MOONQUAKES AND TIDES

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The four station Apollo seismic network is presently detecting moonquakes at a rate of about 3000 per year. A previous analysis (Lammlein, et al. 1973) of the occurrence characteristics of moonquakes revealed the presence of tidal periodicities of about two weeks, one, and 7.5 lunar months. Spectra of the total moonquake activity using over three years of data from the Apollo 12 station and shorter periods of time from the other stations clearly show the presence of a predominant spectral line at a period of nearly 13.6 days. Significant spectral lines are also observed at periods of 27.2 days, 27.5 days, and about 206 days. The 13.6 and 27.2 day periods correspond to the nodical month, the 27.5 day period corresponds to the anomalistic month, and the 206 day period corresponds to longer-term variations in lunar orbital parameters. Tidal periodicities are also observed in the occurrence characteristics of moonquakes from each of the 41 hypocenters identified to date. At each hypocenter moonquakes occur near a characteristic phase of the monthly tidal cycle and their occurrence times can be predicted often to within several hours on this basis. A period of 206 days in the seismic activity of several of the hypocenters is superimposed on a strong one to two year trend where the signal amplitudes decrease to the instrumental detection threshold. Signals from the A_1 moonquake hypocenter are now being detected following a relatively inactive period of over one year. This resurgence in activity was predicted by Lammlein, et al. (1973) on the basis of a close correlation between the amplitude variation of A_1 moonquake signals and a 6 year variation in lunar tides. For this same reason we expect to see in the near future a similar renewal of seismic activity at other presently inactive hypocenters. Because Earth-generated lunar tidal variations occur with periods of 13.6, 27.2, 27.5, 206 days and 6 years, we conclude that lunar tides control the occurrence times and energy release characteristics of moonquakes and that tidal energy is the dominant source of energy released as moonquakes. The close correlation between moonquake focal depths and the depth dependence of tidal strain energy density favors the hypothesis that tidal energy is dissipated by moonquakes in the rigid lunar lithosphere and by inelastic processes in the partially molten asthenosphere.