science for a changing world

TIME-DOMAIN ELECTROMAGNETIC SOUNDINGS NEAR ANTIOCH, ILLINOIS, AND BERRIEN SPRINGS, MICHIGAN

by David L. Campbell[1]

Open-File Report 01-241

2001

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

[1] Denver, Colorado

TIME DOMAIN ELECTROMAGNETIC SOUNDINGS
NEAR ANTIOCH, ILLINOIS, AND BERRIEN SPRINGS, MICHIGAN

by David L. Campbell

CONTENTS

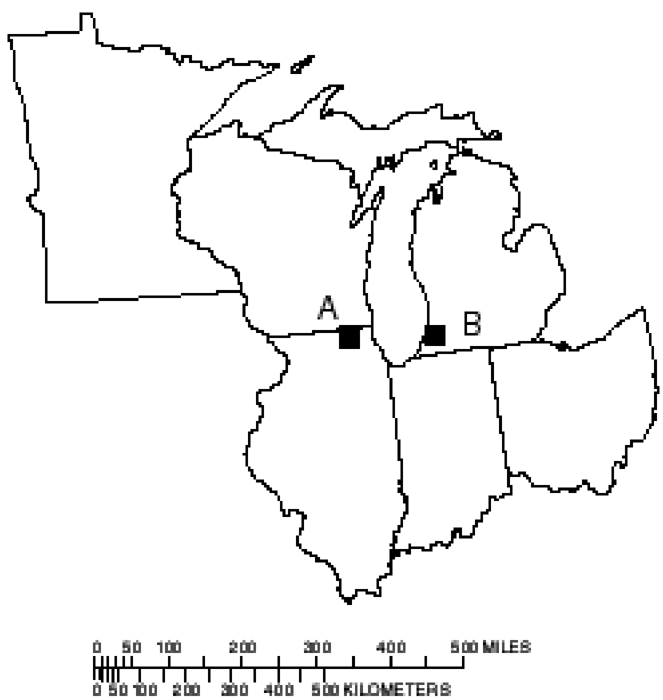


Figure 1. Outline map of the central Great Lakes region, showing locations of Antioch, IL (A) and Berrien Springs, MI (B) areas.

INTRODUCTION

In June, 2000, the U.S. Geological Survey (USGS) made time-domain electromagnetic (TEM) soundings near Antioch, Illinois, and Berrien Springs, Michigan. The soundings measured electrical resistivity to depths of about one hundred meters at these two places on approximately opposite sides of southern Lake Michigan (Fig. 1). The purpose of the work was to help develop a framework for further geoelectrical work to be done under the Central Great Lakes Geologic Mapping Coalition (CGLGMC). The CGLGMC members are USGS and state geological surveys of the states of Ohio, Indiana, Michigan and Illinois. The objective of CGLGMC is to make 3-dimensional geological maps of surficial materials in the coalition area. The TEM work can help constrain such maps, and also is of use in planning airborne electromagnetic surveys over the area’s glacial terranes (Campbell, 2001).

The TEM work in Illinois consisted of 11 soundings at scattered locations in the Antioch 7.5' quadrangle and one sounding in the Fox Lake 7.5' quadrangle, immediately to the west (fig. 6, below). These soundings are called "ANT1, …, ANT11". Many of the Antioch quad soundings were in Lake County Forest Preserve (CFP) parks.

The TEM work in Michigan consisted of 10 soundings ("SJ000, …, SJ-1200") across the St. Joseph River just downstream from the city of Berrien Springs, along the right of way where Route US-31 will extend to the north. The SJ soundings were made to investigate possible depths of incision of the ancestral St. Joseph River valley. One final sounding ("KLOCK") was made on the beach just north of where the St. Joseph River flows into Lake Michigan near the city of Benton Harbor. KLOCK was made to compare with the lithologic log of a drill hole made at that place from the USGS hovercraft.

TEM SOUNDING AND INTERPRETATION PROCEDURE

A detailed discussion of TEM theory and practice may be found in Nabighian and Macnae (1991) and in Fitterman and Stewart (1986). Briefly, TEM measurements involve sending an intermittent current into a transmitter loop so as to induce electrical currents in the ground. During times when the transmitter is off, a receiver loop is used to measure electromagnetic fields caused by the decay of those currents. Different rates of decay reflect geologic units with different electrical resistivities. This survey used PROTEM 47 equipment manufactured by Geonics Ltd., Mississauga, Ontario, Canada. For it, the transmitter (Tx) broadcasted into square loops consisting of insulated wire either 125 ft (38.1 m) or 250 ft (76.2 m) on a side, which lay flat on the ground. The receiver (Rx) measured fields via a rigid, round, 1-m-diameter loop located at the center of the transmitter loop. The Rx loop was mounted horizontally on legs a few inches above the ground surface. TEM soundings of this type will typically investigate geoelectric structures in the range from ~5 to 100+ m depth. Note that they do not give good information about very shallow materials.

TEM results will be influenced by nearby metallic conductors such as wire fences. Our practice, based on experience, is to locate the nearest edge of a 125 ft Tx loop more than 75 ft from the nearest fence, and that of a 250 ft loop more than 150 ft from a fence. Soundings SJ-500, -600, -700, -750, -800, and -900 were made inside a corn field using this rule.

A typical duty cycle for TEM work consists of four steps of equal time duration: 1) Tx on with positive polarity, 2) Tx off and Rx measuring fields, 3) Tx on with negative polarity, and 4) Tx off and Rx measuring. The PROTEM 47 Tx unit allows step durations of 3.51 ms (U range), 13.3 ms (V range), and 33.3 ms (H range). The Rx unit samples signal amplitudes in 20 subintervals ("gates") during each measuring step, averaging the samples in each gate over a specified number of duty cycles so as to improve sampling statistics. The 20 gate widths are distributed exponentially over a measuring interval in each step of 0.8 ms (U range), 3.0 ms (V range), and 8.0 ms (H range). We used the U range for all the soundings, and included measurements in the V and H ranges whenever signal quality was acceptable. Measurements began 0.0030 ms after Tx turn-off when using a 125 ft square Tx loop, and

0.0050 ms after Tx turn-off for 250 ft square loops. Measurements were repeated 3-6 times in each range.

For each sounding, repetitions were averaged and evaluated statistically using NTEMAVG v. 3.04, an unpublished USGS computer program by David V. Fitterman (written commun., 1999). Poor TEM data were dropped and the retained data were modeled using TEMIXGL, a commercial program by Interpex Ltd, Golden, Colorado. A model consists of a stack of successively deeper horizontal layers, each with a fixed thickness and resistivity, which we hope will correspond to thicknesses and resistivities of actual geologic units (or, possibly, lumped groups of thin geologic units). The bottommost layer represents the deepest unit the TEM method can detect, so is taken to have infinite thickness. The TEMIXGL program continually adjusts the thickness and resistivity values for all its model layers until it finds an acceptable fit to the observed TEM data.

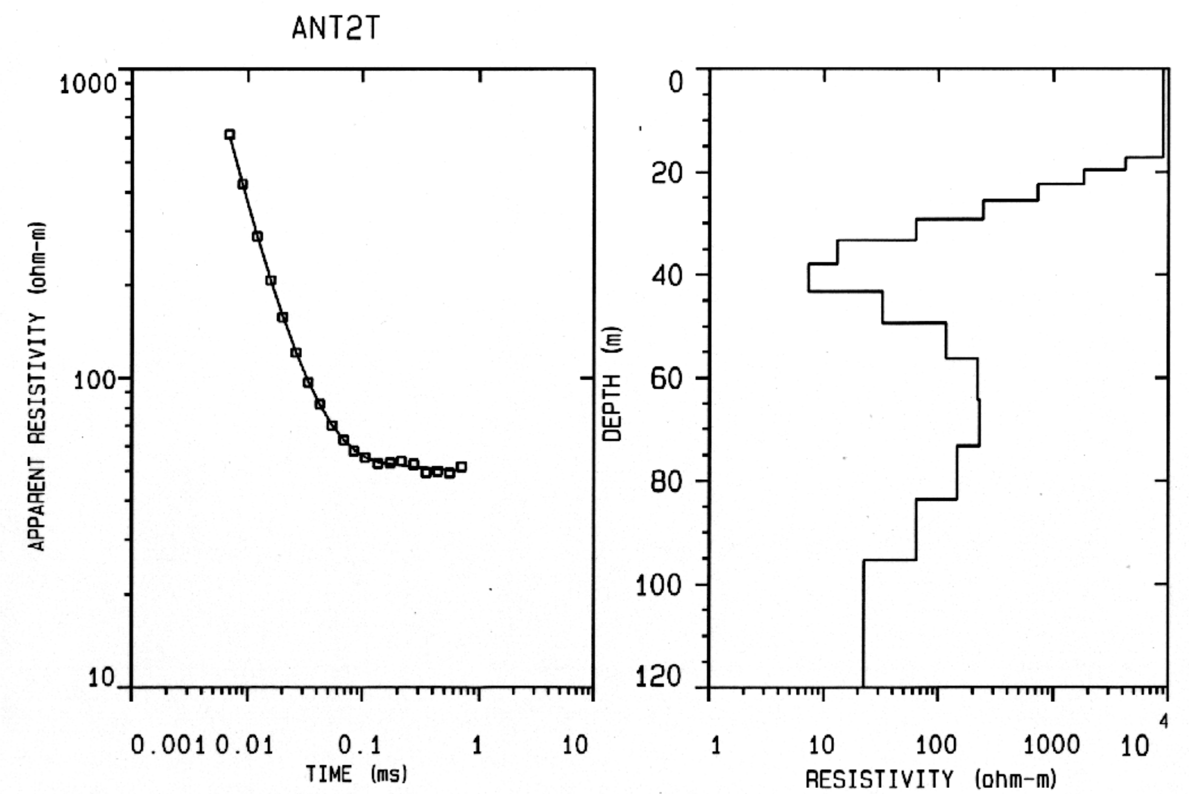


Figure 2. Observed resistivity-vs-time field data (left panel) and 15-layer smooth model (right panel) for sounding ANT2. The curve through the data points on the left panel show data calculated for the smooth model in the right panel.

Using TEMIXGL, a “smooth model” was first found for each sounding. A smooth model has many layers, approximately one per data point. Figure 2 shows the smooth model for sounding ANT2 in the right panel. The left panel shows the observed TEM data points at the ANT2 site, together with the continuous decay curve that results from that smooth model and which, in this case, fits the observed points quite well. We can see that the resistivity of the top layer is high, but as we proceed downward through the many layers their resistivities first drop, then rise, and finally drop again, so that the deepest detected layer has a low resistivity. An alternative way to model this sounding, therefore, would be to use 4 layers only. The resulting model would be a conservative one, in the sense that it uses the minimum number of layers needed to explain the observed data. (Three layers would be too few, for they could not duplicate the high—low—high—low resistivity sequence of the smooth model, whereas using 5 layers would give two adjacent layers with similar resistivity values.) Such minimum-layer-number models usually match geological structure better than do the smooth models, which distribute sharp resistivity interfaces over too large a range of depths (compare figs. 2 and 3). All ANT soundings had smooth models with a high—low—high—low resistivity structure, so were modeled using 4 layers. KLOCK and several of the SJ soundings, however, used 3-layer models.

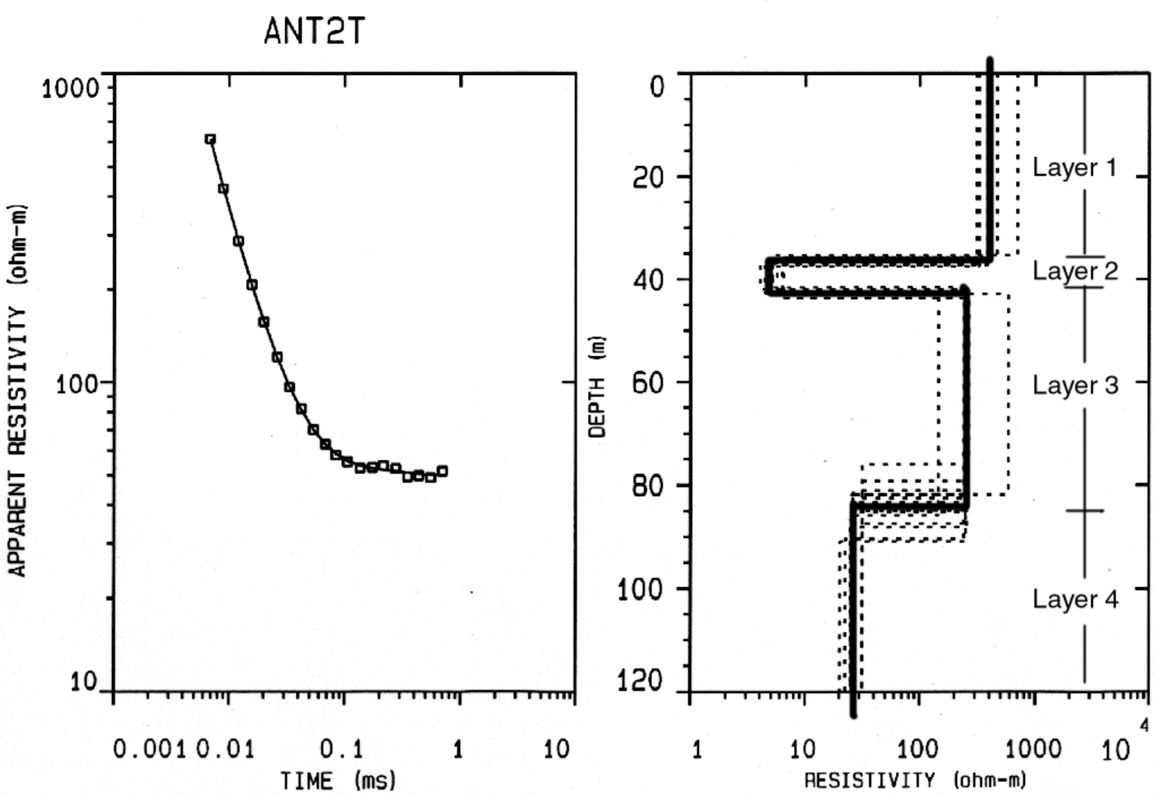


Figure 3. Observed resistivity-vs-time field data (left panel) and 4-layer model (solid lines, right panel) with equivalent models (dashed lines, right panel) for sounding ANT2. The curve through the data points on the left panel show data calculated for the 4-layer model in the right panel.

Figure 3 shows a 4-layer model for the ANT2 sounding (solid line). It fits the observed data with an error of 2.233%. Clearly, there will be other 4-layer models that can fit the data about as well ("equivalent" models). Dashed lines show a number of equivalent models, representative members of a much larger family, which fit the observed data to 2.680% (=1.2 times 2.233%). An equivalent model plot can help one visualize the extent to which model resistivities and thicknesses can vary without substantially changing the fit to the observed data.

HYDROGEOLOGIC INTERPRETATION OF RESISTIVITY VALUES

The electrical resistivity of a geologic unit depends on factors such as its composition and porosity, as well as the amount and purity of the water in its pores. The resistivity of geologic units composed of highly electrically resistive rock can be estimated using Archie's Law (Archie, 1942)

(1) $\rho = \rho_w F$

where ρ is resistivity of the formation, ρ_w that of the pore water or other fluid in the pores, and F is an adjustable parameter called the formation factor. For sandstones,

(2) $F \sim 0.62\ \Phi^{-2.15}$ (Humble formula, quoted by Ward, 1991)

and for low porosity carbonates

(3) $F \sim \Phi^{[1.87 + 0.019 / \Phi]}$ (Shell formula, quoted by Ward, 1991).

In these equations Φ represents porosity of the rock, and the rock is assumed to be fully saturated with water. Unsaturated rocks will have higher resistivities; the drier the rock, the higher its resistivity.

Archie's Law says that to good approximation the resistivity of an appropriate unit will depend largely on that of its pore water. To determine the resistivity of a sandy formation, one merely multiplies that of its pore water by coefficient F, which for sandstones typically falls in the range 5-20 (Humble formula, above). The resistivity of pore water depends in turn on the total dissolved solids (TDS) it contains. Thus, when dealing with sandy unconsolidated aquifers, relatively lower resistivity values can indicate the presense of less potable or even contaminated water, whereas relatively higher resistivity values can indicate purer water. As one proceeds to aquifers with lower and lower porosity, however, factor F rises. A high resistivity value, greater than 1000 ohm-m, say, may therefore indicate a tight sandy aquifer that will produce little water and will recharge slowly.

The formation factor of Archie's Law must be modified for use with units containing clay (Waxman and Smits, 1968). That is because (mineralogical) clay is itself electrically conductive, so that electrical currents pass along the surfaces of clay platelets as well as through interstitial pore water. Such units will have lower resistivities than would be predicted by the standard Archie equation.

The above generalizations can help one infer which geologic unit(s) may be giving rise to a particular measured resistivity. Such an interpretation can be greatly improved using experience in a given study area. Faye and Smith (1994) collected samples of well water from about 120 wells in the coastal plain of the southeastern United States, and found the following power-law regression fits for their data:

(4) $TDS = 5110\ \rho_w^{-0.92}$

(5) $\rho_w = 0.56\ \rho^{0.92}$

Measured values fell within a factor of about 5 from the values predicted by these equations, at a 95-percent prediction level. Some of the Faye-Smith samples came from bedrock aquifers, and many of them contained clays. The presence of clays may explain the relatively low apparent formation factors, F ~ 2, of these samples. Equations (4) and (5) predict that an aquifer having a formation resistivity of 100 ohm-m may be expected to contain water with a resistivity of about 38.7 ohm-m, and that water in turn should have a TDS of about 177 mg/L. At present, no results analogous to these seem to be available for aquifers of the central Great Lakes area. However, a TDS of 177 mg/L may be atypically low for ground water in the midwest. If that is so, we might expect to find many aquifers there with formation resistitivies under 100 ohm-m. On the other hand, the TEM interpretations given below show several inferred aquifers that have measured formation resistivities substantially greater than 100 ohm-m.

Sounding ANT1 was located a few hundred yards east of a drillhole on the Ron Riepe property, for which a good lithologic log was available. Figure 4 shows that lithologic log, with geologic units classified according to grain size, in the left panel. This panel, and the corresponding one in fig. 5, were provided by Andrew J. Stumpf of the Illinois State Geological Survey (written commun., June, 2000). A heavy vertical line has been drawn on the log to distinguish between fine diamict and finer grain sizes (to the left of the line) and fine sand and coarser grain sizes (to the right of the line). The right panel in fig. 4 shows the 4-layer TEM model of ANT1 (from Appendix A), stretched so as to make its depth axis match that of the lithologic log. Horizontal lines have been drawn between the two panels to mark layer boundaries. Layer 1 (756 ohm-m) corresponds to a geologic sequence composed dominantly of diamict, above the water table, and sand and gravel, below it. Apparently dry diamict and wet sand and gravel have similar, fairly high, resistivity values. Layer 2 (26.3 ohm-m) corresponds to a geologic sequence composed dominantly of coarse diamict. It is likely that the coarse diamict unit contains enough clay to bring the formation resistivity down to this observed value. If so, this means that electromagnetic methods cannot distinguish between fine and coarse dimicton sequences. This sequence, though water-saturated, probably contains too much fine-grained material (at least in the upper two-thirds of the sequence) for ready transmission of ground water. Layer 3 (324 ohm-m) corresponds to a geologic sequence whose upper part is composed dominantly of sands and gravels, and which probably represent a good aquifer. The lower part of Layer 3 corresponds to bedrock limestone. Griffiths and King (1965) show that resistivities for typical porous limestones fall in the 100-5,000 ohm-m range. It seems likely, therefore, that the limestone bedrock found in this well probably has a resistivity that is not very different from that of the wet sand and gravel overlying it. This means that geoelectrical measurements probably will be unable to distinguish bedrock limestone in the Antioch area. The top of Layer 4 (20.7 ohm-m) falls in the range 88-110 m depth at the 7.10% error level. Layer 4 therefore lies below the top of the limestone bedrock, which is at 68 m depth. Layer 4 probably represents shale of the Ordovician Maquoketa Shale Group, the unit which lies stratigraphically below the "limestone" (actually, a cherty dolomite of the Silurian Alexandrian Series; Ardith Hansel, Illinois State Geological Survey, written commun., 3/5/01). Griffiths and King (1965) show the histogram for soft shale to fall in the range 0.5-20 ohm-m, whereas that for hard shale spans the range 7-800 ohm-m. We infer that the Maquoketa shale is a low-resistivity hard(?) shale, and that the limestone found at the bottom of Riepe's well is ~30 m thick. This compares with its thickness of ~35 m in a logged well at Round Lake Beach, about 5 mi to the south (Hensel, written commun., 3/5/01).

Another lithologically-logged water well was available at the location of ANT2, on the Sun Lake CFP (fig. 5). Some of the resistivity-lithology correlations found on fig. 4 also hold true at this place, but others do not. In particular, the likely surficial aquifer at ANT2 is composed largely of silt and diamict, but nevertheless has a higher resistivity (lower part of Layer 1, 235 ohm-m). Layer 2, whose lower resistivity (9 ohm-m) is appropriate for clay or diamict, spans depths where sand and gravel are dominant. Broadly speaking, the resistivity characteristics of Layer 2 and the lower part of Layer 1 are reversed from what we expected. Part of this difference could be resolved, though, if some of the "sands" between 35-45m depth were actually sandy clays. The lithologic correlations for Layers 3 and 4 at ANT2 resemble those found at ANT1. At both places Layer 3 has a resistivity of several hundred ohm-m, reflecting a sand and gravel aquifer in the upper part, and a porous limestone bedrock in the lower part, whereas Layer 4 probably reflects shale underlying the limestone unit.

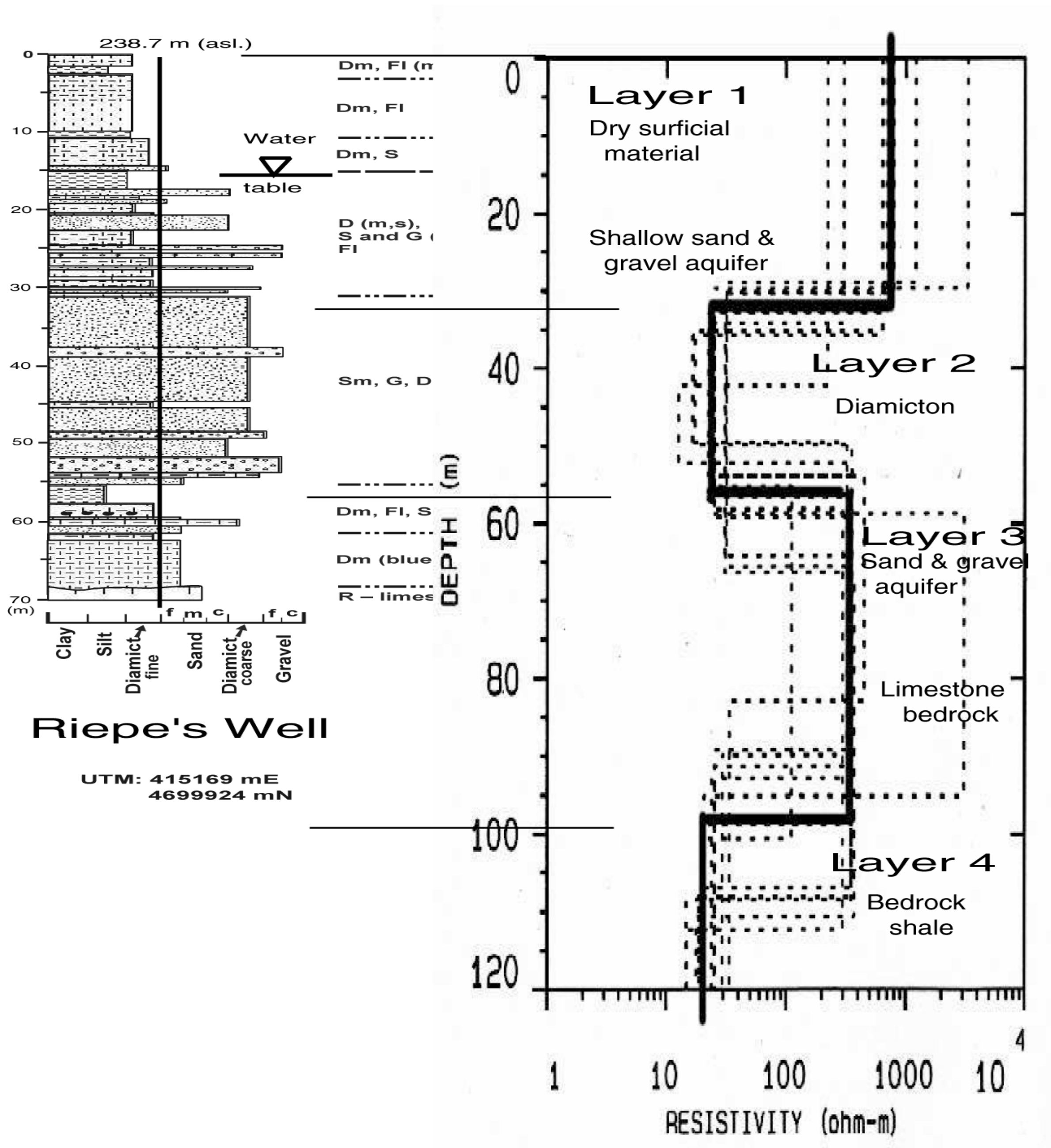


Figure 4. Lithologic log of a water well near ANT1 (left panel) and 4-layer model of the TEM sounding (right panel) near the logged well. Heavy vertical line on well log panel divides grain sizes such that below the water table sequences left of the heavy line roughly correlate with lower resistivity values and those to the right of it roughly correlate with higher ones. Coarse diamict, however, correlates with low resistivities.

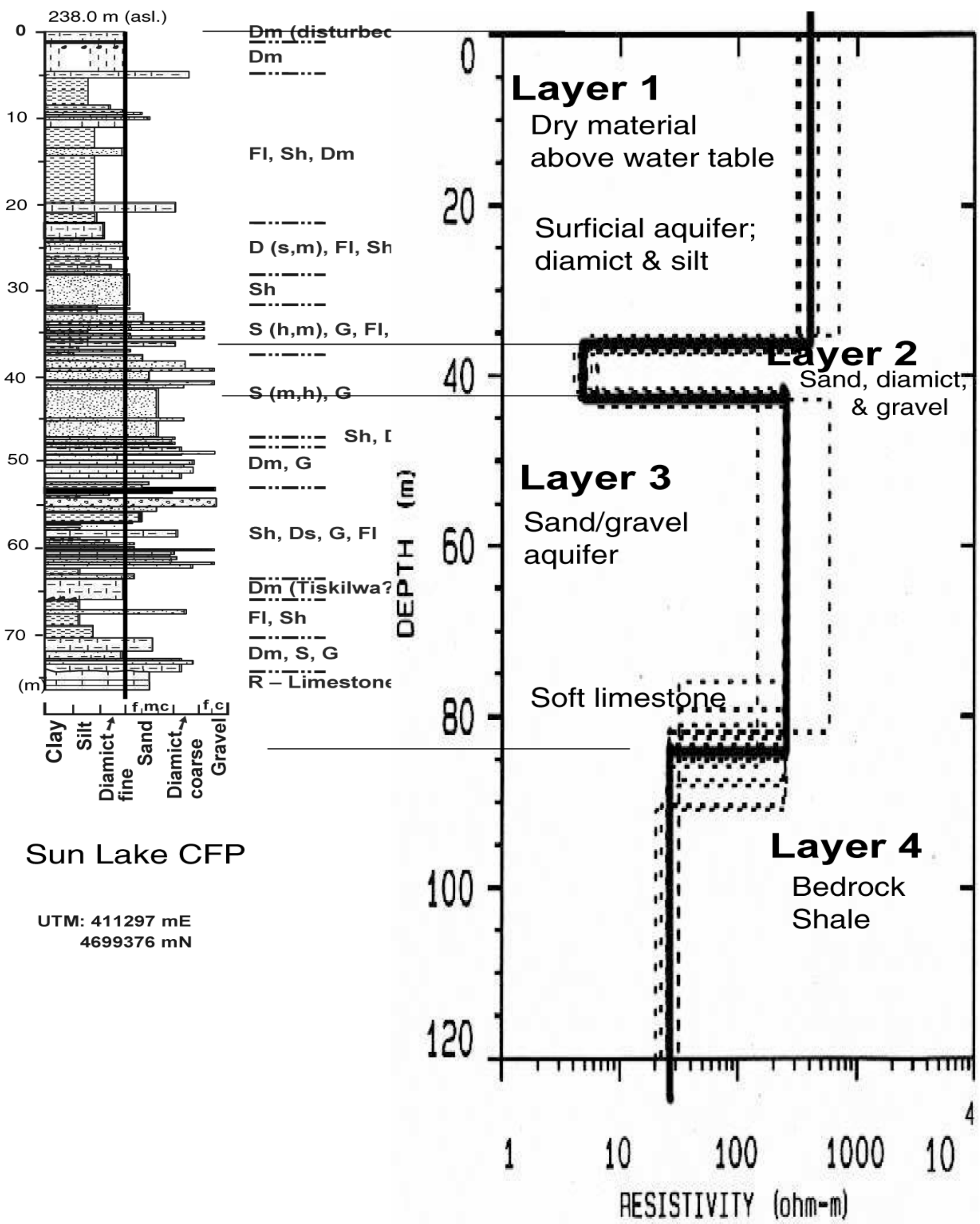


Figure 5. Lithologic log of a water well at Sun Lake CFP and 4-layer model of TEM sounding ANT2, located at the logged well (right panel). Heavy vertical line on well log panel is as on fig. 4, but here the correlation between grain sizes and resistivity is much poorer.

Table 1 pulls together the different strands of evidence discussed in this section to list possible geologic units that may correspond to four ranges of resistivity found in layer models of the TEM soundings.

Table 1. Resistivity ranges and possible geological units that may correlate with them in the central Great Lakes region.

Resistivity (ohm-m)	Possible geology
<30	Units with high clay content. If shallow, water saturated diamicton; If deep, bedrock shale.
30-100	Saturated diamicton/sandy mixtures; higher values mean more sand
100-1000	If shallow, dry surficial material; If deeper, saturated sand and gravel units (good aquifers)
>1000	If shallow, dry surficial material; If deep, low porosity limestone bedrock, limestone (cf., Shell formula).

OTHER TEM SOUNDINGS NEAR ANTIOCH, ILLINOIS

Figure 6 shows locations of the 11 TEM soundings made near Antioch IL. Plots of observed data and 4-layer models for these soundings are given in Appendix A, and a listing of the thicknesses and resistivities of the 4-layer models is given in Table 2. As a guide to our thinking, but subject to revision as we learn more, we characterize the 4 layers of the geoelectric models as follows:

Layer 1 – dry material above water table, and saturated silt, diamict, and sand below it.
Layer 2 – saturated diamict or sandy clay.
Layer 3 – saturated sand-gravel aquifer and bedrock limestone.
Layer 4 – bedrock shale.

The 4-layer models given in Appendix A show interesting differences from place to place in the study area. Figure 7 shows 4 TEM soundings along a 3.5 mile-long, east-west, traverse in the northeast part of the study area. Substantial changes are seen within even this short distance. In particular, diamicton units may thin to the east, and the bedrock shale may become shallower in that direction.

Such substantial changes over short distances may well be typical of glacial terranes like those of the Antioch IL study area. Only about 1.5 miles south of ANT10 and ANT11, for example, in the McDonald Woods CFP, we find very different geoelectric sections at ANT7 and ANT6. There the Layer 3 resistivities are the highest in the data set, 2010 and 1214 ohm-m, respectively. Either the sand-gravel-limestone sequence there is tighter than elsewhere (that is, it has substantially lower porosity and so may not bear water so readily), or else some different lithologic sequence may be present. Nevertheless, at ANT5, only another 0.5 mi south of ANT6, we again find a geoelectric section that is fairly typical for this area, and where the upper part of Layer 3 probably represents a good aquifer.

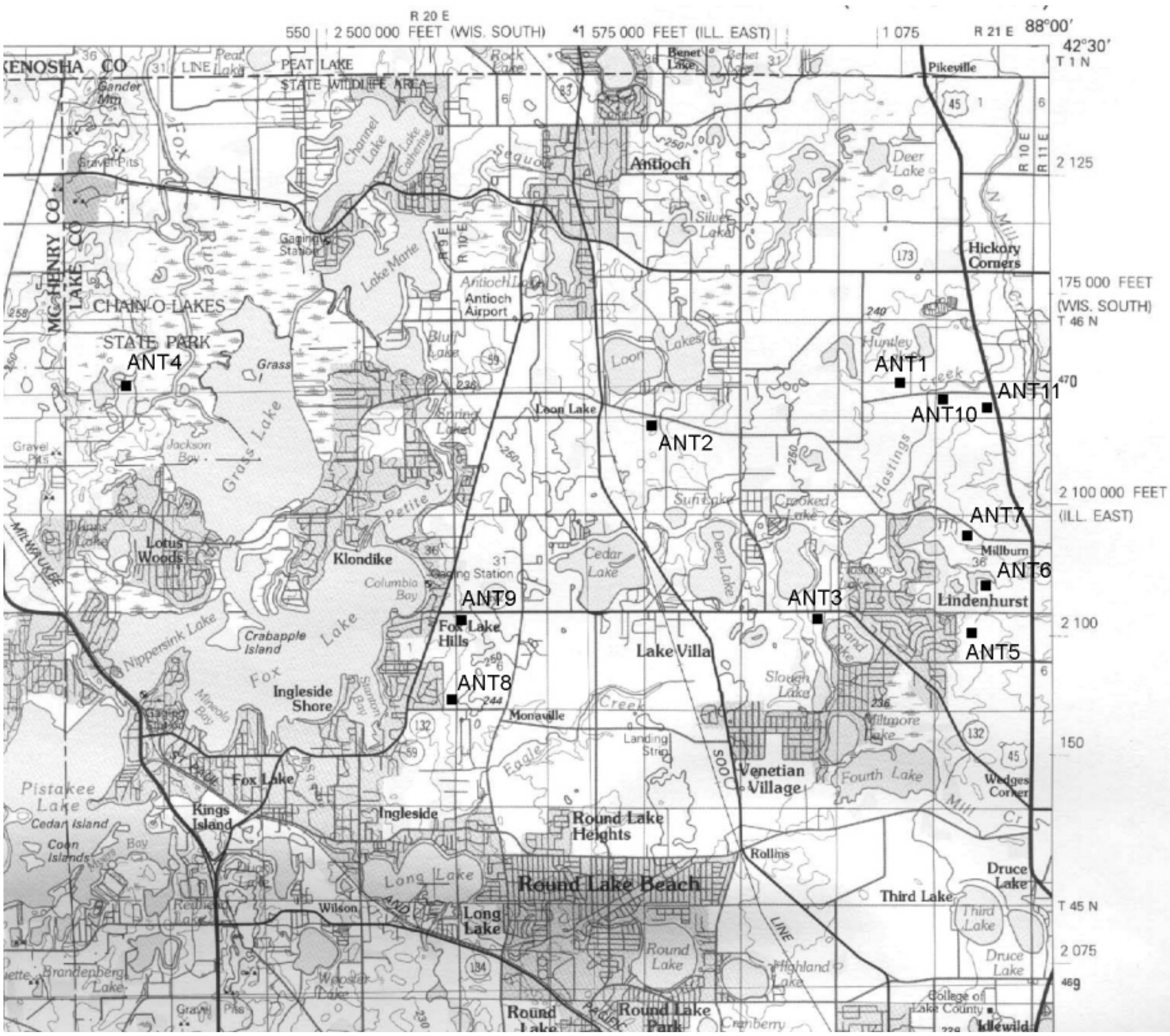


Figure 6. Locations of TEM soundings (ANT1, …, ANT11) near Antioch, Illinois. Base map is a part of the U.S. Geological Survey metric topographic map of the Elgin, Illinois-Wisconsin 30x60 minute quadrangle.

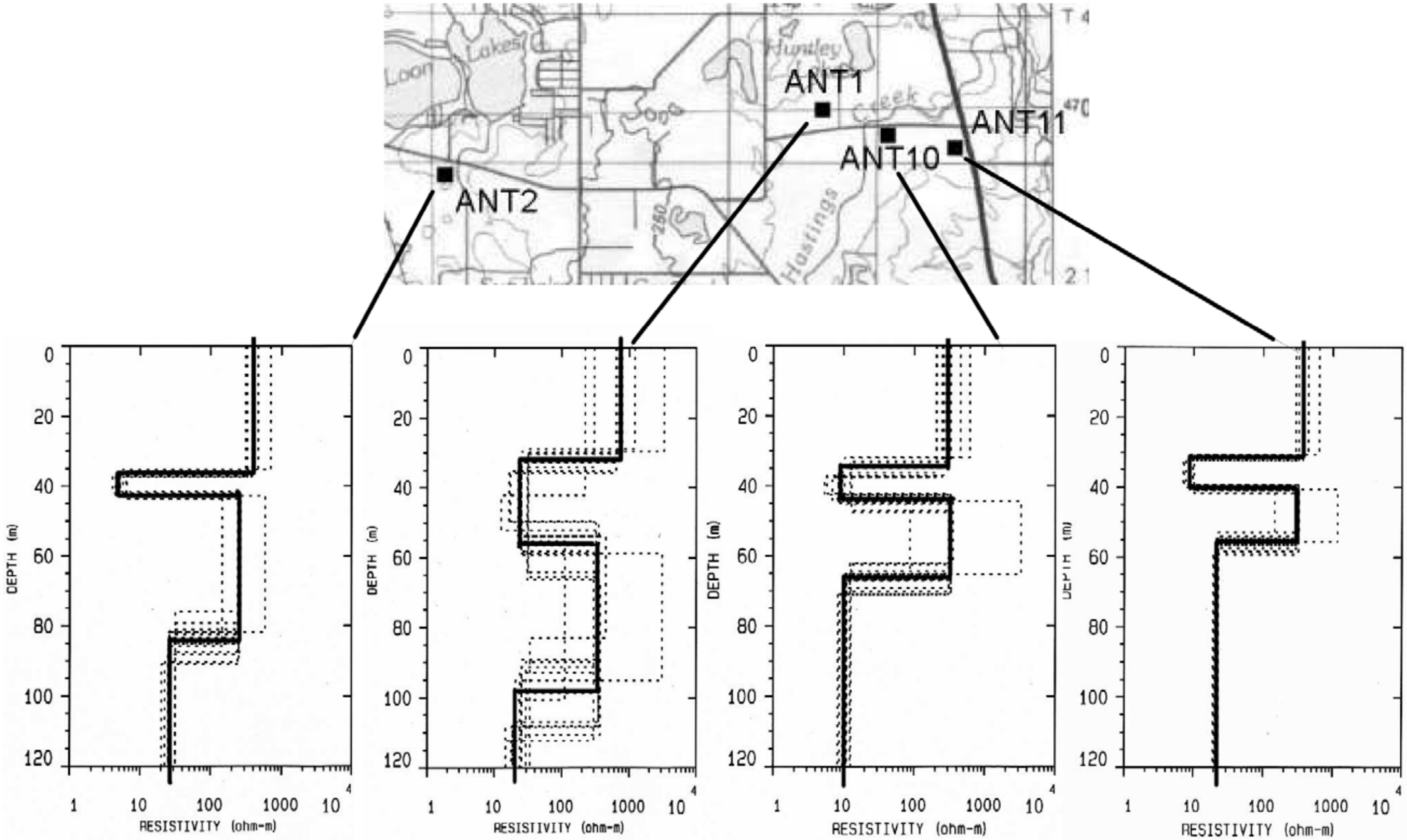


Figure 7. Changes in geoelectric structure along a short east-west traverse near Antioch, IL. Map at top (from fig. 6) shows locations of 4 TEM soundings, whose 4-layer models are displayed below, all to the same scale.

TEM SOUNDINGS NEAR BERRIEN SPRINGS, MICHIGAN

TEM sounding KLOCK (Appendix B; Table 2) was made at Jean Klock Park, on the beach of Lake Michigan immediately north of St. Joseph, MI. Layer 1, which is ~33 m thick, probably represents beach sand saturated with low-TDS Lake Michigan water. This result is consistent with those from a borehole drilled at that location from the USGS hovercraft, which found 5.8 m of esker and fill material above a glacial lake sand, fining downwards to a total depth of ~20 m (Byron Stone, USGS, oral commun., 3/2/01). Layer 2 may represent diamicton, and Layer 3 may represent a shale in the pre-glacial bedrock. Milstein (1987) indicates that the bedrock unit in this area is the upper Devonian Ellsworth Shale, or possibly Antrim shale, also of Devonian age, which lies immediately under the Ellsworth shale.

Soundings SJ000, …, SJ-1200 crossed the valley of the St. Joseph River just downstream from the town of Berrien Springs, MI. Figure 8 is a section view of the results. Under the bluff that bounds the north side of the river, Layer 1 resistivities are quite high. South of the river, Layer 1 resistivities are compatible with surficial sandy units. Layer 2 may represent clay or silt. South of the river, under its broad flood plain, Layer 3 appears to represent a thick wedge of sandy deposits, which might have been deposited by river meanders. This unit disappears as one climbs up out of the river valley to the south. Layer 4 is a very conductive everywhere, and probably represents bedrock shale.

Figure 8 seems to say that the ancestral St. Joseph River incised very deeply into the shale country rock. At SJ-500 the top of the unit we interpret to represent bedrock shale is ~120 m deep; that is, at an elevation of ~63m above present-day sea level. We note for comparison that the present-day elevation of Lake Michigan, into which the St. Joseph River drains, is at 177 m. Could Lake Michigan once have been low enough to provide a base level at less than 63m for the St. Joseph River? Surprisingly, the answer to this question is that that very likely was so. A reconstruction of the recent geological history of the Great Lakes region by Larsen (1987) shows that during the Chippewa low water level, ~9700 B.P., the southern part of Lake Michigan was separated from the rest of ancestral Lake Michigan, and its water level was at ~55m. The ancestral St. Joseph River flowed into that low lake, and at that time could well have incised to ~63m depth near present-day Berrien Springs.

TENTATIVE CONCLUSIONS

This study has led to several tentative conclusions, most of which must be verified and refined by further work.

In the Antioch, IL, area:

- All TEM soundings detected 4 layers, which we think may represent (1) dry material above water table and surficial aquifer below it, (2) water-saturated diamict or diamict-sand sequences, probably a fair aquifer, (3) sand-gravel-limestone sequences, probably a good aquifer, and (4) bedrock shale.
- Geoelectrical methods probably cannot distinguish between dry and wet surficial sediments. In other words, they cannot map the water table.

- Geoelectrical methods probably cannot distinguish between fine diamict and coarse diamict. They can readily distinguish thick sand/gravel aquifers from diamict ones.
- Geoelectrical methods probably cannot distinguish between bedrock limestone and overlying sand-gravel units in the Antioch, IL, area. However, they probably can distinguish the top of the bedrock shale unit below the limestone.
- The bedrock limestone found in the bottom of wells in the Antioch, IL, area is probably only a few 10's of meters thick in most places. There seems to be up to ~40 m of relief on the bedrock shale which underlies that limestone.

In the Berrien Springs, MI, area:

- A series of TEM soundings across the St. Joseph River valley show interpreted units that can reasonably be attributed to downcutting and sedimentation in a meandering river valley. The top of the interpreted bedrock shale unit, however, is ~120 m deep at its deepest point on the profile. This large value seems to imply that the ancestral St. Joseph River once cut down to ~63 m above present-day sea level.

ACKNOWLEDGEMENTS

We thank Lake County, Illinois, for access to Lake County Forest Preserve lands, with special thanks to Joshua Skolnick for showing us around the preserves. We also thank Prof. Ron Riepe of the College of Lake County, Grayslake, Illinois, for many useful discussions of geology and hydrology of the Antioch area, and Mrs. Riepe for iced tea and cookies on several hot June afternoons. Thanks, too, to Marilyn Brant, W.L. Robinson, and Kathy Stuart for letting us work on their properties near Antioch, and Tom Chiddick of Andrews University, Berrien Springs, Michigan, for access to Andrews University farm fields.

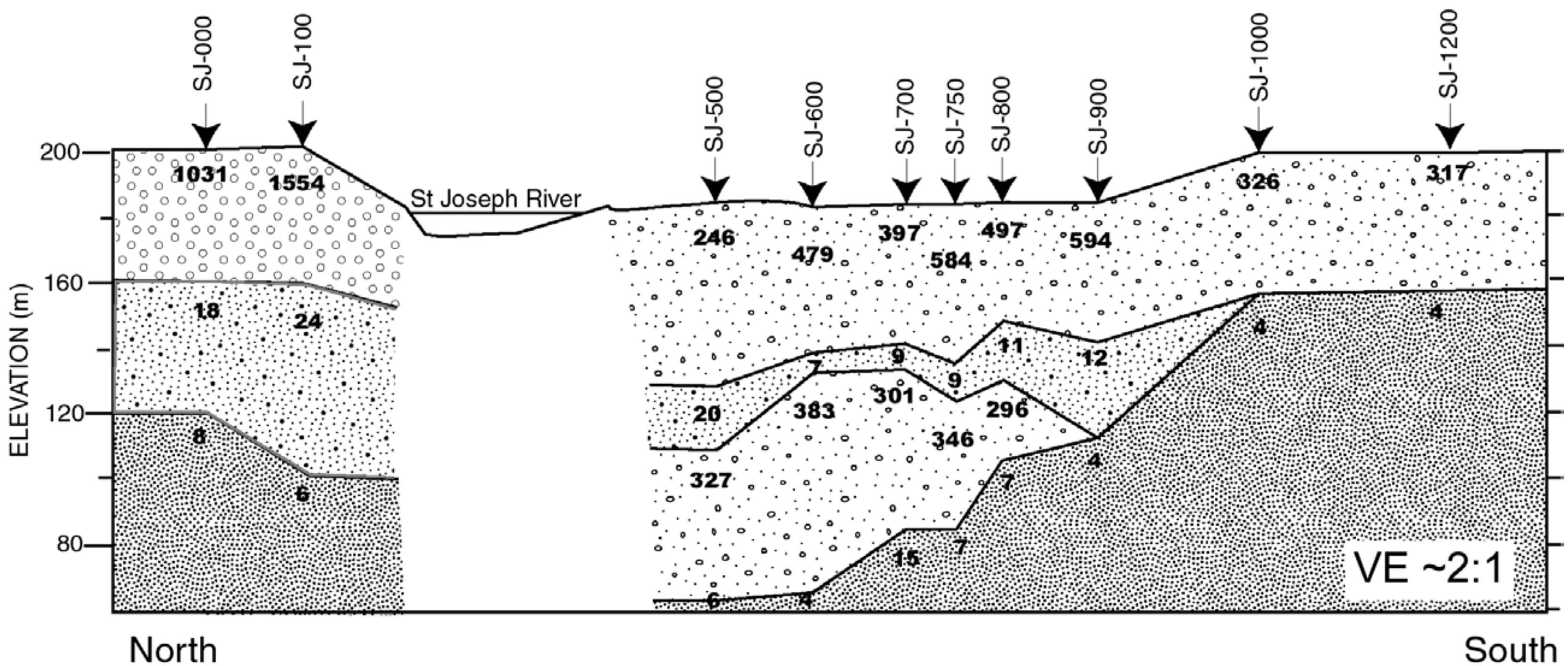


Figure 8. Section view showing TEM layer models across the St. Joseph River just downstream from Berrien Springs MI, along the projected extension of Route US-31. Vertical exaggeration is approximately 2:1. Superposed numbers give layer resistivity in ohm-m. This section implies that the ancestral St. Joseph River may have incised very deeply into the country rock.

Table 2. Best models for the TEM soundings in this report. All elevations are approximate.

Sounding	Fit Error [%]	Layer 1 Surf. Elev (m)	Layer 1 Resist. [ohm-m]	Layer 1 Thickness [m]	Layer 2 Elevation of top [m]	Layer 2 Resistivity [ohm-m]	Layer 2 Thickness [m]	Layer 3 Elev. of top [m]	Layer 3 Resist. [ohm-m]	Layer 3 Thickness [m]	Layer 4 Elev. of top [m]	Layer 4 Resistivity [ohm-m]
ANT01	8.114	237.1	717.2	32.4	204.7	23.7	23.9	180.8	349.9	42.1	138.7	20.7
ANT02	2.125	240.8	394.3	36.5	204.3	5.0	6.0	198.3	248.8	41.7	156.6	25.6
ANT03	5.558	241.7	497.7	39.6	202.1	6.8	8.4	193.7	61.9	24.3	169.4	5.3
ANT04	7.812	227.1	575.8	41.8	185.3	13.1	8.3	177.1	164.0	25.9	151.1	45.0
ANT05	6.008	236.8	471.0	37.9	198.9	7.6	9.0	189.9	110.6	46.0	143.9	8.5
ANT06	6.326	228.6	320.4	32.0	196.6	6.9	6.5	190.1	516.8	51.0	139.1	21.1
ANT07	5.579	235.3	346.4	33.0	202.3	9.1	9.2	193.1	342.4	48.4	144.7	23.8
ANT08	1.542	243.2	331.3	29.2	214.0	9.4	9.7	204.3	75.0	29.4	174.9	13.3
ANT09	0.808	238.4	328.5	29.7	208.8	9.0	9.0	199.7	136.8	52.0	147.7	20.6
ANT10	5.465	235.3	293.8	34.8	200.5	9.0	9.1	191.3	328.6	22.4	168.9	10.3
ANT11	1.616	234.1	373.5	31.6	202.5	8.7	8.8	193.7	320.5	15.6	178.1	21.1
KLOCK	2.341	177.5	1133.5	33.1	144.4	12.1	42.7	101.7	6.0			
SJ-000	4.918	201.2	1030.7	40.8	160.4	18.3	41.2	119.2	8.1			
SJ-100	6.248	201.2	1553.5	41.5	159.7	24.1	57.4	102.3	5.7			
SJ-500	2.245	183.8	246.1	54.7	129.1	19.5	20.9	108.2	326.6	44.9	63.4	5.7
SJ-600	6.356	182.3	478.5	43.3	139.0	6.5	7.4	131.6	383.0	66.0	65.6	4.2
SJ-700	4.894	183.5	397.2	42.4	141.1	8.7	7.1	134.0	300.8	49.4	84.5	14.5
SJ-750	3.477	183.5	583.5	50.2	133.3	8.9	10.0	123.2	346.2	38.4	84.8	7.2
SJ-800	5.081	183.8	496.6	35.7	148.1	10.9	17.9	130.3	295.9	24.4	105.9	7.1
SJ-900	5.752	183.5	593.7	42.2	141.3	11.9	29.8	111.6	4.4			
SJ-1000	11.940	198.7	326.2	43.1	155.6	3.9						
SJ-1200	8.796	198.1	317.4	41.3	156.8	4.2						

REFERENCES

Archie, G.E., 1942, The electrical resistivity log as an aid to determining some reservoir characteristics: Transactions of the American Institute of Mining, Metallurgical and Petroleum Engineering, vol. 146, p. 54-62.

Campbell, D.L., 2001, Airborne geophysical survey and ground-based geoelectrical soundings near Berrien Springs, Michigan (abstract): GSA Abstracts with Programs, v. 33, no. 4, p. A-45.

Faye, R.E., and Smith, W.G., 1994, Relations of borehole resistivity to the horizontal hydraulic conductivity and dissolved-solids concentration in water of clastic coastal plain aquifers in the southeastern United States: U.S. Geological Survey Water-Supply Paper 2414, 33 p.

Fitterman, D.V., and Stewart, M.T., 1986, Transient electromagnetic sounding for groundwater: Geophysics, v. 51, no. 4, p. 995-1005.

Griffiths, D.H., and King, R.F., 1965, Applied geophysics for engineers and geologists: Oxford, Pergamon Press, p. 10.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 2254, 263 p.

Larsen, C.E., 1987, Geological history of glacial Lake Algonquin and the upper Great Lakes: U.S. Geological Survey Bulletin 1801, 36 p.

Milstein, R.L., 1987, Bedrock geology of southern Michigan: State of Michigan Department of Natural Resources, 1 sheet, 1:500,000 scale.

Nabighian, M.N., and Macnae, J.C., 1991, Time domain electromagnetic prospecting methods, *in* Nabighian. M.N., *ed*., Electromagnetic Methods in Applied Geophysics, Volume 2—Applications: Tulsa OK, Society of Exploration Geophysicists, p. 427-520.

Ward, S.H., 1991, Resistivity and induced polarization methods, *in* Ward, S.H., *ed*., Geotechnical and Environmental Geophysics, Volume II—Enviromental and Groundwater: Tulsa OK, Society of Exploration Geophysicists, p. 147-189.

Waxman, M.H., and Smits, L.J.M., 1968, Electrical conductivities in oil-bearing shaly sands: Transactions of the American Institute of Mining, Metallurgy, and Petroleum Engineering, v. 243, Part II, p.107-122.

APPENDIX A: OBSERVED DATA and TEM MODELS, ANTIOCH AREA

TEM Sounding locations were recorded on 1:24,000 scale topographic maps that had 10-ft contour intervals. The UTM coordinates and elevations given below were measured from these field maps. The location given is nominally that of the small Rx loop, which in turn was located in the center of a square Tx loop either 38.1 or 76.2 m on a side. Likely uncertainty in UTM coordinates is thought to be about 20 m, whereas the likely uncertainty in elevations is about half a contour interval, or 5 ft.

Each data set in this appendix contains a header briefly describing the TEM site, followed by a section giving tabled data for each data range (u, v, or h) that was used at that site, and concluding with a graph of the results. The data table includes for each time gate the individual apparent resistivities (rho_a, in ohm-m) that make up a series of repeated measurements, followed by the average apparent resistivity value for the series and standard error of its estimate (%std). The left panel of the graph section shows the time decay of apparent resistivity with measured averages appearing as squares (u range) or diamonds (v and h ranges). The right panel shows models of apparent resistivity versus depth; the heavy line represents the best model that was found, whereas lighter dashed lines represent a suite of equivalent models that fit the observed data almost as well. The continuous line in the left panel is calculated from the best model and shows how well it fits the observed data. All graphs are at the same scale to facilitate comparisons between them.

ANT1: Brant's back yard, 125' Tx loop, 27-JUN-00
UTM X= 415130 m   UTM Y= 4699900 m   ELEVATION= 778 ft

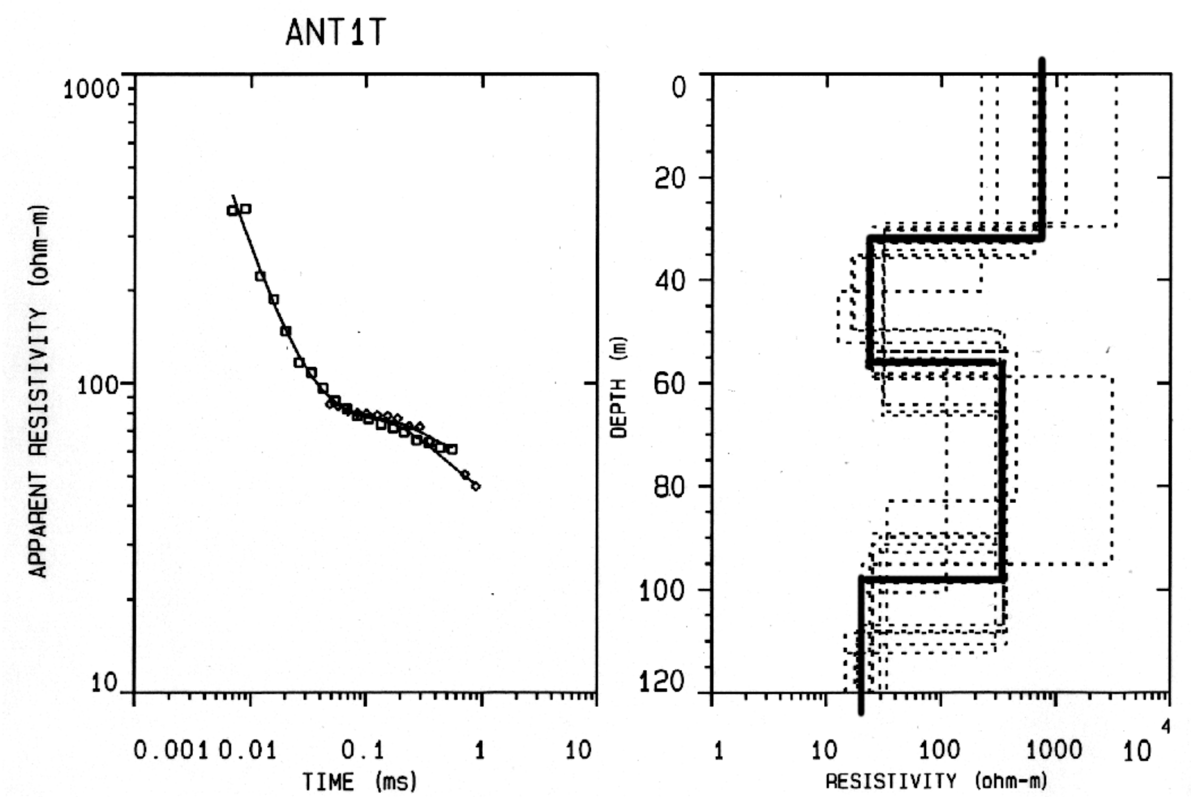
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6	6
NSTK:	8	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	357.6	357.1	363.3	368.4	366.9	362.6	1.4
2	8.95	0.00299	368.2	368.7	367.0	365.8	367.2	367.4	0.3
3	12.08	0.00348	221.6	221.9	222.0	222.7	222.2	222.1	0.2
4	15.72	0.00396	187.0	187.2	187.1	187.2	187.0	187.1	0.1
5	20.05	0.00448	147.5	147.8	146.7	146.7	147.5	147.2	0.3
6	26.17	0.00512	116.7	117.1	116.3	116.5	116.9	116.7	0.3
7	33.45	0.00578	108.2	108.6	107.8	107.6	108.2	108.1	0.3
8	42.10	0.00649	95.69	96.39	96.39	96.39	96.64	96.30	0.4
9	54.10	0.00736	87.05	88.08	87.39	87.74	87.74	87.60	0.4
10	68.20	0.00826	81.13	82.85	82.34	82.49	82.80	82.31	0.9
11	83.80	0.00915	78.61	78.47	78.20	78.20	78.54	78.40	0.2
12	104.60	0.01023	76.82	76.54	76.54	76.49	76.76	76.63	0.2
13	135.60	0.01164	73.57	73.42	73.19	73.13	73.61	73.38	0.3
14	172.30	0.01313	71.72	71.69	70.98	71.78	71.63	71.56	0.5
15	214.90	0.01466	69.59	69.44	68.55	69.49	69.84	69.38	0.7
16	275.00	0.01658	65.59	65.87	64.49	65.05	65.53	65.30	0.8
17	349.00	0.01868	63.13	64.91	63.87	64.11	64.88	64.17	1.2
18	436.00	0.02088	60.29	61.35	59.83	62.00	64.56	61.55	2.9
19	555.00	0.02356	59.16	66.91	57.34	62.84	60.45	61.12	5.8
20	701.00	0.02648	56.40	61.68	55.70	64.51	76.05	61.89	11.8

FREQ:	v	v	v
CUR[A]:	1.5	1.5	1.5
GAIN:	6	6	6
NSTK:	8	8	8
T/O[us]:	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	85.62	85.50	85.02	85.38	0.4
2	0.0569	0.00754	84.45	84.45	83.89	84.26	0.4
3	0.0693	0.00832	81.45	81.37	80.93	81.25	0.3
4	0.0840	0.00917	80.08	80.28	79.33	79.89	0.6
5	0.1010	0.01005	79.36	80.00	79.15	79.50	0.6
6	0.1250	0.01118	78.41	78.90	78.63	78.65	0.3
7	0.1545	0.01243	77.79	79.06	78.09	78.31	0.8
8	0.1890	0.01375	76.75	77.46	76.06	76.75	0.9
9	0.2370	0.01539	72.60	72.60	71.72	72.30	0.7
10	0.2940	0.01715	72.63	71.43	72.33	72.13	0.9
11	0.3570	0.01889	65.02	63.99	65.48	64.82	1.2
12	0.4410	0.02100	63.10	63.10	57.78	61.20	5.2
13	0.5630	0.02373	65.45	54.13	53.83	57.21	10.5
14	0.7100	0.02665	50.58	50.58	50.58	50.58	0.0
15	0.8810	0.02968	47.53	44.49	46.88	46.26	3.5
16	1.122	0.03350	67.49	38.84	41.41	45.77	25.8
17	1.414	0.03760	123.8	30.40	36.62	45.57	72.2
18	1.763	0.04199	61.55	28.76	31.78	35.58	33.0
19	2.240	0.04733	132.5	16.75	17.28	22.64	61.9
20	2.825	0.05315	23.50	10.26	109.1	26.07	>>

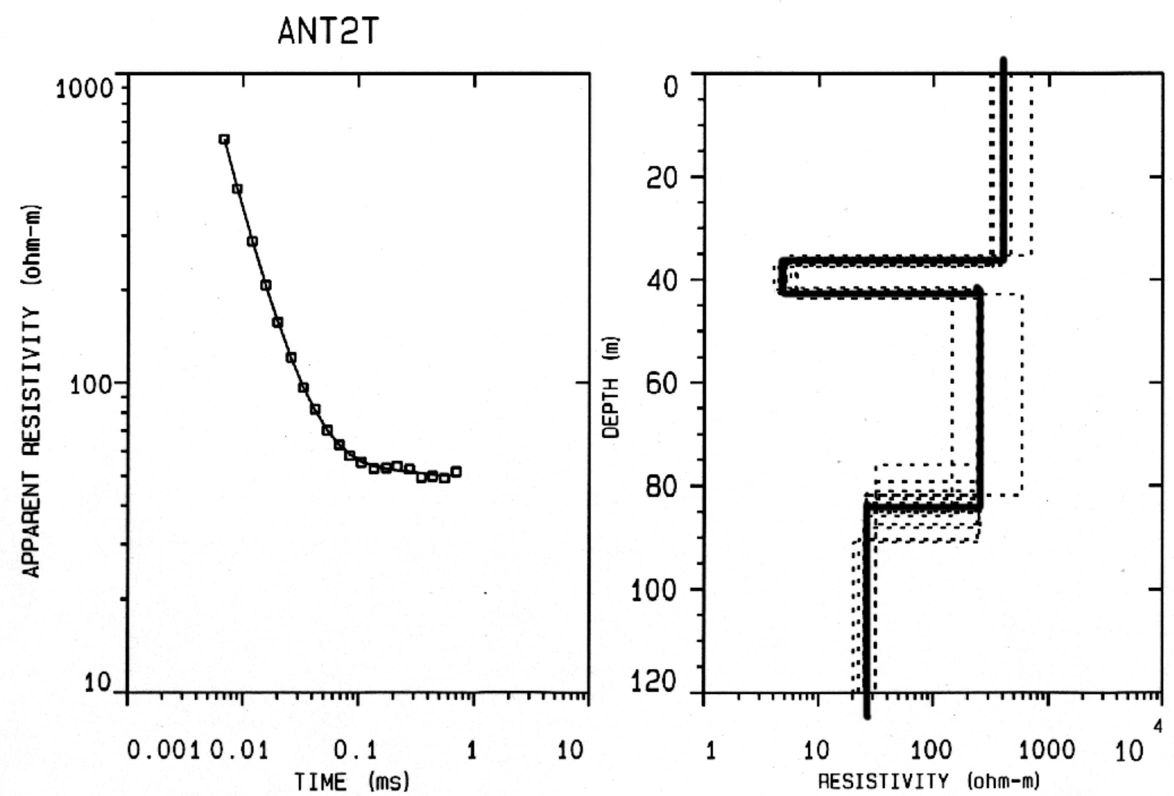


ANT2: Sun Lake CFP, 250' Tx loop, 27-JUN-00
UTM X= 411250 m   UTM Y= 4699370 m   ELEVATION= 790 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 76.2 m   LY= 76.2 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	4.40	4.40	4.40	4.40
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	614.5	615.0	614.9	612.6	614.3	0.2
2	8.95	0.00299	424.4	424.5	424.1	422.8	423.9	0.2
3	12.08	0.00348	287.3	287.2	287.0	286.1	286.9	0.2
4	15.72	0.00396	206.9	206.9	206.8	206.2	206.7	0.2
5	20.05	0.00448	157.1	157.1	157.0	156.5	156.9	0.2
6	26.17	0.00512	120.8	120.8	120.8	120.4	120.7	0.2
7	33.45	0.00578	96.48	96.56	96.41	96.19	96.41	0.2
8	42.10	0.00649	82.14	82.14	82.14	81.82	82.06	0.2
9	54.10	0.00736	70.11	70.11	70.01	69.82	70.01	0.2
10	68.20	0.00826	62.86	62.89	62.92	62.73	62.85	0.1
11	83.80	0.00915	58.02	58.09	58.04	57.86	58.00	0.2
12	104.60	0.01023	55.21	55.27	55.21	55.06	55.19	0.2
13	135.60	0.01164	52.81	52.92	52.81	52.71	52.81	0.2
14	172.30	0.01313	52.93	53.12	53.02	52.93	53.00	0.2
15	214.90	0.01466	53.57	53.93	53.57	53.57	53.66	0.3
16	275.00	0.01658	52.29	52.67	52.52	52.40	52.47	0.3
17	349.00	0.01868	49.40	49.59	49.59	49.12	49.43	0.5
18	436.00	0.02088	49.44	50.16	50.24	49.11	49.73	1.1
19	555.00	0.02356	49.56	49.79	49.27	48.20	49.20	1.5
20	701.00	0.02648	52.19	51.78	51.27	50.60	51.45	1.3



ANT3: Duck Farm CFP, 250' Tx loop, 27-JUN-00
UTM X= 413840 m   UTM Y= 4696110 m   ELEVATION= 793 ft

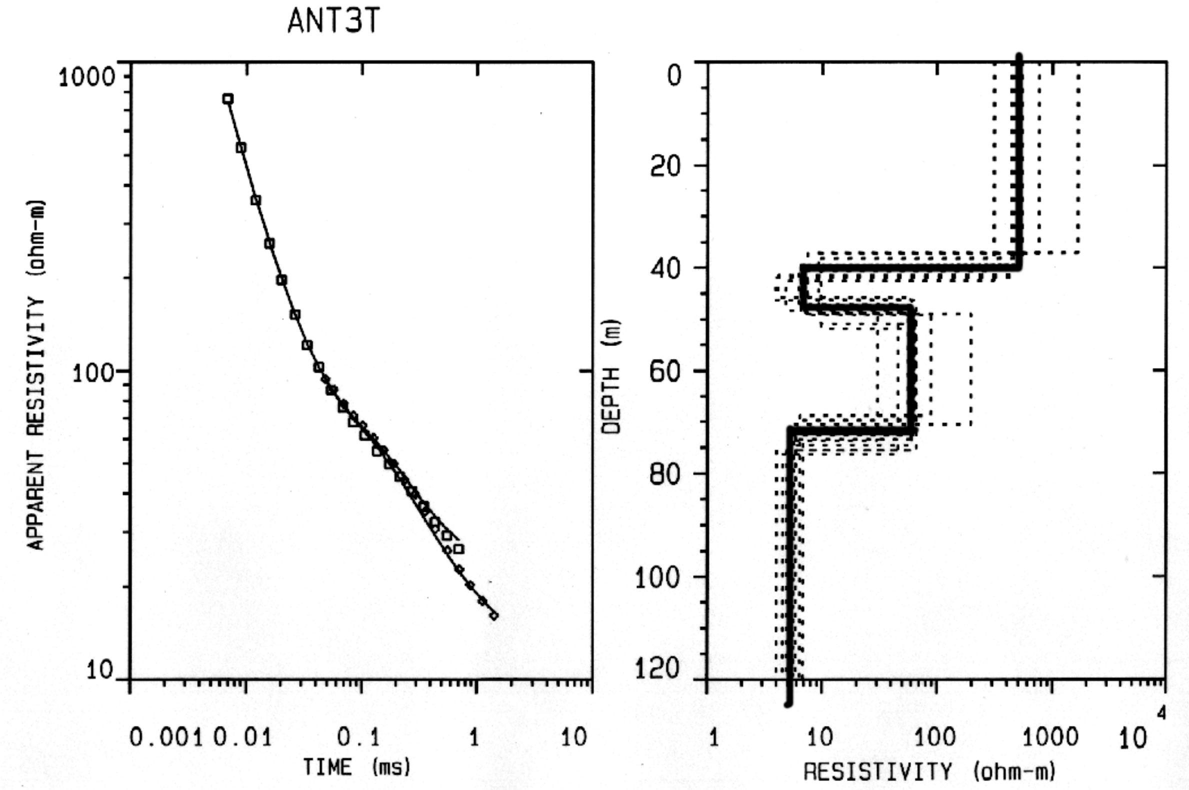
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 76.2 m   LY= 76.2 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u	u
CUR [A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5	5
NSTK:	8	8	8	8	8
T/O[us]:	4.40	4.40	4.40	4.40	4.40
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	758.7	762.5	761.5	759.5	759.5	760.4	0.2
2	8.95	0.00299	526.9	528.2	528.4	528.0	527.4	527.8	0.1
3	12.08	0.00348	357.6	357.7	358.0	357.9	357.6	357.7	0.1
4	15.72	0.00396	258.3	258.6	258.9	258.5	258.3	258.5	0.1
5	20.05	0.00448	196.6	196.7	196.8	196.7	196.6	196.6	0.1
6	26.17	0.00512	151.7	151.7	151.9	151.7	151.7	151.7	0.1
7	33.45	0.00578	121.2	121.2	121.2	121.0	120.9	121.1	0.1
8	42.10	0.00649	102.6	102.5	102.5	102.3	102.5	102.5	0.1
9	54.10	0.00736	86.72	86.55	86.39	86.55	86.39	86.52	0.2
10	68.20	0.00826	76.33	75.84	75.88	75.84	75.88	75.95	0.3
11	83.80	0.00915	67.70	68.03	67.91	67.91	67.94	67.89	0.2
12	104.60	0.01023	61.51	61.67	61.63	61.67	61.71	61.64	0.1
13	135.60	0.01164	54.50	54.73	54.67	54.73	54.73	54.67	0.2
14	172.30	0.01313	49.65	49.73	49.65	49.65	49.65	49.67	0.1
15	214.90	0.01466	45.02	45.35	45.24	45.35	45.24	45.24	0.3
16	275.00	0.01658	40.56	40.63	40.47	40.47	40.59	40.54	0.2
17	349.00	0.01868	36.26	36.21	36.34	36.30	36.34	36.29	0.2
18	436.00	0.02088	32.32	32.32	32.09	32.43	32.43	32.32	0.4
19	555.00	0.02356	29.27	29.11	29.27	29.18	29.10	29.19	0.3
20	701.00	0.02648	26.73	26.13	26.58	26.27	26.50	26.44	0.9

FREQ[A]:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	4.40	4.40	4.40	4.40
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	93.79	93.52	93.52	93.85	93.67	0.2
2	0.0569	0.00754	87.00	86.70	86.75	87.08	86.88	0.2
3	0.0693	0.00832	78.23	77.97	77.85	78.27	78.08	0.3
4	0.0840	0.00917	71.47	71.13	71.13	71.54	71.32	0.3
5	0.1010	0.01005	66.32	65.95	66.05	66.45	66.19	0.4
6	0.1250	0.01118	60.53	60.22	60.28	60.62	60.41	0.3
7	0.1545	0.01243	55.30	55.11	54.91	55.52	55.21	0.5
8	0.1890	0.01375	50.07	49.87	49.78	50.17	49.97	0.4
9	0.2370	0.01539	44.40	44.22	43.92	44.35	44.22	0.5
10	0.2940	0.01715	39.90	39.40	39.27	40.36	39.72	1.3
11	0.3570	0.01889	34.72	34.93	34.98	34.99	34.90	0.4
12	0.4410	0.02100	30.32	30.34	30.70	31.18	30.63	1.3
13	0.5630	0.02373	25.85	25.90	26.46	26.46	26.17	1.3
14	0.7100	0.02665	22.25	22.91	22.85	23.00	22.75	1.5
15	0.8810	0.02968	19.73	20.10	20.46	20.70	20.24	2.1
16	1.122	0.03350	17.88	17.92	17.40	18.67	17.96	2.9
17	1.414	0.03760	16.01	15.51	16.03	17.00	16.12	3.8
18	1.763	0.04199	14.98	13.54	14.02	15.82	14.53	6.9
19	2.240	0.04733	16.57	11.26	11.24	17.34	13.39	23.0
20	2.825	0.05315	15.59	10.43	10.29	14.48	12.16	21.0


ANT3T
APPARENT RESISTIVITY (ohm-m)
1000
100
10
0.001
0.01
0.1
1
10
TIME (ms)
DEPTH (m)
0
20
40
60
80
100
120
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

ANT4: Chain O' Lakes SP, 125' loop, 29-JUN-00
UTM X= 402530 m   UTM Y= 4700230 m   ELEVATION= 745 ft

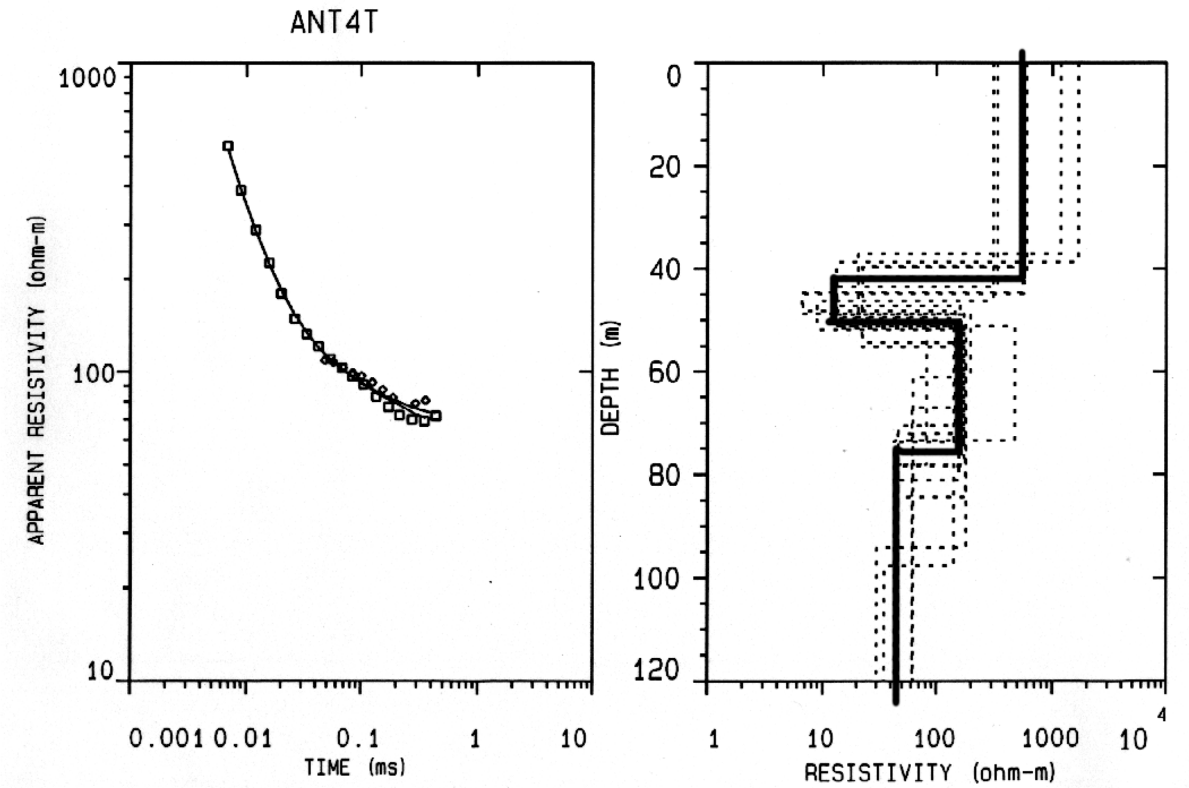
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2 LX= 38.1 m LY= 38.1 m XR= 0 m YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	539.7	539.5	539.3	537.4	539.0	0.2
2	8.95	0.00299	387.1	387.6	388.0	389.6	388.1	0.3
3	12.08	0.00348	288.6	288.3	288.0	287.3	288.0	0.2
4	15.72	0.00396	225.4	225.4	224.8	225.4	225.2	0.1
5	20.05	0.00448	178.7	178.9	178.7	178.9	178.8	0.1
6	26.17	0.00512	148.6	148.6	148.3	148.4	148.5	0.1
7	33.45	0.00578	132.1	132.3	132.2	132.4	132.2	0.1
8	42.10	0.00649	120.8	120.8	120.7	120.8	120.8	0.1
9	54.10	0.00736	110.1	109.8	109.7	110.0	109.9	0.1
10	68.20	0.00826	102.7	102.7	102.8	102.9	102.8	0.1
11	83.80	0.00915	96.41	96.61	96.41	96.41	96.46	0.1
12	104.60	0.01023	90.44	90.78	90.86	90.88	90.74	0.2
13	135.60	0.01164	82.64	82.76	82.83	83.35	82.89	0.4
14	172.30	0.01313	76.68	76.86	76.46	77.35	76.83	0.5
15	214.90	0.01466	72.78	71.63	71.63	72.62	72.16	0.9
16	275.00	0.01658	69.85	70.47	69.36	70.01	69.92	0.7
17	349.00	0.01868	69.56	67.88	69.14	69.65	69.05	1.2
18	436.00	0.02088	70.11	72.14	71.19	74.06	71.84	2.3
19	555.00	0.02356	71.56	81.60	80.22	91.29	80.42	10.0
20	701.00	0.02648	99.65	117.9	98.48	103.4	104.2	7.8

FREQ:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	108.9	108.9	108.7	109.2	108.9	0.2
2	0.0569	0.00754	107.5	107.4	107.1	107.4	107.3	0.2
3	0.0693	0.00832	102.7	103.0	103.3	102.8	102.9	0.3
4	0.0840	0.00917	99.10	98.98	99.57	99.10	99.19	0.3
5	0.1010	0.01005	97.00	96.65	96.31	96.82	96.69	0.3
6	0.1250	0.01118	91.63	92.02	91.89	93.21	92.18	0.8
7	0.1545	0.01243	87.39	85.68	87.88	88.08	87.24	1.3
8	0.1890	0.01375	82.91	81.66	80.99	83.62	82.28	1.4
9	0.2370	0.01539	77.02	78.07	80.52	73.69	77.23	3.7
10	0.2940	0.01715	77.63	76.56	78.36	82.30	78.64	3.1
11	0.3570	0.01889	78.11	83.56	80.33	80.59	80.59	2.8
12	0.4410	0.02100	87.72	86.13	80.43	84.61	84.61	3.8
13	0.5630	0.02373	95.04	93.84	121.4	87.37	97.56	13.1
14	0.7100	0.02665	136.1	126.3	108.1	154.9	128.6	15.1
15	0.8810	0.02968	249.1	190.1	135.3	627.8	1582.	>>
16	1.122	0.03350	148.5	95.21	98.80	96.97	105.4	17.9
17	1.414	0.03760	68.51	50.33	44.48	84.09	57.26	27.4
18	1.763	0.04199	36.68	94.97	170.2	32.12	49.39	57.6
19	2.240	0.04733	27.21	24.61	43.88	28.09	29.17	21.4
20	2.825	0.05315	25.21	24.60	29.81	29.81	27.08	10.4


ANT4T
APPARENT RESISTIVITY (ohm-m)
1000
100
10
0.001
0.01
0.1
1
10
TIME (ms)
DEPTH (m)
0
20
40
60
80
100
120
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

ANT5: McDonald CFP South, 250' loop, 29-JUN-00
UTM X= 416500 m   UTM Y= 4695940   m   ELEVATION= 775 ft

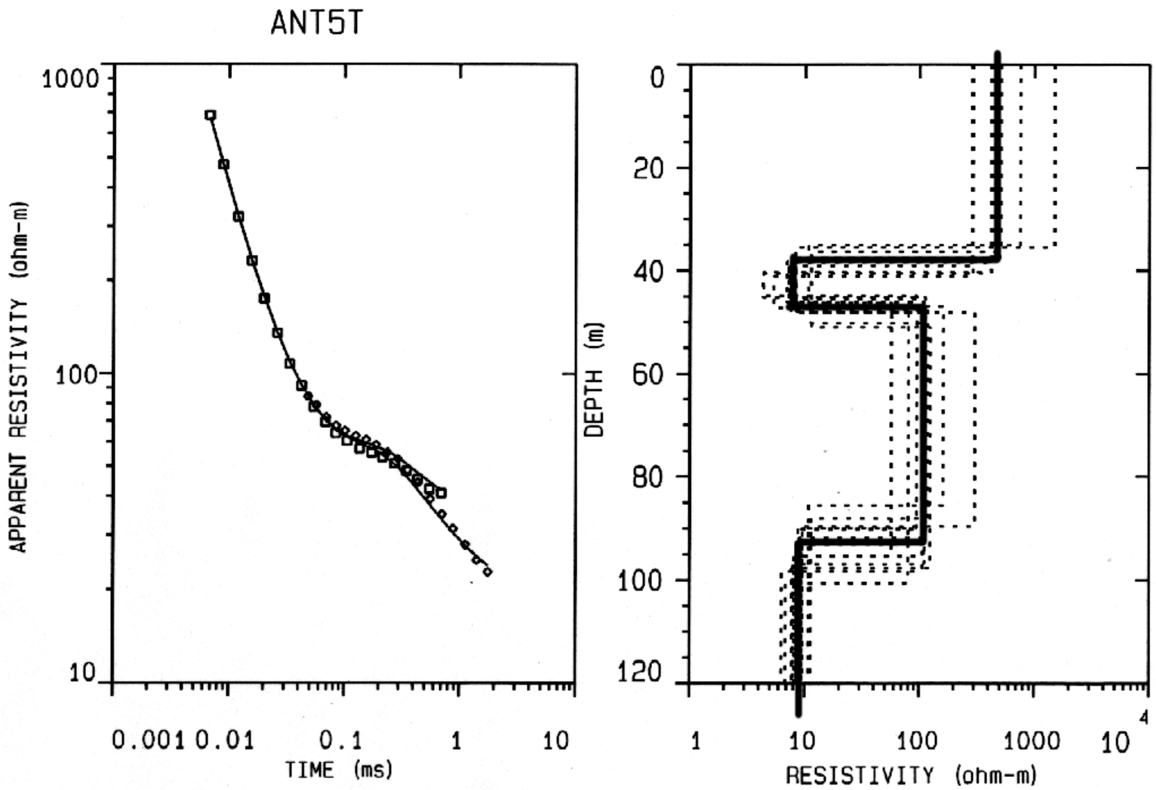
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2 LX= 76.2 m LY= 76.2 m XR= 0 m YR= 0 m

FREQ:	u	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5	5
NSTK:	8	8	8	8	8
T/O[us]:	4.40	4.40	4.40	4.40	4.40
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	683.3	685.4	686.9	686.9	688.0	686.1	0.3
2	8.95	0.00299	474.1	474.7	475.3	475.3	475.6	475.0	0.1
3	12.08	0.00348	321.1	321.5	321.7	321.4	321.6	321.4	0.1
4	15.72	0.00396	231.0	231.1	231.2	230.9	231.1	231.0	0.1
5	20.05	0.00448	175.1	175.2	175.2	175.1	175.2	175.1	0.0
6	26.17	0.00512	134.7	134.8	134.9	134.7	134.8	134.8	0.1
7	33.45	0.00578	107.2	107.3	107.4	107.2	107.3	107.3	0.1
8	42.10	0.00649	91.15	91.25	91.25	91.15	91.26	91.21	0.1
9	54.10	0.00736	77.69	77.69	77.69	77.81	77.81	77.74	0.1
10	68.20	0.00826	69.46	69.57	69.57	69.54	69.61	69.55	0.1
11	83.80	0.00915	63.81	63.88	63.88	63.91	63.93	63.88	0.1
12	104.60	0.01023	60.44	60.48	60.48	60.48	60.52	60.48	0.1
13	135.60	0.01164	57.01	57.01	57.07	57.07	57.14	57.06	0.1
14	172.30	0.01313	55.25	55.25	55.35	55.46	55.35	55.33	0.2
15	214.90	0.01466	53.39	53.39	53.40	53.57	53.57	53.47	0.2
16	275.00	0.01658	51.04	50.91	51.04	51.11	51.02	51.02	0.1
17	349.00	0.01868	48.29	48.30	48.42	48.30	48.29	48.32	0.1
18	436.00	0.02088	45.42	45.42	45.36	45.32	45.36	45.37	0.1
19	555.00	0.02356	42.22	42.07	42.22	42.19	42.19	42.18	0.1
20	701.00	0.02648	41.35	41.06	40.80	40.48	41.06	40.95	0.8

FREQ:	v	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5	5
NSTK:	8	8	8	8	8
T/O[us]:	4.40	4.40	4.40	4.40	4.40
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	84.23	84.18	84.23	84.32	84.39	84.27	0.1
2	0.0569	0.00754	78.89	78.92	78.89	78.95	79.05	78.94	0.1
3	0.0693	0.00832	72.07	72.07	72.15	72.20	72.25	72.15	0.1
4	0.0840	0.00917	67.52	67.63	67.63	67.70	67.63	67.62	0.1
5	0.1010	0.01005	65.03	65.03	65.16	65.16	65.16	65.11	0.1
6	0.1250	0.01118	62.59	62.66	62.66	62.73	62.76	62.68	0.1
7	0.1545	0.01243	60.94	60.84	61.06	60.96	61.10	60.98	0.2
8	0.1890	0.01375	58.54	58.51	58.69	58.60	58.69	58.61	0.1
9	0.2370	0.01539	55.31	55.18	55.58	55.36	55.36	55.36	0.3
10	0.2940	0.01715	52.18	53.00	53.07	52.45	53.21	52.77	0.8
11	0.3570	0.01889	48.76	48.39	48.50	48.57	48.57	48.56	0.3
12	0.4410	0.02100	44.29	44.24	43.95	44.00	44.24	44.15	0.4
13	0.5630	0.02373	38.65	39.31	39.24	39.18	39.11	39.10	0.7
14	0.7100	0.02665	35.14	34.35	34.87	35.32	35.60	35.05	1.4
15	0.8810	0.02968	30.80	31.38	31.61	31.03	32.47	31.45	2.0
16	1.122	0.03350	27.61	28.12	27.88	27.84	28.33	27.95	1.0
17	1.414	0.03760	24.97	24.24	25.41	24.71	25.24	24.91	1.9
18	1.763	0.04199	23.91	21.55	22.58	22.80	23.26	22.79	3.9
19	2.240	0.04733	19.21	18.14	18.95	19.21	21.21	19.28	5.5
20	2.825	0.05315	19.90	15.88	19.90	18.78	18.34	18.40	9.8


ANT5T
1000
100
10
APPARENT RESISTIVITY (ohm-m)
0.001
0.01
0.1
1
10
TIME (ms)
0
20
40
60
80
100
120
DEPTH (m)
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

ANT6: McDonald CFP Central, 125' loop, 29-JUN-00
UTM X= 416690 m   UTM Y= 4696630 m   ELEVATION= 750 ft

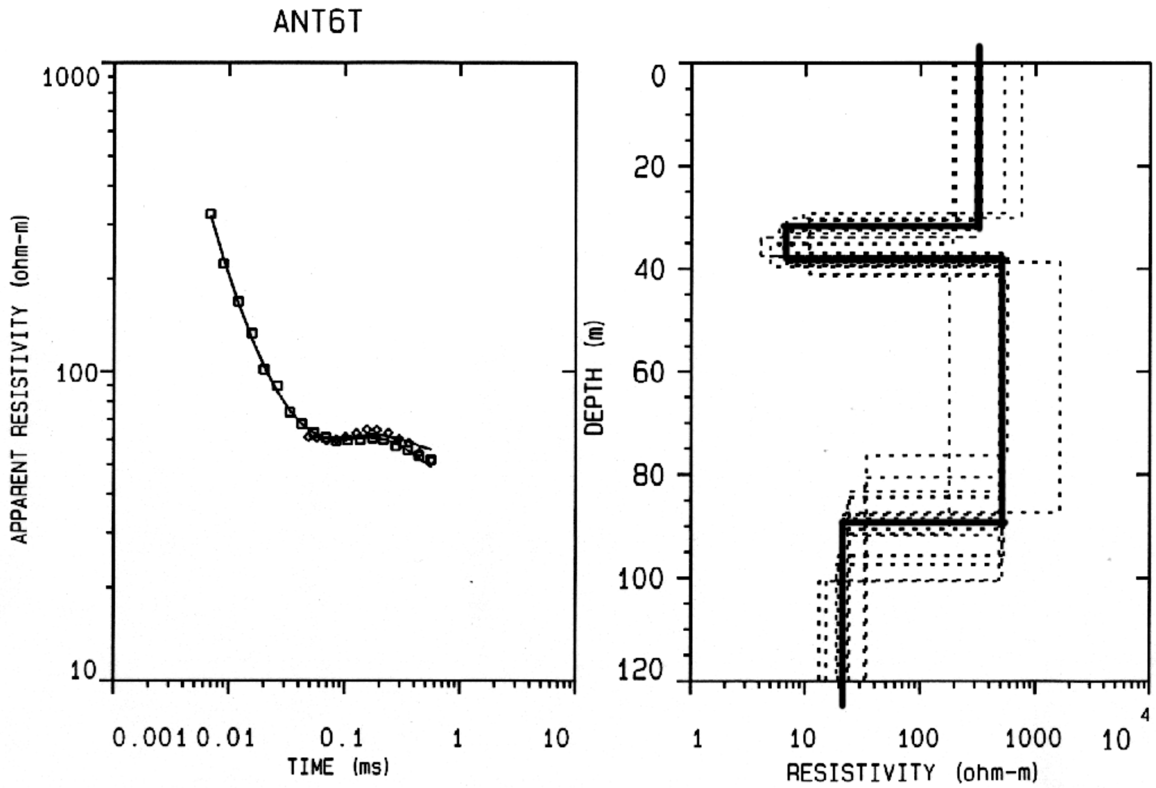
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5	5
NSTK:	8	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	329.6	325.5	323.2	320.8	320.7	323.9	1.1
2	8.95	0.00299	225.5	223.9	223.6	222.9	223.0	223.8	0.5
3	12.08	0.00348	167.6	168.1	168.3	168.7	168.8	168.3	0.3
4	15.72	0.00396	133.6	132.7	132.3	131.8	132.1	132.5	0.5
5	20.05	0.00448	103.0	101.3	101.0	100.5	100.5	101.2	1.0
6	26.17	0.00512	89.56	89.61	89.53	89.56	89.68	89.59	0.1
7	33.45	0.00578	74.84	73.88	73.64	73.29	73.35	73.79	0.8
8	42.10	0.00649	67.81	67.54	67.50	67.50	67.61	67.59	0.2
9	54.10	0.00736	63.20	63.14	63.09	63.14	63.09	63.13	0.1
10	68.20	0.00826	61.07	61.10	61.07	61.15	61.25	61.12	0.1
11	83.80	0.00915	59.57	59.46	59.41	59.29	59.33	59.41	0.2
12	104.60	0.01023	59.94	59.91	59.88	59.79	59.83	59.87	0.1
13	135.60	0.01164	60.33	59.93	59.97	60.10	60.04	60.07	0.3
14	172.30	0.01313	61.00	60.79	60.38	60.71	60.50	60.67	0.4
15	214.90	0.01466	60.34	59.85	59.65	59.99	60.20	60.00	0.5
16	275.00	0.01658	58.28	57.40	57.17	56.80	57.11	57.35	1.0
17	349.00	0.01868	57.11	54.90	54.90	54.21	56.50	55.50	2.2
18	436.00	0.02088	55.13	54.81	51.43	52.00	52.79	53.18	3.1
19	555.00	0.02356	54.10	52.98	49.47	50.42	51.53	51.63	3.6
20	701.00	0.02648	53.59	50.33	45.75	46.98	55.15	50.03	8.1

FREQ:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	61.12	61.33	61.17	61.27	61.22	0.2
2	0.0569	0.00754	60.95	60.90	61.03	60.90	60.95	0.1
3	0.0693	0.00832	59.44	59.84	59.64	59.52	59.61	0.3
4	0.0840	0.00917	59.92	59.92	60.06	60.26	60.04	0.3
5	0.1010	0.01005	61.11	61.78	61.11	60.67	61.16	0.7
6	0.1250	0.01118	62.43	62.68	63.24	63.29	62.91	0.7
7	0.1545	0.01243	64.64	64.28	64.73	64.92	64.64	0.4
8	0.1890	0.01375	64.33	65.10	64.19	64.79	64.60	0.6
9	0.2370	0.01539	62.17	63.66	63.66	62.90	63.09	1.1
10	0.2940	0.01715	60.08	60.47	60.47	60.08	60.27	0.4
11	0.3570	0.01889	56.32	58.77	59.01	59.73	58.42	2.6
12	0.4410	0.02100	55.26	55.26	55.26	52.09	54.42	3.0
13	0.5630	0.02373	52.13	50.07	52.13	51.60	51.47	1.9
14	0.7100	0.02665	51.97	46.90	51.97	39.18	46.71	14.1
15	0.8810	0.02968	50.37	47.53	47.53	42.89	46.88	6.8
16	1.122	0.03350	55.12	51.88	42.06	38.48	45.64	16.9
17	1.414	0.03760	59.51	33.37	61.47	50.33	47.44	31.7
18	1.763	0.04199	313.6	31.11	34.84	35.73	41.20	47.3
19	2.240	0.04733	--	26.80	45.33	24.61	47.75	>>
20	2.825	0.05315	48.88	15.88	33.03	24.60	28.47	78.4


ANT6T
1000
100
10
APPARENT RESISTIVITY (ohm-m)
0.001 0.01 0.1 1 10
TIME (ms)
0
20
40
60
80
100
120
DEPTH (m)
1 10 100 1000 10^4
RESISTIVITY (ohm-m)

ANT7: McDonald CFP North, 125' Tx loop, 29-JUN-00
UTM X= 416440 m   UTM Y= 4697420 m   ELEVATION= 772 ft

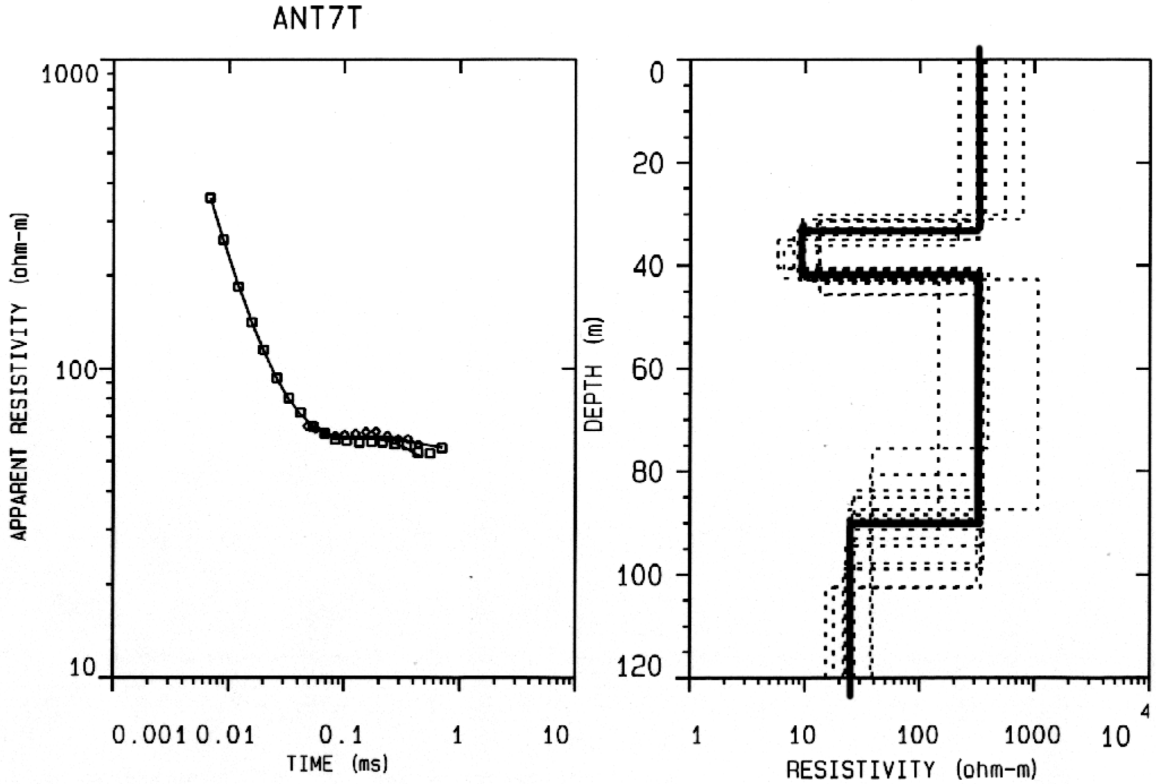
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2 LX= 38.1 m LY= 38.1 m XR= 0 m YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	356.3	357.0	358.2	357.8	357.3	0.2
2	8.95	0.00299	261.7	261.0	260.7	260.3	260.9	0.2
3	12.08	0.00348	184.2	183.6	183.3	183.2	183.6	0.3
4	15.72	0.00396	141.2	140.9	140.8	140.8	140.9	0.2
5	20.05	0.00448	115.0	114.7	114.6	114.2	114.6	0.3
6	26.17	0.00512	93.13	92.89	92.87	92.81	92.93	0.2
7	33.45	0.00578	80.07	79.89	79.78	79.64	79.84	0.2
8	42.10	0.00649	71.97	71.70	71.65	71.55	71.72	0.2
9	54.10	0.00736	64.97	64.77	64.71	64.58	64.76	0.2
10	68.20	0.00826	61.48	61.41	61.30	61.30	61.37	0.1
11	83.80	0.00915	58.94	58.86	58.85	58.86	58.88	0.1
12	104.60	0.01023	58.35	58.14	58.18	58.26	58.23	0.2
13	135.60	0.01164	57.52	57.48	57.36	57.32	57.42	0.2
14	172.30	0.01313	57.55	57.84	57.95	57.95	57.82	0.3
15	214.90	0.01466	57.74	57.55	57.55	57.43	57.57	0.2
16	275.00	0.01658	56.14	56.49	56.88	57.40	56.72	1.0
17	349.00	0.01868	55.61	55.33	57.58	56.90	56.34	1.9
18	436.00	0.02088	51.92	53.70	53.85	54.25	53.41	2.0
19	555.00	0.02356	51.79	52.31	54.24	53.81	53.01	2.2
20	701.00	0.02648	53.09	55.70	57.13	54.62	55.09	3.1

FREQ:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	64.81	64.71	64.91	64.91	64.83	0.2
2	0.0569	0.00754	63.53	63.53	63.68	63.71	63.61	0.1
3	0.0693	0.00832	61.18	61.53	61.49	61.36	61.39	0.3
4	0.0840	0.00917	60.26	59.99	60.53	60.32	60.27	0.4
5	0.1010	0.01005	60.78	60.89	61.11	60.78	60.89	0.3
6	0.1250	0.01118	61.37	61.18	61.23	61.46	61.31	0.2
7	0.1545	0.01243	62.70	61.54	61.95	62.45	62.15	0.8
8	0.1890	0.01375	62.60	62.74	62.18	61.77	62.32	0.7
9	0.2370	0.01539	62.17	57.95	60.75	60.98	60.41	3.0
10	0.2940	0.01715	56.55	60.08	60.08	58.97	58.87	2.9
11	0.3570	0.01889	61.77	56.75	58.77	59.01	59.01	3.5
12	0.4410	0.02100	54.59	59.77	56.31	55.95	56.58	3.8
13	0.5630	0.02373	62.29	52.68	54.43	56.32	56.15	7.0
14	0.7100	0.02665	64.57	42.90	47.66	56.22	51.26	17.6
15	0.8810	0.02968	71.53	48.90	40.96	--	61.02	52.6
16	1.122	0.03350	54.26	42.98	127.1	53.44	56.94	34.0
17	1.414	0.03760	27.46	43.16	--	63.61	46.91	62.9
18	1.763	0.04199	31.11	150.8	53.99	41.20	65.40	>>
19	2.240	0.04733	83.50	40.14	42.54	20.05	37.58	78.7
20	2.825	0.05315	48.88	43.28	--	24.60	65.14	>>

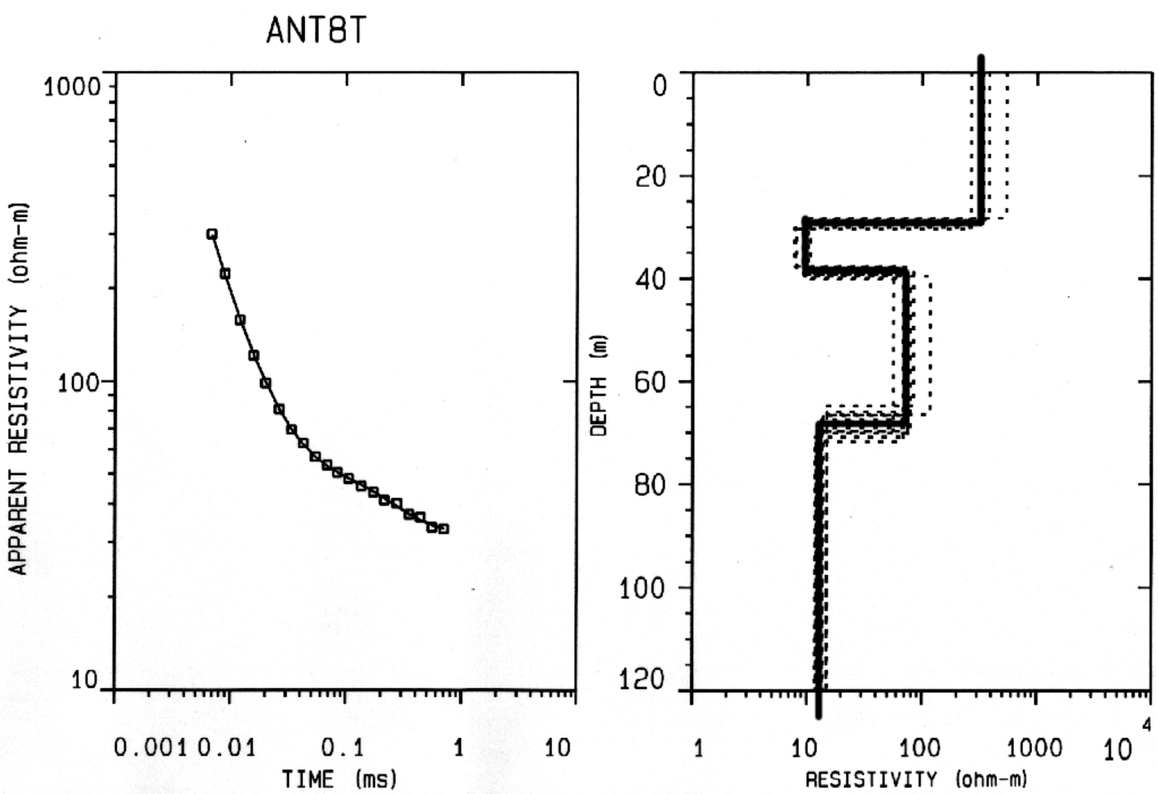

ANT7T
APPARENT RESISTIVITY (ohm-m)
1000
100
10
0.001 0.01
0.1
1
10
TIME (ms)
DEPTH (m)
0
20
40
60
80
100
120
1
10
100
1000
10
4
RESISTIVITY (ohm-m)

ANT8: Grant Woods CFP South, 125' Tx loop, 29-JUN-00
UTM X= 407770 m   UTM Y= 4694810 m   ELEVATION= 798 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2 LX= 38.1 m LY= 38.1 m XR= 0 m YR= 0 m

FREQ:	u	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5	5
NSTK:	8	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	302.1	299.5	298.8	298.9	299.2	299.7	0.4
2	8.95	0.00299	226.0	223.0	222.5	222.4	222.5	223.3	0.7
3	12.08	0.00348	159.6	158.1	157.7	157.6	158.0	158.2	0.5
4	15.72	0.00396	122.1	120.7	120.5	120.4	120.7	120.9	0.6
5	20.05	0.00448	99.63	98.41	98.33	98.25	98.33	98.59	0.6
6	26.17	0.00512	81.78	80.97	80.80	80.80	80.90	81.05	0.5
7	33.45	0.00578	70.38	69.50	69.40	69.37	69.42	69.61	0.6
8	42.10	0.00649	63.43	62.77	62.67	62.67	62.74	62.85	0.5
9	54.10	0.00736	57.55	56.79	56.74	56.74	56.74	56.91	0.6
10	68.20	0.00826	53.92	53.28	53.14	53.24	53.31	53.38	0.6
11	83.80	0.00915	50.93	50.62	50.41	50.24	50.47	50.53	0.5
12	104.60	0.01023	48.72	48.38	48.49	48.12	48.24	48.39	0.5
13	135.60	0.01164	45.90	45.61	45.99	45.09	45.44	45.60	0.8
14	172.30	0.01313	44.45	43.39	43.62	43.58	43.53	43.71	0.9
15	214.90	0.01466	41.26	41.28	41.07	41.42	40.43	41.09	1.0
16	275.00	0.01658	39.82	39.67	41.75	39.11	40.81	40.20	2.6
17	349.00	0.01868	37.36	37.66	36.95	37.92	35.48	37.05	2.7
18	436.00	0.02088	36.44	36.71	36.30	34.58	37.25	36.23	2.9
19	555.00	0.02356	35.51	34.73	32.50	32.66	32.50	33.52	4.2
20	701.00	0.02648	33.76	35.81	34.32	31.24	31.57	33.23	5.8

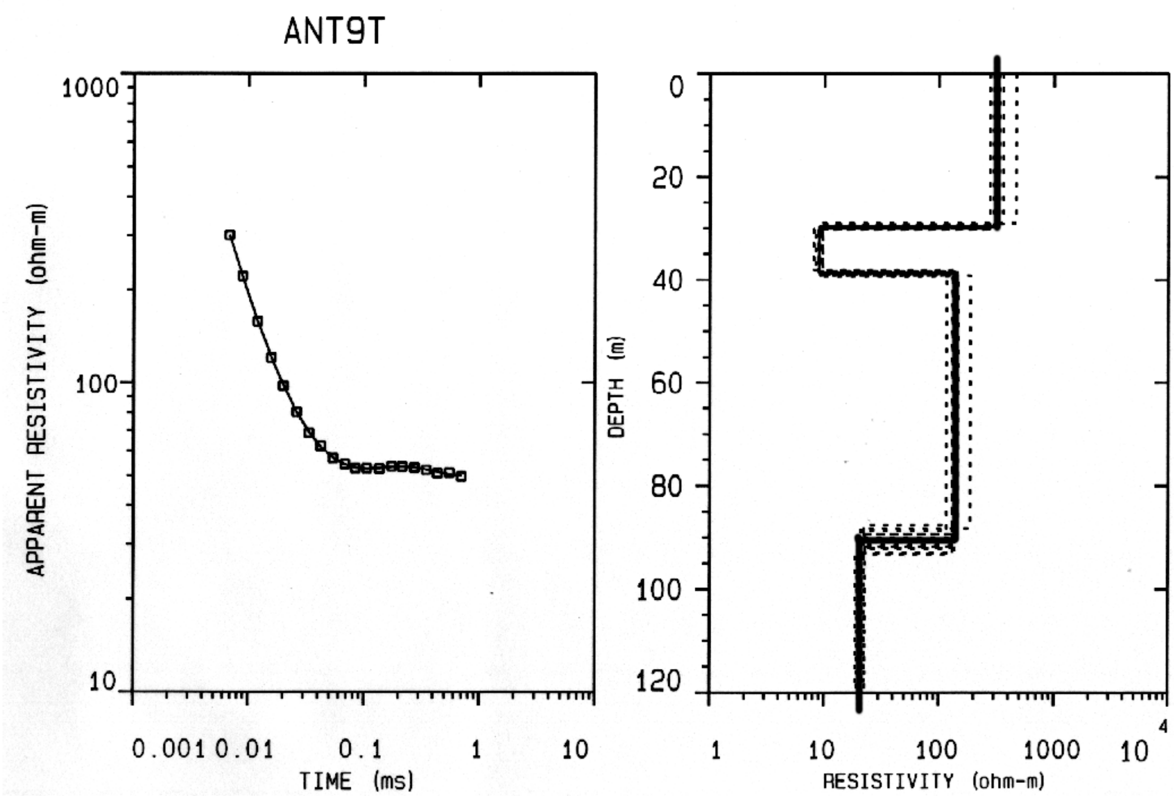


ANT9: Grant Woods CFP North, 125' loop, 29-JUN-00
UTM X= 407880 m   UTM Y= 4696180 m   ELEVATION= 782 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2 LX= 38.1 m LY= 38.1 m XR= 0 m YR= 0 m

FREQ:	u	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5	5
NSTK:	8	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	300.5	300.0	299.2	299.3	300.0	299.8	0.2
2	8.95	0.00299	222.9	221.0	220.6	220.4	220.6	221.1	0.5
3	12.08	0.00348	159.1	157.7	157.1	157.0	157.3	157.6	0.6
4	15.72	0.00396	121.3	120.0	119.7	119.8	119.9	120.1	0.5
5	20.05	0.00448	98.34	97.38	97.16	97.08	97.16	97.42	0.5
6	26.17	0.00512	80.92	80.13	79.93	79.93	80.00	80.18	0.5
7	33.45	0.00578	69.37	68.67	68.52	68.49	68.57	68.72	0.5
8	42.10	0.00649	62.84	62.22	62.13	62.06	62.13	62.27	0.5
9	54.10	0.00736	57.26	56.79	56.70	56.65	56.74	56.83	0.4
10	68.20	0.00826	54.85	54.41	54.23	54.19	54.20	54.37	0.5
11	83.80	0.00915	53.06	52.66	52.68	52.76	52.62	52.76	0.3
12	104.60	0.01023	53.26	52.66	52.55	52.61	52.73	52.76	0.5
13	135.60	0.01164	53.18	52.51	52.56	52.34	52.63	52.64	0.6
14	172.30	0.01313	53.99	53.57	53.42	53.18	53.60	53.55	0.6
15	214.90	0.01466	53.81	53.65	53.39	52.83	53.39	53.41	0.7
16	275.00	0.01658	52.97	52.69	53.02	53.04	53.50	53.04	0.5
17	349.00	0.01868	52.14	52.77	51.49	51.81	52.14	52.07	0.9
18	436.00	0.02088	52.21	50.55	50.29	51.57	50.09	50.93	1.8
19	555.00	0.02356	50.54	49.94	49.94	52.71	52.31	51.05	2.6
20	701.00	0.02648	47.72	49.28	53.59	50.77	47.72	49.70	4.8



ANT10: Kathy Stuart's horse pasture, 125' Tx loop, 30-JUN-00
UTM X= 415940 m   UTM Y= 4699750 m   ELEVATION= 772 ft

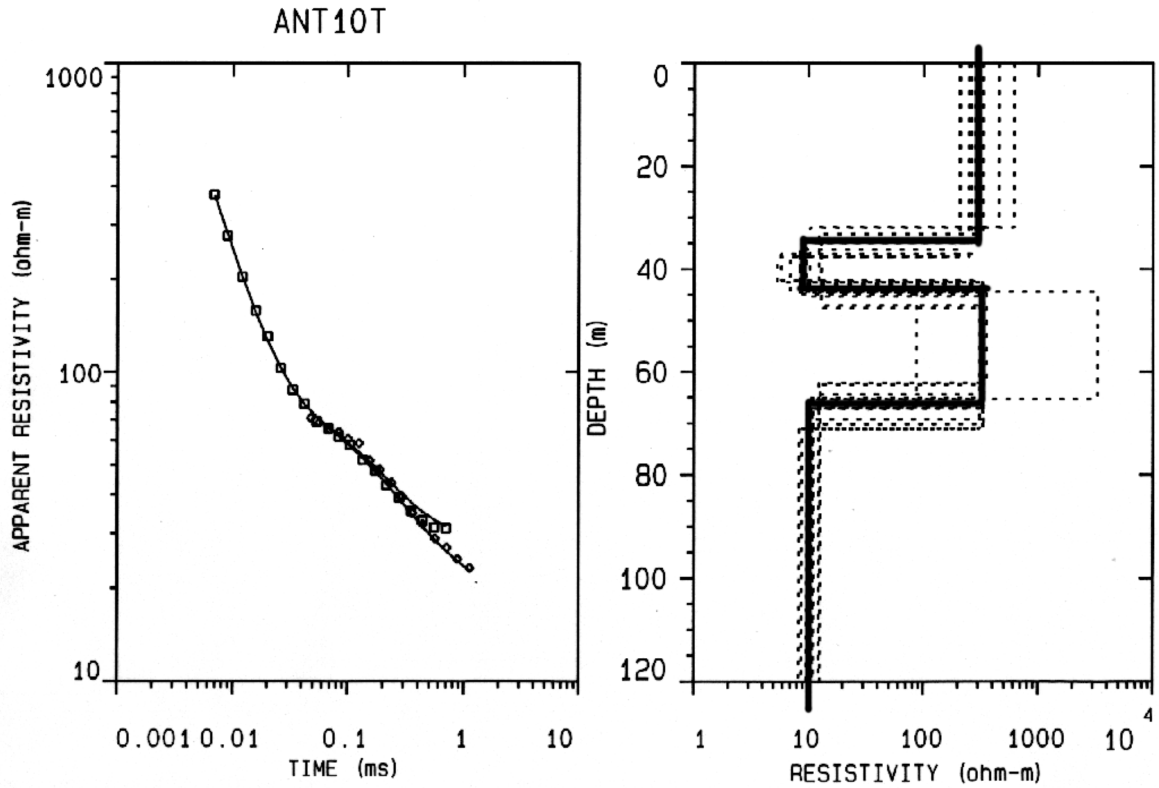
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5	5
NSTK:	8	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	373.4	374.6	375.7	377.0	377.8	375.7	0.5
2	8.95	0.00299	275.9	276.4	276.8	276.7	276.8	276.5	0.1
3	12.08	0.00348	203.1	203.4	203.5	203.7	203.7	203.5	0.1
4	15.72	0.00396	157.6	157.7	157.7	158.0	157.9	157.8	0.1
5	20.05	0.00448	130.0	130.2	130.3	130.5	130.6	130.3	0.2
6	26.17	0.00512	103.1	103.1	103.2	103.1	103.1	103.1	0.0
7	33.45	0.00578	87.60	87.60	87.65	87.65	87.65	87.63	0.0
8	42.10	0.00649	78.71	78.77	78.83	78.89	78.94	78.83	0.1
9	54.10	0.00736	69.03	69.10	69.19	69.19	69.19	69.14	0.1
10	68.20	0.00826	65.44	65.50	65.50	65.63	65.79	65.57	0.2
11	83.80	0.00915	61.35	61.58	61.61	61.57	61.68	61.56	0.2
12	104.60	0.01023	57.90	57.89	58.01	58.03	58.18	58.00	0.2
13	135.60	0.01164	51.74	51.86	51.77	51.74	51.96	51.81	0.2
14	172.30	0.01313	47.93	47.93	47.69	47.80	47.69	47.81	0.3
15	214.90	0.01466	43.00	43.00	43.16	43.00	43.00	43.03	0.2
16	275.00	0.01658	39.22	39.56	39.21	38.77	39.07	39.16	0.7
17	349.00	0.01868	35.43	35.64	35.56	35.33	35.37	35.47	0.4
18	436.00	0.02088	33.33	33.37	32.87	33.42	32.69	33.13	1.0
19	555.00	0.02356	31.46	32.15	31.31	30.85	31.50	31.45	1.5
20	701.00	0.02648	32.26	30.73	30.86	30.42	31.64	31.16	2.4

FREQ:	v	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6	6
NSTK:	8	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	70.68	70.77	70.91	70.75	70.96	70.82	0.2
2	0.0569	0.00754	68.47	68.33	68.43	68.38	68.56	68.43	0.1
3	0.0693	0.00832	65.04	65.12	65.19	65.32	65.32	65.20	0.2
4	0.0840	0.00917	63.55	63.94	63.55	63.98	63.98	63.80	0.4
5	0.1010	0.01005	60.62	61.22	60.35	60.78	60.78	60.75	0.5
6	0.1250	0.01118	59.17	59.08	58.89	58.89	57.82	58.77	0.9
7	0.1545	0.01243	51.94	51.50	52.05	51.26	51.50	51.65	0.6
8	0.1890	0.01375	48.09	47.95	48.53	47.81	48.68	48.21	0.8
9	0.2370	0.01539	43.12	44.38	42.83	44.22	44.22	43.74	1.7
10	0.2940	0.01715	39.84	39.84	39.97	38.97	38.65	39.44	1.5
11	0.3570	0.01889	34.99	35.89	34.86	33.79	35.02	34.90	2.2
12	0.4410	0.02100	31.96	31.88	32.45	32.72	31.83	32.16	1.2
13	0.5630	0.02373	29.75	28.42	29.22	28.13	29.10	28.91	2.2
14	0.7100	0.02665	25.79	26.75	26.84	27.91	28.01	27.03	3.4
15	0.8810	0.02968	23.51	24.59	26.55	24.22	25.66	24.85	4.8
16	1.122	0.03350	23.54	23.38	22.98	24.82	21.74	23.24	4.8
17	1.414	0.03760	22.23	17.88	19.10	21.83	23.52	20.64	11.7
18	1.763	0.04199	17.48	20.46	16.10	17.79	30.18	19.22	20.6
19	2.240	0.04733	14.64	18.30	14.29	13.80	18.30	15.56	13.3
20	2.825	0.05315	17.18	11.13	12.53	20.81	22.05	15.28	30.4

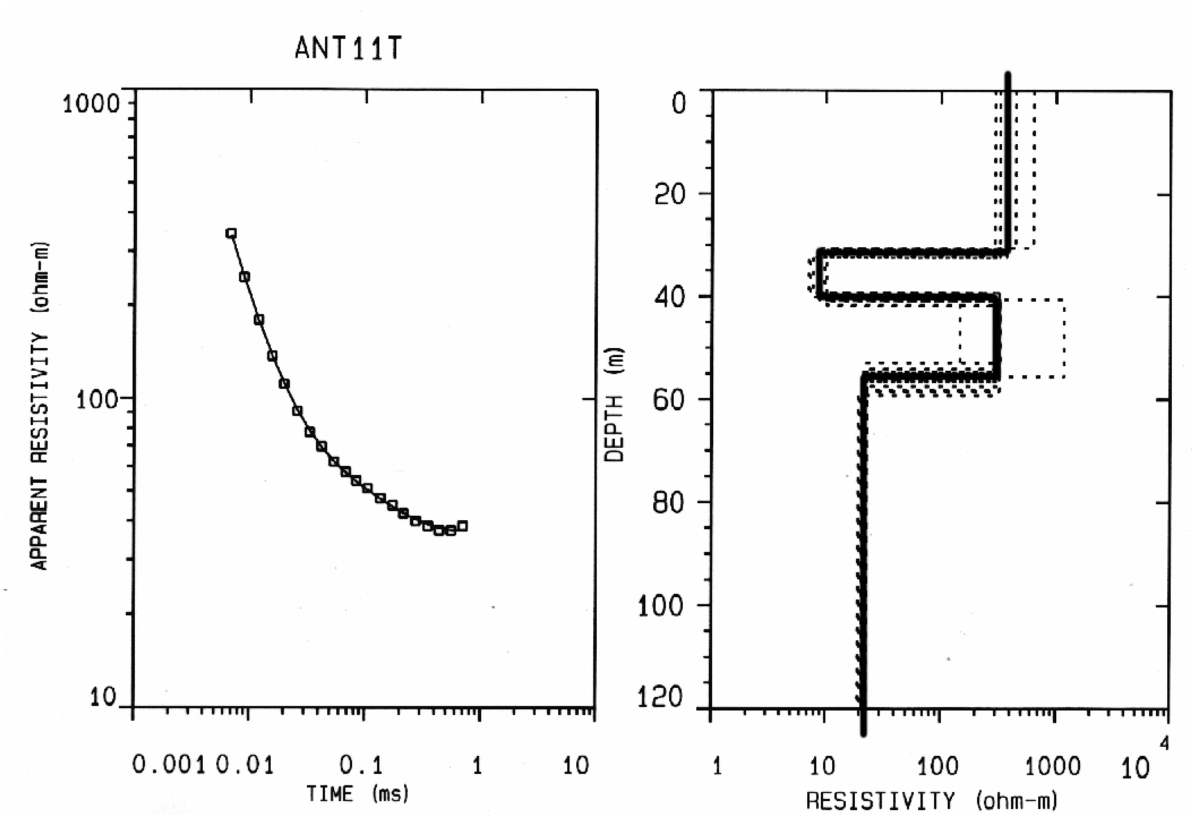

ANT10T
APPARENT RESISTIVITY (ohm-m)
1000
100
10
0.001
0.01
0.1
1
10
TIME (ms)
DEPTH (m)
0
20
40
60
80
100
120
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

ANT11: Robinson farm, 125' Tx loop, 30-JUN-00
UTM X= 416780 m   UTM Y= 4699670 m   ELEVATION= 768 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2 LX= 38.1 m LY= 38.1 m XR= 0 m YR= 0 m

FREQ:	u	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5	5
NSTK:	8	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	341.4	341.0	341.9	342.2	343.2	341.9	0.2
2	8.95	0.00299	246.3	246.2	247.2	246.5	246.8	246.6	0.2
3	12.08	0.00348	180.5	179.8	179.7	179.1	178.6	179.5	0.4
4	15.72	0.00396	137.2	136.9	137.0	136.4	136.4	136.8	0.2
5	20.05	0.00448	111.6	111.3	111.3	111.2	111.0	111.3	0.2
6	26.17	0.00512	91.31	91.06	90.98	90.68	90.55	90.91	0.3
7	33.45	0.00578	77.85	77.55	77.58	77.24	77.18	77.48	0.4
8	42.10	0.00649	69.96	69.87	69.83	69.83	69.83	69.87	0.1
9	54.10	0.00736	62.55	62.37	62.31	62.13	62.13	62.30	0.3
10	68.20	0.00826	57.88	57.81	57.81	57.58	57.63	57.74	0.2
11	83.80	0.00915	54.17	53.87	53.98	54.03	53.91	53.99	0.2
12	104.60	0.01023	51.28	51.06	51.04	50.96	50.98	51.07	0.3
13	135.60	0.01164	47.67	47.44	47.44	47.35	47.22	47.42	0.3
14	172.30	0.01313	45.14	44.89	45.14	44.85	44.89	44.98	0.3
15	214.90	0.01466	42.62	42.38	42.38	42.38	42.44	42.44	0.2
16	275.00	0.01658	40.22	39.81	40.17	40.03	39.82	40.01	0.5
17	349.00	0.01868	38.74	38.72	38.14	38.76	38.53	38.58	0.7
18	436.00	0.02088	37.63	37.69	36.95	37.66	36.86	37.35	1.1
19	555.00	0.02356	38.51	36.44	37.04	37.38	36.93	37.24	2.0
20	701.00	0.02648	39.90	38.85	37.56	37.87	39.08	38.63	2.4



APPENDIX B: OBSERVED DATA and TEM MODELS, BERRIEN SPRINGS AREA

TEM Sounding locations were recorded on 1:24,000 scale topographic maps that had 10-ft contour intervals. The UTM coordinates and elevations given below were measured from these field maps. The location given is nominally that of the small Rx loop, which in turn was located in the center of a square Tx loop either 38.1 or 76.2 m on a side. Likely uncertaintly in elevations is about half a contour interval, or 5 ft, for KLOCK, SJ-500, 600, 700, 750, 800, and 900, but thought to be as much as about 15 ft for SJ-000, 100, 1000, and 1200. Likely uncertainty in UTM coordinates is thought to be about 20 m for Klock, but is about 50 m for the SJ stations. The greater uncertainty for the SJ locations arises because they were sited relative to the graded right of way for the extension of Route US-31, which was not shown on our older topographic maps. The locations of the SJ stations relative to one another were measured by pacing, and are correct within about 5 m.

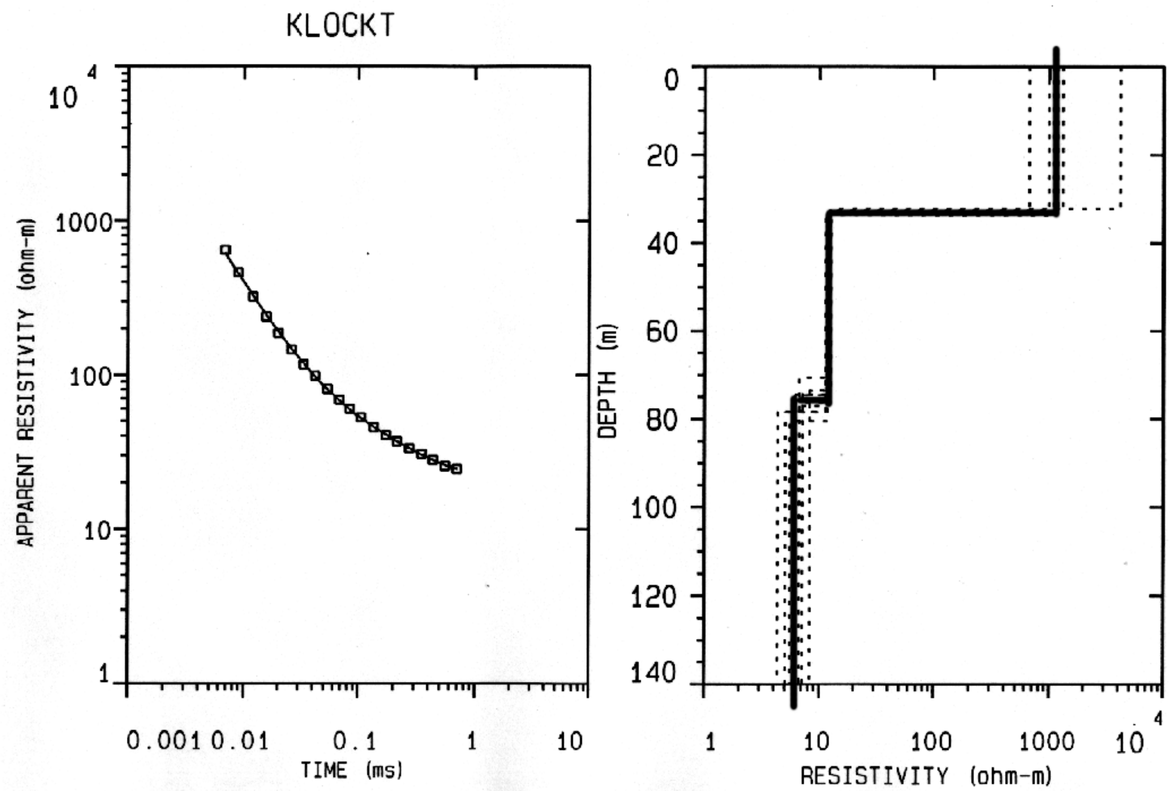
Each data set in this appendix contains a header briefly describing the TEM site, followed by a section giving tabled data for each data range (u, v, or h) that was used at that site, and concluding with a graph of the results. The data table includes for each time gate the individual apparent resistivities (rho_a, in ohm-m) that make up a series of repeated measurements, followed by the average apparent resistivity value for the series and standard error of its estimate (%std). The left panel of the graph section shows the time decay of apparent resistivity with measured averages appearing as squares (u range) or diamonds (v and h ranges). The right panel shows models of apparent resistivity versus depth; the heavy line represents the best model that was found, whereas lighter dashed lines represent a suite of equivalent models that fit the observed data almost as well. The continuous line in the left panel is calculated from the best model and shows how well it fits the observed data. All graphs are at the same scale to facilitate comparisons between them.

KLOCK: Klock Park hovercraft drillhole site, 250' TX loop, 23-JUN-00
UTM X= 543520 m UTM Y= 4663830 m Z= 582 ft

```
NTEMAVG v.3.04        us=microseconds       All resistivity values in ohm-m
INSTRUMENT: EM-47  RXA= 31.4 m^2   LX= 76.2 m   LY= 76.2 m   XR= 0 m   YR= 0 m
FREQ:          u       u       u
CUR[A]:        1.5     1.5     1.5
GAIN:          4       4       4
NSTK:          8       8       8
T/O[us]:       4.40    4.40    4.40
SHIFT[us]:     0.0     0.0     0.0
```

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	646.1	646.9	648.1	647.0	0.2
2	8.95	0.00299	459.3	460.3	460.5	460.0	0.1
3	12.08	0.00348	321.0	320.4	320.8	320.7	0.1
4	15.72	0.00396	238.1	237.6	238.0	237.9	0.1
5	20.05	0.00448	185.6	185.4	185.6	185.6	0.1
6	26.17	0.00512	145.9	145.7	145.9	145.8	0.1
7	33.45	0.00578	116.5	116.5	116.3	116.4	0.1
8	42.10	0.00649	98.44	98.26	98.40	98.37	0.1
9	54.10	0.00736	80.86	81.14	81.14	81.05	0.2
10	68.20	0.00826	68.97	68.42	68.75	68.71	0.4
11	83.80	0.00915	59.98	60.04	59.87	59.96	0.1
12	104.60	0.01023	52.70	52.74	52.84	52.76	0.1
13	135.60	0.01164	45.58	45.47	45.65	45.56	0.2
14	172.30	0.01313	40.59	40.68	40.68	40.65	0.1
15	214.90	0.01466	36.90	36.70	37.02	36.87	0.5

16	275.00	0.01658	33.40	33.16	33.27	33.28	0.4
17	349.00	0.01868	30.66	30.64	30.45	30.58	0.4
18	436.00	0.02088	27.80	27.98	28.34	28.04	1.0
19	555.00	0.02356	26.17	25.23	25.94	25.77	1.9
20	701.00	0.02648	24.41	24.55	24.69	24.55	0.6



SJ-000: US-31 transect-on graded roadbed 200m N of bridge, 125' Tx loop, 23-JUN-00
UTM X= 552180 m   UTM Y= 4648500 m Z= 660 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u
CUR[A]:	1.5	1.5	1.5
GAIN:	6	6	6
NSTK:	8	8	8
T/O[us]:	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0

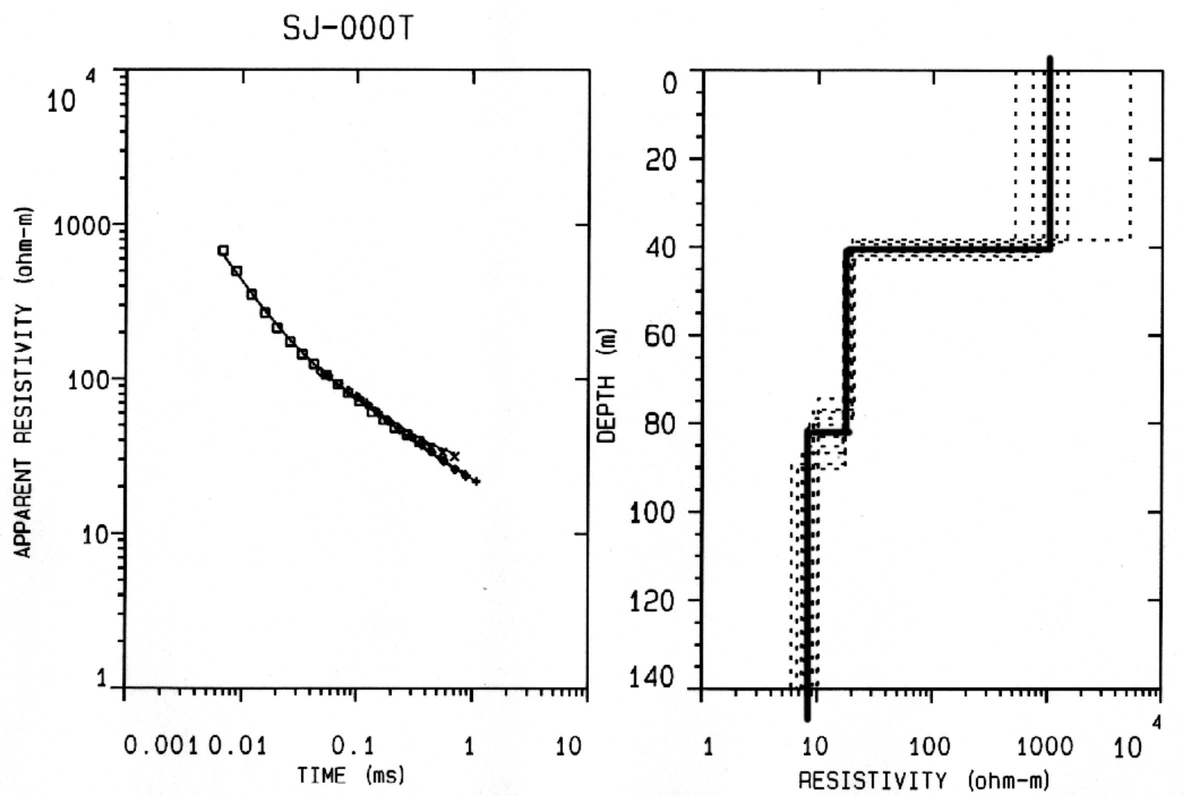
CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	679.2	678.8	678.4	678.8	0.1
2	8.95	0.00299	498.2	498.2	498.2	498.2	0.0
3	12.08	0.00348	351.1	351.4	350.8	351.1	0.1
4	15.72	0.00396	266.6	266.3	266.6	266.5	0.1
5	20.05	0.00448	213.5	213.8	213.8	213.7	0.1
6	26.17	0.00512	172.9	172.9	172.9	172.9	0.0
7	33.45	0.00578	143.3	143.3	143.4	143.3	0.1
8	42.10	0.00649	124.7	124.6	124.6	124.6	0.0
9	54.10	0.00736	105.6	105.8	105.7	105.7	0.1
10	68.20	0.00826	91.76	91.79	91.92	91.82	0.1
11	83.80	0.00915	80.89	80.70	80.93	80.84	0.2
12	104.60	0.01023	71.25	71.32	71.56	71.37	0.2
13	135.60	0.01164	61.10	61.00	61.16	61.09	0.1
14	172.30	0.01313	53.93	53.88	54.13	53.98	0.2
15	214.90	0.01466	48.19	47.87	48.39	48.15	0.5
16	275.00	0.01658	43.14	42.72	43.46	43.11	0.9
17	349.00	0.01868	39.31	38.96	39.79	39.35	1.1
18	436.00	0.02088	35.36	35.74	36.30	35.79	1.3
19	555.00	0.02356	33.55	32.75	33.46	33.25	1.3
20	701.00	0.02648	31.05	31.21	31.41	31.22	0.6

FREQ:	v	v	v
CUR[A]:	1.5	1.5	1.5
GAIN:	6	6	6
NSTK:	8	8	8
T/O[us]:	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	102.1	101.6	101.9	101.9	0.2
2	0.0569	0.00754	95.46	95.02	95.38	95.28	0.2
3	0.0693	0.00832	85.28	84.93	85.38	85.20	0.3
4	0.0840	0.00917	76.53	77.02	76.65	76.73	0.3
5	0.1010	0.01005	69.66	69.51	69.81	69.66	0.2
6	0.1250	0.01118	61.73	61.85	61.75	61.77	0.1
7	0.1545	0.01243	55.05	54.78	55.05	54.96	0.3
8	0.1890	0.01375	48.76	49.10	49.37	49.07	0.6
9	0.2370	0.01539	42.88	42.83	43.37	43.02	0.7
10	0.2940	0.01715	38.84	38.34	39.63	38.93	1.7
11	0.3570	0.01889	35.45	34.55	35.02	35.00	1.3
12	0.4410	0.02100	32.36	30.69	30.69	31.22	3.0
13	0.5630	0.02373	27.73	27.51	26.76	27.32	1.9
14	0.7100	0.02665	24.68	23.69	23.42	23.92	2.7
15	0.8810	0.02968	22.64	21.95	20.46	21.63	5.3
16	1.122	0.03350	20.29	18.67	18.50	19.11	5.0
17	1.414	0.03760	20.95	16.80	17.09	18.05	11.6
18	1.763	0.04199	18.38	15.17	16.61	16.59	9.5
19	2.240	0.04733	23.09	14.82	13.29	15.93	25.5
20	2.825	0.05315	14.03	14.03	13.75	13.94	1.2

FREQ:	h	h	h
CUR[A]:	1.5	1.5	1.5
GAIN:	6	6	6
NSTK:	8	8	8
T/O[us]:	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	avg_r	%std
1	0.1000	0.01000	76.84	77.81	76.65	77.09	0.8
2	0.1210	0.01100	68.72	71.01	69.42	69.70	1.7
3	0.1510	0.01229	60.77	61.07	60.77	60.87	0.3
4	0.1880	0.01371	53.52	54.08	52.78	53.45	1.2
5	0.2310	0.01520	47.61	48.82	47.15	47.85	1.8
6	0.2910	0.01706	42.05	44.68	41.90	42.83	3.6
7	0.3650	0.01910	37.50	37.00	36.34	36.94	1.6
8	0.4520	0.02126	32.51	33.64	34.04	33.38	2.4
9	0.5700	0.02387	28.78	30.31	27.87	28.94	4.2
10	0.7120	0.02668	25.96	24.38	27.83	25.96	6.6
11	0.8710	0.02951	24.68	22.77	24.43	23.92	4.5
12	1.080	0.03286	21.94	21.94	21.32	21.73	1.6
13	1.390	0.03728	17.12	18.95	19.82	18.54	7.6
14	1.750	0.04183	19.44	20.27	20.27	19.98	2.4
15	2.180	0.04669	25.08	11.86	34.67	18.62	56.4
16	2.780	0.05273	20.62	12.87	20.99	17.02	30.0
17	3.520	0.05933	23.78	14.16	13.44	56.31	>>
18	4.390	0.06626	19.68	8.239	12.40	14.61	>>
19	5.560	0.07457	25.10	10.31	9.348	38.17	>>
20	7.040	0.08390	6.956	4.719	8.143	9.115	>>



SJ-100: US-31 transect-on graded roadbed 100m N of bridge, 125' Tx Loop, 23-JUN-00
UTM X= 552130 m   UTM Y= 4648400 m Z= 660 ft

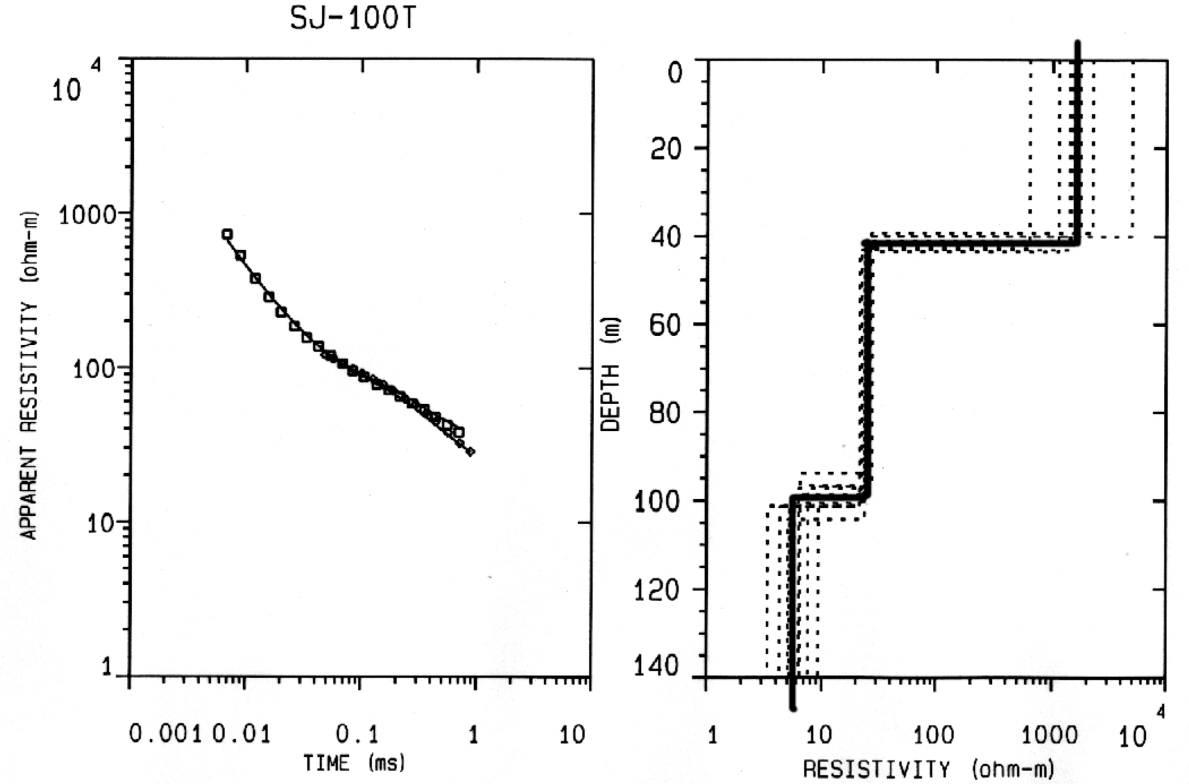
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	773.6	715.4	719.6	716.3	730.2	3.7
2	8.95	0.00299	565.6	523.4	526.0	523.1	533.8	3.7
3	12.08	0.00348	399.9	369.5	372.1	368.4	376.9	3.8
4	15.72	0.00396	303.8	280.3	281.7	280.1	286.1	3.8
5	20.05	0.00448	243.5	224.2	226.3	223.9	229.1	3.9
6	26.17	0.00512	197.6	181.8	183.3	181.2	185.7	4.0
7	33.45	0.00578	165.2	151.5	153.5	151.5	155.2	4.0
8	42.10	0.00649	146.0	133.7	135.2	132.6	136.7	4.3
9	54.10	0.00736	126.8	115.5	117.4	115.8	118.6	4.3
10	68.20	0.00826	113.1	103.6	104.5	103.3	105.9	4.2
11	83.80	0.00915	95.54	94.89	94.61	94.56	94.90	0.5
12	104.60	0.01023	87.39	86.55	86.63	86.63	86.80	0.5
13	135.60	0.01164	78.02	77.39	77.39	77.39	77.54	0.4
14	172.30	0.01313	71.44	70.77	70.95	70.95	71.03	0.4
15	214.90	0.01466	64.81	65.32	64.81	64.81	64.93	0.4
16	275.00	0.01658	58.46	58.67	58.10	58.34	58.39	0.4
17	349.00	0.01868	53.67	53.19	53.59	53.19	53.41	0.5
18	436.00	0.02088	48.12	47.15	48.00	47.89	47.79	0.9
19	555.00	0.02356	42.78	41.62	42.62	42.54	42.38	1.2
20	701.00	0.02648	38.74	36.85	37.15	39.78	38.09	3.6

FREQ:	v	v	v
CUR[A]:	1.5	1.5	1.5
GAIN:	5	5	5
NSTK:	8	8	8
T/O[us]:	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	111.1	111.0	111.1	111.1	0.1
2	0.0569	0.00754	105.4	105.4	105.3	105.3	0.1
3	0.0693	0.00832	96.65	96.65	96.78	96.69	0.1
4	0.0840	0.00917	89.30	89.66	89.66	89.54	0.2
5	0.1010	0.01005	83.89	84.14	84.14	84.06	0.2
6	0.1250	0.01118	76.83	76.59	77.68	77.03	0.7
7	0.1545	0.01243	72.10	70.57	70.35	71.00	1.3
8	0.1890	0.01375	65.10	64.64	65.25	64.99	0.5
9	0.2370	0.01539	59.20	56.00	57.95	57.68	2.8
10	0.2940	0.01715	53.49	51.32	54.07	52.93	2.8
11	0.3570	0.01889	45.77	46.54	45.89	46.06	0.9
12	0.4410	0.02100	39.60	42.35	41.00	40.94	3.3
13	0.5630	0.02373	33.19	35.27	36.12	34.80	4.4
14	0.7100	0.02665	29.08	30.02	30.27	29.78	2.1
15	0.8810	0.02968	26.39	26.10	26.39	26.29	0.7
16	1.122	0.03350	20.89	22.23	24.70	22.47	8.3
17	1.414	0.03760	19.38	19.27	18.51	19.04	2.5
18	1.763	0.04199	17.18	19.20	17.63	17.95	5.7
19	2.240	0.04733	14.37	15.71	16.88	15.57	8.1
20	2.825	0.05315	11.30	17.18	13.36	13.44	20.2



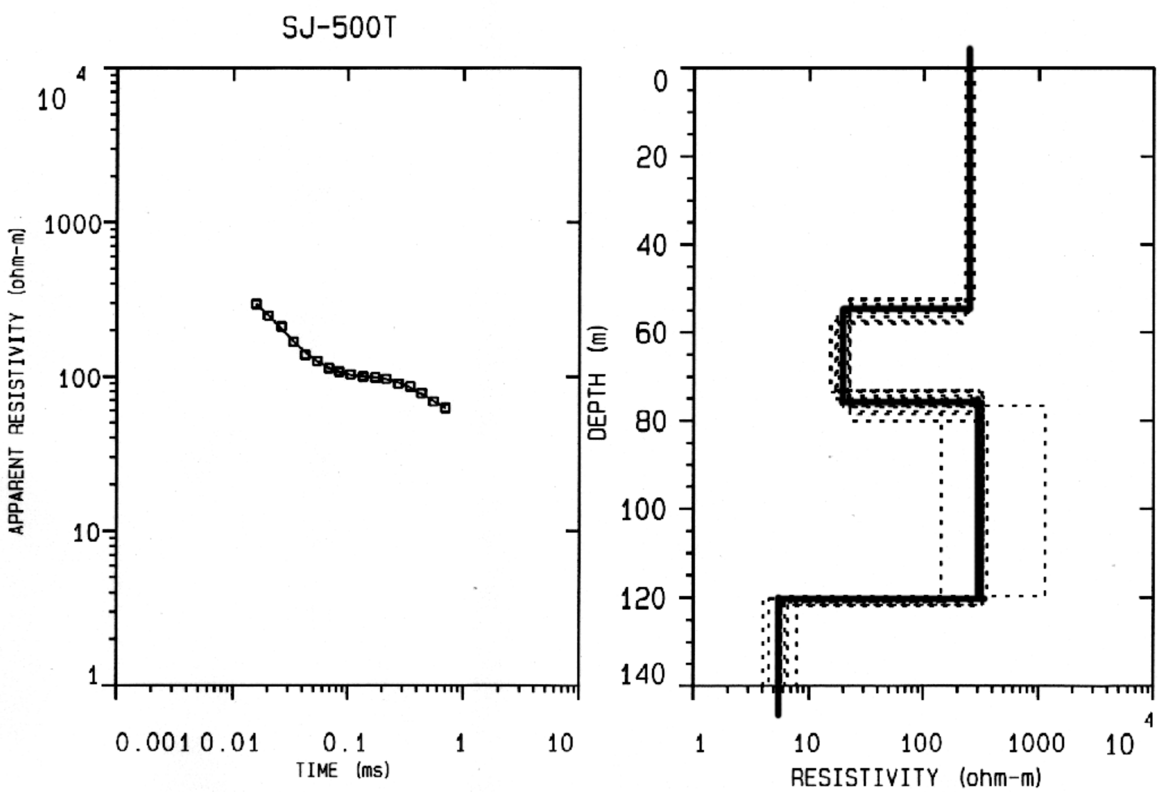
SJ-100T
APPARENT RESISTIVITY (ohm-m)
10^4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
DEPTH (m)
0
20
40
60
80
100
120
140
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

SJ-500: US-31 transect-cornfield SE of bridge, 125' Tx Loop, 23-JUN-00
UTM X= 552110 m   UTM Y= 4647960 m   Z= 603 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47   RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	965.9	942.1	971.9	995.2	968.3	2.3
2	8.95	0.00299	445.9	452.9	449.6	451.8	450.0	0.7
3	12.08	0.00348	419.3	420.6	423.6	421.7	421.3	0.4
4	15.72	0.00396	268.0	272.0	271.4	271.8	270.8	0.7
5	20.05	0.00448	232.0	227.4	227.8	226.8	228.5	1.0
6	26.17	0.00512	193.2	193.9	194.2	193.3	193.7	0.2
7	33.45	0.00578	155.4	153.7	154.2	153.5	154.2	0.6
8	42.10	0.00649	126.8	127.4	127.5	127.2	127.2	0.3
9	54.10	0.00736	114.2	115.9	116.2	115.7	115.5	0.8
10	68.20	0.00826	101.4	105.8	105.3	106.0	104.6	2.1
11	83.80	0.00915	98.66	99.03	98.92	98.96	98.89	0.2
12	104.60	0.01023	95.39	94.74	94.56	95.32	95.00	0.4
13	135.60	0.01164	91.43	91.30	91.81	91.49	91.50	0.2
14	172.30	0.01313	91.18	90.96	89.41	89.73	90.31	1.0
15	214.90	0.01466	88.22	90.09	88.77	86.79	88.45	1.5
16	275.00	0.01658	81.12	82.80	84.58	80.71	82.27	2.1
17	349.00	0.01868	76.29	78.49	79.66	81.99	79.04	3.0
18	436.00	0.02088	69.08	74.84	74.32	68.94	71.66	4.5
19	555.00	0.02356	58.02	68.03	62.12	65.59	63.15	7.0
20	701.00	0.02648	46.27	60.29	64.72	63.53	57.35	17.1



SJ-600: US-31 transect-cornfield 100m S of SJ-500, 125' Tx Loop, 23-JUN-00, Something wrong in Channels 1 & 2 for u range
UTM X= 552100 m   UTM Y= 4647850 m Z= 598 ft

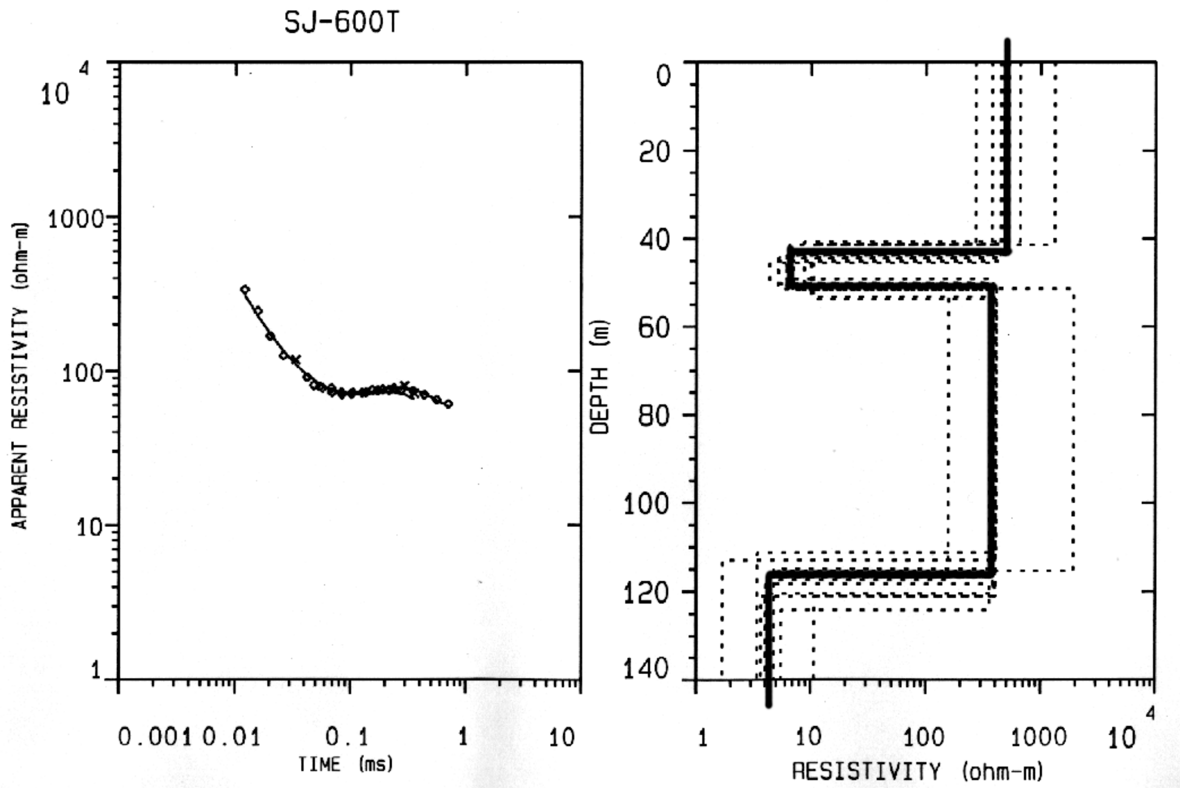
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5	1.5	1.5
GAIN:	6	6	6	5	5	5
NSTK:	8	8	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	297.1	309.4	384.4	1977.	1751.	1637.	545.0	87.3
2	8.95	0.00299	565.3	530.8	471.6	356.8	360.9	362.3	421.6	20.0
3	12.08	0.00348	345.9	338.2	324.5	342.3	334.8	331.5	336.0	2.3
4	15.72	0.00396	245.4	244.1	242.3	246.9	245.0	244.6	244.7	0.6
5	20.05	0.00448	171.9	171.0	169.6	165.5	165.8	165.5	168.2	1.8
6	26.17	0.00512	124.8	125.3	126.6	124.8	125.7	126.2	125.6	0.6
7	33.45	0.00578	119.3	118.4	116.4	117.9	116.5	115.9	117.4	1.1
8	42.10	0.00649	91.22	91.30	91.27	90.93	91.10	91.10	91.15	0.1
9	54.10	0.00736	78.45	78.82	79.19	78.25	78.66	78.76	78.68	0.4
10	68.20	0.00826	77.46	77.86	77.76	76.10	76.64	76.81	77.10	0.9
11	83.80	0.00915	72.69	72.76	72.28	71.84	72.02	72.02	72.27	0.5
12	104.60	0.01023	72.47	72.22	72.22	71.77	71.97	71.59	72.04	0.5
13	135.60	0.01164	72.94	72.48	72.25	72.00	72.53	72.18	72.39	0.5
14	172.30	0.01313	75.02	75.02	75.02	74.71	75.06	73.83	74.78	0.7
15	214.90	0.01466	74.82	77.34	74.82	74.29	76.24	75.62	75.51	1.5
16	275.00	0.01658	74.51	74.24	76.78	74.99	73.99	75.21	74.94	1.3
17	349.00	0.01868	77.48	72.73	74.43	72.68	72.87	73.06	73.83	2.4
18	436.00	0.02088	70.49	68.23	70.19	71.50	70.72	67.81	69.79	2.1
19	555.00	0.02356	66.42	69.20	64.91	64.23	61.72	62.94	64.79	4.0
20	701.00	0.02648	60.97	59.95	56.98	62.77	62.77	62.40	60.89	3.9

FREQ:	v	v	v
CUR[A]:	1.5	1.5	1.5
GAIN:	5	5	5
NSTK:	8	8	8
T/O[us]:	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	76.75	76.94	77.37	77.02	0.4
2	0.0569	0.00754	73.77	73.77	74.19	73.91	0.3
3	0.0693	0.00832	69.51	69.10	69.57	69.39	0.4
4	0.0840	0.00917	67.61	67.25	67.70	67.52	0.3
5	0.1010	0.01005	67.88	67.32	68.17	67.79	0.6
6	0.1250	0.01118	69.12	69.05	68.93	69.03	0.1
7	0.1545	0.01243	72.95	71.74	71.98	72.22	0.9
8	0.1890	0.01375	72.31	75.05	70.18	72.45	3.3
9	0.2370	0.01539	74.25	74.25	73.14	73.87	0.9
10	0.2940	0.01715	81.06	72.63	76.56	76.56	5.5
11	0.3570	0.01889	67.39	71.67	66.42	68.40	4.0
12	0.4410	0.02100	61.49	75.97	66.94	67.50	10.4
13	0.5630	0.02373	52.68	53.83	59.87	55.25	6.7
14	0.7100	0.02665	76.91	45.47	72.17	60.50	31.0
15	0.8810	0.02968	47.53	36.96	55.54	45.06	21.0
16	1.122	0.03350	49.74	40.78	50.42	46.43	12.4
17	1.414	0.03760	34.78	32.10	26.67	30.70	14.0
18	1.763	0.04199	44.04	32.48	45.66	39.54	19.9
19	2.240	0.04733	83.50	101.1	19.66	47.46	>>
20	2.825	0.05315	30.79	18.78	48.88	90.03	>>



SJ-600T
APPARENT RESISTIVITY (ohm-m)
TIME (ms)
DEPTH (m)
RESISTIVITY (ohm-m)

SJ-700: US-31 transect-cornfield 100 m S of -600, 125' TX Loop, 23-JUN-00
UTM X= 552070 m   UTM Y= 4647740 m Z= 602 ft

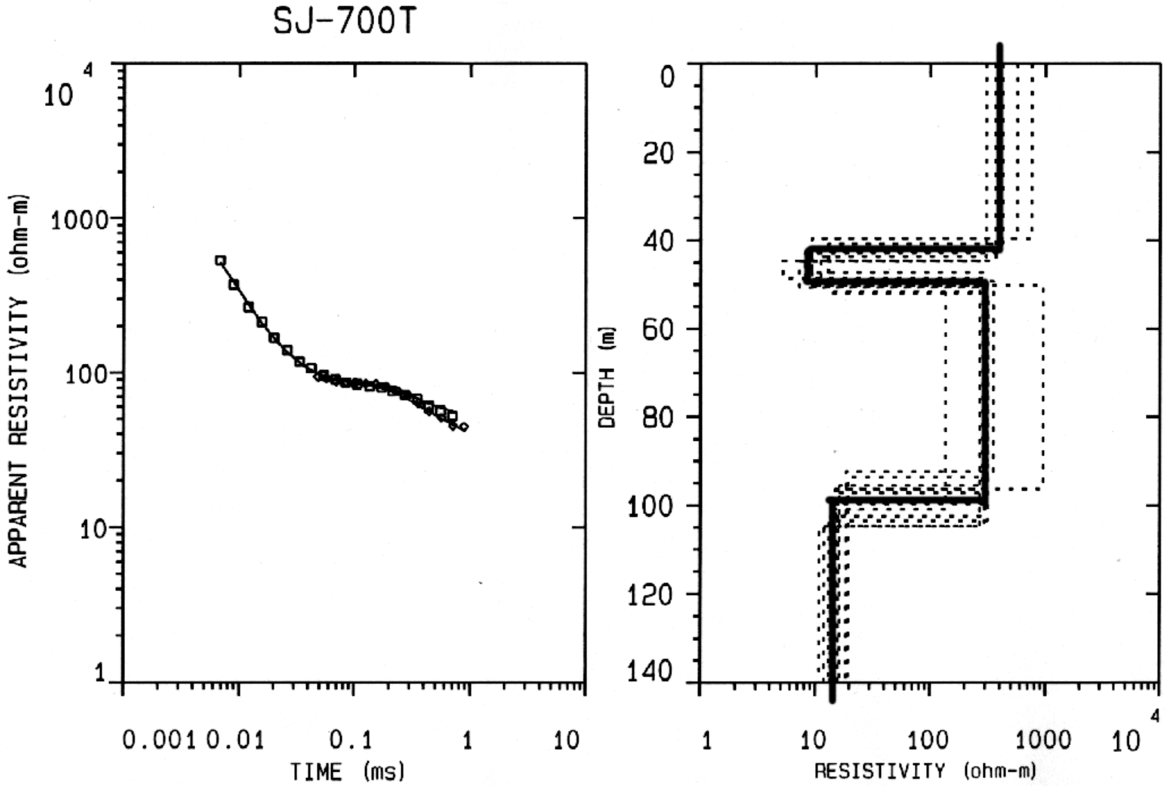
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	24.1
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	511.6	508.0	506.8	506.0	508.1	0.5
2	8.95	0.00299	358.2	355.6	355.3	354.7	355.9	0.4
3	12.08	0.00348	254.5	254.5	254.2	254.7	254.5	0.1
4	15.72	0.00396	204.5	203.7	203.4	203.4	203.7	0.3
5	20.05	0.00448	161.5	160.4	160.1	160.4	160.6	0.4
6	26.17	0.00512	133.8	133.3	133.3	133.3	133.4	0.2
7	33.45	0.00578	112.8	112.6	112.7	112.9	112.7	0.1
8	42.10	0.00649	102.4	102.1	102.1	102.2	102.2	0.1
9	54.10	0.00736	92.20	91.87	92.03	91.87	91.99	0.2
10	68.20	0.00826	86.43	86.43	86.43	86.43	86.43	0.0
11	83.80	0.00915	82.49	82.29	82.37	82.26	82.35	0.1
12	104.60	0.01023	79.97	80.54	80.78	80.62	80.48	0.4
13	135.60	0.01164	77.60	78.02	77.81	77.81	77.81	0.2
14	172.30	0.01313	75.62	76.57	76.57	76.79	76.38	0.7
15	214.90	0.01466	71.57	72.45	73.35	73.12	72.62	1.1
16	275.00	0.01658	67.25	69.75	69.01	68.79	68.68	1.5
17	349.00	0.01868	62.80	65.20	64.63	65.71	64.56	2.0
18	436.00	0.02088	55.97	59.19	59.09	58.70	58.20	2.7
19	555.00	0.02356	51.15	55.43	54.24	55.59	54.03	3.9
20	701.00	0.02648	47.16	52.37	50.12	50.33	49.91	4.4

FREQ:	v	v	v
CUR[A]:	1.5	1.5	1.5
GAIN:	5	5	5
NSTK:	8	8	8
T/O[us]:	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	94.58	94.22	92.80	93.86	1.0
2	0.0569	0.00754	92.42	92.20	90.83	91.81	0.9
3	0.0693	0.00832	88.76	88.21	86.95	87.96	1.1
4	0.0840	0.00917	86.71	86.88	85.08	86.21	1.2
5	0.1010	0.01005	86.42	86.16	84.63	85.73	1.1
6	0.1250	0.01118	84.72	84.72	83.27	84.23	1.0
7	0.1545	0.01243	84.41	84.41	83.01	83.93	1.0
8	0.1890	0.01375	83.33	81.93	78.55	81.21	3.1
9	0.2370	0.01539	75.41	74.63	77.44	75.80	1.9
10	0.2940	0.01715	72.03	72.03	69.17	71.04	2.4
11	0.3570	0.01889	64.28	64.28	61.24	63.22	2.8
12	0.4410	0.02100	57.41	55.60	55.26	56.07	2.0
13	0.5630	0.02373	51.60	48.65	53.25	51.08	4.6
14	0.7100	0.02665	49.27	42.90	43.51	45.01	7.4
15	0.8810	0.02968	43.94	42.89	47.53	44.68	5.3
16	1.122	0.03350	36.80	49.07	36.17	39.72	15.7
17	1.414	0.03760	42.33	50.33	63.61	50.33	19.8
18	1.763	0.04199	51.56	107.2	34.01	49.39	48.1
19	2.240	0.04733	21.32	36.22	40.14	29.55	36.6
20	2.825	0.05315	43.28	142.9	68.71	64.05	50.3


SJ-700T
APPARENT RESISTIVITY (ohm-m)
TIME (ms)
DEPTH (m)
RESISTIVITY (ohm-m)

SJ-750: US-31 transect-cornfield 50m SE of -700, 250' Tx Loop, 24-JUN-00
UTM X= 552090 m   UTM Y= 4647690 m Z= 602 ft

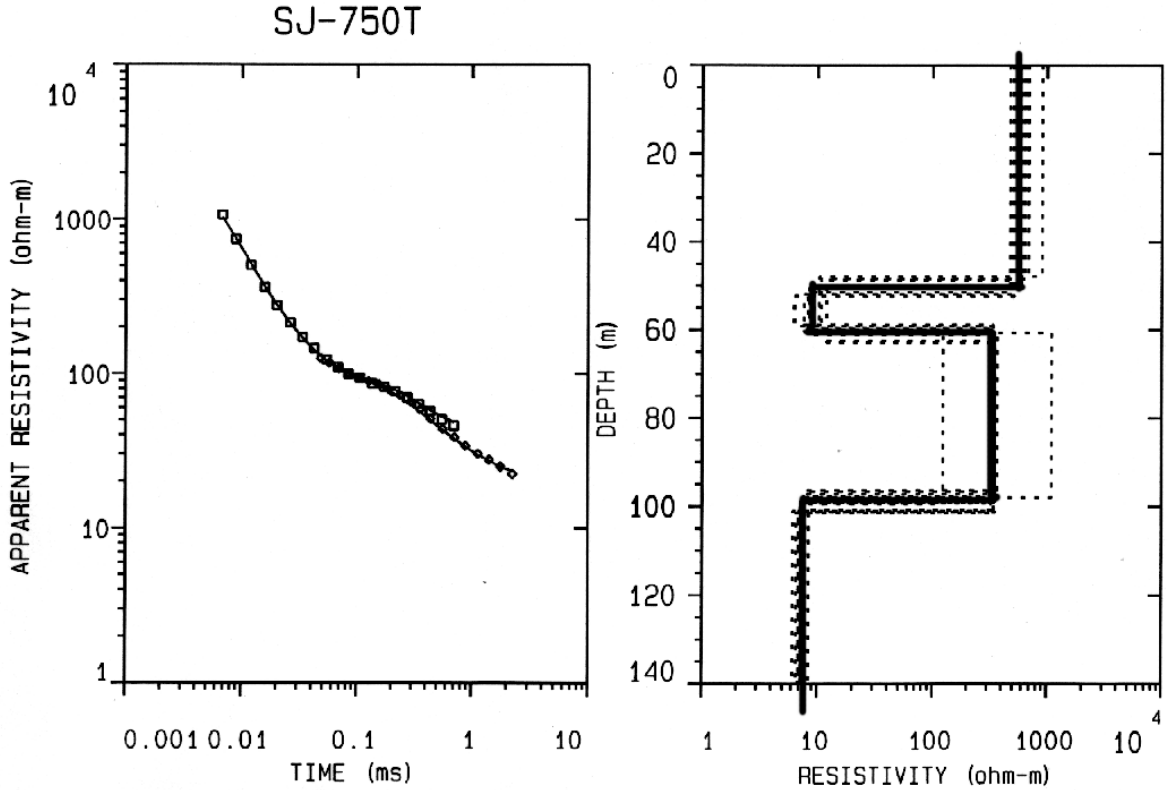
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 76.2 m   LY= 76.2 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	4.40	4.40	4.40	4.40
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	1065.	1069.	1068.	1068.	1067.	0.2
2	8.95	0.00299	741.7	741.7	741.5	742.2	741.8	0.0
3	12.08	0.00348	503.0	502.5	502.1	502.6	502.5	0.1
4	15.72	0.00396	363.4	362.8	362.6	363.0	363.0	0.1
5	20.05	0.00448	277.4	277.0	276.7	277.0	277.0	0.1
6	26.17	0.00512	214.0	213.7	213.7	213.8	213.8	0.1
7	33.45	0.00578	171.1	170.8	170.5	170.6	170.8	0.1
8	42.10	0.00649	145.4	145.0	145.0	145.2	145.2	0.1
9	54.10	0.00736	123.3	123.1	123.1	123.1	123.2	0.1
10	68.20	0.00826	109.4	109.3	109.2	109.4	109.3	0.1
11	83.80	0.00915	99.45	99.26	99.11	99.26	99.27	0.1
12	104.60	0.01023	93.07	92.85	92.80	92.85	92.89	0.1
13	135.60	0.01164	86.15	86.06	86.15	85.97	86.08	0.1
14	172.30	0.01313	81.67	81.52	81.38	81.38	81.48	0.2
15	214.90	0.01466	76.45	76.45	76.24	76.66	76.45	0.2
16	275.00	0.01658	69.69	69.75	69.67	69.43	69.64	0.2
17	349.00	0.01868	63.22	63.26	63.05	63.20	63.18	0.1
18	436.00	0.02088	56.46	56.66	56.89	56.35	56.59	0.4
19	555.00	0.02356	49.98	50.25	50.49	49.55	50.07	0.8
20	701.00	0.02648	46.18	46.01	46.16	45.09	45.85	1.1

FREQ:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	4.40	4.40	4.40	4.40
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	115.8	115.6	115.7	115.7	115.7	0.0
2	0.0569	0.00754	108.1	108.0	108.1	108.2	108.1	0.1
3	0.0693	0.00832	98.11	98.11	98.00	98.11	98.08	0.1
4	0.0840	0.00917	91.33	91.26	91.38	91.19	91.29	0.1
5	0.1010	0.01005	86.65	86.65	86.75	86.65	86.67	0.1
6	0.1250	0.01118	82.03	82.09	82.17	82.13	82.11	0.1
7	0.1545	0.01243	78.27	78.10	78.05	77.90	78.08	0.2
8	0.1890	0.01375	72.72	72.84	72.77	72.90	72.81	0.1
9	0.2370	0.01539	66.12	66.12	66.34	66.44	66.26	0.2
10	0.2940	0.01715	59.80	60.32	60.52	60.37	60.25	0.5
11	0.3570	0.01889	53.55	53.34	53.79	53.39	53.52	0.4
12	0.4410	0.02100	46.70	46.90	46.62	46.43	46.66	0.4
13	0.5630	0.02373	40.49	39.85	40.03	40.31	40.17	0.7
14	0.7100	0.02665	35.19	35.05	36.22	35.19	35.40	1.5
15	0.8810	0.02968	31.55	31.26	31.03	30.80	31.16	1.0
16	1.122	0.03350	28.35	27.80	27.72	27.28	27.78	1.6
17	1.414	0.03760	25.53	25.41	25.41	24.89	25.31	1.1
18	1.763	0.04199	22.95	23.74	23.22	21.98	22.95	3.3
19	2.240	0.04733	21.21	19.34	21.67	19.95	20.49	5.3
20	2.825	0.05315	24.32	19.16	20.16	18.70	20.32	11.0


SJ-750T
APPARENT RESISTIVITY (ohm-m)
10^4
1000
100
10
1
0.001
0.01
0.1
1
10
TIME (ms)
DEPTH (m)
0
20
40
60
80
100
120
140
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

SJ-800: US-31 transect-cornfield 100m SE of -700, 125' Tx Loop, 24-JUN-00
UTM X= 552040 m   UTM Y= 4647640 m Z= 603 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	494.8	495.2	497.1	499.0	496.5	0.4
2	8.95	0.00299	356.4	355.6	355.6	355.8	355.8	0.1
3	12.08	0.00348	249.7	249.0	248.1	248.3	248.8	0.3
4	15.72	0.00396	187.5	186.6	186.6	186.6	186.9	0.2
5	20.05	0.00448	148.3	147.9	147.4	147.7	147.8	0.3
6	26.17	0.00512	117.9	117.6	117.4	117.3	117.5	0.2
7	33.45	0.00578	96.09	95.69	95.63	95.63	95.76	0.2
8	42.10	0.00649	83.09	82.96	82.83	82.83	82.93	0.2
9	54.10	0.00736	70.99	70.74	70.67	70.74	70.79	0.2
10	68.20	0.00826	62.91	62.64	62.56	62.69	62.70	0.2
11	83.80	0.00915	56.89	56.70	57.03	56.78	56.85	0.3
12	104.60	0.01023	52.48	52.35	52.11	52.35	52.32	0.3
13	135.60	0.01164	47.89	47.60	47.73	47.67	47.72	0.3
14	172.30	0.01313	44.79	44.95	44.68	44.64	44.76	0.3
15	214.90	0.01466	42.21	41.92	42.06	41.92	42.03	0.3
16	275.00	0.01658	39.73	39.49	39.43	39.56	39.55	0.3
17	349.00	0.01868	36.78	37.45	36.66	37.25	37.03	1.0
18	436.00	0.02088	34.50	34.48	35.13	34.42	34.63	0.9
19	555.00	0.02356	31.50	32.03	32.11	32.18	31.95	1.0
20	701.00	0.02648	29.59	29.77	27.80	29.71	29.19	3.4

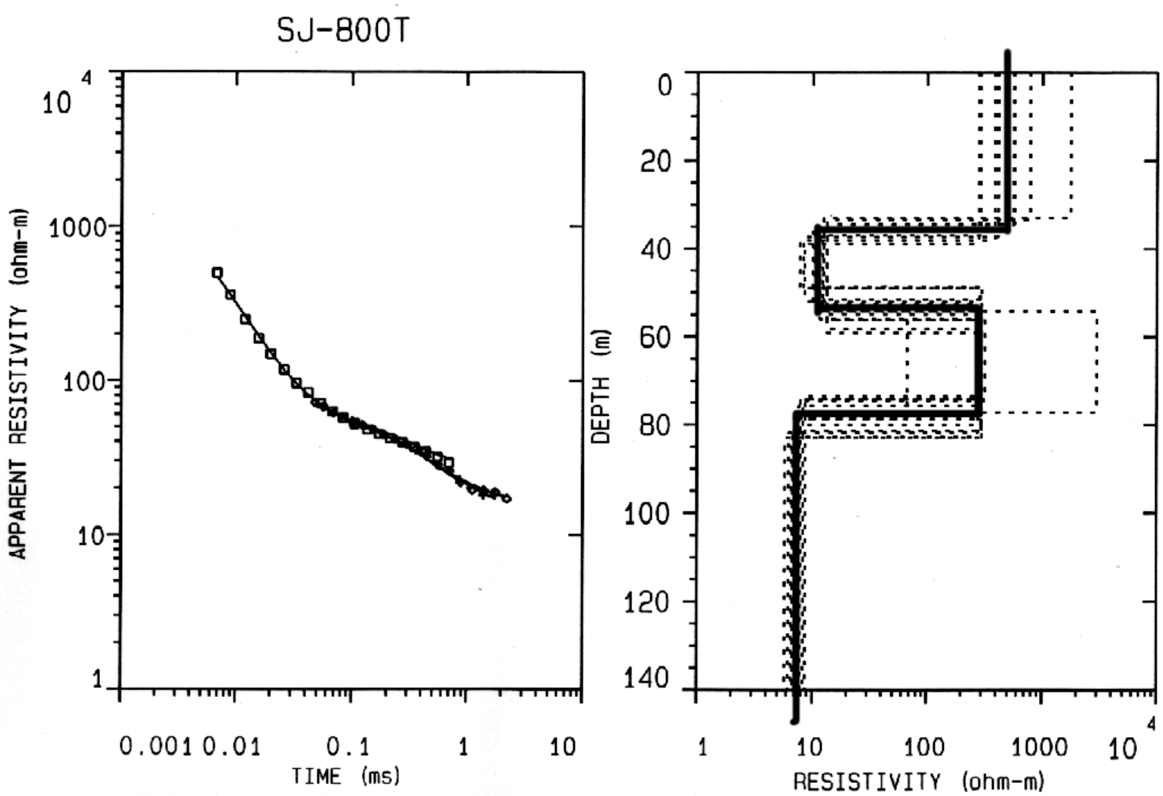
FREQ:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	69.62	72.38	72.56	72.45	71.72	2.0
2	0.0569	0.00754	65.52	68.21	68.14	68.24	67.50	2.0
3	0.0693	0.00832	59.64	62.06	62.02	62.15	61.44	2.0
4	0.0840	0.00917	55.10	57.53	57.53	57.53	56.90	2.2
5	0.1010	0.01005	51.95	54.19	54.61	54.19	53.71	2.3
6	0.1250	0.01118	48.85	50.59	51.21	50.97	50.39	2.2
7	0.1545	0.01243	45.76	48.51	47.55	48.33	47.51	2.7
8	0.1890	0.01375	43.02	44.93	44.39	44.81	44.27	2.0
9	0.2370	0.01539	39.63	41.99	41.72	41.99	41.30	2.9
10	0.2940	0.01715	37.61	39.50	38.46	38.34	38.46	2.0
11	0.3570	0.01889	34.52	36.02	35.82	35.95	35.57	2.0
12	0.4410	0.02100	32.18	33.10	31.58	33.29	32.52	2.5
13	0.5630	0.02373	27.40	28.30	29.29	28.54	28.36	2.8
14	0.7100	0.02665	24.83	27.22	25.30	25.46	25.66	3.9
15	0.8810	0.02968	22.24	22.85	21.30	21.13	21.85	3.7
16	1.122	0.03350	17.90	20.74	20.15	19.09	19.39	6.6
17	1.414	0.03760	19.85	19.27	18.51	19.73	19.32	3.2
18	1.763	0.04199	19.01	21.17	16.89	18.46	18.73	9.2
19	2.240	0.04733	15.93	17.41	17.14	17.70	17.01	4.8
20	2.825	0.05315	17.18	15.88	24.60	13.11	16.61	23.9

FREQ:	h	h	h	h
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std

1	0.1000	0.01000	54.29	54.61	54.45	54.77	54.53	0.4
2	0.1210	0.01100	52.12	51.66	51.66	51.66	51.77	0.4
3	0.1510	0.01229	48.41	48.41	48.58	48.58	48.49	0.2
4	0.1880	0.01371	45.21	44.49	44.72	44.72	44.78	0.7
5	0.2310	0.01520	42.72	42.37	41.03	42.03	42.03	1.8
6	0.2910	0.01706	39.64	39.00	40.18	39.13	39.48	1.4
7	0.3650	0.01910	35.61	33.79	35.61	35.26	35.05	2.6
8	0.4520	0.02126	33.00	32.51	30.93	31.36	31.93	3.0
9	0.5700	0.02387	30.31	27.73	26.89	28.32	28.24	5.0
10	0.7120	0.02668	27.58	25.34	25.75	26.18	26.18	3.6
11	0.8710	0.02951	22.87	23.08	22.87	21.71	22.61	2.8
12	1.080	0.03286	19.96	21.03	20.48	18.80	20.02	4.9
13	1.390	0.03728	18.74	16.66	18.74	17.98	17.98	5.7
14	1.750	0.04183	17.10	19.84	20.72	15.58	18.01	13.3
15	2.180	0.04669	18.82	12.72	17.66	14.36	15.41	18.3
16	2.780	0.05273	14.27	10.82	40.12	11.60	14.06	37.9
17	3.520	0.05933	47.62	12.62	10.74	12.25	13.91	38.5
18	4.390	0.06626	13.86	12.40	7.262	8.731	9.713	29.7
19	5.560	0.07457	18.35	15.81	46.24	4.321	9.493	>>
20	7.040	0.08390	12.38	15.00	9.449	5.371	11.04	>>



SJ-900: US-31 transect-cornfield 100m S of -800, 125' Tx Loop, 24-JUN-00
UTM X= 552000 m   UTM Y= 4647540 m Z= 602 ft

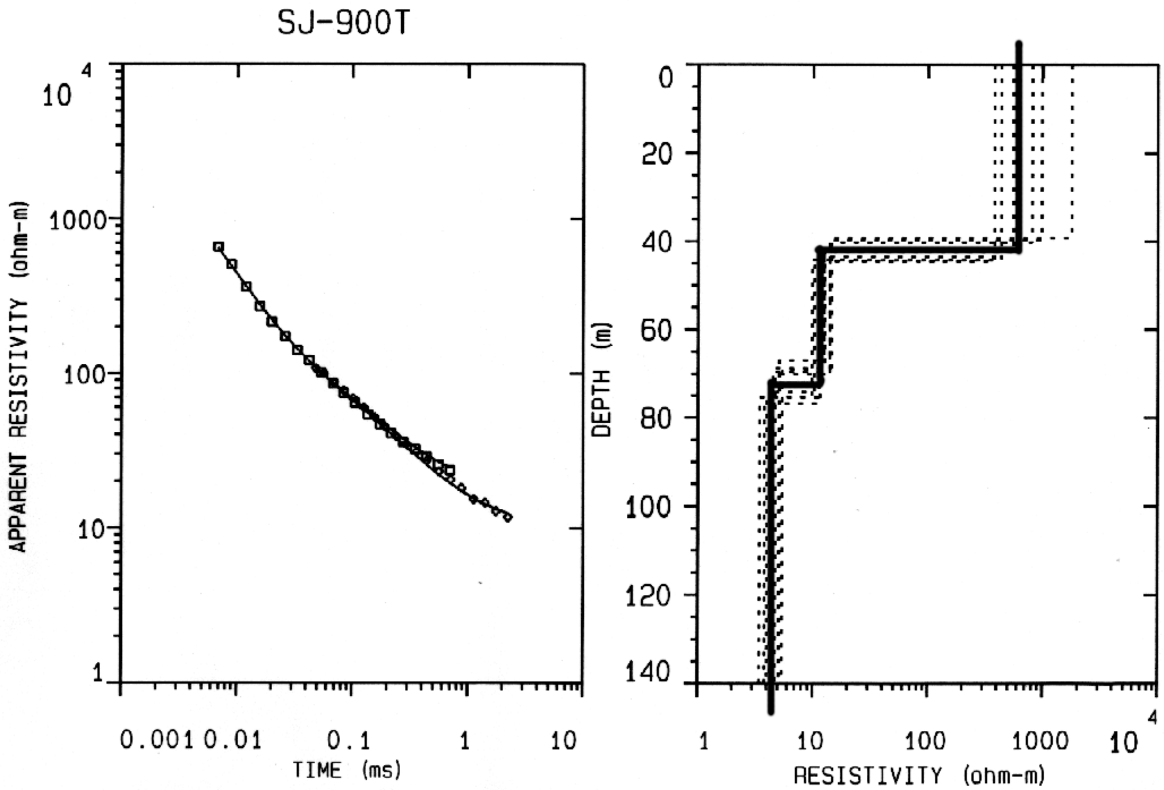
NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	658.3	655.4	652.2	649.4	653.8	0.6
2	8.95	0.00299	508.5	507.7	507.5	506.9	507.6	0.1
3	12.08	0.00348	362.7	362.3	362.1	362.0	362.3	0.1
4	15.72	0.00396	271.5	271.2	270.9	270.7	271.1	0.1
5	20.05	0.00448	216.0	215.6	215.3	215.0	215.5	0.2
6	26.17	0.00512	173.9	173.9	173.6	173.6	173.8	0.1
7	33.45	0.00578	141.2	141.2	140.9	140.9	141.1	0.1
8	42.10	0.00649	121.4	121.2	121.4	121.2	121.3	0.1
9	54.10	0.00736	101.5	101.3	101.1	101.3	101.3	0.2
10	68.20	0.00826	86.31	86.24	86.17	86.00	86.18	0.2
11	83.80	0.00915	74.57	74.39	74.48	74.26	74.43	0.2
12	104.60	0.01023	64.39	64.32	64.10	64.28	64.27	0.2
13	135.60	0.01164	53.91	54.01	53.84	53.79	53.89	0.2
14	172.30	0.01313	46.66	46.55	46.49	46.44	46.53	0.2
15	214.90	0.01466	40.98	40.98	40.90	40.69	40.89	0.3
16	275.00	0.01658	35.83	35.85	35.73	35.76	35.79	0.2
17	349.00	0.01868	32.18	32.23	32.19	32.56	32.29	0.6
18	436.00	0.02088	28.89	28.76	28.77	28.81	28.81	0.2
19	555.00	0.02356	25.60	25.36	25.85	25.94	25.68	1.0
20	701.00	0.02648	23.76	23.50	23.40	23.63	23.57	0.7

FREQ:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	107.8	107.4	107.7	107.6	107.6	0.2
2	0.0569	0.00754	99.37	99.37	99.37	99.10	99.30	0.1
3	0.0693	0.00832	87.26	87.68	87.47	87.26	87.42	0.2
4	0.0840	0.00917	77.08	77.71	77.33	77.33	77.36	0.3
5	0.1010	0.01005	68.61	68.90	68.90	68.76	68.79	0.2
6	0.1250	0.01118	59.72	59.81	59.90	59.98	59.85	0.2
7	0.1545	0.01243	52.29	52.18	52.18	52.08	52.18	0.2
8	0.1890	0.01375	45.62	45.30	45.49	45.37	45.44	0.3
9	0.2370	0.01539	39.63	38.93	39.16	39.24	39.24	0.7
10	0.2940	0.01715	35.02	34.53	34.72	34.53	34.70	0.7
11	0.3570	0.01889	30.72	31.00	30.86	30.81	30.84	0.4
12	0.4410	0.02100	27.18	27.18	27.18	26.96	27.13	0.4
13	0.5630	0.02373	22.96	23.17	23.10	23.39	23.15	0.8
14	0.7100	0.02665	20.25	20.53	20.72	20.34	20.46	1.0
15	0.8810	0.02968	18.36	18.00	17.88	18.12	18.09	1.1
16	1.122	0.03350	15.27	15.38	15.13	15.41	15.30	0.8
17	1.414	0.03760	14.31	14.59	13.75	15.37	14.48	4.6
18	1.763	0.04199	13.04	12.35	12.75	13.11	12.80	2.7
19	2.240	0.04733	12.51	11.73	10.97	11.73	11.70	5.4
20	2.825	0.05315	9.882	12.87	11.64	9.764	10.86	13.0



SJ-900T
APPARENT RESISTIVITY (ohm-m)
10^4
1000
100
10
1
0.001 0.01
0.1
1
10
TIME (ms)
DEPTH (m)
0
20
40
60
80
100
120
140
1
10
100
1000
10^4
RESISTIVITY (ohm-m)

SJ-1000: US-31 transect-on graded roadbed ~100m S of -900 projection onto road, 125' TX Loop, 24-JUN-00
UTM X= 551890 m   UTM Y= 4647400 m Z= 652 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	596.7	600.4	606.5	610.3	603.4	1.0
2	8.95	0.00299	611.5	612.6	621.2	625.3	617.6	1.1
3	12.08	0.00348	389.9	378.9	375.3	371.4	378.7	2.1
4	15.72	0.00396	272.4	272.1	274.5	276.4	273.9	0.7
5	20.05	0.00448	224.5	219.6	218.1	217.2	219.8	1.4
6	26.17	0.00512	165.4	163.1	163.2	163.3	163.7	0.7
7	33.45	0.00578	129.3	127.3	127.4	127.5	127.9	0.7
8	42.10	0.00649	105.6	104.1	103.9	103.7	104.3	0.8
9	54.10	0.00736	84.43	83.08	82.97	83.08	83.39	0.8
10	68.20	0.00826	68.64	67.52	67.54	67.51	67.80	0.8
11	83.80	0.00915	56.62	56.47	56.62	56.58	56.57	0.1
12	104.60	0.01023	47.61	47.57	47.40	47.48	47.52	0.2
13	135.60	0.01164	38.78	38.73	38.63	38.68	38.70	0.2
14	172.30	0.01313	32.69	32.69	32.69	32.63	32.68	0.1
15	214.90	0.01466	28.08	28.15	28.08	28.15	28.12	0.2
16	275.00	0.01658	24.26	24.20	24.17	24.22	24.21	0.2
17	349.00	0.01868	21.33	21.26	21.21	21.28	21.27	0.2
18	436.00	0.02088	19.07	19.13	19.04	18.95	19.05	0.4
19	555.00	0.02356	17.00	17.04	17.08	17.04	17.04	0.2
20	701.00	0.02648	15.97	15.90	15.94	16.02	15.96	0.3

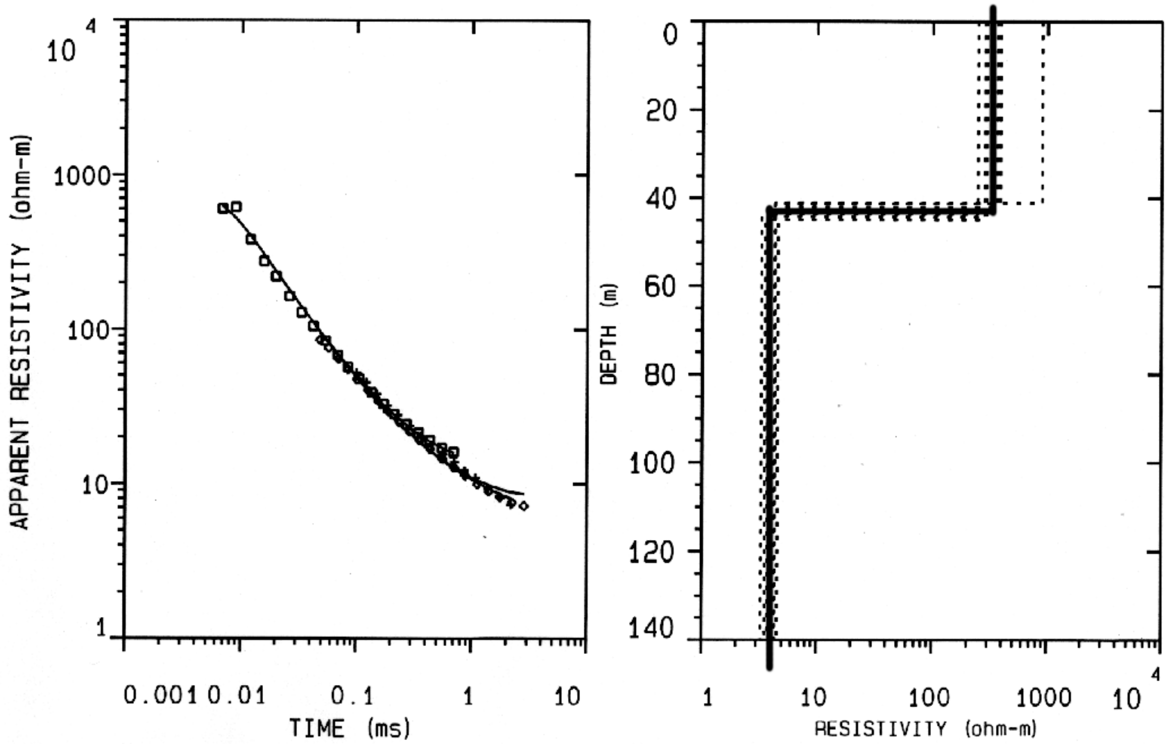
FREQ:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	84.59	85.16	85.06	85.06	84.97	0.3
2	0.0569	0.00754	75.05	75.76	75.38	75.63	75.46	0.4
3	0.0693	0.00832	63.48	64.06	63.67	63.98	63.80	0.4
4	0.0840	0.00917	54.31	54.52	54.68	54.68	54.55	0.3
5	0.1010	0.01005	46.86	47.46	46.91	47.14	47.09	0.6
6	0.1250	0.01118	39.88	40.08	40.21	40.13	40.07	0.4
7	0.1545	0.01243	33.96	34.14	34.20	34.25	34.14	0.4
8	0.1890	0.01375	29.06	29.32	29.25	29.24	29.22	0.4
9	0.2370	0.01539	24.66	25.03	24.69	24.89	24.82	0.7
10	0.2940	0.01715	21.57	21.62	21.53	21.60	21.58	0.2
11	0.3570	0.01889	18.92	19.10	18.96	19.10	19.02	0.5
12	0.4410	0.02100	16.58	16.75	16.75	16.76	16.71	0.5
13	0.5630	0.02373	14.25	14.63	14.36	14.47	14.43	1.1
14	0.7100	0.02665	12.57	12.66	12.67	12.80	12.68	0.7
15	0.8810	0.02968	11.28	11.34	11.43	11.30	11.34	0.6
16	1.122	0.03350	9.739	10.06	9.774	10.37	9.977	2.9
17	1.414	0.03760	8.726	8.844	8.984	9.199	8.934	2.3
18	1.763	0.04199	8.330	7.850	8.189	8.318	8.166	2.8
19	2.240	0.04733	7.453	6.966	7.995	7.804	7.528	6.2
20	2.825	0.05315	6.634	7.634	7.090	7.451	7.176	6.3

FREQ:	h	h	h	h
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.1000	0.01000	52.05	51.91	52.05	52.27	52.07	0.3
2	0.1210	0.01100	44.85	45.14	45.30	45.14	45.11	0.4
3	0.1510	0.01229	37.73	38.05	38.10	38.05	37.98	0.4
4	0.1880	0.01371	31.95	31.80	32.06	31.85	31.91	0.4
5	0.2310	0.01520	27.67	27.73	27.79	27.85	27.76	0.3
6	0.2910	0.01706	23.53	23.66	23.51	23.59	23.57	0.3
7	0.3650	0.01910	20.49	20.18	20.21	20.51	20.35	0.9
8	0.4520	0.02126	17.76	17.84	17.84	17.94	17.84	0.4
9	0.5700	0.02387	15.54	15.58	15.28	15.64	15.51	1.1
10	0.7120	0.02668	13.59	13.93	13.89	13.71	13.78	1.2
11	0.8710	0.02951	12.48	11.89	12.20	12.20	12.19	2.0
12	1.080	0.03286	11.36	10.57	10.81	11.06	10.94	3.1
13	1.390	0.03728	10.00	8.585	9.313	9.605	9.340	6.6
14	1.750	0.04183	8.557	7.794	8.131	8.557	8.244	4.6
15	2.180	0.04669	7.288	7.532	7.288	7.288	7.347	1.6
16	2.780	0.05273	6.906	6.883	7.477	7.973	7.276	6.9
17	3.520	0.05933	5.804	5.545	5.697	7.606	6.043	13.1
18	4.390	0.06626	5.018	5.719	5.018	6.230	5.439	10.3
19	5.560	0.07457	4.202	5.408	4.449	6.173	4.913	17.1
20	7.040	0.08390	3.555	5.643	5.953	7.211	5.130	33.5

SJ-1000T



SJ-1200: US-31 transect-on graded roadbed 200m S of -1000, 125' Loop, 24-JUN-00
UTM X= 551880 m   UTM Y= 4647200 m Z= 650 ft

NTEMAVG v.3.04   us=microseconds   All resistivity values in ohm-m
INSTRUMENT: EM-47 RXA= 31.4 m^2   LX= 38.1 m   LY= 38.1 m   XR= 0 m   YR= 0 m

FREQ:	h	h	h	h
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.1000	0.01000	47.10	46.50	46.88	46.63	46.78	0.6
2	0.1210	0.01100	40.32	40.32	40.44	40.56	40.41	0.3
3	0.1510	0.01229	34.40	34.69	34.22	34.40	34.43	0.6
4	0.1880	0.01371	28.91	29.16	28.91	29.07	29.01	0.4
5	0.2310	0.01520	25.45	25.65	25.60	25.35	25.51	0.5
6	0.2910	0.01706	22.14	21.65	21.74	21.80	21.83	1.0
7	0.3650	0.01910	19.07	18.99	18.92	19.29	19.07	0.8
8	0.4520	0.02126	16.63	16.37	16.37	16.65	16.50	1.0
9	0.5700	0.02387	14.32	14.46	14.60	14.34	14.43	0.9
10	0.7120	0.02668	12.99	12.48	12.80	12.87	12.78	1.7
11	0.8710	0.02951	11.46	11.15	11.79	11.89	11.56	2.9
12	1.080	0.03286	10.47	10.07	10.70	11.03	10.55	3.9
13	1.390	0.03728	8.915	9.313	9.920	9.530	9.402	4.5
14	1.750	0.04183	7.526	8.314	8.087	8.986	8.187	7.3
15	2.180	0.04669	6.271	7.063	8.244	8.491	7.377	14.4
16	2.780	0.05273	5.551	6.791	6.137	7.654	6.419	13.6
17	3.520	0.05933	4.741	7.065	8.134	7.830	6.545	28.1
18	4.390	0.06626	5.765	5.085	8.731	8.601	6.564	27.1
19	5.560	0.07457	4.449	6.610	12.07	35.29	7.519	61.4
20	7.040	0.08390	5.793	5.247	3.649	8.143	5.159	33.0

FREQ:	v	v	v	v
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	6	6	6	6
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(ms)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	0.0483	0.00695	84.10	84.33	84.33	84.27	84.26	0.1
2	0.0569	0.00754	73.98	74.21	74.15	73.94	74.07	0.2
3	0.0693	0.00832	62.24	62.13	62.42	62.35	62.28	0.2
4	0.0840	0.00917	53.01	53.25	53.01	53.13	53.10	0.2
5	0.1010	0.01005	46.08	46.22	46.13	46.00	46.11	0.2
6	0.1250	0.01118	39.20	39.10	39.20	39.39	39.22	0.3
7	0.1545	0.01243	33.61	33.54	33.73	33.70	33.65	0.3
8	0.1890	0.01375	29.04	29.11	29.11	28.83	29.02	0.5
9	0.2370	0.01539	24.90	24.61	24.84	24.79	24.79	0.5
10	0.2940	0.01715	21.90	21.86	21.97	21.97	21.92	0.2
11	0.3570	0.01889	19.34	19.20	19.42	19.31	19.32	0.5
12	0.4410	0.02100	16.91	17.08	17.19	16.87	17.01	0.9
13	0.5630	0.02373	14.68	14.60	14.77	14.61	14.66	0.5
14	0.7100	0.02665	13.15	13.67	12.99	13.50	13.32	2.3
15	0.8810	0.02968	11.80	11.64	12.14	11.19	11.68	3.4
16	1.122	0.03350	10.47	10.57	10.03	10.40	10.36	2.3
17	1.414	0.03760	9.763	9.111	9.878	9.661	9.592	3.7
18	1.763	0.04199	8.793	8.711	9.049	8.440	8.741	2.9
19	2.240	0.04733	8.624	7.879	8.262	8.015	8.183	3.9
20	2.825	0.05315	8.375	7.251	8.621	8.258	8.081	8.0

FREQ:	u	u	u	u
CUR[A]:	1.5	1.5	1.5	1.5
GAIN:	5	5	5	5
NSTK:	8	8	8	8
T/O[us]:	2.41	2.41	2.41	2.41
SHIFT[us]:	0.0	0.0	0.0	0.0

CHN	T(us)	sqr(T)	rho_a	rho_a	rho_a	rho_a	avg_r	%std
1	6.85	0.00262	1315.	1268.	1251.	1238.	1267.	2.6
2	8.95	0.00299	449.0	449.3	449.8	450.7	449.7	0.2
3	12.08	0.00348	443.0	442.6	444.5	443.5	443.4	0.2
4	15.72	0.00396	263.4	264.5	264.3	265.2	264.4	0.3
5	20.05	0.00448	207.8	206.5	206.6	205.9	206.7	0.4
6	26.17	0.00512	162.9	162.3	162.1	162.1	162.4	0.2
7	33.45	0.00578	120.0	119.5	119.3	119.0	119.5	0.3
8	42.10	0.00649	93.86	93.50	93.33	93.33	93.50	0.3
9	54.10	0.00736	74.91	74.81	74.72	74.62	74.76	0.2
10	68.20	0.00826	60.49	60.32	60.36	60.27	60.36	0.2
11	83.80	0.00915	50.69	50.62	50.62	50.61	50.63	0.1
12	104.60	0.01023	42.59	42.54	42.58	42.57	42.57	0.1
13	135.60	0.01164	35.01	34.87	34.85	34.89	34.90	0.2
14	172.30	0.01313	29.64	29.70	29.59	29.68	29.65	0.2
15	214.90	0.01466	25.80	25.71	25.68	25.67	25.72	0.2
16	275.00	0.01658	22.28	22.36	22.25	22.37	22.32	0.3
17	349.00	0.01868	19.82	19.66	19.74	19.68	19.73	0.4
18	436.00	0.02088	17.69	17.77	17.75	17.78	17.75	0.2
19	555.00	0.02356	16.30	16.09	15.98	16.02	16.10	0.9
20	701.00	0.02648	14.90	15.11	15.18	15.01	15.05	0.8