latitudes as is the case with some geophysical phenomena. The region of study consists of a strip of width 10° with the equator as the center. The whole region was subdivided into zones and sub-regions. We discovered that the global Seismicity increased with time in all the regions. And going from North to South, in all the zones and sub-regions, the global Seismicity increased suddenly after crossing the equator. The cause of this global phenomenon which may be responsible for asymmetric shapes of the American and African plates is yet to be understood.

Key words: Seismicity, aseismic, intraplate, subduction, epicenter

INTRODUCTION

Seismicity is the global distribution of earthquake sources. Earthquake sources are not uniformly distributed over the earth surface. They are concentrated along certain regions in between the lithospheric plates across the equator (Stein and Wysession, 2003). The major world seismic zones are the Circum-pacific zone, which produces 75-80% of the annual global earthquakes and the Mediterranean-Tran-Asiatic/Aphid zones, which is responsible for 15-20% global events (Stein and Wysession, 2003). These zones extend from Indonesian through Himalayas to Mediterranean.

The ocean ridges also contribute to a minute proportion of the global events (Kearey and Vine, 1996) especially Mid-Atlantic ridge which cut across the equator. Mid oceanic ridges are centre of ocean floor spreading which is a notable phenomenon that enhances the motion of lithospheric plates across the equator (Tarling and Runcorn, 1976). Deep and intermediate earthquakes which contribute about 2% of the world global activities are concentrated in the circum-pacific zone at the southern part of the equator (Kess and Robert, 1973).

Some parts of the earth like African plates and American plates that are mostly at the southern parts of the equator are considered to be aseismic that is, seismically inactive (Ernst, 1975). Meanwhile, no part of this earth can be said to be free of earthquakes, since there are intraplate earthquakes. About 1% of the global Seismicity is of this type (Fuchs and Soffel, 1985).

MATERIALS AND METHODS

The data used for this study, were extracted from the earthquake catalogue of Advanced National Seismic System (ANSS), a Website of Northern California Earthquake Data Centre U.S.A. on April 2006 at the University of Ibadan Library Information Unit. The region of study which consists of a strip of width 10° around the world with the equator as the center was located from global seismicity map. This region covers 5° above the equator and 5° below the equator.

The data were obtained for the magnitude 5.0- 8.0 for earthquakes that occurred in the zones: latitude +0.9° to +5°, latitude -0.9° to +0.9° and latitude -5° to -0.9° for the period of 1970-2004. There were 7,178 earthquakes in all. Each datum comprised date of occurrence of earthquake, Origin time, coordinates of epicenter, magnitude, event identification and focal depth of earthquake.

The whole region was subdivided into three zones: latitude +0.9° to +5°, latitude -0.9° to +0.9° and latitude -5° to -0.9° (Table 1). Each of these zones was divided into 13 regions. The regions under latitude 0.9° to +5° are longitude -37° to -30° (Mid Atlantic ridge), longitude 124° to 133.5° (circum pacific belt zone), longitude -102° to -97.5° (circum pacific belt) longitude 124° to 133.5° (circum pacific belt zone) longitude +96° to +98° (subduction zone) and longitude +65 to +70.5° (Mid-Indian ridge). The regions under latitude -0.9° to +0.9° are longitude -24° to -30° (Mid -Atlantic ridge), longitude -100° to -97.5° (circum pacific zone), longitude 121.5° to 137.5° (circum pacific belt zone), longitude 98° to 102° (subduction zone) and

Corresponding Author: O.S. Hammed, Department of Physical Sciences, Bells University of Technology, Ota, Nigeria

Table 1: Number-magnitude distribution of events in zones

	Zones		
Magnitude	-5° to -0.9°	-0.9°-to +0.9°	0.9° to +5°
5.0-5.9	3,490	1028	2,200
6.0-6.9	237	78	96
7.0-7.9	32	5	9
8.0-8.9	2	1	-

Table 2: Focal depth distribution of events in northern part of the equator

Magnitude	Shallow depth 0-70 km	Intermediate depth 70-300 km	Deep depth 300 -700 km
5.0-5.9	1017	461	-
6.0-6.9	44	16	-
7.0-7.9	5	-	-
8.0-8.9	-	-	-

Latitude +0.9° to +5°

Table 3: Focal depth distribution of events in mid-part of the equator

Magnitude	Shallow depth 0-70 km	Intermediate depth 70-300 km	Deep depth 300 -700 km
5.0-5.9	492	323	-
6.0-6.9	34	9	-
7.0-7.9	2	-	-
8.0-8.9	-	-	-

Latitude-0.9° to +0.9°

Table 4: Focal depth distribution of events in southern part of the equator

Magnitude	Shallow depth 0-70 km	Intermediate depth 70-300 km	Deep depth 300 -700 km
5.0-5.9	1,380	684	27
6.0-6.9	149	8	-
7.0-7.9	16	-	-
8.0-8.9	2	-	-

Latitude -0.5° to -0.9°

longitude 66.5°-70.5° (Mediterranean/Trans-Asiatic zone). The regions under latitude -5° to -0.9° are: longitude -26° to -11° (Mid-Atlantic ridge), longitude -105.5° to -100° (circum pacific belt zone) and longitude 102° to 109° (subduction zone).

The following features of the events were considered: magnitude distribution, focal depth distribution and frequency distribution. The possibility of earthquake migration along the Mid-Atlantic ridge portion of the region of study was also investigated.

Number-magnitude distribution of events: The distribution of magnitudes with the number of events in the zones was shown in Table 1.

Classification of events according to their focal depths: In each region the earthquakes were categorized according to their focal depths using the following ranges:

- Shallow earthquakes; occurring at 0 - 70 km depth
- Intermediate earthquakes; occurring at 70 -300 km
- Deep earthquakes; occurring at 300-700; (Table 2-4).

Table 5: Frequency distribution of events in zone A (Northern part of the equator

	Year: 1970 -1980			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquake	501	10	2	0
	Year: 1981-2001			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquakes	1025	46	2	0
	Year: 1970-2000			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquake	1526	56	4	0

Latitude: + 0.9° to + 5°

Table 6: Frequency distribution of events in zone B (Mid-part of the equator)

	Year: 1970 -1980			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquake	254	11	1	0
	year: 1981 -2001			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquake	505	25	1	1
	Year: 1970 -2000			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquake	759	36	2	1

Latitude: -0.9° to +0.9°

Table 7: Frequency distribution of events in zone C (Southern part of the equator)

	Year: 1970 -1980			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquake	655	46	5	1
	Year: 1981 -2001			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquake	1077	84	10	1
	Year: 1970 -2000			
Magnitude	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9
No of earthquake	1735	120	15	2

Latitude:-5° to -0.9°

Classification of events according to their frequencies: The earthquakes were classified according to their frequencies in order to investigate the variation in the seismicity in the regions of study. The time intervals of 10 years (1970-1980), 20 years (1981-2001) and 30 years (1970-2000) were used. The number of events was recorded in each of the regions and zones (Table 5-7).

RESULTS AND DISCUSSION

The frequency distribution of earthquakes that occurred between the time intervals of 30 years is more than that of 20 years and 10 years in each zone (Table 5-7). This shows that the relative motion between the lithospheric plates is increasing with time which leads to the large accumulation of tectonic stress. Thus, this large tectonic stress accumulation, leads to the more seismic events with time. The rate of increase in seismicity at the Southern part of the equator is higher than that of the Northern part of the equator Table 1, 5-7. This shows that there is a notable variation of seismicity across the equator.

The rapid increase in seismicity at the lower part of the equator signifies that the other phenomena that are associated with seismicity such as rate of divergence and convergence of lithospheric plates are higher in the Southern part of the equator. Current information on motions at plate boundaries from United States Geological Services, Reuters, Encarta Encyclopedia confirms these phenomena. We are yet to understand the cause of this notable global phenomenon across the equator which may be responsible for the asymmetric shapes of African and American plates.

Shallow earthquakes with lower magnitudes were found to be more than intermediate and deep earthquakes in all the zones. Two thousand seven hundred and forty eight out of the total events were shallow earthquakes. This is in line with Gutenberg and Richter earthquakes Frequency-Magnitude relations.

The spatial distribution of earthquakes in the Mid-Atlantic ridge in the Northern part of the equator increased with time implying more intraplate activity and there was no notable migration of earthquakes along the ridge. There was no noticeable increase in spatial distribution in the Southern part of the ridge because the epicenters of earthquakes in this region were clustered along the ridge.

CONCLUSION

The global seismicity across the equator had been investigated by using earthquake data of the regions of study. The following conclusions are deduced based on the results obtained:

- The global seismicity increased with time in all the regions. This implies that the lithospheric layer is becoming more unstable and tectonic stress accumulation is increasing;
- The rate of increase in seismicity at the southern part of the equator is higher than that of the northern part of the equator. This implies that the other phenomena that are associated with seismicity such as rate of divergence and convergence of lithospheric plates are higher in the southern part of the equator. Current information on motions at plate boundaries from united states geological services, reuters, encarta encyclopedia confirms these phenomena. We do not understand the cause of this notable global phenomenon across the equator.
- The deep earthquakes are observed only at the southern part of the equator i.e. the region of latitude -5° to -0.9° .
- The shallow earthquakes are more prominent than intermediate and deep earthquakes in all the zones.
- The spatial distribution of earthquakes in the northern part of the ridge increased with time. This implies that more intraplate activity occurred in this region and there was no notable migration of earthquake. There was no noticeable increase in spatial distribution in the southern part of the ridge because epicenters of earthquakes in this region were clustered along the ridge.

REFERENCES

Ernst, W.G., 1975. Metamorphism and global plate tectonics Regimes; Published by Dowden Hutchinson and Ross Incorporation and Stroudsburg Pennyslvania, 1: 517-523.

Fuchs, K. and H. Soffel, 1985. Geophysics of the solid Earth, the moon and the planets, Published by Landolt-Bernstein, Springer-Verlag, Berlin, 2: 218.

Kearey, P. and F.J. Vine, 1996. Global tectonics, Blackwell Science Publishing Limited. (2nd Edn.), pp: 204-211.

Kess, A.D. and S. Robert, 1973. Gravity and Tectonics published by John Willey and sons, New York. London. Sydney Toronto (3rd Edn.), pp: 503-509.

Stein, S. and M. Wysession, 2003. An introduction to seismology, earthquakes and earth structure Published by Black well Publishing Limited. (1st Edn.), pp: 205-211.

Tarling, D.H. and S.K. Runcorn, 1973. Implications of continental Drift to the earth sciences (2nd Edn.), Published by Academic Press; London and New York, pp: 572-576.