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ΣΕΙΣΜΟΛΟΓΙΑ. — **Difference in the Interoccurrence Time of the Major Interplate and Intraplate Earthquakes in the Most Seismically Active Source Zones of Ionian and Aegean Region,** by *A. G. Galanopoulos**

ABSTRACT

The present paper aims to address the importance of knowing the distribution of actual repeat times for a really reliable estimation of probability of occurrence of a certain earthquake magnitude or magnitude range for a given time elapsed since the last event of the same class.

It is interesting that two samples from square sources of equal size but of quite different tectonic settings show the same type of distribution of earthquake occurrences in terms of actual interevent times. It must be added that while the first sample covers two cycles of earthquake occurrences of maximum credible magnitude ever observed in historical times, the second sample does not include any earthquake occurrence of maximum magnitude observed over the instrumental period of Greece. It is amazing that the frequency-actual repeat time relation, expressed as unit time the mean recurrence time for a given magnitude range, is for both samples very similar to that generally observed for aftershock sequences.

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It might be added that the earthquakes of magnitude 7.5 or larger observed all over the world follow exactly the same negative power law.

## INTRODUCTION

The magnitude distribution of earthquake occurrences is generally observed to follow for every region, small or large, the Gutenberg-Richter relationship (1944):

$$\text{Log}\ (N_c) = a\text{-}bM$$

where $N_c$ is the number of events greater than or equal to magnitude M and a and b constants. Applied for a given source zone over a certain time period, the number of earthquakes in a given magnitude range is obtained, yielding a characteristic recurrence time for that magnitude based on the assumption that the process is stochastic, i.e. that the occurrence rate is not a function of time.

The constant a provides a measure of the overall occurrence rate of earthquakes in the zone considered and is the zero magnitude intercept on a semilog plot; therefore it is considered the activity parameter. The slope b, or b value, is controlled by the distribution of events between the higher - and lower - magnitude ranges. Both constants influence derived recurrence times.

The magnitude of the "once-per year" earthquake, $M_o$, derived from the ratio of the two constants, a/b, is the annual maximum magnitude that has a probability of 63% of being exceeded in one year. The annual maximum magnitude for the instrumental period is a reliable and suitable measure of local and regional seismicity (Galanopoulos, 1972; 1979; 1981) and can be used for comparative studies of the earthquake activity of various regions provided this is referred to the same unit area (Comninakis, 1975). The influence of the length of the observing period on the ratio of the constants of the magnitude-recurrence relation does not exceed the limits of error of earthquake magnitude determination (Galanopoulos, 1971).

For estimating the recurrence intervals of high-magnitude infrequent earthquakes the least squares technique is considered more suitable (Johnston and Nava, 1985). The average return period or recurrence interval for a given magnitude range as derived from a cumulative frequency-magnitude relation for a certain region does not in and of itself supply sufficient information to determine probability of occurrence. It is also necessary to know the frequency distribution of actual recurrence intervals for a given magnitude or magnitude range. That is, for a time span much greater than the average return period, what is the actual frequency of earthquake occurences in terms of recurrence intervals having as unit time the average return period?

The number of earthquakes for a given magnitude range as a function of observed interoccurrence times, i.e. the distribution function of earthquake occurrences in terms of actual interevent times is shown to follow a negative exponential distribution, Log $N(t) = k\ (t+c)^{-p}$, quite similar to that generally observed for the aftershock sequences (Utsu, 1961). Given the average return period, the type of distribution of earthquake occurrences in terms of actual interevent times, the standard deviation of the observations, and the time of occurrence of the last event, either cumulative probability (the probability that an earthquake would already have happened) or future probability (conditional) may be ascertained (Johnston and Nava, 1985).

## DATA AND METHOD USED

The actual interevent times and magnitude data used for this study have been compiled from the revised lists of strong shocks with $M_s \geq 5\ 1/2$ occurred in and around the Aegean microplate (Galanopoulos, 1977; 1985). Since the published lists are not complete to the same extent over the instrumental period 1911-1983, the compilation has been limited to the time interval 1951-1983 that starts with the monitoring of the earthquake activity in Greece under my own guidance. The data for the 1983 have been taken from the unpublished continuation of the above lists.

As source zones were chosen two square sources of equal size in the seismically most active centres of the Ionian and Aegean region (Galanopoulos, 1973; 1981). The Cephalonia - Zante centre (37°N39°, 20°E22°) covers the western segment of the Hellenic arc. The other, the Rhodes-Cos centre (35°N37°, 26°E28°), in the southeastern segment of the back-arc area, harbours the majority of the intermediate depth foci observed in the area of Greece. The two centres of higher earthquake activity in the area considered differ completely in the tectonic setting and probably in the origin of the stress field. The first centre is a source of interplate earthquakes, while the second generates mostly intraplate shocks.

Over the time interval of 33 years (1951-1983) the number of earthquakes with $M_s \geq 5\ 1/2$ occurred in the first square source (37°N39°, 20°E22°) amounts to 175; the shocks with $M_s \geq 6$, $M_s \geq 6\ 1/2$· and $M_s \geq 7$ are respectively 63, 15 and 3. Given that earthquakes occurred in historical times in the above area never reached a $M_s \geq 7\ 1/2$, the time span of 33 years seems to cover two credible cycles of higher earthquake activity.

Assuming now that the majority of interdependent events (foreshocks and aftershocks) have interoccurrence times 0-1 days, to get a sampling of almost independent events we must remove all the shocks falling in the above category. The resulting sample (s. Table Ia) consists of 114 shocks with $M_s \geq 5\ 1/2$, 45 with $M_s \geq 6$, 14 with $M_s \geq 6\ 1/2$ and 3 with $M_s \geq 7$.

Data corresponding to the second square source (35°N37°, 26°E28°) are given in a similar way in Table $I_b$. The shocks with $M_s \geq 6\ 1/2$ cover at least two cycles of seismic activity of that level, but the sample period is too much smaller than the return period for a $M_s$ 8.2 earthquake occurred (36.5° N, 27.5° E; h=100 km) in 1926, June 26 (Meyer et al., 1984/85). From the regression equation: Log $N_3$ = 7.588-1.301 $M_s$ holding for the resulting sample of roughly independent events, $N_3$, the average return period for a $M_s$ 8.2 earthquake is about 1200 years.

TABLE Ia

Cumulative Frequency of Earthquakes in Magnitude Increments $\Delta M$=0.5. Source Region: 37°N39°, 20°E22°. Sample Period: 1951-1983

| Magnitude / Frequency | $M_s \geq 5\ 1/2$ | $M_s \geq 6$ | $M_s \geq 6\ 1/2$ | $M_s \geq 7$ |
|---|---|---|---|---|
| $N_1$ | 175 | 63 | 15 | 3 |
| $N_2$ | 61 | 18 | 1 | 0 |
| $N_3$ | 114 | 45 | 14 | 3 |

TABLE Ib

Cumulative Frequency of Earthquakes in Magnitude Increments $\Delta M$=0.5. Source Region: 35°N37°, 26°E28°. Sample Period: 1951-1983

| Magnitude / Frequency | $M_s \geq 5\ 1/2$ | $M_s \geq 6$ | $M_s \geq 6\ 1/2$ |
|---|---|---|---|
| $N_1$ | 89 | 26 | 4 |
| $N_2$ | 9 | 1 | 0 |
| $N_3$ | 80 | 25 | 4 |

$N_1$ Number of earthquakes over the sample period 1951-1983

$N_2$ Number of earthquakes with interoccurence time 0-1 days

$N_3$ Number of earthquakes after the removal of the $N_2$ events.

In the following Tables IIa and IIb we give the average and maximum interevent time (days) for the $N_3$ events: Observed ($T_{ia}$, $T_{im}$) and derived ($T'_{ia}$, $T'_{im}$) from the related frequency-magnitude equations based on least squares regression.

TABLE IIa

Average and maximum intervent time (days) of the $N_3$ events of Table Ia: Observed ($T_{ia}$, $T_{im}$) and derived ($T'_{ia}$, $T'_{im}$) from the cumulative recurrence equation: Log $N_3$ = 6.373 - 1.049 $M_s$; S.D. = ± 0.076

| Magnitude / Interoccurrence T | $M_s \geq 5\ 1/2$ | $M_s \geq 6$ | $M_s \geq 6\ 1/2$ | $M_s \geq 7$ |
|---|---|---|---|---|
| $T_{ia}$ | 106 | 268 | 860 | 4015 |
| $T_{im}$ | 776 | 1343 | 3077 | 8458 |
| $T'_{ia}$ | 91 | 304 | 1018 | 3625 |
| $T'_{im}$ | 108 | 362 | 1213 | 4058 |

TABLE IIb

Average and maximum interevent time (days) of the $N_3$ events of Table Ib: Observed ($T_{ia}$, $T_{im}$) and derived ($T'_{ia}$, $T'_{im}$) from the cumulative recurrence equation: Log $N_3$ = 7.588-1.301$M_s$; S.D. = ± 0.084

| Magnitude / Interoccurrence T | $M_s \geq 5\ 1/2$ | $M_s \geq 6$ | $M_s \geq 6.5$ |
|---|---|---|---|
| $T_{ia}$ | 151 | 482 | 3011 |
| $T_{im}$ | 811 | 1397 | 1707 |
| $T'_{ia}$ | 135 | 603 | 2696 |
| $T'_{im}$ | 164 | 732 | 3272 |

Both Tables IIa and IIb show inexpectedly a large discrepancy between the observed and computed values for the average and particularly for the maximum interevent times. This seems to make the usefulness of the computed values for a long-term prediction of any earthquake magnitude range very questionable. For $2\sigma$ (= S.D.), i.e. for the 95 per cent confidence interval, the maximum return periods for any magnitude range derived from the cumulative frequency-magnitude equations for the first and second sample are, respectively, 1.42 and 1.47 times longer than the corresponding average recurrence intervals. The actual maximum interevent times for the first and second sample are, respectively, 2.11-7.32 and 0.57-5.37 longer than the related average return periods. This means that the difference between the computed and observed values can not be removed with the use of 2 standard deviations.

The observed average interevent times, $T_{ia}$, for the two samples (s. Tables IIa and IIb) fit, respectively, to

$$\text{Log } (T_{ia}) = 1.048\ M_s - 6.366, \qquad \text{S.D.} = \pm\ 0.078$$

and $$\text{Log } (T_{ia}) = 1.3\ M_s - 7.581, \qquad \text{S.D.} = \pm\ 0.084$$

These equations are equivalent to the relative standard cumulative recurrence equations:

$$\text{Log } (N_3) = 6.373\ M_s - 1.049, \qquad \text{S.D.} = \pm\ 0.076$$

and $$\text{Log } (N_3) = 7.588\ M_s - 1.301, \qquad \text{S.D.} = \pm\ 0.084$$

The recurrence intervals computed by the Gutenberg-Richter relation generally used for a long-term prediction are not explicit and realistic for any magnitude range.

The large difference between the computed and actual repeat times has led us to address the type of the frequency-interevent time relation. Tables IIIa and IIIb show the distribution of actual repeat times of earthquake occurrences for the first and second sample expressed as unit time the average interoccurrence time for the $N_3$ events of the related magnitude range (s. Table IIa and IIb).

A frequency-actual repeat time semilog plot of the sample data sets for both square sources appears to follow a negative exponential distribution; Log N (t) = k $(t+c)^{-p}$, very similar to that generally observed for the aftershock sequences (Utsu, 1961).

For the first two magnitude ranges of the first sample the corresponding formulae are: Log N = 3.78 $(t+1)^{-1.1}$ and Log N = 2.92 $(t+1)^{-1.1}$ with S.D. = ± 0.27 and ± 0.44, respectively (s. Fig. 1). For the magnitude range $M_s \geq 6$ 1/2 the corresponding formula is: Log N = 1.91 $(t+1)^{-1.1}$ with S.D. = ± 0.38.

For the first two magnitude ranges of the second sample the corresponding formulae are: Log N = 3.46 $(t+1)^{-1.2}$ and Log N = 2.41 $(t+1)^{-1.2}$ with S.D. = ± 0.35 and ± 0.12, respectively (s. Fig. 2). It is worth noting the relatively small standard deviation (± 0.12) of the earthquake occurrences for the magnitude range $M_s \geq 6$. The strong

TABLE IIIa

Distribution of earthquake occurrences per actual repeat time for the first sample expressed as unit time the average interoccurrence time for the $N_3$ events of the related magnitude range (s. Table IIa).

| Repeat T / $M_s$ - Range | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| $M_s \geq 5$ 1/2 | 78 | 18 | 9 | 2 | 4 | — | — | 2 | 113 |
| $M_s \geq 6$ | 29 | 11 | 1 | 1 | 1 | 1 | — | — | 44 |
| $M_s \geq 6$ 1/2 | 9 | — | 3 | 1 | — | — | — | — | 13 |
| $M_s \geq 7$ | 1 | — | 1 | — | — | — | — | — | 2 |

TABLE IIIb

Distribution of earthquake occurrences per actual repeat time for the second sample expressed as unit time the average interoccurrence time for the $N_3$ events of the related magnitude range (s. Table IIb)

| Repeat T / $M_s$ - Range | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| $M_s \geq 5$ 1/2 | 54 | 10 | 11 | 1 | 1 | 2 | — | — | 79 |
| $M_s \geq 6$ | 16 | 5 | 3 | — | — | — | — | — | 24 |
| $M_s \geq 6$ 1/2 | 3 | — | — | — | — | — | — | — | 3 |

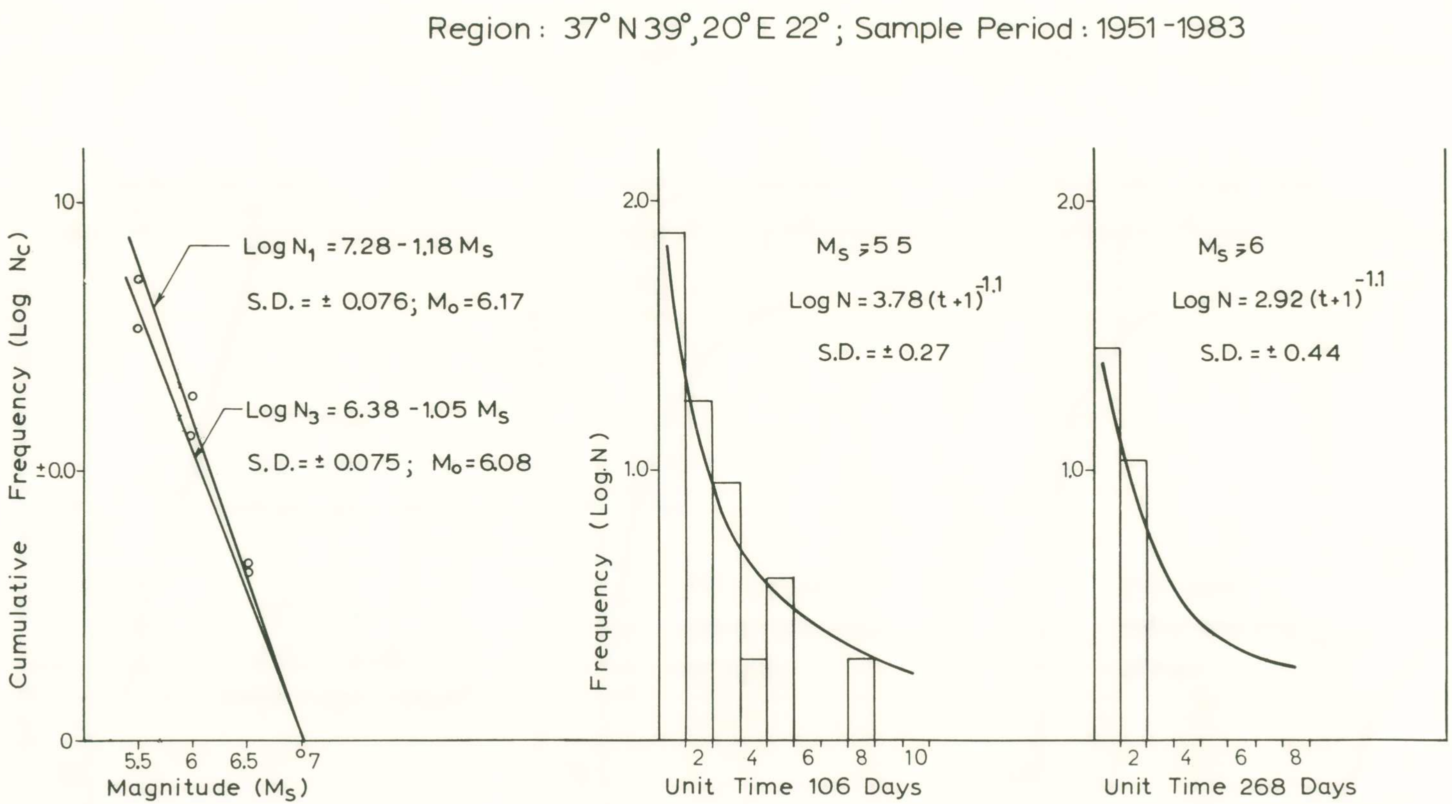


Fig. 1. Frequency-magnitude and frequency-actual repeat time semilog plots of the sample data sets for the Ionian sample. Note that the rate parameter, a, and the distribution parameter, b, were recomputed in the text.

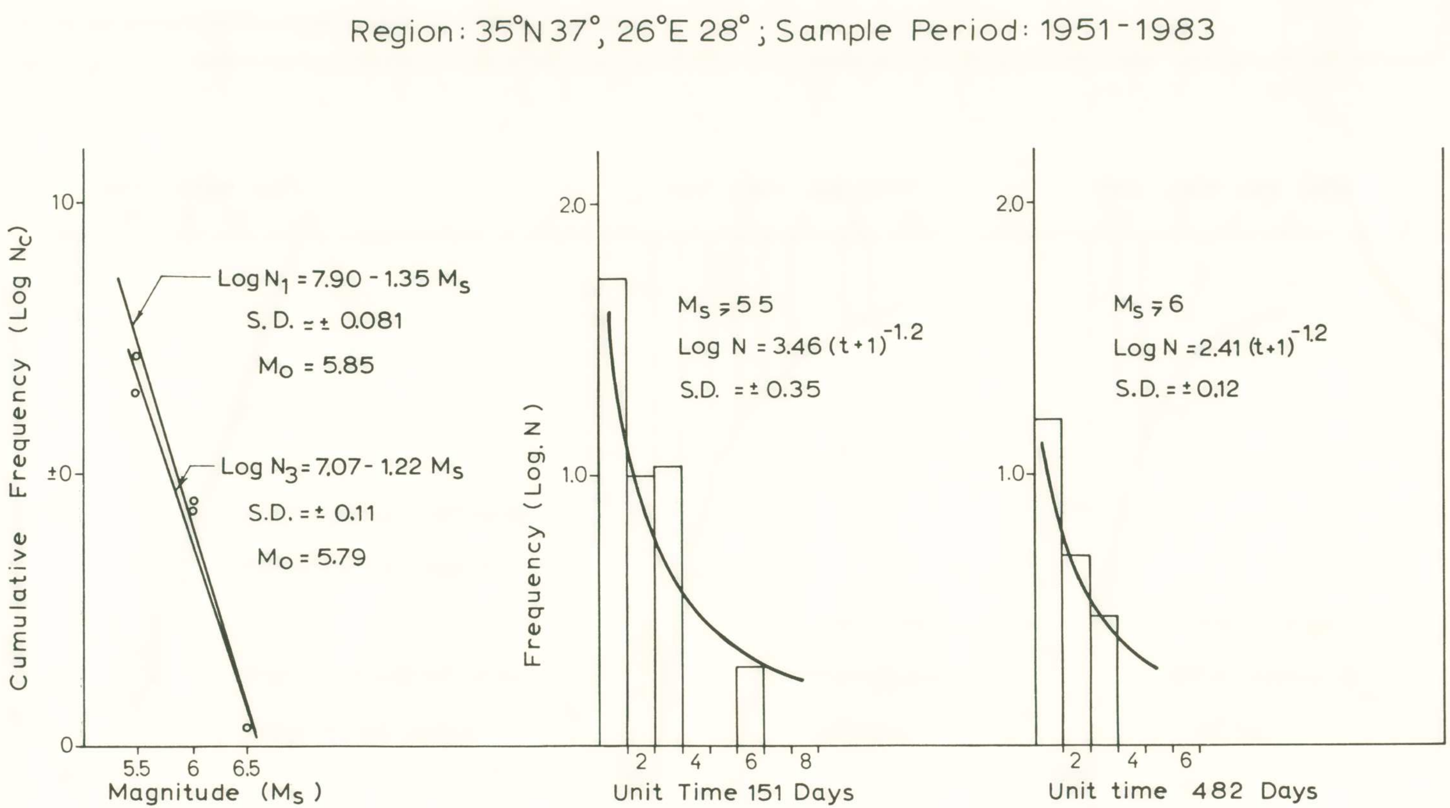


Fig. 2. Frequency-magnitude and frequency-actual repeat time semilog plots of the sample data sets for the Aegean sample. Note that the rate parameter, a, and the distribution parameter, b, were recomputed in the text.

earthquakes occurring in the second square source, mostly of intermediate focal depth, are in general associated with very few foreshocks, if any, and aftershocks of very small size (3-4 magnitude units smaller than the principal shock). Thus for the magnitude range $M_s \geq 6$ the earthquake listing for the second source is completely free of foreshocks and aftershocks. It is then obvious that foreshocks and aftershocks still smear all the other samples, $N_3$, that result by rejecting merely the events with interoccurrence time 0-1 days.

However, the data in Tables IIIa and IIIb fit much better to the cumulative frequency of earthquake occurrences versus actual repeat times.

For $M_s \geq 5$ 1/2 the values of the two samples correspond, respectively, to

$\text{Log}\ (N_c) = 2.070\text{-}0.254t$, S.D. = $\pm$ 0.17

and $\text{Log}\ (N_c) = 2.107\text{-}0.324t$, S.D. = $\pm$ 0.13

or, alternatively, to

$\text{Log}\ (N_c) = 4.1\ (t+1)^{-1}$, S.D. = $\pm$ 0.18

and $\text{Log}\ (N_c) = 3.8\ (t+1)^{-1}$, S.D. = $\pm$ 0.19

For $M_s \geq 6$ the values of the two samples fit much more closely to

$\text{Log}\ (N_c) = 1.793\text{-}0.313t$, S.D. = $\pm$ 0.146

and $\text{Log}\ (N_c) = 1.822\text{-}0.4515t$, S.D. = $\pm$ 0.013

It is worth noting the almost perfect fitting of the sample from the second source (S.D. = $\pm$ 0.013).

## DISCUSSION AND CONCLUSION

It is apparently important to know the distribution pattern of actual repeat times of earthquake occurrences for a given magnitude or magnitude range. Table IV shows that for both samples 68-69% of the earthquake occurrences with $M_s \geq 5$ 1/2 have interoccurrence times equal to or smaller than the average return period. The rest of the events of the same magnitude range have actual repeat times 2-8 times longer than the mean recurrence interval. This information can not be revealed by the frequency-magnitude relation Gutenberg-Richter. Table IV puts forward strikingly indeed the importance of knowing the distribution of actual interevent times. The frequency-actual repeat time relation carries information about seismic cycles or classes of actual repeat times appropriate for a really reliable estimation of probability of occurrence of a certain earthquake magnitude or magnitude range for a given time elapsed since the last event of the same class.

TABLE IV

Distribution of percentage of earthquake occurrences in terms of actual interoccurrence times for the first two magnitude ranges in samples A and B

| Repeat T / $M_s$ - Range | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample A | $M_s \geq 5\ 1/2$ | 69 | 16 | 8 | 2 | 3 | — | — | 2 | 100 |
| | $M_s \geq 6$ | 66 | 25 | 2 | 2 | 2 | 2 | — | — | 99 |
| Sample B | $M_s \geq 5\ 1/2$ | 68 | 13 | 14 | 1 | 1 | 3 | — | — | 100 |
| | $M_s \geq 6$ | 67 | 21 | 12 | — | — | — | — | — | 100 |

It is indeed interesting that two samples from square sources of equal size but of quite different tectonic settings show the same type of distribution of earthquake occurrences in terms of actual interevent time. It must be added that while the first sample covers two cycles of earthquake occurrences of maximum credible magnitude ever observed during the historical times, the second sample does not include any earthquake occurrence of maximum magnitude observed over the instrumental period of Greece. It is amazing that the frequency-actual repeat time relation, expressed as unit time the proper mean recurrence time, is for both samples very similar to that generally observed for aftershock sequences.

Finally, it might be of some meaning that while the actual average return period of earthquake occurrences is 1.4 (= 151:106) and 1.8 (= 482:268) times longer for the first two magnitude ranges for the second square source (s. Tables IIa and IIb), the related maximum interevent times (811:776 and 1397:1343) are of the same order of magnitude (for both magnitude ranges 1.04 times longer for the second sample).

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## APPENDIX

Anxious to see if the frequency-actual repeat time relation, Log N (t) = k $(t+c)^{-p}$, holds for every region, we tried the same methodology on the complete sample of earthquakes of magnitude 7.5 or larger observed all over the world since 1897. The data were taken from Table 3 published in KGRD No. 21, Summary of Earthquake Data Base, National Geophysical Data Center, Boulder, Colorado, October 1985.

Of the 45 earthquakes with interoccurrence time 0-1 days only 27 have the same

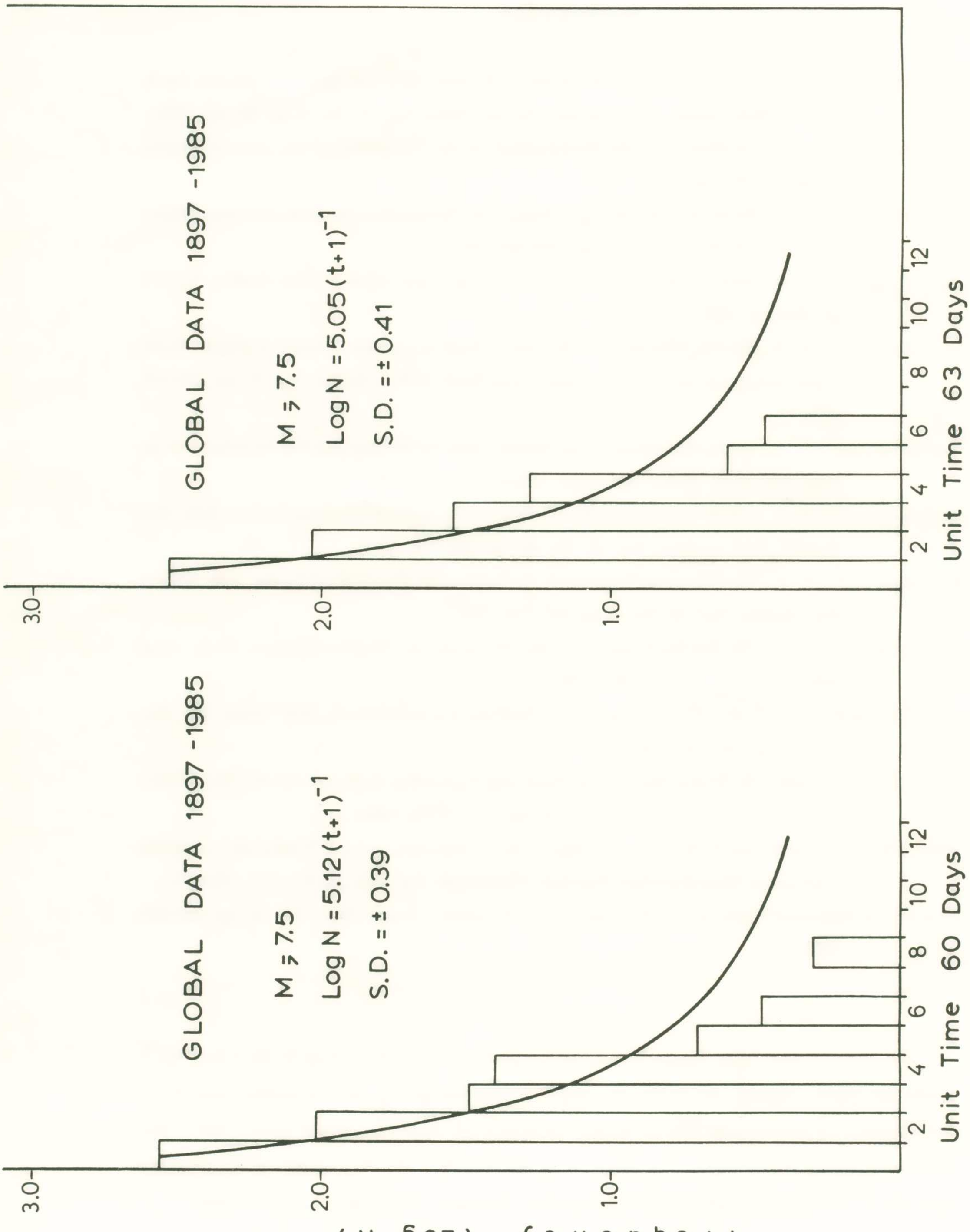


Fig. 3. Frequency-actual repeat time semilog plots of the complete sample of earthquakes of magnitude 7.5 or larger observed all over the world since 1897.

source volume with the next occurrence. The same happens for 3 other earthquakes in 1897 (10:18 and 10:20), 1973 (06:17 and 06:24) and 1980 (07:08 and 07:17).

The distribution of earthquake occurrences per actual repeat time is given in Table V and Fig. 3. The 3 earthquake data sets follow the same negative power law. The corresponding formulae are: $\text{Log } N = 5.12\ (t+1)^{-1}$, $\text{Log } N = 5.05\ (t+1)^{-1}$ and $\text{Log } N = 5.03\ (t+1)^{-1}$ with S.D. = $\pm 0.39$, $\pm 0.41$ and $\pm 0.42$, respectively. Or for $t<9$, $\text{Log } (N_c) = 5.564\ (t+1)^{-1}$, $\text{Log } (N_c) = 5.414\ (t+1)^{-1}$ and $\text{Log } (N_c) = 5.39\ (t+1)^{-1}$ with S.D. = $\pm 0.31$, $\pm 0.31$ and $\pm 0.30$, respectively.

TABLE V

Distribution of earthquake occurrences all over the world of magnitude 7.5 or larger per actual repeat time; Unit time the average repeat time. Sample period: 32219 days

| Number of Events | Average Rep. Time | Actual Repeat Times | | | | | | | | | | | | Total Percentage |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | |
| 540* | 60 | 361 | 104 | 39 | 25 | 5 | 3 | 0 | 2 | 0 | 0 | 0 | 1 | |
| | | 67 | 19 | 7 | 5 | 1 | | | | | | | | 99 |
| 510** | 63 | 336 | 110 | 35 | 19 | 4 | 3 | 1 | 1 | 0 | 0 | 0 | 1 | |
| | | 66 | 21 | 7 | 4 | 1 | | | | | | | | 99 |
| 495*** | 65 | 327 | 109 | 33 | 17 | 4 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | |
| | | 66 | 22 | 7 | 3 | 1 | | | | | | | | 99 |

* Total number of earthquakes, minus the first, over the time period 1897-1985 (April 19).

** Number of earthquakes after the removal of 30 interdependent events.

*** Number of earthquakes after the removal of 45 events with interoccurrence time 0-1 days, regardless of interdependence.

It we disregard the values N = 1, the data in Table V fit much better to the cumulative frequency of earthquake occurrences versus actual repeat times.

For the first data set (N = 540*) and $t \leq 8$,

$\text{Log } (N_c) = 2.986 - 0.367\ t$, S.D. = $\pm 0.13$.

For the second data set (N = 510**) and $t \leq 6$,

$\text{Log } (N_c) = 3.142 - 0.448\ t$, S.D. = $\pm 0.04$.

It is worth noting that for the third data set (N = 495***) even for $t \leq 8$, i.e. for all values but one, the accurracy is still great.

$$Log (N_c) = 2.971\text{-}0.386\ t, \qquad S.D. = \pm\ 0.086$$

The distribution of intervals between events in a Poisson process, being a special case of the random - interval model, is described by the exponential distribution. For a Poisson process, intervals between successive events are independent; there is no tendency for an interval appreciably shorter than the mean to be followed immediately by an interval longer than the mean.

The probability of an event occurring in a unit of time is constant without regard to the time of occurrence of previous events. The probability that the interevent interval exceeds t is exp (- t/m) where m is the average interevent interval.

The standard deviation of the individual intervals in the exponential distribution is equal to mean m (Savage and Cockerham, 1987). Considering that the 95 per cent confidence limits are not defined by $\pm\ 2\sigma$ but rather $\pm\ 2.776\sigma$ (Student's t distribution with 4 degrees of freedom), the 95 per cent confidence interval is expected in the third seismic cycle, i.e. when t = 3 m. This happens indeed when the period of observation is long and the sample free of interdependent events (s. Table V); otherwise the 95 per cent confidence limit is roughly approached in the third class of actual repeat times.

Judging from the least square fittings to the data used and the related standard deviations, the model Log $(N_c)$ = a - bt is somehow more accurate than the earthquake recurrence model Log $(N_c) = k\ (t + c)^{-P}$. Although both models reproduce pretty well the observed earthquake recurrence behavior in a given data set, the second model has an obvious drawback; it does not give the return period range for the magnitude considered and over. The same holds for the widely used cumulative frequency-magnitude relation: Log $(N_c)$ = a-bm.

In any case it is useful to remember the Chulick-Herrmann's notion (1986):. "The earthquake models used to fit the data represent just one set of possible parameters with which these data can be fit".

It is worth noting that the percentage of earthquakes with interoccurrence time equal to or smaller than the average return period, 66-67% (s. Table V), compares very well with that previously found (s. Table IV). The rest of the events have actual repeat times 2-12 times longer than the mean recurrence interval*. About 99% of the earthquakes occur within 5 time units.

As a rule, the return period range for a given magnitude and over consists of several seismic cycles or classes of actual repeat times. In each seismic cycle, large events of any possible magnitude may occur. There is no tendency for association of larger events with higher classes of repeat times.


ΠΕΡΙΛΗΨΗ

**Διαφορὰ στὸ χρόνο διαδοχῆς ἰσχυρῶν διατεμαχικῶν καὶ ἐνδοτεμαχικῶν σεισμῶν σὲ δύο ἑστιακοὺς ὄγκους περισσότερον ἐνεργοὺς στὴν περιοχὴ τοῦ Ἰονίου καὶ Αἰγαίου πελάγους**

Σὲ κάθε περιοχή, μικρὴ ἢ μεγάλη, ἔχει παρατηρηθεῖ ὅτι οἱ σεισμικὲς δονήσεις ἀκολουθοῦν τὴν ἐμπειρικὴ σχέση Gutenberg-Richter:

$$\text{Log}\ (N_c) = a\text{-}bM$$

ὅπου $N_c$ τὸ σύνολο τῶν σεισμῶν ποὺ ἔχουν μέγεθος ἴσο ἢ μεγαλύτερο τοῦ M, καὶ a,b σταθερὲς ποὺ χαρακτηρίζουν δοθεῖσα περιοχὴ σὲ ὁρισμένη χρονικὴ περίοδο. Μὲ τὴν σχέση αὐτὴ εὑρίσκομε τὸ μέσο πλῆθος τῶν σεισμῶν ποὺ παράγονται κάθε χρόνο σὲ δοθεῖσα περιοχὴ μὲ ὁρισμένο μέγεθος, M, καὶ ἄνω. Τὸ ἀντίστροφο τοῦ ἀριθμοῦ ποὺ ἀντιστοιχεῖ στὸ πλῆθος αὐτὸ εἶναι ὁ μέσος χρόνος ἐπαναλήψεως τῶν σεισμῶν μεγέθους M καὶ ἄνω.


* **Footnote added in the proofs:** Between the 7.63M earthquake of 1961, September 9, and the 7¾M event of 1963, August 15, occurred the killer earthquake of September 1, 1962, with 7.3M and 12,225 deaths in Iran.

If we are allowed to include the Iran event in the set of world earthquakes with M≥7.5, as well as the 7.7M earthquake of February 8, 1954, and the 7.5M event of March 7, 1961, listed in the "Catalog of significant Earthquakes 2000 B.C.-1979" (World Data Center A for Solid Earth Geophysics, Report SE-27, July 1981), the distribution of earthquake occurrences all over the world of magnitude 7.5 or larger per actual repeat time is as follows:

| Number of Events | Average Rep. time | Actual Repeat Times | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 543 | 59 | 362 | 104 | 40 | 25 | 6 | 4 | 2 |

In that case the regression equation for the implemented data set (N=543) is:

$$\text{Log}\ (N_c) = 3.096\text{-}0.395t, \qquad \text{S.D.} = 0.045$$