UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Schlumberger Soundings In Fish Lake Valley Area, Nevada

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In June 1977, the United States Geological Survey made a total of 10 Schlumberger resistivity soundings and two very low frequency (VLF) and Slingram[1] electromagnetic traverses in the Fish Lake Valley area, Nevada. The work was performed as a part of a program to determine the best methods for exploring and defining potential lithium-bearing brines. Fish Lake Valley is adjacent to Clayton Valley, the only area in the United States where lithium is being produced from brines. The Schlumberger soundings were made to help determine the geoelectric section within the Fish Lake Valley basin, and the Slingram and VLF traverses were made to help define the conductivity of the uppermost rock units in the basin.

Figure 1 shows the seven Schlumberger sounding stations and the VLF and Slingram traverse in Fish Lake Valley. Figure 2 shows the three Schlumberger sounding stations and the VLF and Slingram traverse in Columbus Salt Marsh. The appendix presents the Schlumberger data, interpretations of the sounding curves, and the Slingram and VLF data. All the sounding curves were

[1] The use of brand names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

automatically processed and interpreted using computer programs developed by Zohdy (1973 and 1975), and are shown in the graphs given in the appendix.

The Slingram and VLF traverses, which are plotted in profile form, will be used for examination of the resistive structures of the subsurface rocks.

The Slingram method has been discussed by Keller and Frischknecht (1966) in detail, and therefore no discussion of the method will be presented here. The Slingram data were collected at five frequencies (222, 444, 888, 1777 and 3555 Hz); however, only two frequencies (444 and 1727 Hz) are shown here.

The VLF method has been thoroughly discussed by Patterson and Ronka (1971). Briefly, the VLF method measures dip or tilt angle, the ellipticity of the ellipse of polarization of the magnetic field, the phase of the surface impedance, and the apparent resistivity in ohm-m.

Appendix

Each graph shows the following information:

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

(2) The continuous "field" curve (represented by the square symbols) was obtained by maintaining the position of the last segment and shifting each of the previous segments, up or down so that the last point on each segment coincided with the corresponding point on the following segment (Zohdy and others, 1973).

(3) The field curve was digitized at the rate of six points per logarithmic cycle. The individual digitized points are shown as diamond symbols and are connected by solid lines. The field curve data was then smoothed by a computer program using a bicubic spline function (Anderson, 1971). The resultant smoothed data were then passed to an automatic interpretation program to obtain the best-fitting theoretical sounding curve for a horizontally layered medium (Zohdy, 1973). The automatic interpretation program used here was identical to that in a program recently written for inverting Wenner sounding curves (Zohdy and Bisdorf, 1975).

(4) The theoretical best-fitting sounding curve plotted as (+) symbols.

(5) The detailed layering for which the theoretical curve was calculated and plotted.

(6) The D.Z. (Dar-Zarrouk) curve for the detailed layering. The ordinate values for the D.Z. curves were shifted upward or downward by one logarithmic cycle to avoid cluttering the graphs. The D.Z. curves can be used to obtain equivalent and simpler solutions containing fewer number of layers. They can also be used to impose certain constraints on the layer thicknesses and resistivities (Zohdy, 1974).

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

References

Anderson, W. L., 1971, Application of bicubic spline functions to two-dimensional gridded data: U.S. Dept. Commerce, Springfield, VA, Rept. PB-203579.

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Keller, G. V. and Frischknecht, F. C., 1966, Electrical methods in geophysical prospecting: Oxford, Pergamon Press, p.380-396.

Patterson, M. R. and Ronka, V., 1971, Five years of surveying with the very-low frequency electromagnetic method: Geoexploration, v. 9, p. 7-26.

Zohdy, A. A. R., 1973, A computer program for the automatic interpretation of Schlumberger sounding curves over horizontally stratified media: U.S. Dept. Commerce, Springfield, VA, Rept. PB-232703/AS, 25 p.

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

Zohdy, A. A. R., 1974b, Automatic interpretations of Schlumberger sounding curves using modified Dar-Zarrouk functions: U.S. Geol. Survey Bull. 1313-E, 39 p.

Zohdy, A. A. R., and Bisdorf, F. J., 1975, Computer programs for the forward calculation and automatic inversion of Wenner sounding curves: U.S. Dept. Commerce, Springfield VA, Rept. PB-247265/AS.

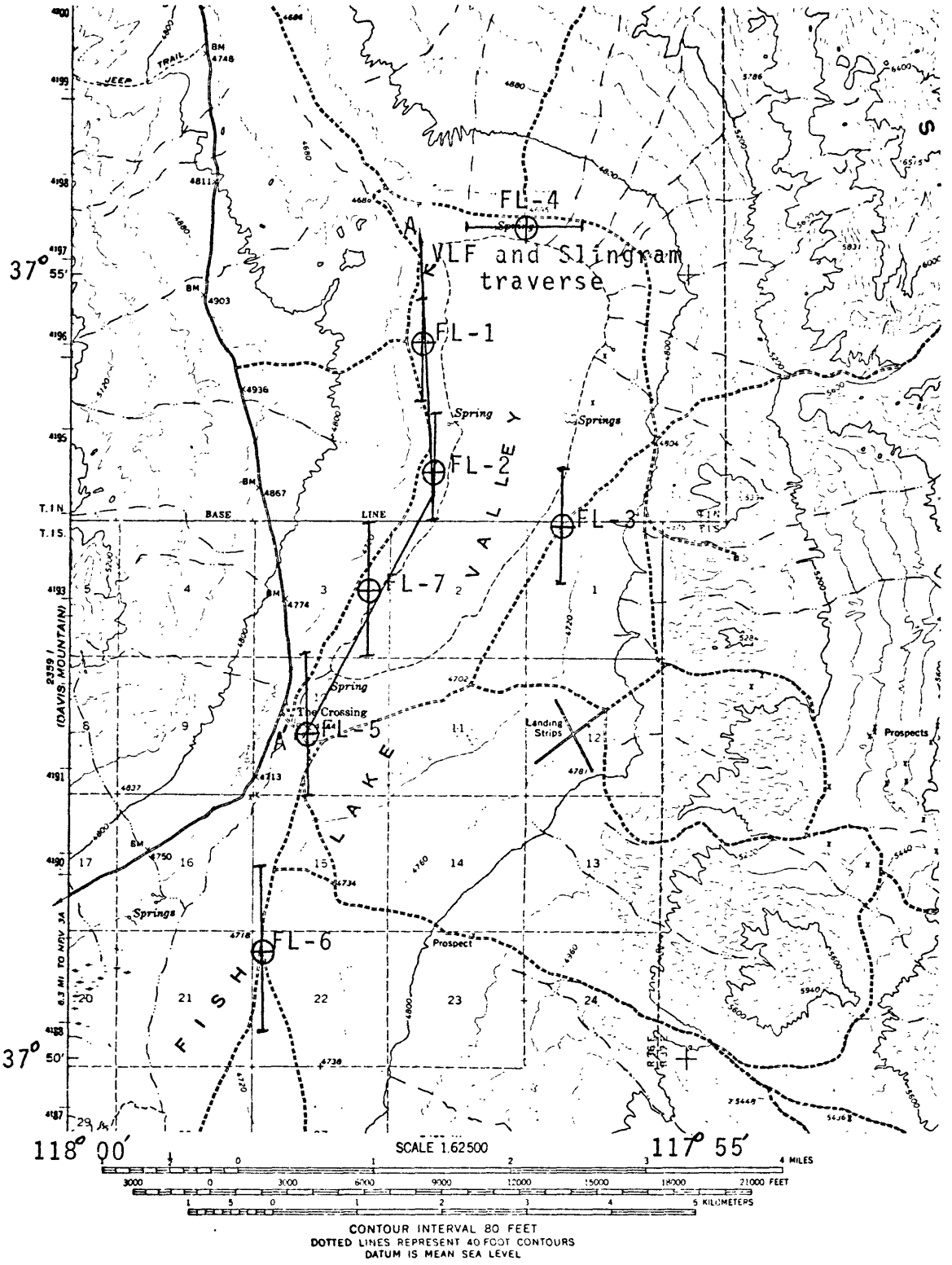


Figure 1. Map of Fish Lake Valley, Neveda, showing number, location, and azimuth of seven Schlumberger sounding stations and a VLF and Slingram traverse (A-A'). Base from U.S. Geological Survey 1:62500, Rhyolite, 1963.

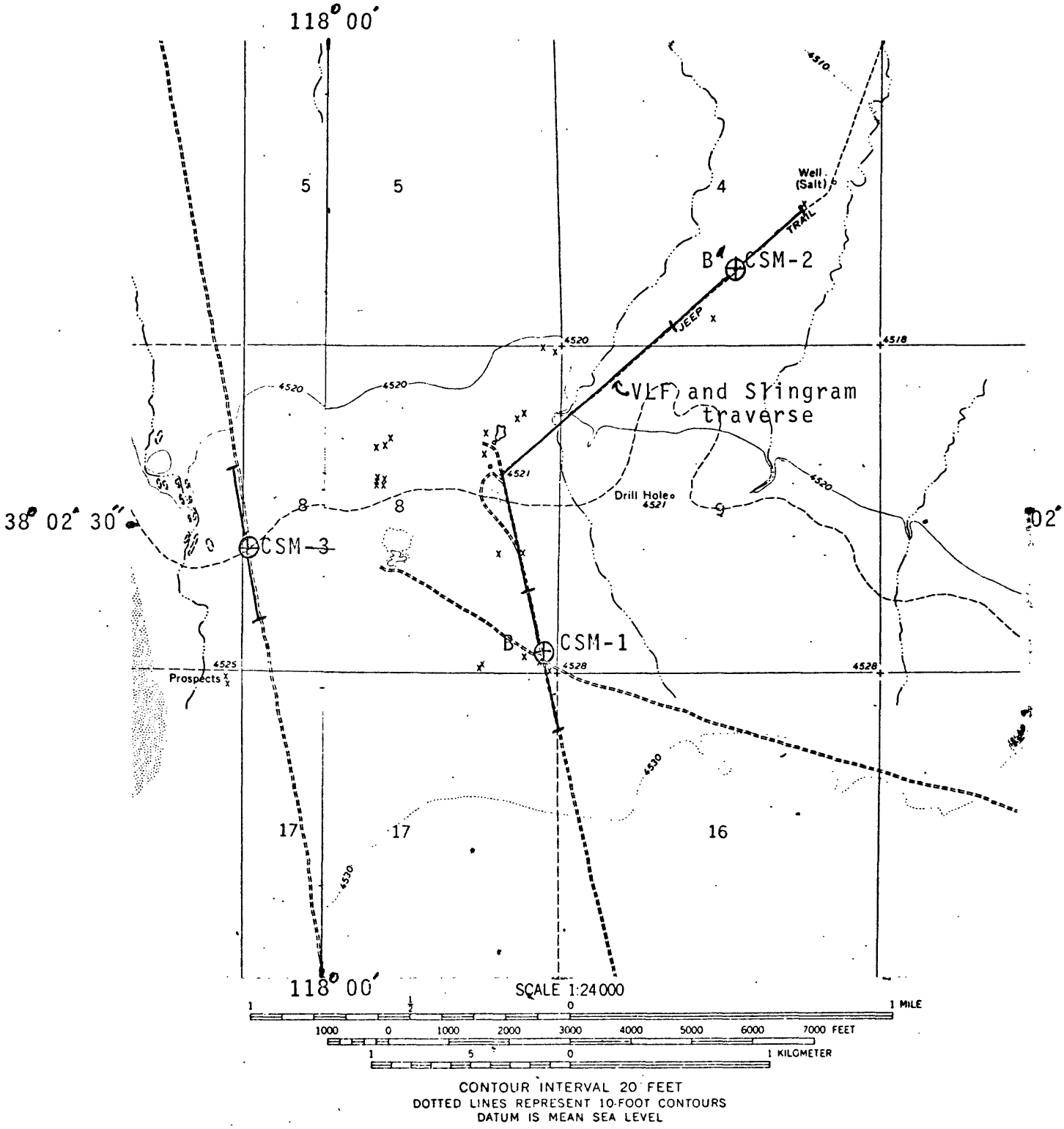
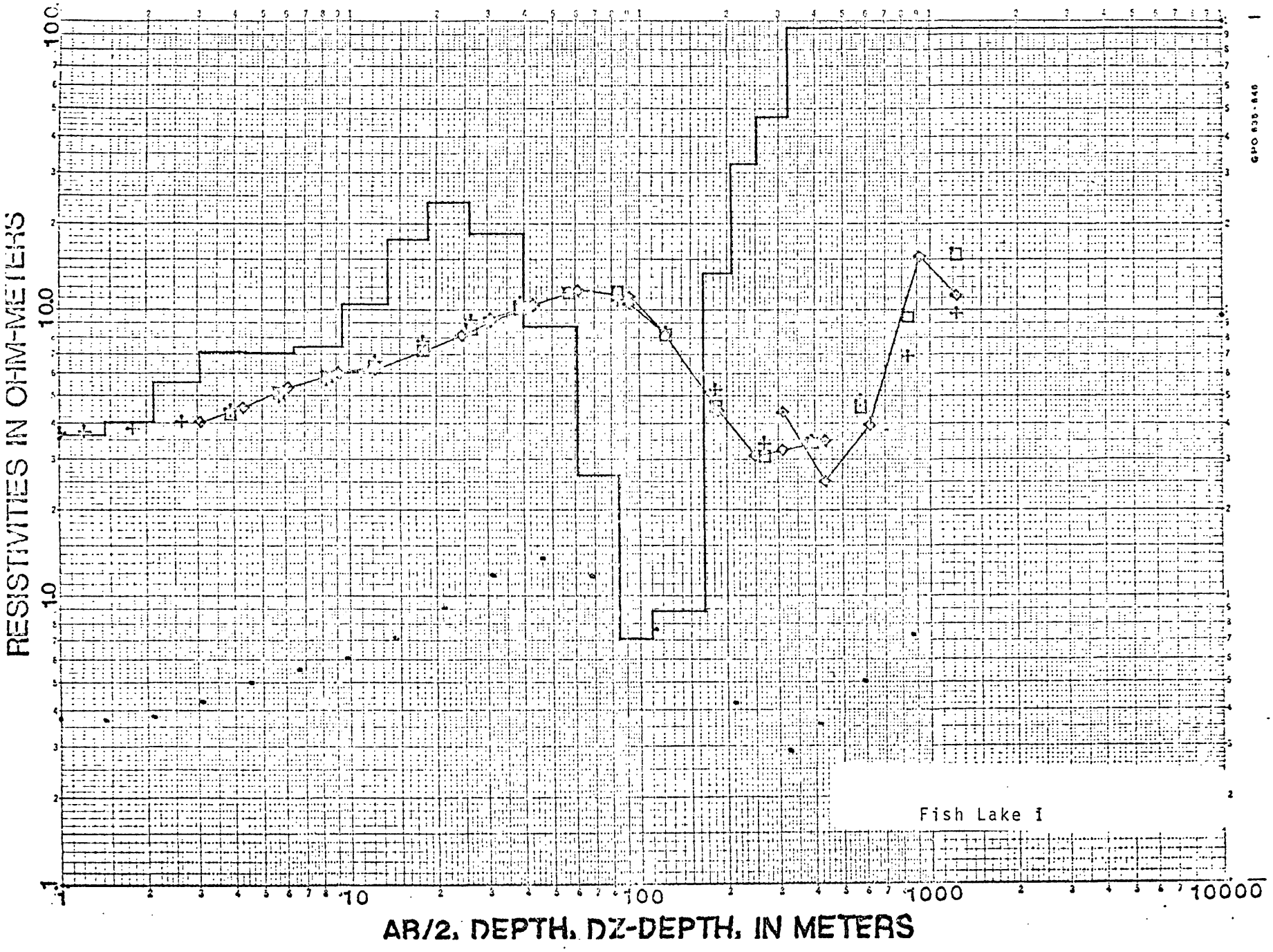
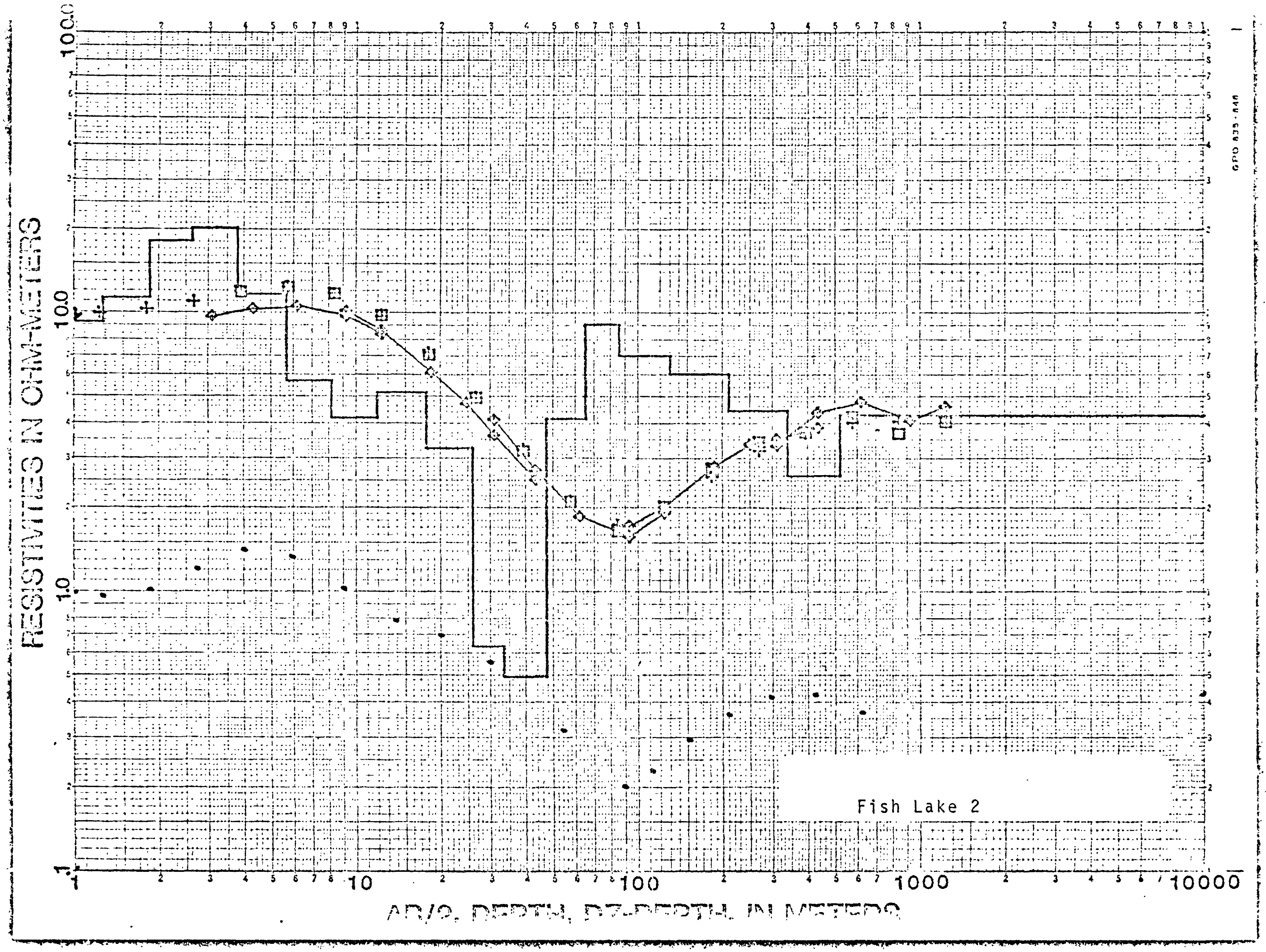
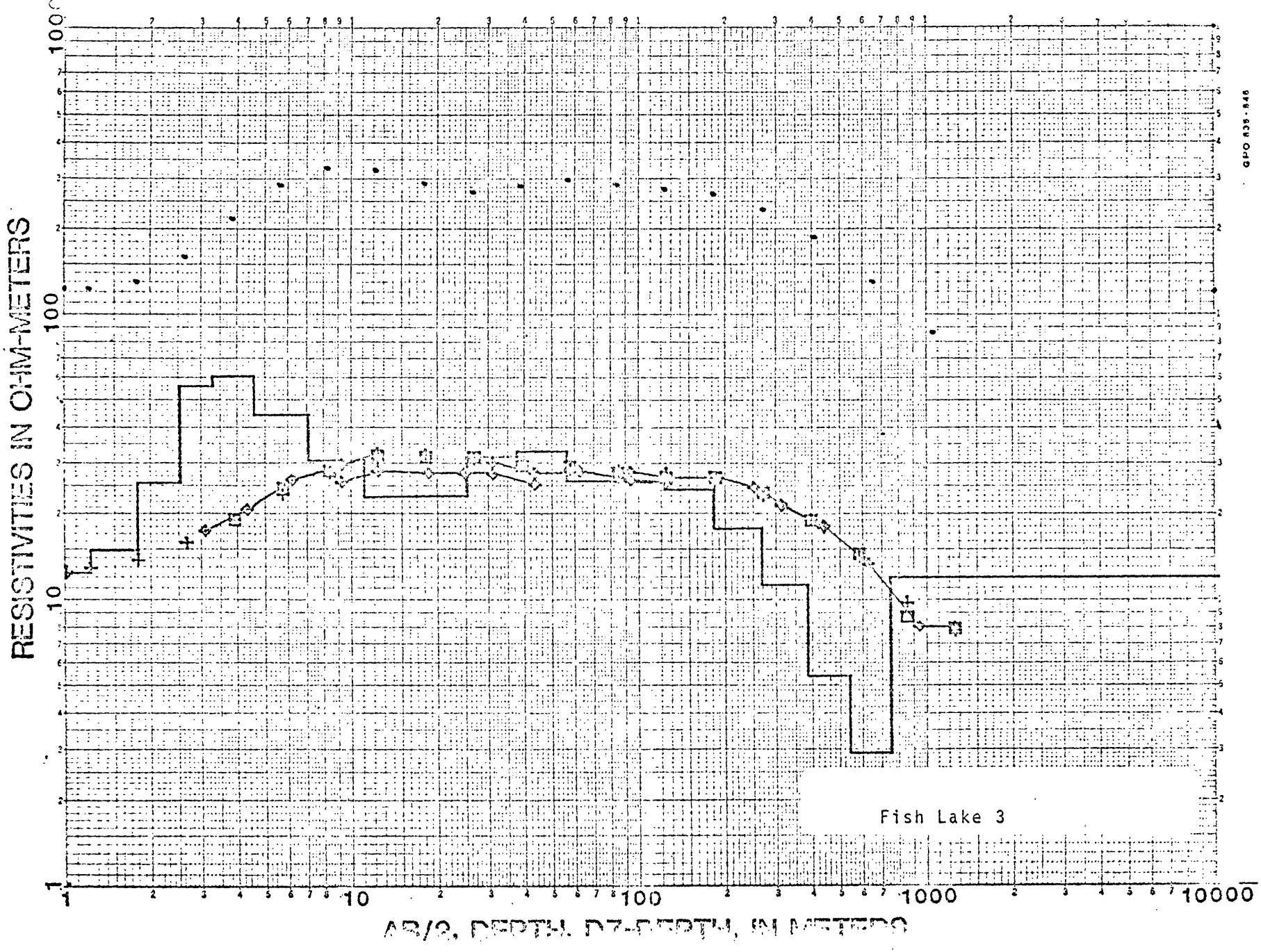


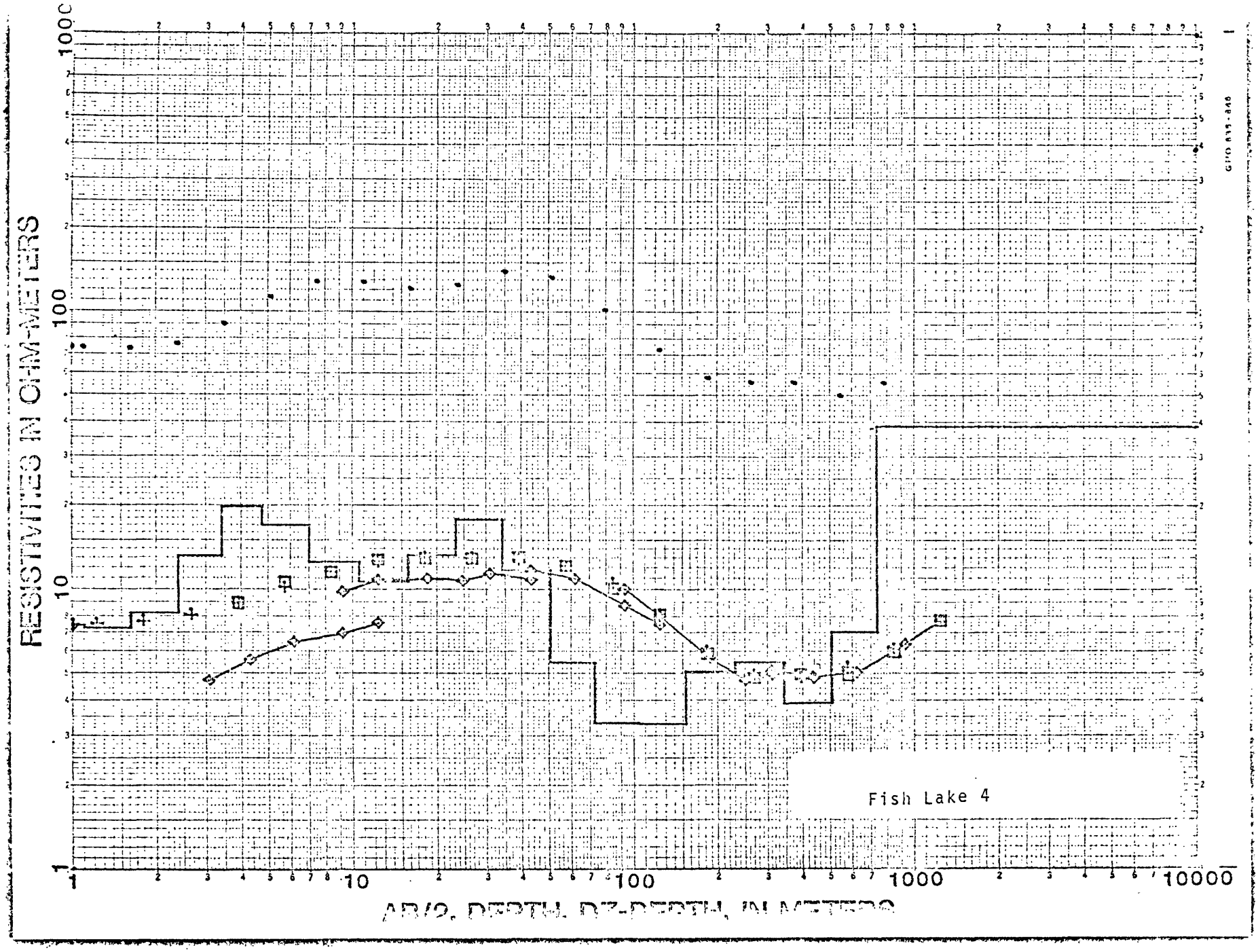
Figure 2. Map of part of Columbus Salt Marsh, Neveda, showing,number, location, and azimuth of three Schlumberger sounding stations and a VLF and Slingram traverse (B-B'). Base from U.S. Geological Survey 1:24000,Columbus and Coaldale, 1968.

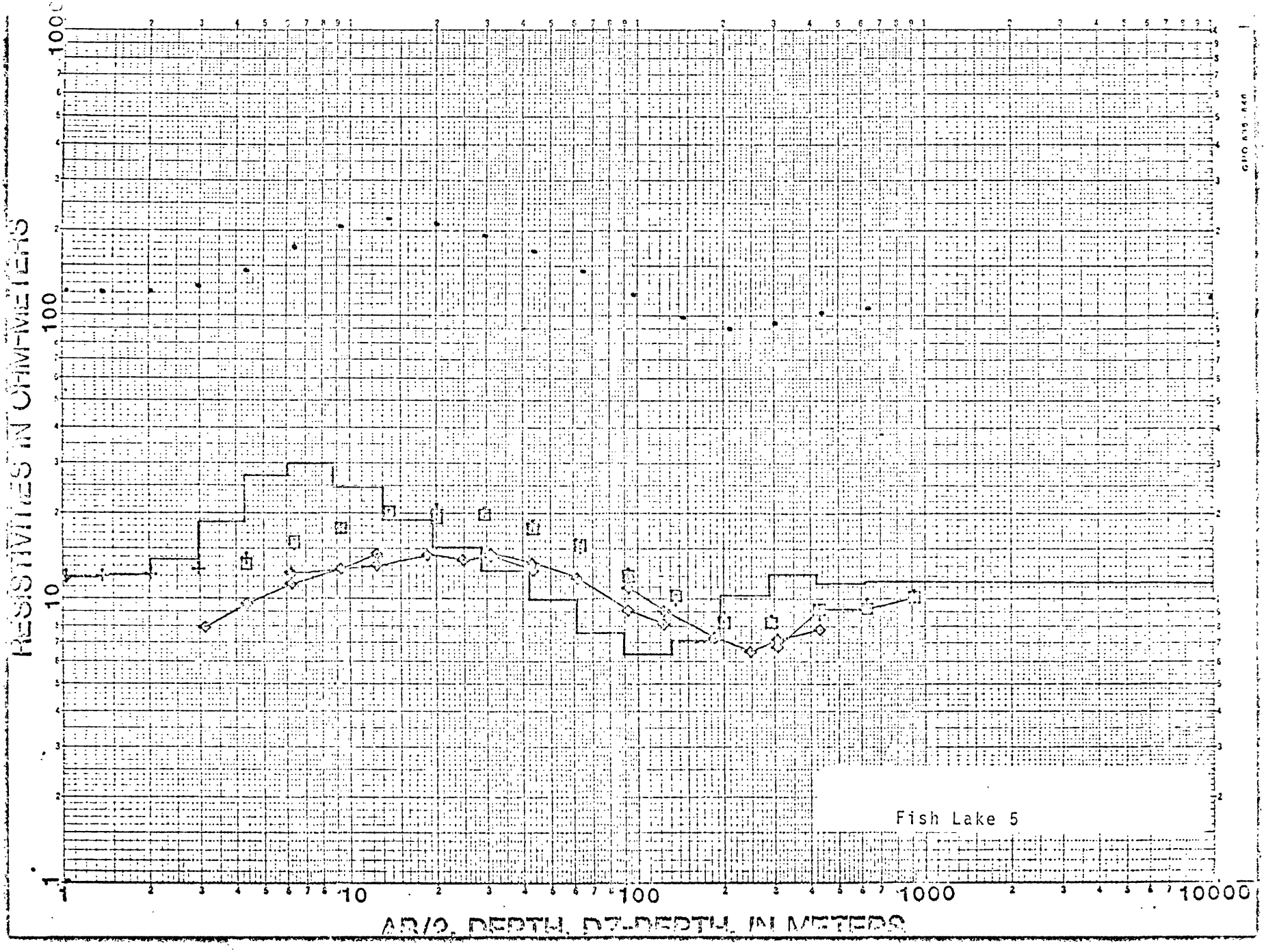

RESISTIVITIES IN OHM-METERS
100
10.0
1.0
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
Fish Lake I
GPO 835-846

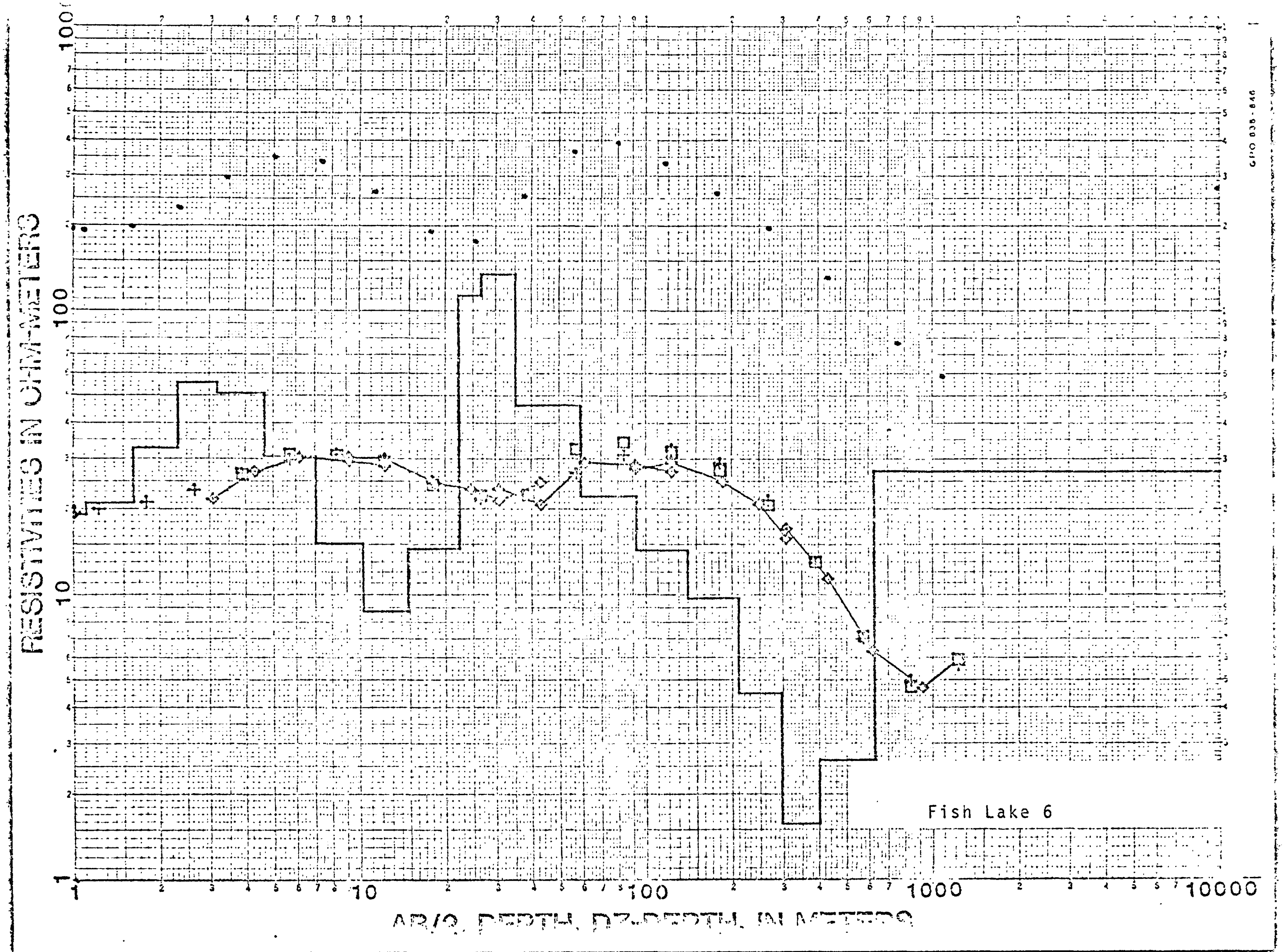


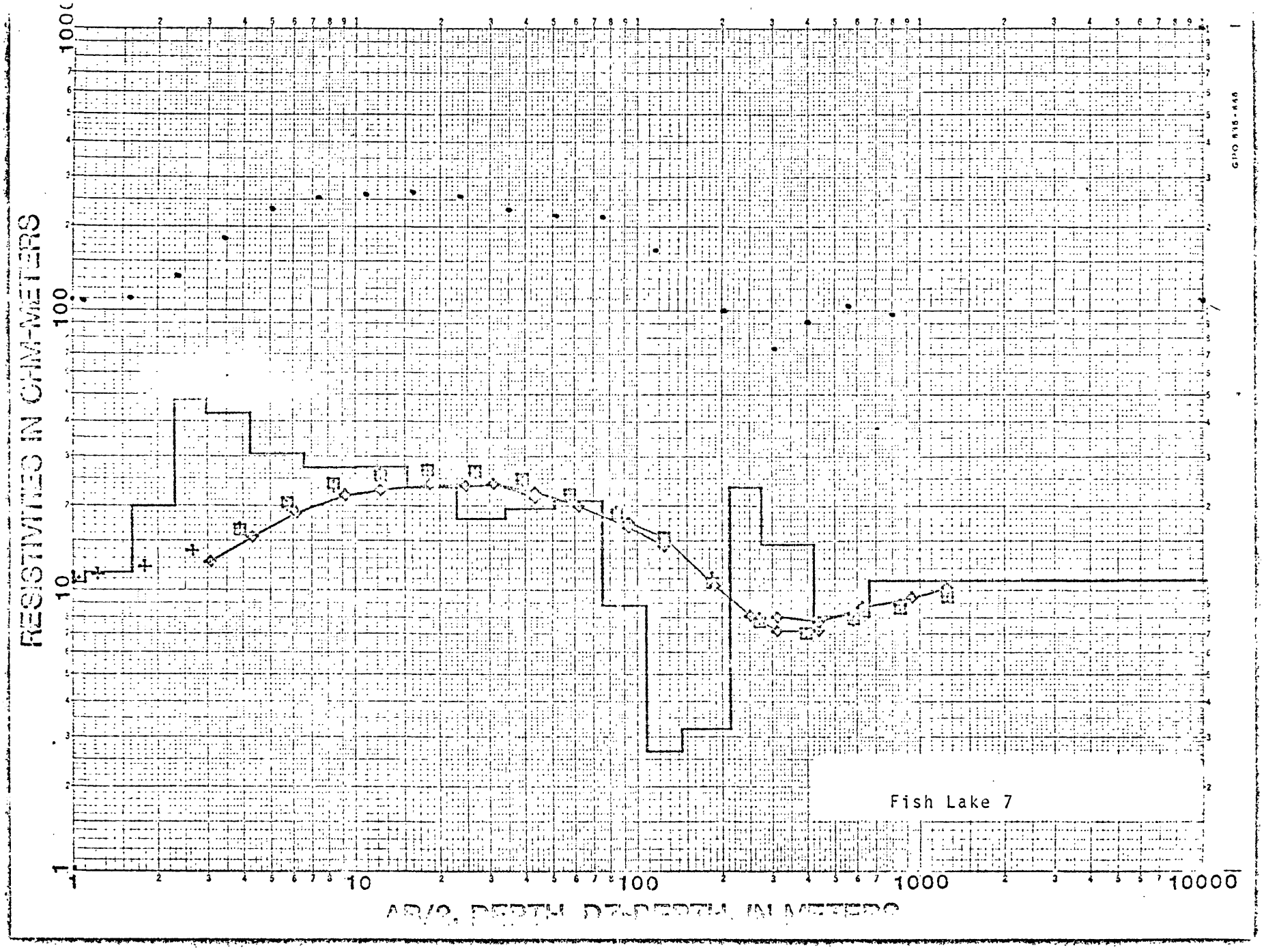
Fish Lake 2
RESISTIVITIES IN OHM-METERS
AB/2, DEPTH, DZ-DEPTH, IN METERS
.1
1.0
10.0
100.0
1
10
100
1000
10000
GPO 835-446

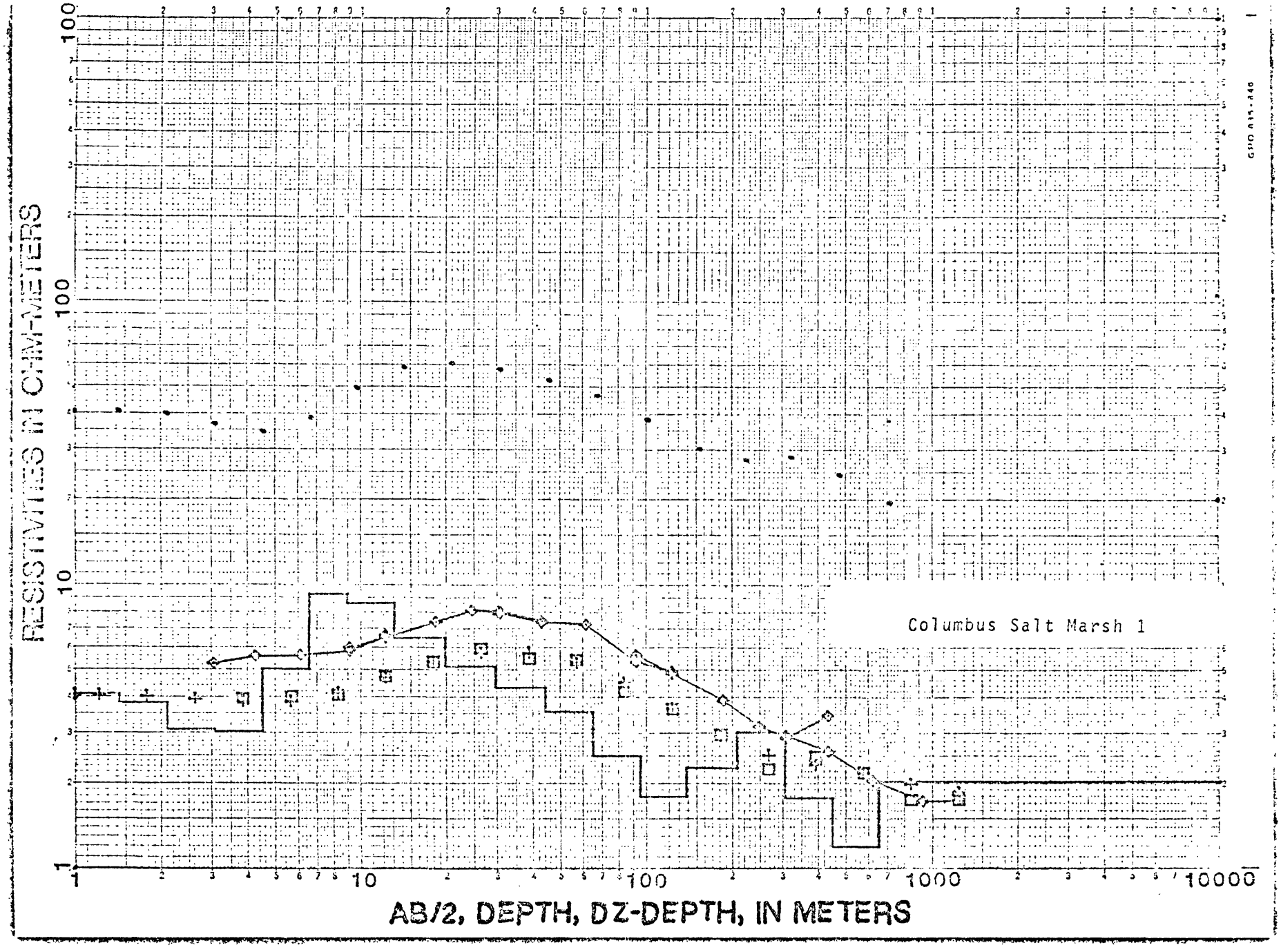

RESISTIVITIES IN OHM-METERS
100
10
1
1
10
100
1000
10000
Fish Lake 3
GPO 835-846

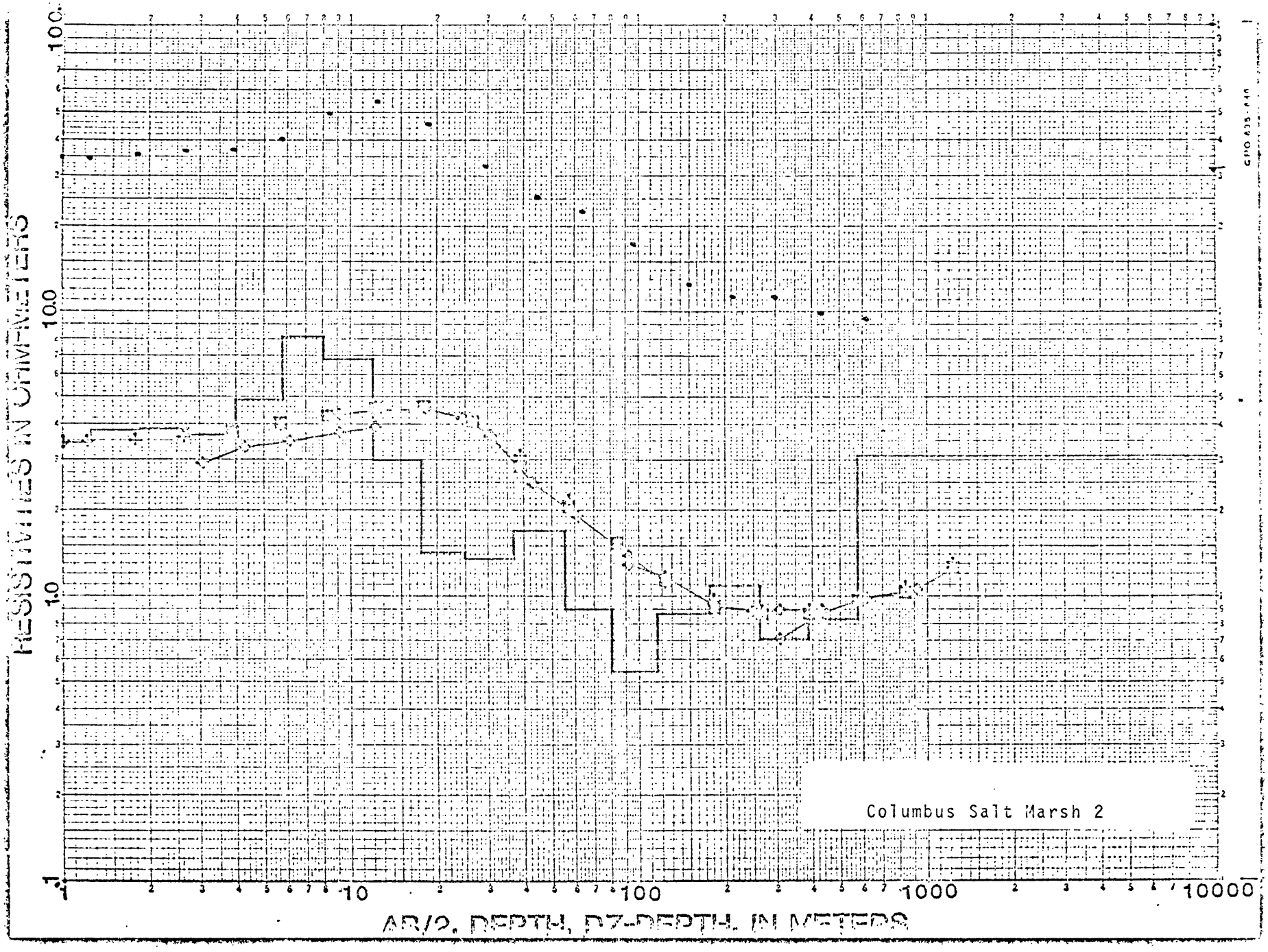

RESISTIVITIES IN OHM-METERS
100
10
1
1
10
100
1000
10000
Fish Lake 4

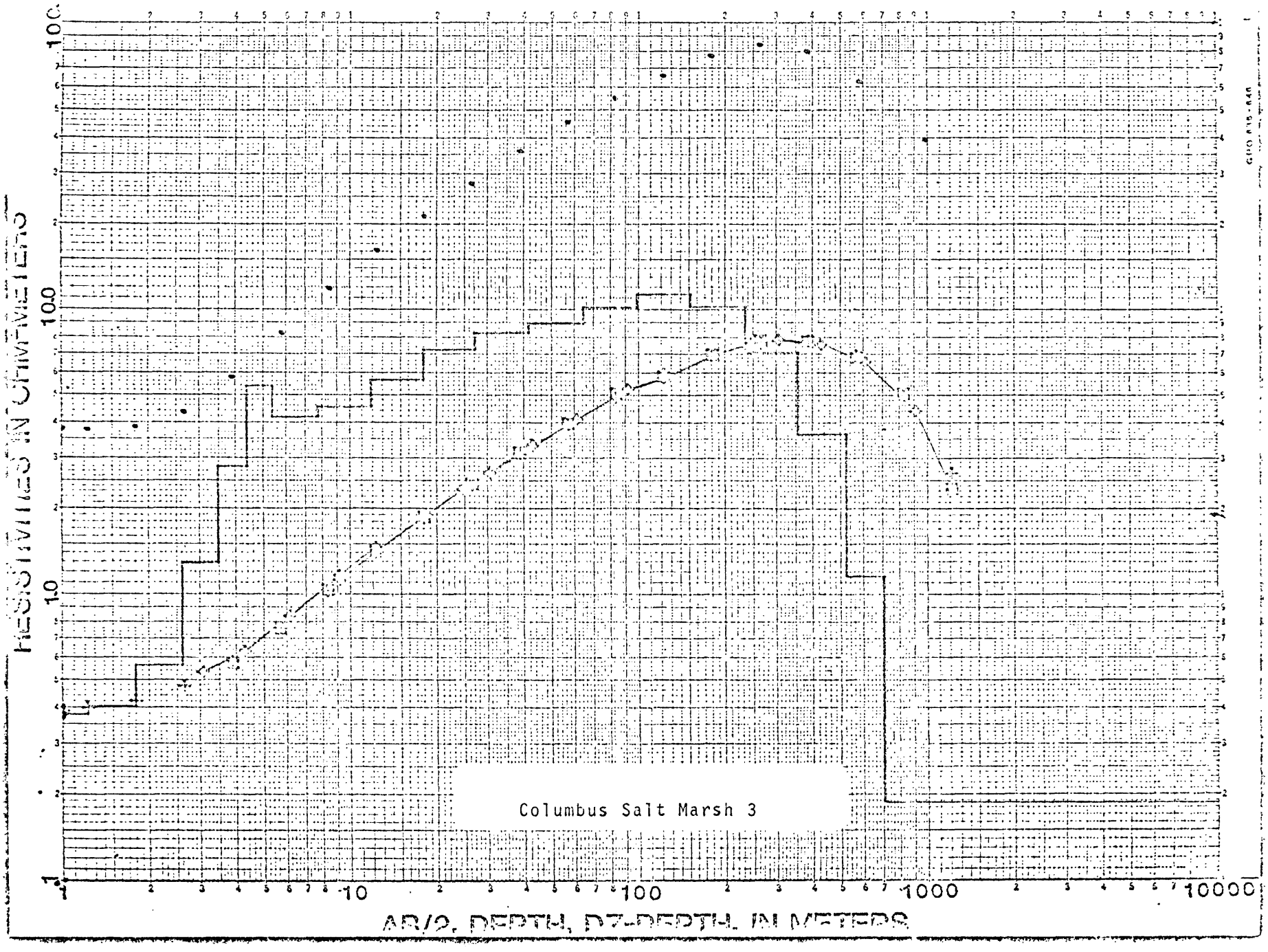

RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH, DI-DEPTH IN METERS
Fish Lake 5

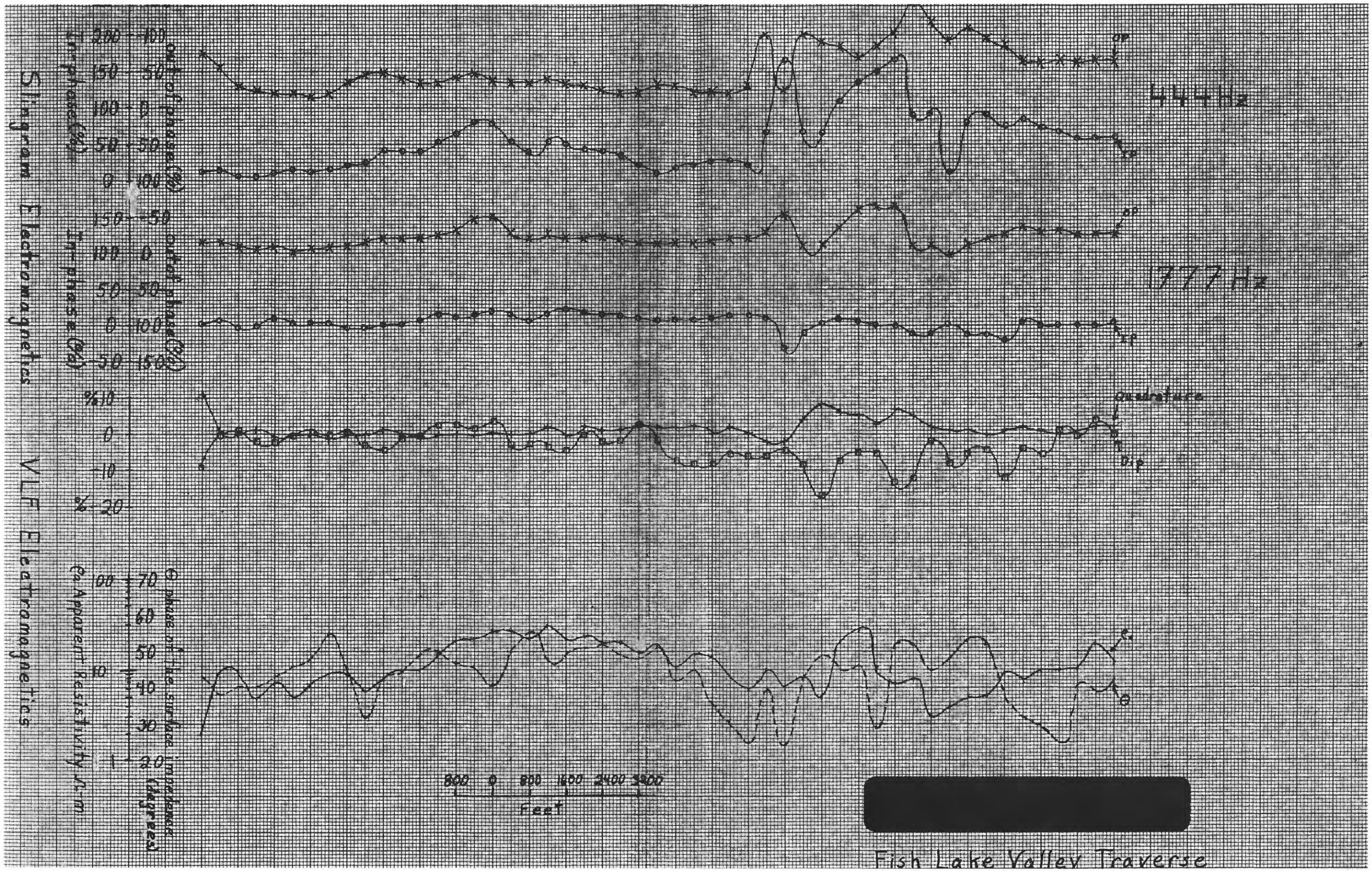

RESISTIVITIES IN OHM-METERS
1000
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
Fish Lake 6
GPO 838-846


RESISTIVITIES IN OHM-METERS
1000
100
10
1
10
100
1000
10000
AB/2, DEPTH DEPTH IN METERS
Fish Lake 7

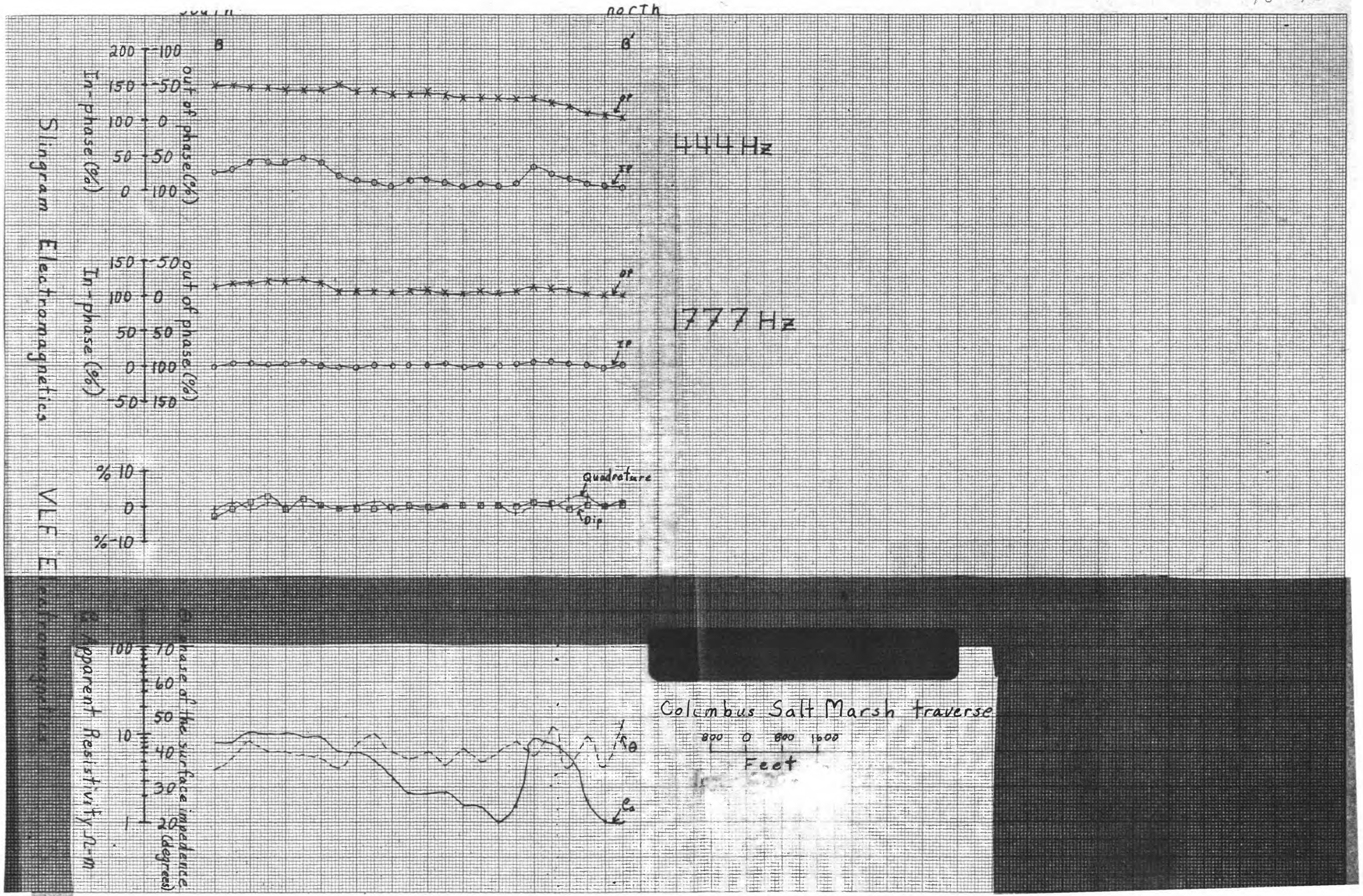

RESISTIVITIES IN OHM-METERS
100
10
1
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
Columbus Salt Marsh 1


RESISTIVITIES IN OHM-METERS
100
10.0
1.0
.1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH IN METERS
Columbus Salt Marsh 2


RESISTIVITY IN OHM-METERS
100
10.0
1.0
1
10
100
1000
10000
AB/2, DEPTH, DZ-DEPTH, IN METERS
Columbus Salt Marsh 3


Slingram Electromagnetics
VLF Electromagnetics
444 Hz
177 Hz
conductive
Fish Lake Valley Traverse
Feet

78-373


South
North
B
B'
200
150
100
50
0
100
50
0
50
100
In-phase (%)
out of phase (%)
IP
OP
444 Hz
777 Hz
Slingram Electromagnetics
%10
0
%-10
Quadrature
Dip
VLF EM
Apparent Resistivity Ω-m
100
10
1
70
60
50
40
30
20
Phase of the surface impedance (degrees)
Colombus Salt Marsh traverse
800
0
800
1600
Feet