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THE FORTNIGHTLY TIDE AND THE TIDAL TRIGGERING OF EARTHQUAKES

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In the short note by Hartzell and Heaton (1989) we used a periodicity of 13.66 days to check for fortnightly tidal effects in earthquake occurrence. The 13.66-day period is the lunar declinational tide associated with the movement of the moon to northerly and southerly declinations. The correct periodicity to use in that study is 14.765 days, which is the modulation of the short-period semidiurnal and diurnal tides by the movement of the moon from conjunction with the sun, to opposition, and returning to conjunction (from new moon to full moon, and back to new moon).

We have redone the calculations for the correct period of 14.765 days. The results for the southern California earthquake catalog and the worldwide catalog are given in Table 1. The tabulated information includes the probability that a random sequence in time would result in the indicated number of steps from the origin. Also listed is the net phase relationship of the distribution of earthquakes with respect to the maximum in the fortnightly tide. A phase of zero indicates perfect correlation with the new or full moon. The conclusions remain the same for the southern California earthquake catalog. That is, after removing the nonrandom effects of aftershock sequences by using a declustered catalog, and by using a lower magnitude cutoff of 2.5 to avoid completeness level problems, no tidal periodicity is seen. However, the worldwide catalog shows a weak, but statistically significant, correlation with the fortnightly tide, even with a lower magnitude cutoff of 5.0. The effect is equivalent to taking a completely random catalog and adding approximately 1 out of every 80 events in phase. However, the phase varies from 40° to 95° (1.6 days to 3.9 days following the new or full moon), when different sections of the catalog are considered. Although the distribution of earthquakes is nonrandom, the correlation with the fortnightly tidal period is weakened by the fact that the events are not in phase with the maximum in the tide, and because of our experience with

TABLE 1

TESTS FOR FORTNIGHTLY TIDAL PERIODICITY OF 14.765 DAYS

Catalog	Years	Magnitude Cutoff	Number of Events	Steps from Origin	Phase (degrees)	Probability P_R
Southern California	1932–1988	none	156654	1974	97	1.57×10^{-11}
Southern California	1932–1988	2.5	32306	912	342	6.41×10^{-12}
Declustered Southern California	1932–1988	none	30366	198	165	0.273
Declustered Southern California	1932–1988	2.5	14979	101	183	0.507
Worldwide	1900–1988	none	189393	1115	20	1.40×10^{-3}
Worldwide	1900–1988	5.0	38634	468	63	3.43×10^{-3}
Worldwide	1900–1975	5.0	18822	224	95	6.85×10^{-2}
Worldwide	1976–1988	5.0	19813	302	40	9.93×10^{-3}

the large nonrandom effects of aftershocks in the southern California catalog. The same declustering algorithm (Reasenberg, 1985) could not be used on the worldwide catalog to test this hypothesis because of the lack of smaller events.

References

Reasenberg, P. (1985). Second-order moment of central California seismicity, 1969–1982, *J. Geophys. Res.* **90,** 5479–5495.