

The foregoing research was finished many months ago, but I delayed publishing it in the hope of being able to announce at the same time the formation of lactic acid by a similar process. I find, however, from the 'Annalen der Chemie und Pharmacie' of last month that I have been anticipated by Wislicenus, who has succeeded in forming lactic acid in the manner I have just described.

December 17, 1863.

Major-General SABINE, President, in the Chair.

The following communications were read:—

- I. "First Analysis of 177 Magnetic Storms, registered by the Magnetic Instruments in the Royal Observatory, Greenwich, from 1841 to 1857." By GEORGE BIDDELL AIRY, Astronomer Royal. Received November 28, 1863.

(Abstract.)

The author first refers to his paper in the *Philosophical Transactions*, 1863, "On the Diurnal Inequalities of Terrestrial Magnetism as deduced from Observations made at the Royal Observatory, Greenwich, from 1841 to 1857." These results were obtained by excluding the observations of certain days of great magnetic disturbance; it is the object of the present paper to investigate the results which can be deduced from these omitted days.

The author states his reasons for departing from methods of reduction which have been extensively used, insisting particularly on the necessity of treating every magnetic storm as a coherent whole. And he thinks that our attention ought to be given, in the first instance, to the devising of methods by which the complicated registers of each storm, separately considered, can be rendered manageable; and in the next place, to the discussion of the laws of disturbance which they may aid to reveal to us, and to the ascertaining of their effects on the general means in which they ought to be included.

The author then describes the numerical process (of very simple character) by which, when the photographic ordinates have been converted into numbers, any storm can be separated into two parts, one consisting of waves of long period, and the other consisting of irregularities of much more rapid recurrence. He uses the term "Fluctuation" in a technical sense, to denote the area of a wave-curve between the limits at which the wave-ordinate vanishes. The Waves, Fluctuations, and Irregularities, as inferred from separate treatment of each storm, constitute the materials from which the further results of the paper are derived.

Table I. exhibits the Algebraic Sum of Fluctuations for each storm, with the Algebraic Mean of Disturbances, and Tables II. and III. exhibit the

Aggregate or Mean for each year, and the Aggregate for the seventeen years. The Aggregate for the Northerly Force is negative in every year. That for the Westerly Force is on the whole negative; the combination of the two indicates that the mean force is directed about 10° to the east of south. That for the Nadir Force appears negative, but its existence is not certain.

Some peculiarities of the numbers of waves with different signs are then pointed out. For Westerly Force and also for Nadir Force, the numbers of + waves and — waves are not very unequal; but for Northerly Force there are 177 + waves and 277 — waves. In Nadir Force it is almost an even chance whether a storm begins with a + wave or with a — wave; and the same with regard to its ending; in Westerly Force the chances at beginning and ending are somewhat in favour of a + wave; but in Northerly Force two storms out of three begin with a — wave, and ten storms out of eleven end with a — wave.

The beginnings and ends of the storms are also arranged by numeration of the combination of waves of different character in the different elements (as, for instance, Westerly Force + with Northerly Force —, Northerly force + with Nadir Force +, &c.); but no certain result appears to follow, except what might be expected from the special preponderances mentioned above, leaving the relative numbers of the combinations a matter of chance in other respects.

Tables IV., V., VI. exhibit the Absolute Aggregates of Fluctuations and Absolute Means of Disturbances without regard to sign. In interpreting these it is remarked that the large — mean force in the northerly direction necessarily increases the Aggregate and diminishes the Number of Waves. With probable fair allowance for this, it appears that the Numbers of Waves are sensibly equal, that the Sums of Fluctuations are sensibly equal, and that the Means of Disturbances are sensibly equal for Westerly Force and for Northerly Force. But the Number of Waves for Nadir Force is less than half that for the other forces; while the Sum of Fluctuations is almost three times as great as that for the others, and the Mean of Disturbances almost three times as great.

Attempts are made to compare the epochs of the waves in the different directions, but no certain result is obtained.

Tables VII., VIII., IX. exhibit for each storm, and for each year, and for the whole period the Number of Irregularities, the Absolute Sum of Irregularities, and the Mean Irregularity. It appears that the value of Mean Irregularity is almost exactly the same in the three directions, that the number of irregularities is almost exactly the same in Westerly Force and in Northerly Force, but that the number in Nadir Force is almost exactly half of the others.

It is certain that the times of Irregularities in the Westerly and Northerly directions do not coincide. There appears some reason to think that Nadir Irregularities frequently occur between Westerly Irregularities.

In Table X. the Aggregates of Fluctuations and Irregularities are arranged

by months, but no certain conclusions follow. In Table XI. the Wave-disturbances and the Irregularities are arranged by hours; for the Wave-disturbances results are obtained which may be compared with those of previous investigators; in Table XII. it is shown that these may be represented by a general tendency of wave-disturbances, different at different hours, which general tendency is itself subject to considerable variations. For the Irregularities it is found that the coefficient is largest in the hours at which storms are most frequent. It does not appear that any sensible correction is required to the Diurnal Inequalities of the former paper on account of these disturbed days.

The author then treats of the physical inference from these numerical conclusions. And in the first place he states his strong opinion that it is impossible to explain the disturbances by the supposition of definite galvanic currents or definite magnets suddenly produced in any locality whatever. The absolute want of simultaneity (especially in the Irregularities), and the great difference of numbers between the Waves and Irregularities for the Nadir Force (in which the Irregularities are just as strongly marked as in the Westerly and Northerly, and the Wave-disturbances are much more strongly marked), and those for the other Forces, appear fatal to this.

It is then suggested that the relations of the forces found from the investigations above, bear a very close resemblance to what might be expected if we conceived a fluid (to which for facility of language the name "Magnetic Ether" is given) in proximity to the earth, to be subject to occasional currents produced by some action or cessation of action of the sun, which currents are liable to interruptions or perversions of the same kind as those in air and water. He shows that in air and in water the general type of irregular disturbance is travelling circular forms, sometimes with radial currents, but more frequently with tangential currents, sometimes with increase of vertical pressure in the centre, but more frequently with decrease of vertical pressure; and in considering the phenomena which such travelling forms would present to a being over whom they travelled, he thinks that the magnetic phenomena would be in great measure imitated.

The author then remarks that observations at five or six observatories, spread over a space less than the continent of Europe, would probably suffice to decide on these points. He would prefer self-registering apparatus, provided that its zeros be duly checked by eye-observations, and that the adjustments of light give sufficient strength to the traces to make them visible in the most violent motions of the magnet. For primary reduction he suggests the use of the method adopted in this paper, with such small modifications as experience may suggest.