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ELECTRICAL MODEL INVESTIGATIONS USING THE HORIZONTAL PROFILING TECHNIQUE

BY

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in partial fulfillment of the requirements for the
Degree of
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in
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January, 1960
Rolla, Missouri

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I. INTRODUCTION

Electrical exploration methods have been used for many years as a means of determining subsurface structures and in the search for mineral deposits. Vertical profiling techniques can be used to determine rather accurately the resistivity and thichness of horizontal or gently dipping beds for cases up to four layers. Mathematical calculations have been made for multiple layers and theoretical curves have been computed and published for four and more layers. The vertical profiling method is not particularly well suited to the problem of locating lateral changes in resistivity produced by such features as ore bodies, sinks and channels. These features can more easily be determined using the horizontal profiling method.

A set of horizontal profile curves, showing the effects of size, depth of burial, and the edges of the various anomalous subsurface features liable to be encountered in the field are desired. It is possible to compute theoretical curves for simple shapes, but many of the features encountered in practice are quite complex. The curves for these complex shapes are impossible to compute, and even for those simple shapes for which curves can be computed, the calculations that are necessary are long and laborious.

Laboratory investigations of models of geological structures might be a means of providing this needed set of curves. In order to determine if horizontal profile curves could be produced from a laboratory model system, a study was made of the electrical method of exploration as applied to a small scale model system. The necessary equipment was assembled and a number of model measurements was made. To show that the equipment provided results that would be useful and reliable, curves obtained using a model conductive hemisphere were compared with theoretically computed curves for this same case. Finally, a series of measurements was made over several different models and the resulting horizontal profiles are presented as examples of the type of curves that can be produced using a small scale model system.

II. LITERATURE REVIEW

An investigation was undertaken to determine the procedure and apparatus needed to carry out small scale electrical model experiments in the laboratory. Some previous studies had been made on electrical models and a brief history of that work is presented here.

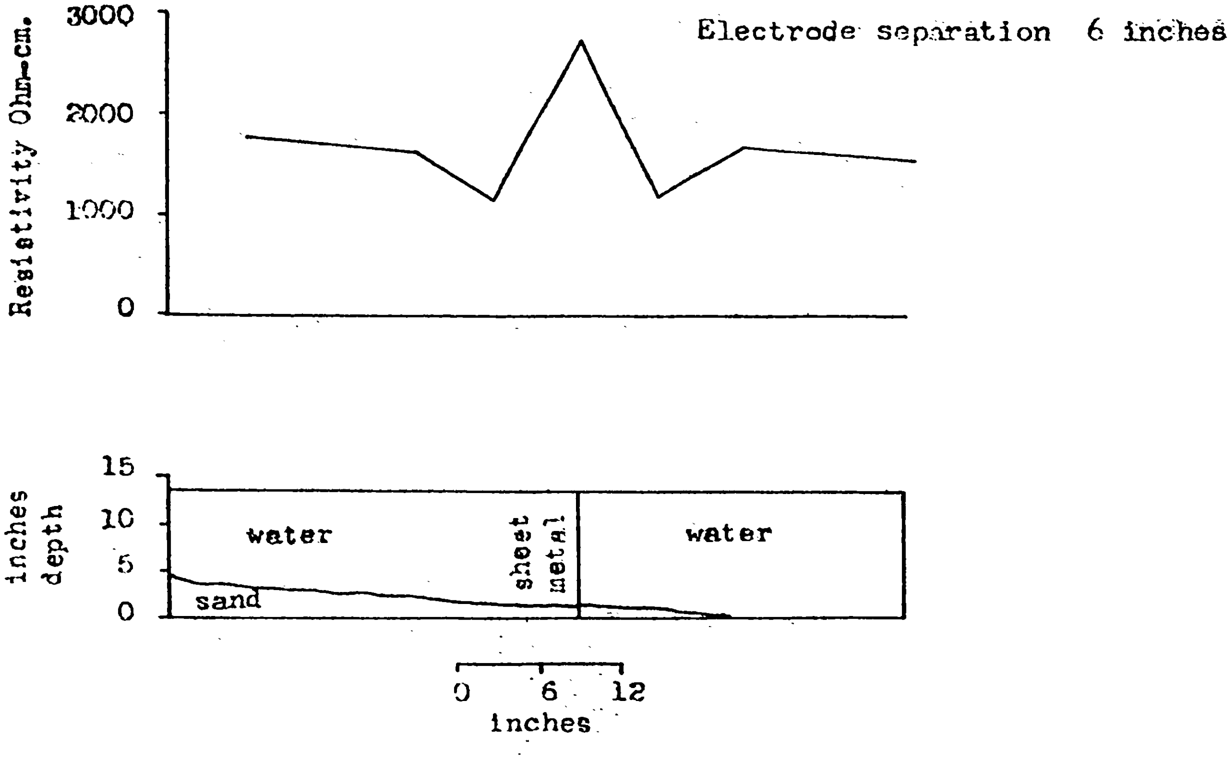
Early model experiments were run in 1929 by J. H. Swartz (11). The investigation was an attempt to determine the effect of topography on the character of the curves obtained from resistivity surveys. It was desired also to learn which of the electrode configurations available produced the most easily interpreted data. Artificial beds were prepared in the following manner. First, a hole 15 feet long, 12 feet wide, and 3 feet deep was dug in the ground. Three layers of sand separated by layers of clay were placed in the hole and measurements were taken at points along a line across these artificial beds using different electrode configurations.

The results of Swartz's investigation showed that Lee's method of partitioning gave the sharpest, most easily interpreted data. A topographic correction was found to be necessary since the current electrode was moved over an uneven surface during normal expansion of the configuration. In any attempt to calculate depth, the measurements should be calculated from the elevation of the current electrode. If the depth is to be determined for the center of the configuration, as is usually the case, a correction must be made for any difference in elevation between the current electrode and the center of the configuration.

M. King Hubbert (5) refers to a model that was used to check the results of an electrical survey made across a fault. A piece of sheet metal was placed vertically in a tank of water, and measurements taken along a traverse across the strike of the plate using the Wenner configuration and an electrode separation of six inches. The resulting profile, over the sheet metal plate, was in the shape of a W with the center peak of the curve being sharply resistive over the center of the plate as shown in figure 1. Hubbert believed that this peak should not be sharply resistive, but should have a more gentle slope. L. G. Howell, in discussion of Hubbert's paper, related that, in tests made in a wooden tub, it was found that sheet metal with an uncleaned surface or a grease film on the surface produced very high resistivity peaks over the sheet. A cleaned copper sheet showed a smoother rounded curve over the metal sheet.

T. A. Manhart (8) experimented with models placed in a large tank. The purpose of his study was to provide a means of interpreting resistivity depth curves, and also to check, by experiment, the theory of interpretation of resistivity curves which had been developed by Hummel (6). Sand, clay, and muddy water made up the three layers for these tests. Both empirical and mathematical means were used to interpret the model curves. Hummel's theory is an indirect method of interpretation while Tagg's (12) method is an example of a direct interpretation. Manhart says that the Gish-Rooney depth interpretation, which states that depth is approximately equal to electrode spacing, is seldom valid, and then only under certain conditions. The results of Manhart's investigation showed that the theory developed by Hummel gives exact results if properly used while extreme care must be taken when correlating depth to electrode spacing. The depth relationship, between the true depth and the electrode spacing, held for only a few of the experimental tests.

FIGURE 1



Experimental traverse profile across a piece of sheet metal immersed in water. (after Hubbert)

Jakosky (7) mentions that small scale model experiments are useful to determine the effects of conductive ore bodies buried in a more resistive media. Some of the experiments that have been performed are described and the results obtained are explained. The proper procedure for conducting such experiments is outlined along with a caution as to interpretation of model results.

A model of the earth has been prepared by Pritchett (9) for study of various types of structures that might be found by electrical prospecting. The model was scaled dimensionally with respect both to size and resistivity. The resistivity required was not found in any natural occurring material, so a mixture of wax and brass filings was prepared. This model had the desired resistivity needed to approximate a scaled model of the earth. Spring loaded electrodes were made to insure a good contact with the model and were accurately positioned in a lucite plate placed on the top surface of the model. Many of the investigations were made using inductive coupling, but the author mentions that a surface survey made with the Wenner configuration over a model of a salt dome showed only a minor anomoly.

Sumi (10) relates that he used model experiments to check the results of theoretical and field curves using horizontal profiling across an inclined thin bed. He used a tank filled with water and placed strips of metal along the end walls to act as current electrodes. The measurements were taken over a metallic inclined plate and also over a plastic resistive material placed in the same position. Measurements were taken at the same points along the traverse without the models. These values were subtracted from the values obtained with the models in the tank and the results plotted as potential curves for the models. There was good agreement between the results of the model runs and the field and theoretical curves.

The effect of the material used for tank walls has been investigated by Goudswaard (4). He found that, by trial and error, the walls of the tank could be compensated to produce a larger usable surface area, free from tank effect, for model experiments. Both resistive and conductive materials were used as wall materials. The resistive Perspex tank walls did not give as much usable surface area as did the walls when partially covered with brass screening. The fluid used was salt water and copper electrodes were set up in the Wenner configuration for the measurements. The results also showed that when the outer electrode approached close to the tank wall, erratic effects were noted. The resistivity of the solution used was determined to have little influence on the amount of usable surface area available.

Cagniard and Neale (1) found that the problem of accurately duplicating the positioning of electrodes could be solved by preparing a plexiglas plate containing a large number of precisely spaced and drilled holes. The lower face of the plexiglas, when placed upon a liquid surface, represents the surface of the earth. Measurements are then made by placing the electrodes in the proper holes of the plexiglas to give the desired position for the configuration. Copper electrodes and a copper sulphate solution were used so that a D. C. excitation was possible. The technique used for this experiment eliminated the problem of positioning electrodes quickly and accurately.

Most of the aforementioned investigations deal only with a small part of the problem of setting up an arrangement that can be used to make small scale model studies. Since the present problem was that of making horizontal profiles for specific geometric shapes representing geologic structures that might be found by electrical field surveys, special equipment was designed for the investigation. The conditions found in the field were simulated by construction of a large tank, which when filled with a material that would approximate a layer of earth and with models placed in it, would give results similar to those obtained from theoretical calculations or by actual field surveys. Models were prepared for use in the tank, and the necessary accessory equipment was obtained for use with the Wenner (13) configuration for all experimental runs. This configuration was used because a Megger Ground Tester, which is designed for the Wenner Configuration, was available and the results of experimental runs would be easier to handle. Wenner showed that, if on the surface of a homogeneously conducting medium having a plane surface with one side of that plane surface being of infinite extent, and with four electrodes placed in a straight line with an equal spacing between them, then the following relationship is true. $\rho = 2\pi a\, E/I$ where ρ is the specific resistivity of the medium, E the potential difference between the inner electrodes, I the current between the two outer electrodes, and a the distance between electrodes.

The Wenner configuration can be used with either vertical or horizontal profiling methods. Vertical profiling necessitates increasing the spacing between electrodes, keeping the center of the configuration fixed for all measurements, and taking a series of readings for this one surface point using many different electrode separations. Horizontal profiling involves moving the entire configuration to a number of different surface positions keeping the electrode separation constant for all measurements.

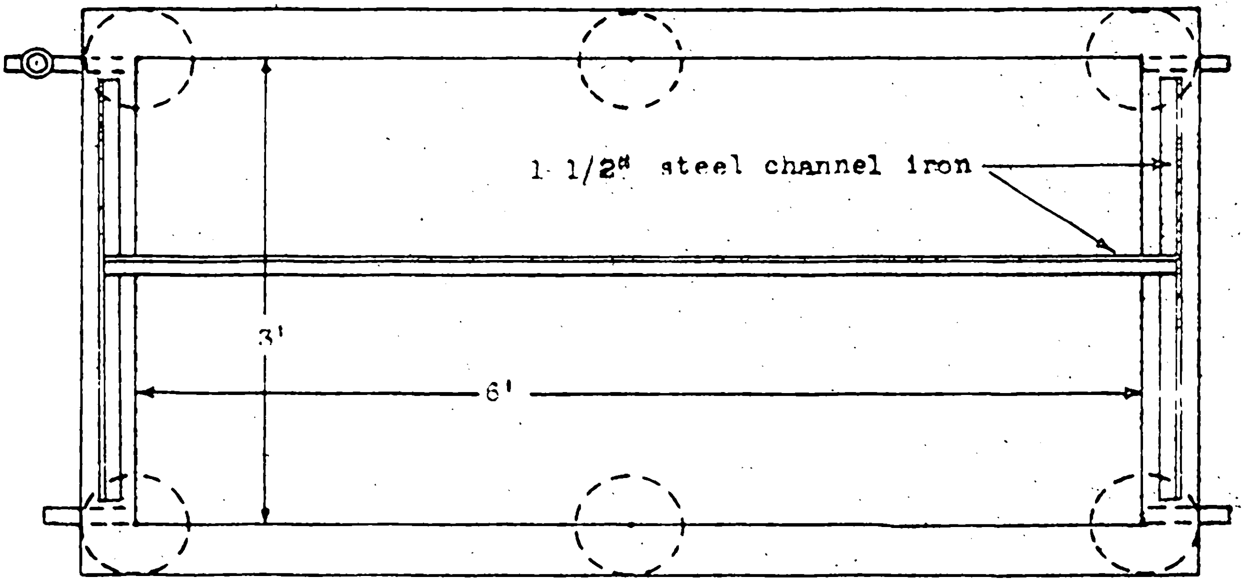
III. EQUIPMENT

Model Tank. A concrete tank was designed and built as shown in figure 2. The four inch walls and six inch base are reinforced with three sixteenths inch wire mesh. The four drain pipes are located in the corners of the tank since it was believed that having four drains would make a more uniform deviation of any effect that might be introduced by the metal pipe. A hose was connected to the drain pipe with gate valve attached so the tank could be drained. The other drains were fitted with plugs. The tank was waterproofed by applying three coats of Pittsburg Plate Glass Company masonry water repellent. A one and one half inch angle iron was placed along the length of the tank and a scale, marked in inches, was pasted on it. The center of this scale is marked zero, the graduations to one side of the center are positive, and those to the other side of the center are negative. The measurements taken are listed in this manner in the tables.

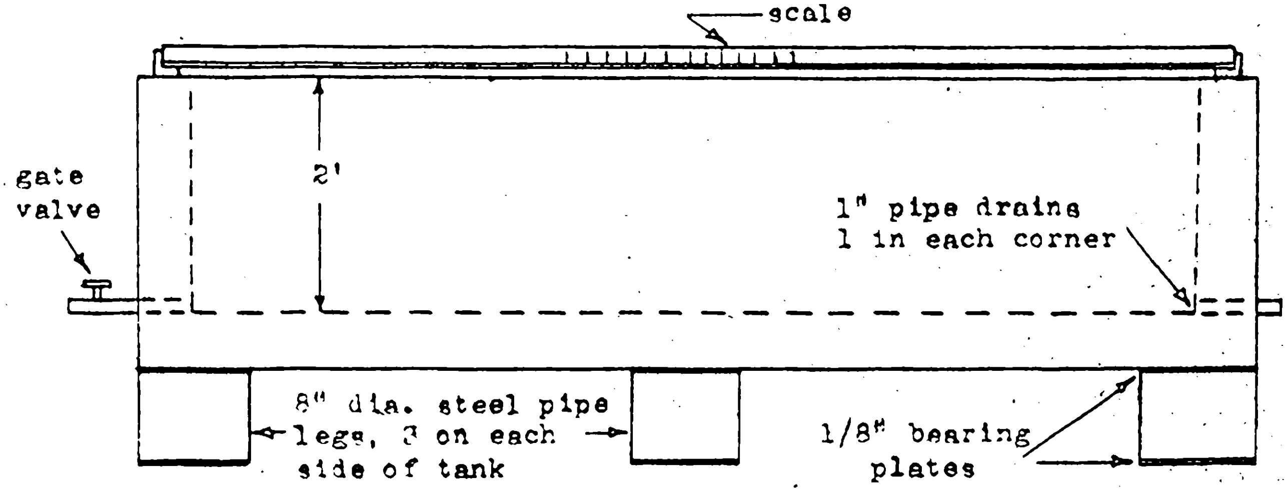
Electrodes. Ordinary lead pencils were used for electrodes since graphite electrodes will tend to decrease the amount of electrolysis usually occuring when metal electrodes are used. The soft lead pencils were turned on a lathe to produce round electrodes with graphite centers. The end that was to be used as contact with the fluid surface was sharpened in a pencil sharpener and then stroked across a piece of paper. The resulting point is sharp and slender and approximates a point source when used as an electrode. The graphite at the other end of the pencil was bared so that a good electrical contact could be made by using baby alligator clips on the connecting cable.

FIGURE 2

Top View



Side View



Tank used for model investigations.

Electrode Holders. Special electrode holders were made in the shape of a clip. The clip slides along the angle iron and a hole drilled through the overhanging edge of the clip holds the electrode upright. Four separate electrode clips were prepared for vertical profiling using the Wenner configuration. For making horizontal profiles, the electrode spacing is fixed. A compact one piece holder was constructed with the holes for the electrodes spaced such that the points of the electrodes were in a horizontal line and at the desired separation. Two separate holders for the different electrode spacings to be used for the horizontal profiling were made to facilitate ease of operation. The experimental measurements were made across the length of the tank using electrode spacings of one, two, three, and four inches. The two inch spacing was made as one electrode holder while the other spacings used were incorporated in a single holder.

Measuring Instrument. The instrument used to take resistivity measurements for the experimental tests was the Megger Ground Resistance Tester. The Megger supplies commutated direct current to the ground being tested. Commutated direct current will eliminate the effect of polarization present with direct current and will minimize the effects of electrolysis of the material under study and stray currents that may be present. Current supplied by a self contained direct current generator passes through the current coil of an ohm meter, and then through the segments of a commutator attached to the generator shaft. The potential drop between the two potential electrodes is picked up at those electrodes and converted back into direct current after which it goes to the potential coil of the same ohm meter that the current first passed through. The two coils of the ohm meter are mounted on the same shaft and work in opposition to each other in the field of a permanent magnet. The opposing torques of the current and potential coils automatically perform the division of volts by amperes so that the result is read directly as resistance on the ohm meter. Since the value for resistivity in ohm-cm. equals 2 a E/I for the Wenner configuration, where a is the electrode separation in cm., it is only necessary to multiply the resistance read on the Megger by the appropriate constant for the particular electrode separation used to convert the reading to the correct resistivity value in ohm-cm.

Normally, the instrument is hand cranked, and at a speed of 100 rpm will produce a current with a frequency of 50 cps. The voltage across the open potential circuit is of the order of 50 volts and the current is less than 0.5 amp. The hand crank was removed from the Megger, and an 86 rpm, 115 volt A. C., 1.8 amp. electric motor was connected to the shaft of the instrument. A flexible shaft coupling was utilized between the motor and the instrument to reduce the strain caused by mis-alignment of the two shafts. The slight decrease of cranking speed (from 100 rpm to 86 rpm) did not apparently influence the readings. An on-off switch was connected between the motor and the A. C. source so that the motor could be shut off while the electrodes were being moved. When making horizontal profiles, this precaution is not necessary if care is taken that the electrodes do not break contact with the fluid layer while the configuration is being moved.

Connecting Cable. The Megger is constructed so that it is necessary to have two current electrodes and two potential electrodes to operate properly. Therefore, there must be four connecting leads from the instrument to the electrodes. A cable, connecting the instrument to the electrodes, was made in two sections to minimize any vibrations that might be transmitted to the electrodes. The first section consists of four No. 14 wires with spade clips on the instrument ends while the other ends are permanently connected to a terminal strip mounted on the top of the tank wall. The second section consists of four No. 20 varnished wires permanently connected on one end to the terminal strip. The free ends of these wires have small alligator clips soldered to them. The alligator clips are clipped on the bared graphite ends of the electrodes and the spade clips are connected to the proper terminals on the Megger, thus completing the electrical circuit. With the electrodes positioned in the media contained in the tank, the apparatus is set up for testing and calibration. A photograph of equipment set up preparatory to experimental runs is shown in figure 3.

FIGURE 3

Tank and resistivity measuring apparatus set up for an experimental run.

Models. The models used during the investigation were both conductive and resistive. The conductive models included an aluminum hemisphere with a diameter of three and one half inches to be used for the correlation run. Also, an aluminum block two inches thick, five inches wide and ten inches long was used as both a vertical and horizontal conductor.

Resistive models were made of one and three quarter inch plywood waterproofed with three coats of marine spar varnish. The models were twelve inches wide and thirty-four inches long and when placed in the tank the ends were approximately one inch from the side wall of the tank. This model when placed vertically would represent a resistive vertical bed or a resistive fault zone. Placed horizontally the model might represent a tabular type of structure.

Models of stream channels were prepared by removing some of the top of the sand layer in the shape of a channel completely across the tank. The width of the channel was varied by removing more of the sand to enlarge the channel. The sides of the channel were always similar since three fourths of an inch of fluid covered the entire surface of the sand and the water caused the sides of the channel to seek their natural angle of repose.

IV. TESTING OF EQUIPMENT

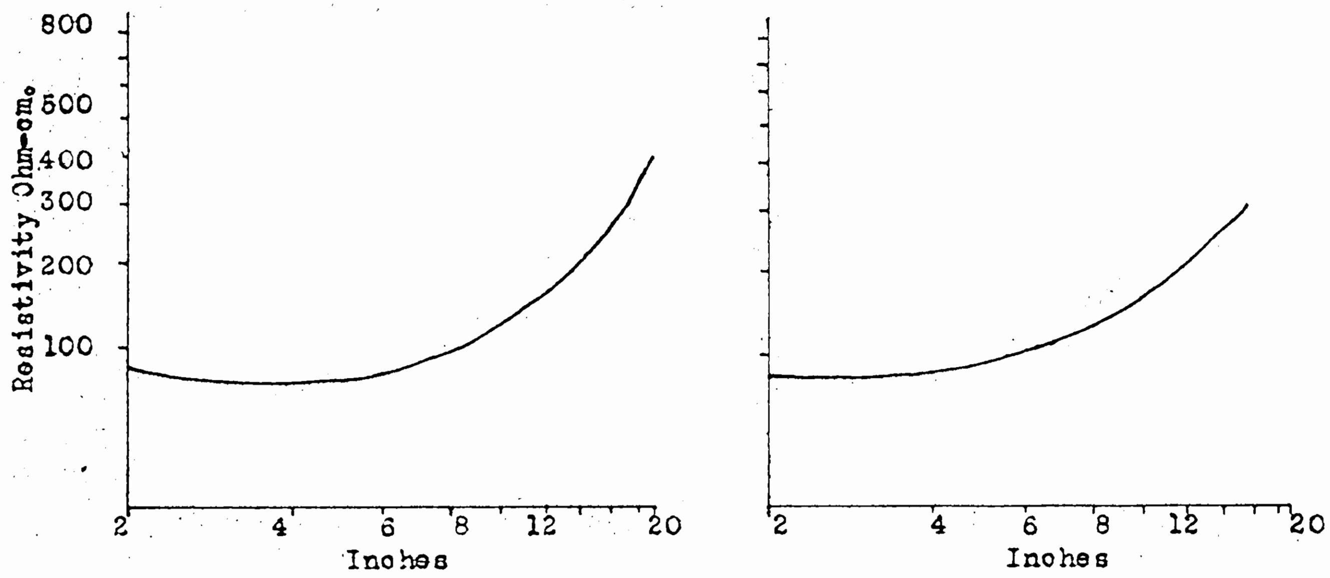
Calibration tests were made with the tank filled with a solution of water and sodium chloride. Sodium chloride was added until the resistivity of the solution was within the potential circuit calibration range of the instrument used for measurements. The Megger has a PR adjust control which brings the total resistance of the potential circuit, including the resistance to earth of the potential electrodes, to a pre-determined value, on the basis of which the instrument is calibrated.

The first series of tests were vertical profiles, with the Wenner configuration, taken at several points on a traverse along the center of the long dimension of the tank, and with the tank filled to a depth of 20 inches of salt water. The depth to the bottom of the tank could not be interpreted from the data obtained because the electrode separation could be expanded to a maximum spacing of only twenty-two inches. The thickness of the fluid layer was twenty inches and to interpret a curve for this thickness, it would have been necessary to have measurements for spacings some distances greater than the actual depth to the bottom of the tank. All of the curves plotted for vertical profiles along this traverse showed the same characteristics, that of a rapidly increasing resistivity for electrode spacings greater than six inches. These data were interpreted as an indication that the main tank effect was due to the bottom of the tank, although some small effect from the walls was noted. There was a range of about six inches depth that was relatively free from any tank effect. These profiles are shown in figure 4.

Since the tank was designed primarily for horizontal profiling, runs using the Wenner configuration were made across the length of the tank for several different fixed electrode separations. The term "run" as used in this paper, refers to a series of measurements taken on a traverse along the entire length of the tank. The results of the horizontal profile calibration runs are shown in figure 5. These graphs indicate that, for the depths probed, there was no effect from the ends of the tank until the outer electrode approached nearer than twelve inches. The erratic results for the two inch electrode separation were caused by not keeping a constant depth of penetration of the electrodes. The values of resistivity calculated from the average values of resistance measured for the one, three, and four inch electrode separations are 108.46 ohm-cm., 106.18 ohm-cm., and 103.35 ohm-cm. respectively. These values are within the tolerance for observed readings made with the Megger. Allowing for the area of the tank where there may be tank effects present, the usable surface area appears to be the center four feet of the tank for electrode separations of one to four inches.

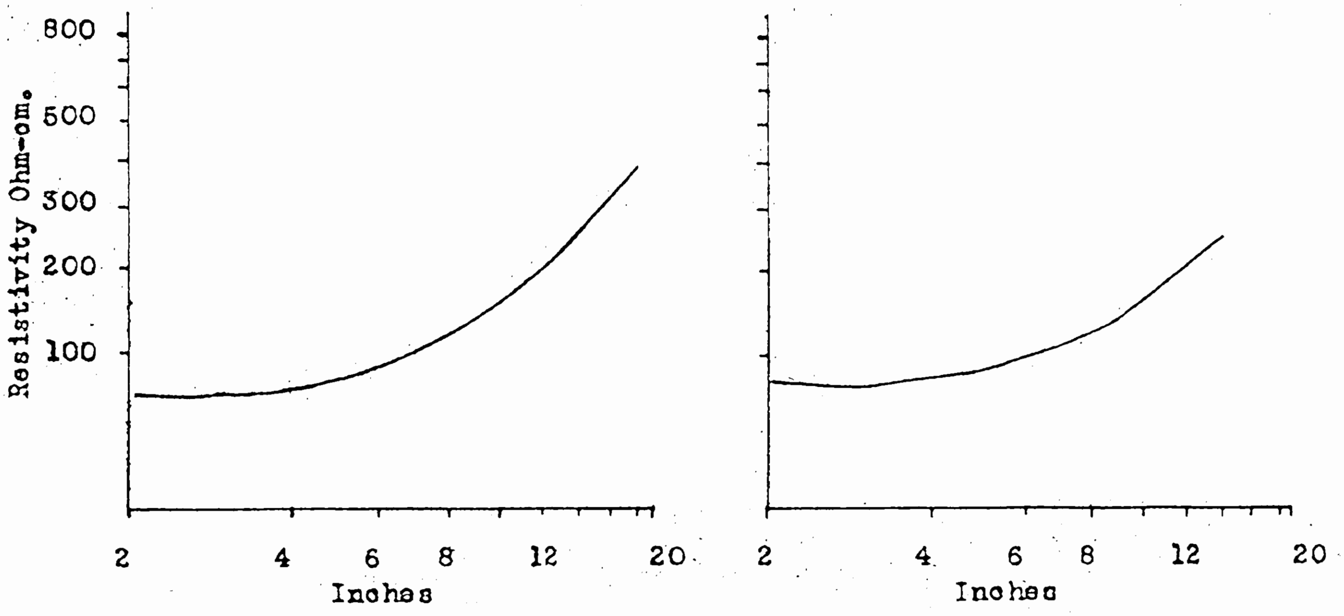
A final check of the tank was made to be certain that anomalies large enough to be measured would be present for the models that were intended to be used in the tank. A hydrostone hemispherical model, three and three quarter inches in diameter, containing copper filings, was prepared for testing. The high porosity of the model allowed the salt water solution to saturate the model to the extent that there was not a large enough resistivity contrast between model and enclosing medium to be measurable. After several trials with hydrostone models,

FIGURE 4



Position 0

Position 4

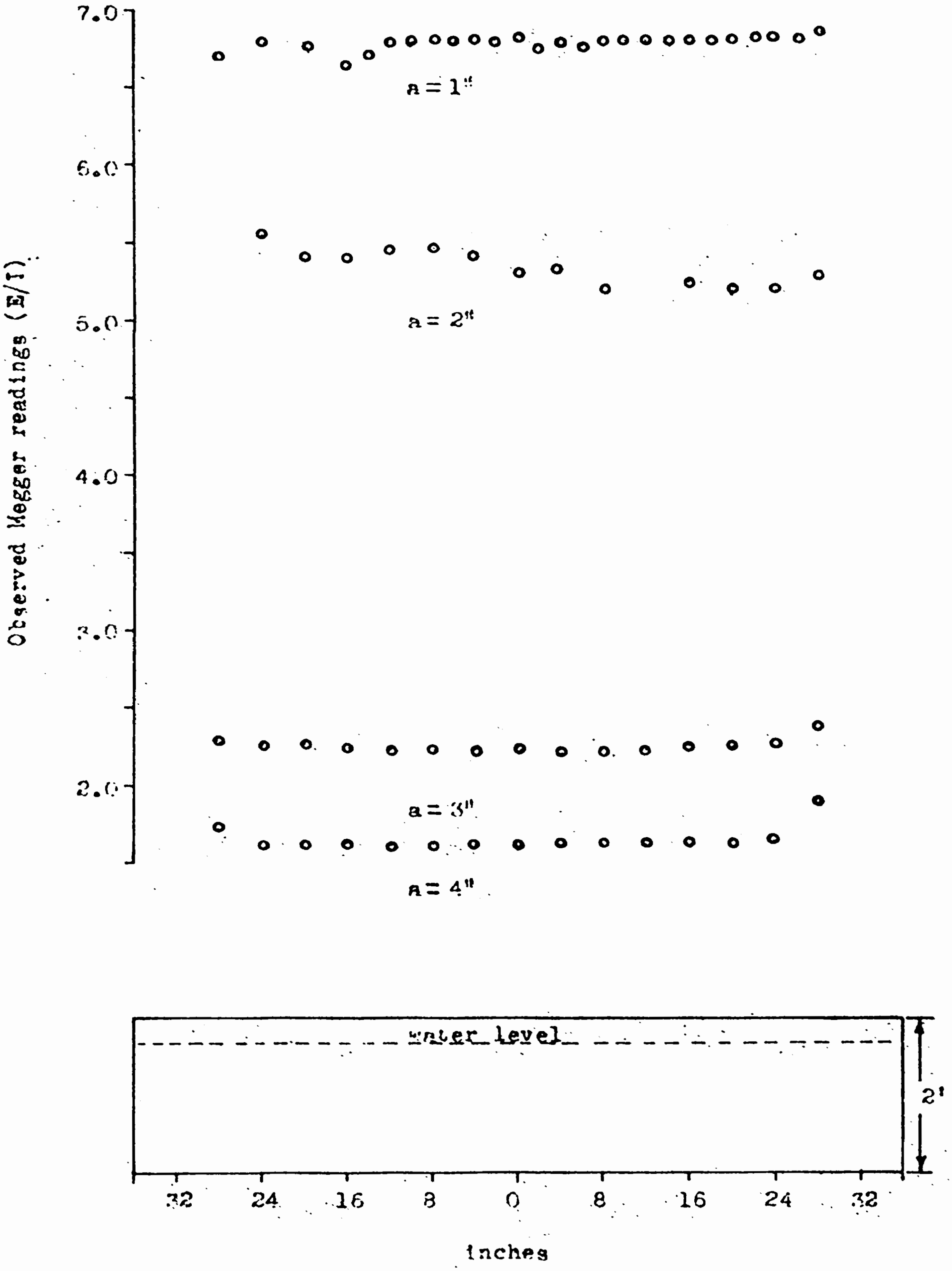


Position -4

Position -6

Vertical profiles for several points along a traverse along the length of the tank containing twenty inches of fluid solution.

FIGURE 5



Calibration curves for tank with only salt water solution using varying electrode separations.

an aluminum hemisphere with a diameter of three and one half inches was prepared and tested. This test showed that conductive aluminum models would produce anomalies large enough to be measured.

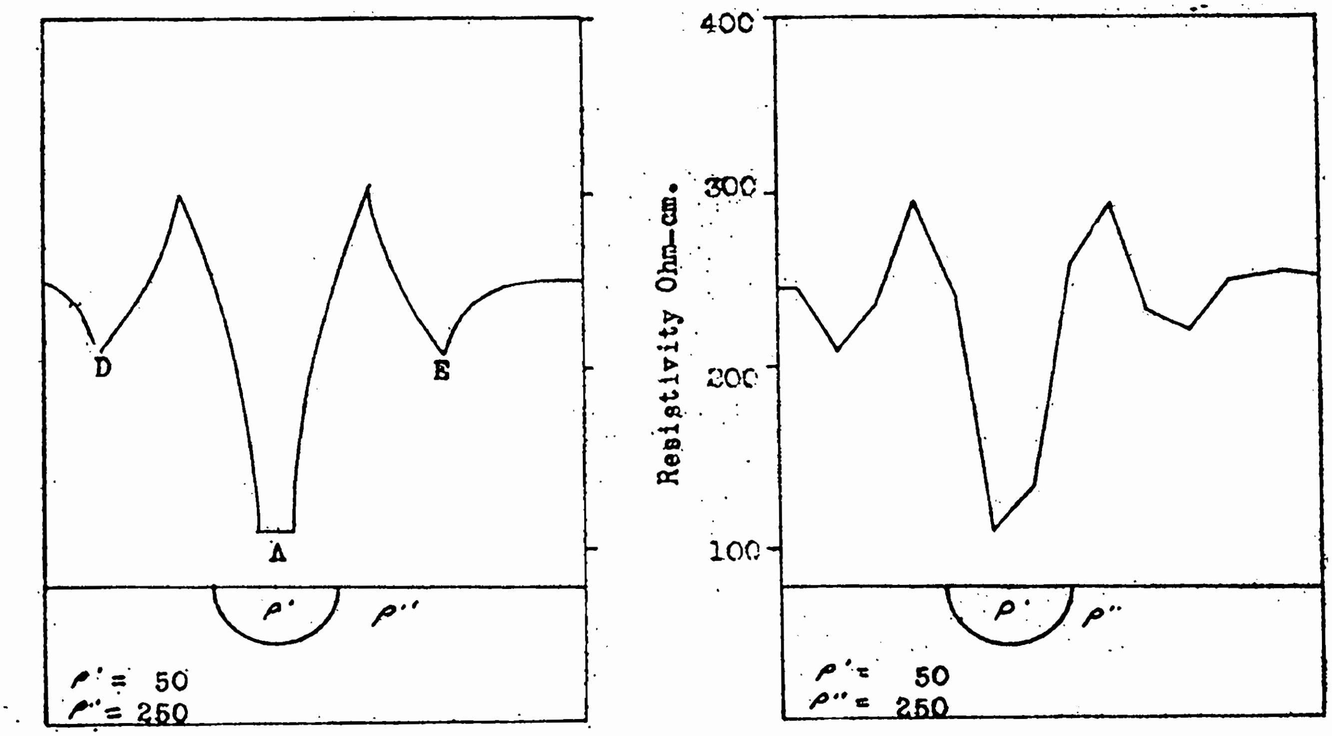
V. EXPERIMENTAL MODEL RUNS

Conductive Models. The first series of model runs was made using an aluminum hemisphere with a three and one half inch diameter. The resistivity horizontal profiles obtained over this model were to be compared with theoretical curves computed by Cook and Van Nostrand (2) for a conductive hemisphere enclosed in a more resistive media with the top of the hemisphere being flush with the surface of the resistive media. This comparison was to be made on the basis of the diagnostic features of the computed curves in relation to those which would appear on the model curves. A close agreement between the model curves and the computed curves would indicate that the results obtained from other model runs would be reliable. The laboratory runs were made under conditions similar to those assumed by Cook and Van Nostrand in making their computations, except for the resistivity contrast. The contrast assumed for the theoretical computations was fifty ohm meters for the hemisphere and two hundred fifty ohm-meters for the enclosing media while the model used in the experimental run was about 3×10^{-6} ohm-cm. and the enclosing media was approximately one hundred ohm-cm. The aluminum hemisphere was suspended in a twenty inch fluid layer so that the top of the hemisphere was one sixteenth of an inch below the surface of the fluid. It was necessary to have some fluid above the model to insure a good electrical contact for the electrodes. Runs were made across the model using electrode separations of one and two inches and the results are presented in figures 7 and 8.

Since it was difficult to suspend models of any size in a single fluid layer and also since two different layers were desired to more closely approximate field conditions, nineteen inches of fine river sand was then placed in the tank. All remaining model runs were made with sand and fluid layers in the tank. The sand was added to salt water so that there would be no areas of the sand layer where the saturating liquid solution would have a different salt content. When nineteen inches of sand and two inches of fluid were obtained in the tank, calibration runs were made which showed a uniform resistivity across the tank for the different electrode separations used. The surface of the sand had been smoothed to form a horizontal surface for these runs. Then salt water was drawn off by means of the bottom drain until three quarters of an inch of fluid remained above the sand. Calibration runs were made again, and it was discovered that the resistivity for any one depth was no longer uniform across the tank. This resultant calibration curve was not linear but was uneven along the traverse and had a decidedly lower resistivity on the drain end with respect to the opposite end of the tank. After several unsuccessful attempts to correct this condition and produce a linear gradient in the tank, it was decided to continue the model runs and to make a calibration run for each model run so that the data could be corrected to a common datum prior to interpretation.

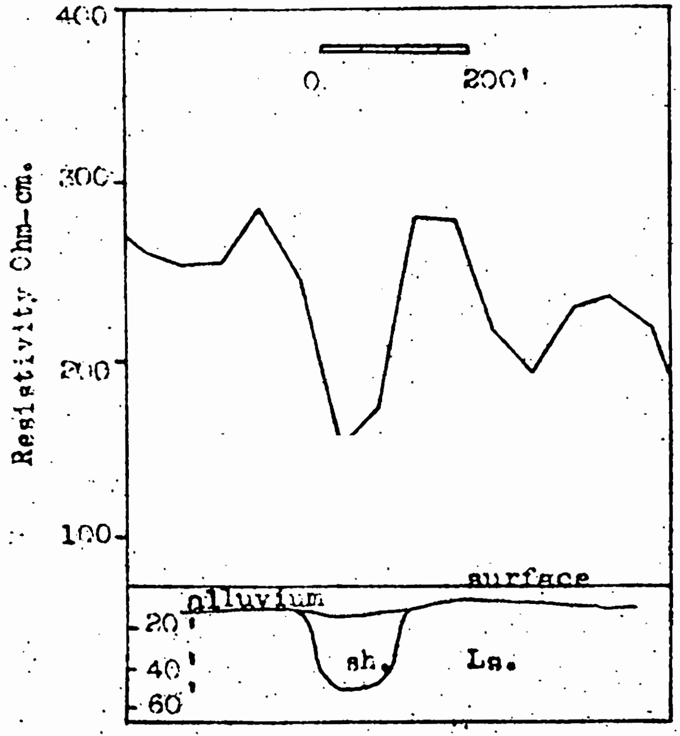
The conductive aluminum block that had been prepared was used to simulate a vertical bed and later a horizontal tabular deposit. The aluminum block has the dimensions two inches by five inches by ten inches. When used as a vertical model, the block was buried in the sand with the longest dimension perpendicular to the traverse line and with the shortest dimension parallel to the traverse line. The

FIGURE 6



a) Continuous theoretical curve.

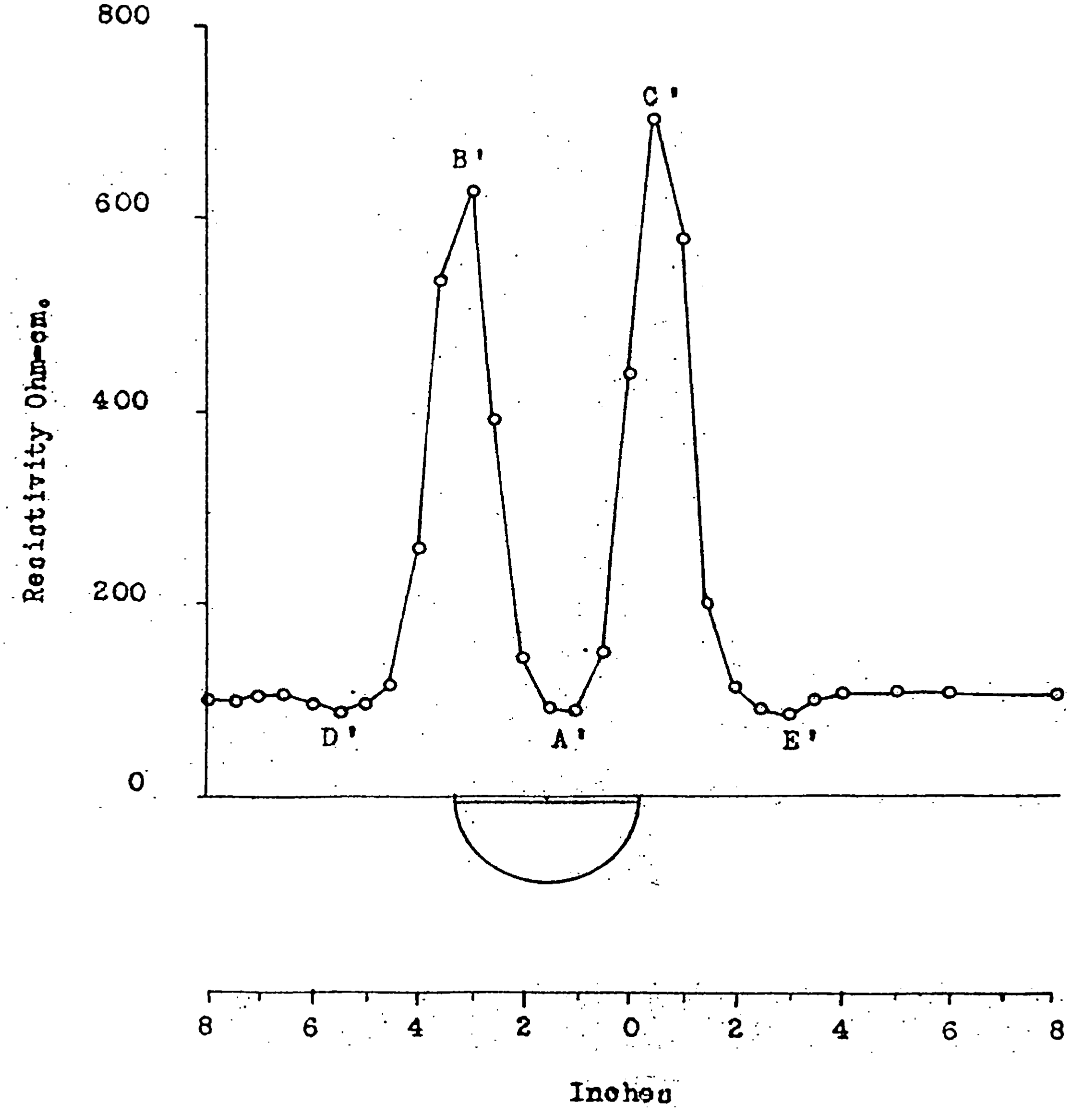
b) Theoretical Field curve



c) Observed field curve

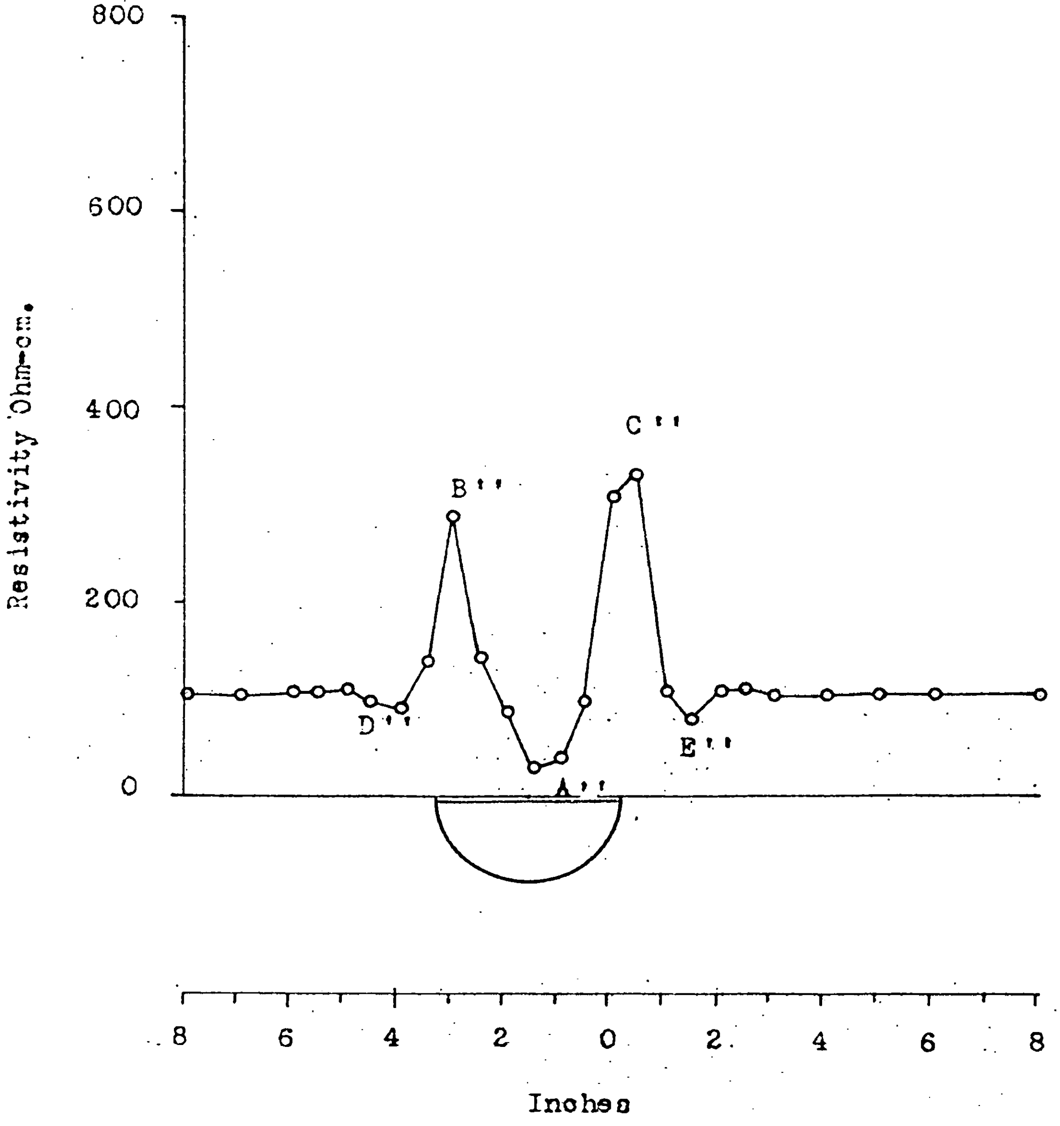
Theoretical and field curves for conductive hemispheres and a similar sink structure. (after Cook)

FIGURE 7



Experimental horizontal profile for an electrode separation of two inches across a conductive hemisphere enclosed within a more resistive medium.

FIGURE 8



Experimental horizontal profile for an electrode separation of one inch across a conductive hemisphere enclosed within a more resistive medium.

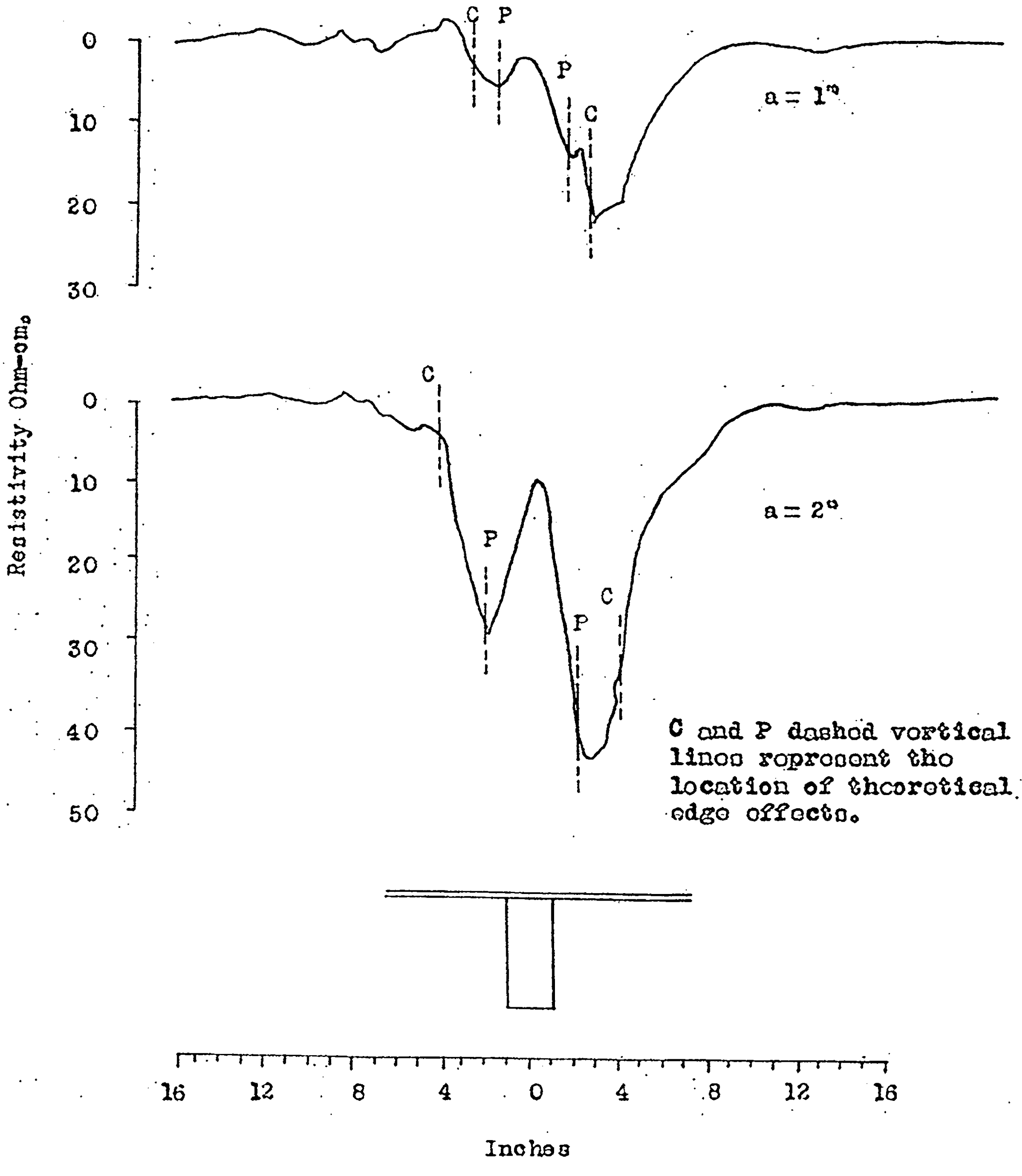
two inch face of the model was flush with the top of the sand and covered with a layer of fluid. The results of horizontal profiling across this model are shown in figures 9, 10, and 11.

Tabular deposits were prepared first with the ten inch dimension perpendicular to the line of traverse, the five inch dimension parallel to the line of traverse, and the two inch dimension vertical. Next, the model was placed with ten inch and five inch dimensions interchanged. Runs were made across both models for electrode separations of one and two inches. The results of these runs are shown in figures 12 and 13.

Models of stream channels were prepared by removing sand from the top of the sand layer in the shape of a stream channel and allowing this space to fill with salt water. The first channel was five inches wide and two and one half inches deep. The results of resistivity measurements made across this model for electrode separations of one and two inches are shown in figure 14. Another channel was prepared under the same conditions having a width of ten inches and a depth of two and one half inches. One run, with a two inch electrode separation, was made across this model and the resulting horizontal profile is shown in figure 15.

Resistive Models. The resistive models used in this investigation were designed to simulate both vertical and horizontal structures. The vertical model, one and three quarter inch by twelve inches by thirty four inches, was placed in the sand so that the longest dimension was perpendicular to the line of traverse, the shortest dimension parallel to the line of traverse and flush with the top of the sand, and the twelve inch dimension vertical. The model was covered by a

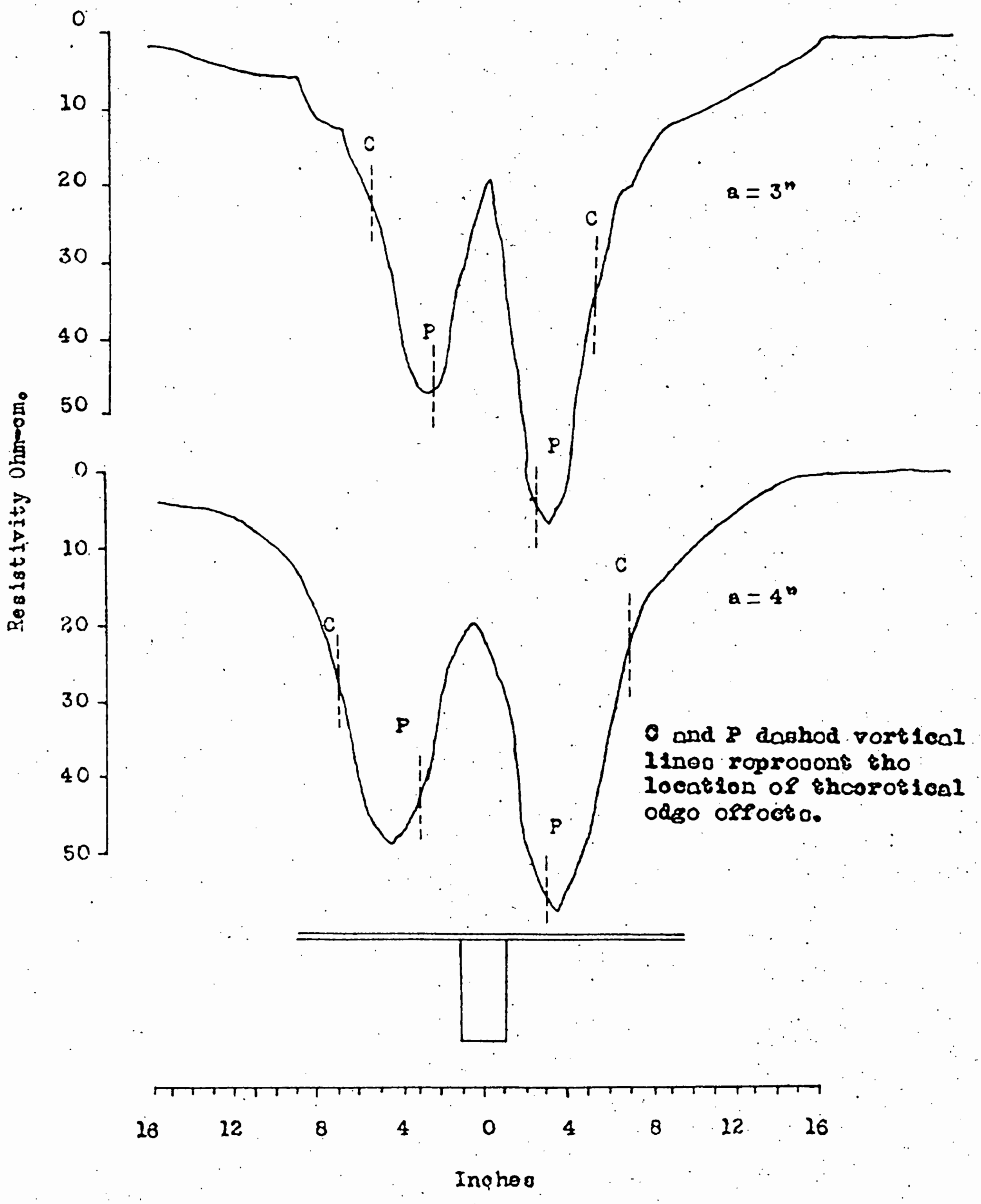
FIGURE 9



C and P dashed vertical lines represent the location of theoretical edge effects.

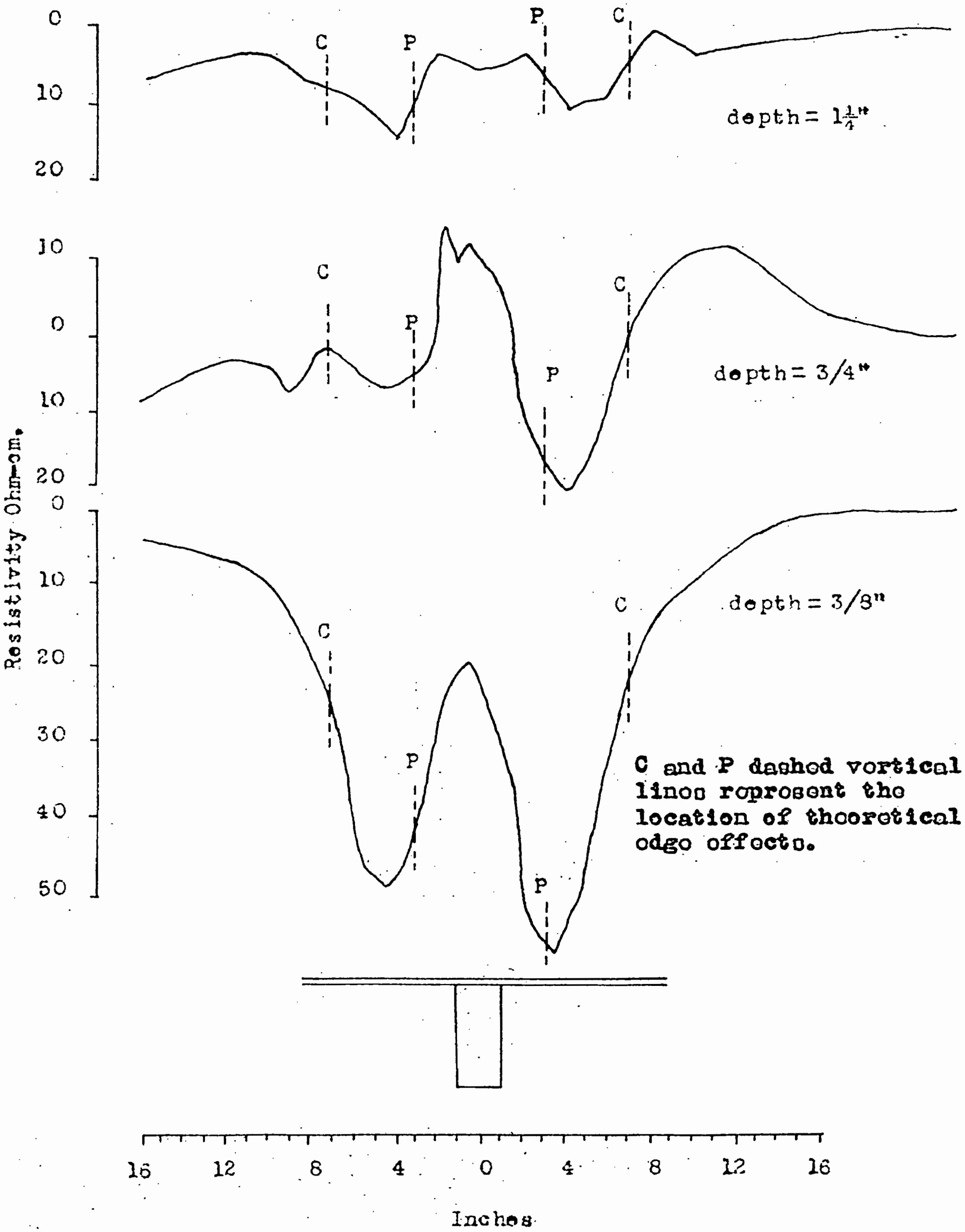
Experimental horizontal profiles over a buried vertical conductor for electrode separations of one and two inches with an overlying fluid layer three-eighth inch thick.

FIGURE 10



Experimental horizontal profiles over a buried vertical conductor for electrode separations of three and four inches with an overlying fluid layer three-eighths inch thick.

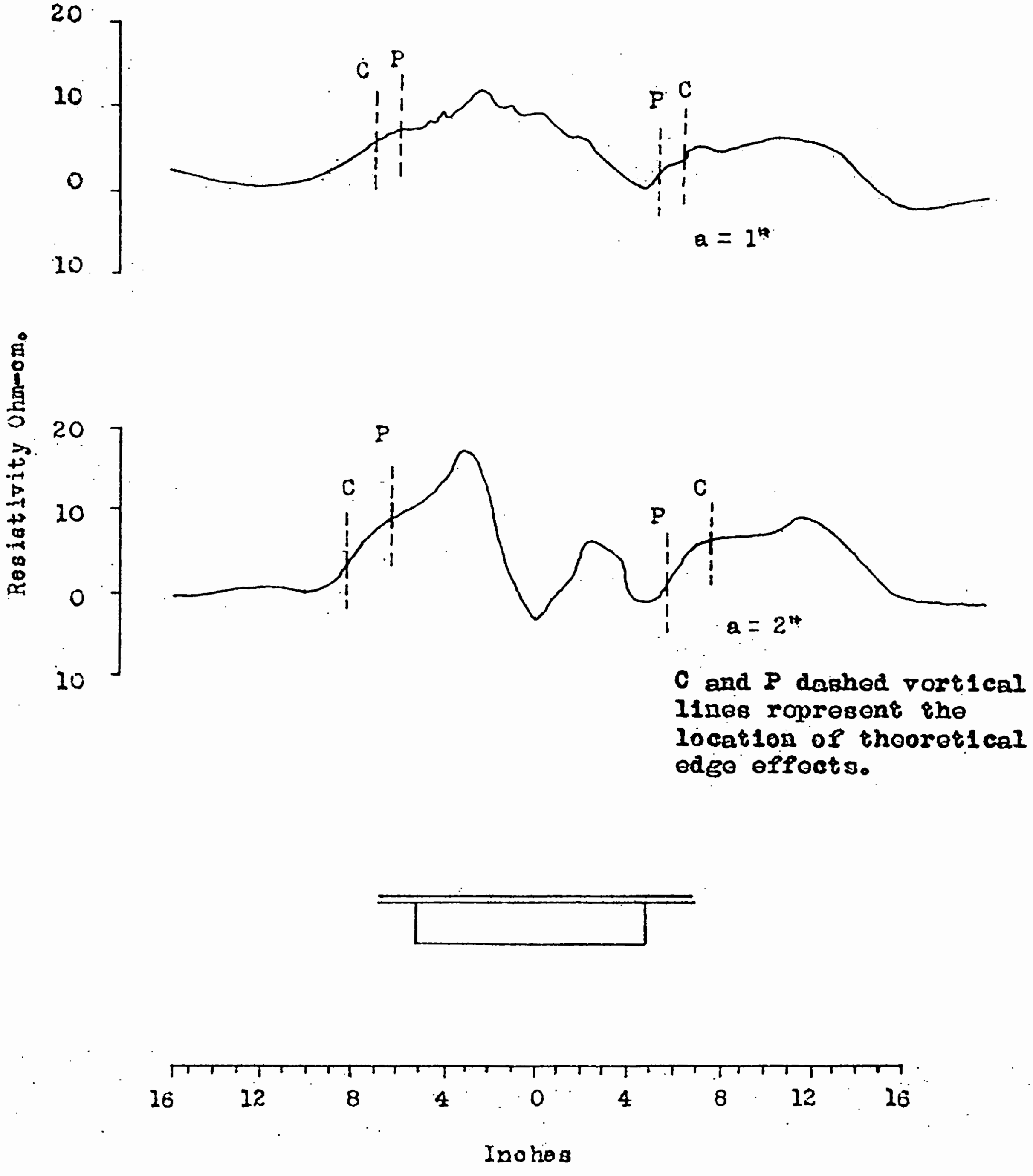
FIGURE 11



C and P dashed vertical lines represent the location of theoretical edge effects.

Experimental horizontal profiles across a buried vertical conductor for a constant electrode separation of four inches and varying thicknesses of top fluid layer.

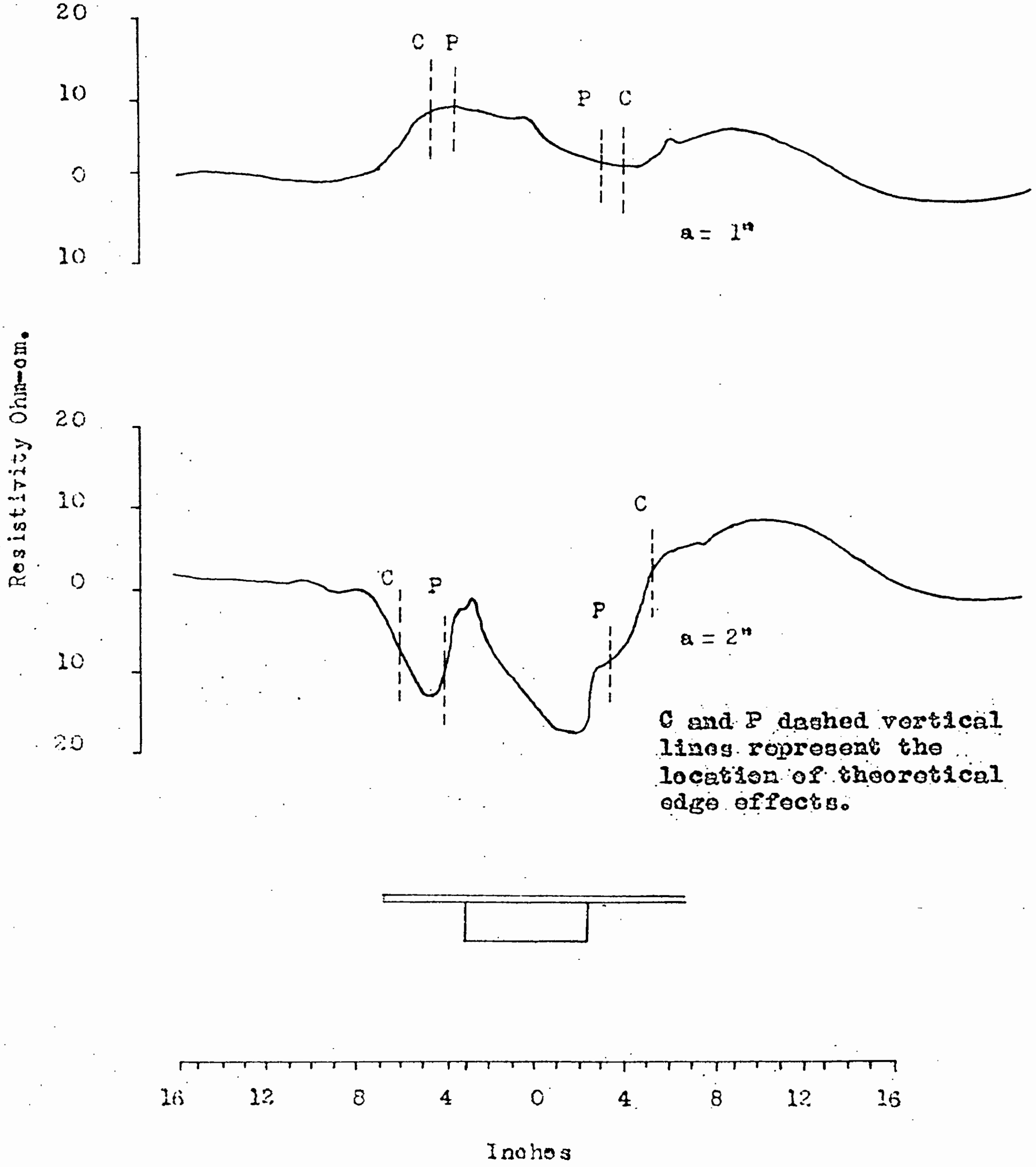
FIGURE 12



C and P dashed vertical lines represent the location of theoretical edge effects.

Experimental horizontal profiles over a buried conductive slab five inches in width.

FIGURE 13



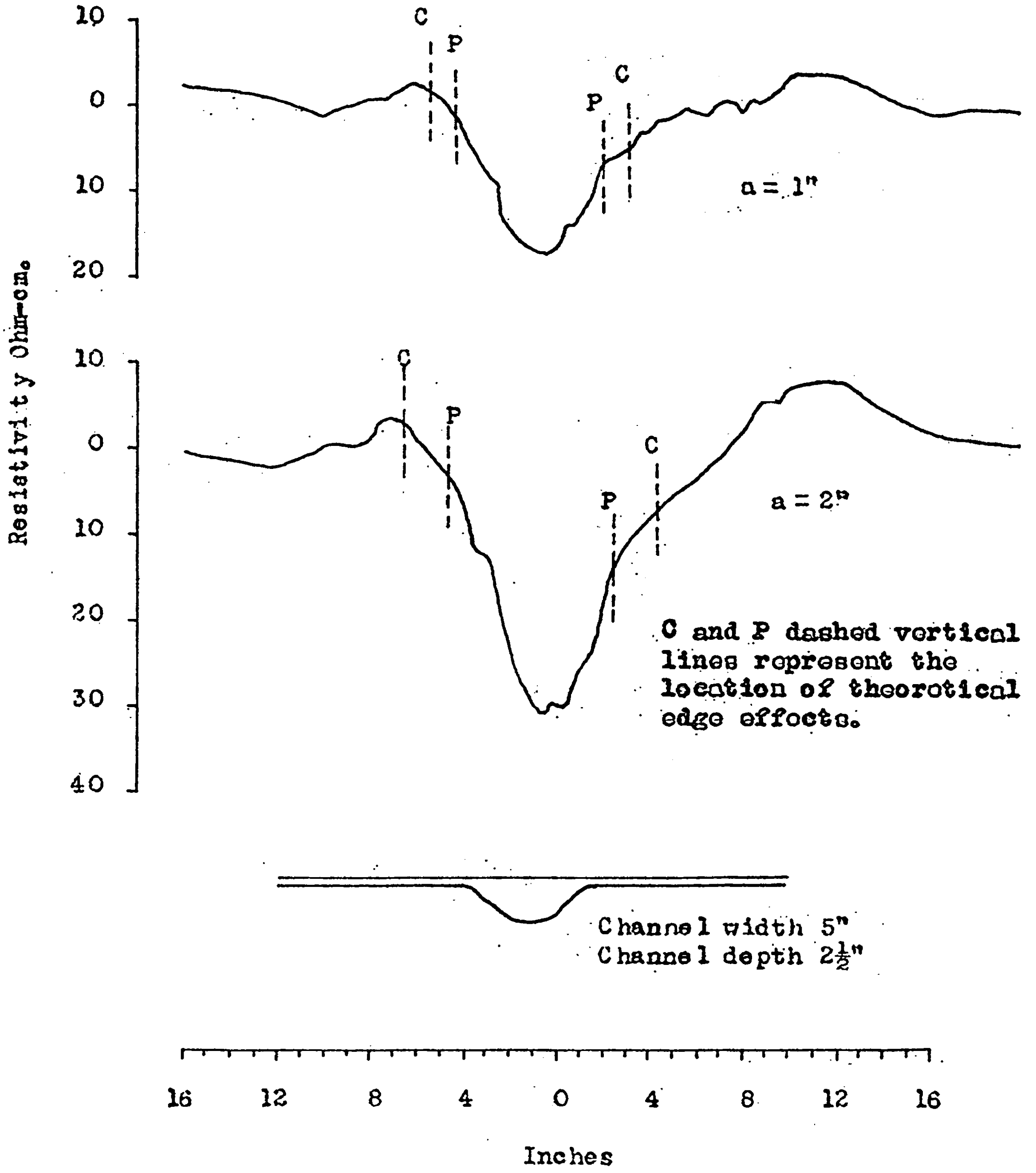
C and P dashed vertical lines represent the location of theoretical edge effects.

Experimental horizontal profiles over a buried conductive slab ten inches in width.

three quarter inch fluid layer. Electrode separations for this series of runs were one, two, and four inches and the resultant profiles are shown in figures 16 and 17. For the horizontal structure, the model was placed with the twelve inch and the one and three quarter inch dimensions interchanged. The model was covered with three quarters of an inch of sand to hold it in place and the entire sand layer was then covered with a three quarter inch fluid layer. Results of runs with one, two, and four inch electrode separations are shown in figure 18.

Composite Model. This model was intended to represent a resistive bed cut through the center by a stream channel and the entire structure enclosed in a less resistive medium. Two plywood boards, one and three quarter inch by twelve inches by thirty four inches, were placed five inches apart in the tank and two inches below the surface of the sand. The longest dimension was perpendicular to the line of traverse and the twelve inch dimension was parallel to the line of traverse. The shortest dimension was vertical and the entire sand layer was covered by a three quarter inch fluid layer. The results obtained for electrode separations of two, three, and four inches are shown in figure 19.

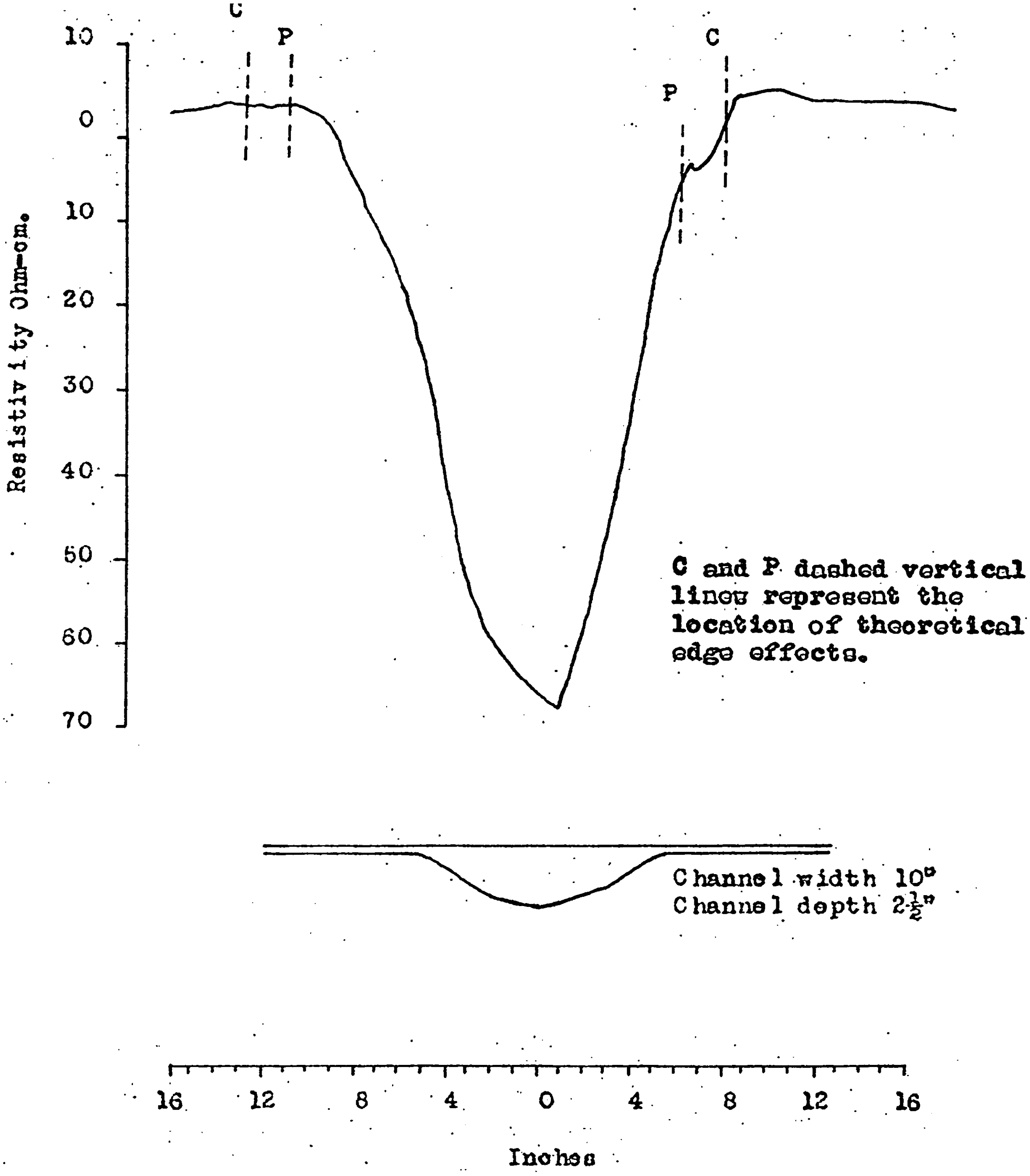
FIGURE 14



C and P dashed vertical lines represent the location of theoretical edge effects.

Horizontal profiles for electrode separations of one and two inches across a model of a buried stream channel.

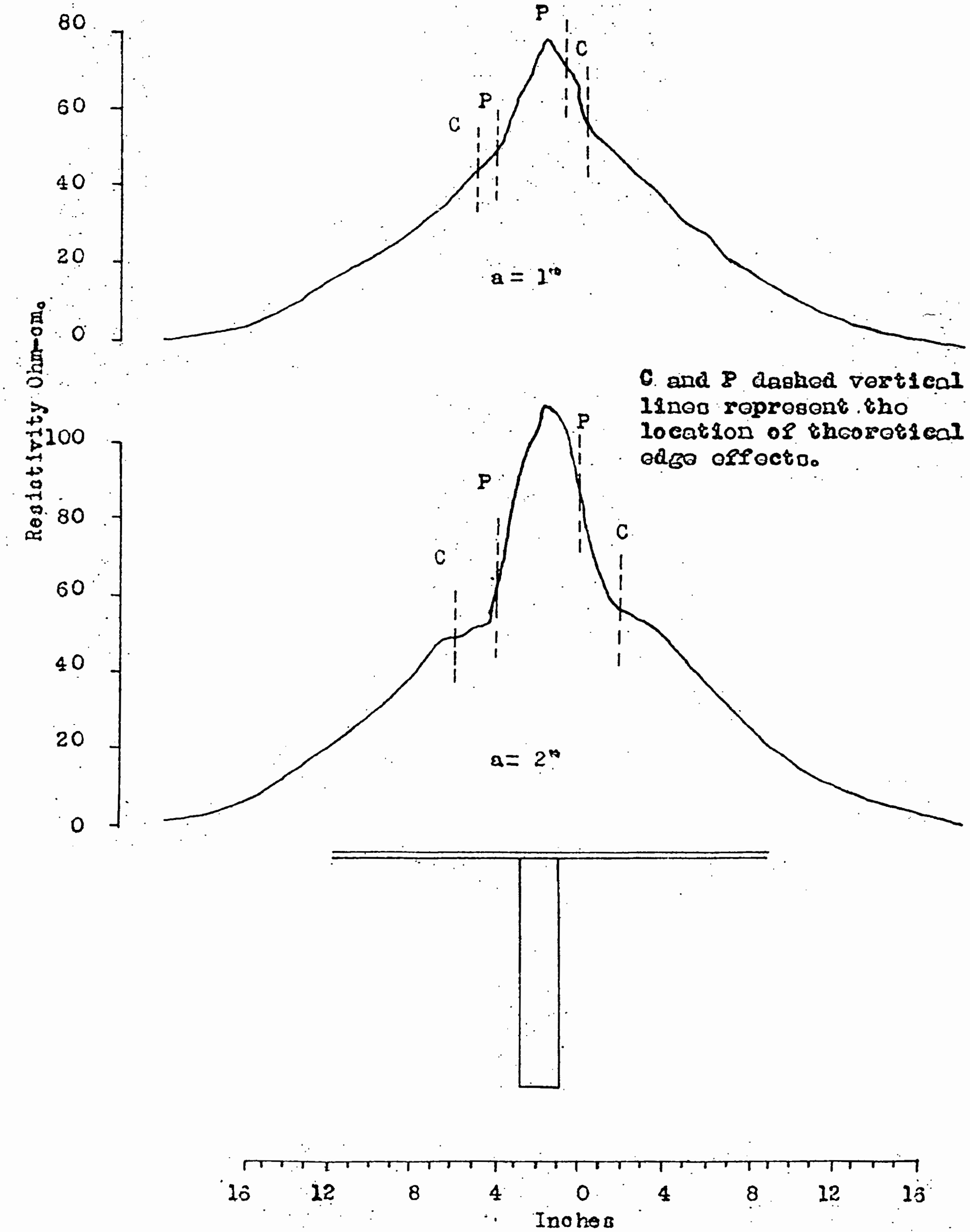
FIGURE 15



C and P dashed vertical lines represent the location of theoretical edge effects.

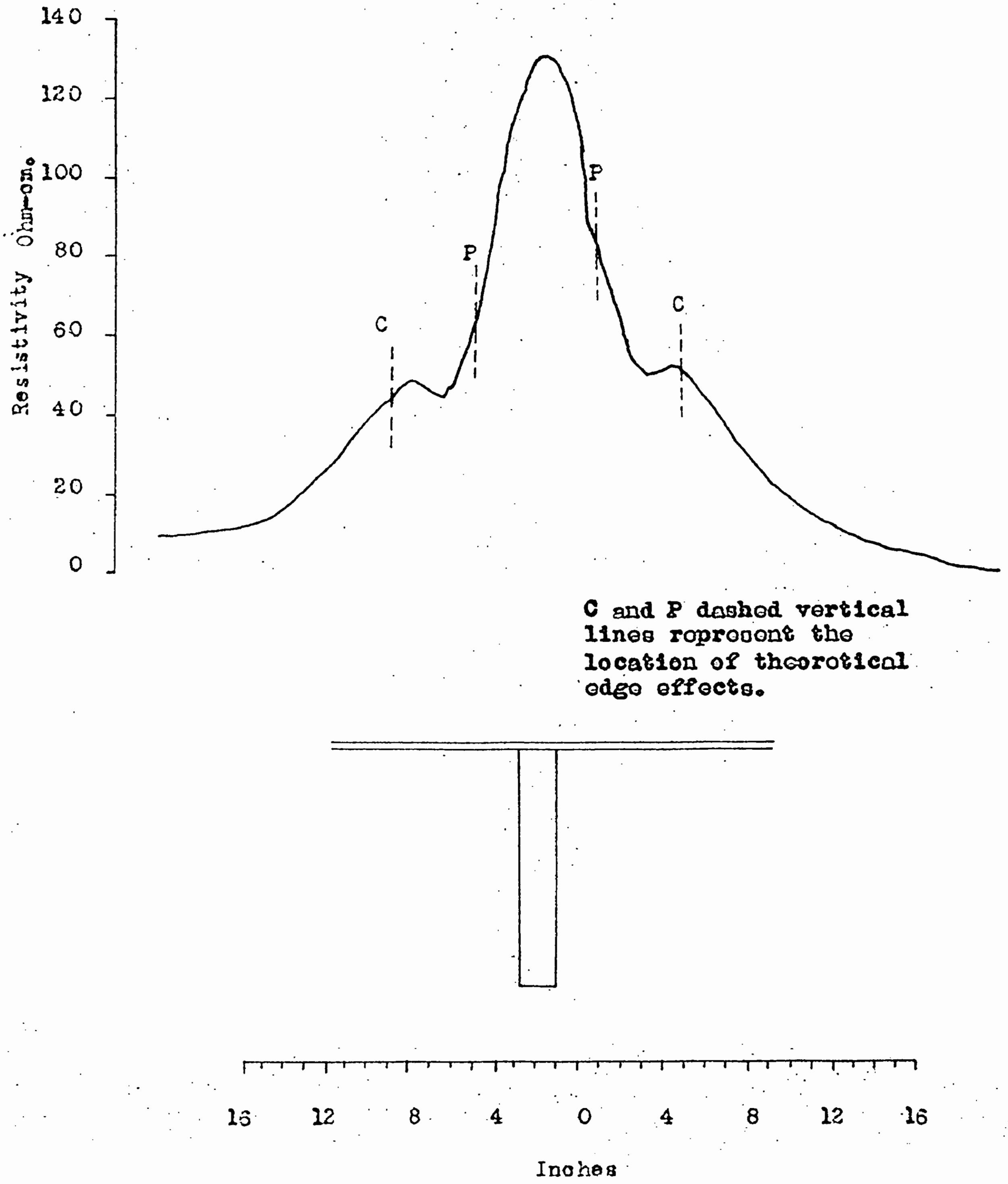
Horizontal profile for an electrode separation of two inches across a model of a buried stream channel.

FIGURE 16



Experimental horizontal profiles across a buried vertical insulator using electrode separations of one and two inches.

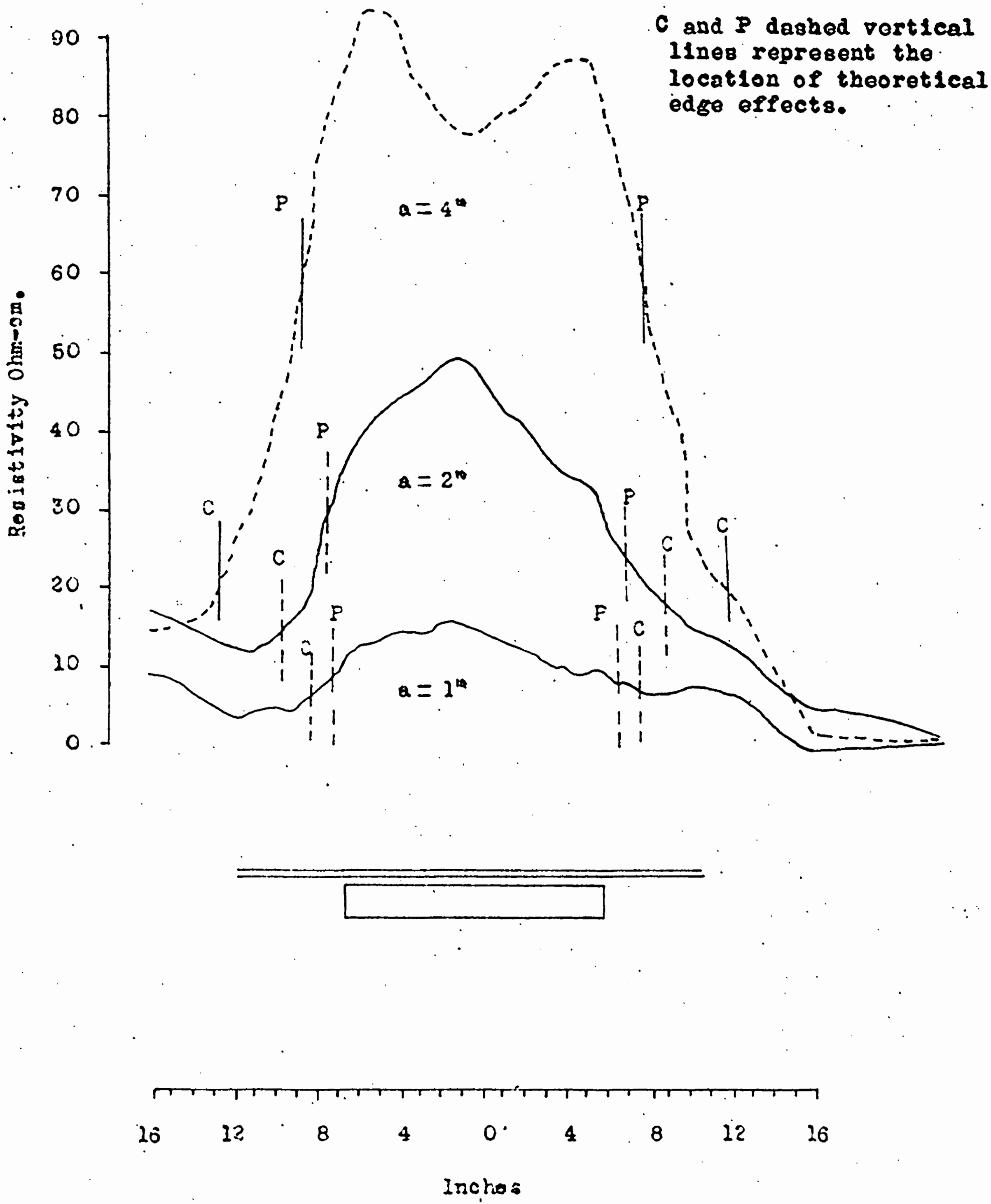
FIGURE 17



C and P dashed vertical lines represent the location of theoretical edge effects.

Experimental horizontal profile over a buried vertical insulator for an electrode separation of four inches.

FIGURE 18



C and P dashed vertical lines represent the location of theoretical edge effects.

Experimental horizontal profiles for electrode separations of one, two, and four inches over a buried horizontal insulator.

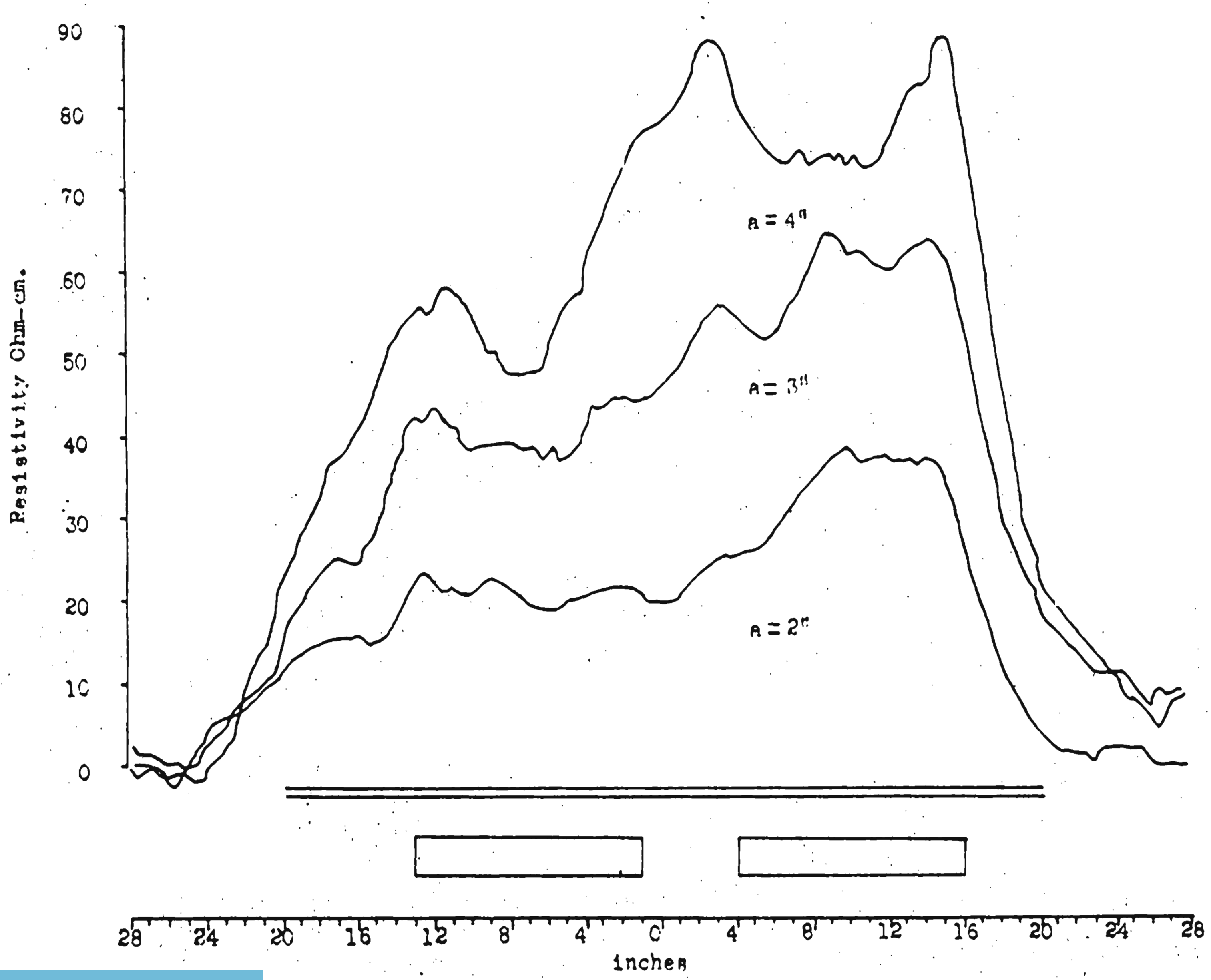


FIGURE 18

Horizontal profiles over composite model.

VI. DISCUSSION OF RESULTS

Comparison of Model Results with Theoretical Curves. Comparison of the results of resistivity measurements made on a traverse across a conductive model hemisphere with resistivity profiles computed by Cook and Van Nostrand for a conductive hemisphere enclosed in a more resistive medium showed many points of similarity. The theoretical horizontal profiles presented by Cook and Van Nostrand represent calculated resistivity values for the Wenner configuration under the following conditions:

1. Resistivity contrast between model and enclosing medium is 1:5.
2. Diameter of the hemisphere is equal to 3/2 of the electrode separation.
3. The top of the hemisphere is flush with the surface.
4. The resistivity profiles are for a traverse across the center of the hemisphere.

The laboratory arrangement duplicated these conditions as closely as possible with the exception of the resistivity contrast. The diameter of the model was slightly greater than 3/2 of the electrode separation for the measurements made with the two inch electrode separation. The top of the hemisphere was as close to the surface of the fluid as possible while still maintaining good electrical contact and the measurements were made on a traverse across the center of the hemispherical model. The results of the resistivity measurements are shown in figures 7 and 8, and the theoretical results are shown in figure 6. Cook and Van Nostrand (3) show five diagnostic points on a continuous theoretical horizontal profile across a hemisphere under the conditions listed above. The points (B, C, D, and E on figure 6) occur on the profile as one of the electrodes makes contact with an edge of the hemisphere. The points consist of a central low over the center of the hemisphere (point A on figure 6) having a resistivity lower than any other point on the profile; peaks of greater than normal resistivity (points B and C on figure 6) flanking the central low on either side; and troughs of lower than normal resistivity (points D and E on figure 6). The theoretical curve shows that the troughs are located at a distance 3a/2 from the edges of the hemisphere; the peaks are a distance a/2 from the edges of the hemisphere and are separated from each other by a distance equal to the diameter of the hemisphere plus "a" where a is equal to the electrode separation. The most diagnostic points as mentioned by Cook and Van Nostrand are the central low and the two high peaks because, in field surveys, the smaller magnitude of the flanking troughs is often obscured.

The model results for the measurements made with the two inch electrode separation (diameter of hemisphere is 7a/4) show troughs (points D' and C' on figure 7) which are 2.6 inches from the right edge and 2.4 inches from the left edge of the hemisphere; peaks (points B' and C' on figure 7) which are above the edges of the hemisphere, and a central low (point A' on figure 7) which is directly over the center of the hemisphere. The theoretical results, for a conductive hemisphere with <u>no</u> resistive covering, and for a two inch electrode separation would produce troughs that are three inches from the edges of the body, peaks that are one inch from the edges, and a central low over the center of the body. The results of the model measurements show that both the flanking troughs and peaks are too close to the edges of the body. Also, the experimental peak magnitudes are much greater than those obtained on a theoretical curve, and the central low is not the lowest point on the curve.

The high peaks for the model measurements may be caused by the high resistivity contrast between model and enclosing medium. The resistivity of aluminum is approximately 3×10^{-6} ohm-cm. whereas the resistivity of the salt water was approximately one hundred ohm-cm. Thus the contrast is of the order of $1/3 \times 10^{8}$.

The apparent mis-placement of the flanking peaks and troughs may be partly the result of the discreet points for which the resistivity measurements were taken. This mis-placement may also be caused by a contact reaction between the conduction through the solution and the conduction through the model at the surface of the model. This may be due to a thin grease film or oxidation on the surface of the model which could cause a high resistivity reading directly above the edges of the model. Galvanic action, between the salt water and the aluminum model could be another cause of the high peaks. The chemical action could produce a galvanic current that might either reinforce or buck the instrument current. This also may cause a high resistive reading over the edges of the model. These effects may also pull in the troughs, but to a lesser degree since the potential electrodes, between which the measurements are taken, are still some distance from the edges of the model when the current electrode passes over the edges. The central low, which on this two inch electrode separation profile, does not extend below the lowest point on the curve may be caused by an electro-chemical reaction producing a potential on the surface of the model.

For the theoretical calulations the electrode separation is greater than the radius of the hemisphere, but the top of the hemisphere is flush with the surface and the electrodes make contact directly with the hemisphere. For the model runs, with a fluid covering over the model, the depth probed for measurement was below the bottom of the model and included more resistive material in the average which was measured.

Results of the resistivity measurements made over the hemispherical model at an electrode separation of one inch show essentially the same features as the profile for a two inch separation, but in this case the central low (point A" on figure 8) does extend below the lowest point on the curve and the magnitude of the peaks (points B" and C" on figure 8) is less than that for the two inch electrode separation. The lower magnitude of the central low may be explained as being caused by a greater mass of conductive model material being measured relative to the electrode separation. Such a lowering of peak magnitude is shown by Cook and Van Nostrand (2) in their figure 9 showing theoretical curves over differently shaped bodies. The location of the peaks is again above the edges of the model while the troughs (points D" and E" on figure 8) are 1.1 inches from the edge on the right side and 0.8 inches from the edge on the left side of the model. The same reasons as applied to the two inch electrode separation profile for the misplacement of the peaks and troughs could apply to this profile as well.

For both electrode separations, one inch and two inches, the model curve is more similar to the actual field curve (figure 6c) over a conductive filled sink structure, which has an overlying resistive layer, than to the continuous theoretical curve computed by Cook and Van Nostrand.

Although the aluminum hemisphere indicated that erratic results are obtained with aluminum models in salt water, it was decided to test other models, including an aluminum block, to determine if the poor results were caused by the models themselves.

Interpretation of Remaining Model Results. The remaining model runs were made with 19 inches of sand in the tank covered with a fluid layer of salt water. The sand was necessary to support the weight of the models. Interpretation of the remaining model measurements was made more difficult because of the inhomogeneity of the sand layer. A calibration measurement was made across the tank with no model. The measured value obtained without the model was subtracted from the measured value obtained with the model in place. The result is the value (E/I) of the residual anomaly which was next corrected to a zero reference. This was accomplished by shifting the entire curve up or down until the normal resistivity value away from the anomaly approached zero. This zero correction was necessary because all experimental runs could not be made at the same time, and over any long period of time the resistivity of the salt water solution was changed by a measureable amount. The value used as the zero correction was determined by taking the average amount needed to bring the sides of the model profile close to the zero value. The corrected values of the residual anomaly (E/I) were then converted to ohm-cm. and plotted as horizontal profiles.

As an example, figure 10 for the four inch electrode separation run over a buried vertical conductor covered by a three-eights inch fluid layer, was plotted from data in Table VIII in the following manner:

For position 24"

(E/I) value with model	4.23
(E/I) value without model	4.13
Residual (E/I)	.10
Zero correction for this curve	-.10
Corrected residual (E/I)	0
Resistivity at this position	0

Similarly for position 8"

(E/I) value with model	4.15
(E/I) value without model	4.31
Residual (E/I)	-.16
Zero correction for this curve	-.10
Corrected residual (E/I)	-.26

Resistivity = $2\pi a\ E/I$ where a = electrode separation

Resistivity = $2\ (3.14)\ (10.16)\ (-.26) = -16.16$ ohm-cm.

Although the results obtained using aluminum hemispherical models indicated that a metal model was unsuitable for the investigation, additional tests were made with other aluminum models to determine if the poor results were actually the fault of the model. Electrical resistivity horizontal profiles, for electrode separations of one, two, three, and four inches, plotted from measurements made on a single traverse over a buried vertical metallic conductor are shown in figures 9, 10, and 11. The conductor was an aluminum block two inches by five inches by ten inches. This block was buried in the sand with the longest dimension perpendicular to the traverse line and with the shortest dimension parallel to the traverse line, with the two inch face of the block flush with the top of the sand. A one sixteenth inch layer of salt water solution was used over the model to obtain a low resistance electrode contact. Figures 9 and 10 show the resistivity horizontal profiles obtained over the model for electrode separations of one to four inches and with a constant fluid layer thickness of three-eighth inches. Figure 10 shows the effect, on the horizontal profile for a fixed electrode separation of four inches, produced by changing the thickness of the overlying fluid layer.

Figures 9 and 10 do not show characteristic edge effects and also they show a high peak over the center of the model. While it was expected that some edge effects would show on the profiles, a high resistivity peak over the center of the model was unexpected. To illustrate where, theoretically for each electrode separation, these edge effects would appear, a dashed line has been drawn through the curve and marked C for current electrode effects and P for potential electrode effects. The curves do not show well defined peaks and troughs indicating edge effects, but at many of the points where the theoretical edge effects would appear, they show a change in slope or a reversal in slope of the curve. Perhaps the effect from the model is of such large magnitude that the smaller edge effects are obscured and appear only as a change in slope.

The high peak in the center of the curve may be explained by analyzing figures 9, 10, and 11. For a fluid layer of three-eighths of an inch, this peak is rather prominent and is especially well defined for the larger electrode separations. The character of this peak appears to remain unchanged for the different electrode separations, although the trough flanking the peak on the left increases in magnitude for increased electrode separations. The increase of this trough may be the result of the surrounding sand being packed looser on the right side of the model nearer to the surface. The troughs are approaching equal magnitude with larger electrode separations, which are effectively probing deeper in the sand layer, and are measuring the resistivity of sand that is more uniformly compacted. The cause of the peak may be a chemical reaction, occuring on the surface of the model, between the metal of the model and the salt water solution saturating the sand surrounding the model. If this is true, the magnitude of this reaction is felt most strongly at a shallow fluid layer. Figure 11 showing the resistivity profiles for a four inch electrode separation and for varying fluid layers, gives support to this possibility. At a fluid layer of three-eighths of an inch, there is one peak A-A' over the center of the model. As the thickness of the fluid layer increases, this peak separates forming two separate peaks. The curve for a fluid layer of three-quarters of an inch shows the peaks, A and A', definitely separate but still close together and the curve for one and one-quarter inch of fluid layer shows them even farther apart. Perhaps there is a fluid layer at which these peaks will be far enough apart to appear in the position that the theoretical peaks appear. The separation of this peak with a increase in fluid layer indicates that the effect model produces on this high peak decreased apparently indicating that the possibility of a reaction on the surface of the model may be reality.

The results of measurements made over the conductive aluminum block placed so that the ten inch dimension was perpendicular to the traverse line, the five inch dimension parallel to the traverse and flush with the top of the sand, and the two inch dimension vertical, are shown in figure 12. Profiles for this model with the ten inch and five inch dimensions reversed are shown in figure 13. These curves do not show a high central peak, but do show a trough which indicates that an electrochemical effect, if present, is dependent upon the surface area presented to the current path through the sand layer. There was much more surface area encountered by the current passing through the sand layer when the model was placed vertically than there was when the model was placed horizontally.

After interpreting the results of the profiles made using the aluminum block model, it was believed that this type of model did not produce profiles that can be used for determining accurately the edges, depth, or shape of the body producing the anomaly. Since aluminum models were thought unsuitable for laboratory profiling, tests were made on models using only the sand and fluid in the tank. The models were in the shape of stream channels which were made by removing some of the sand from the top of the sand layer and allowing this space to fill with salt water. The resulting horizontal profiles are shown in figure 14 for a channel five inches wide and two and one half inches deep, and in figure 15 for a channel ten inches wide and two and one half inches deep. A fluid layer of three-quarters of an inch overlying the top of the sand layer was present for the measurements taken over both channels. No well defined edge effects appear on the curves, but there are changes in the slope of the curves for the profiles over the smaller channel. This indicates, as did the aluminum models, that the magnitude of the edge effects was small enough to be undiscernable on the resistivity profiles. The results of the measurements made over the ten inch model stream channel show no indication of edge effects on the left side of the curve in figure 15 but the right side of the curve has inflection points close to the position that theoretical edge effects would have. This would seem to be an indication that the edge effects from the aluminum models may not have been large enough to have been well defined even if there had been no effect from a reaction on the model surface.

Horizontal profiles were obtained also for measurements made over resistive models. The models were made of one and three-quarter inch by twelve inches by thirty four inches, plywood boards, waterproofed with three coats of marine spar varnish. To simulate a vertical bed, the model was placed in the tank so that the longest dimension was perpendicular to the line of traverse, the one and three-quarter inch dimension parallel to the traverse and flush with the top of the sand, and the twelve inch dimension vertical and extending its full length into the sand. The model was covered by a three-quarter inch fluid layer. The results of the measurements taken over this model for electrode separations of one and two inches are shown in figure 16 and the results for an electrode separation of four inches are shown in figure 17. These curves, as expected show a high central peak, and for the larger electrode separations show also flanking troughs and peaks which may be caused by edge effects. For these curves, the edge effects do not occur as they would theoretically, but for many of the points where they are expected, there are changes in slope.

Figure 18 shows the curves plotted for measurements taken over a horizontal resistive model. For these measurements, the model was placed so that the 34 inch length was perpendicular to the line of traverse, the 12 inch and the one and three-quarters inch dimensions parallel to the line of traverse, with the 12 inch face parallel to the top of the sand layer and covered with three-quarters of an inch of sand and the sand in turn covered with a three-quarters inch fluid layer. These profiles also show changes in slope of the curve at many points where theoretical edge effects would appear. The curve for a four inch electrode separation shows a separation of the high central peak over the model indicating that the depth probed is below the model and that more of the conductive salt water saturated sand is averaged in the measurements.

A composite model was prepared by placing two of the plywood boards in the tank so that they were positioned as for the horizontal resistive model and separated by a distance of five inches. The models were covered by two inches of sand and three-quarters of an inch of salt water solution above the sand. Some of the points where edge effects would occur do show a change in slope, but these are not as prominent as for some of the other models tested. The results of the measurements made for a two inch electrode separation show, perhaps, the best defined edge effects for this model. A central high peak over the right hand model occurs, and as in the case of the single horizontal resistor, it separates into two separate peaks which are separated by a lower trough. The left side of the curve shows these peaks as having a magnitude lower than that of the right side. This may be explained as a result of the model placement. The model was put in place while the sand was still saturated with salt water. The water was not removed since this would have involved using the bottom drain which would have introduced a further non-homogeneity into the sand layer. A large area of the sand was removed, model placed in the hole, and then covered with sand. It is likely that the sand under the model on the left side is more loosely compacted than that under the model on the right side, thus producing a lower resistivity for the entire left side of the curve.

Although the curves for some of the models tested do show characteristics points for edge effects, the results of the model investigations indicate that most of the models tested were unsuitable. The best results were obtained with the models of stream channels and with the resistive models.

Difficulties Encountered. During the course of experimentation a number of unexpected difficulties were encountered. A rigid shaft coupling from the motor to the Megger was used at first. This proved unsatisfactory because the shafts were not exactly aligned and the strain created by this misalignment caused the shaft of the instrument to fail. After repair to the instrument shaft, a flexible coupling was utilized between motor and instrument. This arrangement worked satisfactorily for the term of the investigation.

Using lead pencils for graphite electrodes solved one problem but presented another. It was found that moving of the electrode holders produced a torque on the wires to the electrodes and caused the alligator clips to twist around on the bared pencil lead. After a short time the clips had worn a groove on the lead and, if not carefully checked periodically, the clips became loose and only part of the voltage was imparted to the material in the tank, the rest being dropped across the poor electrical connection of clip on pencil. This was avoided to some extent by moving electrodes and cable together, but there was always some twisting action present.

The channel iron that was used to position the electrode holders along the length of the tank had some small amount of sag in the middle.

This sag amounted to only about one sixteenth of an inch but necessitated the careful raising and lowering of the electrodes to keep the tip of the electrode just making contact with the fluid so that it would always approximate a point source on the surface.

The most troublesome disaster was not encountered until model runs with the sand layer were begun. Using unsized fine river sand and then draining fluid from the tank through one drain caused a migration of small conductive particles towards the drain end of the tank. This produced a completely non-homogeneous sand layer, necessitated making a calibration run for each model run, and more than doubled the work involved. Also, placement of models in the sand disturbs the sand adjacent to the model and can cause erratic readings. Compaction of the top portion of the sand layer is not as great as that below the surface so that a non-uniform resistivity may be present in the top few inches of sand.

Recommendations. There are numerous ways in which this investigation could be extended and improved. A major improvement would be the use of a more homogeneous material to replace the sand layer. Small glass beads or carefully sized rounded sand would seem most desirable. Careful placement of the models and replacing material around the model might produce curves showing edge effects more clearly than the present experimental results.

A more refined method of positioning of the electrodes is to be desired. Perhaps an electrode holder machined to fit a carefully milled slide bar with an etched scale attached would produce a more accurate positioning system. Replacement of the alligator clips presently in use by some other type of connector would insure that a good electrical contact is maintained.

This investigation could, with the above improvements, be extended to investigate the many problems associated with depth of burial, multiple models, effect of resistivity contrast, and by use of multiple layers it could be expanded to include vertical profiling.

VII. CONCLUSIONS

The results of this investigation show that horizontal resistivity profiles can be produced in the laboratory using small scale models. Untreated aluminum models, as used in this study, have been shown to be unsuitable when immersed in a salt water solution. The characteristic edge effects which were expected on the model results were not present. The departures from expected results may have been due to electrochemical reactions. It is believed that further refinement of the equipment and the use of suitable models will produce usable results.

VIII. APPENDIX

TABLE I

LIST OF EXPERIMENTAL MODEL RUNS AND THE CONDITIONS UNDER WHICH EACH WAS MADE.

Run No.	Type of Model	"a" Spacing	Fluid Thickness	Sand Thickness	Data Presented in; Table	Figure
1.	None	1"	20"	0	III	5
2.	None	2"	20"	0	III	5
3.	None	3"	20"	0	III	5
4.	None	4"	20"	0	III	5
5.	Conductive Hemisphere	1"	20"	0	IV	8
6.	Conductive Hemisphere	2"	20"	0	IV	7
7.	Vertical Conductor	1"	3/8"	19"	V	9
8.	Vertical Conductor	2"	3/8"	19"	VI	9
9.	Vertical Conductor	3"	3/8"	19"	VII	10
10.	Vertical Conductor	4"	3/8"	19"	VIII	10, 11
11.	Vertical Conductor	4"	3/4"	19"	IX	11
12.	Vertical Conductor	4"	$1\frac{1}{4}$"	19"	X	11
13.	Horizontal Conductor 5" Wide	1"	3/4"	19"	XI	12
14.	Horizontal Conductor 5" Wide	2"	3/4"	19"	XII	12
15.	Horizontal Conductor 10" Wide	1"	3/4"	19"	XIII	13

TABLE I cont.

Run No.	Type of Model	"a" Spacing	Fluid Thickness	Sand Thickness	Data Presented in; Table	Figure
16.	Horizontal Conductor 10" Wide	2"	3/4"	19"	XIV	13
17.	Stream Channel 5" Wide	1"	3/4"	19"	XV	14
18.	Stream Channel 5" Wide	2"	3/4"	19"	XVI	14
19.	Stream Channel 10" Wide	2"	3/4"	19"	XVII	15
20.	Vertical Insulator	2"	3/4"	19"	XVIII	16
21.	Vertical Insulator	3"	3/4"	19"	XIX	16
22.	Vertical Insulator	4"	3/4"	19"	XX	17
23.	Horizontal Insulator	1"	3/4"	3/4" Over Model 19" Total	XXI	18
24.	Horizontal Insulator	2"	3/4"	3/4" Over Model; 19" Total	XXII	18
25.	Horizontal Insulator	4"	3/4"	3/4" Over Model; 19" Total	XXIII	18
26.	Composite	2"	3/4"	2" Over Model; 19" Total	XXIV	19
27.	Composite	3"	3/4"	2" Over Model; 19" Total	XXV	19
28.	Composite	4"	3/4"	2" Over Model; 19" Total	XXVI	19

TABLE II

RESISTIVITY VALUES OBTAINED FOR VERTICAL PROFILES AT SEVERAL POINTS ON A TRAVERSE ACROSS THE LENGTH OF THE TANK. DATA PLOTTED IN FIGURE 4.

Electrode Separation Inches	Position 0 Resistivity Ohm-cm.	Position 4 Resistivity Ohm-cm.	Position -4 Resistivity Ohm-cm.	Position -6 Resistivity Ohm-cm.
2	90.60	89.32	83.58	90.92
4	93.15	95.06	96.98	90.60
6	95.13	108.87	110.99	107.81
8	112.83	118.43	122.46	118.34
10	132.21	135.60	123.74	133.91
12	157.09	161.12	151.05	140.98
14	181.97	188.97	184.31	186.64
16	206.86	222.77	217.46	238.68
18	246.59		273.33	
20	299.39			

TABLE III

OBSERVED VALUES OF RESISTANCE (E/I) DURING CALIBRATION RUNS ACROSS TANK CONTAINING TWENTY INCHES OF SALT WATER FOR ELECTRODE SEPARATIONS OF ONE TO FOUR INCHES. DATA PLOTTED IN FIGURE 5.

Position	One Inch Electrode Separation	Two Inches Electrode Separation	Three Inches Electrode Separation	Four Inches Electrode Separation
28	6.85	5.30	2.38	1.90
24	6.82	5.20	2.28	1.65
20	6.81	5.20	2.25	1.63
16	6.81	5.25	2.25	1.63
14	6.79			
12	6.80		2.23	1.63
10	6.81			
8	6.79	5.20	2.23	1.63
6	6.75			
4	6.78	5.32	2.23	1.62
2	6.75			
0	6.82	5.30	2.23	1.62
-2	6.82			
-4	6.82	5.42	2.24	1.62
-6	6.81			
-8	6.80	5.46	2.24	1.62
-10	6.79			
-12	6.79	5.45	2.24	1.61
-16	6.65	5.42	2.25	1.62
-20	6.75	5.42	2.27	1.62
-24	6.80	5.30	2.26	1.61
-28	6.65		2.29	1.73

TABLE IV

RESISTIVITY VALUES OBTAINED FOR A TRAVERSE ACROSS A BURIED CONDUCTIVE HEMISPHERE. DATA PLOTTED IN FIGURES 7 AND 8.

	Electrode separation 1"		Electrode separation 2"	
Position	Observed (E/I)	Calculated Resistivity Ohm-cm.	Observed (E/I)	Calculated Resistivity Ohm-cm.
14	6.33	100.96	3.23	103.04
12	6.38	101.76	3.23	103.04
10	6.38	101.76	3.23	103.04
9	6.39	101.92	3.23	103.04
8	6.39	101.92	3.23	103.04
7			3.24	103.36
6½			3.24	103.36
6	6.39	101.92	3.25	103.68
5½			3.26	103.99
5			3.29	104.95
4½			3.30	105.27
4	6.44	102.72	3.39	108.14
3½	6.45	102.88	3.20	102.08
3	6.50	103.68	2.67	85.17
2½	6.62	105.59	2.88	91.87
2	6.55	104.47	3.48	111.01
1½	4.89	78.00	6.15	196.19
1	6.49	103.52	18.40	586.96
½	20.20	322.19	22.20	708.18
0	19.30	307.84	13.90	443.41
-½	5.93	94.42	4.70	149.43
-1	2.33	37.16	2.87	91.55
-1½	1.88	29.99	2.97	94.74
-2	5.19	82.78	4.36	139.08
-2½	8.75	139.56	10.00	391.00
-3	17.90	285.51	19.90	634.81
-3½	8.62	137.49	16.80	532.92
-4	5.58	89.00	8.14	259.67
-4½	5.90	94.11	3.68	117.39
-5	6.68	106.55	3.03	96.66
-5½	6.54	104.31	2.79	89.00
-6	6.51	103.83	3.02	96.34
-6½	6.47	103.20	3.42	109.10
-7	6.45	102.88	3.36	107.18
-7½	6.46	103.04	3.31	105.59
-8	6.43	102.56	3.30	105.27
-9			3.28	104.63
-10	6.43	102.56	3.27	104.31
-12	6.43	102.56	3.28	104.63
-14	6.45	102.88	3.28	104.63

TABLE V

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF ONE INCH OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL CONDUCTIVE MODEL TWO INCHES IN WIDTH AND COVERED BY A THREE-EIGHTHS INCH FLUID LAYER. ZERO CORRECTION IS -.55. DATA PLOTTED IN FIGURE 9.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	7.21	6.65	.01	.16
16	7.32	6.74	.03	.48
12	7.50	7.01	-.06	-.96
10	7.64	7.13	.04	.64
9	7.54	7.00	-.01	-.16
8	7.30	6.82	-.07	-1.12
7½	7.16	6.71	-.10	-1.60
7	7.02	6.62	-.15	-2.39
6½	6.84	6.54	-.25	-3.99
6	6.69	6.51	-.37	-5.91
5½	6.61	6.49	-.43	-6.85
5	6.48	6.48	-.55	-8.78
4½	6.21	6.49	-.83	-13.23
4	6.00	6.54	-1.09	-17.40
3½	5.96	6.62	-1.21	-19.30
3	5.97	6.76	-1.34	-20.40
2½	6.02	6.87	-1.40	-22.30
2	6.61	6.91	-.85	-13.57
1½	6.63	6.99	-.91	-14.52
1	6.91	7.02	-.66	-10.53
½	7.07	6.98	-.46	-7.34
0	7.18	6.91	-.28	-4.46
-½	7.31	6.86	-.10	-1.60
-1	7.18	6.81	-.18	-2.87
-1½	6.94	6.72	-.33	-5.26
-2	6.88	6.67	-.34	-5.42
-2½	6.92	6.62	-.25	-3.99
-3	7.01	6.59	-.13	-2.07
-3½	7.09	6.52	.02	.32
-4	7.12	6.40	.17	2.71
-4½	7.03	6.37	.11	1.76
-5	6.94	6.36	.03	.48
-5½	6.88	6.32	.01	.16
-6	6.86	6.30	.01	.16
-6½	6.82	6.29	-.02	-.32
-7	6.72	6.26	-.09	-1.44
-8	6.72	6.15	.02	.32
-9	6.54	5.98	.01	.16
-10	6.37	5.83	-.01	-.16
-12	6.11	5.54	.02	.32
-16	5.95	5.49	-.09	-1.43
-20	6.05	5.50	0	0

TABLE VI

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF TWO INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL CONDUCTIVE MODEL TWO INCHES IN WIDTH AND COVERED BY A THREE-EIGHTHS INCH FLUID LAYER. ZERO CORRECTION IS 0. DATA PLOTTED IN FIGURE 9.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	5.85	5.87	-.02	-.638
16	5.97	5.95	.02	.638
12	6.10	6.11	-.01	-.391
10	6.23	6.25	-.02	-.638
9	6.14	6.18	-.04	-1.28
8	5.98	6.12	-.14	-4.47
7½	5.91	6.10	-.19	-6.06
7	5.82	6.08	-.26	-8.31
6½	5.74	6.03	-.29	-9.26
6	5.69	6.02	-.33	-10.55
5½	5.64	5.98	-.34	-10.83
5	5.49	5.94	-.45	-14.35
4½	5.30	5.92	-.62	-19.77
4	5.04	5.92	-.88	-28.10
3½	4.81	5.95	-1.14	-36.29
3	4.70	6.02	-1.32	-42.15
2½	4.71	6.08	-1.37	-43.70
2	4.84	6.16	-1.32	-42.15
1½	5.16	6.18	-1.02	-32.51
1	5.42	6.18	-.76	-24.28
½	5.71	6.17	-.46	-14.67
0	5.80	6.13	-.33	-10.55
-½	5.69	6.11	-.42	-13.40
-1	5.46	6.05	-.59	-18.82
-1½	5.26	6.02	-.76	-24.25
-2	5.09	5.99	-.90	-28.70
-2½	5.16	5.98	-.82	-26.20
-3	5.33	5.94	-.61	-19.45
-3½	5.48	5.92	-.44	-14.04
-4	5.63	5.87	-.24	-7.67
-4½	5.67	5.79	-.12	-3.82
-5	5.65	5.74	-.09	-2.87
-5½	5.60	5.72	-.12	-3.84
-6	5.59	5.71	-.12	-3.84
-6½	5.62	5.70	-.08	-2.55
-7	5.63	5.69	-.06	-1.98
-8	5.62	5.61	.01	.32
-9	5.51	5.49	.02	.64
-10	5.36	5.39	-.03	-.96
-12	5.21	5.18	.03	.96
-16	5.03	5.04	-.01	-.32
-20	5.09	5.07	.02	.64

TABLE VII

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF THREE INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL CONDUCTIVE MODEL TWO INCHES IN WIDTH AND COVERED BY A THREE-EIGHTHS INCH FLUID LAYER. ZERO CORRECTION IS -.17. DATA PLOTTED IN FIGURE 10.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	4.88	4.71	0	0
16	4.99	4.82	0	0
12	5.01	5.00	-.16	-7.65
10	5.09	5.15	-.23	-11.00
9	4.98	5.05	-.24	-11.48
8	4.86	4.97	-.30	-14.35
7½	4.79	4.97	-.35	-16.70
7	4.71	4.97	-.43	-20.60
6½	4.67	4.93	-.43	-20.60
6	4.59	4.91	-.49	-23.40
5½	4.42	4.91	-.66	-31.60
5	4.23	4.87	-.81	-38.70
4½	4.09	4.88	-.96	-45.70
4	3.94	4.89	-1.22	-58.45
3½	3.83	4.95	-1.29	-61.75
3	3.81	5.00	-1.36	-65.05
2½	3.89	5.03	-1.31	-62.70
2	4.13	5.06	-1.10	-52.65
1½	4.34	5.08	-.91	-43.50
1	4.59	5.09	-.67	-32.10
½	4.73	5.05	-.49	-23.40
0	4.78	5.02	-.41	-19.60
-½	4.66	4.98	-.49	-23.40
-1	4.49	4.95	-.63	-30.05
-1½	4.34	4.92	-.75	-35.84
-2	4.18	4.92	-.91	-43.50
-2½	4.08	4.91	-1.00	-47.85
-3	4.06	4.88	-.99	-47.30
-3½	4.09	4.87	-.95	-45.50
-4	4.17	4.83	-.83	-39.65
-4½	4.28	4.82	-.71	-33.95
-5	4.38	4.78	-.57	-27.25
-5½	4.49	4.78	-.46	-22.00
-6	4.54	4.77	-.40	-19.10
-6½	4.57	4.77	-.37	-17.65
-7	4.62	4.72	-.27	-12.90
-8	4.63	4.72	-.26	-12.45
-9	4.63	4.57	-.11	-5.27
-10	4.54	4.49	-.12	-5.75
-12	4.41	4.34	-.10	-4.79
-16	4.31	4.18	-.04	-1.92
-20	4.33	4.27	-.11	-5.27

TABLE VIII

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF FOUR INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL CONDUCTIVE MODEL TWO INCHES IN WIDTH AND COVERED BY A THREE-EIGHTHS INCH FLUID LAYER. ZERO CORRECTION IS -.10. DATA PLOTTED IN FIGURES 10 AND 11.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	4.26	4.16	0	0
16	4.28	4.18	0	0
12	4.34	4.31	-.07	-4.46
10	4.32	4.38	-.16	-10.20
9	4.28	4.38	-.20	-12.76
8	4.15	4.31	-.26	-16.61
7½	4.08	4.29	-.31	-19.80
7	3.97	4.23	-.36	-23.95
6½	3.83	4.21	-.48	-30.64
6	3.69	4.17	-.58	-37.00
5½	3.58	4.15	-.67	-42.70
5	3.50	4.16	-.76	-48.60
4½	3.47	4.19	-.82	-52.30
4	3.46	4.23	-.87	-55.60
3½	3.45	4.26	-.91	-58.10
3	3.49	4.26	-.87	-55.60
2½	3.58	4.30	-.82	-52.34
2	3.72	4.32	-.70	-44.60
1½	3.88	4.34	-.56	-35.80
1	4.01	4.35	-.44	-28.10
½	4.09	4.35	-.36	-23.95
0	4.11	4.34	-.33	-21.10
-½	4.10	4.31	-.31	-19.78
-1	4.03	4.28	-.35	-22.30
-1½	3.91	4.23	-.42	-26.82
-2	3.81	4.20	-.49	-31.25
-2½	3.68	4.17	-.59	-37.65
-3	3.59	4.16	-.67	-42.70
-3½	3.53	4.15	-.72	-45.95
-4	3.50	4.16	-.76	-48.60
-4½	3.51	4.17	-.76	-48.60
-5	3.53	4.17	-.74	-47.30
-5½	3.58	4.16	-.68	-43.40
-6	3.67	4.16	-.59	-37.60
-6½	3.74	4.14	-.50	-31.90
-7	3.82	4.14	-.42	-26.80
-8	3.89	4.10	-.31	-19.80
-9	3.94	4.04	-.20	-12.76
-10	3.92	3.97	-.15	-9.57
-12	3.83	3.83	-.10	-6.38
-16	3.85	3.81	-.06	-3.84
-20	3.82	3.75	-.03	-1.92

TABLE IX

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF FOUR INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL CONDUCTIVE MODEL TWO INCHES IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS .40. DATA PLOTTED IN FIGURE 11.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	3.33	3.72	.01	.64
16	3.36	3.71	.05	3.19
12	3.37	3.59	.18	11.48
10	3.35	3.58	.17	10.83
9	3.31	3.57	.14	8.93
8	3.26	3.58	.08	5.10
7½	3.22	3.58	.04	2.55
7	3.16	3.57	-.01	-.64
6½	3.10	3.57	-.07	-4.46
6	3.02	3.58	-.16	-10.20
5½	2.96	3.58	-.22	-14.04
5	2.92	3.58	-.26	-16.60
4½	2.87	3.58	-.31	-19.80
4	2.87	3.59	-.32	-20.42
3½	2.87	3.57	-.30	-19.20
3	2.90	3.56	-.26	-16.60
2½	2.96	3.54	-.18	-11.48
2	3.04	3.53	-.09	-5.74
1½	3.12	3.51	.01	.64
1	3.19	3.49	.10	6.38
½	3.21	3.48	.13	8.30
0	3.23	3.47	.16	10.20
-½	3.24	3.46	.18	11.48
-1	3.21	3.46	.15	9.57
-1½	3.28	3.46	.22	11.48
-2	3.11	3.46	.05	3.19
-2½	3.01	3.45	-.04	-2.55
-3	2.95	3.43	-.08	-5.10
-3½	2.94	3.43	-.09	-5.74
-4	2.93	3.43	-.10	-6.38
-4½	2.93	3.44	-.11	-7.02
-5	2.95	3.45	-.10	-6.38
-5½	2.97	3.46	-.09	-5.74
-6	3.01	3.48	-.07	-4.46
-6½	3.03	3.49	-.06	-3.84
-7	3.07	3.50	-.03	-1.92
-8	3.07	3.56	-.09	-5.74
-9	3.06	3.58	-.12	-7.65
-10	3.13	3.60	-.07	-4.46
-12	3.12	3.58	-.06	-3.84
-16	3.05	3.59	-.14	-8.93
-20	2.92	3.57	-.25	-15.95

TABLE X

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF FOUR INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL CONDUCTIVE MODEL TWO INCHES IN WIDTH AND COVERED BY A ONE AND ONE-FOURTH INCH FLUID LAYER. ZERO CORRECTION IS 0. DATA PLOTTED IN FIGURE 11.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
28	3.10	3.10	0	0
24	2.82	2.82	0	0
20	2.80	2.79	-.01	-.64
16	2.77	2.79	.02	1.27
12	2.74	2.79	.05	3.19
10	2.71	2.77	.06	3.84
8	2.68	2.67	-.01	-.64
6	2.67	2.52	-.15	-9.57
4	2.66	2.49	-.17	-10.83
2	2.65	2.60	-.05	-3.15
0	2.59	2.68	.09	5.74
-2	2.65	2.59	-.06	-3.84
-4	2.64	2.42	-.22	-14.04
-6	2.62	2.47	-.15	-9.57
-8	2.65	2.53	-.12	-7.65
-10	2.67	2.61	-.06	-3.84
-12	2.65	2.59	-.06	-3.84
-16	2.65	2.54	-.11	-7.02
-20	2.59	2.55	-.04	-2.55
-24	2.58	2.58	0	0
-28	2.78	2.76	-.02	-1.27

TABLE XI

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF ONE INCH OBTAINED ON A TRAVERSE ACROSS A BURIED HORIZONTAL CONDUCTIVE MODEL FIVE INCHES IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS .75. DATA PLOTTED IN FIGURE 12.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	5.85	6.73	-.13	-2.07
16	5.72	6.61	-.14	-2.23
12	5.80	6.32	-.23	3.66
10	5.90	6.31	.34	5.43
9	6.03	6.36	.42	6.70
8	6.02	6.39	.38	6.05
7½	6.02	6.39	.38	6.05
7	5.99	6.38	.36	5.74
6½	5.99	6.47	.27	4.31
6	5.98	6.43	.30	4.79
5½	5.98	6.44	.29	4.62
5	5.95	6.53	.17	2.71
4½	5.89	6.54	.10	1.60
4	5.86	6.53	.08	1.28
3½	5.87	6.53	.09	1.44
3	5.89	6.52	.12	1.92
2½	5.88	6.47	.16	2.55
2	5.87	6.44	.18	2.87
1½	5.86	6.40	.21	3.35
1	5.87	6.37	.25	3.99
½	5.88	6.34	.29	4.62
0	5.92	6.30	.37	5.90
-½	5.93	6.29	.39	6.21
-1	5.93	6.21	.47	7.51
-1½	5.92	6.19	.48	7.67
-2	5.92	6.18	.49	7.82
-2½	5.93	6.18	.50	7.98
3	5.97	6.16	.56	8.94
-3½	5.97	6.16	.56	8.94
-4	5.96	6.14	.57	9.08
-4½	5.96	6.14	.57	9.08
-5	5.95	6.16	.54	8.62
-5½	5.88	6.19	.44	7.02
-6	5.78	6.19	.34	5.42
-6½	5.69	6.22	.22	3.51
-7	5.65	6.29	.11	1.76
-8	5.66	6.37	.04	.64
-9	5.68	6.41	.02	.32
-10	5.66	6.43	-.02	-.32
-12	5.59	6.36	-.02	-.32
-16	5.53	6.22	.06	.96
-20	5.51	6.23	.03	.48

TABLE XII

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF TWO INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED HORIZONTAL CONDUCTIVE MODEL FIVE INCHES IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS .56. DATA PLOTTED IN FIGURE 12.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	4.46	5.05	-.06	-1.98
16	4.40	4.96	0	0
12	4.45	4.78	.23	7.35
10	4.49	4.80	.25	7.98
9	4.49	4.81	.24	7.67
8	4.47	4.83	.20	6.38
7½	4.47	4.87	.16	5.12
7	4.49	4.88	.17	5.44
6½	4.49	4.89	.16	5.12
6	4.49	4.90	.15	4.78
5½	4.43	4.89	.10	3.19
5	4.34	4.88	.02	.64
4½	4.22	4.87	-.09	-2.87
4	4.12	4.87	-.19	-6.06
3½	4.02	4.83	-.25	-7.98
3	3.88	4.82	-.28	-8.95
2½	3.77	4.76	-.43	-13.71
2	3.66	4.75	-.53	-16.94
1½	3.59	4.72	-.57	-18.20
1	3.57	4.70	-.57	-18.20
½	3.54	4.64	-.54	-17.26
0	3.53	4.60	-.51	-16.30
-½	3.56	4.57	-.45	-14.35
-1	3.59	4.55	-.40	-12.78
-1½	3.62	4.53	-.35	-11.15
-2	3.71	4.53	-.26	-8.31
-2½	3.77	4.53	-.20	-6.38
-3	3.92	4.53	-.05	-1.60
-3½	4.07	4.53	.05	1.60
-4	4.23	4.56	.23	7.34
-4½	4.37	4.57	.36	11.50
-5	4.46	4.59	.43	13.74
-5½	4.45	4.64	.37	11.84
-6	4.37	4.63	.30	9.58
-6½	4.34	4.65	.25	7.98
-7	4.23	4.66	.13	4.16
-8	4.22	4.78	0	0
-9	4.28	4.83	.01	.32
-10	4.28	4.82	.02	.64
-12	4.24	4.79	.01	.32
-16	4.16	4.67	.05	1.60
-20	4.17	4.69	.04	1.28

TABLE XIII

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION FOR ONE INCH OBTAINED ON A TRAVERSE ACROSS A BURIED HORIZONTAL CONDUCTIVE MODEL TEN INCHES IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS .86. DATA PLOTTED IN FIGURE 13.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	5.81	6.73	-.06	-.96
16	5.65	6.61	-.10	-1.60
12	5.85	6.32	.39	6.23
10	5.84	6.31	.39	6.23
9	5.85	6.36	.35	5.58
8	5.84	6.39	.31	4.94
7½	5.85	6.39	.32	5.12
7	5.85	6.38	.33	5.26
6½	5.83	6.47	.22	3.51
6	5.79	6.43	.22	3.51
5½	5.75	6.44	.17	2.71
5	5.72	6.53	.05	.80
4½	5.72	6.54	.04	.64
4	5.77	6.53	.10	1.60
3½	5.83	6.53	.15	2.49
3	5.93	6.52	.27	4.31
2½	5.99	6.47	.38	6.05
2	5.95	6.44	.37	5.91
1½	5.97	6.40	.43	6.85
1	6.04	6.37	.52	8.29
½	6.08	6.34	.60	9.58
0	6.07	6.30	.63	10.05
-½	6.02	6.29	.59	9.42
-1	5.99	6.21	.64	10.20
-1½	5.98	6.19	.65	10.35
-2	6.04	6.18	.72	11.47
-2½	6.06	6.18	.74	11.80
-3	5.97	6.16	.67	10.65
-3½	5.84	6.16	.54	8.92
-4	5.90	6.14	.62	9.89
-4½	5.79	6.14	.51	8.13
-5	5.80	6.16	.50	7.97
-5½	5.81	6.19	.48	7.67
-6	5.79	6.19	.46	7.34
-6½	5.78	6.22	.42	6.70
-7	5.76	6.29	.33	5.26
-8	5.74	6.37	.23	3.68
-9	5.72	6.41	.17	2.71
-10	5.68	6.43	.11	1.76
-12	5.54	6.36	.04	.64
-16	5.51	6.22	.15	2.39
-20	5.48	6.23	.11	1.76

TABLE XIV

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF TWO INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED HORIZONTAL CONDUCTIVE MODEL TEN INCHES IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS .55. DATA PLOTTED IN FIGURE 13.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	4.48	5.08	-.05	-1.60
16	4.40	4.96	-.01	-.32
12	4.52	4.78	.29	9.26
10	4.46	4.80	.21	6.71
9	4.47	4.81	.21	6.71
8	4.48	4.83	.20	6.40
7½	4.47	4.87	.15	4.79
7	4.44	4.88	.11	3.62
6½	4.39	4.89	.05	1.60
6	4.33	4.90	-.02	-.64
5½	4.31	4.89	-.03	-.96
5	4.31	3.88	-.02	-.64
4½	4.33	4.87	-.01	-.32
4	4.38	4.87	.06	1.92
3½	4.42	4.83	.14	4.47
3	4.44	4.82	.17	5.44
2½	4.41	4.76	.20	6.38
2	4.33	4.75	.13	4.16
1½	4.24	4.72	.07	2.23
1	4.15	4.70	0	0
½	4.03	4.64	-.06	-1.92
0	3.95	4.60	-.10	-3.19
-½	3.98	4.57	-.04	-1.28
-1	4.08	4.55	.08	2.55
-1½	4.23	4.53	.25	7.98
-2	4.38	4.53	.40	12.78
-2½	4.49	4.53	.51	16.30
-3	4.52	4.53	.54	17.26
-3½	4.49	4.53	.51	16.30
-4	4.43	4.56	.42	13.40
-4½	4.39	4.57	.37	11.81
-5	4.38	4.59	.34	10.83
-5½	4.38	4.64	.29	9.26
-6	4.38	4.63	.30	9.58
-6½	4.37	4.65	.27	8.60
-7	4.35	4.66	.24	7.67
-8	4.31	4.78	.08	2.55
-9	4.30	4.83	.02	.64
-10	4.29	4.82	.02	.64
-12	4.17	4.79	.03	.96
-16	4.09	4.67	-.03	-.96
-20	4.11	4.69	-.03	-.96

TABLE XV

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF ONE INCH OBTAINED ON A TRAVERSE ACROSS A MODEL OF A STREAM CHANNEL FIVE INCHES IN WIDTH. ZERO CORRECTION IS .75. DATA PLOTTED IN FIGURE 14.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	5.95	6.73	-.03	-.48
16	5.75	6.61	-.11	-1.76
12	5.81	6.32	.24	3.83
10	5.79	6.31	.23	3.67
9	5.74	6.36	.13	2.07
8	5.71	6.39	.07	1.12
7½	5.66	6.39	.02	.32
7	5.64	6.38	.01	.16
6½	5.64	6.47	-.08	-1.27
6	5.64	6.43	-.04	-.64
5½	5.66	6.44	-.03	-.48
5	5.70	6.53	-.08	-1.27
4½	5.68	6.54	-.11	-2.71
4	5.61	6.53	-.17	-2.71
3½	5.57	6.53	-.21	-3.35
3	5.45	6.52	-.32	-5.12
2½	5.37	6.47	-.35	-5.58
2	5.26	6.44	-.43	-6.85
1½	5.02	6.40	-.63	-10.05
1	4.80	6.37	-.82	-13.05
½	4.71	6.34	-.88	-14.00
0	4.63	6.30	-1.02	-16.30
-½	4.47	6.29	-1.07	-17.10
-1	4.45	6.21	-1.01	-16.15
-1½	4.48	6.19	-.96	-15.32
-2	4.57	6.18	-.86	-13.72
-2½	4.72	6.18	-.71	-11.36
-3	4.94	6.16	-.47	-7.50
-3½	5.06	6.16	-.35	-5.58
-4	5.22	6.14	-.17	-2.71
-4½	5.40	6.17	.01	.16
-5	5.48	6.16	.07	1.12
-5½	5.54	6.19	.10	1.60
-6	5.60	6.19	.16	2.55
-6½	5.62	6.22	.15	2.39
-7	5.60	6.29	.06	.96
-8	5.66	6.37	.04	.64
-9	5.63	6.41	-.03	-.48
-10	5.60	6.43	-.08	-1.28
-12	5.62	6.36	.01	.16
-16	5.61	6.22	.14	2.23
-20	5.61	6.23	.13	2.07

TABLE XVI

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF TWO INCHES OBTAINED ON A TRAVERSE ACROSS A MODEL OF A STREAM CHANNEL FIVE INCHES IN WIDTH. ZERO CORRECTION IS .50. DATA PLOTTED IN FIGURE 14.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	4.61	5.08	.03	.96
16	4.50	4.96	.04	1.27
12	4.56	4.78	.26	8.31
10	4.52	4.80	.22	7.24
9	4.47	4.81	.16	5.12
8	4.42	4.83	.09	2.87
7½	4.38	4.87	.01	.32
7	4.34	4.88	-.04	-1.27
6½	4.31	4.89	-.08	-2.55
6	4.29	4.90	-.11	-3.62
5½	4.24	4.89	-.15	-4.79
5	4.20	4.88	-.18	-5.75
4½	4.15	4.87	-.22	-7.24
4	4.09	4.87	-.28	-8.95
3½	4.02	4.83	-.31	-9.90
3	3.94	4.82	-.36	-11.50
2½	3.82	4.76	-.44	-14.03
2	3.69	4.75	-.56	-17.87
1½	3.50	4.72	-.72	-22.90
1	3.37	4.70	-.83	-26.48
½	3.20	4.64	-.94	-30.00
0	3.14	4.60	-.96	-30.65
-½	3.11	4.57	-.96	-30.65
-1	3.13	4.55	-.92	-29.42
-1½	3.21	4.53	-.82	-26.20
-2	3.30	4.53	-.73	-23.29
-2½	3.49	4.53	-.54	-17.26
-3	3.63	4.53	-.40	-12.76
-3½	3.65	4.53	-.38	-12.13
-4	3.81	4.56	-.25	-7.98
-4½	3.92	4.57	-.15	-4.80
-5	4.02	4.59	-.07	-2.23
-5½	4.09	4.64	-.05	-1.59
-6	4.16	4.63	.03	.96
-6½	4.20	4.65	.05	1.59
-7	4.26	4.66	.10	3.19
-8	4.31	4.78	.03	.96
-9	4.33	4.83	0	0
-10	4.33	4.82	.01	.32
-12	4.21	4.79	-.08	-2.55
-16	4.15	4.67	-.02	-.64
-20	4.13	4.69	-.06	-1.91

TABLE XVII

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF TWO INCHES OBTAINED ON A TRAVERSE ACROSS A MODEL OF A STREAM CHANNEL TEN INCHES IN WIDTH. ZERO CORRECTION IS 0. DATA PLOTTED IN FIGURE 15.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
28	5.11	5.10	.01	.32
24	4.99	4.95	.04	1.28
20	4.94	4.86	.08	2.55
16	4.84	4.70	.14	4.47
12	4.88	4.74	.14	4.47
10	4.89	4.71	.18	5.75
9½	4.85	4.69	.16	5.12
9	4.85	4.69	.16	5.12
8½	4.85	4.69	.16	5.12
8	4.70	4.69	.01	.32
7½	4.63	4.69	-.06	-1.99
7	4.57	4.69	-.12	-3.82
6½	4.58	4.69	-.11	-3.52
6	4.41	4.68	-.27	-8.63
5½	4.29	4.66	-.37	-11.81
5	4.13	4.68	-.55	-17.55
4½	3.90	4.69	-.79	-25.15
4	3.68	4.70	-1.02	-32.52
3½	3.41	4.72	-1.31	-41.82
3	3.21	4.74	-1.53	-48.80
2½	3.06	4.74	-1.68	-53.65
2	2.94	4.74	-1.80	-57.50
1½	2.93	4.76	-1.83	-64.85
1	2.66	4.78	-2.12	-67.70
½	2.67	4.77	-2.10	-67.05
0	2.68	4.77	-2.09	-66.70
-½	2.71	4.77	-2.06	-65.75
-1	2.77	4.77	-2.00	-63.80
-1½	2.84	4.78	-1.94	-61.95
-2	2.91	4.78	-1.87	-59.75
-2½	3.04	4.81	-1.77	-56.54
-3	3.20	4.82	-1.62	-51.70
-3½	3.39	4.83	-1.44	-46.00
-4	3.59	4.85	-1.26	-40.30
-4½	3.85	4.85	-1.00	-31.90
-5	4.05	4.85	-.80	-25.50
-5½	4.21	4.86	-.65	-20.70
-6	4.33	4.87	-.54	-17.23
-6½	4.42	4.88	-.46	-14.65
-7	4.51	4.88	-.37	-11.81
7½	4.61	4.87	-.26	-8.31
-8	4.71	4.87	-.16	-5.12

TABLE XVII cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
-8½	4.79	4.86	-.07	-2.23
-9	4.89	4.85	.05	1.60
-9½	4.94	4.87	.07	2.23
-10	4.98	4.89	.09	2.87
-11	5.06	4.94	.12	3.82
-12	5.09	4.97	.12	3.82
-14	5.21	5.09	.12	3.82
-16	5.26	5.17	.09	2.87
-20	5.39	5.19	.20	6.38
-24	5.58	5.40	.18	5.75
-28	5.22	5.55	-.33	-10.55

TABLE XVIII

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF TWO INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL RESISTIVE MODEL ONE AND THREE QUARTERS OF AN INCH IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS .25. DATA PLOTTED IN FIGURE 16.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	5.31	5.64	-.09	-2.87
16	5.27	5.52	0	0
12	5.19	5.27	.17	5.43
10	5.23	5.09	.39	12.45
9	5.21	4.99	.47	15.00
8	5.23	4.95	.53	16.90
7½	5.23	4.92	.56	17.87
7	5.25	5.84	.66	21.05
6½	5.27	4.73	.79	25.20
6	5.27	4.67	.85	27.12
5½	5.27	4.62	.90	28.70
5	5.28	4.58	.95	30.30
4½	5.29	4.53	1.01	32.20
4	5.33	4.48	1.10	35.10
3½	5.38	4.40	1.23	39.28
3	5.41	4.36	1.30	41.50
2½	5.45	4.32	1.38	44.10
2	5.50	4.29	1.46	46.60
1½	5.55	4.28	1.52	48.50
1	5.62	4.28	1.59	50.80
½	5.73	4.27	1.71	54.60
0	5.91	4.29	1.87	59.60
-½	6.19	4.29	2.15	68.60
-1	6.39	4.29	2.35	75.00
-1½	6.51	4.30	2.46	78.50
-2	6.44	4.31	2.38	75.90
-2½	6.29	4.33	2.21	70.50
-3	6.12	4.37	2.00	63.80
-3½	5.88	4.39	1.74	55.50
-4	5.74	4.43	1.56	49.80
-4½	5.68	4.46	1.47	46.90
-5	5.59	4.47	1.37	43.70
-5½	5.52	4.48	1.29	41.10
-6	5.42	4.48	1.19	37.90
-6½	5.37	4.48	1.14	36.29
-7	5.30	4.50	1.05	33.50
-8	5.25	4.57	.93	29.70
-9	5.22	4.62	.85	27.15
-10	5.19	4.68	.76	24.28
-12	5.14	4.90	.49	15.63
-16	5.15	5.30	.10	3.19
-20	5.18	5.46	-.03	-.96

TABLE XIX

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF THREE INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL RESISTIVE MODEL ONE AND THREE-QUARTERS OF AN INCH IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS .35. DATA PLOTTED IN FIGURE 16.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	4.47	4.87	-.05	-2.39
16	4.45	4.74	.06	2.87
12	4.40	4.55	.20	9.58
10	4.42	4.47	.30	14.35
9	4.46	4.38	.43	20.60
8	4.47	4.30	.52	24.90
7½	4.47	4.25	.57	27.25
7	4.49	4.19	.65	31.15
6½	4.49	4.14	.70	33.50
6	4.51	4.11	.75	35.95
5½	4.53	4.07	.81	38.70
5	4.57	4.02	.90	43.10
4½	4.61	4.01	.95	45.50
4	4.63	3.97	1.01	48.40
3½	4.65	3.94	1.06	50.80
3	4.67	3.90	1.12	53.70
2½	4.65	3.89	1.11	53.20
2	4.65	3.88	1.12	53.70
1½	4.69	3.86	1.18	56.50
1	4.80	3.85	1.30	62.25
½	5.00	3.81	1.54	73.75
0	5.25	3.81	1.79	75.60
-½	5.50	3.82	2.03	97.20
-1	5.68	3.82	2.21	105.80
-1½	5.77	3.83	2.29	109.70
-2	5.73	3.83	2.25	107.70
-2½	5.64	3.85	2.14	102.50
-3	5.45	3.87	1.93	92.00
-3½	5.19	3.91	1.63	78.10
-4	4.97	3.93	1.39	66.60
-4½	4.81	3.97	1.19	57.00
-5	4.72	3.98	1.09	52.20
-5½	4.68	3.99	1.04	49.85
-6	4.67	3.99	1.03	49.35
-6½	4.65	3.99	1.01	48.40
-7	4.61	4.00	.96	46.00
-8	4.52	4.04	.83	36.95
-9	4.48	4.10	.73	34.90
-10	4.44	4.18	.61	29.25
-12	4.39	4.30	.44	21.05
-16	4.39	4.61	.13	6.23
-20	4.38	4.70	.03	1.44

TABLE XX

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF FOUR INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED VERTICAL RESISTIVE MODEL ONE AND THREE-QUARTERS OF AN INCH IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS .25. DATA PLOTTED IN FIGURE 17.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
20	3.93	4.19	-.01	-.64
16	3.92	4.10	.07	4.46
12	3.91	3.97	.19	12.12
10	3.92	3.89	.28	17.85
9	3.94	3.82	.37	23.57
8	3.98	3.76	.47	29.98
7½	3.98	3.78	.50	31.90
7	4.00	3.70	.55	35.10
6½	4.03	3.67	.61	38.90
6	4.07	3.61	.71	45.30
5½	4.09	3.59	.75	47.90
5	4.10	3.55	.80	51.00
4½	4.10	3.54	.81	51.60
4	4.08	3.52	.81	51.60
3½	4.06	3.51	.80	51.00
3	4.03	3.49	.79	50.40
2½	4.07	3.48	.84	53.50
2	4.12	3.45	.92	58.74
1½	4.23	3.44	1.04	66.20
1	4.42	3.42	1.25	79.70
½	4.43	3.42	1.36	86.70
0	4.86	3.40	1.71	109.10
-½	5.05	3.41	1.89	120.50
-1	5.19	3.41	2.03	129.40
-1½	5.23	3.42	2.06	131.20
-2	5.23	3.43	2.05	130.80
-2½	5.18	3.46	1.97	125.60
-3	5.04	3.48	1.81	115.50
-3½	4.86	3.48	1.63	104.00
-4	4.61	3.50	1.36	86.70
-4½	4.42	3.51	1.16	74.00
-5	4.26	3.52	.99	63.10
-5½	4.13	3.53	.85	54.25
-6	4.07	3.55	.77	49.20
-6½	4.03	3.57	.71	45.30
-7	4.05	3.57	.73	46.60
-8	4.08	3.57	.76	48.50
-9	4.03	3.60	.68	43.40
-10	3.99	3.65	.59	37.65
-12	3.92	3.77	.40	25.50
-16	3.92	3.98	.19	12.12
-20	3.90	4.01	.14	8.93

TABLE XXI

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF ONE INCH OBTAINED ON A TRAVERSE ACROSS A BURIED HORIZONTAL RESISTIVE MODEL TWELVE INCHES IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS O. DATA PLOTTED IN FIGURE 18.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
28	6.44	6.48	-.04	-.64
24	6.59	6.59	0	0
20	6.73	6.73	0	0
16	6.60	6.61	-.01	-.16
12	6.71	6.32	.39	6.23
10	6.77	6.31	.46	7.34
9½	6.78	6.36	.42	6.70
9	6.78	6.36	.42	6.70
8½	6.80	6.37	.43	6.85
8	6.81	6.39	.42	6.70
7½	6.82	6.39	.43	6.85
7	6.87	6.38	.49	7.82
6½	6.91	6.47	.44	7.10
6	6.99	6.43	.56	8.94
5½	7.04	6.44	.60	9.58
5	7.06	6.53	.53	8.45
4½	7.09	6.54	.55	9.10
4	7.11	6.53	.58	9.25
3½	7.12	6.53	.59	9.42
3	7.18	6.52	.66	10.53
2½	7.19	6.47	.72	11.47
2	7.19	6.44	.75	11.95
1½	7.19	6.40	.79	12.60
1	7.19	6.37	.82	13.05
½	7.19	6.34	.85	13.55
0	7.19	6.30	.89	14.20
-½	7.19	6.29	.90	14.35
-1	7.19	6.21	.98	15.65
-1½	7.18	6.19	.99	15.79
-2	7.14	6.18	.96	15.32
-2½	7.09	6.18	.91	14.52
-3	7.08	6.16	.92	14.65
-3½	7.04	6.16	.88	14.03
-4	7.03	6.14	.89	14.20
-4½	7.00	6.14	.86	13.72
-5	6.99	6.16	.83	13.23
-5½	6.98	6.16	.79	12.60
-6	6.96	6.19	.77	12.25
-6½	6.92	6.22	.70	11.15
-7	6.85	6.29	.56	8.94
-7½	6.81	6.32	.49	7.82
-8	6.76	6.37	.39	6.23

TABLE XXI cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
-9	6.72	6.41	.31	4.94
-10	6.72	6.43	.29	4.62
-12	6.58	6.36	.22	3.51
-16	6.79	6.22	.57	9.08
-20	6.54	6.23	.31	4.94
-24	6.40	6.42	-.02	-.32
-28	6.40	6.36	.04	.64

TABLE XXII

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF TWO INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED HORIZONTAL RESISTIVE MODEL TWELVE INCHES IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS -.07. DATA PLOTTED IN FIGURE 18.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
28	5.06	4.98	.01	.32
24	5.09	5.02	0	0
20	5.23	5.08	.08	2.55
16	5.15	4.96	.12	3.82
12	5.27	4.78	.42	13.42
10	5.33	4.80	.46	14.68
9½	5.39	4.81	.51	16.30
9	5.42	4.81	.54	17.26
8½	5.47	5.82	.58	18.54
8	5.53	4.83	.63	20.70
7½	5.61	4.87	.67	21.38
7	5.69	4.88	.74	23.62
6½	5.80	4.89	.84	26.81
6	5.89	4.90	.92	29.42
5½	5.98	4.89	1.02	32.60
5	5.99	4.88	1.04	33.20
4½	6.00	4.87	1.06	33.90
4	6.01	4.87	1.07	34.20
3½	6.03	4.83	1.13	36.00
3	6.07	4.82	1.18	37.70
2½	6.08	4.76	1.25	39.90
2	6.10	4.75	1.28	40.80
1½	6.08	4.72	1.29	41.10
1	6.13	4.70	1.36	43.45
½	6.12	4.64	1.41	45.10
0	6.14	4.60	1.47	46.90
-½	6.16	4.57	1.52	48.50
-1	6.17	4.55	1.55	49.40
-1½	6.13	4.53	1.53	48.80
-2	6.10	4.53	1.50	47.95
-2½	6.06	4.53	1.46	46.60
-3	6.02	4.53	1.42	45.30
-3½	5.98	4.53	1.38	44.10
-4	5.98	4.56	1.35	43.10
-4½	5.97	4.57	1.33	42.50
-5	5.97	4.59	1.31	41.80
-5½	5.95	4.64	1.24	39.60
-6	5.91	4.63	1.21	38.65
-6½	5.86	4.65	1.14	36.29
-7	5.73	4.66	1.00	31.90
-7½	5.64	4.70	.87	27.80
-8	5.55	4.78	.70	22.38

TABLE XXII cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
-8½	5.47	4.81	.59	18.85
-9	5.39	4.83	.49	15.63
-9½	5.36	4.83	.46	14.70
-10	5.31	4.82	.42	13.42
-11	5.22	4.80	.35	11.20
-12	5.24	4.79	.38	12.13
-16	5.28	4.67	.54	17.25
-20	5.12	4.69	.36	11.50
-24	5.00	4.84	.09	2.87
-28	5.00	4.79	.14	4.48

TABLE XXIII

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF FOUR INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED HORIZONTAL RESISTIVE MODEL TWELVE INCHES IN WIDTH AND COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS -.05. DATA PLOTTED IN FIGURE 18.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
28	4.17	4.17	-.05	-3.20
24	3.75	3.79	-.01	-.64
20	3.77	3.72	0	0
16	3.77	3.71	.01	.64
15	3.80	3.70	.05	3.19
14	3.82	3.66	.11	7.02
13	3.88	3.62	.21	13.40
12	3.94	3.59	.30	19.28
11	4.05	3.59	.41	26.18
10	4.17	3.58	.54	34.46
9½	4.24	3.56	.63	40.20
9	4.32	3.57	.70	44.65
8½	4.41	3.57	.79	50.45
8	4.51	3.58	.88	56.20
7½	4.62	3.58	.99	63.22
7	4.73	3.57	1.11	70.90
6½	4.81	3.57	1.19	75.90
6	4.90	3.58	1.27	81.00
5½	4.96	3.58	1.33	84.90
5	4.99	3.58	1.36	86.70
4½	4.99	3.58	1.36	86.70
4	4.99	3.59	1.35	86.22
3½	4.97	3.57	1.35	86.20
3	4.93	3.56	1.32	84.20
2½	4.85	3.54	1.30	82.95
2	4.87	3.53	1.29	82.30
1½	4.82	3.51	1.26	80.40
1	4.80	3.49	1.26	80.40
½	4.77	3.48	1.24	79.20
0	4.74	3.47	1.22	77.80
-½	4.73	3.46	1.22	77.80
-1	4.74	3.46	1.23	78.50
-1½	4.77	3.46	1.26	80.40
-2	4.78	3.46	1.27	81.00
-2½	4.80	3.45	1.30	82.95
-3	4.82	3.43	1.34	85.48
-3½	4.85	3.43	1.37	87.40
-4	4.91	3.43	1.43	91.25
-4½	4.94	3.44	1.45	92.60
-5	4.96	3.45	1.46	93.20
-5½	4.97	3.46	1.46	93.20
-6	4.93	3.48	1.40	89.30

TABLE XXIII cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
-6½	4.89	3.49	1.35	86.20
-7	4.84	3.50	1.29	82.30
-7½	4.77	3.52	1.20	76.55
-8	4.69	3.56	1.08	69.95
-8½	4.56	3.57	.94	60.00
-9	4.43	3.58	.80	51.00
-9½	4.34	3.59	.70	44.60
-10	4.26	3.60	.61	38.90
-11	4.11	3.59	.47	29.98
-12	3.99	3.58	.36	23.95
-13	3.91	3.58	.28	17.85
-14	3.88	3.58	.25	15.97
-15	3.88	3.59	.24	15.33
-16	3.87	3.59	.23	14.65
-20	3.79	3.57	.17	10.83
-24	3.76	3.67	.04	2.55
-28	3.97	3.82	.10	6.38

TABLE XXIV

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF TWO INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED COMPOSITE MODEL COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS 0. DATA PLOTTED IN FIGURE 19.

Position	Observed (E/I) With Models	Observed (E/I) Without Models	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
28	4.97	4.97	0	0
27½	4.98	5.00	-.02	-.64
27	4.98	5.00	-.02	-.64
26½	4.98	5.00	-.02	-.64
26	4.98	5.00	-.02	-.64
25½	4.98	4.95	.03	.96
25	4.98	4.94	.04	1.27
24½	5.01	4.97	.04	1.27
24	5.04	4.99	.05	1.59
23½	5.07	5.02	.05	1.59
23	5.03	5.04	-.01	-.32
22½	5.07	5.02	.02	.64
22	5.09	5.06	.03	.96
21½	5.09	5.06	.03	.96
21	5.09	5.05	.04	1.27
20½	5.10	5.02	.08	2.55
20	5.12	4.99	.13	4.15
19½	5.17	4.99	.18	5.75
19	5.21	4.97	.24	7.67
18½	5.28	4.94	.34	10.83
18	5.32	4.90	.42	13.40
17½	5.37	4.87	.50	15.95
17	5.41	4.79	.62	19.77
16½	5.48	4.73	.75	23.95
16	5.54	4.65	.89	28.39
15½	5.61	4.62	.99	31.60
15	5.68	4.58	1.10	35.10
14½	5.71	4.57	1.14	36.29
14	5.71	4.57	1.14	36.29
13½	5.71	4.58	1.13	36.00
13	5.73	4.58	1.15	36.64
12½	5.75	4.62	1.13	36.00
12	5.79	4.63	1.16	36.98
11½	5.80	4.64	1.16	36.98
11	5.81	4.66	1.15	36.64
10½	5.85	4.69	1.16	36.98
10	5.87	4.67	1.20	38.22
9½	5.88	4.71	1.17	37.26
9	5.89	4.73	1.16	36.98
8½	5.88	4.79	1.09	34.80
8	5.88	4.83	1.05	33.50
7½	5.88	4.88	1.00	31.90

TABLE XXIV cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
7	5.87	4.91	.96	30.65
6½	5.86	4.95	.91	29.05
6	5.84	4.98	.86	27.45
5½	5.82	5.01	.81	25.85
5	5.81	5.02	.79	25.15
4½	5.81	5.03	.78	24.82
4	5.80	5.03	.77	24.50
3½	5.79	5.00	.79	24.82
3	5.74	4.98	.76	24.28
2½	5.72	4.98	.74	23.62
2	5.69	4.99	.70	22.38
1½	5.68	5.00	.68	21.62
1	5.65	5.03	.62	19.77
½	5.65	5.03	.62	19.77
0	5.64	5.03	.61	19.45
-½	5.64	5.02	.62	19.77
-1	5.66	5.00	.66	21.00
-1½	5.67	5.01	.66	21.00
-2	5.67	5.01	.66	21.00
-2½	5.67	5.01	.66	21.00
-3	5.64	4.99	.65	20.70
-3½	5.61	4.98	.63	20.10
-4	5.68	4.97	.61	19.45
-4½	5.56	4.95	.61	19.45
-5	5.54	4.95	.59	18.82
-5½	5.53	4.95	.58	18.54
-6	5.52	4.95	.57	18.20
-6½	5.52	4.93	.59	18.82
-7	5.53	4.92	.61	19.45
-7½	5.56	4.91	.65	20.67
-8	5.57	4.89	.68	21.62
-8½	5.58	4.88	.70	22.38
-9	5.58	4.88	.70	22.38
-9½	5.55	4.89	.66	21.00
-10	5.52	4.89	.63	20.10
-10½	5.51	4.88	.63	20.10
-11	5.52	4.88	.64	20.35
-11½	5.51	4.85	.66	21.00
-12	5.52	4.79	.73	23.20
-12½	5.52	4.80	.72	22.90
-13	5.52	4.82	.70	22.38
-13½	5.52	4.91	.61	19.45

TABLE XXIV cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
-14	5.51	4.98	.53	16.86
-14½	5.49	5.00	.49	15.63
-15	5.46	4.99	.47	14.97
-15½	5.41	4.96	.45	14.32
-16	5.38	4.89	.49	15.63
-16½	5.35	4.86	.49	15.63
-17	5.33	4.87	.46	14.65
-17½	5.32	4.85	.47	14.97
-18	5.32	4.87	.45	14.35
-18½	5.32	4.88	.44	14.00
-19	5.33	4.90	.43	13.74
-19½	5.35	4.93	.42	13.40
-20	5.36	4.99	.37	11.81
-20½	5.36	5.01	.35	11.20
-21	5.37	5.07	.30	9.57
-21½	5.38	5.10	.28	8.82
-22	5.37	5.14	.23	7.35
-22½	5.38	5.18	.20	6.38
-23	5.40	5.20	.20	6.38
-23½	5.41	5.22	.19	6.06
-24	5.39	5.26	.13	4.16
-24½	5.37	5.30	.07	2.23
-25	5.34	5.36	-.02	-.64
-25½	5.32	5.38	-.06	-1.99
-26	5.31	5.37	-.06	-1.99
-26½	5.31	5.32	-.01	-.32
-27	5.28	5.28	0	0
-27½	5.24	5.22	.02	.64
-28	5.24	5.23	.01	.32

TABLE XXV

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF THREE INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED COMPOSITE MODEL COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS 0. DATA PLOTTED IN FIGURE 19.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
28	4.78	4.61	.17	8.16
27½	4.72	4.58	.14	6.72
27	4.69	4.53	.16	7.65
26½	4.67	4.49	.18	8.63
26	4.61	4.48	.13	6.23
25½	4.61	4.47	.14	6.72
25	4.62	4.44	.18	8.63
24½	4.62	4.40	.22	10.55
24	4.62	4.40	.22	10.55
23½	4.63	4.39	.24	11.48
23	4.62	4.38	.24	11.48
22½	4.64	4.39	.25	11.98
22	4.65	4.39	.26	12.45
21½	4.68	4.38	.30	14.35
21	4.69	4.37	.32	15.35
20½	4.71	4.37	.34	16.30
20	4.75	4.35	.40	19.20
19½	4.79	4.35	.44	21.05
19	4.85	4.35	.50	23.95
18½	4.91	4.32	.59	28.13
18	4.98	4.30	.68	32.60
17½	5.03	4.27	.76	36.40
17	5.16	4.22	.94	45.05
16½	5.21	4.18	1.03	49.35
16	5.28	4.14	1.14	54.55
15½	5.32	4.09	1.23	58.90
15	5.38	4.08	1.30	62.25
14½	5.40	4.08	1.32	63.15
14	5.41	4.09	1.32	63.15
13½	5.41	4.10	1.31	62.70
13	5.40	4.12	1.28	61.40
12½	5.40	4.15	1.25	59.90
12	5.40	4.16	1.24	59.35
11½	5.41	4.16	1.25	59.90
11	5.42	4.13	1.29	61.75
10½	5.43	4.14	1.29	61.75
10	5.44	4.15	1.29	61.75
9½	5.47	4.14	1.33	63.80
9	5.48	4.14	1.34	64.20
8½	5.48	4.18	1.30	62.25
8	5.47	4.22	1.25	60.00
7½	5.46	4.27	1.19	57.00

TABLE XXV cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
7	5.46	4.31	1.15	55.30
6½	5.46	4.33	1.13	54.30
6	5.46	4.38	1.08	51.85
5½	5.46	4.39	1.07	51.30
5	5.46	4.37	1.09	52.20
4½	5.48	4.37	1.11	53.20
4	5.48	4.35	1.13	54.30
3½	5.48	4.33	1.15	55.30
3	5.48	4.32	1.16	55.75
2½	5.44	4.32	1.12	53.70
2	5.41	4.34	1.07	51.30
1½	5.39	4.36	1.03	49.35
1	5.37	4.38	.99	47.30
½	5.35	4.37	.97	46.50
0	5.33	4.39	.94	45.05
-½	5.31	4.39	.92	44.10
-1	5.30	4.38	.92	44.10
-1½	5.29	4.38	.91	43.50
-2	5.28	4.36	.92	44.10
-2½	5.24	4.33	.91	43.50
-3	5.22	4.32	.90	43.15
-3½	5.20	4.32	.88	43.00
-4	5.13	4.30	.83	39.85
-4½	5.10	4.31	.79	37.80
-5	5.09	4.32	.77	36.80
-5½	5.08	4.30	.78	38.05
-6	5.07	4.30	.77	36.80
-6½	5.07	4.29	.78	38.05
-7	5.09	4.29	.80	38.18
-7½	5.09	4.28	.81	38.70
-8	5.09	4.28	.81	38.70
-8½	5.09	4.28	.81	38.70
-9	5.09	4.29	.80	38.18
-9½	5.09	4.28	.80	38.18
-10	5.07	4.27	.80	38.18
-10½	5.07	4.22	.85	41.55
-11	5.06	4.21	.85	41.55
-11½	5.08	4.20	.88	43.00
-12	5.09	4.21	.88	43.00
-12½	5.10	4.25	.85	41.55
-13	5.11	4.29	.82	42.30
-13½	5.11	4.33	.78	38.05

TABLE XXV cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
-14	5.09	4.38	.71	34.70
-14½	5.08	4.41	.67	32.75
-15	5.02	4.45	.57	27.25
-15½	4.99	4.45	.54	25.90
-16	4.93	4.43	.50	23.90
-16½	4.89	4.39	.50	23.90
-17	4.86	4.33	.53	25.40
-17½	4.81	4.31	.50	23.90
-18	4.79	4.32	.47	22.50
-18½	4.78	4.33	.45	21.52
-19	4.78	4.40	.38	18.22
-19½	4.78	4.42	.36	17.25
-20	4.77	4.48	.29	13.90
-20½	4.75	4.52	.23	11.04
-21	4.75	4.56	.19	9.10
-21½	4.76	4.59	.17	8.16
-22	4.78	4.60	.18	8.63
-22½	4.78	4.65	.13	6.22
-23	4.78	4.68	.10	4.79
-23½	4.79	4.70	.09	4.31
-24	4.79	4.73	.06	2.87
-24½	4.79	4.79	0	0
-25	4.79	4.81	-.02	-.94
-25½	4.80	4.82	-.02	-.94
-26	4.81	4.81	0	0
-26½	4.81	4.80	.01	.48
-27	4.82	4.79	.03	1.44
-27½	4.82	4.79	.03	1.44
-28	4.86	4.80	.06	2.87

TABLE XXVI

RESISTIVITY VALUES FOR AN ELECTRODE SEPARATION OF FOUR INCHES OBTAINED ON A TRAVERSE ACROSS A BURIED COMPOSITE MODEL COVERED BY A THREE-FOURTHS INCH FLUID LAYER. ZERO CORRECTION IS 0. DATA PLOTTED IN FIGURE 19.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
28	4.57	4.42	.15	9.57
27½	4.43	4.31	.12	7.65
27	4.31	4.21	.10	6.38
26½	4.21	4.16	.05	3.19
26	4.16	4.10	.06	3.84
25½	4.14	4.05	.09	5.74
25	4.10	3.99	.11	7.02
24½	4.09	3.97	.12	7.65
24	4.09	3.92	.17	10.83
23½	4.09	3.92	.17	10.83
23	4.09	3.89	.20	12.76
22½	4.10	3.88	.22	14.04
22	4.12	3.88	.24	15.35
21½	4.13	3.89	.24	15.35
21	4.17	3.88	.29	18.50
20½	4.19	3.88	.31	19.80
20	4.23	3.88	.35	22.30
19½	4.30	3.88	.42	26.80
19	4.38	3.86	.52	33.20
18½	4.46	3.83	.63	40.20
18	4.51	3.80	.71	45.30
17½	4.60	3.77	.83	53.00
17	4.69	3.71	.98	62.50
16½	4.77	3.69	1.08	69.90
16	4.83	3.56	1.27	81.00
15½	4.89	3.54	1.35	86.10
15	4.90	3.52	1.38	88.00
14½	4.92	3.62	1.30	82.90
14	4.92	3.63	1.29	82.20
13½	4.91	3.62	1.29	82.20
13	4.89	3.65	1.24	79.10
12½	4.88	3.67	1.21	77.20
12	4.83	3.68	1.15	73.30
11½	4.81	3.67	1.14	72.80
11	4.81	3.67	1.14	72.80
10½	4.82	3.67	1.15	73.30
10	4.80	3.67	1.13	72.10
9½	4.82	3.67	1.15	73.30
9	4.82	3.67	1.15	73.30
8½	4.83	3.69	1.14	72.80
8	4.84	3.71	1.13	72.10
7½	4.89	3.73	1.16	74.00

TABLE XXVI cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
7	4.90	3.76	1.14	72.80
6½	4.92	3.79	1.13	72.10
6	4.96	3.80	1.16	74.00
5½	4.98	3.81	1.17	74.60
5	5.01	3.80	1.21	77.20
4½	5.03	3.78	1.25	79.74
4	5.07	3.77	1.30	82.90
3½	5.09	3.74	1.35	86.10
3	5.09	3.73	1.36	87.80
2½	5.09	3.73	1.36	87.80
2	5.08	3.74	1.34	85.50
1½	5.04	3.75	1.29	82.20
1	5.02	3.73	1.25	79.70
½	5.02	3.79	1.23	78.55
0	5.01	3.79	1.22	77.90
-½	5.00	3.79	1.21	77.20
-1	4.98	3.79	1.19	75.90
-1½	4.95	3.79	1.16	74.00
-2	4.90	3.79	1.11	70.80
-2½	4.86	3.78	1.08	69.00
-3	4.81	3.78	1.03	65.70
-3½	4.73	3.76	.97	61.90
-4	4.68	3.74	.94	60.00
-4½	4.62	3.74	.88	56.10
-5	4.59	3.73	.86	54.90
-5½	4.54	3.73	.81	51.70
-6	4.51	3.75	.76	48.60
-6½	4.49	3.75	.74	47.30
-7	4.49	3.75	.74	47.30
-7½	4.49	3.75	.74	47.30
-8	4.49	3.74	.75	47.94
-8½	4.51	3.73	.78	49.75
-9	4.51	3.72	.79	50.40
-9½	4.53	3.70	.83	52.95
-10	4.55	3.70	.85	54.30
-10½	4.58	3.69	.89	56.80
-11	4.60	3.69	.91	58.10
-11½	4.61	3.71	.90	57.40
-12	4.62	3.76	.86	54.90
-12½	4.66	3.79	.87	55.60
-13	4.68	3.82	.86	54.90
-13½	4.69	3.86	.83	52.95

TABLE XXVI cont.

Position	Observed (E/I) With Model	Observed (E/I) Without Model	Corrected Residual Anomaly	Calculated Resistivity Ohm-cm.
-14	4.68	3.87	.81	51.70
-14½	4.65	3.88	.77	49.15
-15	4.62	3.91	.71	45.35
-15½	4.58	3.92	.66	42.10
-16	4.52	3.90	.62	39.60
-16½	4.48	3.88	.60	38.30
-17	4.41	3.84	.57	36.40
-17½	4.38	3.82	.56	35.80
-18	4.32	3.82	.50	31.90
-18½	4.30	3.83	.47	30.00
-19	4.27	3.85	.42	26.80
-19½	4.25	3.88	.37	23.60
-20	4.22	3.92	.30	19.20
-20½	4.22	3.97	.25	15.95
-21	4.21	4.00	.21	13.38
-21½	4.20	4.03	.17	10.83
-22	4.20	4.09	.11	7.02
-22½	4.21	4.14	.07	4.46
-23	4.21	4.19	.02	1.28
-23½	4.22	4.21	.01	.64
-24	4.23	4.23	0	0
-24½	4.25	4.28	-.03	-1.92
-25	4.27	4.29	-.02	-1.28
-25½	4.28	4.30	-.02	-1.28
-26	4.29	4.32	-.03	-1.92
-26½	4.32	4.33	-.01	-.64
-27	4.37	4.38	-.01	-.64
-27½	4.41	4.44	-.03	-1.92
-28	4.49	4.50	-.01	-.64

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