THE

QUARTERLY JOURNAL

OF

THE GEOLOGICAL SOCIETY OF LONDON.

VOL. LXXVII

FOR 1921.

1. *A* SEASONAL VARIATION *in the* FREQUENCY *of* EARTHQUAKES. *(Second Communication.)*

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IN an earlier communication to this Society[1] it was shown that there is a slight excess of frequency of earthquakes, above the general average, during the day in summer and during the night in winter. It was also pointed out that this might possibly be a result of the unequal range of variation of the gravitational stresses set up by the sun, and, if so, might be expressed in the form that there was an excess of frequency of earthquakes during that half of the day which contained the upper meridian passage when the declination of the stress-producing body and the latitude of the place were of the same name, and during the half which contained the lower meridian passage when they were different. If this were the true statement of the variation, a similar effect ought to be noticeable, and of greater amplitude, when the record was tabulated by lunar time and declination. Such was actually found to be the case in the only record already tabulated in a form permitting the application of the test, but the number of shocks contained in this record was not large enough to give more than very small weight to the numerical values obtained from it.

Since then I have been able, with the assistance of the Government grant of the Royal Society, to prepare a fresh tabulation of the records of Italian earthquakes by lunar, as well as by solar, hour-angle and declination. The period chosen was the 19-year lunar cycle covering the years 1896 to 1914, this being the period for

[1] Q. J. G. S. vol. lxxiv (1918–19) pp. 99–104.

which the most complete record was available in England; and the tabulation was confined to those earthquakes which originated within the limits of Italy proper, excluding all those which originated in the Alpine districts, or outside the limits, of Italian territory. The number of earthquakes dealt with was 6607, and an abstract tabulation by quarter days is appended to this paper.

Taking the day and night halves of the solar and lunar day, the number of shocks recorded in each, and the ratio of these numbers to each other, come out as in the tabular statement below.

	Solar.				Lunar.			
	Shocks.		*Ratio.*		*Shocks.*		*Ratio.*	
	Day.	Night.	Day.	Night.	Day.	Night.	Day.	Night.
Declination North	1449	2006	836	1164	1694	1667	1008	992
Whole Record	2733	3874	827	1173	3269	3338	989	1011
Declination South	1293	1868	818	1182	1575	1671	970	1030

From these figures it appears that the same difference in the ratio of day to night shocks, when the declination is north or south, as compared with the general average ratio of the whole period, is in the same direction in both solar and lunar tabulations, and that the magnitude of the variation in the latter is about double that found in the former, the actual ratio being 9 : 19 in the solar and lunar tabulations respectively. As the ratio of magnitude of the corresponding gravitational stresses is about 9 : 21, or practically the same as that of the variation in frequency, the figures may be taken as confirmatory of, and as giving a considerable degree of probability to, the interpretation suggested in the earlier communication.

Distribution of Earthquakes in Italy, 1896–1914.

[Hour-angles are reckoned from the lower meridian passage.]

Hour-Angles.	0–6.	6–12.	12–18.	18–24.
Solar:				
Declination North	1150	710	730	856
Declination South	1032	723	570	836
Whole Record	2182	1433	1300	1692
Lunar:				
Declination North	790	824	870	877
Declination South	835	733	842	836
Whole Record	1625	1557	1712	1713

[The distribution of shocks by hours is not tabulated here, but was extracted and submitted to the usual process of harmonic analysis. The solar record gave for the diurnal and semidiurnal periods the formula

$$F = 1 + \cdot 30 \sin (t + 58^\circ\ 30') + \cdot 10 \sin (t + 12^\circ),$$

which is very close to the formula (1) on p. 103 (*op. cit.*), and, as in that case, almost completely covers the diurnal variation in frequency. The lunar record, treated similarly, gives the formula

$$F = 1 + \cdot 05 \sin (t + 151^\circ\ 30') + \cdot 015 \sin (2t + 168^\circ).$$

Here the epochs of maximum frequency are very different from those of the solar record, but the coefficients, which do not, even in the case of the solar record, exceed the expectancy, are also reduced to an insignificant magnitude; the real meaning, therefore, of the formula is that there is no indication of either diurnal or semidiurnal variation of frequency which can be correlated with the hour-angle of the moon. Hence we may conclude that the variation in frequency of earthquakes at different times of the day, which is conspicuous and consistent, so far as Italy and the last quarter-century are concerned, cannot be attributed in any appreciable degree to the gravitational stresses set up by the sun.

This leaves the third term of the formula (5) as the only one which can be attributed to this cause.]