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## Second Workshop on Non-Linear Dynamics and Earthquake Prediction

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# *The Hypotheses of the Prediction of the Parkfield Earthquake*

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# The hypotheses of the prediction of the Parkfield earthquake

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Great attention has been recently given to the moderate (M > 6) earthquakes sequence which occurred at Parkfield, namely in the years 1857, 1881, 1901, 1922, 1933, 1966, or about one avery 20 years (Bakun and McEvilly 1984, Bakun and Lindh 1985, Sheaver 1985 a and b, Wyss et al. 1990 a and b, Savage 1993).

It was noted that the regularity of that sequence of events implied that a moderate earthquake should occur no later than March 1992 (Wyss et al. 1992 a and b) or pryor to January 1993 (Sheaver 1985 a and b).

The earthquakes of the sequence occur at very regular time intervals with the exception of the 1934 event which, to keep strictly the regularity, should have occurred in 1944; the predictions mentioned above were made shifting the 1934 event to 1944 (hypothesis $Q_0$).

Savage (1993) noted that the prediction did not consider the following alternative hypotheses which he calls $Q_1$ and $Q_2$ ; in $Q_1$ the hypothesis $Q_0$ is considered false and it is assumed that the time intervals between the earthquakes are a random distributon with mean 21.9 yr and a standard deviation of 7.2 yr implying a 28% probability that the next event occurs after 1993.0 but only 5 % probability that it occurs after 2003.65.

The hypothesis $Q_2$ considers the time of the earthquake occurrence as function of the events numerical order in the sequence and also that the events are predictable to an accuracy given by the random variable describing the scatter about linearity.

With $Q_2$ Savage (1993) estimates that there is a 99% probability that the next event occurs after 1993.0 and 5% probability that it occurs after 1996.0.

However there is also the hypothesis, not fully considered by Savage (1993), that the regularity of the sequence of 6 earthquakes is limited in time. To discuss this hypothesis we consider a sequence of earthquakes with intensity $I \geq X$, which has some similarity with that of the Parkfield area, and occurred in an area A of 140 km radius around the Messina Straits. Concerning the intensities $I \geq X$ the catalogues of Italian earthquakes are considered complete since 1550. Between 1550 and 1783, in the area A around the Messina Straits there are 4 earthquakes which seem randomly distributed in time and the last occurred in 1693.

However beginning in 1783 there seems to be an almost regular pattern of occurrence in which the events occur in sets of two or more in a limited time interval $T_1$, each set being separated from the following by a time interval $T_2$ much larger than the duration of the set as shown in figure 1.

The average value of $T_1$ is 5 yr with st. dev. 2.2 and that of $T_2$ is 35 yr with standard deviation of 7.5 yr.

The cumulative distribution with mean 1905 + 35 = 1940 and standard deviation 7.5 is given by the t distribution with two

degrees of freedom and implies that thefollowing sequence had 3.2% probability to occur after the year 1993 and 3.0 % probability to occur after the year 2000.

Since no earthquake with intensity I$\geq$ X occurred in the area A untill 1993, it is reasonable to assume that the regularity presumed between 1783 and 1908 has ceased and that another regime of energy release may have begun.

The same hypothesis may be considered also for the Parkfield sequence. The tectonic energy which accumulates in that area will eventually be released, however it is difficult to estimate when a new pattern of regularity will possibly be established because at the moment have been studied only the sequences of Parkfield and that of the Messina Strait and the latter indicates that the setting of a new pattern of events occurring at regular intervals may take more than 230 years as was the length of the quiesence before the pattern begun in 1783.

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Figure caption

Figure 1. Time of occurrence of earthquakes, in the area of 140 km radius around the Messina Straits, as function of the number in the sequence. The dashed line is a linear fit to the times of occurrence of the events.