A PRELIMINARY INVESTIGATION OF THE USE OF RADIO WAVES IN GEOPHYSICAL RECONNAISSANCE

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

It is well known that the actual field intensity of a radio frequency transmitter differs considerably from the theoretical or calculated field intensity distribution at any given instant of time. Among the phenomena known to effect electromagnetic fields are: disturbances of the earth's magnetic field, sun spot activity, fluctuations in the conditions and height of the ionosphere, atmospheric conditions, man made disturbances and geologic conditions. It would obviously be a formidable task to attempt to consider all or even a few of these phenomena. However, it is believed that the effects caused by variations in geology can be more easily studied because such effects will always be present in a given locality. Regardless of the fluctuations produced by one or any combination of other phenomena listed above, the effect of a given geological feature should always show up as a strengthing or weakening of the electromagnetic field relative to the intensity of the field outside of the influence of the geologic feature. In other words, any consistent localized anomaly in an electromagnetic field should be detectable as a relative field strength fluctuation

regardless of the presence or absence of various regional effects. Some regional effect may mask the local anomaly on a particular record, but it is extremely unlikely that it would do so on a series of records taken at different times.

In considering the electromagnetic field produced by a radio transmitter, one must take into account the boundary that exists between the earth and the atmosphere. Reflections from the ionosphere may be neglected in this particular case since only areas close to the antenna in the region of the direct wave will be considered. Usually, in considering the field of a transmitter, the earth is assumed to be homogeneous as far as its electrical properties are concerned. Without this simplifying assumption, the problem would be extremely difficult to treat by mathematical analysis, except perhaps in simple two layer cases with plane or at least regular boundaries. However, actual conditions in the earth rarely conform with these assumptions. The earth is composed of materials of widely varying electrical properties. In some areas formations of contrasting electrical properties lie adjacent to each other and exposed on the surface. An outcroping igneous dike surrounded by sediments is one example among many. In cases where the formations are exposed at the surface, actual field experiments have shown

that the geology does have a measurable effect on a radio frequency electromagnetic field.[1] A similar result in cases where the geologic feature was not exposed at the surface would of course be of much greater significance.

The possibility of detecting the presence of a sub-surface geologic feature by its effect on an electromagnetic field at the surface of the earth depends of course on penetration of the earth by the electromagnetic waves of the primary field. While it is generally agreed that low frequency radio waves do achieve some penetration under special conditions there is considerable disagreement in the literature as to the degree of penetration of the earth by electromagnetic waves, especially at higher frequencies.

It will be the purpose of this paper to present the results of an investigation of the effect on a radio frequency electromagnetic field of a vertical column of igneous rock surrounded by sedimentary beds of contrasting electrical properties. In order to facilitate the field work and eliminate random effects at the surface the field strength measurements were made from a low flying aircraft.

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[1]References listed at end of each chapter.