

my communication to NATURE, vol. xvii. p. 183, to show the latter fact as far as the observations go up to the present time. I did not, however, venture in that article to make a guess as to the future, which really could have little weight till we have another year's observations. Yet I thought it desirable, nearly two months ago, to place in the hands of Prof. Balfour Stewart the evidence that the possibility of such an event, as an obvious conclusion from my results, had not escaped me. As Mr. Jenkins has published his guess, I may do the same with mine. The latter differs, however, from his in a very important way. He supposes the next maximum will be in 1887, whereas I suppose that the weak maximum of 1797 may be repeated near 1880. In this latter case the interval between the two will be nearly double that found by me (forty-two years), during which the sun-spot period appears to have all its different lengths.

February 1

JOHN ALLAN BROWN

Terrestrial Magnetism

I HEREWITH submit a notice of an experiment for illustrating to a class the action of terrestrial magnetism. In a simple way it clearly exhibits to a large audience the action of the currents of electricity that pass around the earth. The experiment was suggested on reading a paper by Prof. J. W. Mallet, F.R.S., of the University of Virginia, on "The Apparent Alteration in Weight of a Wire placed East and West, and Traversed by an Electric Current" (*Phil. Mag.*, November, 1877).

Instead of disconnecting the wires placed east and west from the portion of the rectangle, as was done by Prof. Mallet in the experiment alluded to, whereby the attractive or repulsive action of the earth currents on one side only of the rectangle was obtained, it occurred to me to suspend the whole rectangle to a balance. Properly arranged in this way the attraction for parallel currents in same direction, and repulsion for currents in opposite direction would generate a couple, tending to produce rotation around an east and west horizontal axis, and hence augment the deflection of the balance.

A rectangular frame was made of light poplar wood, of section three by two centimetres, whose sides were one metre in length by three-fourths of a metre in breadth. About the perimeter of this rectangle there were wrapped twenty coils of insulated copper wire. Each extremity of the wire was made to terminate near the centre of one of the shorter sides, and passing through the wooden frame, was fastened and cut off about 3 c.m. from the frame.

This rectangular frame was then so suspended, in a horizontal position, by wires attached to the pans of an ordinary Delenil's hydrostatic balance, that the longer sides were at right-angles to the beam. By adjusting weights in the scale pans the index of the balance was brought to the zero. Two small orifices bored in a block of wood a centimetre apart, served as mercury cups, in which the extremities of the short terminal wires were immersed; near the bottom and through the walls of these wooden mercury-cups were screened small brass hooks, which served as connectors, to which the wires of the battery were attached. The balance was now so placed that the longer sides of the suspended rectangle were at right-angles with the magnetic meridian, or in the magnetic east and west line.

When the current from the battery was made to pass around the rectangle from east to west, on the northern side, and from west to east, on the southern side, by the theory of terrestrial magnetism, the north side of the rectangle would be attracted to the earth, and the south side repelled, and that this was so the corresponding deflection of the balance rendered plainly visible. When the current was reversed the deflection was in the opposite direction. By breaking and closing the circuit at proper intervals to augment the oscillations, the large frame was readily made to oscillate through an arc of 5°. When the sides of the rectangle were placed north-east and south-west, the current produced no sensible effect. A bichromate of potash battery of sixteen cells was used with plates of zinc and carbon 25 cm. by 6 cm.

With a rectangle containing a larger number of coils of wire attached to a delicate balance by the use of a constant battery, the variations in the earth's magnetism might be thus observed.

WM. LEROY BROWN

Vanderbilt University, Nashville, Tenn., January 11

Seiches and Earthquakes

IN the last number of NATURE (p. 234) you make an allusion to the fact that the earthquake of October 8, 1877, has not been

traced by the self-registering "limnimeters" (tide-gauge) of M. Ph. Plantamour at Geneva, and myself at Morges. Let me take the opportunity of the great publicity of your excellent paper to ask the naturalists who live in other countries more frequently visited by earthquakes, for an explanation.

I believe I have demonstrated in many different papers that the phenomenon called *seiches*, which consists in rhythmical movements of the level of the lake, is a balancing-wave, a wave of stationary uninodal oscillation. The water moves in balancing oscillation in the two principal diameters of the lake, in the direction of the greatest length and of the greatest breadth. For setting the water in such an oscillatory movement there are two possible causes:—

1. A shock given to the water itself is the most frequent case, and I can prove that generally the *seiches* are caused by some rupture of the equilibrium of the atmospheric pressure; many storms, and especially those that fall somewhat abruptly on the lake, are accompanied by very high *seiches*, and I have many examples of the beginning of the oscillatory movement of the water exactly at the same time the storm commences.

2. A movement of the soil on which the water lies, an earthquake. It is evident that a shock given to a basin can put the water in oscillatory movement. In fact, it happens frequently. I will only recall the colossal transmission-waves in the Pacific Ocean on August 13, 1868, after the earthquake of Arica; that of May 9, 1877, at Iquique; and in earlier times, the earthquakes at Messina, 1783; at Port-Royal (Jamaica), 1692; at Callao, 1586, &c. If such enormous waves had taken place in a closed basin, as our lakes, it would probably have brought about an oscillatory movement of *seiches*. I could bring many facts to prove it; only one example, the earthquake of Lisbon (1755), was noticed in Switzerland and Germany, chiefly by the movements of the water of the lakes; the description of these movements recalls perfectly the *seiches*.

It is also theoretically probable that the shock given to the ground extends to the waters, and that an earthquake will produce *seiches* in a lake. Unfortunately the facts observed up to this time do not confirm this theoretical view. Since I established at Morges a self-registering limnimeter of the greatest sensitiveness, in March, 1876, six different earthquakes have been noticed in our country, and specially three earthquakes were felt at Morges itself—May 7 and November 29, 1876, and October 8, 1877. Not one of those six earthquakes has been traced by the self-registering limnimeter; not one has interrupted the rhythmic oscillation of the *seiches* which were taking place; not the smallest alteration of the curve has shown that the water had been acted upon in a peculiar manner; neither was the limnimeter of M. Ph. Plantamour, which was at work during the earthquake of October 8, 1877, influenced by that very severe shock. And yet our apparatus are extremely sensitive; when the lake is sufficiently calm my limnimeter can show the waves originated by a steamboat which passes 10–15 kilometres off the apparatus, or it registers the waves caused by a steamer which has passed by my observatory two or three hours before.

How can these contradictory facts be explained? On one hand, the earthquakes cause in many places enormous waves; on the other, three earthquakes strong enough to have awakened men out of their sleep, have not put in movement the most sensitive, always working, self-registering apparatus.

I suppose that the shocks of the earth do not transfer always the movement to the water; that only in a special direction of the shock a special intensity, a special duration, the water itself is put in movement and takes the rhythmic oscillation of the *seiches*. If I shake a basin the water is not always and necessarily put in oscillatory movement. I think it is the same for the *seiches*, and I believe that only certain movements of the earth cause the water of the lakes to move.

It is the point on which I seek an answer from naturalists who have more opportunity to observe the effects of earthquakes. I ask if each earthquake is accompanied by waves of the sea; if each shock of the same intensity is accompanied by waves of the same amplitude; if there are not differences between the different earthquakes; if some have the enormous waves of Iquique or Arica; if others are without those waves?

I should be very thankful to receive an answer to the above questions.

F. A. FOREL

Morges, Switzerland, January 24