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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

RESISTIVITY SOUNDING INVESTIGATION BY THE SCHLUMBERGER METHOD IN THE YUCCA MOUNTAIN AND JACKASS FLATS AREA, NEVADA TEST SITE, NEVADA

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GEOLOGICAL SURVEY

Resistivity sounding investigation by the Schlumberger method in the Yucca Mountain and Jackass Flats area, Nevada Test Site, Nevada

by

R. M. Senterfit[1], D. B. Hoover[1], and M. Chornack[2]

This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards.

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Contents

Introduction

A Schlumberger resistivity survey was made in the west-central sector of the Nevada Test Site (fig. 1) as part of an extensive program to assess and identify potential repositories for high-level nuclear waste. The survey area is located within the Topopah Spring 15-minute quadrangle, part of which is shown in plate 1. The intent of the survey was to determine the geoelectric characteristics of the area and to relate them to the thicknesses and horizontal continuity of lithologic units in the Yucca Mountain and Jackass Flats area, and to locate faulting within the survey area. A total of 29 soundings is included in this report. The field data were interpreted in terms of rock layer resistivity and thickness by computer methods (Zohdy, 1973), and cross-sections were constructed to illustrate lateral resistivity variations within the near-surface rock.

Schlumberger vertical electrical sounding

Vertical electrical soundings (VES) were made with a four electrode configuration commonly referred to as the Schlumberger array (Keller and Frischknecht, 1966). The method uses four in-line electrodes; the inner pair for recording electrical potential as a current is passed through the outer pair. Measurements are made in a series of readings involving successively larger current electrode separations. The data are plotted on a logarithmic scale (see Appendix) to produce a sounding curve representing apparent resistivity variations as a function of half current-electrode separation (AB/2). For Schlumberger soundings, the greater the current, or outer electrode separation, the greater the depth of exploration. Sounding curves numbered YM-1 through YM-3, 24 through 27, 29 through 45, 47 through 50, and 79-3 show the results of these measurements. All the soundings used in this report are contained in the Appendix. The locations of the Schlumberger soundings are shown on plate 1. Each sounding curve has been inverted by use of a computer program to give a one-dimensional layered model (Zohdy, 1973). Interpretation of the sounding data assumes homogeneous, horizontal layering, therefore, where lateral heterogeneities in resistivity exist within the influence of the energizing current field, the sounding may exhibit distortions which, when present, the computer will model as horizontal layering. Data distortion resulting from lateral variations in rock resistivity are not always recognizable from the shape of the field curve.

Vertical geoelectrical sections

Three geoelectric cross sections were prepared from the computer derived one-dimensional layered models to illustrate resistivity variations within the sectors of the study area. The locations of the cross sections are shown on plate 1. The sections were compiled with a vertical exaggeration of 14.5 and contoured with seven logarithmically scaled intervals per decade. Each cross section includes at least one litholgoic log on-line with the Schlumberger soundings in that cross-section to provide comparison of geoelectric and lithologic data.

Resistivity cross section A-A' is shown on figure 2. This cross section is constructed in a northwest-southeast direction across the northern part of Jackass Flats. Lithologic data from drillholes J-11 and J-13 are included. Resistivity values show a general decrease with depth, beginning at about 250 meters, which indicates that more conductive rocks are being sensed at increasing depths. Between VES 24 and 25, an abrupt change in depth to the conductive zone is shown. The Mine Mountain fault, mapped by Ekren and Sargent (1965) as a left-lateral strike-slip fault, striking northeast and down-dropped to the southeast, is mapped approximately 6 kilometers to the northeast of VES 25 and 24 (Orkild, 1968) and is inferred to pass between those two stations (D. L. Hoover, USGS, oral commun., 1981). From depths of about 150 meters and continuing downward through the section between VES 25 and 27, the resistivity contours have an apparent dip to the northwest. At VES 24, the apparent dip of the resistivity contours is more gradual to the southeast. These changes in apparent dip of the resistivity contours from VES 25 to the northwest and from VES 25 to the southeast support geologic evidence placing the Mine Mountain fault between VES 25 and 24 (Ekren and Sargent, 1965). At VES 25, beginning at a depth of about 150 meters, the resistivity contours show a gradient decreasing in value with depth, indicating the sensing of a more conductive zone. At VES 24, a similar gradient is seen beginning at a depth of about 280 meters, which supports evidence that the Mine Mountain fault is down-dropped to the southeast (Ekren and Sargent, 1965).

The two areas of low resistivity seen on cross section A-A′ at depth intervals of 50 to 150 meters are probably caused by an increase in amounts of clay and other fine-grained material within alluvial fill (see lithologic data for drillholes J-11 and J-13, cross section A-A′). The area of high resistivity seen at a depth interval of 100 to 160 meters beneath VES 26 may be due to the presence of local basalts which occur throughout this area (McKay and Williams, 1964). The water table, at a depth of about 300 meters, does not appear to have been detected by the soundings in this area.

Cross section B-B′ (fig. 3) runs from the top of Yucca Wash to Fortymile Wash. Lithologic information from drillhole J-13 is included. Geologic mapping of this area (Lipman and McKay, 1965; Christiansen and Lipman, 1965) indicates a thick section of volcanics dipping gently to the east. The geoelectrical data shows a general decrease in resistivity beginning at a depth of about 300 meters and continuing downward through the section, which indicates the presence of a more conductive layer within the tuffs. Several areas of high or low resistivity are seen along cross section B-B′ from the surface to a depth of about 200 meters, indicating significant lateral variations in rock resistivity within this depth range. These lateral changes are attributed to differences in fracturing, faulting, and lithology of the tuffs throughout the area, and to varying amounts of clay and other fine-grained materials in the alluvium.

Cross section C-C′ (fig. 4) runs from the northeast end of Drillhole Wash to the north-south road along Fortymile Wash. Lithologic data from drillhole Ue 25a-1 is included with the cross section. The deeper ranges sensed show a decrease in resistivity with depth, indicating the presence of more conductive rock in the lower part of the section. The variations in resistivity within the upper 100 meters of the section are associated with volcanic rocks, principally the Tiva formation mapped by Lipman and McKay as outcropping throughout the area. The area of high resistivity seen from VES 39 to VES 37, at a depth interval of 100 meters to about 450 meters, is probably a reflection of the Topopah Spring member of the Paintbrush Tuff (Spengler and others, 1979). In the vicinity of VES 37 and 36, sharp changes in resistivity values are shown in the depth interval of 80 to about 350 meters. These changes could be a reflection of vertical displacement caused by faults crossing the line of the cross section.

Conclusions

The interpreted results of some of the 29 Schlumberger resistivity soundings, as shown in the cross sections of figures 2, 3, and 4, indicate some lateral discontinuities which appear to be caused by vertical displacement due to faulting. Because the lithologic section in this survey area is composed primarily of ash-flow tuffs beneath alluvium (Lipman and McKay, 1965), many of the lateral resistivity variations are probably caused by differences in amounts of clay and other fine-grained materials within the alluvium, variations of lithology within the volcanic rocks, and the effects of fracturing within the rock types.

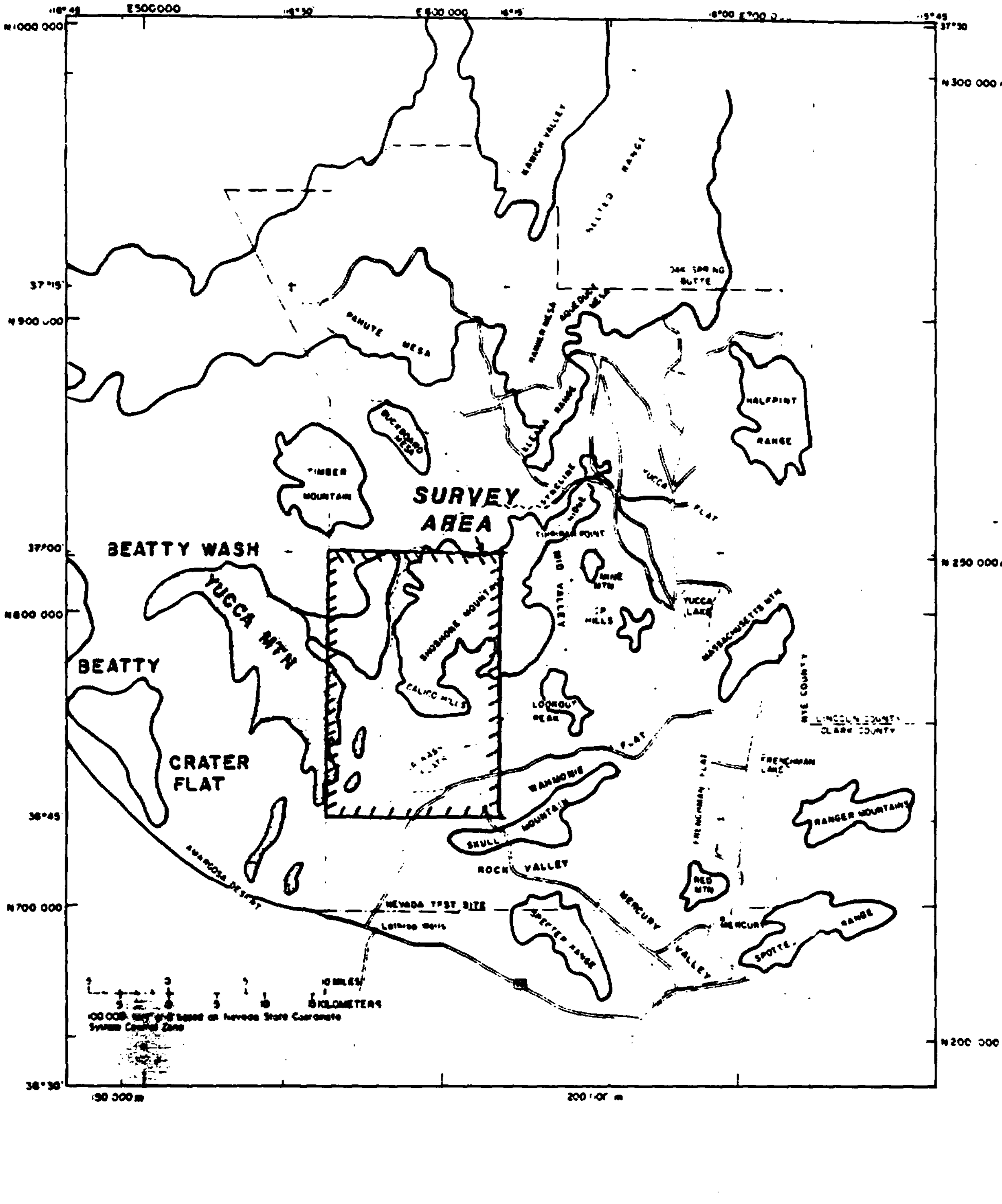

Figure 1. Index map of the Nevada Test Site and vicinity showing the location of the Topopah Spring quadrangle.

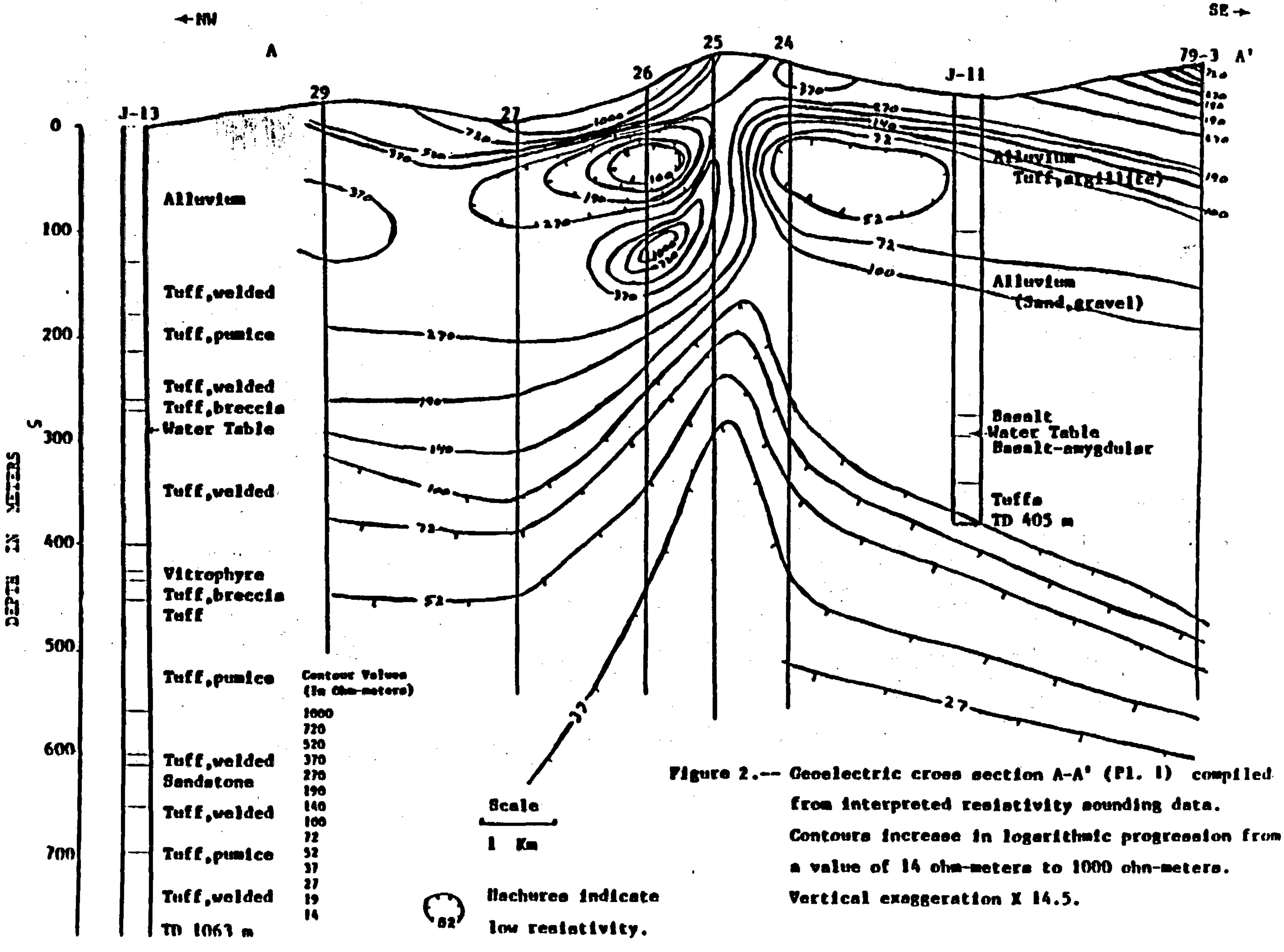

Figure 2.-- Geoelectric cross section A-A' (Pl. 1) compiled from interpreted resistivity sounding data. Contours increase in logarithmic progression from a value of 14 ohm-meters to 1000 ohm-meters. Vertical exaggeration X 14.5.

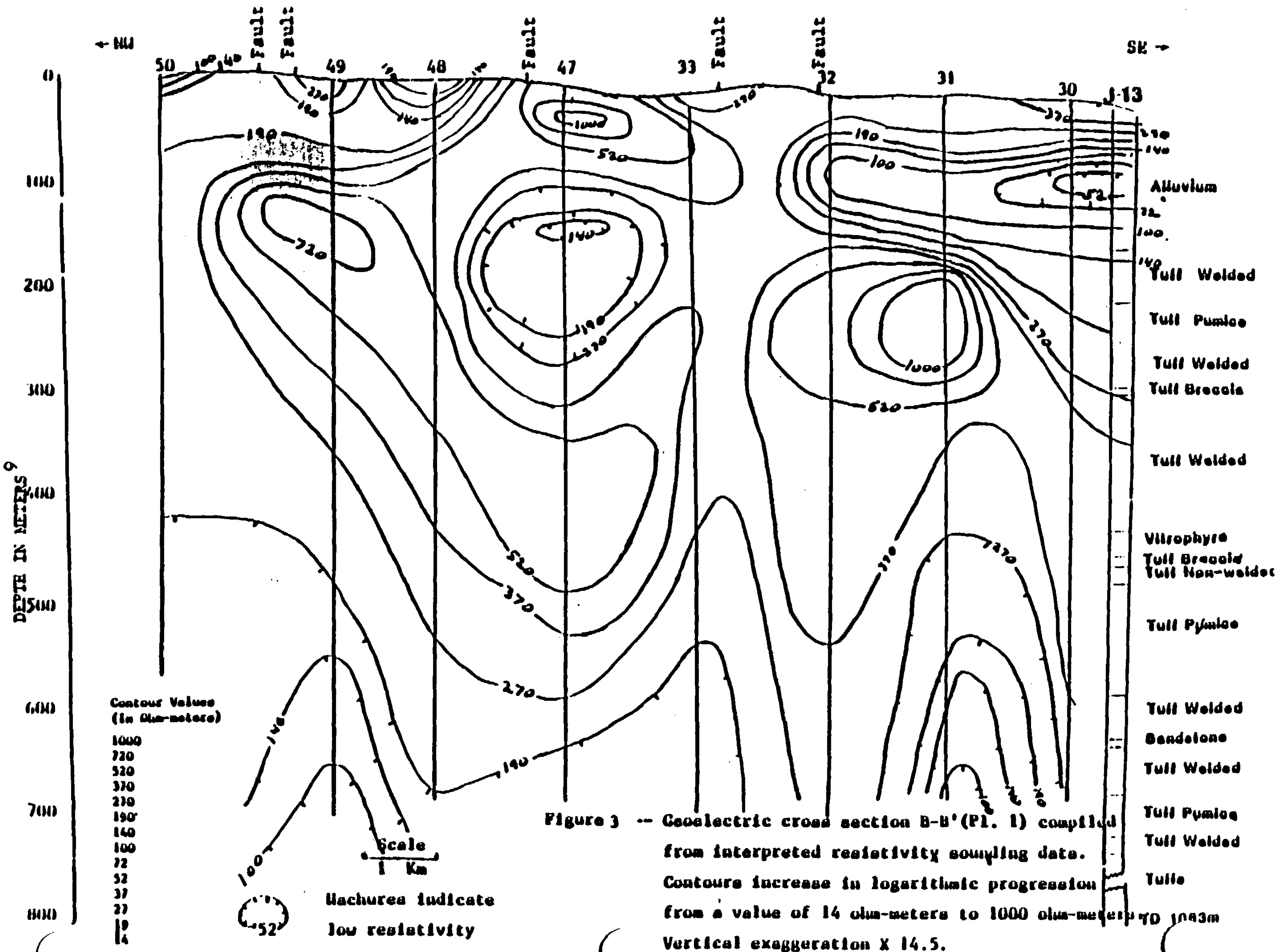

Figure 3 -- Geoelectric cross section B-B'(Pl. 1) compiled from interpreted resistivity sounding data. Contours increase in logarithmic progression from a value of 14 ohm-meters to 1000 ohm-meters. Vertical exaggeration X 14.5.

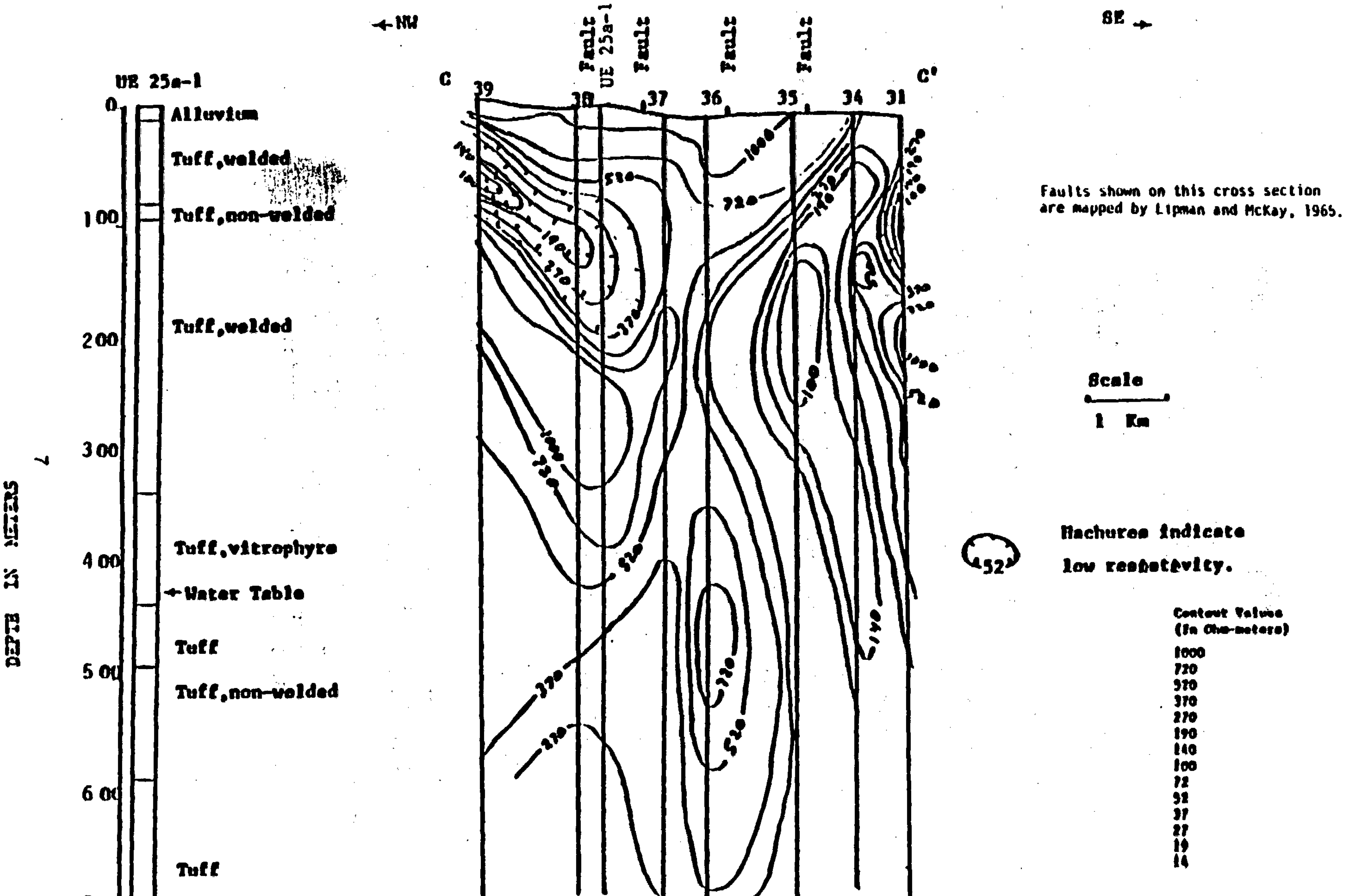

Figure 4.-- Geoelectric cross section C-C' (Pl.1) compiled from interpreted resistivity sounding data. Contours increase in logarithmic progression from a value of 14 ohm-meters to 1000 ohm-meters. Vertical exaggeration X 14.5.

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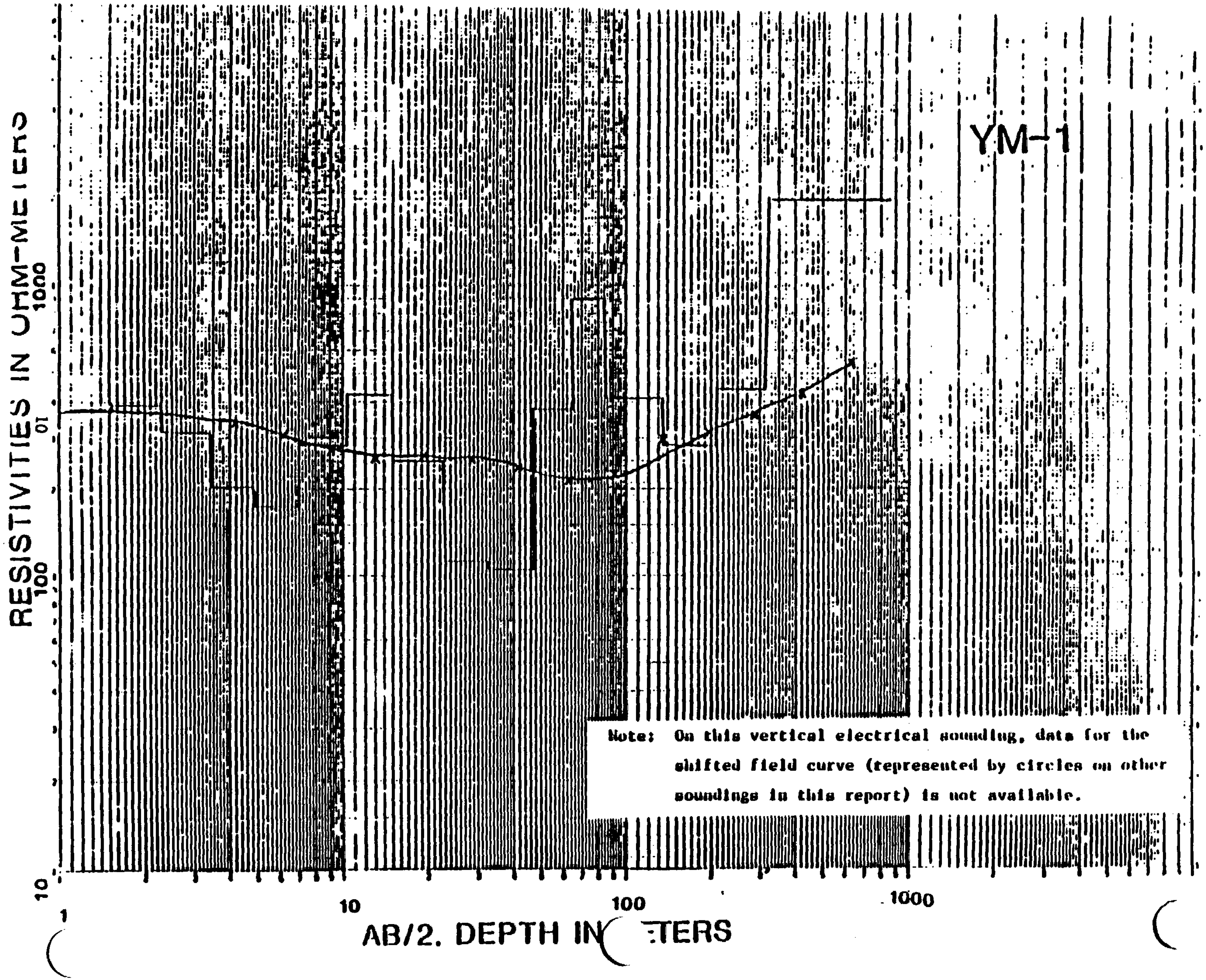
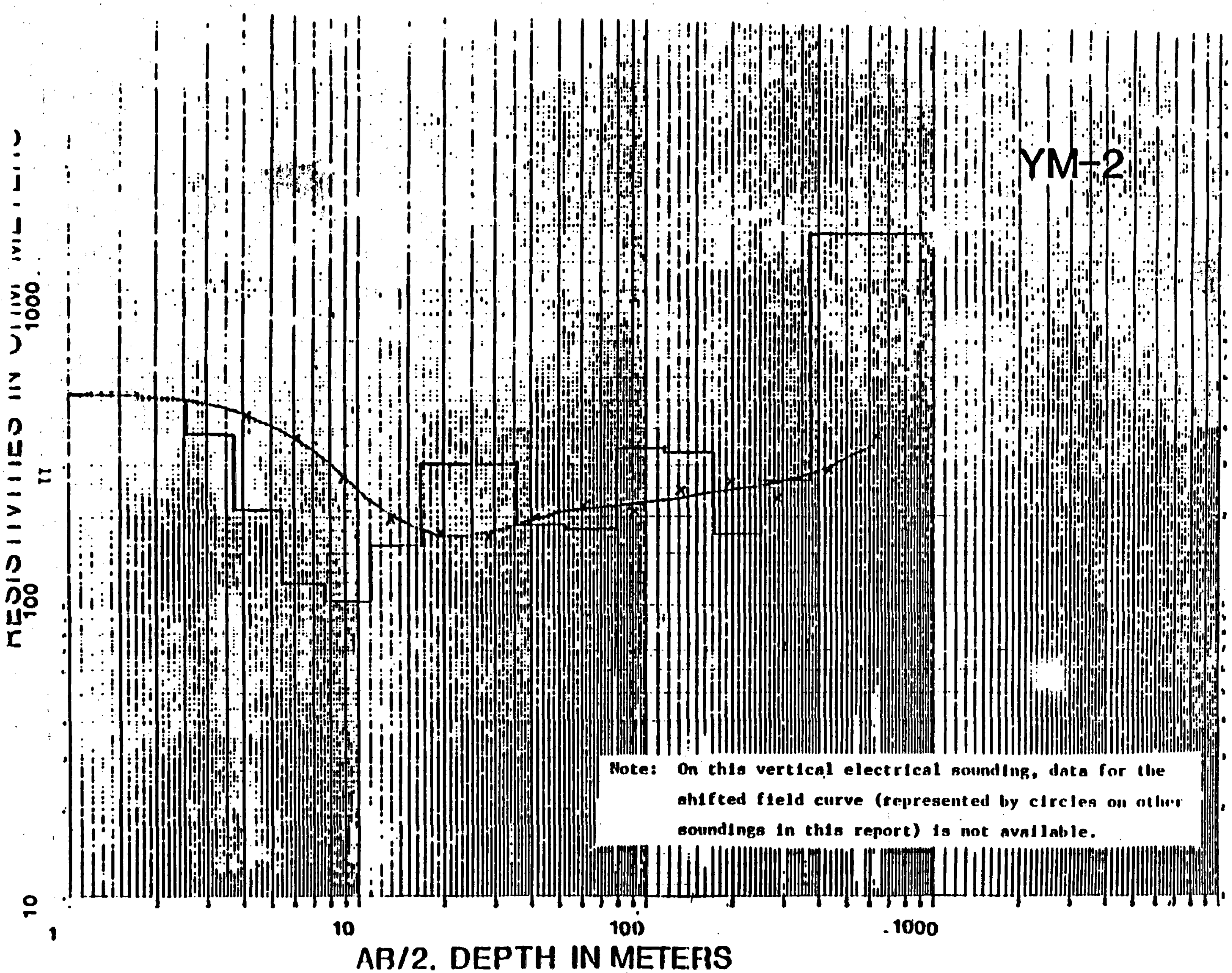
Appendix

Vertical electrical soundings YM-1 through YM-3, 24 through 27, 29 through 45, 47 through 50, and 79-3. On each curve the measured field data are represented by the symbol X, connected by straight line segments; the circles portray a shifted field curve obtained by vertical adjustment of individual segments relative to the last segment on the right-hand side of the sounding curve (Zohdy, 1973); the resistivity model is represented by the columnar graph wherein the width of a particular column designates the thickness of an individual layer and its vertical position corresponds to the resistivity of that layer.


YM-1
RESISTIVITIES IN OHM-METERS
10
100
1000
1
10
100
1000
AB/2. DEPTH IN METERS
Note: On this vertical electrical sounding, data for the shifted field curve (represented by circles on other soundings in this report) is not available.



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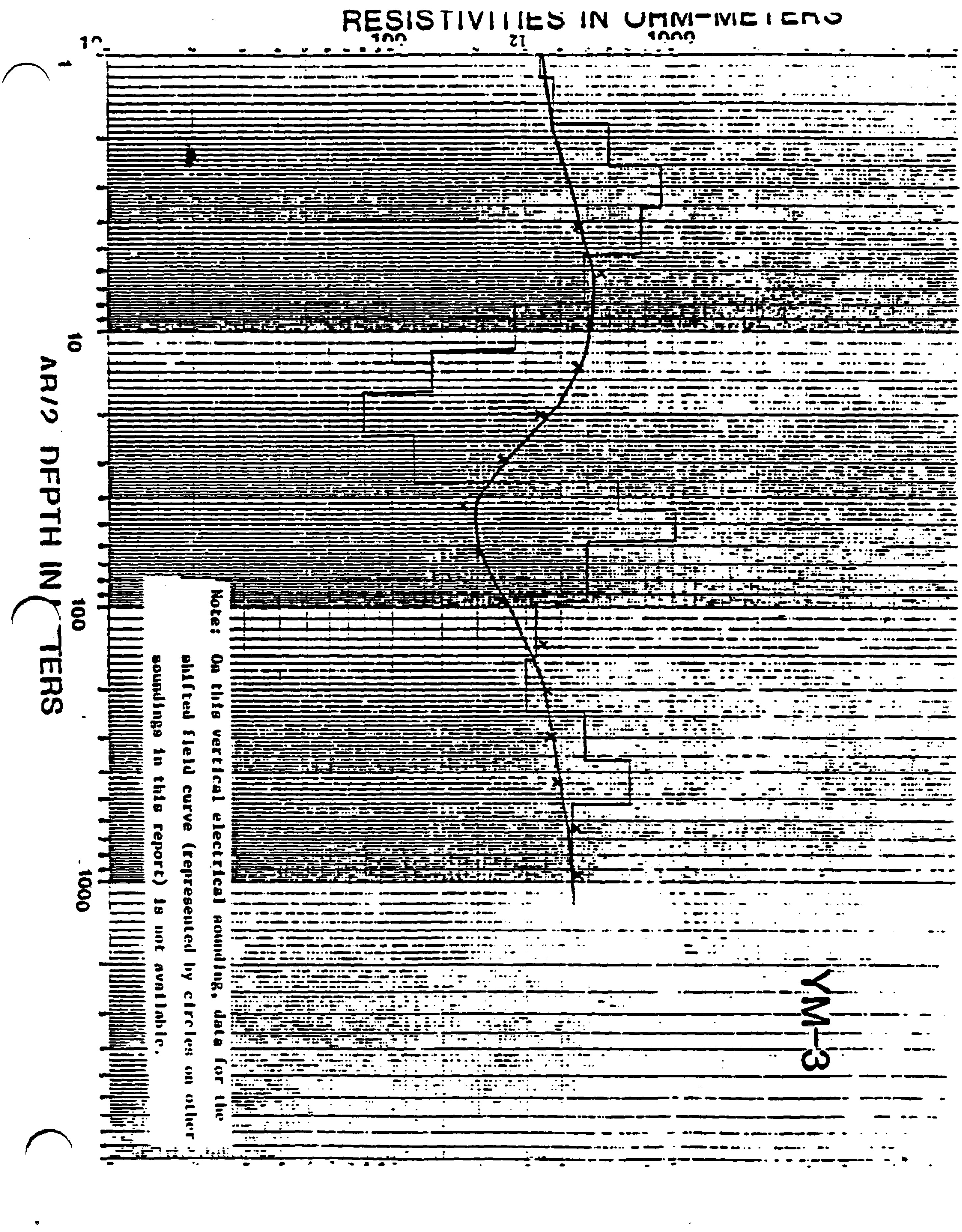
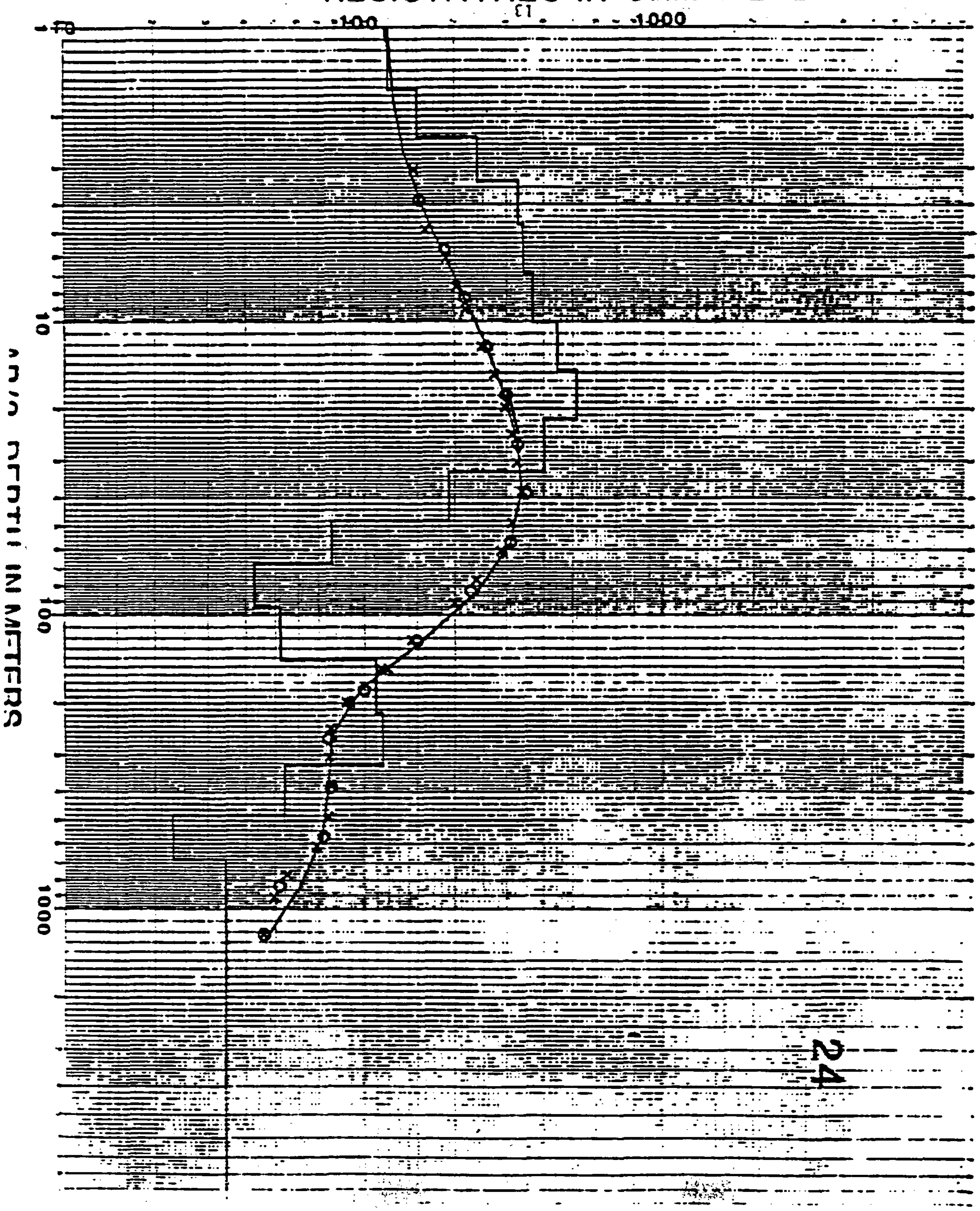
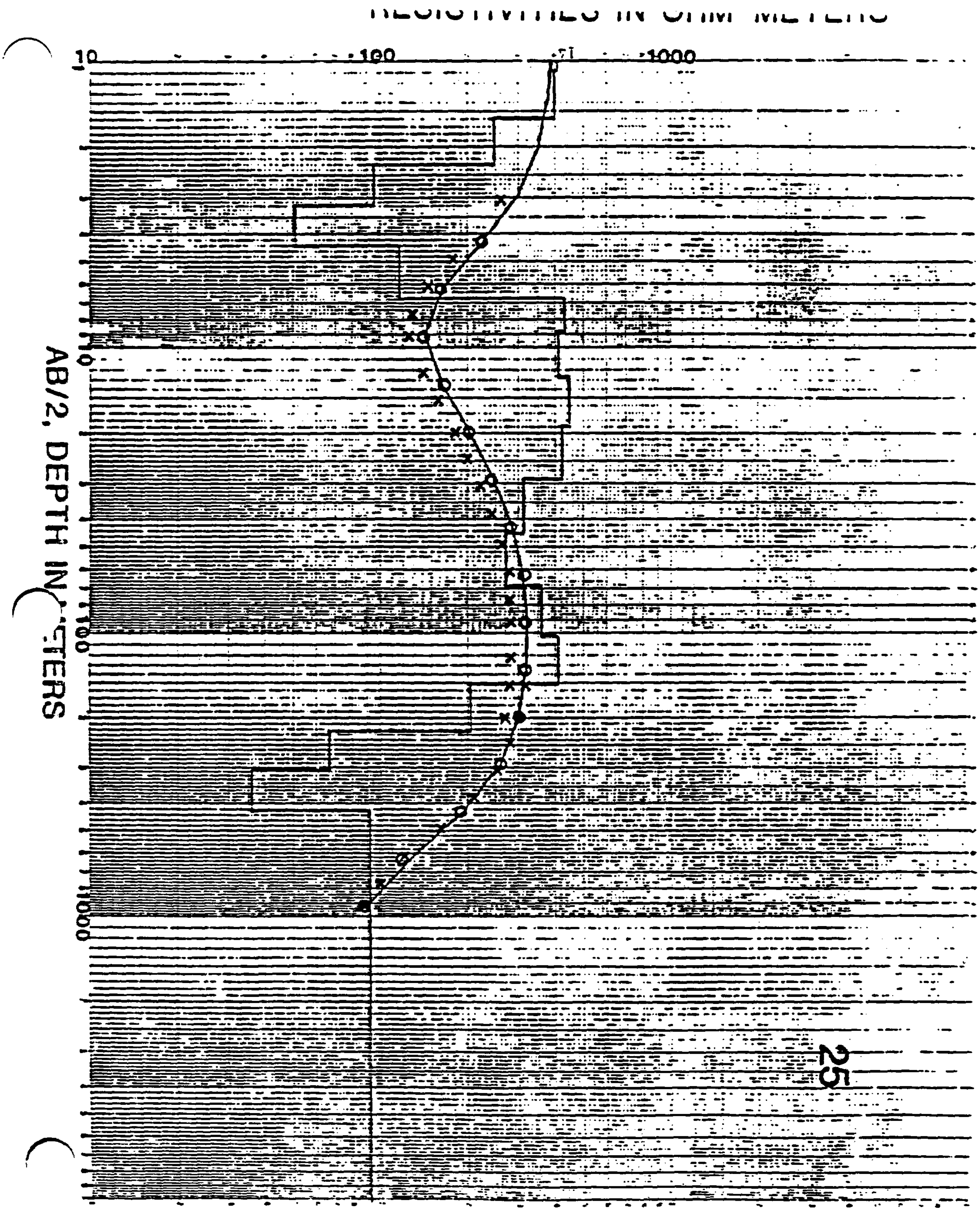
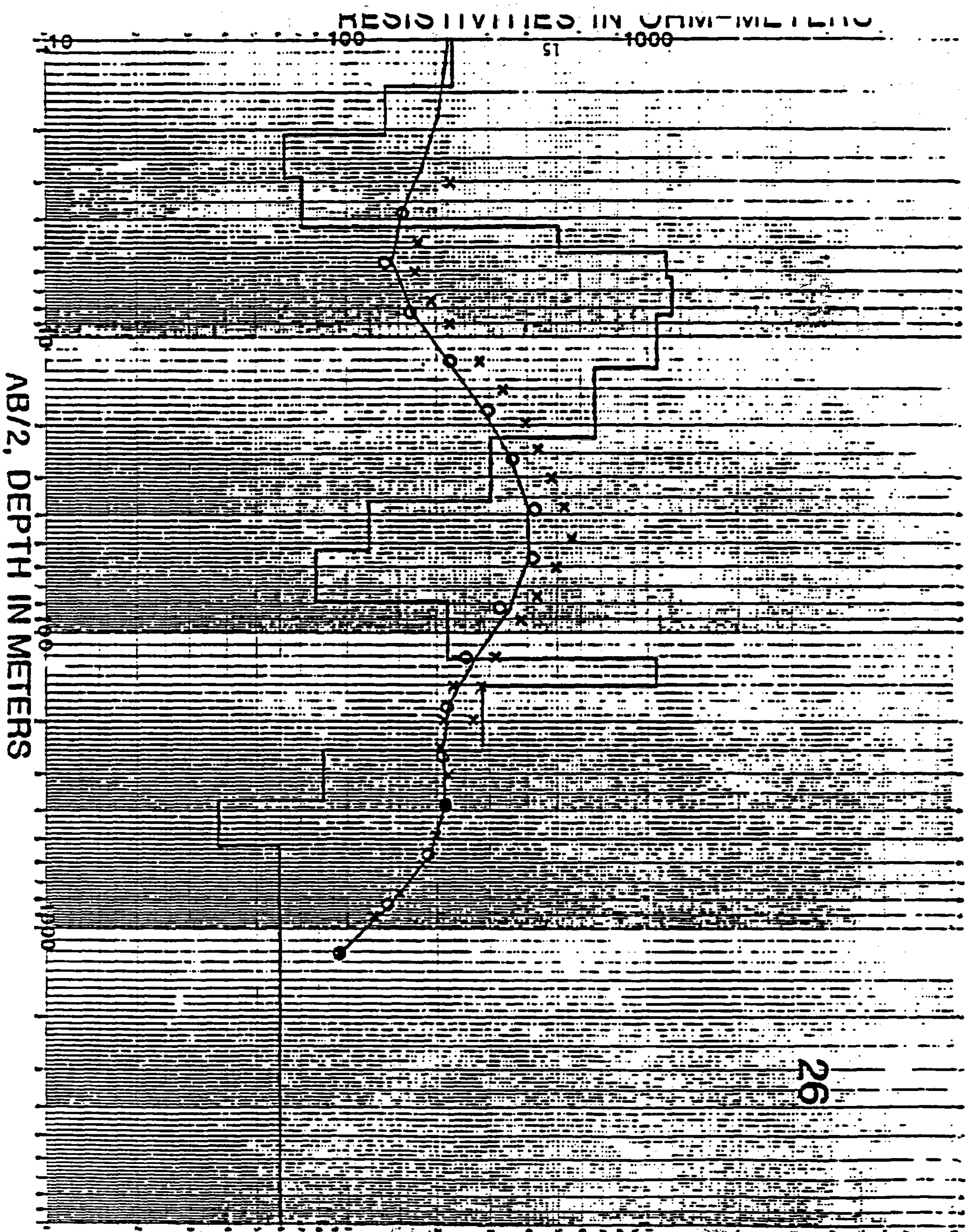
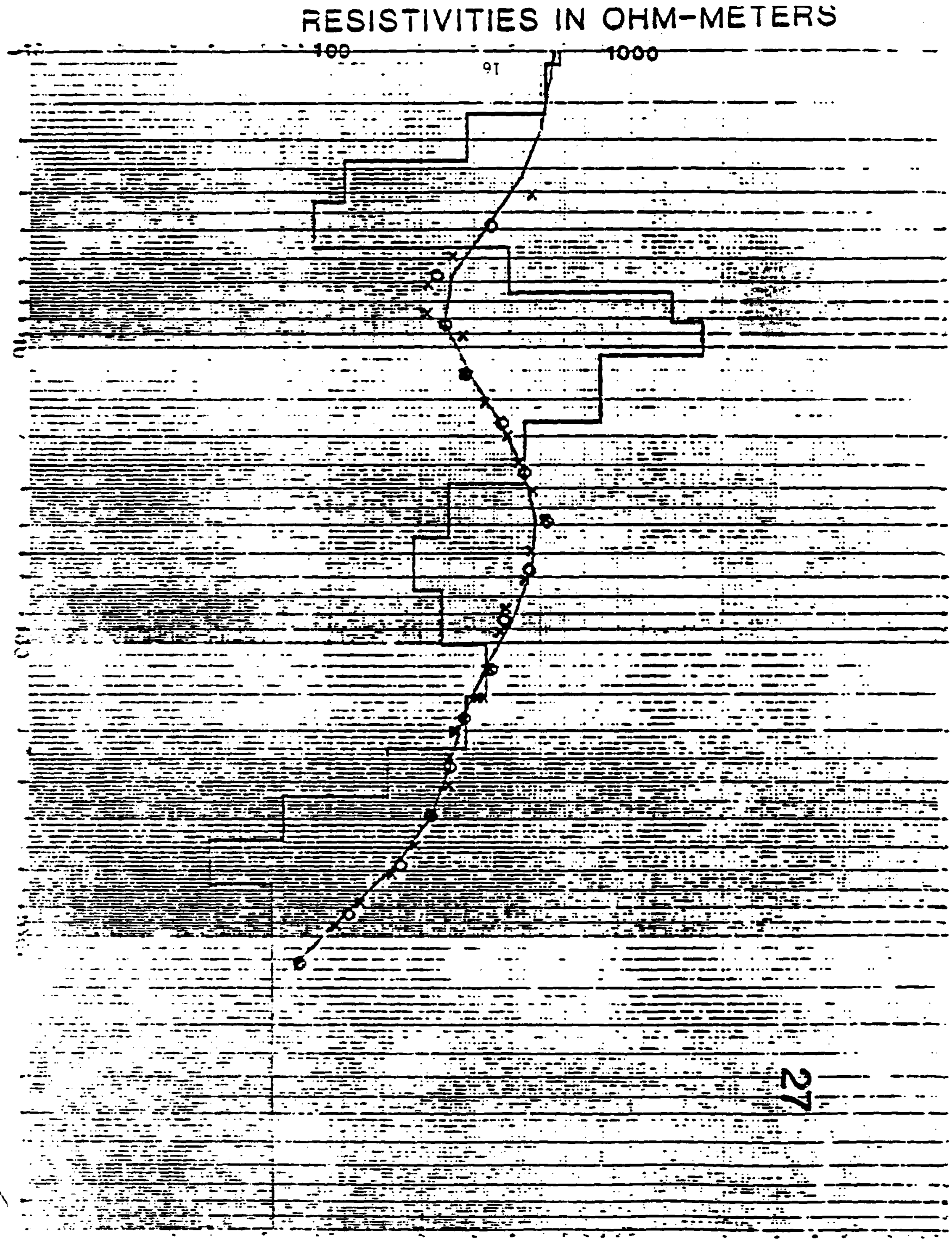

RESISTIVITIES IN OHM-METERS
10
100
1000
DEPTH IN
TERS
10
100
1000
YM-3
Note: On this vertical electrical sounding, data for the shifted field curve (represented by circles on other soundings in this report) is not available.

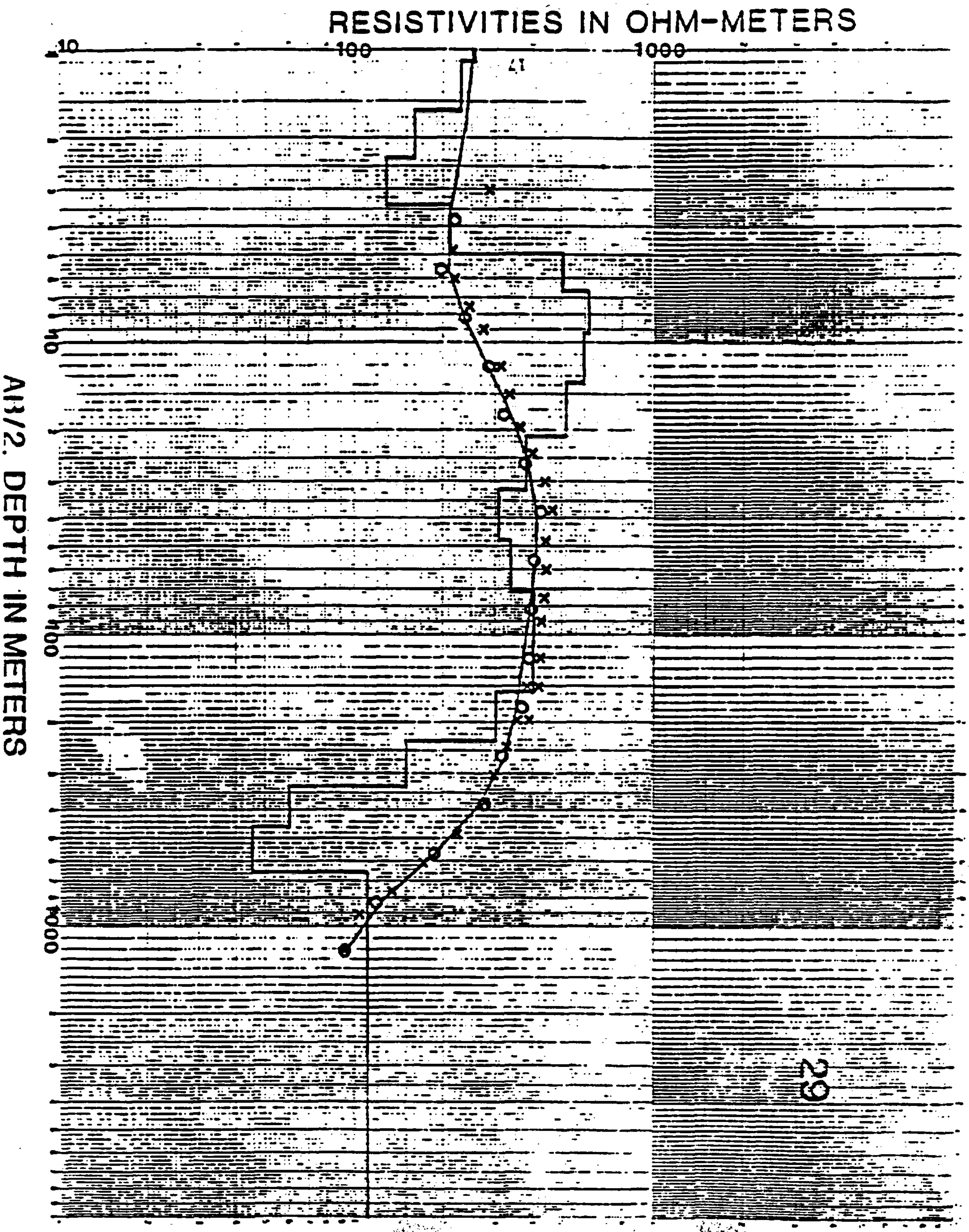
RESISTIVITIES IN OHM-METERS

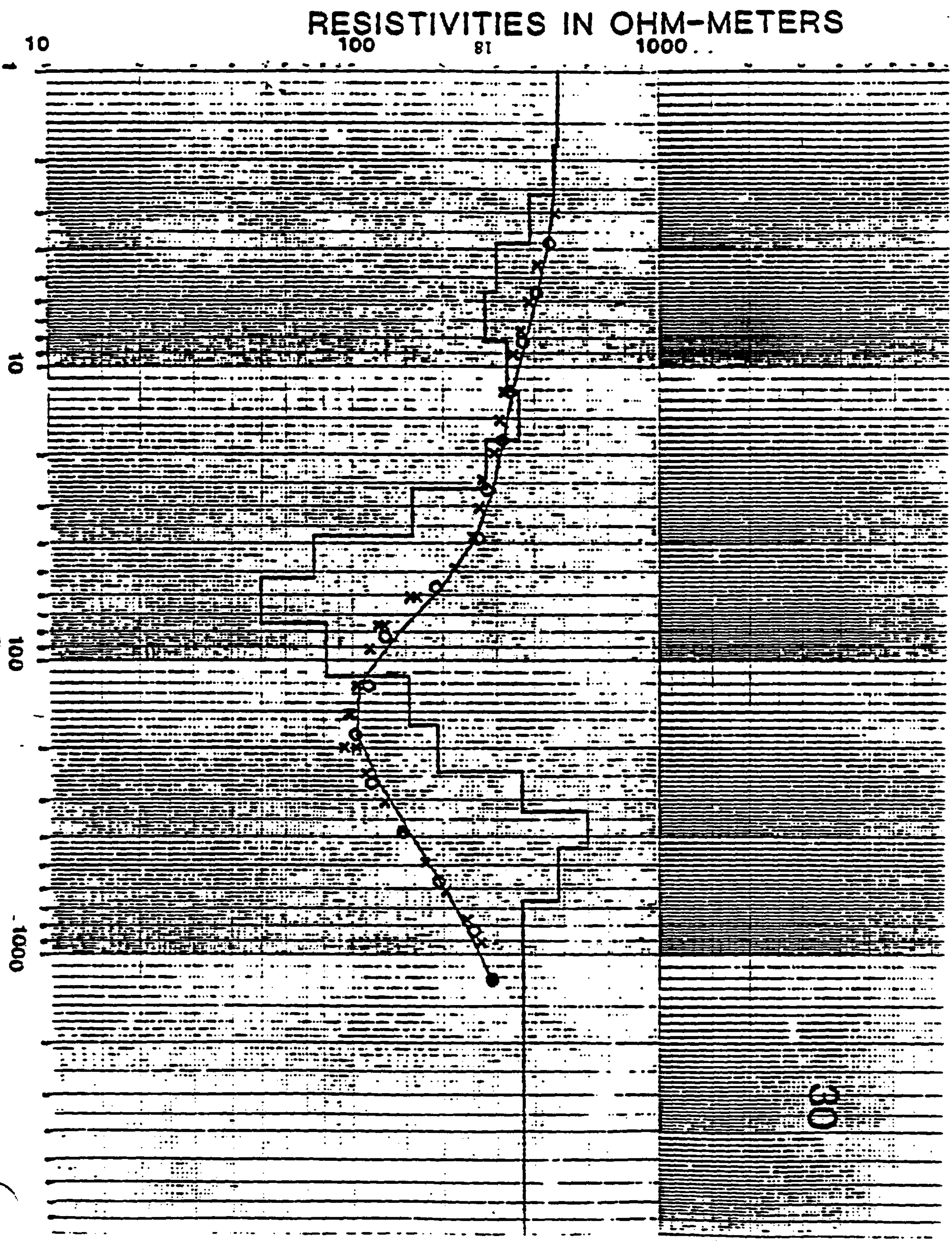



RESISTIVITIES IN OHM METERS
10
100
1000
AB/2, DEPTH IN METERS
10
100
1000

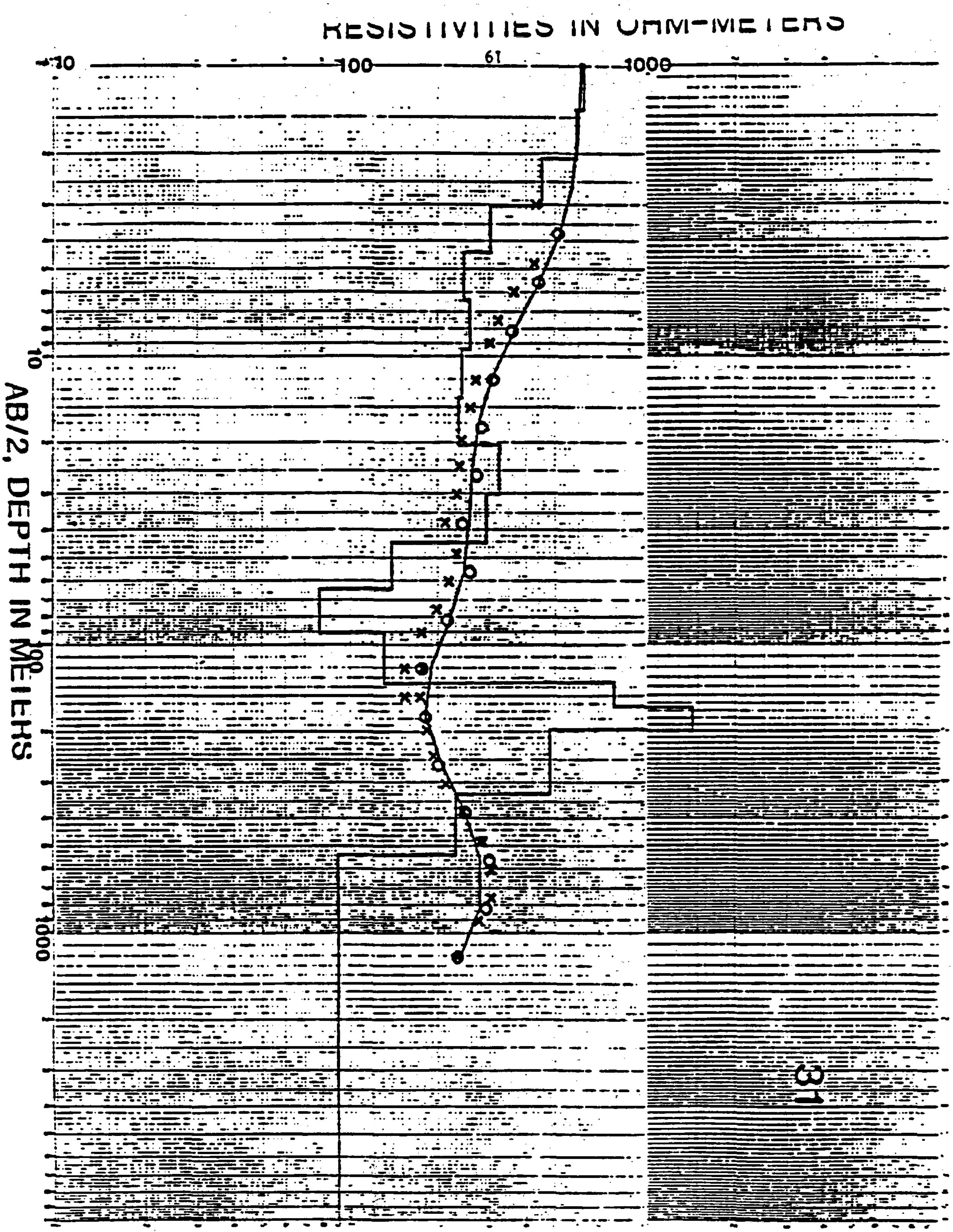

RESISTIVITIES IN OHM-METERS
10
100
1000
AB/2, DEPTH IN METERS
10
100
1000

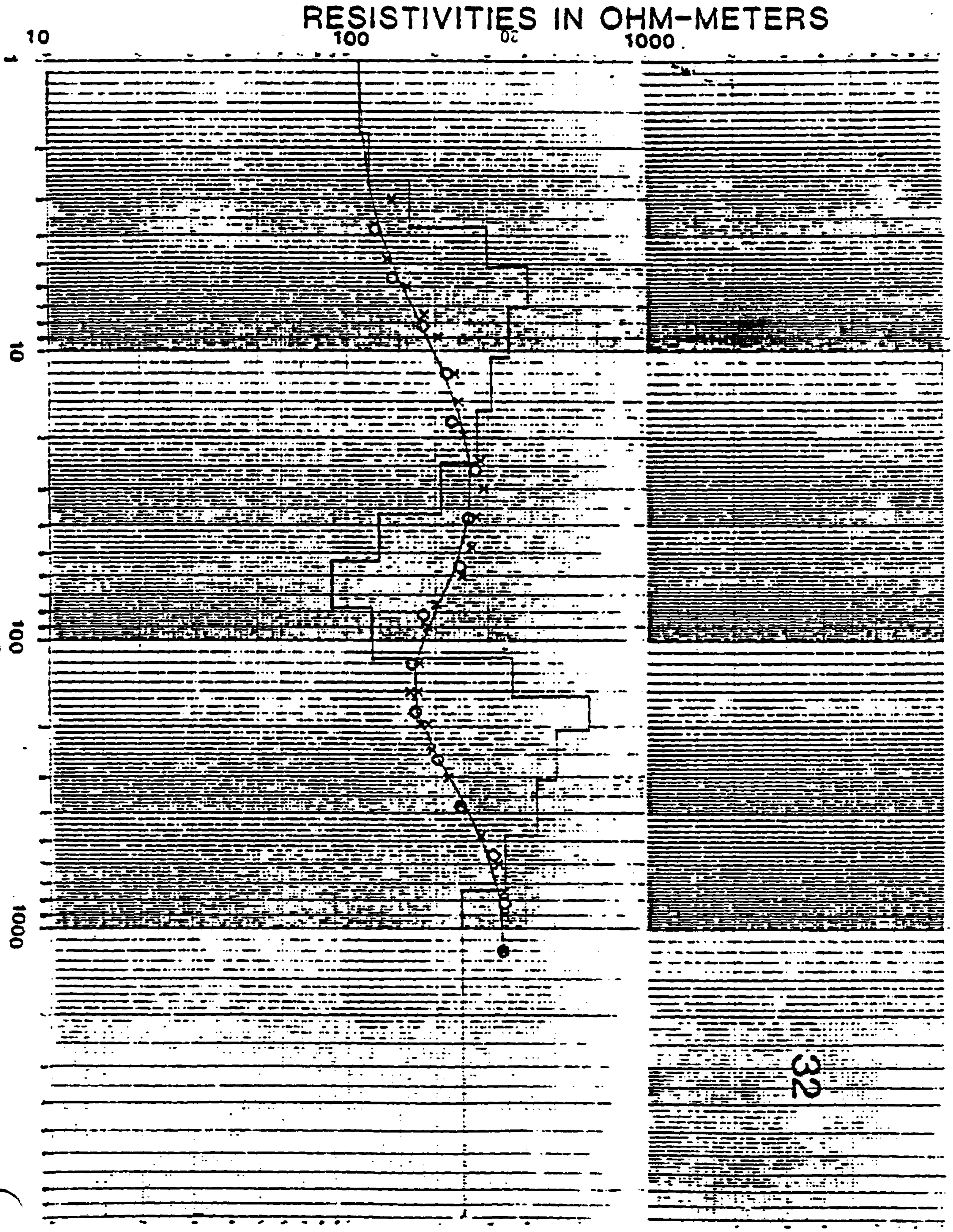

RESISTIVITIES IN OHM-METERS
100
1000


RESISTIVITIES IN OHM-METERS
10
100
1000
AB/2. DEPTH IN METERS
10
100
1000



RESISTIVITIES IN OHM-METERS
10
100
1000
AB/2 DEPTH IN METERS
10
100
1000
30


RESISTIVITIES IN OHM-METERS
10
100
61
1000
AB/2, DEPTH IN METERS
10
100
1000



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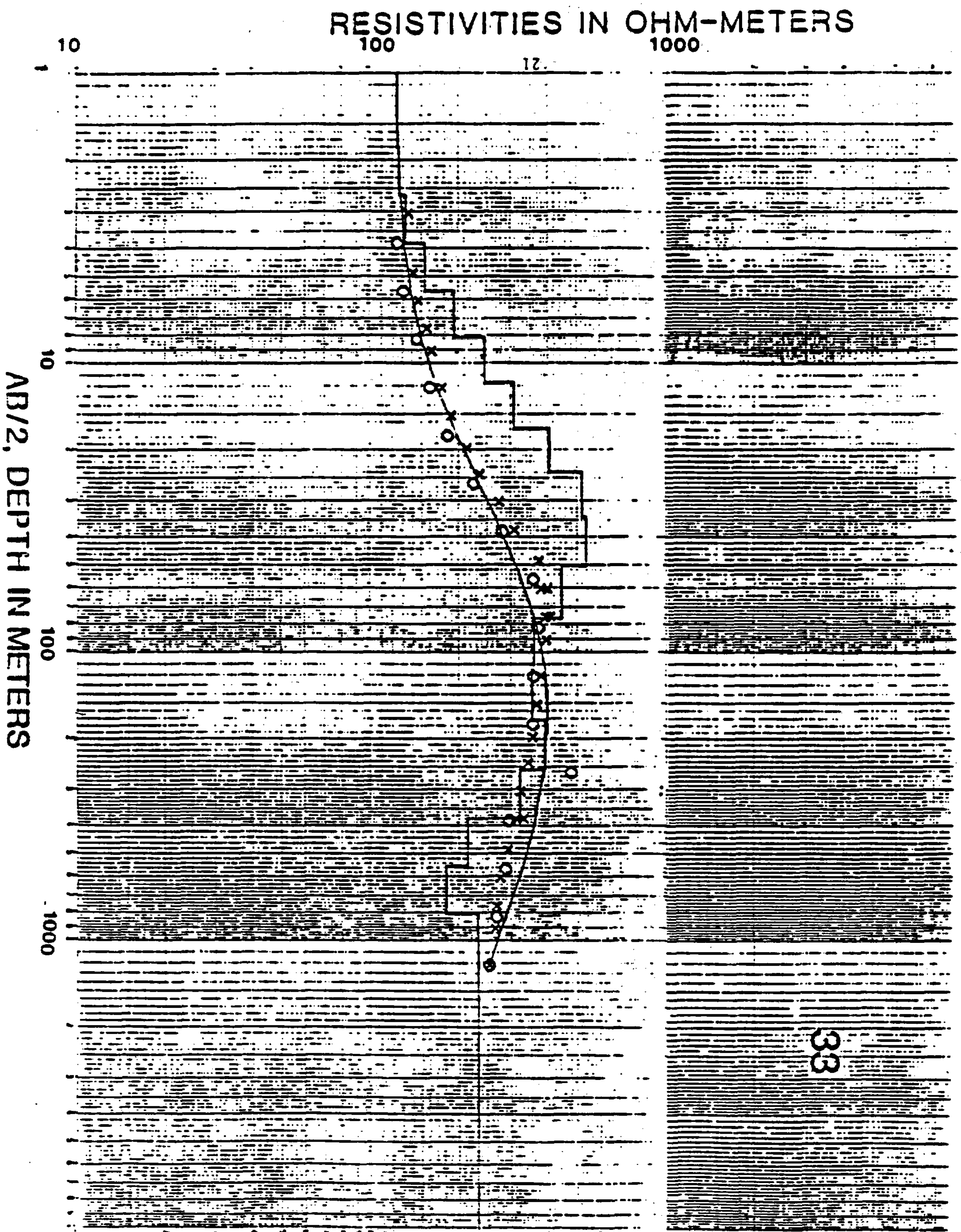
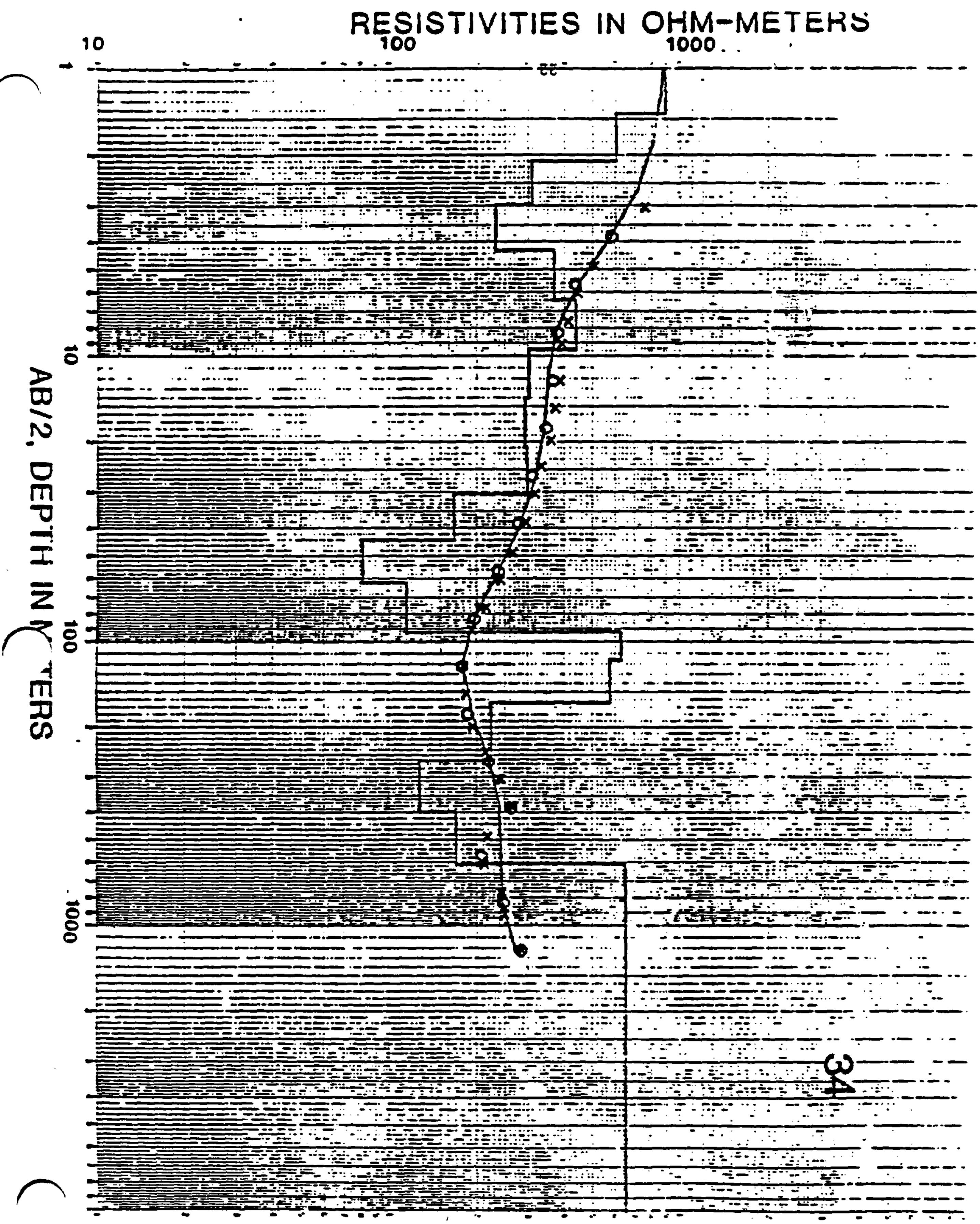
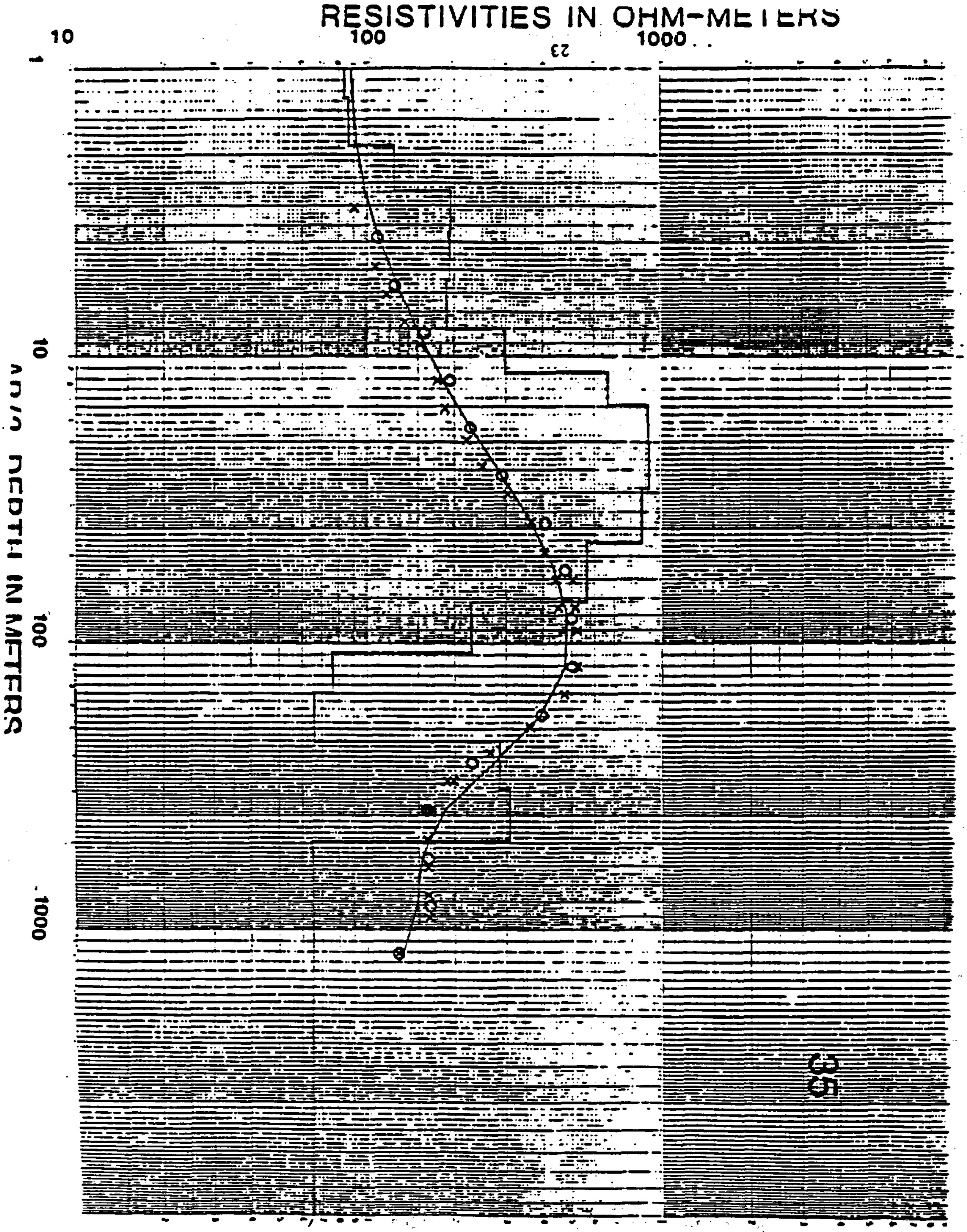
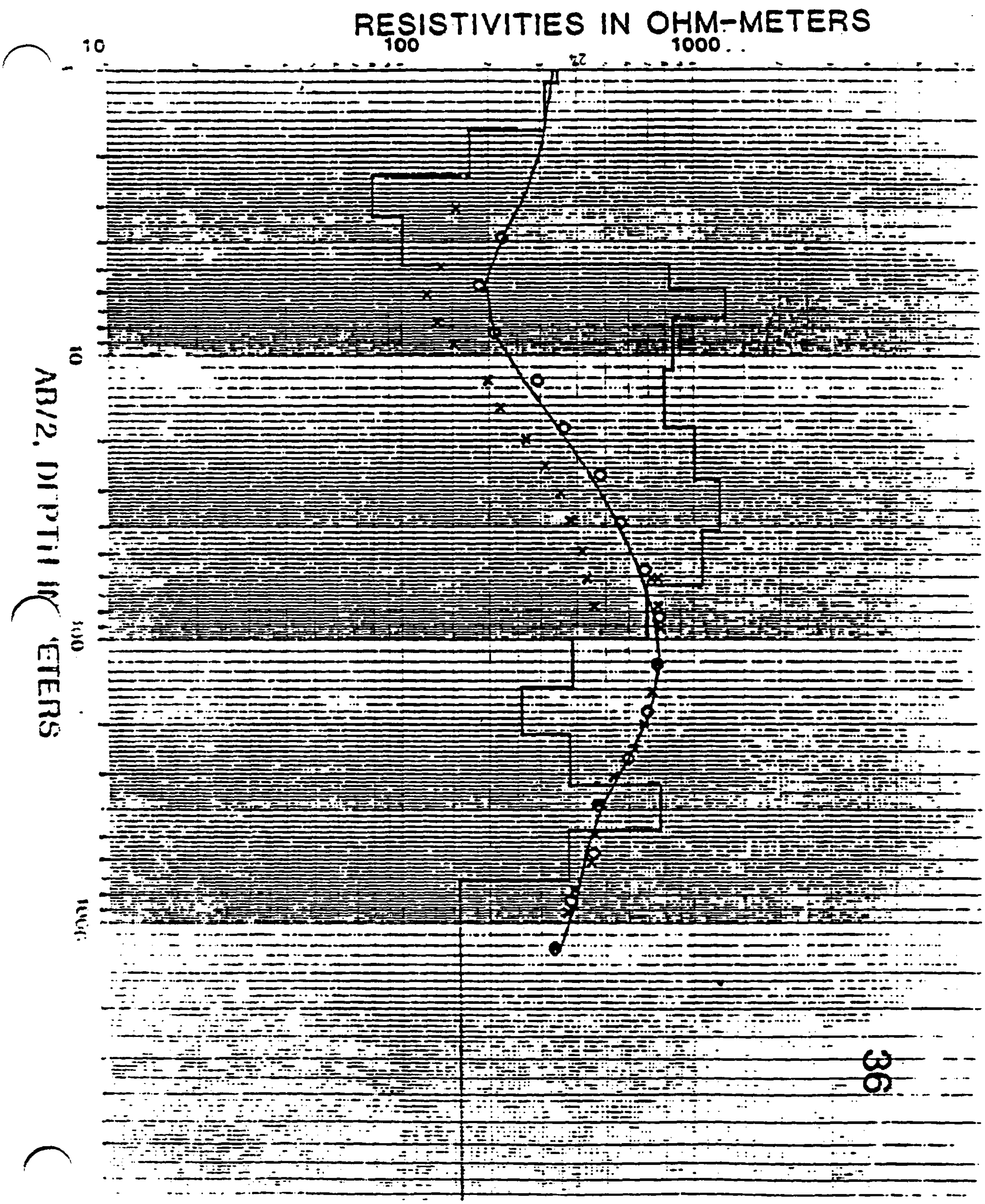
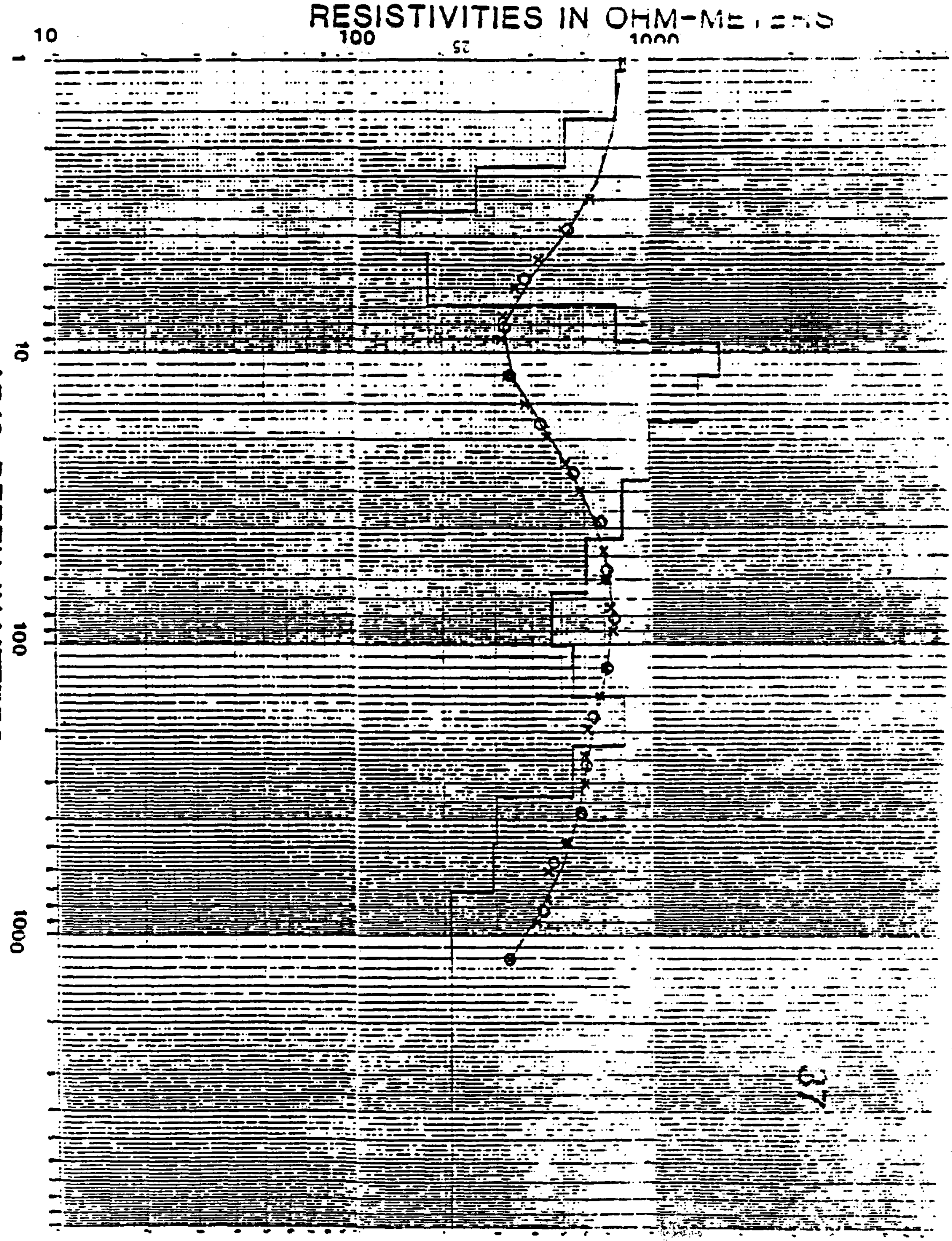

RESISTIVITIES IN OHM-METERS
10
100
1000
AB/2, DEPTH IN METERS
10
100
1000
33


RESISTIVITIES IN OHM-METERS
10
100
1000
1
10
100
1000
AB/2, DEPTH IN
TERS

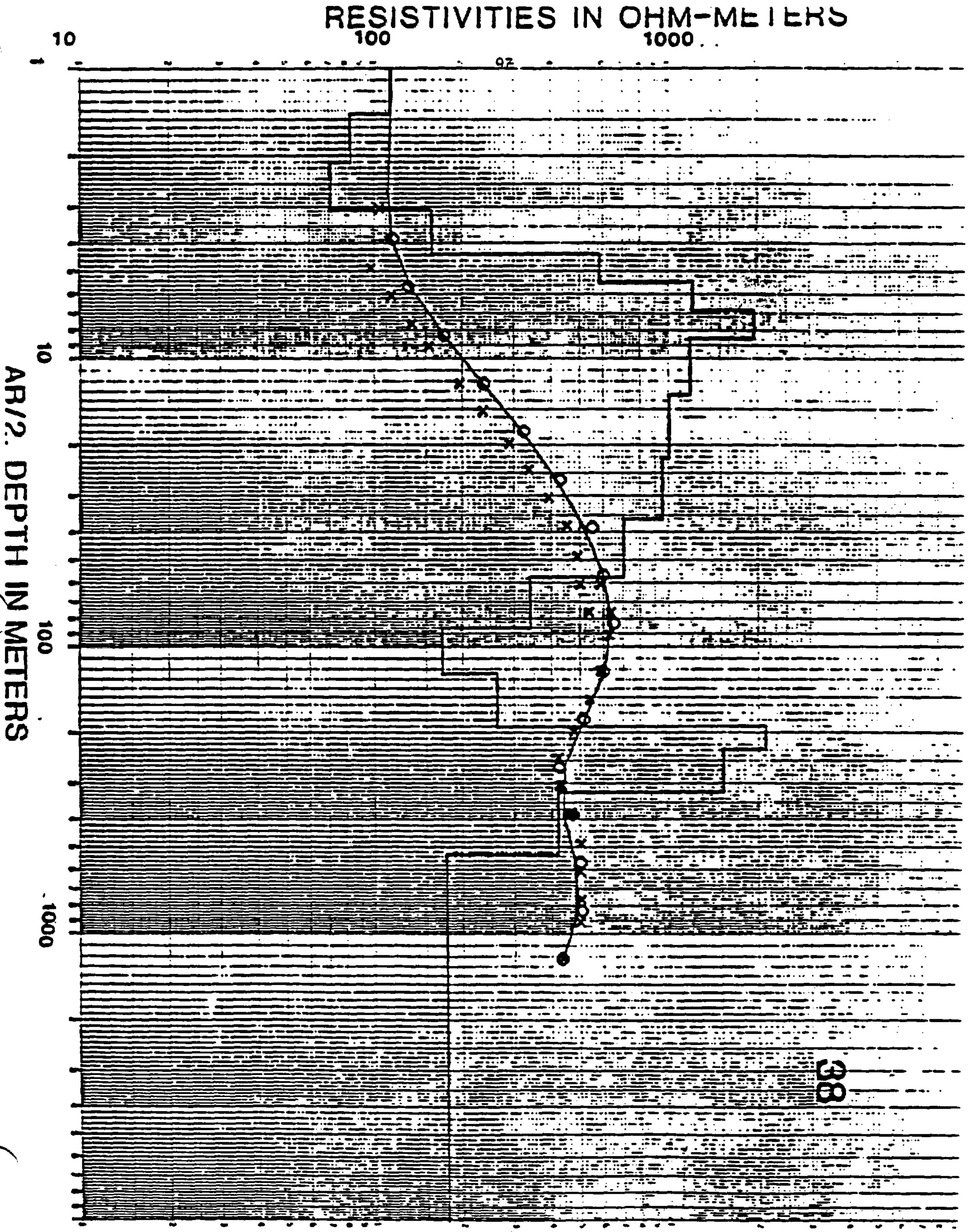


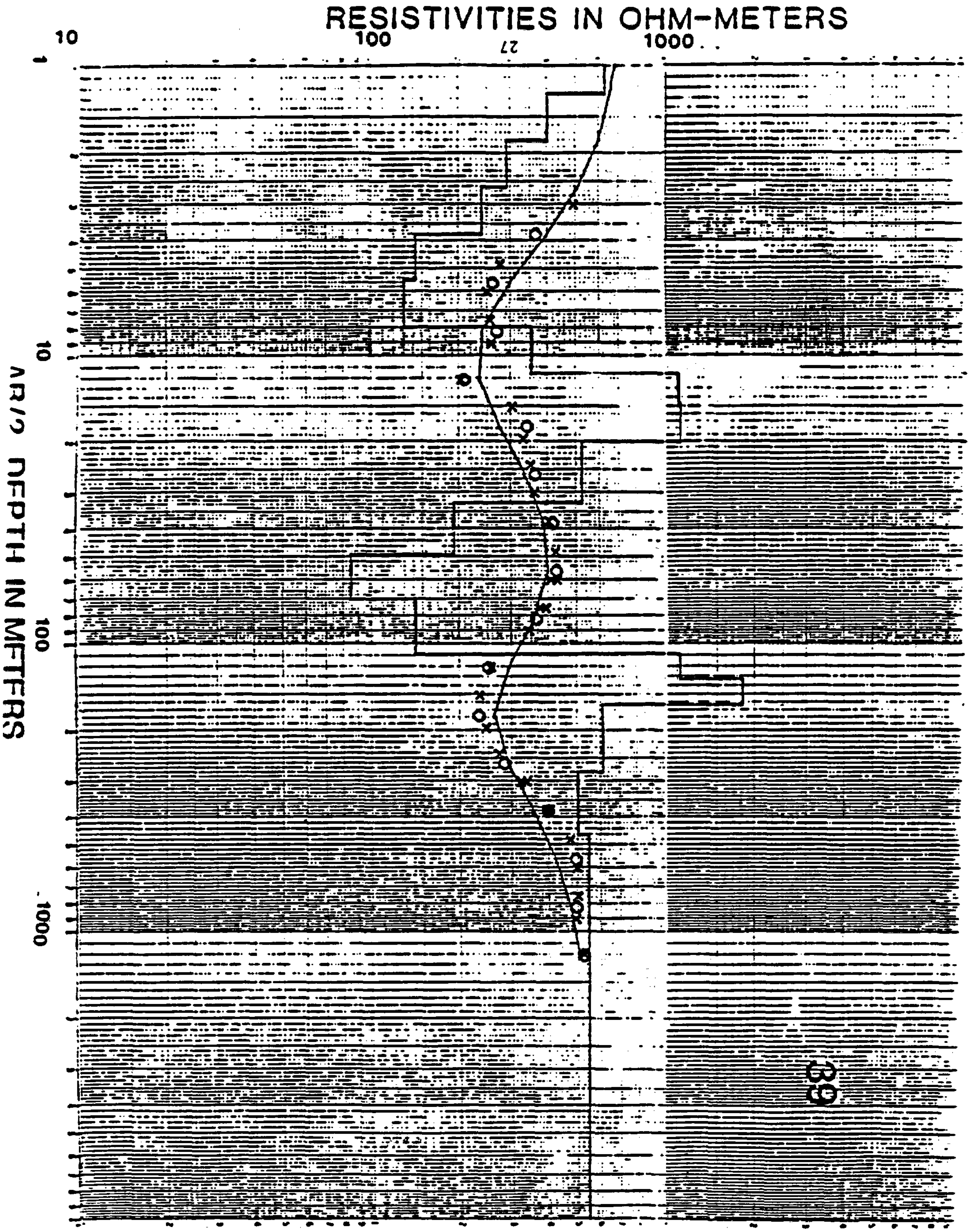
RESISTIVITIES IN OHM-METERS
10
100
1000
AB/2 DEPTH IN METERS
10
100
1000
35

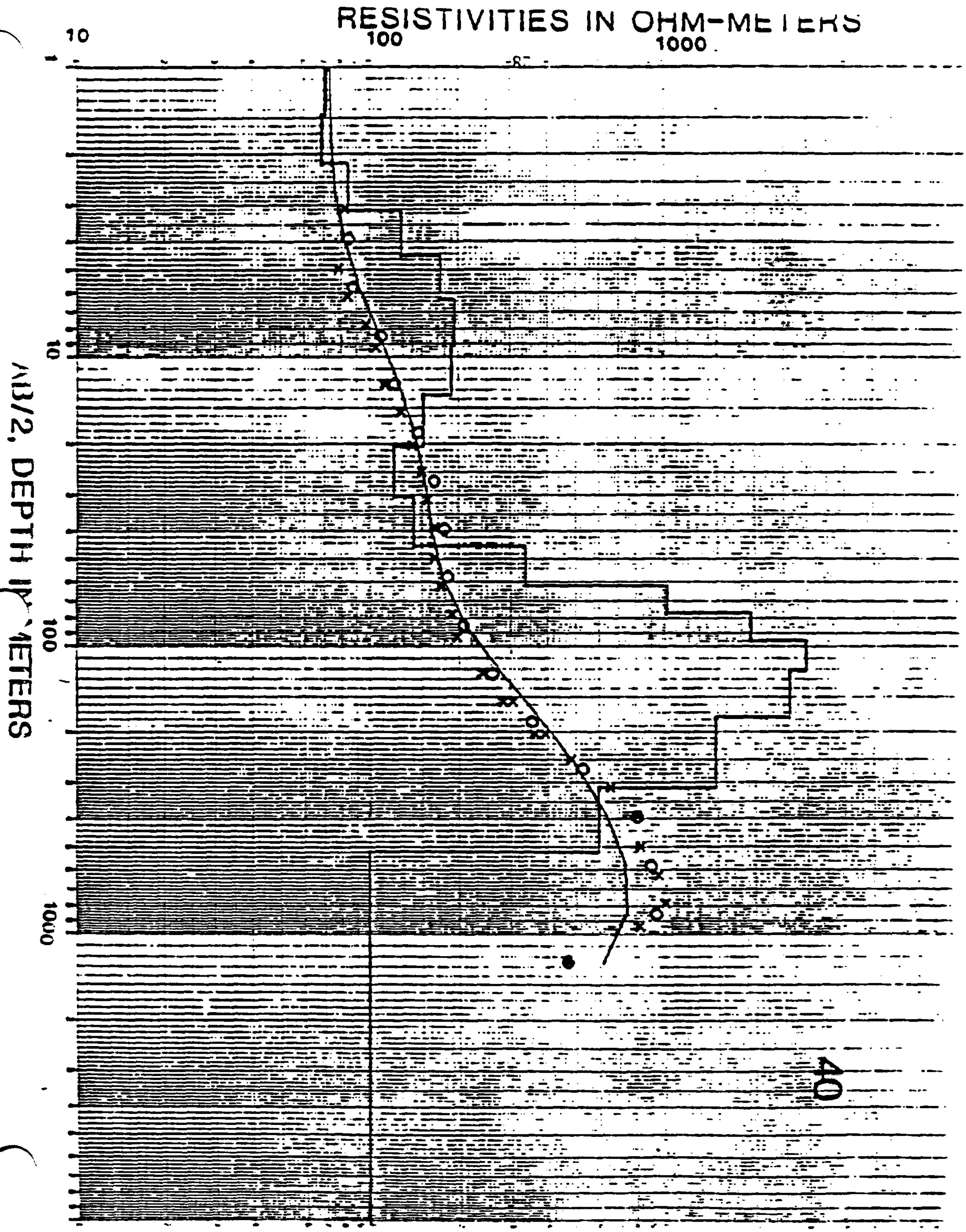

RESISTIVITIES IN OHM-METERS
10
100
1000
10
100
1000
AB/2, DEPTH I
ETERS

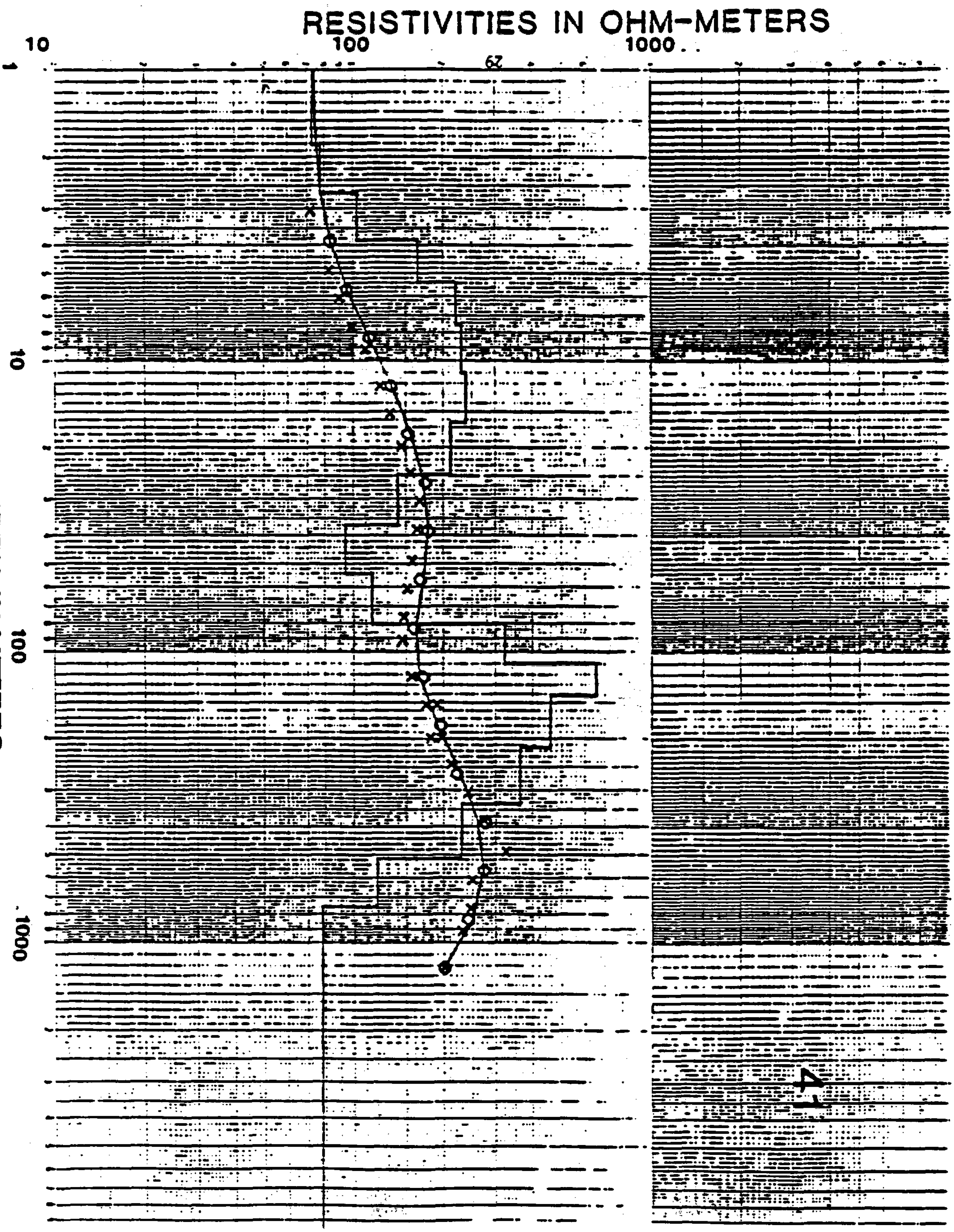


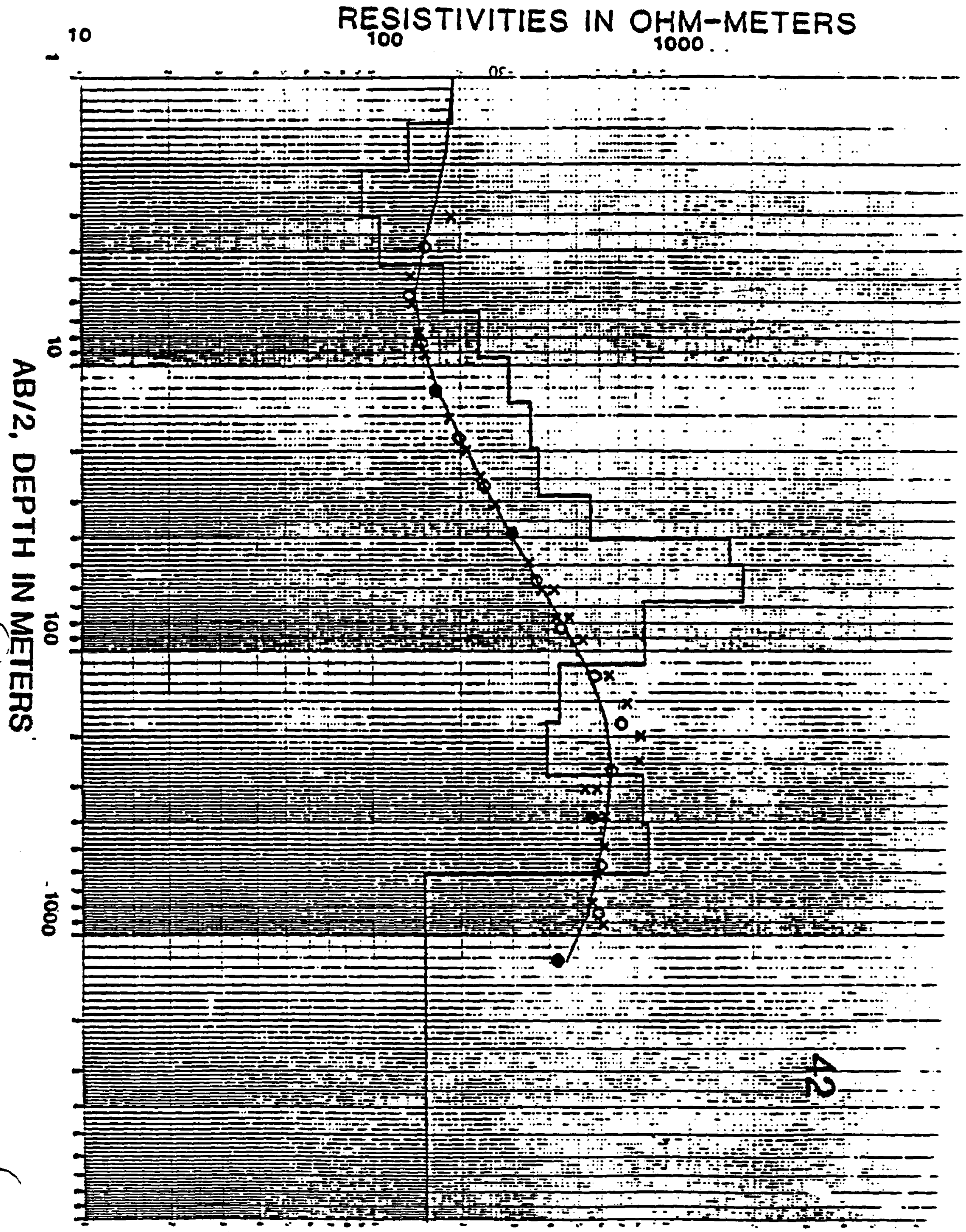
RESISTIVITIES IN OHM-METERS
10
100
1000
DEPTH IN METERS
1
10
100
1000
37

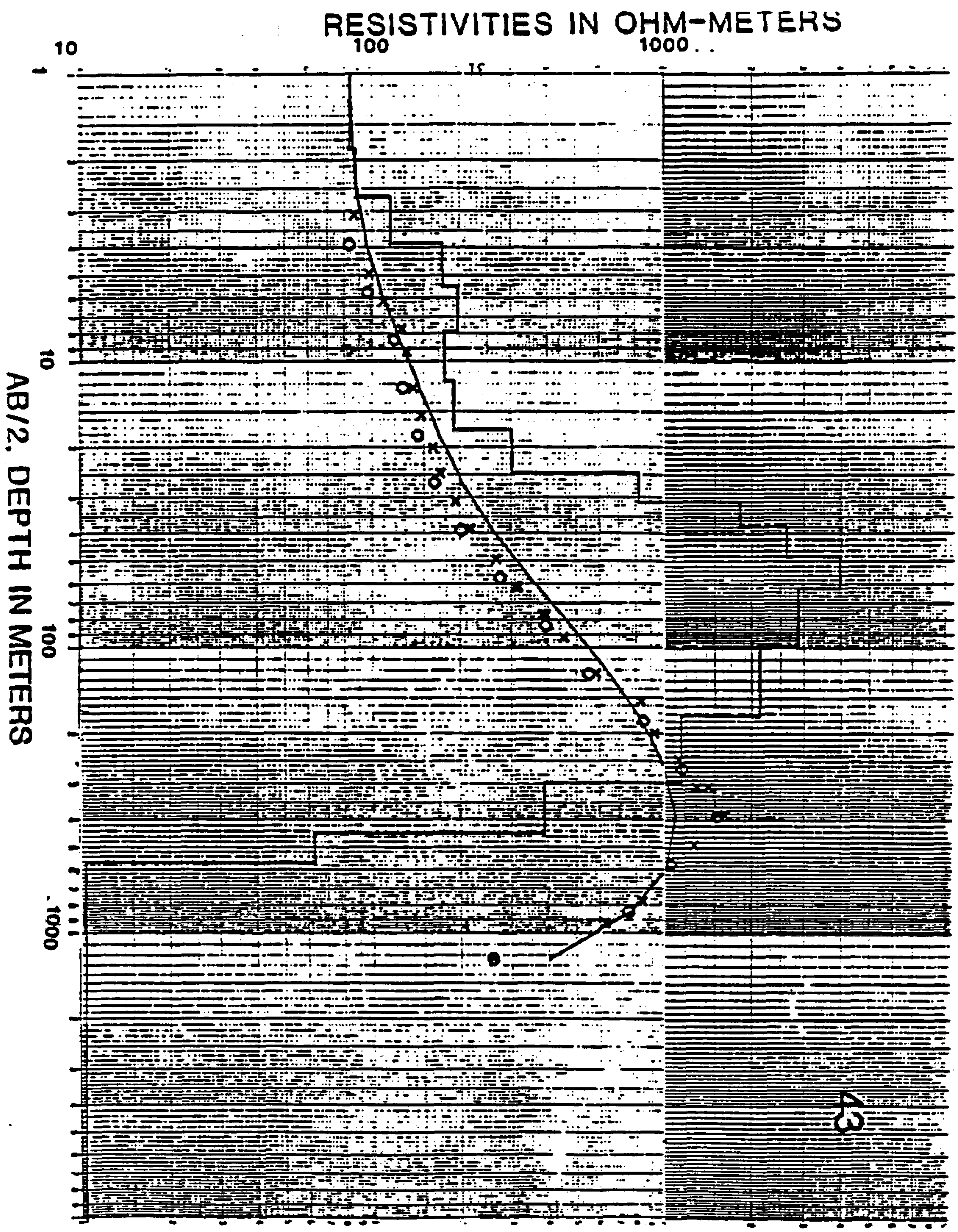

RESISTIVITIES IN OHM-METERS
10
100
1000
AB/2, DEPTH IN METERS
10
100
1000
38


RESISTIVITIES IN OHM-METERS
10
100
1000
1
10
100
1000
AB/2 DEPTH IN METERS

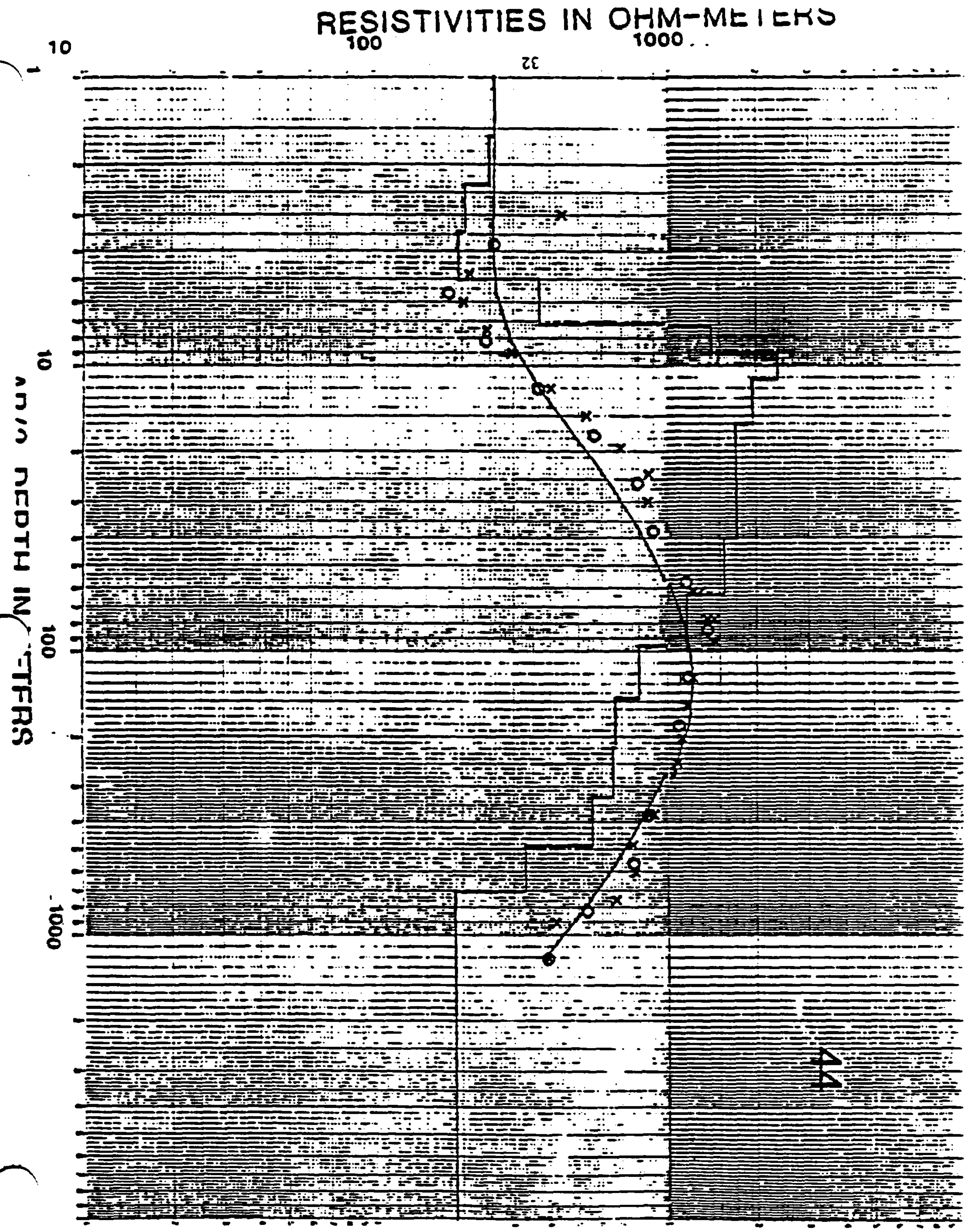

RESISTIVITIES IN OHM-METERS
10
100
1000
AB/2, DEPTH
ETERS
10
100
1000

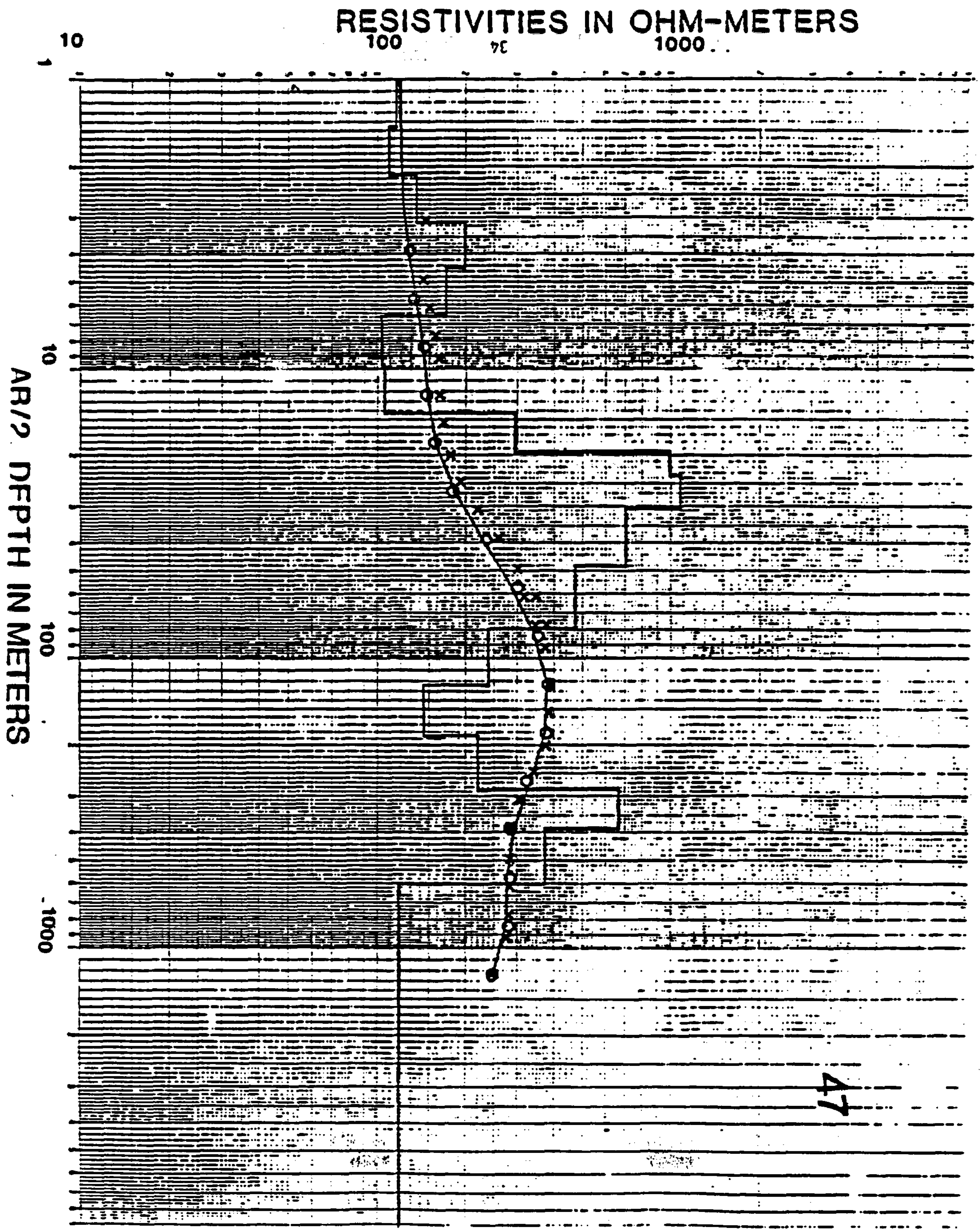

RESISTIVITIES IN OHM-METERS
10
100
1000
62
1
10
100
1000
APP. DEPTH IN METERS
41


RESISTIVITIES IN OHM-METERS
10
100
1000
1
10
100
1000
AB/2, DEPTH IN METERS
42

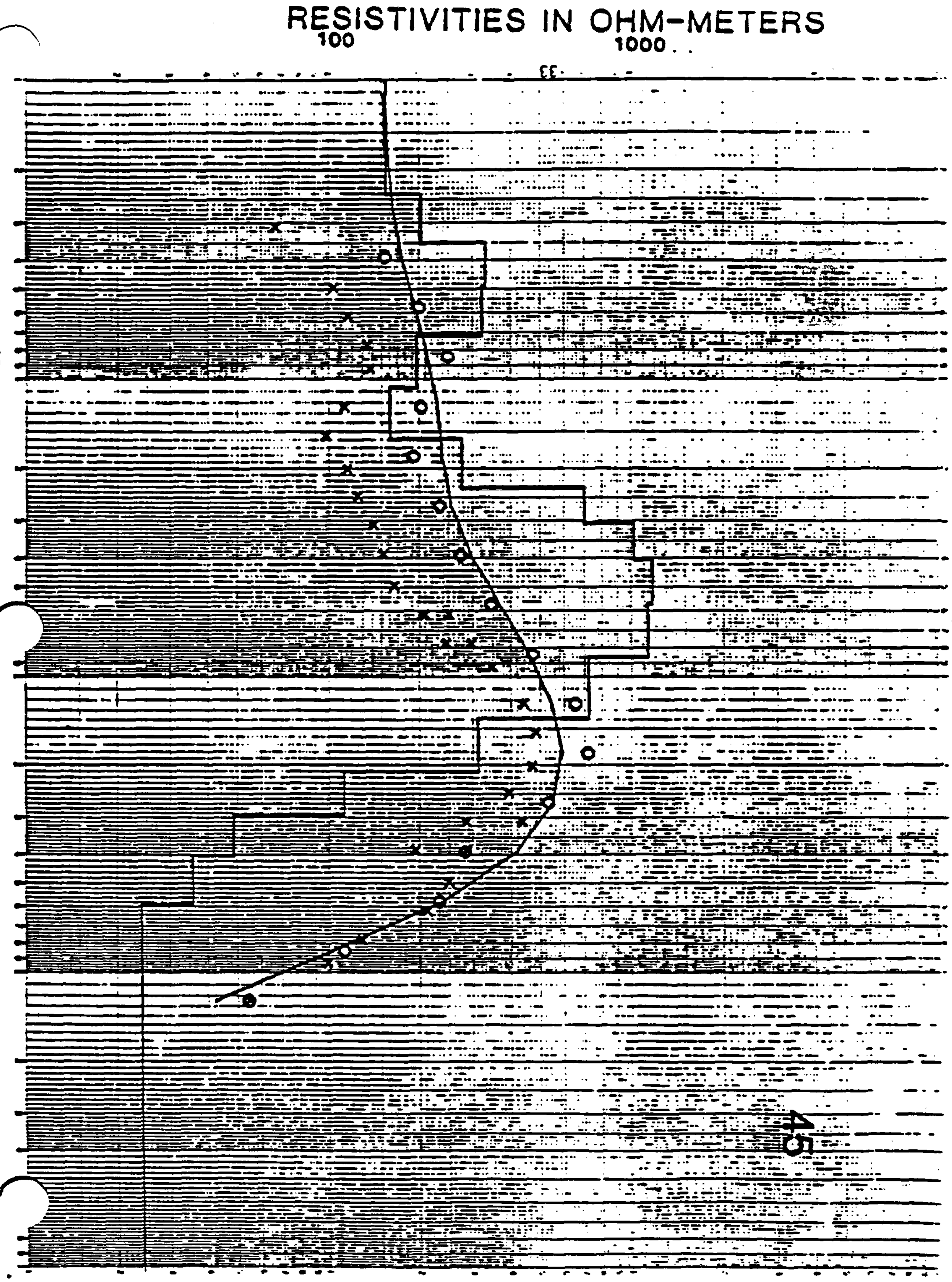


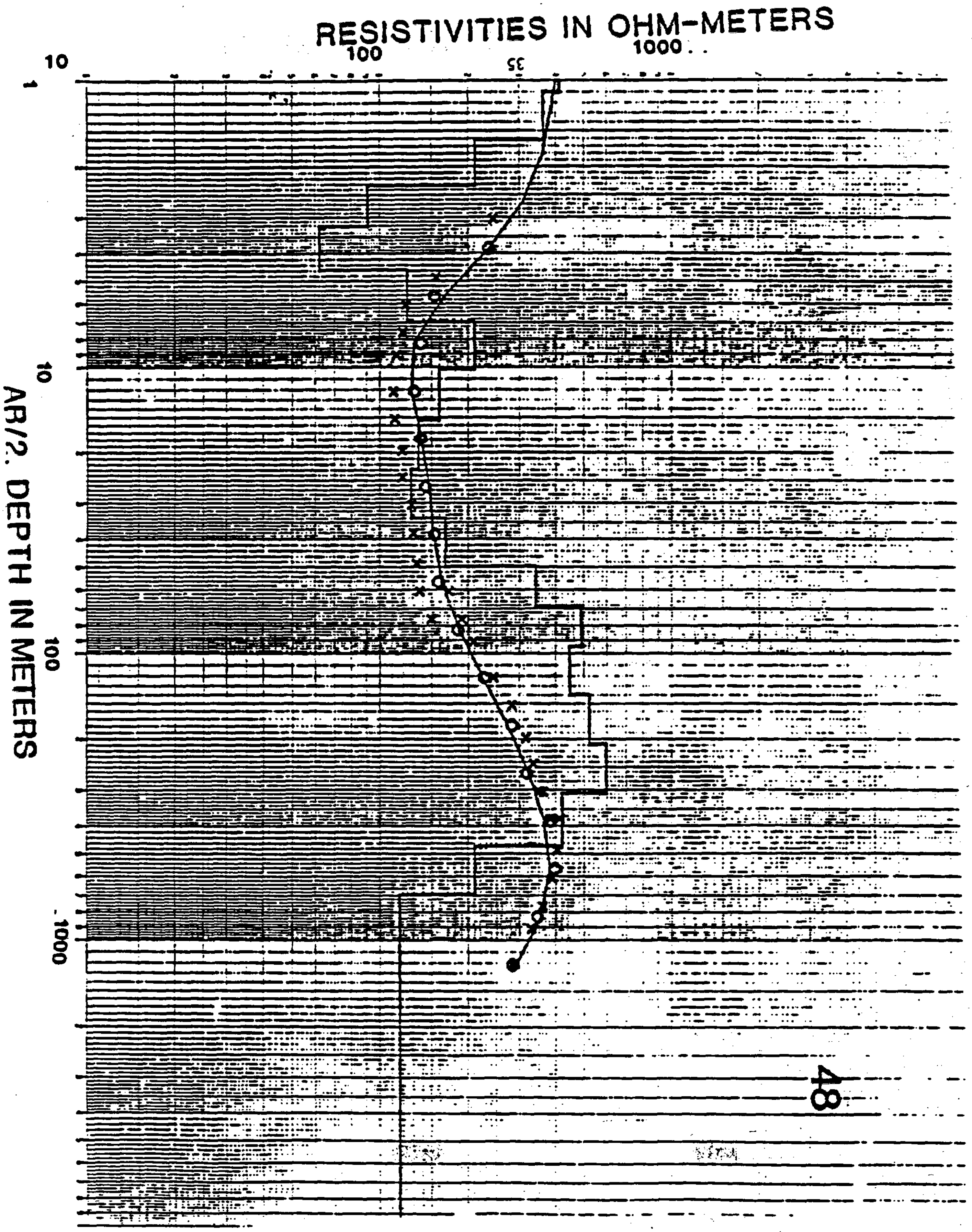
RESISTIVITIES IN OHM-METERS
10
100
1000
1
10
100
1000
AB/2. DEPTH IN METERS
43

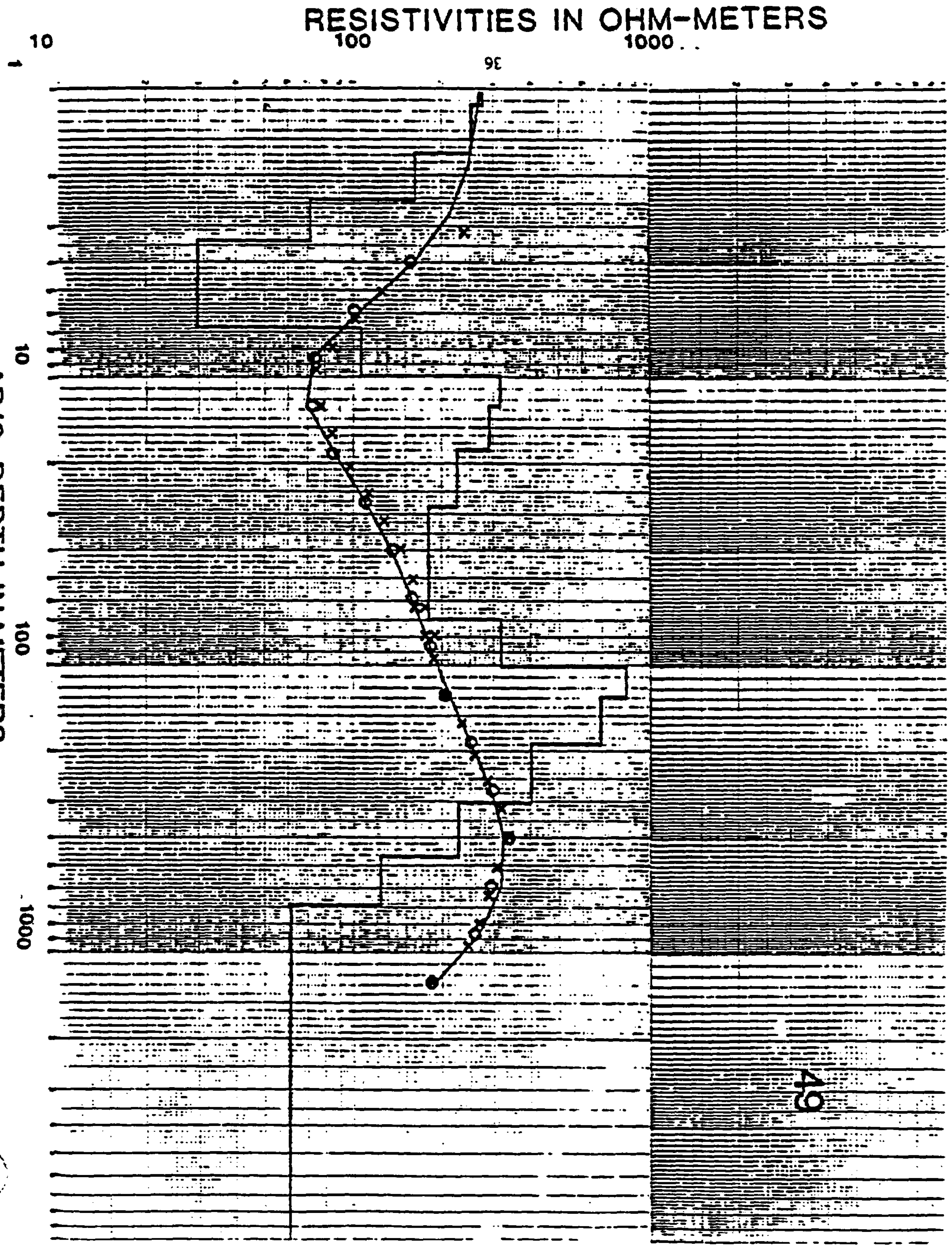

RESISTIVITIES IN OHM-METERS
10
100
1000
32
10
100
1000
DEPTH IN
44



RESISTIVITIES IN OHM-METERS
10
100
1000
1
10
100
1000
DEPTH IN METERS


RESISTIVITIES IN OHM-METERS
100
1000
10
45


RESISTIVITIES IN OHM-METERS
10
100
1000
35
1
10
100
1000
AB/2. DEPTH IN METERS


RESISTIVITIES IN OHM-METERS
10
100
1000
AB/2 DEPTH IN METERS
10
100
1000
36
49

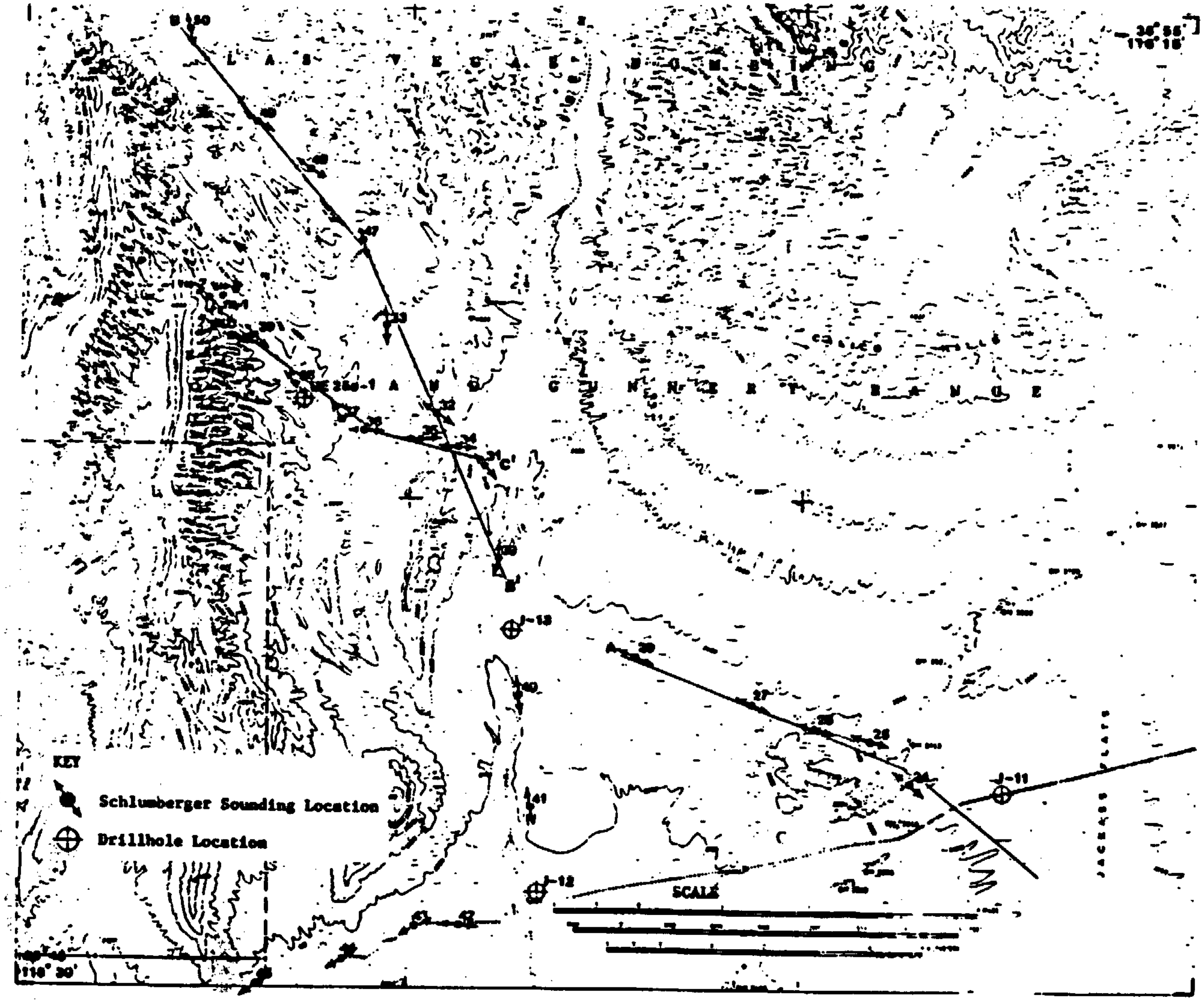
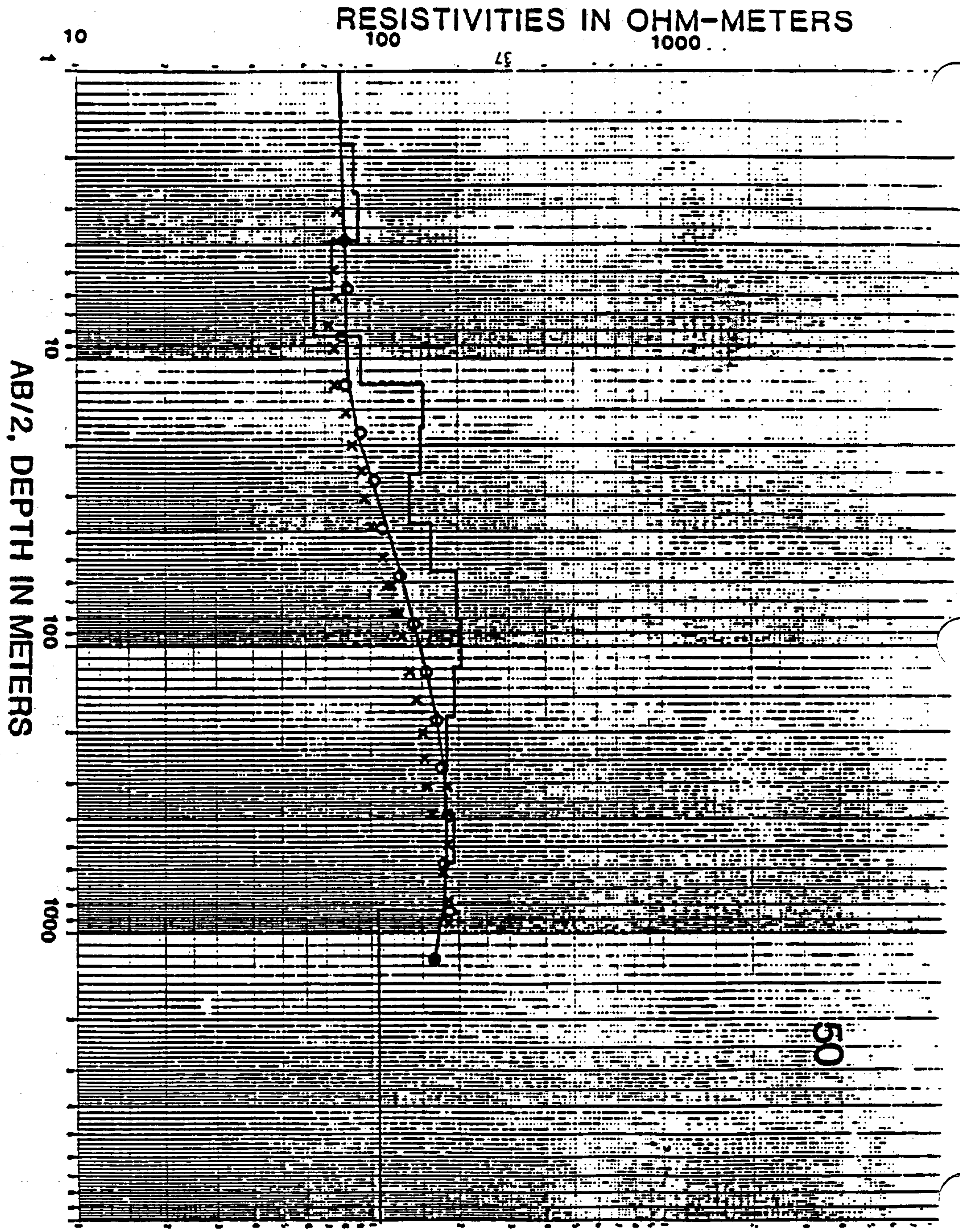
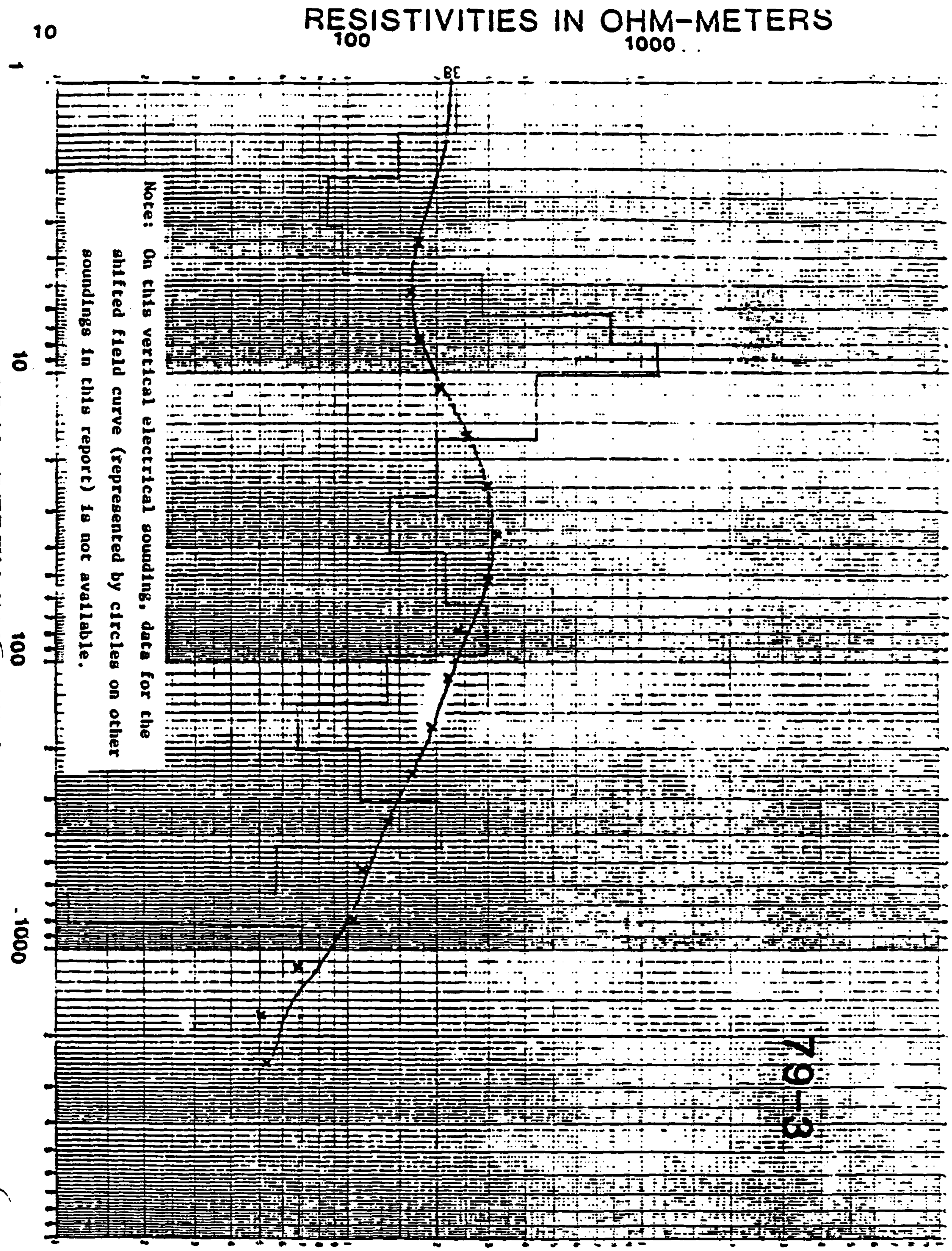


Plate 1.-- Map of part of the Topopah Spring Quadrangle, Nev., showing the location of the Schlumberger soundings included in this report.


RESISTIVITIES IN OHM-METERS
10
100
1000
37
1
10
100
1000
AB/2, DEPTH IN METERS
50


RESISTIVITIES IN OHM-METERS
10
100
1000
38
1
10
100
1000
AB/2 DEPTH IN
Note: On this vertical electrical sounding, data for the shifted field curve (represented by circles on other soundings in this report) is not available.
79-3