On remarkable Lunar Periodicities in Earthquakes, Oscillations of the Sea, and great Atmospherical Changes.

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In my former Paper,* on the earthquakes and extraordinary agitations of the sea in Cornwall, were noticed three remarkable periods of about 118 days, or four lunations, each: the first occurring between the two disturbances of the sea at and after the great earthquake of 1755, the second between those at and after the great earthquake of 1761, and the third between those on the 5th of July and the 30th of October, 1843. These three periods are separated by large intervals of time from each other. I have now to notice eleven such periods; six following each other in one series, and five in another. I have also to notice several series of successive periods of single lunations, other series of half-lunations, and others again of quarter-lunations; each period, in every series, commencing with an earthquake, oscillation of the sea, or some remarkable state of the atmosphere.

But before I proceed, I would mention that the oscillation on the 5th of July, 1843, which was observed at Penzance pier about half-an-hour before noon, was not confined to Mount's-bay, but occurred also at Scilly,† Falmouth, Plymouth, Bristol, along the eastern coast of Scotland, and at the Orkneys.

In Falmouth, as Mr. Hunt informed me, it was observed between 1 and 2, p.m., along the shore between Falmouth quay and Penryn. At Plymouth it was noticed about 11, a.m.; at Bristol about 2, p.m.; at Dunbar a little after 6, p.m.; at North Berwick between 1 and 2, p.m., and twice afterwards on the same day; at

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* Cornwall Geological Transactions, 1843, p. 111.

† A gentleman of St. Mary's, Scilly, informs me that the sea there was at "an unusual "height," and "at a short distance from the most southern part of the island, was much "agitated, as if some violent force from beneath were lifting the body of water above, while "the surrounding water was perfectly calm and smooth."

Arbroath at 5, p.m.; at the Orkneys on the following day at 3, a.m.; and at the Shetland Isles at 10, a.m.

It was observed again, on the 6th and 7th, at Arbroath and other places on the east coast of Scotland, and at the Shetland Isles. On the 8th, at 10, a.m., it occurred near Tynemouth, on the coast of Northumberland.

The storm which passed over Britain on the 5th of July, 1843, was one "which for severity and extent has been rarely equalled."* In Mount's-bay it commenced with a sudden gale from the south, between 2 and 3, p.m., at which time the oscillation of the sea had not subsided. A violent thunder-storm was experienced in Gloucester at 3, p.m.; at Sheffield and Liverpool between 5 and 6, p.m.; at York, Dumfries, Edinburgh, Glasgow, and Arbroath, at 7, p.m., during the oscillation at the last of these places; at Aberdeen at 8, p.m.; at Kinnaird's Head at 9, p.m.; and in the same night at the Orkneys, where the agitation of the sea was observed at 3 o'clock the following morning.

"In Scotland for some days before there had prevailed a cold "and parching wind from the north-east, whilst in the south of "England the temperature ranged about 80°. When these two "aërial currents, so different in all respects, came into contact, a "violent disturbance was the necessary consequence." "At Brigh-"ton the 5th of July was the warmest day of the summer, the "thermometer having stood at 78°."† It was at the same height at Birmingham; and at Boston it was 81°·5.

The agitations of the sea on the 5th of July, 1843, were very similar to those on the day of the great earthquake of 1755. On each occasion, the atmosphere was in a most remarkable condition,—manifested in 1843 by the depressed state of the barometer and violent thunder-storms; and in 1755 by the extraordinary height ‡ of the barometer and the unusually calm and fine weather. And as the agitations generally of 1755 and 1843 arrived at different places at times corresponding in some degree to their

* Mr. Milne, Edinburgh Transactions, vol. 15, p. 622.

† Ibid, p. 632. From this Paper I have derived most of the preceding particulars relative to the phenomena of the 5th of July.

‡ Higher than for three years before in Cornwall.—Borlase's Nat. Hist. of Cornw. p. 53.

respective distances from a supposed point,* they might all have resulted from local submarine shocks occurring progressively as the highly-electrified state of the earth or air spread itself from some centre. That certain sea-ports were passed over without experiencing any agitations,†—that others experienced them at periods widely differing from the general rate of progress,—some having taken place, in 1755, even half-an-hour before the great earthquake,—are circumstances, mutatis mutandis, common also in thunder-storms. Shocks of earthquakes, when they occur in non-volcanic districts, have been considered by many, as the effects of electrical discharges from the atmosphere into the earth,‡ or from the earth into the atmosphere.|| But whether, during earthquakes, the electricity usually passes from the air into the earth, or from the earth into the air,—or whether it may not sometimes pass between two differently-electrified portions of the earth, as lightning often does between two differently-electrified portions of the atmosphere, are points which I believe have not yet been ascertained by observation.

On a former occasion § I explained how an oscillation of the sea might be produced by a simple submarine shock or vibration, without any explosion or the displacement of any portion of the bed of the sea. These submarine shocks must doubtless often happen without any indication of their occurrence, except the subsequent agitations of the sea. And shocks are often felt at low levels without being perceived at higher elevations, as was the case with the shock on 30th Dec., 1832, hereafter mentioned, which does not appear to have been felt any where in Cornwall except Hayle, on a spot only a few feet above the sea. Humboldt,¶ too, states that in Chili, Peru, and Terra Firma, the shocks follow the line of the shore, which is the lowest part of the land, and extend but little inwards: he also says that "sometimes in the same rock the "superior strata form invincible obstacles to the propagation of "the motion,—thus in the mines of Saxony we have seen workmen

* Mr. Milne, Edinburgh Philosophical Journal, October, 1841, pp. 263—269.

† Mr. Milne, Edinburgh Transactions, vol. 15, p. 615.

‡ Rees' Cyclopædia.—Earthquake. || Edinburgh Philosophical Journal, Oct., 1841, p. 309.

§ Cornwall Geol. Trans., 1843, p. 117. ¶ Personal Narrative, vol. 2, pp. 222, 224.

" hasten up affrighted by oscillations which were not felt at the " surface."

But in 1755, on the day of the great earthquake, shocks were actually felt in this island, and the waters of our ponds agitated, at the very times when some of the oscillations of the sea were taking place; which seems almost to establish the fact, that such oscillations are produced by local submarine shocks. I may also mention that in 1788 the sea at Dunbar suddenly receded a foot and a half on the day that a shock was experienced in the Isle of Man.* So also a shock was felt in Perthshire on the 10th of March, 1842, and on the following day a disturbance of the sea (the effect, probably, of another shock) took place in the western isles of Scotland: † and it has been observed in Perthshire that " shocks " seldom occur single,"—but " come very frequently in groups." ‡ I will here introduce a passage from the Edinburgh Philosophical Journal|| to shew the general nature of these oscillations, and the opinion commonly entertained respecting them.

" Arbroath.—A singular phenomenon has lately been very " frequently observed at our harbour. When the tide is making, " the tide will come rushing two or three feet in the harbour at the " rate of four miles an hour for ten minutes or so, and all at once " turn and rush out again as fast,—and again turn and pour into " the harbour with its former violence, and continue frequently to " advance and recede; when apparently without any cause it will " resume its former quiet manner of fulfilling its destinies. At " Perth, Leith, and at Valetta in Malta, the same phenomenon has " occurred, and has been ascribed to earthquakes."

Mr. Milne, however, thinks that the oscillations of 1843 may have been produced " partly by the mechanical pressure of the " wind in the storm,—blowing first in one direction, and thereafter " in an opposite direction,—and partly by the sudden diminution of " atmospheric pressure accompanying its progress," § without the

* Edinburgh Philosophical Journal, July, 1841, p. 108. † See Table ii.

‡ Edinburgh Philosophical Journal, October, 1841, p. 286. || Jan., 1844, p. 188.

§ In Cornwall and Devon the fall of one inch in the barometer corresponds with the rise of sixteen inches in the level of the sea, and vicê versâ.—Edinb. Trans., vol. 15, pp. 635—637.

intervention of submarine shocks: and he brings forward numerous examples to shew that such agitations are usually preceded or attended by violent storms or other proofs of great atmospheric disturbance: but these examples are quite as favorable to my hypothesis as to his own, for they are equally applicable to earthquakes which have often occurred during storms and hurricanes.* The first earthquake which Humboldt felt at Cumana was during a severe thunder storm. "At the moment of the strongest electric "explosion there were two considerable shocks of an earthquake."† And the excessive minima of the barometer which have been observed during oscillations of the sea have been also observed at the times of earthquakes:—thus Humboldt, on a certain occasion, observed that "the mercury was *precisely* at its *minimum* height "at the moment of the third and last shock."‡ On the 10th of November, 1782, when Loch Rannoch was violently agitated, the barometer in Scotland sunk to within one-tenth of the bottom of the scale (probably 27·1 inches). During the extraordinary depression of the barometer throughout Europe on the 25th of December, 1821, a slight shock of an earthquake was felt at Mayence.||

Mr. Milne has collected eighteen instances during the last hundred years, to prove the connection between great disturbances of the atmosphere and extraordinary oscillations of the sea. I have endeavoured to prove that the intermediate links of this connection are submarine shocks. I now proceed to shew that such disturbances in the air, earth, and sea, are probably often occasioned by the action of the moon.

I cannot better introduce the subject than by the following passage from Humboldt.‡ "On the 5th November, 1799, exactly "at the same hour as the preceding day (when the earthquake "already noticed took place during a severe thunder-storm) there "was (as on the 4th) a violent gust of wind, attended by thunder "and a few drops of rain. No shock was felt. The wind and "storm returned for five or six days, at the same hour, almost at "the same minute. The inhabitants of Cumana, and of many

* Edinburgh Philosophical Journal, 1841, pp. 294—297.

† Personal Nar., vol. 3, p. 316. ‡ Ibid, p. 319. || Edin. Phil. Jour., Oct., 1841, pp. 295, 296.

"other places between the tropics, have long ago made the obser-
" vation, that those atmospherical changes which appear the most
" accidental, follow, for whole weeks, a certain type with astonish-
" ing regularity. The same phenomenon exists in summer under
" the temperate zone; nor has it escaped the sagacity of astronomers
" who often see clouds form in a serene sky, during three or four
" days together, at the same part of the firmament, take the same
" direction, and dissolve at the same height,—sometimes before,
" sometimes after, the passage of a star over the meridian; con-
" sequently within a few minutes of the same point of apparent
" time. M. Arago and I paid great attention to this phenomenon
" in the years 1809 and 1810, at the observatory of Paris."

Here is an example of *solar* periodicity in the recurrence of storms and great atmospherical changes, coincident with which, on one occasion, was an earthquake. The following are examples of *lunar* periodicities in the recurrence of storms and great atmospherical changes, coincident with which, on many occasions, were earthquakes, or extraordinary oscillations of the sea.

The first series of lunar periodicity begins with the 23rd of October, 1841, and consists of seven remarkable days connected with one another by periods of four lunations each. The 1st, 2nd, 5th, and 6th, of these days were remarkable for earthquakes in Scotland, Cornwall, and Guadaloupe; the 3rd, for being the hottest day of the hottest June since 1826; the 4th, for the extraordinary maximum of the barometer; and the 7th, for an eruption of Vesuvius. The days in this series are distinguished, in the following Table, by single asterisks.

The next series of periods, of four lunations each, begins with the 11th of November, 1842, and consists of six days: on the 1st of which was an unusual depression of the barometer; on the 2nd, an earthquake at Manchester; on the 3rd and 4th, oscillations of the sea; on the 5th and 6th, most unusual disturbances of the atmosphere. The days of this series are marked with double asterisks.

Each of the above thirteen days was either that of the moon's first quarter, or the day before or after it, except the 9th of October, 1842, which was the second day before it.

TABLE I.

Remarkable days at or near the Moon's first quarters:—those marked with single asterisks, forming one series of periods of four lunations each: and those marked with double asterisks, forming another such series.

Explanations.—A date in large figures is the day of one of the Moon's four quarters. When a date has a dot *above* it (thus $\dot{2}3$rd) it is the day next *after* a quarter day. When it has a dot *under* it (thus $\underset{\cdot}{1}9$th) it is the day next *before* a quarter day. When a date has two dots above or under it, it is the second day after or before a quarter day.

The signs in the third column of the Table are explained in the notes referred to under the dates of October 23rd, and January 19th.

Dates.	Barometer at Chiswick.†		Earthquakes and Atmospherical Phenomena.
1841			
* Oct. $2\dot{3}$	29·034	‡$-\left\{\begin{matrix}15\\37\end{matrix}\right.$	Considerable shock‖ in Perthshire,—none for 18 days before and 11 days afterwards. On $\dot{8}$th October, bar. 29·027 $-\left\{\begin{matrix}270\\51.\end{matrix}\right.$ On **6**th & $\dot{7}$th Nov., 30·391 $+\left\{\begin{matrix}240\\60\end{matrix}\right.$ On $\underset{\cdot}{5}$th, **6**th, $\dot{7}$th, and $\ddot{8}$th Nov., shocks in Perthshire.
Nov. $\dot{2}2$	29·170	$-\left\{\begin{matrix}8\\7\end{matrix}\right.$	
Dec. $\underset{\cdot\cdot}{19}$	29·188	$-\left\{\begin{matrix}16\\38\end{matrix}\right.$	
1842			
Jan. **19**	30·452	§$+\left\{\begin{matrix}314\\26\end{matrix}\right.$	
Feb. $\underset{\cdot\cdot}{16}$	30·488	$+\left\{\begin{matrix}391\\235\end{matrix}\right.$	
* „ $\underset{\cdot}{17}$	—	—	Shock in Cornwall. On $\underset{\cdot}{9}$th, bar. 29·512 $-\left\{\begin{matrix}14\\14.\end{matrix}\right.$ On $\underset{\cdot}{2}$4th, 29·115 $-\left\{\begin{matrix}83\\240.\end{matrix}\right.$
Mar. **19**	29·280	$-\left\{\begin{matrix}10\\49\end{matrix}\right.$	
April **18**	30·201	$+\left\{\begin{matrix}7\\26\end{matrix}\right.$	Violent shocks in different parts of Greece.¶
May $\underset{\cdot}{16}$	30·390	$+\left\{\begin{matrix}89\\89\end{matrix}\right.$	
June $\underset{\cdot\cdot}{13}$			

† The barometrical observations referred to in this Paper were made at the Horticultural Society's Gardens at Chiswick, the only ones I have seen, in which the daily maxima and minima are stated. I find, however, in the barometrical observations taken at London, Boston, and Dumfriesshire, that in almost every instance, when the maximum or minimum at Chiswick has been noticed, the barometers at those other places have also been at nearly corresponding maxima or minima, either on the same day or on the day adjoining.

‡ $\left(-\left\{\begin{matrix}15\\37\end{matrix}\right.\right)$ This signifies that the barometer, on 23rd of October, was *lower* than for 15 days before, and 37 days afterwards.

‖ Edinburgh Philosophical Journal, Jan., 1842, pp. 119—127.

§ $\left(+\left\{\begin{matrix}314\\26\end{matrix}\right.\right)$ This denotes that the barometer, on the 19th of January was *higher* than for 314 days before, and 26 days after that day.

¶ Quarterly Journal of Meteorology, p. 216.

TABLE I. (continued.)

Dates.	Barometer at Chiswick.		Earthquakes and Atmospherical Phenomena.
1842 * June 14	30·293	+ { 16 31	The hottest day of the hottest June at Boston since 1826, as remarked in the monthly meteorological report. At Chiswick, therm. 88°. On 1st, 2nd, and 8th of June, shocks in Perthshire.
July 15	30·388	+ { 60 29	
August 13	30·399	+ { 178 56	
Sept. 10	29.385	— { 126 13	
* Oct. 9	30·490	+ { 626 349	Except on 18th of the following month.
** Nov. 11	—	—	At Penzance, the minimum occurred this day, and was much lower than at Chiswick on the following day. On 18th, a shock in Perthshire:—none for twenty-two days before nor for eleven days after,—bar. at Chiswick being 30·532 higher than for years before and since. On 24th, it was 28·793 lower than for years before.
„ 12	29·050	— { 20 12	
Dec. 8	30·404	+ { 4 11	Remarkable electrical phenomenon seen on the 9th at Comrie, and other places, noticed by D. Forbes, Esq., in a Paper read before the Meteorological Society.†
1843 Jan. 8	—	—	From this first quarter until the full moon, the atmosphere was in a more disturbed state than for some years before; ‡ and near the first quarters and the full moons of the two following months, earthquakes happened in different parts of the globe.
* Feb. 8	30·038	+ { 13 22	Great earthquake at Guadaloupe. On 13th, severe shock in Calabria. On 3rd March, another shock in Guadaloupe,‖—three-quarters of a lunation after the last.
March 9	30·380	+ { 49 179	
** „ 10	—	—	Earthquake at Manchester. On 17th, shocks in the north of England, and in Dumfriesshire, Isle of Man, Belfast, Jersey, and Guernsey. On 23rd, severe shock in Perthshire. On 31st, bar. at a minimum of 29·384.
April 7	29·436	— { 3 29	Violent shocks in Holland on 6th and 7th.§ *The last-mentioned six days* (3rd, 10th, 17th, 23rd, 31st March, and 7th April) *are all remarkable for earthquakes, except the* 31st March, *when there was a considerable minimum of the barometer; and they are connected with each other by periods of about quarter-lunations. The following seven days are also remarkable for their lunar periodicity: viz.,*—6th, 14th, and 28th May, 4th, 10th and 17th June, and 2nd July.

† Quar. Jour. of Meteorol., p. 374. ‡ Edinb. Phil. Journal, April, 1843, p. 371. ‖ Ibid, July, 1843, p. 184. § Ibid, July, 1843, p. 183.

TABLE I. (continued.)

Dates.	Barometer at Chiswick.		Earthquakes and Atmospherical Phenomena.
1843 May 6	29·258	— { 67 / 29	On 14th and 28th, slight shocks in Perthshire.
* June 4	29·223	— { 96 / 123	Considerable shocks in Perthshire this day, and also on the 10th and 17th, and a slight one on 2nd July.
** July 5	29·643	— { 7 / 17	Oscillations of the sea in England and Scotland, and great thunder-storm throughout the island.† A most violent thunder-storm occurred in Yorkshire ‡ on the *eighth* day *after* this. On the *eighth* day *before*, the bar. at Chiswick was 29·629— { 19 / 24. On the **19**th, a remarkable electrical discharge from the earth into a cloud was observed on the Cotswold Hills.‖
Aug. 4	29·527	— { 12 / 18	At Penzance, the minimum was on the 3rd, and lower than at Chiswick on the 4th.
Sept. 2	30·333	+ { 177 / 3	Considerable shock in Perthshire: therm. at Chiswick 85°;—highest for the year.
* „ **30**	29·788	— { 2 / 6	Eruption of Vesuvius.§
Oct. 28	29·093	— { 16 / 121	The minimum occurred at Orkney on the 29th, and was 28·85.
** „ **30**	—	—	Oscillations of the sea in Mount's-bay and Plymouth.¶ *The agitation of the sea on the* **30***th Oct.*, 1843, *and the extraordinary state of the atmosphere on* **26***th Feb. following, were almost on the same days of the year as the agitations of* 1*st Nov.*, 1755, *and* 27*th Feb. following*.
Nov. 29	—	—	At Penzance, the maximum was much greater this day than at Chiswick on the following day.
„ 30	30·381	+ { 68 / 12	
Dec. **28**	30·498	+ { 96 / 92	On 22nd (a quarter-lunation before) shocks in Guernsey, Cherburg, and Exmouth. On **14**th (a quarter lunation before these shocks) the bar. was 30·490 higher than since the **23**rd of Sept.
1844 Jan. 26	30·282	+ { 10 / 62	
** Feb. **26**	28·624	— { 409	Barometer at Penzance 28·50— it had fallen *nearly two inches* within the preceding 36 hours. Thunder-storm at Boston this day, and at Penzance the preceding day.
March 29	30·505	+ { 188	
April **25** / May **25** / ** June **23**			*These three months are supposed to have been the driest in England since* 1785, *and it is remarkable that in Cornwall the driest day in each of these months was that of the moon's first quarter*.††

† Ante, pp. 196—197. ‡ Gentleman's Magazine, 1843, p. 125. ‖ Quarterly Journal of Meteorology, p. 434.
§ Edinburgh Philosophical Journal, Oct. 1844, p. 407. ¶ Cornwall Geological Trans., 1843, p. 119.

†† The driest day in the above three months was the 25th of May, "when the thermometer stood at 71°, "and the dew point was 34°, indicating 37 degrees of dryness, which is the greatest degree of dryness we "ever witnessed in the open air." Monthly Agricultural Report for Cornwall, published in the West Briton newspaper. The observations were made at Sir William Molesworth's Seat, near Bodmin.

TABLE I. (continued.)

Dates.	Barometer at Chiswick.		Earthquakes and Atmospherical Phenomena.
1844			
June 23 continued	—	—	On the evening of 23rd June, an unusually-severe and protracted thunder-storm with heavy rain, in Cornwall and Dumfriesshire, and on the following morning at Boston and Liverpool. Thermometer on 23rd, at Chiswick, 91°;—highest for the year previously. A thermometer at Greenwich Observatory, placed in the sun's rays, at 1, p.m., on a piece of raw wool, rose in seven minutes to 155°. The 23rd of June was exactly twelve (4+3) lunations after the oscillation of 5th July, 1843. The storm on each of these occasions pursued a northern course in England, and was preceded by unusually-hot weather and a southerly wind of two or three days continuance. After the great thunder-storm of the 23rd June, the weather at Penzance was fine until the 30th, when the sky threatened another storm from the east, and it rained very heavily two miles east of Penzance, whilst at Exeter a violent thunder-storm occurred. Such was the state of the weather on the 30th June, the quarter-lunation *after* the storm. On the 16th, the quarter-lunation *before* it, the bar. at Penzance was higher than for twenty days before and thirty-four days after; and on the 17th and three following days were shocks in the town of Palestrina. As the state of the atmosphere was thus remarkable at each of the three quarters nearest to the great storm of 23rd June, 1844, so it was also, as already stated, at each of the three quarters nearest the great storm and oscillation of 5th July, 1843.
July 21	30·275	+ 67	
„ 22	—	—	Therm. generally, in England and Scotland on 22nd or 23rd, highest for the year, except on 23rd or 24th of the preceding month, when it was about the same height. At Penzance, on 21st and 22nd, sky very clear, as it was also for two days before the great thunder-storm of the preceding month; but in the afternoon of the 23rd July it became unusually dark, as if another thunder-storm were approaching, and the barometer fell to a considerable minimum, on which day there was a thunder-storm in Dumfriesshire. On the 30th, a violent storm of wind at Penzance, the bar. there being lower than for seventeen days before: and on the following day there was a thunder-storm in Boston. On 14th and 15th, severe thunder-storm in Sheffield.

The remarkable days noticed in the preceding Table were at or near the moon's four quarters, and principally at her first quarters. Those in the two following Tables did not occur near any of her quarters, but are, nevertheless, connected with one another, by intervening periods of single lunations.

TABLE II.

Four remarkable days (including that of the great earthquake of St. Domingo), each occurring about three days before new moon.

Dates.	Barometer at Chiswick.		Earthquakes and Atmospherical Phenomena.
1842			
March 9	29·152	†— { 13 / 227	At Penzance, at 5, p.m., barometer 28·19, and within seventeen hours afterwards, 29·18,—nearly an inch higher. Shock in Perthshire, on the 10th, at 1, p.m.,—none for two months before, and six weeks afterwards,—and a dreadful hurricane at Brighton, at 10, p.m. On the 11th, at the western isles of Scotland, the tide (neap) did not rise or fall more than three feet (instead of nine) during the whole day, and a most violent thunder-storm occurred there.‡
April 7	29·800	— { 4 / 23	
May 7	29·197	— { 59 / 168	Great earthquake at St. Domingo.‖
June 5	29·809	— { 10 / 13	

† These signs are explained in the notes at p. 202, ante.

‡ Edinburgh Phil. Trans., vol. 15, p. 621.

‖ On the 13th and 14th May (a quarter-lunation after this earthquake), about an hour before sun-set, and again about the same time after sun-rise, that luminary, although seen in a cloudless sky, and with a very clear outline, emitted so faint a light, owing to an unusual thickness in the atmosphere, that it appeared not brighter than the moon when seen in the east while the sun is shining above the western horizon. In the Gentleman's Magazine for 1754, p. 492, is an account of a similar phenomenon observed in France, on the 7th of March, 1750, the day before the last earthquake in London.

TABLE III.

Four remarkable days (including that of a violent shock in Scotland), each occurring about three days after full moon.

Dates.	Barometer at Chiswick.		Earthquakes and Atmospherical Phenomena.
1842			
August 25	29·702	†— 15 12	
Sept. 24	29·341	— 139 23	Shock in Perthshire, the most violent since that of 9th Sept., 1841.
October 23	28·802	— yrs. 32	Extraordinary depression of the barometer.
Nov. 22	29·268	—	Barometer fell above half-an-inch from the day preceding,—and from this day until the 29th (a quarter-lunation), it was most unusually low, the minimum on the 24th being 28·793, and on the 28th, 28·893 : but it rose more than six-tenths on the 29th, when a shock was felt in Perthshire greater than any since 24th Sept., above mentioned, and until 23rd March following.

† These signs are explained in the notes at p. 202, ante.

In 1832, there occurred another series of remarkable maxima and minima of the barometer, connected with one another by single lunations. The 30th of June is one of the days of this series. About midnight of the 29th–30th, I saw an intensely-bright ball of fire, "approaching the full moon in size and the sun "in splendour,"* passing rapidly towards the south. It was seen in France as well as in different parts of England. Meteors of this nature have been frequently observed on the days when earthquakes have happened.† In the month of July following, the sea at the Shetland Isles was "in a state of oscillation similar to what "occurred in July," 1843.‡ The day of the month is not stated; but it will be seen from the following table that the 30th of June and the 15th and 30th of July (which are connected together by half-lunations) are all remarkable for the great maxima of the barometer.

* Mr. Prideaux, London and Edinburgh Philosophical Magazine, 1832, p. 307. In the preceding article of the same Magazine I have also given a description of this meteor.

† Mr. Milne, Edinburgh Philosophical Journal, 1841, p. 301.

‡ Edinburgh Transactions, vol. 15, p. 620.

TABLE IV.

Seven remarkable days near the days of new moon, and connected with each other by periods of single lunations.

Dates.	Barometer at Chiswick.		Atmospherical Phenomena.
1832			
April 30	29·315	†− { 10 / 120	
May 31	29·469	− { 28 / 6	
June 30	30·416	+ { 51 / 81	The meteor before mentioned.
July 30	30·390	+ { 15 / 51	At the half-lunation (15th July), the maximum was 30·407;—higher than for fifteen days before and sixty-six days after.
Aug. 28	29·156	− { 260 / 158	
Sept 25	30·427	+ { 3 / 29	
Oct. 25	30·471	+ { 33 / 23	

† These signs are explained in the notes at p. 202, ante.

On the 30th of December, in the same year (1832), on the day of the moon's first quarter, about the time of sun-rise, a shock of an earthquake was felt at Hayle, eight miles from Penzance, on the northern coast of Cornwall. One of my informants, whose house was only a few feet above the level of the sea, felt his bed under him to shake with considerable violence. The neighbouring houses, which stand on higher ground, do not appear to have experienced any shock. I neglected to mention this in my former Paper, which contained a list of Cornish earthquakes; and it is only now, I believe, for the first time recorded. It is, however, particularly worthy of attention, as the same shock appears to have been felt also in Swansea:* and Hayle and Swansea, as far as I

* "Dec. 30.—A shock of an earthquake was heard in the neighbourhood of Swansea. A "correspondent thus describes the effect:—"I was in my garden and at twenty minutes past 8 "o'clock, I heard a noise like the distant firing of heavy artillery which came booming from "S.W. by W.; in about two or three seconds it was succeeded by about four violent vibra-"tory motions which continued altogether from a second to a second and half, and passed "on in a direction N.E. by E., the sound apparently preceding the shock. As there was no "obstacle for several miles, it was distinctly heard passing in that direction for several "seconds after the shock had ceased. The motion seemed to be that of a wave extending "in a N.W. and S.E. direction, and passed from S.W. by W. to N.E. by E. Its effects were "very considerable, I felt myself shaken to and fro several times."—Gent's. Mag., 1832, p. 640.

can learn, are the only places where it was noticed. The barometer at Chiswick on the preceding day was at a minimum of 29·560, but on this day it was above six-tenths of an inch higher; and for ten days afterwards it was at a most extraordinary elevation. On the 8th of January, it was 30·732, and on the 23rd (a half-lunation afterwards), 30·783,—the highest I remember to have met with in any meteorological journal. On the 20th of February (a lunation after this extraordinary maximum), it was 29·061, lower than for eighteen days before and until the 28th of February (a quarter-lunation afterwards), when it sunk to the most unusual minimum of 28·898. This February, at Penzance, "was the wettest month "for fifteen years," as stated by the late Mr. Giddy, in his monthly meteorological report in the Philosophical Magazine. In the monthly report from Chiswick it is also stated that "a large "quantity of rain has fallen this month."

1755–1761. In my former Paper was shewn the lunar periodicity of the earthquakes and extraordinary agitations of the sea in Cornwall, from the 1st of Nov., 1755, to the 28th of July, 1761,—since which time the first known disturbance in this county appears to have been the shock now described as felt at Hayle on the 30th of
1832. Dec., 1832, the day of the moon's first quarter.

1837. On the 20th of Oct., 1837, the day before the moon's last quarter, a slight shock was felt in the eastern part of Cornwall. The barometer at Chiswick on the 21st (the quarter day) was 30·652, which (except on the 14th and 15th of the same month, and the 2nd of Jan., 1836, when it was respectively 30·713, 30·664, and 30·733) was higher than for some years before and afterwards.

The next recorded shock in Cornwall occurred at Scilly, on the 21st of Jan., 1839, the day before the first quarter; in connection with which must be noticed two remarkable days preceding it at intervals of half-lunations.

1838. Dec. 23. Day before first quarter. Shocks in Leicestershire and Naples. The Barometer at Chiswick on the 24th (the quarter day) was 29·312;—lower than for twenty-four days before, and thirteen days afterwards.

1839. Jan. 7. Moon's last quarter. Hurricane in England and Ireland, probably not exceeded by any in these islands during the present century. Barometer at Chiswick 29·096;—lower than for thirty-eight days before and twenty-three days afterwards.

1839. Jan. 21. Day before first quarter. Shock at the Scilly Isles. Barometer at Chiswick on this day 29·677, and on the four days following, 30·445, 30·551, 30·573, and 29·989.

1842. Feb. 17. The last shock in Cornwall was on the 17th of Feb., 1842, as mentioned in Table I. On the previous day the barometer at Chiswick was at an unusual maximum; while, at the quarter-lunation *after* the shock, it was at an unusual minimum. It was also at a considerable minimum at the quarter-lunation *before* the shock.

In the former part of this Paper it has been seen that earthquakes, oscillations of the sea, great atmospherical changes, and electrical phenomena, are closely connected with each other: and I have endeavoured to show that they may all result principally from the action of the moon. In support of this hypothesis, I have noticed two oscillations of the sea at and after the great earthquake of 1755, and two others at and after the great earthquake of 1761, the interval in each case being four lunations. I have also, in Table I., noticed eleven other such intervals,—six following each other in one series, and five in another. Each of the thirteen days forming these two series was remarkable for an earthquake, oscillation of the sea, or some very unusual state of the atmosphere, except on one occasion, when, however, an eruption of Vesuvius took place. In the same Table are many other similarly-remarkable days, forming series of periods of single lunations, or of half or quarter-lunations. All the remarkable days in Tables I. and IV., as well as those in the last two pages, connected with the earthquakes in Cornwall, occurred at or near the moon's quarters, and generally at or near her first quarters. But the remarkable days in Tables II. and III. did not happen near any of the four quarters, yet are, nevertheless, connected with each other by single lunations; so that the phenomena which occurred on these days were apparently as much influenced by the action of the moon as those which happened at or near her quarters.