ADDITIONAL RESULTS OF EARTH-CURRENT OBSERVATIONS AT JERSEY, ENGLAND.

I am persuaded that the new facts which I have derived from the continued study of my observations of a subterranean electric current at Jersey, since I sent you the notes in January and February last,¹ will clear away more than one of the objections which may be raised either regarding the manner of capturing the earth-current without an aerial wire, or to the first and curious results which it has furnished.

The diurnal variation of two nearly equal oscillations which I obtained from my first observations is and should be of the same form as the diurnal variation in height of the water in a seaport open to the ocean tide. Twice in 24 hours the port is filled and emptied alternately, and these two oscillations of the sea are perceptibly equal in a given day. The variation of the potential observed at Jersey is a veritable *electric tide* which is produced in the Earth's crust parallel to the ocean tide at its surface.

What are the essential characteristics of an ocean tide? They are of two orders. Obeying the combined attractions of the Sun and the Moon, principally the Moon, on the Earth, the tide, from one day to another, presents a mean delay of 50 minutes, which nearly amounts to a delay of 24 hours in a period of 29 to 30 days. This is the length of a lunation. The potential of the Earth undergoes, under the influence of the Sun and the Moon in its diurnal variation, the same vicissitudes as the ocean. Each of its two daily maxima and minima is registered one day 50 minutes later than on the preceding day, so that in a lunar month of 29 to 30 days, each one of them has been registered once in every hour of the day and night. This plainly denotes an electric tide.

Another characteristic of the oscillations of the ocean tide is their amplitudes measured by the variation in the height of the water in a port between the low and high tides. When the attractions of the Moon and the Sun are added, as at the time of the new and the full Moon, the two bodies being then in conjunction or in opposition, the tides are greater. When the attractions counteract each other at the time of the first and last quarters, the action of the two celestial bodies being exerted at right angles, the tides are smaller. This second characteristic belongs also to the electric tide.

All this is shown in Table I, where I have collected, in accordance with the six lunations studied from October 1917 to April 1918, the essential elements of this phenomenon.

If this is true, it will be objected, the diurnal variation of the earth-current is radically variable. How did it happen that in my previous note I said it was essentially fixed? The two statements are not contradictory. In my first note, I presented only the monthly and seasonal means which are really fixed as regards the position of the mean maxima

¹See *Terr. Mag.*, vol. 23, pp. 37-39.

TABLE 1.—Variations in the voltage of the earth-current at Jersey during 6 synodic revolutions of the Moon from October 27, 1917 to April 25, 1918 for each hour of G. M. T., expressed in ten-thousandths of a volt.

G.M.T.	New Moon		First Quarter		Full Moon		Last Quarter		Mean Variation per Lunation	General variation in 1917
h										
0	+41	+37	-9	+10	+52	+49	-14	-13	+19.1	+16.1
1	+18	+48	+14	-12	+34	+60	+3	-33	+16.5	+10.8
2	-11	+44	+38	-31	+3	+54	+18	-42	+9.1	+3.5
3	-38	+26	+43	-39	-25	+32	+27	-38	+1.0	-5.2
4	-56	0	+40	-25	-47	0	+27	-27	-11.7	-13.8
5	-59	-28	+25	-21	-48	-27	+17	-3	-18.0	-20.6
6	-47	-48	+3	-1	-38	-48	+1	+17	-20.1	-24.0
7	-21	-56	-19	+20	-18	-54	-15	+31	-16.5	-22.8
8	+10	-49	-35	+36	+6	-45	-26	+36	-8.4	-16.1
9	+40	-30	-42	+42	+28	-23	-27	+31	+2.4	-5.2
10	+61	-3	-39	+37	+44	+4	-21	+19	+12.7	+8.7
11	+66	+25	-26	+23	+51	+31	-6	+3	+20.9	+20.2
Noon	+56	+47	-8	+3	+47	+49	+9	-14	+23.6	+26.7
13	+32	+58	+11	-18	+34	+57	+22	-33	+20.4	+26.3
14	+1	+56	+27	-36	+8	+51	+29	-37	+12.4	+18.5
15	-29	+41	+37	-45	-20	+31	+30	-38	+0.9	+5.8
16	-51	+17	+38	-44	-47	+4	+24	-29	-11.0	-6.8
17	-58	-10	+30	-33	-63	-27	+15	-3	-18.6	-16.0
18	-50	-35	+14	-13	-64	-51	+3	+10	-23.3	-18.7
19	-29	-50	-7	+10	-48	-64	-10	+30	-21.0	-14.5
20	-1	-51	-26	+30	-17	-60	-21	+43	-12.9	-5.8
21	+27	-38	-37	+42	+18	-41	-30	+45	-1.8	+4.3
22	+46	-14	-39	+42	+47	-10	-32	+33	+9.1	+12.7
23	+51	+14	-29	+30	+61	+23	-26	+12	+17.0	+16.2
Mean Voltage	0.1068	0.1078	0.1025	0.1075	0.1075	0.1074	0.1066	0.1065	0.10658	0.08981

and minima. By about a day, the civil month and the lunation are the same (see the next to the last column of Table 1); the two maxima of the mean day will always fall at midnight and midday corresponding with the passages of the two bodies at the meridian, and the two minima at 6 h. and 18 h. corresponding with the two bodies at the horizon. This fixity of the phases of the mean diurnal variation of the current is further verified by the last column of the table where will be found the mean diurnal variation resulting from the 365 days of the year 1917.

It is necessary, moreover, to insist much on the explanation to be given to this mean fixity which I thought well to indicate in my previous communication. In the series of calm days in 1917, the greatest number has shown what I thought I might give as the normal variation of the earth-current; the others presented themselves with an opposite variation, maxima and minima having interchanged their hours of registration. The fact that the calm days as a whole, in each month of the year, always have the form of the mean diurnal variation of the whole lunation, shows

that the frequency of days of electric calm is greatest at the syzygies, epochs which impose on the mean lunation their common forms of variation that places the maxima of potential at midnight and midday and the minima at 6 h. and 18 h. On the other hand, since all opposition between the attracting forces should cease as soon as the resulting effect is a maximum or a minimum, the electric calms are again found at the epochs of the quadratures which are the epochs of the minima of resultant action. But at the quadratures, the maxima of potential arrive 6 hours later than at the syzygies. The variation should then be reversed, as is seen in our table in the 2 columns, "First Quarter" and "Last Quarter."

A final proof of the conformity of the two tides. It is known that the solar and lunar actions combined are strongest at the equinoxes and weakest at the solstices, causing the greatest and the smallest tides of the year.

The following is what has been observed, in this connection, at Jersey this year:

	Mean Amplitudes of the Tides		
	Electric Volts	Ocean m	Theoretical Coefficients
At the solstice (28, 29, 30 Dec. 1917) =	0.0093	8.66	84
At the equinox (13, 14, 16 Mar. 1918) =	0.0173	12.12	119

A satisfactory agreement; it is the same phenomenon under two different aspects. And yet the agreement is not absolute all along the line. There is one point, and a point that must be considered seriously, where there is disagreement. The ocean tide is later than the Moon, in the sense that the day of the new Moon the high sea does not coincide with the passage of our satellite at the meridian, but arrives a certain time afterwards, at Jersey 6 hours later. Now the electric tide is ahead of the Moon, the maximum of potential nearest the hour of the passage of the Moon at the meridian of Jersey being always in advance by one hour at the syzygies, and by 2 to 3 hours at the quadratures. This is the fact: it is a real discordance, which demands an explanation but which does not weaken in any degree the conclusion from what precedes. There is an electric tide just as there is on our globe an oceanic tide; the first like the second is immediately dependent upon the combined attractions of the Moon and Sun.

The phenomenon here under discussion is being further investigated.
Jersey, England, May, 1918. MARC DESCHEVRENS, S. J.