UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Three-layer Inversions for 18 TDEM Soundings in the Cone Crater Area, SW Rift Zone of Kilauea Volcano, Hawaii

by

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INTRODUCTION

In August and September, 1984, 18 time-domain electromagnetic (TDEM) soundings were made in the Cone Crater geothermal area on the southwest rift zone (SWRZ) of Kilauea Volcano (fig. 1) using a Mark II SIROTEM system designed by CSIRO (Buselli and O'Neill, 1979). All the soundings were made using the short-offset coincident-loop configuration (Buselli, 1982) and except for sounding 18 all the loops were 152-m on a side. Sounding 18 was 304-m on a side. The measurement times used (after the transmitter loop was shut off) ranged from 0.8*10E-3 sec to 52.5*10E-3 sec.

The soundings were interpreted using a non-linear least-squares inversion program (Anderson, 1982). Appendix 1 shows the model fits to the observed data plus the layer depths and resistivities. In the interpretation of this data, corrections were not made for the finite turn-off time of the transmitter. Even though measurements at the two earliest times, 0.4 and 0.6 milliseconds were not used, neglect of the effect of turnoff time no doubt causes some error in the results; primarily in the determination of the upper layer resistivity.

REFERENCES CITED

Anderson, W.L., 1982, Nonlinear least-squares inversion of transient soundings for a coincident loop system (Program NLSTCO): U.S.G.S. Open-File report 82-1064, 34p.

Buselli, G., 1982, The effect of near-surface superparamagnetic material on electromagnetic measurements: Geophysics, v.47, p. 1315-1324.

Buselli, G., and O'Neill, B., 1977, SIROTEM: A new portable instrument for multichannel transient electromagnetic measurements: Australian Society of Exploration Geophysics, V.8, no. 3, p. 82-87.

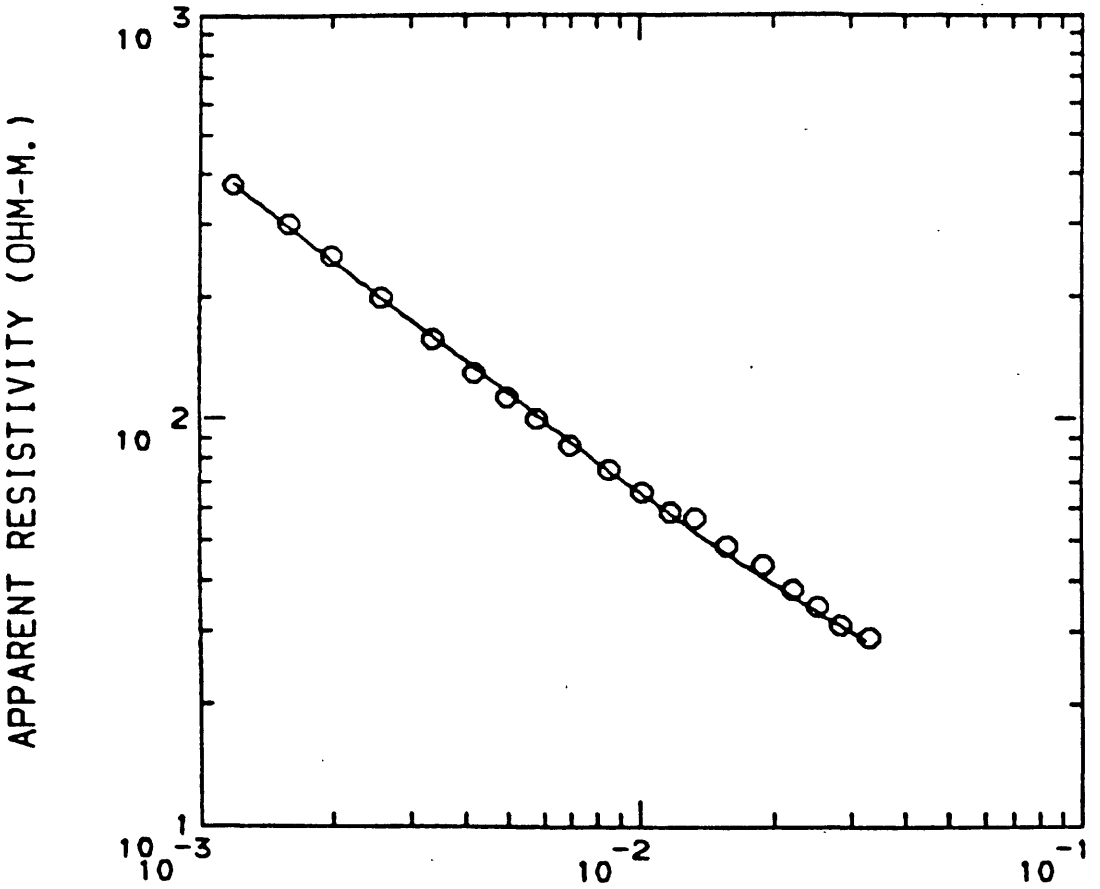
Saint Ours, P. de, 1982, Structural map of the summit area of Kilauea Volcano, Hawaii: U.S. Geological Survey, Map MF1368, sale 1:24,000.

Appendix #1: Apparent resistivity curves and 3 layer solutions for TDEM soundings 1-18, Cone Crater area, Kilauea volcano, Hawaii.

FIGURES

Figure 1. Location map of TDEM soundings near Cone Crater, southwest rift zone of Kilauea Volcano, Hawaii. Map base from Saint Ours, 1982.

SW RIFT STA #1 3LY

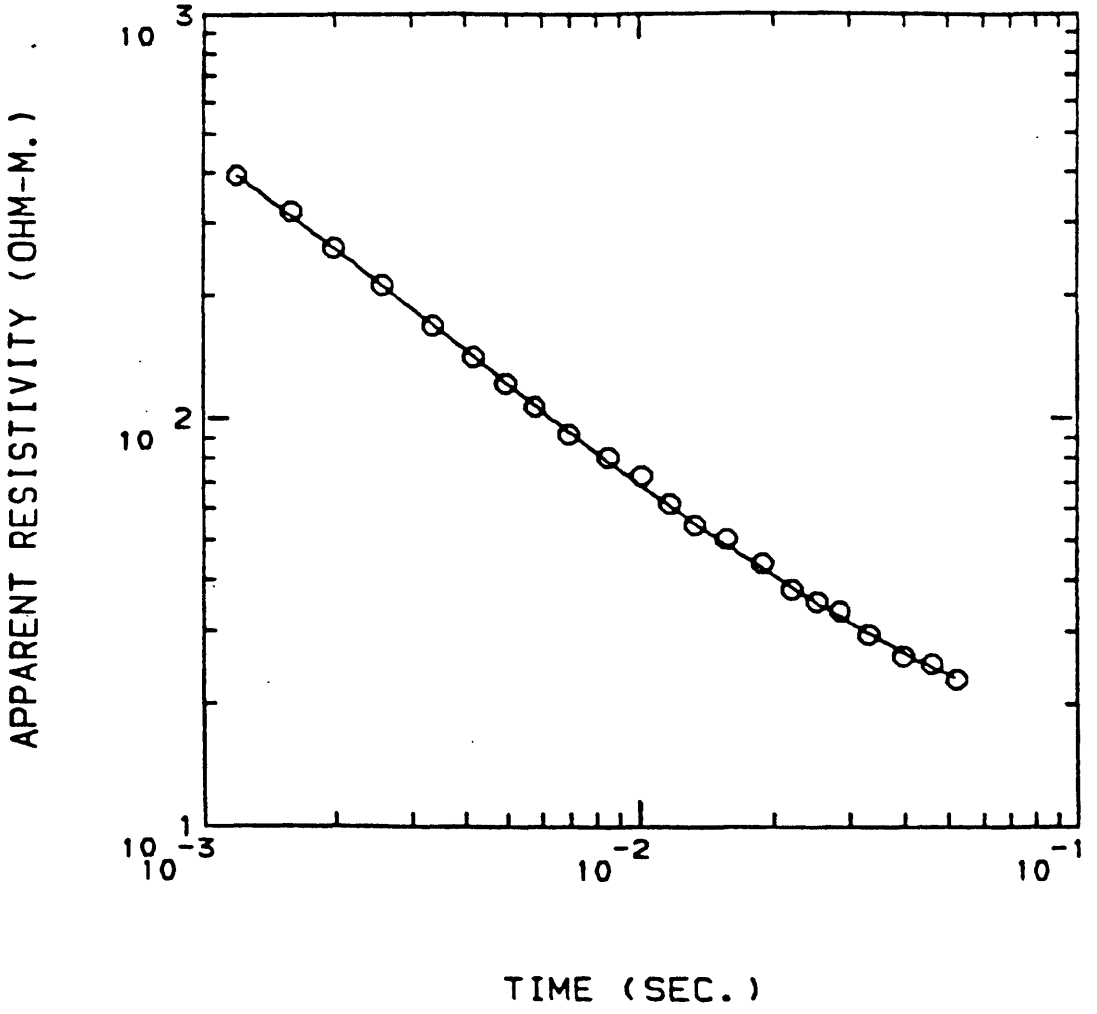


******** E N D ******** SW RIFT STA #1 3LY

PARAMETER	NAME		FINAL SOLUTION		RESISTIVITY	LAYER DEPTH
1	SIGMA(1)	=	0.51027501E-03	1	0.19597275E+04	
2	SIGMA(2)	=	0.70091158E-01	2	0.14267135E+02	
3	SIGMA(3)	=	0.16442406E+00	3	0.60818348E+01	
4	THICK(1)	=	0.42853488E+03			1 0.42853488E+03
5	THICK(2)	=	0.16175485E+03			2 0.59028973E+03
6 *	SHIFT	=	0.10000000E+01			

* FIXED

SW RIFT STA #2 3LY

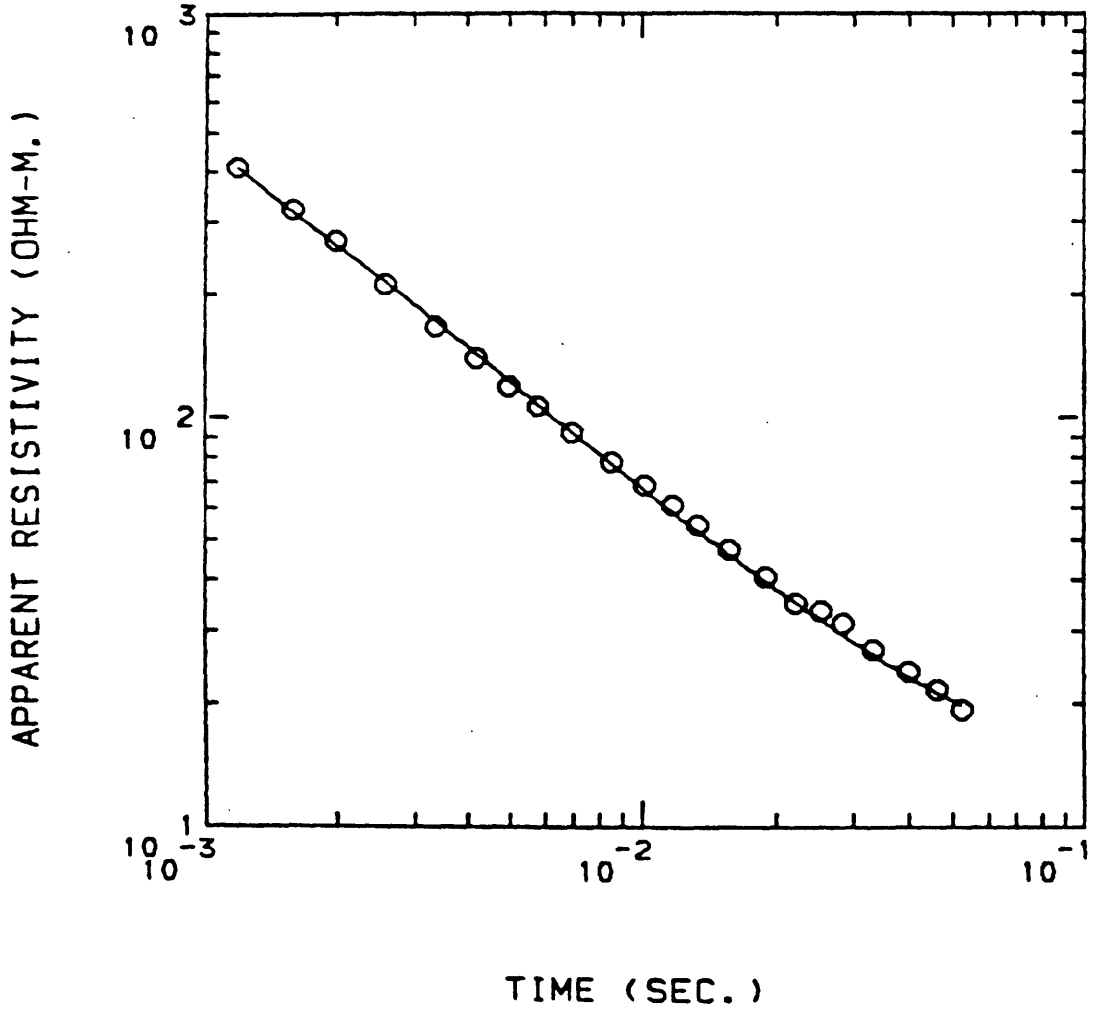


******** E N D ******** SW RIFT STA #2 3LY

PARAMETER	NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	SIGMA(1)	=	0.51337294E-03	1	0.19479016E+04		
2	SIGMA(2)	=	0.57652909E-01	2	0.17345179E+02		
3	SIGMA(3)	=	0.15330215E+00	3	0.65230660E+01		
4	THICK(1)	=	0.43096756E+03			1	0.43096756
5	THICK(2)	=	0.16014203E+03			2	0.59110962
6 *	SHIFT	=	0.10000000E+01				

* FIXED

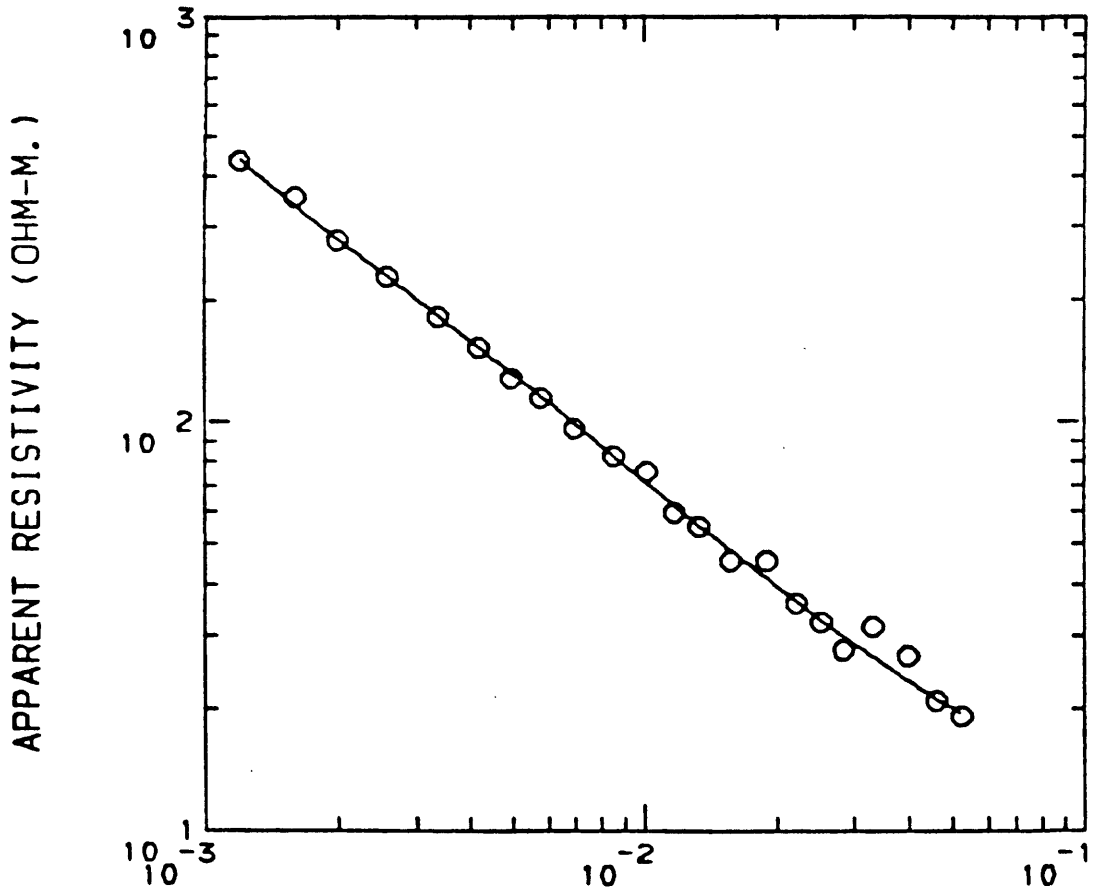
SW RIFT STA #3 3LY



******** E N D ******** SW RIFT STA #3 3LY

PARAMETER	NAME		FINAL SOLUTION		RESISTIVITY	LAYER DEPTH	
1	SIGMA(1)	=	0.28367570E-03	1	0.35251521E+04		
2	SIGMA(2)	=	0.76763463E-01	2	0.12696242E+02		
3 *	SIGMA(3)	=	0.23999999E+00	3	0.41666670E+01		
4	THICK(1)	=	0.4381b141E+03			1	0.43816141E+0
5	THICK(2)	=	0.15686732E+03			2	0.59502875E+0

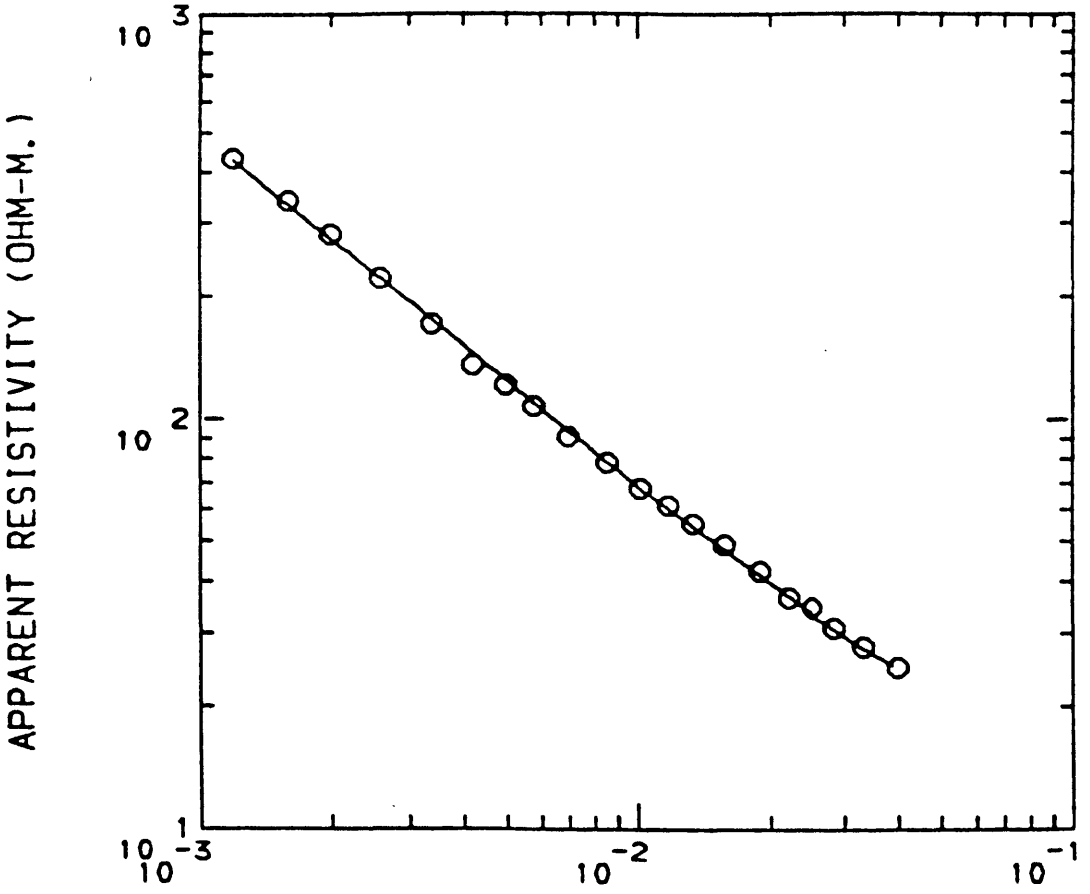
SW RIFT STA #4 3LY



PARAMETER NAME		FINAL SOLUTION		RESISTIVITY	LAYER DEPTH	
1	SIGMA(1) =	0.11135444E-03	1	0.89803330E+04		
2	SIGMA(2) =	0.82464052E-01	2	0.12123556E+02		
3	SIGMA(3) =	0.28210545E+00	3	0.35447738E+01		
4	THICK(1) =	0.45146585E+03			1	0.45146585E+0
5	THICK(2) =	0.16230588E+03			2	0.61377173E+0
6 *	SHIFT =	0.10000000E+01				

* FIXED

SW RIFT STA #5 3LY

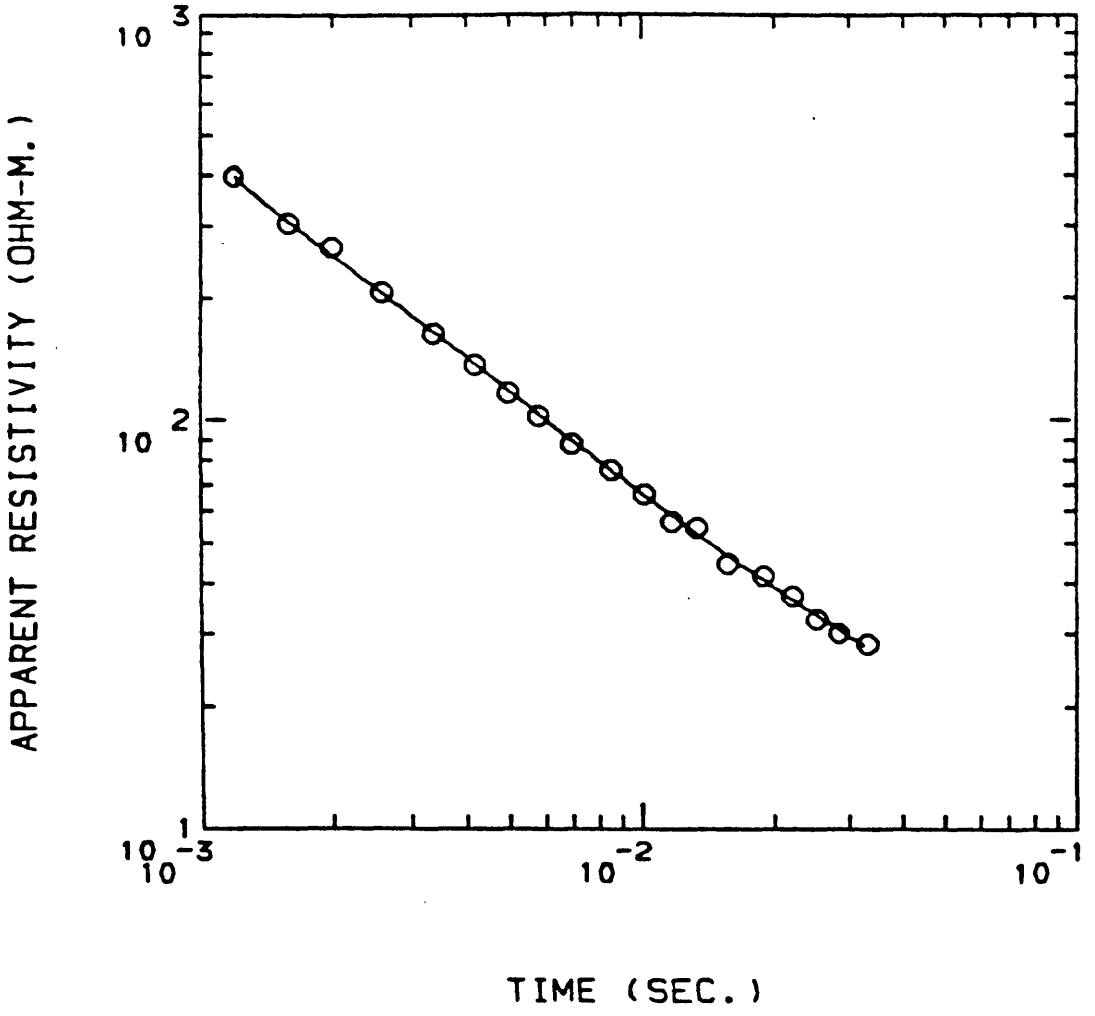


******** E N D ******** SW RIFT STA #5 3LY

PARAMETER	NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	SIGMA(1)	=	0.12670540E-03	1	0.78923232E+04		
2	SIGMA(2)	=	0.74273326E-01	2	0.13463784E+02		
3	SIGMA(3)	=	0.20115227E+00	3	0.49713583E+01		
4	THICK(1)	=	0.44454657E+03			1	0.44454657E+03
5	THICK(2)	=	0.15191434E+03			2	0.59646094E+03
6 *	SHIFT	=	0.10000000E+01				

* FIXED

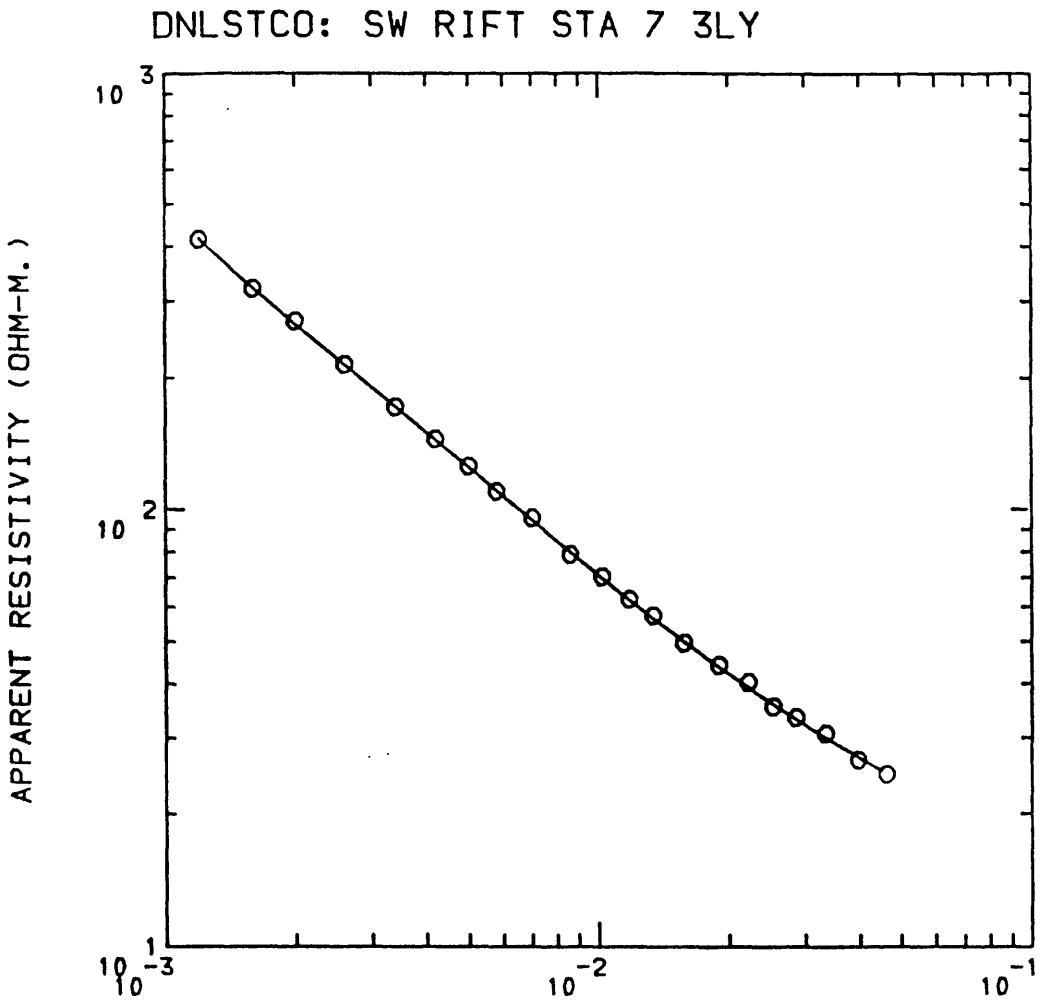
SW RIFT STA #6 3LY



******** E N D ******** SW RIFT STA #6 3LY

	PARAMETER NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	SIGMA(1)	=	0.19693682E-03	1	0.50777705E+04		
2	SIGMA(2)	=	0.71863204E-01	2	0.13915327E+02		
3	SIGMA(3)	=	0.17988311E+00	3	0.55591655E+01		
4	THICK(1)	=	0.43092694E+03			1	0.43092694E+03
5	THICK(2)	=	0.15870363E+03			2	0.58963055E+03
6 *	SHIFT	=	0.10000000E+01				

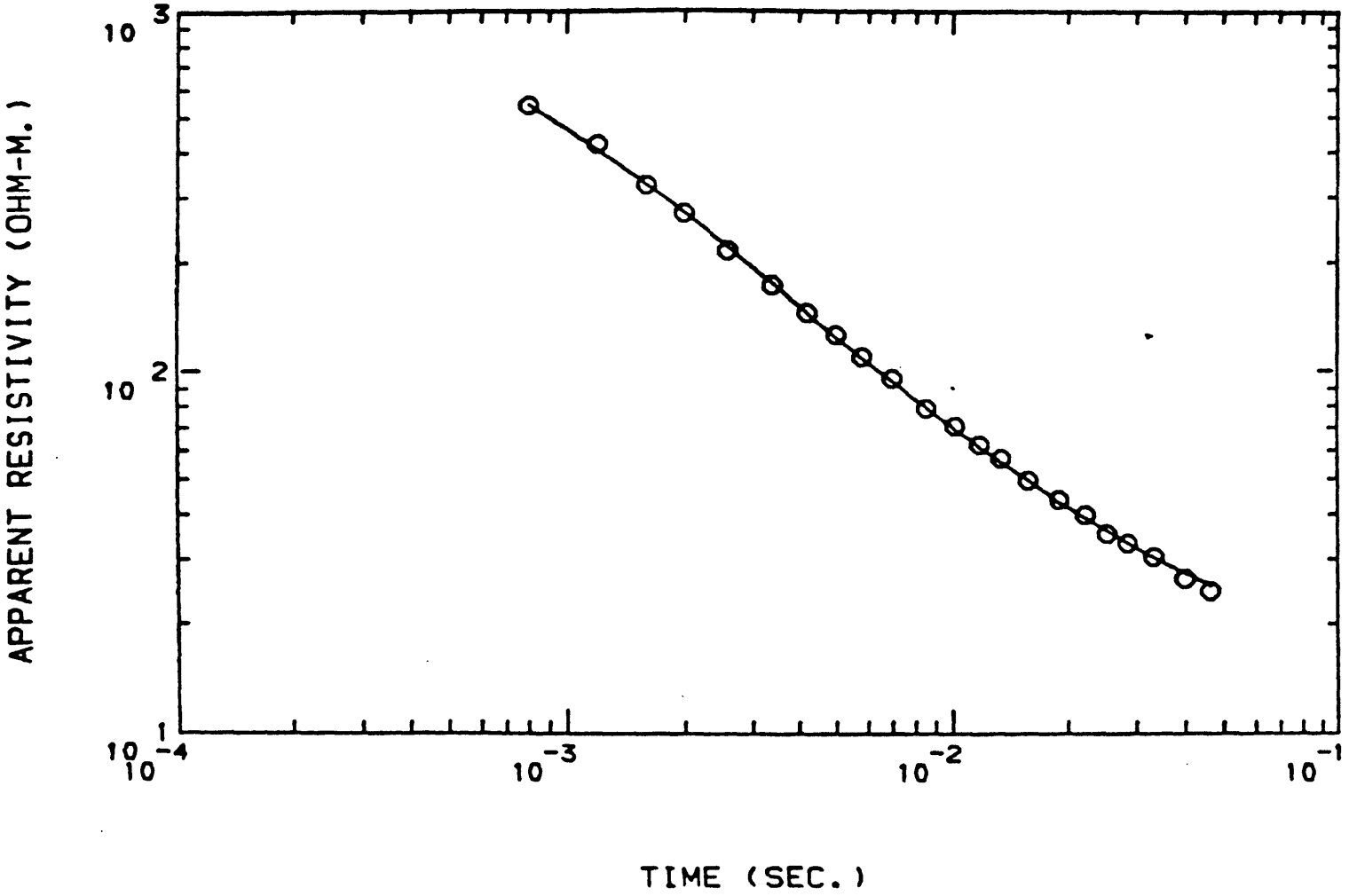
* FIXED



PARAMETER	NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	SIGMA(1)	=	0.59511705D-03	1	0.16803417D+04		
2 *	SIGMA(2)	=	0.70000000D-01	2	0.14285714D+02		
3	SIGMA(3)	=	0.15966276D+00	3	0.62624166D+01		
4	THICK(1)	=	0.45261054D+03			1	0.45261054D+03
5	THICK(2)	=	0.16474436D+03			2	0.61735489D+03
6 *	SHIFT	=	0.10000000D+01				

* FIXED

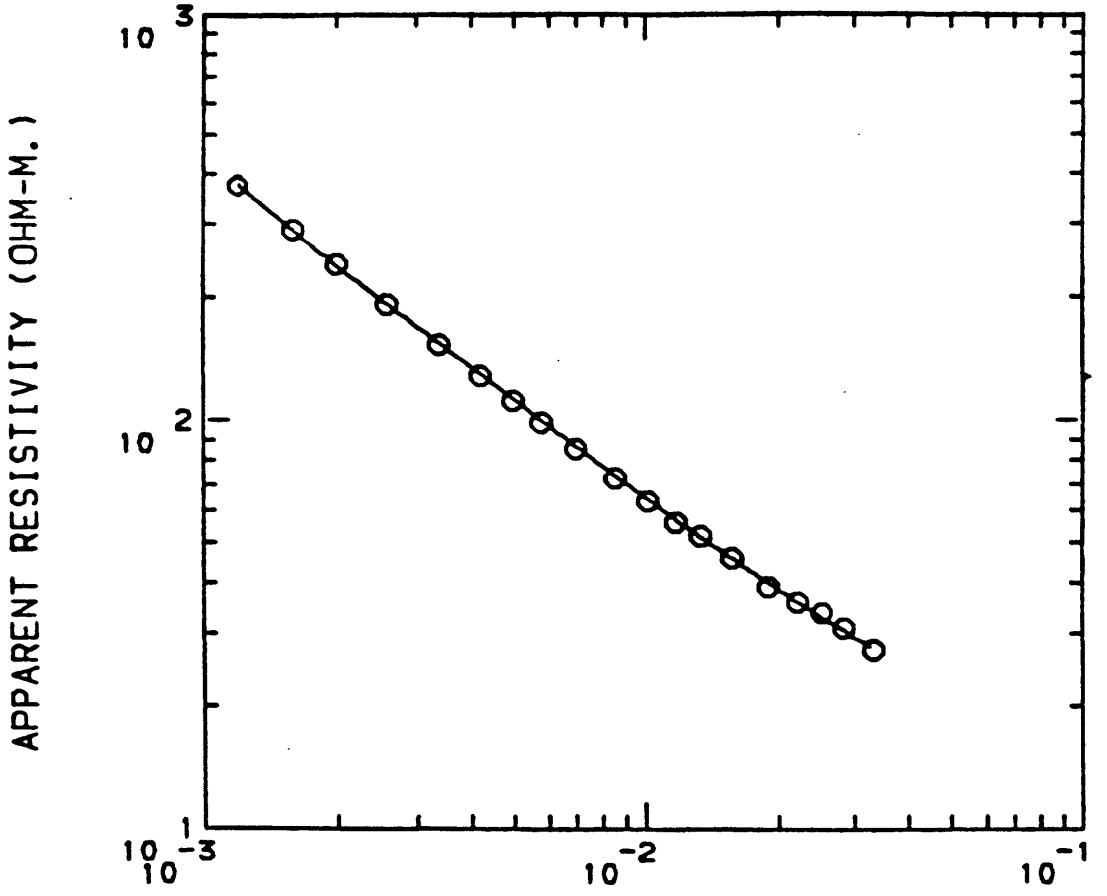
SW RIFT STA 7 3LY



******** E N D ******** SW RIFT STA 7 3LY

PARAMETER NAME	FINAL SOLUTION	RESISTIVITY	LAYER DEPTH
1 SIGMA(1) =	0.11332271E-03	1 0.88243564E+04	
2 SIGMA(2) =	0.31667985E-01	2 0.31577633E+02	
3 SIGMA(3) =	0.13705643E+00	3 0.72962651E+01	
4 THICK(1) =	0.39033041E+03		1 0.39033041E+03
5 THICK(2) =	0.17031068E+03		2 0.56064111E+03
6 * SHIFT =	0.10000000E+01		

SW RIFT STA #8 3LY

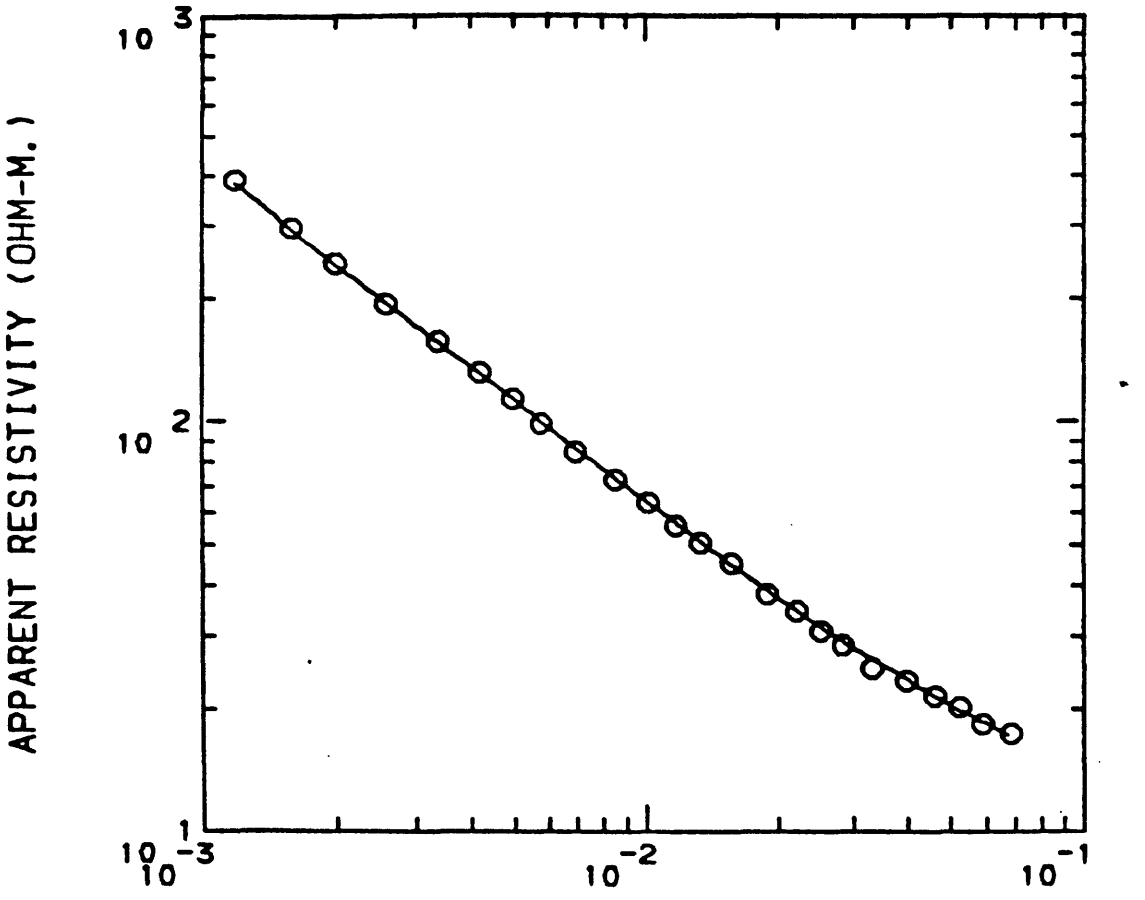


******** E N D ******** SW RIFT STA #8 3LY

	PARAMETER NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	SIGMA(1)	=	0.73448702E-03	1	0.13614944E+04		
2	SIGMA(2)	=	0.84707081E-01	2	0.11805388E+02		
3	SIGMA(3)	=	0.18440157E+00	3	0.54229474E+01		
4	THICK(1)	=	0.43543164E+03			1	0.43543164E+03
5	THICK(2)	=	0.17438071E+03			2	0.60981238E+03
6 *	SHIFT	=	0.10000000E+01				

* FIXED

SW RIFT STA #9 3LY

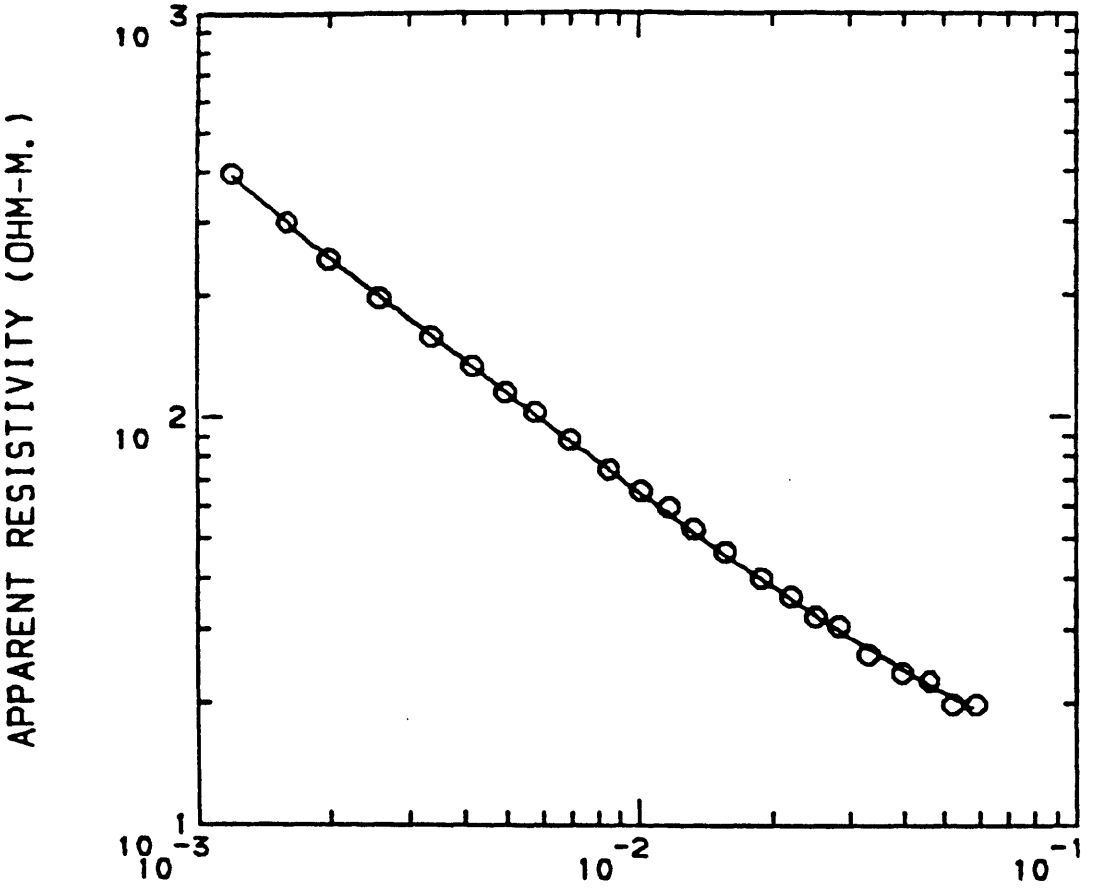


******** E N D ******** SW RIFT STA #9 3LY

PARAMETER NAME	FINAL SOLUTION	RESISTIVITY · LAYER DEPTH	
1 * SIGMA(1) =	0.23000001E-03	1	0.43478262E+04
2 SIGMA(2) =	0.86486280E-01	2	0.11562528E+02
3 SIGMA(3) =	0.21103244E+00	3	0.47386079E+01
4 THICK(1) =	0.42909125E+03	1	0.42909125E+03
5 THICK(2) =	0.16930891E+03	2	0.59840015E+03
6 * SHIFT =	0.10000000E+01		

* FIXED

SW RIFT STA #10 3LY

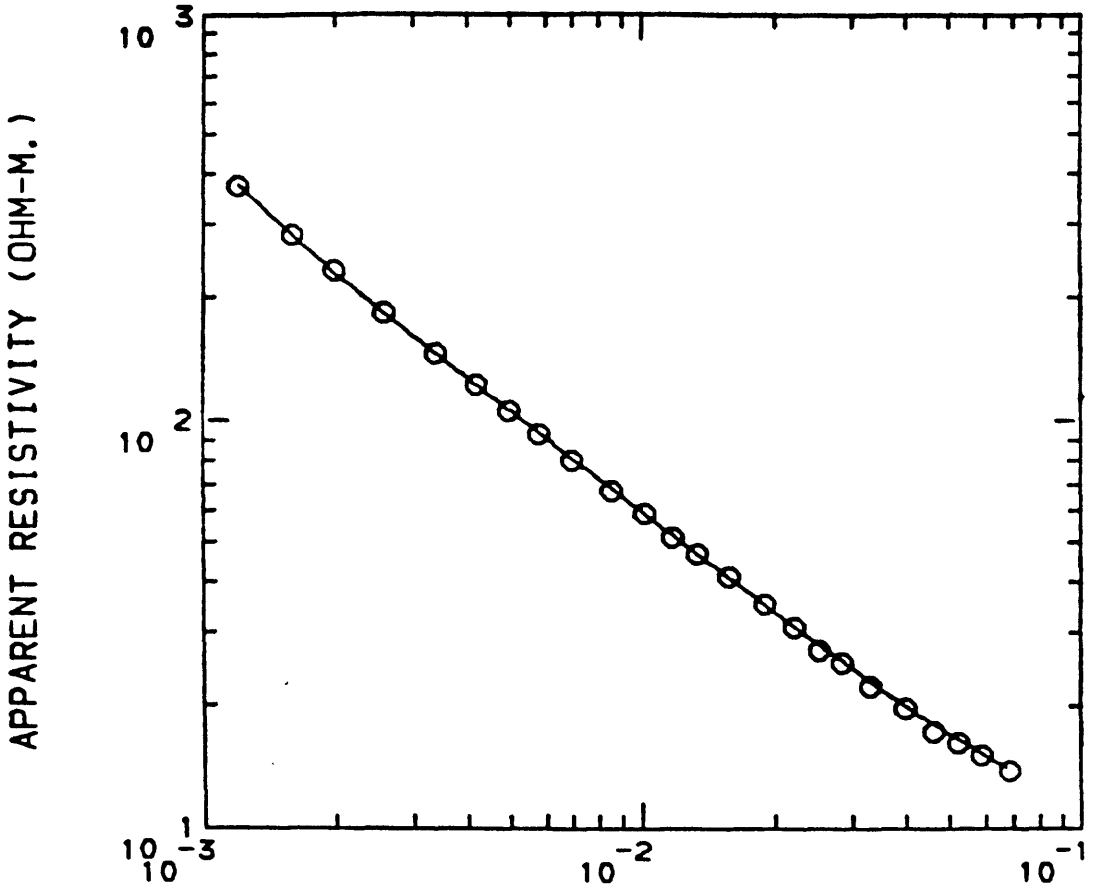


******** E N D ******** SW RIFT STA #10 3LY

PARAMETER NAME		FINAL SOLUTION		RESISTIVITY	LAYER DEPTH	
1	SIGMA(1) =	0.35647518E-03	1	0.28052444E+04		
2	SIGMA(2) =	0.82180567E-01	2	0.12168326E+02		
3	SIGMA(3) =	0.19359133E+00	3	0.51655207E+01		
4	THICK(1) =	0.43424106E+03			1	0.43424106E+03
5	THICK(2) =	0.16391794E+03			2	0.59815900E+03
6 *	SHIFT =	0.10000000E+01				

* FIXED

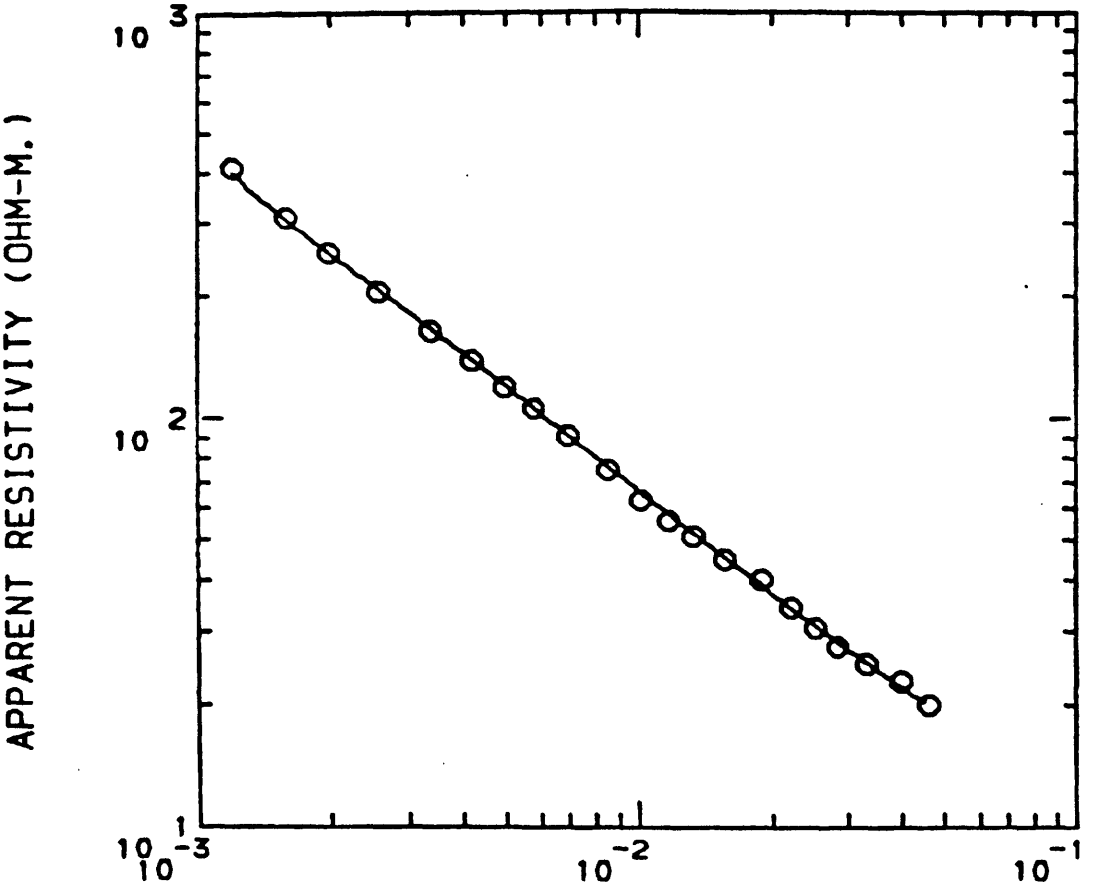
SW RIFT STA 11 3LY



	PARAMETER NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	SIGMA(1)	=	0.72715711E-03	1	0.13752186E+04		
2	SIGMA(2)	=	0.12785178E+00	2	0.78215570E+01		
3	SIGMA(3)	=	0.34330133E+00	3	0.29128928E+01		
4	THICK(1)	=	0.42878018E+03			1	0.42878018E+03
5	THICK(2)	=	0.16043927E+03			2	0.58921948E+03
6 *	SHIFT	=	0.10000000E+01				

* FIXED

SW RIFT STA 12 3LY

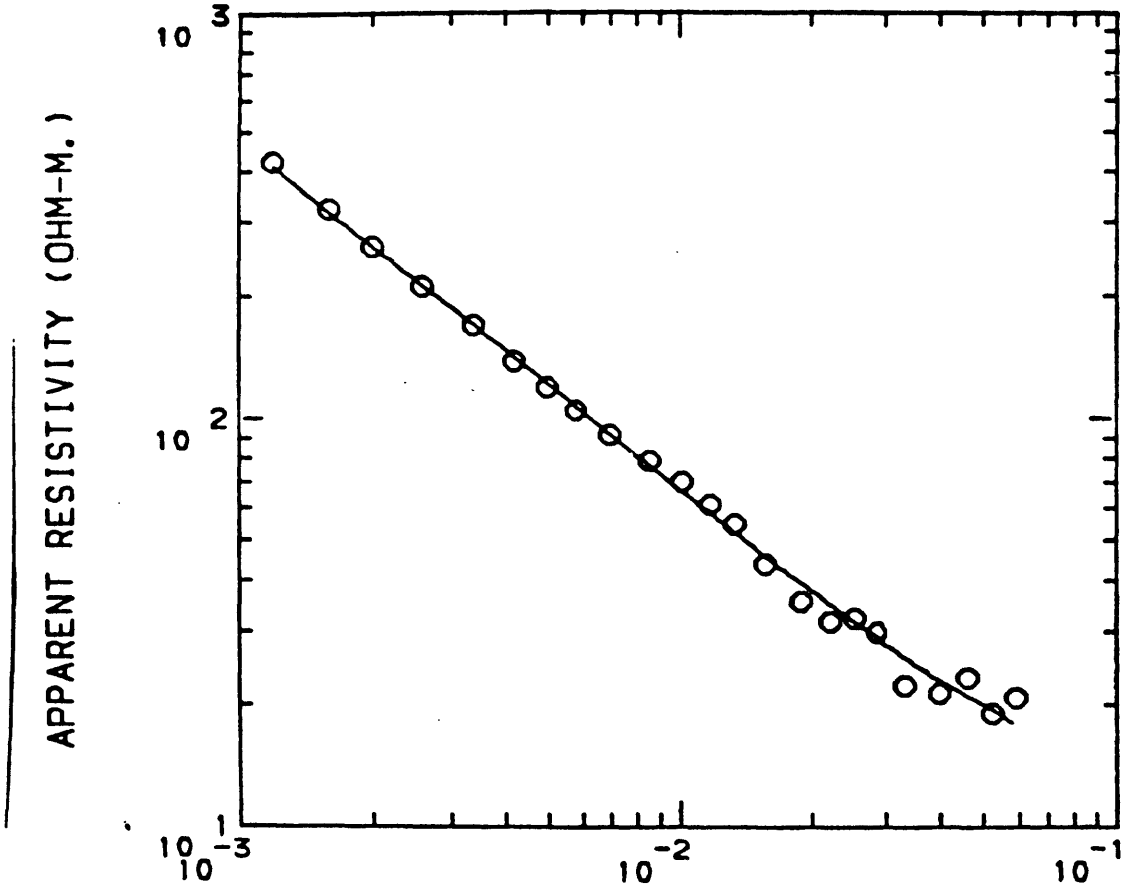


******** E N D ******** SW RIFT STA 12 3LY

PARAMETER	NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	* SIGMA(1)	=	0.23000001E-03	1	0.43478262E+04		
2	SIGMA(2)	=	0.90544418E-01	2	0.11044303E+02		
3	SIGMA(3)	=	0.29352197E+00	3	0.34068999E+01		
4	THICK(1)	=	0.43480658E+03			1	0.43480658E+03
5	THICK(2)	=	0.16409923E+03			2	0.59890582E+03
6	* SHIFT	=	0.10000000E+01				

* FIXED

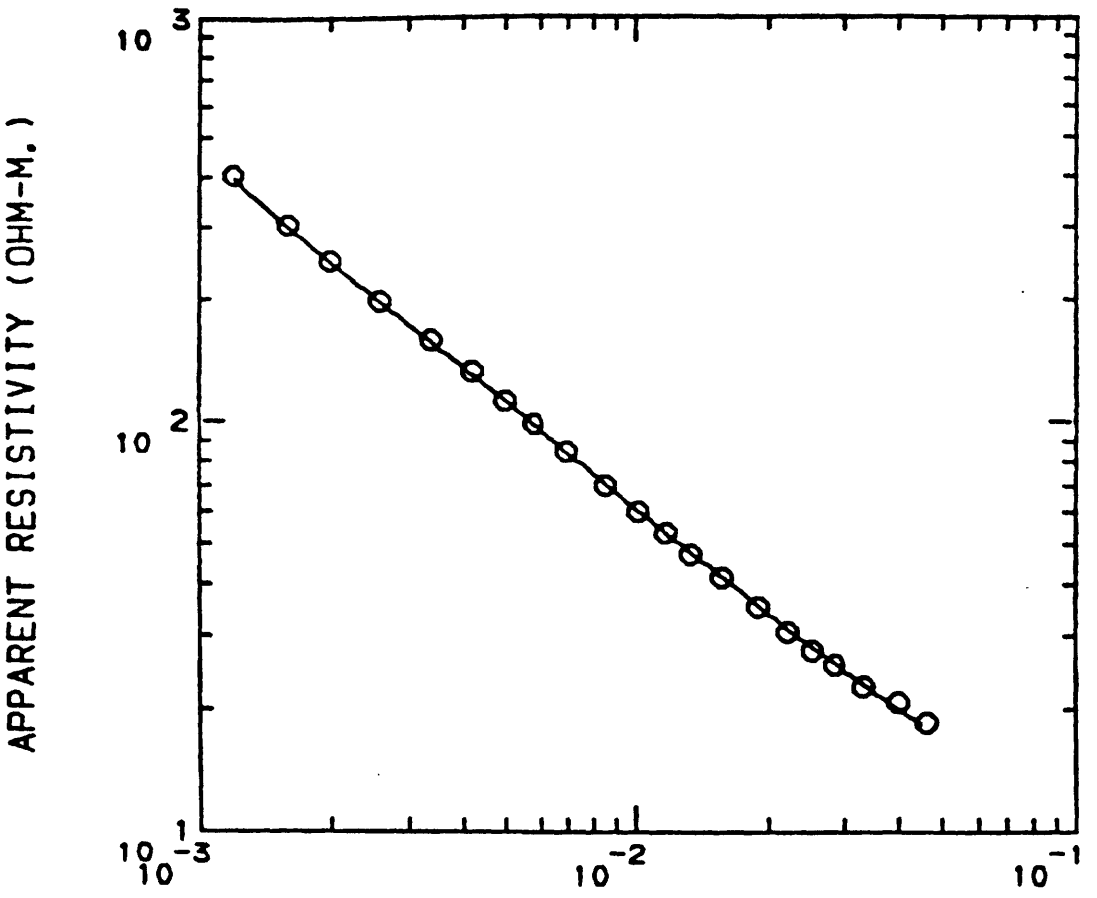
SW RIFT STA 13 3LY



PARAMETER	NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	SIGMA(1)	=	0.36082725E-03	1	0.27714092E+04		
2	SIGMA(2)	=	0.83415039E-01	2	0.11988246E+02		
3	SIGMA(3)	=	0.24829192E+00	3	0.40275173E+01		
4	THICK(1)	=	0.43965881E+03			1	0.43965881E+03
5	THICK(2)	=	0.15389381E+03			2	0.59355261E+03
6 *	SHIFT	=	0.10000000E+01				

* FIXED

SW RIFT STA 14 3LY

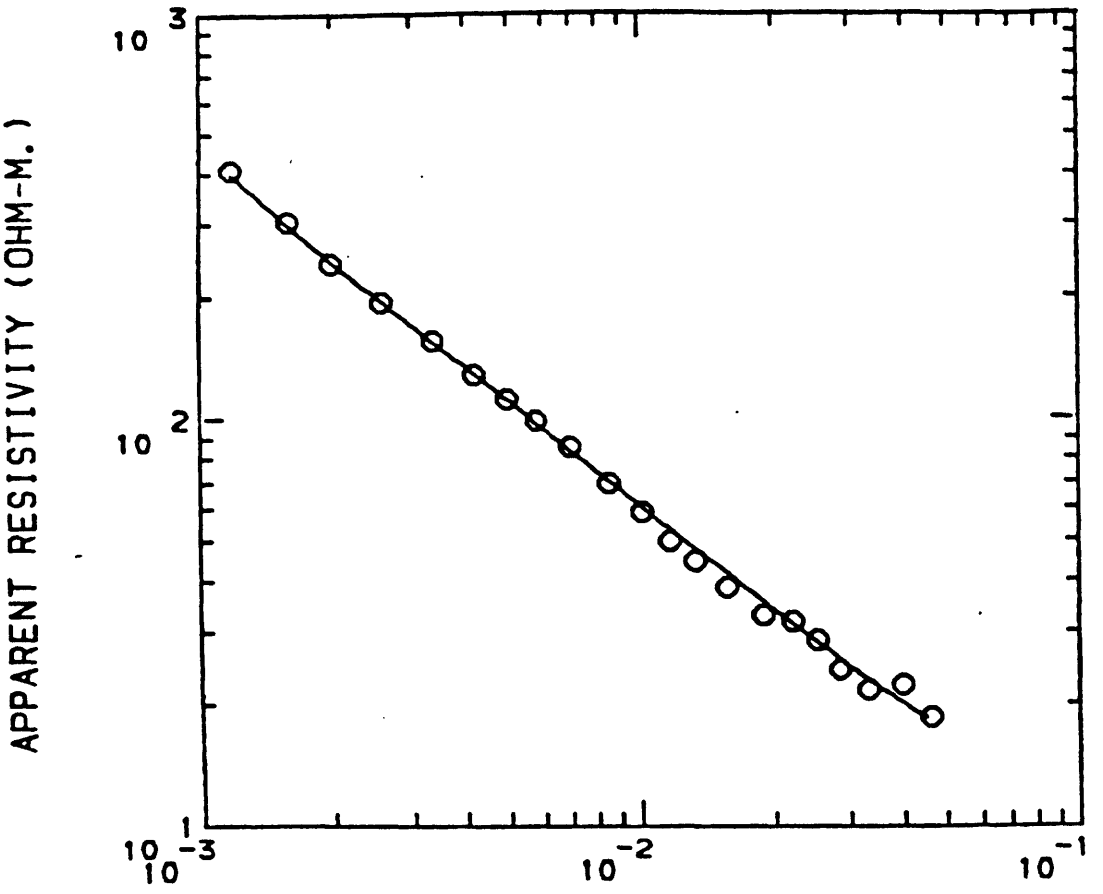


******** E N D ******** SW RIFT STA 14 3LY

PARAMETER	NAME		FINAL SOLUTION		RESISTIVITY	LAYER	DEPTH
1	SIGMA(1)	=	0.84409508E-03	1	0.11847007E+04		
2	SIGMA(2)	=	0.12686998E+00	2	0.78820853E+01		
3	SIGMA(3)	=	0.34872922E+00	3	0.28675544E+01		
4	THICK(1)	=	0.43824066E+03			1	0.43824066E+03
5	THICK(2)	=	0.14264539E+03			2	0.58088605E+03
6 *	SHIFT	=	0.10000000E+01				

* FIXED

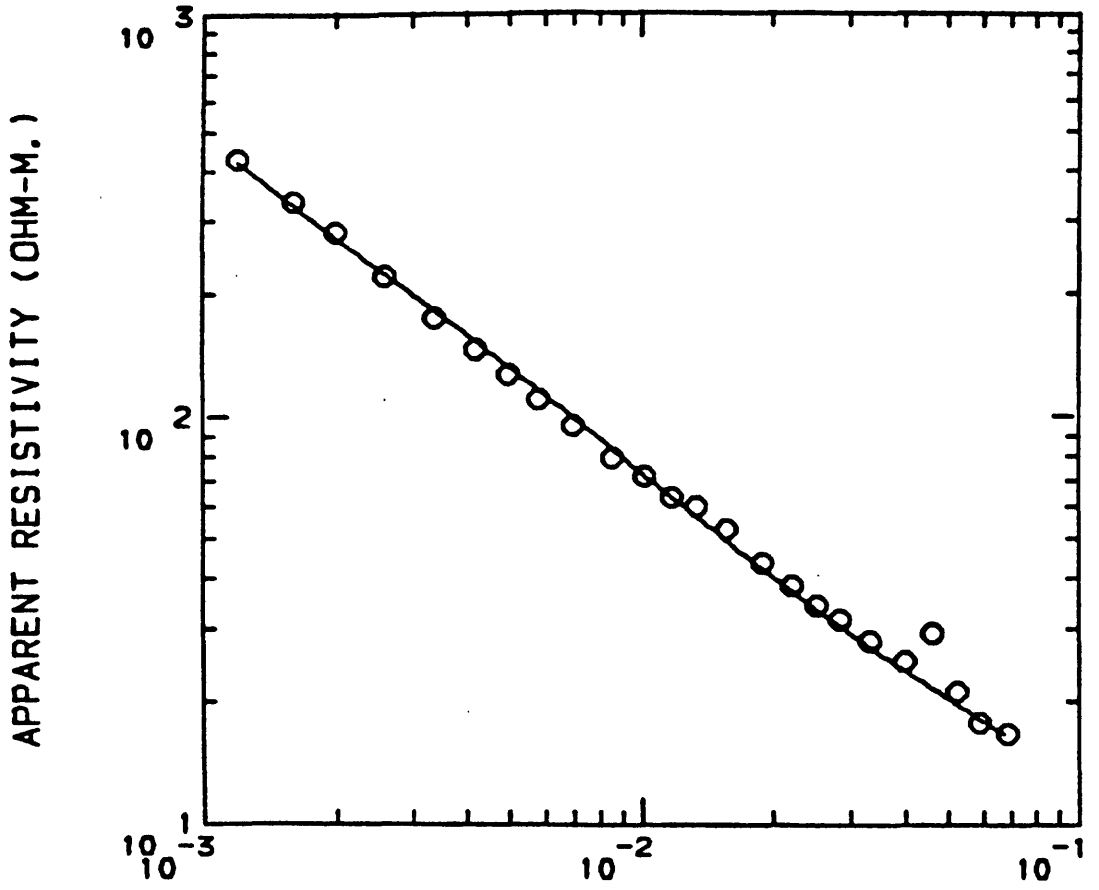
SW RIFT STA 15 3LY



PARAMETER NAME		FINAL SOLUTION		RESISTIVITY	LAYER DEPTH	
1	SIGMA(1) =	0.11829702E-03	1	0.84532979E+04		
2	SIGMA(2) =	0.12154587E+00	2	0.82273464E+01		
3	SIGMA(3) =	0.33715510E+00	3	0.29659939E+01		
4	THICK(1) =	0.43051968E+03			1	0.43051968E+03
5	THICK(2) =	0.15169315E+03			2	0.58221283E+03
6 *	SHIFT =	0.10000000E+01				

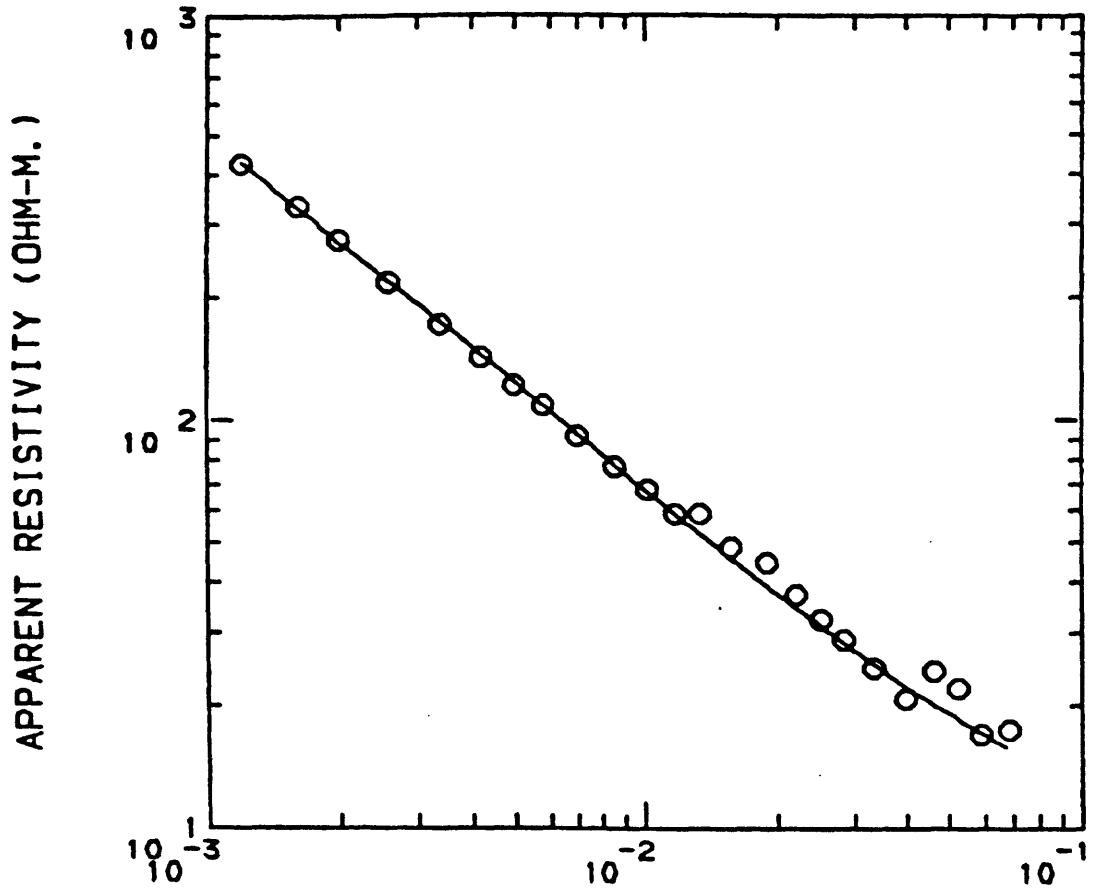
* FIXED

SW RIFT STA 16 3LY



	PARAMETER NAME		FINAL SOLUTION		RESISTIVITY	LAYER DEPTH	
1	SIGMA(1)	=	0.15812130E-03	1	0.63242588E+04		
2	SIGMA(2)	=	0.76920241E-01	2	0.13000480E+02		
3	SIGMA(3)	=	0.29015502E+00	3	0.34464335E+01		
4	THICK(1)	=	0.44520505E+03			1	0.44520505E+03
5	THICK(2)	=	0.17662296E+03			2	0.62182800E+03
6 *	SHIFT	=	0.10000000E+01				

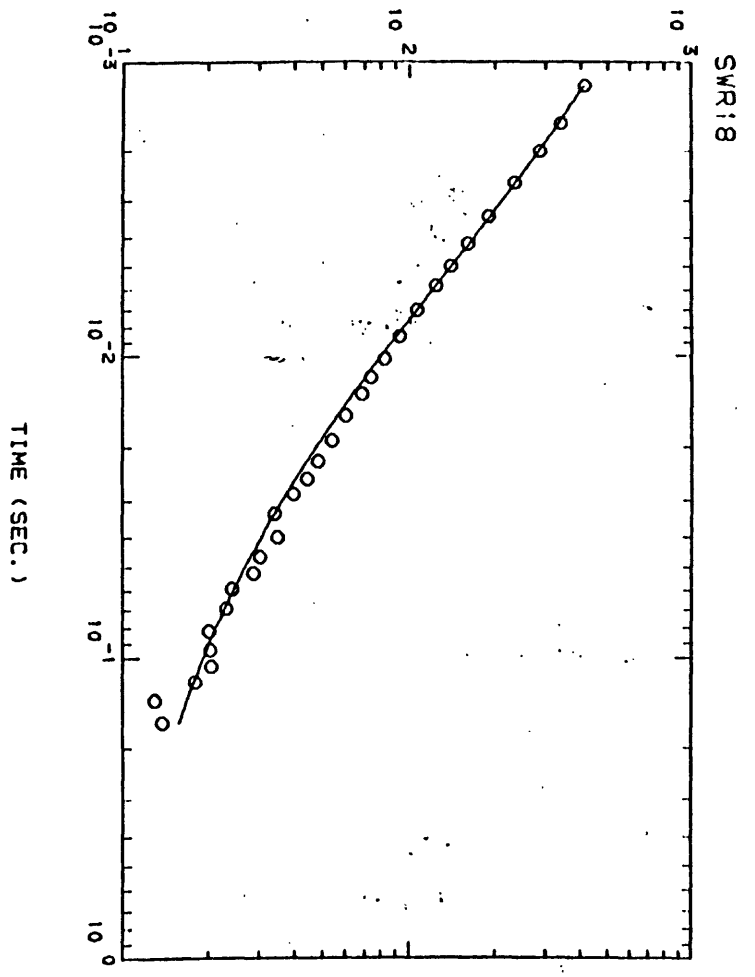
* FIXED



******** E N D ******** SW RIFT STA 17 3LY

	PARAMETER NAME		FINAL SOLUTION		RESISTIVITY	LAYER DEPTH
1 *	SIGMA(1)	=	0.20600000E-03	1	0.48543691E+04	
2	SIGMA(2)	=	0.93370251E-01	2	0.10710050E+02	
3	SIGMA(3)	=	0.28421086E+00	3	0.35185144E+01	
4	THICK(1)	=	0.44601913E+03			1 0.44601913E+03
5	THICK(2)	=	0.14798763E+03			2 0.59400677E+03
6 *	SHIFT	=	0.10000000E+01			

* FIXED

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 5 -0.4892E+00 -0.3266E+00 -0.9845E-01 -0.3817E+00  0.1000E+01

  **PARM_SOL.    STD_ERROR    REL_ERROR     % ERROR **

 1   0.1388E-02  0.1993E-04  0.5370E-02  0.5370E+00
 2   0.4780E-01  0.1041E-03  0.4761E-02  0.4761E+00
 3   0.1458E+00  0.2554E-03  0.6687E-02  0.6687E+00
 4   0.4615E+03  0.1983E-02  0.2657E-02  0.2657E+00
 5   0.1969E+03  0.3301E-02  0.7195E-02  0.7195E+00


******** E N D ********     SWR18

PARAMETER NAME       FINAL SOLUTION        RESISTIVITY   LAYER DEPTH

   1   SIGMA( 1) =  0.13880690E-02   1  0.72042529E+03
   2   SIGMA( 2) =  0.47795612E-01   2  0.20922422E+02
   3   SIGMA( 3) =  0.14584716E+00   3  0.68564930E+01
   4   THICK( 1) =  0.46150635E+03                      1  0.46150635E+03
   5   THICK( 2) =  0.19689980E+03                      2  0.65840613E+03
   6 * SHIFT     =  0.10000000E+01

     * FIXED
```

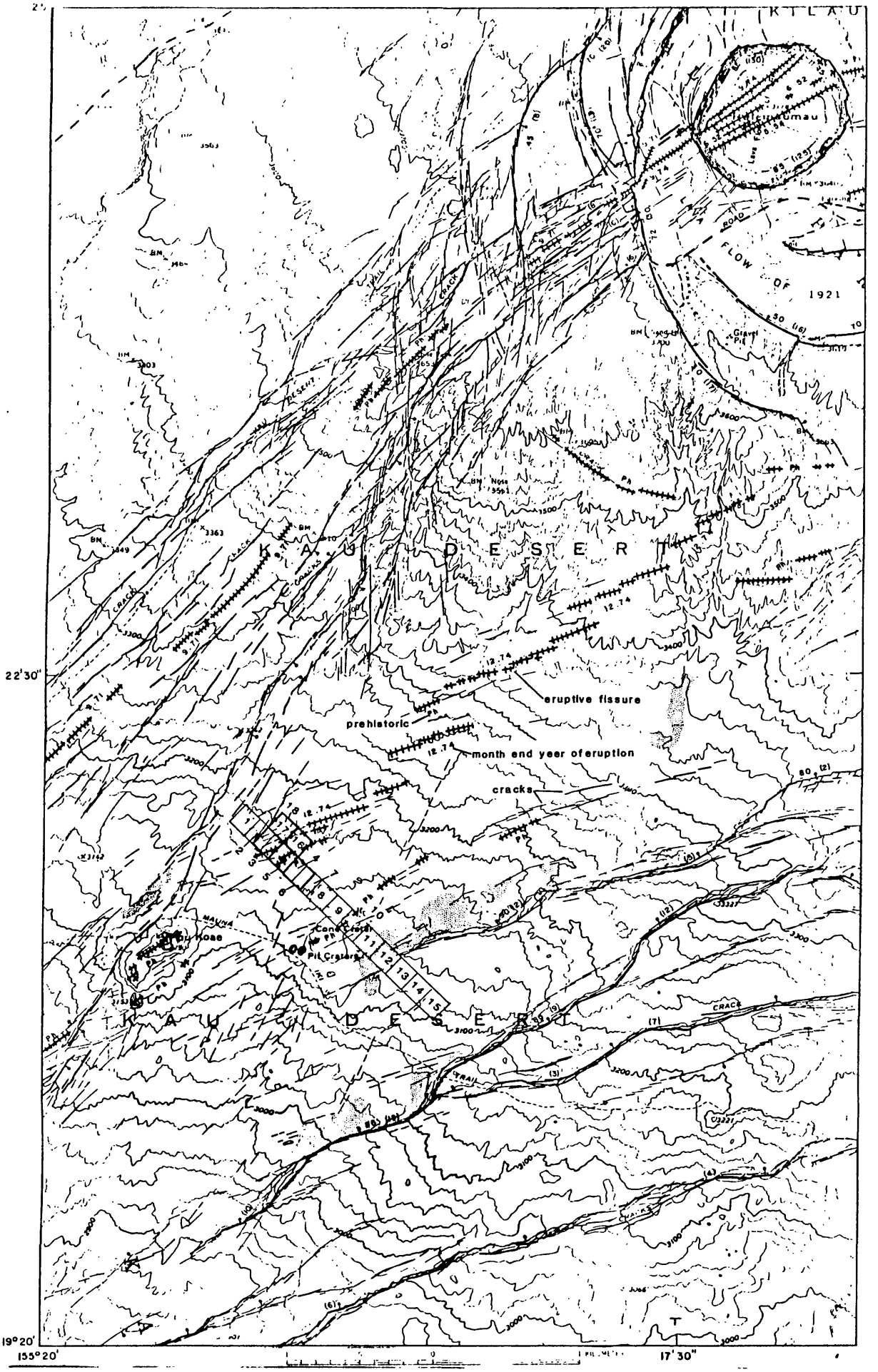

Figure 1. Location of TDEM soundings near Cone Crater, SW rift zone of Kilauea Volcano, Hawaii. Structure map base from Saint Ours, 1982. Topographic base from U.S. Geological Survey, 1:24,000, Kilauea Crater, Volcano, Makaopuhi Crater, Kau Desert, 1963.