



Investigation of alternating components of earth potentials  
by Weston B Farrand

A Thesis Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of  
Master of Science in Engineering Physics  
Montana State University  
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Abstract:

The presence of alternating earth potentials is established by use of a ground wire and a grounded vacuum tube voltmeter.

The alternating potentials appear to consist of several frequencies and energies. The investigation was carried out using filter circuits, vacuum tube voltmeter and wire recorder. The potential varies from day to day in energy values. The maximum value reported is 45 millivolts for 1000 foot electrode separation. The frequency range is from 800 to 5000 cycles per second with the higher frequencies containing a great deal more energy than the lower frequencies.

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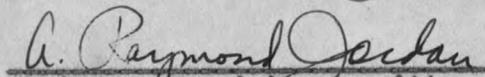
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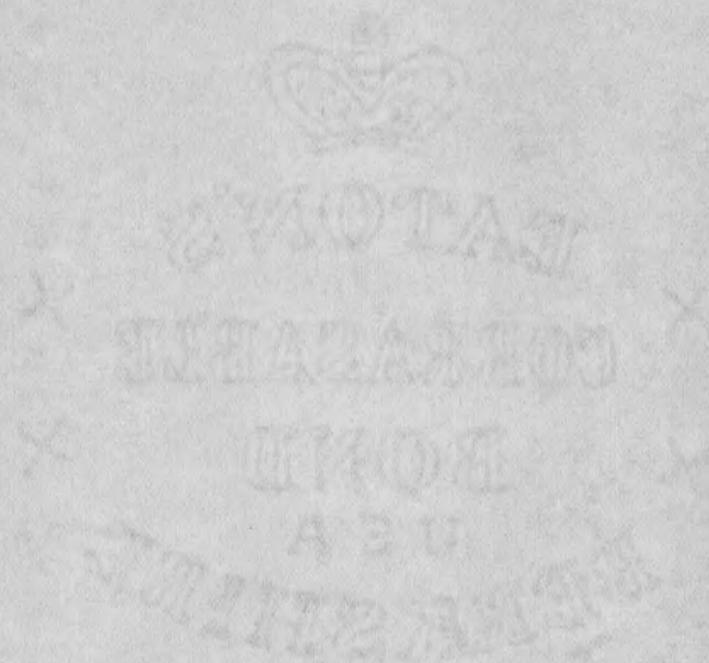
  
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### Abstract

The presence of alternating earth potentials is established by use of a ground wire and a grounded vacuum tube voltmeter. The alternating potentials appear to consist of several frequencies and energies. The investigation was carried out using filter circuits, vacuum tube voltmeter and wire recorder. The potential varies from day to day in energy values. The maximum value reported is 45 millivolts for 1000 foot electrode separation. The frequency range is from 800 to 5000 cycles per second with the higher frequencies containing a great deal more energy than the lower frequencies.

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## Introduction

The problem consisted of (1) determining if low frequency earth potentials existed; (2) determining some of the characteristics of the potentials if they did exist; (3) determining, if possible, some of the causes of such potentials.

## Historical Background

The literature cites this type of problem under the title of "Earth Currents". The strict definition of "earth currents" should be construed as excluding all man-made flow of electricity like that due to leakage from power lines and currents that are purely local in nature.<sup>8</sup> In order to determine current flow, it is necessary to know the potential gradient and the specific conductivity of the region of earth involved in the investigation. The measurement of the horizontal potential gradient is not a difficult task, but the determination of the specific conductivity is almost impossible. This difficulty arises from the fact that the earth is made up of a heterogeneous mixture of various types of soils, all with different specific conductivities.<sup>9</sup> Thus it is apparent that the proper title should be "earth potentials".

Previous investigations have dealt with the direct component of the potentials only. In trying to measure the DC component of the potential, several things have to be taken into account. Contact potential between the earth and the electrode has caused a great deal of trouble. If the contact potential were steady it could be taken into account, but the degree of moisture in the soil changes the value of the contact potential. These contact potential changes, coupled with the contact resistance changes,

gave great current variations through the recording D'Arsonval galvanometer. Because these changes were unpredictable, correction factors became only approximations, and no conclusion could be drawn concerning the actual potential level.<sup>10</sup>

Because of the difficulties mentioned, W. J. Rooney, one of the recent investigators of earth potentials, has stated that only the variations can be considered. Rooney has pointed out that world-wide variations in earth-potentials coincide with world-wide variations in magnetic fields. In fact, the presence of a world-wide magnetic storm coincides with earth-potential storms. He points out that these also coincide with sunspot activity.<sup>10</sup>

Using the data from the 20 to 30 stations located about the earth, O. H. Gish has mapped the direction of the potential gradient and the results indicate that there is a circulatory tendency to the DC component of earth potentials. The areas where these circulatory actions seem to take place coincide with the general land areas. That is, on the continent of North America there is a closed flow of electricity. On the Europe-Asia continent there is another closed flow; on all other continents there is the same type of closed flow.<sup>3</sup>

The presence of earth-potential storms and magnetic storms often coincides with brilliant auroral displays. The effect of polar disturbances is also detected in the recordings of earth-potentials.<sup>4</sup>

One of the present day theories concerning the causes of earth-potentials and magnetic fields is the circulation of ionized air in the ionosphere. When the correlation between auroral displays and earth































