LETTERS TO THE EDITORS

GEOPHYSICS

Correlation between Earth-Current and Geomagnetic Disturbance

THE relation between earth-current and magnetic activity is generally known, but we have not noted any quantitative data in the form of correlation coefficients.

W. J. Rooney[1] presents curves of earth-current activity, magnetic activity and sunspot numbers for the epoch 1910–1930, showing close correlation between geoelectric and geomagnetic activity. He states that true earth-current disturbances (as opposed to interference phenomena) are always accompanied by magnetic disturbances. Frequent comparison of magnetic and earth-current records taken at College, Alaska, during the past several years substantiates Rooney's observation. To arrive at a quantitative measure of the relation, correlation coefficients were calculated for each of several months. The correlations were made between the equivalent daily amplitude, A_{co}, of the College magnetic activity and the mean daily earth-current activity.

The College equivalent daily amplitude, A_{co} in gammas, is determined by converting the eight scaled K-indices to field intensity according to the following schedule, and taking the arithmetic mean[2].

K	0	1	2	3	4	5	6	7	8	9
γ	0	30	70	150	270	480	800	1400	2400	4000

The mean daily earth-current activity was determined by scaling the earth-current records for amplitude activity on the 3-hr. periods corresponding to the K scaling and taking the arithmetic mean of the 8 values for the day. Only north-south records were scaled because of the generally undirectional flow of the earth-current disturbances at College. The values of the correlation coefficients for six randomly selected months are given in Table 1.

Table 1

September	1957	..	..	..	..	0·946
February	1958	..	..	..	..	0·941
March	1958	..	..	..	..	0·939
April	1958	..	..	..	..	0·975
September	1958	..	..	..	..	0·948
November	1958	..	..	..	..	0·939

In conjunction with the calculation of the correlation coefficients, scatter diagrams were plotted and least squares regression lines calculated for each of the six months. There were no widely scattered points. Fig. 1 is the scatter diagram and regression line of earth-current activity on geomagnetic activity for April, 1958.

To obtain an additional measure of the relation between these two phenomena the correlation coefficient of earth-current activity in mV./km. versus magnetic activity in gammas was calculated for the
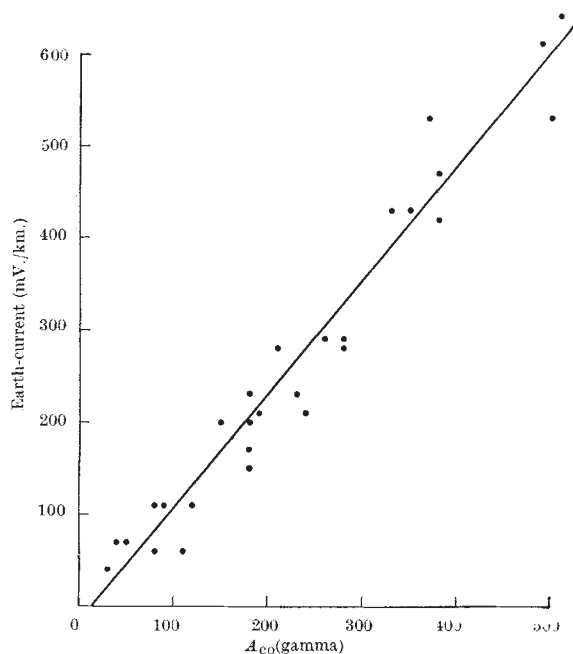

Fig. 1. Scatter diagram and least-square regression line. Earth-current activity versus magnetic activity at College, Alaska, April, 1958

3-hr. periods of April, 1958. The correlation coefficient for this set of 240 values is 0·833.

These very high correlation coefficients show that earth-currents may be used interchangeably with the magnetic disturbances as an indicator of ionospheric activity. In areas where d.c. interference such as street railway systems is not a problem an earth-current recording system can be set up much more readily than a comparable magnetic system. To indicate activity only one recorder and one pair of electrodes oriented in the preferred direction of the earth-current disturbance is required. Furthermore, none of the equipment needs to be isolated from the usual laboratory activities which would interfere with the operation of a magnetometer.

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[1] Fleming, "Terrestrial Magnetism and Electricity", 291 (Dover Publications, 1949).
Bartels, "Annals of the International Geophysical Year", 4, Part 4, 229.