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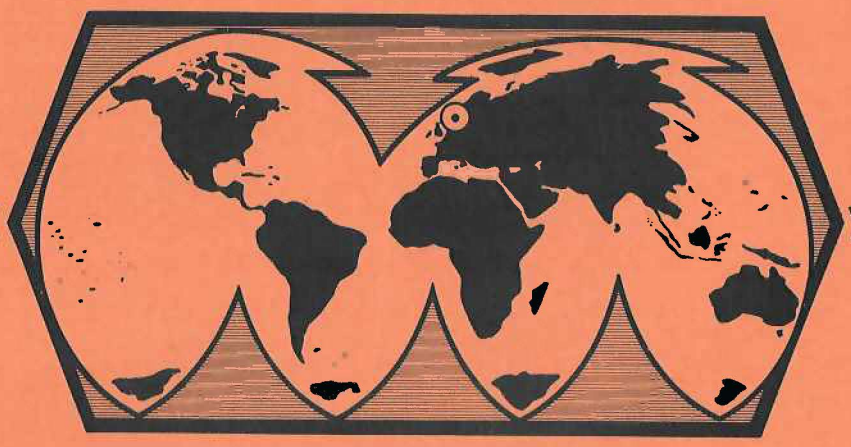


M. QUASI- AND SUPERCYCLICITY OF EARTHQUAKES AND TIME-MAGNITUDE GAPS IN EARTHQUAKE PREDICTION

The problem in earthquake prediction is to locate (with some probability) future earthquakes in time, space and magnitude, which are the three essential components of the earthquake prediction problem. Up to the present, most predictions (for large earthquakes) have been performed assuming that one or two of these components are constants (or varying in a chosen interval), the prediction being given for the remaining one. For example, Fedotov (1965), Mogi (1968, 1964), Sykes (1971) and Kelleher et al (1973) established and applied some criteria for the prediction in space when $M \geq 7$ or 7.8 and the time is restricted to 10-50 years.

The present analysis has been performed in the case when the space component is constant and prediction is attempted in time and magnitude (Purcaru, 1974a). Because all predictions are based on assumptions about the underlying causalities, expressed through regularities in the occurrence of the events, we established such regularities for the Vrancea-Carpathian seismic region. The region is characterized by a clustering of earthquakes of earthquakes in space ($\approx 1^{\circ} \times 1^{\circ}$) with depths of 50-200 km. They occur rarely for $M \geq 5$-6 and are not in general followed by aftershock sequences. The strong earthquakes have M varying between 6 3/4 - 7 3/4. We compiled and carefully analyzed all information about strong-destructive shocks in this region for the years 1100-1974 for $M \geq 6$ 3/4 ($I_{max} \geq 8^{\circ}$), where M is the G-R's magnitude The values of M have been calculated from macroseismic observations using the relation (Purcaru, 1974b):

$$M = -2.13 + 9.85 \log I_{max},$$

for

$5 \leq M \leq 7\ 3/4$

H=50 - 180 km.

After many trials we found that the occurrence of Vrancea-Carpathian earthquakes in the above time period (from 1300-1450 we have no data) is characterized by a regularity expressed through a clear alternation of seismic (active) and aseismic (inactive) periods corresponding to three time-bands $B_{ST}^{(1)}$, $B_{ST}^{(2)}$ and $B_{ST}^{(3)}$ for the former ones (see Fig.M.1). These three time-bands represent the first and strongest regularity in the occurrence of these shocks. The periods are covering the years 0-10 (period P_1), 30-40 (period P_2) and 70-90 (period P_3) of every century. In every P_i (i=1,2,3) we established another regularity expressed by the fact that the shocks occur quasicyclic from about 100 to 100 year. These intervals called quasicycles have the following lengths: $\bar{T}(P_1)=96 \pm 7$ yr, $\bar{T}(P_2)=100 \pm 15$ yr and $\bar{T}(P_3)=104 \pm 16$ yr. Furthermore in the occurrence of shocks with M≃7 1/4 - 7 3/4 it has been observed another regularity: these shocks occur in every active period with recurrence time of about 300 years. These intervals have been called supercycles, which, together with the established quasicycles were used to estimate time-magnitude gaps defined as the likely positions in time and size for future destructive earthquakes. Although the occurrence of the shocks in every P_i is characterized by the quasi- and supercycles, the occurrence of events in these seismic periods are not strictly periodic. If a shock does occur in such a prediction position, we have a stop-gap in time and magnitude correspondingly. Also the time influence of the size of a shock on the next one was established and used in the attempted prediction. Thus, following an algorithm of extrapolation, the final

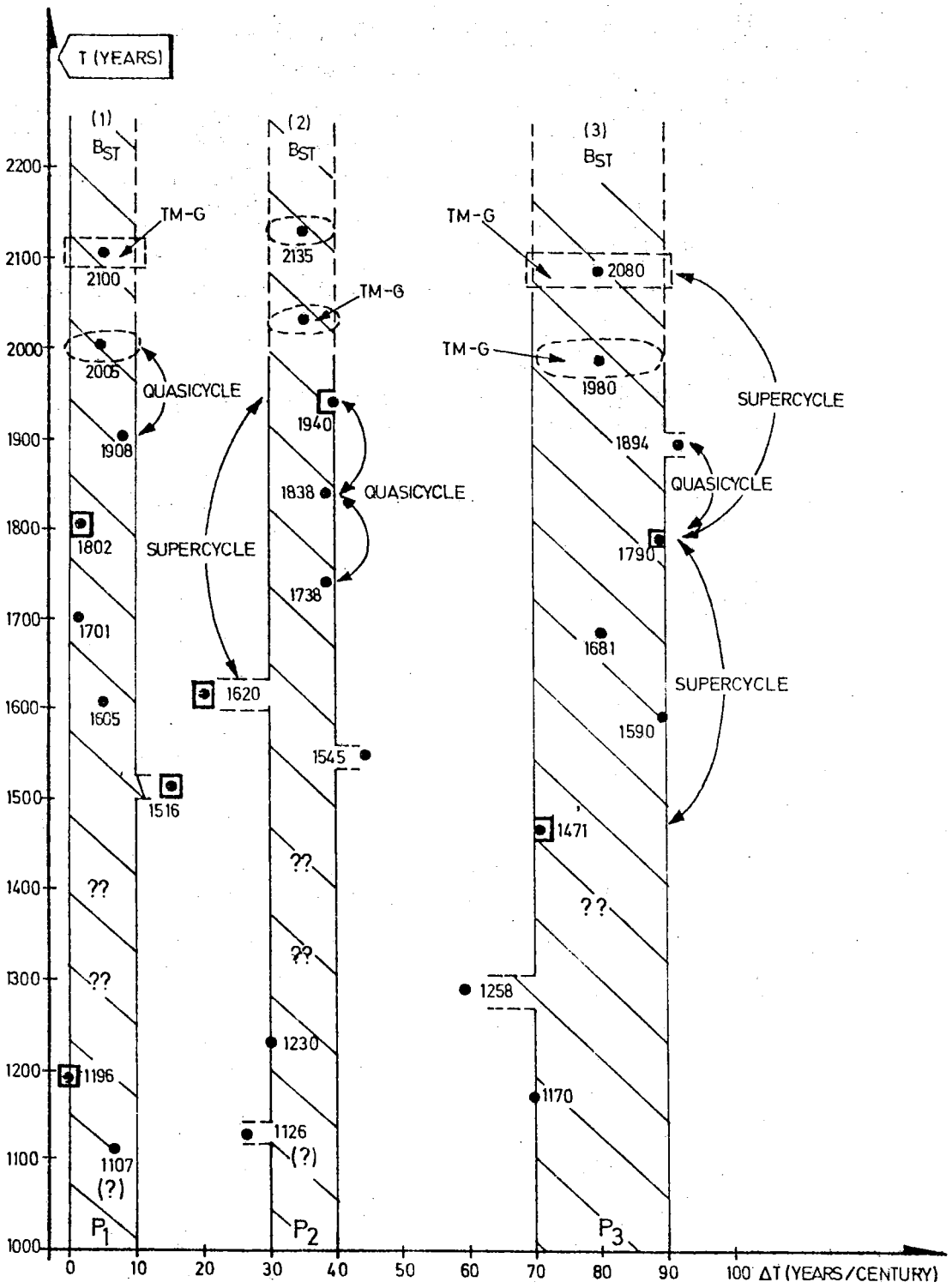


Fig. M.1 Time-magnitude pattern of Vrancea-Carpathian strong intermediate earthquakes. (text continued next page)

Fig. M.1 (Text continued)

ΔT: time period of a century, in year/century

$B_{ST}^{(1)}$, $B_{ST}^{(2)}$, $B_{ST}^{(3)}$: seismic time bands

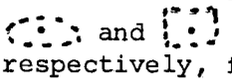
P_1, P_2, P_3: time periods corresponding to $B_{ST}^{(1)}$, $B_{ST}^{(2)}$, $B_{ST}^{(3)}$, respectively, in every century

• and |•|: time distribution of earthquakes with (1) M=6 3/4-7 and (2) 7 1/4$\leq$M$\leq$7 3/4, respectively.

??: no information

The attached number represents the year of occurrence of earthquakes.

TM-G: time-magnitude gaps

 and : TM-G, corresponding to (1) and (2), respectively, for prediction.

results appear to indicate the occurrence of a shock with M≈6 3/4 - 7 in 1980 ± 13 years. Later earthquakes were predicted in 2005, in 2030-40 (M≈6 3/4 - 7) and one with nearly maximum magnitude (M = 7 1/2 - 7 3/4) in 2070-90.

G. Purcaru

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