UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Preliminary report on
Electrical Studies Conducted During 1983
on São Miguel Island
Azores, Portugal

by

Donald Hoover[1], Herb Pierce[1], Roberto Amaral[2], Charles Tippens[1]

Open-File Report 85-19

1985

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

[1]U.S. Geological Survey, Denver, Colorado

[2]Laboratorio de Geociencias e Technologia, Azores, Portugal

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INTRODUCTION

The Laboratorio de Geociencias e Technologia (LGT) an agency of the Azorean Regional Government, has an ongoing program for the exploration and development of the geothermal resources on the various islands of the Azores group. To assist in that program the Agency for International Development (AID) of the United States Department of State funded the U.S. Geological Survey to carry out limited geological, geochemical and geophysical surveys on the island of São Miguel (Moore, 1983, Hoover and others, 1983). Additional funding was provided by AID in fiscal year 1983 supplemented by funds from the USGS Geothermal Program and the LGT, which permitted further studies on São Miguel. This report presents the preliminary results of 53 audio-magnetotelluric (AMT) soundings and 3 telluric traverses obtained during August and September 1983. These results will be integrated with other data when all final results become available.

São Miguel island is dominated by three major late Quaternary silicic volcanic centers (figure 1) in which calderas have developed. All three centers, Sete Cidades, Agua de Pau and Furnas, have erupted explosively numerous times during the past 5000 years and all at least once since the island was settled in the fifteenth century (Booth and others, 1978). Exploration and development of the geothermal potential on São Miguel have been concentrated at lower elevations on the north side of Agua de Pau (Meidav, 1981) through various groups contracted by the LGT. To complement this work the USGS began geological and geochemical studies in 1980 with the geological work focusing on the Furnas and Sete Cidades volcanic centers. Electrical investigations were made in September 1982 on the Sete Cidades and Furnas centers to supplement the geological studies. The work presented in this report focused on Agua de Pau with additional AMT soundings made on Sete Cidades to provide better definition of anomalous structures revealed by the 1982 survey. A self potential (SP) survey of Sete Cidades is nearing completion with most of the field measurements being made by LGT technicians. This SP work will be reported on separately after field measurements have been completed.

The lower north slope of Agua de Pau has been the center of various electrical surveys for a number of years. Several exploration and production steam wells have been drilled, primarily based on results of these electrical surveys. A 3 mega-watt power plant has been installed to utilize the geothermal energy from production well PV-1 (figure 2). Additional steam, however, is required and production from current wells appears to be in an outflow zone of a convecting hydrothermal system from a source or sources higher on the mountain. A. Truesdell (A. Truesdell, oral communication, 1983) had postulated that the upward convecting region of the hydrothermal system was located beneath areas higher on the mountain, probably in the vicinity of Caldeira Velha (figure 2). Only limited electrical geophysics have been conducted higher up the slopes of Agua de Pau in part because of the difficult terrain which precludes the placing of long lengths of wire required by most conventional electrical methods. The AMT method used by the USGS, however, requires only limited space, 25 meters, in order to obtain sounding information. It was considered to be an ideal means for obtaining reconnaissance electrical data in this environment. The object of the present work was to extend the electrical surveys already obtained on the lower slopes, to higher elevations on the volcano in an effort to define the region where geothermal fluids were rising before flowing outward and cooling to feed the present production wells. The results described below demonstrated the effectiveness of AMT methods in such difficult terrain. A zone of high electrical conductivity has been defined, located below a region at about 600 meters elevation, which is interpreted to be associated with upward convecting geothermal fluids. This is the probable source for the present production wells. In addition, a region on the south side of Agua de Pau has been identified which also may have geothermal potential.

DESCRIPTION OF THE METHODS

Magnetotellurics (MT) is an electromagnetic sounding method in which variations in earth resistivity as a function of depth are measured (Keller and Frischknecht, 1966). These soundings are obtained by measuring the earth's surface electromagnetic fields at different frequencies. Because lower frequencies penetrate further into the earth before they are absorbed relative to higher frequencies, measurement of the electromagnetic fields over a broad frequency range gives information on resistivity variations with depth. If these measurements are made in the audio-frequency range then the technique is called audio-magnetotellurics (AMT). This method is discussed in detail by Strangway and others (1973) and application and details of the USGS AMT system are given by Hoover and others (1976, 1978) and Hoover and Long (1976).

The AMT method has important advantages over galvanic resistivity techniques in places like the Azores where near-surface resistive layers make it difficult to get sufficient electrical current into the ground to obtain deep sounding data. Additionally long lengths of wire stretched along the surface are not required for AMT soundings. These advantages, especially the latter, were important on São Miguel because of rugged topography in many parts of the island. In the AMT survey 25 meter-long electric dipoles were used to measure the electric field. The magnetic field was measured with a portable induction coil of USGS manufacture.

The depth of exploration is a function of both frequency (f) and resistivity ρ and is approximated by the skin depth δ of the electromagnetic waves. The skin depth is the depth at which the fields have decreased to 37% (1/e) of their surface value and is given by

$$\delta = 503 \sqrt{\rho/f} \text{ meters}$$

where ρ is in ohm-meters and f in Hertz.

A more accurate estimate of depth of exploration can be obtained directly from the sounding graph (see figure 3). In the graph the ordinate and abscissa give, respectively, apparent resistivity and frequency. The dashed vertical lines are the frequencies measured by our receiver systems.

For a homogeneous half-space a sounding curve would show a horizontal line at the intrinsic resistivity of the half-space. However, if a horizontal perfect conductor is present at depth, the sounding curve would descend along a diagonal "depth" line beginning at the point where the upper layer resistivity line intersects the diagonal line corresponding to the conductor depth. These "depth" lines are given by

$$D = \sqrt{\frac{\bar{\rho}}{w\mu_o}} = 355 \sqrt{\frac{\bar{\rho}}{f}} \text{ meters}$$

and run at 34 degrees to the abscissa for the particular scales chosen. This gives a more practical estimáte of depth of exploration, particularly if a well defined descending branch is seen on a sounding curve. For example, if the surface material had a uniform 100 ohm-meter resistivity to a depth of 300 meters, and then a thick 1 ohm-meter layer was encountered, the sounding curve would approximately lie on the 100 ohm-meter line to a frequency of 140 Hz then it will descend along the 300 m line to a value of about 2 ohm-meters from which the curve would then asymptotically approach the 1 ohm-meter value. A very resistive layer would cause the curve to rise at 34 degrees for these particular graph scales, along a line of constant conductance. The basis for this relationship is given by Bostick (1977). Figure 3 may be used for estimating depths to resistivity interfaces from the sounding curves given in appendix 2.

As in any sounding technique it should be remembered that the earth is being sampled laterally as well as vertically below the measuring station. Thus, in areas of complex geology, simple one-dimensional model interpretations give, at best, only a crude average approximation of the vertical distribution of resistivity beneath the sounding site.

Signal sources for AMT may be either artificial or natural. The USGS equipment used in this survey has been designed for use with natural sources. The principal source of natural electromagnetic energy in the audiofrequencies is electrical discharge during lightning storms. Typically, signal strength is low except when generated by local storms, and thus data quality may be poor, especially in parts of the frequency spectrum where energy is more strongly attenuated. These limitations are discussed more fully in relation to natural source AMT exploration by Hoover and others (1978). During our field measurements lightning storms in the Azores group were not common. As a result signals in the 1 to 4 KiloHertz range were very weak or below system noise levels. This is illustrated on the sounding curves by the lack of data points in this range, and increased scatter in the data near this range. Signals at 4.5 Hz, which is below the first Schumann resonance (Galejs, 1964) at about 7.5 Hz, also were generally very weak during the field season. Care should thus be used in interpretation of the sounding curves at 4.5 Hz.

Two sources of man-generated electromagnetic signals were noted during the survey; these caused minor problems in data acquisition. These sources were powerlines, and portable electric fences. Nearby power lines and electric fences contribute noise to the data because these are active sources of electromagnetic energy which are too close to give plane waves required in the computation of apparent resistivity (Strangway and others, 1973). We minimized this problem by selecting sites as distant as possible from such sources. In general, 200 meters from power lines proved to be an acceptable operating distance for reduction of the amplitude of the man-made signals to sufficiently small levels for reception of the more distant natural signals. In some cases electric fences were turned off during data acquisition.

The three telluric traverses were measured using two channels of the USGS AMT receiver. In this method, the telluric voltages occurring simultaneously on two co-linear dipoles are measured at one or more frequencies. The system is then advanced along the line by one dipole length and the process repeated as many times as desired. The relative voltage across any dipole may then be computed, referenced to the first dipole. A plot of these data thus represents the electric field variation along the line. If the traverse is run normal to the strike of two-dimensional structures, then the relative voltage represents the transverse magnetic (TM) mode electric field across the structures (Beyer, 1977). This is proportional to the square root of the TM mode resistivity variation along the traverse. It is a useful method for identifying lateral boundaries. If AMT resistivities are avaiable on one of the dipoles then scalar apparent resistivities may be calculated along the entire traverse as well.

For the three traverses made on Agua de Pau 125 meter dipoles were used, and relative voltage measured at 7.5, 14, and 27 Hz. Signals at 4.5 Hz were also measured but data quality, due to low signals, was too poor to use. The data are presented as profiles of relative telluric voltage. A full discussion of the method and typical model results may be found in Beyer (1977).

PRIOR GEOPHYSICAL DATA

Gravity Data

A gravity survey of the central part of São Miguel was made by the Instituto National de Meteorologia e Geofisica (INMG), Lisbon. Data available from the survey consisted of a Bouguer (complete?) anomaly map and a residual map. Station elevations were principally obtained by barometric leveling (Aquater, 1982). Parameters used in the computation of the Bouguer map are unknown as is the means used to compute the residual map. Additional information has been requested from INMG, but was unavailable at the time of writing this report.

Magnetic Data

An aeromagnetic map flown by INMG was also available for the whole island. Flight elevation is given as 5,000 ft for the eastern half and 4,000 ft for the western half. Flight line direction is unknown. Both the Furnas and Sete Cidades calderas show associated magnetic lows (figure 4; Hoover and others, 1983) with the lows centered within the calderas where electrical resistivity lows also were observed (Hoover and others, 1983). The lows are attributed in part to destruction of magnetite by hydrothermal solutions, but also may be related to a relatively shallow Curie isotherm. By contrast, Agua de Pau does not have a magnetic low associated with its caldera (figure 4). It sits on a gradient produced by a high region on the west, near Lagoa, and a low near Vila Franca. The magnetic high near Lagoa appears to be related to the numerous basaltic cones in the region. It is interesting to observe that no closed lows were seen on the north side of Agua de Pau in the vicinity of the producing geothermal field or by fumaroles at Caldeiras and Caldeira Velha (figure 2). Flight line data in these areas should be examined, if available, to determine if local faults have a magnetic expression which can be used for delineation.

Electrical Data

A fairly extensive suite of electrical data exists with the greatest quantity of data having been obtained by Geonomics in 1976 (Geonomics, 1977). Geonomics performed an extensive reconnaissance survey using the roving dipole method, covering all of Agua de Pau, ran 8 dipole-dipole resistivity lines and made 13 Schlumberger or modified Schlumberger vertical electrical soundings (VESes). The composite interpretation map of Geonomics is reproduced as figure 5. This work identified an area of low resistivity centered on Pico Vermelho which became the focus of subsequent work by LGT. It should be noted that Geonomics recognized that the southern boundary of the low resistivity zone was poorly defined.

Subsequent electrical work contracted by LGT was in the low resistivity region identified by Geonomics and was generally below about 200 meters elevation because of access problems at higher elevations.

This subsequent work consisted of four short dipole-dipole lines and three VESes conducted by INMG in the area of production well PV-1. Four VESes were also made by the Portuguese company Acavaco (Aquater, 1982) in the same area. Recently an Italian contractor, Aquater, has made 23 VESes in the region with AB/2 spacings of 2000 to 4000 meters (Aquater, 1983). In addition a 117 station magnetotelluric (MT-5-EX) electromagnetic survey was made by General Electro-Magnetic Prospecting, Inc. (GEMP) also within the small area identified by Geonomics.

Results from the MT-5-EX survey were presented in the form of a total conductance map. No indication is given of the depth of exploration or of the lowest equivalent frequency used in the survey. Electric dipoles of 25 meters were reportedly used. Based on results from our AMT work, it is unlikely that frequencies much below the Schumann resonance at 7.5 Hz were observed by the MT-5-EX survey because of the short dipoles used. We observe that the apparent resistivity in virtually all of our AMT soundings is descending at the lower frequencies, indicating a conductor at depth. We therefore question the significance of the MT-5-EX survey results. Lower frequency signals are required to penetrate to a resistive substratum in order to map the conductance of the low resistivity layer. We also question the validity of the MT-5-EX results because of the lack of good correlation with results from other electrical methods or with results from drilling.

The Aquater VES data and maps provide the best data set for comparison with the AMT data, and give good definition of resistivity changes at lower elevations in the region of PV-1. All Aquater soundings were expanded until a rising curve (resistive lower layer) was observed. The Aquater VES curves generally show features similar to those observed by Hoover and others (1983). A resistive near-surface layer of varying thickness is observed underlain by layers whose resistivity decreases with depth, until (for all Aquater soundings) a resistive lower layer or basement is observed. The majority of the rising legs of the Aquater VES curves, however, are too steep to be caused by any layered earth situation, which suggests that electrical line leakage problems occurred compromising interpretation of depth to electrical basement. The conductive layer, however, is well defined by the VES. An apparent resistivity map for an AB/2 of 1500 meters adapted from Aquater (1983) is shown in figure 6. This map shows two northwest trending zones of low resistivity. One runs through Pico Vermelho in the vicinity of the production wells PV-1 and PV-2 and the other is near Caldeiras, 1.5 Km east, where fumaroles occur. These low resistivity zones are believed to be related to rock alteration and fracturing along faults through which thermal waters are flowing. The resistivity trend at Pico Vermelho, if extrapolated southeast, passes by the Caldeira Velha fumarole, the highest thermal manifestation known on Agua de Pau.

AMT AND TELLURIC DATA

Preliminary processing of the AMT data at 7.5 and 26 Hz was done routinely during the survey to assist in selecting subsequent field stations. Complete computer data reduction was accomplished in Denver, Colorado, using unpublished programs provided by C. Long. Tabulated data for all the soundings is presented in appendix 1 and accompanying sounding graphs are shown in appendix 2.

At each station, location two scalar AMT soundings were made for orthogonal orientations of the electric and magnetic field sensors. The directions noted on the data sheets, northwest-southeast or northeast-southwest, refer to the orientation of the electric field dipole. These directions were chosen to be parallel or perpendicular to the major geological structures so that in many cases the soundings would represent transverse magnetic (TM) or transverse electric (TE) mode resistivities. The difference in TM and TE mode resistivities near lateral electrical boundaries caused by a laterally inhomogeneous geologic environment is apparent on some of the soundings.

Figure 7 shows the locations of the AMT soundings that were obtained on Agua de Pau and locations of three telluric traverses that were performed. At two of the AMT sites, 42, and 22, only one sounding was obtained because steep topography and thick vegetation precluded placement of an orthogonal 25 meter dipole. Site 24 was abandoned because ground motion and noise from the escaping steam at the Caldeira Velha fumarole was too great for a reliable sounding to be obtained; a move of 300 meters was made to site 25 in order to obtain reliable soundings. The telluric traverse results are shown in figures 13A, B, and C.

Figure 8 shows the location of all stations obtained on Sete Cidades including the new stations, numbers SC-39 through SC-44.

PRELIMINARY INTERPRETATION

The 1983 AMT data like the AMT data obtained in 1982 and the VES data obtained earlier by others, suggests that the geoelectrical environment is similar throughout the survey area. Three electrical units are observed: (1) a surficial layer a few tens of meters thick of intermediate resistivity (110 to 200 ohm meters), which is underlain by (2) a higher resistivity unit (100 to 1000 ohm-meters). These upper units appear to be associated with rocks above the water table. Below these upper two electrical units, resistivities decrease to the maximum depth of exploration. Because of the low resistivities encountered most soundings do not penetrate deep enough to clearly identify electrical basement seen on some of the longer VES expansions.

Comparison of AMT and VES data at the same site (Hoover and others, 1983) showed good equivalence between methods considering the way in which differences of lateral resistivity are averaged and the complexity of the geology.

Agua de Pau

Apparent resistivity maps for both sounding directions were prepared at frequencies of 7.5 and 27 Hz, figures 9A and B, and 10A and B. 7.5 Hz is the lowest, and hence deepest looking, frequency at which signal strengths are adequate to give good data quality. This provides measurement of a large volume of earth around the site and thus is an appropriate frequency to use for identifying deep or regional resistivity trends. However, because measured apparent resistivities are an average of a volume of earth from the surface to some maximum depth, dependent on the frequency and resistivity, these apparent resistivity maps will reflect shallow as well as deep conditions. The good correlation between the 27 and 7.5 Hz maps is, in part, due to this averaging over the measured volume of rock.

Low apparent resistivities were observed in the vicinities of the fumaroles at Caldeiras and Caldeira Velha as well as within the entire principal area identified by Geonomics and subsequently by Aquater. Apparent resistivities within this region are all near or generally below 10 ohm-meters. These very conductive zones are clearly associated with the known geothermal system in the area. The two northwest resistivity trends seen in the Aquater data also appear in the AMT maps. The Pico Vermelho-Caldeira Velha trend appears to have lower resistivities and interestingly extends to station 4 at about 600 meters elevation, significantly higher on the volcano than previously known. The Caldeiras trend is less well defined in the AMT data but appears to extend to station 17 at Lombadas where carbonated springs occur.

Low resistivities were also observed on the southern flank of Agua de Pau in a region not previously identified with a geothermal potential. A fumarole or carbonated spring in this area has been noted by Booth and others (1978). The top of the low resistivity layer is well above sea level and extends up the volcano to station 42 at an elevation of about 500 meters. This suggests that sea water incursion is not a probable cause of these anomalies. The similarity of the region to the known geothermal field on the north side of Agua de Pau clearly suggests the potential for a second geothermal system on the south side of Agua de Pau.

The apparent resistivity maps show that within the caldera of Agua de Pau resistivities are more than an order of magnitude higher than the north and south flanks where hydrothermal convection cells appear to have formed. Also, the caldera of Sete Cidades is more resistive than its northwest flank (Hoover and others, 1983), These higher intra-caldera resistivities, and the lack of thermal manifestations with the calderas, suggest that relatively low porosity material lies below the caldera. This material may act as a central plug to prevent the escape of fluids and steam within the caldera, forcing escape to be controlled by ring and radial fractures. The higher intra-caldera resistivities at Agua de Pau and Sete Cidades could also be due to a dry steam system within the rocks. This, however, is considered less likely because there is no evidence of a low resistivity layer which would be expected to result from acid leaching in the zone of condensation at the top of the dry steam system (Fournier, 1983).

To better view the vertical distribution of resistivities suggested by the AMT data, two resistivity cross-sections were prepared (figures 11 and 12) along northeast-southwest and northwest-southeast directions (figure 2 and 7). These sections are based on one-dimensional inversion (Bostick, 1977) of the sounding curves and thus do not consider lateral effects. At each station, a smoothed curve of the logarithmic average of the apparent resistivities in the two polarizations was used as the basis for inversion, these are tabulated in appendix 1. Each curve was constrained not to rise or fall more steeply than is possible for a one-dimensional layered earth. The curves used for inversion are shown by the dashed curve on the soundings.

Figure 11 shows section AA′ trending northeast and crossing the northern slope of Agua de Pau in the vicinity of Caldeira Velha at site 25 (figure 2). The cross-section shows a distinct boundary southwest of Caldeira Velha. To the southwest resistivities are significantly higher than on the northeast. Resistivities below 10 ohm-meters are seen at elevations well above sea level on the entire northeast half of the section. We infer that these low values are associated with thermal waters and associated rock alteration, at depth, in this area.

The second cross-section, figure 12, runs northwest-southeast essentially along the Pico Vermelho-caldeira Velha trend crossing the volcano on the south side (figures 2 and 7). The central resistive core of the volcano is readily apparent in the section along with the two regions of low resistivity. The section suggests that upward convecting parts of the hydrothermal systems occur in the vicinity of sites 4 and 42 on this section and then, thermal waters flow down gradient to the sea. Control for the upward convecting region would be expected to be related to caldera rim fractures and permeable radial fractures.

Three telluric traverses (figure 13) were made in order to better define the rim and radial fractures. Line 1, figure 13A was run radially from the summit in the vicinity of station 30. It shows a definite voltage low and hence, low resistivity zone on dipole 1S-2S. This is north of the latest formed caldera rim of Agua de Pau but close to the inferred location of an earlier caldera wall. The E-field telluric low is associated with low resistivity rocks which we infer defines the position of an earlier rim. The zone of low resistivity is attributed to a zone of fracturing and possibly alteration along the rim fault.

The small change in the telluric low with frequency as well as the short spacial wavelength of the anomaly indicate the top of the zone is shallow in comparison to the exploration depth for these frequencies. The slight increase in amplitude of the anomaly with decreasing frequency implies, however, that the low resistivity zone extends to depth and is not just a surface phenomenon.

Line 2, figure 13B runs along the Caldeira Velha trend from the vicinity of site 4 towards Caldeira Velha. Topographic barriers prevented the line from extending further up the mountain. No significant changes in resistivity were seen along the line. The traverse appears to be confined entirely to an area of low resistivities based on AMT sounding 33 made using a 125 m dipole between telluric station 0 and 1N.

Line 3, figure 13C, is situated close to the most recent caldera rim on its north side. The line runs normal to the Caldeira Velha low resistivity trend and crosses the southward projection of the trend. On this line also, no significant resistivity changes were observed. The resistivities are high along the entire line, based on resistivities observed in sounding 31, which was made between station 1E and 2E. Either the Caldeira Velha trend is terminated before reaching this line, probably at a caldera rim, or it has no resistivity expression within the caldera at the exploration depths employed.

Sete Cidades

The new soundings at Sete Cidades did not reveal any areas which might have geothermal potential, but they provided better definition of the geothermal potential in the Mosteiros graben. For completeness, the earlier AMT resistivity maps at 7.5 Hz (Hoover and others, 1983) have been revised to include these new data. These maps are shown in figures 14A and B.

CONCLUSIONS AND RECOMMENDATIONS

We consider natural source AMT surveys to be useful for geothermal reconnaissance. They can be used to obtain regional information with less effort and at lower cost than is possible using controlled source techniques. AMT surveys are used to identify target areas for more detailed study. In the geological setting of São Miguel the AMT soundings probably do not probe to great enough depth to identify magma, if any is present. However, they can identify areas in which convective hydrothermal systems are active or where such systems have altered and mineralized rock. The method therefore, serves to identify, indirectly, permeable parts of the volcano.

Low resistivities imply high porosity, but not necessarily high permeability, for rocks well below melting temperatures. High porosity and low resistivity may be associated with the development of clay and zeolite minerals which may restrict permeability along fractured zones.

At Agua de Pau, the most favorable place for development of new production wells is in the region southeast of Caldeira Velha in the low resistivity zone, or as close to that area as practical. The southeastern part of the Caldeiras trend should be considered for possible future exploration, particularly if access can be improved.

The data presented here are not as definitive as one would like to define a drilling target. The presumed target is a fault zone along which the thermal fluids are convecting upward before flowing laterally down gradient. These data define only the approximate trend and position of such structures. It would be desireable to conduct detailed electrical traverses in the more favorable area. However, the topography and vegetation make such an undertaking extremely expensive. We suggest that a mise-a-la-masse survey might be the most cost-effective way of better defining the Caldeira Velha trend. This could be accomplished by placing one current electrode at the Caldeira Velha fumarole, and the other outside the conductive zone.

The low resistivity region on the south side of Agua de Pau should be kept in mind for possible future power development. The area is closer than Caldeira Velha is to the major population center of São Miguel. We recommend further reconnaissance electrical work in order to better define the limits of this conductive zone.

ACKNOWLEDGEMENTS

We wish to thank the numerous personnel of the Laboratorio de Geociencias e Technology who directly and indirectly assisted in the geophysics program and especially Dr. A. Rodrigues da Silva director of the laboratory for the magnificent support given our operations. Without their support we would not have been able to operate effectively. To the personnel of AID in Ponta Delgada, Lisbon, and Washington and to the LGT we also extend our appreciation for providing the most important funds for this work.

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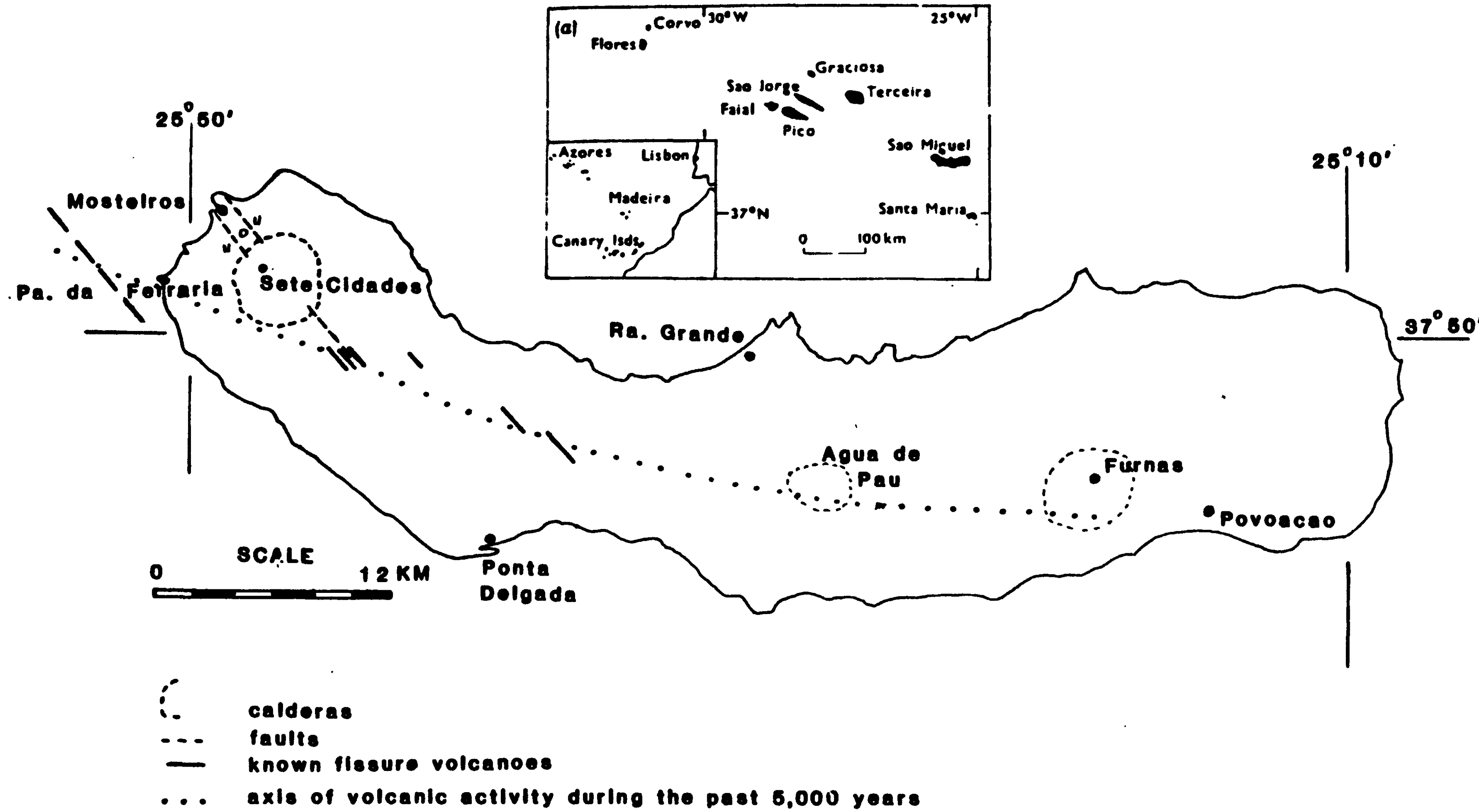


Figure 1. Map of São Miguel showing major volcanic centers, trend of recent volcanism and fissures, adapted from Booth and others (1978).

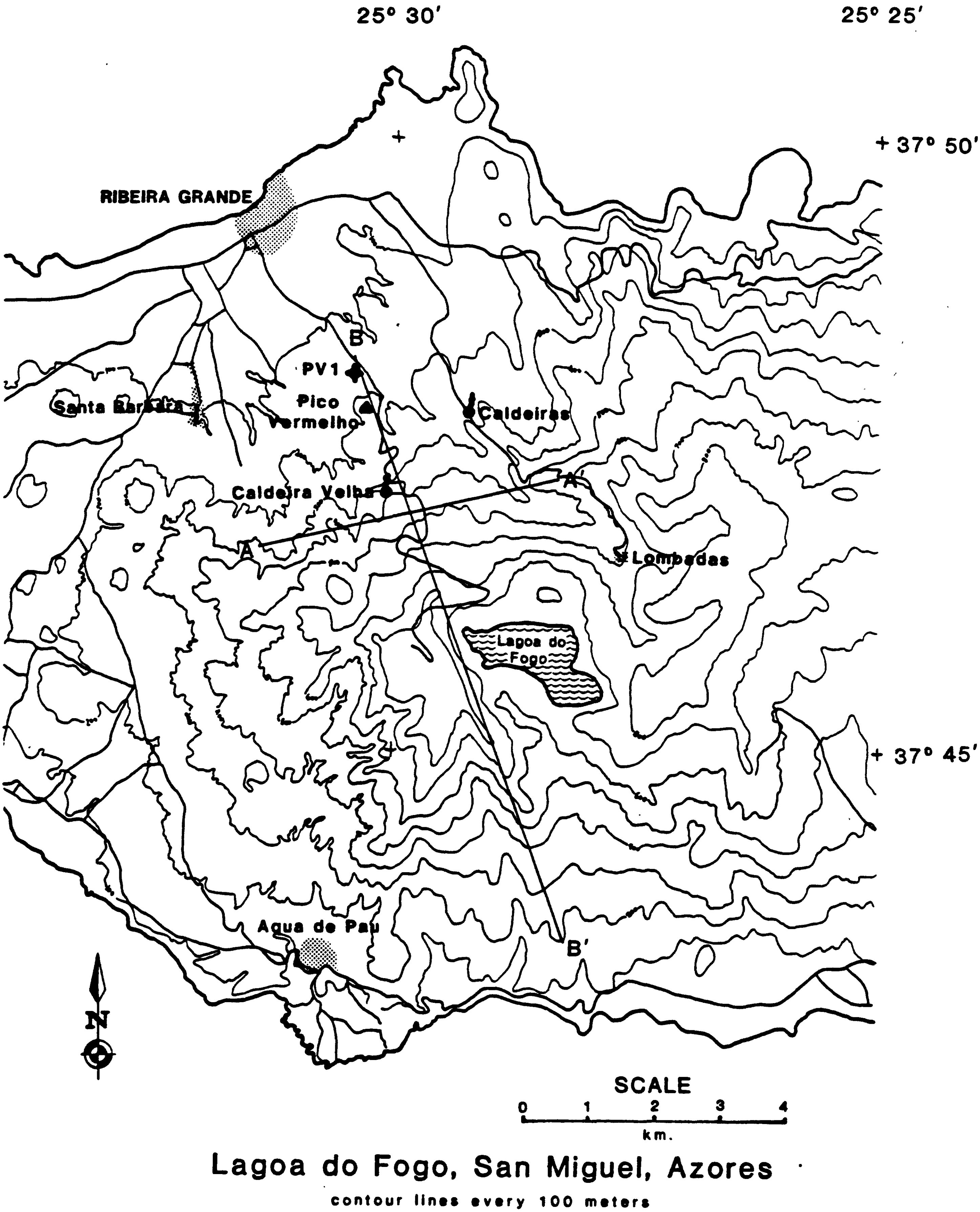


Figure 2. Map of Agua de Pau area showing location of fumaroles at Caldeiras and Caldeira Velha, production well PV-1, and geoelectric section lines AA′ and BB′.

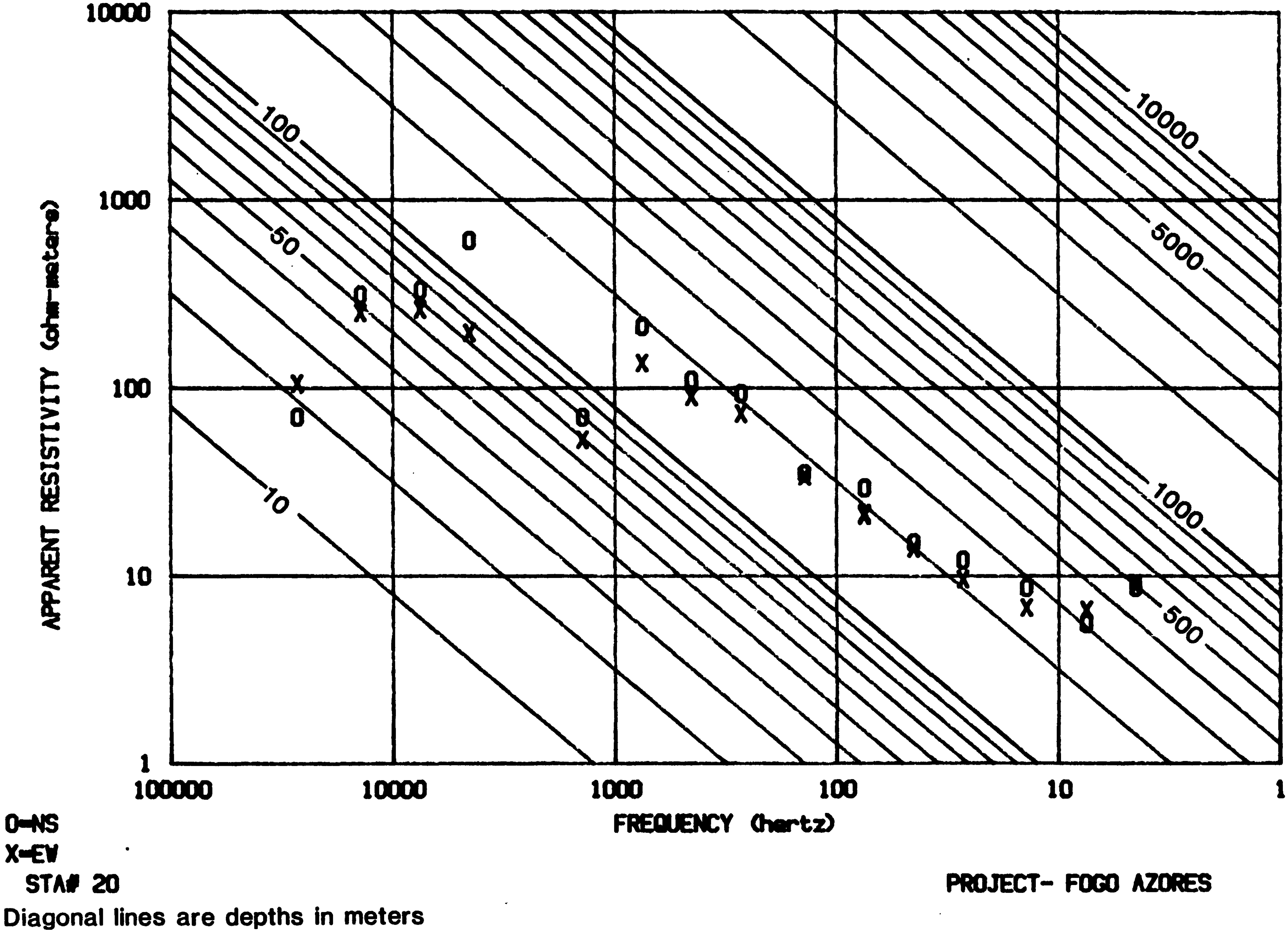


Figure 3. Graph showing relationship between resistivity, frequency, and depth of exploration for AMT soundings. See text for details.

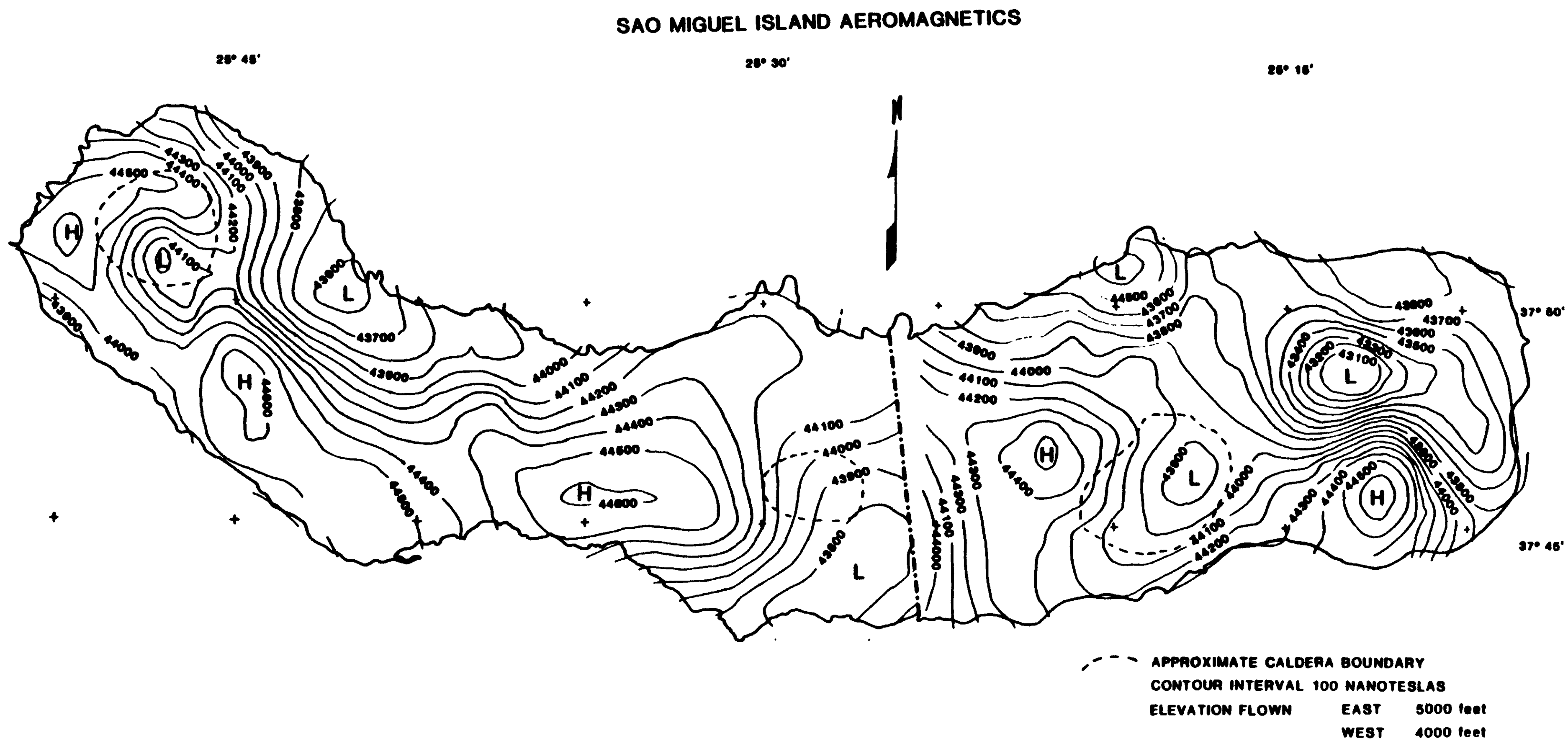


Figure 4. Aeromagnetic map of São Miguel Island adapted from an unpublished map flown by the Instituto National de Meteorologia e Geophysica, Lisbon, Portugal. The calderas of Sete Cidades, Agua de Pau, and Furnas are shown by the dashed lines.

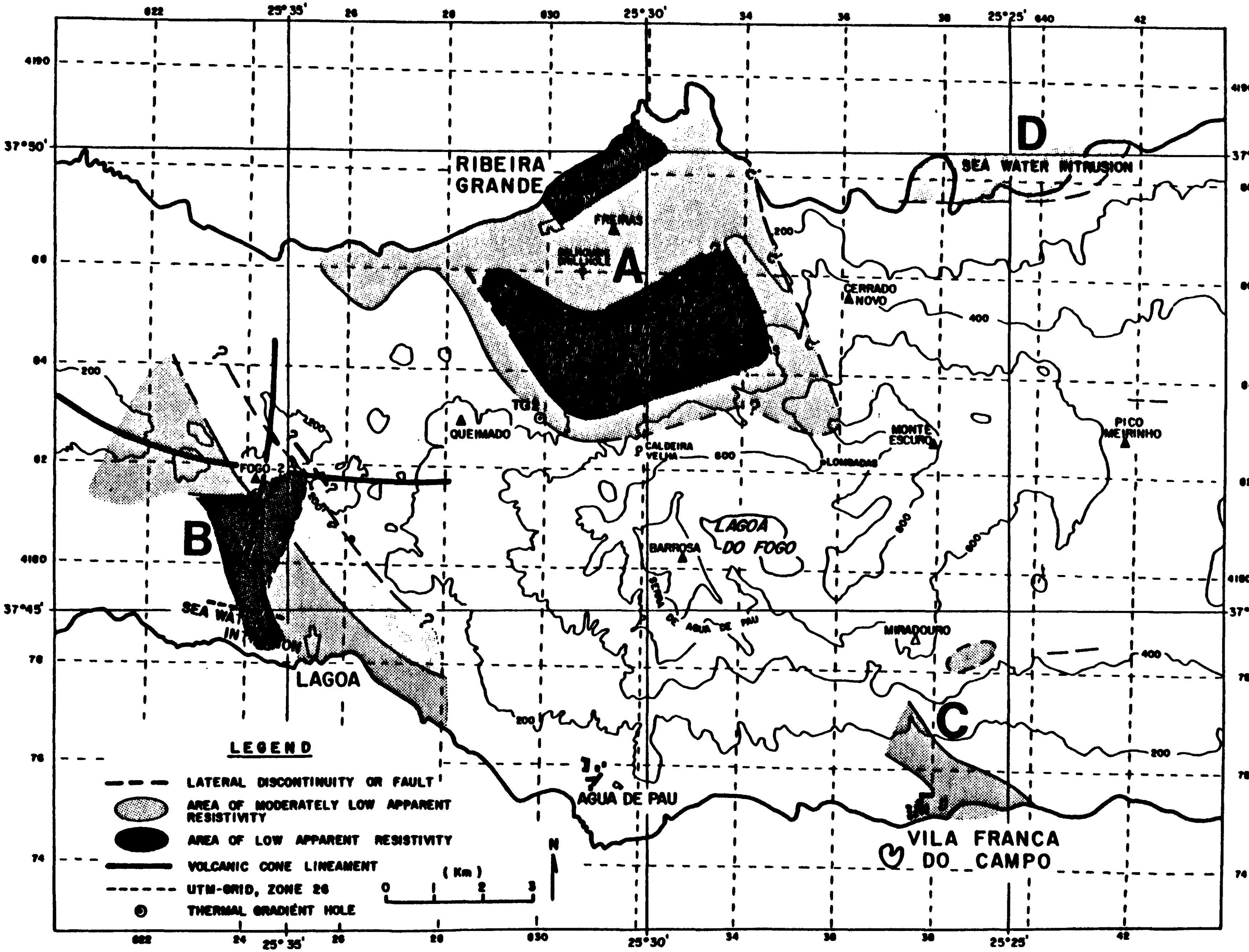


Figure 5. Geoelectric composite interpretation map based on Schlumberger VESes, roving dipole, and dipole-dipole resistivity data from Geonomics (1977).

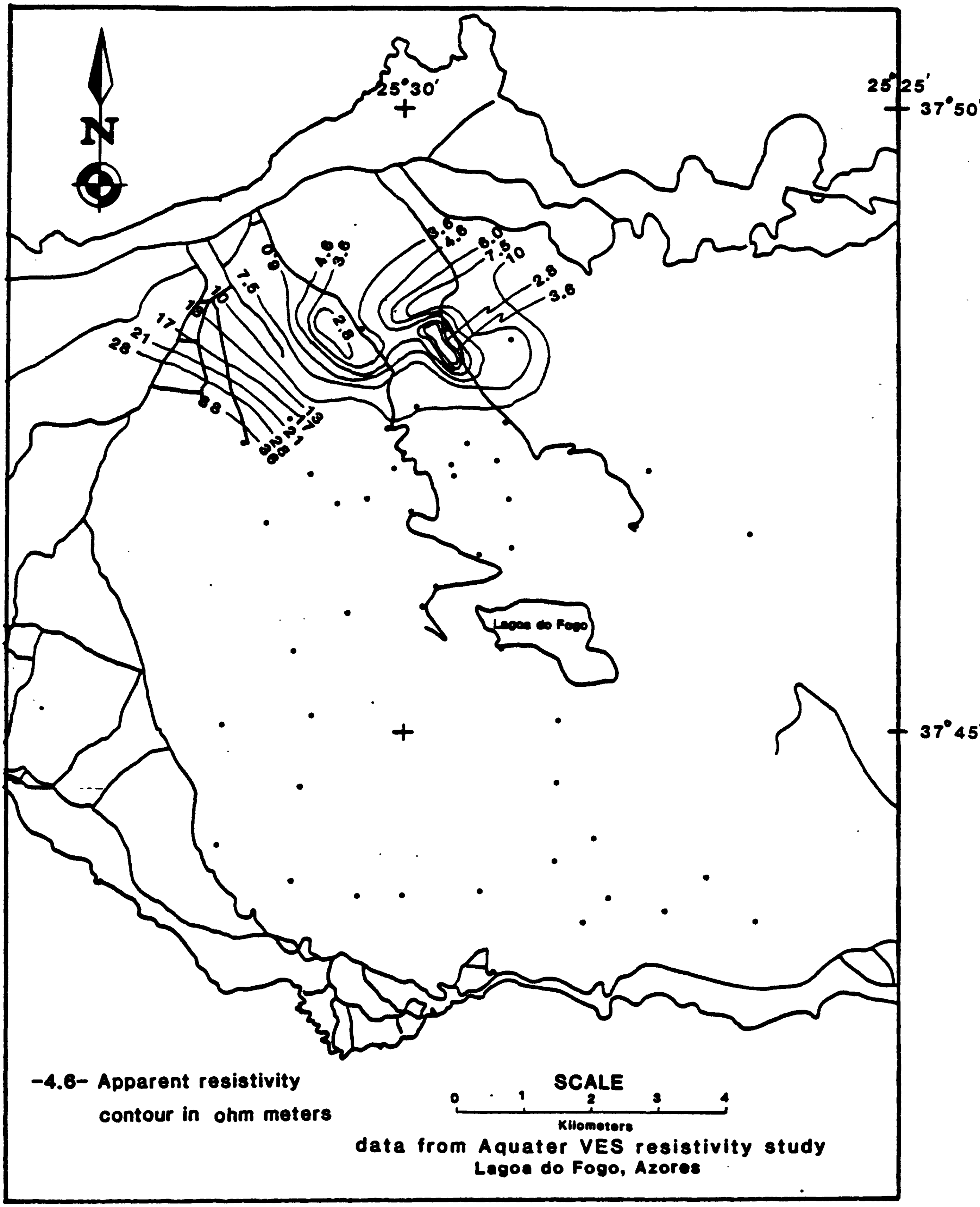


Figure 6. Apparent resistivity map of the Pico Vermelho area from Schlumberger VES data at an AB/2 of 1500 meters from Aquater (1983).

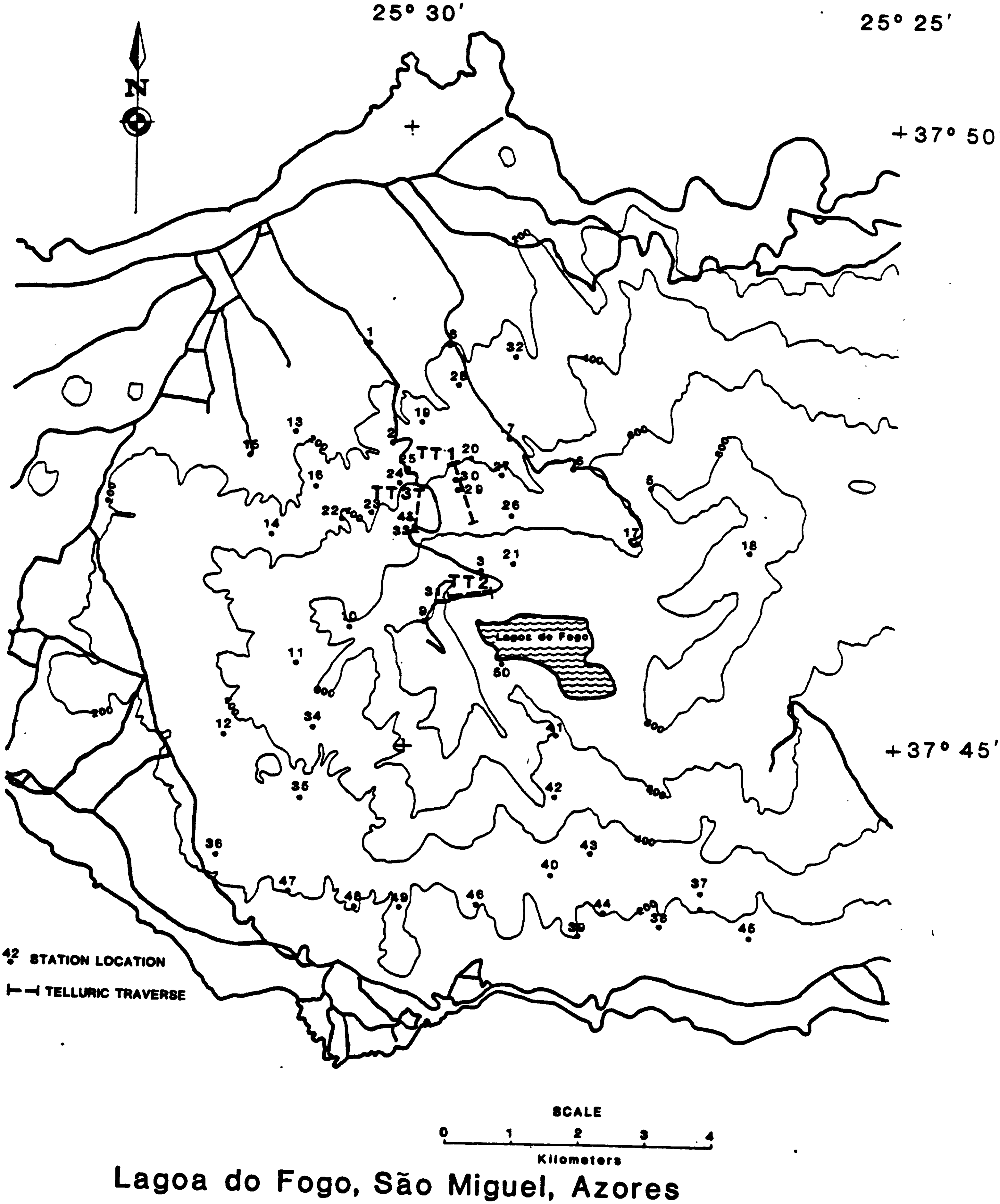


Figure 7. Map showing locations of AMT soundings and telluric traverses on Agua de Pau

AMT station location map

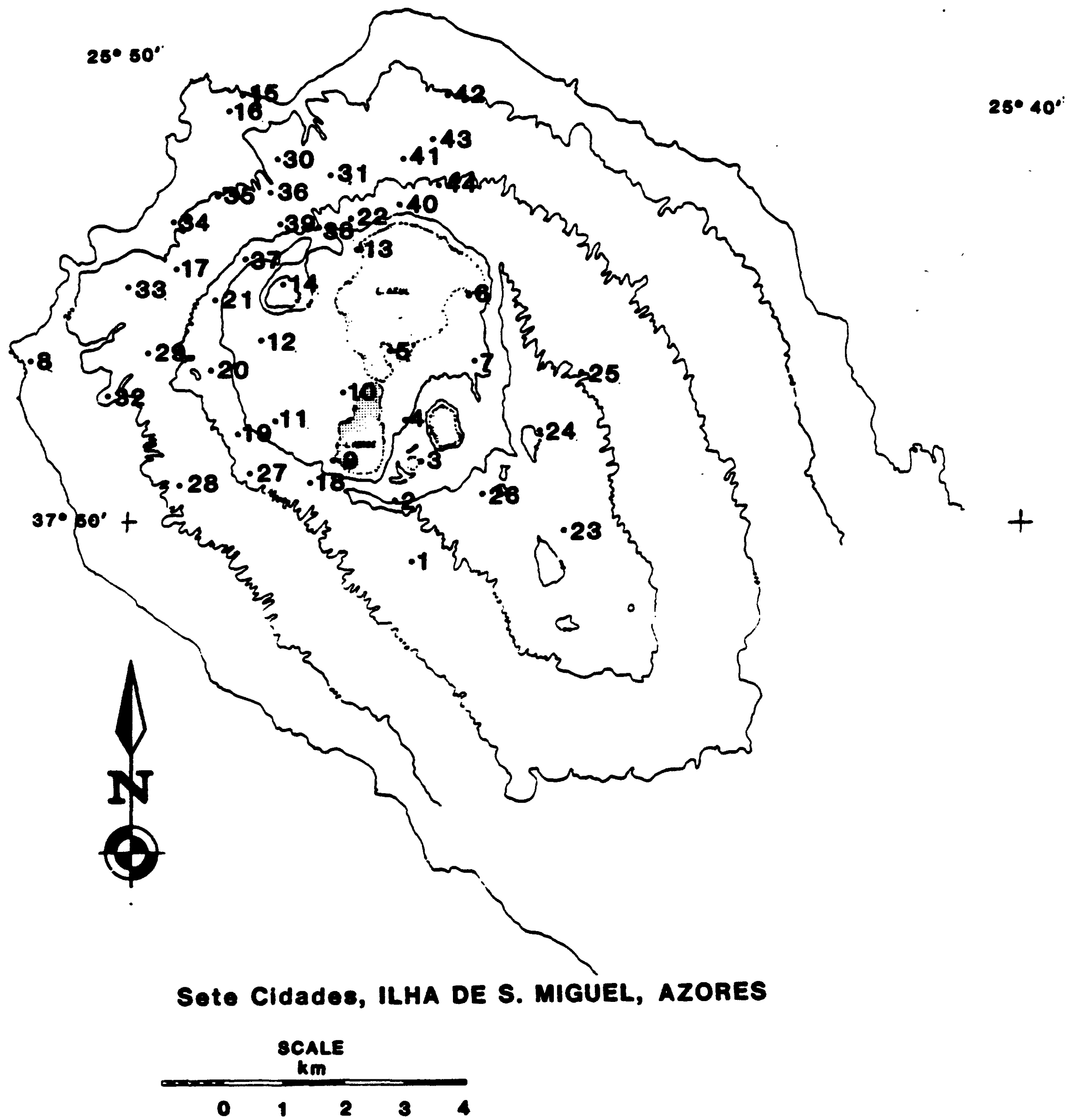
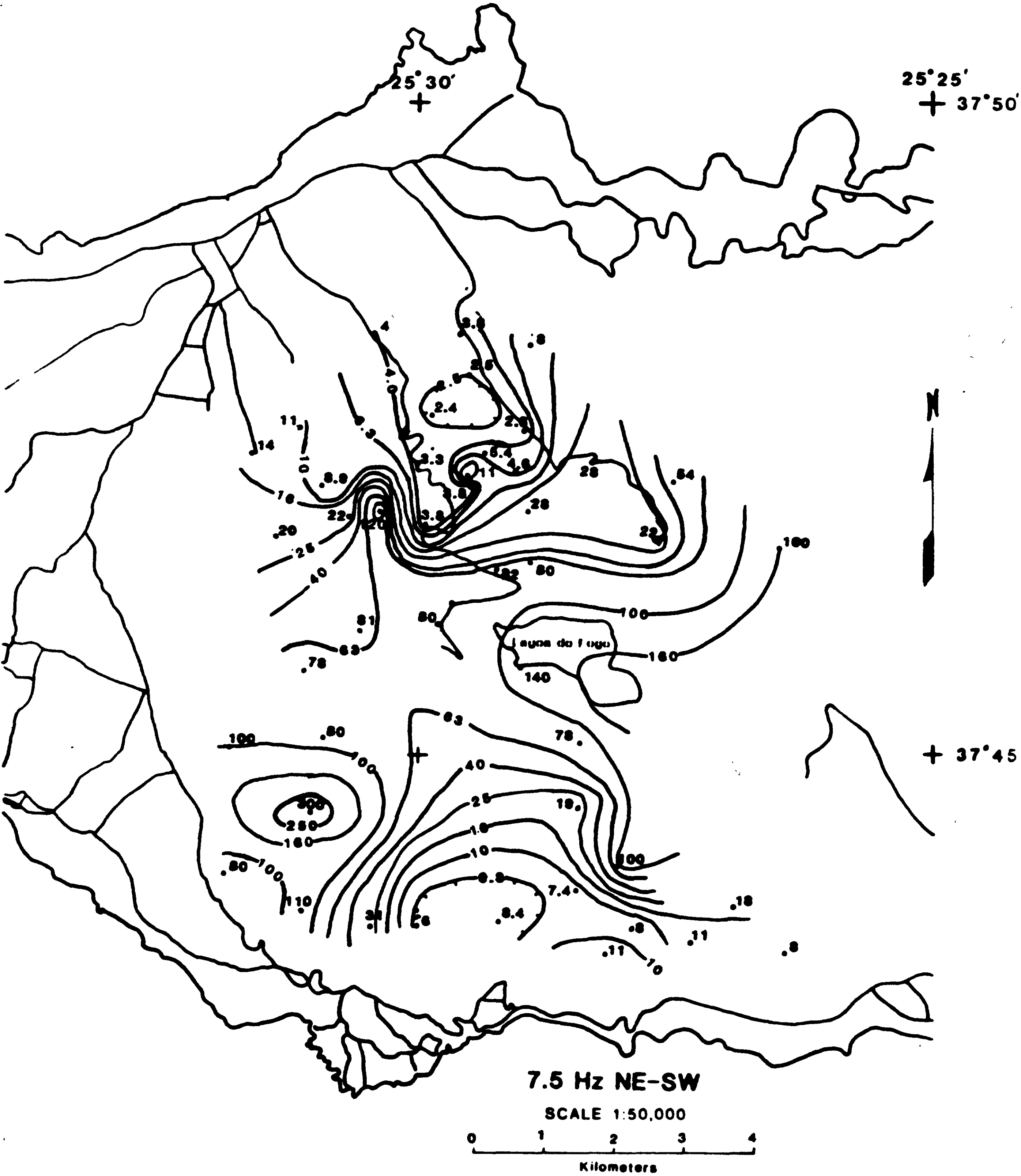


Figure 8. Map showing location of AMT soundings obtained on Sete Cidades.

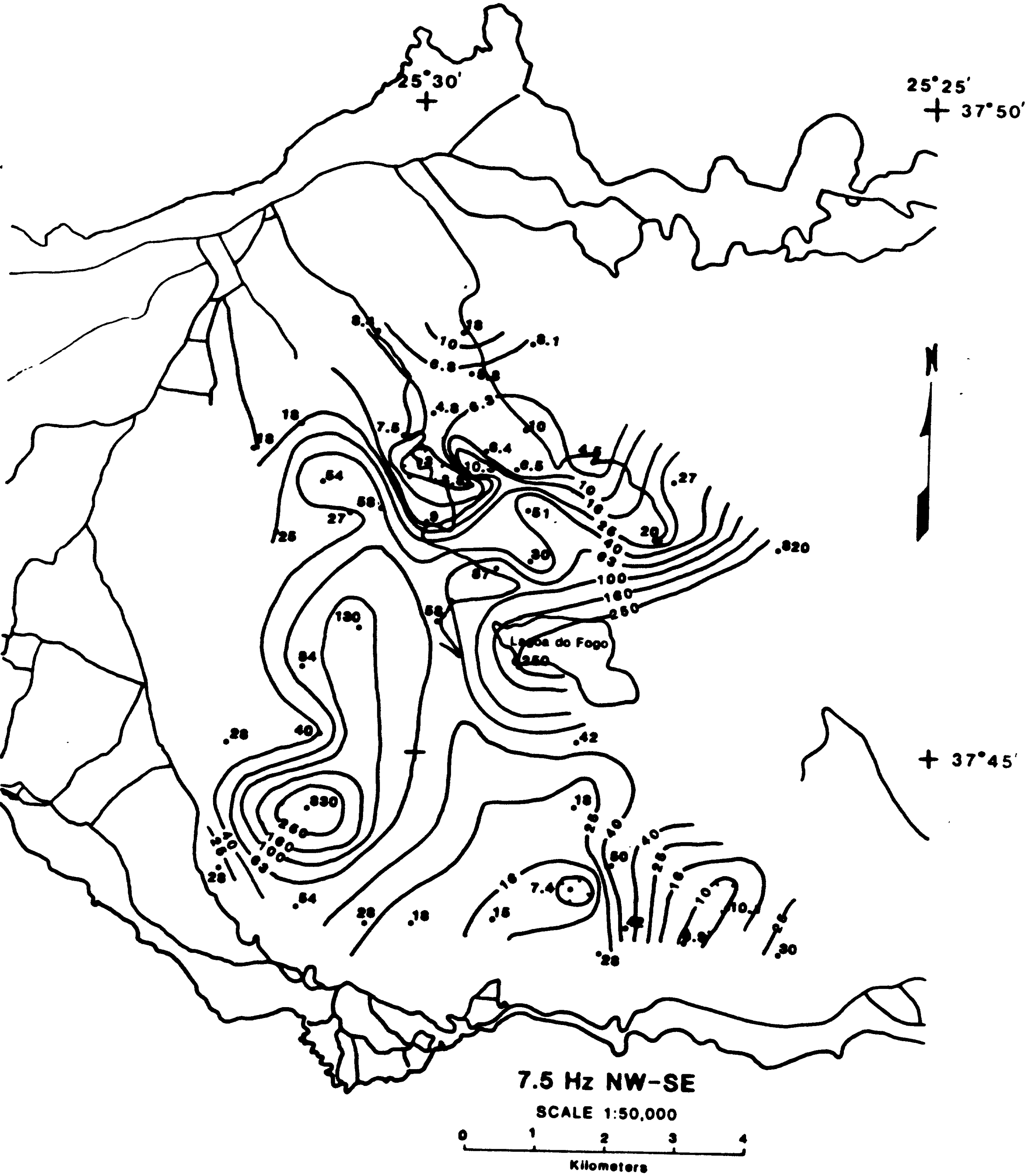
LAGOA DO FOGO, SAO MIGUEL, AZORES



16 • AMT station location and apparent resistivity in ohm meters
Log contours five per decade

Figure 9A. Audio-magnetotelluric scalar apparent resistivity map at 7.5 Hz of Agua de Pau, for a northeast orientation of the telluric dipole.

LAGOA DO FOGO, SAO MIGUEL, AZORES



45 • AMT station location and apparent resistivity in ohm meters

Log contours five per decade

Figure 9B. Audio-magnetotelluric scalar apparent resistivity map at 7.5 Hz of Agua de Pau, for a northwest orientation of the telluric dipole.

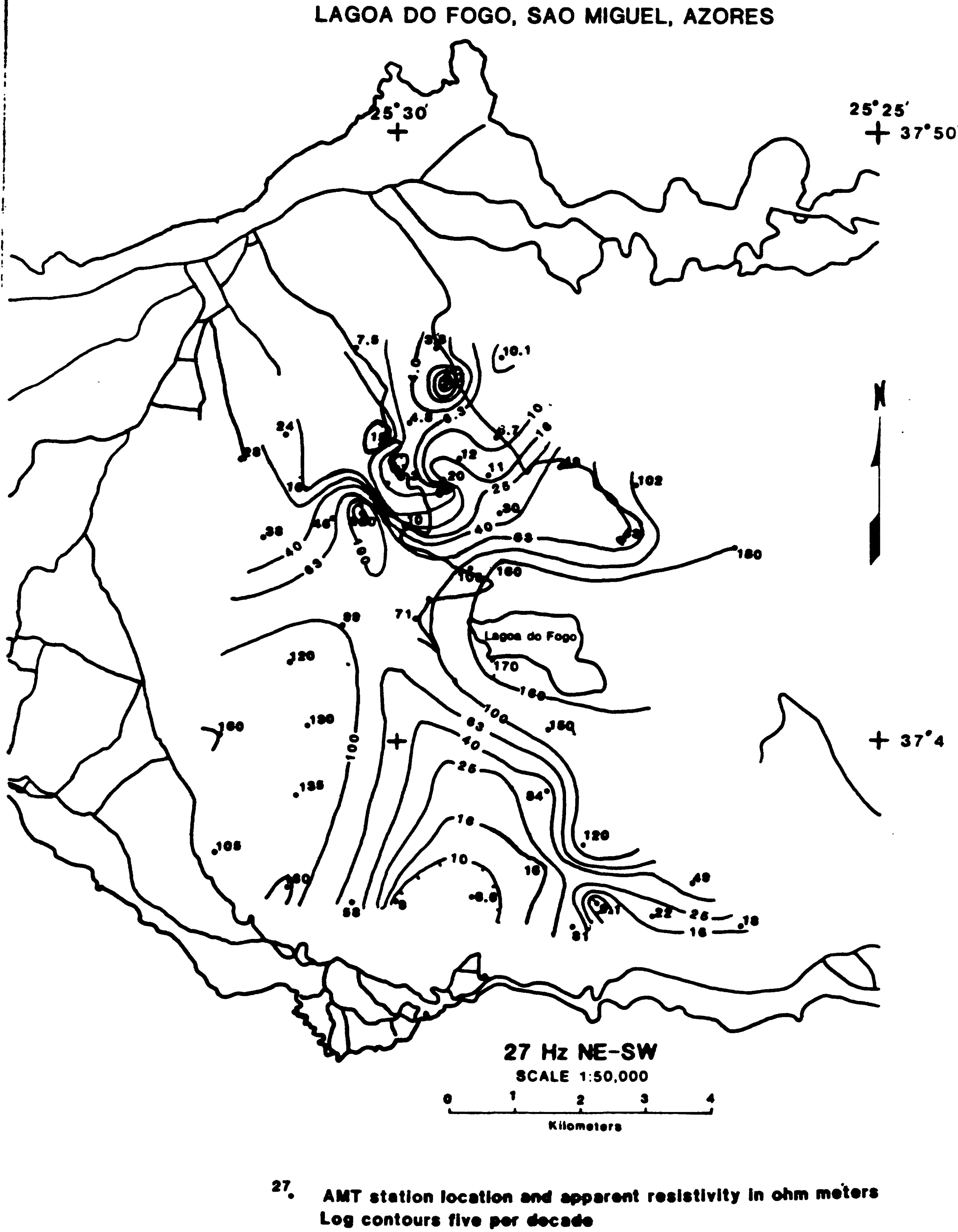


Figure 10A. Audio-magnetotelluric scalar apparent resistivity map at 27 Hz of Agua de Pau, for a northeast orientation of the telluric dipole.

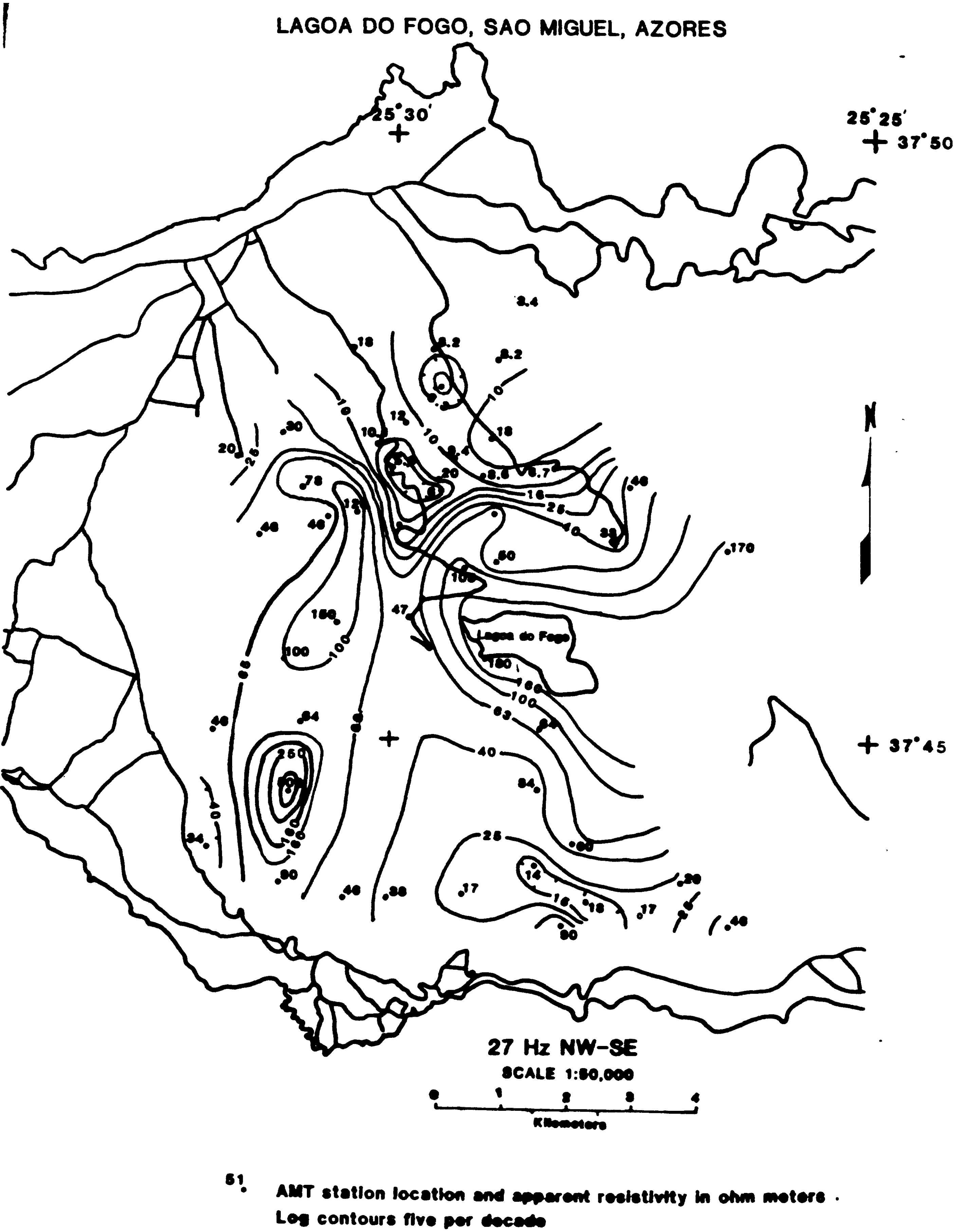


Figure 10B. Audio-magnetotelluric scalar apparent resistivity map at 27 Hz of Agua de Pau, for a northwest orientation of the telluric dipole.

SW-NE Lagoa do Fogo

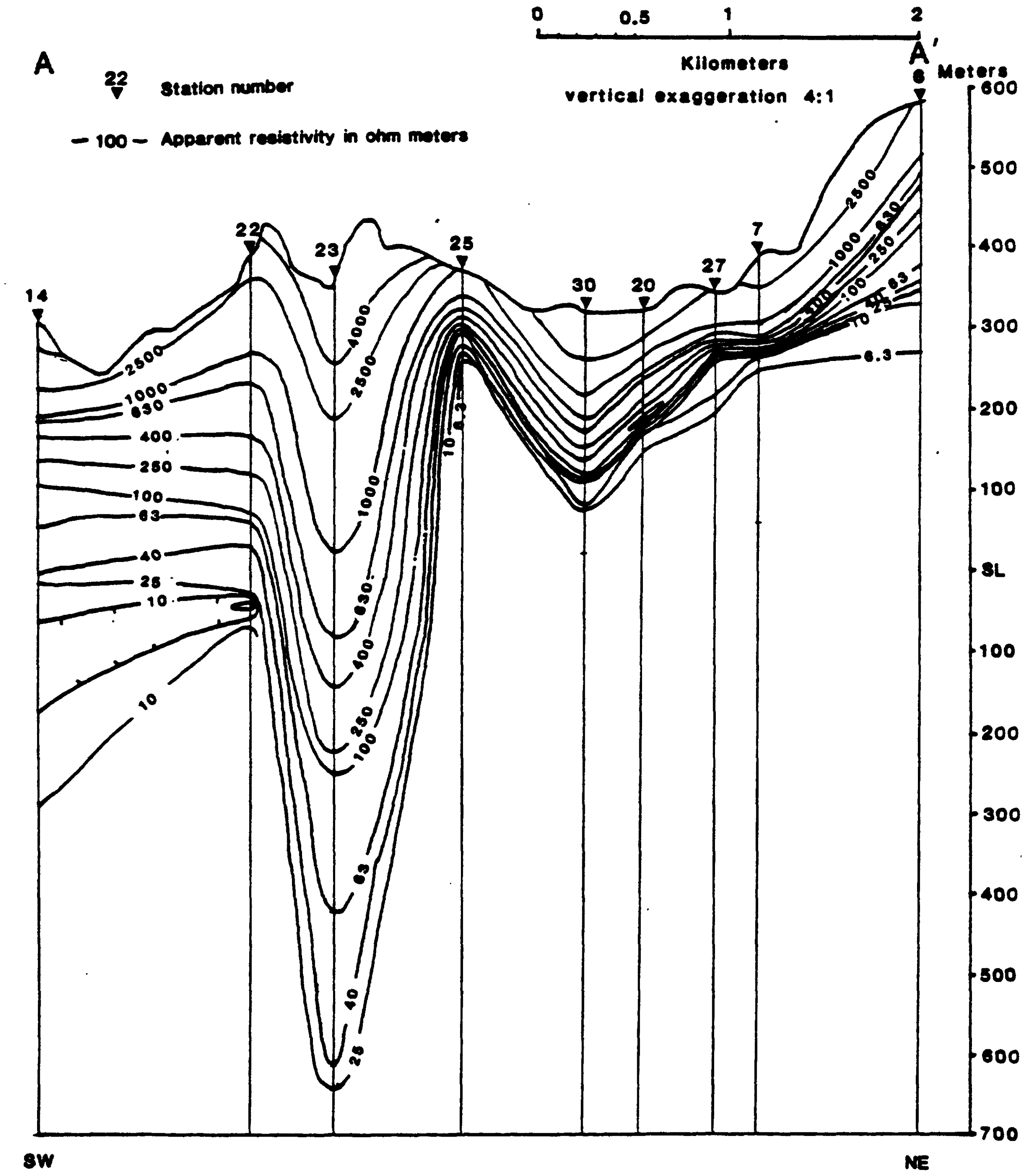


Figure 11. Geoelectric section AA' (figures 2 and 7) trending northeast through Caldeira Velha, station 25, showing a shallow conductive zone related to the geothermal system.

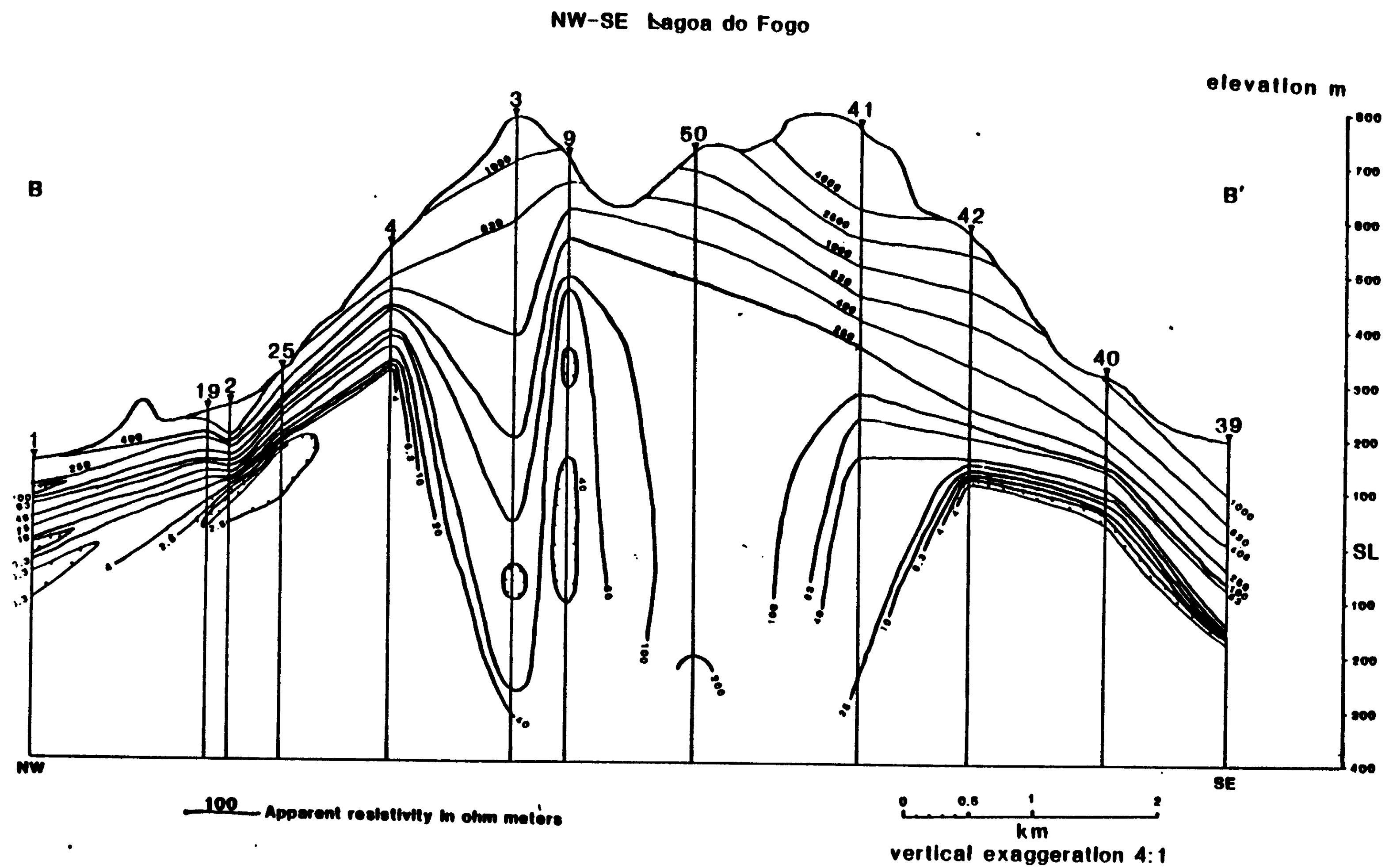


Figure 12. Geoelectric section BB' (figures 2 and 7) trending northwest across Agua de Pau volcano.

TELLURIC TRAVERSES

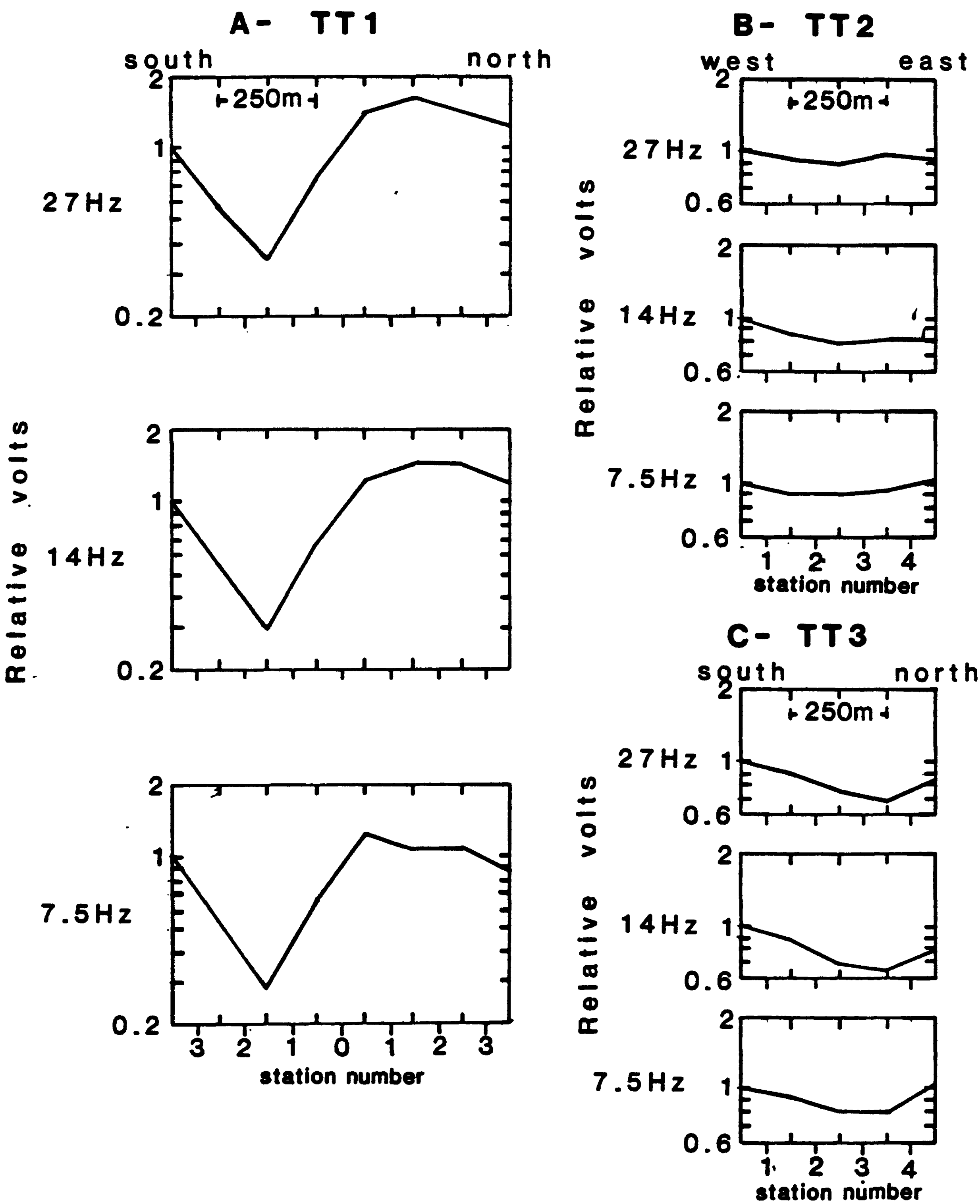


Figure 13. Telluric profile data for Agua de Pau shown as relative voltage along the profile. Voltages are shown on a logarithmic scale at 27, 14, and 7.5 Hz. A, profile 1; B, profile 2; and C, profile 3.

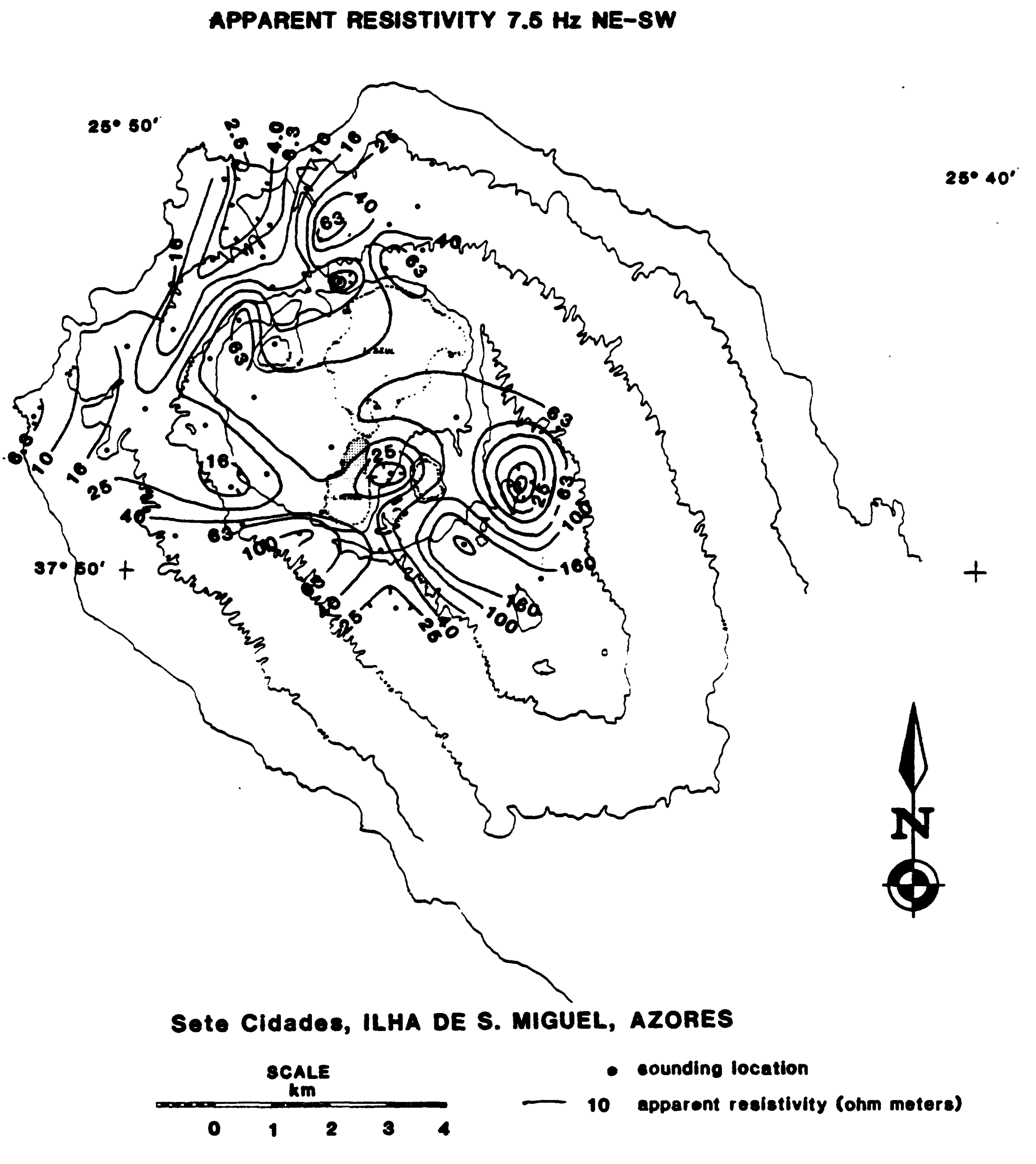


Figure 14A. Audio-magnetotelluric scalar apparent resistivity map at 7.5 Hz of Sete Cidades for a northeast orientation of the telluric dipole.

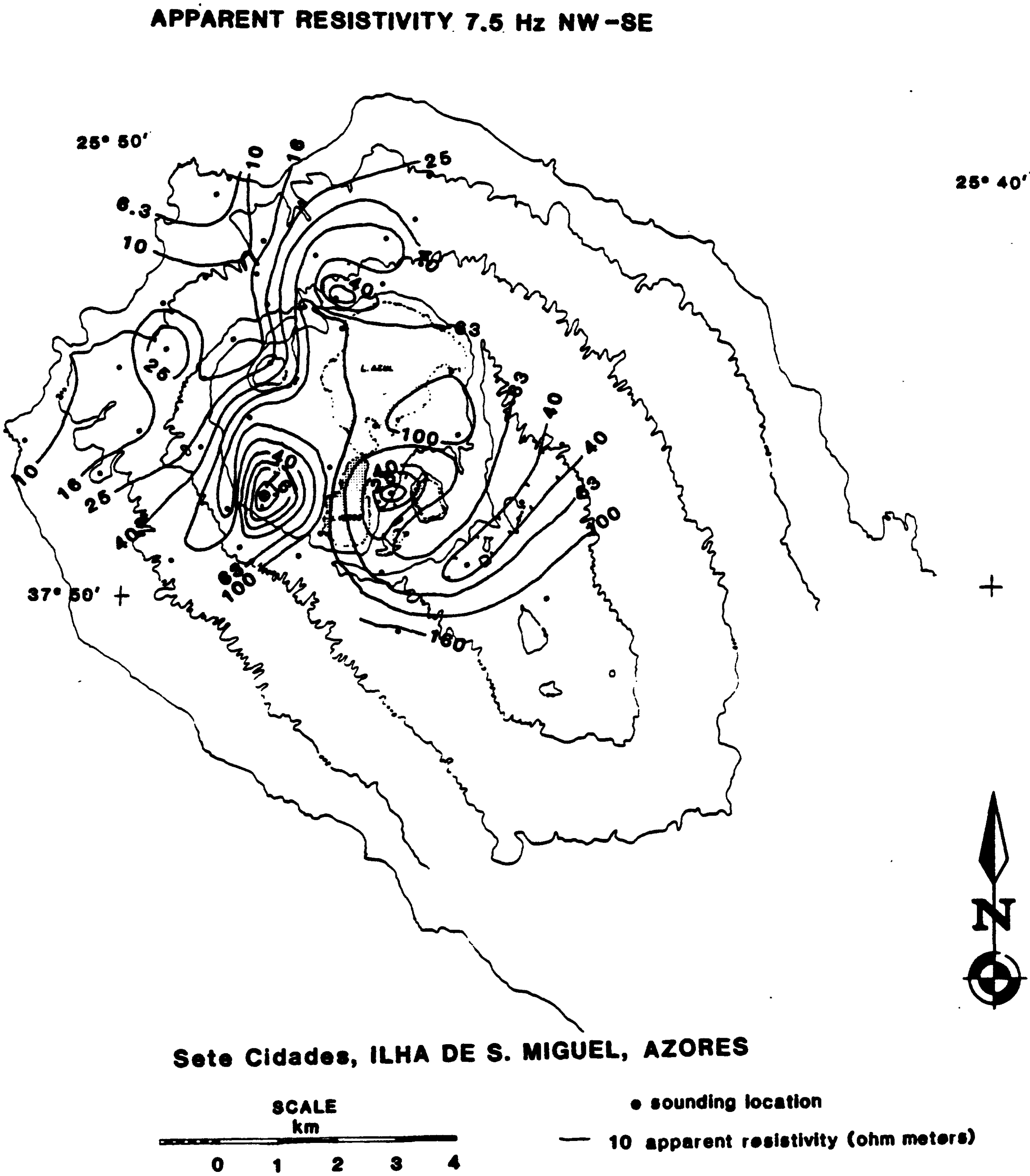


Figure 14B. Audio-magnetotelluric scalar apparent resistivity map at 7.5 Hz of Sete Cidades for a northwest orientation of the telluric dipole.

Appendix 1

Tabulated AMT data for São Miguel Island, Azores. Data obtained during August-September 1983. At each station two independent scalar soundings are presented. The computer printout lists a north-south (NS) or east-west (EW) orientation for each scaler sounding. For this survey the north-south labeled orientation was in a northeast southwest direction and the east-west labeled orientation was northwest-southeast.

The tabulation gives the station number, orientation, and number of frequencies observed, followed by a line showing frequency, apparent resistivity, the number of individual events used to calculate the apparent resistivity, and the standard error.

Station identification is SC for Sete Cidades, and Fogo for Agua de Pau.

PROJECT=FOGO AZORES

STATION ID_1 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	4.88	2	1.47
7.5	4.18	13	.54
14.0	4.57	10	.39
27.0	7.51	11	.65
45.0	9.42	8	.80
75.0	13.04	11	.83
140.0	18.38	10	1.47
270.0	30.26	12	1.58
450.0	46.53	12	2.64
750.0	45.84	12	3.89
1400.0	13.98	5	.91
4500.0	90.21	12	4.56
7500.0	96.10	11	5.18
14000.0	127.80	12	2.56
27000.0	58.60	13	2.47

STATION ID_1 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	4.90	2	.03
7.5	6.35	9	.70
14.0	9.10	10	.80
27.0	12.51	11	1.54
45.0	14.13	10	.52
75.0	16.86	10	1.07
140.0	30.35	10	1.32
270.0	59.79	8	4.79
450.0	49.44	10	1.94
750.0	55.40	10	2.16
1400.0	97.83	1	0.00
2700.0	573.74	10	89.48
4500.0	72.53	11	7.20
7500.0	109.09	10	8.23
14000.0	86.67	14	9.57
27000.0	.81	9	.09

PROJECT=FOGO AZORES

STATION ID_2 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	10.91	2	8.41
7.5	3.90	9	.50
14.0	3.74	10	.36
27.0	18.99	9	1.56
45.0	6.08	11	.13
75.0	9.36	10	.16
140.0	14.28	10	.50
270.0	33.84	10	1.57
450.0	51.82	10	2.60
750.0	96.91	10	14.68
1400.0	32.75	3	29.00
2700.0	3.62	1	0.00
4500.0	32.49	9	2.66
7500.0	144.26	10	2.35
14000.0	.45	12	.01

STATION ID_2 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	7.22	3	5.25
7.5	7.66	6	1.47
14.0	7.76	11	.63
27.0	10.28	9	.41
45.0	13.29	10	.47
75.0	21.28	11	.56
140.0	29.02	11	1.43
270.0	50.66	10	3.11
450.0	80.74	12	2.73
750.0	83.69	9	9.09
1400.0	14.40	4	1.73
2700.0	8.91	4	1.45
4500.0	45.25	10	2.48
7500.0	267.94	10	12.03
14000.0	318.29	9	38.63
27000.0	885.66	8	295.59

PROJECT=FOGO AZORES

STATION ID_3 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	50.96	8	14.72
7.5	83.07	11	17.24
14.0	104.51	11	4.52
27.0	155.27	11	6.47
45.0	184.73	10	8.74
75.0	258.56	11	16.81
140.0	279.88	11	22.08
270.0	412.60	11	26.44
450.0	432.44	11	27.16
750.0	496.49	10	42.72
1400.0	73.38	2	74.46
2700.0	14.82	5	1.48
4500.0	819.24	10	79.48
7500.0	4073.40	10	329.38
14000.0	2907.20	10	90.98
27000.0	223.83	10	14.96

STATION ID_3 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	62.24	10	7.34
7.5	86.80	10	9.24
14.0	132.66	9	9.25
27.0	150.78	11	11.22
45.0	216.71	11	12.95
75.0	261.06	10	20.16
140.0	401.65	10	35.86
270.0	479.75	11	31.41
450.0	8.70	5	2.43
750.0	568.11	12	57.79
1400.0	129.40	3	10.95
2700.0	33.52	3	12.10
4500.0	949.38	11	62.98
7500.0	1047.20	11	35.43
14000.0	819.28	10	83.42
27000.0	2.86	12	.37

PROJECT=FOGO AZORES

STATION ID_4 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	36.31	8	9.96
7.5	3.62	11	.81
14.0	8.06	8	.90
27.0	10.18	9	.76
45.0	12.57	10	1.08
75.0	16.31	9	2.44
140.0	39.08	10	2.58
270.0	35.36	10	3.87
450.0	80.35	10	7.48
750.0	110.26	10	15.93
1400.0	22.41	4	14.03
2700.0	23.05	5	7.23
4500.0	585.89	9	79.36
7500.0	2.39	12	.25
14000.0	338.84	10	21.67
27000.0	88.16	10	10.26

STATION ID_4 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	43.89	7	8.30
7.5	9.08	9	.86
14.0	10.10	11	.48
27.0	14.51	10	.59
45.0	23.49	11	1.87
75.0	35.90	11	2.25
140.0	71.85	10	7.78
270.0	81.77	11	[illegible]
450.0	153.24	9	22.78
750.0	117.08	10	17.22
1400.0	29.49	7	5.63
2700.0	9.99	7	1.58
4500.0	414.49	12	29.72
7500.0	564.52	10	46.27
14000.0	399.00	11	63.64
27000.0	621.53	13	59.00

PROJECT=FOGO AZORES

STATION ID_5 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	83.11	5	16.16
7.5	54.41	9	3.78
14.0	64.11	10	3.10
27.0	118.23	10	6.51
45.0	147.04	11	5.97
75.0	212.82	10	10.12
140.0	257.98	10	18.21
270.0	369.62	11	27.93
450.0	272.84	10	23.75
750.0	168.37	8	26.26
2700.0	175.97	5	27.43
4500.0	3077.20	10	272.07
7500.0	2709.30	11	110.22
14000.0	749.47	10	71.11
27000.0	243.85	11	17.97

STATION ID_5 EW NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	39.97	4	12.54
7.5	28.22	10	2.40
14.0	44.61	5	6.35
27.0	47.31	10	1.70
45.0	96.15	10	7.01
75.0	125.73	10	3.75
140.0	202.98	10	11.57
270.0	333.43	10	18.81
450.0	312.84	11	19.31
750.0	67.88	7	12.56
2700.0	20.09	4	5.86
4500.0	2698.00	10	227.82
7500.0	2074.90	10	207.32
14000.0	1139.00	10	109.38
27000.0	366.37	10	178.24

PROJECT=FOGO AZORES

STATION ID_6 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	23.11	6	3.53
7.5	24.72	10	1.47
14.0	38.02	11	3.00
27.0	49.18	10	6.60
45.0	81.15	10	6.42
75.0	128.67	10	3.90
140.0	205.97	10	18.59
270.0	277.28	10	25.69
450.0	395.59	10	22.78
750.0	539.63	8	71.16
1400.0	24.70	4	27.44
2700.0	2.04	12	.48
4500.0	1227.00	11	92.05
7500.0	1388.20	10	42.51
14000.0	1034.10	10	54.25
27000.0	224.17	11	14.44

STATION ID_6 EW NO FREQ= 18

FREQ	AP-RES	N OBS	STD ERR
4.5	2.37	8	.39
4.5	30.85	4	8.38
7.5	4.57	7	.84
7.5	4.63	4	1.66
14.0	5.91	10	.68
27.0	6.75	10	.44
45.0	8.03	7	1.07
75.0	14.38	11	1.84
140.0	23.92	11	1.24
270.0	26.80	10	4.90
450.0	49.10	10	6.16
750.0	28.82	10	4.82
1400.0	16.82	9	2.34
2700.0	5.43	2	.04
4500.0	142.62	10	23.47
7500.0	143.26	10	12.44
14000.0	52.16	10	6.71
27000.0	25.08	9	3.05

PROJECT=FOGO AZORES

STATION ID_7 NS NO FREQ= 17

FREQ	AP-RES	N OBS	STD ERR
4.5	2.72	6	1.01
7.5	2.72	8	.37
14.0	3.88	12	.32
27.0	6.14	10	.27
27.0	7.26	11	.56
45.0	6.88	11	.66
75.0	9.08	10	.25
140.0	13.39	11	.88
270.0	22.06	10	1.33
450.0	32.85	10	3.18
750.0	52.92	10	5.36
1400.0	24.61	6	5.60
2700.0	2.20	3	.24
4500.0	209.13	11	28.72
7500.0	375.48	10	20.11
14000.0	299.88	10	25.42
27000.0	220.61	9	20.97

STATION ID_7 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	12.81	8	4.23
7.5	10.32	10	1.02
14.0	9.75	10	.98
27.0	16.52	10	.47
45.0	17.21	11	.95
75.0	29.85	10	4.39
140.0	38.62	11	3.09
270.0	73.38	10	9.73
450.0	110.46	11	10.93
750.0	70.70	10	13.01
1400.0	12.77	5	10.80
2700.0	3.70	5	.96
4500.0	5855.00	11	745.02
7500.0	9807.00	10	877.20
14000.0	18049.00	10	849.50
27000.0	13782.00	10	4263.70

PROJECT=FOGO AZORES

STATION ID_8 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	6.20	3	2.71
7.5	3.72	10	.29
14.0	3.79	10	.28
27.0	5.42	10	.21
45.0	8.23	10	.33
75.0	11.27	10	.60
140.0	17.83	8	1.31
270.0	32.47	10	1.99
450.0	46.91	10	4.16
750.0	113.41	7	32.28
1400.0	406.98	9	43.15
2700.0	97.84	5	27.45
4500.0	425.65	10	41.48
7500.0	432.26	10	24.32
14000.0	308.40	11	18.94
27000.0	160.30	12	19.57

STATION ID_8 EW NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	16.07	3	5.56
7.5	13.38	6	5.24
14.0	8.35	10	.60
27.0	8.33	10	.83
45.0	18.73	10	.96
75.0	28.22	11	2.58
140.0	39.38	10	2.24
270.0	77.09	11	5.39
450.0	116.39	11	15.07
750.0	109.47	7	21.23
2700.0	160.83	3	43.57
4500.0	224.16	9	19.44
7500.0	184.18	10	11.67
14000.0	238.75	11	8.26
27000.0	414.99	10	95.17

PROJECT=FOGO AZORES

STATION ID_9 NS NO FREQ= 20

FREQ	AP-RES	N OBS	STD ERR
4.5	62.08	5	21.98
7.5	91.41	10	14.37
14.0	69.32	10	8.45
27.0	72.15	10	6.65
45.0	84.64	10	9.13
75.0	119.86	10	7.29
140.0	126.67	10	5.35
270.0	247.53	10	13.87
450.0	207.17	10	16.55
750.0	395.48	8	21.60
1400.0	264.39	9	22.98
2700.0	614.78	6	102.52
2700.0	126.66	8	50.75
4500.0	898.76	5	207.67
4500.0	515.20	10	49.66
4500.0	549.76	9	108.56
7500.0	113.60	8	51.29
7500.0	2411.40	11	273.59
14000.0	502.54	8	28.83
27000.0	150.43	7	3.48

STATION ID_9 EW NO FREQ= 19

FREQ	AP-RES	N OBS	STD ERR
4.5	11.65	9	1.78
7.5	58.79	9	15.26
14.0	38.19	10	6.37
27.0	47.68	9	3.48
45.0	50.21	10	8.95
75.0	47.87	10	2.84
140.0	53.43	11	3.80
270.0	87.78	10	3.99
450.0	105.01	10	8.63
750.0	103.30	8	10.21
1400.0	149.16	9	107.28
2700.0	355.55	5	110.97
2700.0	154.15	3	19.85
4500.0	287.56	10	122.64
4500.0	589.98	7	159.96
7500.0	251.82	9	22.72
14000.0	364.25	15	15.52
14000.0	414.33	8	99.76
27000.0	67.35	10	3.37

PROJECT=FOGO AZORES

STATION ID_10 NS NO FREQ= 18

FREQ	AP-RES	N OBS	STD ERR
4.5	41.20	8	5.92
4.5	43.41	6	10.79
7.5	62.16	10	6.87
14.0	77.16	10	2.56
27.0	97.56	10	4.26
45.0	97.11	10	3.71
75.0	126.58	10	4.58
140.0	148.43	10	8.93
270.0	933.68	10	38.74
450.0	304.69	10	12.88
750.0	274.03	11	18.72
1400.0	24.34	5	19.99
1400.0	65.07	4	29.36
2700.0	24.54	8	36.80
4500.0	522.73	10	37.23
7500.0	398.83	10	10.34
14000.0	290.22	10	22.08
27000.0	230.71	11	16.14

STATION ID_10 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	63.99	10	2.19
7.5	127.83	11	7.90
14.0	168.67	10	11.63
27.0	161.28	10	11.02
45.0	420.33	12	120.32
75.0	370.21	11	23.04
140.0	486.65	11	36.12
270.0	769.97	11	48.61
450.0	909.89	11	44.28
750.0	471.41	10	100.04
1400.0	182.56	3	151.33
2700.0	65.04	4	19.14
4500.0	606.22	11	36.54
7500.0	640.37	11	31.8
14000.0	596.38	10	24.5
27000.0	591.55	10	50.76

PROJECT=FOGO AZORES

STATION ID_11 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	59.29	10	4.02
7.5	74.95	10	6.03
14.0	91.24	9	4.51
27.0	116.26	10	5.15
45.0	141.59	11	3.83
75.0	192.88	11	9.04
140.0	234.10	10	7.20
270.0	358.63	10	27.24
450.0	398.33	10	20.12
750.0	274.17	10	52.88
1400.0	901.79	3	460.84
2700.0	487.23	11	100.25
4500.0	1354.90	11	143.27
7500.0	1059.50	10	43.22
14000.0	753.81	10	43.99
27000.0	376.16	11	26.97

STATION ID_11 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	47.74	9	6.38
7.5	81.83	10	4.55
14.0	96.66	10	6.04
27.0	101.78	15	3.00
45.0	137.66	11	5.38
75.0	193.54	10	5.89
140.0	210.81	11	11.45
270.0	299.50	11	13.55
450.0	310.23	11	14.51
750.0	249.81	11	17.83
1400.0	65.18	6	125.45
2700.0	159.66	5	36.61
4500.0	489.78	10	33.82
7500.0	390.47	10	40.81
14000.0	261.86	9	26.14
27000.0	273.78	10	20.11

PROJECT=FOGO AZORES

STATION ID_12 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	155.84	7	14.34
7.5	100.88	10	3.70
14.0	135.41	10	6.89
27.0	161.42	10	6.04
45.0	172.64	10	8.37
75.0	214.88	10	8.14
140.0	229.08	11	7.73
270.0	284.13	10	12.31
450.0	230.79	11	8.02
750.0	157.92	11	16.75
1400.0	127.91	7	23.17
2700.0	980.51	14	63.58
4500.0	127.63	10	5.68
7500.0	117.89	11	12.80
14000.0	74.77	11	2.27
27000.0	63.86	9	5.42

STATION ID_12 EW NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	170.13	5	10.48
7.5	28.57	10	2.01
14.0	38.07	11	2.00
27.0	47.36	10	5.04
45.0	60.47	11	2.78
75.0	84.70	11	6.06
140.0	100.46	11	4.62
270.0	120.31.	10	11.14
450.0	150.34	11	7.13
750.0	92.98	3	27.00
1400.0	23.64	9	2.79
4500.0	36.24	11	2.46
7500.0	171.13	15	8.30
14000.0	116.48	12	9.73
27000.0	249.44	10	24.54

PROJECT=FOGO AZORES

STATION ID_13 NS NO FREQ= 17

FREQ	AP-RES	N OBS	STD ERR
4.5	17.62	8	7.90
7.5	10.37	9	.44
7.5	12.58	10	2.33
14.0	17.07	11	.82
27.0	24.04	11	.78
45.0	34.85	11	1.90
75.0	48.48	10	2.03
140.0	73.99	10	4.09
270.0	107.22	10	4.98
450.0	142.16	10	8.34
750.0	218.11	13	11.51
1400.0	71.78	9	10.44
2700.0	16.15	8	7.71
4500.0	174.33	12	7.08
7500.0	178.27	12	11.07
14000.0	106.39	13	8.59
27000.0	67.22	11	8.81

STATION ID_13 EW NO FREQ= 17

FREQ	AP-RES	N OBS	STD ERR
4.5	22.14	9	16.08
7.5	13.08	10	1.26
7.5	17.77	9	3.19
14.0	19.90	10	1.17
27.0	30.46	10	1.78
45.0	38.32	10	2.79
75.0	56.51	13	2.86
140.0	74.52	11	4.45
270.0	119.98	10	6.18
450.0	120.31	11	4.23
750.0	241.79	10	20.48
1400.0	83.22	9	40.67
2700.0	8.90	2	4.32
4500.0	125.35	10	4.98
7500.0	139.69	11	12.58
14000.0	95.46	10	11.7[illegible]
27000.0	26.79	10	3.37

PROJECT=FOGO AZORES

STATION ID_14 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	13.85	5	2.40
7.5	19.84	10	1.09
14.0	19.52	10	1.14
27.0	33.70	10	2.17
45.0	48.74	10	2.93
75.0	65.92	10	4.92
140.0	94.06	10	6.90
270.0	121.67	10	6.58
450.0	178.88	10	7.88
750.0	228.18	10	15.40
1400.0	93.23	8	37.77
2700.0	11.83	5	1.46
4500.0	211.14	10	12.75
7500.0	214.53	10	5.85
14000.0	160.79	10	5.34
27000.0	2176.60	10	145.91

STATION ID_14 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	25.30	9	4.43
7.5	23.06	10	1.77
14.0	30.32	10	1.73
27.0	45.48	10	3.84
45.0	42.87	10	8.80
75.0	112.31	10	6.23
140.0	162.80	11	11.56
270.0	245.14	10	19.49
450.0	241.10	11	13.29
750.0	328.88	10	15.94
1400.0	435.91	6	465.30
2700.0	1099.00	2	942.35
4500.0	3960.30	10	389.60
7500.0	382.71	10	65.35
14000.0	214.14	10	16.37
27000.0	3325.70	8	313.33

PROJECT=FOGO AZORES

STATION ID_15 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	10.51	6	1.94
7.5	13.88	11	1.21
14.0	16.44	11	.92
27.0	25.51	11	.78
45.0	33.16	10	1.34
75.0	51.61	10	.83
140.0	65.12	11	1.52
270.0	117.35	11	2.64
450.0	152.26	10	11.61
750.0	214.62	11	20.17
1400.0	128.01	5	45.41
2700.0	1171.00	1	0.00
4500.0	305.69	10	50.53
7500.0	282.89	10	14.61
14000.0	212.19	10	6.10
27000.0	50.56	9	4.96

STATION ID_15 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	14.46	5	.93
7.5	12.94	10	.58
14.0	16.86	12	1.47
27.0	20.20	10	.88
45.0	32.27	7	3.20
75.0	54.59	10	3.66
140.0	66.66	10	2.42
270.0	110.65	11	4.23
450.0	142.26	10	4.10
750.0	165.80	11	8.94
1400.0	137.25	8	31.39
2700.0	187.19	7	56.39
4500.0	248.34	12	24.16
7500.0	374.45	10	73.03
14000.0	147.64	11	4.85
27000.0	88.97	6	17.35

PROJECT=FOGO AZORES

STATION ID_16 NS NO FREQ= 20

FREQ	AP-RES	N OBS	STD ERR
4.5	9.85	3	.72
4.5	17.50	4	3.54
7.5	6.79	9	.78
14.0	11.02	6	1.17
14.0	10.30	5	1.82
27.0	15.75	13	.86
45.0	23.89	10	1.63
75.0	35.56	10	1.55
140.0	50.06	10	1.95
270.0	79.85	10	2.26
450.0	114.45	10	3.61
750.0	113.75	11	8.19
1400.0	59.05	5	8.35
2700.0	66.84	3	43.27
2700.0	181.00	3	14.77
4500.0	244.09	10	26.96
7500.0	192.97	11	8.06
14000.0	202.18	9	17.97
27000.0	554.08	10	77.51
27000.0	7822.10	9	809.00

STATION ID_16 EW NO FREQ= 19

FREQ	AP-RES	N OBS	STD ERR
4.5	85.39	4	35.51
4.5	173.60	4	427.92
7.5	53.40	6	34.39
14.0	42.57	11	1.39
27.0	72.75	12	4.15
45.0	96.81	13	3.65
75.0	153.33	11	7.68
140.0	224.69	11	20.74
270.0	408.02	11	22.97
450.0	551.30	11	16.97
750.0	617.95	11	26.15
1400.0	6.66	3	4.00
2700.0	46.44	5	16.22
4500.0	803.12	12	50.19
7500.0	3766.90	7	1351.10
7500.0	2700.60	8	1544.70
14000.0	1219.90	11	58.64
27000.0	3269.00	11	700.26
27000.0	1125.50	9	112.39

PROJECT=FOGO AZORES

STATION ID_17 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	33.36	5	12.97
7.5	23.13	10	2.05
14.0	30.59	12	1.29
27.0	42.54	12	1.28
45.0	45.47	10	2.70
75.0	60.96	12	3.33
140.0	81.61	13	4.05
270.0	128.71	10	6.63
450.0	154.75	10	9.52
750.0	195.64	11	19.57
1400.0	260.87	7	69.97
4500.0	247.36	10	14.70
7500.0	225.33	11	13.30
14000.0	165.56	10	11.26
27000.0	113.62	13	7.75

STATION ID_17 EW NO FREQ= 17

FREQ	AP-RES	N OBS	STD ERR
4.5	35.08	6	6.55
7.5	22.19	10	1.56
14.0	31.27	10	1.85
27.0	32.88	13	1.05
45.0	35.92	10	1.78
75.0	47.72	10	2.10
140.0	66.65	10	3.63
270.0	108.40	10	3.42
450.0	97.24	10	3.84
750.0	103.52	11	7.82
1400.0	251.56	12	55.63
4500.0	103.40	12	20.89
7500.0	29.25	9	3.45
7500.0	25.92	10	5.17
14000.0	70.49	12	7.95
27000.0	63.17	4	19.17
27000.0	50.15	10	8.89

PROJECT=FOGO AZORES

STATION ID_18 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
7.5	171.07	5	47.53
14.0	141.01	9	15.86
27.0	177.42	12	12.76
45.0	238.68	10	17.71
75.0	291.49	10	25.88
140.0	496.63	10	50.55
270.0	949.40	10	169.09
450.0	1206.50	12	98.88
750.0	1491.30	11	97.48
1400.0	12418.00	10	10544.00
4500.0	6414.10	10	1333.50
7500.0	1691.70	10	143.14
14000.0	453.53	11	30.74
27000.0	104.58	10	[illegible].59

STATION ID_18 EW NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
7.5	327.08	10	67.12
14.0	244.41	8	37.89
14.0	265.09	7	395.49
27.0	175.22	10	11.35
45.0	240.32	11	11.01
75.0	318.11	10	28.82
140.0	413.49	10	41.14
270.0	951.30	12	42.39
450.0	1521.30	8	602.11
750.0	1838.70	10	233.09
1400.0	18894.00	6	5920.50
4500.0	13129.00	12	4271.40
7500.0	2227.20	8	425.07
14000.0	435.08	10	93.66
27000.0	40.74	10	2.24

PROJECT=FOGO AZORES

STATION ID_19 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	3.09	5	.54
7.5	2.43	11	.23
14.0	2.99	12	.16
27.0	4.82	11	.44
45.0	6.92	11	.49
75.0	10.24	10	.65
140.0	12.43	11	.65
450.0	33.90	10	1.22
750.0	53.51	10	4.06
1400.0	38.06	4	13.79
4500.0	197.19	10	13.30
7500.0	230.11	10	12.41
14000.0	159.60	10	17.56
27000.0	82.10	10	9.23

STATION ID_19 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	10.21	5	1.77
7.5	4.86	9	.24
14.0	7.53	9	.83
27.0	11.24	10	.41
45.0	17.00	10	3.25
75.0	19.29	10	1.63
140.0	33.19	10	1.62
270.0	20.22	11	.79
270.0	59.52	11	3.22
450.0	75.27	10	2.44
750.0	104.42	10	2.97
1400.0	53.40	9	12.36
4500.0	180.46	10	12.44
7500.0	262.70	9	5.54
14000.0	265.31	10	9.56
27000.0	96.05	9	13.05

PROJECT=FOGO AZORES

STATION ID_20 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	8.60	6	5.69
7.5	5.53	10	.29
14.0	8.62	10	.65
27.0	12.06	10	.71
45.0	14.96	10	.86
75.0	29.10	10	1.85
140.0	34.93	11	1.67
270.0	92.99	10	13.22
450.0	109.84	10	9.77
750.0	211.65	11	14.70
1400.0	69.66	9	15.72
4500.0	604.54	10	33.85
7500.0	330.81	11	36.88
14000.0	311.65	10	23.25
27000.0	69.62	10	13.99

STATION ID_20 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	8.83	8	2.79
7.5	6.55	10	1.09
14.0	6.76	10	.53
27.0	9.56	13	.50
45.0	13.98	11	.77
75.0	20.83	10	1.44
75.0	21.37	12	1.12
140.0	33.73	10	2.05
270.0	72.89	11	3.21
450.0	89.63	10	4.12
750.0	135.10	10	4.76
1400.0	52.80	5	10.98
4500.0	196.02	11	12.01
7500.0	261.71	10	13.77
14000.0	250.90	11	15.04
27000.0	104.81	9	12.03

PROJECT=FOGO AZORES

STATION ID_21 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	58.96	10	3.26
7.5	78.80	10	3.14
14.0	114.03	10	5.44
27.0	163.71	10	5.99
45.0	205.66	10	11.40
75.0	327.90	11	12.31
140.0	339.32	12	12.77
270.0	556.32	10	25.21
450.0	585.47	10	30.91
750.0	762.84	10	66.87
1400.0	159.41	5	36.61
4500.0	1004.60	10	104.19
7500.0	801.67	10	21.93
14000.0	293.68	13	46.43
27000.0	160.12	12	23.72

STATION ID_21 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	26.58	7	5.91
7.5	29.99	6	3.96
14.0	34.34	9	2.01
27.0	51.15	15	2.37
45.0	56.93	10	2.41
75.0	94.92	11	5.09
140.0	116.28	10	4.83
270.0	210.89	9	9.02
450.0	202.49	10	12.74
750.0	248.12	10	17.15
1400.0	35.91	4	5.98
4500.0	437.19	9	36.03
4500.0	548.11	9	79.84
7500.0	746.26	10	103.14
14000.0	3901.50	9	319.17
27000.0	87.19	7	16.61

PROJECT=FOGO AZORES

NO DATA N-S

STATION ID_22 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	21.65	6	3.82
7.5	26.55	8	2.41
7.5	28.55	9	3.70
14.0	37.80	10	2.81
27.0	46.38	11	3.12
45.0	72.90	10	5.52
75.0	124.39	10	5.81
140.0	192.62	10	13.98
270.0	324.64	8	27.43
450.0	420.35	10	33.82
750.0	513.10	10	59.69
1400.0	403.03	6	56.02
4500.0	726.67	6	112.8[illegible]
7500.0	608.37	10	82.[illegible]
14000.0	297.62	10	10.37
27000.0	862.37	10	147.57

PROJECT=FOGO AZORES

STATION ID_23 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	82.22	6	11.17
7.5	134.47	11	4.27
14.0	158.88	11	12.80
27.0	221.02	10	8.88
45.0	300.64	10	27.03
75.0	529.60	10	31.55
140.0	775.91	10	38.35
270.0	1043.80	10	88.42
450.0	1275.70	10	97.63
750.0	1664.20	10	122.71
1400.0	440.35	4	141.38
4500.0	3010.80	7	242.09
7500.0	4355.50	9	345.30
14000.0	2798.90	12	171.20
27000.0	449.26	10	48.91

STATION ID_23 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	47.05	11	5.26
7.5	53.80	10	8.30
14.0	78.69	10	10.32
27.0	116.31	12	8.88
45.0	110.70	7	11.57
75.0	176.61	10	14.70
140.0	367.68	10	16.19
270.0	653.32	13	56.95
450.0	755.65	10	226.11
750.0	785.80	6	218.64
750.0	1071.40	7	360.81
1400.0	349.42	2	364.79
4500.0	1803.90	13	148.89
7500.0	1372.00	10	91.20
14000.0	1046.40	9	407.24
27000.0	169.14	13	17.01

PROJECT=FOGO AZORES

STATION ID_24 NS NO FREQ= 5

FREQ	AP-RES	N OBS	STD ERR
27.0	.70	6	.29
45.0	2.08	9	.14
75.0	3.08	10	.13
140.0	4.69	10	.19
270.0	7.63	11	.63

STATION ID_24 EW NO FREQ= 5

FREQ	AP-RES	N OBS	STD ERR
27.0	2.59	6	.76
45.0	1.59	6	.45
75.0	3.47	9	.19
140.0	6.28	8	.47
270.0	20.29	8	3.90

PROJECT=FOGO AZORES

STATION ID_25 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	133.20	3	21.71
7.5	3.38	11	.45
14.0	2.62	10	.32
27.0	3.29	11	.37
45.0	5.20	9	.68
75.0	6.39	14	.48
140.0	12.51	10	1.22
270.0	27.82	10	1.66
450.0	35.55	11	3.56
750.0	42.18	10	3.16
1400.0	38.95	4	17.36
4500.0	170.64	10	17.28
7500.0	154.42	11	10.59
14000.0	192.85	10	12.55
27000.0	666.64	9	57.62

STATION ID_25 EW NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	9.68	1	0.00
7.5	3.03	7	.23
14.0	3.39	9	.33
27.0	5.37	11	.22
45.0	7.84	12	.51
75.0	11.76	10	.82
140.0	23.92	11	1.24
270.0	49.56	12	2.88
450.0	58.77	11	4.34
750.0	77.32	10	10.99
1400.0	11.29	3	5.20
4500.0	11.23	10	1.13
7500.0	448.89	9	152.35
14000.0	381.19	10	13.07
27000.0	957.26	11	255.12

PROJECT=FOGO AZORES

STATION ID_26 NS NO FREQ= 17

FREQ	AP-RES	N OBS	STD ERR
4.5	16.87	4	7.15
4.5	5.36	10	.44
7.5	23.38	10	3.48
14.0	23.47	11	4.29
27.0	31.00	10	2.30
75.0	58.77	11	2.36
140.0	63.46	10	5.92
270.0	227.21	11	21.27
450.0	207.41	10	22.87
750.0	370.34	11	28.01
1400.0	2944.40	4	1077.90
1400.0	3588.70	9	1709.40
2700.0	458.21	4	692.69
4500.0	4365.90	9	652.31
7500.0	1210.70	11	79.59
14000.0	383.04	11	21.79
27000.0	1868.90	10	526.91

STATION ID_26 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	75.32	3	32.34
7.5	51.19	10	6.99
14.0	45.00	11	3.58
27.0	67.33	11	4.62
45.0	109.17	10	5.98
75.0	139.59	10	9.82
140.0	147.58	10	8.23
270.0	565.94	10	35.36
450.0	409.72	10	90.73
750.0	452.89	11	39.31
1400.0	3346.30	7	731.33
2700.0	2014.80	5	566.97
4500.0	462.79	10	138.06
7500.0	548.94	11	48.26
14000.0	624.02	9	167.88
27000.0	1260.10	7	167.06

PROJECT=FOGO AZORES

STATION ID_27 NS NO FREQ= 17

FREQ	AP-RES	N OBS	STD ERR
4.5	26.32	3	16.02
4.5	101.26	2	45.36
7.5	4.68	10	.22
14.0	7.31	11	.36
27.0	11.38	10	.93
45.0	13.33	10	.55
75.0	22.22	10	1.22
140.0	30.27	10	1.67
270.0	56.60	10	1.99
450.0	52.42	11	1.15
750.0	126.43	10	5.46
1400.0	264.47	9	34.13
2700.0	46.58	5	30.87
4500.0	387.02	13	23.04
7500.0	116.80	11	8.73
14000.0	386.56	12	34.93
27000.0	1341.80	12	143.87

STATION ID_27 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	35.82	2	3.92
7.5	6.60	10	1.25
14.0	1.65	11	.17
27.0	9.70	12	1.06
45.0	11.10	10	1.78
75.0	22.61	11	2.77
140.0	24.70	10	4.82
270.0	28.54	10	2.44
450.0	35.53	11	5.83
750.0	42.95	10	3.50
1400.0	147.22	6	31.44
2700.0	91.53	5	16.60
4500.0	473.31	12	77.57
7500.0	277.32	10	29.43
14000.0	648.32	10	89.16
27000.0	672.73	10	207.98

PROJECT=FOGO AZORES

STATION ID_28 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	4.42	4	.93
7.5	2.44	6	2.90
14.0	.50	11	.07
27.0	.72	12	.06
45.0	.94	11	.09
75.0	1.31	10	.09
140.0	1.68	11	.10
270.0	3.89	10	[illegible]
450.0	4.84	13	.35
750.0	9.45	9	1.22
1400.0	43.00	5	12.62
2700.0	36.69	3	25.30
4500.0	51.60	10	5.45
7500.0	56.92	10	[illegible]
14000.0	74.38	11	[illegible]
27000.0	93.34	10	15.11

STATION ID_28 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	46.95	3	10.95
7.5	5.76	5	1.16
14.0	3.36	13	.24
27.0	4.50	10	.33
45.0	5.65	12	.32
75.0	10.13	11	.55
140.0	17.62	10	.97
270.0	34.81	12	1.08
450.0	44.43	11	2.03
750.0	58.36	10	3.45
1400.0	81.11	7	36.00
2700.0	53.09	4	27.22
4500.0	213.06	10	31.57
7500.0	196.22	10	9.27
14000.0	274.70	10	18.01
27000.0	270.98	8	41.71

PROJECT=FOGO AZORES

NO DATA N-S

STATION ID_29 EW NO FREQ= 10

FREQ	AP-RES	N OBS	STD ERR
4.5	14.82	3	120.97
7.5	14.82	9	38.79
7.5	17.86	6	97.36
14.0	19.51	10	57.88
27.0	27.03	10	62.26
27.0	22.47	12	86.29
45.0	37.33	11	78.99
75.0	41.67	10	87.81
140.0	70.01	10	347.98
270.0	195.44	6	1372.30

PROJECT=FOGO AZORES

STATION ID_30 NS NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	13.08	4	5.82
7.5	11.40	10	1.17
7.5	12.25	7	1.05
14.0	15.04	10	1.01
27.0	19.39	13	1.04
45.0	33.43	10	1.16
75.0	49.43	11	2.64
140.0	81.44	10	2.38
270.0	107.38	12	9.28
450.0	205.11	10	17.71
750.0	268.03	10	27.61
1400.0	160.02	4	25.79
4500.0	1703.20	10	266.55
7500.0	1451.20	11	53.13
14000.0	782.80	11	39.14
27000.0	383.81	10	66.55

STATION ID_30 EW NO FREQ= 16

FREQ	AP-RES	N OBS	STD ERR
4.5	16.74	5	3.99
7.5	13.11	10	1.14
14.0	16.98	9	1.19
27.0	19.96	14	1.04
45.0	24.83	12	1.87
75.0	49.21	10	2.47
140.0	74.58	12	4.77
270.0	108.78	13	7.70
450.0	177.85	10	19.86
750.0	290.09	10	23.72
1400.0	18.54	3	3.08
2700.0	57.56	2	28.79
4500.0	6433.60	10	447.05
7500.0	723.62	10	21.06
14000.0	344.95	10	48.87
27000.0	123.27	11	10.83

PROJECT=FOGO AZORES

NO DATA N-S

STATION ID_31 EW NO FREQ= 9

FREQ	AP-RES	N OBS	STD ERR
4.5	26.10	2	6.39
4.5	2.78	2	.40
7.5	71.32	10	7.75
14.0	97.92	10	9.65
27.0	153.26	13	11.23
45.0	263.36	12	44.35
75.0	326.45	11	16.22
140.0	464.69	11	31.45
270.0	686.08	11	83.37

PROJECT=FOGO AZORES

STATION ID_32 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	15.72	4	4.[illegible]
7.5	7.99	3	4.24
14.0	9.72	6	2.86
27.0	10.40	12	1.76
45.0	13.26	11	.93
75.0	20.45	11	.50
140.0	26.95	10	.84
270.0	67.48	15	.83
450.0	67.49	10	1.87
750.0	71.14	10	2.05
4500.0	402.66	10	6.47
7500.0	178.46	7	11.39
14000.0	501.64	6	42.28
27000.0	456.89	7	58.98

STATION ID_32 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	12.26	3	4.24
7.5	6.18	6	2.86
14.0	4.85	11	.50
27.0	8.40	12	.56
45.0	8.74	11	.60
75.0	12.06	11	.75
140.0	26.91	11	1.07
270.0	28.61	10	1.92
450.0	59.79	10	8.92
750.0	35.94	5	16.94
4500.0	85.41	10	17.51
7500.0	221.65	10	17.72
14000.0	386.79	10	22.16
27000.0	769.80	6	75.45

PROJECT=FOGO AZORES

NO DATA N-S

STATION ID_33 EW NO FREQ= 7

FREQ	AP-RES	N OBS	STD ERR
7.5	45.47	9	6.38
14.0	28.77	9	5.23
27.0	40.88	10	3.86
45.0	60.85	11	12.40
75.0	81.09	9	10.77
140.0	91.68	10	10.49
270.0	210.36	7	24.14

PROJECT=FOGO AZORES

STATION ID_34 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	91.39	4	21.75
7.5	80.55	10	7.80
14.0	93.86	9	15.84
27.0	124.26	10	11.66
45.0	131.23	10	12.22
75.0	133.09	10	18.51
140.0	144.48	10	17.87
270.0	166.07	8	41.54
450.0	224.43	10	26.90
750.0	148.25	12	17.64
4500.0	223.35	10	35.11
7500.0	218.05	10	35.47
14000.0	216.55	10	30.38
27000.0	611.76	7	239.82

STATION ID_34 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	24.98	9	5.57
7.5	40.99	10	5.53
14.0	47.21	13	1.76
27.0	67.57	11	4.27
45.0	75.00	10	3.47
75.0	107.42	11	9.34
140.0	115.73	10	8.17
270.0	125.81	11	7.62
450.0	135.75	10	6.14
750.0	107.91	7	10.85
4500.0	181.11	12	36.40
7500.0	228.22	10	15.59
14000.0	187.94	11	9.48
27000.0	194.98	12	36.94

PROJECT=FOGO AZORES

STATION ID_35 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	96.86	3	11.57
7.5	300.01	10	31.54
14.0	327.00	10	55.82
27.0	136.54	11	24.99
45.0	412.14	8	50.17
75.0	677.76	10	70.39
140.0	626.02	8	95.14
270.0	1169.50	10	237.13
450.0	762.64	11	175.55
750.0	646.82	7	47.11
4500.0	1141.30	10	175.38
7500.0	1411.90	11	192.17
14000.0	1563.50	4	1015.50
27000.0	144.77	8	22.81

STATION ID_35 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	116.90	6	27.61
7.5	340.83	9	25.32
14.0	437.27	10	20.51
27.0	506.48	11	31.11
45.0	701.41	10	63.97
75.0	783.53	10	38.28
140.0	1027.70	10	89.70
270.0	932.17	13	44.29
450.0	985.81	8	32.47
750.0	516.08	11	60.33
4500.0	1821.10	10	162.12
7500.0	2519.70	11	472.87
14000.0	1914.50	13	403.30
27000.0	3877.90	5	1348.90

PROJECT=FOGO AZORES

STATION ID_36 NS NO FREQ= 13

FREQ	AP-RES	N OBS	STD ERR
4.5	78.37	13	8.02
7.5	82.27	11	3.54
14.0	74.92	10	7.11
27.0	109.13	12	7.29
45.0	120.35	10	5.79
75.0	141.22	10	6.16
140.0	164.94	10	12.16
270.0	231.13	10	8.01
450.0	149.66	5	28.73
4500.0	2764.10	9	341.65
7500.0	509.06	11	49.16
14000.0	225.29	10	34.40
27000.0	145.00	7	12.99

STATION ID_36 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	26.78	6	14.49
7.5	19.93	11	1.91
14.0	18.85	10	2.48
27.0	34.88	12	1.84
45.0	42.21	11	2.63
75.0	66.25	11	9.08
140.0	80.06	11	4.77
270.0	121.17	10	6.72
450.0	107.23	10	7.66
750.0	166.43	2	28.61
4500.0	182.27	8	34.85
7500.0	494.71	10	127.57
14000.0	195.46	10	27.61
27000.0	52.68	6	11.54

PROJECT=FOGO AZORES

STATION ID_37 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	10.15	7	1.84
7.5	18.55	10	.69
14.0	21.56	9	1.00
27.0	39.12	13	2.39
45.0	48.79	11	3.42
75.0	77.90	10	4.73
140.0	108.25	12	5.62
270.0	215.52	10	13.89
450.0	467.01	11	34.19
750.0	432.25	5	43.39
4500.0	563.81	10	53.13
7500.0	687.54	13	79.18
14000.0	236.90	10	24.98
27000.0	53.31	9	7.79

STATION ID_37 EW NO FREQ= 17

FREQ	AP-RES	N OBS	STD ERR
4.5	15.70	2	3.36
4.5	19.51	3	15.02
7.5	10.47	10	1.93
14.0	19.24	8	4.27
14.0	16.79	10	1.66
27.0	20.02	12	3.47
45.0	19.90	8	3.98
75.0	26.42	9	2.79
140.0	56.48	5	14.83
270.0	117.81	4	40.18
270.0	70.47	8	15.28
450.0	71.17	7	22.09
750.0	53.96	5	14.33
4500.0	51.50	11	14.23
7500.0	106.61	11	11.28
14000.0	132.14	6	22.65
27000.0	213.29	5	24.01

PROJECT=FOGO AZORES

STATION ID_38 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	9.03	9	1.06
7.5	11.47	10	.64
14.0	12.77	11	.66
27.0	22.40	5	7.20
45.0	27.85	11	2.00
75.0	37.82	11	2.65
140.0	51.82	10	3.45
270.0	88.07	7	14.99
450.0	133.58	10	13.25
750.0	262.89	10	25.65
4500.0	640.79	10	108.25
7500.0	427.93	11	55.02
14000.0	515.45	11	30.62
27000.0	145.88	10	13.50

STATION ID_38 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	23.21	4	4.39
7.5	9.81	11	1.23
14.0	12.01	10	.99
27.0	17.56	14	1.98
45.0	20.52	11	1.73
75.0	26.82	10	1.50
140.0	42.13	11	2.43
270.0	291.27	12	17.36
450.0	82.83	10	11.59
750.0	48.93	8	20.41
4500.0	319.22	10	170.43
7500.0	170.34	10	18.25
14000.0	239.62	9	60.52
27000.0	465.25	6	143.93

PROJECT=FOGO AZORES

STATION ID_39 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	6.87	5	2.91
7.5	11.22	12	1.05
14.0	12.13	9	1.15
27.0	30.88	11	2.73
45.0	29.97	10	3.29
75.0	62.50	11	1.82
140.0	105.21	10	7.47
270.0	269.12	12	5.52
450.0	253.43	11	7.71
750.0	219.83	4	97.02
4500.0	1005.00	9	55.39
7500.0	951.77	9	51.74
14000.0	443.66	9	79.47
27000.0	384.32	12	112.49

STATION ID_39 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	28.06	5	4.16
7.5	22.56	10	2.04
14.0	37.01	10	2.44
27.0	50.76	10	1.54
45.0	78.25	10	2.69
75.0	121.18	10	4.07
140.0	172.61	11	13.05
270.0	285.24	10	16.91
450.0	233.51	10	10.94
750.0	937.76	2	310.51
4500.0	5193.80	10	461.38
7500.0	367.92	11	36.70
14000.0	310.35	12	9.87
27000.0	174.65	9	13.53

PROJECT=FOGO AZORES

STATION ID_40 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	9.66	7	3.47
7.5	7.44	11	.52
14.0	10.24	10	.21
27.0	16.72	12	1.21
45.0	21.16	12	.75
75.0	32.64	10	1.75
140.0	55.13	10	3.19
270.0	93.80	12	14.86
450.0	147.56	10	8.01
750.0	189.54	10	13.26
4500.0	377.53	10	53.72
7500.0	347.08	11	45.16
14000.0	222.69	11	8.20
27000.0	118.63	7	32.08
27000.0	91.29	8	7.70

STATION ID_40 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	8.02	7	2.13
7.5	7.50	12	1.10
14.0	10.24	13	.87
27.0	14.82	13	.65
45.0	19.84	11	1.41
75.0	36.61	11	1.51
140.0	58.35	12	3.10
270.0	102.75	14	3.94
450.0	142.68	11	4.75
750.0	169.56	8	6.52
4500.0	412.50	10	85.78
7500.0	303.57	10	55.[illegible]4
14000.0	130.26	8	12.56
27000.0	57.49	11	11.77

PROJECT=FOGO AZORES

STATION ID_41 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	39.63	10	3.23
7.5	73.66	10	3.10
14.0	105.52	11	5.57
27.0	149.91	10	7.34
45.0	190.56	10	12.72
75.0	261.07	10	19.33
140.0	334.55	10	26.76
270.0	683.78	11	54.26
450.0	926.17	10	89.16
750.0	1025.60	9	96.93
4500.0	3446.60	9	451.55
7500.0	2856.50	11	104.75
14000.0	3609.50	11	272.28
27000.0	3722.90	5	2034.30
27000.0	3401.10	8	676.21

STATION ID_41 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	36.08	11	5.36
7.5	42.96	10	2.20
14.0	56.35	11	3.20
27.0	65.63	12	2.86
45.0	97.72	10	8.56
75.0	147.94	11	4.41
140.0	259.22	10	25.99
270.0	419.05	11	36.61
450.0	543.09	8	93.10
750.0	505.37	8	88.64
4500.0	1117.80	9	66.36
7500.0	1706.40	11	99.73
14000.0	2350.80	6	623.66
27000.0	433.94	8	114.68

PROJECT=FOGO AZORES

STATION ID_42 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	12.02	4	1.15
4.5	15.89	3	4.27
7.5	18.52	10	1.79
14.0	31.73	10	3.24
27.0	34.67	11	3.97
45.0	60.43	7	6.98
75.0	157.82	10	27.16
140.0	217.18	11	18.33
270.0	404.81	8	52.63
750.0	423.67	4	82.74
4500.0	168.96	10	14.42
7500.0	215.13	10	33.12
14000.0	330.61	10	53.58
27000.0	771.53	10	97.91

NO DATA E-W

PROJECT=FOGO AZORES

STATION ID_43 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	66.24	1	0.00
7.5	98.96	9	9.13
14.0	83.89	10	6.75
27.0	117.81	11	8.29
45.0	190.01	10	28.60
75.0	291.20	10	18.41
140.0	334.80	10	18.02
270.0	600.99	10	56.85
450.0	894.48	9	41.33
750.0	994.86	7	71.07
4500.0	1832.10	11	87.05
7500.0	2042.60	12	61.65
14000.0	1025.10	12	24.18
27000.0	151.26	12	5.55

STATION ID_43 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	65.29	6	39.75
7.5	50.82	10	7.31
14.0	36.62	10	1.86
27.0	61.18	12	2.50
45.0	91.11	11	13.36
75.0	117.03	11	6.19
140.0	158.61	9	10.86
270.0	250.73	10	31.83
450.0	176.05	4	18.38
750.0	520.29	5	43.42
4500.0	1432.00	10	52.73
7500.0	1067.00	6	87.29
14000.0	418.89	10	16.59
27000.0	140.78	7	5.31

PROJECT=FOGO AZORES

STATION ID_44 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	33.40	3	5.36
7.5	9.18	9	1.99
14.0	6.10	11	.41
27.0	9.28	10	.61
45.0	12.90	10	1.41
75.0	17.19	11	1.21
140.0	20.52	9	1.97
270.0	34.93	11	4.09
450.0	46.18	3	1.65
750.0	54.58	6	10.16
4500.0	120.25	10	7.34
7500.0	193.36	10	36.92
14000.0	89.64	11	4.96
27000.0	34.91	10	6.13

STATION ID_44 EW NO FREQ= 12

FREQ	AP-RES	N OBS	STD ERR
4.5	34.69	5	17.34
7.5	12.03	10	1.86
14.0	9.63	10	1.23
27.0	12.72	12	1.62
45.0	13.41	10	1.60
75.0	20.11	10	2.21
140.0	29.52	10	2.50
270.0	34.71	9	7.59
4500.0	123.10	12	5.50
7500.0	235.70	12	5.68
14000.0	171.44	12	5.16
27000.0	97.00	5	11.14

PROJECT=FOGO AZORES

STATION ID_45 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	3.39	6	.28
7.5	7.98	10	.75
14.0	7.74	10	.48
27.0	15.64	13	.70
45.0	20.40	10	1.85
75.0	33.45	10	2.18
140.0	56.38	10	3.01
270.0	80.10	10	6.98
450.0	145.44	5	20.10
750.0	48.30	3	72.92
4500.0	64.20	3	5.26
7500.0	266.47	13	7.36
14000.0	195.93	11	2.80
27000.0	59.80	10	3.69

STATION ID_45 EW NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	24.83	10	4.11
7.5	29.66	11	3.26
14.0	38.91	10	2.93
27.0	47.64	11	2.53
45.0	72.48	10	7.98
75.0	127.11	10	6.28
140.0	159.27	10	14.38
270.0	300.96	11	19.26
450.0	345.07	10	14.52
750.0	126.42	3	64.22
750.0	113.70	2	24.68
4500.0	1844.10	10	171.97
7500.0	526.00	10	10.43
14000.0	257.76	9	7.13
27000.0	151.79	9	11.48

PROJECT=FOGO AZORES

STATION ID_46 NS NO FREQ= 13

FREQ	AP-RES	N OBS	STD ERR
4.5	6.20	3	1.43
7.5	4.43	7	.39
14.0	5.54	9	1.02
27.0	6.69	10	.64
45.0	9.60	11	.79
75.0	11.57	11	.55
140.0	15.53	11	.43
270.0	24.13	9	2.16
450.0	49.22	10	2.10
750.0	43.35	6	6.42
4500.0	24.81	8	3.37
14000.0	103.51	10	3.01
27000.0	69.06	9	3.72

STATION ID_46 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	22.47	3	2.88
7.5	14.41	11	2.13
14.0	9.86	10	.57
27.0	17.40	7	1.81
45.0	19.89	10	2.65
75.0	29.16	11	4.00
140.0	32.10	11	3.89
270.0	55.70	10	5.35
450.0	73.00	9	7.11
750.0	50.61	5	10.20
4500.0	57.14	9	5.43
7500.0	208.56	12	9.10
14000.0	157.42	11	4.48
27000.0	410.65	8	66.39

PROJECT=FOGO AZORES

STATION ID_48 NS NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	82.52	3	10.87
7.5	30.70	11	5.61
14.0	34.57	10	2.73
27.0	55.82	10	6.23
45.0	43.39	11	3.83
75.0	55.95	11	5.80
140.0	63.25	10	5.43
270.0	92.97	11	4.42
450.0	99.82	11	7.44
750.0	115.20	10	7.84
4500.0	160.26	11	5.80
7500.0	186.02	11	14.28
14000.0	166.56	10	11.38
27000.0	91.62	11	12.66
27000.0	74.10	6	7.23

STATION ID_48 EW NO FREQ= 15

FREQ	AP-RES	N OBS	STD ERR
4.5	46.28	10	11.19
7.5	27.04	10	3.11
14.0	31.82	11	3.41
27.0	47.97	9	5.39
45.0	72.32	10	11.33
75.0	100.56	8	12.59
140.0	115.64	10	12.57
270.0	84.52	10	14.58
450.0	152.11	7	21.49
750.0	70.20	8	26.85
4500.0	146.57	10	6.47
7500.0	186.48	11	7.83
14000.0	176.42	11	38.04
27000.0	21.33	5	6.62
27000.0	107.65	6	20.93

PROJECT=FOGO AZORES

STATION ID_49 NS NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	3.03	10	.46
7.5	6.07	11	.97
14.0	6.23	11	.62
27.0	8.88	13	1.70
45.0	7.55	9	.73
75.0	9.87	13	.87
140.0	13.01	9	3.36
270.0	19.63	13	1.01
450.0	29.39	10	4.07
750.0	35.90	9	9.39
4500.0	508.30	11	15.32
7500.0	546.08	11	30.91
14000.0	456.35	10	49.54
27000.0	221.93	7	66.05

STATION ID_49 EW NO FREQ= 14

FREQ	AP-RES	N OBS	STD ERR
4.5	12.21	12	2.91
7.5	19.07	10	3.10
14.0	36.02	10	3.60
27.0	38.27	10	5.61
45.0	35.10	11	5.11
75.0	54.83	7	9.83
140.0	121.08	10	17.59
270.0	71.47	9	24.08
450.0	149.42	10	29.11
750.0	141.81	9	36.64
4500.0	149.61	11	18.74
7500.0	294.09	10	13.64
14000.0	429.86	11	14.66
27000.0	1361.70	12	222.93

PROJECT=FOGO AZORES

STATION ID_50 NS NO FREQ= 14

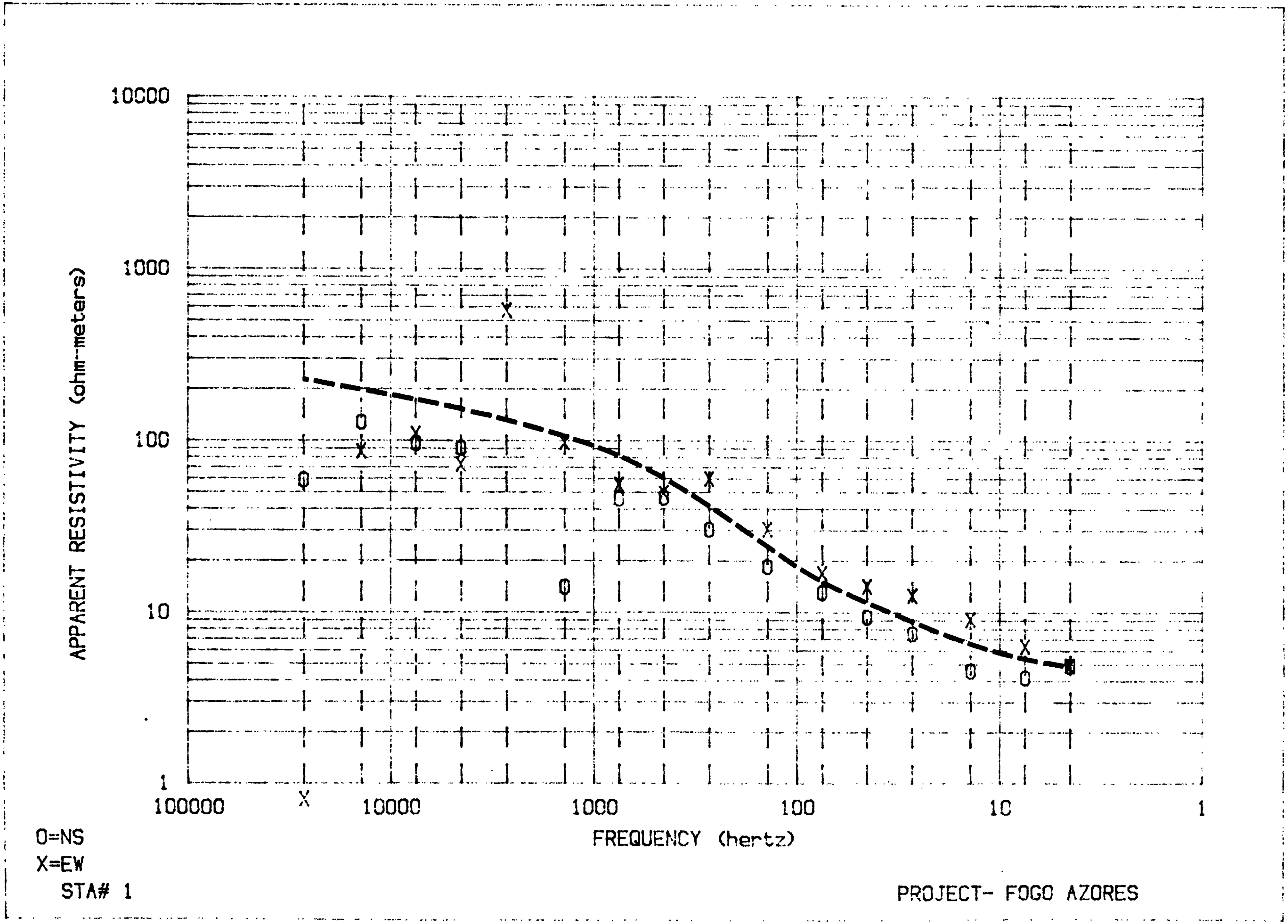
FREQ	AP-RES	N OBS	STD ER
4.5	177.74	3	32.1
7.5	143.07	10	12.0
14.0	176.06	10	12.4
27.0	169.11	10	11.0
45.0	203.34	10	12.
75.0	131.71	10	12.5
140.0	206.13	10	8.1
270.0	234.54	10	11.
450.0	360.63	6	75.8
750.0	318.83	2	53.
4500.0	401.05	9	20.
7500.0	722.99	10	35.
14000.0	524.23	6	30.
27000.0	123.90	5	5.

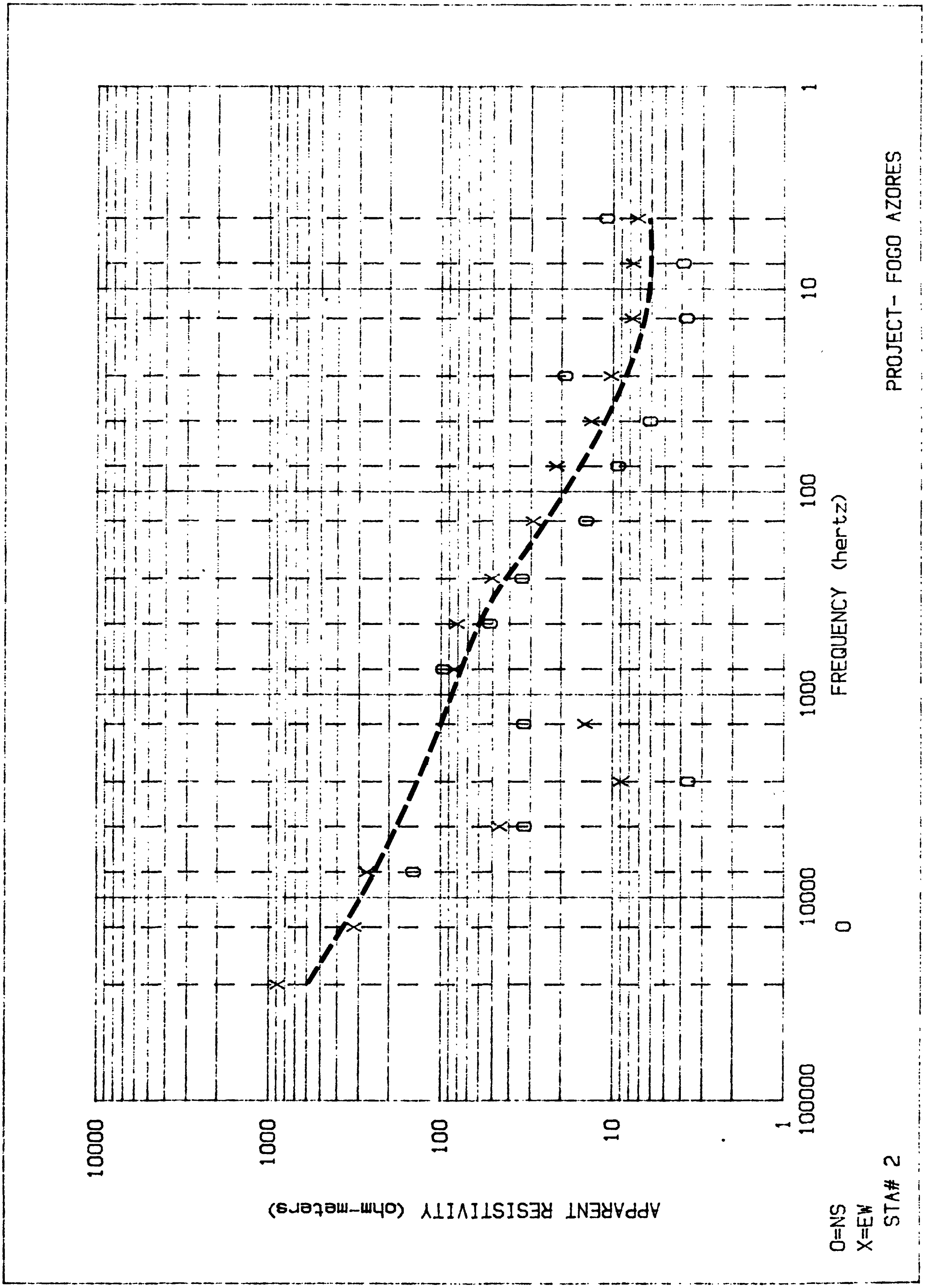
STATION ID_50 EW NO FREQ= 14

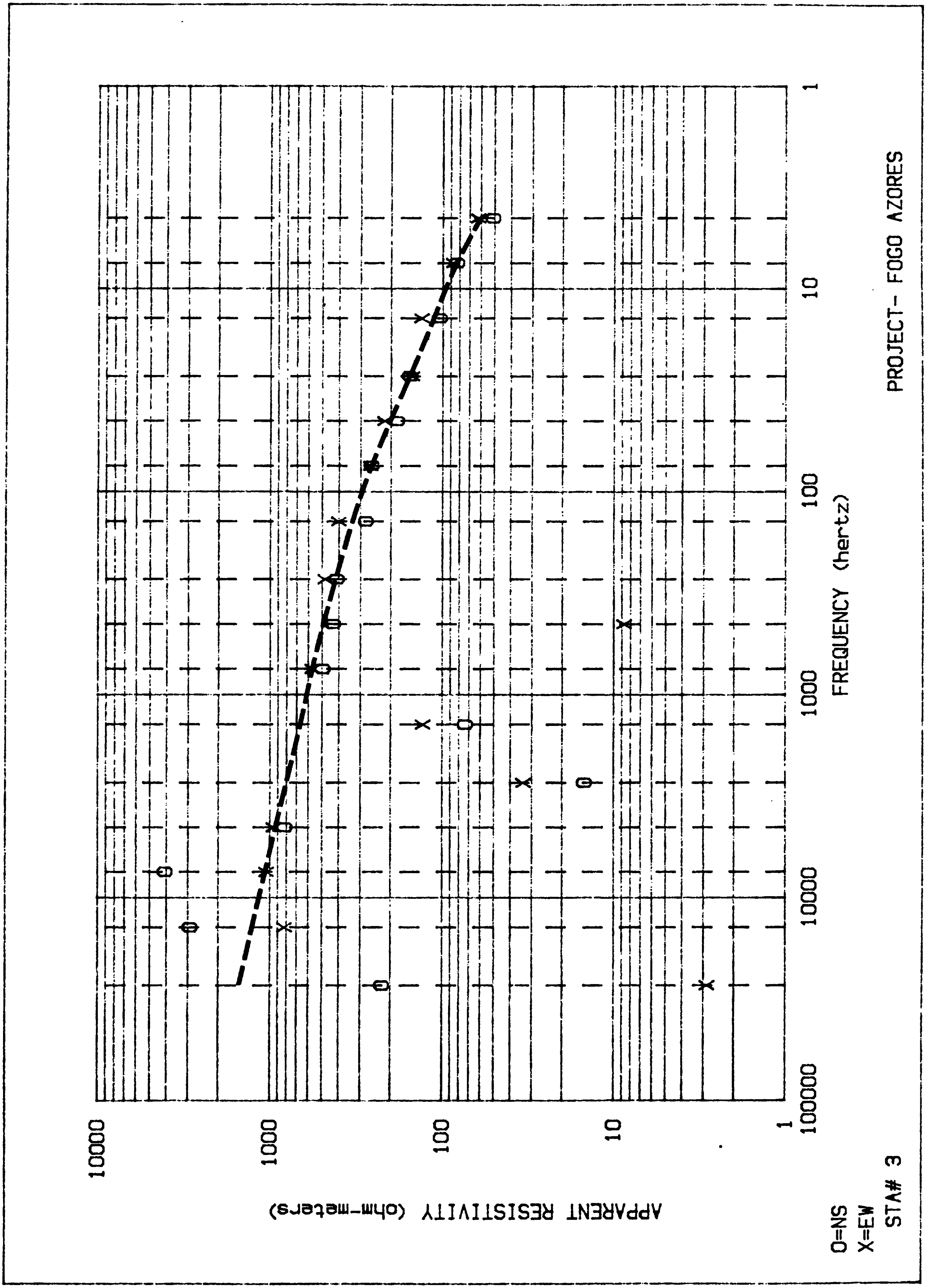
FREQ	AP-RES	N OBS	STD E
4.5	272.51	4	20.
7.5	263.00	5	82.
14.0	181.00	9	11.
27.0	182.00	10	11.
45.0	173.08	10	22.
75.0	189.80	10	12.
140.0	287.64	10	25.
270.0	234.13	10	12.
450.0	372.69	5	36.
750.0	298.56	1	0.
4500.0	430.75	4	137
7500.0	879.85	9	33
14000.0	682.02	10	23
27000.0	163.40	5	5

Appendix 2

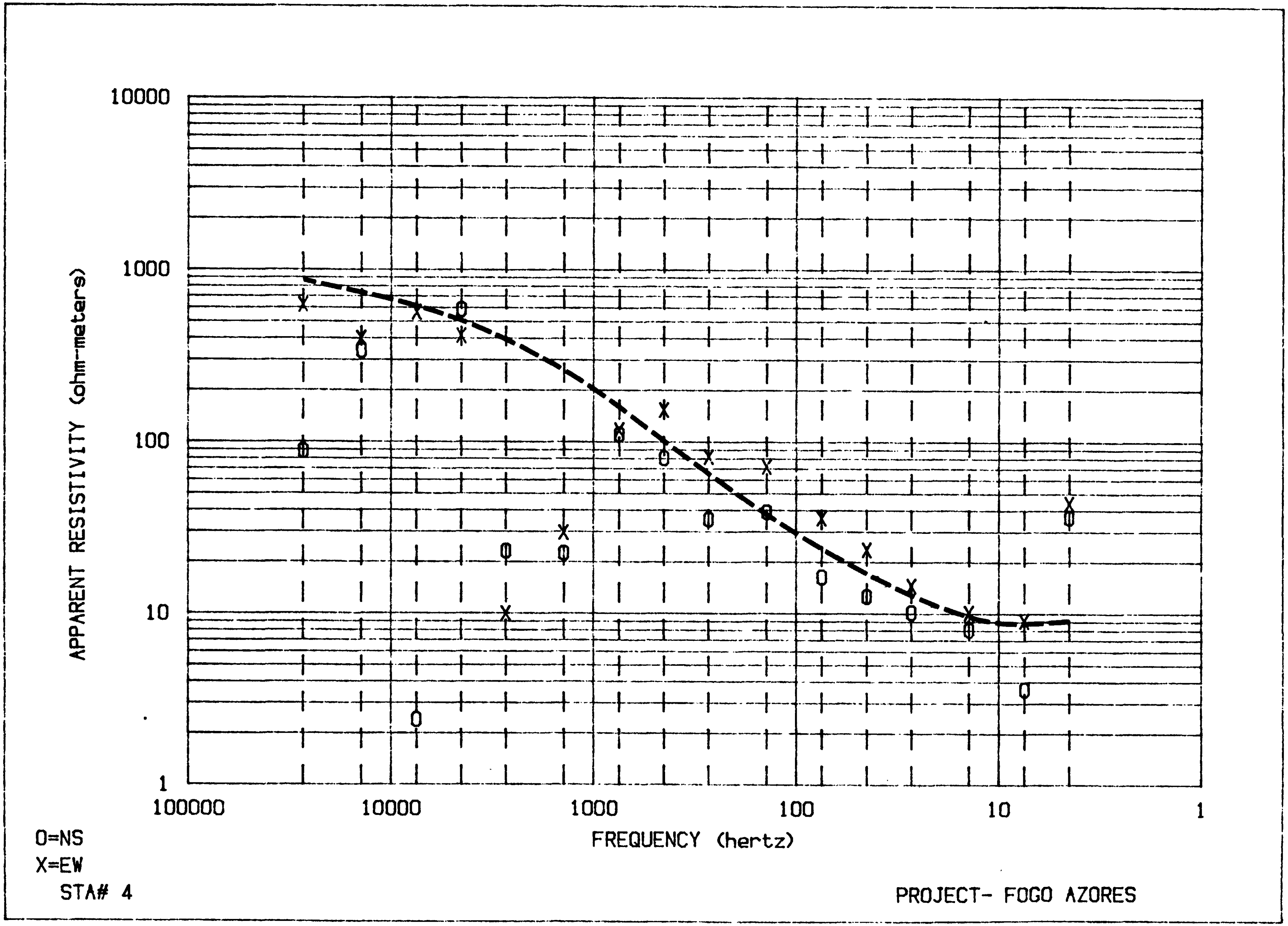
Plots of AMT sounding data given in appendix 1. Each plot shows apparent resistivity versus frequency for the two scalar soundings at each location. The 0 (NS) is for a NE-SW orientation of the telluric dipole and X (EW) for a NW-SE show increasing depth to the right for easier comparison with galvanic sounding methods.

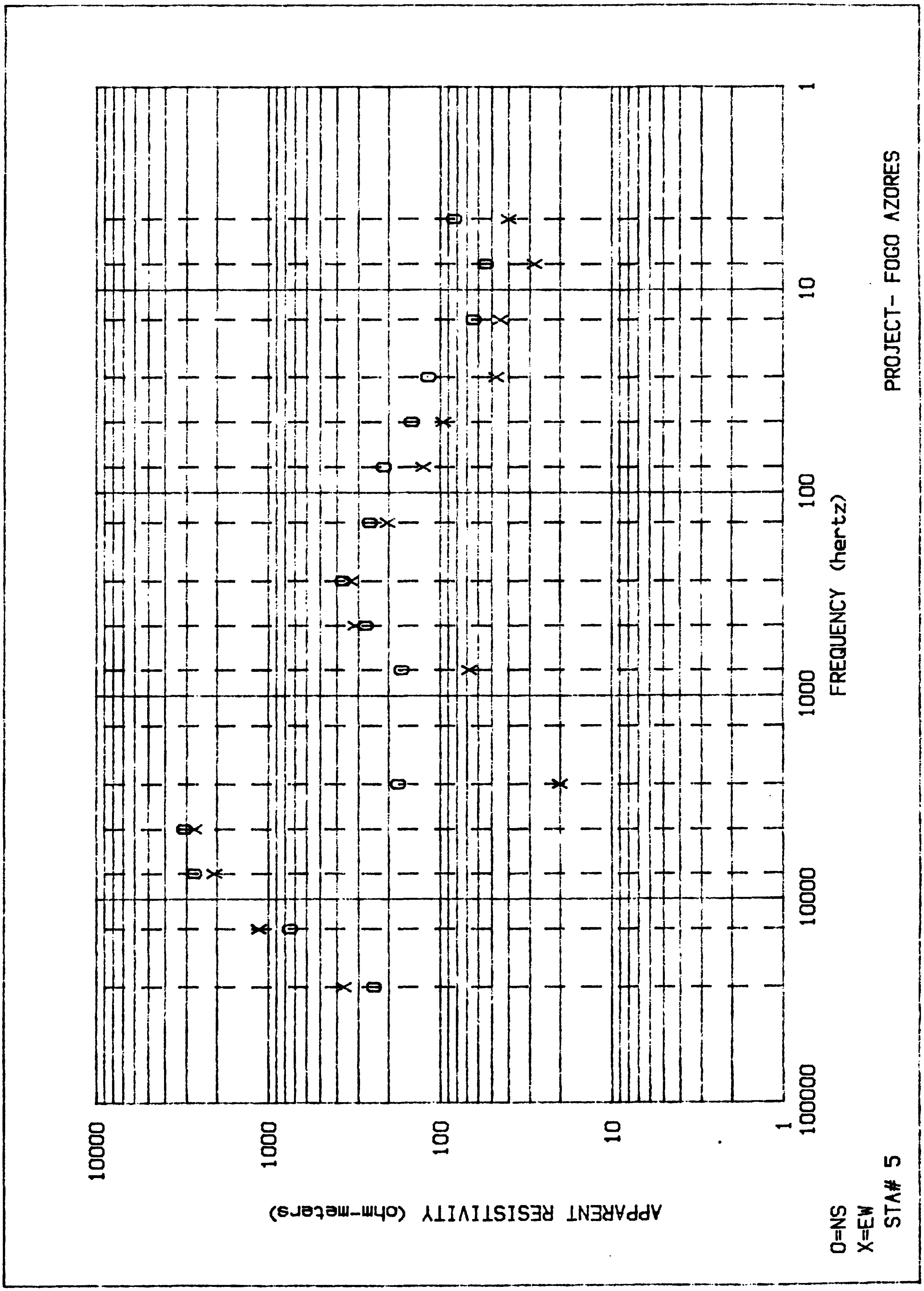

10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 1
PROJECT- FOGO AZORES

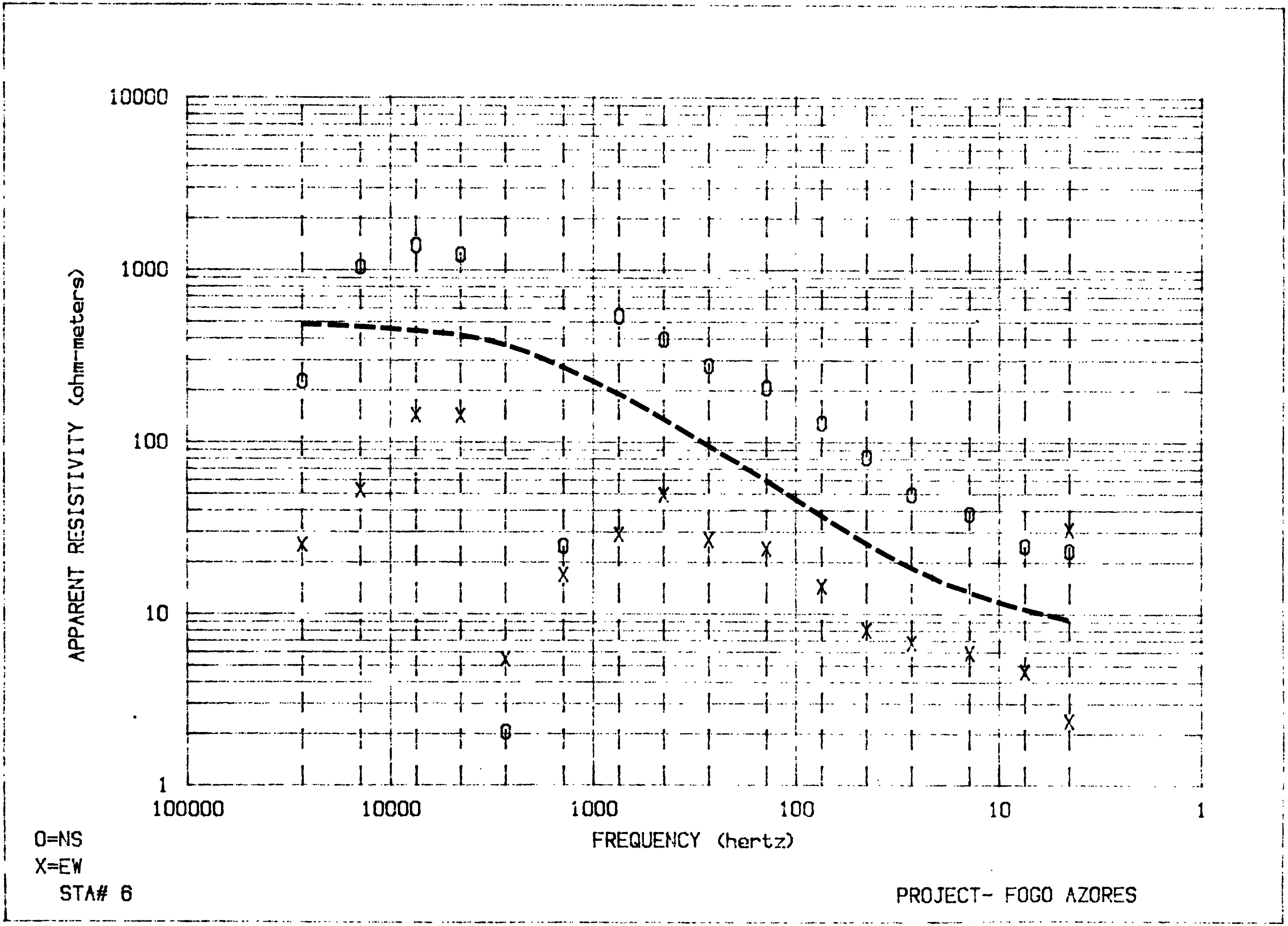

APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
FREQUENCY (hertz)
100000
10000
1000
100
10
1
0
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 2



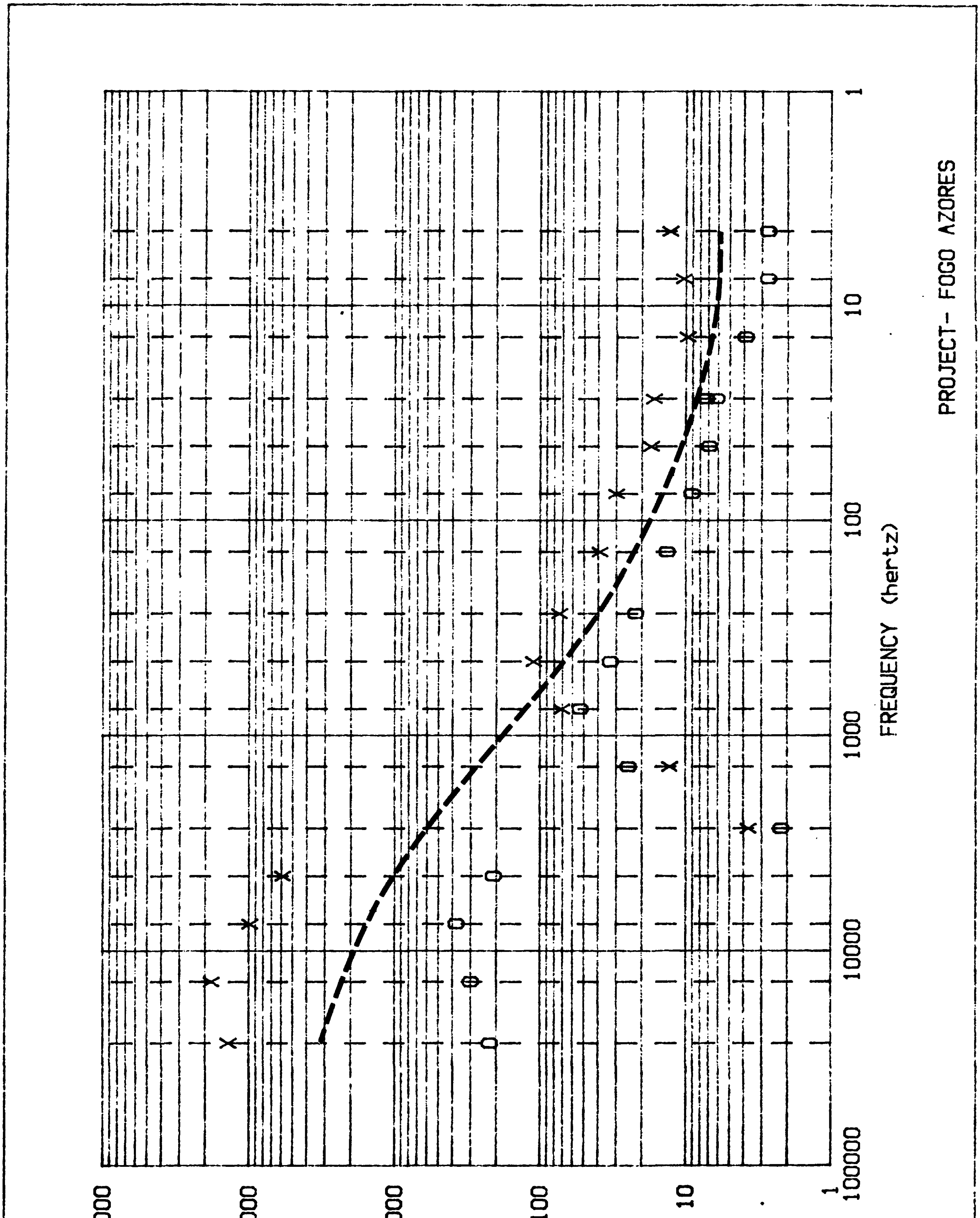
PROJECT- FOGO AZORES
FREQUENCY (hertz)
APPARENT RESISTIVITY (ohm-meters)
O=NS
X=EW
STA# 3
10000
1000
100
10
1
100000
10000
1000
100
10
1


10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 4
PROJECT- FOGO AZORES

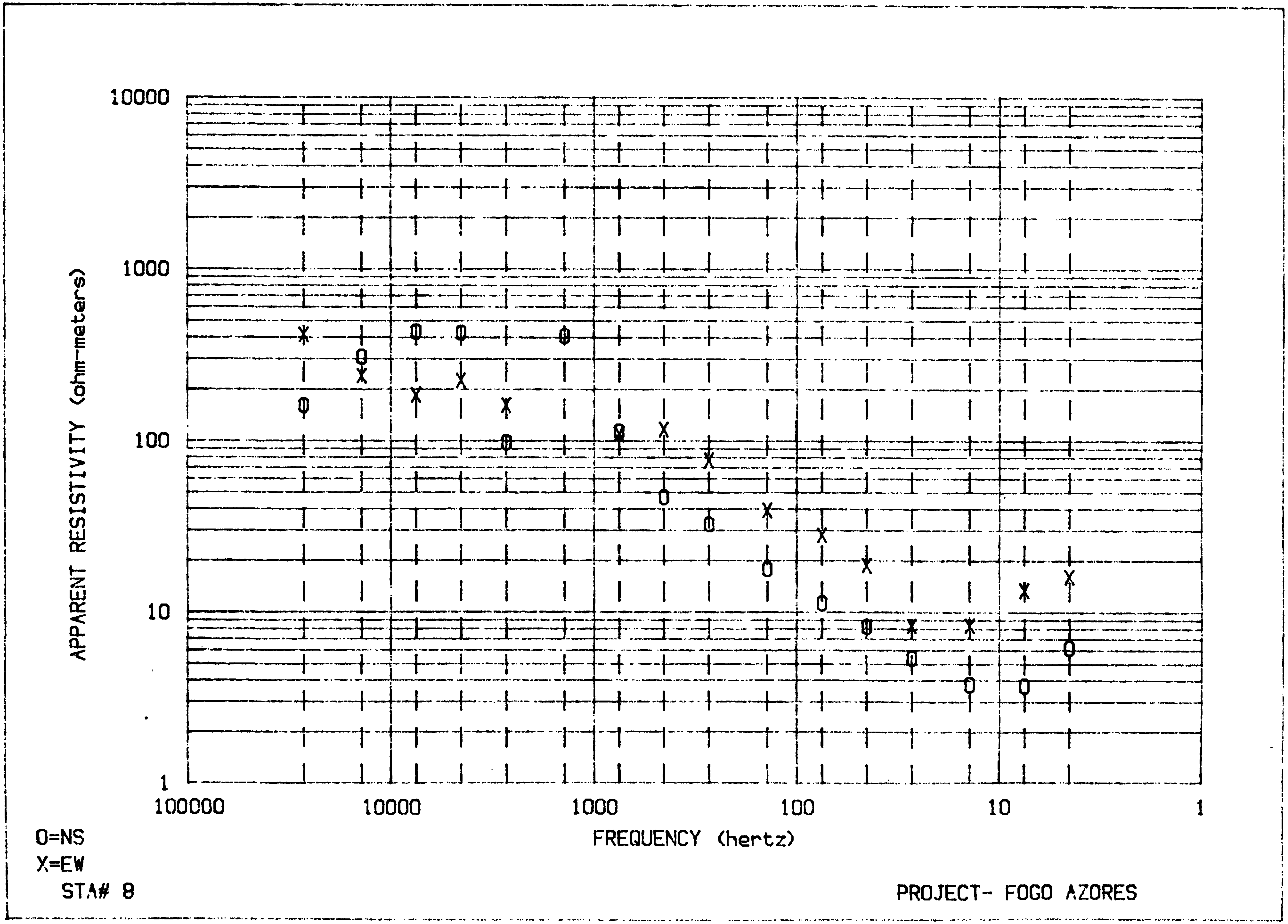

APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
FREQUENCY (hertz)
100000
10000
1000
100
10
1
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 5

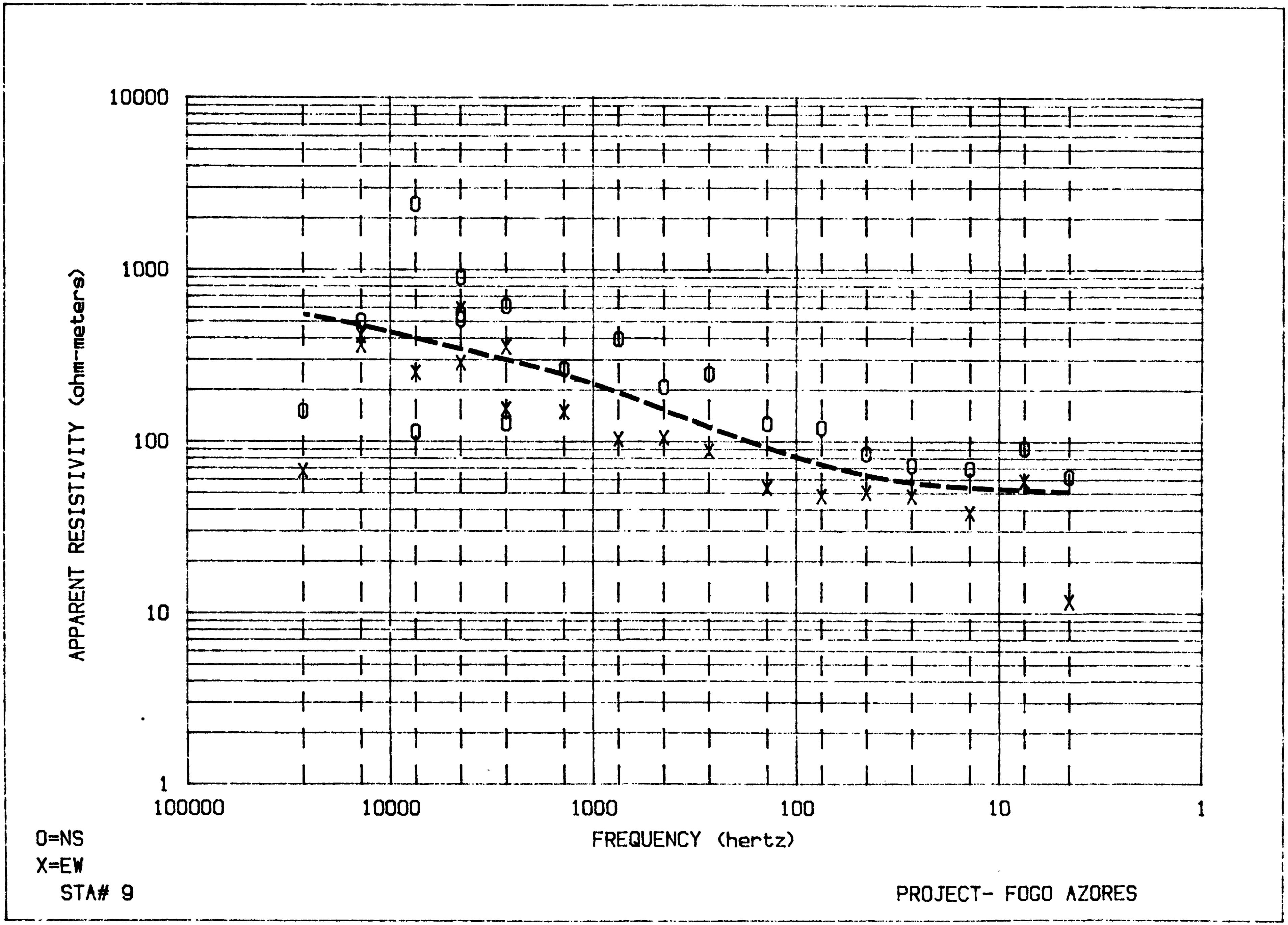


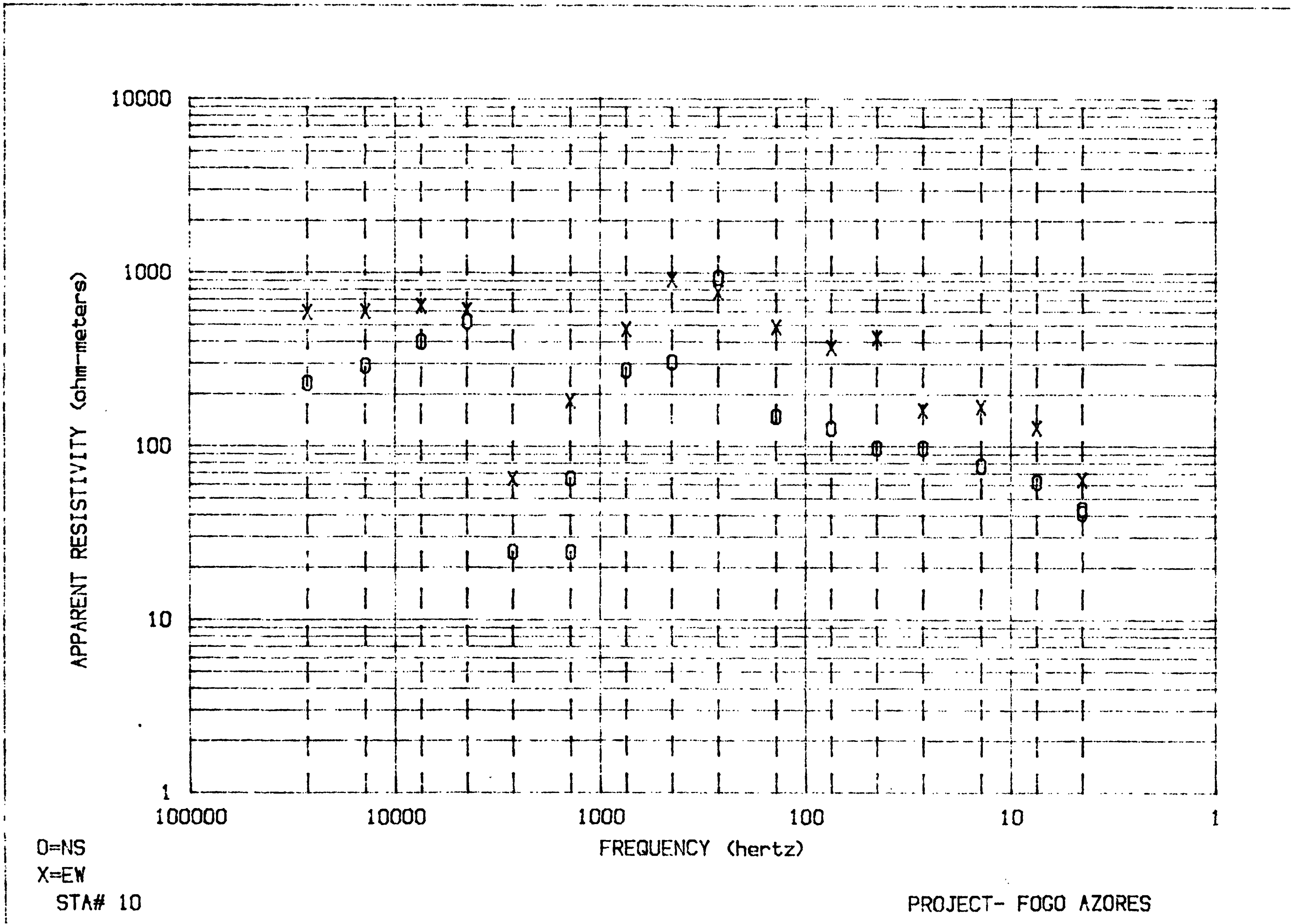
APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 6
PROJECT- FOGO AZORES



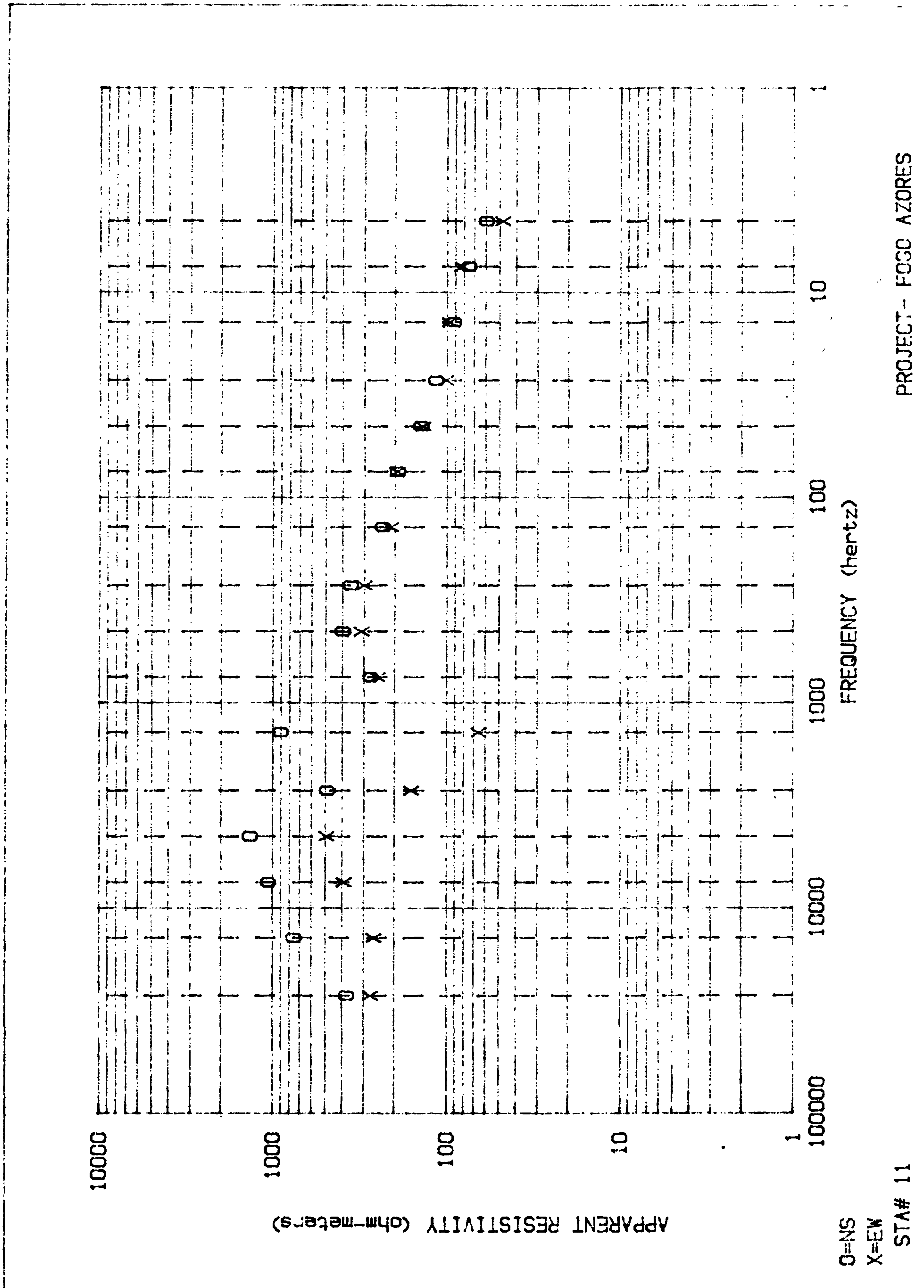
PROJECT- FOGO AZORES
FREQUENCY (hertz)
100000
10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
O=NS
X=EW
STA# 7

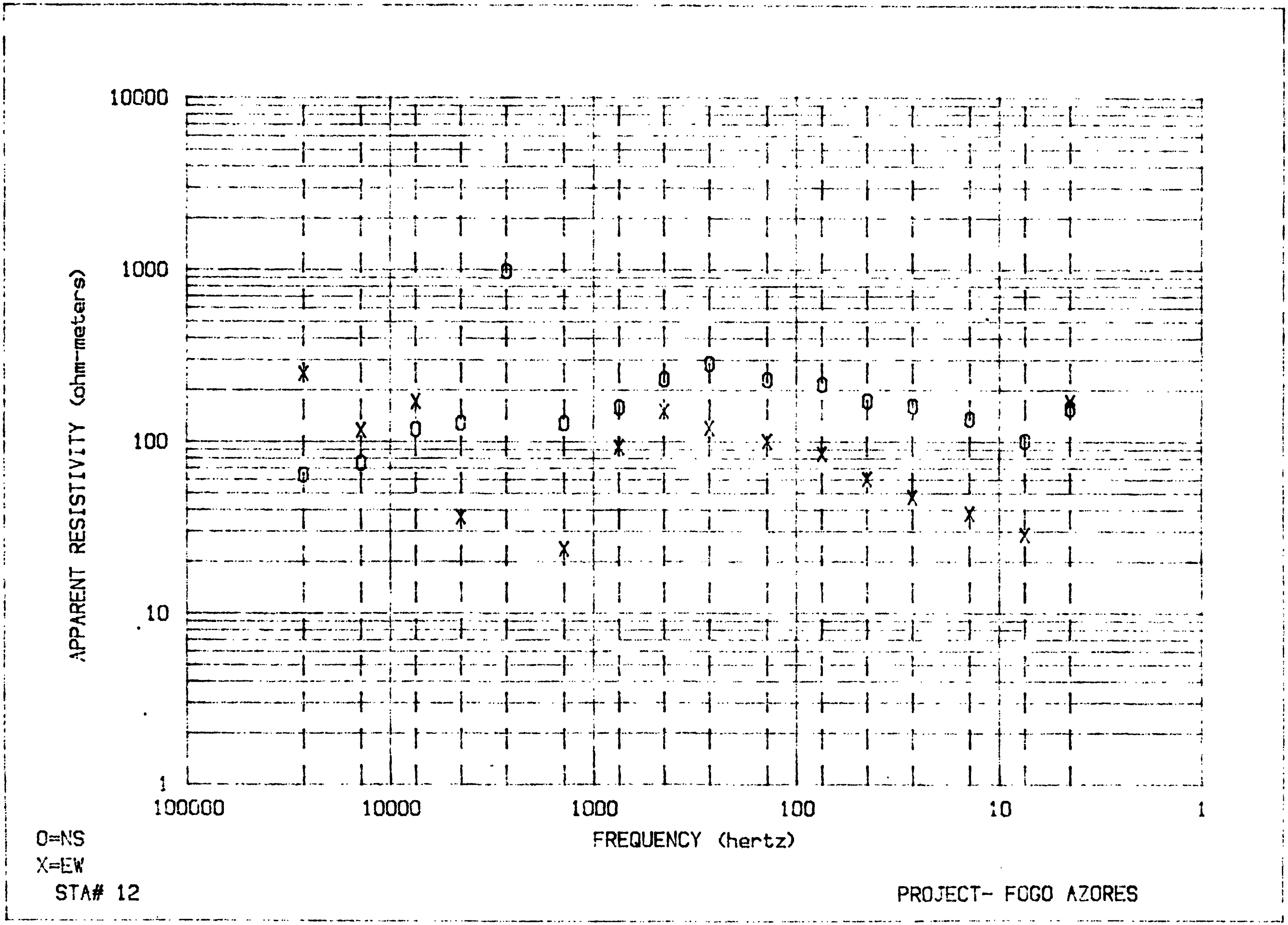

10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 8
PROJECT- FOGO AZORES

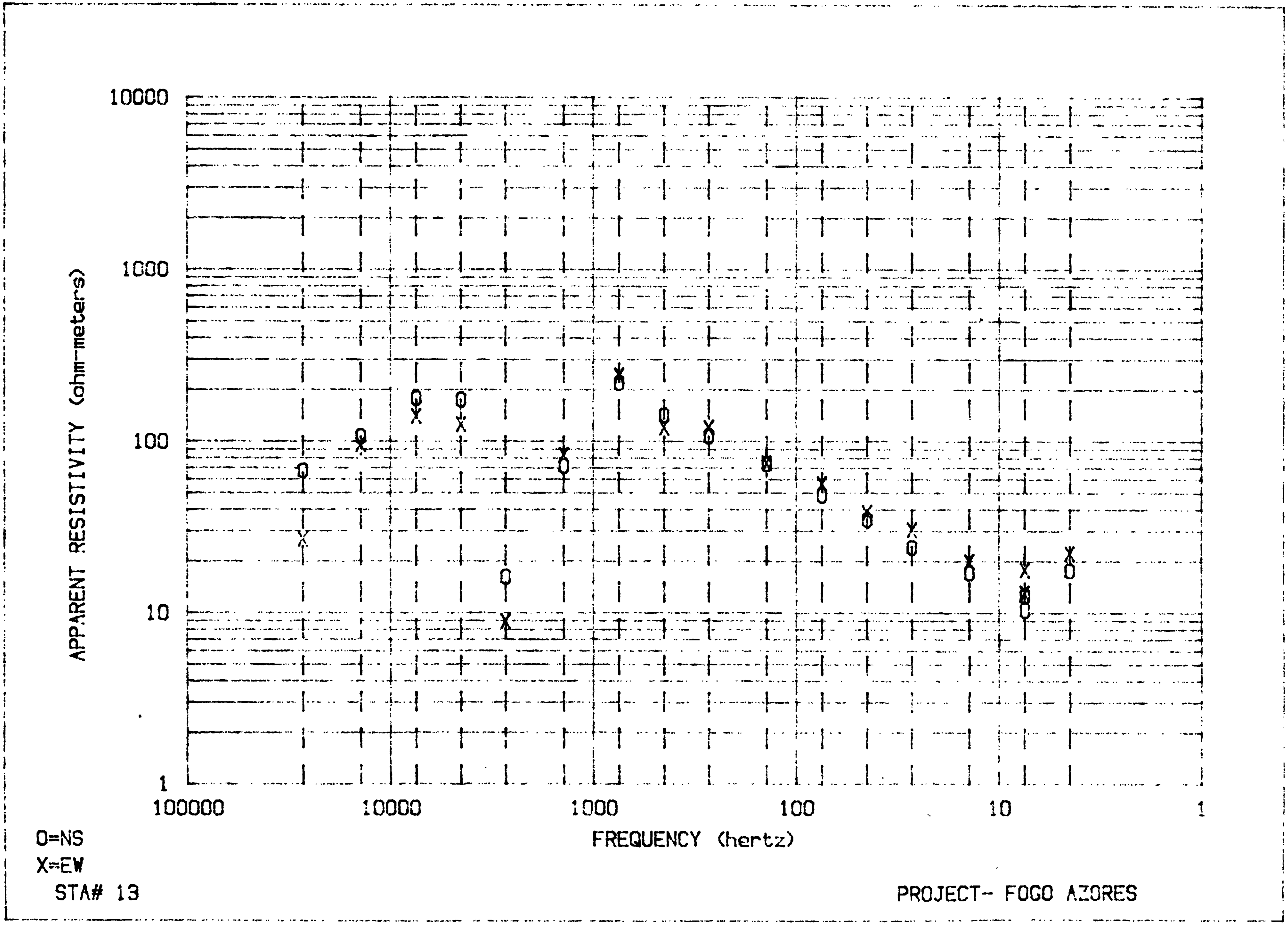

10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 9
PROJECT- FOGO AZORES

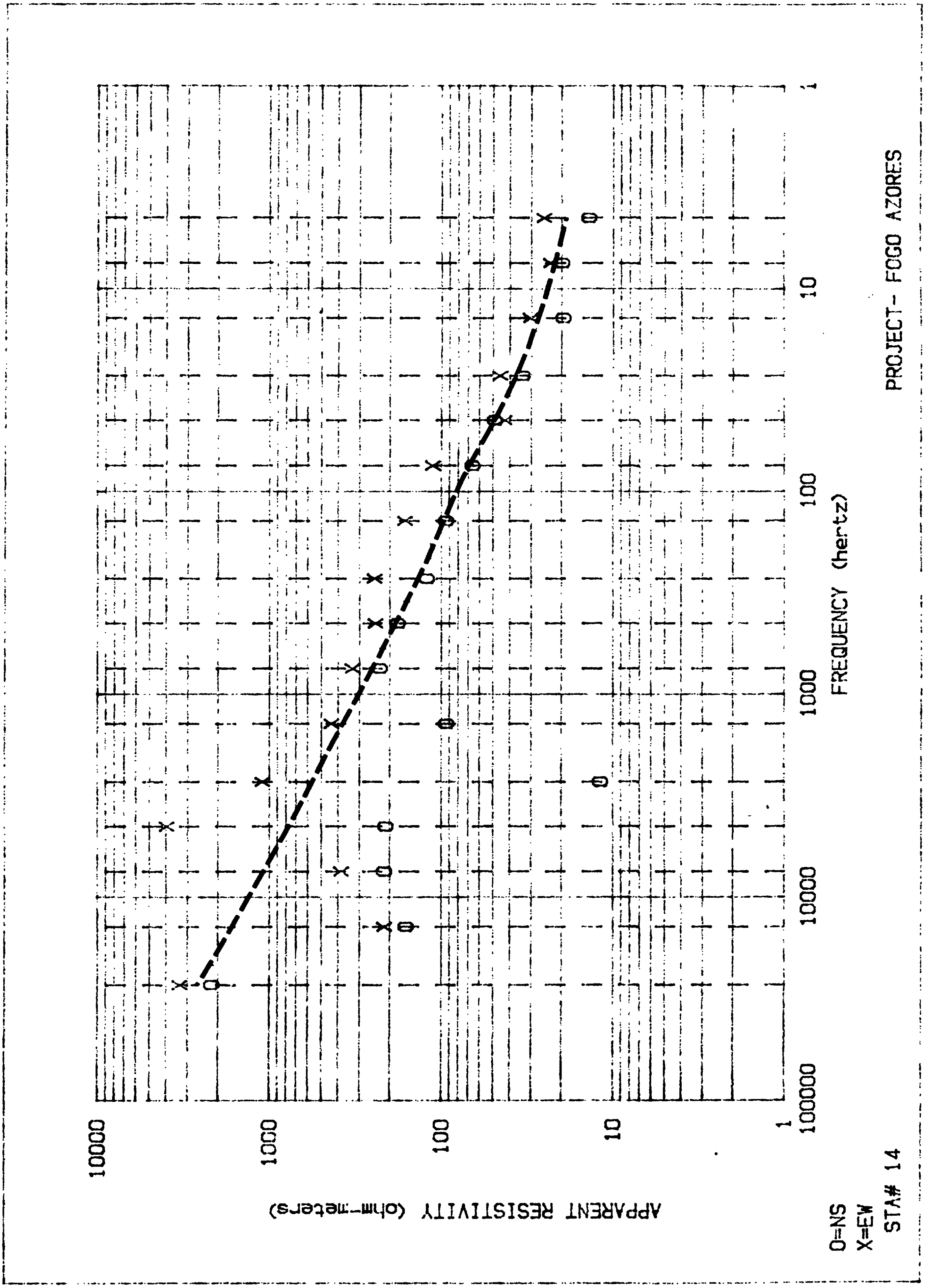


10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 10
PROJECT- FOGO AZORES


APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
100000
10000
1000
100
10
1
FREQUENCY (hertz)
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 11


APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 12
PROJECT- FOGO AZORES


10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 13
PROJECT- FOGO AZORES


APPARENT RESISTIVITY (ohm-meters)
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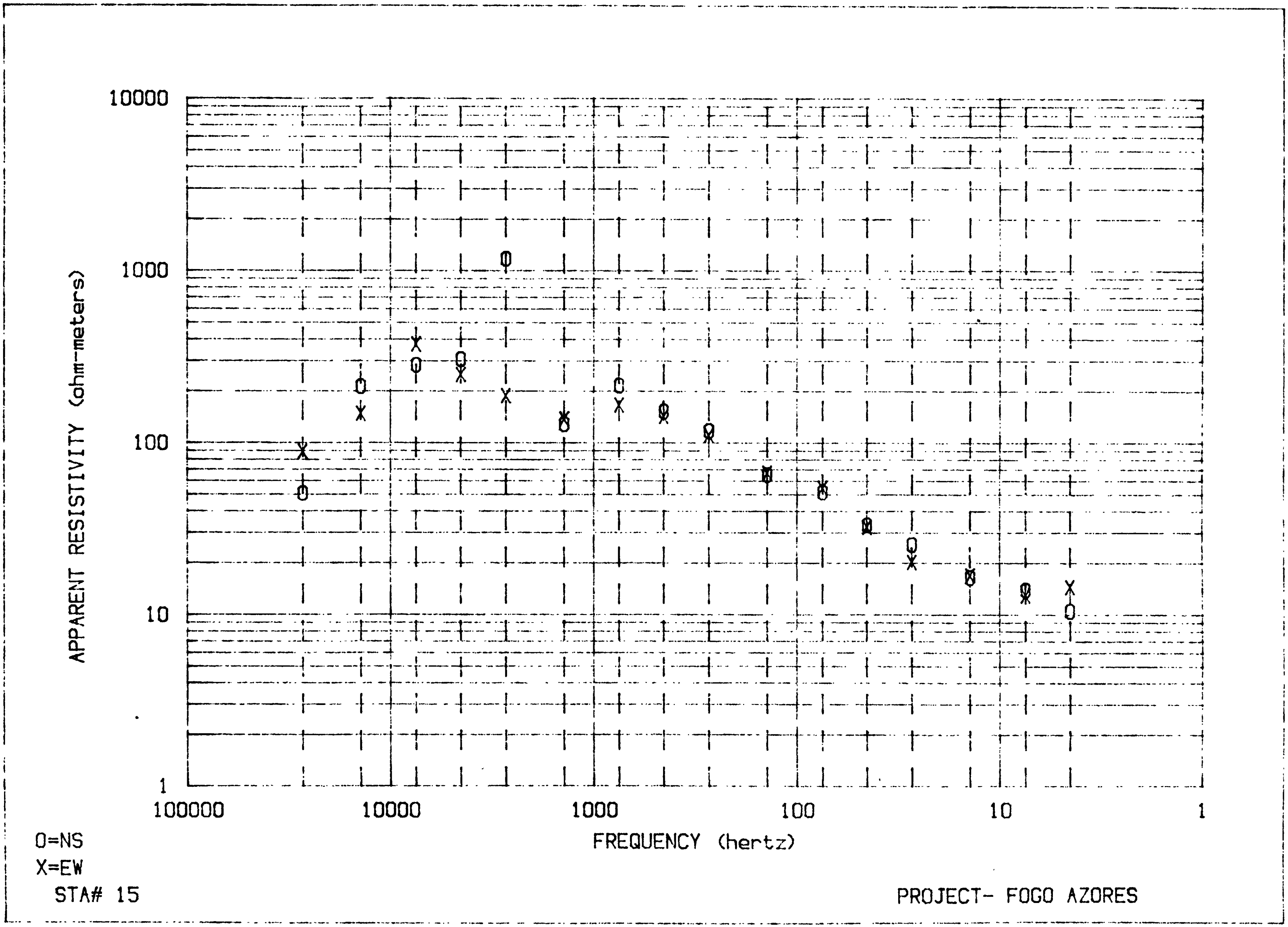
100
10
1
100000
10000
1000
100
10
1
FREQUENCY (hertz)
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 14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1
APPARENT RESISTIVITY (ohm-meters)
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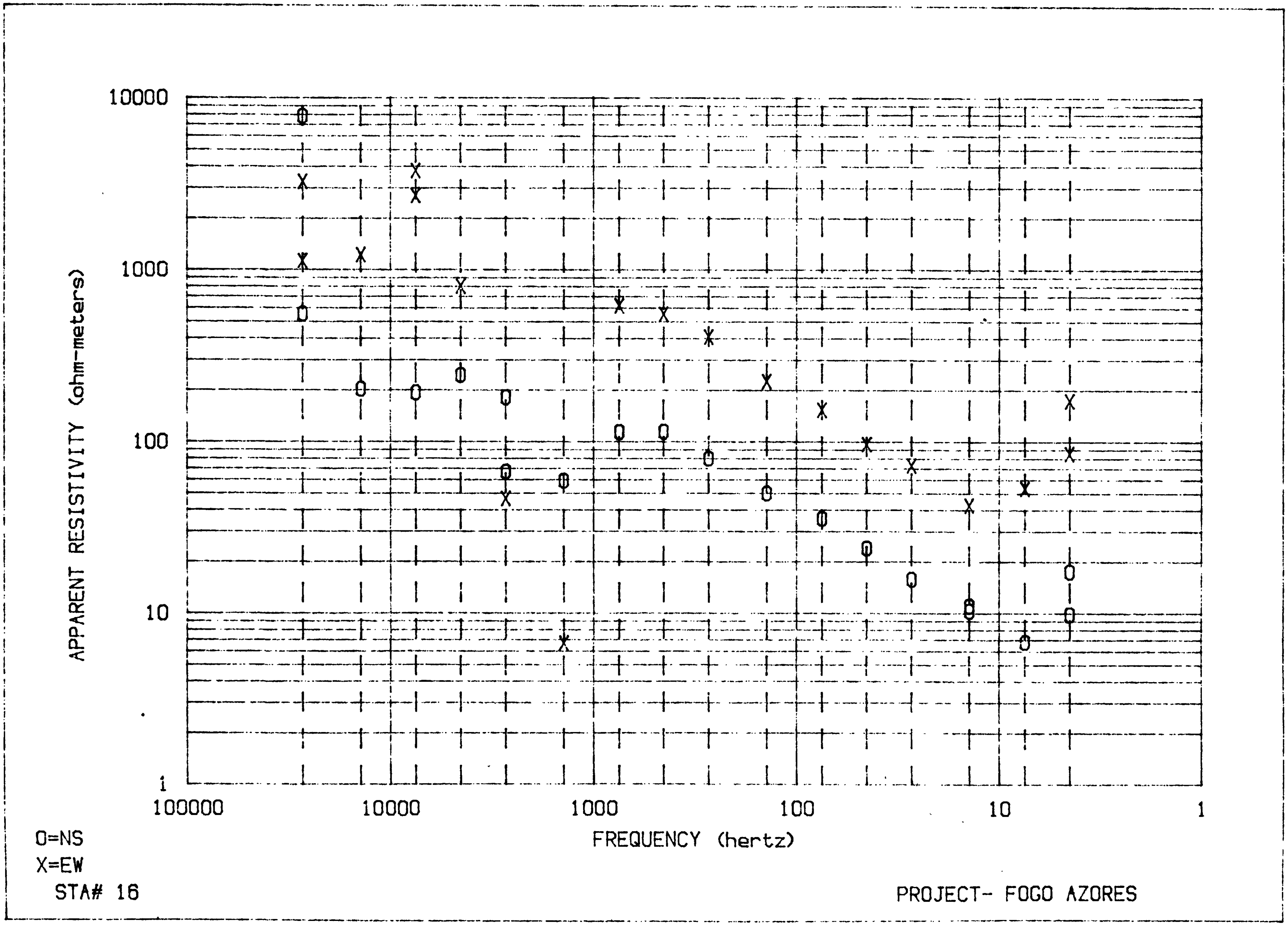
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 15
PROJECT- FOGO AZORES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1000
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10
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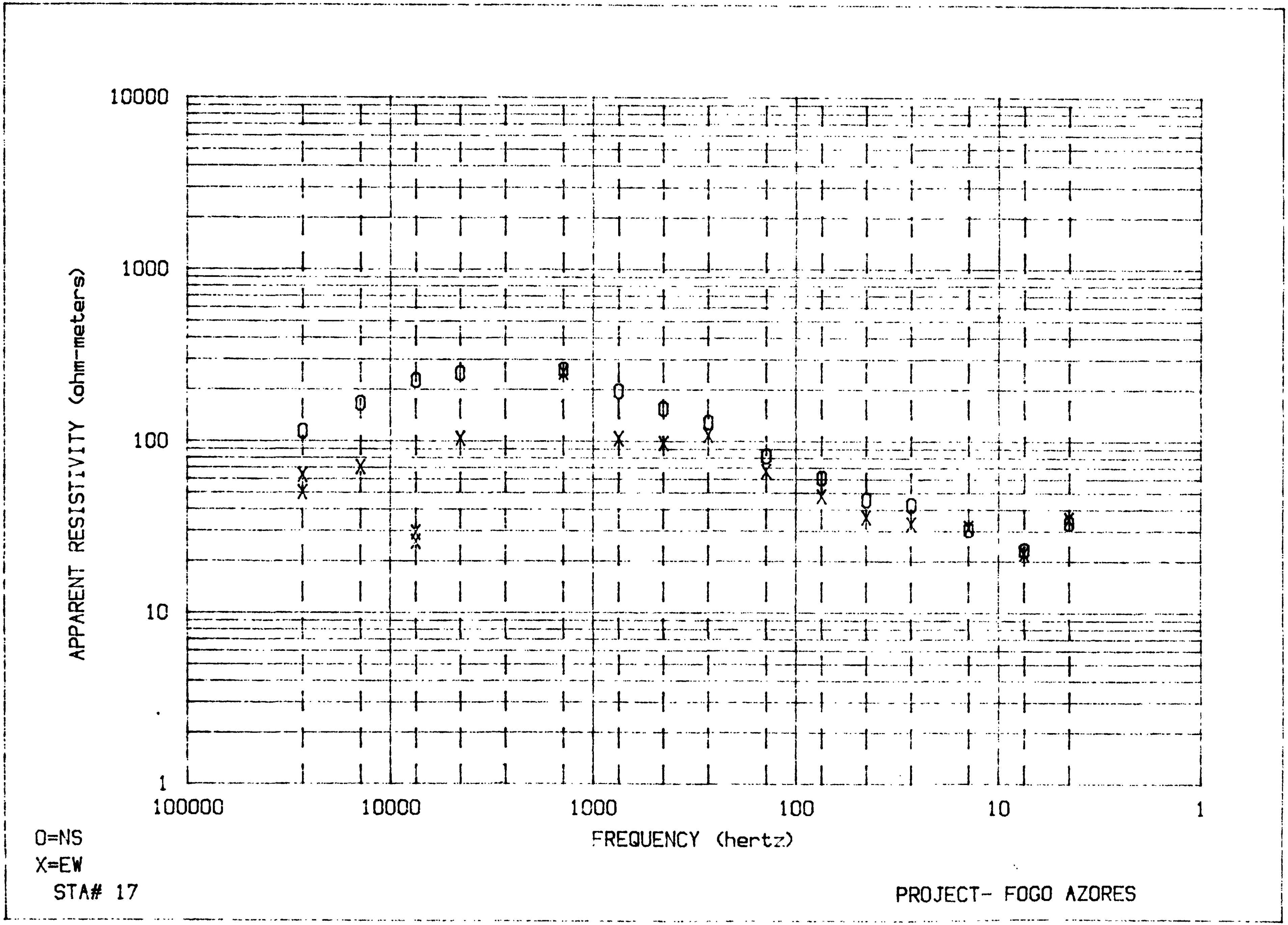
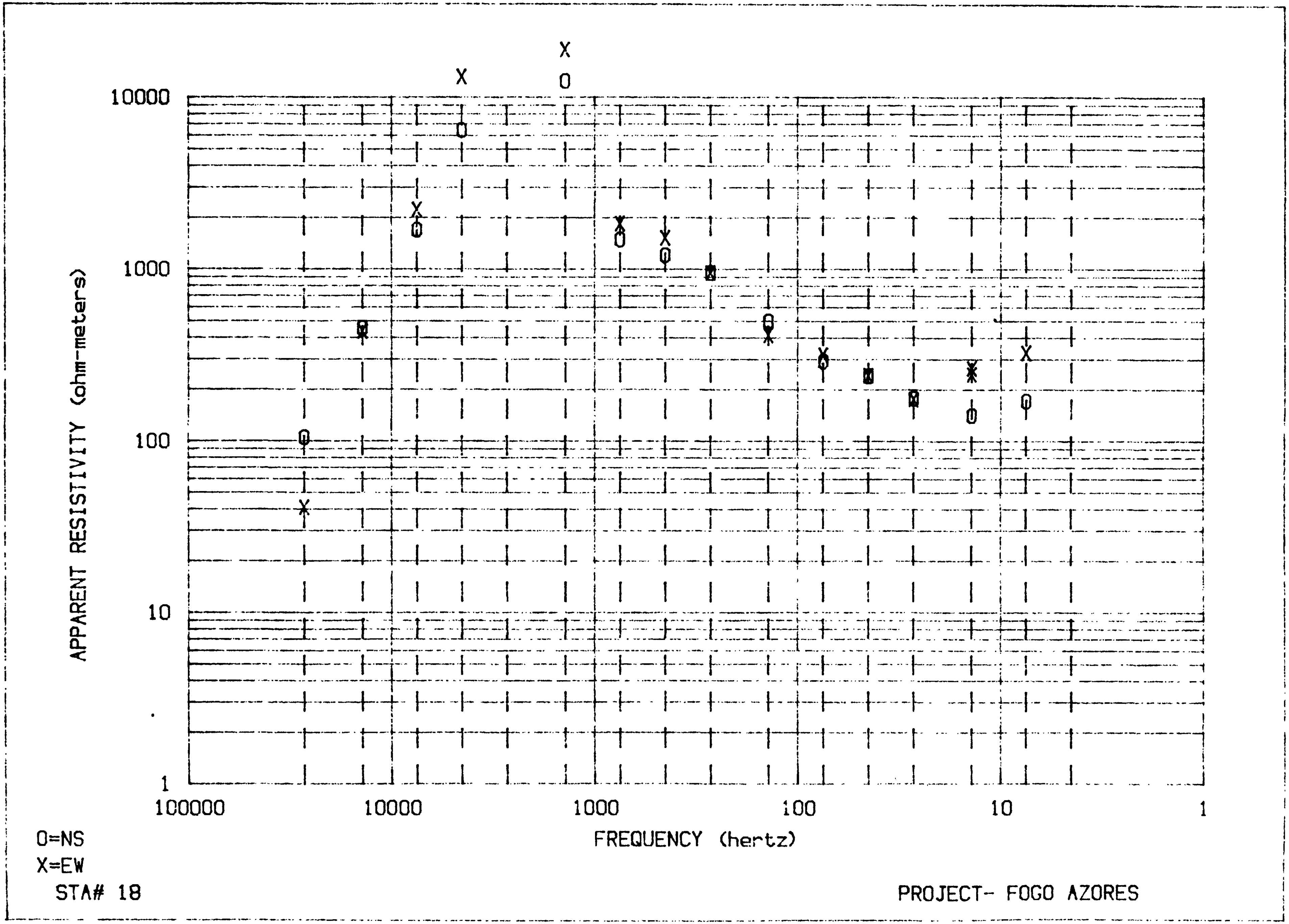
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 16
PROJECT- FOGO AZORES


10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 17
PROJECT- FOGO AZORES


10000
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1
APPARENT RESISTIVITY (ohm-meters)
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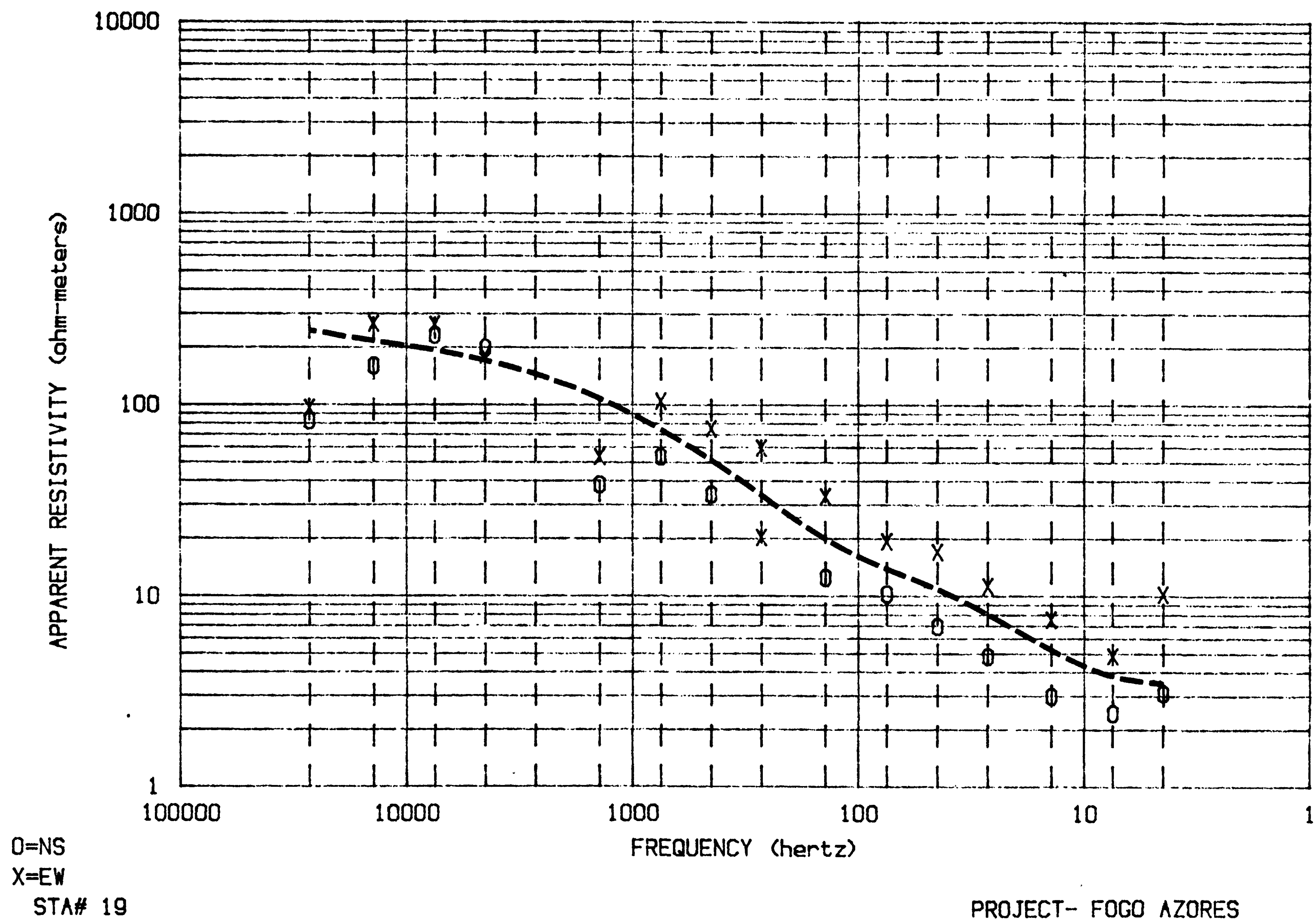
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 18
PROJECT- FOGO AZORES


10000
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APPARENT RESISTIVITY (ohm-meters)
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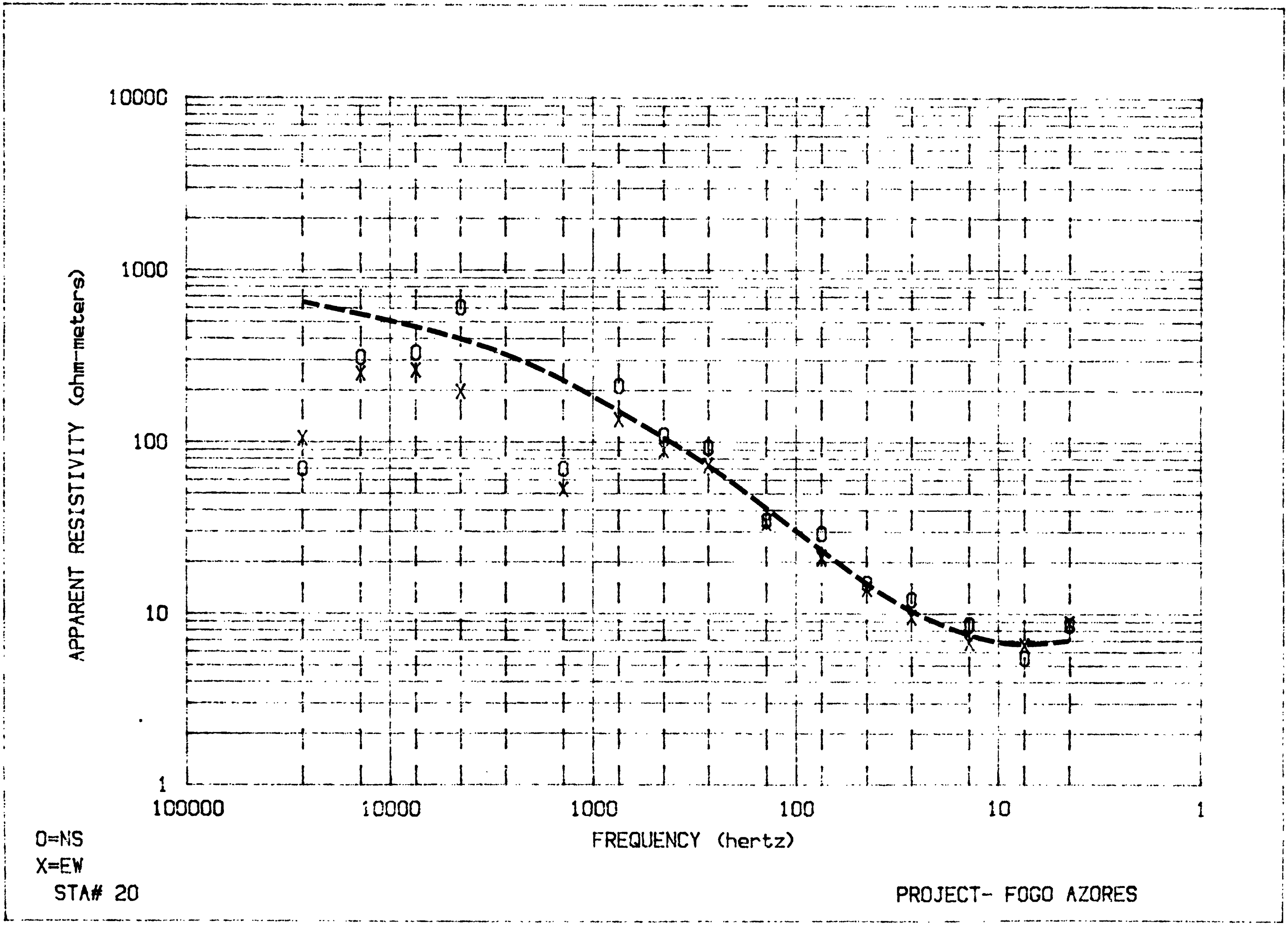
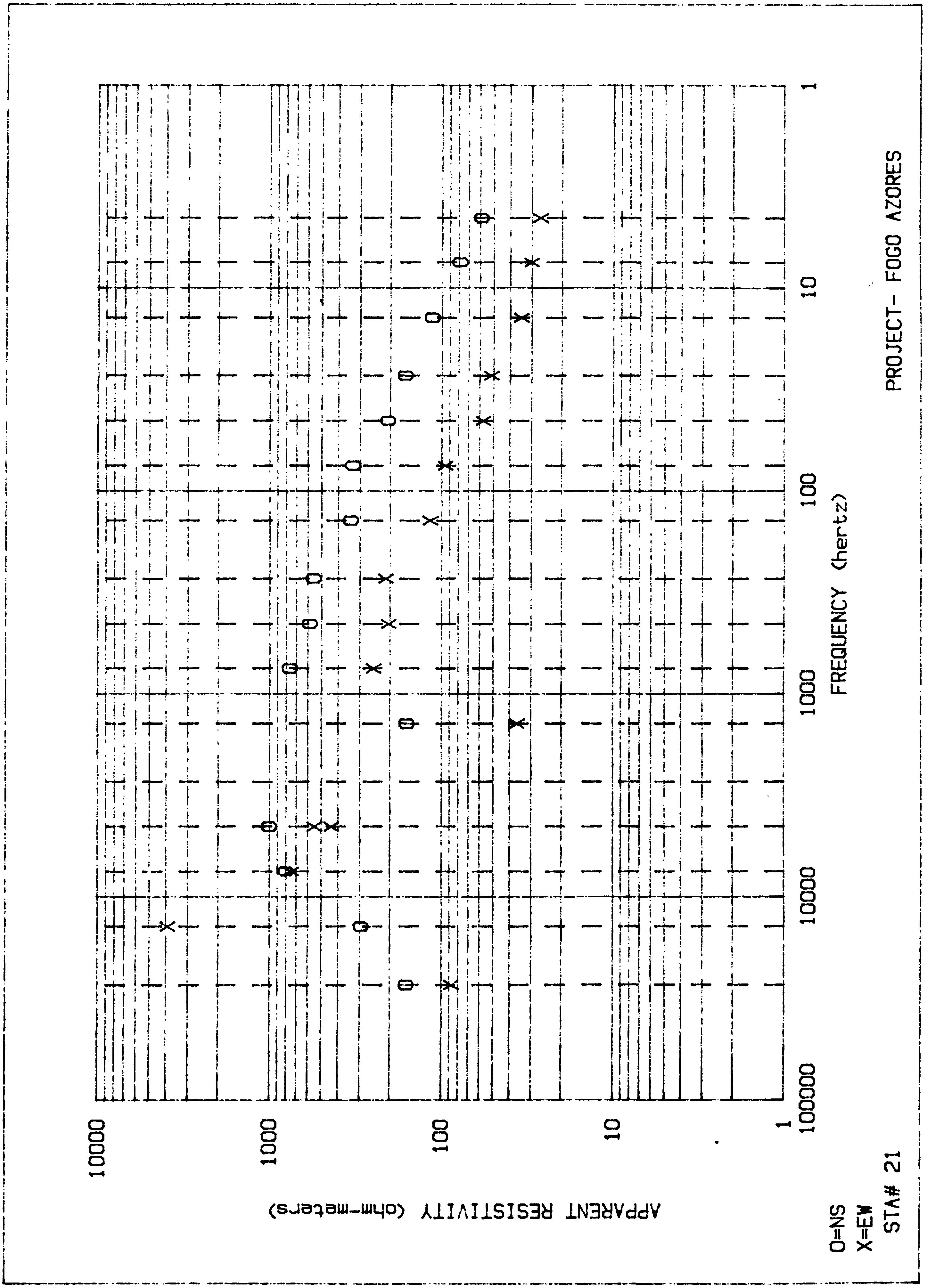
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 19
PROJECT- FOGO AZORES



10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 20
PROJECT- FOGO AZORES


PROJECT- FOGO AZORES
FREQUENCY (hertz)
APPARENT RESISTIVITY (ohm-meters)
O=NS
X=EW
STA# 21
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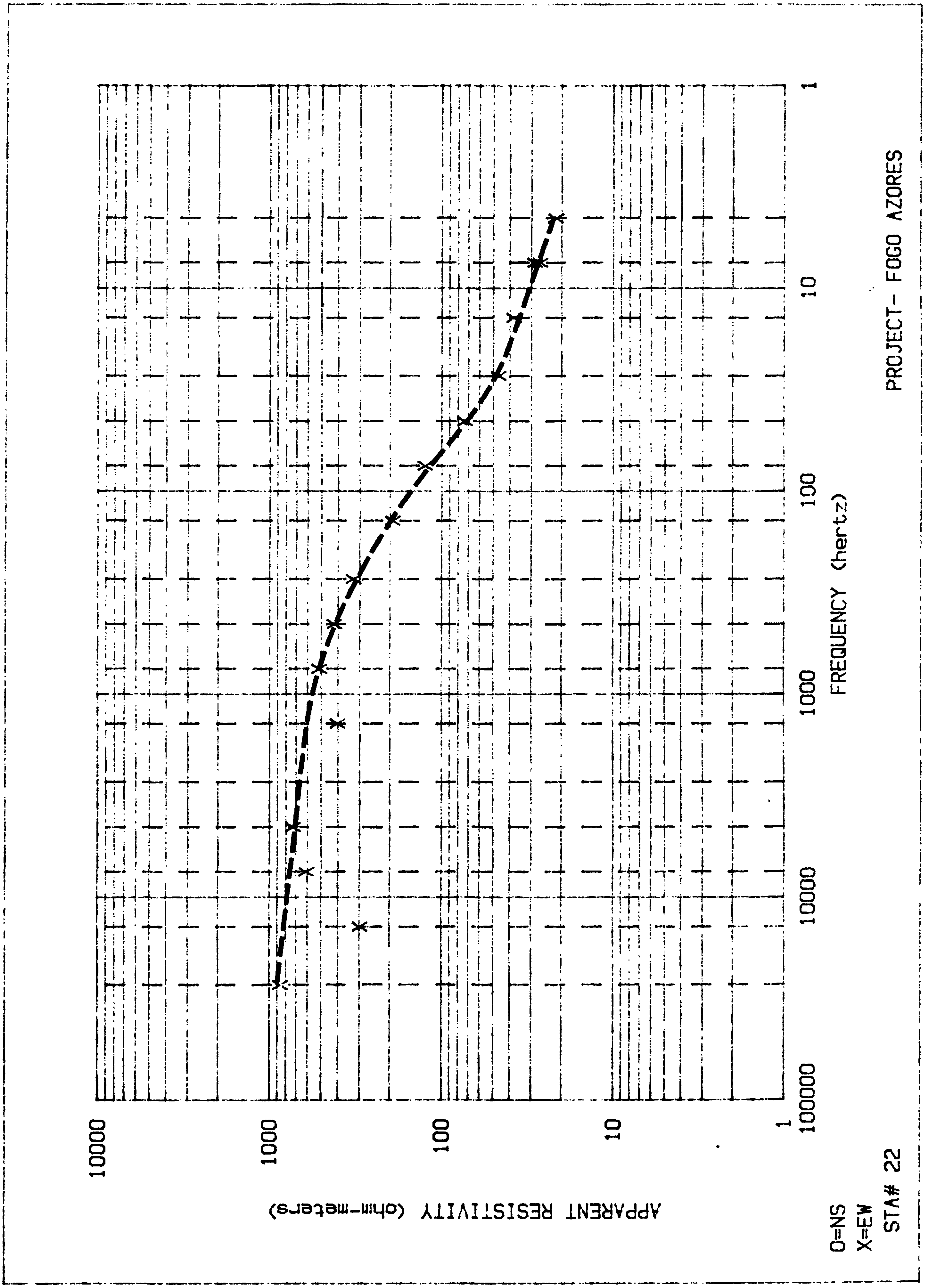
10000
1000
100
10
1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FREQUENCY (hertz)
APPARENT RESISTIVITY (ohm-meters)
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X=EW
STA# 22
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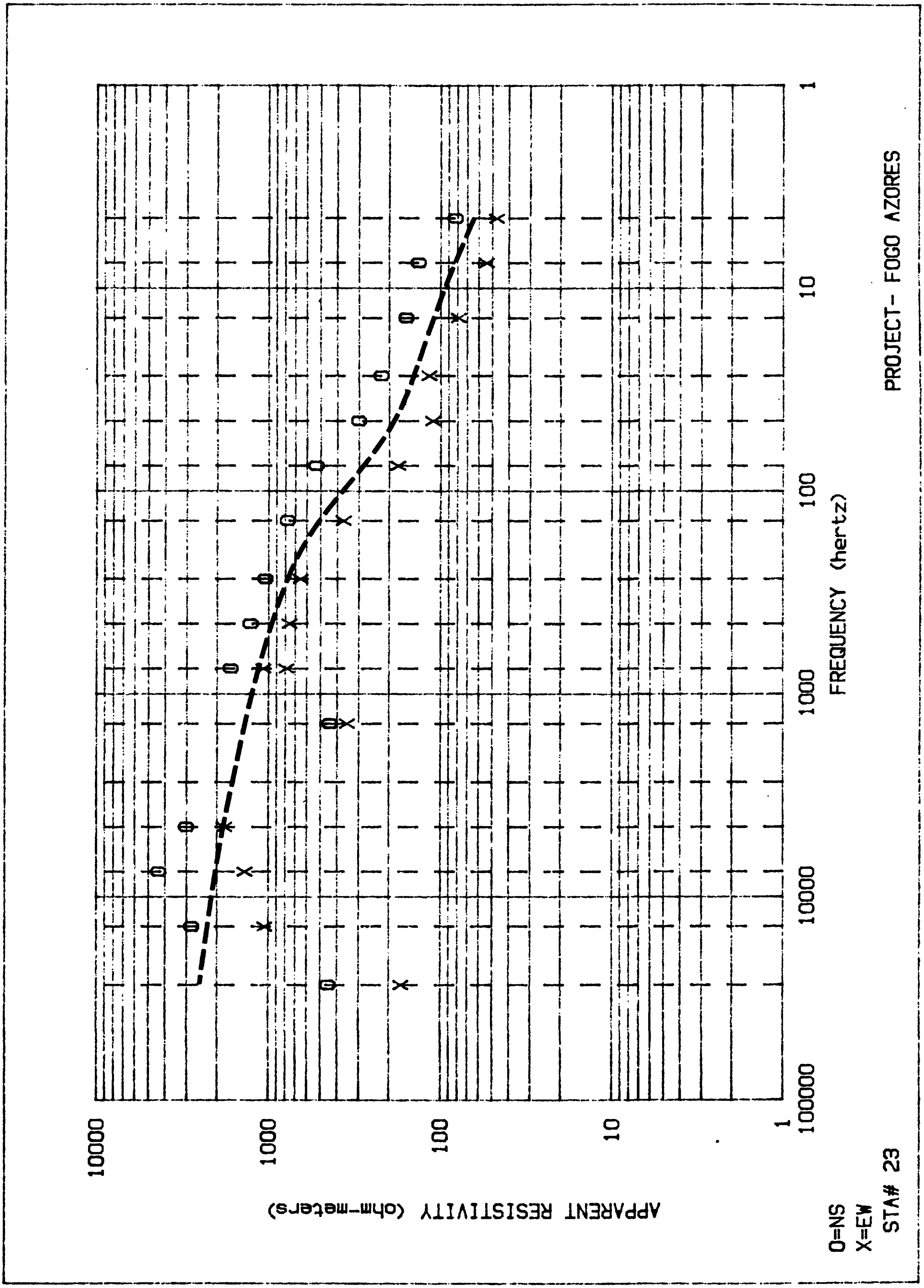
10000
1000
100
10
1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100
10
1
FREQUENCY (hertz)
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10000
1000
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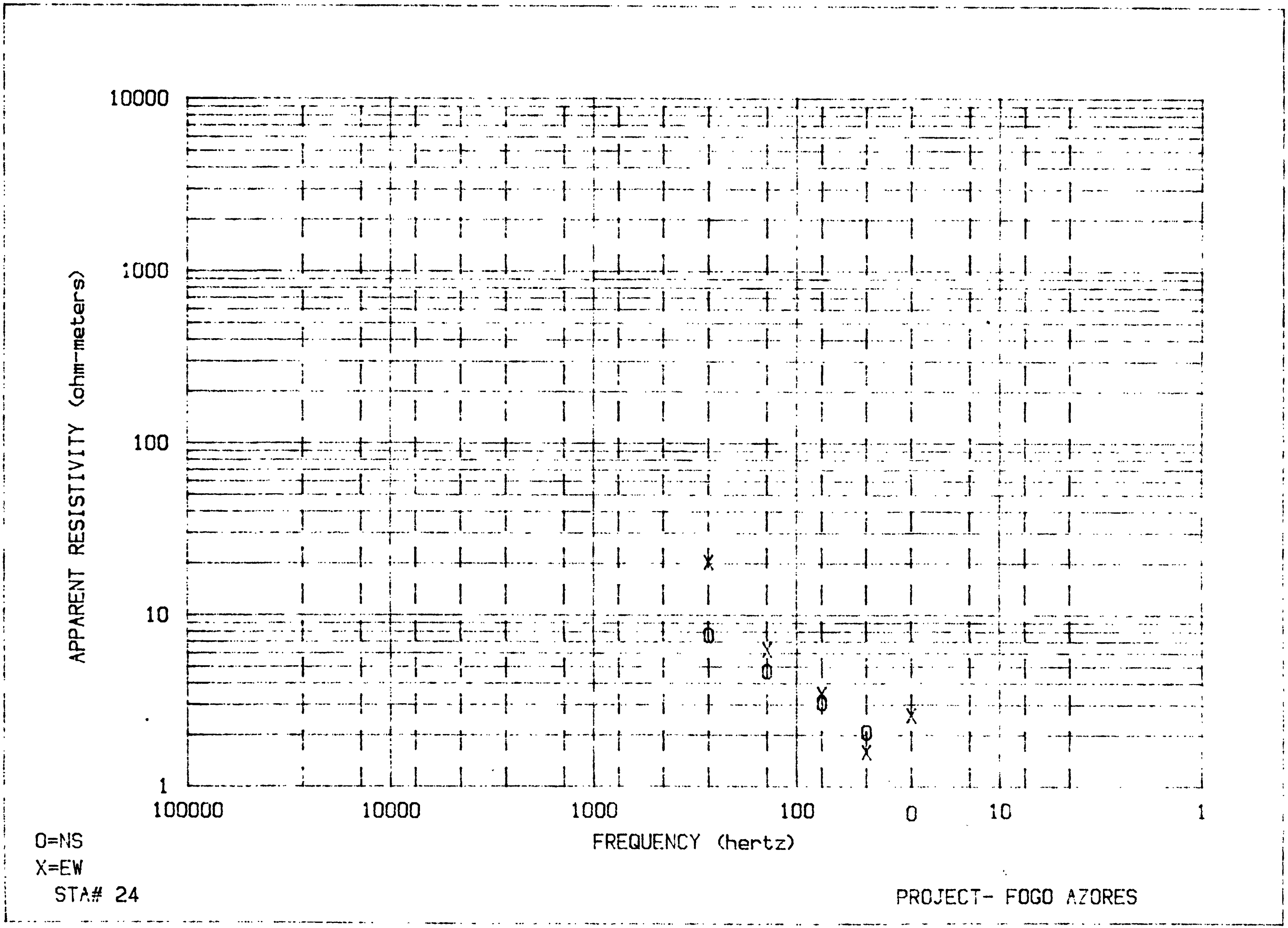
10
1
O=NS
X=EW
STA# 23
PROJECT- FOGO AZORES


10000
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1
APPARENT RESISTIVITY (ohm-meters)
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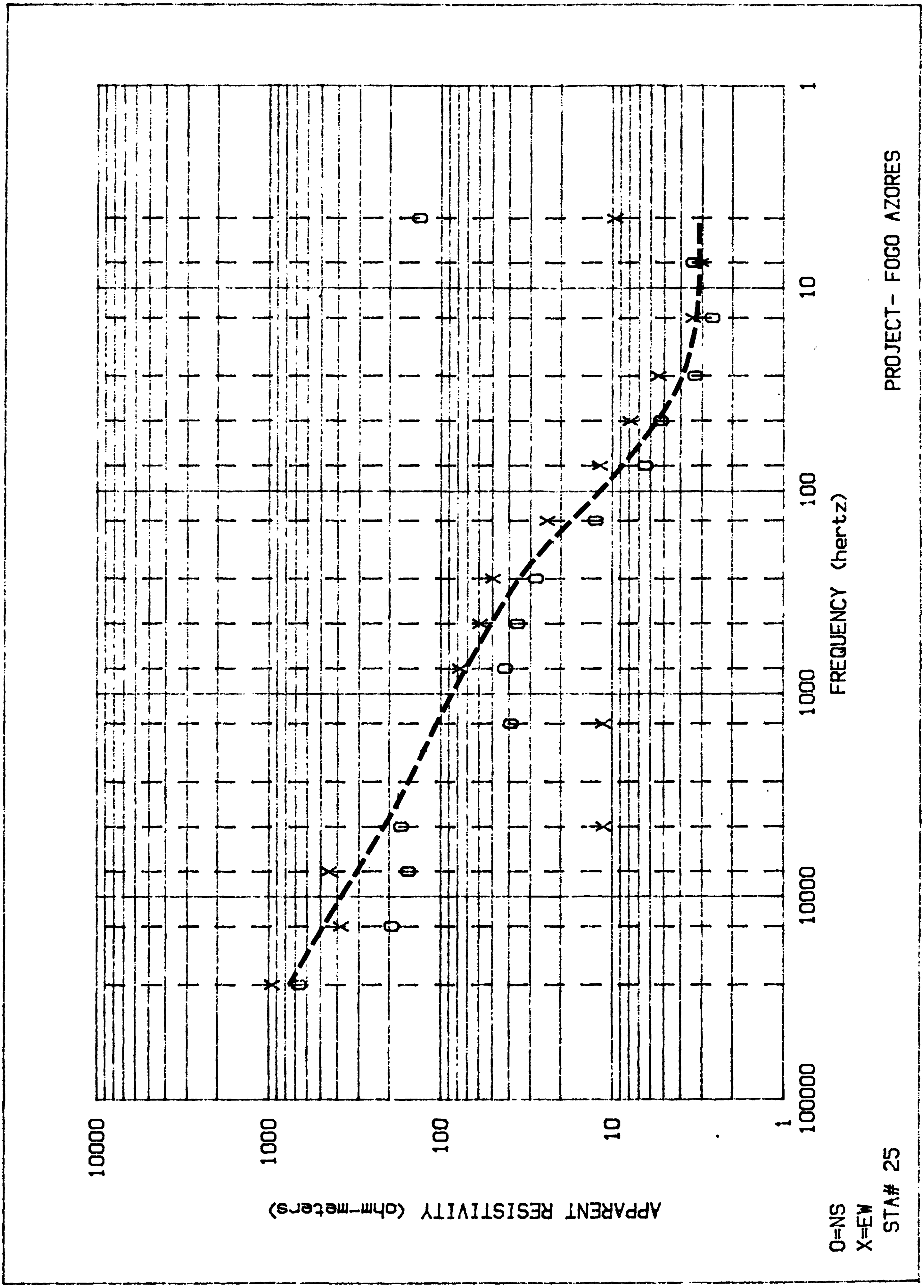
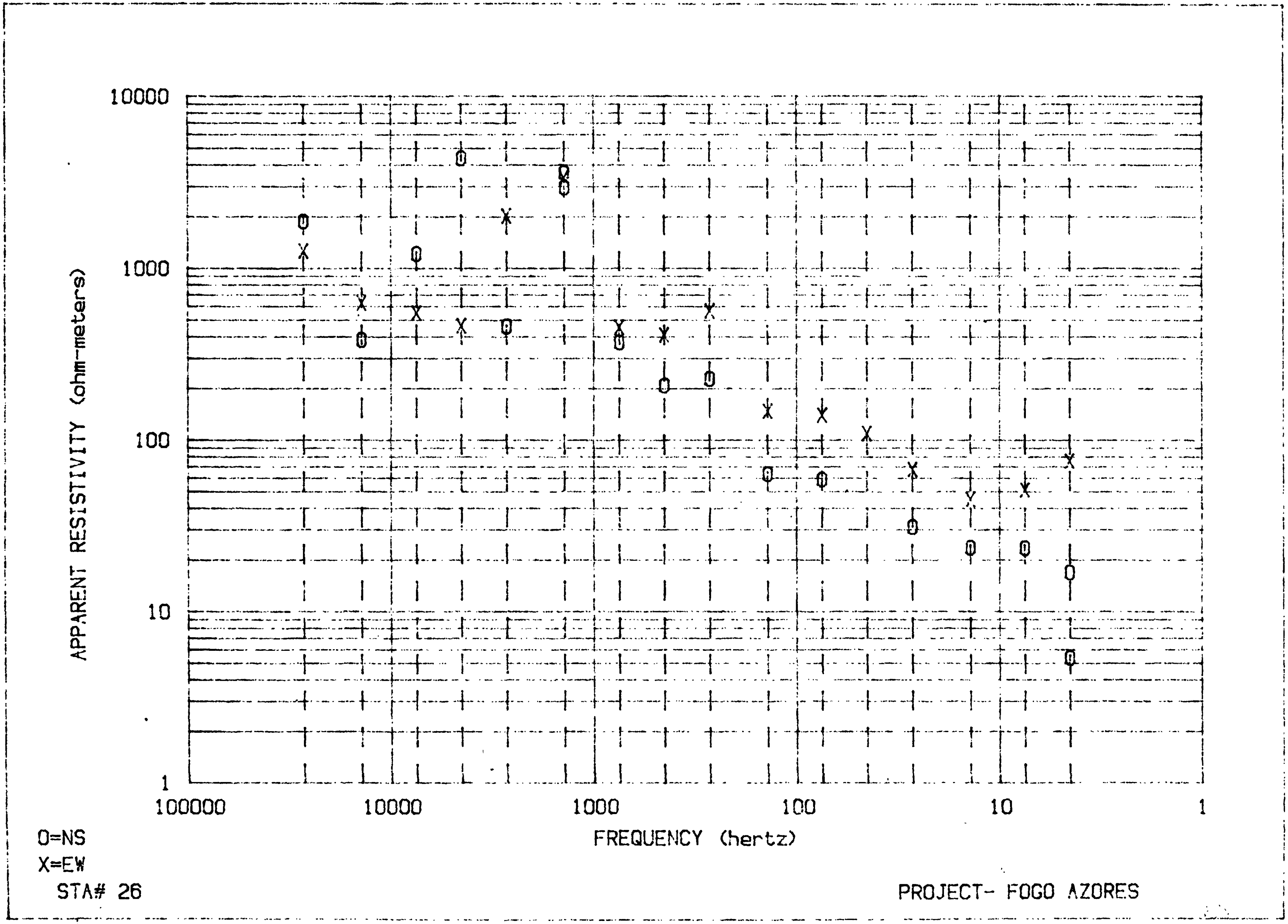
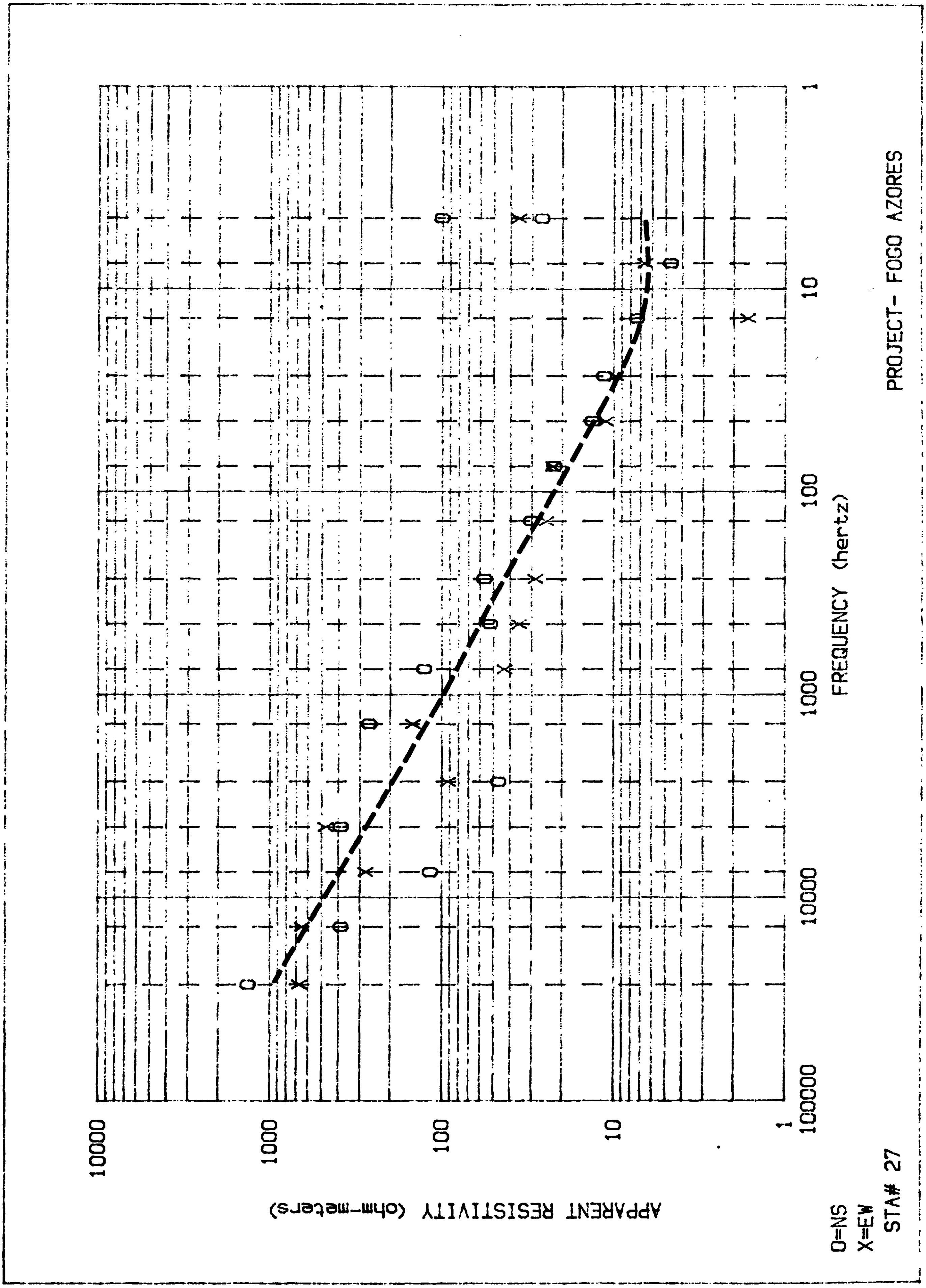
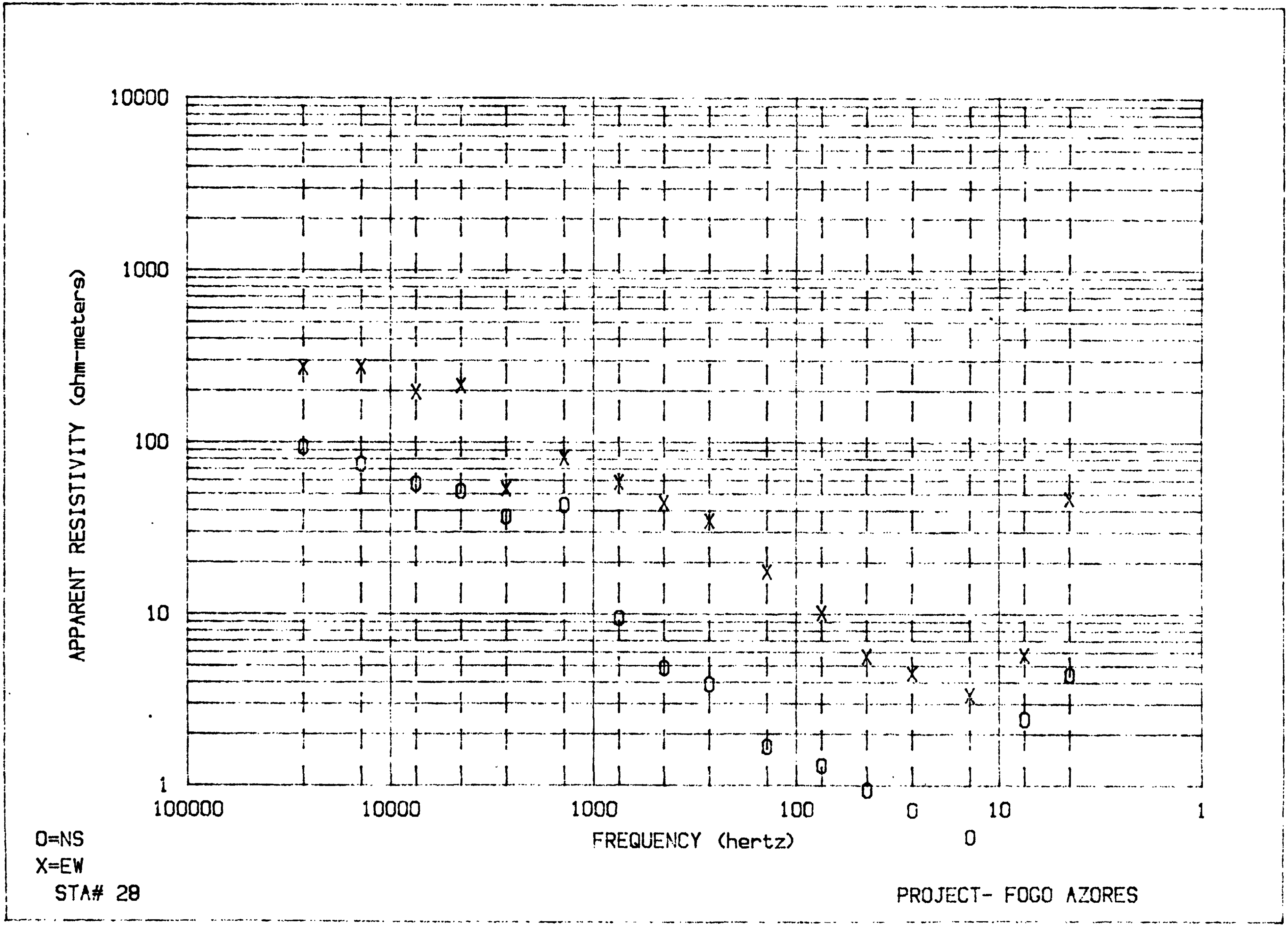
100
0
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 24
PROJECT- FOGO AZORES

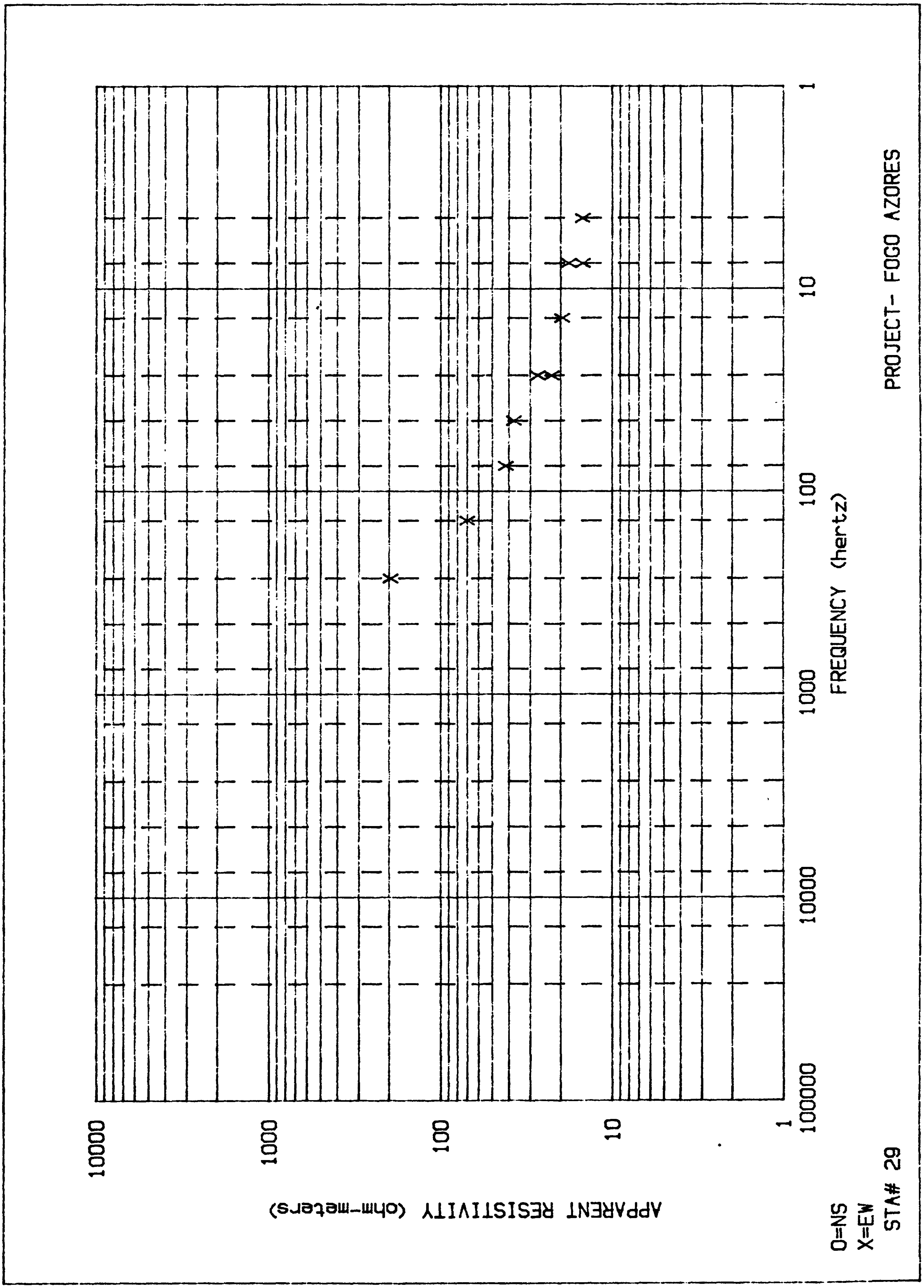

APPARENT RESISITIVITY (ohm-meters)
10000
1000
100
10
1
100000
10000
1000
100
10
1
FREQUENCY (hertz)
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 25


10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 26
PROJECT- FOGO AZORES

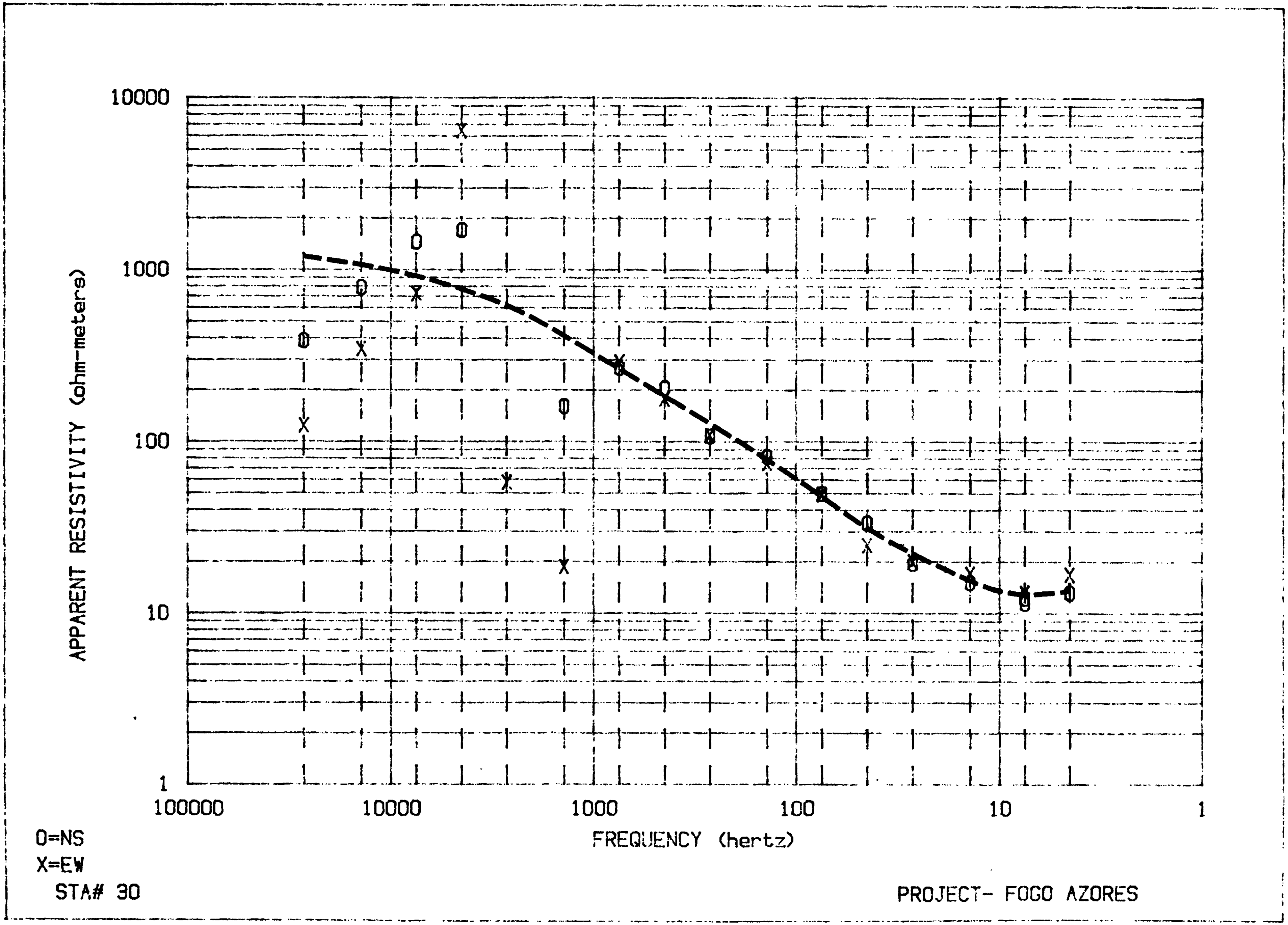

APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
FREQUENCY (hertz)
100000
10000
1000
100
10
1
O=NS
X=EW
STA# 27
PROJECT- FOGO AZORES

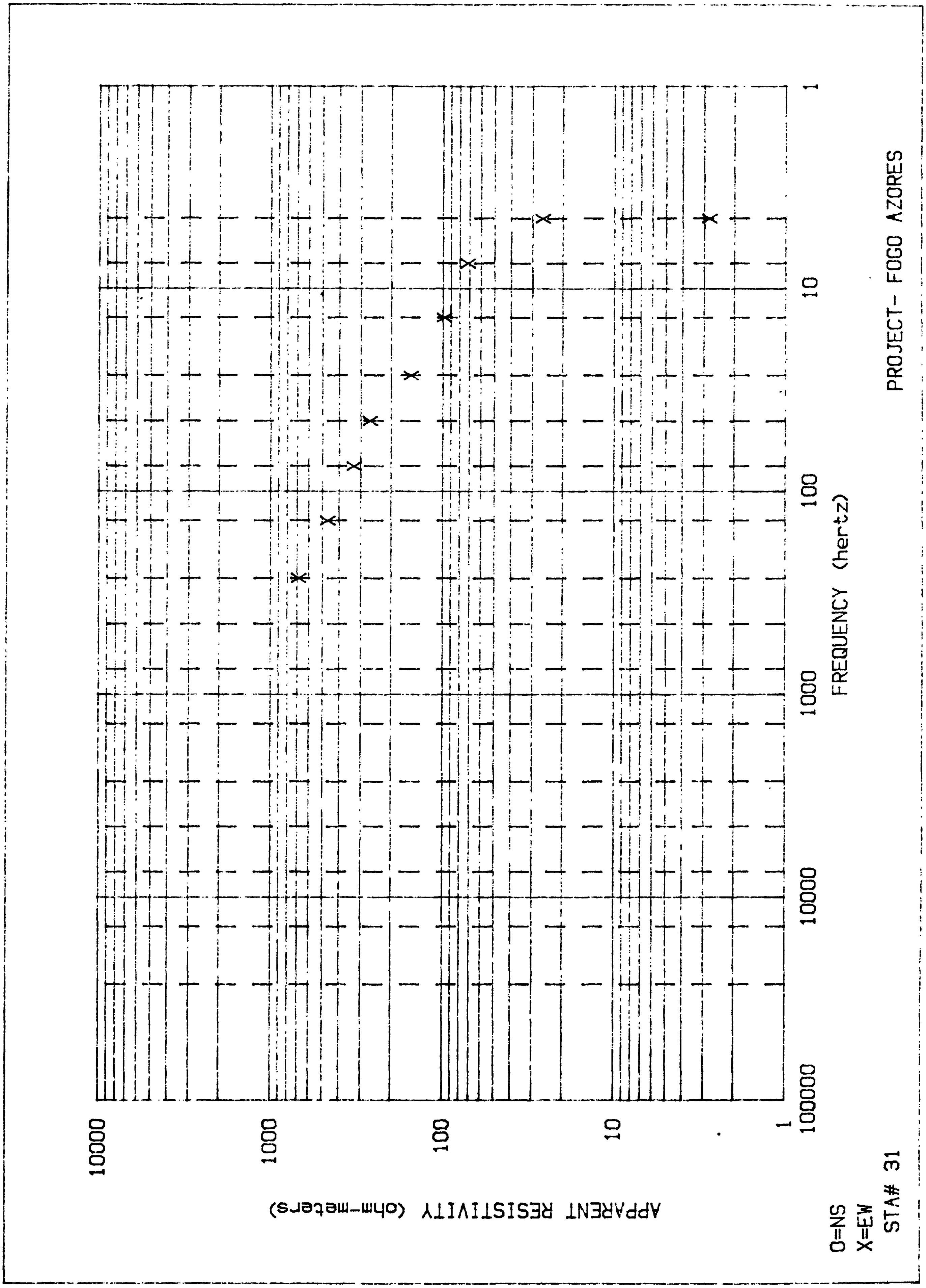


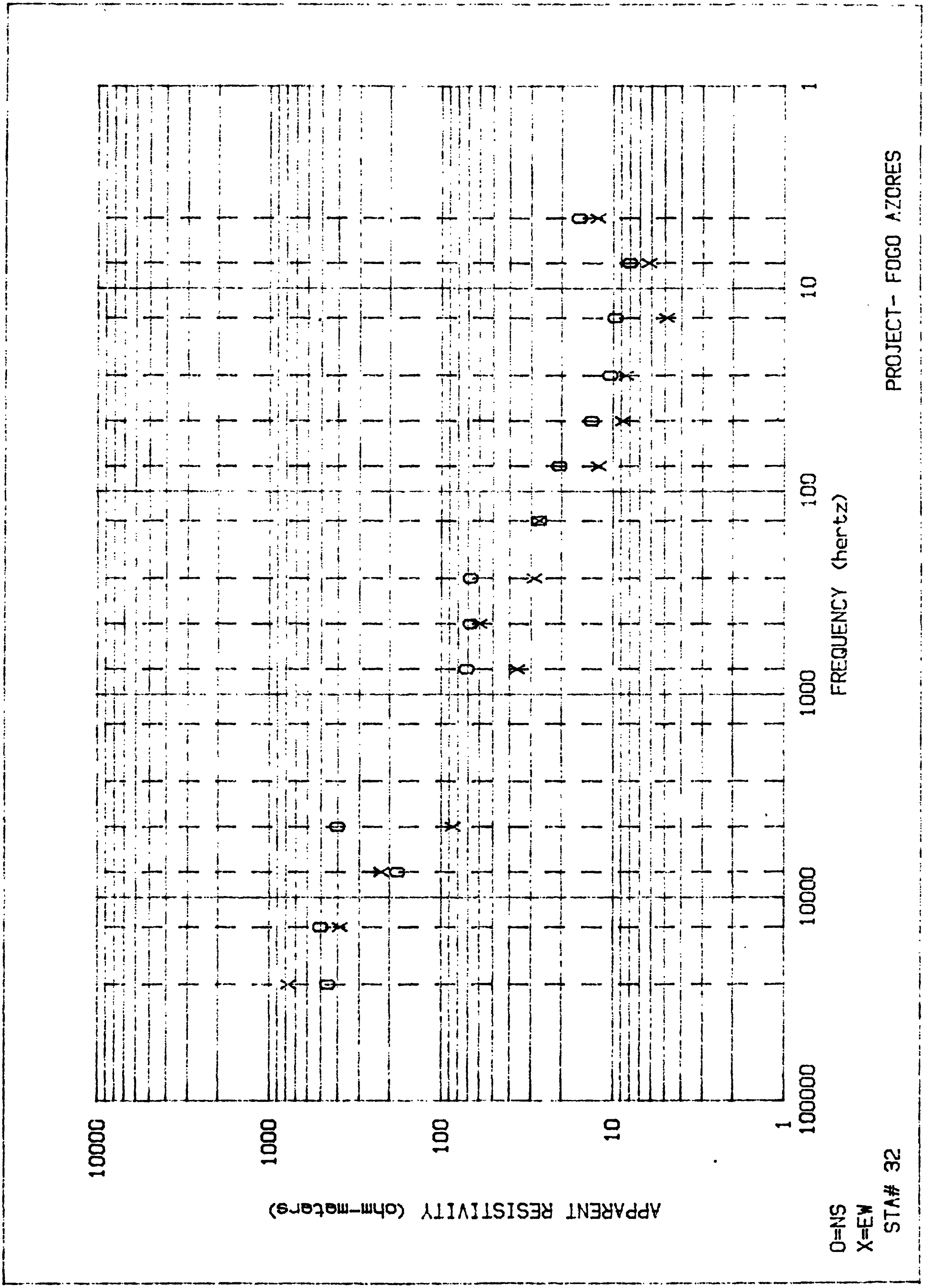
APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 28
PROJECT- FOGO AZORES

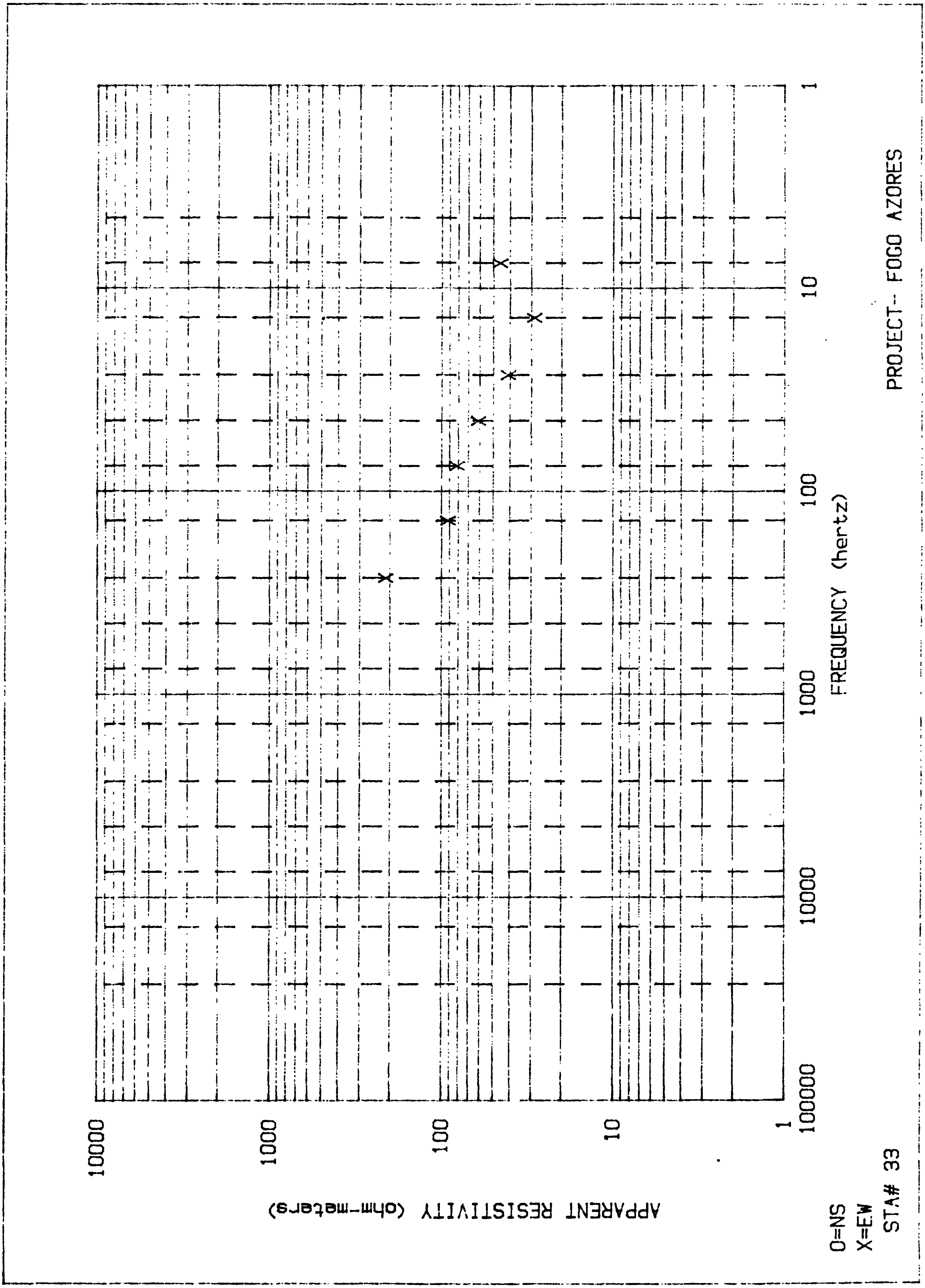


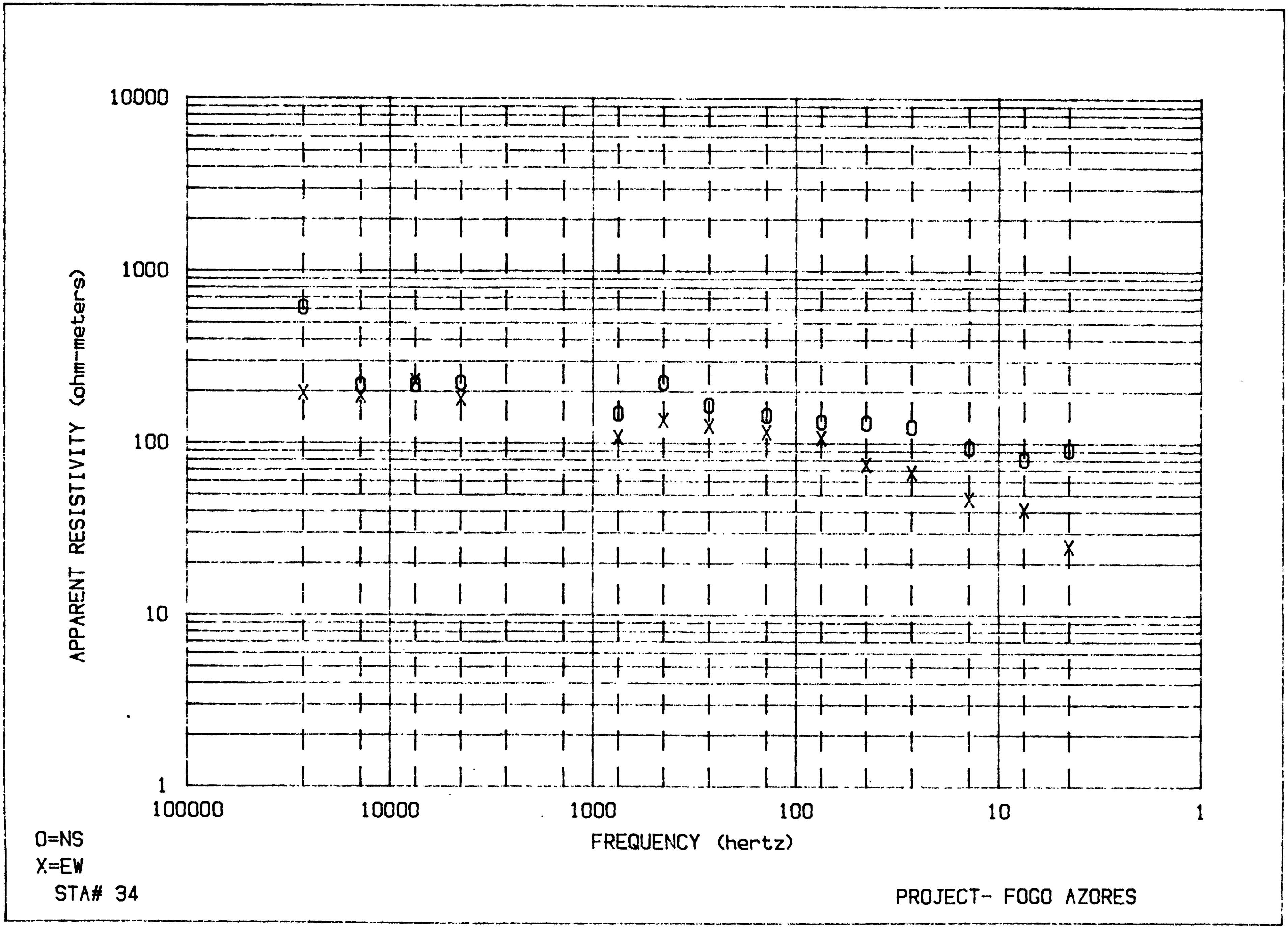
APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
FREQUENCY (hertz)
100000
10000
1000
100
10
1
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 29

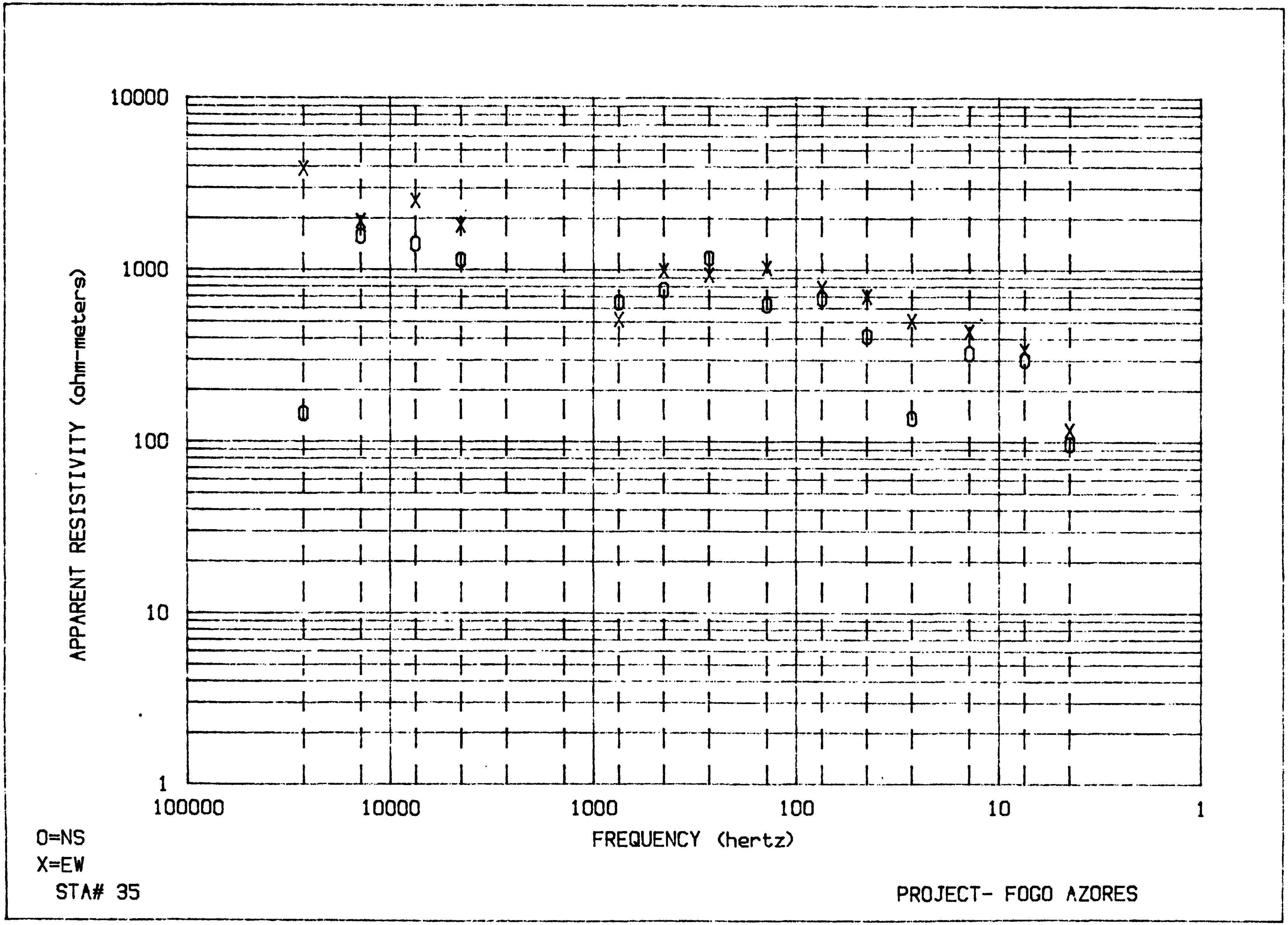

10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 30
PROJECT- FOGO AZORES


APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
FREQUENCY (hertz)
100000
10000
1000
100
10
1
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 31

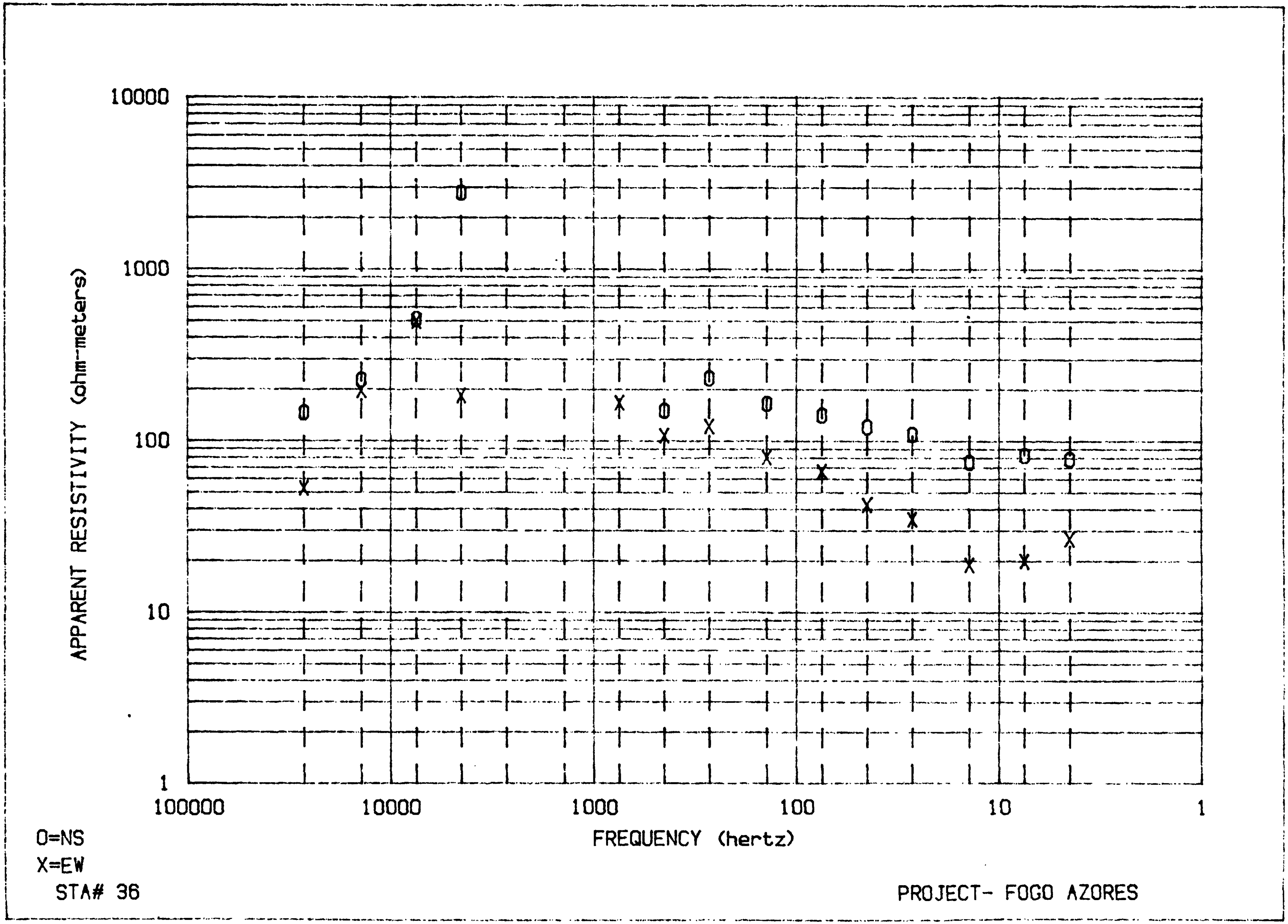

APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
100000
10000
1000
100
10
1
FREQUENCY (hertz)
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 32


APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
FREQUENCY (hertz)
100000
10000
1000
100
10
1
PROJECT- FOGO AZORES
O=NS
X=EW
STA# 33


10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 34
PROJECT- FOGO AZORES



10000
1000
100
10
1
100000
10000
1000
100
10
1
APPARENT RESISTIVITY (ohm-meters)
FREQUENCY (hertz)
O=NS
X=EW
STA# 35
PROJECT- FOGO AZORES


APPARENT RESISTIVITY (ohm-meters)
10000
1000
100
10
1
100000
10000
1000
100
10
1
FREQUENCY (hertz)
O=NS
X=EW
STA# 36
PROJECT- FOGO AZORES