of species here is in direct proportion to the amount of rainfall. The stream gradient at this altitude is very high, but great humidity permits standing pools of water outside of the rivers themselves. Full tables of the distribution of the fishes of Colombia and Ecuador will be given in the final complete reports.

ARTHUR HENN

SPECIAL ARTICLES

POSSIBLE FACTORS IN THE VARIATIONS OF THE EARTH'S MAGNETIC FIELD

NEWALL[1] has described a very interesting experiment in which "a lamp flame held under an iron or steel wire (which is in circuit with a galvanometer), so that a short portion of the wire becomes red hot, is made to travel slowly under the wire, and it is found that a current appears in the galvanometer, the direction of the current depending on the direction in which the flame travels. Tomlinson[2] described a similar experiment at an earlier date than Newall. While this current is described as due to difference in thermo-electric quality between the iron or steel in the magnetic and non-magnetic state, yet it is suggestive of what might happen in the crust of the earth as the sun's rays fall upon its surface and warm it.

The following simple experiments were carried out with a view to getting more light on the phenomenon of earth currents and their relation to the earth's magnetic field. A board, seventy-five centimeters long and four centimeters wide, Fig. 1, had a shallow rim fastened around it so as to form a tray. At either end was fastened a zinc strip, both of which were in turn soldered to copper wires leading to a galvanometer. In this tray and covering the zinc terminals, a fairly homogeneous paste of mud was placed about one half centimeter thick. The water used in making up the mud paste was slightly acidulated with sulphuric acid to make it a better conductor. When a Bunsen flame was allowed to play on this strip of mud for some little time and then slowly moved in one or the other direction lengthwise of the tray, a current was set up in the galvanometer, depending upon the direction of the motion of the flame.

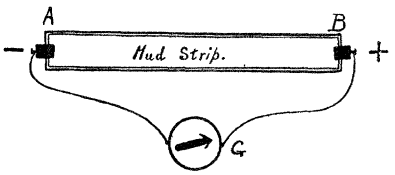

FIG. 1

If the electrode marked *B*, Fig. 1, was made positive by applying the positive pole of a dry cell to it and the negative pole to *A*, then the galvanometer gave a deflection to the left. When the flame was slowly moved from *A* toward *B*, the deflection of the galvanometer was to the right, and when the motion of the flame was reversed the current was also. This indicated that the direction of the current was opposite to that of the burner.

Suppose now this condition exists in the surface of the rotating earth as the heat rays of the sun falling upon it move from east to west. A current will be set up in the opposite direction, *i. e.*, from west to east, which will locally complete itself on the earth's surface somewhat as shown in Fig. 2.

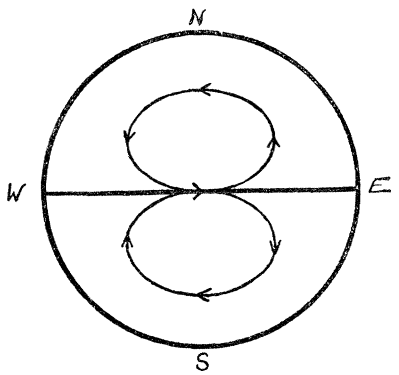

FIG. 2

It was found that the hotter the Bunsen flame for a given rate of moving, the greater

[1] Newall, *Philosophical Magazine*, June, 1888. See also Ewing's "Magnetic Induction," p. 184, 3d ed.

[2] Tomlinson, *Philosophical Magazine*, January, 1888, p. 50.

the deflection of the galvanometer. Hence we would expect that the maximum current density would be set up in the earth's crust, most directly under the sun and parallel with the equator. Consequently the resultant of all of the current filaments set up in the earth's crust would be represented by Fig. 2, in which the currents in the southern hemisphere would be opposite to that in the northern.

As this current sheet advances westward with the sun, and its magnetic field strikes the various magnetometer needles, there will be the conditions for a westward deflection in the northern hemisphere and an eastward deflection in the southern hemisphere, followed later in the day by a reversed deflection in both cases.

This experiment on the mud strip was repeated and the same results obtained with several kinds of soil to be found here locally. The relation of direction of current and direction of motion of flame was the same for the mud strip as for the iron wire investigated by Tomlinson.[2] From what we know of thermo-electric elements, it would seem possible to find conditions where the direction of the current would be the same as the flame. For instance, in large areas covered by glacial deposits if one edge of the deposit was heated more than the opposite edge we might possibly find a condition as just stated. Certain it is that oceanic areas would differ from land areas for these thermo-electric earth currents.

It was interesting to note the effect of pouring water on the strip of mud. Fairly large disturbances were produced when one or the other edge of the wet portion was heated. Local showers might thus produce local magnetic disturbances.

Blowing air either on one side or the other of a heated section of the strip also produced regular disturbances. Winds in this respect may be a possible cause of magnetic disturbances.

The cooling effect of a cloud passing over the sun or the shadow of the moon sweeping across the earth's surface in an eclipse may be made manifest by setting up these thermo-electric currents which will affect the earth's magnetic field. The temperature to which the mud was heated was bearable to the hand.

Whether these thermo-electric currents actually exist in the earth's crust as due to the heat of the sun's rays, and whether they could be picked out from other earth currents, is a matter to be investigated further, but for the present it does seem worth while to learn more about these thermo-electric currents due to a moving heat source or sink in all sorts of conductors, particularly electrolytic.

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CHANGES OF DRAINAGE IN OHIO

THERE is probably no state in the union in which the advance of the ice caused more decided and interesting changes in drainage than Ohio. Almost every stream of any importance in the state is now running in a new channel for at least a part of its course, and most of them for practically their entire distance.

During the progress of the reconnaissance soil survey of Ohio the writer had an opportunity to visit every section of the state and to make some study of the adjustments in drainage which resulted from the advance of the ice. Some observations and conclusions are believed to be of general interest and may be of value in interpreting changes in drainage elsewhere.

The most important relates to the probable interglacial rather than preglacial origin of many old valleys in Ohio, but the gravelly nature of all terraces along streams in or issuing from the glaciated section of the state, as contrasted with the silt and clay character of the terraces along nonglacial streams, is also worthy of mention, as this fact often helps to determine the age as well as the direction of flow of some old streams.

The course of the old Kanawha River was definitely traced many years ago through the hills east of the Scioto in southern Ohio as far north as Waverly, but as to its further course there has been some doubt. The occurrence of deposits, similar to those in its old