A STATISTICAL STUDY OF EARTHQUAKE OCCURRENCE

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DIGEST

The search for patterns in earthquake occurrence has
interested seismologists for over 60 years. Further work
in this area is warranted because:

1.) The previous studies have resulted in contradictory
results.

2.) In the past there has been no explicit definition
of aftershocks. Hence it is difficult to decide
if an apparent pattern is caused by aftershocks or
by independent earthquakes.

3.) The results in previous works usually were not
examined for statistical significance.

4.) With the passage of time, longer, more complete and
more accurate lists of earthquakes have become
available.

5.) Some additional tests for occurrence patterns have
been devised.

In this dissertation two earthquake catalogs were used.
The first was a listing of California earthquakes of magnitude
four and above published by the California Department of Water
Resources. Statistical tests indicate this catalog is complete
and accurate for the time span 1934-1961, inclusive. The
second catalog was Duda's list of events of magnitude seven
and over occurring anywhere in the world. It is complete in
the time span 1918-1964, inclusive.

A major reason previous studies have indicated earthquakes are not randomly distributed is because in these studies aftershocks (which are known to cluster, and not to be randomly distributed) were not eliminated. Autocorrelation tests, distribution function tests, and runs tests all indicate that with the California data (i.e., with earthquakes of magnitude four and above) an earthquake can be considered to be an aftershock if it occurs within one degree arcuate distance and within a hundred days after another earthquake. In the worldwide data (i.e., with earthquakes of magnitude seven and above) the distance used to determine an aftershock is five degrees arcuate distance and time used is one year. When aftershocks are eliminated by these criteria, the number of earthquakes per time span is Poisson distributed, and is not periodic in time.

A cross correlation technique similar to that developed by Tsuboi indicates that in California seismic activity tends to migrate in a Northwesterly or Southeasterly direction. A test based on the two dimensional Fourier transform did not detect any earthquake migration patterns in the Circum-Pacific area. A test based on the distribution of α, the angle formed by lines connecting successive earthquakes listed in the worldwide catalog, shows there is a statistically significant tendency for α to be near 180°. It is hypothesized that this results from earthquakes occurring at alternate ends of a fault.