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DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Stop 964, Box 25046
Federal Center, Denver, Colorado 80225

SCHLUMBERGER SOUNDINGS AND GEOELECTRIC CROSS-SECTIONS IN YUCCA LAKE, NEVADA TEST SITE, NEVADA

by

Adel A. R. Zohdy and

Robert J. Bisdorf

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In 1977, the U.S. Geological Survey made fifty two (52) symmetric Schlumberger resistivity soundings (Zohdy and others, 1974) in the Yucca Lake area, Nevada Test Site, Nevada. The purpose of the survey was to study the five large cracks that have opened successively, in the lake deposits, from pre-1950 to 1969. The results of the study indicate that:

(1) There are no large gravel deposits near the open cracks.

(2) It is easy to determine the thickness of the lake deposits with the Schlumberger sounding method.

(3) There is strong evidence for the presence of faults in the NNW-SSE direction.

(4) There is evidence for faults in the ENE-WSW direction; they are located in the vicinity of the cracks.

Figure 1 is an index map showing the location, number, and azimuth of the Schlumberger sounding stations and also the location of five cross sections. Figure 2 shows a simplified geologic interpretation of the five computer-generated geoelectric sections (DF, CG, EA, DA, and EB) shown in figures 3, 4, 5, 6, and 7. The geoelectric sections depict contours of interpreted true resistivities in ohm-meters. In each of figures 3, 4, 5, 6, and 7, the top part represents a ten to one vertically exaggerated representation of the upper 215 meters, whereas

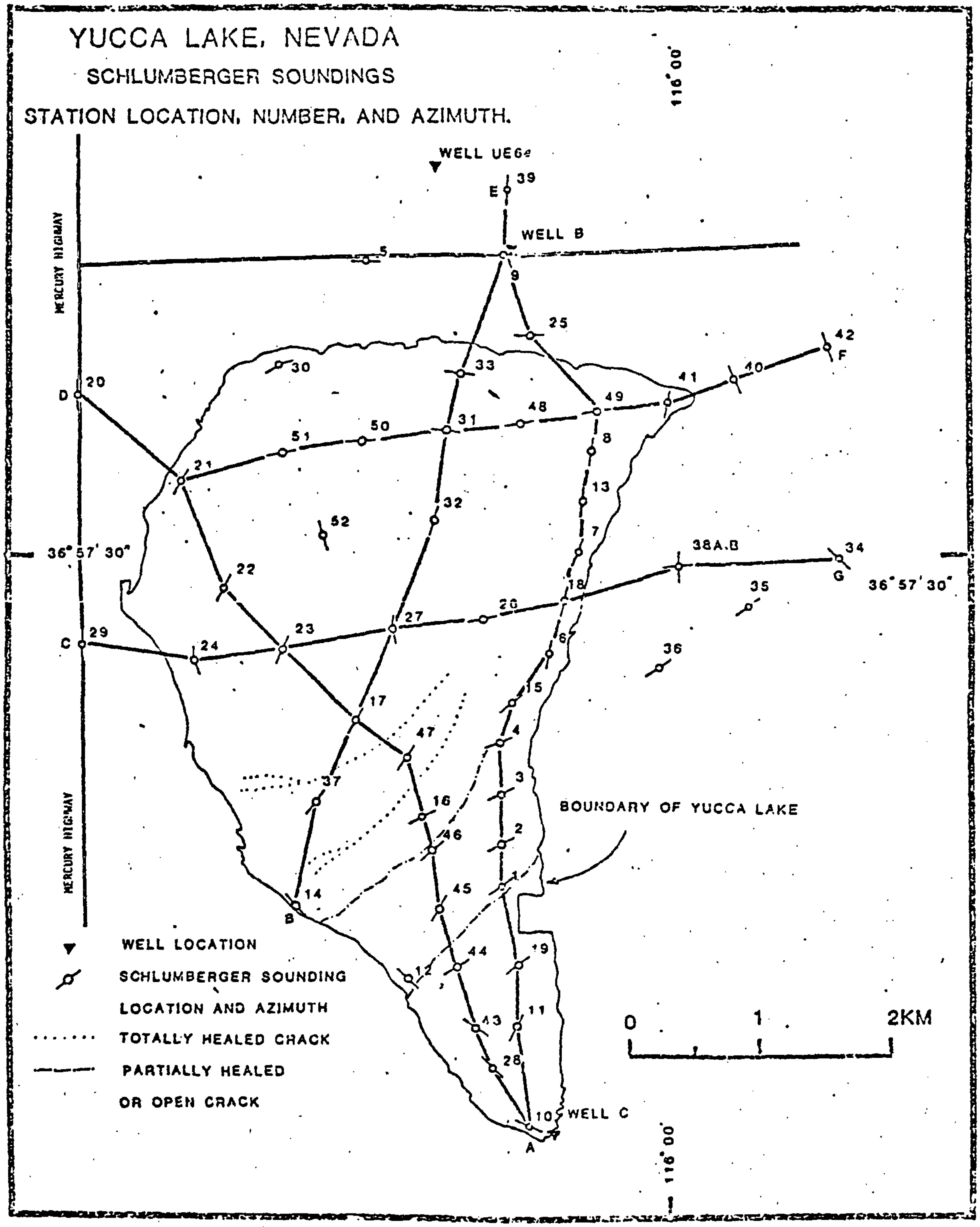


Figure 1.--Index map of Yucca Lake, Nye Country, Nevada, showing location of Schlumberger soundings. Mapped cracks from McKeown and others (1976).

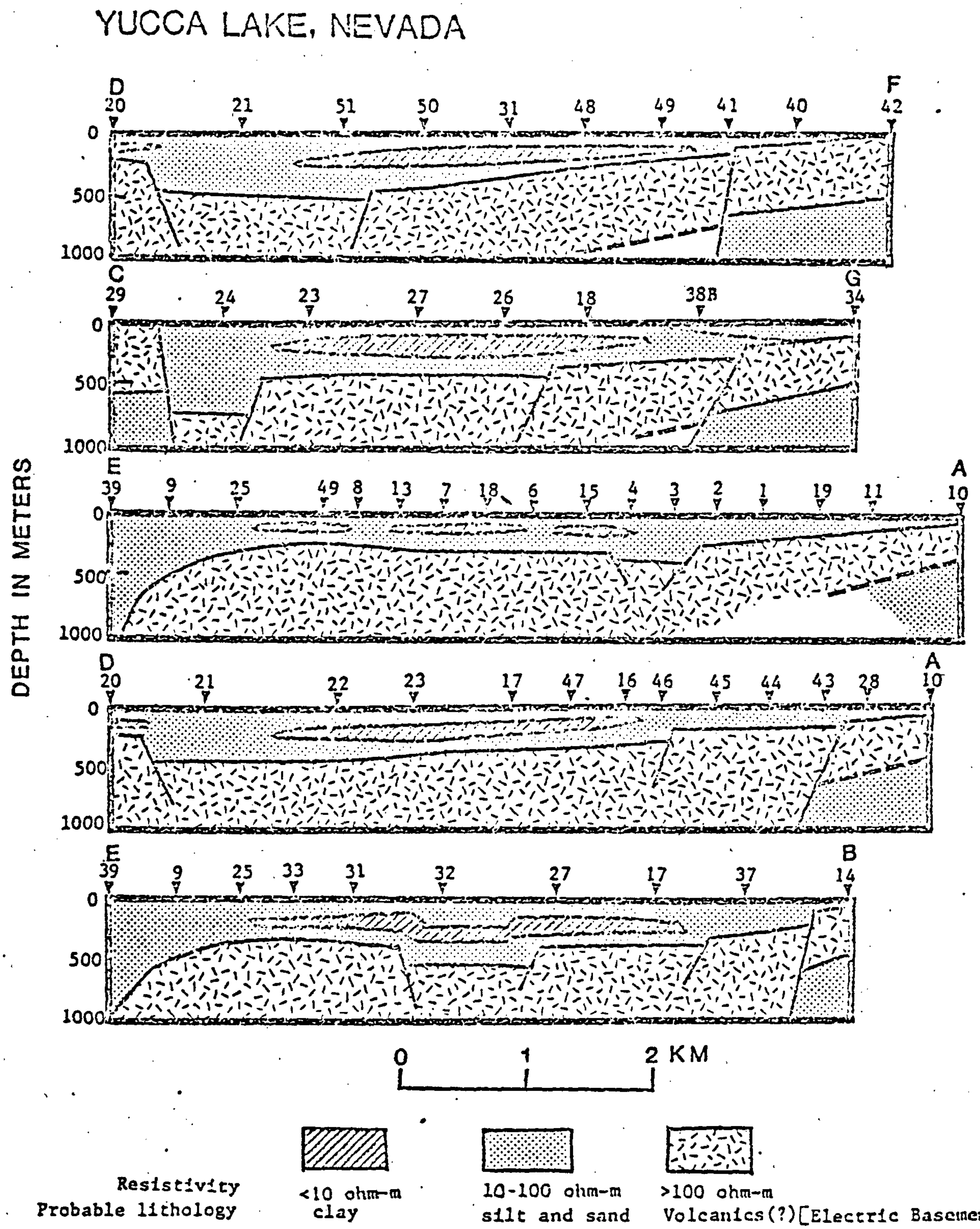


Figure 2.--Interpreted geologic cross sections in Yucca Lake.
See figure 1 for locations.

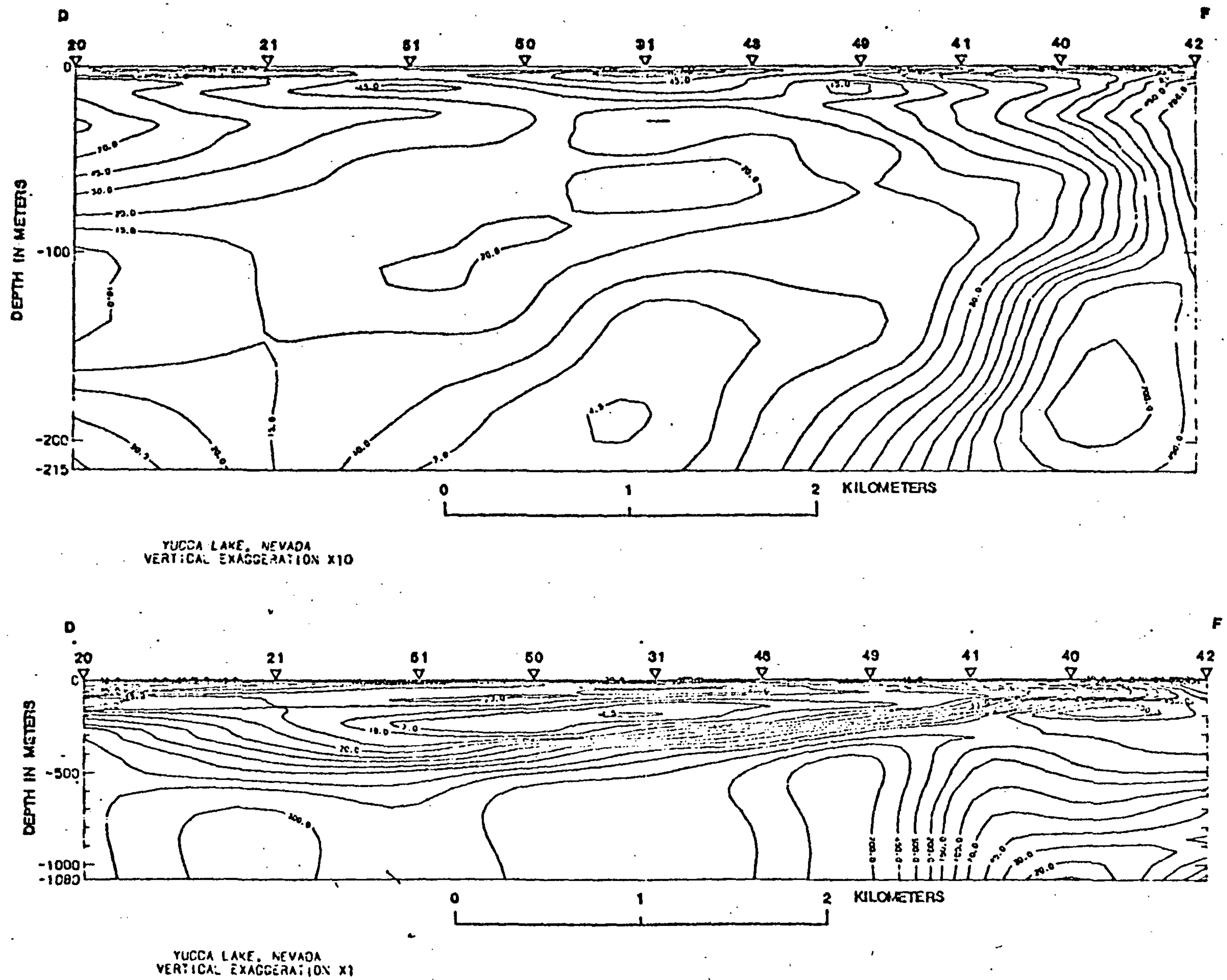
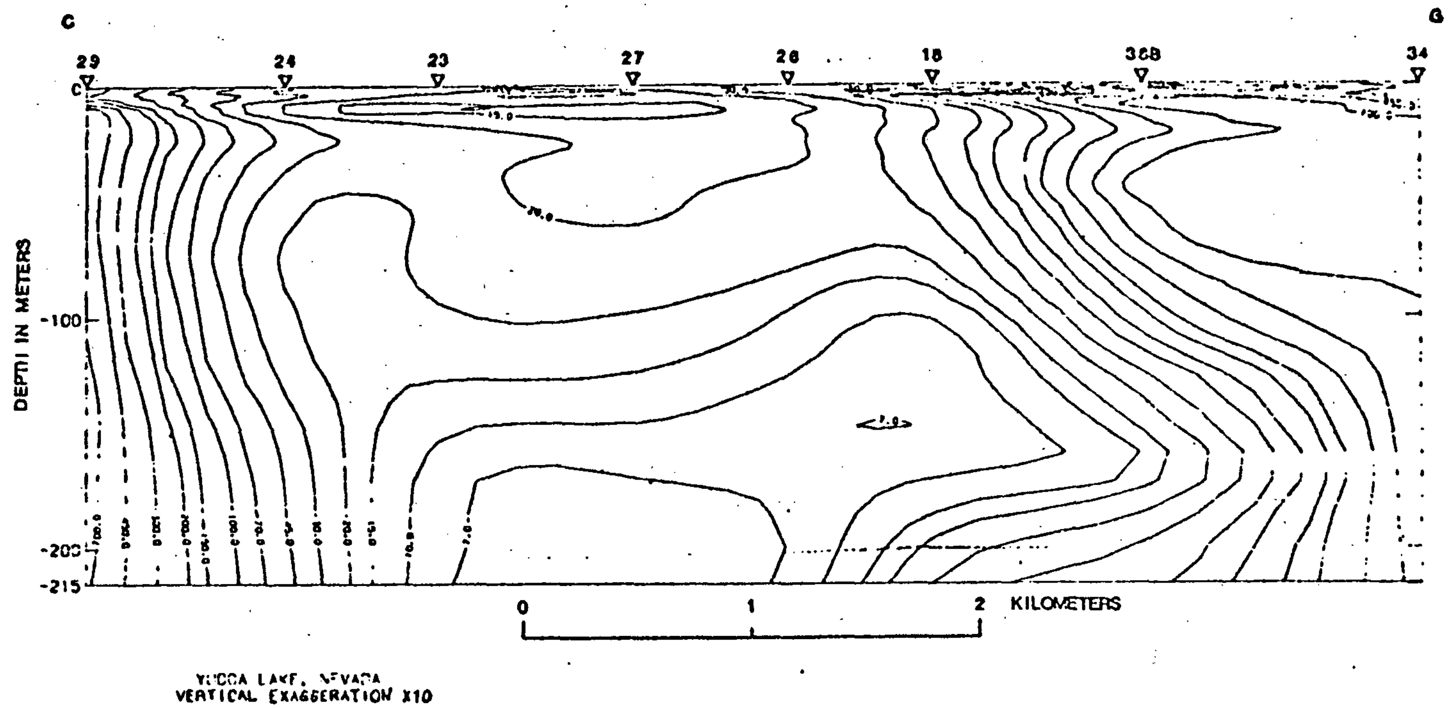


Figure 3.--Geoelectric section D-F, contours in ohm-meters.



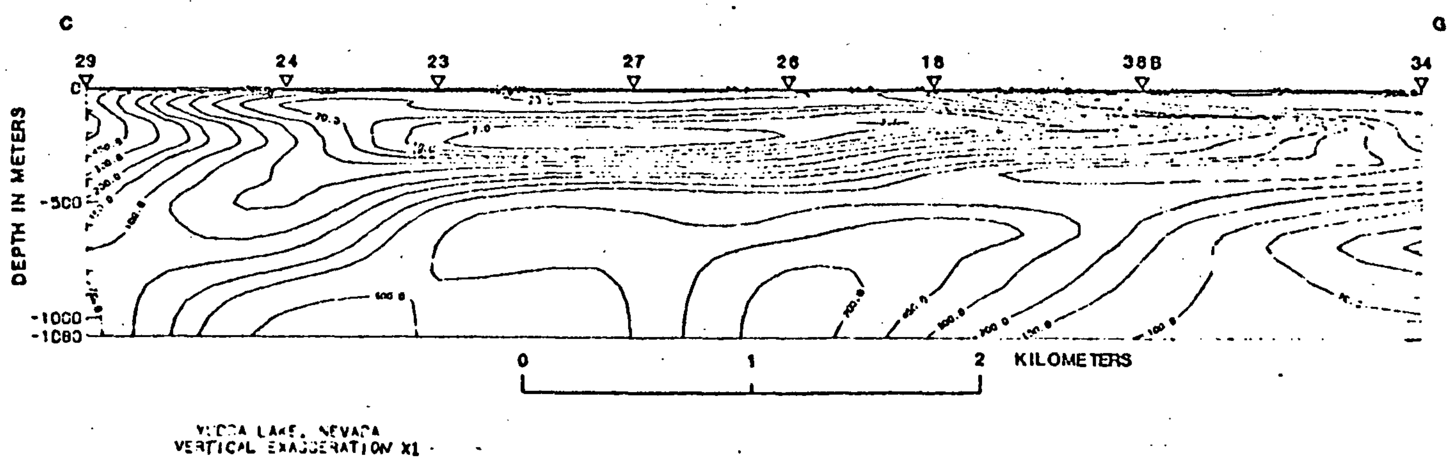


Figure 4.--Geoelectric section C-G, contours in ohm-meters.

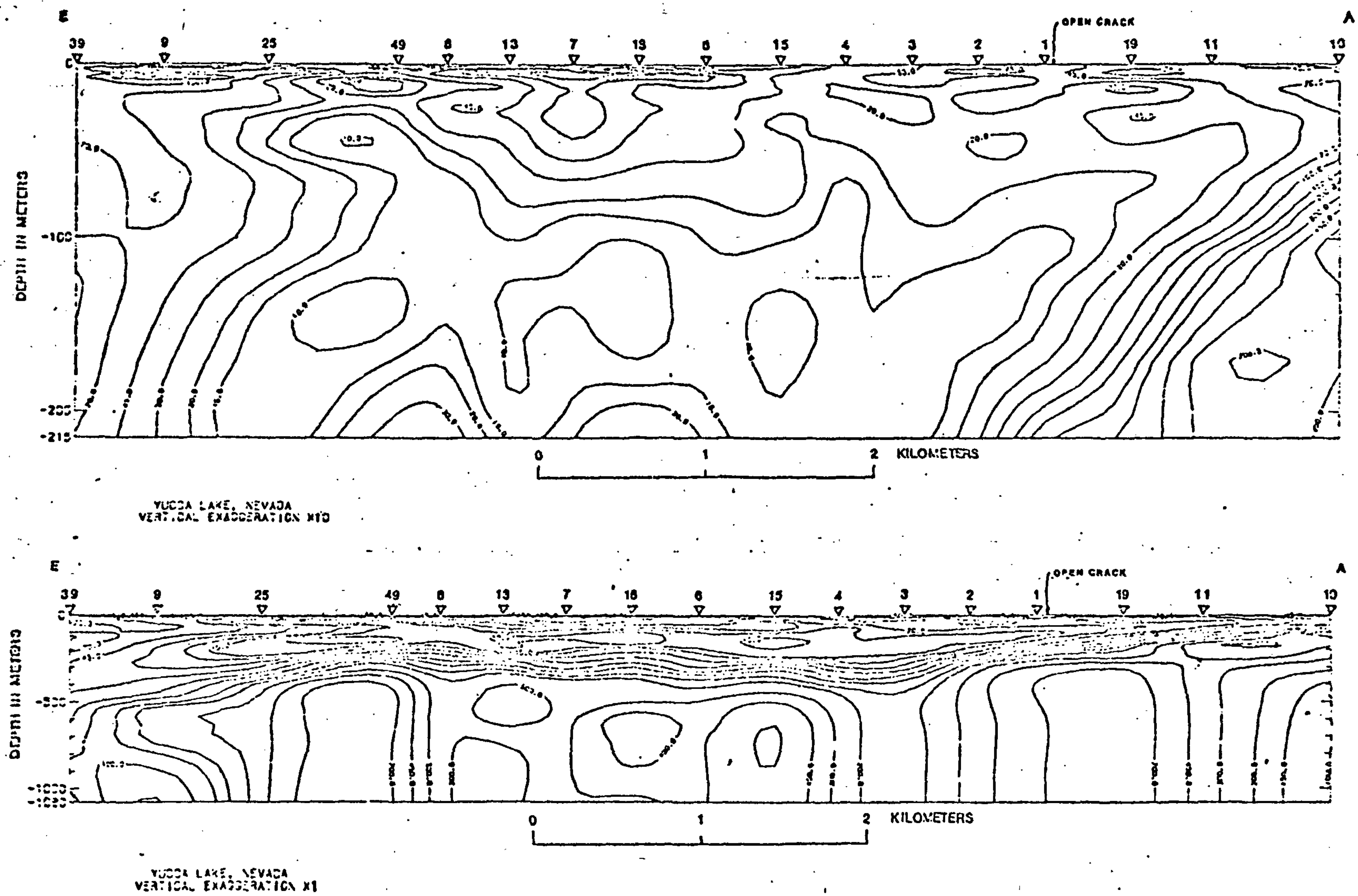


Figure 5.--Geoelectric section E-A, contours in ohm-meters.

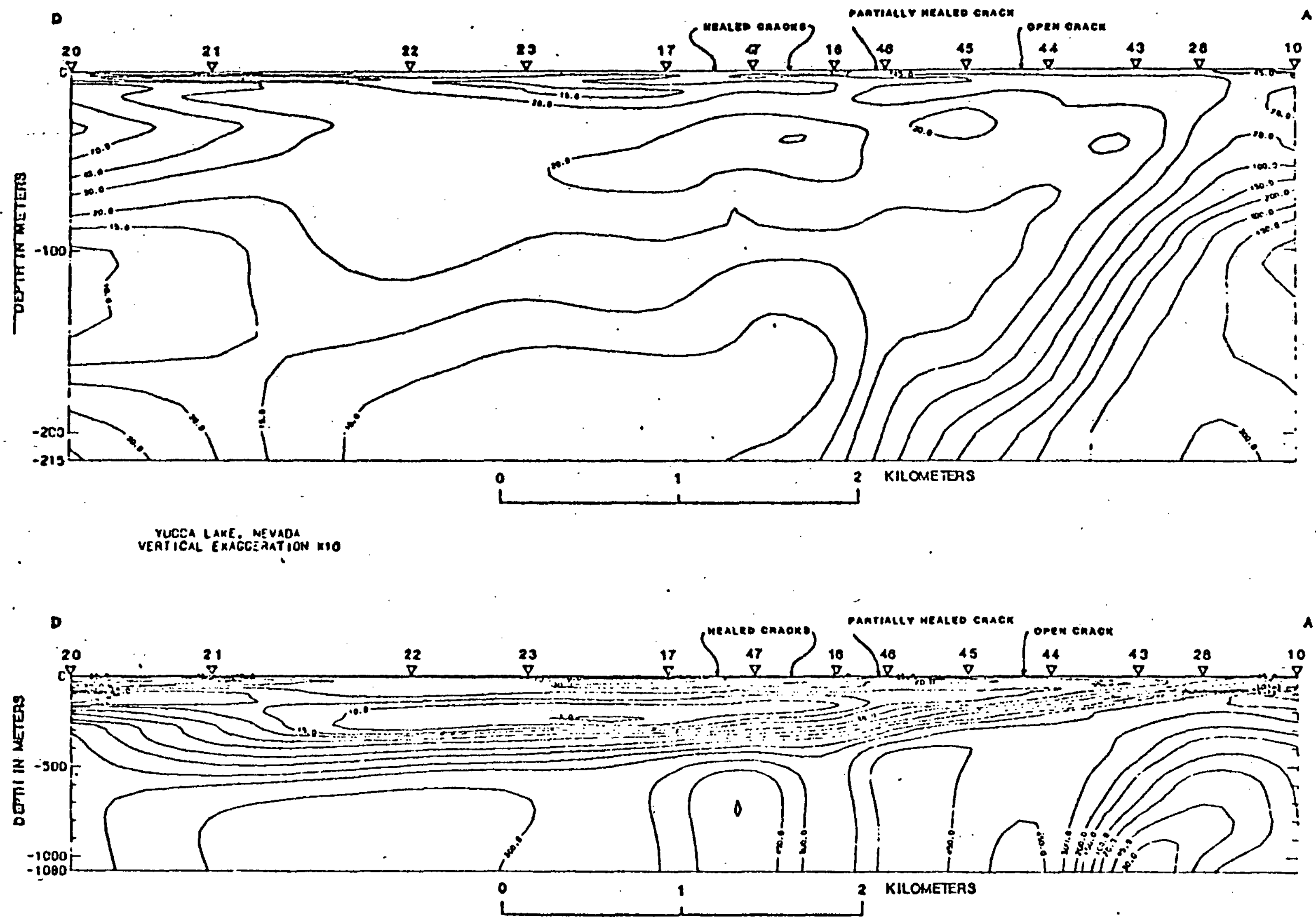


Figure 6.--Geoelectric section D-A, contours in ohm-meters.

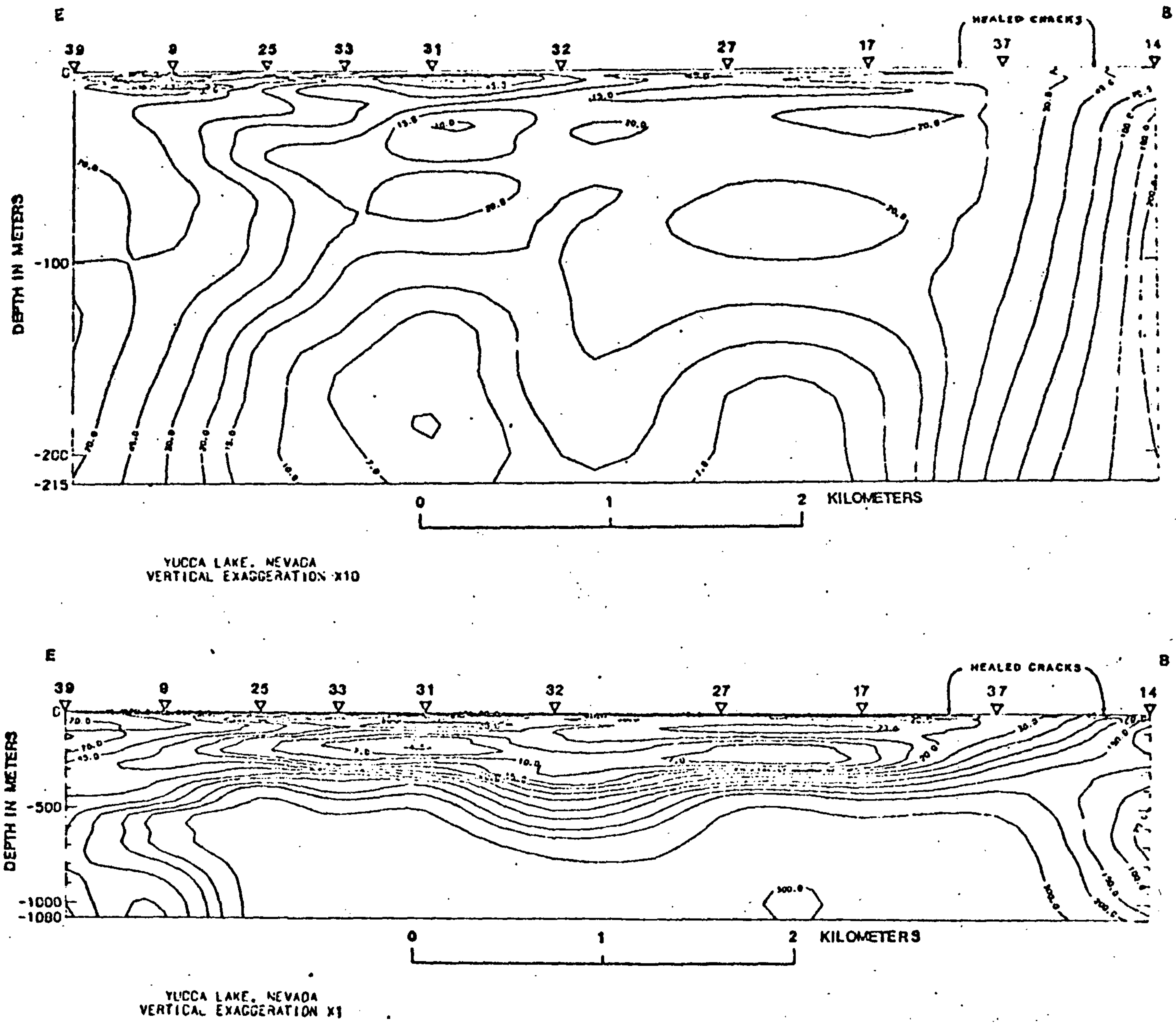


Figure 7.--Geoelectric section E-B, contours in ohm-meters.

the bottom part represents a one to one (no vertical exaggeration) representation of the upper 1080 meters in the section. In general, low resistivities are associated with an increase in porosity, clay content, and pore-water salinity. Extremely low resistivities of one ohm-meter or less, which often are measured in other playas (see for example Bisdorf and Smith, 1976), were not measured in the Yucca Lake deposits. This indicates that the salinity of the Yucca Lake deposits is low, and that the relatively low resistivities of 4.5-10 ohm-meters, which were measured at intermediate depths in the section, are probably caused by an enrichment in clay deposits rather than by very high salinity. In fact, the measured resistivities in Yucca Lake are, on the average, 10-20 times higher than in most other playas.

Figure 8 is a map showing the location of inferred faults in the electric basement. The electric basement here is defined as rocks of very high resistivity (>500 ohm-meters) underlying the lake deposits. This electric basement may correspond to the welded tuffs of Pliocene and Miocene age described by McKeown and others (1976). It is interesting to note that some of these inferred faults have the same (ENE-WSW) trend and location as the cracks, which indicates that the crack formation may be in part structurally controlled.

The sounding curves are given in the Appendix and are numbered from Yucca Lake #1 to Yucca Lake #52. The maximum electrode spacings (AB/2) ranged from about 610 meters (2,000 feet), as for Yucca Lake #1, to about 4,877 meters (16,000 feet), as for Yucca Lake #41. For soundings Yucca Lake #2, #5, and #37, the asymmetric Schlumberger array was used to compute a symmetric Schlumberger apparent resistivity using a correction formula (Zohdy and Bisdorf, 1976; Zohdy, 1978).

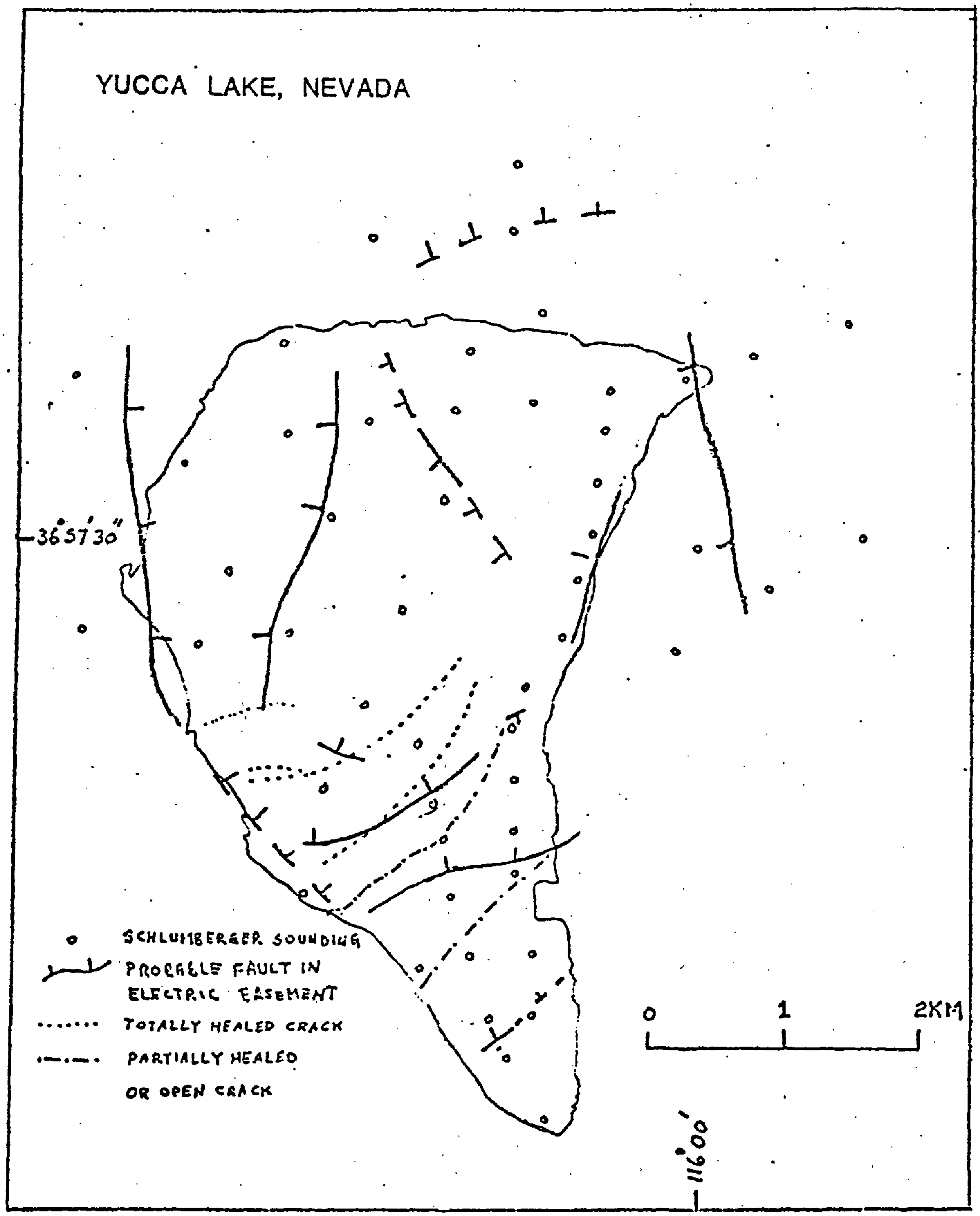


Figure 8.--Map showing location of inferred faults in electric basement. Crack locations are from McKeown and others (1976).

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, or shifted field curve, which is 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). Because of the remarkably homogeneous character of the lake deposits, the magnitude of the required shift for most curves was minimal or nonexistent.

(b) the digitized curves 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, 1973, 1975) to obtain the best fitting theoretical sounding curve for a horizontally layered medium. The computer program used here is an updated version of the one (Zohdy, 1973) referred to above.

(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. curve are shifted upward or downward by one logarithmic cycle to avoid cluttering the graph. A D.Z. curve can be used to obtain equivalent and simpler solutions containing fewer number of layers and in which certain constraints can be imposed on the layer thicknesses and resistivities (Zohdy, 1974).

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.

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_____ 1974, The use of Dar Zarrouk curves in the interpretation of VES data: U.S. Geol. Survey Bull. 1313-D, 41 p.

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Survey Techniques of Water-Resources Inv. TWI2-D1, 116 p. p.

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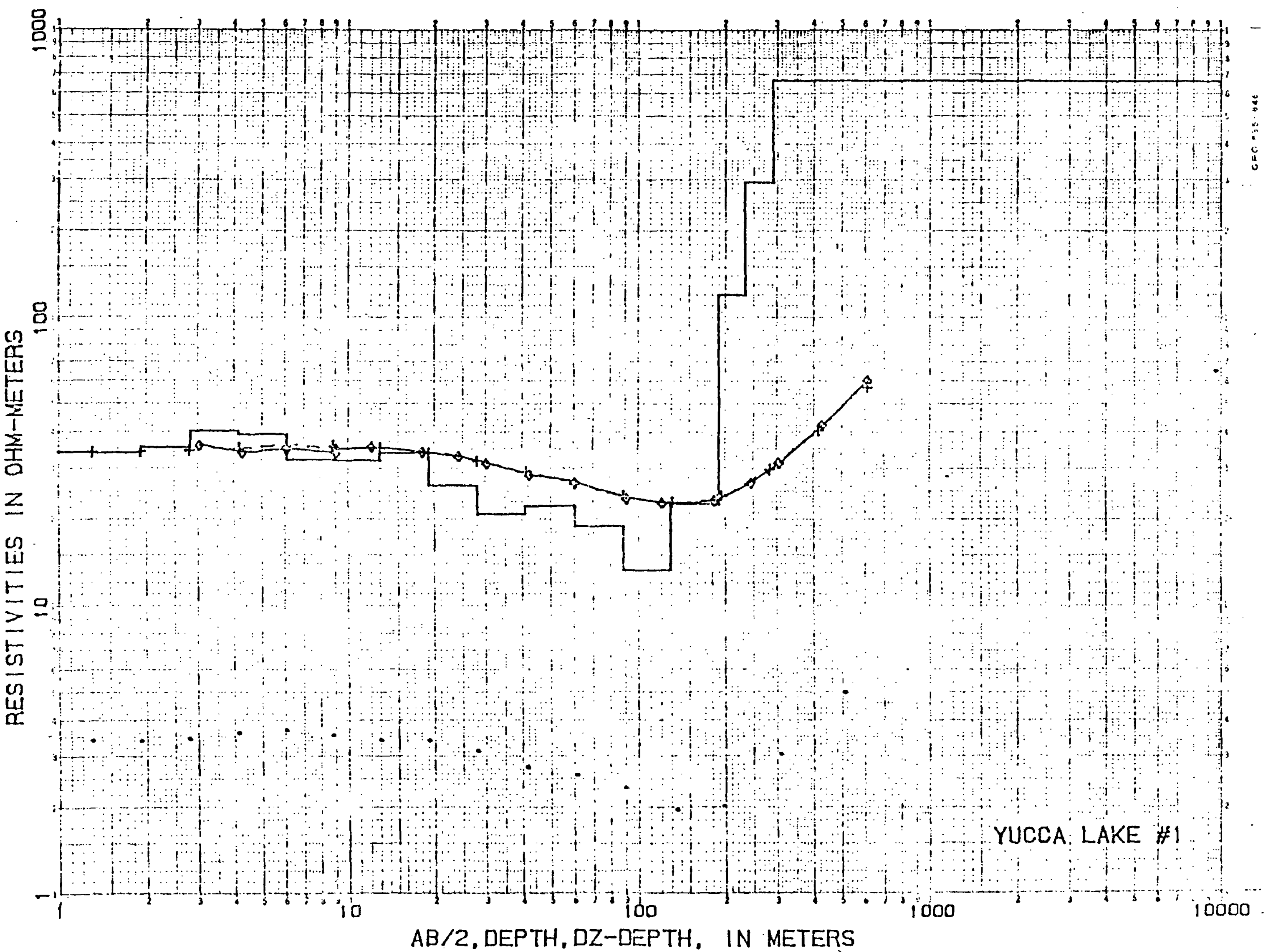
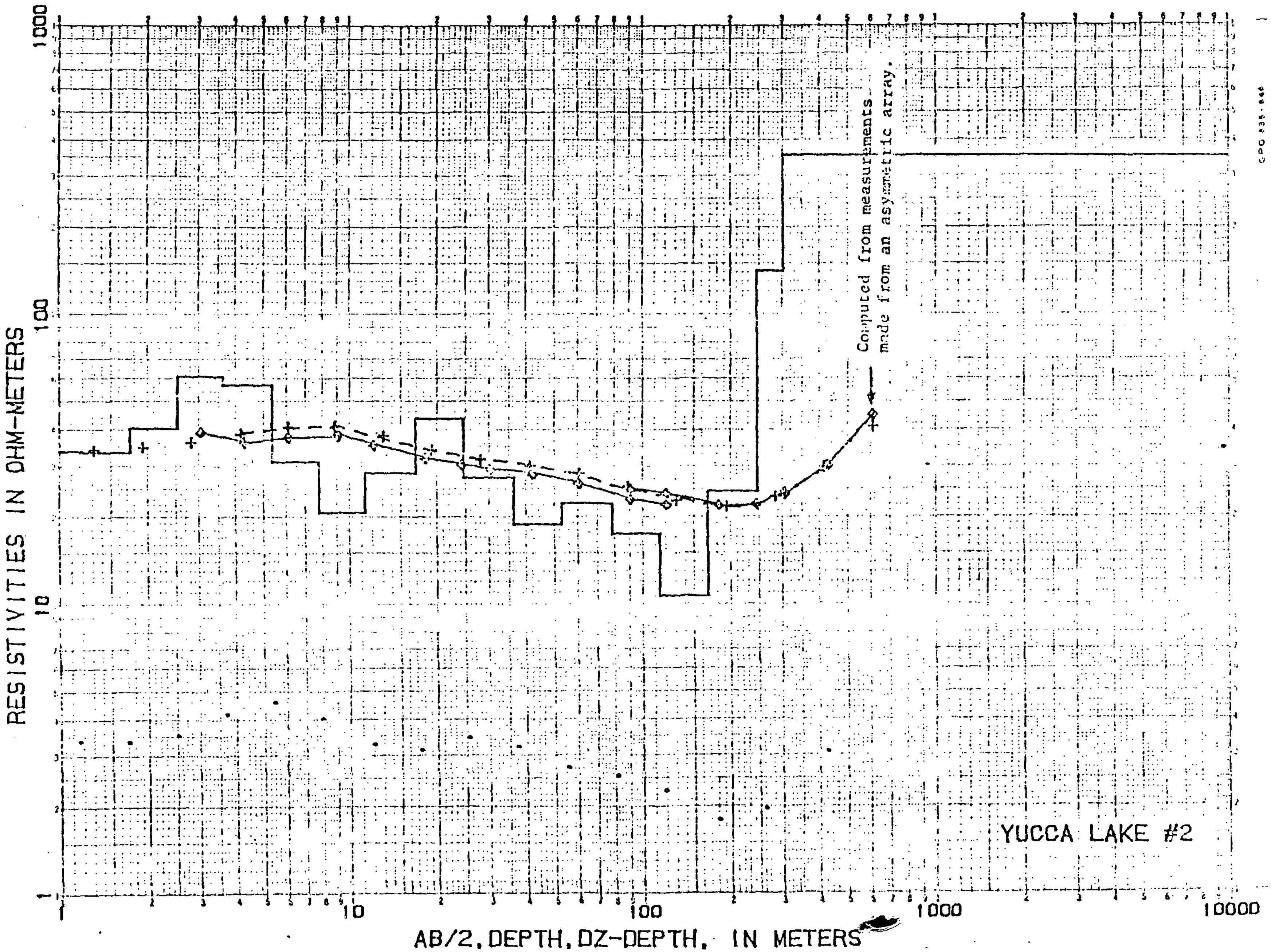
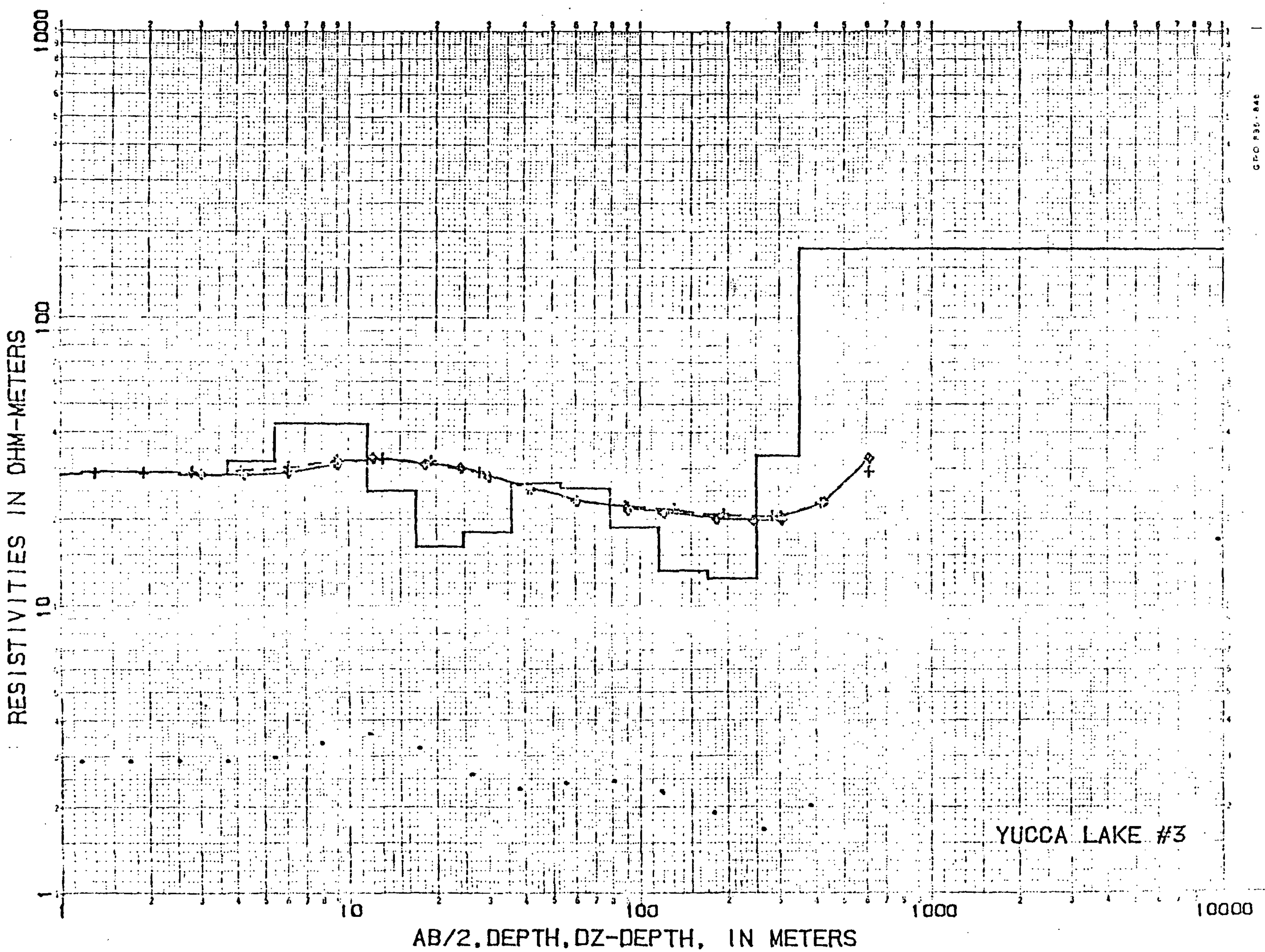
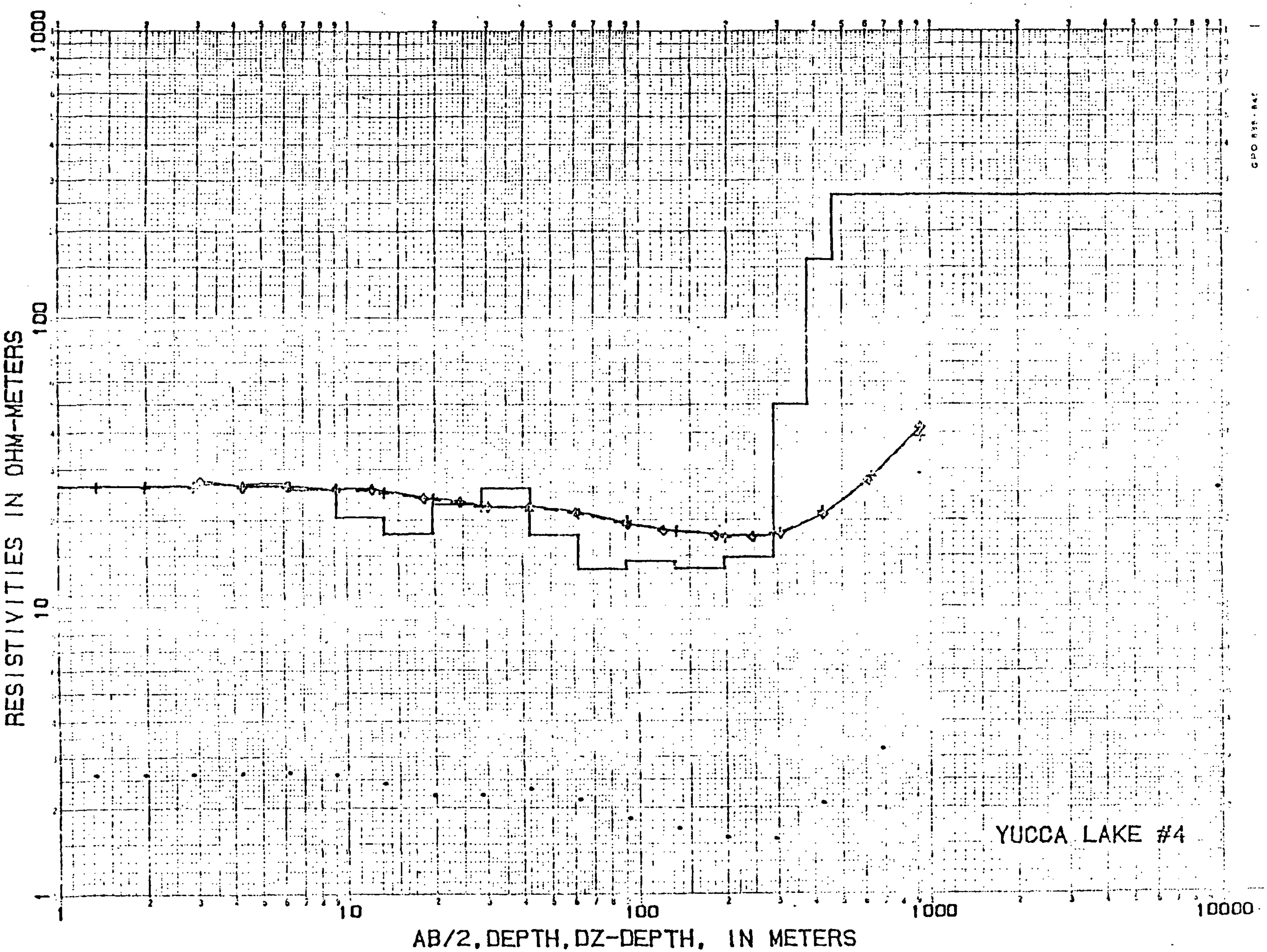
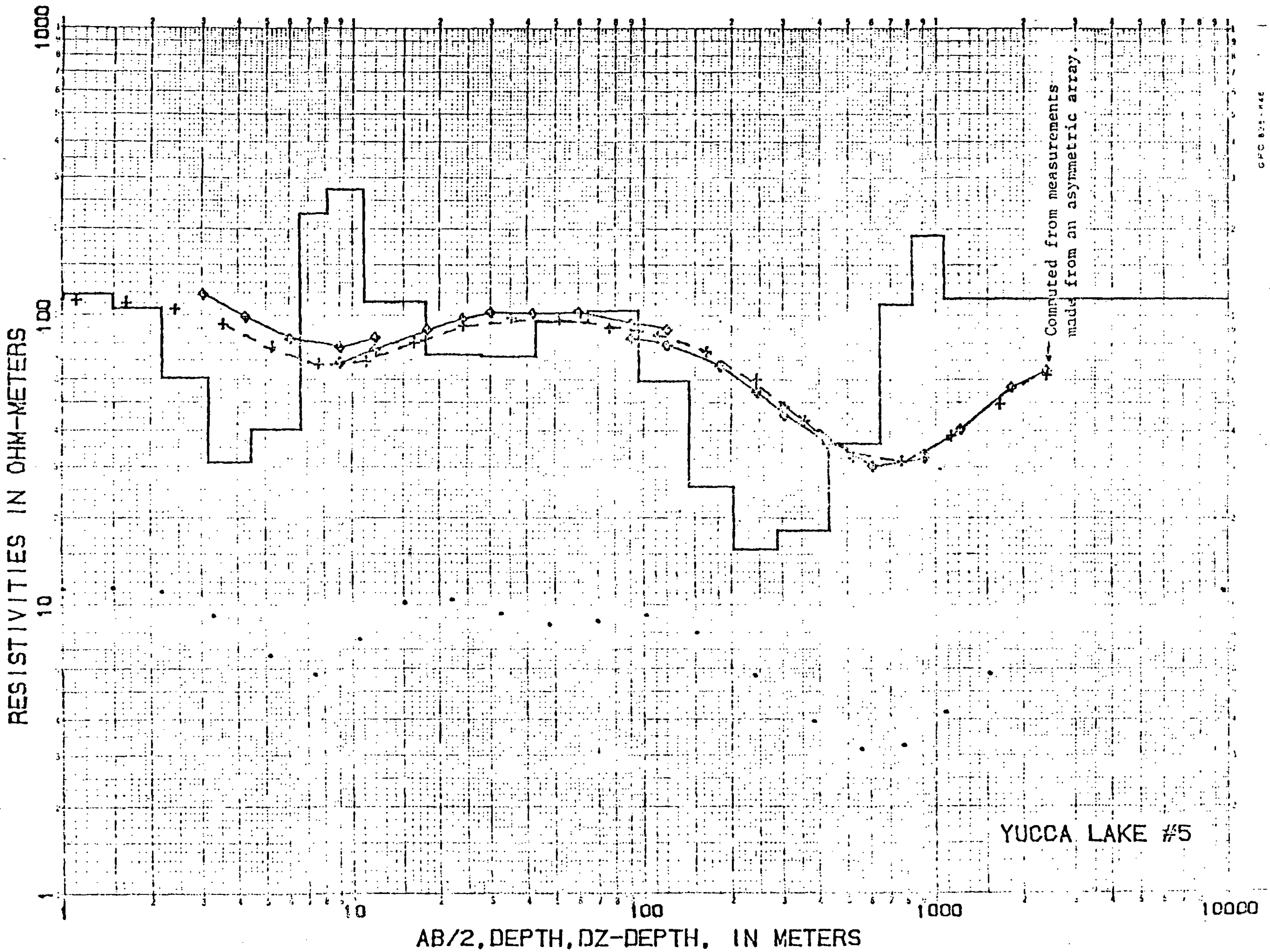
APPENDIX

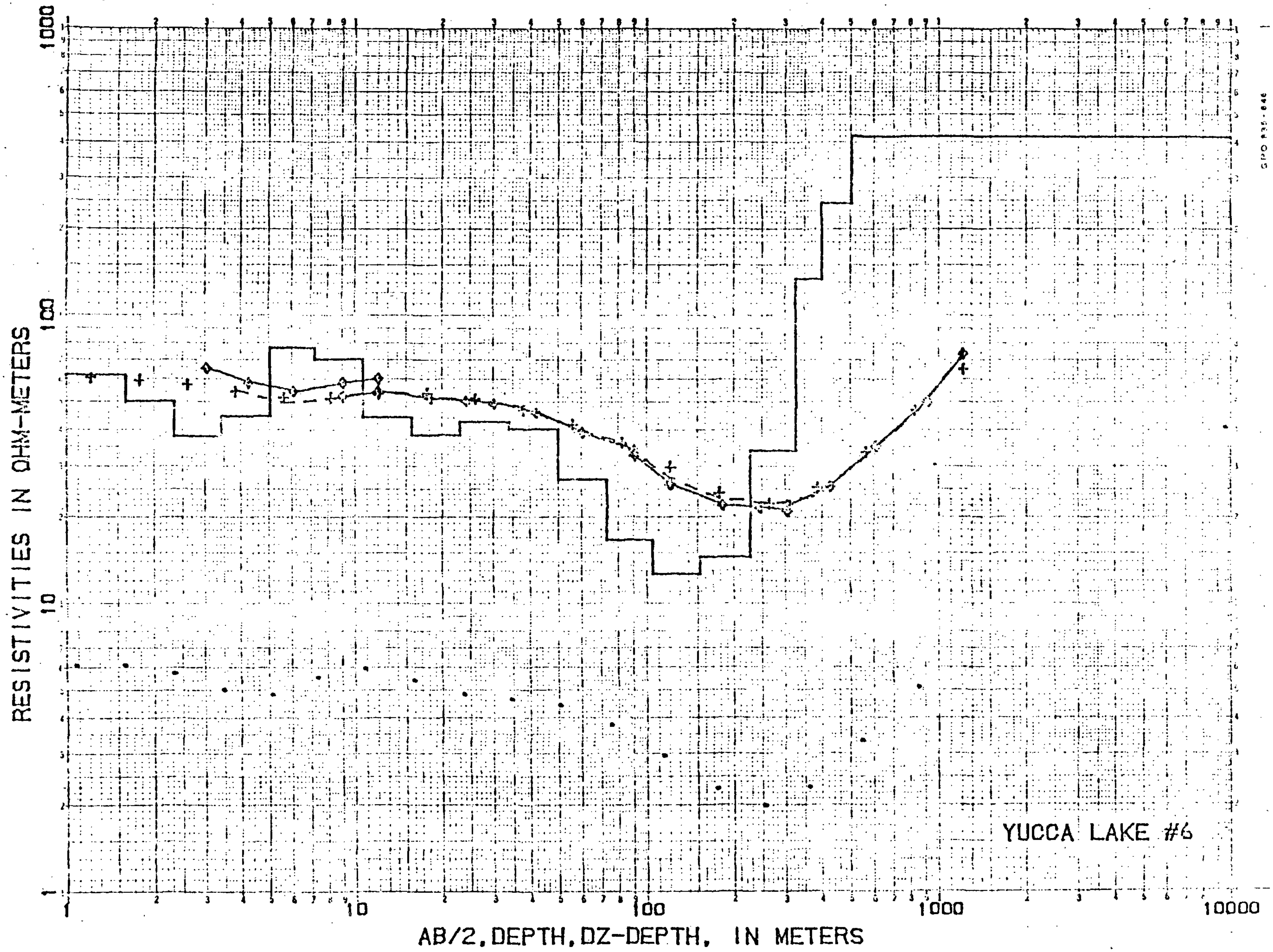

RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #1

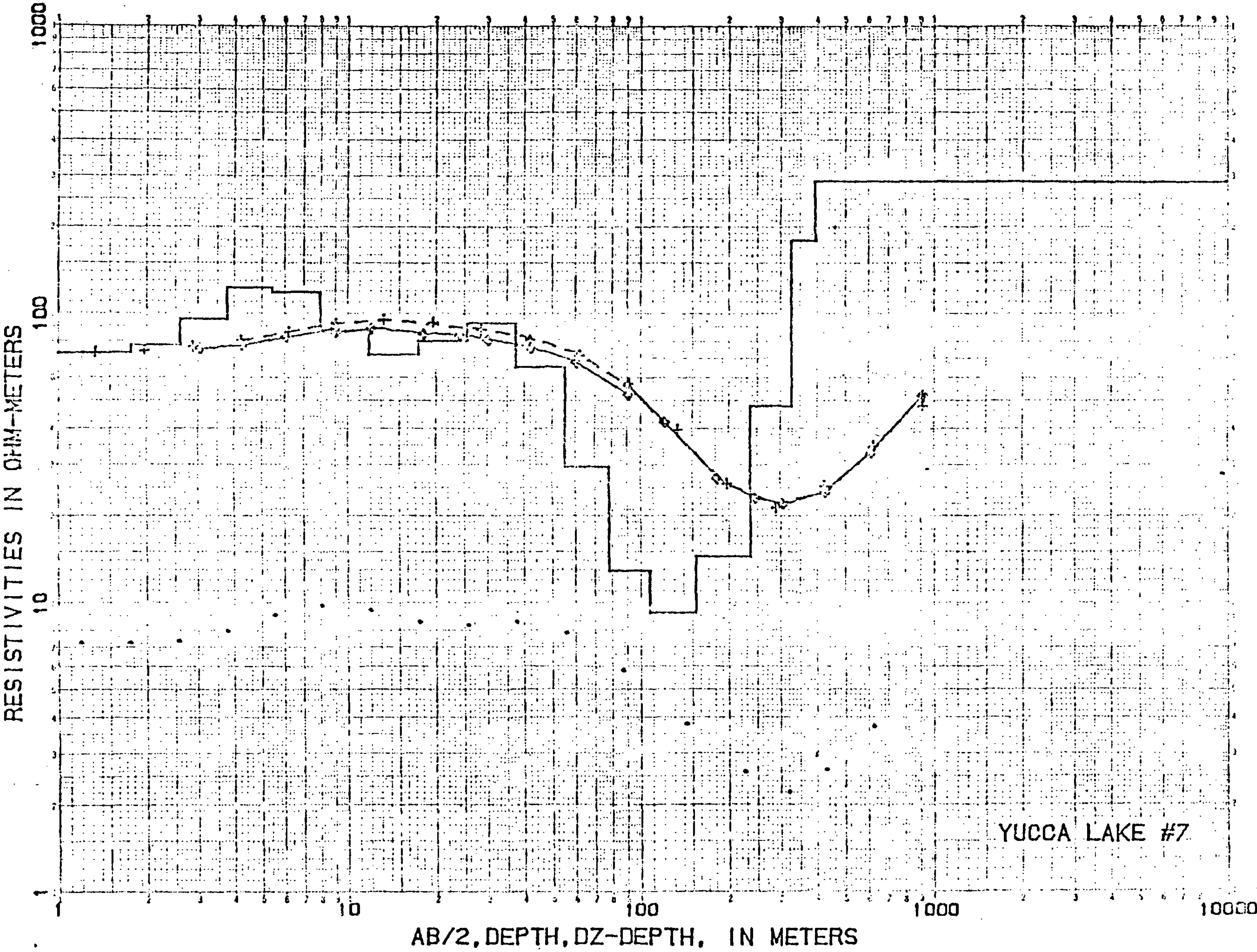

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
Computed from measurements made from an asymmetric array.
YUCCA LAKE #2

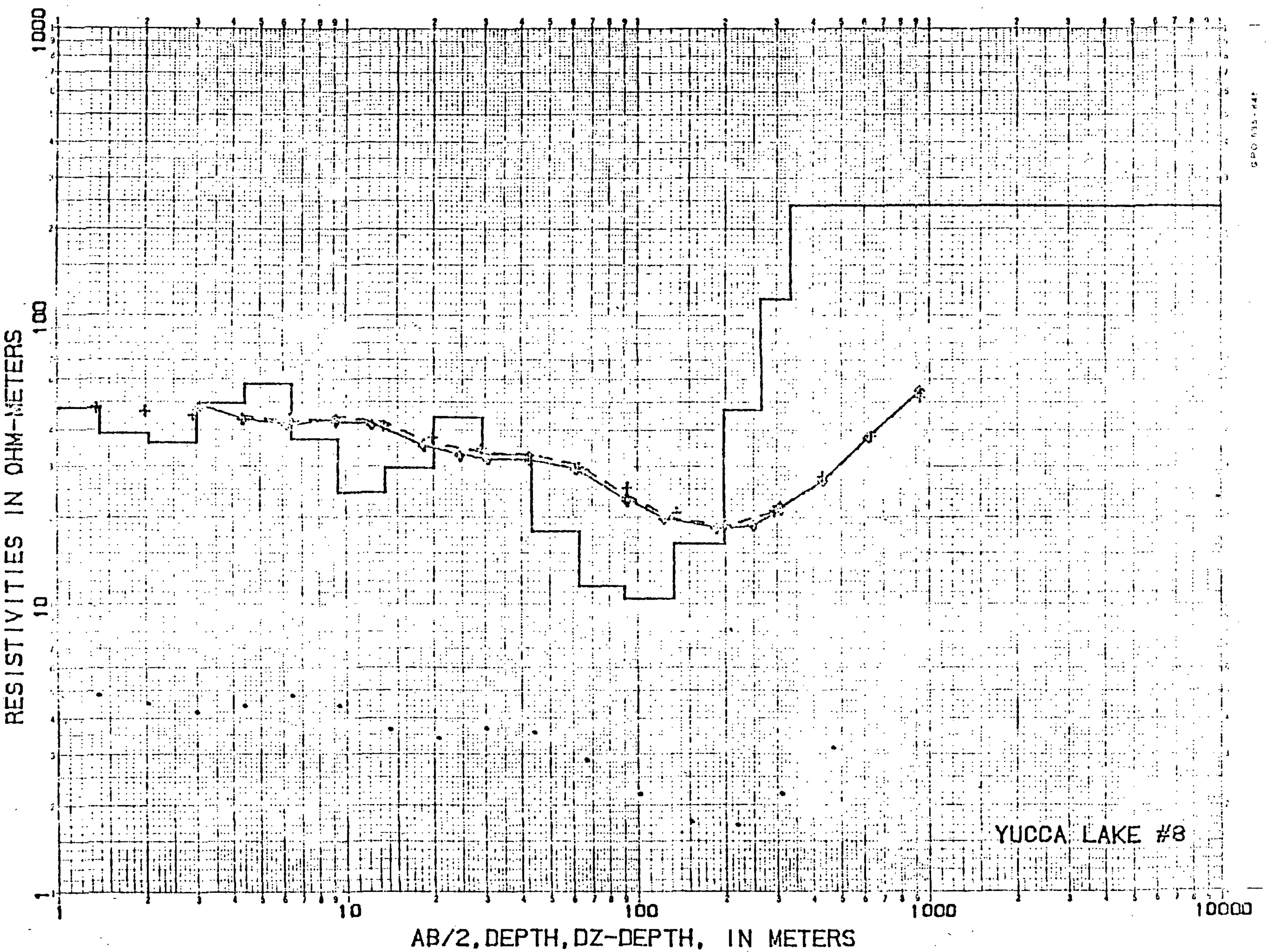

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #3

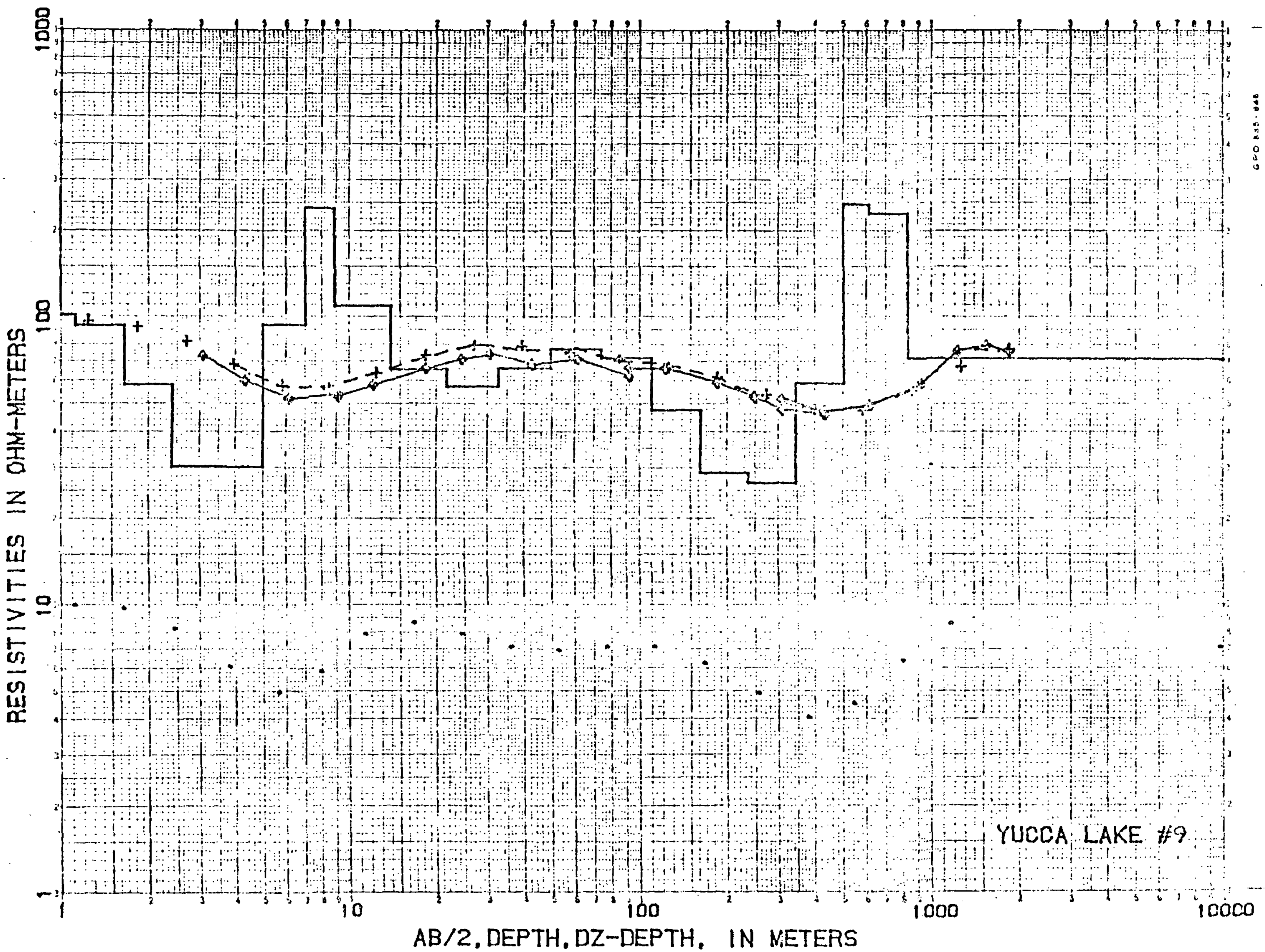

RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
1
10
100
1000
10000
YUCCA LAKE #4

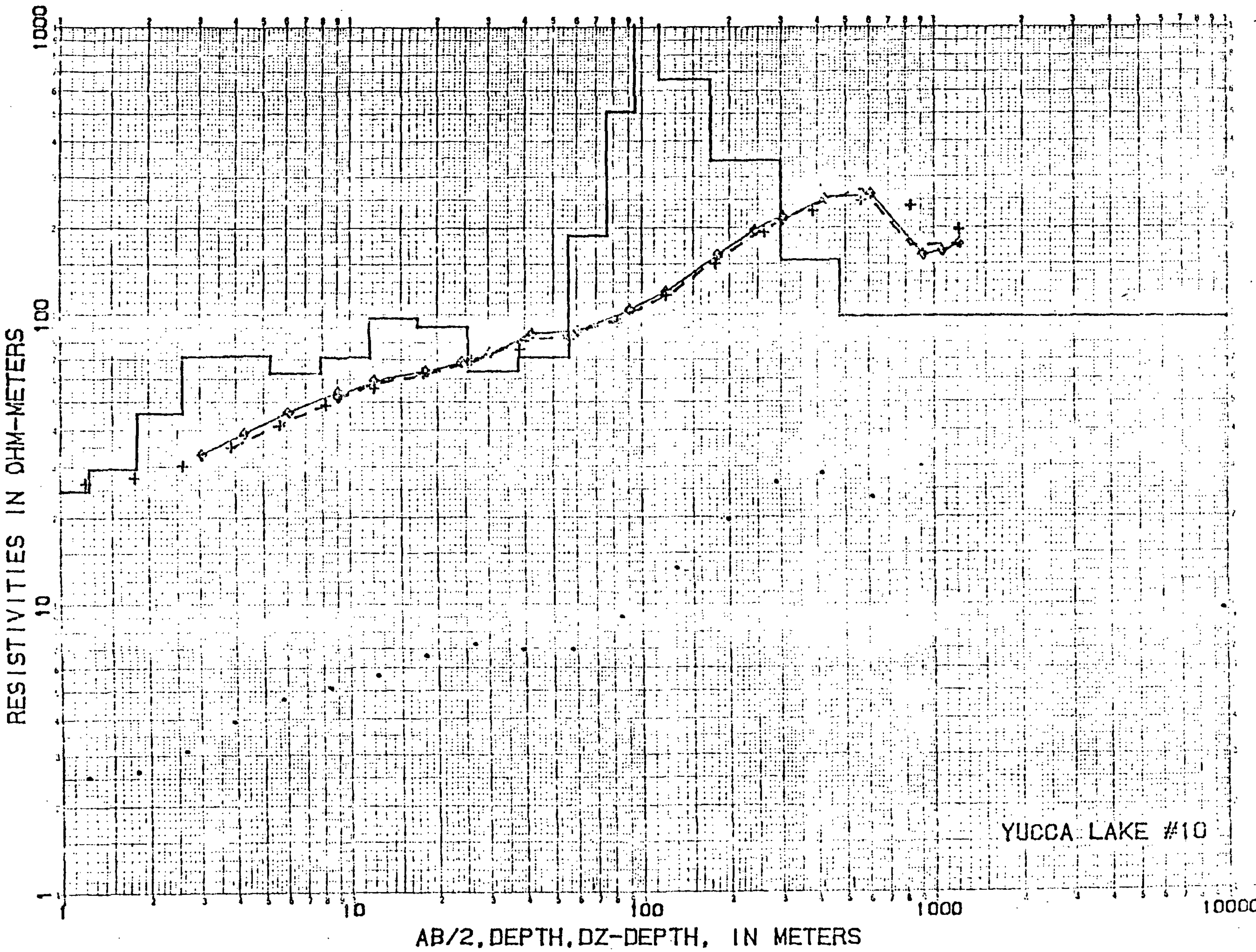

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
Computed from measurements made from an asymmetric array.
YUCCA LAKE #5

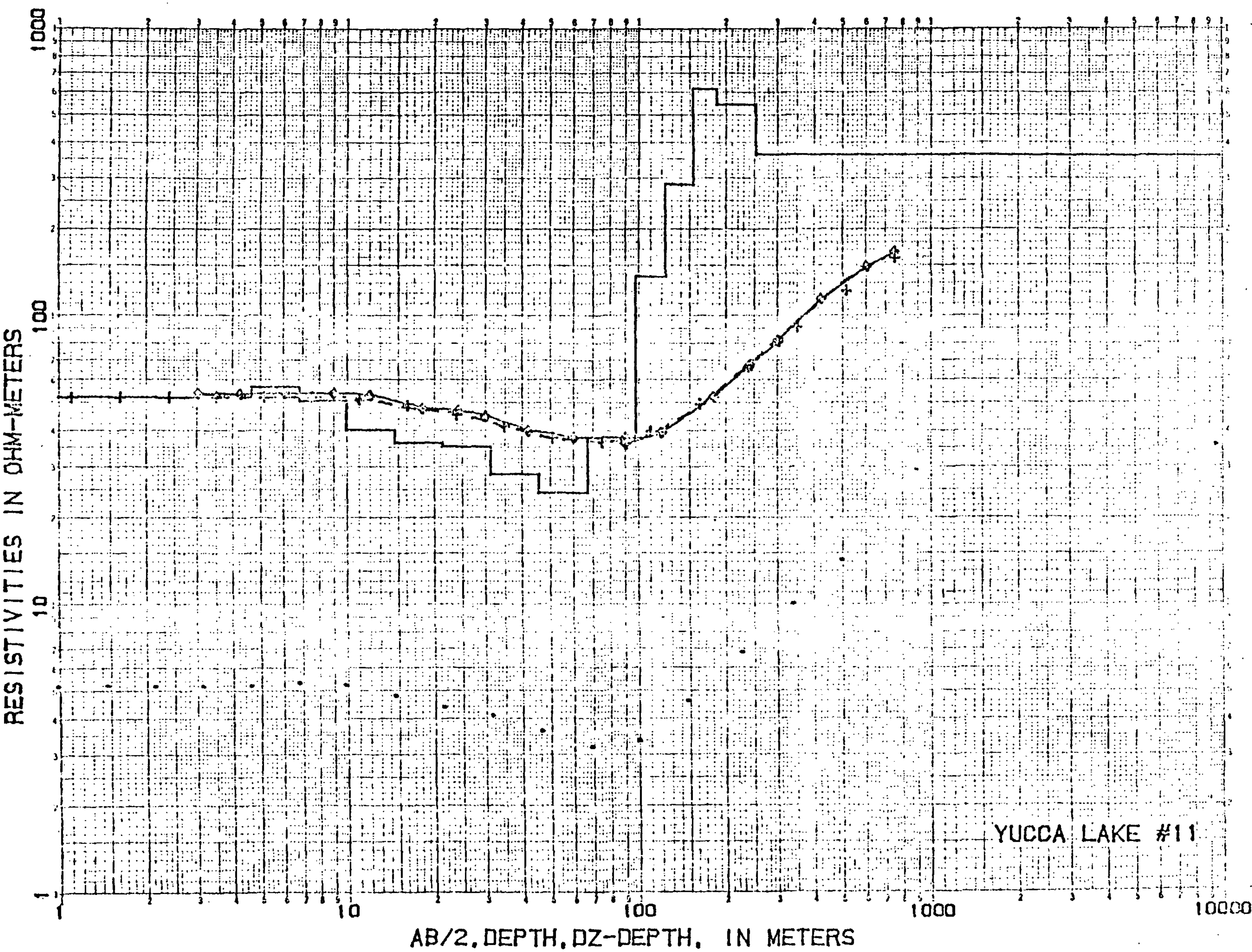

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #6


RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #7

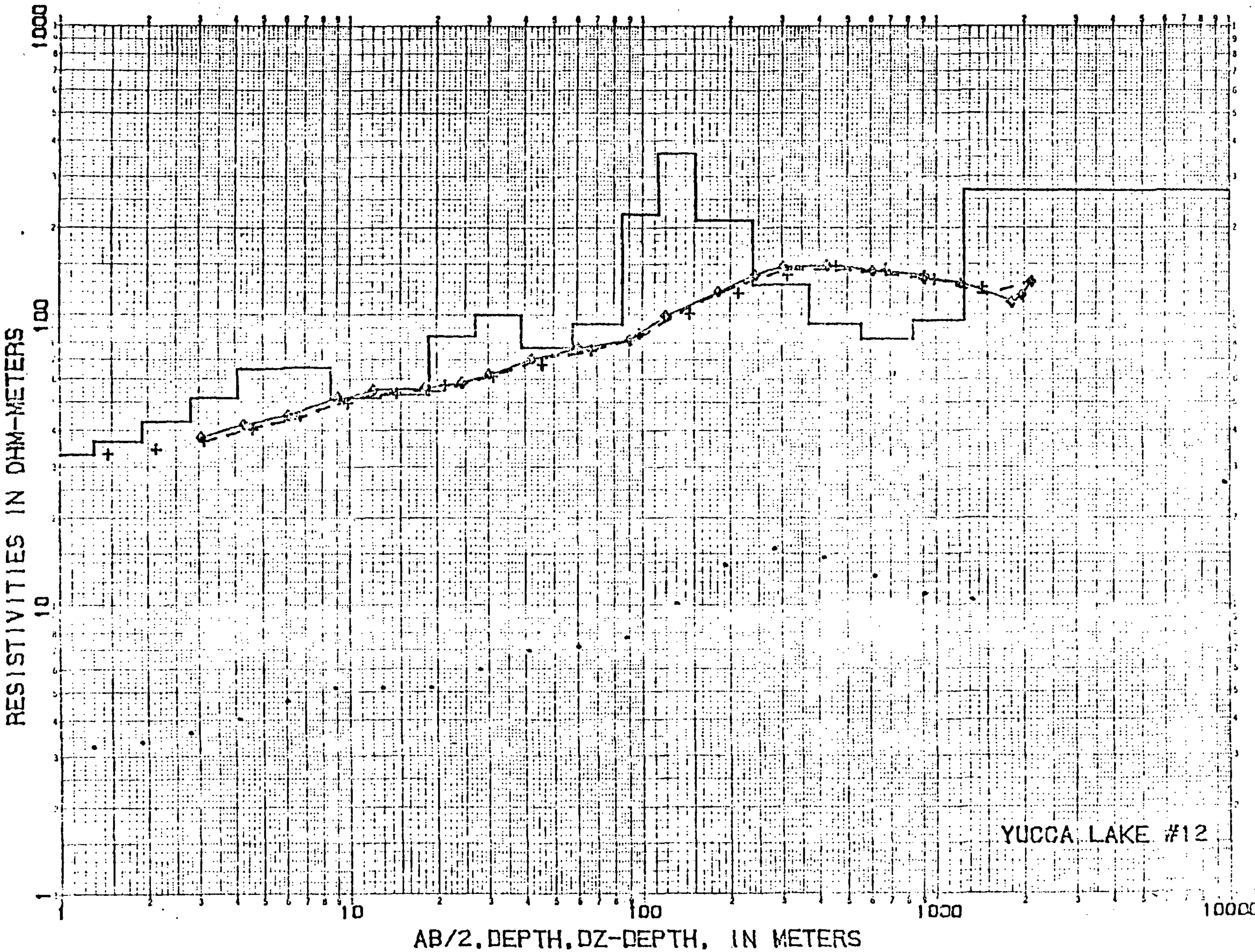

YUCCA LAKE #8
RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
1000
100
10
1
10
100
1000
10000

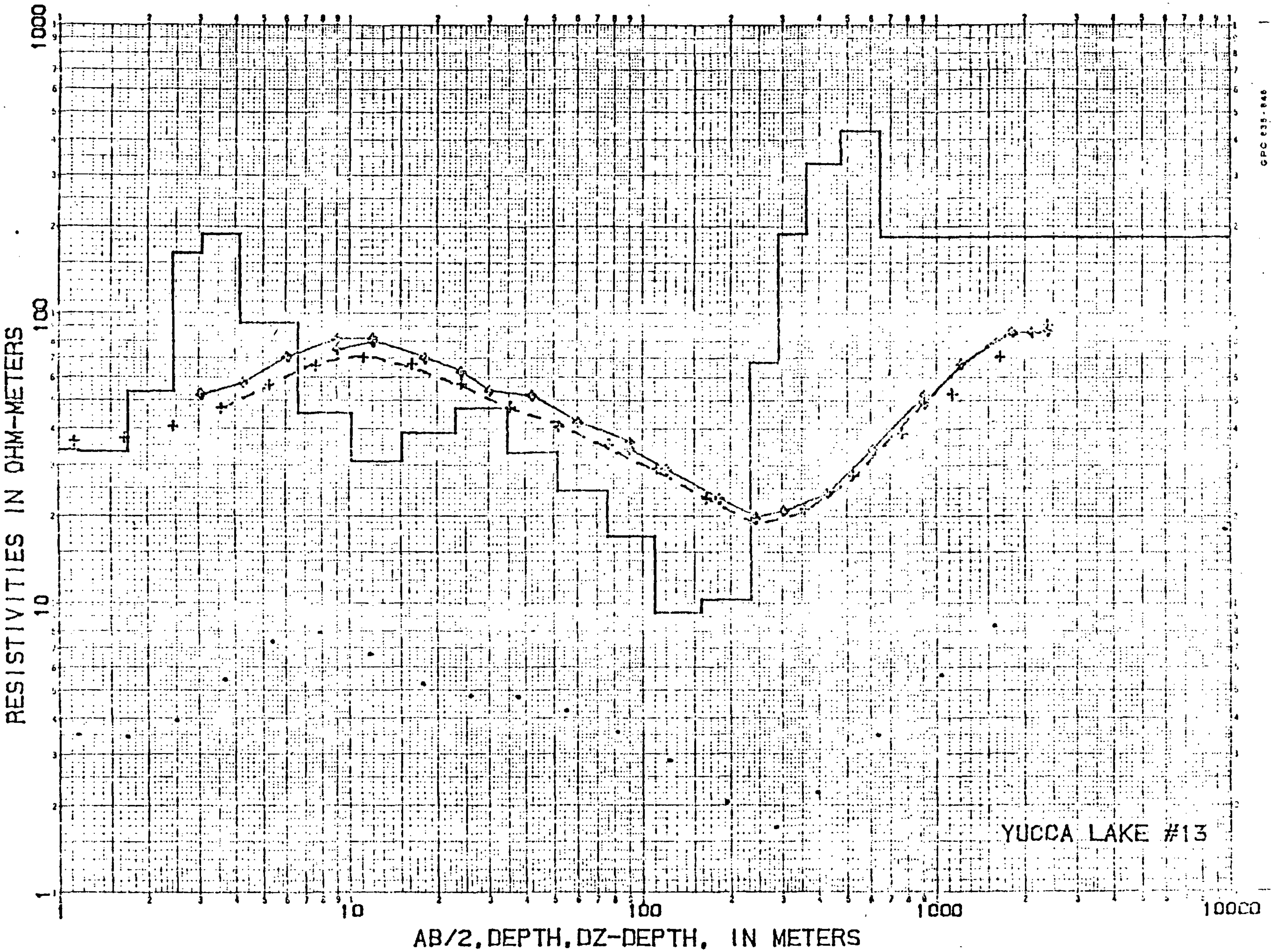

RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #9
1000
100
10
1
10
100
1000
10000

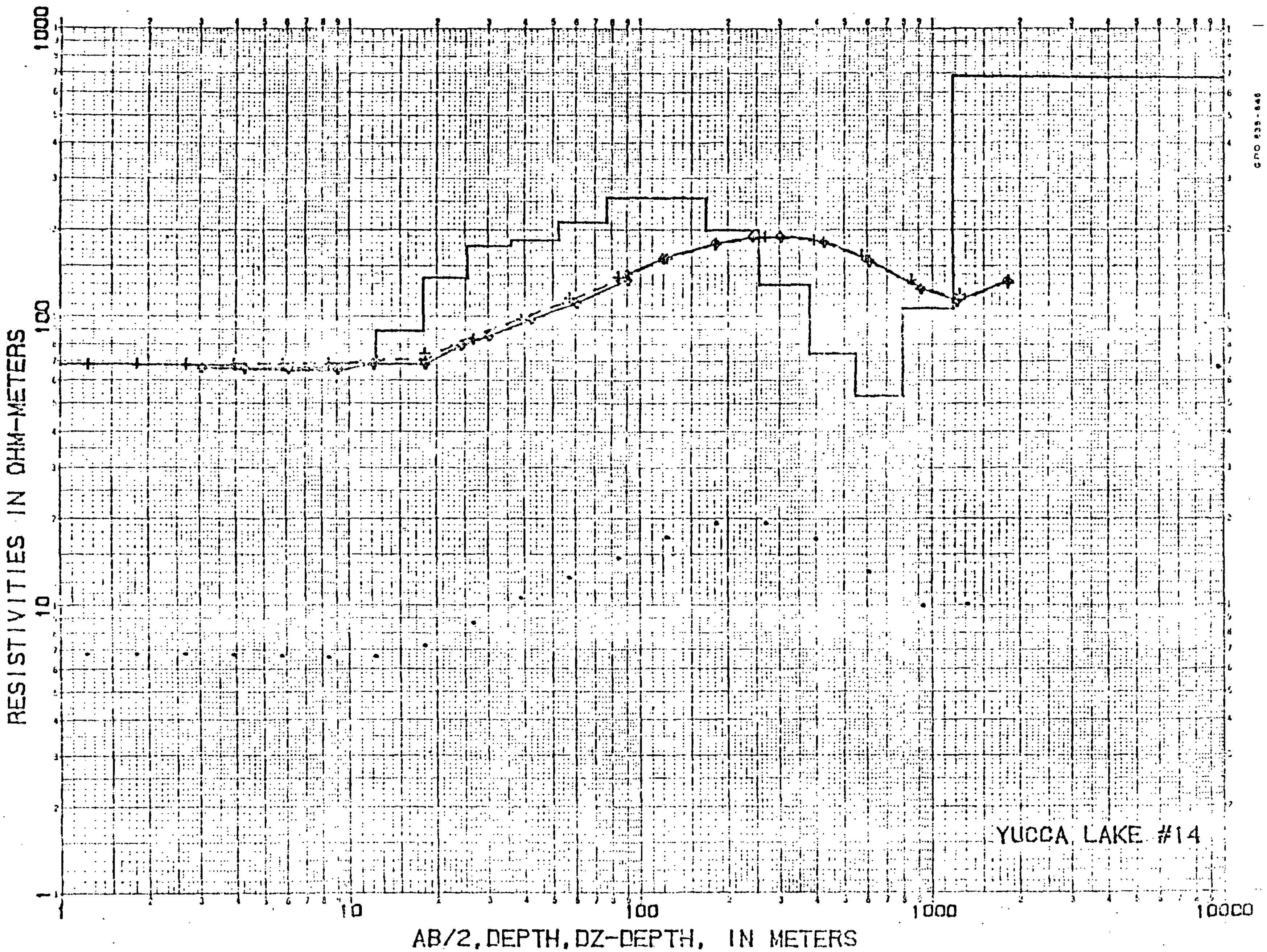

RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #10
1000
100
10
1
10
100
1000
10000



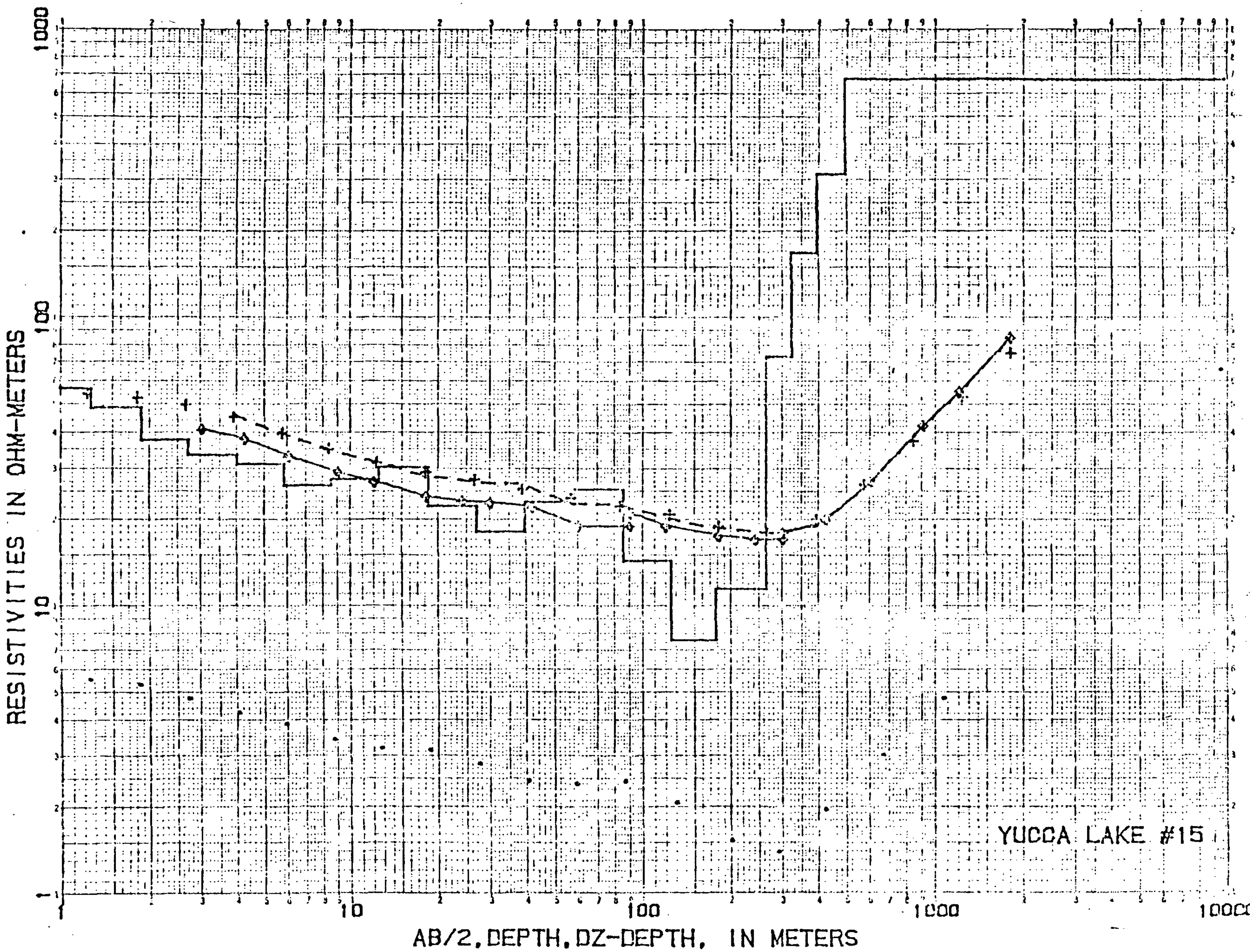
RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #11

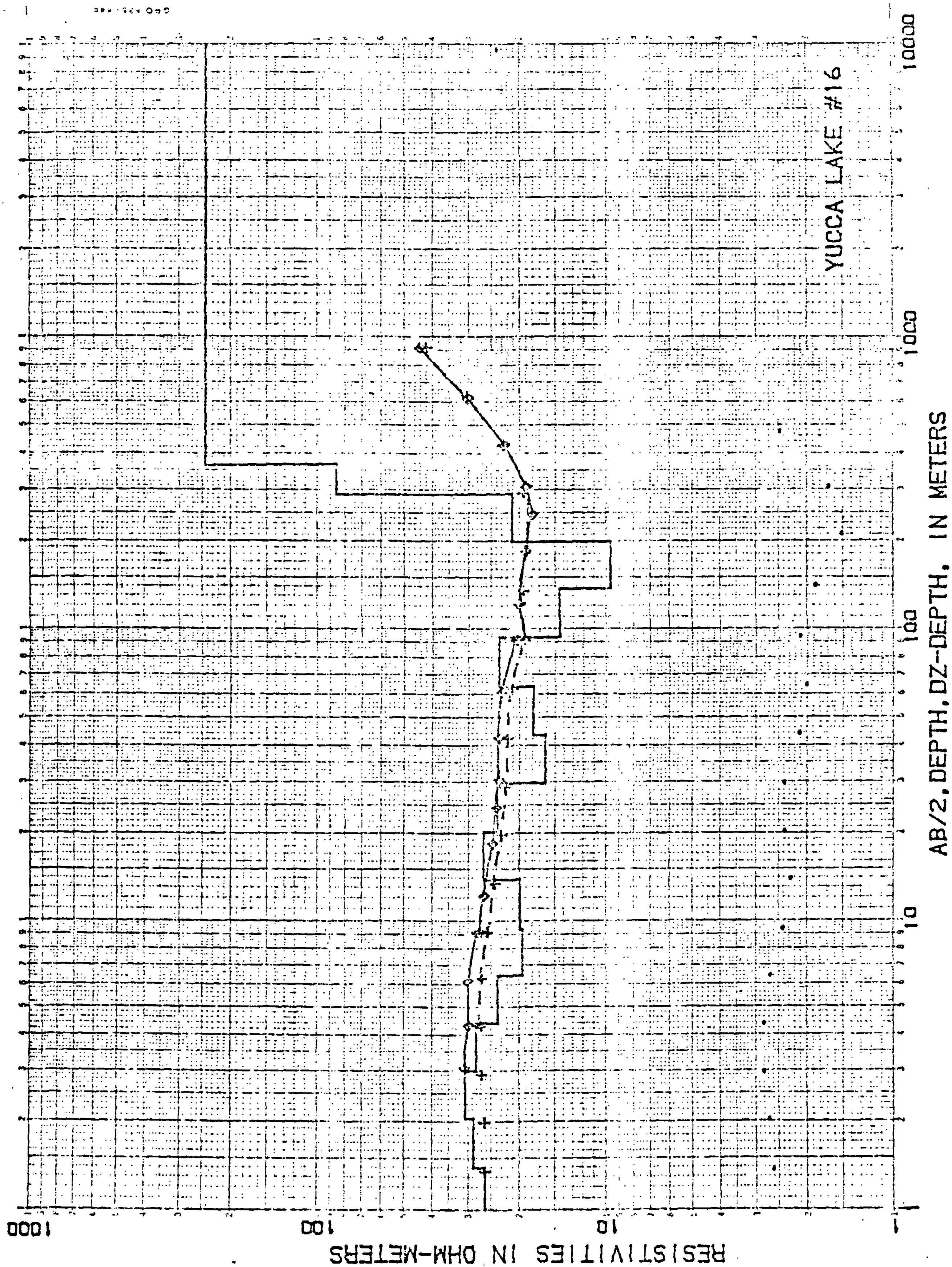

RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #12
1000
100
10
1
1
10
100
1000
10000

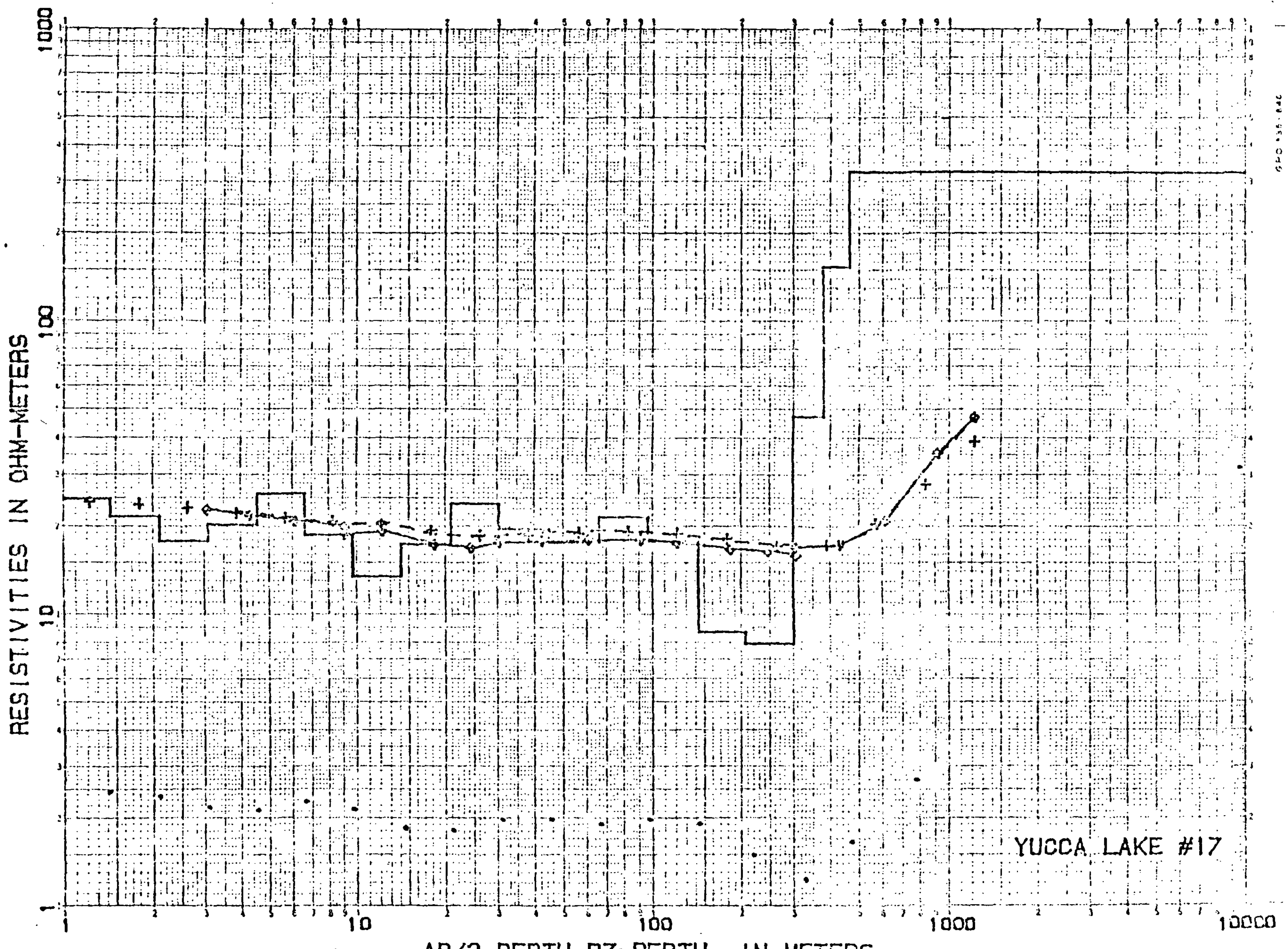

RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #13



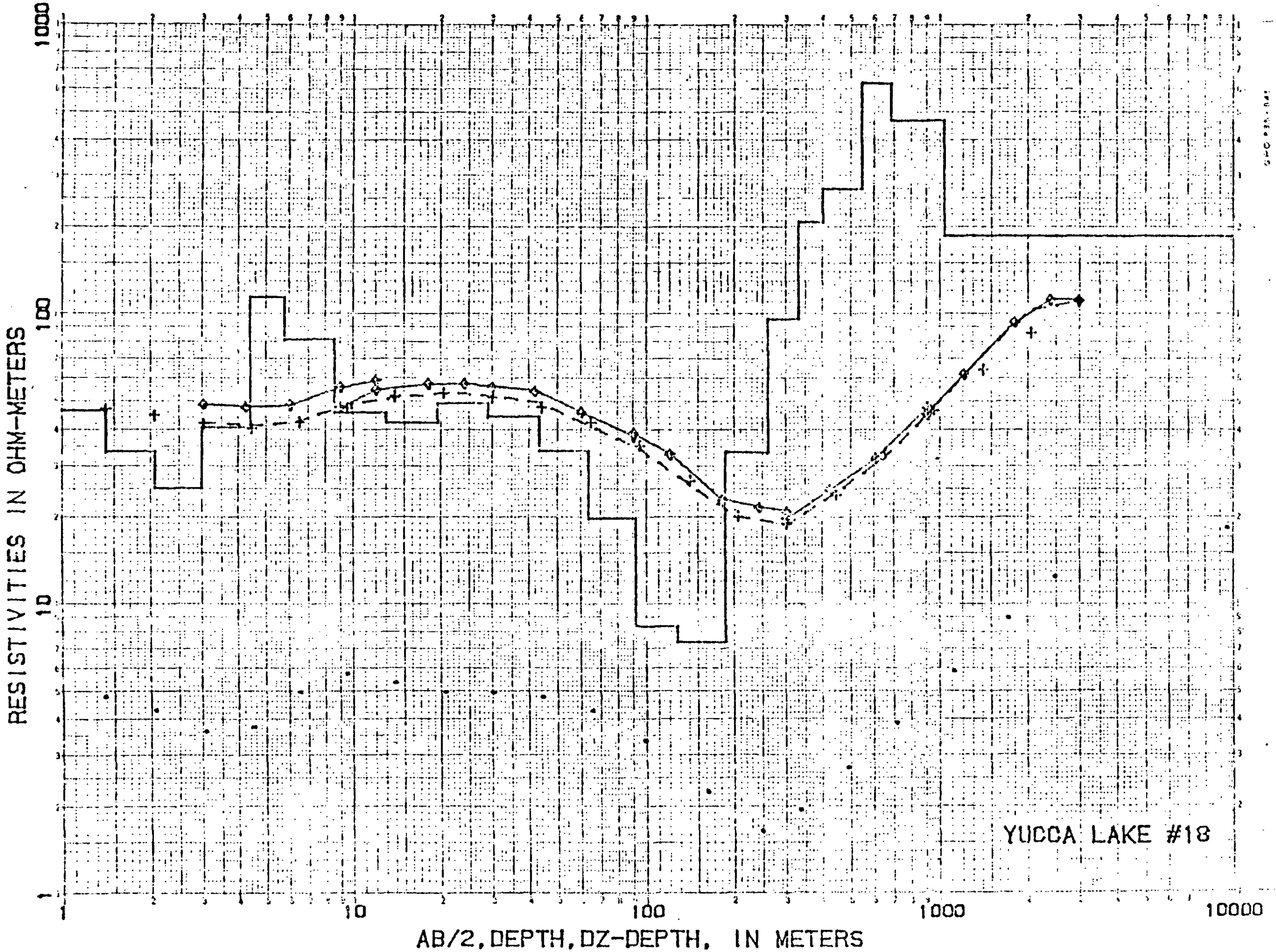
YUCCA LAKE #14
RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
1
10
100
1000
10000


1000
100
10
1
10
100
1000
10000
RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #15

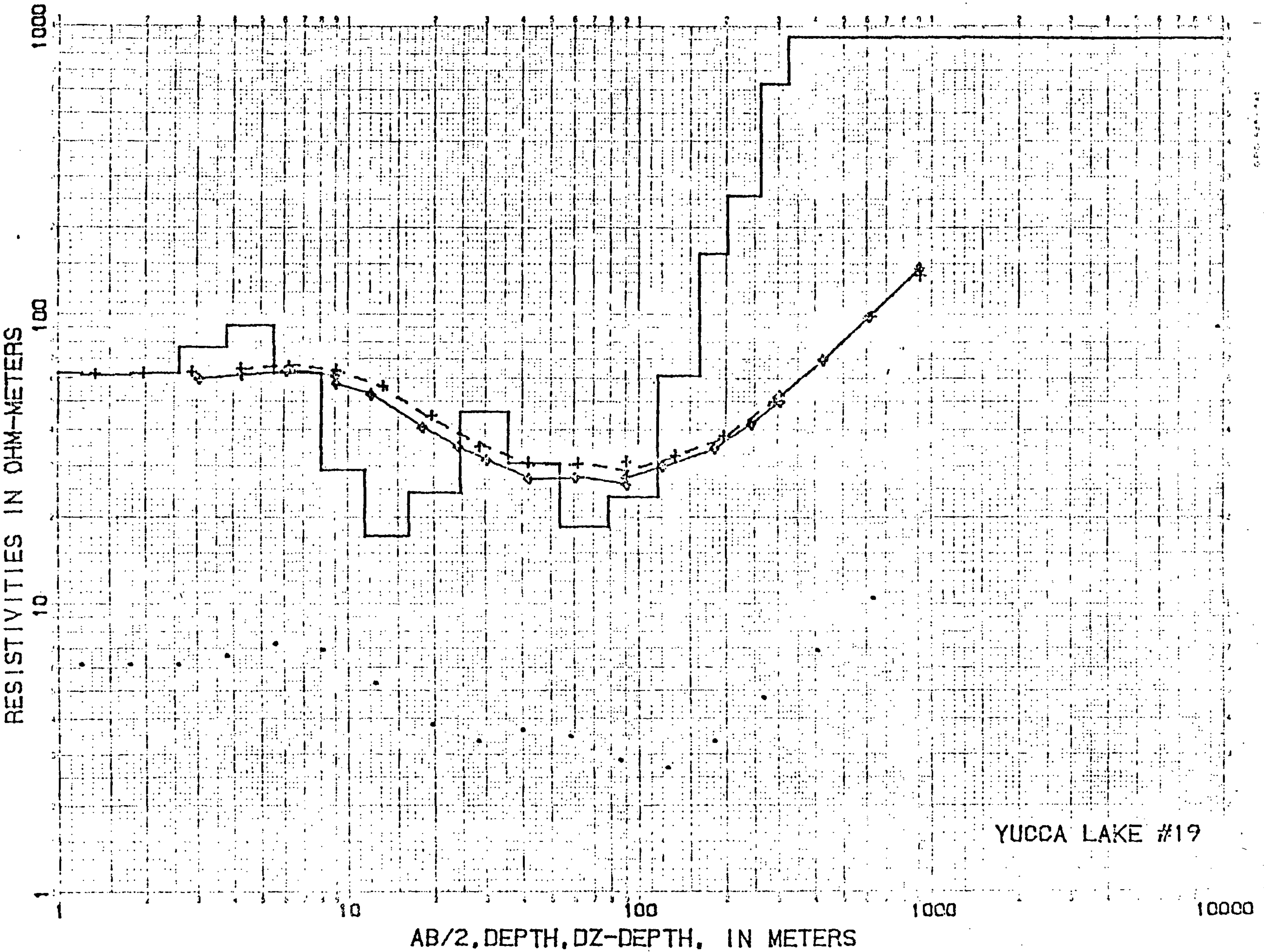

YUCCA LAKE #16
AB/2, DEPTH, DZ-DEPTH, IN METERS
RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000

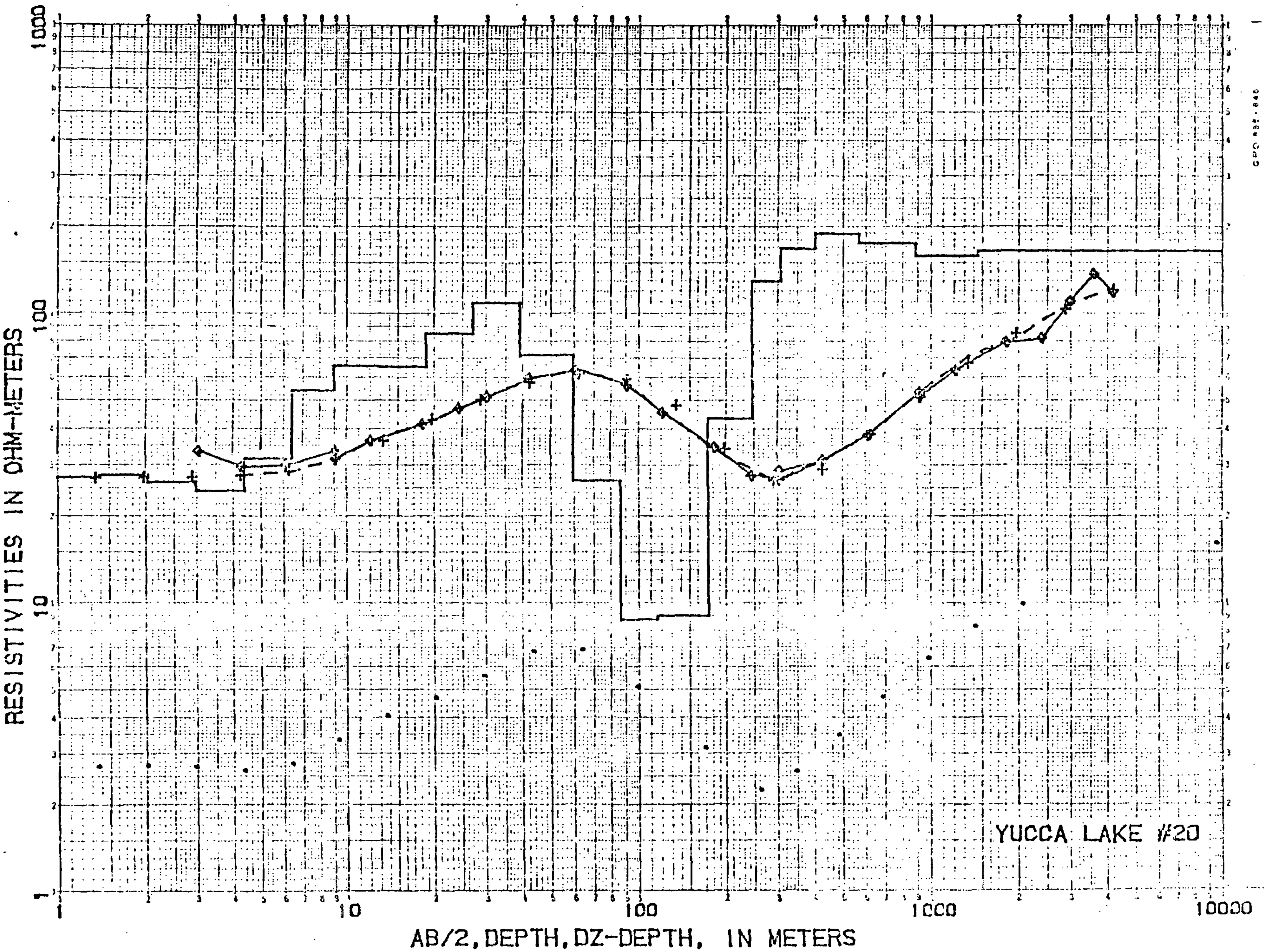


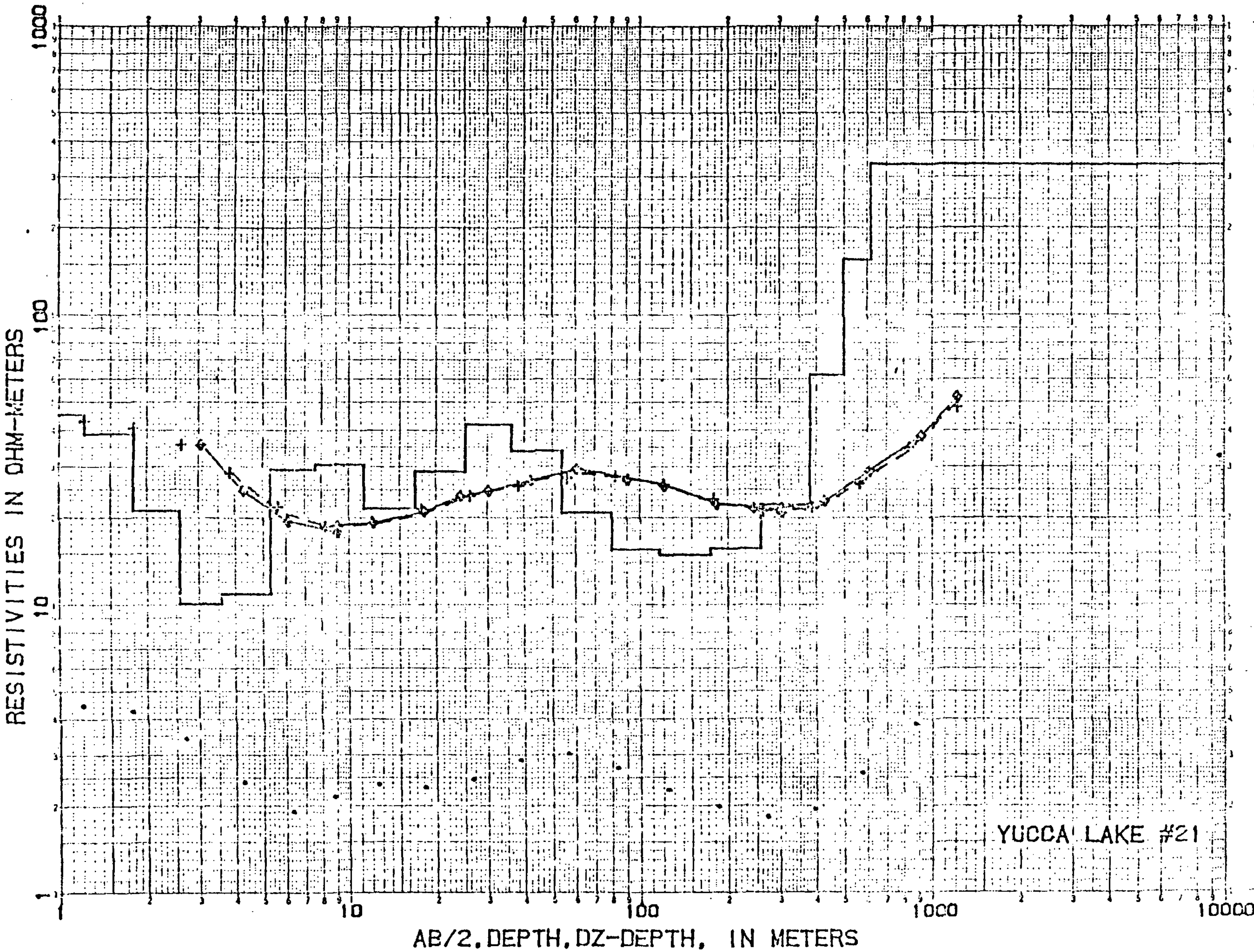
RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #17

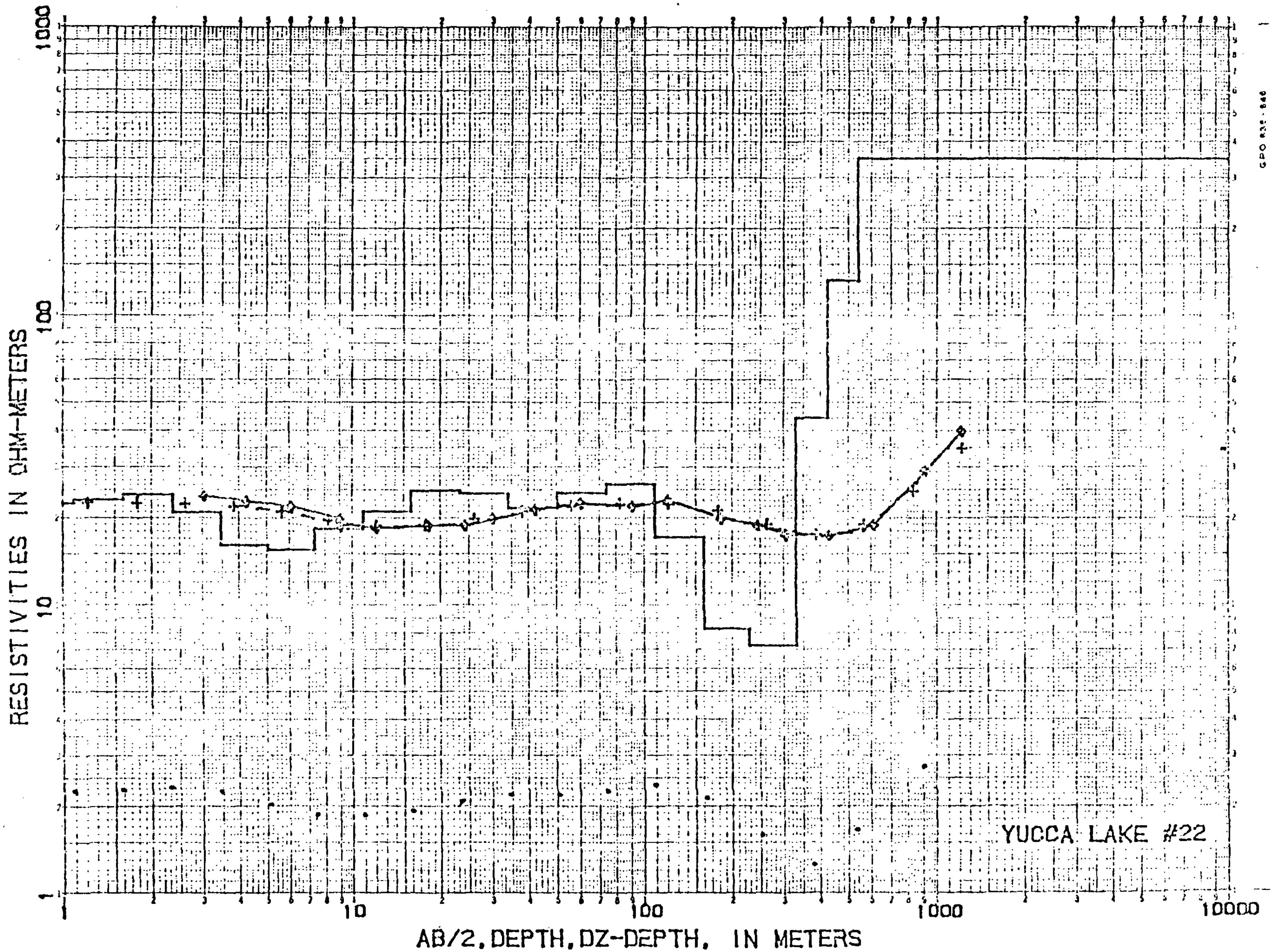


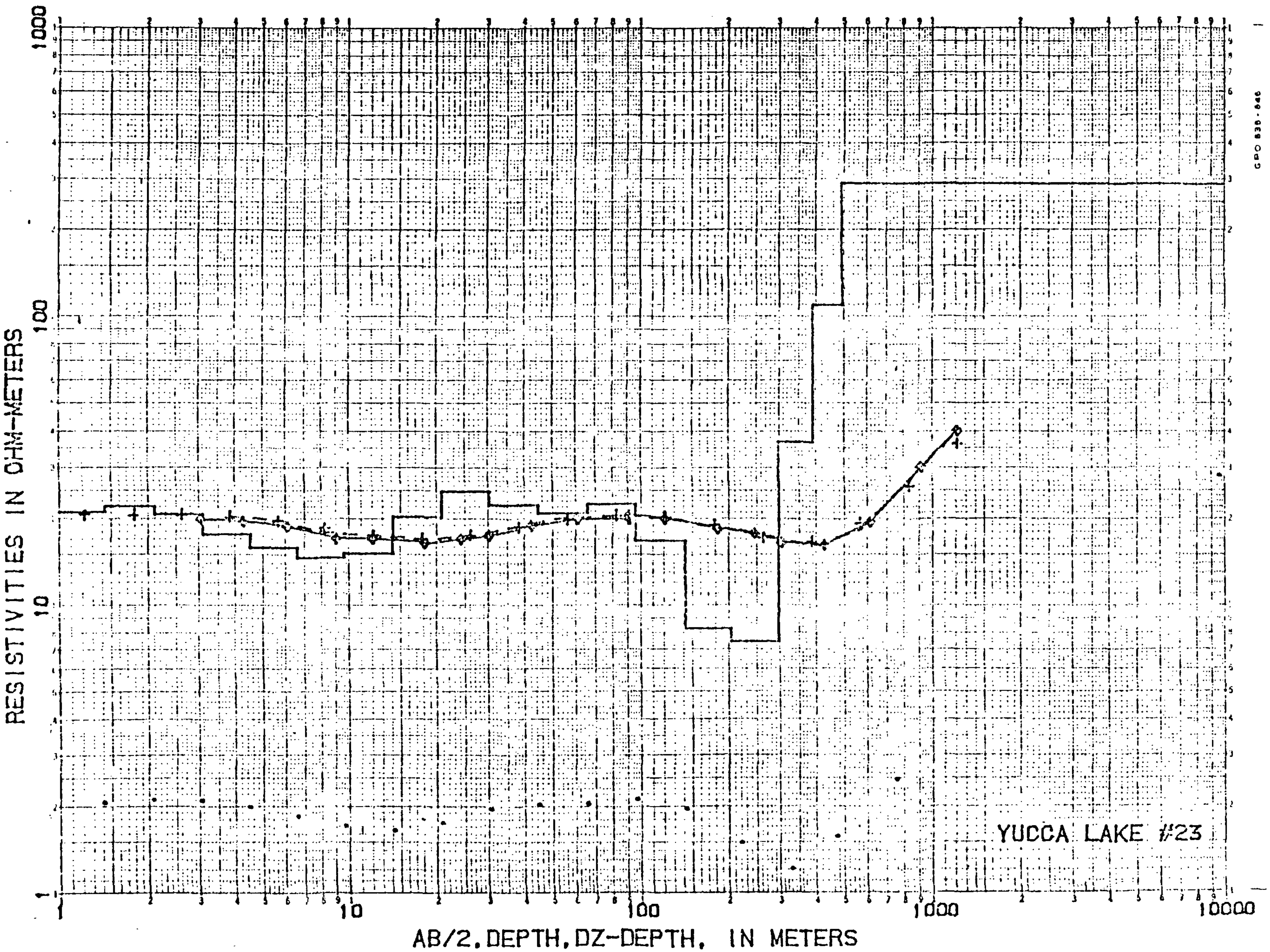
1000
100
10
RESISTIVITIES IN OHM-METERS
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #18

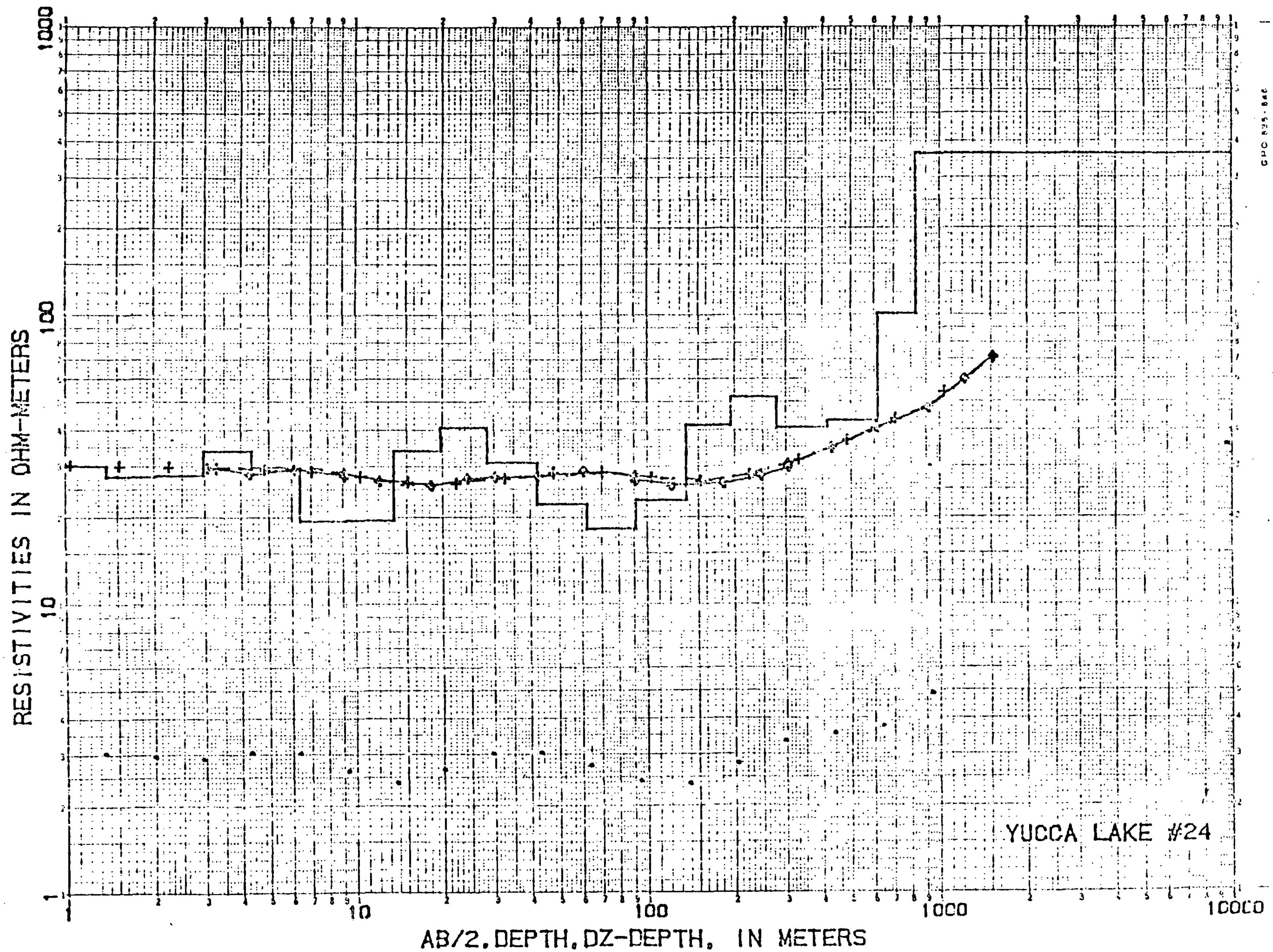

RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #19

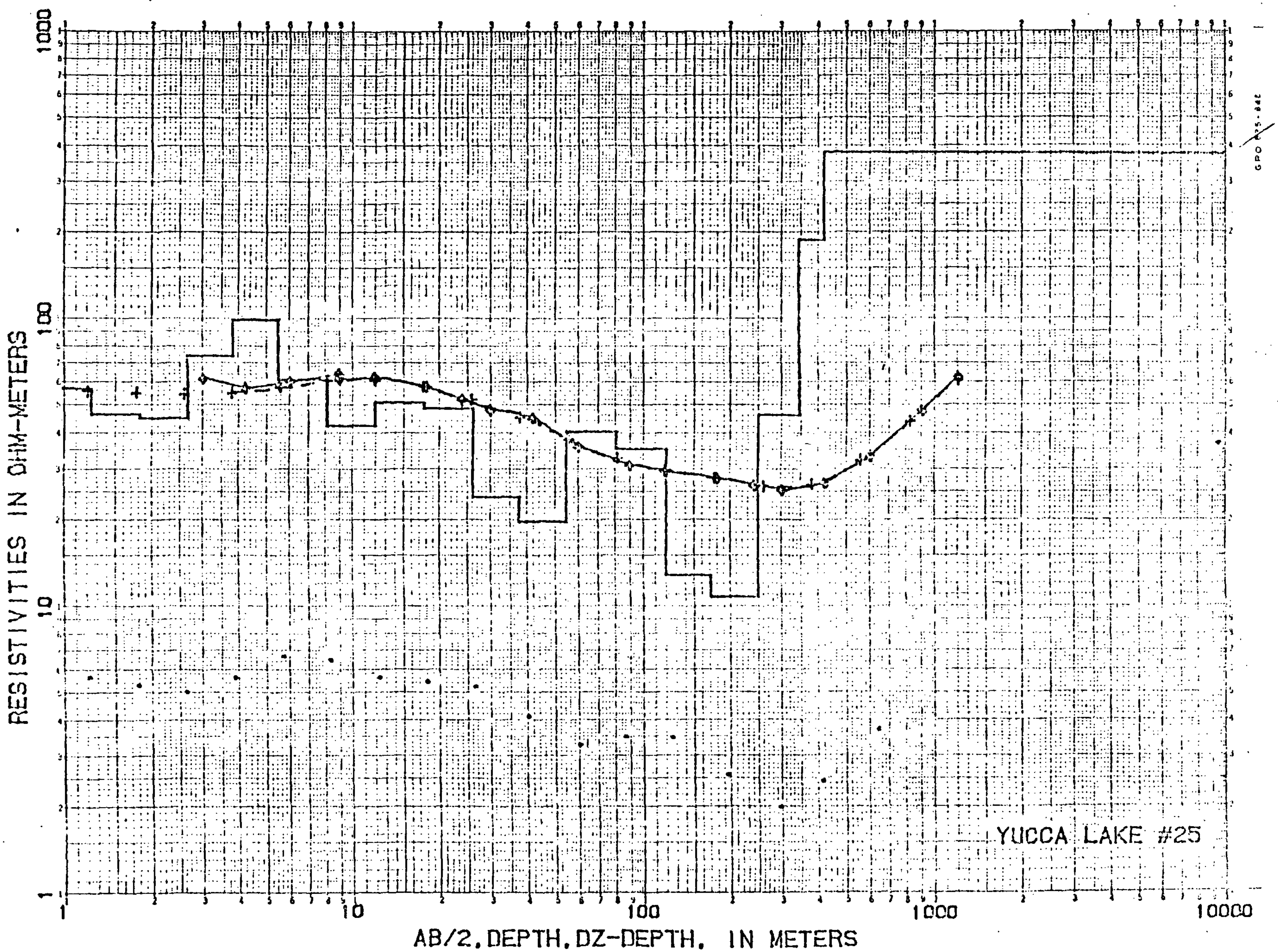

RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #20

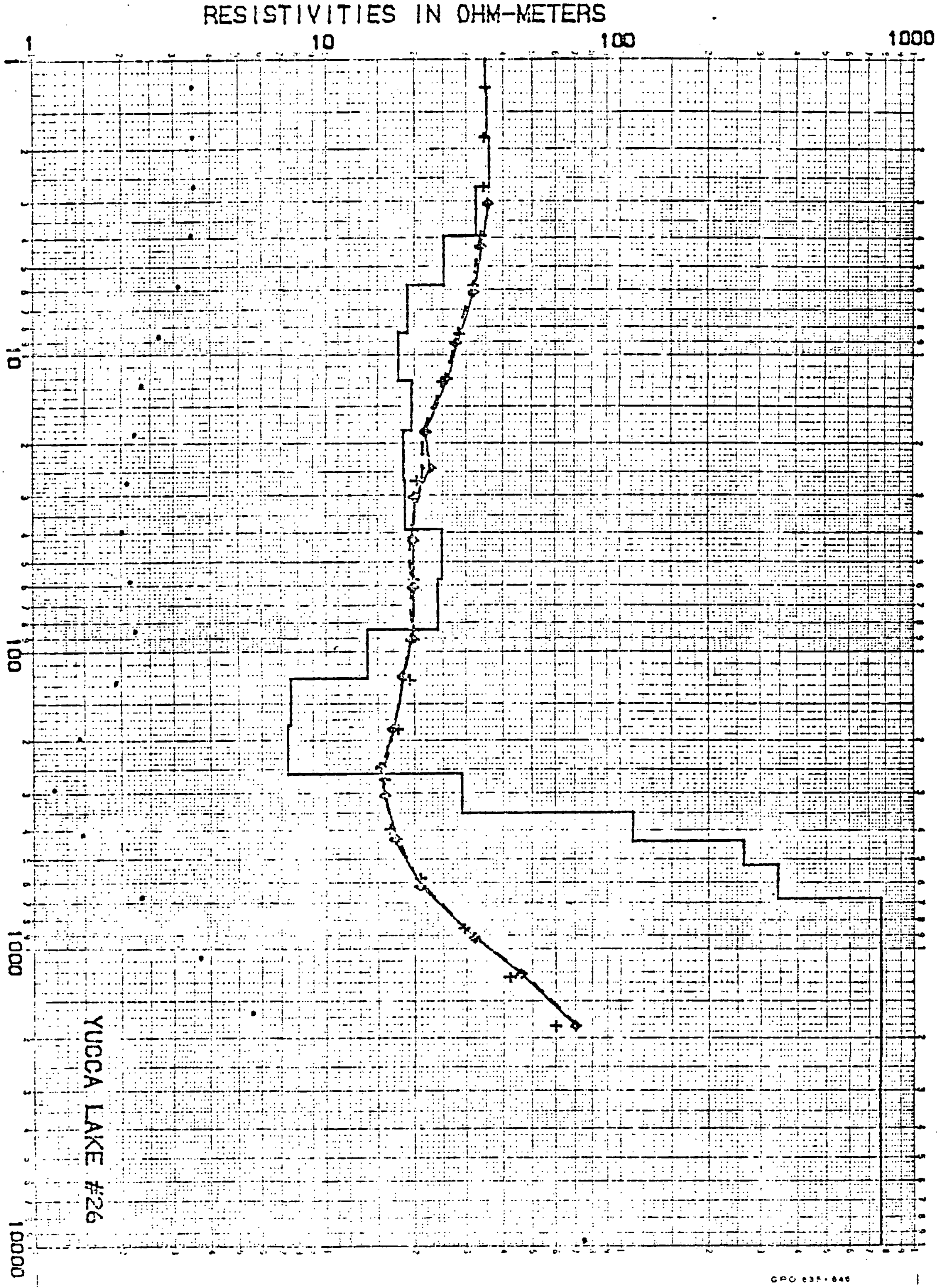

1000
100
10
1
RESISTIVITIES IN OHM-METERS
1
10
100
1000
10000
AB/2. DEPTH. DZ-DEPTH, IN METERS
YUCCA LAKE #21

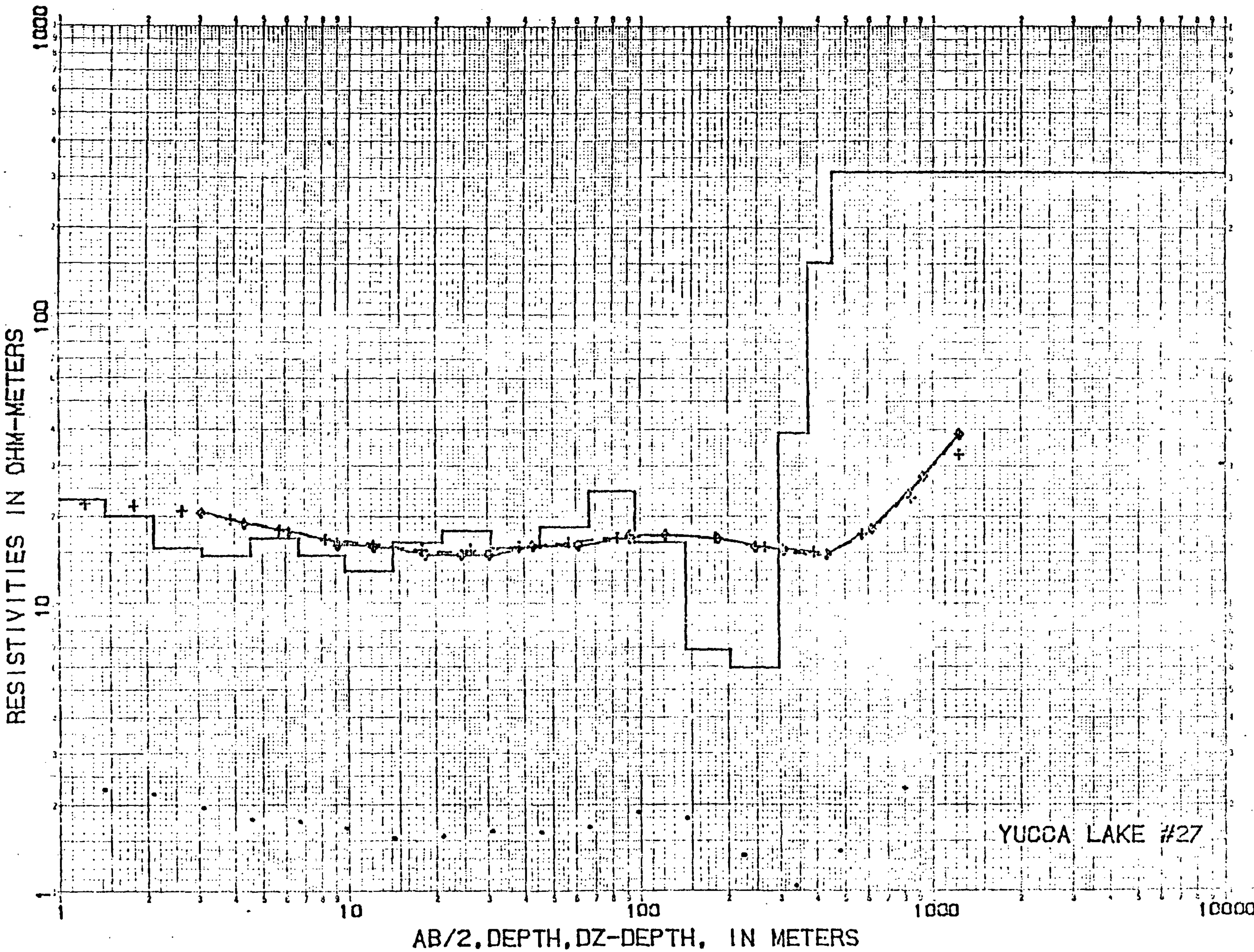

1000
100
10
1
RESISTIVITIES IN OHM-METERS
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #22

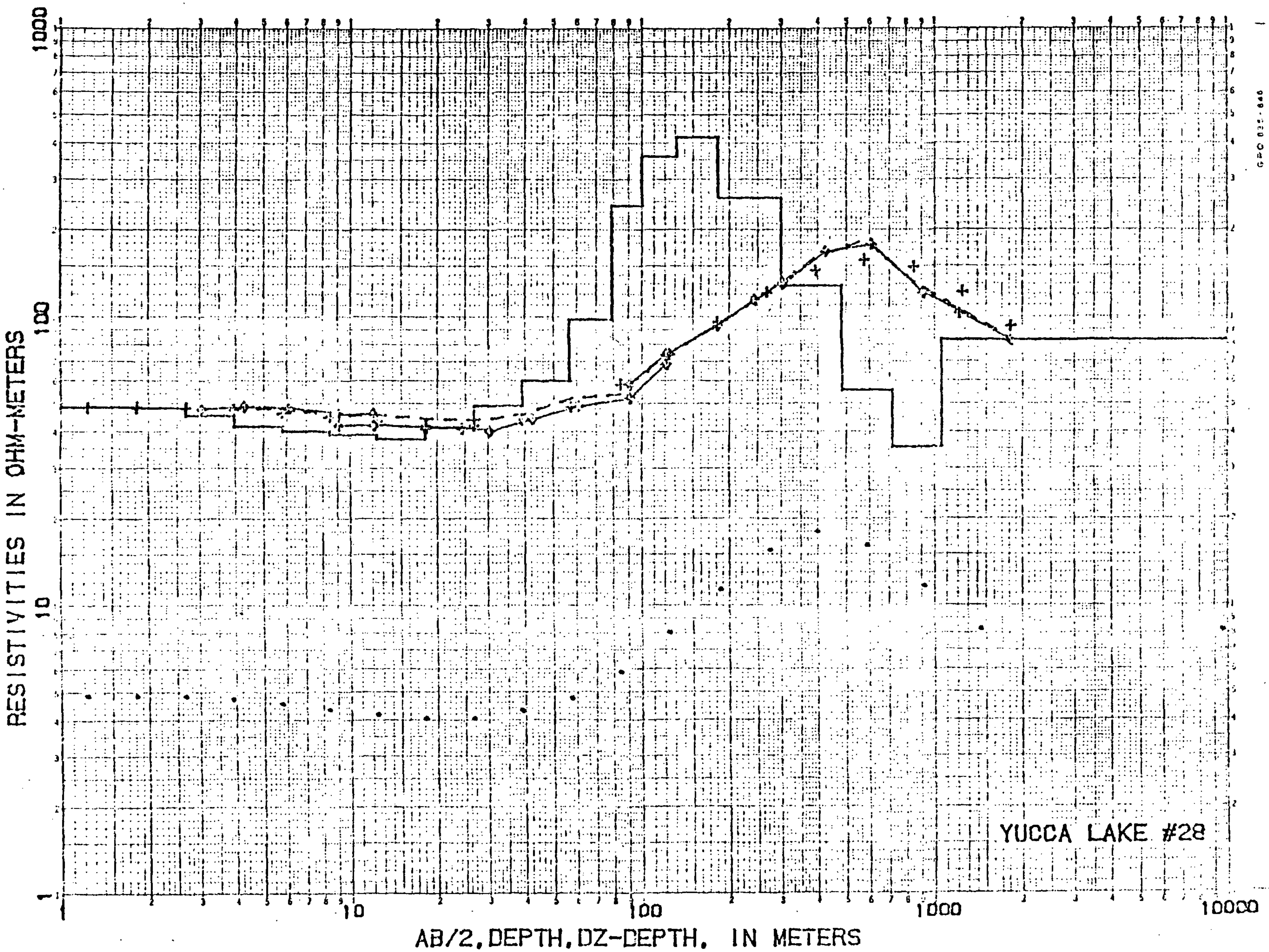

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #23

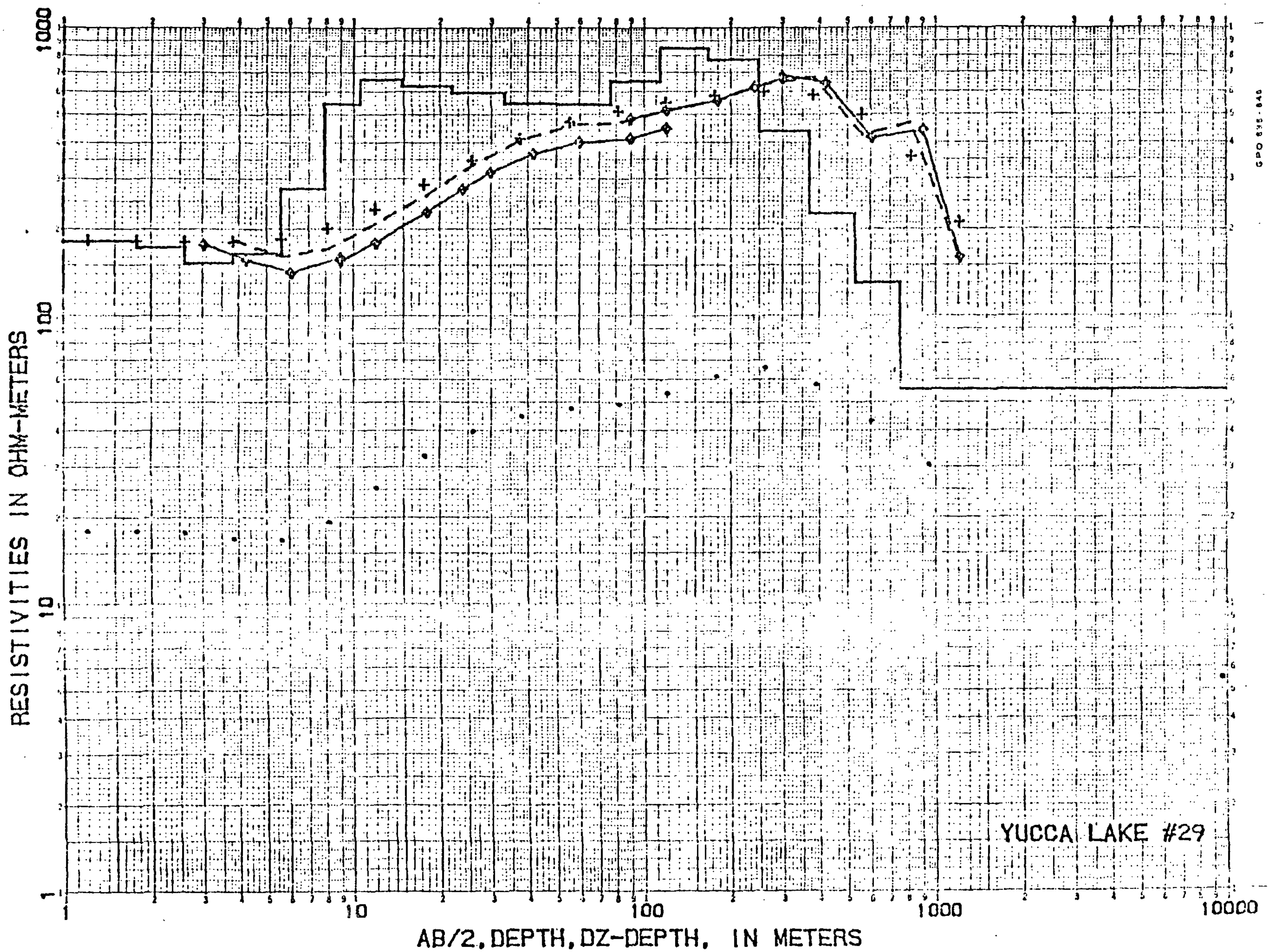

RESISTIVITIES IN OHM-METERS
AB/2.DEPTH.DZ-DEPTH. IN METERS
YUCCA LAKE #24
1
10
100
1000
10000

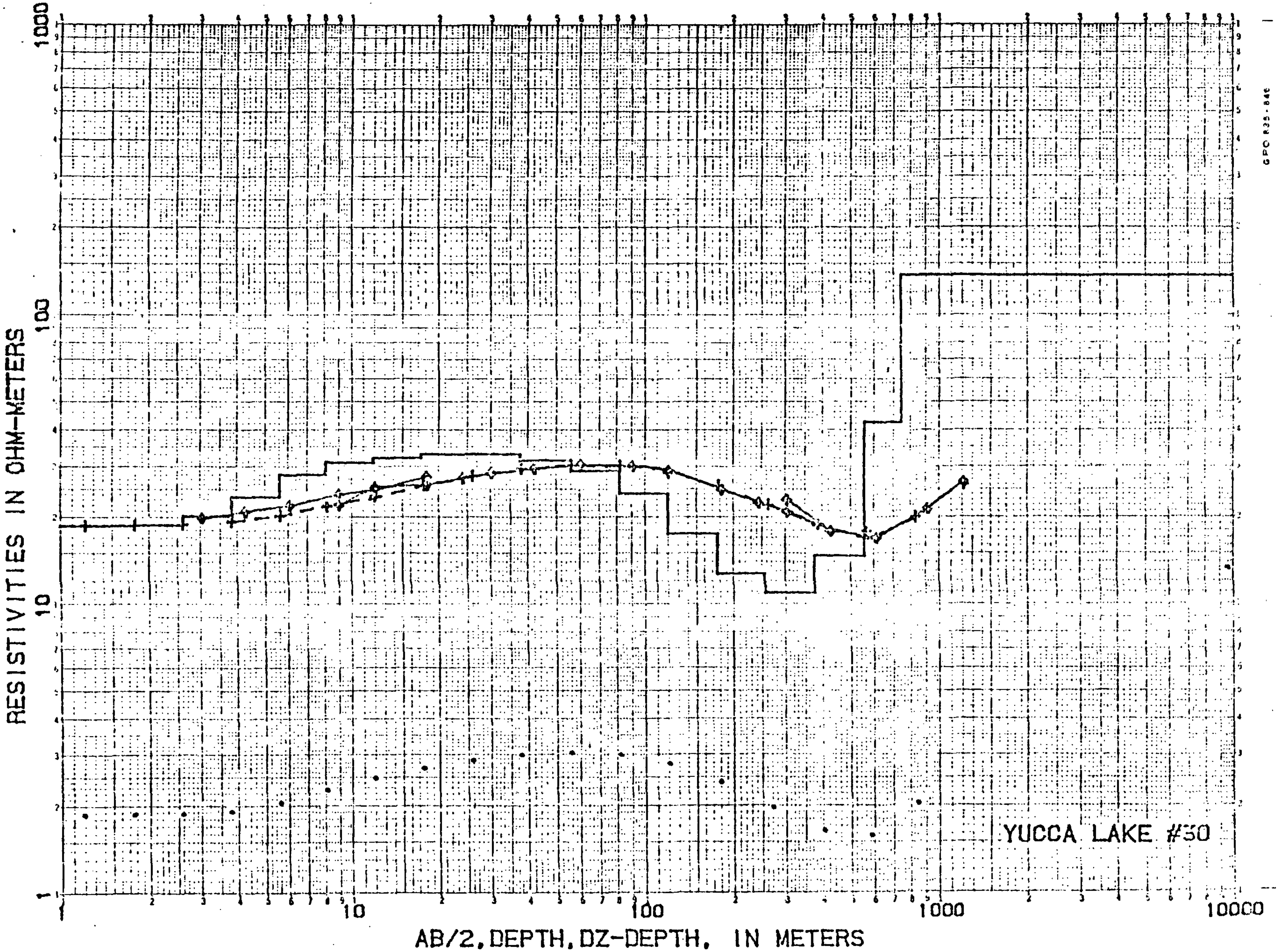

1000
100
10
1
RESISTIVITIES IN OHM-METERS
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #25

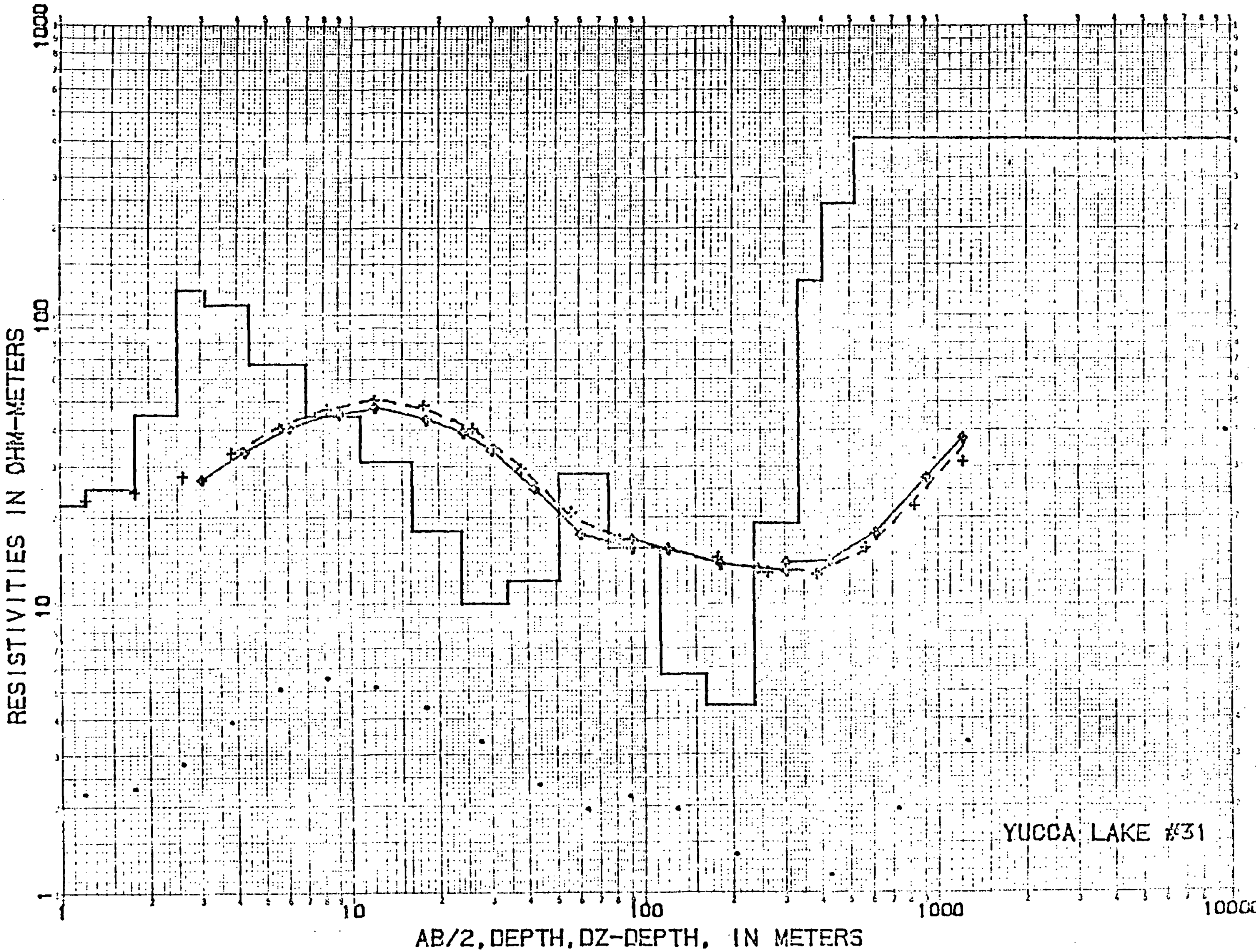

RESISTIVITIES IN OHM-METERS
1
10
100
1000
AB/2,DEPTH,DZ-DEPTH, IN METERS
10
100
1000
10000
YUCCA LAKE #26

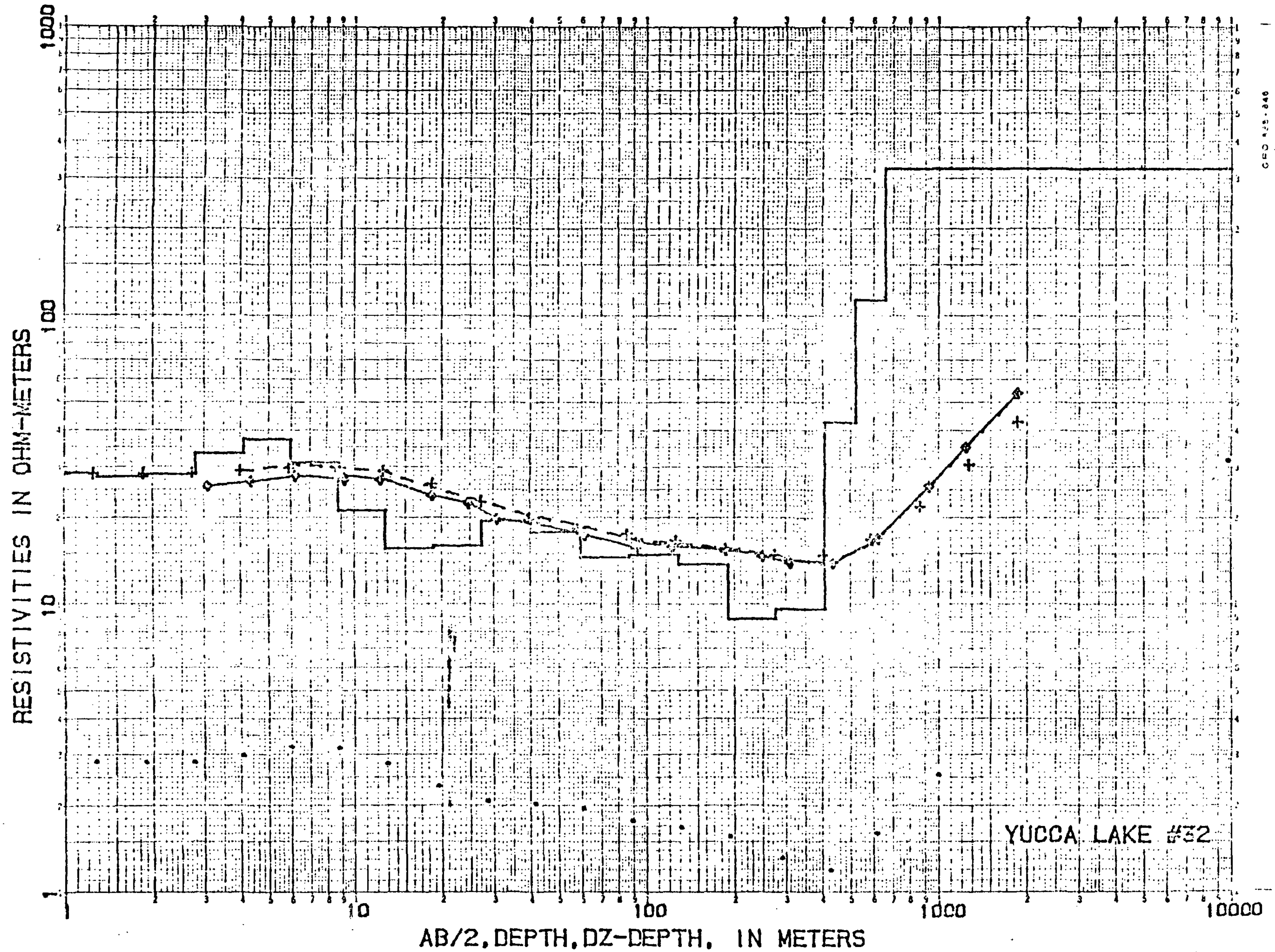

RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #27
1
10
100
1000
10000

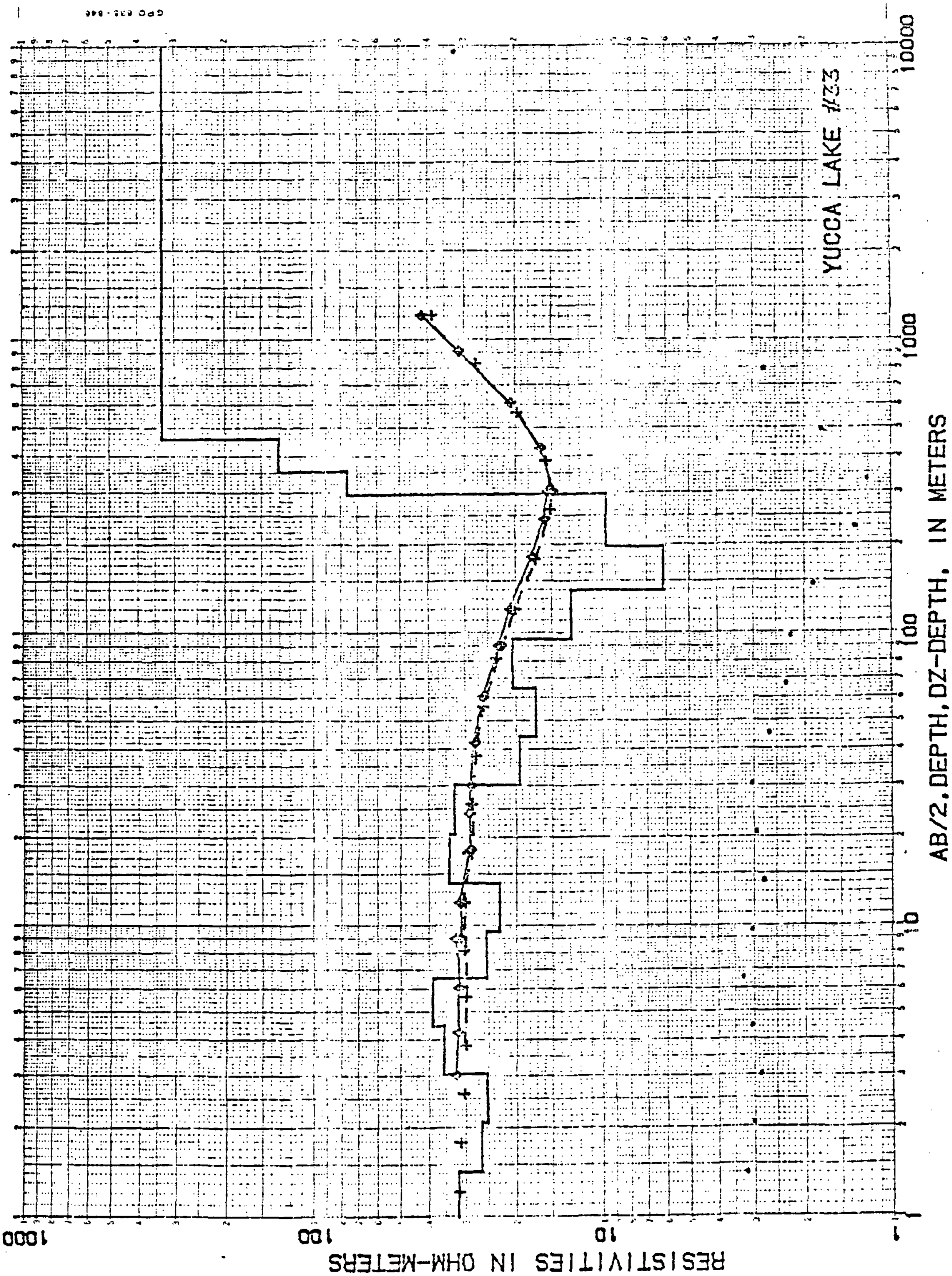

YUCCA LAKE #28
RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
1
10
100
1000
10000

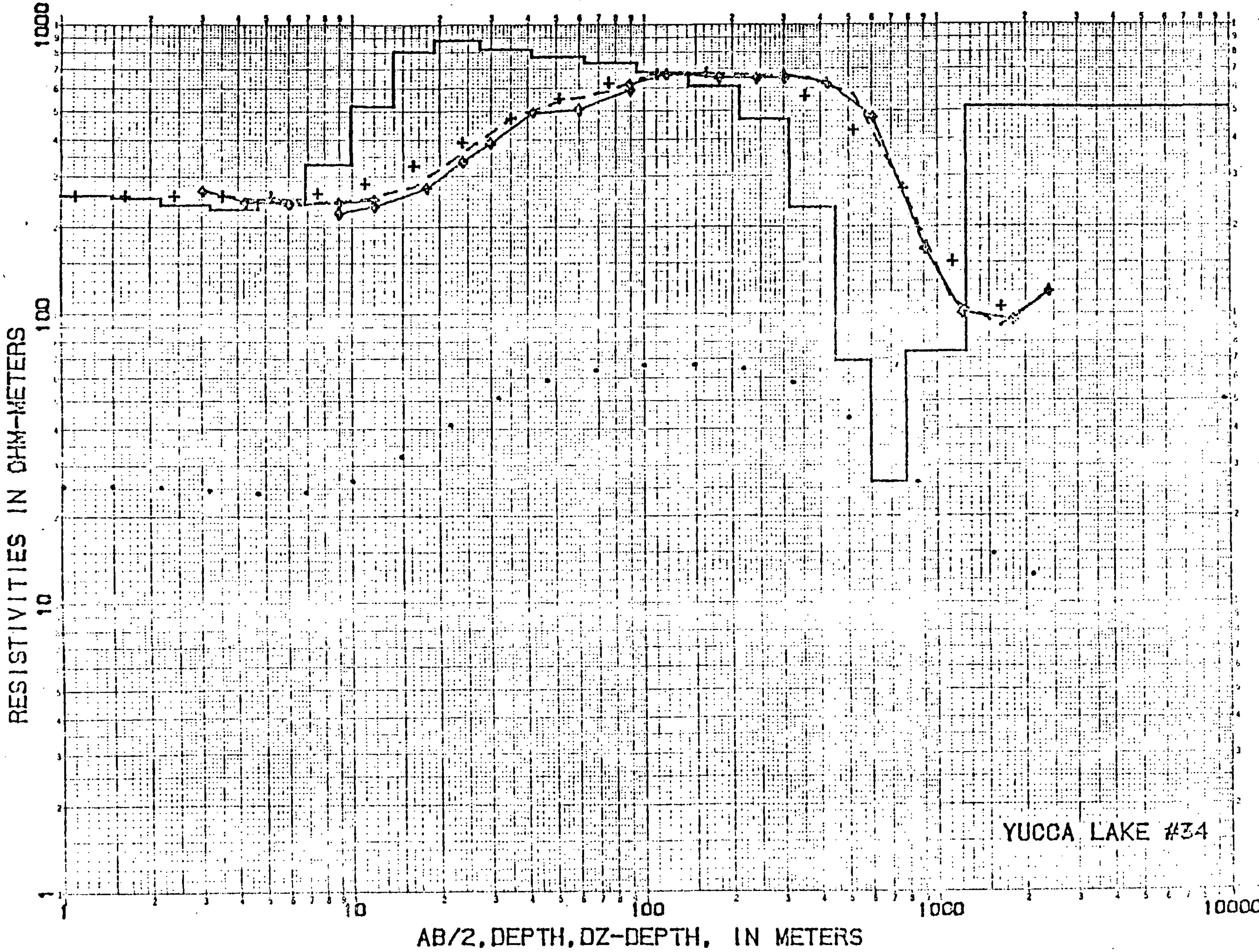

YUCCA LAKE #29
RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
1
10
100
1000
10000
GPO 835-848

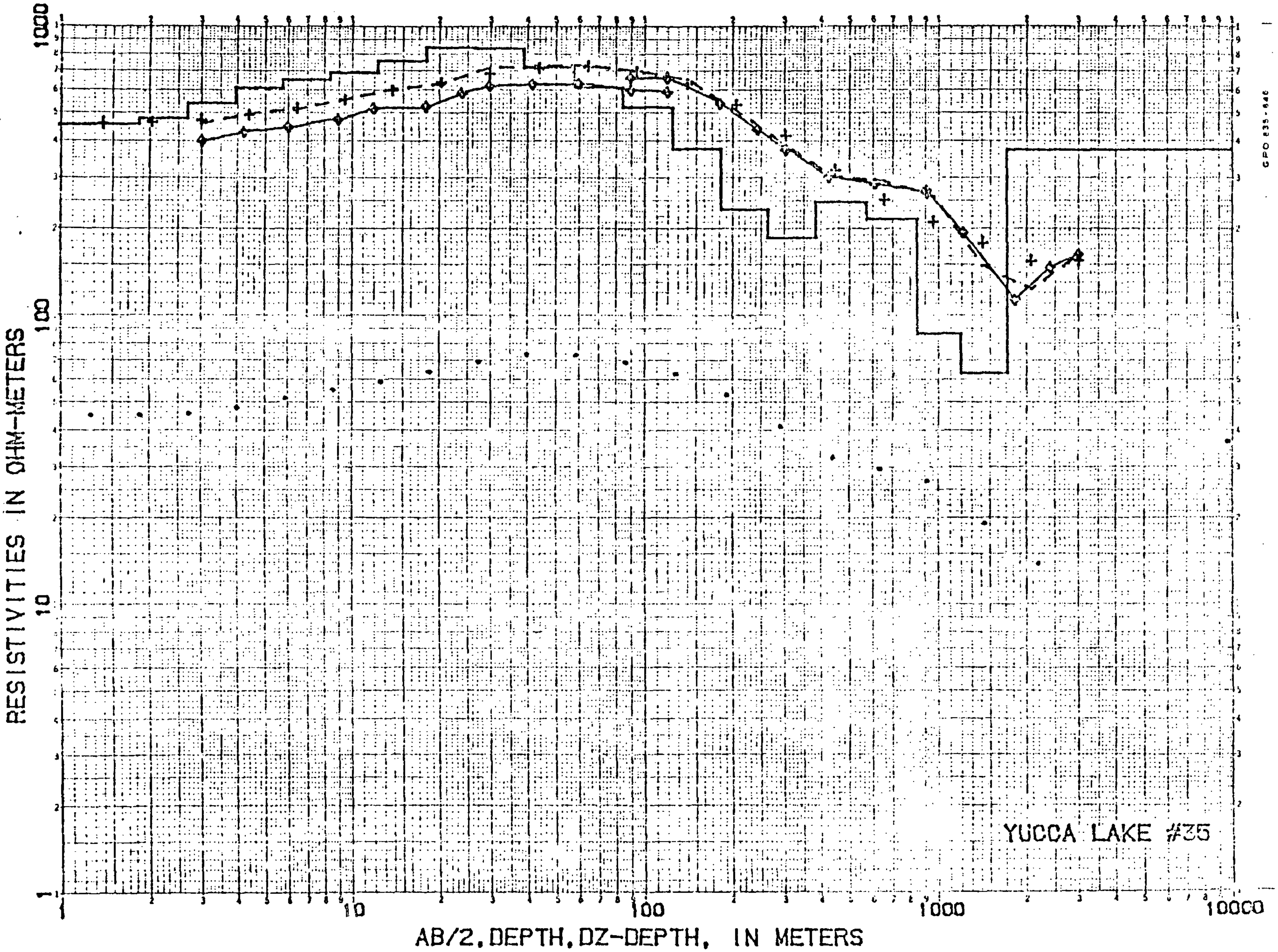

RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #50
1000
100
10
1
1
10
100
1000
10000


YUCCA LAKE #31
RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
1
10
100
1000
10000

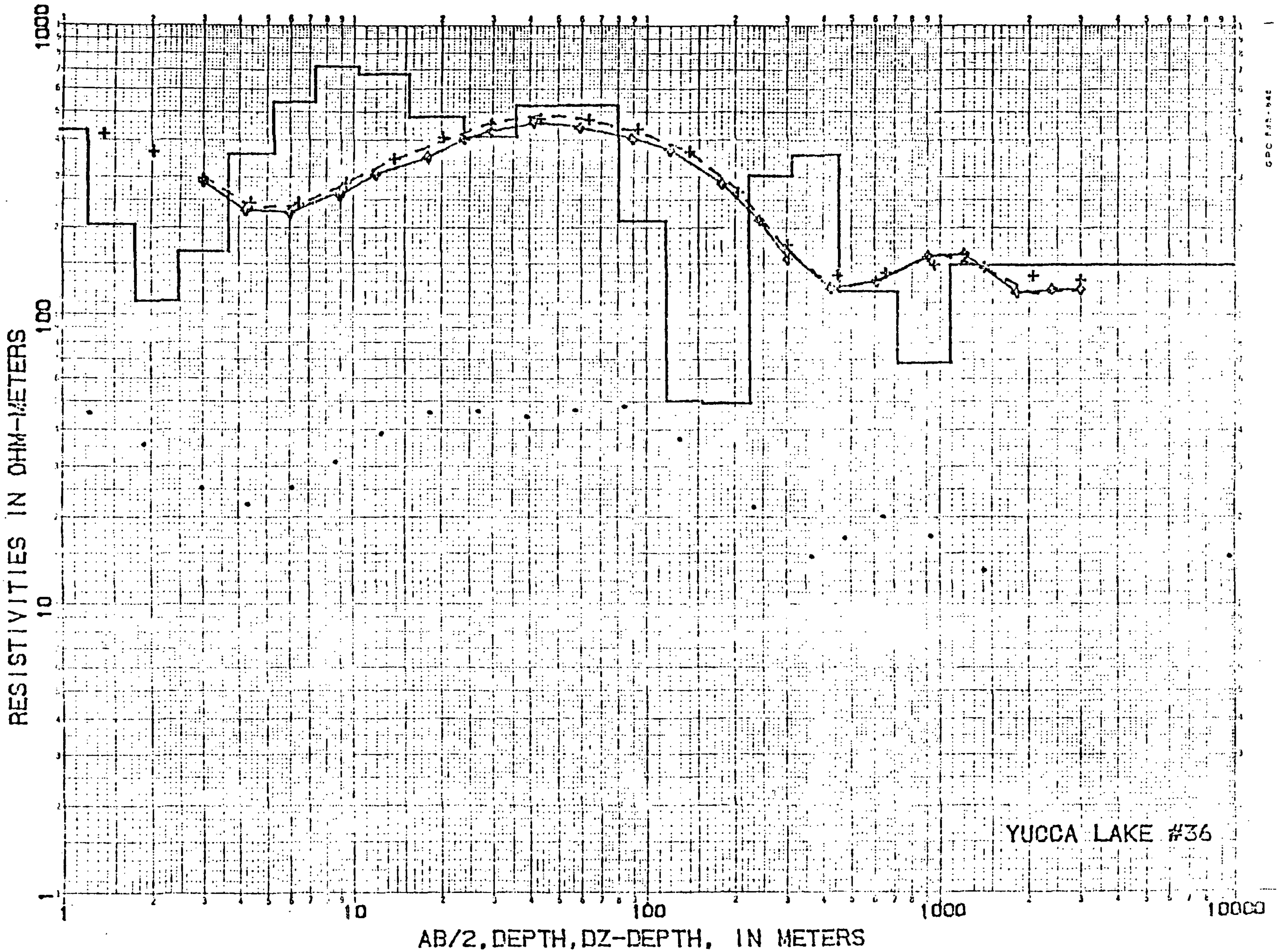

RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #32

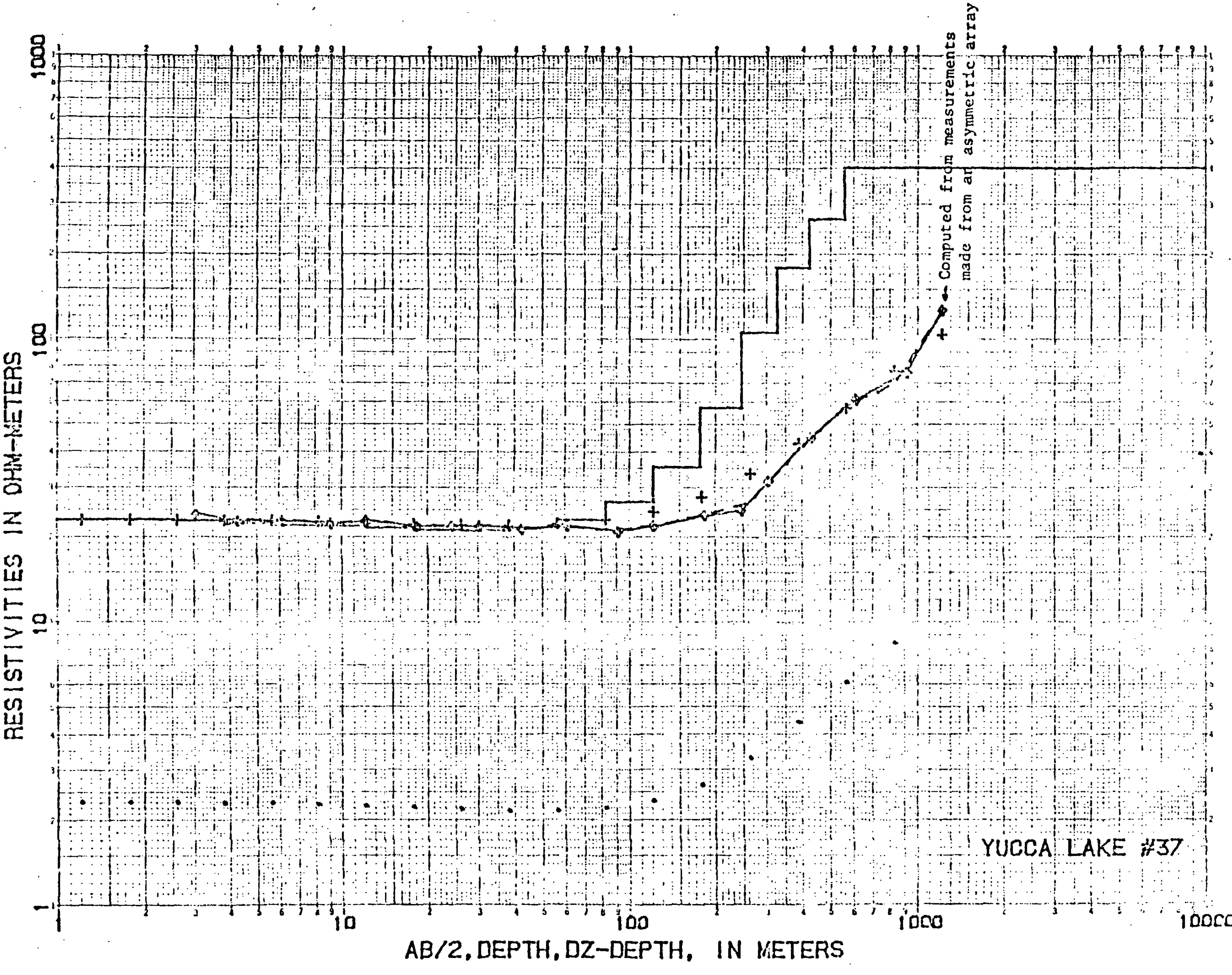

YUCCA LAKE #33
AB/2,DEPTH,DZ-DEPTH, IN METERS
1
10
100
1000
10000
RESISTIVITIES IN OHM-METERS
1000
100
10
1


RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #34

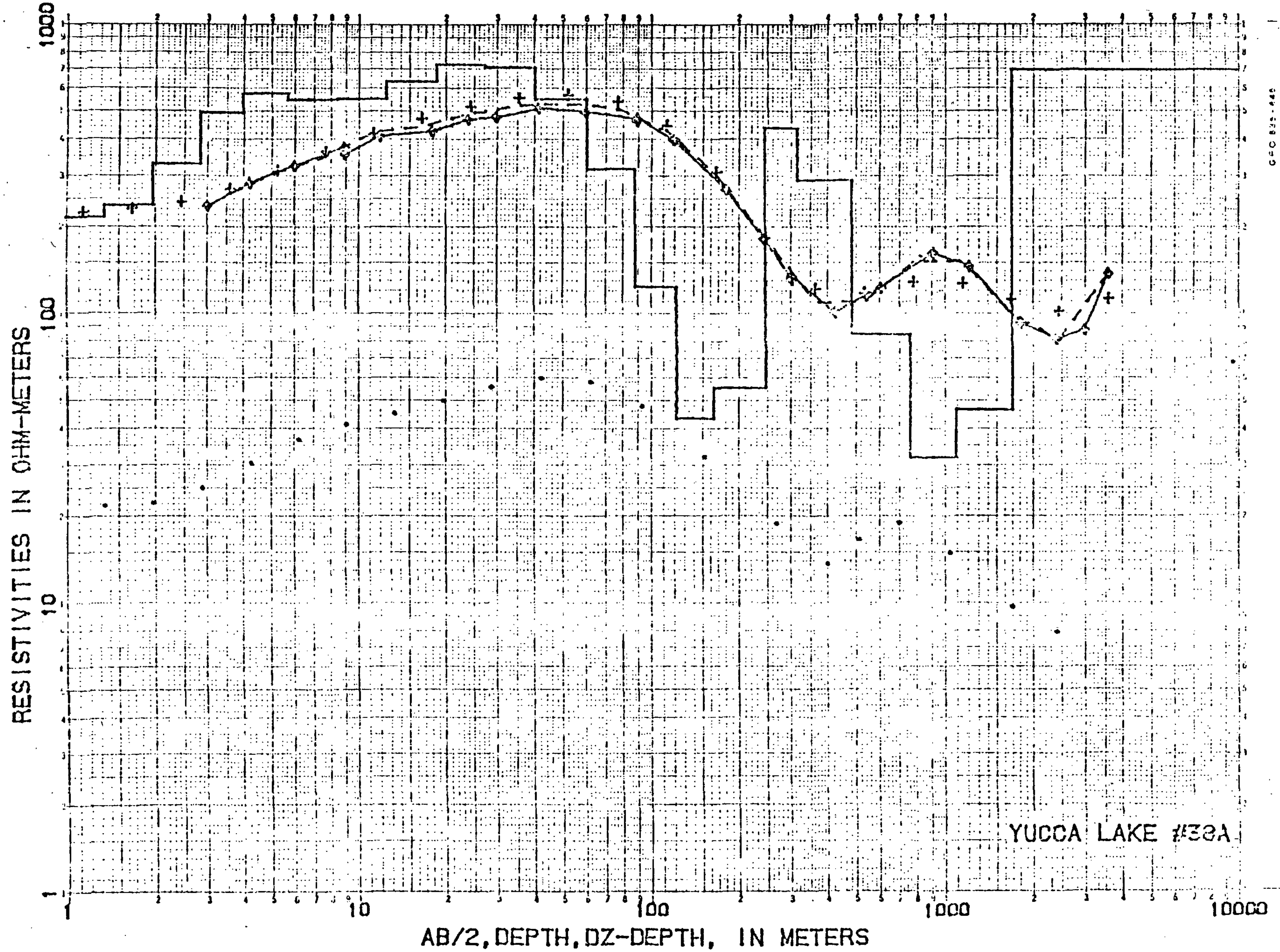


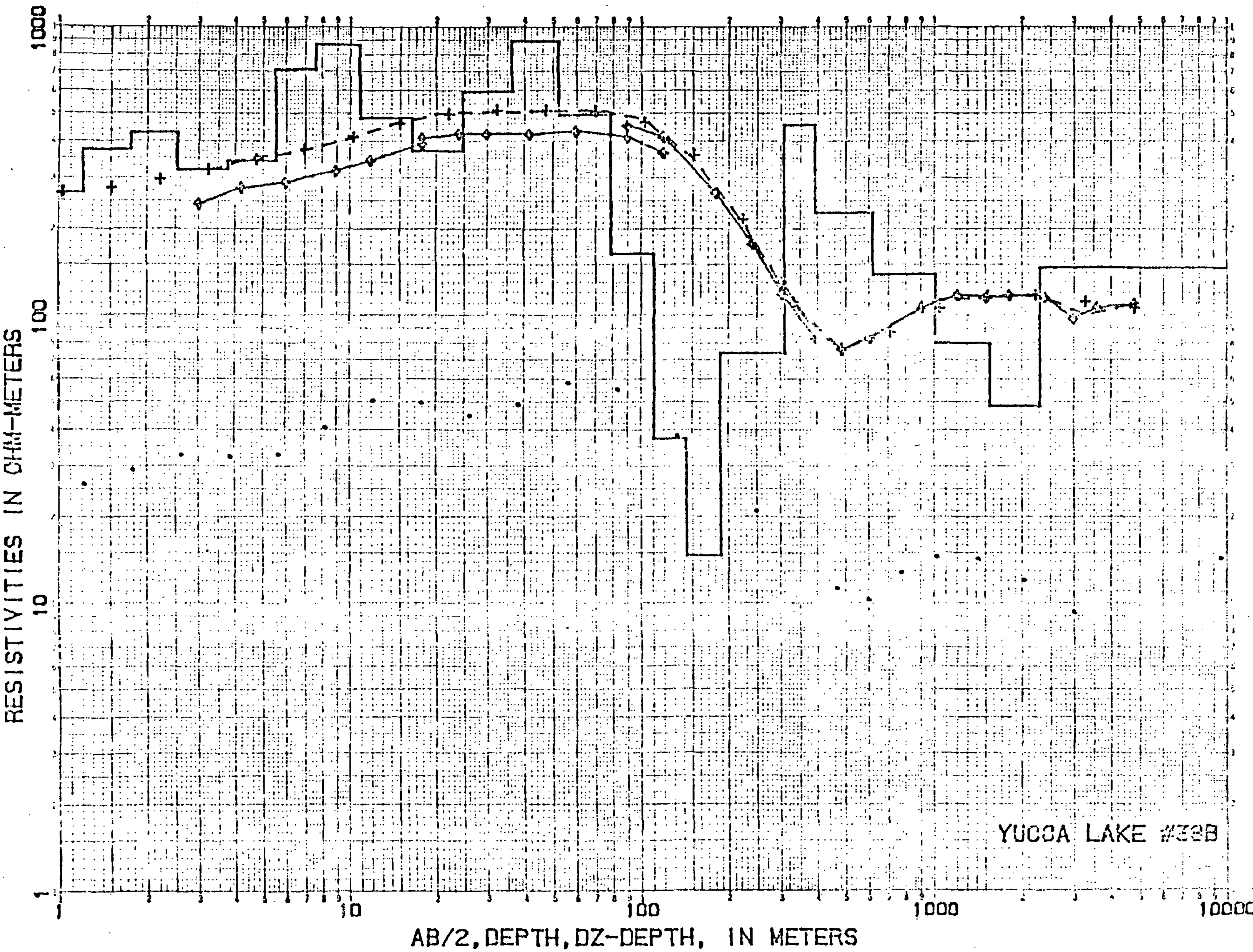
RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #35

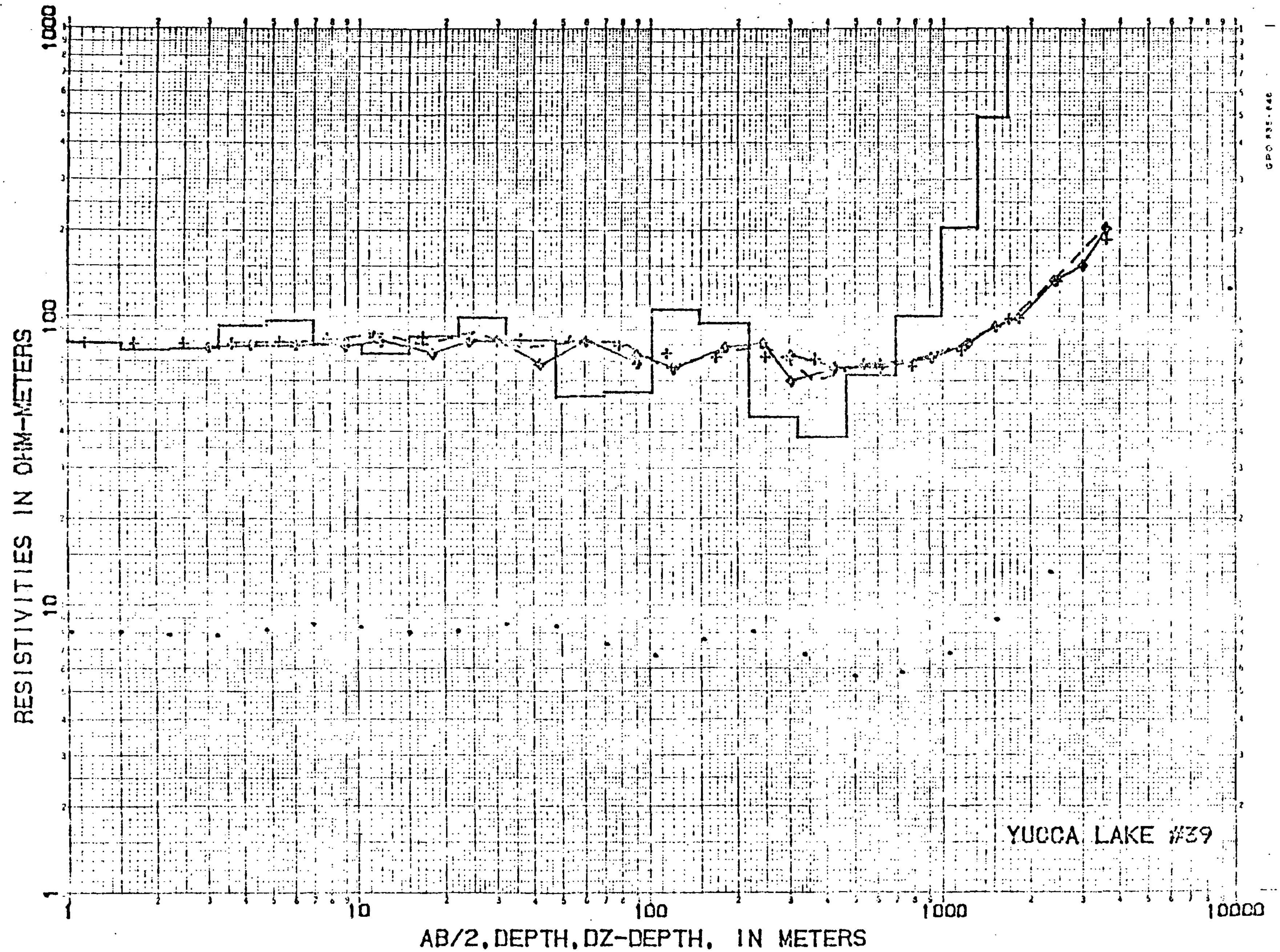

RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2,DEPTH,DZ-DEPTH, IN METERS
YUCCA LAKE #36

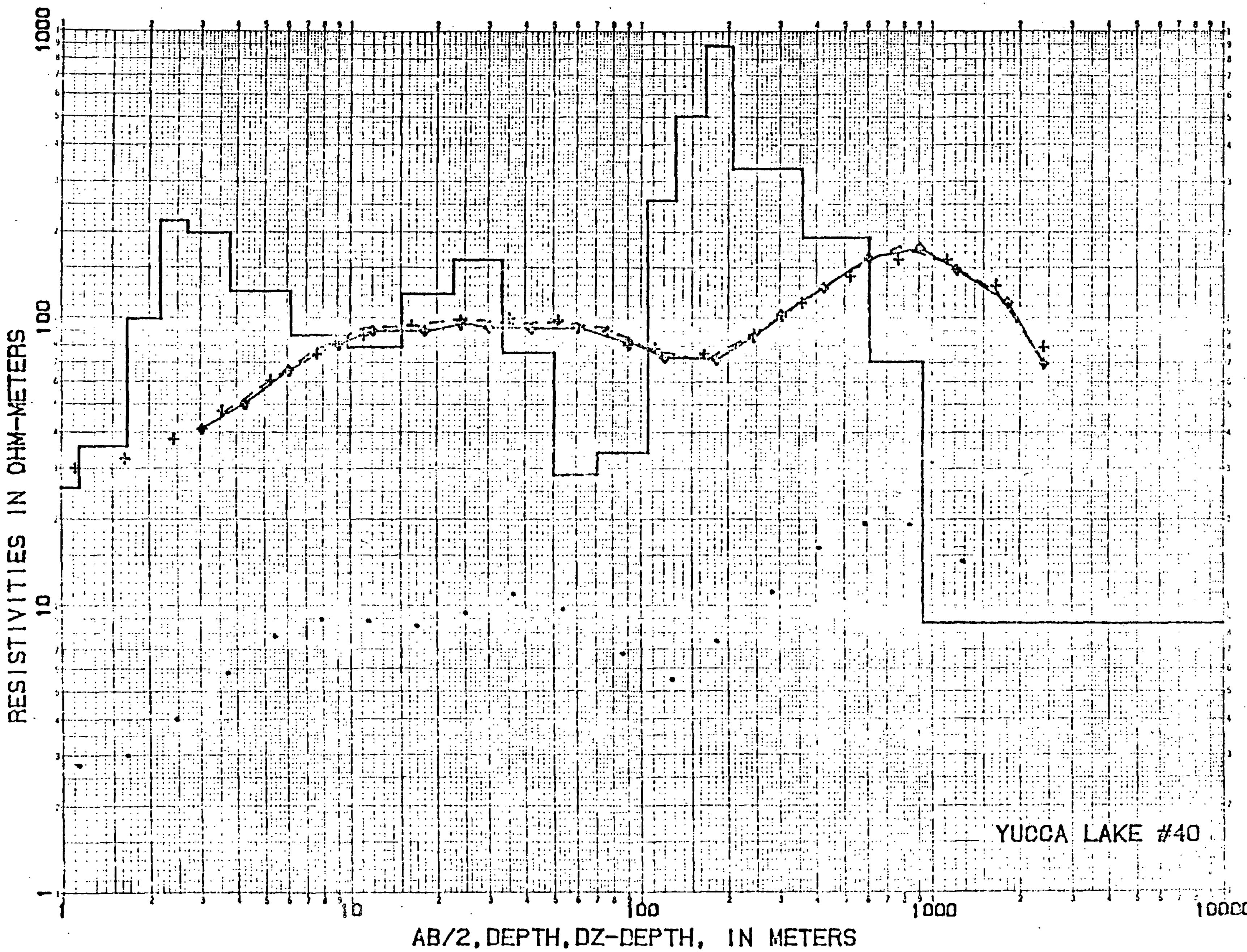


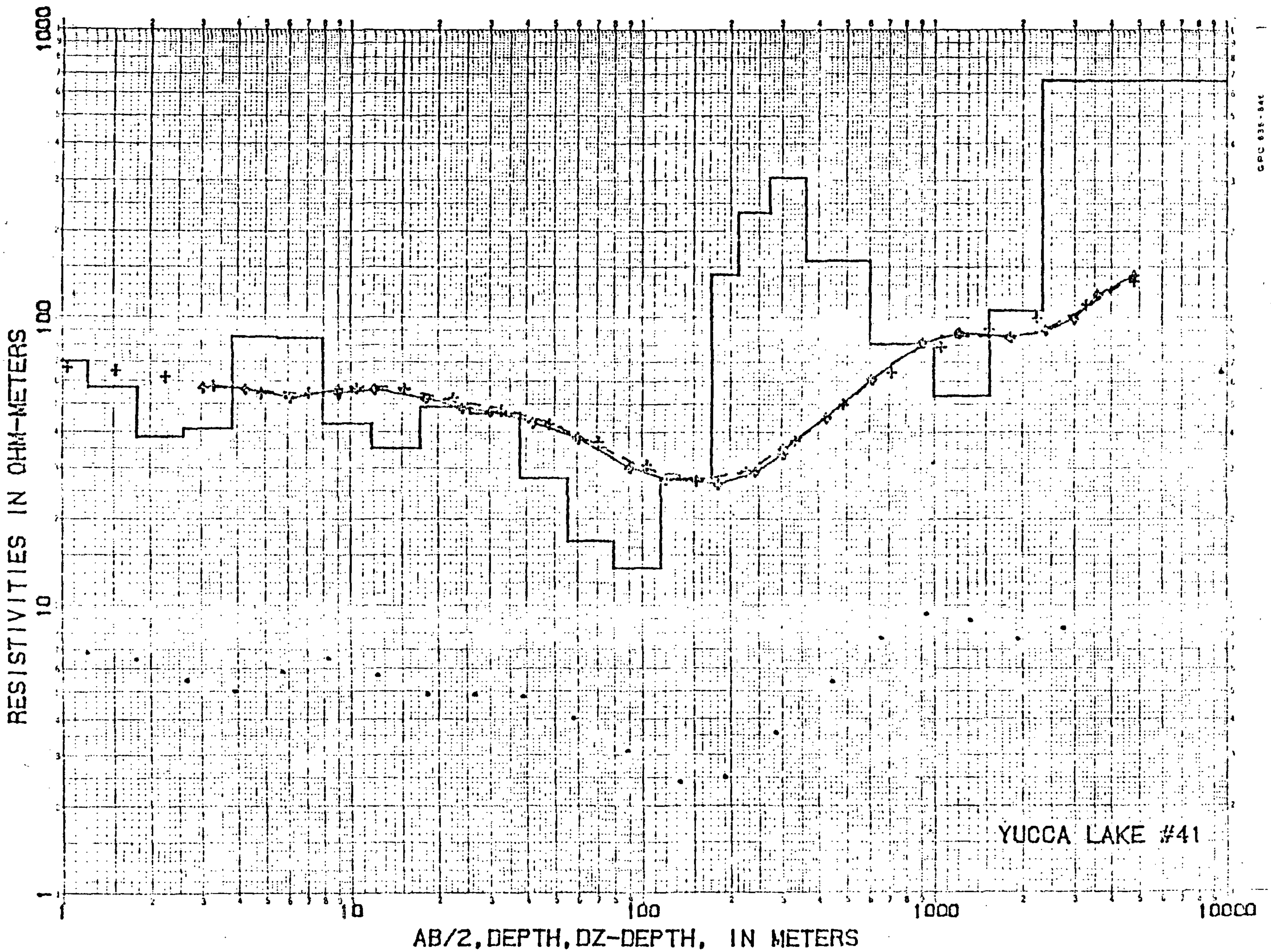
RESISTIVITIES IN OHM-METERS
1000
100
10
1
AB/2, DEPTH, DZ-DEPTH, IN METERS
1
10
100
1000
10000
Computed from measurements made from an asymmetric array
YUCCA LAKE #37


1000
100
10
1
1
10
100
1000
10000
RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #33A

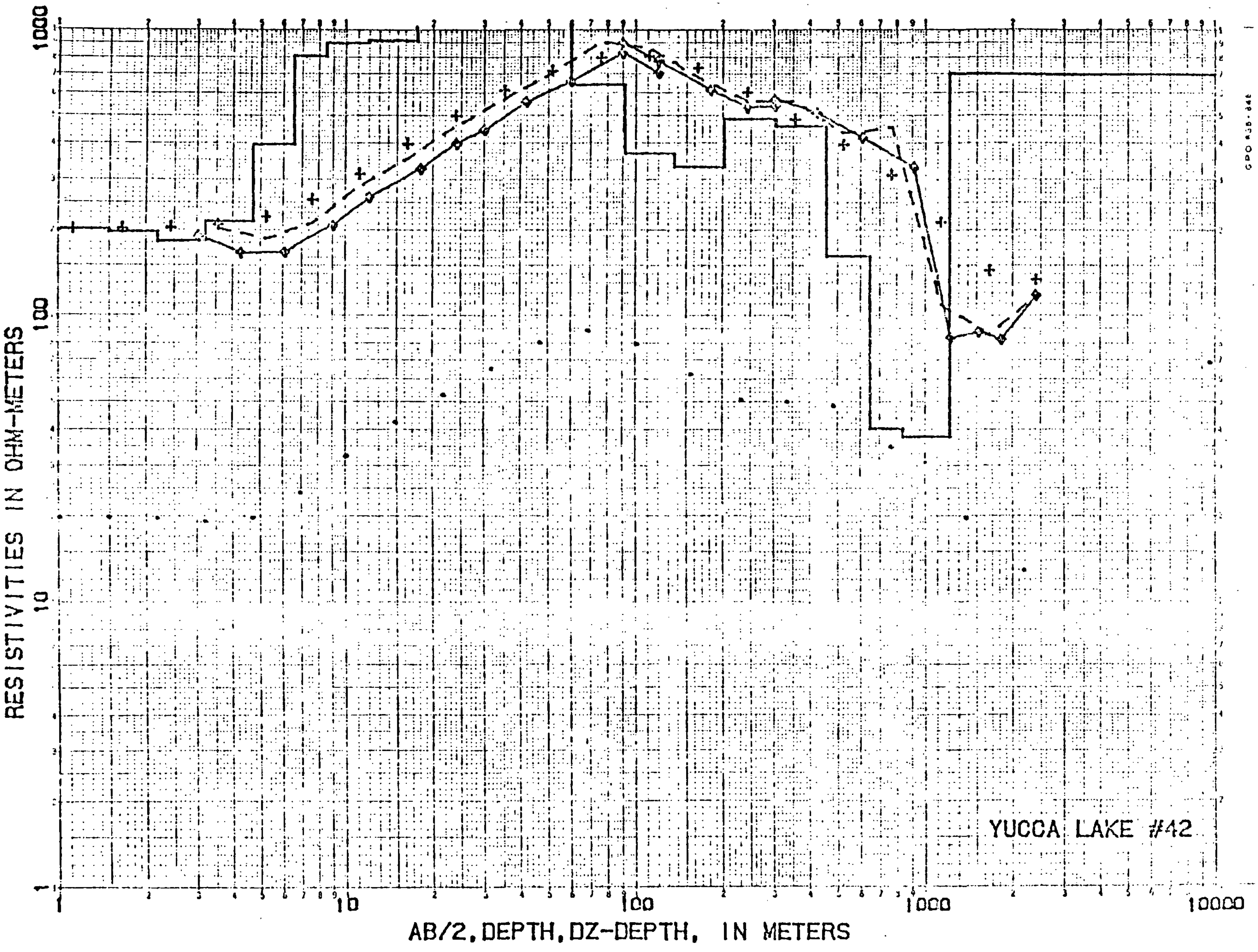

RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #33B
1000
100
10
1
1
10
100
1000
10000

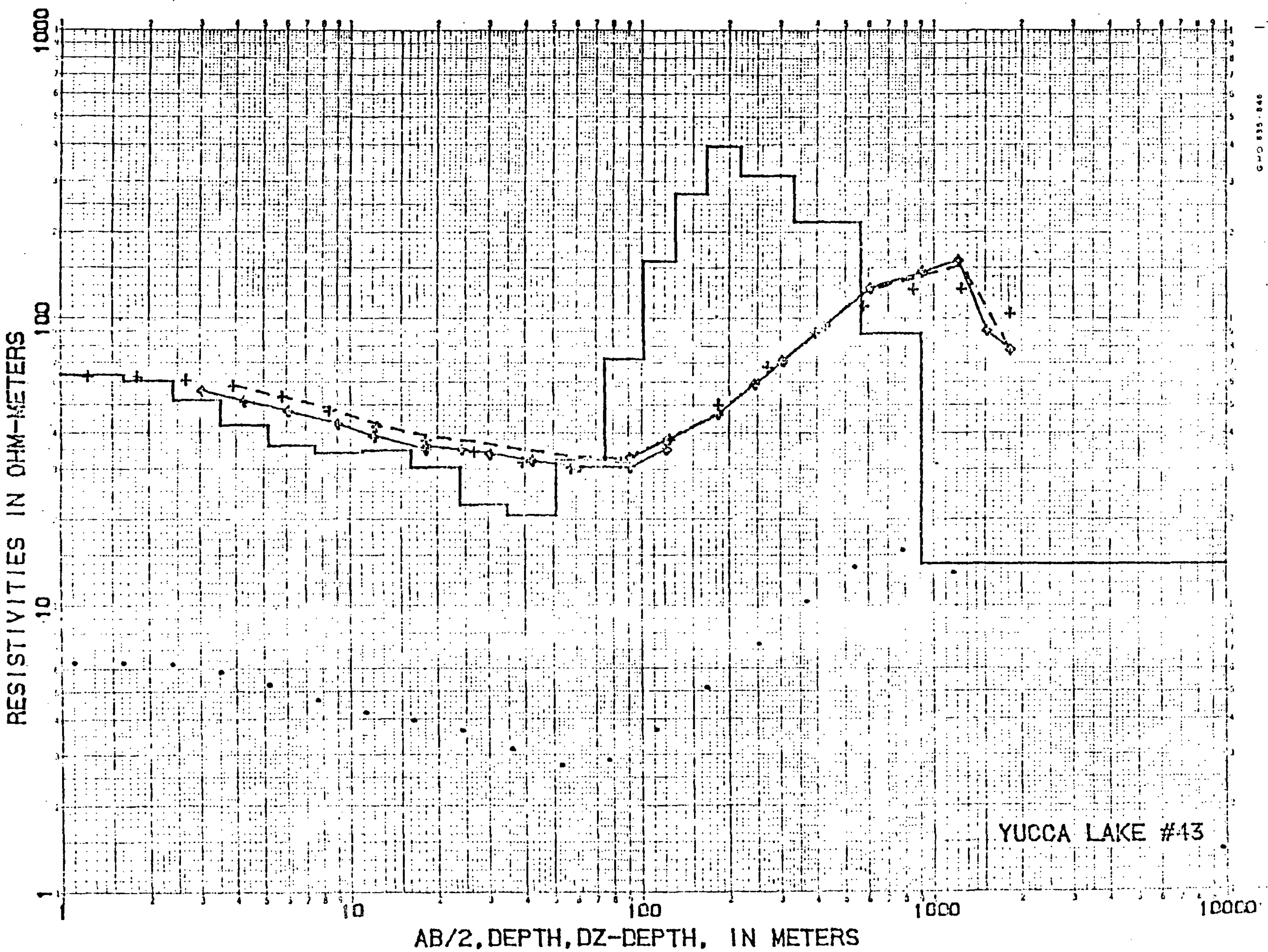

RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #39

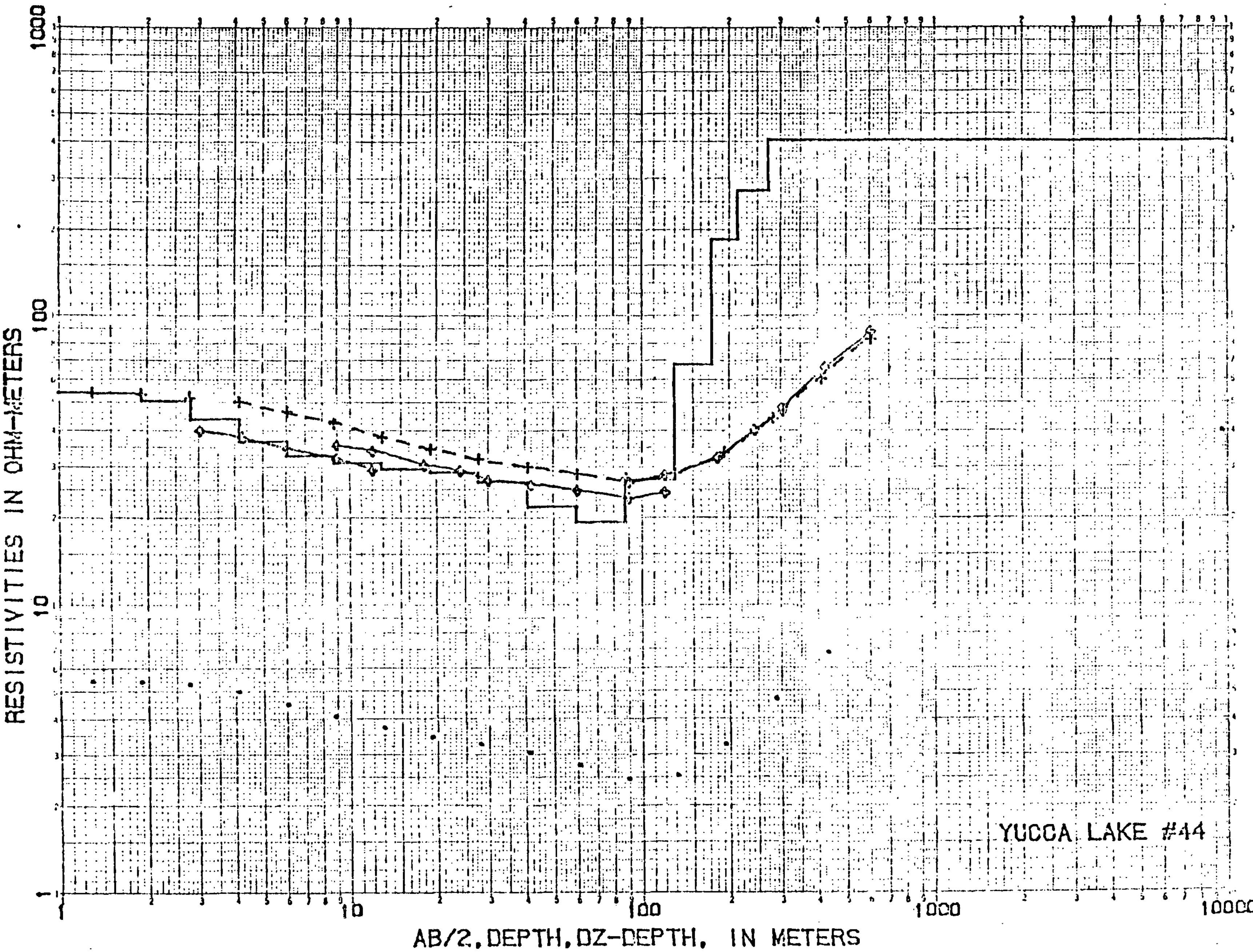

YUCCA LAKE #40
RESISTIVITIES IN OHM-METERS
1000
100
10
1
AB/2, DEPTH, DZ-DEPTH, IN METERS
1
10
100
1000
10000

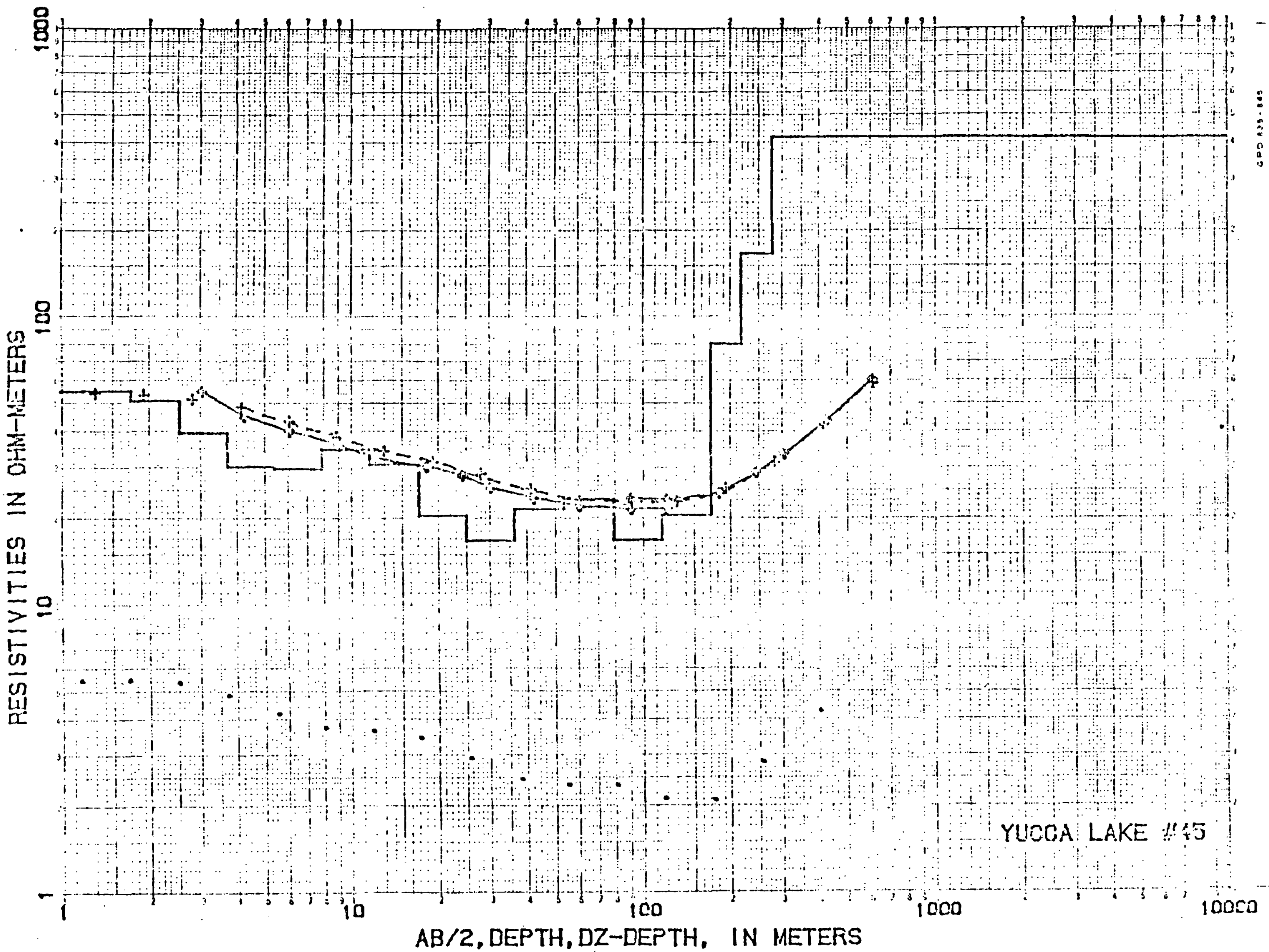


RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #41

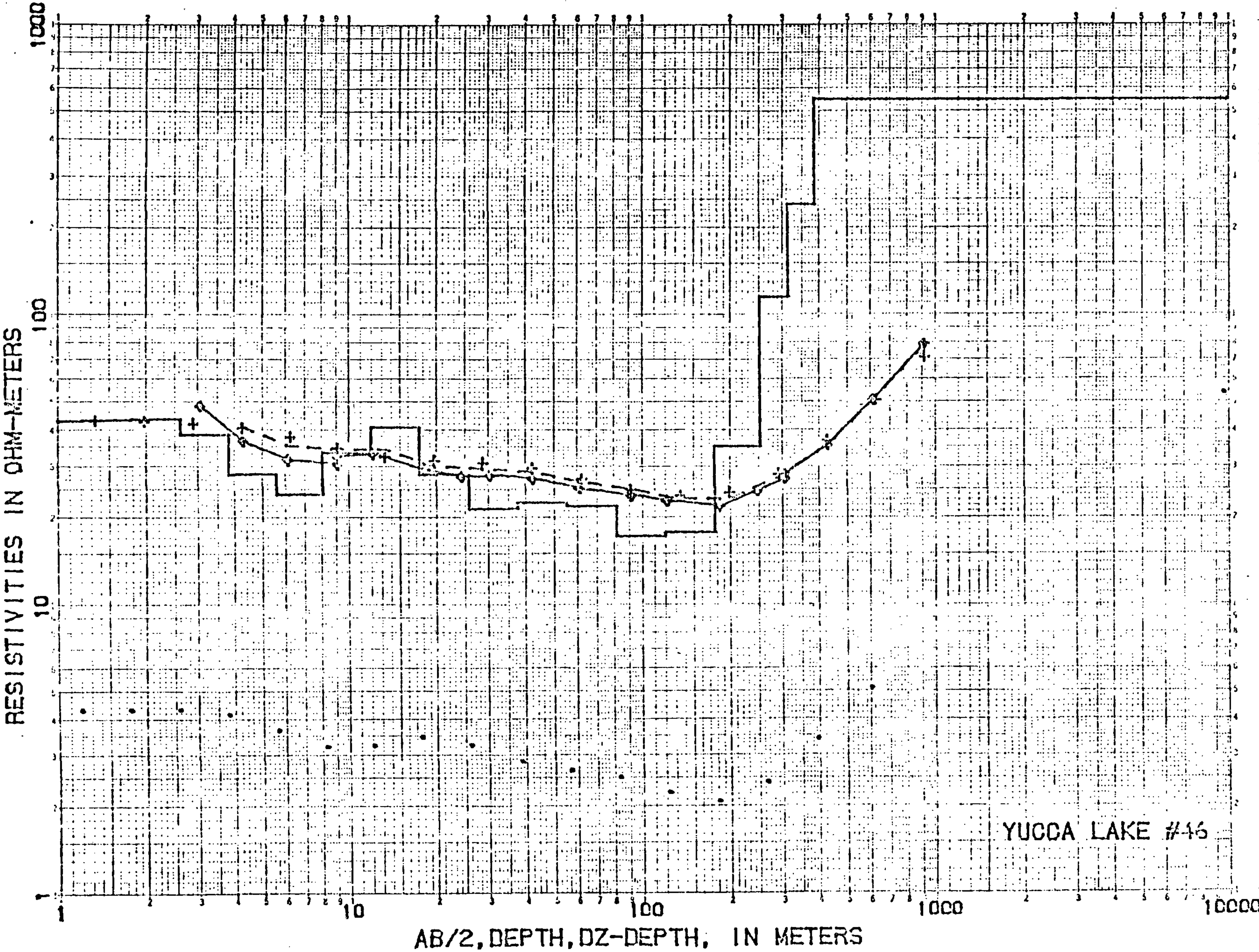

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #42

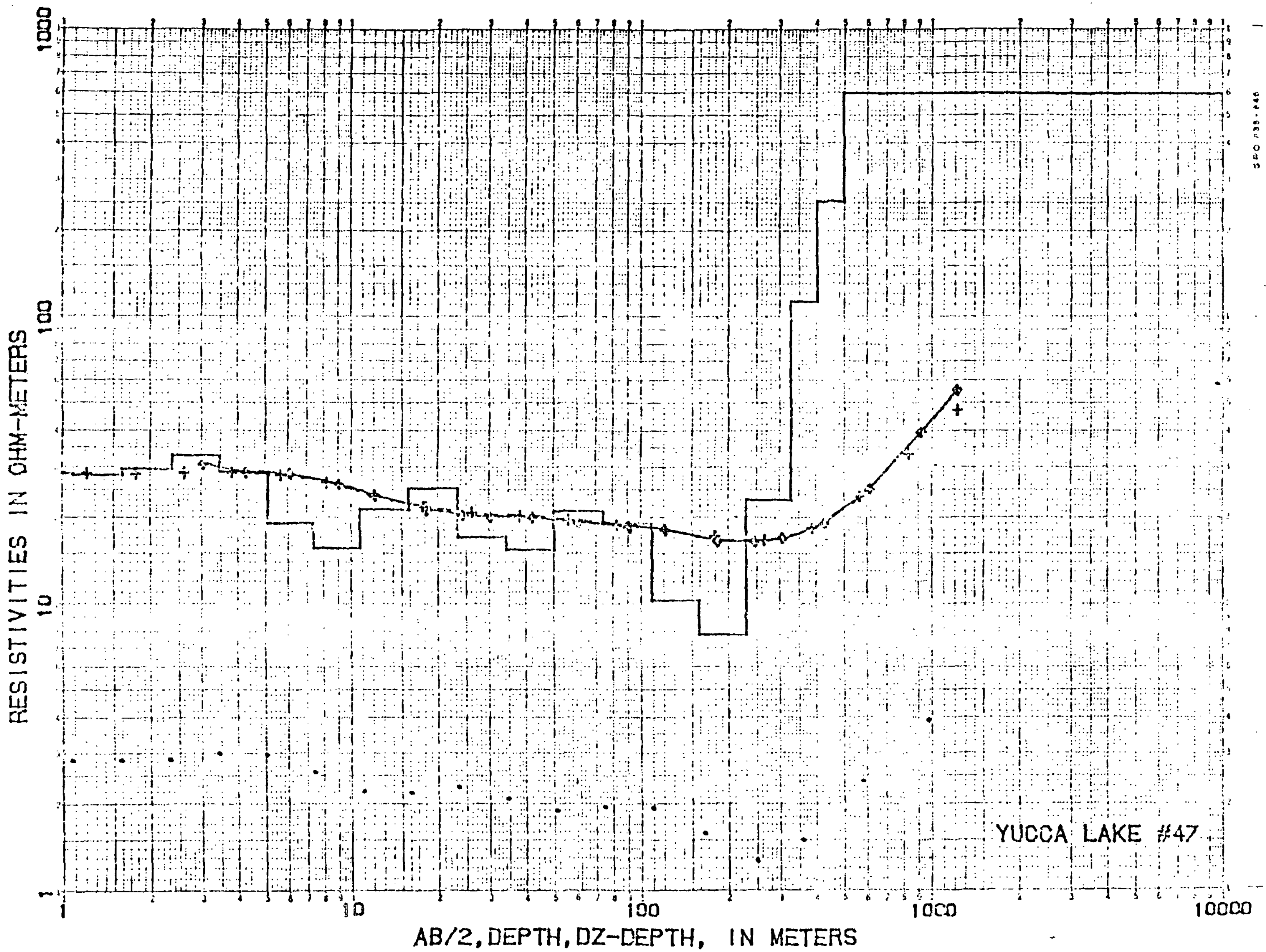

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #43

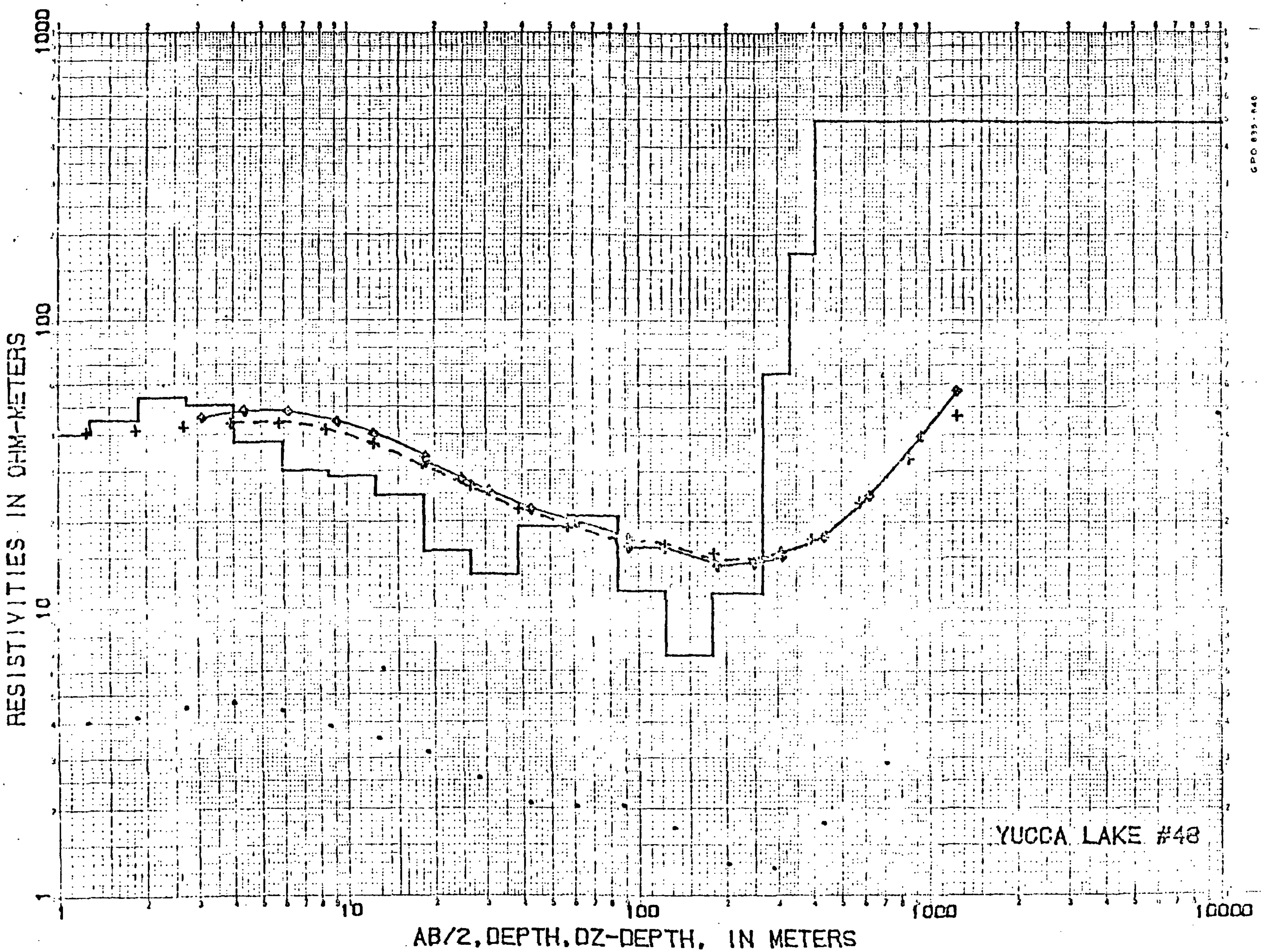

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #44



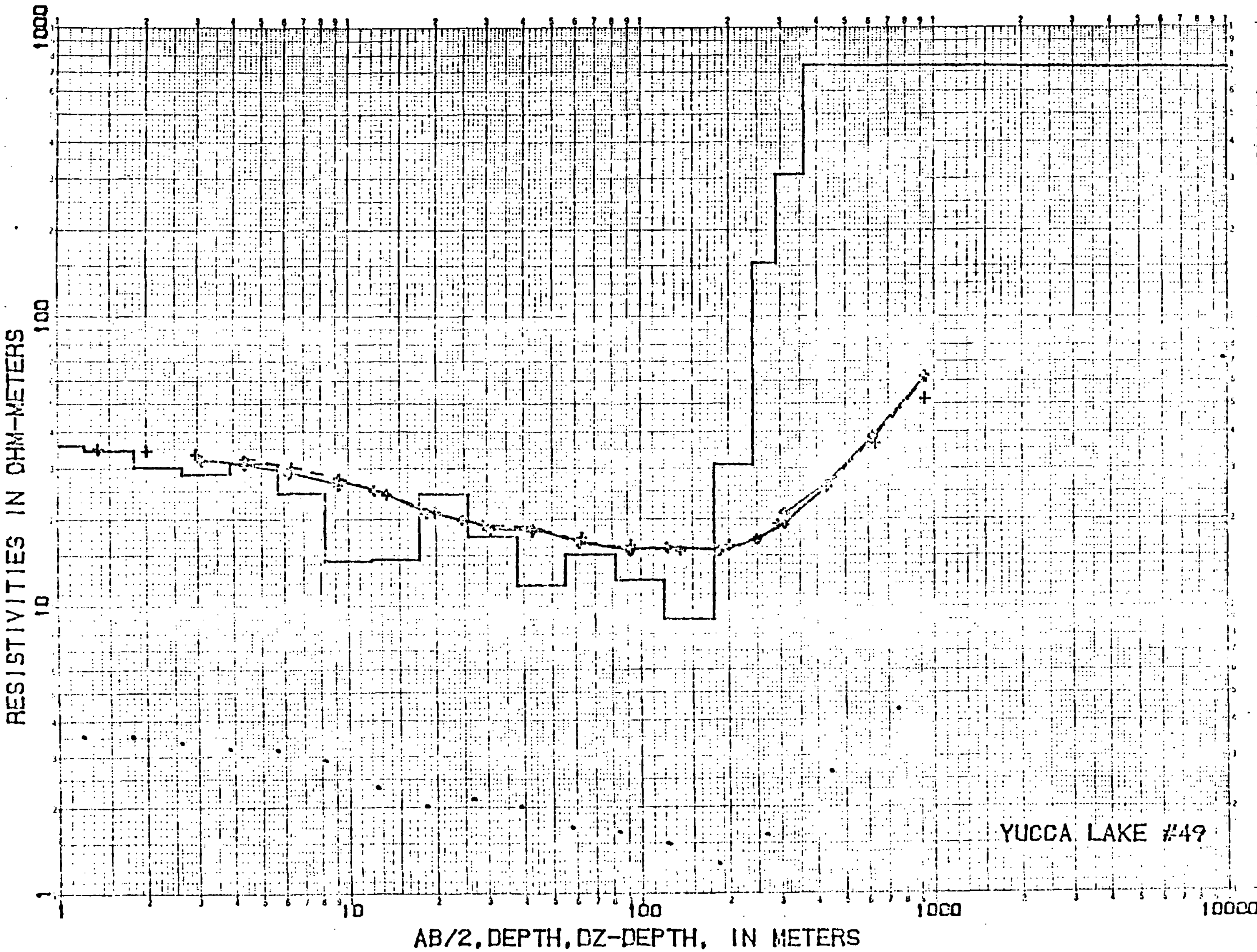
RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #45


RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #46
1
10
100
1000
10000

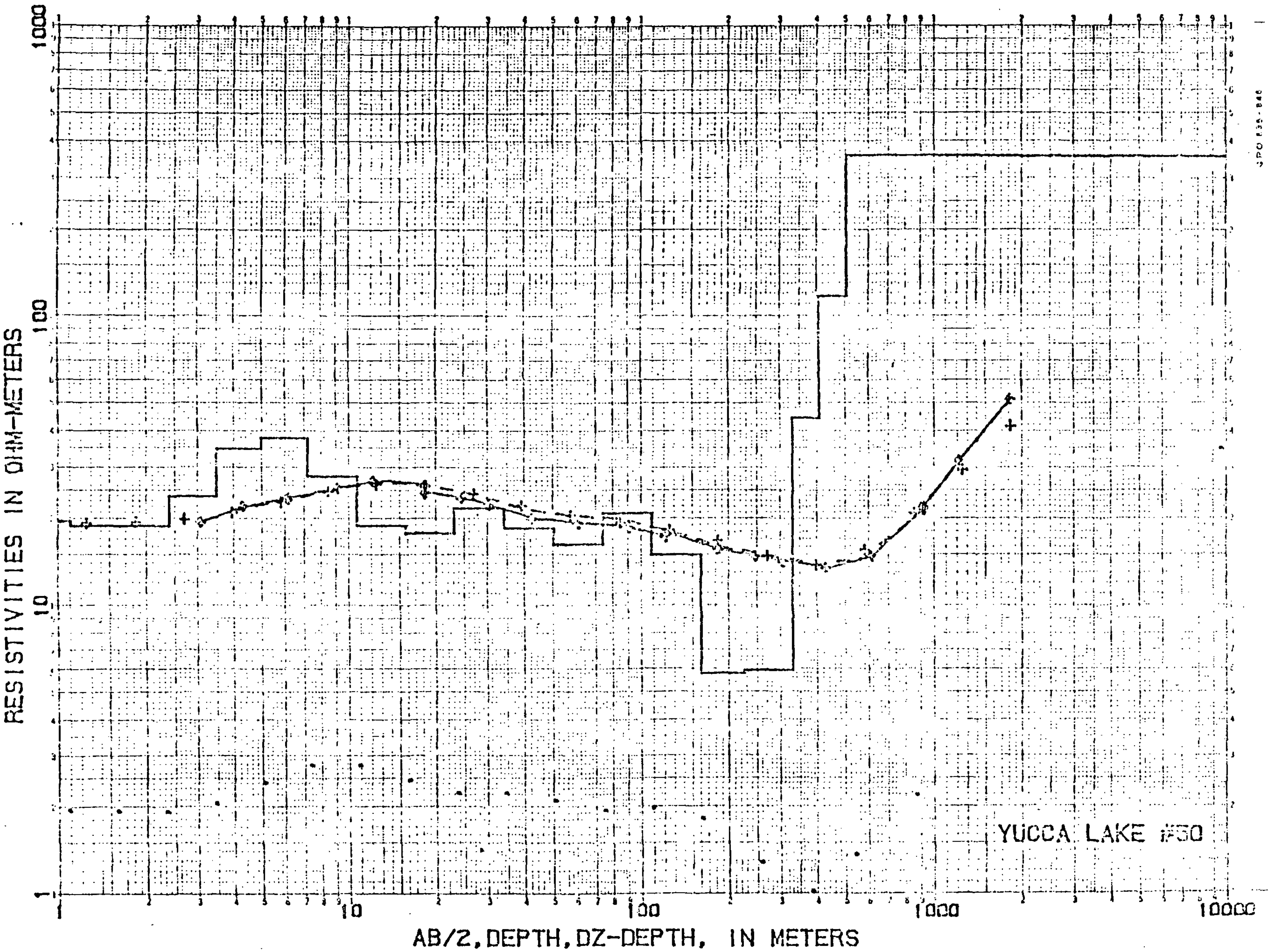

RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #47
1
10
100
1000
10000

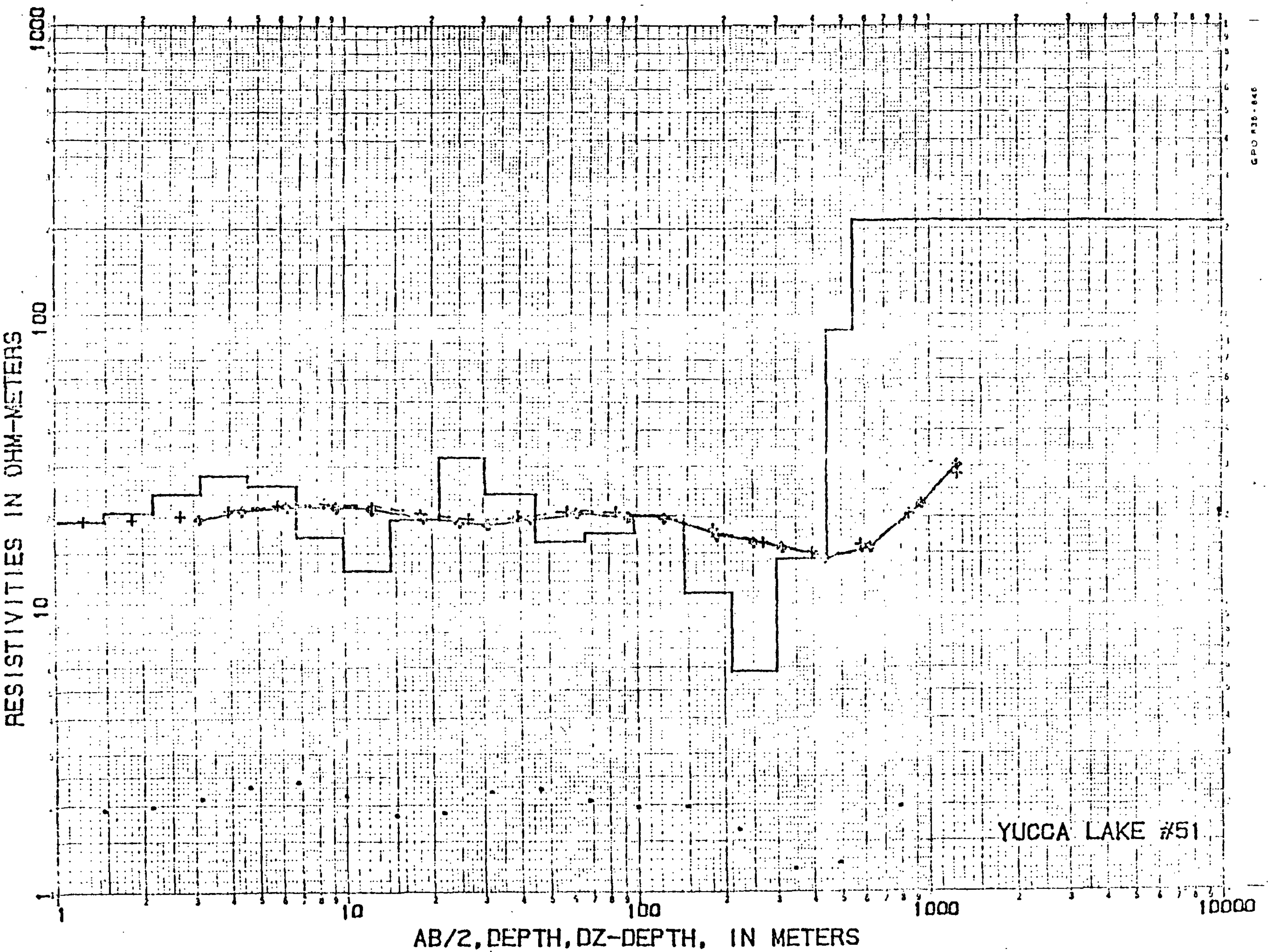


RESISTIVITIES IN OHM-METERS
1000
100
10
1
AB/2, DEPTH, DZ-DEPTH, IN METERS
1
10
100
1000
10000
YUCCA LAKE #48

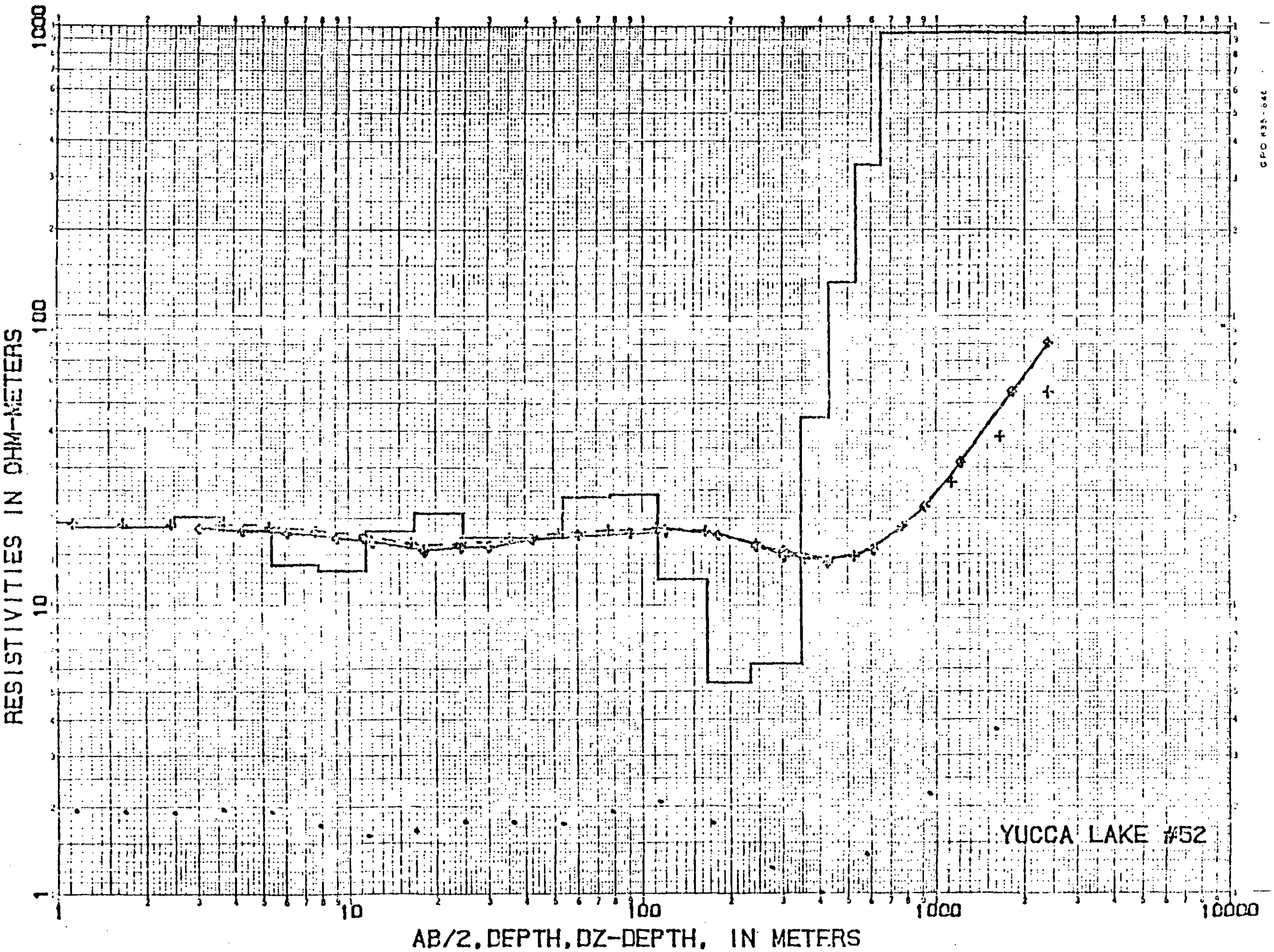


RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #49
1
10
100
1000
10000


RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #50



RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #51



RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
YUCCA LAKE #52