Bulletin of the Seismological Society of America. Vol. 54, No. 6, pp. 1865–1870. December, 1964

EARTH TIDES AS A TRIGGERING MECHANISM FOR EARTHQUAKES

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ABSTRACT

Since earth tides represent the largest short-period oscillatory strains in the earth, a test has been made to see if any correlation exists between the times of occurrence of earthquakes in Southern California and the tidal potential. Two tests have been made, one of them a cross-correlation. On either basis, a statistically significant sample of earthquake events gives a correlation with the tidal potential that is of the same magnitude as a random sample.

During the twenty-four year period 1934–1957, over 9000 local earthquakes having magnitude 2 or greater were recorded by the Pasadena network. This large body of data has been stored in a manner suitable for further data processing. Such a large number of events, combined with the ease of fast computational procedures, provides us with an opportunity to make statistical studies of the seismicity of small earthquakes on a scale not hitherto possible; the volume of data available reduces the statistical uncertainties by as much as an order of magnitude over earlier computations of correlations with natural phenomena performed by hand.

A large number of searches for diurnal and semi-diurnal or monthly and fortnightly periodicities among earthquake events have been made earlier, but statistically small numbers of events have been used. Some of the reports claim to find positive correlations of earthquake events with solar or lunar periodicities and others do not; it is clear that the statistically small samples used leave the resolution of these correlations in doubt. A listing of some of the early studies is given by Aki (1956).

The largest single periodic strain in the earth is the solid earth-tide. The maximum peak-to-peak strain is about $\frac{1}{2} \times 10^{-7}$. This is the most likely candidate for a possible triggering mechanism; if strain energy were accumulated in the rocks of the outermost parts of the earth from some geologic source, then the tidal strains, superimposed upon this secular term, could pretrigger or posttrigger an earthquake when some critical stress is reached. Therefore there should be a correlation between the times of occurrence of earthquakes and the tide-producing force of sun and moon whether phase lags in the earth tide, compared with the tide-producing force, are present or not.

In principle, a Fourier analysis of the times of occurrence of earthquakes, all considered as events with equal weight, should show periodicities corresponding to the lunar or solar terms. However, as is well known, the tide-producing force has a spectrum which has a population in a large number of lines. Thus, if a weak correlation with earth tides is present then the population in each of the lines may be extremely small; therefore it may be quite difficult to determine whether a positive correlation is present or not. For the time scale used here, the earth tides must be considered as almost periodic rather than as periodic. For this reason a correlation in real-time instead of a harmonic analysis was performed. The two types of correlations performed upon the data are described below.

The list of earthquake events was truncated to give a list having epicenters lo-