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ENVIRONMENTAL SURVEILLANCE REPORT FOR THE NEVADA TEST SITE (JANUARY 1982 THROUGH DECEMBER 1982)

JUNE 1983

WAYNE A. SCOGGINS

REYNOLDS ELECTRICAL & ENGINEERING CO., INC.
POST OFFICE BOX 14400
LAS VEGAS, NV 89114

PREPARED FOR THE

U.S. DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE UNDER CONTRACT
DE-AC08-76NV00410

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ABSTRACT

This report documents the environmental surveillance program at the Nevada Test Site as conducted by the Department of Energy (DOE) onsite radiological safety contractor from January 1982 through December 1982. The results and evaluations of measurements of radioactivity in air and water, and of direct gamma radiation exposure rates are presented. Relevancy to DOE concentration guides (CG'S) is established.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

Credit must be given to D. Wilson and S. Pfeuffer for their excellent work in the program. I would also like to thank J. Morrison and the reviewers of this report for their cooperation and assistance.

A. INTRODUCTION

This report documents the program conducted at the Nevada Test Site (NTS) for monitoring of radioactivity in the general onsite environment as performed by Reynolds Electrical & Engineering Co., Inc. (REECo) during the calendar year of 1982. As part of its contract, DE-AC08-76NV00410, REECo is responsible for providing radiological safety services within the confines of the test site. For a number of years, the environmental surveillance program has been part of a Department of Energy (DOE) program designed to control, minimize, and document exposures to the NTS working population.

The NTS covers an area of 3,711 square kilometers, with terrain and climate conditions typical of the high southwest desert region and mountainous areas (Figure 1). Temperatures vary from -20°C to 50°C. The area is subject to high winds, dust-laden atmosphere, and low humidity. Elevations range from dry lake beds to rugged mountains as high as 2,300 meters. The NTS, since 1951, has been the primary location for testing the nation's nuclear devices (Figure 1).

The monitoring program originally was designed to examine the environment for levels of radioactivity that are of interest in documenting the radiation exposure to NTS workers; i.e., a backup for the onsite personnel dosimetry system. This program also could provide data concerning onsite releases or be a monitoring locale for the detection of worldwide fallout in Nevada from foreign sources. The program follows the standards presented in "A Guide For Environmental Radiological Surveillance at U.S. Department of Energy

NEVADA TEST SITE

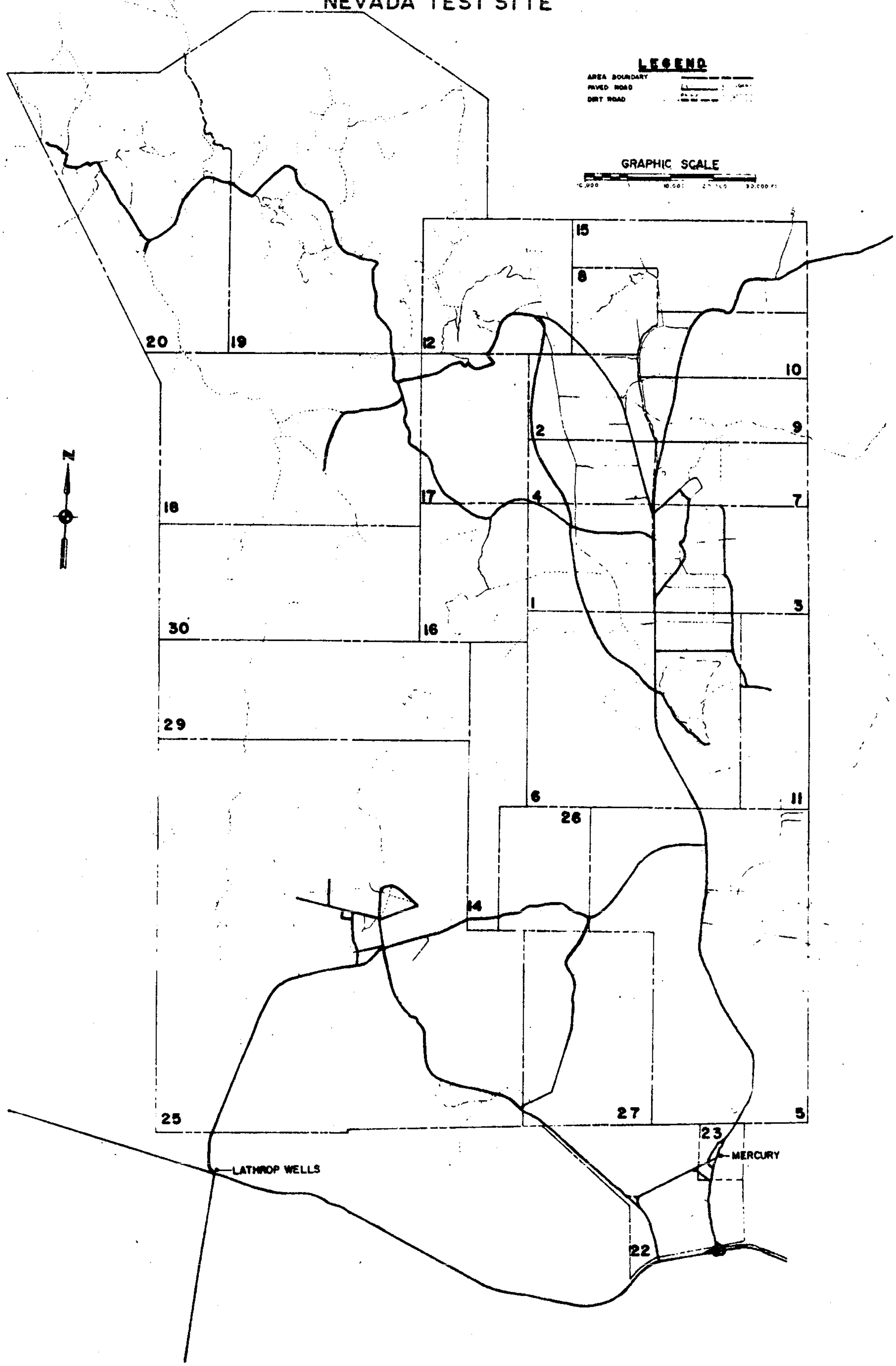

Figure 1

Installations," DOE/EP-0023 (Reference 2). The standards dictate the following objectives for the protection of the public:

(1) Evaluation of containment of radioactivity onsite.

(2) Detection of rapid changes and evaluation of long-term trends.

(3) Assessment of doses-to-man from radioactive releases as a result of DOE operations.

(4) Collection of data bearing on the movement of contaminants released to the environment, with the intent of discovering unknown pathways of exposure.

(5) Maintenance of a data base.

(6) Detection and evaluation of radioactivity from offsite sources.

(7) Demonstration of compliance with applicable regulations and legal requirements concerning releases to the environment.

These objectives are met through the operation of the environmental surveillance program. A summary of the environmental plan is shown in Table 1. Air and potable water samples are collected at specific areas where personnel spend significant amounts of time. Additional air sampling stations are located at sites throughout the NTS in support of the testing program and the radiological waste management program. Water sampling of supply wells, open reservoirs, natural springs, contaminated ponds, and sewage ponds is also done to evaluate the possibility of any movement of radioactive contaminants into the NTS water system. The rate of sampling for each of these surveillance networks is related to potential personnel exposure; i.e., weekly water samples at each cafeteria. Thermoluminescent dosimeters (TLD's) are used to survey the ambient NTS external gamma levels and are collected on a quarterly

TABLE 1

SUMMARY OF ENVIRONMENTAL PROGRAM

Sample Type	Description	Collection Frequency	Number of Samples	Analysis
Air	Continuous sampling through Whatman GF/A glass filter and a charcoal cartridge	Weekly	47	Gamma spectroscopy, gross beta, plutonium (monthly composite)
	Low-volume sampling through silica gel	Bimonthly	16	HTO
	Continuous low volume sampling	Weekly	6	^{85}Kr and ^{133}Xe
Potable Water	1-liter grab sample	Weekly	8	Gross gamma, gross beta, plutonium (quarterly)
	1-liter grab sample	Monthly	8***	Gross beta (quarterly composite)
	4-liter grab sample	Daily	8***	Gross alpha, ^{131}I, ^{90}Sr, ^{3}H (5-day composites)
Supply Wells	1-liter grab sample	Monthly	12	Gross gamma, gamma spectroscopy*, gross beta, plutonium (quarterly)
	1-liter grab sample	Monthly	9***	Gross beta (quarterly composite)
	4-liter grab sample	Daily	9***	Gross alpha, ^{131}I, ^{90}Sr, ^{3}H (5-day composites)
	4-liter grab sample	Quarterly	5****	Gross alpha, gross beta, ^{90}Sr, ^{3}H, ^{239}Pu

* If the gross gamma measurement can be determined with a two sigma error of less than ten percent.
** All of these locations were not sampled due to inaccessibility or lack of water.
*** Onsite sampling to comply with Safe Drinking Water Act.
**** Tonopah Test Range sampling to comply with Safe Drinking Water Act.

TABLE 1, (Continued)

SUMMARY OF ENVIRONMENTAL PROGRAM

Sample Type	Description	Collection Frequency	Number of Samples	Analysis
Open Reservoirs	1-liter grab sample.	Monthly	17**	Gross gamma, gamma spectroscopy*, gross beta, plutonium (quarterly)
Natural Springs	1-liter grab sample.	Monthly	9	Gross gamma, gamma spectroscopy*, gross beta, plutonium (quarterly)
Contaminated Ponds	1-liter grab sample.	Monthly	7	Gross gamma, gamma spectroscopy*, gross beta, plutonium (quarterly)
Effluent Ponds	3-liter grab sample.	Quarterly	7	Gross gamma, gamma spectroscopy* gross beta, plutonium
External Gamma Radiation Levels	CaF_2:Dy Thermoluminescent Dosimeters	Quarterly	163	Total integrated exposure over field cycle.

* If the gross gamma measurement can be determined with a two sigma error of less than ten percent.

** All of these locations were not sampled due to inaccessibility or lack of water.

*** Onsite sampling to comply with Safe Drinking Water Act.

**** Tonopah test Range sampling to comply with Safe Drinking Water Act.

cycle. Except for removal of a station, inaccessibility of the location, or loss of data, sampling was continuous during this reporting period. A review of all analyses from this sampling program relative to the DOE concentration guides were performed daily to insure that potential problems were noted in a timely fashion. Table 2 lists the CG's used in the evaluations of this program (Reference 3).

All laboratory analyses appropriate to the environmental surveillance program are shown in Table 3. The analysis that provided the most information on the majority of test site samples has been the gross beta analysis. It allowed for rapid determinations of trends in gross radioactivity, and because of counting system characteristics, had a low detection limit. This meant that positive measurements were obtained down to the lowest limits of ambient radioactivity. The remaining analyses show their worth to the program in more specific instances. Gamma spectroscopy and noble gas sampling have proved their importance by indicating whether increases of radioactivity in air were caused by the Nevada Test Site or other offsite sources. TLD analysis of direct gamma radiation onsite has shown: (1) elevated exposure rates at the coordinates of the NTS atmospheric tests; and (2) consistent exposure rates at all radiation levels when the TLD's are integrated over a three month period. Plutonium analysis was primarily an indicator of the small amounts of plutonium-239 in the air near areas with histories of safety shots. Tritium analysis was used principally as a check of the water in the ponds below the Area 12 tunnels. Gross gamma analysis was used as a screening tool for elevated gamma activity in NTS water samples. It was found to be of minimal use to this program.

TABLE 2

DOE CONCENTRATION GUIDES (CGs) FOR CONTROLLED AREAS*

Nuclide	CG for Air (μCi/cc)	CG for Major NTS Waters (μCi/ml)	CG for Drinking Water (μCi/ml)
^{3}H	5×10^{-6}	1×10^{-1}	3×10^{-3}
^{7}Be	6×10^{-6}	5×10^{-2}	2×10^{-3}
^{85}Kr	1×10^{-5}	--------	--------
^{89}Sr	3×10^{-8}	3×10^{-4}	3×10^{-6}
^{90}Sr	1×10^{-9}	1×10^{-5}	3×10^{-7}
^{95}Zr	1×10^{-7}	2×10^{-3}	6×10^{-5}
^{131}I	4×10^{-9}	3×10^{-5}	3×10^{-7}
^{132}Te	2×10^{-7}	9×10^{-4}	3×10^{-5}
^{133}Xe	1×10^{-5}	-------	--------
^{137}Cs	6×10^{-8}	4×10^{-4}	2×10^{-5}
^{140}Ba	1×10^{-7}	8×10^{-4}	3×10^{-5}
^{238}Pu	2×10^{-12}	1×10^{-4}	5×10^{-6}
^{239}Pu	2×10^{-12}	1×10^{-4}	5×10^{-6}

* This table contains the concentration guides for the nuclides of major interest at the NTS (DOE Order 5480.1, Chapter XI).

TABLE 3

LABORATORY ANALYTICAL PROCEDURES

Type of Analysis	Type of Sample	Analytical Equipment	Counting Period (Min.)	Analytical Procedures	Sample Size	Detection Limit
Gross Beta	Air	Wide Beta II	20	Place filter on a 12.7 cm stainless steel planchet.	10^9 cc	2×10^{-16} µCi/cc
	Water	Wide Beta II	100	Evaporate, transfer residue to a 12.7 cm stainless steel planchet.	1000 ml	1×10^{-9} µCi/ml
Gross Gamma	Water	23 cm x 23 cm NaI Well crystal	20	Aliquot sample into Nalgene bottle.	500 ml	6×10^{-8} µCi/ml
Gamma Spectroscopy	Air (particulate)	Ge(Li)	20	Same as for gross beta.	10^9 cc	5×10^{-15} µCi/cc
	Air (gaseous)	Ge(Li)	20	Place charcoal cartridge in plastic bag.	10^9 cc	5×10^{-15} µCi/cc
	Water	Ge(Li)	20	Count the planchet after beta analysis.	500 ml	1×10^{-8} µCi/ml
Iodine-131	Water	Wide Beta II	100	Iodine carrier added to sample then purified by anion exchange resin column and mounted on a stanless steel planchet.	2000 ml	5×10^{-10} µCi/ml
Krypton-85	Air	Liquid Scintillation Counter	200	Cryogenic-gas chromatographic techniques used to collect krypton into liquid scintillation solution.	3×10^5 cc	4×10^{-12} µCi/cc
Plutonium-239	Air	Silicon Semiconductor	333	Filter is ashed and put in solution. Pu is purified by anion exchange resin column, then electrodeposited on a stainless steel disc.	4×10^9 cc	1×10^{-17} µCi/cc
	Water	Silicon Semiconductor	333	Pu is concentrated with $Fe(OH)_3$ and purified with anion resin column. Electrodeposited on a stainless steel disc.	1000 ml	1×10^{-11} µCi/ml

TABLE 3, (Continued)

Type of Analysis	Type of Sample	Analytical Equipment	Counting Period (Min.)	Analytical Procedures	Sample Size	Detection Limit
Strontium-90	Water	Wide Beta II	100	^{90}Sr precipitated and counted. ^{90}Y allowed to grow to equilibrium and counted.	1000 ml	3×10^{-10} µCi/ml
Tritium	Air	Liquid Scintillation Counter	100	Distill the H_2O and aliquot 5 ml into a scintillation solution.	6×10^{6} cc	3×10^{-13} µCi/cc
	Water	Liquid Scintillation Counter	100	Aliquot 10 ml into a scintillation solution.	2 ml	9×10^{-7} µCi/ml
Xenon-133	Air	Liquid Scintillation Counter	200	Cryogenic-gas chromatographic techniques used to collect xenon into liquid scintillation solution.	3×10^{5} cc	10×10^{-12} µCi/cc
Direct Gamma Radiation	TLD	Harshaw 2000		Post-anneal at 115°C for 15 minutes. Readout to 270° for 25 seconds.		5 mR/quarter

B. SUMMARY OF RESULTS

The results obtained from the environmental surveillance program for the reporting period of CY-1982 show that the radioactivity in air and water in the NTS environments was low compared to DOE guidelines. External gamma radiation at certain NTS sites approached the rate that could provide the annual dose commitment guide exposure for an individual in a controlled area (5 rem/y).

The maximum CY-1982 average gross beta concentration in air was 2.6 X 10^{-14} μCi/cc at station 38, Area 15 EPA Farm. This average represents 0.0026 percent of the applicable concentration guide of 1 X 10^{-9} μCi/cc as listed in DOE Order 5480.1, Chapter XI (assuming ^{90}Sr is the beta emitter present). The other stations during this report period demonstrated similar results. The site average for the forty-seven stations was 2.3 X 10^{-14} μCi/cc with one standard deviation being six percent. These gross beta concentrations are considered to be normal background concentrations at the Nevada Test Site. An increase in gross beta activity occurred during the week of September 20, 1982, at the A-12 Complex and A-15 EPA Farm. This was attributed to a routine tunnel ventillation. The measured concentrations were 1.3 x 10^{-13} and 1.7 x 10^{-13} μCi/cc which represents 0.013 and 0.017 percent of the concentration guide (assuming ^{90}Sr is the beta emitter present), respectively. ^{239}Pu concentrations in air were primarily on the order of 10^{-17} μCi/cc as compared with the concentration guide of 2 X 10^{-12} μCi/cc (DOE Order 5480.1, Chapter XI). The highest average ^{239}Pu concentration occurred in Area 9 at the 9-300 Bunker. This ^{239}Pu concentration of 2.15 X 10^{-16} μCi/cc represents 0.011

percent of the concentration guide. The majority of NTS air sampling stations measured plutonium concentrations similar to those found in the basecamp (Mercury) and all were negligible in terms of exposure to NTS personnel.

Fourteen tritium in air samplers were added while two locations were dropped during CY-1982. The data showed large fluctuations throughout the year. The highest average tritium in air concentration occurred in Area 23, Bldg. 790 of 6.3×10^{-9} μCi/cc. This represents 0.13 percent of the concentration guide.

Six locations were monitored for noble gases during CY-1982. One minor release, caused by drillback operations, was detected during the week of December 6, 1982 at Area 1 BJY. The ^{133}Xe concentration was 140×10^{-12} μCi/cc or 0.0014 percent of the concentration guide. Another set of positive results for ^{133}Xe came during the week of October 4, 1982. The two stations with positive results were Area 1 BJY and Area 5 Gate 200. The highest concentration was 71.0×10^{-12} μCi/cc at Gate 200 and the other value was 43.3×10^{-12} μCi/cc at BJY. This represents 0.0007 and 0.0004 percent of the concentration guide, respectively.

Measurements of radioactivity in the principal NTS water system showed that no release or movement of radionuclides occurred during the reporting period. It was shown that the radioactivity in the closed water system (supply wells and potable waters) was determined by the specific activity of the associated potassium concentration (naturally occurring ^{40}K). The highest average gross beta concentration in potable waters and supply wells was 9.9×10^{-9} μCi/ml from the Area 6 Cafeteria and 1.3×10^{-8} μCi/ml from Area 6 Well C1. Water from one open reservoir (A-5 reservoir) showed gross beta activities believed to be associated with the occasional influx of radionuclides from surface contamination in the surrounding areas. There was no human consumption of this water, and the activity was still within the applicable concentration guides.

A special study was conducted, as required by the Safe Water Drinking Act of 1976, on supply wells at the Tonopah Test Range and Nevada Test Site along with the NTS potable water locations. All but two results were below the screening levels for gross alpha and beta activity and maximum contaminant levels for man made radionuclides. The two positive gross beta concentrations at Well C and Well C-1 can be attributed to their ^{40}K content as shown by Figure 7.

The highest ^{239}Pu concentration from noncontaminated waters was 1.5×10^{-10} μCi/ml at Tub Springs. This represents 0.003 percent of the concentration guide for ^{239}Pu. All of the positive plutonium results have a high percentage error associated with them and are possibly due to statistical fluctuations of the counting system.

Starting June 1, 1982 a different method was used for calculating the detection limit. Previously, the minimum detection limit was defined as that value for which the relative two sigma counting error was 100 percent. We are now using the method described in the HASL-300 publication (19). This yields a lower limit of detection of 9×10^{-7} μCi/cc for tritium. The highest concentration of tritium in noncontaminated water occurred at White Rock

Springs. This concentration of 1.8×10^{-5} μCi/ml represents 0.5 percent of the concentration guide. Positive results close to the detection limit may have been caused by statistical fluctuations in the counter.

Measurable amounts of tritium were present in the contaminated waste ponds. The amounts of effluent released to the environment for the year were calculated and reported to DOE Headquarters in accordance with DOE Order 5484.1, Chapter IV.

TLD measurements of the NTS gamma radiation rates at the 163 locations showed minimal changes throughout CY-1982. A nine station control network displayed similar results to previous years, while the remaining 154 stations recorded only a few small changes related to known effects. The maximum dose rate of 3180 mrem/y occurred at the 4-04 road station, but the majority of NTS locations measured in the range of approximately 100-160 mrem/y.

The maximum dose to an individual living at the NTS boundary was calculated for CY-1982. The maximum calculated dose to the total body, bone, and lung was 0.18 mrem, 2.0 mrem, and 0.24 mrem respectively. Using the values from Reference 17, these doses represent risks for radiation-induced cancers of 3.0×10^{-8} (total body), 4.8×10^{-9} (bone), and 4.0×10^{-8} (lung) to the individual.

C. SAMPLING AND ANALYSIS

1. Air Monitoring

Air sampling units were located at 47 stations on the NTS to measure the radionuclides in the form of particulates and halogens. All placements were chosen primarily to provide monitoring of radioactivity at sites with high occupational factors. Geographical coverage, access, and availability of commercial power were also considered.

The sampling units consist of a positive displacement pump drawing air at approximately 100 liters per minute through a 9-centimeter Whatman GF/A filter for particulates, followed by a charcoal cartridge for radioiodines, and mounted on a plastic sample holder. A dry-gas meter was utilized to measure the volume of air displaced over the sampling period which was typically seven days. The total volume sampled was approximately 1000 cubic meters.

The samples were held for about seven days prior to analysis to allow the naturally-occurring radioactive noble gas products to decay to insignificant levels. Gross beta counting was performed with a gas flow proportional counter (Beckman WIDE BETA II) for 20 minutes. The lower limit of detection for typical parameters involved was 2 X 10^{-16} $\mu Ci/cc$. Gamma spectroscopy was accomplished using a lithium-drifted germanium detector with an input to 2000 channels which were calibrated at 1 keV per channel from 0 to 2 MeV.

The weekly air samples for a given sampling station were batched on a monthly basis and radiochemically analyzed for ^{239}Pu. The procedure incorporated an acid dissolution and an ion exchange recovery on a resin bed. Plutonium was deposited by plating on a stainless steel disc. The chemical yield of the plutonium was determined with an internal ^{236}Pu tracer. Alpha spectroscopy was performed utilizing a solid state silicon surface barrier detector. The lower limit of detection for the parameters involved was 2 X 10^{-17} $\mu Ci/cc$.

A separate sampler was designed for the collection of airborne tritium (HT) and tritiated water vapor (HTO) (Reference 4). Studies performed in the spring showed that the conversion of $2\ HT + O_2 \xrightarrow{Pt} 2\ HTO$ would not work properly and the analysis of HT has been discontinued. The portable sampler was capable of unattended operation for up to two weeks in desert areas. A small electronic pump drew air into the apparatus at approximately 0.5 liters per minute, and the HTO was removed from the air stream by two silica gel drying columns. Appropriate aliquots of condensed moisture were obtained by heating the silica gel. Counting via liquid scintillation techniques allowed for the determination of the HTO activity. A lower limit of detection for this analysis was 2 X 10^{-13} $\mu Ci/cc$.

The six noble gas sampling stations previously run by EPA were taken over by REECo and replaced in the spring with a new sampler. The new sampling units are housed in a metal tool box with three metal air bottles attached with quick disconnect hoses. A vacuum is maintained on the first bottle which causes a steady flow of air to be collected in the other two bottles. The flow rate is approximately 0.5 cubic centimeters per minute. The two collection bottles are exchanged weekly which yield a sample volume of about 3×10^5 cubic centimeters.

The noble gases are separated and collected from the atmospheric sample by a series of cryogenic-gas chromatographic techniques. Water and carbon dioxide are removed at room temperature and the krypton and xenon are collected on charcoal at liquid nitrogen temperatures. These gases are transfered to a molecular sieve where they are separated from any remaining gases and each other. The krypton and xenon are transfered to separate scintillation vials and counted on a liquid scintillation counter. The lower limits of detection for the krypton and zenon are 4×10^{-12} and 10×10^{-12} µCi/cc, respectively.

2. Water Monitoring

Water samples were collected at various frequencies from selected potable water consumption points, supply wells, natural springs, open reservoirs, final effluent ponds and contaminated ponds. Frequency was determined on the basis of a preliminary radiological pathways analysis; i.e., potable water weekly, supply wells monthly, etc. Samples were collected in 1-liter glass containers. All samples were analyzed for gross beta and tritium concentrations, and were screened for gross gamma. Plutonium analyses were performed on a quarterly basis.

A 500-ml aliquot was taken from the original sample and counted in a Nalgene bottle for gross gamma activity in a NaI(Tl) well crystal. A 2-ml sample was aliquoted and subjected to tritium analysis via liquid scintillation. The remainder of the original sample was evaporated to 15-ml, transferred to a stainless steel counting planchet, and evaporated to dryness after the addition of a wetting agent. Beta counting was accomplished as described in Section 1 except that the water samples were counted for 100 minutes. Lower limits of detection were: (1) gross gamma, 6×10^{-8} $\mu Ci/ml$; (2) tritium, 9×10^{-7} $\mu Ci/ml$; and (3) gross beta, 1×10^{-9} $\mu Ci/ml$.

For the quarterly plutonium analysis, an additional 1-liter sample was collected. The radiochemical procedure was similar to that described in Section 1. As mentioned, alpha spectroscopy was used to measure any ^{239}Pu. The lower limits of detection for this procedure was 4×10^{-11} μCi/ml.

In accordance with the Safe Drinking Water Act of 1976, special water sampling was conducted during CY-1982 on all supply wells that supply potable water at the Tonopah Test Range and the Nevada Test Site. The potable water locations on the Nevada Test Site were also included. Three supply wells on the NTS do not supply potable water (Well Ue5c, Well 2, Well U19c) and, therefore, were not included in this study.

There were five wells sampled at the Tonopah Test Range. Since there are no nuclear facilities present the monitoring requirements for community water systems were used. The sampling occurred on a quarterly basis and the analyses were performed for tritium, ^{90}Sr, ^{239}Pu, and gross alpha and beta activities. The ^{239}Pu analysis was included because of previous safety shots at the Tonopah Test Range.

Nine supply wells and eight potable water locations were sampled on the NTS according to the more stringent requirements for water systems near nuclear facilities. Each month a 1-liter sample was taken at each location, composited on a quarterly basis, and analyzed for gross beta activity. On a quarterly basis a 4-liter sample was taken for five consecutive days and composited. These composite samples were analyzed for ^{131}I, ^{90}Sr, tritium, and gross alpha and beta activities. Additional analyses were not performed because the screening levels for gross alpha and beta activities were not exceeded.

3. Gamma Monitoring (TLD)

TLD's were located at 163 stations on the NTS to measure the external gamma radiation from the environment. These locations were chosen to: (1) provide a low-level control type network; (2) provide an arc coverage for the nuclear testing program; (3) measure the residual activity from the atmospheric testing program; and (4) document the radiological conditions at the radioactive waste management sites (RWMS).

The dosimeters used were CaF_2:Dy (TLD-200) 0.6 cm X 0.6 cm x 0.09 cm chips from Harshaw Chemical Company. A badge consisting of two chips shielded by 0.12 cm cadmium (1030 mg/cm^2) inside a 0.13 cm plastic (140 mg/cm^2) holder was placed about one meter above the ground at each location. The dosimeters detected gamma radiation above an energy cutoff of approximately 70 keV. The known systematic errors of the dosimeter in this application were the minimized detection of lower energy photons and fade of the phosphor's stored energy with time. Previous research indicated that only about 5-10% of the total exposure from natural background was from gamma emitters below 150 keV (Reference 5).

Fade in TLD-200 can be high when used in elevated temperatures such as those encountered at certain NTS locations. This loss of the phosphor's stored energy was minimized both physically and analytically by the REECo dosimetry group. Before readout, the chips were annealed at 115°C for 15 minutes to reduce the high-fade, low temperature traps. Calibration TLD's were stored in a lead pig to empirically determine the value of this minimized fade (usually less than 10 percent).

Random errors included dosimeter variance, source calibration, and transit exposure. One method of error analysis was contained in a paper by Burke and Gesell, "Error Analysis of Environmental Radiation Measurements Made with Integrating Detectors," NBS Special Publication 456, pp. 187-198, (1976), (Reference 6). For our purposes, a less rigid statistical evaluation was sufficient. All analyses are being evaluated as to their compliance with ANSI N545-1975, "American National Standard Performance, Testing, and Procedural Specification for Thermoluminescent Dosimetry (Environmental Applications)" (Reference 7).

4. Data Treatment

Each set of data obtained from this program underwent a thorough inspection as to its accuracy. Not only is the data analyzed automatically by computer, it is also verified by the REECo Environmental Sciences Department (ESD) personnel prior to acceptance. If serious differences were found from the expected value, a review of the field handling, sample preparation, and processing was done. On the occasions when the problem could not be resolved by an environmental analyst, a recount or second sample was secured whenever possible.

All data were plotted on a daily basis or listed in tabular form. This treatment facilitated the data review process and revealed trends or periodicity. Each station's data were plotted against a logarithmic axis because of the possible magnitudes of variation in environmental data. The averaging plots in each section show arithmetic means and the range of data at each point. Arithmetic means, although severely affected by outliers (suspicious data), were those values compared to the CG's and listed in all tables. The plots provided reassurance to the means by graphically demonstrating the data file.

In this program, the value used to check for inaccuracies, trends, or periodicity was the central tendency of the plots. This statistic showed the center of the data file with a strong resistance to outliers and allowed the judgement of the analyst to be imposed upon the system. Any suspected data were checked against the station's central tendency and prior measures of dispersion.

D. RADIOACTIVITY IN AIR

Ambient air monitoring was performed at the 47 locations shown in Figures 2 and 3. The computer plotted displays of the gross beta and ^{239}Pu activities for the entire air surveillance network are presented in Appendix A. In the first plot, the forty-seven weekly values were arithmetically averaged to show a smoothed presentation of the changes in airborne radioactivity over the surveillance period. The data ranges are included for each of these points. The remaining plots in Appendix A depict the actual measurements at each station.

Figures 2 and 3 summarize the 1982 gross beta and ^{239}Pu yearly locational averages, respectively. Tables 4 and 5 list these yearly averages along with the half-year averages. The network average for the whole year for gross beta activity was 2.3×10^{-14} or 0.023 percent of the applicable concentration guide of 1×10^{-9} µCi/cc listed in DOE Order 5480.1, Chapter XI (assuming ^{90}Sr is the beta emitter present). During the week of September 20, 1982, a small increase of gross beta activity was detected at A-12 Complex and A-15 EPA Farm. The concentrations measured were 1.3×10^{-13} and 1.7×10^{-13} µCi/cc or 0.013 and 0.017 percent of the concentration guide (assuming ^{90}Sr was the beta emitter present), respectively. The cause from a routine ventilation of a tunnel.

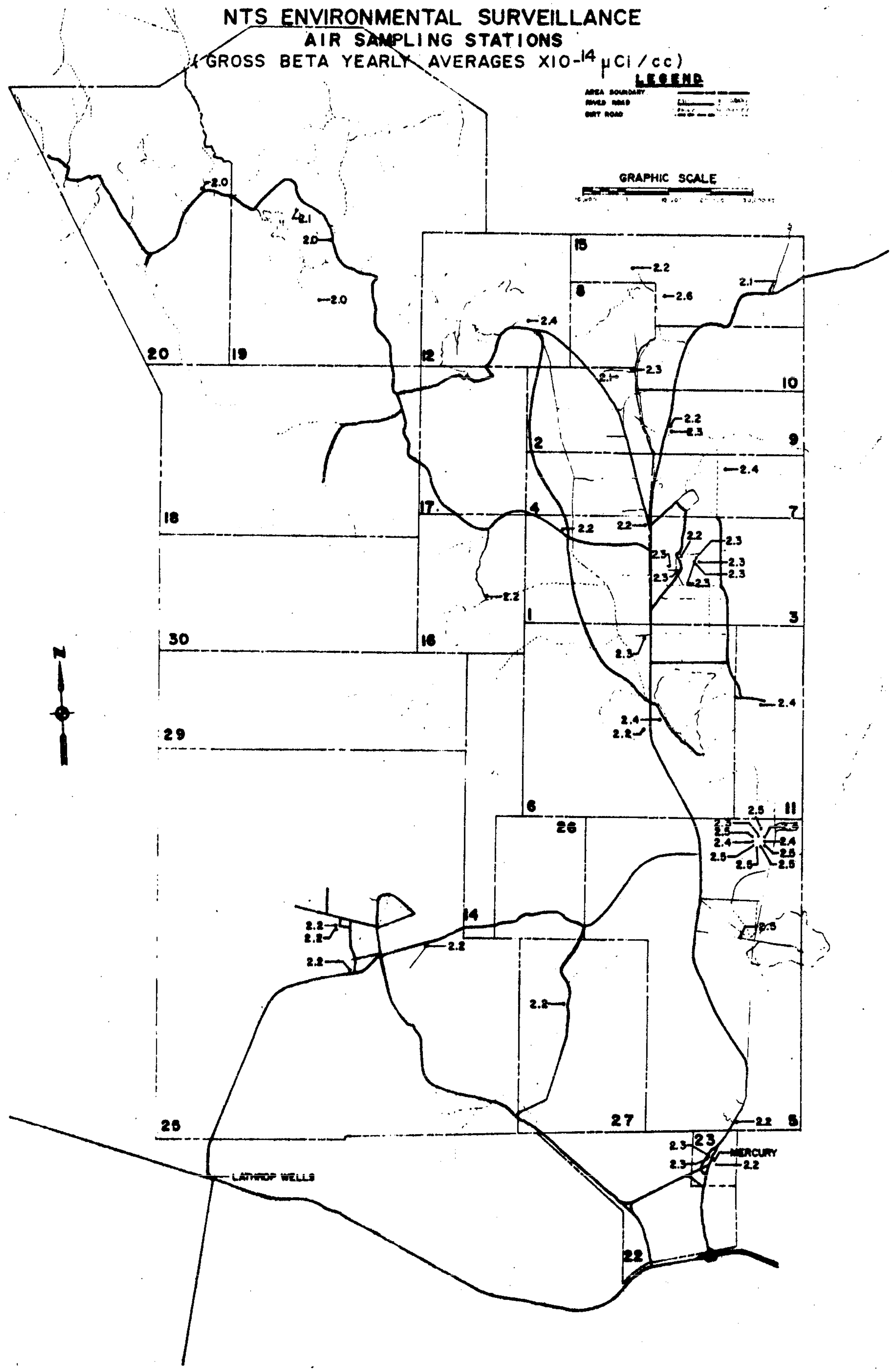
NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10-14 μCi/cc)
LEGEND
GRAPHIC SCALE
N
LATHROP WELLS
MERCURY
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Figure 2

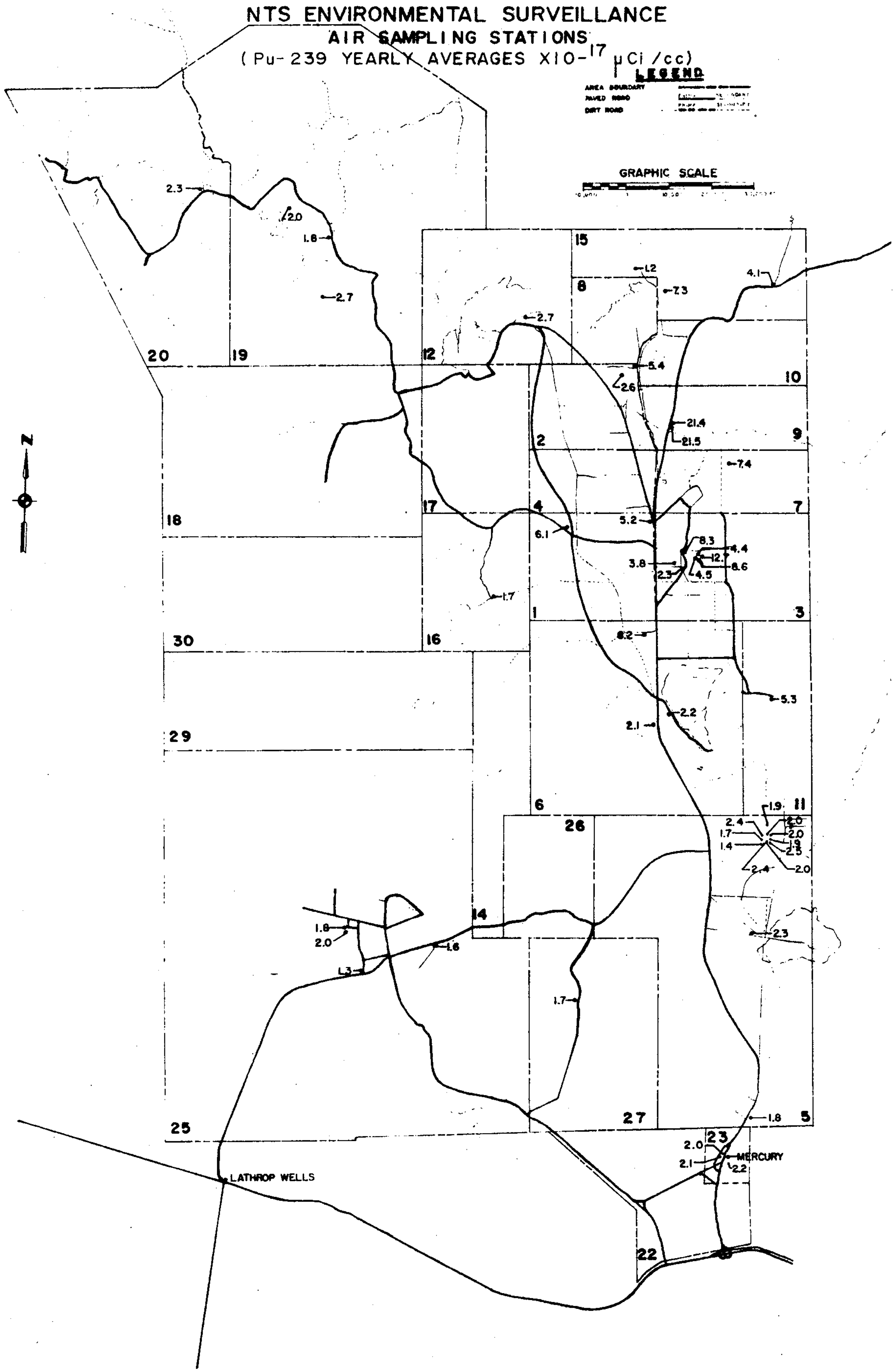

NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING STATIONS
(Pu-239 YEARLY AVERAGES X10^{-17} μCi /cc)
LEGEND
GRAPHIC SCALE
LATHROP WELLS
MERCURY

Figure 3

Table 5 lists the ^{239}Pu concentrations for the year. All stations averaged below 10^{-15} μCi/cc for CY-1982, with the majority being on the order of 10^{-17} μCi/cc. The highest activity was found at 9-300 Bunker. The average concentration at this location was 2.15 X 10^{-16} μCi/cc, or 0.11 percent of the controlled area concentration guide of 2 X 10^{-12} μCi/cc. Figure 3 shows the ^{239}Pu yearly results at their respective locations. This map highlights the areas of plutonium contamination. The radioactivity is primarily due to tests conducted before 1960 in which nuclear devices were detonated with high explosives (safety shots). These tests spread low-fired plutonium throughout the eastern and northeastern areas of the NTS. Two decades later, the effects of these tests are still demonstrated in increased plutonium concentrations in air in Areas 1, 2, 3, 7, 8, 9, 10, and 15.

Additional tritium in air samplers were added throughout the CY-1982. The following six locations formerly monitored by EPA were added:

Area 23	Bldg. 790	Area 15	EPA Farm
Area 25	EMAD	Area 1	BJY
Area 12	Base Camp	Area 51	Far Forward

The Area 51 sampler was moved to Area 15 Gate 700 in October of 1982. Two samplers were removed from within RWMS, RWMS-2 and -3, because of the many problems encountered with the solar collectors. Eight more samplers were placed around the perimeter of RWMS. The locations of all of these samplers along with their yearly averages are shown in Figure 4. All of these stations were sampled for two week intervals. Substantial fluctuations occurred

TABLE 4

AVERAGES OF AIR SURVEILLANCE DATA FOR GROSS BETA

($X\ 10^{-14}\ \mu Ci/cc$)

Station			1/1/82-6/30/82	7/1/82-12/31/82	1/1/82-12/31/82
Area	1	BJY	2.5	2.0	2.2
Area	1	Gravel Pit	2.5	2.0	2.2
Area	2	Cable Yard	2.5	2.1	2.3
Area	2	Compound	2.4	1.9	2.1
Area	3	Compound	2.6	2.1	2.3
Area	3	Complex #2	2.5	2.1	2.3
Area	3	3-300 Bunker	2.5	2.0	2.2
Area	3	U3ax South	2.6	2.1	2.3
Area	3	U3ax East	2.5	2.0	2.3
Area	3	U3ax North	2.6	2.0	2.3
Area	3	U3ax West	2.6	2.1	2.3
Area	5	DOD Yard	2.7	2.4	2.5
Area	5	Gate 200	2.7	1.8	2.2
Area	5	RWMS #1	2.6	2.4	2.5
Area	5	RWMS #2	2.7	2.3	2.5
Area	5	RWMS #3	2.5	2.4	2.4
Area	5	RWMS #4	2.6	2.3	2.4
Area	5	RWMS #5	2.6	2.1	2.3
Area	5	RWMS #6	2.7	2.3	2.5
Area	5	RWMS #7	2.6	2.3	2.4
Area	5	RWMS #8	2.7	2.3	2.5
Area	5	RWMS #9	2.7	2.3	2.5
Area	5	Well 5B	2.6	2.3	2.5
Area	6	CP Complex	2.5	2.0	2.2
Area	6	Well 3 Complex	2.5	2.1	2.3
Area	6	Yucca Complex	2.6	2.1	2.4
Area	7	UE7ns	2.6	2.1	2.4
Area	9	9-300 Bunker	2.6	2.0	2.3
Area	9	9-300 Bunker #2	2.5	2.0	2.2
Area	11	Gate 293	2.6	2.1	2.4
Area	12	Compound	2.3	2.4	2.4
Area	15	EPA Farm	2.5	2.7	2.6
Area	15	Gate 700	2.3	1.9	2.1
Area	15	Piledriver	2.4	1.9	2.2
Area	16	Substation	2.4	2.0	2.2
Area	19	Echo Peak	2.3	1.7	2.0
Area	19	Substation	2.2	1.8	2.0
Area	19	19-3 Substation	2.3	2.0	2.1
Area	20	Dispensary	2.1	1.8	2.0
Area	23	Bldg. 790	2.5	2.1	2.3
Area	23	Bldg. 790 #2	2.6	2.0	2.3
Area	23	H&S Roof	2.5	2.0	2.2
Area	25	E-MAD South	2.5	2.0	2.2
Area	25	E-MAD North	2.5	2.0	2.2
Area	25	NRDS Warehouse	2.5	2.0	2.2
Area	25	Henre Site	2.4	1.9	2.2
Area	27	Cafeteria	2.5	2.0	2.2

TABLE 5

AVERAGES OF AIR SURVEILLANCE DATA FOR PLUTONIUM

($\times 10^{-17}$ μCi/cc)

Station		1/1/82-6/30/82	7/1/82-12/31/82	1/1/82-12/31/82
Area 1	Gravel Pit	9.7	2.5	6.1
Area 2	Cable Yard	4.6	6.3	5.4
Area 2	Compound	2.5	2.6	2.6
Area 3	BJY	5.6	5.0	5.2
Area 3	Compound	4.2	3.4	3.8
Area 3	Complex #2	2.1	2.6	2.3
Area 3	U3ax South	7.7	9.5	8.6
Area 3	U3ax East	9.9	15.5	12.7
Area 3	U3ax North	6.8	2.0	4.4
Area 3	U3ax West	5.7	3.3	4.5
Area 3	3-300 Bunker	5.5	11.2	8.3
Area 5	DOD Yard	2.1	1.7	1.9
Area 5	Gate 200	2.2	1.3	1.8
Area 5	RWMS #1	2.4	1.6	2.0
Area 5	RWMS #2	3.2	1.8	2.5
Area 5	RWMS #3	2.1	1.6	1.9
Area 5	RWMS #4	1.7	2.3	2.0
Area 5	RWMS #5	1.1	2.9	2.0
Area 5	RWMS #6	1.3	2.7	2.0
Area 5	RWMS #7	1.0	2.5	1.7
Area 5	RWMS #8	1.1	1.7	1.4
Area 5	RWMS #9	3.0	1.8	2.4
Area 5	Well 5B	3.0	1.6	2.3
Area 6	CP Complex	2.0	2.1	2.1
Area 6	Well 3 Complex	9.7	2.7	6.2
Area 6	Yucca Complex	2.3	2.1	2.2
Area 7	UE7ns	1.3	14.7	7.4
Area 9	9-300 Bunker	27.1	15.9	21.5
Area 9	9-300 Bunker #2	23.5	19.3	21.4
Area 11	Gate 293	1.7	9.0	5.3
Area 12	Compound	2.7	2.7	2.7
Area 15	EPA Farm	12.1	2.5	7.3
Area 15	Gate 700	3.7	4.5	4.1
Area 15	Piledriver	0.8	1.6	1.2
Area 16	Substation	1.8	1.7	1.7
Area 19	Echo Peak	3.4	2.1	2.7
Area 19	Substation	1.7	2.0	1.8
Area 19	19-3 Substation	1.8	2.1	2.0
Area 20	Dispensary	2.1	2.6	2.3
Area 23	Bldg. 790	1.3	2.7	2.1
Area 23	Bldg. 790 #2	2.1	1.9	2.0
Area 23	H&S Roof	2.5	2.0	2.2
Area 25	E-MAD South	1.8	2.2	2.0
Area 25	E-MAD North	2.0	1.5	1.8
Area 25	Henre Site	1.4	1.7	1.6
Area 25	NRDS Warehouse	1.3	1.4	1.3
Area 27	Cafeteria	2.0	1.4	1.7

NTS ENVIRONMENTAL SURVEILLANCE
TRITIUM IN AIR SAMPLING STATIONS
(HTO YEARLY AVERAGES $\times 10^{-11}$ μCi/cc)

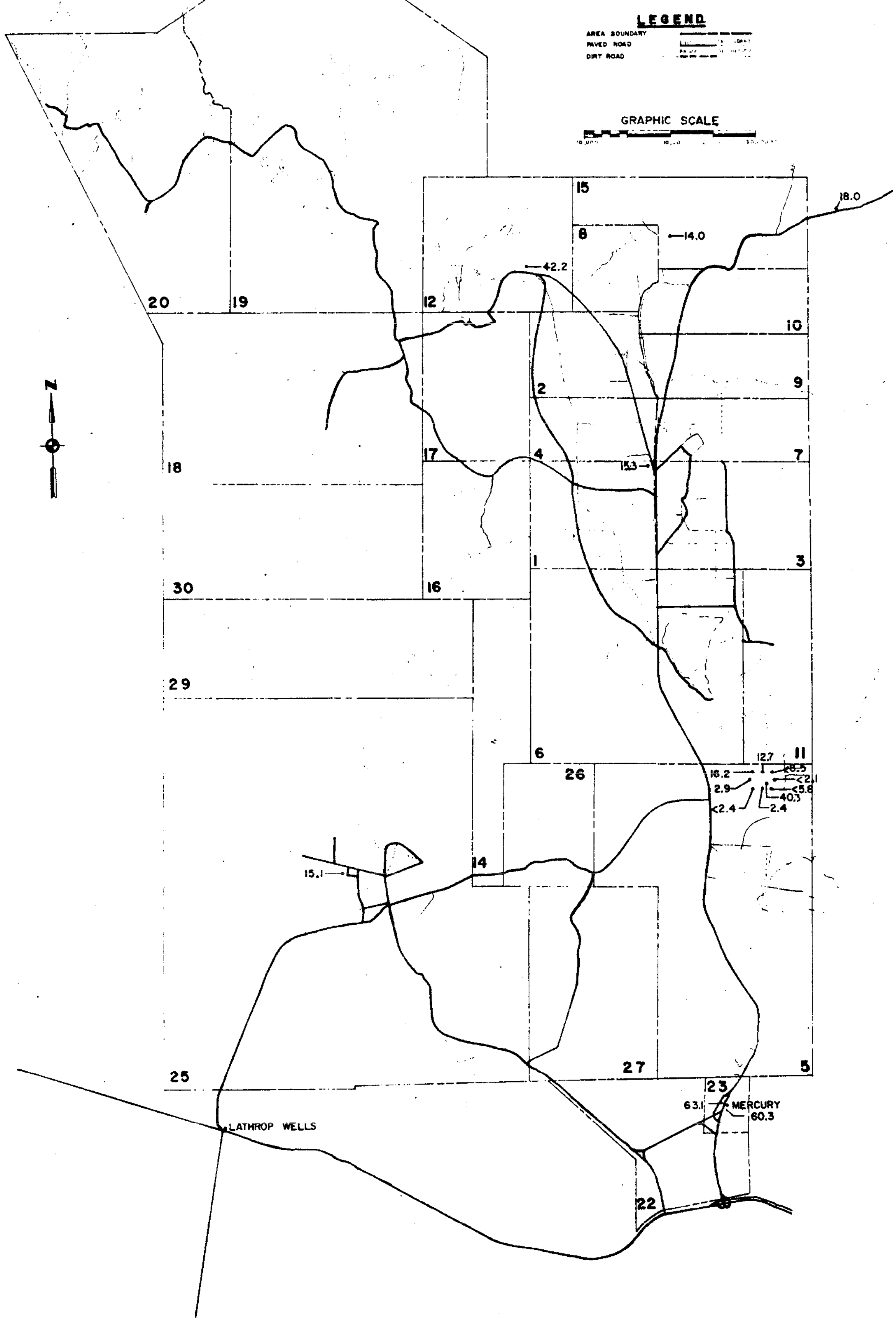


Figure 4

throughout the year with most of the samplers. This may be due to the small volumes of air sampled or mechanical problems with the sampler.

The highest average concentration of HTO occurred at Building 790 of 6.3 x 10^{-9} µCi/cc which represents 0.13 percent of the concentration guide. Both Buildings 650 and 790 release small amounts of tritium from processing samples. Due to the close proximity of the two tritium in air samplers, elevated concentrations of HTO are detected. Table 6 lists the maximums, minimums, and averages along with the percent of the concentration guide. Appendix B has the actual measurements plotted for each location.

At the beginning of CY-1982 REECo took over the following noble gas sampling stations from EPA:

Area 23	Bldg. 790	Area 12	Base Camp
Area 25	EMAD	Area 15	EPA Farm
Area 1	BJY	Area 51	Far Forward

Two of the samplers were moved to different locations. The Area 51 sampler was moved to Area 15 Gate 700 and the Area 23, Bldg. 790 sampler was moved to Area 5, Gate 200. The yearly averages for each station are shown in Figure 5.

An unexplained set of positive results occurred during the week of October 4, 1982. The highest concentration of ^{133}Xe was 71.0 x 10^{-12} µCi/cc at Area 5 Gate 200 and the other valve was 43.3 x 10^{-12} µCi/cc at Area 1 BJY. These concentrations represent 0.0007 and 0.0004 percent of the concentration guide

TABLE 6

TRITIUM IN AIR

Concentrations
(μCi/cc)

Stations	Maximum	Minimum	Average	% of CG
Area 1 BJY	7.54E-10	1.80E-12	1.53E-10	0.0003
Area 5 RWMS-1	9.20E-09	1.53E-11	4.03E-10	0.0081
Area 5 RWMS-SE	3.18E-10	<1.14E-13	<5.80E-11	<0.0012
Area 5 RWMS-(SE-NE)	1.36E-10	<1.86E-13	<2.10E-11	<0.0004
Area 5 RWMS-NE	7.80E-10	<1.44E-13	<8.54E-11	<0.0017
Area 5 RWMS-(NE-SW)	5.9E-10	8.40E-12	1.27E-10	0.0025
Area 5 RWMS-NW	9.54E-10	2.17E-12	1.62E-10	0.0032
Area 5 RWMS-(NW-SW)	1.00E-10	5.30E-12	2.95E-11	0.0006
Area 5 RWMS-SW	8.70E-11	<9.70E-14	<2.41E-11	<0.0005
Area 5 RWMS-(SW-SE)	2.50E-11	2.20E-11	2.38E-11	0.0005
Area 12 Base Camp	4.40E-09	2.50E-12	4.22E-10	0.0084
Area 15 EPA Farm	7.58E-10	3.04E-11	1.40E-10	0.0028
Area 23 Bldg. 790	1.08E-07	9.30E-13	6.31E-09	0.1262
Area 23 Bldg. 650	5.00E-08	1.10E-11	6.03E-09	0.1206
Area 25 EMAD	1.10E-09	3.90E-12	1.51E-10	0.0030
Area 51 Far Forward	1.40E-09	1.70E-13	1.80E-10	0.0036

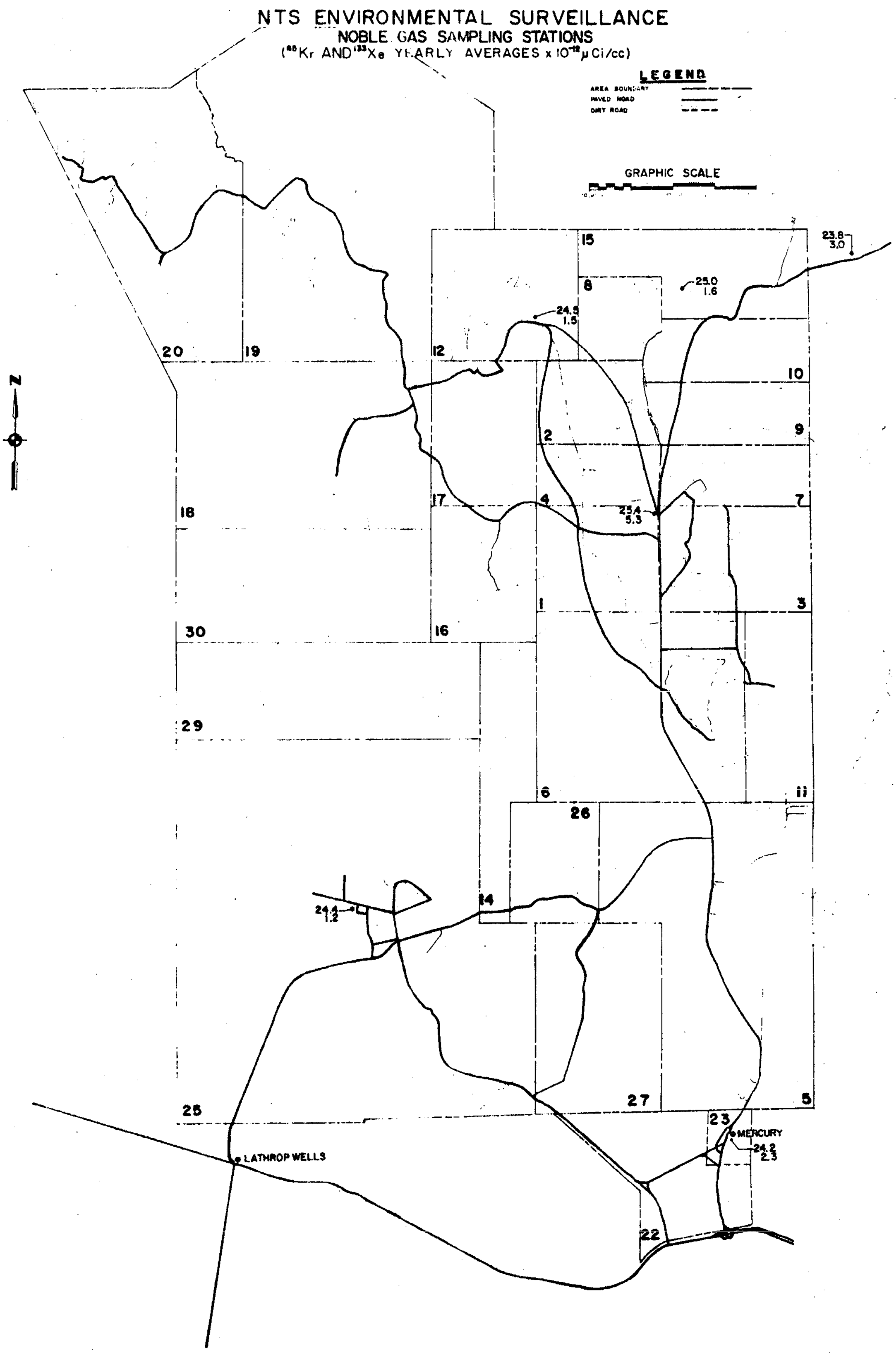

NTS ENVIRONMENTAL SURVEILLANCE
NOBLE GAS SAMPLING STATIONS
(^{85}Kr AND ^{133}Xe YEARLY AVERAGES x 10^{-12} μCi/cc)
LEGEND
AREA BOUNDARY
PAVED ROAD
DIRT ROAD
GRAPHIC SCALE
N
15
8
12
20
19
10
9
2
7
17
4
18
1
3
30
16
29
6
11
26
14
27
5
25
23
22
23.8
3.0
25.0
1.6
24.5
1.5
23.4
5.3
24.4
1.2
24.2
2.3
MERCURY
LATHROP WELLS

Figure 5

for ^{133}Xe, respectively. A small release, caused by a drillback operation, was detected during the week of December 6, 1982, at the Area 1 BJY station. The ^{133}Xe concentration was 140 x 10^{-12} µCi/cc or 0.0014 percent of the concentration guide.

Table 7 lists the average ^{85}Kr and ^{133}Xe concentrations at each location along with the lowest and highest values detected.

E. RADIOACTIVITY IN SURFACE AND GROUND WATER

The principal water distribution system on the NTS consists of twelve supply wells, nine potable water stations, and seventeen open reservoirs. The wells feed directly to many of the reservoirs, and the drinking water was pumped from the wells to the points of consumption. While the air surveillance network consisted of forty-seven stations measuring general atmospheric radioactivity, results from the water stations would only correspond where there was direct "communication" of fluid. This was the critical pathway for the ingestion of waterborne radionuclides, so the system was routinely sampled and evaluated. All drinking water was collected weekly to provide a constant check of the end use activity and to allow frequent comparisons to the radioactivity of the water in the wells. This also created a large data base to evaluate long-term trends or intermittent changes in activity. The supply wells and open reservoirs were collected on a monthly schedule. The identification of any radionuclides above natural background in this system initiated a closer review of the drinking water. The supply wells that supply drinking water and the potable water locations were also sampled on a special basis in accordance with the Safe Drinking Water Act. A summary of this sampling is given in Table 1.

TABLE 7

NOBLE GASES IN AIR

Stations	Concentrations (X 10^{-12} μCi/cc)					
	^{85}Kr			^{133}Xe		
	Max	Min	Avg	Max	Min	Avg
Area 1 BJY	31.5	20.0	25.4	140.0	-3.4	5.3
Area 12 Base Camp	29.1	20.3	24.5	9.8	-11.7	1.5
Area 15 EPA Farm	25.0	19.8	25.0	7.1	-3.0	1.6
Area 23 Bldg. 790	31.8	17.4	24.2	71.0	-7.0	2.3
Area 25 EMAD	28.2	19.9	24.4	12.4	-11.0	1.2
Area 51 Far Forward	28.2	18.4	23.8	10.8	-3.3	3.0

The other water systems monitored onsite were the natural springs, contaminated ponds, and effluent ponds. The springs were collected monthly. The contaminated and effluent ponds were collected on non-routine schedules because of limitations in the amount of water at each location.

1. <u>Supply Wells</u>

Water from twelve supply wells was used for a variety of sanitary and industrial purposes. The criteria for collection was primarily based on potential for human consumption. The yearly gross beta averages are shown at their respective locations in Figure 6. Appendix B consists of the plots of each station for measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the mean of the network throughout the reporting period. The range at each point is also given. Table 8 lists the 1982 averages for each location. The highest average recorded was 1.29×10^{-8} μCi/ml at Well C1. This was 4.3 present of the concentration guide (assuming ^{90}Sr is the beta emitter present). The lowest average gross beta activity for the onsite supply wells was 1.6×10^{-9} μCi/ml at Well U19c.

The activities of each well and the entire network average appeared consistent over this report period. No trends in the plots were discernible, verifying that no movement of radionuclides occurred in this

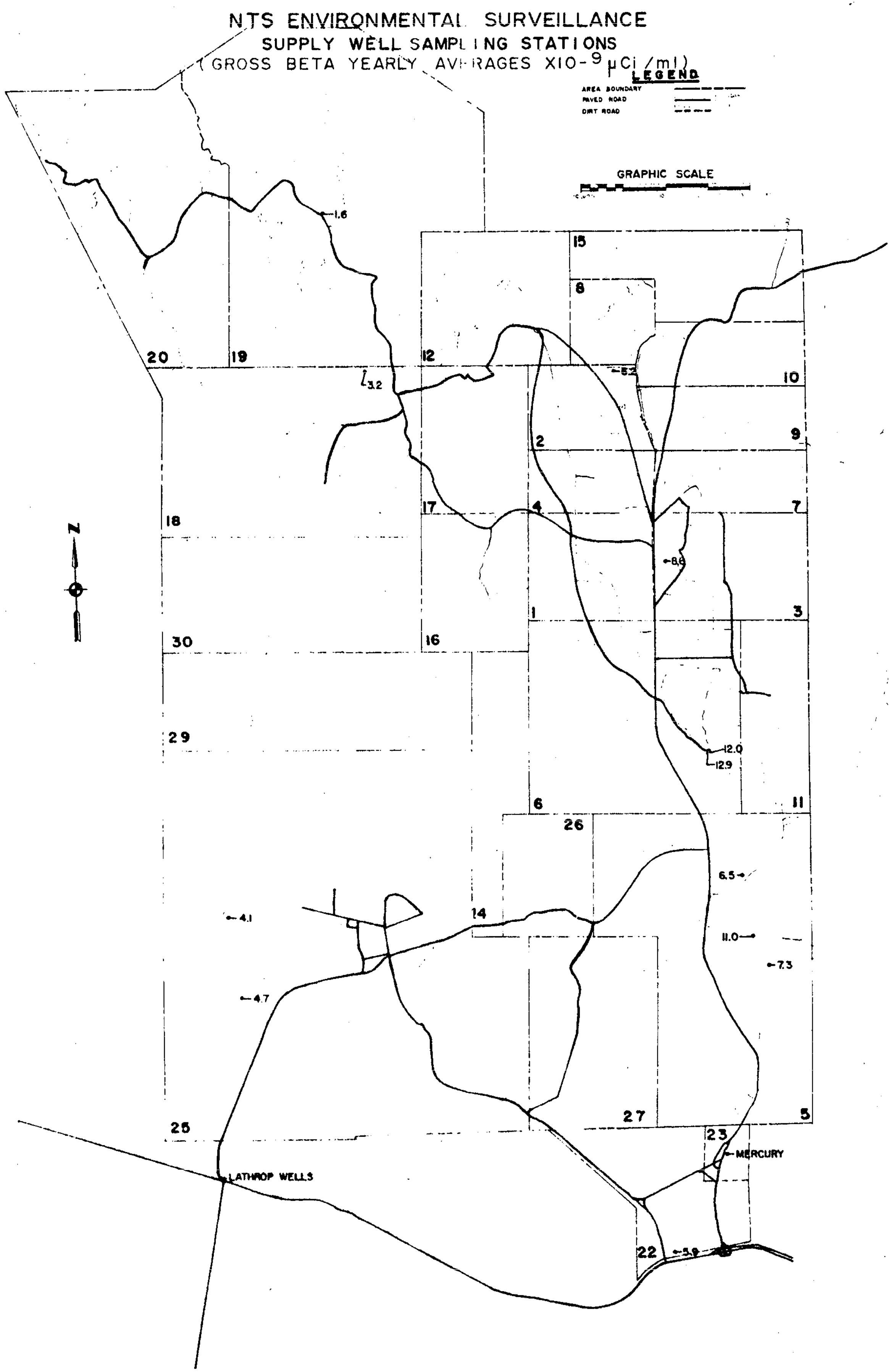

NTS ENVIRONMENTAL SURVEILLANCE
SUPPLY WELL SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10-9 μCi/ml)
LEGEND
AREA BOUNDARY
PAVED ROAD
DIRT ROAD
GRAPHIC SCALE
N
1.6
3.2
8.2
8.8
12.0
12.9
6.5
11.0
7.3
4.1
4.7
5.9
20
19
12
15
8
10
9
2
17
4
7
18
1
3
30
16
29
6
11
26
14
27
5
25
23
22
MERCURY
LATHROP WELLS

Figure 6

TABLE 8

AVERAGES OF SUPPLY WELL DATA FOR GROSS BETA

Station	Gross Beta Yearly Average (X 10^{-9} µCi/ml)
Area 2 Well 2	6.2
Area 3 Well A	8.6
Area 5 Well 5B	11.0
Area 5 Well 5C	7.3
Area 5 Well Ue5c	6.5
Area 6 Well C	12.0
Area 6 Well C1	12.9
Area 18 Well 8	3.2
Area 19 Well U19c	1.6
Area 22 Army Well #1	5.9
Area 25 Well J12	4.7
Area 25 Well J13	4.1

NTS water system. The average of the entire network, as compared to previous years was:

Year	Mean (X 10^{-9} μCi/ml)
CY-1982	7.0
CY-1981	8.3
CY-1980	8.8
CY-1979	9.4
CY-1978	9.1
July-December 1977	10.9
FY-1977	10.4
FY-1976	9.1

As in previous years the beta emitting isotope of potassium, ^{40}K, having a natural abundance of 0.012 percent, was shown to be the primary source of radioactivity in the NTS supply wells. Figure 7 graphically displays the relationship for the primary waters onsite. A linear regression from the supply well data obtained the following equation: Gross Beta = [0.16 + 0.78 (potassium in mg/liter)] X 10^{-9} μCi/ml. The correlation coefficient was 0.90. Therefore, the variation of gross beta results in NTS water was principally dependent upon the beta emitter ^{40}K.

Calculations of the specific activity associated with the amount of ^{40}K in this water was determined using Reference 10. The results of these calculations were the basis for the solid line shown in Figure 7.

$$A = \lambda N$$

where: N = Number of radioactive atoms per unit mass (1mg)
λ = Decay constant
A = Activity

$$N = \frac{(0.001\ g)(N_o)(a)}{(\text{Atomic Mass})}$$

where: N_o = Avogadro's number
a = ^{40}K abundance

$$= \frac{(0.001g)\ (6.02\ X\ 10^{23})\ (1.18\ X\ 10^{-4})}{39.1}$$

$$= 1.82 \times 10^{15}\ {}^{40}K \text{ atoms/mg}$$

$$\lambda = \frac{\text{Ln } 2}{(1.26\ X\ 10^{9})(365.25)(1440)}$$

$$= 1.04 \times 10^{-15} \text{ minutes}^{-1}$$

Thus, A(dpm/mg) $= \lambda N$

$$= 1.82 \times 10^{15} \times 1.04 \times 10^{-15}$$

$$= 1.90$$

$$A(\mu Ci/mg) = \frac{1.90}{2.22 \times 10^{6}}$$

$$A = 8.56\ X\ 10^{-7}\ \mu Ci/mg(\text{potassium})$$

or

$$A = 8.56\ X\ 10^{-10}\ \mu Ci/ml \text{ per mg/liter}$$

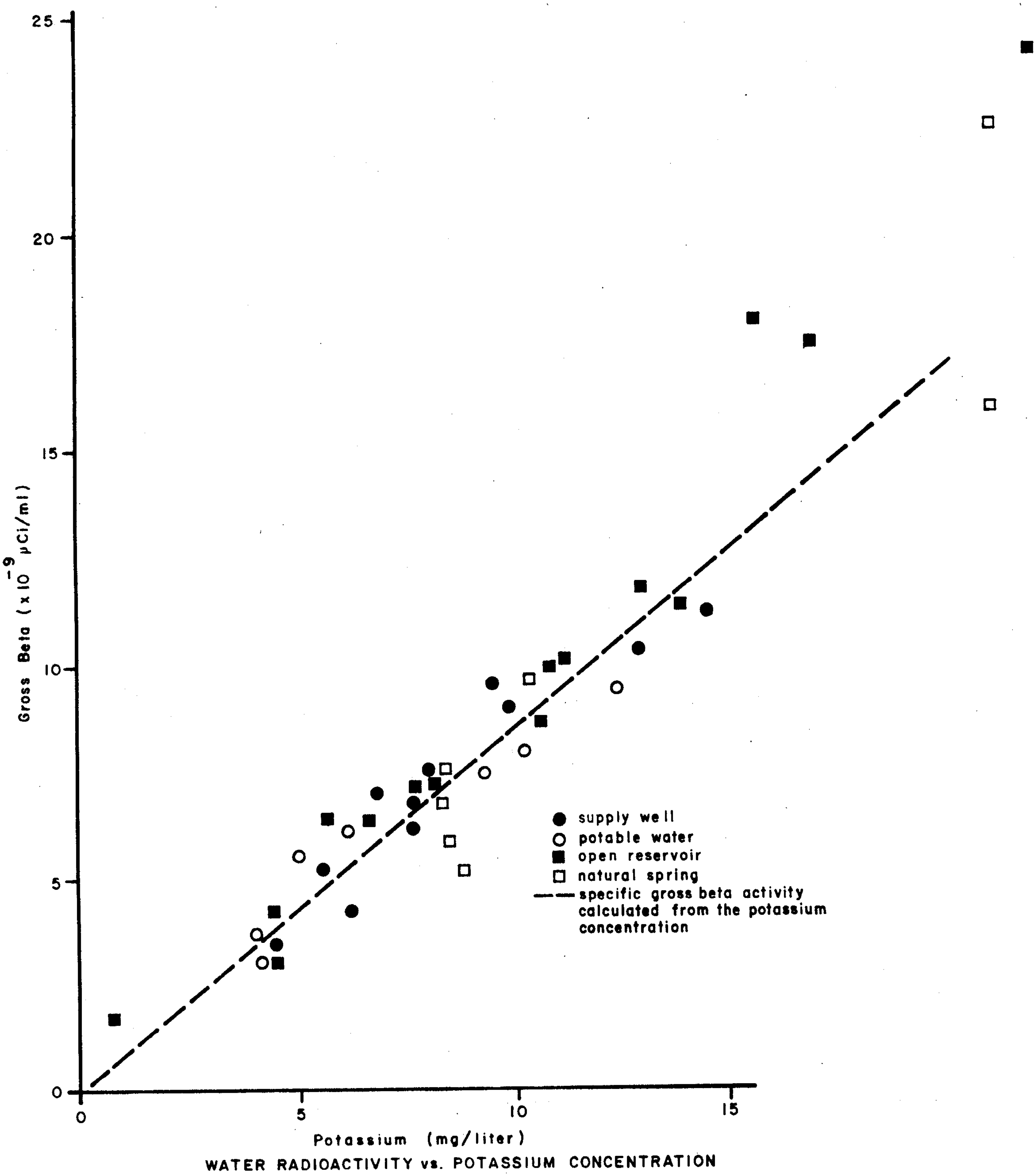

Gross Beta (x 10^-9 µCi/ml)
Potassium (mg/liter)
supply well
potable water
open reservoir
natural spring
specific gross beta activity calculated from the potassium concentration
WATER RADIOACTIVITY vs. POTASSIUM CONCENTRATION

Figure 7

The calculated activity of 8.56 X 10^{-10} µCi/ml per mg/liter correlated reasonably well with 7.8 X 10^{-10} µCi/ml per mg/liter from the linear regression analysis of the supply well data. This demonstrated conclusively that naturally-occurring potassium was the determining factor of the radioactivity in the NTS water. No other radionuclides could give rise to more than ten percent of the measured gross beta activity.

Appendix C includes plots of the network monthly averages for tritium and plutonium. Due to the change in calculations the lower limit of detection increased. The positive tritium results are given in Table 9. The highest value was 1.2 x 10^{-6} µCi/ml from Well 2. This is 0.4 percent of the concentration guide for tritium in drinking water. The majority of the positive measurements are near the detection limits of the system. The positive values with a high percentage error are assumed to be caused by a fluctuation of the counter. There were no positive plutonium results for the supply wells for CY-1982.

The supply well results for the Safe Water Drinking Act Study are given in Tables 11 and 12. The screening levels and maximum contaminant levels for man made radionuclides are given for the Tonopah Test Range and Nevada Test Site supply wells on the bottom of the two tables. Only two locations, Well C and Well C-1, had a result above the screening level for gross beta activity. This gross beta activity was attributed to ^{40}K and not any man made radionuclides as shown in Figure 7.

TABLE 9

TRITIUM VALUES ABOVE DETECTION LIMITS
FROM NONCONTAMINATED WATERS

WATER TYPE	STATION	DATE	µCi/ml
Potable Water	Area 2 Rest Room	02/08/82	8.5E-07 ± 65.1%
Potable Water	Area 3 Cafe	01/18/82	8.1E-07 ± 55.0%
		01/25/82	4.7E-07 ± 92.5%
		04/06/82	7.4E-07 ± 57.7%
Potable Water	Area 23 Cascade Water	01/18/82	7.1E-07 ± 63.2%
		01/25/82	8.1E-07 ± 55.4%
Potable Water	Area 6 Cafe	01/18/82	5.3E-07 ± 80.6%
Potable Water	Area 12 Cafe	01/13/82	6.6E-07 ± 64.6%
		01/25/82	5.6E-07 ± 79.0%
		04/12/82	1.1E-06 ± 40.4%
Potable Water	Area 23 Cafe	01/11/82	6.3E-07 ± 67.8%
Potable Water	Area 25 Service Station	01/25/82	6.1E-07 ± 71.8%
		10/05/82	7.9E-06 ± 10.7%
Potable Water	Area 27 Cafe	04/12/82	4.5E-07 ± 93.3%
Natural Spring	Captain Jack Springs	03/24/82	8.5E-07 ± 49.9%
		05/20/82	1.3E-05 ± 4.9%
Natural Spring	Topopah Springs	02/17/82	7.5E-07 ± 57.5%
		05/20/82	5.7E-07 ± 68.9%
Natural Spring	Area 5 Cane Springs	01/22/82	7.9E-07 ± 65.6%
Natural Spring	Area 7 Reitmann Seep	01/22/82	7.7E-07 ± 57.2%
		02/03/82	5.7E-06 ± 9.7%
Natural Spring	Area 12 White Rock Springs	02/05/82	4.3E-07 ± 98.6%
		04/14/82	4.3E-07 ± 91.6%
		06/02/82	1.8E-05 ± 4.1%
Natural Spring	Area 15 Tub Springs	10/21/82	1.5E-06 ± 28.8%
		12/07/82	1.7E-06 ± 25.4%
Open Reservoir	Well A Reservoir	01/14/82	5.2E-07 ± 81.7%
		03/03/82	4.8E-07 ± 87.0%
Open Reservoir	Well 5B Reservoir	01/20/82	1.0E-06 ± 45.3%
		02/05/82	1.0E-06 ± 43.4%

WATER TYPE	STATION	DATE	µCi/ml
Open Reservoir	Well UE5c Reservoir	01/20/82	8.1E-07 ± 54.0%
Open Reservoir	Well 2 Reservoir	01/26/82	4.7E-07 ± 92.6%
Open Reservoir	Well 3 Reservoir	01/14/82	6.9E-07 ± 63.6%
		12/01/82	1.9E-06 ± 23.0%
Open Reservoir	Well C1 Reservoir	01/14/82	1.1E-06 ± 40.0%
Open Reservoir	Well U19c Reservoir	03/29/82	1.7E-06 ± 27.2%
Open Reservoir	Area 5 Reservoir	01/20/82	4.1E-06 ± 12.7%
		02/05/82	3.9E-06 ± 13.2%
		03/10/82	2.5E-06 ± 18.5%
		05/13/82	5.4E-05 ± 2.1%
		10/08/82	1.1E-06 ± 38.0%
		11/03/82	1.7E-06 ± 25.6%
		12/01/82	1.1E-06 ± 39.0%
Open Reservoir	Well 20A Reservoir	03/29/82	6.5E-07 ± 65.4%
Open Reservoir	Area 23 Swimming Pool	01/21/82	5.8E-07 ± 75.6%
Open Reservoir	Area 3 Mud Plant Reservoir	01/14/82	4.3E-07 ± 97.1%
		02/03/82	4.2E-07 ± 99.9%
Open Reservoir	Well J-11 Reservoir	01/22/82	1.0E-06 ± 44.3%
		05/13/82	5.2E-07 ± 76.0%
		07/01/82	3.2E-06 ± 14.3%
Open Reservoir	Well 8 Reservoir	04/20/82	4.4E-07 ± 89.9%
Supply Well	Well 2	01/21/82	8.3E-07 ± 52.4%
		03/12/82	4.5E-07 ± 94.9%
		08/02/82	1.2E-06 ± 35.5%
Supply Well	Well UE5C	01/10/82	5.6E-07 ± 76.6%
		04/03/82	5.8E-07 ± 75.1%
Supply Well	Well C	01/21/82	4.6E-07 ± 95.5%
		04/05/82	7.9E-07 ± 55.6%
Supply Well	Well C1	01/21/82	5.1E-07 ± 85.4%
Supply Well	Well 8	01/21/82	8.3E-07 ± 53.6%
Supply Well	Well J-13	04/03/82	5.6E-07 ± 77.3%
Supply Well	Well U19C	01/21/82	8.3E-07 ± 52.6%
Supply Well	Well A	01/21/82	6.7E-07 ± 65.4%
		04/03/82	5.8E-07 ± 74.2%

TABLE 10

PLUTONIUM VALUES ABOVE DETECTION LIMITS
FROM NONCONTAMINATED WATERS

WATER TYPE	STATION	DATE	μCi/ml
Natural Spring	White Rock Springs	12/02/82	1.1E-10 ± 37.5%
Natural Spring	Tub Springs	09/29/82	1.5E-10 ± 35.9%
Natural Spring	Captain Jack	03/24/82	2.3E-11 ± 86.3%
Natural Spring	Reitmann Seep	03/04/82	6.6E-11 ± 52.4%
		09/10/82	1.3E-10 ± 42.8%
		12/02/82	1.1E-10 ± 36.5%
Open Reservoir	Area 5 Reservoir	03/10/82	1.2E-10 ± 33.3%

TABLE 11

TONOPAH TEST RANGE SUPPLY WELLS
SAFE DRINKING WATER ACT RESULTS

Type of Analysis	Location: Well 6	Well 3A	Well 1A	Well AF	Well 9
Gross Alpha* ($\times 10^{-9}$ µCi/ml)					
Max	1.28	4.38	0.81	<0.59	<0.59
Min	<0.59	0.76	<0.40	<0.40	<0.32
Avg	<0.96	2.50	<0.60	<0.53	<0.50
Gross Beta** ($\times 10^{-9}$ µCi/ml)					
Max	6.99	5.83	7.50	9.87	8.25
Min	5.04	4.38	5.09	7.19	5.75
Avg	6.24	4.89	6.29	8.17	6.96
^{3}H*** ($\times 10^{-7}$ µCi/ml)					
Max	<9.20	<9.20	<9.20	<9.20	<9.20
Min	<4.20	<4.10	<4.10	<4.20	<4.20
Avg	<7.53	<7.47	<7.43	<7.53	<7.47
^{90}Sr*** ($\times 10^{-9}$ µCi/ml)					
Max	<1.25	<1.58	<7.93	<1.53	<2.46
Min	<0.83	<0.68	<1.08	<0.66	<0.64
Avg	<1.04	<1.11	<3.45	<1.13	<1.33
^{239}Pu ($\times 10^{-11}$ µCi/ml)					
Max	<3.90	<4.60	<4.30	<2.30	<3.90
Min	<1.70	<2.50	<2.20	<5.80	<1.40
Avg	<2.87	<3.47	<3.20	<3.70	<2.73

* Screening level for gross alpha activity is 5×10^{-9} µCi/ml.

** Screening level for gross beta activity in surface water is 5×10^{-8} µCi/ml

*** Maximum contaminant levels for ^{90}Sr and ^{3}H are 8×10^{-9} µCi/ml and 2×10^{-5} µCi/ml, respectively.

TABLE 12

NTS SUPPLY WELLS
SAFE DRINKING WATER ACT RESULTS

Type of Analysis	Location: Well J-13	Army Well #1	Well 5B	Well 5C	Well C-1
Gross Alpha* ($\times 10^{-9}$ μCi/ml)					
Max	1.02	1.72	1.76	4.54	2.20
Min	<0.53	<0.63	0.89	1.96	1.23
Avg	<0.69	<1.01	1.31	3.17	1.69
Gross β** ($\times 10^{-9}$ μCi/ml					
Max	5.00	7.13	12.30	8.74	15.90
Min	4.27	3.99	9.93	7.28	13.20
Avg	4.60	5.53	10.84	7.82	14.40
^{3}H*** ($\times 10^{-7}$ μCi/ml					
Max	<9.20	<9.20	<9.20	<9.20	<9.20
Min	<9.10	<9.20	<9.00	<9.00	<9.20
Avg	<9.17	<9.20	<9.10	<9.10	<9.20
^{131}I*** ($\times 10^{-10}$ μCi/ml					
Max	<7.94	<13.80	<8.53	<7.60	<8.74
Min	<3.12	<3.82	<4.88	<3.60	<2.94
Avg	<5.39	<7.86	<6.49	<6.16	<6.27
^{90}Sr*** ($\times 10^{-9}$ μCi/ml					
Max	<0.95	<0.89	<0.92	<0.87	<1.55
Min	<0.76	<0.73	<0.72	<0.47	<0.68
Avg	<0.86	<0.79	<0.84	<0.71	<1.09

* Screening level for gross alpha activity is 5×10^{-9} μCi/ml.

** Screening level for gross beta activity near a nuclear facility is 1.5×10^{-8} μCi/ml.

*** Maximum contaminant levels for ^{3}H, ^{131}I, and ^{90}Sr are 2×10^{-5} μCi/ml, 3×10^{-9} μCi/ml, and 8×10^{-9} μCi/ml, respectively.

Table 12, Continued

Type of Analysis	Location: Well A	Well C	Well 8	Well J-12
Gross Alpha* ($X\ 10^{-9}$ µCi/ml)				
Max	2.53	3.23	<0.70	<0.73
Min	1.08	1.15	<0.53	<0.53
Avg	1.64	1.94	<0.61	<0.63
Gross Beta** ($X\ 10^{-9}$ µCi/ml)				
Max	8.82	15.60	3.35	4.51
Min	8.17	12.20	2.81	4.44
Avg	8.47	14.17	3.04	4.48
^{3}H*** ($X\ 10^{-7}$ µCi/ml)				
Max	<9.20	<9.20	<9.20	22.90
Min	<9.00	<9.10	<9.00	<9.30
Avg	<9.10	<9.13	<9.13	<16.10
^{131}I*** ($X\ 10^{-10}$ µCi/ml)				
Max	<8.35	<8.09	<7.01	<7.35
Min	<3.45	<3.34	<3.75	<5.28
Avg	<5.58	<6.14	<5.74	<6.31
^{90}Sr*** ($X\ 10^{-9}$ µCi/ml)				
Max	<1.34	<1.17	<1.23	<3.80
Min	<0.88	<0.02	<0.89	<0.70
Avg	<1.04	<0.60	<1.11	<2.25

* Screening level for gross alpha activity is 5×10^{-9} µCi/ml.

** Screening level for gross beta activity near a nuclear facility is 1.5×10^{-8} µCi/ml.

*** Maximum contaminant levels for ^{3}H, ^{131}I, and ^{90}Sr are 2×10^{-5} µCi/ml, 3×10^{-9} µCi/ml, and 8×10^{-9} µCi/ml, respectively.

2. Potable Water

As a check of any effect the water distribution system might have on end use activity, eight consumption points were sampled during the reporting period. The locations of all stations are shown in Figure 8 with their gross beta yearly averages.

Appendix D contains the computer plots of the measured gross beta activity with the 2σ error bars included. An average plot is provided which shows the network mean trend throughout the reporting period along with the range at each point. Table 13 contains a list of the average gross beta activity measured at each sample location for CY-1982. The highest average recorded was 9.9×10^{-9} μCi/ml at the Area 6 Cafeteria. This was 3.3 percent of the concentration guide for drinking water (assuming ^{90}Sr is the beta emitter present). The lowest average gross beta activity, excluding Cascade brand bottled water, was 3.4×10^{-9} μCi/ml at the Area 12 Cafeteria. The Cascade water was demineralized water brought in from offsite and was used as a check of the laboratory system. It was included in the results listing because the bottles were stored onsite and the water was consumed by NTS personnel.

Gross beta measurements at these potable water stations demonstrated that no release or movement of radionuclides occurred in the NTS water system throughout CY-1982. No discernible trends were seen on the plotted data.

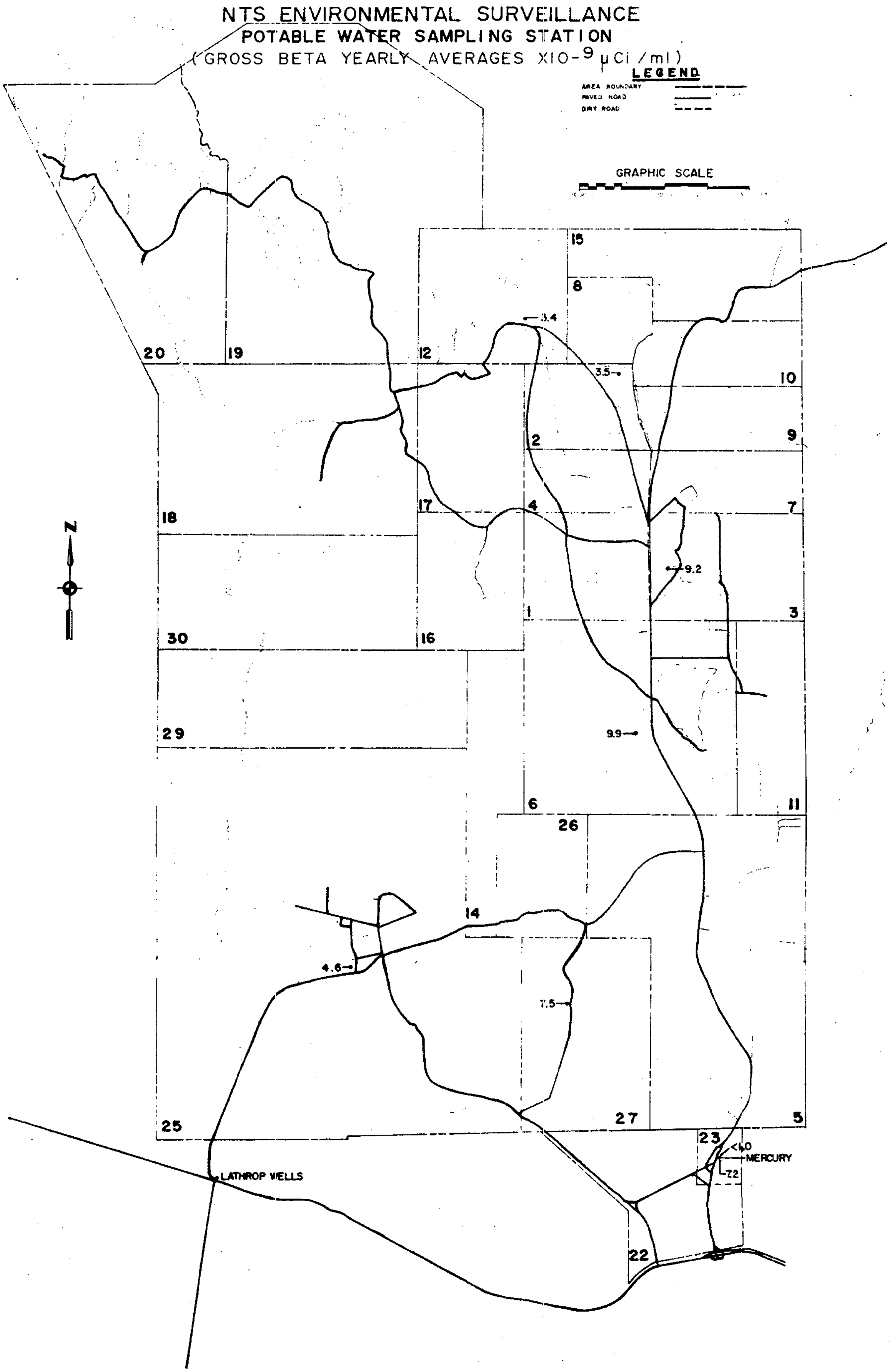

NTS ENVIRONMENTAL SURVEILLANCE
POTABLE WATER SAMPLING STATION
(GROSS BETA YEARLY AVERAGES X10-9 μCi/ml)
LEGEND
AREA BOUNDARY
PAVED ROAD
DIRT ROAD
GRAPHIC SCALE
N
15
8
3.4
20
19
12
3.5
10
9
2
7
17
4
18
9.2
1
3
30
16
29
9.9
6
11
26
14
4.6
7.5
25
27
5
23
<4.0
MERCURY
7.2
LATHROP WELLS
22

Figure 8

TABLE 13

AVERAGES OF POTABLE WATER DATA FOR GROSS BETA

Station	Gross Beta Yearly Average (X 10^{-9} $\mu Ci/ml$)
Area 2 Restroom	3.5
Area 3 Cafeteria	9.2
Area 6 Cafeteria	9.9
Area 12 Cafeteria	3.4
Area 23 Cafeteria	7.2
Area 23 Cascade Water	<1.0
Area 25 Service Station	4.6
Area 27 Cafeteria	7.5

The average of the entire network, as compared to averages reported in previous environmental reports, was:

Year	Mean (X 10^{-9} $\mu Ci/ml$)
CY-1982	5.8
CY-1981	7.9
CY-1980	5.8
CY-1979	6.5
CY-1978	6.7
July-December 1977	7.8
FY-1977	7.3
FY-1976	7.4

All potable water, except Cascade bottled water, was obtained from the supply wells. A comparison of these waters and their suppliers is shown in Table 14. As shown in the previous section, the majority of radioactivity in supply well water and, therefore, in potable water was from the naturally occurring potassium. Figure 7 showed this graphically.

The potable water results lie close to the line calculated from the specific activity of the associated potassium results. The linear regression of the potable water data was: Gross Beta = [0.50 + 0.74 (potassium in mg/liter)] X 10^{-9} $\mu Ci/ml$. The correlation coefficient was 0.92.

Appendix D also includes the plots of the network averages for tritium and plutonium. The positive tritium results were given in Table 9. The highest value was 7.9 x 10^{-6} $\mu Ci/ml$ for Area 25 Service Station. This is 0.26 percent of the concentration guide for tritium in drinking water. The majority of the fourteen positive measurements are near the detection limit of the system and are believed to be caused by fluctuations in the counting system. There were no positive plutonium results for the CY-1982.

TABLE 14

COMPARISON OF END USE AND SUPPLY WATER

FOR GROSS BETA AVERAGES

(X 10^{-9} μCi/ml)

Station (end use/supply)	CY-1982
Area 2 Restroom	3.5
Area 18 Well 8	3.2
Area 3 Cafeteria	9.2
Area 3 Well A	8.6
Area 6 Cafeteria	9.9
Area 6 Well C/C1	12.0/12.9
Area 12 Cafeteria	3.4
Area 18 Well 8	3.2
Area 23 Cafeteria	7.5
Area 5 Well 5B/5C	11.0/7.3
Area 22 Army Well #1	5.9
Area 23 Cascade Water	<1.0
(Demineralized Bottled Water)	—
Area 27 Cafeteria	7.5
Area 5 Well 5B/5C	11.0/7.3
Area 22 Army Well #1	5.9

Table 15 gives the potable water results for the Safe Water Drinking Act study along with the screening levels and maximum contaminant levels for man made radionuclides. During CY-1982 none of the eight stations showed concentrations above these levels and more extensive analyses were not performed.

3. Open Reservoirs

Open reservoirs have been established at various locations on the NTS for industrial purposes. Fifteen of these impoundments were sampled during the report period. The locations are shown in Figure 9 along with their gross beta yearly averages.

Appendix E consists of the plots of each station of the measured gross beta activity with 2σ error bars. An averaging plot is included which shows the entire network mean trend throughout the reporting period. The range at each point is also given. These plots demonstrate consistent concentrations of gross beta activity at all locations throughout CY-1982.

TABLE 15

NTS POTABLE WATERS RESULTS

Type of Analysis	Location: A-3 Cafe	A-2 Restroom	A-12 Cafe	Mercury Cafe	A-27 Cafe
Gross Alpha* ($X 10^{-9}$ µCi/ml)					
Max	2.71	0.87	<0.70	3.14	3.92
Min	1.24	<0.53	<0.53	0.64	0.68
Avg	2.11	<0.70	<0.66	1.93	1.78
Gross Beta** ($X 10^{-9}$ µCi/ml)					
Max	8.94	4.04	4.18	8.42	8.44
Min	7.68	3.07	2.46	4.74	7.46
Avg	8.16	3.50	3.20	6.23	7.99
^{3}H*** ($2 X 10^{-7}$ µCi/ml)					
Max	<9.40	<9.20	<9.20	<9.20	<41.60
Min	<9.10	<9.00	<9.10	<9.00	<9.10
Avg	<9.23	<9.10	<9.17	<9.10	<19.93
^{131}I*** ($X 10^{-10}$ µCi/ml)					
Max	<7.75	<9.32	<5.31	<9.14	<9.87
Min	<4.24	<2.57	<3.71	<5.32	<2.76
Avg	<5.46	<5.33	<4.32	<6.60	<5.80
^{90}Sr*** ($X 10^{-9}$ µCi/ml)					
Max	<1.66	<1.25	<1.09	<1.19	<1.42
Min	<0.75	<0.81	<0.77	<0.69	<0.74
Avg	<1.25	<1.04	<0.91	<0.92	<1.09

* Screening level for gross alpha activity is $5 X 10^{-9}$ µCi/ml.

** Screening level for gross beta activity near a nuclear facility is $1.5 X 10^{-8}$ µCi/ml.

*** Maximum contaminant levels for ^{3}H, ^{131}I, and ^{90}Sr are $2 X 10^{-5}$ µCi/ml, $3 X 10^{-9}$ µCi/ml, and 8 X 10-9 µCi/ml, respectively.

Table 15, Continued

Type of Analysis	Location		
	Cascade Water	A-6 Cafe	A-25 Service Station
Gross Alpha* ($\times 10^{-9}$ μCi/ml)			
Max	<0.68	2.00	<0.73
Min	<0.53	1.39	<0.53
Avg	<0.58	1.69	<0.60
Gross Beta** ($\times 10^{-9}$ μCi/ml)			
Max	1.27	11.40	9.30
Min	<1.10	7.51	4.34
Avg	<1.16	10.07	6.00
^{3}H*** ($\times 10^{-7}$ μCi/ml)			
Max	<9.20	<9.20	<9.20
Min	<9.10	<9.00	<9.00
Avg	<9.13	<9.10	<9.10
^{131}I*** ($\times 10^{-10}$ μCi/ml)			
Max	<9.87	<8.83	<8.31
Min	<4.42	<3.81	<2.63
Avg	<7.81	<5.88	<5.14
^{90}Sr*** ($\times 10^{-9}$ μCi/ml)			
Max	<1.20	<1.99	<1.23
Min	<0.95	<0.43	<0.74
Avg	<1.08	<1.08	<0.99

* Screening level for gross alpha activity is 5×10^{-9} μCi/ml.

** Screening level for gross beta activity near a nuclear facility is 1.5×10^{-8} μCi/ml.

*** Maximum contaminant levels for ^{3}H, ^{131}I, ^{90}Sr are 2×10^{-5} μCi/ml, 3×10^{-9} μCi/ml, and 8×10^{-9} μCi/ml, respectively.

NTS ENVIRONMENTAL SURVEILLANCE
OPEN RESERVOIR SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10-9 μCi/ml)

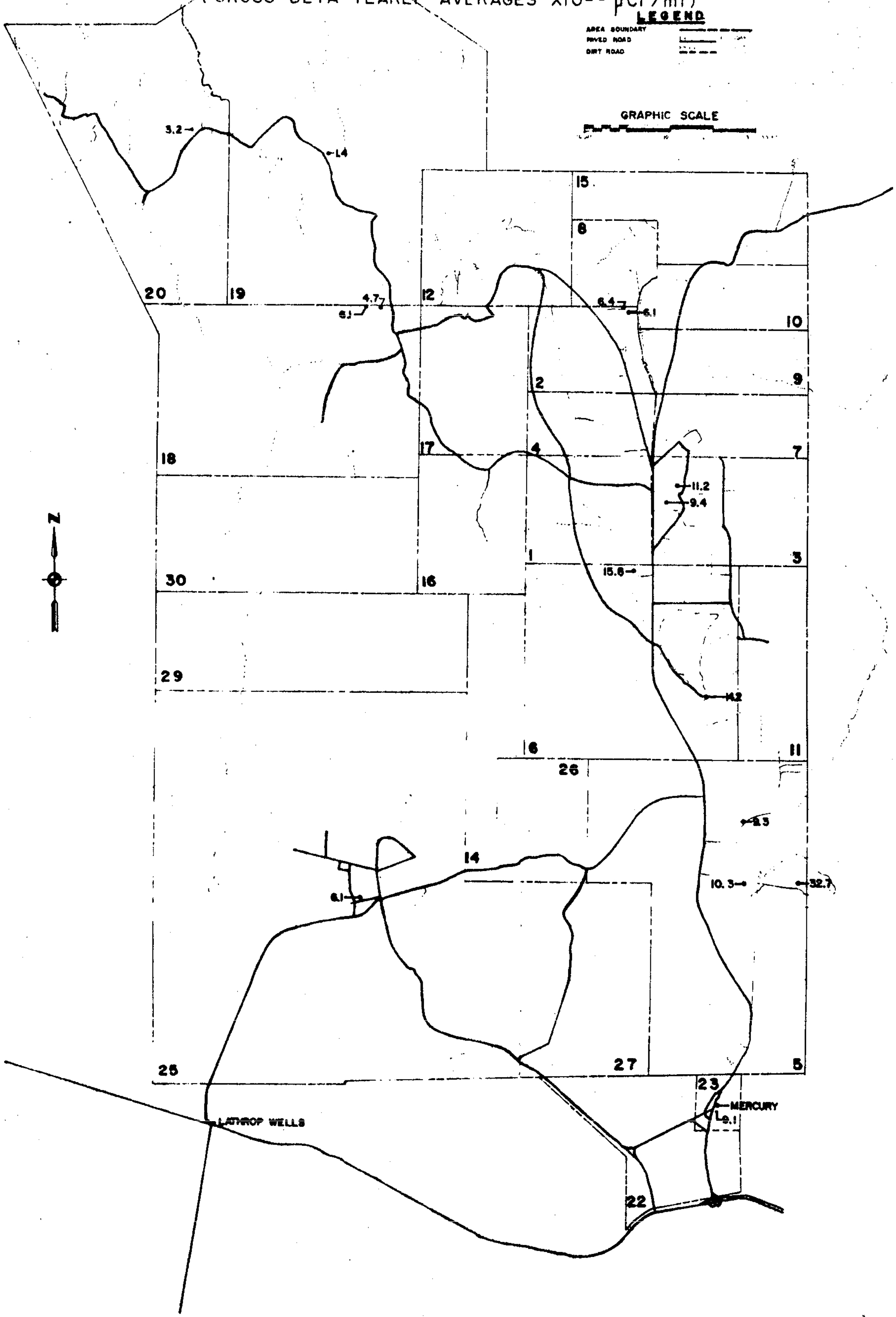


Figure 9

Flat trends were seen for the network, although the data were more variable than the supply well data. The large variation could have been caused by real activity fluctuations or, simply, more variable sampling procedures since some of the open reservoirs are difficult to sample. The average of the entire network, as compared to previous years was:

Year	Mean (X 10^{-9} µCi/ml)
CY-1982	9.7
CY-1981	13.6
CY-1980	8.1
CY-1979	10.9
CY-1978	13.1
July-December 1977	19.4
FY-1977	19.6
FY-1976	22.0

Table 16 includes a list of the CY-1982 gross beta averages at each location. The highest average beta concentration was 3.27 X 10^{-8} µCi/ml at Area 5 Reservoir. This result was 0.6 percent of the concentration guide (assuming ^{90}Sr is the beta emitter present). The lowest gross beta average was 1.4 X 10^{-9} µCi/ml at Well U19c Reservoir.

Table 17 shows the gross beta activities of the open reservoirs that were supplied by wells, along with the activities of the associated wells. The values for the reservoirs were similar to those of the suppliers.

TABLE 16

AVERAGES OF OPEN RESERVOIR DATA FOR GROSS BETA

Station	Gross Beta Yearly Average (X 10^{-9} $\mu Ci/ml$)
Area 2 Well 2 Reservoir	6.4
Area 2 Mud Plant Reservoir	6.1
Area 3 Well A Reservoir	9.4
Area 3 Mud Plant Reservoir	11.2
Area 5 Well 5B Reservoir	10.3
Area 5 Well Ue5c Reservoir	9.3
Area 5 Reservoir	32.7
Area 6 Well 3 Reservoir	15.8
Area 6 Well C1 Reservoir	14.2
Area 18 Camp 17 Reservoir	4.7
Area 18 Well 8 Reservoir	6.1
Area 19 Well 19c Reservoir	1.4
Area 20 Well 20A Reservoir	3.2
Area 23 Swimming Pool	9.1
Area 25 Well J-11 Reservoir	6.1

TABLE 17

COMPARISON OF OPEN RESERVOIRS AND SUPPLY WATER FOR GROSS BETA AVERAGES

($\times 10^{-9}$ $\mu Ci/ml$)

Station (Reservoir/Supply)	CY-1982
Area 2 Well 2 Reservoir	6.4
Area 2 Well 2	6.2
Area 3 Well A Reservoir	9.4
Area 3 Well A	8.6
Area 5 Well 5B Reservoir	10.3
Area 5 Well 5B	11.0
Area 5 Well Ue5c Reservoir	9.3
Area 5 Well Ue5c	6.5
Area 6 Well C1 Reservoir	14.2
Area 6 Well C1	12.9
Area 19 Well U19c Reservoir	1.4
Area 19 Well U19c	1.6

As shown in the supply well section, the majority of the radioactivity in the water of the supply wells and, therefore, in the open reservoirs was from the naturally occurring potassium. The results from the reservoirs lie above the calculated potassium line, as shown in Figure 7, in most instances. These cases may be caused by runoff from surface contamination in the surrounding areas.

Appendix E also includes the plots of the network averages for tritium and plutonium. There were twenty-five positive tritium values, the highest was 5.4×10^{-5} μCi/ml at Area 2 Mud Plant Reservoir. This is 0.05 percent of the tritium concentration guide. There was one positive plutonium result at the Area 5 Reservoir. The concentration plutonium concentration was 1.2×10^{-10} μCi/ml or 0.0001 percent of the concentration guide. The positive tritium and plutonium results can be seen in Tables 9 and 10.

4. Natural Springs

The term "natural springs" was a label given to the spring supplied pools located within the NTS. There was no known human consumption from these springs. Nine such locations were sampled on a monthly basis or when accessible, and are shown in Figure 10 along with their gross beta yearly averages.

Appendix F consists of the plots of all stations of the measured gross beta activity with 2σ error bars. An averaging plot is included which shows the trend of the network mean throughout the reporting period.

NTS ENVIRONMENTAL SURVEILLANCE
NATURAL SPRING SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10-^{9} μCi/ml)

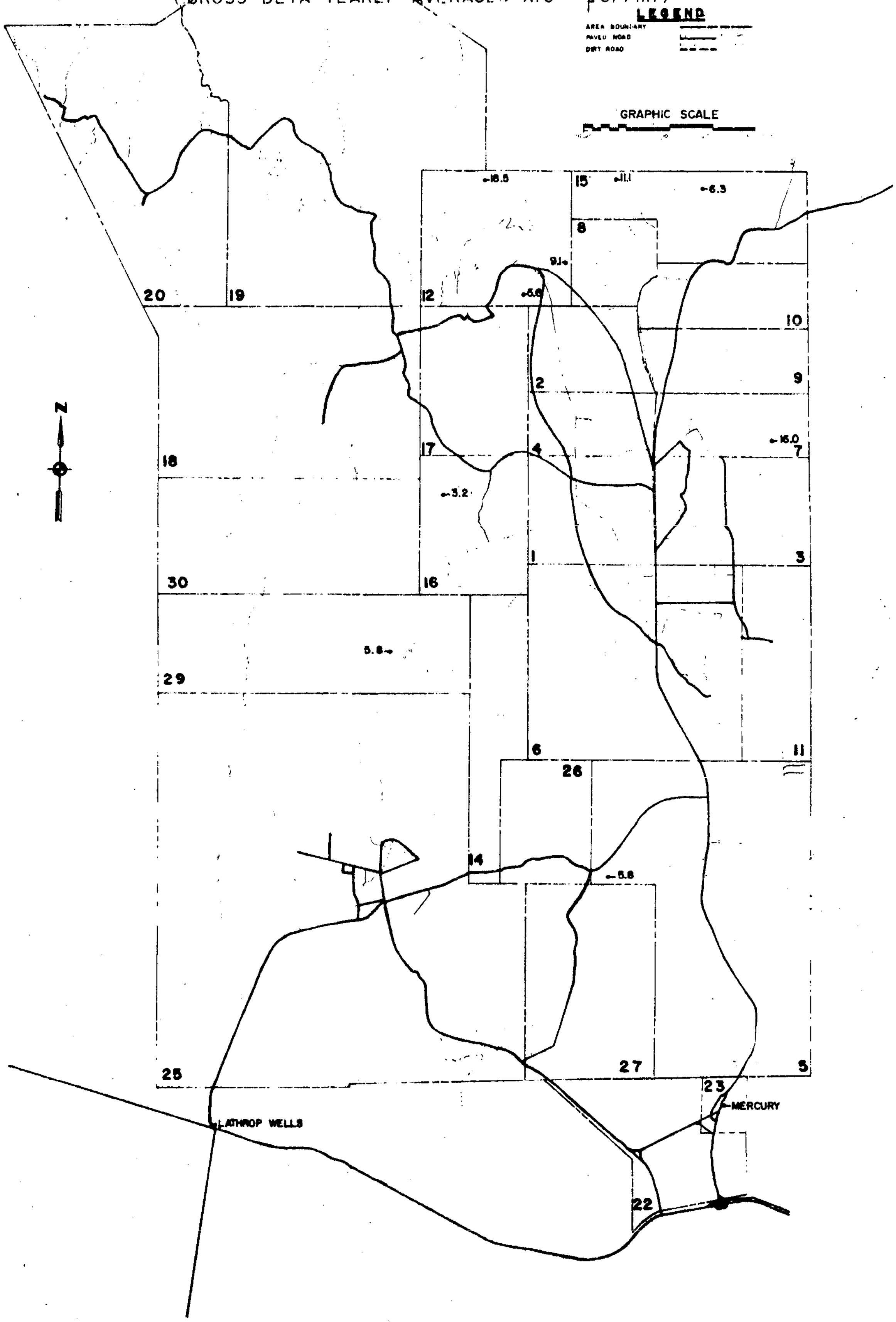


Figure 10

The range at each point is also given. Table 18 includes a list of the averages at each location. The highest average recorded was 1.8 X 10^{-8} μCi/ml at Gold Meadows Pond. This was 0.2 percent of the CG (assuming ^{90}Sr is the beta emitter present). The lowest beta concentration was 3.2 X 10^{-9} μCi/ml at Tippipah Spring.

Gold Meadows Spring's gross beta activity was in excess of that calculated from its potassium concentration as shown in Figure 7. Even though this station showed an excess of gross beta activity, it was still within the applicable concentration guide (assuming ^{90}Sr is the beta emitter present).

The network average, as compared to those presented in previous reports, was:

Year	Mean (X 10^{-9} μCi/ml)
CY-1982	9.0
CY-1981	10.5
CY-1980	16.7
CY-1979	22.1
CY-1978	23.7
July-December 1977	24.4
FY-1977	15.2
FY-1976	14.6

Appendix F includes plots of the network averages for tritium and plutonium. The highest value for tritium was 1.8 x 10^{-5} μCi/ml at Tippipah Springs. This represents 0.02 percent of the concentration guide for tritium. The highest plutonium value was 1.5 x 10^{-10} μCi/ml at

TABLE 18

AVERAGES OF NATURAL SPRINGS DATA FOR GROSS BETA

Station	Gross Beta Yearly Average ($\times 10^{-9}$ μCi/ml)
Area 5 Cane Spring	5.8
Area 7 Reitmann Seep	16.0
Area 12 White Rock Spring	9.1
Area 12 Captain Jack Spring	5.6
Area 12 Gold Meadows Pond	18.5
Area 15 Oak Butte Spring	11.1
Area 15 Tub Spring	6.3
Area 16 Tippipah Spring	3.2
Area 29 Topopah Spring	5.8

Tub Springs. This is 0.0001 percent of the concentration guide for plutonium. The positive results for tritium and plutonium are listed in Tables 9 and 10.

5. Contaminated Ponds

Five contaminated ponds were sampled on a special study basis. The locations are shown in Figure 11. These ponds were impound waters from tunnel test areas, a laboratory waste sump, and a contaminated laundry release point. They are monitored in accordance with DOE Order 5484.1, Chapter IV to provide a data base for calculations of any offsite releases. These calculations for tritium are reported to DOE Headquarters on an annual basis.

Table 19 is a list of the gross beta, tritium, and ^{239}Pu averages at the seven active stations. The first two pages of Appendix G contain the contaminated pond network averages and the remaining plots show the gross beta, ^{239}Pu, and tritium concentrations at each station. The differences between CY-1981 and CY-1982 can be attributed to the decrease or increase in use of the ponds.

6. Effluent Ponds

Samples from seven effluent pond locations were collected during CY-1982. These ponds are closed systems which contain both sanitary and radioactive waste for evaporative treatment. Contact with the working

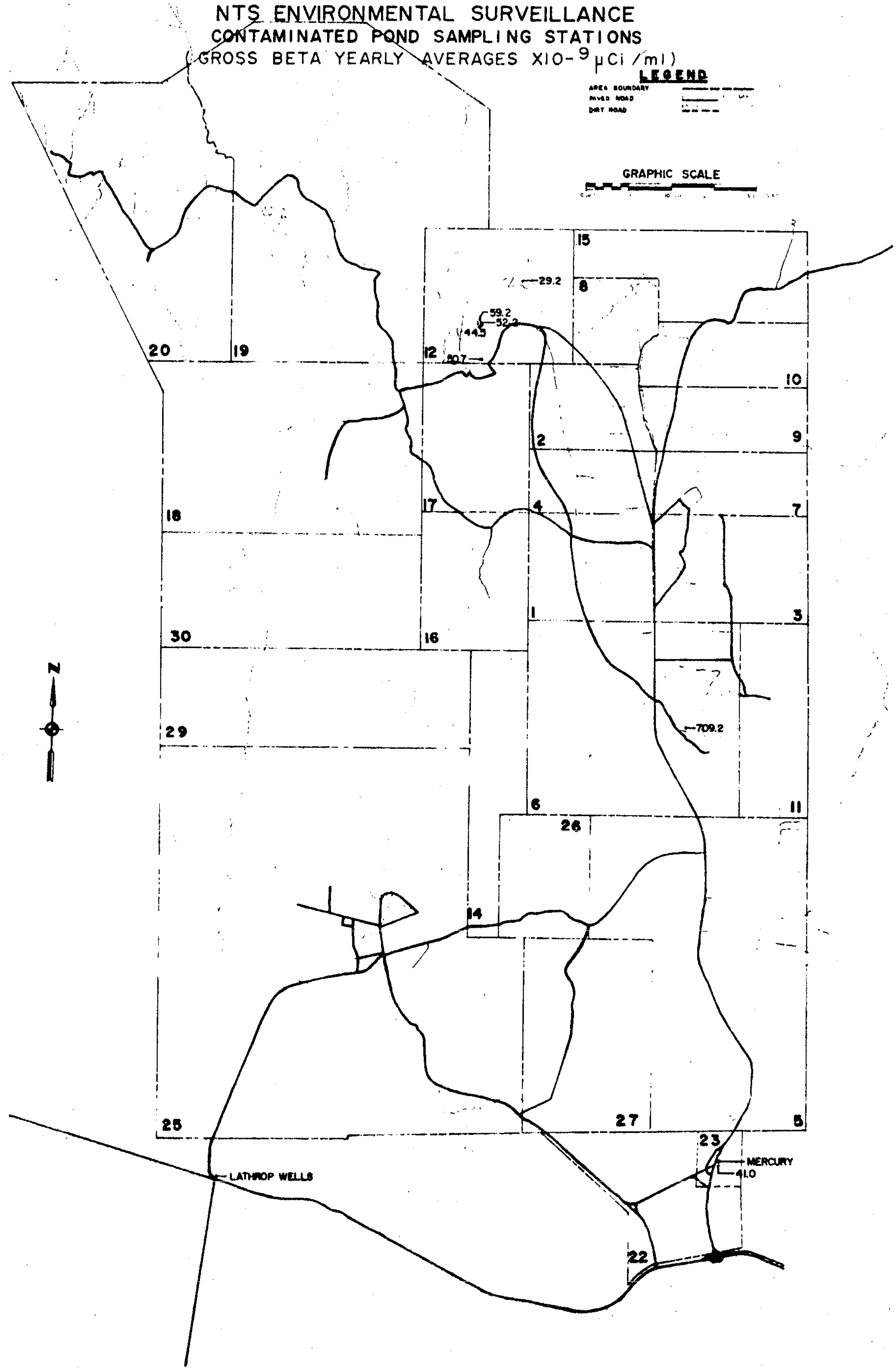

NTS ENVIRONMENTAL SURVEILLANCE
CONTAMINATED POND SAMPLING STATIONS
(GROSS BETA YEARLY AVERAGES X10-9 μCi/ml)
LEGEND
GRAPHIC SCALE
N
15
8
29.2
59.2
52.2
44.5
50.7
20
19
12
10
9
2
18
17
4
7
1
3
30
16
709.2
29
6
11
26
14
25
27
5
23
MERCURY
41.0
LATHROP WELLS
22

Figure 11

TABLE 19

CONTAMINATED POND YEARLY CONCENTRATION AVERAGES

Station	Tritium Yearly Average ($\times 10^{-6}$ µCi/ml)	Gross Beta Yearly Average ($\times 10^{-9}$ µCi/ml)	^{239}Pu Yearly Average ($\times 10^{-11}$ µCi/ml)
Area 6 Yucca Waste Pond	12.1	709.2	<12.5
Area 12 N Upper	2,536.0	59.2	<5.2
Area 12 N Middle	2,305.0	52.2	<3.8
Area 12 N Lower	1,967.0	44.5	<4.3
Area 12 G Waste	23,850.0	50.7	<5.4
Area 12 Upper Mint Lake	990.0	29.2	<4.4
Area 23 H&S Sump	0.5	41.0	*

*H&S Sump was dry during quarterly sampling.

population was minimal. The highest average tritium value was 3.16×10^{-5} $\mu Ci/ml$ and 7.4×10^{-11} $\mu Ci/ml$ for plutonium. All results are within the applicable concentration guides.

F. AMBIENT GAMMA MONITORING

A program to measure the ambient gamma exposure rates on the NTS was established in 1977 with 21 stations. In CY-1978, the program was expanded to 86 locations, 139 stations in CY-1979, 152 stations in CY-1980, and 163 stations since CY-1981. Table 20 lists the maximum, minimum, and average dose rates, along with the adjusted annual dose for each monitoring station. Due to the inadvertent placement of unbatched chips in the field during the fourth quarter of CY-1982 the period of measurement in Table 20 goes only to October of 1982.

Nine control-type stations from the 1977 network were retained for comparison to all new stations and for detection of any small variations in the general NTS background. The nine locations that comprised the original control network demonstrated similar dose rates as in previous years. Table 21 summarizes the nine locations average dose rates from 1977-1982. The largest variance was 0.05 mrem/d from the previous year. The overall network range of these stations was 0.18 mrem/d to 0.38 mrem/d, with an average natural background on NTS of approximately 0.28 mrem/d (100 mrem/y). This corresponds favorably with rates measured at offsite Nevada locations by the Environmental Protection Agency (Reference 11).

TABLE 20

GAMMA MONITORING RESULTS - SUMMARY OF 1982

STATION (AREA)	MEASUREMENT PERIOD	DOSE RATE (mrem/d) MAX.	MIN.	AVG.	1981 ADJUSTED ANNUAL DOSE (mrem/y)	1982 ADJUSTED ANNUAL DOSE (mrem/y)
A-90 Road (18)	01/08/82 - 10/01/82	0.46	0.43	0.44	165	160
A-100 Road (18)	01/08/82 - 10/01/82	0.44	0.43	0.43	165	155
A-108 Road (18)	01/08/82 - 10/01/82	0.46	0.43	0.44	170	160
A-116 Road (20)	01/08/82 - 10/01/82	0.49	0.48	0.48	175	175
A-130 Road (20)	01/08/82 - 10/01/82	0.49	0.37	0.43	170	155
A-132 Road (20)	01/19/82 - 10/05/82	0.43	0.41	0.42	165	155
A-136 Road (20)	01/19/82 - 10/05/82	0.44	0.41	0.43	185	155
Angle Road (3)	01/13/82 - 10/04/82	1.87	1.60	1.71	670	625
Bldg. 190 (23)	01/05/82 - 10/01/82	0.24	0.21	0.22	90	80
Bldg. 610 Fence (23)	01/05/82 - 10/01/82	0.21	0.19	0.20	70	75
Bldg. 610 X-Ray Area (23)	01/06/82 - 10/01/82	17.06	0.63	6.79	1890	2480
Bldg. 650 Dosimetry Room (23)	01/05/82 - 10/01/82	0.20	0.17	0.19	75	70
Bldg. 650 Roof (23)	01/05/82 - 10/01/82	0.19	0.15	0.18	65	60
Bldg. 650 Sample Storage (23)	01/05/82 - 10/01/82	0.66	0.47	0.56	345	205
B.J.Y. (3)	01/13/82 - 10/04/82	0.38	0.35	0.37	155	135
C-16 Road (19)	01/19/82 - 10/05/82	0.50	0.46	0.48	145	175
C-25 Road (19)	01/19/82 - 10/05/82	0.48	0.43	0.45	165	165
C-27 Road (19)	01/19/82 - 10/05/82	0.51	0.45	0.49	165	180
C-31 Road (19)	01/19/82 - 10/05/82	0.51	0.45	0.48	170	175
Cable Yard (2)	01/13/82 - 10/04/82	0.47	0.40	0.44	155	160
Cafeteria (27)	01/05/82 - 10/01/82	0.41	0.31	0.37	150	135
Campsite (20)	01/19/82 - 10/05/82	0.44	0.40	0.42	155	155
Circle & L Road (10)	01/13/82 - 10/04/82	0.42	0.41	0.42	165	155
Complex (3)	01/13/82 - 10/04/82	0.40	0.37	0.39	140	140
Complex (12)	01/08/82 - 09/27/82	0.51	0.39	0.43	155	155
CP Complex (6)	01/13/82 - 10/01/82	0.26	0.13	0.20	90	75
CP-50 Calibration Bench (6)	01/13/82 - 10/01/82	0.46	0.35	0.42	740	155
CP-50 Instrument Calib. Door (6)	01/13/82 - 10/01/82	0.52	0.44	0.48	200	175
CA-14 (10)	01/13/82 - 10/04/82	0.92	0.40	0.59	170	215
Decon Pad Front Office (6)	01/13/82 - 10/01/82	0.55	0.24	0.37	110	135
Decon Pad Back Office (6)	01/13/82 - 10/01/82	1.26	0.39	0.70	140	255
Desert Rock Weather Stn. (22)	01/05/82 - 10/01/82	0.20	0.20	0.20	75	75
E-MAD East (25)	01/05/82 - 10/01/82	0.36	0.35	0.36	130	130
E-MAD North (25)	01/05/82 - 10/01/82	0.72	0.68	0.70	380	255
E-MAD Tile Bed (25)	01/05/82 - 10/01/82	0.35	0.32	0.33	135	120
E-MAD West (25)	01/05/82 - 10/01/82	0.35	0.32	0.34	125	125
EPA Farm (15)	01/13/82 - 10/04/82	0.36	0.34	0.35	140	130
F-2 Road (20)	01/19/82 - 10/05/82	0.49	0.45	0.47	185	170
F-8 Road (20)	01/19/82 - 10/05/82	0.48	0.46	0.47	190	170
F-12 Road (20)	01/19/82 - 10/05/82	0.44	0.39	0.42	160	155
Gate 100 (23)	01/05/82 - 10/01/82	0.19	0.17	0.18	75	65
Gate 700 (15)	01/13/82 - 10/04/82	0.34	0.31	0.33	130	120
Gravel Pit (1)	01/08/82 - 10/01/82	0.39	0.34	0.36	120	130
Groom Pass L43.5 (15)	01/13/82 - 10/04/82	0.43	0.35	0.40	145	145
Henre Site (28)	01/05/82 - 10/01/82	0.39	0.33	0.37	140	135
J-6 Road (20)	01/19/82 - 10/05/82	0.48	0.43	0.46	170	170

Table 20 (Continued)

STATION (AREA)	MEASUREMENT PERIOD	DOSE RATE (mrem/d) MAX.	MIN.	AVG.	1981 ADJUSTED ANNUAL DOSE (mrem/y)	1982 ADJUSTED ANNUAL DOSE (mrem/h)
J-16 Road (20)	01/19/82 - 10/05/82	0.46	0.44	0.45	140	165
J-24 Road (20)	01/19/82 - 10/05/82	0.47	0.39	0.43	185	165
J-31 Road (20)	01/19/82 - 10/05/82	1.97	1.59	1.74	700	635
L-40 (15)	01/13/82 - 10/04/82	0.52	0.47	0.49	185	180
L-49 (15)	01/13/82 - 10/04/82	0.38	0.31	0.34	130	125
Lamp Shack (15)	01/13/82 - 09/27/82	0.49	0.36	0.41	150	150
LLL Trailer (15)	01/13/82 - 09/27/82	0.42	0.32	0.37	155	135
Logistics Desk (6)	01/13/82 - 10/01/82	0.28	0.24	0.26	90	95
Lower Mint Lake (12)	01/19/82 - 10/01/82	1.32	1.20	1.24	535	455
NRDS Warehouse (25)	01/05/82 - 10/01/82	0.42	0.32	0.38	155	140
Office (15)	01/13/82 - 09/27/82	0.40	0.29	0.34	115	125
Post Office (23)	01/05/82 - 10/01/82	0.20	0.14	0.18	75	65
R-3 Road (19)	01/19/82 - 10/05/82	0.57	0.49	0.52	175	190
R-9 Road (19)	01/19/82 - 10/05/82	0.57	0.49	0.53	185	195
R-20 Road (19)	01/19/82 - 10/05/82	0.47	0.40	0.43	195	155
R-27 Road (19)	01/19/82 - 10/05/82	0.51	0.48	0.50	175	185
R-31 Road (19)	01/19/82 - 10/05/82	0.46	0.40	0.43	170	155
Ramatrol (23)	01/05/82 - 10/01/82	0.41	0.38	0.39	155	140
RWMS East 500' (5)	01/05/82 - 10/01/82	0.37	0.34	0.36	120	130
RWMS East 1000' (5)	01/05/82 - 10/01/82	0.44	0.37	0.40	140	145
RWMS East 1500' (5)	01/05/82 - 10/01/82	0.37	0.35	0.36	140	130
RWMS East Gate (5)	01/05/82 - 10/01/82	0.51	0.38	0.42	135	155
RWMS North 500' (5)	01/05/82 - 10/01/82	0.39	0.36	0.38	145	140
RWMS North 1000' (5)	01/05/82 - 10/01/82	0.39	0.35	0.37	145	135
RWMS North 1500' (5)	01/05/82 - 10/01/82	0.37	0.35	0.36	140	130
RWMS Northeast Corner (5)	01/05/82 - 10/01/82	0.37	0.35	0.36	120	130
RWMS Northwest Corner (5)	01/05/82 - 10/01/82	0.39	0.36	0.37	140	135
RWMS Offices (5)	01/05/82 - 10/01/82	0.48	0.46	0.47	195	170
RWMS South Gate (5)	01/05/82 - 10/01/82	0.32	0.30	0.31	250	115
RWMS South 500' (5)	01/05/82 - 10/01/82	0.40	0.35	0.38	135	140
RWMS Southwest Corner (5)	01/05/82 - 10/01/82	0.35	0.33	0.34	130	125
RWMS West 500' (5)	01/05/82 - 10/01/82	0.38	0.37	0.38	145	140
RWMS West 1000' (5)	01/05/82 - 10/01/82	0.39	0.36	0.37	140	135
RWMS West 1500' (5)	01/05/82 - 10/01/82	0.39	0.38	0.39	150	140
Security Gate 293 (11)	01/13/82 - 10/01/82	0.43	0.33	0.38	160	140
Sedan Crater Visitor's Box (10)	01/13/82 - 10/04/82	0.59	0.56	0.57	205	210
Sedan Crater West Area (10)	01/13/82 - 10/04/82	2.99	2.52	2.72	1075	995
Storage Shed (15)	01/13/82 - 09/27/82	0.39	0.32	0.35	135	130
Substation Bus (15)	01/13/82 - 09/27/82	0.35	0.28	0.31	115	115
TH-1 (6)	01/08/82 - 10/01/82	0.26	0.21	0.23	85	75
TH-9 (6)	01/08/82 - 10/01/82	0.37	0.32	0.34	115	125
TH-18 (1)	01/08/82 - 10/01/82	0.33	0.27	0.30	105	110
TH-27 (1)	01/08/82 - 10/01/82	0.35	0.29	0.33	115	120
TH-37 (1)	01/08/82 - 10/01/82	0.43	0.34	0.38	140	145
TH-47 (4)	01/08/82 - 10/01/82	0.49	0.40	0.44	170	160
TH-57 (2)	01/08/82 - 10/01/82	0.34	0.28	0.32	105	115
TH-67.5 (12)	01/08/82 - 10/01/82	0.35	0.31	0.33	110	120
Upper Haines Lake No. 1 (12)	01/08/82 - 09/27/82	0.42	0.17	0.32	135	115
Upper N Tunnel Pond (12)	01/08/82 - 09/27/82	0.51	0.40	0.44	150	160
U3ax Northeast (3)	01/13/82 - 10/04/82	1.18	1.02	1.09	410	400
U3ax Northwest (3)	01/13/82 - 10/04/82	0.90	0.68	0.78	305	285
U3ax South (3)	01/13/82 - 10/04/82	0.55	0.52	0.53	380	195
U3ax Southeast (3)	01/13/82 - 10/04/82	0.65	0.61	0.62	255	225
U3by North (3)	01/13/82 - 10/04/82	1.22	0.92	1.11	440	405

Table 20 (Continued)

STATION (AREA)	MEASUREMENT PERIOD	DOSE RATE (mrem/d) MAX.	MIN.	AVG.	1981 ADJUSTED ANNUAL DOSE (mrem/y)	1982 ADJUSTED ANNUAL DOSE (mrem/h)
U3by South (3)	01/13/82 - 10/04/82	0.57	0.44	0.53	205	195
U3bz North (3)	01/13/82 - 10/04/82	0.77	0.58	0.70	285	255
U3bz South (3)	01/13/82 - 10/04/82	0.46	0.37	0.42	180	155
U3cj North (3)	01/13/82 - 10/04/82	0.54	0.40	0.49	200	180
U3co North (3)	01/13/82 - 10/04/82	4.95	4.00	4.63	1890	1690
U3co South (3)	01/13/82 - 10/04/82	2.91	2.19	2.62	1105	955
U3du North (3)	01/13/82 - 10/04/82	0.56	0.52	0.54	205	195
U3du South (3)	01/13/81 - 10/04/82	0.67	0.62	0.65	255	235
U3ey South (3)	01/13/82 - 10/04/82	0.44	0.20	0.36	155	130
Well 3 (6)	01/13/82 - 10/04/82	0.38	0.32	0.35	140	130
Well 5B (5)	01/05/82 - 10/01/82	0.36	0.27	0.33	135	120
Well 19C Reservoir (19)	01/19/82 - 10/05/82	0.48	0.39	0.44	155	160
Yucca Complex (6)	01/13/82 - 10/01/82	0.33	0.25	0.29	105	105
2-04 Road (2)	01/13/82 - 10/04/82	7.42	6.70	7.06	2915	2580
2-07 Road (2)	01/13/82 - 10/04/82	1.03	0.95	1.00	385	365
3-03, O.B. Roads (3)	01/13/82 - 10/04/82	0.30	0.26	0.29	115	105
4-04 Road (4)	01/13/82 - 10/04/82	9.30	8.25	8.70	3435	3180
6-09, O.B. Roads (6)	01/13/82 - 10/04/82	0.40	0.38	0.39	140	140
7-300 Bunker (7)	01/13/82 - 10/04/82	1.16	1.12	1.15	480	420
8K 25 (8)	01/13/82 - 10/04/82	0.36	0.31	0.34	125	125
9-300 Bunker (9)	01/13/82 - 10/04/82	0.40	0.38	0.39	150	140
10 A-24 (10)	01/13/82 - 10/04/82	0.88	0.40	0.70	375	255
18-1C Gate (18)	01/08/82 - 10/01/82	1.04	0.40	0.65	155	235
18P 35 (18)	01/08/82 - 10/01/82	0.49	0.44	0.46	180	170
18P 39 (18)	01/08/82 - 10/01/82	0.47	0.39	0.43	175	155
19P 41 (19)	01/08/82 - 10/01/82	0.49	0.47	0.48	160	175
19P 46 (19)	01/08/82 - 10/01/82	0.45	0.38	0.42	155	155
19P 54 (19)	01/08/82 - 10/01/82	0.44	0.38	0.41	170	150
19P 59 (19)	01/08/82 - 10/01/82	0.53	0.48	0.51	195	185
19P 66 (19)	01/08/82 - 10/01/82	0.53	0.48	0.50	185	185
19P 71 (19)	01/08/82 - 10/01/82	0.51	0.44	0.48	155	175
19P 77 (19)	01/08/82 - 10/01/82	0.54	0.46	0.50	180	185
19P 87 (19)	01/08/82 - 10/01/82	0.62	0.53	0.58	205	210
19P 88 (19)	01/08/82 - 10/01/82	0.59	0.51	0.55	170	200
19P 91 (19)	01/08/82 - 10/01/82	0.55	0.50	0.52	195	190
20-4C Gate (20)	01/08/82 - 10/01/82	0.52	0.43	0.47	170	170
25-4P Gate (25)	01/05/82 - 10/01/82	0.42	0.37	0.40	160	145
25-7P Gate (25)	01/05/82 - 10/01/82	0.40	0.34	0.37	140	135
30-1C Gate (30)	01/20/82 - 10/01/82	0.51	0.25	0.38	190	140
130 M (4)	01/13/82 - 10/04/82	0.41	0.33	0.36	130	130
140 M (2)	01/13/82 - 10/04/82	0.44	0.36	0.38	135	140
150 M (2)	01/13/82 - 10/04/82	0.41	0.35	0.39	160	140
168 M (12)	01/08/82 - 09/27/82	0.47	0.38	0.42	140	155
170 M (12)	01/08/82 - 09/27/82	0.40	0.34	0.36	125	130
175 M (12)	01/08/82 - 09/27/82	0.48	0.41	0.45	145	165
185 Holmes Road (17)	01/08/82 - 10/01/82	0.46	0.38	0.41	155	150
190 M (19)	01/08/82 - 10/01/82	0.51	0.45	0.49	185	180
196 M (19)	01/08/82 - 10/01/82	0.49	0.43	0.45	180	165

STATION (AREA)	MEASUREMENT PERIOD	ELEVATION (FT)	DOSE RATE (mrem/d) MAX.	MIN.	AVG.	1981 ADJUSTED ANNUAL DOSE (mrem/y)	1982 ADJUSTED ANNUAL DOSE (mrem/y)
N670,600 E667,300 (22)	01/07/82 - 10/08/82	4000	0.20	0.17	0.18	80	80
N731,300 E638,700 (28)	01/07/82 - 10/08/82	5750	0.30	0.28	0.29	115	105
N754,000 E557,800 (31)	01/07/82 - 10/08/82	4800	0.42	0.35	0.39	160	140
N849,500 E545,000 (30)	01/07/82 - 10/08/82	7100	0.49	0.41	0.45	180	165
N887,000 E558,000 (20)	01/07/82 - 10/08/82	6100	0.55	0.50	0.52	205	190
N948,800 E527,800 (20)	01/07/82 - 10/08/82	5650	0.51	0.48	0.50	195	185
N944,700 E563,300 (19)	01/12/82 - 10/08/82	6300	0.29	0.27	0.28	115	100
N955,500 E614,200 (19)	01/07/82 - 10/11/82	7200	0.46	0.43	0.44	175	160
N935,500 E639,750 (19)	01/08/82 - 10/11/82	6550	0.45	0.42	0.44	165	160
N903,800 E635,500 (12)	01/07/82 - 10/11/82	6900	0.34	0.33	0.34	135	125
N907,600 E686,200 (8)	01/07/82 - 10/11/82	5826	0.46	0.45	0.45	185	165
N874,600 E691,500 (10)	01/07/82 - 10/11/82	5000	0.26	0.22	0.24	95	90
N844,200 E704,900 (3)	01/07/82 - 10/11/82	5100	0.23	0.19	0.21	85	75
N788,800 E709,500 (11)	01/07/82 - 10/11/82	5200	0.43	0.41	0.42	155	155
N710,800 E720,000 (11)	01/07/82 - 10/08/82	4280	0.20	0.18	0.19	70	65

TABLE 21

TLD CONTROL STATION COMPARISON

Station	Dose Rate (mrem/d) 1977	1978	1979	1980	1981	1982
Bldg. 650 Dosimetry Room	0.15	0.16	0.17	0.18	0.21	0.19
Bldg. 650 roof	0.15	0.15	0.15	0.16	0.18	0.18
Area 27 Cafeteria	0.37	0.37	0.35	0.37	0.41	0.37
CP Complex	0.21	0.22	0.21	0.23	0.25	0.20
Henre Site	0.34	0.34	0.33	0.35	0.39	0.37
NRDS Warehouse	0.35	0.35	0.33	0.35	0.40	0.38
Post Office	0.15	0.15	0.15	0.16	0.20	0.18
Well 58	0.32	0.32	0.31	0.34	0.38	0.33
Yucca Complex	0.29	0.31	0.30	0.30	0.32	0.29
Network Average	0.26	0.26	0.26	0.27	0.30	0.28

The remaining 156 stations of the network yielded dose rates which ranged from 0.18 mrem/d to 8.7 mrem/d, about a factor of 50 variation. The majority of individual location measurements were consistent within a range of ± 10 percent between field cycles. This suggested that the elevated gamma dose rates were caused by the presence of long-lived radionuclides, a theory borne out by the fact that most of the soil-deposited NTS fission products were well over a decade old. Few stations displayed substantial variations, and fluctuations were related to known radioactive source movement or moderation.

G. PERIMETER DOSE ASSESSMENT

The maximum postulated dose from the NTS operations was calculated for an individual residing at the site boundary during the entire CY-1982. This was done by calculating the fifty year cummulative dose, except for the dose from air immersion, for the individual receiving a one year intake from measured radionuclide concentrations onsite. The dose from air immersion was calculated for a one year exposure to a semi-infinite cloud. In the calculation the air immersion dose was treated like an external exposure and, therefore, once the radioactive source was considered removed, for the purposes of this calculation the end of CY-1982, there was no further exposure. The dose conversion factors used for calculating the cummulative dose came from References 14 and 20, and are tabulated in Table 22. Basically, these reports used models and parameters equivalent to those used in ICRP Publication 2 (Reference 16). The radionuclides considered for the dose calculations were tritium, ^{133}Xe, ^{239}Pu, and ^{90}Sr (assuming the gross beta concentration in air consists entirely of ^{90}Sr). The critical organs considered for these radionuclides were the total body, bone, and lung.

TABLE 22

DOSE CONVERSION FACTORS*

	Inhalation (mrem/50 y per pCi inhaled)			Ingestion (mrem/50 y per pCi inhaled)		Air Immersion (mrem/y per $\mu Ci/m^3$)
Organ	^{3}H***	^{239}Pu****	^{90}Sr**	^{239}Pu****	^{3}H***	^{133}Xe
Total Body	9.3E-08	1.55E-01	7.62E-04	3.82E-05	6.2E-08	2.19E+02
Bone	0.0	6.38E+00	1.24E-02	1.57E-03	0.0	2.19E+02
Lung	9.3E-08	3.44E-01	1.20E-03	0.0	6.2E-08	2.37E+02

* Taken from References 14 and 20.

** Gross beta activity was assumed to be ^{90}Sr.

*** The dose conversion factor was divided by 1.7 to take into account the change in Quality Factor for weak beta emitters (DOE Order 5840.1, Chapter XI).

**** The dose conversion factor was multiplied by two to take into account the change in Quality Factor for alpha emitters (DOE Order 5840.1, Chapter XI).

1. Dose From Ingestion of Radionuclides

The dose from the ingestion pathways were calculated for an individual living at the NTS boundary during CY-1982. The only pathway considered was the ingestion of water. Ingestion of foodstuffs was not considered because of the lack of locally grown food adjacent to the site boundary. The water was assumed to be similar to the potable water sampled onsite. The radionuclides considered for the calculation were ^{239}Pu and tritium. The gross beta concentration was not used in the calculation because it was shown earlier (E.2.) that the gross beta concentration was due to the naturally occurring ^{40}K content. The Cascade bottled water brought onsite was assumed to have natural background levels of ^{239}Pu and tritium. These background concentrations were subtracted from the potable water stations having the maximum average ^{239}Pu and tritium concentrations to obtain the net concentrations used in the dose calculations. These values are listed in Table 23. The assumed fluid intake for the individual was 1.6 liters per day and was derived from ICRP Publications 23 (Reference 15). The resulting ingestion doses to the total body, lung, and bone for ^{239}Pu and tritium are given in Table 24.

2. Dose from Inhalation of Radionuclides

The doses from the inhalation of tritium, gross beta activity, and ^{239}Pu were calculated for the individual living at the NTS boundary.

The highest tritium in air concentration was extrapolated to the NTS boundary by the use of a disperson factor. The formula for calculating the centerline concentration at ground level was used for estimating the dispersion factor (Reference 21). The station was assumed to be 100 meters from the source and the site boundary 1500 meters away. Type D weather conditions were assumed along with a wind speed of 5.5 meters per second. This calculated concentration was below the average background concentration, therefore, the average background concentration was used in the dose calculation.

The highest gross beta concentration onsite and the highest ^{239}Pu concentration near the NTS boundary were used in the dose calculation after their respective average background concentrations were subtracted. All of the gross beta activity was assumed to be ^{90}Sr. These concentrations were not reduced by a dispersion factor because of the lack of knowledge concerning the source geometry and size, the source term, and the complexity of the calculation. The concentrations used for calculating the inhalation dose are listed in Table 23. The individual was assumed to breathe 8,400 cubic meters of air in one year (Reference 15). The calculated fifty year cummulative doses to the whole body, lungs, and bone are given in Table 24.

3. Dose from Air Immersion

The air immersion dose from ^{133}Xe was calculated for an individual at the NTS boundary. The ^{85}Kr concentrations at all six stations were considered to be at natural background levels and, therefore, were not used in the dose calculation. The ^{133}Xe concentration used in the calculation was obtained by subtracting the average of the stations that had background concentrations from the highest average concentration onsite. A dispersion factor was not used in this calculation. These values are given in Table 23. The calculated doses to the whole body, lungs, and bone are listed in Table 24.

4. Estimated Risk to Individual

The maximum estimated dose to the total body, bone, and lung from NTS operations during CY-1982 was 0.18 mrem, 2.0 mrem, and 0.24 mrem, respectively. Table 25 lists the estimated dose to an individual living at the NTS boundary for one year from natural background radiation. The calculated doses to the individual represent increases of 0.15 percent (total body), 1.31 percent (bone), and 0.11 percent (lung) over natural background at the NTS. ICRP Publication 26 (Reference 17) estimated the risk of fatal health effects per unit dose over the individuals lifetime. Using these values the risk for the total body, bone, and lung were 3.0×10^{-8}, 4.8×10^{-9}, and 4.0×10^{-8}, respectively.

TABLE 23

RADIONUCLIDE CONCENTRATIONS USED FOR DOSE ASSESSMENT

	Air (μCi/cc)				Potable Water (μCi/ml)	
	^{3}H	^{239}Pu	Gross Beta	^{133}Xe	^{239}Pu	^{3}H
Onsite Concentration	1.5E-11*	5.3E-17***	2.6E-14	5.3E-12	<3.7E-11	<8.6E-07
Background Concentration	1.4E-10	2.1E-17	2.3E-14	1.8E-12	<3.1E-11	<7.3E-07
Net Concentration	1.4E-10**	3.2E-17	0.3E-14	3.5E-12	<0.6E-11	<1.3E-07

* This value was obtained by using the maximum average NTS concentration. The concentration was reduced by a dispersion factor which was calculated from the station location to the site boundary.

** Average background concentration on NTS used in calculation because it was larger than the calculated NTS boundary concentration.

*** Maximum average concentration near the NTS boundary.

TABLE 24

50 YEAR CUMMULATIVE DOSES*

Organ	Inhalation (mrem) ^{3}H	Inhalation (mrem) ^{239}Pu	Inhalation (mrem) ^{90}Sr**	Ingestion (mrem) ^{239}Pu	Ingestion (mrem) ^{3}H	Air Immersion (mrem) ^{133}Xe	Total (mrem)
Total Body	1.1E-1	4.2E-02	1.9E-02	<1.3E-04	<4.7E-03	7.7E-04	<1.8E-01
Bone	0.0	1.7E+00	3.1E-01	<5.5E-03	0.0	7.7E-04	<2.0E+00
Lung	1.1E-1	9.2E-02	3.0E-02	0.0	<4.73-03	8.3E-04	<2.4E-01

* 50 year cummulative dose from inhalation and ingestion of radionuclides for one year. The air immersion dose rate was calculated for a one year exposure with no resulting exposure after the CY-1982 ended.

** Assumed all of the gross beta activity was ^{90}Sr.

TABLE 25

ESTIMATED NATURAL BACKGROUND DOSE AT THE NTS BOUNDARY*

Source	Total Body** (mrem/y)	Bone (mrem/y)	Lungs (mrem/y)
Cosmic Radiation***	36	36	36
Cosmic Radionuclides+	0.7	0.8	0.7
External Terrestrial++	56	56	56
Inhaled Radionuclides+++	--	--	100
Radionuclides in the Body+++	27	60	24
Total for One Year	120	153	217
U.S. Average Total	80	120	180

* These values were derived from References 13 and 20.

** The values for the total body are assumed to be the same as those for the gonads in Reference 18.

*** Assumed altitude of 1 km and a 10% reduction from structural shielding.

\+ Variation throughout U.S. very minimal, usually less then 1 mrem/y.

++ Value of 10 µrad/h assumed at the site boundary. Value reduced by 20% for shielding by housing and 20% for shielding by the body.

+++ Average values for the U.S.

Reference 17 estimates that an acceptable risk to any individual in the public is 10^{-6} to 10^{-5} per year. The maximum calculated risk to the individual at the NTS boundary is at least an order of magnitude below this acceptable risk. Due to the conservative assumptions used in the dose calculations and the comparison of risks, the postulated individual living at the NTS boundary during CY-1982 would have no observable ill effects from the operation of the NTS.

H. RADIOACTIVE WASTE MANAGEMENT SITE (RWMS)

The radioactive Waste Management Site is located in Area 5 of the Nevada Test Site (Figure 12). RWMS consists of approximately 37.2 hectares (92 acres) of land which is devoted to surface storage and disposal of defense low-level radioactive wastes. Waste facilities at the site include trenches, pits, and asphalt pads. The type of waste disposed of at RWMS includes tritium contaminated waste, low-level waste, and equipment that is activated or contaminated. The stored waste consists of transuranic (TRU) contaminated waste only. For a more detailed description of RWMS see Reference 12.

Surveillance of the RWMS is accomplished by using eighteen air samplers, nine for tritium and nine for gross fission products and plutonium, and sixteen TLD's, for gamma monitoring, placed strategically in and around the RWMS. Figures 13-15 show the locations of the stations and their yearly averages.

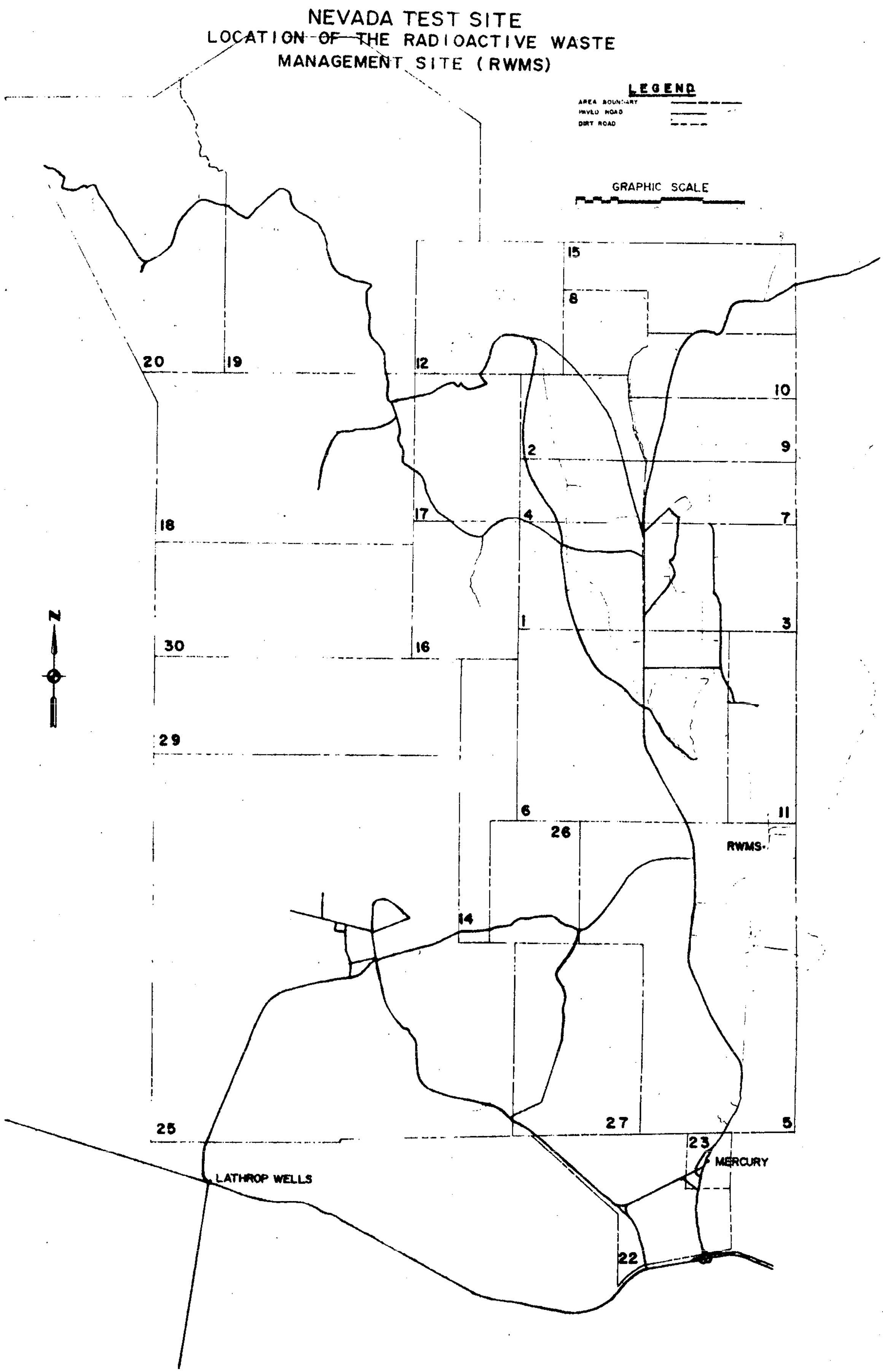

NEVADA TEST SITE
LOCATION OF THE RADIOACTIVE WASTE
MANAGEMENT SITE (RWMS)
LEGEND
GRAPHIC SCALE
15
8
20
19
12
10
2
9
17
4
7
18
1
3
30
16
29
6
11
26
RWMS
14
25
27
5
23
MERCURY
LATHROP WELLS
22
N

Figure 12

NTS ENVIRONMENTAL SURVEILLANCE
RWMS TRITIUM IN AIR SAMPLING STATIONS
(YEARLY AVERAGES x 10^{-11} μCi/cc)

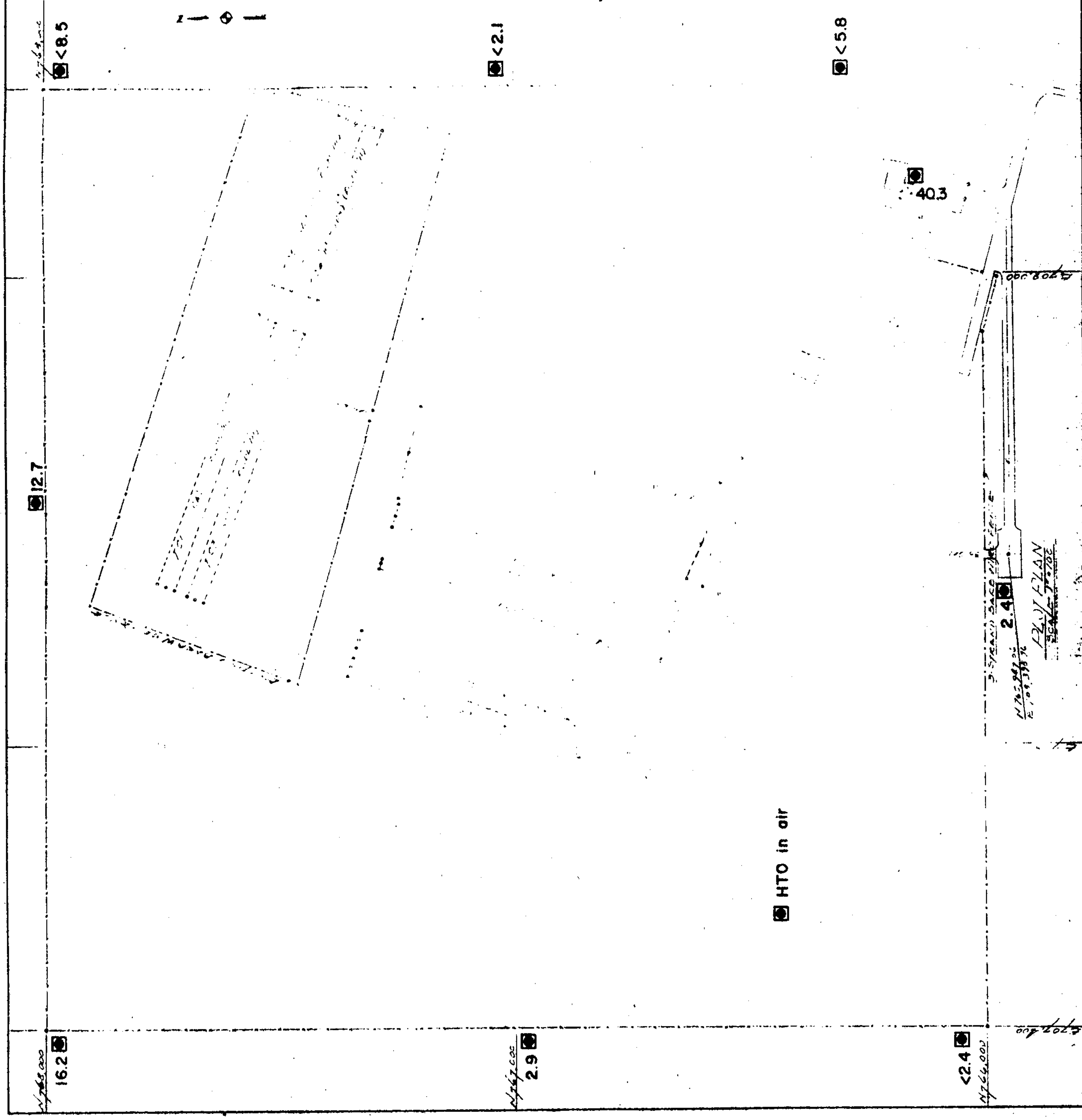
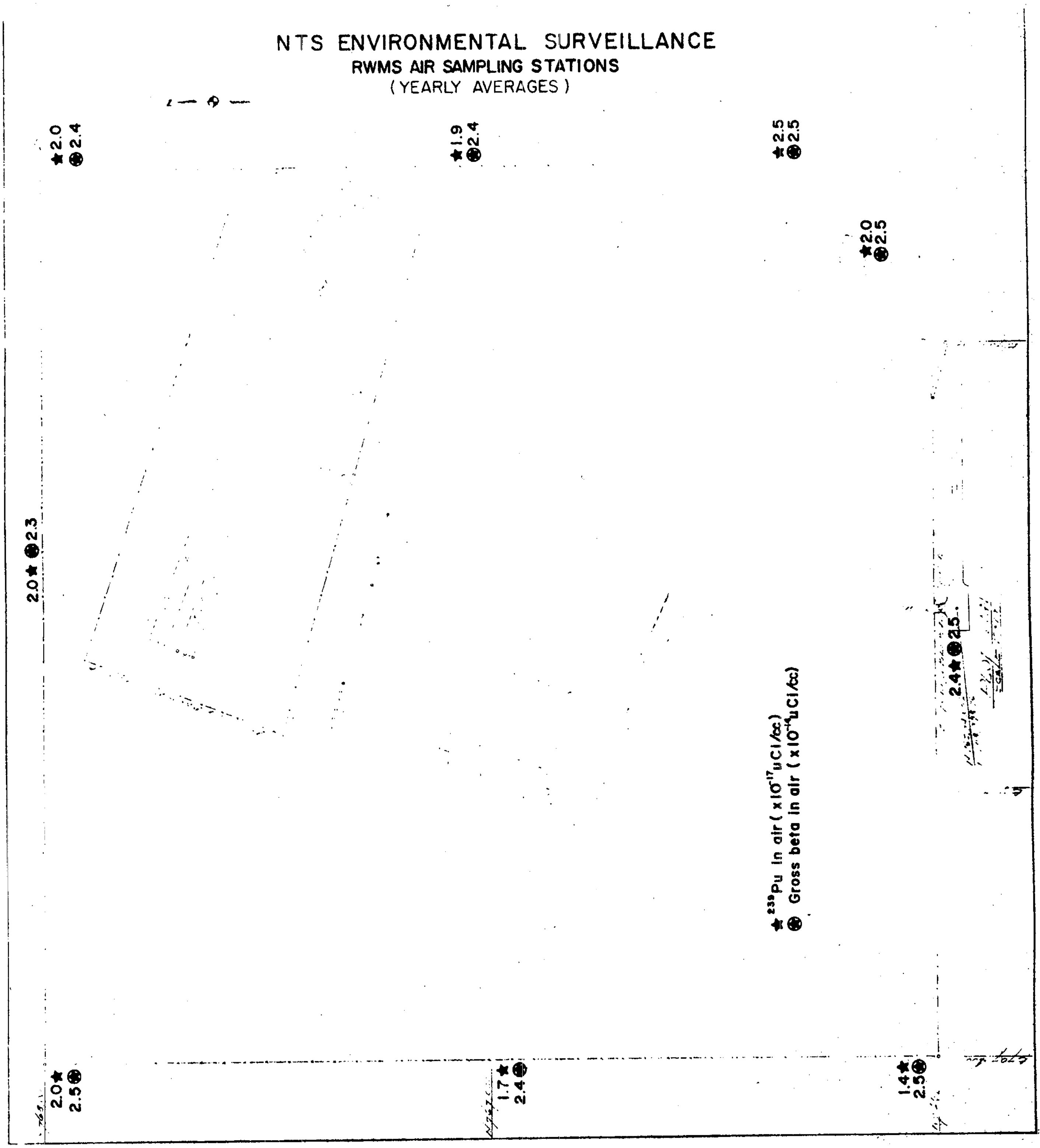


Figure 13



NTS ENVIRONMENTAL SURVEILLANCE
RWMS AIR SAMPLING STATIONS
(YEARLY AVERAGES)
★ ^{239}Pu in air (x10^{-17} µCi/cc)
⊕ Gross beta in air (x10^{-14} µCi/cc)
★2.0 ⊕2.4
★1.9 ⊕2.4
★2.5 ⊕2.5
★2.0 ⊕2.5
2.0★ ⊕2.3
2.4★ ⊕2.5
2.0★ 2.5⊕
1.7★ 2.4⊕
1.4★ 2.5⊕

Figure 14

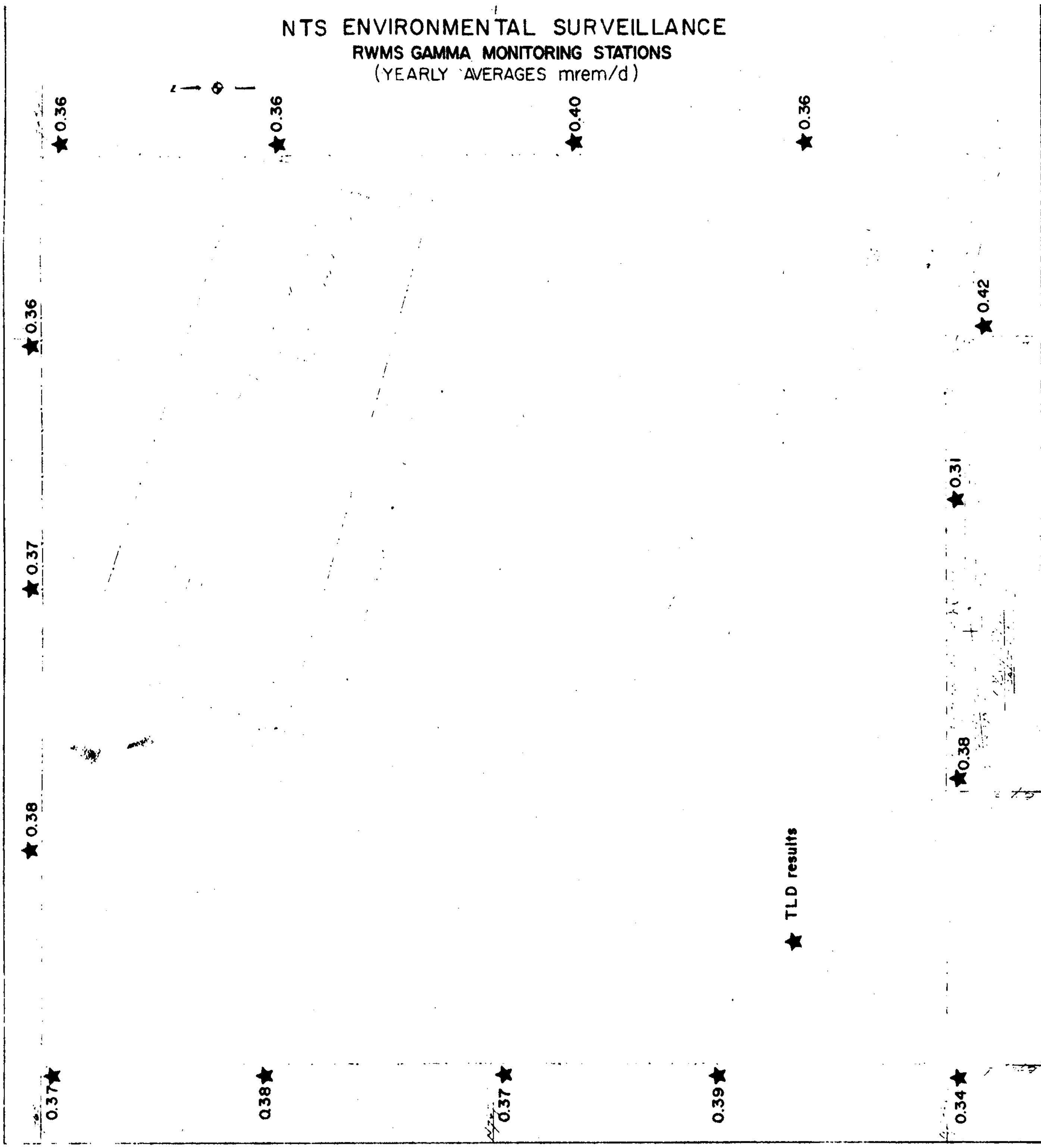

NTS ENVIRONMENTAL SURVEILLANCE
RWMS GAMMA MONITORING STATIONS
(YEARLY AVERAGES mrem/d)
0.36
0.36
0.40
0.36
0.36
0.42
0.31
0.37
0.38
0.38
TLD results
0.37
0.38
0.37
0.39
0.34

Figure 15

The tritium in air samplers are placed around the perimeter of RWMS. Results for the RWMS surveillance are summarized in Table 6. The highest average for HTO was 1.6 x 10^{-10} μCi/cc at RWMS-NW Station, which is 0.32 percent of the concentration guide.

Gross beta and ^{239}Pu in air results for the site are summarized in Tables 4 and 5. The average gross beta concentration was 2.4 x 10^{-14} μCi/cc compared to the network average of 2.3 10^{-14} μCi/cc. This concentration represents 0.024 percent of the concentration guide (assuming ^{90}Sr is the beta emitter present). Results from the nine gross beta stations were grouped closely together and all were within two standard deviations from the average. The average concentration of ^{239}Pu in air at RWMS was 2.0 x 10^{-17} μCi/cc. This is 0.009 percent of the concentration guide for ^{239}Pu.

Table 20 gives a summary of the gamma monitoring results for 1982. The average annual dose was 135 mrem/y or 16 μrem/h. This compared favorably with the natural background of Area 5 of 11-20 μR/h. (Reference 13). Another station, two miles south (Well 5B), had an annual dose rate of 120 mrem/y or 14 μrem/h.

In conclusion the results from this surveillance network around the RWMS indicate that there were no detectable releases of radioactive materials as a result of operations during 1982.

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A P P E N D I X A

NTS Environmental Surveillance

Air Sampling Locations and Plots

Several symbols are used in Appendix A to denote the data points. In the first plot, the air network weekly averages, a square represents the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots of Appendix A show the gross beta and plutonium data of each station. A two-sigma error bar is also added to the data points, and, in all of the plots, a delta with the line to the bottom of the plot means below detection limit.

NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING LOCATIONS

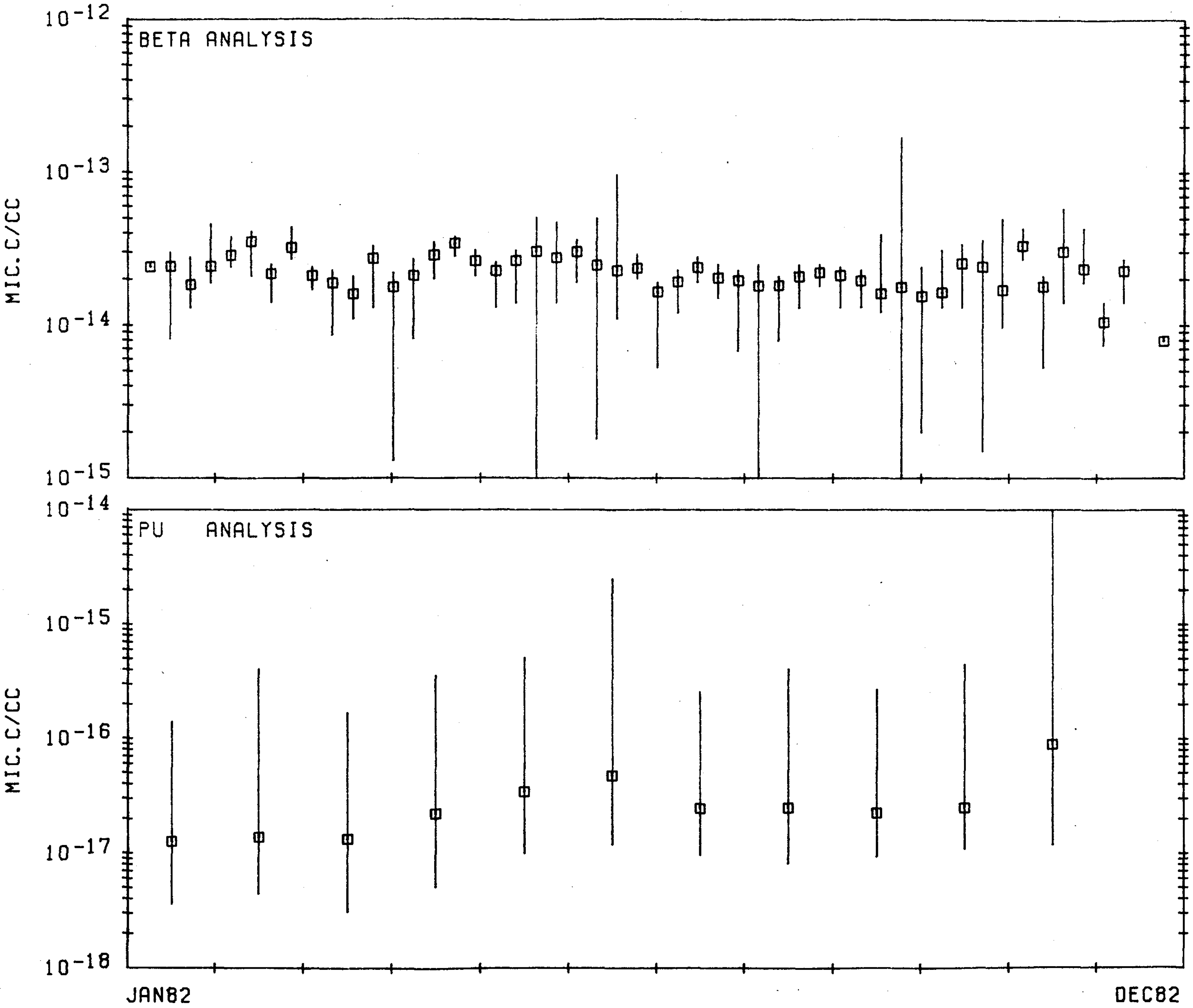
Station Number	Location
1	Area 11 Gate 293
2	Area 6 Well 3 Complex
3	Area 3 Cafeteria
4	Area 9 9-300 Bunker
5	Area 10 Gate 700
6	Area 2 Cable Yard
7	Area 2 Compound
8	Area 12 Changehouse
9	Area 19 Echo Peak
10	Area 19 Substation
11	Area 16 Substation
12	Area 9 9-300 Bunker #2
13	Area 23 H&S Roof
14	Area 23 Building 790
15	Area 23 Bldg. 790 #2
16	Area 27 Cafeteria
17	Area 25 NRDS Warehouse
18	Area 28 Henre Site
19	Area 5 Well 5B
20	Area 5 RWMS #1
21	Area 5 DOD Yard
22	Area 6 Yucca Complex
23	Area 6 CP Complex
25	Area 1 Gravel Pit
26	Area 3 BJY
27	Area 3 3-300 Bunker
28	Area 5 RWMS #2
29	Area 5 RWMS #3
30	Area 25 E-MAD North
31	Area 25 E-MAD South
32	Area 5 RWMS #4

NTS ENVIRONMENTAL SURVEILLANCE
AIR SAMPLING LOCATIONS

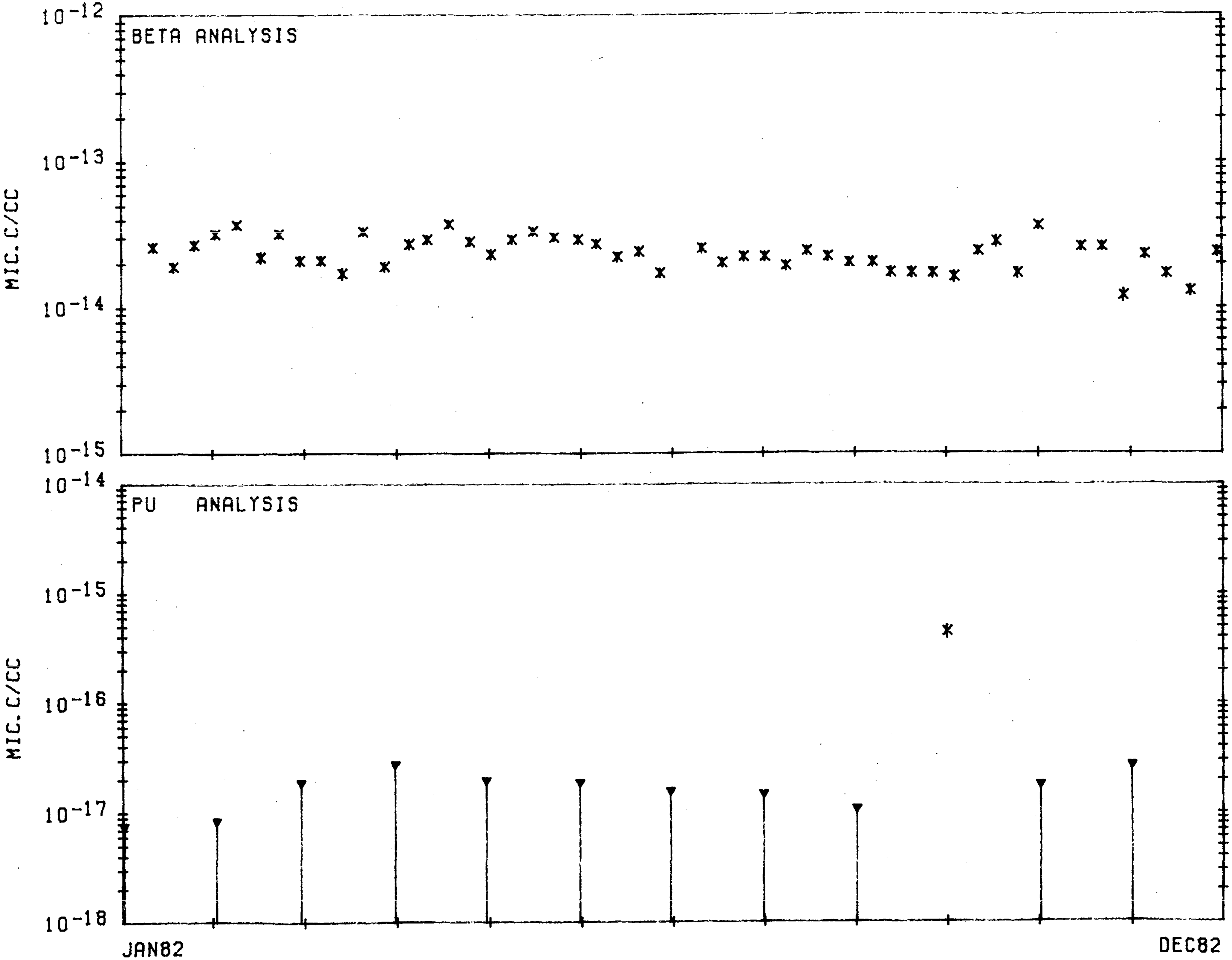
(Continued)

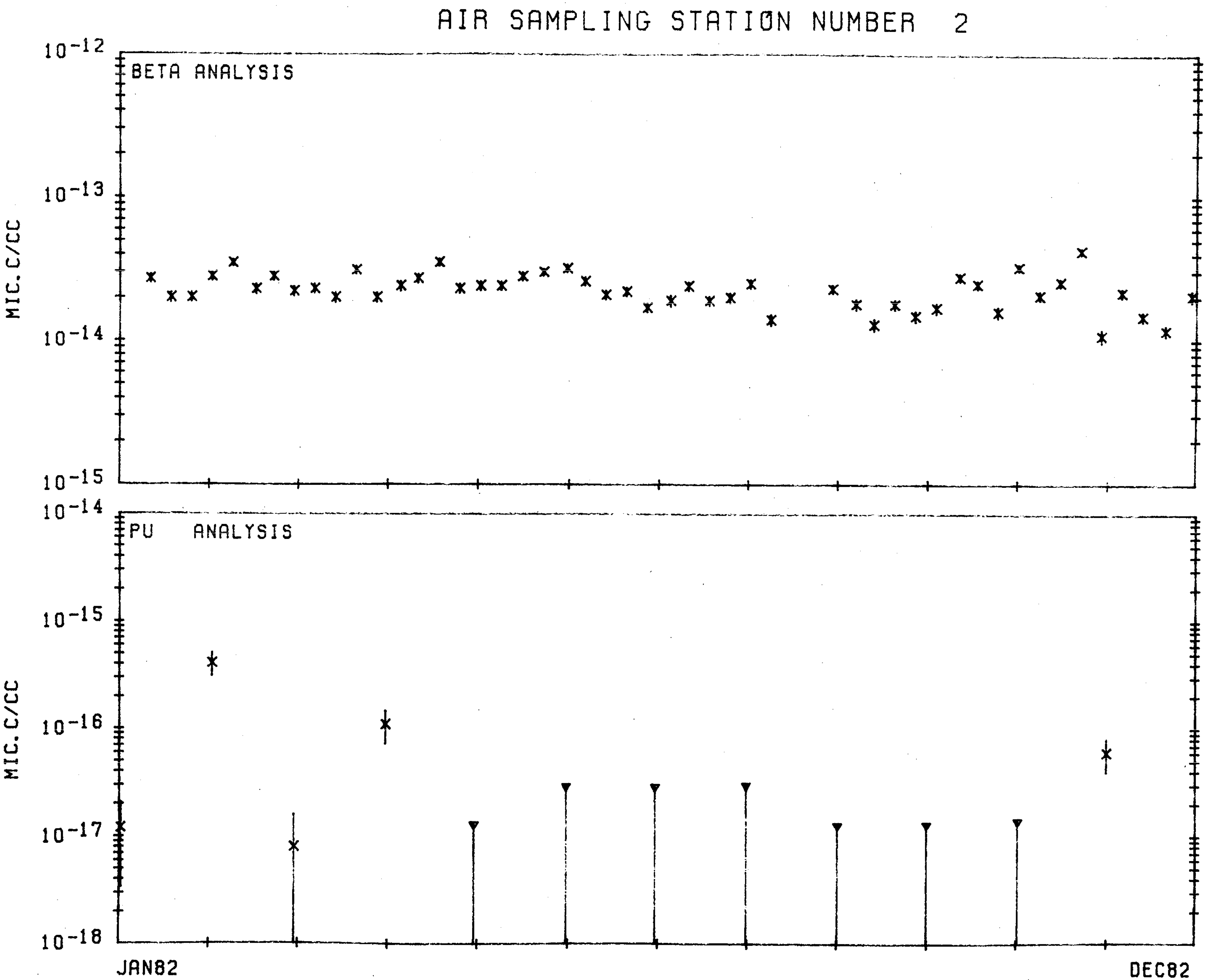
Station Number	Location
33	Area 3 U3ax South
34	Area 3 U3ax East
35	Area 3 U3ax North
36	Area 3 U3ax West
37	Area 7 UE7ns
38	Area 15 EPA Farm
39	Area 5 RWMS #5
40	Area 5 RWMS #6
41	Area 5 RWMS #7
42	Area 5 RWMS #8
43	Area 5 RWMS #9
44	Area 15 Pile Driver
45	Area 19 19-3 Substation
46	Area 20 Dispensary
47	Area 3 Complex #2
50	Area 5 Gate 200

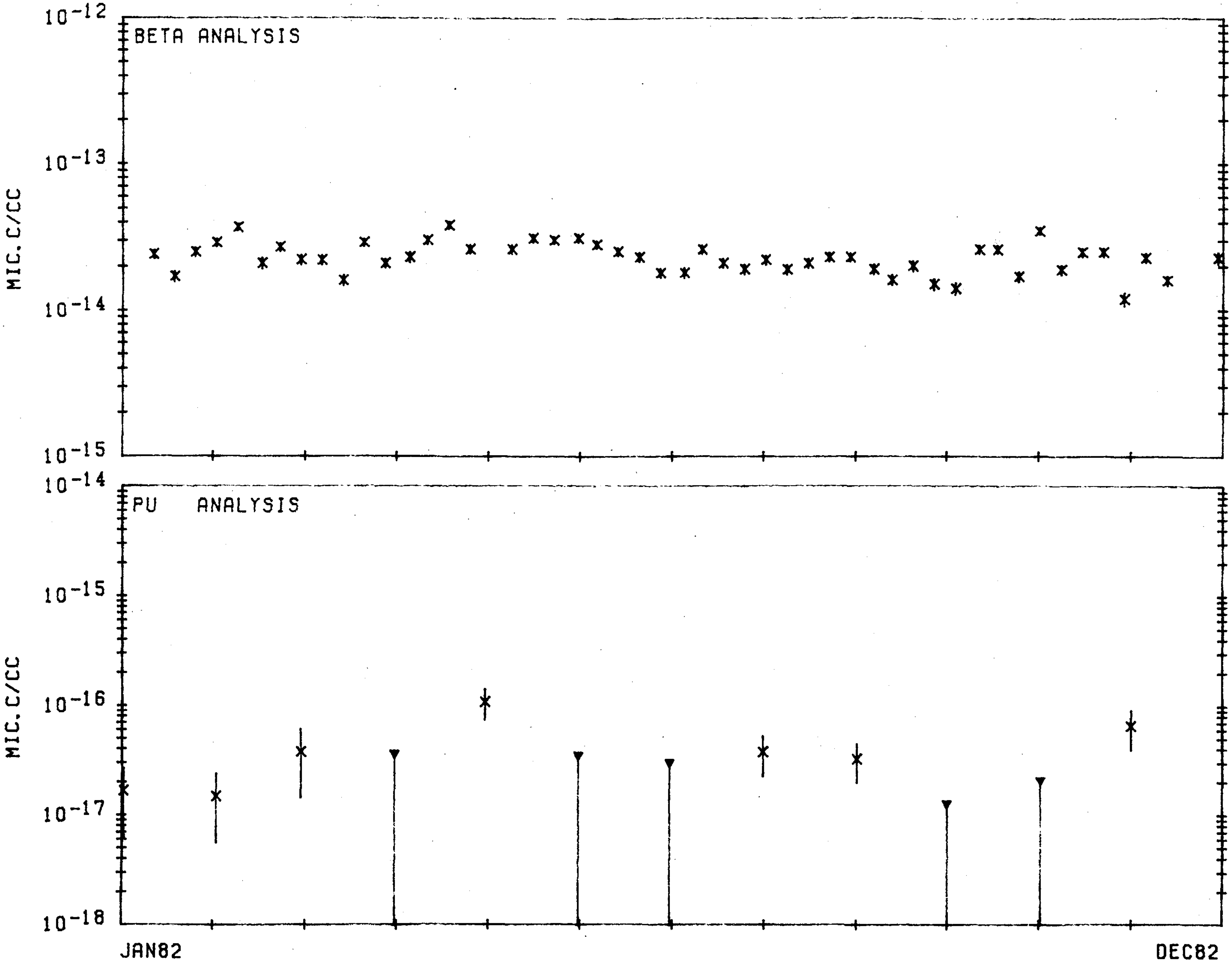
AIR NETWORK AVERAGES

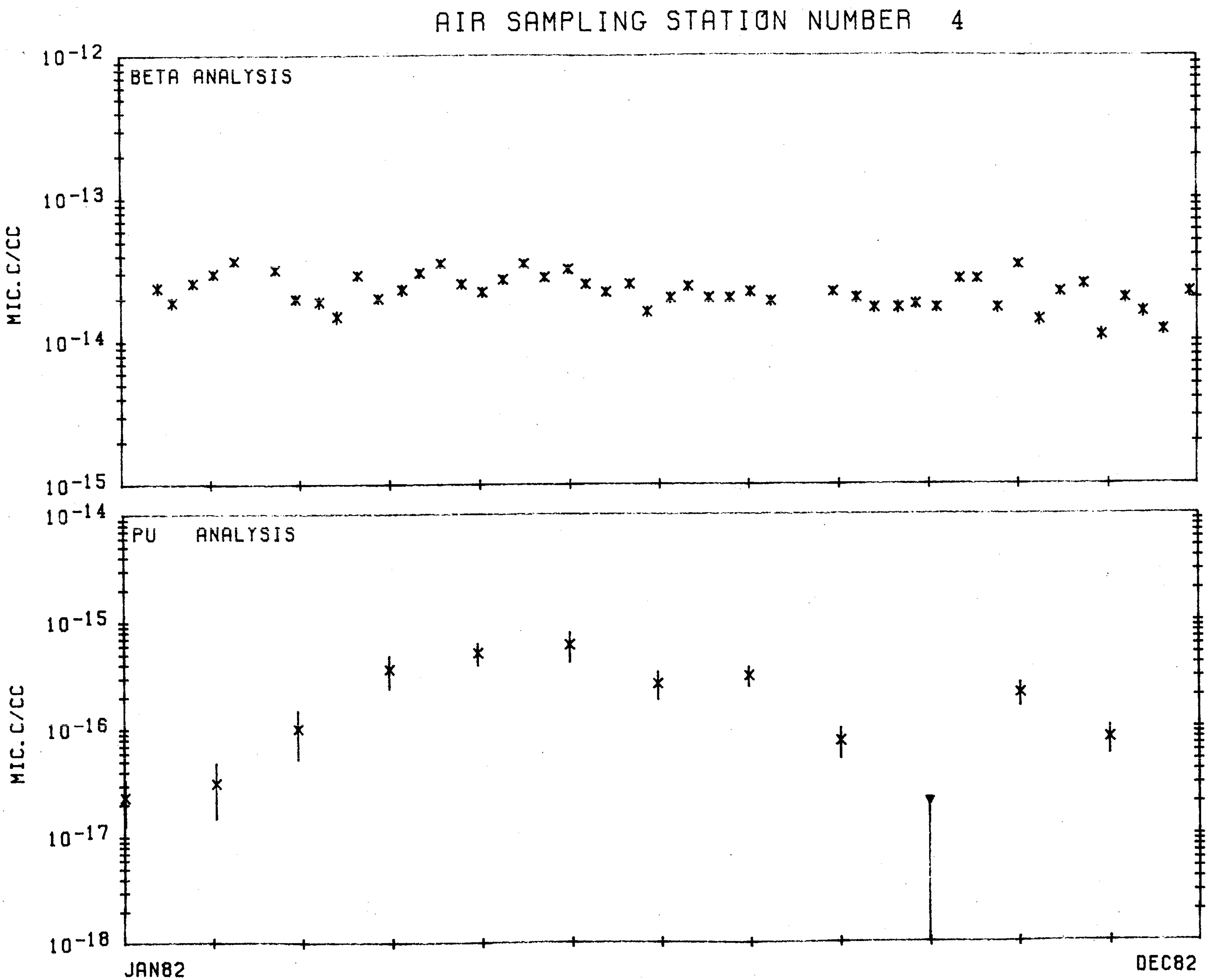


AIR SAMPLING STATION NUMBER 1

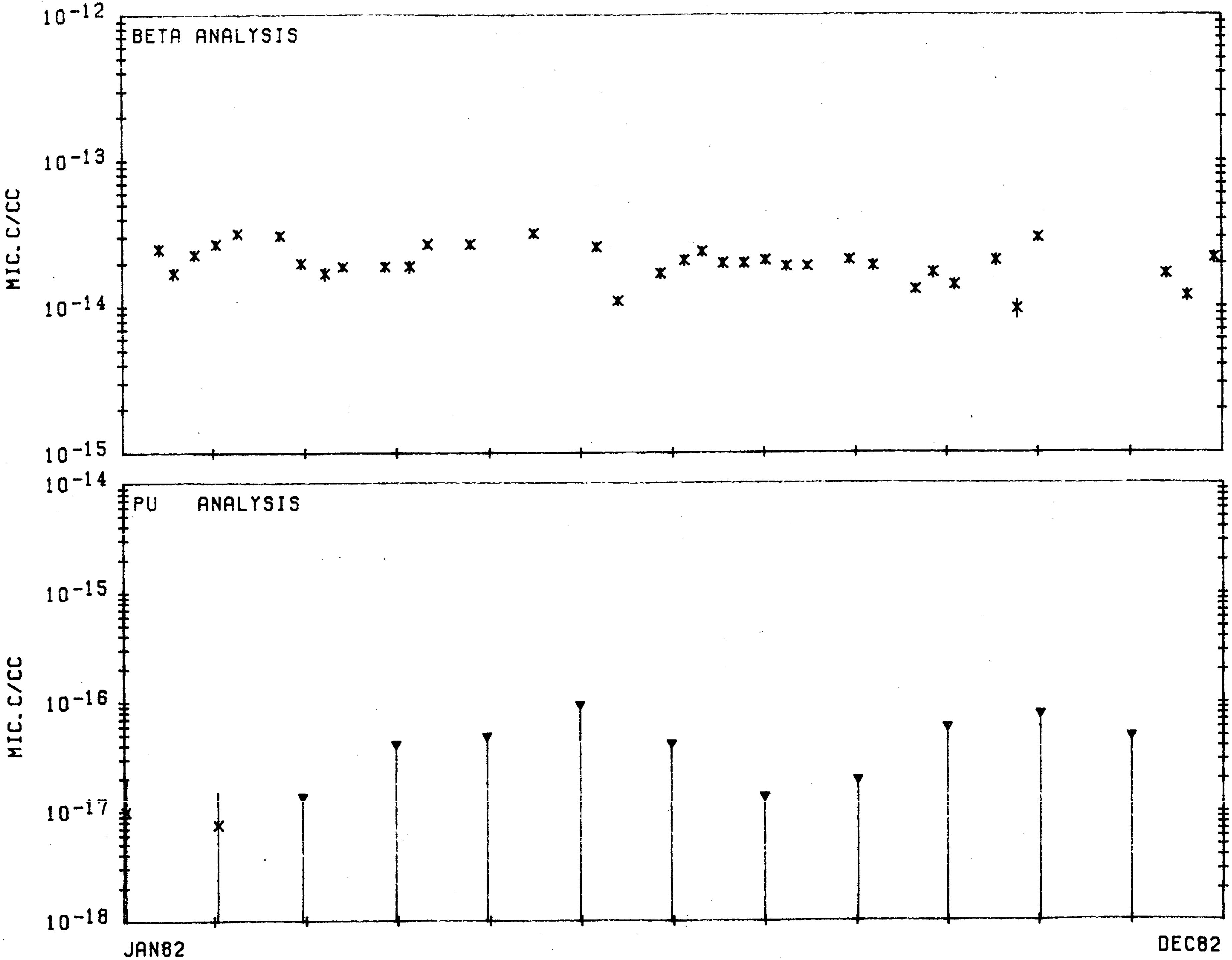


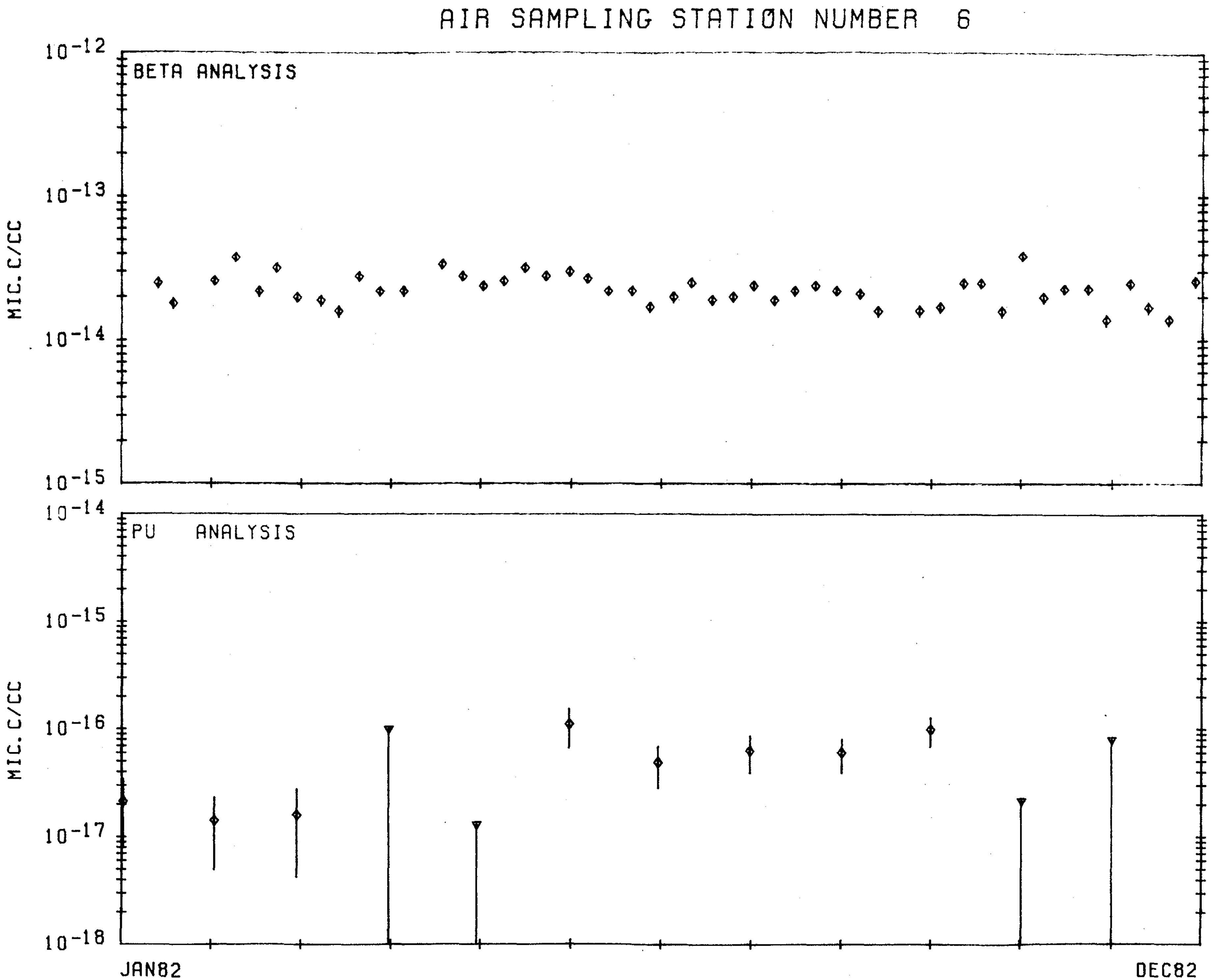

AIR SAMPLING STATION NUMBER 2
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82


BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10-12
10-13
10-14
10-15
10-14
10-15
10-16
10-17
10-18
JAN82
DEC82


AIR SAMPLING STATION NUMBER 4
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
10-12
10-13
10-14
10-15
10-16
10-17
10-18
JAN82
DEC82

AIR SAMPLING STATION NUMBER 5




AIR SAMPLING STATION NUMBER 6
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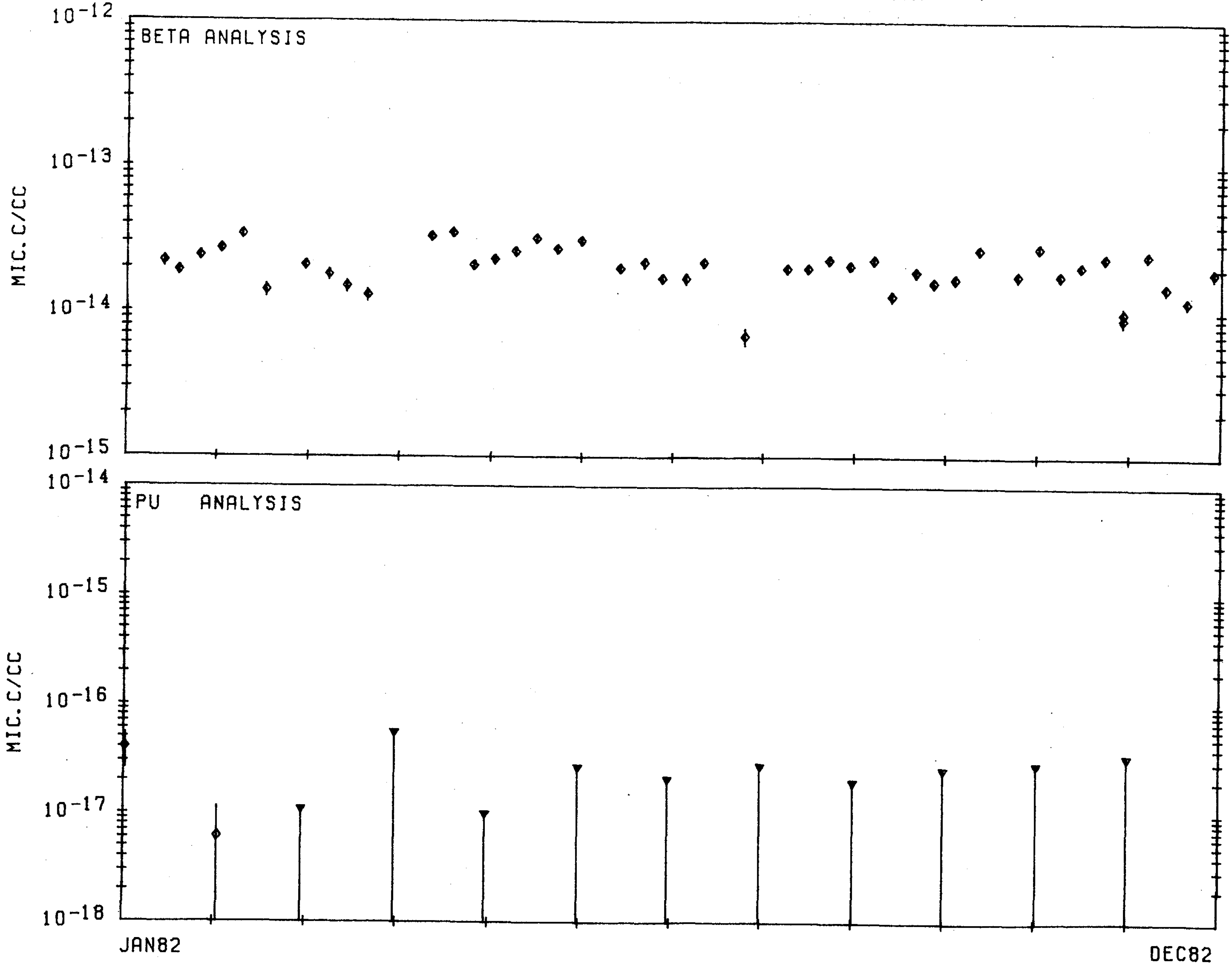
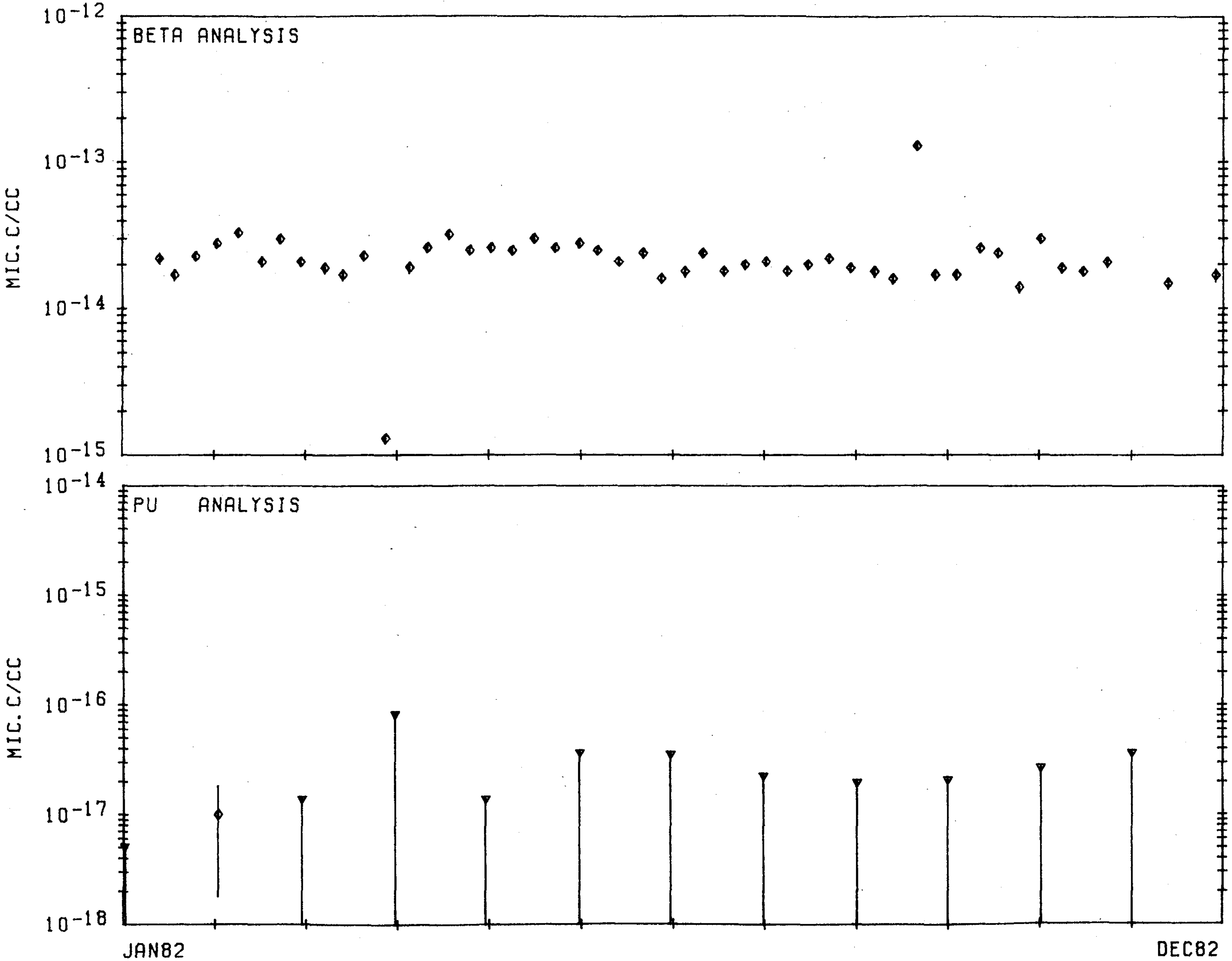
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

-97-

AIR SAMPLING STATION NUMBER 7



AIR SAMPLING STATION NUMBER 8



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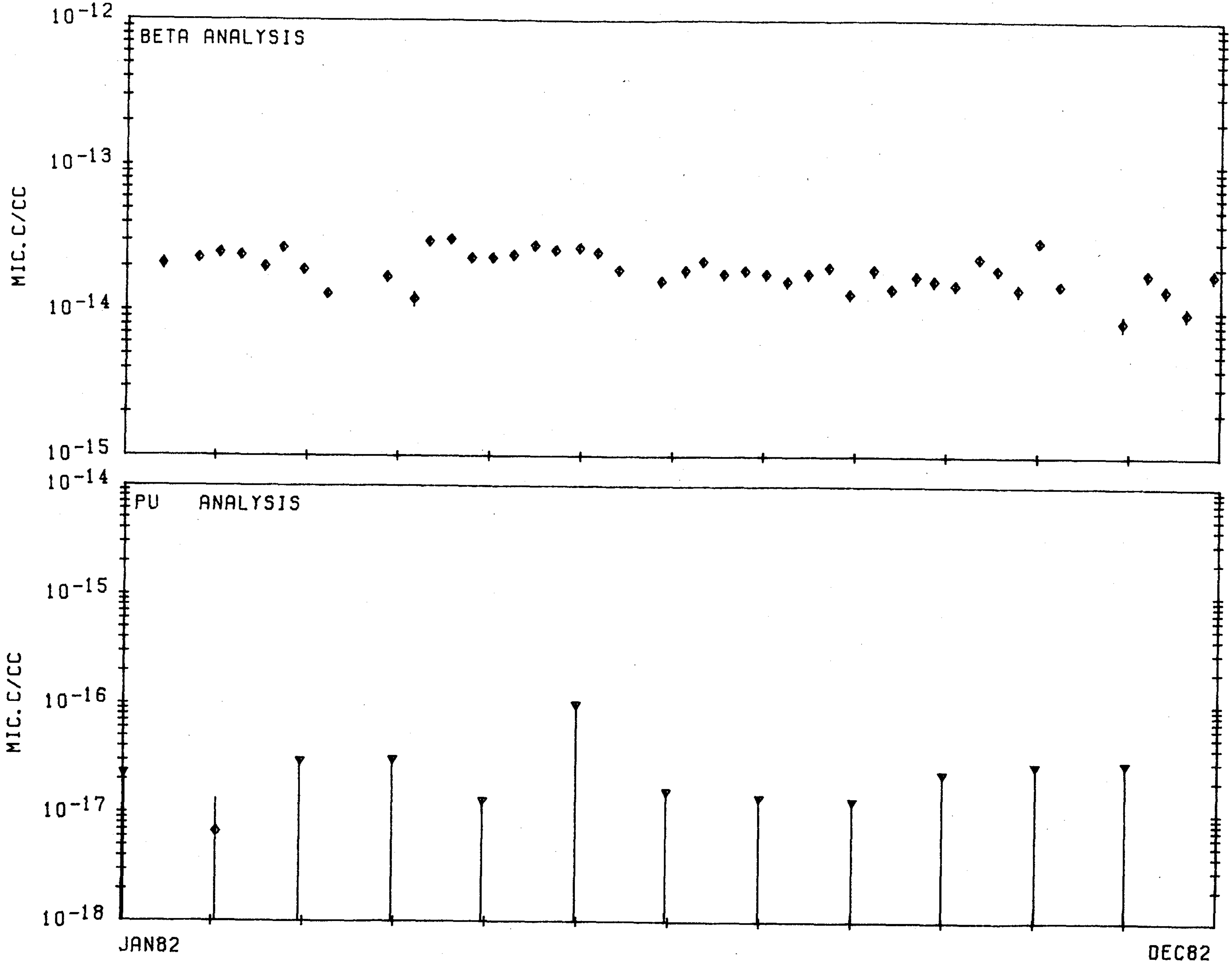
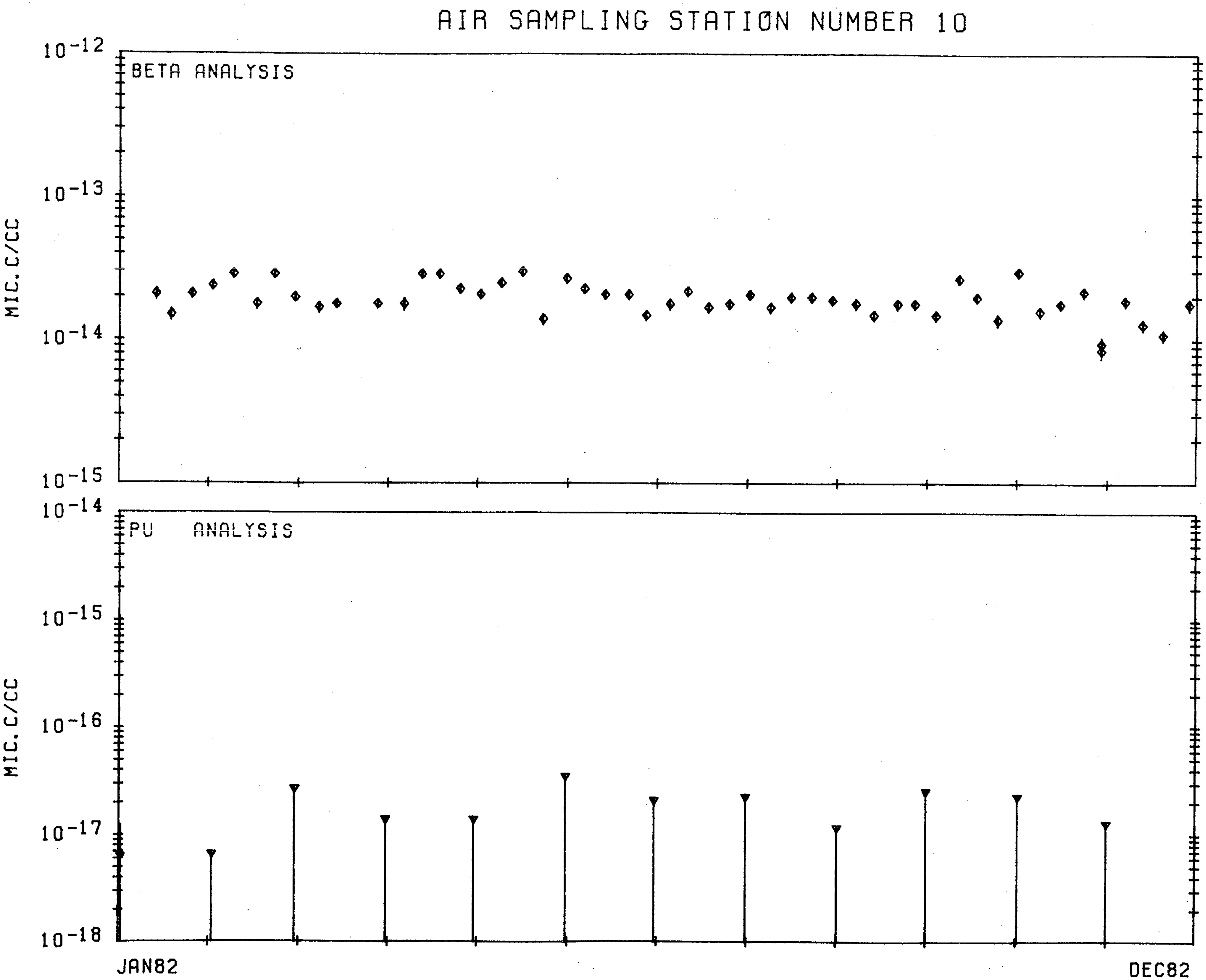
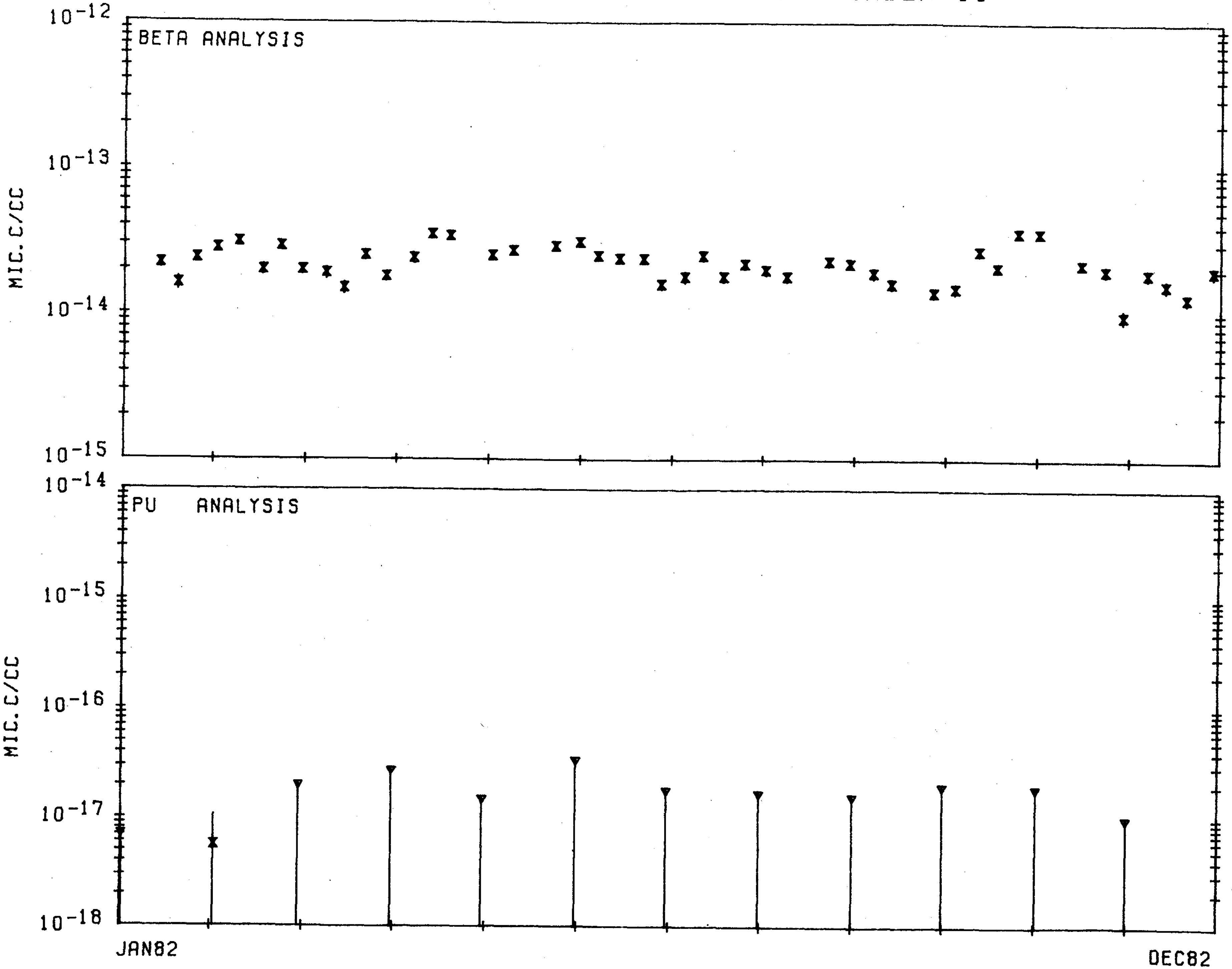
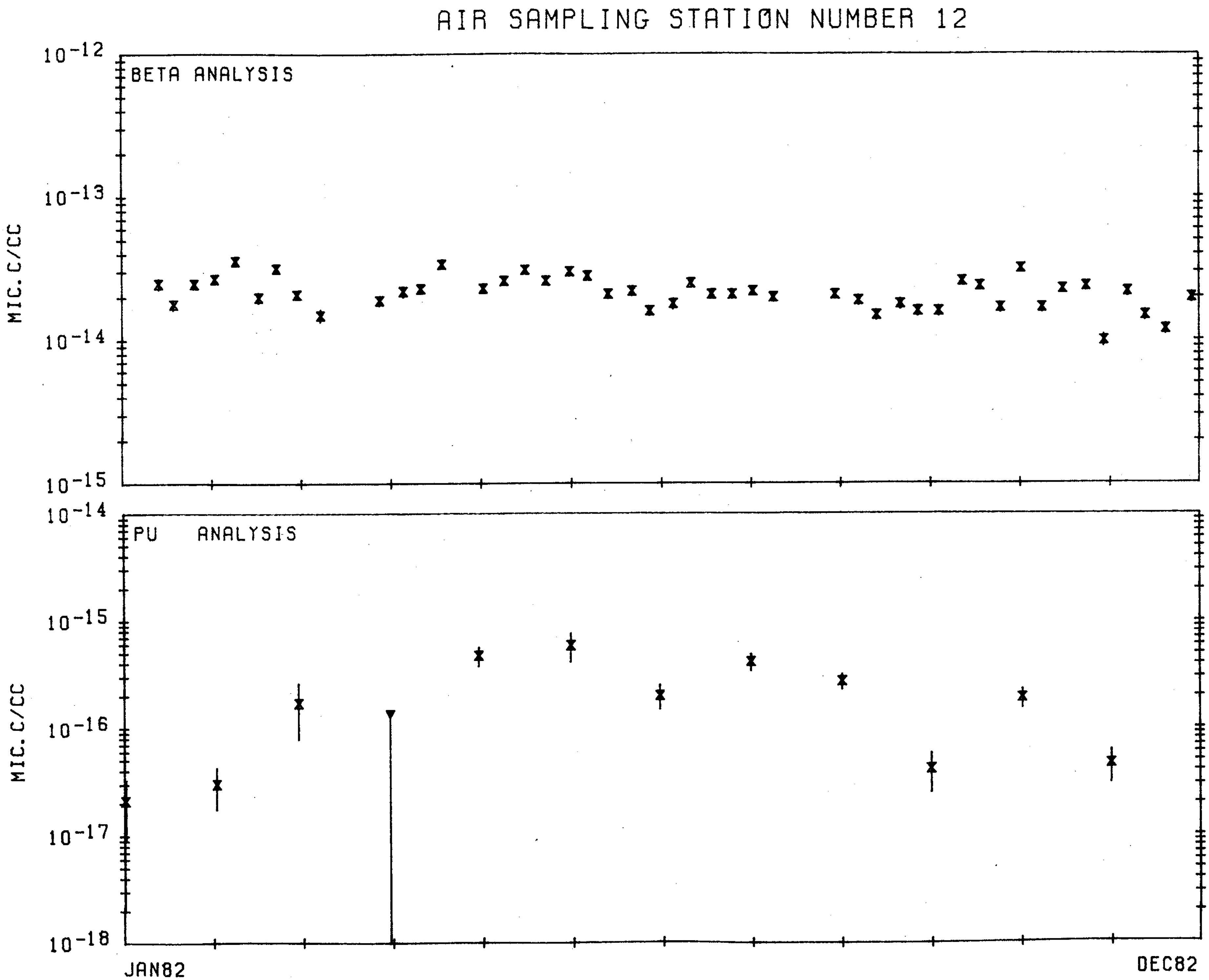




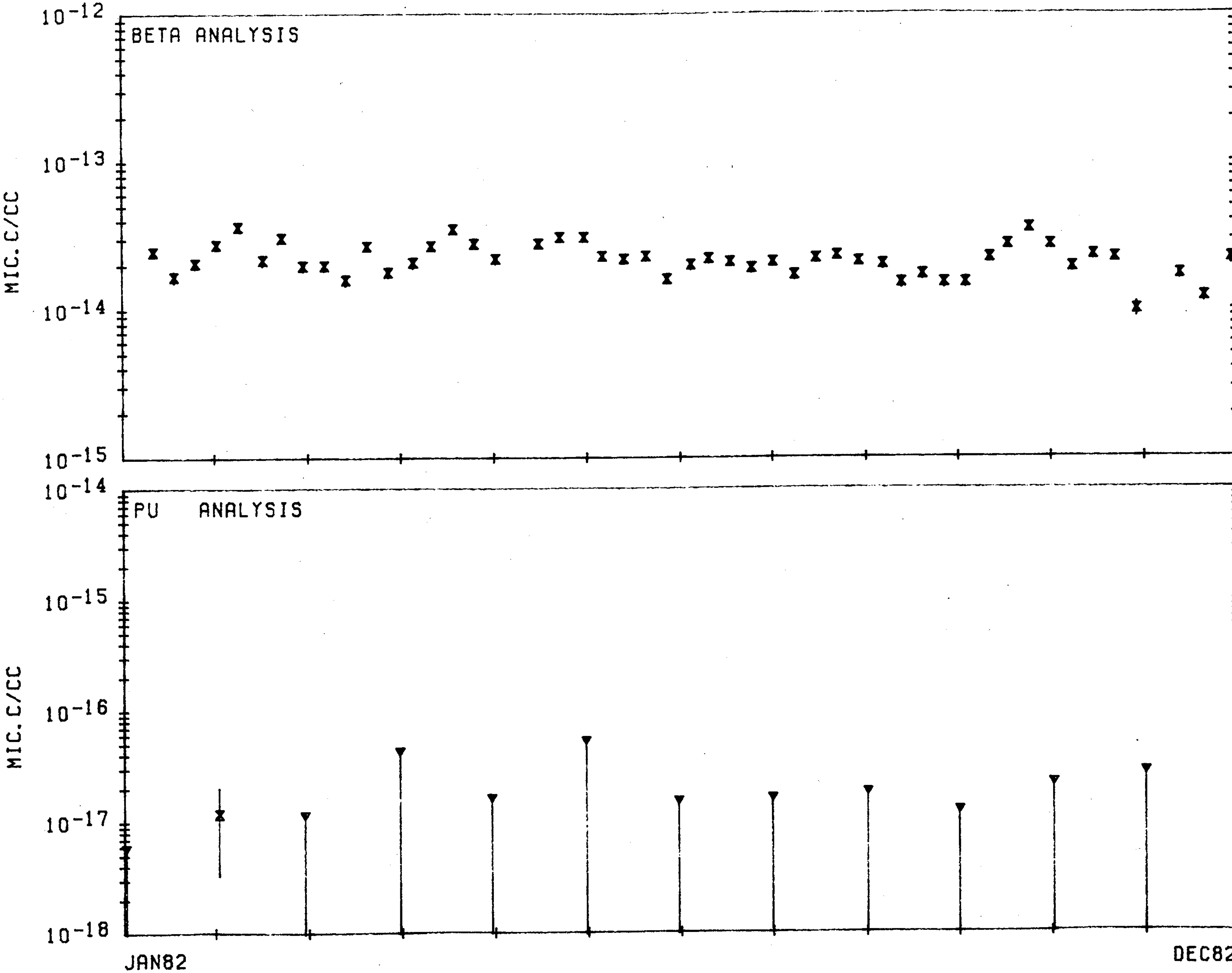
AIR SAMPLING STATION NUMBER 10
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

AIR SAMPLING STATION NUMBER 11

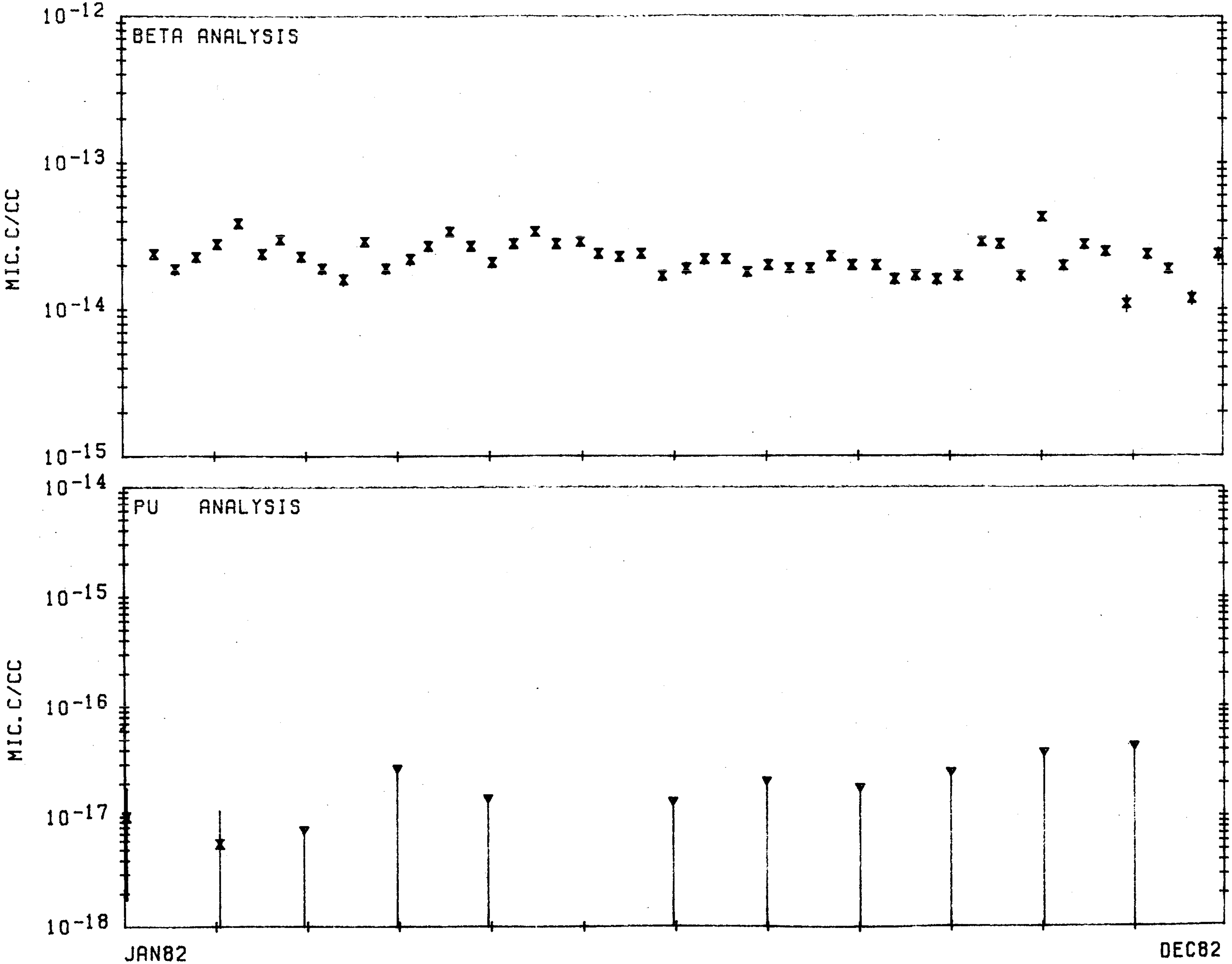



AIR SAMPLING STATION NUMBER 12
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

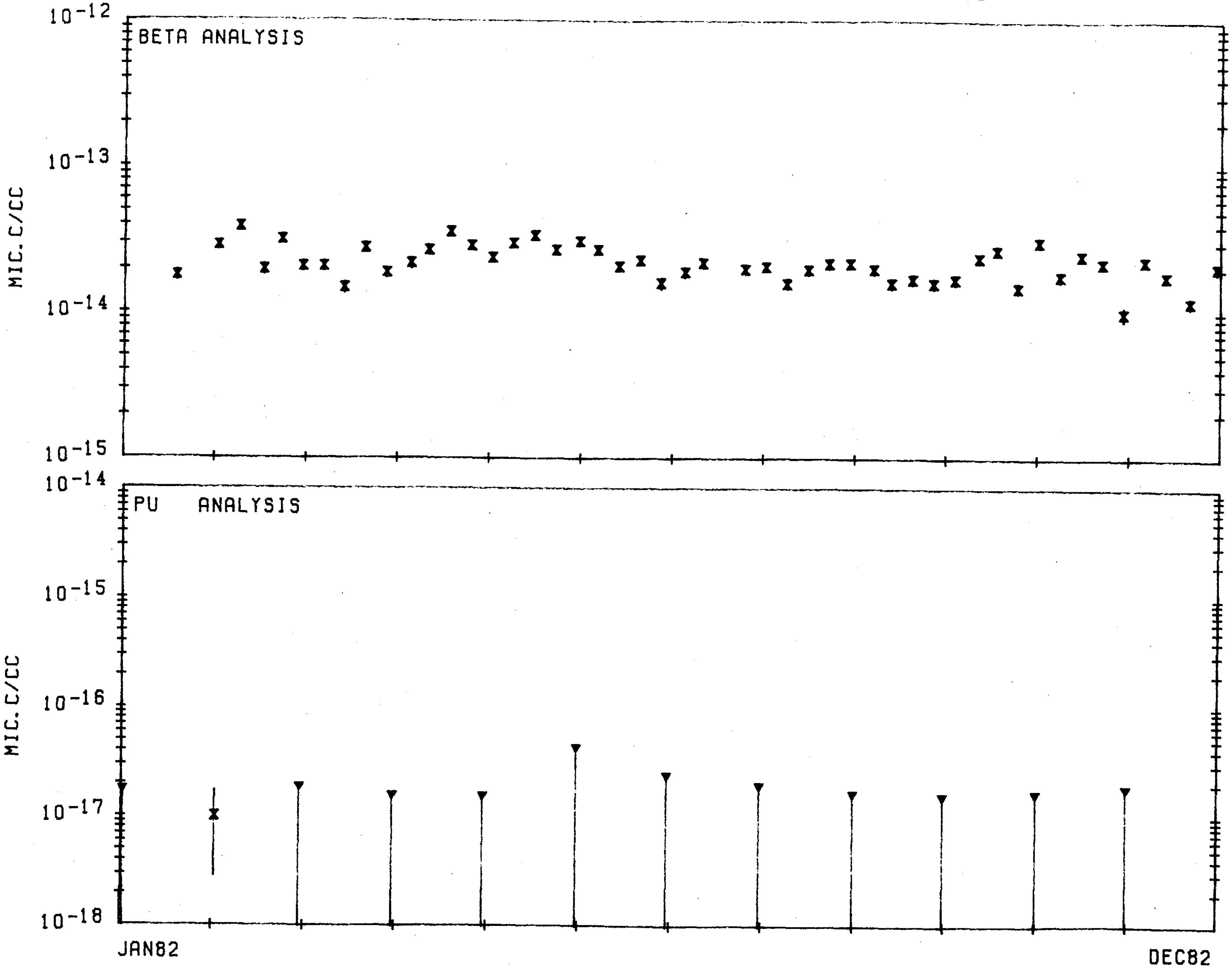
AIR SAMPLING STATION NUMBER 13



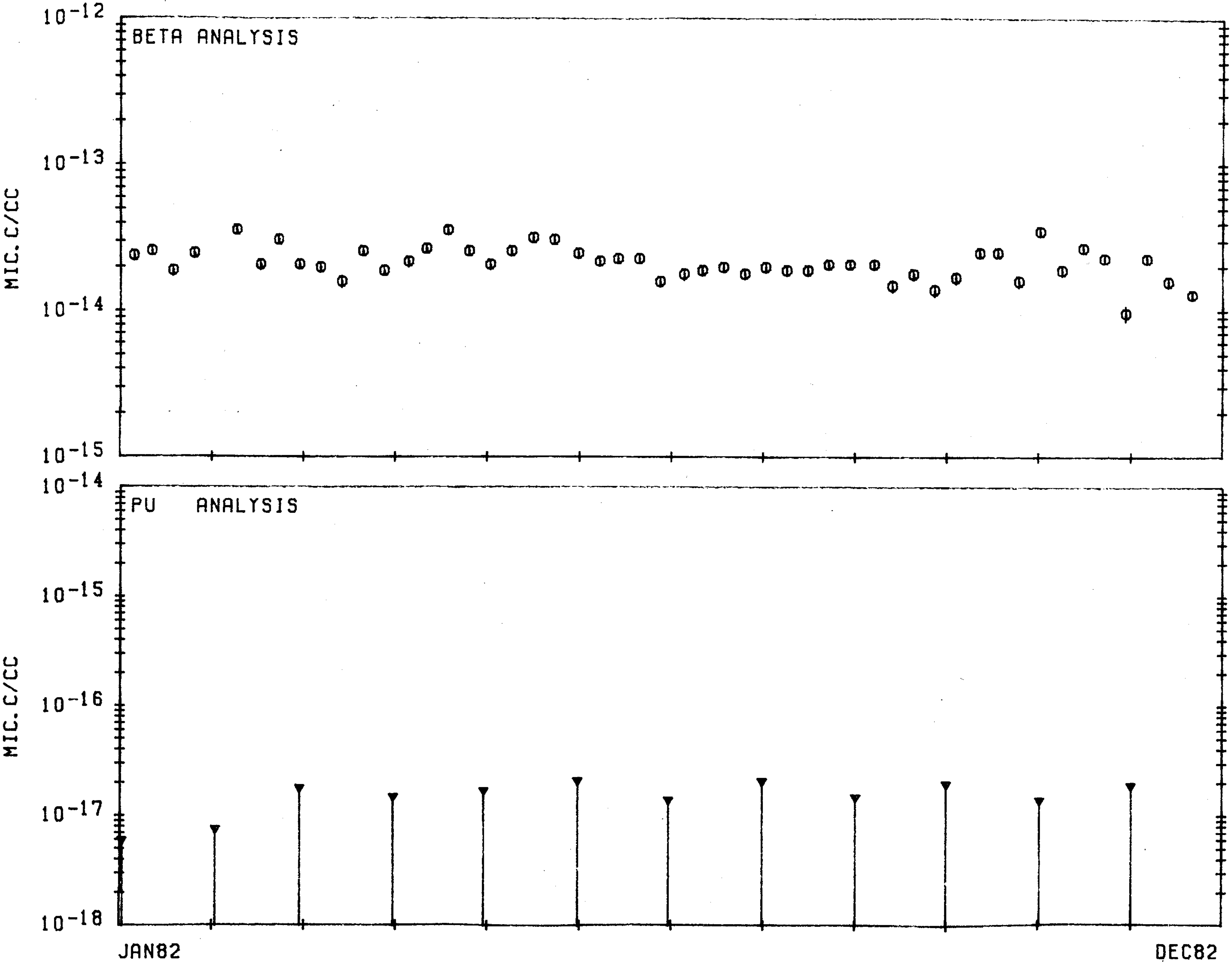
AIR SAMPLING STATION NUMBER 14



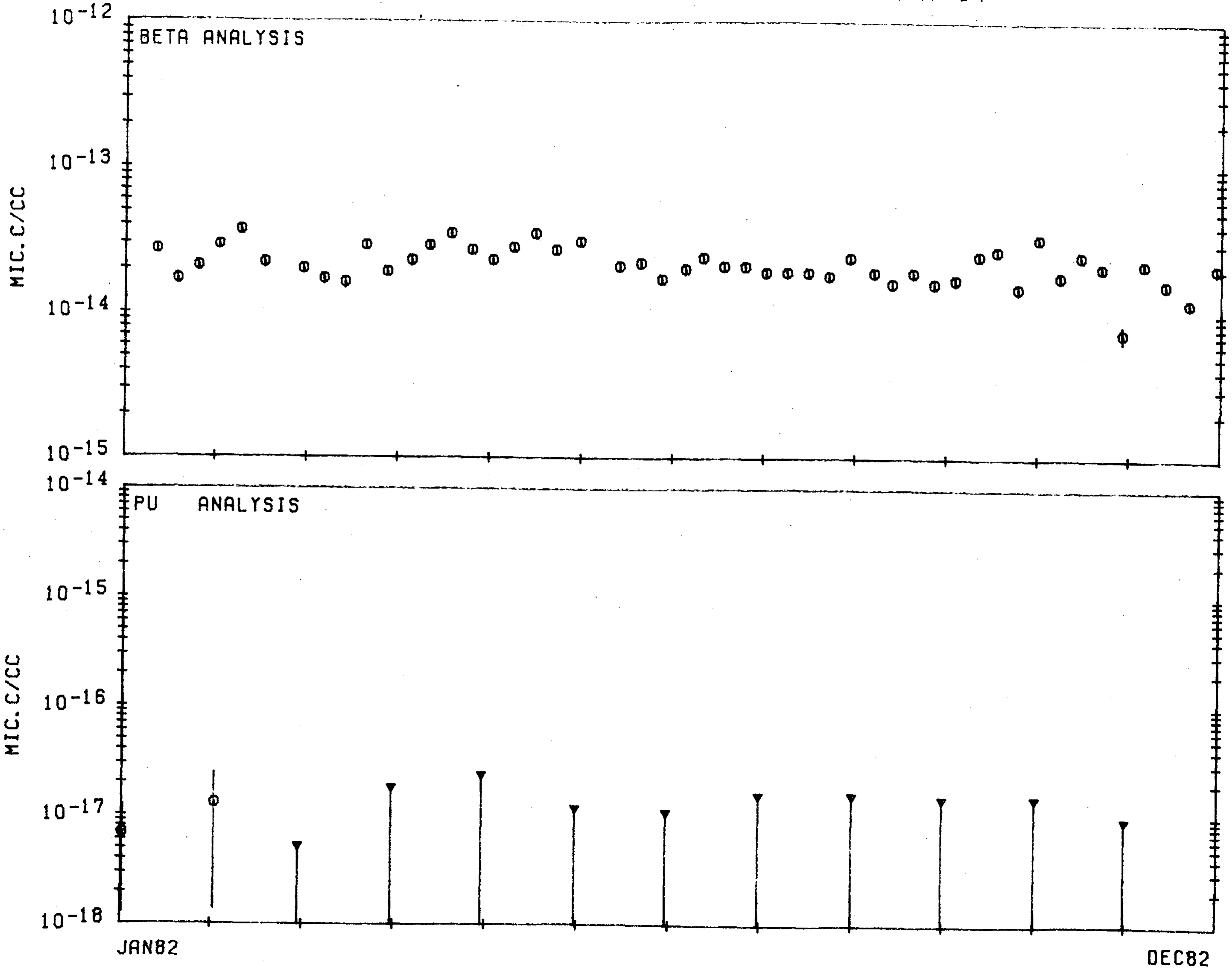
AIR SAMPLING STATION NUMBER 15



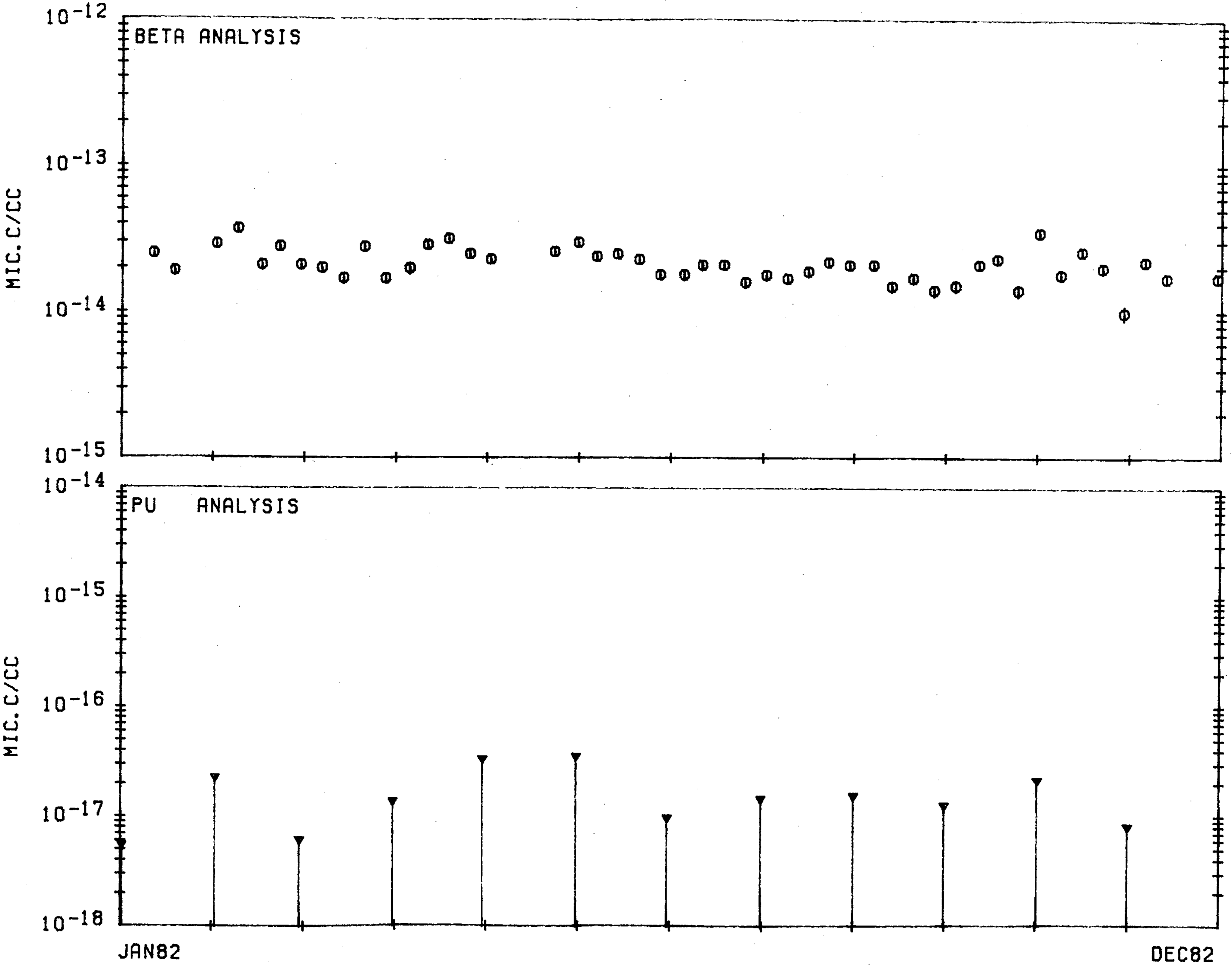
AIR SAMPLING STATION NUMBER 16

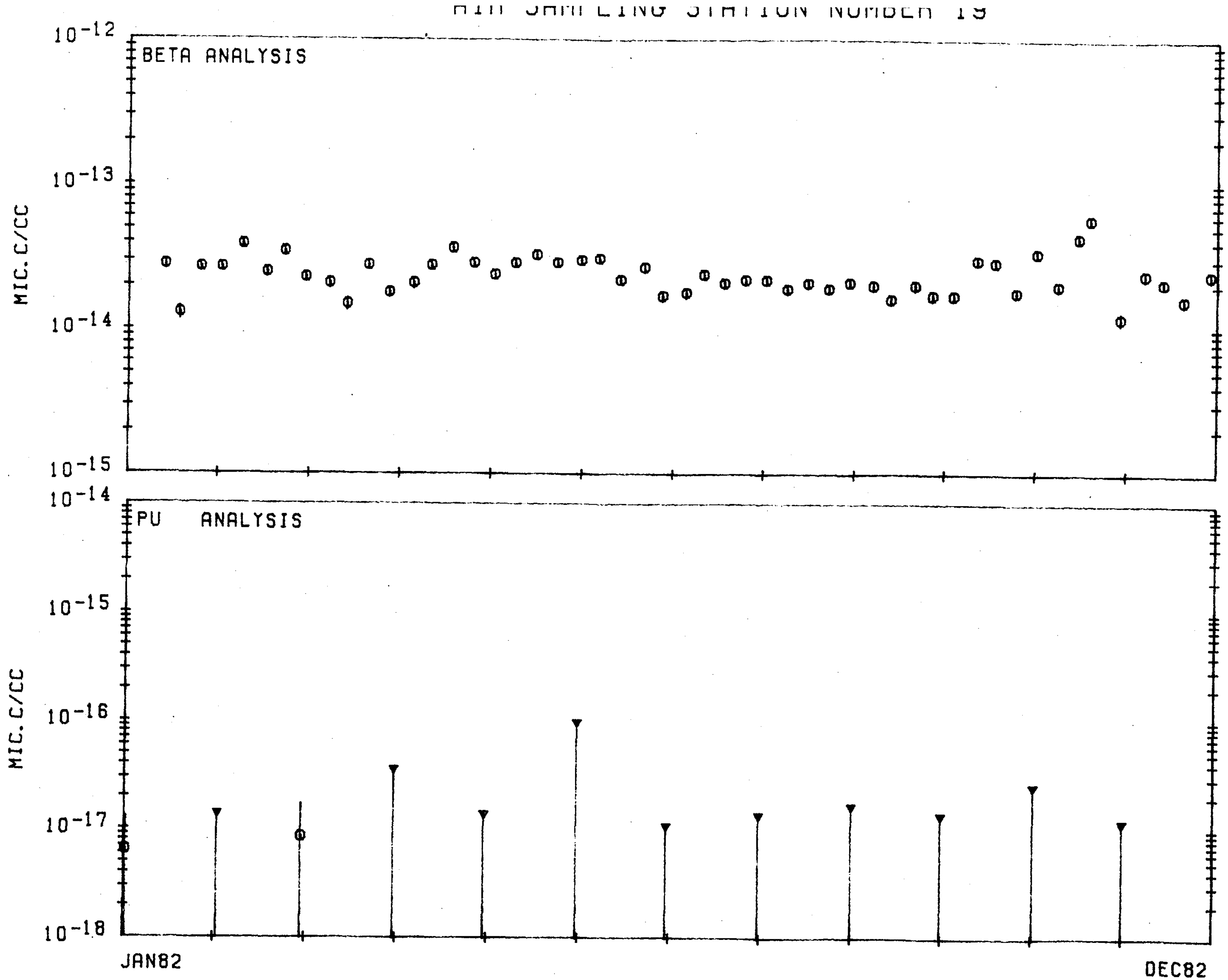


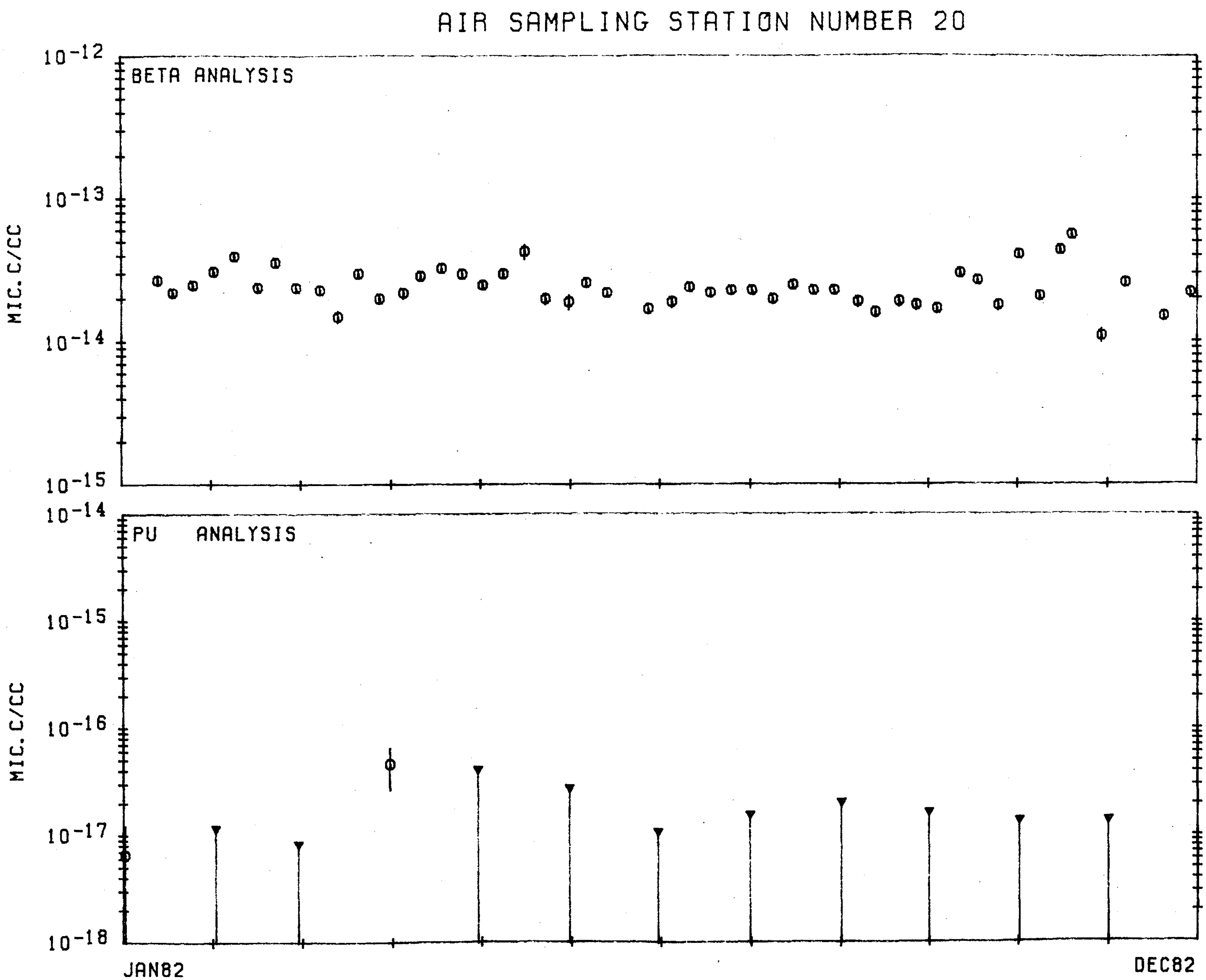
AIR SAMPLING STATION NUMBER 17



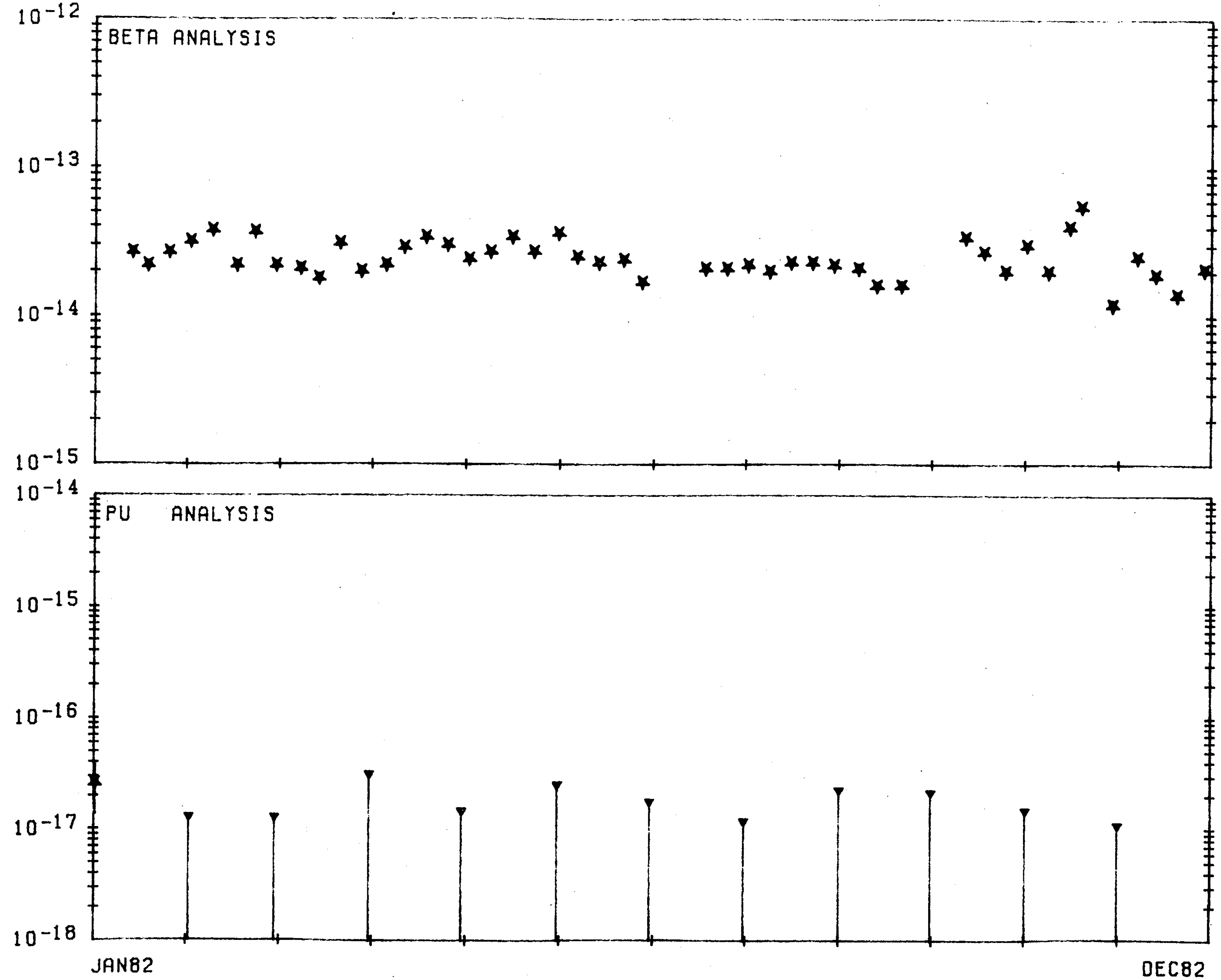
AIR SAMPLING STATION NUMBER 18



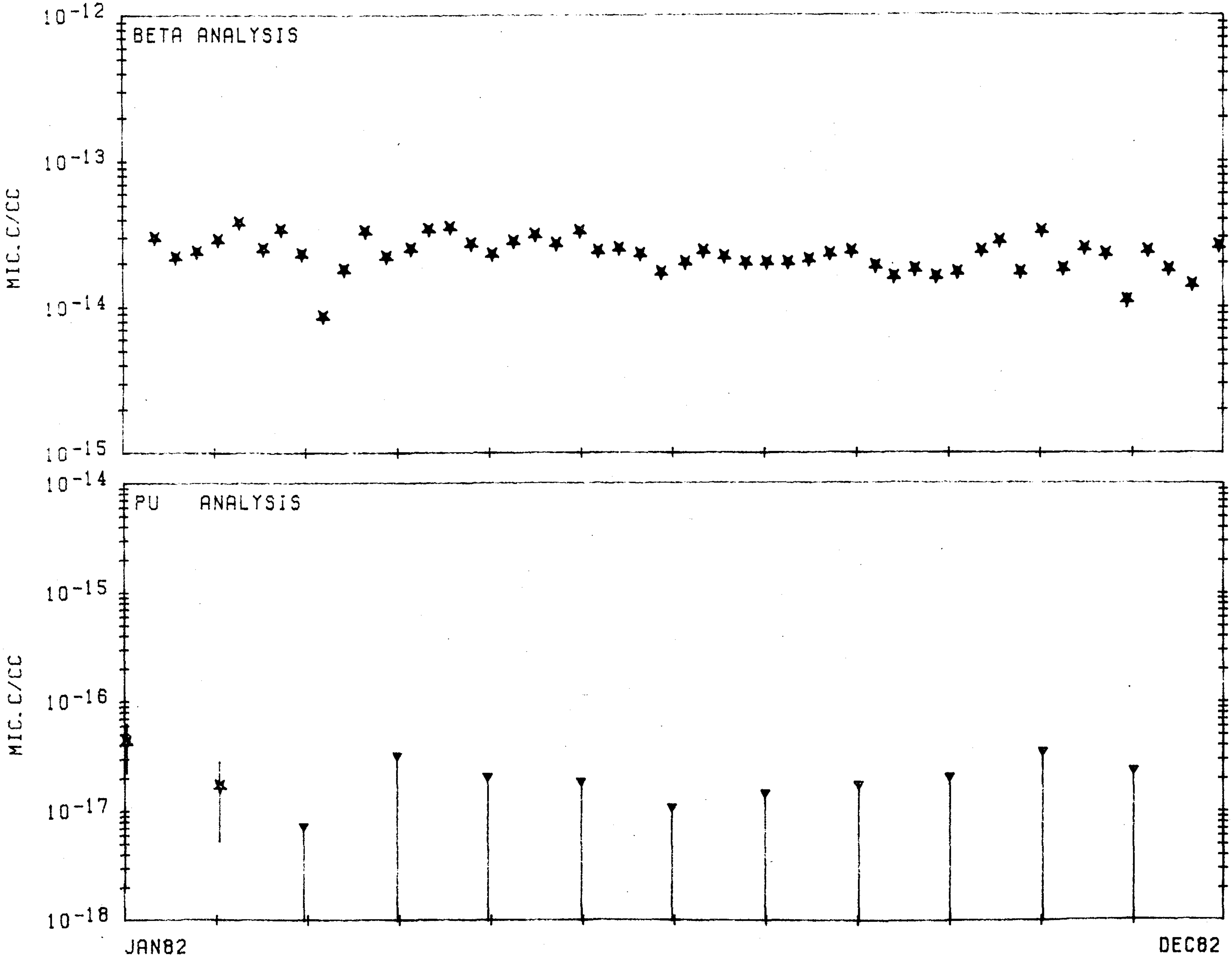

AIR SAMPLING STATION NUMBER 19
BETA ANALYSIS
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
PU ANALYSIS
MIC.C/CC
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82


AIR SAMPLING STATION NUMBER 20
BETA ANALYSIS
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
PU ANALYSIS
MIC.C/CC
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

AIR SAMPLING STATION NUMBER 21



AIR SAMPLING STATION NUMBER 22



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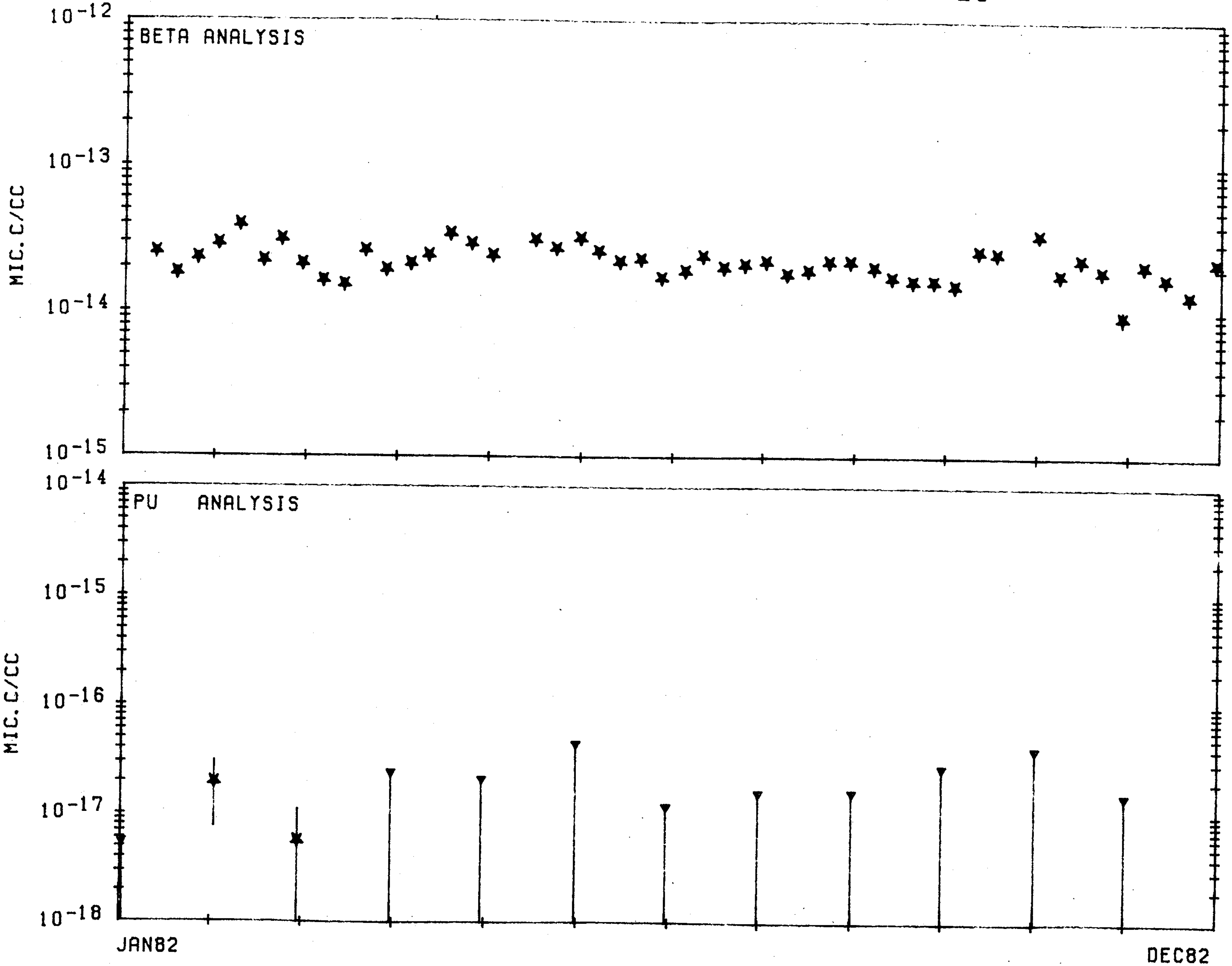

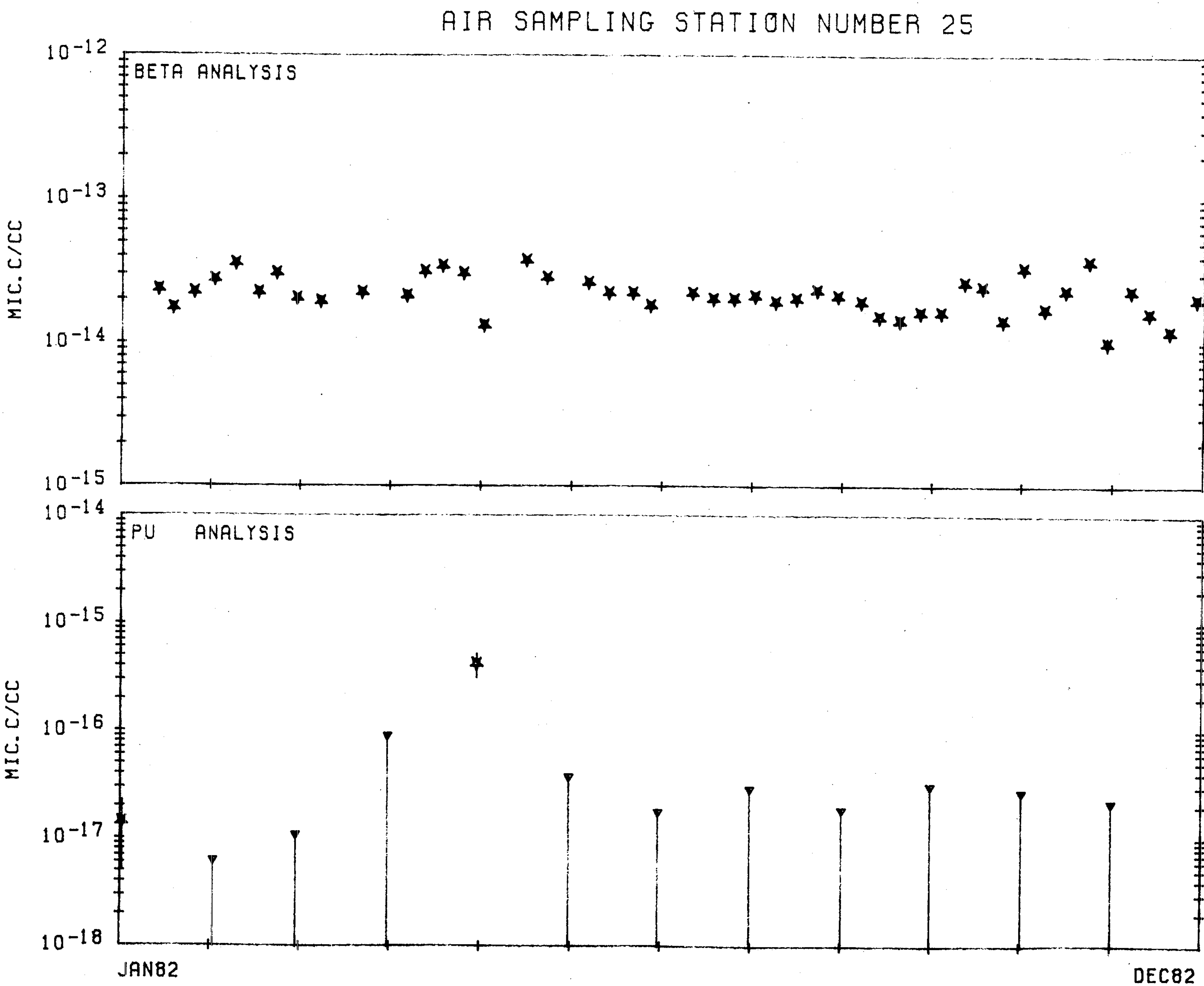
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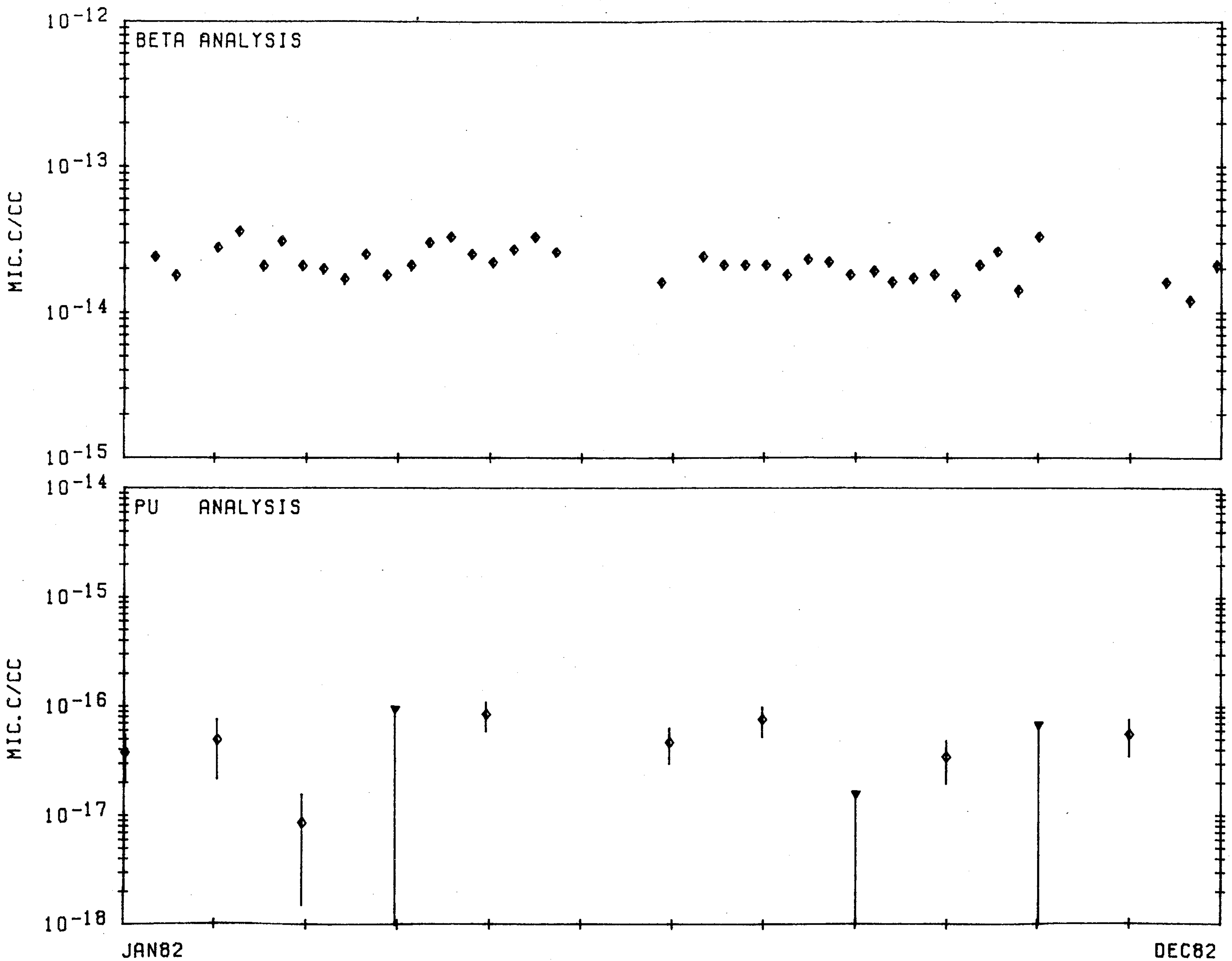
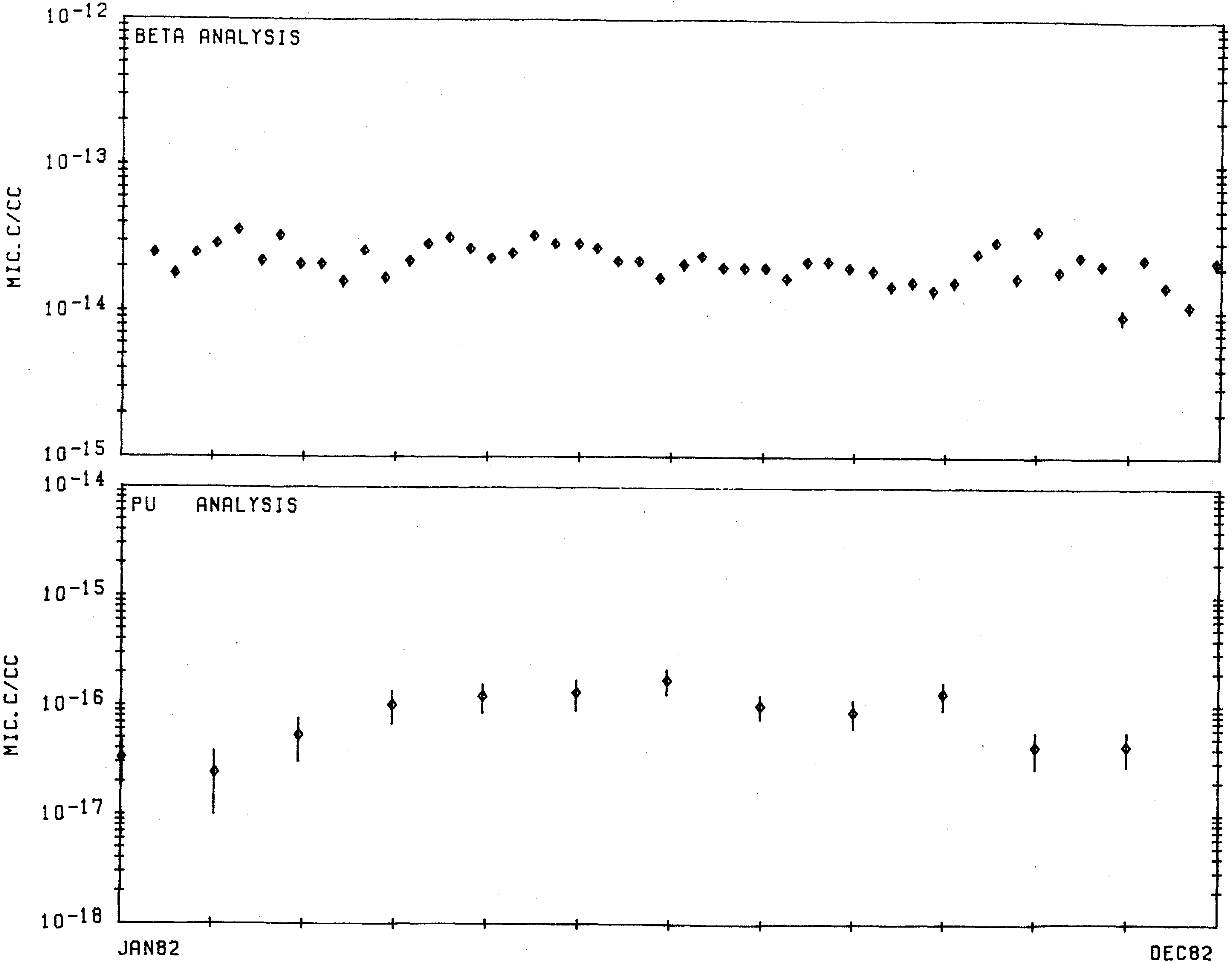
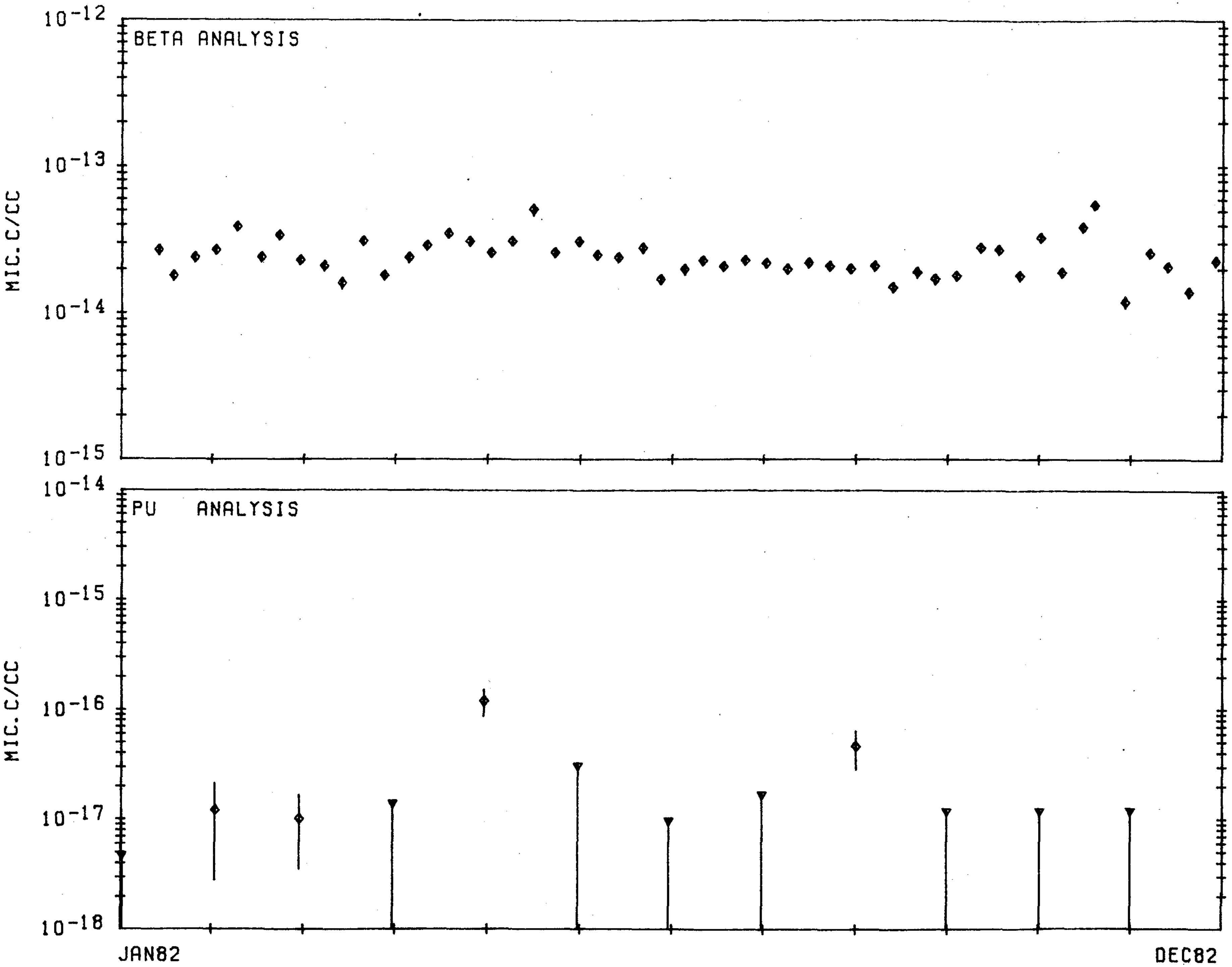
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82



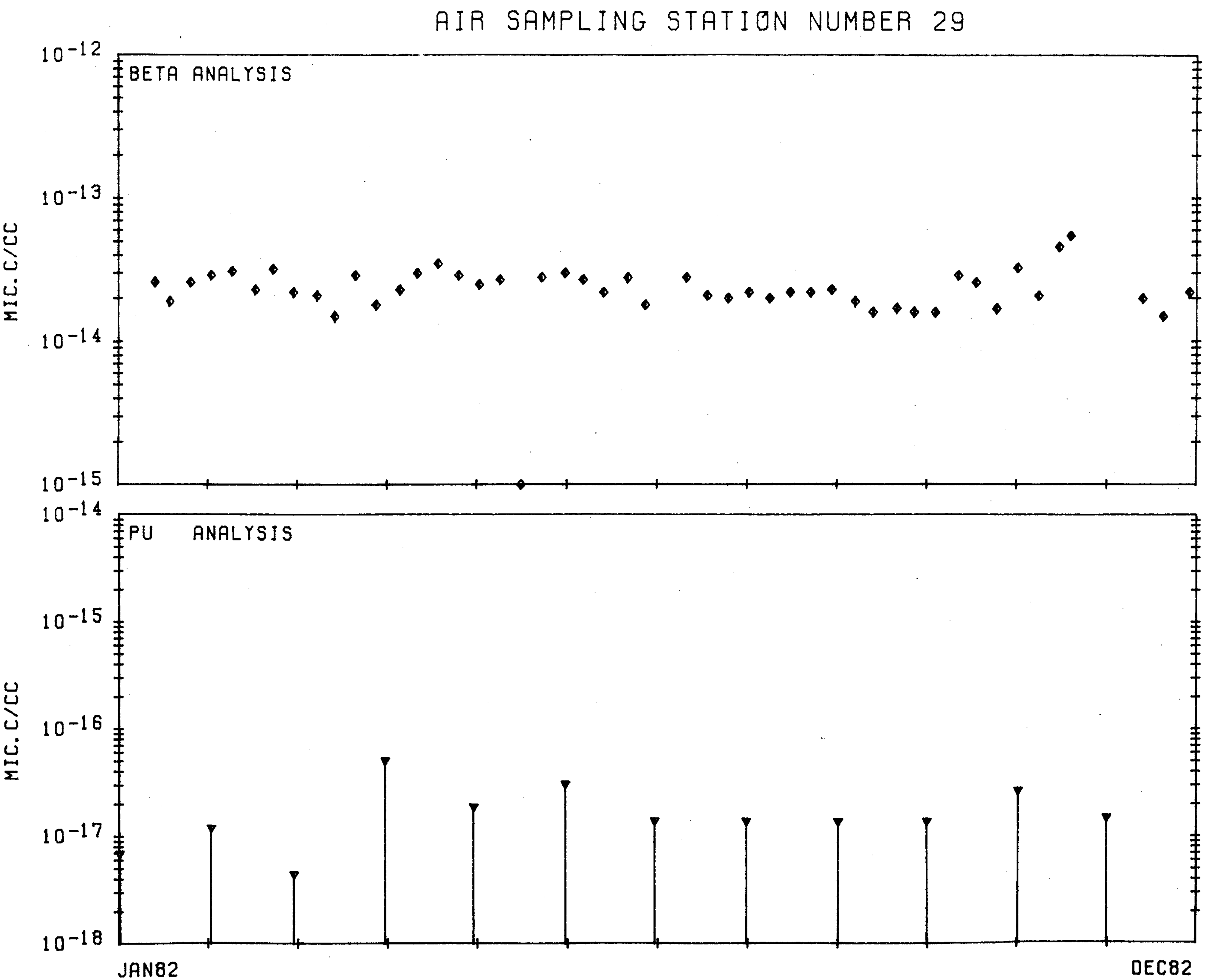
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

AIR SAMPLING STATION NUMBER 27

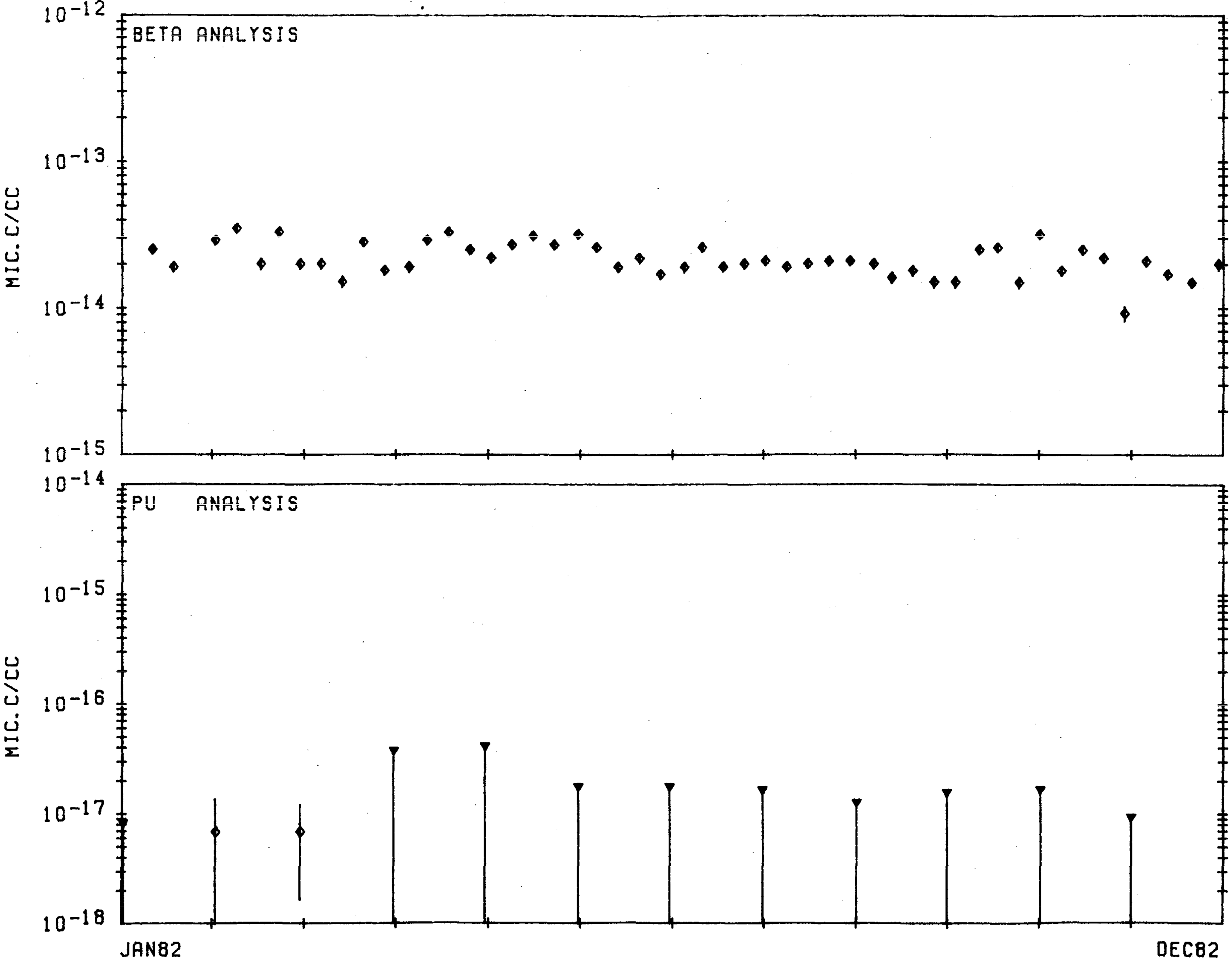




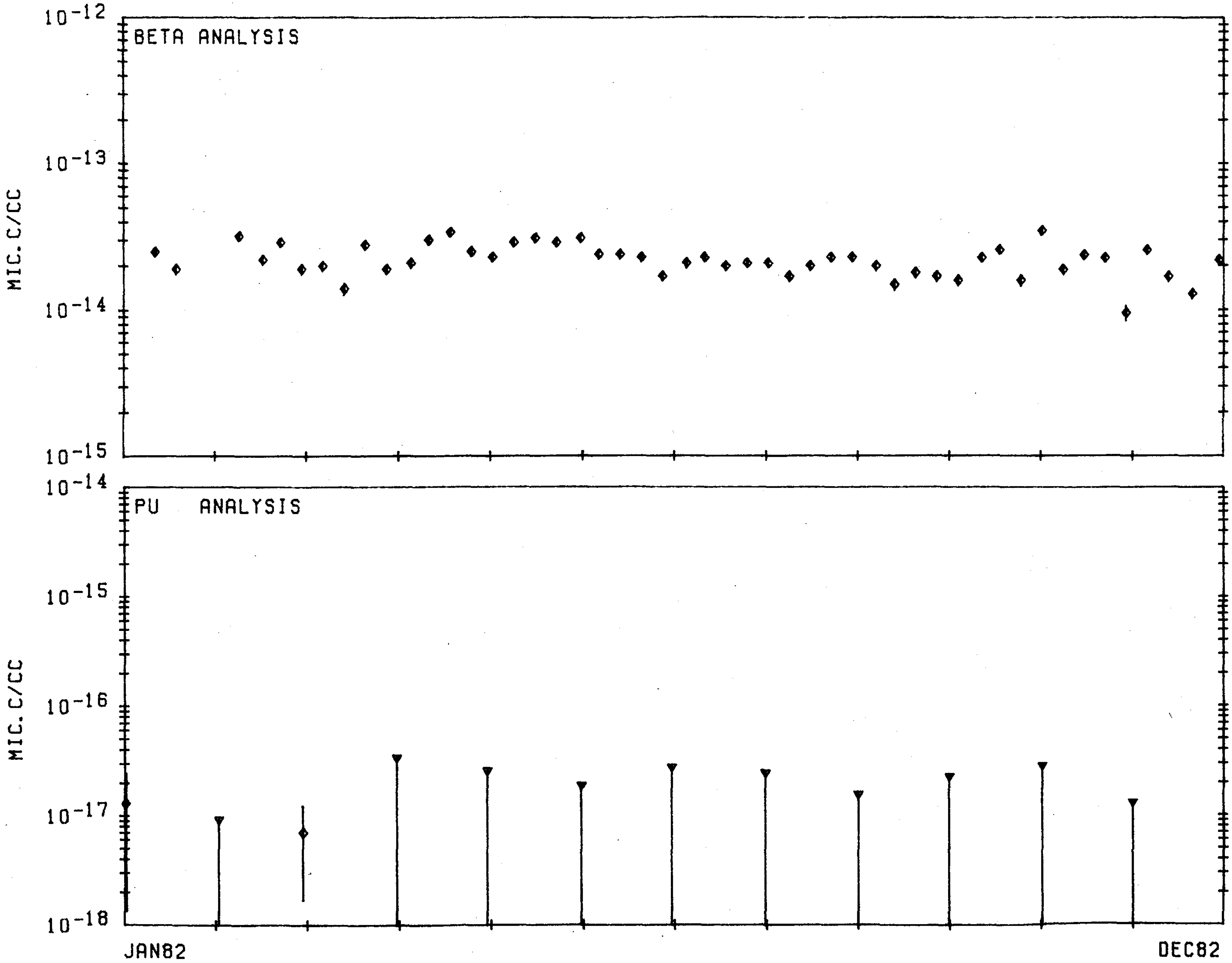
BETA ANALYSIS
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
PU ANALYSIS
MIC.C/CC
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

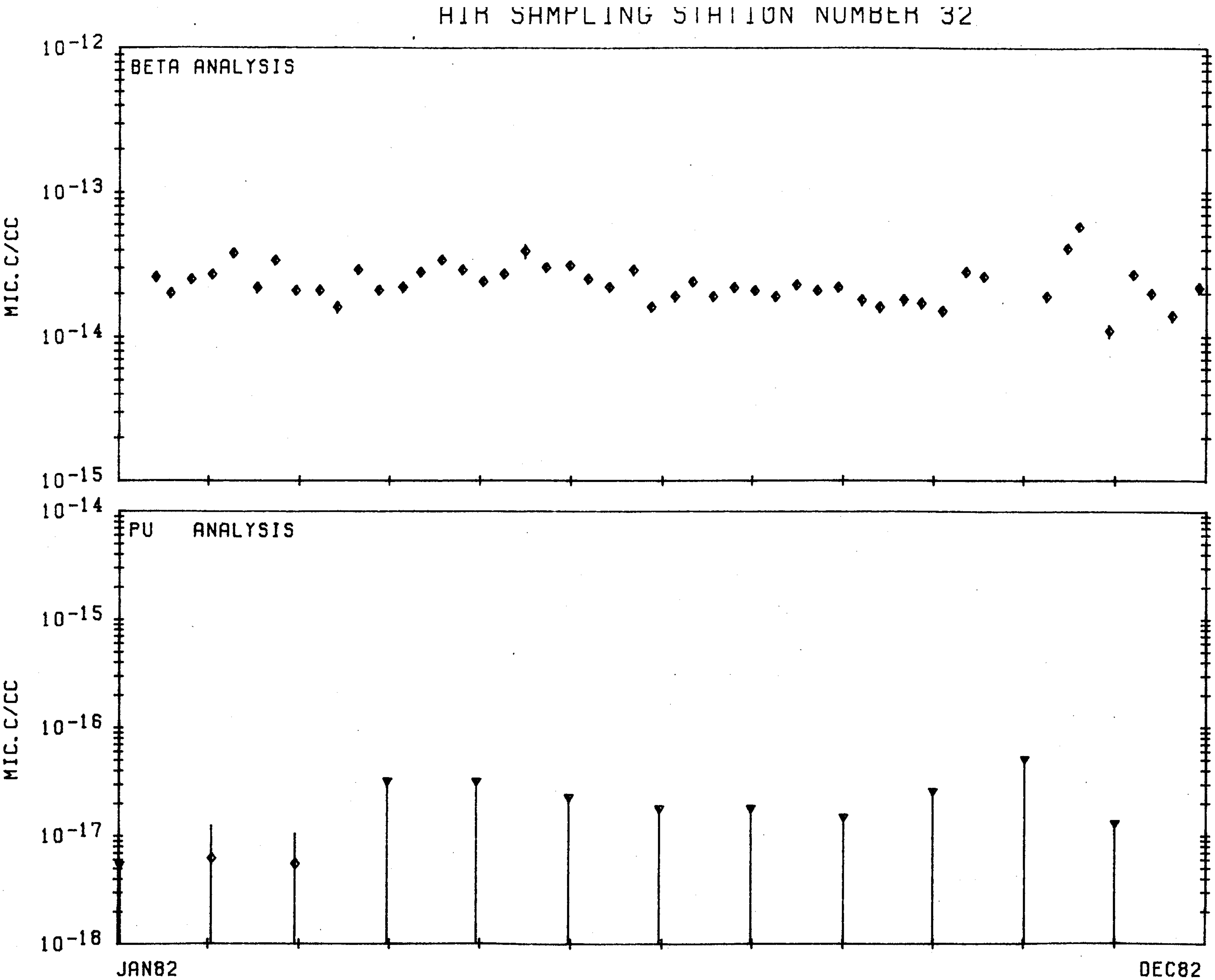

AIR SAMPLING STATION NUMBER 29
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

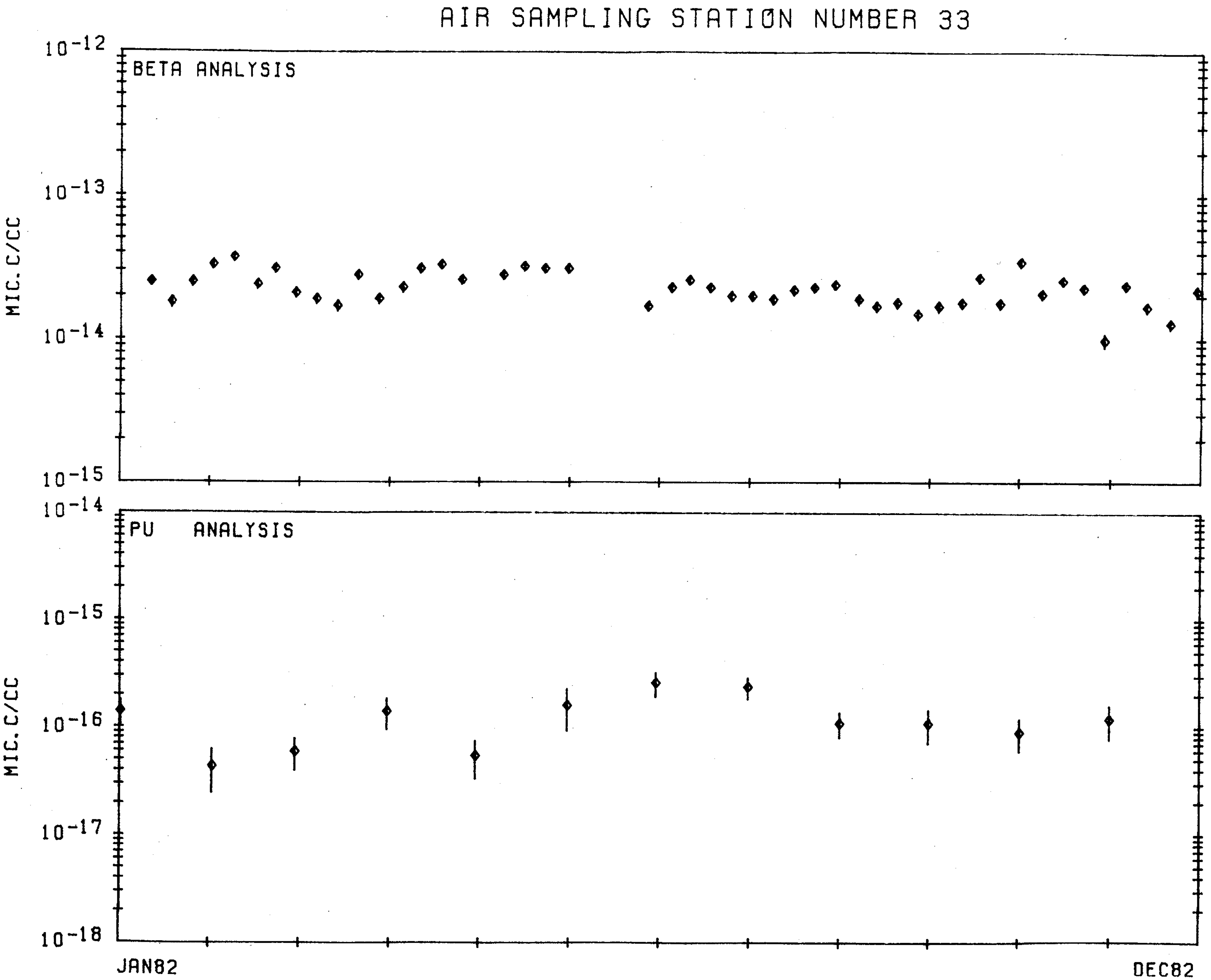
AIR SAMPLING STATION NUMBER



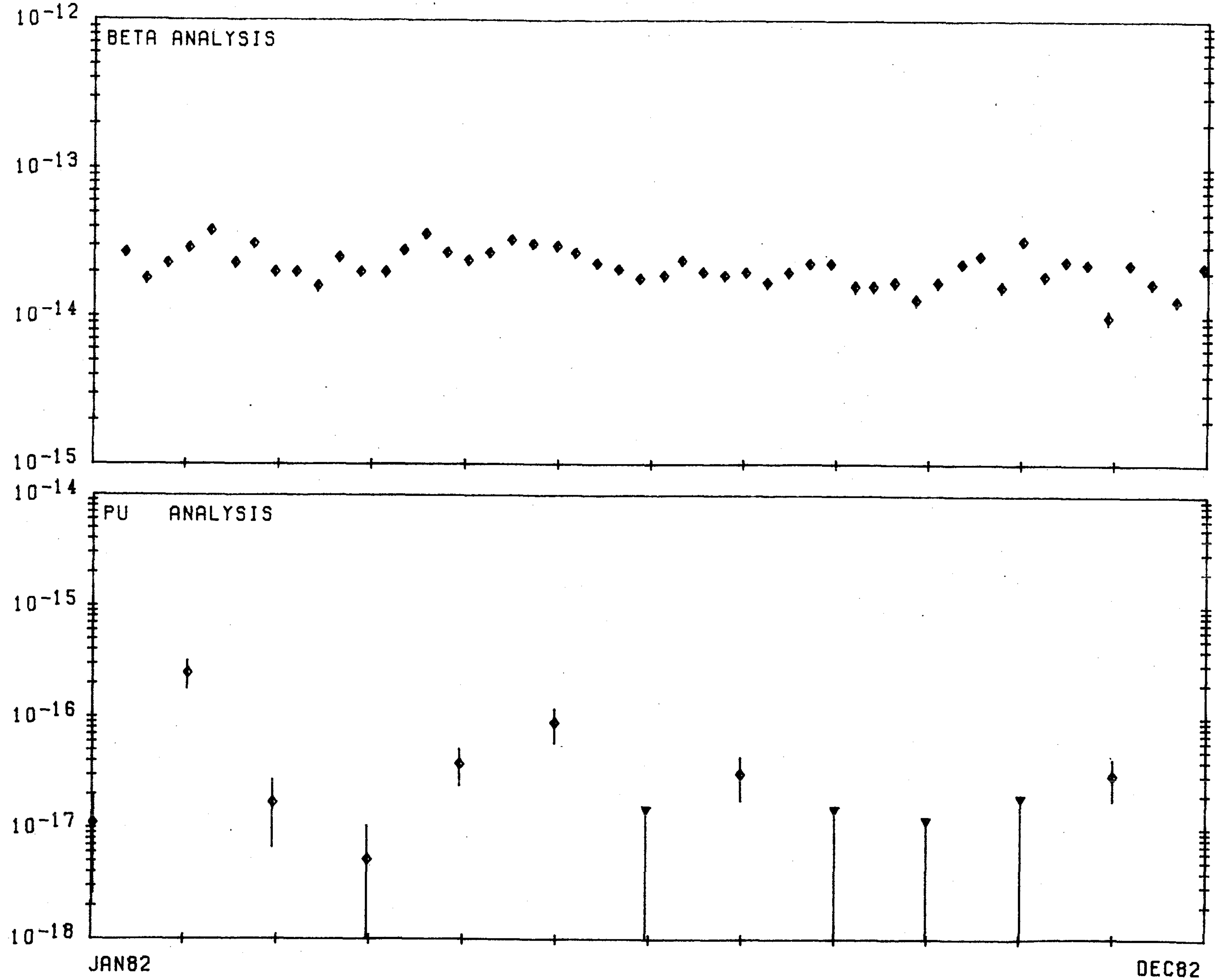
AIR SAMPLING STATION NUMBER 31



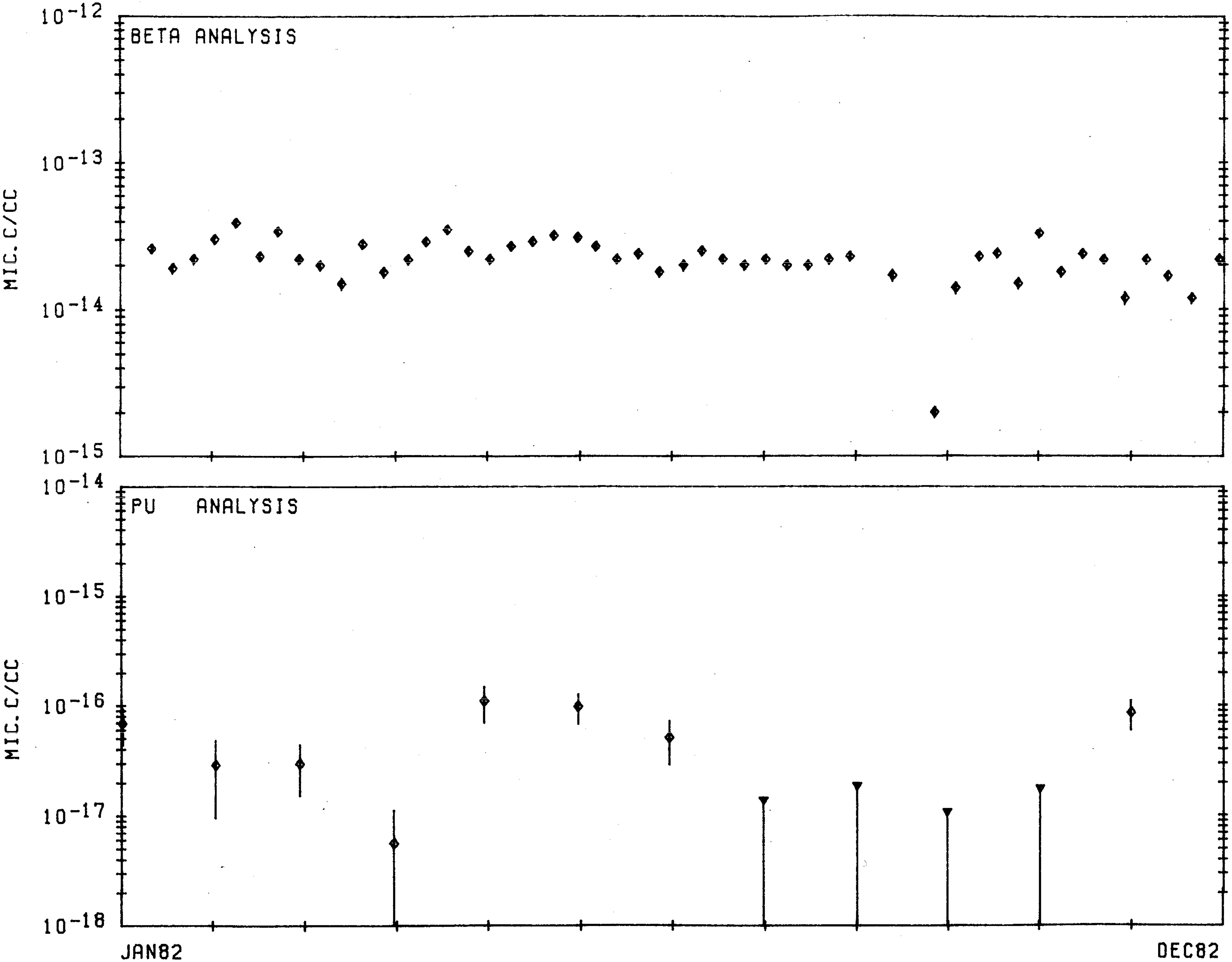

AIR SAMPLING STATION NUMBER 32
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82


AIR SAMPLING STATION NUMBER 33
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

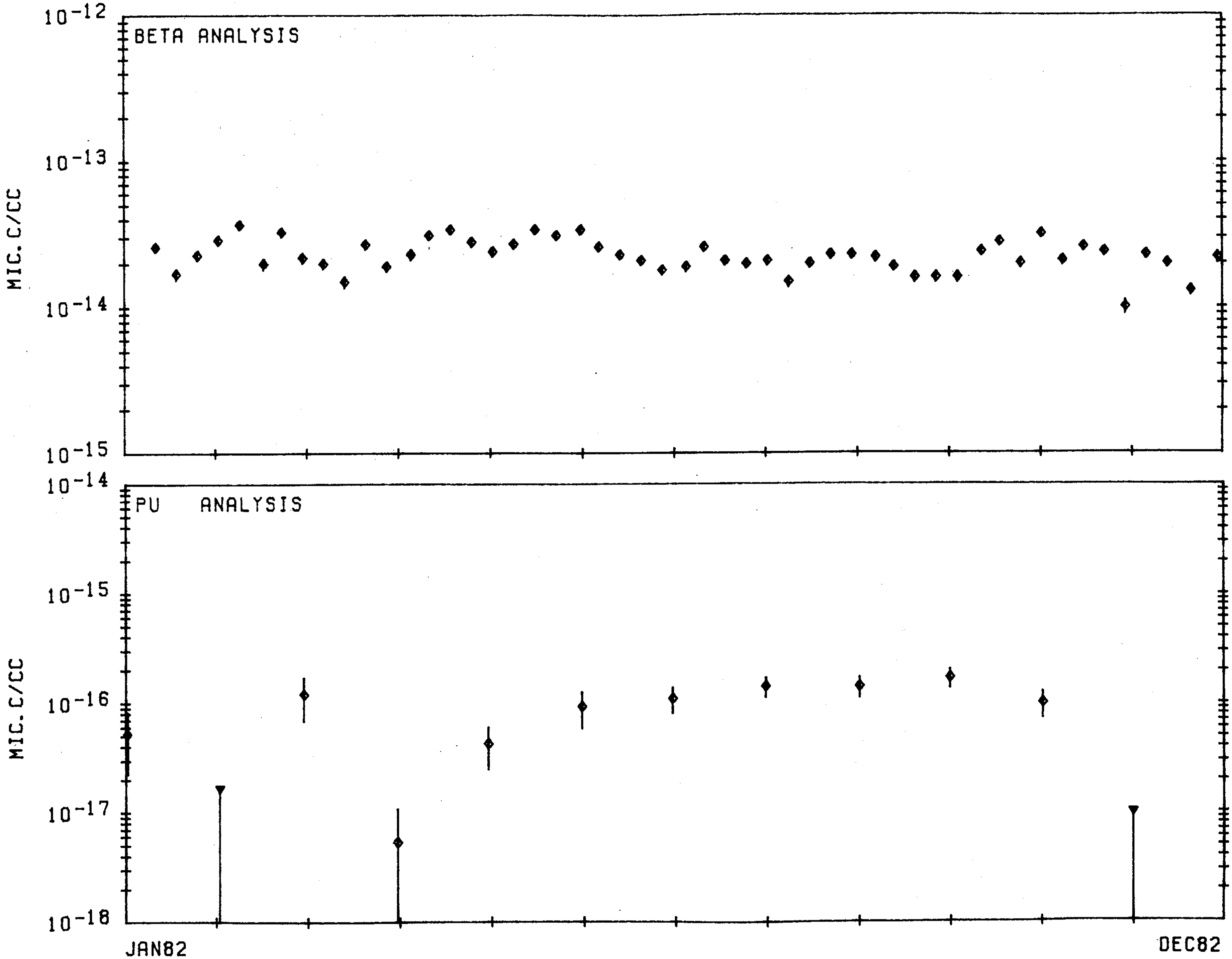
AIR SAMPLING STATION NUMBER 34

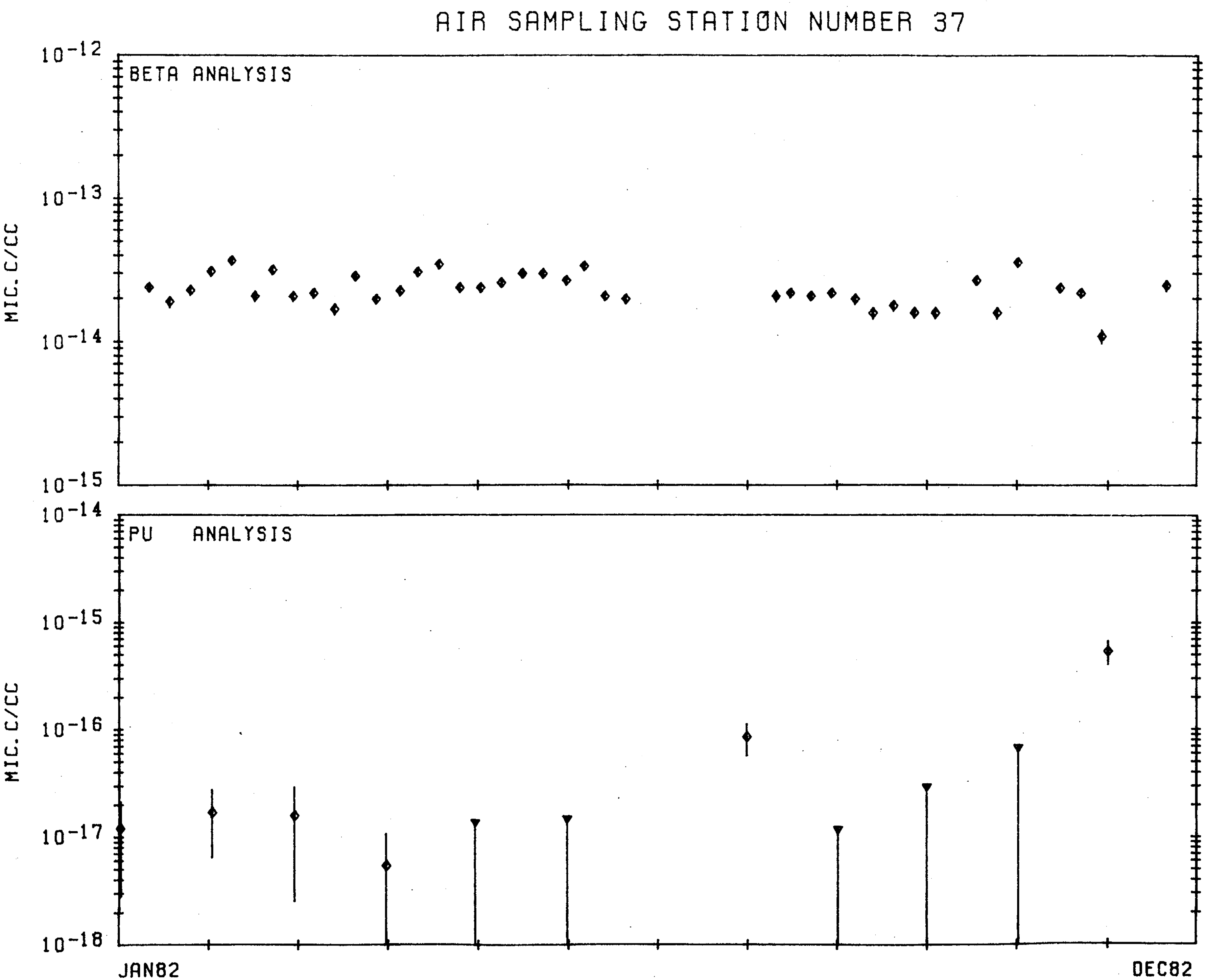


AIR SAMPLING STATION NUMBER 35

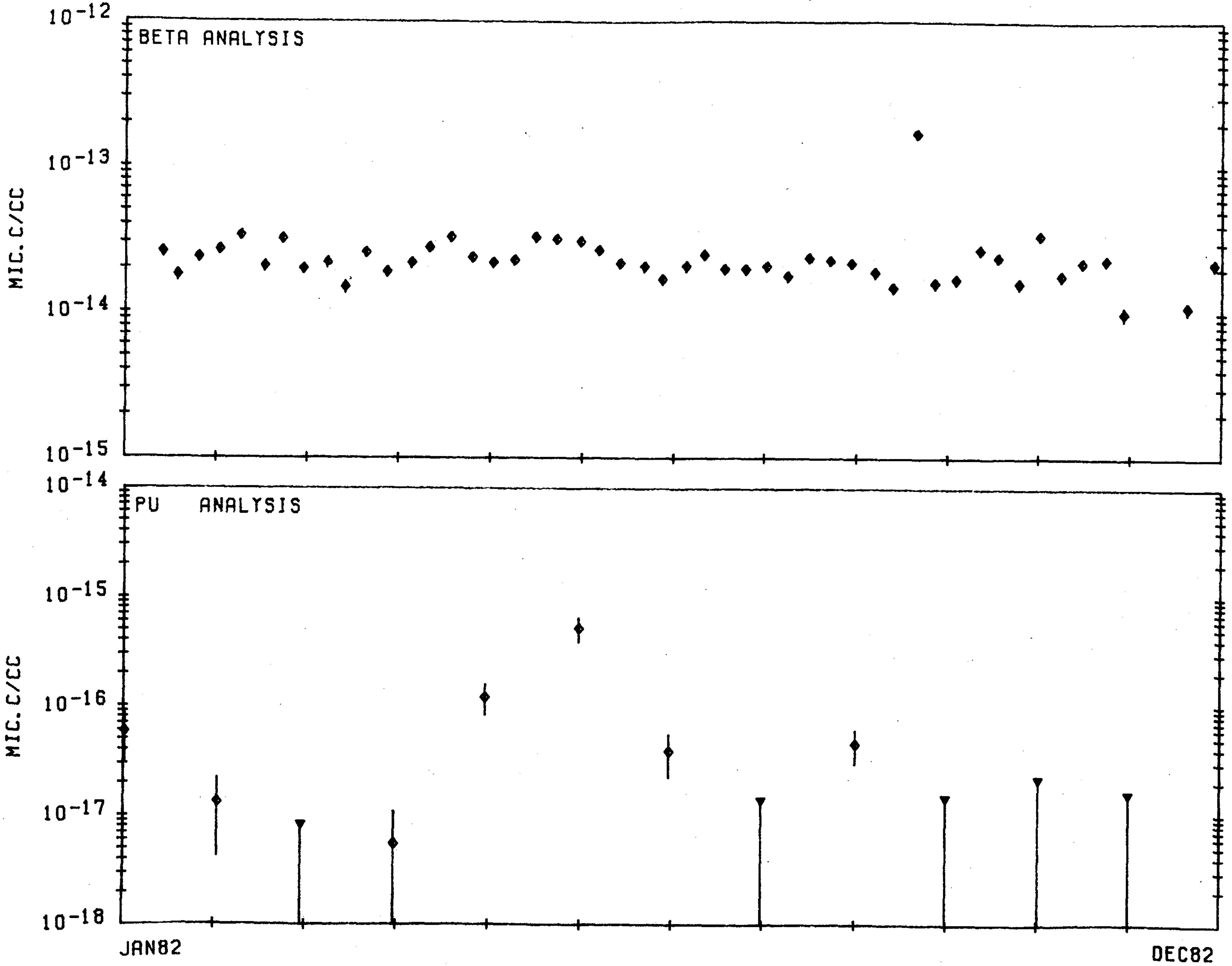


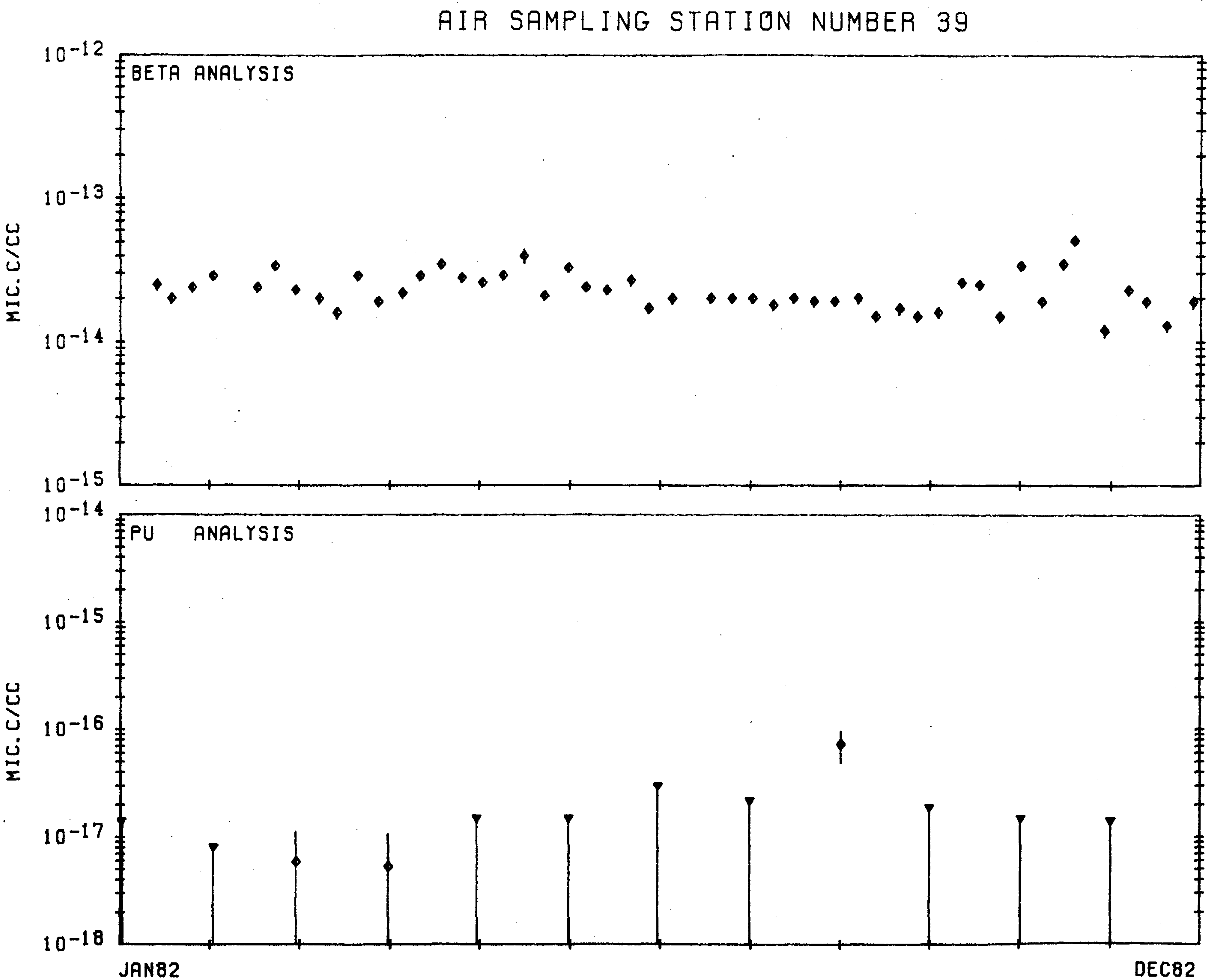
AIR SAMPLING STATION NUMBER 36




AIR SAMPLING STATION NUMBER 37
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

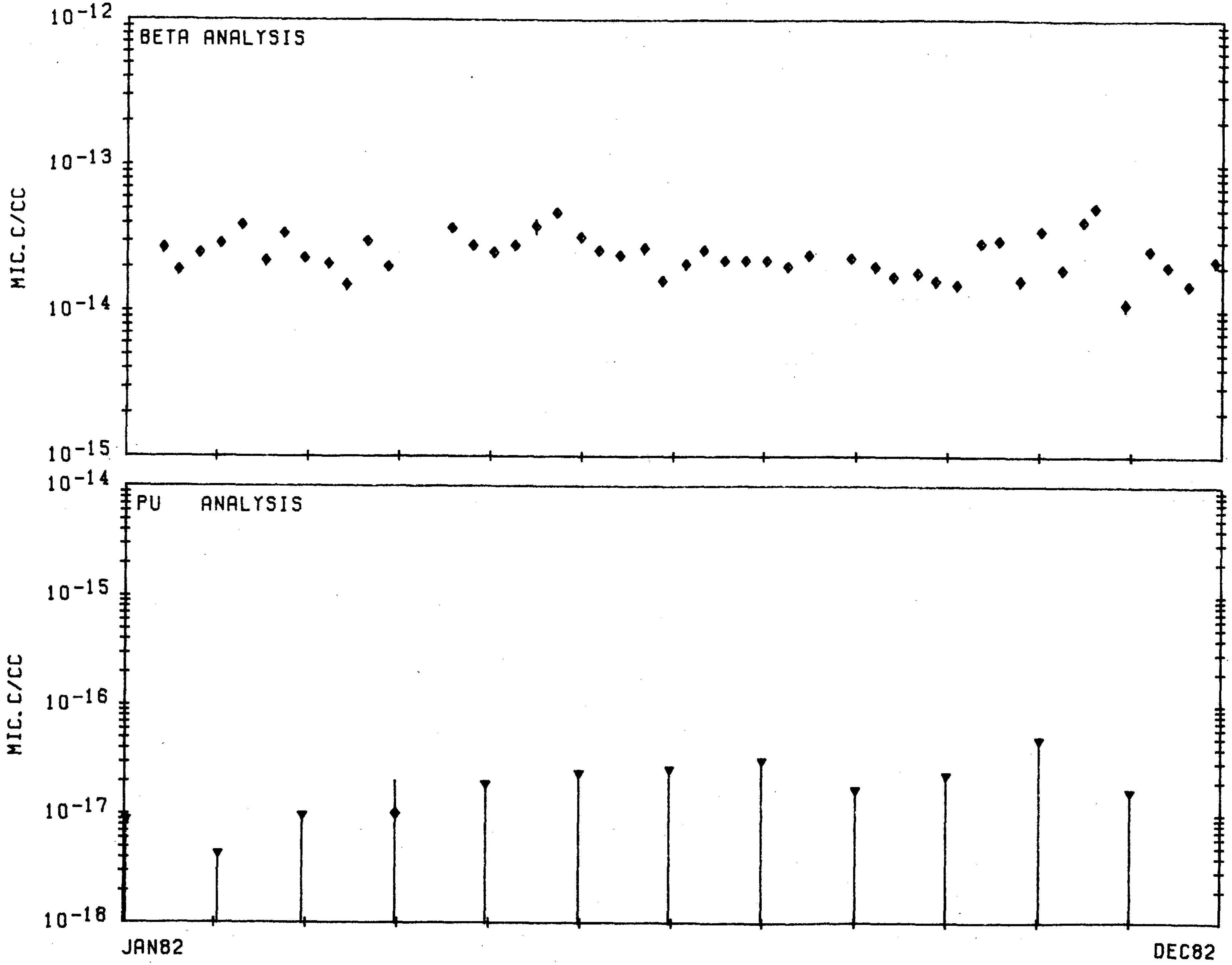
AIR SAMPLING STATION NUMBER 38



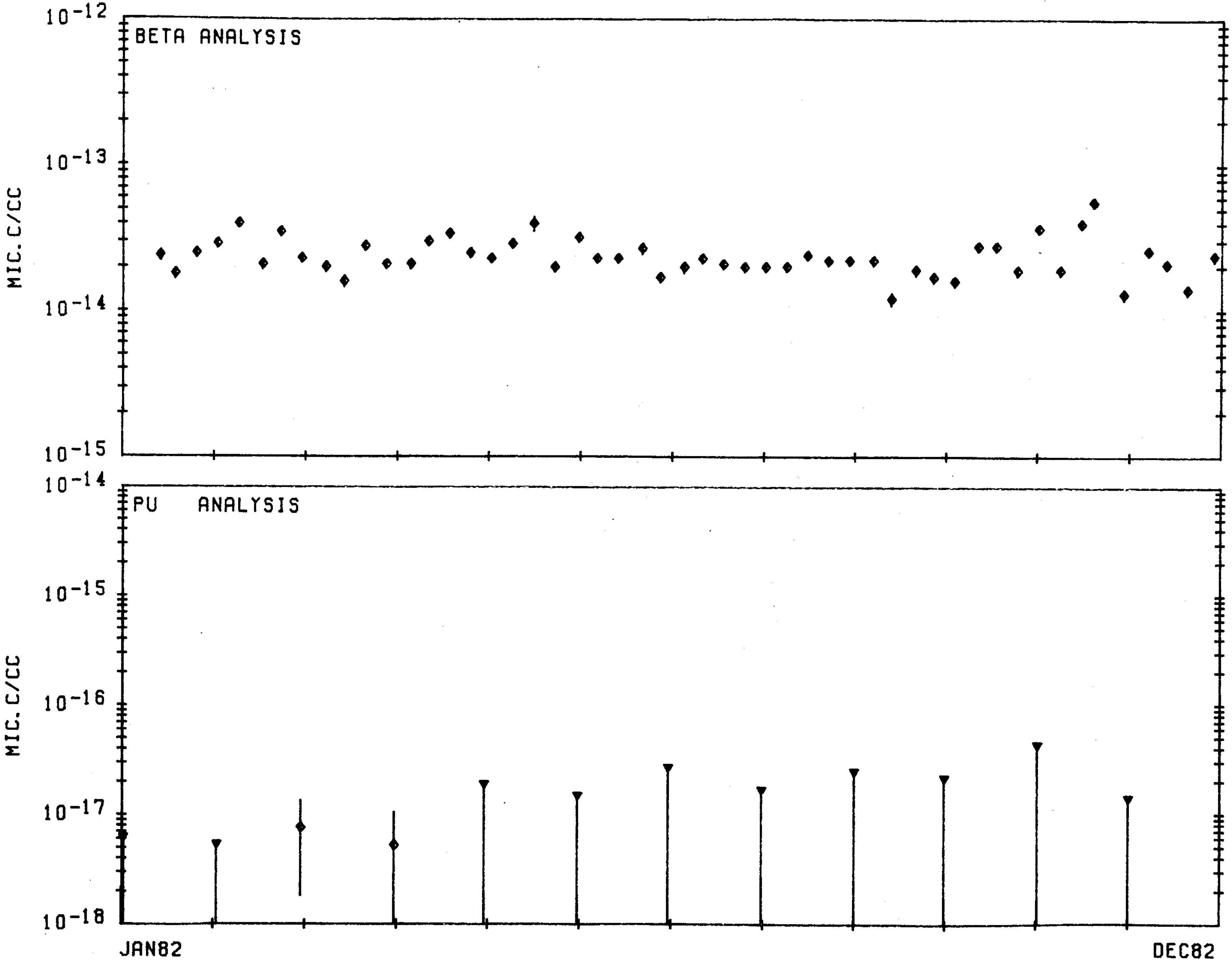


AIR SAMPLING STATION NUMBER 39
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

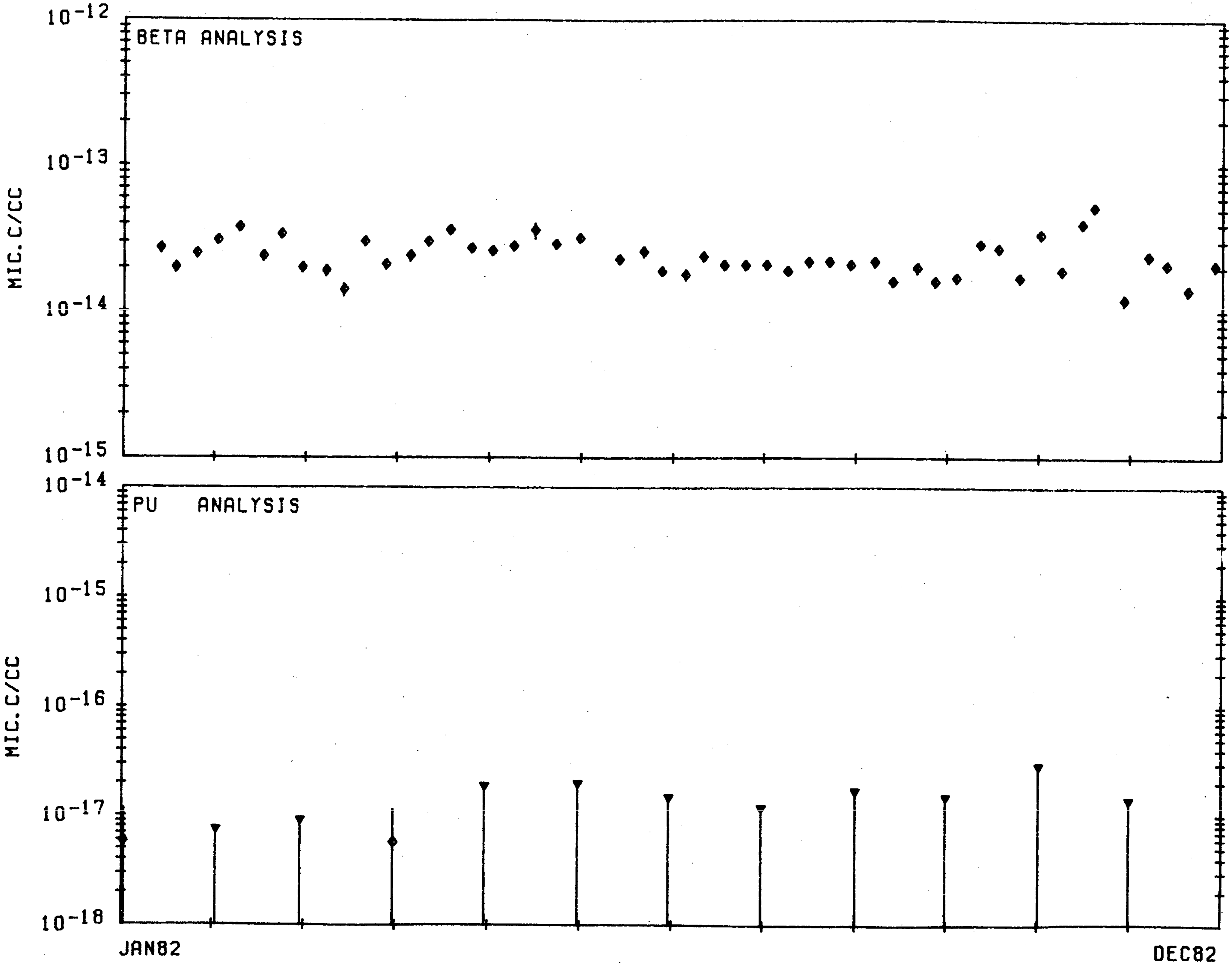
AIR SAMPLING STATION NUMBER 40

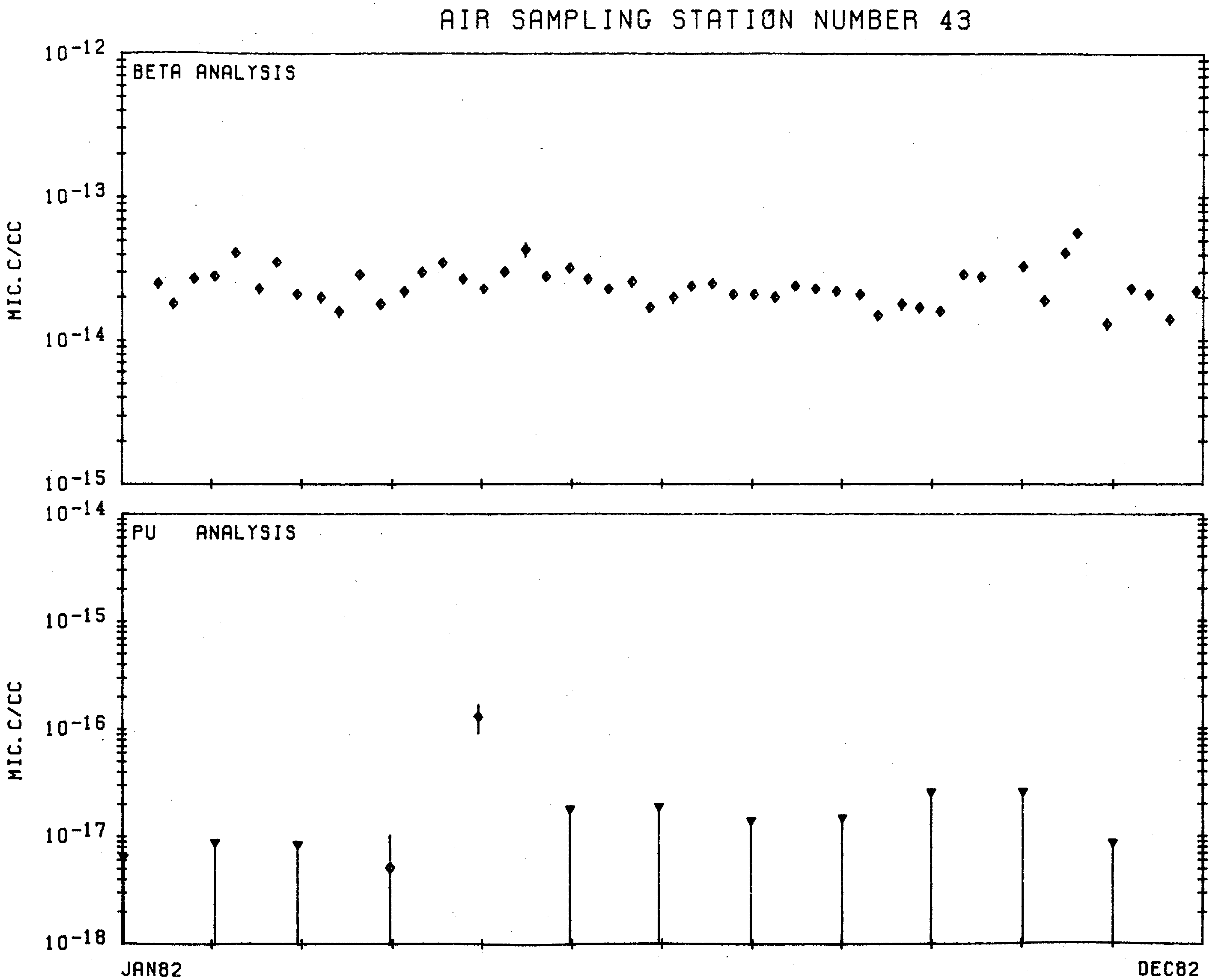


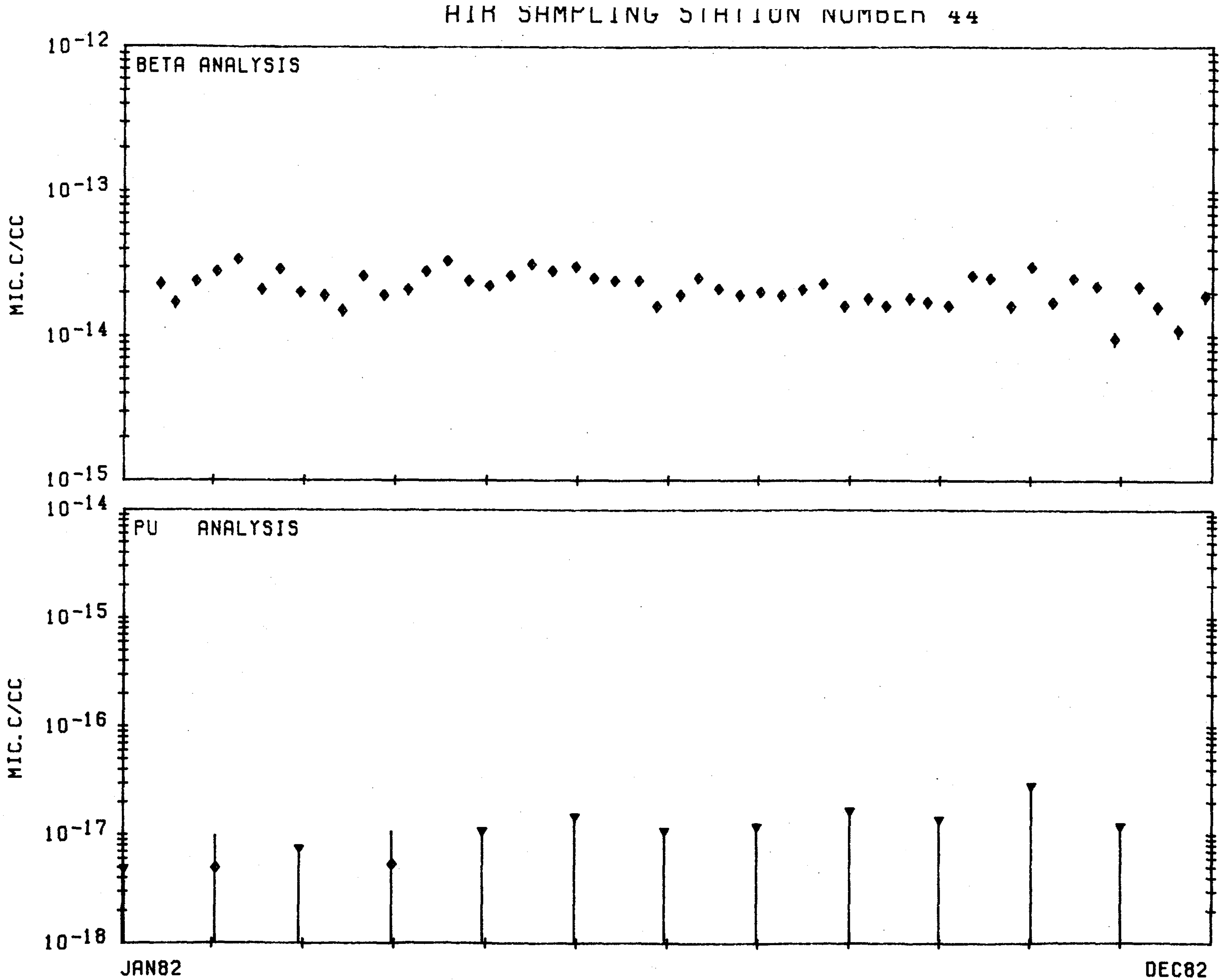
AIR SAMPLING STATION NUMBER 41

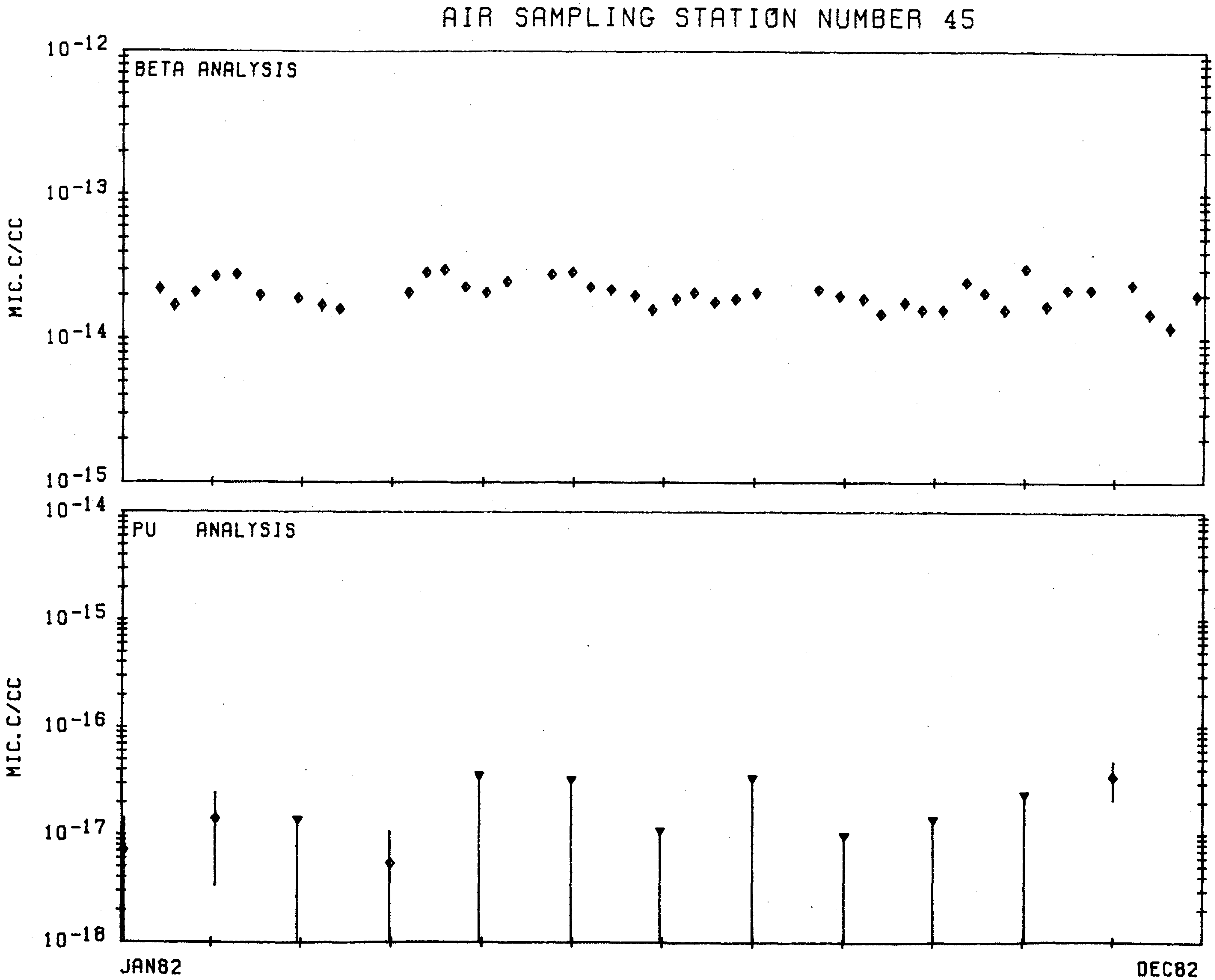


AIR SAMPLING STATION NUMBER 42

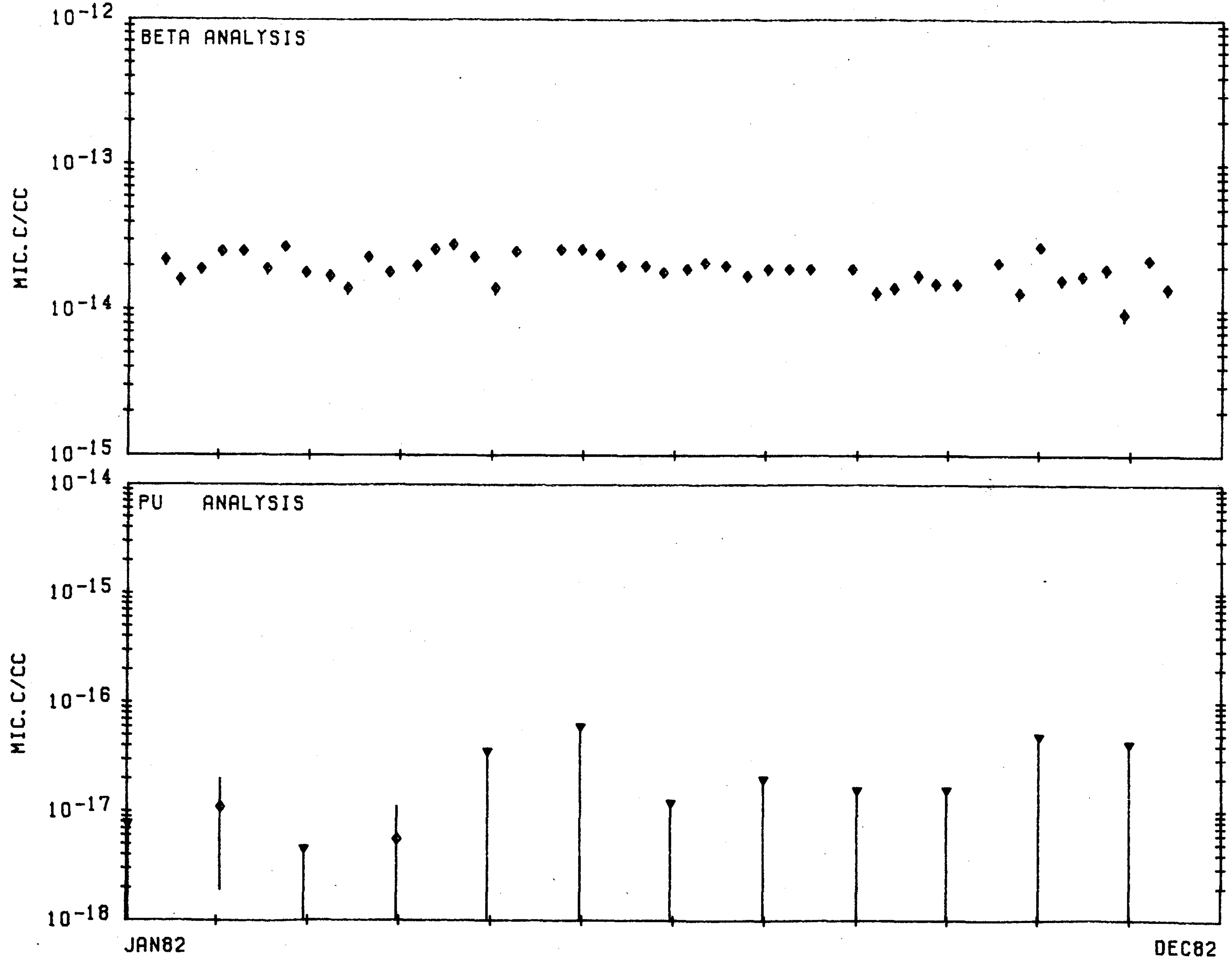


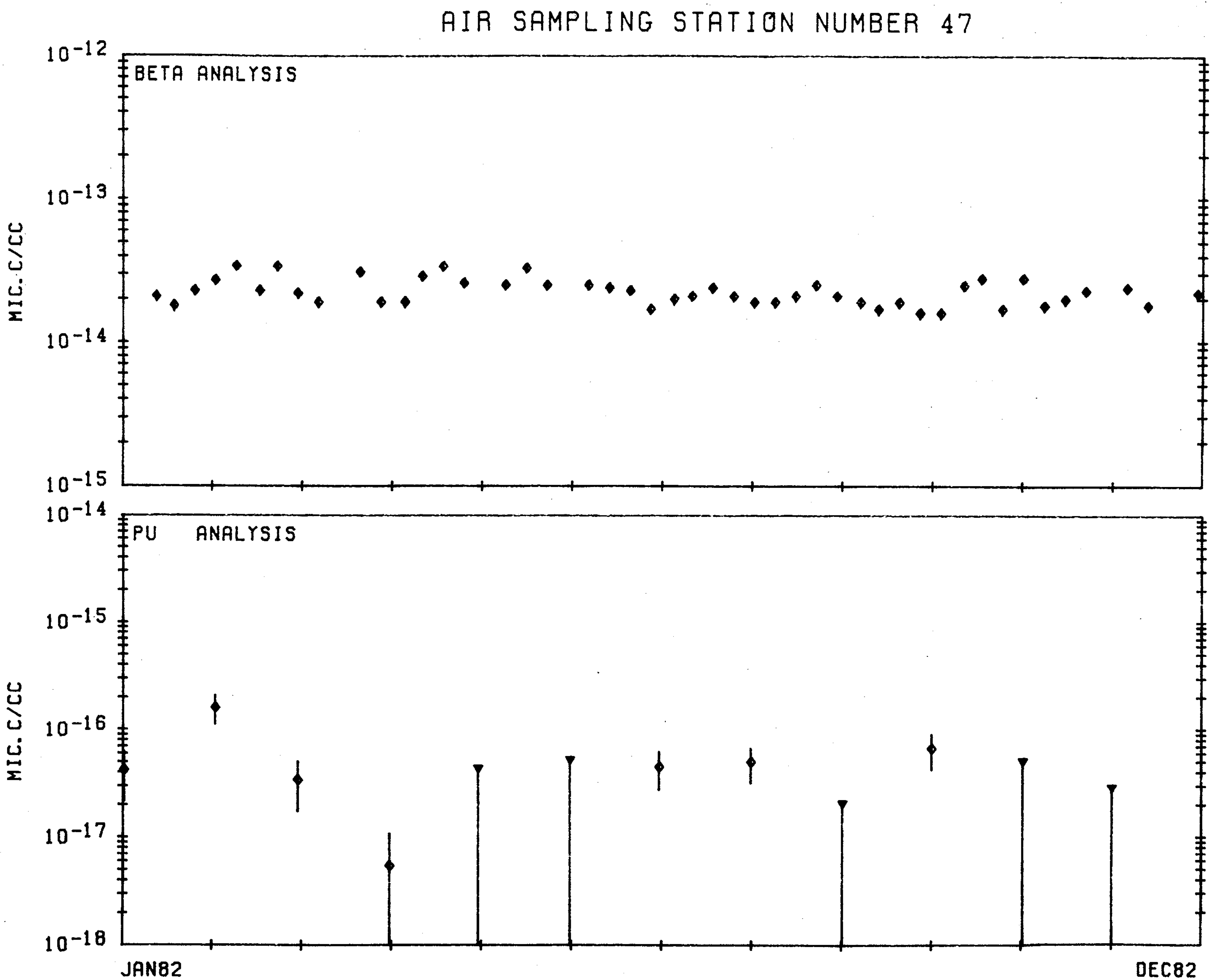

AIR SAMPLING STATION NUMBER 43
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82


AIR SAMPLING STATION NUMBER 44
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

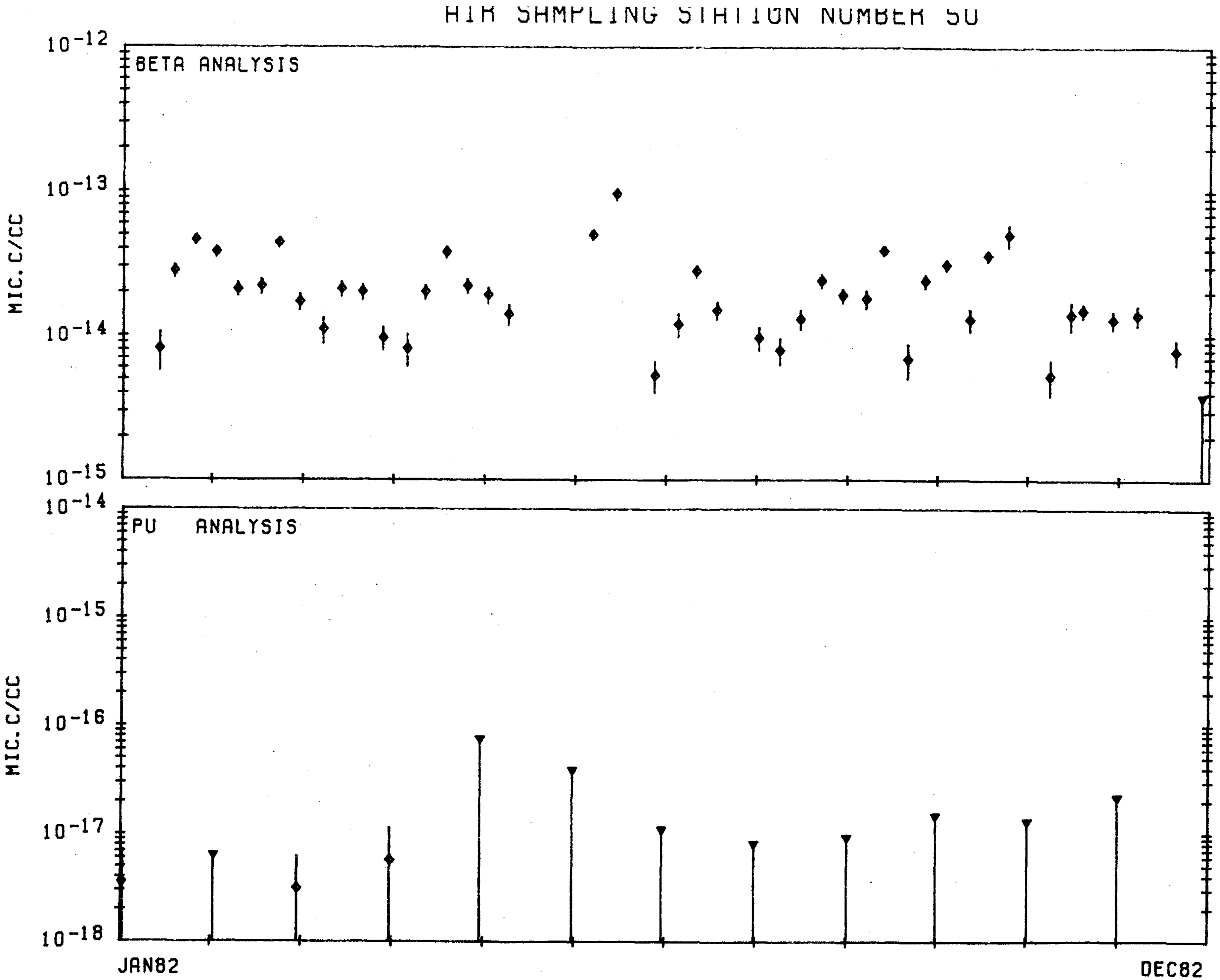

AIR SAMPLING STATION NUMBER 45
BETA ANALYSIS
MIC.C/CC
10-12
10-13
10-14
10-15
PU ANALYSIS
MIC.C/CC
10-14
10-15
10-16
10-17
10-18
JAN82
DEC82

AIR SAMPLING STATION NUMBER 46





AIR SAMPLING STATION NUMBER 47
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82


AIR SAMPLING STATION NUMBER 50
BETA ANALYSIS
PU ANALYSIS
MIC.C/CC
MIC.C/CC
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
10^{-18}
JAN82
DEC82

A P P E N D I X B

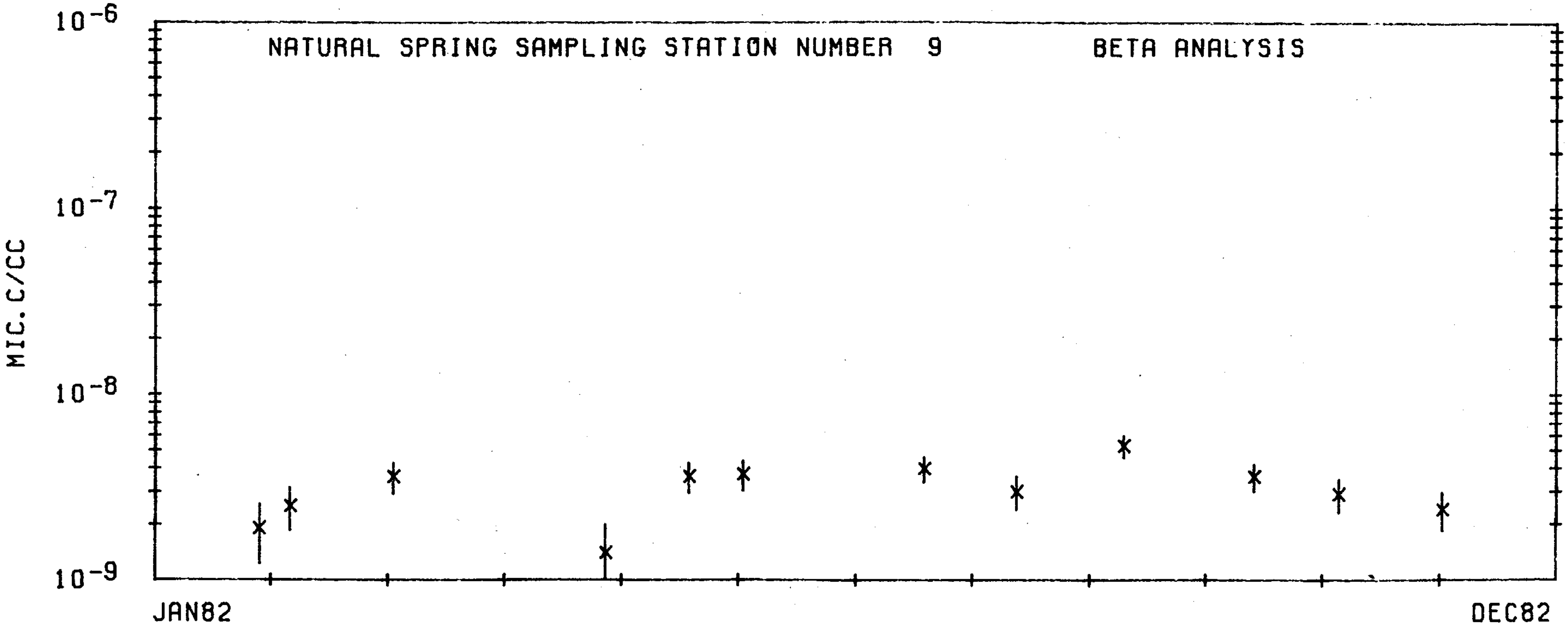
NTS Environmental Surveillance

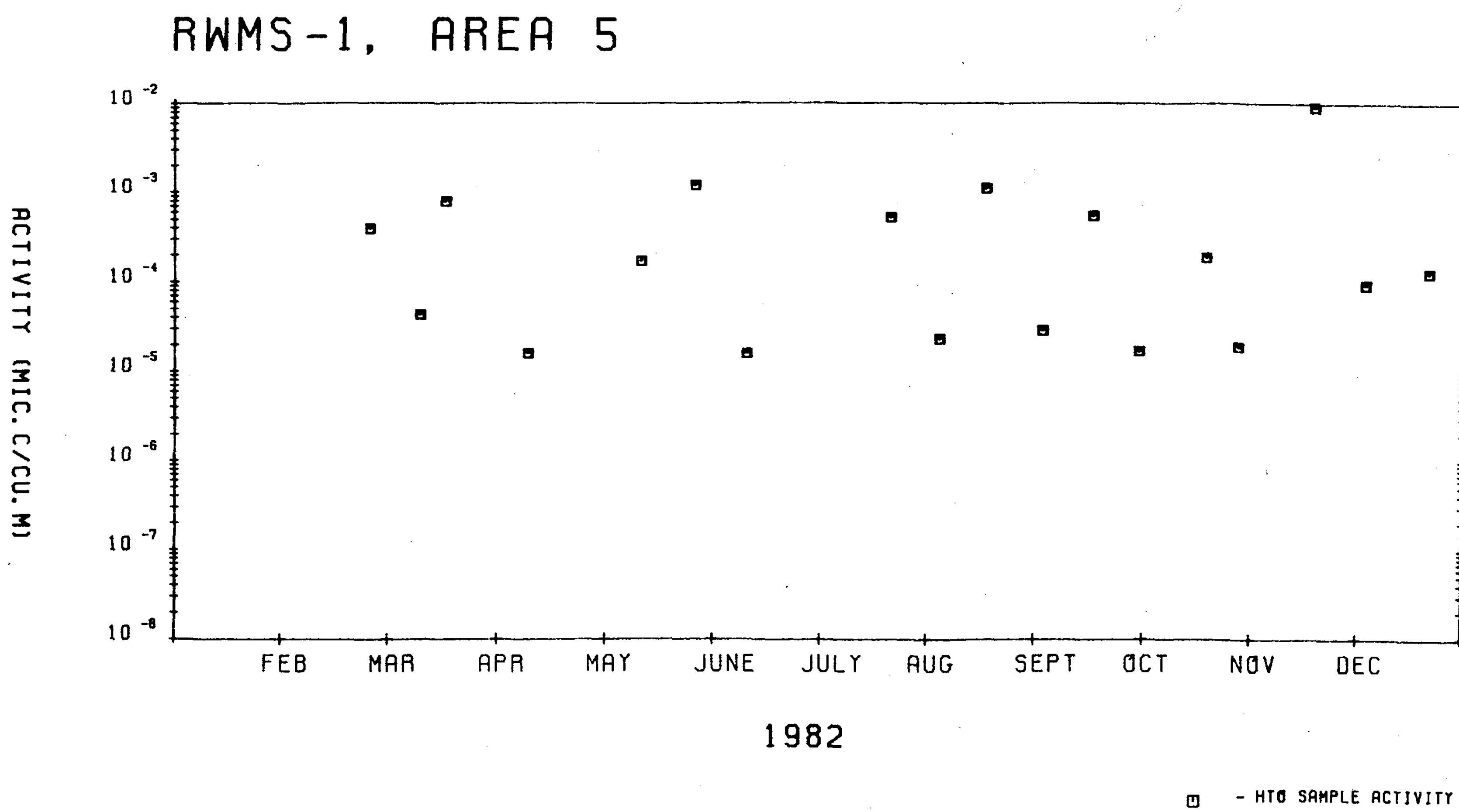
Tritium in Air Sampling Locations and Plots

The tritium in air data for each station is plotted in Appendix B for the entire year.

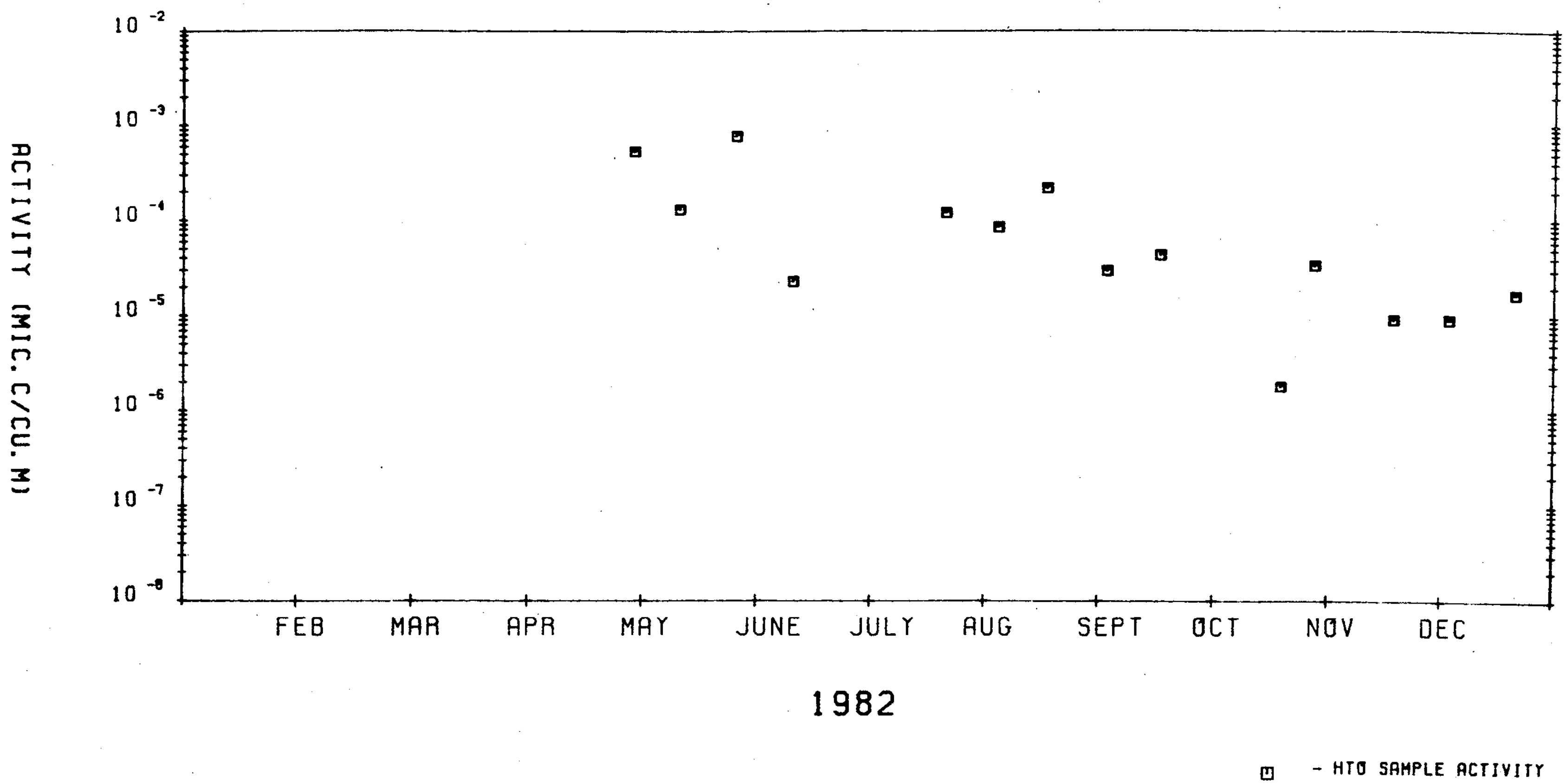
NTS ENVIRONMENTAL SURVEILLANCE
TRITIUM IN AIR SAMPLING LOCATIONS

Area	Location
1	BJY
5	RWMS - 1
5	RWMS - SE
5	RWMS - (SE-NE)
5	RWMS - NE
5	RWMS - (NE-NW)
5	RWMS - NW
5	RWMS - (NW-SW)
5	RWMS - SW
5	RWMS - (SW-SE)
12	Base Camp
15	EPA Farm
23	Bldg. 790
23	Bldg. 650
25	EMAD
51	Far Forward

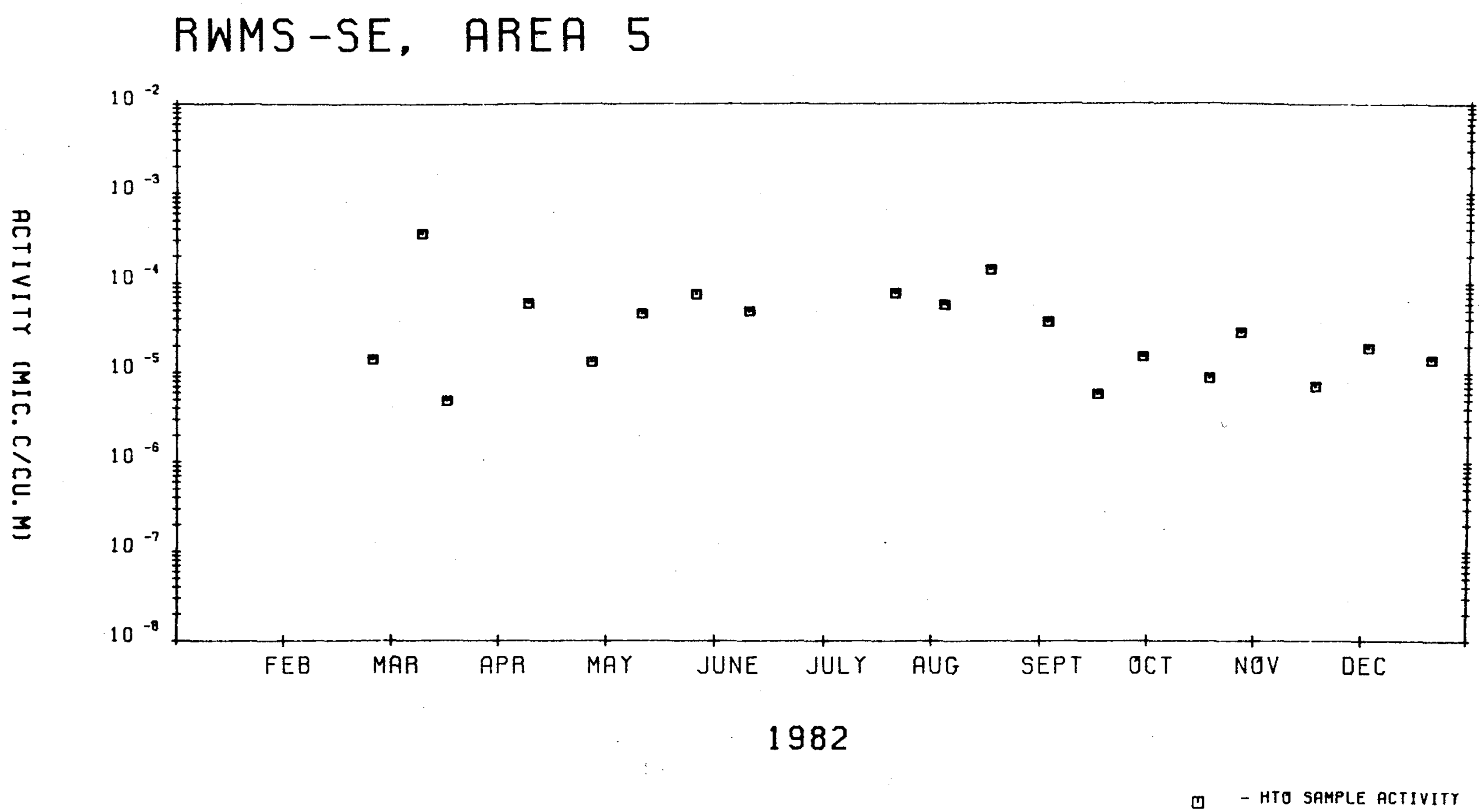

NATURAL SPRING SAMPLING STATION NUMBER 9
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

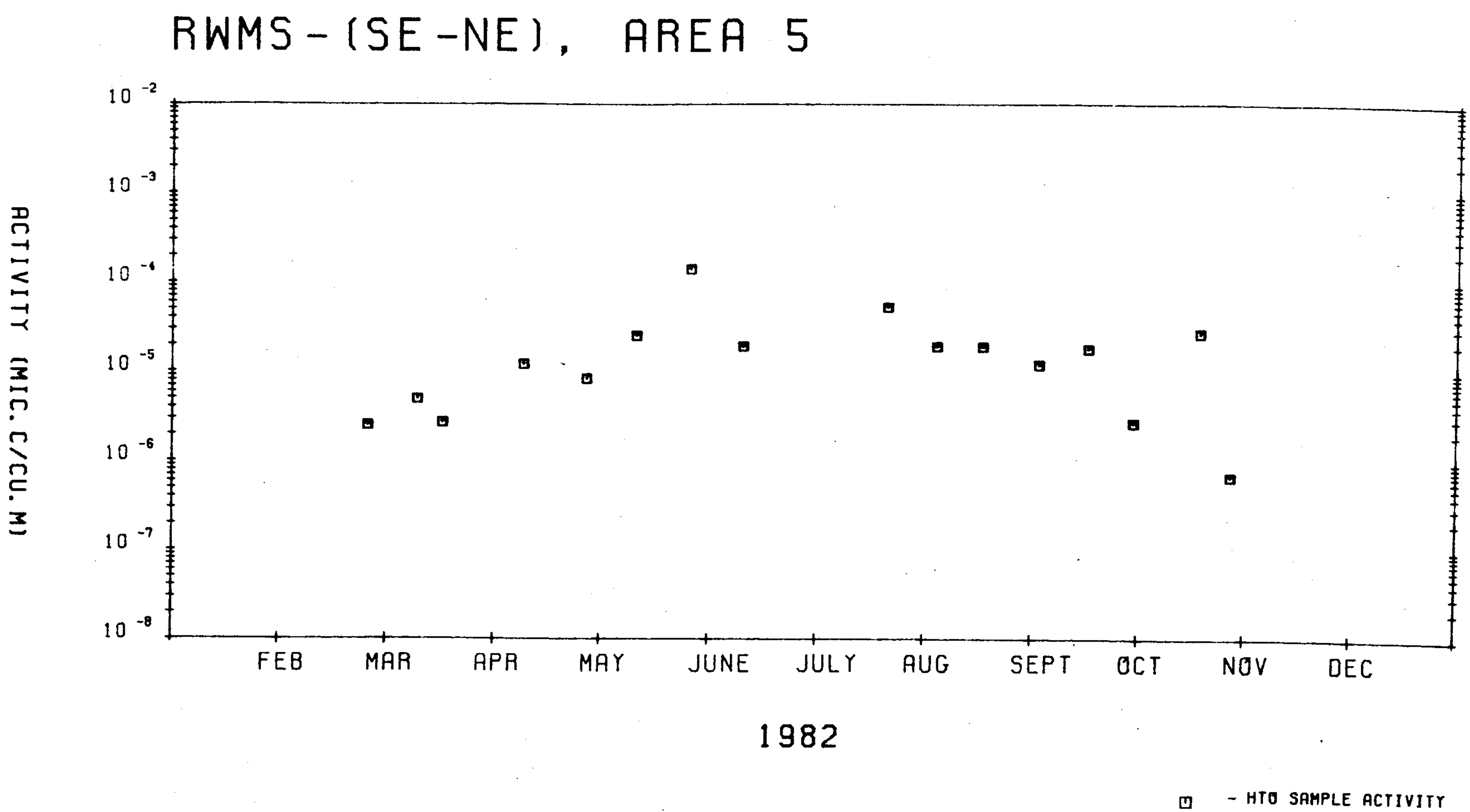

RWMS-1, AREA 5
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
ACTIVITY (MIC.C/CU.M)
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY

BJY, AREA 1

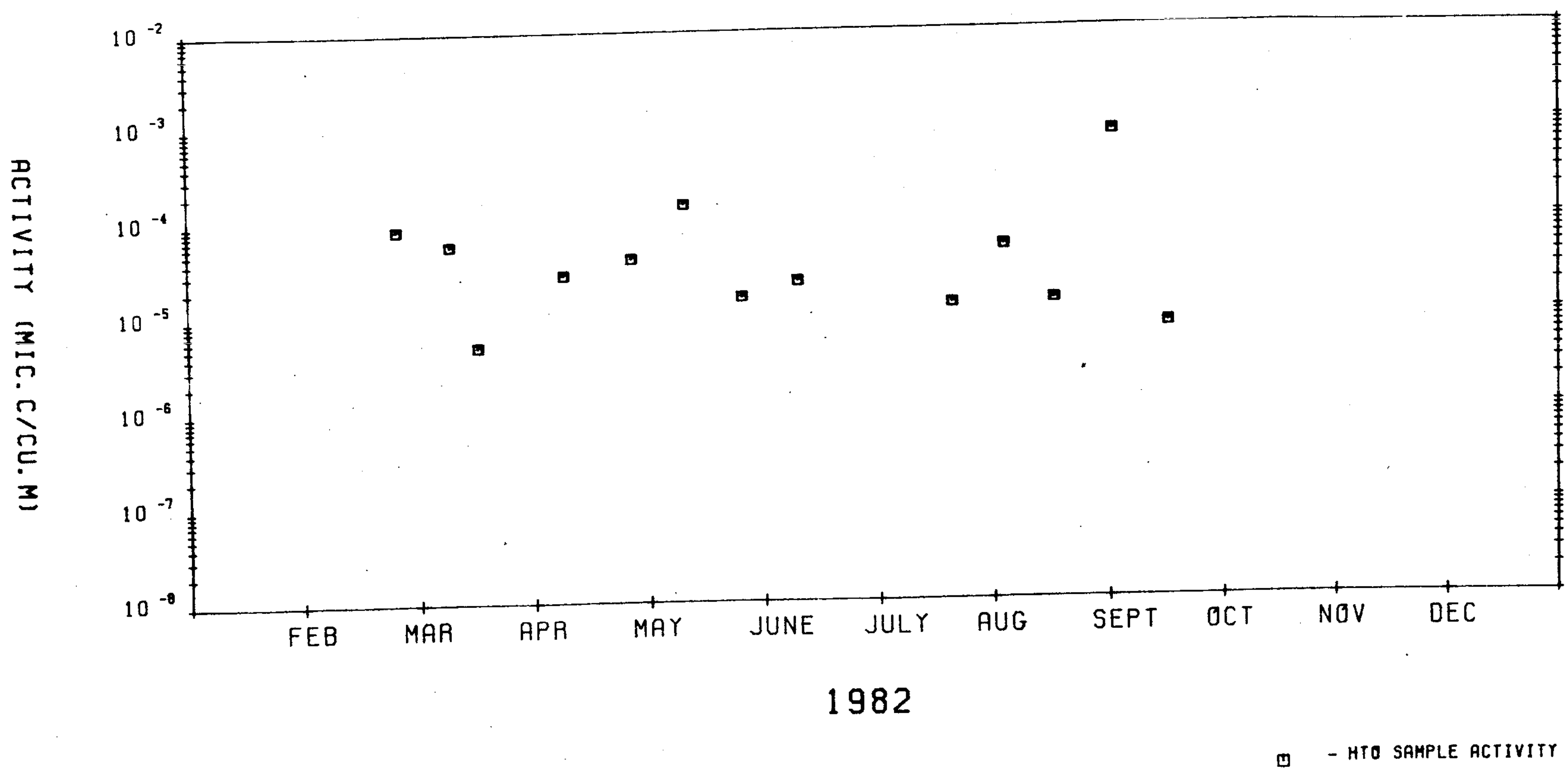


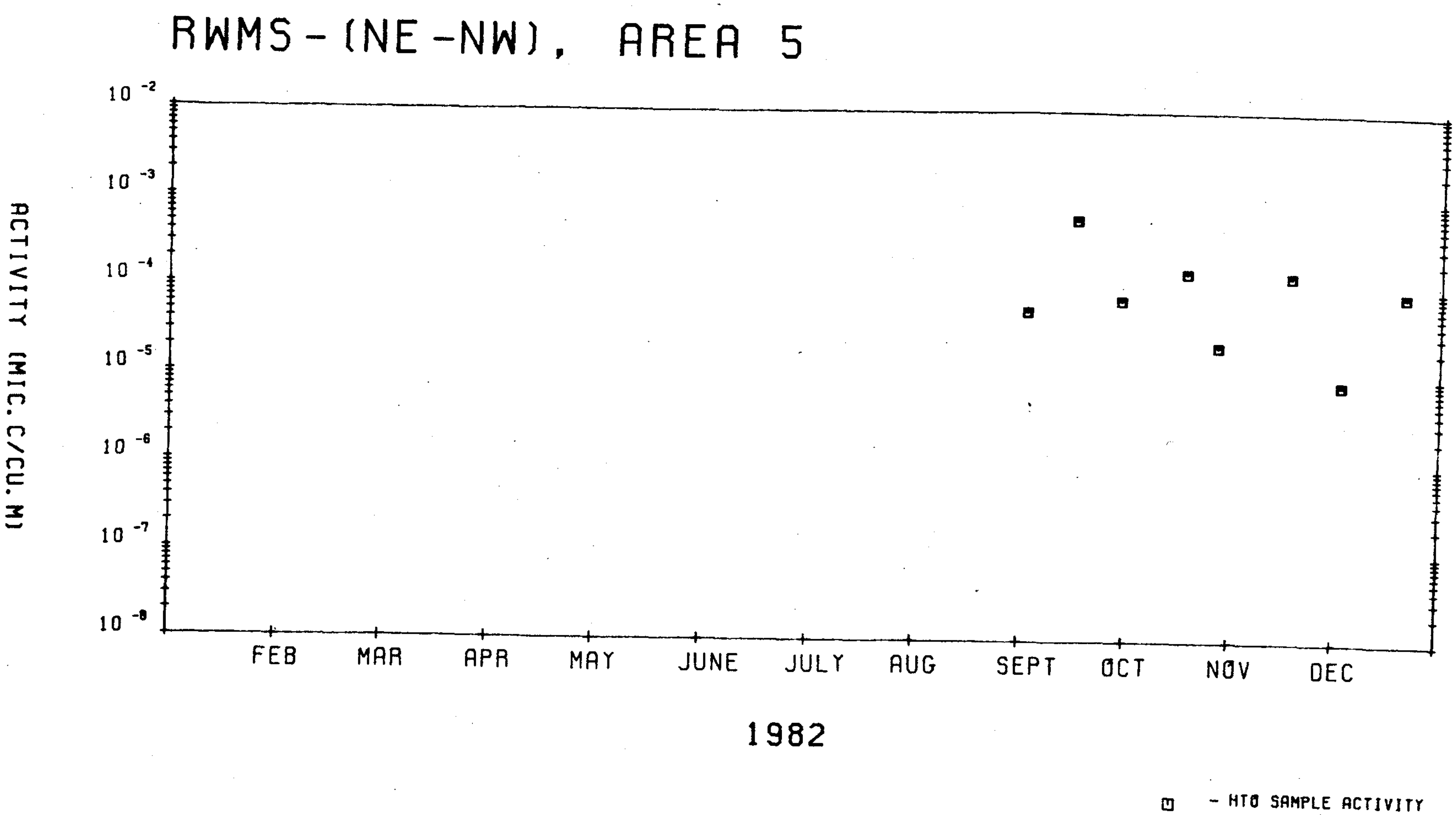
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
ACTIVITY (MIC.C/CU.M)
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY


RWMS-SE, AREA 5
ACTIVITY (MIC.C/CU.M)
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY


RWMS-(SE-NE), AREA 5
ACTIVITY (MIC.C/CU.M)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY

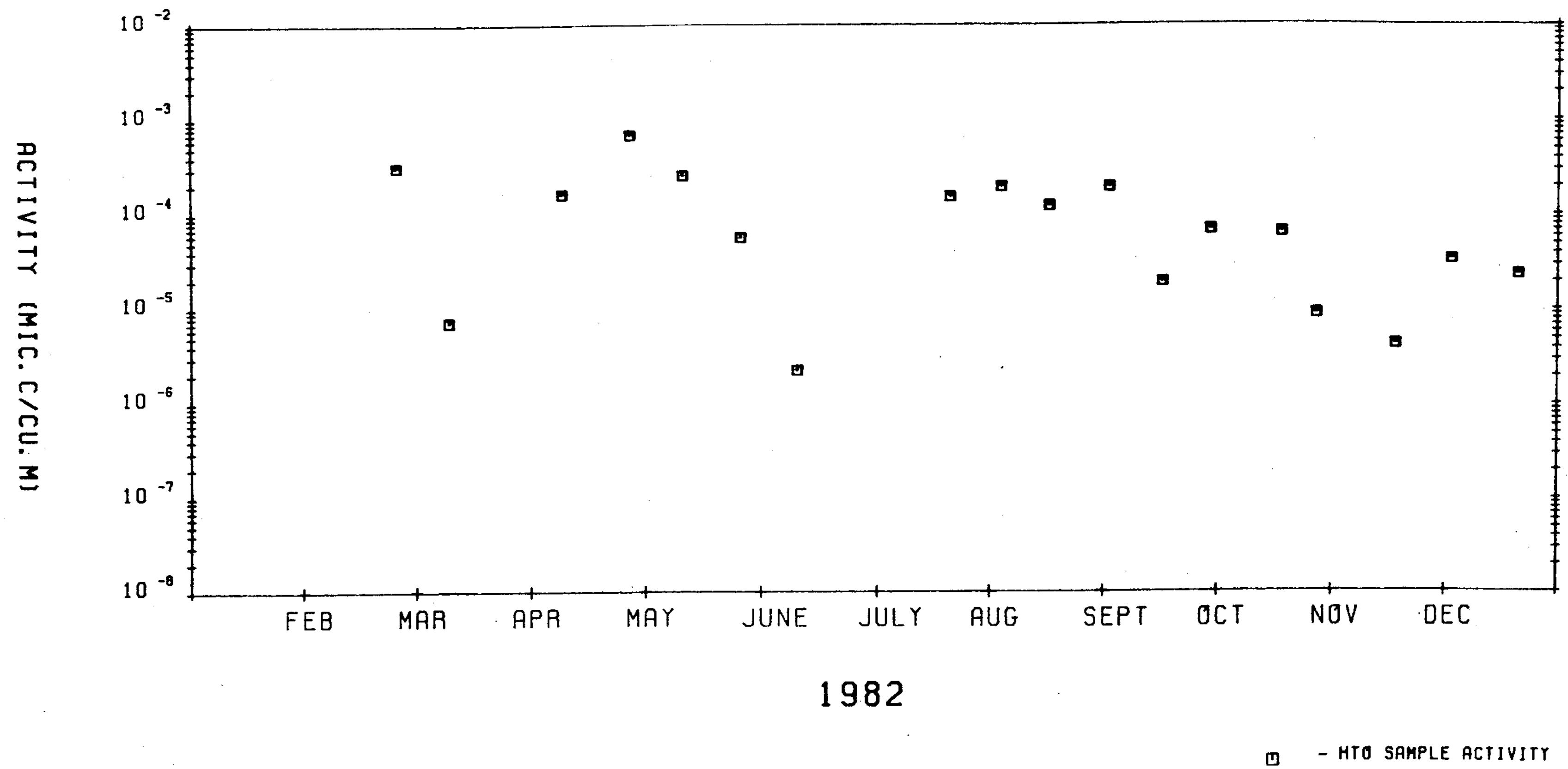
RWMS-NE, AREA 5



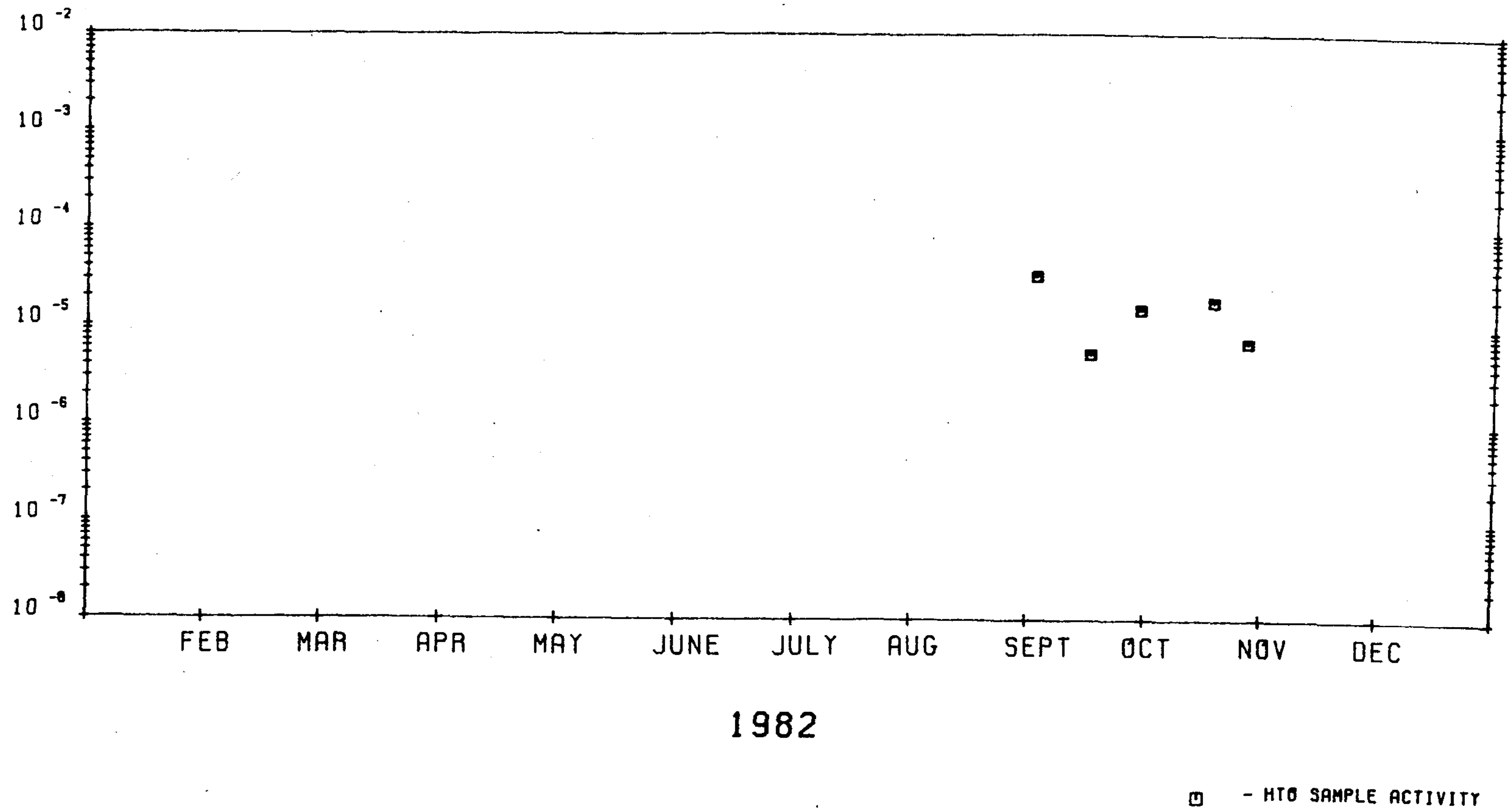


RWMS-(NE-NW), AREA 5
ACTIVITY (MIC.C/CU.M)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY

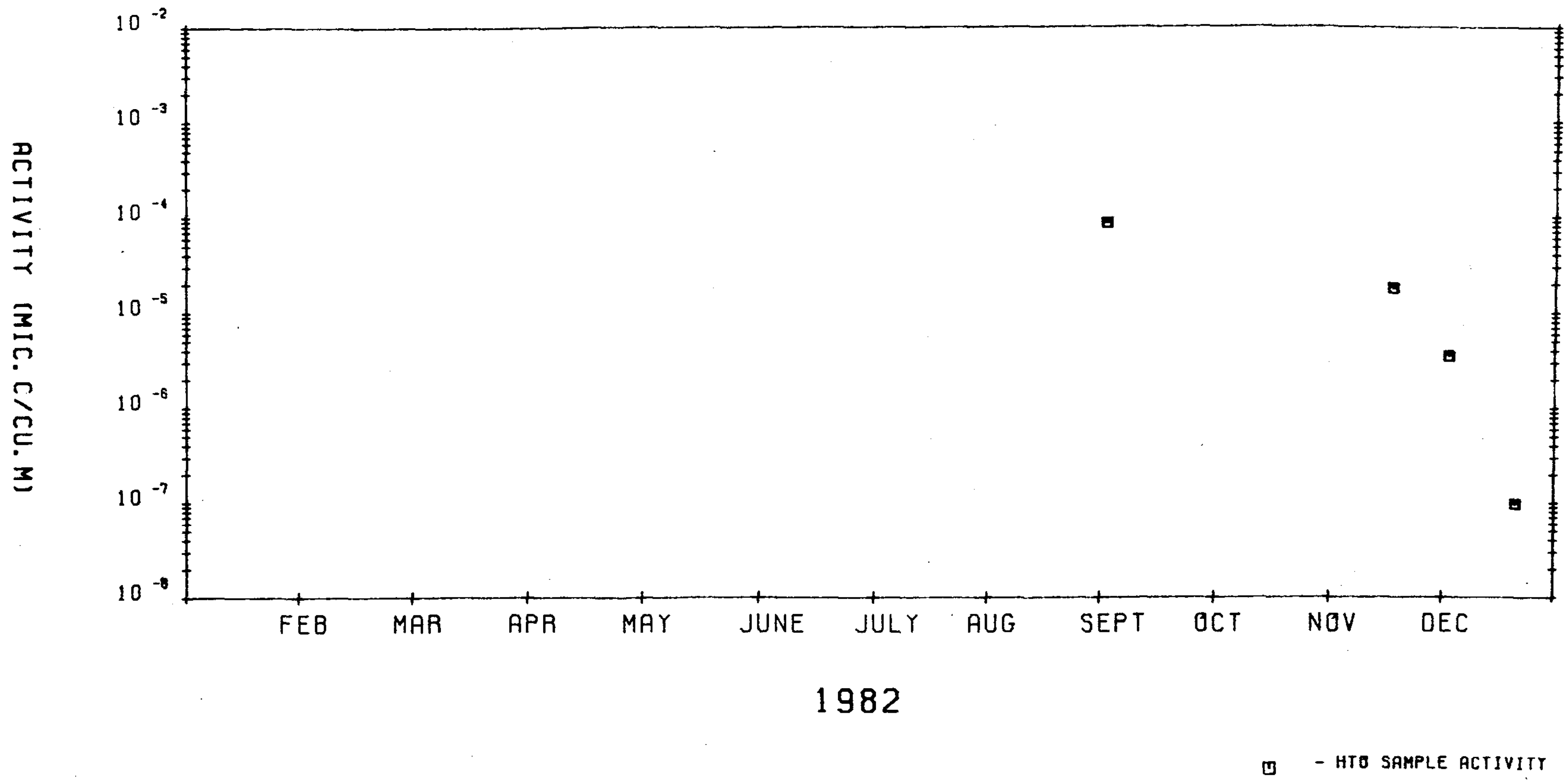
RWMS-NW, AREA 5

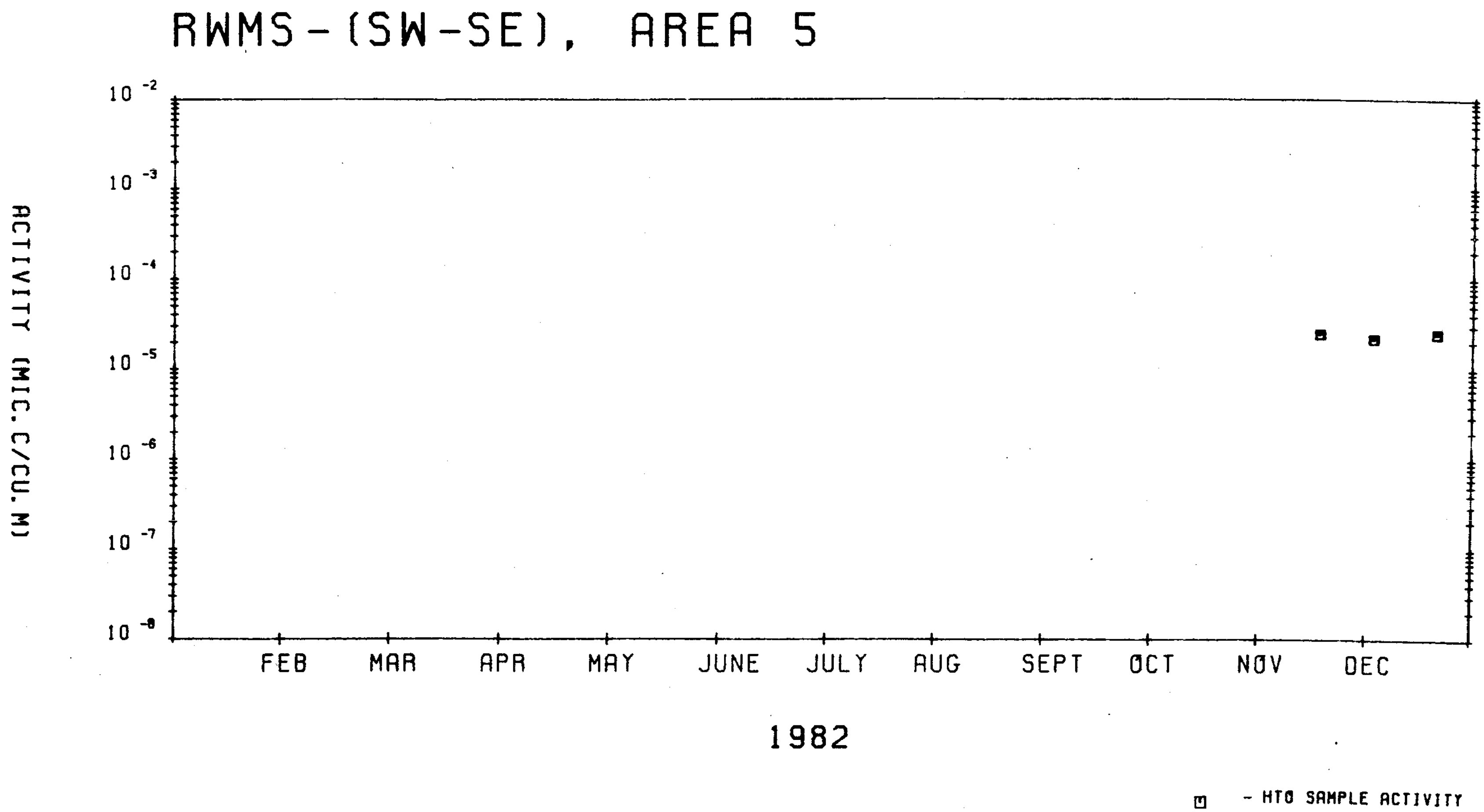


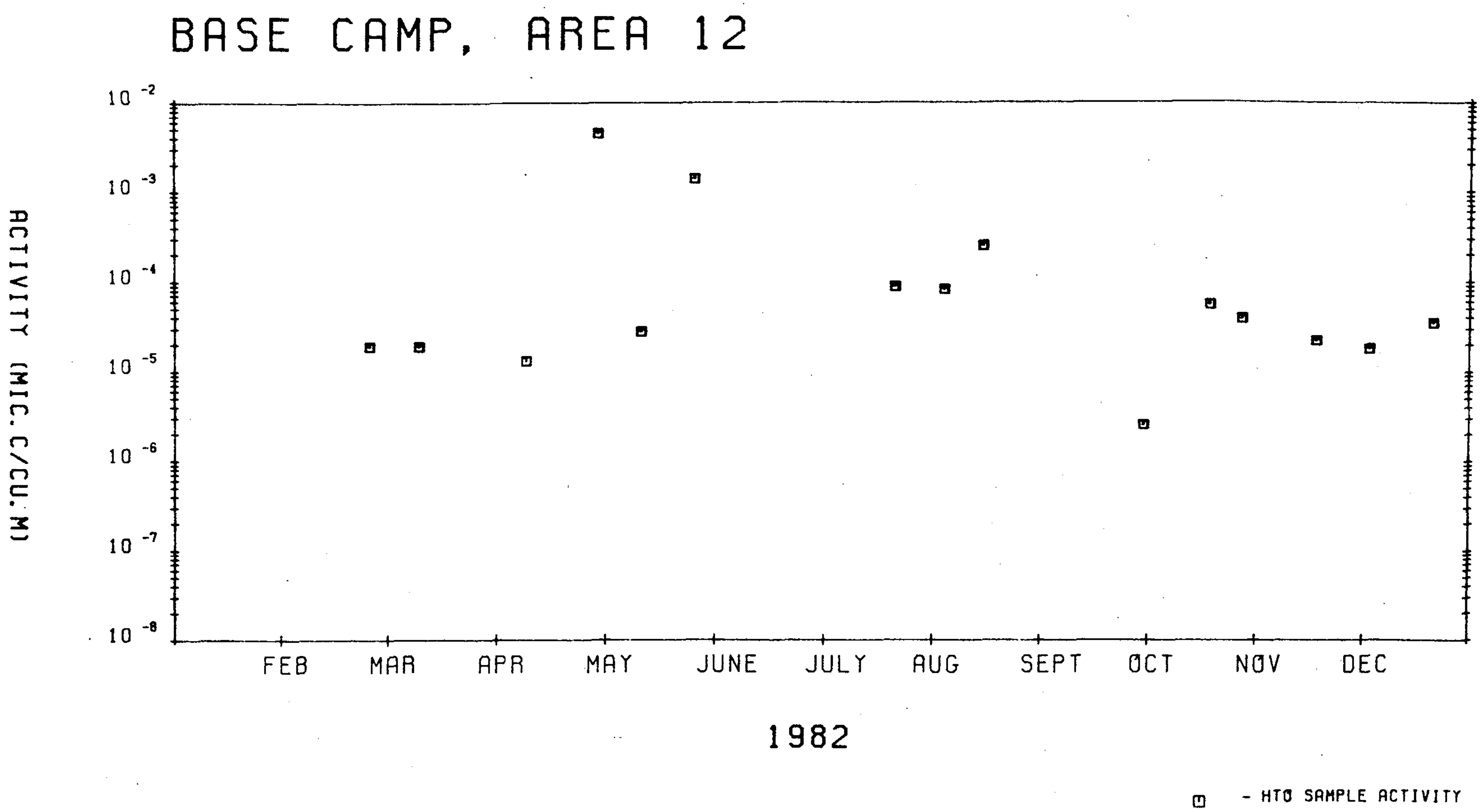
RWMS-(NW-SW), AREA 5

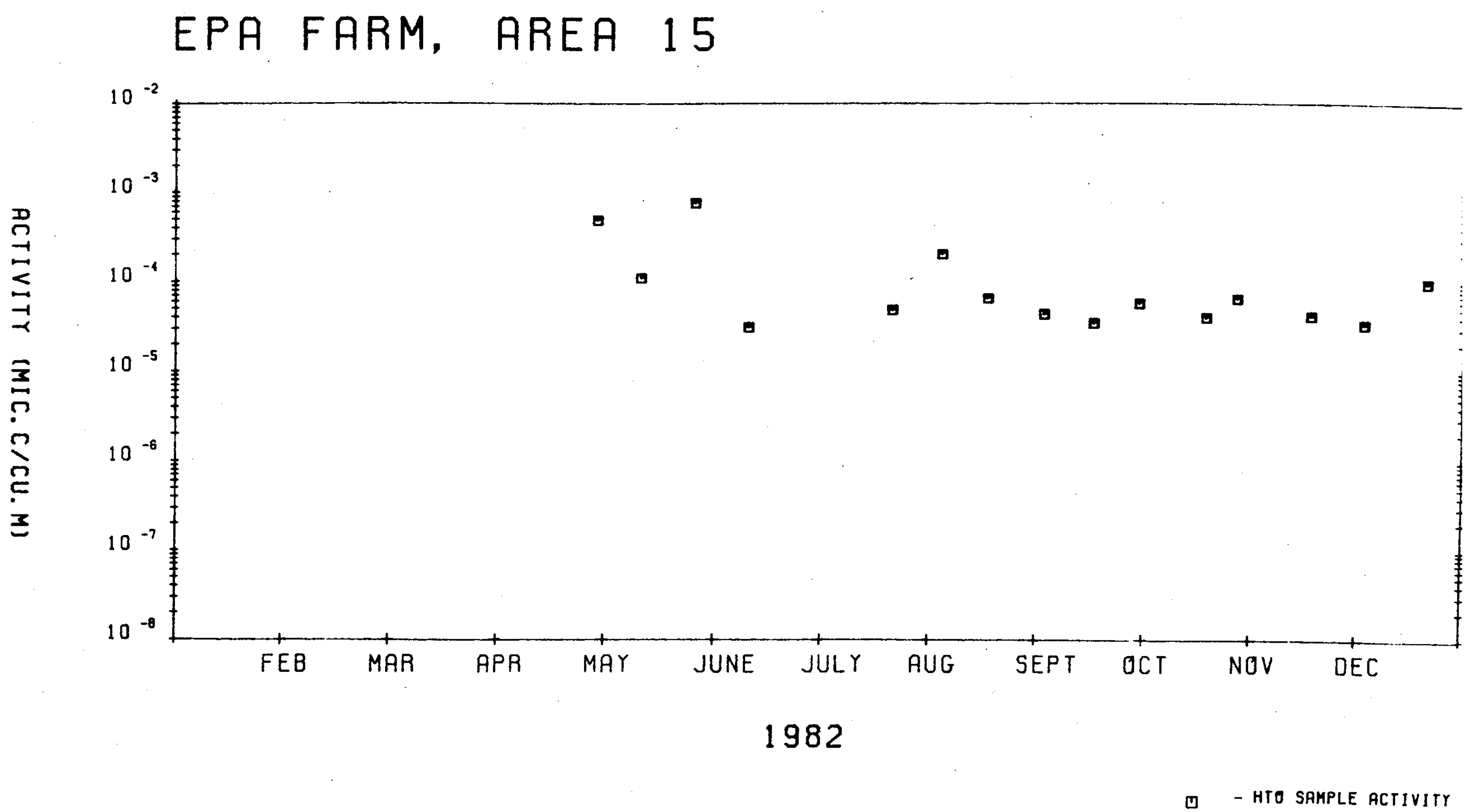


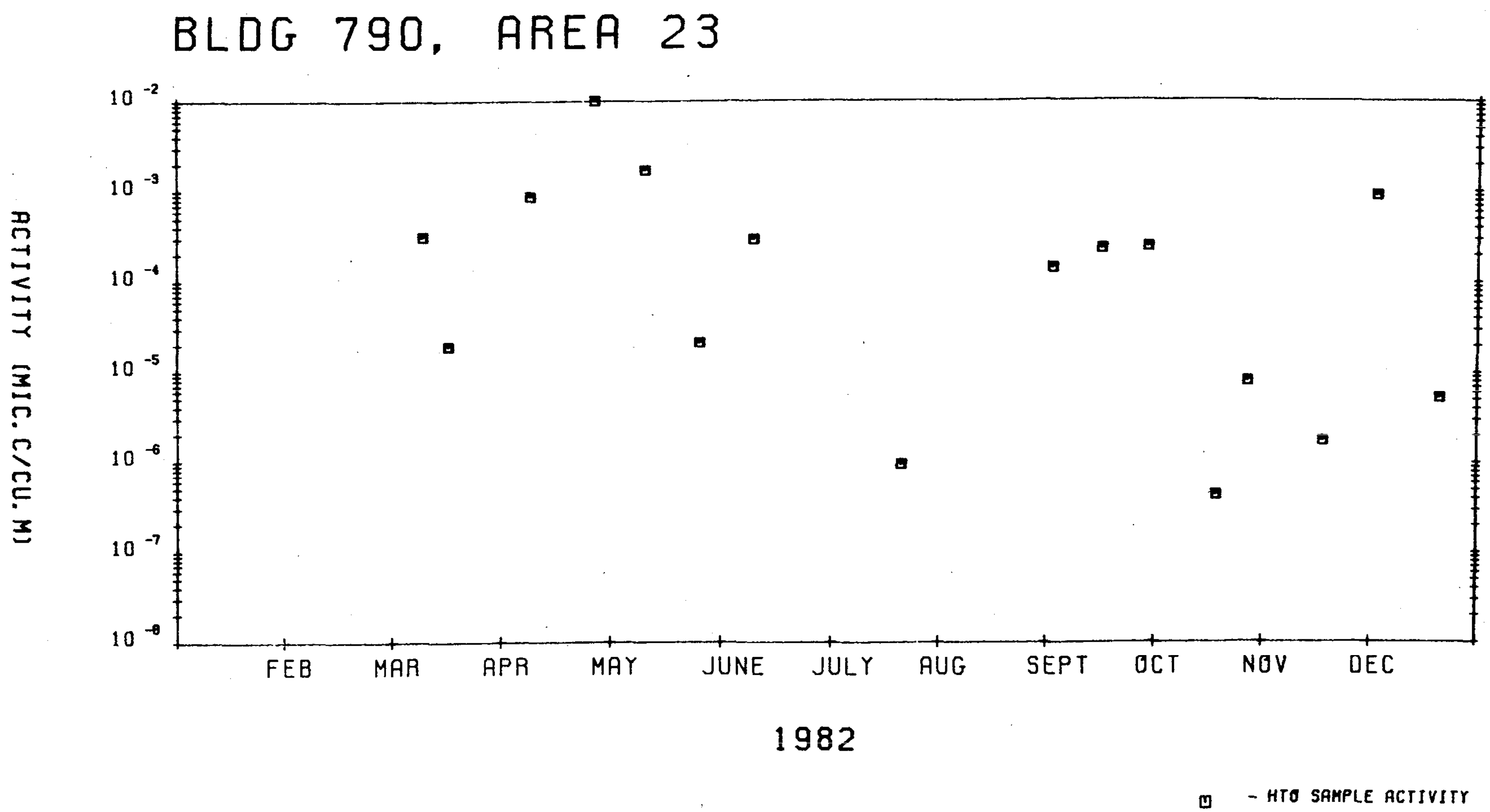
RWMS-SW, AREA 5



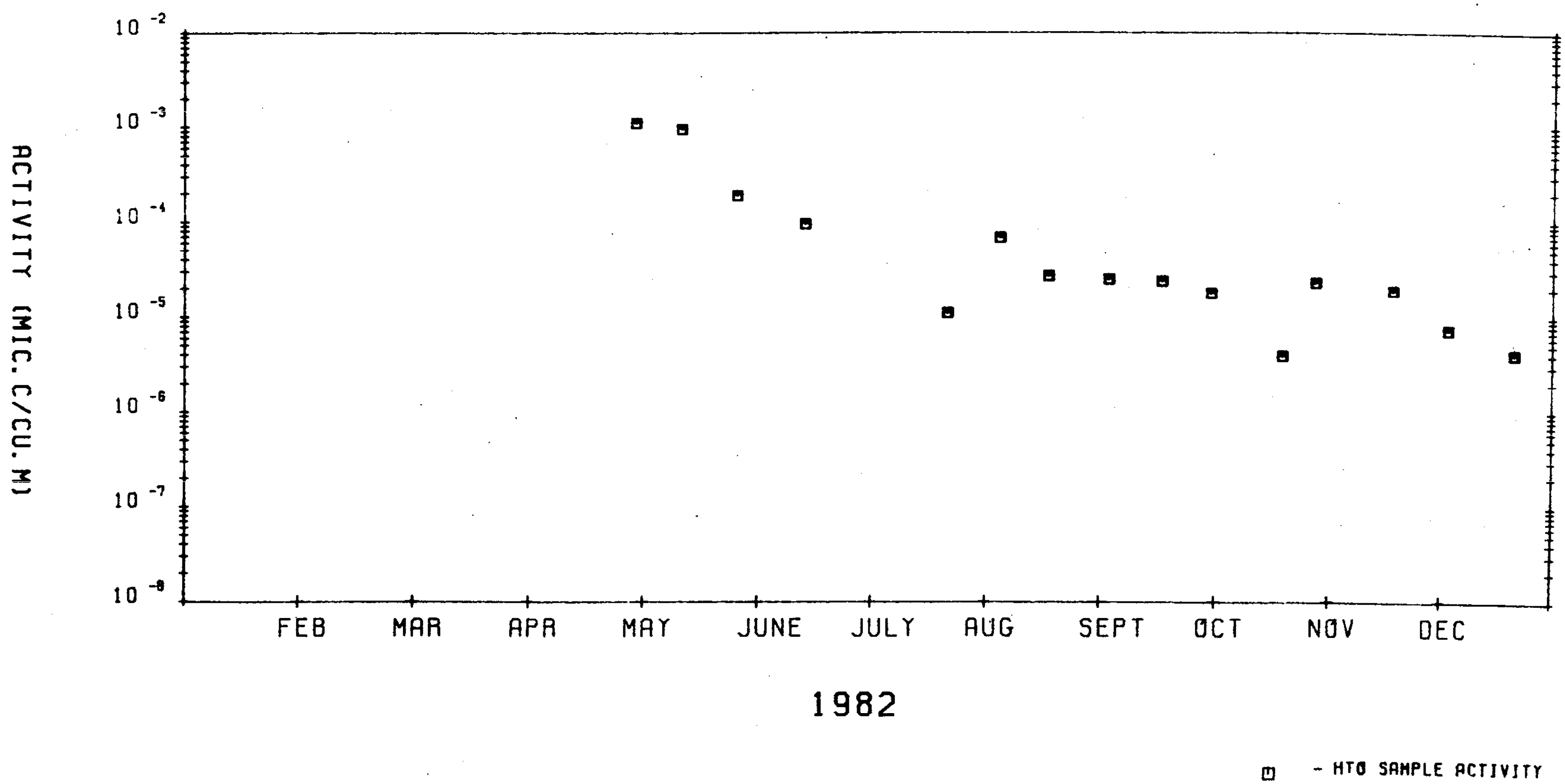

RWMS-(SW-SE), AREA 5
ACTIVITY (MIC.C/CU.M)
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY


BASE CAMP, AREA 12
ACTIVITY (MIC.C/CU.M)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY


EPA FARM, AREA 15
ACTIVITY (MIC.C/CU.M)
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY

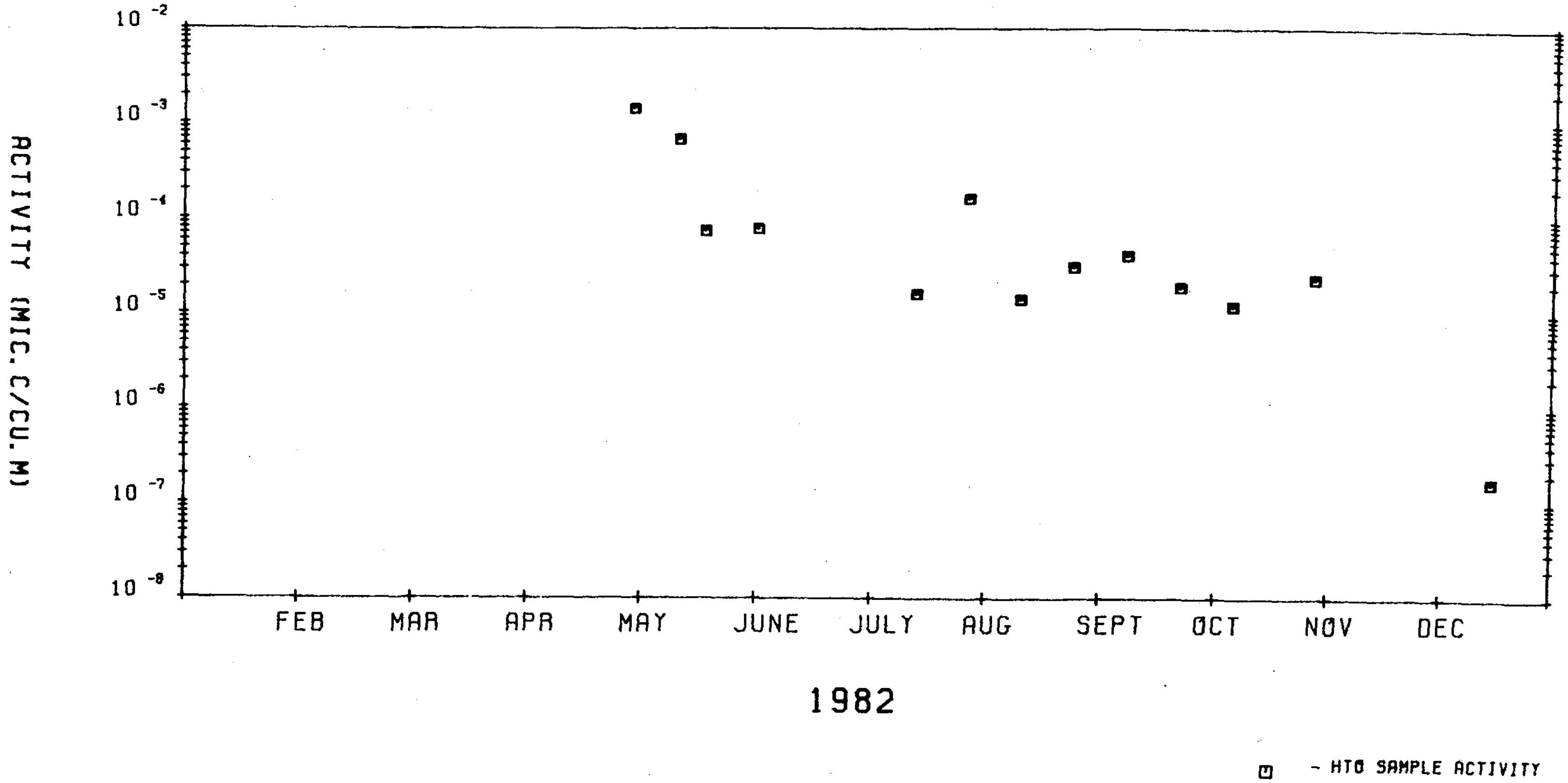

BLDG 790, AREA 23
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
ACTIVITY (MIC.C/CU.M)
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY

EMAD, AREA 25



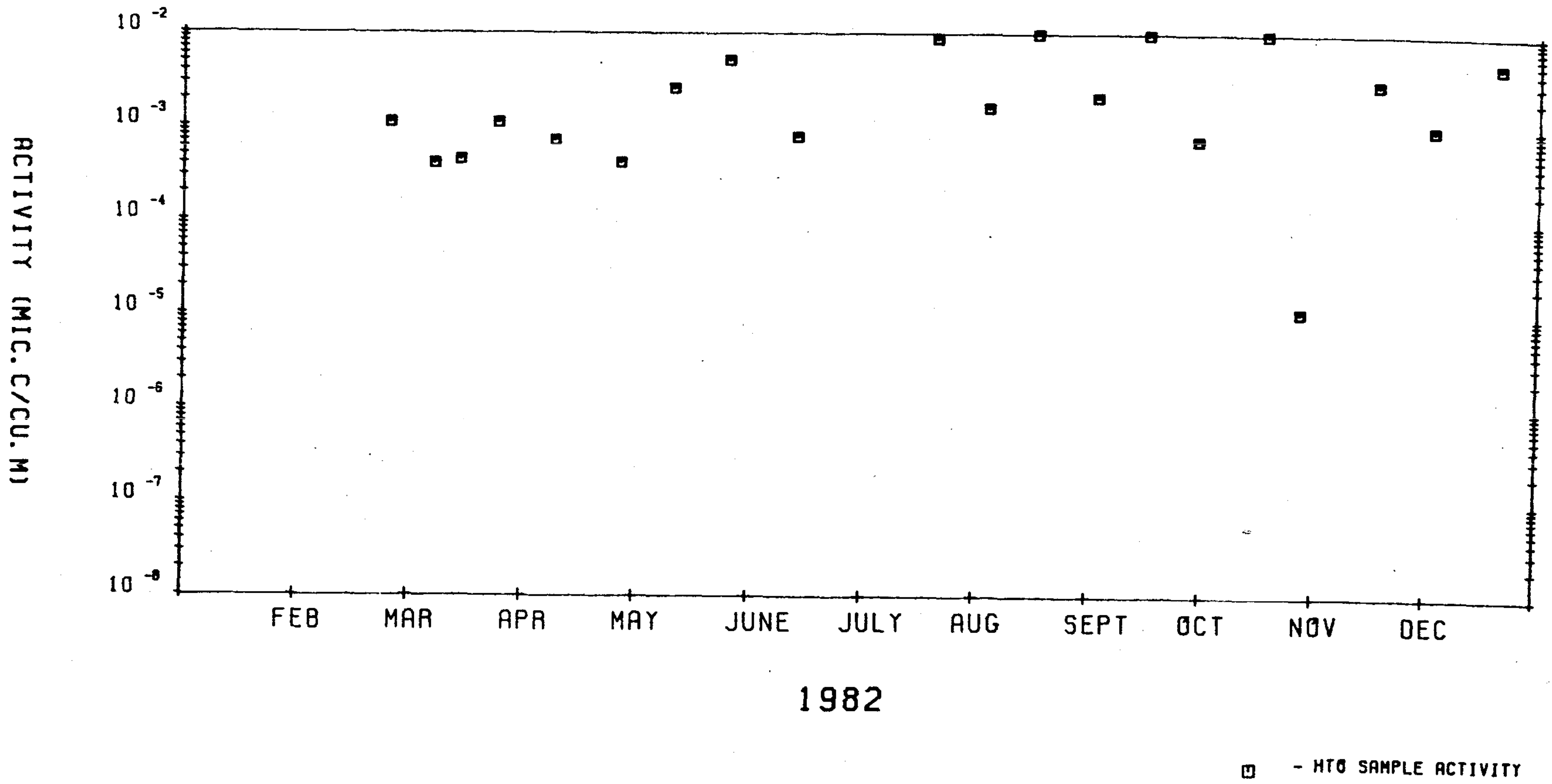
ACTIVITY (MIC.C/CU.M)
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY

FAR FORWARD



ACTIVITY (MIC.C/CU.M)
10 -2
10 -3
10 -4
10 -5
10 -6
10 -7
10 -8
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
1982
- HTO SAMPLE ACTIVITY

BLDG 650, AREA 23



APPENDIX C

NTS Environmental Surveillance

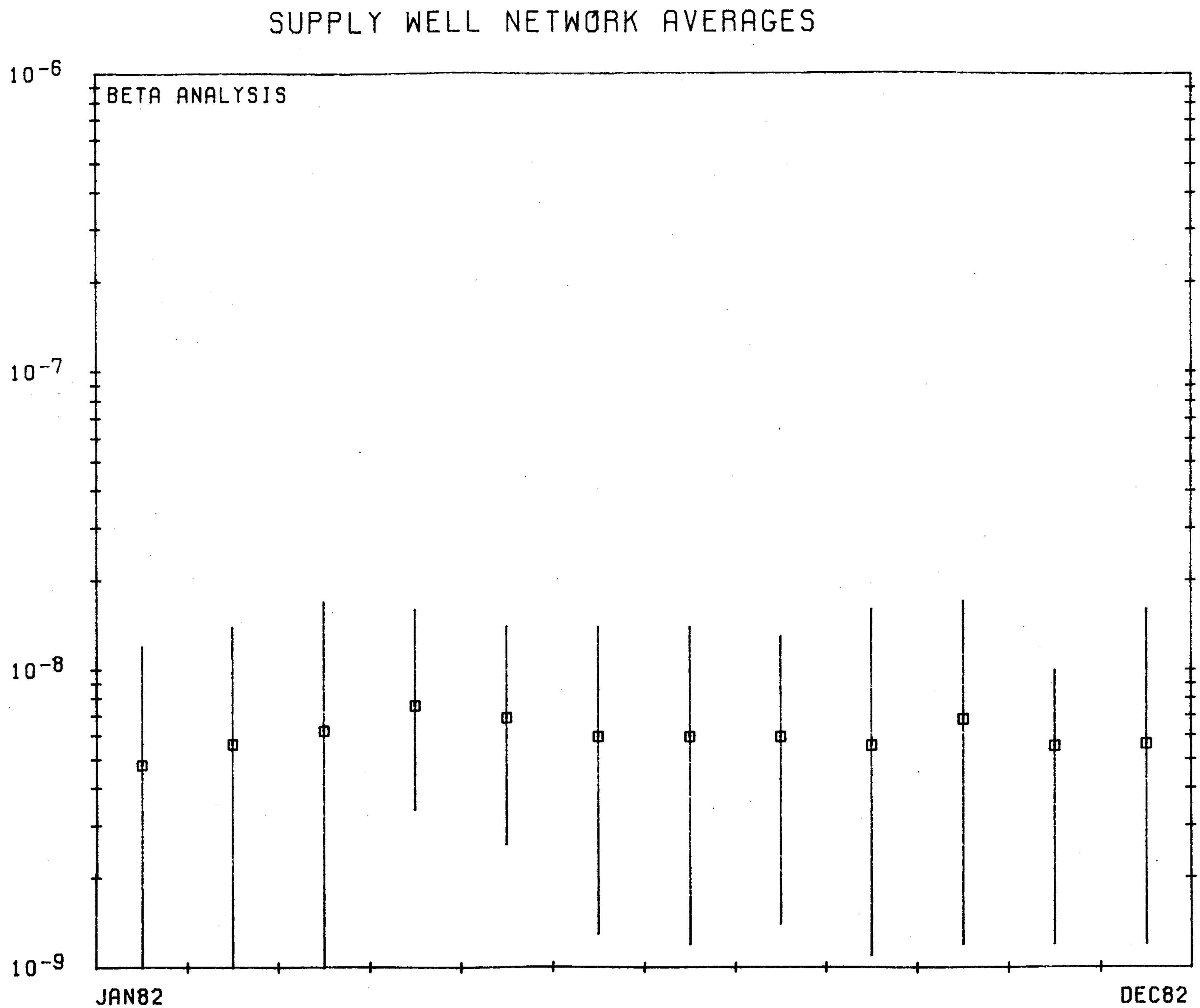
Supply Well Locations and Plots

Several symbols are used in Appendix C to denote the data points. In the first two pages of plots, the supply well network averages, a square represents the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots of Appendix B show the gross beta data of each station. A two-sigma error bar is also added to the data points, and, in all of the plots, a delta with the line to the bottom of the plot means below detection limit.

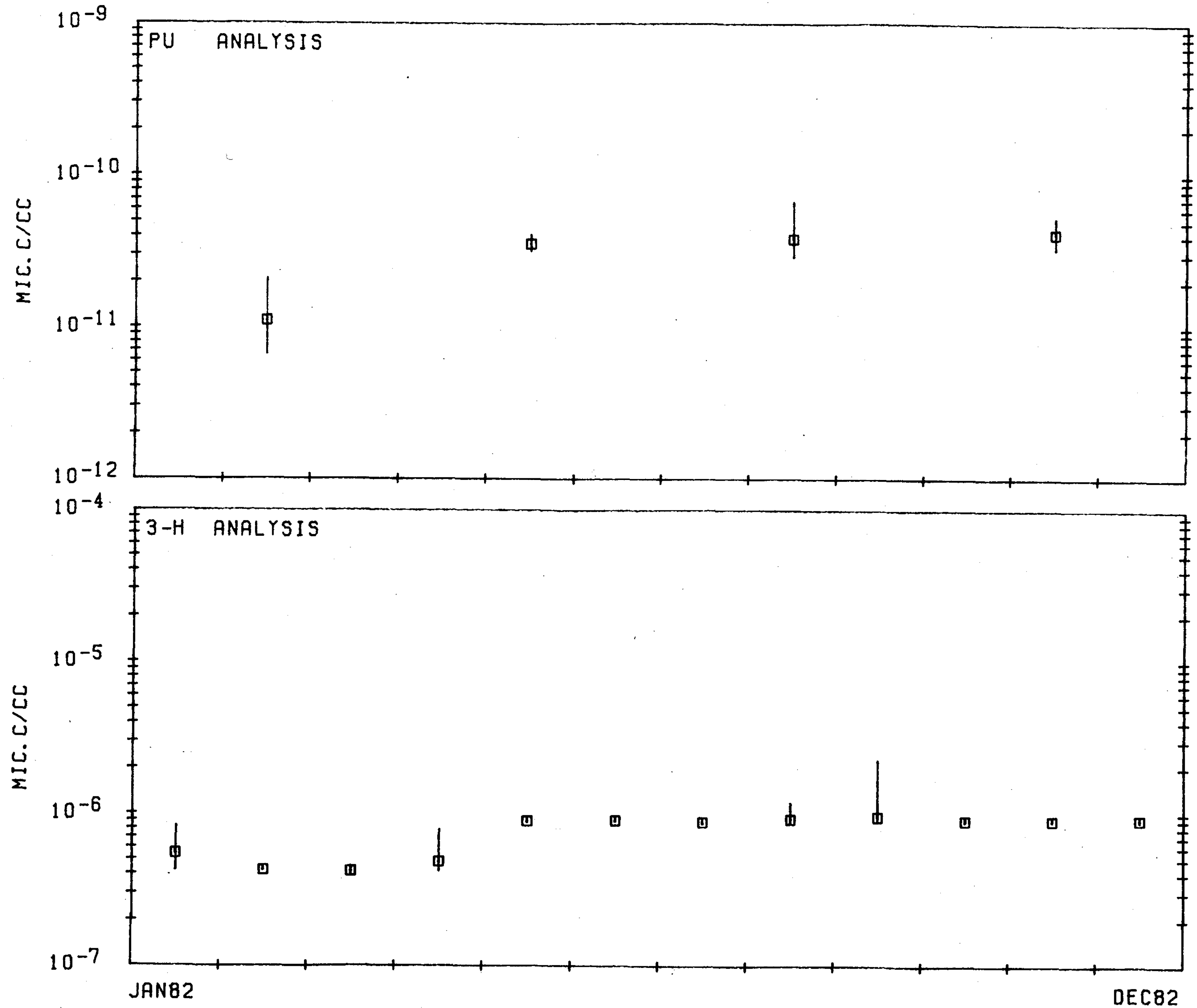
NTS ENVIRONMENTAL SURVEILLANCE
SUPPLY WELLS SAMPLING LOCATIONS

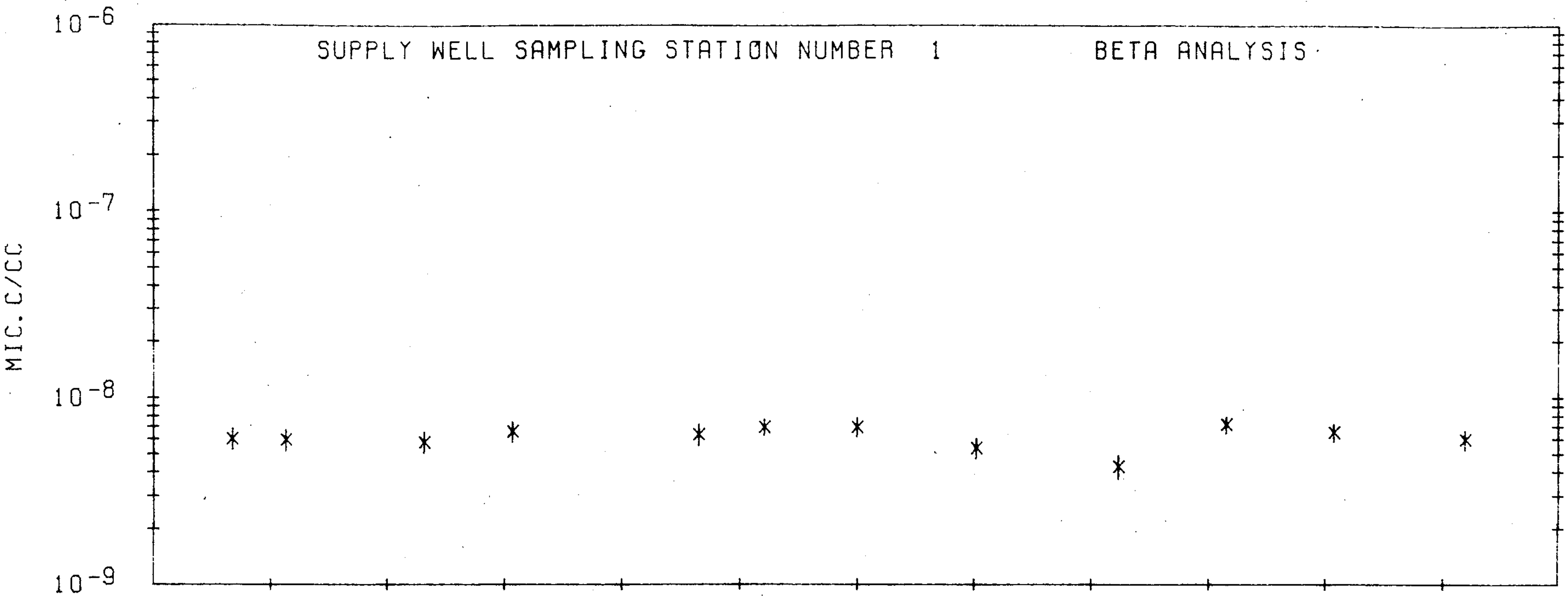
Station Number	Location
1	Area 2 Well 2
2	Area 3 Well A
3	Area 5 Well 5B
4	Area 5 Well 5C
5	Area 5 Well Ue5c
6	Area 6 Well C
7	Area 6 Well C1
9	Area 18 Well 8
13	Area 22 Army Well #1
14	Area 25 Well J12
15	Area 25 Well J13
18	Area 19 Well U19c

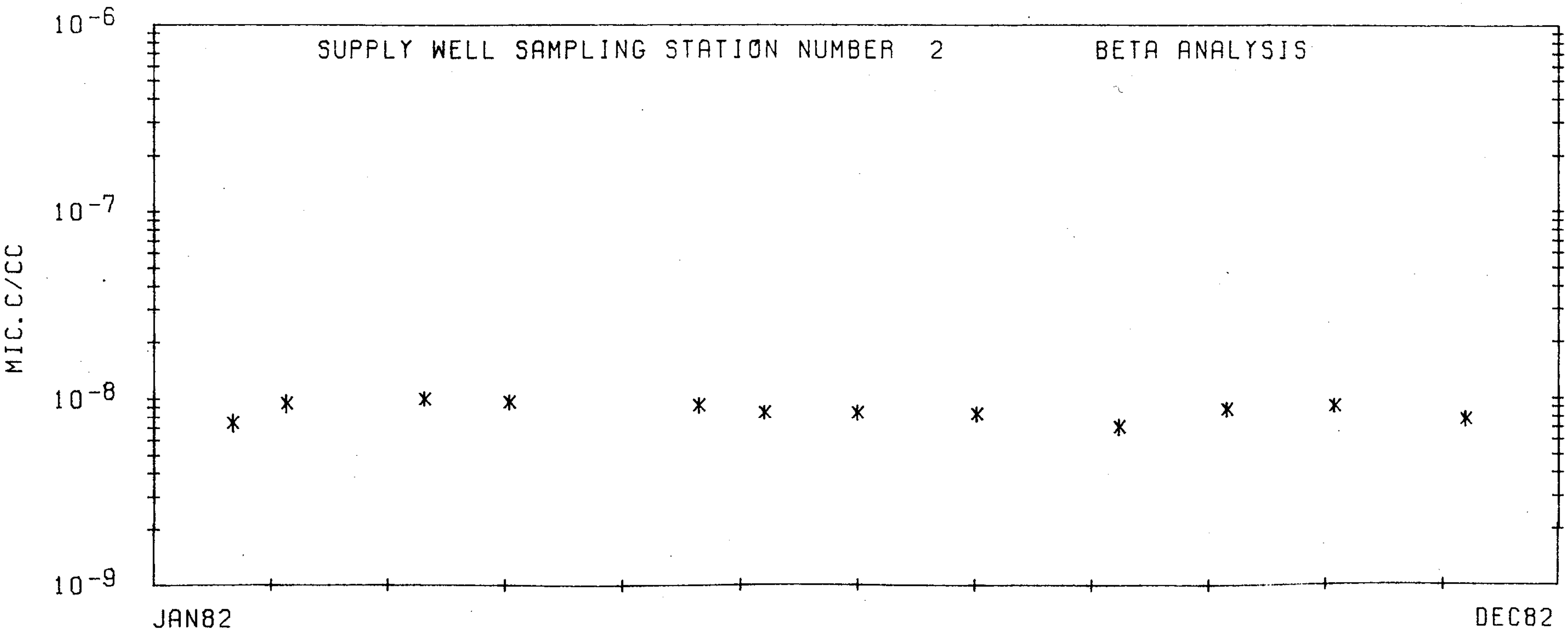


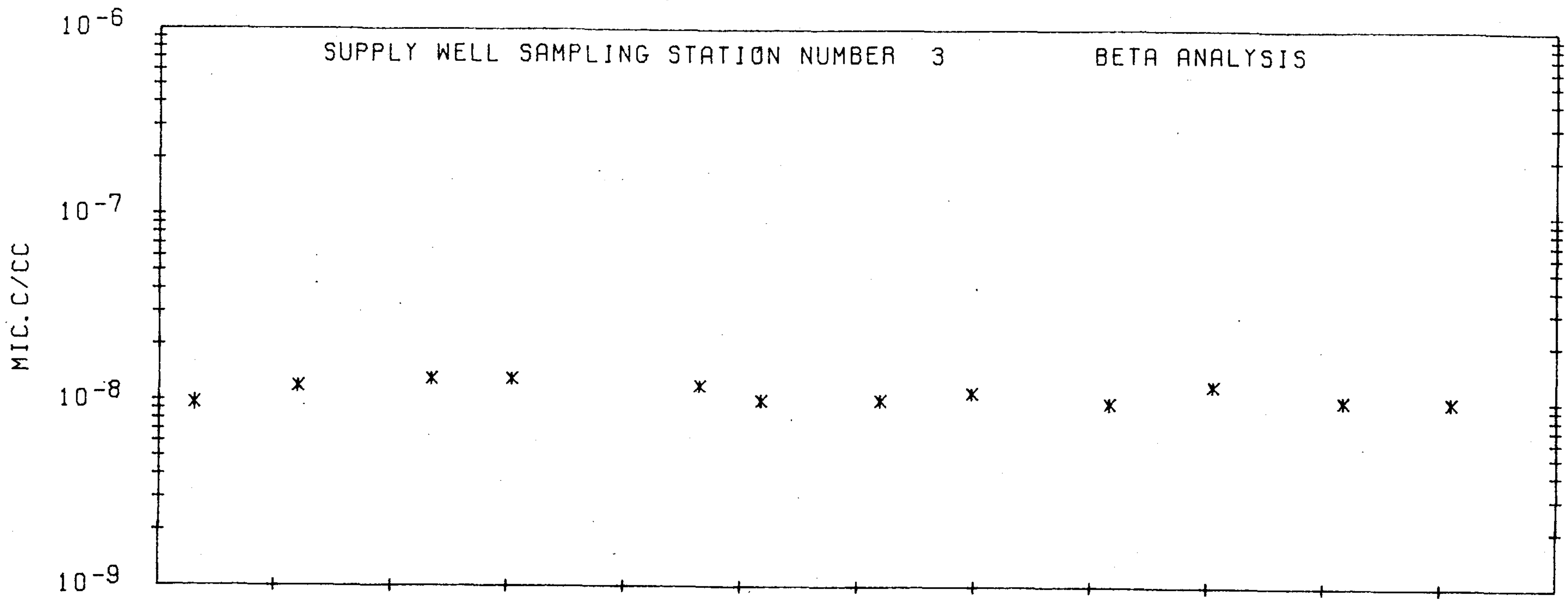
SUPPLY WELL NETWORK AVERAGES
BETA ANALYSIS
10^-6
10^-7
10^-8
10^-9
MIC.C/CC
JAN82
DEC82

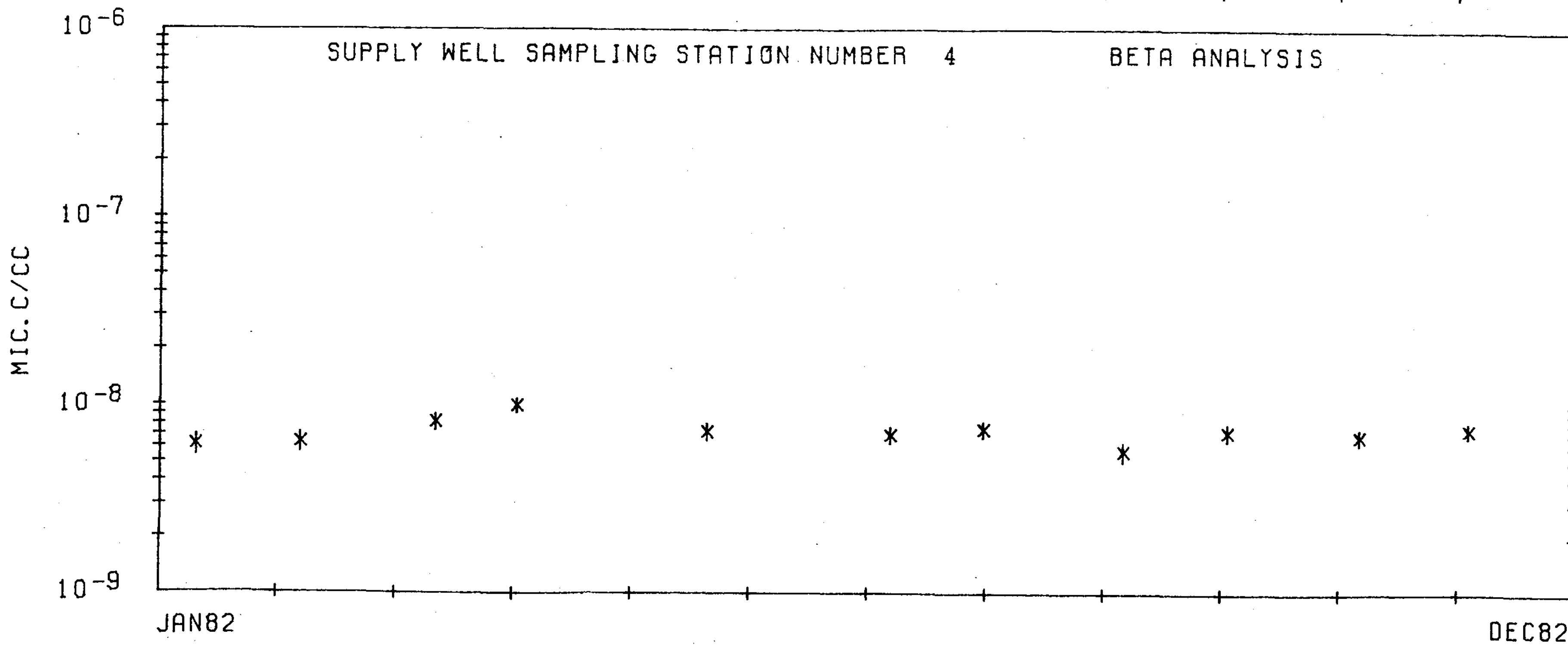
SUPPLY WELL NETWORK AVERAGES

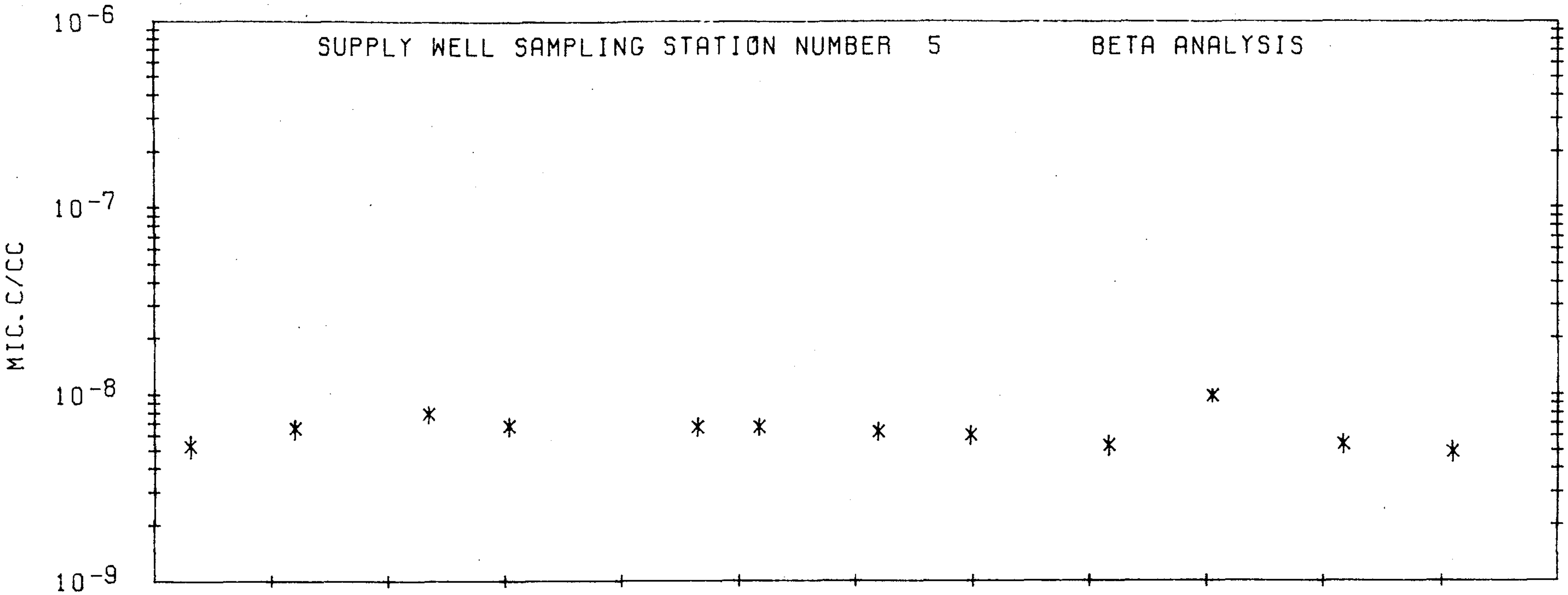


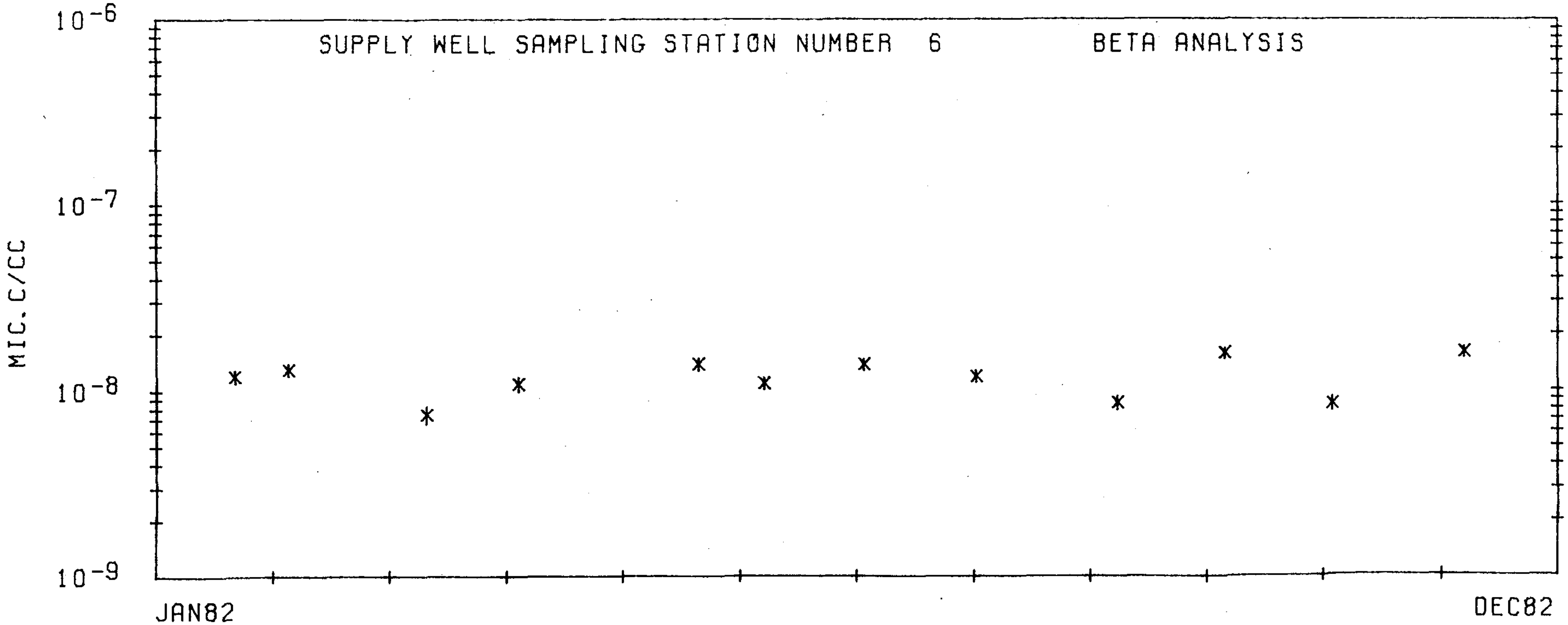

SUPPLY WELL SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

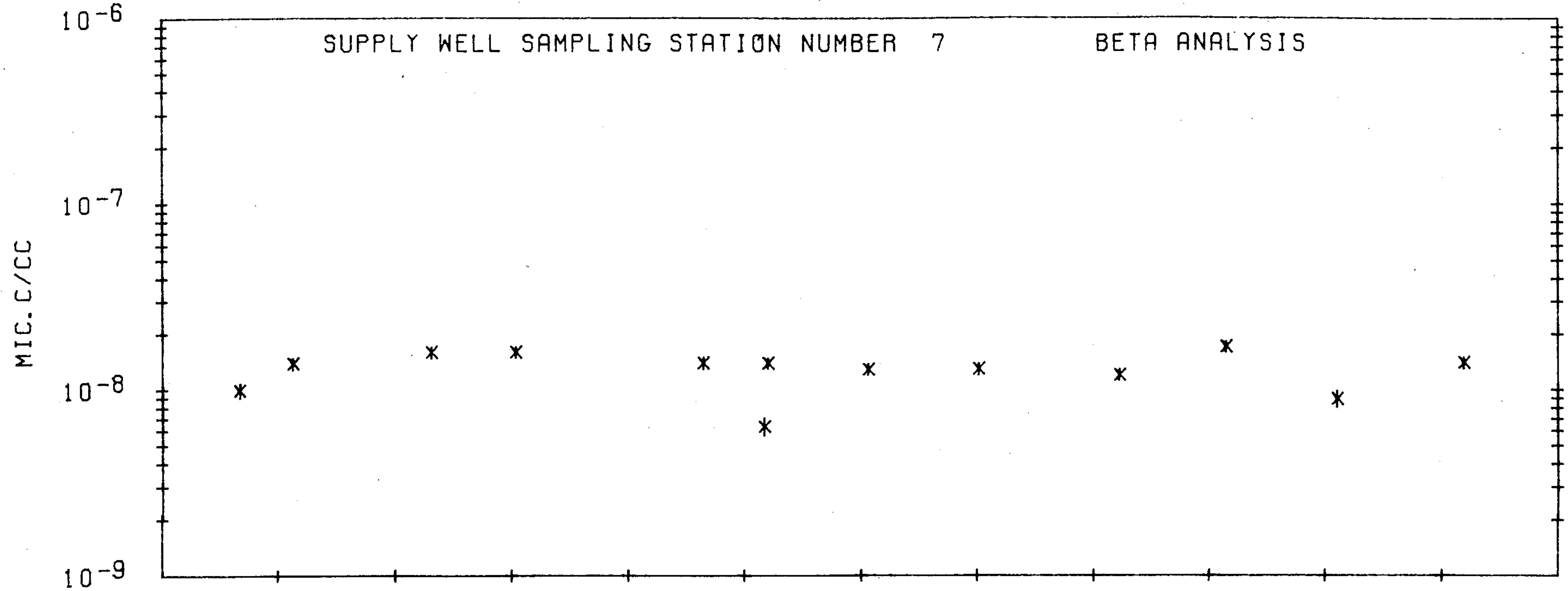

SUPPLY WELL SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

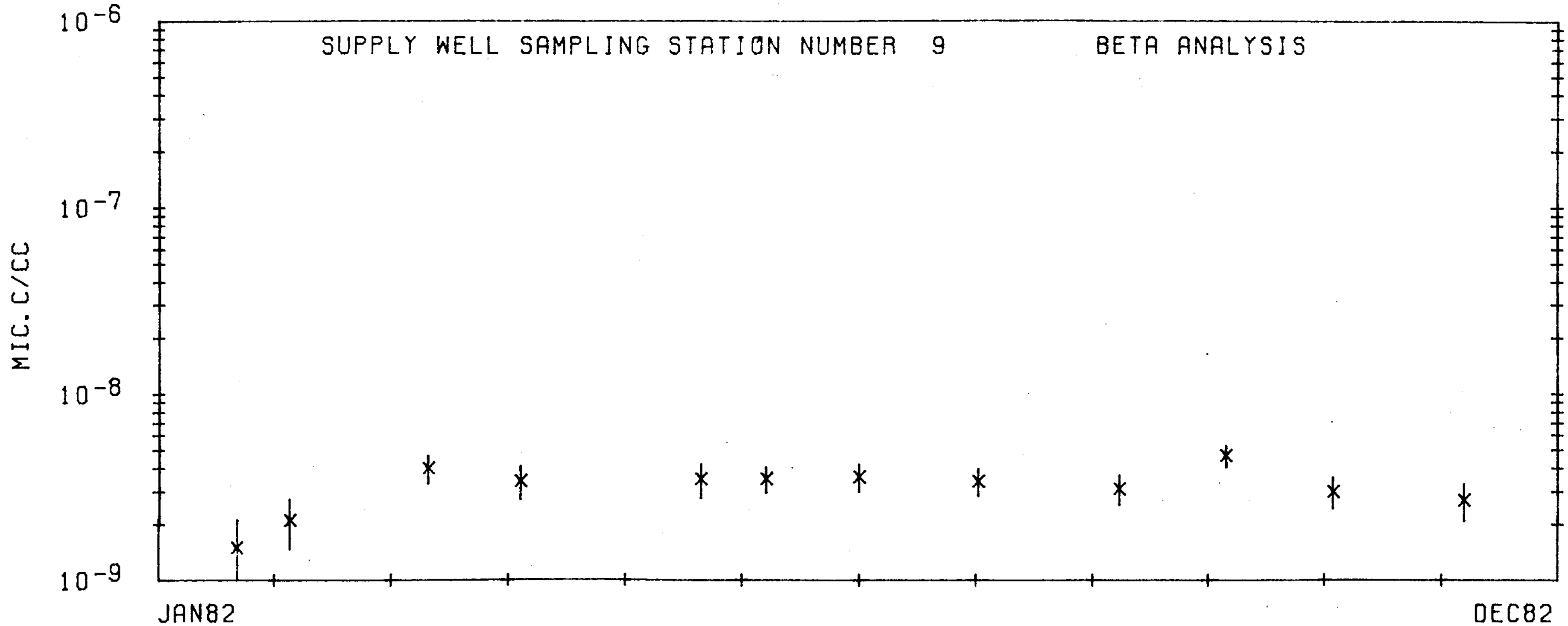

SUPPLY WELL SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9

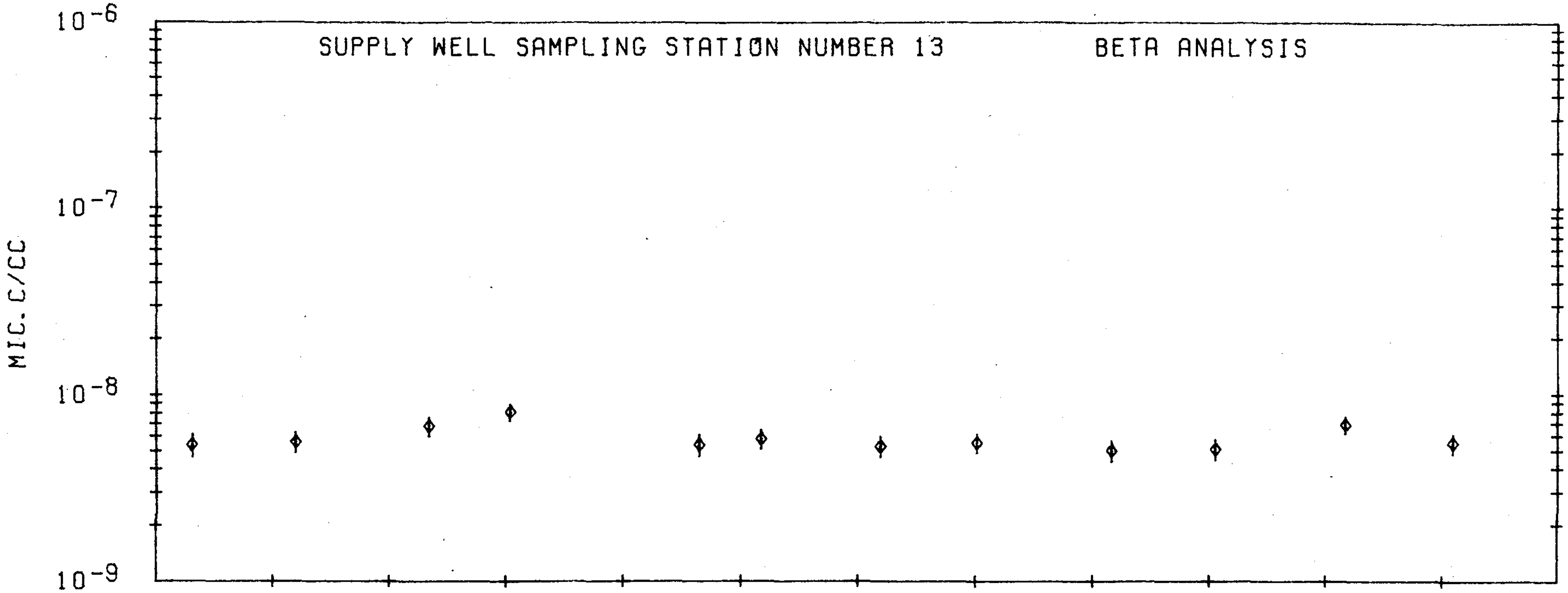

SUPPLY WELL SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN82
DEC82


SUPPLY WELL SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

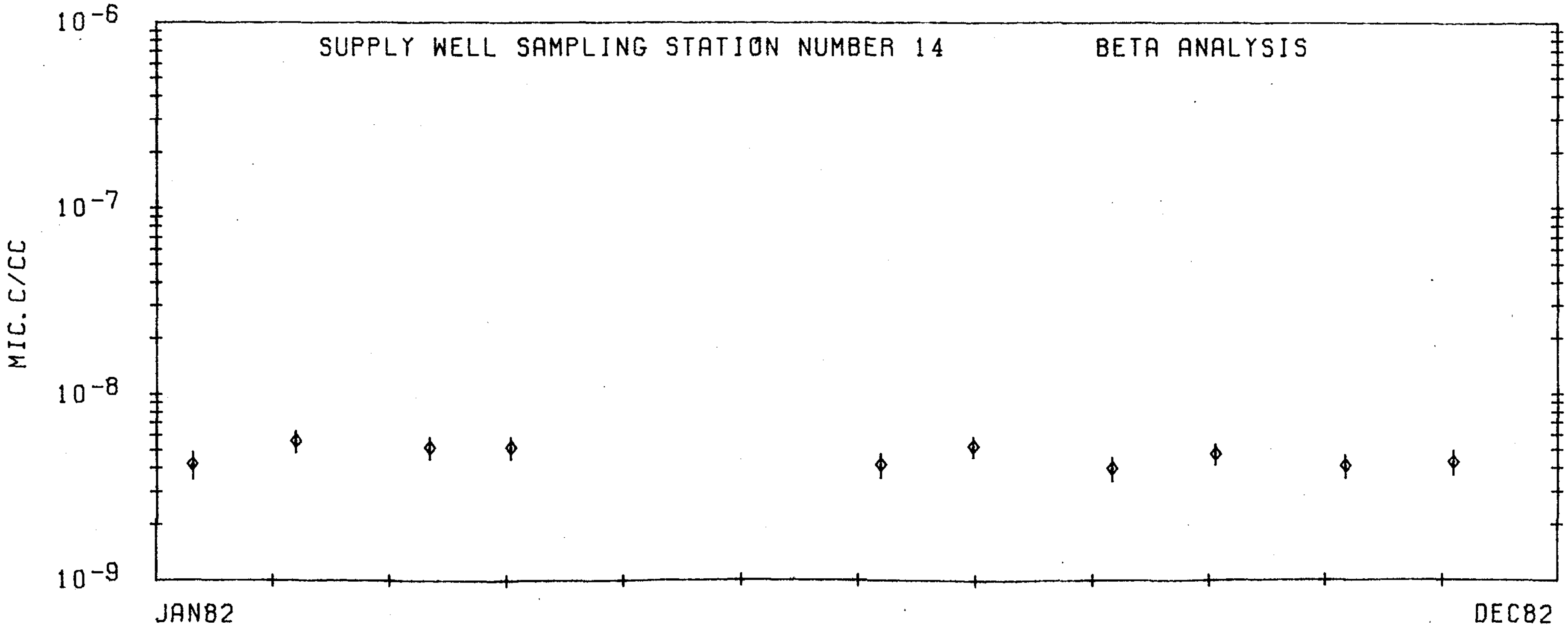

SUPPLY WELL SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82


SUPPLY WELL SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

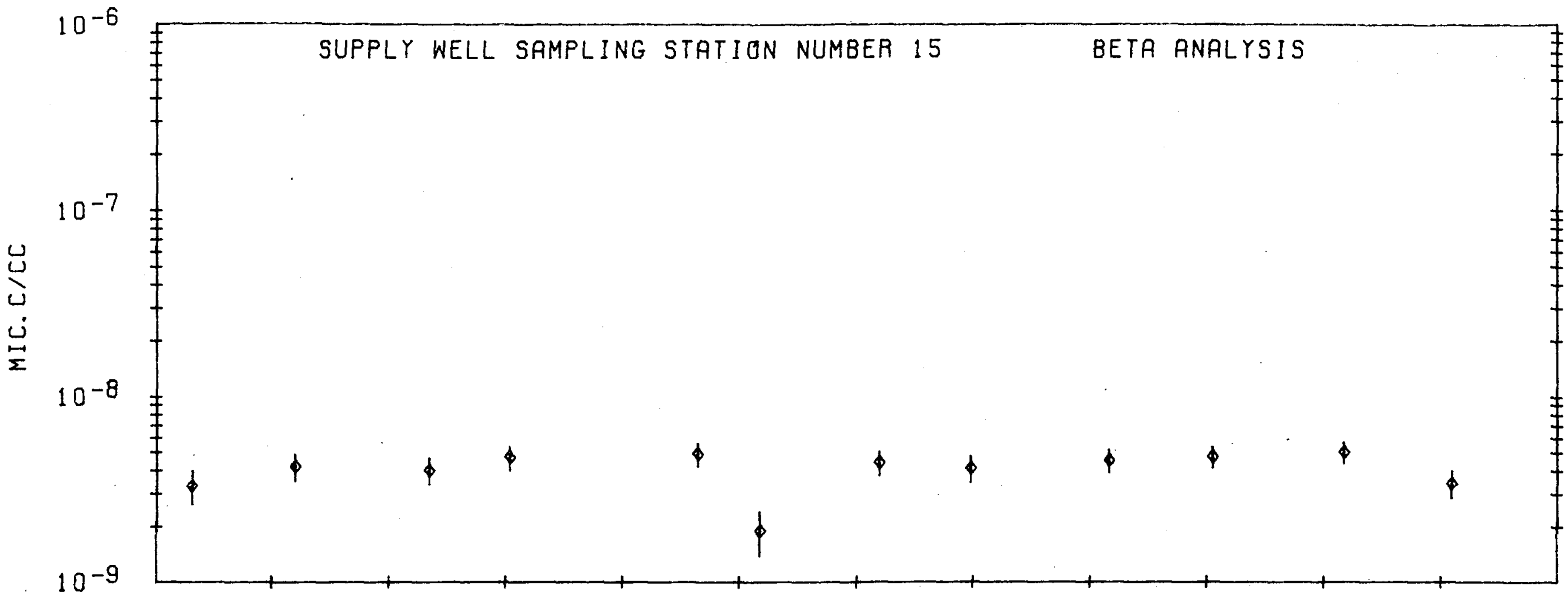

SUPPLY WELL SAMPLING STATION NUMBER 9
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

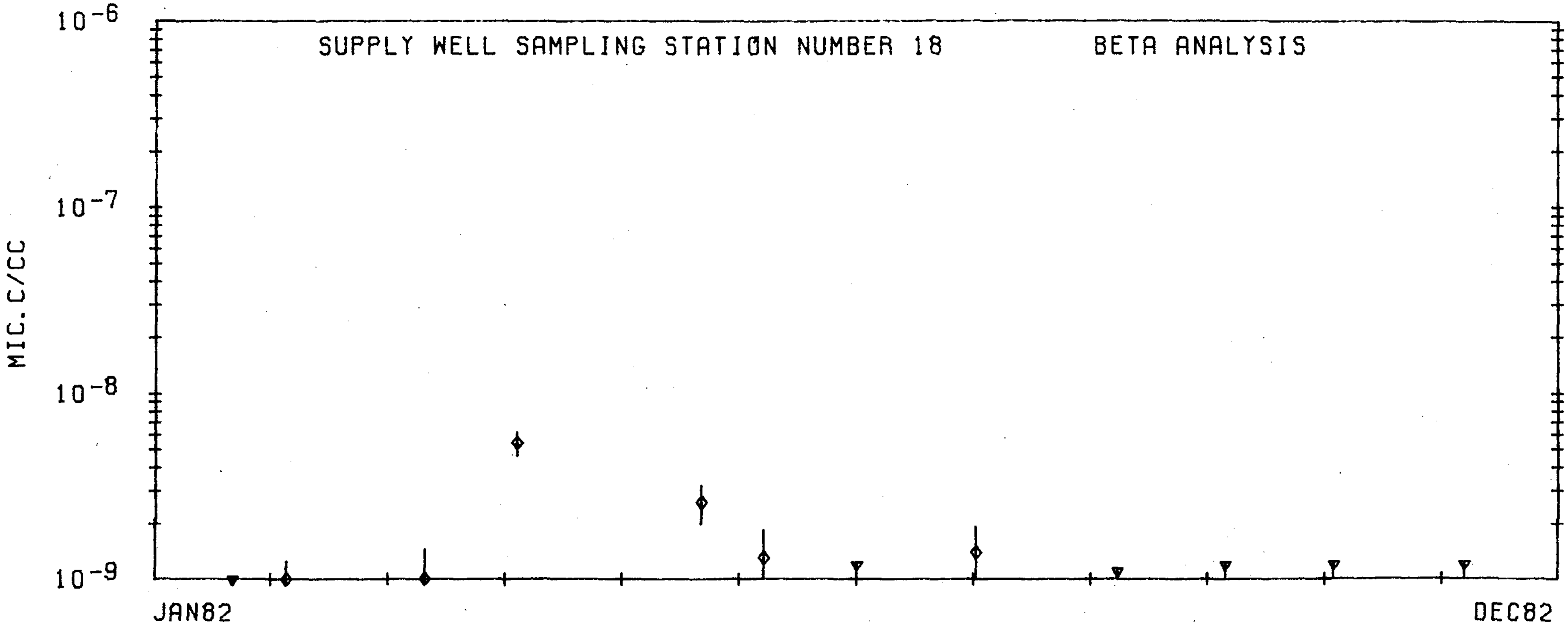


SUPPLY WELL SAMPLING STATION NUMBER 13
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}



SUPPLY WELL SAMPLING STATION NUMBER 14
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82


SUPPLY WELL SAMPLING STATION NUMBER 15
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


SUPPLY WELL SAMPLING STATION NUMBER 18
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

A P P E N D I X D

NTS Environmental Surveillance

Potable Water Locations and Plots

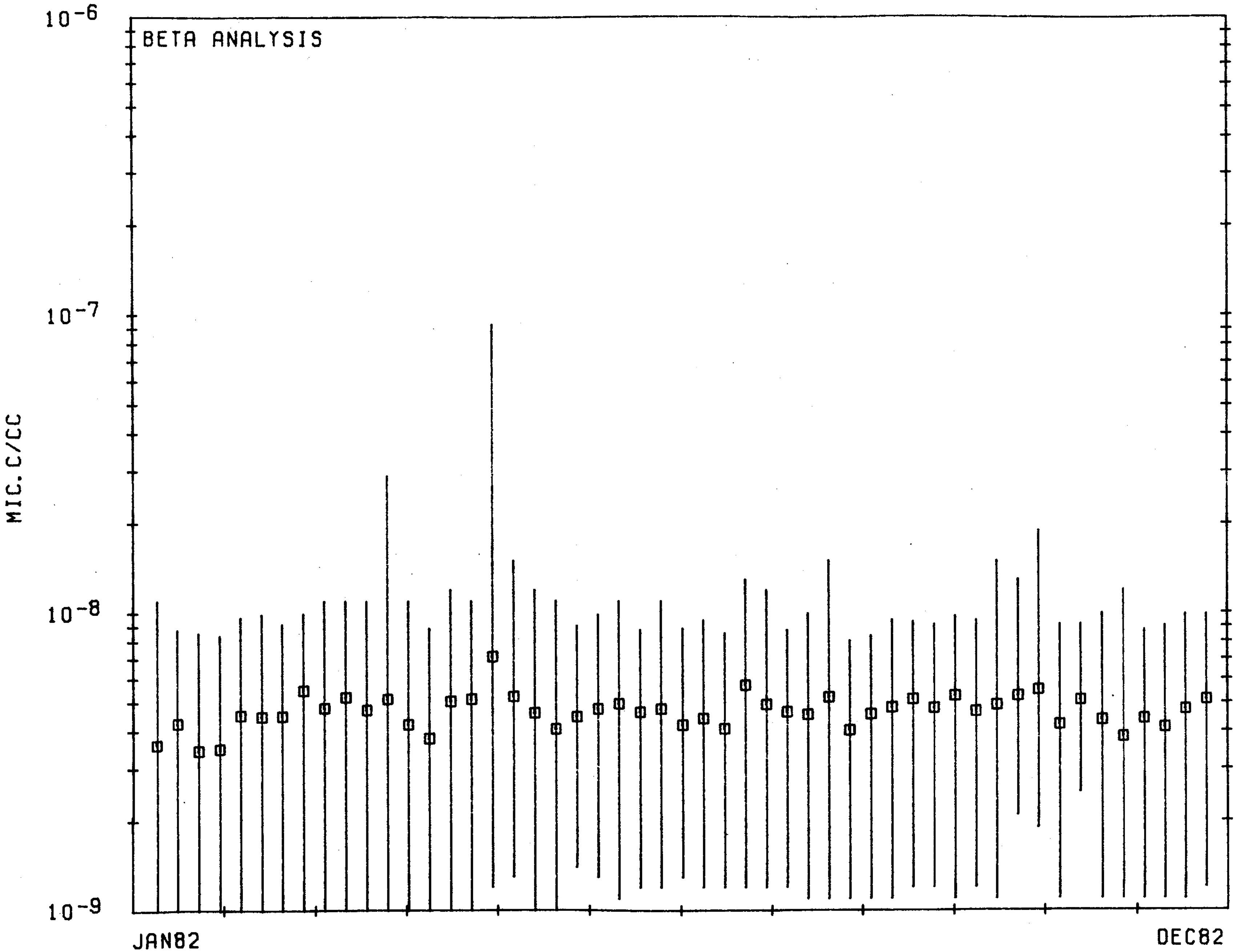
In the first two pages of plots in Appendix D, the potable water network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots show the gross beta data of each station. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

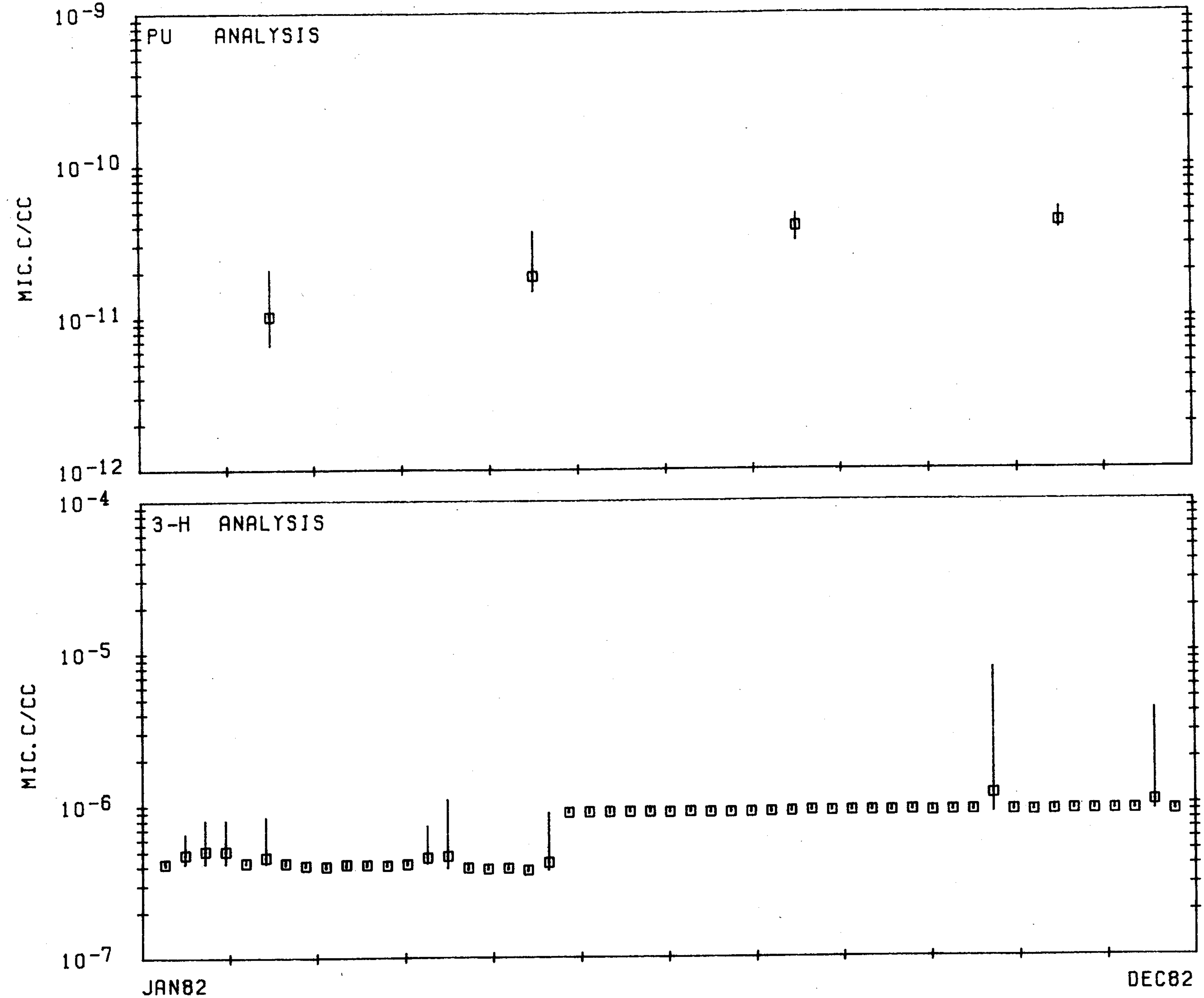
NTS ENVIRONMENTAL SURVEILLANCE
POTABLE WATER SAMPLING LOCATIONS

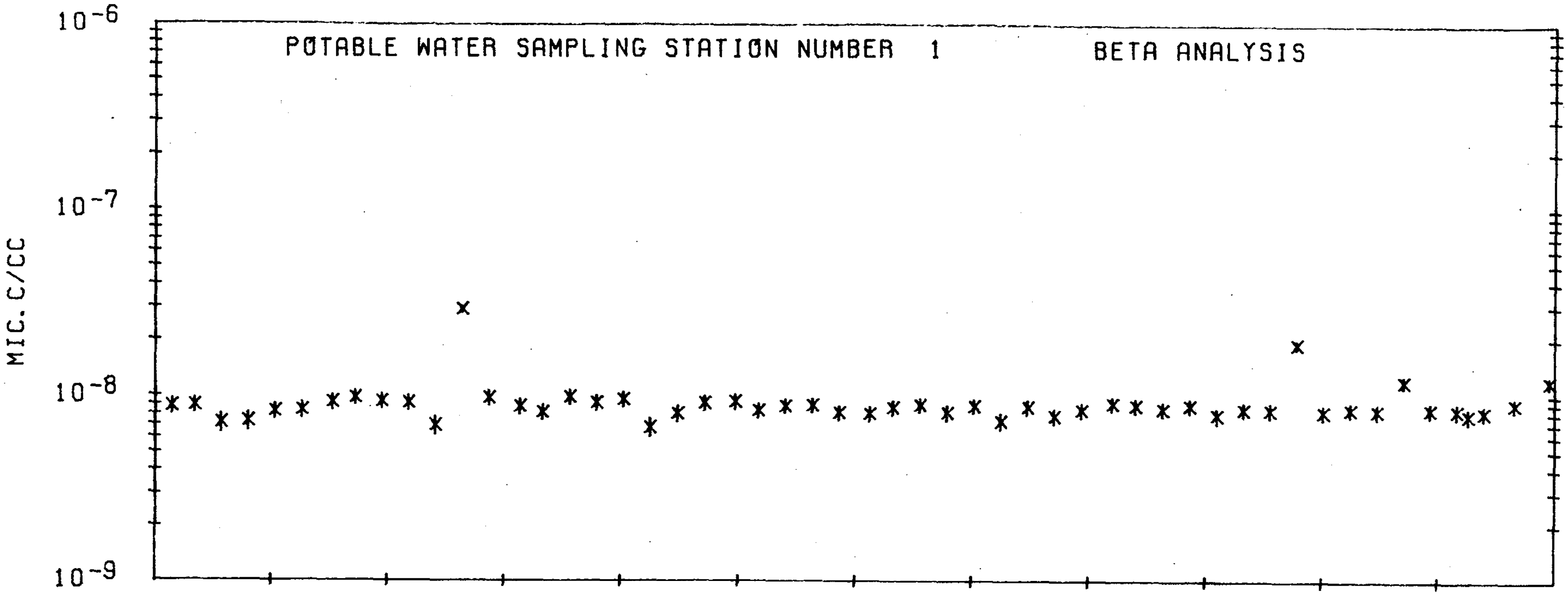
Station Number	Location
1	Area 3 Cafeteria
2	Area 2 Rest Room
3	Area 12 Cafeteria
4	Area 23 Cafeteria
5	Area 27 Cafeteria
6	Area 6 Cascade Water
7	Area 6 Cafeteria
10	Area 25 Service Station

POTABLE WATER NETWORK AVERAGES

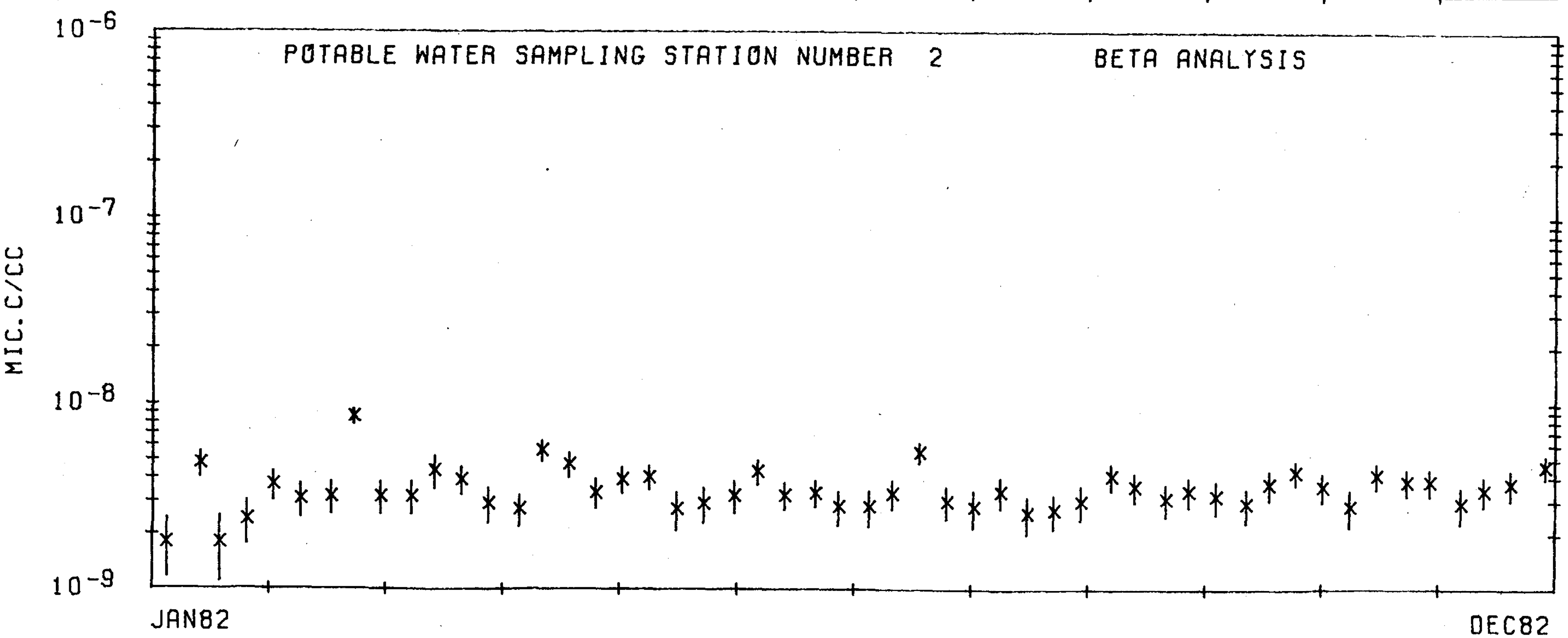


POTABLE WATER NETWORK AVERAGES

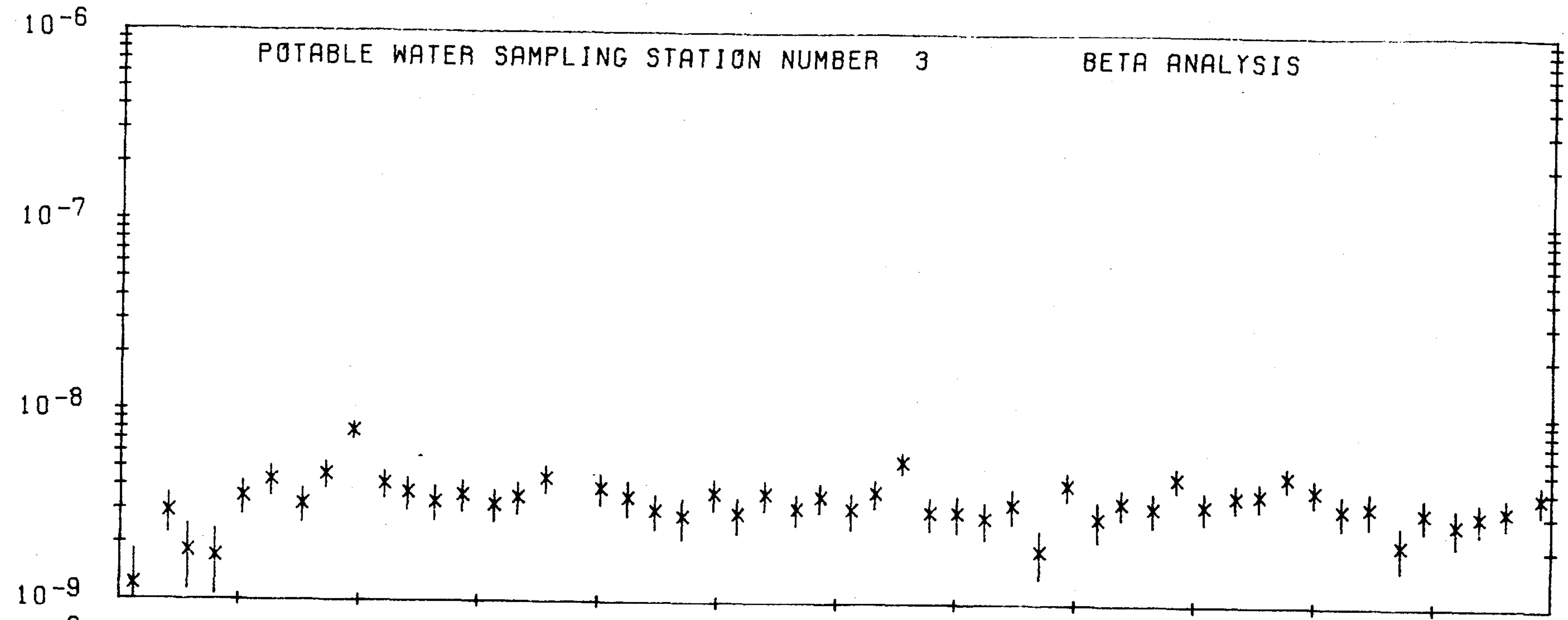


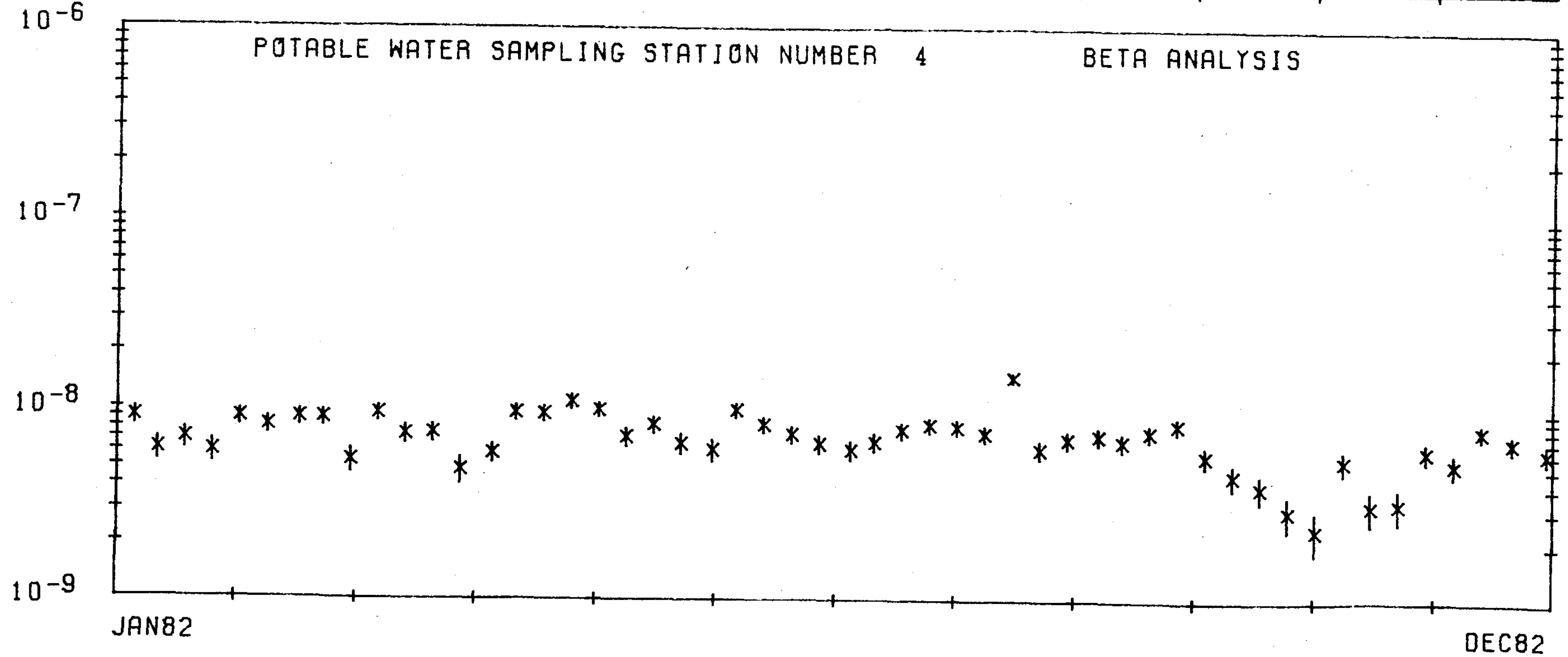


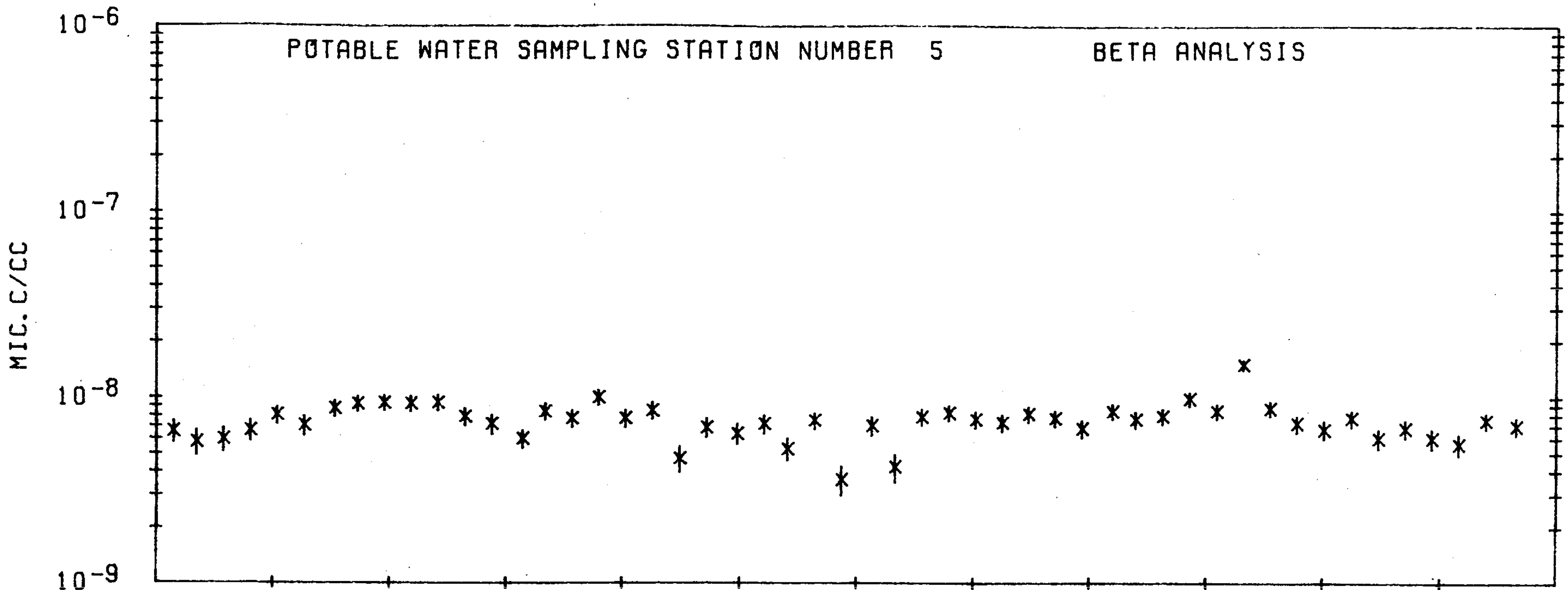
POTABLE WATER SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9



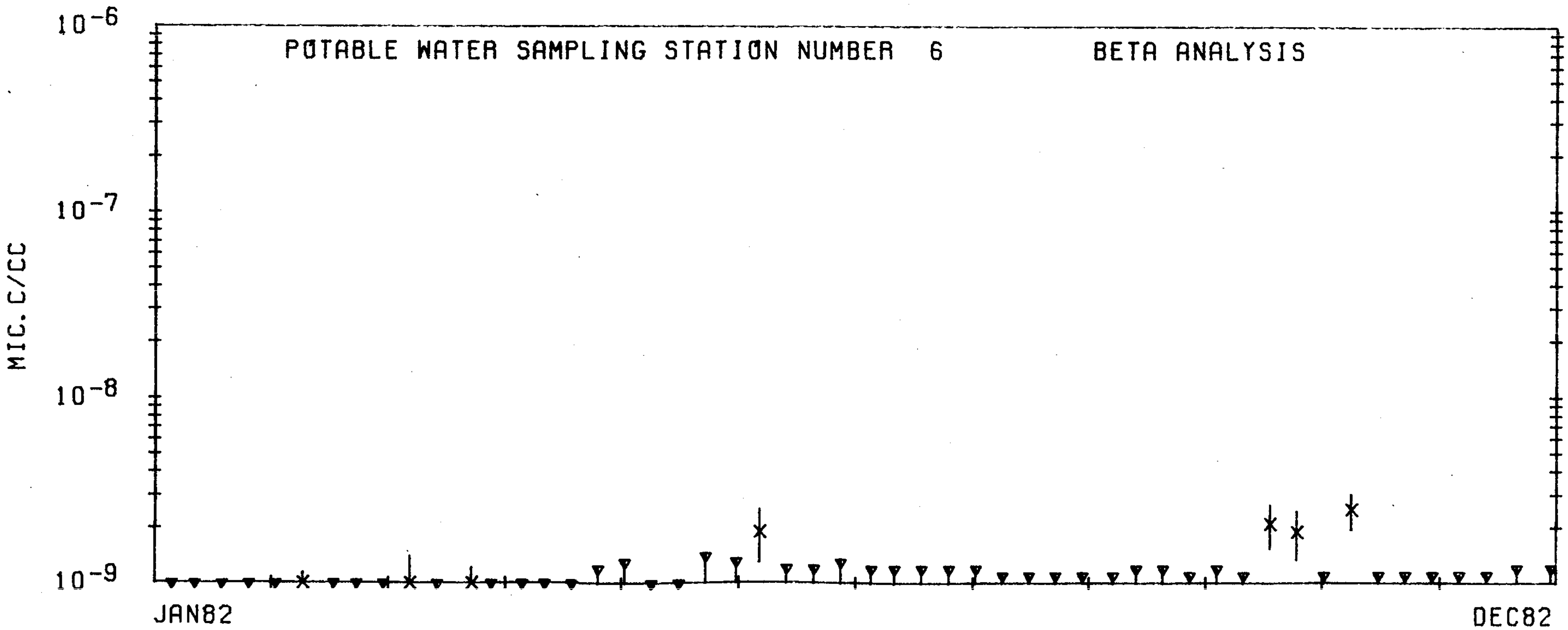
POTABLE WATER SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10^-6
10^-7
10^-8
10^-9
JAN82
DEC82


POTABLE WATER SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

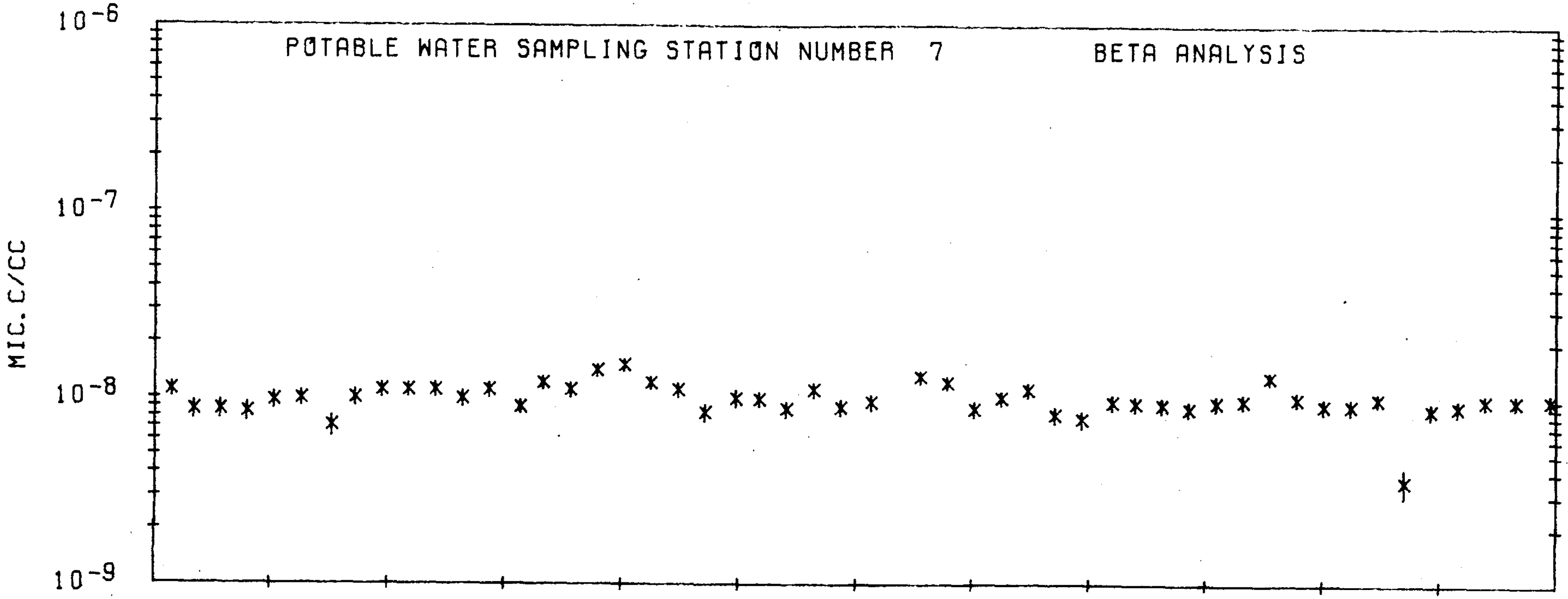

POTABLE WATER SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

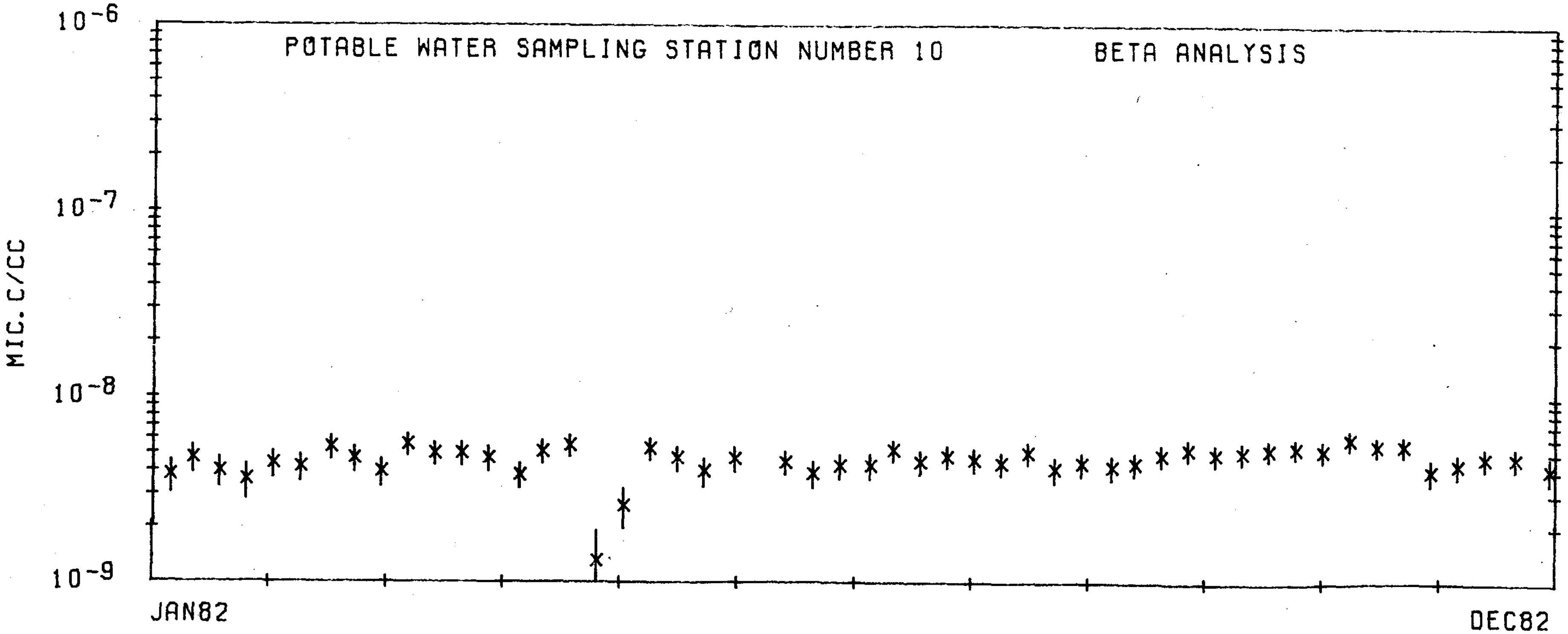


POTABLE WATER SAMPLING STATION NUMBER 5 BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}



POTABLE WATER SAMPLING STATION NUMBER 6 BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82


POTABLE WATER SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


POTABLE WATER SAMPLING STATION NUMBER 10
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

APPENDIX E

NTS Environmental Surveillance

Open Reservoir Locations and Plots

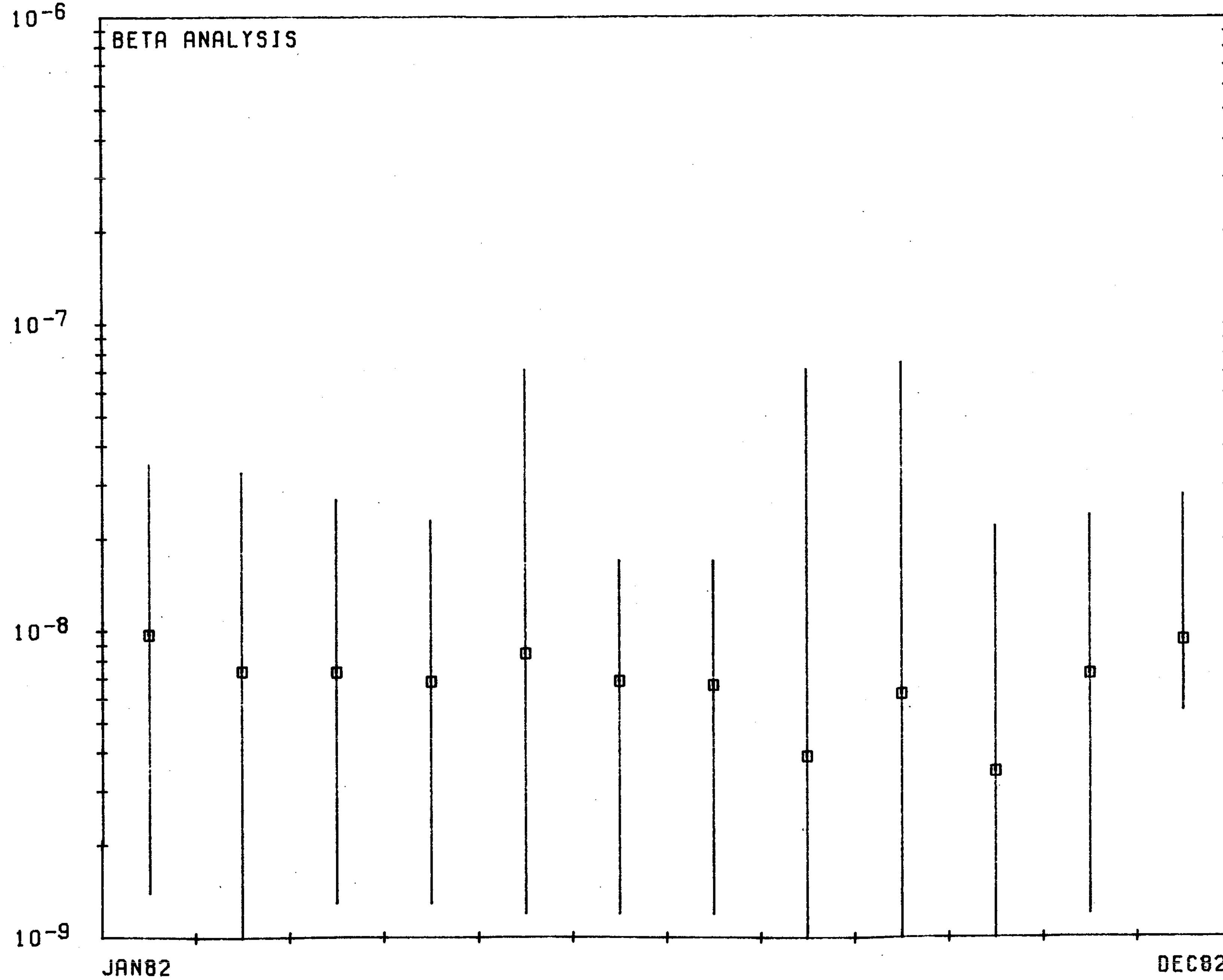
Several symbols are used in Appendix E to denote the data points. In the first two pages of plots, the open reservoir network averages, a square represents the arithmetic mean of all values at that point in time, and the vertical line is the range of the data. The remaining plots of Appendix E show the gross beta data of each station. A two-sigma error is also added to the data points, and, in all plots, a delta with the line to the bottom of the plot means below detection limit.

NTS ENVIRONMENTAL SURVEILLANCE
OPEN RESERVOIRS SAMPLING LOCATIONS

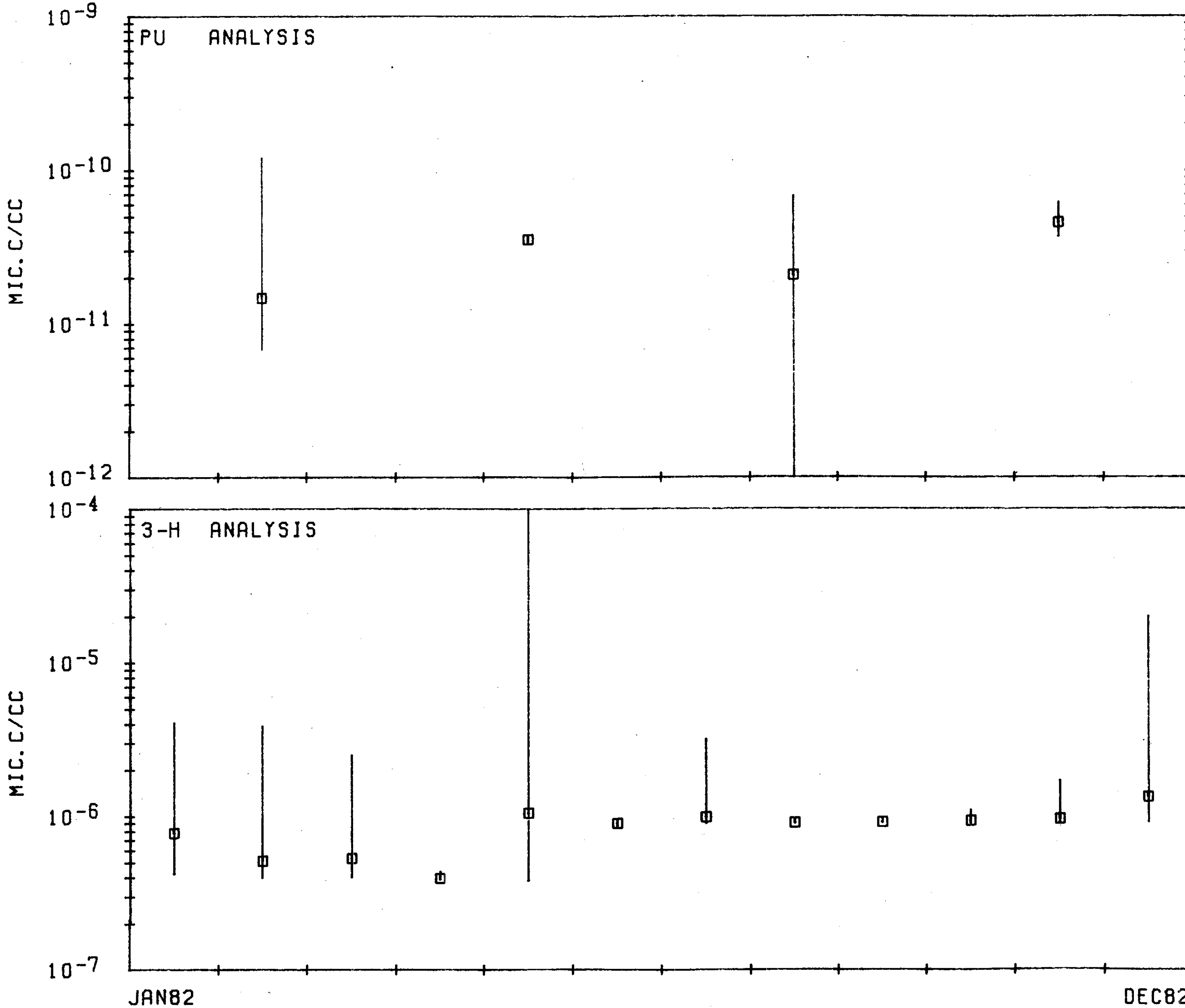
Station Number	Location
1	Area 2 Well 2 Reservoir
2	Area 3 Well A Reservoir
3	Area 5 Well 5B Reservoir
4	Area 5 Well Ue5c Reservoir
5	Area 6 Well 3 Reservoir
6	Area 6 Well C1 Reservoir
* 7	Area 15 Well Ue15d Reservoir
8	Area 18 Camp 17 Reservoir
11	Area 20 Well 20A Reservoir
12	Area 23 Swimming Pool
16	Area 19 Well U19c Reservoir
* 17	Area 25 Well J-12 Reservoir
18	Area 3 Mud Plant Reservoir
19	Area 2 Mud Plant Reservoir
20	Area 25 Well J-11 Reservoir
21	Area 18 Well 8 Reservoir
22	Area 5 Reservoir

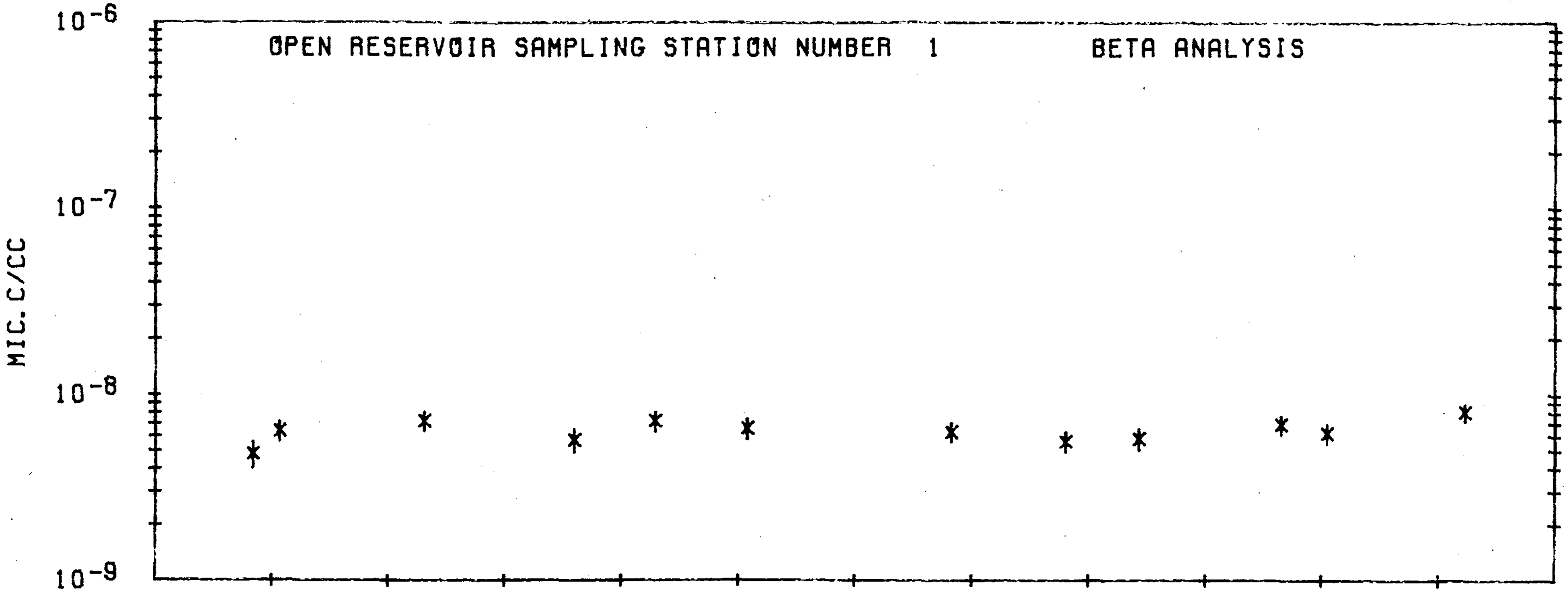
* Reservoirs were dry.

OPEN RESERVOIR NETWORK AVERAGES

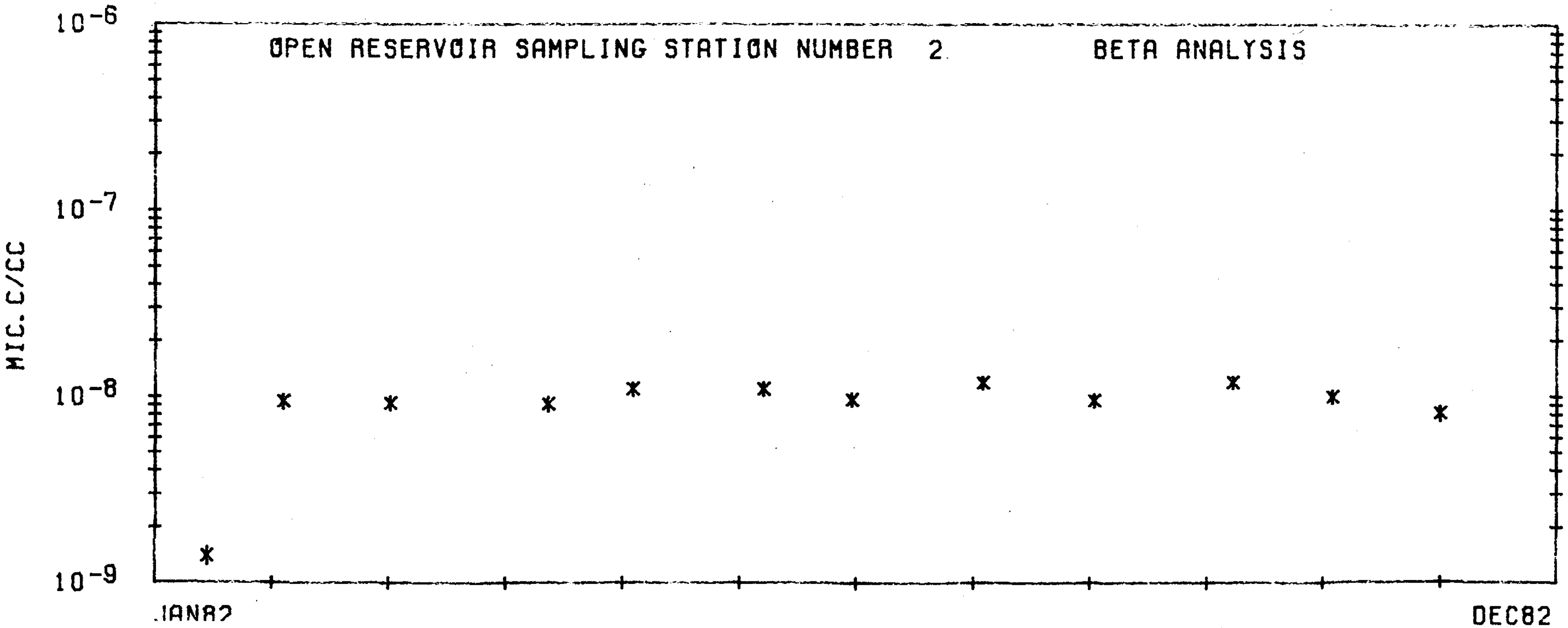


OPEN RESERVOIR NETWORK AVERAGES

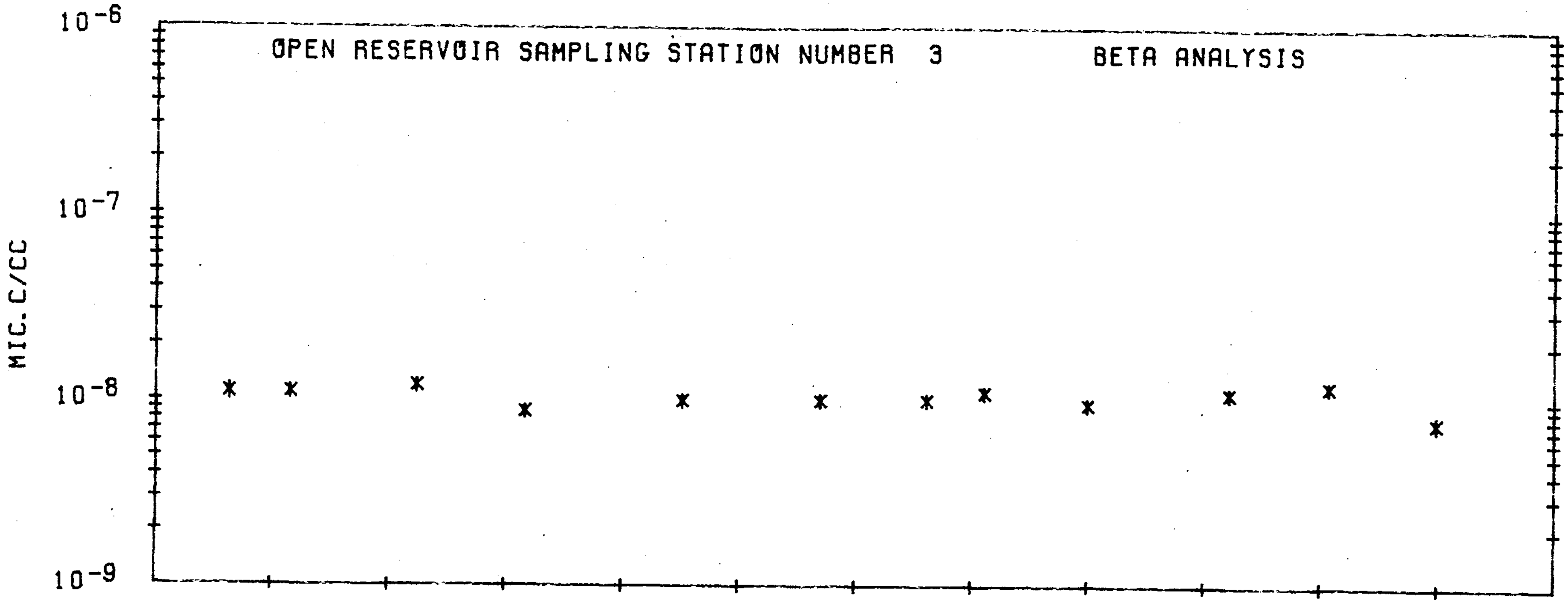


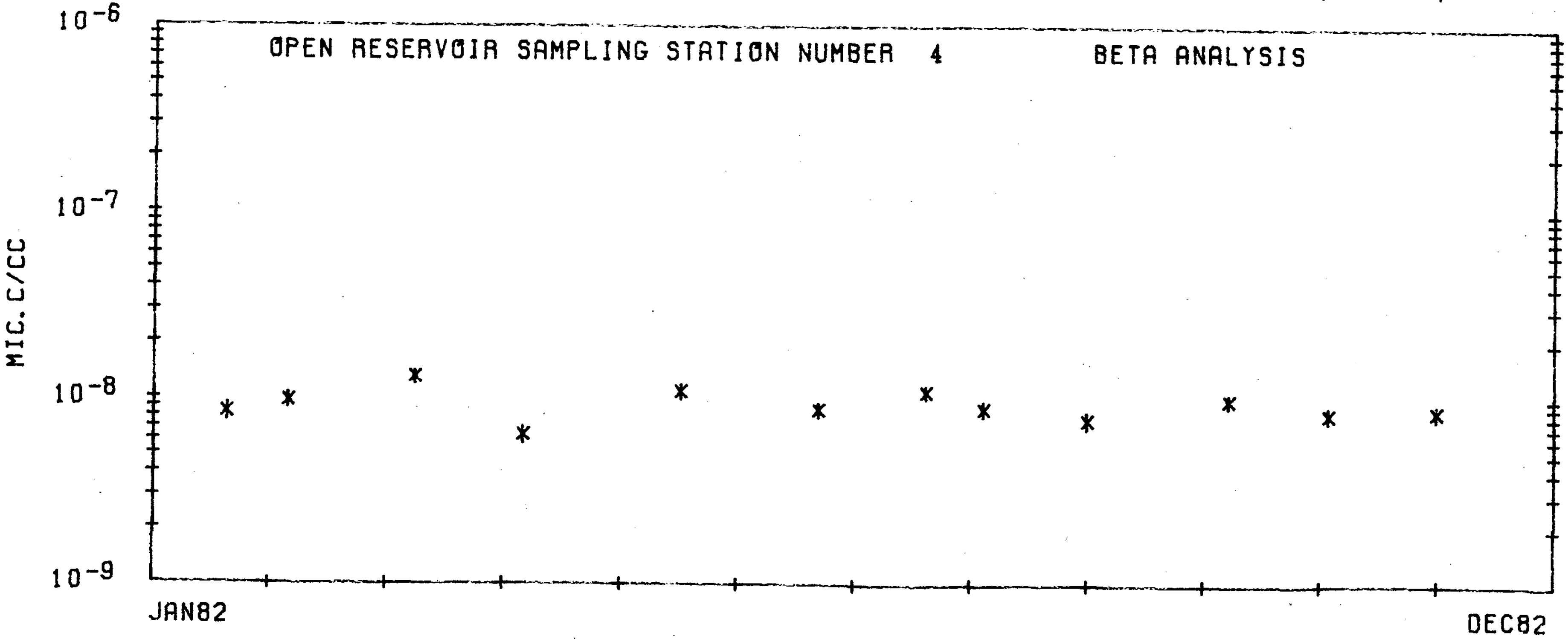


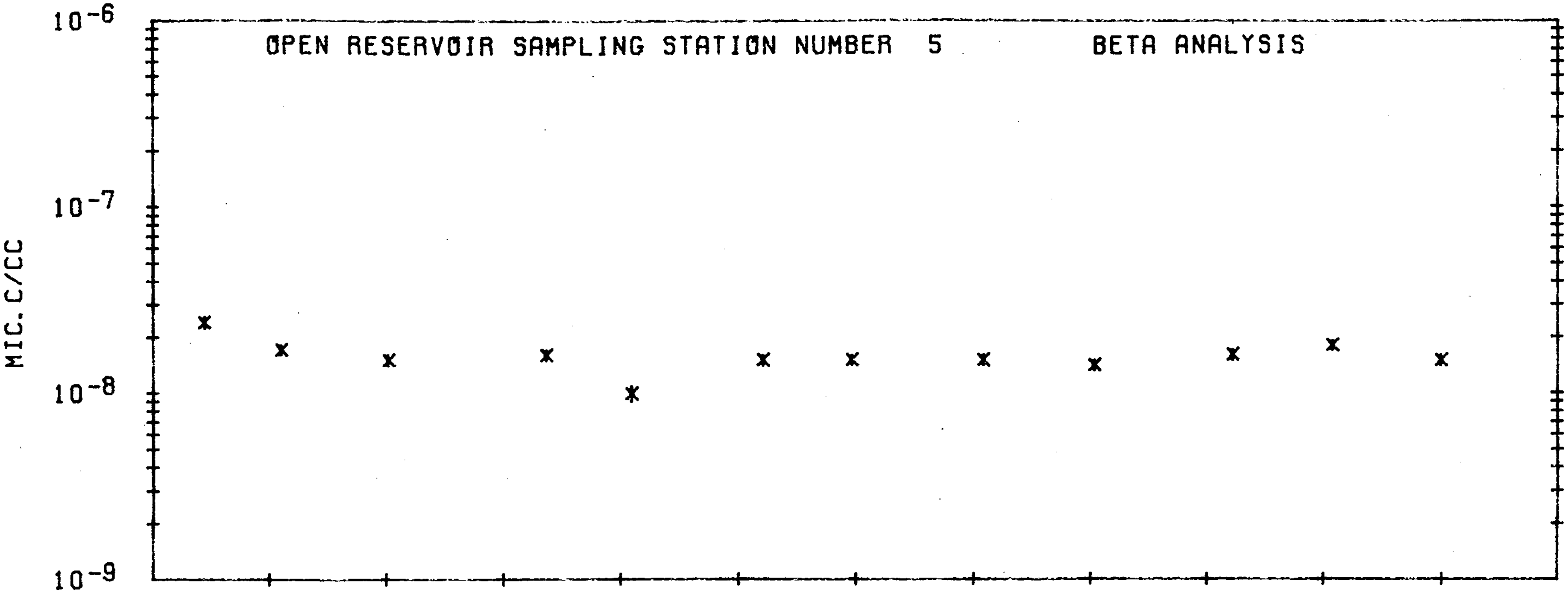
OPEN RESERVOIR SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

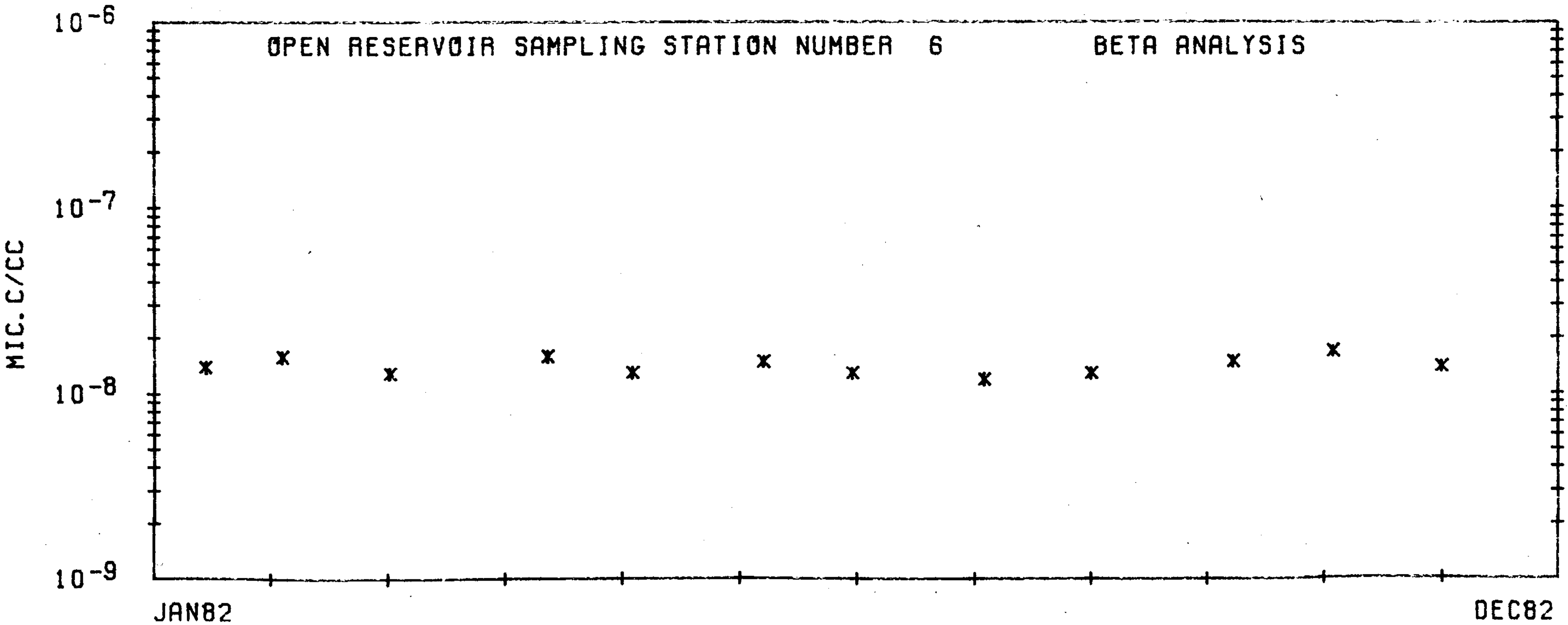


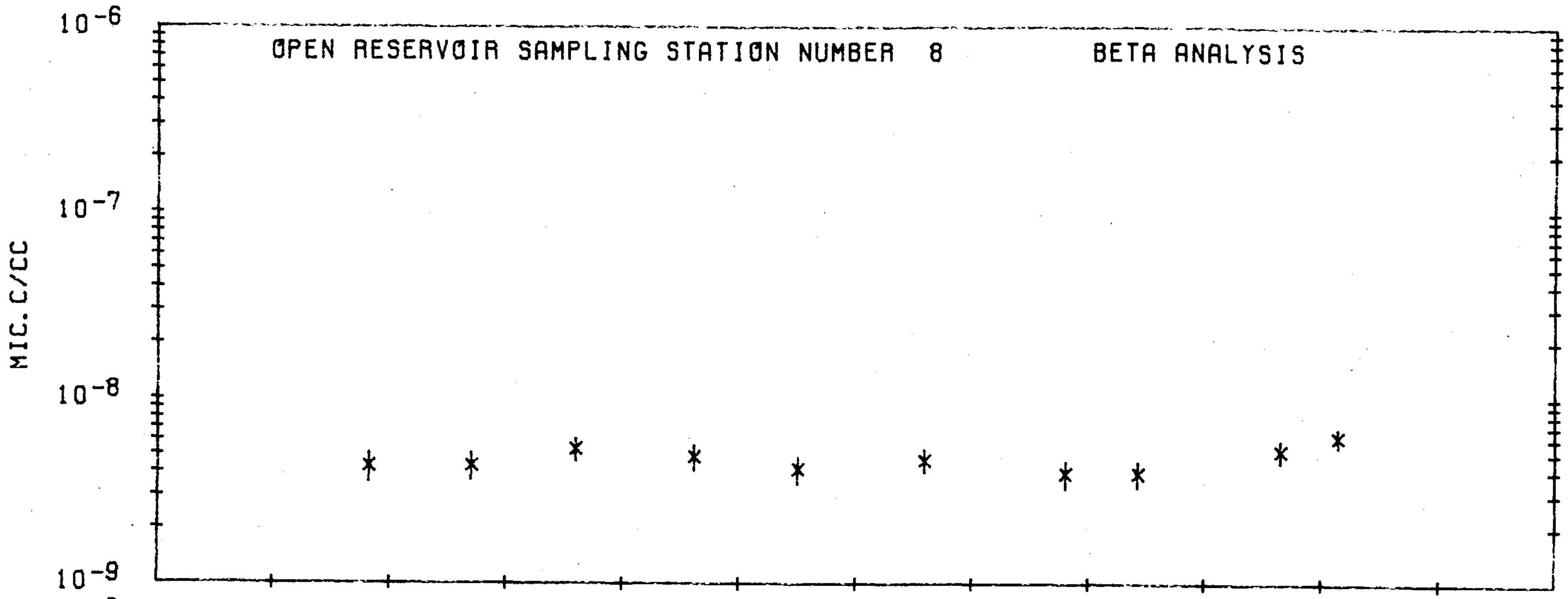
OPEN RESERVOIR SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

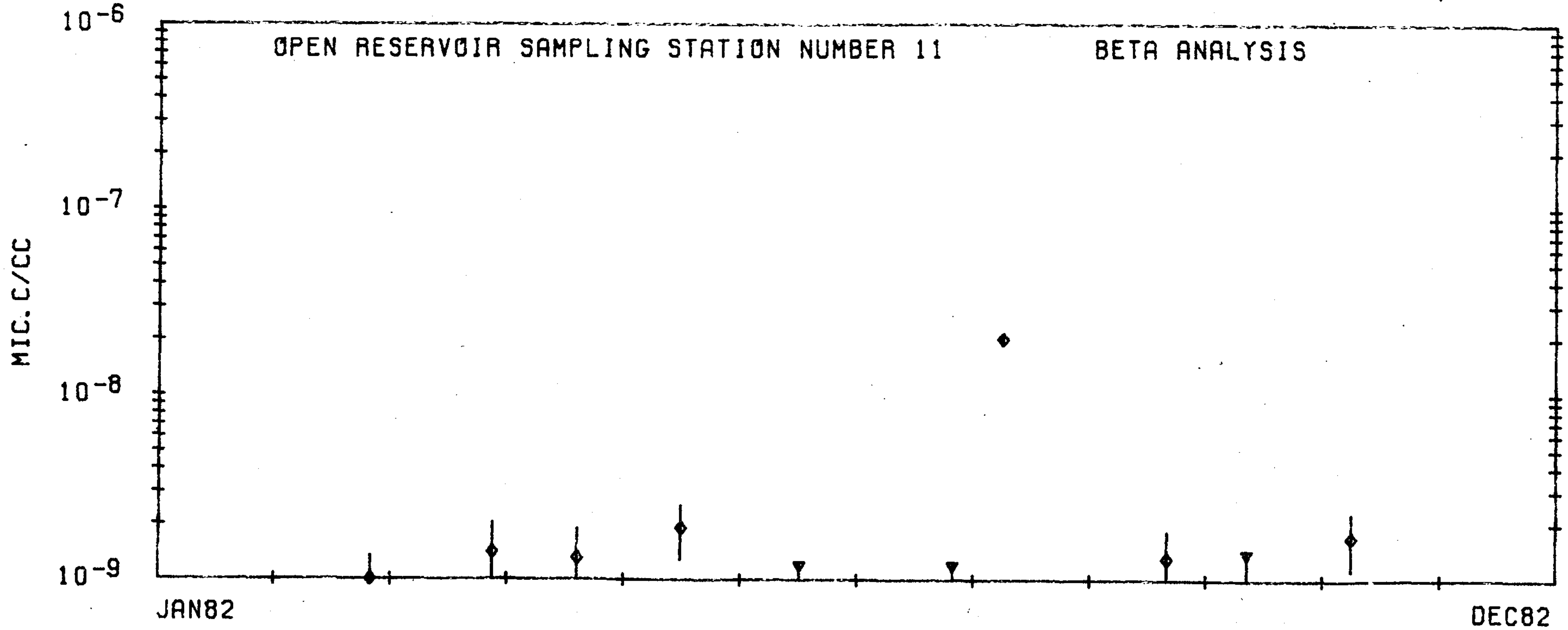

OPEN RESERVOIR SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

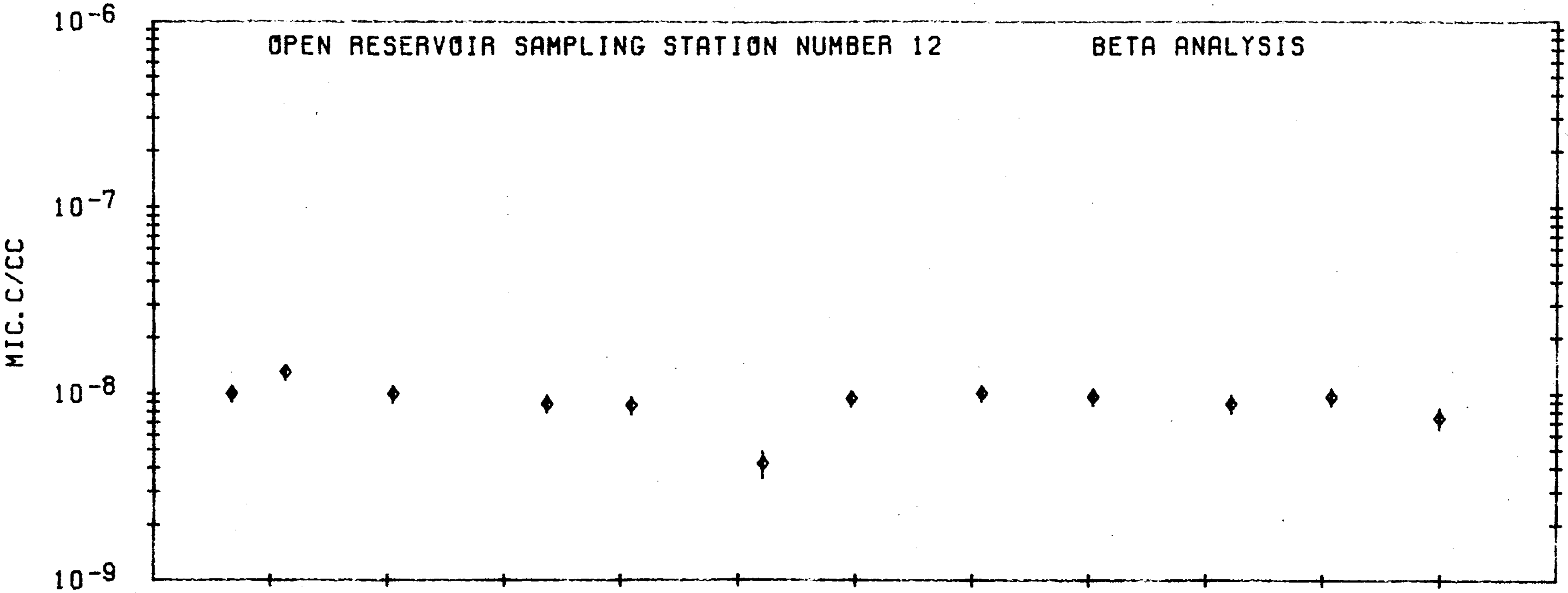

OPEN RESERVOIR SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

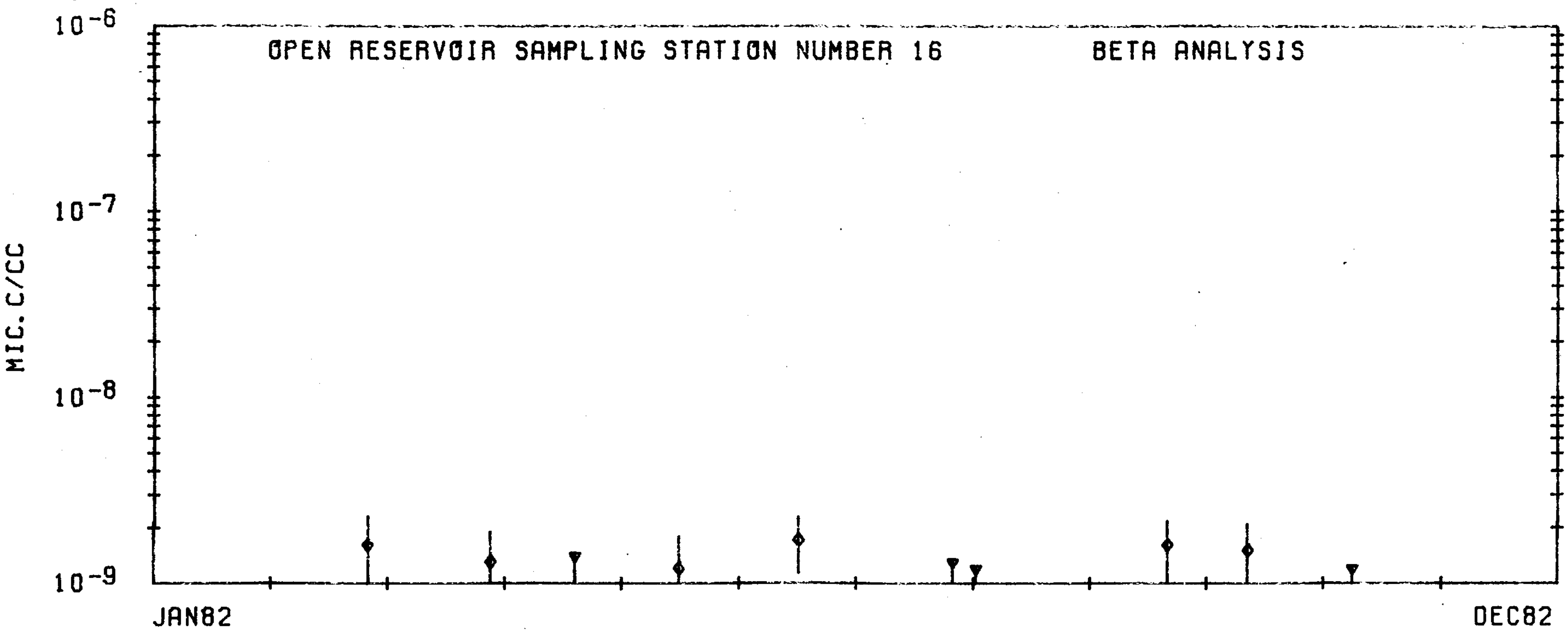

OPEN RESERVOIR SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

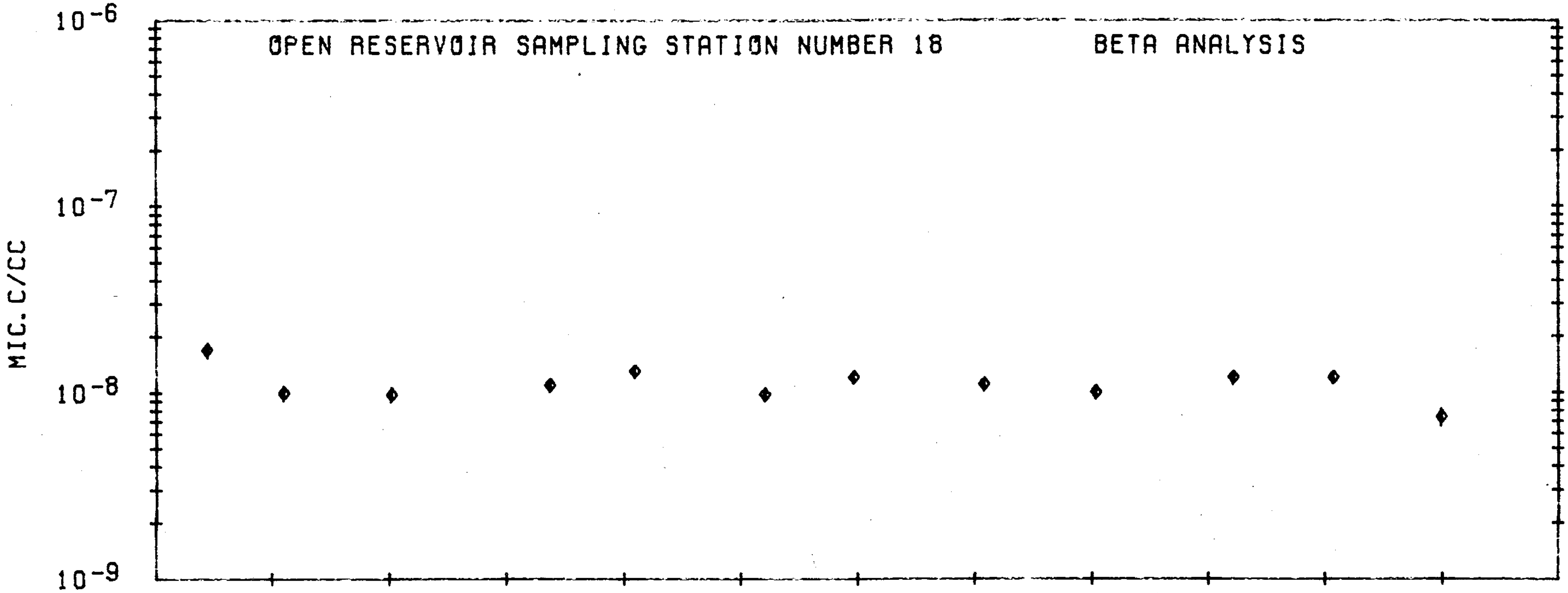

OPEN RESERVOIR SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

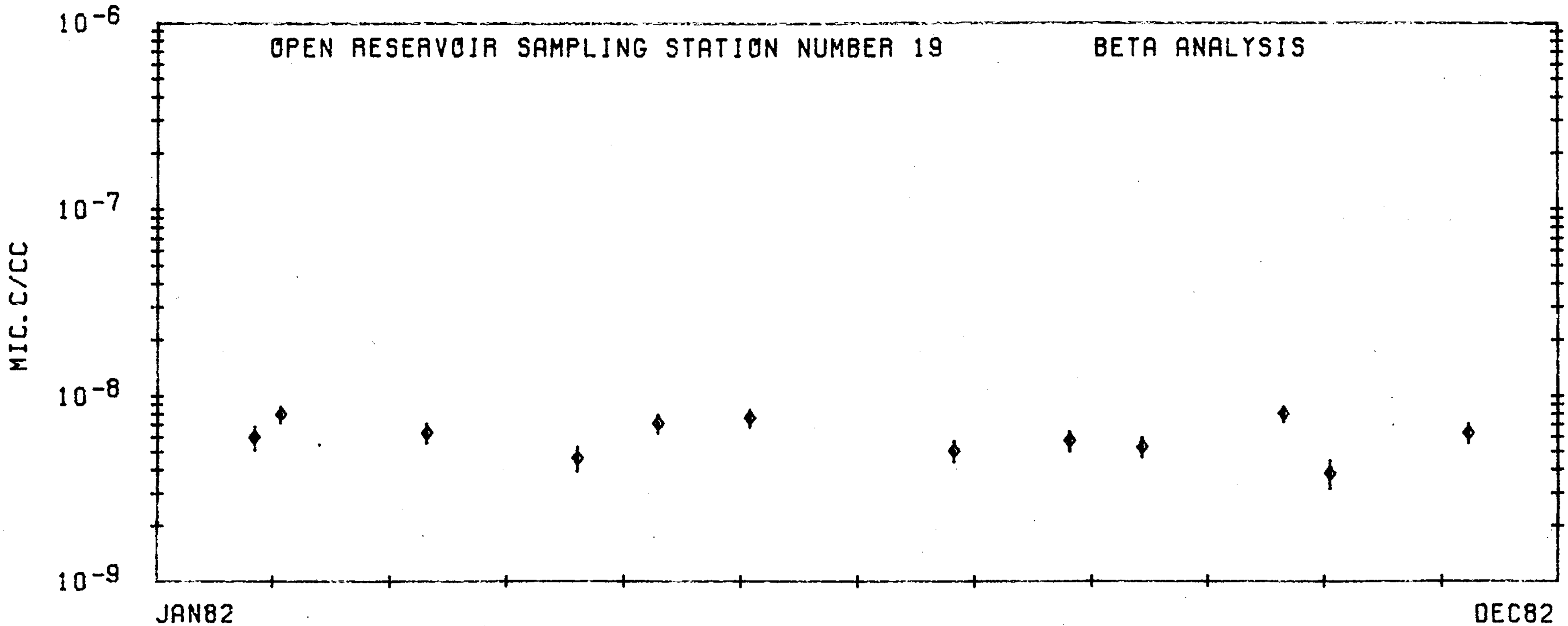

OPEN RESERVOIR SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

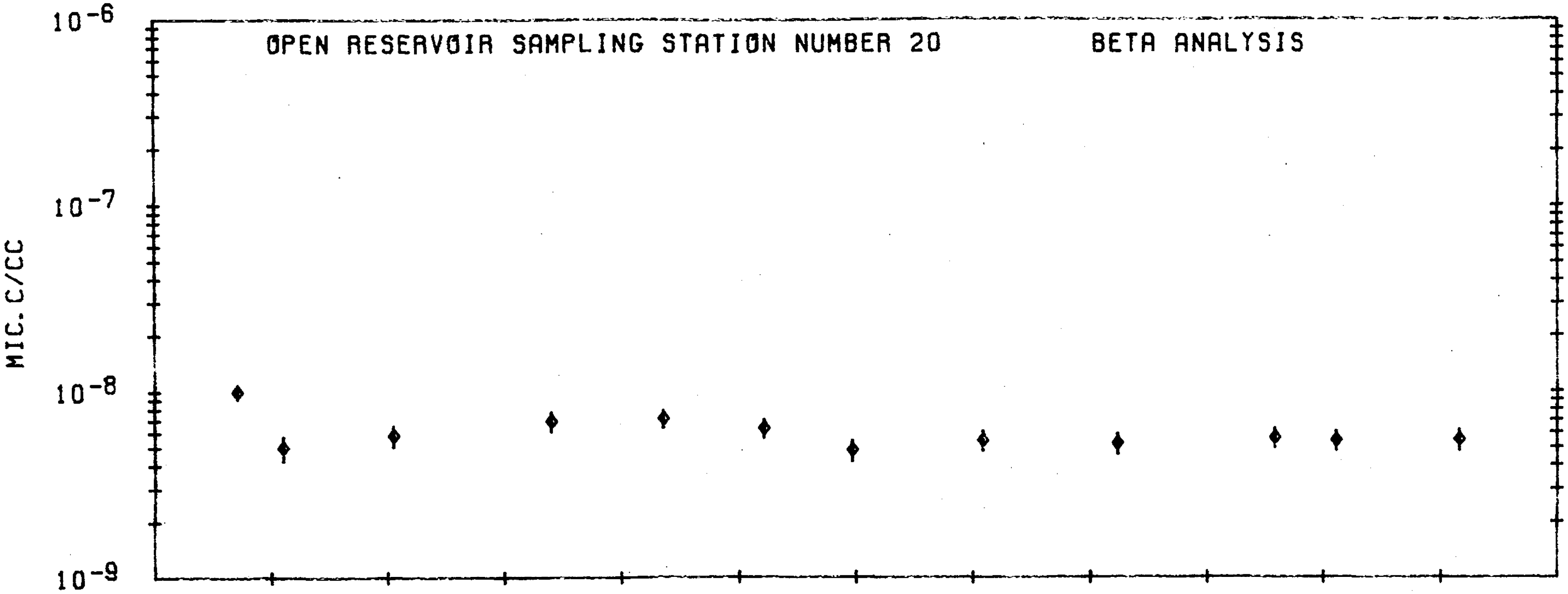

OPEN RESERVOIR SAMPLING STATION NUMBER 11
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

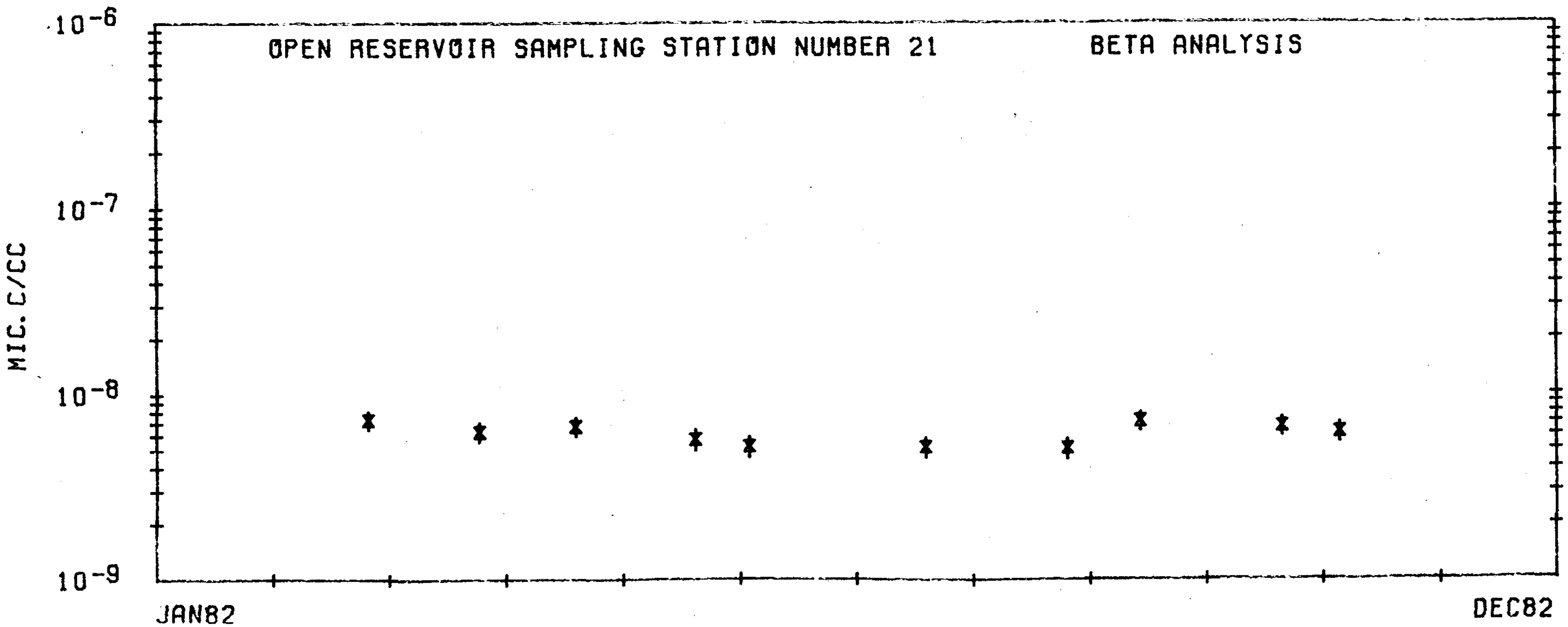

OPEN RESERVOIR SAMPLING STATION NUMBER 12
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}

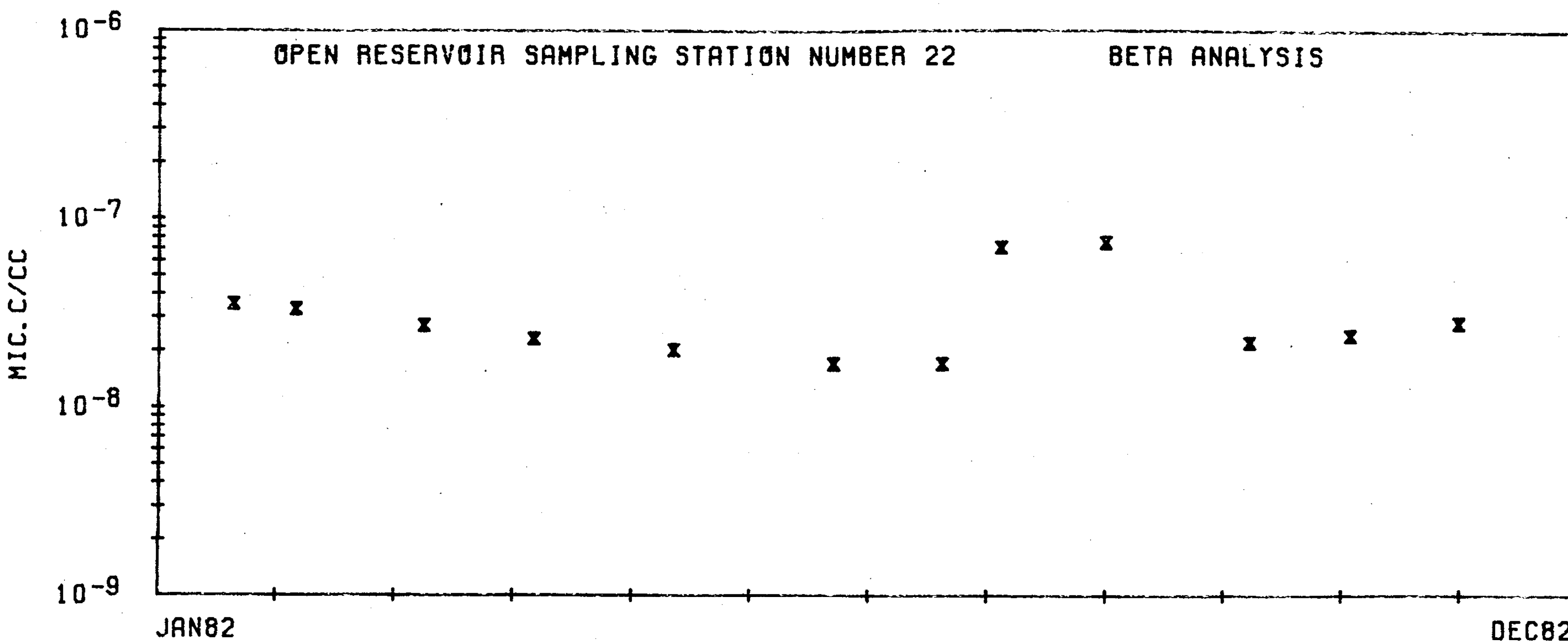

OPEN RESERVOIR SAMPLING STATION NUMBER 16
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82


OPEN RESERVOIR SAMPLING STATION NUMBER 18
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


OPEN RESERVOIR SAMPLING STATION NUMBER 19
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82


OPEN RESERVOIR SAMPLING STATION NUMBER 20
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


OPEN RESERVOIR SAMPLING STATION NUMBER 21
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82


OPEN RESERVOIR SAMPLING STATION NUMBER 22
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

A P P E N D I X   F

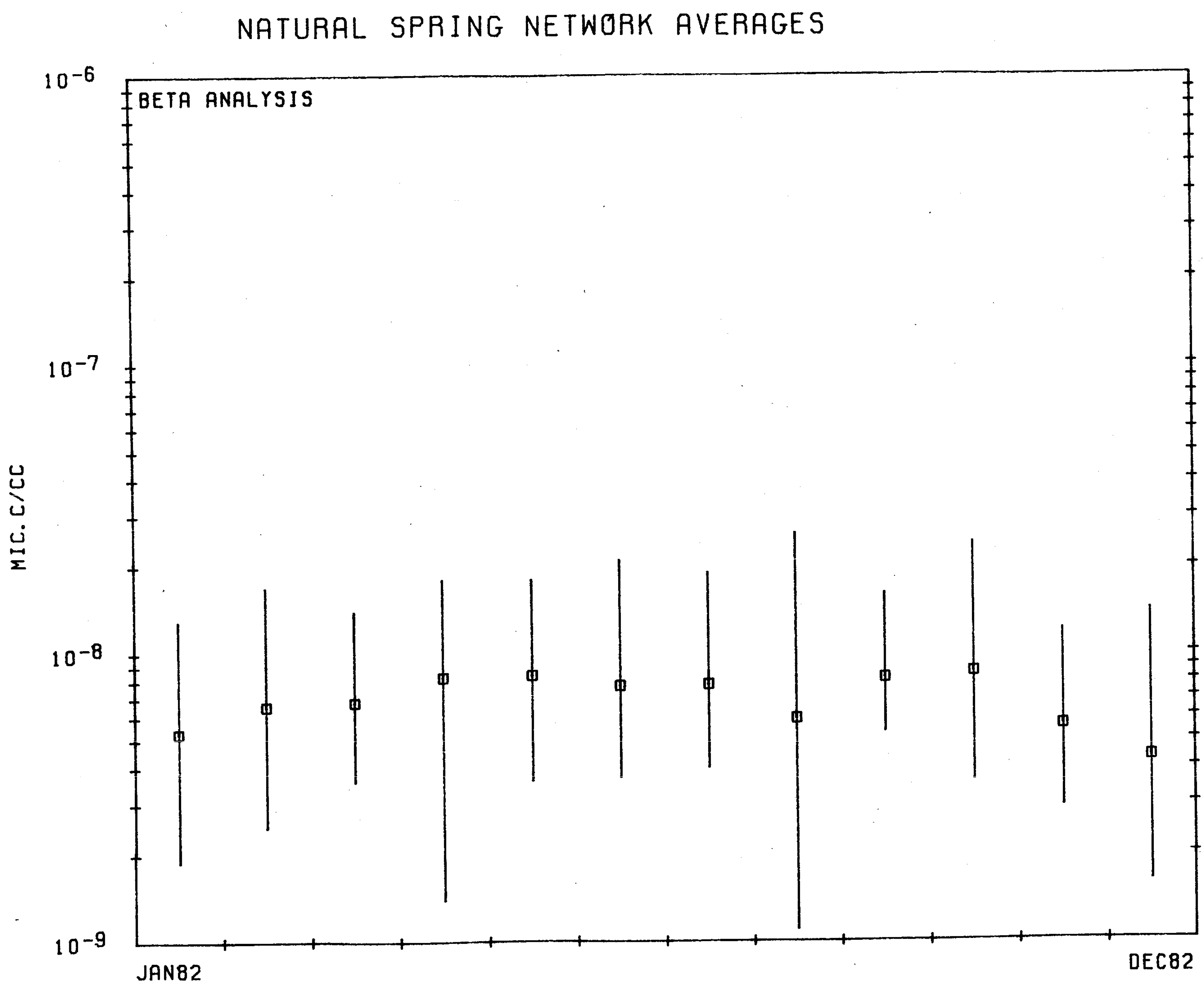
NTS Environmental Surveillance

Natural Spring Locations and Plots

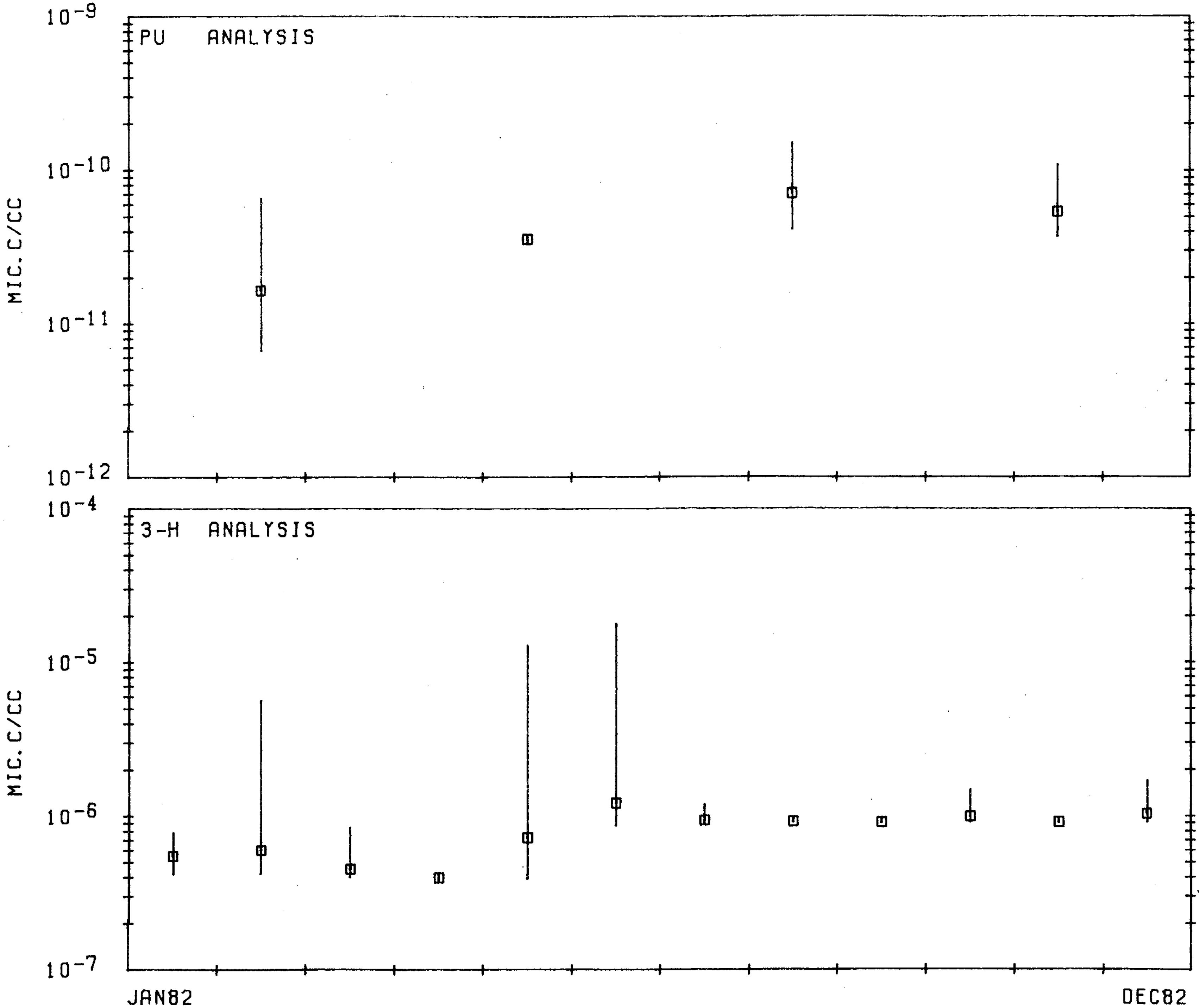
In the first two pages of plots in Appendix F, the natural springs network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data. The remaining plots show the gross beta data of each station. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

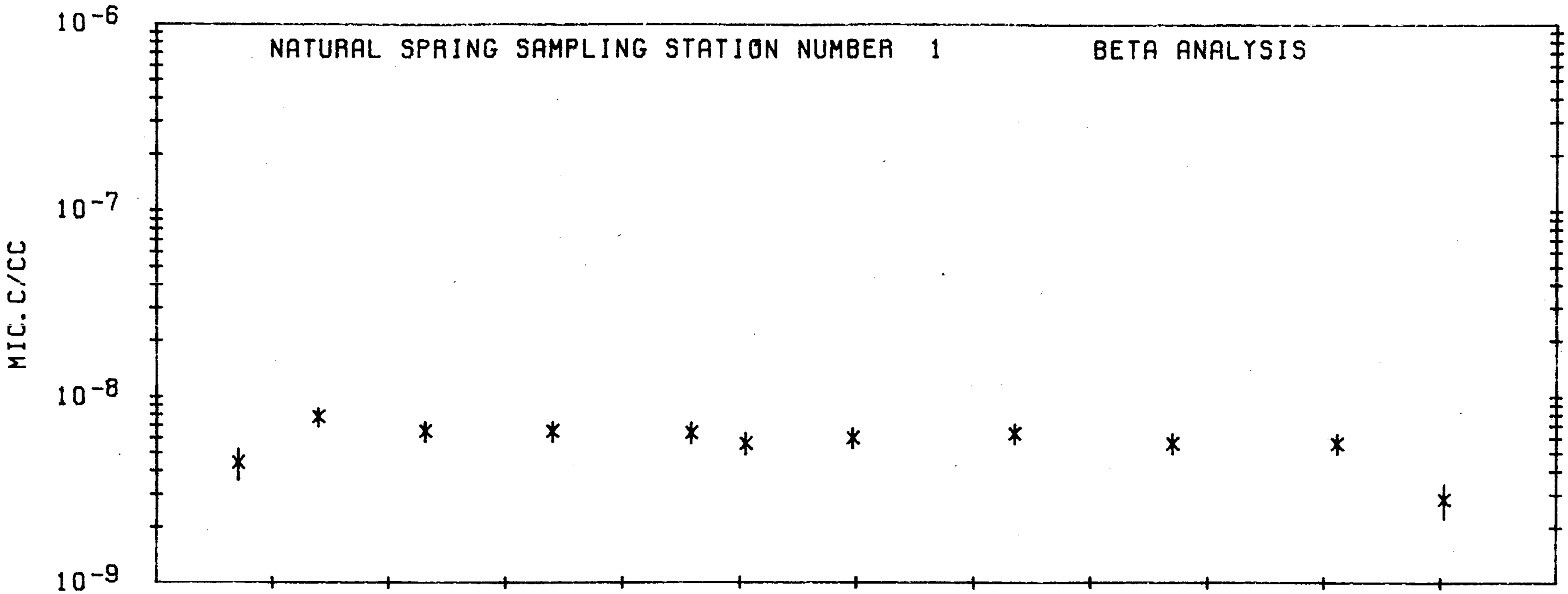
NTS ENVIRONMENTAL SURVEILLANCE
NATURAL SPRINGS SAMPLING LOCATIONS

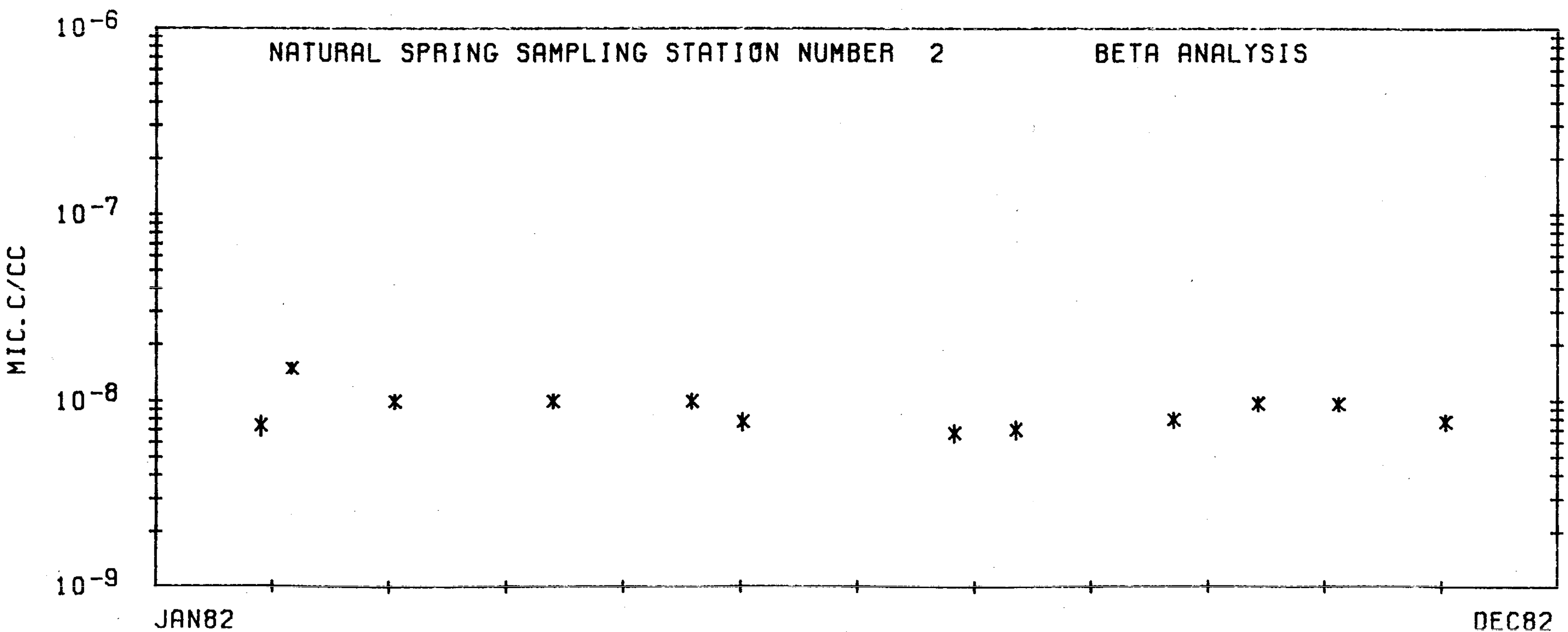
Station Number	Location
1	Area 5 Cane Springs
2	Area 12 White Rock Springs
3	Area 12 Captain Jack Spring
4	Area 12 Gold Meadows Pond
5	Area 15 Oak Butte Spring
6	Area 15 Tub Spring
7	Area 29 Topopah Spring
8	Area 7 Reitmann Seep
9	Area 16 Tippipah Spring

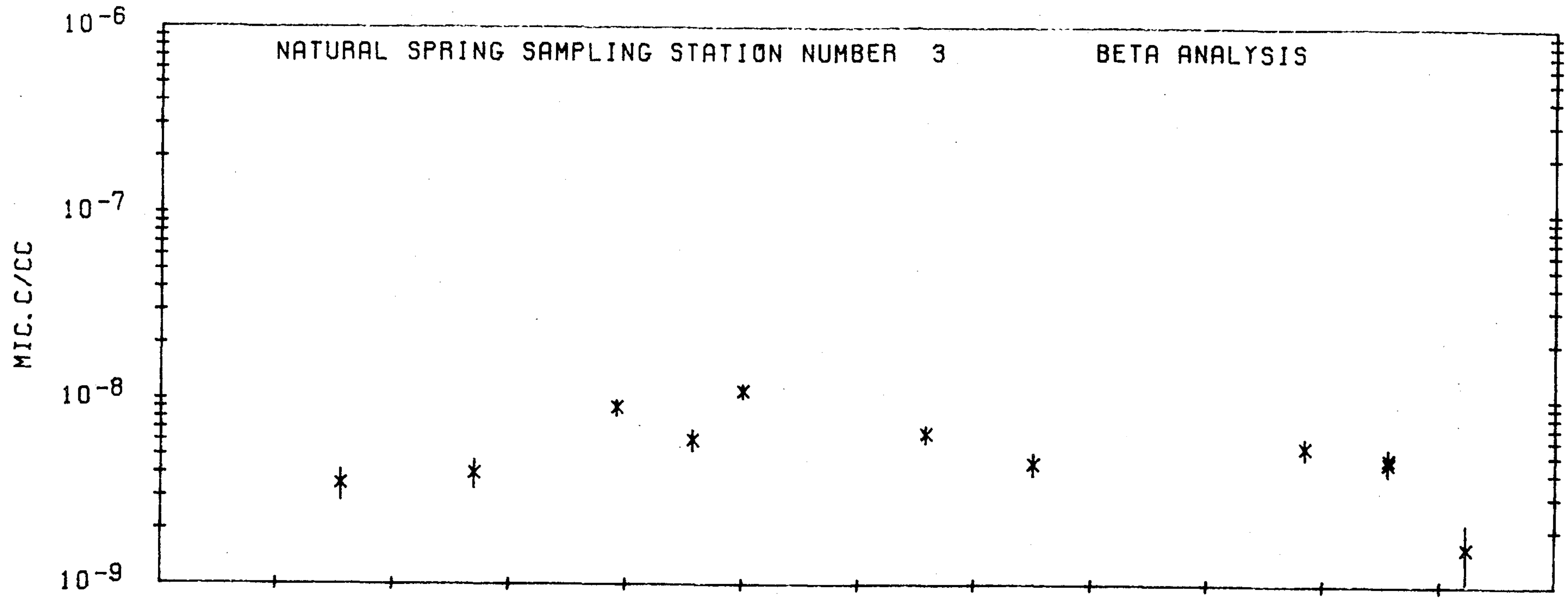

NATURAL SPRING NETWORK AVERAGES
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

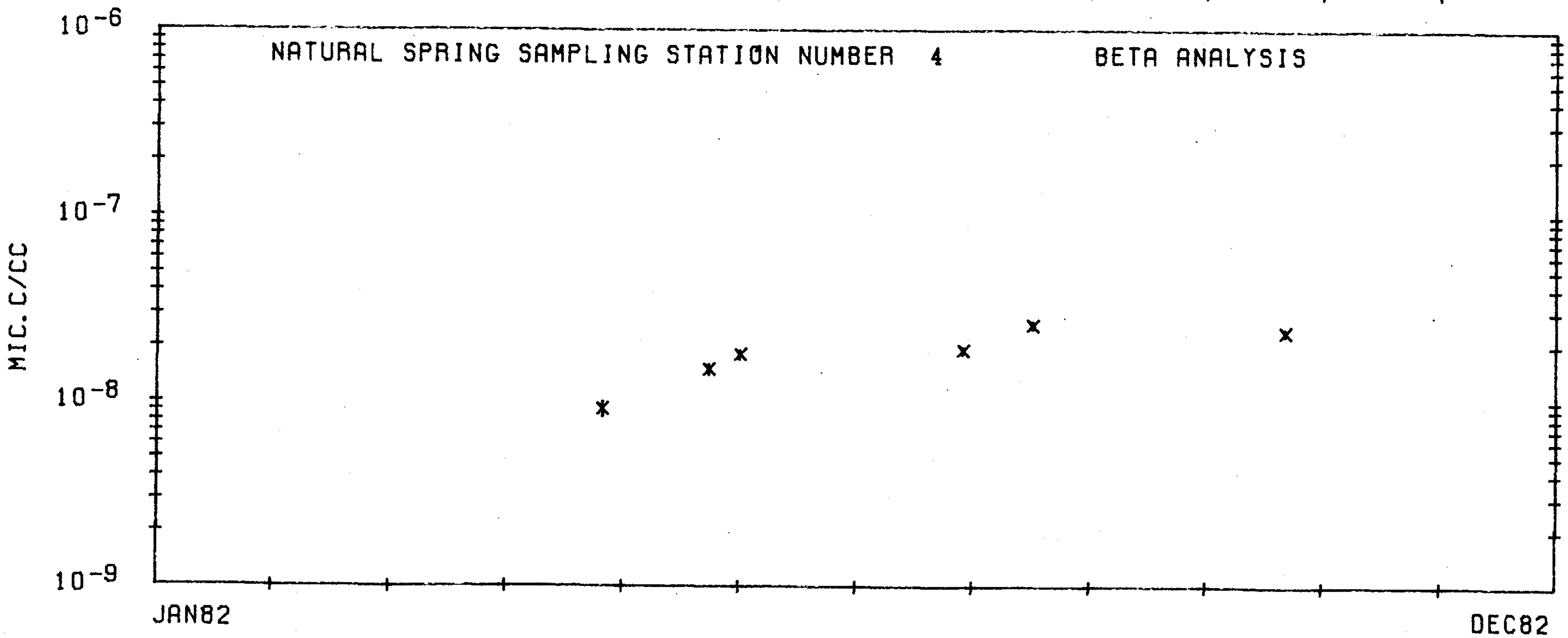
NATURAL SPRING NETWORK AVERAGES

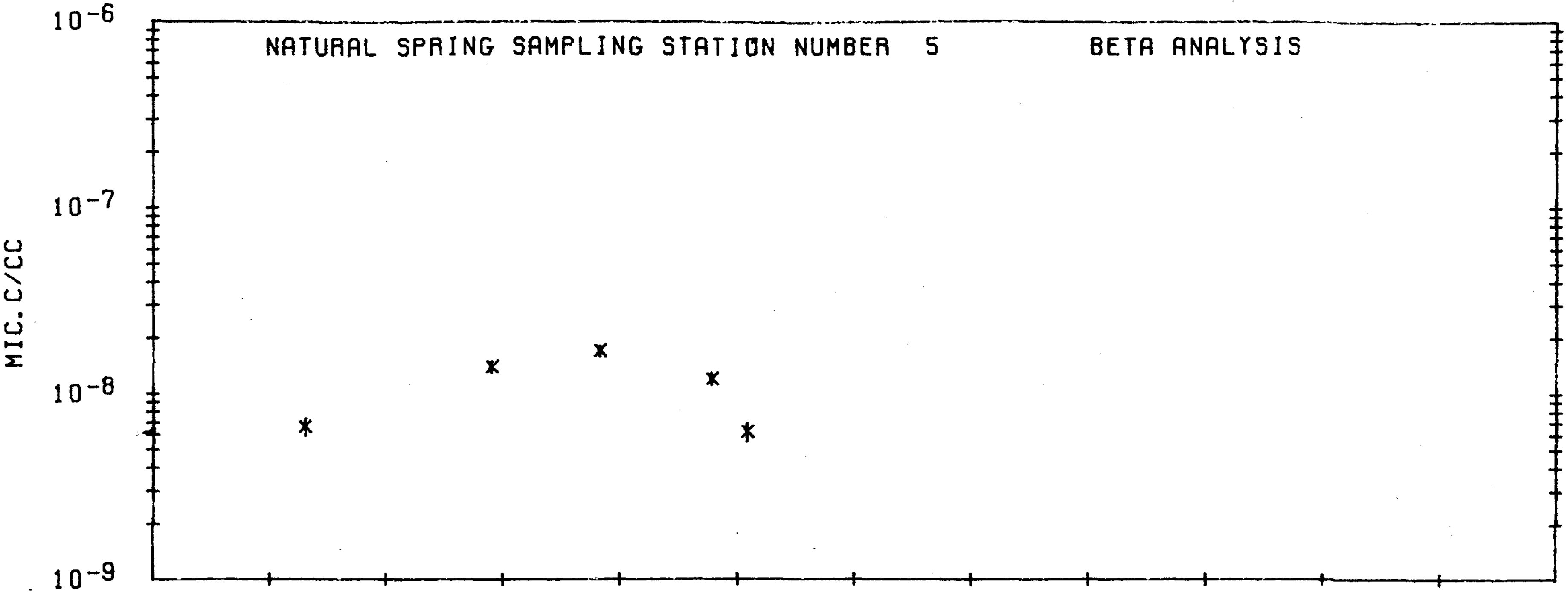


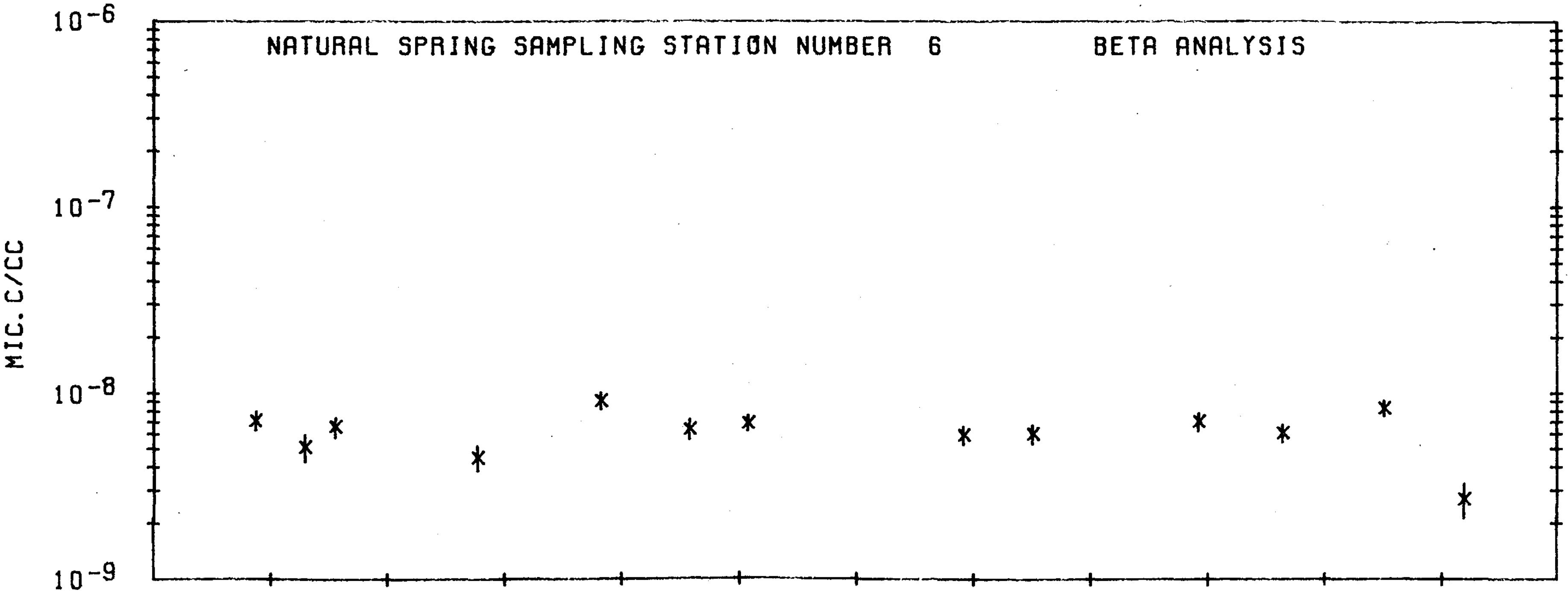

NATURAL SPRING SAMPLING STATION NUMBER 1
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9

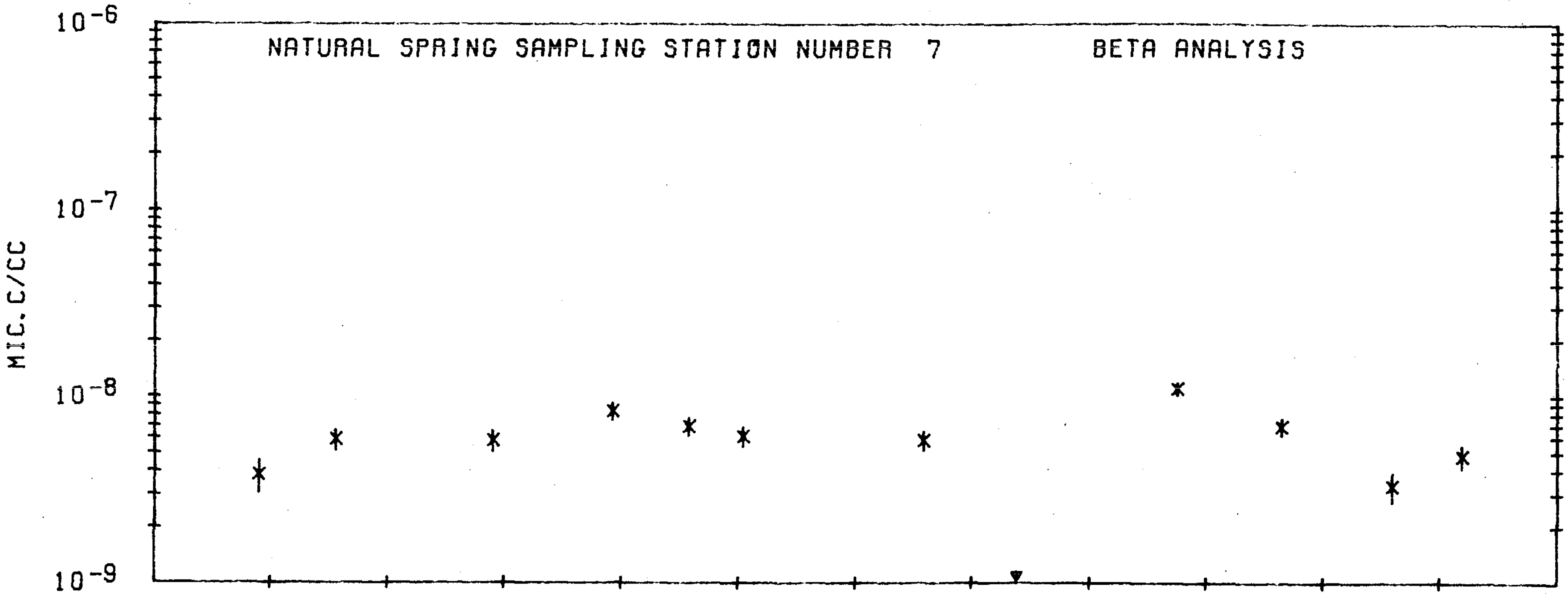

NATURAL SPRING SAMPLING STATION NUMBER 2
BETA ANALYSIS
MIC.C/CC
10-6
10-7
10-8
10-9
JAN82
DEC82

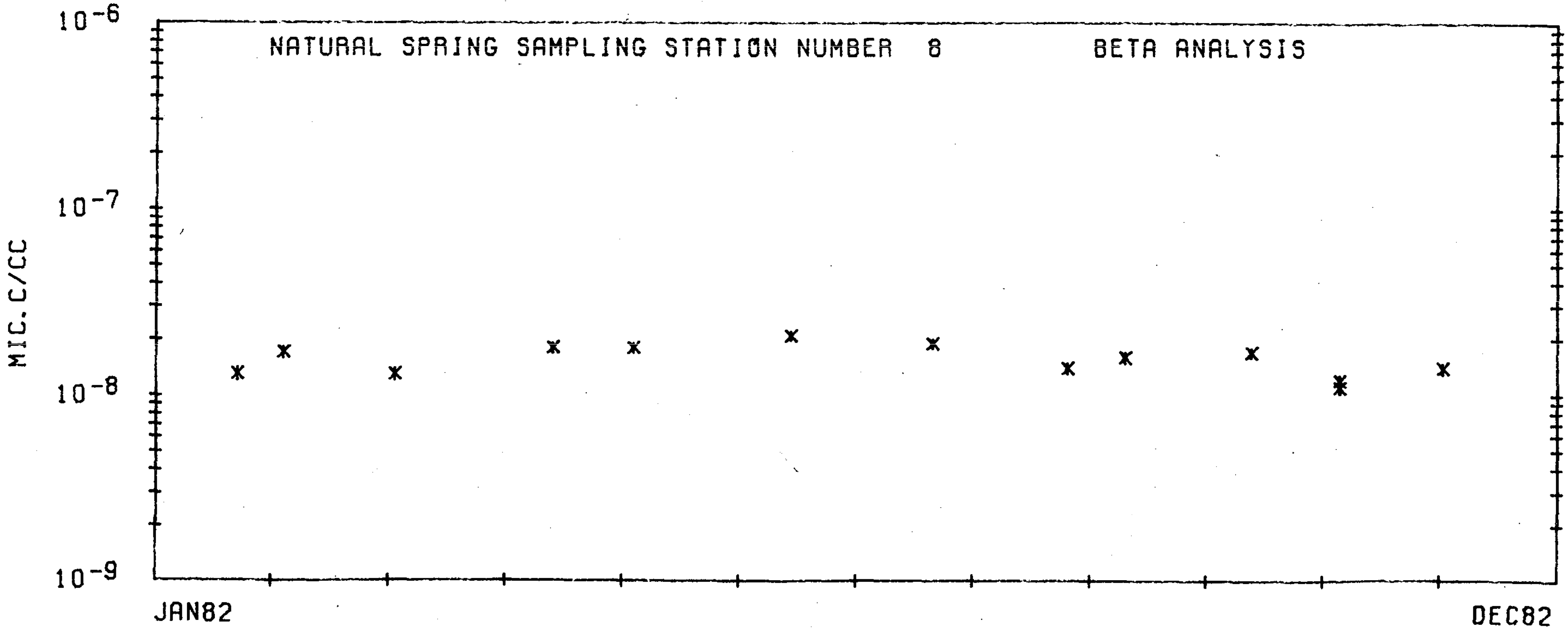

NATURAL SPRING SAMPLING STATION NUMBER 3
BETA ANALYSIS
MIC.C/CC
10 -6
10 -7
10 -8
10 -9


NATURAL SPRING SAMPLING STATION NUMBER 4
BETA ANALYSIS
MIC.C/CC
10 -6
10 -7
10 -8
10 -9
JAN82
DEC82


NATURAL SPRING SAMPLING STATION NUMBER 5
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


NATURAL SPRING SAMPLING STATION NUMBER 6
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


NATURAL SPRING SAMPLING STATION NUMBER 7
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}


NATURAL SPRING SAMPLING STATION NUMBER 8
BETA ANALYSIS
MIC.C/CC
10^{-6}
10^{-7}
10^{-8}
10^{-9}
JAN82
DEC82

APPENDIX G

NTS Environmental Surveillance

Contaminated Pond Locations and Plots

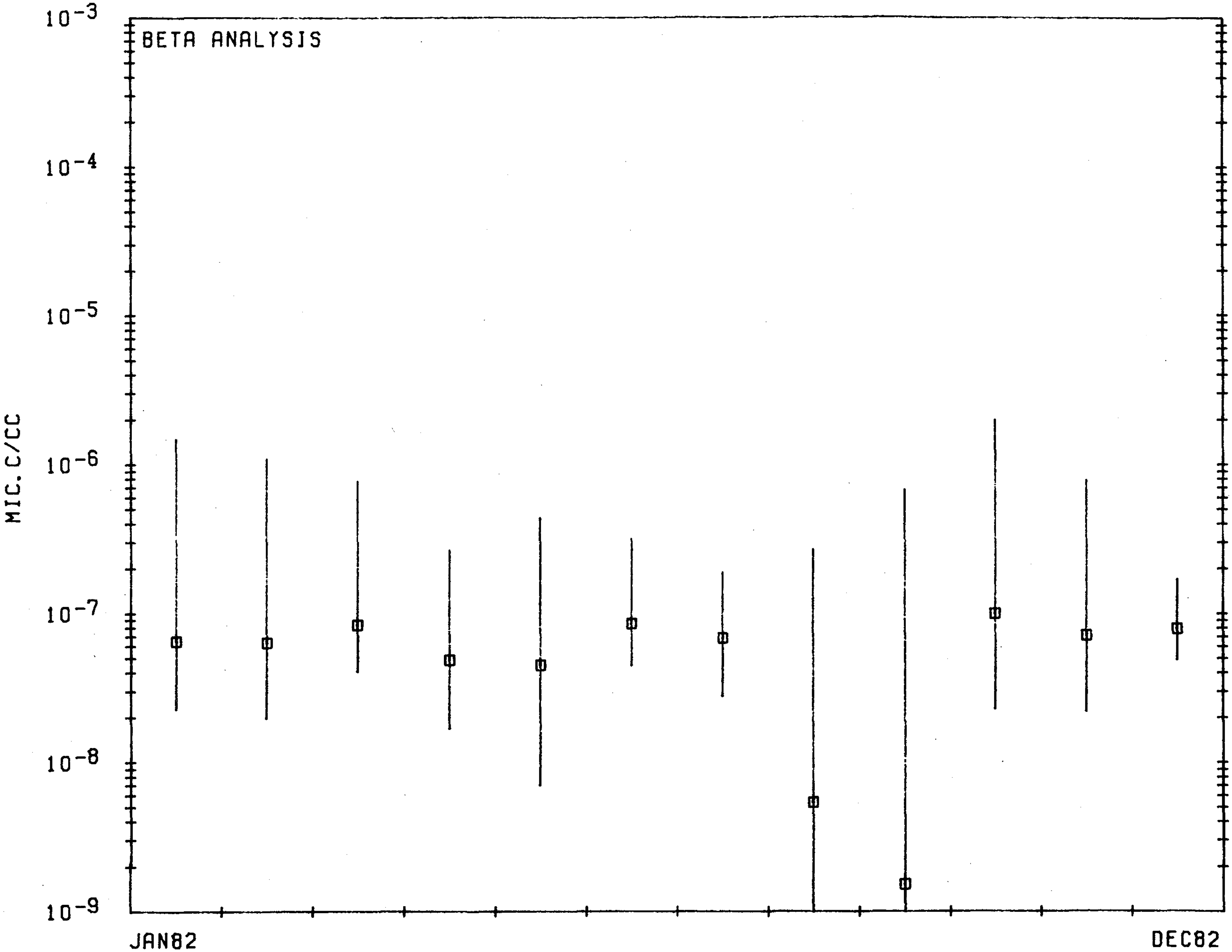
In the first two pages of plots in Appendix G, the contaminated pond network averages, a square is used to represent the arithmetic mean of all values at that point in time, and the vertical line is the range of the data.

The remaining plots show the gross beta of each station. A two-sigma error bar is also added to the data points, and, in all plots, a delta with a line to the bottom of the plot means below detection limit.

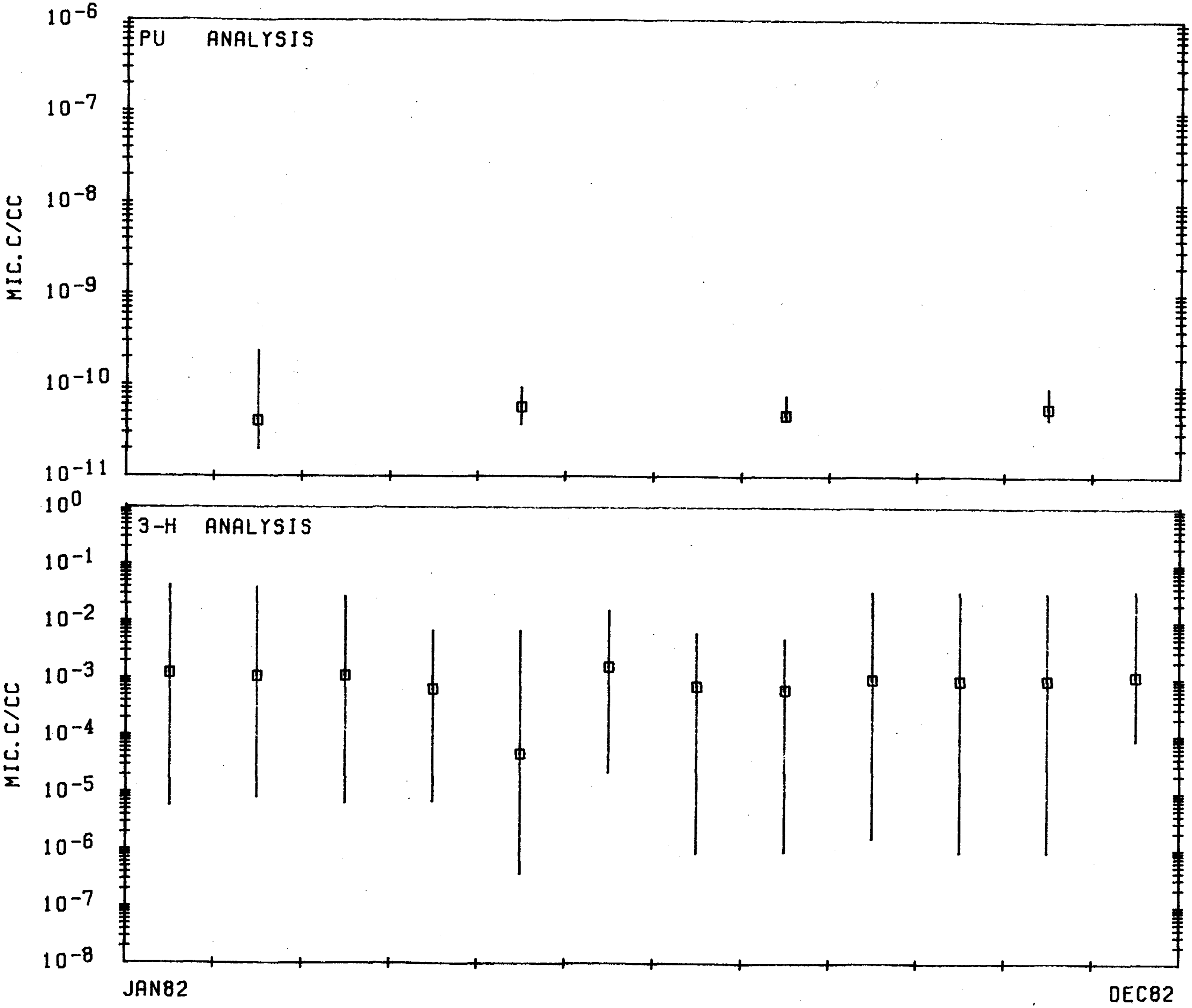
NTS ENVIRONMENTAL SURVEILLANCE
CONTAMINATED PONDS SAMPLING LOCATIONS

Station Number	Location
5	Area 12 Upper Mint Lake
8	Area 12 N Upper
9	Area 12 N Mid
10	Area 12 N Lower
11	Area 12 G Tunnel
12	Area 23 H&S Sump
13	Area 6 Yucca Decontamination Pond

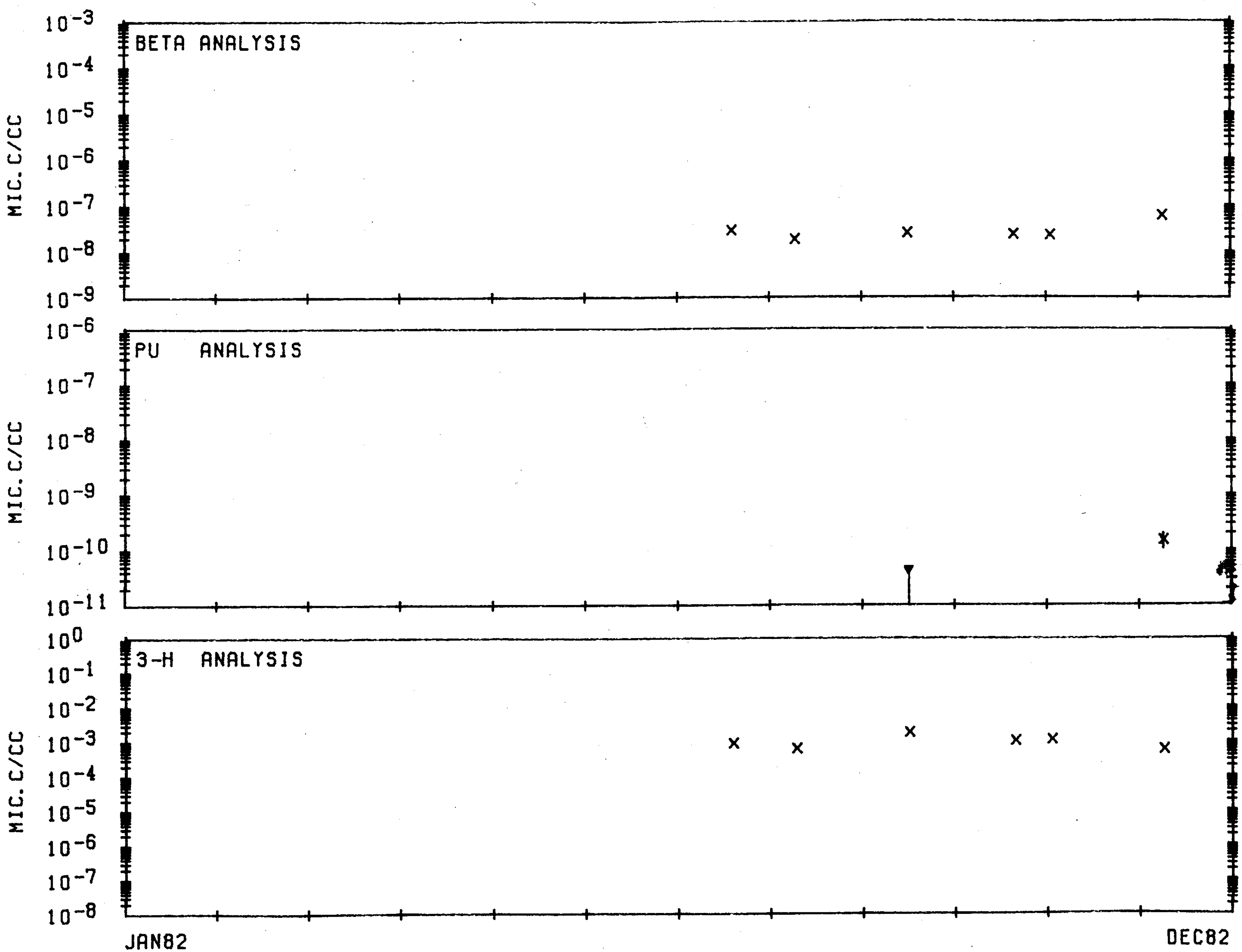
CONTAMINATED POND NETWORK AVERAGES

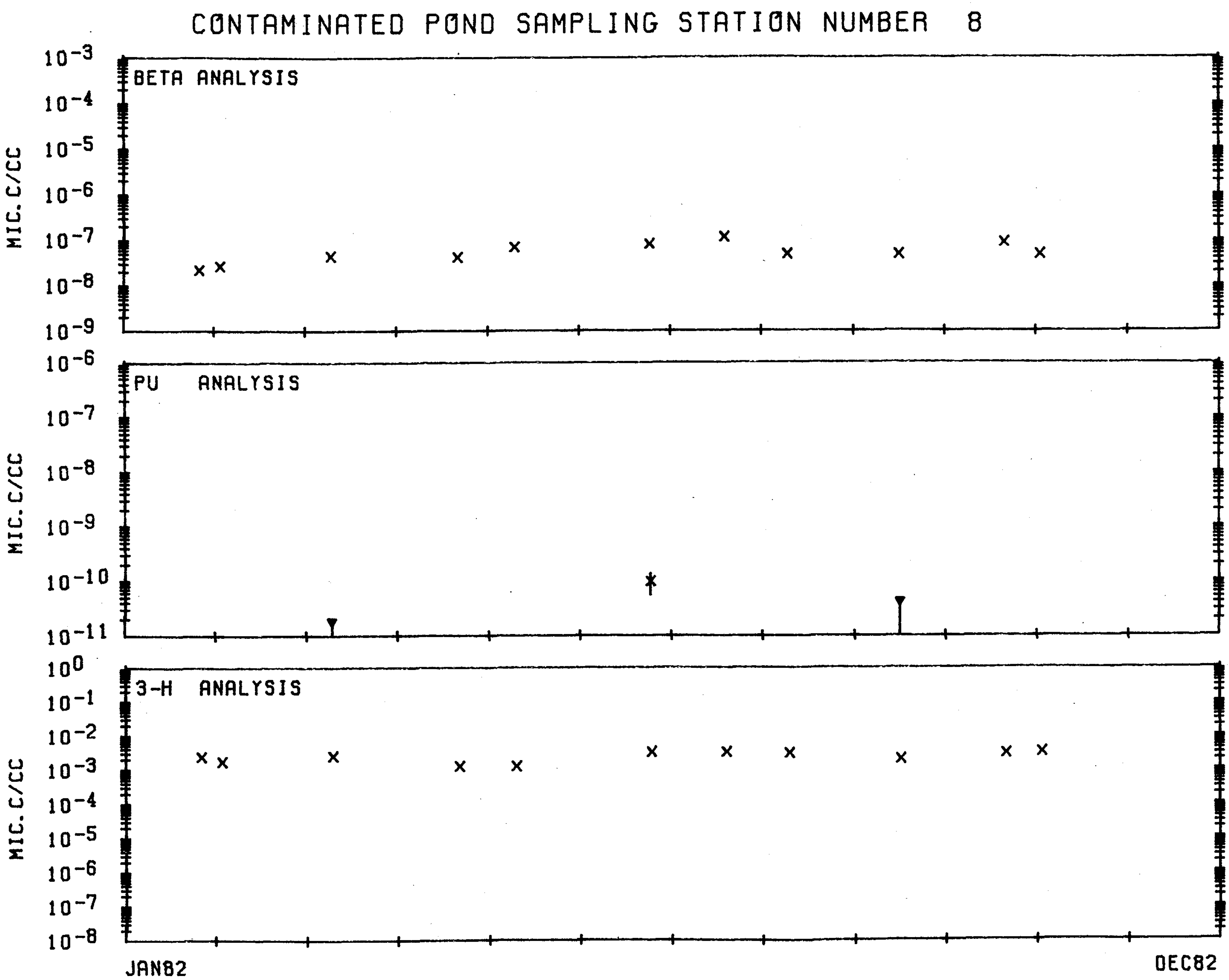


CONTAMINATED POND NETWORK AVERAGES

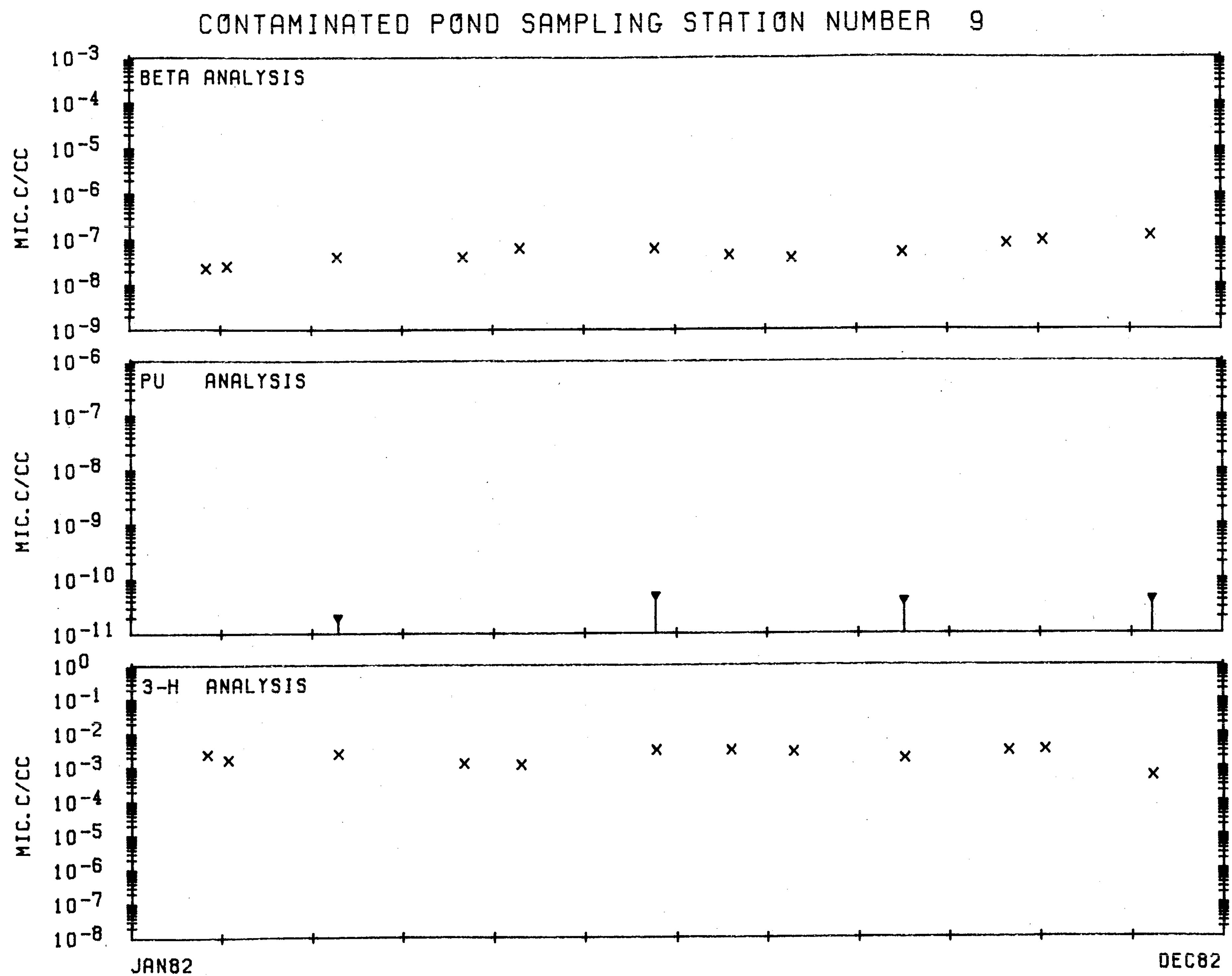


CONTAMINATED POND SAMPLING STATION NUMBER 5

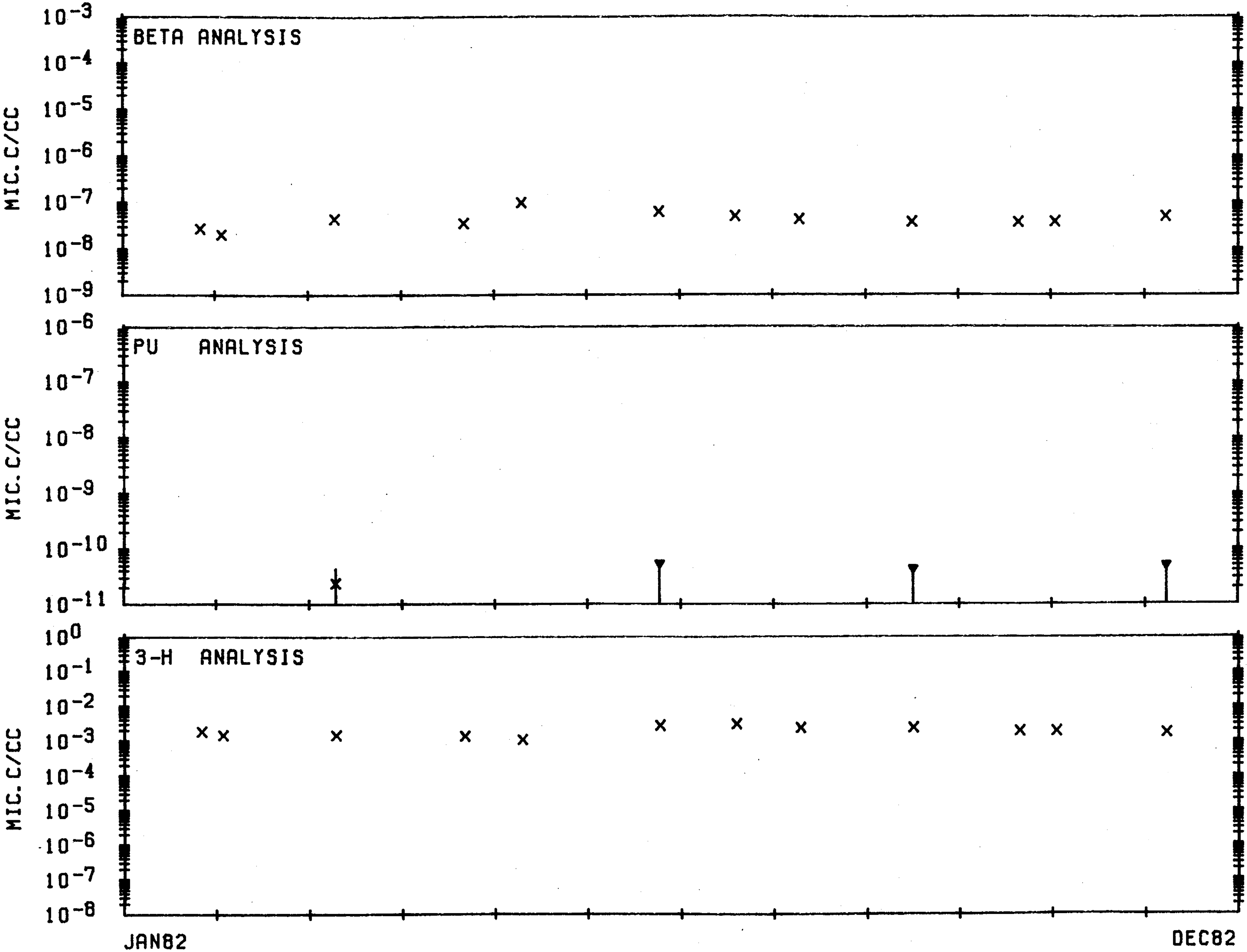


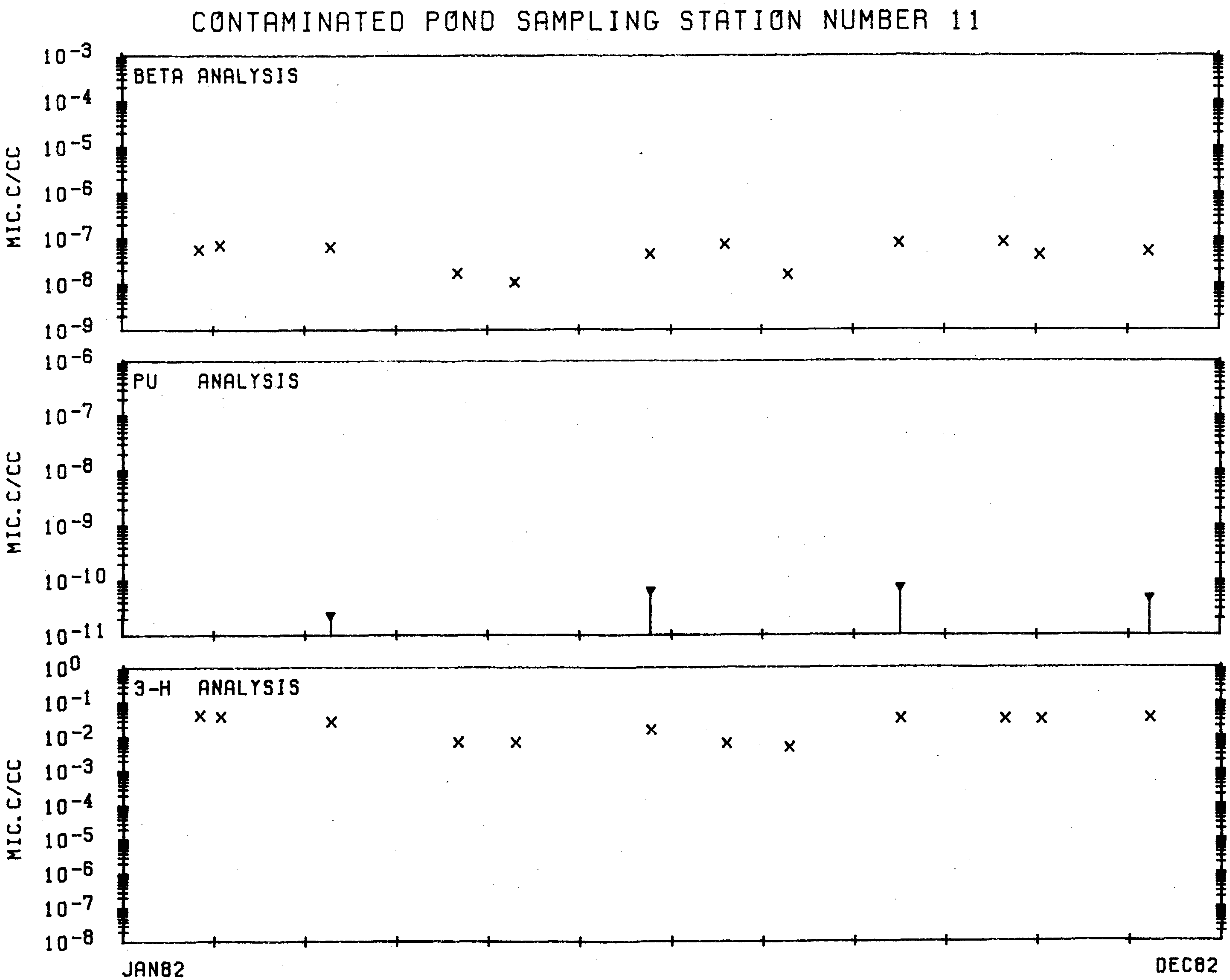


CONTAMINATED POND SAMPLING STATION NUMBER 8
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
10^-9
10^-10
10^-11
10^0
10^-1
10^-2
JAN82
DEC82

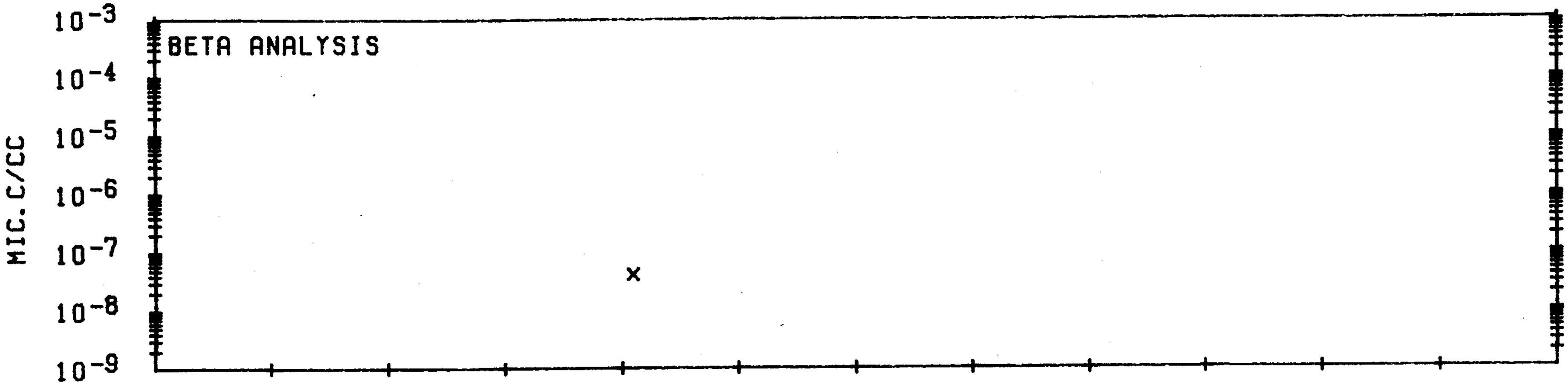

CONTAMINATED POND SAMPLING STATION NUMBER 9
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
JAN82
DEC82

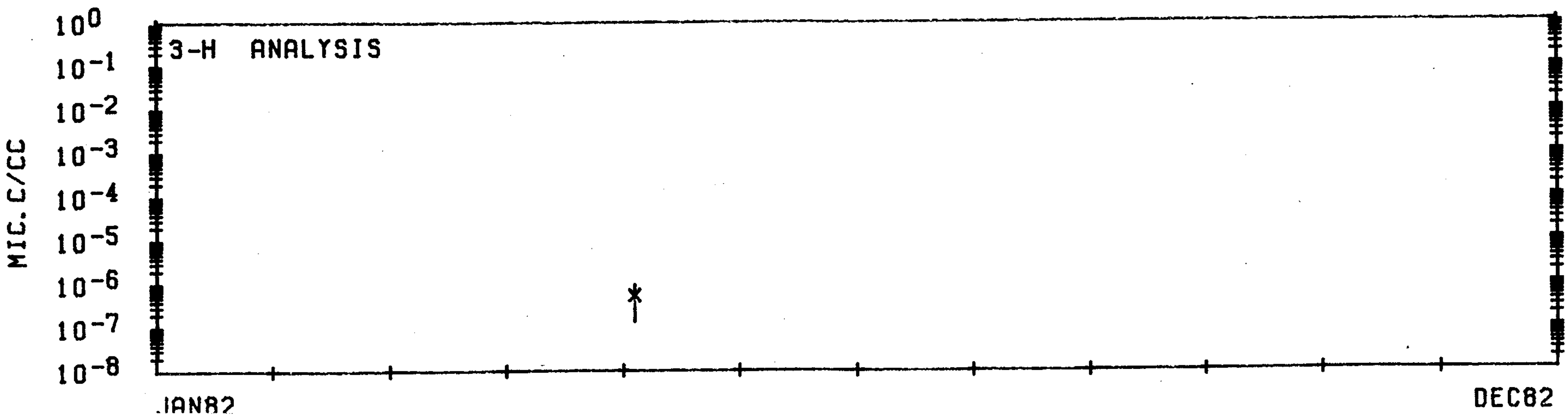
CONTAMINATED POND SAMPLING STATION NUMBER 10

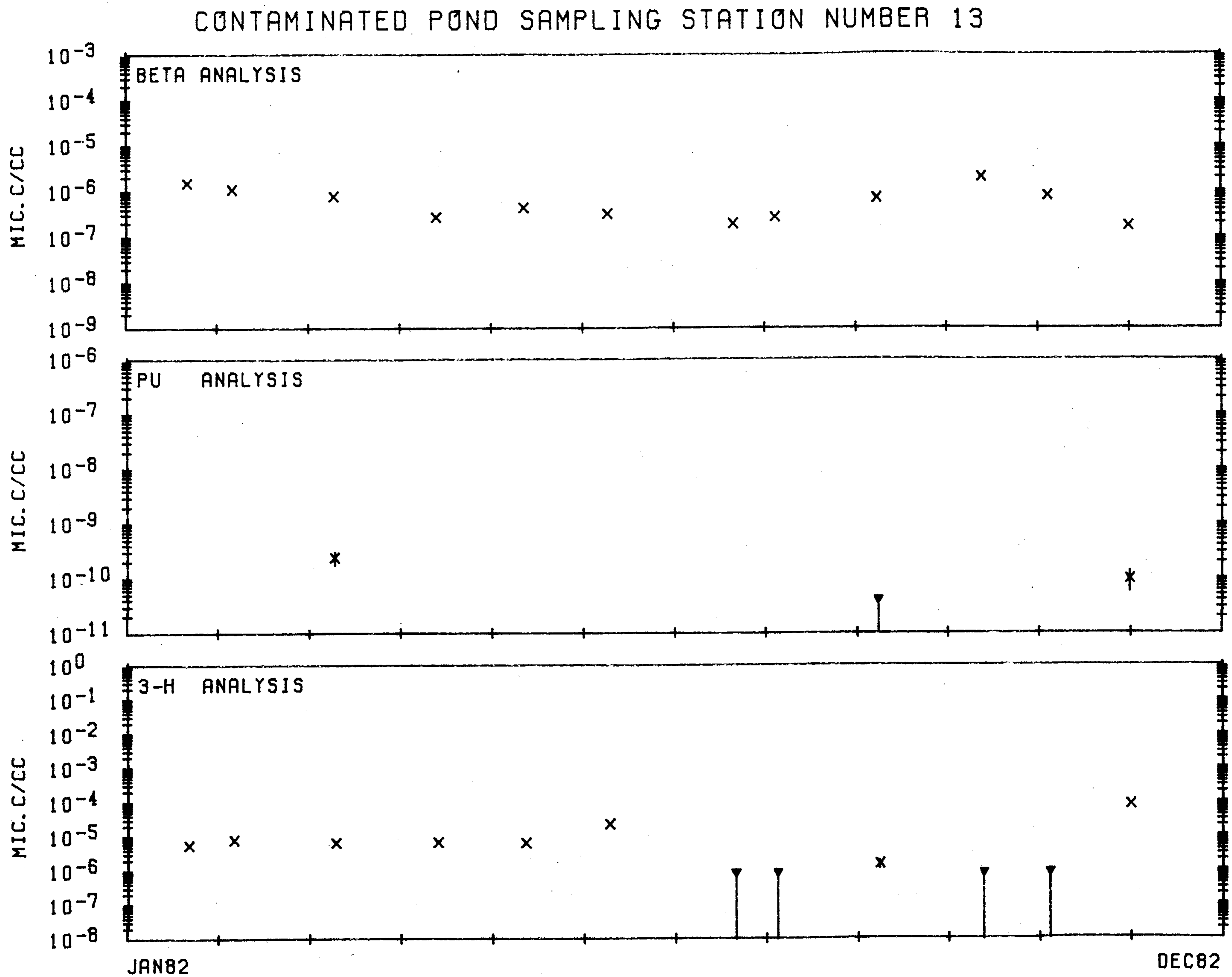



CONTAMINATED POND SAMPLING STATION NUMBER 11
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
JAN82
DEC82

CONTAMINATED POND SAMPLING STATION NUMBER 12






CONTAMINATED POND SAMPLING STATION NUMBER 13
BETA ANALYSIS
PU ANALYSIS
3-H ANALYSIS
MIC.C/CC
10-3
10-4
10-5
10-6
10-7
10-8
10-9
10-10
10-11
10-1
10-2
100
JAN82
DEC82

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