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Schlumberger Soundings and Total Field Measurements in the Raft River Geothermal Area, Idaho

By

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In 1974, the U.S. Geological Survey in cooperation with the Energy Research Development Administration (formerly the U.S. Atomic Energy Commission) made d.c. current measurements in the Raft River geothermal area. Seventy nine symmetric Schlumberger soundings were made and 269 bipole-dipole total field stations were occupied about a current bipole 3.22 km (2 miles) in length. Included in these total field stations are seven repeat stations, and three other stations at which measurements could not be made.

Figure 1 shows the index map for the location, number, and azimuth of the Schlumberger sounding stations. The soundings were numbered from Raft #1 to Raft #43, then from Raft #101 to Raft #136. With the exception of Raft #107 (which was expanded to a maximum electrode spacing, AB/2, of 426 metres (1,400 feet)) the maximum electrode spacing ranged from AB/2 = 914 metres (3,000 feet) to AB/2 = 3,658 metres (12,000 feet). All the sounding curves were automatically processed and interpreted as shown in the graphs given in the appendix. Each graph shows the following:

(1) Field data designated by a segmented solid-line curve with diamond symbols for observed data.

(2) A continuous-dashed curve which represents:

(a) the continuous "field" curve obtained by shifting the various segments upwards or downwards generally with respect to the last segment on the segmented field curve (Zohdy and others, 1973)

(b) the digitized curve at the rate of six points per logarithmic cycle. Although the digitized points are not shown on the dashed curve, they were computed using a subroutine in a computer program for bicubic spline functions (Anderson, 1971). The digitized data were then fed into the automatic interpretation program (Zohdy, 1974a and 1975) to obtain the best fitting theoretical sounding curve for a horizontally layered medium.

(3) The theoretical best fitting sounding curve is plotted as (+) signs.

(4) The detailed layering for which the theoretical curve is calculated.

(5) The D.Z. (Dar Zarrouk) curve for the detailed layering. The ordinate values for the D.Z. curves are shifted upward or downward by one logarithmic cycle or they are plotted on a separate sheet of graph paper (as for Raft #40) to avoid cluttering the graphs. The D.Z. curves can be used to obtain equivalent and simpler solutions containing fewer number of layers and in which certain constraints are imposed on the layer thickness and resistivities (Zohdy, 1974b).

All these graphs were generated on a Hewlett Packard 7203A graphic plotter. The plotter driving subroutines were developed by G. I. Evenden of the U.S. Geological Survey.

Figure 2 shows the simple total-field bipole-dipole apparent resistivity map which is contoured at a logarithmic contour interval, in ohm-m values.

Figure 3 shows the theoretical simple total field bipole-dipole apparent resistivity map that should have been obtained had the ground been horizontally layered over the entire survey area. The calculations (Zohdy and Stanley, 1974) are based on the sounding data obtained at sounding Raft #1 which was made at the center of the current bipole.

Figure 4 shows the normalized (or reduced) apparent resistivity map which is obtained by finding the ratio between the observed values in figure 2 and the theoretical values shown in figure 3. Had the ground been horizontally layered over the entire survey area, all the normalized values should have been equal to unity. In general, areas outlined by values greater than unity indicate that the section contains more resistive materials or that basement rocks are shallower than at Raft #1 sounding. Conversely areas outlined by contour values less than unity designate the opposite. It should be noted, however, that false lows and highs may be caused by the presence of near vertical faulting separating media of large differences in resistivity. The major use of the normalized apparent resistivity map is that it emphasises lateral variations in the subsurface resistivity and thus outline more clearly the trend of possible faulting.

References cited

Anderson, W. L., 1971, Application of bicubic spline functions to two dimentipial guided data: NTIS (National Technical Information Service), No. PB-203579, Springfield, Virginia.

Zohdy, Adel A. R., 1974a, A computer program for the automatic interpretation of Schlumberger sounding curves over horizontally stratified media: NTIS (National Tech. Inform. Service) PB-232703/AS, 25 p., Springfield, Virginia.

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Zohdy, A. A. R., (in press), Automatic interpretation of Schlumberger sounding curves using modified Dar-Zarrouk functions: U.S. Geol. Survey Bull. 1313-E.

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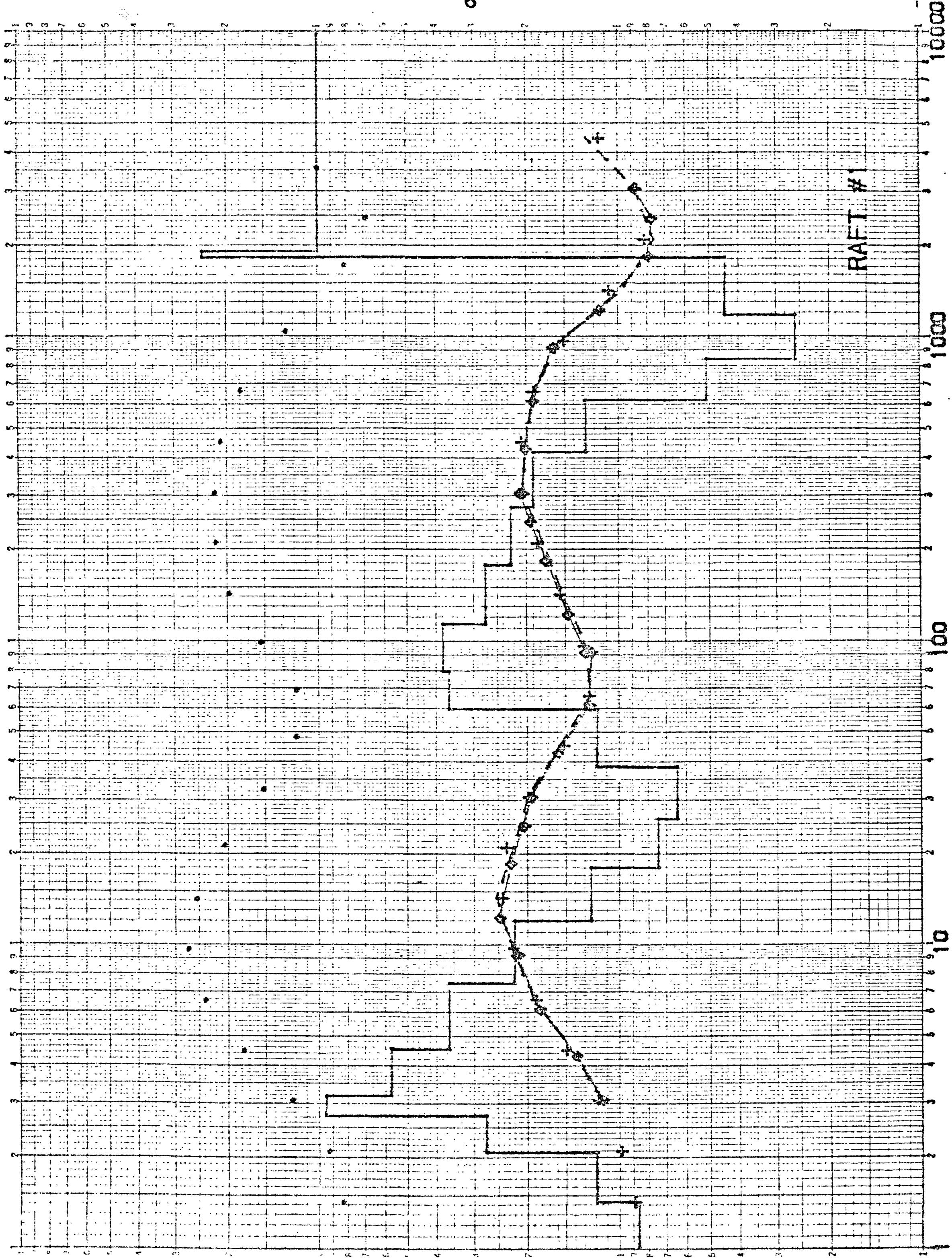
Zohdy, A. A. R., Anderson, L. A., and Muffler, L. J. P., 1973, Resistivity, self potential, and induced polarization surveys of a vapor-dominated geothermal system: Geophysics, v. 38, p. 1130-1144.

APPENDIX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1000
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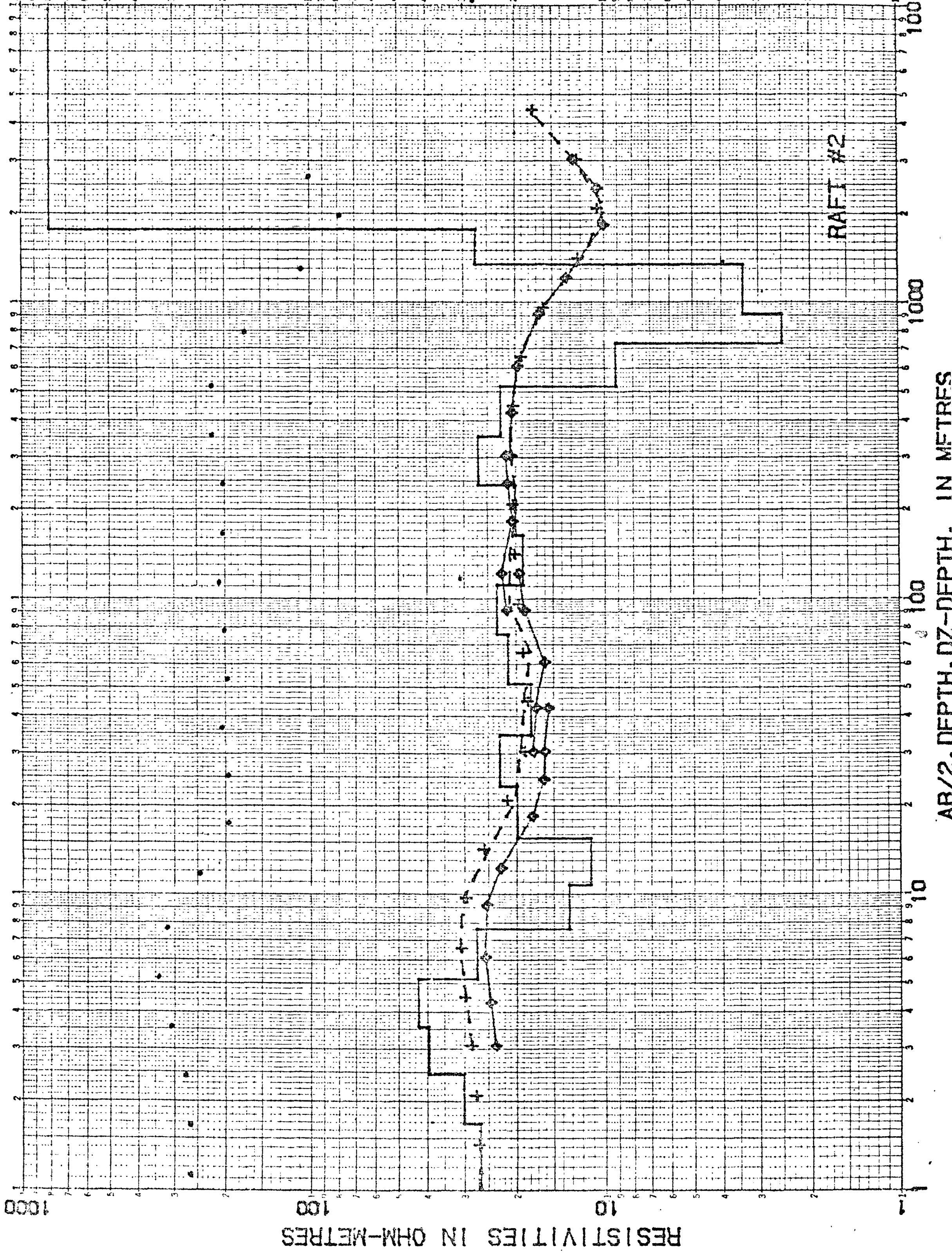
100
10
1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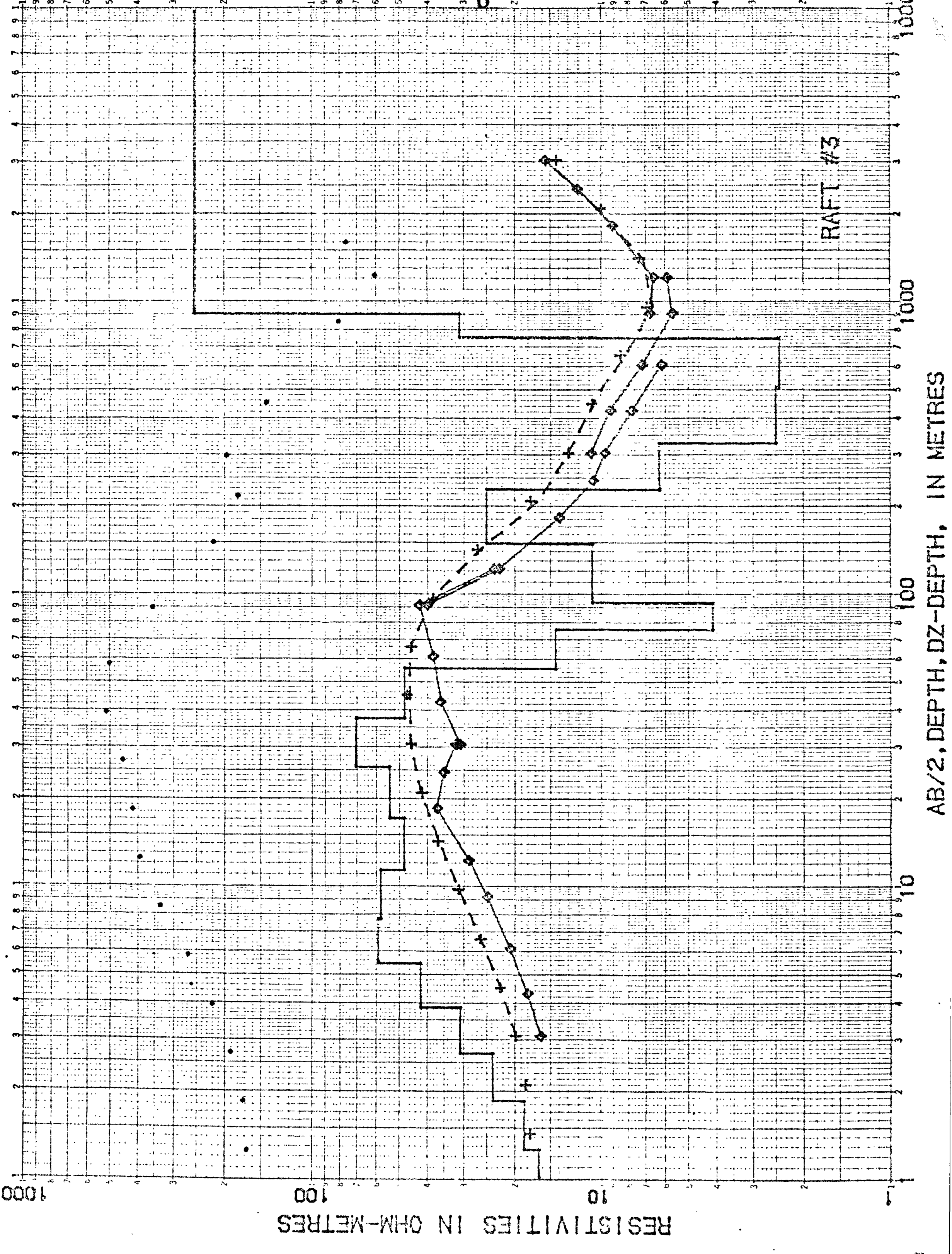
10
1
10
100
1000
10000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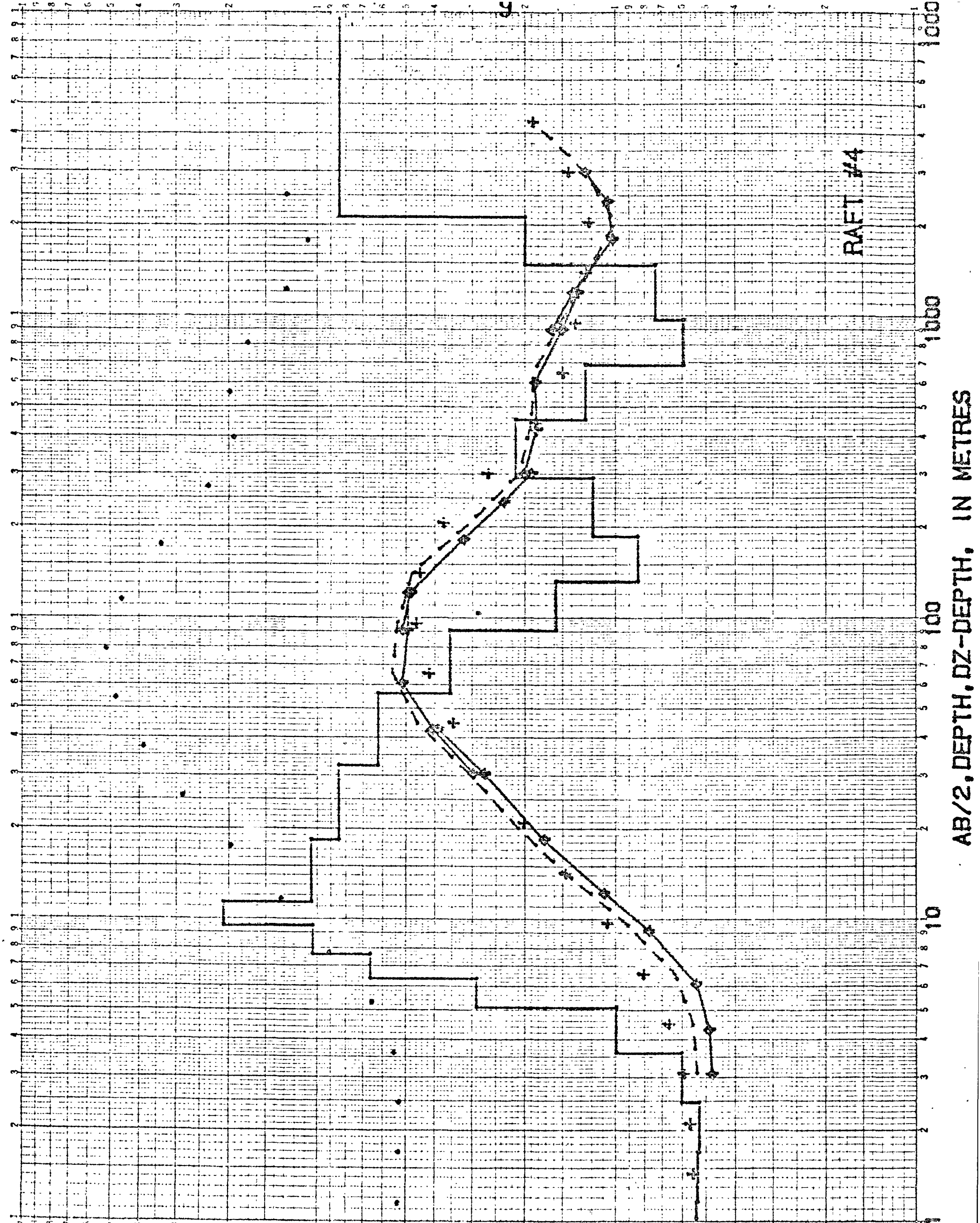
100
10
1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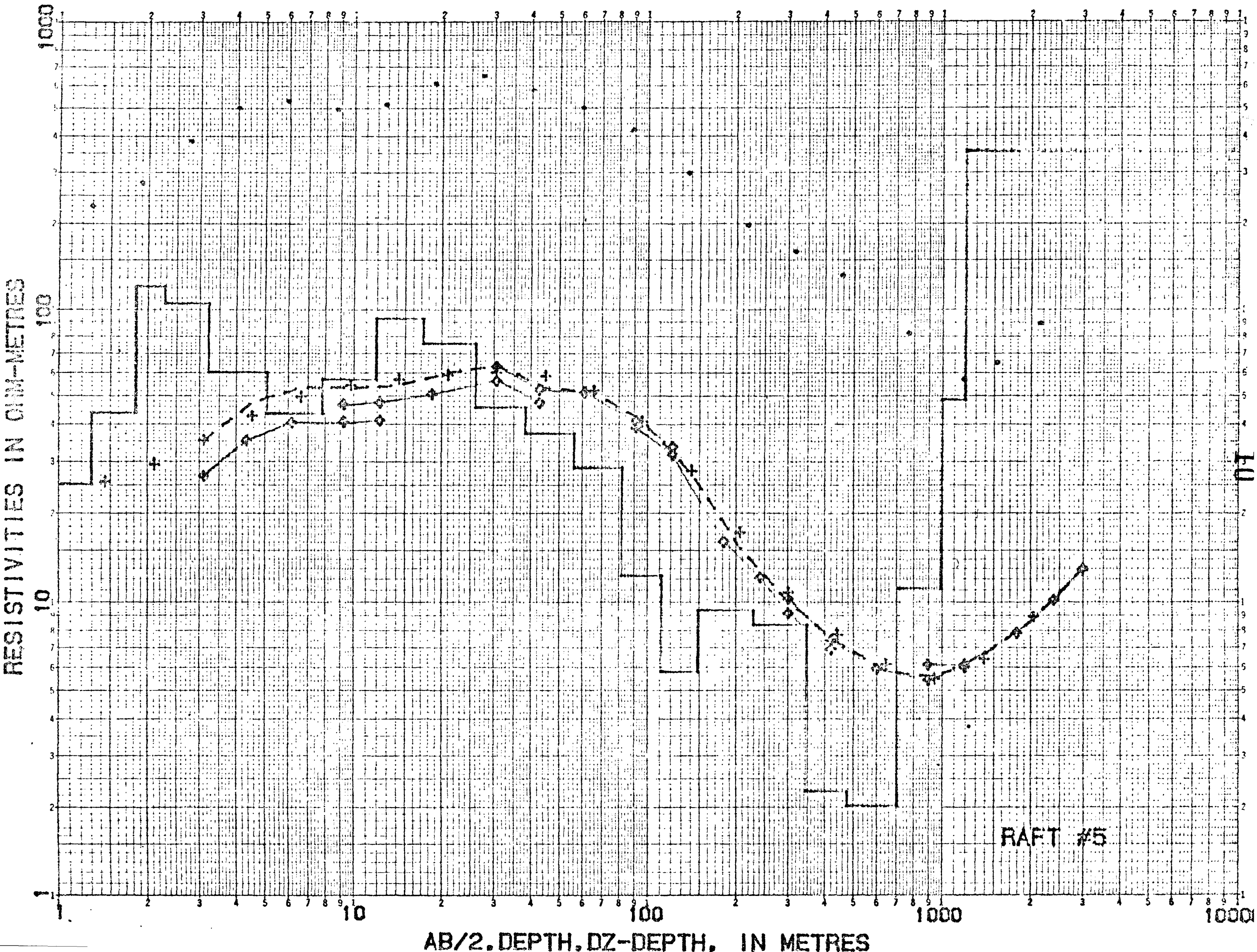
1000
100
10
1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AB/2, DEPTH, DZ-DEPTH, IN METRES
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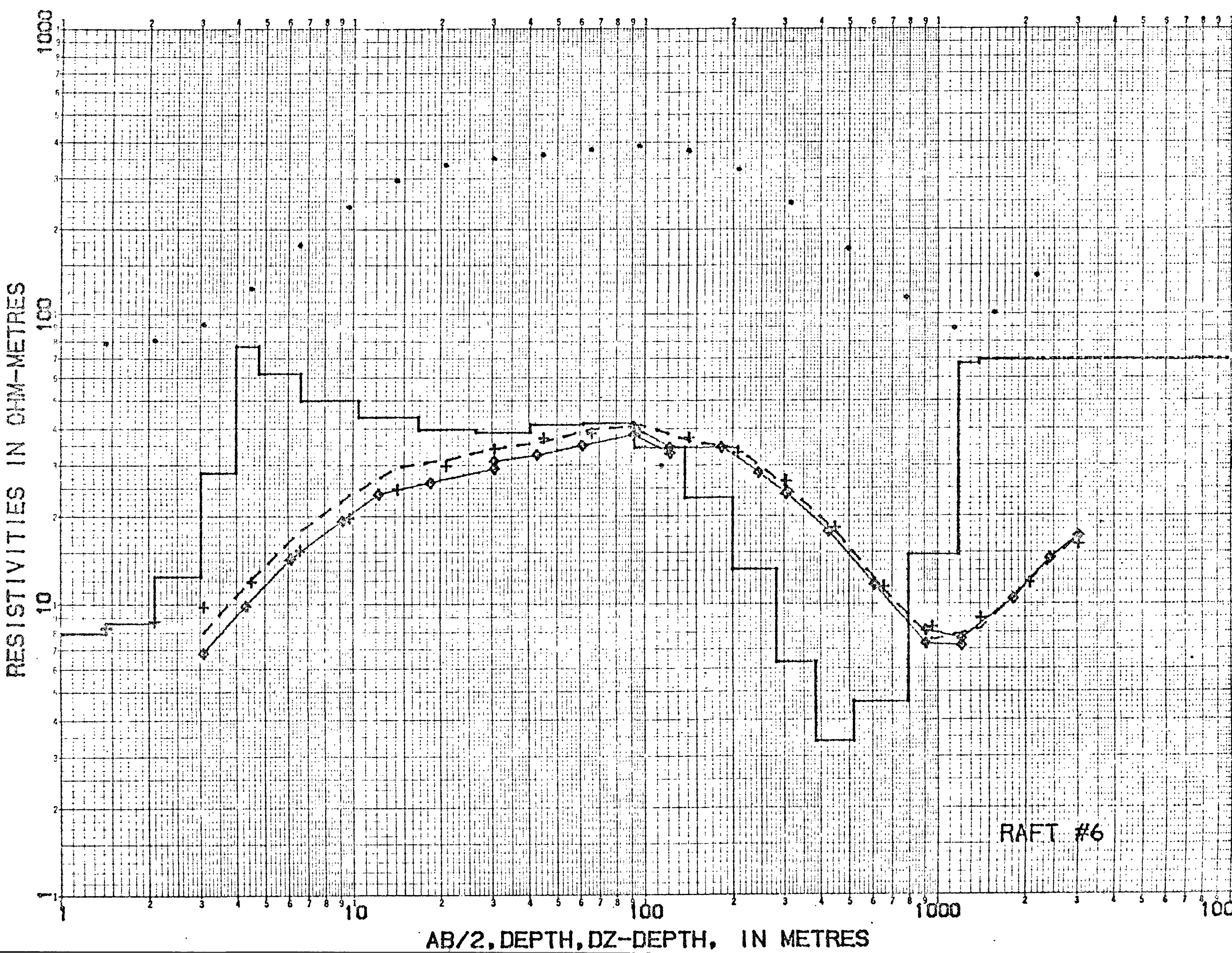
10
100
1000
10000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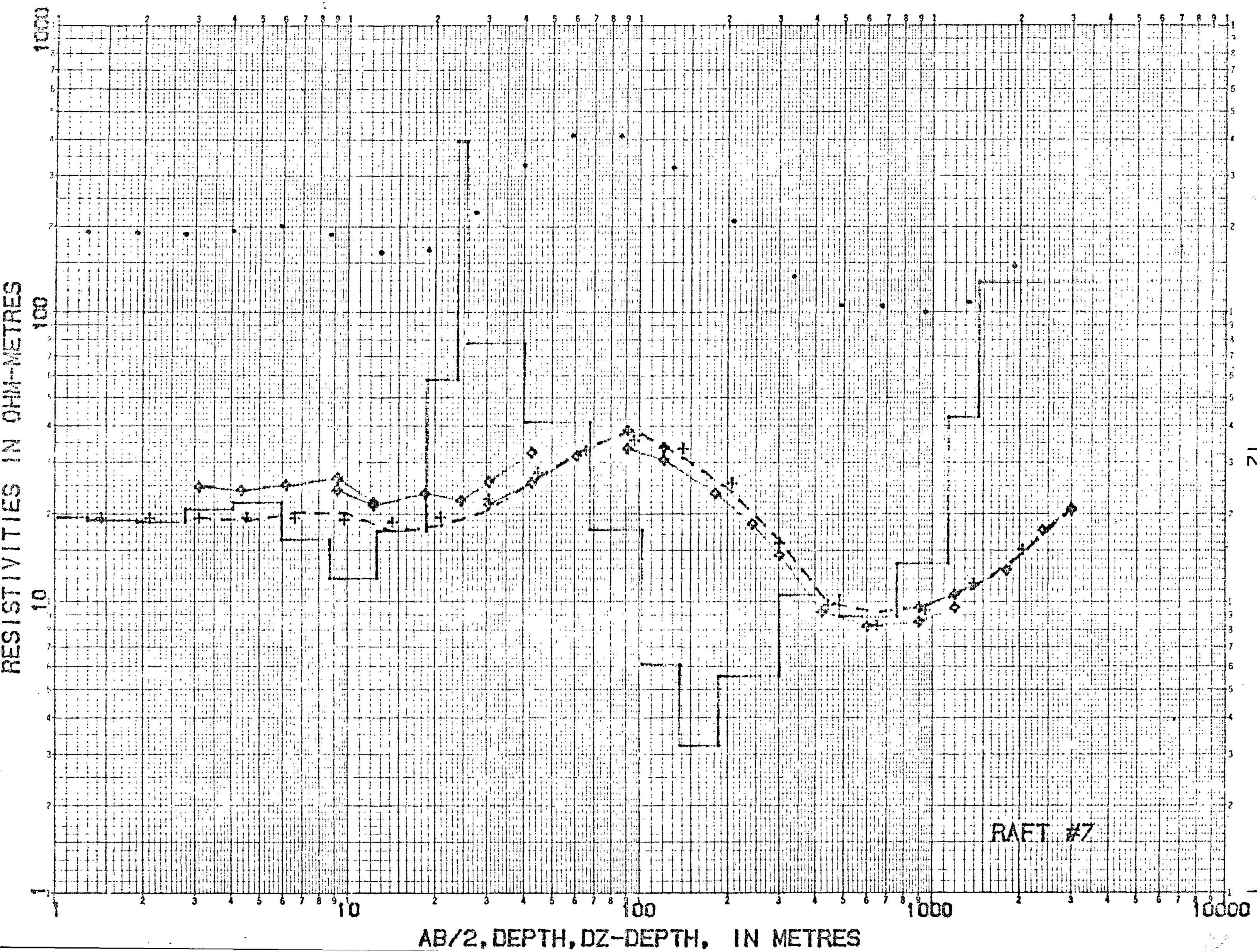
10
100
1000
10000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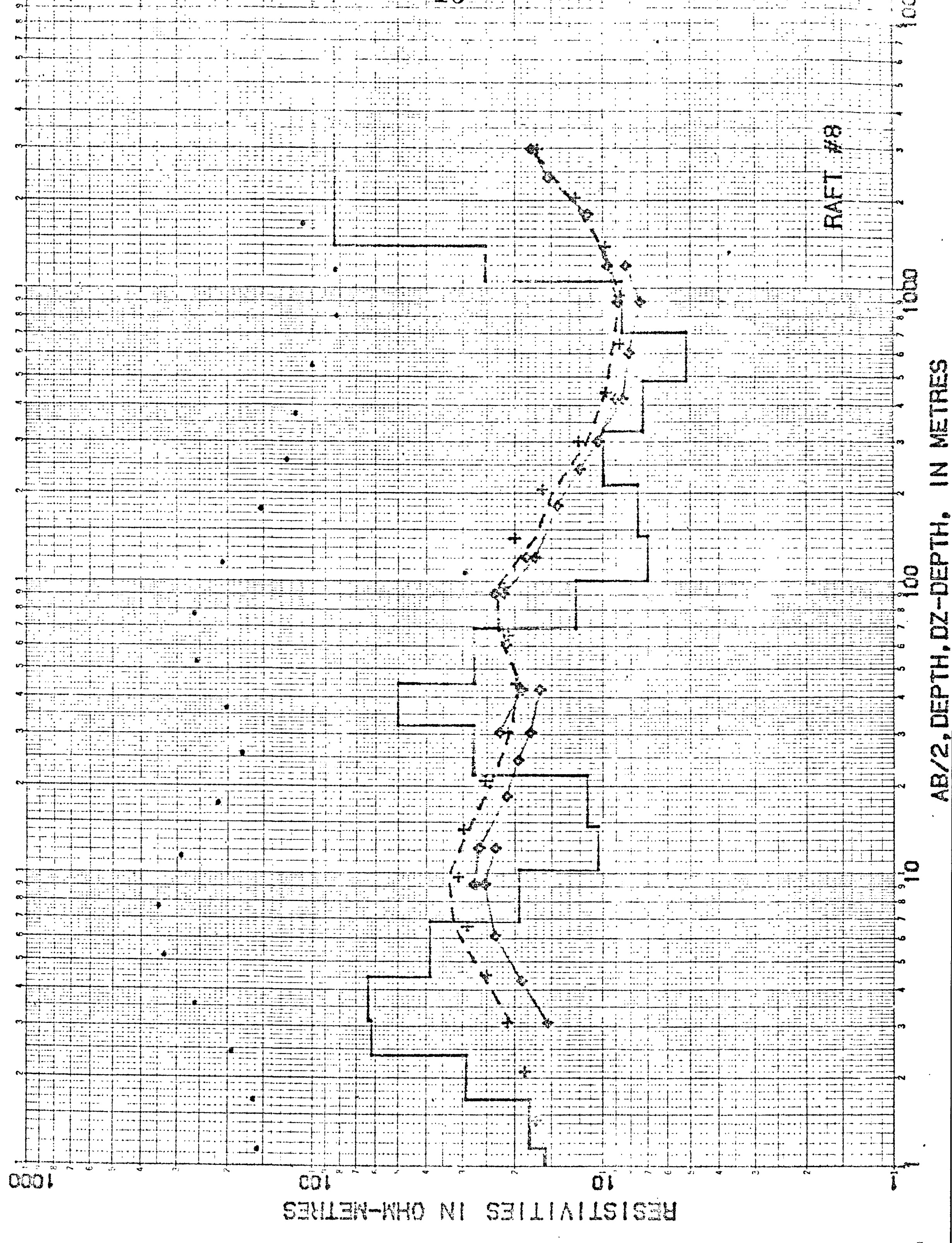
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METRES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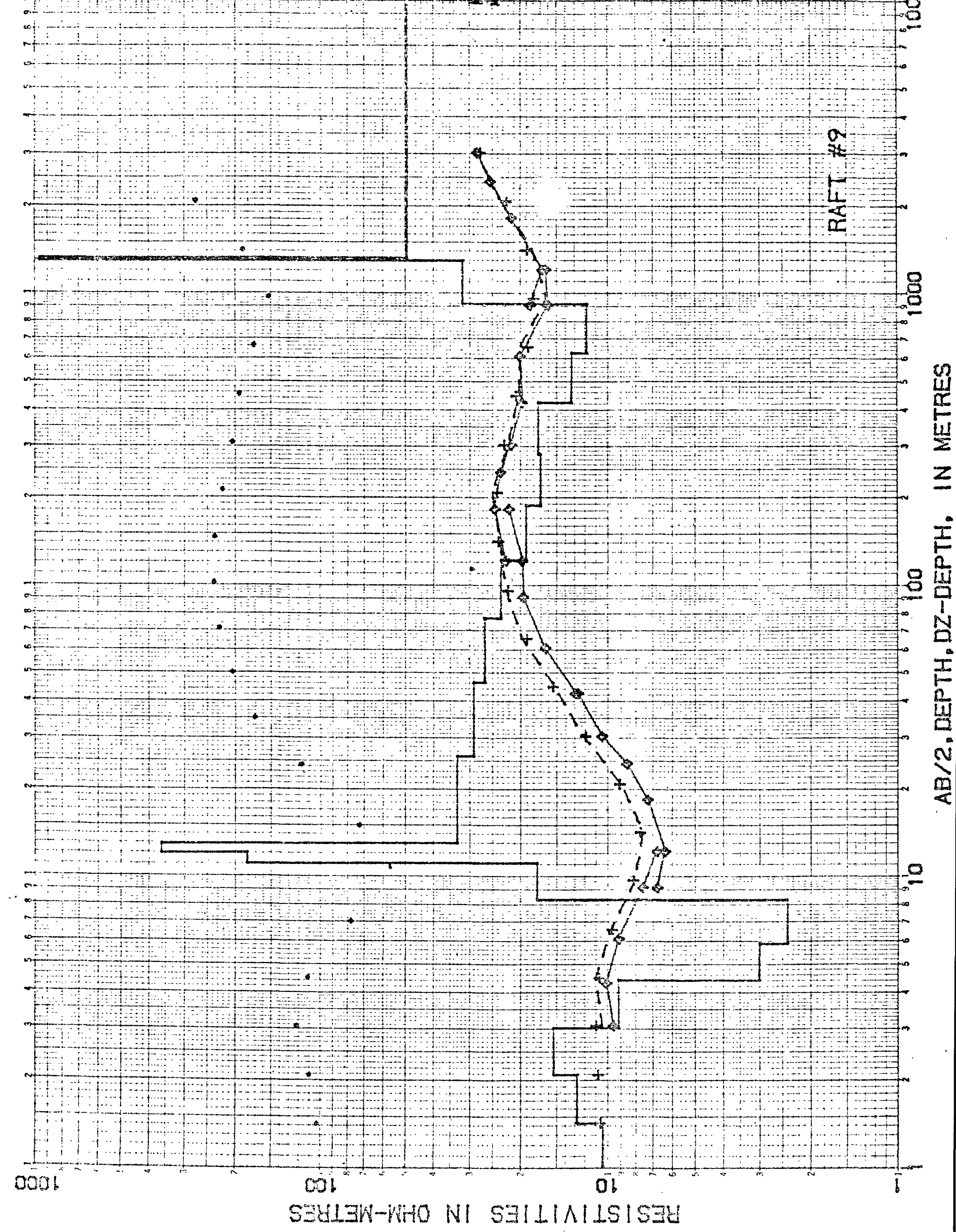
10
100
1000
RESISTIVITIES IN OHM-METRES
1000
100
10
1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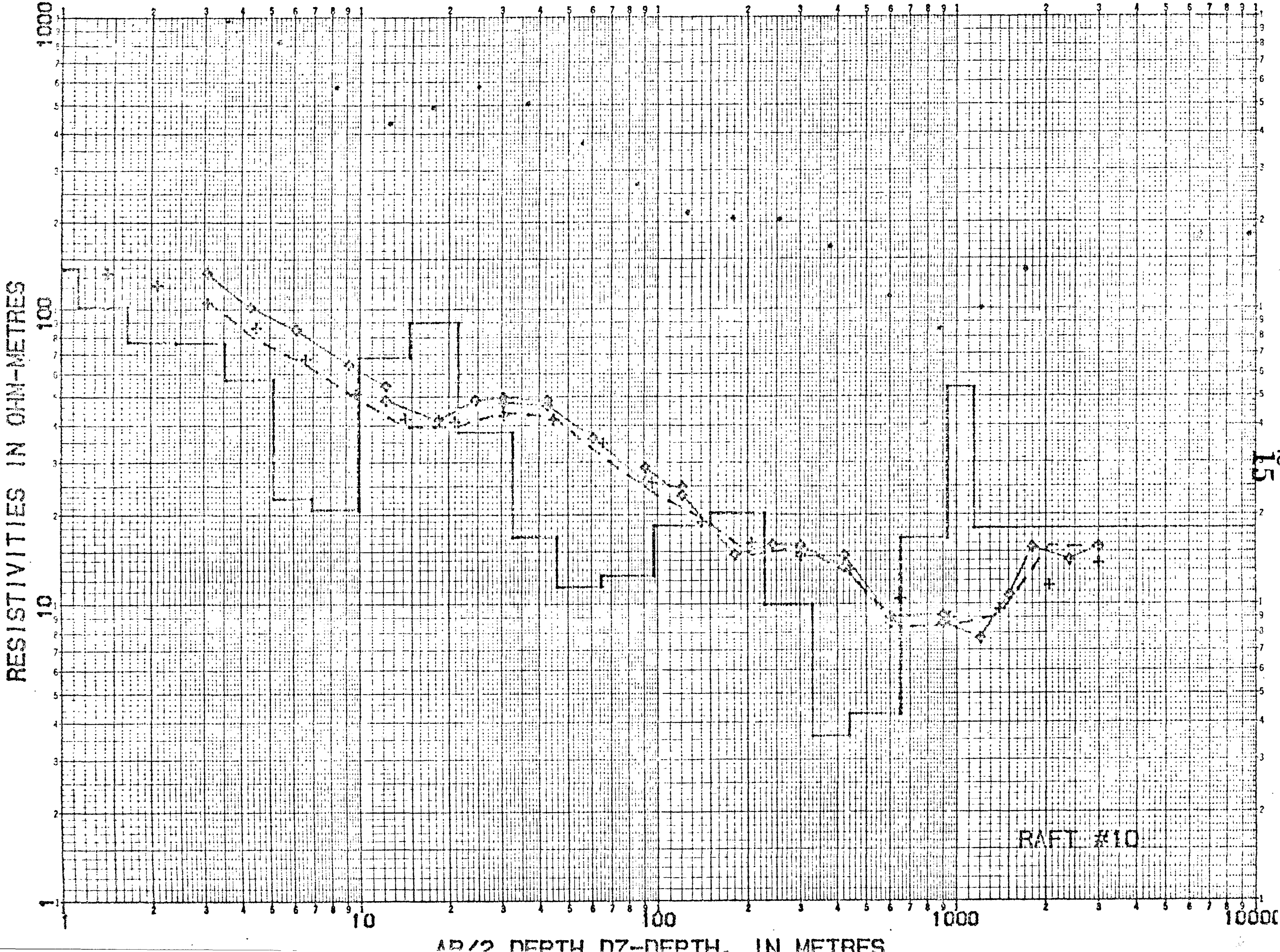
10
100
1000
10000
RESISTIVITIES IN OHM-METRES
1000
100
10
1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10
100
1000
AB/2 DEPTH DZ-DEPTH, IN METRES
1
10
100
1000
10000
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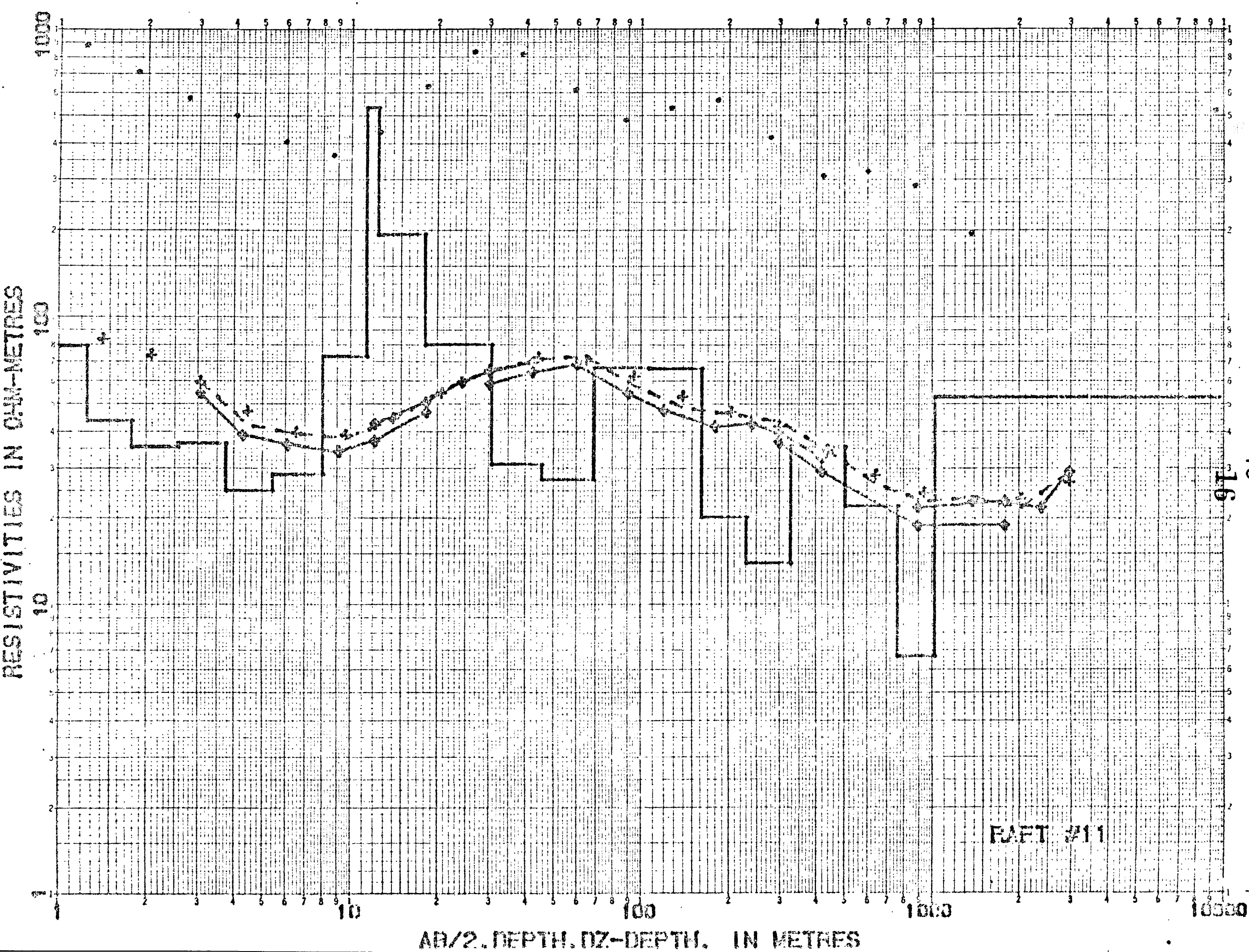
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10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH. IN METRES
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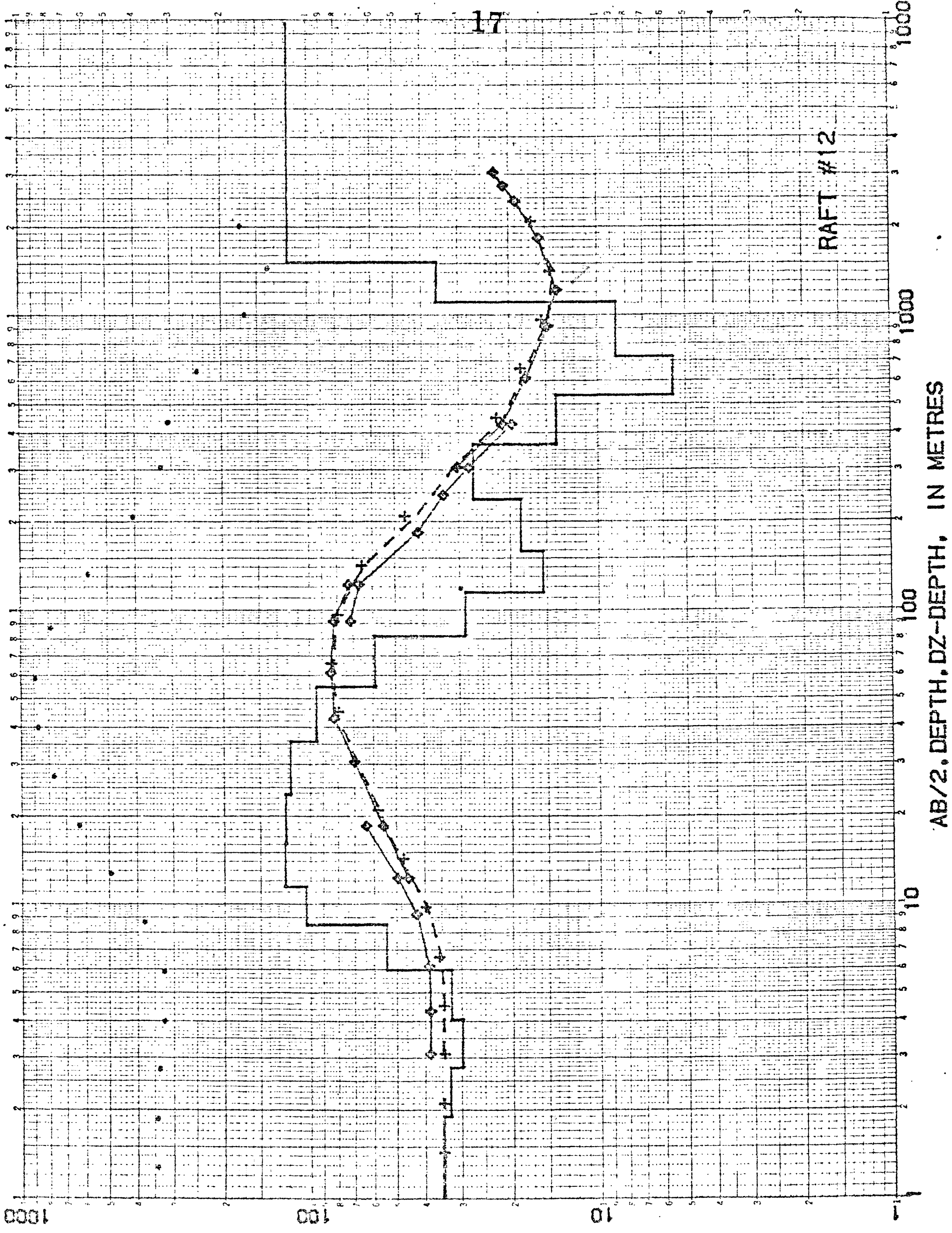
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RESISTIVITIES IN OHM-METRES
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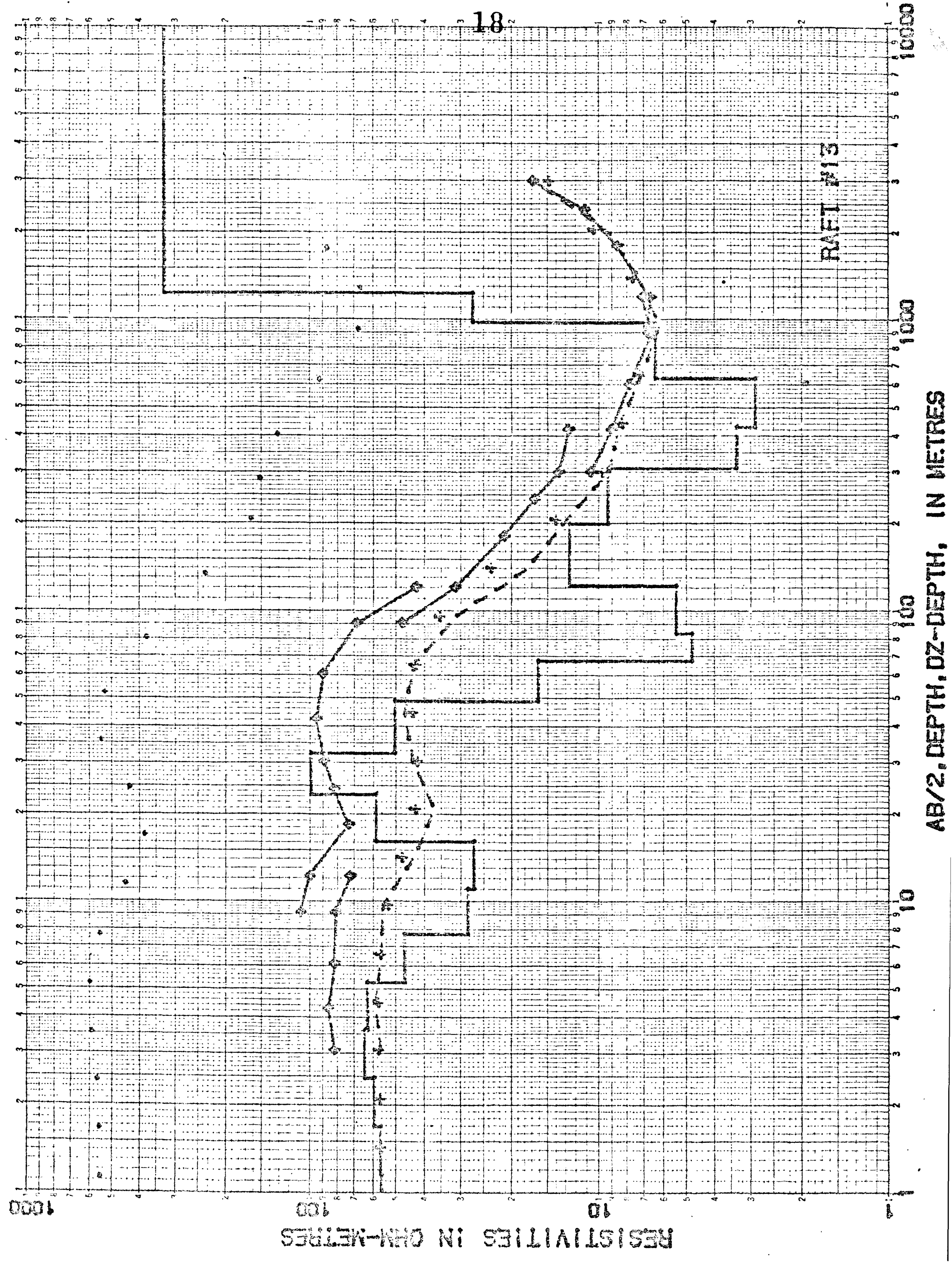
100
10
1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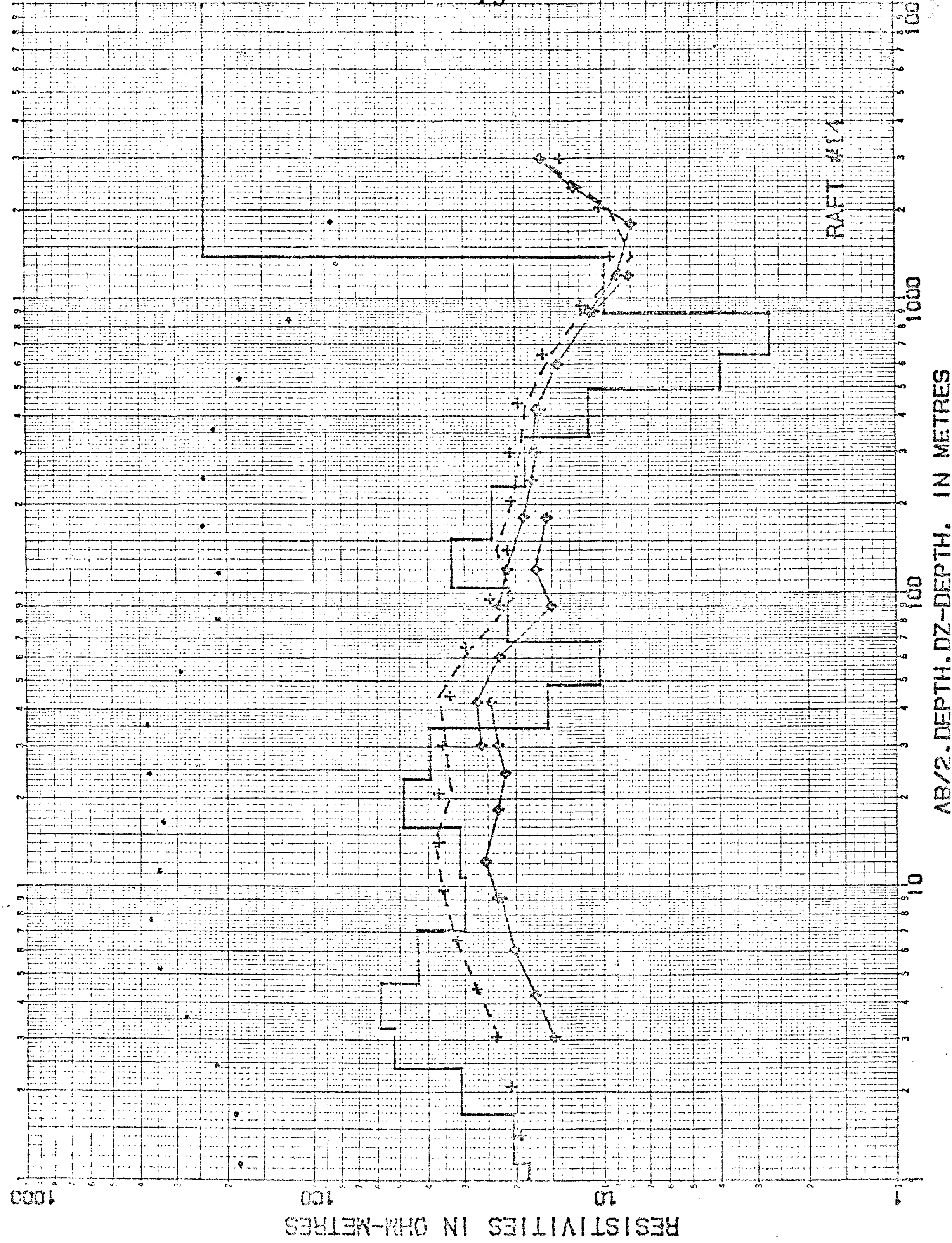
100
1000
10000
RESISTIVITIES IN OHM-METRES
1000
100
10
1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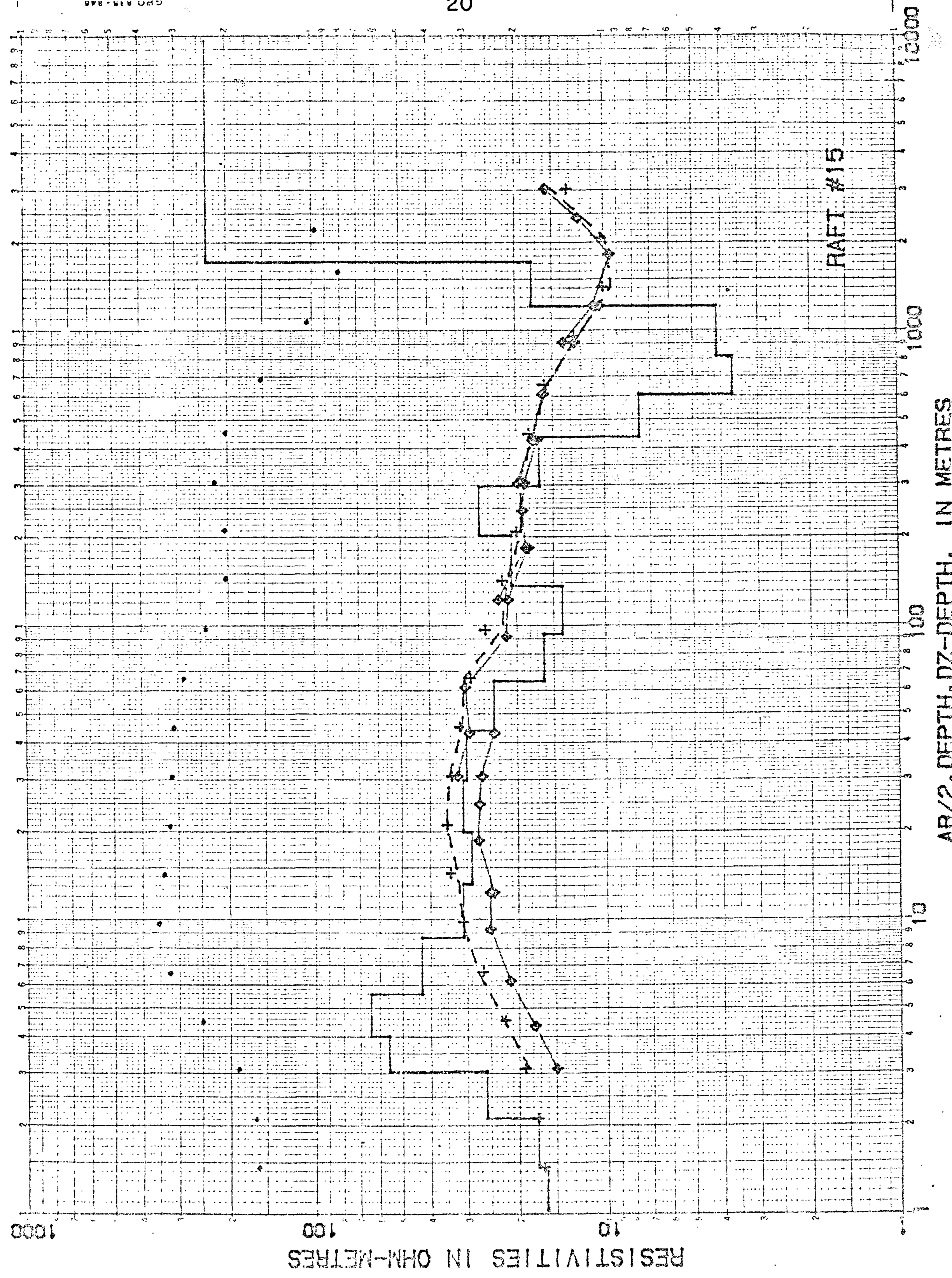
100
10
1
10000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AB/2, DEPTH, DZ-DEPTH, IN METRES
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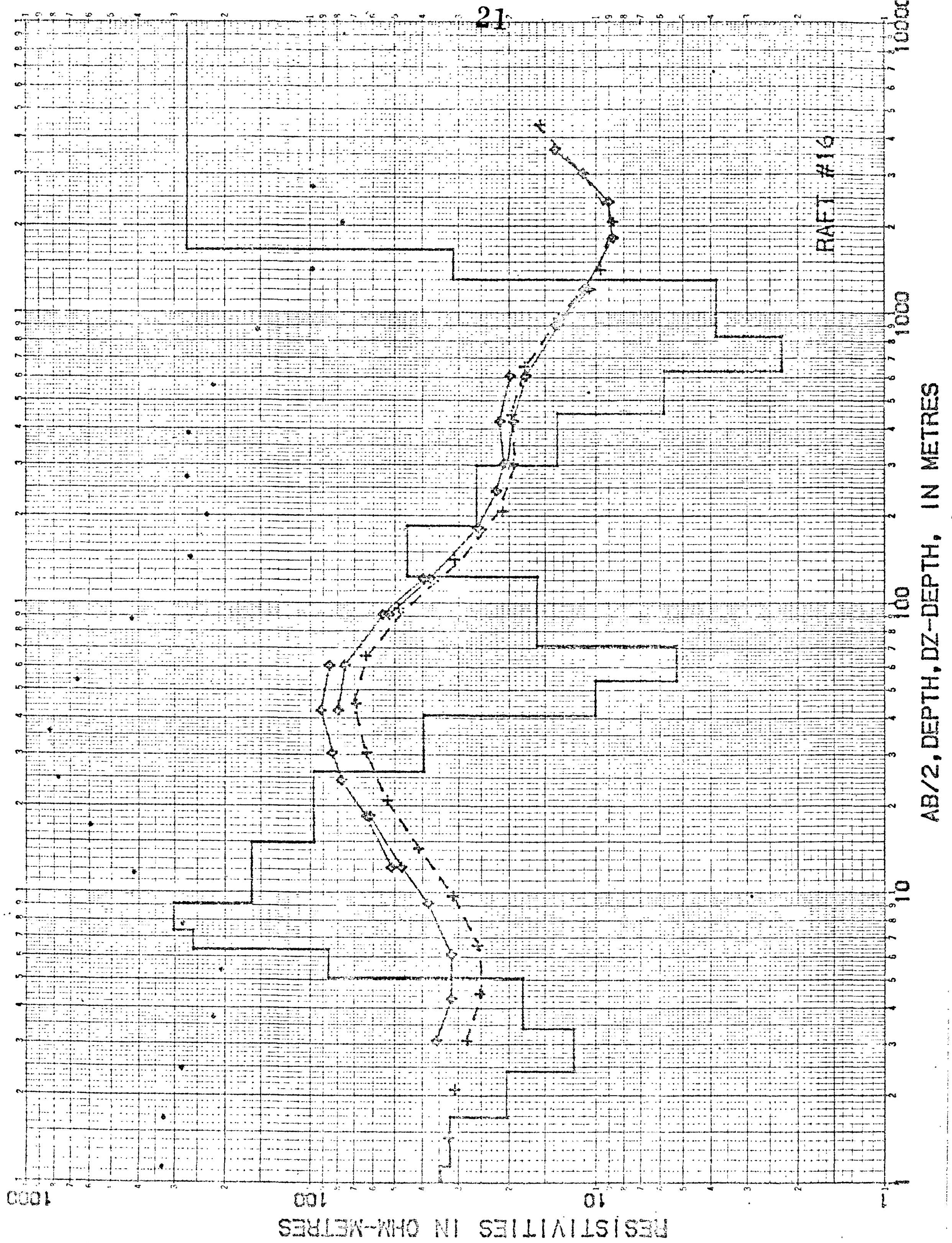
10
1
10
100
1000
10000
GPO 815-848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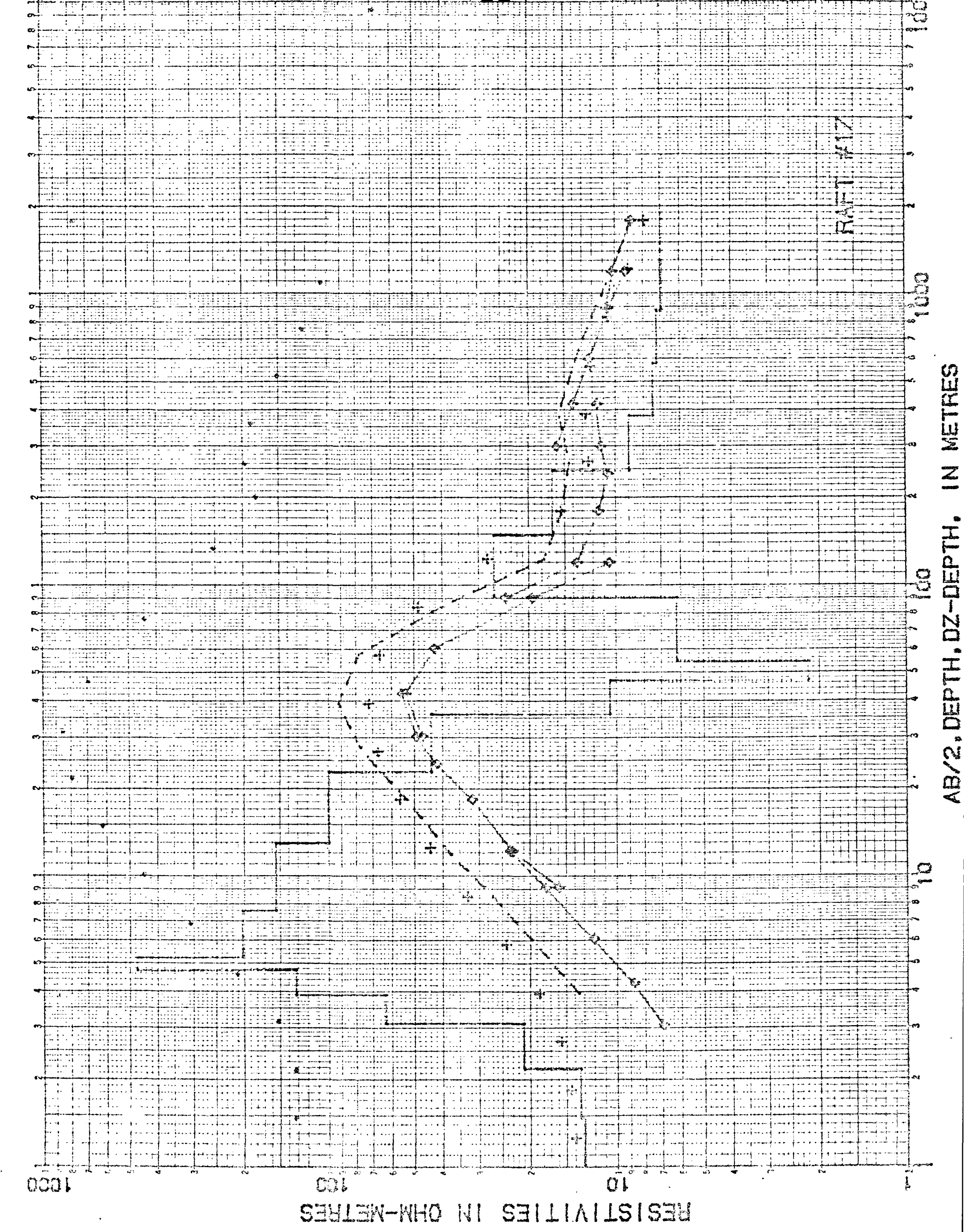
100
1000
10000
1000
100
10
1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100
1000
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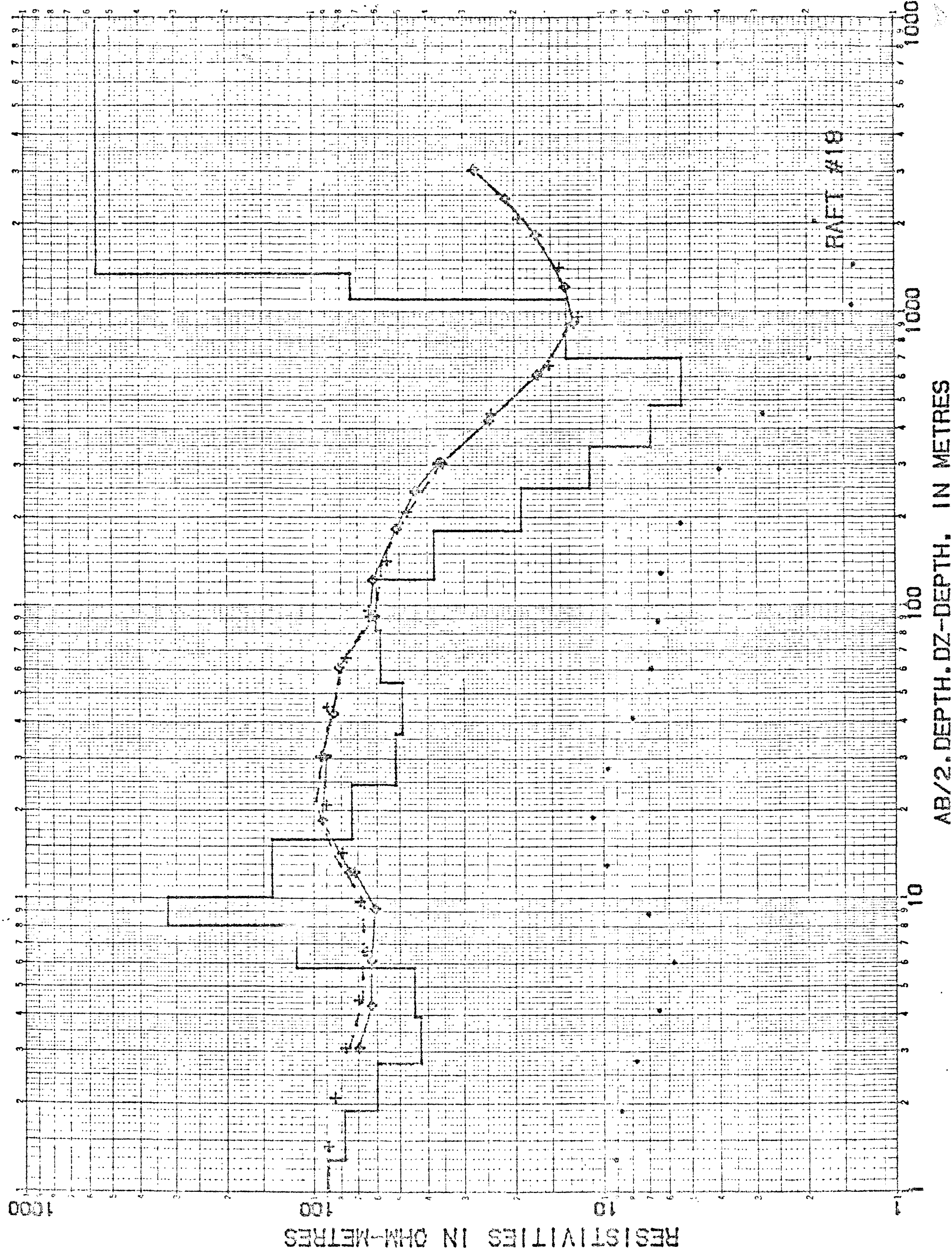
1000
100
10
1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AB/2.DEPTH.DZ-DEPTH. IN METRES
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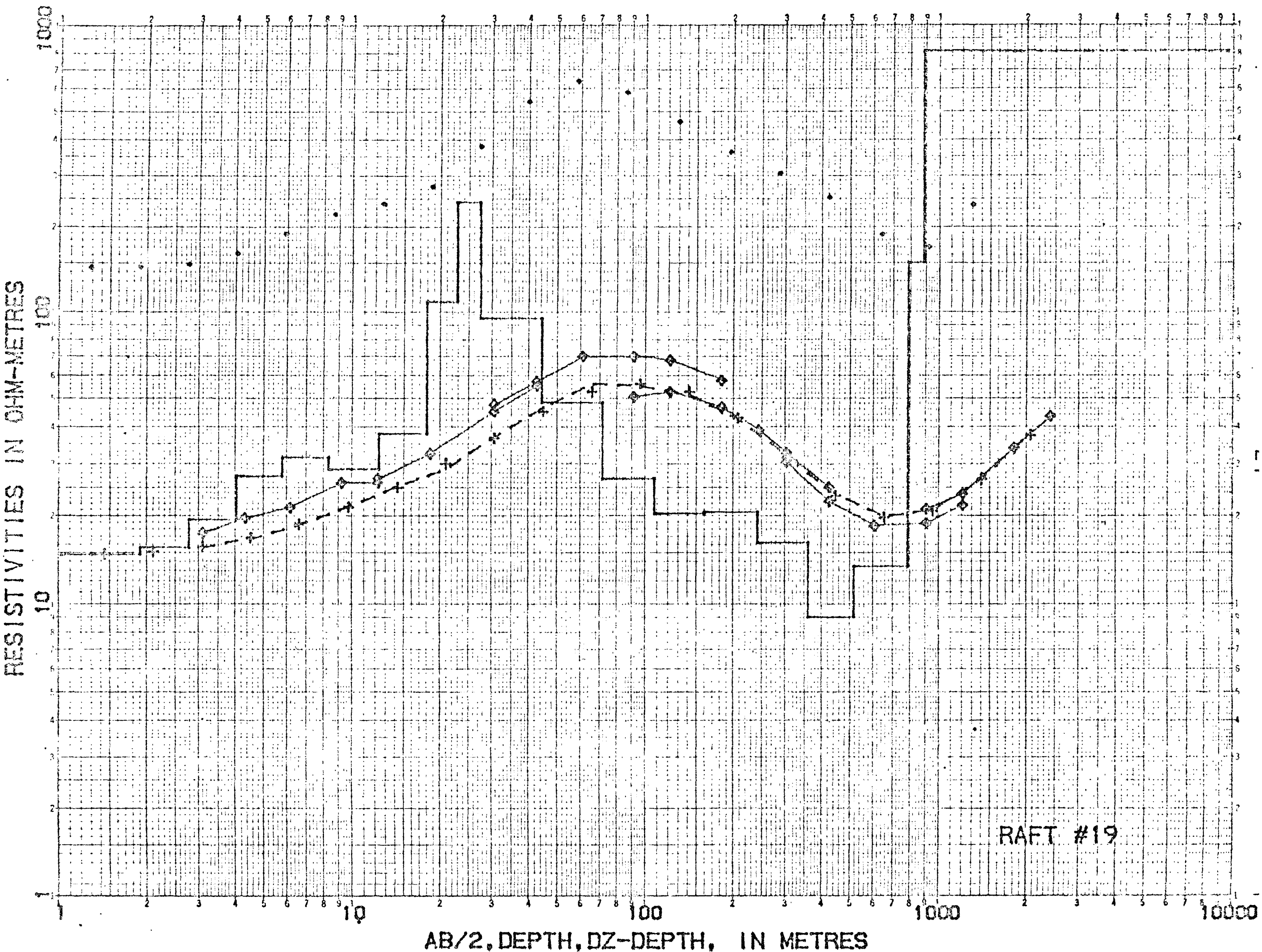
100
10
1
GPO 835-846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AB/2, DEPTH, DZ-DEPTH, IN METRES
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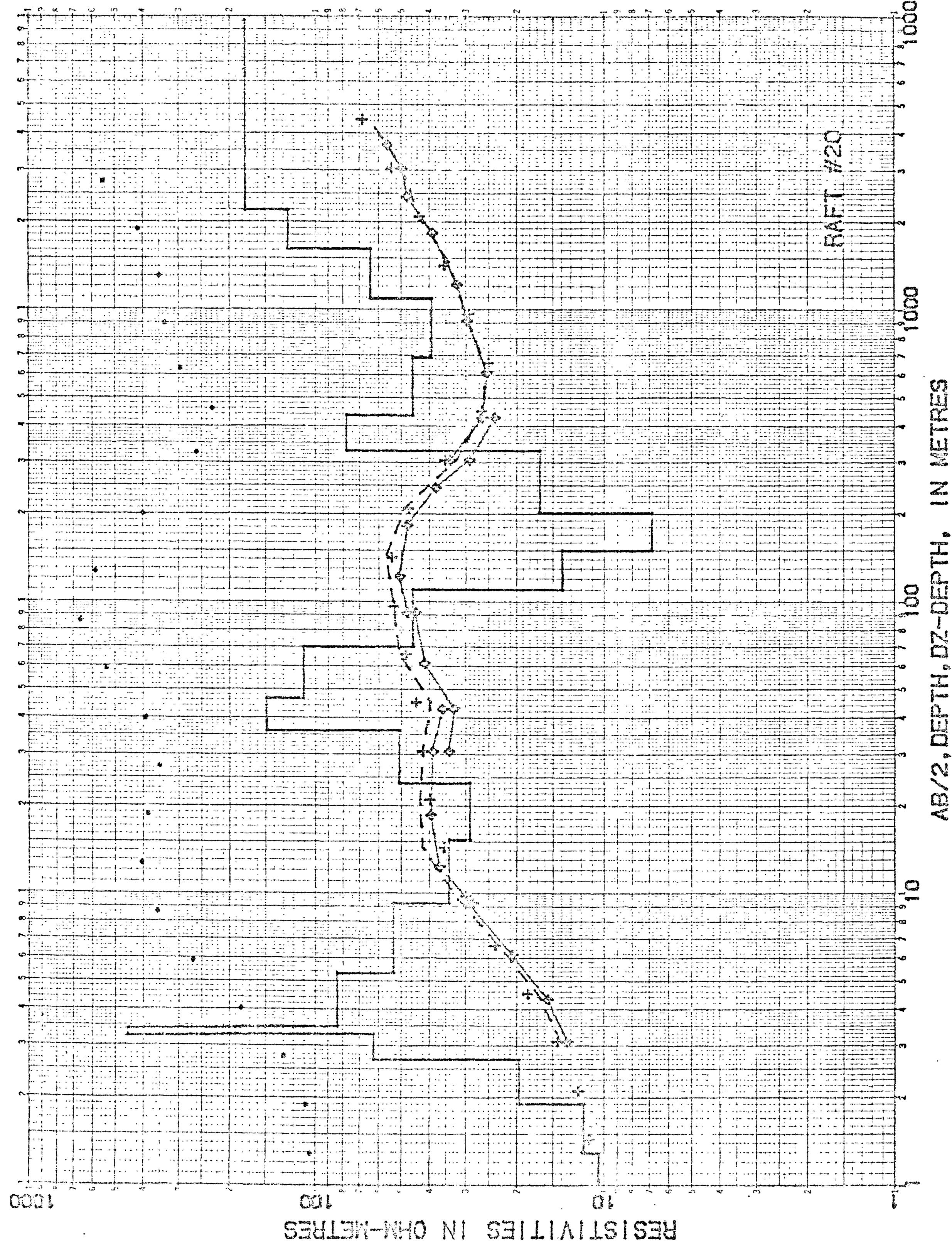
100
1000
10000
1
10
100
1000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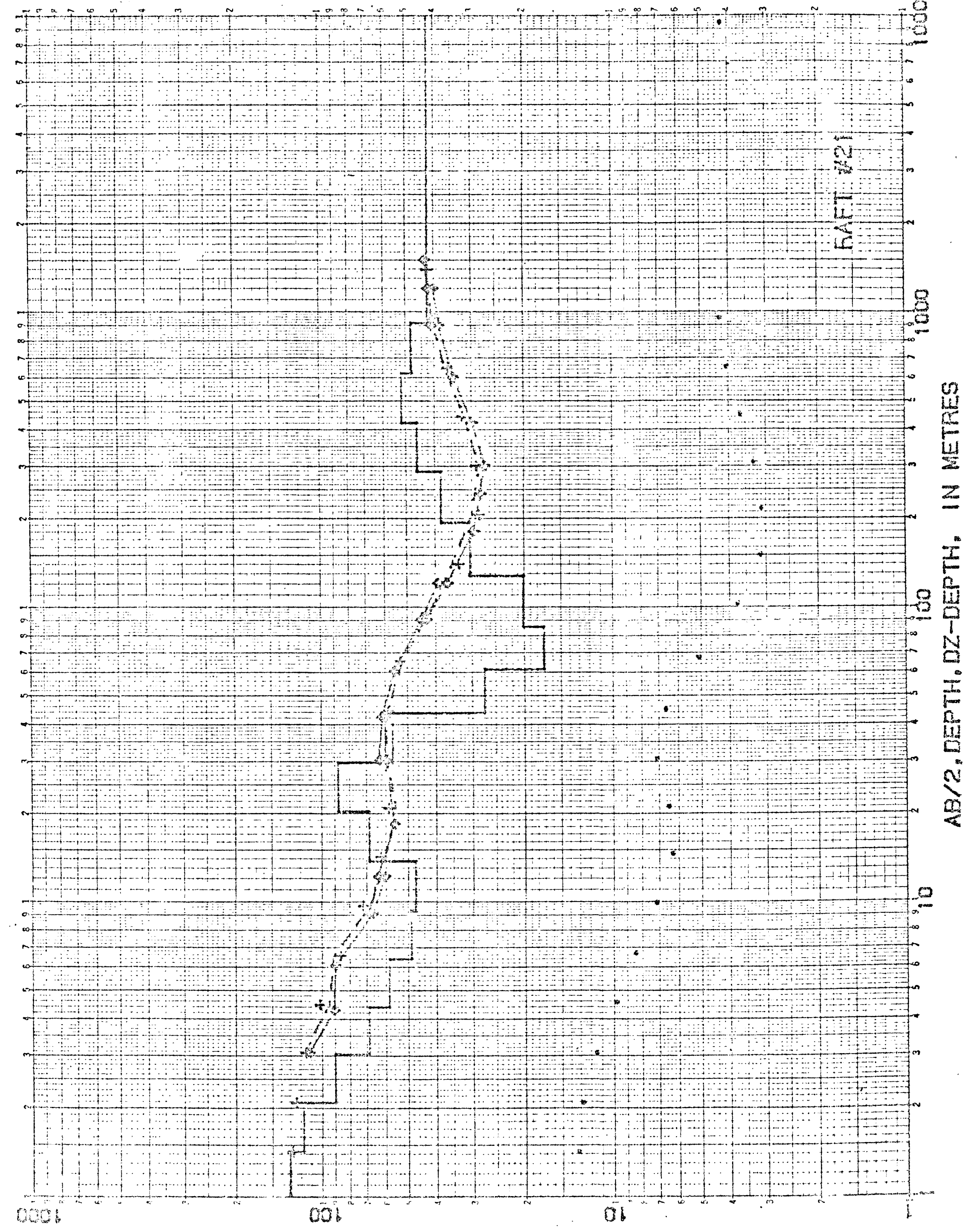
1000
10000
1000
100
10
1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1000
10000
RESISTIVITIES IN OHM-METRES
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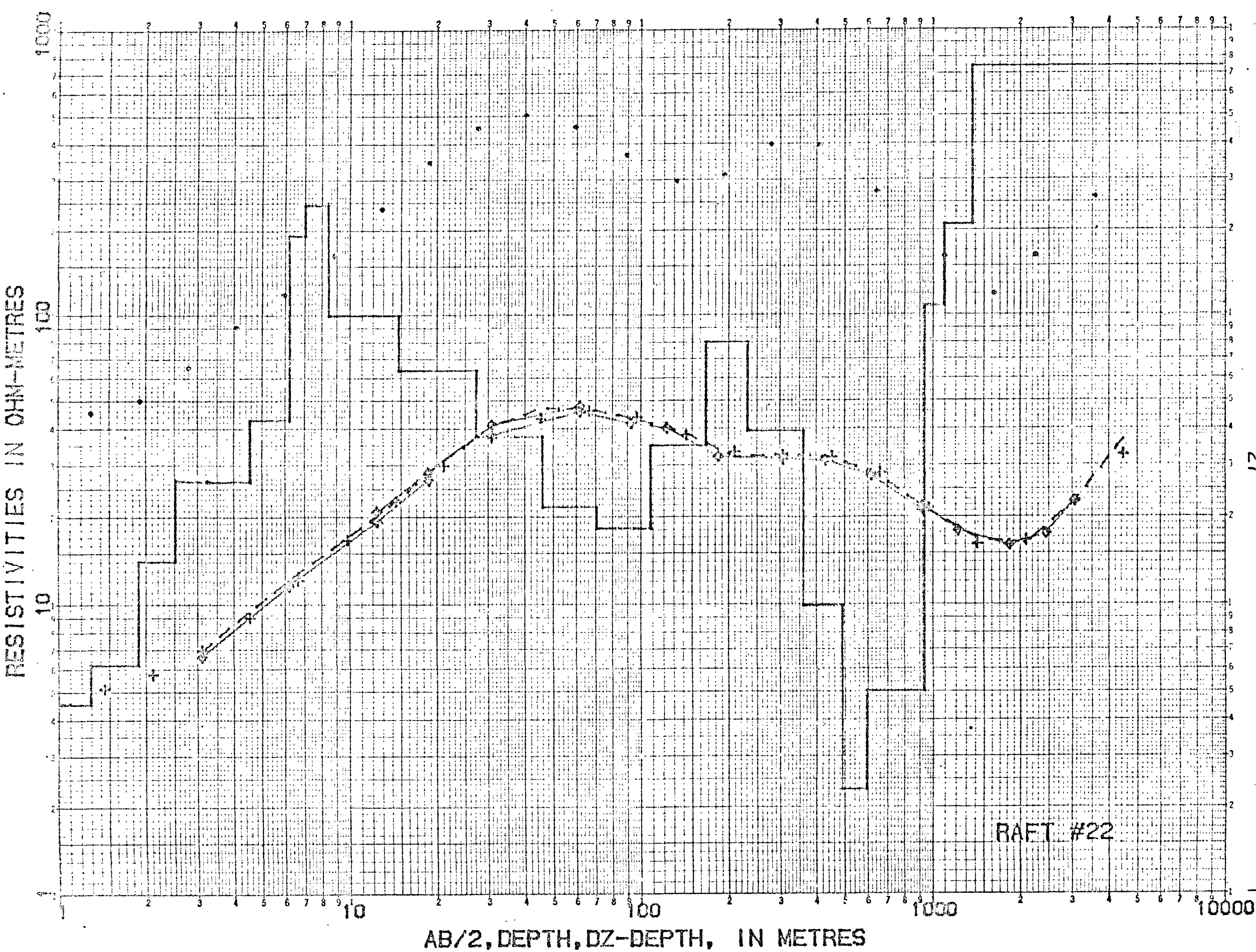
100
10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10
100
1000
AB/2, DEPTH, DZ-DEPTH, IN METRES
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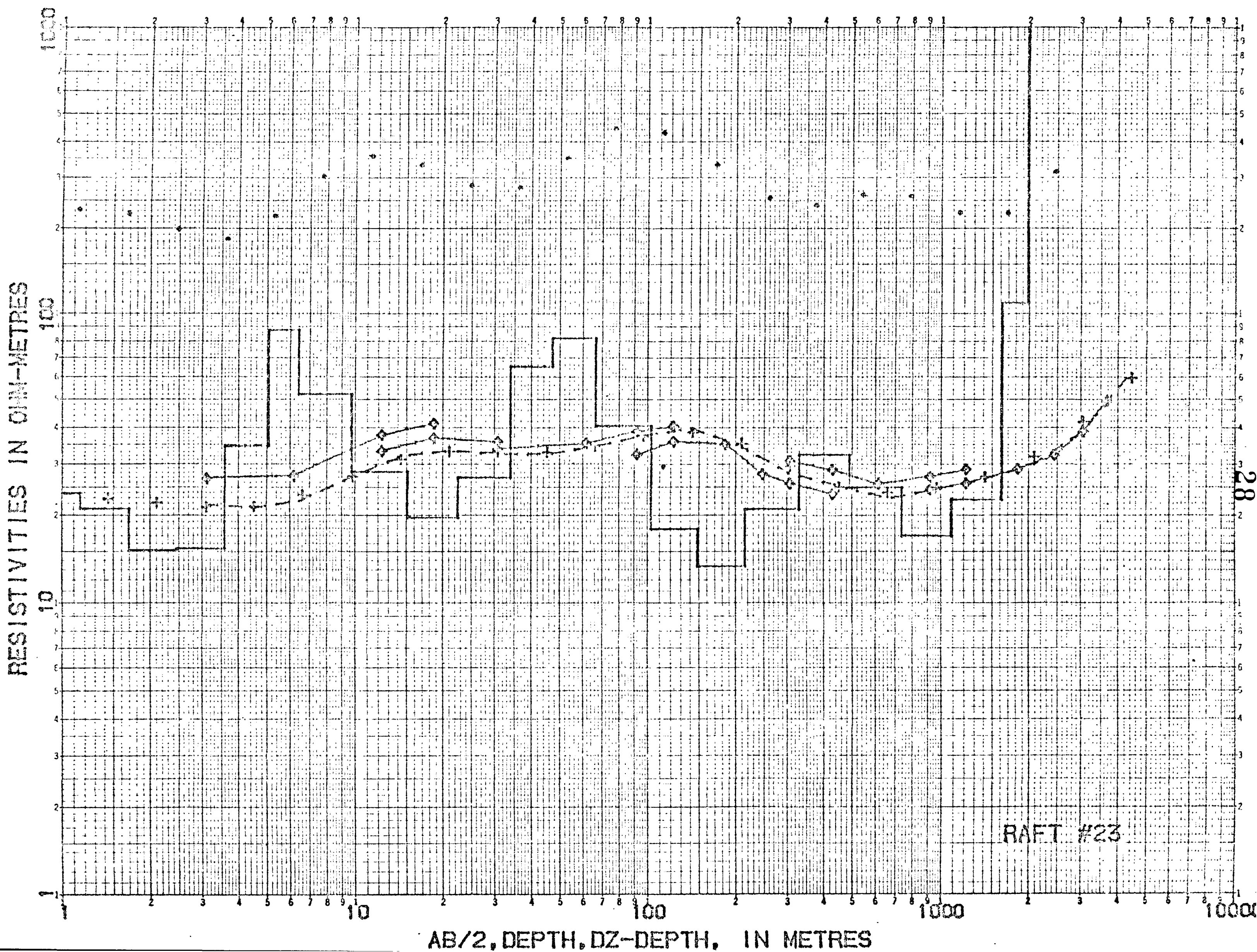
1000
10000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10
1
AB/2, DEPTH, DZ-DEPTH, IN METRES
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10
100
1000
10000
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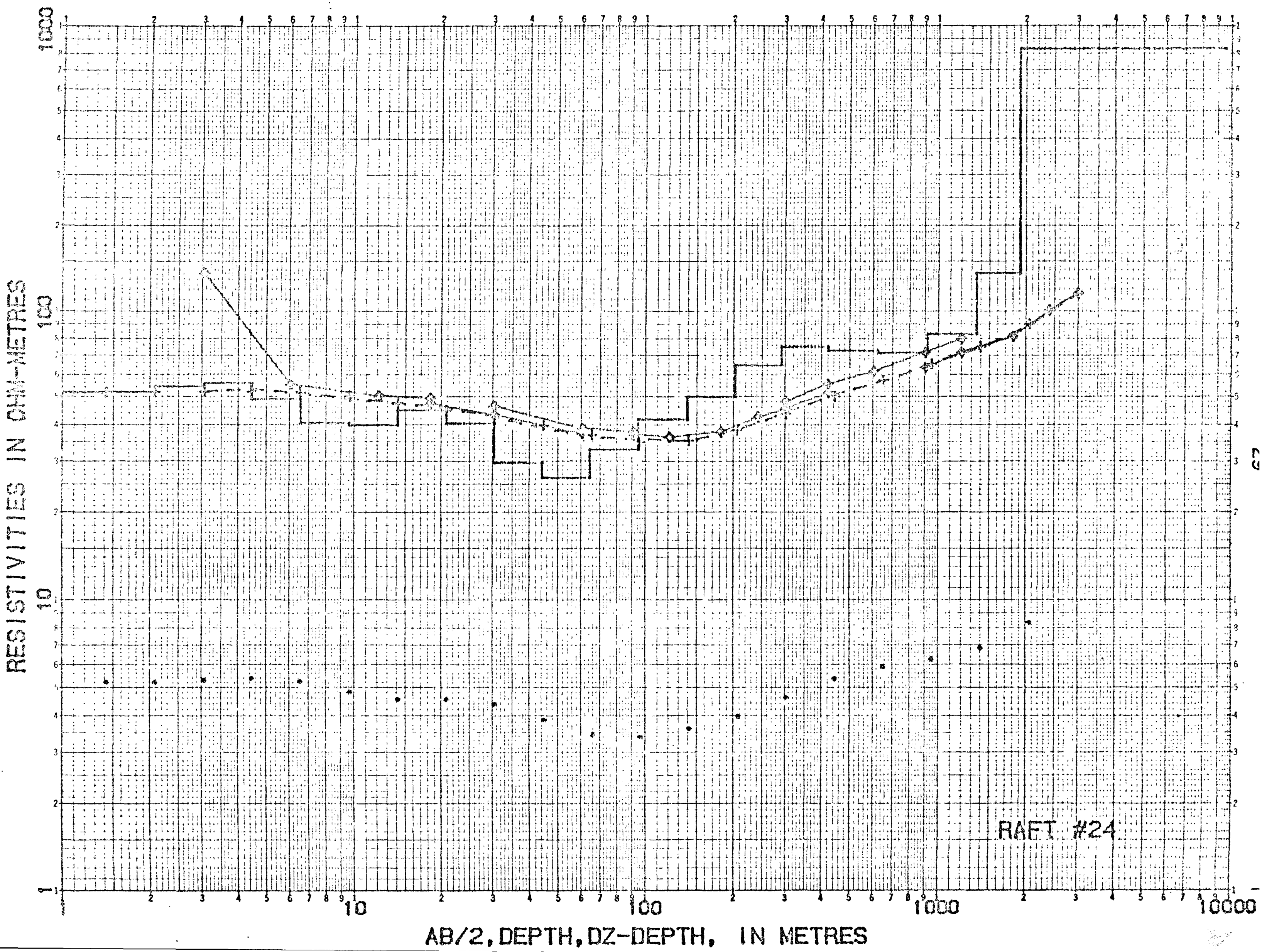
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10
1
AB/2, DEPTH, DZ-DEPTH, IN METRES
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100
1000
10000
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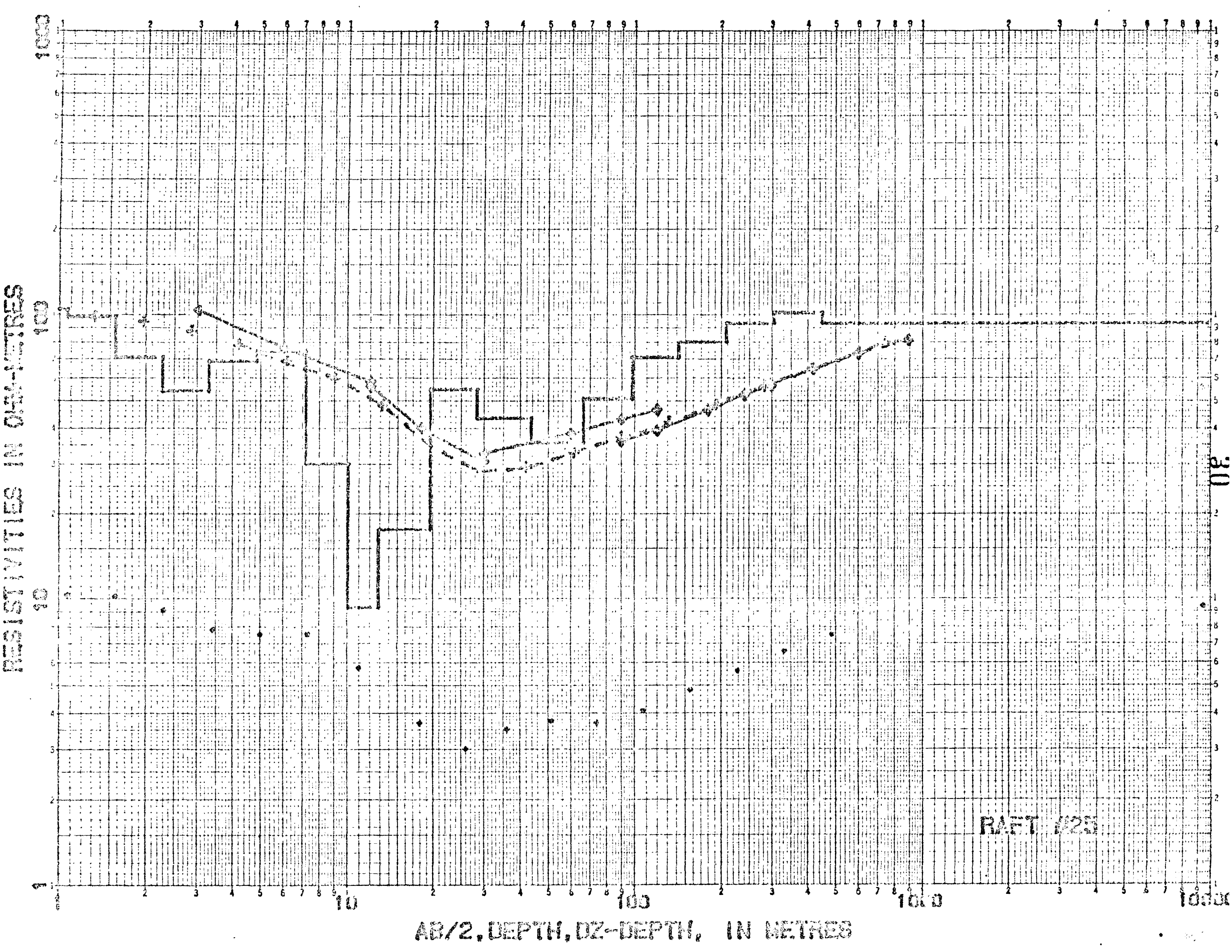
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10
1
AB/2, DEPTH, DZ-DEPTH, IN METRES
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100
1000
10000
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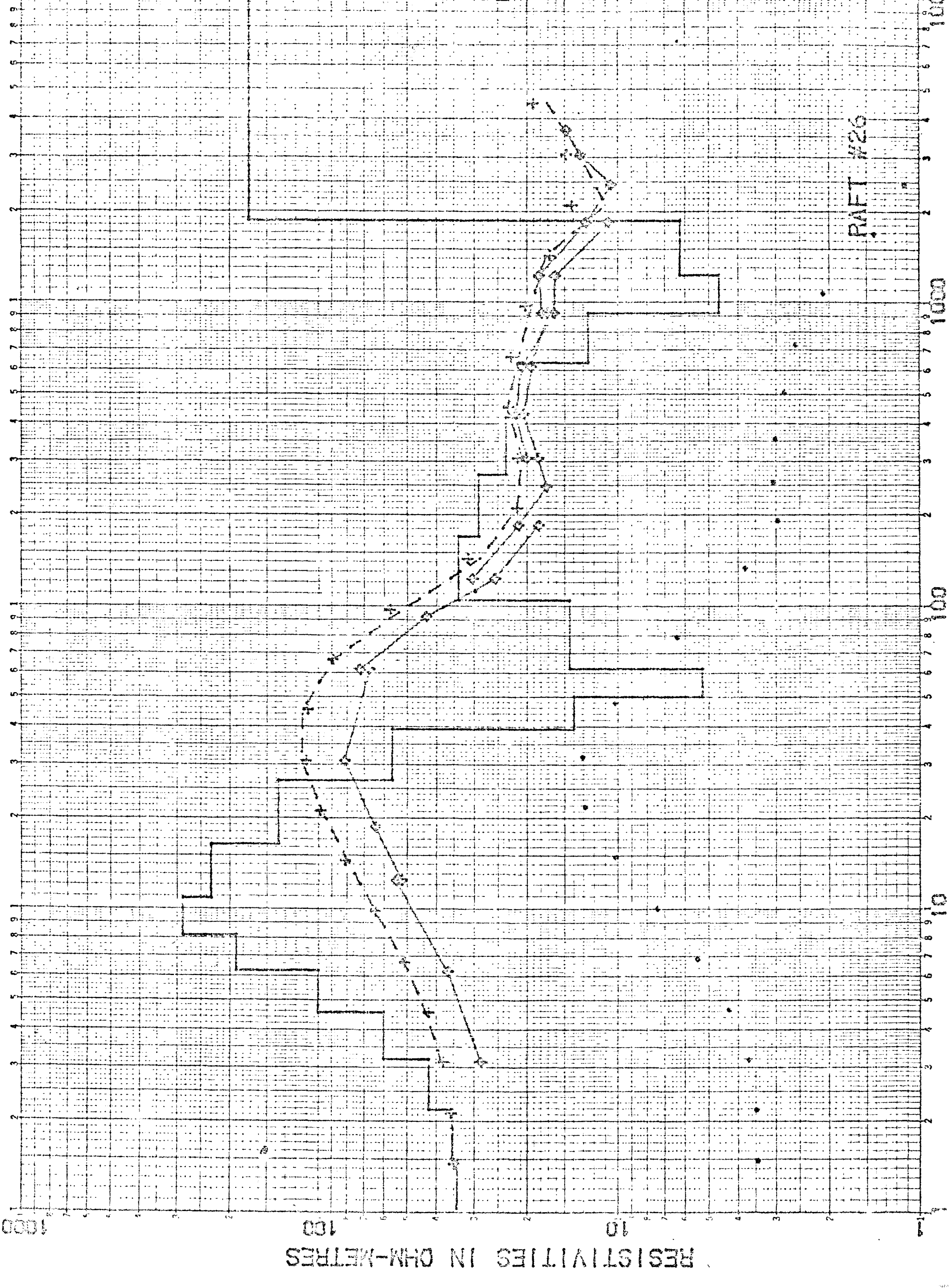
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RESISTIVITIES IN OHM-METRES
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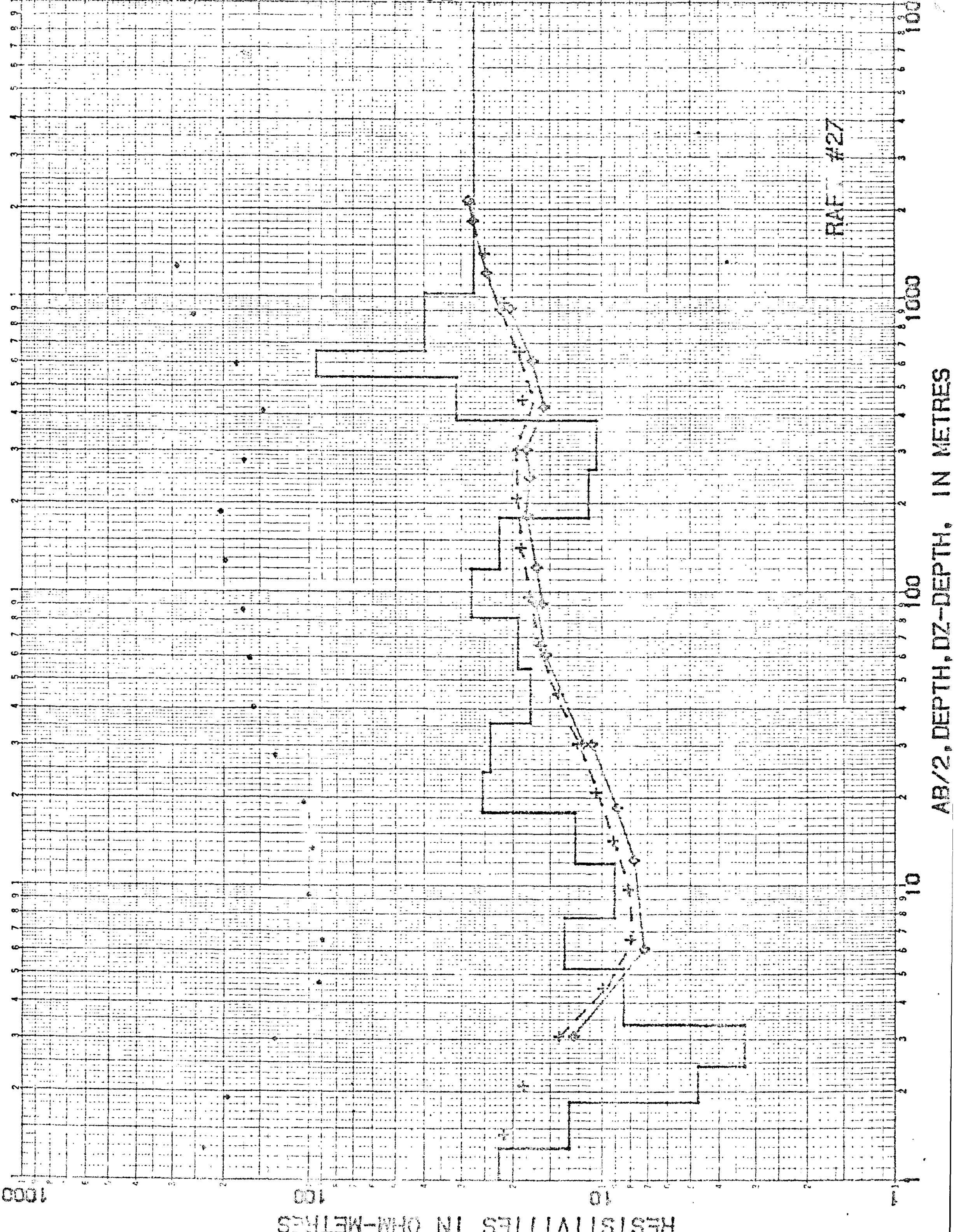
10
100
1000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100
1000
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RESISTIVITIES IN OHM-METRES
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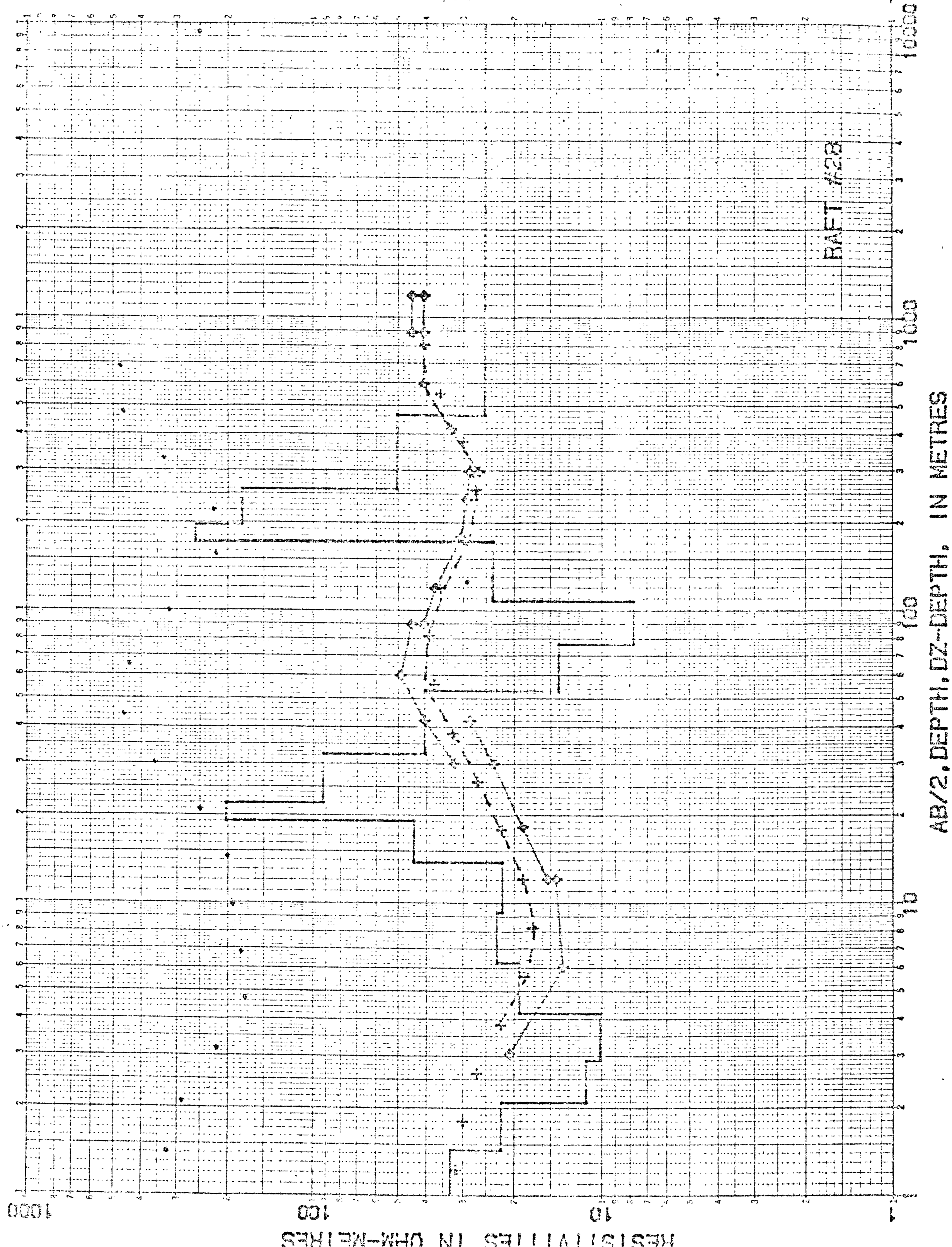
10
100
1000


GPO 835-846
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10
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1000
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RESISTIVITIES IN OHM-METRES
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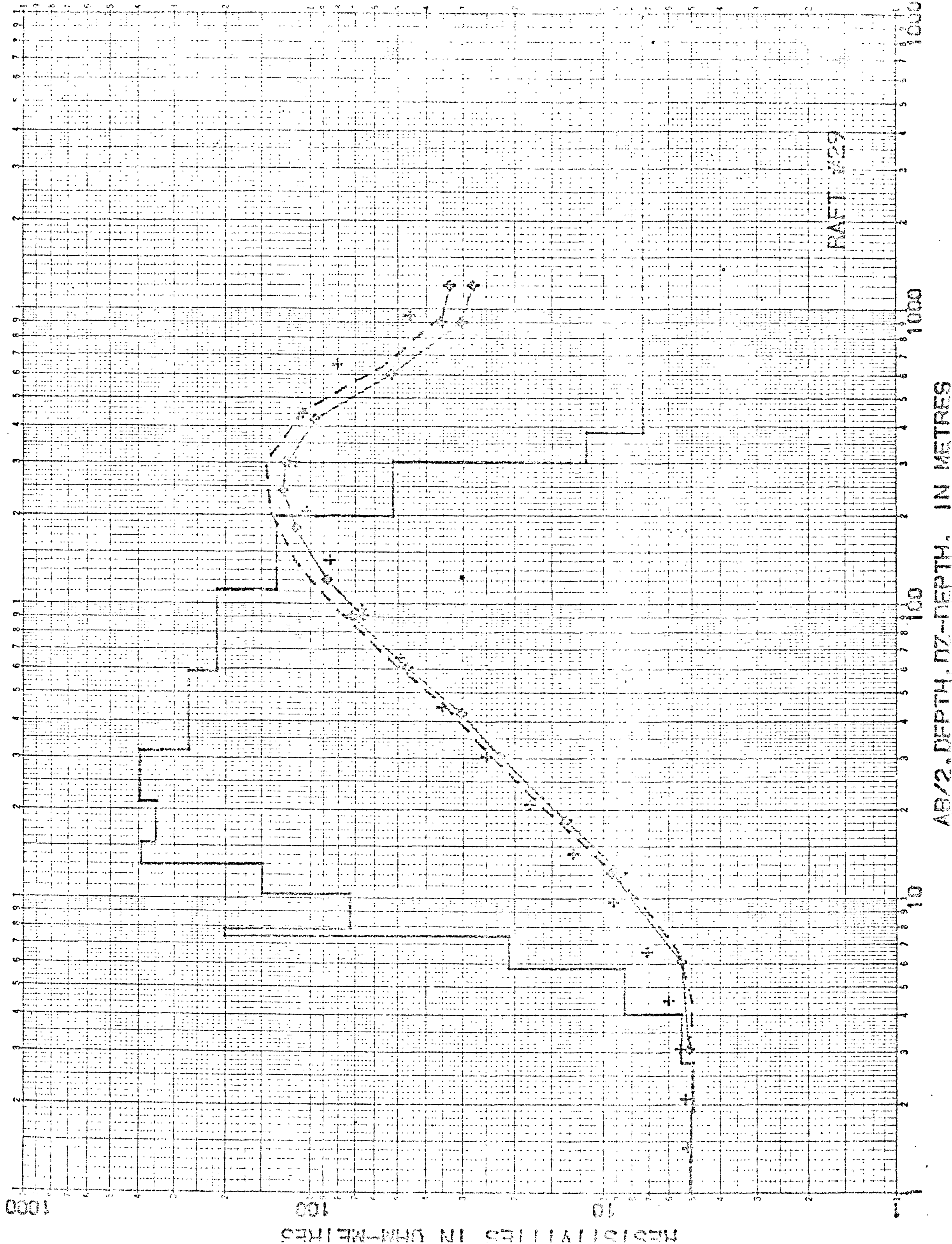
100
10
1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1000
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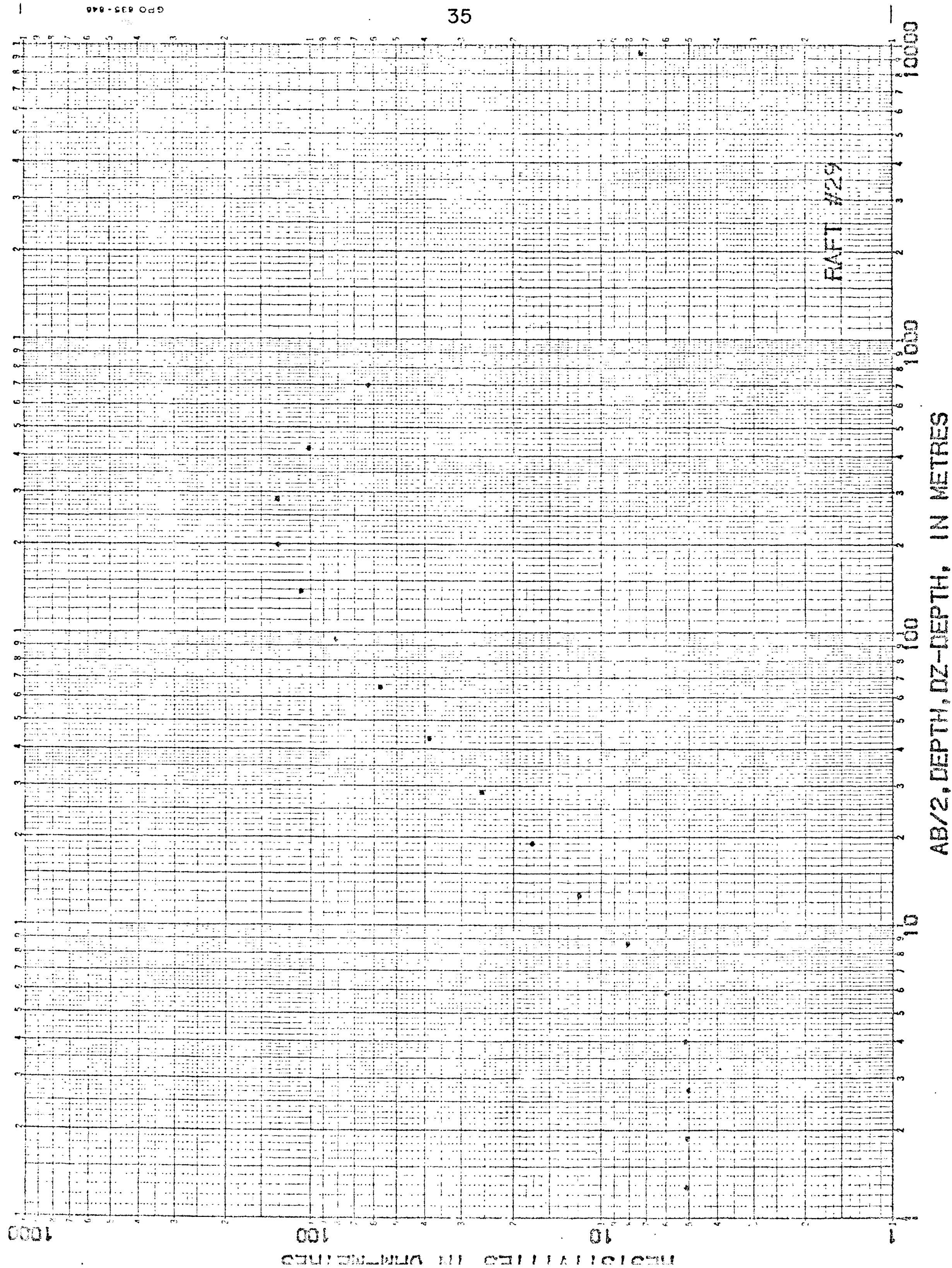
10
1
GPO 835-846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100
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1000
100
10
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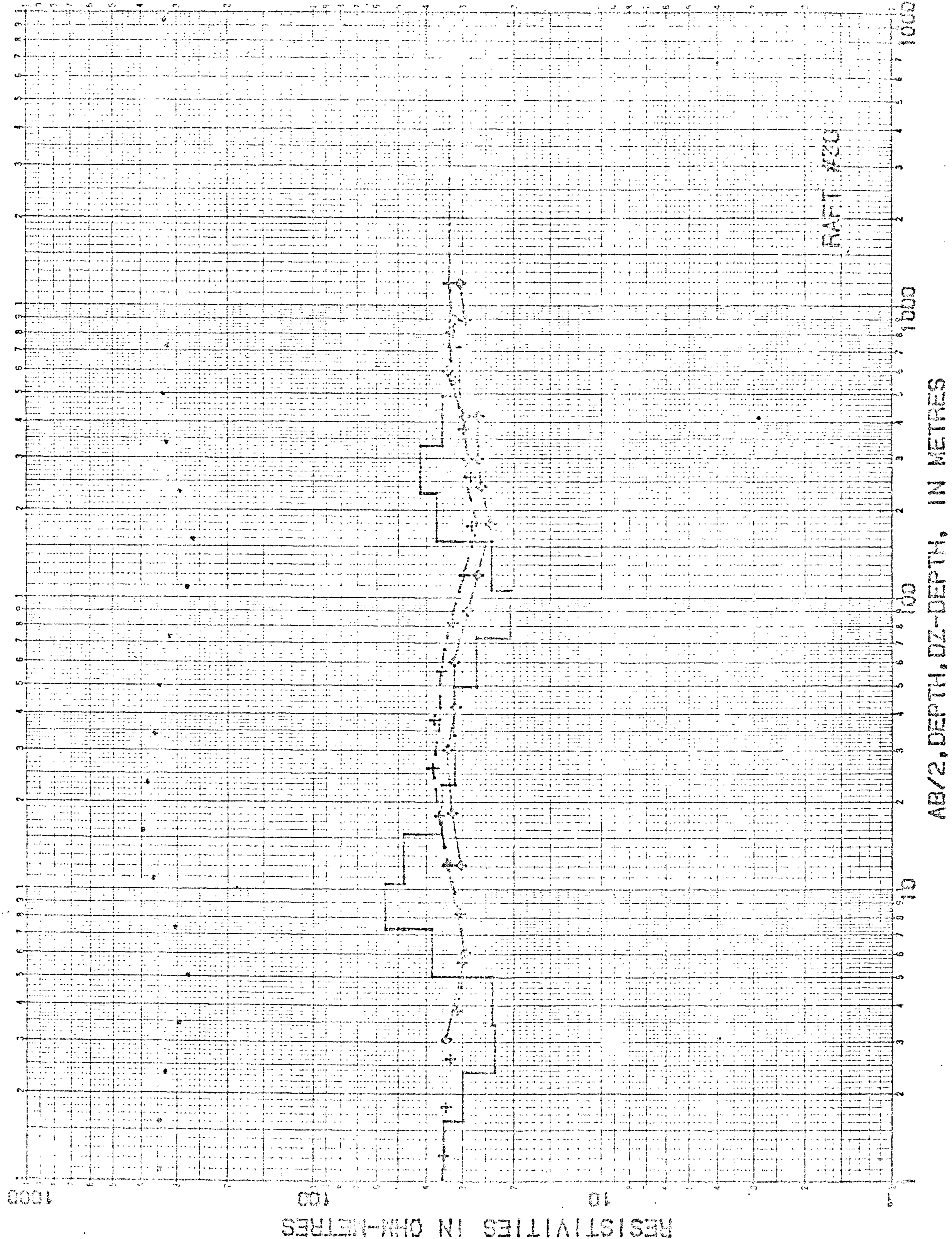
RESISTIVITIES IN OHM-METRES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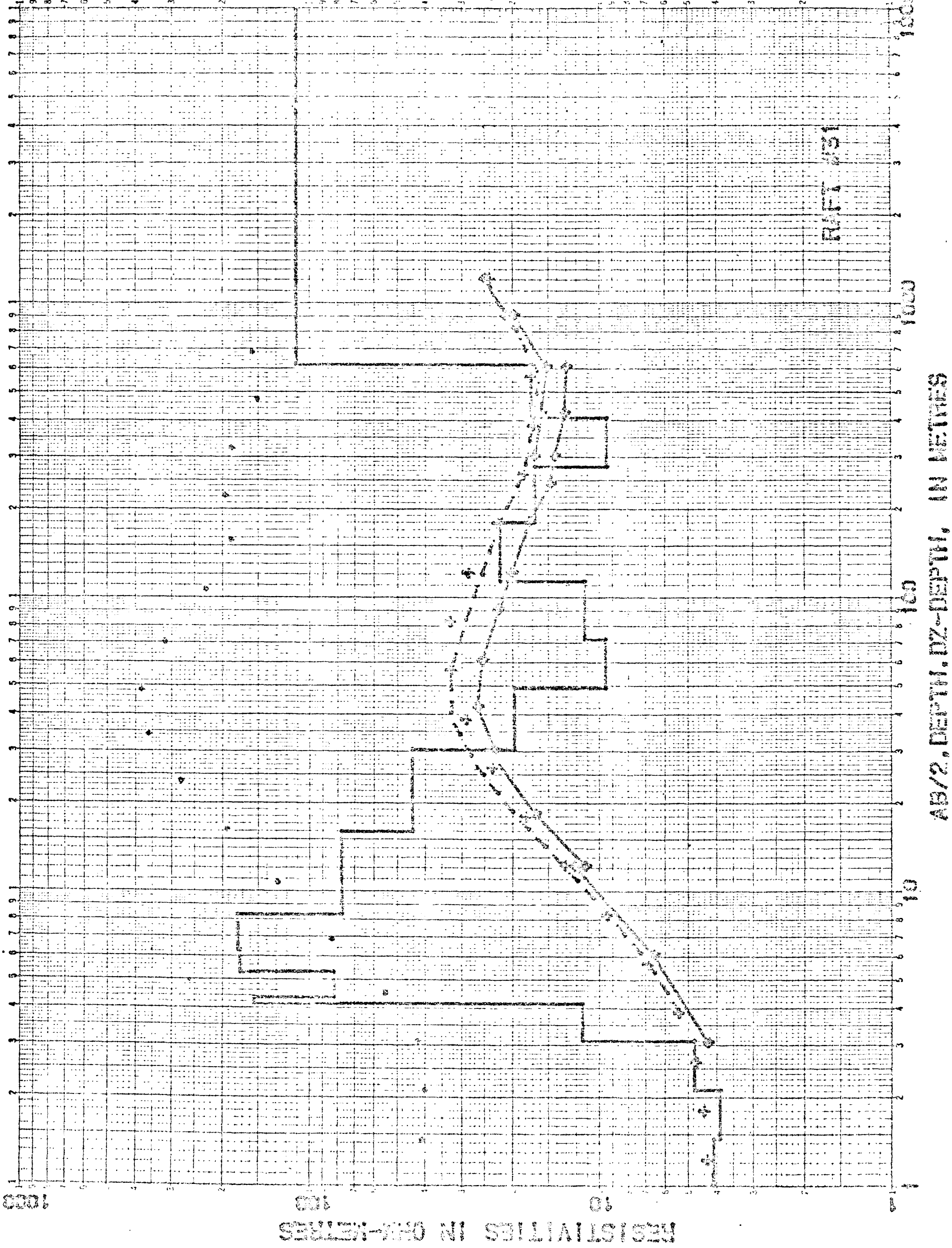
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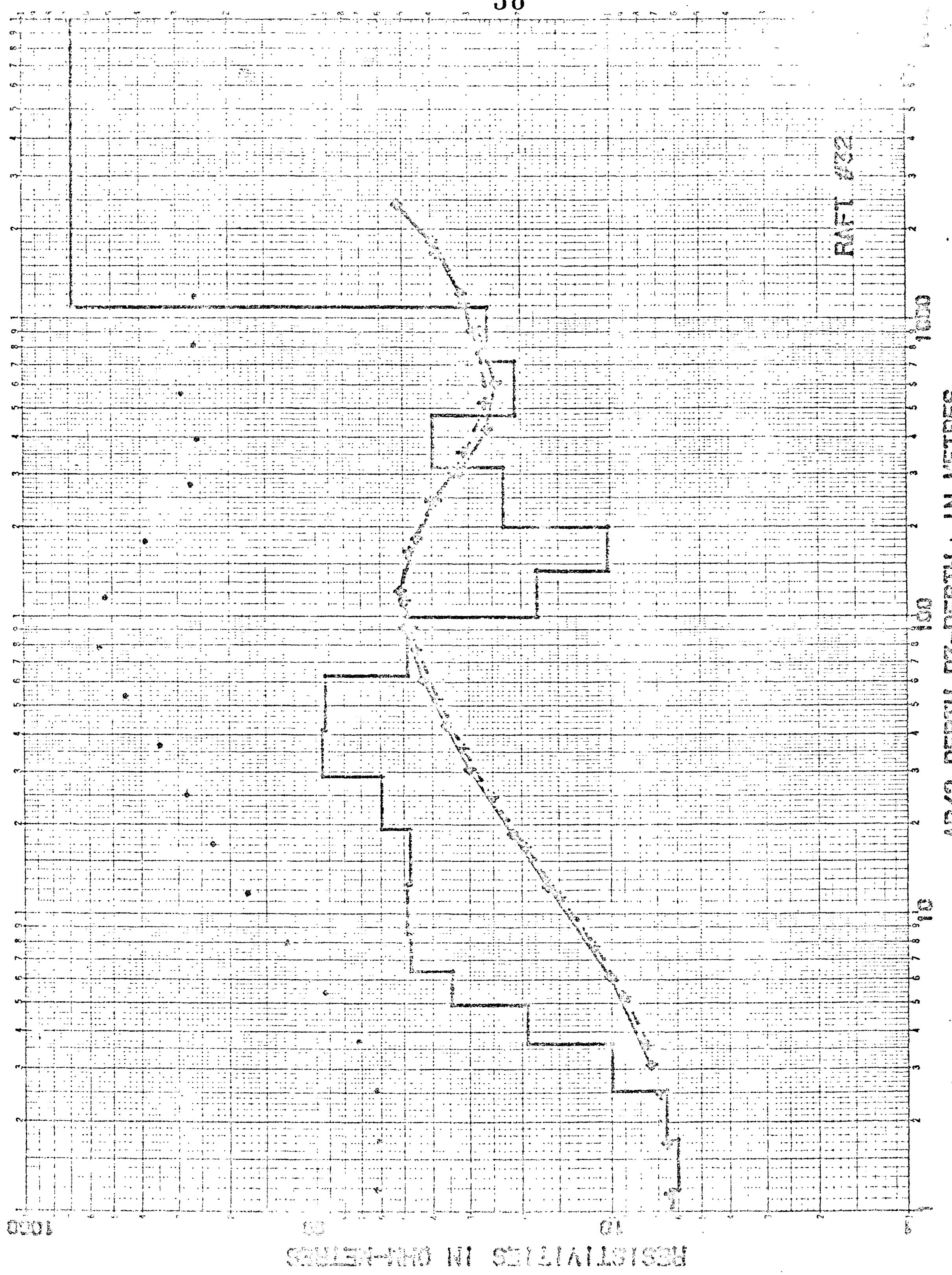
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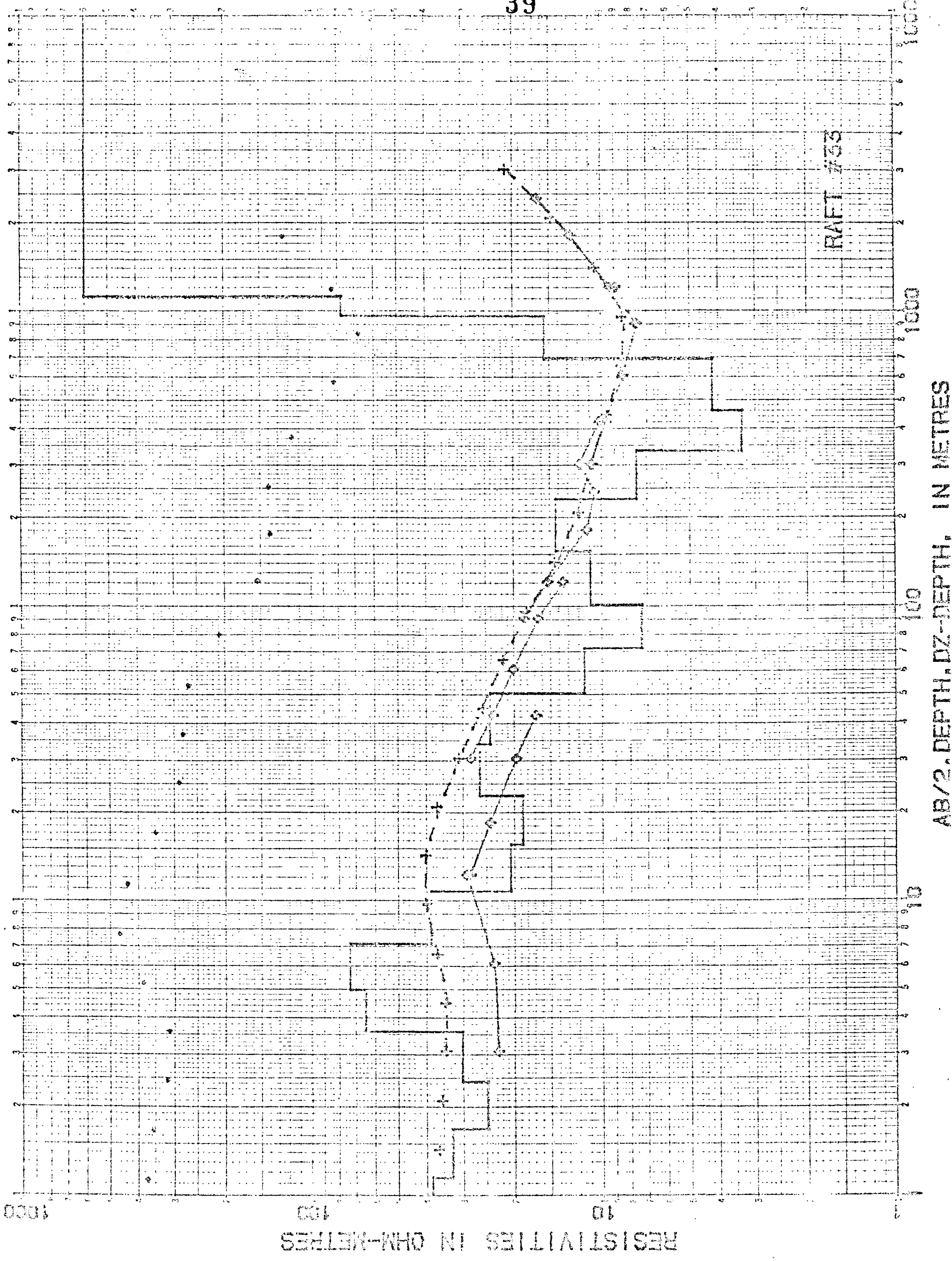
100
10
1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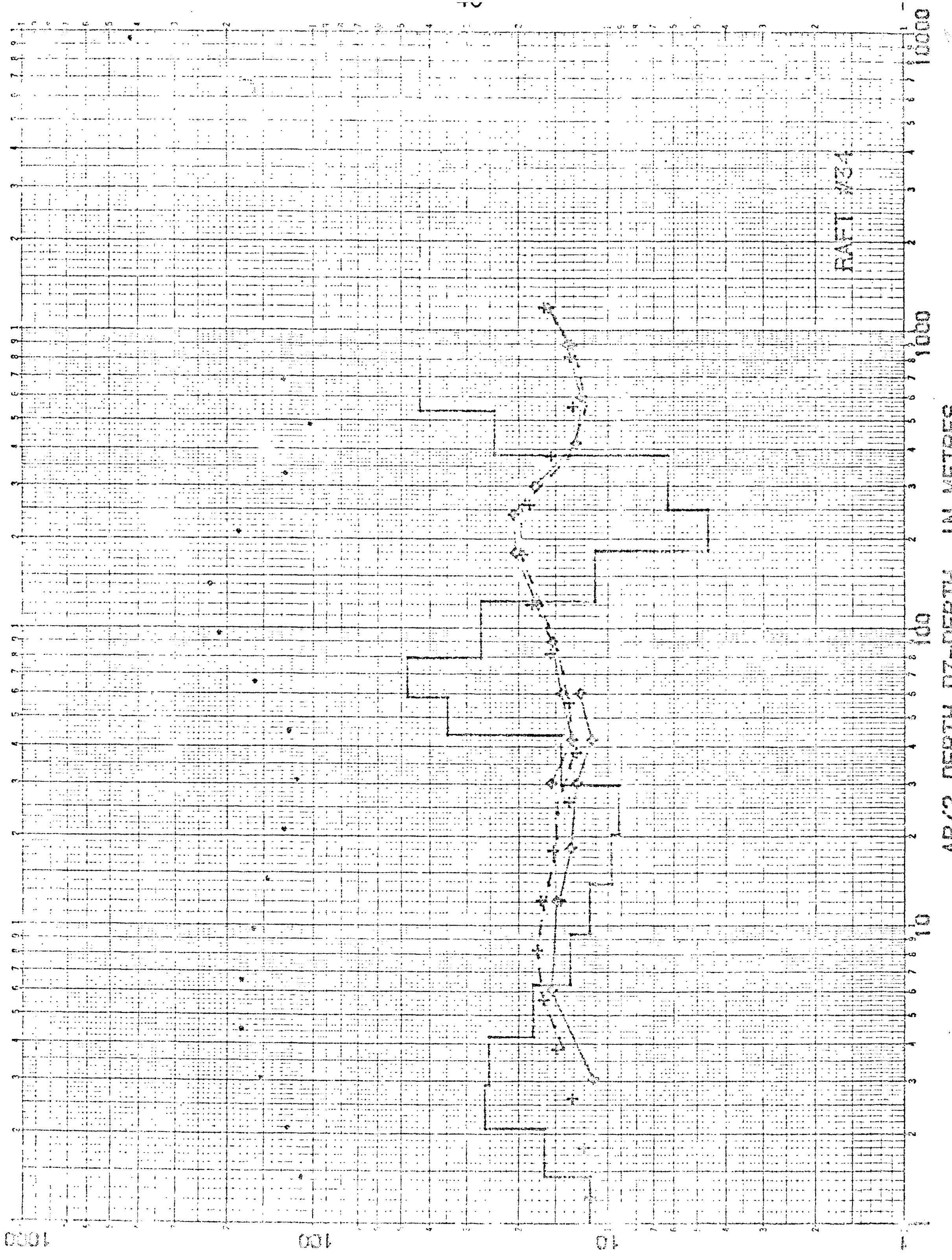
100
10
1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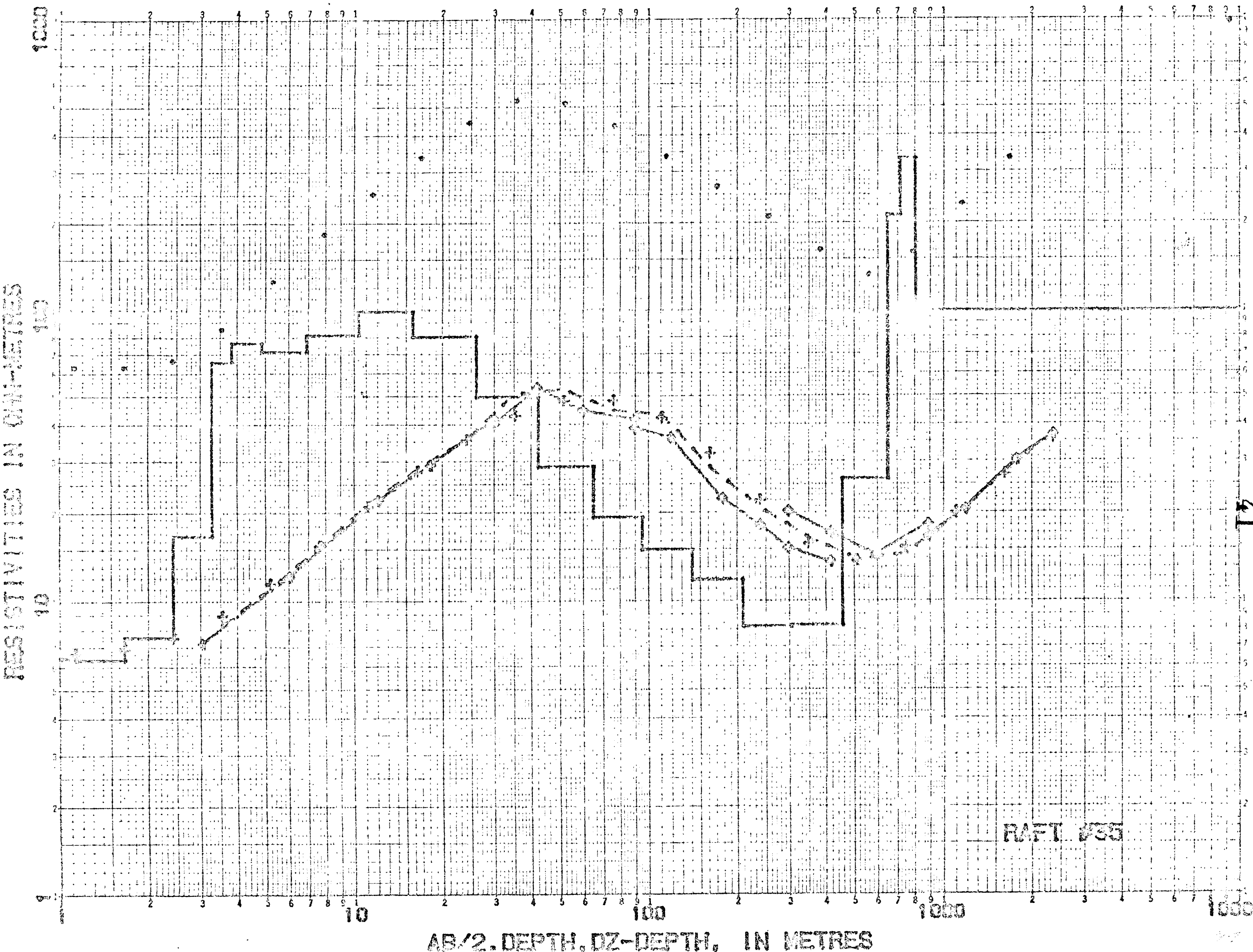
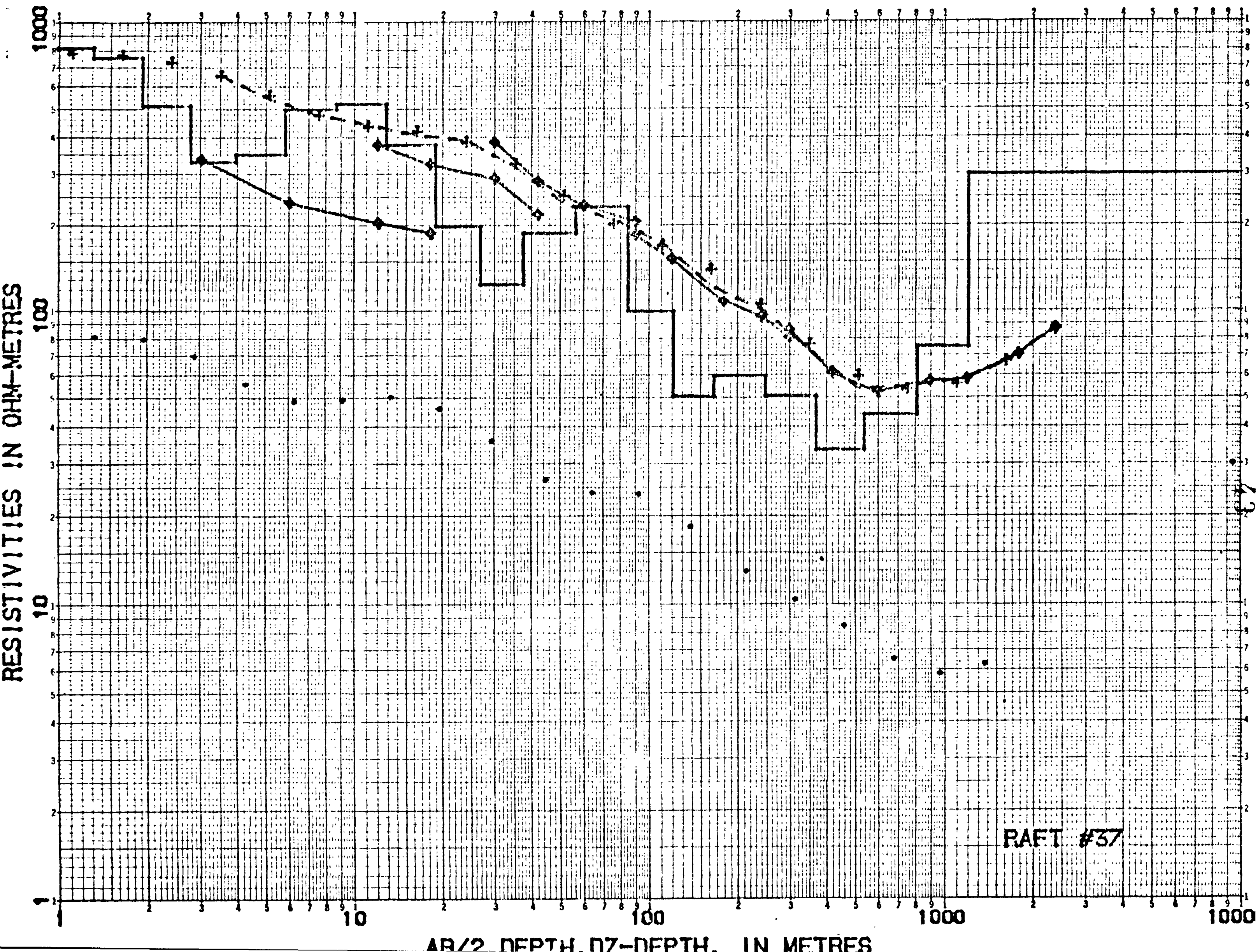
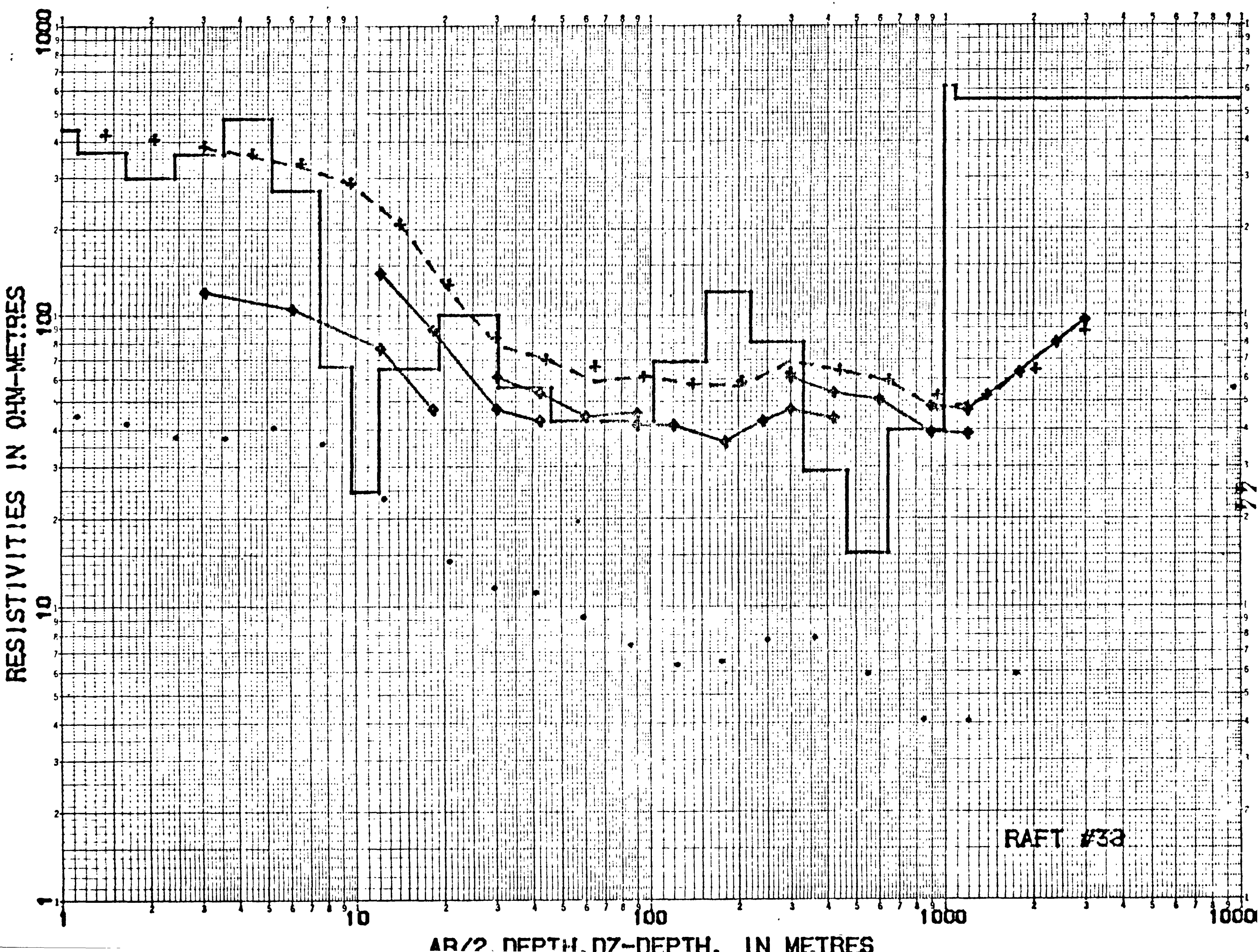
100
1000
10000
1000
100
10
1


RESISTIVITIES IN OHM-METRES
1000
100
10
1
AB/2, DEPTH, DZ-DEPTH, IN METRES
10
100
1000
10000
RAFT #35


RAFT #36
RESISTIVITIES IN OHM-METRES
1000
100
10
1
AB/2, DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
10000


RESISTIVITIES IN OHM-METRES
1000
100
10
1
1
10
100
1000
1000
AB/2 DEPTH DZ-DEPTH, IN METRES
RAFT #37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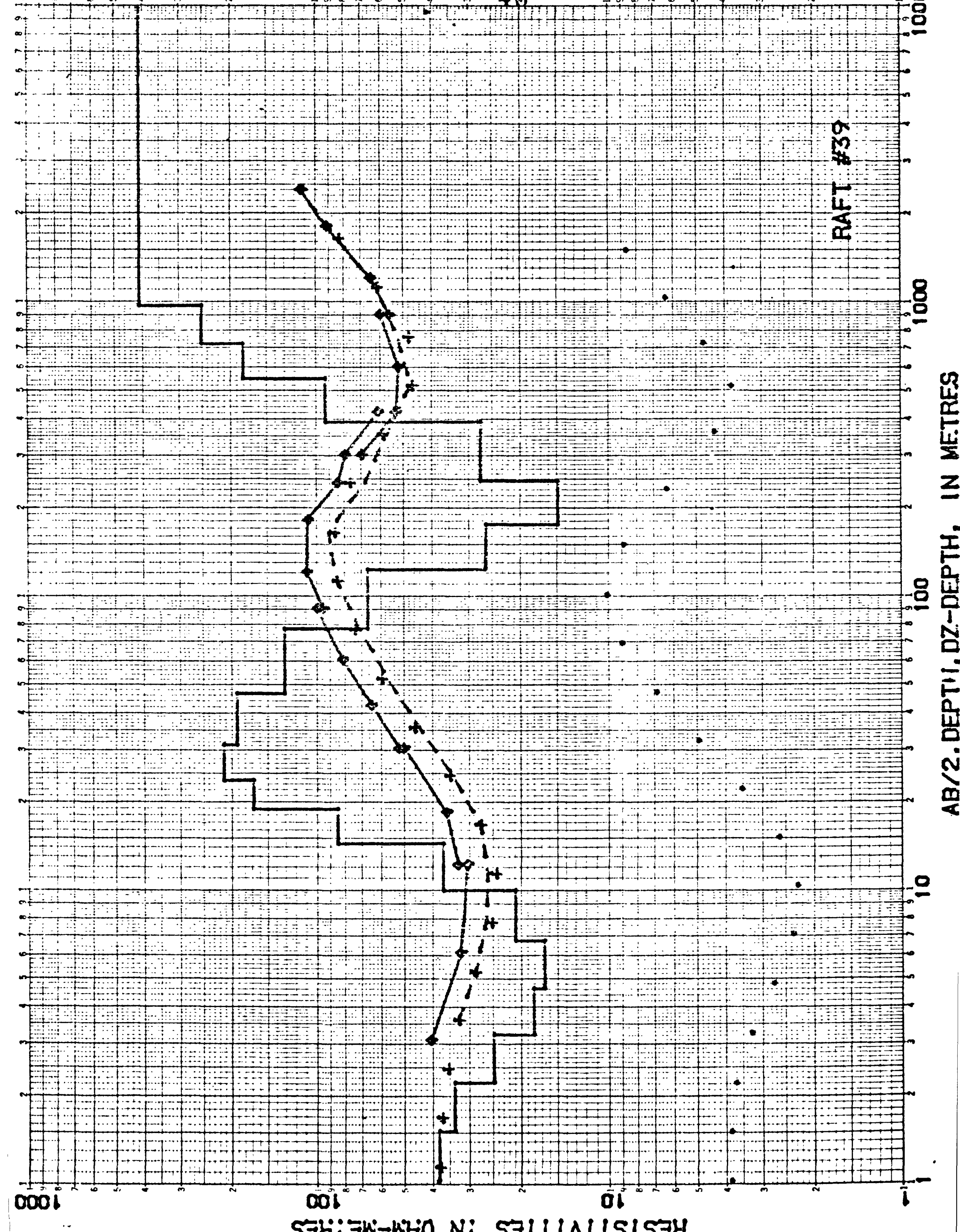
AB/2 DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
1
10
100
1000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AB/2. DEPTH, DZ-DEPTH, IN METRES
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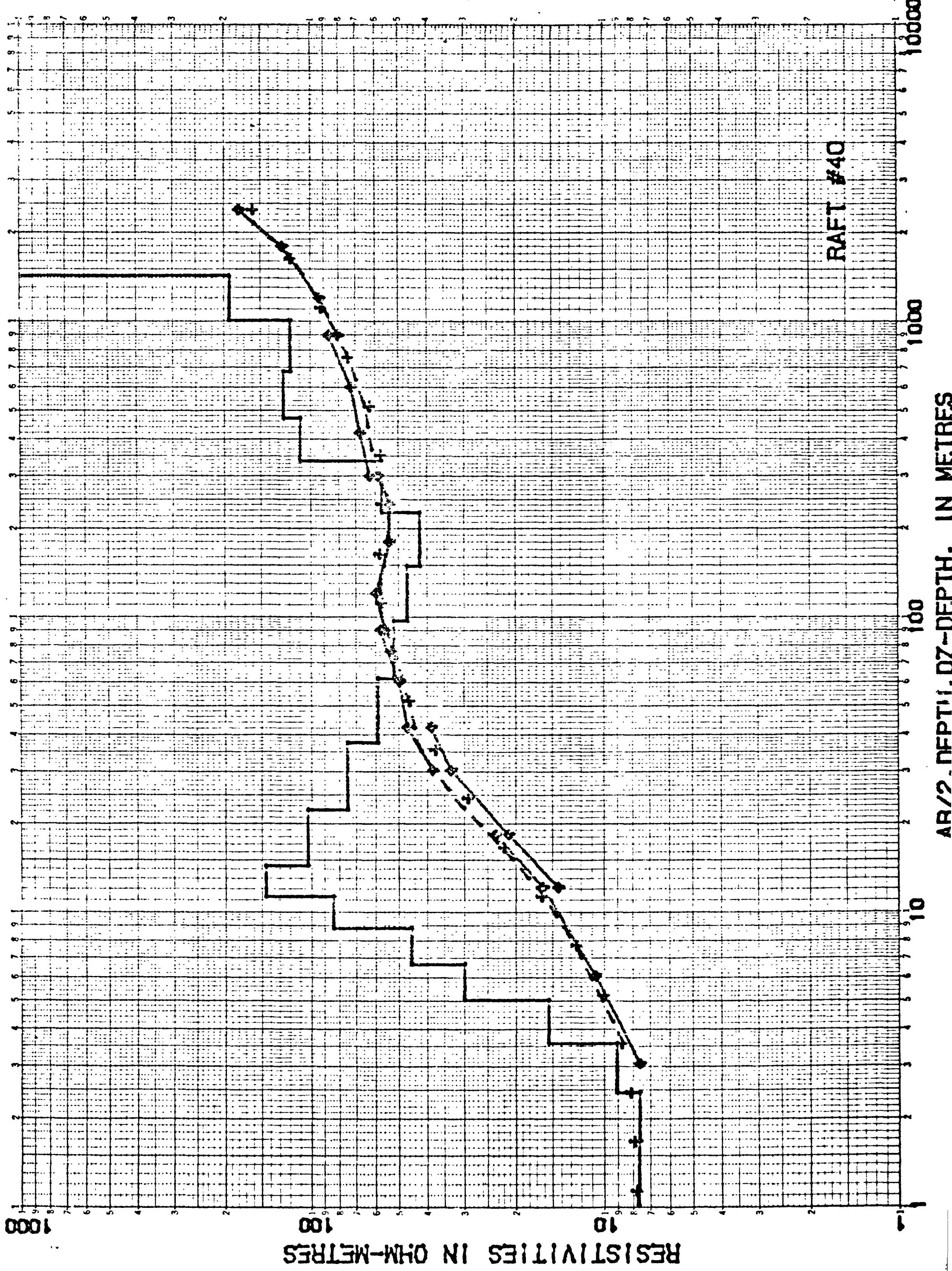
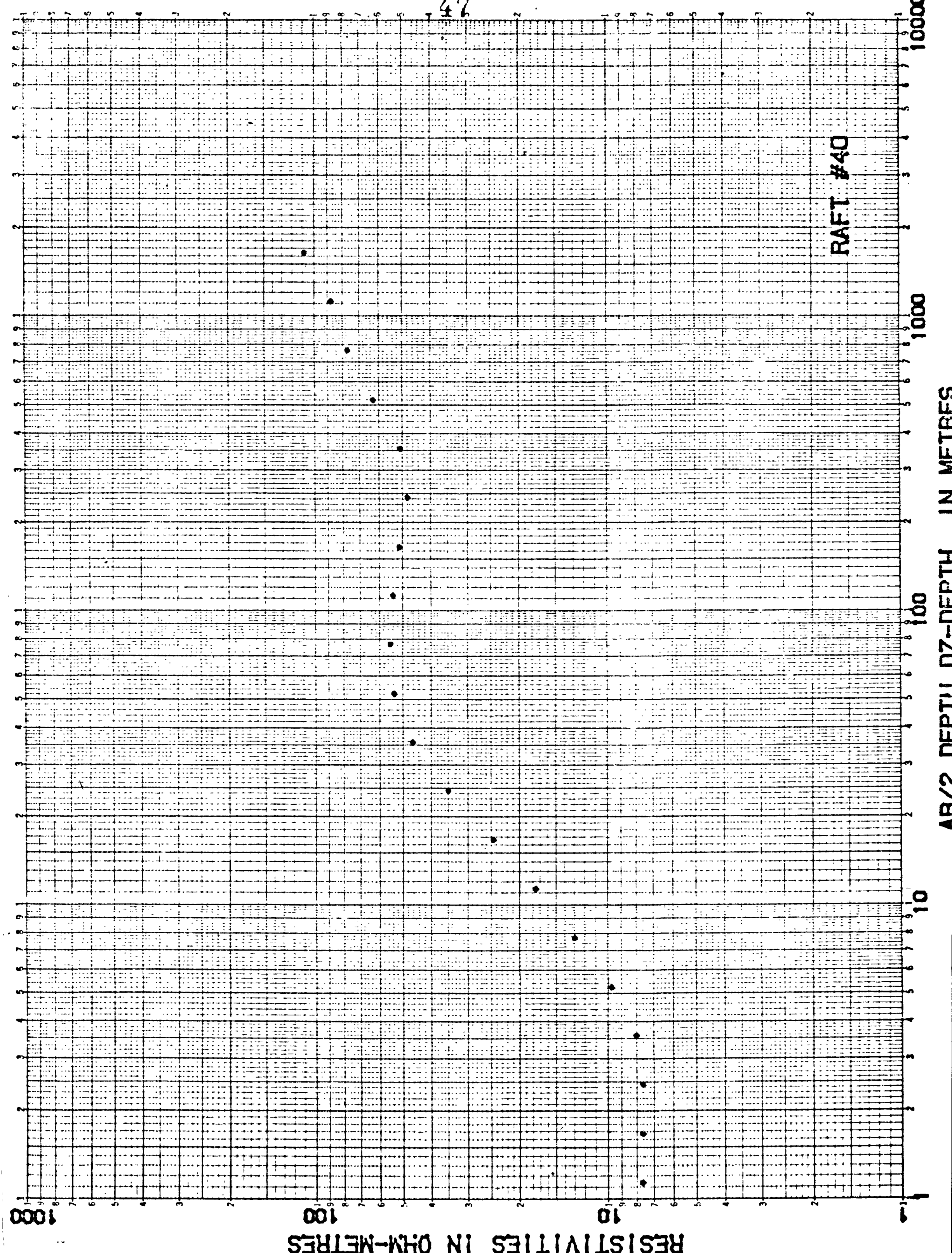
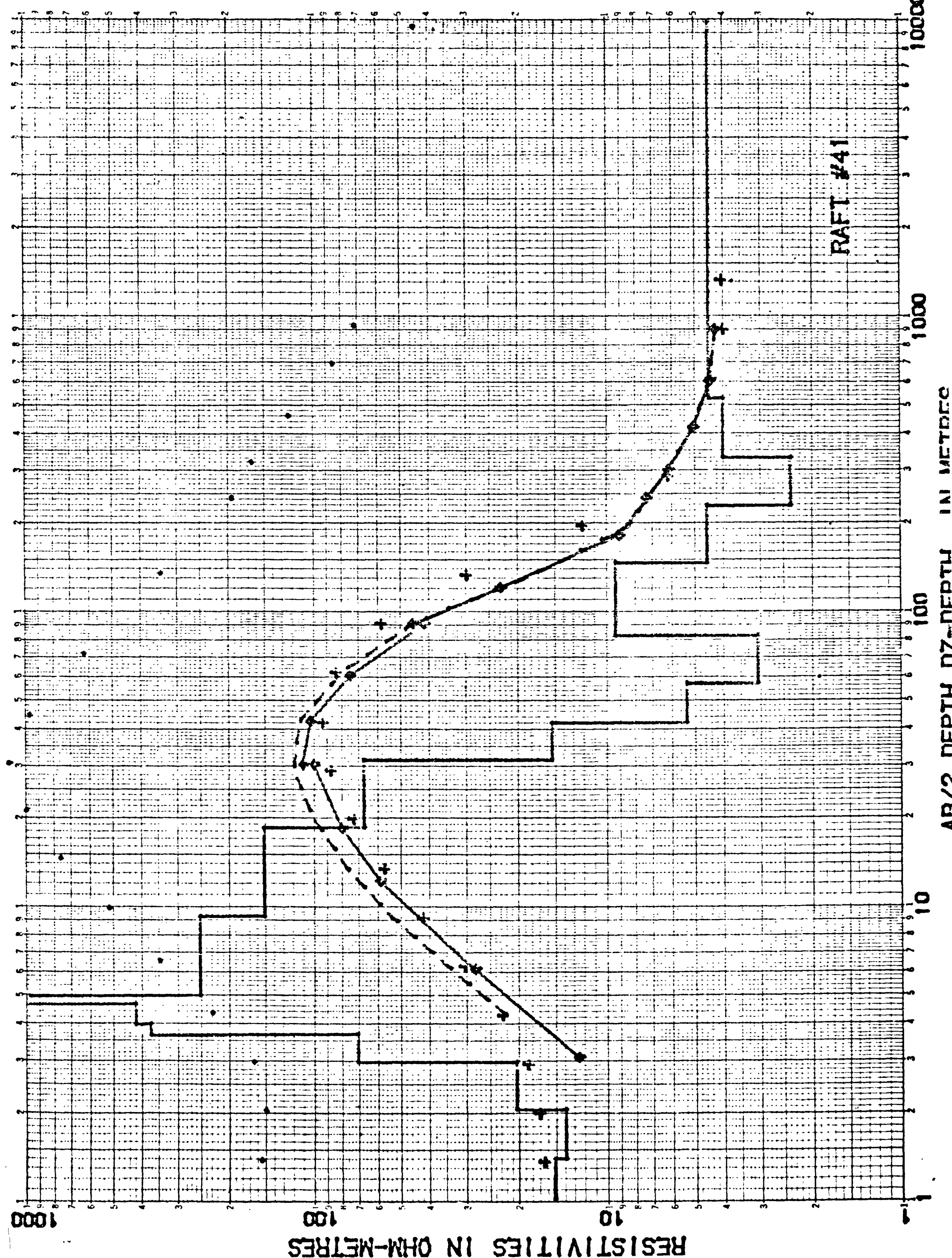
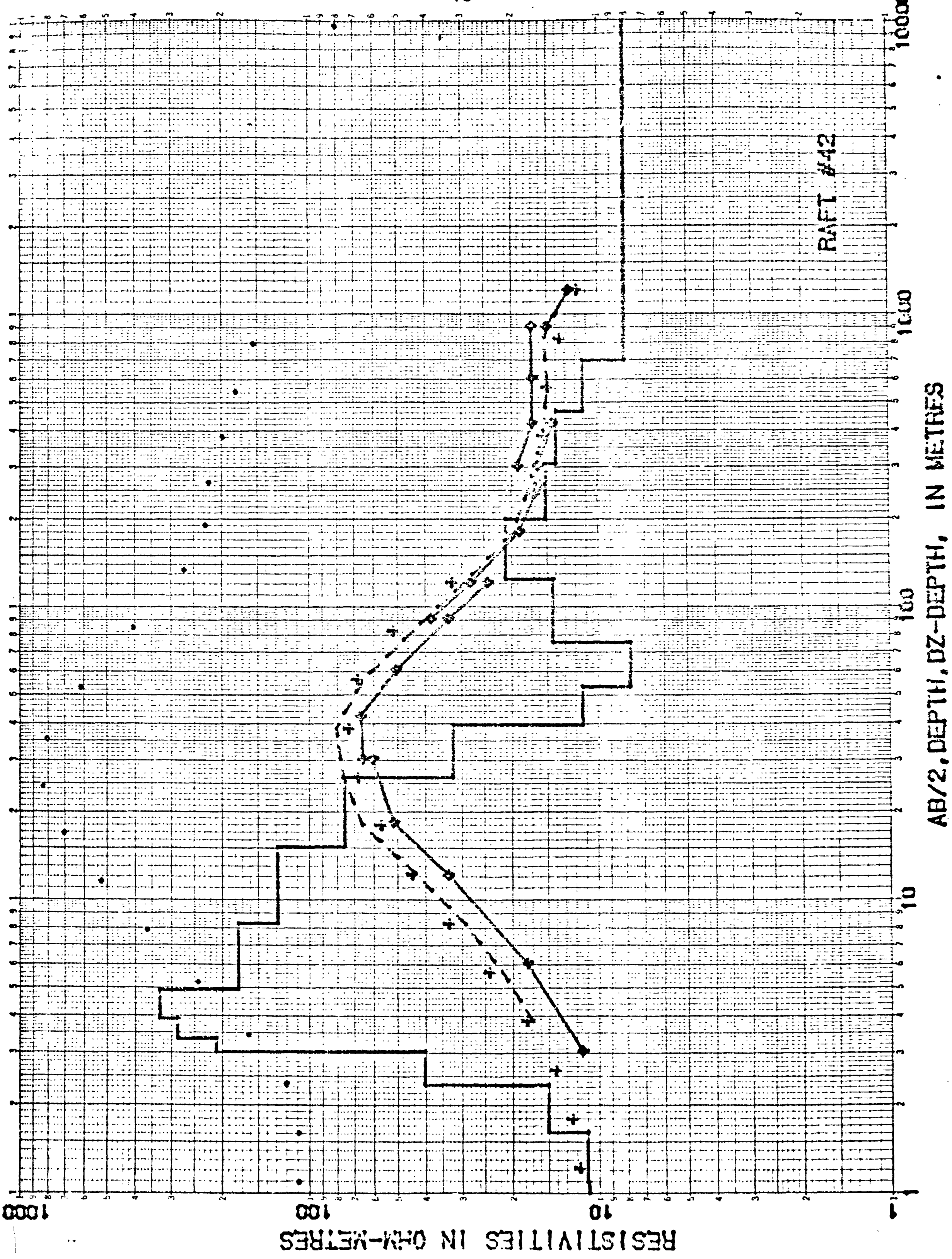
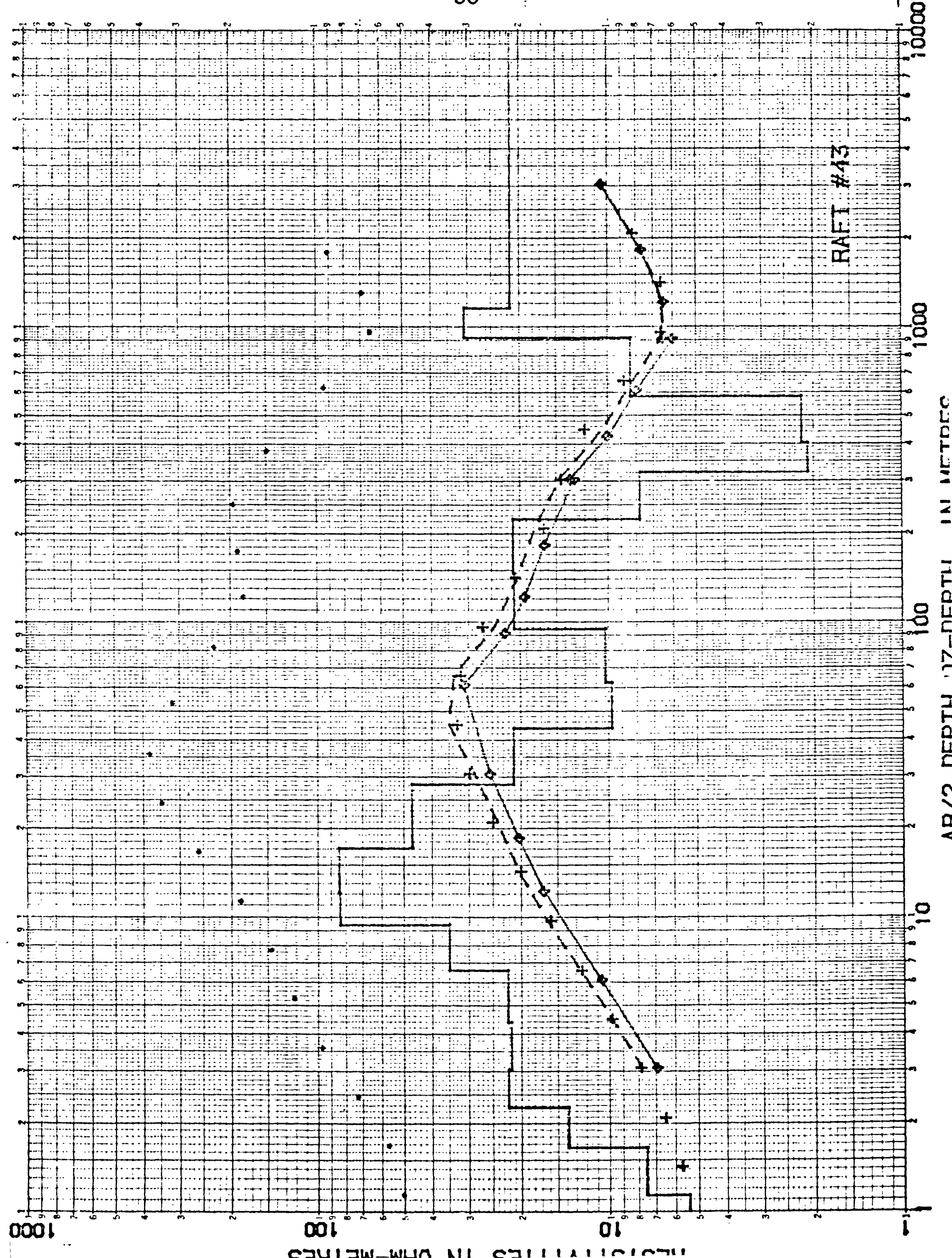
100
1000
10000

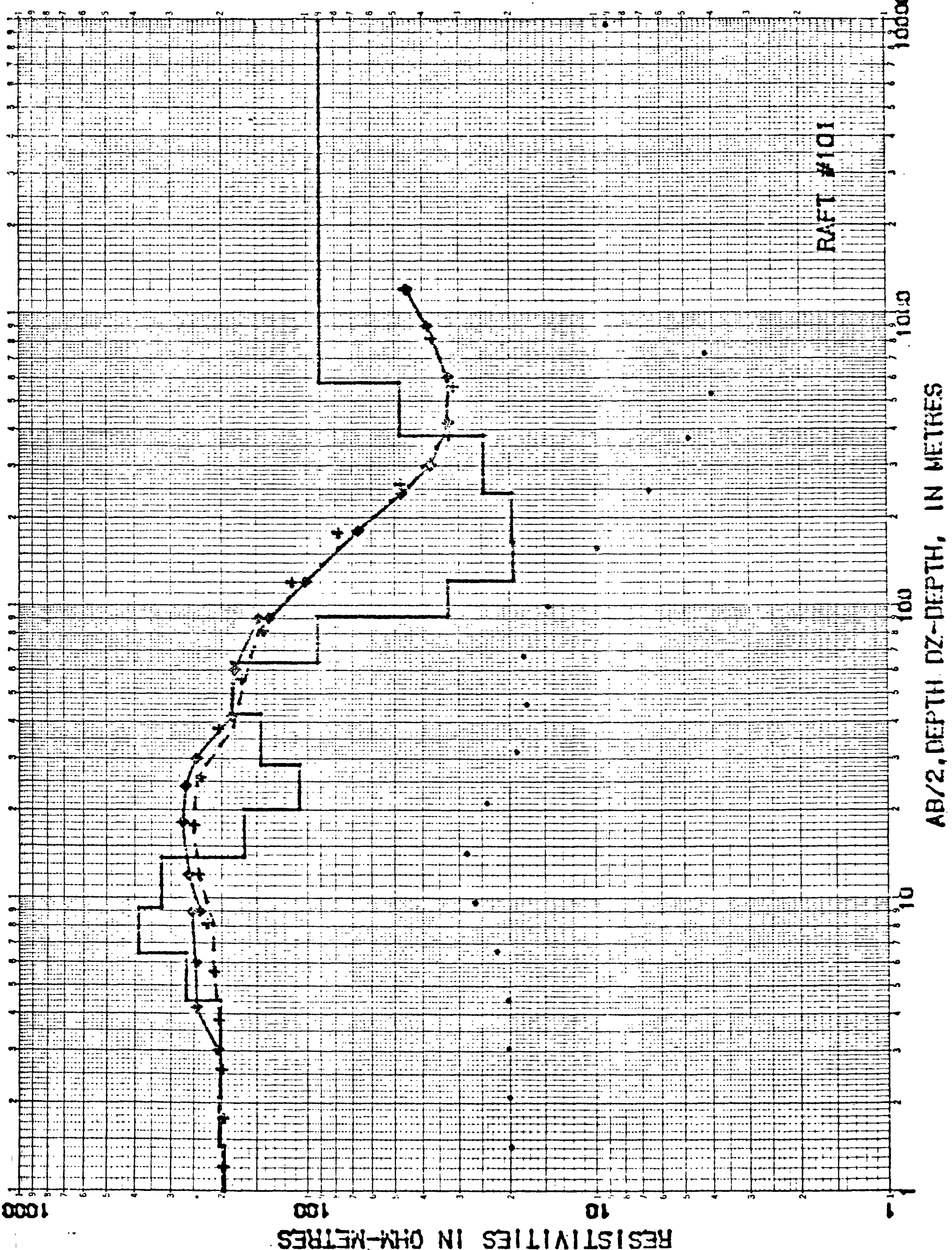

RAFT #40
AB/2-DEPTH, DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000

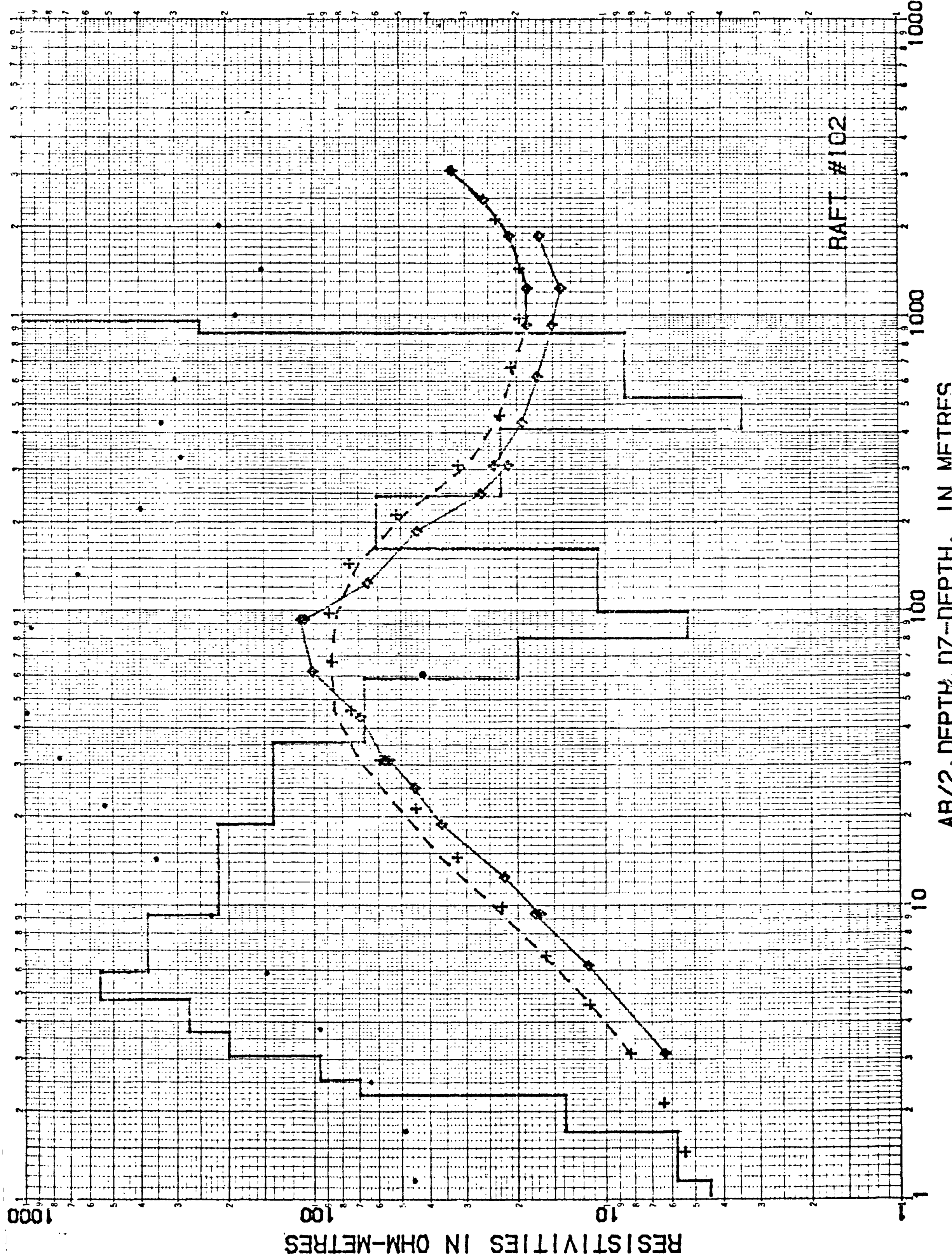

RAFT #40
AB/2 DEPTH DZ-DEPTH IN METRES
10000
1000
100
10
1
RESISTIVITIES IN OHM-METRES
1000
100
10
1

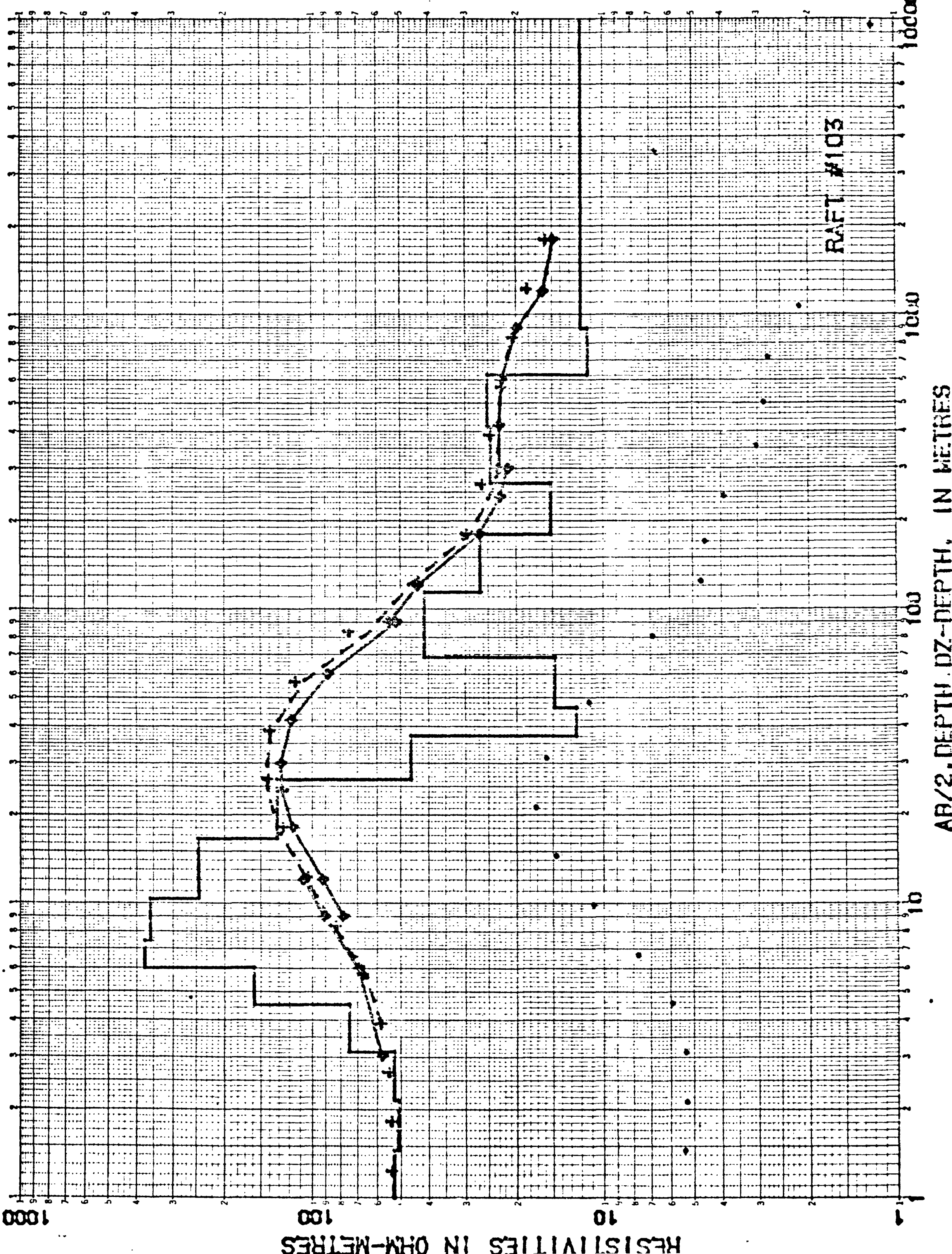

RAFT #41
AB/2 DEPTH DZ-DEPTH IN METRES
1
10
100
1000
10000
RESISTIVITIES IN OHM-METRES
1
10
100
1000

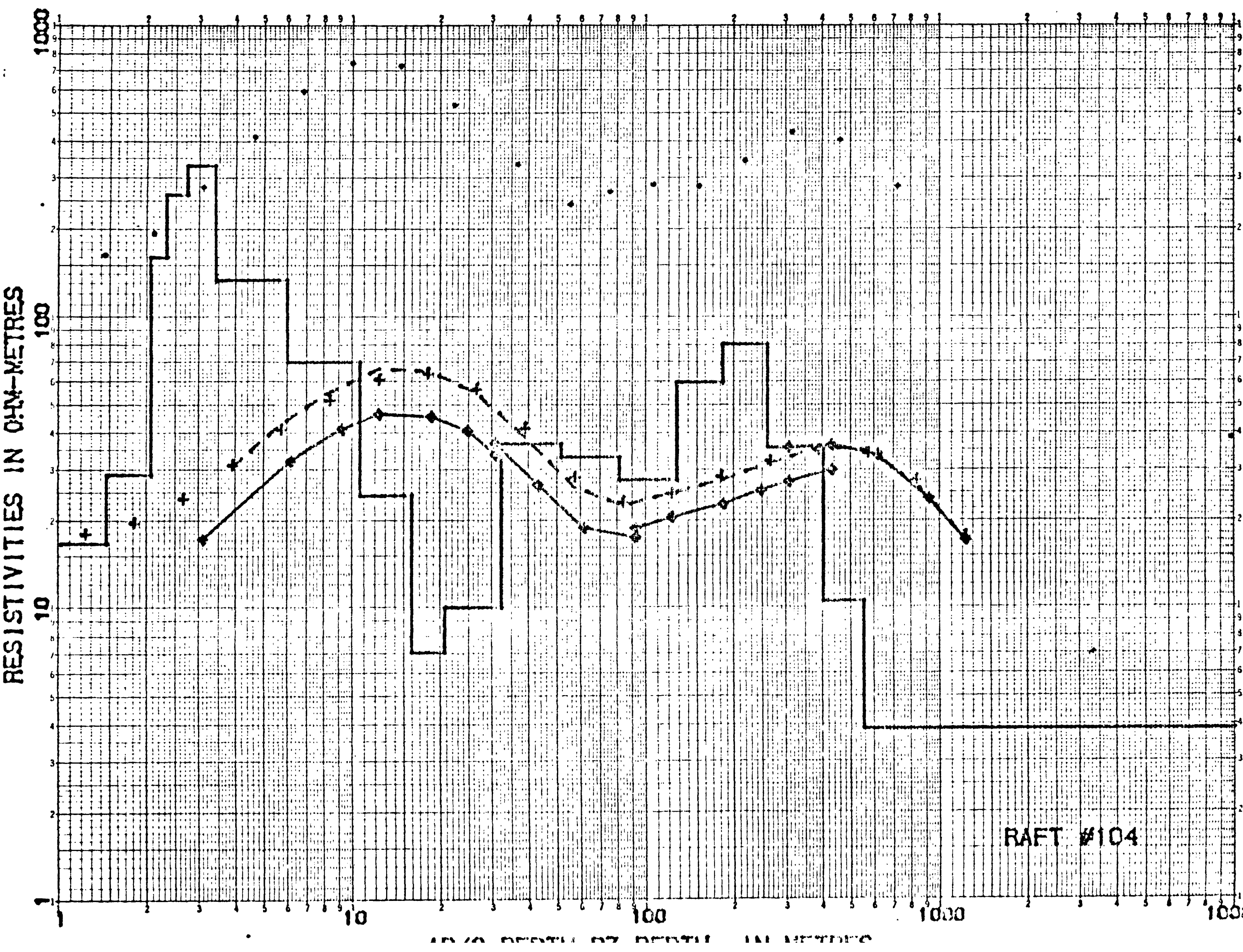

RAFT #42
AB/2, DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
10000
RESISTIVITIES IN OHM-METRES
1000
100
10
1

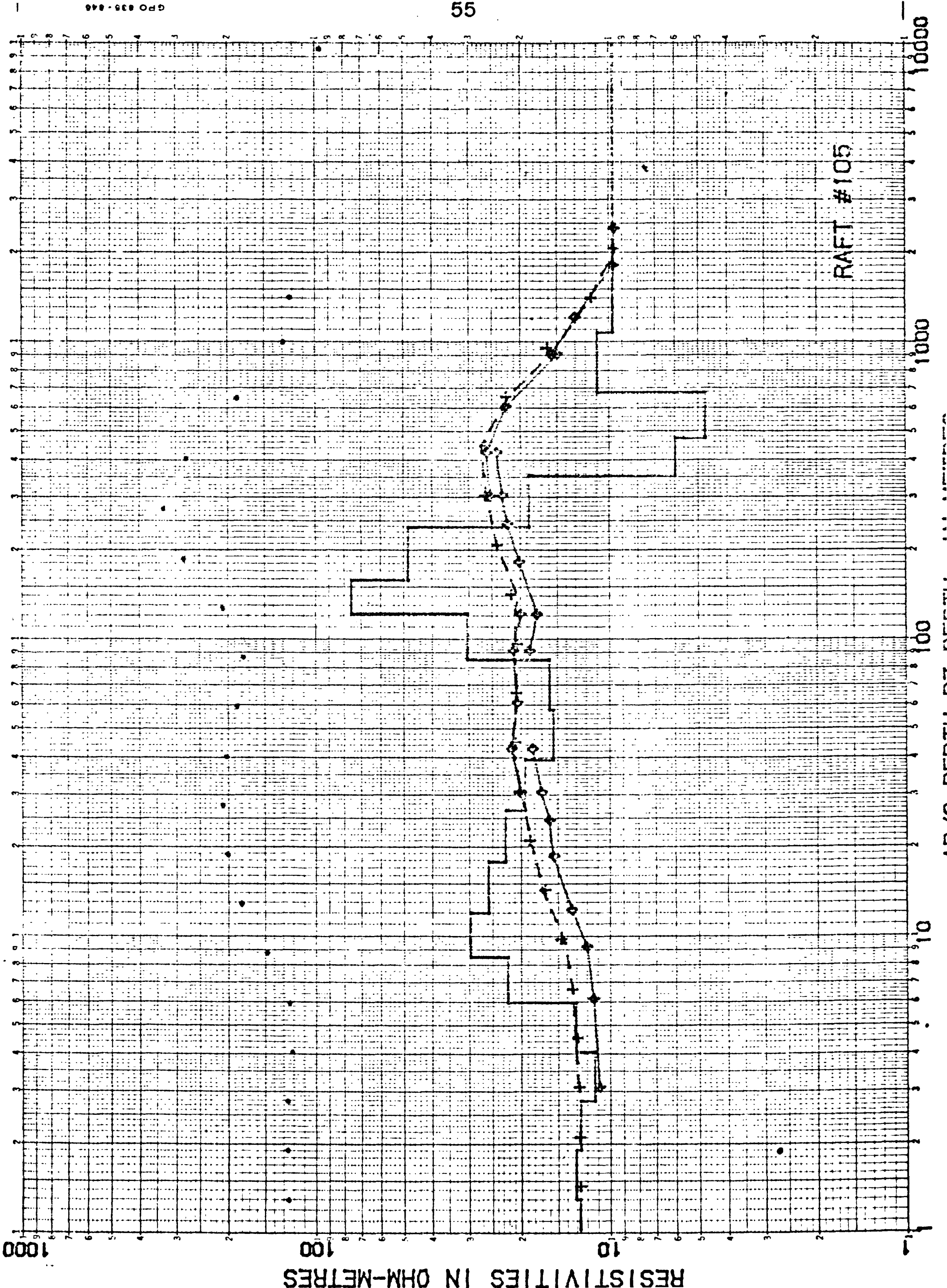

GPO 839-846
RAFT #43
AB/2 DEPTH 'Z'-DEPTH IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
1
10
100
1000

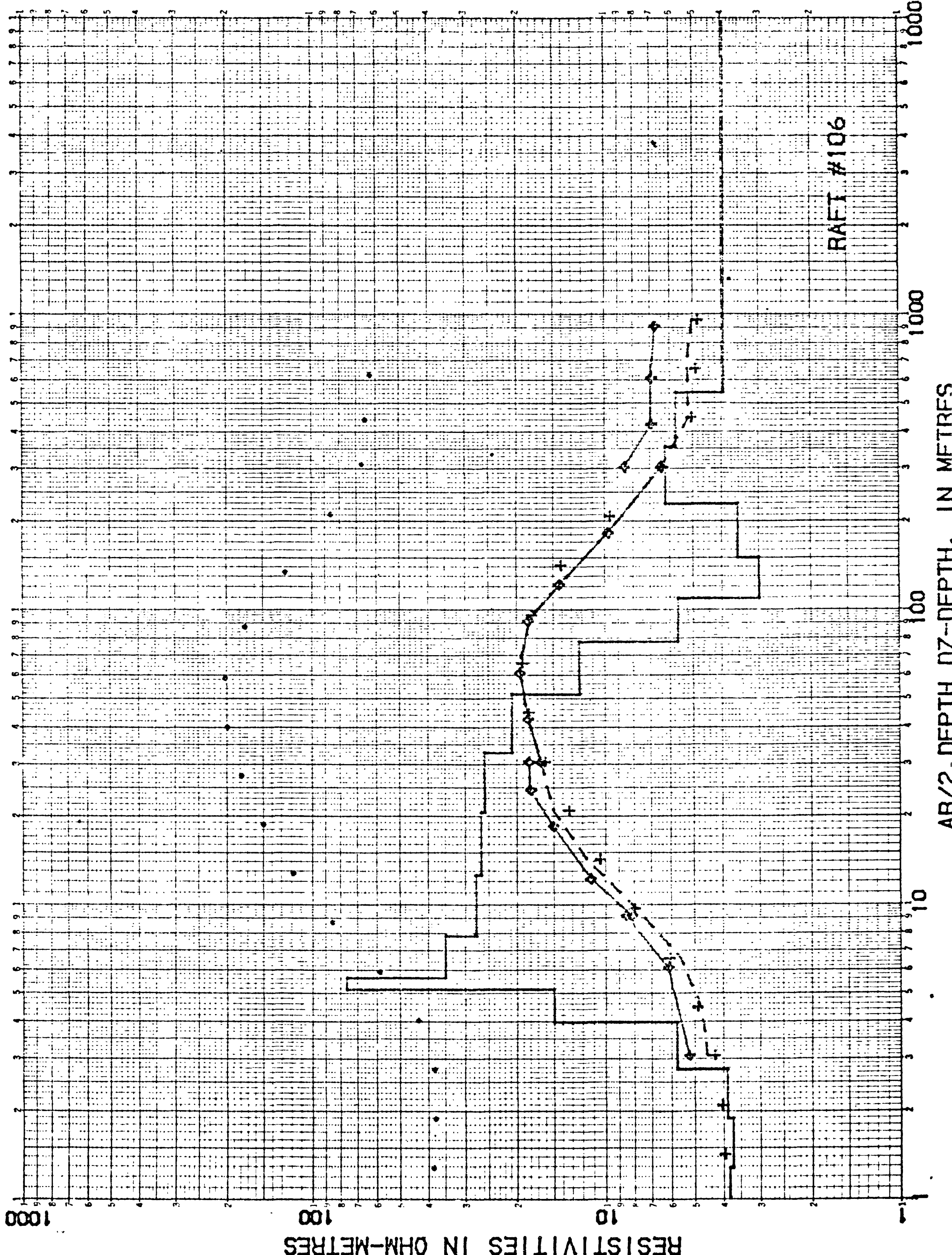

RAFT #101
AB/2, DEPTH DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10
100
1000
10000

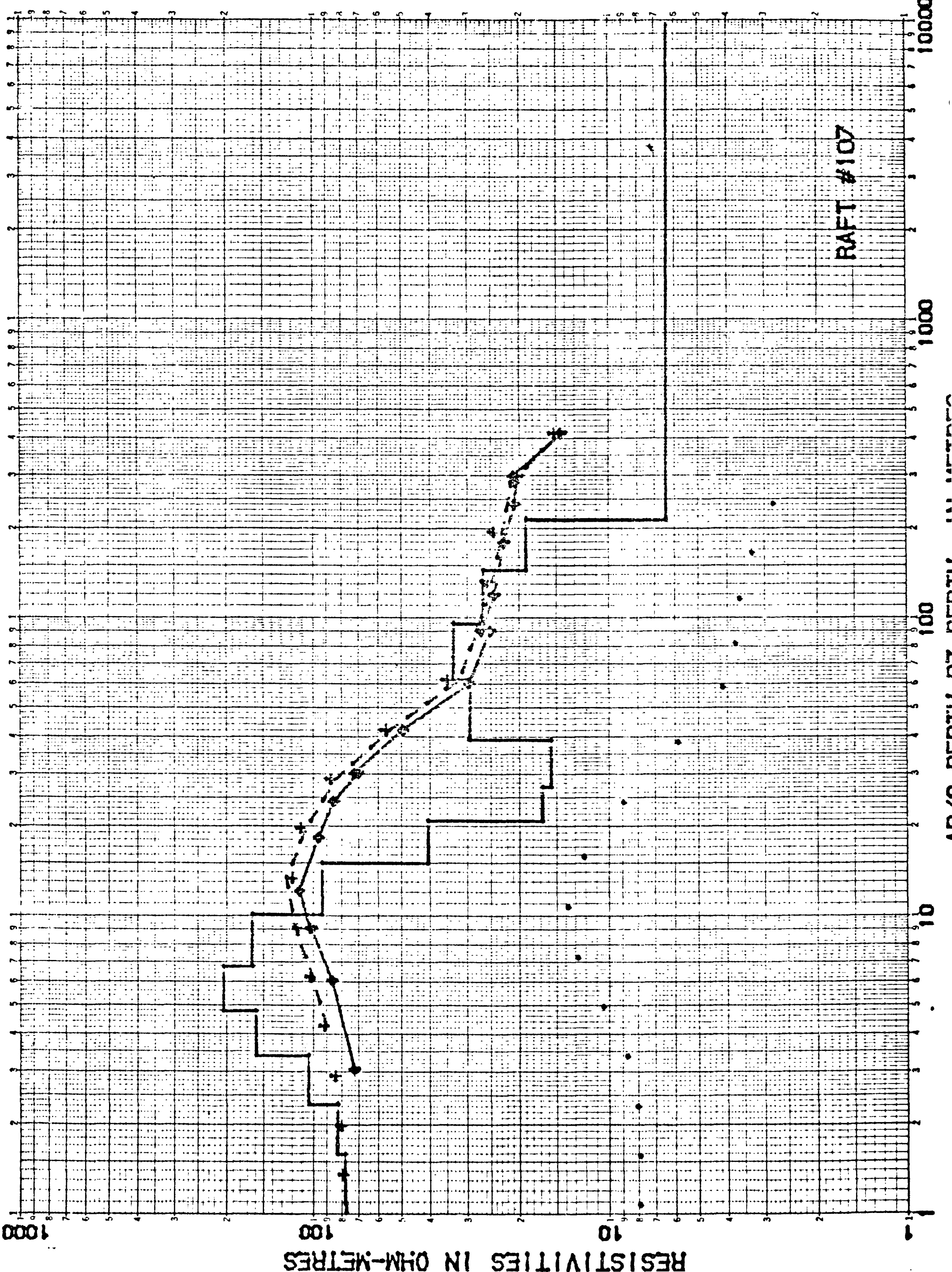

GPO 835-646
RAFT #102
AB/2, DEPTH, DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
10
100
1000
10000
1
10
100
1000

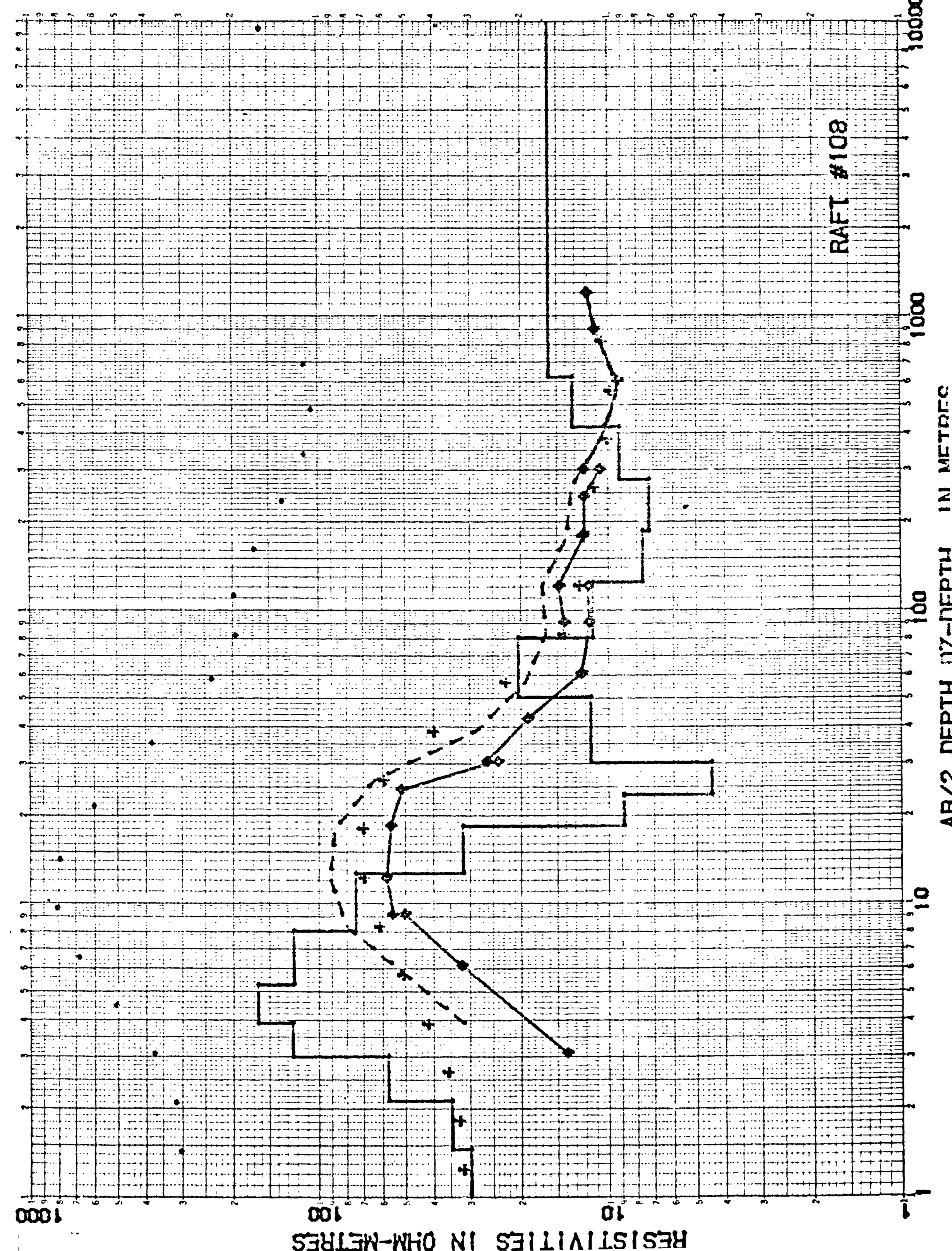

RAFT #103
AB/2, DEPTH, DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
GPO 838-646

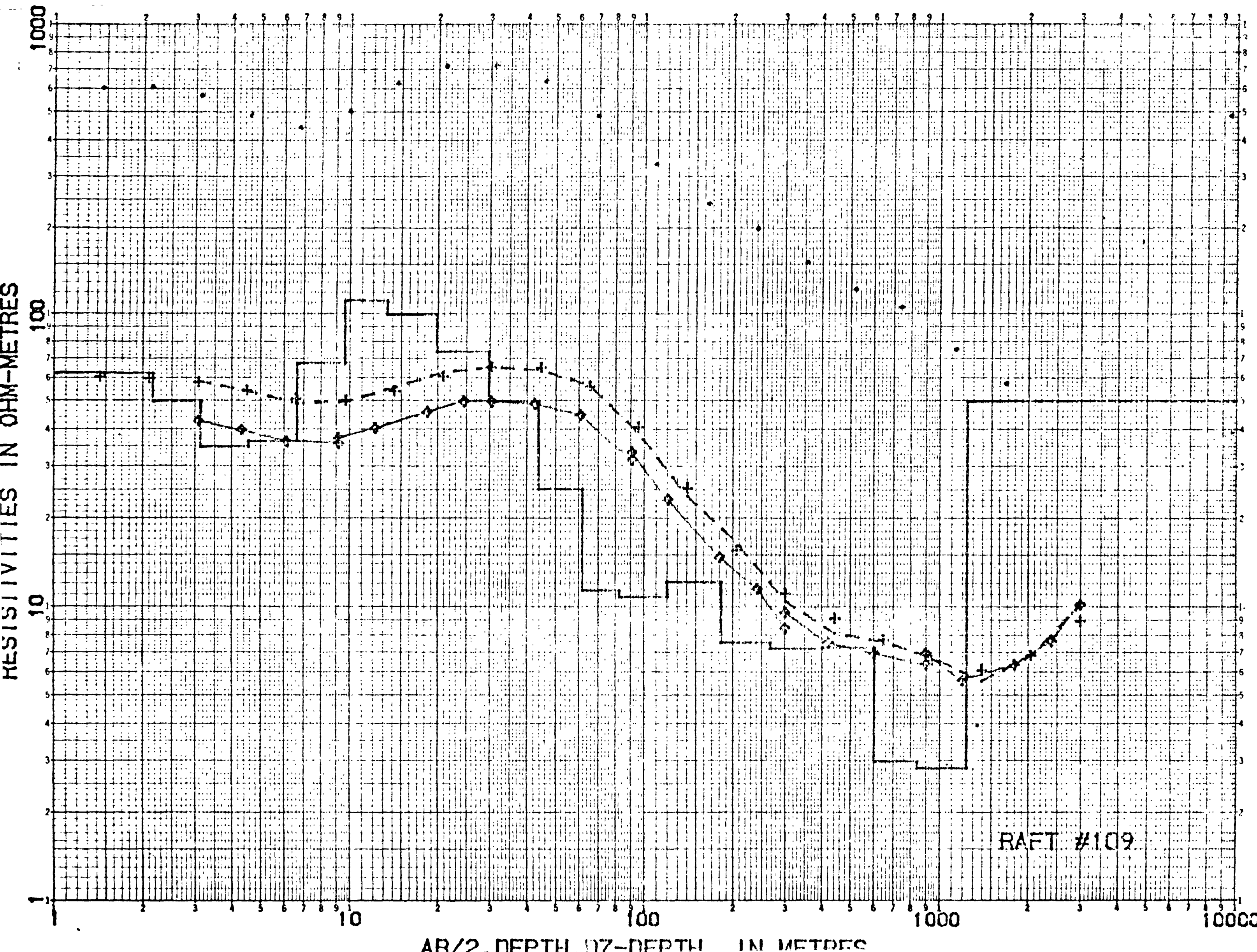

RESISTIVITIES IN OHM-METRES
1000
100
10
1
1
10
100
1000
10000
AB/2 DEPTH, BZ DEPTH, IN METRES
RAFT #104

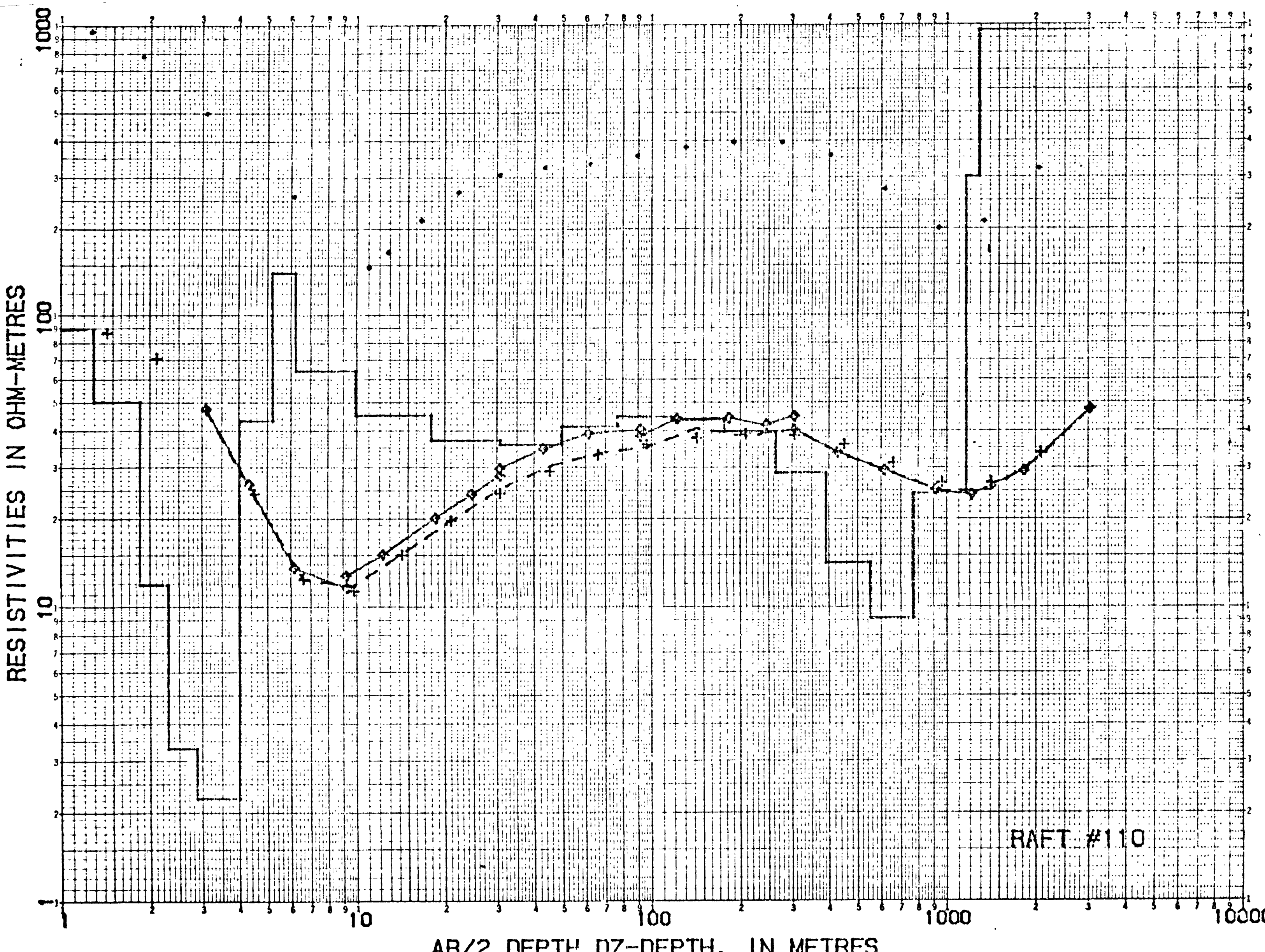

GPO 835-846
RAFT #105
RESISTIVITIES IN OHM-METRES
1000
100
10
1
AB/2 DEPTH IN METRES
10
100
1000
10000

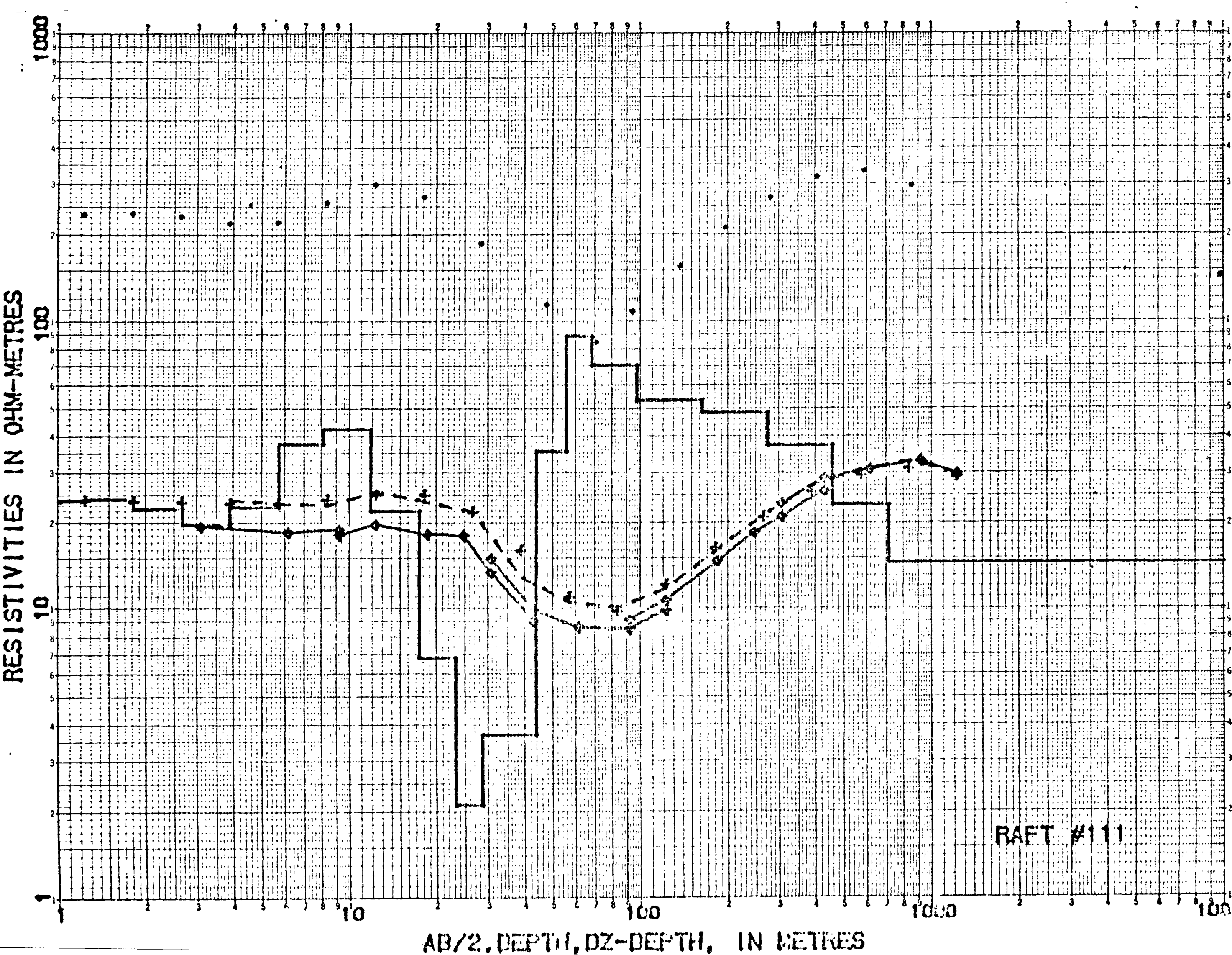

GPO 836-846
RAFT #106
AB/2-DEPTH, IN METRES
1
10
100
1000
10000
RESISTIVITIES IN OHM-METRES
1000
100
10
1

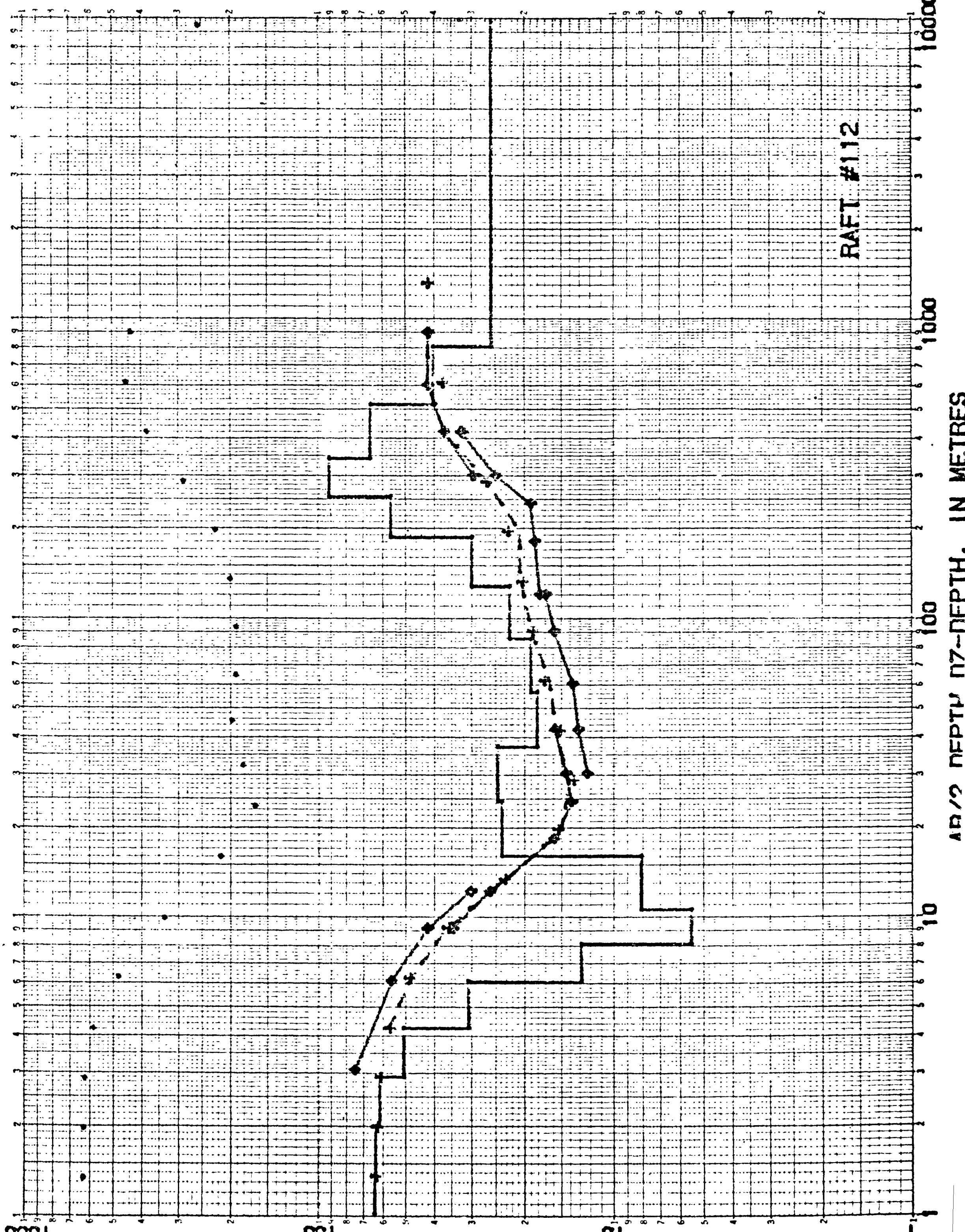

GPO 635-846
RAFT #107
RESISTIVITIES IN OHM-METRES
1000
100
10
1
1
10
100
1000
10000

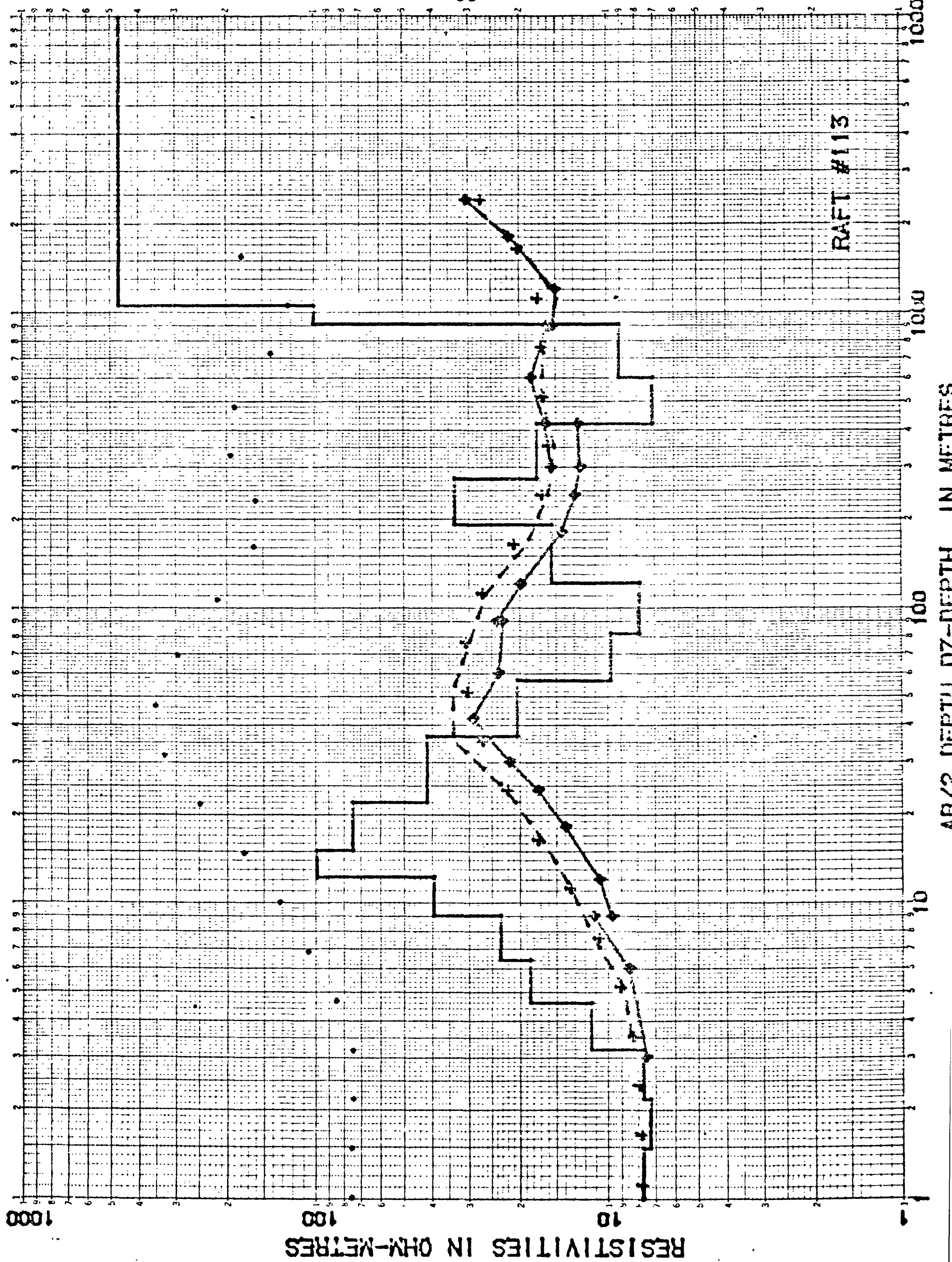

RAFT #108
AB/2 DEPTH DZ-DEPTH IN METRES
1
10
100
1000
10000
RESISTIVITIES IN OHM-METRES
1000
100
10
1

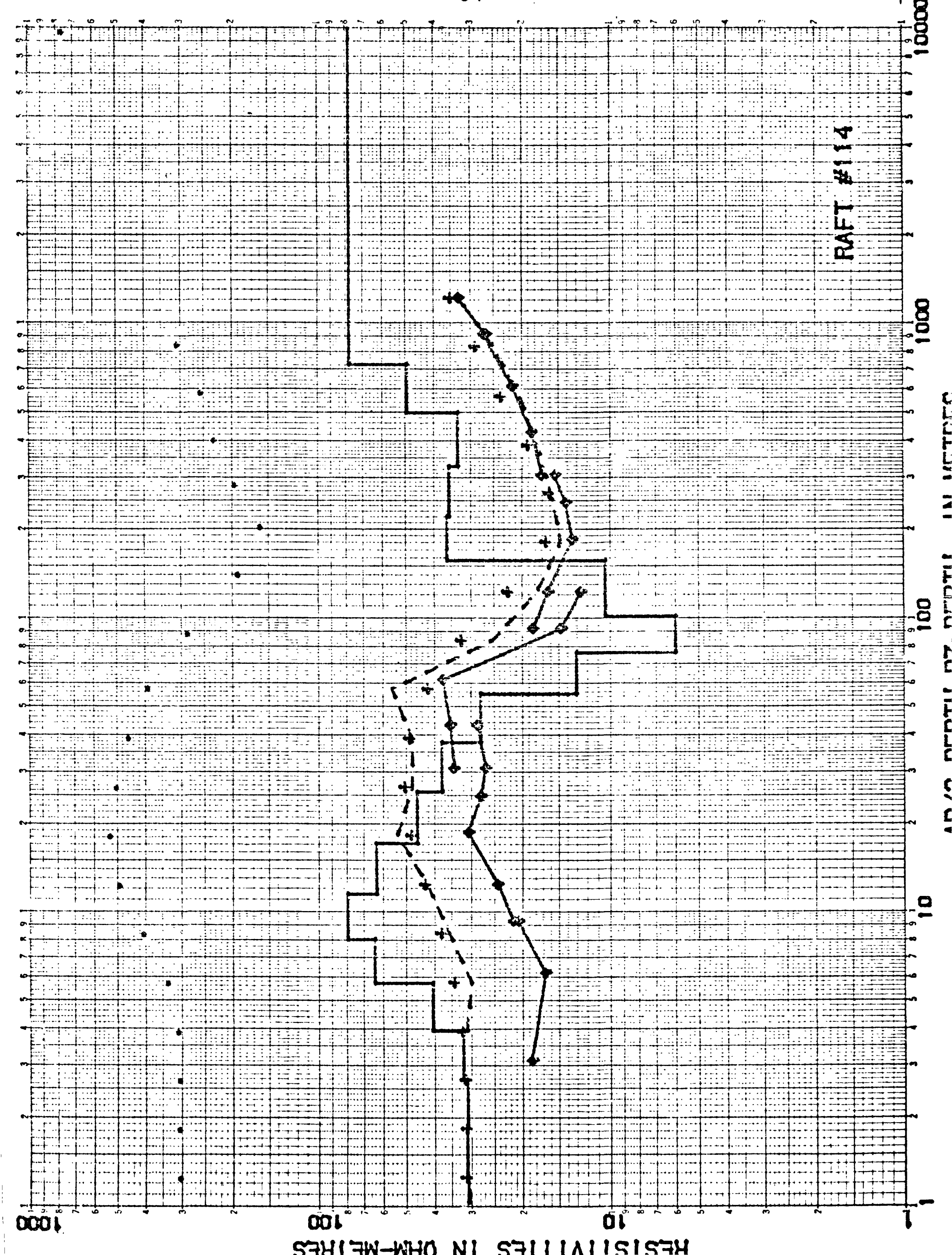

RESISTIVITIES IN OHM-METRES
1000
100
10
1
1
10
100
1000
10000
AB/2 DEPTH, D7-DEPTH IN METRES
RAFT #109

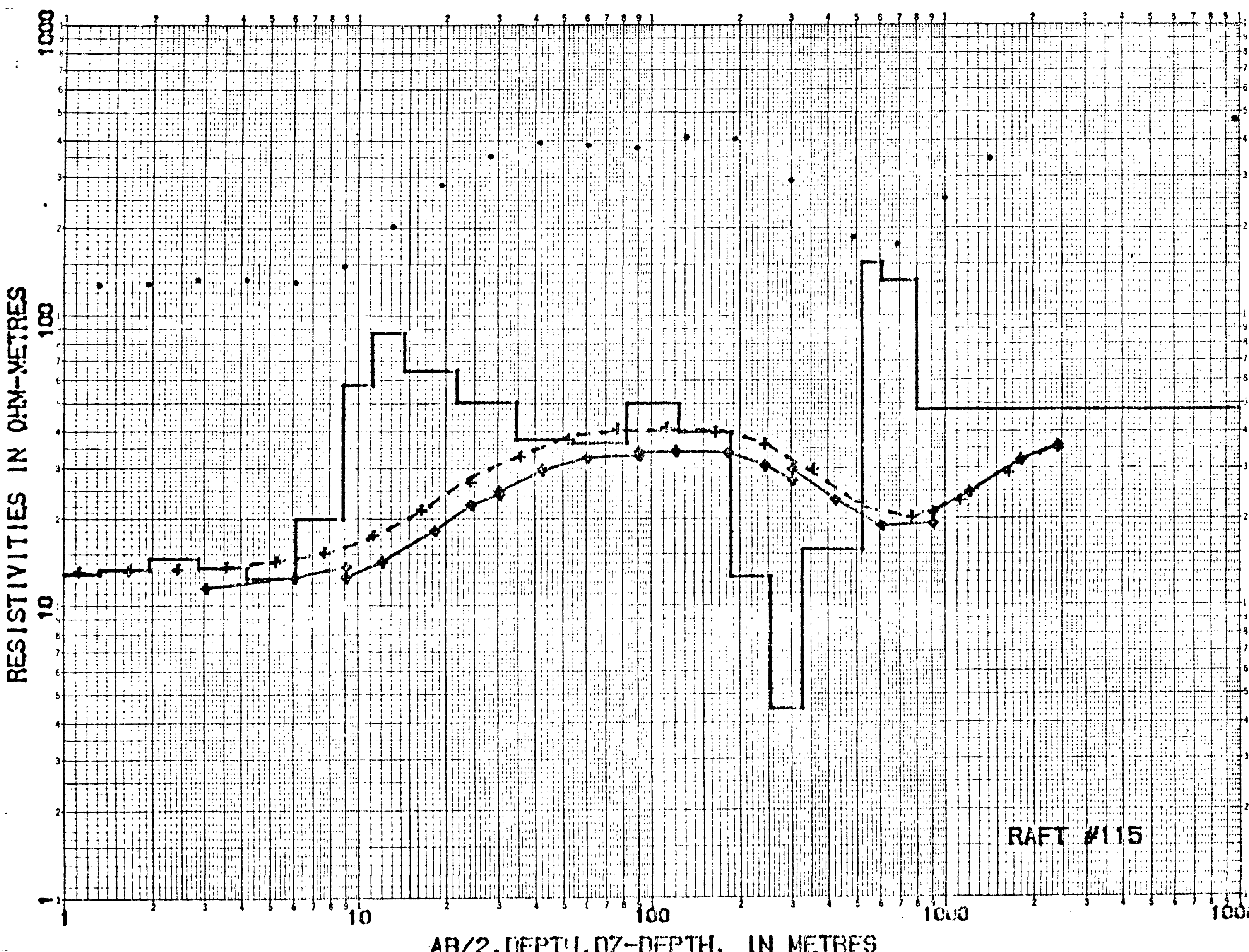

RAFT #110
RESISTIVITIES IN OHM-METRES
AB/2 DEPTH DZ-DEPTH, IN METRES
1
10
100
1000
10000

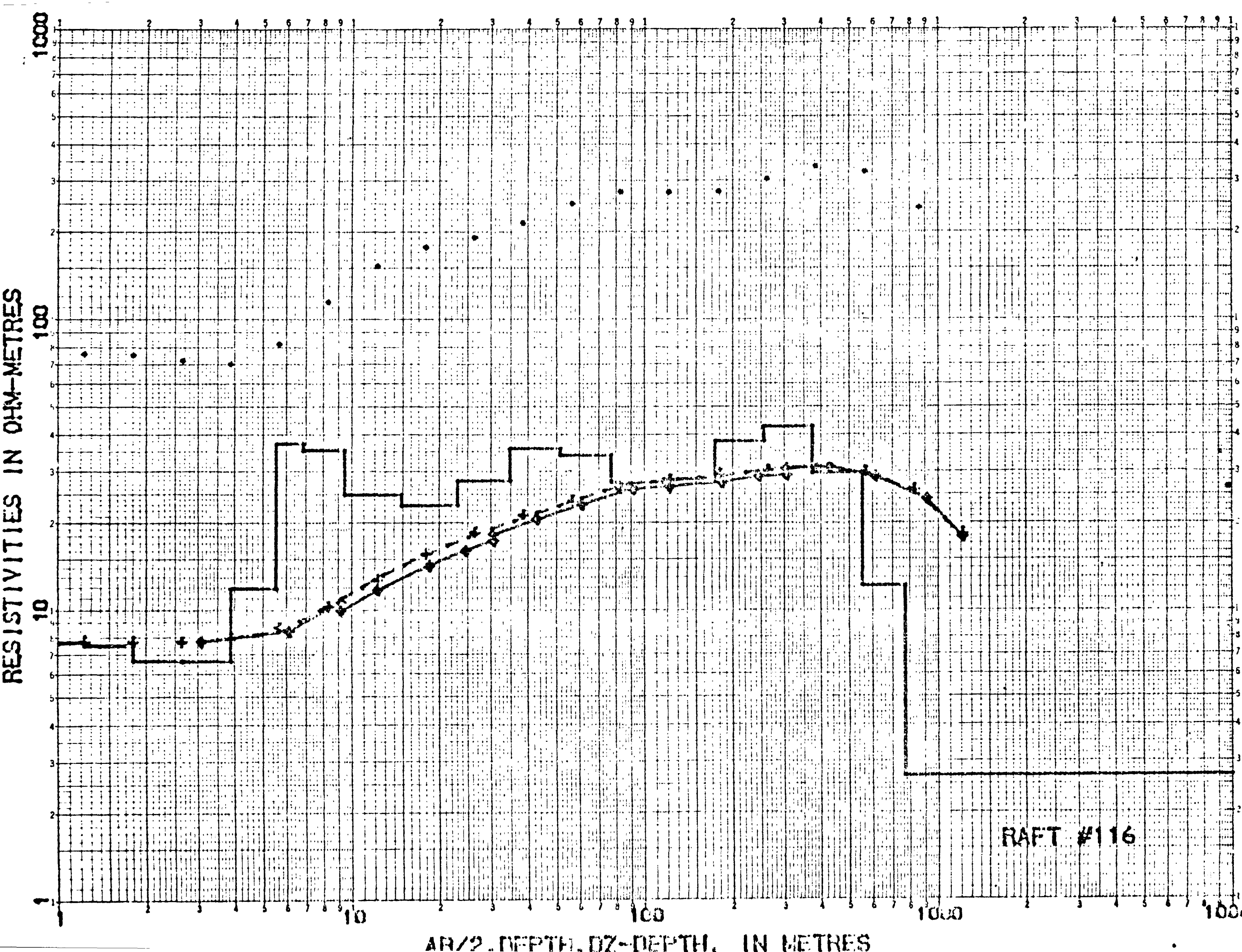

RAFT #111
RESISTIVITIES IN OHM-METRES
1
10
100
1000
AB/2, DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
10000

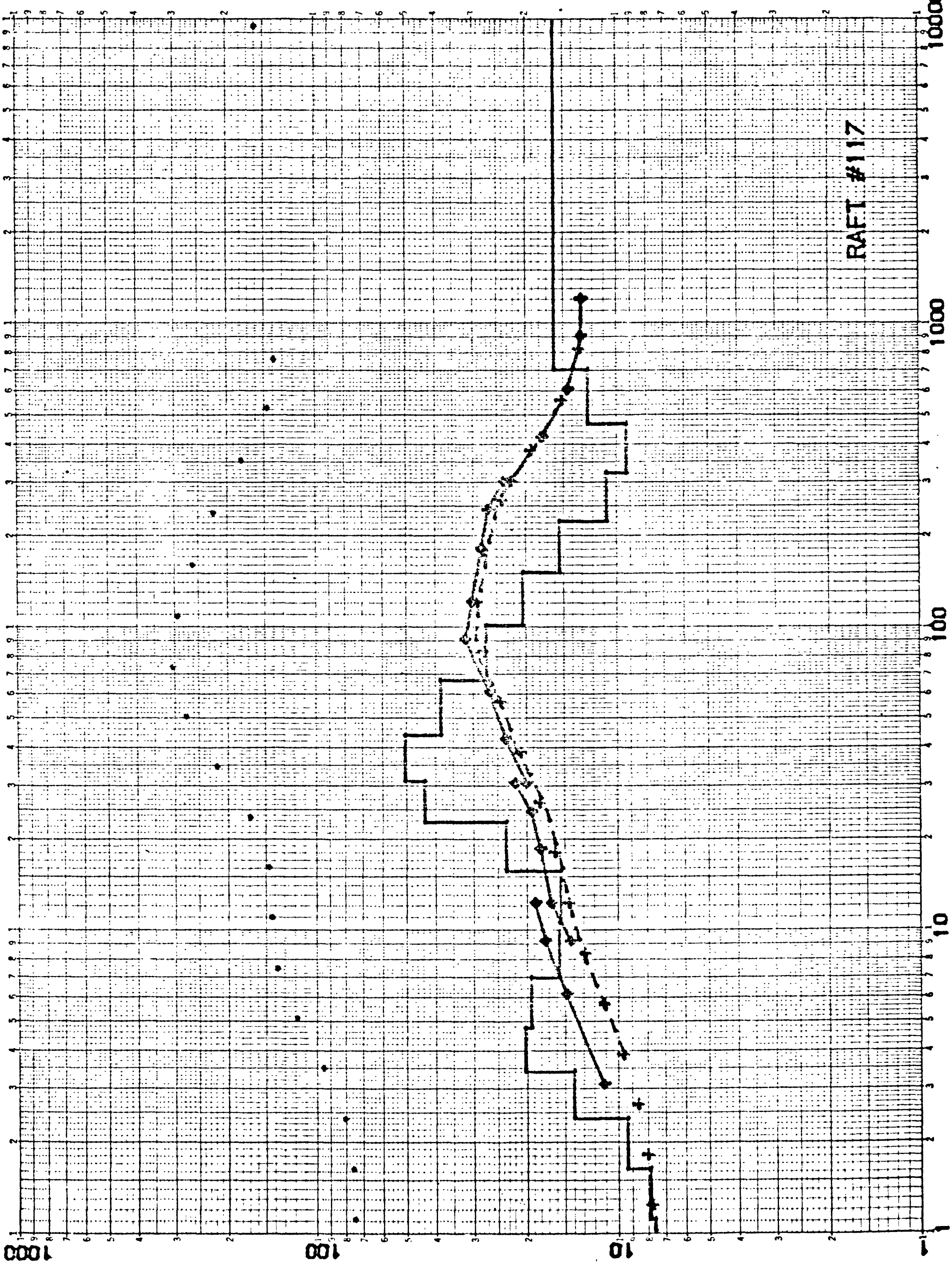

RAFT #112
AB/2 DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
10000
1000
100
10
1
GPO 835-846

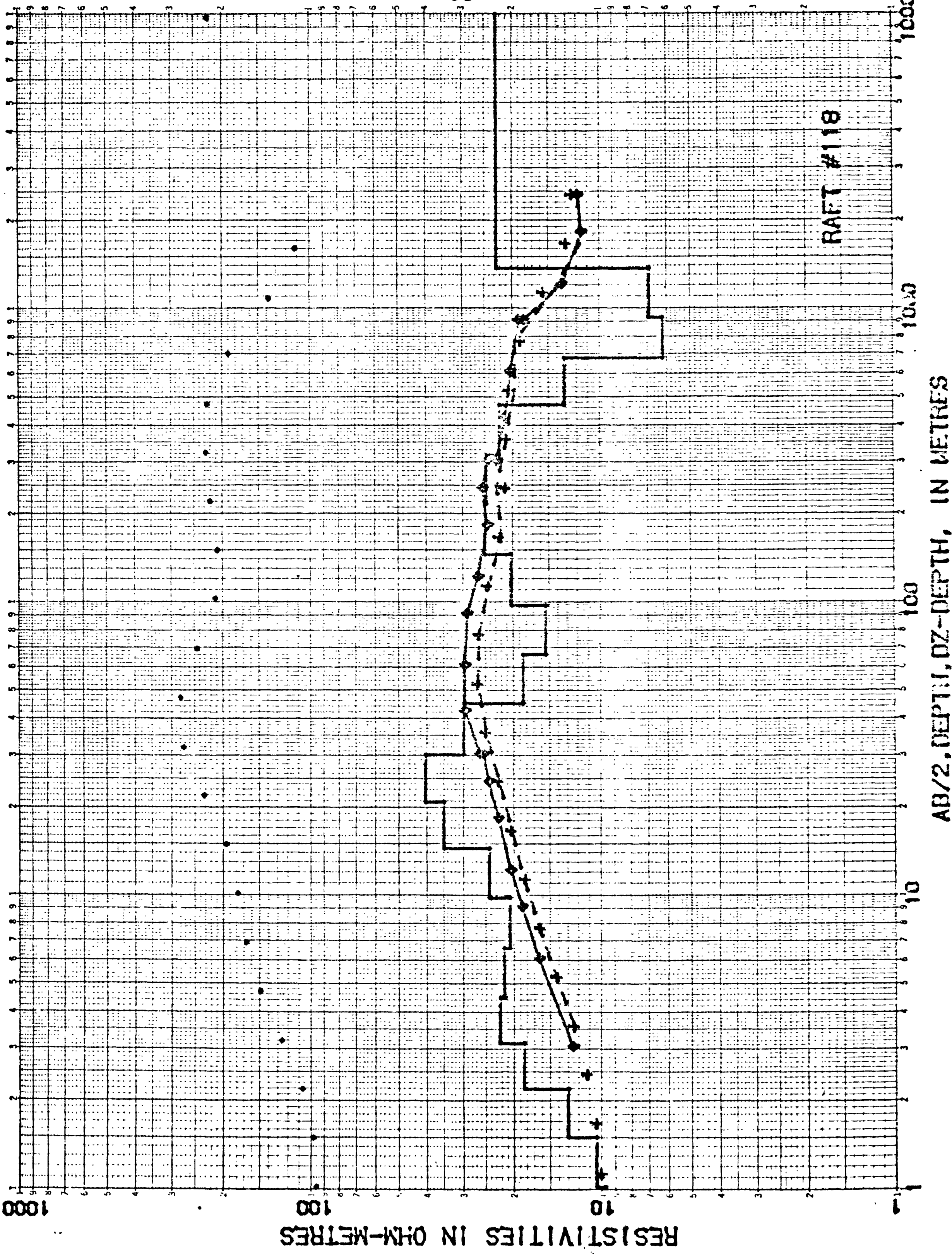

RAFT #113
AB/2 DEPTH IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
1000
100
10
1

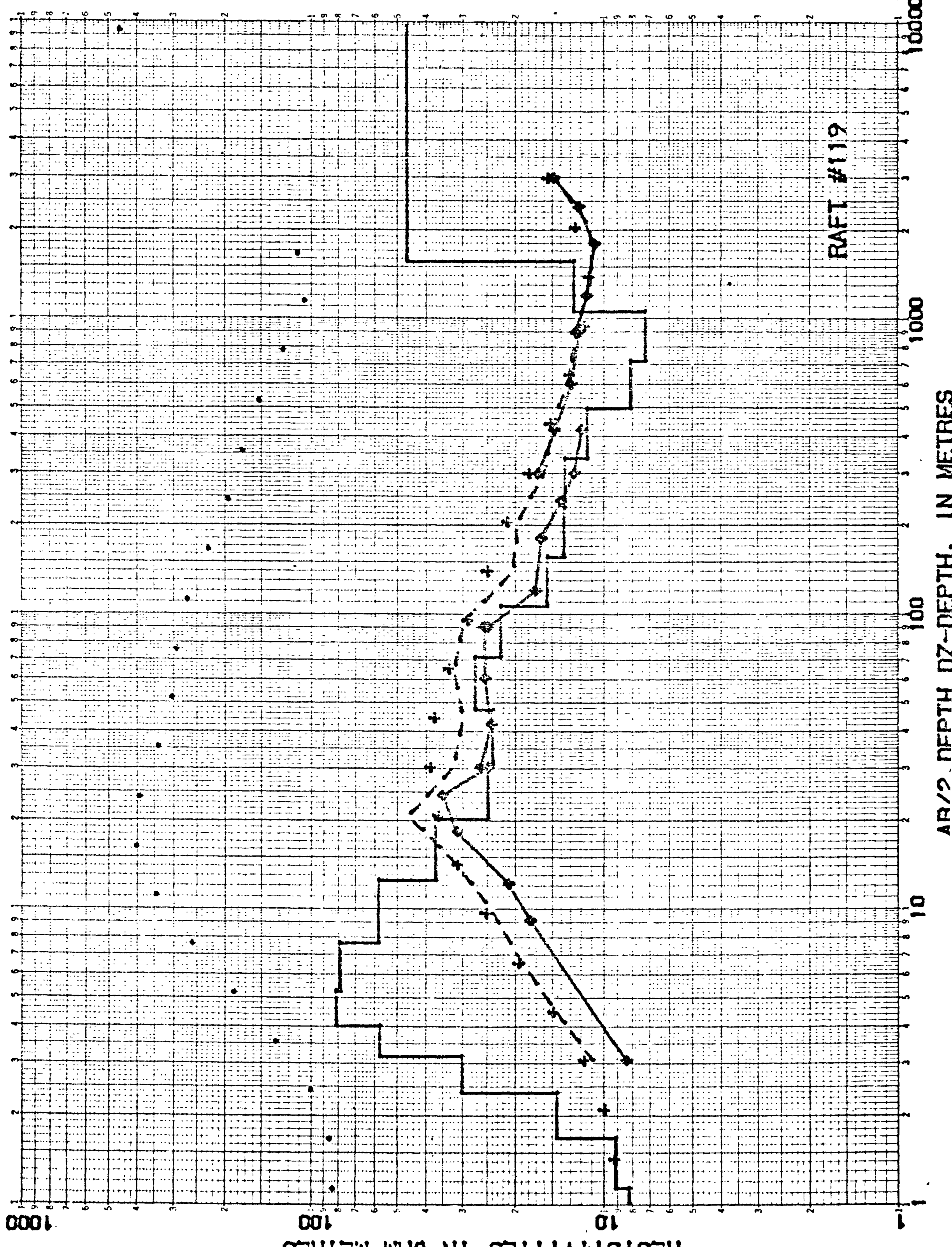

RAFT #114
1
10
100
1000
10000
AB/2 DEPTH OR DEPTH IN METERS
1000
100
10
1
RESISTIVITIES IN OHM-METRES
GPO 835-846

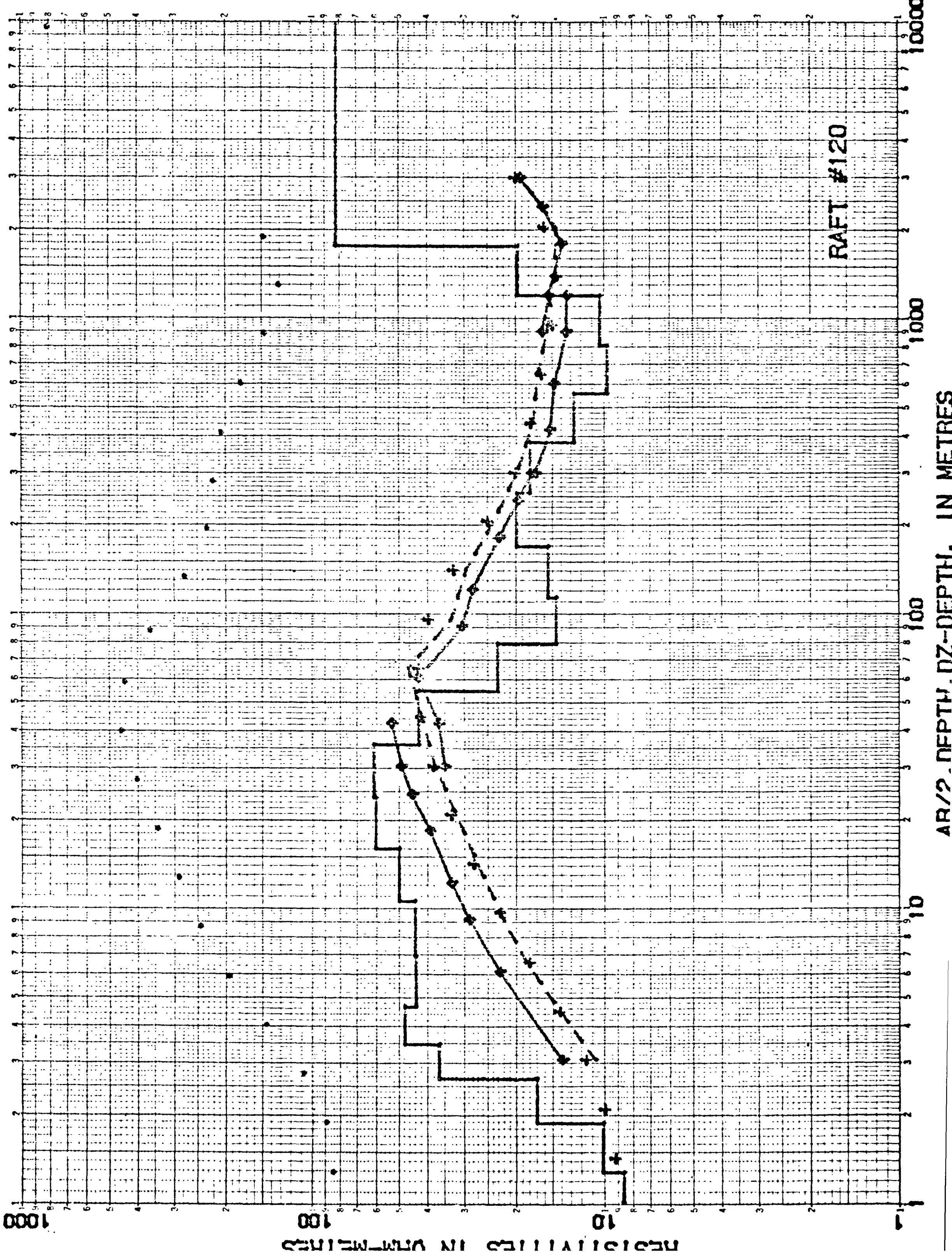

RAFT #115
RESISTIVITIES IN OHM-METRES
1000
100
10
1
1
10
100
1000
10000
AB/2,DEPTH,DZ-DEPTH, IN METRES

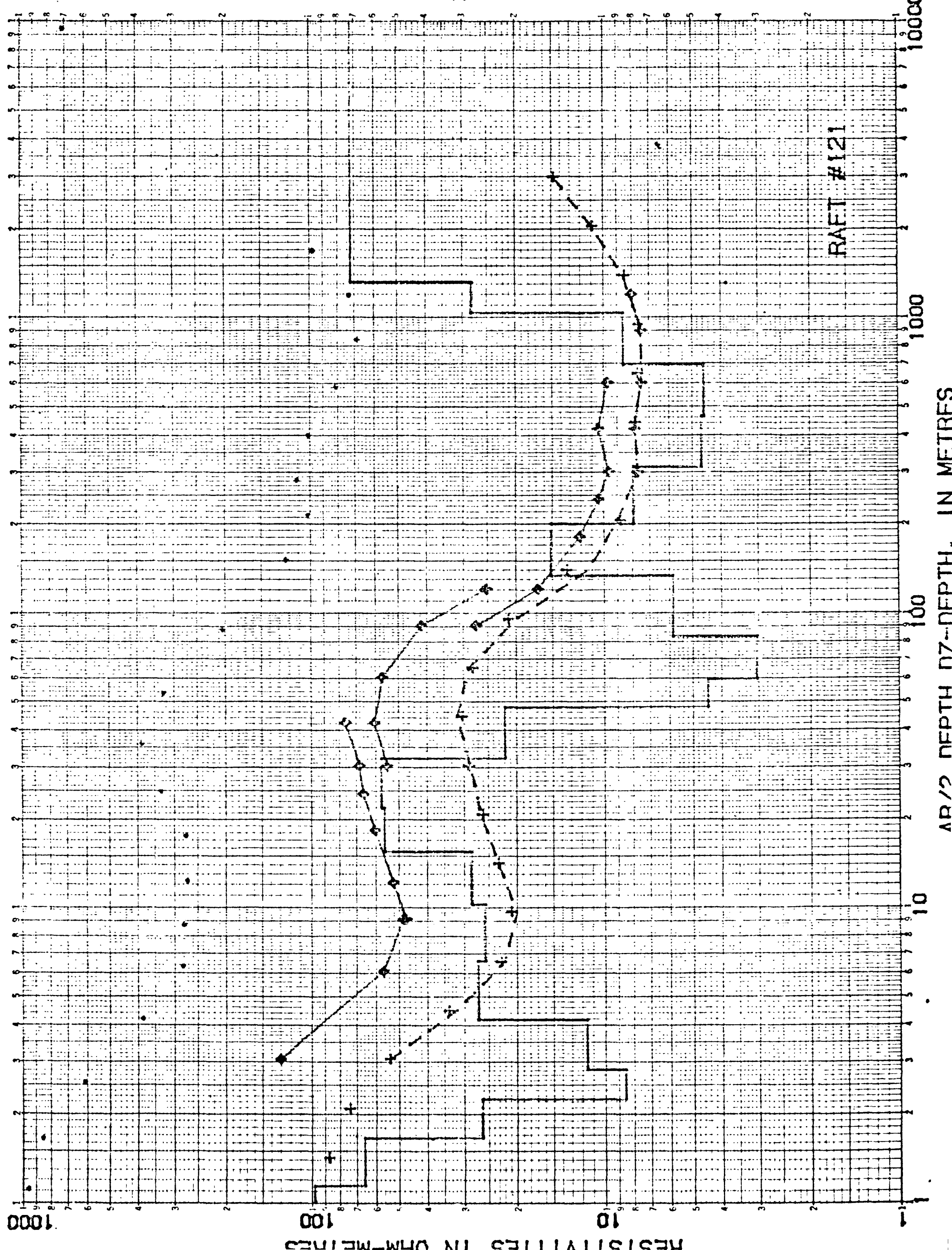

RESISTIVITIES IN OHM-METRES
1000
100
10
1
AB/2, DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
10000
RAFT #116

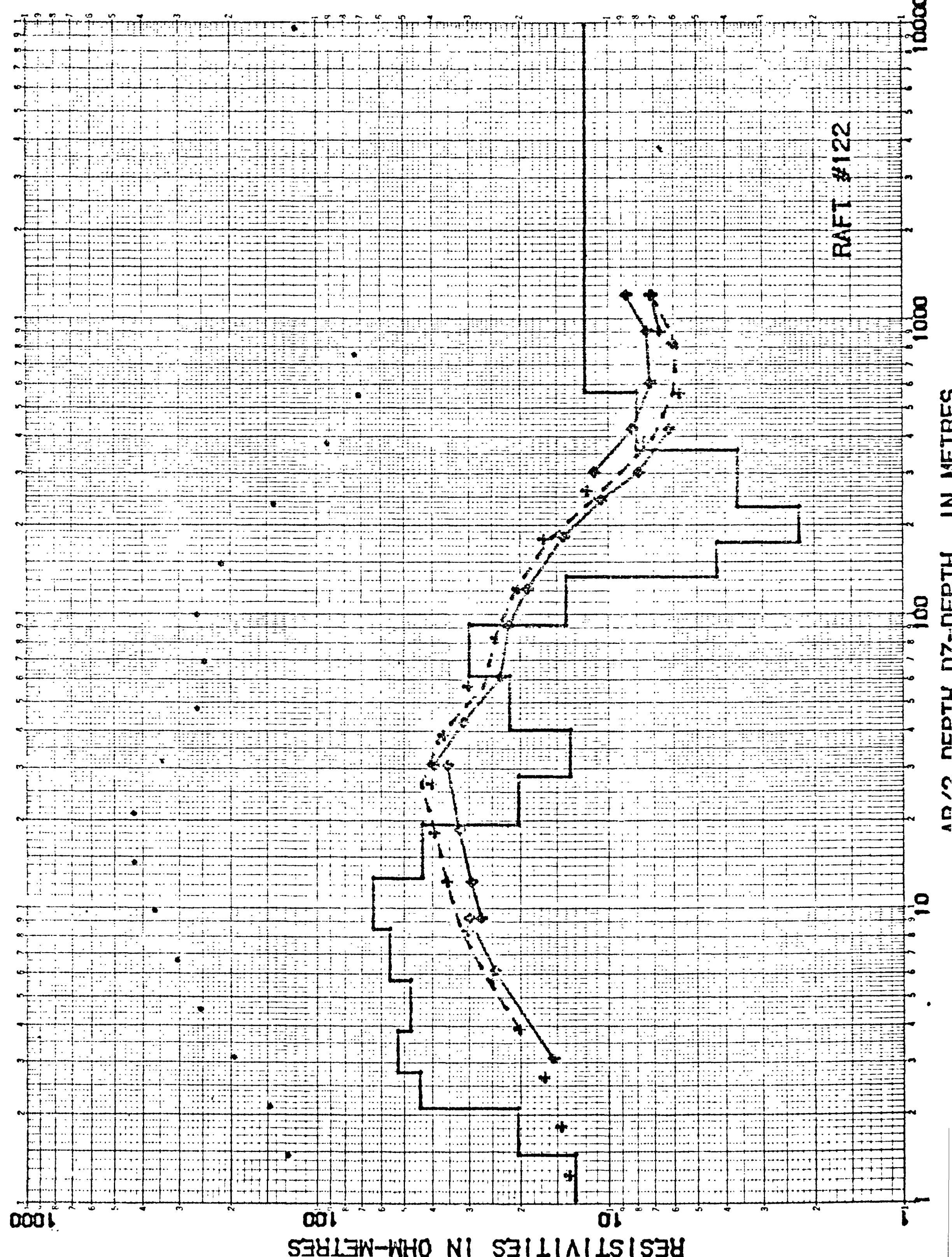

RAFT #117
1000
100
10
1
10
100
1000
10000
RESISTIVITIES IN OHM-METRES
GPO 838-846

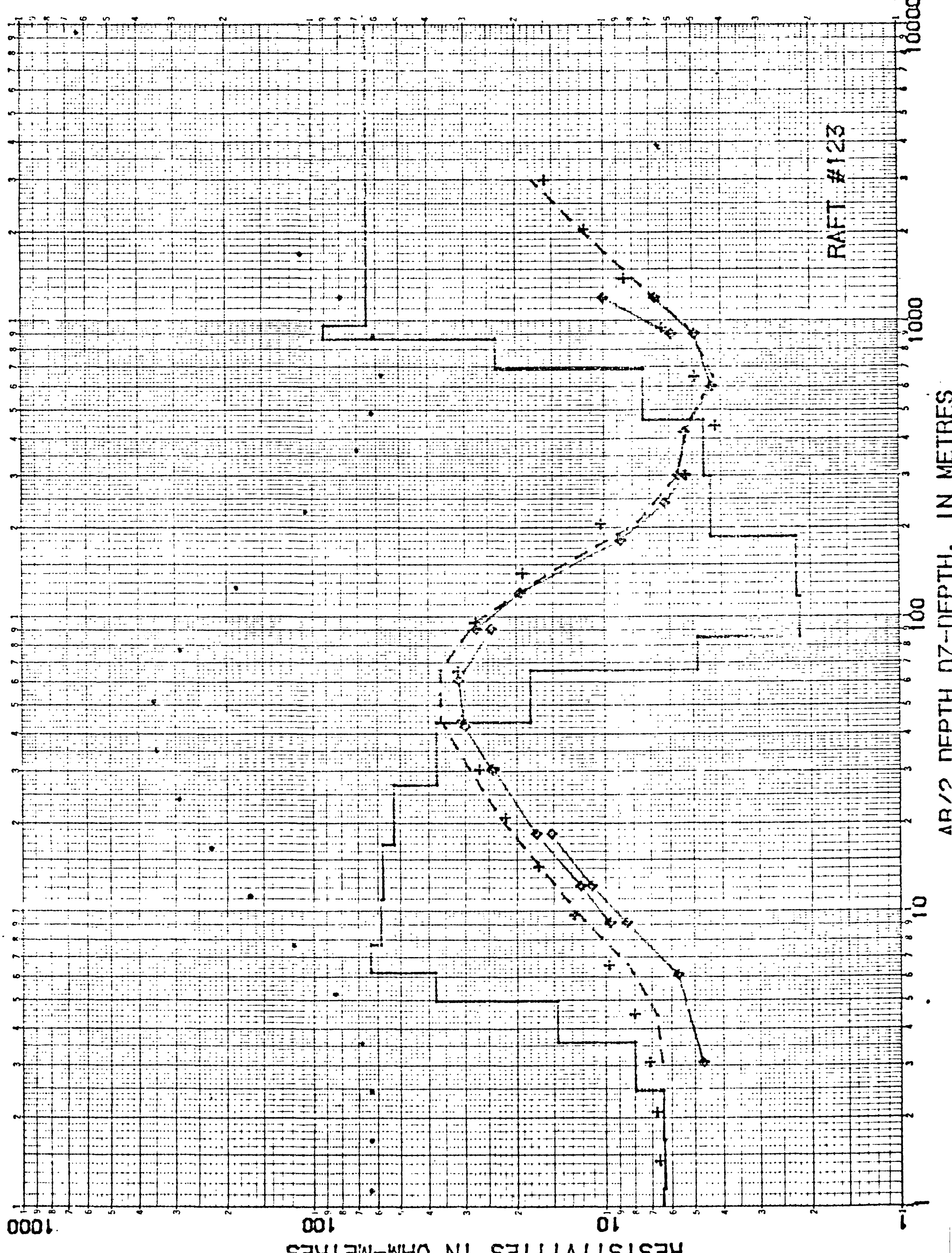

RAFT #118
AB/2, DEPTH, DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
1
10
100
1000

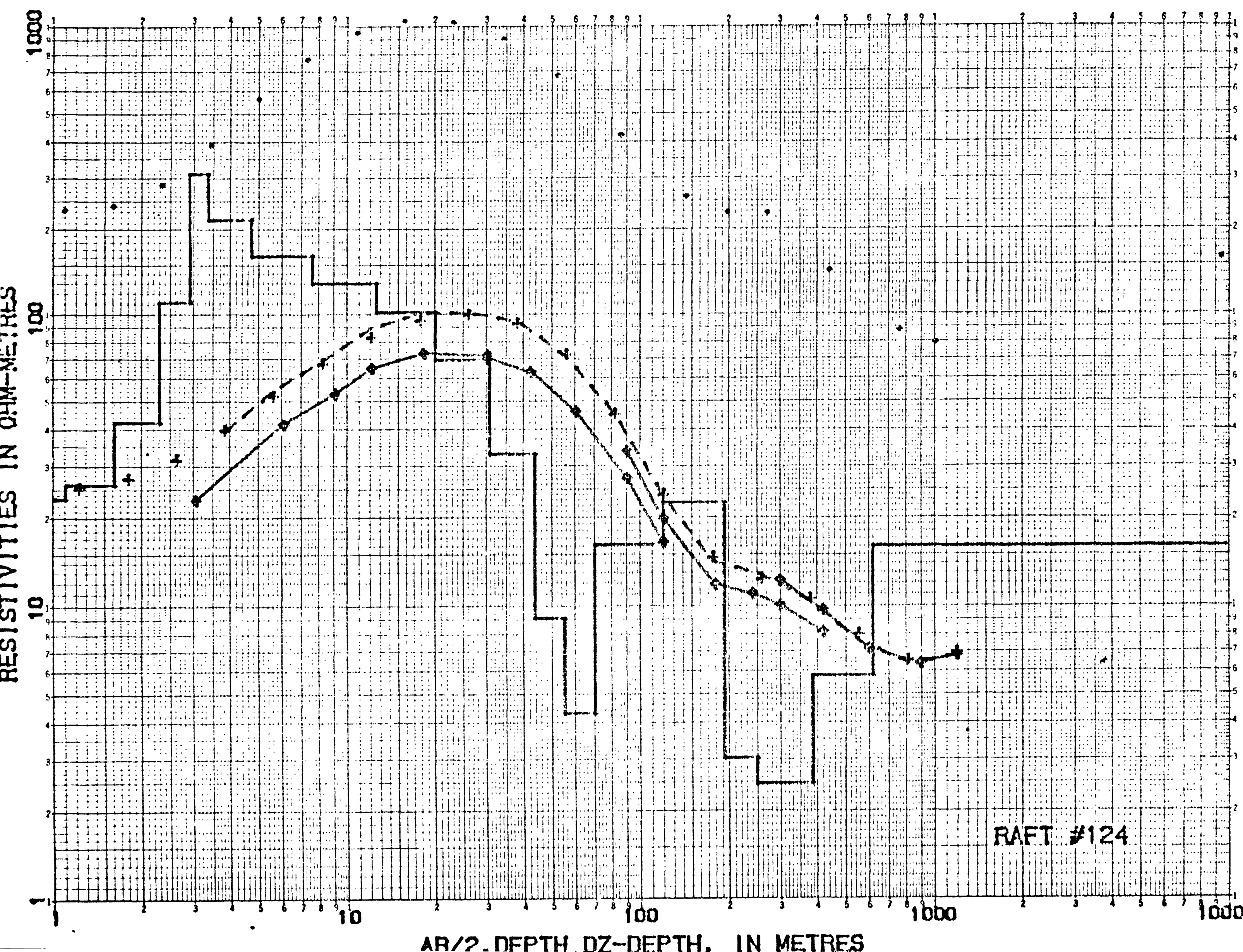

RAFT #119
AB/2 DEPTH DZ-DEPTH, IN METRES
1
10
100
1000
10000
10
100
1000

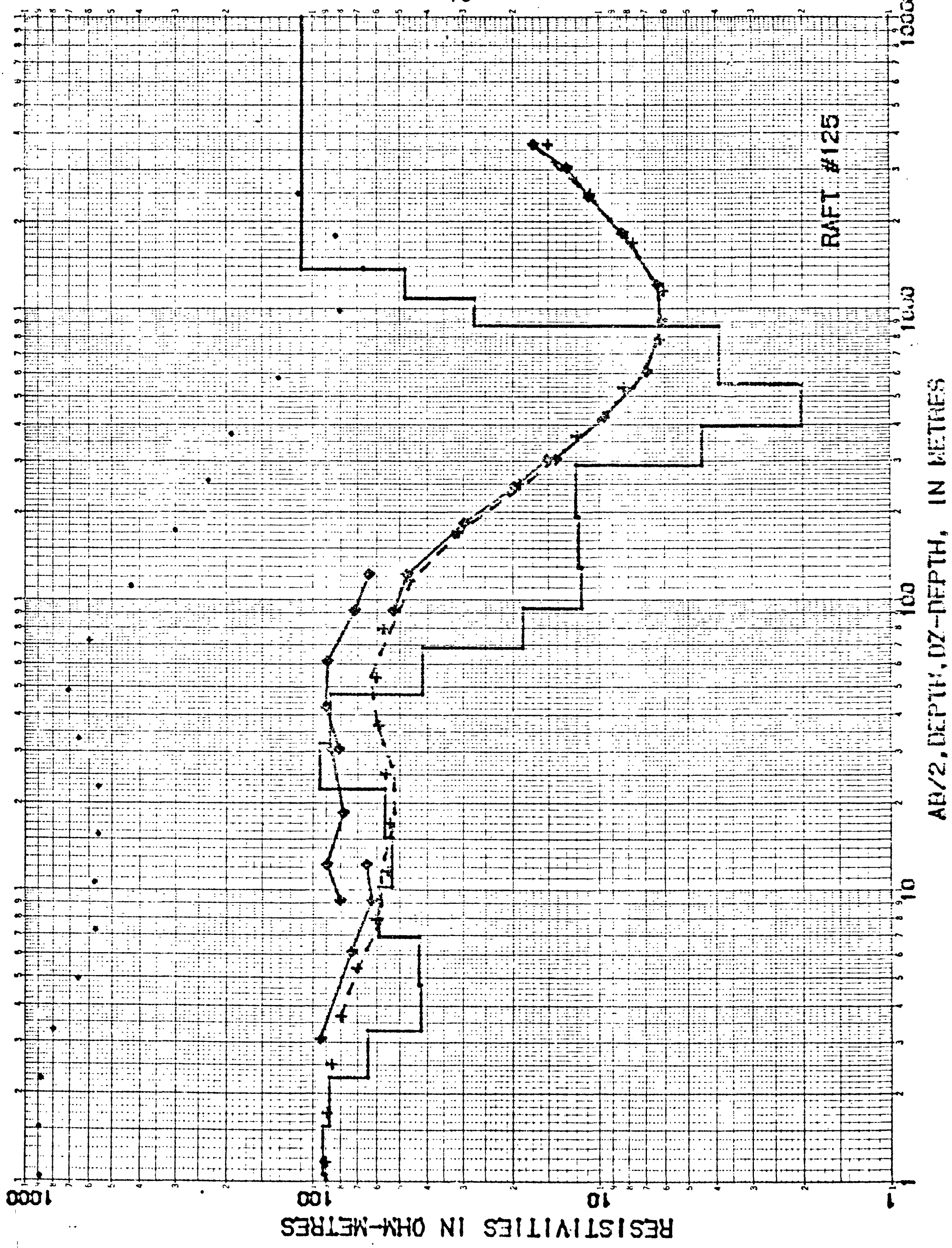

RAFT #120
AB/2, DEPTH, DZ--DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
1000
100
10
1
GPO 835-846

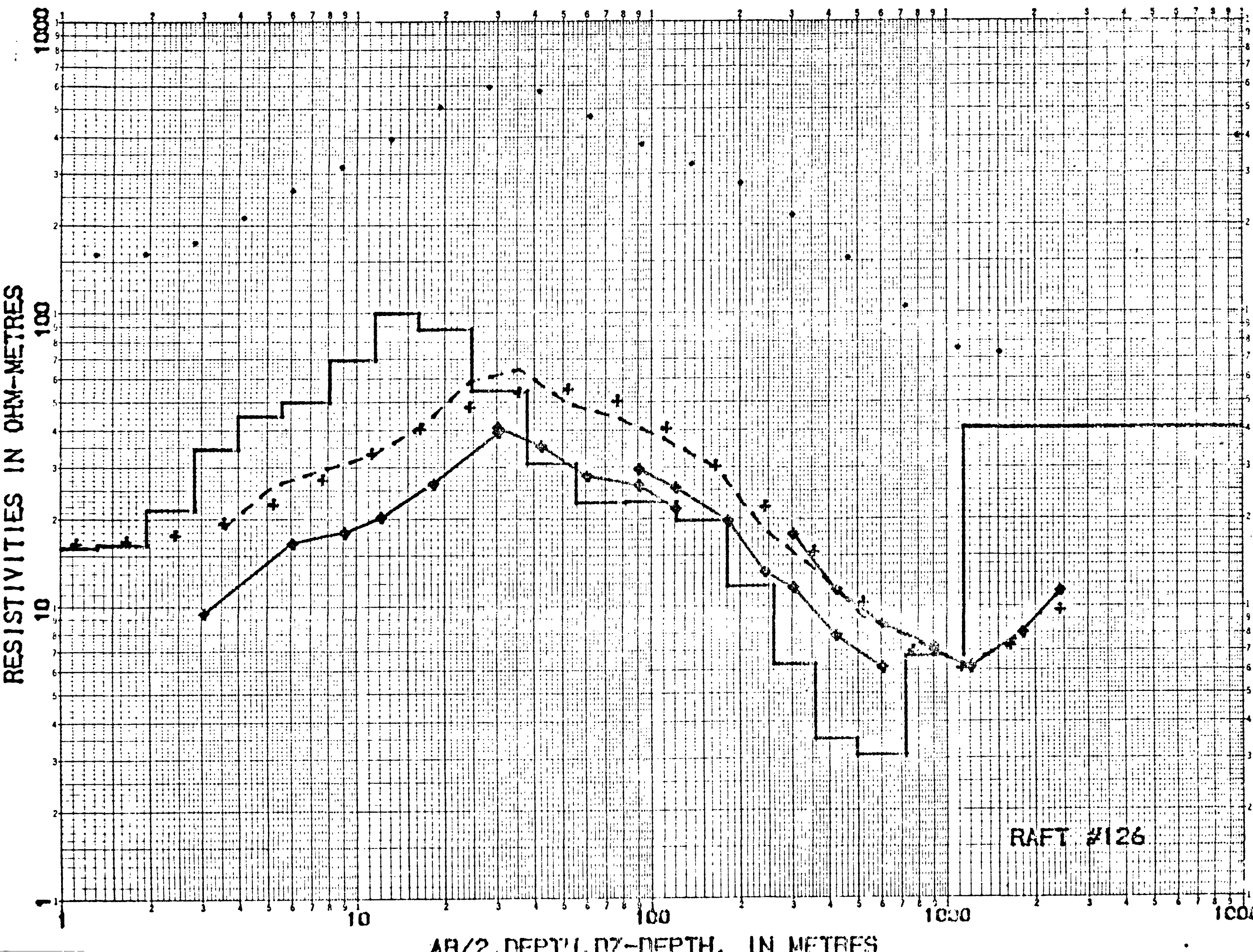

GPO 835-846
RAFT #121
AB/2 DEPTH DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000

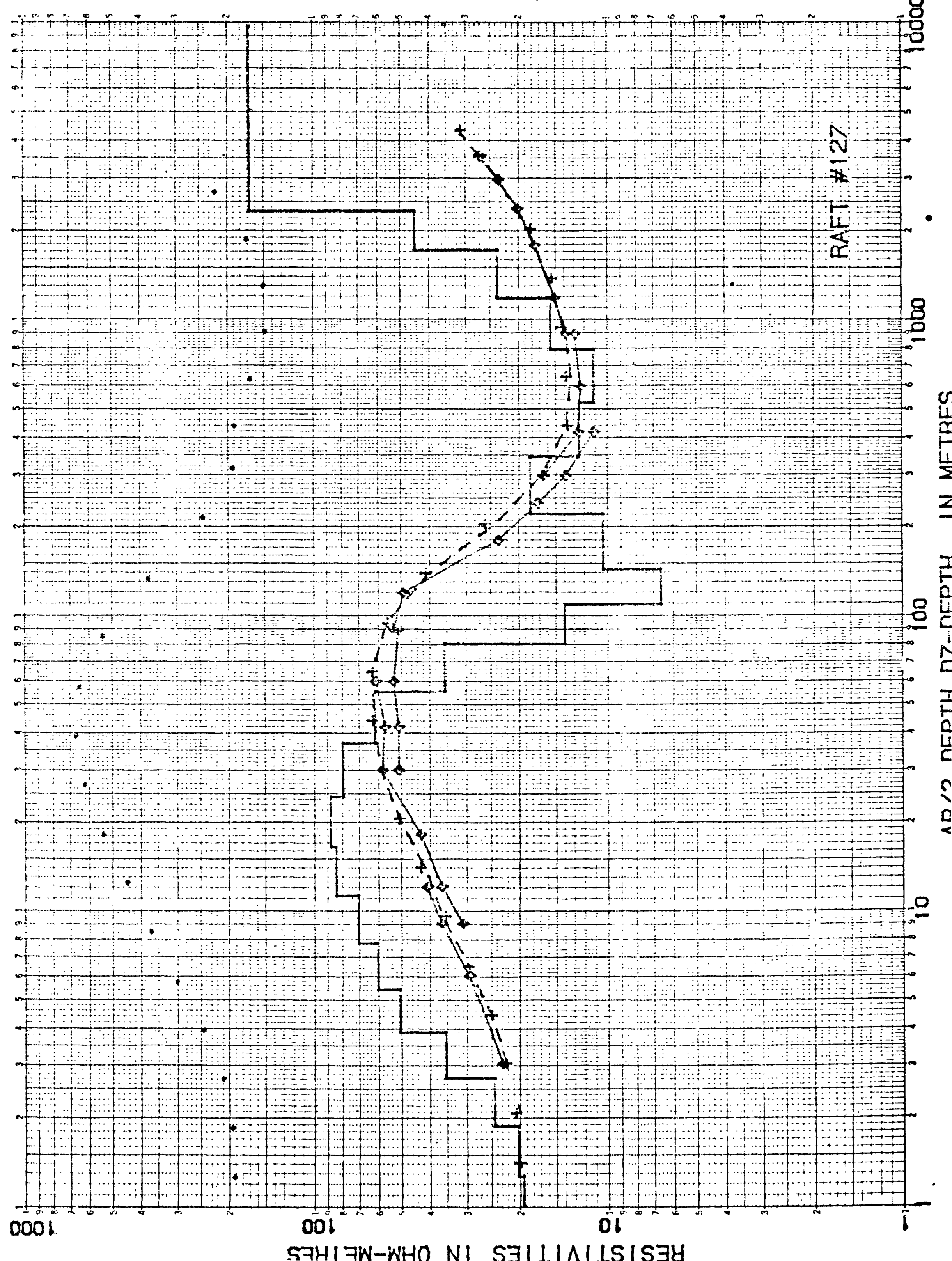

RAFT #122
AB/2 DEPTH DZ-DEPTH IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
1000
100
10
1
GPO 835-846

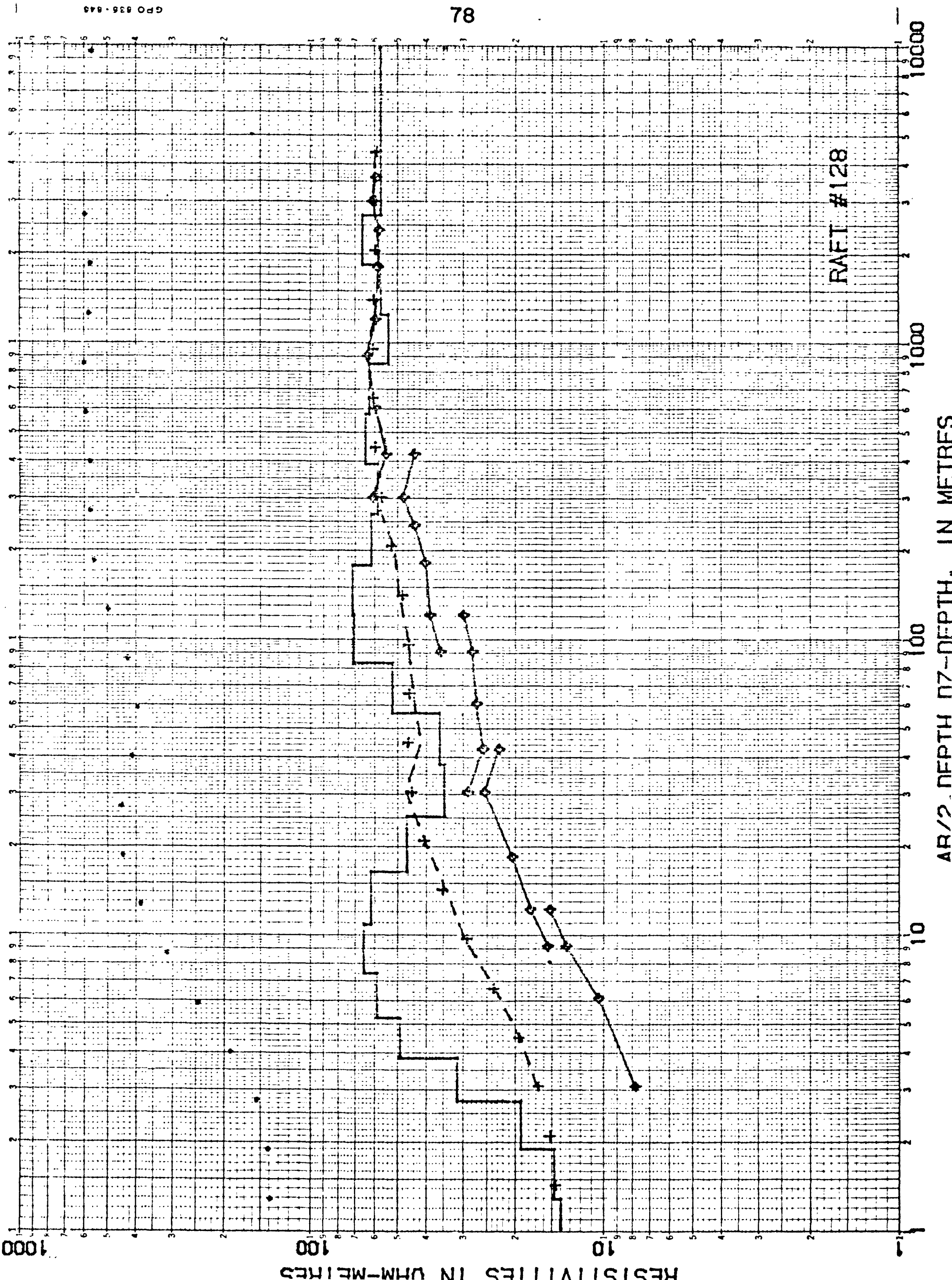

GPO 835-848
RAFT #123
AB/2 DEPTH OZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000

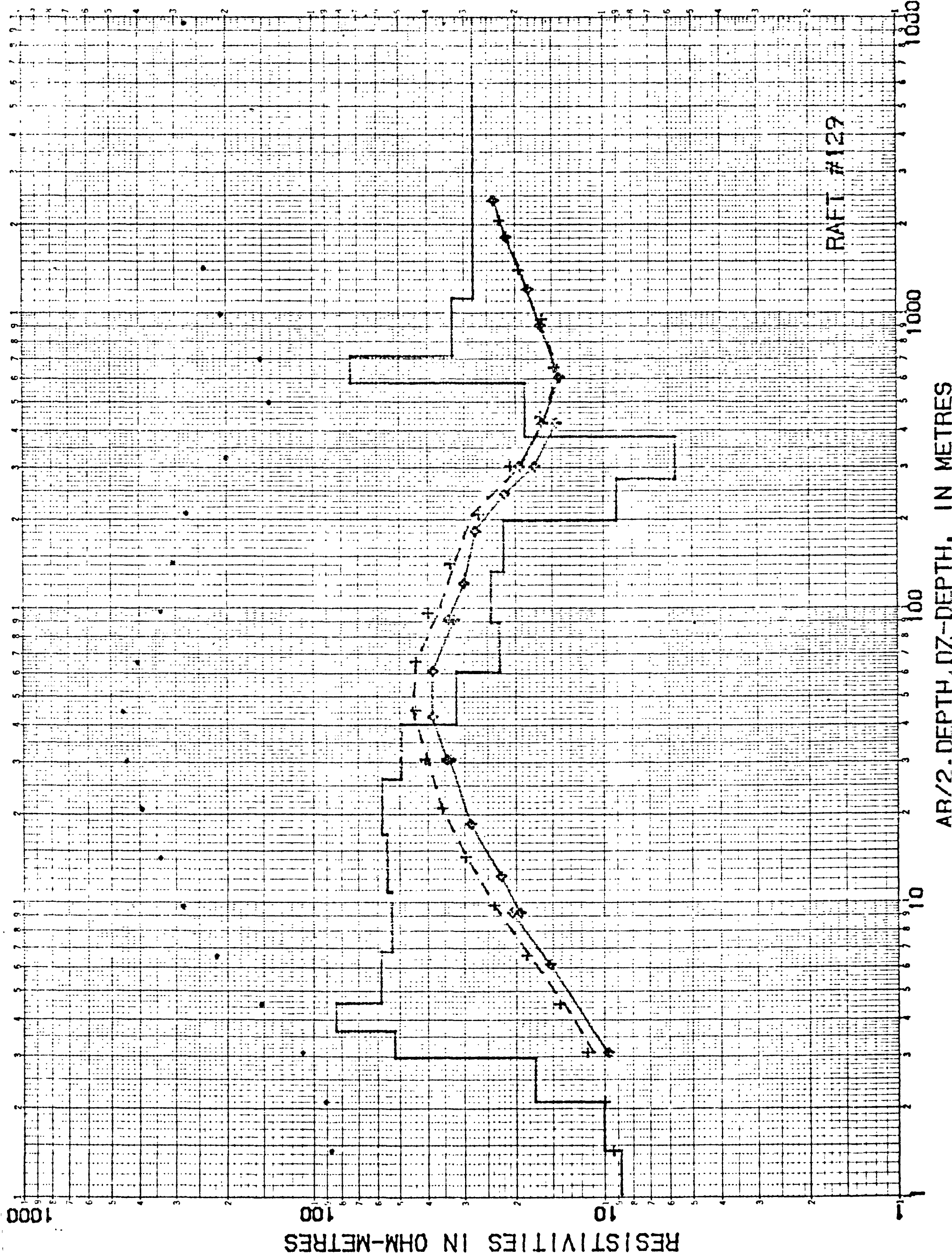

RAFT #124
RESISTIVITIES IN OHM-METRES
AB/2-DEPTH DZ-DEPTH, IN METRES
1
10
100
1000
10000

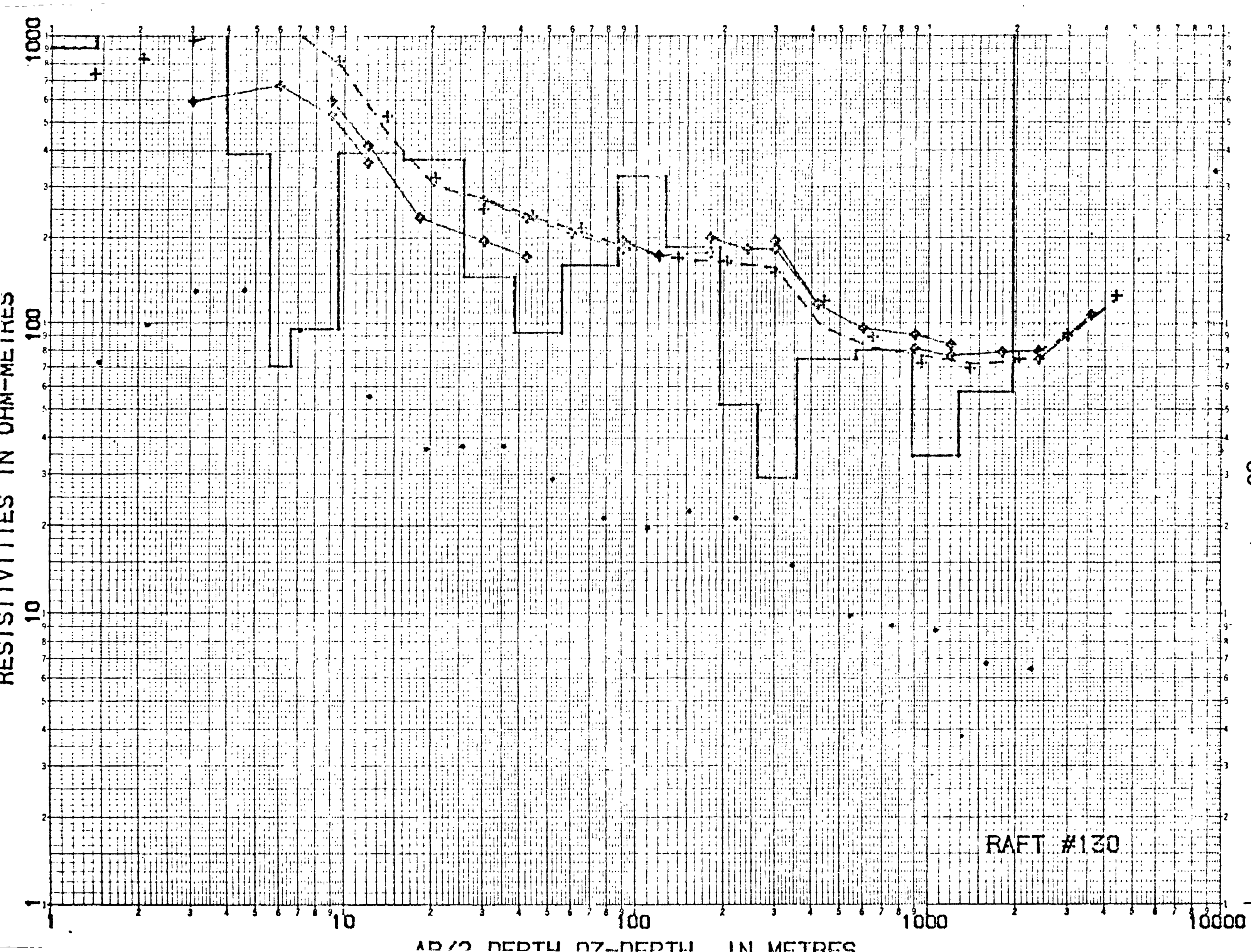

RAFT #125
AB/2, DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
10000
RESISTIVITIES IN OHM-METRES
1000
100
10
1

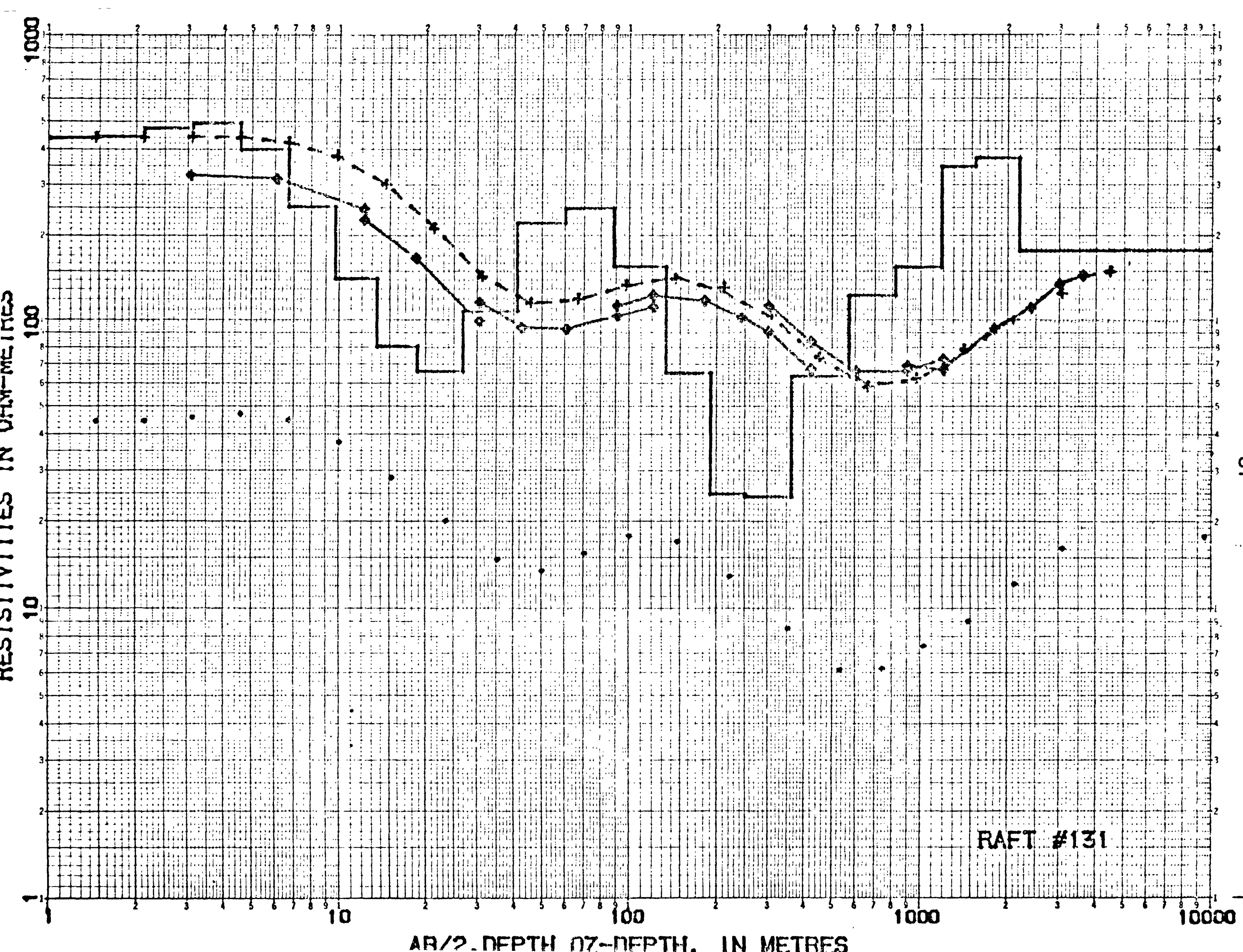

RAFT #126
RESISTIVITIES IN OHM-METRES
AB/2 DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
10000
1
10
100
1000

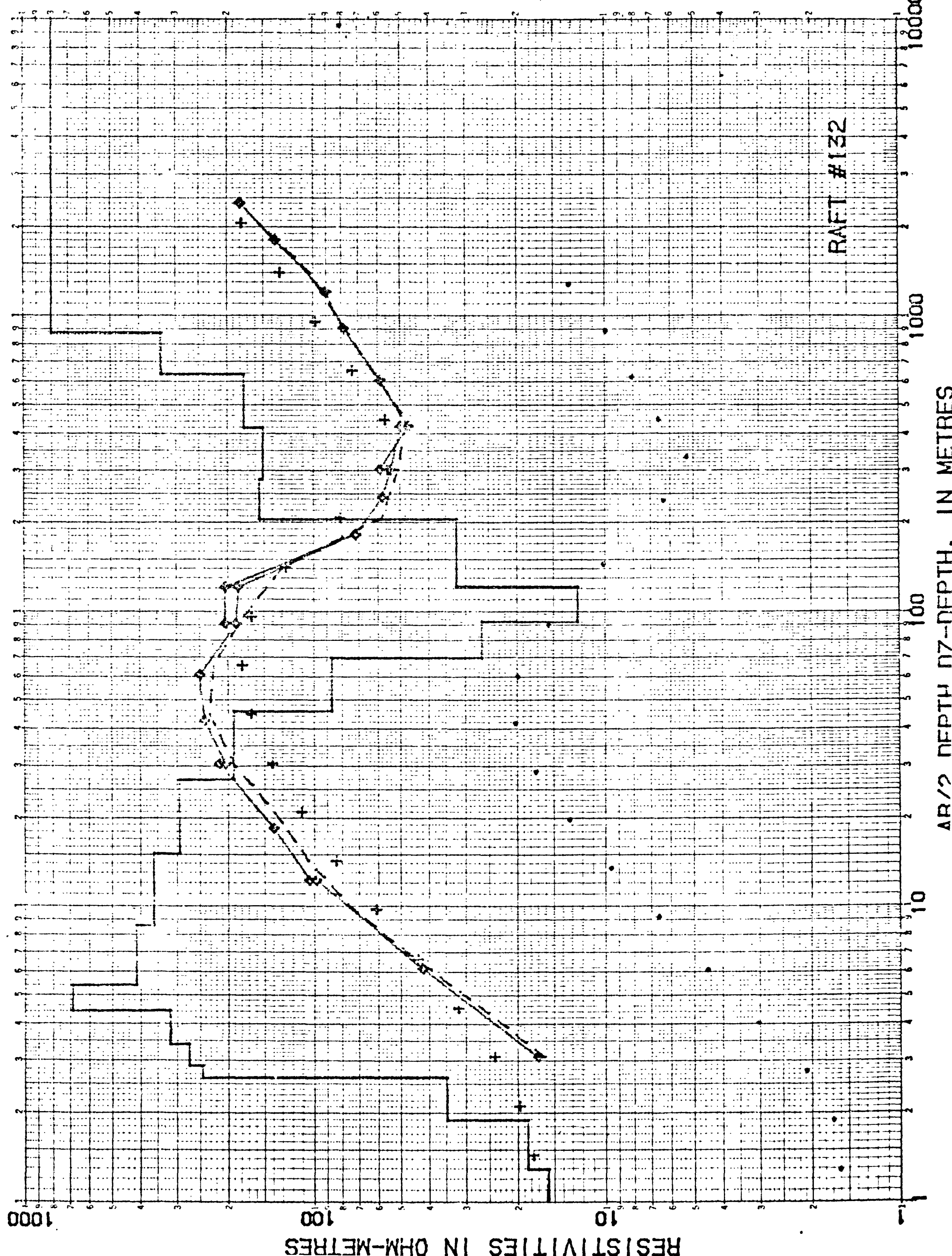

RAFT #127
AB/2 DEPTH DZ-DEPTH IN METRES
RESISTIVITIES IN OHM-METRES
1000
100
10
1
10
100
1000
10000
GPO 838-846

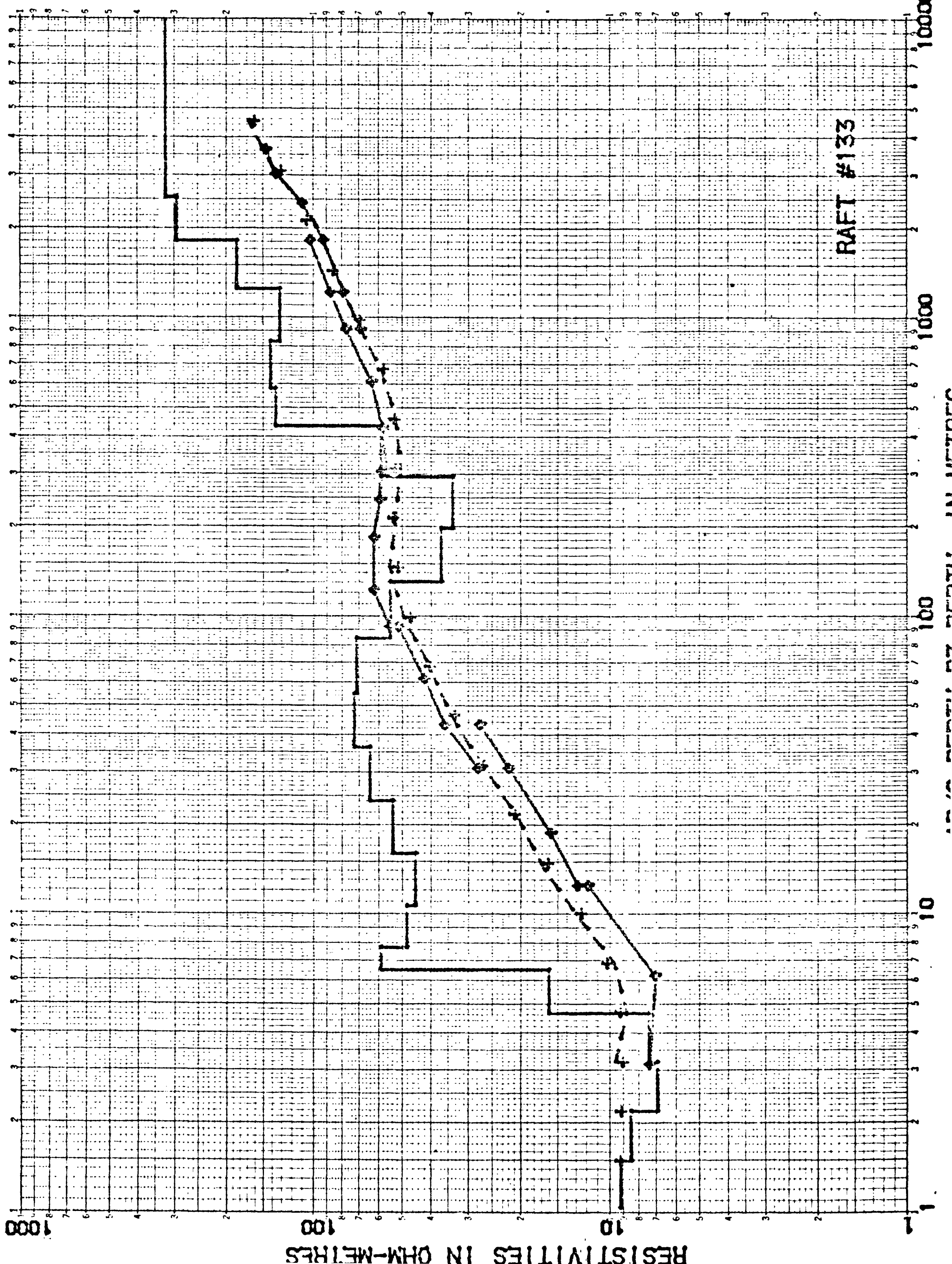

RAFT #128
AB/2 DEPTH DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
GPO 835-845

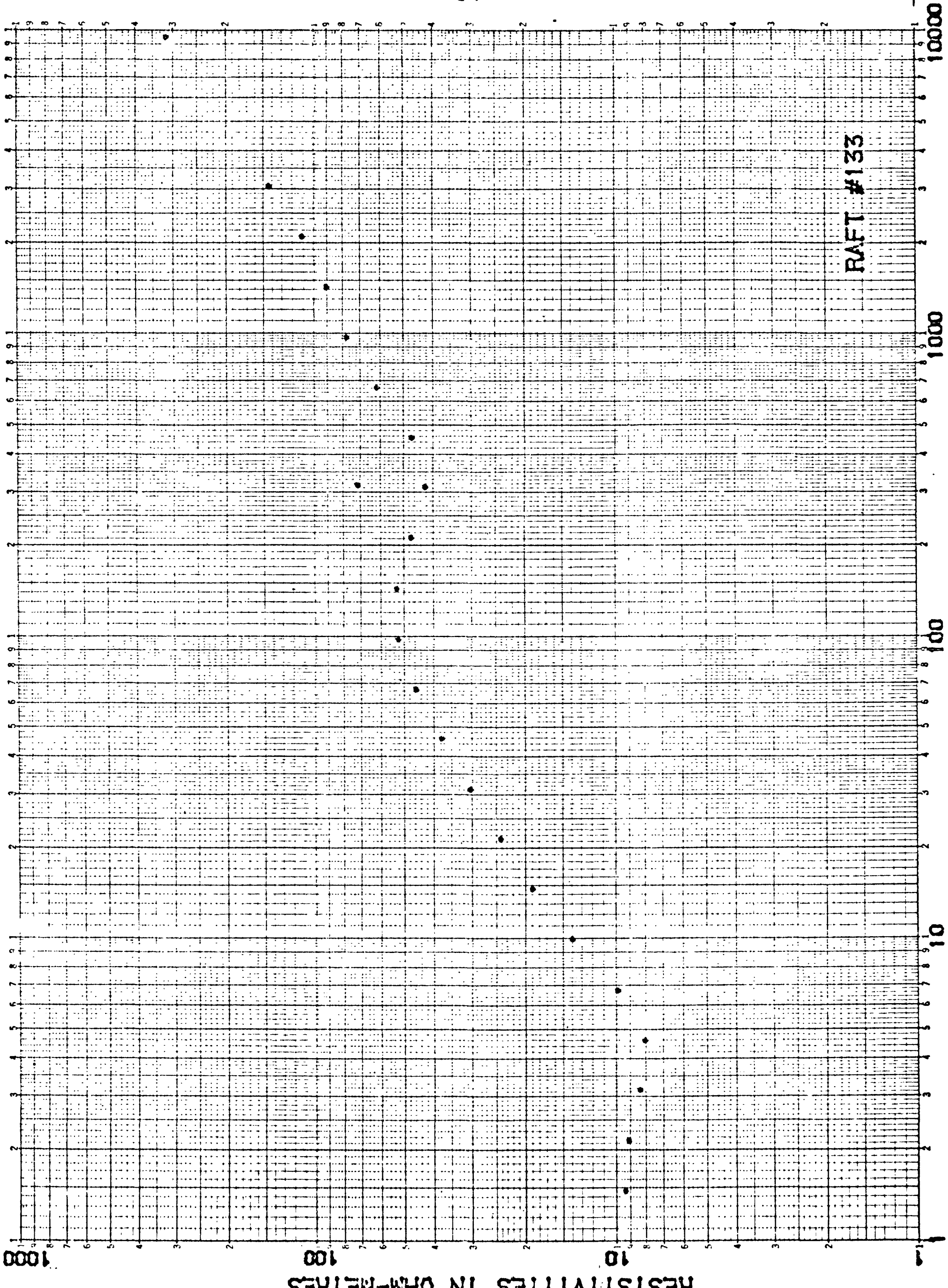

RAFT #129
AB/2, DEPTH, DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
GPO 835-846

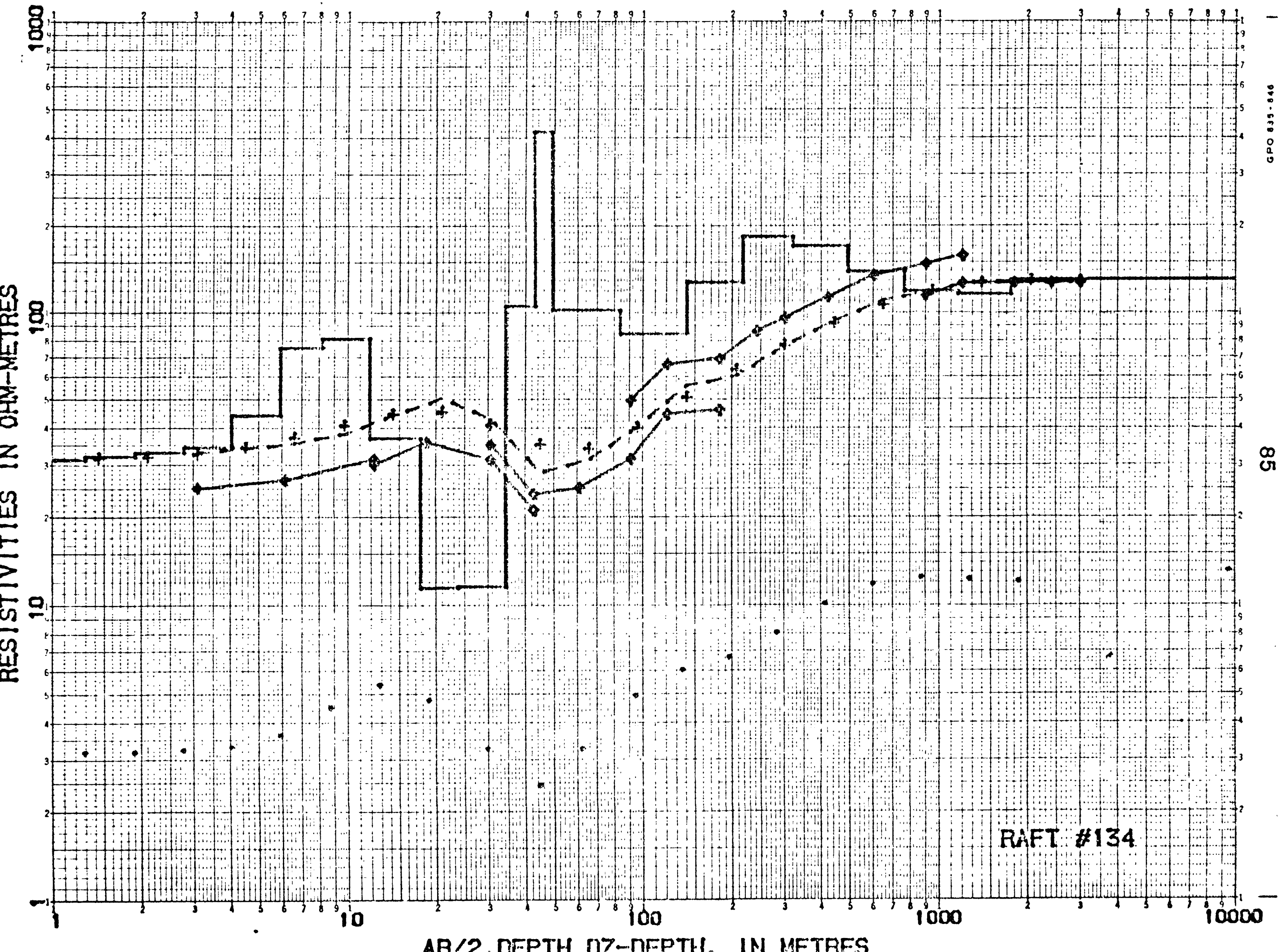

RAFT #130
RESISTIVITIES IN OHM-METRES
AB/2 DEPTH OZ-DEPTH IN METRES
1
10
100
1000
10000
GPO 835-845

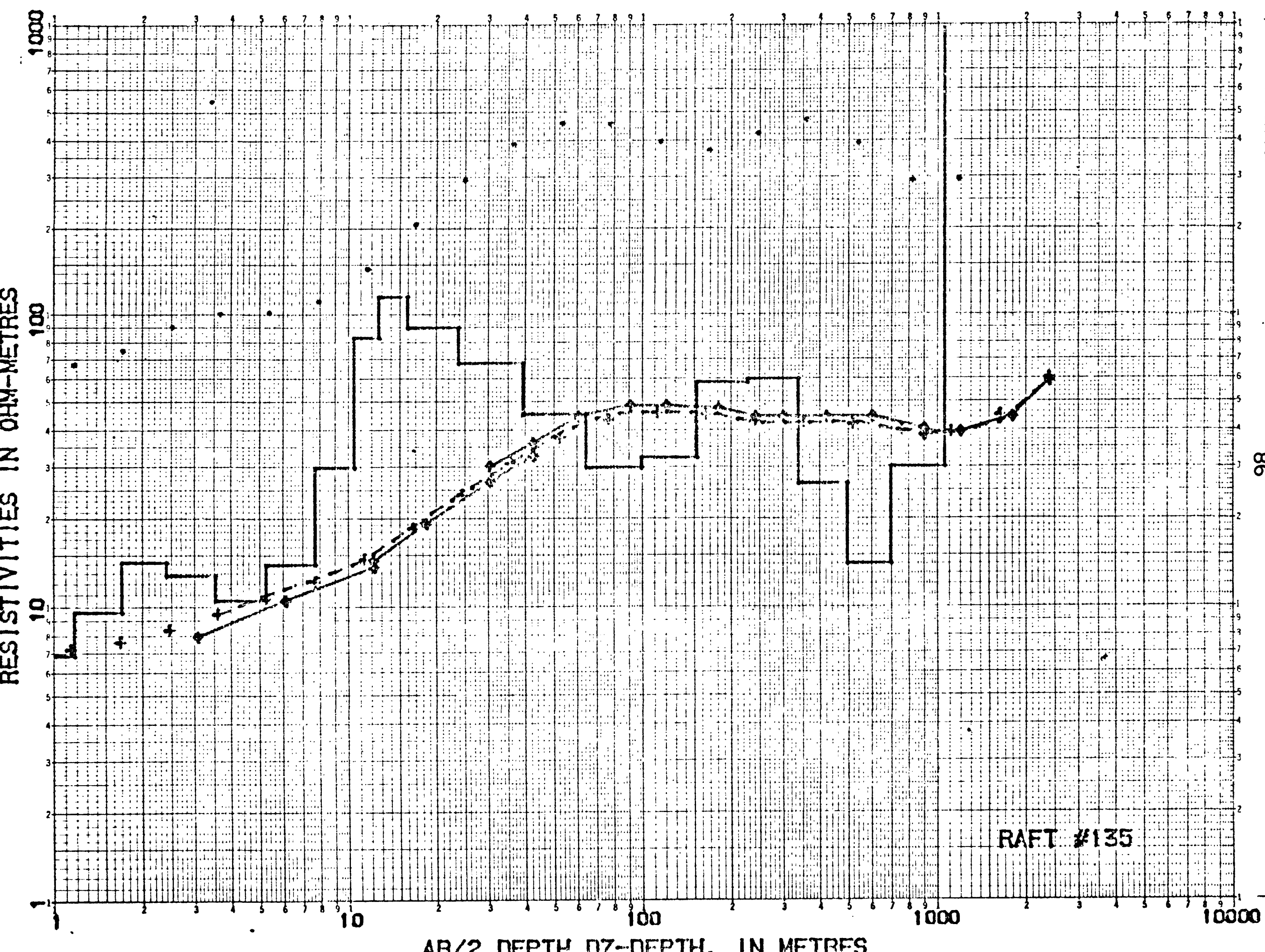

RESISTIVITIES IN OHM-METRES
1000
100
10
1
1
10
100
1000
10000
AB/2-DEPTH OZ-DEPTH, IN METRES
RAFT #131

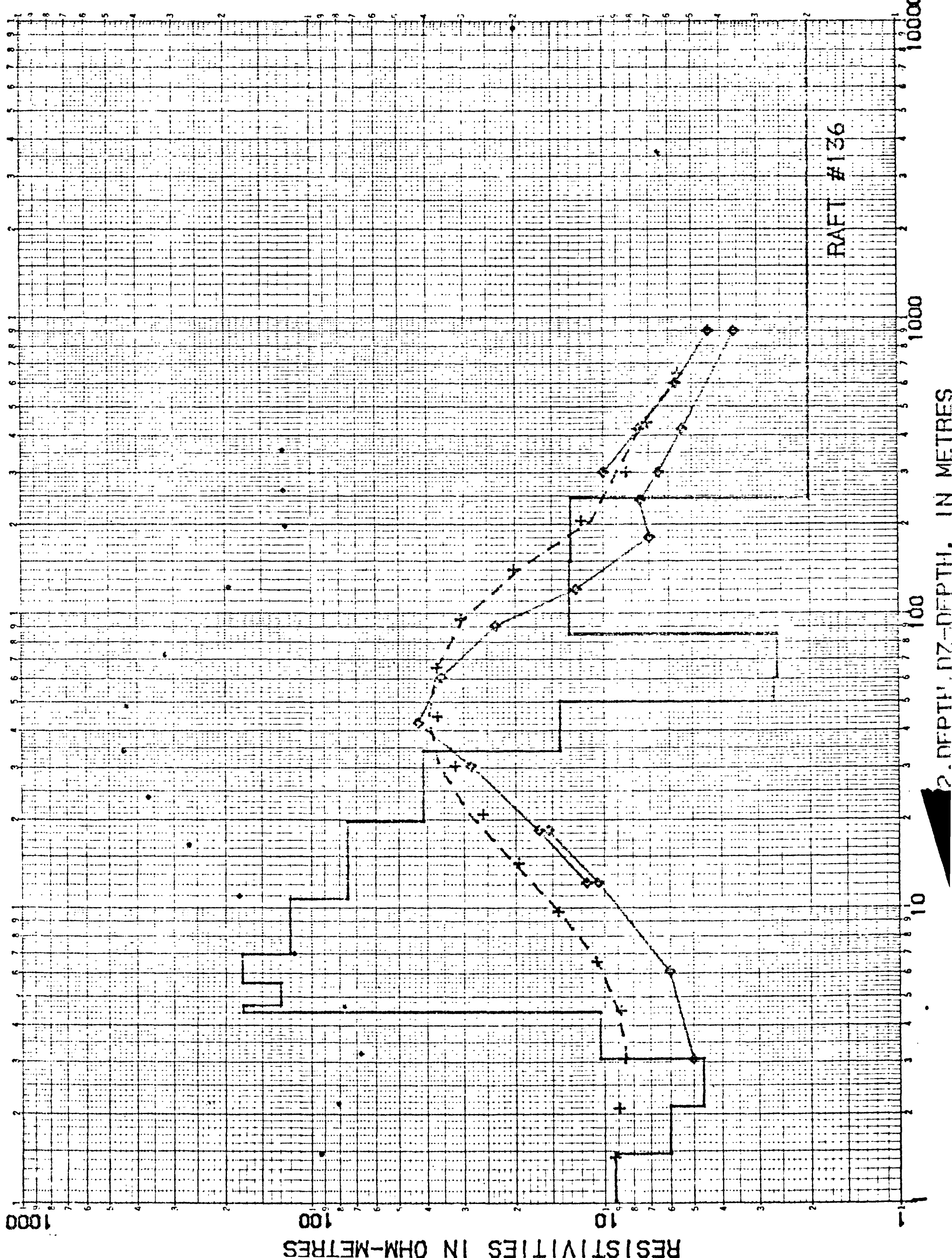

RAFT #132
AB/2 DEPTH, DZ-DEPTH, IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
GPO 835-848


RAFT #133
RESISTIVITIES IN OHM-METRES
1000
100
10
1
AB/2 DEPTH ... IN METRES
1
10
100
1000
10000
GPO 638-646


RAFT #133
AB/2 DEPTH OZ-DEPTH IN METRES
RESISTIVITIES IN OHM-METRES
1
10
100
1000
10000
GPO 835-846


RAFT #134
RESISTIVITIES IN OHM-METRES
AB/2 DEPTH DZ-DEPTH, IN METRES
1
10
100
1000
10000
GPO 835-846


RAFT #135
RESISTIVITIES IN OHM-METRES
1
10
100
1000
AB/2 DEPTH DZ-DEPTH, IN METRES
1
10
100
1000
10000
GPO 835-846


GPO 838-846
RAFT #136
Z-DEPTH, DZ-DEPTH, IN METRES
1
10
100
1000
10000
RESISTIVITIES IN OHM-METRES
1000
100
10
1