COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF SUPPLY AND SHIPPING.

MINERAL RESOURCES SURVEY.

REPORT No. 1943/64B.

-. LOCATING RESISTIVE BODIES IN THE GROUND -

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CANBERRA. 26th November, 1943.

1220. By Authority: L. F. JOHNSTON, Commonwealth Government Printer, Canberra

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Introduction.

The possibility of using resistivity me- [redacted] resistive bodies of finite size buried in the [redacted] investigated. The investigation con- [redacted] series of model tests to determine [redacted] controlled conditions. Secondly, [redacted] which had been subject to [redacted] studied to determine the [redacted] that could normally be expected [redacted] areas of limited size.

Discussion of Model Tests.

The model investigation was primarily based on the use of the four electrode method first developed by Wenner, but the arrangement of the four electrodes was varied to see whether arrangements other than that of equal spacing would tend to intensify the anomalies.

The tests were carried out in a water tank. The water resistivity was approximately 18,000 ohm-cm. The resistive model was a block of paraffin wax 3" x 3" x 1" in size and of resistivity 10^{16} ohm-cm. The resistivity ratio between the resistive body and the enclosing medium was thus approximately 5×10^{11} but it should be realized that the anomalous effect rapidly reaches a maximum when the resistivity ratio is varied from 1/1. In fact there is little change in the anomaly when the resistivity ratio exceeds 10/1.

The results of the model tests are shown in a number of curves which accompany these notes. The current input was kept constant in all measurements and, therefore, it has been possible to express the resistivity anomaly simply in milli-volts.

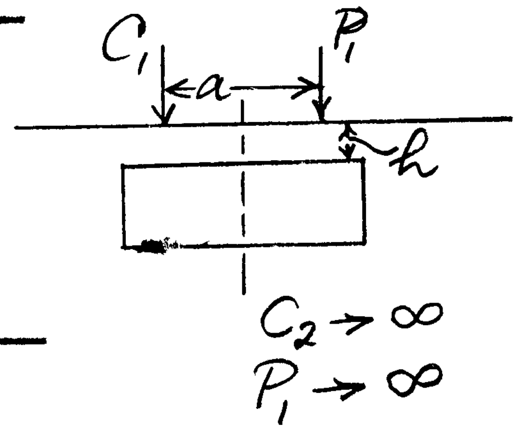
In the tests the appropriate electrode separations were set and the electrodes arranged so that their points just touched the water surface. The paraffin model was then adjusted to have the desired depth below the surface and it was then moved along the line of electrodes. A current of one milliampere was passed through the current electrodes C_1 and C_2 and the potential drop between P_1 and P_2 was observed.

The curves Figures 1 to 12 show the results of these tests. The potential differences (P_1-P_2) are plotted vertically above the centre of the position occupied by the model at the time of the reading.

It will be observed that the maximum anomaly usually occurs when the model lies midway between a pair of adjoining current and potential electrodes. The greatest anomaly was measured in the case represented by Figure 9, although in the case of Figure 5, the anomaly was nearly as great. From an exam-ination of these results it was obvious that the main effect arose out of the influence of the model on the potential distribution near either one of the current electrodes.

It was found that large anomalies could be obtained when only two electrodes (say C_1 and P_1) were brought near the model while the other two C_2 and P_2 were removed to the vicinity of opposite edges of the water tank. A series of tests was made with such an arrangement in which the distance between C_1 and P_1

was varied as well as the depth of the model. The potential drop between P_1 and P_2 was measured with he model arranged midway between C_1 and P_1, i.e. in the position of maximum anomaly, and also with the model absent (normal effect). The results of this test are tabulated below and are shown in the form of curves in Figure 13.



For h = ¼"

a	Normal Value MV/IMA	Value with Block MV/IMA	Anomaly in MV/IMA	Anomaly expressed as Per cent Normal
½"	1090	2900	1810	166
¾"	735	2170	1435	195
1"	600	1860	1260	210
1¼"	530	1400	870	164
1½"	430	1070	640	149
2"	280	510	230	82
2½"	180	270	90	50
3"	125	155	30	24

For h = ½"

a	Normal value MV/IMA	Value with Block MV/IMA	Anomaly in MV/IMA	Anomaly expressed as Per Cent Normal
½"	1090	2240	1150	105
¾"	800	1700	900	112
1"	585	1330	745	127
1¼"	430	960	530	123
1½"	350	680	330	94

For h = ¾"

a	Normal value MV/IMA	Value with Block MV/IMA	Anomaly in MV/IMA	Anomaly expressed as Per Cent Normal
½"	1310	1800	490	37
¾"	775	1235	460	59
1"	530	865	335	63
1½"	354	577	223	66
2"	254	388	134	53
2½"	168	226	58	35
3"	120	144	24	20

For h = 1"

a	Normal Value MV/IMA	Value with Block MV/IMA	Anomaly in MV/IMA	Anomaly expressed as Per Cent Normal
½"	1310	1630	320	24
1"	567	795	228	40
1½"	362	532	170	47
2"	225	313	88	39
2½"	172	232	60	35
3"	106	138	32	30
4"	67.5	74	6.5	9.6

The results of the model tests described can be applied to any problem where the model has different dimensions. If all the dimensions, such as those of the model, its depth below the surface, and the electrode separations, are multiplied by the same factor, then the results described are applicable.

Thus if the resistive model were 12" x 12" x 4" at a depth of 4" below the surface, the maximum anomaly occurs with an electrode separation (C_1 P_1 Fig. 13) of 5¼ inches. This anomaly represents an increase of 50 per cent above normal value. For a model of these same dimensions but at a depth of 2 inches below the surface, the maximum anomaly occurs when the electrode separation in 4½ inches. The change is then approximately 130 per cent.

Discussion of Normal Surface Resistivities.

The second part of the investigation involved the scrutiny of field records and the tabulation of the resistivities measured with an 18" electrode separation at a number of closely spaced observation points. Among the areas so examined was the Herberton Deep Lead in Northern Queensland. The results of the investigation for this area are typical of others examined so that the following discussion will be limited to this area.

The surface material consisted chiefly of a brown loam soil of very even texture overlying basalt. From the appearance of the soil alone, it appeared that the surface resistivities would be fairly uniform. This was not the case, however, and resistivities varied between/limits. /wide

Observation points were, on the average, spaced on a 200 feet grid. Variations between neighbouring stations were frequently of the order of several hundred per cent. Traverse D might be taken as a typical example. This traverse was entirely on basalt soil and for the greater part of its length the soil appeared to be very uniform in character. The resistivities corresponding to this traverse are tabulated below. The resistivity values are distributed erratically along the traverse and there is every reason to suppose that similar variations in surface resistivity would be measured if a series of observation points at intervals of say 3 feet were taken in the vicinity of traverse E.

TRAVERSE.D.

Station	Resistivity. OHM-CM.
300E (ft.)	31,800
600E	15,100
750E	42,300
900E	75,600
1050E	82,500
1200E	67,500
1350E	144,000
1500E	104,000
1800E	73,100
2100E	46,900
2400E	64,000
2700E	107,000

The area in question is one in which particularly uniform surface conditions might be expected owing to even texture of the soil and the fact that the surface was extremely flat and had been undisturbed by cultivation. In addition, it was free from stones or roots of trees.

In desert areas such as Croydon, North Queensland, it was found that surface resistivities were general/

much higher than those found at Herberton and local variations were generally greater.

Conclusion.

It will be appreciated that the normal variations in the surface resistivity of soil can be considerably greater than the anomalies caused by a shallow buried non-conducting body, the maximum effect of which appears to be of the order of a 300 per cent change from normal. It appears, therefore, that under average field conditions the effect of a buried non-conductive body could not be/distinguished from the effects due to local variations in surface resistivity.

/reliably

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CANBERRA, A.C.T.
26th November, 1943.

CURVES OF APPARENT RESISTIVITY
SHOWING THE
EFFECT OF INTRODUCING A NONCONDUCTIVE BODY OF FINITE SIZE INTO A CONDUCTIVE MEDIUM

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Jan 1944