TRANSPORT OF TRITIUM AND POTENTIAL HYDROLOGIC TRACERS IN TUFF FROM YUCCA MOUNTAIN, NEVADA

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HYDROLOGY REPORT NO. H90-3

NEW MEXICO TECH HYDROLOGY REPORT SERIES

HYDROLOGY PROGRAM
SOCORRO, NEW MEXICO 87801

FEBRUARY, 1990

This report was also submitted by Robert L. Liddle as an Independent Study in partial fulfillment of the requirements of the M.S. Degree in Hydrology

Research sponsored by:
Department of Energy
through the United States Geological Survey
under Contract Number 14-08-22637

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New Mexico Institute of Mining and Technology
Socorro, New Mexico

February, 1990

ABSTRACT

Laboratory column studies were performed on five lithologically different crushed volcanic tuff samples from the proposed High Level Nuclear Waste Repository site at Yucca Mountain, Nevada, in order to evaluate bromide, iodide, and borate as potential tracers for hydrological site characterization at Yucca Mountain.

The studies were comprised of an experimental portion and a modeling portion. In the experimental portion, solutions containing tritiated water (tritium), bromide, iodide, and borate were leached through the packed columns under both saturated and unsaturated flow conditions. In addition, four fluorobenzoate tracers and ^{18}O-enriched water were added during one of the unsaturated flow experiments as additional tracers. Effluent fractions were collected and analyzed for tracer concentrations and other hydrochemical characteristics. In the modeling portion, transport parameters were determined for the potential tracers and tritium using the one-dimensional solute transport code CXTFIT (Parker and van Genuchten, 1984).

Two different leaching solutions coupled with nominal 10 ppm and 20 ppm tracer concentrations were used under both saturated and unsaturated flow conditions, resulting in eight flow experiments. One of the leaching solutions was geochemically equivalent to the Yucca Mountain tuff pore water, while the other was geochemically equivalent to the local well water (J-13 well water).

No difference in transport characteristics was seen between those flow experiments that used the pore water leaching solution and those that used the well water leaching solution. In addition, no significant difference

was observable between those flow experiments that used nominal 10 ppm tracer solutions and those that used nominal 20 ppm tracer solutions.

Throughout all eight flow experiments, bromide and iodide were seen to behave identically to each other. Retardation factors calculated for these two anionic tracers ranged from 0.71 to 0.98. The retardation factors were lower (i.e. a higher degree of anion exclusion) in those columns that had a high cation exchange capacity. The retardation factors, overall, were also lower for the unsaturated flow experiments.

The retardation factors for boron ranged from 0.91 to 1.21 . The retardation factors for boron varied less between the saturated and unsaturated flow experiments than did those for bromide and iodide.

The four fluorobenzoates were shown to be conservative in nature and to behave identically to bromide.

$H_2{}^{18}O$ was seen to have the same transport characteristics as tritiated water, indicating that whatever processes act to produce "non-ideal" behavior of tritium operate identically with respect to $H_2{}^{18}O$ in these porous media.

Overall, the potential tracers bromide, iodide, borate, and the fluorobenzoates appear to be suitable for subsequent field tracer tests. The retardation factors calculated for these tracers were similar within the saturated and unsaturated flow experiments, thereby, providing values which can be incorporated into transport equations when calculating arrival times and flow velocities in the natural environment. The conservative nature of all of these potential tracers indicates their usefulness for hydrological studies.

Due to its proven effectiveness as a groundwater tracer, bromide would be the tracer of choice in hydrological studies of Yucca Mountain tuffs. In addition, one or more of the fluorobenzoate tracers should be used in conjunction with bromide as an added scientific validation of the obtained analytical results. The use of more than one tracer that behave identically to one another will give a greater degree of confidence to the obtained results. If any problems of quantitation arise during the analyses of one of the tracers, analysis of one of the other tracers will, most likely, be able to be performed.

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ACKNOWLEDGMENTS

Funding for this project was provided by the Department of Energy through the United States Geological Survey under contract number 14-08-22637.

I wish to express my gratitude and appreciation to my advisor, Dr. Robert Bowman, for his support, wisdom, and guidance during my stay at New Mexico Tech.

Special thanks go out to Kathy Turney who worked with me on the project and got stuck doing the tedious and monotonous sample preparations. She was a big help in keeping things running smoothly.

Thanks are also due to Dave Grabka and Joe Gibbens who were my "office" mates during my first two years here at Tech. They helped me out with course work and my initial research on a vast number of occasions. Added thanks go out to Dave Grabka who constantly came up with "easy" ways of getting around research problems that always seemed like they would take months to accomplish and cost a fortune (although they were always interesting ideas).

Also deserving of gratitude are the rest of the hydrology students, old and new, all of whom kept things interesting all of the time.

Finally, a heartfelt thank you to my family, who made graduate school possible, and my surrogate family at the grad dorm, Mike Hiskey, Abdul Mujeeb, Jim Gridley, Ann Stark, Darren Naud, and the rest, who made grad school bearable.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Department of Energy through the United States Geological Survey under Contract Number 14–08–22637.

The following individuals contributed to this research project: Kathy Turney, Dave Grabka, and Joe Gibbens.

I. INTRODUCTION

Delineation of fluid flow pathways in porous media, and determination of solute velocities and dispersion coefficients, requires the use of tracers. While no single tracer is ideal for use in all porous media, there are three main requirements for a useful tracer: (i) the tracer should not be significantly sorbed or otherwise retarded by the porous medium; (ii) the tracer should be exotic to the environment in which it is to be used, or should be present naturally at very low levels; (iii) the tracer should be conservative in that it is not significantly degraded chemically or biologically during the time period of interest. Other considerations in choosing a tracer include ease of quantitation in a complex solution matrix, and the potential for adverse environmental impacts.

In general, the ability of tracers to meet the criteria outlined above must be tested in model experiments under controlled conditions. This is best done by comparing the transport characteristics of potential tracers to those of a "proven", or index, tracer, in the porous medium of interest.

The studies undertaken in this research compared the transport characteristics of three potential tracers (bromide, iodide, and borate) to those of the index tracer tritiated water in samples of volcanic tuff from Yucca Mountain, Nevada. Due to its similarity to pure water, tritiated water was assumed to behave identically to pure water in the hydrologic system.

The studies were comprised of an experimental portion and a modeling portion. In the experimental portion, solutions containing tritiated water (tritium), bromide, iodide, and borate were leached through laboratory columns packed with tuff, under both saturated and unsaturated conditions. In addition, four fluorobenzoate tracers and ^{18}O enriched water were added during one of the unsaturated flow experiments. Effluent fractions were collected and analyzed for tracer concentrations and other hydrochemical characteristics. In the modeling portion, transport parameters were determined for the potential tracers and tritium using the one-dimensional solute transport code CXTFIT (Parker and van Genuchten, 1984).

The addition of $H_2{}^{18}O$ to one of the flow experiments was performed in response to concerns that tritium may be subject to sorption and retardation in one or more of the Yucca Mountain tuffs. Bowman (1982) and van Genuchten and Wierenga (1977), have measured tritium retardation factors which are different from, and generally greater than, 1.0 . ^{18}O is potentially less subject to isotopic variations in transport behavior than tritium. By comparing the breakthrough curves of $^{3}H_2O$ and $H_2{}^{18}O$ for each tuff in one of the flow experiments, any non-ideal behavior of tritium could be detected.

Due to the conservative nature of the fluorobenzoate tracers and their similarity in transport characteristics to that of bromide in soil and groundwater studies (Bowman, 1984), these tracers may prove very useful for studies of solute transport in the Yucca Mountain tuffs.

The purpose of these studies was to (i) evaluate bromide, iodide, borate, and four fluorobenzoates as tracers for hydrological studies in volcanic tuff, and (ii) be able to incorporate the transport of these tracers, at a later date, into an adsorption computer code that will simulate the mass transport behavior of the tracer anions.

The results from coupling the flow and transport modeling of tritium to the transport behavior of the potential tracers will be utilized by the USGS when they perform saturated zone and unsaturated zone tracer tests at the proposed High Level Nuclear Waste Repository site at Yucca Mountain, Nevada.

II. MATERIALS AND METHODS

A. Apparatus

Figure 1 shows the design of the Plexiglas soil columns used in the eight flow experiments. The column had a 5.0 cm inner diameter, and soil media could be packed in the column to a length of 30.0 cm . Stainless steel porous end plates 0.2 cm thick, with a bubbling pressure of approximately 250 mbar, were in contact with the soil medium on both ends of the column. Plexiglas end caps were fitted in both ends of the column to create a tight seal between the porous end plates and the soil medium. Two rubber o-rings were used to create a leak-proof seal around the porous end plate. Each end cap had a beveled area 5.0 cm in diameter by 0.03 cm deep to help convey effluent from the entire surface area of the porous end plate to the center of the end cap where it then flowed out. Two tensiometer ports could be screwed into the column at points 5 cm from either end. A porous stainless steel disk was used as the contact between the soil medium and the water in the tensiometer port. The five columns used in this project were purchased from Soil Measurement Systems, Tucson, Arizona.

Nylon luer fittings were used as necessary at the column inlet and outlet.

A syringe pump was used to inject fluid into or onto the soil columns. The pumping rate could be varied by changing the time interval between syringe plunger strokes, by changing the stroke lengths, or by changing the syringe diameters. A 6-channel Syringe Pump from Soil Measurement Systems, Tucson, Arizona, was used during the course of the experiments.

Effluent samples from each column were collected over specific time intervals using a fraction collector. Each collector could hold forty-two 20 ml vials. Collection time intervals from 0.1 minutes to 999 minutes

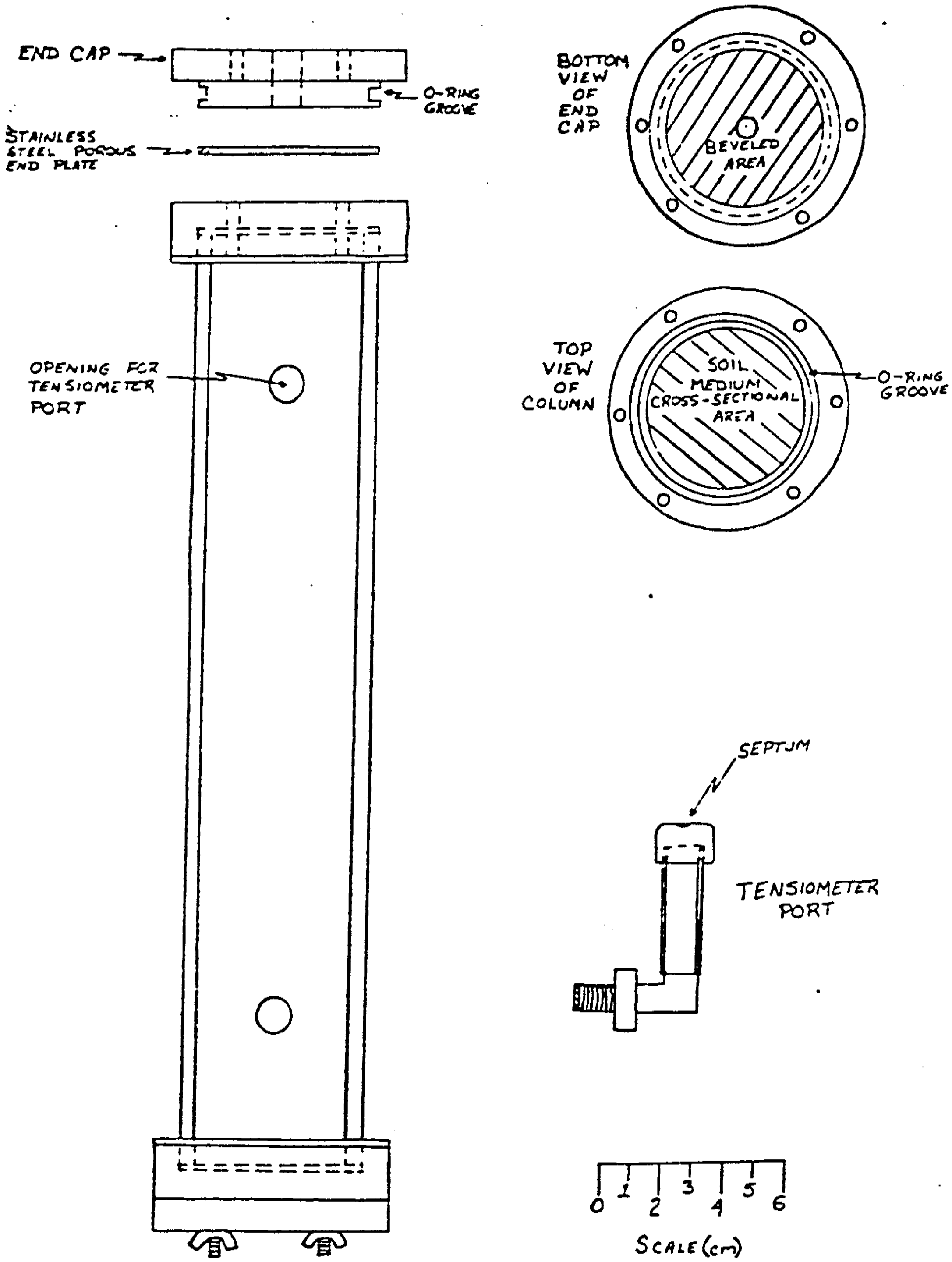

Figure 1 Design of the Plexiglas soil columns used in the eight flow experiments.

could be chosen. Retriever II fraction collectors from Isco, Inc., Lincoln, Nebraska, were used during the experiments.

During the unsaturated flow experiments, each fraction collector was placed inside a vacuum chamber so that effluent samples could be collected while the column outlet was exposed to a constant applied vacuum. Each vacuum chamber was constructed of steel with a Plexiglas cover, and was 46 cm in diameter and 30 cm high. Vacuum chambers were purchased from Soil Measurement Systems, Tucson, Arizona . Model number 2306 vacuum/pressure regulators, used to provide a controlled vacuum to the chambers during the experiments, were purchased from Moore Products Co., Springe House, Pennsylvania.

B. Porous Media

Five lithologically different crushed volcanic tuffs were supplied by the USGS for use in the column flow studies. Three naturally occurring volcanic tuffs were mined from distinctive sedimentary layers from the proposed High Level Nuclear Waste Repository Site at Yucca Mountain, Nevada. These three volcanic tuffs were crushed by the USGS and sieved so that they contained particles between 250 and 150 micrometers in diameter.

The two other "tuffs" were synthetic. Each was designed to mimic the mineralogy of fractures occurring naturally in the welded tuffs at Yucca Mountain, Nevada. These two porous media were sieved by the USGS so that they contained particles between 250 and 75 micrometers in diameter.

Appendix I contains the mineralogical analyses for the five crushed volcanic tuffs as determined by the USGS. Available cation exchange capacities (CEC), also determined by the USGS, are listed as well.

C. Column Packing

The column assembly with its associated fittings was weighed empty prior to the addition of porous medium. Each of the five columns was then filled with a tuff sample using a 15-cm diameter plastic funnel attached to a 40-cm length of 0.6-cm I.D. Tygon tubing. Maneuverability of the flexible tubing when filling the columns was facilitated with a long steel rod affixed to the tubing end.

Porous medium was directly transferred from its plastic shipping bag into the plastic funnel, using a 100 ml beaker, with as little agitation of grains as possible. Deposition of the porous medium into the funnel was done with a dumping motion rather than a slow pour to inhibit grain sorting. The funnel/tubing connection was hand-pinched shut to prevent free-fall of porous medium down the tubing length. While one person held the funnel upright, allowing the full length of tubing to hang vertically, another person facilitated the slow flow of the porous medium with as little free-fall as possible down the tubing length. This was accomplished with a hand-over-hand pinching shut of the flexible tubing down the tubing length.

The column was rotated approximately 80° from the vertical, and the end of the porous medium-filled tube was inserted into the column and abutted against the bottom end plate. The column was then rotated to the vertical position and filling of the column with porous medium proceeded.

During the entire process of column filling, the funnel was held so that the flexible tubing was always vertical. While one person held and deposited the porous medium into the funnel, another person manipulated the tubing end within the column. The column was filled by raising the tubing end just above the material in the bottom of the column and moving the tubing end around to uniformly cover the surface. Great care was taken to prevent particle sorting due to mounding of the porous medium within the column, or fast flow of porous medium within the funnel and down the tubing length. The crushed volcanic tuff samples were packed in all five columns to dimensions of 2.5 cm in radius by 30.0 cm in length.

Each column was sealed with an inlet end plate and weighed to determine the initial mass of the porous medium. Calculated masses represented air-dry volcanic tuff packed in each column. The air-dry moisture content of each tuff was considered minimal and was ignored. All five columns were then positioned vertically with the inlet at the bottom.

D. Tracer Leaching Experiments

Eight column leaching experiments were performed: four under saturated flow conditions, and four under unsaturated flow conditions. The effluent samples were identified as follows: GT-a-b-c-d-e , where "a" was the rock number, "b" was SC for saturated column or UC for unsaturated column, "c" was #1 for leaching solution #1 or #2 for leaching solution #2, "d" was 10T for 10ppm input concentration of tracers or 20T for 20ppm input concentration of tracers, and "e" was a number indicating the sequence of the effluent sample from a specific column test.

A solution identified as synthetic J-13 well water was used as leaching solution #1 and a solution identified as Pore Water was used as leaching solution #2. Table 1 lists the molarity, and resulting concentration in milligrams per liter, for the ionic species bicarbonate, calcium, chloride, potassium, sodium and sulfate for the two leaching solutions. The compositions listed were specified by the USGS, and were based on water analyses from the Yucca Mountain, Nevada area.

The ground tuff samples were identified as GT-2, GT-5, GT-7, Column 1, and Column 2. Column 1 and Column 2 were the synthetic tuff samples.

Samples eluted from the synthetic tuff samples were identified as Col-a-b-c-d-e.

Table 1. Compositions of Leaching Solutions

	J-13 well water		Pore Water	
	Molarity	mg/l	Molarity	mg/l
Bicarbonate	1.58×10^{-3}	96.4	7.05×10^{-4}	43.0
Calcium	2.10×10^{-4}	8.42	1.36×10^{-3}	54.5
Chloride	9.30×10^{-4}	33.0	2.72×10^{-3}	96.4
Potassium	1.15×10^{-4}	4.50	2.82×10^{-4}	11.0
Sodium	2.45×10^{-3}	56.4	3.08×10^{-3}	70.8
Sulfate	2.40×10^{-4}	23.0	1.33×10^{-3}	127.8

1. Saturated Flow Experiments

During the saturated experiments, the column apparatus was configured as shown in Figure 2.

All five columns were flooded simultaneously from the bottom, for approximately twenty-four hours, with CO_2 in order to displace the air entrapped in the soil matrix. Since the aqueous solubility of CO_2 is much higher than that of air, this insured a more complete initial saturation with the leaching solution.

A reservoir containing synthetic J-13 well water was attached to the inlet of each column (at the bottom for these saturated flow experiments) through the multi-channel syringe pump. A flow rate was chosen so as not to exceed the hydraulic conductivity of the porous end plates or the porous media, and wetting of the columns from the bottom up was initiated. Effluent from the top of the column was directed to a collection vessel and monitored

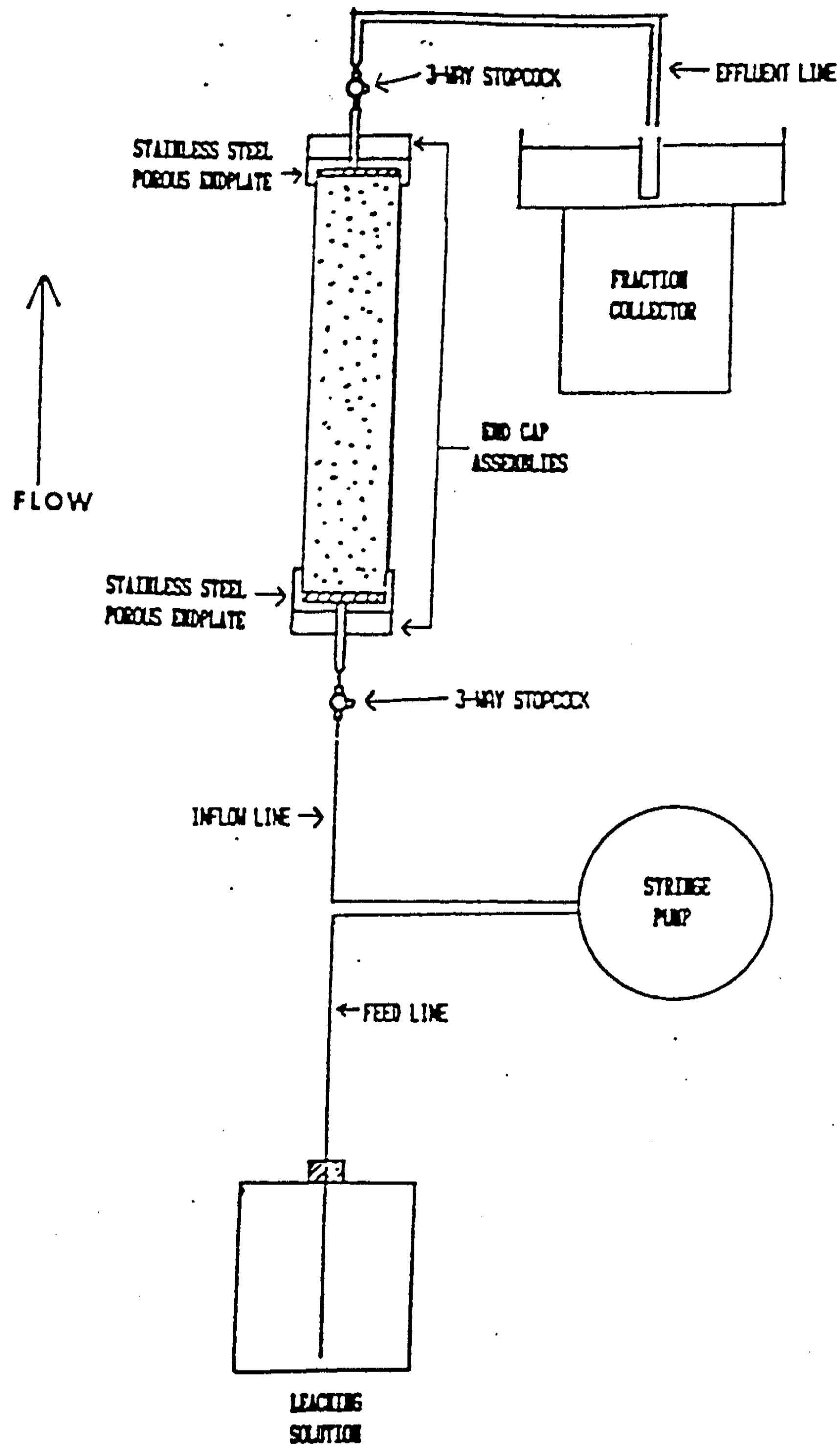

Figure 2 Column apparatus configuration for the saturated flow experiments.

daily until a constant flow rate over time was achieved. At this point, the inlet and outlet of each column was closed off using a 3-way stopcock so as not to allow any drainage of the matrix water when the column was removed. Each column was then removed and weighed to determine its saturated pore volume. The columns were then reattached, and flow through the columns was resumed.

Small volume syringes (1cc), along with a small pump arm throw and frequent pumping interval, were used in the multi-channel syringe pump to minimize any "pulsing" of fluid through the columns. The leaching solution application volume was approximately 0.18 ml every 45 seconds. Exact flow rates for each experiment are presented in the Results and Discussion section.

The initial column leachate was analyzed for major cations and anions and was compared to subsequent leachate samples to determine if effluent composition was changing over time. Conductivities and pH's were also measured over time as indicators of column equilibration. Due to the low ionic strength and buffering capacity of the effluent, two pH readings were taken. The first reading was taken after allowing the pH probe to remain in the effluent sample for two minutes. The second reading was taken after bubbling compressed air through the sample for three minutes in order to equilibrate samples with atmospheric CO_2. A pH 7 buffer check was also performed after each pair of readings, in addition to the 2-point pH calibration of the instrument (using pH 7 and pH 10 buffers) at the beginning and end of a set of measurements.

Standard 1000 ppm solutions of boron, bromide, and iodide were prepared in distilled deionized water from A.C.S. certified reagent grade salts. The specific salts used to prepare these standards were sodium borate, sodium bromide and sodium iodide. Six liters of nominal 10 ppm tracer solution was prepared in synthetic J-13 well water leaching solution using these solutions, and 0.45 mCi per liter of tritium was added at a later time. The tracer solution was stirred over a sufficient time period to ensure that it was well mixed. An aliquot of input solution was reserved for subsequent analysis.

Before the start of each saturated experiment, the syringe pump was turned off and the inlets and outlets of all five columns were closed using the attached 3-way stopcocks. Each column was removed and weighed to determine its initial pore volume. The effluent line of each column was drained so as not to mix pre-experiment effluent with experiment effluent. The columns were returned to their original positions, and their inflow and effluent lines were reattached. The feed lines were removed from the leaching solution reservoir, and a 30 cc syringe was attached to the 3-way stopcock and used to remove the leaching solution from the feed lines and inflow lines. The feed lines were placed in the tracer solution reservoir and a 30 cc syringe was used to flush the feed lines and inflow lines with tracer solution. The syringes attached to the syringe pump were also flushed with tracer solution prior to the start of the experiment. Syringes used in the syringe pump were not replaced during the course of an experiment to ensure that no change in fluid input rate took place.

The fraction collectors were filled with labeled polyethylene scintillation vials and advanced so that the last vial was positioned under the effluent line. The inlets and outlets of the columns were reopened, and the syringe pump turned on. At the same time, the fraction collectors were turned on, thereby, advancing the vials so that the first one was positioned under the effluent line. This time marked the beginning of an experiment.

Tracer solution was injected until approximately one pore volume had been input into the column having the largest pore volume. At this time, the pump was again turned off, and the inlets and outlets of the columns closed off. The feed lines were removed from the tracer reservoir and were rinsed off with leaching solution. A large volume syringe was again employed to remove tracer solution from the feed lines and inflow lines. Distilled water was then flushed through the lines and the syringe pump syringes to ensure that no tracer contamination of the leaching solution took place. The feed lines were placed back in the leaching solution reservoir and, along with the inflow lines and the syringe pump syringes, were flushed with leaching solution. The column inlets and outlets were reopened and the syringe pump turned back on. During this procedure, the effluent lines were not drained and the fraction collectors were left on. This procedure was done as quickly as possible so as not to interrupt flow conditions for too long. Approximately twenty minutes was required.

Effluent fractions were collected at approximately 0.05 pore volume intervals until an additional three pore volumes of leaching solution had been injected into the columns.

During the course of each experiment, effluent collection vials were capped at four-hour intervals during the day to minimize evaporation of the effluent samples. No sample was left uncapped for more than 10 hours (i.e., those that collected overnight). By leaving a partially filled extra vial uncapped for twenty-four hours in one of the fraction collectors, it was determined that only 0.50 ml (or less than 3% of a typical effluent fraction) evaporated over the time interval.

At the completion of each experiment, the columns were again removed and weighed to determine a final pore volume. In addition, the last effluent sample collected was immediately removed and checked for pH and specific conductance.

In the first saturated experiment, tritium activity was measured for every effluent sample to delineate the breakthrough curve (BTC). Knowing when the BTC occurred, a minimum of 15 effluent samples were chosen along the rising and falling limbs and along the peak plateau to be analyzed for boron, bromide, and iodide.

The second saturated experiment was conducted using a nominal 20 ppm tracer solution prepared in synthetic J-13 well water leaching solution. Additional leaching solution was prepared, when needed, from reagent grade salts.

After the completion of the second saturated experiment, the leaching solution was changed to that identified as Pore Water. The columns were left leaching on Pore Water until the specific conductance of effluent samples from successive column pore volumes varied by no more than approximately ten micromhos per centimeter, thereby indicating that the column effluent composition had reached steady-state. Due to difficulties in obtaining a unique pH value for effluent samples, pH was not used as an indicator for column equilibration.

The third saturated experiment used a nominal 10 ppm tracer solution prepared in Pore Water leaching solution, and the fourth saturated experiment consisted of a nominal 20 ppm tracer solution prepared in Pore Water leaching solution.

2. Unsaturated Flow Experiments

Following completion of the final saturated experiment, the syringe pump was turned off and the columns were rotated 180 degrees and repositioned as shown in Figure 3. The inflow end plate was removed and replaced with a piece of filter paper to disperse fluid applied to a column over the entire soil surface. All of the end fittings on the inflow end caps were removed, leaving a hole in which the inflow line could be placed. The 3-way stopcocks were also removed from the outflow end caps to shorten

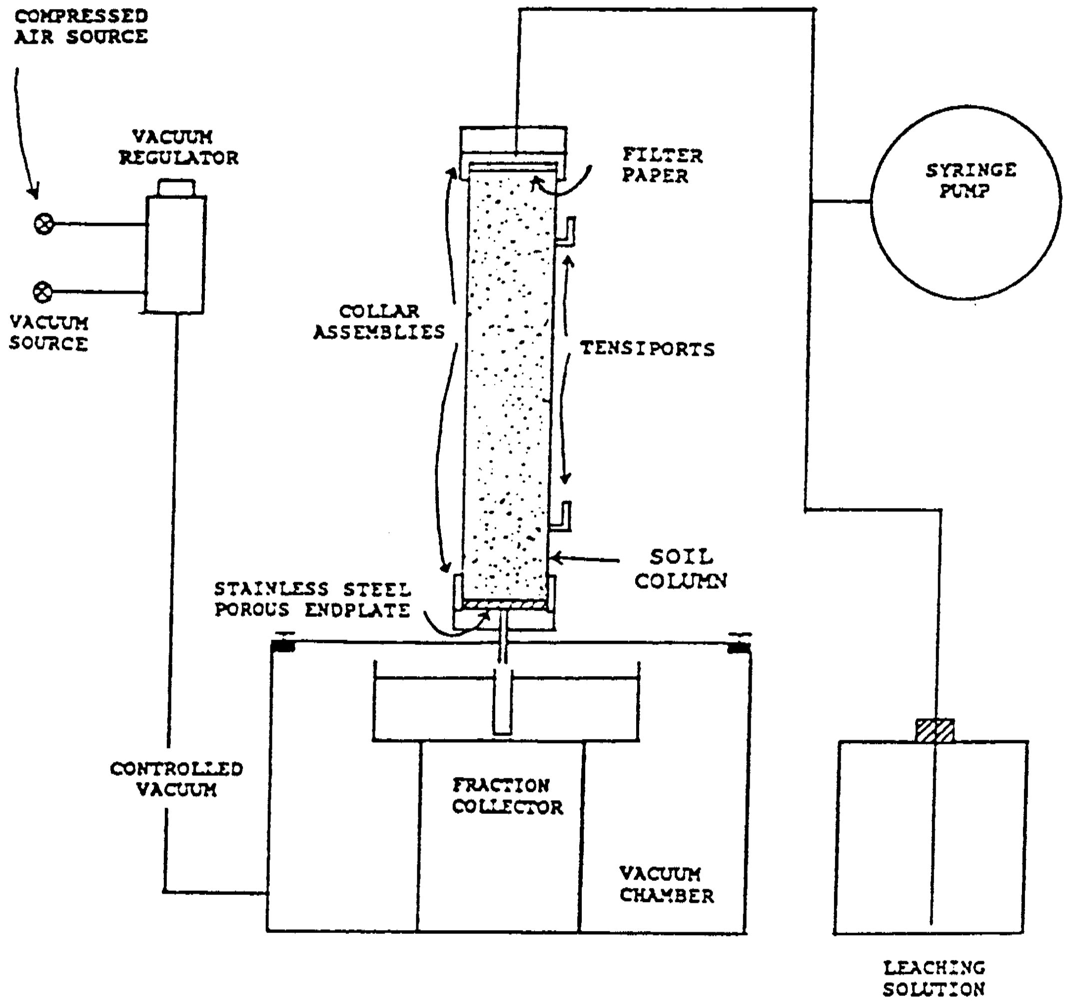

Figure 3 Column apparatus configuration for the unsaturated flow experiments.

the mixing volume present between the column and the collection vials.

A regulated vacuum source was applied to the column vacuum chambers, and the columns were allowed to drain with the same flux of Pore Water leaching solution applied as that in the saturated experiments. After the columns had sufficiently drained, stainless steel plugs in the sides of the columns were replaced with tensiometer ports.

Over approximately the next two weeks, an attempt was made to achieve unit gradient in the columns by adjusting the flow rate and the applied vacuum. Unit gradient could not be achieved within the pressure range of the porous endplates, so the flow rate and applied vacuum that minimized the tension difference between the upper and lower tensiometers was chosen. The leaching solution application volume for all four unsaturated flow experiments was approximately 0.18 ml every 100 seconds. Exact flow rates are presented in the Results and Discussion section.

The tracer solution for the first unsaturated experiment contained a nominal 10 ppm solution of the tracers boron, bromide, and iodide, and was made up in Pore Water leaching solution. Prior to the addition of the tracer slug, the pump and vacuum were turned off for approximately fifteen minutes, and the columns removed and weighed to determine an initial column pore volume. Labelled collection vials were placed in the fraction collectors and the feed lines and inflow lines were flushed with the tracer solution. The pump and fraction collectors were turned on and the vacuum reestablished to start the experiment. The last vial containing effluent that was removed prior to the start of the experiment was measured for pH and specific conductance. After approximately one pore volume had been applied to the column having the largest pore volume, the pump was turned off and the feed lines removed from the tracer solution reservoir. The outside of the feed lines were washed with leaching solution and the feed lines and inflow lines were flushed with distilled water and then leaching solution before the flow of leaching solution was resumed. During this procedure, the applied vacuum was maintained on all five columns.

During the time at which one of the last vials in the fraction collector was being filled, the vacuum chamber was turned off and the inflow line removed from a single column at a time so that the vacuum chamber could be opened, the filled vials capped, and enough new vials placed in the fraction collector to collect the remaining effluent from the experiment. During this time, the column was also removed and weighed. The vacuum was then reestablished and the inflow line replaced on the column. By performing this procedure on one column at a time, the time period at which the column was off the vacuum was minimized to approximately six minutes. When the last effluent fraction was collected, the vacuum and inflow line were, again, removed from one column at a time, and the collection vials capped and replaced with new ones. The last vial containing effluent was measured for pH and specific conductance. The columns were allowed to leach until enough effluent fractions had been collected to bulk for analyses of major cations and anions.

The tracer solution for the second unsaturated experiment was made up in Pore Water leaching solution and contained tritiated water and nominal 20 ppm of the tracers boron, bromide, and iodide. In addition, this tracer solution also contained nominal 10 ppm o-trifluoromethylbenzoic acid and m-trifluoromethylbenzoic acid, nominal 15 ppm of 2,6-difluorobenzoic acid, nominal 20 ppm of pentafluorobenzoic acid, and 82 permil of ^{18}O-enriched water.

At the completion of the second experiment, the leaching solution was changed back to synthetic J-13 well water, and the columns were allowed to leach until column equilibration was reached, as evidenced by stabilized effluent specific conductances.

The tracer solution for the third unsaturated flow experiment was made up in synthetic J-13 well water leaching solution and contained nominal 10 ppm of the tracers boron, bromide and iodide along with tritiated water. The tracer concentrations in the fourth unsaturated flow experiment were 20 ppm.

When all of the flow experiments were completed, the vacuum applied to the columns was increased and air drawn through the columns until they returned to air-dry water content. The columns were sealed and placed in a refrigerator at approximately 6 degrees Celsius.

E. Tuff Moisture Release Curves

Moisture release curves were determined for the five different crushed tuff samples using two different methods.

The first method made use of the same packed columns used in the saturated and unsaturated flow experiments. The five columns were removed from the refrigerator and flooded from the bottom with CO_2. Each column was saturated from the bottom up with synthetic J-13 well water leaching solution. The columns were then inverted, and flow was initiated from the column inlet to the column outlet. When the columns were fully saturated, they were turned so that the column inlet was, again, above the outlet, and the inlet porous plates were removed. The moisture content of each column was then determined by weighing. All five columns were then attached to a regulated vacuum chamber, and a 20 mbar vacuum was applied. The columns were allowed to equilibrate (as determined by a constant weight) for approximately 48 hours, and matric potential readings were taken in the upper and lower tensiometers at this equilibrium. The equilibrium moisture content for each column was determined by weighing. Equilibrium readings were, again, taken at 40, 60, 80, and 100 mbar applied vacuums. Appendix II contains the data collected. Tabulated values are of the average of the actual upper and lower column tensiometer readings. Plots of volumetric water content versus matric potential are also shown. Curves connecting the data points were drawn by hand.

The second method used to obtain the moisture release curves used a hanging column apparatus. Soil sampling rings packed with fresh samples of crushed tuff were used in these determinations. Standard hanging column procedure was used for this method (Vomocil, 1965). Appendix II contains the tabulated data collected along with plots of volumetric water content versus matric potential for the five crushed tuff samples. Curves connecting the data points were drawn by hand. Also in Appendix II is Table AII.3 showing the bulk densities of the crushed tuff samples in the soil sampling rings.

F. Chemical Analyses

To be able to quantify all of the necessary ionic species and tritium, a number of analytical techniques were used.

The concentrations of bromide and iodide, from the saturated flow experiments, were measured to a detection limit of less than 1 milligram per liter (1 ppm) using ion chromatography. Chloride and sulfate were also measured to a detection limit of less than 1 ppm using ion chromatography. A Dionex System 4000 Ion Chromatograph was used to quantify these anions. When quantifying bromide and iodide, the injected effluent sample was split into two separate flow paths. Two-thirds of the sample passed through a Dionex AS-4A anion column, and bromide was detected by a conductivity cell. The other one-third of the sample injection passed through a Dionex AS-5 anion column, and iodide was detected through the use of a pulsed amperometric detector. When quantifying chloride and sulfate, the injected sample was passed through a Dionex AS-5 anion column and the two anions were detected by a conductivity cell. Detector signals were monitored with a Spectrophysics Model 745 Integrator. Both anion columns were 250 mm long by 4.6 mm I.D. The mobile phase used for both columns was a carbonate/bicarbonate buffered solution recommended for the columns by Dionex. The flow rate of the mobile phase was 2 ml/min. Sample concentrations were determined by running a calibration standard after every five injections. Calibration standards were prepared from A.C.S. certified reagent grade salts. Additionally, the bromide and iodide standards were double-checked by gravimetric analysis (Ramette, 1981).

The concentrations of boron and silica were measured colorimetrically to a detection limit of 1 ppm using a Bausch and Lomb Spectronic 20 Spectrophotometer. Sample concentrations were determined by comparison to calibration curves created using standards prepared from certified reference solutions. The boron analyses followed the Carmine Method procedure, and the silica analyses followed the Heteropoly Blue Colorimetric Method procedure, both of which are outlined in Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 1985).

Tritium was quantified to a standard deviation of 0.50 using a Packard Tri-Carb 460-C Liquid Scintillation Counter set to a maximum counting time of ten minutes. Sample activities were determined through the use of an external NBS-traceable Carbon-14 standard built into the machine.

Quantitation of the cations sodium, potassium and calcium was carried out to a detection limit of 1 ppm. Quantitation of aluminum and magnesium was carried out to a detection limit of 0.10 ppm. Quantitation of all of these cations, except aluminum, was performed via atomic absorption spectroscopy using an Instrumentation Laboratory Video 12 Atomic Absorption Spectrophotometer. Sample concentrations were determined by creating internal instrumental calibration curves using standards prepared from certified atomic absorption reference solutions. Aluminum was analyzed on a Bausch and Lomb Spectronic 20 Spectrophotometer using the Eriochrome Cyanine R Method colorimetric procedure outlined in Standard Methods for the Examination of Water and Wastewater (APHA, 1985). Sample concentrations were determined by comparison to a calibration curve created using standards prepared from certified reference solutions.

Quantitation of the fluorobenzoate tracers was carried out to a detection limit of 0.1 ppm using High Pressure Liquid Chromatography (HPLC). The HPLC instrumentation consisted of a Model 501 pump, Model U6K syringe injector and Model 481 variable-wavelength UV absorption detector set to 205 nanometers, all by Waters Assoc. (Milford, MA). Signal output was monitored with a Waters Model 745 Data Module Integrator.

The HPLC analytical column was a Rexchrom strong anion exchange column (250 x 4.6 mm I.D.) packed with five micron diameter particles by Regis Chemical Co. (Morton Grove, IL). The mobile phase used during analyses was 0.035 molar potassium dihydrogen phosphate buffer, pH adjusted to 2.85 with orthophosphoric acid, with 20% acetonitrile as an organic modifier. The flow rate of the mobile phase was 1.2 ml/min.

Fluorobenzoate sample concentrations relative to the input concentration were determined by running the input tracer solution after every fifth unknown effluent injection. Actual concentrations were determined by running standards of the fluorobenzoate tracers prepared from reagents of the highest available purity (98% to 99% pure).

Bromide and iodide effluent concentrations from the unsaturated flow experiments were also determined via HPLC. Due to occasional problems with the bromide and iodide detectors on the ion chromatograph, and subsequent insufficient sample volume, a few bromide and iodide effluent concentrations from the saturated flow experiments were also determined using (HPLC).

Actual sample concentrations were determined by comparison to standards prepared from reagent grade chemicals. Appendix III contains tabulated data indicating which effluent samples from the saturated flow experiments were run for bromide and iodide via HPLC.

The concentrations of bicarbonate and carbonate were measured to an accuracy of 1 ppm via acid titration. Sample concentrations were determined by comparison to a certified reference solution.

The pH of samples was determined to an accuracy of 0.01 units using a Beckman Model 045 pH Meter. A two-point calibration of the instrument was performed prior to and subsequent to the actual pH measurements of effluent samples. National Bureau of Standards (NBS) traceable 7.0 and 10.0 pH reference solutions were used to calibrate the instrument.

Conductivities were quantified to a detection limit of one micromho per centimeter using a Beco Model 250-C Universal Impedance Bridge. The instrument was internally calibrated by performing a calibration check of the ratio arms A, B and of the LRC Decade Rheostat with a Fluke 27 Digital Multimeter on 8 June 1989. The instrument was externally calibrated by comparison to a standard prepared from reagent grade potassium chloride prior to sample measurements.

Column tensions and applied vacuum were measured to within one millibar using a Soil Measurement Systems Tensicorder. The instrument was calibrated through the use of a water manometer.

Mass measurements were made to 0.01 grams on a Mettler model PJ 3600 Delta Range Electronic Pan Balance, or to 0.1 grams on a Mettler model PM11 Heavy Weight Balance. Balances were calibrated at one week intervals using NBS-traceable calibration weights.

The 6-channel Syringe Pump precision was checked by weighing fluid pumped over a known time period.

III. EXPERIMENTAL RESULTS

A. Saturated Flow Experiments

The mass of tuff packed in each column (Ms) and the resulting bulk densities (ρ_b) are listed in Table 2.

Table 2. Bulk Densities and Masses of Porous Media

Porous Medium	Mass (g)	Bulk Density (g/cm^3)
GT-2	526.5	0.89
GT-5	760.3	1.29
GT-7	704.4	1.20
COL-1	678.2	1.15
COL-2	636.7	1.08

Prior to the start of the first experiment, the initial leachate from the columns, immediately after flow was induced, was analyzed for major cations and anions over a period of two weeks to determine if any chemical changes were taking place. The effluent analyses, listed in Appendix IV, show definite differences and trends in chemical composition from that of the synthetic J-13 well water leaching solution for a few of the porous media. In porous medium GT-2, an initially low bicarbonate concentration trended upwards to that of the leaching solution over time. Potassium consistently read approximately 70% below that of the leaching solution, while sulfate, chloride, and sodium were equivalent to that of the leaching solution. Calcium was present at less than 1 ppm in all of the effluent samples. Appendix I contains the mineralogical analyses for the five crushed tuff samples. The high cation exchange capacity (134 meq/100g) of porous medium GT-2 suggests that cation exchange was taking place within the matrix. Approximately 18 liters of synthetic J-13 well water was leached through each column prior to the first experiment. Since synthetic J-13 well water had approximately 0.42 meq/L of calcium cations, it would take almost 1700 liters of leaching solution to satisfy the cation exchange capacity for the soil column containing the porous medium GT-2 (assuming total calcium exchange for sodium).

Porous medium GT-5 showed an initially low calcium concentration which trended upwards over time. Magnesium was present in detectable quantities of approximately 0.50 ppm suggesting dissolution or exchange from the soil matrix. All other species were equivalent to that of the leaching solution.

Porous medium GT-7 behaved identically to that of GT-5 with the exception that calcium equilibrated more rapidly.

In the synthetic tuff sample Col-1, bicarbonate was present in the effluent samples at concentrations 30% higher than the leaching solution, while potassium was present at only 10% of the leaching solution concentration. Calcium was present at approximately 2.5 times the leaching solution concentration. Magnesium was initially present at highly elevated concentrations but decreased rapidly over time. Sulfate, chloride, and sodium were present at concentrations equivalent to that of the leaching solution.

Bicarbonate was almost 3 times as high as that of the leaching solution in the effluent samples from the synthetic tuff sample Col-2. Potassium was slightly low, while magnesium was below the detection limit. The calcium concentration was less than 1 ppm, while the sodium concentration was over 16 times that of the leaching solution. Since 20% of this soil is composed of a zeolite, cation exchange was the most probable cause of the elevated sodium and diminished calcium concentrations.

Specific conductance and pH of the effluent were two other measurements used in determining whether steady-state had been reached in the columns.

Appendix V lists the values of pH and specific conductance, and the dates on which they were taken, for each column. The date of each tracer experiment is also shown. As can be seen by reviewing the data, the specific conductance and pH were allowed to stabilize prior to the start of each experiment. Equilibration after switching leaching solutions is especially evident by looking at the stabilization of the specific conductance. Leaching solution analyses can be found in Appendix VI.

Table 3 lists the flow rate (q) (i.e. Darcy flux) applied to each column during the four saturated flow experiments. The variation in applied flow rate among experiments is most likely due to slightly different syringe diameters resulting from the changing of syringes between flow experiments. Likewise, the difference in applied flow rate between columns in any given flow experiment is most likely due to different syringe diameters. The actual column pore volume was determined by weighing the saturated column. The average column pore volume (PV) along with the values of volumetric water content (θ) and mean pore water velocity (v) are also listed in Table 3 for the saturated flow experiments. Mean pore water velocity equals q/θ.

The actual tracer input concentrations for the four saturated flow experiments are shown in Table 4. The tracer concentrations are given in milligrams per liter (ppm) and tritium is given in disintegrations per minute per milliliter (dpm/ml). It should be noted that due to a pipetting error, the tracer concentrations in the third saturated experiment (SC-#2-10T) were half of what they were meant to be.

Table 5 lists the fraction of a pore volume of effluent collected in a vial for each column in the saturated flow experiments. The fraction of a pore volume of effluent contained in each vial was determined by dividing the volume contained in the vial by the average of the initial and final column pore volumes.

Table 3. Physical Parameters For Saturated Experiments

Porous Medium	Experiment	Column Pore Volume	Volumetric Water Content (cm^3/cm^3)	Flow Rate (cm/hr)	Mean Pore Water Velocity (cm/hr)
GT-2	SC-#1-10T	386.31	0.656	0.751	1.146
	SC-#1-20T	387.94	0.659	0.729	1.107
	SC-#2-10T	387.94	0.659	0.734	1.115
	SC-#2-20T	388.44	0.659	0.673	1.021
GT-5	SC-#1-10T	352.01	0.598	0.729	1.219
	SC-#1-20T	351.81	0.597	0.666	1.115
	SC-#2-10T	353.32	0.600	0.761	1.269
	SC-#2-20T	353.62	0.600	0.735	1.224
GT-7	SC-#1-10T	339.82	0.577	0.729	1.263
	SC-#1-20T	340.68	0.578	0.752	1.301
	SC-#2-10T	341.48	0.580	0.776	1.338
	SC-#2-20T	341.88	0.580	0.756	1.302
COL-1	SC-#1-10T	312.31	0.530	0.743	1.401
	SC-#1-20T	314.00	0.533	0.753	1.413
	SC-#2-10T	314.10	0.533	0.746	1.400
	SC-#2-20T	314.60	0.534	0.710	1.330
COL-2	SC-#1-10T	323.25	0.549	0.718	1.308
	SC-#1-20T	319.11	0.542	0.640	1.181
	SC-#2-10T	323.69	0.550	0.700	1.273
	SC-#2-20T	324.19	0.550	0.705	1.281

Table 4. Actual Tracer Input Concentrations For Saturated Experiments

Experiment	Boron (ppm)	Bromide (ppm)	Iodide (ppm)	Tritium (dpm/ml)
SC-#1-10T	13.0	9.6	9.7	958605
SC-#1-20T	24.0	22.6	19.4	1020892
SC-#2-10T	6.3	4.5	4.7	978335
SC-#2-20T	23.3	22.7	20.0	992851

Table 5. Fraction of Pore Volume Collected per Vial During Saturated Experiments

Porous Medium	SC-#1-10T	SC-#1-20T	SC-#2-10T	SC-#2-20T
GT-2	0.05	0.05	0.05	0.05
GT-5	0.05	0.05	0.05	0.05
GT-7	0.05	0.06	0.06	0.05
COL-1	0.06	0.06	0.06	0.06
COL-2	0.06	0.06	0.06	0.05

The tracer concentrations as a function of pore volume eluted for each saturated flow experiment are listed in Appendix VII. The data are presented in terms of dimensionless time and dimensionless effluent concentration. Dimensionless time is equivalent to cumulative effluent volume divided by the average column pore volume. Dimensionless effluent concentration is defined as C/CO , where C is the actual effluent concentration for a given tracer and CO is the input concentration for the same tracer.

Individual Breakthrough Curves (BTC's) of C/CO vs. PV for each tracer, in each column, in the four saturated flow experiments are shown in Appendix VIII. BTC's for all the tracers applied to a column in a single experiment (composite BTC's) are also shown in Appendix VIII.

By looking at the composite BTC's, the relative position of the potential tracer BTC's to that of tritium can easily be seen. For the porous medium GT-2, anion exclusion for the tracers bromide and iodide is evident. The occurrence of this phenomenon, shown by the relative shift of the BTC's to an earlier time than tritium, is plausible given the high CEC of the porous medium. Boron can be seen acting identically to that of tritium. By looking at the species distribution plot of $B(OH)_4^-$ (based on the ionization constants of boron and pure water) and the pH range of the effluent, it is seen that approximately 92% of the species is in the uncharged state. Therefore, we would expect boron to behave almost identically to tritium. Mass recoveries were calculated for the three potential tracers and tritium, and the results are presented in Appendix IX. The percentage of mass recovered was determined by calculating the area under the BTC for each tracer and dividing by the input slug duration (in terms of pore volume). The low recovery for boron may be explained by the lower precision of the analytical technique used to determine the boron concentration, relative to the other tracers. The composite BTC's from the other three saturated experiments for the porous medium GT-2 show the same relative positions of the tracer BTC's with respect to tritium as was seen in the first saturated experiment. The mass recoveries were all around 100% for the tracers, with boron's fluctuating the most.

The composite BTC for the porous medium GT-5 shows very slight anion exclusion for the tracers bromide and iodide, and slight retardation for the tracer boron, with respect to tritium in all four of the saturated flow experiments. The percent mass recoveries for the tracers were all near 100%, indicating the conservative nature of the tracers. It has been suggested that the slight retardation of boron is due to adsorption onto biotite present in the soil medium (Anne Lewis-Russ, personal communication). At the pH of the matrix water, 99% of boron should be in the form $B(OH)_3$.

The composite BTC for the porous medium GT-7 shows all four of the individual tracer BTC's occurring on top of each other in all of the saturated experiments. This indicates that all three tracers behave identically to that of tritium in this medium. The mass recoveries are also near 100%, with boron, again, having a greater fluctuation than either bromide, iodide, or tritium.

The composite BTC's for the synthetic porous medium Col-1 look almost identical to those for porous medium GT-5. Bromide and iodide both show slight anion exclusion, while boron was retarded slightly with respect to tritium. The mass recoveries were also near 100% for all of the tracers.

The composite BTC's for the synthetic porous medium Col-2 resemble those for porous medium GT-2, in that bromide and iodide show a greater degree of anion exclusion due to the presence of zeolite in the synthetic porous medium. However, the Col-2 porous medium also shows a very slight boron anion exclusion on three of the four saturated flow experiments. This is evident by the fact that the boron and tritium curves do not directly overlap one another. This slight anion exclusion is probably caused by the presence of a greater percent of negatively charged $B(OH)_4^-$ (approximately 49% of the total borate, as determined by the species distribution plot) due to the higher pH of the soil matrix water. The mass recoveries were, again, near 100%, with the exception of a few boron mass recoveries, for the tracers in all four saturated experiments. Again, boron recoveries fluctuated to a greater extent than did the other tracers.

For all five porous media, the bromide and iodide BTC's were virtually identical.

Analyses were performed on composited samples from the peaks and tails of the BTC's to determine the concentrations of major soluble species. Samples that occurred during the peak concentration of tritium were bulked together as were those that occurred during the tail of the tritium BTC. The species analyzed were aluminum, calcium, magnesium, silica, sodium, potassium, bicarbonate, carbonate (when necessary due to a high pH), chloride, and sulfate. Specific conductance and pH were also determined for the peak and tail composited samples. Appendix X contains the data collected from the measurements along with the sample numbers that were bulked.

A number of interesting observations can be made when reviewing the data. In the two porous media that contained zeolite, GT-2 and synthetic Col-2, the concentration of calcium was noticeably lower than that of the leaching solution, while the concentration of sodium was higher. This would suggest that cation exchange was still taking place within these soil columns. Bicarbonate was present in much greater concentrations in the effluent of synthetic Col-2 than was present in the leaching solution. Silica was also present in relatively higher concentrations in the effluent from the two synthetic tuff samples, Col-1 and Col-2. Potassium appeared to be present in the effluent from the porous medium GT-2 and synthetic Col-2 in concentrations half of what the leaching solution was in those saturated experiments in which Pore Water was used as the leaching solution. Magnesium was present in the effluent from porous medium GT-5 and synthetic Col-1, while it was below the detection limit in the effluent from porous media GT-2, synthetic Col-2, and most of GT-7. Aluminum was only present in detectable concentrations in the effluent from porous medium GT-7 during the first two saturated experiments. The specific conductance was close to being equivalent between peak and tail samples of a column in any given experiment. The pH of the effluent from the synthetic porous medium Col-2 was also measured to be one full unit above the pH's of the other four porous media.

A charge balance was calculated on each composited sample analysis for all four saturated experiments. The contribution of the anions bromide and iodide was taken into account when determining the charge balance for the peak. Silica and aluminum were not included in the charge balance. Appendix X includes values for the sum of the absolute equivalents of cations and anions, and the percent difference between the two, for all of the experiments. The percent difference was calculated by dividing the average of the absolute equivalents of cations and anions into the difference of cations minus anions. Although many of the percent differences for the saturated experiments are near enough to zero to be accounted for by analytical technique inaccuracies, there are a few charge balances that show a significant excess of cations. One reason for this may be that, in some cases, there was an insufficient sample volume to be able to determine the bicarbonate concentration accurately by titration.

B. Unsaturated Flow Experiments

Table 6 lists the applied vacuum values to each column for the four unsaturated flow experiments. Table 7 lists the flow rate applied to each column and the resulting average column pore volume and volumetric water content. The mean pore water velocity and column saturation are also listed in Table 7 for the four unsaturated flow experiments. Column saturations were computed assuming the average column pore volumes during the saturated flow experiments were indeed the maximum saturation values obtainable.

The actual tracer input concentrations for the four unsaturated flow experiments are listed in Table 8. Also listed in Table 8 are the input concentrations for the four fluorobenzoate tracers and the ^{18}O enriched water used in the second unsaturated experiment (UC-#2-20T).

The fraction of a pore volume of column effluent collected in a vial during each unsaturated flow experiment is shown in Table 9.

The chemical analyses results from the four unsaturated flow experiments are tabulated in Appendix XI. The data are presented as a function of dimensionless time and concentration. The time at which a sample was taken is given in cumulative pore volumes eluted (PV), and its concentration is given in terms of relative concentration (C/CO).

Table 6. Applied Vacuums (mbar) During Unsaturated Experiments

Porous Medium	UC-#2-10T	UC-#2-20T	UC-#1-10T	UC-#1-20T
GT-2	184	182	186	187
GT-5	172	170	170	171
GT-7	114	111	113	114
COL-1	86	83	86	86
COL-2	172	170	168	173

Table 7. Physical Parameters For Unsaturated Experiments

Porous Medium	Experiment	Column Pore Volume	Volumetric Water Content (cm^3/cm^3)	Flow Rate (cm/hr)	Mean Pore Water Velocity (cm/hr)	Column Saturation (%)
GT-2	UC-#2-10T	264.63	0.449	0.336	0.747	68.26
	UC-#2-20T	262.38	0.445	0.303	0.681	67.68
	UC-#1-10T	244.53	0.415	0.322	0.776	63.08
	UC-#1-20T	269.38	0.457	0.329	0.718	69.49
GT-5	UC-#2-10T	249.71	0.424	0.360	0.850	70.80
	UC-#2-20T	251.26	0.427	0.355	0.832	71.24
	UC-#1-10T	240.56	0.408	0.360	0.882	68.21
	UC-#1-20T	241.66	0.410	0.357	0.870	68.52
GT-7	UC-#2-10T	173.15	0.294	0.367	1.250	50.78
	UC-#2-20T	168.15	0.286	0.358	1.252	49.32
	UC-#1-10T	153.10	0.260	0.356	1.370	44.90
	UC-#1-20T	163.30	0.277	0.353	1.275	47.89
COL-1	UC-#2-10T	195.00	0.331	0.356	1.074	62.15
	UC-#2-20T	195.20	0.331	0.357	1.076	62.22
	UC-#1-10T	172.35	0.293	0.355	1.215	54.93
	UC-#1-20T	173.76	0.295	0.351	1.188	55.38
COL-2	UC-#2-10T	279.70	0.475	0.354	0.745	86.40
	UC-#2-20T	269.45	0.457	0.362	0.792	83.24
	UC-#1-10T	285.40	0.485	0.324	0.669	88.17
	UC-#1-20T	276.75	0.470	0.340	0.725	85.49

Table 8. Actual Tracer Input Concentrations For Unsaturated Experiments

Experiment	Boron (ppm)	Bromide (ppm)	Iodide (ppm)	Tritium (dpm/ml)
UC-#2-10T	11.5	8.6	10.0	984395
UC-#2-20T	21.0	21.1	21.1	962547
UC-#1-10T	10.4	9.9	10.0	1005363
UC-#1-20T	20.8	21.6	17.7	978851

Experiment	m-TFMBA (ppm)	o-TFMBA (ppm)	PFBA (ppm)	2,6-DFBA (ppm)	^{18}O (permil)
UC-#2-20T	11.80	11.13	22.15	16.65	18.586

Table 9. Fraction of Pore Volume Collected per Vial During Unsaturated Experiments

Porous Medium	UC-#2-10T	UC-#2-20T	UC-#1-10T	UC-#1-20T
GT-2	0.04	0.05	0.05	0.04
GT-5	0.05	0.05	0.06	0.06
GT-7	0.08	0.08	0.09	0.08
COL-1	0.07	0.07	0.08	0.08
COL-2	0.05	0.05	0.04	0.05

Breakthrough curves of C/CO vs. PV for each tracer from the unsaturated flow experiments are shown in Appendix XII. Composite BTC's are also shown.

By looking at the composite BTC, the relative position of the potential tracer BTC's to that of tritium can easily be seen. For the porous medium GT-2, the same anion exclusion of bromide and iodide was seen in the four unsaturated flow experiments as was seen in the saturated flow experiments. The degree of exclusion is slightly greater in the unsaturated flow experiments than in the saturated flow experiments due to the lower water content. The tracers in the unsaturated flow experiments behaved identically in all four experiments, with the exception of boron in the third unsaturated flow experiment (UC-#1-10T). By looking at the composite BTC for this experiment, it can be seen that boron is slightly retarded with regard to tritium. In the other three unsaturated flow experiments, boron behaves identically to tritium. The reason for the slight retardation in experiment UC-#1-10T is not known. The mass recoveries calculated for the tracers and tritium for porous medium GT-2, as well as other porous media, are presented in Appendix IX. The mass recoveries were near 100% for all of the tracers.

The composite BTC for the porous medium GT-5, again, shows very slight anion exclusion for the tracers bromide and iodide, and slight retardation for the tracer boron, with respect to tritium in all four of the unsaturated flow experiments. By comparing the composite BTC's from the saturated flow experiments to those from the unsaturated flow experiments, it can be seen that the degree of anion exclusion was approximately the same in both types of flow experiments. However, boron was retarded to a greater extent in the unsaturated flow experiments than in the saturated flow experiments. The reason for this is not known. The mass recoveries were near 100% for all of the tracers.

The composite BTC's for the porous medium GT-7 show, as in the saturated flow experiments, all of the tracers behaving identically to tritium in all four of the unsaturated flow experiments. The mass recoveries were all near 100% for all of the tracers.

The composite BTC's for the synthetic porous medium Col-1 show anion exclusion for the tracers bromide and iodide, and retardation for the tracer boron, with respect to tritium in all four unsaturated flow experiments. Comparing the unsaturated flow cumulative BTC's to those from the saturated flow experiments, it can be seen that boron is retarded to approximately the same degree. However, there is a greater degree of anion exclusion for the tracers bromide and iodide in the unsaturated flow experiments due to the column saturation being less than 100% . The mass recoveries for the tracers were all near 100% for all four of the unsaturated flow experiments.

The composite BTC's for the synthetic porous medium Col-2 show anion exclusion for all three potential tracers in all four unsaturated flow experiments. Bromide and iodide are excluded to a greater degree than is boron. Comparing the unsaturated flow BTC's to those from the saturated flow experiments, it can be seen that the degree of anion exclusion is approximately the same in both types of flow experiments, due, most likely, to the fact that column saturation was only slightly less than 100% . All four of the unsaturated flow experiments had mass recoveries near 100% for all of the tracers.

In the second unsaturated experiment, UC-#2-20T, four fluorobenzoate tracers were added along with the other three potential tracers and tritium. Also in this experiment, ^{18}O-enriched water was added. The chemical analysis results from the experiment are tabulated in Appendix XIII. The data is presented in terms of dimensionless time and concentration. Breakthrough curves of C/CO vs. PV for each tracer from all five columns are shown in Appendix XIV. Also shown in Appendix XIV is a composite BTC showing the fluorobenzoate BTC's relative to the tracer bromide, and a composite BTC showing ^{18}O relative to the index tracer tritium, for each of the five columns. As can be seen by examining the fluorobenzoate composite BTC's, the four fluorobenzoate tracers behave identically to bromide in all five porous media. The mass recoveries for the fluorobenzoate tracers, tabulated in Appendix XV, are all near 100% indicating the conservative nature of the tracers. The slightly higher mass recoveries calculated for porous medium GT-2 are most likely due to underestimating the average column pore volume due to plugging problems (see below). As can be seen by examining the composite BTC's of ^{18}O and tritium, ^{18}O and tritium behave essentially identically to one another with respect to peak position, and thus retardation factor. The mass recoveries for ^{18}O, tabulated in Appendix XV, are near 100% for the porous media GT-2, GT-5 and COL-1. Porous medium GT-7 shows a high mass recovery, while COL-2 shows a low mass recovery. These discrepancies could have been caused by problems that arose while preparing the effluent samples for analyses on the mass spectrometer.

Analyses were performed on composited samples from the peaks and tails of the BTC's to determine the concentrations of major soluble species. Samples that occurred during the peak concentration of tritium were bulked together as were those that occurred during the tail of the tritium BTC. The species analyzed were aluminum, calcium, magnesium, silica, sodium, potassium, bicarbonate, carbonate (when necessary due to a high pH), chloride, and sulfate. Specific conductance and pH were also determined for the peak and tail composited samples. Appendix X contains the data collected from the measurements along with the sample numbers that were bulked.

A number of interesting observations can be made when reviewing the data. In the two porous media that contained zeolite, GT-2 and synthetic Col-2, the concentration of calcium was noticeably lower than that of the leaching solution, while the concentration of sodium was higher. This indicates that cation exchange was still taking place within these soil columns. Bicarbonate was present in much greater concentrations in the effluent of synthetic Col-2 than was present in the leaching solution. Silica was also present in relatively higher concentrations in the effluent from the two synthetic tuff samples, Col-1 and Col-2. Potassium was present in the effluent from the porous media GT-2 and synthetic Col-2 in concentrations one half to one third of that of the Pore Water leaching solution. Magnesium was present in the effluent from porous media GT-5 and synthetic Col-1 in the unsaturated experiments UC-#2-10T and UC-#2-20T, while it was below the detection limit in the effluent from porous media GT-2, synthetic Col-2 and GT-7. Aluminum was below the detection limit for all five of the porous media in all four unsaturated flow experiments. The specific conductance was approximately the same between peak and tail samples of a column in any given experiment. The pH of the effluent from the synthetic porous medium Col-2 was measured to be almost one full unit above the pH's of the other four porous media.

Comparing the composited sample analyses from the saturated and unsaturated experiments, it can be seen that most of the soluble species behaved identically in both types of flow experiments. However, one noticeable exception can be observed. The concentration of silica is approximately three times greater in the composited effluent samples from the unsaturated experiments than from the saturated experiments in all five of the porous media. The reason for this is unknown.

A charge balance was calculated on each composited sample analysis for all four unsaturated experiments. The contribution of the anions bromide and iodide was taken into account when determining the charge balance for the peak. Silica and aluminum were not included in the charge balance. Appendix X also includes values for the sum of the absolute equivalents of cations and anions, and the percent difference between the two, for all of the experiments. The percent difference was calculated by dividing the average of the absolute equivalents of cations and anions into the difference of cations minus anions. Although many of the percent differences for the unsaturated experiments are near enough to zero to be accounted for by analytical technique inaccuracies, there are a few charge balances that show a significant excess of cations. As for the saturated flow experiment analyses, one plausible explanation for this may be that, in some cases, there was an insufficient sample volume to be able to determine the bicarbonate concentration accurately by titration. Also, particularly in the samples where synthetic J-13 well water was the leaching solution, absolute concentrations of species are relatively low, resulting in relatively large analytical variability.

Appendix II contains the moisture release curves for the five different tuff samples. The curves from the two different methods are both plotted on the same graph. Table 10 lists the average column matric potentials and column moisture contents from the last unsaturated flow experiment (UC-#1-20T). Also listed are the moisture content values obtained from the moisture release curves at the specified matric potential. By comparing the actual moisture content to those obtained from the moisture release curves, it is seen that the moisture release curves obtained using the actual soil columns more closely fit the observed average matric potentials seen in the columns. This is especially clear for porous medium GT-2. The other four porous media have similar results for both methods. It is postulated that the large discrepancy between the two theoretical moisture values for porous medium GT-2 was due, in part, to the constant wetting/drying that took place in the soil column due to the plugging of the porous end plate (as explained below).

Table 10. Water Content Comparison Between Moisture Release Curves and Experiment UC-#1-20T

Porous Medium	UC-#1-20T Matric Potential (mbar)	UC-#1-20T Water Content (cm^3/cm^3)	Hanging Column Derived Matric Potential (mbar)	Soil Column Derived Matric Potential (mbar)
GT-2	-30	0.457	-90	-42
GT-5	-53	0.410	-44	-50
GT-7	-44	0.277	-46	-50
COL-1	-66	0.295	-76	-75
COL-2	-54	0.470	-50	-58

Appendix XVI contains tables and plots of the matric potential data collected from the five columns during the unsaturated flow experiments. Each plot of time versus pressure indicates points at which the vacuum on the column was broken during the experiment. The difference between the upper and lower column matric potentials is plotted on the graph along with the upper and lower column matric potentials. During the unsaturated flow experiments the applied vacuum had to be temporarily increased on the column containing porous medium GT-2 to unplug the porous end plate. The time at which this was done is also indicated on the column matric potential plots. This end plate plugging phenomenon also occurred during the third unsaturated experiment on the column containing the synthetic porous medium Col-2. The porous end plate is hypothesized to have plugged as a result of very fine migrating particles forming a low conductivity layer at the end plate. Although all of the crushed tuff samples were sieved so that they contained particles between 250 and 150 micrometers, mechanical breakdown of porous medium GT-2 apparently took place during the flow experiments. This mechanical breakdown created the very fine particles that formed the plugging layer. Effluent from GT-2 occasionally had a light brown tint, apparently due to particles so small that they actually passed through the plate.

By looking at the matric potential data plots of porous medium GT-2, certain trends can be seen. Over time, the matric potentials at both the upper and lower tensiometers increase, indicating that the soil column is getting wetter. The two points at which the applied vacuum is broken (i.e. at the beginning of the experiment and when the vials are changed), the matric potentials can be seen to rapidly decrease over a short period of time and then slowly increase again. This rapid decrease in matric potentials can also be seen when the applied vacuum is temporarily increased. It appears that during both of these situations the soil column desaturated over a short period of time, and then slowly started to saturate back up. A sharp increase in the difference between the upper and lower matric potentials occurred at the point at which the applied vacuum is temporarily increased. This occurred because the porous end plate was unplugged by the temporary increase in applied vacuum, and the column commenced drainage from the top down. It was seen that the top of the column drained first, thereby, decreasing the matric potential read in the upper tensiometer while the bottom of the column drained a short time later. As the bottom of the column drained, the matric potential in the lower tensiometer also decreased, decreasing the difference between the two tensiometers. It can also be seen that after the applied vacuum was broken, the difference between the upper and lower tensiometers decreased for approximately the same time period as the column matric potentials decreased. As the column matric potentials increased, the difference between the upper and lower matric potentials increased. This constant wetting and drying of column GT-2 may have led to an underestimate of the column pore volume as postulated above.

The matric potential data plots for porous medium GT-5 show that the column matric potentials remained relatively steady over time except when the applied vacuum was broken. Again, when the applied vacuum was broken, the upper and lower column matric potentials were seen to sharply decrease and them increase back to those matric potentials present prior to the breaking of the applied vacuum. However, the difference between the upper and lower matric potentials remained relatively constant even during this time period, indicating that the upper and lower matric potentials changed at the same time and to the same degree.

The matric potential data plots for porous medium GT-7 also show the column matric potentials remaining relatively constant throughout the experiments except when the applied vacuum was broken. The matric potential data from the third unsaturated flow experiment, UC-#1-10T, shows that the upper and lower matric potentials were almost identical throughout the experiment. This indicates that there was a uniform moisture content distribution in the soil column throughout the experiment.

During the first two unsaturated flow experiments, UC-#2-10T and UC-#2-20T, the matric potential data from the soil column containing the porous medium Col-1 shows the characteristic decrease in matric potentials after the applied vacuum was broken. The sharp decrease in the difference between the upper and lower matric potentials after the applied vacuum was broken indicates that the lower tensiometer responded quicker than the upper tensiometer when the column matric potential decreased. The final two unsaturated flow experiments, UC-#1-10T and UC-#1-20T, had conditions near that of uniform moisture content (i.e. a unit gradient present) throughout the column as shown by the upper and lower matric potential lines almost overlapping one another.

With the exception of the third unsaturated flow experiment, the column containing the porous medium Col-2 showed a constant difference between the upper and lower matric potentials throughout an entire experiment. The sharp decrease in matric potentials after the applied vacuum was broken, and the subsequent gradual increase in matric potentials afterwards, are seen in the plots, but the upper and lower matric potentials change at the same time and to the same degree. During the third unsaturated flow experiment the porous end plate continuously plugged up, thereby, requiring the applied vacuum to be temporarily increased to unplug it. The times at which this was done are indicated on the matric potential data plot. Both the upper and lower matric potentials can be seen to decrease sharply after the porous plate is unplugged, and then increase gradually as the porous plate plugs back up and leaching solution backs up in the column. The two points at which the applied vacuum was temporarily increased also show a sharp decrease in the difference between the upper and lower matric potentials, while the two points at which the applied vacuum was broken do not.

IV. MODELING RESULTS

A. General Transport Equation

Transport of a single reactive solute species during steady fluid flow in a one-dimensional homogeneous system may be described by

$$D\frac{\partial^2 C}{\partial x^2} - v\frac{\partial C}{\partial x} = \frac{\partial C}{\partial t} + \frac{\rho}{\theta}\frac{\partial S}{\partial t} \qquad [1]$$

where C is the solute concentration in the liquid phase (ML^{-3}), S is the adsorbed concentration per unit mass of the solid phase (MM^{-1}), x is distance (L), t is time (T), D is a dispersion coefficient coefficient reflecting the combined effects of diffusion and mechanical dispersion on transport (L^2T^{-1}), v is the average pore water velocity (LT^{-1}), ρ is the porous medium bulk density (ML^{-3}) and θ is the volumetric water content (L^3L^{-3}) (Parker and van Genuchten, 1984).

Initial and boundary conditions for Eq. [1] must also be stated for the system under study. If solute is not initially present, the initial condition used is

$$C(x,0) = 0.0 \qquad [2]$$

When dealing with column experiments, a flux-averaged concentration (i.e. mass of solute per unit volume of fluid passing through a given cross-section during an elementary time interval) is appropriate (Kreft and Zuber, 1978). The appropriate boundary conditions are taken as

$$C(0,t) = \begin{cases} C_0 & 0<t\leq t_0 \\ 0 & t>t_0 \end{cases} \quad \text{, upper boundary} \qquad [3]$$

$$\frac{\partial C}{\partial x}(\infty,t) = 0.0 \quad \text{, lower boundary} \qquad [4]$$

where C_0 is the input concentration (ML^{-3}) and t_0 is the input slug duration (T).

When assuming that sorption reactions are fully reversible and can be described by a linear isotherm of the form

$$S = K_d C \qquad [5]$$

where K_d is a solid-liquid phase distribution constant (L^3M^{-1}), Eq. [1] can be rewritten as

$$R\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial x^2} - v\frac{\partial C}{\partial x} \qquad [6]$$

where the dimensionless retardation factor R is defined as

$$R = 1 + \frac{\rho K_d}{\theta} \qquad [7]$$

An ideal non-reactive tracer will have a retardation factor equal to 1.0 . Apparent retardation may be seen due to the presence of dead-end pores and the exchange of the tracer between mobile and immobile regions.

B. Tritium Modeling Results

Due to the fact that the flux rate was held constant during the flow experiments and the volumetric water content was known for the soil columns, the mean pore water velocity was assumed to be constant during the course of the flow experiments and was fixed when modeling the BTC data. The velocities used when modeling the tritium BTC's from the saturated experiments can be found in Table 3, while those velocities from the unsaturated experiments can be found in Table 7. The nonlinear least-squares inversion method computer code CXTFIT was used to model the BTC data (Parker and van Genuchten, 1984).

Using the conventional mono-continuum model which assumes no mobile-immobile water partitioning (model 2 in CXTFIT), the parameters retardation factor, pulse and dispersion coefficient were fitted to the input data, while the mean pore water velocity was held fixed at the appropriate value. Table 11 lists the modeling results from the four saturated flow experiments. As can be seen by reviewing the data, the two soil media that contained zeolite, GT-2 and COL-2, appear to have a retardation factor, R, between 1.07 and 1.10 . The two porous media GT-5 and GT-7 show retardation factors approximately equal to that of an ideal tracer (i.e. R = 1.0) while the porous medium COL-1 shows a retardation factor slightly less than 1.0 .

Table 12 lists the modeling results from the four unsaturated flow experiments. Again, the two porous media GT-2 and COL-2 show apparent retardation of tritium (R = 1.07 to 1.12). However, the other three porous media, GT-5, GT-7 and COL-1, all show apparent exclusion of tritium (R = 0.93). The reason for this is unknown.

Table 11. Tritium Modeling Results From Saturated Experiments

Porous Medium	Experiment	Retardation Factor	Dispersion Coefficient (cm^2/hr)	Input Slug (PV)	Dispersivity (cm)
GT-2	SC-#1-10T	1.080	0.112	1.072	0.098
	SC-#1-20T	1.099	0.076	1.029	0.069
	SC-#2-10T	1.100	0.065	1.072	0.058
	SC-#2-20T	1.104	0.066	0.959	0.065
GT-5	SC-#1-10T	1.000	0.066	1.121	0.054
	SC-#1-20T	0.994	0.069	1.043	0.062
	SC-#2-10T	0.995	0.069	1.226	0.054
	SC-#2-20T	0.994	0.072	1.128	0.059
GT-7	SC-#1-10T	0.979	0.069	1.186	0.055
	SC-#1-20T	0.975	0.127	1.224	0.098
	SC-#2-10T	0.987	0.090	1.293	0.067
	SC-#2-20T	0.983	0.084	1.209	0.065
COL-1	SC-#1-10T	0.959	0.121	1.313	0.086
	SC-#1-20T	0.966	0.133	1.326	0.094
	SC-#2-10T	0.963	0.121	1.361	0.086
	SC-#2-20T	0.962	0.095	1.220	0.071
COL-2	SC-#1-10T	1.071	0.103	1.274	0.079
	SC-#1-20T	1.079	0.113	1.248	0.096
	SC-#2-10T	1.087	0.079	1.253	0.062
	SC-#2-20T	1.090	0.081	1.178	0.063

Also shown in Tables 11 and 12 are the calculated values of dispersivity

$$\alpha = D/v \qquad [8]$$

for the tritium BTC's. The values are within the range typically seen for laboratory soil columns. An interesting observation to note, is that the dispersivities during the unsaturated flow experiments are approximately four to eight times greater than those during the saturated flow experiments. Since the dispersivity takes into account column saturation (in the velocity term), the value for unsaturated flow experiments should be equivalent to that of saturated flow experiments. Possible explanations for

Table 12. Tritium Modeling Results From Unsaturated Experiments

Porous Medium	Experiment	Retardation Factor	Dispersion Coefficient (cm^2/hr)	Input Slug (PV)	Dispersivity (cm)
GT-2	UC-#2-10T	1.122	0.243	1.269	0.325
	UC-#2-20T	1.120	0.188	1.306	0.276
	UC-#1-10T	1.124	0.327	1.366	0.421
	UC-#1-20T	1.065	0.221	1.219	0.308
GT-5	UC-#2-10T	0.933	0.222	1.368	0.261
	UC-#2-20T	0.947	0.201	1.363	0.242
	UC-#1-10T	0.954	0.198	1.444	0.224
	UC-#1-20T	0.917	0.218	1.416	0.251
GT-7	UC-#2-10T	0.931	0.484	1.964	0.387
	UC-#2-20T	0.926	0.572	2.064	0.457
	UC-#1-10T	0.906	0.824	2.140	0.601
	UC-#1-20T	0.884	0.682	2.054	0.535
COL-1	UC-#2-10T	0.938	0.797	1.719	0.742
	UC-#2-20T	0.936	0.604	1.732	0.561
	UC-#1-10T	0.928	0.846	1.942	0.696
	UC-#1-20T	0.924	0.819	1.905	0.689
COL-2	UC-#2-10T	1.065	0.191	1.209	0.256
	UC-#2-20T	1.092	0.236	1.235	0.298
	UC-#1-10T	1.081	0.169	1.176	0.253
	UC-#1-20T	1.090	0.161	1.164	0.222

this observed deviation could be variable column saturation or non-steady state flow conditions.

Table 13 lists the fitted value for the input slug for each saturated column experiment and how it compares to the measured value obtained during the experiment (i.e. measured value equals the volume of effluent obtained during the period of tracer input divided by the average column pore volume). If the fitted value equals the measured value, the ratio of measured value to fitted value would equal 1.00 . By reviewing Table 13, it can be seen that the fitted and measured values, indeed, are all within 1% of each other. This good agreement is evidence that flow measurements during the experiments were quite accurate, as were measured saturated column pore volumes.

Table 13. Input Slug Comparison For Saturated Experiments

Porous Medium	Experiment	Fitted Value For Input Slug (PV)	Measured Value For Input Slug (PV)	Measured Value Divided by Fitted Value
GT-2	SC-#1-10T	1.072	1.06	0.99
	SC-#1-20T	1.029	1.03	1.00
	SC-#2-10T	1.072	1.06	0.99
	SC-#2-20T	0.959	0.96	1.00
GT-5	SC-#1-10T	1.121	1.13	1.01
	SC-#1-20T	1.043	1.05	1.01
	SC-#2-10T	1.226	1.22	1.00
	SC-#2-20T	1.128	1.12	0.99
GT-7	SC-#1-10T	1.186	1.18	0.99
	SC-#1-20T	1.224	1.21	0.99
	SC-#2-10T	1.293	1.29	1.00
	SC-#2-20T	1.209	1.20	0.99
COL-1	SC-#1-10T	1.313	1.31	1.00
	SC-#1-20T	1.326	1.33	1.00
	SC-#2-10T	1.361	1.36	1.00
	SC-#2-20T	1.220	1.23	1.01
COL-2	SC-#1-10T	1.274	1.26	0.99
	SC-#1-20T	1.248	1.25	1.00
	SC-#2-10T	1.253	1.25	1.00
	SC-#2-20T	1.178	1.18	1.00

Table 14 lists the fitted and measured values for the input slug for each unsaturated column experiment. For the column containing porous medium GT-2, the ratio of the measured value to that of the fitted value deviates from 1.0 by upto 8%, and is consistently less than 1.0 . This would indicate that the average column pore volume was overestimated. This is, presumably, due to the constant wetting/drying that took place in the column during the unsaturated flow experiments. The limited number of measurements taken to determine the average column pore volume (in most cases two) would lead to an average column pore volume that would not be well defined under wetting/drying conditions. The columns containing the other four porous media showed considerably less deviation from a ratio of 1.0 (1% to 4%), with the exception of the third unsaturated flow experiment in porous medium

Table 14. Input Slug Comparison For Unsaturated Experiments

Porous Medium	Experiment	Fitted Value For Input Slug (PV)	Measured Value For Input Slug (PV)	Measured Value Divided by Fitted Value
GT-2	UC-#2-10T	1.269	1.23	0.97
	UC-#2-20T	1.306	1.20	0.92
	UC-#1-10T	1.366	1.28	0.94
	UC-#1-20T	1.219	1.12	0.92
GT-5	UC-#2-10T	1.368	1.33	0.97
	UC-#2-20T	1.363	1.34	0.98
	UC-#1-10T	1.444	1.44	1.00
	UC-#1-20T	1.416	1.37	0.97
GT-7	UC-#2-10T	1.964	1.99	1.01
	UC-#2-20T	2.064	2.02	0.98
	UC-#1-10T	2.140	2.07	0.97
	UC-#1-20T	2.054	1.98	0.96
COL-1	UC-#2-10T	1.719	1.68	0.98
	UC-#2-20T	1.732	1.72	0.99
	UC-#1-10T	1.942	1.93	0.99
	UC-#1-20T	1.905	1.88	0.99
COL-2	UC-#2-10T	1.209	1.19	0.98
	UC-#2-20T	1.235	1.24	1.00
	UC-#1-10T	1.176	1.26	1.07
	UC-#1-20T	1.164	1.17	1.01

COL-2. For this particular flow experiment, the data shows that the average column pore volume was underestimated by 7% . The constant wetting/drying that took place during this flow experiment is the probable cause for this underestimation.

C. Boron, Bromide and Iodide Modeling Results

When modeling the two anionic tracers and boron, the parameters retardation factor and dispersion coefficient were fitted to the conventional mono-continuum model. The fitted value for pulse, obtained from the tritium modeling, was fixed during the modeling of these tracers. Table 15 lists the modeling results for boron from the four saturated flow experiments, while Table 16 lists the results for bromide and Table 17 lists the results for iodide. Also shown in each table is the ratio of the tracer retardation factor to that of tritium for each flow experiment.

As can be seen by reviewing the data for porous medium GT-2, the tracer boron had retardation factors equivalent to that of tritium, while bromide and iodide had retardation factors 21-25% less than that of tritium.

Boron had retardation factors approximately 8% greater than that of tritium for porous medium GT-5, while bromide and iodide had retardation factors approximately 4% less than that of tritium.

Porous medium GT-7 had retardation factors for boron, bromide and iodide all approximately equivalent to that of tritium.

Porous medium COL-1 had boron retardation factors 4-10% greater than that of tritium, and bromide and iodide retardation factors about 10% less than that of tritium.

Boron had retardation factors within 1% of the tritium retardation factors in porous medium COL-2, while bromide and iodide had retardation factors approximately 20% less than that of tritium.

Table 15. Modeling Results For Boron From Saturated Experiments

Porous Medium	Experiment	Retardation Factor	Tracer Retardation Relative to Tritium	Dispersion Coefficient (cm^2/hr)	Dispersivity (cm)
GT-2	SC-#1-10T	1.069	0.990	0.074	0.065
	SC-#1-20T	1.096	0.997	0.061	0.055
	SC-#2-10T	1.095	0.995	0.031	0.028
	SC-#2-20T	1.098	0.995	0.076	0.074
GT-5	SC-#1-10T	1.075	1.075	0.119	0.098
	SC-#1-20T	1.057	1.063	0.067	0.060
	SC-#2-10T	1.071	1.076	0.074	0.058
	SC-#2-20T	1.069	1.075	0.072	0.059
GT-7	SC-#1-10T	0.997	1.018	0.113	0.089
	SC-#1-20T	0.991	1.016	0.067	0.051
	SC-#2-10T	1.014	1.027	0.084	0.063
	SC-#2-20T	1.007	1.024	0.075	0.058
COL-1	SC-#1-10T	1.026	1.070	0.145	0.103
	SC-#1-20T	1.007	1.042	0.117	0.083
	SC-#2-10T	1.063	1.104	0.175	0.125
	SC-#2-20T	1.022	1.062	0.124	0.093
COL-2	SC-#1-10T	1.037	0.968	0.201	0.154
	SC-#1-20T	1.032	0.956	0.124	0.105
	SC-#2-10T	1.058	0.973	0.089	0.070
	SC-#2-20T	1.054	0.967	0.117	0.091

Table 16. Modeling Results For Bromide From Saturated Experiments

Porous Medium	Experiment	Retardation Factor	Tracer Retardation Relative to Tritium	Dispersion Coefficient (cm^2/hr)	Dispersivity (cm)
GT-2	SC-#1-10T	0.812	0.752	0.103	0.090
	SC-#1-20T	0.834	0.759	0.064	0.058
	SC-#2-10T	0.860	0.782	0.044	0.039
	SC-#2-20T	0.869	0.787	0.063	0.062
GT-5	SC-#1-10T	0.949	0.949	0.048	0.039
	SC-#1-20T	0.953	0.959	0.051	0.046
	SC-#2-10T	0.965	0.970	0.044	0.035
	SC-#2-20T	0.959	0.964	0.050	0.041
GT-7	SC-#1-10T	0.967	0.988	0.058	0.046
	SC-#1-20T	0.965	0.990	0.076	0.058
	SC-#2-10T	0.980	0.993	0.090	0.067
	SC-#2-20T	0.976	0.993	0.071	0.055
COL-1	SC-#1-10T	0.867	0.904	0.064	0.046
	SC-#1-20T	0.872	0.903	0.067	0.047
	SC-#2-10T	0.879	0.913	0.057	0.041
	SC-#2-20T	0.877	0.912	0.049	0.037
COL-2	SC-#1-10T	0.857	0.800	0.092	0.070
	SC-#1-20T	0.864	0.801	0.082	0.069
	SC-#2-10T	0.880	0.810	0.053	0.042
	SC-#2-20T	0.878	0.806	0.064	0.050

Table 17. Modeling Results For Iodide From Saturated Experiments

Porous Medium	Experiment	Retardation Factor	Tracer Retardation Relative to Tritium	Dispersion Coefficient (cm^2/hr)	Dispersivity (cm)
GT-2	SC-#1-10T	0.819	0.758	0.141	0.123
	SC-#1-20T	0.834	0.759	0.077	0.070
	SC-#2-10T	0.871	0.792	0.031	0.028
	SC-#2-20T	0.867	0.785	0.053	0.052
GT-5	SC-#1-10T	0.957	0.957	0.051	0.042
	SC-#1-20T	0.952	0.958	0.046	0.041
	SC-#2-10T	0.959	0.964	0.069	0.054
	SC-#2-20T	0.959	0.965	0.057	0.047
GT-7	SC-#1-10T	0.967	0.988	0.075	0.059
	SC-#1-20T	0.969	0.994	0.082	0.063
	SC-#2-10T	0.991	1.004	0.064	0.048
	SC-#2-20T	0.967	0.984	0.083	0.064
COL-1	SC-#1-10T	0.864	0.901	0.053	0.038
	SC-#1-20T	0.874	0.905	0.066	0.047
	SC-#2-10T	0.878	0.912	0.055	0.039
	SC-#2-20T	0.875	0.910	0.058	0.044
COL-2	SC-#1-10T	0.853	0.796	0.073	0.056
	SC-#1-20T	0.859	0.796	0.084	0.071
	SC-#2-10T	0.879	0.809	0.076	0.060
	SC-#2-20T	0.879	0.806	0.049	0.038

Table 18 lists the modeling results from the four unsaturated flow experiments for boron, while Table 19 lists the results for bromide and Table 20 lists the results for iodide.

Porous medium GT-2 shows retardation factors for boron approximately equal to that of tritium and retardation factors for bromide and iodide 30-36% less than that of tritium.

Porous medium GT-5 shows retardation factors for boron 12-17% greater than that of tritium. Bromide and iodide, on the other hand, showed retardation factors 4-7% less than that of tritium.

Porous medium GT-7 shows retardation factors for boron 1-5% greater than that of tritium, and retardation factors for bromide and iodide 3-5% less than that of tritium.

Boron shows retardation factors 8-12% greater than that of tritium in porous medium COL-1. Bromide and iodide showed retardation factors 17-22% less than that of tritium.

Bromide and iodide showed retardation factors 23% less than that of tritium in porous medium COL-2. Boron showed retardation factors 3-5% less than that of tritium.

Each of the four fluorobenzoates showed BTC's virtually identical to that of bromide (Appendix XIV), therefore, the retardation factors for all of the fluorobenzoates are the same as that listed for bromide in Table 19.

Overall, there appeared to be a larger difference between the retardation factors of the three tracers and tritium in the unsaturated flow experiments than in the saturated flow experiments. This makes sense when dealing with anion exclusion, whose degree is dependent on porous medium saturation.

Appendix XVII contains graphs for each porous medium showing the retardation factor for the two anionic tracers, boron and tritium and the 95% confidence limits for R obtained from CXTFIT. As can be seen through

Table 18. Modeling Results For Boron From Unsaturated Experiments

Porous Medium	Experiment	Retardation Factor	Tracer Retardation Relative to Tritium	Dispersion Coefficient (cm^2/hr)	Dispersivity (cm)
GT-2	UC-#2-10T	1.157	1.031	0.300	0.402
	UC-#2-20T	1.141	1.019	0.266	0.391
	UC-#1-10T	1.213	1.079	0.384	0.495
	UC-#1-20T	1.093	1.026	0.281	0.391
GT-5	UC-#2-10T	1.055	1.131	0.277	0.326
	UC-#2-20T	1.059	1.118	0.239	0.287
	UC-#1-10T	1.120	1.174	0.213	0.241
	UC-#1-20T	1.073	1.170	0.287	0.330
GT-7	UC-#2-10T	0.941	1.011	0.452	0.362
	UC-#2-20T	0.969	1.046	0.653	0.522
	UC-#1-10T	0.947	1.045	0.723	0.528
	UC-#1-20T	0.908	1.027	0.557	0.437
COL-1	UC-#2-10T	1.053	1.123	0.747	0.696
	UC-#2-20T	1.015	1.084	0.738	0.686
	UC-#1-10T	1.040	1.121	0.789	0.649
	UC-#1-20T	1.010	1.093	0.808	0.680
COL-2	UC-#2-10T	1.032	0.969	0.185	0.248
	UC-#2-20T	1.060	0.971	0.329	0.415
	UC-#1-10T	1.045	0.967	0.226	0.338
	UC-#1-20T	1.038	0.952	0.150	0.207

Table 19. Modeling Results For Bromide From Unsaturated Experiments

Porous Medium	Experiment	Retardation Factor	Tracer Retardation Relative to Tritium	Dispersion Coefficient (cm^2/hr)	Dispersivity (cm)
GT-2	UC-#2-10T	0.781	0.696	0.244	0.327
	UC-#2-20T	0.779	0.696	0.194	0.285
	UC-#1-10T	0.721	0.641	0.292	0.376
	UC-#1-20T	0.709	0.666	0.188	0.262
GT-5	UC-#2-10T	0.884	0.947	0.174	0.205
	UC-#2-20T	0.900	0.950	0.166	0.200
	UC-#1-10T	0.894	0.937	0.151	0.171
	UC-#1-20T	0.852	0.929	0.197	0.226
GT-7	UC-#2-10T	0.902	0.969	0.406	0.325
	UC-#2-20T	0.898	0.970	0.503	0.402
	UC-#1-10T	0.862	0.951	0.582	0.425
	UC-#1-20T	0.843	0.954	0.503	0.395
COL-1	UC-#2-10T	0.763	0.813	0.510	0.475
	UC-#2-20T	0.778	0.831	0.439	0.408
	UC-#1-10T	0.725	0.781	0.452	0.372
	UC-#1-20T	0.721	0.780	0.502	0.423
COL-2	UC-#2-10T	0.817	0.767	0.134	0.180
	UC-#2-20T	0.840	0.769	0.175	0.221
	UC-#1-10T	0.832	0.770	0.082	0.123
	UC-#1-20T	0.839	0.770	0.099	0.291

Table 20. Modeling Results For Iodide From Unsaturated Experiments

Porous Medium	Experiment	Retardation Factor	Tracer Retardation Relative to Tritium	Dispersion Coefficient (cm^2/hr)	Dispersivity (cm)
GT-2	UC-#2-10T	0.787	0.701	0.148	0.198
	UC-#2-20T	0.784	0.700	0.150	0.220
	UC-#1-10T	0.726	0.646	0.235	0.303
	UC-#1-20T	0.709	0.666	0.140	0.195
GT-5	UC-#2-10T	0.884	0.947	0.092	0.108
	UC-#2-20T	0.904	0.955	0.114	0.137
	UC-#1-10T	0.893	0.936	0.081	0.092
	UC-#1-20T	0.853	0.930	0.135	0.155
GT-7	UC-#2-10T	0.897	0.963	0.207	0.166
	UC-#2-20T	0.897	0.969	0.368	0.294
	UC-#1-10T	0.871	0.961	0.375	0.274
	UC-#1-20T	0.840	0.950	0.361	0.283
COL-1	UC-#2-10T	0.765	0.816	0.337	0.314
	UC-#2-20T	0.778	0.831	0.350	0.325
	UC-#1-10T	0.721	0.777	0.272	0.224
	UC-#1-20T	0.719	0.778	0.374	0.315
COL-2	UC-#2-10T	0.816	0.766	0.075	0.101
	UC-#2-20T	0.841	0.770	0.125	0.156
	UC-#1-10T	0.837	0.774	0.056	0.084
	UC-#1-20T	0.838	0.769	0.072	0.099

inspection, the 95% confidence limits were closer together during the saturated flow experiments (1 through 4 on the graph) than during the unsaturated flow experiments (5 through 8). The more precise estimate for the average column pore volume during the saturated flow experiments would lead to a more accurate determination of the time at which a sample was eluted (in terms of cumulative pore volumes) and, hence, would result in a better fitting of the data.

As in the modeling of the tritium BTC's, the dispersivities for the anionic tracers and boron (listed in Tables 15 through 20) are approximately four to five times greater in the unsaturated flow experiments than in the saturated flow experiments. The reasons for this are not clear. One possibility is a relative increase in apparatus-induced dispersion in the unsaturated experiments.

In porous medium GT-2, the dispersivity for the tracers bromide and iodide were equivalent to that of tritium, while boron's dispersivity was slightly less than tritium's in the saturated flow experiments and slightly greater in the unsaturated flow experiments.

Porous medium GT-5 showed dispersivities for bromide and iodide slightly less than that of tritium, and boron dispersivities slightly greater than that of tritium.

Porous medium GT-7 showed dispersivities for boron, bromide and iodide less than that of tritium.

The dispersivities for bromide and iodide were approximately the same, but were less than that of tritium in porous media COL-1 and COL-2, while boron's dispersivities were approximately equivalent to that of tritium.

V. SUMMARY AND CONCLUSIONS

Results from the four saturated flow and four unsaturated flow experiments provide substantial information about the transport characteristics of the three potential water tracers bromide, iodide and boron in Yucca Mountain tuffs.

No difference in transport characteristics was seen between those flow experiments that used Pore water and those that used synthetic J-13 well water. In addition, no significant difference was observable between those flow experiments that used nominal 10 ppm tracer solutions and those that used nominal 20 ppm tracer solutions.

The four fluorobenzoate tracers were shown to be conservative in nature under unsaturated flow conditions. Since unsaturated conditions provide the maximum opportunity for dissipative processes such as volatilization, chemical oxidation and biodegradation, the indicated conservative nature of the four tracers should then be applicable to other flow conditions. These four tracers were seen to behave identically to bromide.

$H_2{}^{18}O$ was seen to act identically to tritiated water, indicating that whatever processes act to produce "non-ideal" behavior of tritium operate identically with respect to $H_2{}^{18}O$.

CXTFIT modeling results gave r^2 regression coefficients in the upper 90's percentile for almost all of the tracer BTC's. This would indicate that the observed data generally fit the ideal behavior associated with the one-dimensional advection-dispersion equation. The dispersion coefficients for both types of flow experiments were sufficiently small enough to be in the range seen for column studies.

Overall, the potential tracers bromide, iodide, boron, and the fluorobenzoates appear to be suitable for subsequent field tracer tests. The retardation factors calculated for these tracers were similar within the saturated and unsaturated flow experiments, thereby, providing a value which can be incorporated into the advection-dispersion equation when calculating arrival times and flow velocities in the natural environment. The conservative nature of all of these potential tracers indicates their usefulness as water tracers. Additionally, the retardation factors for ^3H_2O varied by no more than 21%, which would not be a major factor in field testing. As mentioned earlier, at lower saturations the anion exclusion that is seen for the anionic tracers is greater than at higher saturations. This phenomenon will have to be taken into account when calculating tracer arrival times in the unsaturated zone.

When making a final decision on which tracer, or tracers, to use in hydrological flow studies at Yucca Mountain, Nevada, factors such as analytical ease of quantitation, quantitative accuracy, detection limits, expeditious quantitation and cost will have to be addressed. As can be seen by reviewing the boron data, the colorimetric analytical technique used tended to have a lower accuracy compared to the bromide and iodide analyses. The inconsistent mass recovery of boron was probably due to analytical errors. The magnitude of these errors makes the boron colorimetric technique undesirable. There is always the option of using a different analytical technique than was used during this research project. ICP would allow for excellent quantitative accuracy while analyses on an HPLC would provide analytical ease along with excellent quantitative accuracy and low detection limits. However, the cost associated with either of these two techniques could be a limiting factor.

The detection limits needed to accurately define tracer BTC's from field experiments will, most likely, be in the range 0.01 to 0.1 ppm, which is much lower than what either the the IC or colorimetric analytical techniques could provide. To achieve these low detection limits, an analytical technique such as HPLC would be required.

Interference during sample analysis by other locally-occurring ions has to be taken into account when choosing a tracer. High nitrate or chloride levels could interfere with the detection of bromide or iodide. One possible solution to this problem would be to use one or more of the fluorobenzoate tracers in place of, or in addition to, bromide or iodide.

The conservative nature of a tracer in the natural environment is an important consideration when choosing a groundwater tracer. Both anionic tracers and boron were shown to be conservative in the column flow studies undertaken, as were the fluorobenzoates. However, concerns may still arise as to whether boron, in the form of borate, will be subject to sorption in the natural environment. As was seen in porous medium GT-5, boron can, indeed, be slightly retarded. At higher pH values boron may actually go through anion exclusion as was seen in porous medium COL-2. In a heterogeneous medium that is not well characterized, the usefulness of boron as a groundwater tracer might be limited. Although iodide was found to be conservative in these column flow studies, it was rapidly lost to oxidation and/or irreversible sorption on soil organic matter under unsaturated conditions in the field (Bowman, 1984).

In conclusion, due to its proven effectiveness as a groundwater tracer, bromide, along with its retardation factors calculated from these flow experiments, would be the most useful tracer to use in water flow studies through Yucca Mountain tuffs. In addition, one or more of the fluorobenzoate tracers should be used in conjunction with bromide as an added scientific validation of the obtained analytical results. The use of more than one tracer, especially when they behave identically to one another, gives a greater degree of confidence to any results. If any problems of quantitation arise during the analyses of one of the tracers, analysis of one of the other tracers will, most likely, be able to be performed.

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APPENDIX I

POROUS MEDIA MINERALOGICAL ANALYSES

ANALYZED MINERAL CONTENT

POROUS MEDIUM GT-2

CEC=134.9 meq/100 g

MINERAL	WT. PERCENT
GLASS GT-2	40.23
HEMATITE	0.39
FERRIC ILLITE	5.73
CLINOPTILOLITE	47.93
MICROCLINE (Ab 30)	4.30
PYRITE	0.03
QUARTZ	1.31

POROUS MEDIUM GT-5

CEC=4.3 meq/100 g

MINERAL	WT. PERCENT
GOETHITE	0.28
GLASS GT-5	8.50
FERRIC ILLITE	4.46
MICROCLINE (Ab 30)	46.41
BIOTITE	3.92
OLIGOCLASE (Ab 80)	8.82
PYRITE	0.09
QUARTZ	27.48
RUTILE	0.02

POROUS MEDIUM GT-7

CEC=2.1 meq/100 g

MINERAL	WT. PERCENT
TRIDYMITE	14.72
FERRIC ILLITE	6.34
SANIDINE (Ab 40)	49.24
OLIGOCLASE (Ab 80)	13.49
PYRITE	0.04
CRISTOBALITE	16.05

POROUS MEDIUM COL-1

MINERAL	WT. PERCENT
CRISTOBALITE/TRIDYMITE	70.00
GOETHITE	10.00
CALCITE	20.00

POROUS MEDIUM COL-2

MINERAL	WT. PERCENT
CRISTOBALITE/TRIDYMITE	80.00
CLINOPTILOLITE	20.00

APPENDIX II

MOISTURE RELEASE CURVE DATA AND PLOTS

Table AII.1

Moisture Release Curve Data
From Actual Soil Columns

POROUS MEDIUM GT-2

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.621	0.0
0.511	38.0
0.396	48.0
0.378	51.5
0.366	51.5
0.341	53.5

POROUS MEDIUM GT-5

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.569	0.0
0.379	54.0
0.379	52.5
0.258	74.0
0.222	84.5
0.204	95.0

POROUS MEDIUM GT-7

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.563	0.0
0.342	43.5
0.218	59.0
0.180	73.0
0.171	78.5
0.164	84.5

POROUS MEDIUM COL-1

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.510	0.0
0.457	47.5
0.354	66.5
0.314	73.0
0.233	89.0
0.194	99.0

POROUS MEDIUM COL-2

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.531	0.0
0.524	26.5
0.510	44.5
0.468	57.5
0.436	62.0
0.386	68.0

Table AII.2

Moisture Release Curve Data
From Hanging Columns

POROUS MEDIUM GT-2

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.6620	0.0
0.6570	20.5
0.6070	33.9
0.5500	49.5
0.4980	62.7
0.4730	87.0

POROUS MEDIUM GT-5

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.4999	0.0
0.4999	20.9
0.4649	35.3
0.3829	50.2
0.3059	59.2
0.2119	75.3
0.1749	86.1
0.1449	107.4

POROUS MEDIUM GT-7

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.5047	0.0
0.4947	20.2
0.4447	33.6
0.3297	43.2
0.2167	53.0
0.1477	67.5
0.1177	82.0
0.1037	101.3

POROUS MEDIUM COL-1

VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.4746	0.0
0.4686	21.5
0.4676	41.7
0.4266	55.2
0.3856	63.1
0.2686	79.0
0.2066	87.2
0.1556	104.1

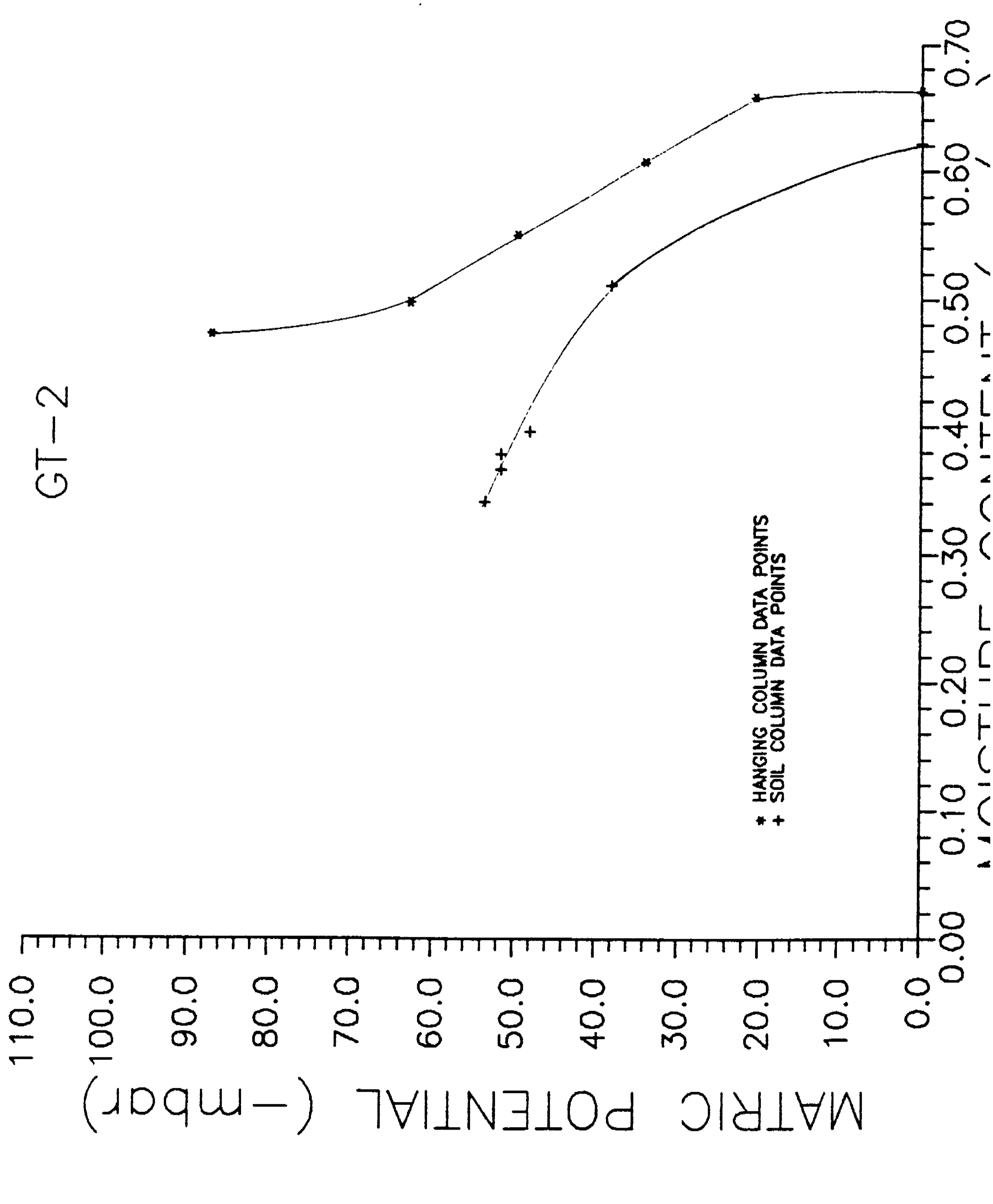
POROUS MEDIUM COL-2

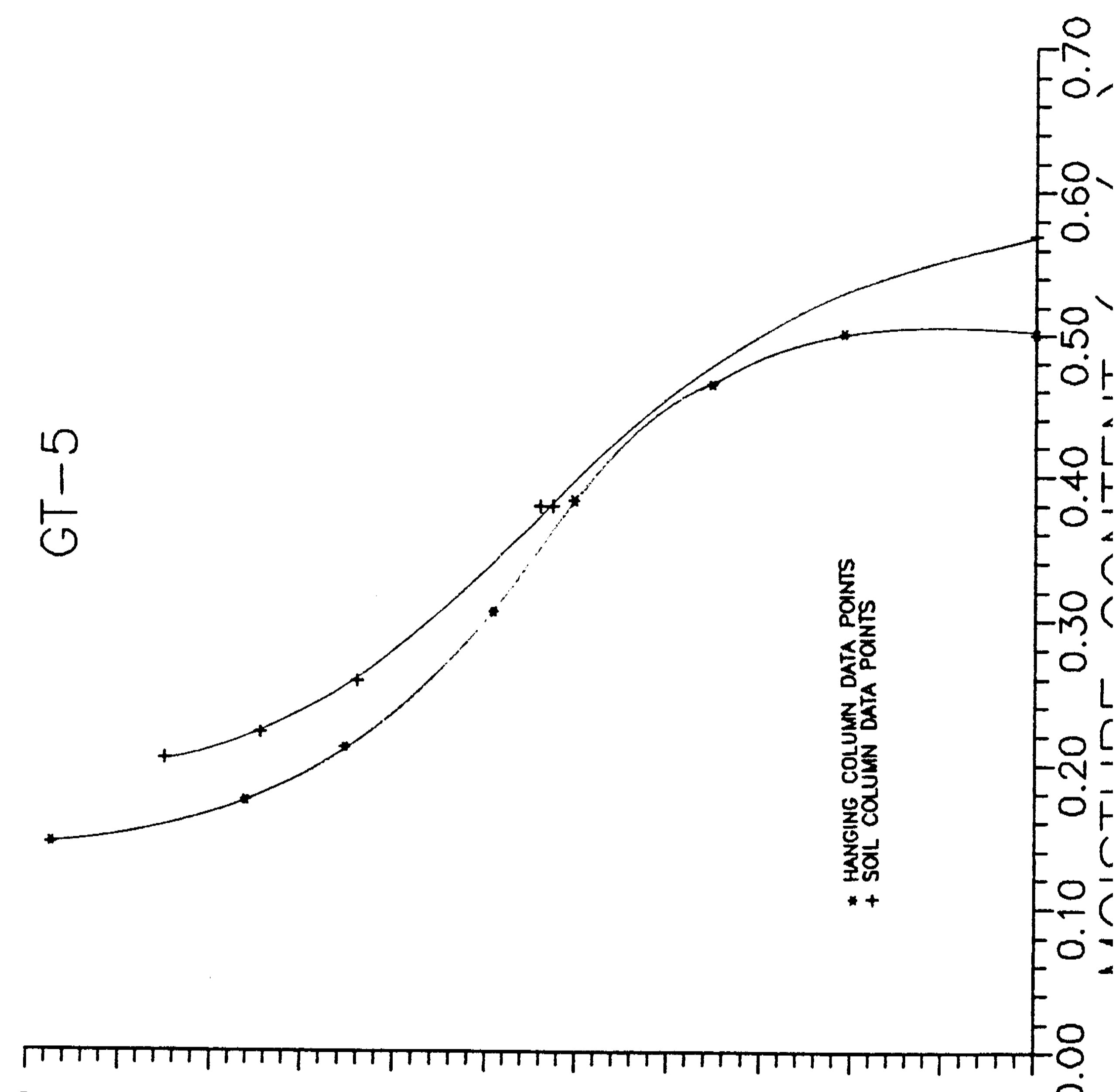
VOLUMETRIC WATER CONTENT (cm^3/cm^3)	AVERAGE MATRIC POTENTIAL (-cm H_2O)
0.5344	0.0
0.5284	20.0
0.5124	39.4
0.4614	53.0
0.3874	60.9
0.3054	69.0
0.2264	81.7
0.1654	108.1

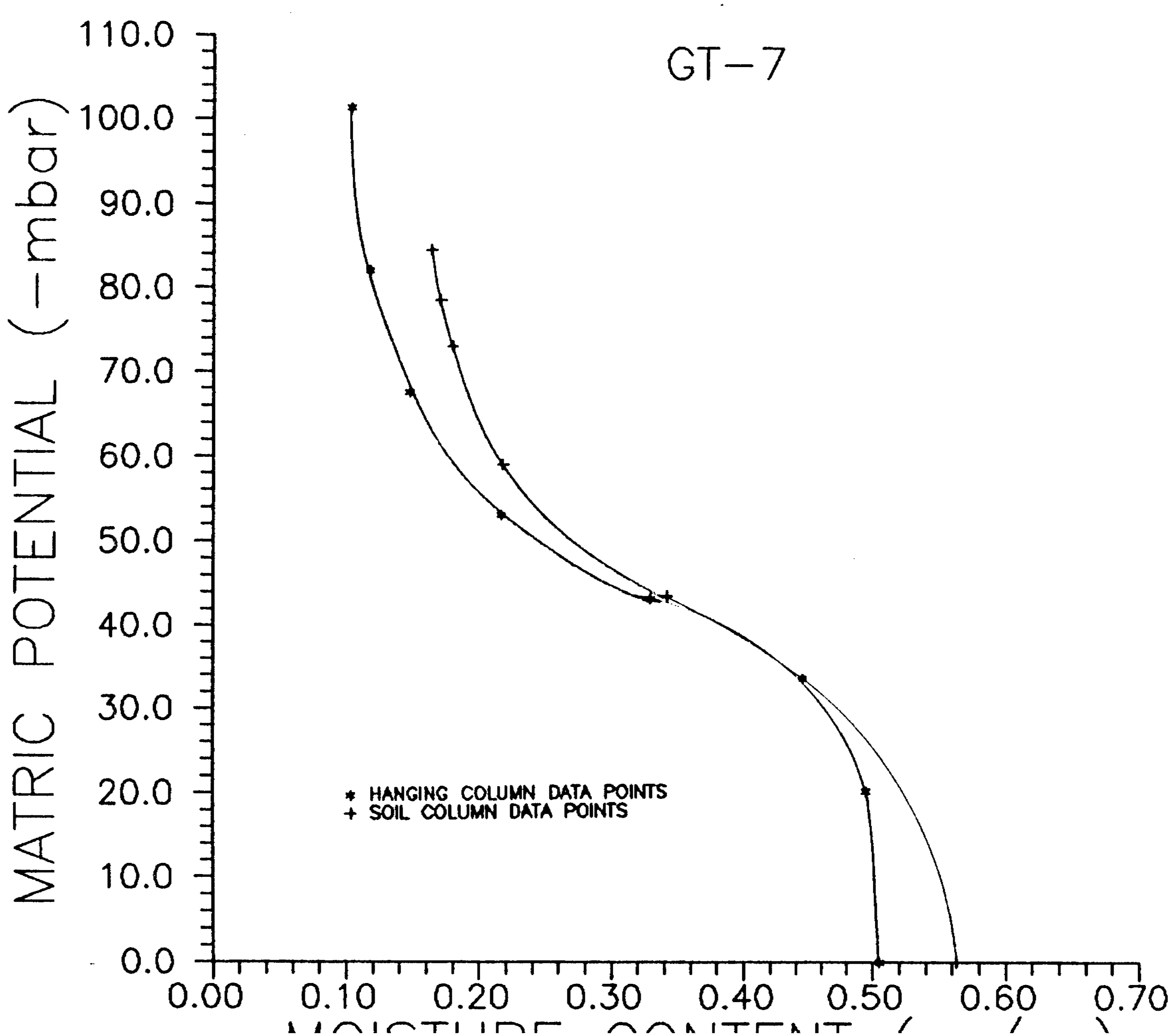
Table AII.3

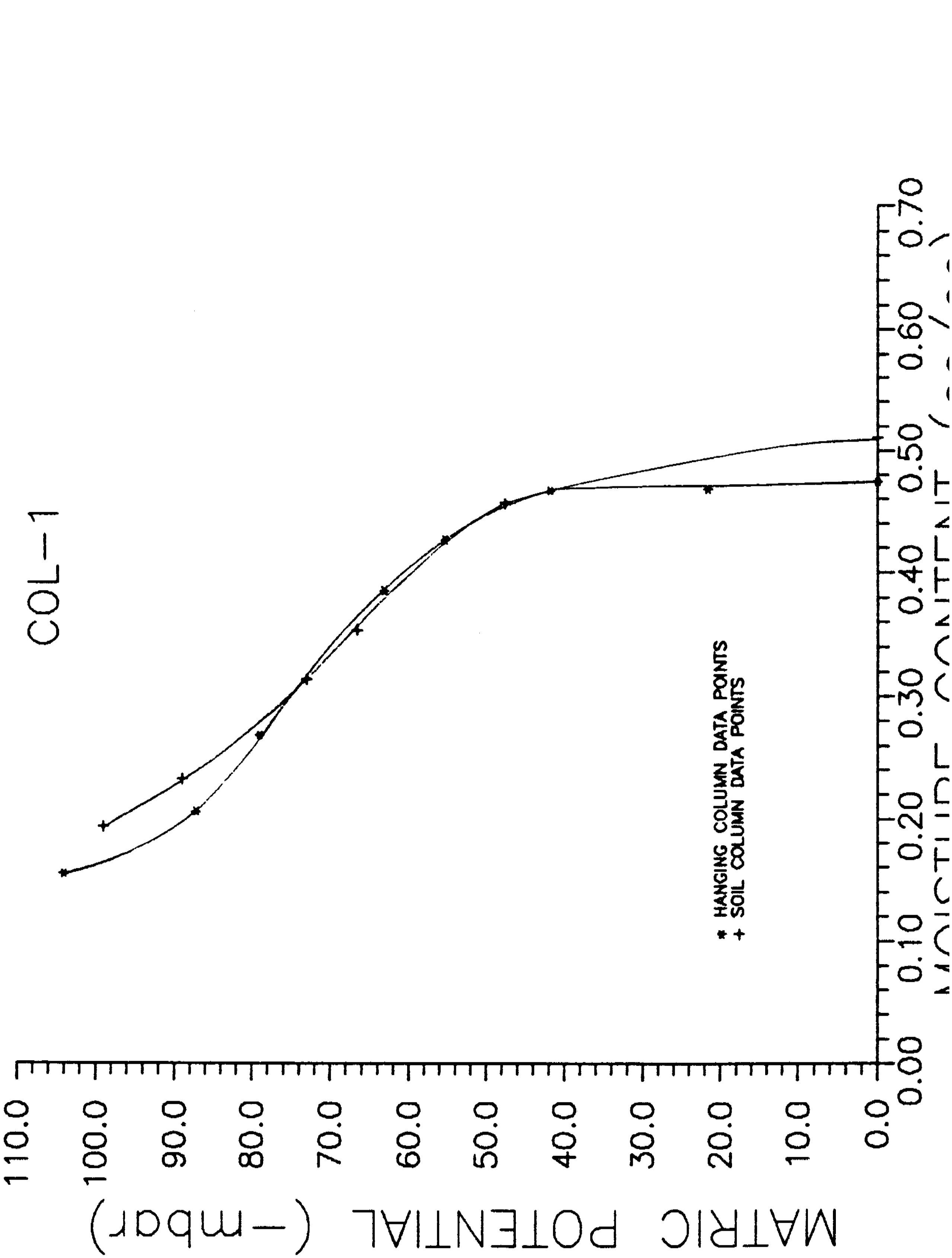
Repacked Tuff Ring Sample Densities

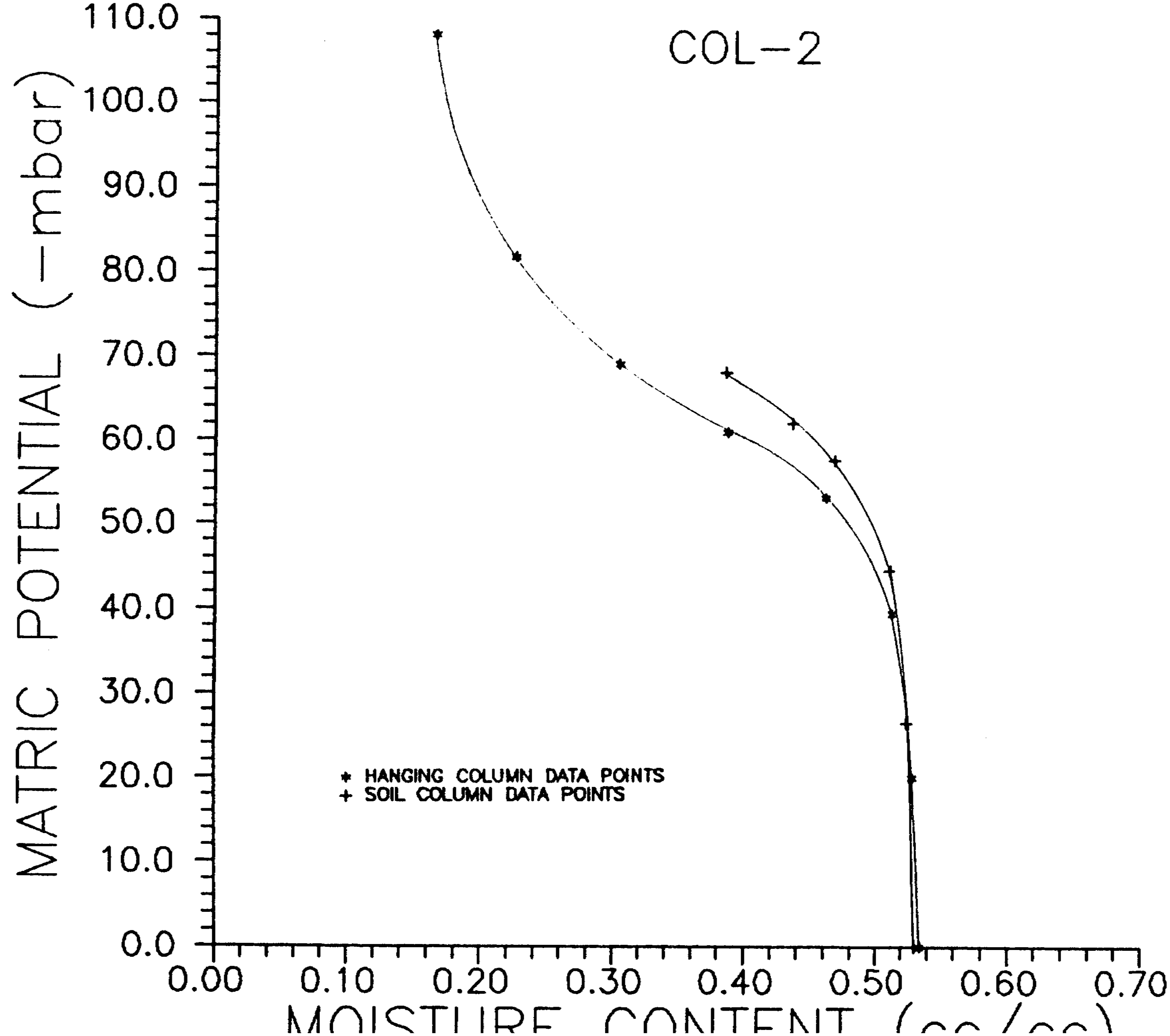
POROUS MEDIUM	ACTUAL SOIL COLUMN BULK DENSITY (g/cm^3)	REPACKED TUFF RING BULK DENSITY (g/cm^3)	PERCENT DIFFERENCE
GT-2	0.89	0.87	3.4 %
GT-5	1.29	1.22	5.4 %
GT-7	1.20	1.18	1.7 %
COL-1	1.15	1.15	0.0 %
COL-2	1.08	1.07	0.9 %


GT—2
MATRIC POTENTIAL (—mbar)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
* HANGING COLUMN DATA POINTS
+ SOIL COLUMN DATA POINTS


GT—5
MATRIC POTENTIAL (—mbar)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
* HANGING COLUMN DATA POINTS
+ SOIL COLUMN DATA POINTS


GT-7
MATRIC POTENTIAL (-mbar)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
* HANGING COLUMN DATA POINTS
+ SOIL COLUMN DATA POINTS


COL—1
MATRIC POTENTIAL (—mbar)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
* HANGING COLUMN DATA POINTS
+ SOIL COLUMN DATA POINTS


COL-2
MATRIC POTENTIAL (-mbar)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
MOISTURE CONTENT (cc/cc)
* HANGING COLUMN DATA POINTS
+ SOIL COLUMN DATA POINTS

APPENDIX III

BROMIDE AND IODIDE RERUNS ON THE HPLC

Experiment	Sample	Br^-	I^-
GT-2-SC-#1-10T	19		*
	29	*	
	38	*	*
GT-5-SC-#1-10T	39		*
GT-7-SC-#1-10T	23	*	
	28	*	*
	32	*	*
	35	*	*
	38	*	*
	42	*	
COL-1-SC-#1-10T	37	*	*
GT-2-SC-#1-20T	15	*	
	21	*	
	22	*	
	26	*	
	29	*	
	34	*	
	39	*	*
GT-5-SC-#1-20T	24	*	
	26	*	
	32	*	
COL-1-SC-#1-20T	17	*	
	35	*	*
COL-2-SC-#1-20T	13	*	*
	53	*	*
	55	*	*
GT-2-SC-#2-10T	18	*	*
	19	*	*
	20	*	
	21	*	
	22	*	
GT-5-SC-#2-10T	22	*	
	27	*	
	41		*
GT-7-SC-#2-10T	29	*	
COL-1-SC-#2-10T	15	*	
	16	*	
	17	*	
	18	*	
	19	*	
	25	*	
	32	*	
	37	*	
	38	*	
	39	*	
	40	*	
COL-2-SC-#2-10T	15	*	*
	16	*	*
	17	*	*
	18	*	*
	19		*
	23		*
	31		*
	38	*	*
	39		*
	40	*	*
	41	*	*
GT-2-SC-#2-20T	18	*	*
	19	*	*
	41	*	*
COL-1-SC-#2-20T	14	*	*
	19		*
	20		*
	28		*
	31		*
	34		*
	35	*	*
	37	*	*
	38	*	*
COL-2-SC-#2-20T	15	*	*
	16	*	*
	37	*	*
	38	*	*

NOTE: * indicates the sample was rerun for the specified ion

APPENDIX IV

INITIAL COLUMN EFFLUENT ANALYSES

POROUS MEDIUM	SAMPLE	BICARBONATE (ppm)	CALCIUM (ppm)	CHLORIDE (ppm)	POTASSIUM (ppm)
GT-2	DAY 11	77.0	< 1.0	29	1.3
GT-2	DAY 14	97.0	< 1.0	29	1.4
GT-2	DAY 15	92.0	< 1.0	30	1.4
GT-5	DAY 11	99.0	6.0	29	4.5
GT-5	DAY 14	103.0	6.7	29	4.6
GT-5	DAY 15	99.0	6.7	29	4.7
GT-7	DAY 11	101.0	7.5	29	4.8
GT-7	DAY 14	104.0	8.7	29	4.9
GT-7	DAY 15	102.0	8.7	29	4.8
COL-1	DAY 11	129.0	21.0	29	0.4
COL-1	DAY 14	119.0	18.0	29	0.4
COL-1	DAY 15	120.0	18.0	28	0.4
COL-2	DAY 11	292.0	< 1.0	29	3.8
COL-2	DAY 14	280.0	< 1.0	29	3.6
COL-2	DAY 15	284.0	< 1.0	30	3.5

POROUS MEDIUM	SAMPLE	SODIUM (ppm)	SULFATE (ppm)	MAGNESIUM (ppm)
GT-2	DAY 11	53	23	< 0.03
GT-2	DAY 14	51	23	< 0.03
GT-2	DAY 15	62	24	< 0.03
GT-5	DAY 11	51	23	0.43
GT-5	DAY 14	51	23	0.49
GT-5	DAY 15	49	23	0.50
GT-7	DAY 11	51	23	0.41
GT-7	DAY 14	51	23	0.08
GT-7	DAY 15	51	23	0.05
COL-1	DAY 11	50	24	1.54
COL-1	DAY 14	51	23	1.16
COL-1	DAY 15	50	22	0.03
COL-2	DAY 11	135	26	0.03
COL-2	DAY 14	133	25	< 0.03
COL-2	DAY 15	133	25	< 0.03

NOTE: Leaching rate was 28 cm/day

APPENDIX V

COLUMN EFFLUENT SPECIFIC CONDUCTANCE AND pH DATA

POROUS MEDIUM	DATE	TWO MINUTE pH	THREE MINUTE pH WITH BUBBLING	pH 7 BUFFER CHECK	SPECIFIC CONDUCTANCE (micromhos per cm)
GT-2	05/14/89	8.23			345
GT-2	05/14/89	8.18			347
GT-2	05/15/89	7.92	8.04		
GT-2	05/16/89		8.15		347
		Experiment	GT-2-SC-#1-10T		
GT-2	05/19/89	7.81	8.07		350
GT-2	05/21/89				345
GT-2	05/23/89	7.82			345
		Experiment	GT-2-SC-#1-20T		
GT-2	05/26/89	7.72	8.10		357
GT-2	05/30/89				690
GT-2	05/31/89				679
GT-2	06/01/89				670
GT-2	06/02/89				690
GT-2	06/03/89	7.54	7.84		702
GT-2	06/04/89	7.49	7.82		679
GT-2	06/05/89	7.58	7.83		715
GT-2	06/06/89	7.40	7.93	7.03	707
GT-2	06/06/89	7.35	7.81	7.00	
GT-2	06/07/89	7.37	7.85	7.01	704
GT-2	06/08/89	7.46	7.97	7.03	700
GT-2	06/09/89	7.44	7.98	7.01	677
GT-2	06/09/89				700
GT-2	06/10/89	7.51	8.03	7.00	710
		Experiment	GT-2-SC-#2-10T		
GT-2	06/13/89	7.45	7.93	6.99	724
GT-2	06/15/89	7.36	7.93	7.00	712
GT-2	06/16/89	7.31	7.87	6.98	720
GT-2	06/17/89	7.24	7.80	7.01	713
		Experiment	GT-2-SC-#2-20T		
GT-2	06/20/89	7.16	7.83	7.00	722
GT-2	07/26/89	7.50	7.75	7.00	653
GT-2	07/28/89	7.49	7.77	7.00	653
		Experiment	GT-2-UC-#2-10T		
GT-2	08/06/89	7.58	7.91	7.01	721
		Experiment	GT-2-UC-#2-20T		
GT-2	08/11/89	7.78	7.96	7.00	726
GT-2	08/24/89	7.81	8.17	7.00	354
GT-2	08/27/89	7.76	8.12	7.00	321
GT-2	08/30/89	7.78	8.11	6.99	328
GT-2	09/05/89	7.65	8.09	7.00	324
GT-2	09/08/89	7.76	8.18	7.00	331
		Experiment	GT-2-UC-#1-10T		
GT-2	09/14/89	8.19	8.31	6.98	327
GT-2	09/17/89	8.07	8.23	7.01	326
GT-2	09/19/89	7.98	8.10	7.00	315
		Experiment	GT-2-UC-#1-20T		
GT-2	09/24/89	8.17	8.26	7.00	331

POROUS MEDIUM	DATE	TWO MINUTE pH	THREE MINUTE pH WITH BUBBLING	pH 7 BUFFER CHECK	SPECIFIC CONDUCTANCE (micromhos per cm)
GT-5	05/14/89	7.05			344
GT-5	05/14/89	7.07			345
GT-5	05/15/89	8.00	8.08		
GT-5	05/16/89		8.05		346
		Experiment	GT-5-SC-#1-10T		
GT-5	05/19/89	7.54	8.24		352
GT-5	05/21/89				348
GT-5	05/23/89	7.57			353
		Experiment	GT-5-SC-#1-20T		
GT-5	05/26/89	7.69	8.11		376
GT-5	05/30/89				665
GT-5	05/31/89				664
GT-5	06/01/89				652
GT-5	06/02/89				668
GT-5	06/03/89	7.23	7.84		675
GT-5	06/04/89	7.63	7.58		658
GT-5	06/05/89	7.50	7.79		693
GT-5	06/06/89	7.44	7.95	7.05	691
GT-5	06/06/89	7.35	7.85	7.05	
GT-5	06/07/89	7.41	7.96	7.02	684
GT-5	06/08/89	7.35	7.96	7.06	693
GT-5	06/09/89	7.31	7.98	7.02	667
GT-5	06/09/89				690
GT-5	06/10/89	7.23	7.93	7.01	683
		Experiment	GT-5-SC-#2-10T		
GT-5	06/13/89	7.04	7.88	7.04	691
GT-5	06/15/89	7.00	7.88	7.05	680
GT-5	06/16/89	7.12	7.91	6.98	692
GT-5	06/17/89	7.10	7.94	7.08	673
		Experiment	GT-5-SC-#2-20T		
GT-5	06/20/89	7.11	7.91	7.04	701
GT-5	07/26/89	7.40	7.86	7.04	653
GT-5	07/28/89	7.39	7.82	6.99	653
		Experiment	GT-5-UC-#2-10T		
GT-5	08/06/89	7.29	7.93	7.04	692
		Experiment	GT-5-UC-#2-20T		
GT-5	08/11/89	7.74	8.00	7.04	702
GT-5	08/24/89	7.54	7.94	7.05	351
GT-5	08/27/89	7.57	8.20	7.00	325
GT-5	08/30/89	7.77	8.21	7.00	332
GT-5	09/05/89	7.77	8.22	6.99	332
GT-5	09/08/89	7.71	8.25	7.04	328
		Experiment	GT-5-UC-#1-10T		
GT-5	09/14/89	8.01	8.38	6.99	339
GT-5	09/18/89	7.69	8.21	7.05	321
GT-5	09/19/89	7.70	8.12	7.01	318
		Experiment	GT-5-UC-#1-20T		
GT-5	09/24/89	8.09	8.24	7.00	336

POROUS MEDIUM	DATE	TWO MINUTE pH	THREE MINUTE pH WITH BUBBLING	pH 7 BUFFER CHECK	SPECIFIC CONDUCTANCE (micromhos per cm)
GT-7	05/14/89	7.96			345
GT-7	05/14/89	7.98			346
GT-7	05/15/89	7.93	8.14		
GT-7	05/16/89		8.01		341
		Experiment GT-7-SC-#1-10T			
GT-7	05/19/89	7.72	8.06		356
GT-7	05/21/89				345
GT-7	05/23/89	7.76			345
		Experiment GT-7-SC-#1-20T			
GT-7	05/26/89	7.94	8.15		362
GT-7	05/30/89				651
GT-7	05/31/89				653
GT-7	06/01/89				642
GT-7	06/02/89				664
GT-7	06/03/89	7.02	7.85		669
GT-7	06/04/89	7.24	7.21		653
GT-7	06/05/89	7.13	7.83		683
GT-7	06/06/89	7.01	7.72	7.00	679
GT-7	06/06/89	6.96	7.78	7.01	
GT-7	06/07/89	6.93	7.81	7.01	672
GT-7	06/08/89	7.11	7.95	6.99	689
GT-7	06/09/89	7.07	7.92	7.01	662
GT-7	06/09/89				667
GT-7	06/10/89	7.13	7.93	7.01	680
		Experiment GT-7-SC-#2-10T			
GT-7	06/13/89	7.12	7.87	6.99	692
GT-7	06/15/89	7.05	7.87	7.00	683
GT-7	06/16/89	7.03	7.90	6.98	690
GT-7	06/17/89	6.99	7.86	7.01	688
		Experiment GT-7-SC-#2-20T			
GT-7	06/20/89	7.45	7.97	7.01	701
GT-7	07/26/89	7.36	7.79	7.02	653
GT-7	07/28/89	7.34	7.74	6.99	653
		Experiment GT-7-UC-#2-10T			
GT-7	08/06/89	7.36	7.95	7.01	697
		Experiment GT-7-UC-#2-20T			
GT-7	08/11/89	7.95	8.07	7.00	711
GT-7	08/24/89	7.81	8.26	7.04	332
GT-7	08/27/89	7.85	8.20	7.01	325
GT-7	08/30/89	7.87	8.21	7.00	337
GT-7	09/05/89	7.83	8.21	7.00	336
GT-7	09/08/89	7.77	8.23	7.02	320
		Experiment GT-7-UC-#1-10T			
GT-7	09/14/89	7.93	8.47	7.01	332
GT-7	09/18/89	7.74	8.19	7.00	309
GT-7	09/19/89	7.73	8.15	7.00	313
		Experiment GT-7-UC-#1-20T			
GT-7	09/24/89	8.17	8.32	7.01	327

POROUS MEDIUM	DATE	TWO MINUTE pH	THREE MINUTE pH WITH BUBBLING	pH 7 BUFFER CHECK	SPECIFIC CONDUCTANCE (micromhos per cm)
Column 1	05/14/89	8.03			359
Column 1	05/14/89	8.09			362
Column 1	05/15/89	8.12	8.24		
Column 1	05/16/89		8.19		359
		Experiment COL-1-SC-#1-10T			
Column 1	05/19/89	7.90	8.28		376
Column 1	05/21/89				367
Column 1	05/23/89	8.10			364
		Experiment COL-1-SC-#1-20T			
Column 1	05/26/89	7.87	8.12	7.04	384
Column 1	05/30/89				667
Column 1	05/31/89				670
Column 1	06/01/89				664
Column 1	06/02/89				681
Column 1	06/03/89	7.49	7.84		696
Column 1	06/04/89	7.76	7.74		674
Column 1	06/05/89	7.73	7.86		706
Column 1	06/06/89	7.67	7.98	7.01	699
Column 1	06/06/89	7.62	7.86	7.00	
Column 1	06/07/89	7.78	7.99	7.01	693
Column 1	06/08/89	7.58	8.00	7.01	698
Column 1	06/09/89	7.72	8.05	7.01	702
Column 1	06/09/89				698
Column 1	06/10/89	7.67	8.07	7.01	705
		Experiment COL-1-SC-#2-10T			
Column 1	06/13/89	7.54	7.98	7.00	722
Column 1	06/15/89	7.54	8.00	7.00	708
Column 1	06/16/89	7.62	8.02	6.98	716
Column 1	06/17/89	7.55	7.98	7.02	718
		Experiment COL-1-SC-#2-20T			
Column 1	06/20/89	7.55	7.99	6.99	731
Column 1	07/26/89	7.70	7.98	6.99	653
Column 1	07/28/89	7.68	7.98	6.99	653
		Experiment COL-1-UC-#2-10T			
Column 1	08/06/89	7.58	7.99	6.99	711
		Experiment COL-1-UC-#2-20T			
Column 1	08/11/89	7.84	8.08	7.00	716
Column 1	08/24/89	7.81	8.12	7.02	348
Column 1	08/27/89	8.02	8.21	7.00	347
Column 1	08/30/89	7.79	8.11	6.98	359
Column 1	09/05/89	7.92	8.18	7.02	361
Column 1	09/08/89	7.58	8.08	7.01	338
		Experiment COL-1-UC-#1-10T			
Column 1	09/14/89	8.25	8.42	7.01	347
Column 1	09/18/89	7.91	8.15	7.00	336
Column 1	09/19/89	7.87	8.12	7.00	338
		Experiment COL-1-UC-#1-20T			
Column 1	09/24/89	8.29	8.37	7.03	342

POROUS MEDIUM	DATE	TWO MINUTE pH	THREE MINUTE pH WITH BUBBLING	pH 7 BUFFER CHECK	pH 10 BUFFER CHECK	SPECIFIC CONDUCTANCE (micromhos per cm)
Column 2	05/14/89	9.00				527
Column 2	05/14/89	8.98				528
Column 2	05/15/89	9.19	9.38			
Column 2	05/16/89		9.45			534
		Experiment	COL-2-SC-#1-10T			
Column 2	05/19/89	9.37	9.45	7.00	10.03	564
Column 2	05/21/89					527
Column 2	05/23/89	9.36		7.00	10.01	523
		Experiment	COL-2-SC-#1-20T			
Column 2	05/27/89	9.10	9.15	7.04	10.04	544
Column 2	05/30/89					798
Column 2	05/31/89					789
Column 2	06/01/89					774
Column 2	06/02/89					803
Column 2	06/03/89	9.25	9.25	7.04	10.08	813
Column 2	06/04/89	9.18	9.16	7.01	10.05	789
Column 2	06/05/89	9.29	9.25	7.06	10.06	828
Column 2	06/06/89	9.21	9.16	7.02	10.01	815
Column 2	06/06/89	9.23	9.16	7.01	10.03	
Column 2	06/07/89	9.16		7.00	10.01	794
Column 2	06/08/89	9.10	9.04	7.00	10.11	810
Column 2	06/09/89	9.24	9.16	7.00		806
Column 2	06/09/89					806
Column 2	06/10/89	9.25	9.18	7.01	10.09	813
		Experiment	COL-2-SC-#2-10T			
Column 2	06/13/89	9.08	9.02	7.01	10.00	840
Column 2	06/15/89	9.11	9.06	7.00	10.02	815
Column 2	06/16/89	9.12	9.06	7.00	10.00	820
Column 2	06/17/89	9.08	9.04	7.01	10.01	818
		Experiment	COL-2-SC-#2-20T			
Column 2	06/20/89	8.97	8.87	7.00	9.99	842
Column 2	07/26/89	8.66	8.55	7.00		804
Column 2	07/28/89	8.23	8.27	7.00	9.99	804
		Experiment	COL-2-UC-#2-10T			
Column 2	08/06/89	8.98	8.91	7.00	10.00	804
		Experiment	COL-2-UC-#2-20T			
Column 2	08/11/89	8.98	8.94	6.99	10.00	803
Column 2	08/24/89	9.07	9.02	6.97		448
Column 2	08/27/89	9.14	9.10	7.02		443
Column 2	08/30/89	9.01	8.97	7.01		443
Column 2	09/05/89	9.04	8.98	6.97	9.98	447
Column 2	09/08/89	9.00	9.01	7.00	10.03	403
		Experiment	COL-2-UC-#1-10T			
Column 2	09/14/89	8.94	8.96	7.00	10.02	418
Column 2	09/17/89	8.95	8.95	7.01	10.03	408
Column 2	09/19/89	8.93	8.92	7.01	10.02	402
		Experiment	COL-2-UC-#1-20T			
Column 2	09/24/89	8.86	8.86	7.00	10.00	399

APPENDIX VI

LECHING SOLUTION ANALYSES

SYNTHETIC J-13 WELL WATER

BATCH NUMBER	BICARBONATE (ppm)	CALCIUM (ppm)	CHLORIDE (ppm)	POTASSIUM (ppm)	SODIUM (ppm)	SULFATE (ppm)
1	106.0	9.2	28	3.8	50	24
3	103.0	9.1	28	3.8	53	24
4	104.0	9.0	27	3.9	54	24
5	103.0	9.0	27	3.5	51	24
6	104.0	8.3	33	5.5	57	22
7	99.0	8.1	28	4.6	55	22
8 !	100.0	17.1 @	40 #	5.6	60	26 #
9 !	107.0	14.3 @	39 #	5.5	60	26 #
10	103.0	9.0	32	4.2	59	21
11	99.0	10.0	31	4.2	60	21

PORE WATER

BATCH NUMBER	BICARBONATE (ppm)	CALCIUM (ppm)	CHLORIDE (ppm)	POTASSIUM (ppm)	SODIUM (ppm)	SULFATE (ppm)
1	44.0	49.0	95	11.7	67	127
2	45.0	50.0	95	11.7	66	127
3	44.3	51.0	96	11.0	70	128
4	42.9	55.0	97	11.0	71	129
5	45.0	52.0	100	11.9	78	138
6 *	48.0	53.0	94	3.3 @	78	137
7	30.0	46.0	94	11.4	71	134
8	48.2	55.0	107	11.4	74	117

NOTE: All batches were 20 liters in volume unless otherwise noted.
* 6 liter batch
@ Problem with Atomic Absorbtion Spectrophotometer analyses.
# Problem with Ion Chromatography analyses.
! Analyized at the same time.

APPENDIX VII

COLUMN EFFLUENT ANALYSES FROM SATURATED FLOW EXPERIMENTS

GT-2-SC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.07				
3	0.12				
4	0.17				
5	0.22				
6	0.26				
7	0.31	0.00			
8	0.36				
9	0.41	0.00			
10	0.46				
11	0.50	0.00			
12	0.55				
13	0.60	0.00			
14	0.65		0.00	0.00	
15	0.69	0.00	0.00	0.00	
16	0.74	0.00	0.08	0.10	
17	0.79	0.00	0.35	0.42	
18	0.84	0.00	0.67	0.65	0.00
19	0.89	0.00	0.79	0.75	
20	0.94	0.02	0.94	0.87	0.00
21	0.98	0.11		0.91	0.00
22	1.03	0.30		0.93	0.35
23	1.07	0.50	0.96	0.95	0.53
24	1.11	0.67		0.94	0.66
25	1.16	0.80	0.98	0.96	0.80
26	1.21	0.88	0.97	0.98	0.77
27	1.25	0.93	0.97		0.84
28	1.30	0.95			
29	1.35	0.95	0.98	0.99	
30	1.40	0.97			
31	1.45	0.98	1.02	0.99	0.89
32	1.49	0.98			
33	1.54	0.99	0.98	1.01	0.91
34	1.59	1.00	0.99	0.00	
35	1.64	1.01	0.98	1.00	0.91
36	1.69	0.99	0.99		
37	1.73	1.01	1.00	1.01	0.91
38	1.78	0.99	0.99	1.00	
39	1.83	1.01	0.80	0.82	0.91
40	1.88	1.00	0.46	0.54	
41	1.92	1.00	0.20	0.29	
42	1.97	1.00	0.09	0.10	0.94
43	2.02	0.97	0.06	0.06	
44	2.07	0.87	0.00	0.00	0.91
45	2.11	0.67	0.00	0.00	0.74
46	2.16	0.41	0.00	0.00	0.16

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.21		0.00	0.00	0.12
48	2.25	0.13	0.00	0.00	0.10
49	2.30				0.00
50	2.35	0.05			0.00
51	2.40				
52	2.44	0.03			
53	2.49				
54	2.54	0.01			
55	2.58				
56	2.63				
57	2.68				
58	2.72				
59	2.77				
60	2.82				
61	2.87				
62	2.91				
63	2.96				

GT-2-SC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.07				
3	0.12				
4	0.17				
5	0.21				
6	0.26				
7	0.31				
8	0.36				
9	0.40				
10	0.45				
11	0.50				
12	0.55				
13	0.59				
14	0.64				
15	0.69	0.00	0.00	0.00	
16	0.74	0.00	0.00	0.02	
17	0.78	0.00	0.13	0.16	
18	0.83	0.00	0.45	0.48	
19	0.88	0.00	0.78	0.78	
20	0.92	0.00	0.96	0.92	
21	0.97	0.02	0.98	0.97	0.00
22	1.01	0.09	0.98	0.99	0.10
23	1.04	0.23		0.99	0.28
24	1.08	0.43	0.98	1.00	0.43
25	1.13	0.67		1.00	0.77
26	1.18	0.85	1.01	1.01	0.97
27	1.23	0.94	0.97	1.01	1.00
28	1.27	0.96		1.01	1.03
29	1.32	0.98	1.01	1.01	
30	1.37	0.99			
31	1.42	0.99			1.08
32	1.46	0.99	0.96	1.01	
33	1.51	0.98			
34	1.56	1.00	1.00	1.00	1.08
35	1.60	0.99			
36	1.65	0.99	0.97	1.00	
37	1.70	0.99			1.08
38	1.74	0.99	0.98	1.00	
39	1.79	0.99	0.91	0.88	
40	1.83	0.99	0.71	0.71	1.10
41	1.88	0.98	0.32	0.37	
42	1.93	1.01	0.11	0.12	
43	1.97	0.98	0.00	0.00	1.10
44	2.02	0.95	0.00	0.00	1.05
45	2.06	0.82			0.83
46	2.11	0.60			0.63

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.15	0.35			0.36
48	2.20	0.17			0.20
49	2.24	0.07			0.13
50	2.29	0.03			0.12
51	2.33				0.08
52	2.38				0.05
53	2.43				0.06
54	2.47				
55	2.52				
56	2.56				
57	2.61				
58	2.65				
59	2.70				
60	2.74				
61	2.78				
62	2.83				
63	2.87				
64	2.90				

GT-2-SC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.06				
3	0.11				
4	0.16				
5	0.21				
6	0.25				
7	0.30				
8	0.35				
9	0.39				
10	0.44				
11	0.49				
12	0.53				
13	0.58				
14	0.62				
15	0.67	0.00			
16	0.72	0.00			
17	0.76	0.00	0.00	0.00	
18	0.81	0.00	0.17	0.00	
19	0.86	0.00	0.49	0.24	
20	0.90	0.00	0.83	0.79	
21	0.95	0.01	0.96	0.95	0.00
22	1.00	0.05	1.01	0.98	0.00
23	1.04	0.20		0.99	0.00
24	1.08	0.42		1.00	0.21
25	1.13	0.65		1.00	0.61
26	1.17	0.85		1.01	0.74
27	1.22	0.95			0.80
28	1.27	0.98	1.00	1.00	0.83
29	1.31	0.99			0.90
30	1.36	1.00			0.90
31	1.40	1.00			
32	1.45	1.00	1.00	1.00	
33	1.50	1.00			0.96
34	1.54	1.00			
35	1.59	1.00			
36	1.64	1.00	1.00	0.99	
37	1.68	0.99			
38	1.73	0.99			0.94
39	1.78	1.00	1.02	1.00	
40	1.82	1.00			
41	1.87	1.00	0.90	0.91	0.90
42	1.92	1.00	0.63	0.61	
43	1.96	1.00	0.24	0.26	
44	2.01	1.00	0.00	0.06	
45	2.06	0.98	0.00	0.00	0.86
46	2.10	0.86			0.86

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.15	0.63			0.53
48	2.19	0.36			0.00
49	2.24	0.16			0.00
50	2.29	0.06			0.00
51	2.33	0.02			
52	2.38	0.01			
53	2.43	0.01			
54	2.47	0.00			
55	2.52	0.00			
56	2.56	0.00			
57	2.61	0.00			
58	2.66	0.00			
59	2.70	0.00			
60	2.75	0.00			

GT-2-SC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.06				
3	0.11				
4	0.15				
5	0.20				
6	0.25				
7	0.29				
8	0.34				
9	0.38				
10	0.42				
11	0.47				
12	0.51				
13	0.55				
14	0.60				
15	0.64				
16	0.68				
17	0.72				
18	0.77		0.00	0.00	
19	0.81	0.00	0.16	0.07	
20	0.85	0.00	0.37	0.49	
21	0.90	0.00	0.66	0.77	0.00
22	0.94	0.00	0.85	0.93	0.00
23	0.97	0.02	0.94	0.99	0.00
24	1.01	0.09	0.95	1.01	0.12
25	1.06	0.26	0.96	0.99	0.39
26	1.10	0.51	0.99	1.02	0.68
27	1.15	0.75	1.00	0.99	0.79
28	1.19	0.88	1.02	1.03	0.89
29	1.24	0.95			
30	1.28	0.97			
31	1.33	0.97			0.94
32	1.37	0.99	0.99	1.03	
33	1.41	0.99			
34	1.46	1.00			0.94
35	1.50	0.99	0.96	1.03	
36	1.54	0.98			
37	1.59	0.99			0.93
38	1.63	0.99	1.00	1.03	
39	1.67	0.99			
40	1.71	0.98	1.00	1.02	0.98
41	1.75	1.00	0.93	0.92	
42	1.79	0.99	0.76	0.80	
43	1.83	0.99	0.43	0.46	0.99
44	1.87	0.98	0.16	0.25	
45	1.91	0.98	0.05	0.09	0.96
46	1.95	0.95	0.00	0.03	0.96

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	1.99	0.84	0.00	0.00	0.88
48	2.03	0.67			0.69
49	2.07	0.45			0.45
50	2.11	0.25			0.28
51	2.15	0.12			0.19
52	2.19	0.05			0.13
53	2.23	0.02			
54	2.27				
55	2.32				
56	2.36				
57	2.40				
58	2.44				
59	2.48				
60	2.52				

GT-5-SC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02	0.00			
2	0.07	0.00			
3	0.12	0.00			
4	0.18	0.00			
5	0.23	0.00			
6	0.28	0.00			
7	0.33	0.00			
8	0.38	0.00			
9	0.43	0.00			
10	0.48	0.00			
11	0.53	0.00			
12	0.58	0.00			
13	0.64	0.00			
14	0.69	0.00			
15	0.74	0.00			
16	0.79	0.00	0.00	0.00	0.00
17	0.84	0.00	0.00	0.02	
18	0.89	0.04	0.12	0.16	
19	0.94	0.17	0.43	0.46	0.00
20	1.00	0.49	0.86	0.84	0.15
21	1.05	0.83	1.00	0.95	0.51
22	1.10	0.96	1.00		0.75
23	1.14	0.97		0.99	0.80
24	1.18	0.99			
25	1.24	1.00	1.02	0.99	0.93
26	1.29	1.00			
27	1.34	1.01			
28	1.39	0.99			
29	1.44	1.00	1.00	0.99	0.90
30	1.50	1.00			
31	1.55	1.01			0.94
32	1.60	0.99			
33	1.65	0.99	1.01	0.99	0.93
34	1.70	1.00			
35	1.75	0.99			
36	1.81	0.99		0.99	0.99
37	1.86	1.00			
38	1.91	1.00			1.00
39	1.96	1.00	0.98	0.98	0.95
40	2.01	0.97	0.90	0.90	0.93
41	2.06	0.84	0.56	0.76	0.92
42	2.11	0.55	0.24	0.27	0.88
43	2.16	0.25	0.00	0.00	0.71
44	2.21	0.07	0.00	0.00	0.51
45	2.26	0.02	0.00	0.00	0.24
46	2.31	0.01	0.00	0.00	0.14

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.36	0.00			
48	2.41	0.00			
49	2.46	0.00			
50	2.51	0.00			
51	2.56	0.00			
52	2.61	0.00			0.00
53	2.66	0.00			
54	2.71	0.00			
55	2.76				
56	2.80				
57	2.85				
58	2.90				
59	2.95				
60	3.00				
61	3.05				
62	3.10				
63	3.15				

GT-5-SC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.07				
3	0.12				
4	0.16				
5	0.21				
6	0.26				
7	0.31				
8	0.35				
9	0.40				
10	0.45				
11	0.50				
12	0.55				
13	0.59				
14	0.64	0.00			
15	0.69	0.00			
16	0.74	0.00			
17	0.79	0.00	0.00	0.00	
18	0.83	0.00	0.00	0.01	0.00
19	0.88	0.03	0.08	0.08	0.00
20	0.93	0.15	0.29	0.32	0.00
21	0.98	0.41	0.62	0.70	0.06
22	1.02	0.69	0.83	0.89	0.34
23	1.05	0.81	1.04	1.04	0.52
24	1.08	0.90	0.98	0.99	0.78
25	1.13	0.96	0.93	1.02	0.89
26	1.18	0.98	0.99	0.99	0.99
27	1.23	0.97			
28	1.28	0.98		1.00	1.03
29	1.33	0.98		1.00	
30	1.38	0.98			
31	1.43	0.98			0.96
32	1.47	0.97	0.99	1.03	
33	1.52	0.98			
34	1.57	0.98		1.01	0.96
35	1.62	0.98	0.95	1.03	
36	1.67	0.98			
37	1.72	0.98			0.99
38	1.76	0.99	1.00		
39	1.81	0.98			
40	1.86	0.98	1.00	1.01	0.99
41	1.91	0.97	0.98	0.96	0.99
42	1.96	0.90	0.72	0.76	0.99
43	2.00	0.71	0.38	0.41	0.97
44	2.05	0.41	0.12	0.15	0.79
45	2.10	0.17	0.00	0.03	0.54
46	2.14	0.05	0.00	0.00	0.38

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.19	0.02	0.00	0.00	0.15
48	2.24	0.01	0.00	0.00	0.11
49	2.28	0.01			0.07
50	2.33	0.00			0.05
51	2.37				
52	2.42				
53	2.46				
54	2.50				
55	2.54				
56	2.58				
57	2.62				
58	2.66				
59	2.70				
60	2.74				
61	2.78				
62	2.82				
63	2.86				
64	2.88				

GT-5-SC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.08				
3	0.13				
4	0.18				
5	0.24				
6	0.29				
7	0.35				
8	0.40				
9	0.45				
10	0.50				
11	0.56				
12	0.61				
13	0.66				
14	0.71	0.00			0.00
15	0.77				0.00
16	0.82	0.00	0.00	0.00	
17	0.87	0.02	0.00	0.00	0.00
18	0.93	0.12	0.23	0.24	0.00
19	0.98	0.41	0.55	0.61	0.00
20	1.03	0.75	0.87	0.90	0.18
21	1.09	0.93	0.95	0.98	0.61
22	1.14	0.97	1.01	1.00	0.80
23	1.19	0.99			0.93
24	1.24	0.98			
25	1.29			0.99	
26	1.34	0.99			0.99
27	1.39	1.00	0.99	0.99	
28	1.45	1.00			0.98
29	1.50	0.99			
30	1.55	0.99		1.00	0.93
31	1.61	0.99			
32	1.66	1.00	0.98	1.00	
33	1.71	1.00			
34	1.77	1.00			
35	1.82		0.97	1.00	0.90
36	1.87	1.00			
37	1.93	1.00	0.98	1.00	
38	1.98	1.00	0.94	1.00	
39	2.03	1.00			
40	2.09	0.99	0.91	0.97	
41	2.14	0.92	0.88	0.66	0.88
42	2.19	0.67	0.44	0.43	0.83
43	2.25	0.32	0.00	0.13	0.69
44	2.30	0.10	0.00	0.00	0.45
45	2.35	0.02			0.18
46	2.40	0.01			0.00

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.46	0.01			
48	2.51	0.00			
49	2.56	0.00			
50	2.61	0.00			
51	2.67				
52	2.72				
53	2.77				
54	2.82				
55	2.88				
56	2.93				
57	2.98				
58	3.03				
59	3.08				
60	3.13				

GT-5-SC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.07				
3	0.13				
4	0.18				
5	0.23				
6	0.28				
7	0.33				
8	0.39				
9	0.44				
10	0.48				
11	0.53				
12	0.59				
13	0.64				
14	0.69	0.00			
15	0.74	0.00			0.00
16	0.79	0.00			0.00
17	0.84	0.00	0.00	0.00	0.00
18	0.89	0.04	0.08	0.10	0.00
19	0.94	0.21	0.35	0.39	0.00
20	1.00	0.54	0.74	0.75	0.15
21	1.05	0.82	0.98	0.96	0.53
22	1.10	0.95		1.01	0.84
23	1.14	0.97	1.00	1.02	0.92
24	1.19	0.99			0.99
25	1.24	0.98			
26	1.29	0.99	1.00	1.02	0.97
27	1.34	0.99			
28	1.40	1.00			1.00
29	1.45	0.98	1.04	1.03	
30	1.50	0.98			0.95
31	1.55	0.99			
32	1.60	1.00			
33	1.65	1.00	0.98	1.02	
34	1.70	0.99			
35	1.75	0.99			
36	1.81	0.99	0.96	1.02	
37	1.86				
38	1.91	0.99			
39	1.96	0.98	1.00	1.02	
40	2.01	0.97	0.96	0.95	
41	2.06	0.85	0.68	0.69	1.00
42	2.11	0.57	0.28	0.32	0.95
43	2.16	0.25	0.07	0.09	0.78
44	2.21	0.08	0.00	0.00	0.51
45	2.26	0.02	0.00	0.00	0.28
46	2.31	0.01			0.18

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.36	0.01			0.08
48	2.41	0.00			0.00
49	2.46	0.00			
50	2.51	0.00			
51	2.56				
52	2.61				
53	2.66				
54	2.72				
55	2.77				
56	2.82				
57	2.87				
58	2.92				
59	2.97				
60	3.02				

GT-7-SC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03	0.00			
2	0.08	0.00			
3	0.13	0.00			
4	0.19	0.00			
5	0.24	0.00			
6	0.30	0.00			
7	0.35	0.00			
8	0.40				
9	0.46	0.00			
10	0.51				
11	0.56	0.00			
12	0.62				
13	0.67	0.00			
14	0.73				
15	0.78	0.00	0.00	0.00	0.00
16	0.83		0.00	0.00	
17	0.89	0.05	0.00	0.05	
18	0.94	0.26	0.27	0.39	0.00
19	0.99	0.60	0.66	0.78	0.56
20	1.05	0.87	0.94	0.88	0.75
21	1.10	0.98	0.98	0.96	0.93
22	1.15	1.00	1.03	0.99	0.91
23	1.20	1.00	1.03	1.00	0.84
24	1.24	1.00			
25	1.29	1.01			
26	1.35	1.02	0.99	0.99	0.84
27	1.40	1.03			0.84
28	1.46	1.01	1.01	1.01	
29	1.52	1.01			
30	1.57	1.02			
31	1.62	1.03		0.98	0.84
32	1.68	1.02	1.03	1.03	
33	1.74	1.02			
34	1.79	1.02			
35	1.84	1.03	1.01	1.01	0.84
36	1.90	1.02			
37	1.95	1.02			
38	2.01	1.02	1.01	1.01	
39	2.06	0.99	0.93	0.93	0.84
40	2.12	0.79	0.69	0.70	0.75
41	2.17	0.45	0.34	0.51	0.45
42	2.23	0.16	0.13	0.10	0.30
43	2.28	0.04	0.00	0.00	0.11
44	2.34	0.01	0.00	0.00	0.00
45	2.39	0.01	0.00	0.00	0.00
46	2.45	0.00	0.00	0.00	0.00

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.50				
48	2.55	0.00			
49	2.61				
50	2.66	0.00			
51	2.71				
52	2.76	0.00			
53	2.81				
54	2.87	0.00			
55	2.92				
56	2.97				
57	3.02				
58	3.07				
59	3.12				
60	3.17				
61	3.23				
62	3.28				
63	3.33				

GT-7-SC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.08				
3	0.13				
4	0.19				
5	0.24				
6	0.30				
7	0.36				
8	0.41				
9	0.47				
10	0.52				
11	0.58				
12	0.63				
13	0.69		0.00	0.00	
14	0.74	0.00	0.00	0.00	
15	0.80	0.00	0.00	0.00	0.00
16	0.85	0.14	0.00	0.02	0.00
17	0.91		0.12	0.15	0.00
18	0.96	0.42	0.46	0.44	0.34
19	1.02	0.72	0.75	0.76	0.75
20	1.07	0.89	0.93	0.93	0.92
21	1.13	0.95	1.03	0.99	1.02
22	1.18	0.97	1.05	1.01	1.08
23	1.23	0.97			
24	1.27	0.98			1.02
25	1.33	0.98	1.04	1.01	
26	1.38	0.98			1.15
27	1.44	0.97			
28	1.49	0.98	1.04	1.01	
29	1.55	0.98			1.12
30	1.60	0.98			
31	1.66	0.98	0.99	1.02	
32	1.71	0.97			1.08
33	1.77	0.98			
34	1.82	0.98			
35	1.88	0.99	1.03	1.02	1.12
36	1.93	0.98			
37	1.98	0.98			
38	2.04	0.98	1.00	1.02	1.12
39	2.09	0.94	0.93	0.97	1.08
40	2.14	0.79	0.74	0.77	0.95
41	2.20	0.49	0.37	0.42	0.53
42	2.25	0.22	0.13	0.16	0.34
43	2.31	0.07	0.00	0.04	0.15
44	2.36	0.02	0.00	0.00	0.07
45	2.41	0.01	0.00	0.00	0.00
46	2.47	0.01	0.00	0.00	

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.52	0.00			
48	2.57	0.00			
49	2.63	0.00			
50	2.68	0.00			
51	2.73				
52	2.79				
53	2.84				
54	2.89				
55	2.94				
56	3.00				
57	3.05				
58	3.10				
59	3.15				
60	3.20				
61	3.26				
62	3.31				
63	3.36				
64	3.39				

GT-7-SC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.14				
4	0.19				
5	0.25				
6	0.31				
7	0.36				
8	0.42				
9	0.48				
10	0.53				
11	0.59				
12	0.64				
13	0.70				
14	0.76	0.00			
15	0.81	0.00			
16	0.87	0.03	0.00	0.00	0.00
17	0.92	0.17	0.15	0.12	0.00
18	0.98	0.47	0.44	0.34	0.29
19	1.04	0.78	0.76	0.82	0.64
20	1.09	0.94	0.92	0.95	0.80
21	1.15	0.99	0.97	0.99	0.90
22	1.20	0.99			0.96
23	1.26	1.00		0.99	0.94
24	1.31	0.99			
25	1.36	0.99		0.99	
26	1.42	0.99			
27	1.47	0.99	0.98	0.99	
28	1.53	0.99			1.01
29	1.58	1.00	1.01		
30	1.64	1.00		1.00	1.01
31	1.69	1.00		1.01	
32	1.75	1.00			
33	1.81	1.00			
34	1.86	1.00			
35	1.92	1.00	0.98	1.00	
36	1.97	1.00			
37	2.03	0.99		1.00	
38	2.09				
39	2.14	0.99	0.96	1.01	1.01
40	2.20	0.91	0.83	0.91	0.96
41	2.25	0.66	0.55	0.67	0.77
42	2.31	0.32	0.25	0.31	0.42
43	2.36	0.10	0.00	0.04	0.16
44	2.42	0.02	0.00	0.00	0.00
45	2.47	0.01			0.00
46	2.53	0.01			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.58	0.00			
48	2.64	0.00			
49	2.70	0.00			
50	2.75	0.00			
51	2.81				
52	2.86				
53	2.92				
54	2.97				
55	3.03				
56	3.08				
57	3.14				
58	3.19				
59	3.25				
60	3.30				

GT-7-SC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.13				
4	0.19				
5	0.24				
6	0.30				
7	0.35				
8	0.41				
9	0.46				
10	0.52				
11	0.57				
12	0.62				
13	0.68				
14	0.73	0.00			
15	0.79	0.00	0.00	0.00	0.00
16	0.84	0.01	0.00	0.00	0.00
17	0.90	0.08	0.06	0.11	0.00
18	0.95	0.33	0.31	0.38	0.26
19	1.01	0.66	0.67	0.72	0.58
20	1.06	0.89	0.90	0.92	0.87
21	1.12	0.98	0.96	0.97	1.01
22	1.17	0.99			1.04
23	1.22	0.99			
24	1.27	0.99	0.98	0.98	
25	1.32	0.99			
26	1.38	0.97			
27	1.43	1.00			
28	1.49	0.98	0.98	0.99	
29	1.54	0.99			
30	1.60	0.98			
31	1.65	0.99			0.99
32	1.70	1.00	0.99	0.99	
33	1.76	0.99			
34	1.81	0.99			
35	1.87	1.00		0.98	0.97
36	1.92	0.99			
37	1.97	0.99			0.99
38	2.03	0.99	0.98	0.98	
39	2.08	0.95	0.93	0.95	0.96
40	2.14	0.79	0.75	0.65	0.94
41	2.19	0.50	0.40	0.37	0.68
42	2.24	0.21	0.12	0.13	0.41
43	2.30	0.06	0.02	0.03	0.15
44	2.35	0.02	0.00	0.01	0.06
45	2.41	0.01	0.00	0.00	0.00
46	2.46	0.01			0.00

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.51	0.00			0.00
48	2.57	0.00			
49	2.62	0.00			
50	2.67	0.00			
51	2.73				
52	2.78				
53	2.83				
54	2.89				
55	2.94				
56	2.99				
57	3.05				
58	3.10				
59	3.15				
60	3.21				

COL-1-SC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03	0.00			
2	0.09				
3	0.15	0.00			
4	0.21				
5	0.27	0.00			
6	0.33				
7	0.39	0.00			
8	0.45				
9	0.51	0.00			
10	0.57				
11	0.63	0.00			
12	0.69				
13	0.75	0.00	0.00	0.00	
14	0.81		0.09	0.07	0.00
15	0.87	0.08	0.44	0.51	0.00
16	0.93	0.36	0.86	0.93	0.00
17	0.99	0.69	0.96	0.96	0.32
18	1.04	0.87	0.97	0.98	0.63
19	1.10	0.94	0.98	1.00	0.80
20.	1.16	0.96	0.97	1.01	0.89
21	1.22	0.98	0.96	0.99	0.86
22	1.28	0.98			
23	1.33	0.98			
24	1.37	0.98			
25	1.43	1.00	0.97	1.01	0.90
26	1.49	1.01			
27	1.55	1.01			
28	1.61	0.99	1.00	1.02	0.91
29	1.67	1.01			
30	1.72	1.01			
31	1.78	1.00	1.00	1.00	0.92
32	1.84	1.01			
33	1.90	1.00			0.94
34	1.96	1.01			
35	2.02	1.02			
36	2.07	1.02	1.02	0.98	0.95
37	2.13	1.01	0.79	0.80	
38	2.19	0.90	0.33	0.34	0.96
39	2.25	0.58	0.00	0.00	0.89
40	2.31	0.27	0.00	0.00	0.53
41	2.37	0.13	0.00	0.00	0.31
42	2.43	0.07	0.00	0.00	0.15
43	2.49	0.05	0.00	0.00	0.10
44	2.54	0.04			0.08
45	2.60	0.03			0.08
46	2.66	0.03			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.72				
48	2.77	0.02			
49	2.83				
50	2.89	0.01			
51	2.95				
52	3.01				
53	3.06				
54	3.12				
55	3.17				
56	3.23				
57	3.28				
58	3.34				
59	3.39				
60	3.45				
61	3.51				
62	3.56				
63	3.62				

COL-1-SC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.09				
3	0.15				
4	0.21				
5	0.27				
6	0.33				
7	0.39				
8	0.45				
9	0.51				
10	0.57				
11	0.63		0.00	0.00	
12	0.69		0.00	0.00	
13	0.75	0.00	0.00	0.00	
14	0.82	0.01	0.13	0.14	0.00
15	0.88	0.10	0.51	0.56	0.00
16	0.94	0.40	0.94	0.90	0.13
17	1.00	0.71	0.99	0.96	0.52
18	1.06	0.86		1.00	0.82
19	1.12	0.92	1.00	1.01	0.88
20	1.18	0.94	1.05	0.97	0.97
21	1.24	0.95	1.03	0.97	
22	1.30	0.96	1.03	1.01	0.97
23	1.35	0.96	1.02	0.98	
24	1.40	0.97			
25	1.46	0.97	1.00	0.96	
26	1.52	0.98			
27	1.58	0.98			1.00
28	1.64	0.98			
29	1.70	0.98	0.99	0.98	
30	1.76	0.98			0.97
31	1.82	0.99			
32	1.88	0.99	1.02	0.98	
33	1.94	0.98			0.97
34	2.00	0.98			
35	2.06	0.98	1.00	0.99	
36	2.12	0.98	0.88	0.97	1.00
37	2.18	0.96	0.61	0.65	1.00
38	2.24	0.78	0.17	0.20	1.00
39	2.29	0.45	0.00	0.02	0.62
40	2.35	0.20	0.00	0.00	0.39
41	2.41	0.10	0.00	0.00	0.20
42	2.47	0.06	0.00	0.00	0.12
43	2.53	0.04	0.00	0.00	0.08
44	2.59	0.04			0.05
45	2.65	0.03			0.00
46	2.70	0.02			0.00

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.76	0.02			
48	2.82	0.02			
49	2.87	0.02			
50	2.93	0.01			
51	2.99	0.01			
52	3.04	0.01			
53	3.10	0.01			
54	3.16	0.01			
55	3.21	0.01			
56	3.27				
57	3.33				
58	3.38				
59	3.44				
60	3.49				
61	3.55				
62	3.60				
63	3.66				
64	3.69				

COL-1-SC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.14				
4	0.20				
5	0.26				
6	0.32				
7	0.38				
8	0.44				
9	0.50				
10	0.56				
11	0.62				
12	0.68				
13	0.74	0.00			
14	0.80	0.00	0.00	0.00	
15	0.86	0.04	0.33	0.32	0.00
16	0.91	0.25	0.78	0.76	0.00
17	0.97	0.57	0.95	0.95	0.00
18	1.03	0.83	1.00	0.97	0.43
19	1.09	0.91	1.00	1.00	0.56
20	1.15	0.95		0.99	0.82
21	1.21	0.96			0.85
22	1.27	0.96			0.85
23	1.33	0.97			0.96
24	1.38	0.97			
25	1.43	0.98	0.97	1.01	
26	1.49	0.98			
27	1.55	0.98			
28	1.61	0.98		1.01	
29	1.67	0.98			
30	1.72	0.98		1.01	0.99
31	1.78	0.99			
32	1.84	0.99	0.99		
33	1.90	0.99			1.01
34	1.96	0.99		1.00	
35	2.02	0.99			0.99
36	2.07	0.99			
37	2.13	0.99	0.99	0.99	
38	2.19	0.98	0.86	0.83	
39	2.25	0.87	0.39	0.35	0.99
40	2.31	0.56	0.12	0.07	0.88
41	2.36	0.26	0.00	0.00	0.69
42	2.42	0.12			0.37
43	2.48	0.07			0.21
44	2.54	0.04			0.19
45	2.60	0.04			0.00
46	2.65	0.03			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.71	0.03			
48	2.77	0.02			
49	2.83	0.02			
50	2.89	0.02			
51	2.94	0.01			
52	3.00	0.01			
53	3.06	0.01			
54	3.12	0.01			
55	3.17	0.01			
56	3.23				
57	3.29				
58	3.34				
59	3.40				
60	3.46				

COL-1-SC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.14				
4	0.20				
5	0.25				
6	0.31				
7	0.37				
8	0.42				
9	0.48				
10	0.54				
11	0.59				
12	0.64				
13	0.70	0.00			
14	0.75	0.00	0.00	0.00	0.00
15	0.81	0.00	0.08	0.07	0.00
16	0.87	0.07	0.46	0.50	0.00
17	0.92	0.30	0.89	0.87	0.05
18	0.98	0.63	0.86	0.86	0.31
19	1.03	0.82	0.99	0.99	0.68
20	1.09	0.90	1.00	1.00	0.84
21	1.14	0.93	1.00	0.89	0.85
22	1.20	0.96	1.00	0.91	0.95
23	1.25	0.95			1.00
24	1.30	0.95			
25	1.35	0.95	1.00	1.03	
26	1.41	0.97			0.95
27	1.47	0.97			
28	1.52	0.97	1.01	1.01	
29	1.58	0.98			1.03
30	1.64	0.96			
31	1.69	0.95	1.01	1.01	
32	1.75	0.98			
33	1.81	0.99			
34	1.86	0.98	1.03	0.99	
35	1.92	0.99	0.99	0.98	1.00
36	1.97	0.97			
37	2.03	0.98	0.99	0.99	1.02
38	2.08	0.94	0.65	0.59	
39	2.14	0.77	0.19	0.21	0.91
40	2.19	0.45	0.03	0.04	0.84
41	2.25	0.20	0.00	0.01	0.37
42	2.31	0.10	0.00	0.00	0.25
43	2.36	0.07			0.15
44	2.42	0.05			0.10
45	2.47	0.04			0.07
46	2.53	0.03			0.05

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.58	0.03			0.00
48	2.64	0.02			0.00
49	2.69	0.02			0.00
50	2.74	0.02			
51	2.80	0.01			
52	2.85	0.01			
53	2.90	0.01			
54	2.96	0.01			
55	3.01	0.01			
56	3.07				
57	3.12				
58	3.17				
59	3.23				
60	3.28				

COL-2-SC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03	0.00			
2	0.09				
3	0.14	0.00			
4	0.20				
5	0.26	0.00			
6	0.32				
7	0.38	0.00			
8	0.44				
9	0.50	0.00			
10	0.55				
11	0.61	0.00			
12	0.66				
13	0.72	0.00	0.00	0.00	
14	0.78		0.00	0.04	
15	0.83	0.00	0.28	0.33	
16	0.89	0.00	0.67	0.74	0.00
17	0.95	0.04	0.90	0.97	0.12
18	1.01	0.19	0.98	0.98	0.38
19	1.06	0.48		1.01	0.63
20	1.12	0.75		1.00	0.74
21	1.17	0.89		1.00	0.82
22	1.23	0.95		1.01	0.89
23	1.28			1.02	
24	1.33	1.00			0.89
25	1.39	1.00			
26	1.45	1.00	0.99	1.02	0.89
27	1.50	1.01			
28	1.56	1.01		1.01	
29	1.62	1.01			
30	1.68	1.02	1.00		0.88
31	1.74	1.01			
32	1.80	1.02			0.91
33	1.86	1.01			
34	1.92	1.02			
35	1.97	1.02	0.98	1.01	0.89
36	2.03	1.01	0.94	0.97	
37	2.09	1.03	0.67	0.73	
38	2.15	1.03	0.29	0.30	0.90
39	2.21	0.99	0.09	0.06	0.82
40	2.27	0.83	0.00	0.00	0.57
41	2.33	0.55	0.00	0.00	0.35
42	2.39	0.28	0.00	0.00	0.19
43	2.44	0.12	0.00	0.00	0.09
44	2.50	0.06	0.00	0.00	0.00
45	2.56	0.03	0.00	0.00	
46	2.62	0.02			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.68		0.00	0.00	0.00
48	2.73	0.01			
49	2.79		0.00	0.00	
50	2.85	0.01			
51	2.91				
52	2.96				
53	3.02				
54	3.08	0.01	0.00	0.00	0.00
55	3.12				
59	3.15				
60	3.21				
61	3.27				
62	3.33				
63	3.38				

COL-2-SC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.14				
4	0.19				
5	0.25				
6	0.31				
7	0.36				
8	0.42				
9	0.48				
10	0.53				
11	0.59				
12	0.64				
13	0.70		0.00	0.00	
14	0.75		0.00	0.02	
15	0.81	0.00	0.14	0.20	
16	0.87	0.00	0.46	0.54	0.00
17	0.92	0.02	0.78	0.80	0.10
18	0.98	0.11	0.94	0.92	0.33
19	1.04	0.33	0.99	0.97	0.53
20	1.09	0.60		0.97	0.87
21	1.15	0.80	1.00	0.97	0.93
22	1.21	0.90	1.00	0.98	0.92
23	1.25	0.94	0.99	1.01	0.98
24	1.28	0.95			1.02
25	1.31	0.95	0.98	0.99	
26	1.34				
27	1.36	0.96			
28	1.37				
29	1.38				
30	1.39				
31	1.40				
32	1.40				
33	1.41				
34	1.41				
35	1.42				
36	1.42				
37	1.43				
38	1.43				
39	1.43				
40	1.44				
41	1.45	0.97	1.02		
42	1.48	0.97			
43	1.54	0.99		0.98	0.98
44	1.59	0.96			
45	1.64	0.99			
46	1.69	0.97			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	1.74	0.98	0.98	0.99	
48	1.78	0.99			1.02
49	1.83	0.99			
50	1.88	0.99			
51	1.92	0.99	0.97	0.98	
52	1.97	0.98			0.98
53	2.01	0.98	0.99	0.97	
54	2.06	1.00	0.72	0.79	
55	2.11	0.99	0.49	0.41	
56	2.15	0.99	0.16	0.18	0.97
57	2.20	0.95	0.04	0.05	0.87
58	2.24	0.85	0.00	0.00	0.67
59	2.29	0.68	0.00	0.00	0.45
60	2.33	0.45	0.00	0.00	0.25
61	2.38	0.24			0.18
62	2.43	0.12			0.11
63	2.47	0.06			0.09
64	2.52	0.04			0.06
65	2.56	0.03			0.05
66	2.61	0.02			0.05
67	2.66				0.04
68	2.70	0.01			
69	2.74				
70	2.79	0.01			
71	2.83				
72	2.88				
73	2.93				
74	2.97				
75	3.02				
76	3.06				

COL-2-SC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.08				
3	0.13				
4	0.19				
5	0.24				
6	0.30				
7	0.35				
8	0.41				
9	0.46				
10	0.52				
11	0.57				
12	0.63				
13	0.68				
14	0.74				
15	0.79	0.00	0.00	0.00	
16	0.84	0.00	0.28	0.28	
17	0.90	0.00	0.67	0.51	
18	0.95	0.01	0.93	0.93	
19	1.00	0.07	0.98	1.00	0.00
20	1.06	0.36	0.99		0.40
21	1.11	0.67	0.96		0.67
22	1.17	0.86	0.96		0.83
23	1.22	0.95	0.97	1.03	0.83
24	1.27	0.97			0.74
25	1.32	0.98			0.74
26	1.37	0.98			
27	1.42	0.99			
28	1.48	0.99	0.96		
29	1.53	0.99			
30	1.58	0.99			0.77
31	1.63	0.99	0.97	1.04	
32	1.69	1.00			
33	1.74	0.99			0.80
34	1.79	1.00			
35	1.84	1.00	0.98		0.83
36	1.89	1.00			
37	1.95	0.99			
38	2.00	0.99	1.00	0.99	
39	2.05	0.99	0.95	0.91	0.88
40	2.11	0.99	0.75	0.60	
41	2.16	0.99	0.27	0.27	
42	2.21	0.99	0.00	0.00	0.80
43	2.27	0.86	0.00		0.59
44	2.32	0.59			0.32
45	2.37	0.30			0.00
46	2.43	0.13			0.00

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.48	0.06			0.00
48	2.53	0.03			0.00
49	2.58	0.02			
50	2.63	0.02			
51	2.69	0.02			
52	2.74	0.01			
53	2.79	0.01			
54	2.84	0.01			
55	2.89	0.01			
56	2.94	0.01			
57	2.99	0.01			
58	3.04	0.01			
59	3.09	0.01			
60	3.14	0.00			

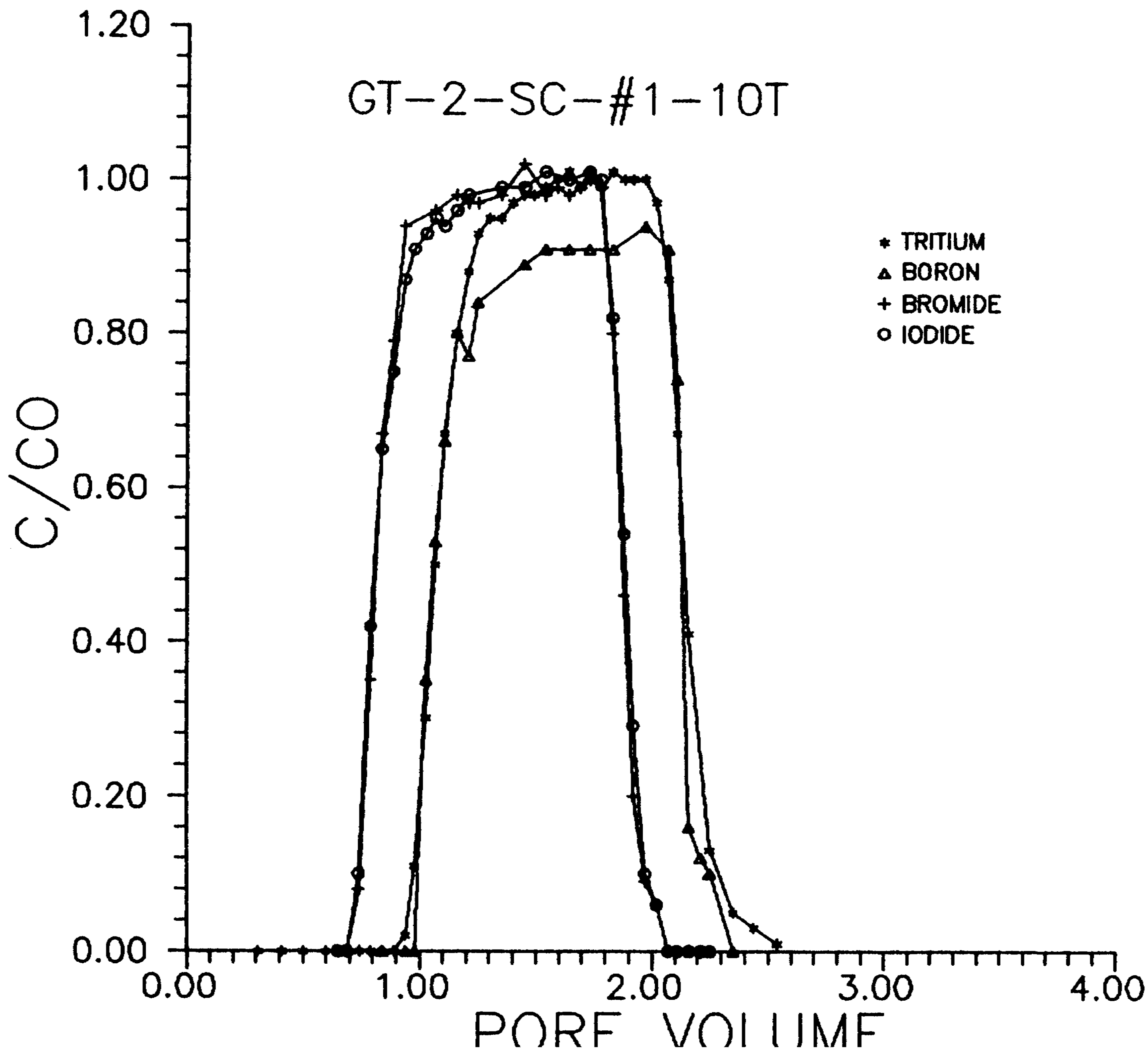
COL-2-SC-#2-20T

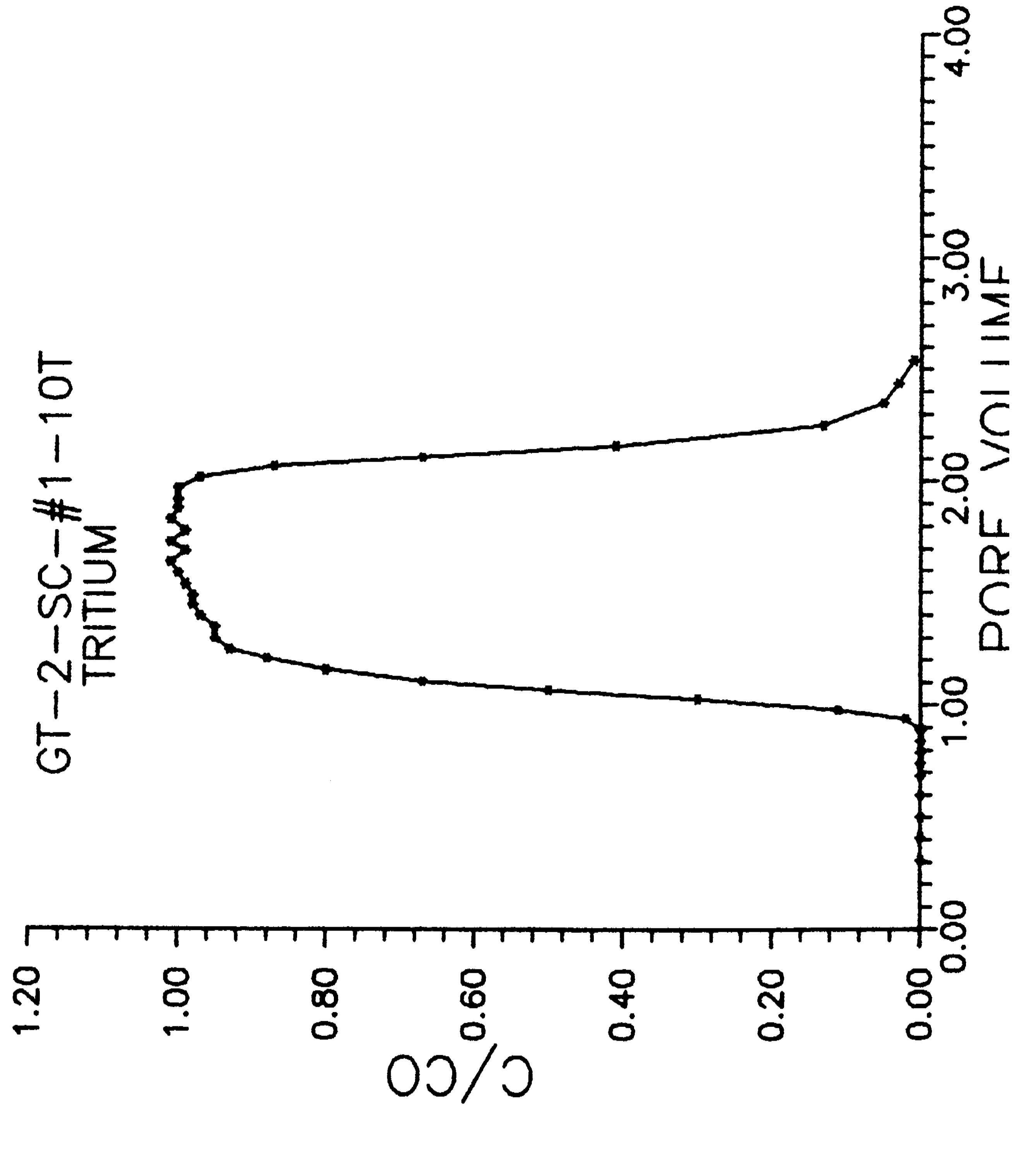
SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.08				
3	0.13				
4	0.18				
5	0.24				
6	0.29				
7	0.35				
8	0.40				
9	0.46				
10	0.51				
11	0.56				
12	0.62				
13	0.67				
14	0.72				
15	0.78	0.00	0.00	0.00	
16	0.83	0.00	0.17	0.08	
17	0.88	0.00	0.53	0.58	0.00
18	0.94	0.01	0.85	0.92	0.00
19	0.99	0.07	0.94	0.99	0.20
20	1.05	0.28	0.96	1.01	0.54
21	1.10	0.59	0.96	1.01	0.82
22	1.15	0.82	0.97		0.92
23	1.20	0.91			0.91
24	1.24	0.96	0.97	0.99	0.92
25	1.30	0.95			
26	1.35	0.97	0.97	0.99	1.00
27	1.41	0.96			
28	1.46	0.97			
29	1.51	0.98	0.98	1.01	
30	1.57	0.97			1.00
31	1.62	0.98			
32	1.67	0.98	0.99	1.02	
33	1.73	0.99			
34	1.78	0.99			1.00
35	1.83	0.99		1.02	
36	1.89				
37	1.94	0.99	1.03	1.03	0.93
38	1.99	0.99	0.90	0.88	
39	2.05		0.54	0.59	
40	2.10	0.99	0.15	0.19	0.99
41	2.16	0.95	0.03	0.04	0.96
42	2.21	0.81	0.00	0.01	0.70
43	2.26	0.52	0.00	0.00	0.45
44	2.31	0.25			0.23
45	2.37	0.10			0.15
46	2.42	0.05			0.14

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.47	0.03			0.06
48	2.53	0.02			0.05
49	2.58	0.02			0.05
50	2.63	0.01			0.00
51	2.69	0.01			
52	2.74	0.01			
53	2.79	0.01			
54	2.84	0.01			
55	2.90	0.01			
56	2.95				
57	3.00				
58	3.06				
59	3.11				
60	3.16				

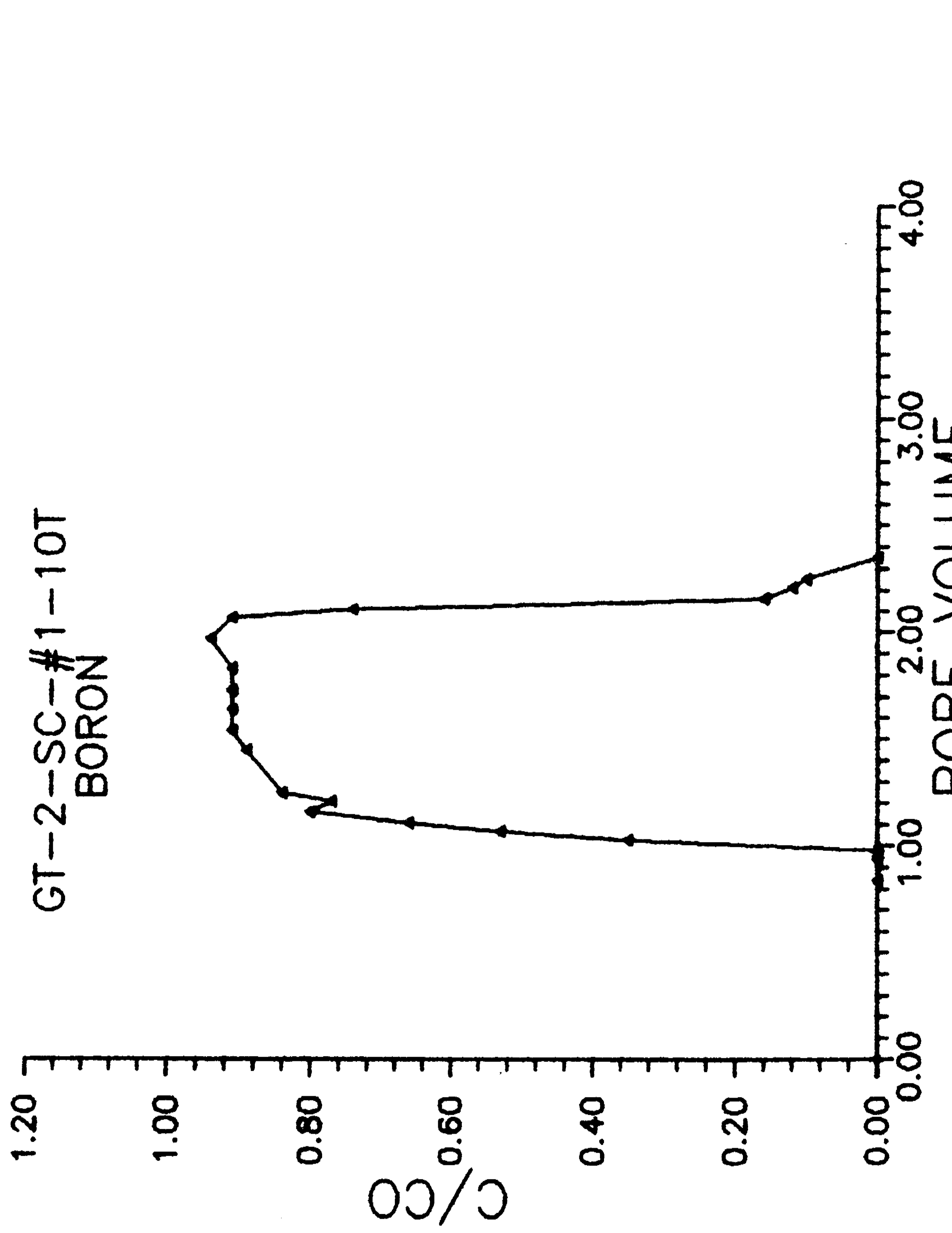
APPENDIX VIII

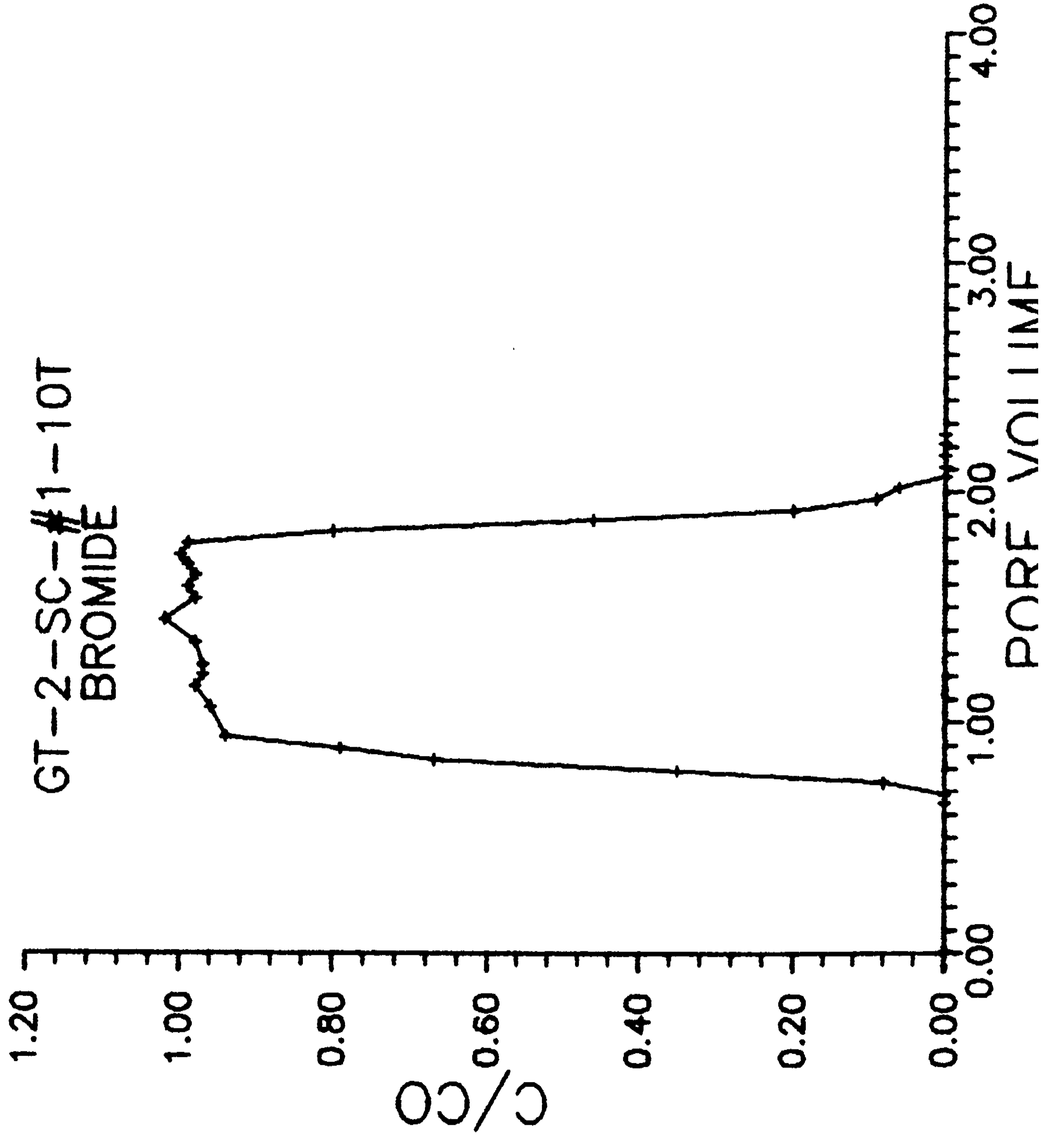
PLOTS OF PV VS. C/CO FOR SATURATED FLOW EXPERIMENTS

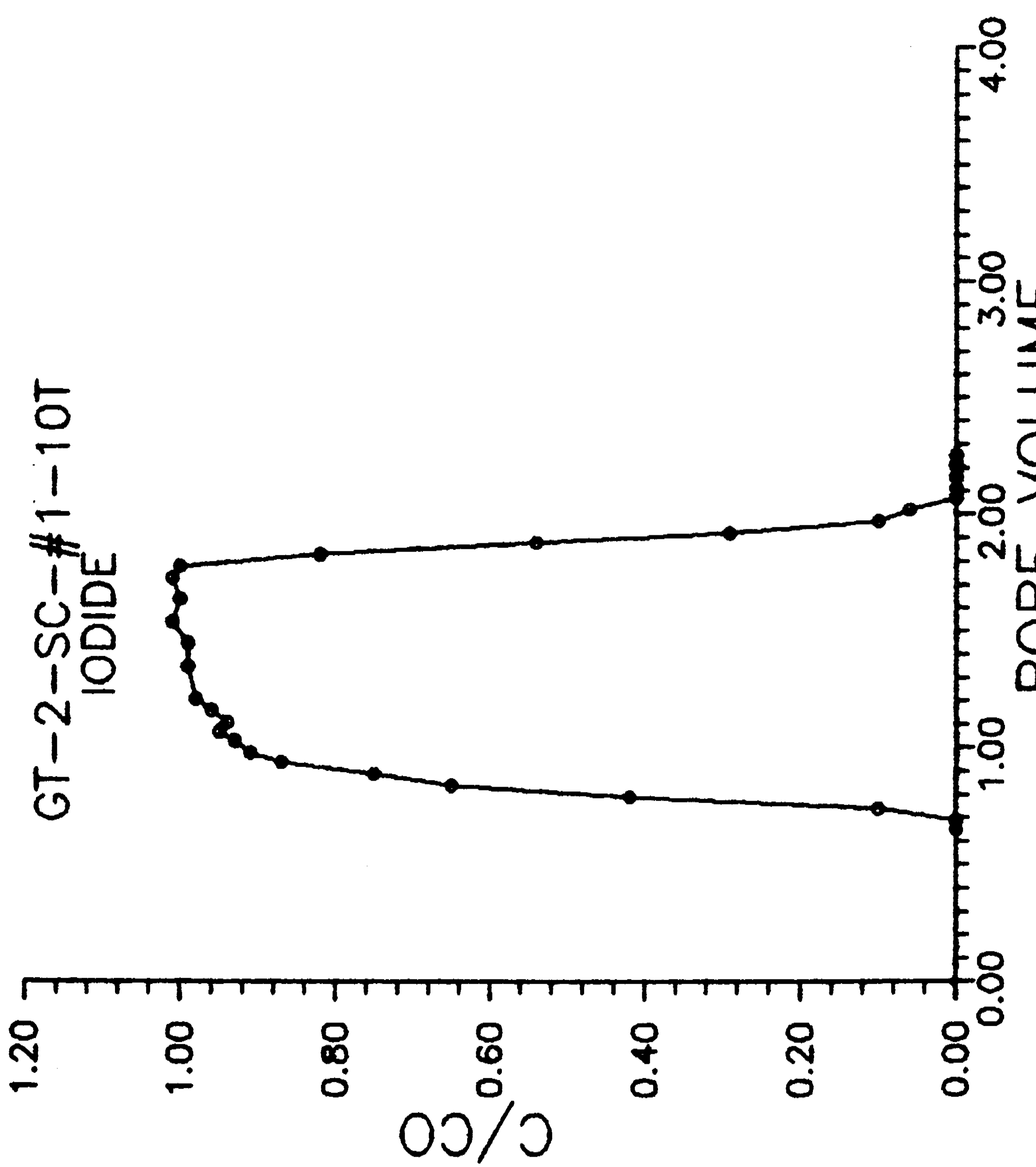

GT-2-SC-#1-10T
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME
TRITIUM
BORON
BROMIDE
IODIDE

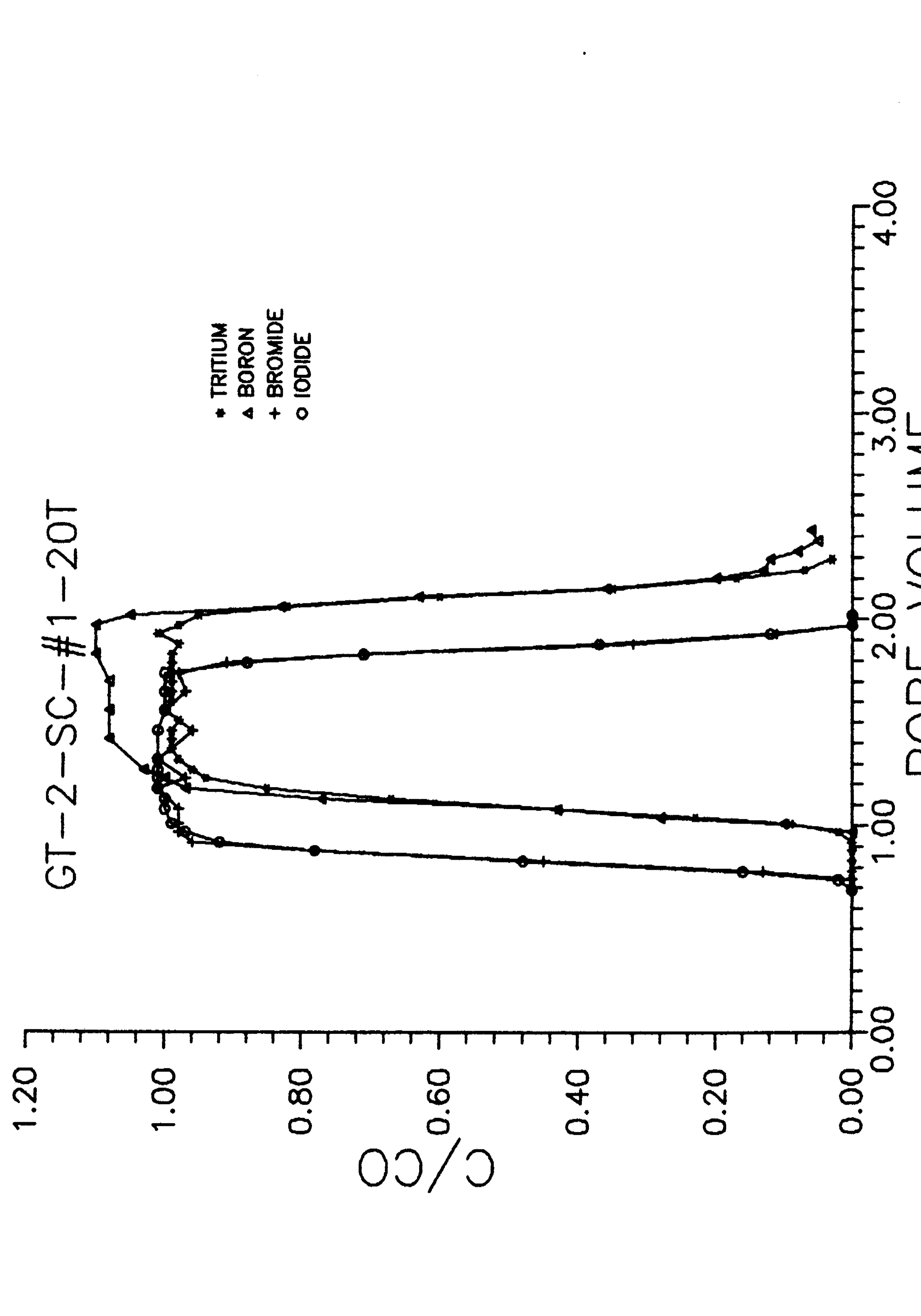


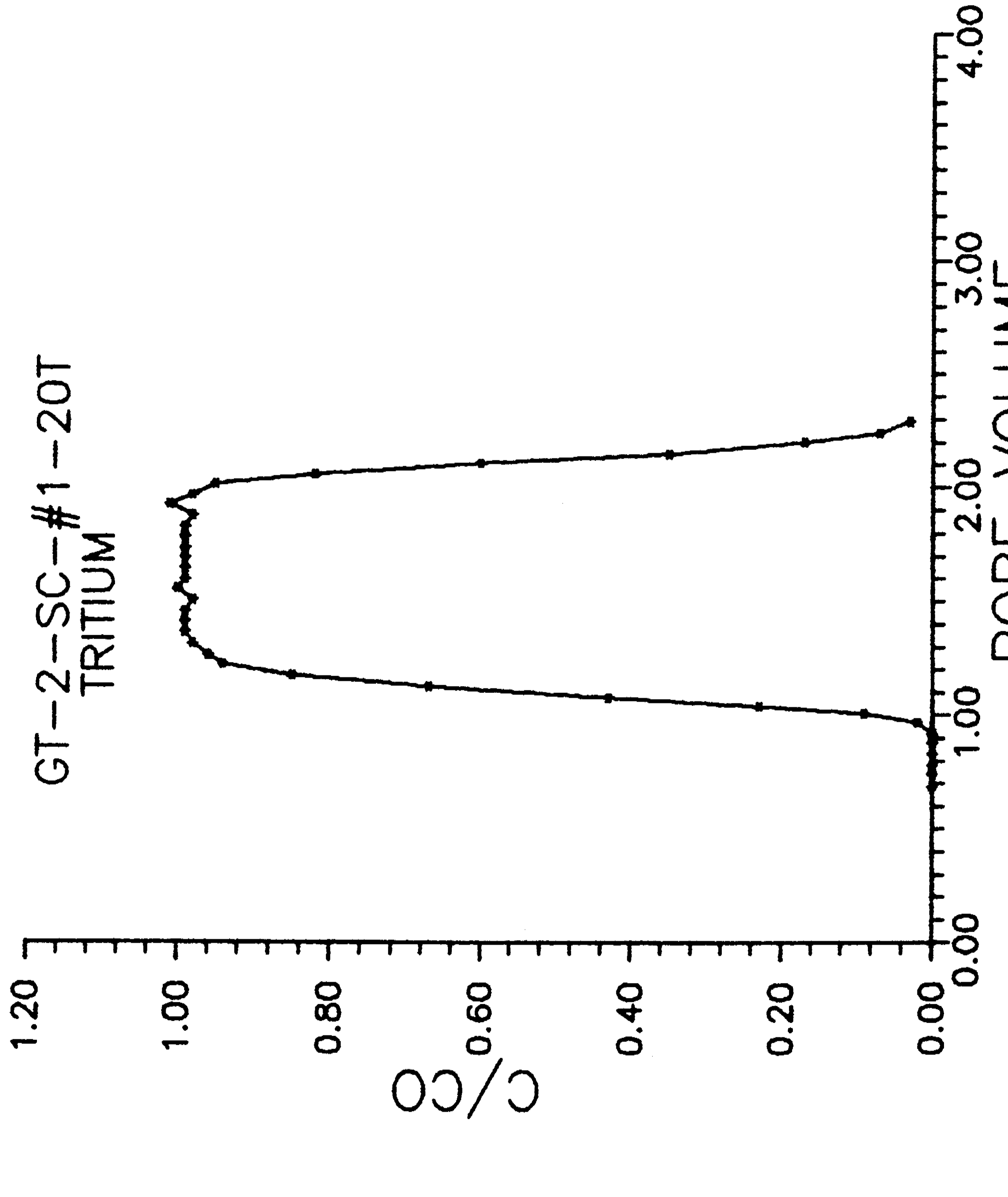
GT-2-SC-#1-10T
TRITIUM
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

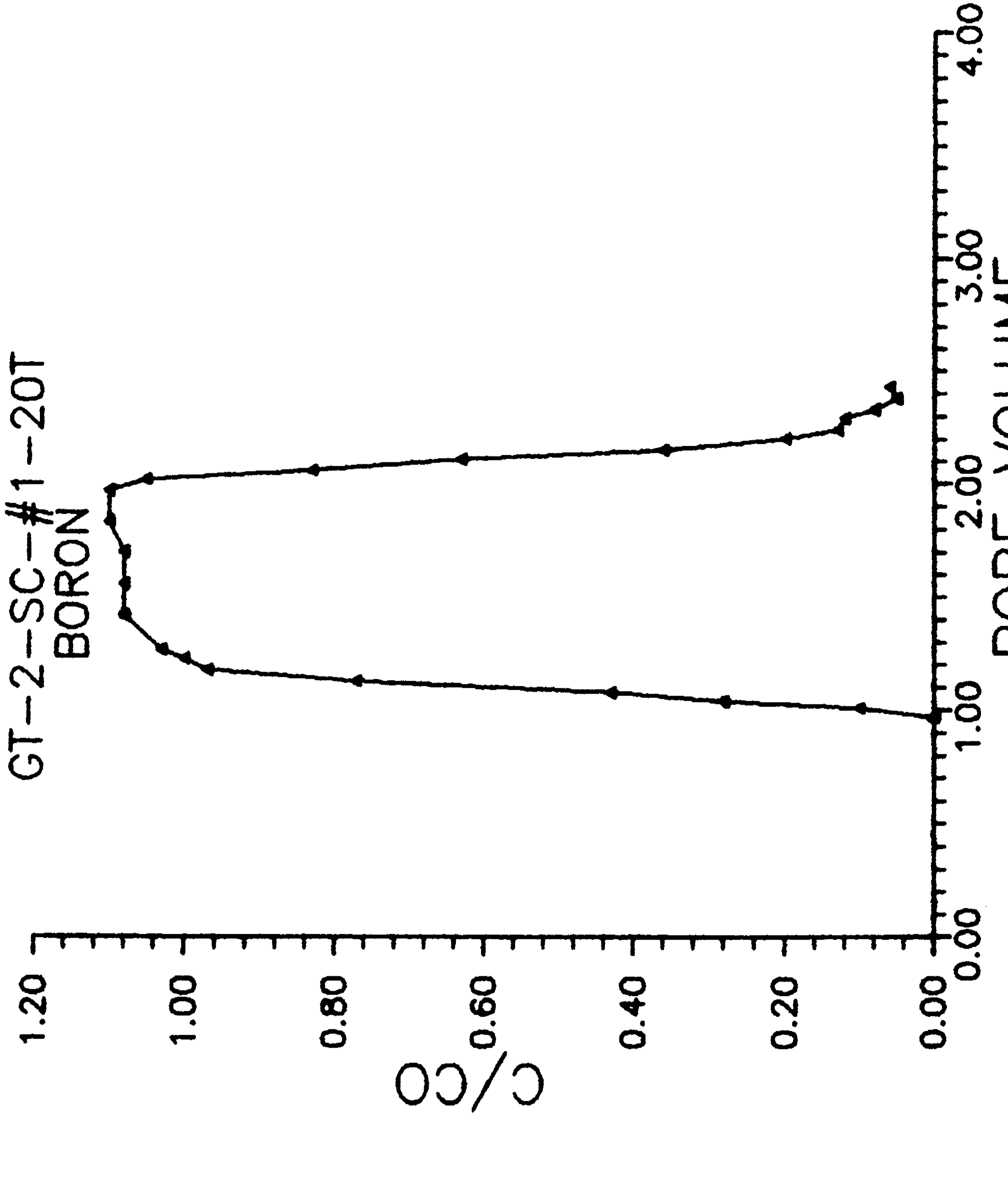

GT—2—SC—#1—10T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

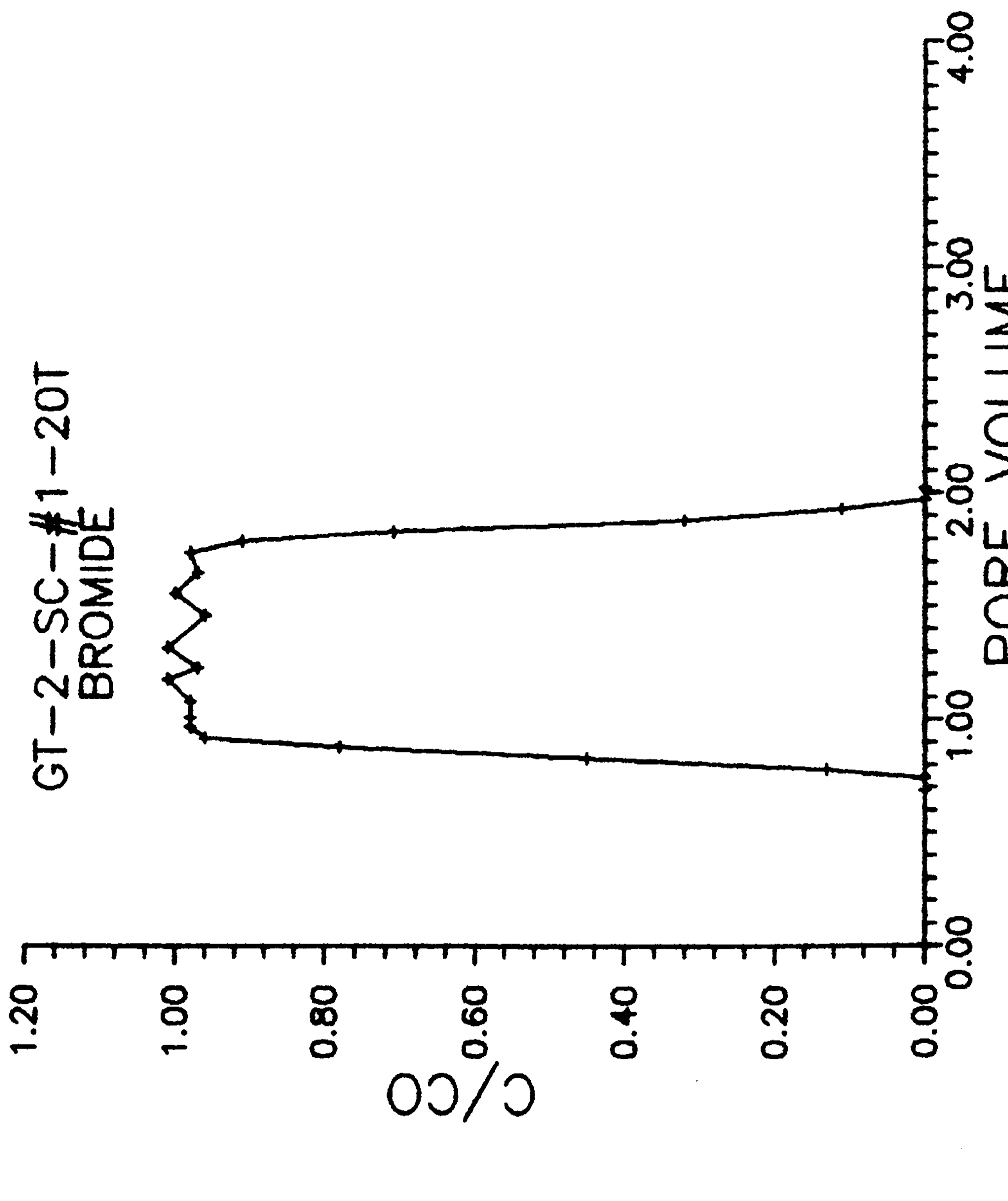

GT-2-SC-#1-10T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

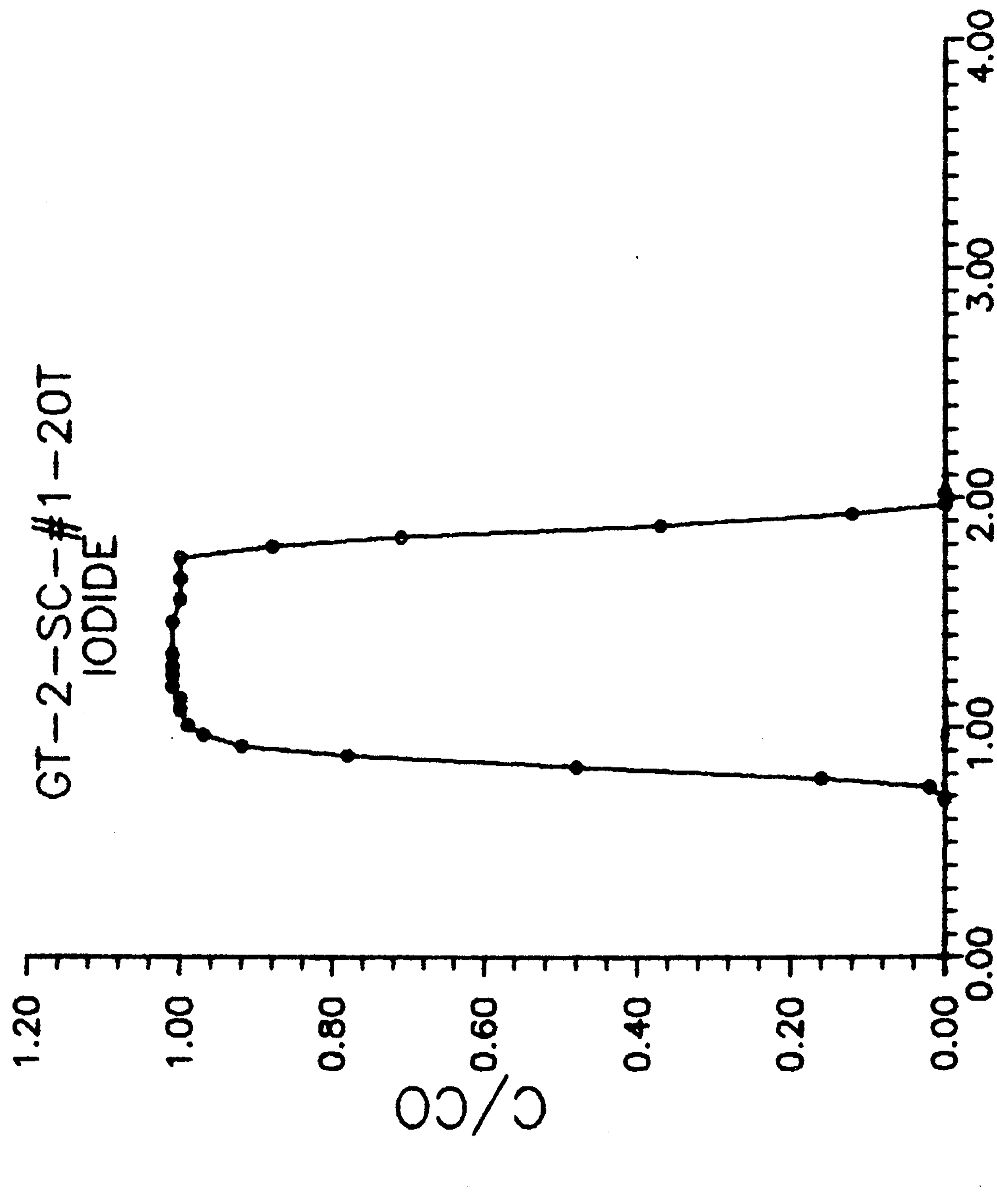

GT-2-SC-#1-10T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

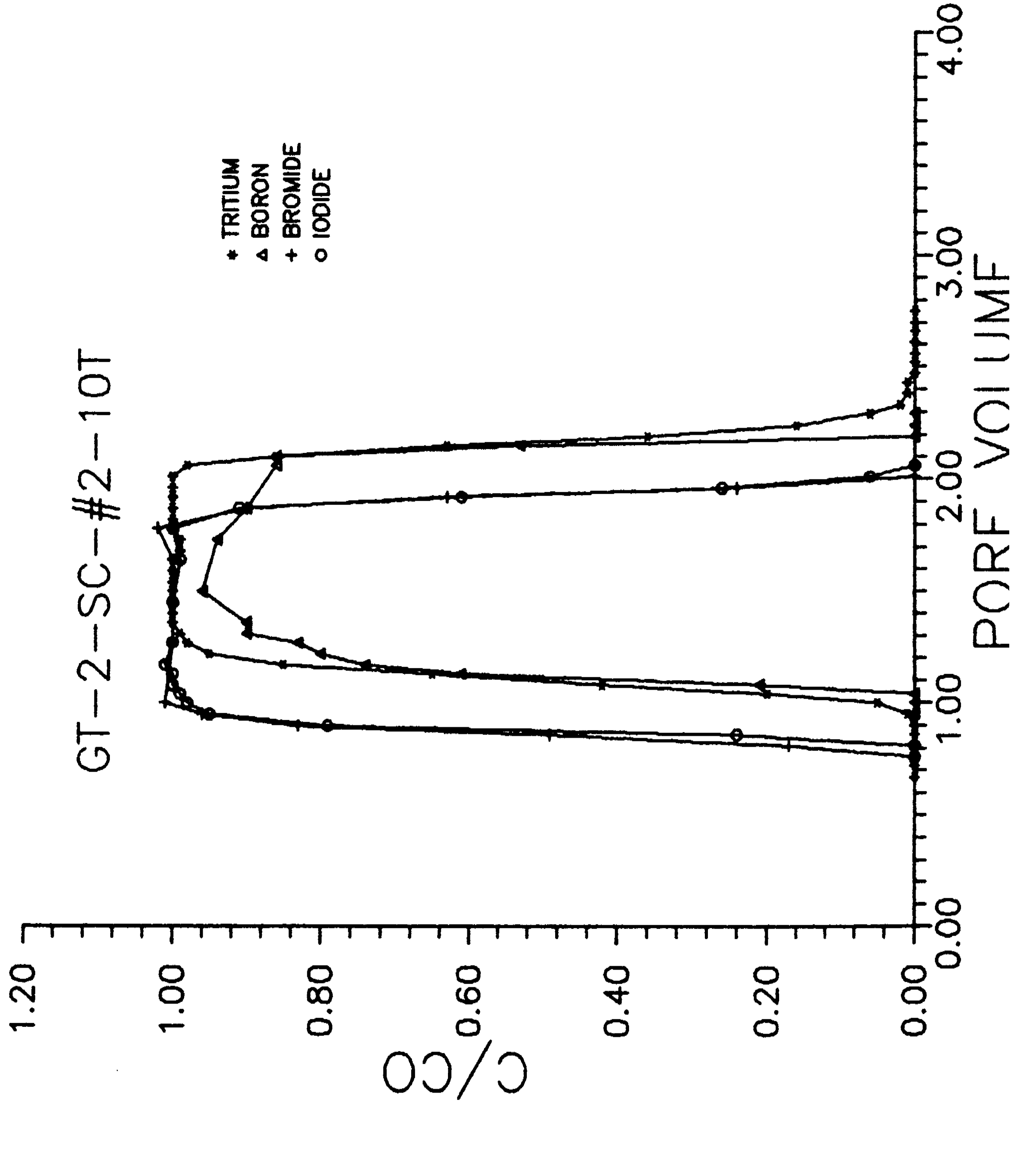

GT-2-SC-#1-20T
* TRITIUM
△ BORON
+ BROMIDE
○ IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

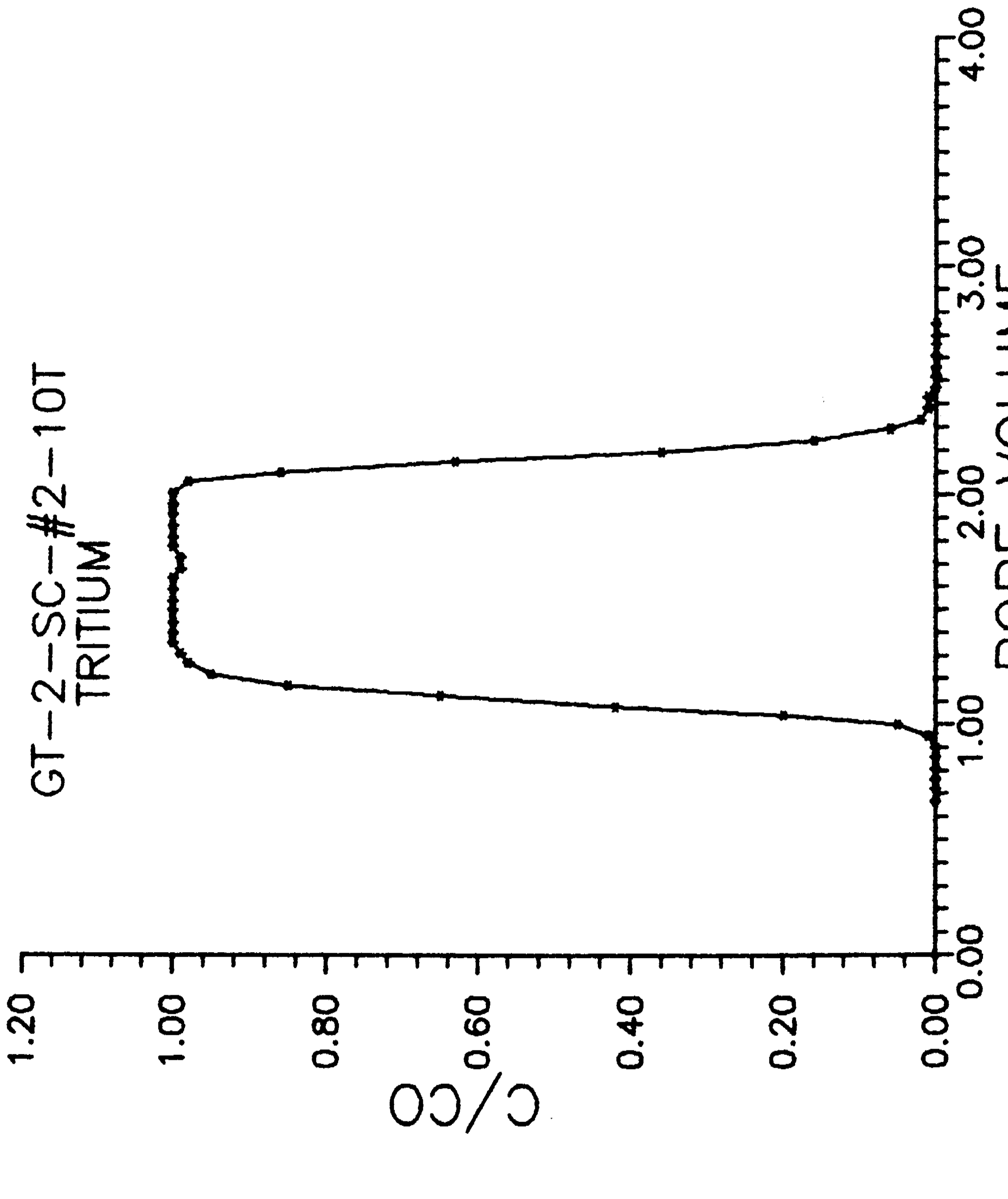

GT-2-SC-#1-20T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

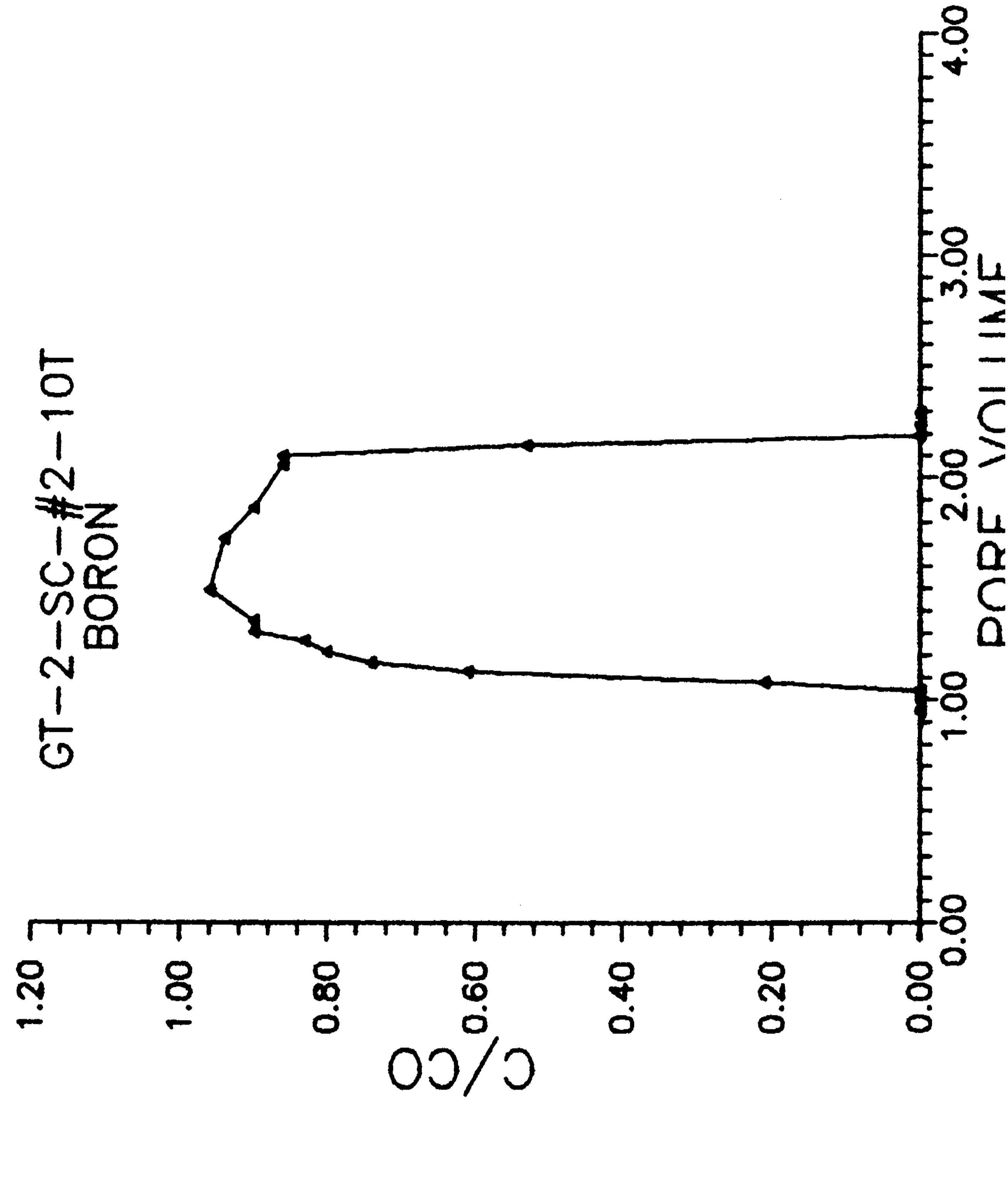

GT-2-SC-#1-20T
BORON
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

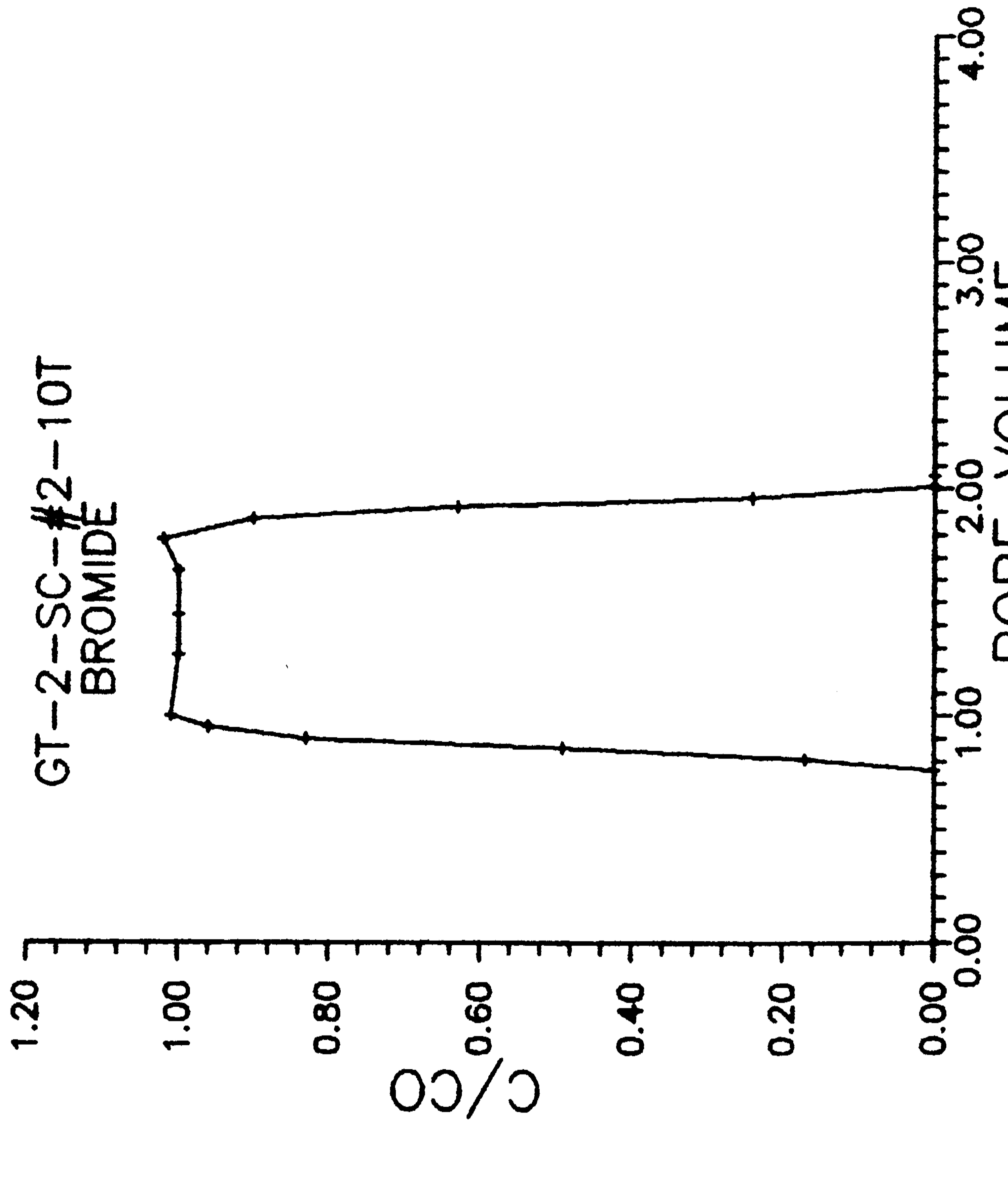

GT-2-SC-#1-20T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

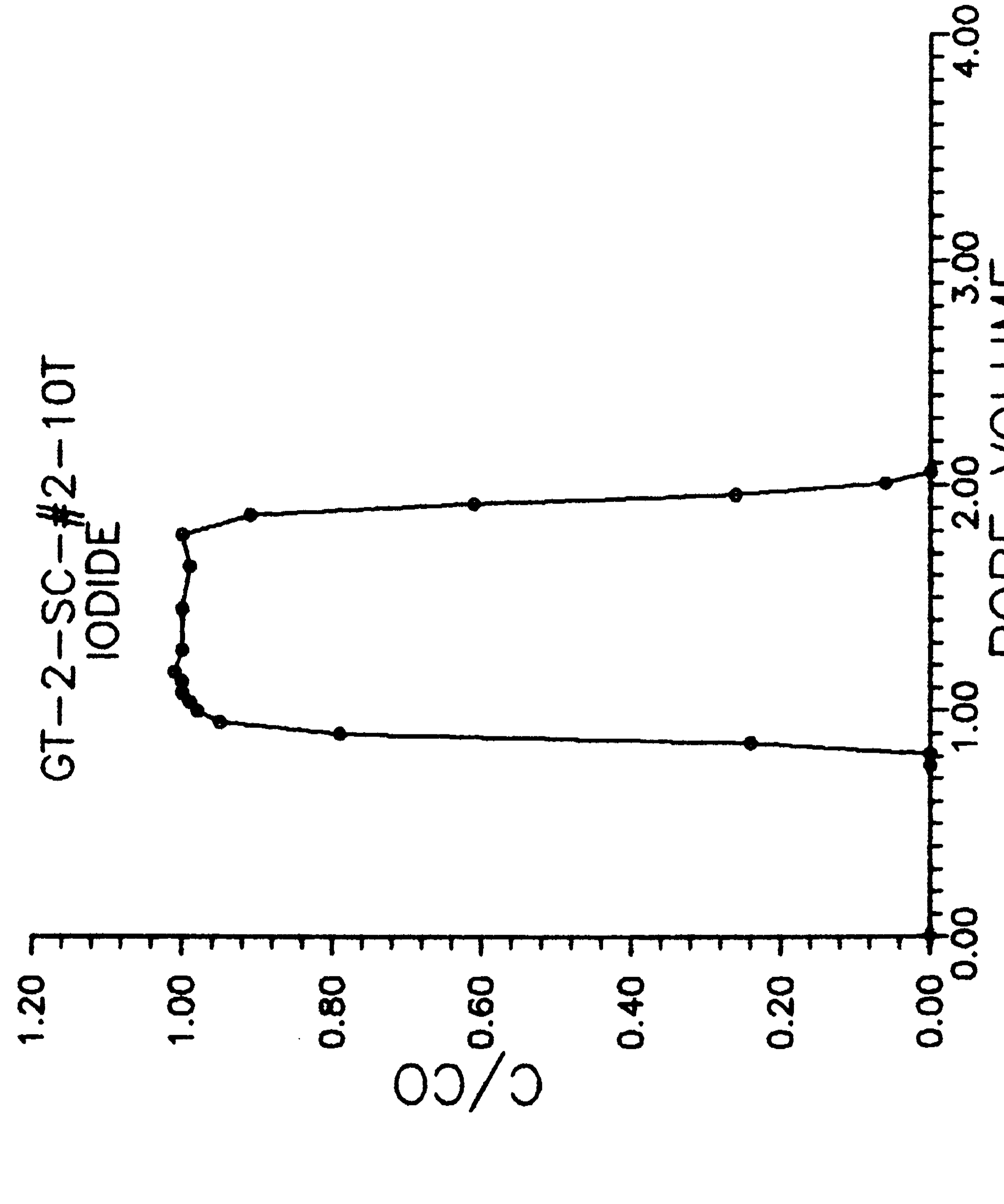

GT-2-SC-#1-20T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

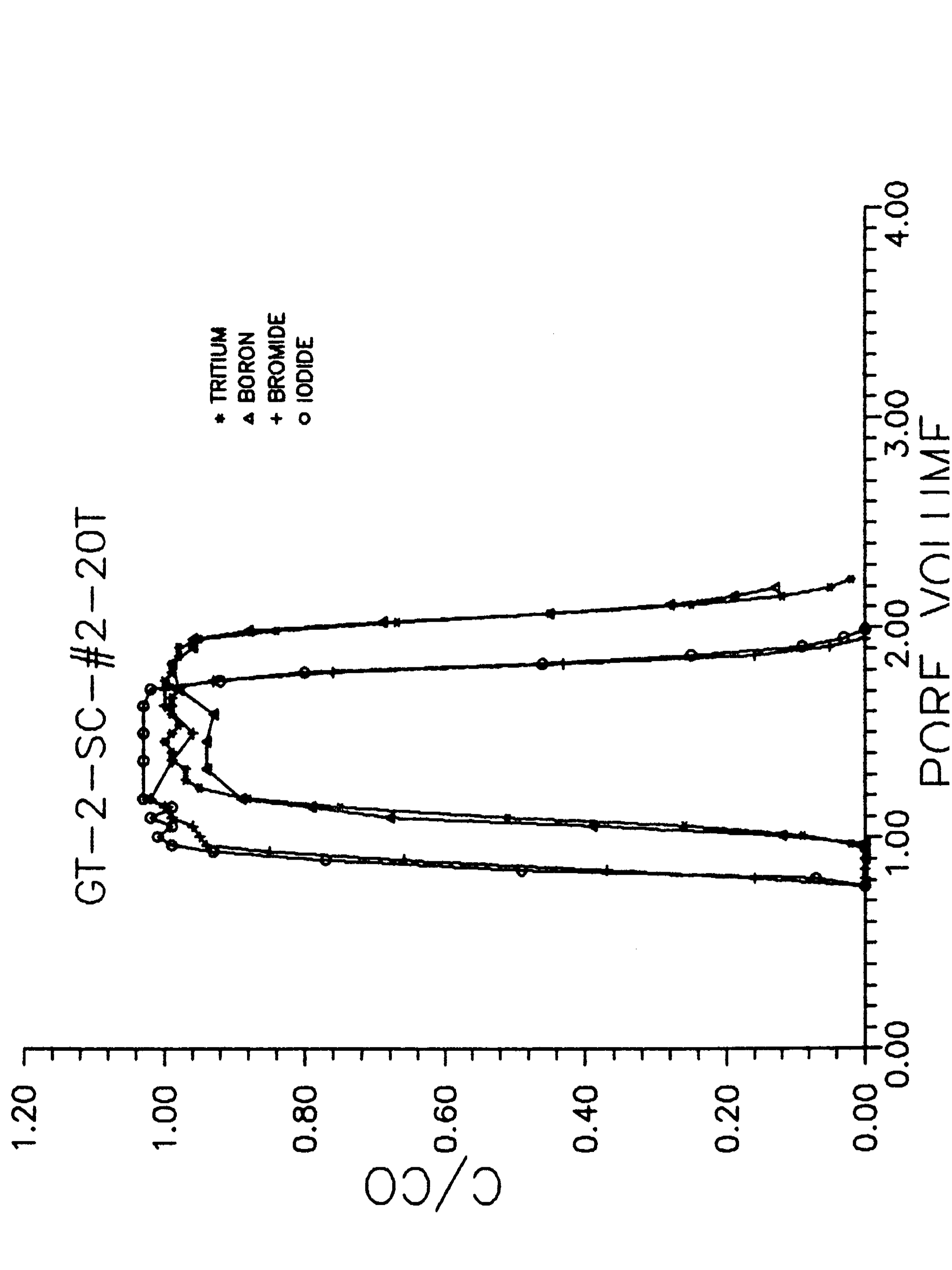

GT-2-SC-#2-10T
* TRITIUM
Δ BORON
+ BROMIDE
o IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

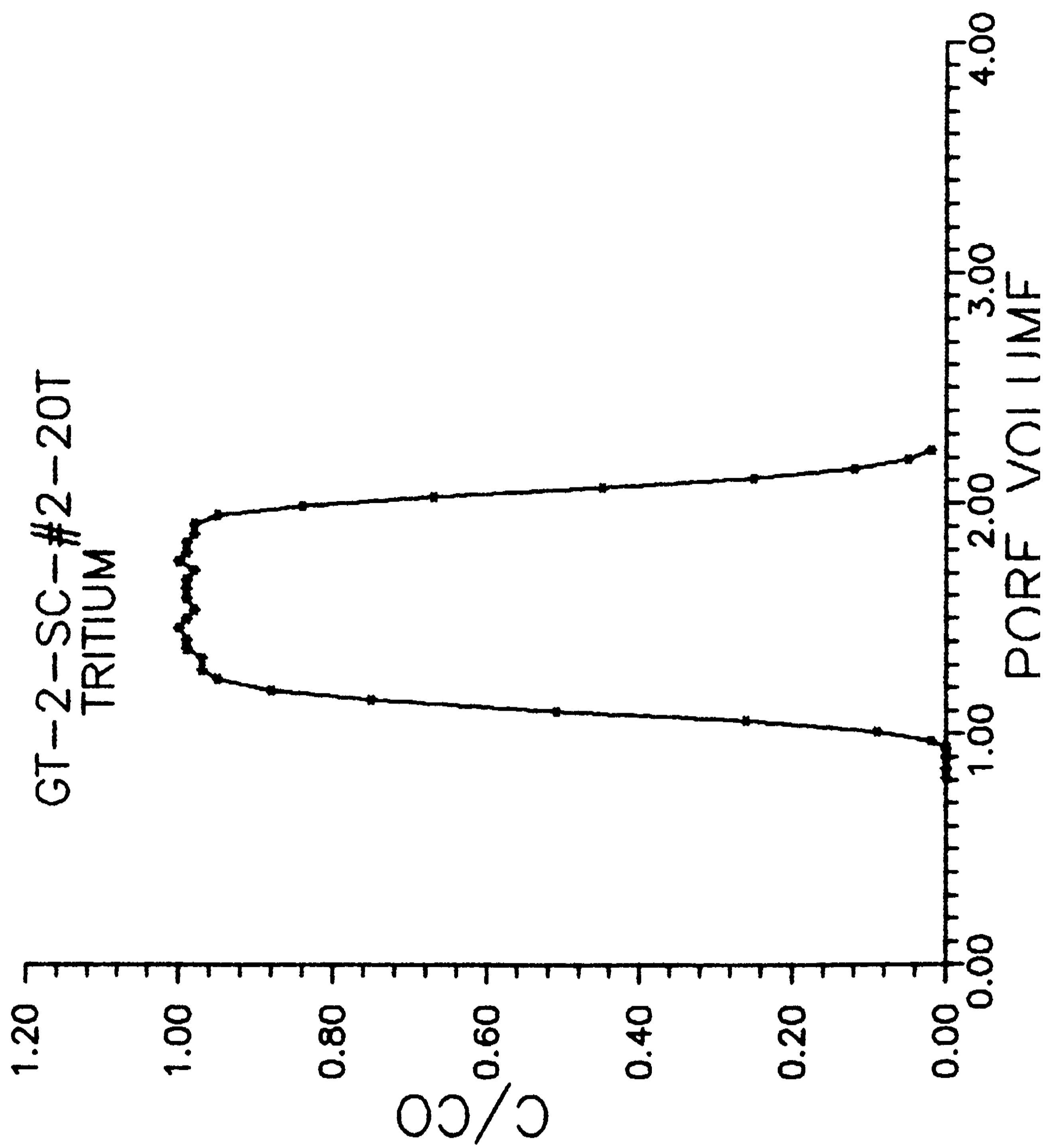

GT-2-SC-#2-10T
TRITIUM
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

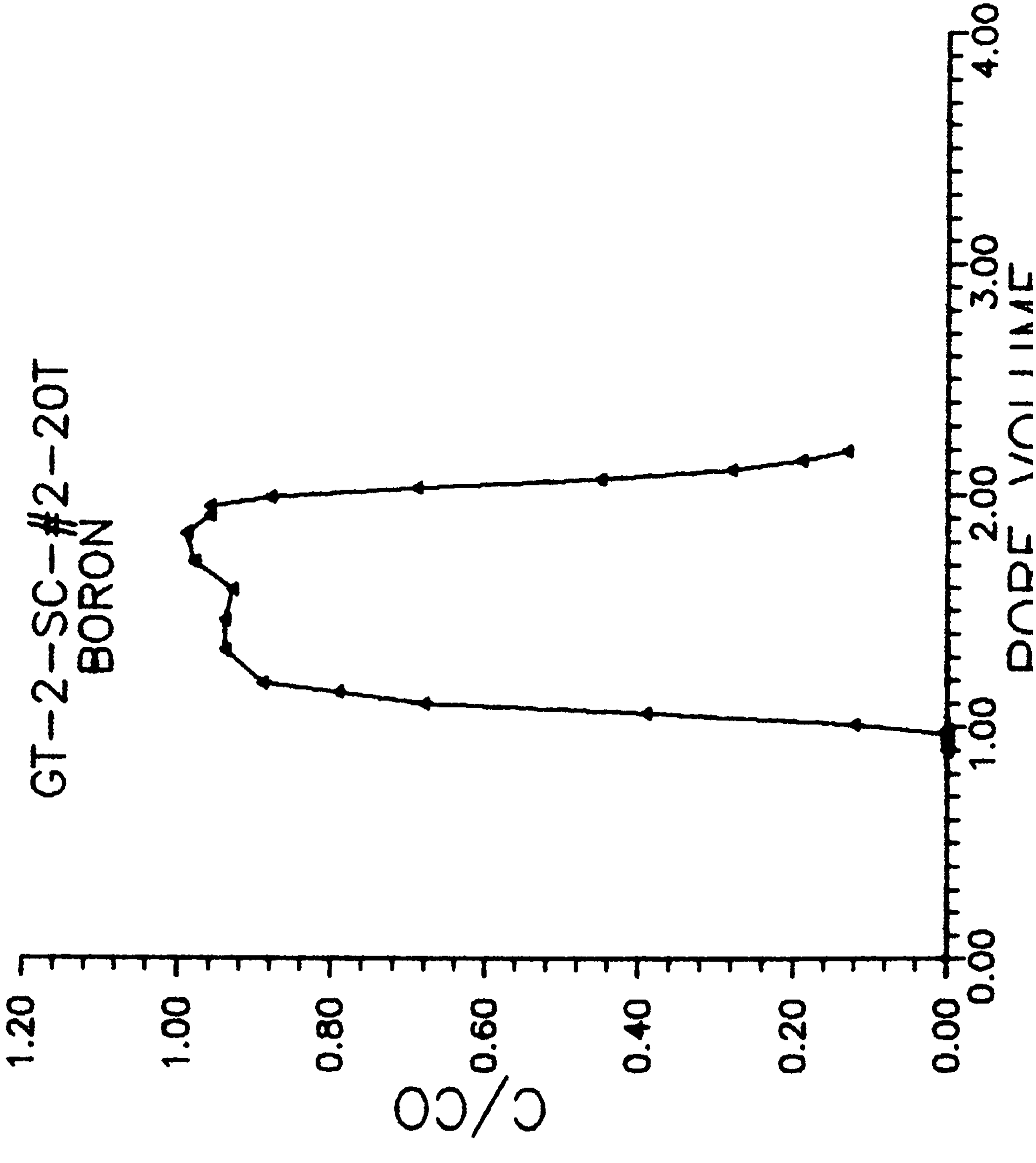

GT-2-SC-#2-10T
BORON
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-SC-#2-10T
BROMIDE
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

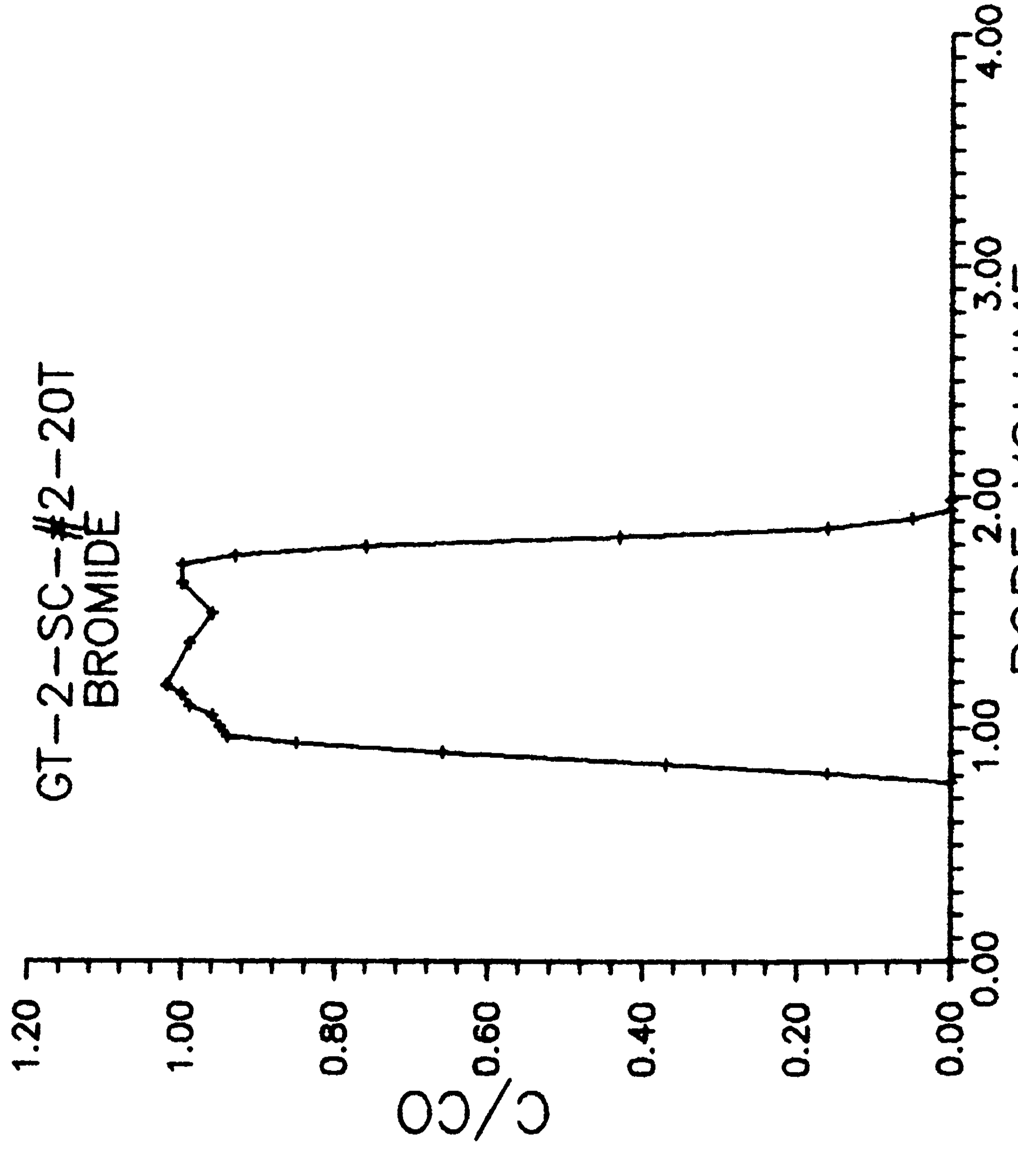

GT-2-SC-#2-10T
IODIDE
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

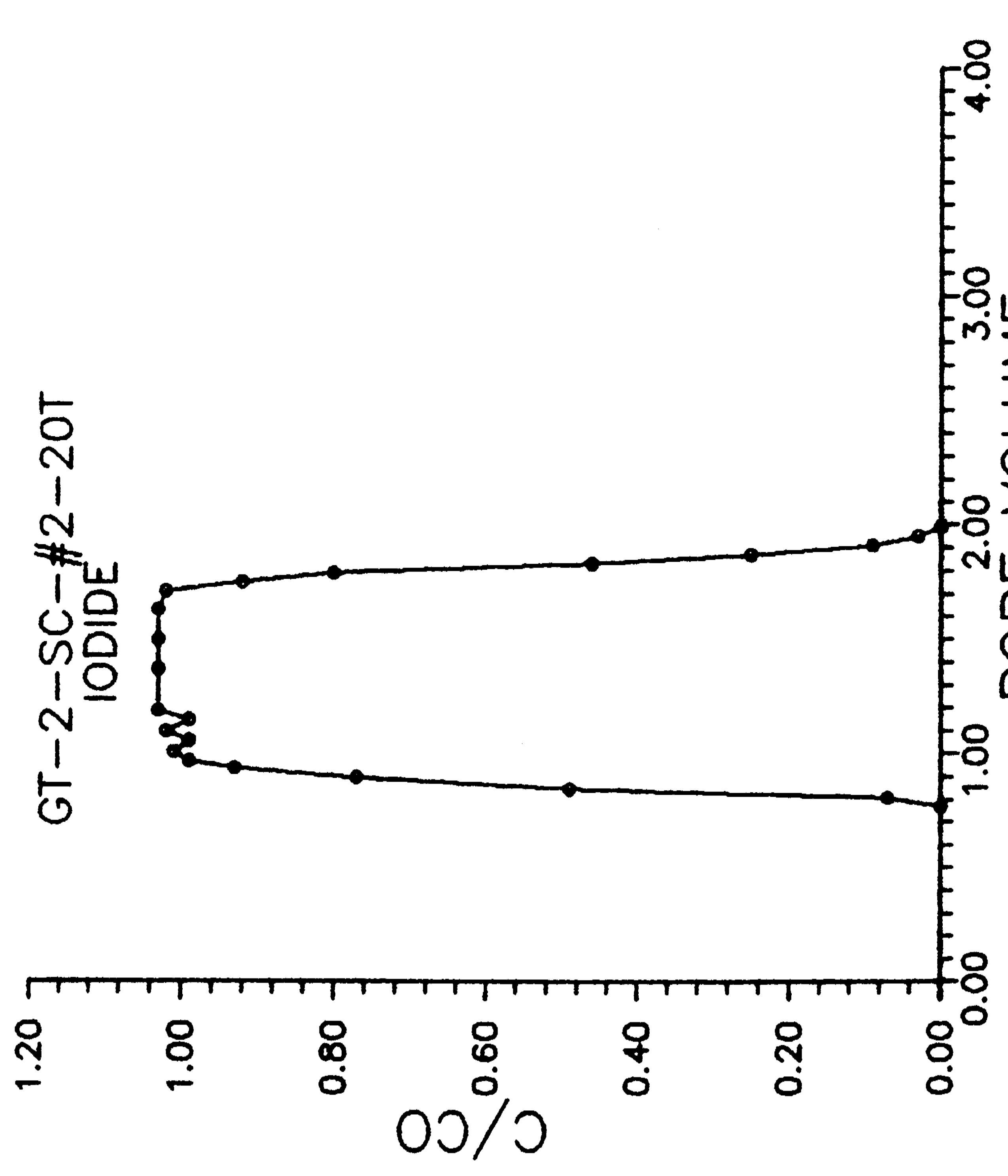

GT-2-SC-#2-20T
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME
* TRITIUM
△ BORON
+ BROMIDE
o IODIDE

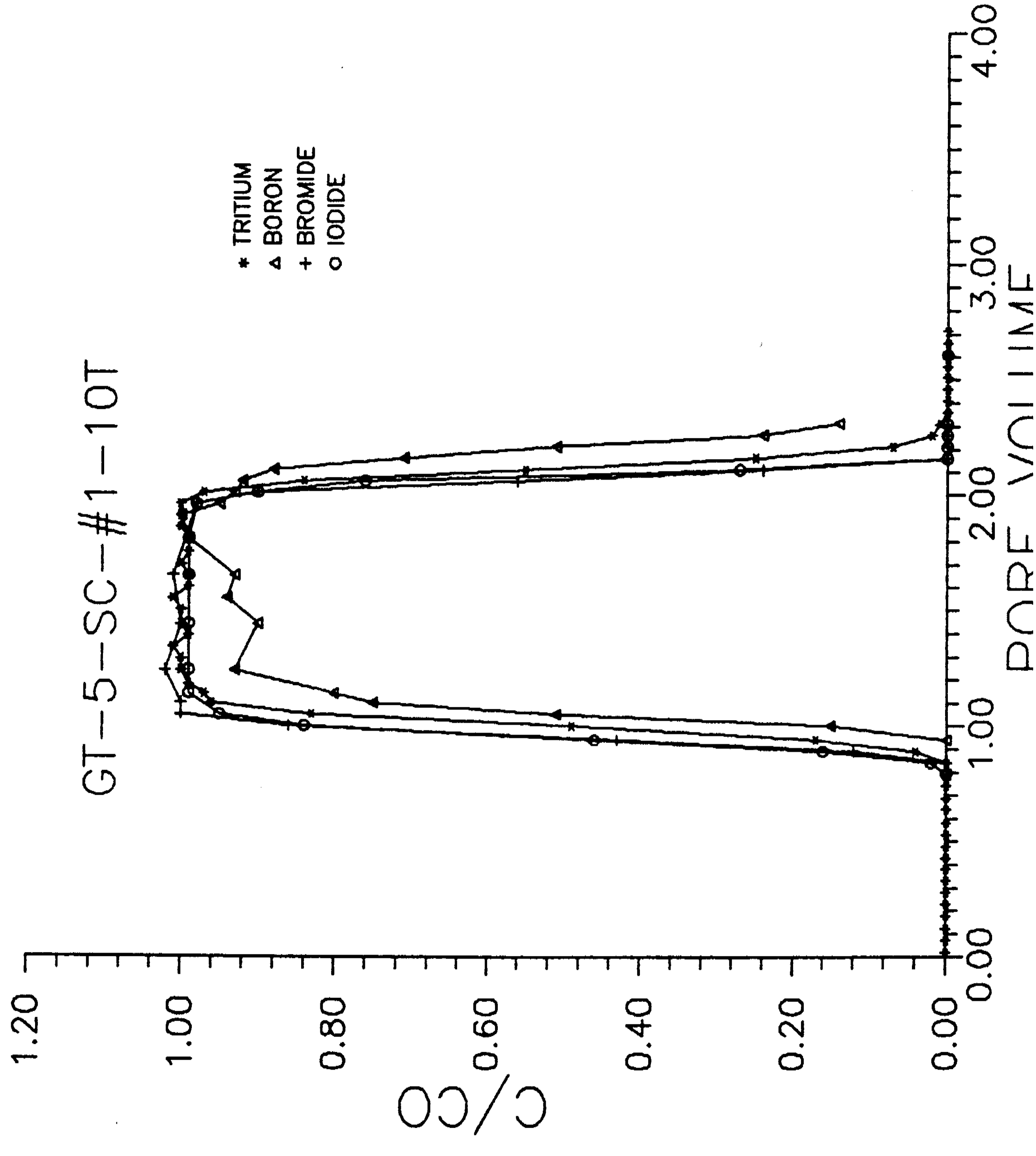

GT-2-SC-#2-20T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME



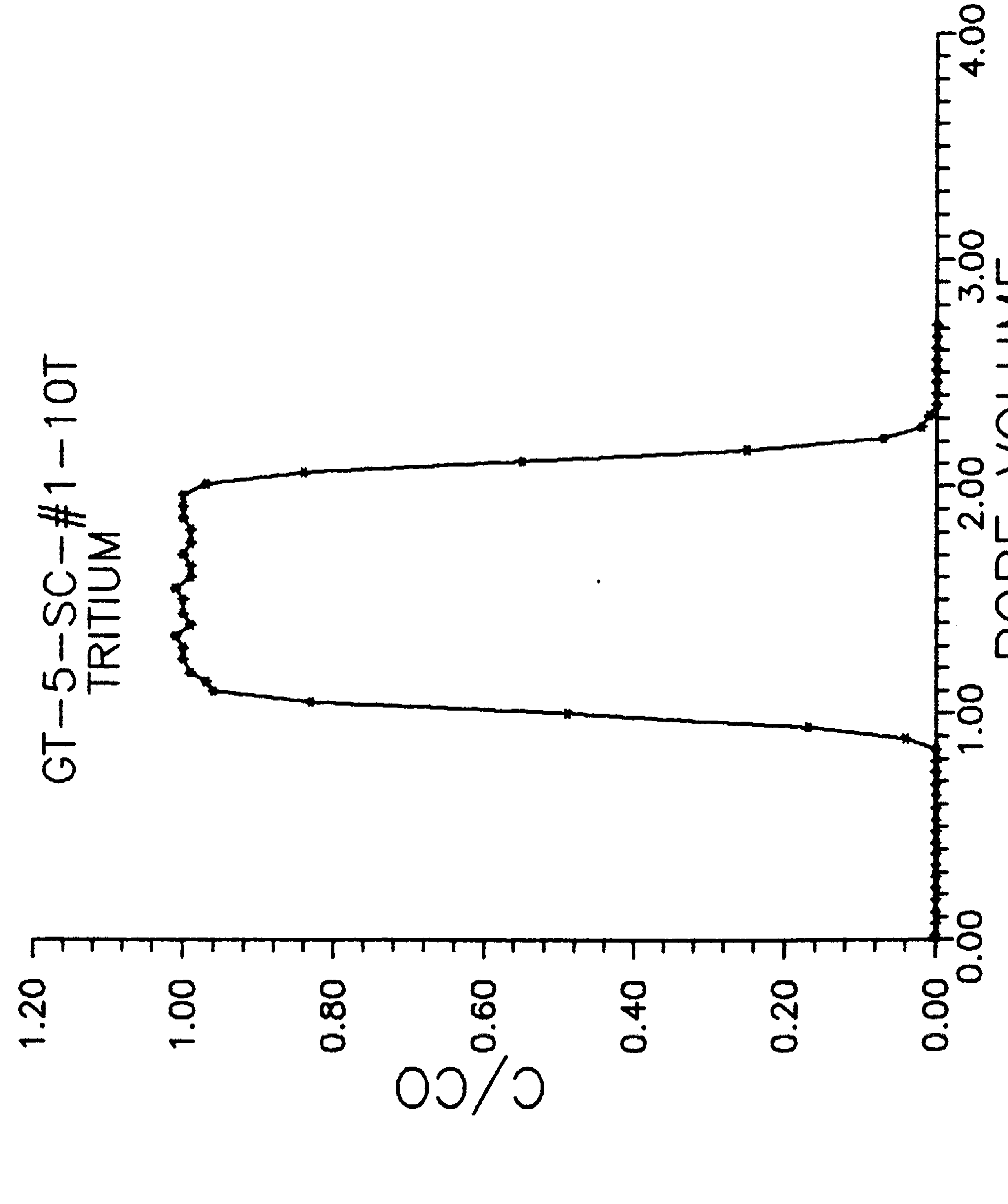
GT-2-SC-#2-20T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

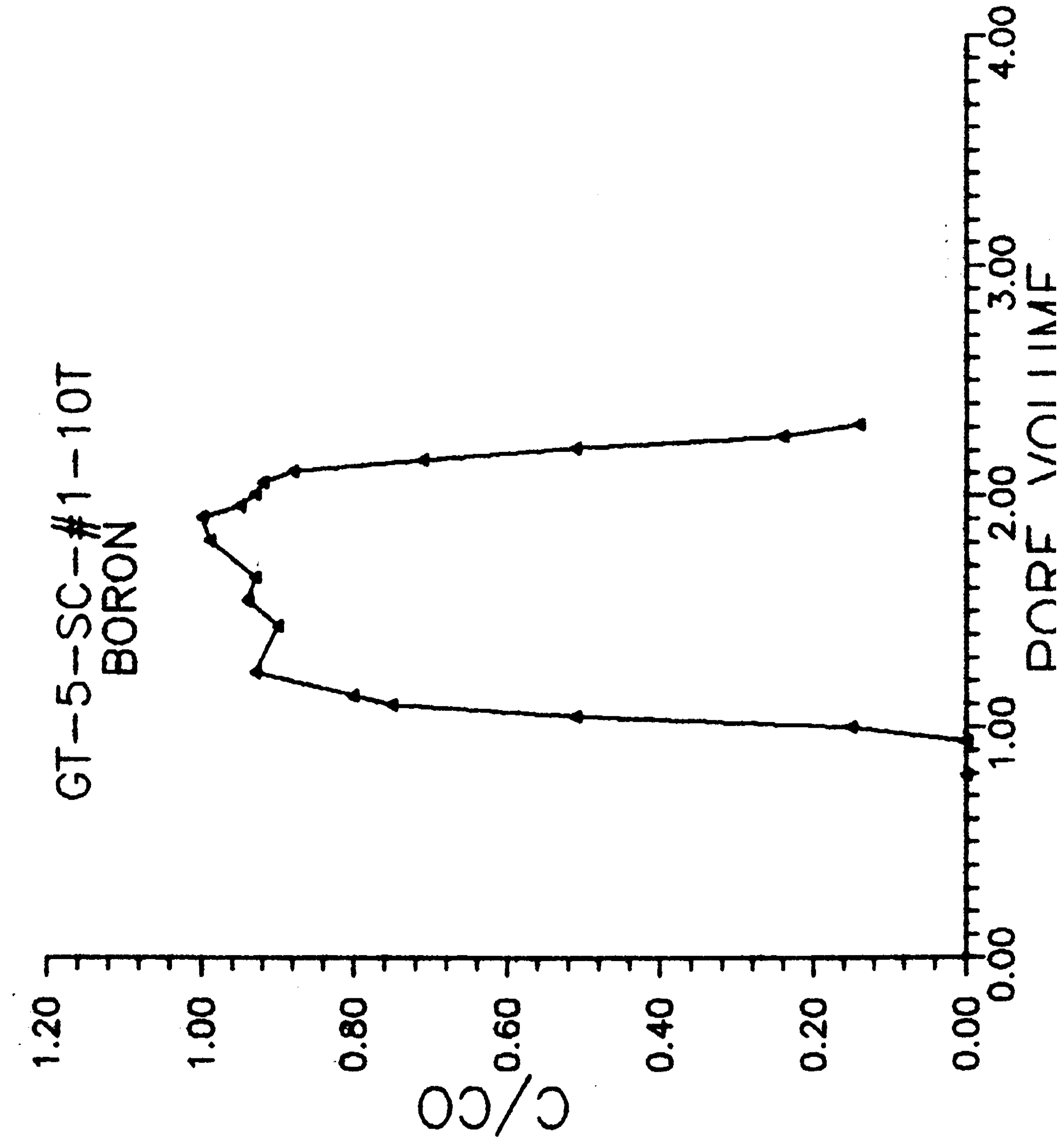

GT-2-SC-#2-20T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-SC-#2-20T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

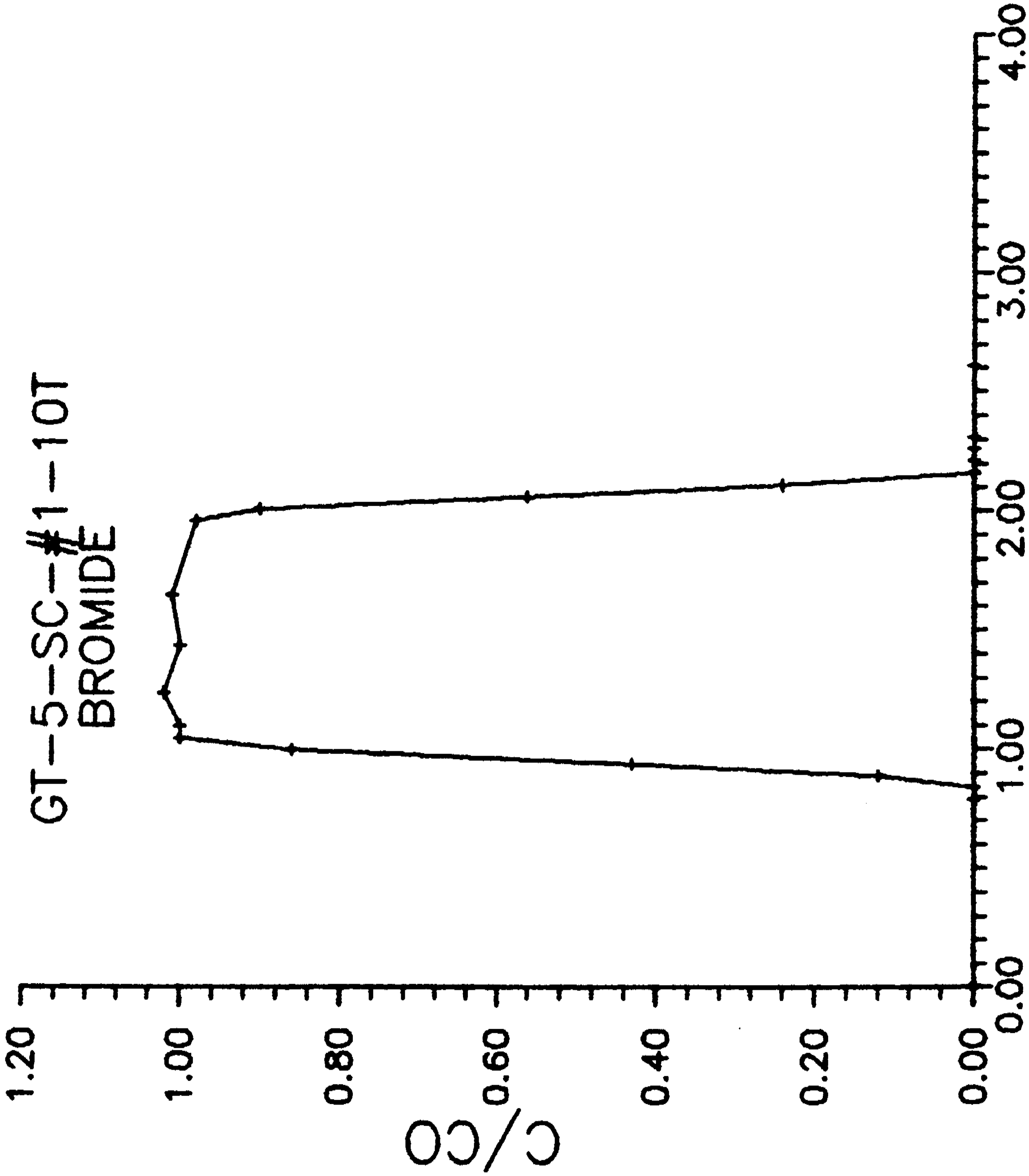


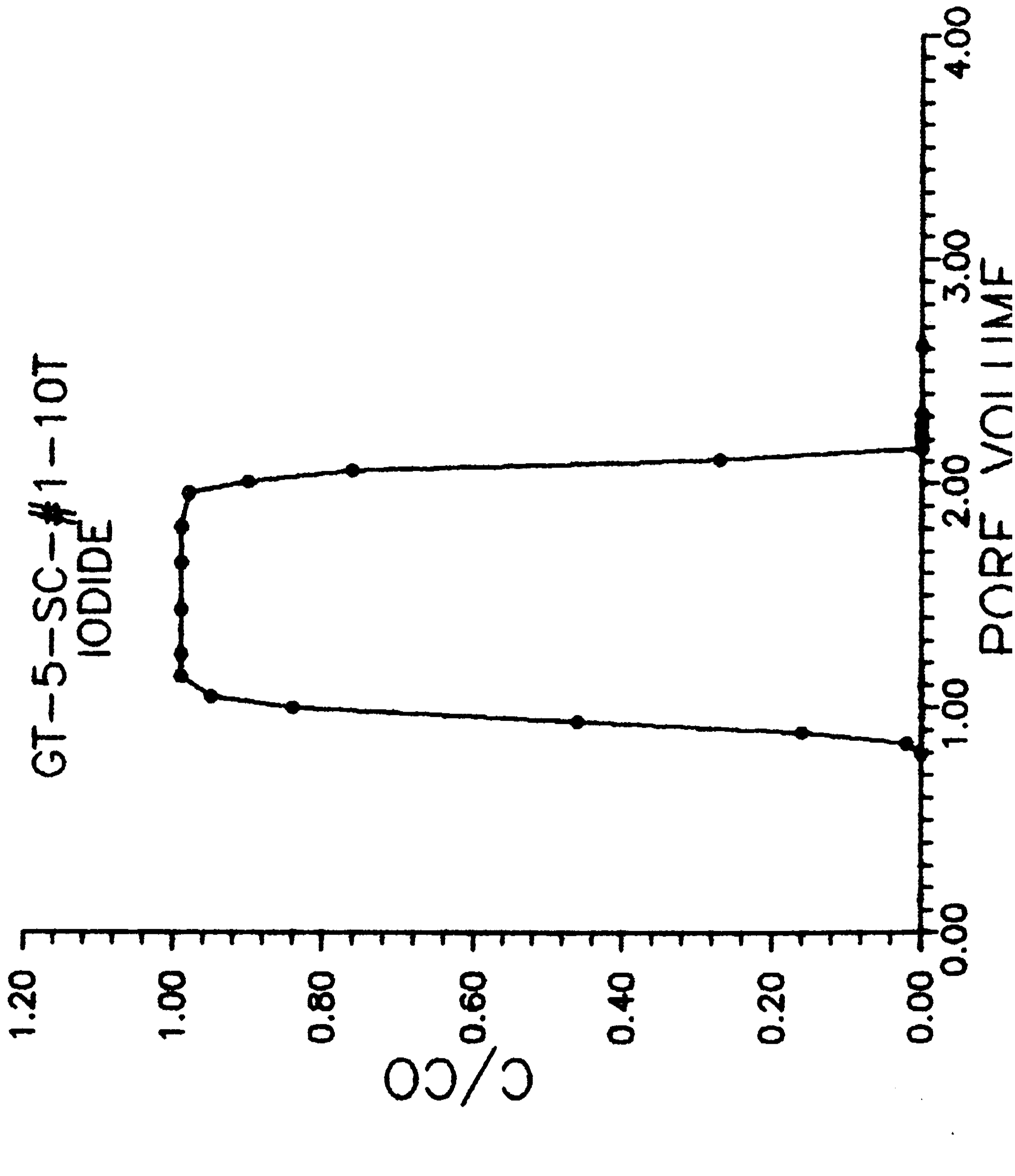
GT-5-SC-#1-10T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

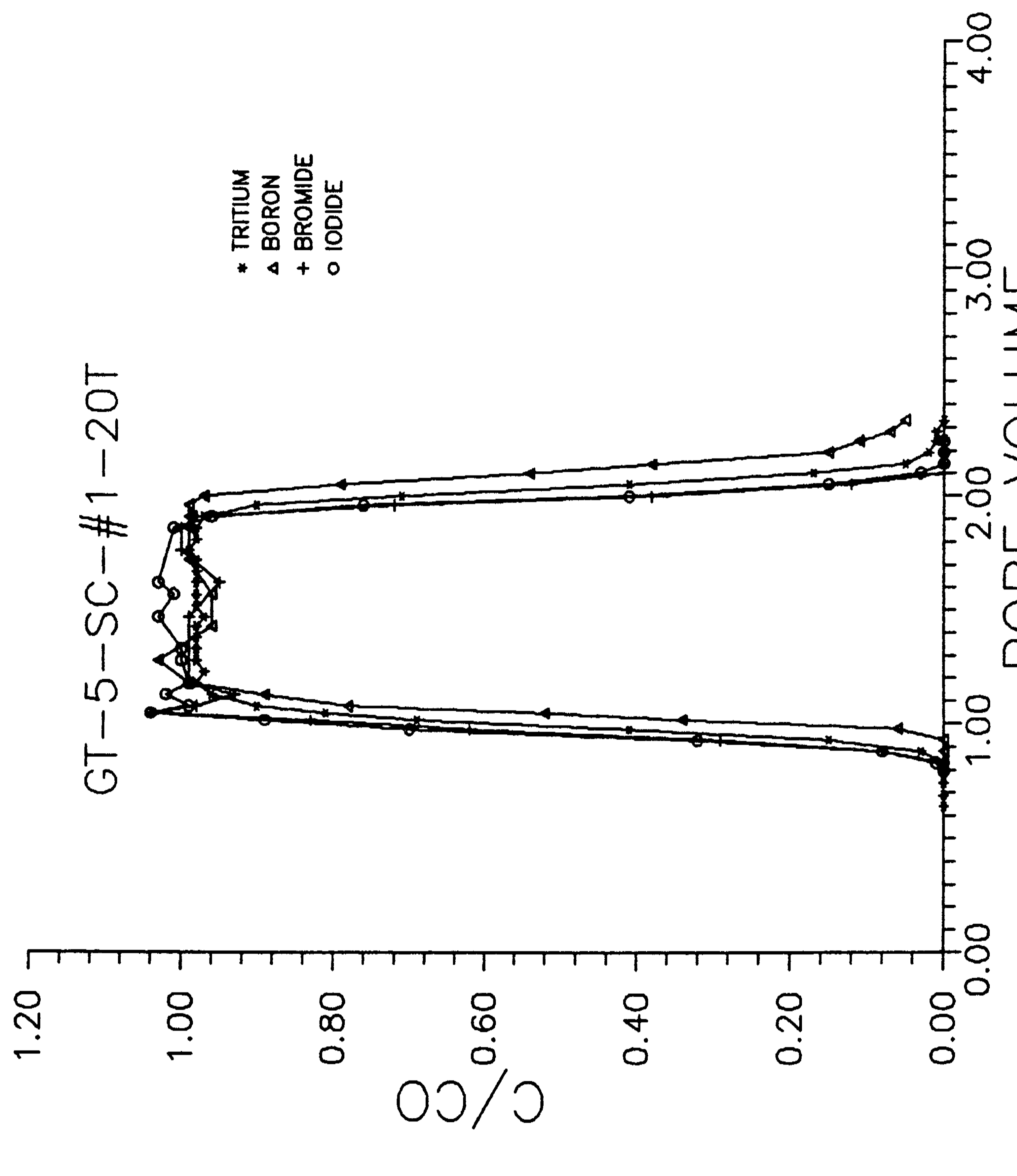

GT—5—SC—#1—10T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00

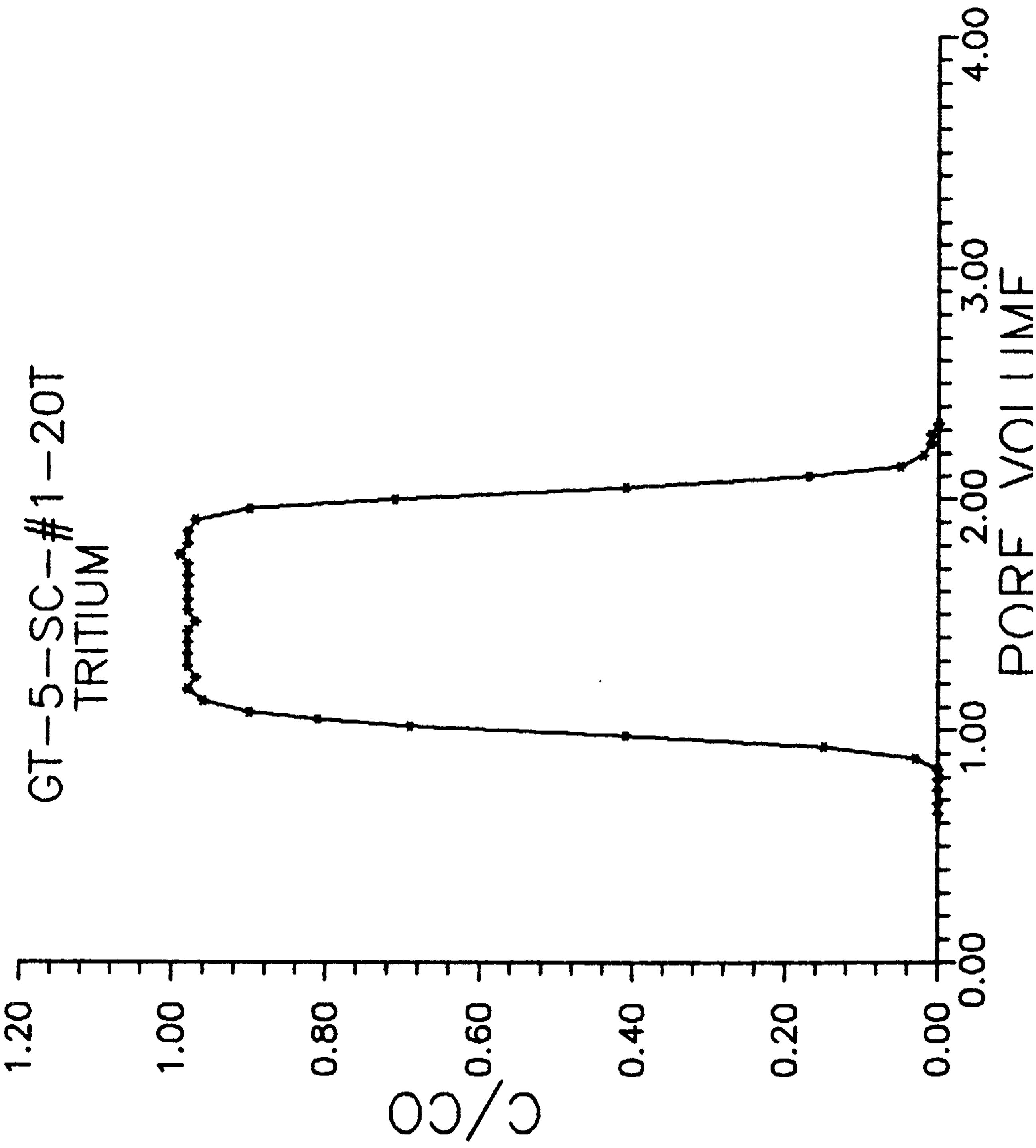


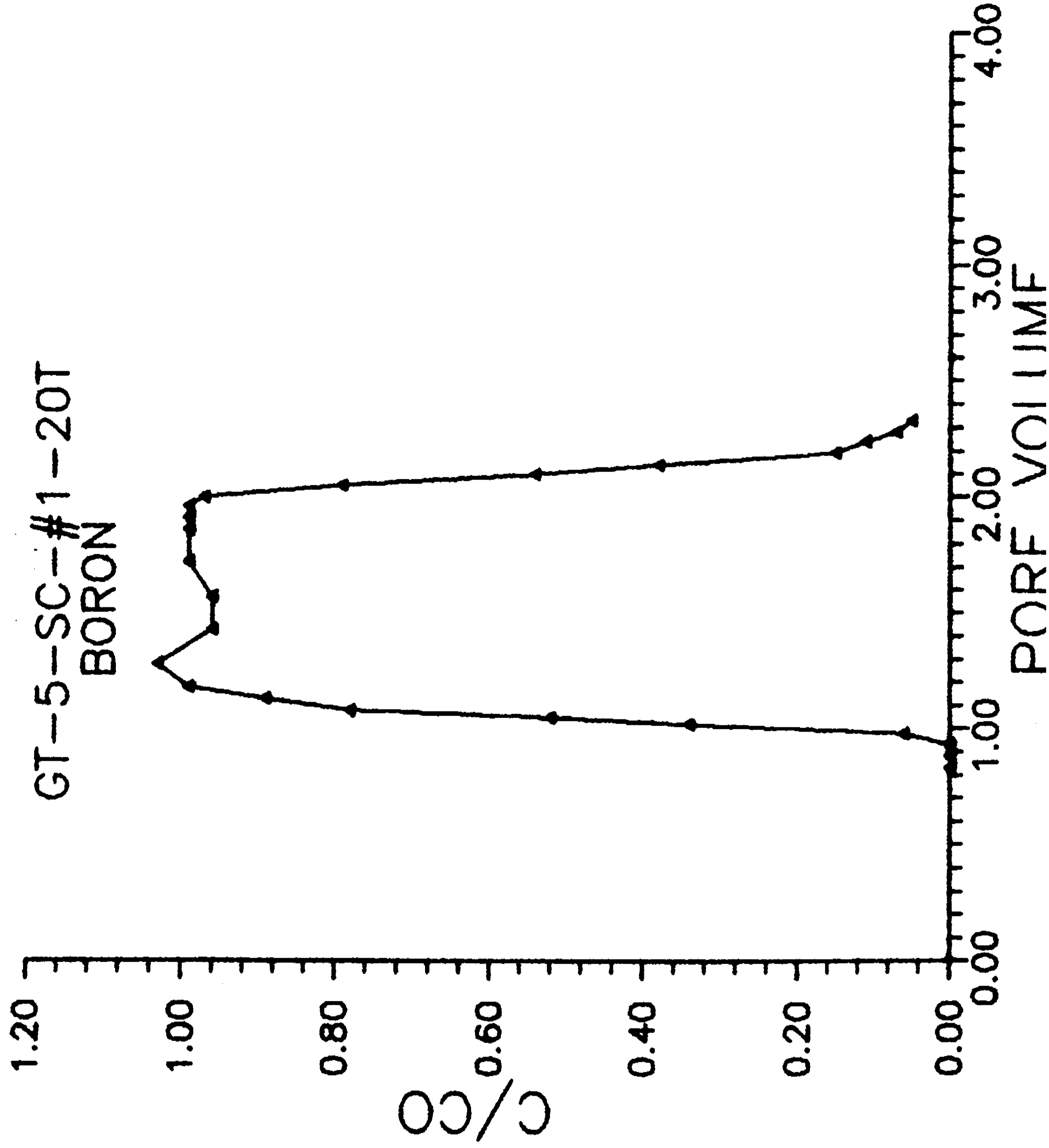
GT-5-SC-#1-10T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
PORE VOLUME
0.00
1.00
2.00
3.00
4.00

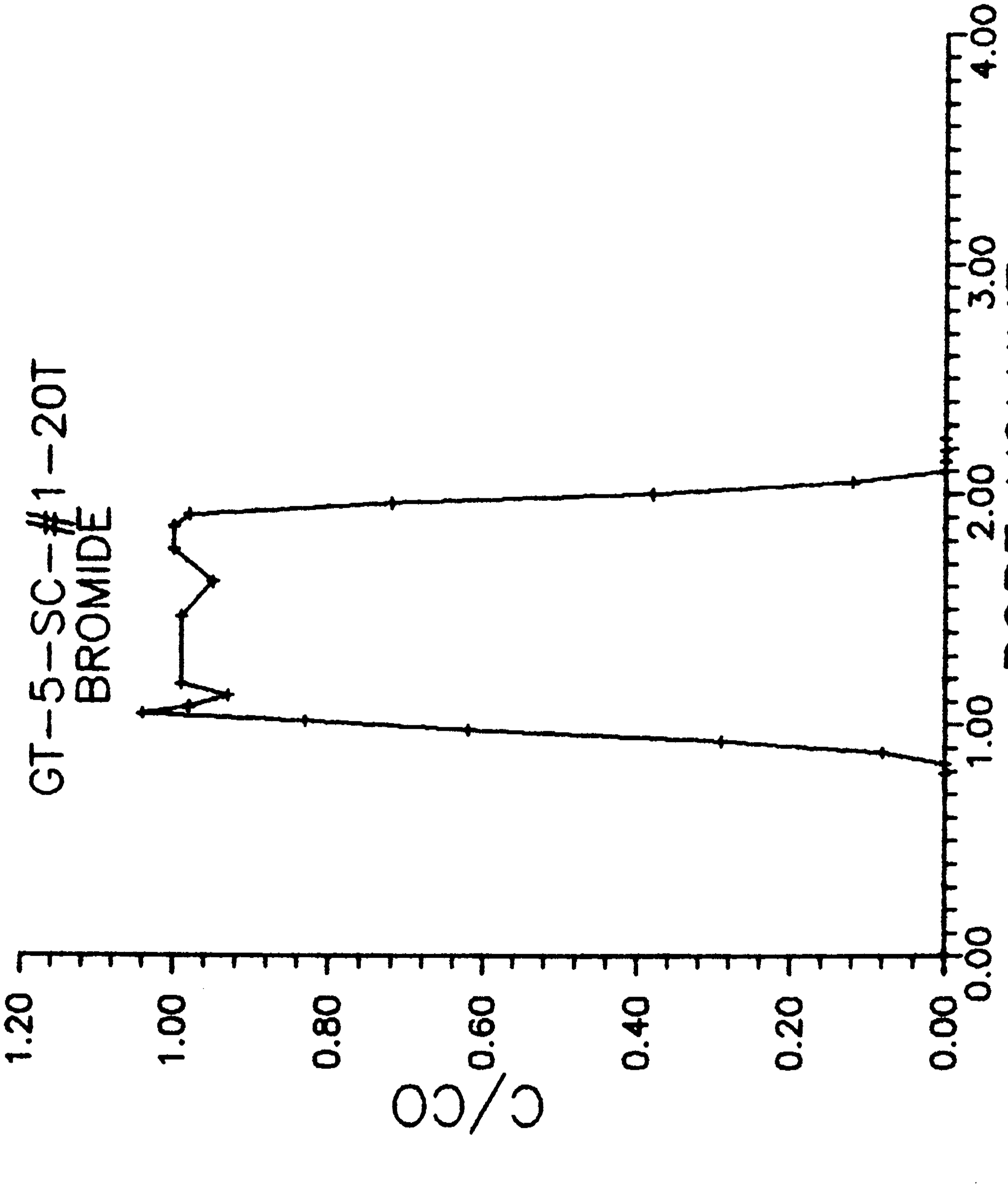

GT-5-SC-#1-10T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

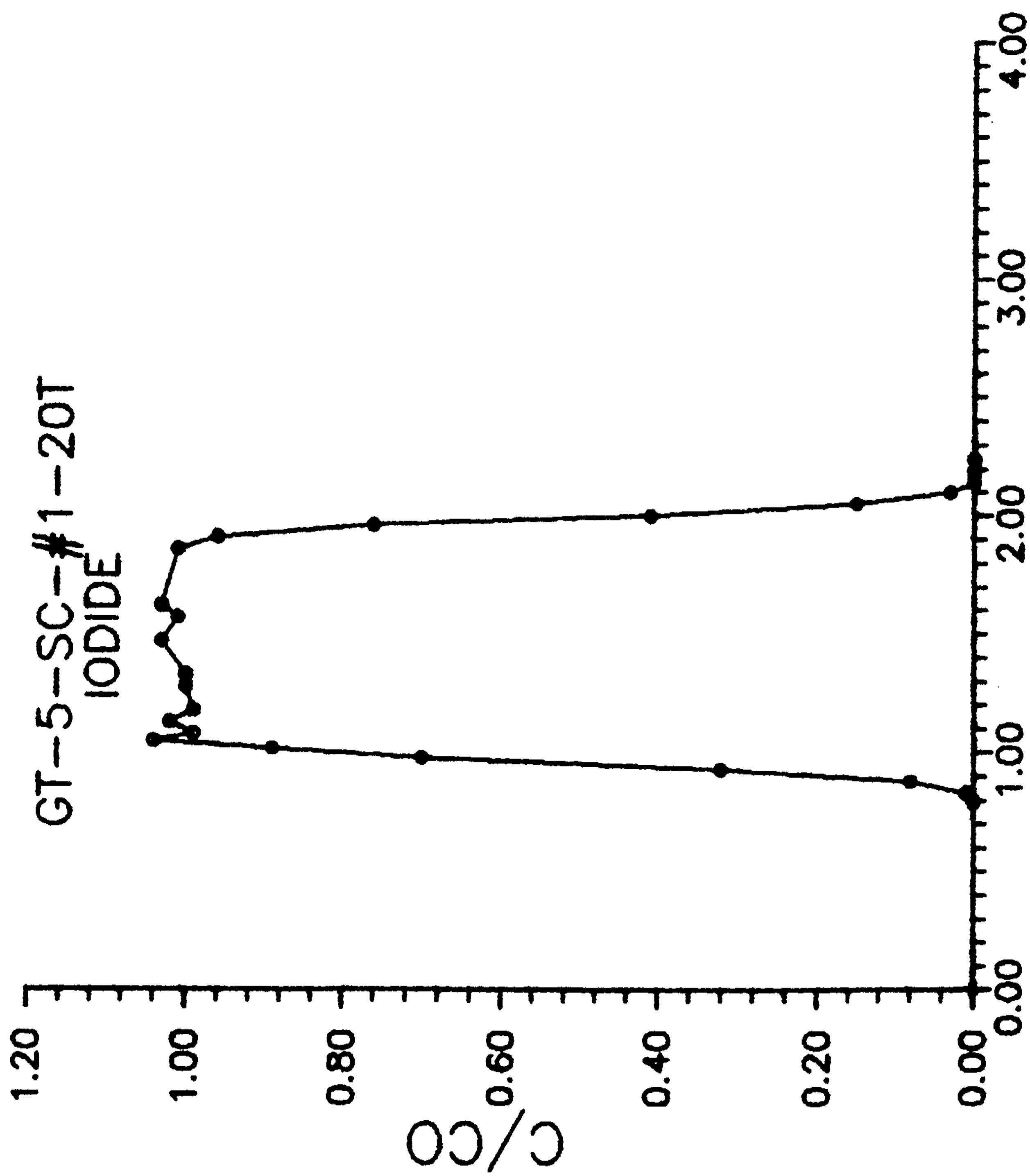

GT—5—SC—#1—10T
IODIDE
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

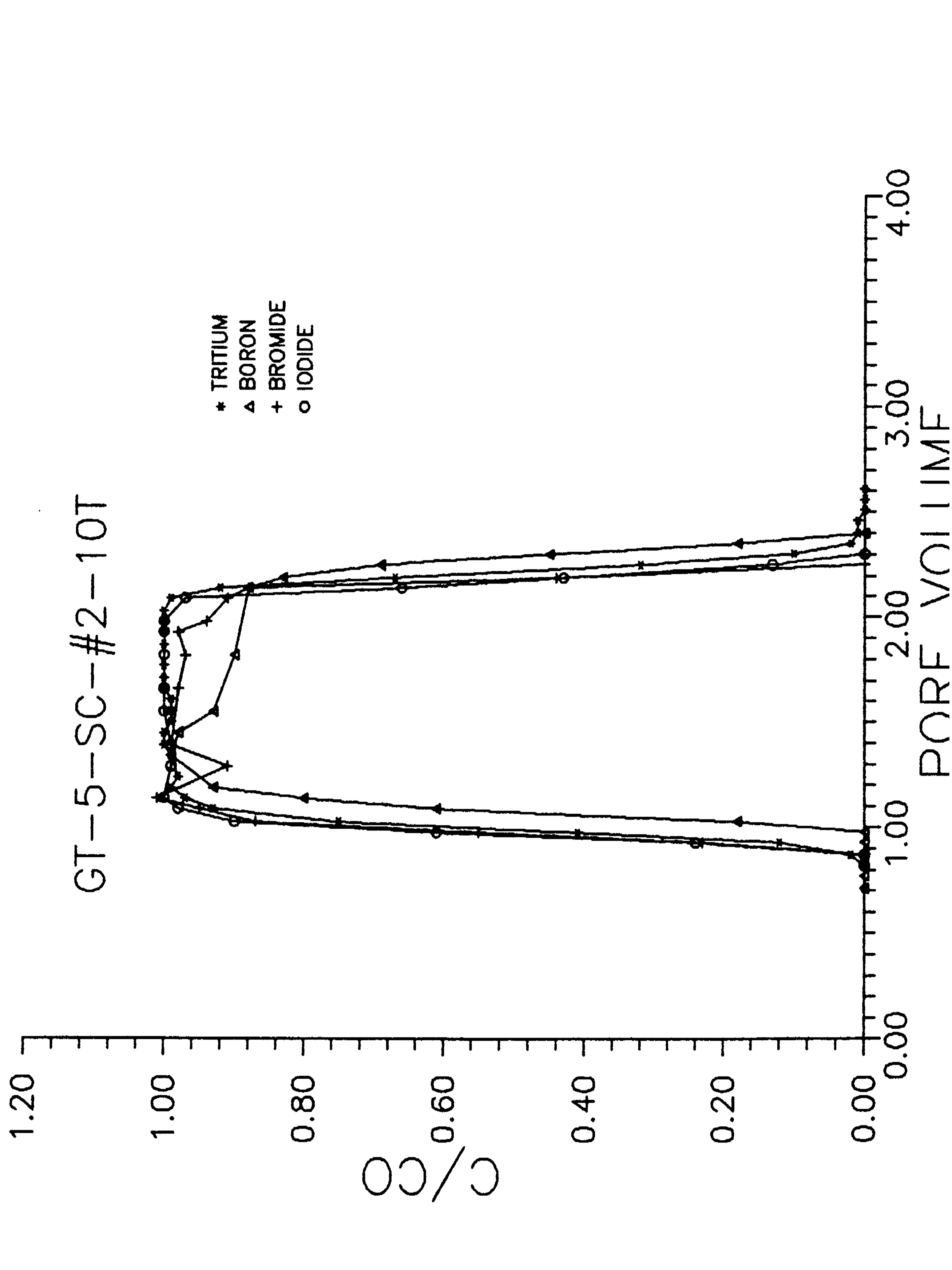

GT-5-SC-#1-20T
* TRITIUM
Δ BORON
+ BROMIDE
o IODIDE
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
PORE VOLUME
0.00
1.00
2.00
3.00
4.00

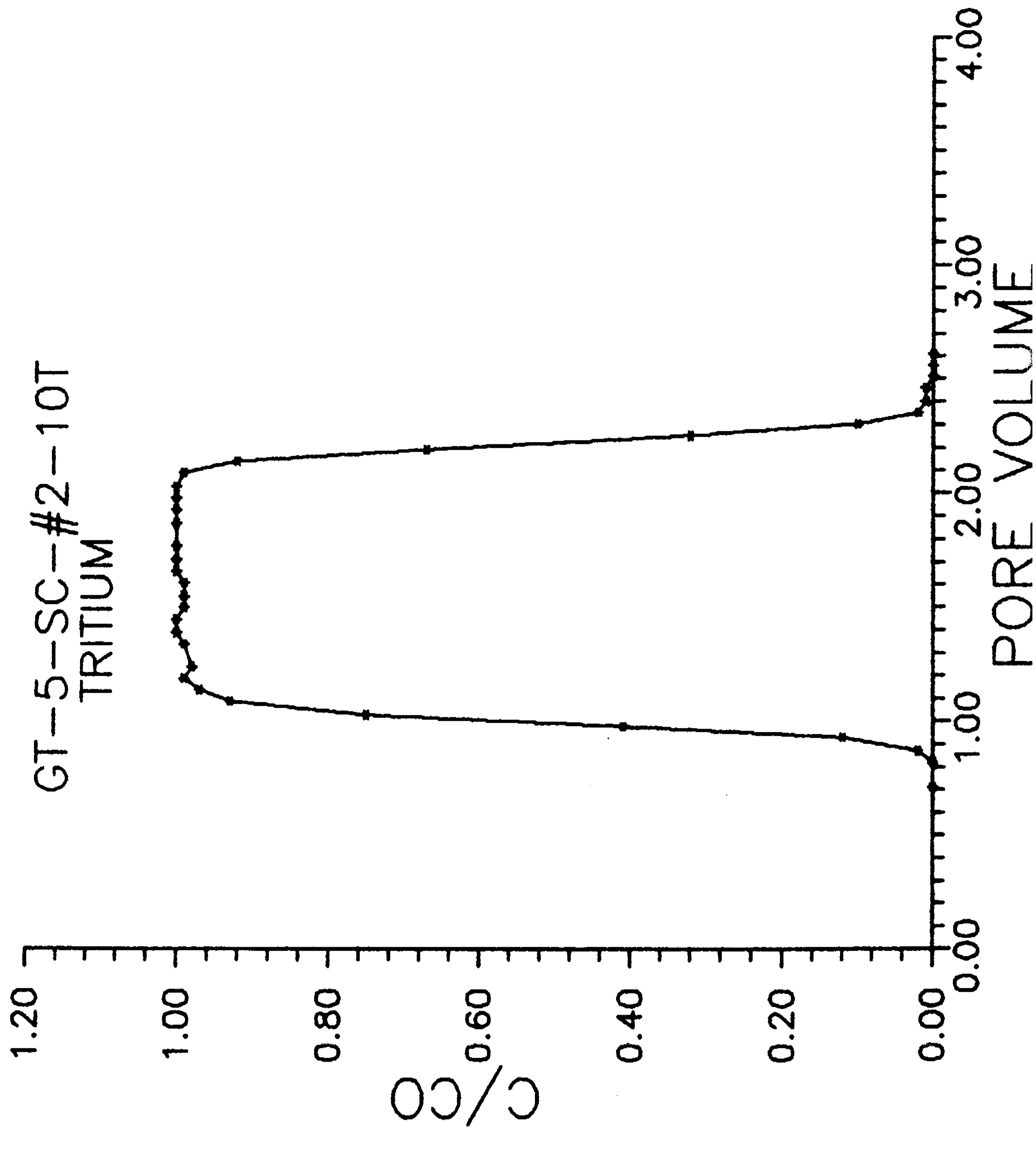

GT-5-SC-#1-20T
TRITIUM
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

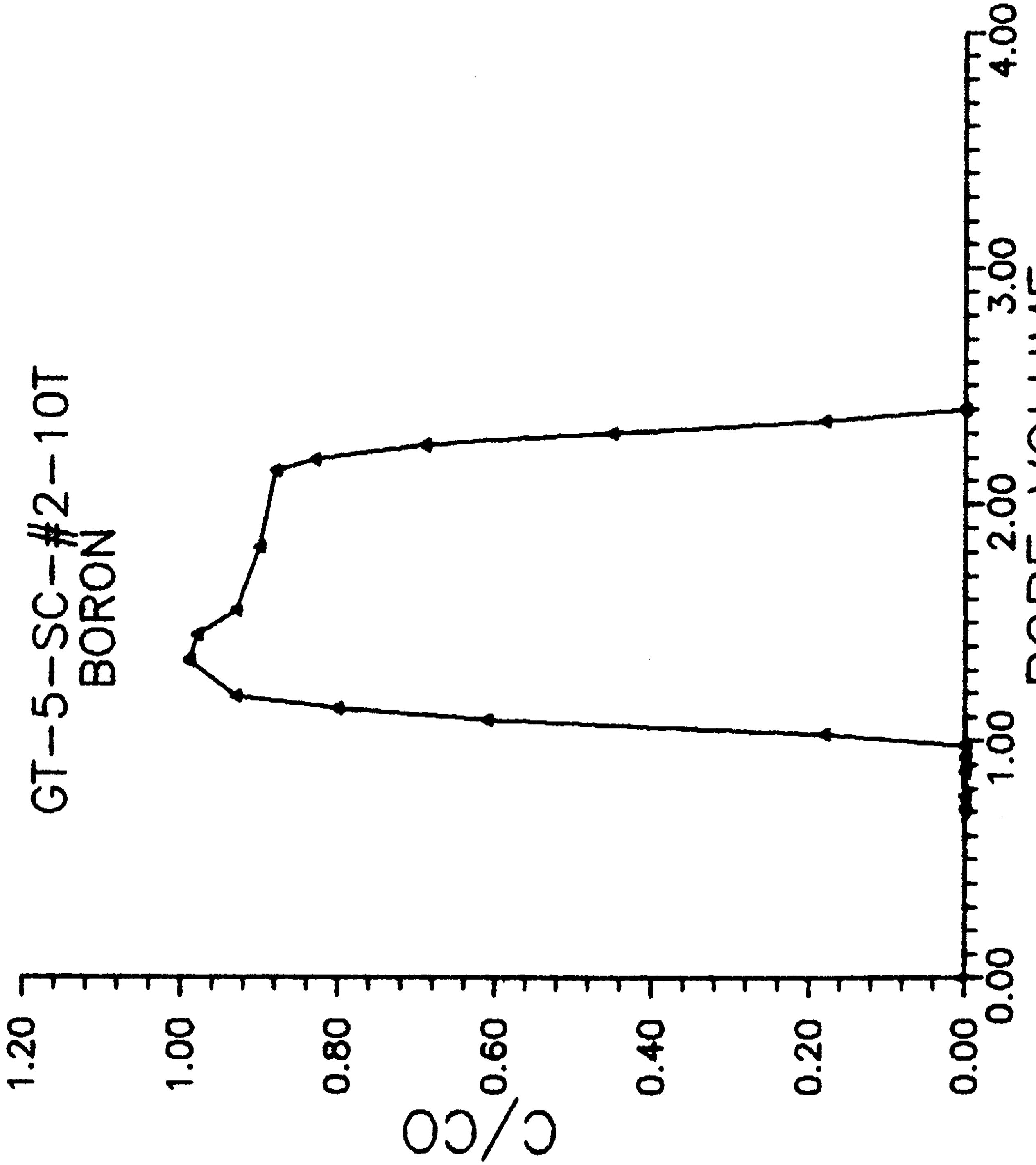

GT-5-SC-#1-20T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-5-SC-#1-20T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00


GT-5-SC-#1-20T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-5-SC-#2-10T
* TRITIUM
Δ BORON
+ BROMIDE
o IODIDE
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
PORE VOLUME
0.00
1.00
2.00
3.00
4.00


GT-5-SC-#2-10T
TRITIUM
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
PORE VOLUME
0.00
1.00
2.00
3.00
4.00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C/CO
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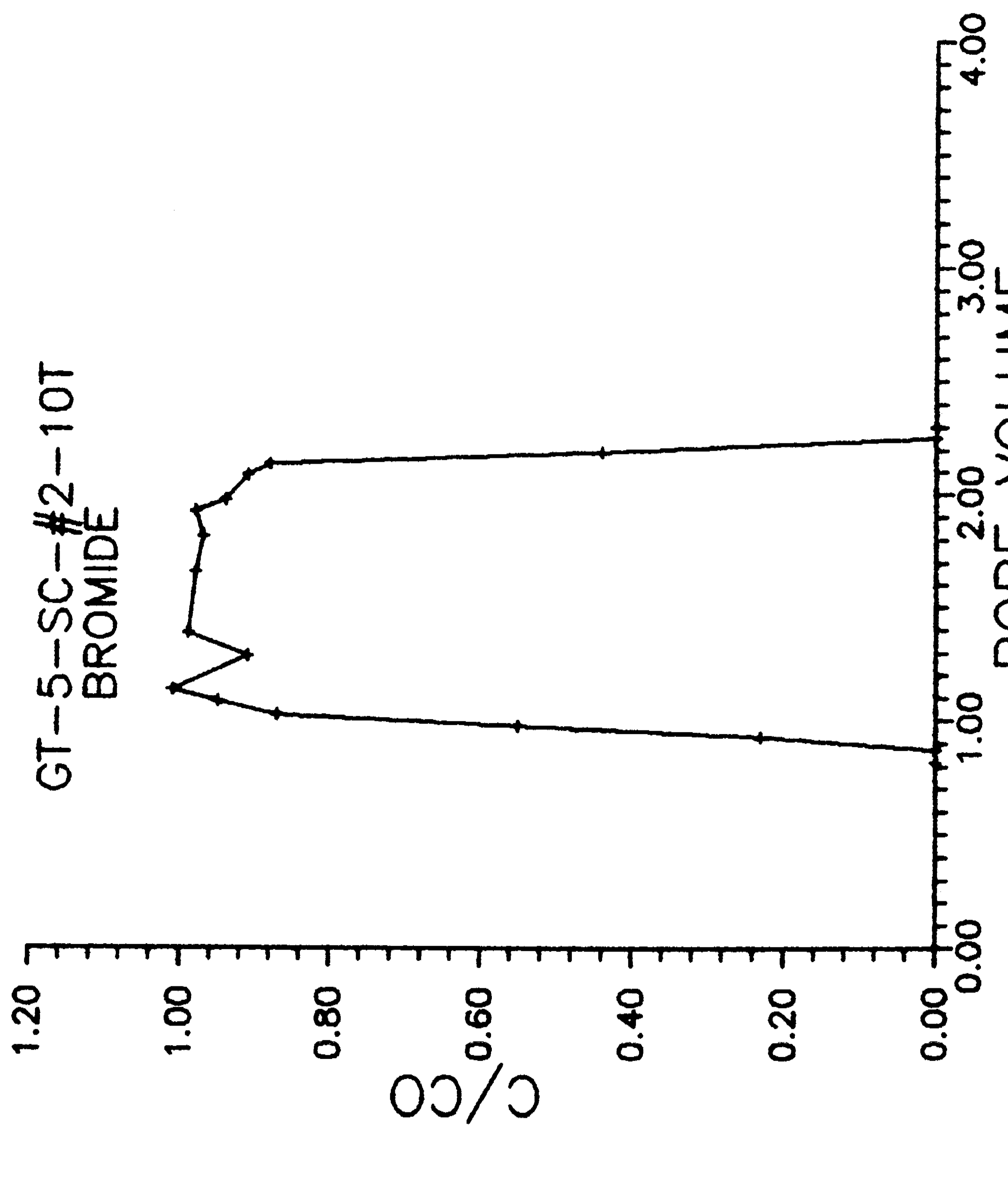
PORE VOLUME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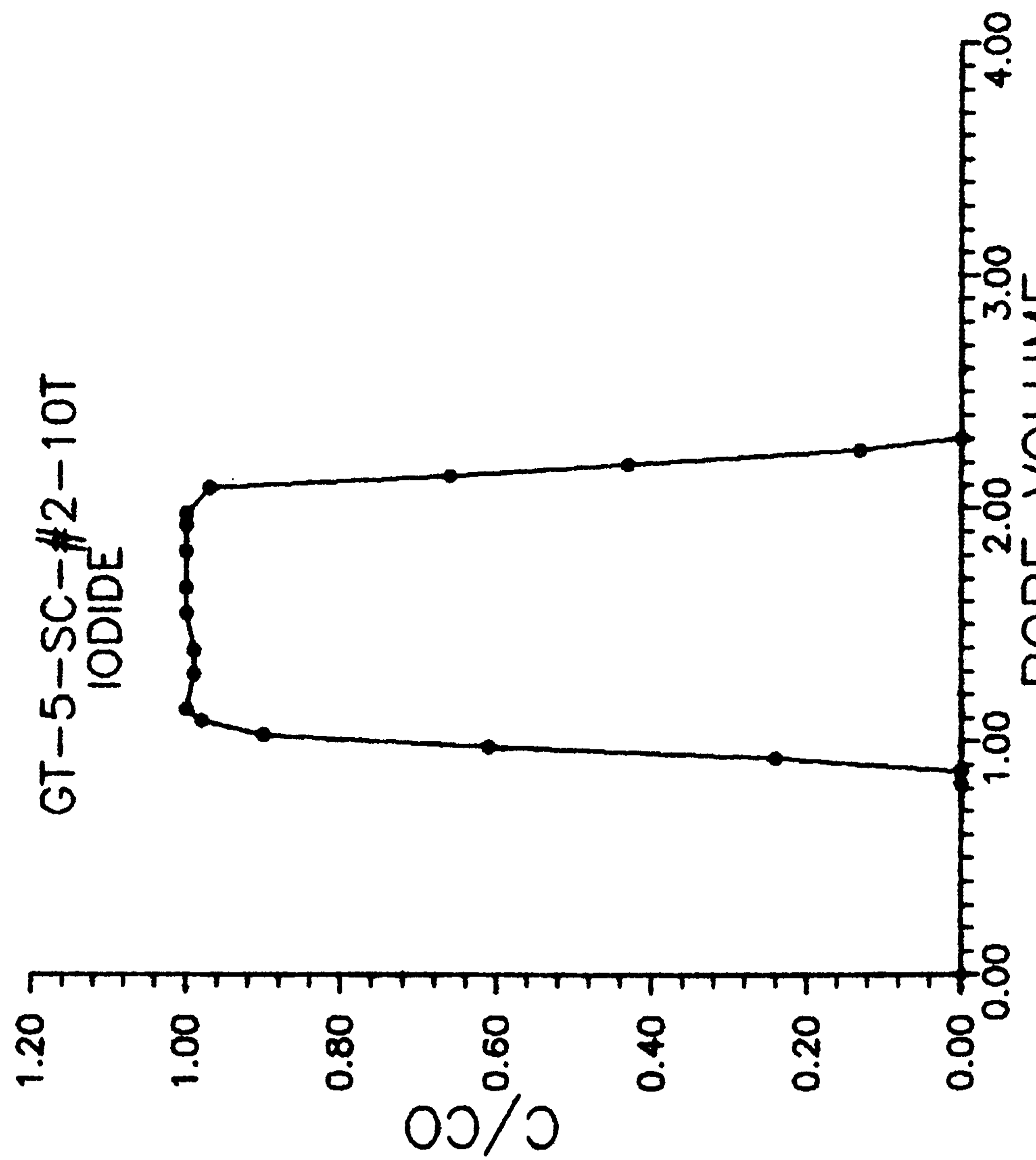
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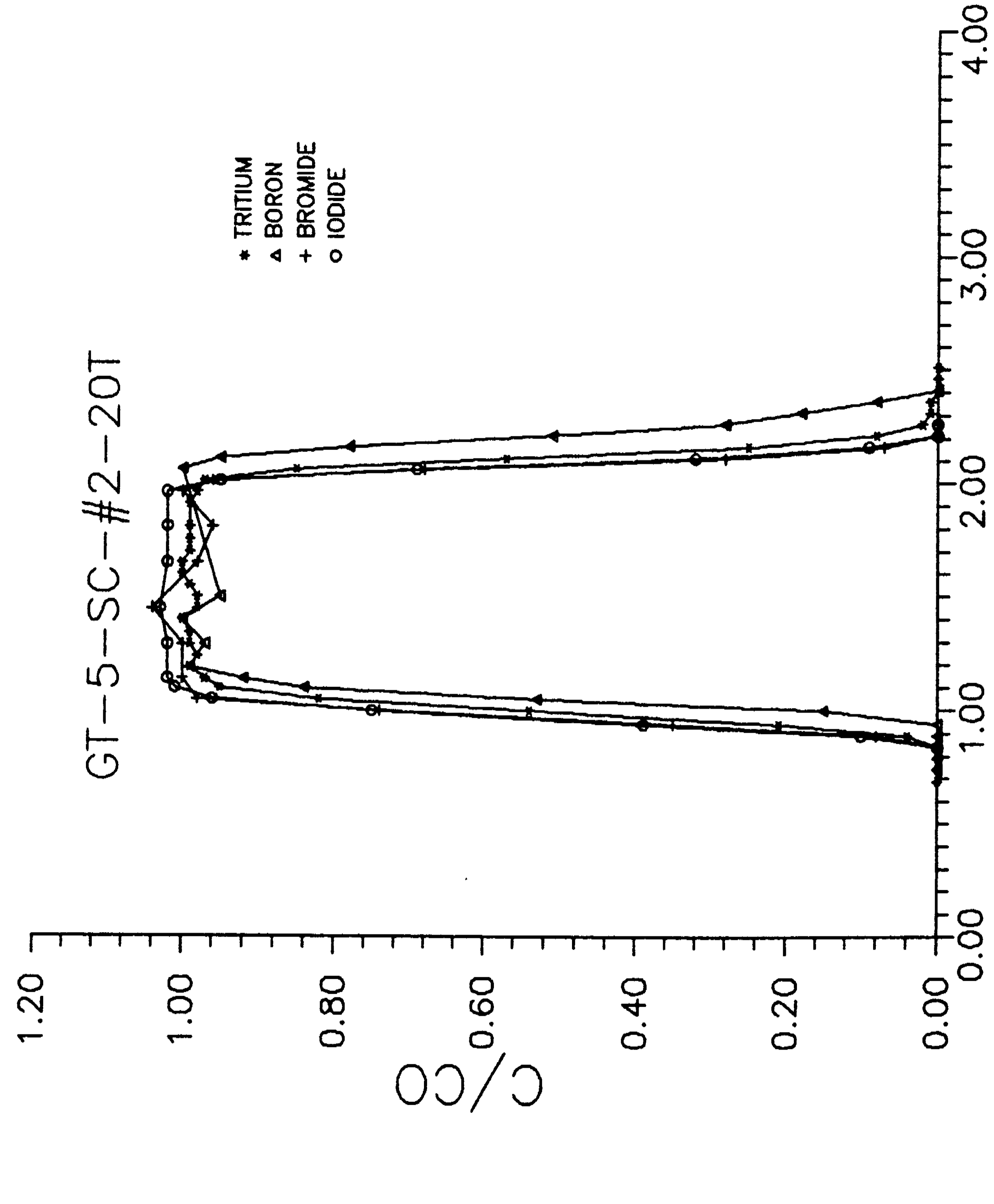
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Δ BORON
+ BROMIDE
o IODIDE
C/CO
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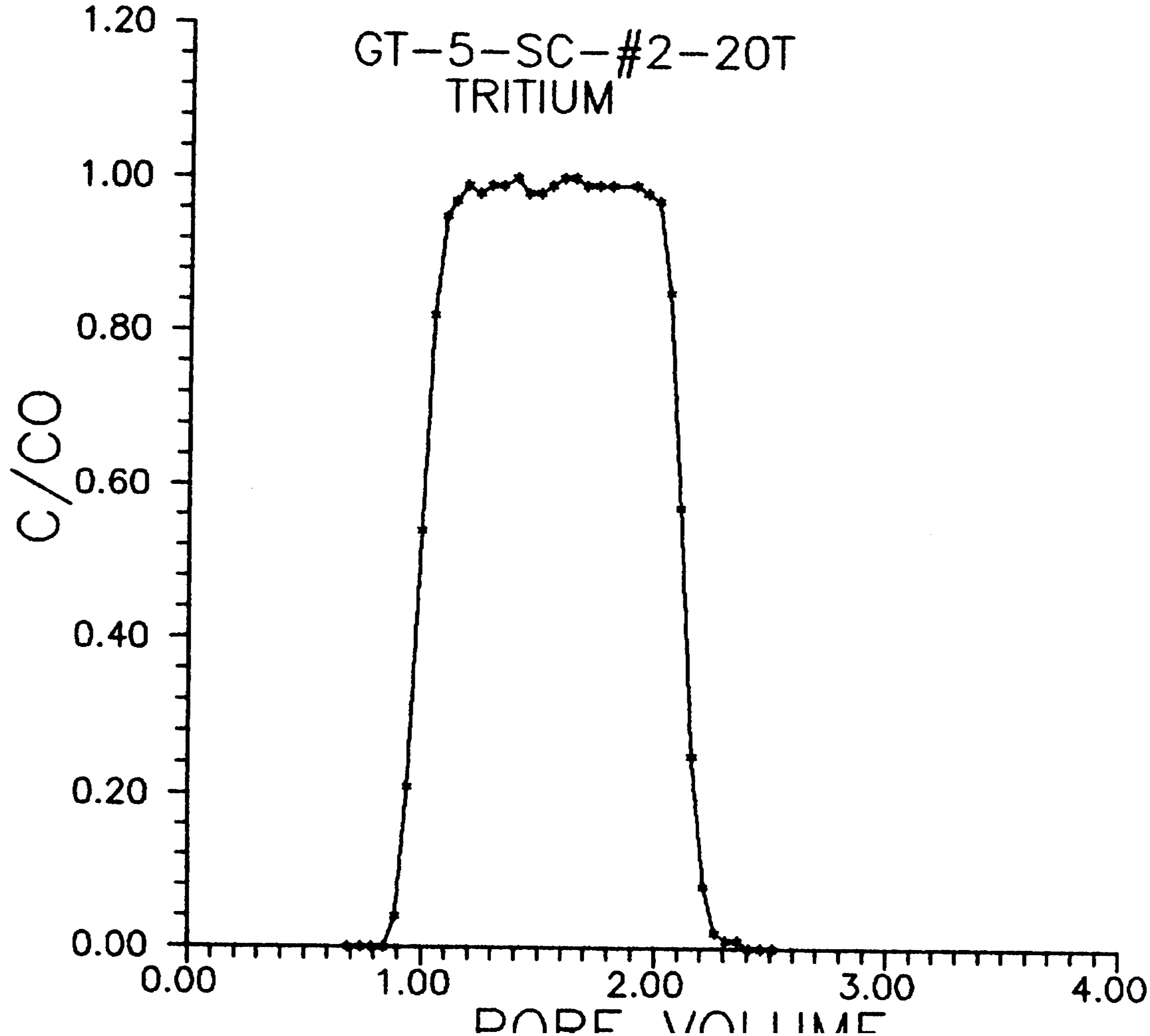
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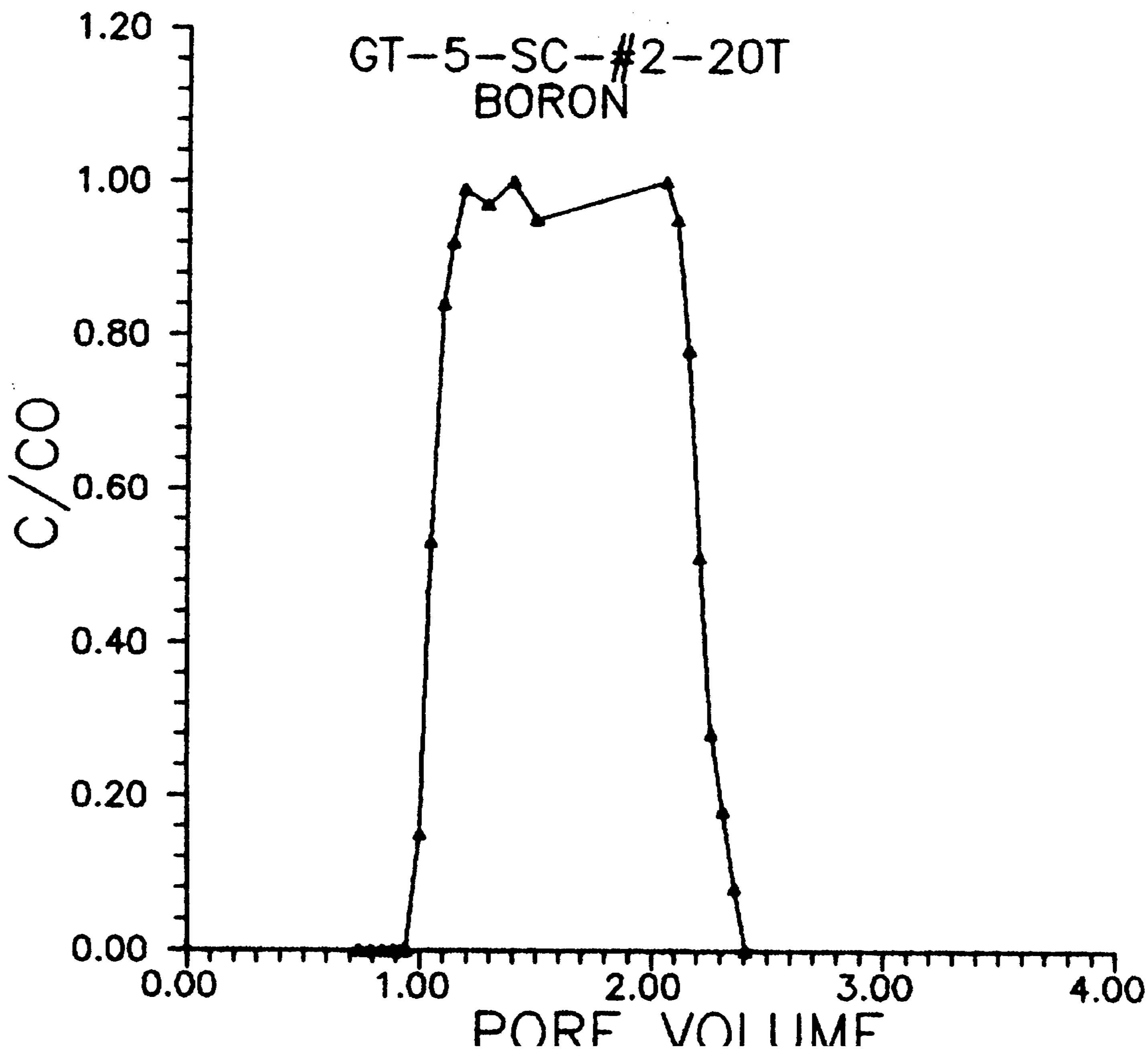
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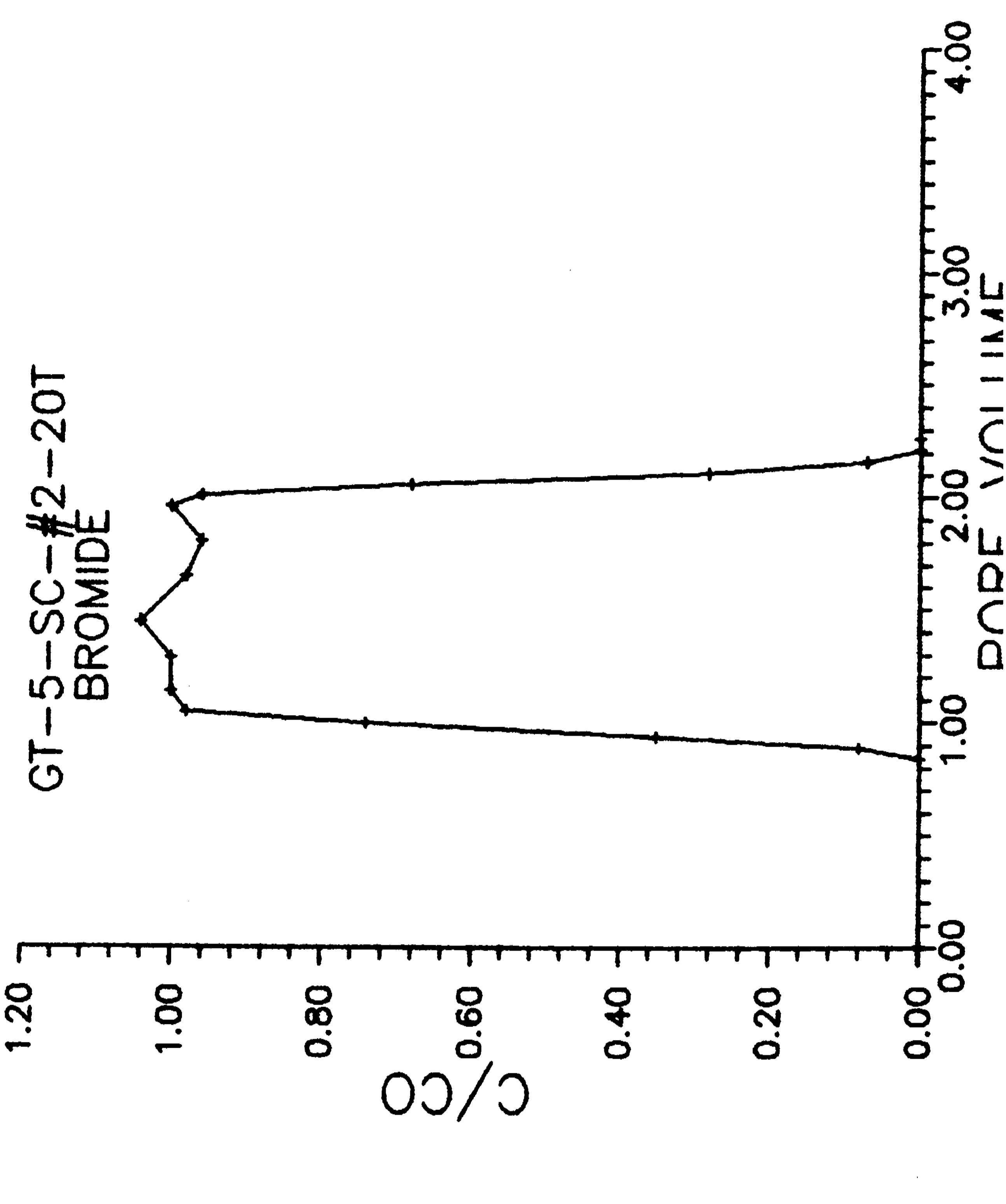
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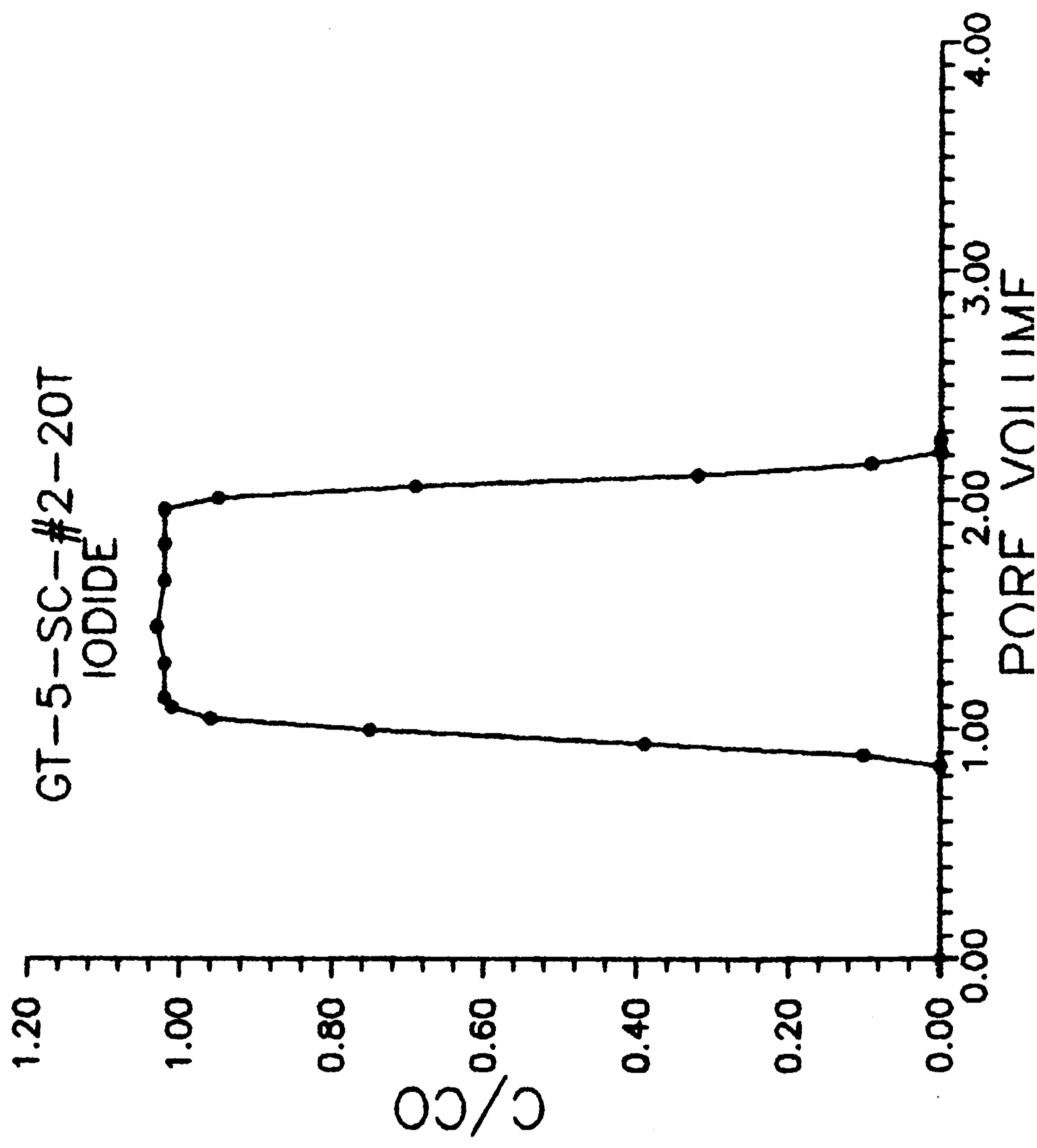
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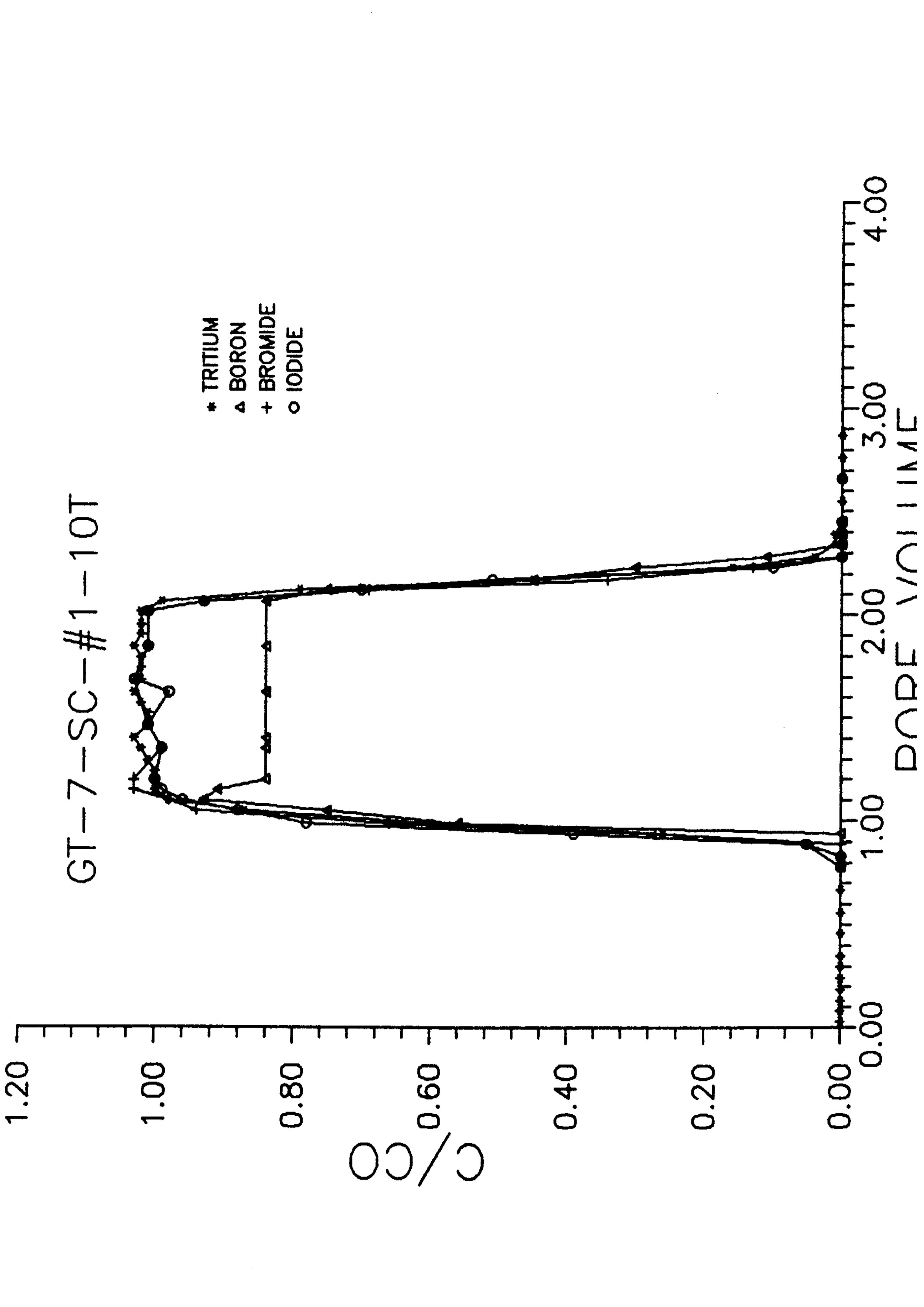
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IODIDE
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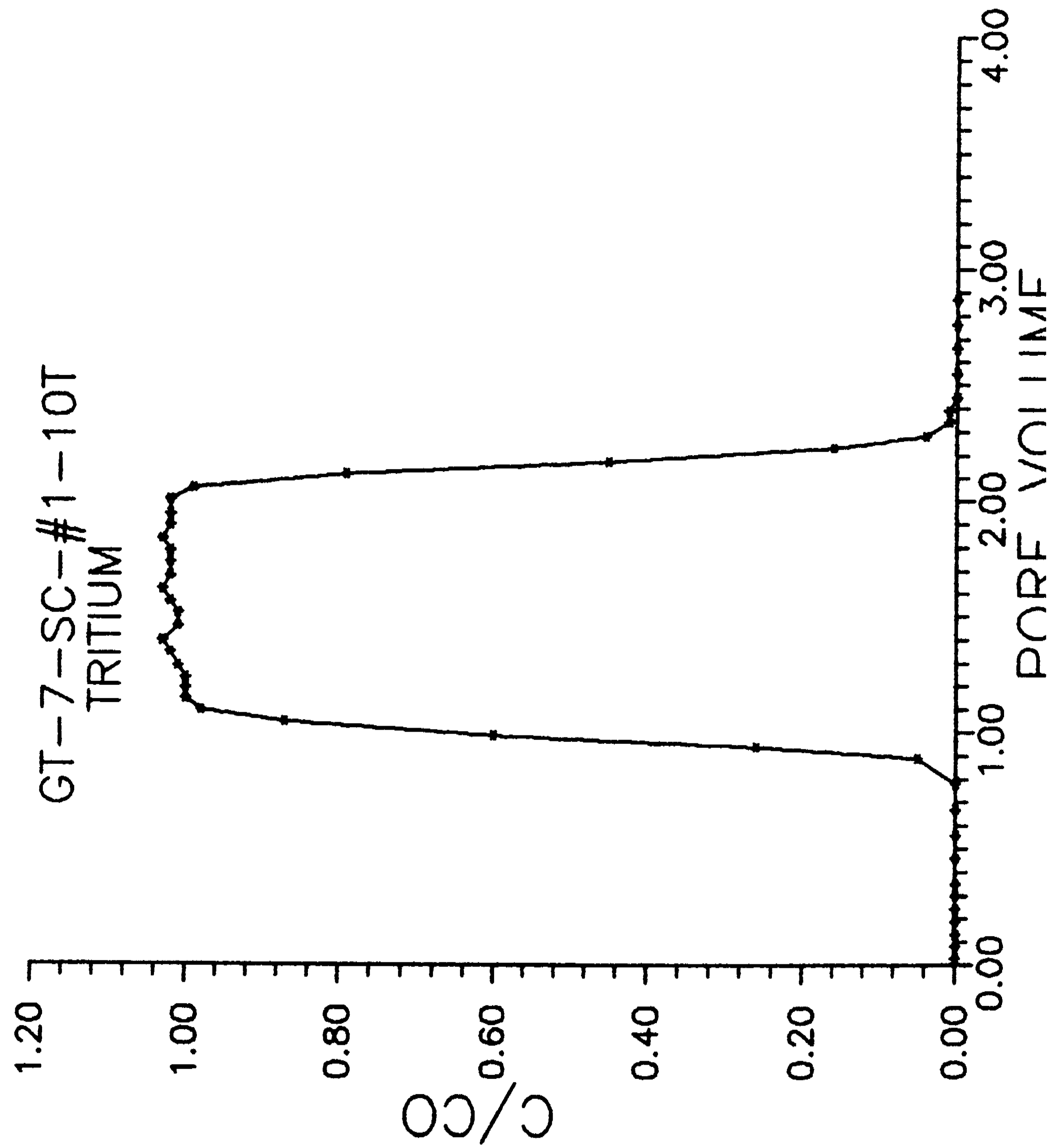
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C/CO
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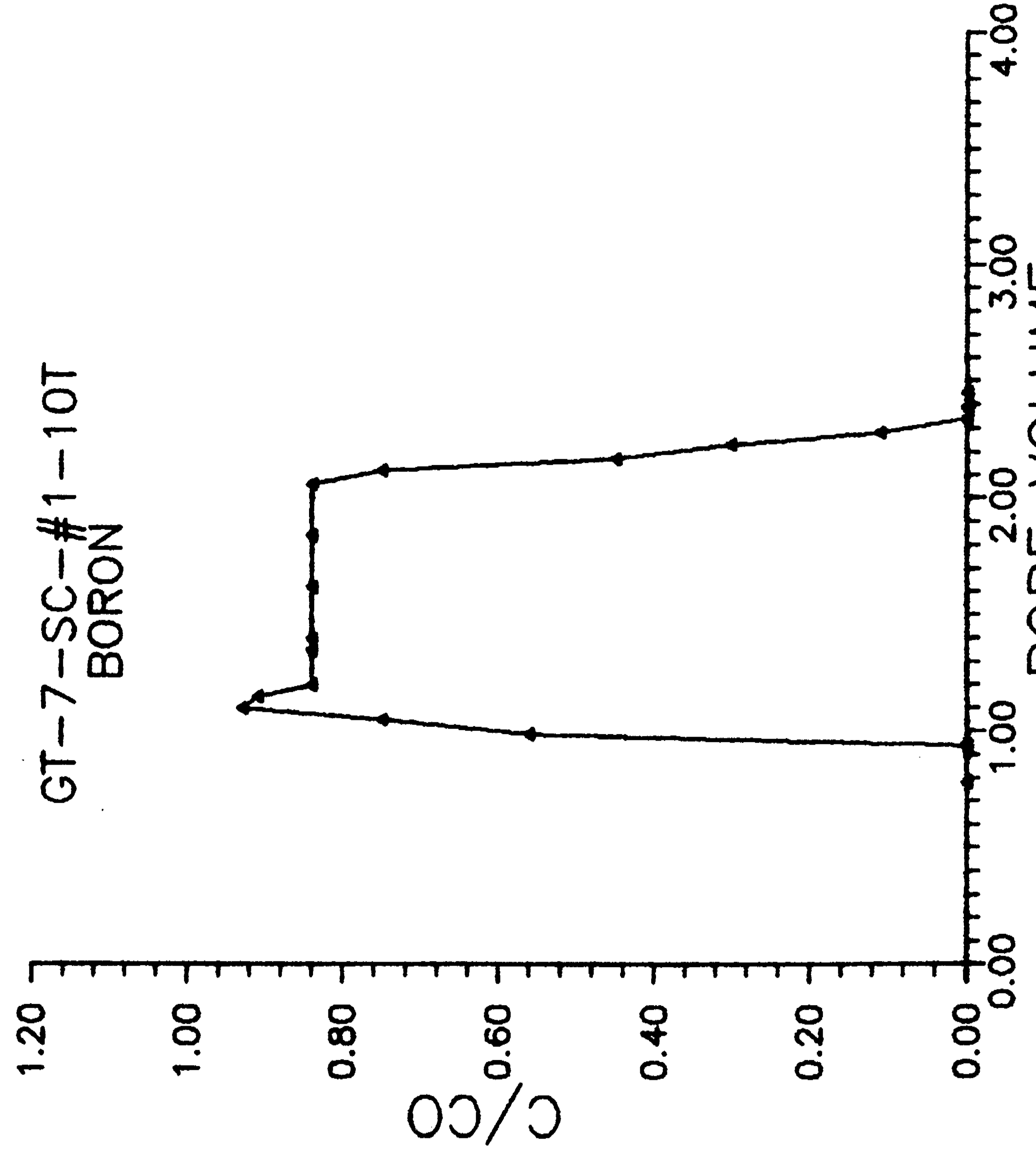
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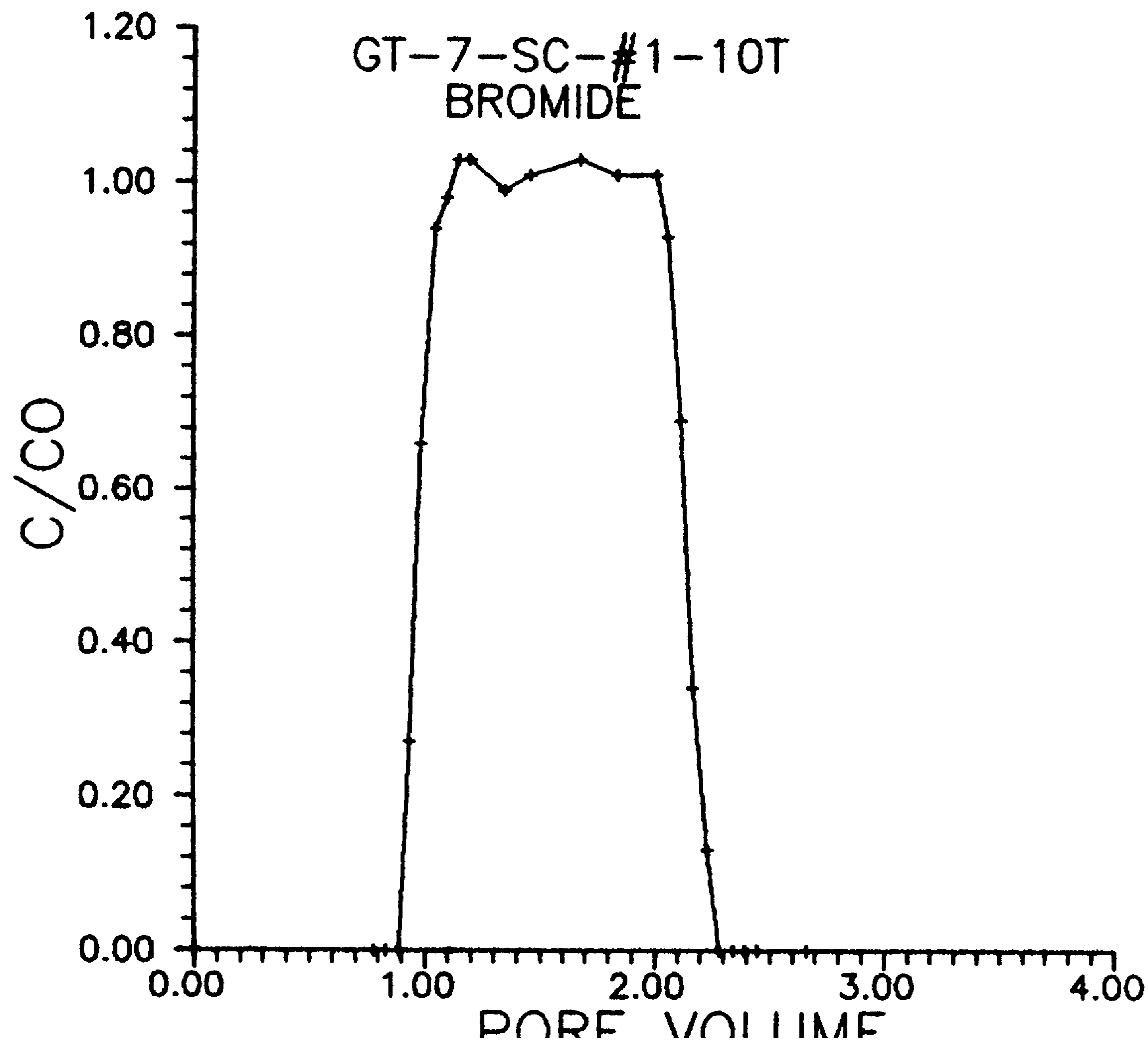
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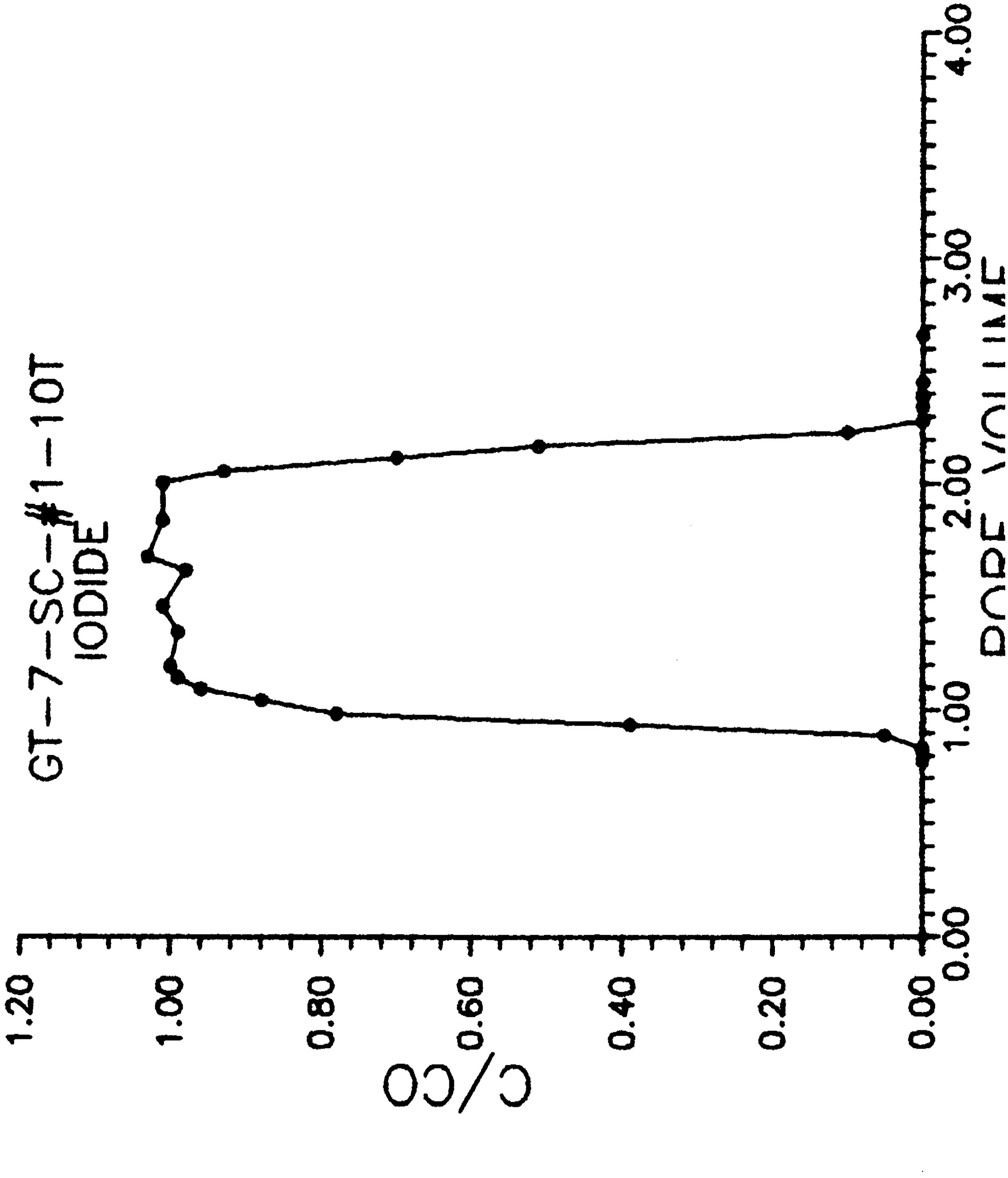
PORE VOLUME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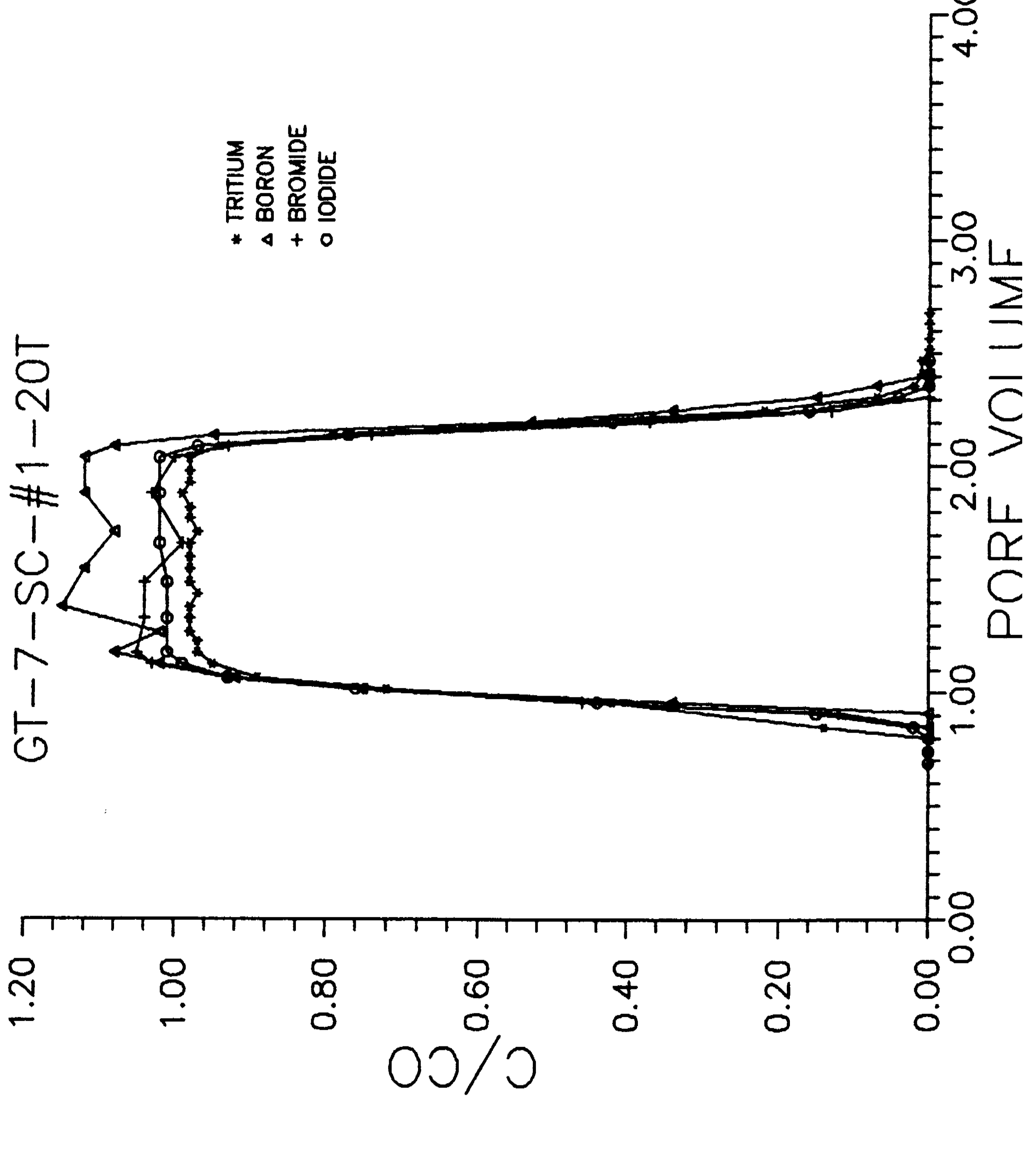
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Δ BORON
+ BROMIDE
o IODIDE
C/CO
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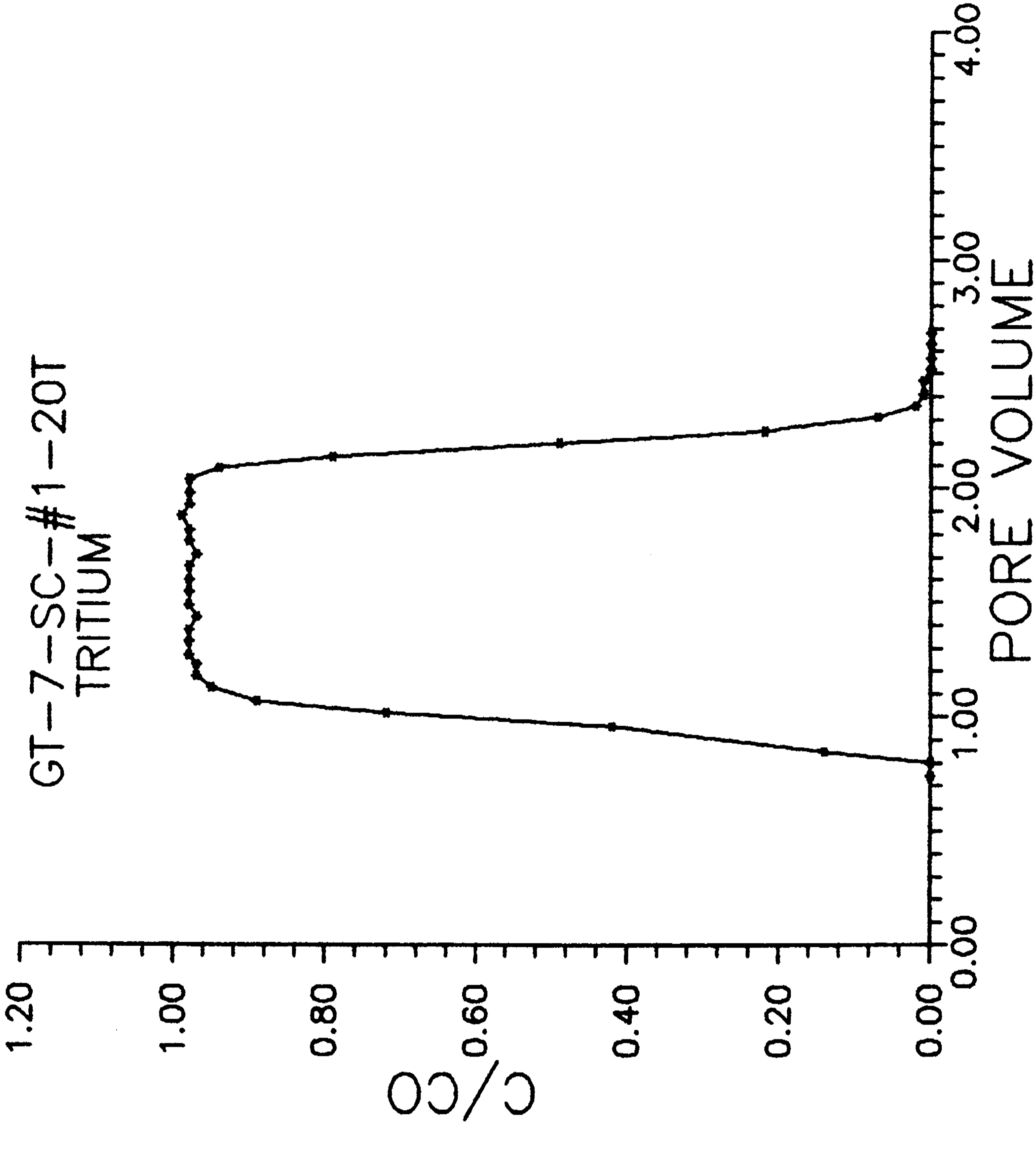
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C/CO
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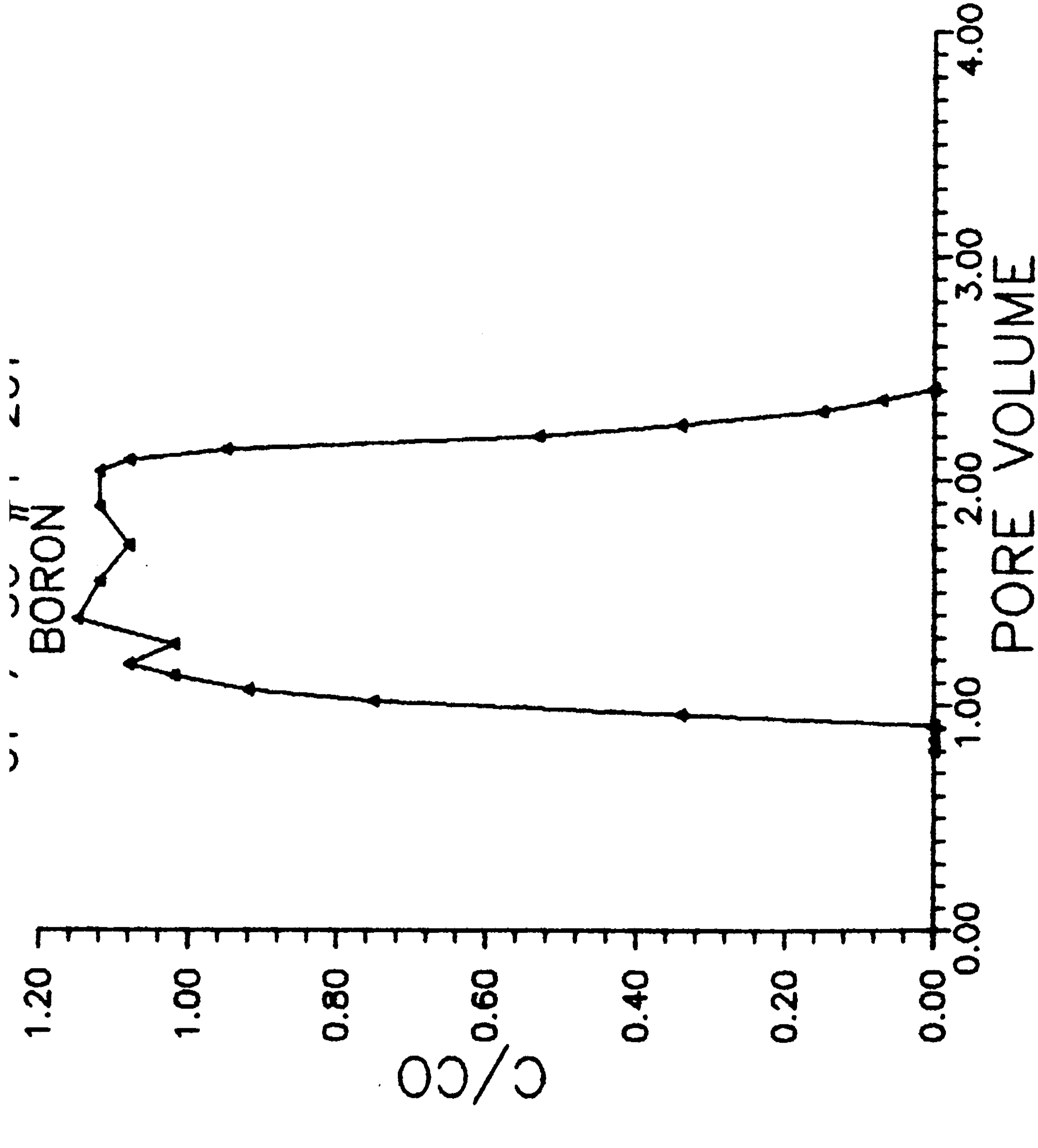

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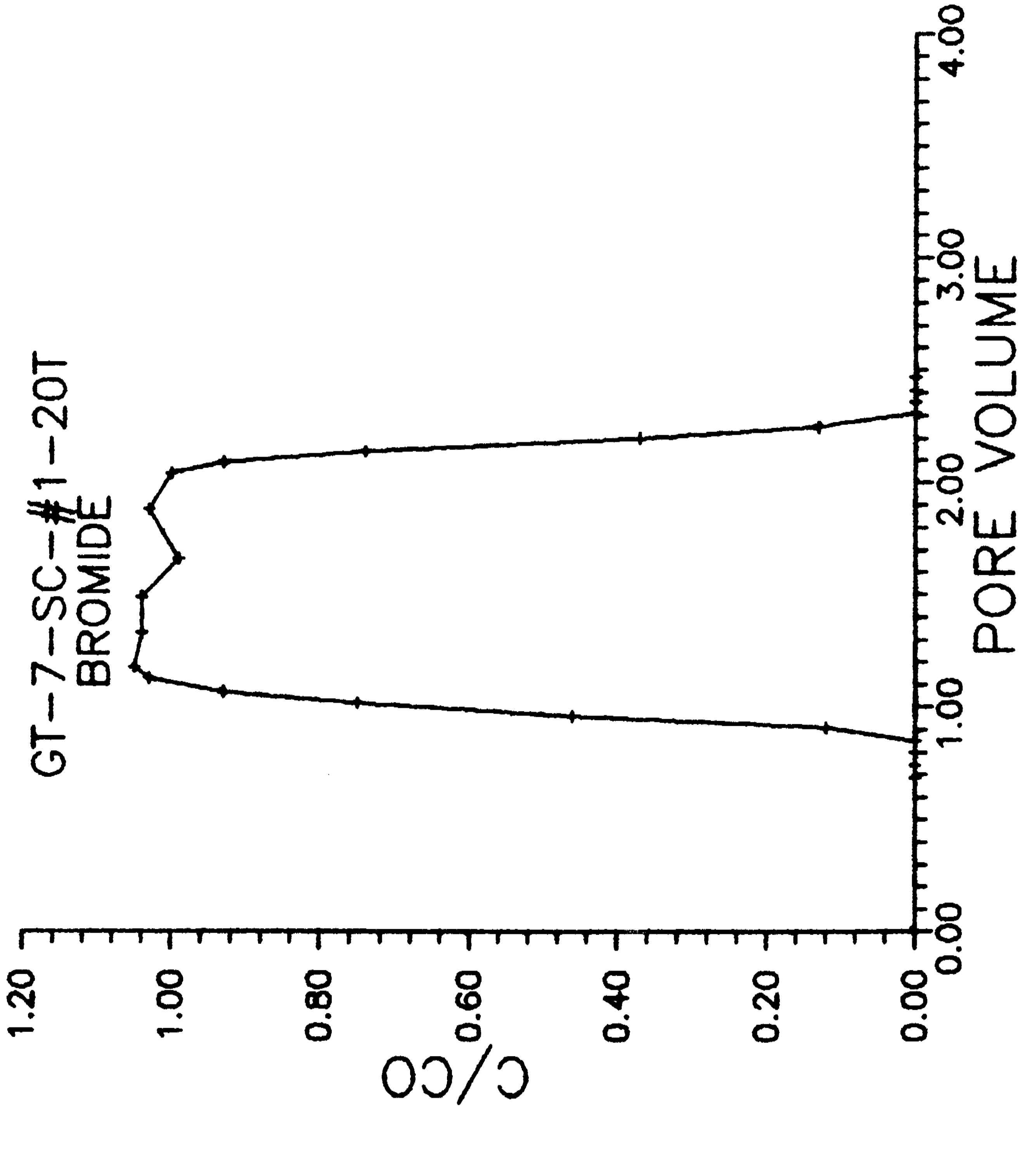

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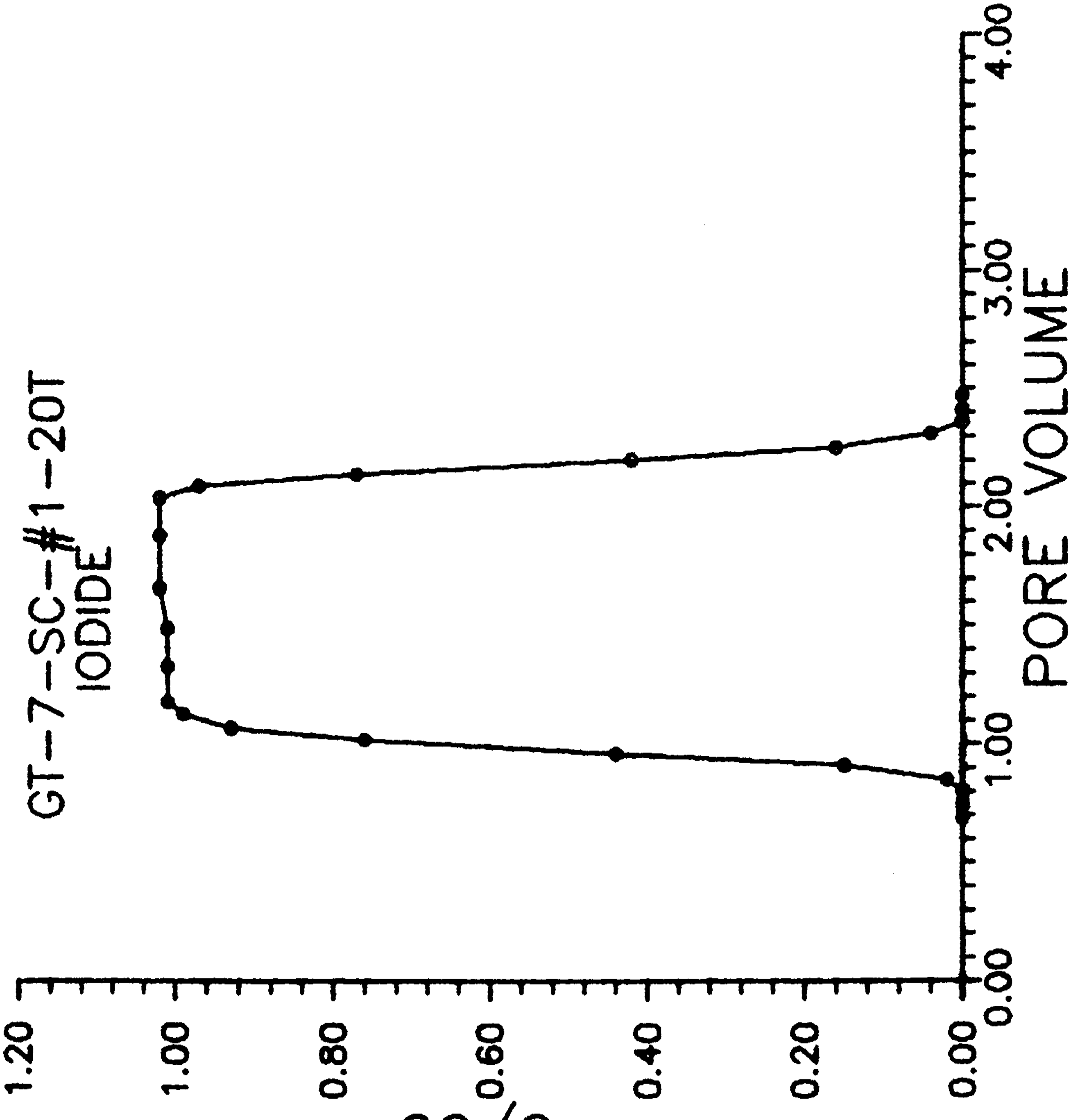
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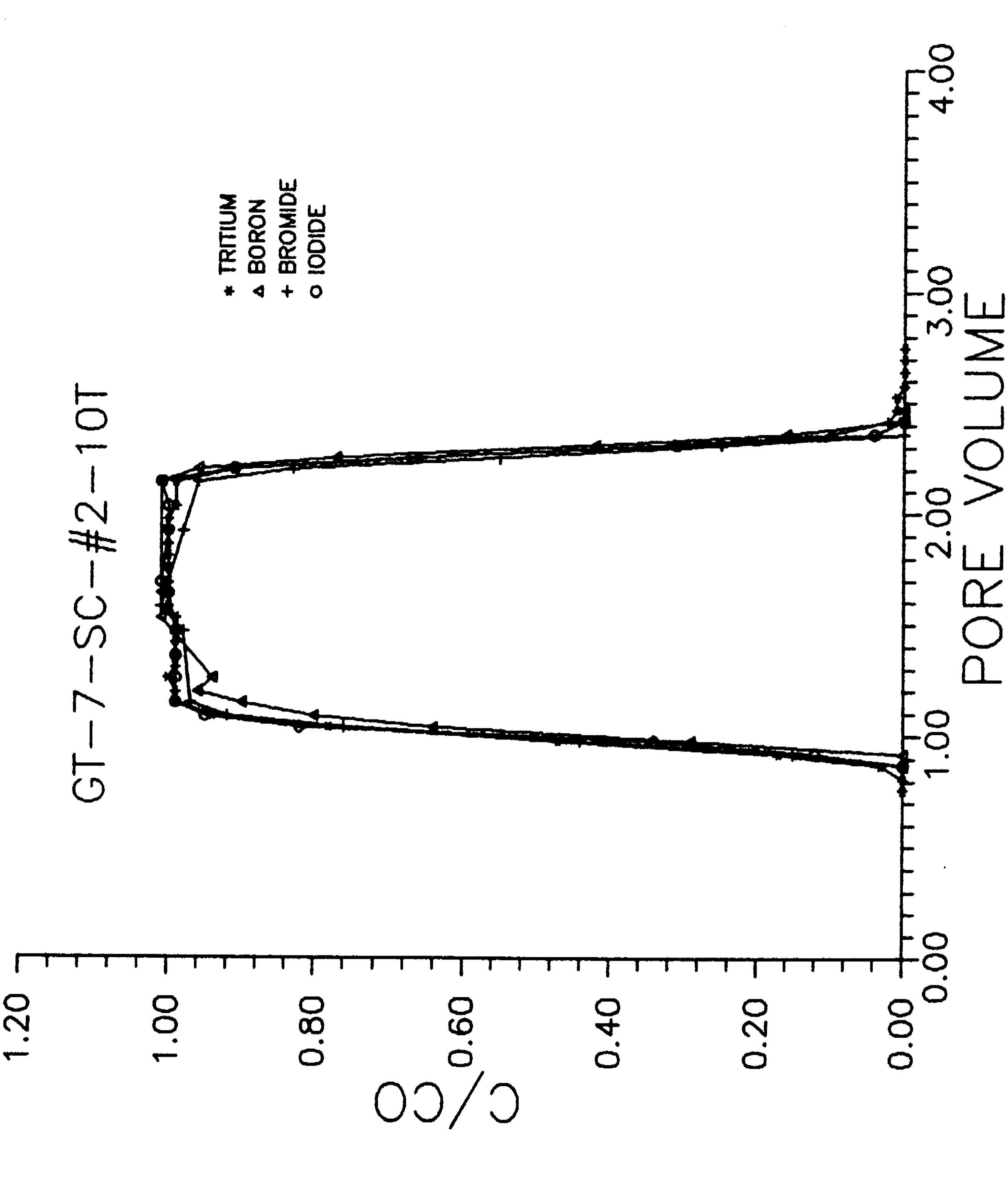
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o IODIDE
C/CO
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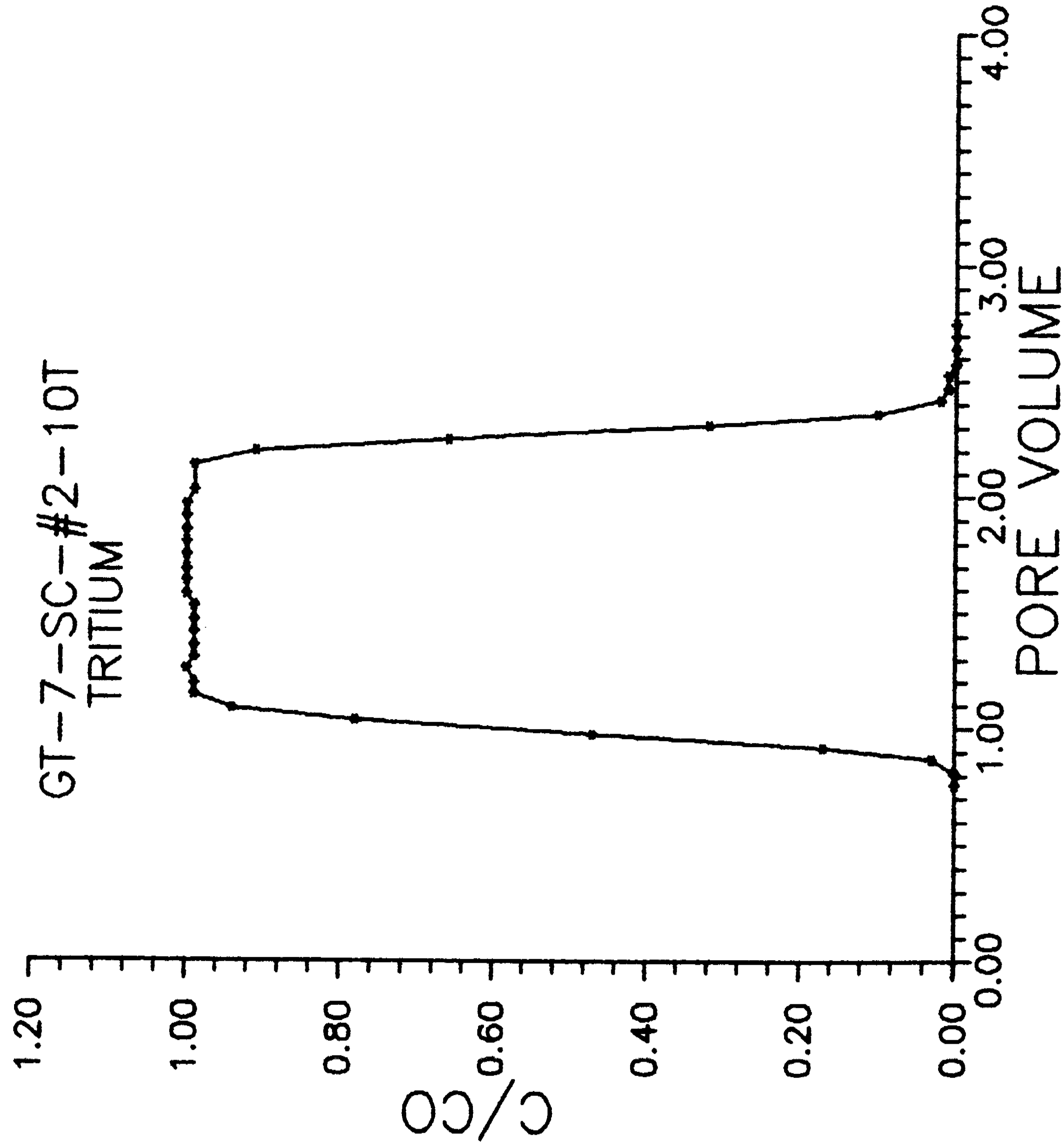
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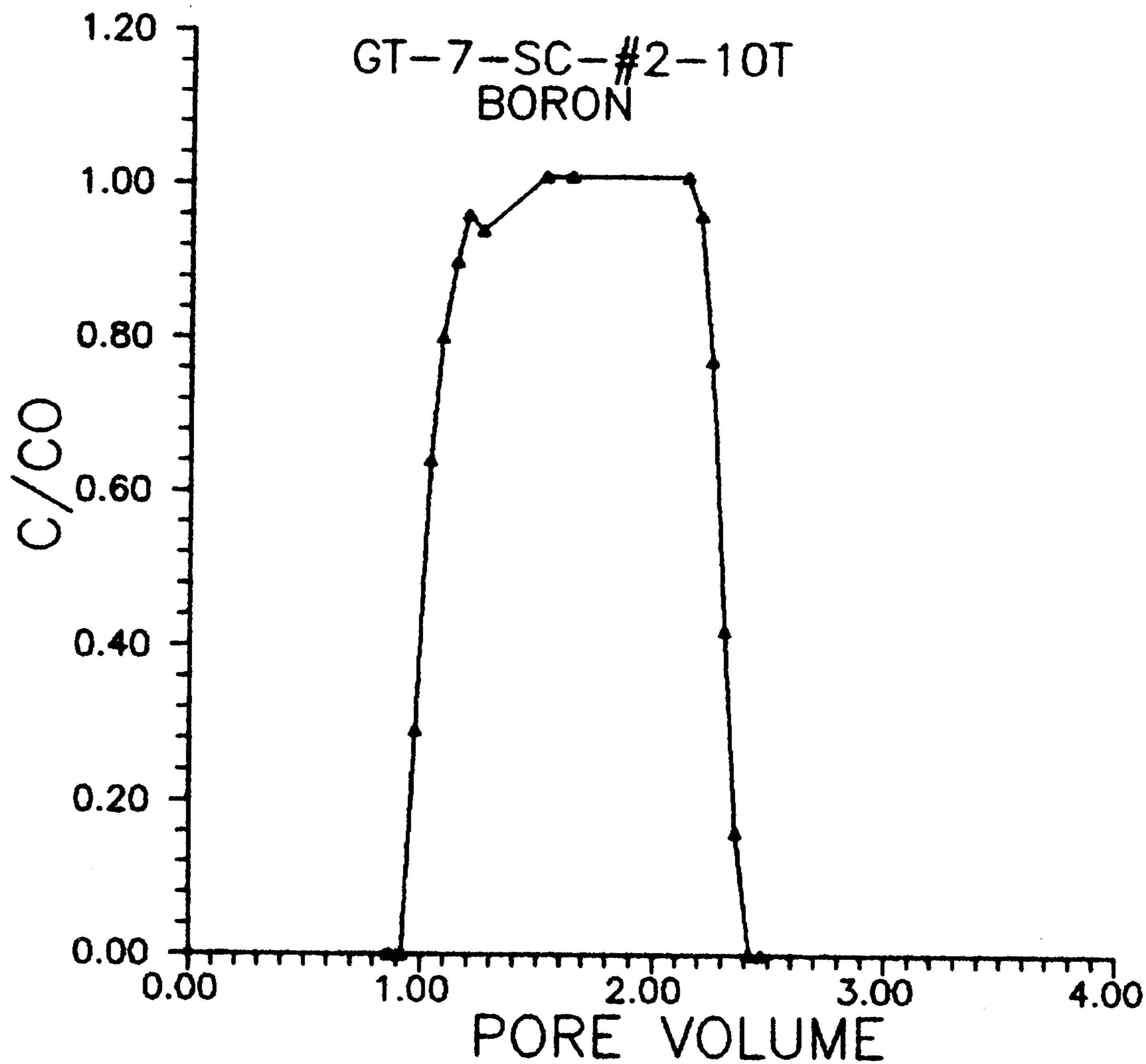
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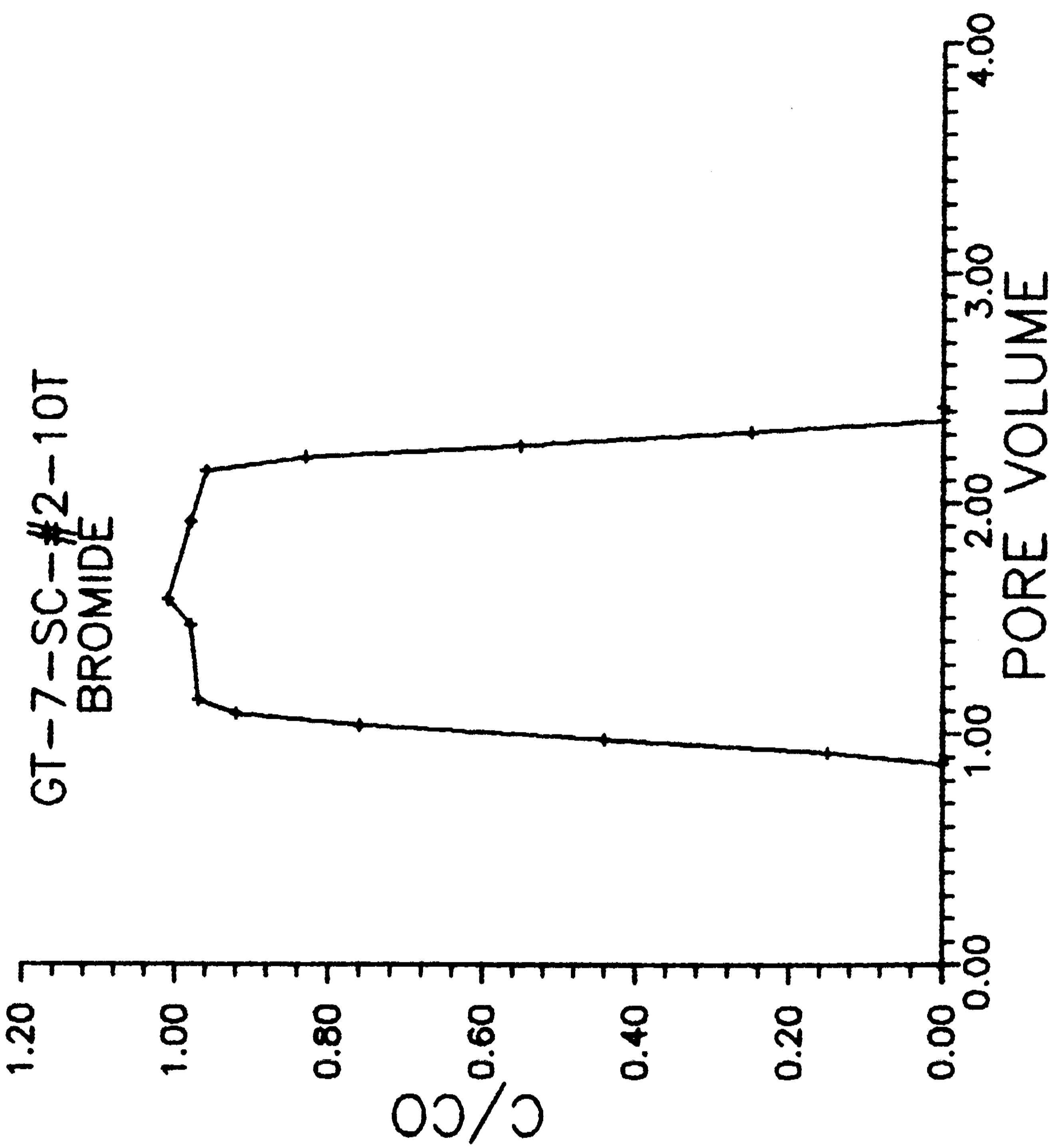
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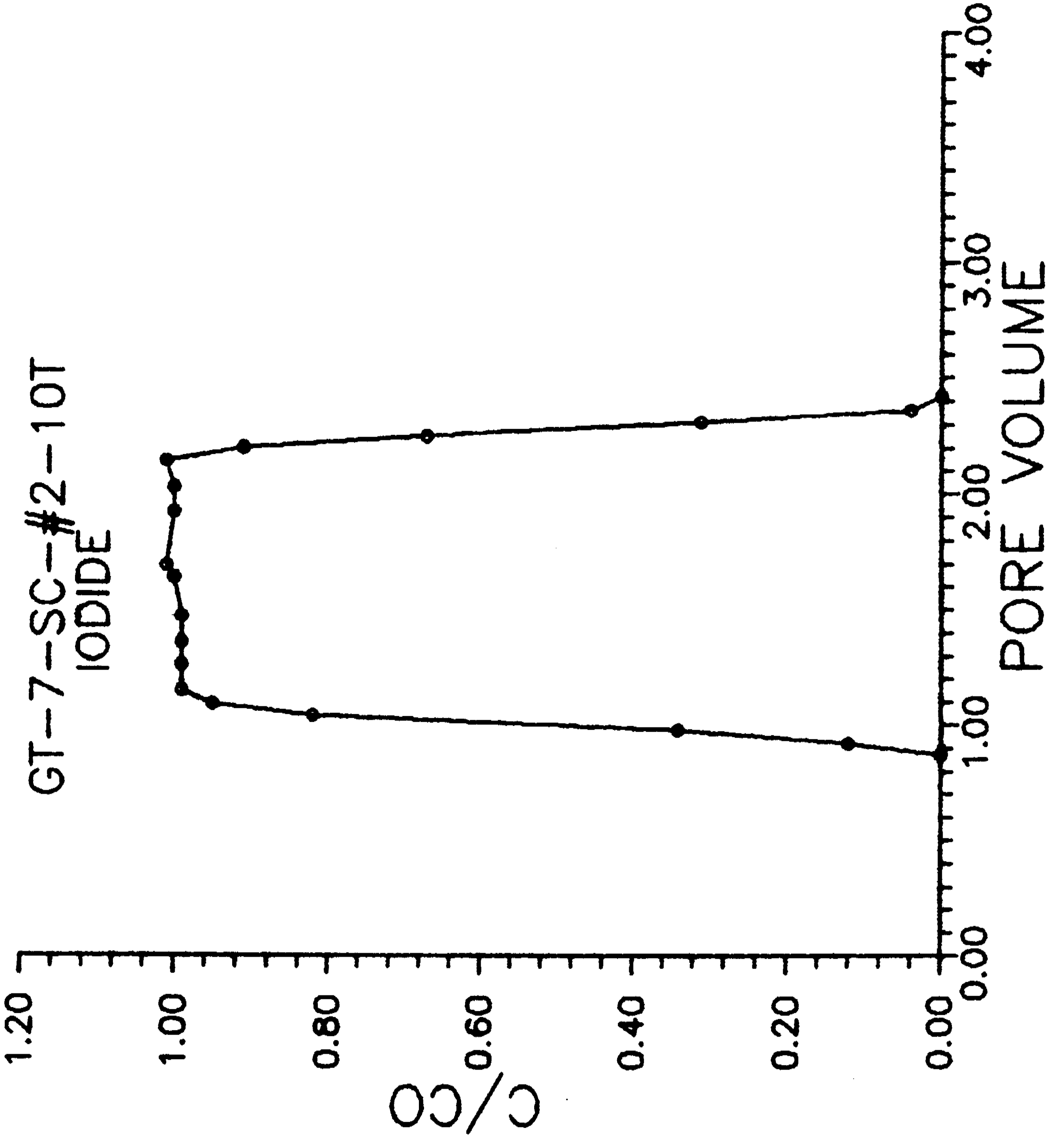
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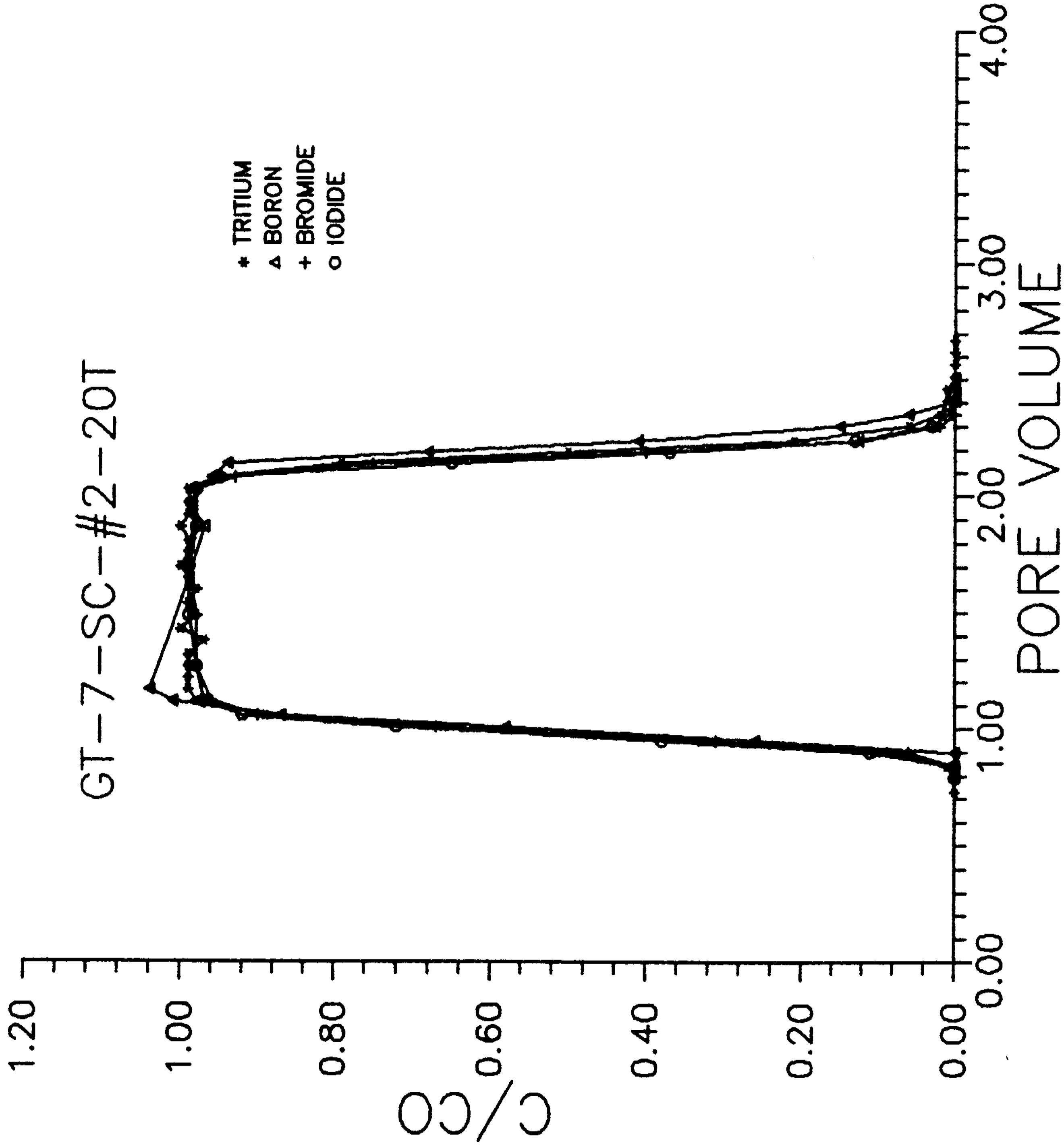
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C/CO
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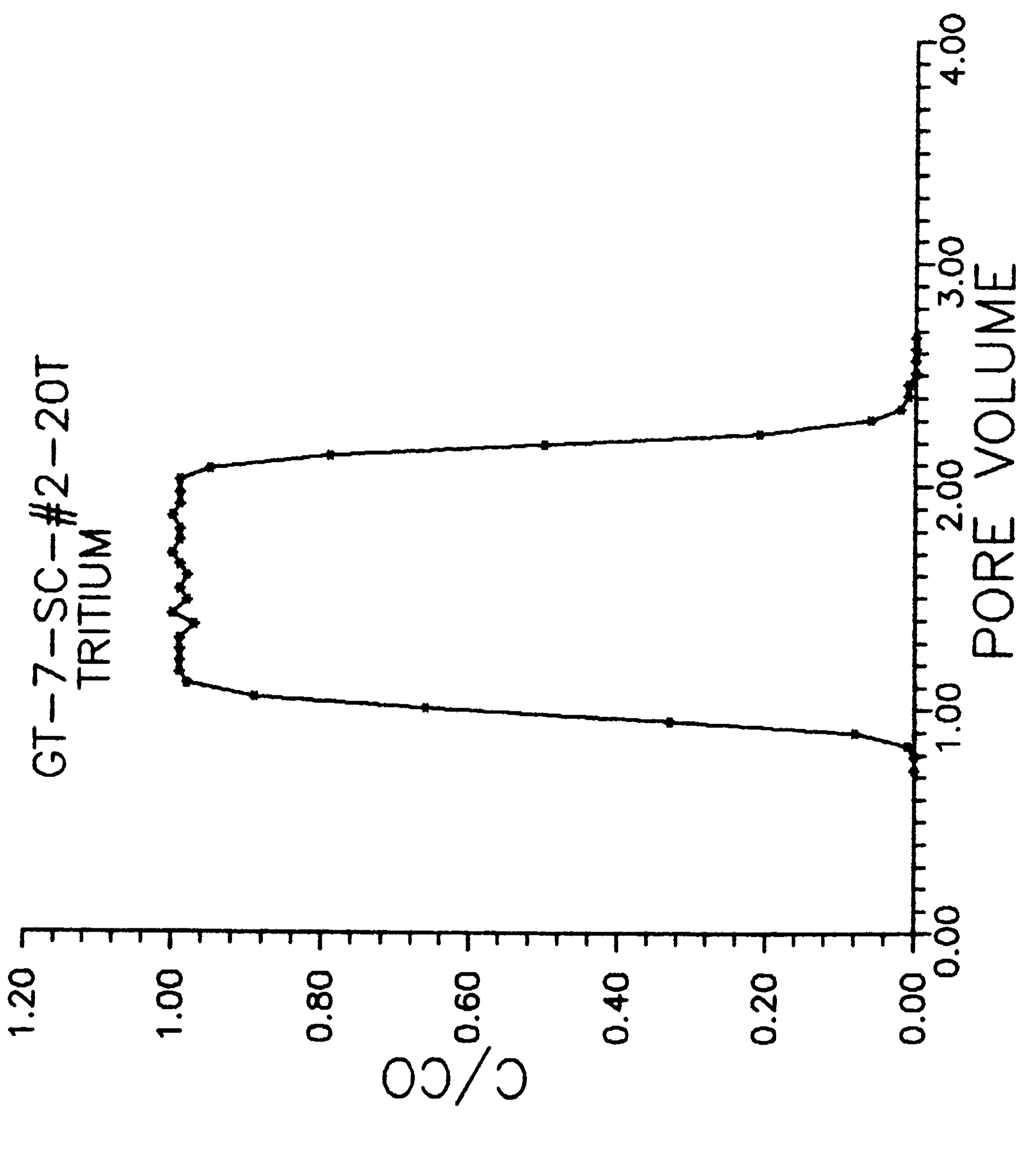

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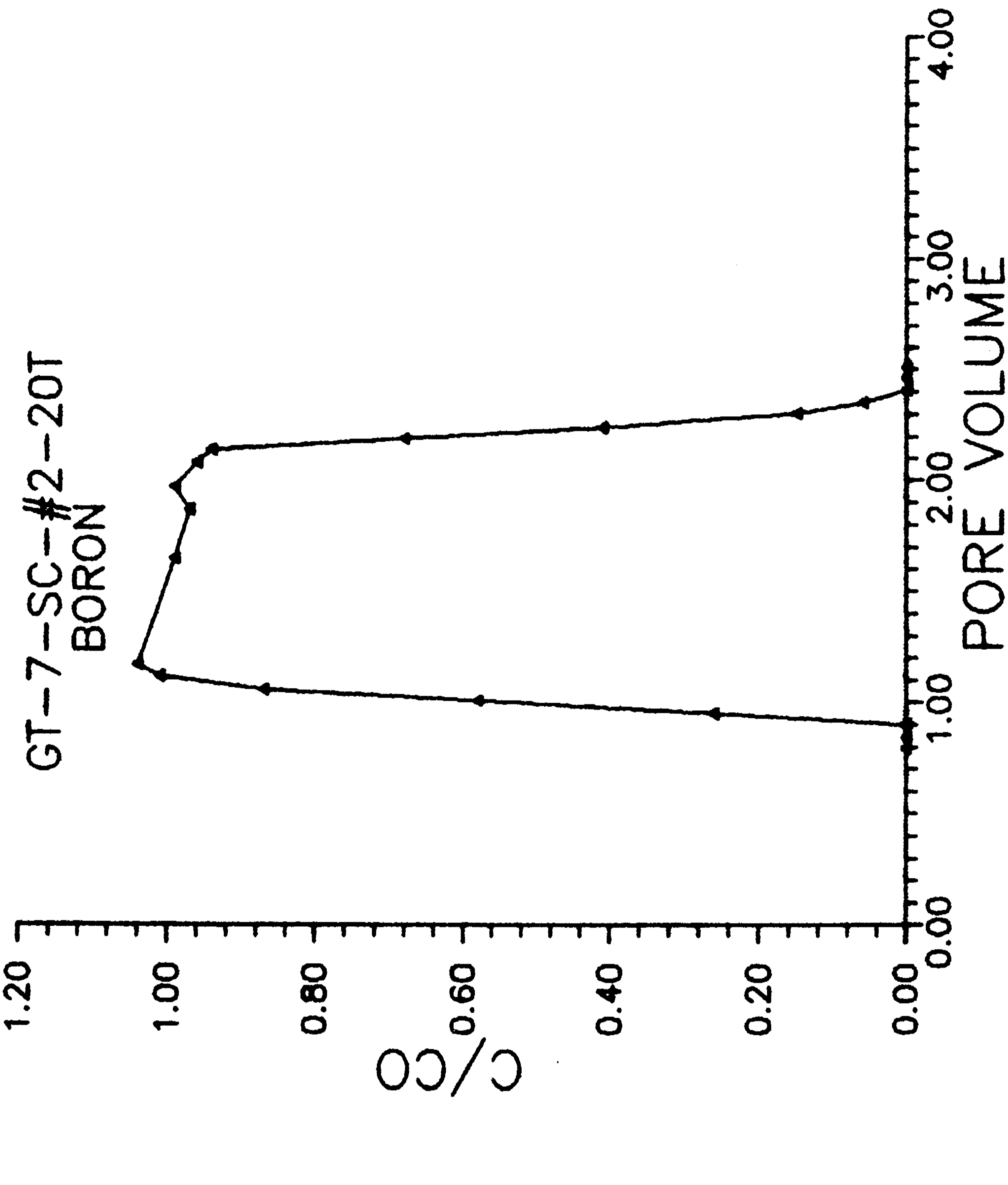
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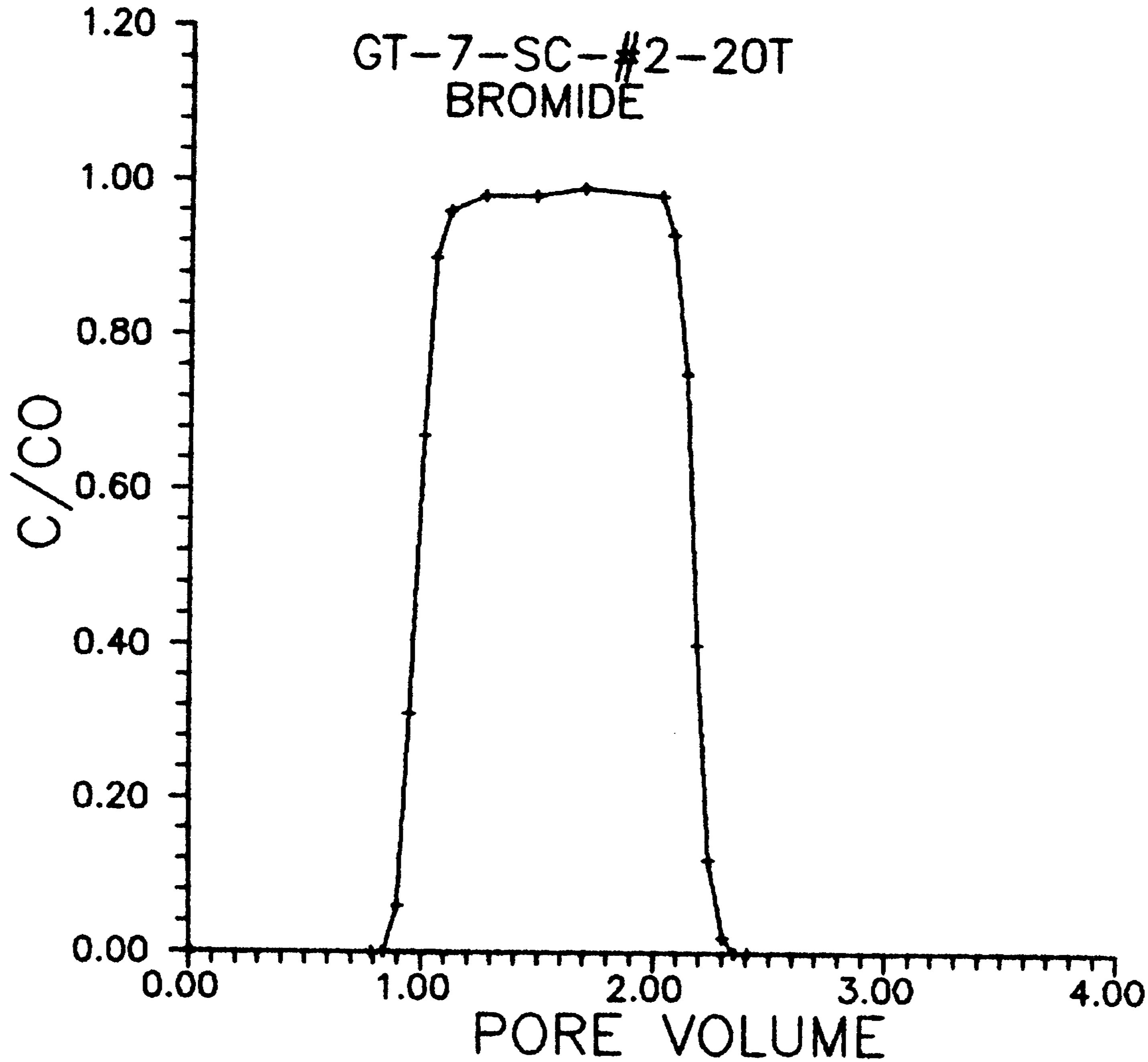
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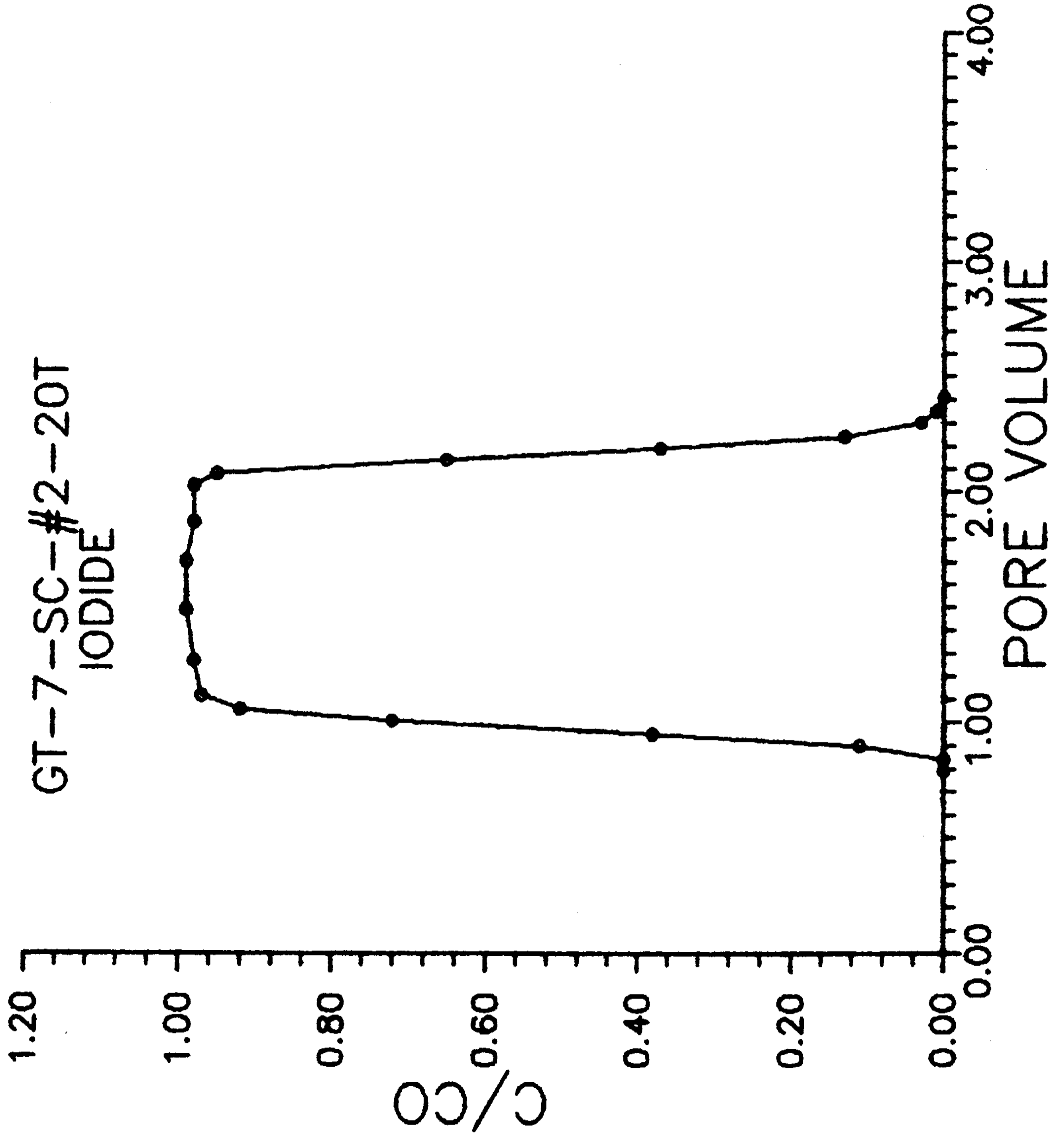
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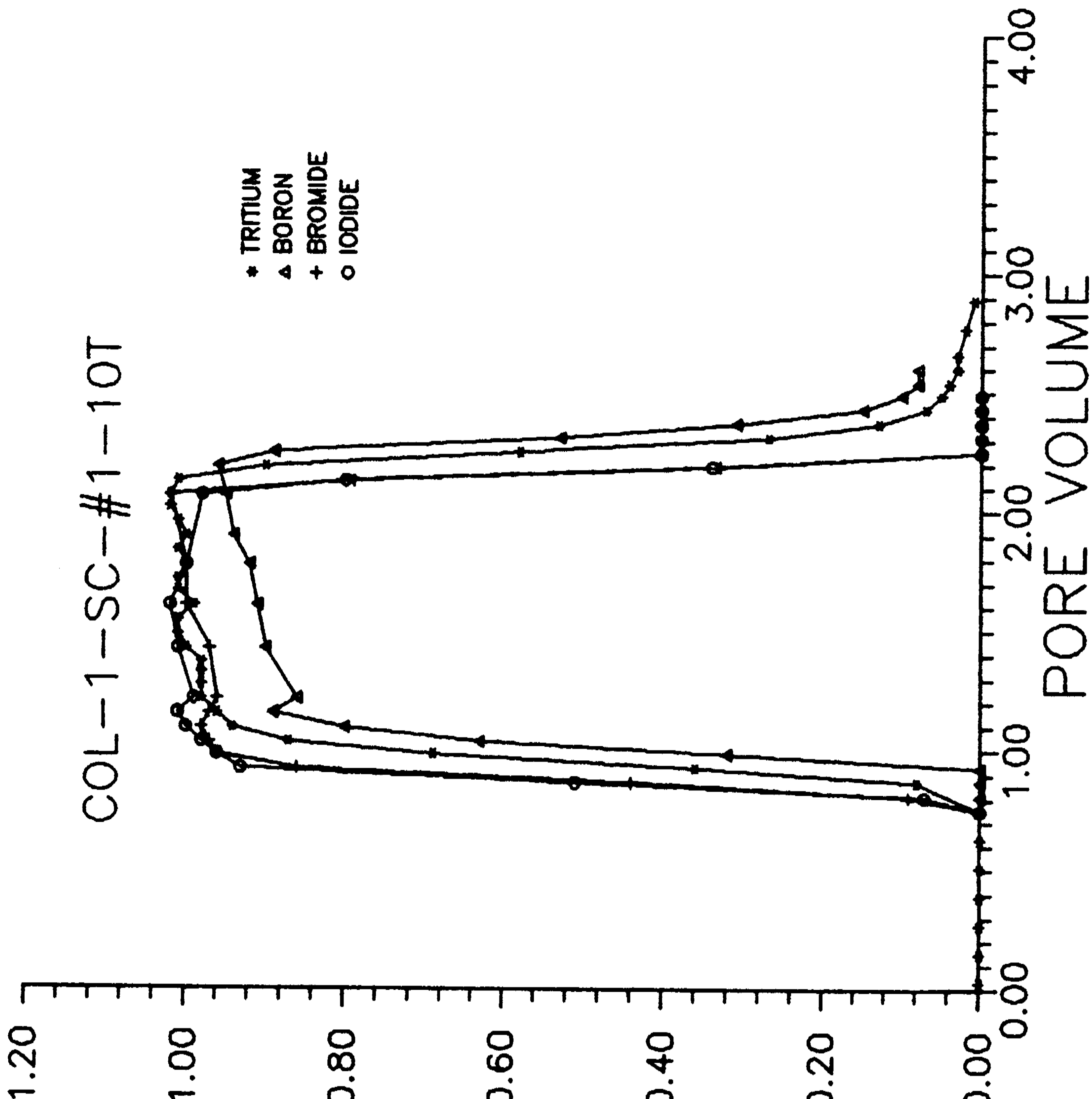
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o IODIDE
C/CO
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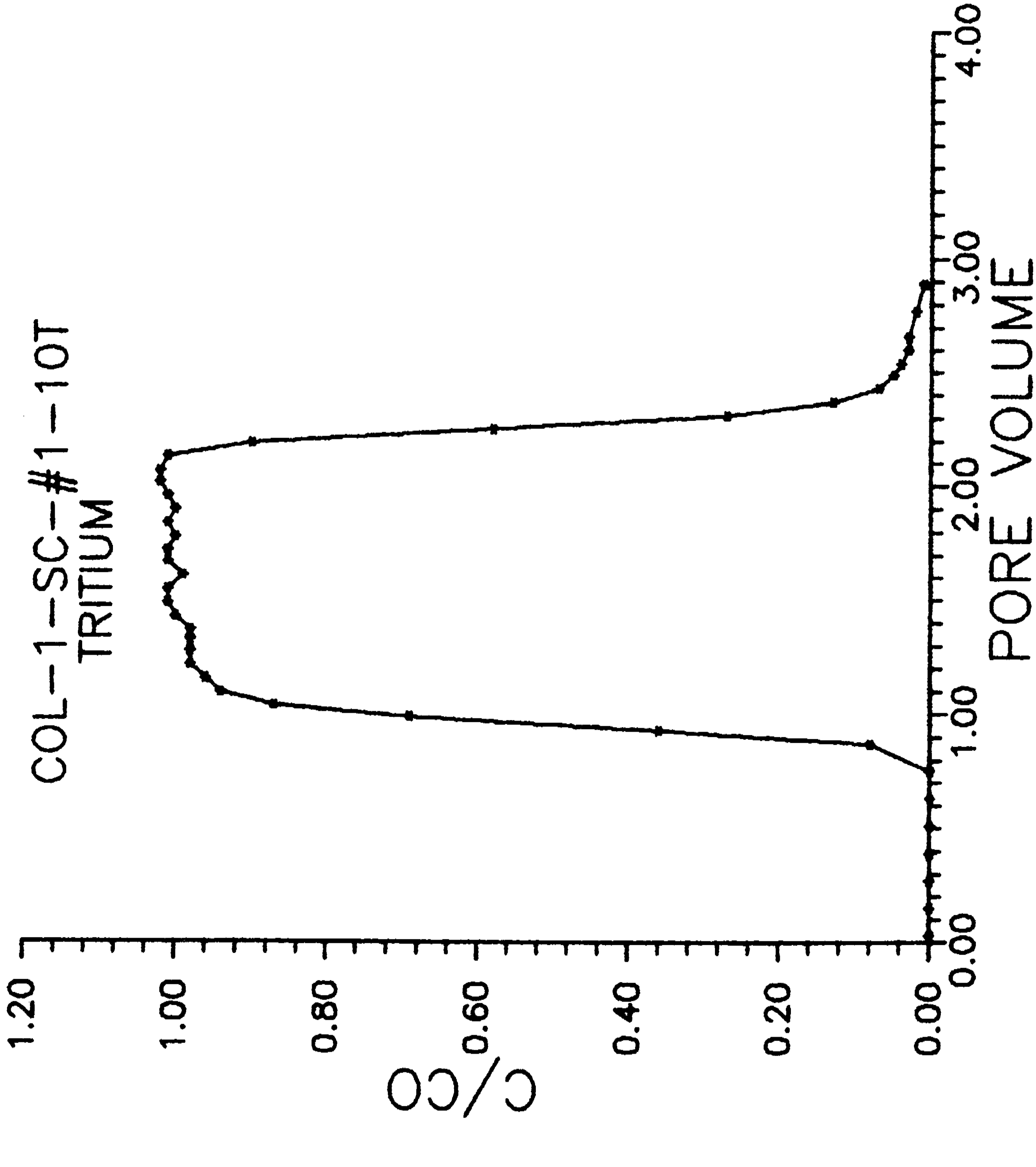
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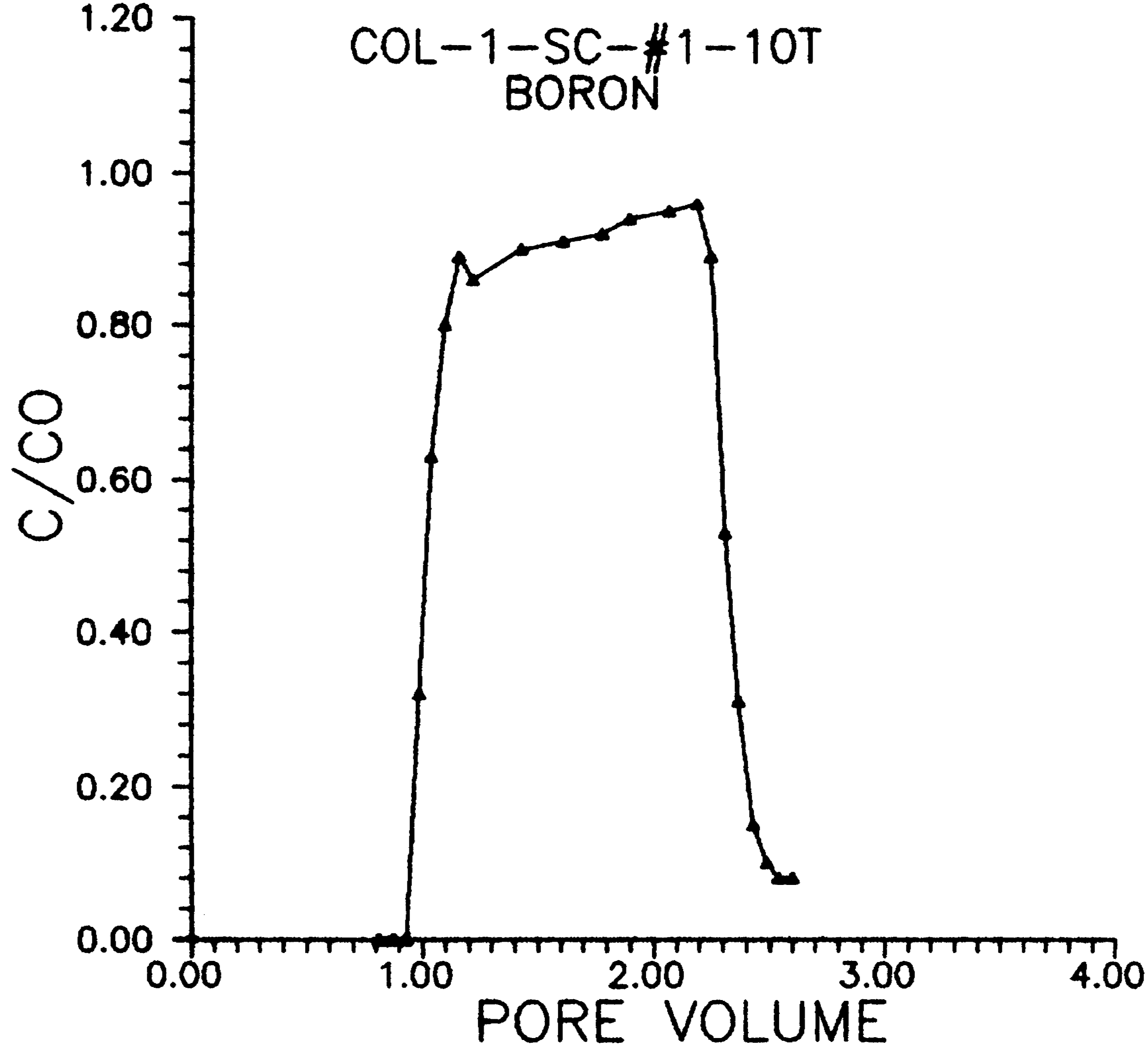
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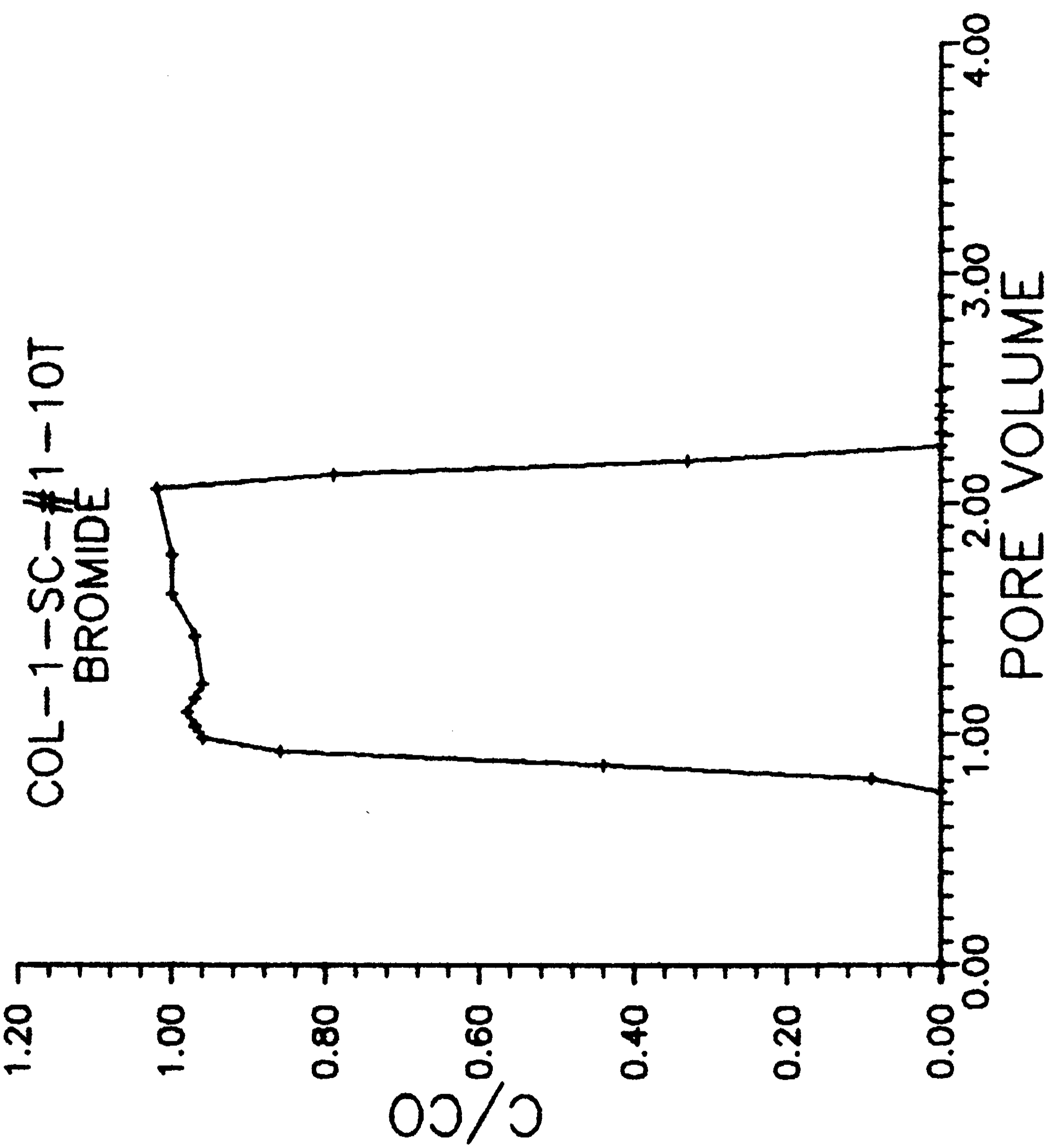
PORE VOLUME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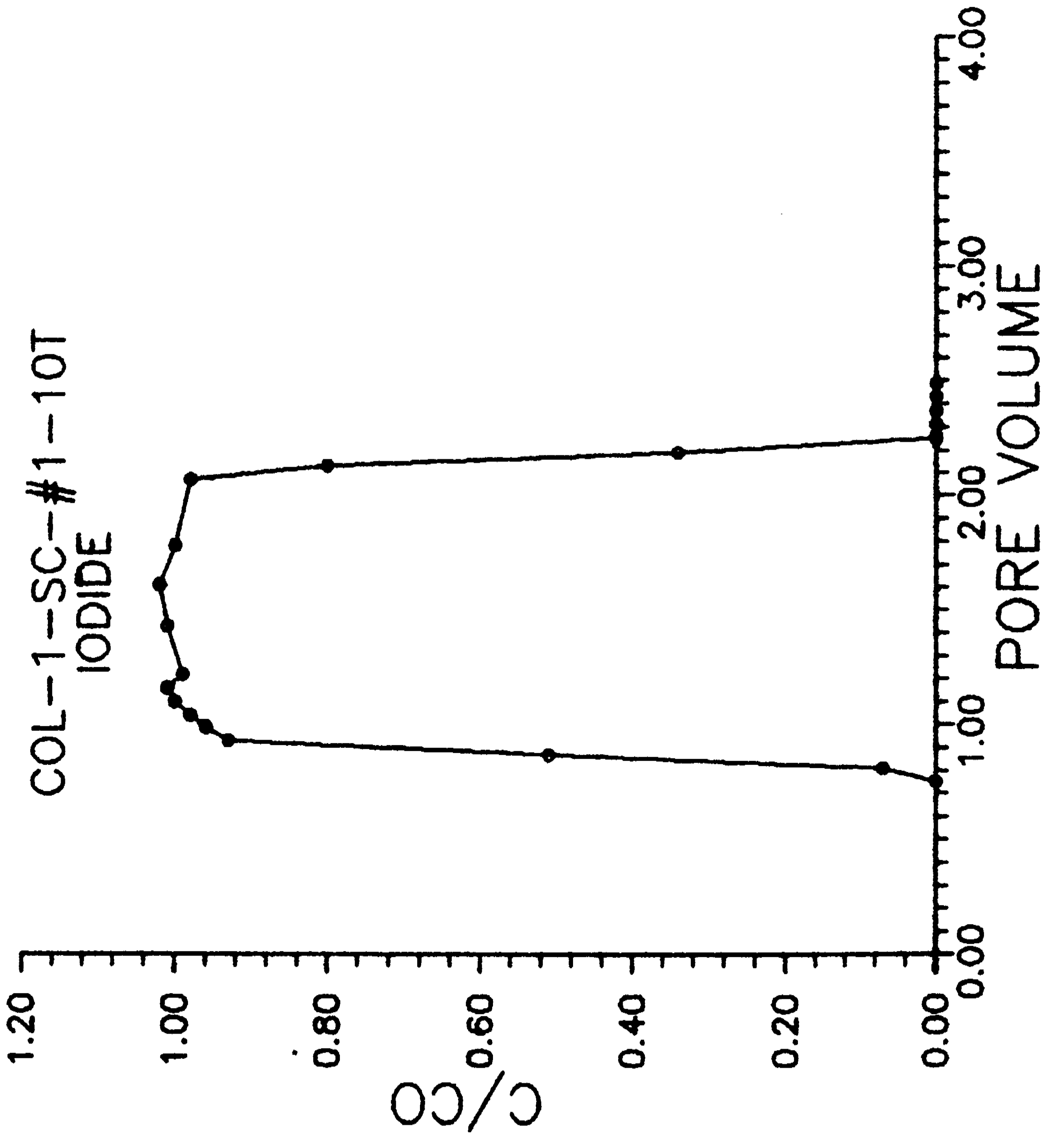

COL—1—SC—#1—10T
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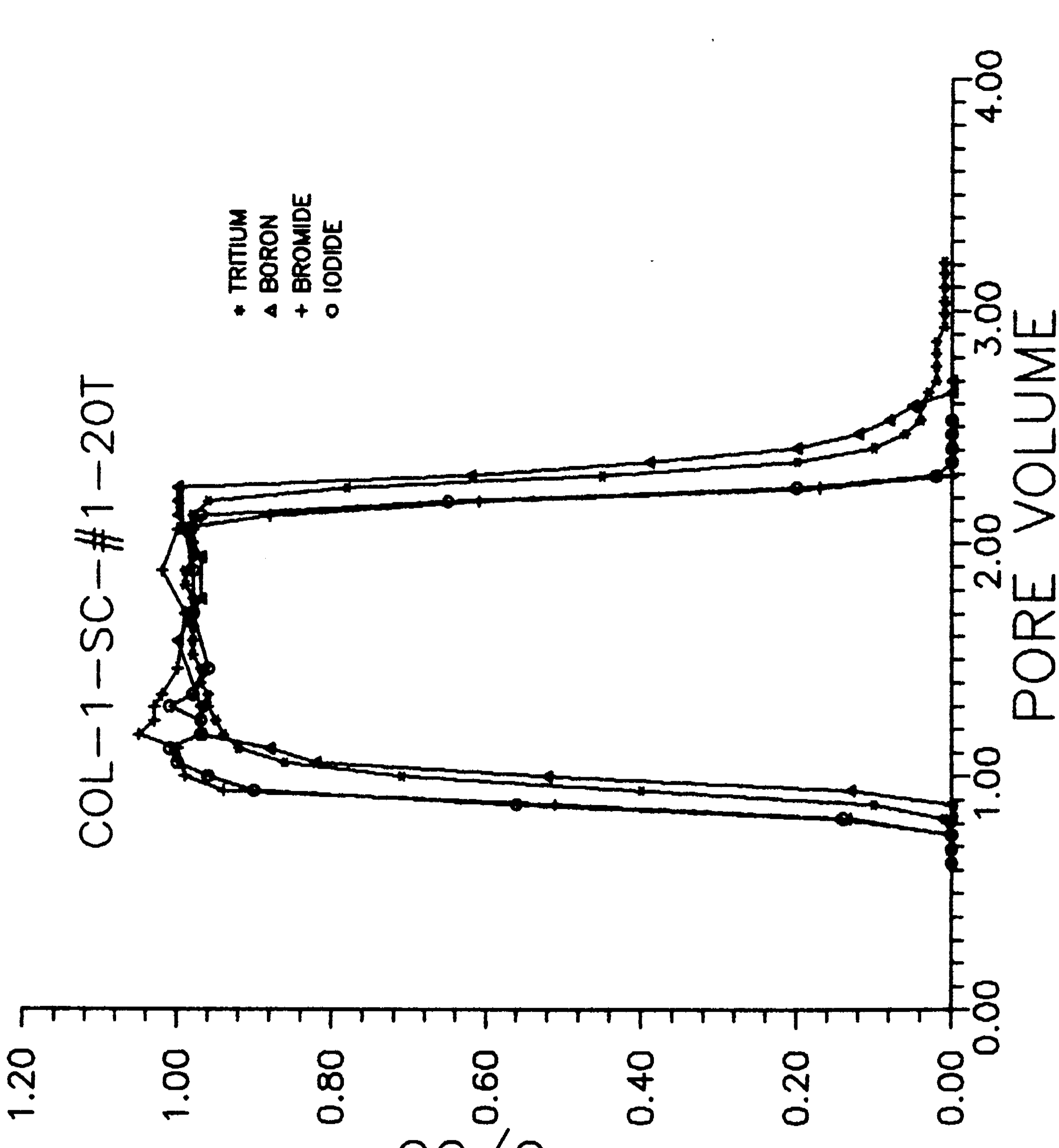
PORE VOLUME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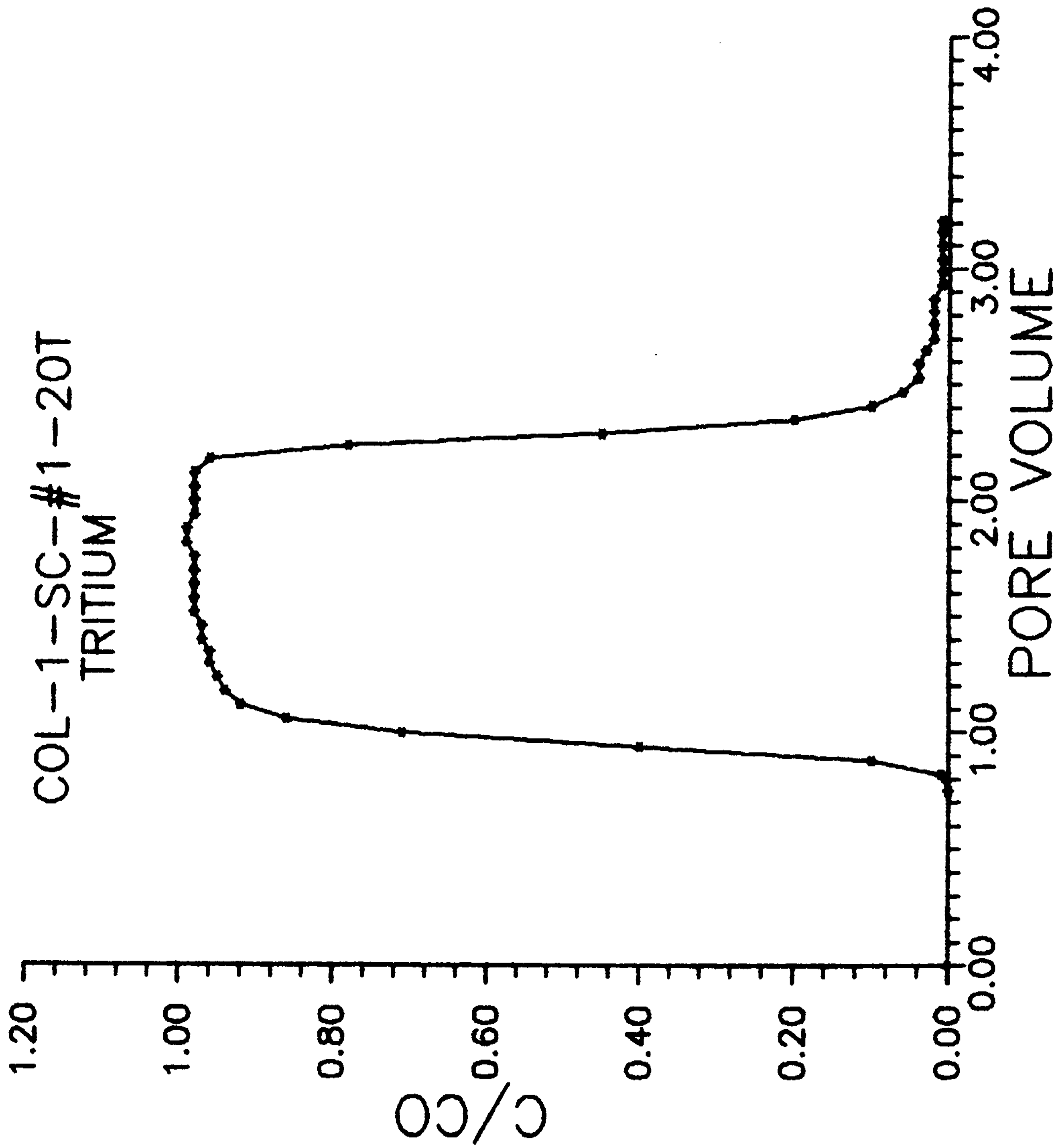
PORE VOLUME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C/CO
PORE VOLUME
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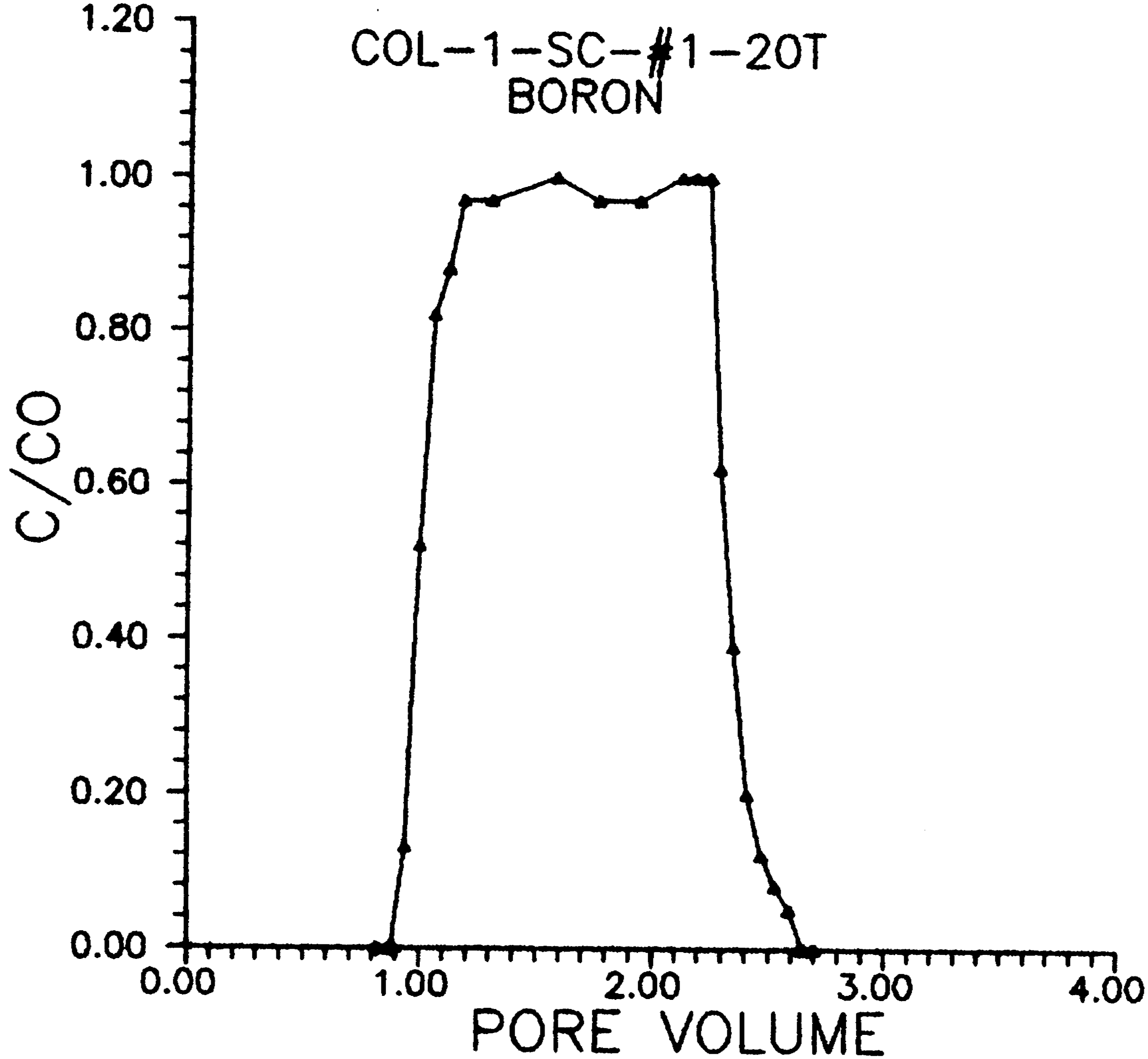
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C/CO
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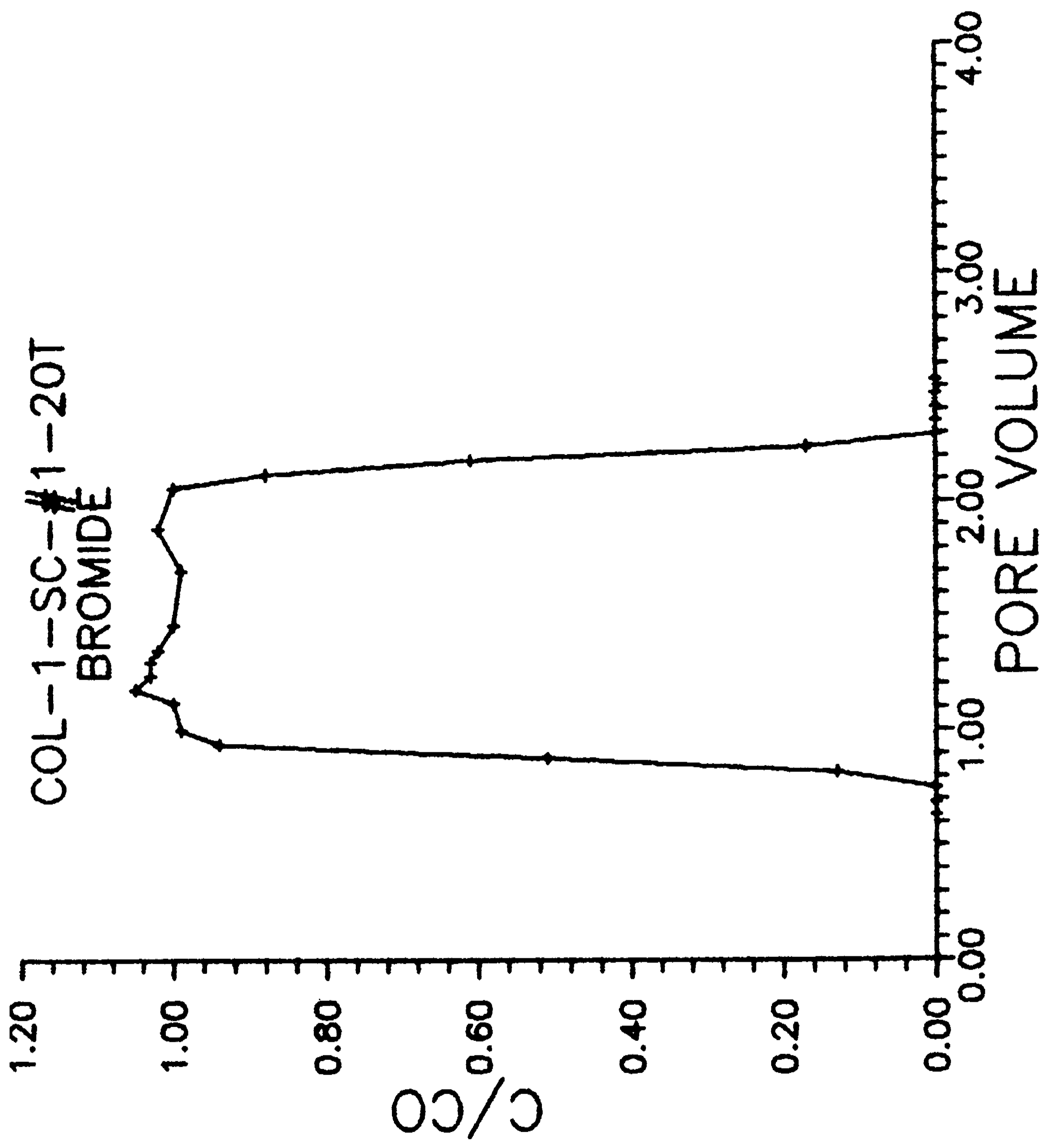
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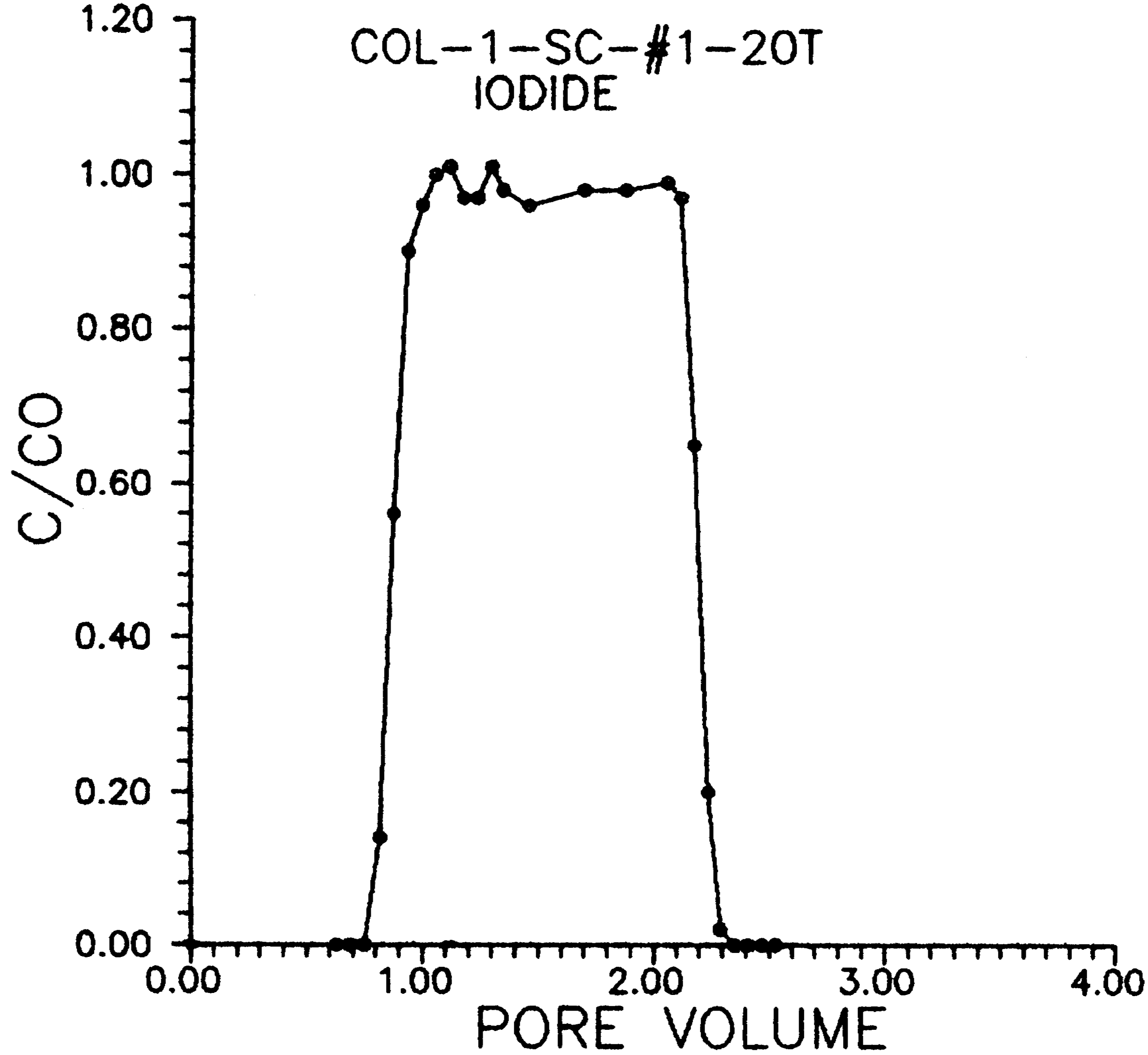
PORE VOLUME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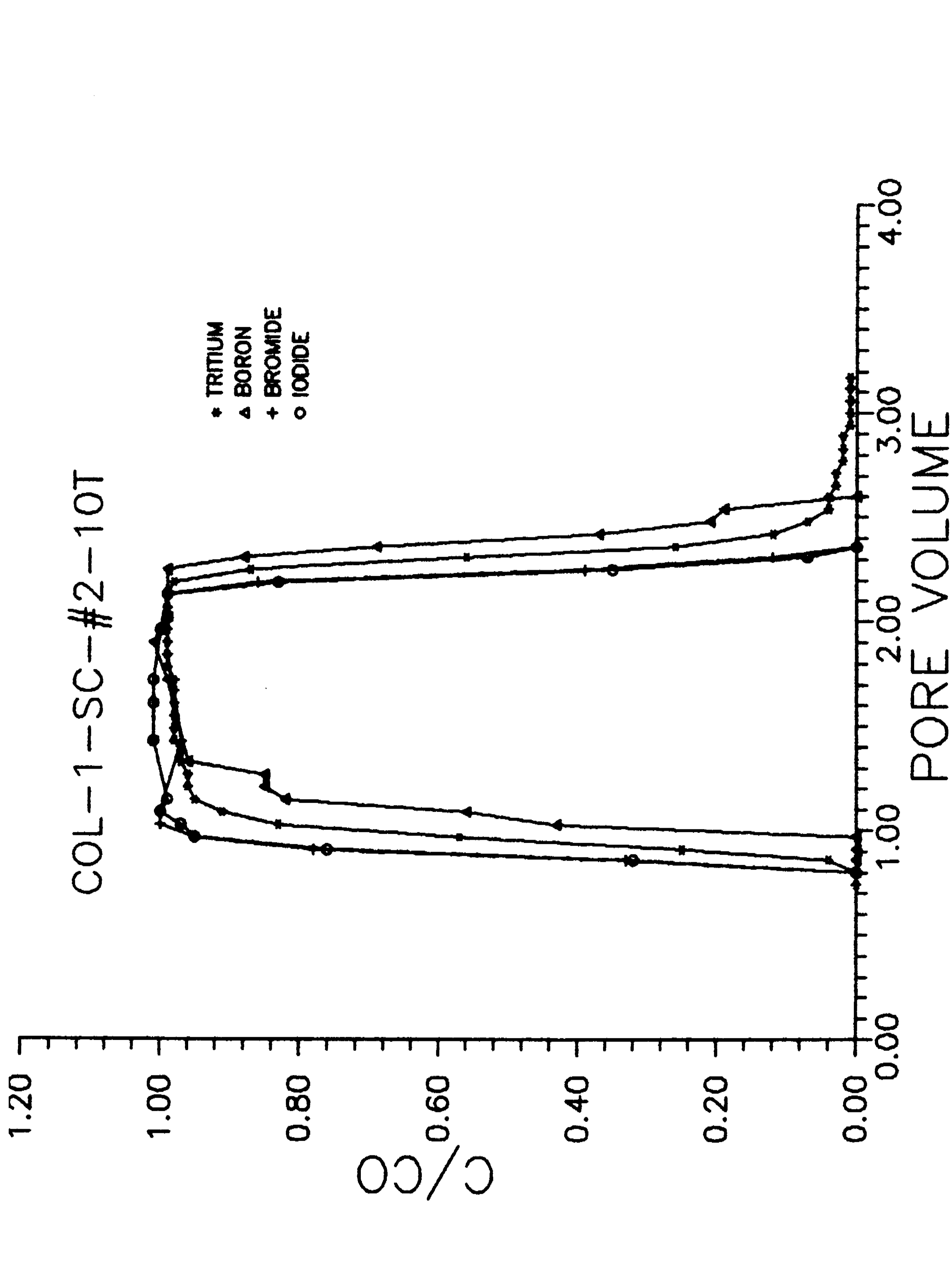

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△ BORON
+ BROMIDE
○ IODIDE
C/CO
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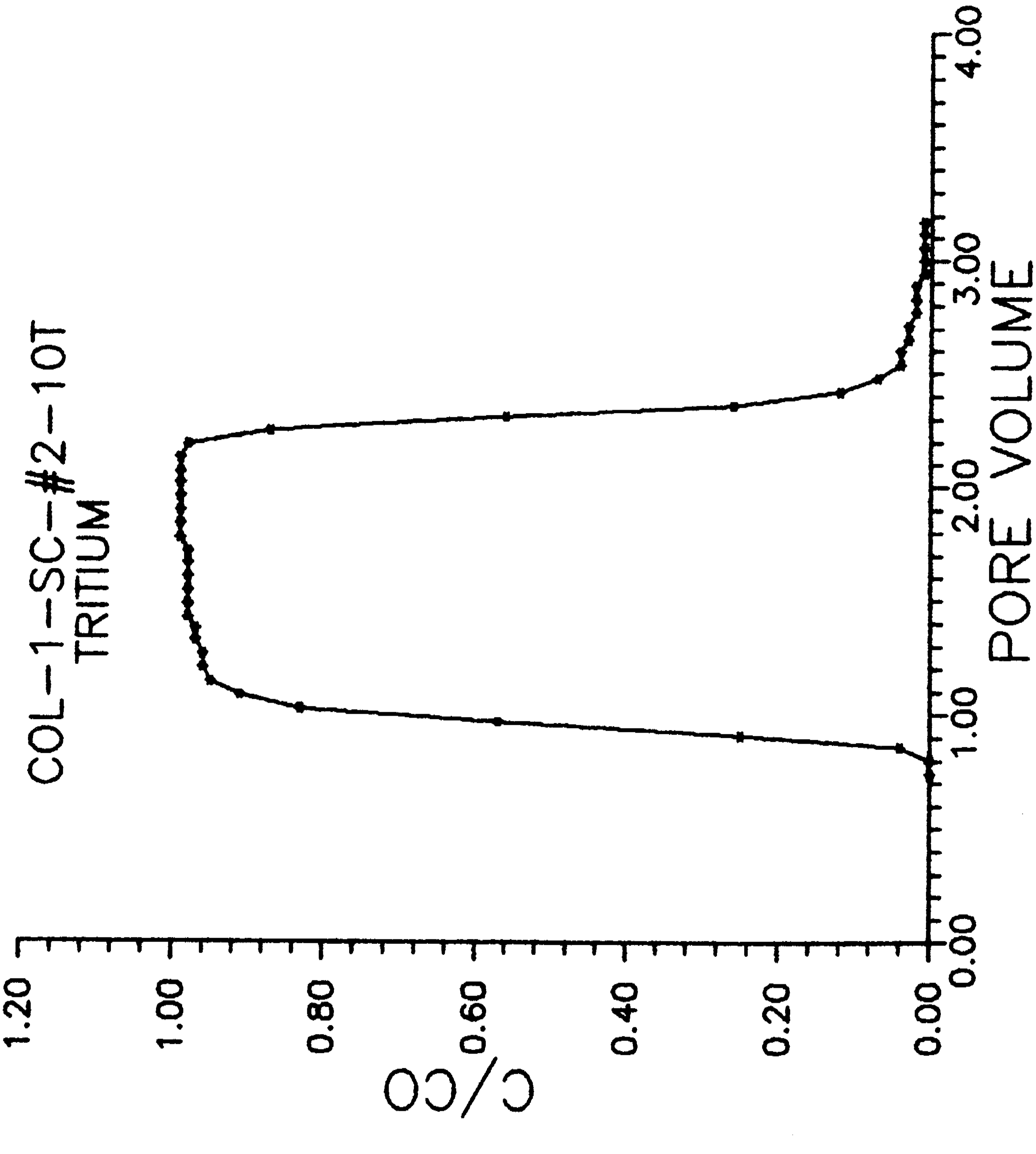
PORE VOLUME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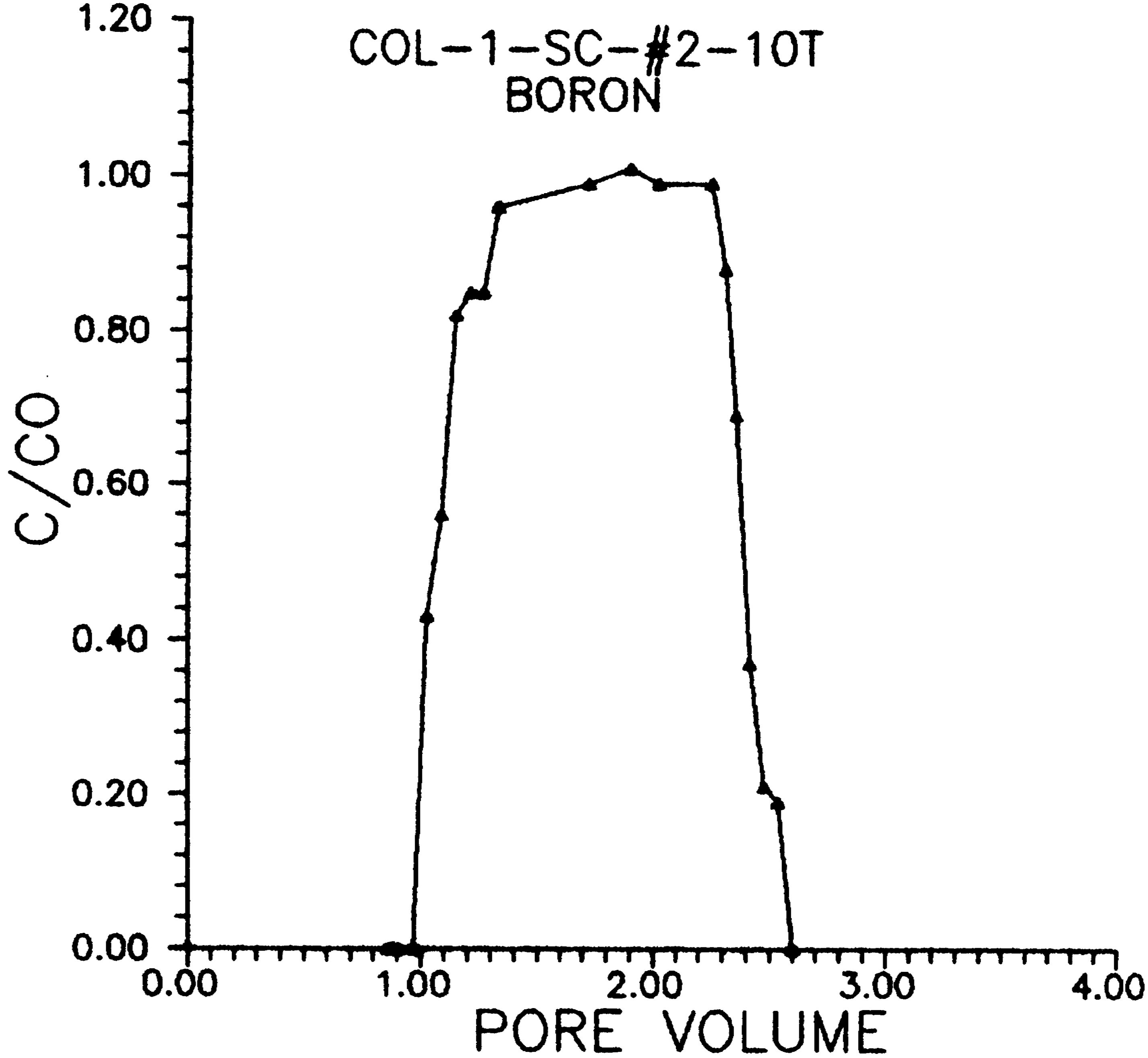
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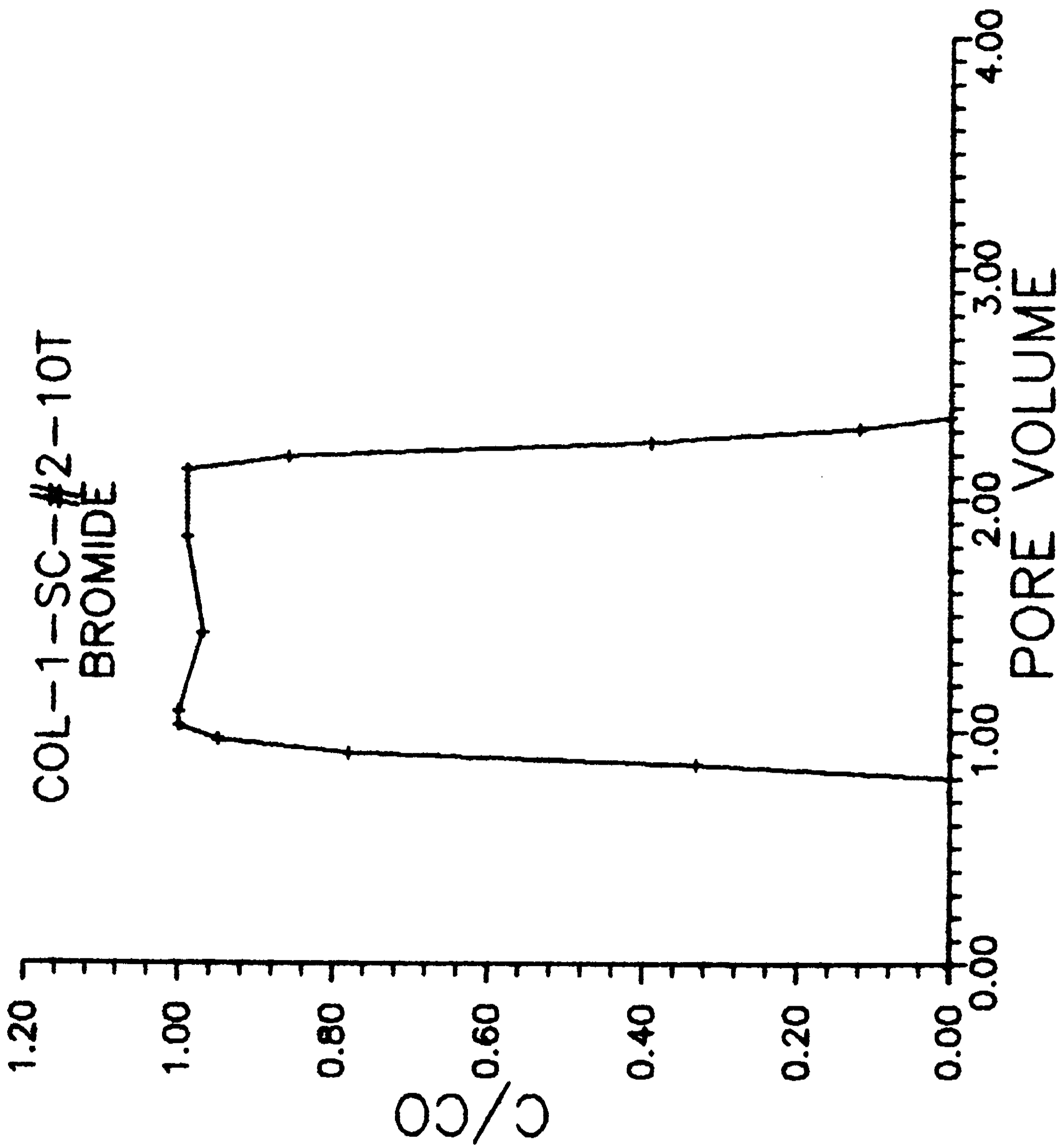
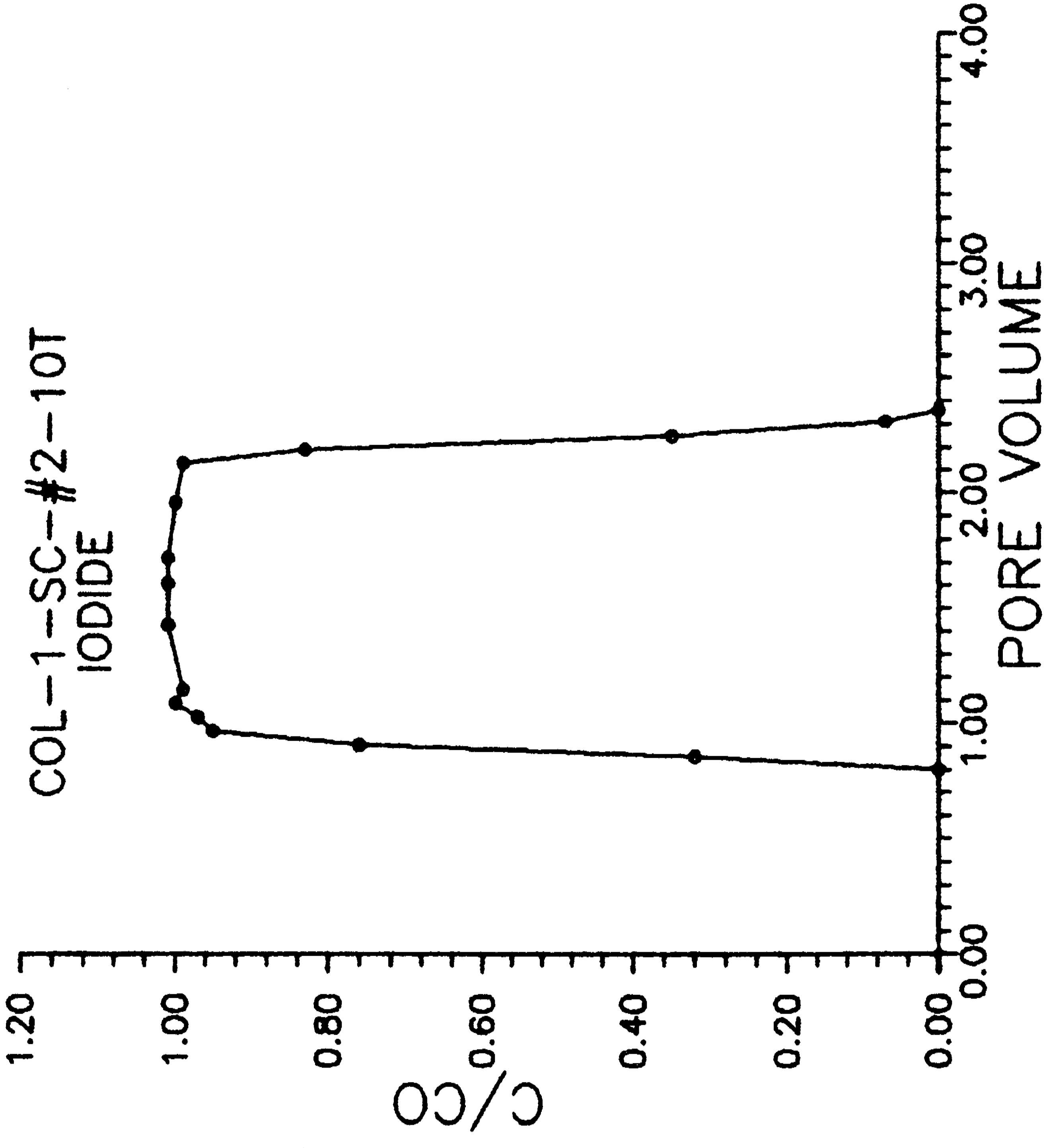
4.00
PORE VOLUME



COL-1-SC-#2-10T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


COL-1-SC-#2-10T
IODIDE
C/CO
PORE VOLUME
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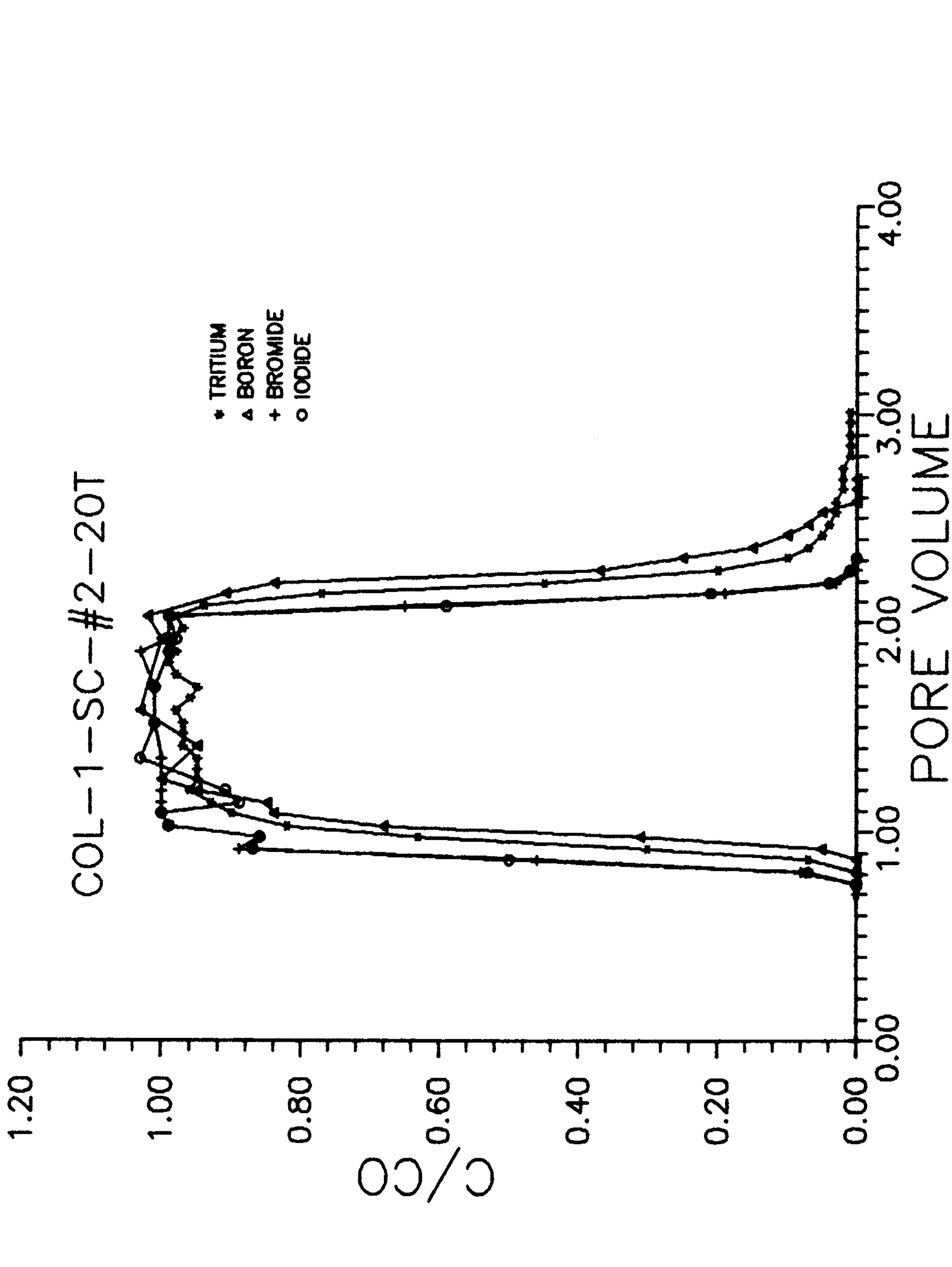
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00



COL-1-SC-#2-20T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
PORE VOLUME
0.00
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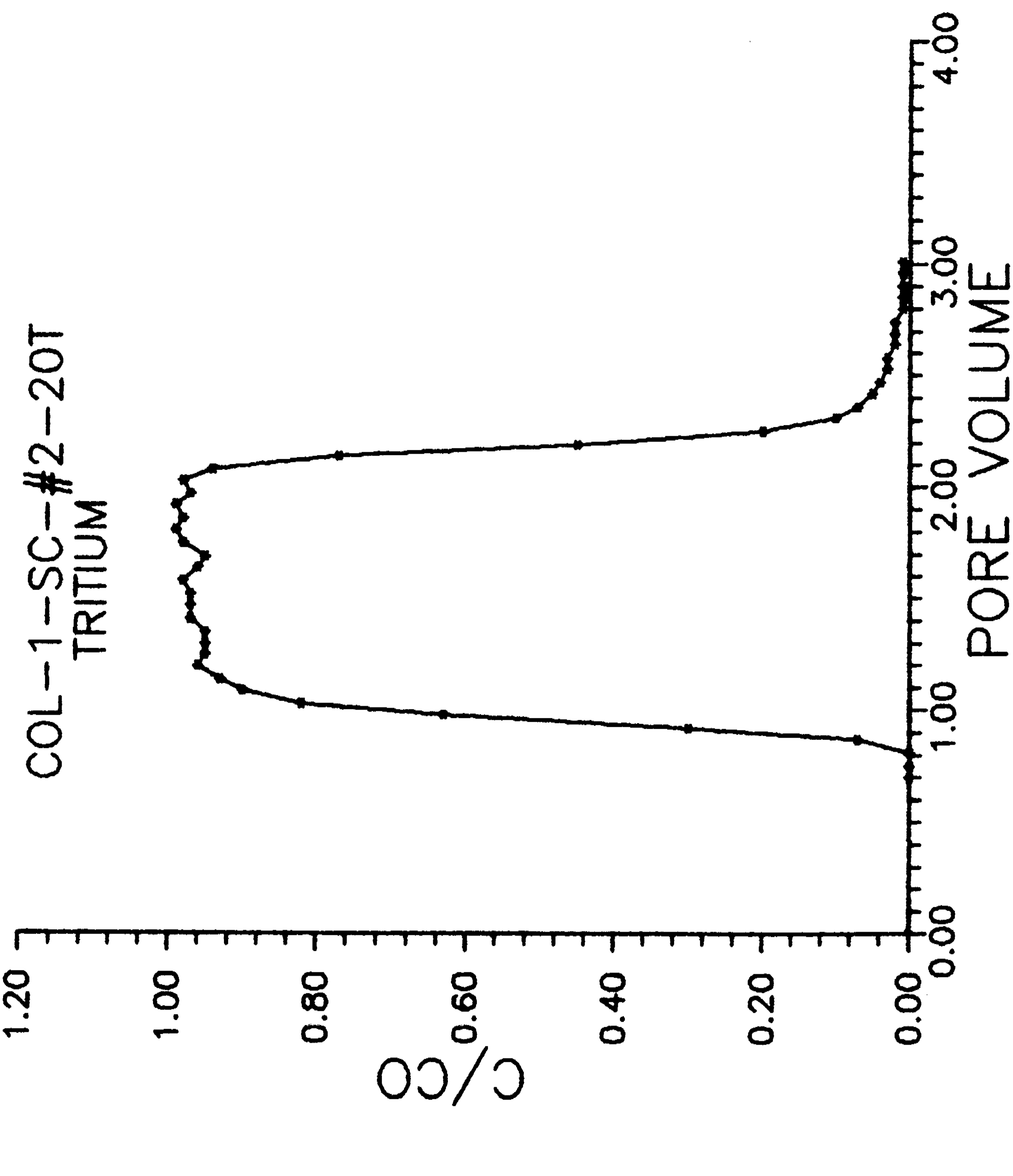
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00



COL-1-SC-#2-20T
TRITIUM
C/CO
PORE VOLUME
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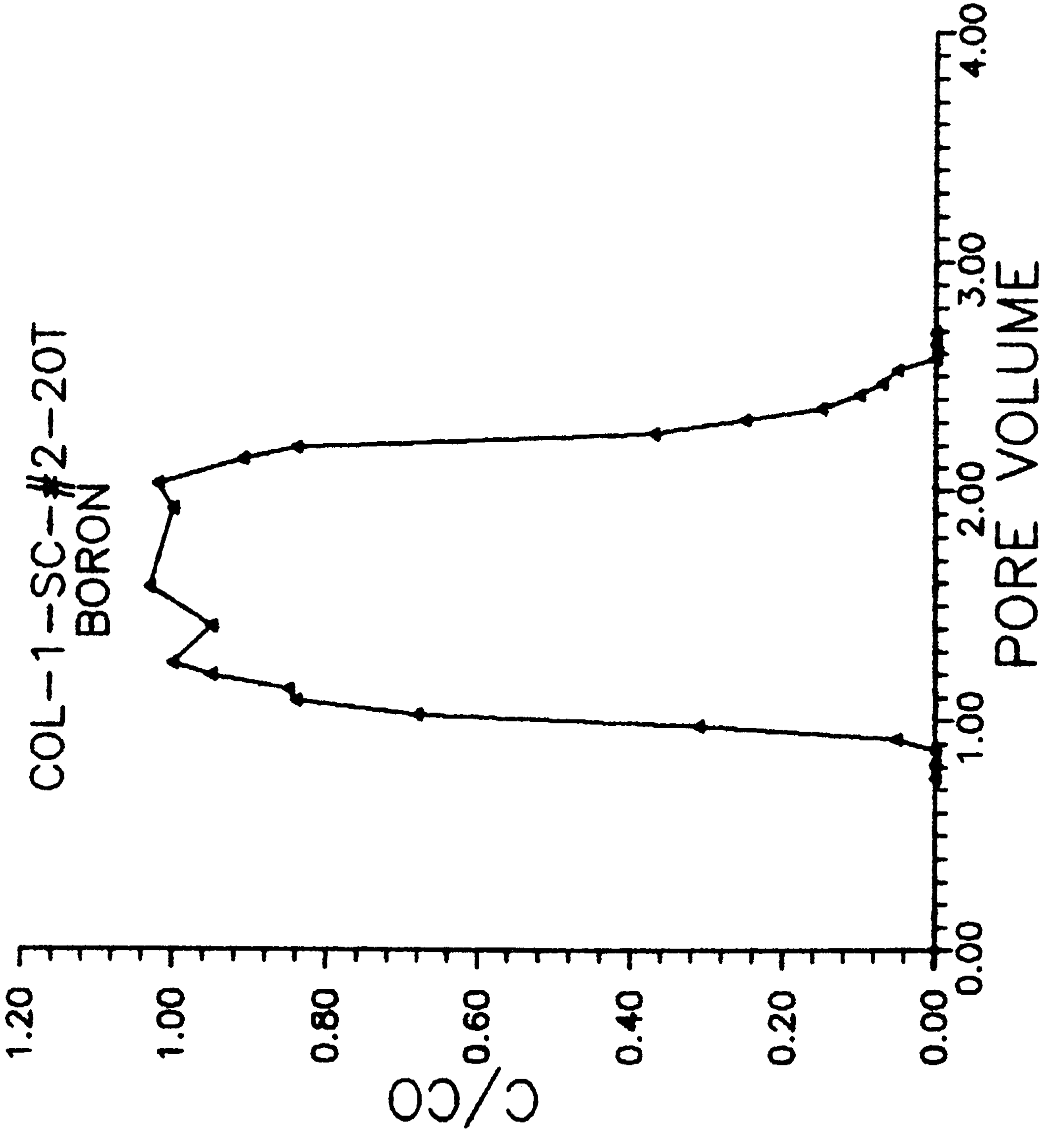
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00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BORON
C/CO
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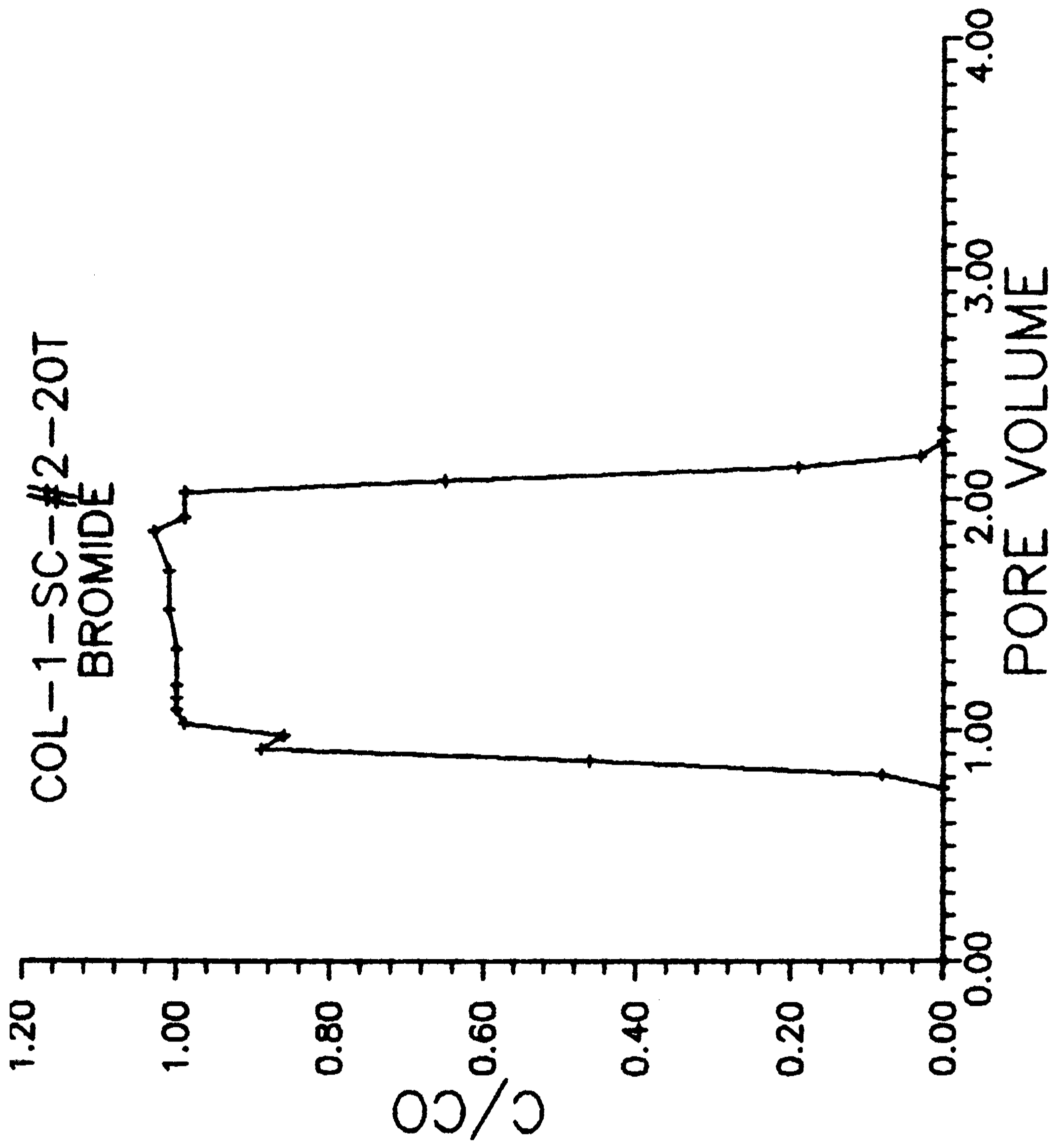
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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C/CO
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0.40
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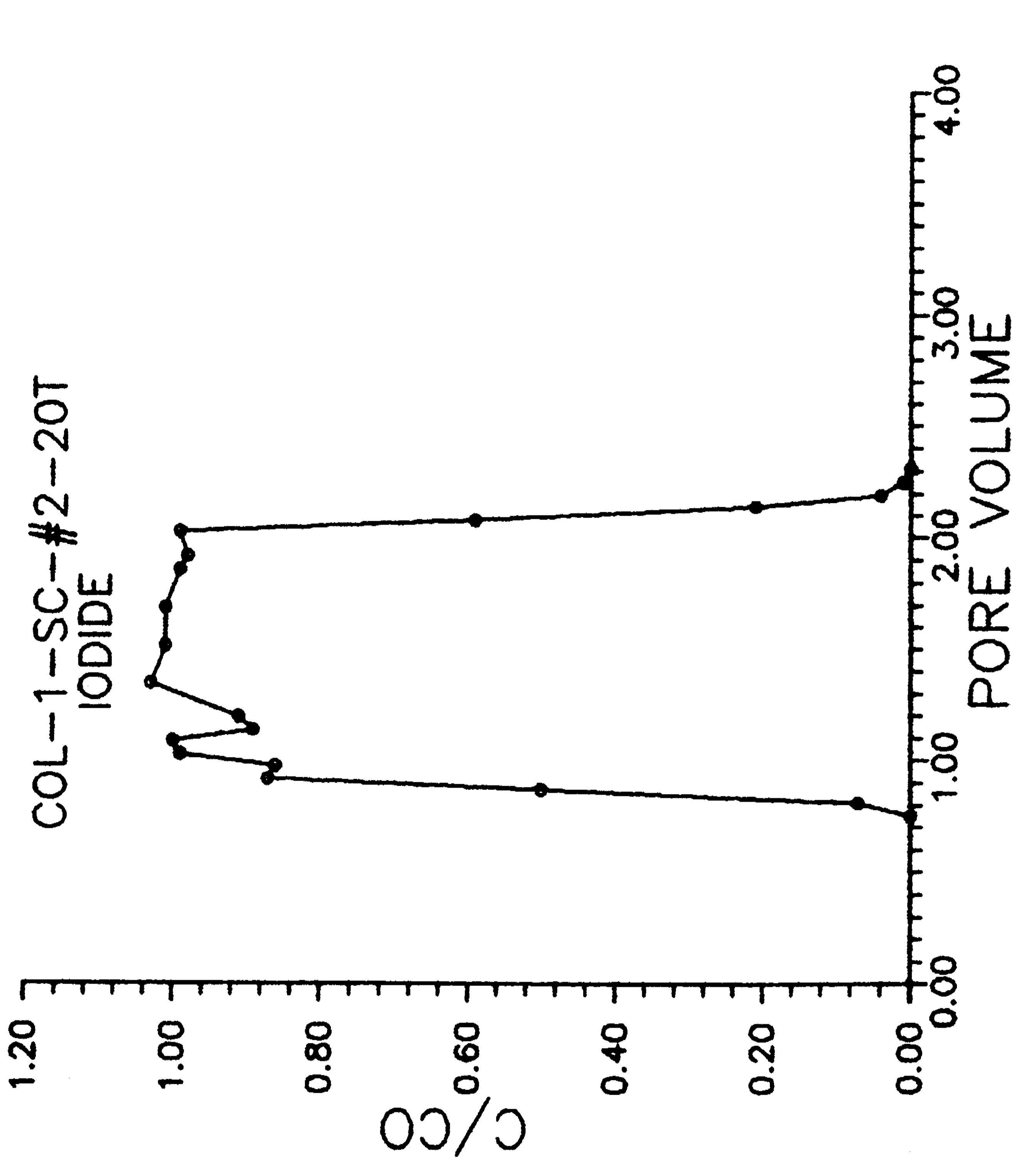
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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IODIDE
C/CO
PORE VOLUME
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1.00
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0.40
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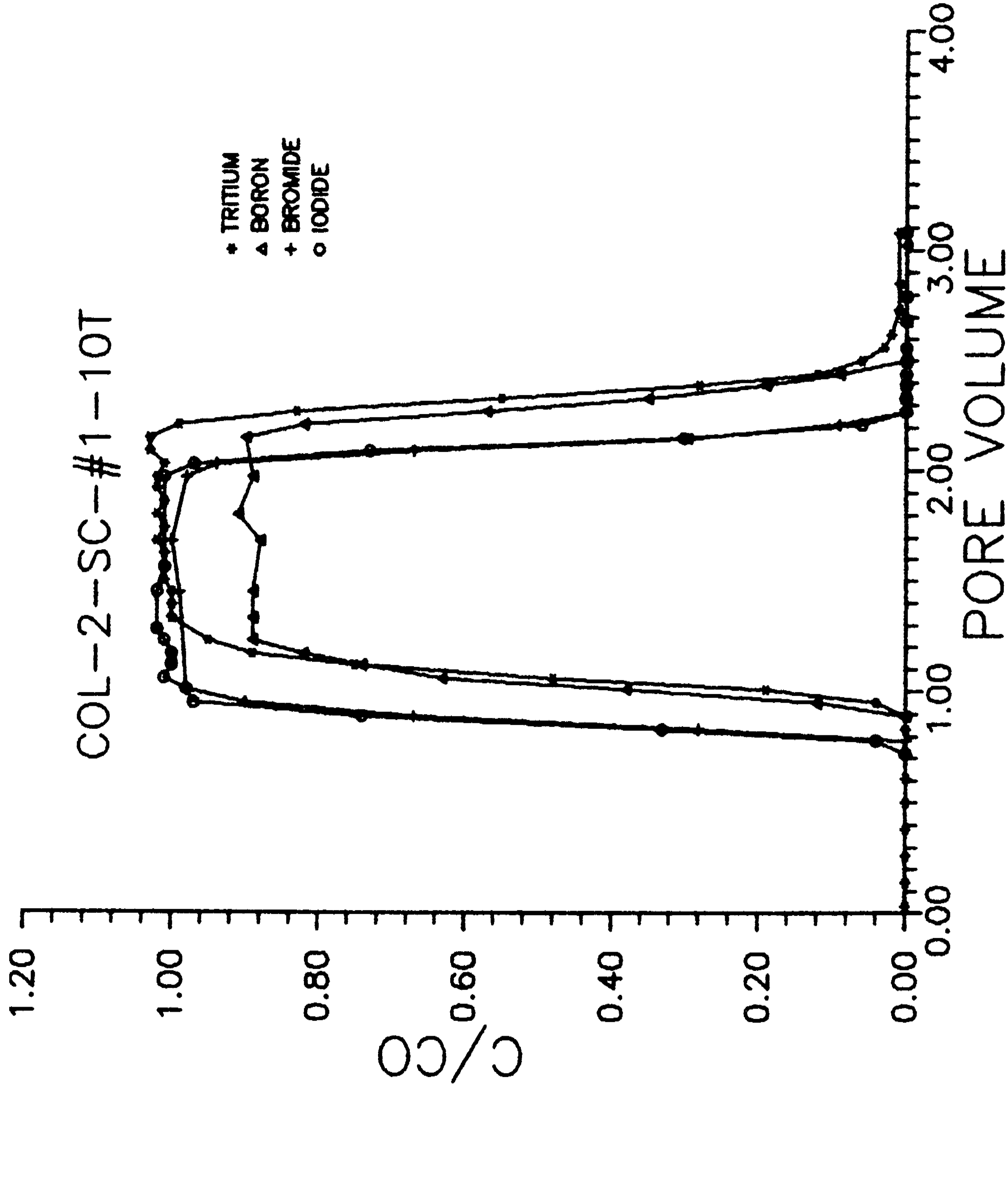
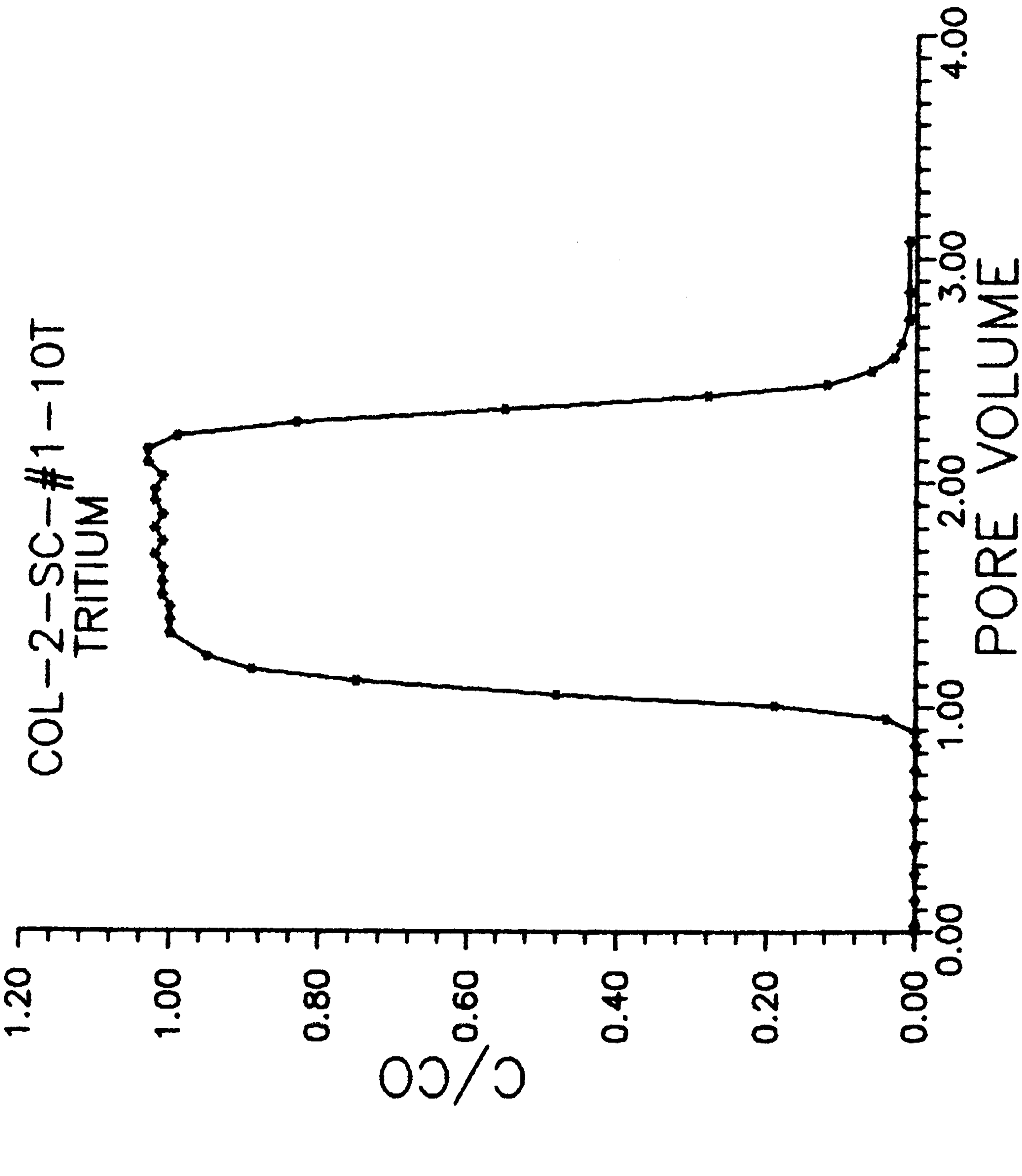
0.00
1.00
2.00
3.00
4.00


COL-2-SC-#1-10T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
PORE VOLUME
0.00
1.00
2.00
3.00
4.00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TRITIUM
C/CO
1.20
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0.80
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0.40
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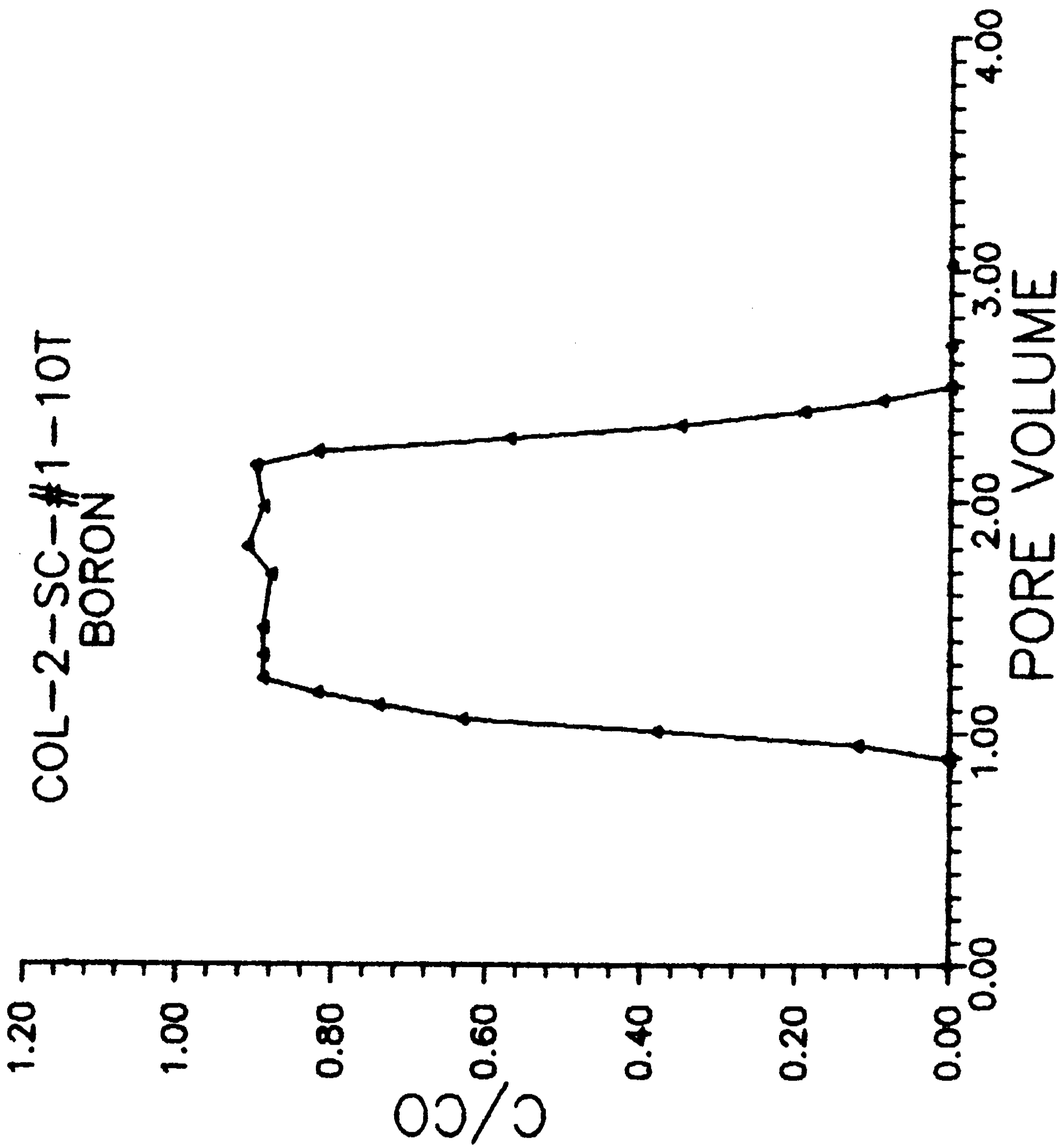
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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C/CO
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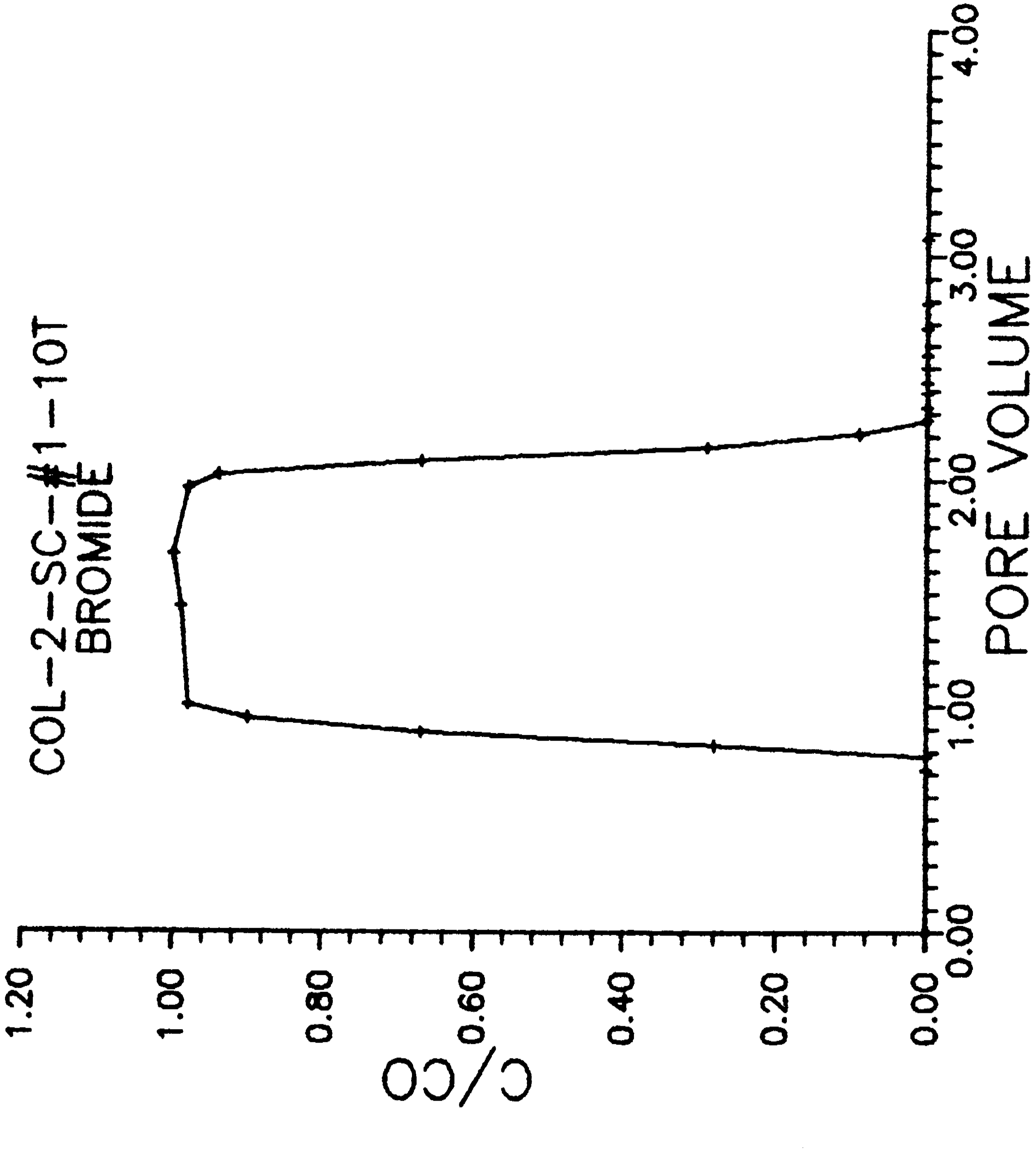
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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BROMIDE
C/CO
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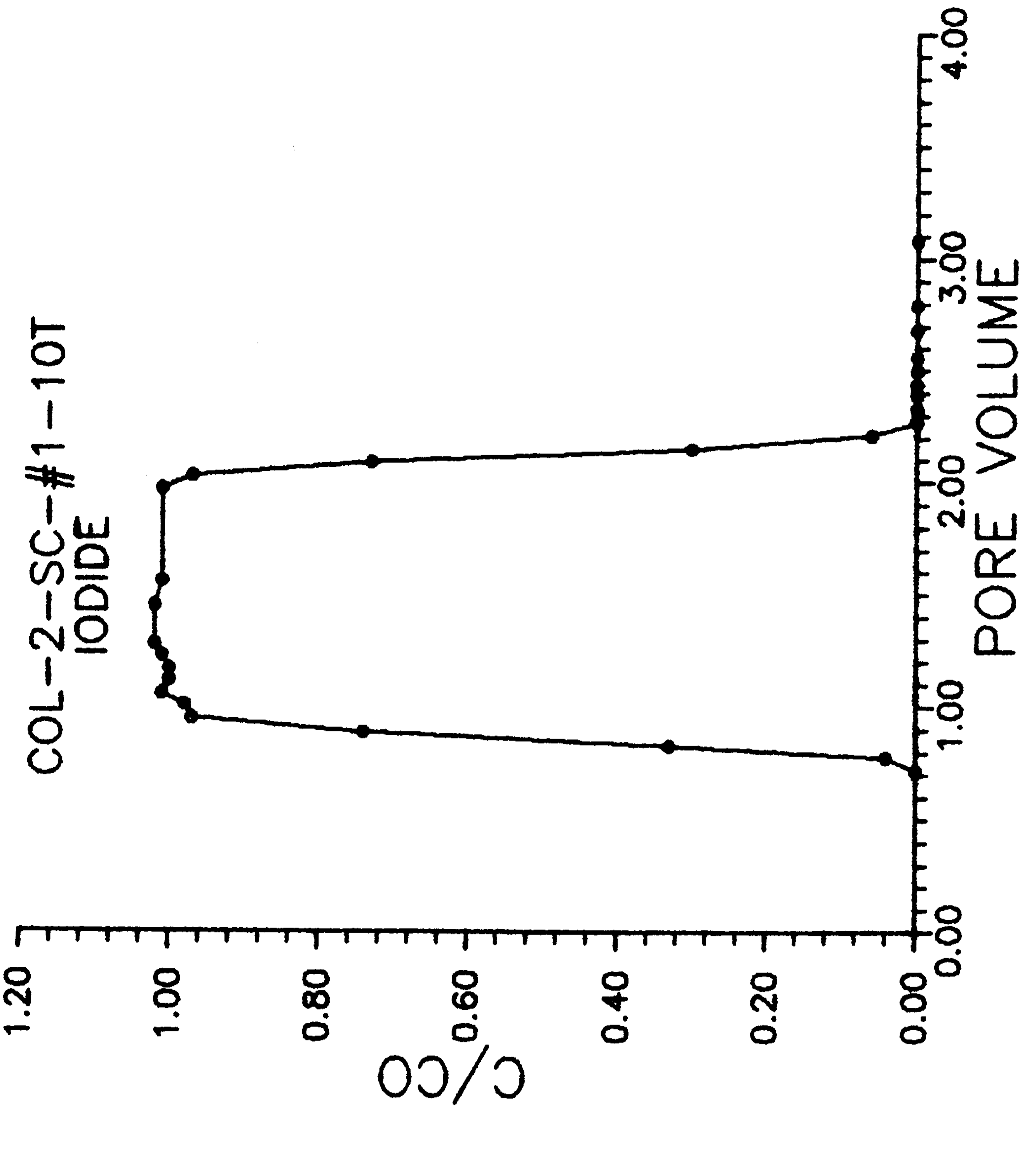
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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C/CO
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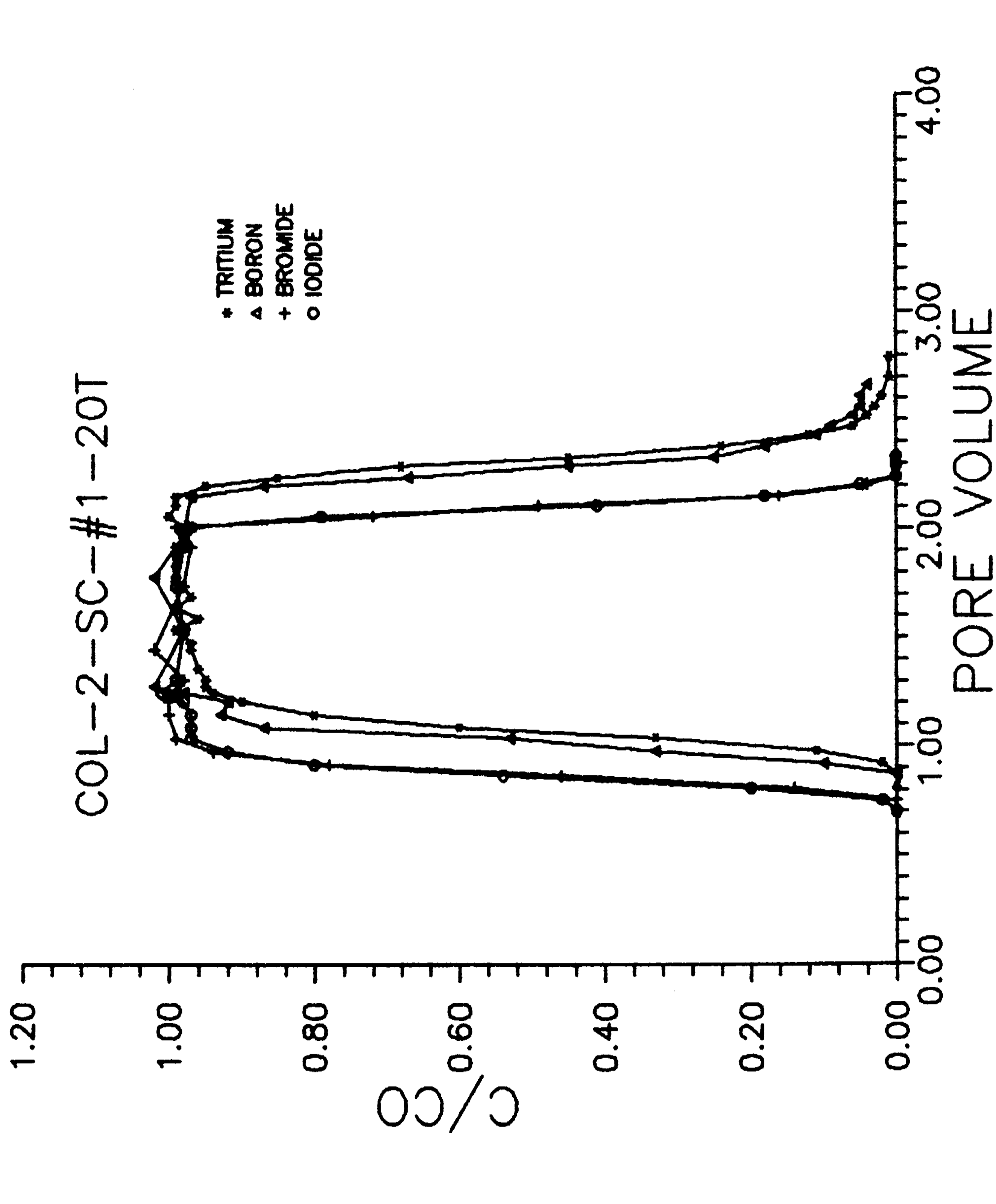
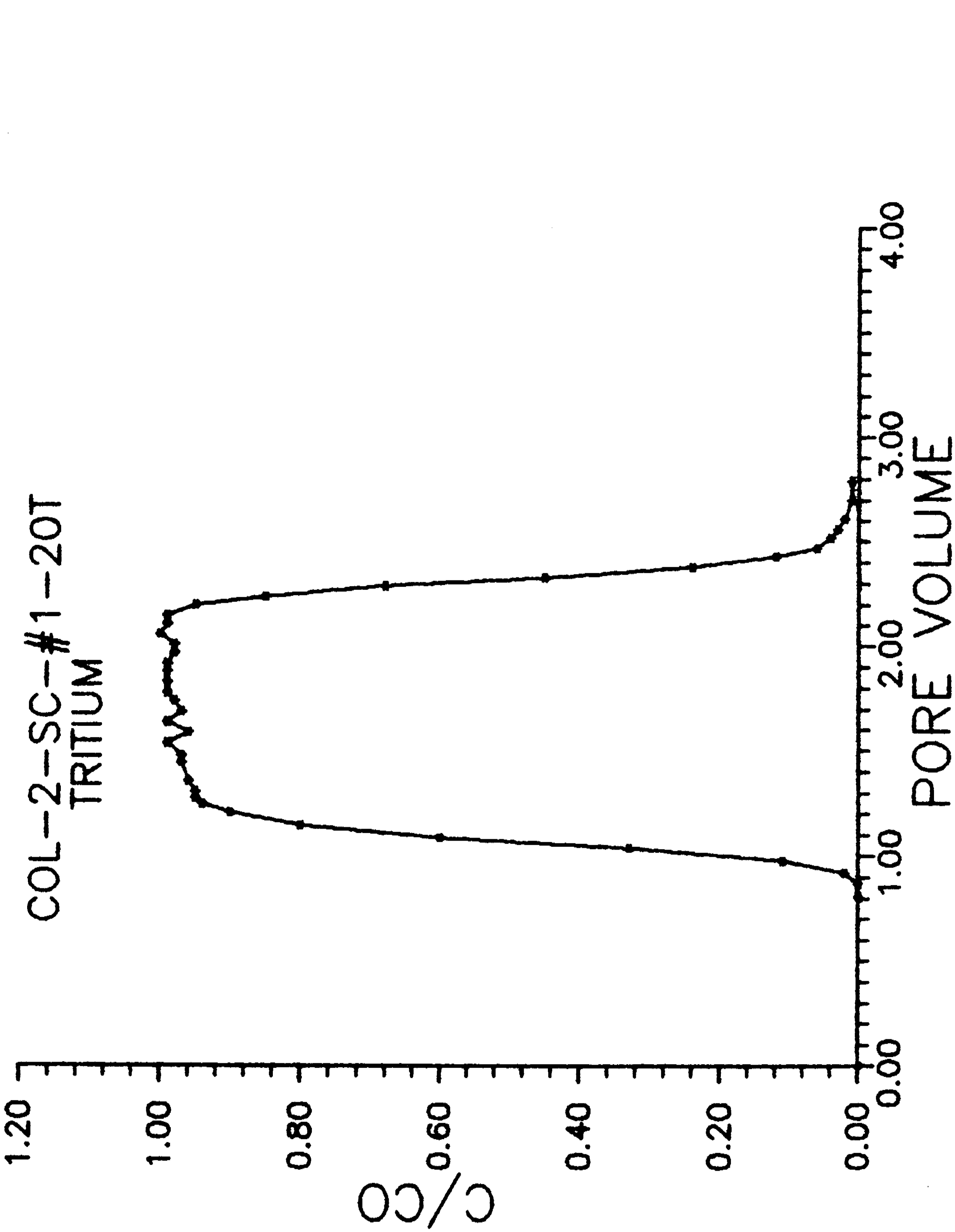
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


COL-2-SC-#1-20T
* TRITIUM
Δ BORON
+ BROMIDE
o IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
PORE VOLUME
0.00
1.00
2.00
3.00
4.00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TRITIUM
C/CO
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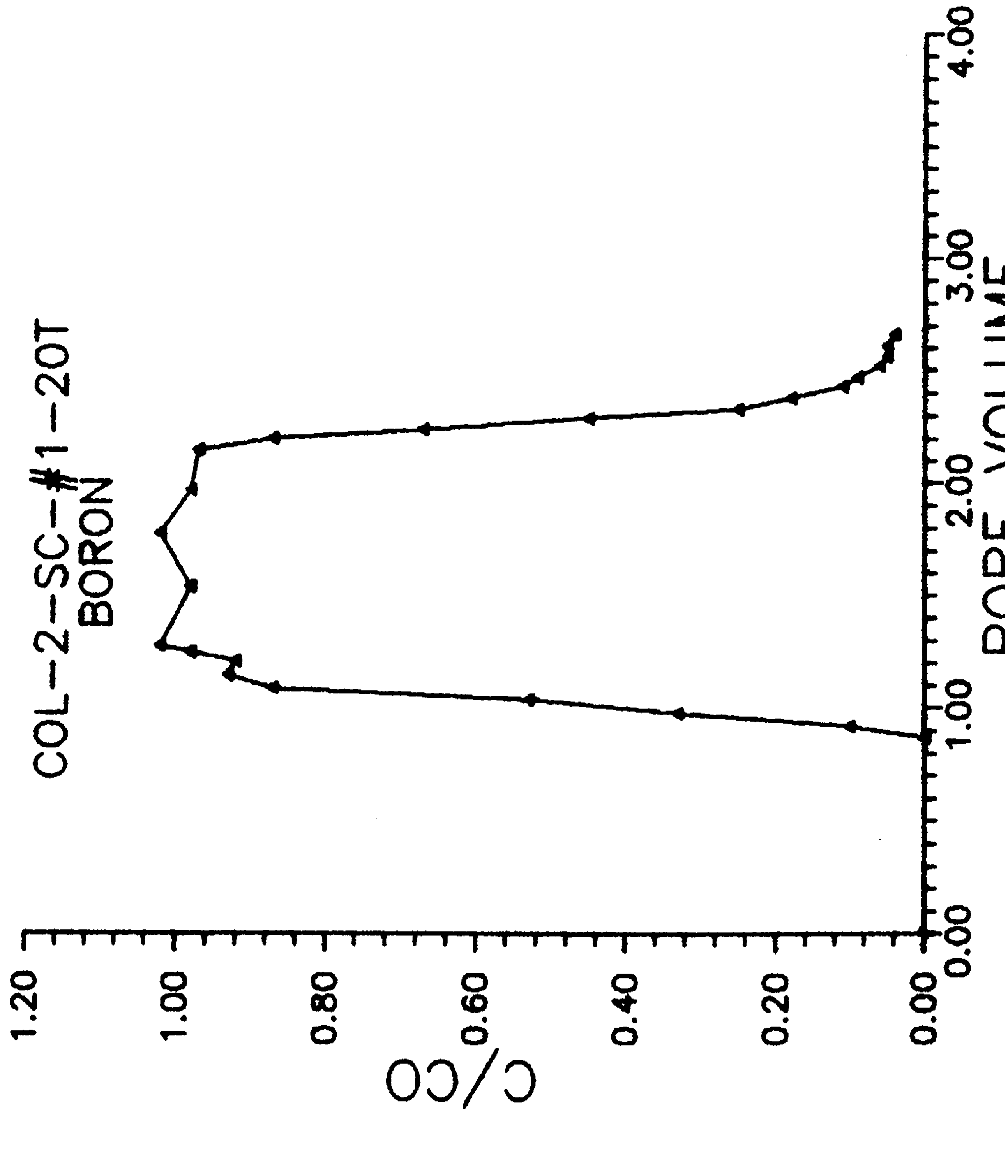
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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BORON
C/CO
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0.60
0.80
1.00
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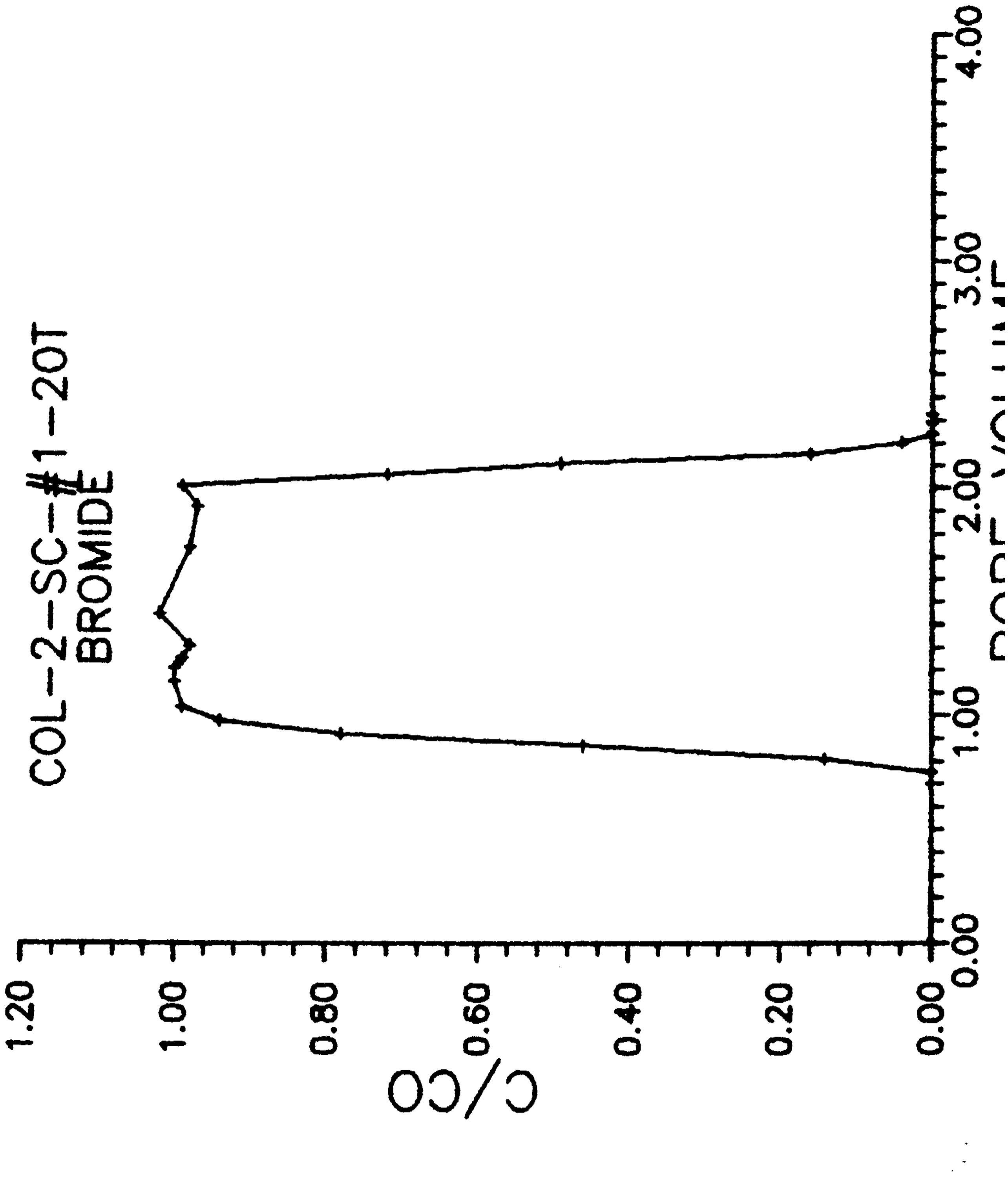
0.00
1.00
2.00
3.00
4.00


COL-2-SC-#1-20T
BROMIDE
C/CO
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0.40
0.20
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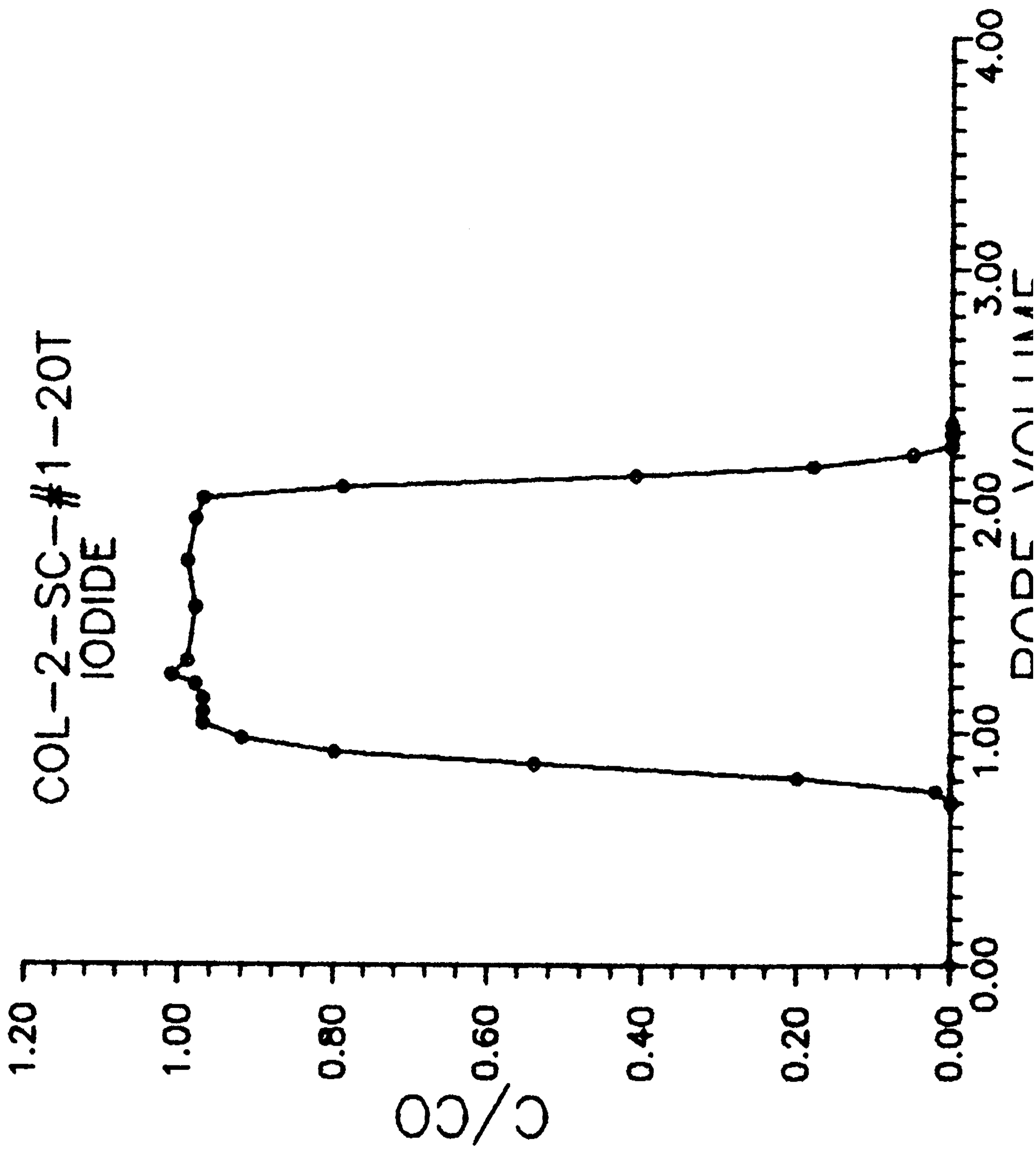
0.00
1.00
2.00
3.00
4.00



COL—2—SC—#1—20T
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C/CO
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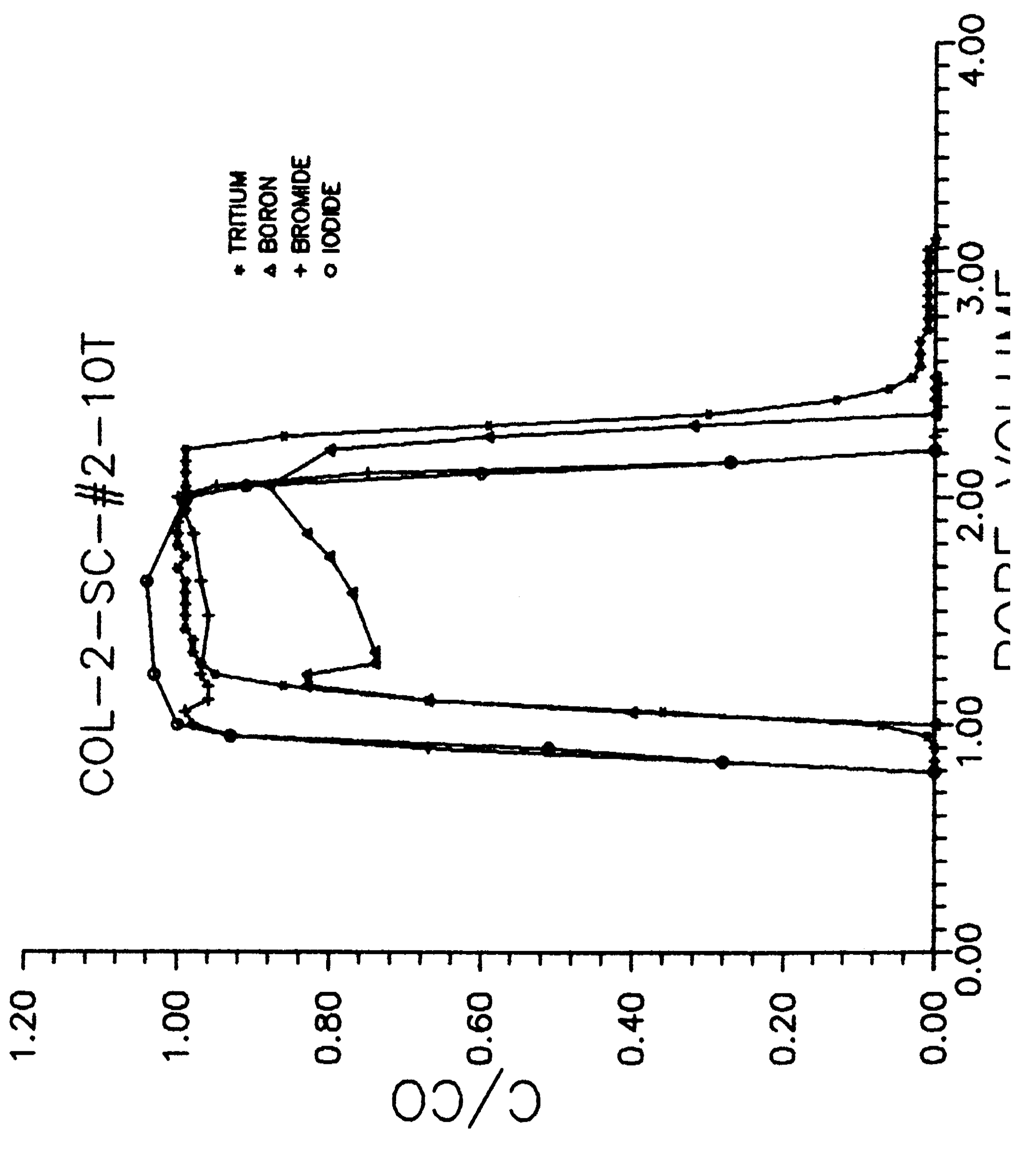

COL-2-SC-#2-10T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
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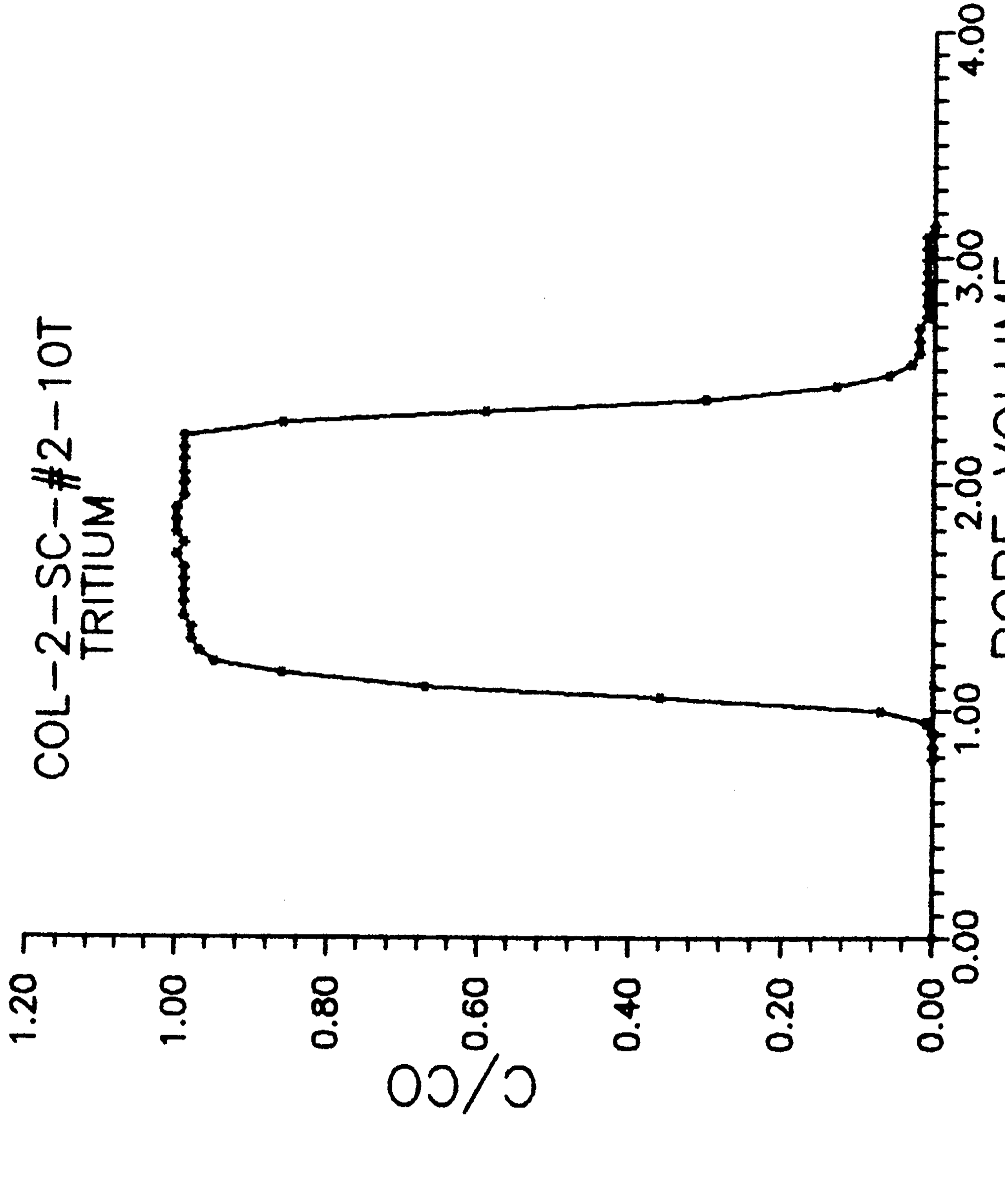
3.00
4.00


COL-2-SC-#2-10T
TRITIUM
C/CO
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0.20
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0.00
1.00
2.00
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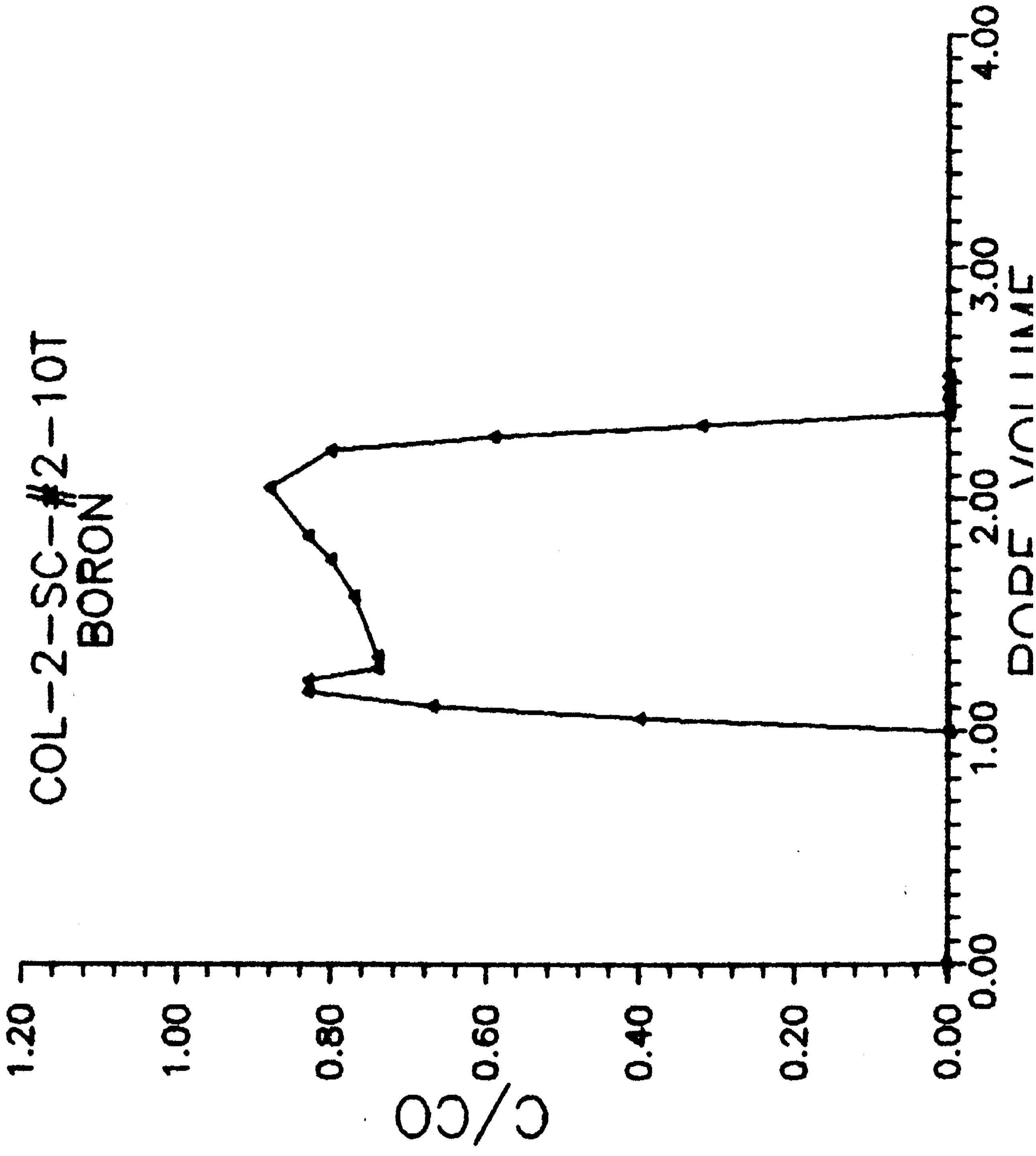
4.00


COL-2-SC-#2-10T
BORON
C/CO
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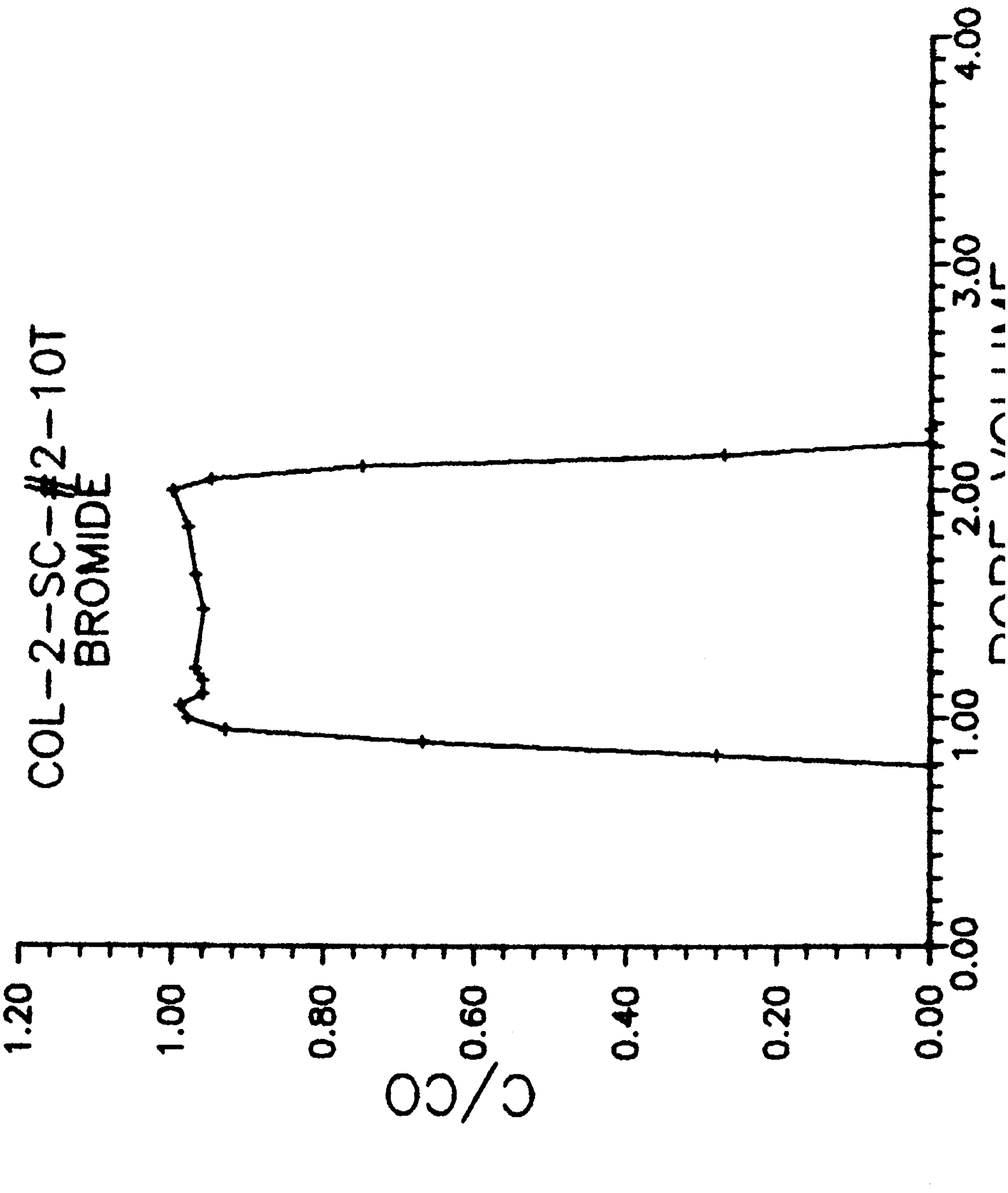
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00


COL—2—SC—#2—10T
BROMIDE
C/CO
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0.60
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0.20
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0.00
1.00
2.00
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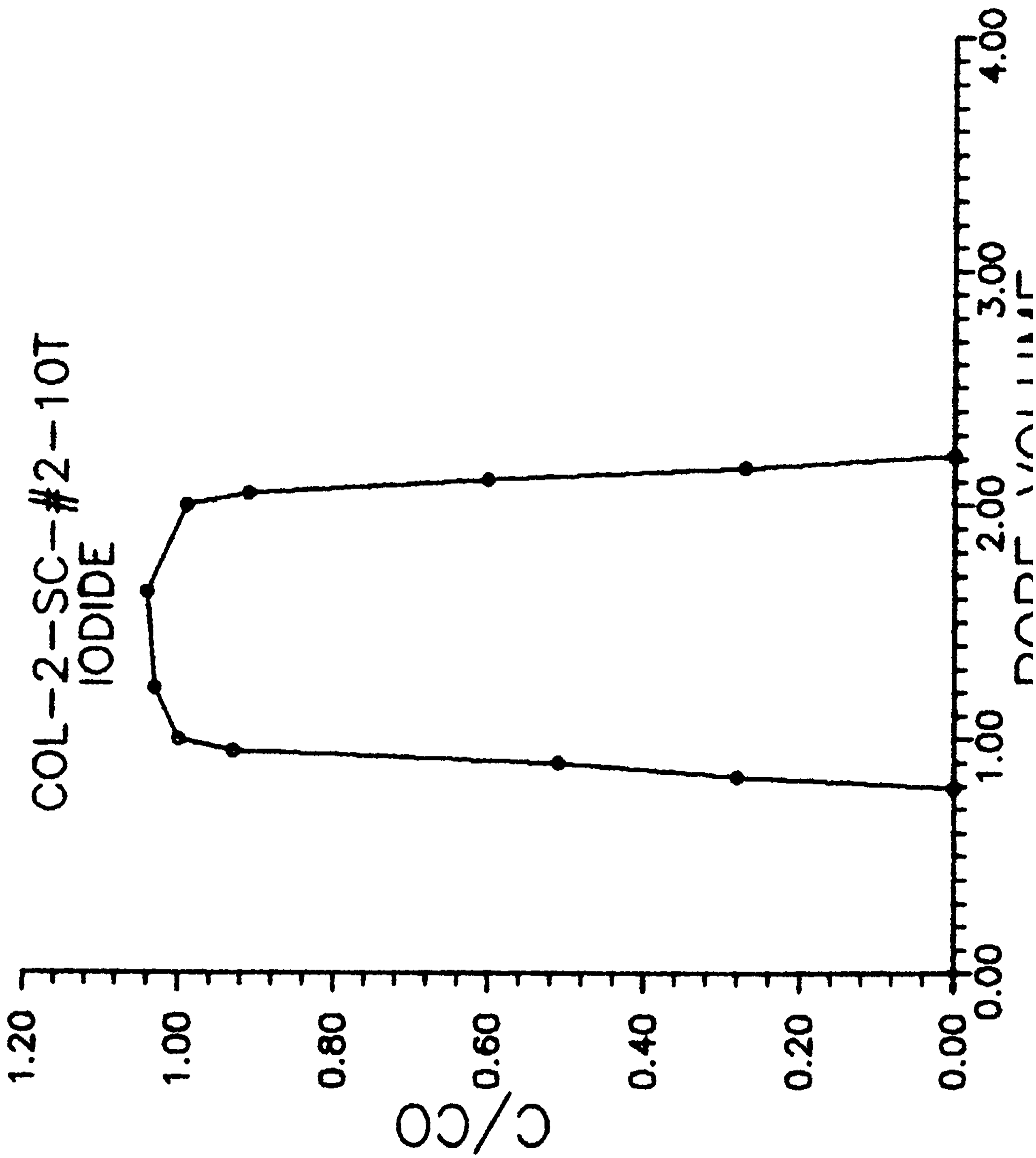

COL-2-SC-#2-10T
IODIDE
C/CO
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0.00
1.00
2.00
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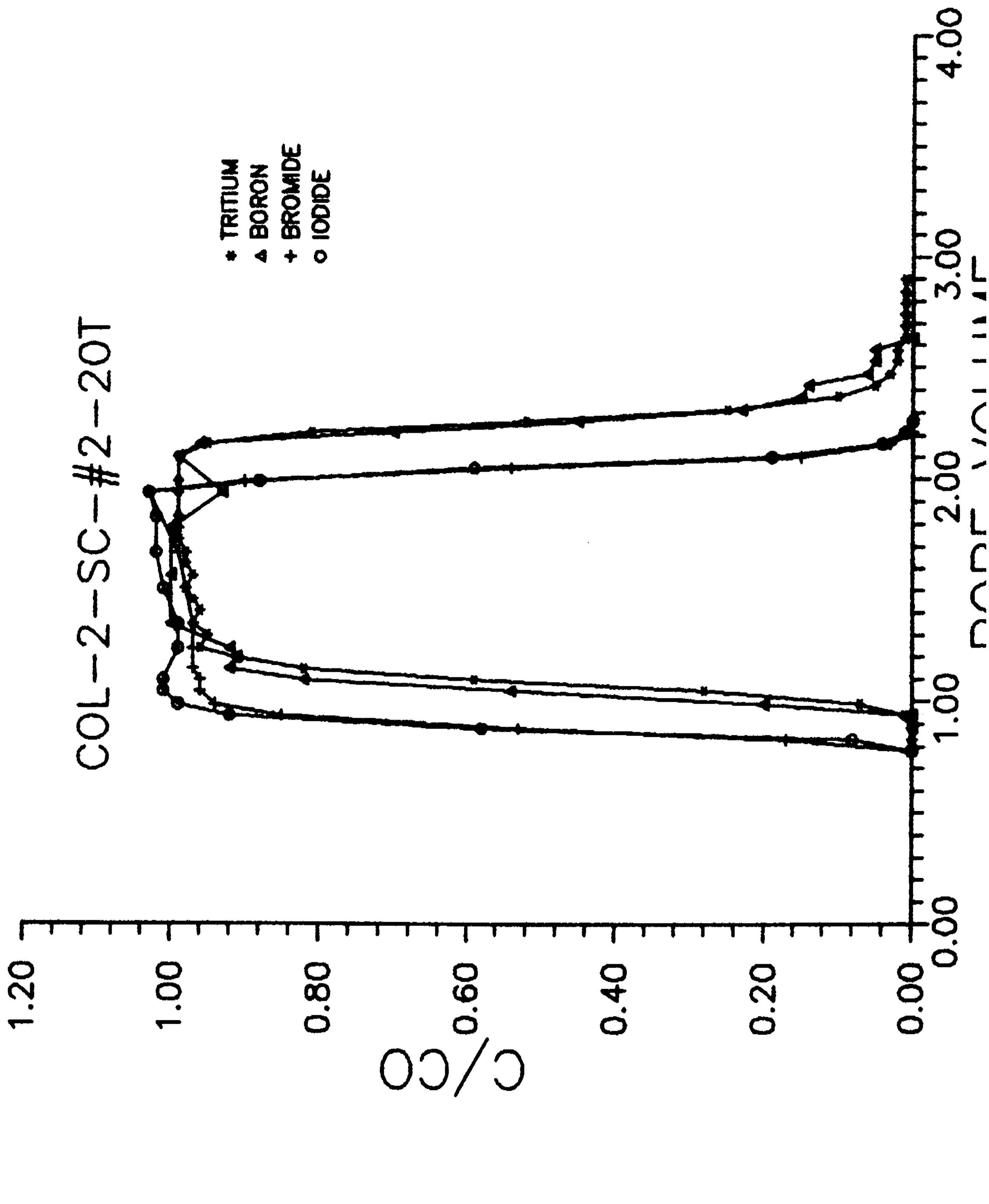
4.00


COL-2-SC-#2-20T
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BROMIDE
IODIDE
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0.00
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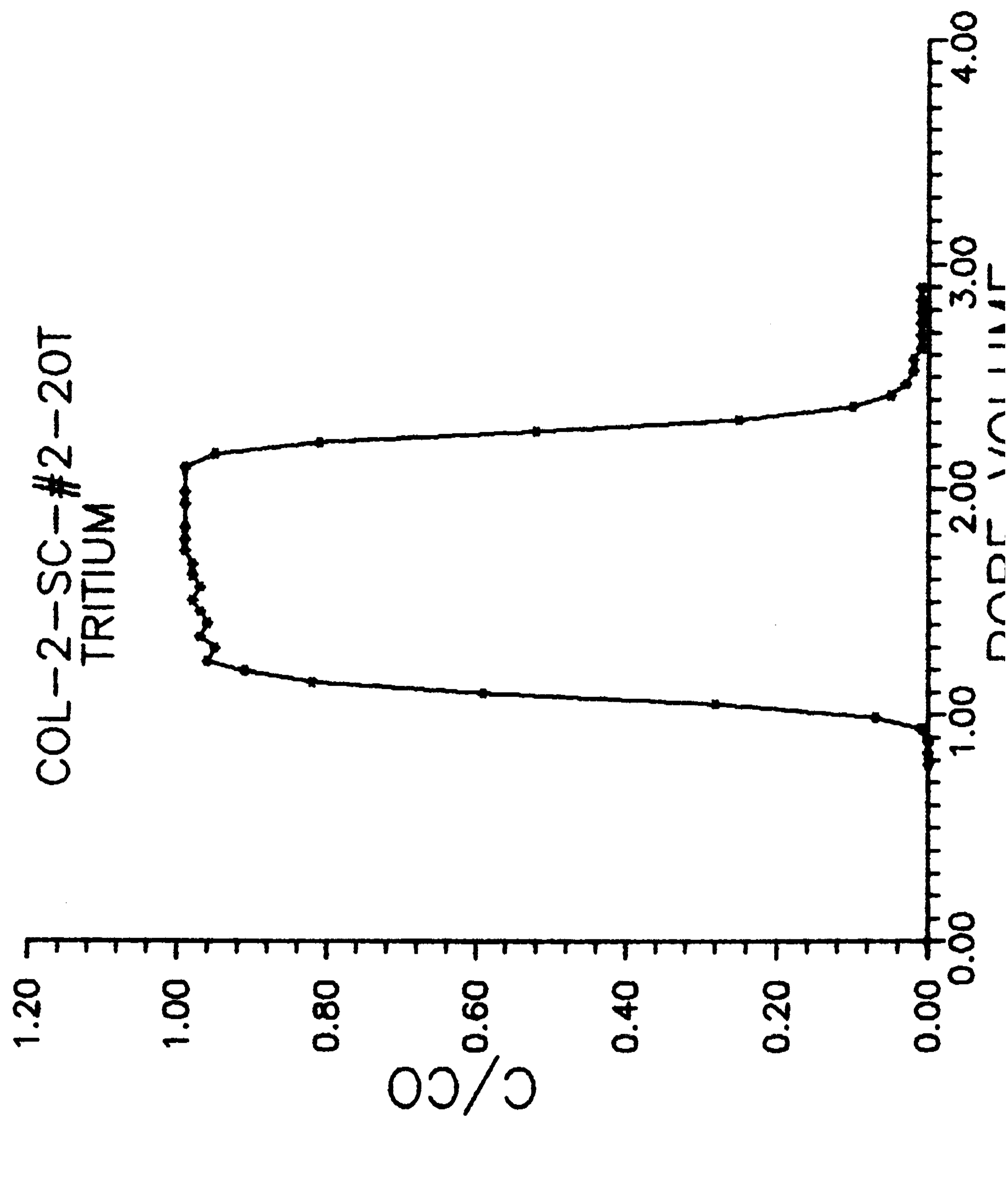
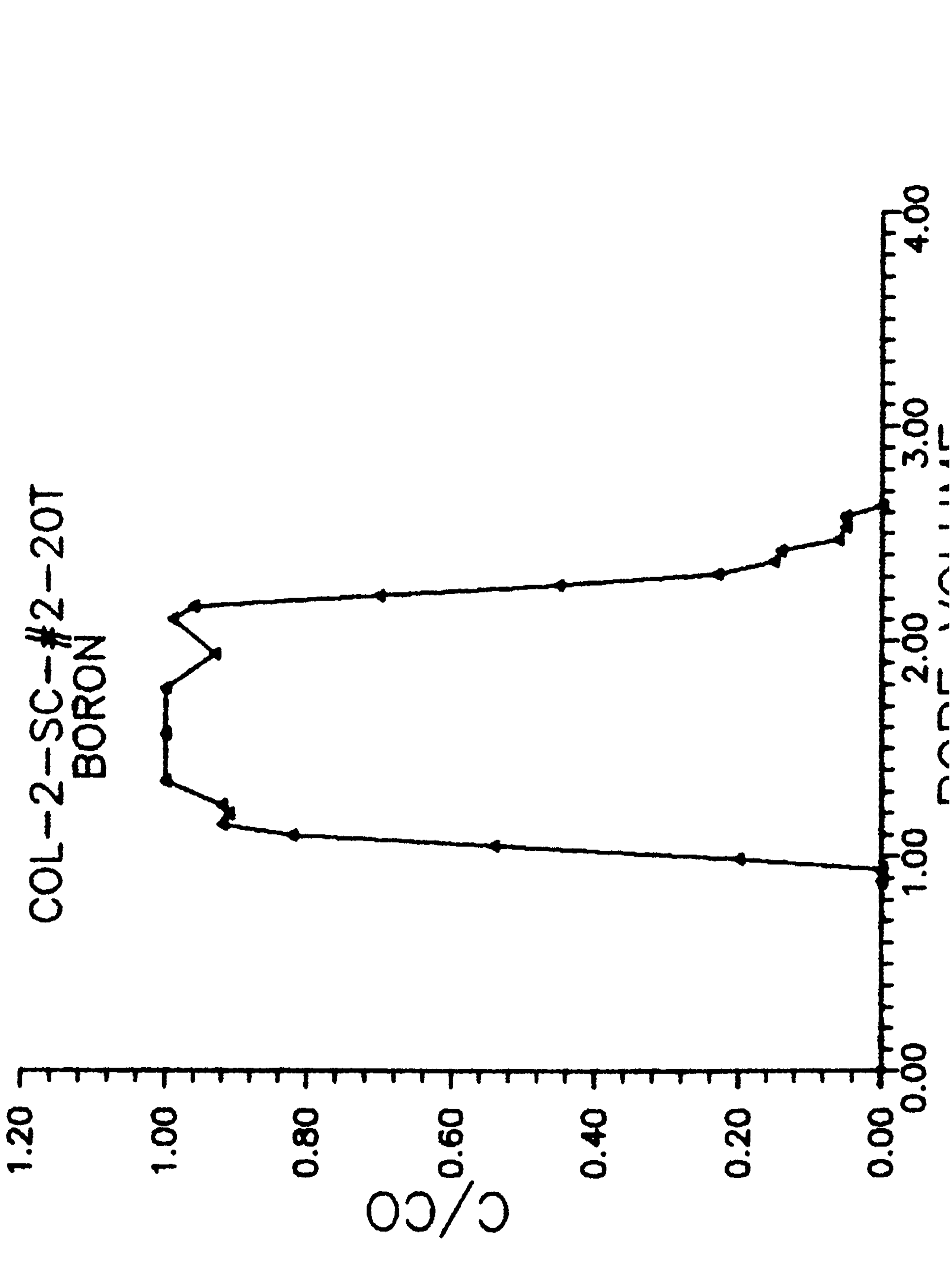
2.00
3.00
4.00


COL-2-SC-#2-20T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


COL-2-SC-#2-20T
BORON
C/CO
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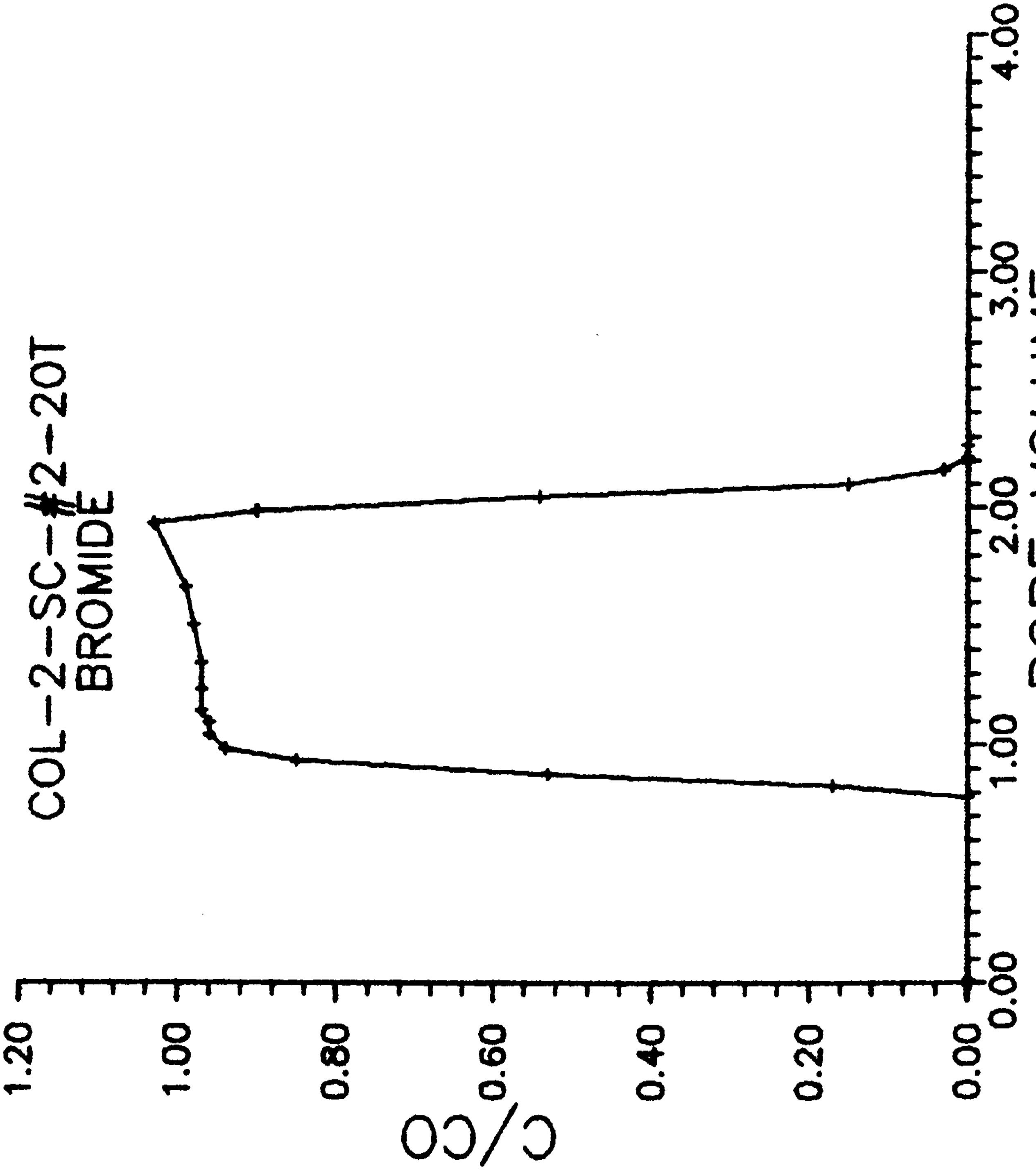
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


COL-2-SC-#2-20T
BROMIDE
C/CO
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0.00
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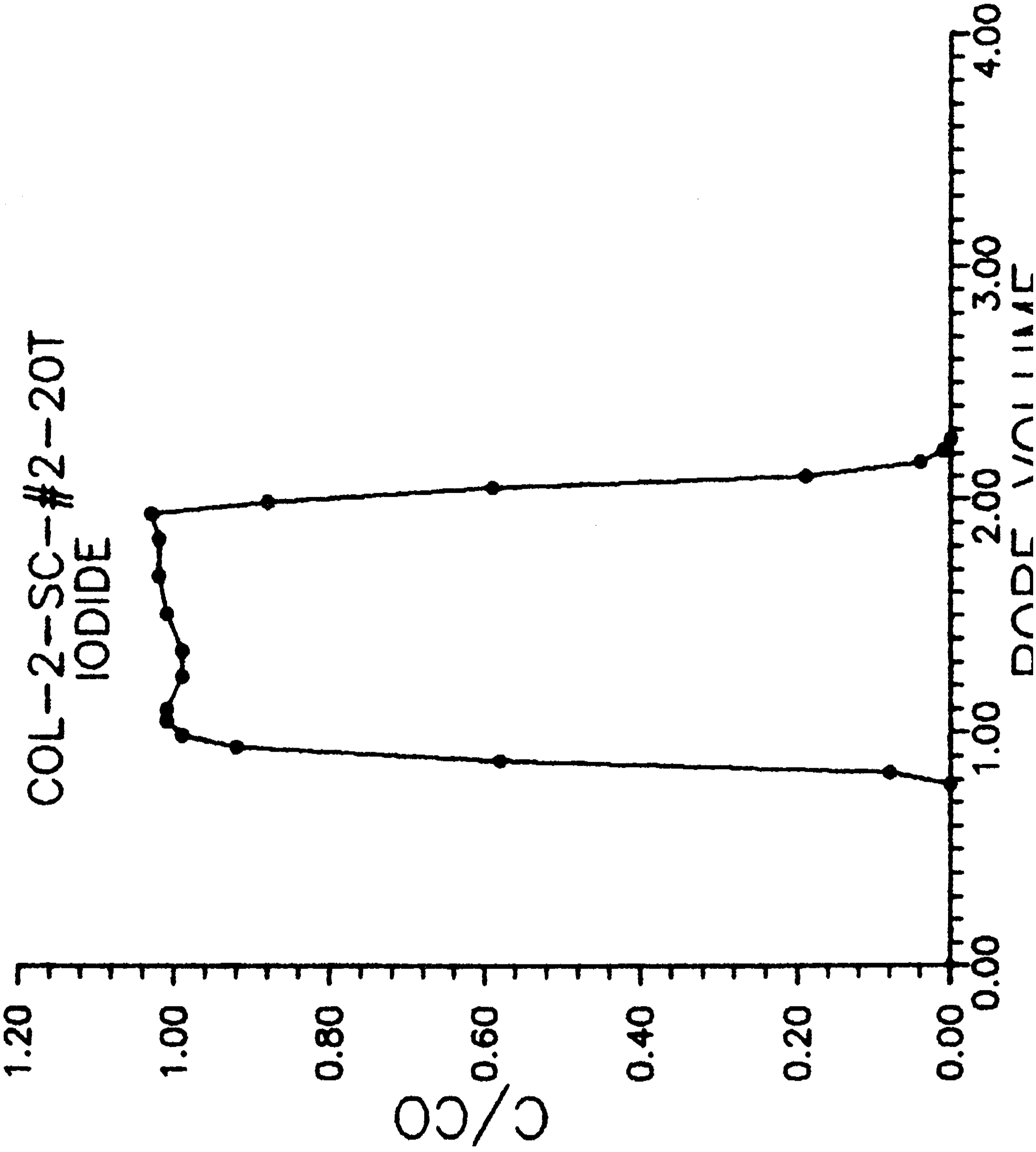
4.00


COL-2-SC-#2-20T
IODIDE
C/CO
1.20
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0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00

APPENDIX IX

MASS RECOVERIES FOR TRITIUM, BROMIDE, IODIDE, AND BORON

PERCENT MASS RECOVERIES

EXPERIMENT	BORON	BROMIDE	IODIDE	TRITIUM
GT-2-SC-#1-10T	92.30%	98.74%	99.10%	100.68%
GT-2-SC-#1-20T	109.43%	97.86%	99.64%	98.99%
GT-2-SC-#2-10T	98.20%	101.84%	98.95%	101.16%
GT-2-SC-#2-20T	99.28%	98.04%	103.06%	98.95%
GT-2-UC-#2-10T	101.25%	104.50%	98.64%	101.95%
GT-2-UC-#2-20T	106.93%	102.87%	99.90%	108.27%
GT-2-UC-#1-10T	103.24%	102.48%	96.33%	105.04%
GT-2-UC-#1-20T	107.04%	103.39%	99.75%	107.98%
GT-5-SC-#1-10T	96.09%	99.72%	99.76%	99.11%
GT-5-SC-#1-20T	101.05%	97.69%	100.67%	97.86%
GT-5-SC-#2-10T	92.76%	96.69%	99.26%	100.10%
GT-5-SC-#2-20T	102.56%	100.00%	102.60%	100.00%
GT-5-UC-#2-10T	101.01%	103.63%	98.89%	101.43%
GT-5-UC-#2-20T	96.08%	103.18%	105.03%	100.57%
GT-5-UC-#1-10T	99.33%	101.58%	97.39%	98.54%
GT-5-UC-#1-20T	106.76%	103.31%	99.65%	102.20%
GT-7-SC-#1-10T	83.74%	101.00%	101.67%	102.13%
GT-7-SC-#1-20T	110.71%	101.49%	101.70%	100.17%
GT-7-SC-#2-10T	97.64%	97.11%	99.22%	100.00%
GT-7-SC-#2-20T	103.58%	98.39%	98.44%	100.02%
GT-7-UC-#2-10T	99.71%	103.53%	100.59%	96.41%
GT-7-UC-#2-20T	99.71%	101.99%	99.71%	100.34%
GT-7-UC-#1-10T	104.20%	102.71%	99.00%	100.43%
GT-7-UC-#1-20T	106.04%	103.53%	100.70%	102.19%
COL-1-SC-#1-10T	93.13%	98.69%	99.68%	101.24%
COL-1-SC-#1-20T	99.29%	99.53%	97.86%	98.84%
COL-1-SC-#2-20T	98.59%	98.85%	99.44%	99.61%
COL-1-SC-#2-20T	100.73%	100.30%	99.17%	98.57%
COL-1-UC-#2-10T	98.31%	104.26%	101.12%	99.88%
COL-1-UC-#2-20T	98.90%	102.13%	99.22%	98.65%
COL-1-UC-#1-10T	102.03%	101.90%	97.55%	97.52%
COL-1-UC-#1-20T	101.50%	103.19%	100.12%	100.04%
COL-2-SC-#1-10T	90.94%	99.10%	101.33%	102.61%
COL-2-SC-#1-20T	102.49%	97.76%	97.34%	98.80%
COL-2-SC-#2-10T	79.99%	98.43%	101.70%	100.26%
COL-2-SC-#2-20T	102.36%	99.04%	100.84%	99.05%
COL-2-UC-#2-10T	101.88%	102.76%	97.48%	99.83%
COL-2-UC-#2-20T	97.40%	103.95%	101.02%	98.06%
COL-2-UC-#1-10T	88.38%	105.84%	103.79%	96.17%
COL-2-UC-#1-20T	99.86%	101.92%	98.70%	98.28%

APPENDIX X

COMPOSITED SAMPLE ANALYSES FOR PEAKS AND TAILS

EXPERIMENT	SAMPLE NUMBERS BULKED	MAGNESIUM (ppm)	POTASSIUM (ppm)	SODIUM (ppm)	SULFAT (ppm)
GT-2-SC-#1-10T-PEAK	22-46	< 0.10	7.9	82	25
GT-2-SC-#1-10T-TAIL	3-11,50-54	< 0.10	10.0	75	22
GT-2-SC-#1-20T-PEAK	24-47	< 0.10	3.0	81	23
GT-2-SC-#1-20T-TAIL	1-10,60-64	< 0.10	2.9	77	22
GT-2-SC-#2-10T-PEAK	28-44	< 0.10	4.8	130	117
GT-2-SC-#2-10T-TAIL	61-70	< 0.10	4.9	140	114
GT-2-SC-#2-20T-PEAK	27-48	< 0.10	5.0	140	115
GT-2-SC-#2-20T-TAIL	61-70	< 0.10	4.7	130	119
GT-2-UC-#2-10T-PEAK	21-39,45-50	< 0.06	5.4	132	117
GT-2-UC-#2-10T-TAIL	61-70	< 0.06	5.4	130	117
GT-2-UC-#2-20T-PEAK	21-39,45-50	< 0.06	5.3	135	118
GT-2-UC-#2-20T-TAIL	61-70	< 0.06	5.3	133	122
GT-2-UC-#1-10T-PEAK	21-39,45-50	< 0.06	2.0	67	22
GT-2-UC-#1-10T-TAIL	61-70	< 0.06	2.0	67	23
GT-2-UC-#1-20T-PEAK	21-39,45-50	< 0.06	2.2	65	21
GT-2-UC-#1-20T-TAIL	61-70	< 0.06	3.9	61	21
GT-5-SC-#1-10T-PEAK	22-46	0.93	6.9	64	20
GT-5-SC-#1-10T-TAIL	1-10,50-54	0.83	6.6	60	23
GT-5-SC-#1-20T-PEAK	19-47	0.73	6.6	66	20
GT-5-SC-#1-20T-TAIL	1-6,55-64	0.76	6.3	66	22
GT-5-SC-#2-10T-PEAK	23-42	1.79	12.0	73	113
GT-5-SC-#2-10T-TAIL	61-70	0.30	12.0	69	113
GT-5-SC-#2-20T-PEAK	22-38	0.16	12.0	74	113
GT-5-SC-#2-20T-TAIL	61-70	0.15	11.0	76	111
GT-5-UC-#2-10T-PEAK	22-38,45-50	0.09	12.0	72	117
GT-5-UC-#2-10T-TAIL	54-63	0.09	11.0	67	118
GT-5-UC-#2-20T-PEAK	22-38,45-50	0.09	13.0	77	117
GT-5-UC-#2-20T-TAIL	54-63	0.07	11.0	82	109
GT-5-UC-#1-10T-PEAK	22-38,45-50	< 0.06	5.3	57	23
GT-5-UC-#1-10T-TAIL	51-60	< 0.06	5.1	58	24
GT-5-UC-#1-20T-PEAK	22-38,45-50	< 0.06	5.5	58	21
GT-5-UC-#1-20T-TAIL	51-60	< 0.06	5.1	57	21
GT-7-SC-#1-10T-PEAK	21-46	< 0.10	5.5	68	21
GT-7-SC-#1-10T-TAIL	1-12	< 0.10	5.8	62	21
GT-7-SC-#1-20T-PEAK	25-43	0.22	5.1	80	20
GT-7-SC-#1-20T-TAIL	1-10,61-63	0.44	5.6	65	22
GT-7-SC-#2-10T-PEAK	20-37	< 0.10	12.0	76	119
GT-7-SC-#2-10T-TAIL	61-70	< 0.10	12.0	71	115
GT-7-SC-#2-20T-PEAK	21-36	< 0.10	11.0	100	116
GT-7-SC-#2-20T-TAIL	61-70	< 0.10	12.0	71	112
GT-7-UC-#2-10T-PEAK	17-32,39-44	< 0.06	14.0	77	116
GT-7-UC-#2-10T-TAIL	49-58	< 0.06	14.0	71	119
GT-7-UC-#2-20T-PEAK	17-32,39-44	< 0.06	14.0	88	116
GT-7-UC-#2-20T-TAIL	48-57	< 0.06	14.0	69	120
GT-7-UC-#1-10T-PEAK	17-32,39-44	< 0.06	4.9	61	23
GT-7-UC-#1-10T-TAIL	51-60	< 0.06	4.6	58	23
GT-7-UC-#1-20T-PEAK	17-32,39-44	< 0.06	4.9	65	20
GT-7-UC-#1-20T-TAIL	51-60	< 0.06	3.9	61	21
COL-1-SC-#1-10T-PEAK	19-38	< 0.10	5.6	63	19
COL-1-SC-#1-10T-TAIL	1-10,50-54	0.13	5.4	59	21

EXPERIMENT	SAMPLE NUMBERS BULKED	MAGNESIUM (ppm)	POTASSIUM (ppm)	SODIUM (ppm)	SULFA (ppm
COL-1-SC-#1-20T-PEAK	19-36	< 0.10	5.9	64	21
COL-1-SC-#1-20T-TAIL	1-8,59-64	0.10	5.6	60	22
COL-1-SC-#2-10T-PEAK	22-38	0.19	11.0	75	120
COL-1-SC-#2-10T-TAIL	61-70	0.12	11.0	72	107
COL-1-SC-#2-20T-PEAK	19-45	0.10	12.0	78	115
COL-1-SC-#2-20T-TAIL	61-70	< 0.10	11.0	73	112
COL-1-UC-#2-10T-PEAK	17-31,39-44	0.07	12.0	77	116
COL-1-UC-#2-10T-TAIL	51-60	0.08	11.0	71	116
COL-1-UC-#2-20T-PEAK	17-31,39-44	0.08	12.0	78	125
COL-1-UC-#2-20T-TAIL	56-65	0.08	12.0	75	129
COL-1-UC-#1-10T-PEAK	17-31,39-44	< 0.06	6.6	57	23
COL-1-UC-#1-10T-TAIL	51-60	< 0.06	6.2	53	22
COL-1-UC-#1-20T-PEAK	17-31,39-44	< 0.06	6.2	59	20
COL-1-UC-#1-20T-TAIL	51-60	< 0.06	5.6	55	24
COL-2-SC-#1-10T-PEAK	16-46	< 0.10	4.6	125	25
COL-2-SC-#1-10T-TAIL	3-12,51-54	< 0.10	4.1	120	30
COL-2-SC-#1-20T-PEAK	41-65	< 0.10	4.8	140	19
COL-2-SC-#1-20T-TAIL	1-10,73-76	< 0.10	4.3	110	24
COL-2-SC-#2-10T-PEAK	25-42	< 0.10	5.8	170	120
COL-2-SC-#2-10T-TAIL	61-70	< 0.10	5.7	160	115
COL-2-SC-#2-20T-PEAK	24-40	< 0.10	6.6	196	120
COL-2-SC-#2-20T-TAIL	61-70	< 0.10	5.8	172	113
COL-2-UC-#2-10T-PEAK	22-36,46-51	< 0.06	6.8	158	115
COL-2-UC-#2-10T-TAIL	61-70	< 0.06	6.7	151	116
COL-2-UC-#2-20T-PEAK	22-36,46-51	< 0.06	7.0	161	115
COL-2-UC-#2-20T-TAIL	61-70	< 0.06	6.6	153	120
COL-2-UC-#1-10T-PEAK	22-36,46-51	< 0.06	3.3	84	22
COL-2-UC-#1-10T-TAIL	61-70	< 0.06	3.0	83	20
COL-2-UC-#1-20T-PEAK	22-36,46-51	< 0.06	3.5	87	20
COL-2-UC-#1-20T-TAIL	61-70	< 0.06	3.0	71	22

EXPERIMENT	CARBONATE (ppm)	BICARBONATE (ppm)	CALCIUM (ppm)	CHLORIDE (ppm)
GT-2-SC-#1-10T-PEAK		118	0.26	32
GT-2-SC-#1-10T-TAIL		120	0.29	36
GT-2-SC-#1-20T-PEAK		115	0.15	35
GT-2-SC-#1-20T-TAIL		104	0.15	36
GT-2-SC-#2-10T-PEAK		63	0.43	87
GT-2-SC-#2-10T-TAIL		55	0.32	84
GT-2-SC-#2-20T-PEAK		56	0.48	88
GT-2-SC-#2-20T-TAIL		55	0.60	88
GT-2-UC-#2-10T-PEAK		45	0.71	87
GT-2-UC-#2-10T-TAIL		46	1.50	87
GT-2-UC-#2-20T-PEAK		47	0.68	85
GT-2-UC-#2-20T-TAIL		59	0.69	88
GT-2-UC-#1-10T-PEAK		106	0.13	33
GT-2-UC-#1-10T-TAIL		106	0.12	33
GT-2-UC-#1-20T-PEAK		106	0.10	33
GT-2-UC-#1-20T-TAIL		104	0.18	31
GT-5-SC-#1-10T-PEAK		128	9.60	28
GT-5-SC-#1-10T-TAIL		105	7.40	37
GT-5-SC-#1-20T-PEAK		115	8.90	29
GT-5-SC-#1-20T-TAIL		103	7.10	36
GT-5-SC-#2-10T-PEAK		60	50.00	84
GT-5-SC-#2-10T-TAIL		51	49.00	83
GT-5-SC-#2-20T-PEAK		58	54.00	86
GT-5-SC-#2-20T-TAIL		51	47.00	82
GT-5-UC-#2-10T-PEAK		45	61.00	87
GT-5-UC-#2-10T-TAIL		45	58.00	87
GT-5-UC-#2-20T-PEAK		51	59.00	85
GT-5-UC-#2-20T-TAIL		50	49.00	76
GT-5-UC-#1-10T-PEAK		115	11.00	33
GT-5-UC-#1-10T-TAIL		105	10.00	33
GT-5-UC-#1-20T-PEAK		109	10.00	33
GT-5-UC-#1-20T-TAIL		106	8.90	32
GT-7-SC-#1-10T-PEAK		111	8.40	30
GT-7-SC-#1-10T-TAIL		96	9.50	35
GT-7-SC-#1-20T-PEAK		145	5.60	28
GT-7-SC-#1-20T-TAIL		100	8.60	39
GT-7-SC-#2-10T-PEAK		55	46.00	88
GT-7-SC-#2-10T-TAIL		51	52.00	84
GT-7-SC-#2-20T-PEAK		55	34.00	89
GT-7-SC-#2-20T-TAIL		56	53.00	82
GT-7-UC-#2-10T-PEAK		49	57.00	86
GT-7-UC-#2-10T-TAIL	0.0	47	63.00	87
GT-7-UC-#2-20T-PEAK		59	52.00	85
GT-7-UC-#2-20T-TAIL		51	61.00	84
GT-7-UC-#1-10T-PEAK		123	11.00	33
GT-7-UC-#1-10T-TAIL		107	10.00	32
GT-7-UC-#1-20T-PEAK	3.6	101	8.40	33
GT-7-UC-#1-20T-TAIL		104	5.70	32
COL-1-SC-#1-10T-PEAK		140	15.00	26
COL-1-SC-#1-10T-TAIL		114	13.00	35
COL-1-SC-#1-20T-PEAK		127	16.00	30

EXPERIMENT	CARBONATE (ppm)	BICARBONATE (ppm)	CALCIUM (ppm)	CHLORIDE (ppm)
COL-1-SC-#1-20T-TAIL		114	14.00	37
COL-1-SC-#2-10T-PEAK		78	57.00	89
COL-1-SC-#2-10T-TAIL		67	56.00	80
COL-1-SC-#2-20T-PEAK		83	57.00	88
COL-1-SC-#2-20T-TAIL		65	52.00	83
COL-1-UC-#2-10T-PEAK		62	64.00	89
COL-1-UC-#2-10T-TAIL		58	68.00	87
COL-1-UC-#2-20T-PEAK		65	64.00	89
COL-1-UC-#2-20T-TAIL		59	64.00	90
COL-1-UC-#1-10T-PEAK		123	16.00	34
COL-1-UC-#1-10T-TAIL		116	14.00	32
COL-1-UC-#1-20T-PEAK		117	15.00	34
COL-1-UC-#1-20T-TAIL		113	13.00	37
COL-2-SC-#1-10T-PEAK	21.0	175	0.75	29
COL-2-SC-#1-10T-TAIL	7.9	191	0.73	36
COL-2-SC-#1-20T-PEAK	28.0	176	0.82	33
COL-2-SC-#1-20T-TAIL	7.2	192	0.68	38
COL-2-SC-#2-10T-PEAK		147	1.60	90
COL-2-SC-#2-10T-TAIL		126	1.40	86
COL-2-SC-#2-20T-PEAK	18.0	118	2.00	92
COL-2-SC-#2-20T-TAIL		124	2.20	84
COL-2-UC-#2-10T-PEAK	5.0	93	4.50	89
COL-2-UC-#2-10T-TAIL		110	4.30	89
COL-2-UC-#2-20T-PEAK	10.0	76	2.70	86
COL-2-UC-#2-20T-TAIL		109	2.30	89
COL-2-UC-#1-10T-PEAK	9.0	142	0.98	33
COL-2-UC-#1-10T-TAIL	11.0	94	0.73	29
COL-2-UC-#1-20T-PEAK	11.0	114	1.00	33
COL-2-UC-#1-20T-TAIL	9.1	92	0.74	31

EXPERIMENT	SPECIFIC CONDUCTANCE (micromho)	pH	DISSOLVED SILICA (ppm)	ALUMINUM (ppm)
GT-2-SC-#1-10T-PEAK	341	8.1	8.40	0.10
GT-2-SC-#1-10T-TAIL	347	8.2	6.80	0.22
GT-2-SC-#1-20T-PEAK	353	8.1	7.00	< 0.06
GT-2-SC-#1-20T-TAIL	333	8.2	5.20	< 0.06
GT-2-SC-#2-10T-PEAK	676	8.1	4.70	< 0.06
GT-2-SC-#2-10T-TAIL	662	8.0	5.90	< 0.06
GT-2-SC-#2-20T-PEAK	671	7.9	5.80	< 0.06
GT-2-SC-#2-20T-TAIL	658	7.9	4.00	< 0.06
GT-2-UC-#2-10T-PEAK	653	7.6	16.00	< 0.10
GT-2-UC-#2-10T-TAIL	653	7.4	17.00	< 0.10
GT-2-UC-#2-20T-PEAK	653	7.7	17.00	< 0.10
GT-2-UC-#2-20T-TAIL	653	7.2	16.00	< 0.10
GT-2-UC-#1-10T-PEAK	299	8.0	17.00	< 0.10
GT-2-UC-#1-10T-TAIL	299	8.1	17.00	< 0.10
GT-2-UC-#1-20T-PEAK	307	8.2	19.00	< 0.10
GT-2-UC-#1-20T-TAIL	290	7.7	17.00	< 0.10
GT-5-SC-#1-10T-PEAK	342	8.3	2.30	0.06
GT-5-SC-#1-10T-TAIL	336	8.1	2.60	< 0.06
GT-5-SC-#1-20T-PEAK	341	8.3	2.00	0.06
GT-5-SC-#1-20T-TAIL	340	8.2	2.10	< 0.06
GT-5-SC-#2-10T-PEAK	645	7.9	2.10	< 0.06
GT-5-SC-#2-10T-TAIL	641	7.9	1.60	< 0.06
GT-5-SC-#2-20T-PEAK	658	7.9	1.20	< 0.06
GT-5-SC-#2-20T-TAIL	637	7.8	1.40	< 0.06
GT-5-UC-#2-10T-PEAK	653	7.6	4.70	< 0.10
GT-5-UC-#2-10T-TAIL	653	7.5	4.90	< 0.10
GT-5-UC-#2-20T-PEAK	653	7.6	4.50	< 0.10
GT-5-UC-#2-20T-TAIL	653	7.4	4.30	< 0.10
GT-5-UC-#1-10T-PEAK	317	8.0	4.30	< 0.10
GT-5-UC-#1-10T-TAIL	299	7.9	4.30	< 0.10
GT-5-UC-#1-20T-PEAK	327	8.1	4.30	< 0.10
GT-5-UC-#1-20T-TAIL	299	7.7	4.50	< 0.10
GT-7-SC-#1-10T-PEAK	346	8.3	0.85	0.06
GT-7-SC-#1-10T-TAIL	337	8.1	0.80	0.07
GT-7-SC-#1-20T-PEAK	379	8.2	0.70	0.11
GT-7-SC-#1-20T-TAIL	333	8.1	1.20	0.08
GT-7-SC-#2-10T-PEAK	633	8.0	0.75	< 0.06
GT-7-SC-#2-10T-TAIL	633	7.7	0.60	< 0.06
GT-7-SC-#2-20T-PEAK	704	7.9	0.60	< 0.06
GT-7-SC-#2-20T-TAIL	641	7.9	2.90	< 0.06
GT-7-UC-#2-10T-PEAK	653	7.6	3.20	< 0.10
GT-7-UC-#2-10T-TAIL	653	7.5	3.90	< 0.10
GT-7-UC-#2-20T-PEAK	653	7.7	3.60	< 0.10
GT-7-UC-#2-20T-TAIL	653	7.3	4.70	< 0.10
GT-7-UC-#1-10T-PEAK	327	8.2	3.20	< 0.10
GT-7-UC-#1-10T-TAIL	299	8.1	3.60	< 0.10
GT-7-UC-#1-20T-PEAK	337	8.4	3.90	< 0.10
GT-7-UC-#1-20T-TAIL	290	7.8	3.60	< 0.10
COL-1-SC-#1-10T-PEAK	351	8.3	20.00	< 0.06
COL-1-SC-#1-10T-TAIL	365	8.2	20.00	< 0.06

EXPERIMENT	SPECIFIC CONDUCTANCE (micromho)	pH	DISSOLVED SILICA (ppm)	ALUMINUM (ppm)
COL-1-SC-#1-20T-PEAK	358	8.3	22.00	0.07
COL-1-SC-#1-20T-TAIL	346	8.1	25.00	< 0.06
COL-1-SC-#2-10T-PEAK	641	8.1	22.00	< 0.06
COL-1-SC-#2-10T-TAIL	654	7.8	19.00	< 0.06
COL-1-SC-#2-20T-PEAK	690	8.0	23.00	< 0.06
COL-1-SC-#2-20T-TAIL	667	7.7	18.00	< 0.06
COL-1-UC-#2-10T-PEAK	653	7.6	54.00	< 0.10
COL-1-UC-#2-10T-TAIL	653	7.6	53.00	< 0.10
COL-1-UC-#2-20T-PEAK	653	7.7	53.00	< 0.10
COL-1-UC-#2-20T-TAIL	653	7.4	52.00	< 0.10
COL-1-UC-#1-10T-PEAK	327	7.9	54.00	< 0.10
COL-1-UC-#1-10T-TAIL	307	8.0	50.00	< 0.10
COL-1-UC-#1-20T-PEAK	337	8.1	54.00	< 0.10
COL-1-UC-#1-20T-TAIL	307	7.9	49.00	< 0.10
COL-2-SC-#1-10T-PEAK	529	9.0	29.00	< 0.06
COL-2-SC-#1-10T-TAIL	510	8.9	23.00	< 0.06
COL-2-SC-#1-20T-PEAK	585	8.9	28.00	< 0.06
COL-2-SC-#1-20T-TAIL	513	8.9	22.00	< 0.06
COL-2-SC-#2-10T-PEAK	763	8.9	21.00	< 0.06
COL-2-SC-#2-10T-TAIL	752	7.9	22.00	< 0.06
COL-2-SC-#2-20T-PEAK	840	9.0	20.00	< 0.06
COL-2-SC-#2-20T-TAIL	741	7.9	19.00	< 0.06
COL-2-UC-#2-10T-PEAK	697	8.4	55.00	< 0.10
COL-2-UC-#2-10T-TAIL	697	7.9	56.00	< 0.10
COL-2-UC-#2-20T-PEAK	746	8.4	48.00	< 0.10
COL-2-UC-#2-20T-TAIL	746	7.7	49.00	< 0.10
COL-2-UC-#1-10T-PEAK	402	8.4	42.00	< 0.10
COL-2-UC-#1-10T-TAIL	373	8.6	40.00	< 0.10
COL-2-UC-#1-20T-PEAK	410	8.6	40.00	< 0.10
COL-2-UC-#1-20T-TAIL	360	8.9	41.00	< 0.10

EXPERIMENT	SUMMATION CATIONS (meq)	SUMMATION ANIONS (meq)	PERCENT DIFFERENCE
GT-2-SC-#1-10T-PEAK	0.003782	0.003504	7.631073
GT-2-SC-#1-10T-TAIL	0.003533	0.003441	2.638371
GT-2-SC-#1-20T-PEAK	0.003608	0.003661	-1.458247
GT-2-SC-#1-20T-TAIL	0.003431	0.003178	7.656226
GT-2-SC-#2-10T-PEAK	0.005799	0.006004	-3.473693
GT-2-SC-#2-10T-TAIL	0.006231	0.005645	9.868643
GT-2-SC-#2-20T-PEAK	0.006241	0.006124	1.892438
GT-2-SC-#2-20T-TAIL	0.005805	0.005861	-0.960055
GT-2-UC-#2-10T-PEAK	0.005915	0.005767	2.539197
GT-2-UC-#2-10T-TAIL	0.005868	0.005644	3.897092
GT-2-UC-#2-20T-PEAK	0.006042	0.005909	2.218117
GT-2-UC-#2-20T-TAIL	0.005955	0.005988	-0.559327
GT-2-UC-#1-10T-PEAK	0.002972	0.003265	-9.395543
GT-2-UC-#1-10T-TAIL	0.002971	0.003147	-5.753514
GT-2-UC-#1-20T-PEAK	0.002889	0.003383	-15.752550
GT-2-UC-#1-20T-TAIL	0.002763	0.003017	-8.789610
GT-5-SC-#1-10T-PEAK	0.003516	0.003460	1.605505
GT-5-SC-#1-10T-TAIL	0.003216	0.003244	-0.866873
GT-5-SC-#1-20T-PEAK	0.003544	0.003452	2.630074
GT-5-SC-#1-20T-TAIL	0.003449	0.003162	8.682499
GT-5-SC-#2-10T-PEAK	0.006125	0.005795	5.536913
GT-5-SC-#2-10T-TAIL	0.005778	0.005530	4.386275
GT-5-SC-#2-20T-PEAK	0.006234	0.006171	1.015719
GT-5-SC-#2-20T-TAIL	0.005945	0.005460	8.505042
GT-5-UC-#2-10T-PEAK	0.006490	0.005767	11.802707
GT-5-UC-#2-10T-TAIL	0.006097	0.005646	7.685051
GT-5-UC-#2-20T-PEAK	0.006633	0.005933	11.137888
GT-5-UC-#2-20T-TAIL	0.006299	0.005245	18.265702
GT-5-UC-#1-10T-PEAK	0.003164	0.003434	-8.184298
GT-5-UC-#1-10T-TAIL	0.003152	0.003152	0.000000
GT-5-UC-#1-20T-PEAK	0.003163	0.003432	-8.157695
GT-5-UC-#1-20T-TAIL	0.003054	0.003078	-0.782779
GT-7-SC-#1-10T-PEAK	0.003518	0.003255	7.766130
GT-7-SC-#1-10T-TAIL	0.003319	0.002998	10.163052
GT-7-SC-#1-20T-PEAK	0.003908	0.003956	-1.220753
GT-7-SC-#1-20T-TAIL	0.003436	0.003197	7.206392
GT-7-SC-#2-10T-PEAK	0.005908	0.005955	-0.792380
GT-7-SC-#2-10T-TAIL	0.005990	0.005600	6.729940
GT-7-SC-#2-20T-PEAK	0.006328	0.006269	0.936731
GT-7-SC-#2-20T-TAIL	0.006040	0.005563	8.222012
GT-7-UC-#2-10T-PEAK	0.006552	0.005790	12.340619
GT-7-UC-#2-10T-TAIL	0.006590	0.005696	14.555388
GT-7-UC-#2-20T-PEAK	0.006781	0.006070	11.060869
GT-7-UC-#2-20T-TAIL	0.006403	0.005686	11.856686
GT-7-UC-#1-10T-PEAK	0.003328	0.003565	-6.876541
GT-7-UC-#1-10T-TAIL	0.003140	0.003136	0.127470
GT-7-UC-#1-20T-PEAK	0.003372	0.003400	-0.826934
GT-7-UC-#1-20T-TAIL	0.003038	0.003045	-0.230150
COL-1-SC-#1-10T-PEAK	0.003632	0.003612	0.552181
COL-1-SC-#1-10T-TAIL	0.003364	0.003293	2.133093

EXPERIMENT	SUMMATION CATIONS (meq)	SUMMATION ANIONS (meq)	PERCENT DIFFERENCE
COL-1-SC-#1-20T-PEAK	0.003733	0.003801	-1.805150
COL-1-SC-#1-20T-TAIL	0.003460	0.003371	2.605768
COL-1-SC-#2-10T-PEAK	0.006404	0.006380	0.375469
COL-1-SC-#2-10T-TAIL	0.006217	0.005583	10.745763
COL-1-SC-#2-20T-PEAK	0.006552	0.006562	-0.152509
COL-1-SC-#2-20T-TAIL	0.006051	0.005739	5.292621
COL-1-UC-#2-10T-PEAK	0.006856	0.006064	12.261253
COL-1-UC-#2-10T-TAIL	0.006769	0.005823	15.032274
COL-1-UC-#2-20T-PEAK	0.006900	0.006444	6.834468
COL-1-UC-#2-20T-TAIL	0.006769	0.006202	8.748617
COL-1-UC-#1-10T-PEAK	0.003447	0.003583	-3.869132
COL-1-UC-#1-10T-TAIL	0.003163	0.003262	-3.081712
COL-1-UC-#1-20T-PEAK	0.003473	0.003550	-2.192795
COL-1-UC-#1-20T-TAIL	0.003184	0.003396	-6.443769
COL-2-SC-#1-10T-PEAK	0.005592	0.005043	10.324401
COL-2-SC-#1-10T-TAIL	0.005361	0.005034	6.291486
COL-2-SC-#1-20T-PEAK	0.006253	0.005396	14.713709
COL-2-SC-#1-20T-TAIL	0.004929	0.004959	-0.606796
COL-2-SC-#2-10T-PEAK	0.007623	0.007529	1.240760
COL-2-SC-#2-10T-TAIL	0.007175	0.006886	4.110661
COL-2-SC-#2-20T-PEAK	0.008794	0.008033	9.044987
COL-2-SC-#2-20T-TAIL	0.007740	0.006755	13.590893
COL-2-UC-#2-10T-PEAK	0.007271	0.006754	7.372536
COL-2-UC-#2-10T-TAIL	0.006954	0.006722	3.393883
COL-2-UC-#2-20T-PEAK	0.007317	0.006687	8.992319
COL-2-UC-#2-20T-TAIL	0.006939	0.006819	1.751066
COL-2-UC-#1-10T-PEAK	0.003787	0.004155	-9.267187
COL-2-UC-#1-10T-TAIL	0.003723	0.003142	16.926438
COL-2-UC-#1-20T-PEAK	0.003924	0.003860	1.644399
COL-2-UC-#1-20T-TAIL	0.003202	0.003144	1.827923

APPENDIX XI

COLUMN EFFLUENT ANALYSES FROM UNSATURATED FLOW EXPERIMENTS

GT-2-UC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.04				
2	0.12				
3	0.19				
4	0.25				
5	0.30				
6	0.35				
7	0.40				
8	0.45				
9	0.49				
10	0.53				
11	0.58	0.01			
12	0.62	0.01	0.13	0.00	
13	0.66	0.01	0.21	0.00	
14	0.71	0.01	0.32	0.14	
15	0.75	0.02	0.49	0.32	
16	0.79	0.03	0.56	0.44	
17	0.84	0.04	0.73	0.64	0.00
18	0.88	0.07	0.86	0.81	0.09
19	0.92	0.12	0.93	0.91	0.13
20	0.96	0.17	0.99	0.98	0.17
21	1.00	0.24			0.21
22	1.04	0.32			0.27
23	1.08	0.41			0.38
24	1.16	0.62			0.55
25	1.27	0.82	1.03	1.03	0.75
26	1.34	0.90			0.82
27	1.42	0.96			
28	1.48				
29	1.53	0.96			
30	1.57				
31	1.61	0.96	1.03	1.04	0.93
32	1.65				
33	1.69	0.97			
34	1.73				
35	1.78	0.98			
36	1.82	0.98			1.00
37	1.86	0.98	0.98	0.97	
38	1.91				
39	1.96	0.98	0.83	0.78	
40	2.00		0.71	0.60	
41	2.06	0.95	0.54	0.39	
42	2.13	0.93	0.28	0.09	
43	2.20	0.88	0.11	0.00	0.95
44	2.27	0.78			0.85
45	2.33	0.64			0.64
46	2.39	0.48			0.54

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.45	0.33			0.42
48	2.51	0.21			0.32
49	2.56	0.13			0.19
50	2.61	0.08			0.17
51	2.67	0.05			
52	2.72	0.03			
53	2.77	0.02			
54	2.82	0.01			
55	2.87	0.01			
56	2.91				
57	2.96				
58	3.01				
59	3.05				
60	3.10				

GT-2-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.05				
2	0.12				
3	0.16				
4	0.21				
5	0.26				
6	0.30				
7	0.35				
8	0.39				
9	0.44				
10	0.49				
11	0.53				
12	0.58		0.07	0.00	
13	0.63		0.14	0.06	
14	0.68		0.25	0.16	
15	0.73	0.00	0.40	0.32	
16	0.78	0.01	0.55	0.48	
17	0.83	0.03	0.70	0.65	
18	0.88	0.06	0.85	0.83	0.10
19	0.93	0.11	0.95	0.93	0.15
20	0.98	0.20			0.22
21	1.03	0.30			0.33
22	1.08	0.43	1.05	1.05	
23	1.13	0.55			0.54
24	1.18	0.66			0.66
25	1.23	0.76	0.96	0.97	0.72
26	1.27	0.83			
27	1.32	0.88			0.88
28	1.37		0.99	1.00	0.89
29	1.41				
30	1.46	0.97			
31	1.50		0.97	0.97	
32	1.55				
33	1.59	1.01			
34	1.63		1.01	1.02	
35	1.68				
36	1.72	1.00			0.91
37	1.76		1.03	1.02	
38	1.80	1.00			
39	1.86				
40	1.93	0.98	1.01	1.00	
41	2.00	0.98	0.87	0.83	
42	2.07	0.98	0.59	0.00	1.01
43	2.16	0.97	0.26	0.17	0.99
44	2.24	0.93	0.08	0.02	0.89
45	2.31	0.80			0.83
46	2.37	0.64			0.69

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.42	0.49			0.57
48	2.47	0.34			
49	2.51	0.24			0.31
50	2.55	0.17			0.28
51	2.60	0.12			
52	2.64	0.09			0.17
53	2.69	0.07			0.16
54	2.73				
55	2.78				
56	2.82				
57	2.87				
58	2.91				
59	2.96				
60	3.00				

GT-2-UC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.04				
2	0.11				
3	0.16				
4	0.21				
5	0.28				
6	0.33				
7	0.38				
8	0.43				
9	0.48				
10	0.53				
11	0.57		0.17	0.00	
12	0.62		0.26	0.09	
13	0.67				
14	0.71		0.50	0.35	
15	0.76	0.04			
16	0.81	0.06	0.83	0.78	
17	0.86	0.09	0.92	0.89	0.00
18	0.91	0.13	0.98	0.97	0.00
19	0.95	0.19	1.00	0.99	0.14
20	1.00	0.26			0.18
21	1.05	0.36			0.22
22	1.10	0.47			0.29
23	1.16	0.59			0.40
24	1.21	0.70			0.51
25	1.26	0.78	1.00	0.98	0.66
26	1.31	0.86			
27	1.36	0.90			0.73
28	1.42				
29	1.49				
30	1.56	0.97			0.92
31	1.62		1.01	1.00	
32	1.68				
33	1.74	0.97			
34	1.79		0.99	0.99	
35	1.84		0.97	0.97	
36	1.89	0.97	0.96	0.92	0.96
37	1.95		0.89	0.83	
38	2.00	0.98	0.80	0.72	
39	2.05		0.72	0.61	
40	2.10	0.97			
41	2.16				
42	2.22	0.90	0.16	0.00	1.00
43	2.28	0.85			
44	2.34	0.79			0.85
45	2.40	0.69			0.72
46	2.45	0.58			0.70

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.50	0.46			0.60
48	2.55	0.34			
49	2.60	0.24			0.42
50	2.65	0.17			
51	2.70	0.11			
52	2.75	0.08			0.18
53	2.80	0.06			
54	2.85	0.04			0.11
55	2.89				
56	2.94				
57	2.99				
58	3.03				
59	3.08				
60	3.13				

GT-2-UC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.06				
3	0.11				
4	0.17				
5	0.22				
6	0.27				
7	0.32				
8	0.37				
9	0.41				
10	0.46				
11	0.50				
12	0.54		0.06	0.00	
13	0.59		0.14	0.00	
14	0.63	0.01	0.27	0.17	
15	0.68	0.01	0.43	0.33	
16	0.72	0.01	0.63	0.55	
17	0.77	0.03	0.81	0.78	
18	0.81	0.05	0.92	0.91	0.06
19	0.86	0.08	0.97	0.97	0.09
20	0.90	0.13			0.14
21	0.95	0.21			0.21
22	0.99	0.32			
23	1.04	0.45			0.35
24	1.08	0.58			0.53
25	1.13	0.71	1.02	1.02	0.74
26	1.18	0.79			
27	1.23	0.86			0.80
28	1.30				
29	1.37				0.88
30	1.46	0.97			
31	1.52		1.02	1.01	
32	1.56				
33	1.60	0.97			
34	1.64				
35	1.68				
36	1.72	0.98			0.95
37	1.76		0.97	0.96	
38	1.80	1.01	0.94	0.92	
39	1.84		0.86	0.83	
40	1.88	1.00	0.73	0.67	
41	1.93		0.56	0.47	
42	1.97	0.95	0.38	0.28	
43	2.03	0.92	0.16	0.11	0.95
44	2.09	0.88	0.06	0.00	0.89
45	2.15	0.81			0.85
46	2.21	0.70			0.75

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.26	0.54			0.59
48	2.32	0.39			
49	2.37	0.25			0.36
50	2.42	0.16			0.27
51	2.47	0.11			
52	2.51	0.08			0.14
53	2.56	0.06			0.10
54	2.61	0.04			0.07
55	2.66	0.03			
56	2.70	0.03			
57	2.75	0.02			
58	2.80				
59	2.85				
60	2.89				

GT-5-UC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.14				
4	0.19				
5	0.24				
6	0.30				
7	0.35				
8	0.40				
9	0.46				
10	0.51				
11	0.57				
12	0.63				0.00
13	0.68	0.01			0.00
14	0.74	0.04	0.12	0.00	0.00
15	0.80	0.12	0.25	0.06	0.00
16	0.85	0.26	0.45	0.28	0.00
17	0.91	0.46	0.67	0.54	0.14
18	0.97	0.65	0.85	0.78	0.41
19	1.02	0.78	0.97	0.95	0.50
20	1.08	0.88	1.00	1.00	0.63
21	1.13	0.93			0.73
22	1.19	0.92			
23	1.24	0.97			
24	1.30	0.96			0.92
25	1.36		1.03	1.03	
26	1.41	0.97			
27	1.47	0.98			
28	1.53	0.98			1.00
29	1.58	0.98	1.02	1.04	
30	1.64				
31	1.70	0.98			
32	1.75				0.93
33	1.81	0.98	1.01	1.02	
34	1.87	0.99			
35	1.92	1.00			
36	1.98				0.93
37	2.04	0.99	1.02	1.03	
38	2.10	0.97	0.95	0.93	
39	2.17	0.88	0.84	0.77	
40	2.24	0.64	0.59	0.47	0.93
41	2.30	0.50	0.38	0.18	0.75
42	2.35	0.33	0.22	0.00	0.68
43	2.40	0.19	0.11	0.00	0.57
44	2.46	0.10			0.42
45	2.51	0.05			
46	2.57	0.02			0.24

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.62	0.01			
48	2.68	0.01			
49	2.74				
50	2.80				
51	2.85				
52	2.91				
53	2.97				

GT-5-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.10				
3	0.15				
4	0.20				
5	0.26				
6	0.31				
7	0.36				
8	0.42				
9	0.47				
10	0.53				
11	0.58				
12	0.64			0.00	
13	0.69	0.01	0.04	0.03	
14	0.75	0.04	0.11	0.09	0.00
15	0.81	0.12	0.24	0.22	0.00
16	0.86	0.25	0.44	0.43	0.06
17	0.92	0.44	0.65	0.72	0.19
18	0.98	0.62	0.81	0.92	0.29
19	1.03	0.77	0.93	0.98	0.46
20	1.09	0.88	0.99	0.99	0.63
21	1.14	0.93	1.01	1.00	0.74
22	1.20	0.96			0.82
23	1.25				
24	1.31				
25	1.36	0.97	1.02	1.01	
26	1.42				
27	1.47	0.98			0.91
28	1.53				
29	1.58	0.99	1.01	1.01	
30	1.64				
31	1.70	0.98			
32	1.75				
33	1.81	1.00	1.01	1.01	0.98
34	1.87				
35	1.93	0.99			
36	1.98				
37	2.04	0.99	1.00	1.00	0.99
38	2.11	0.95	0.97	0.99	1.01
39	2.17	0.89	0.86	0.94	0.95
40	2.22	0.76	0.71	0.83	0.95
41	2.27	0.63	0.51	0.57	0.86
42	2.32	0.44	0.31	0.34	0.78
43	2.38	0.27	0.17	0.18	0.52
44	2.43	0.14	0.08	0.07	0.47
45	2.48	0.07		0.03	0.36
46	2.54	0.03			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.60	0.02			
48	2.65				
49	2.71				
50	2.76				
51	2.82				
52	2.88				
53	2.94				

GT-5-UC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.04				
2	0.11				
3	0.16				
4	0.22				
5	0.28				
6	0.33				
7	0.39				
8	0.45				
9	0.51				
10	0.57				
11	0.63				
12	0.69	0.01			
13	0.75	0.04	0.12	0.00	
14	0.81	0.12	0.27	0.09	
15	0.87	0.26	0.49	0.33	0.00
16	0.93	0.44	0.70	0.58	0.00
17	0.99	0.64	0.87	0.84	0.19
18	1.05	0.80	0.97	0.96	0.34
19	1.11	0.87	1.01	1.01	0.54
20	1.17	0.94	0.97	0.97	0.70
21	1.23	0.96			0.80
22	1.29				0.88
23	1.35				
24	1.41				
25	1.46	0.95	1.02	1.03	
26	1.52				
27	1.58	0.98			0.96
28	1.64				
29	1.70	0.97	1.01	1.02	
30	1.76				
31	1.82	0.98			
32	1.88				
33	1.94	0.98	1.00	1.01	1.00
34	2.00				
35	2.06	0.99			
36	2.12				
37	2.19	0.99	0.97	0.96	1.00
38	2.25	0.91	0.91	0.89	
39	2.31	0.79	0.67	0.56	1.00
40	2.37	0.59	0.40	0.23	1.00
41	2.42	0.39	0.20	0.00	0.81
42	2.48	0.21	0.10	0.00	0.70
43	2.53	0.11			0.56
44	2.58	0.05			0.43
45	2.64	0.03			0.33
46	2.69	0.01			0.21

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.75	0.01			0.16
48	2.81	0.01			
49	2.87				
50	2.93				

GT-5-UC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.04				
2	0.10				
3	0.16				
4	0.21				
5	0.27				
6	0.33				
7	0.38				
8	0.43				
9	0.49				
10	0.54				
11	0.59				
12	0.65	0.01	0.03	0.00	
13	0.71	0.04	0.10	0.00	
14	0.76	0.09	0.22	0.12	
15	0.82	0.21	0.41	0.29	0.00
16	0.88	0.38	0.63	0.55	0.11
17	0.93	0.59	0.81	0.77	0.20
18	0.99	0.74	0.94	0.92	0.32
19	1.05	0.87	1.00	1.00	0.56
20	1.11	0.93			0.69
21	1.17	0.94			0.79
22	1.23	0.96			0.88
23	1.29				
24	1.34				
25	1.40	0.98	1.03	1.03	
26	1.45				
27	1.51	0.98			1.00
28	1.57				
29	1.63	0.99	1.02	1.02	
30	1.69				
31	1.74	0.99			
32	1.80				
33	1.86	0.99	1.01	1.01	1.00
34	1.92				
35	1.98	0.99			
36	2.04		1.06	1.07	
37	2.09	0.98	0.96	0.95	
38	2.15	0.94			
39	2.21	0.85	0.72	0.66	1.00
40	2.27	0.71	0.49	0.39	0.91
41	2.34	0.46	0.28	0.16	0.85
42	2.41	0.23	0.10	0.00	0.72
43	2.48	0.10	0.04	0.00	0.53
44	2.53	0.05			0.42
45	2.58	0.02			0.30
46	2.64	0.01			0.19

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.70	0.01			0.15
48	2.76	0.01			0.10
49	2.81				
50	2.87				

GT-7-UC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.06				
2	0.15				
3	0.22				
4	0.30				
5	0.37				
6	0.46	0.01			
7	0.54	0.01			
8	0.62	0.01			0.00
9	0.70	0.03	0.07	0.00	0.00
10	0.79	0.15	0.23	0.03	0.14
11	0.87	0.38	0.49	0.34	0.36
12	0.96	0.63	0.76	0.67	0.68
13	1.04	0.80	0.91	0.89	0.82
14	1.13	0.87	0.95	0.94	0.97
15	1.21	0.91	0.98	0.99	0.97
16	1.29	0.92			0.98
17	1.38	0.93			
18	1.46	0.95			
19	1.54	0.95			
20	1.62		1.01	1.03	1.00
21	1.70	0.96			
22	1.78				
23	1.86	0.97			
24	1.95		1.01	1.04	1.00
25	2.03	0.96			
26	2.10	0.93			
27	2.18	0.97			
28	2.27		1.02	1.04	
29	2.35	0.98			1.00
30	2.43	0.98			
31	2.51	0.98			
32	2.60				
33	2.68	0.97	0.97	0.97	0.85
34	2.76	0.83	0.81	0.77	0.85
35	2.85	0.60	0.58	0.45	0.72
36	2.93	0.35	0.35	0.15	0.45
37	3.02	0.18	0.16	0.00	0.27
38	3.10	0.09	0.10	0.00	0.14
39	3.18	0.06			0.10
40	3.27	0.03			0.00
41	3.36	0.02			
42	3.44	0.01			
43	3.53	0.01			
44	3.61				
45	3.70				
46	3.79				

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	3.87				
48	3.96				

GT-7-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.06				
2	0.16				
3	0.24				
4	0.32				
5	0.40				
6	0.47				
7	0.55				
8	0.64	0.01	0.00	0.00	
9	0.72	0.06	0.09	0.02	0.00
10	0.80	0.21	0.29	0.20	0.14
11	0.88	0.45	0.53	0.46	0.36
12	0.97	0.66	0.76	0.72	0.58
13	1.06	0.81	0.88	0.86	0.75
14	1.14	0.88	0.92	0.92	0.81
15	1.23	0.91	0.96	0.98	0.89
16	1.31	0.93			0.92
17	1.40	0.94			0.92
18	1.48	0.95			0.93
19	1.56				
20	1.65	0.97	1.01	1.02	1.00
21	1.73				
22	1.81	0.97			
23	1.89				
24	1.98		1.00	1.01	
25	2.06	0.98			0.99
26	2.14				
27	2.22				
28	2.30	0.98	1.01	1.01	
29	2.38				
30	2.46				
31	2.54	0.98			
32	2.62				
33	2.70	0.99	1.01	1.00	0.98
34	2.78	0.95	0.95	0.95	0.98
35	2.86	0.81	0.77	0.74	0.83
36	2.94	0.58	0.55	0.52	0.68
37	3.03	0.34	0.32	0.23	0.45
38	3.14	0.16	0.15	0.07	0.25
39	3.26	0.08	0.09	0.02	0.11
40	3.36	0.05	0.07	0.00	0.09
41	3.44	0.04			
42	3.52	0.03			
43	3.60				
44	3.68				
45	3.76				
46	3.84				

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	3.92				

GT-7-UC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.05				
2	0.13				
3	0.21				
4	0.29				
5	0.38				
6	0.46				
7	0.55	0.01			
8	0.63	0.03	0.05	0.00	
9	0.72	0.12	0.18	0.00	0.00
10	0.80	0.31	0.40	0.22	0.26
11	0.89	0.53	0.62	0.49	0.44
12	0.98	0.71	0.81	0.75	0.57
13	1.06	0.82	0.92	0.89	0.77
14	1.16	0.86	0.97	0.96	0.88
15	1.24	0.90	1.02	1.03	0.92
16	1.33	0.92			0.96
17	1.42	0.93			
18	1.50	0.93			0.96
19	1.59				
20	1.67	0.94	1.02	1.03	0.96
21	1.76				
22	1.85	0.96			
23	1.94				
24	2.03		1.03	1.04	
25	2.12	0.96			1.00
26	2.20				
27	2.29				
28	2.38	0.96	1.02	1.03	
29	2.47				
30	2.56				
31	2.65	0.98			
32	2.74		1.01	1.03	
33	2.83	0.94	0.94	0.92	0.96
34	2.92	0.77	0.72	0.61	0.84
35	3.01	0.54			0.65
36	3.10	0.31	0.26	0.08	0.41
37	3.19	0.17	0.14	0.00	0.24
38	3.28	0.10			0.14
39	3.38	0.07			0.11
40	3.49	0.04			0.00
41	3.57	0.03			0.00
42	3.66	0.02			
43	3.75	0.01			
44	3.83				
45	3.92				
46	4.01				

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	4.10				
48	4.19				
49	4.28				
50	4.37				

GT-7-UC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.06				
2	0.16				
3	0.24				
4	0.33				
5	0.41				
6	0.49				
7	0.58	0.02			
8	0.65	0.04	0.06	0.00	
9	0.73	0.15	0.21	0.11	0.10
10	0.80	0.34	0.44	0.33	0.28
11	0.88	0.55	0.66	0.59	0.47
12	0.95	0.71	0.84	0.81	0.73
13	1.03	0.82	0.93	0.90	0.83
14	1.11	0.87	0.96	0.95	0.94
15	1.19	0.92			0.94
16	1.27	0.93			0.94
17	1.35	0.94			0.98
18	1.44	0.95			
19	1.52				
20	1.61	0.98	1.03	1.04	1.02
21	1.69				
22	1.78	0.96			
23	1.86				
24	1.94		1.05	1.05	
25	2.03	0.97			1.02
26	2.11				
27	2.19				
28	2.28	0.98	1.01	1.02	
29	2.37				
30	2.45				0.98
31	2.54	0.99			
32	2.62		1.07	1.08	
33	2.70	0.97	0.97	0.97	
34	2.78	0.87	0.80	0.76	0.94
35	2.86	0.65	0.60	0.52	0.78
36	2.95	0.41	0.35	0.23	0.49
37	3.03	0.24	0.19	0.09	0.32
38	3.12	0.14	0.11	0.00	0.22
39	3.21	0.09	0.08	0.00	0.13
40	3.30	0.06			0.09
41	3.39	0.04			0.06
42	3.51	0.03			
43	3.62	0.02			
44	3.70	0.02			
45	3.78				
46	3.86				

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	3.94				
48	4.03				
49	4.12				
50	4.20				

COL-1-UC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.06				
2	0.15				
3	0.21				
4	0.28				
5	0.34				
6	0.41	0.01			
7	0.48	0.01			
8	0.54	0.01			
9	0.61	0.02	0.16	0.00	
10	0.67	0.07	0.32	0.13	0.00
11	0.74	0.16	0.55	0.37	0.00
12	0.81	0.29	0.69	0.58	0.19
13	0.88	0.44	0.85	0.78	0.26
14	0.95	0.60	0.96	0.94	0.36
15	1.02	0.70	1.01	1.03	0.51
16	1.09	0.78			0.61
17	1.16	0.85			0.75
18	1.23	0.87			
19	1.30	0.92			
20	1.37	0.92			
21	1.44	0.91	1.03	1.05	
22	1.50	0.95			0.90
23	1.57	0.92			
24	1.65	0.94			
25	1.72	0.94			
26	1.79	0.96	1.03	1.03	
27	1.86	0.96			0.89
28	1.93				
29	2.00	0.97			
30	2.08				
31	2.15	0.96			0.96
32	2.22		1.01	1.02	
33	2.29	0.97	0.96	0.94	
34	2.37	0.94	0.83	0.78	1.00
35	2.44	0.90	0.66	0.55	0.96
36	2.51	0.77	0.47	0.28	0.89
37	2.59	0.61	0.26	0.15	0.85
38	2.66	0.44	0.12	0.00	0.65
39	2.74	0.28			0.53
40	2.82	0.17			0.41
41	2.91	0.09			0.27
42	2.99	0.05			0.14
43	3.07	0.05			
44	3.14	0.04			
45	3.21	0.03			
46	3.28	0.03			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	3.35	0.02			
48	3.42	0.02			
49	3.49	0.02			
50	3.56				

COL-1-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.04				
2	0.11				
3	0.18				
4	0.25				
5	0.31				
6	0.38				
7	0.45				
8	0.51				
9	0.58	0.01	0.06	0.00	
10	0.65	0.03	0.19	0.10	0.00
11	0.72	0.09	0.37	0.29	0.05
12	0.79	0.21	0.59	0.52	0.10
13	0.86	0.37	0.77	0.73	0.25
14	0.93	0.54	0.89	0.88	0.36
15	1.00	0.68	0.98	0.97	0.51
16	1.07	0.80	1.05	1.06	0.63
17	1.14	0.87			0.77
18	1.22	0.90			
19	1.29	0.92	1.02	1.01	
20	1.36	0.93			0.92
21	1.43	0.94	1.03	1.03	
22	1.50	0.95			0.92
23	1.57	0.95			
24	1.64	0.96	1.03	1.03	1.01
25	1.71	0.97			
26	1.78	0.96	1.01	1.01	
27	1.84	0.97			
28	1.92				
29	1.99	0.97			1.00
30	2.06		0.99	0.98	
31	2.13	0.97			
32	2.20		0.98	0.97	
33	2.27	0.98	0.98	0.98	
34	2.34	0.98	0.89	0.87	0.96
35	2.41	0.94	0.80	0.77	0.92
36	2.48	0.86	0.62	0.55	0.90
37	2.56	0.74	0.37	0.28	
38	2.64	0.54	0.16	0.08	0.69
39	2.73	0.30	0.05	0.00	0.40
40	2.83	0.15			0.33
41	2.90	0.09			0.23
42	2.97	0.06			0.17
43	3.03	0.05			
44	3.10	0.04			
45	3.17	0.03			
46	3.24	0.03			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	3.31	0.02			
48	3.38				
49	3.45				
50	3.53				
51	3.61				
52	3.68				
53	3.75				
54	3.83				
55	3.90				

COL-1-UC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.04				
2	0.13				
3	0.20				
4	0.28				
5	0.36				
6	0.43				
7	0.51		0.04	0.00	
8	0.60		0.14	0.00	
9	0.68	0.05	0.39	0.22	
10	0.76	0.17	0.67	0.56	0.00
11	0.84	0.37	0.89	0.86	0.20
12	0.92	0.56	1.00	1.00	0.35
13	1.00	0.72	1.02	1.02	0.52
14	1.09	0.81			0.68
15	1.16	0.86			0.77
16	1.24	0.88			0.83
17	1.32	0.90			0.87
18	1.40	0.91			
19	1.48	0.92	1.01	1.01	
20	1.56	0.94			0.96
21	1.64	0.93			
22	1.72	0.94			0.98
23	1.81	0.94			
24	1.89	0.94			
25	1.96	0.95			0.98
26	2.04	0.94	1.01	1.01	
27	2.12	0.95			
28	2.20				
29	2.28	0.97			1.00
30	2.36		1.00	1.01	
31	2.44	0.97	1.00	1.02	
32	2.52	0.97	0.91	0.87	
33	2.61	0.93	0.68	0.58	
34	2.69	0.83	0.43	0.27	
35	2.78	0.67	0.21	0.00	0.88
36	2.86	0.49	0.08	0.00	0.70
37	2.94	0.29			
38	3.03	0.17			0.40
39	3.11	0.10			0.30
40	3.19	0.07			0.20
41	3.27	0.05			0.16
42	3.35	0.04			0.00
43	3.43	0.04			0.00
44	3.51	0.03			
45	3.58	0.03			
46	3.66	0.02			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	3.75	0.02			
48	3.83	0.02			
49	3.91				
50	3.99				

COL-1-UC-#1-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.05				
2	0.13				
3	0.21				
4	0.28				
5	0.36				
6	0.44				
7	0.51	0.01	0.03	0.00	
8	0.59	0.02	0.16	0.06	
9	0.67	0.06	0.37	0.26	
10	0.74	0.17	0.61	0.53	
11	0.82	0.33	0.82	0.78	0.20
12	0.90	0.51	0.96	0.95	0.35
13	0.98	0.66	1.02	1.02	0.51
14	1.06	0.79			0.63
15	1.14	0.85			0.73
16	1.21	0.89			0.89
17	1.29	0.92			1.00
18	1.37	0.93			
19	1.45	0.95	1.03	1.03	
20	1.53	0.96			1.00
21	1.61	0.96			
22	1.69	0.96			1.00
23	1.76	0.96			
24	1.84	0.97	1.03	1.03	1.00
25	1.92	0.97			
26	2.00	0.97			
27	2.08	0.97			
28	2.16				
29	2.24	0.97			1.00
30	2.32		0.99	0.99	
31	2.39	0.98	0.97	0.96	
32	2.47	0.98	0.93	0.91	
33	2.55	0.97	0.72	0.66	
34	2.63	0.88	0.49	0.39	
35	2.71	0.71	0.26	0.15	0.81
36	2.80	0.52	0.10	0.00	0.77
37	2.88	0.34	0.03	0.00	
38	2.96	0.20			0.34
39	3.04	0.12			0.27
40	3.13	0.08			0.18
41	3.21	0.06			0.18
42	3.29	0.05			0.13
43	3.37	0.04			0.05
44	3.45	0.03			0.00
45	3.53	0.03			
46	3.60	0.03			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	3.68	0.02			
48	3.76	0.02			
49	3.84	0.02			
50	3.92				

COL-2-UC-#2-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.13				
4	0.18				
5	0.23				
6	0.28				
7	0.33				
8	0.38				
9	0.42				
10	0.47				
11	0.52				
12	0.57	0.00			
13	0.61	0.00			
14	0.67	0.00	0.08	0.00	
15	0.72	0.00	0.20	0.00	
16	0.78	0.01	0.44	0.24	
17	0.83	0.02	0.60	0.47	
18	0.88	0.07	0.81	0.76	0.09
19	0.93	0.16	0.94	0.91	0.25
20	0.98	0.29	0.98	0.98	0.43
21	1.03	0.44			0.54
22	1.08	0.58			0.67
23	1.13	0.70	1.01	1.01	0.76
24	1.18	0.80			0.84
25	1.23	0.87			0.93
26	1.27	0.91			0.96
27	1.32	0.92			
28	1.37	0.94			
29	1.42	0.95	0.99	1.00	
30	1.47	0.94			1.02
31	1.52	0.97			
32	1.56				
33	1.61	0.97			
34	1.66				1.02
35	1.71	0.98	1.02	1.03	
36	1.76	0.98			
37	1.81	0.98			0.98
38	1.86	0.99	1.00	1.00	
39	1.91		0.98	0.98	
40	1.96		0.82	0.75	
41	2.01	0.95	0.60	0.47	
42	2.06	0.94	0.39	0.19	0.94
43	2.12	0.88	0.19	0.00	
44	2.17	0.78	0.09	0.00	
45	2.22	0.66			0.56
46	2.27	0.48			0.41

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.32	0.34			0.30
48	2.37	0.21			0.22
49	2.42	0.13			0.00
50	2.47	0.07			0.00
51	2.52	0.05			0.00
52	2.57	0.03			
53	2.62	0.02			
54	2.66	0.02			
55	2.71	0.01			
56	2.76	0.01			
57	2.81	0.01			
58	2.86				
59	2.91				
60	2.95				

COL-2-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.14				
4	0.19				
5	0.25				
6	0.30				
7	0.35				
8	0.40				
9	0.46				
10	0.51				
11	0.56				
12	0.61				
13	0.66		0.04	0.00	
14	0.71		0.12	0.04	
15	0.76		0.28	0.17	
16	0.81		0.47	0.38	
17	0.86	0.05	0.65	0.59	0.09
18	0.91	0.12	0.79	0.75	0.19
19	0.97	0.22	0.91	0.90	0.35
20	1.02	0.34	0.95	0.95	
21	1.07	0.47			0.58
22	1.12	0.60			0.70
23	1.17	0.72	1.02	1.03	
24	1.22	0.81			0.79
25	1.27	0.88			
26	1.32	0.91	1.02	1.03	0.94
27	1.38	0.94			0.95
28	1.43	0.95			
29	1.48	0.98	1.04	1.04	
30	1.53	0.96			
31	1.58	0.98			0.95
32	1.63		1.03	1.04	
33	1.68				
34	1.73	0.98			
35	1.78		1.03	1.03	
36	1.84				
37	1.89	0.97			0.95
38	1.94		0.97	0.96	
39	1.99		0.88	0.85	
40	2.05	0.95	0.62	0.57	1.00
41	2.11	0.92	0.39	0.31	0.90
42	2.16	0.86	0.23	0.14	0.70
43	2.22	0.78	0.11	0.03	0.65
44	2.27	0.63	0.05	0.00	0.52
45	2.32	0.49			0.40
46	2.37	0.36			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.42	0.24			0.33
48	2.48	0.15			0.12
49	2.53	0.09			0.08
50	2.58	0.05			0.07
51	2.63	0.03			
52	2.69	0.02			
53	2.74	0.02			
54	2.79	0.02			
55	2.84				
56	2.89				
57	2.94				
58	2.99				
59	3.05				
60	3.10				

COL-2-UC-#1-10T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.02				
2	0.07				
3	0.12				
4	0.16				
5	0.21				
6	0.25				
7	0.30				
8	0.34				
9	0.38				
10	0.43				
11	0.47				
12	0.53				
13	0.59				
14	0.65				
15	0.70	0.00			
16	0.73	0.00	0.12	0.00	
17	0.77	0.00	0.28	0.10	0.00
18	0.81	0.00	0.47	0.28	0.00
19	0.85	0.01	0.65	0.54	0.00
20	0.88	0.04	0.82	0.75	
21	0.92	0.09	0.92	0.90	0.18
22	0.96	0.18	0.97	0.97	0.34
23	1.00	0.30	1.01	1.04	
24	1.04	0.43			0.49
25	1.08	0.54			
26	1.13	0.69			0.72
27	1.21	0.83			0.78
28	1.27	0.89			
29	1.32	0.90	1.05	1.07	
30	1.36				
31	1.40	0.93			0.85
32	1.45				
33	1.49				
34	1.53	0.95			
35	1.57		1.03	1.06	
36	1.62				
37	1.66	0.96			0.88
38	1.70				
39	1.75		1.03	1.06	
40	1.79	0.96	0.98	0.97	0.88
41	1.83	0.98	0.96	0.93	0.90
42	1.88	0.92	1.01	1.01	0.96
43	1.94	0.93	0.89	0.84	1.00
44	1.99	0.93	0.67	0.51	0.92
45	2.05	0.91	0.41	0.25	0.84
46	2.10	0.87			

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.14	0.80	0.09	0.00	0.67
48	2.19	0.68			0.50
49	2.24	0.52			0.41
50	2.29	0.40			0.24
51	2.34	0.26			
52	2.39	0.16			
53	2.43	0.06			
54	2.48	0.10			
55	2.53				
56	2.58				
57	2.62				
58	2.67				
59	2.72				
60	2.76				

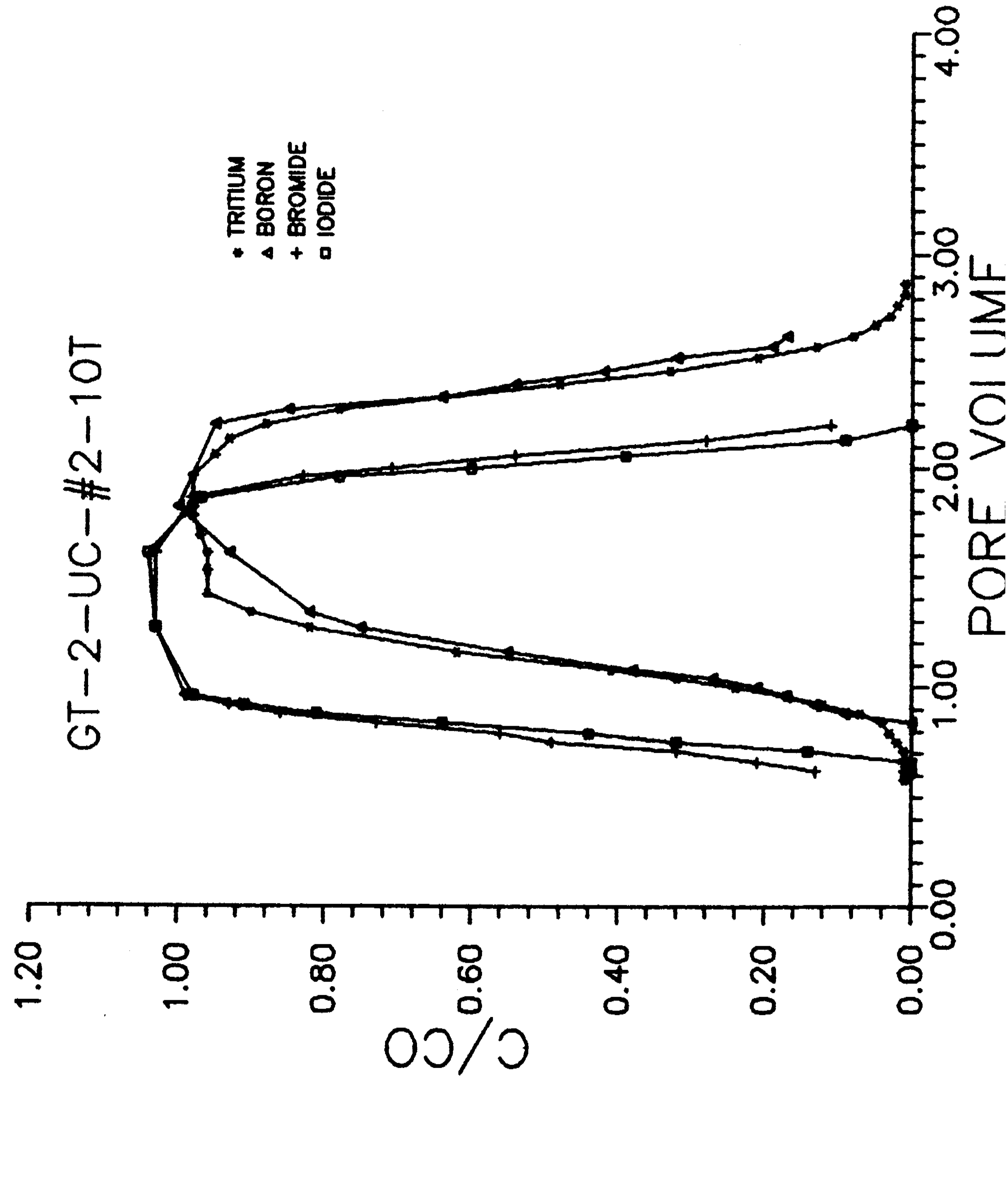
COL-2-UC-#1-20T

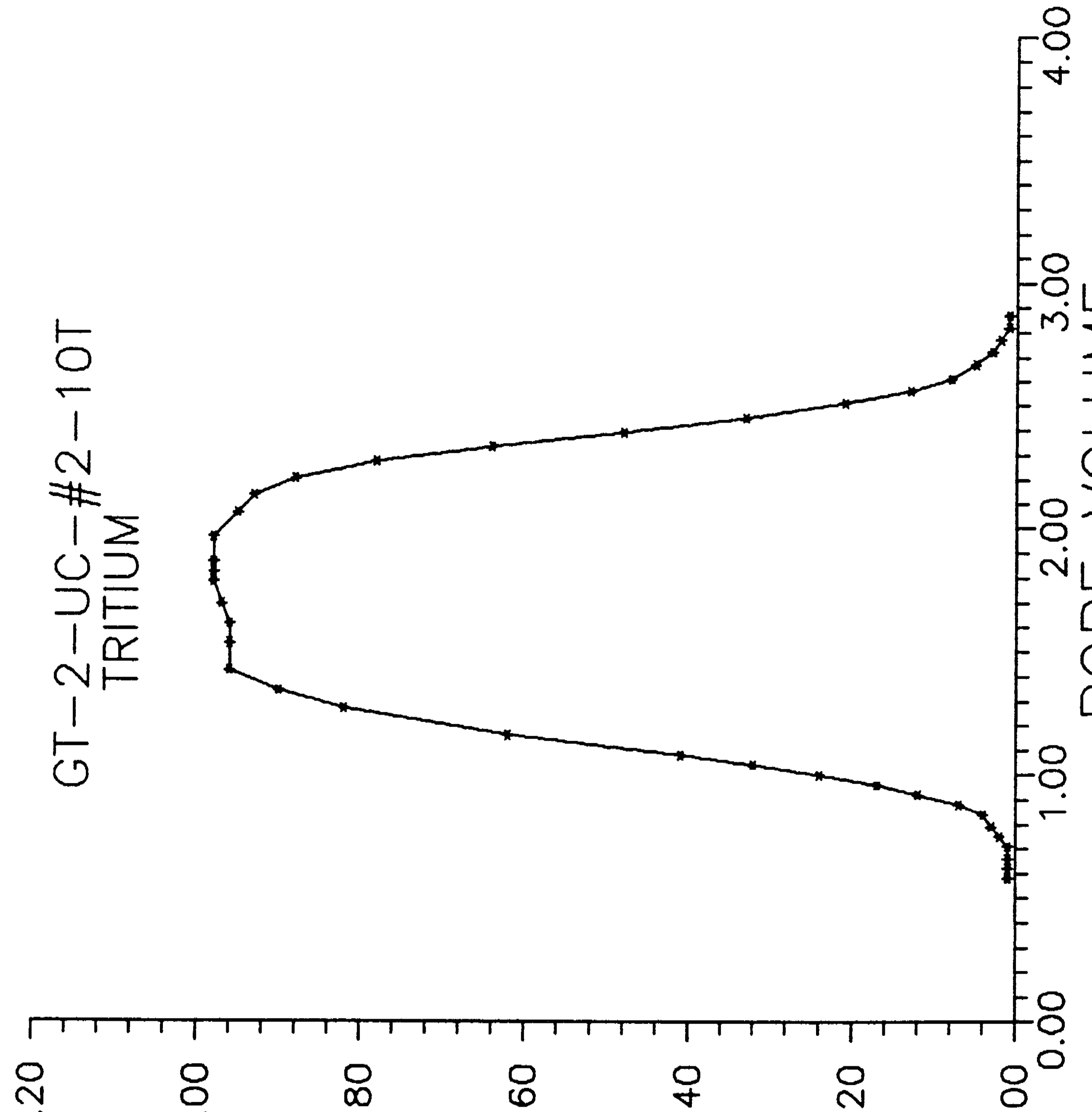
SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
1	0.03				
2	0.08				
3	0.13				
4	0.19				
5	0.24				
6	0.29				
7	0.34				
8	0.39				
9	0.43				
10	0.48				
11	0.53				
12	0.58				
13	0.62				
14	0.67				
15	0.72		0.08	0.00	
16	0.77		0.25	0.14	0.00
17	0.82		0.47	0.37	0.00
18	0.86		0.69	0.63	0.05
19	0.91	0.06	0.85	0.83	0.17
20	0.96	0.15	0.94	0.94	
21	1.01	0.28	1.00	0.99	0.51
22	1.06	0.44			0.67
23	1.10	0.58			
24	1.15	0.71			0.83
25	1.20	0.80			
26	1.25	0.87	1.00	1.00	0.92
27	1.29	0.90			
28	1.34	0.95			
29	1.39	0.96			
30	1.44				
31	1.48	0.97			0.97
32	1.53		1.00	1.00	
33	1.58				
34	1.63	0.98			
35	1.68				
36	1.72				
37	1.77	0.99			0.97
38	1.82		1.00	0.99	
39	1.87		0.99	0.97	
40	1.92	0.98	0.88	0.84	1.00
41	1.97	1.01	0.71	0.64	1.00
42	2.02	0.95	0.48	0.39	1.00
43	2.07	0.92	0.24	0.13	0.93
44	2.12	0.86	0.09	0.00	0.74
45	2.17	0.74			0.61
46	2.22	0.58			

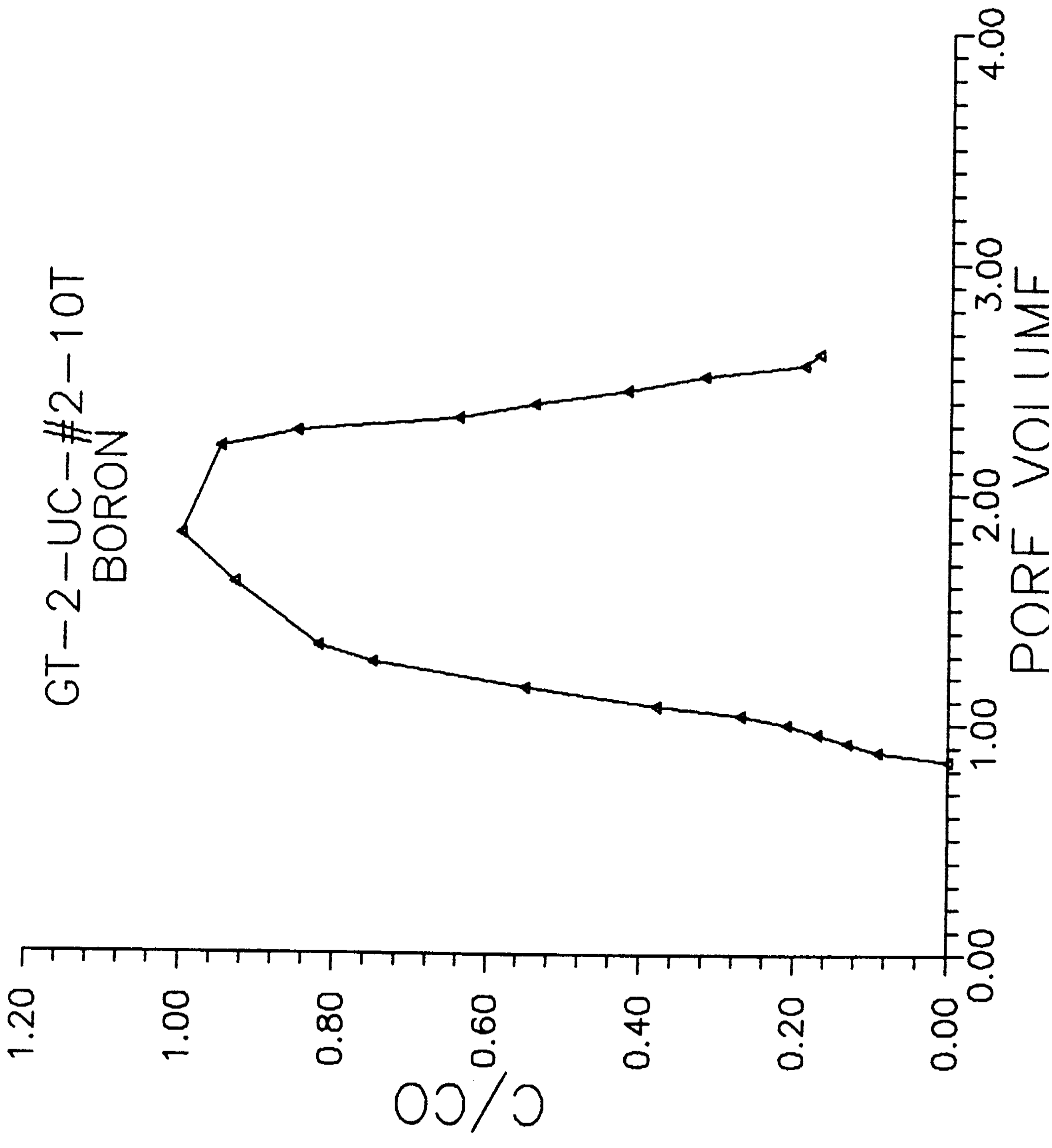
SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. IODIDE	RELATIVE CONCEN. BORON
47	2.27	0.42			0.30
48	2.32	0.28			0.22
49	2.37	0.17			0.12
50	2.42	0.11			0.05
51	2.46	0.07			
52	2.51	0.05			
53	2.56	0.03			
54	2.60	0.03			
55	2.65	0.02			
56	2.69	0.02			
57	2.74	0.02			
58	2.78				
59	2.83				
60	2.88				

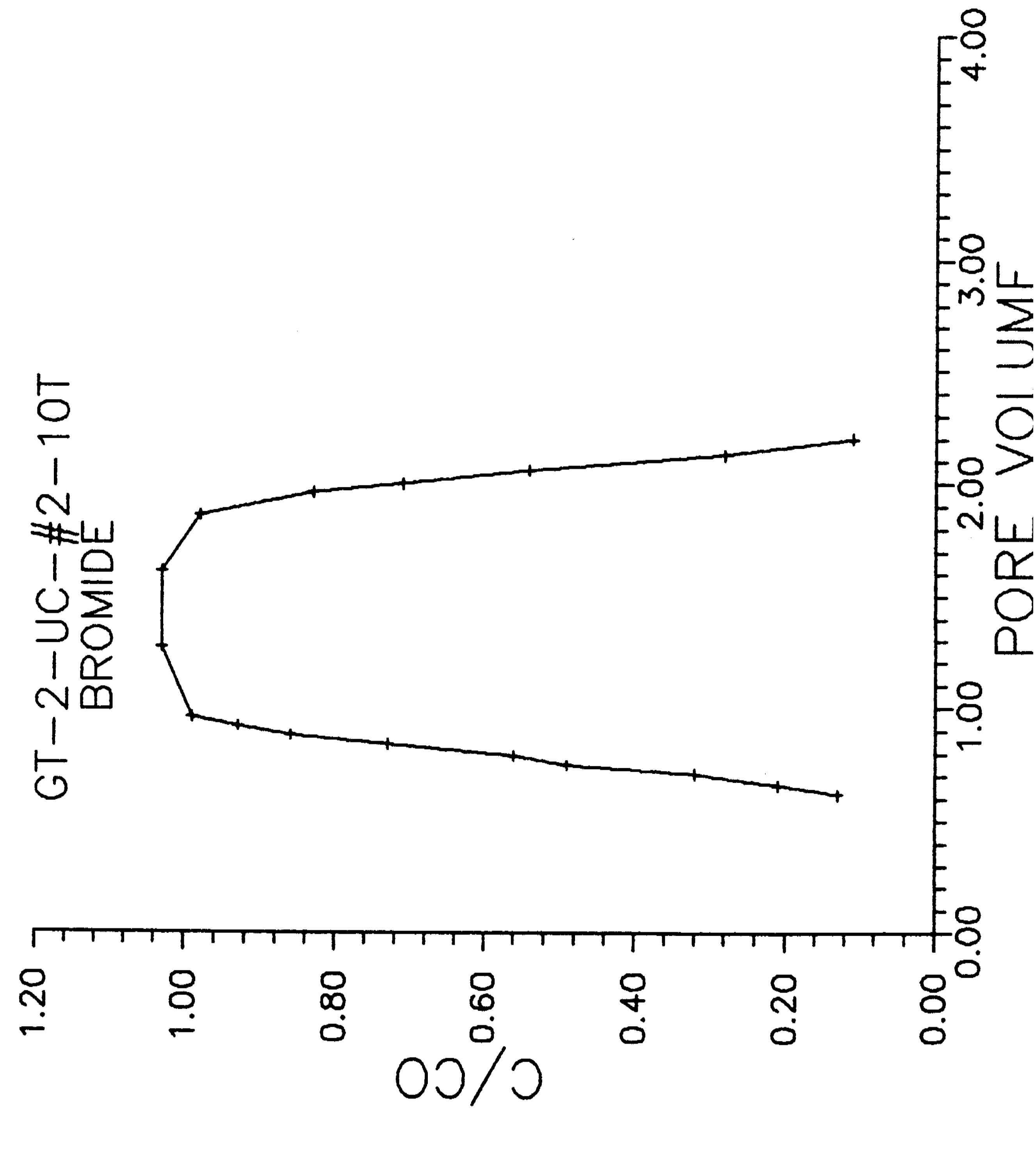
APPENDIX XII

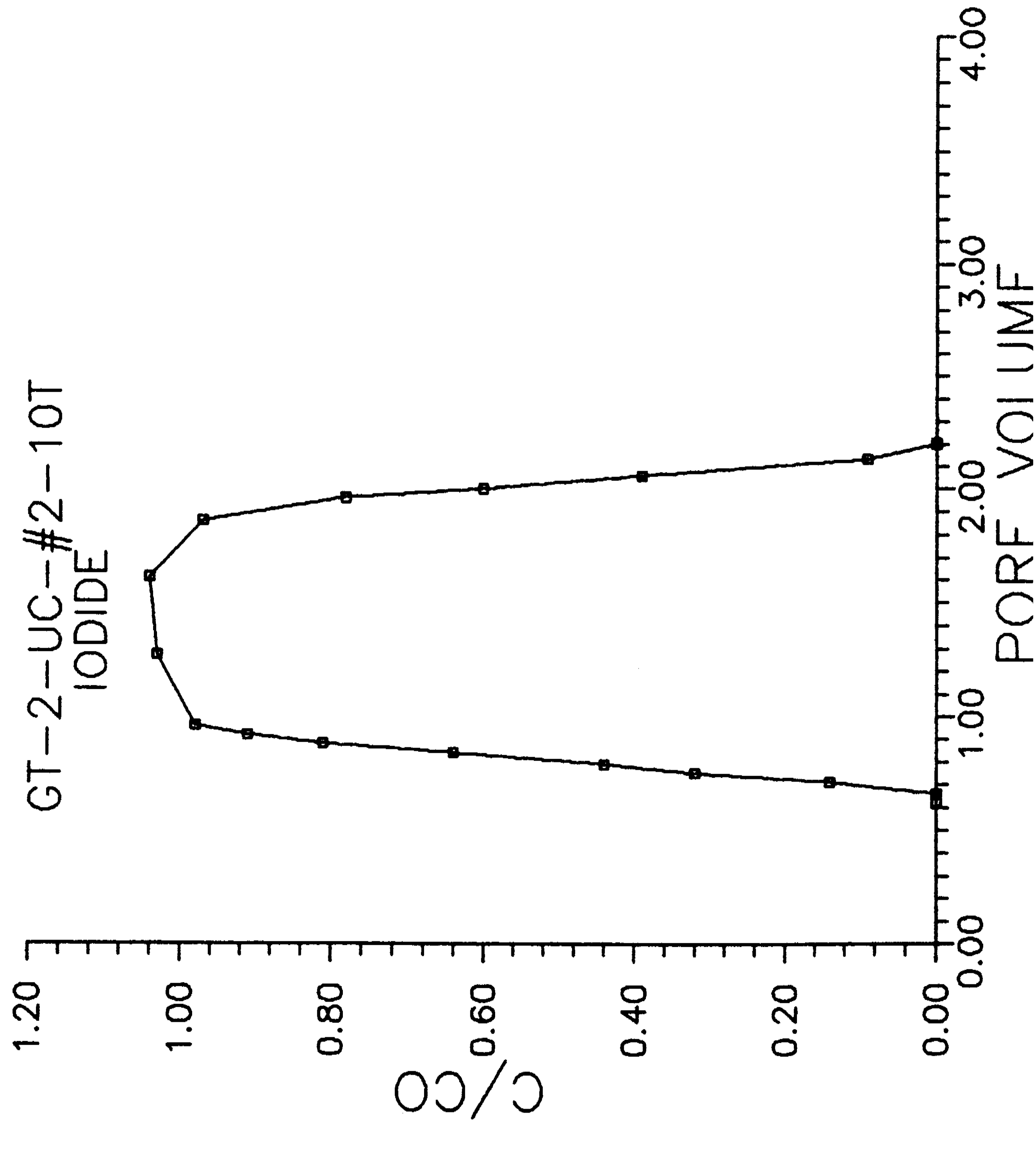
PLOTS OF PV VS. C/CO FOR UNSATURATED FLOW EXPERIMENTS

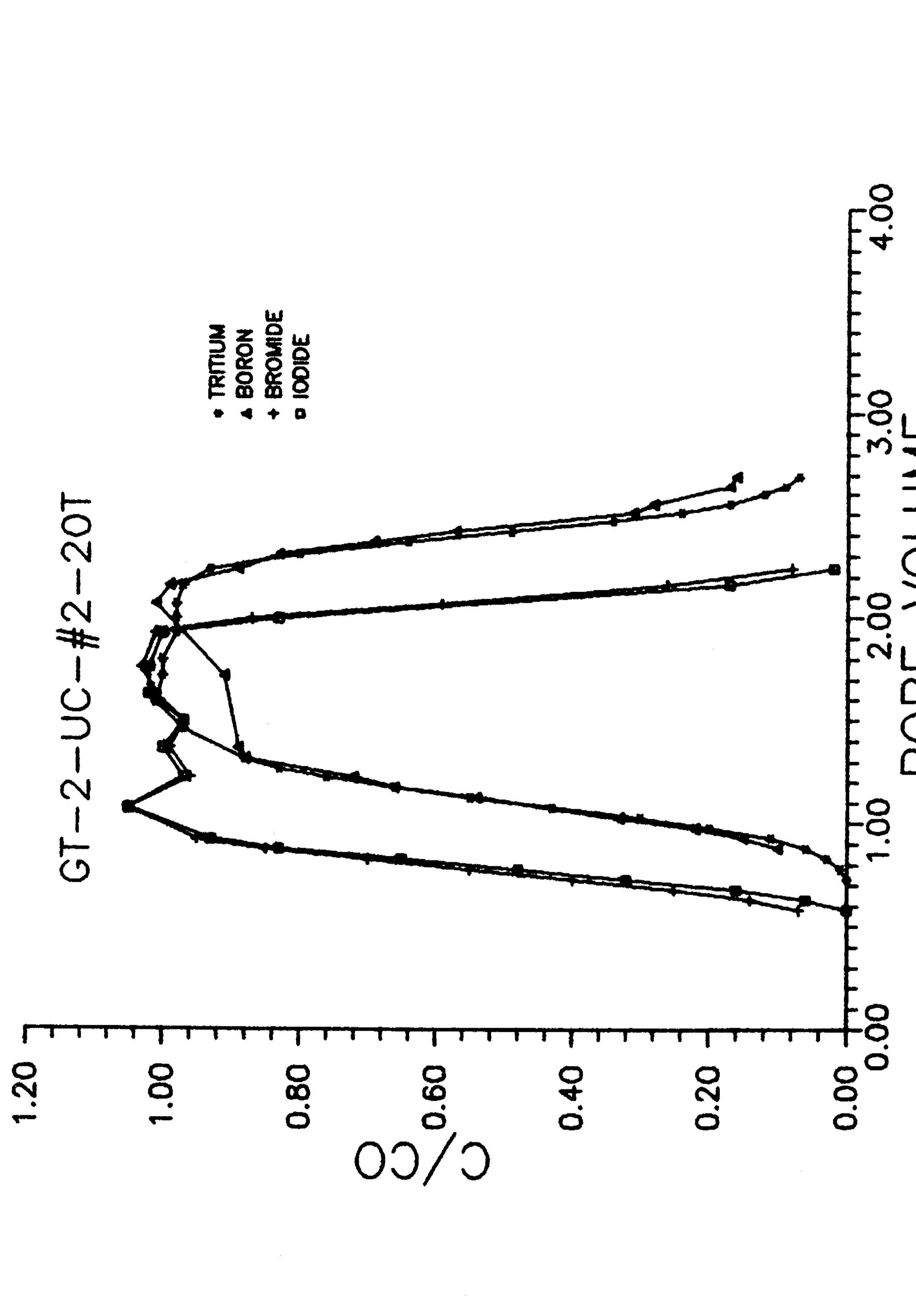

GT-2-UC-#2-10T
C/CO
PORE VOLUME
TRITIUM
BORON
BROMIDE
IODIDE
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00

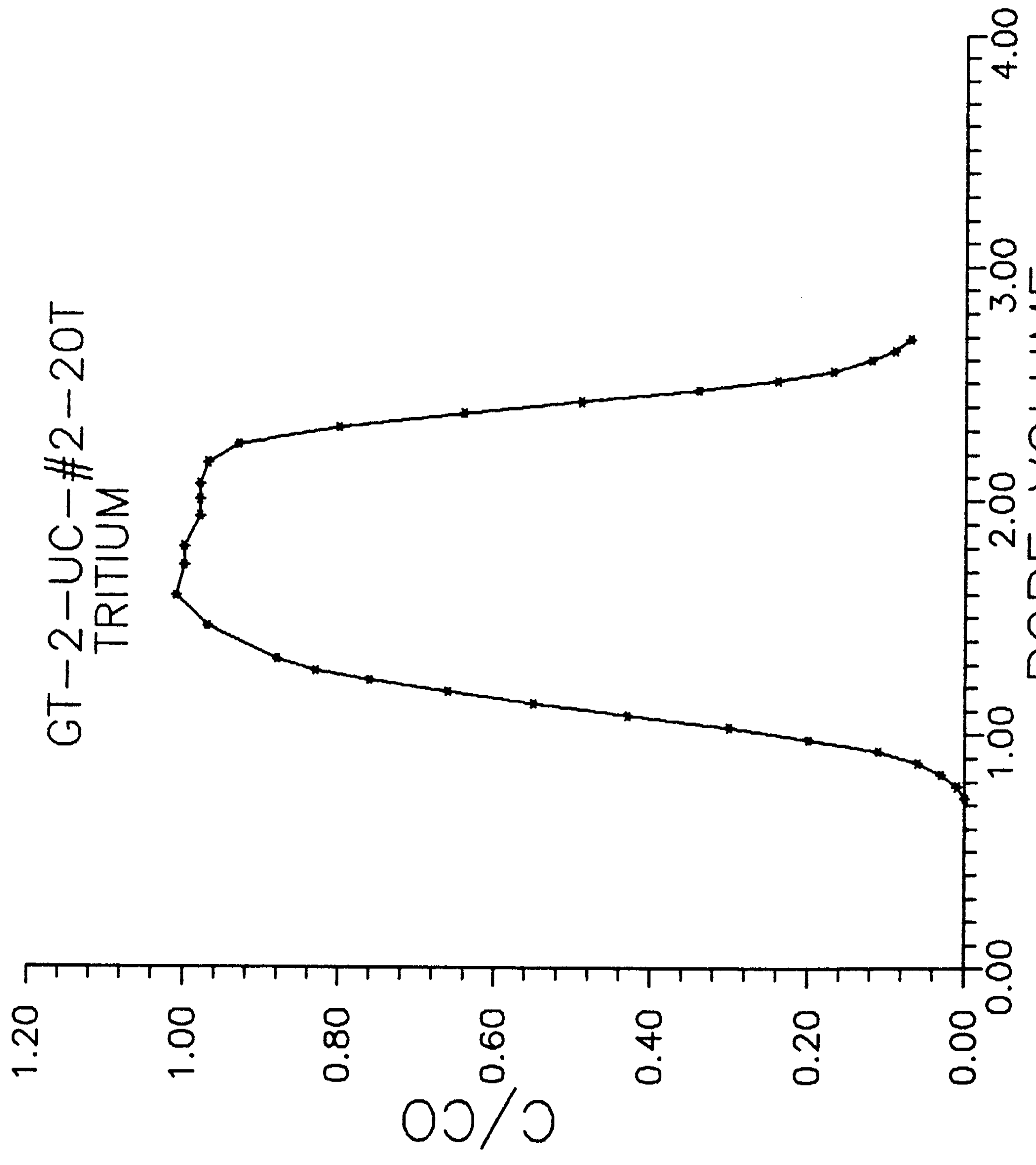

GT-2-UC-#2-10T
TRITIUM
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

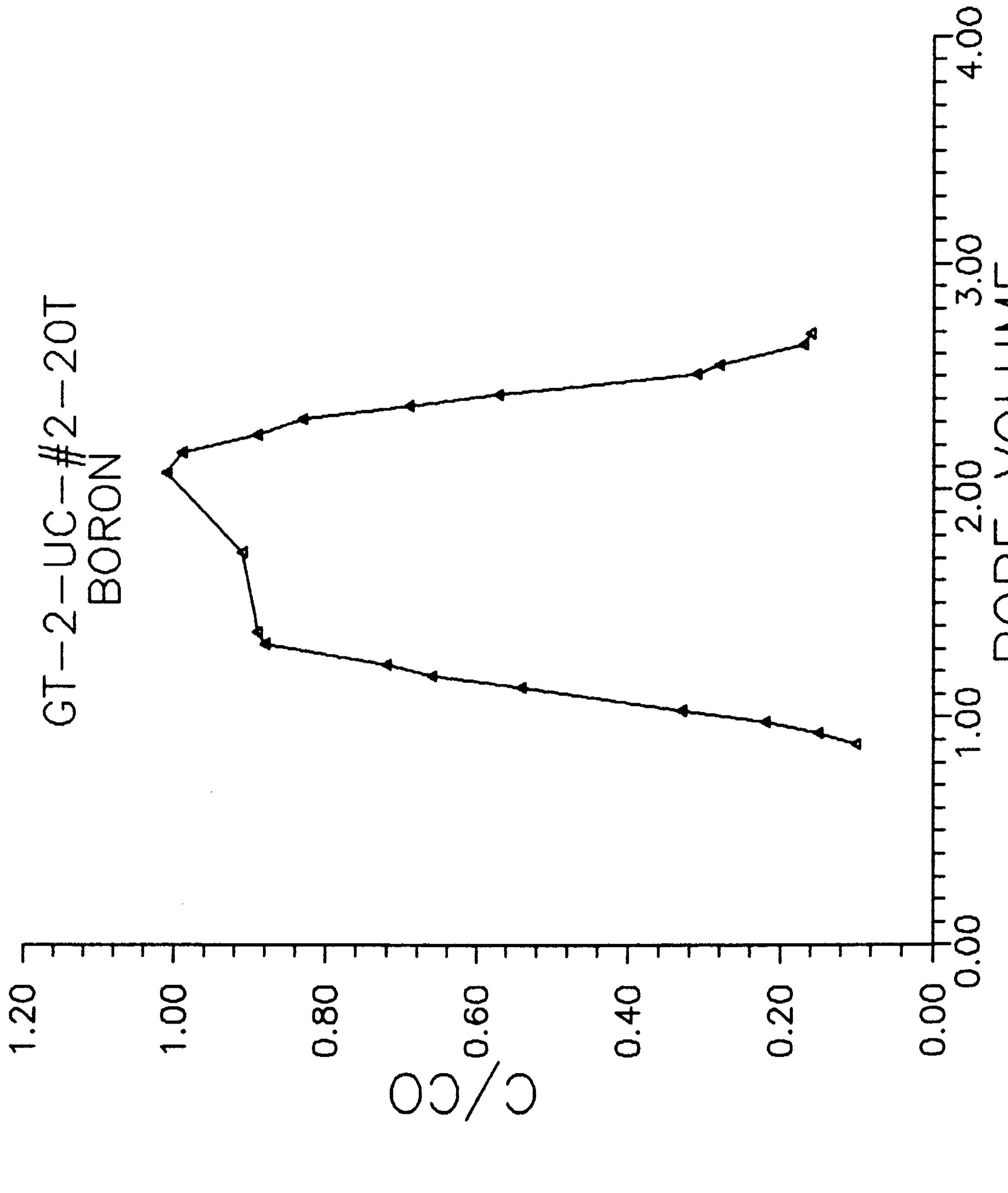

GT-2-UC-#2-10T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

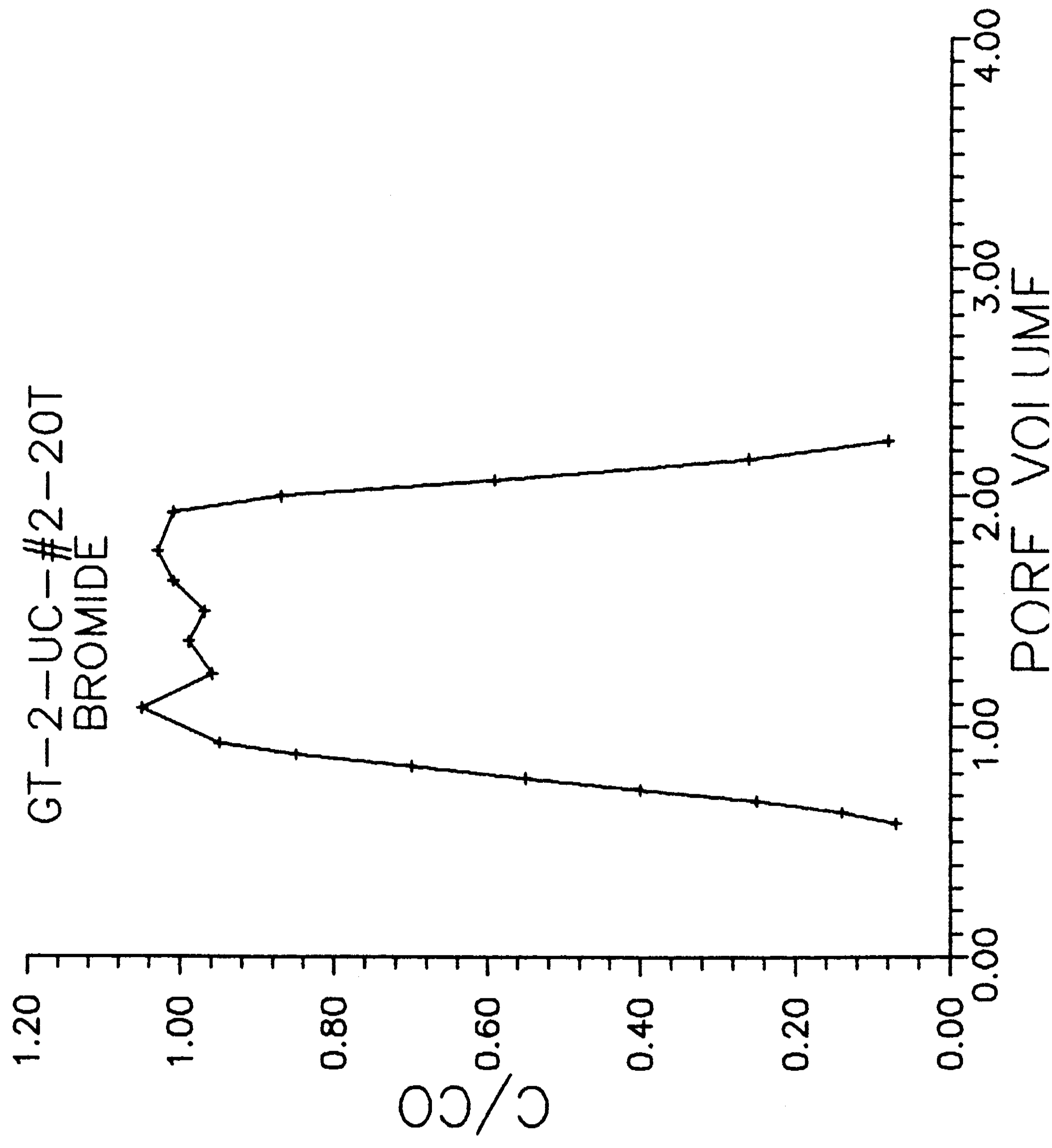

GT-2-UC-#2-10T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#2-10T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#2-20T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#2-20T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#2-20T
BORON
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00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C/CO
0.00
0.20
0.40
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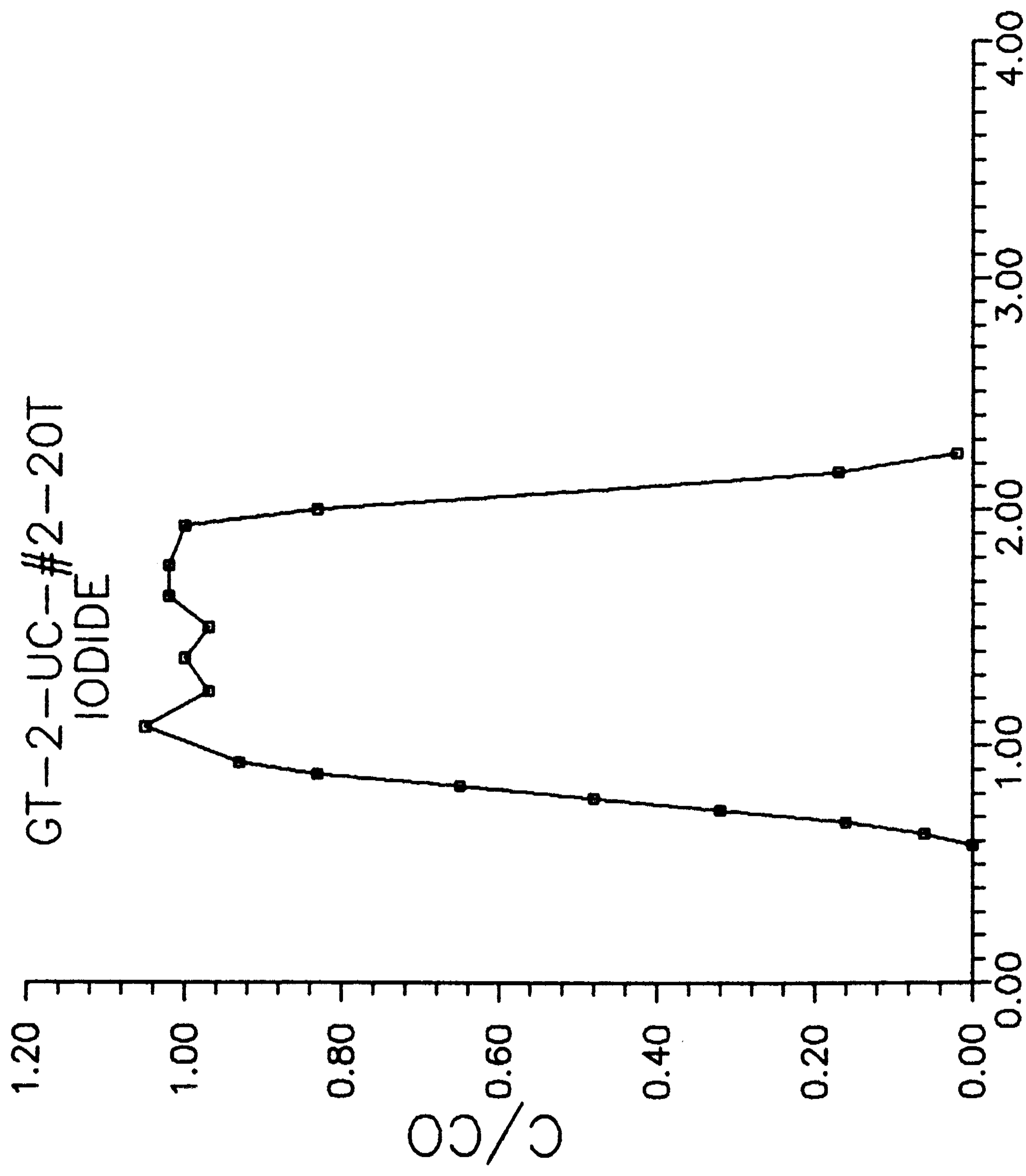
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#2-20T
IODIDE
C/CO
PORE VOLUME
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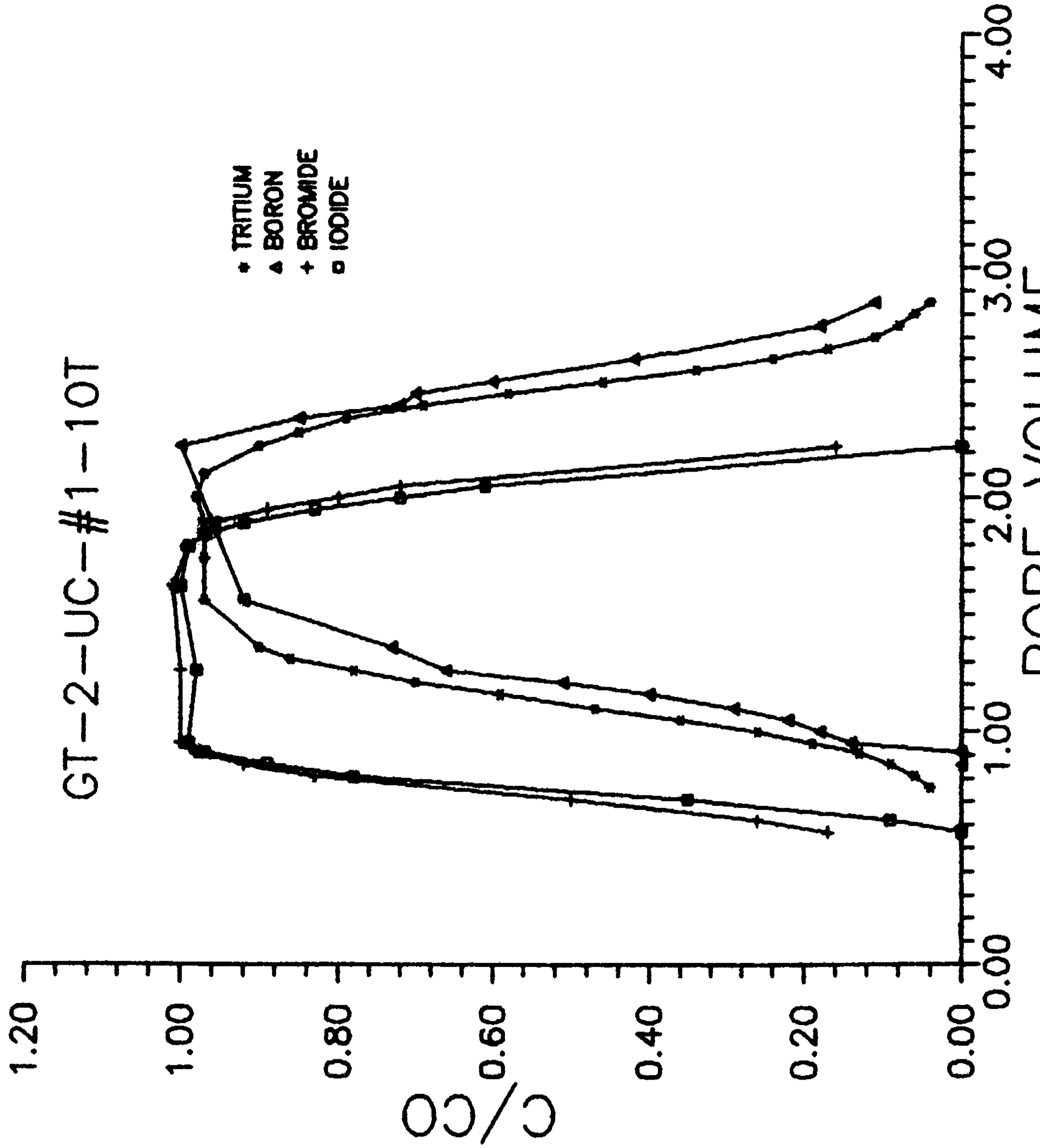
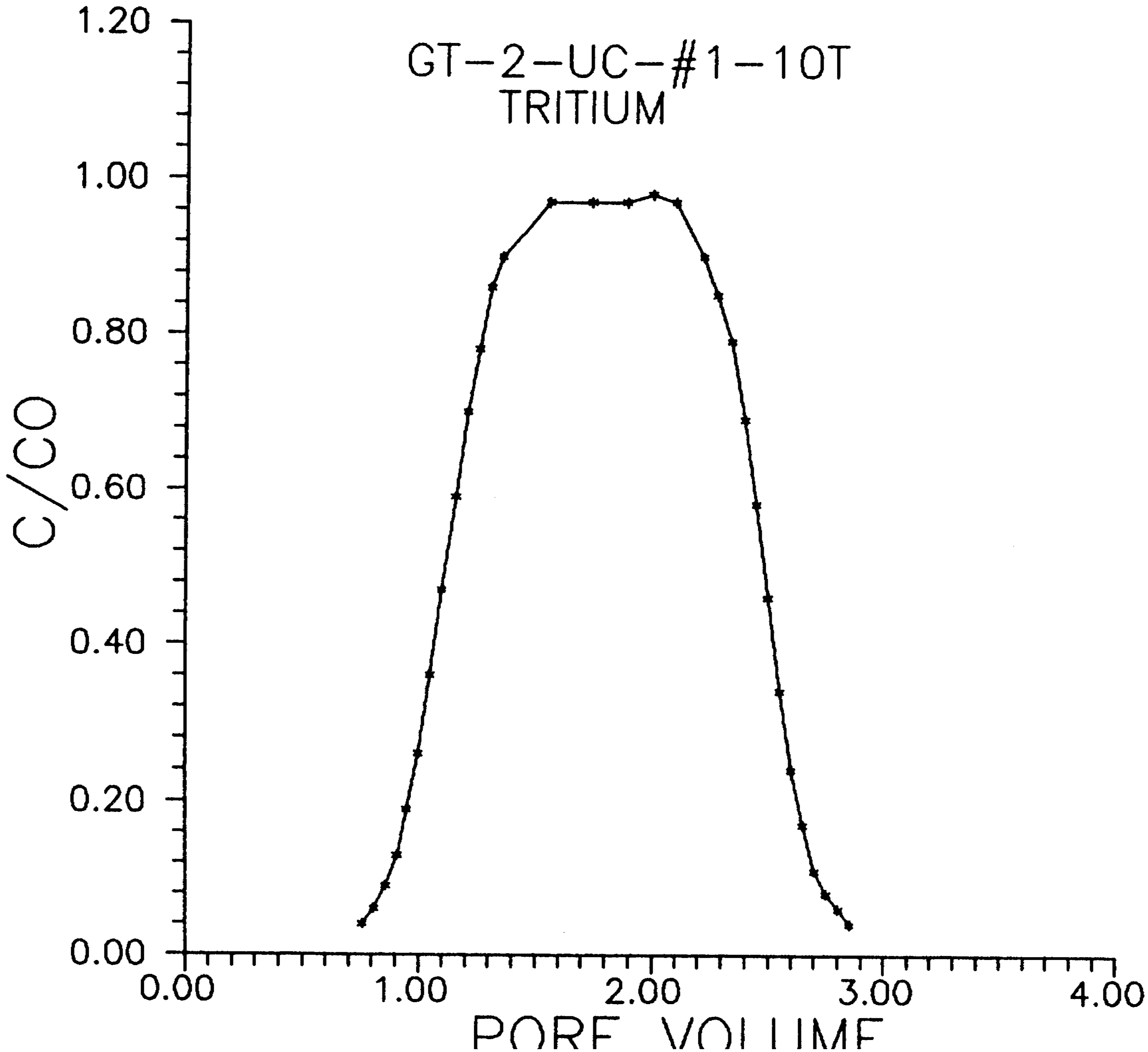
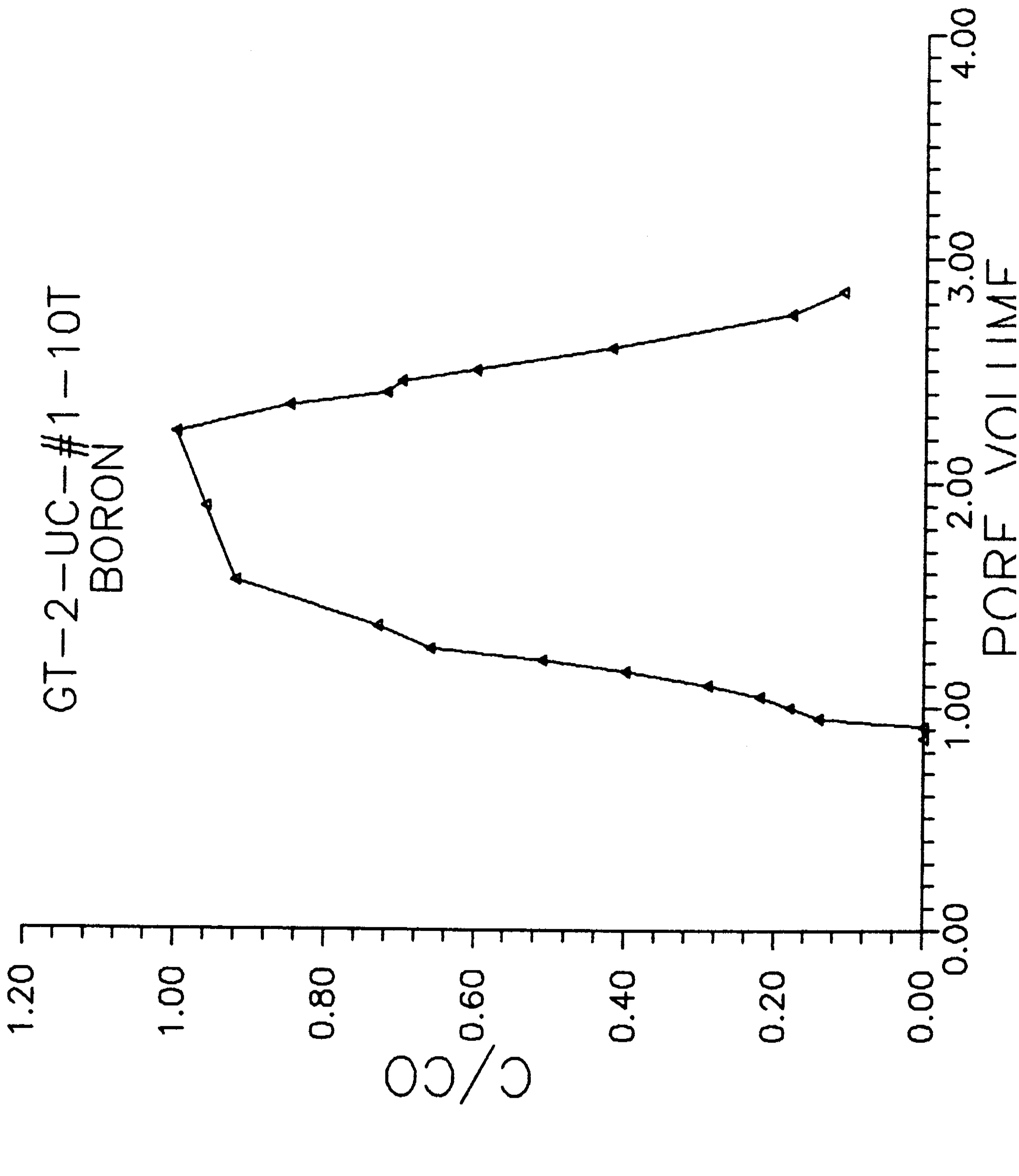
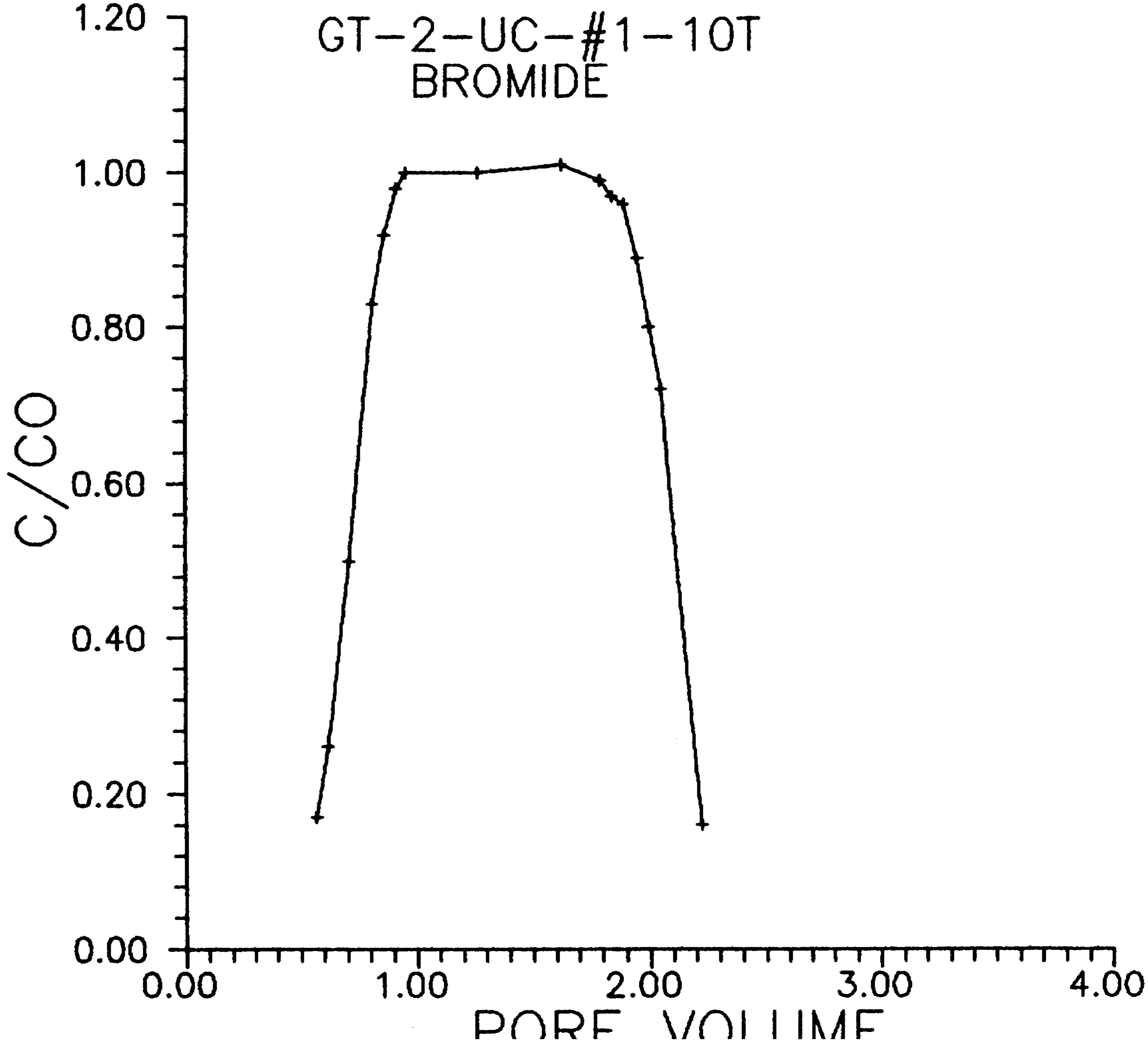
0.20
0.40
0.60
0.80
1.00
1.20
1.00
2.00
3.00
4.00


GT-2-UC-#1-10T
C/CO
PORE VOLUME
TRITIUM
BORON
BROMIDE
IODIDE
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


GT-2-UC-#1-10T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#1-10T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#1-10T
BROMIDE
C/CO
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0.80
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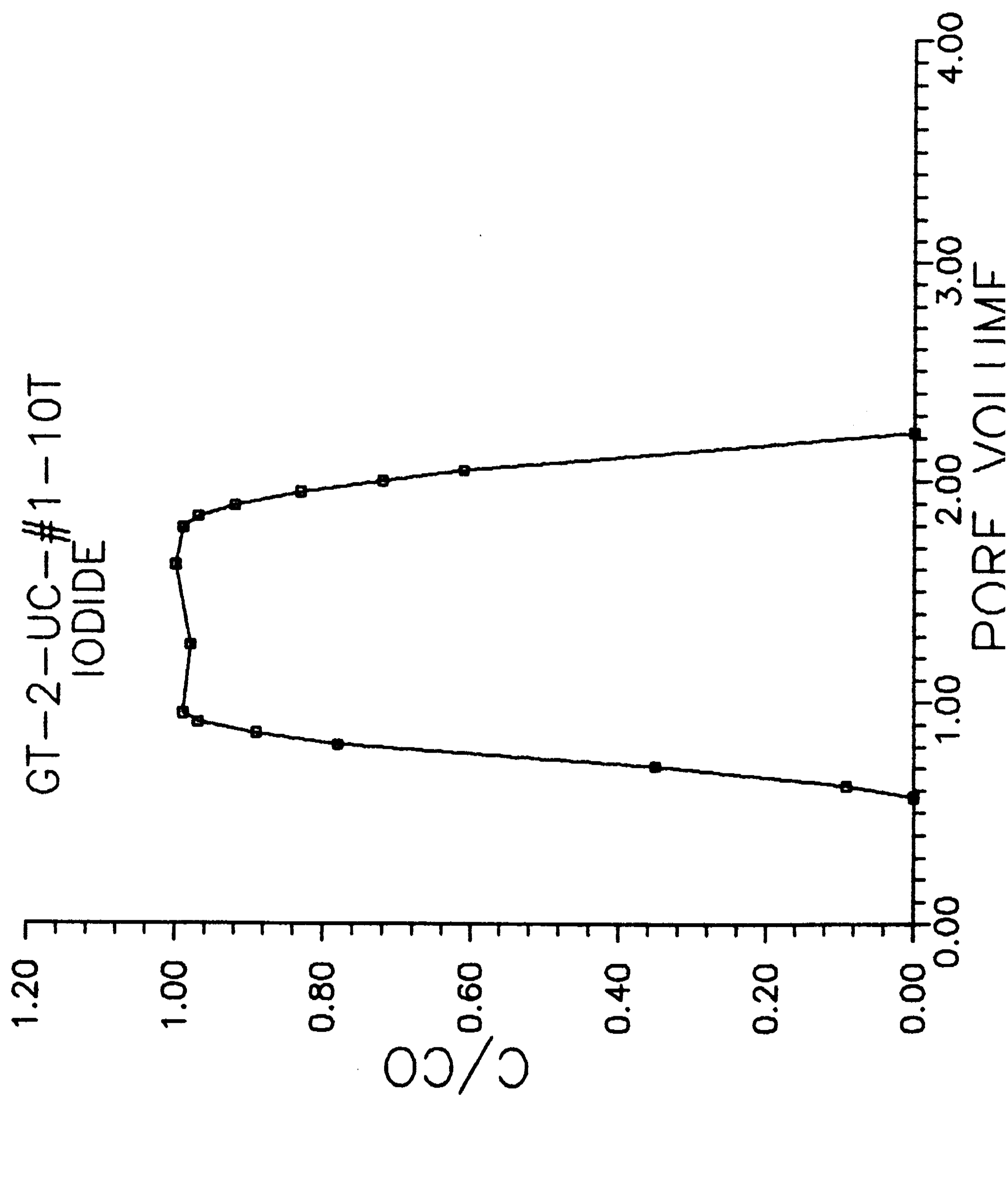
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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IODIDE
C/CO
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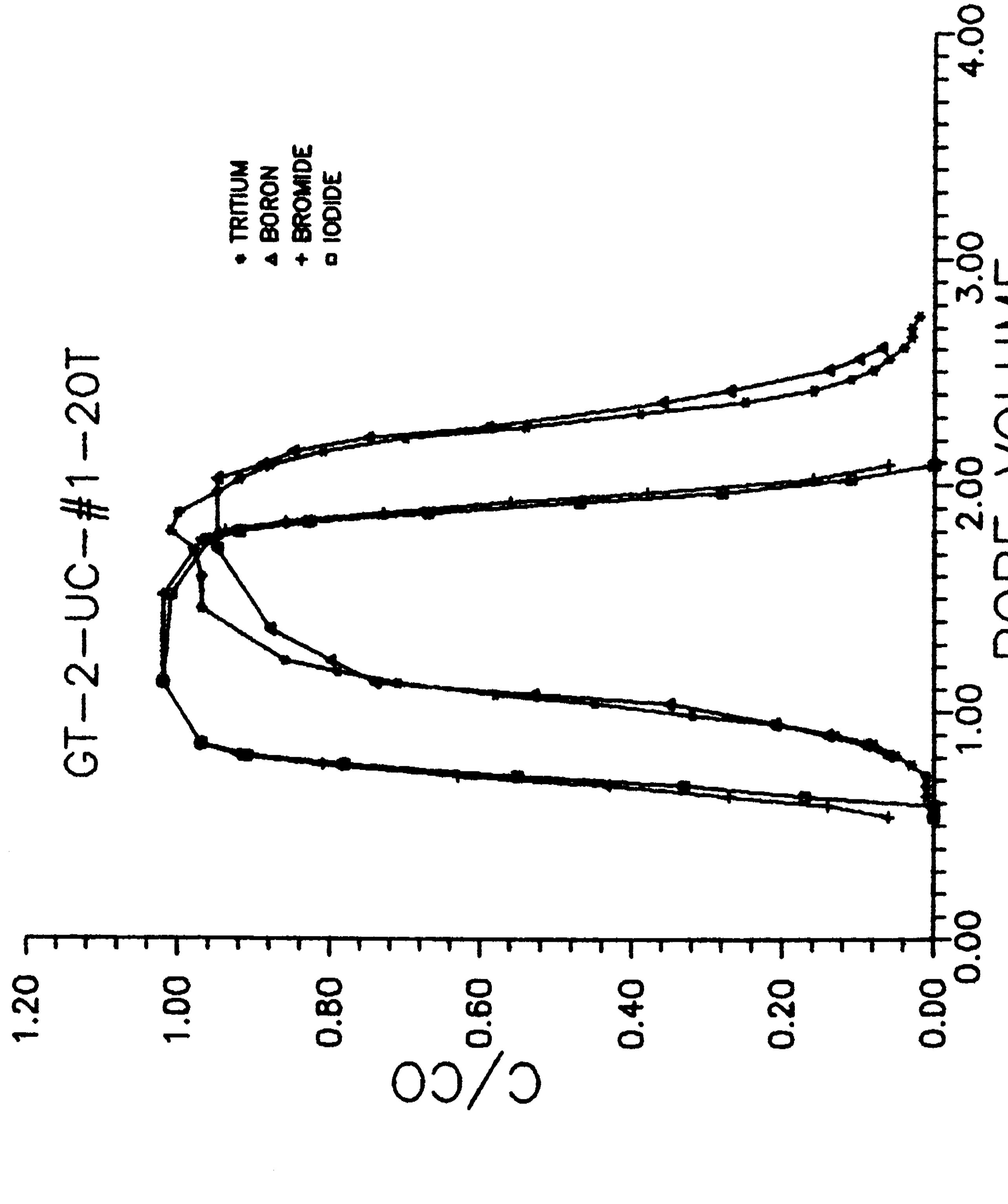
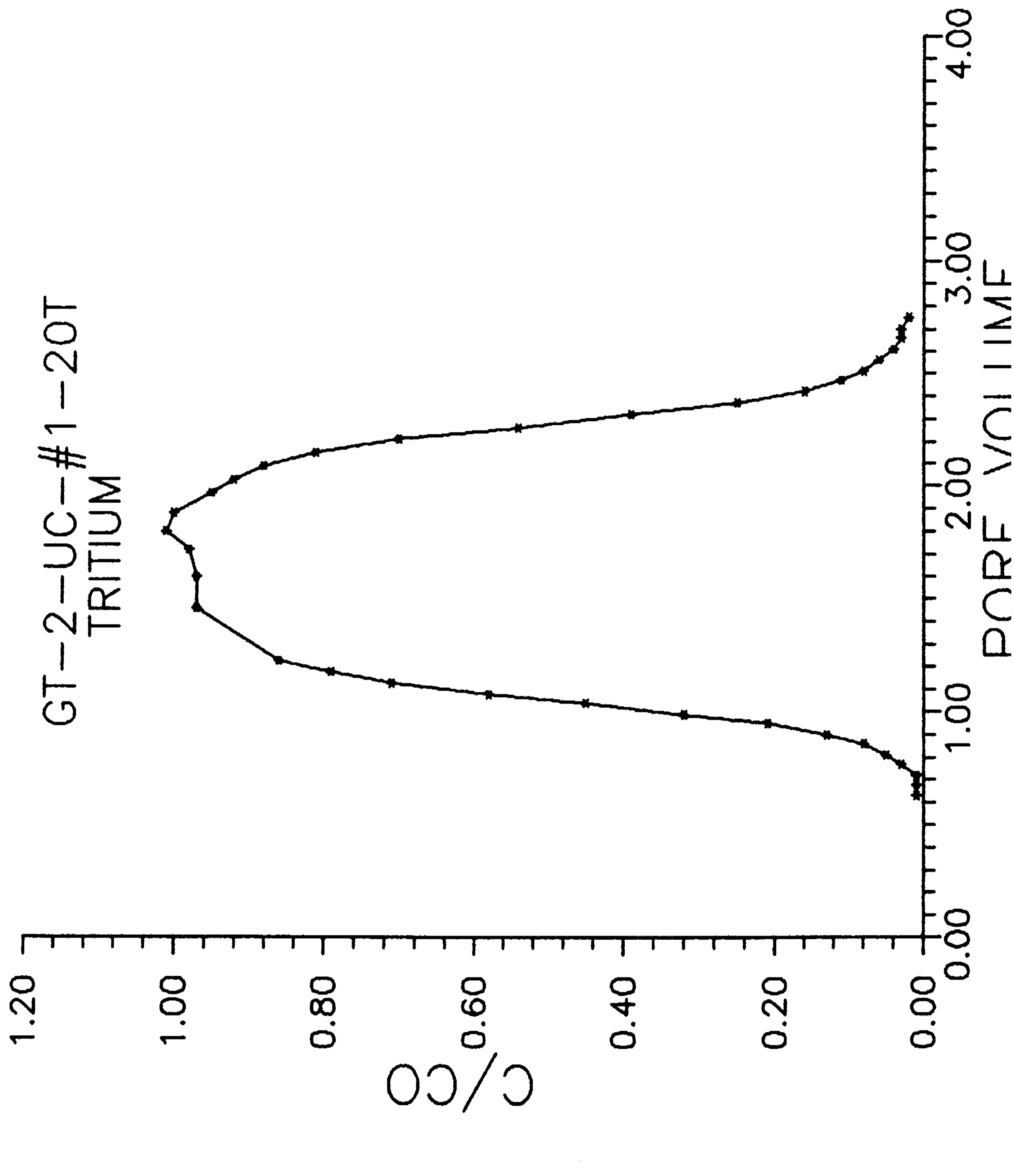
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME



GT-2-UC-#1-20T
C/CO
PORE VOLUME
TRITIUM
BORON
BROMIDE
IODIDE
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00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C/CO
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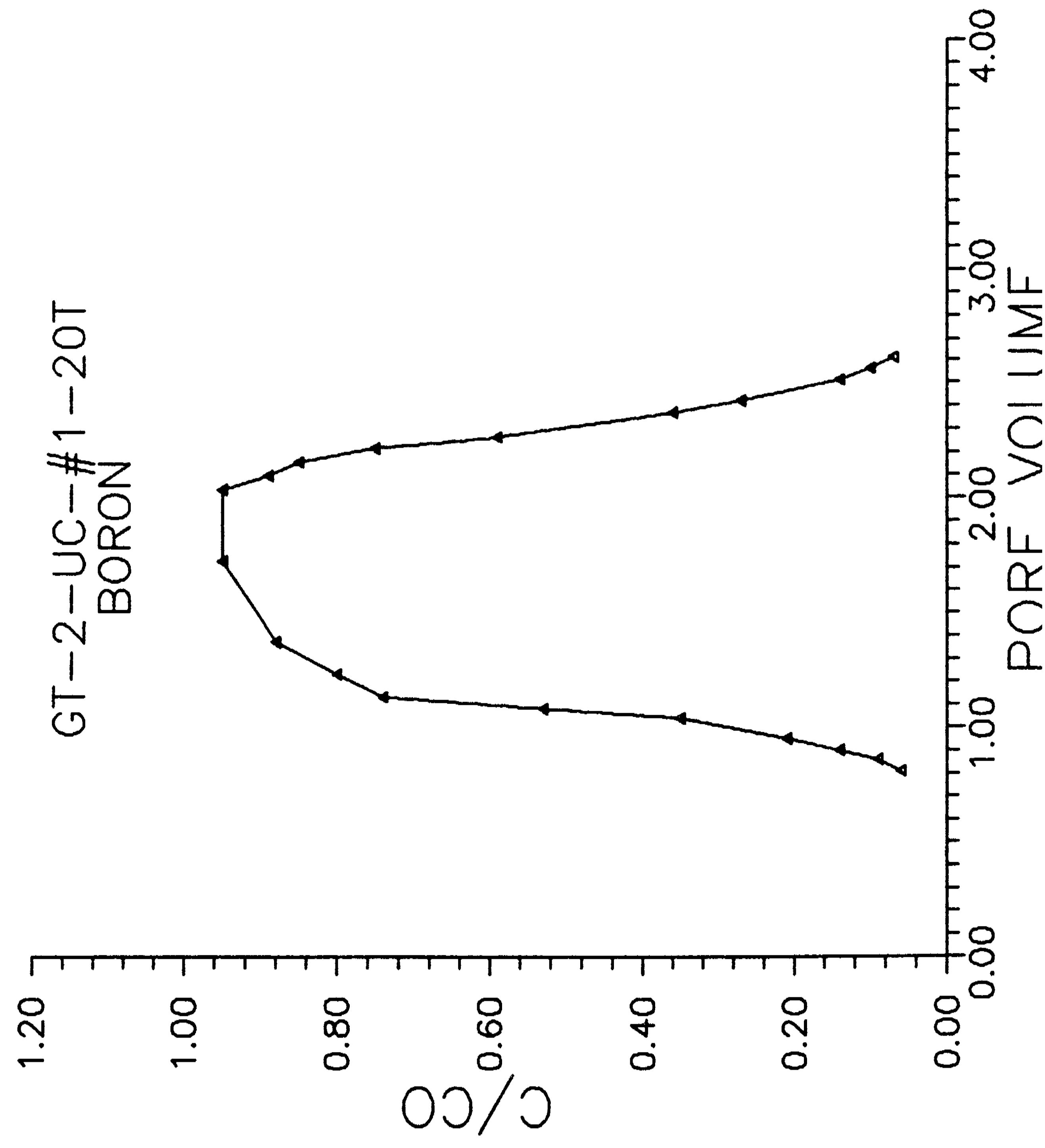
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#1-20T
BORON
C/CO
PORE VOLUME
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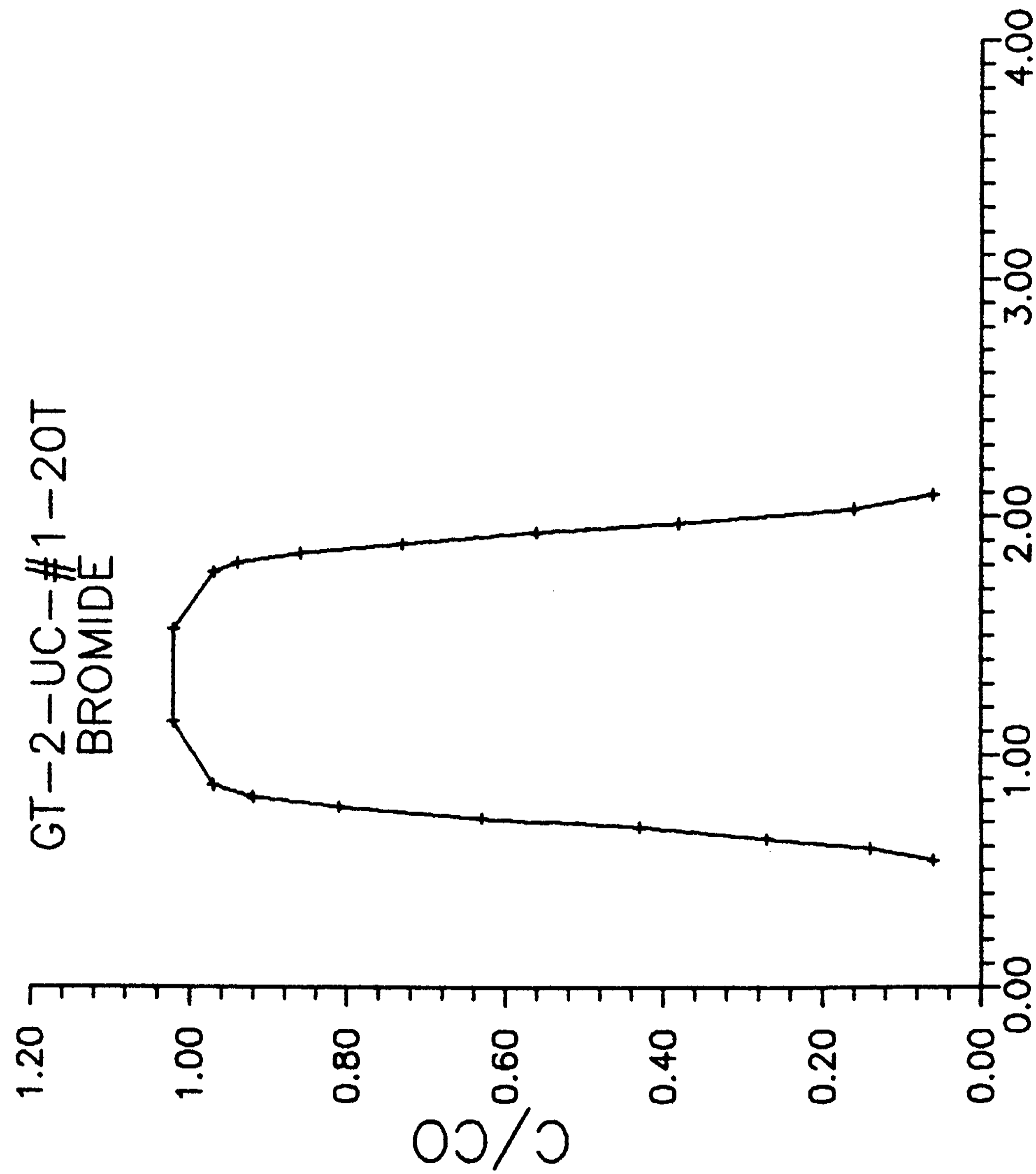
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00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C/CO
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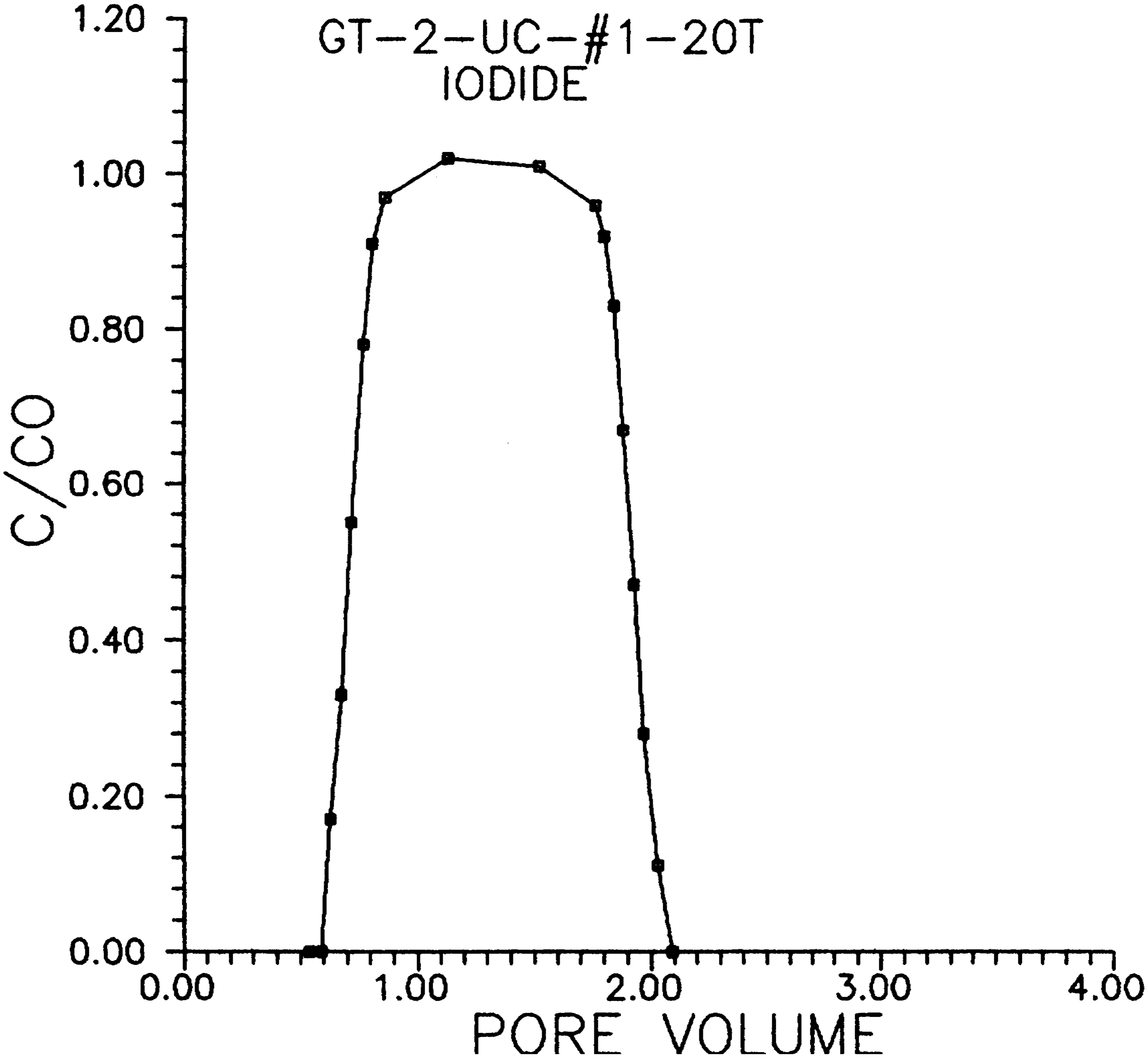
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-2-UC-#1-20T
IODIDE
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1.00
0.80
0.60
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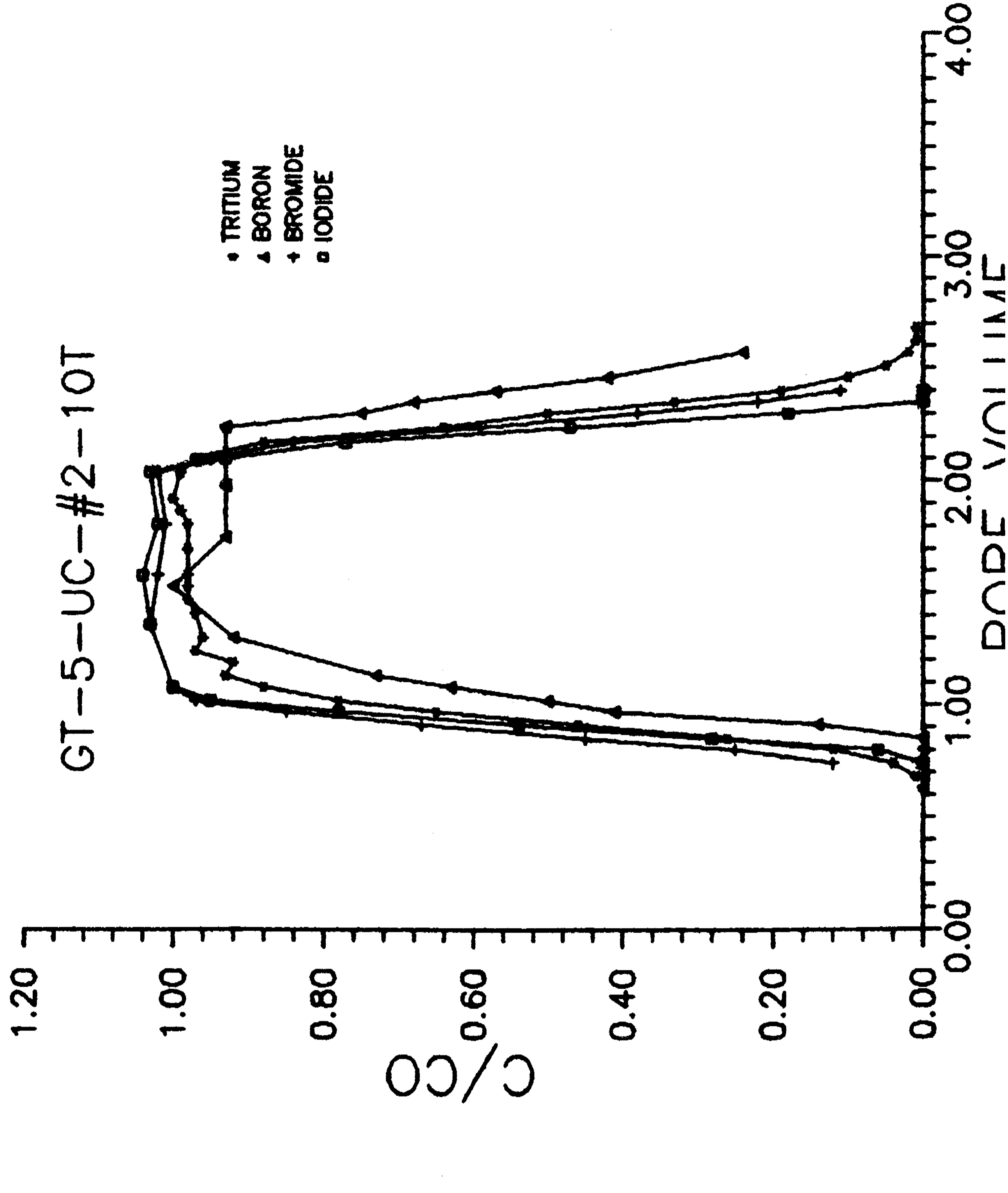
0.20
0.00
C/CO
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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TRITIUM
BORON
BROMIDE
IODIDE
C/CO
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0.80
0.60
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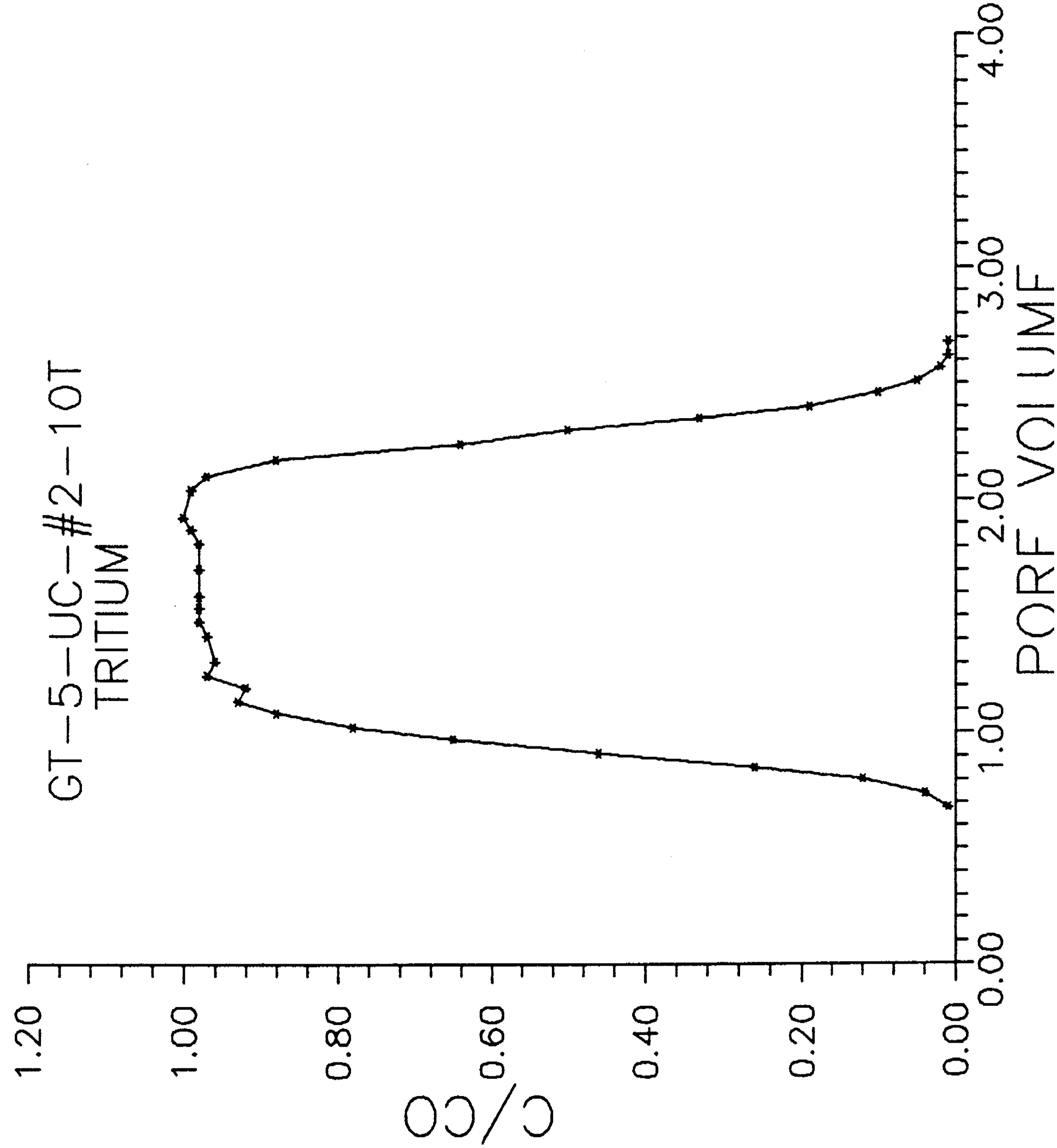
0.20
0.00
0.00
1.00
2.00
3.00
4.00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TRITIUM
C/CO
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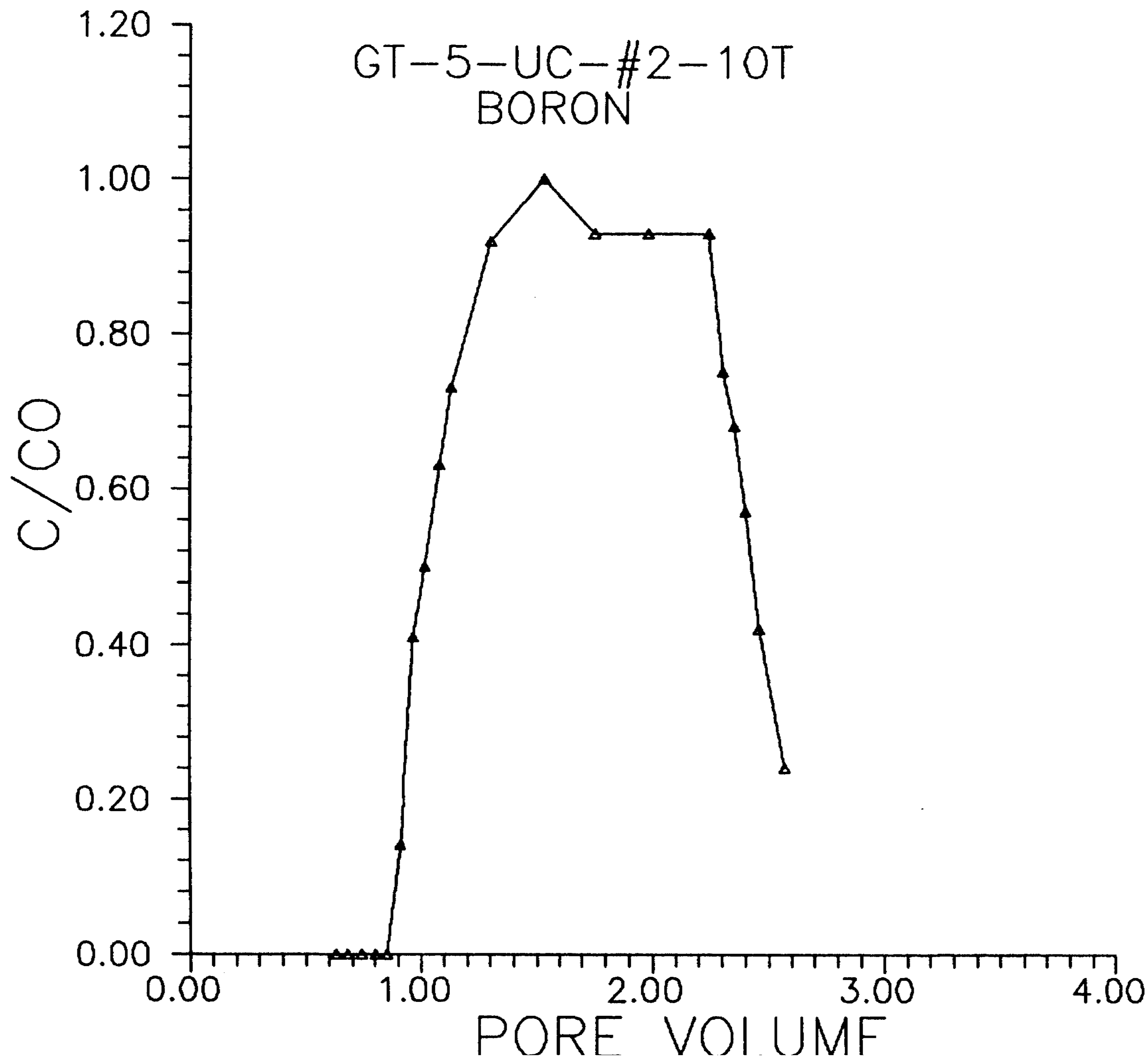
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00
PORF VOLUMF


GT-5-UC-#2-10T
BORON
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1.00
0.80
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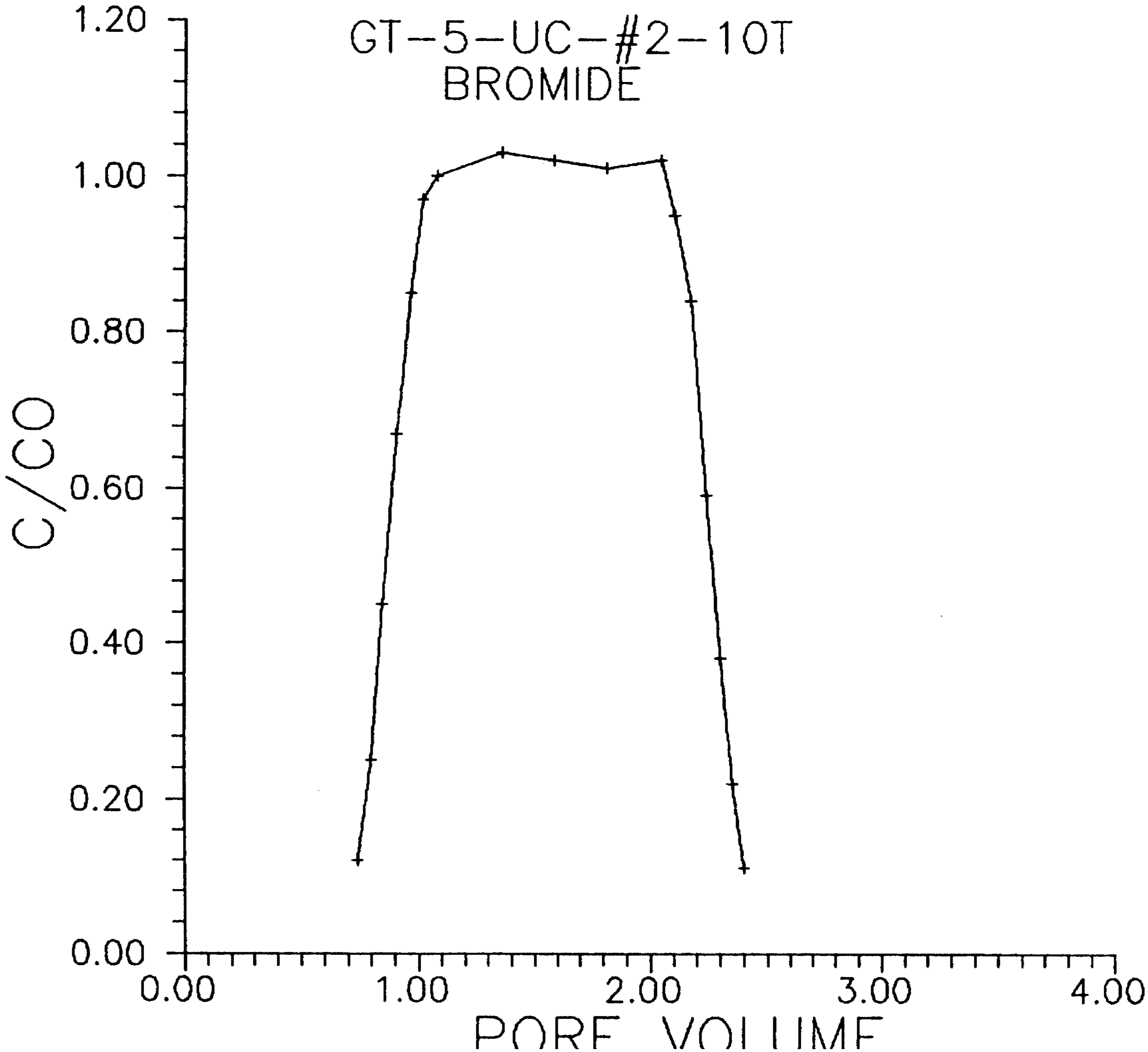
0.40
0.20
0.00
C/CO
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-5-UC-#2-10T
BROMIDE
C/CO
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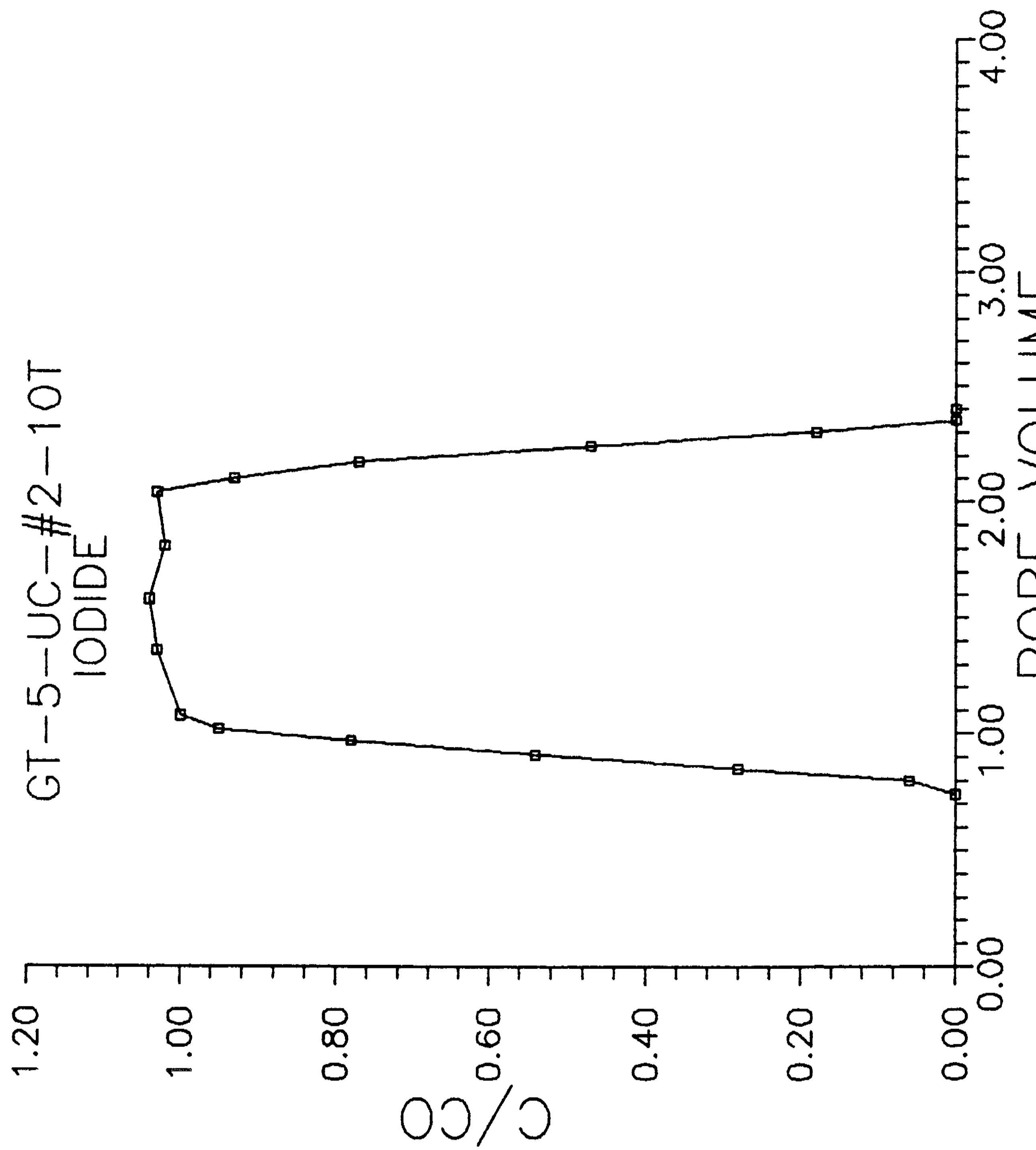
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT—5—UC—#2—10T
IODIDE
C/CO
PORE VOLUME
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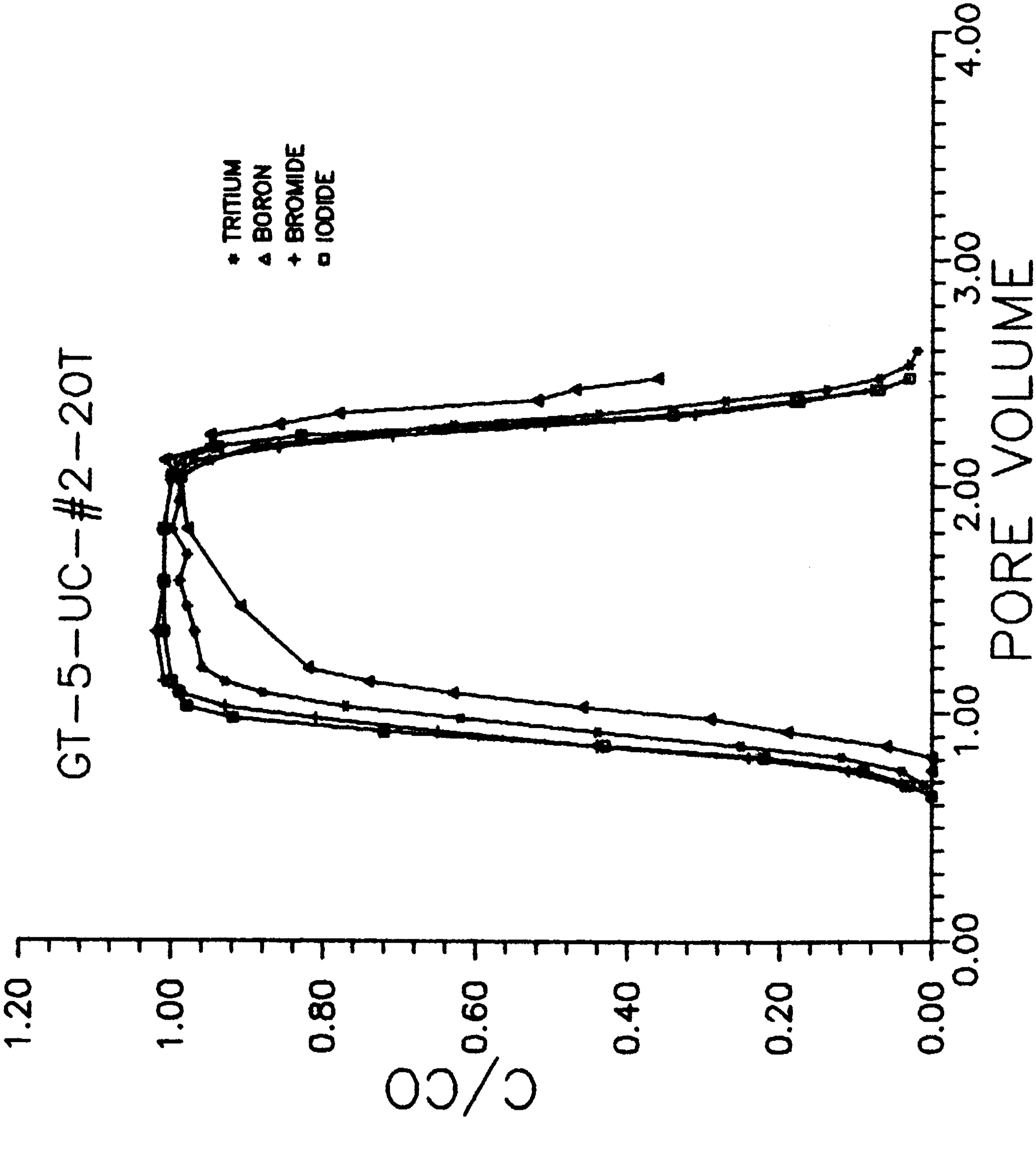
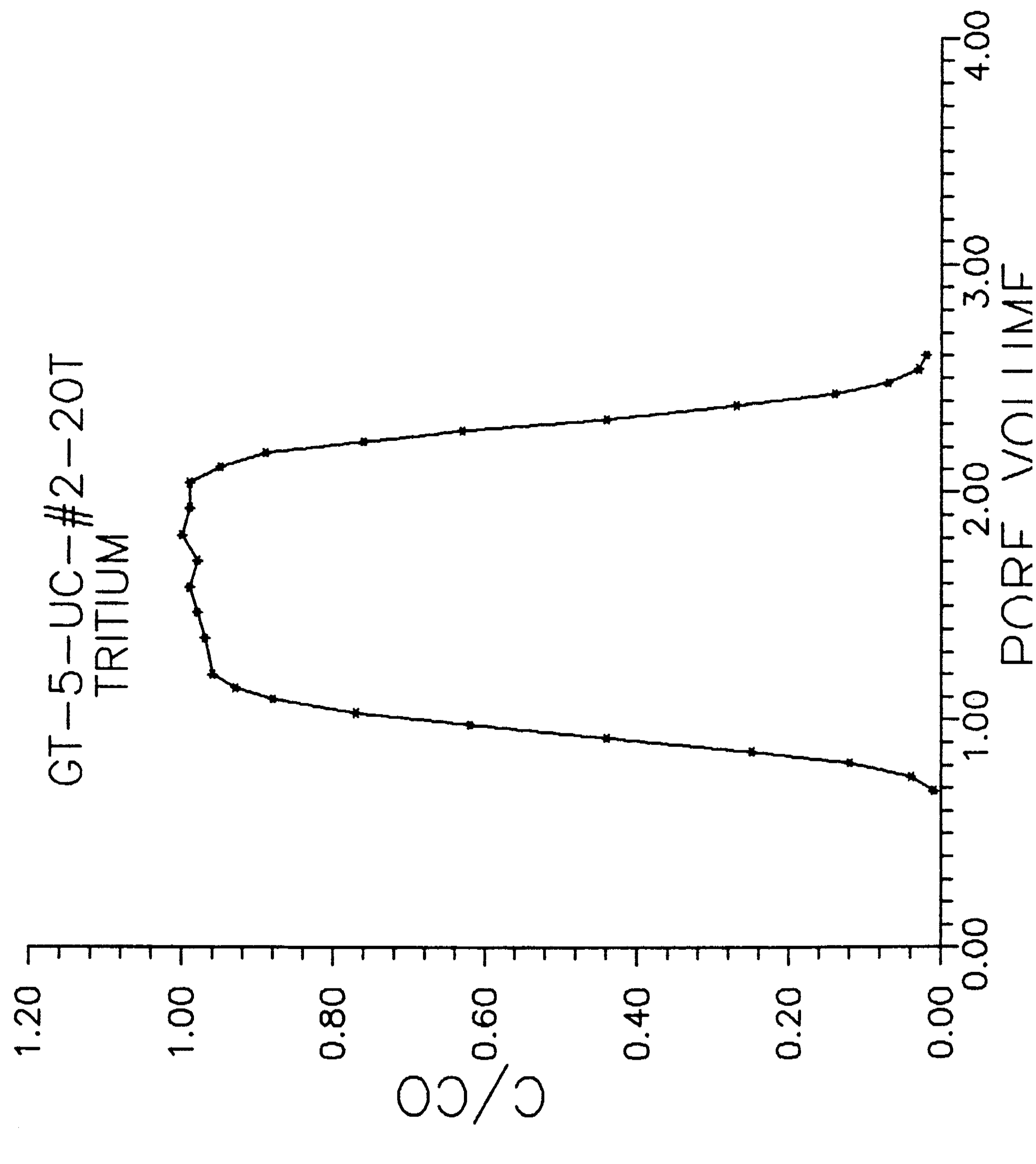
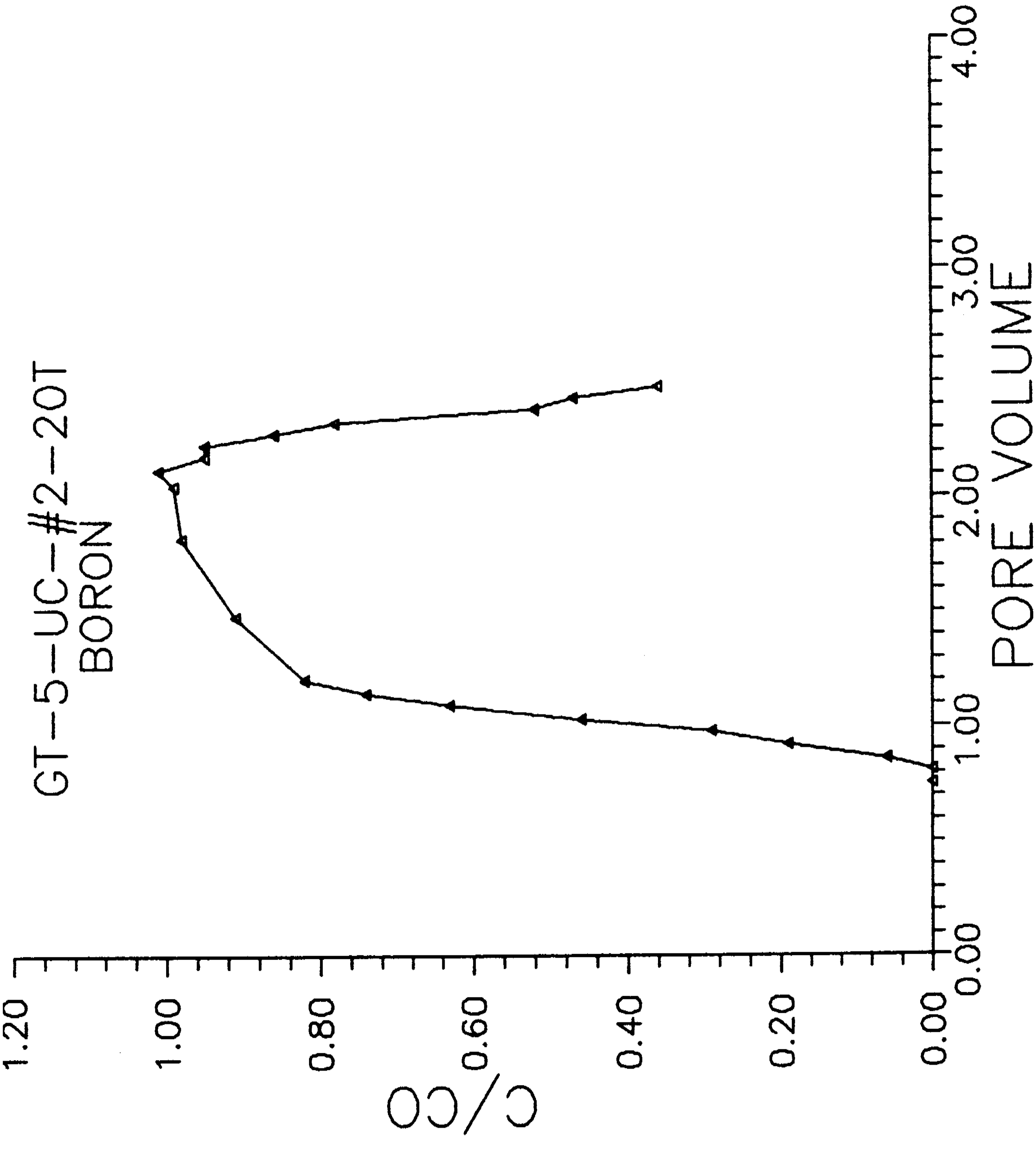
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00



GT-5-UC-#2-20T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


GT-5-UC-#2-20T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME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BORON
C/CO
PORE VOLUME
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0.20
0.40
0.60
0.80
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1.20
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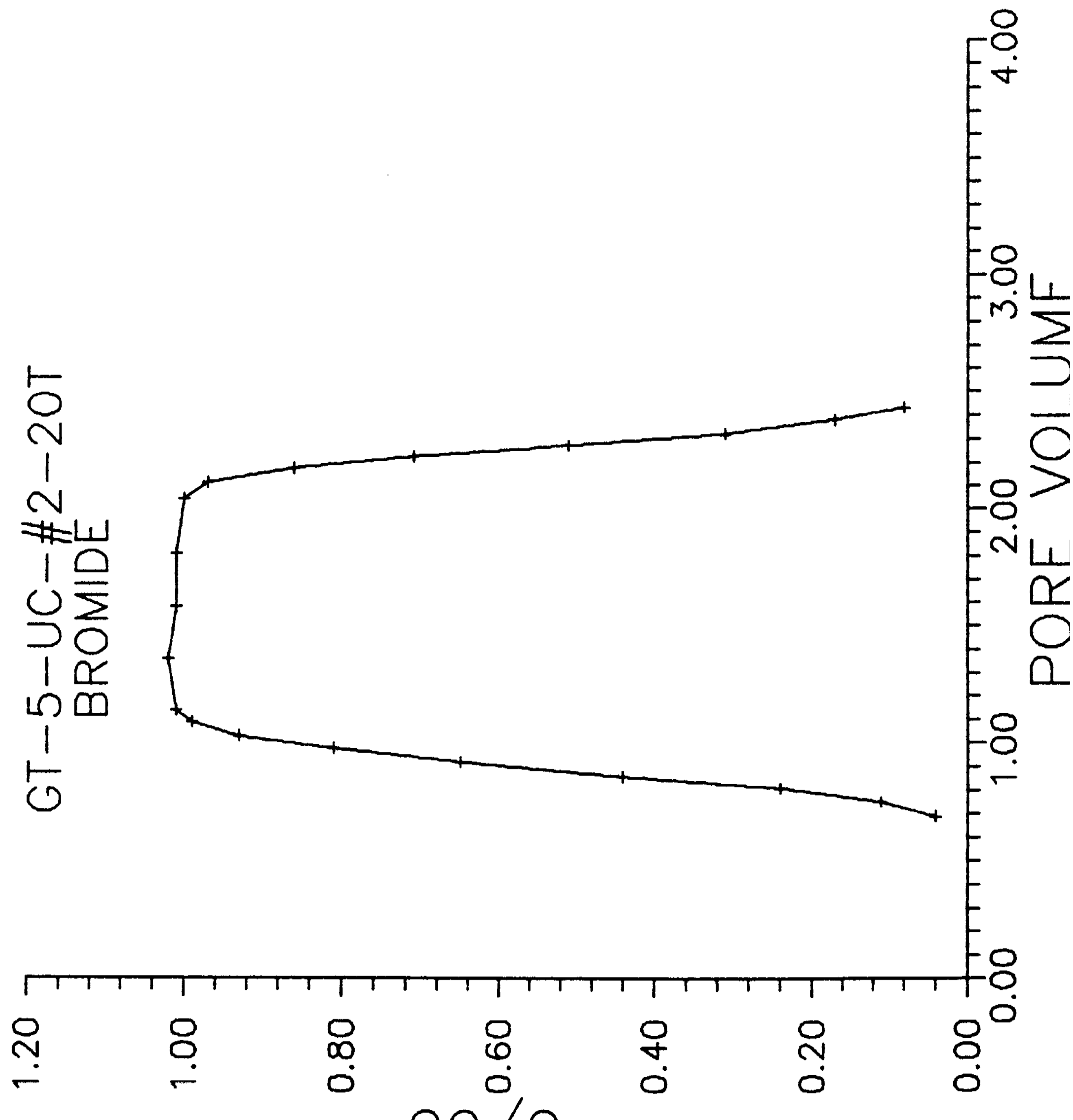
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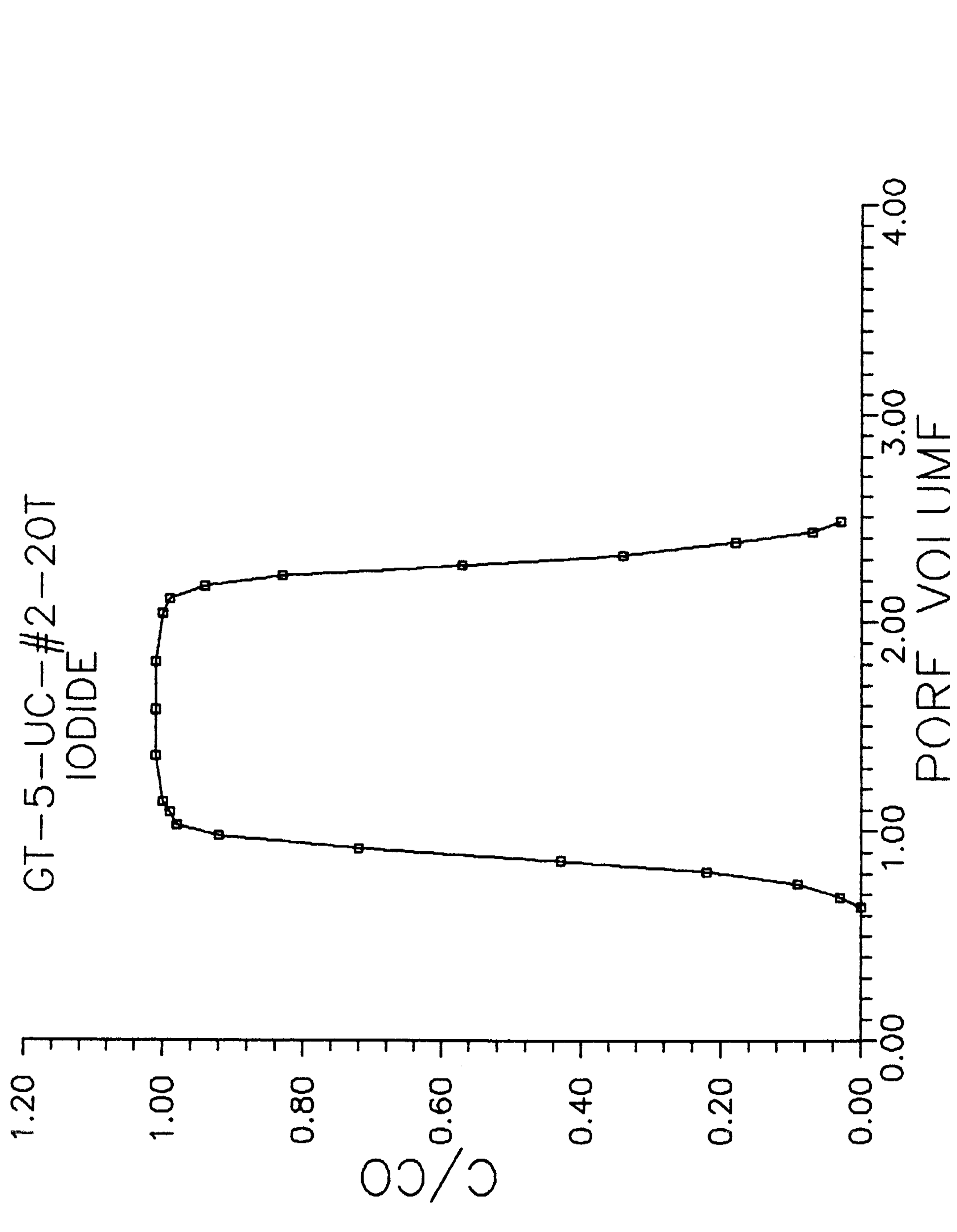
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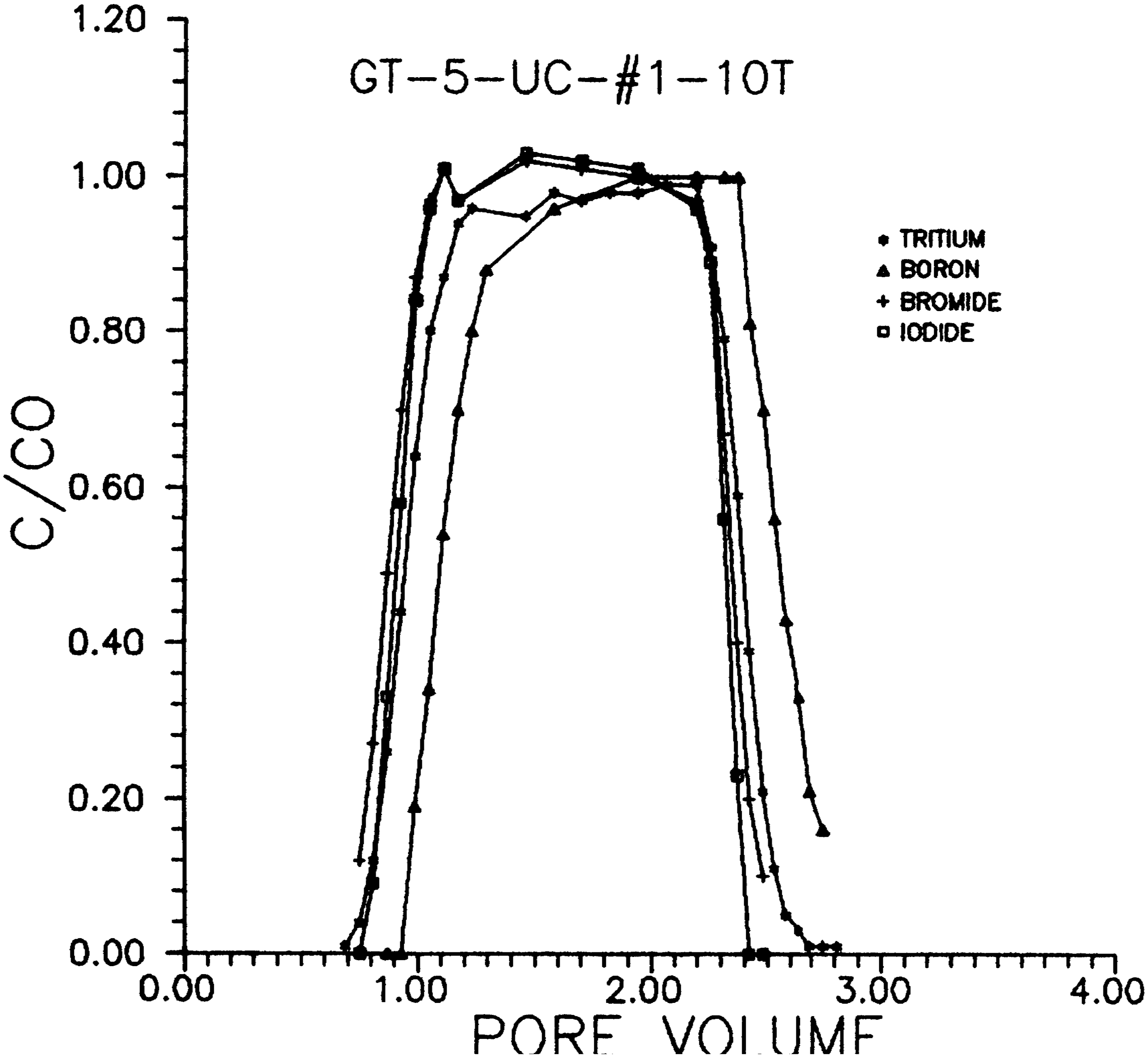
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C/CO
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BROMIDE
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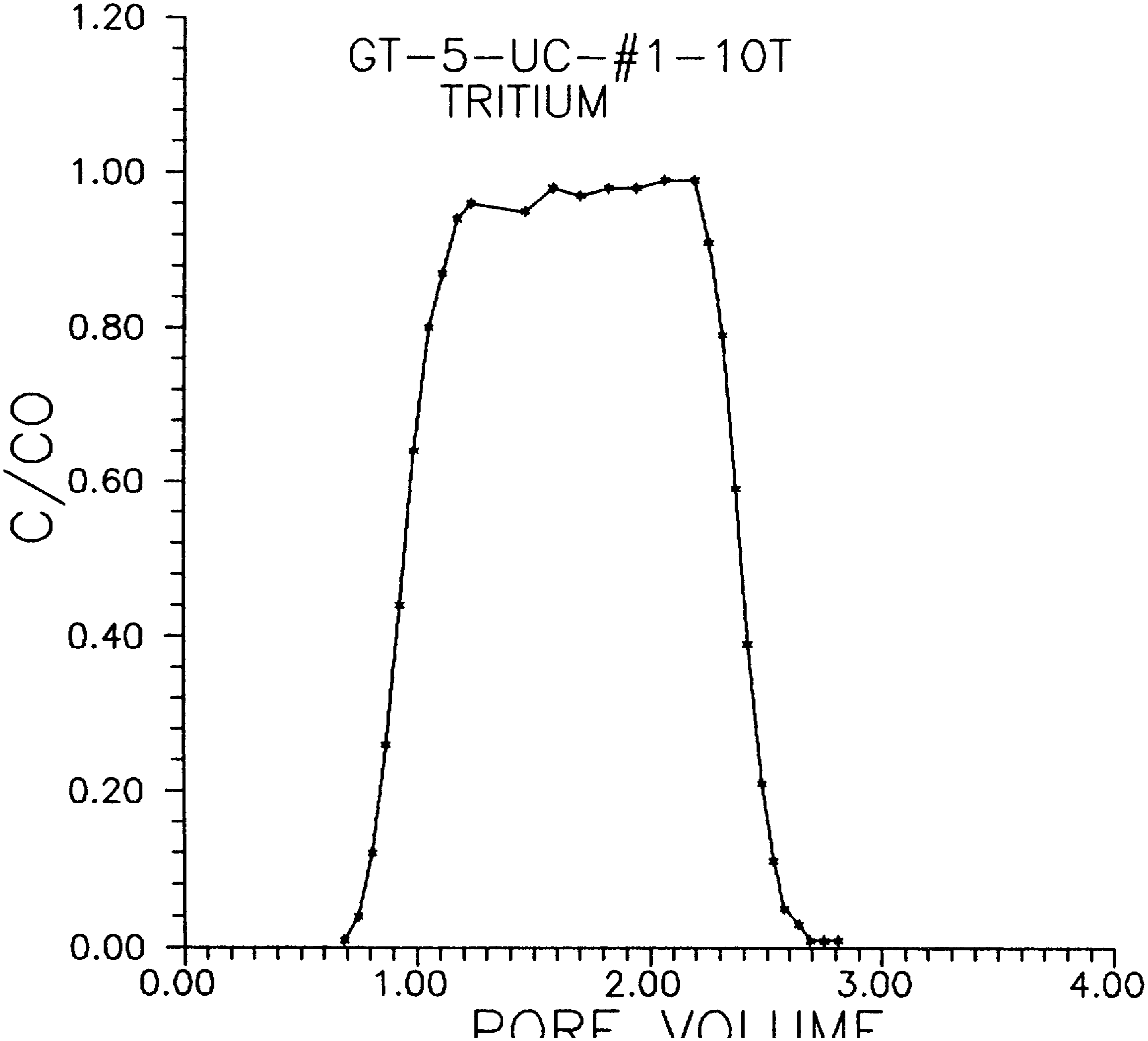
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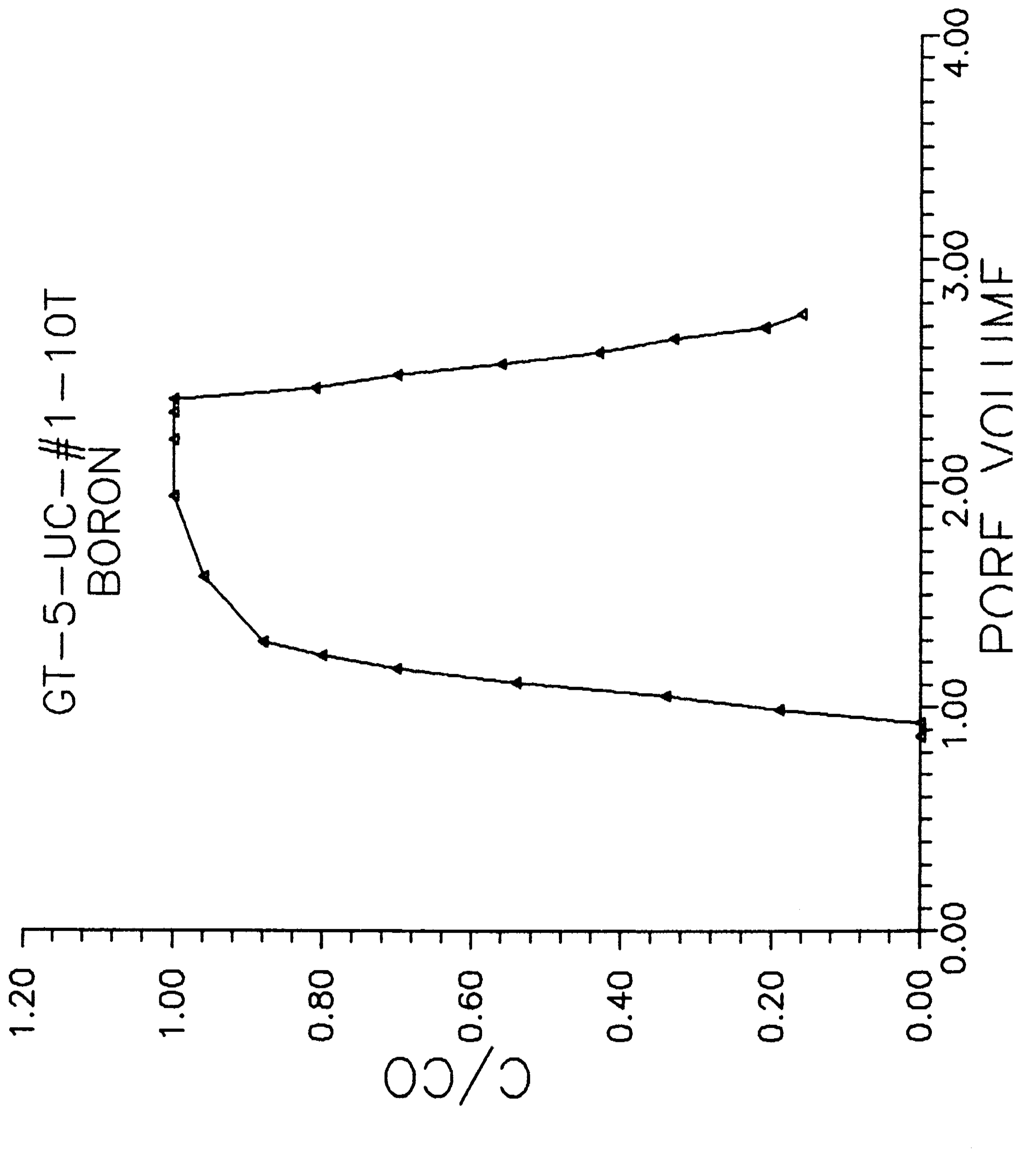

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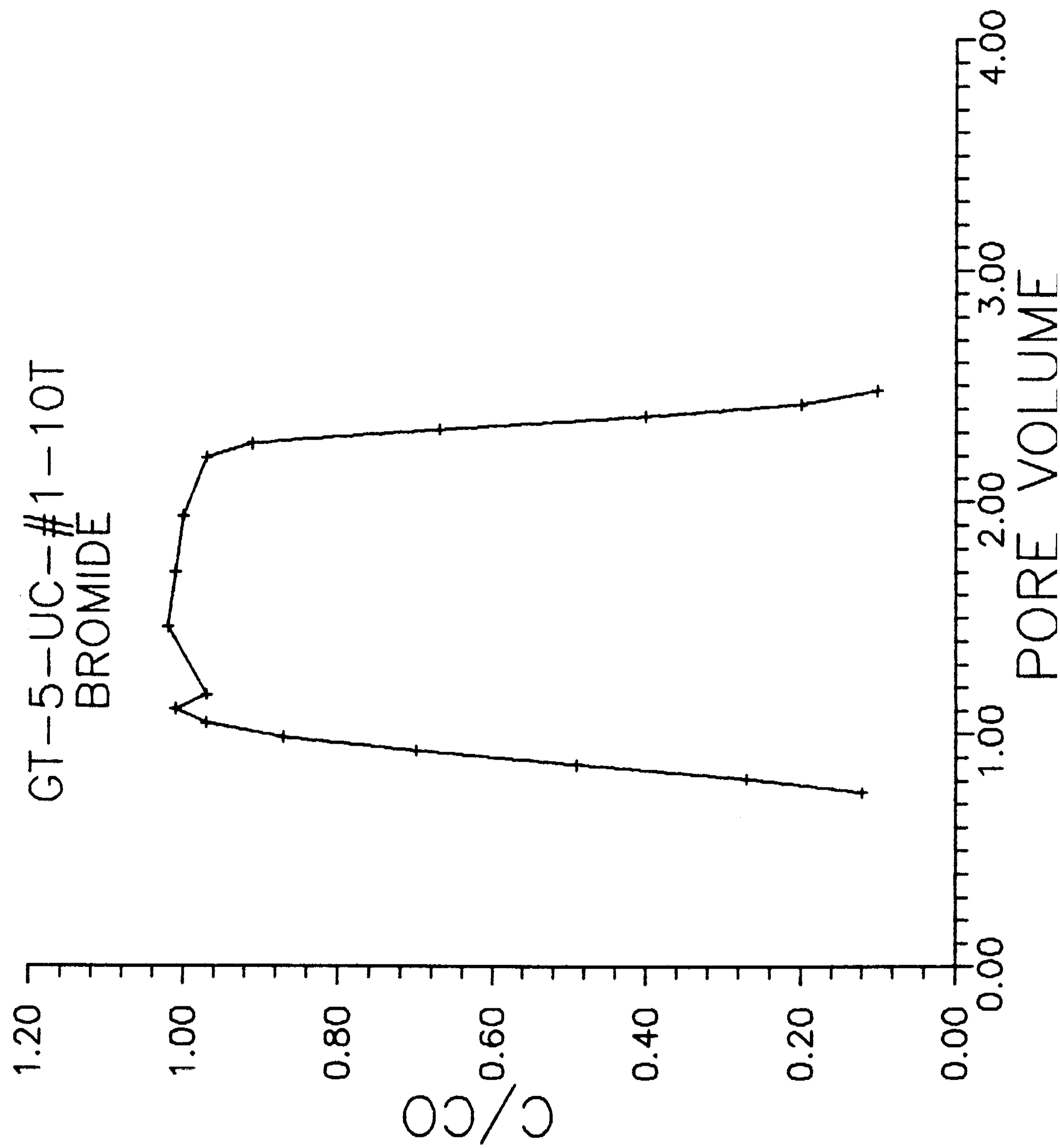
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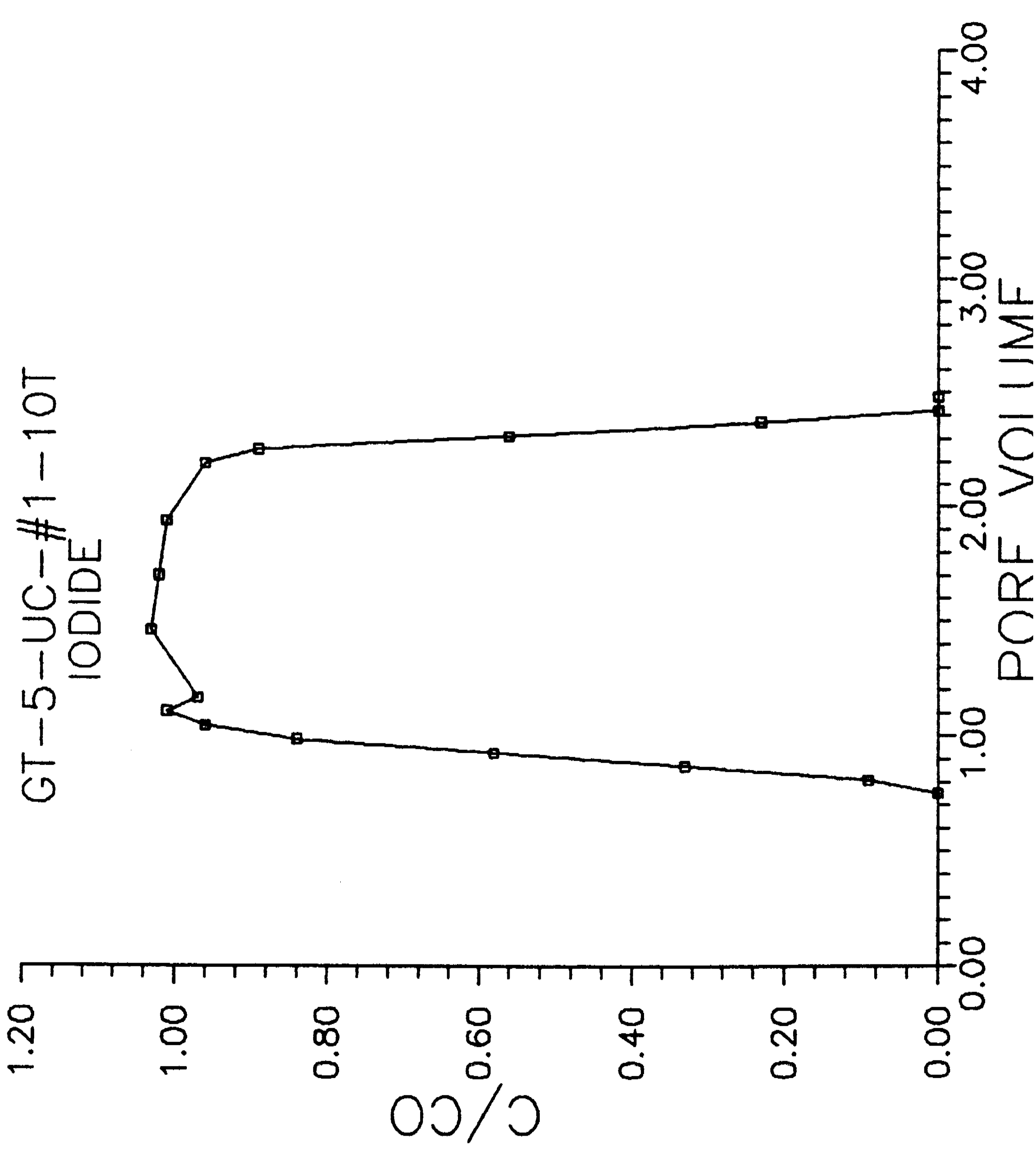
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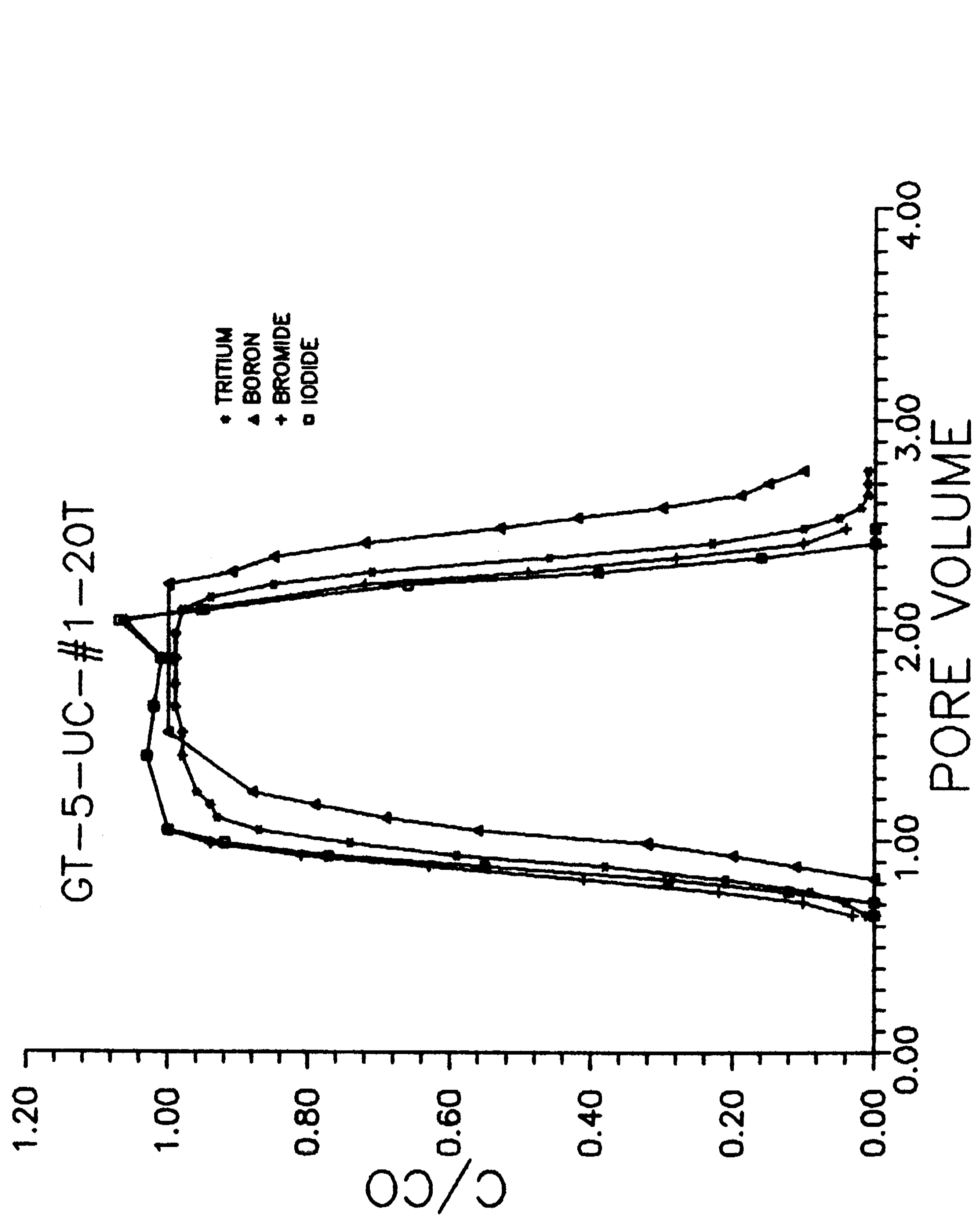
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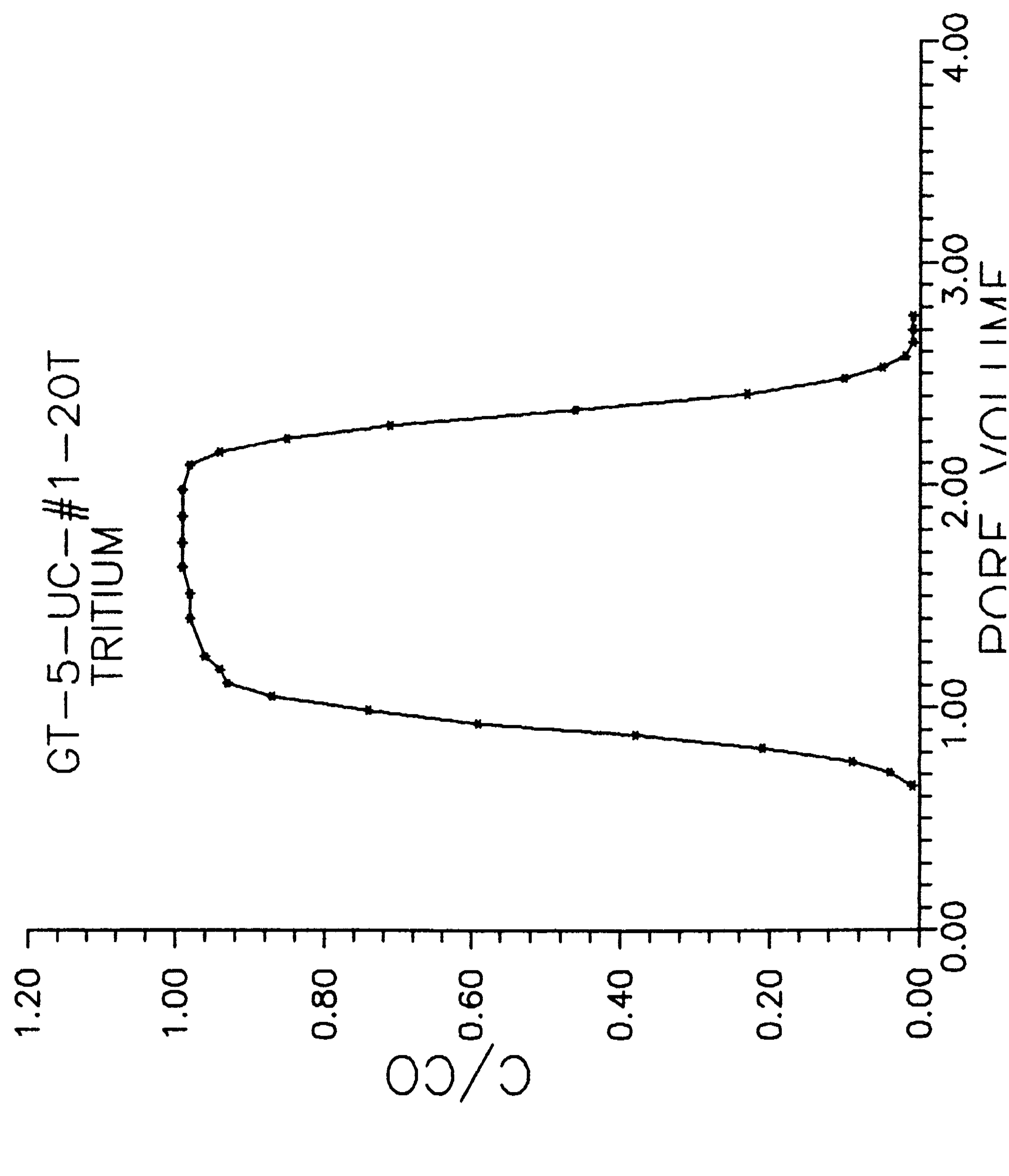
BROMIDE
IODIDE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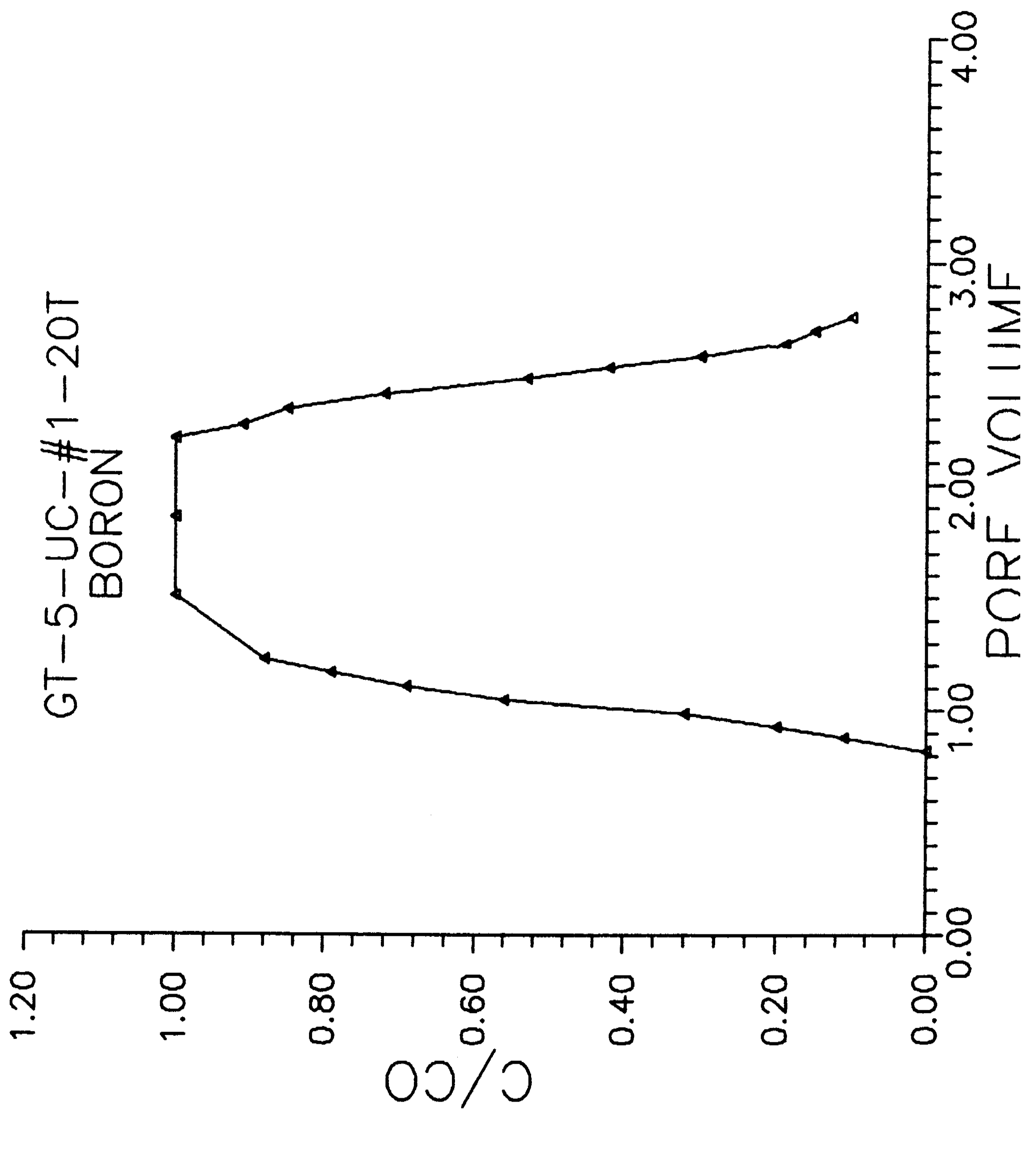
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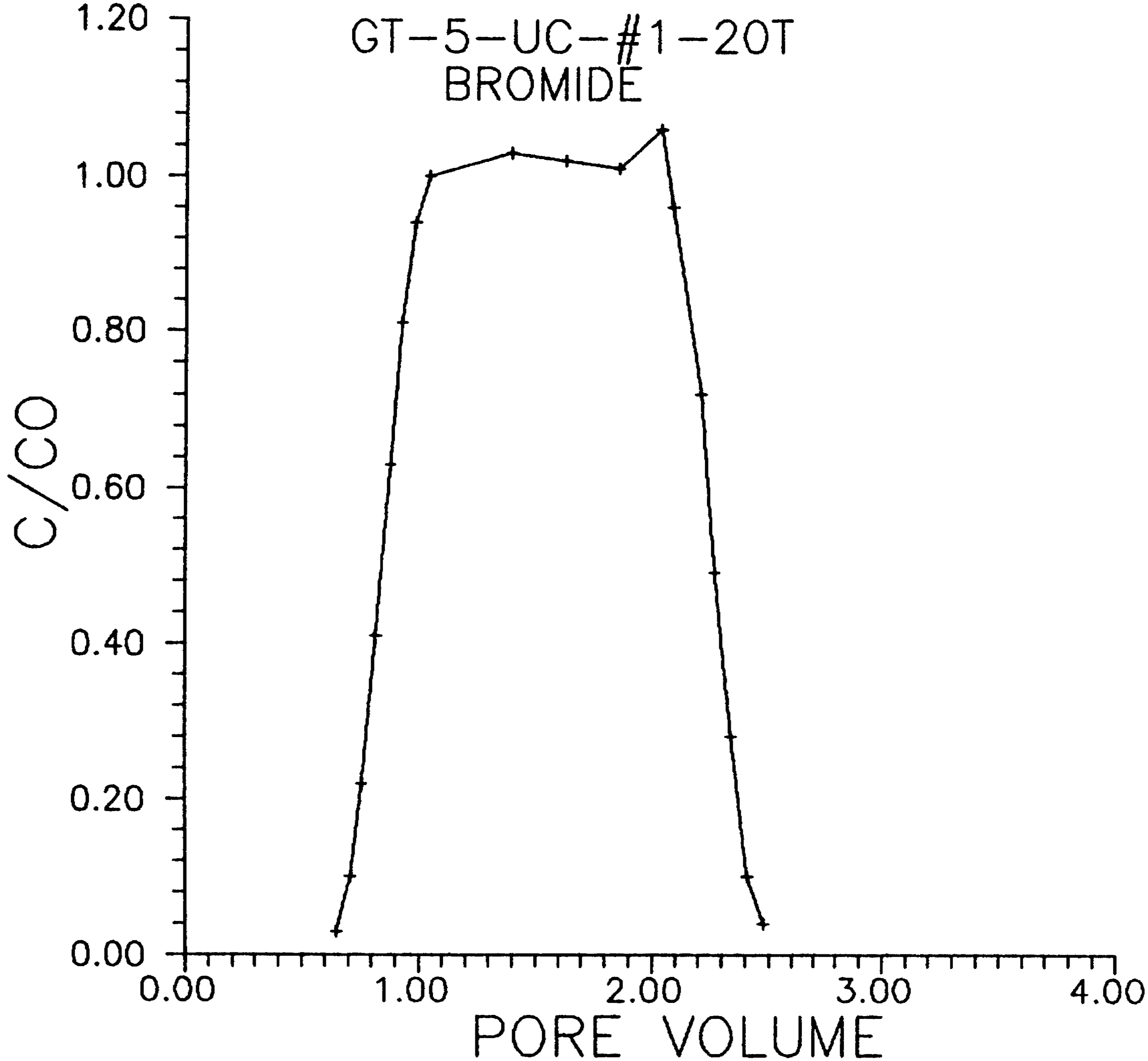
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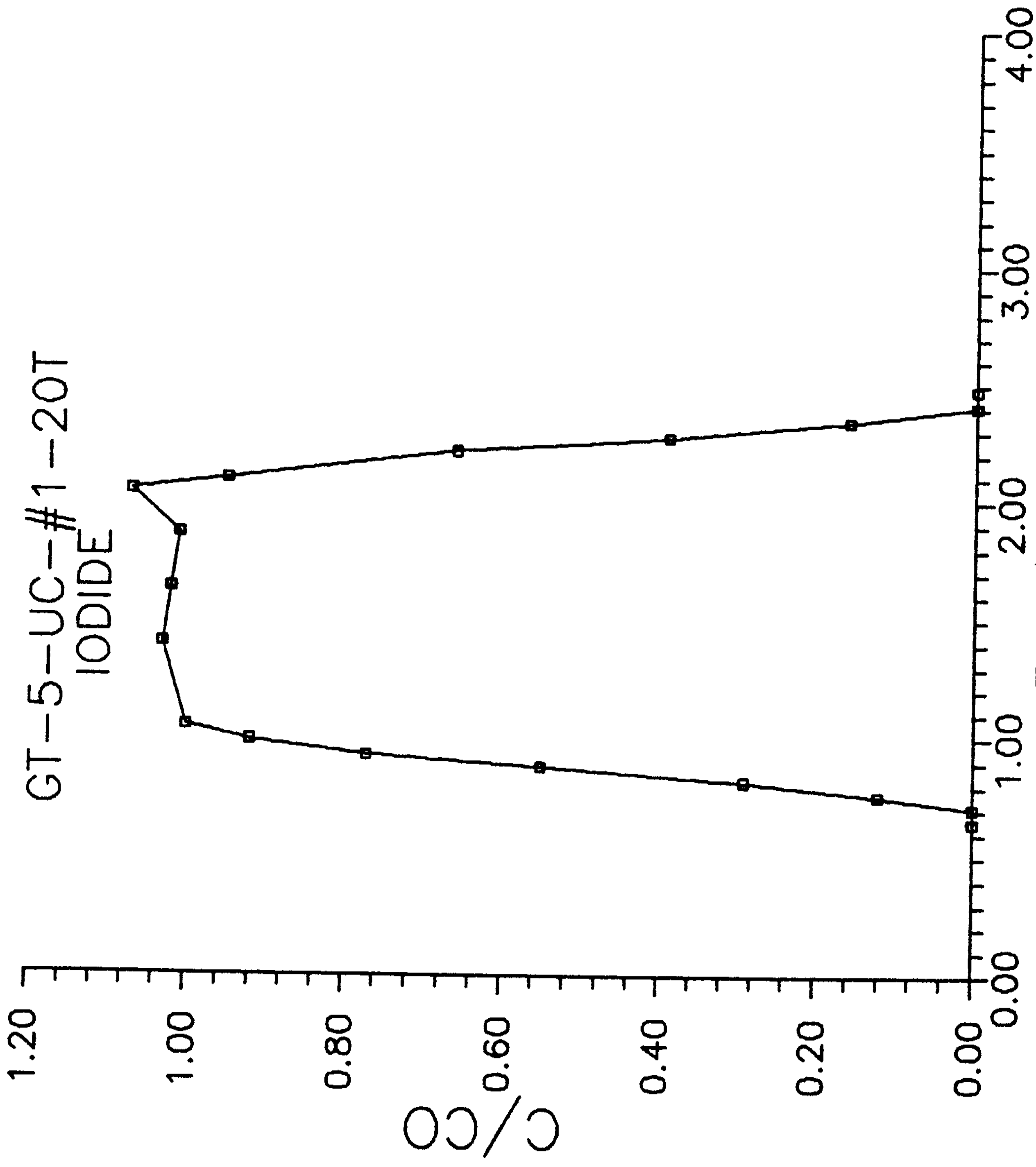
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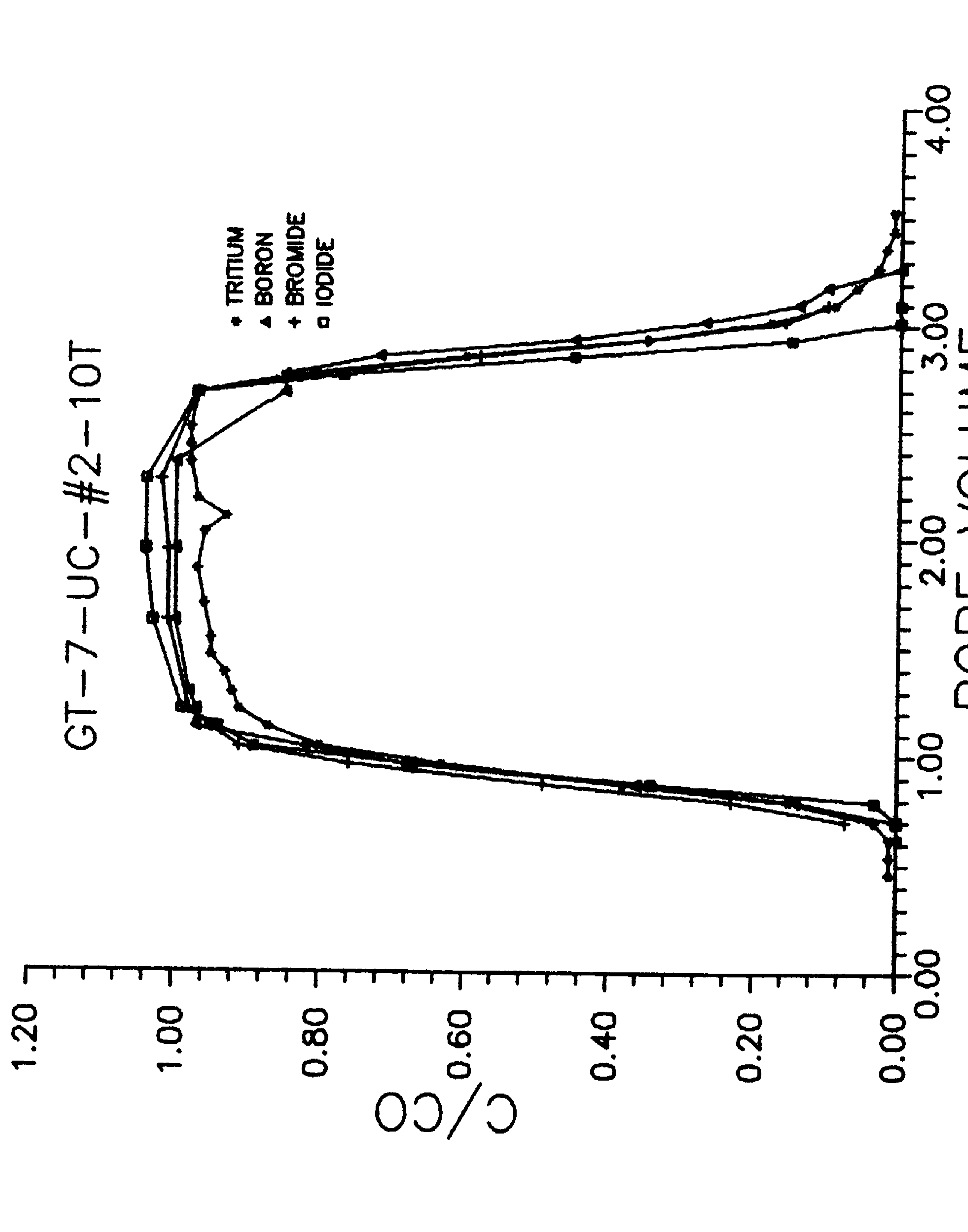
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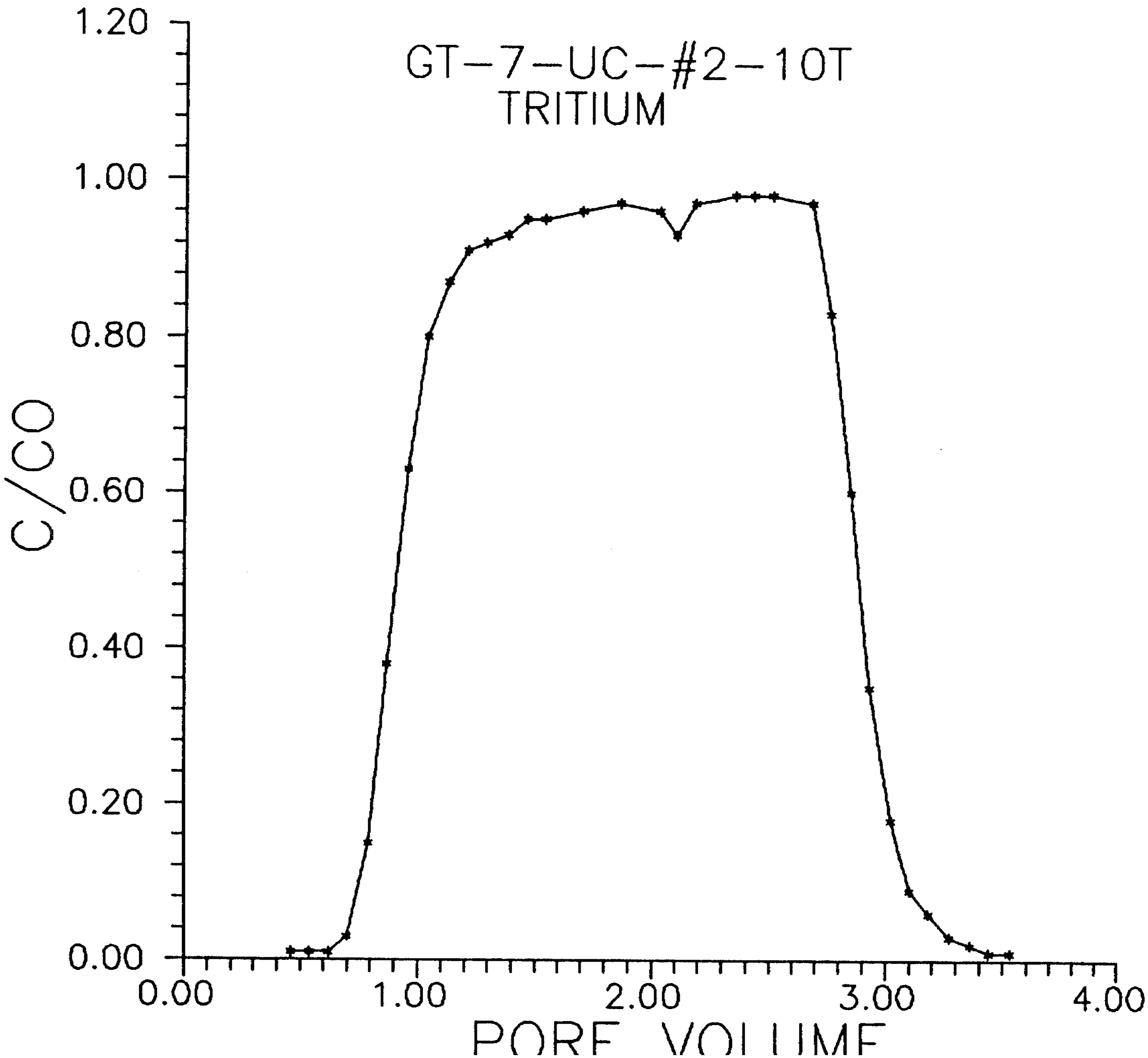
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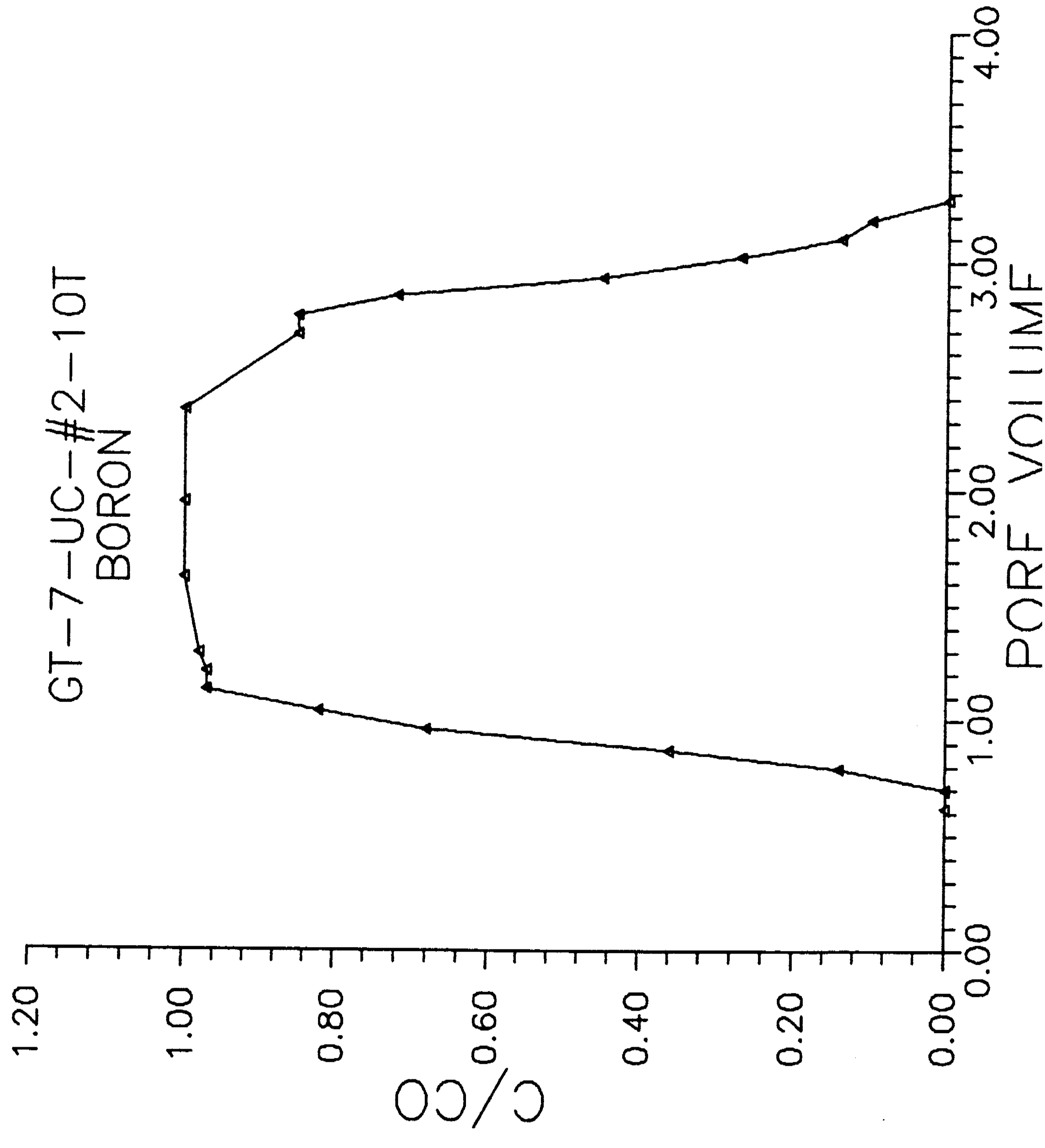
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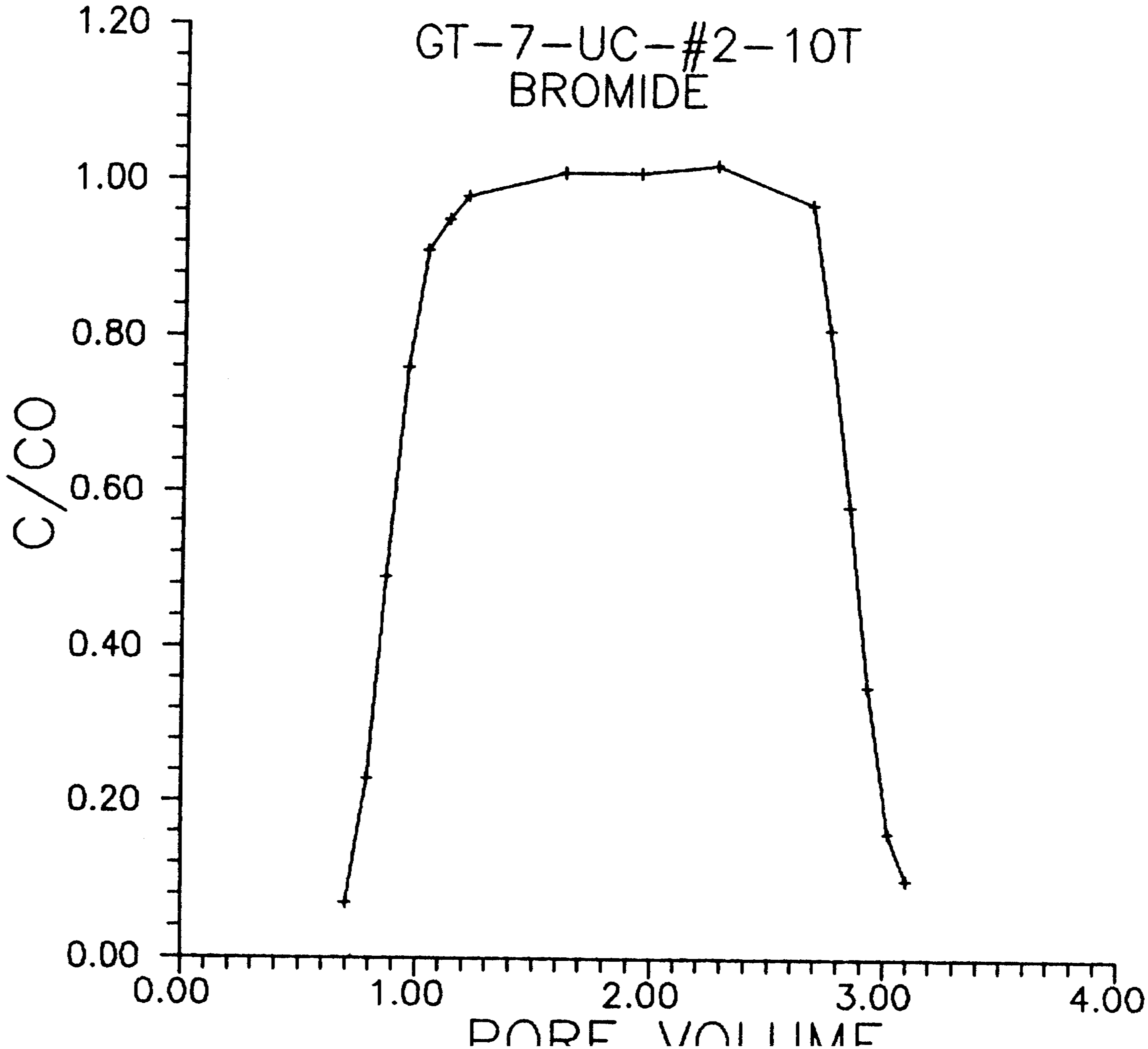
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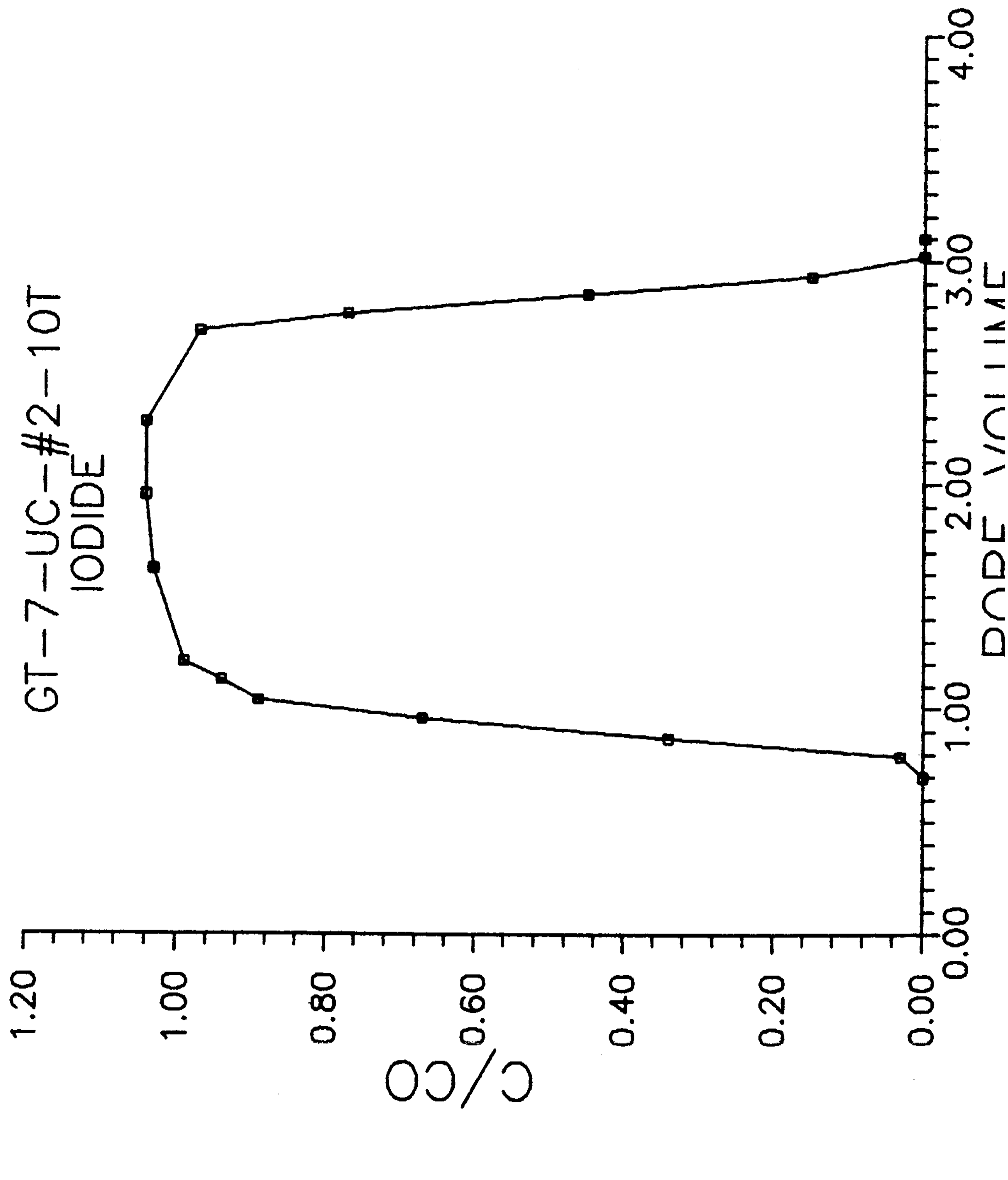
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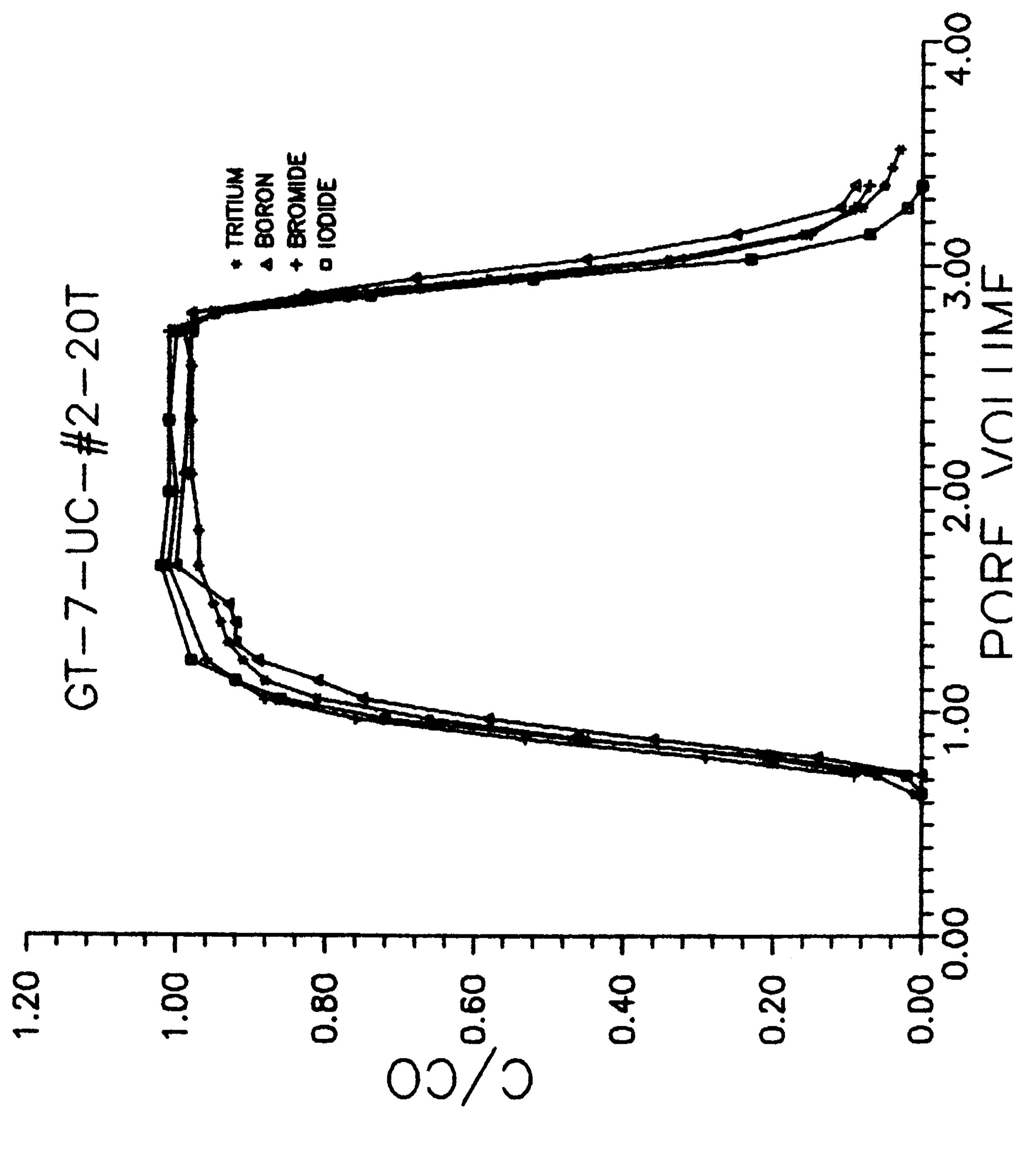
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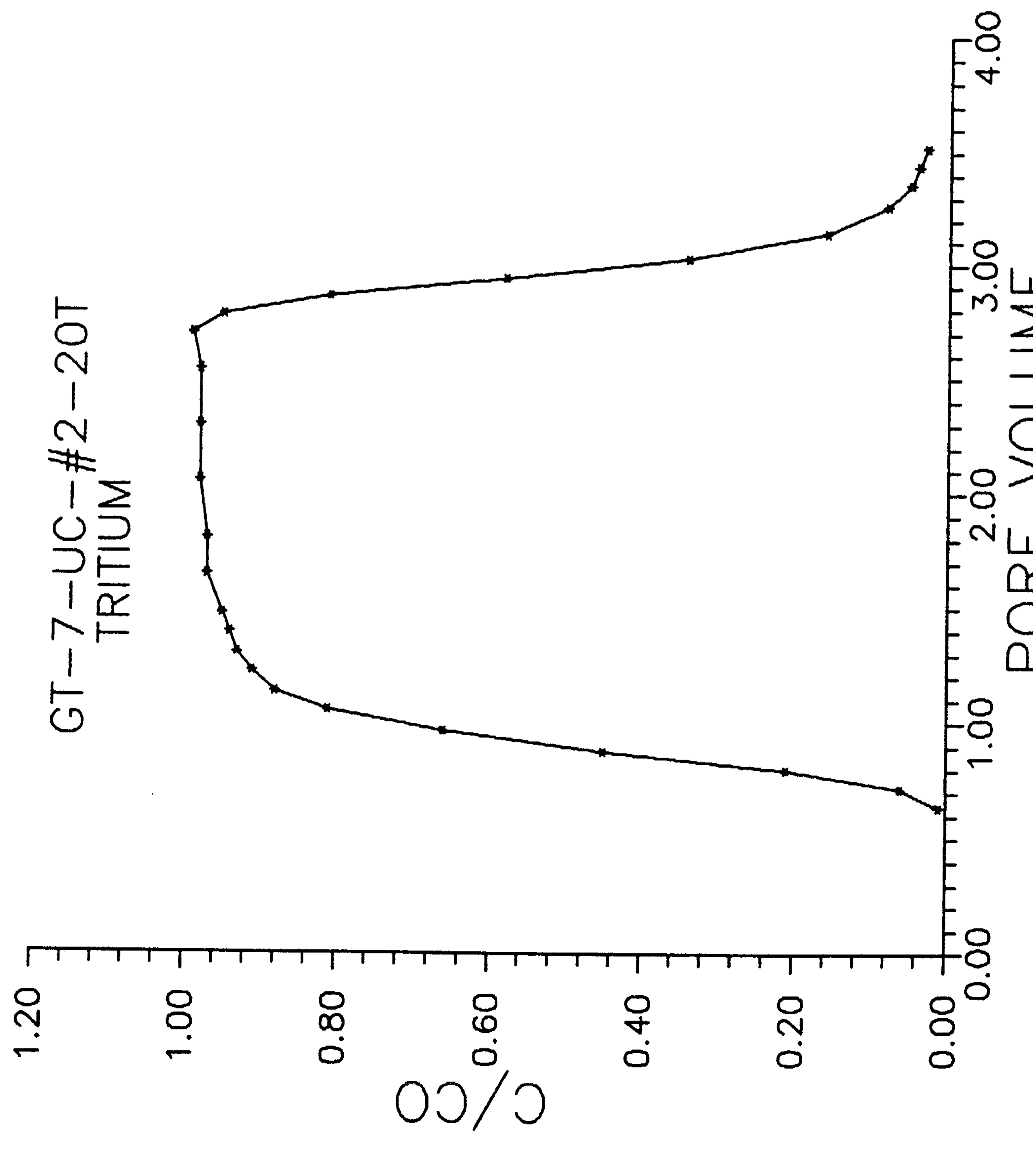
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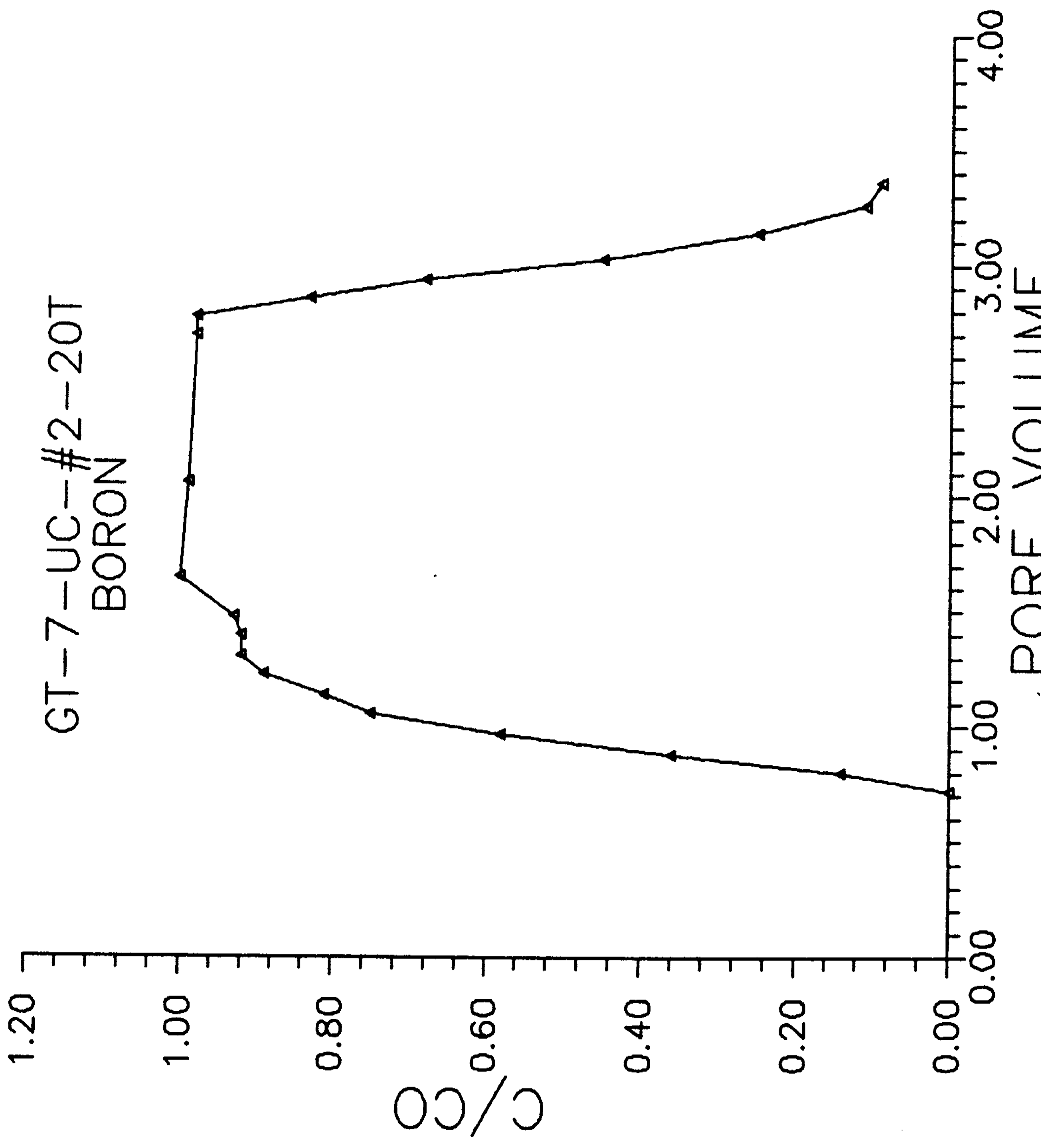
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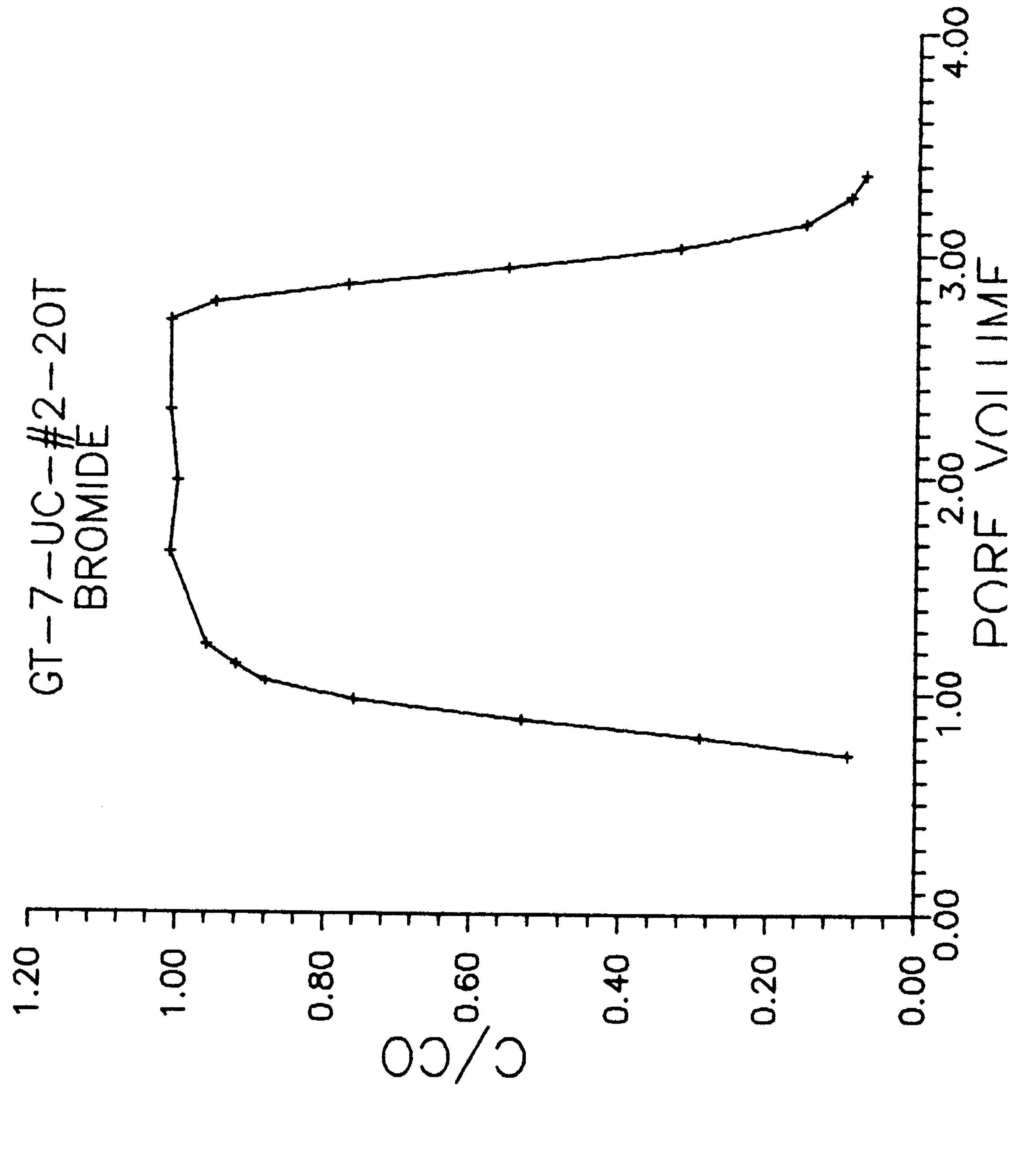
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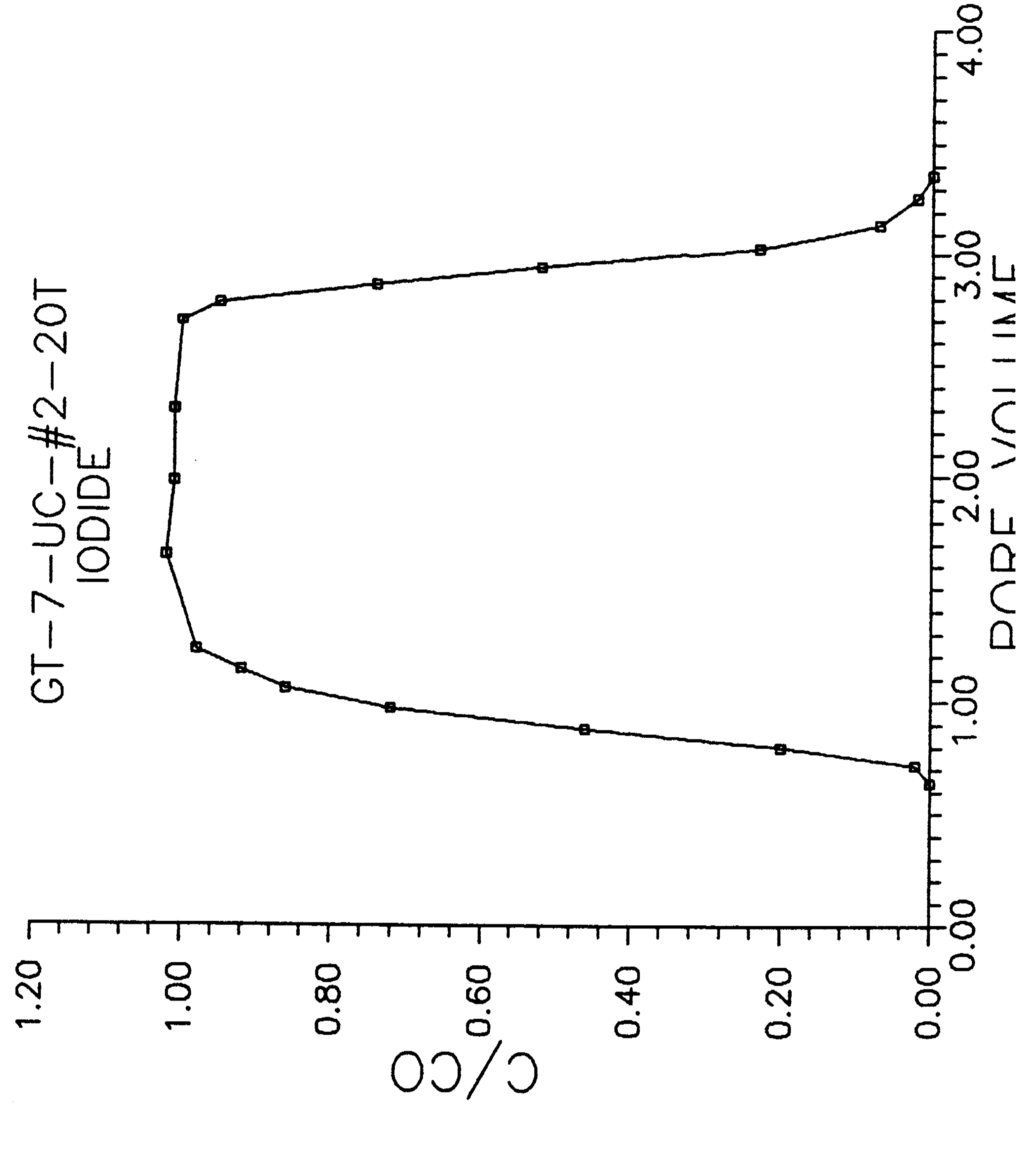

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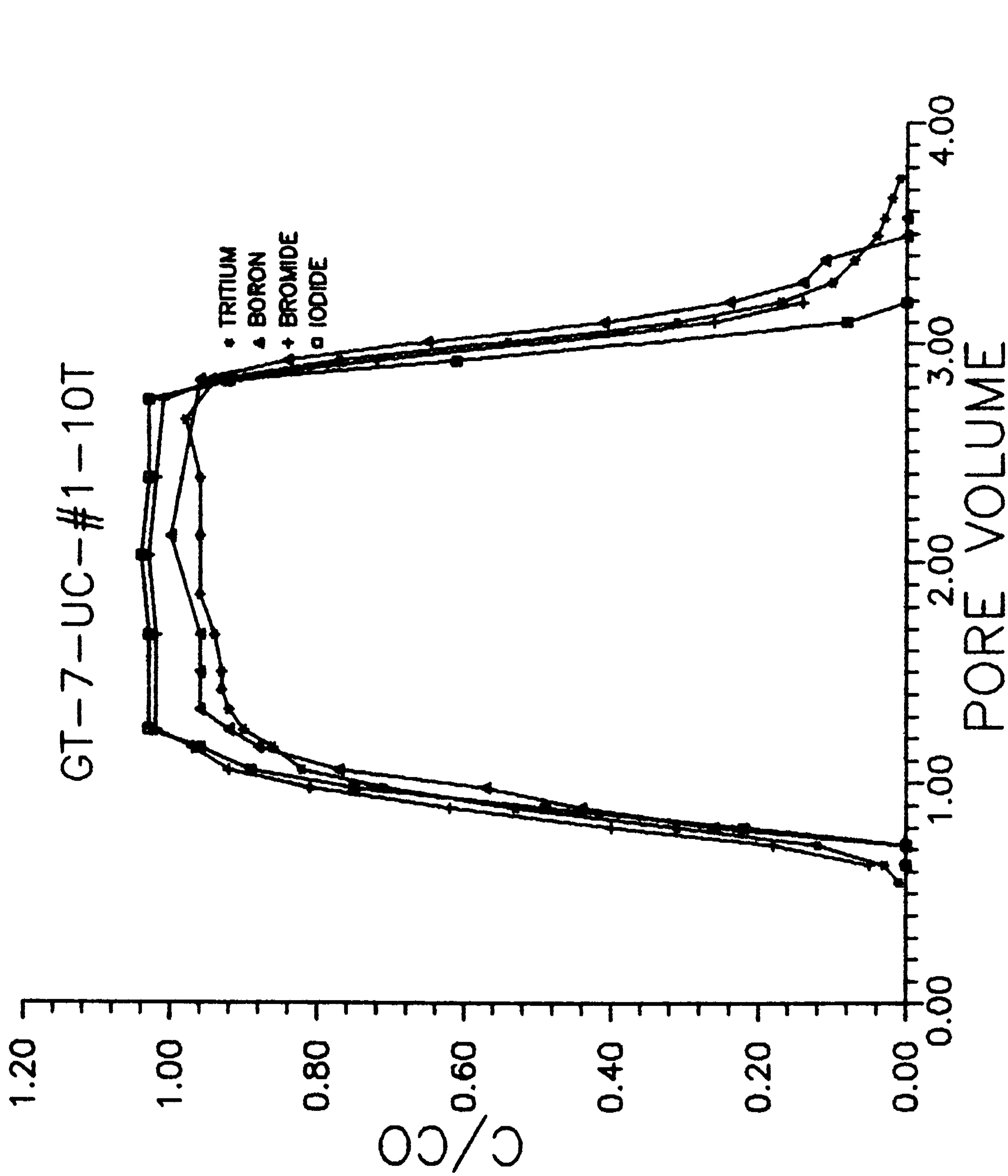
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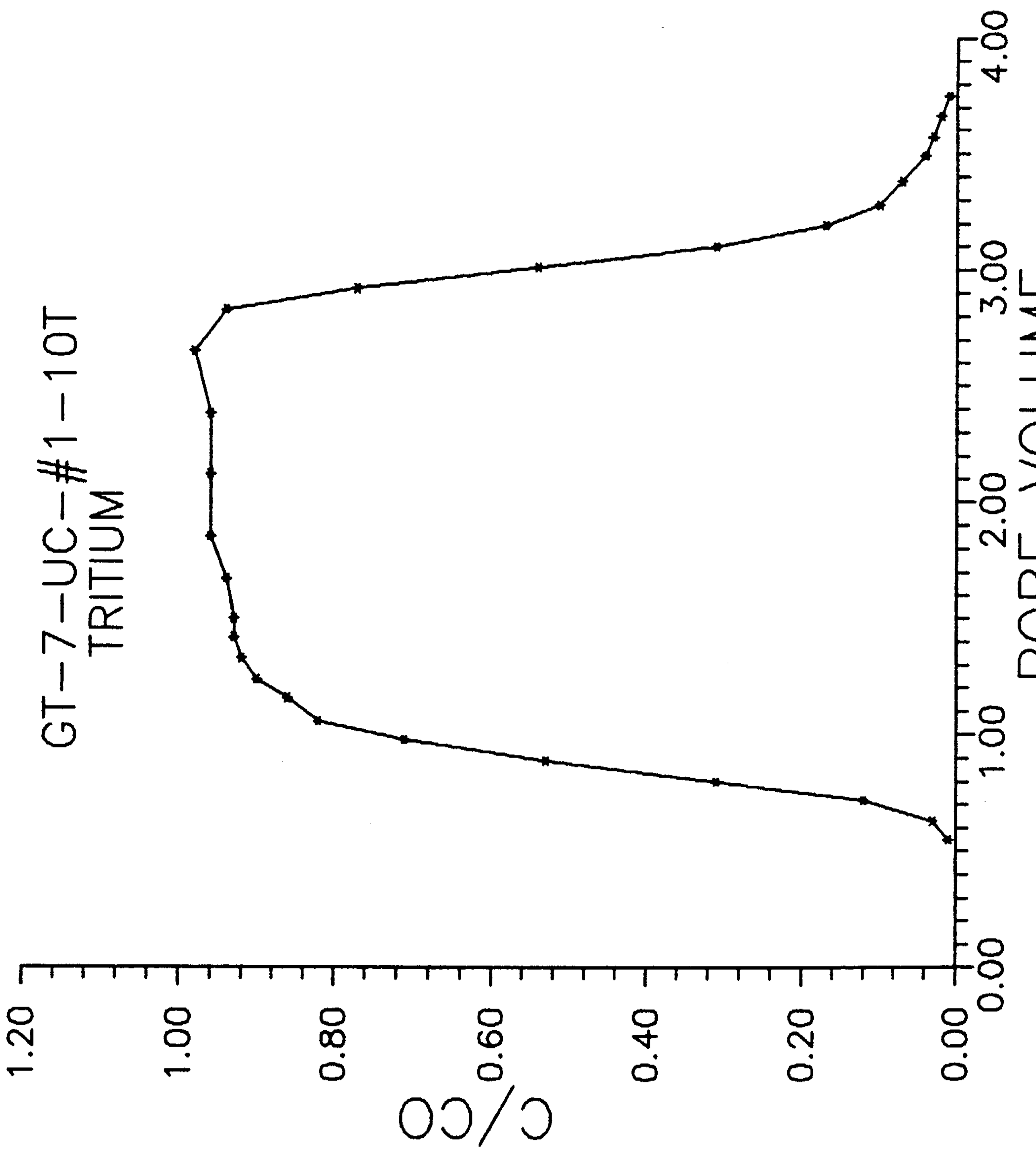

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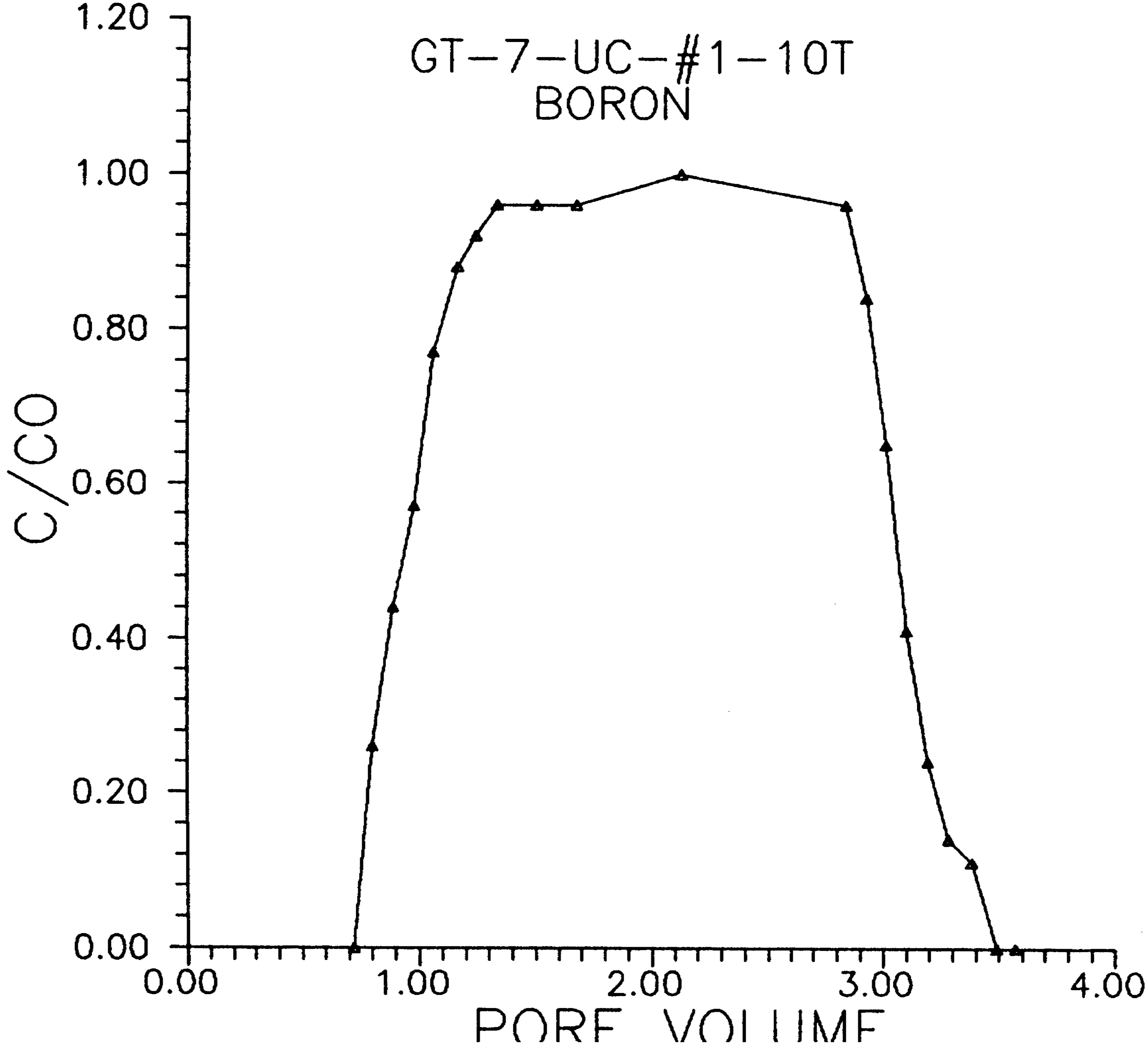
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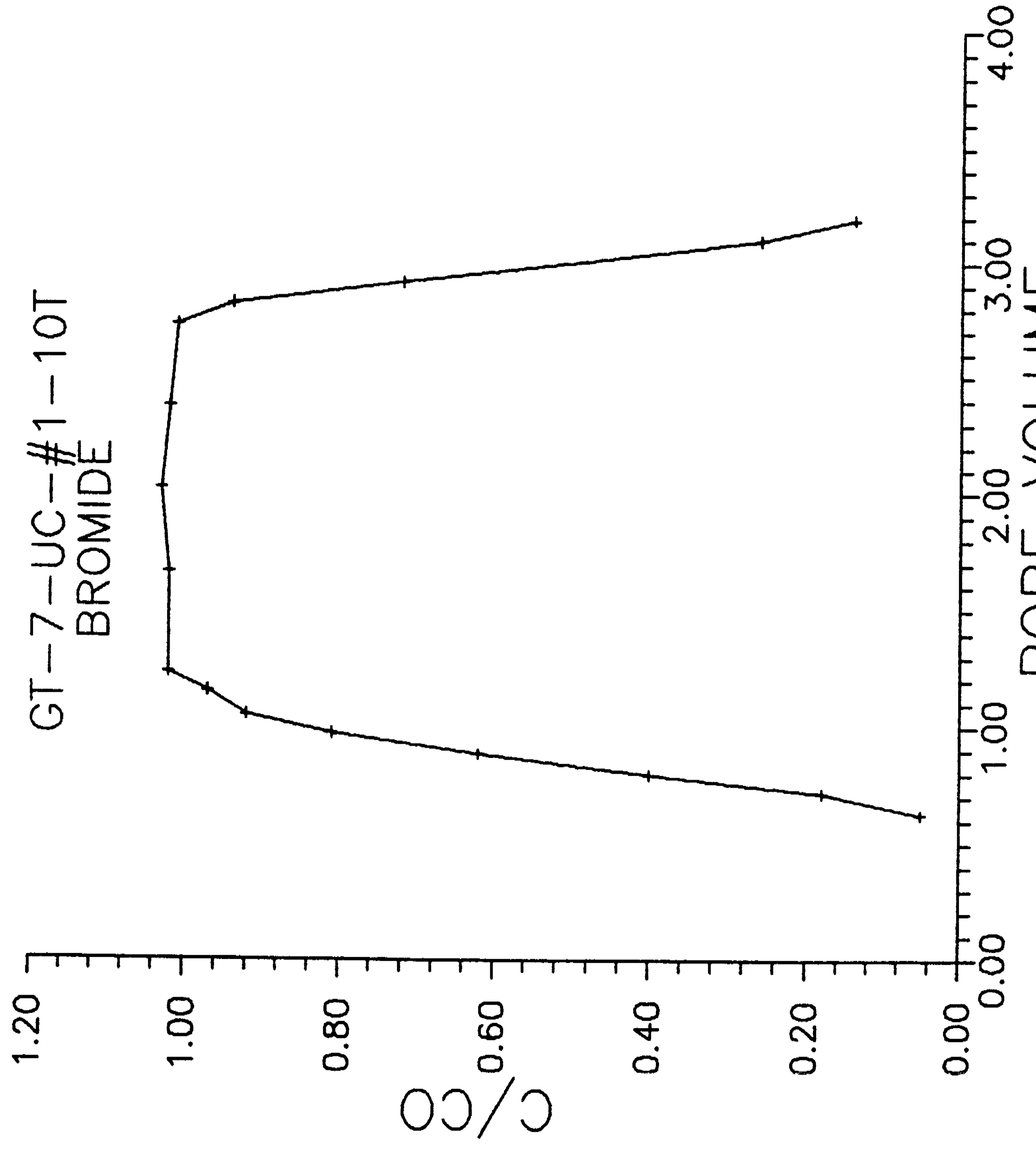
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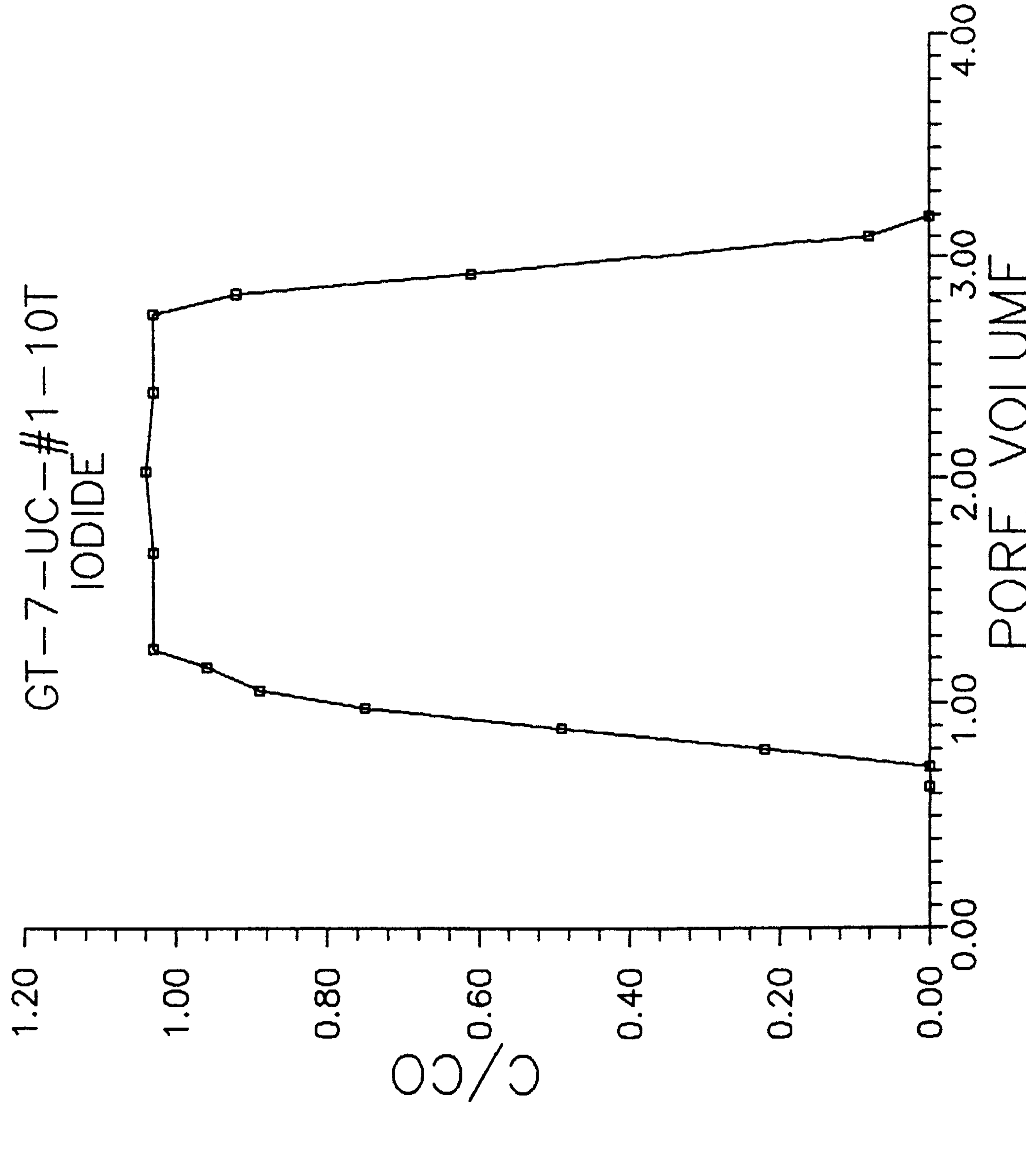
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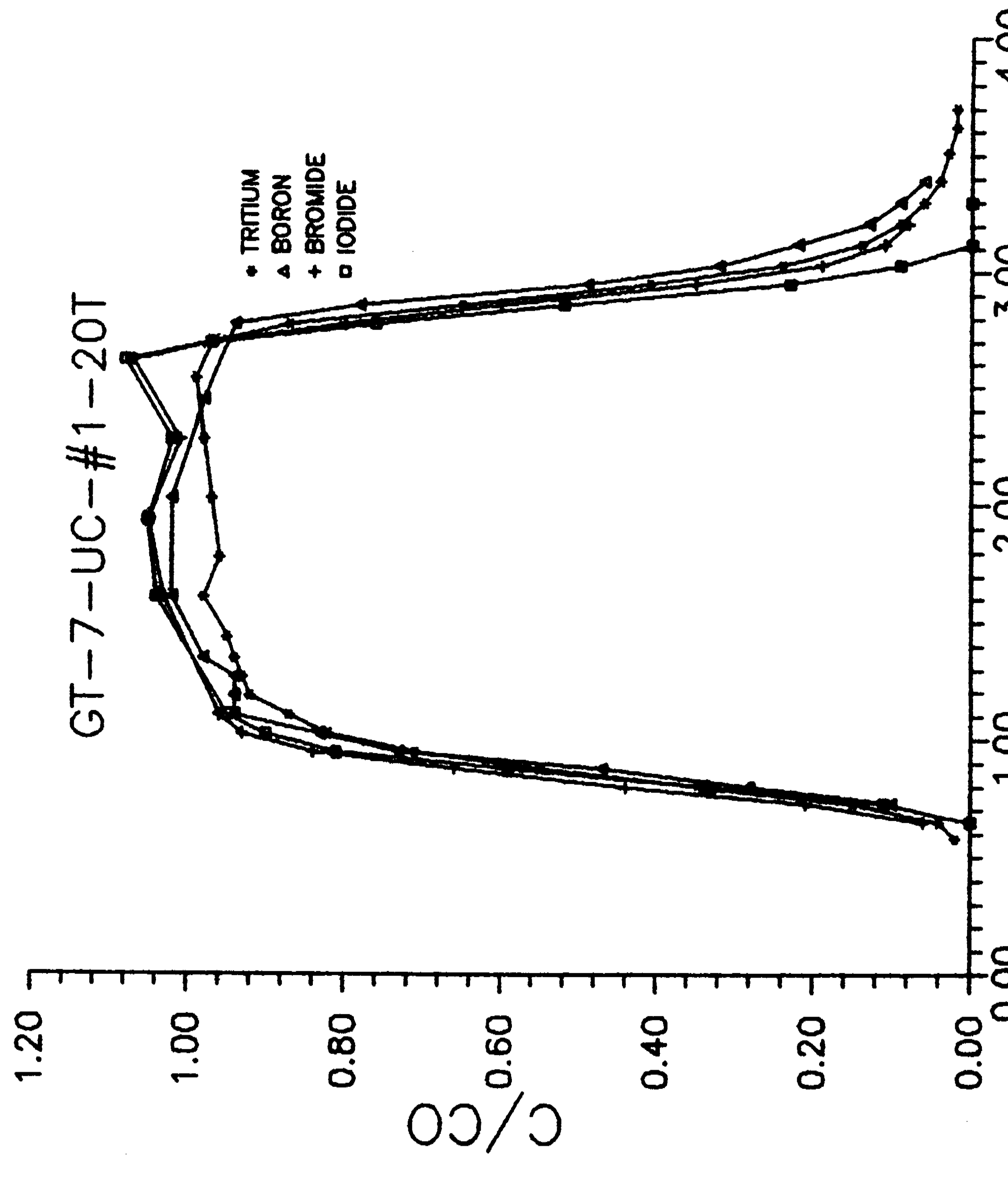
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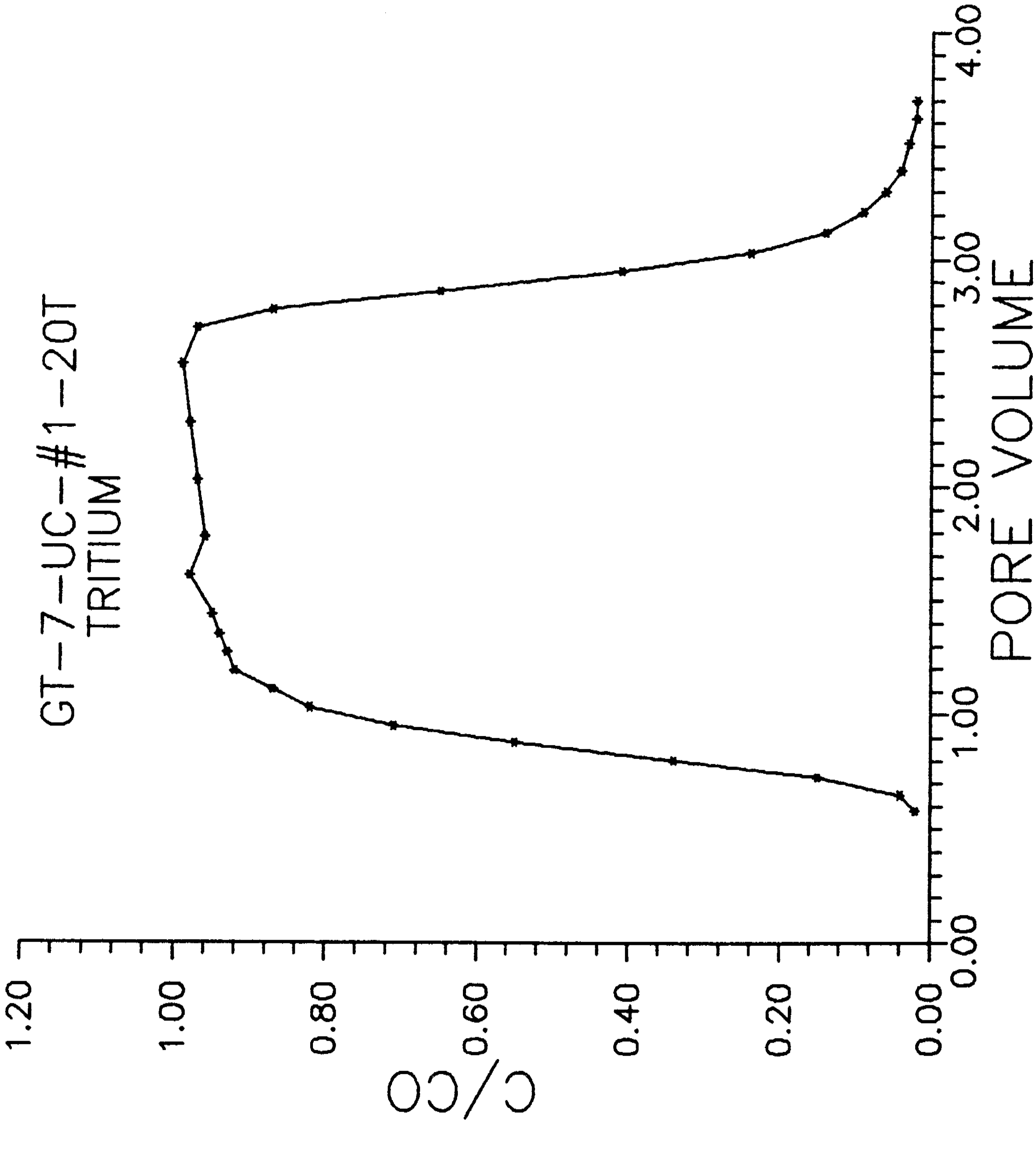
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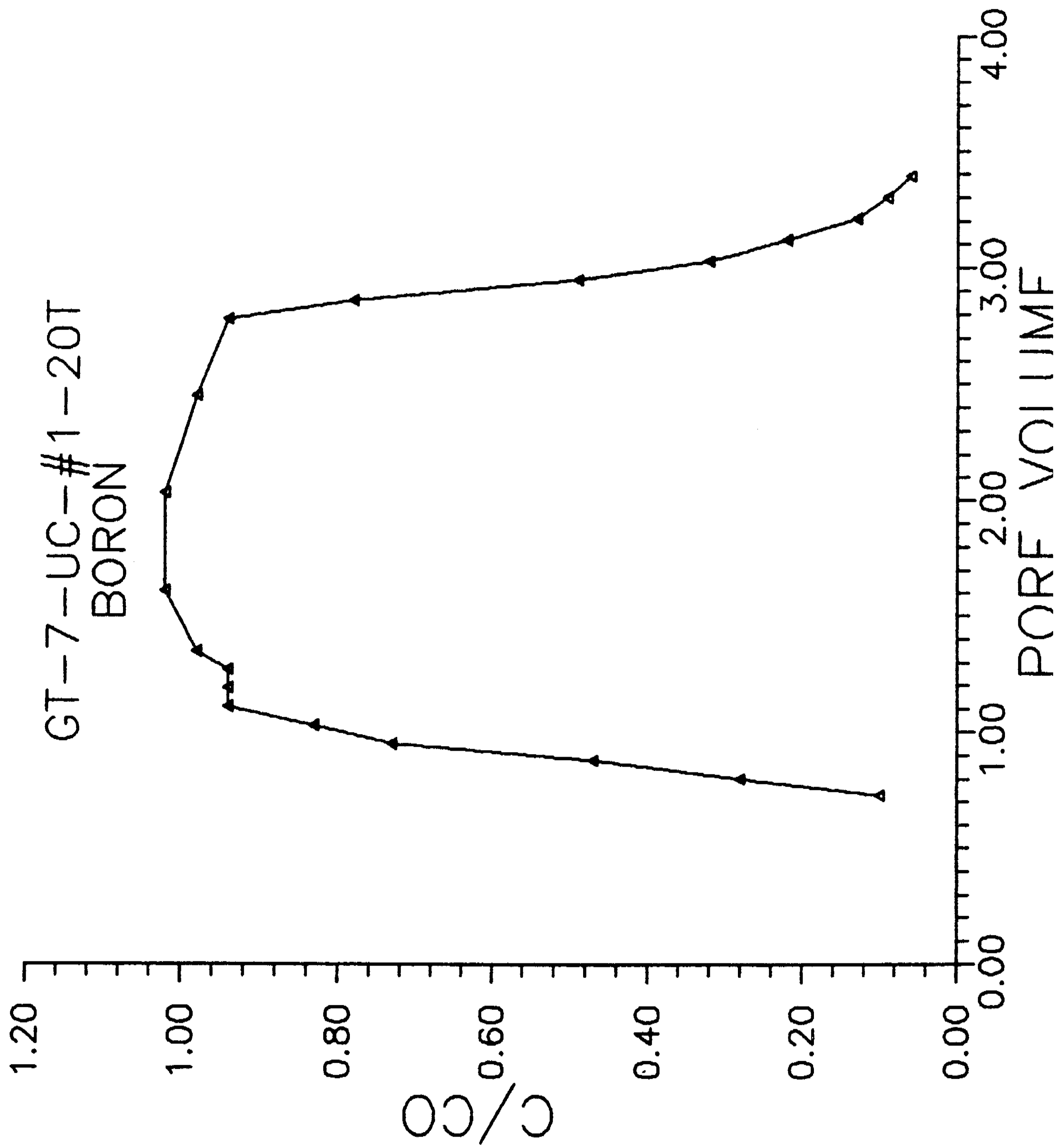
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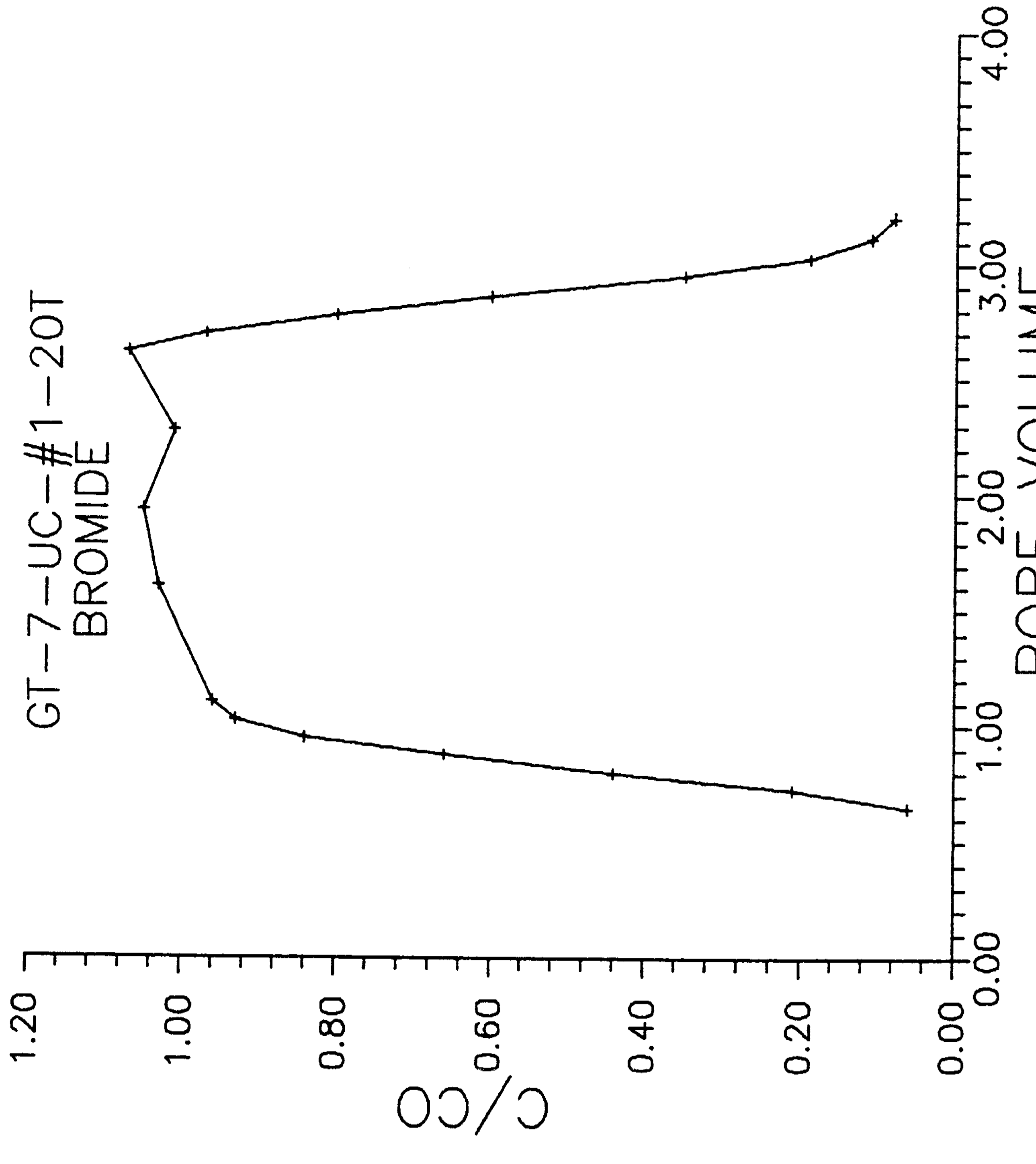
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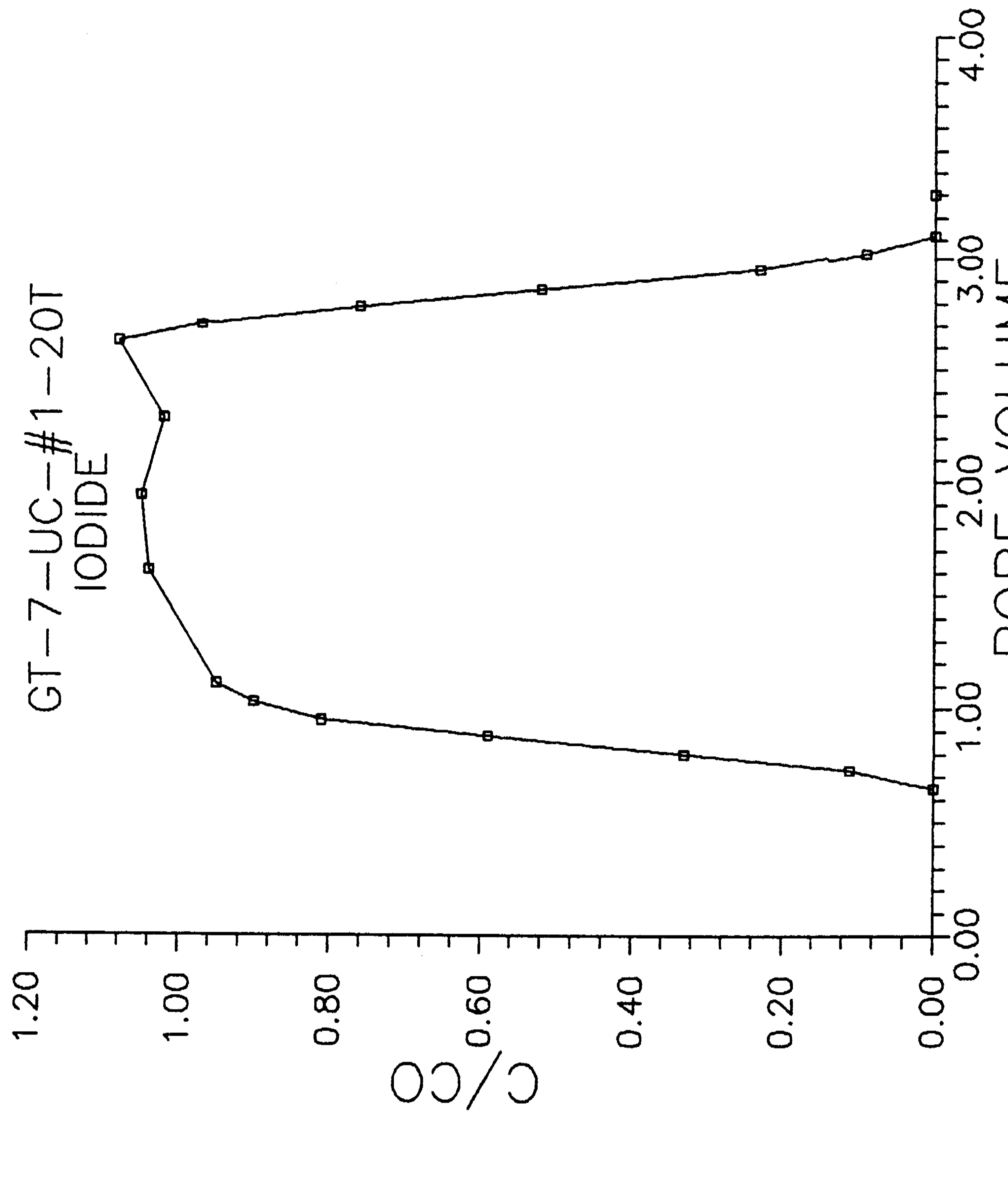
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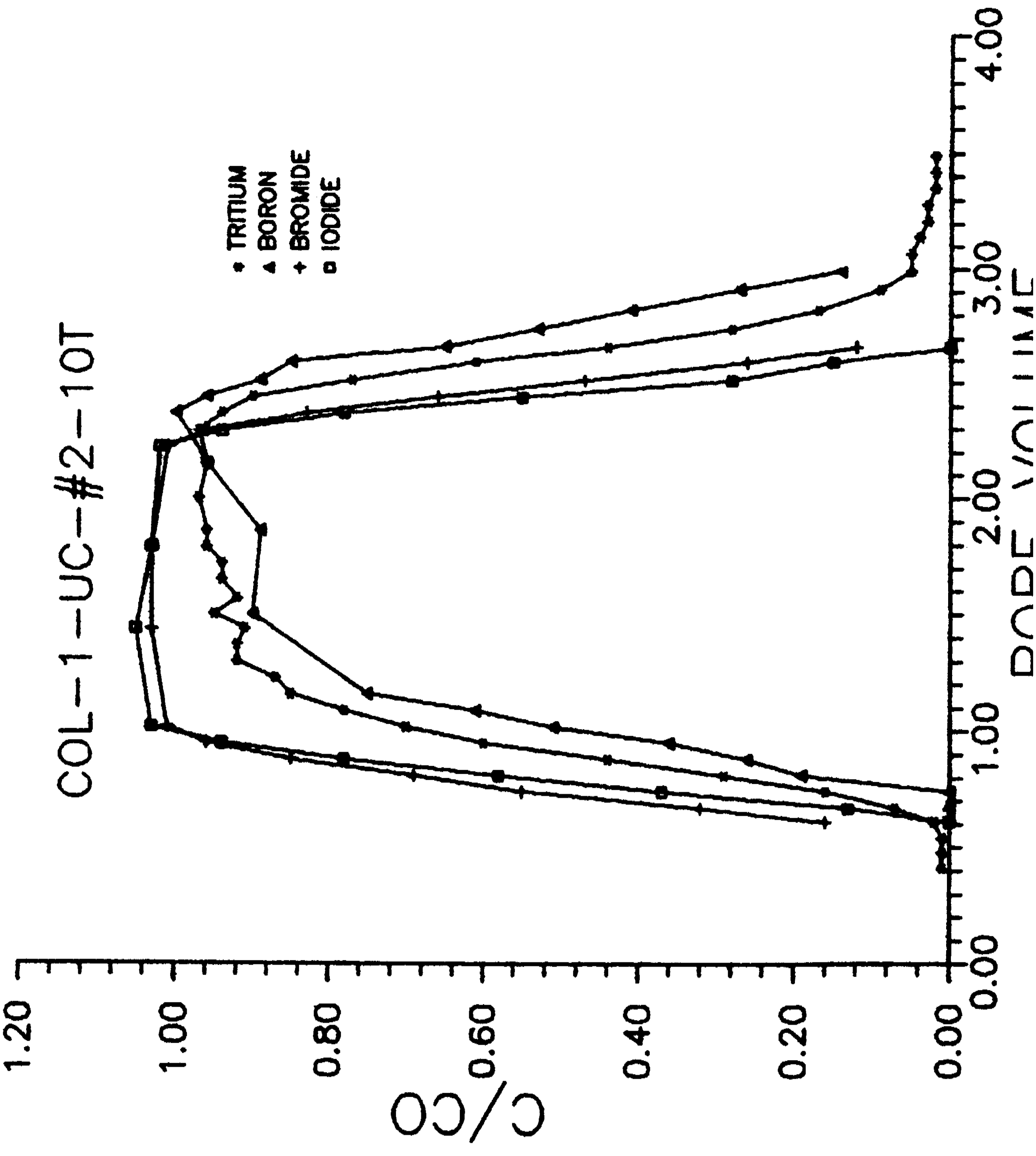
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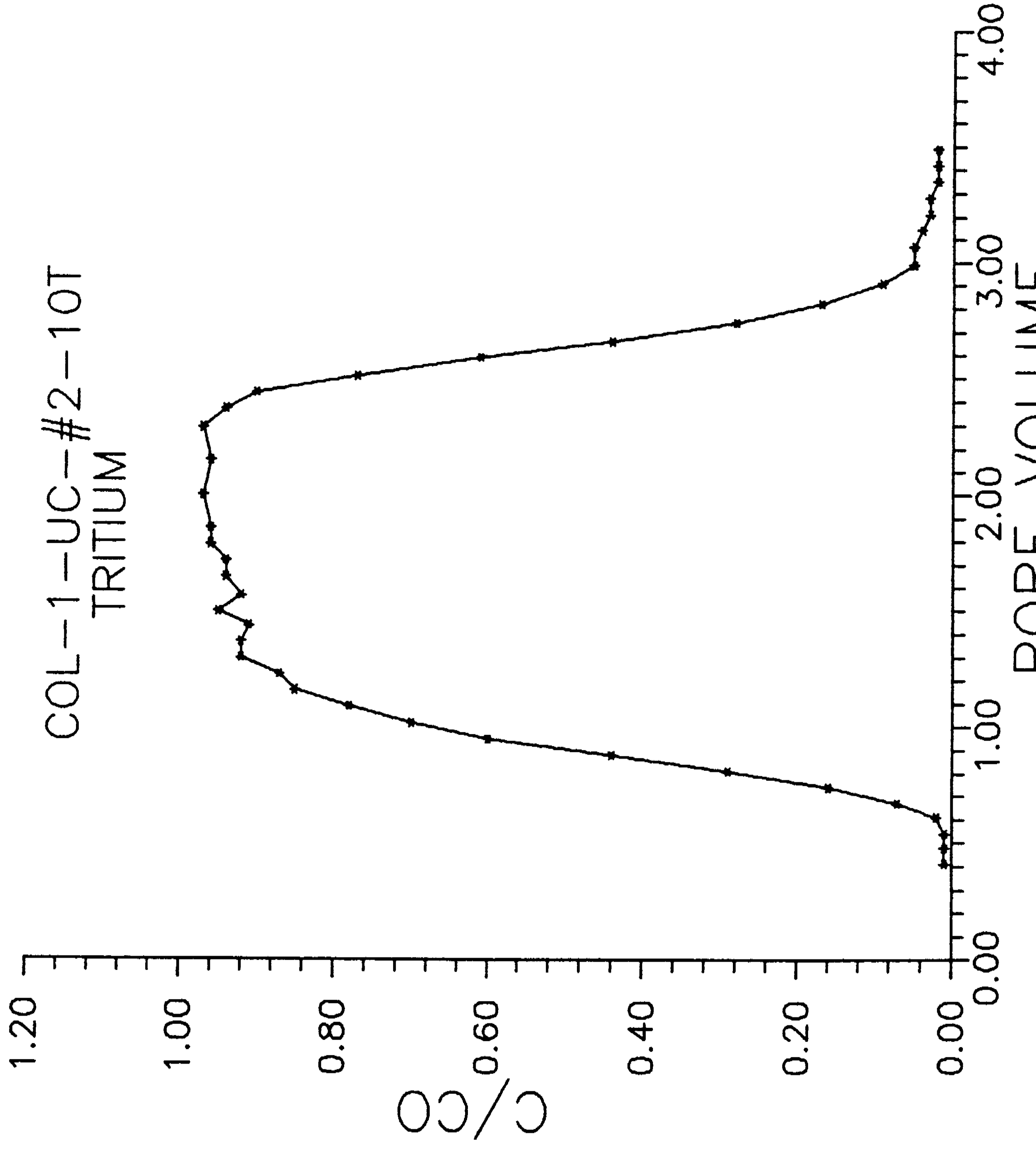
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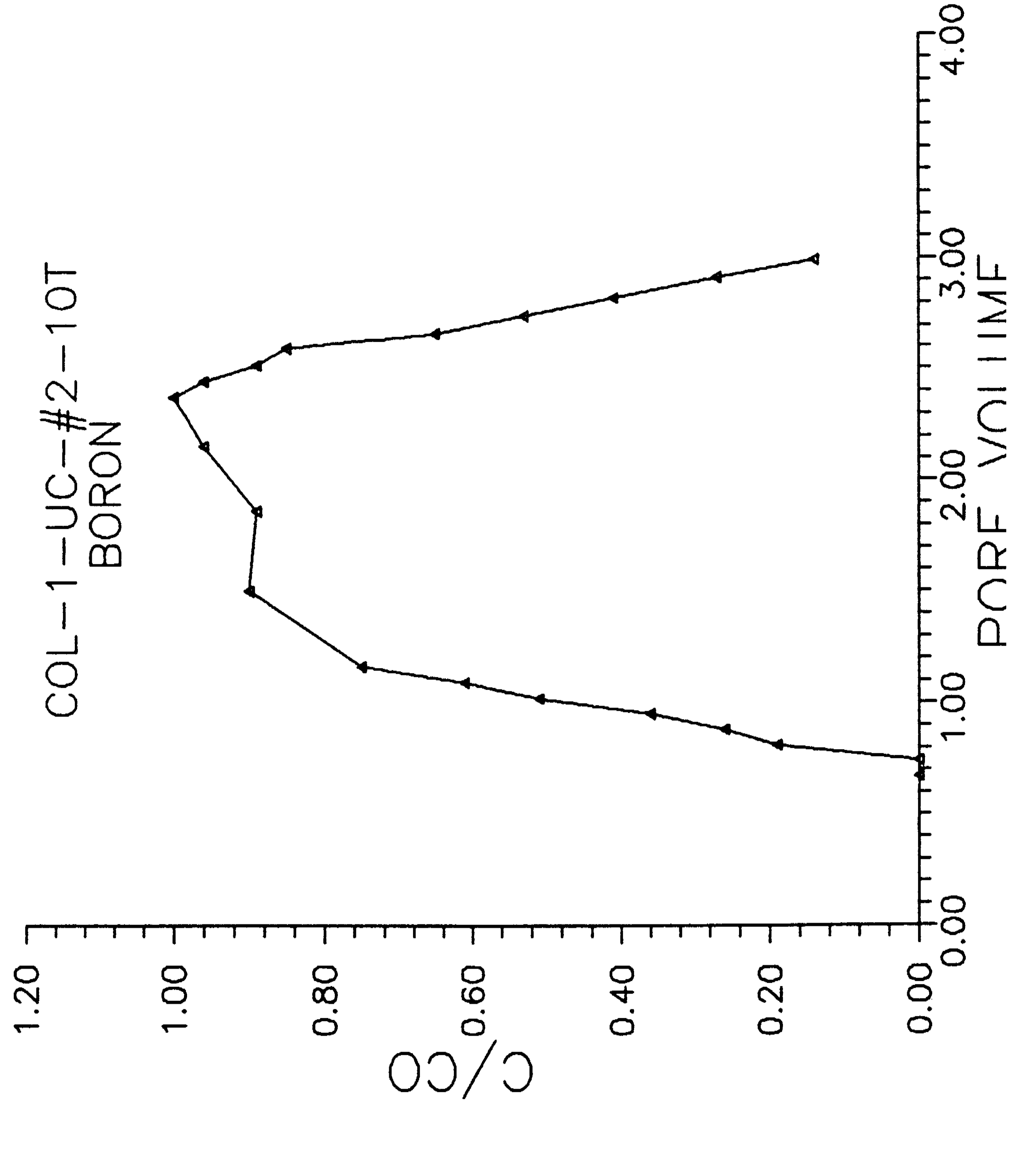
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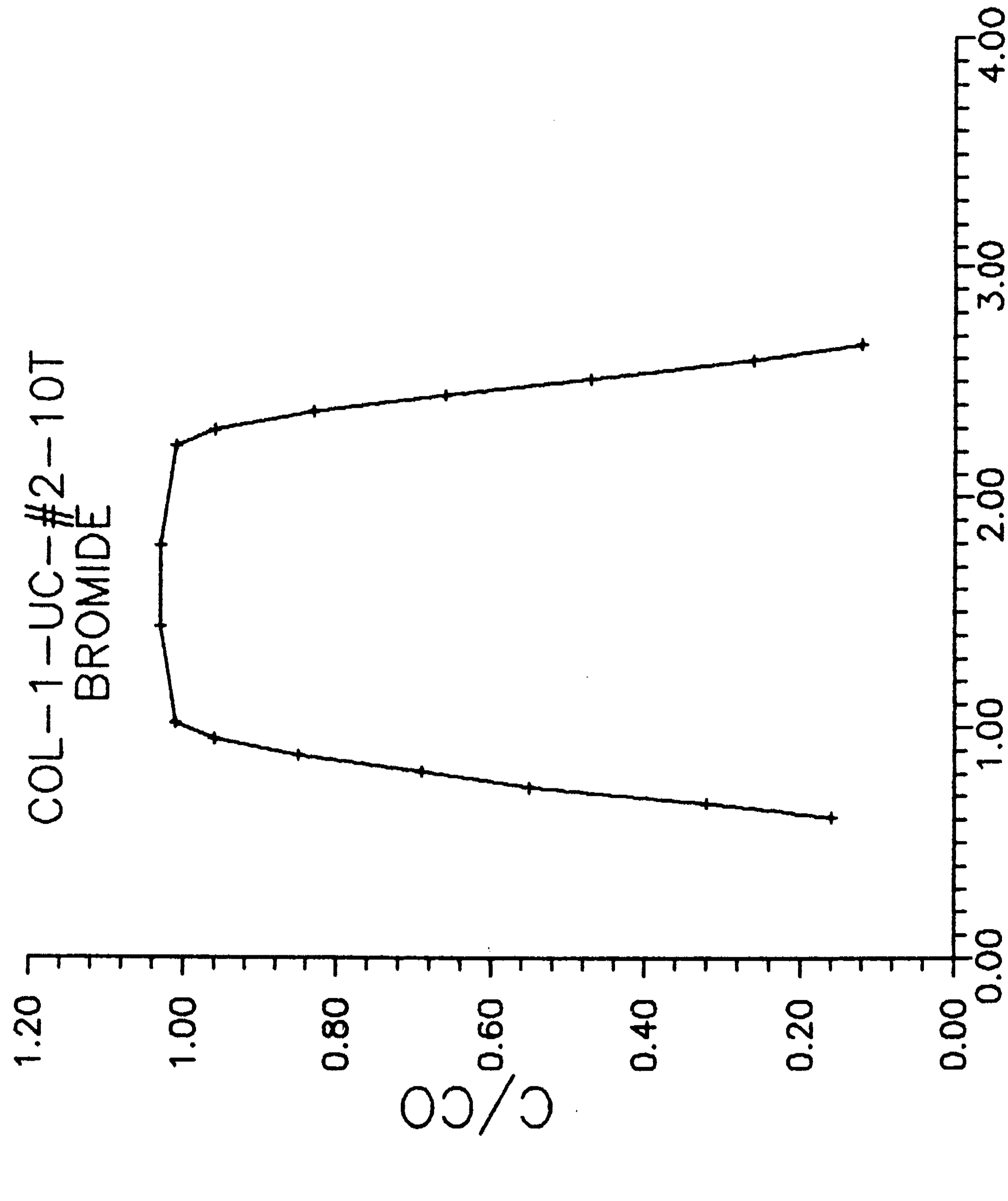
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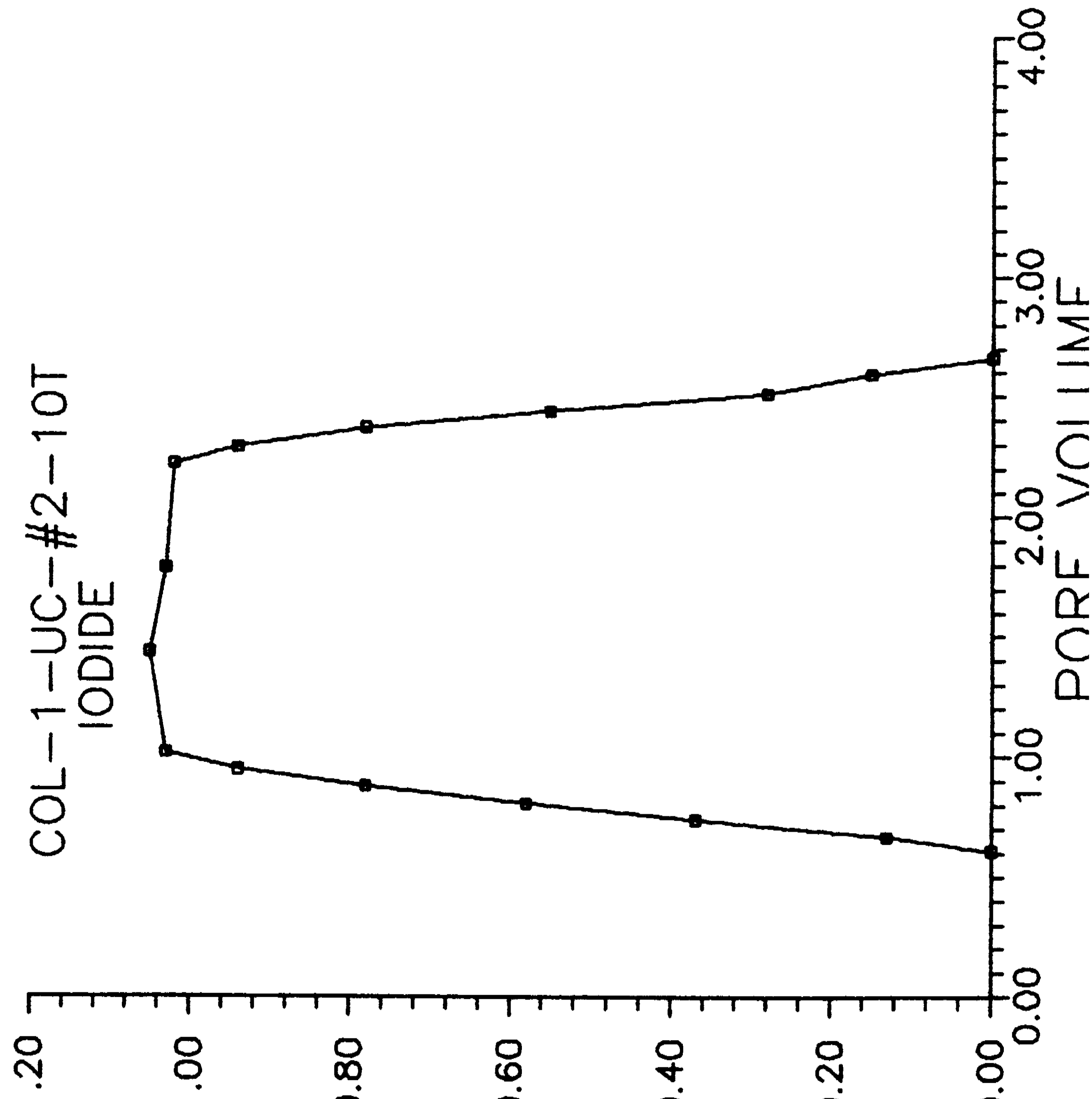
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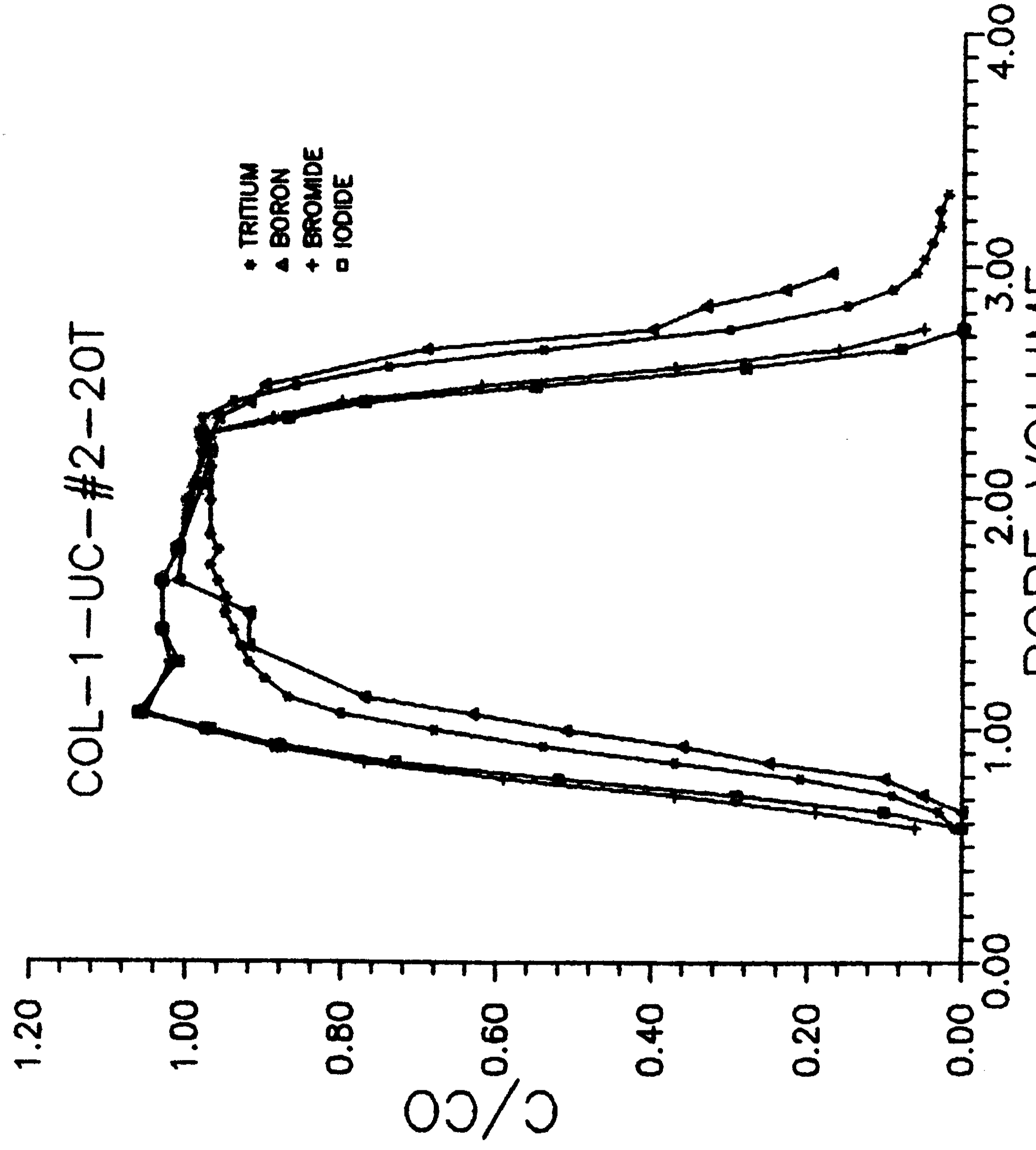
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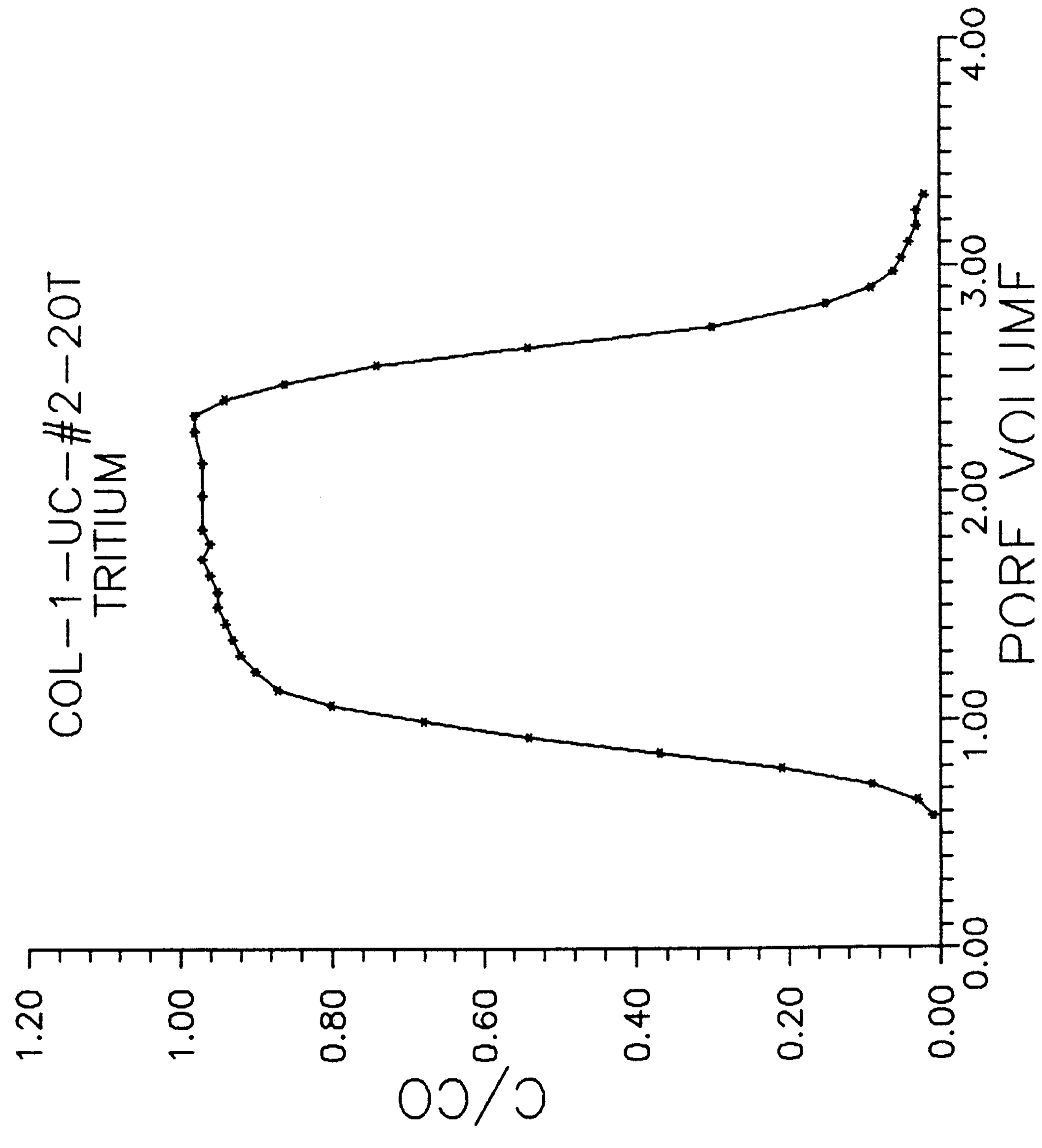
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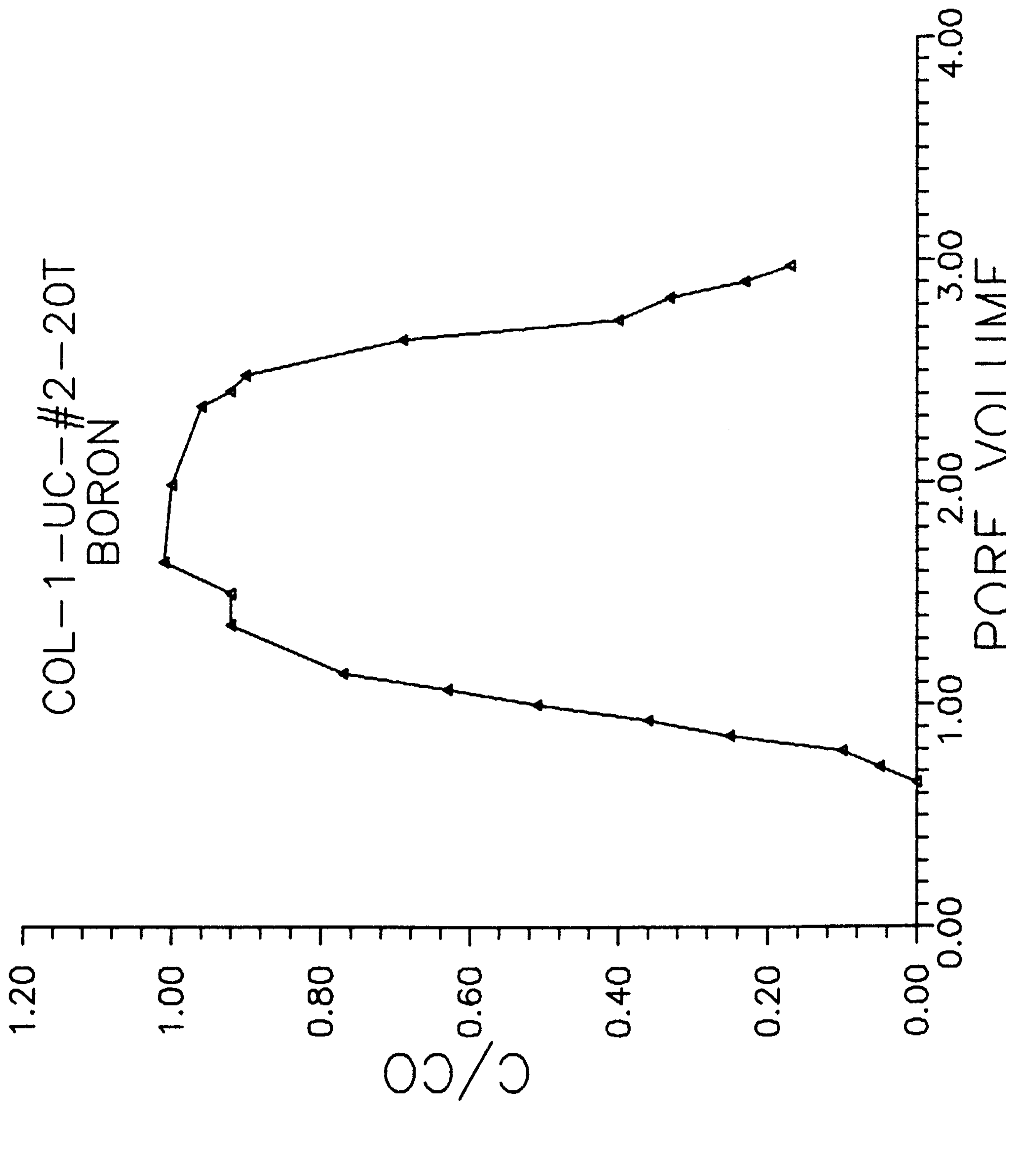
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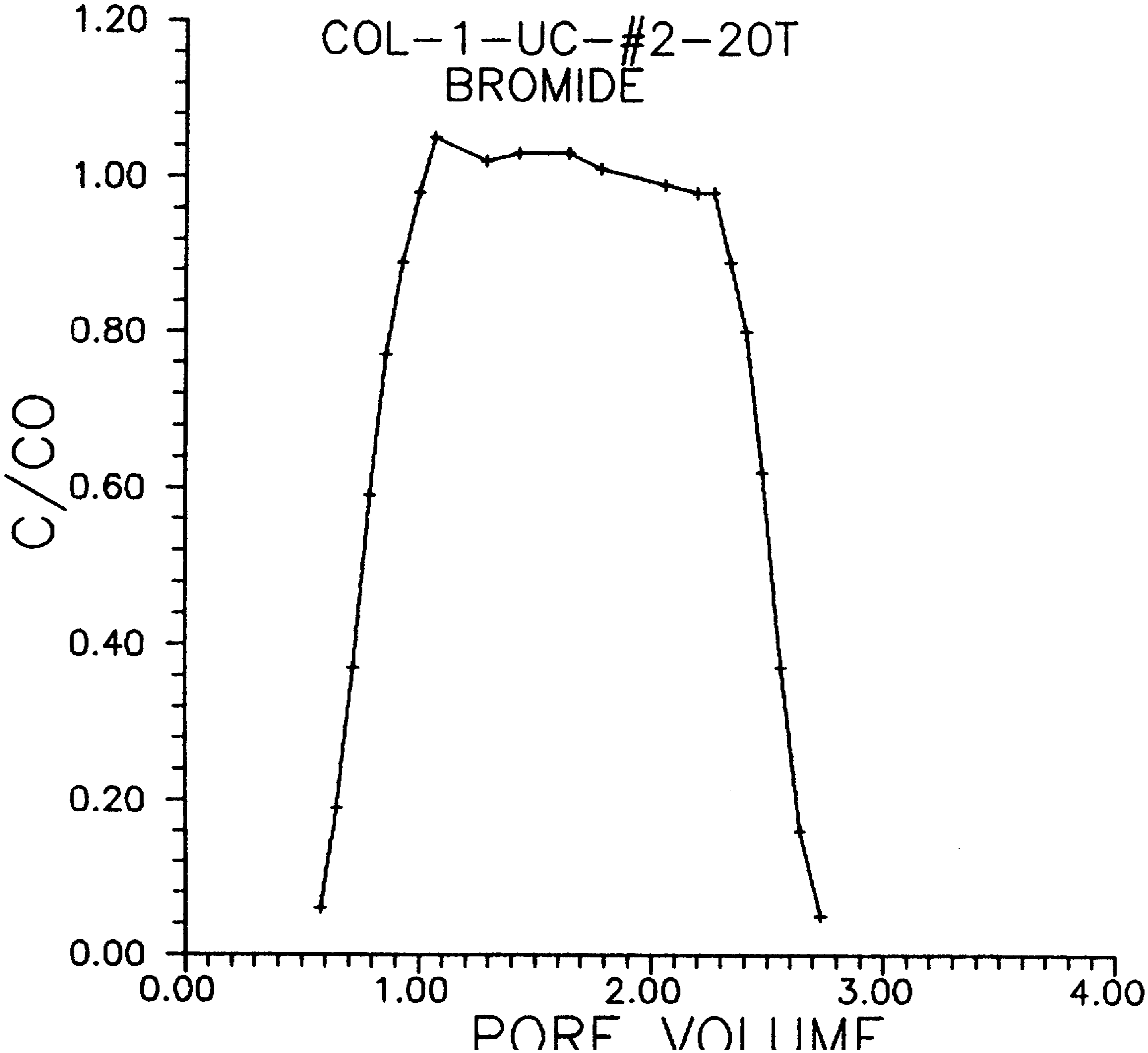
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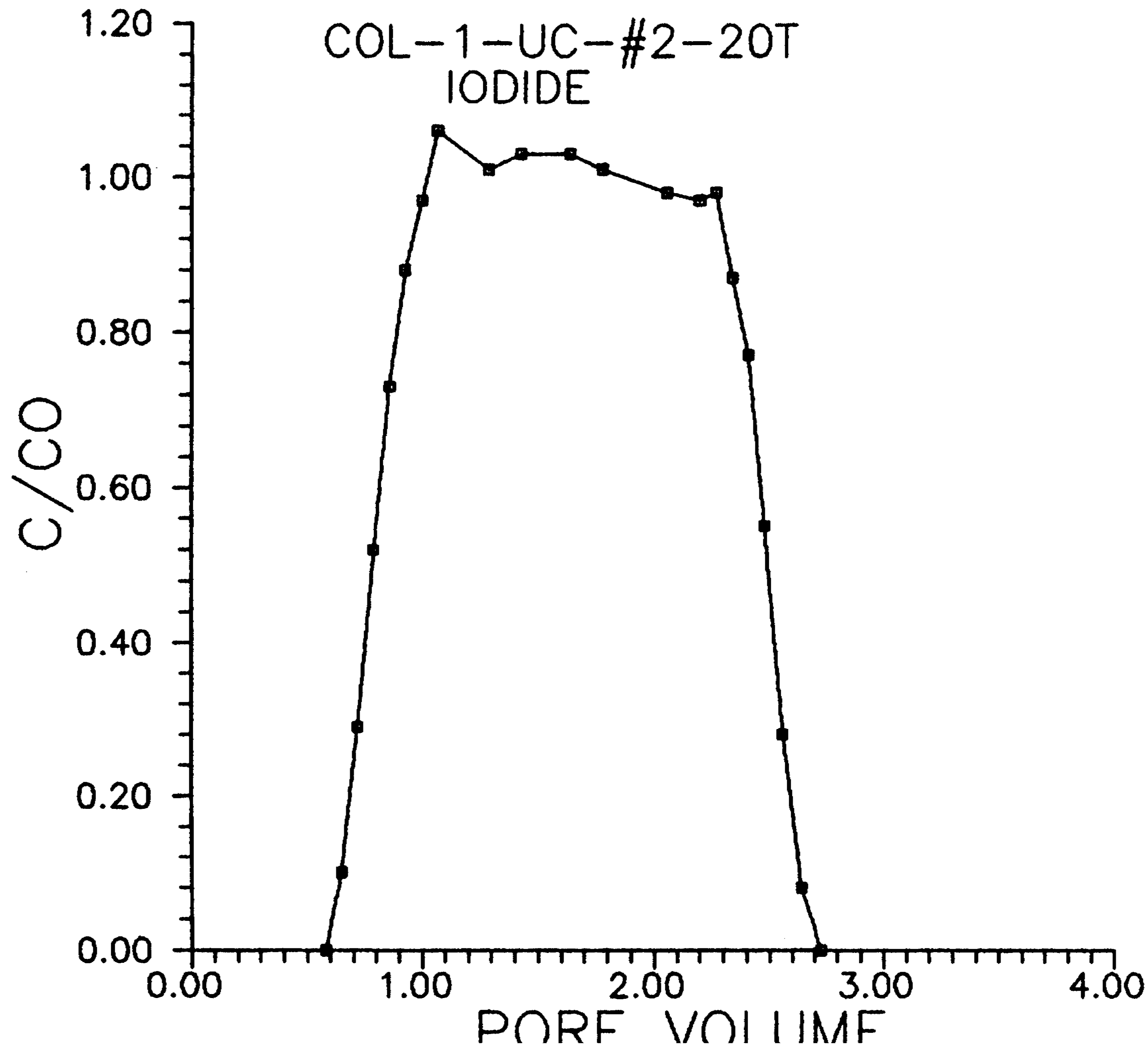
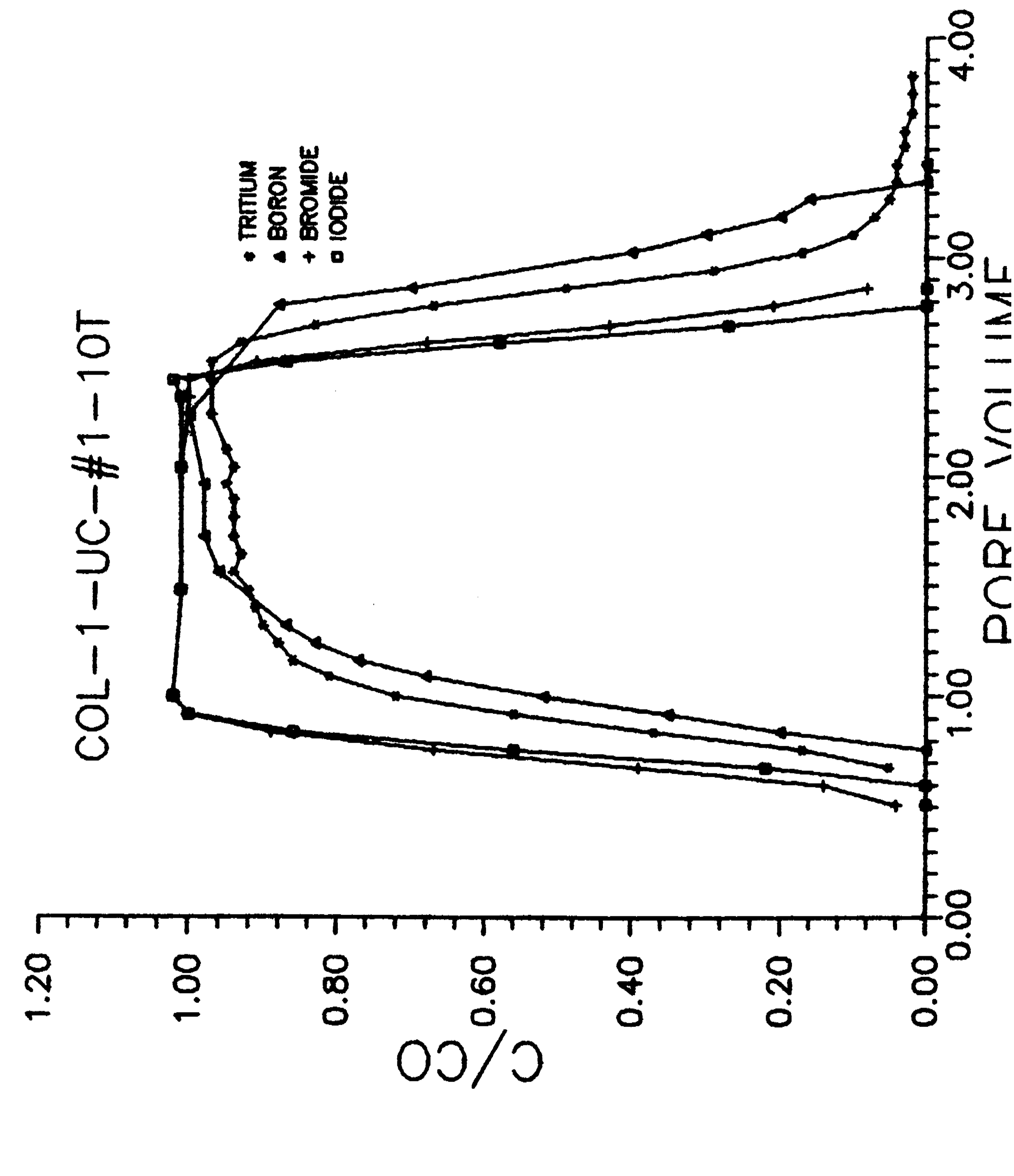
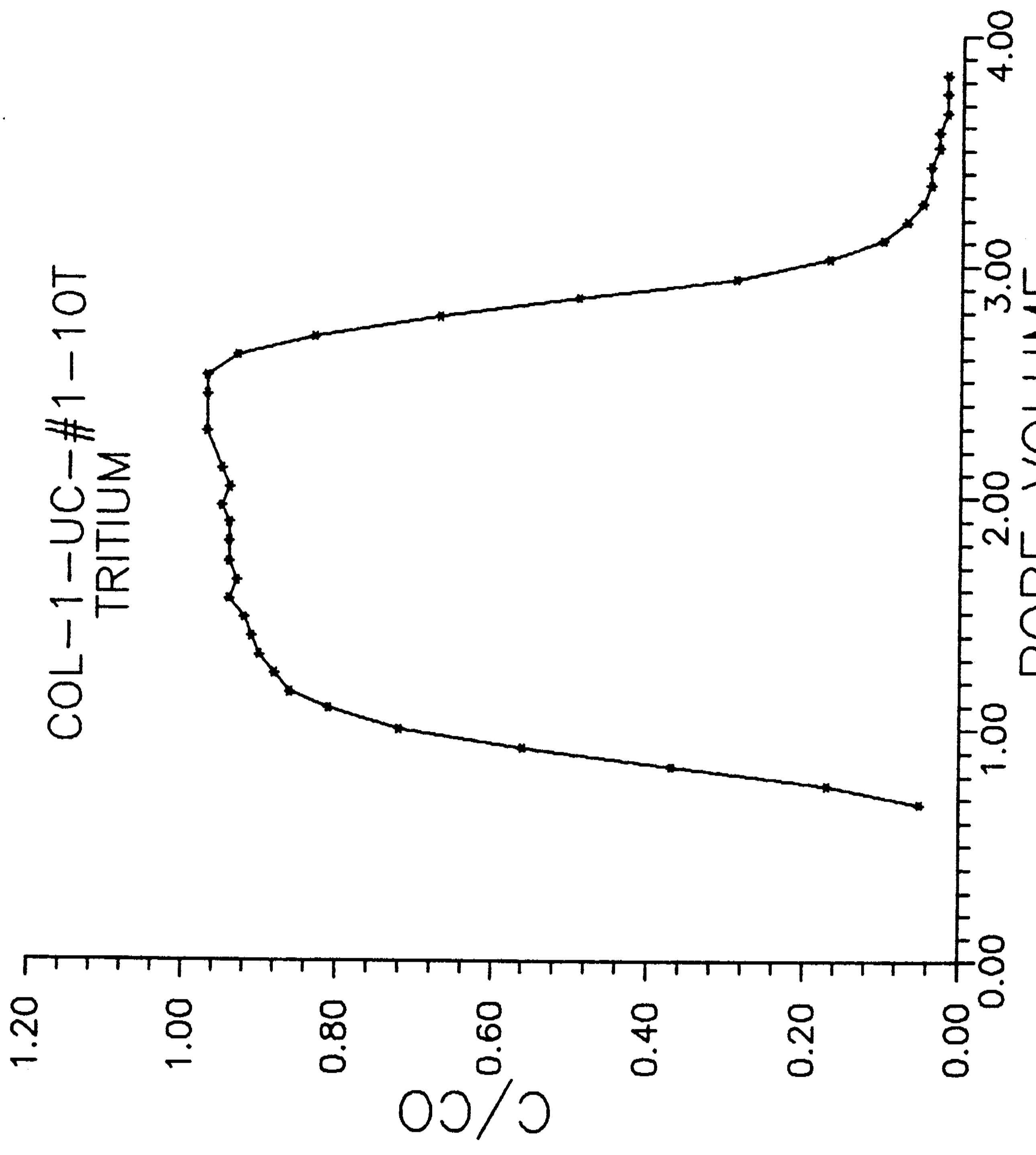
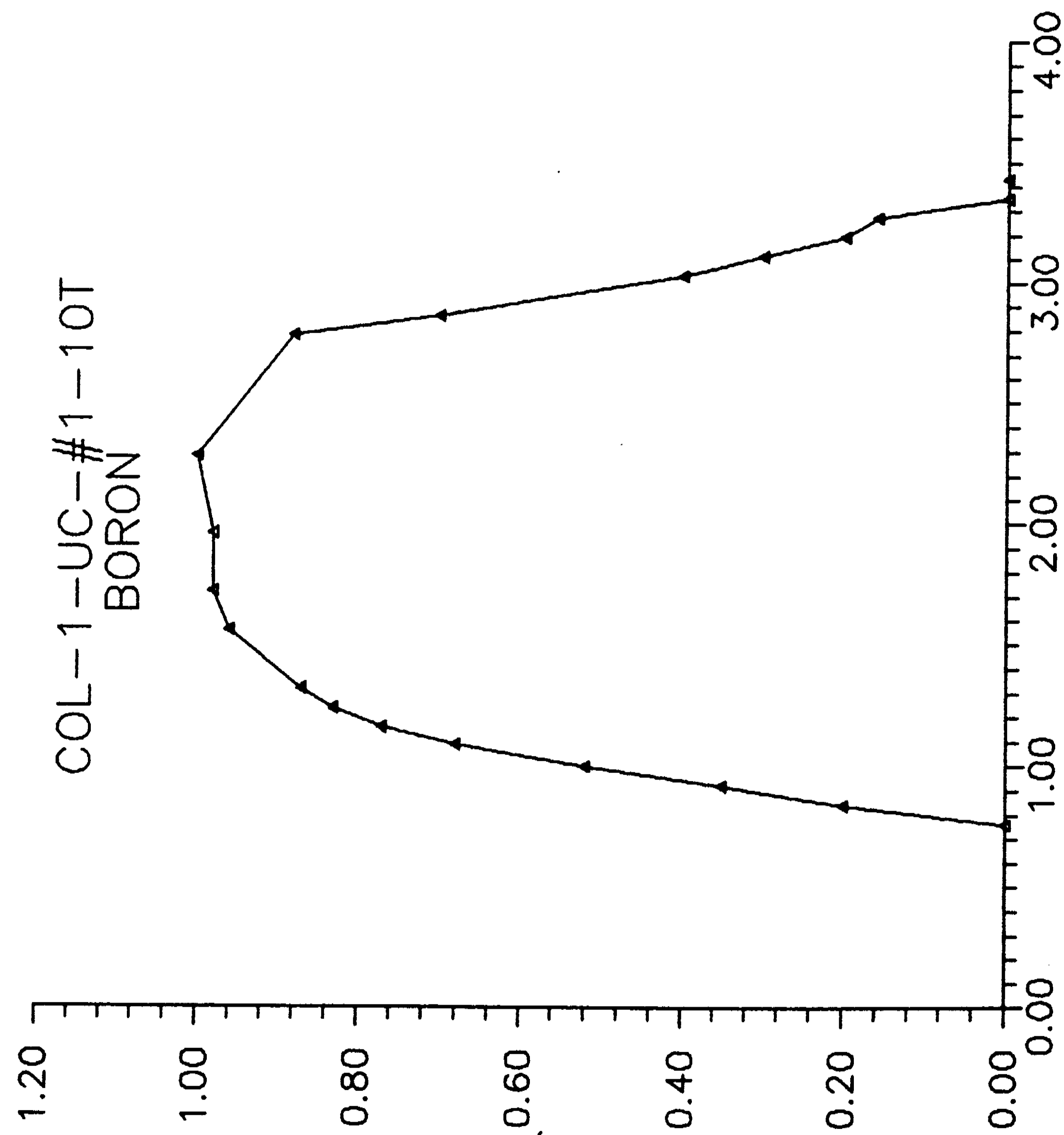
PORE VOLUME

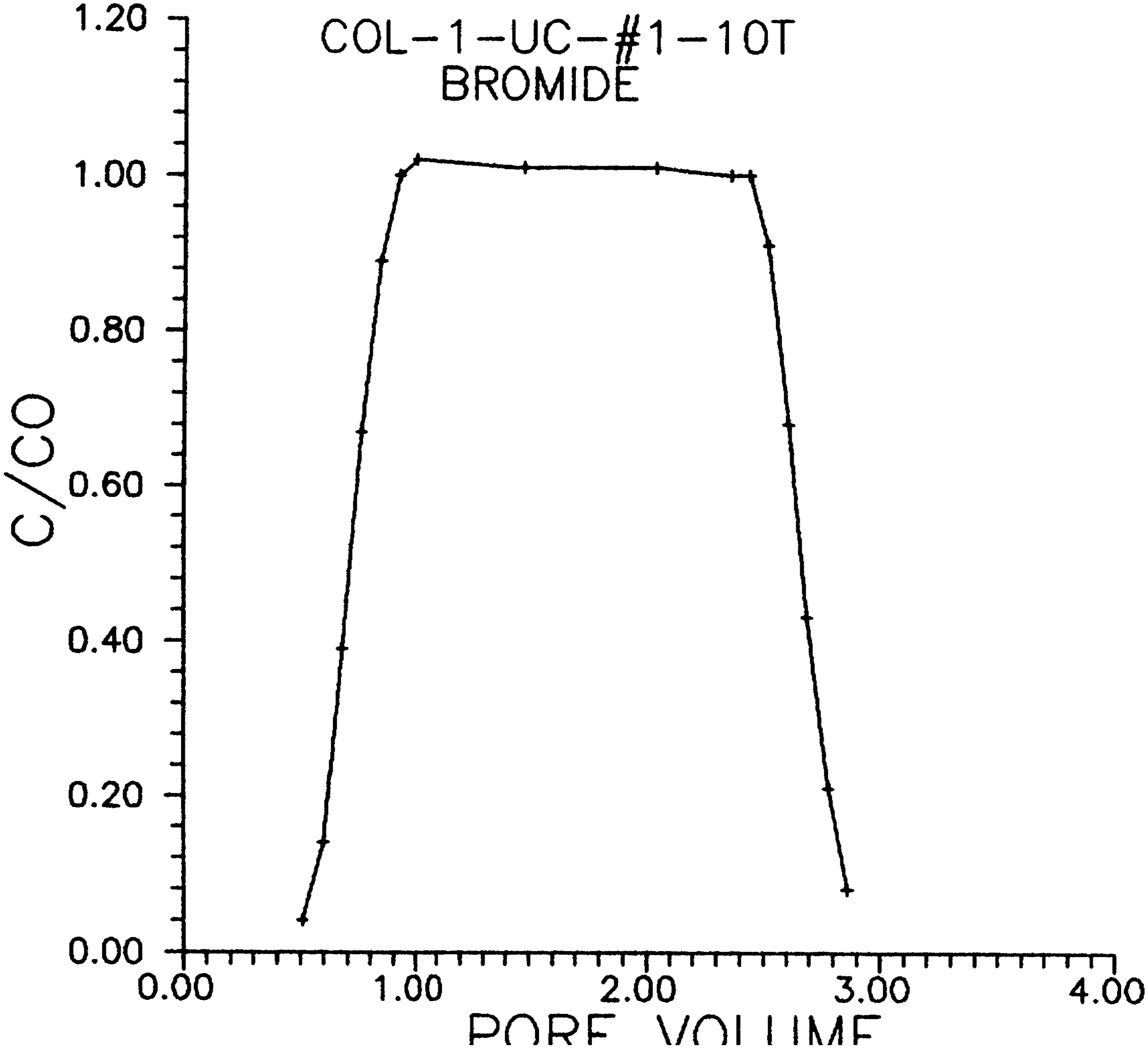


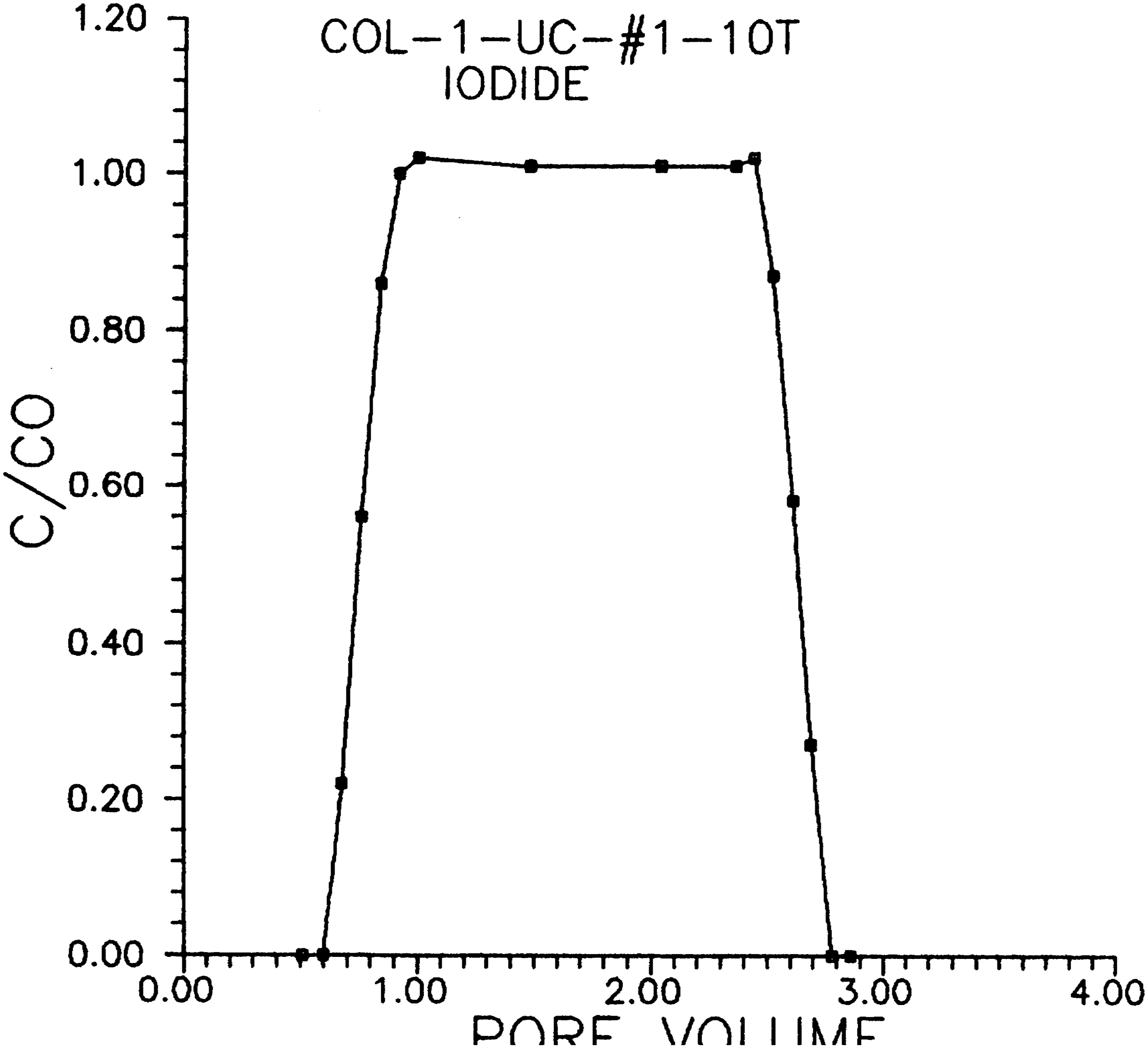
COL-1-UC-#2-20T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

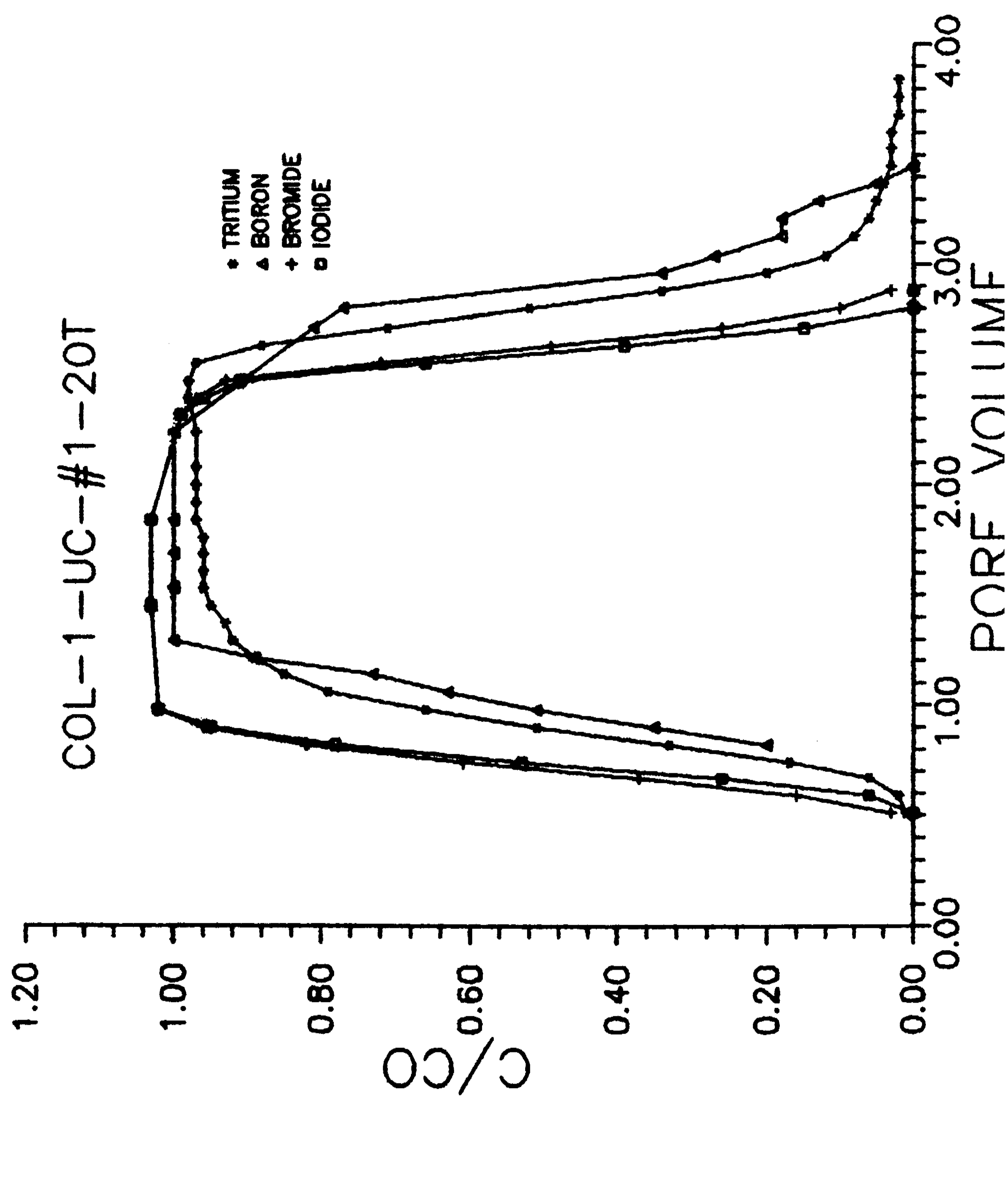

COL-1-UC-#1-10T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

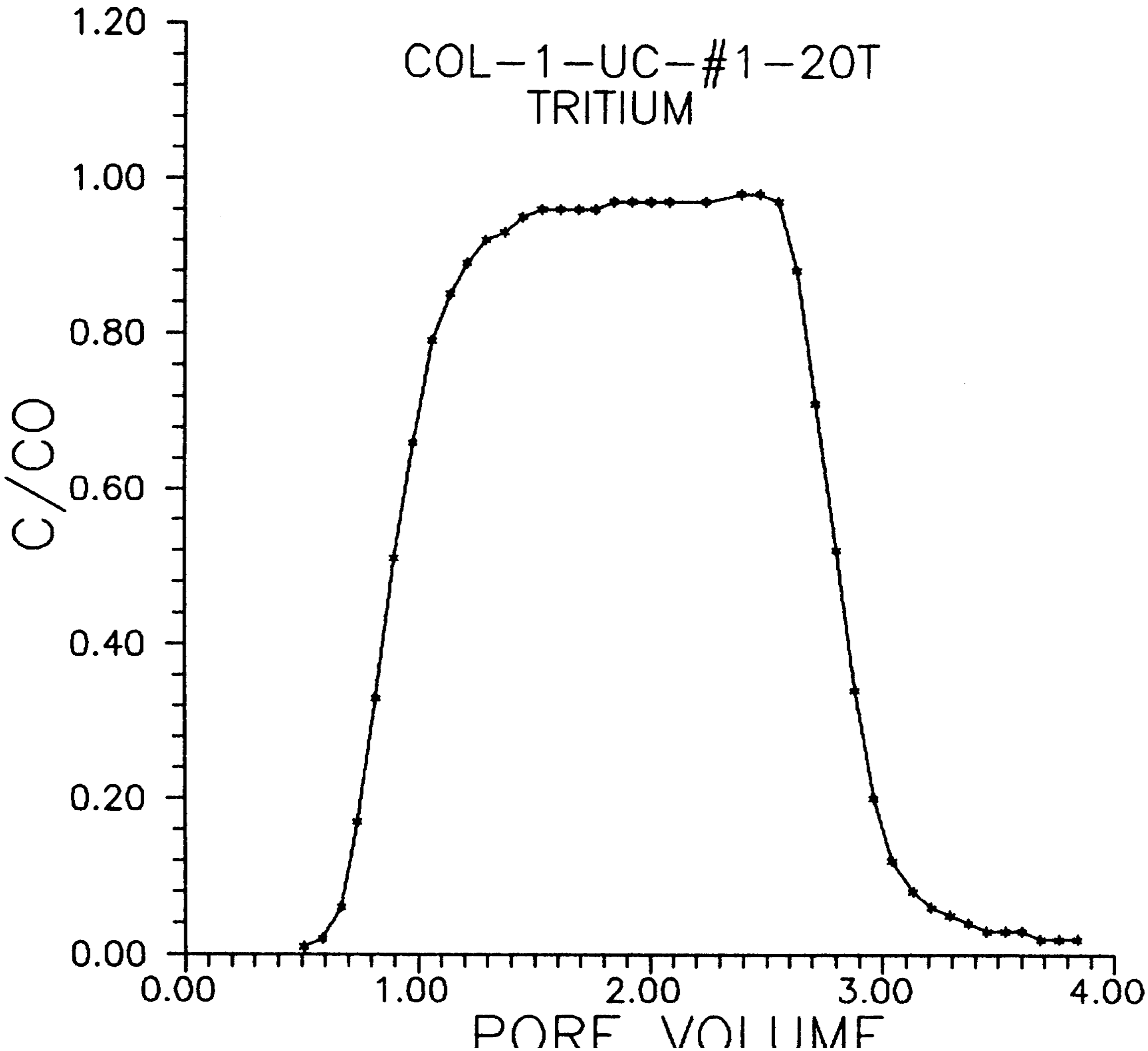

COL-1-UC-#1-10T
TRITIUM
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

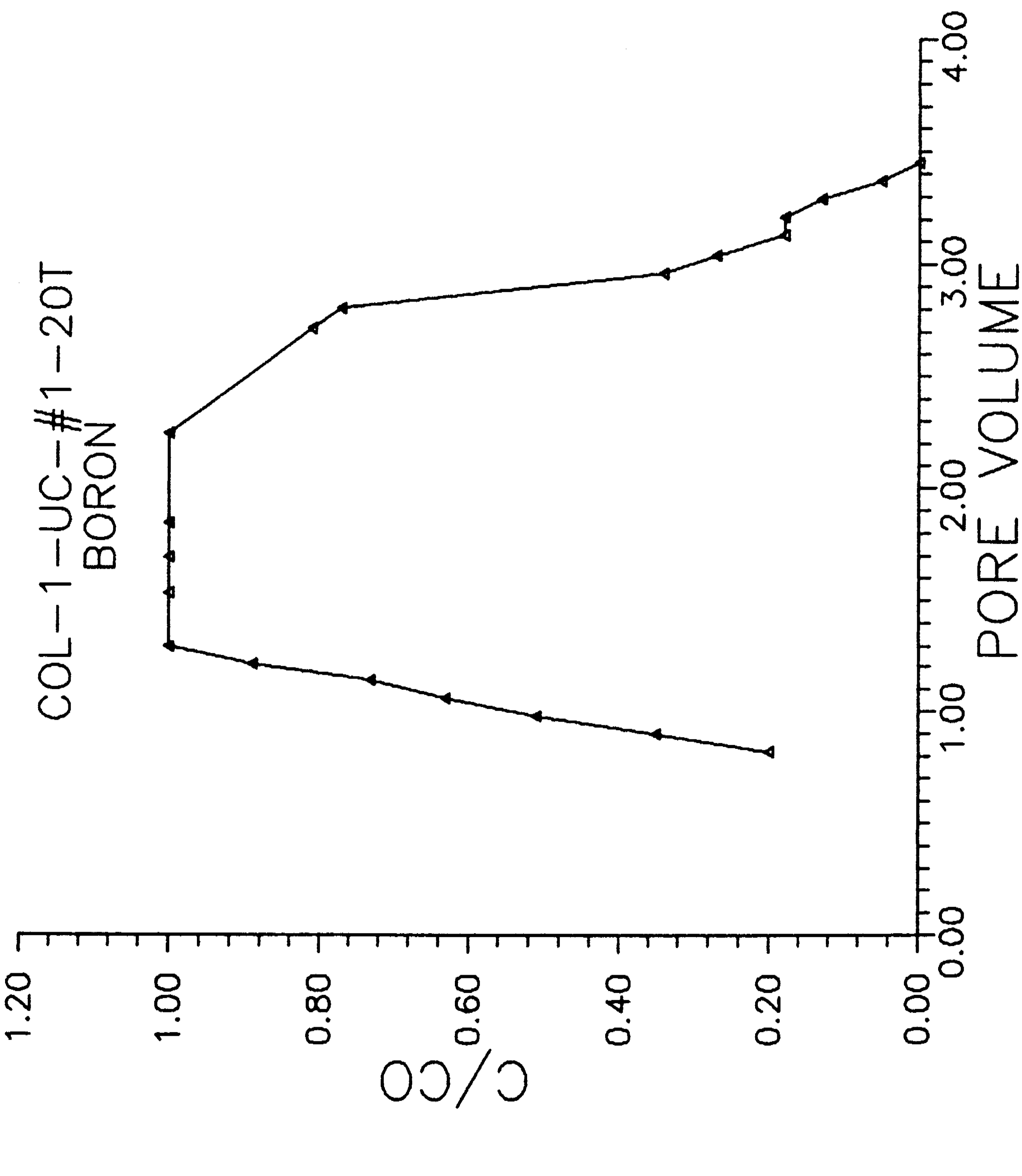

COL—1—UC—#1—10T
BORON
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


COL-1-UC-#1-10T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

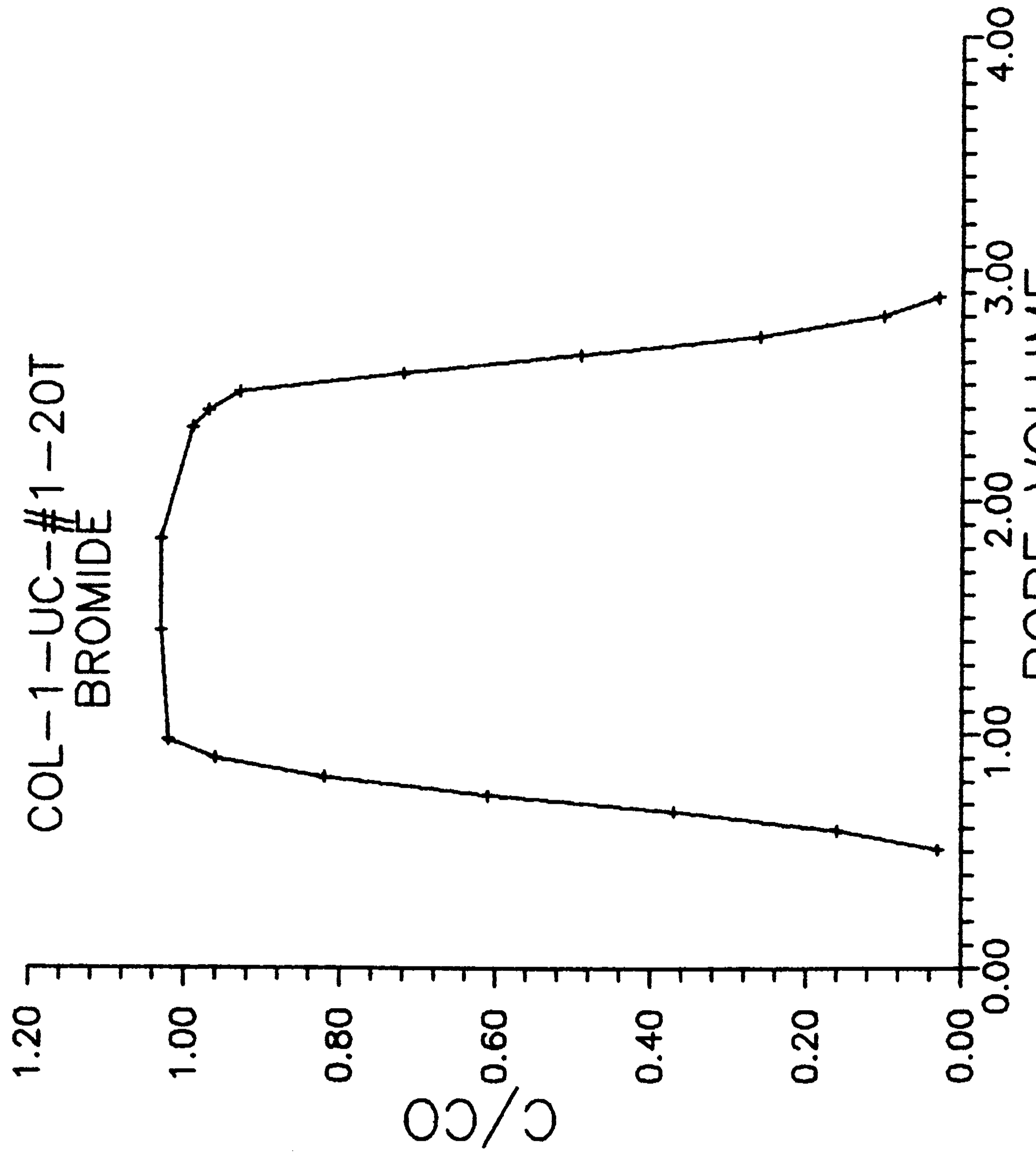

COL-1-UC-#1-10T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

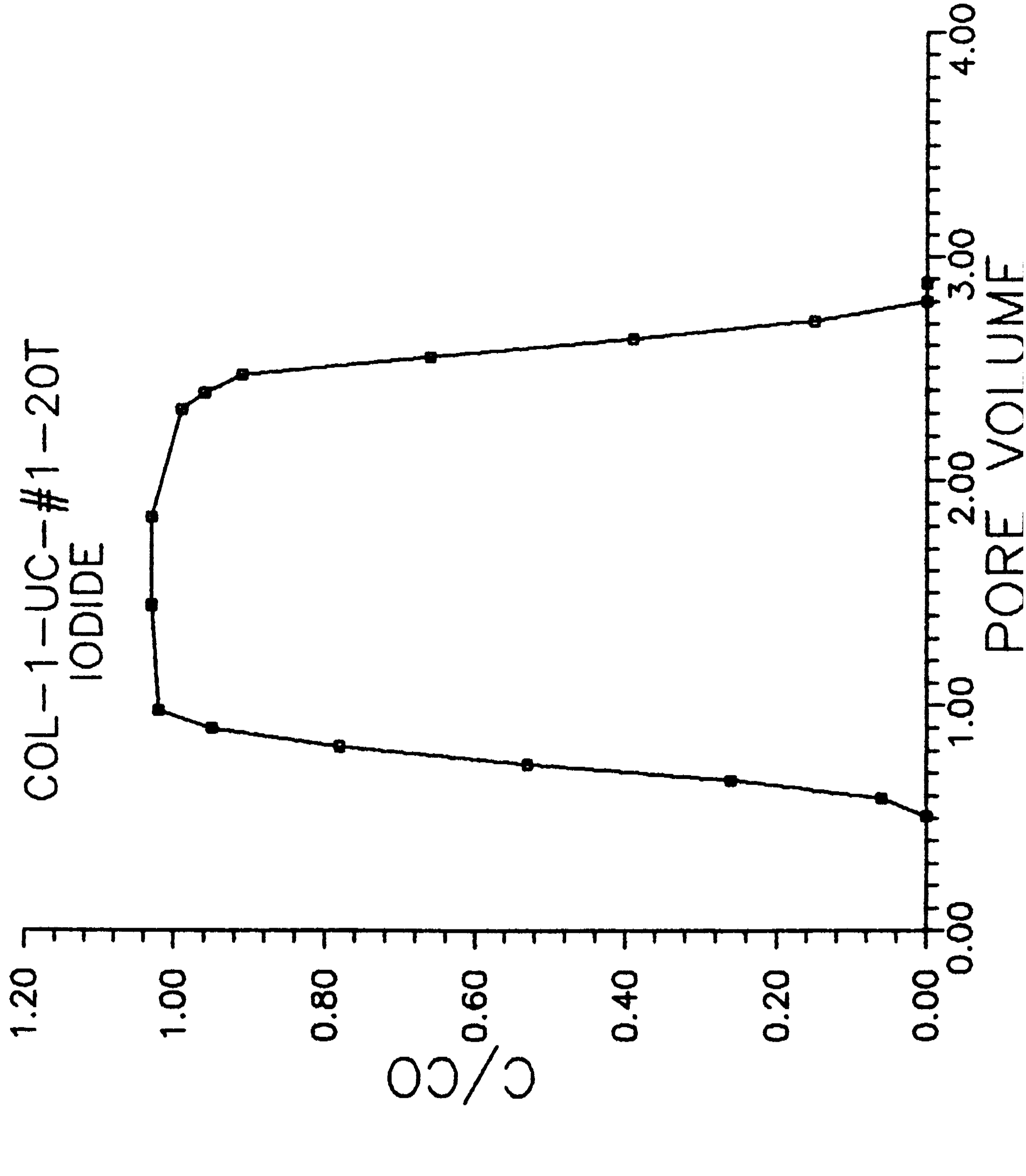

COL-1-UC-#1-20T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

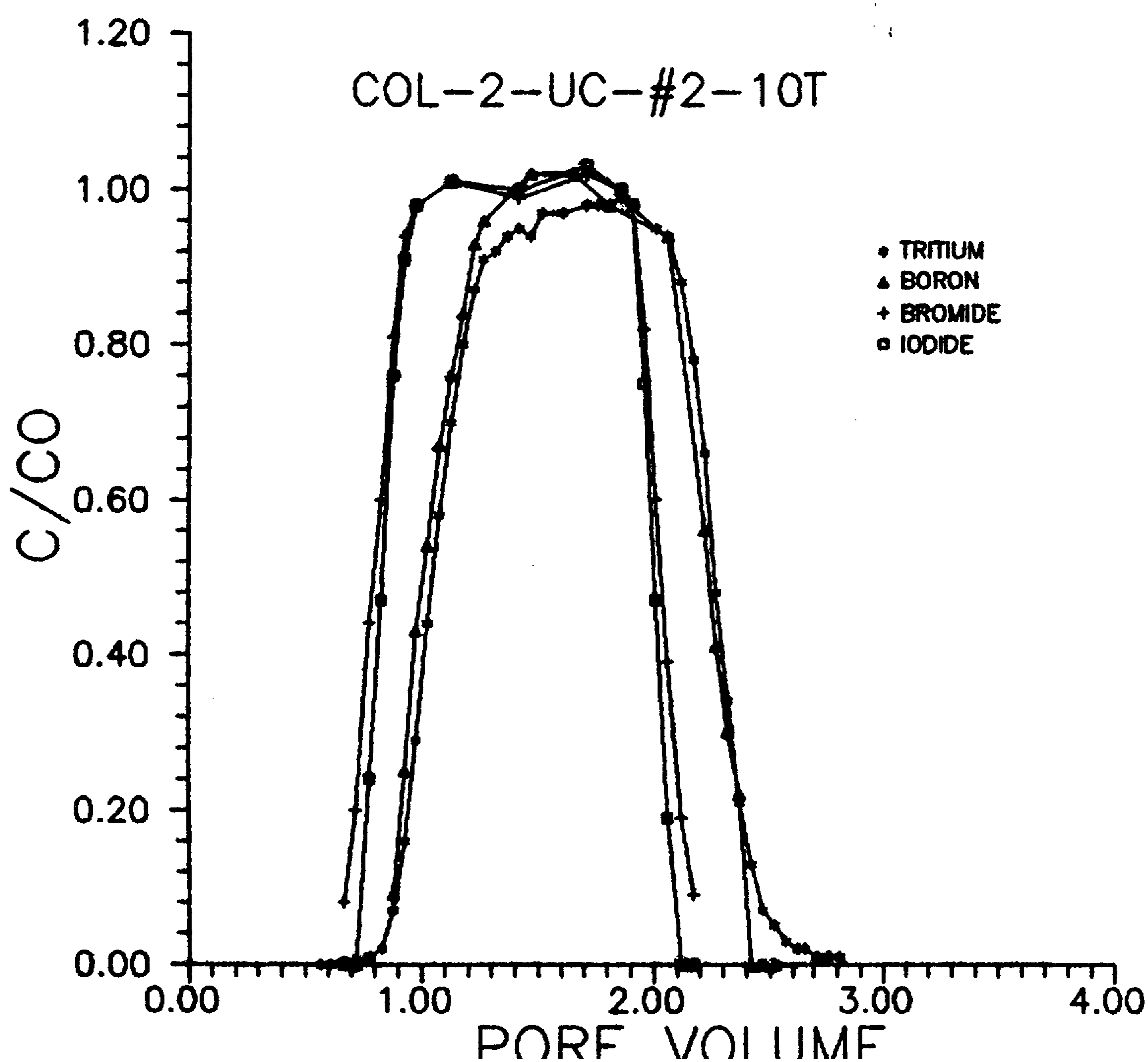

COL-1-UC-#1-20T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

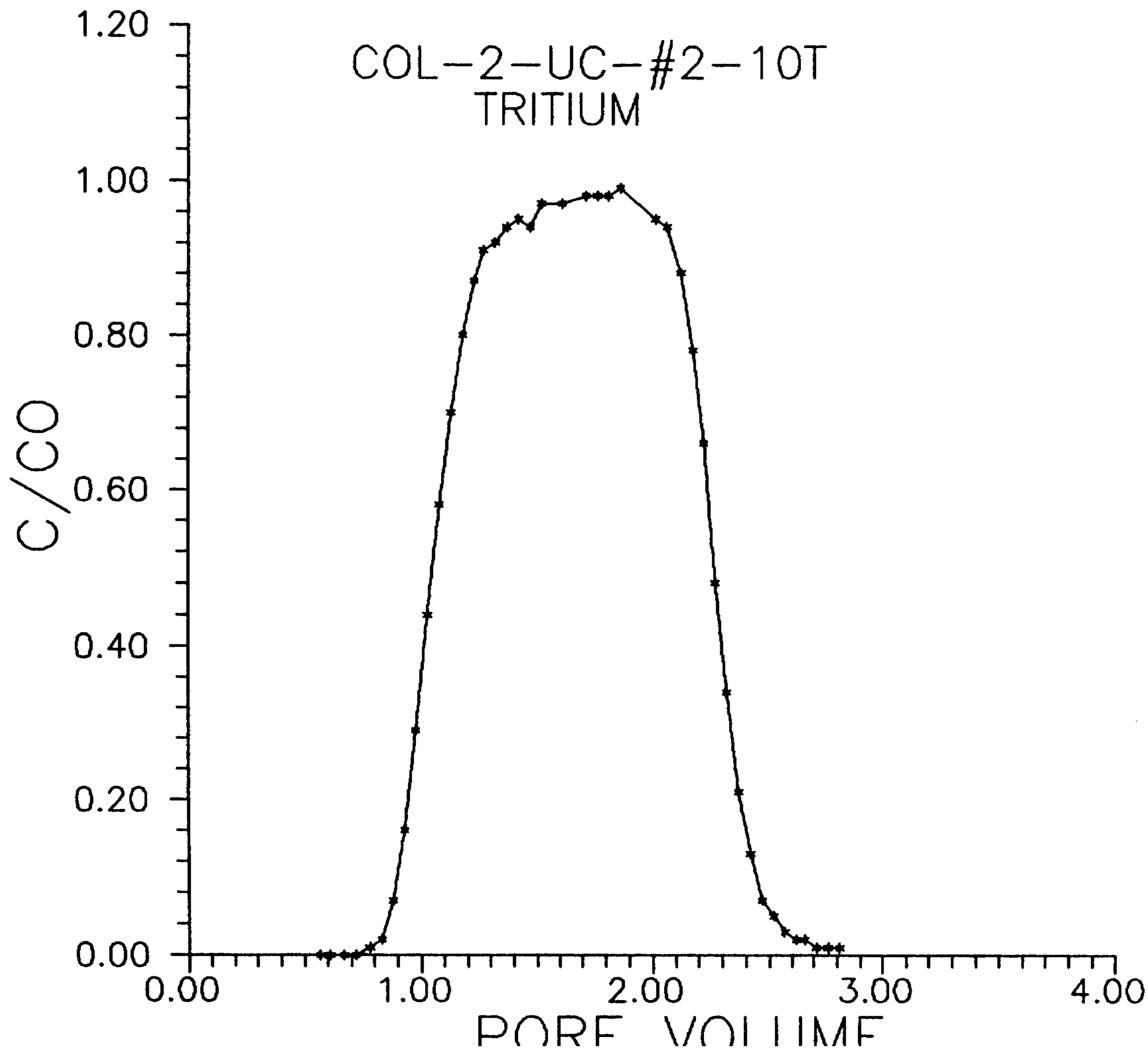


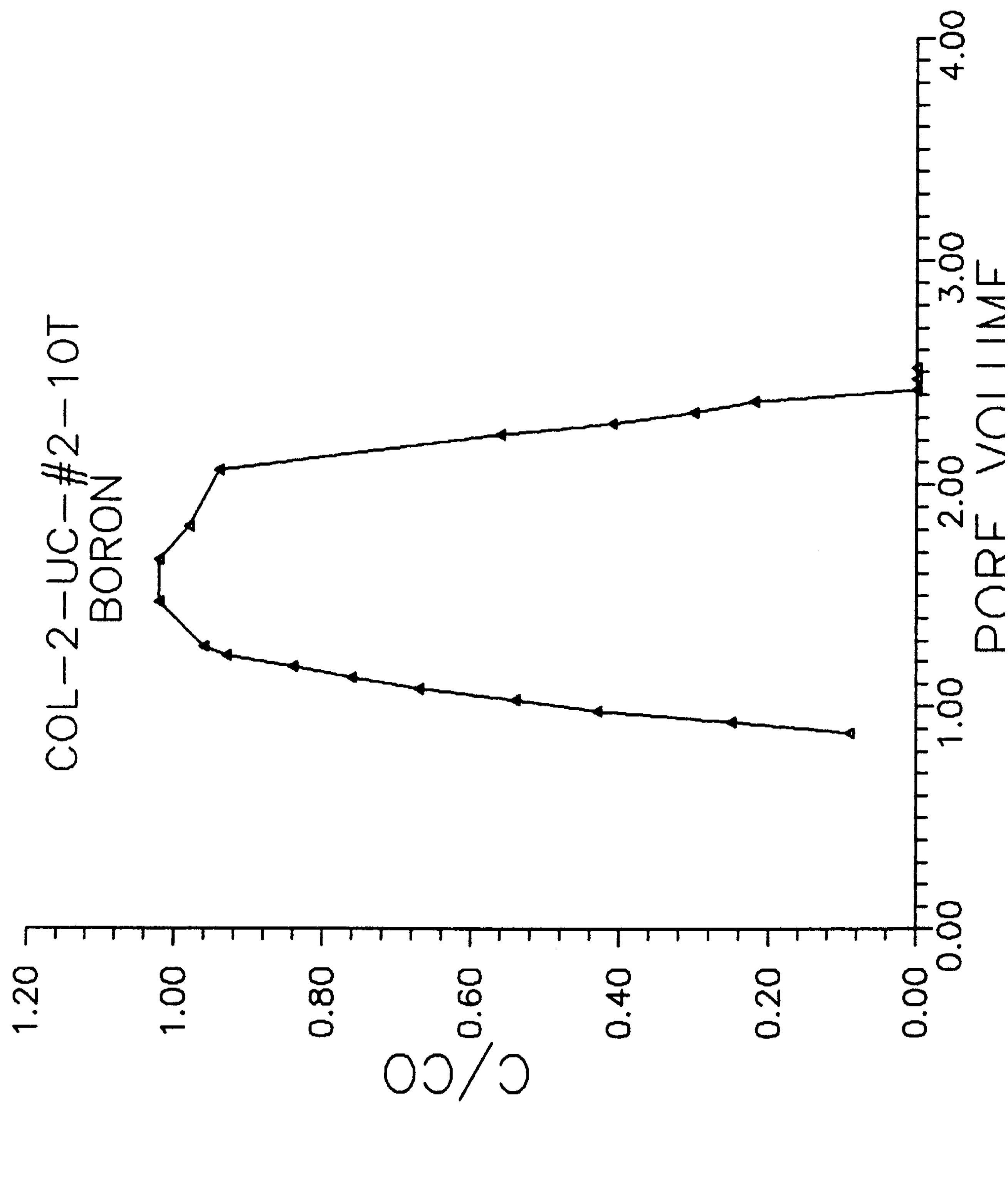
COL-1-UC-#1-20T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

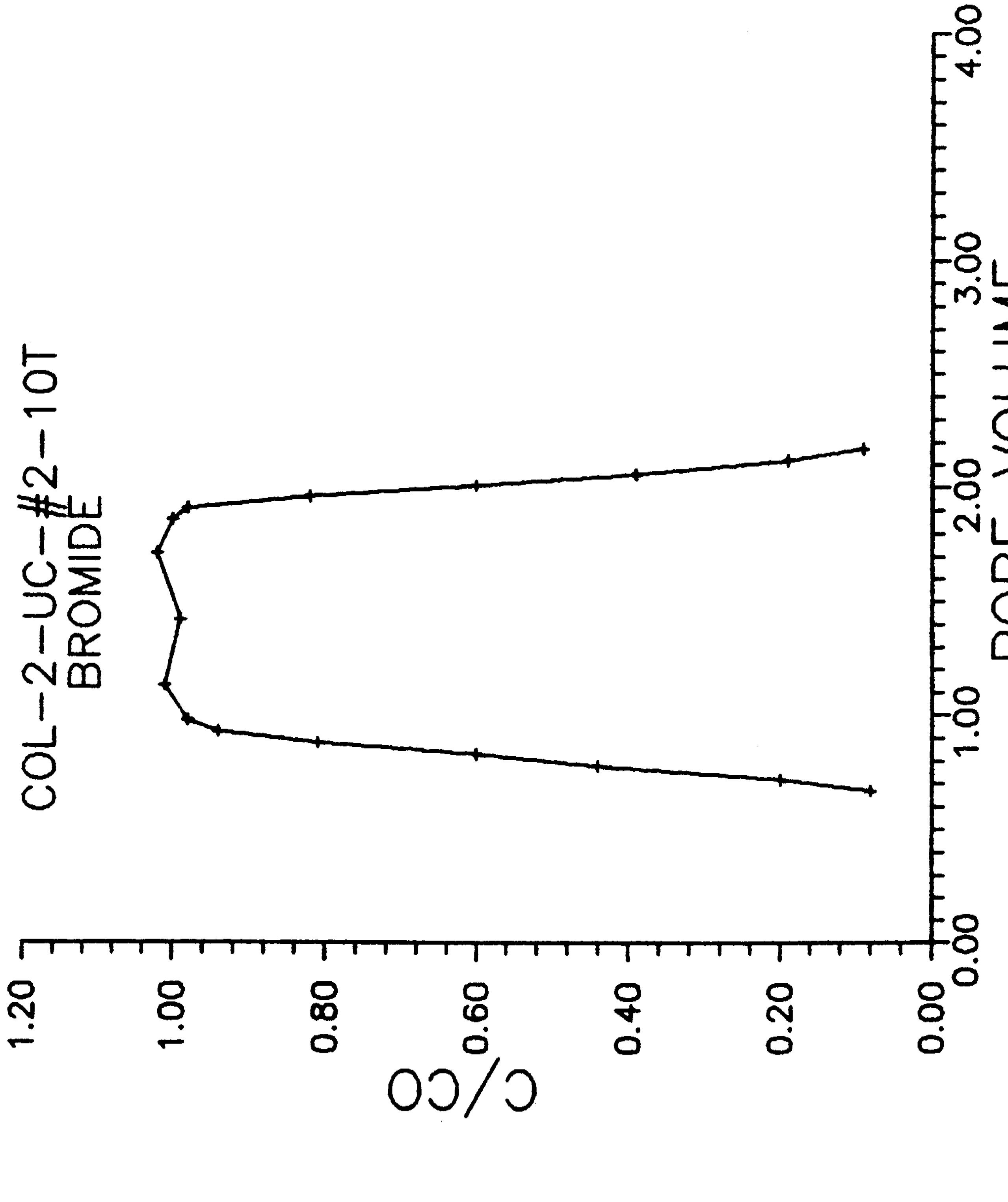

COL-1-UC-#1-20T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

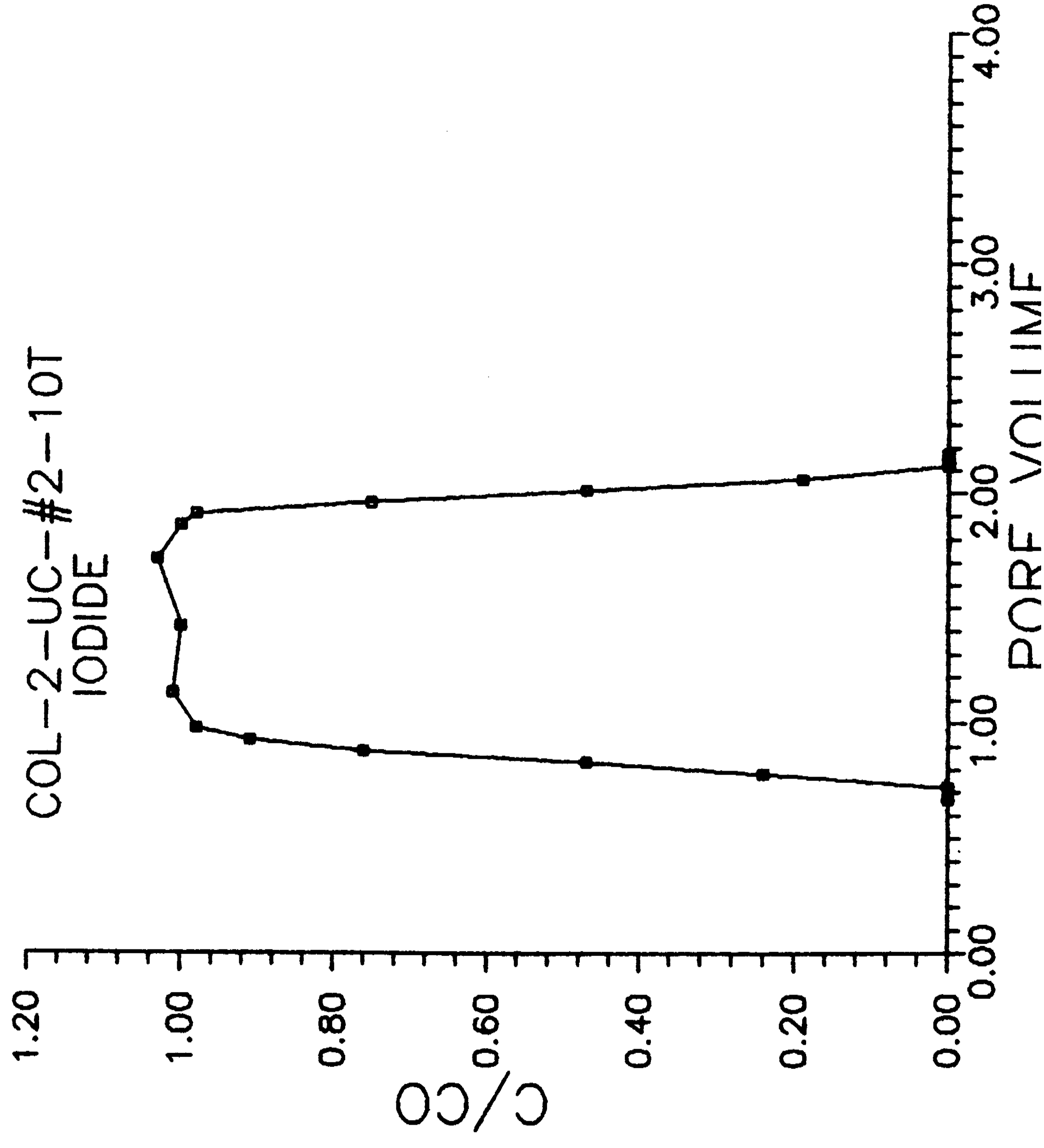

COL—1—UC—#1 —20T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

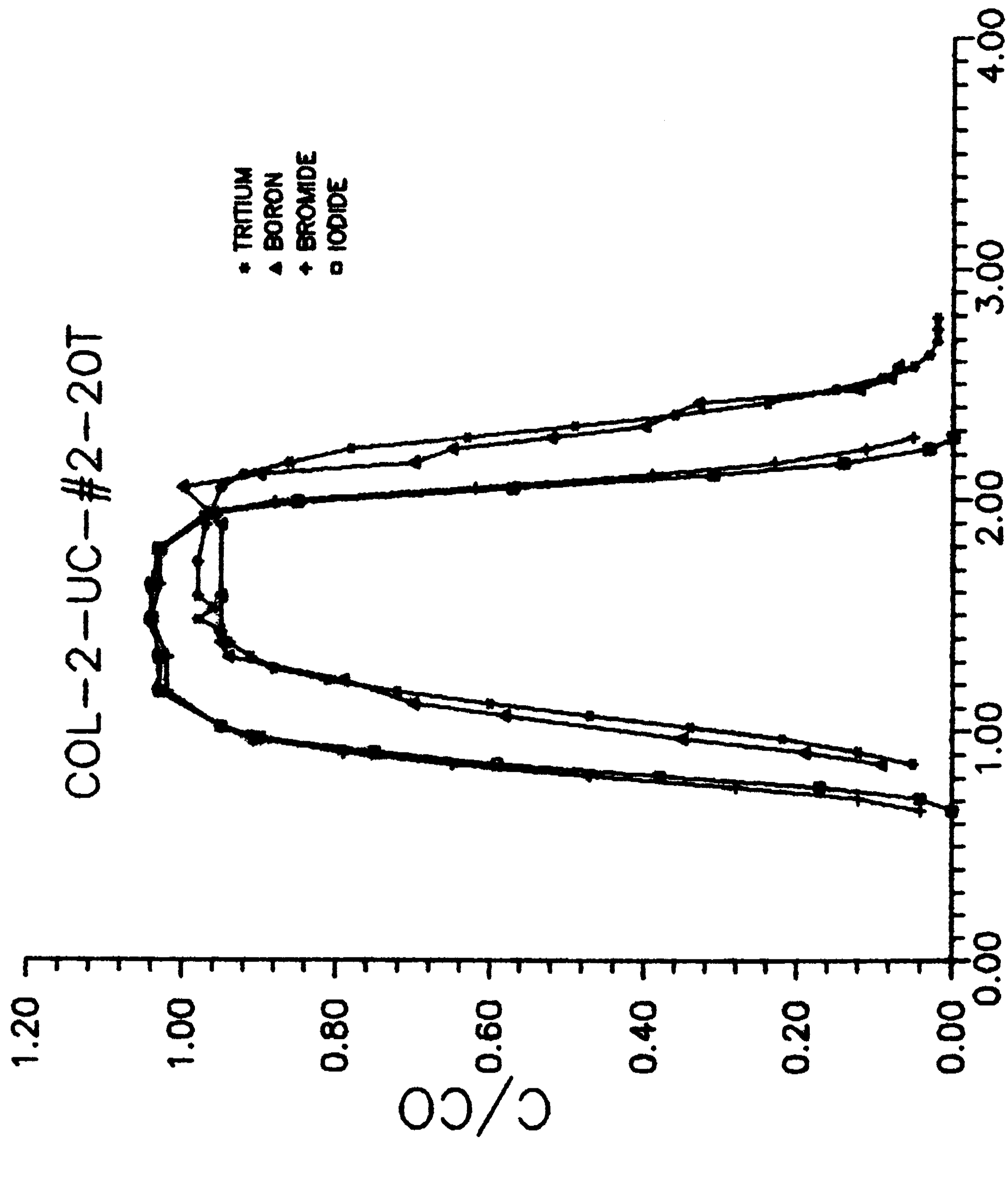

COL-2-UC-#2-10T
C/CO
PORE VOLUME
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
TRITIUM
BORON
BROMIDE
IODIDE

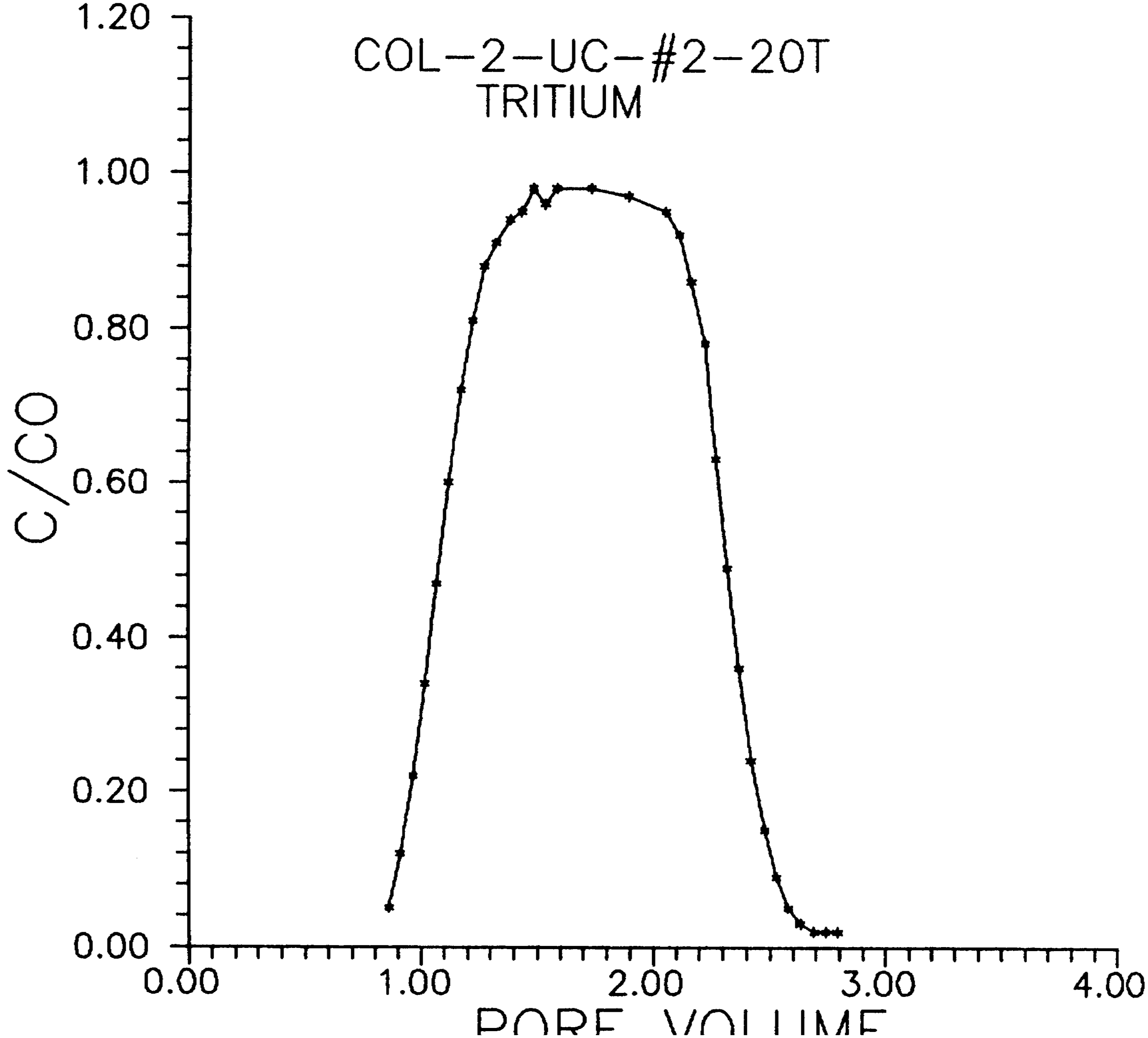

COL-2-UC-#2-10T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

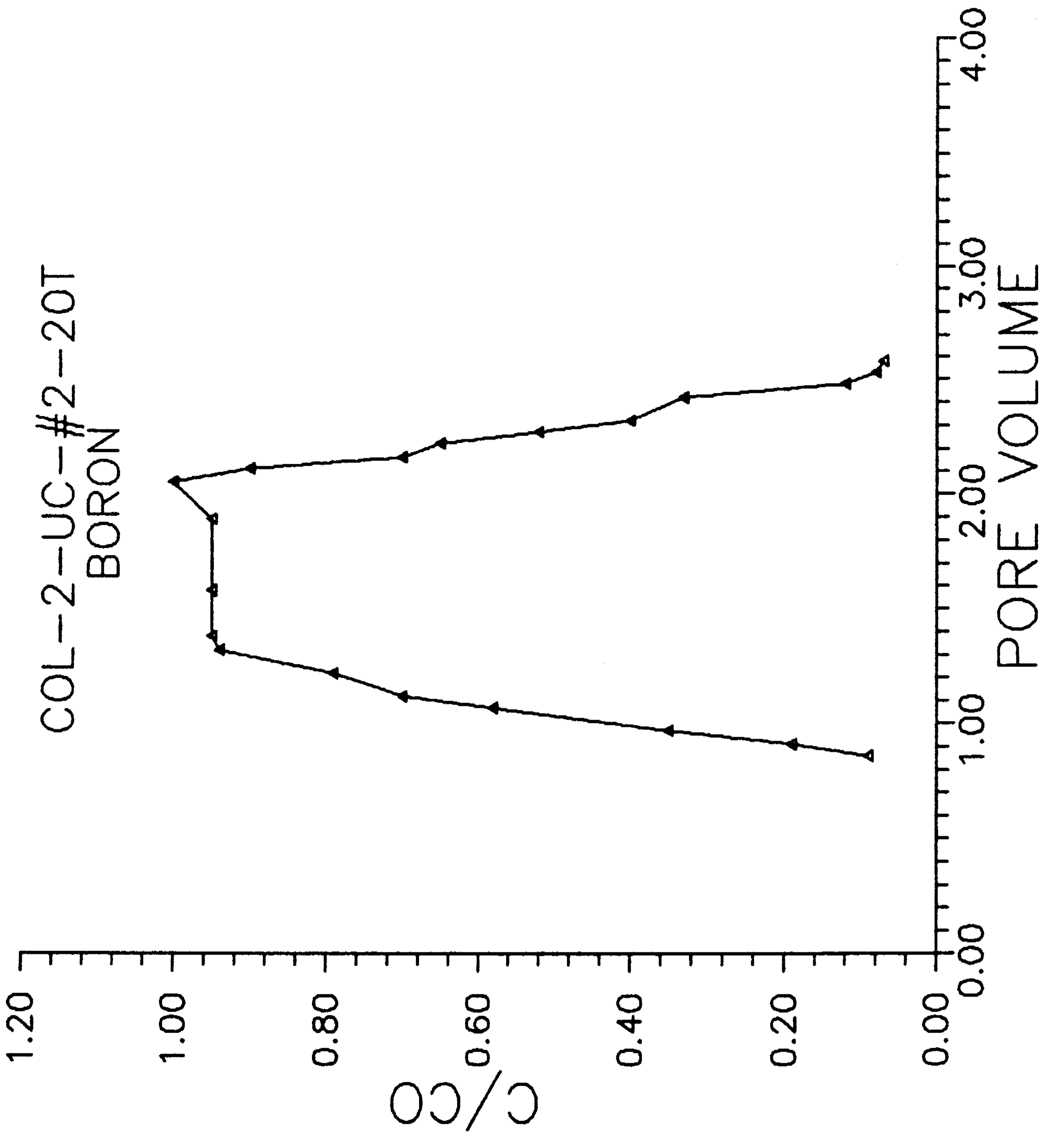

COL-2-UC-#2-10T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

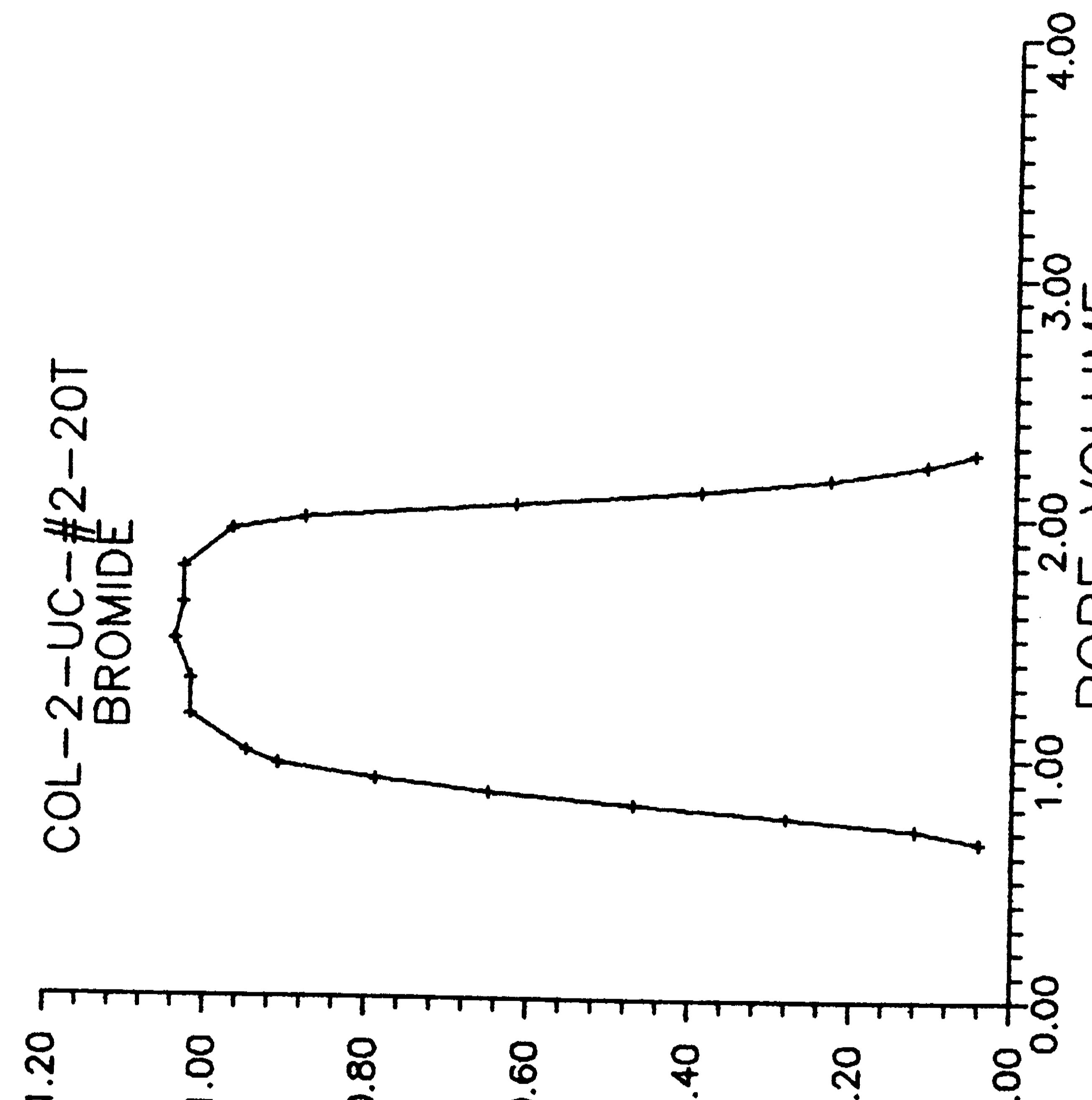

COL-2-UC-#2-10T
BROMIDE
C/CO
PORE VOLUME
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00

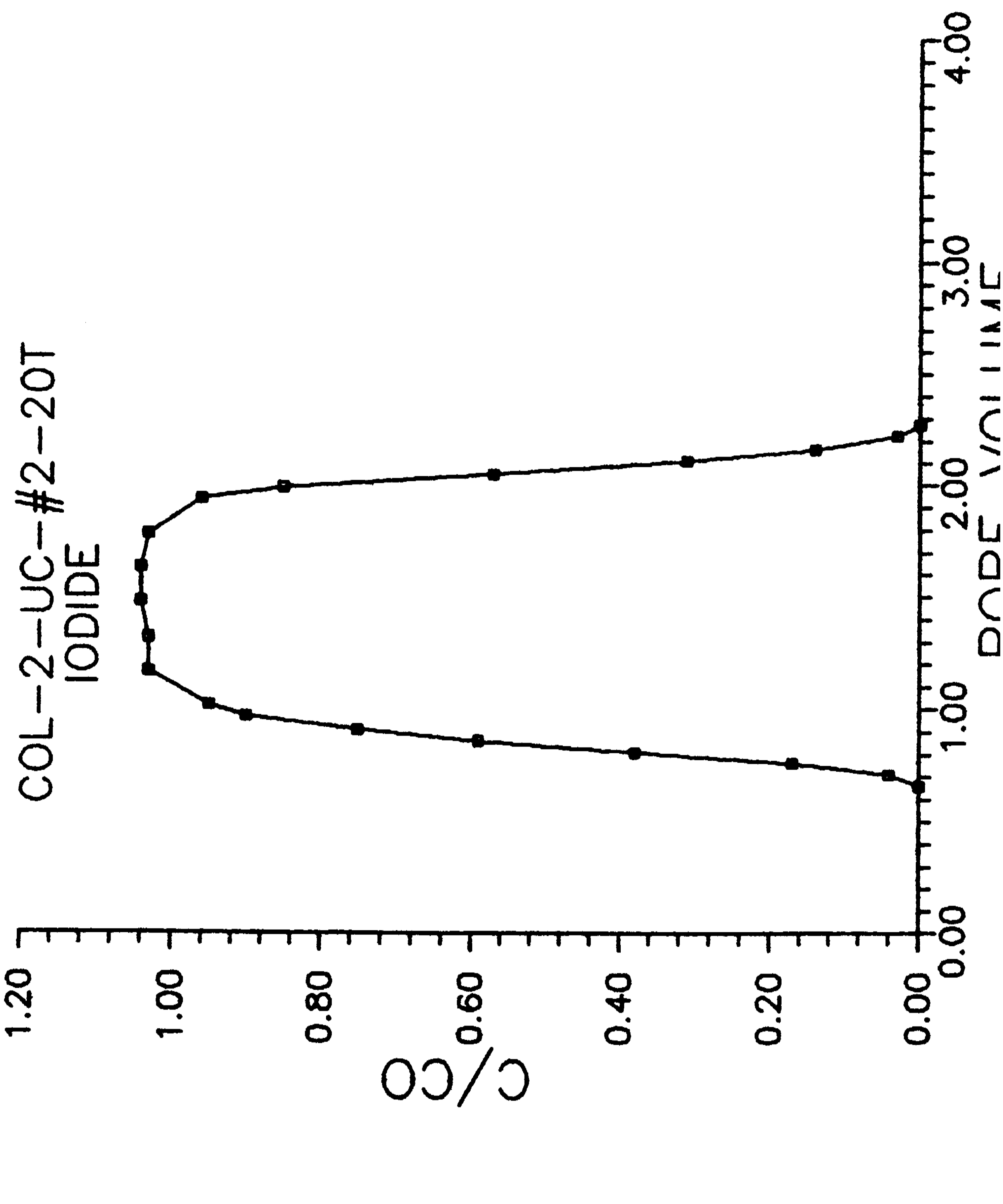

COL-2-UC-#2-10T
IODIDE
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

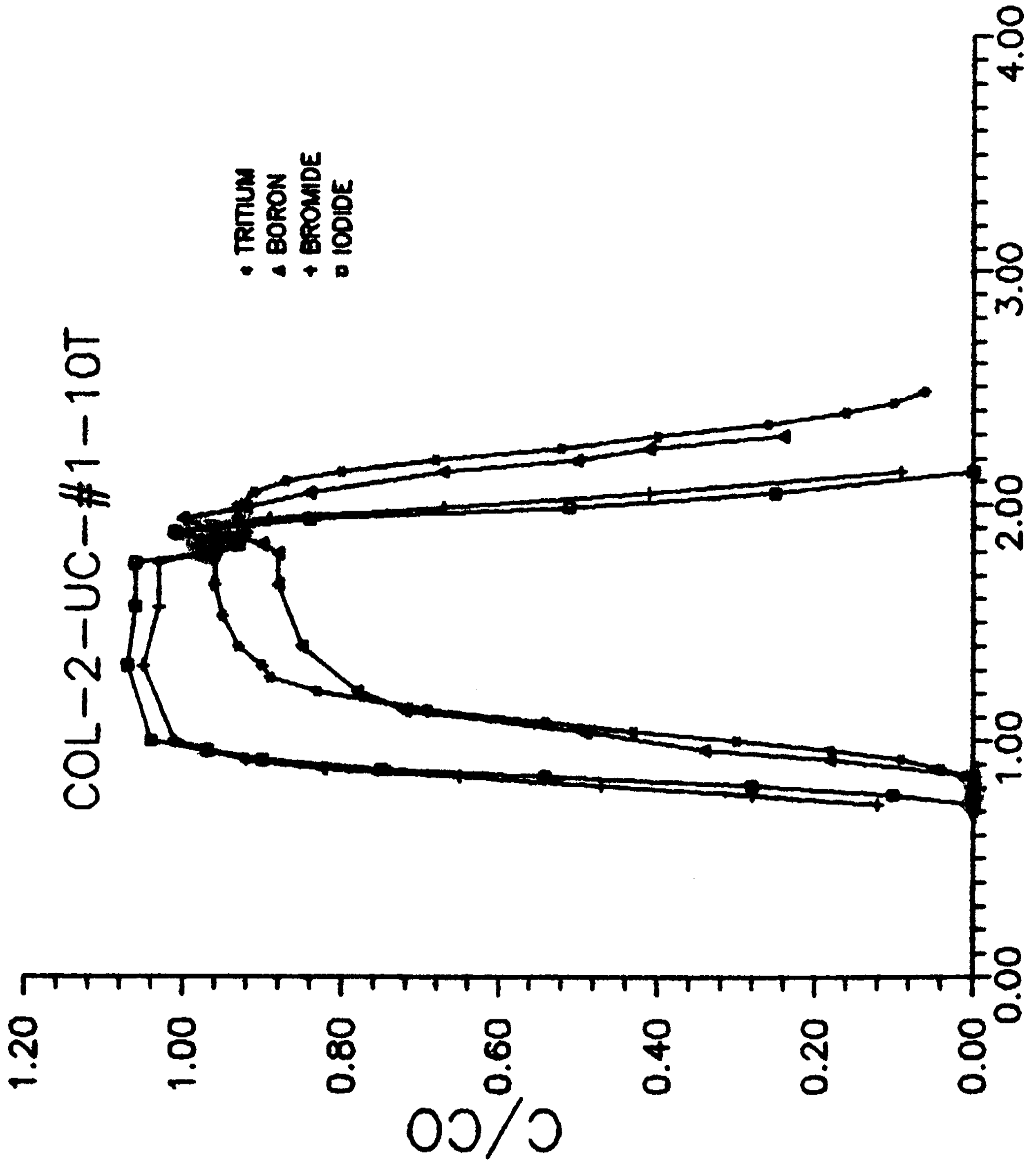

COL-2-UC-#2-20T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00


COL—2—UC—#2—20T
TRITIUM
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

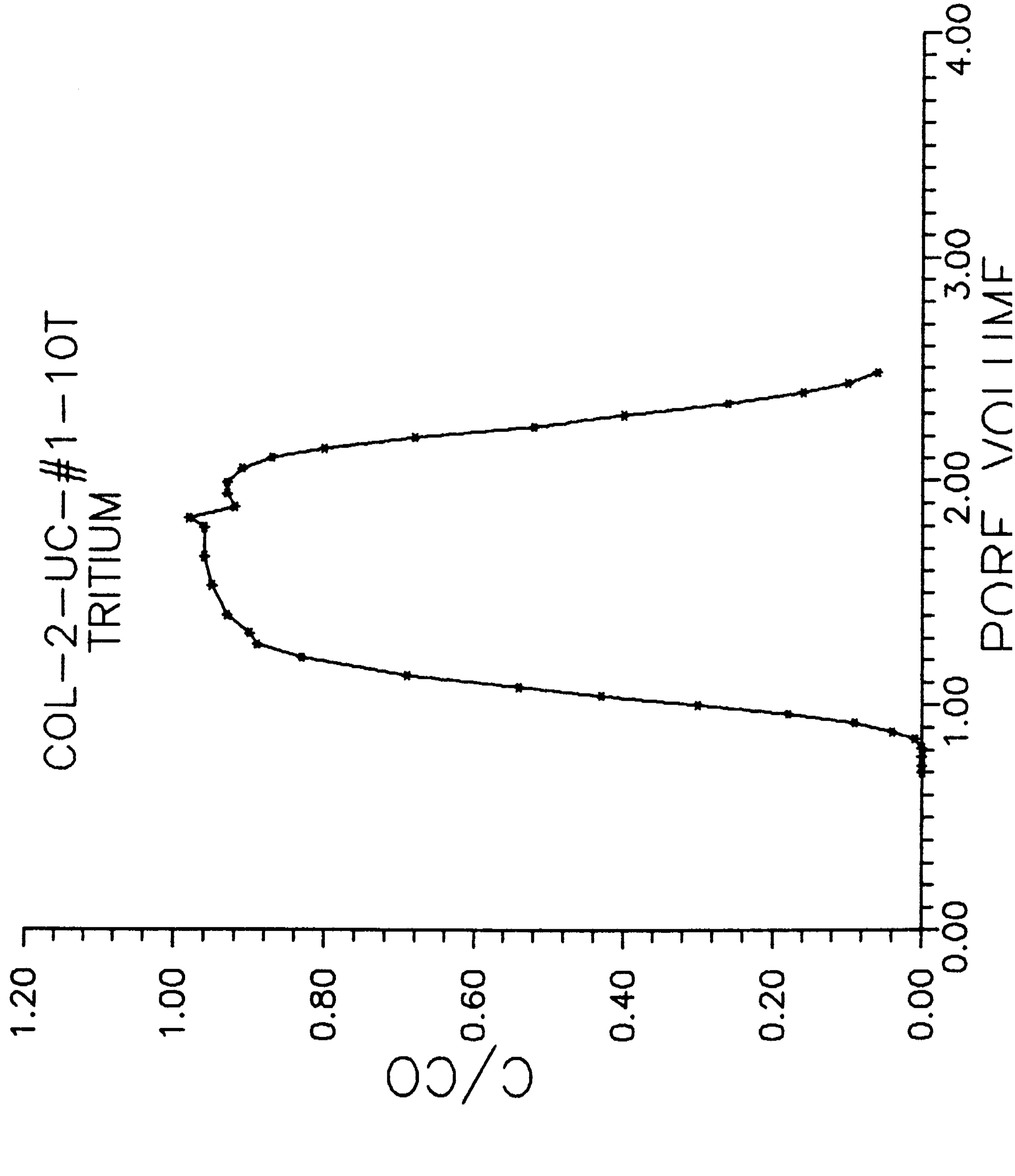

COL-2-UC-#2-20T
BORON
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00
PORE VOLUME


COL-2-UC-#2-20T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

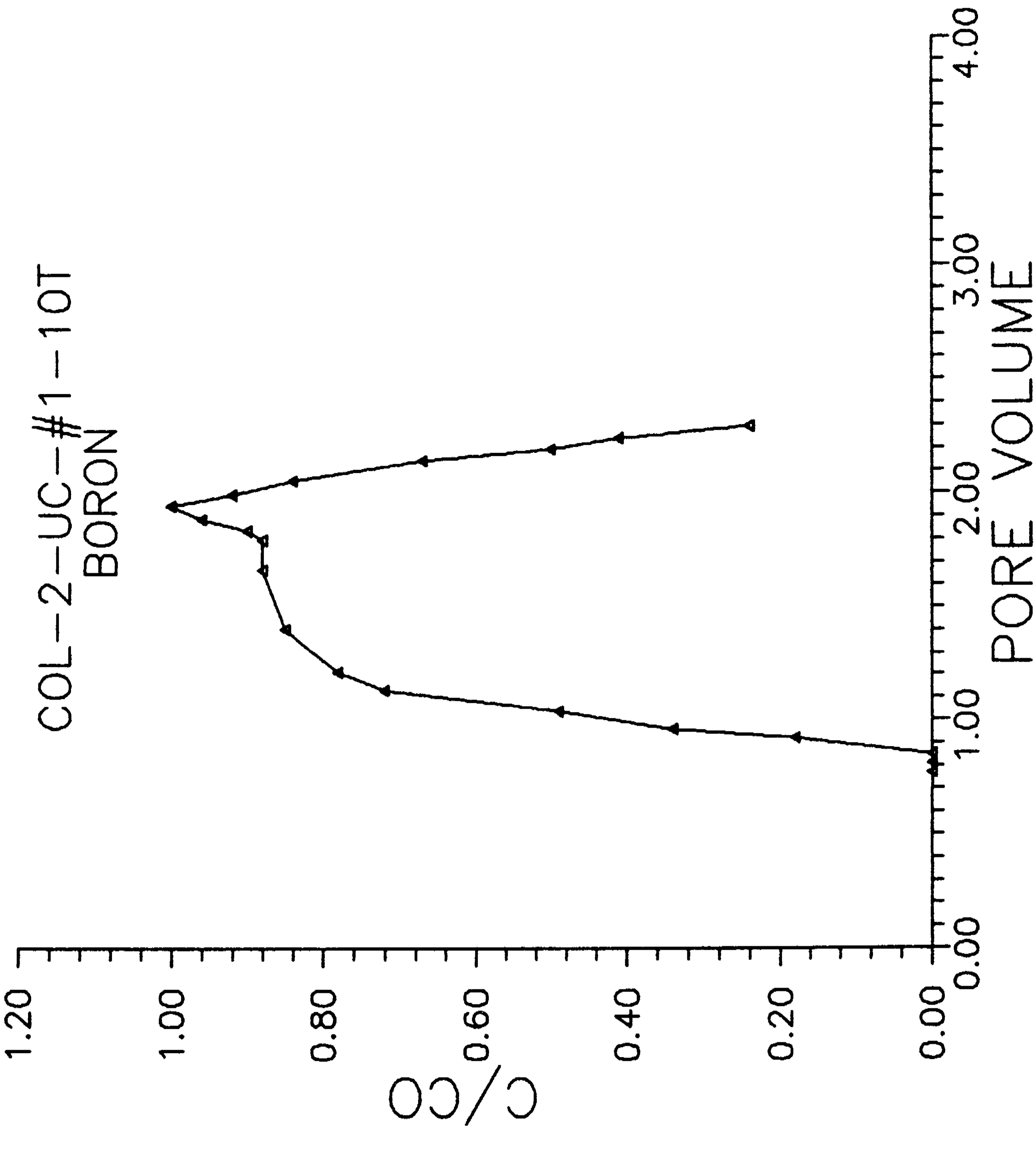

COL-2-UC-#2-20T
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME



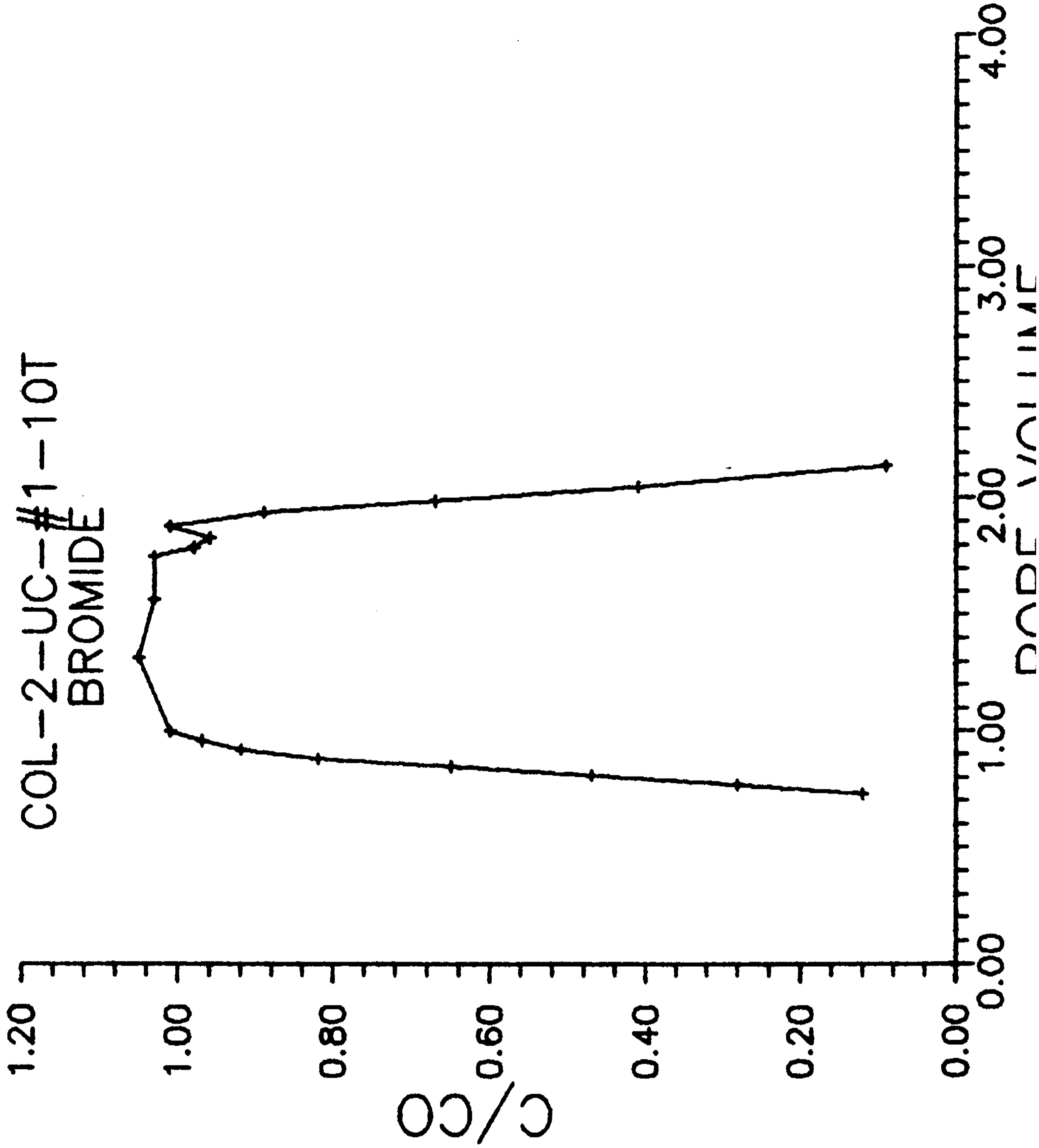
COL—2—UC—#1—10T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

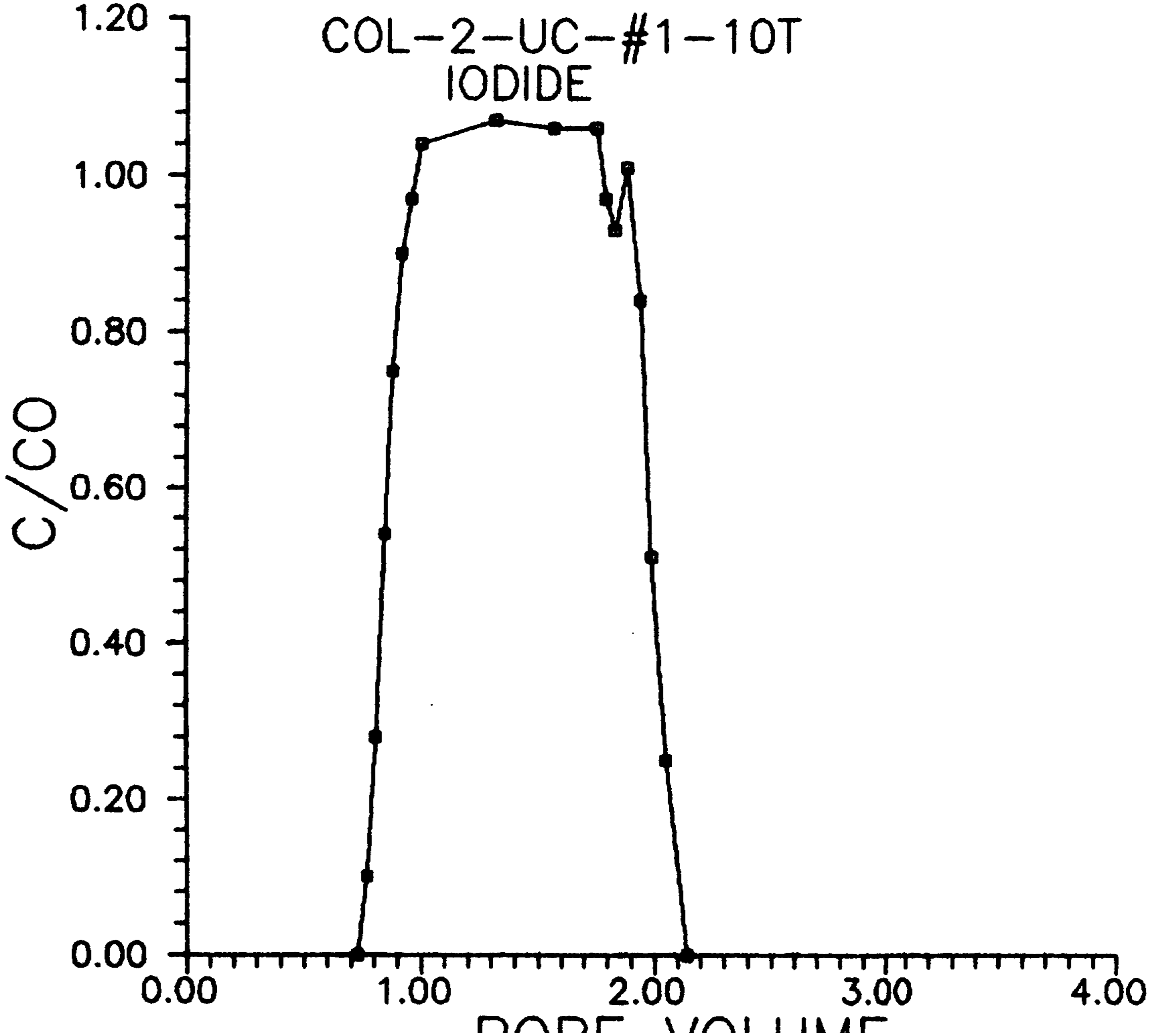


COL—2—UC—#1—10T
TRITIUM
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00



COL-2-UC-#1-10T
BORON
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
PORE VOLUME
0.00
1.00
2.00
3.00
4.00


COL–2–UC–#1–10T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00


COL-2-UC-#1-10T
IODIDE
C/CO
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0.60
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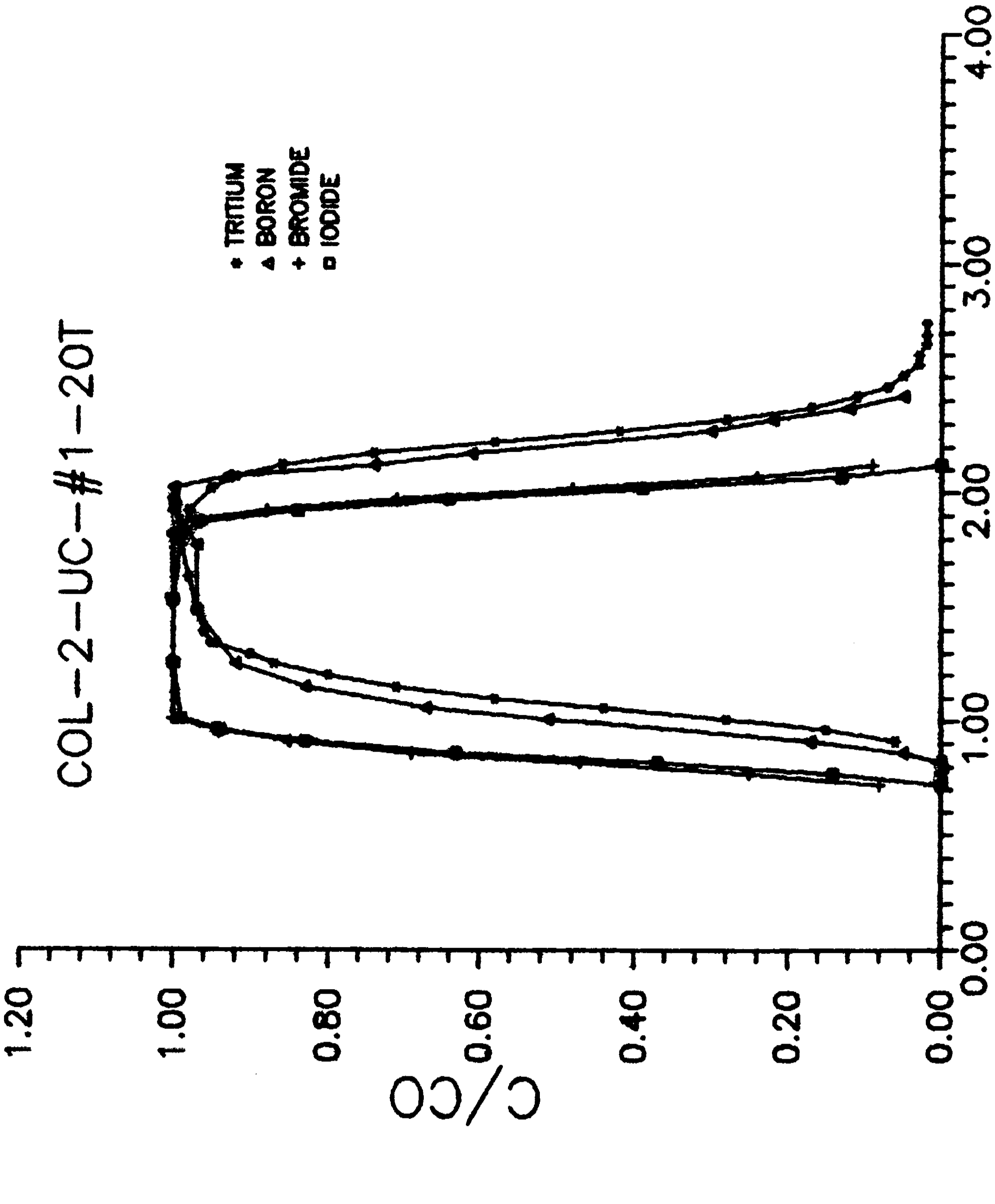
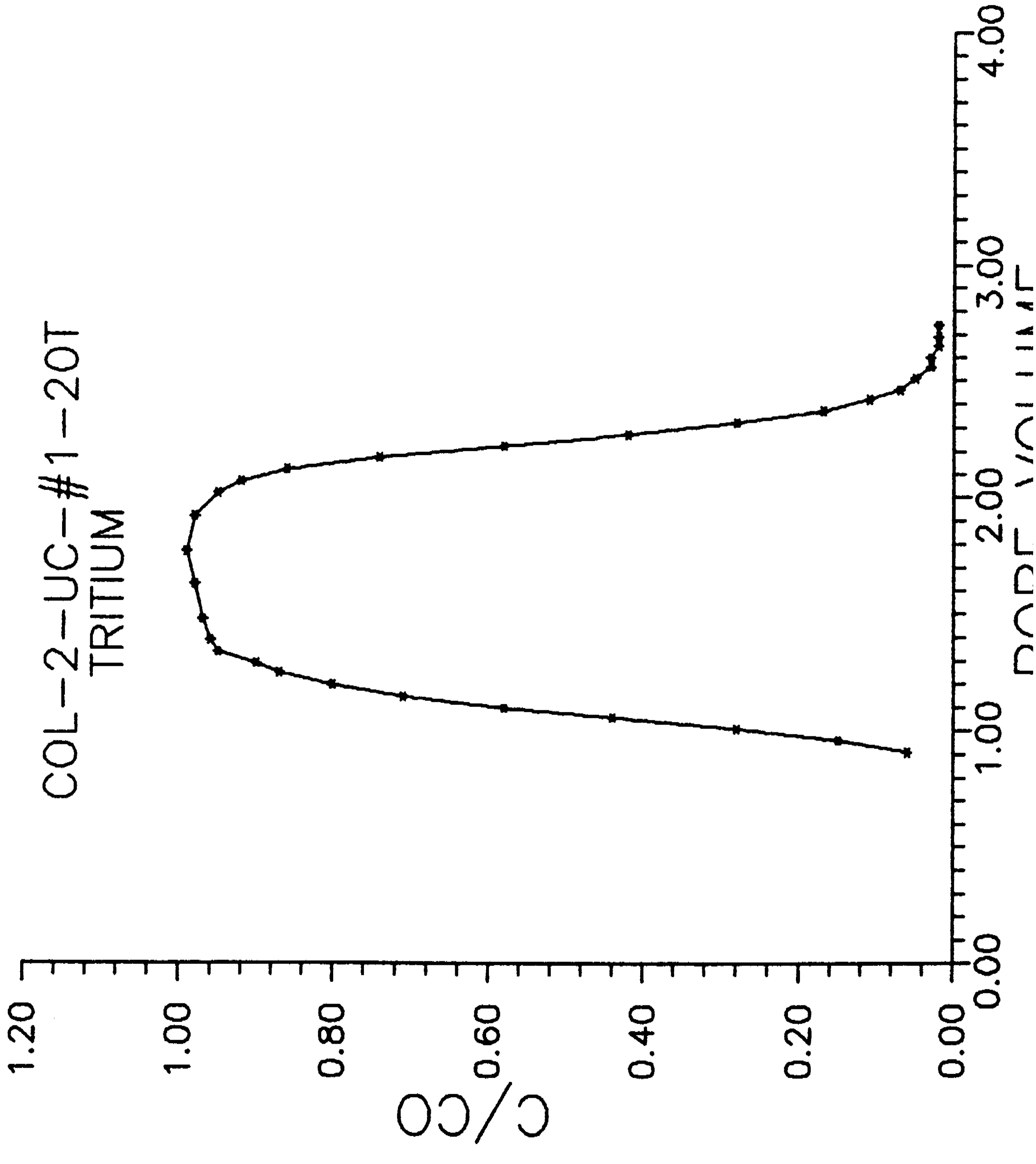
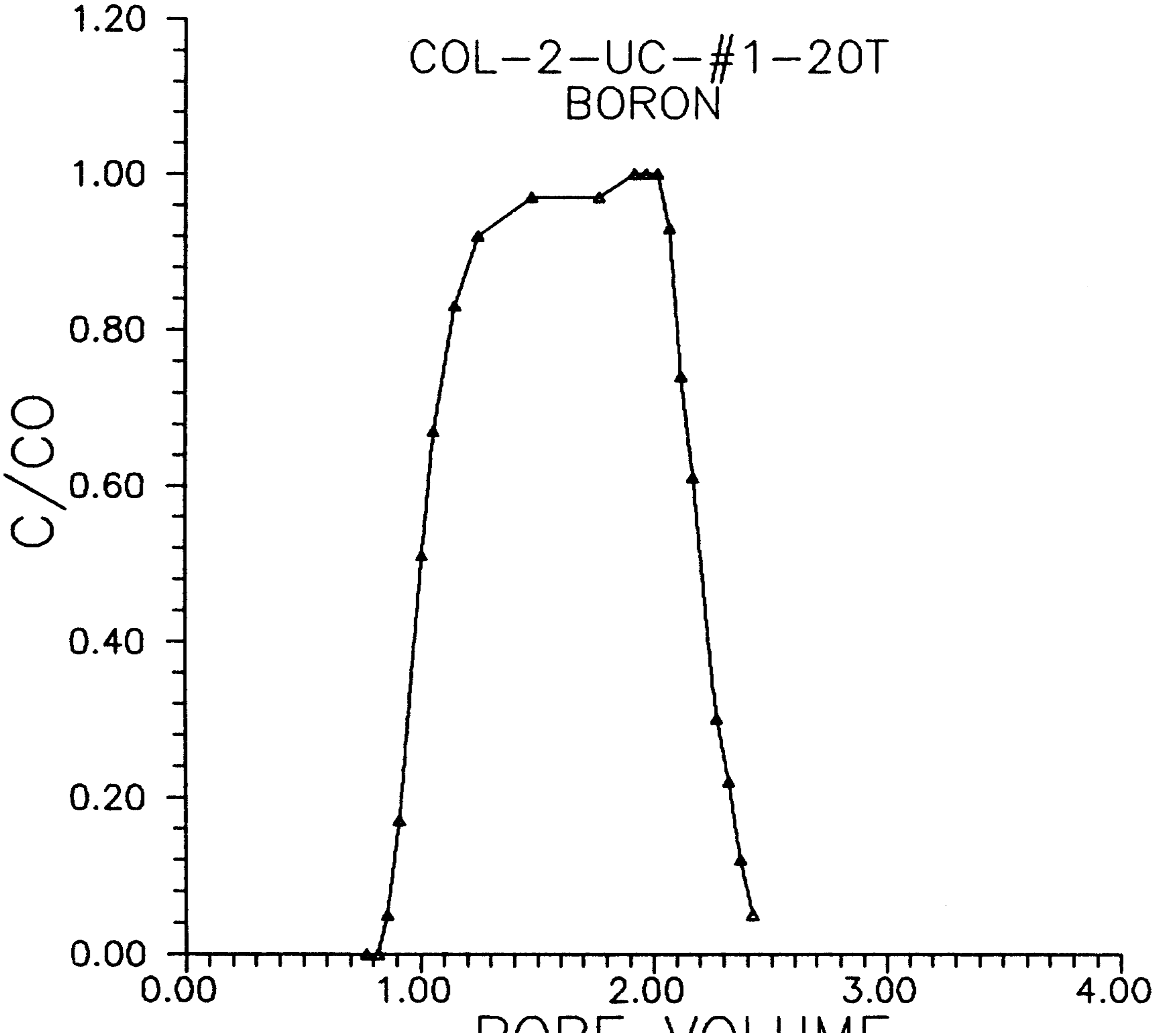
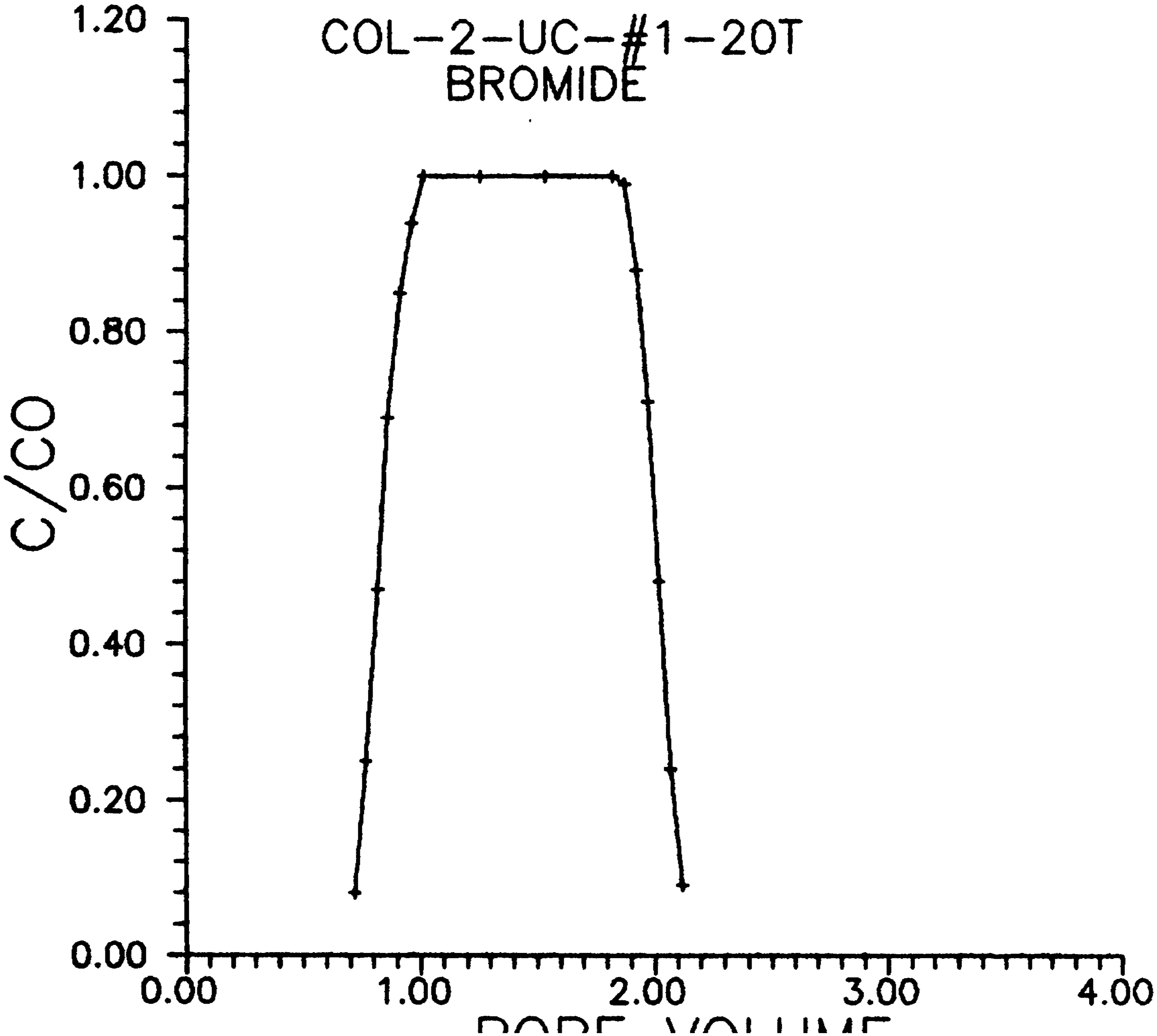
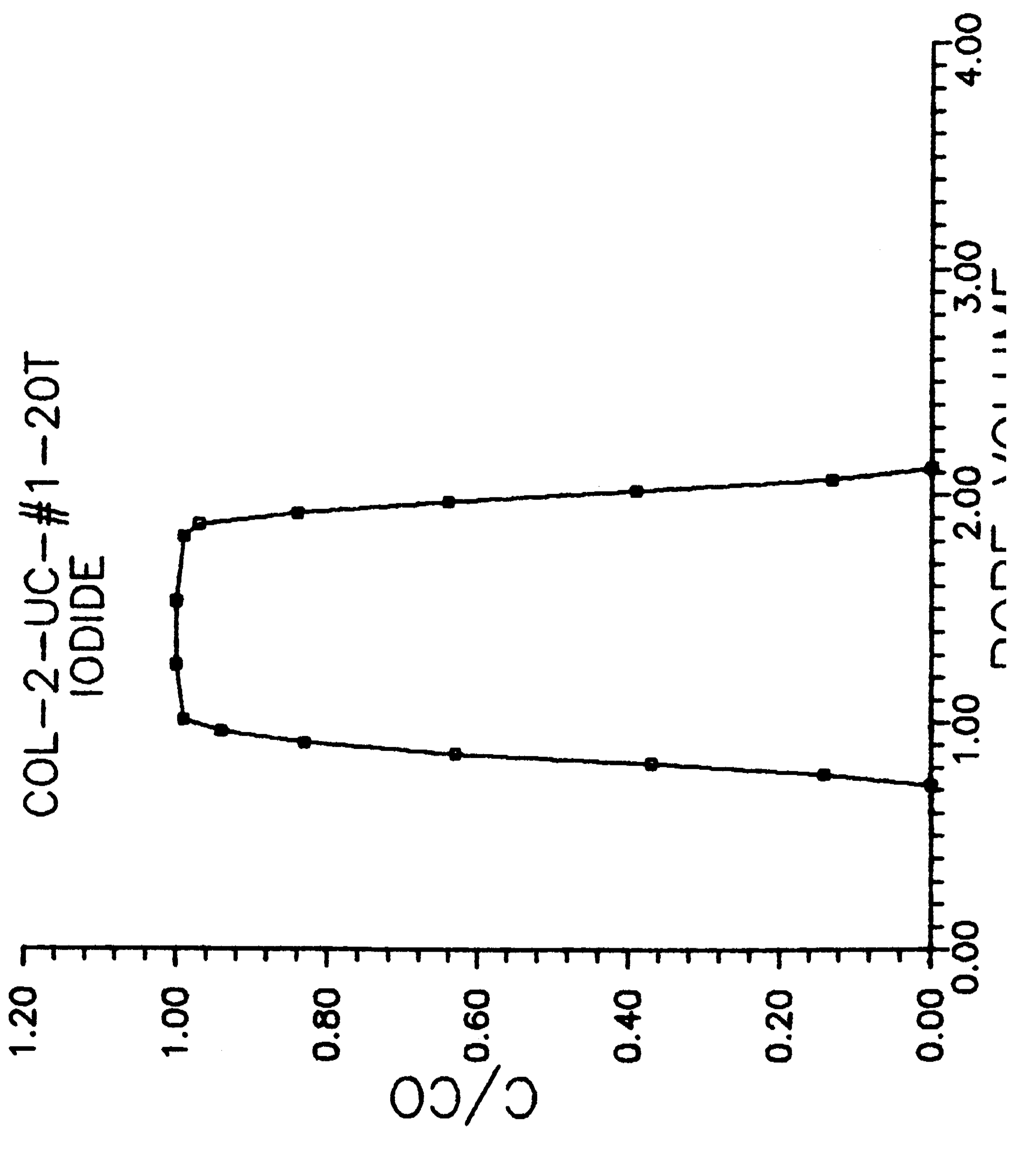
0.00
1.00
2.00
3.00
4.00


COL-2-UC-#1-20T
TRITIUM
BORON
BROMIDE
IODIDE
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


COL—2—UC—#1—20T
TRITIUM
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


COL-2-UC-#1-20T
BORON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00


COL-2-UC-#1-20T
BROMIDE
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00


COL-2-UC-#1-20T
IODIDE
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00

APPENDIX XIII

EFFLUENT ANALYSES FOR FLUOROBENZOATES AND ^{18}O

GT-2-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
1	0.05					
2	0.12					
3	0.16					
4	0.21					
5	0.26					
6	0.30					
7	0.35					
8	0.39					
9	0.44					
10	0.49					
11	0.53					
12	0.58	0.07	0.072	0.075	0.073	0.071
13	0.63	0.14	0.160	0.152	0.150	0.149
14	0.68	0.25	0.276	0.256	0.261	0.253
15	0.73	0.40	0.416	0.391	0.399	0.391
16	0.78	0.55	0.550	0.528	0.536	0.528
17	0.83	0.70	0.689	0.674	0.678	0.671
18	0.88	0.85	0.854	0.837	0.853	0.847
19	0.93	0.95	0.949	0.941	0.951	0.945
20	0.98					
21	1.03					
22	1.08	1.05	1.060	1.045	1.070	1.065
23	1.13					
24	1.18					
25	1.23	0.96	0.969	0.959	0.970	0.961
26	1.27					
27	1.32					
28	1.37	0.99	0.996	0.987	0.996	0.991
29	1.41					
30	1.46					
31	1.50	0.97	0.969	0.969	0.967	0.961
32	1.55					
33	1.59					
34	1.63	1.01	1.008	0.995	1.008	1.002
35	1.68					
36	1.72					
37	1.76	1.03	1.031	1.031	1.035	1.035
38	1.80					
39	1.86					
40	1.93	1.01	1.003	1.001	1.006	1.003
41	2.00	0.87	0.869	0.870	0.870	0.865
42	2.07	0.59	0.597	0.599	0.592	0.588
43	2.16	0.26	0.257	0.244	0.240	0.236
44	2.24	0.08	0.069	0.061	0.066	0.060
45	2.31					
46	2.37					
47	2.42					

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
48	2.47					
49	2.51					
50	2.55					
51	2.60					
52	2.64					
53	2.69					
54	2.73					
55	2.78					
56	2.82					
57	2.87					
58	2.91					
59	2.96					
60	3.00					

GT-5-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
1	0.03					
2	0.10					
3	0.15					
4	0.20					
5	0.26					
6	0.31					
7	0.36					
8	0.42					
9	0.47					
10	0.53					
11	0.58					
12	0.64					
13	0.69	0.04	0.025	0.025	0.027	0.023
14	0.75	0.11	0.106	0.095	0.099	0.097
15	0.81	0.24	0.261	0.229	0.245	0.237
16	0.86	0.44	0.460	0.425	0.444	0.436
17	0.92	0.65	0.643	0.636	0.660	0.648
18	0.98	0.81	0.812	0.804	0.809	0.796
19	1.03	0.93	0.921	0.915	0.928	0.923
20	1.09	0.99	0.982	0.977	0.989	0.985
21	1.14	1.01	1.004	1.001	0.997	0.996
22	1.20					
23	1.25					
24	1.31					
25	1.36	1.02	1.021	1.014	1.016	1.013
26	1.42					
27	1.47					
28	1.53					
29	1.58	1.01	1.006	1.003	1.004	1.001
30	1.64					
31	1.70					
32	1.75					
33	1.81	1.01	1.011	1.006	1.010	1.007
34	1.87					
35	1.93					
36	1.98					
37	2.04	1.00	0.991	0.991	0.992	0.988
38	2.11	0.97	0.968	0.963	0.960	0.959
39	2.17	0.86	0.857	0.853	0.850	0.847
40	2.22	0.71	0.706	0.704	0.694	0.690
41	2.27	0.51	0.517	0.510	0.497	0.494
42	2.32	0.31	0.318	0.308	0.299	0.294
43	2.38	0.17	0.169	0.157	0.154	0.149
44	2.43	0.08	0.071	0.070	0.066	0.064
45	2.48					
46	2.54					
47	2.60					

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
48	2.65					
49	2.71					
50	2.76					
51	2.82					
52	2.88					
53	2.94					

GT-7-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
1	0.06					
2	0.16					
3	0.24					
4	0.32					
5	0.40					
6	0.47					
7	0.55					
8	0.64	0.00		0.006	0.007	0.006
9	0.72	0.09	0.091	0.083	0.084	0.085
10	0.80	0.29	0.320	0.288	0.301	0.297
11	0.88	0.53	0.546	0.516	0.528	0.525
12	0.97	0.76	0.775	0.753	0.766	0.765
13	1.06	0.88	0.877	0.867	0.873	0.870
14	1.14	0.92	0.919	0.917	0.913	0.909
15	1.23	0.96	0.952	0.949	0.956	0.951
16	1.31		0.989	0.985	0.988	0.989
17	1.40					
18	1.48					
19	1.56					
20	1.65	1.01	1.008	0.996	1.009	1.011
21	1.73					
22	1.81					
23	1.89					
24	1.98	1.00	0.998	0.992	0.996	0.997
25	2.06					
26	2.14					
27	2.22					
28	2.30	1.01	1.009	1.000	1.010	1.010
29	2.38					
30	2.46					
31	2.54					
32	2.62					
33	2.70	1.01	1.004	0.999	1.008	1.006
34	2.78	0.95	0.935	0.933	0.931	0.928
35	2.86	0.77	0.773	0.766	0.762	0.761
36	2.94	0.55	0.525	0.542	0.532	0.527
37	3.03	0.32	0.323	0.312	0.304	0.300
38	3.14	0.15	0.154	0.140	0.139	0.134
39	3.26	0.09	0.077	0.074	0.070	0.070
40	3.36	0.07	0.059	0.057	0.055	0.052
41	3.44					
42	3.52					
43	3.60					
44	3.68					
45	3.76					
46	3.84					
47	3.92					

COL-1-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
1	0.04					
2	0.11					
3	0.18					
4	0.25					
5	0.31					
6	0.38					
7	0.45					
8	0.51					
9	0.58	0.06	0.056	0.052	0.057	0.054
10	0.65	0.19	0.210	0.190	0.197	0.190
11	0.72	0.37	0.401	0.366	0.382	0.375
12	0.79	0.59	0.601	0.570	0.588	0.581
13	0.86	0.77	0.760	0.733	0.754	0.748
14	0.93	0.89	0.884	0.856	0.878	0.875
15	1.00	0.98	0.966	0.948	0.963	0.963
16	1.07	1.05	1.052	1.036	1.049	1.049
17	1.14					
18	1.22					
19	1.29	1.02	1.015	1.013	1.013	1.014
20	1.36					
21	1.43	1.03	1.029	1.028	1.026	1.028
22	1.50					
23	1.57					
24	1.64	1.03	1.023	1.025	1.021	1.019
25	1.71					
26	1.78	1.01	1.002	1.004	0.997	0.997
27	1.84					
28	1.92					
29	1.99					
30	2.06	0.99	0.984	0.988	0.983	0.983
31	2.13					
32	2.20	0.98	0.975	0.974	0.976	0.976
33	2.27	0.98	0.976	0.973	0.976	0.976
34	2.34	0.89	0.877	0.875	0.872	0.873
35	2.41	0.80	0.792	0.794	0.783	0.786
36	2.48	0.62	0.614	0.620	0.601	0.603
37	2.56	0.37	0.385	0.384	0.365	0.366
38	2.64	0.16	0.176	0.183	0.160	0.165
39	2.73	0.05	0.036	0.046	0.037	0.037
40	2.83					
41	2.90					
42	2.97					
43	3.03					
44	3.10					
45	3.17					
46	3.24					
47	3.31					

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
48	3.38					
49	3.45					
50	3.53					
51	3.61					
52	3.68					
53	3.75					
54	3.83					
55	3.90					

COL-2-UC-#2-20T

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
1	0.03					
2	0.08					
3	0.14					
4	0.19					
5	0.25					
6	0.30					
7	0.35					
8	0.40					
9	0.46					
10	0.51					
11	0.56					
12	0.61					
13	0.66	0.04	0.035	0.031	0.404	0.035
14	0.71	0.12	0.138	0.127	0.134	0.130
15	0.76	0.28	0.317	0.294	0.307	0.297
16	0.81	0.47	0.504	0.476	0.496	0.485
17	0.86	0.65	0.637	0.613	0.630	0.622
18	0.91	0.79	0.765	0.739	0.760	0.763
19	0.97	0.91	0.891	0.879	0.890	0.885
20	1.02	0.95	0.944	0.921	0.947	0.946
21	1.07					
22	1.12					
23	1.17	1.02	1.026	1.015	1.029	1.025
24	1.22					
25	1.27					
26	1.32	1.02	1.021	0.999	1.023	1.021
27	1.38					
28	1.43					
29	1.48	1.04	1.034	1.015	1.036	1.032
30	1.53					
31	1.58					
32	1.63	1.03	1.023	1.006	1.028	1.027
33	1.68					
34	1.73					
35	1.78	1.03	1.024	1.009	1.027	1.022
36	1.84					
37	1.89					
38	1.94	0.97	0.962	0.939	0.962	0.961
39	1.99	0.88	0.854	0.823	0.849	0.851
40	2.05	0.62	0.611	0.587	0.600	0.599
41	2.11	0.39	0.418	0.393	0.406	0.402
42	2.16	0.23	0.274	0.254	0.261	0.255
43	2.22	0.11	0.124	0.114	0.119	0.113
44	2.27	0.05	0.036	0.035	0.039	0.035
45	2.32					
46	2.37					
47	2.42					

SAMPLE	CUMULAT. PORE VOLUME	RELATIVE CONCEN. BROMIDE	RELATIVE CONCEN. o-TFMBA	RELATIVE CONCEN. m-TFMBA	RELATIVE CONCEN. PFBA	RELATIVE CONCEN. 2,6-DFBA
48	2.48					
49	2.53					
50	2.58					
51	2.63					
52	2.69					
53	2.74					
54	2.79					
55	2.84					
56	2.89					
57	2.94					
58	2.99					
59	3.05					
60	3.10					

GT-2-UC-#2-20T

SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
1	0.05		
2	0.12		
3	0.16		
4	0.21		
5	0.26		
6	0.30		
7	0.35		
8	0.39		
9	0.44		
10	0.49		
11	0.53		
12	0.58		
13	0.63		
14	0.68		
15	0.73	0.00	0.000
16	0.78	0.01	
17	0.83	0.03	
18	0.88	0.06	0.009
19	0.93	0.11	0.084
20	0.98	0.20	0.210
21	1.03	0.30	
22	1.08	0.43	0.442
23	1.13	0.55	
24	1.18	0.66	0.724
25	1.23	0.76	
26	1.27	0.83	0.917
27	1.32	0.88	
28	1.37		
29	1.41		
30	1.46	0.97	1.039
31	1.50		
32	1.55		
33	1.59	1.01	
34	1.63		
35	1.68		
36	1.72	1.00	
37	1.76		
38	1.80	1.00	
39	1.86		
40	1.93	0.98	1.000
41	2.00	0.98	0.929
42	2.07	0.98	0.902
43	2.16	0.97	0.886
44	2.24	0.93	0.869
45	2.31	0.80	
46	2.37	0.64	0.616
47	2.42	0.49	0.438

SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
48	2.47	0.34	0.344
49	2.51	0.24	
50	2.55	0.17	0.169
51	2.60	0.12	
52	2.64	0.09	
53	2.69	0.07	
54	2.73		
55	2.78		
56	2.82		
57	2.87		
58	2.91		
59	2.96		
60	3.00		

GT-5-UC-#2-20T

SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
1	0.03		
2	0.10		
3	0.15		
4	0.20		
5	0.26		
6	0.31		
7	0.36		
8	0.42		
9	0.47		
10	0.53		0.001
11	0.58		
12	0.64		0.003
13	0.69	0.01	0.011
14	0.75	0.04	0.037
15	0.81	0.12	0.108
16	0.86	0.25	0.264
17	0.92	0.44	0.355
18	0.98	0.62	0.649
19	1.03	0.77	0.822
20	1.09	0.88	0.908
21	1.14	0.93	0.923
22	1.20	0.96	
23	1.25		0.968
24	1.31		
25	1.36	0.97	
26	1.42		0.967
27	1.47	0.98	
28	1.53		
29	1.58	0.99	0.978
30	1.64		
31	1.70	0.98	
32	1.75		0.972
33	1.81	1.00	
34	1.87		
35	1.93	0.99	
36	1.98		0.953
37	2.04	0.99	
38	2.11	0.95	
39	2.17	0.89	0.844
40	2.22	0.76	0.824
41	2.27	0.63	0.664
42	2.32	0.44	0.466
43	2.38	0.27	0.270
44	2.43	0.14	0.115
45	2.48	0.07	0.054
46	2.54	0.03	0.015
47	2.60	0.02	0.000

SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
48	2.65		
49	2.71		
50	2.76		0.000
51	2.82		
52	2.88		
53	2.94		

GT-7-UC-#2-20T

SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
1	0.06		0.000
2	0.16		
3	0.24		0.000
4	0.32		
5	0.40		
6	0.47		
7	0.55		
8	0.64	0.01	0.000
9	0.72	0.06	
10	0.80	0.21	0.170
11	0.88	0.45	0.409
12	0.97	0.66	0.630
13	1.06	0.81	0.760
14	1.14	0.88	0.849
15	1.23	0.91	0.910
16	1.31	0.93	1.073
17	1.40	0.94	
18	1.48	0.95	
19	1.56		
20	1.65	0.97	
21	1.73		
22	1.81	0.97	
23	1.89		
24	1.98		
25	2.06	0.98	
26	2.14		
27	2.22		
28	2.30	0.98	1.112
29	2.38		
30	2.46		
31	2.54	0.98	
32	2.62		
33	2.70	0.99	1.116
34	2.78	0.95	1.075
35	2.86	0.81	0.751
36	2.94	0.58	0.529
37	3.03	0.34	0.282
38	3.14	0.16	0.121
39	3.26	0.08	
40	3.36	0.05	0.024
41	3.44	0.04	
42	3.52	0.03	
43	3.60		
44	3.68		
45	3.76		
46	3.84		0.000
47	3.92		

COL-1-UC-#2-20T

SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
1	0.04		
2	0.11		
3	0.18		
4	0.25		
5	0.31		
6	0.38		
7	0.45		
8	0.51		
9	0.58	0.01	
10	0.65	0.03	0.026
11	0.72	0.09	0.053
12	0.79	0.21	0.143
13	0.86	0.37	0.337
14	0.93	0.54	0.526
15	1.00	0.68	0.645
16	1.07	0.80	0.728
17	1.14	0.87	0.773
18	1.22	0.90	0.764
19	1.29	0.92	
20	1.36	0.93	
21	1.43	0.94	
22	1.50	0.95	0.913
23	1.57	0.95	
24	1.64	0.96	
25	1.71	0.97	
26	1.78	0.96	
27	1.84	0.97	
28	1.92		0.965
29	1.99	0.97	
30	2.06		
31	2.13	0.97	
32	2.20		
33	2.27	0.98	0.952
34	2.34	0.98	0.948
35	2.41	0.94	0.931
36	2.48	0.86	0.852
37	2.56	0.74	0.727
38	2.64	0.54	0.537
39	2.73	0.30	
40	2.83	0.15	0.139
41	2.90	0.09	0.079
42	2.97	0.06	
43	3.03	0.05	
44	3.10	0.04	
45	3.17	0.03	
46	3.24	0.03	
47	3.31	0.02	

SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
48	3.38		
49	3.45		0.000
50	3.53		
51	3.61		
52	3.68		
53	3.75		
54	3.83		
55	3.90		

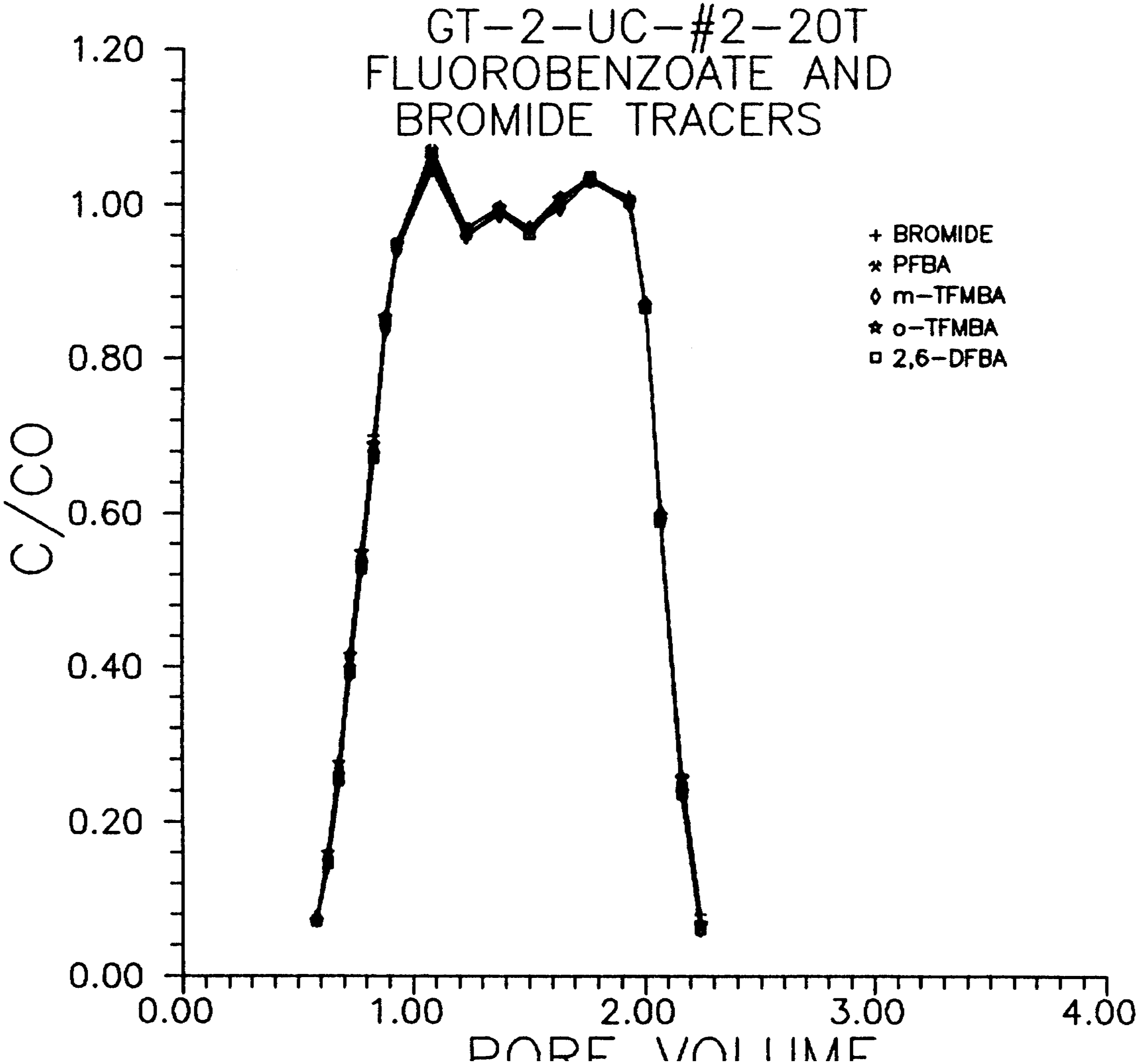
COL-2-UC-#2-20T

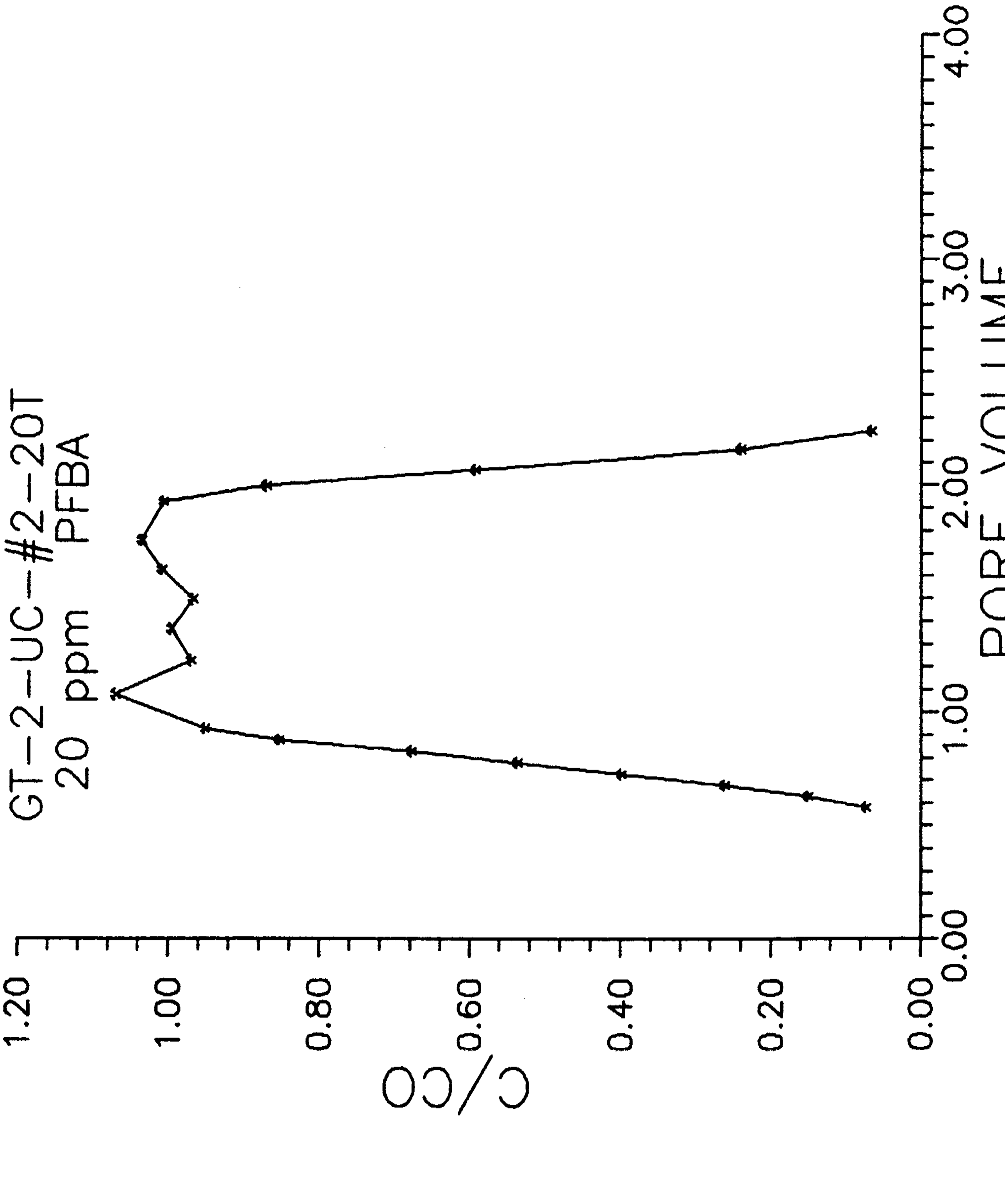
SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
1	0.03		
2	0.08		
3	0.14		
4	0.19		
5	0.25		
6	0.30		
7	0.35		
8	0.40		
9	0.46		
10	0.51		
11	0.56		
12	0.61		
13	0.66		
14	0.71		
15	0.76		
16	0.81		0.009
17	0.86	0.05	
18	0.91	0.12	0.115
19	0.97	0.22	0.206
20	1.02	0.34	0.327
21	1.07	0.47	0.471
22	1.12	0.60	0.611
23	1.17	0.72	
24	1.22	0.81	0.649
25	1.27	0.88	0.735
26	1.32	0.91	
27	1.38	0.94	
28	1.43	0.95	
29	1.48	0.98	
30	1.53	0.96	0.806
31	1.58	0.98	
32	1.63		
33	1.68		
34	1.73	0.98	
35	1.78		0.802
36	1.84		
37	1.89	0.97	
38	1.94		
39	1.99		
40	2.05	0.95	0.834
41	2.11	0.92	0.807
42	2.16	0.86	0.764
43	2.22	0.78	0.649
44	2.27	0.63	0.559
45	2.32	0.49	
46	2.37	0.36	0.305
47	2.42	0.24	

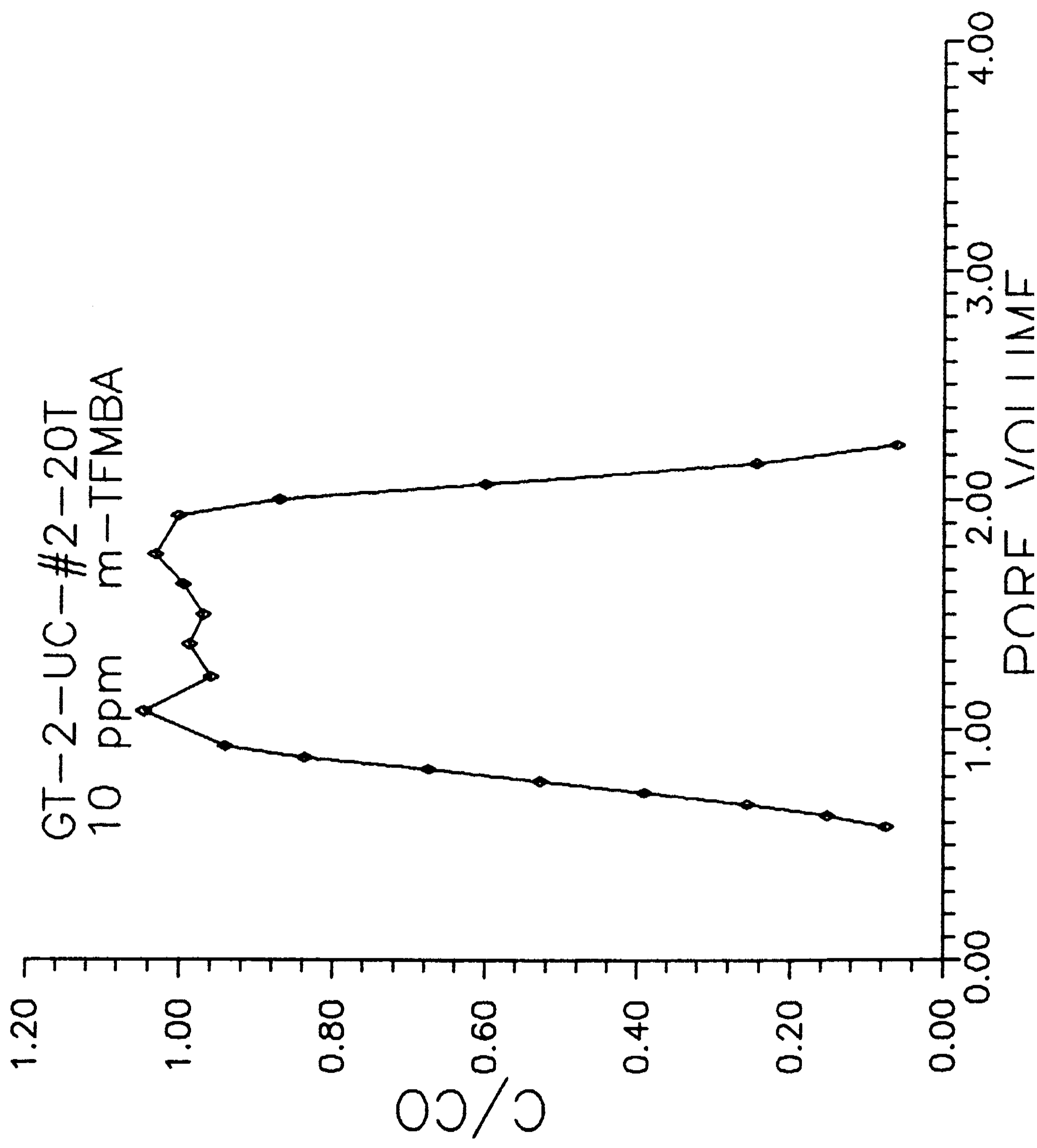
SAMPLE	CUMULAT PORE VOLUME	RELATIVE CONCEN. TRITIUM	RELATIVE CONCEN. OXYGEN 18
48	2.48	0.15	
49	2.53	0.09	0.000
50	2.58	0.05	0.038
51	2.63	0.03	
52	2.69	0.02	
53	2.74	0.02	
54	2.79	0.02	
55	2.84		
56	2.89		
57	2.94		
58	2.99		
59	3.05		
60	3.10		

APPENDIX XIV

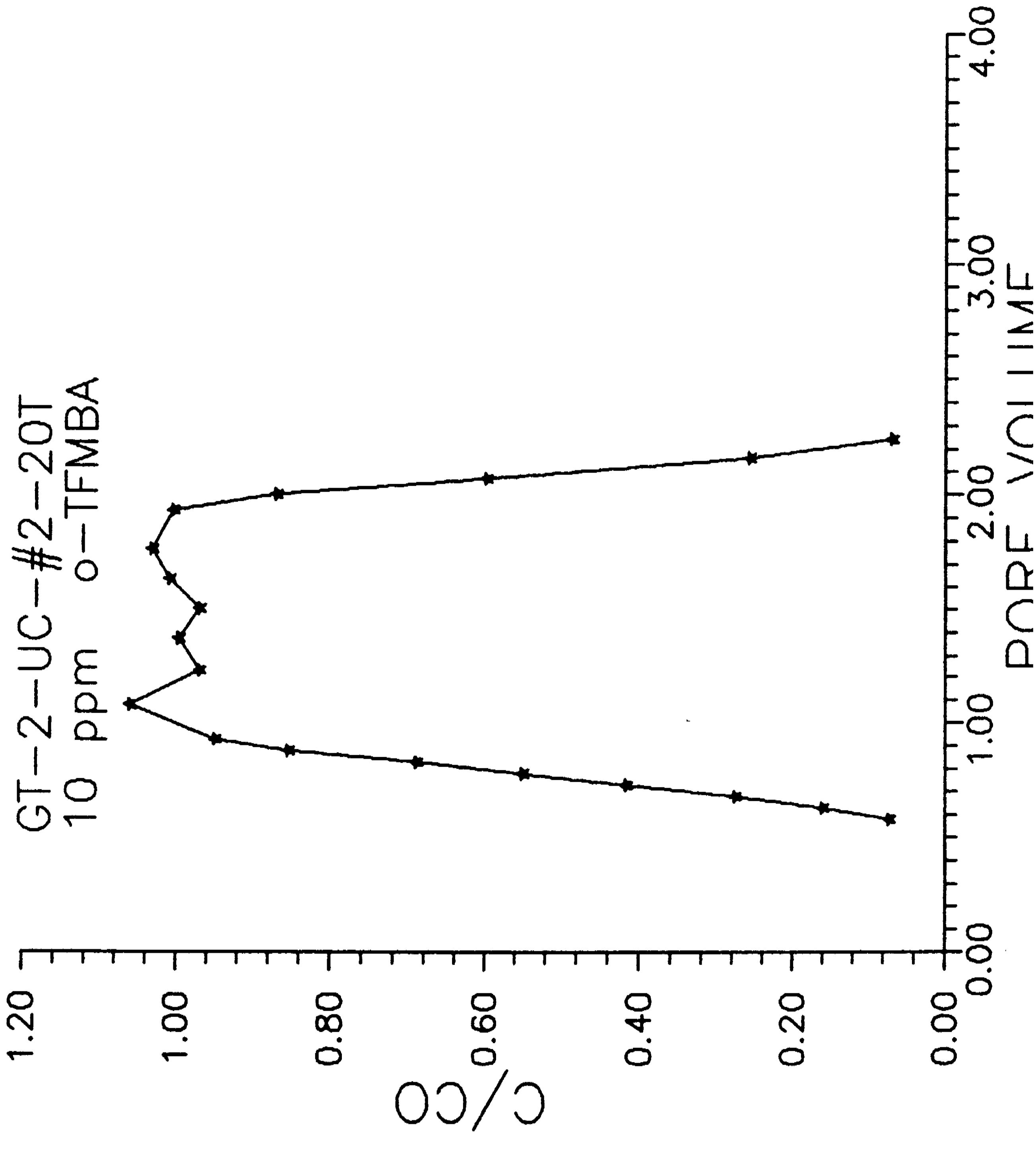
COMPARISON PLOTS OF BROMIDE VS. FLUOROBENZOATES AND $^{3}H_2O$ VS. $H_2{}^{18}O$

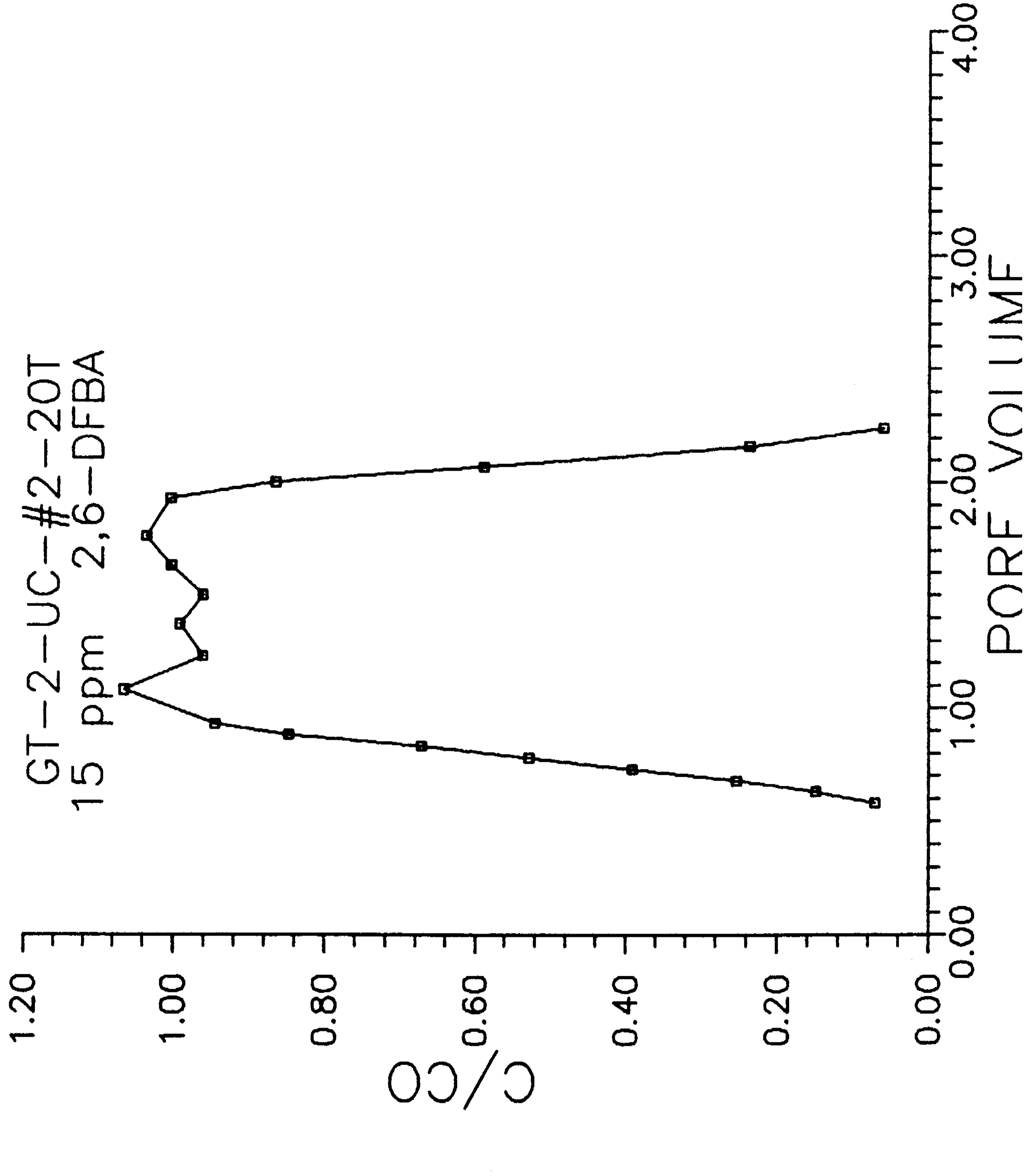

GT-2-UC-#2-20T
FLUOROBENZOATE AND
BROMIDE TRACERS
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME
+ BROMIDE
* PFBA
◊ m-TFMBA
☆ o-TFMBA
□ 2,6-DFBA

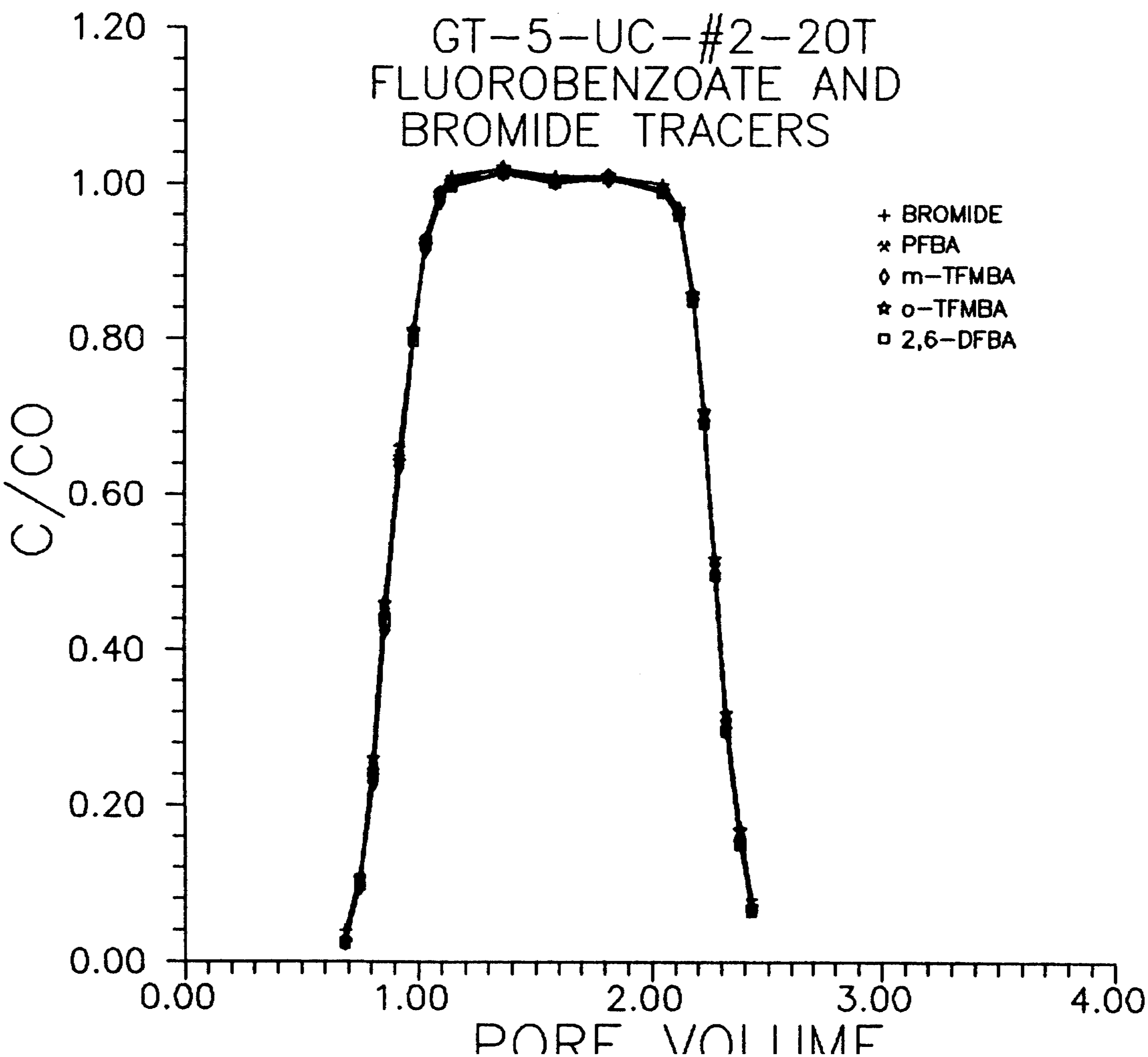

GT-2-UC-#2-20T
20 ppm PFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

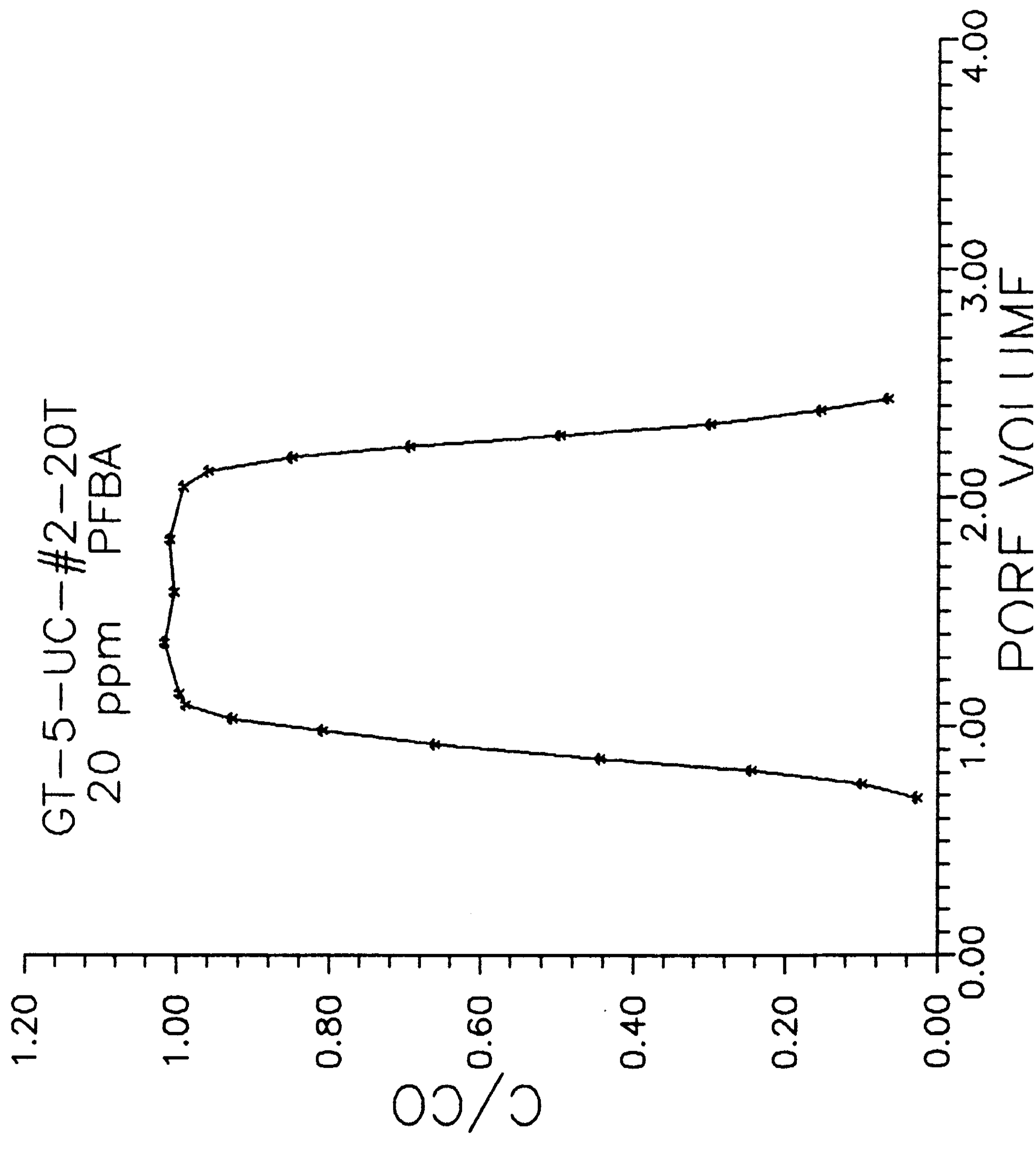


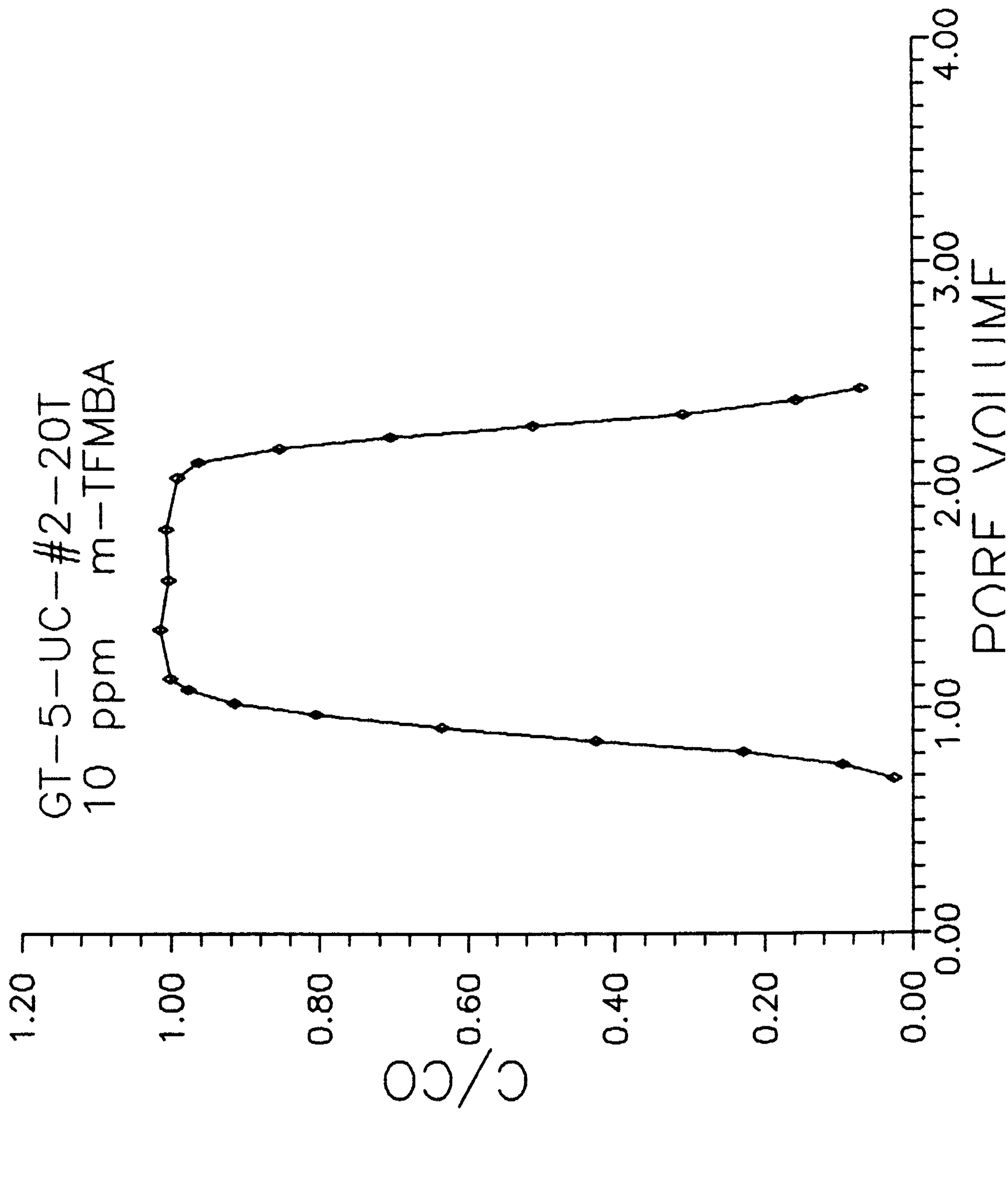
GT-2-UC-#2-20T
10 ppm m-TFMBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

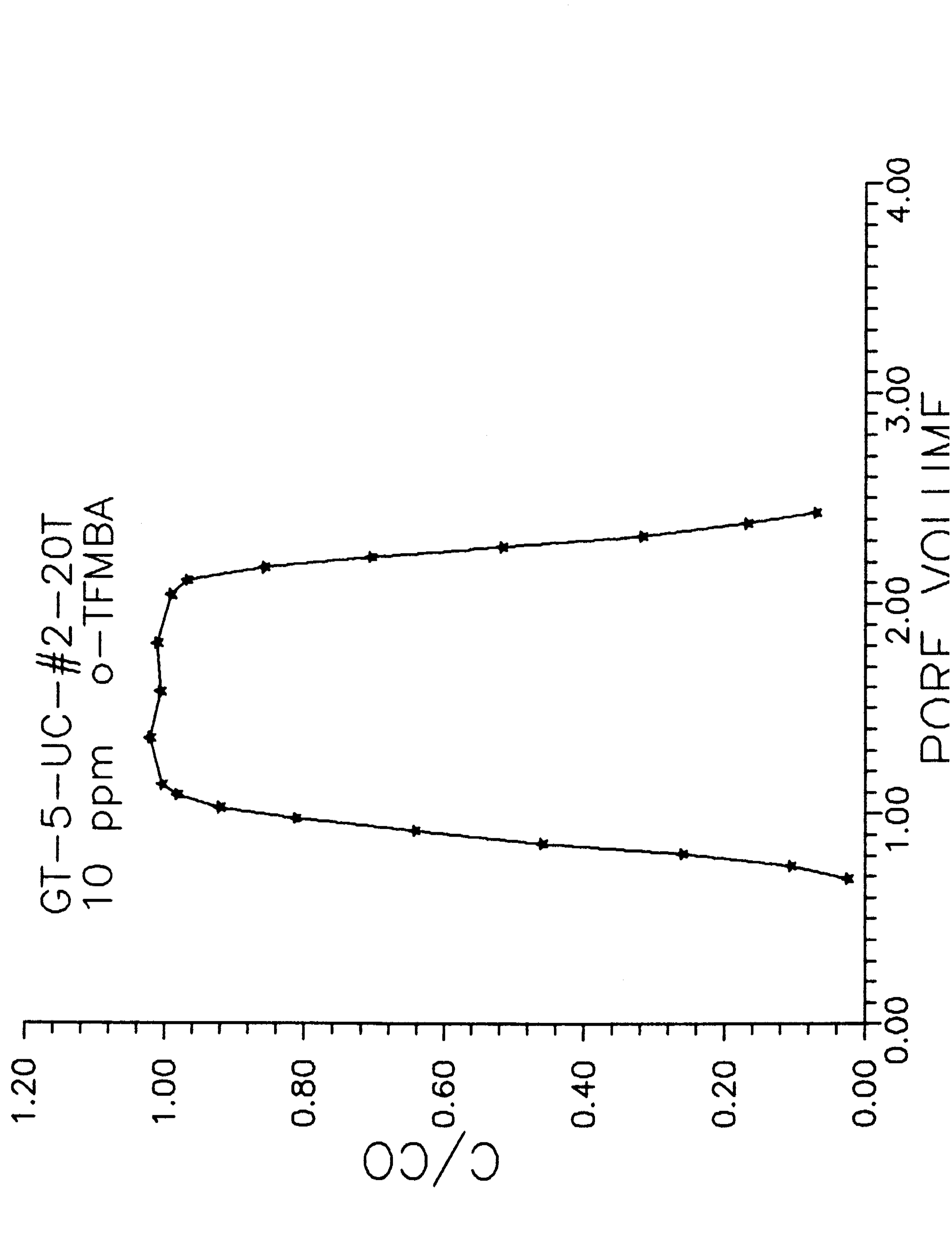

GT-2-UC-#2-20T
10 ppm o-TFMBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

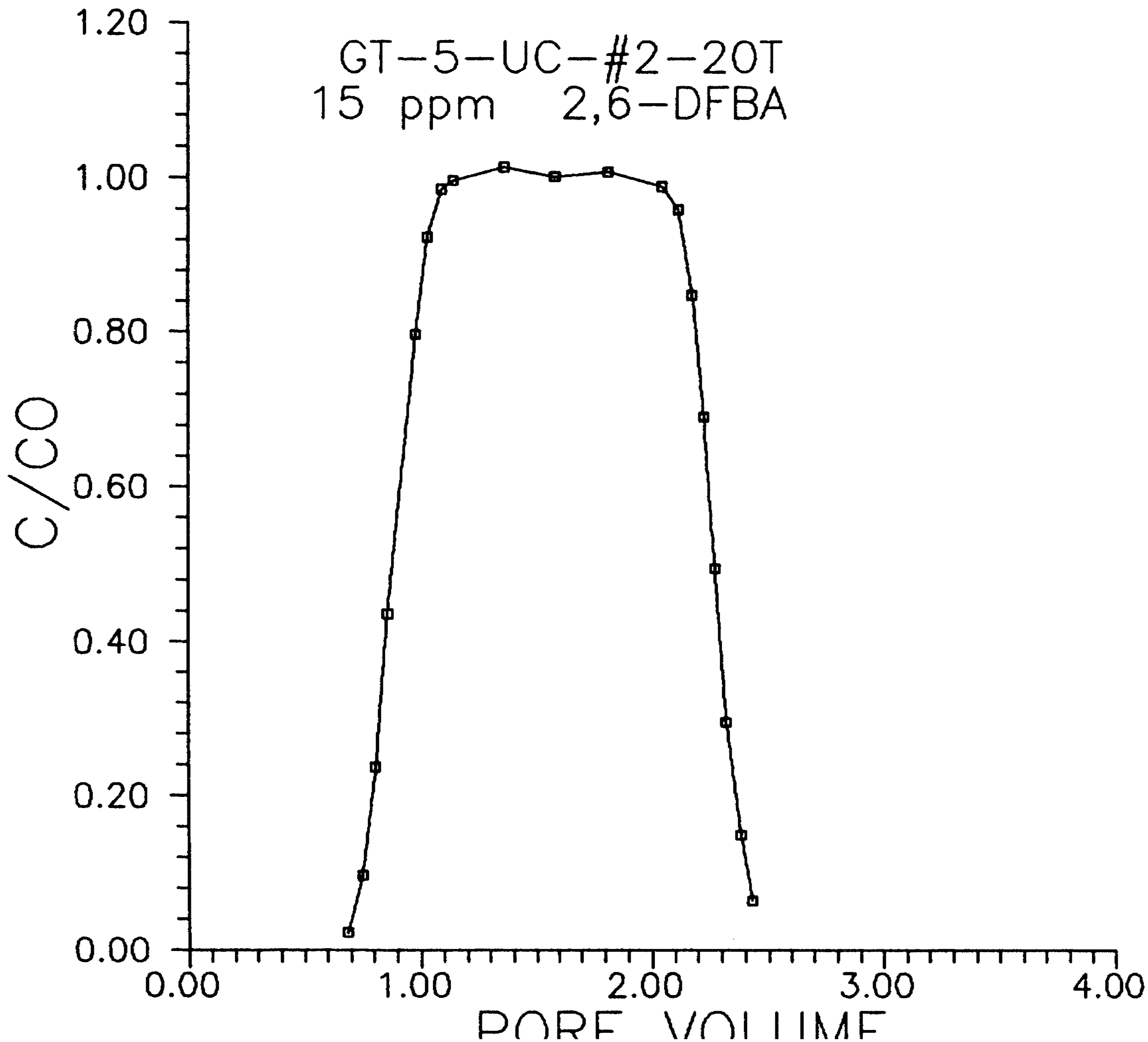

GT-2-UC-#2-20T
15 ppm 2,6-DFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

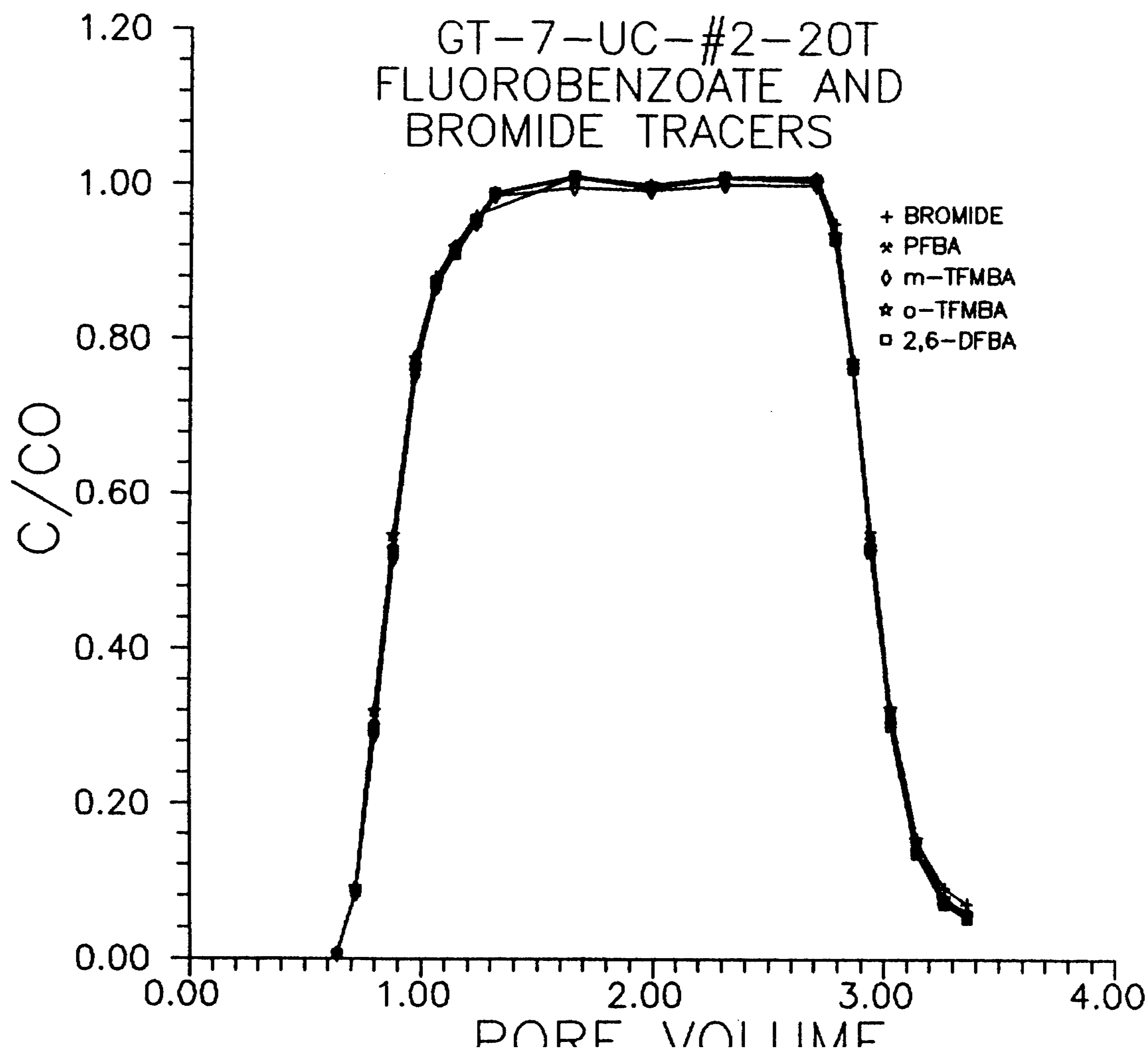

GT-5-UC-#2-20T
FLUOROBENZOATE AND
BROMIDE TRACERS
+ BROMIDE
PFBA
m-TFMBA
o-TFMBA
2,6-DFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

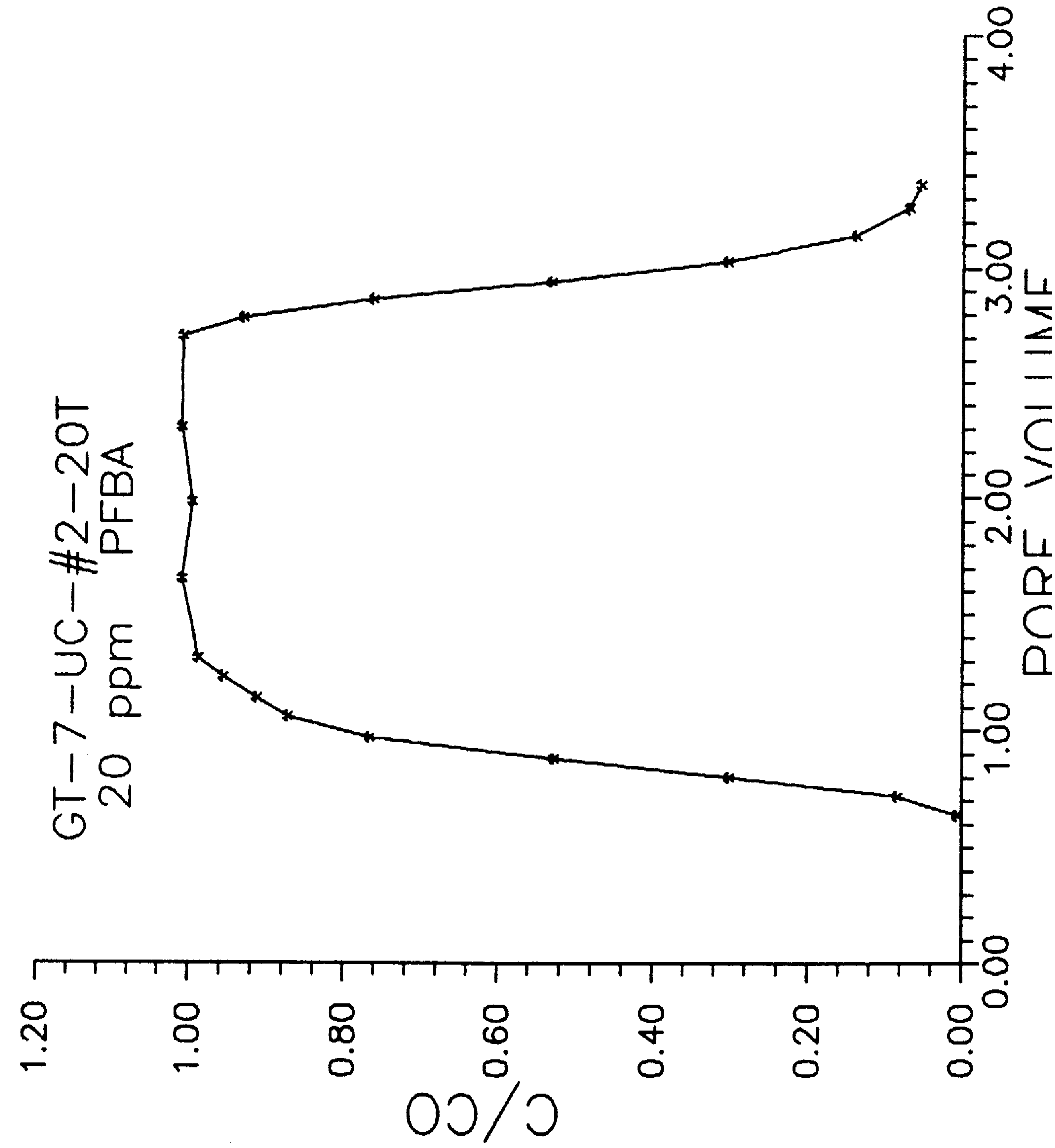

GT-5-UC-#2-20T
20 ppm PFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

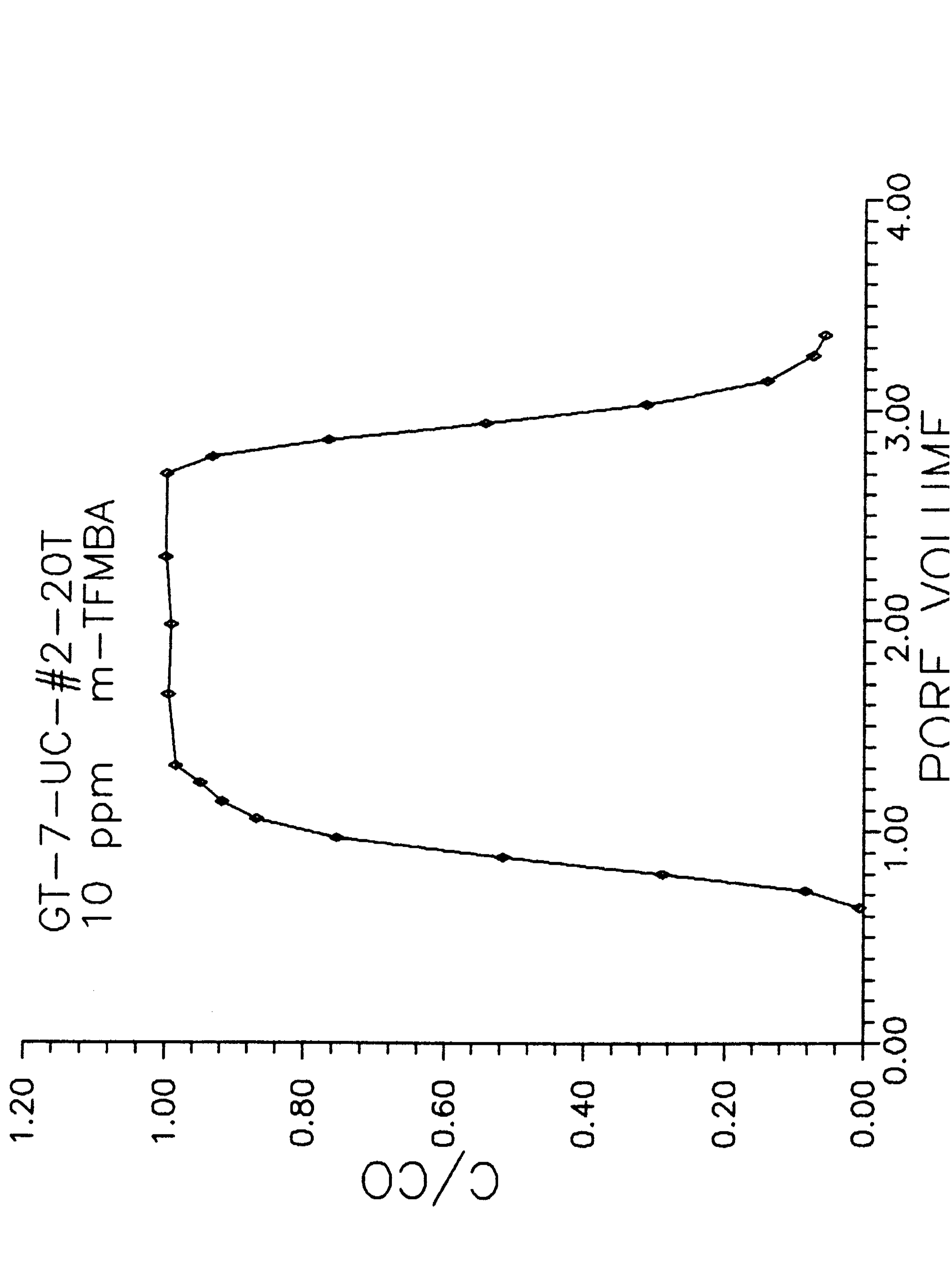

GT-5-UC-#2-20T
10 ppm m-TFMBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

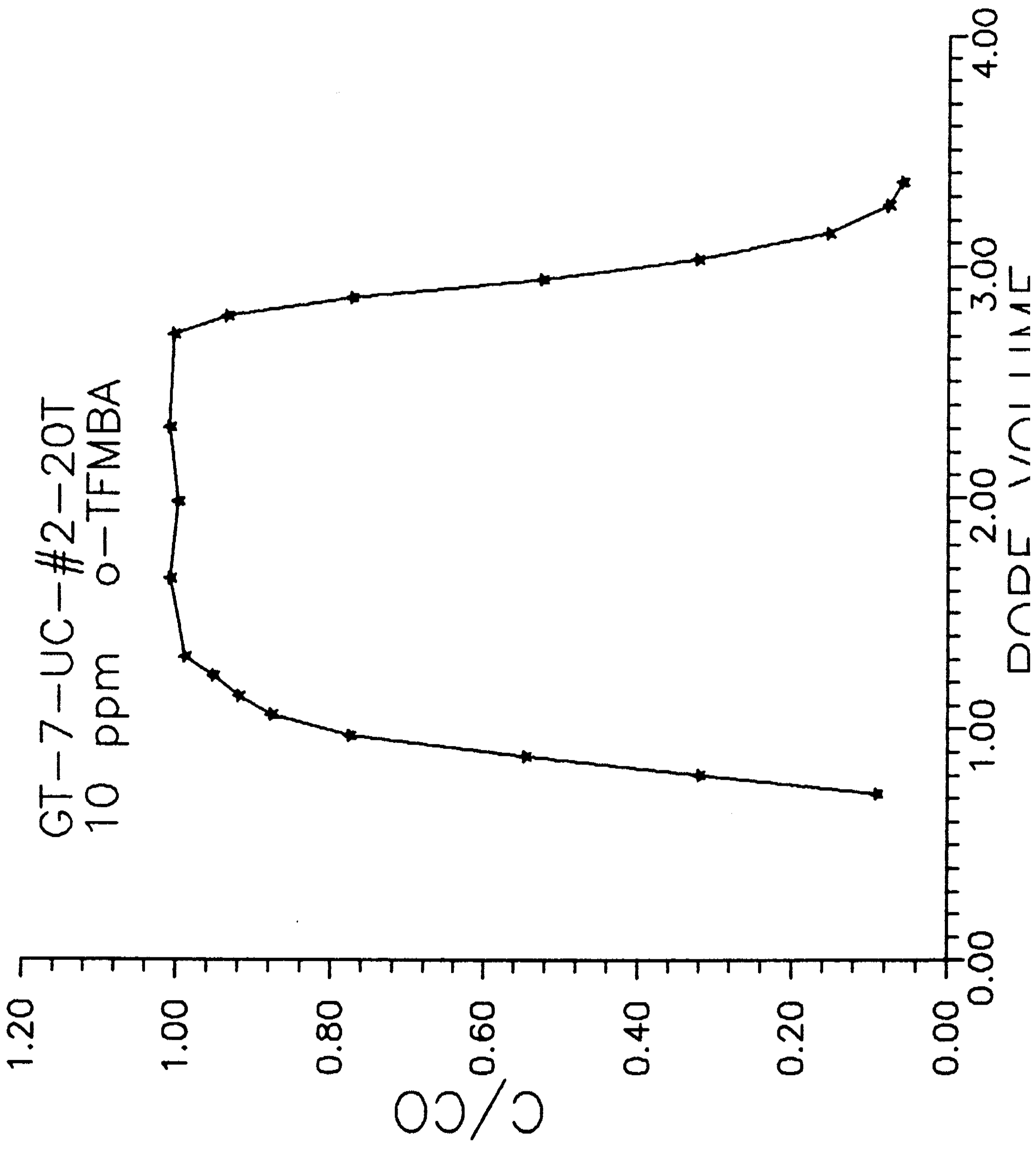

GT-5-UC-#2-20T
10 ppm o-TFMBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

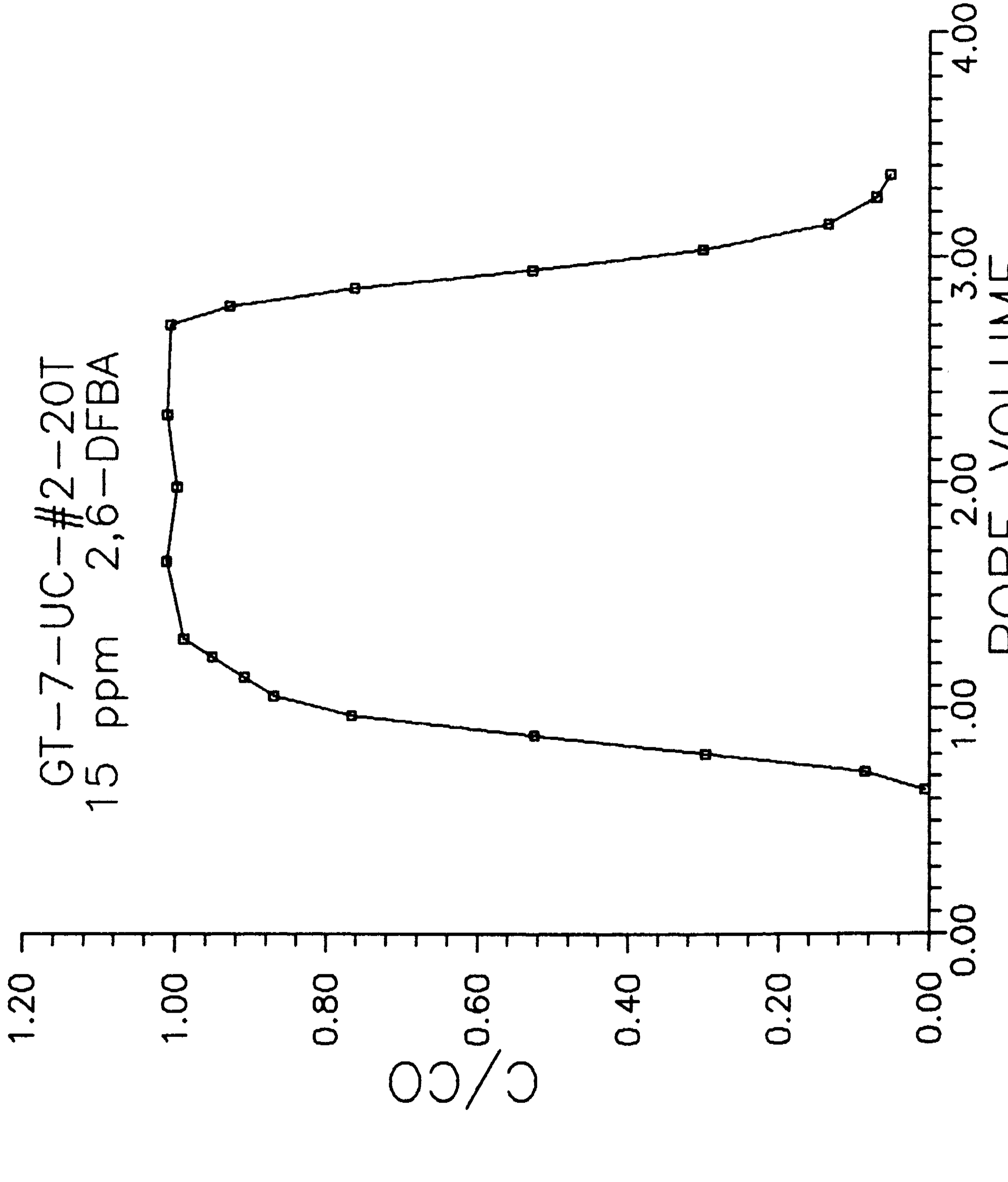

GT-5-UC-#2-20T
15 ppm 2,6-DFBA
1.20
1.00
0.80
0.60
0.40
0.20
0.00
C/CO
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

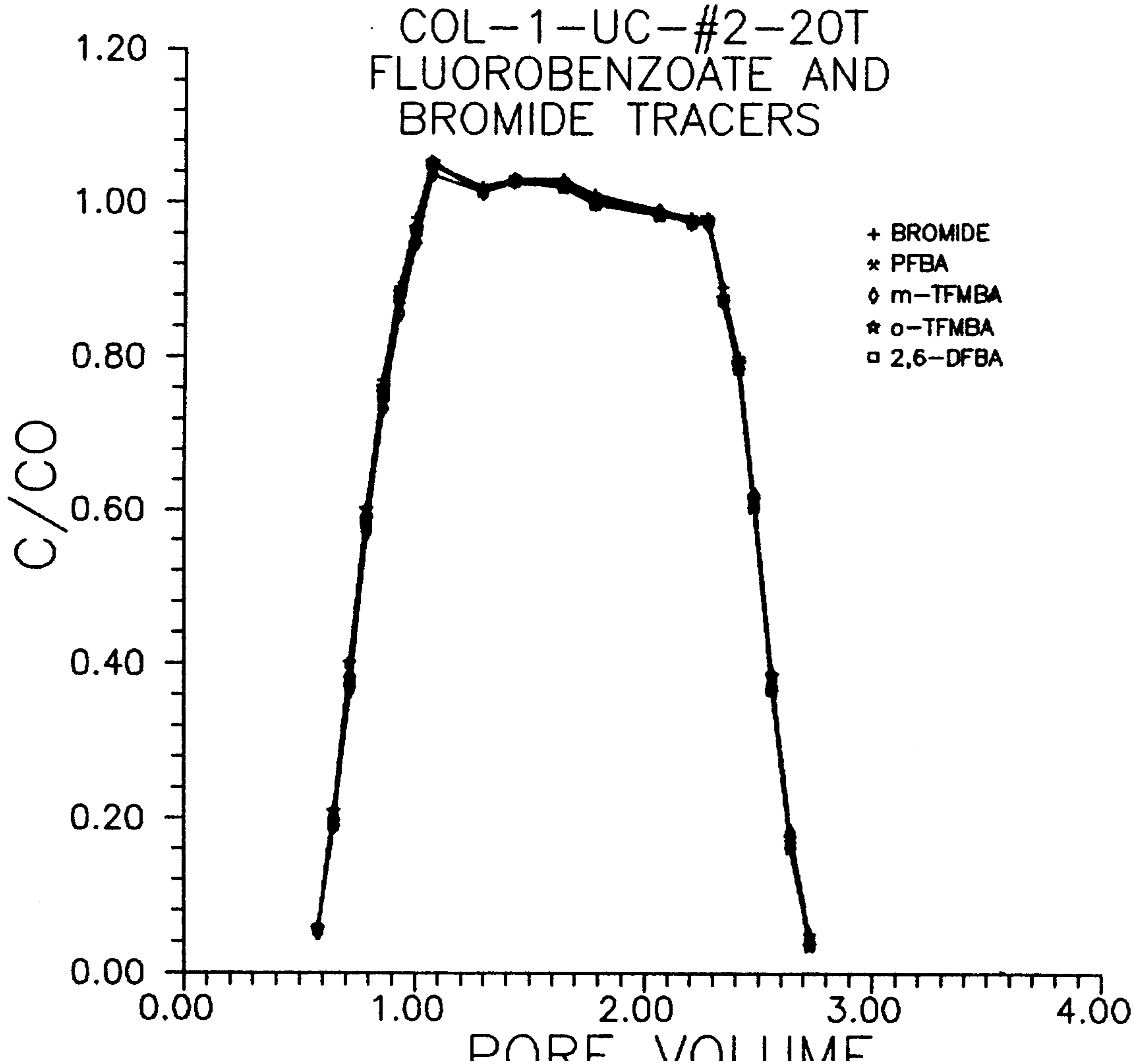

GT-7-UC-#2-20T
FLUOROBENZOATE AND
BROMIDE TRACERS
+ BROMIDE
* PFBA
◊ m-TFMBA
☆ o-TFMBA
□ 2,6-DFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

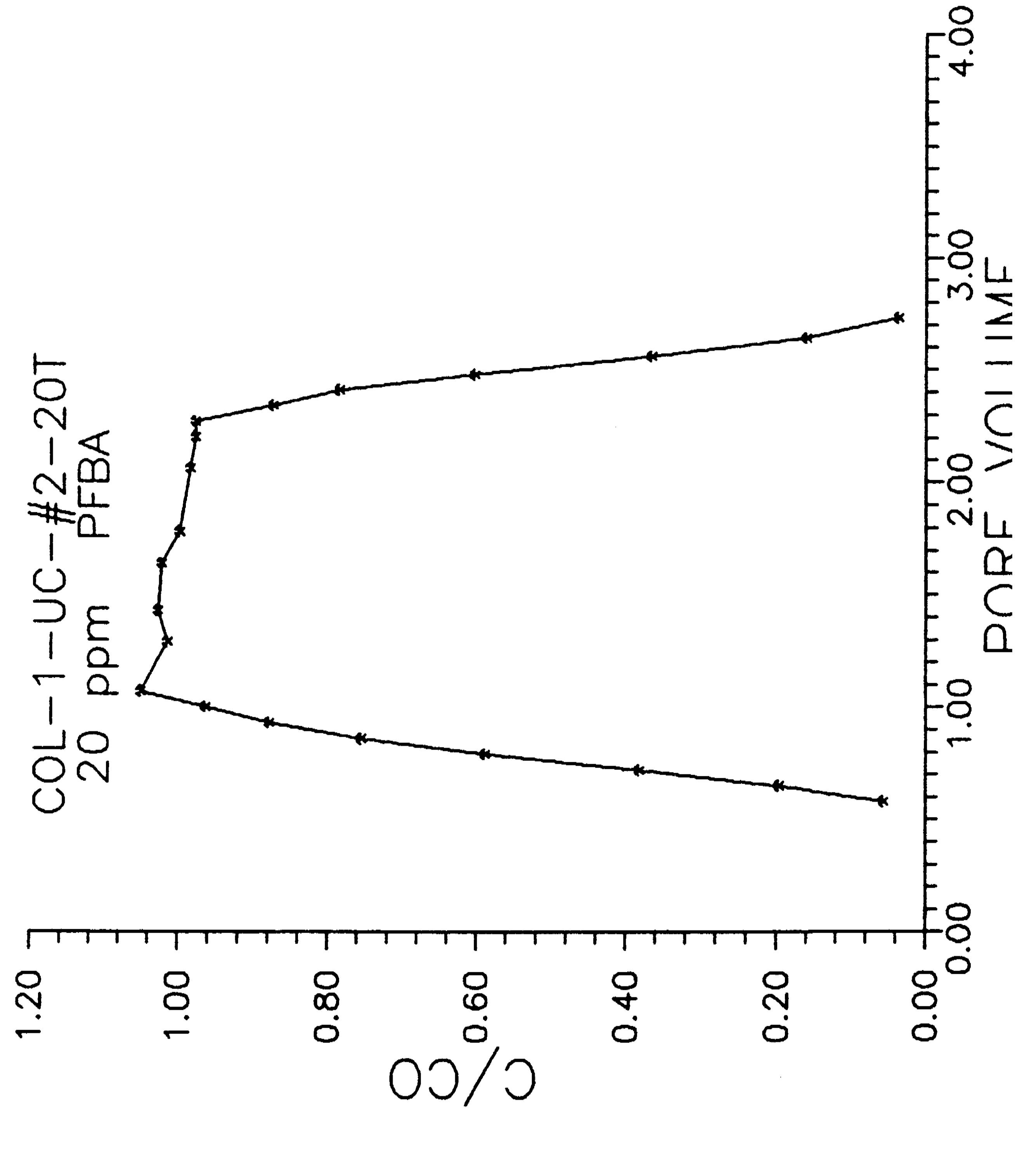

GT—7—UC—#2—20T
20 ppm PFBA
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

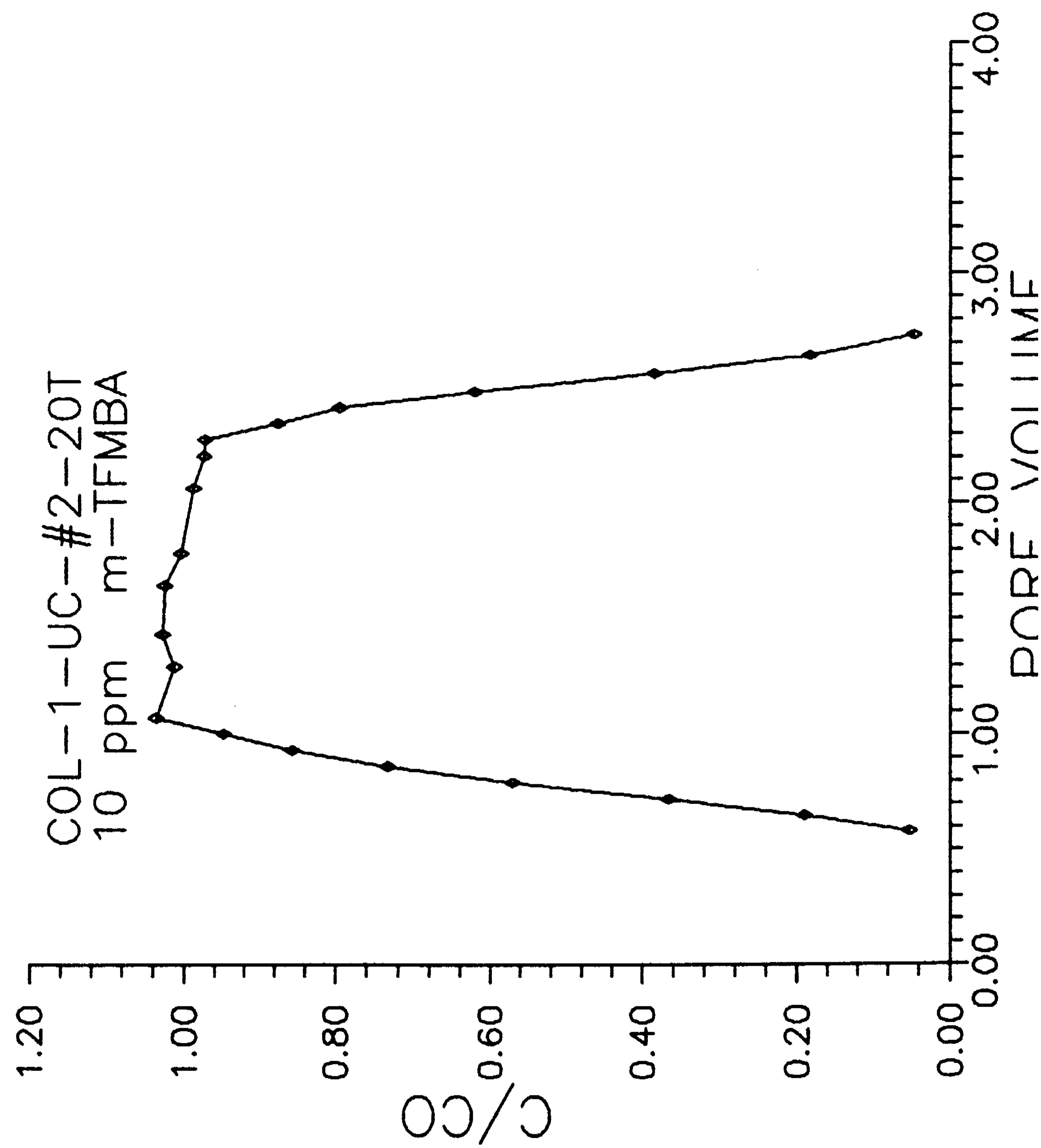

GT-7-UC-#2-20T
10 ppm m-TFMBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

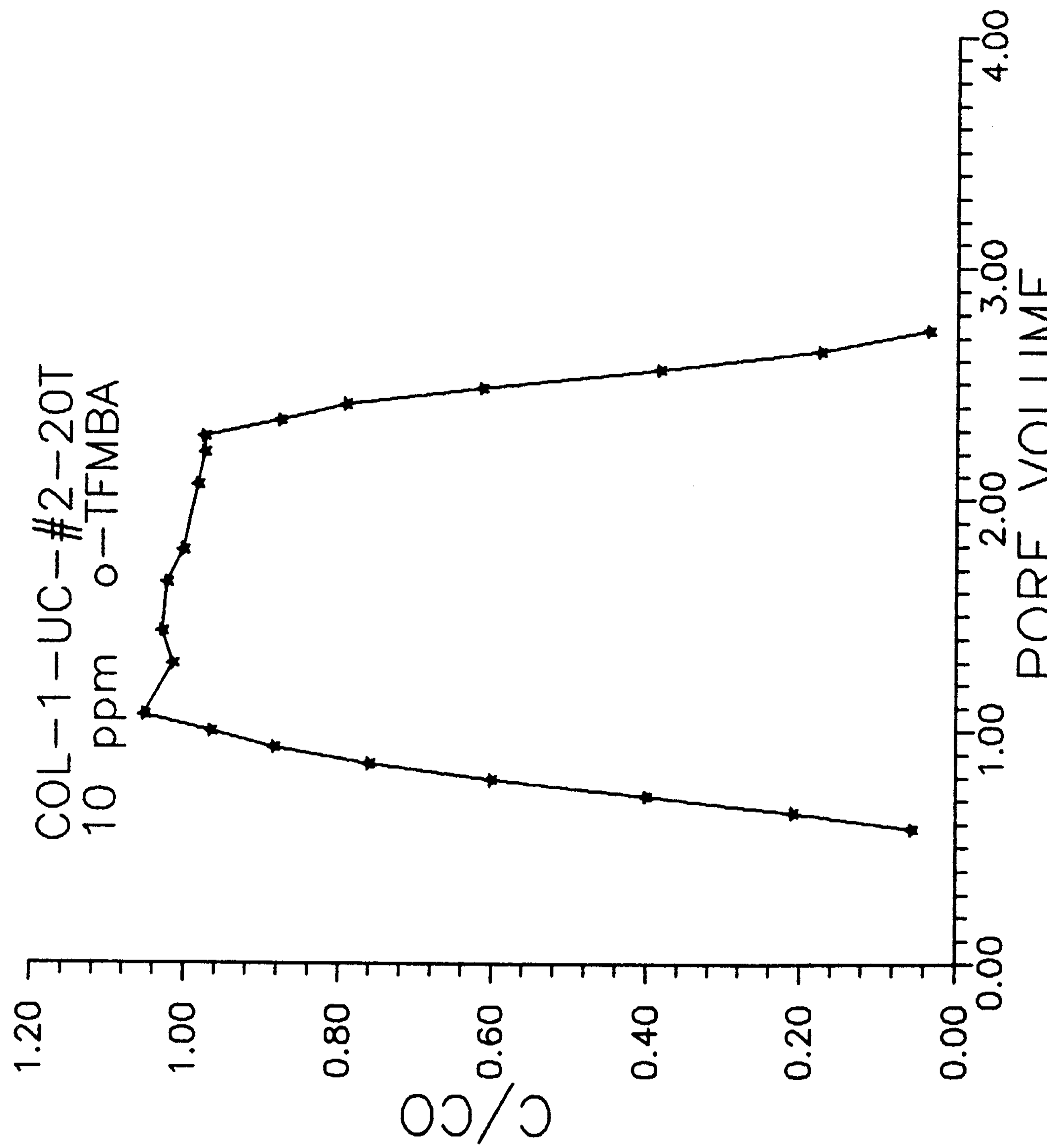

GT-7-UC-#2-20T
10 ppm o-TFMBA
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


GT-7-UC-#2-20T
15 ppm 2,6-DFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

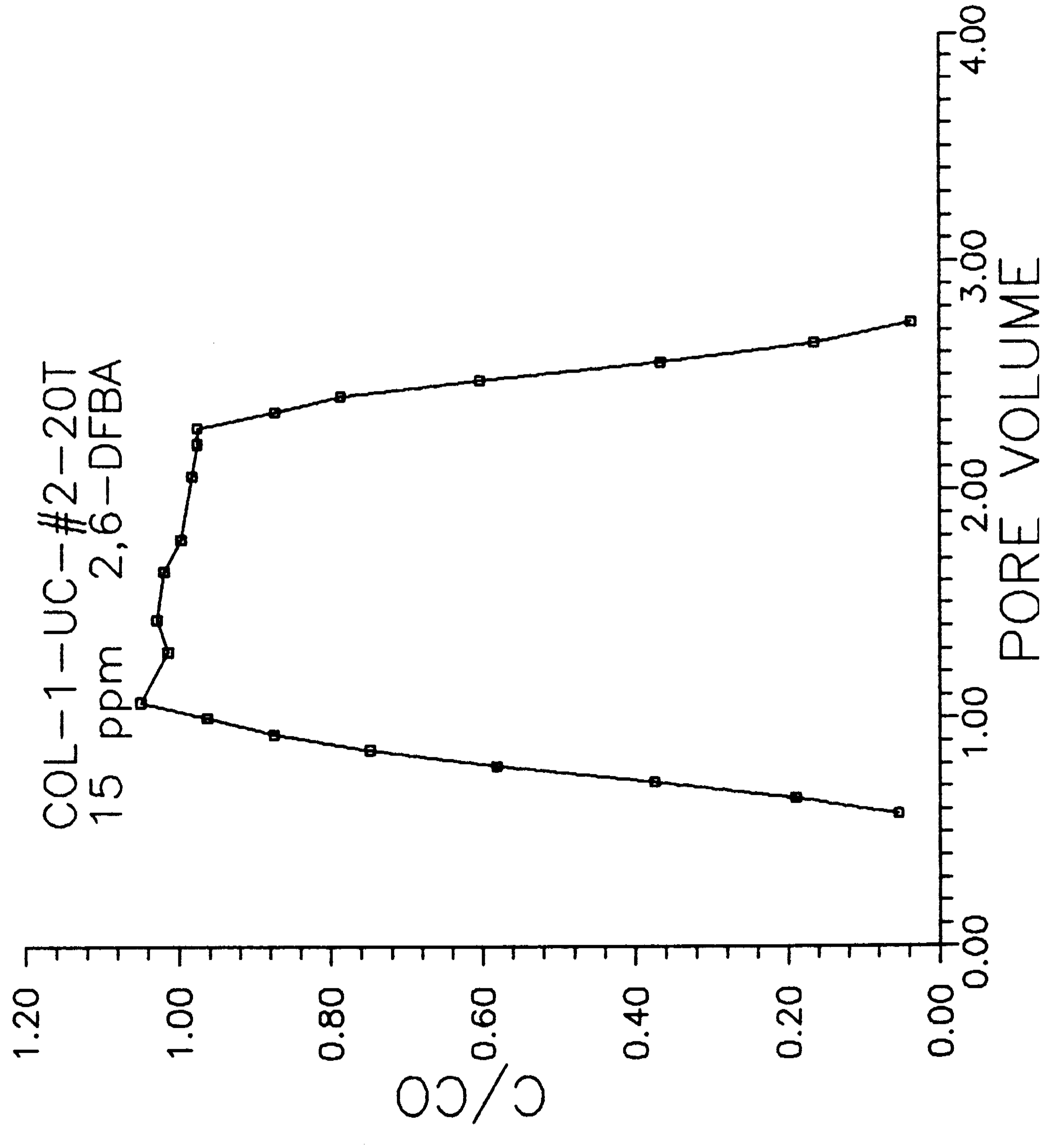

COL-1-UC-#2-20T
FLUOROBENZOATE AND
BROMIDE TRACERS
+ BROMIDE
PFBA
m-TFMBA
o-TFMBA
2,6-DFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00

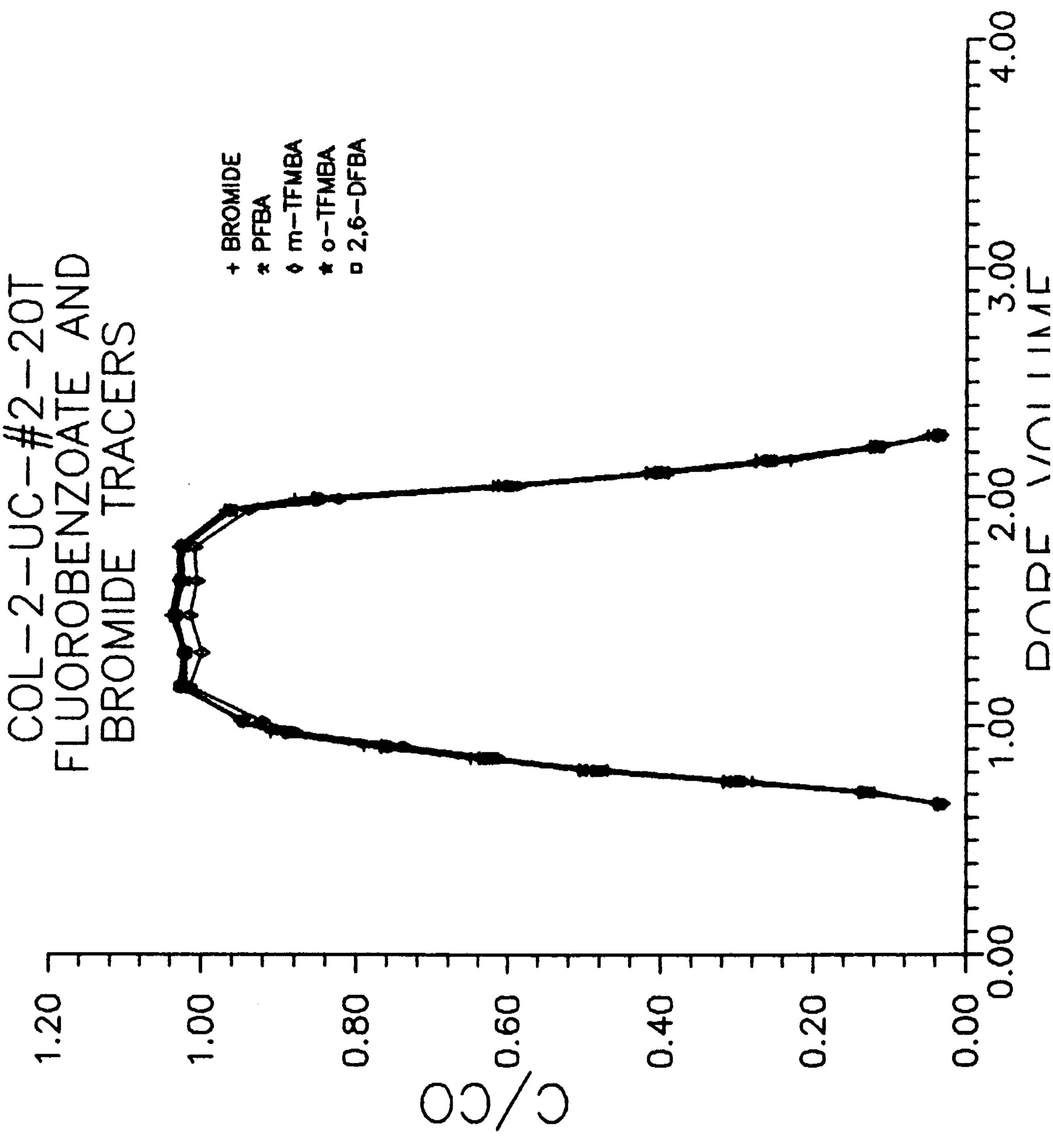

COL-1-UC-#2-20T
20 ppm PFBA
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

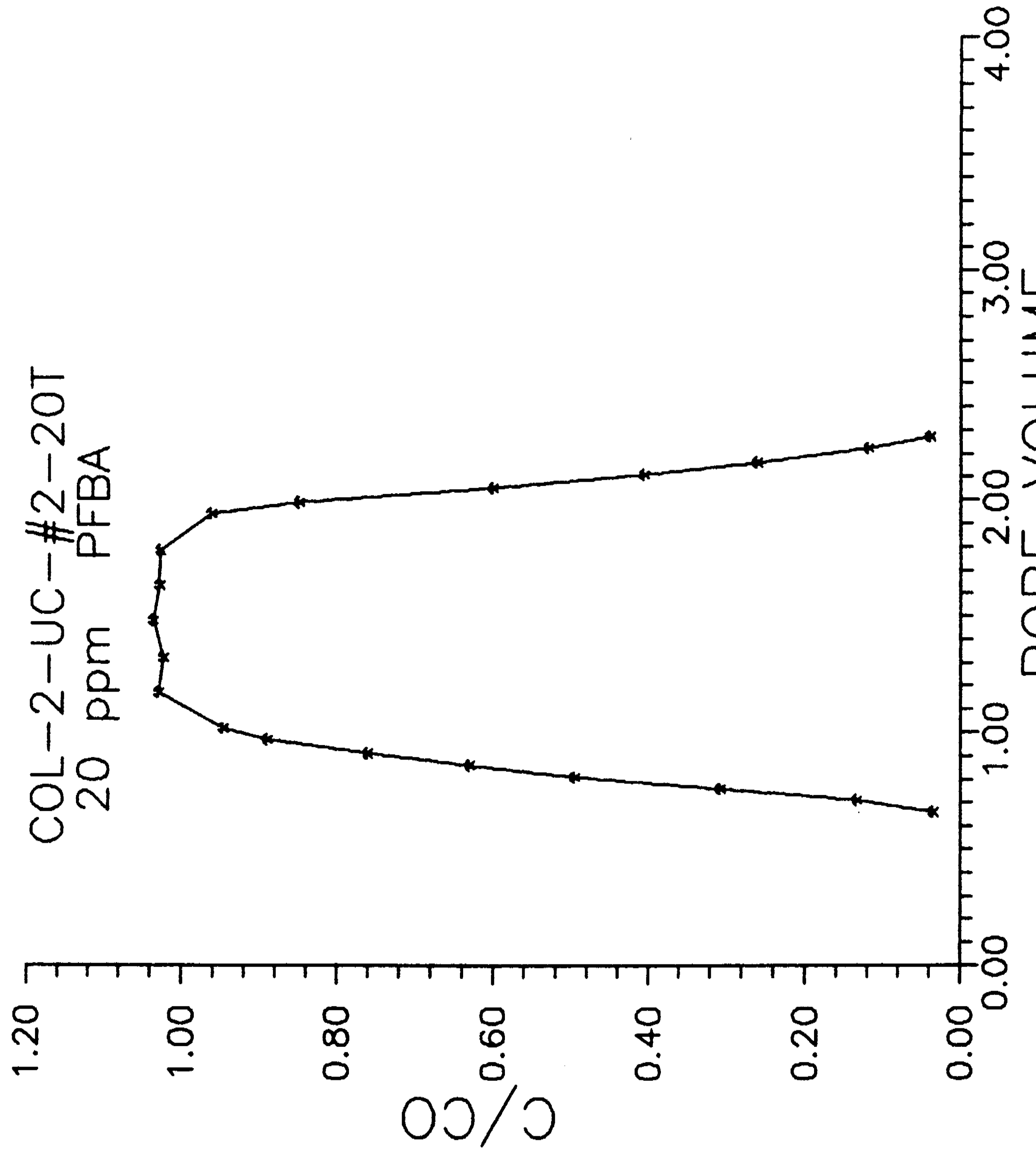

COL-1-UC-#2-20T
10 ppm m-TFMBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME



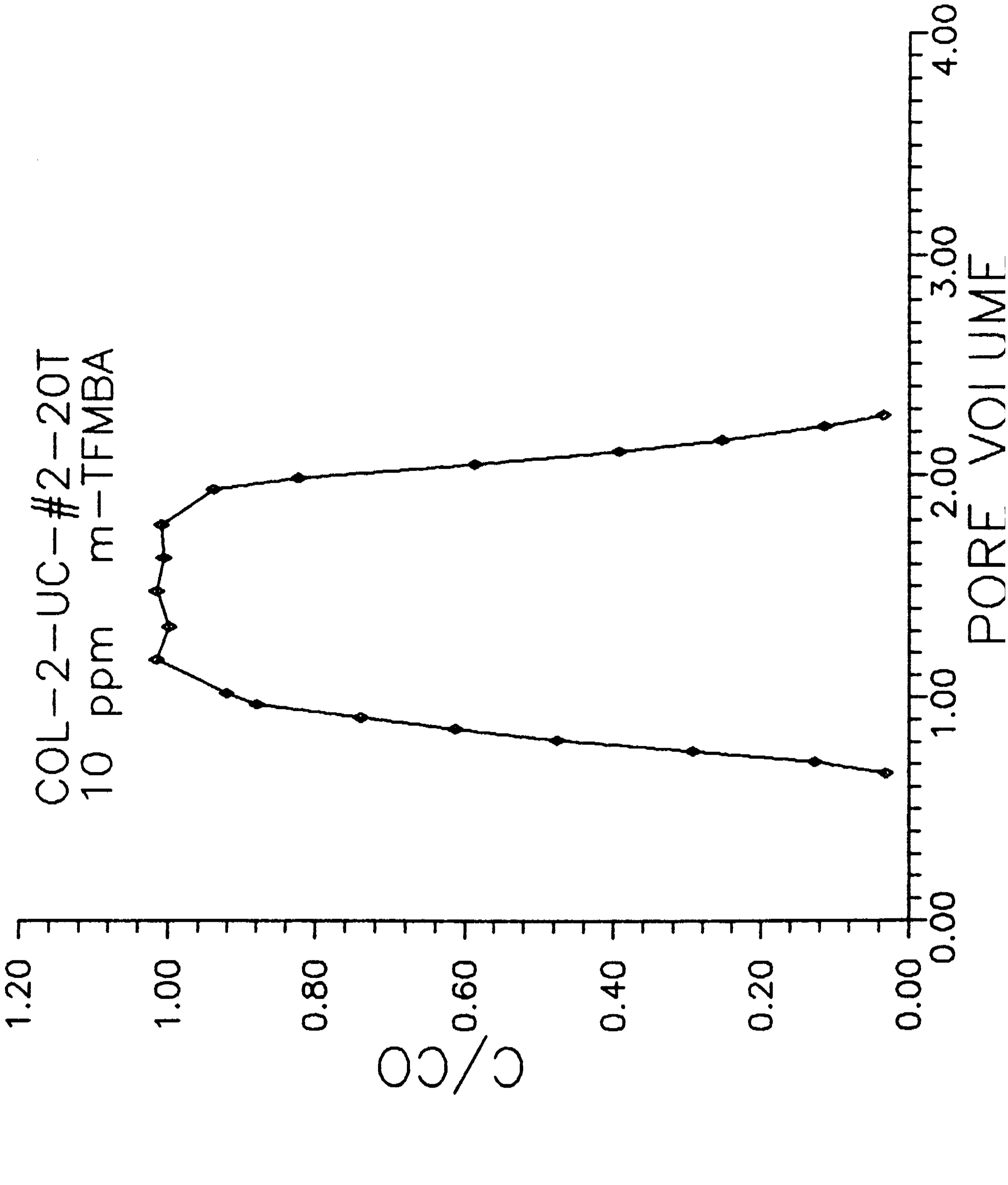
COL-1-UC-#2-20T
10 ppm o-TFMBA
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
PORE VOLUME
0.00
1.00
2.00
3.00
4.00

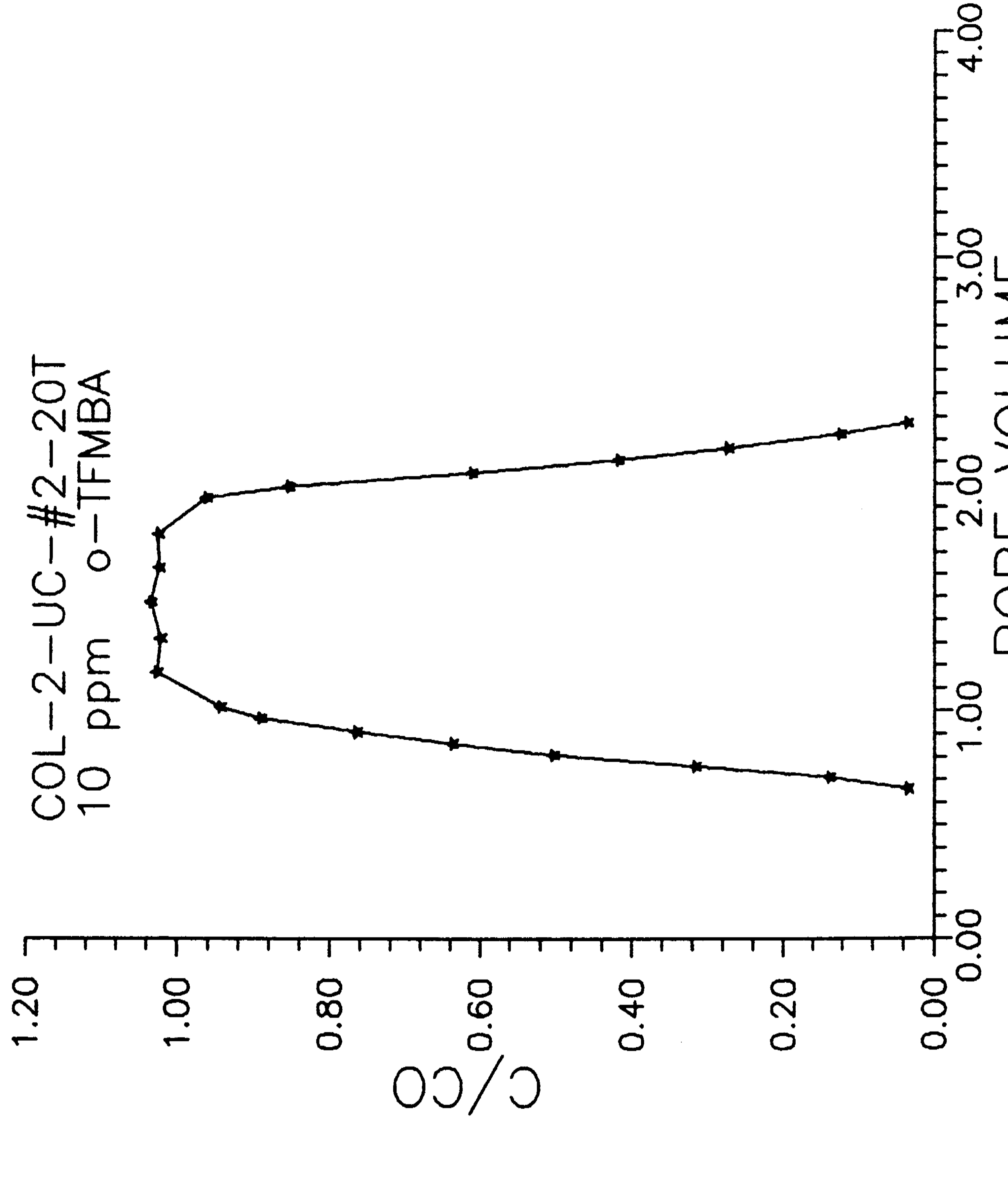

COL-1-UC-#2-20T
15 ppm 2,6-DFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

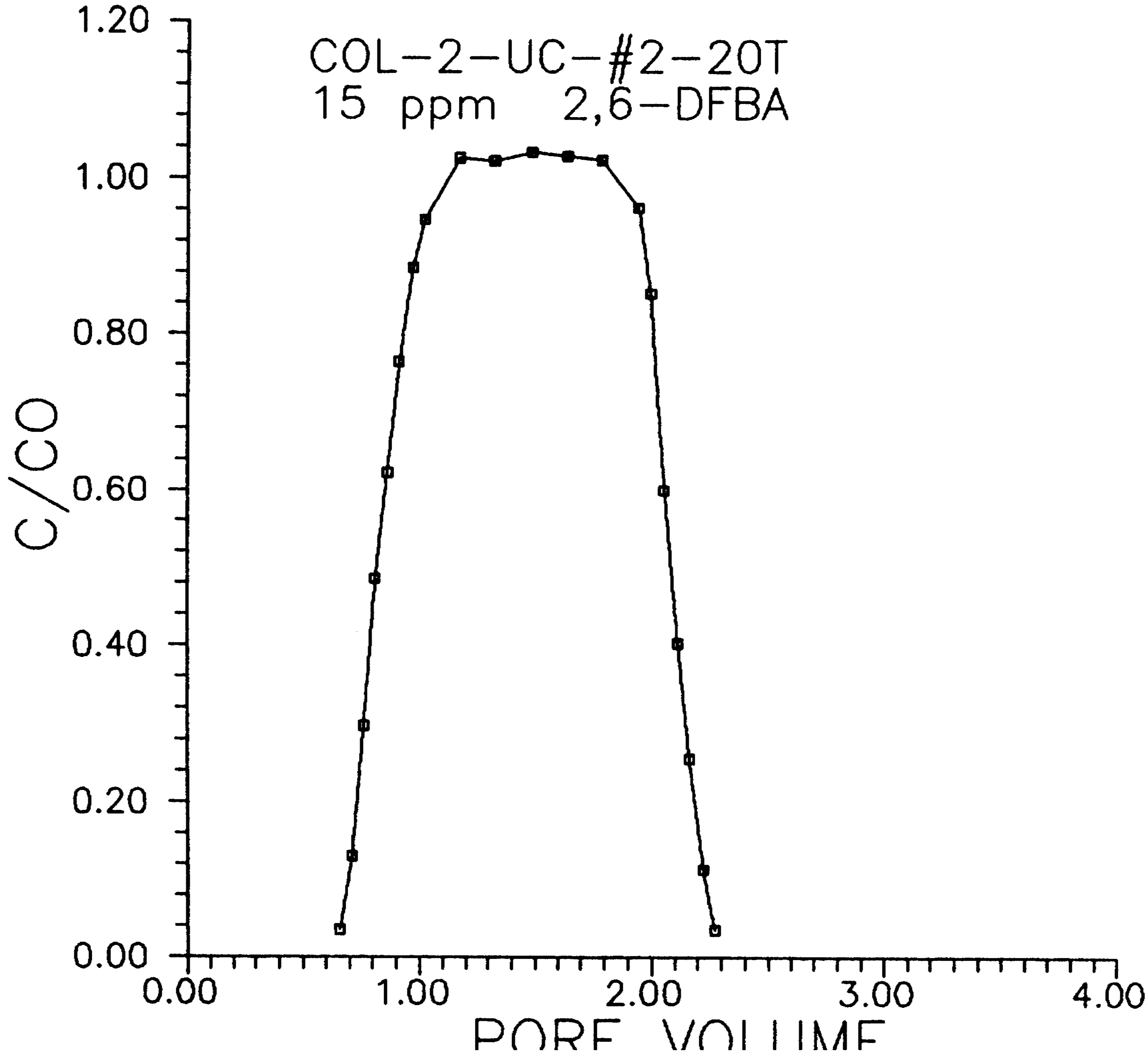

COL-2-UC-#2-20T
FLUOROBENZOATE AND
BROMIDE TRACERS
+ BROMIDE
* PFBA
◊ m-TFMBA
* o-TFMBA
□ 2,6-DFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00

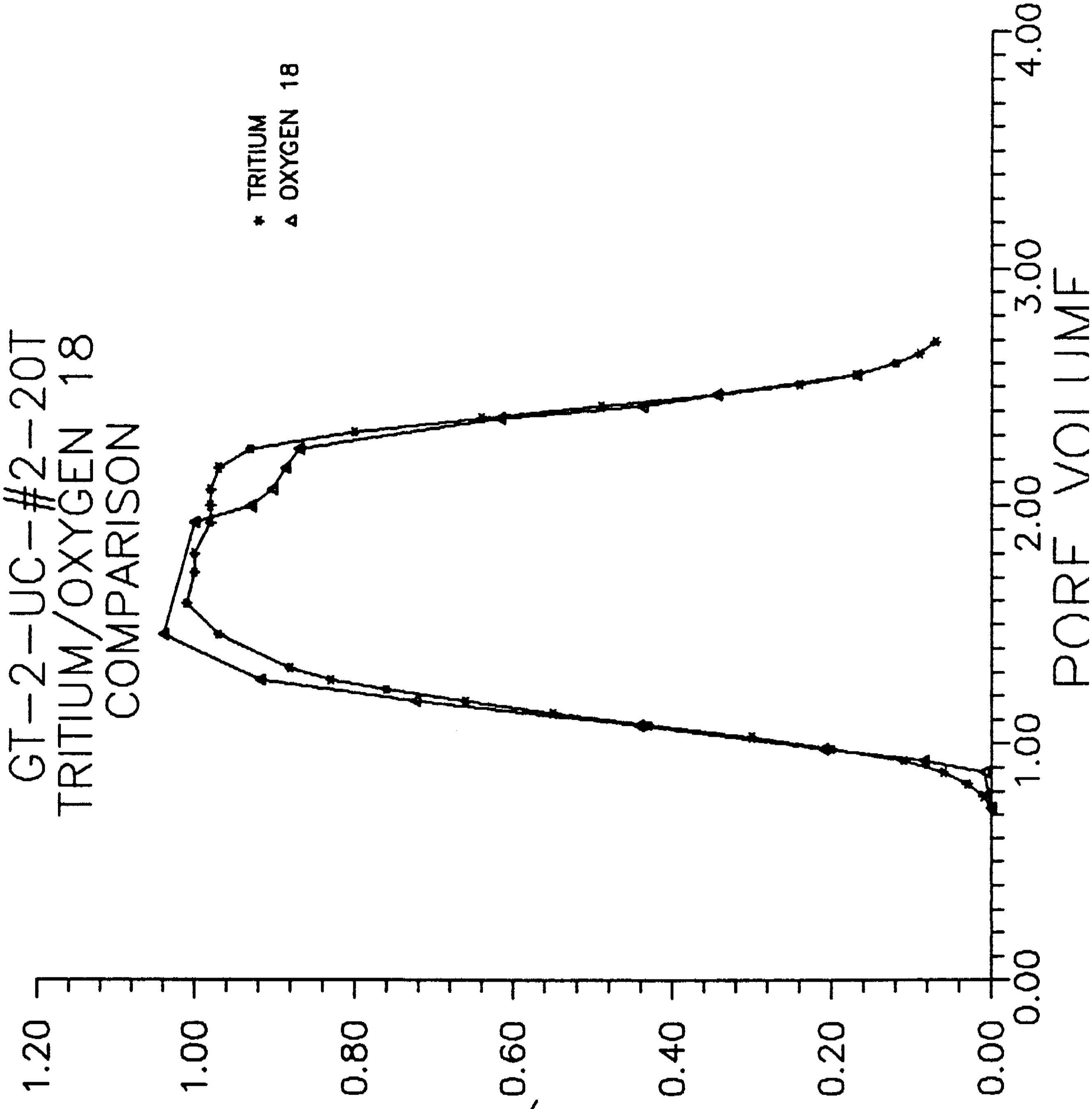


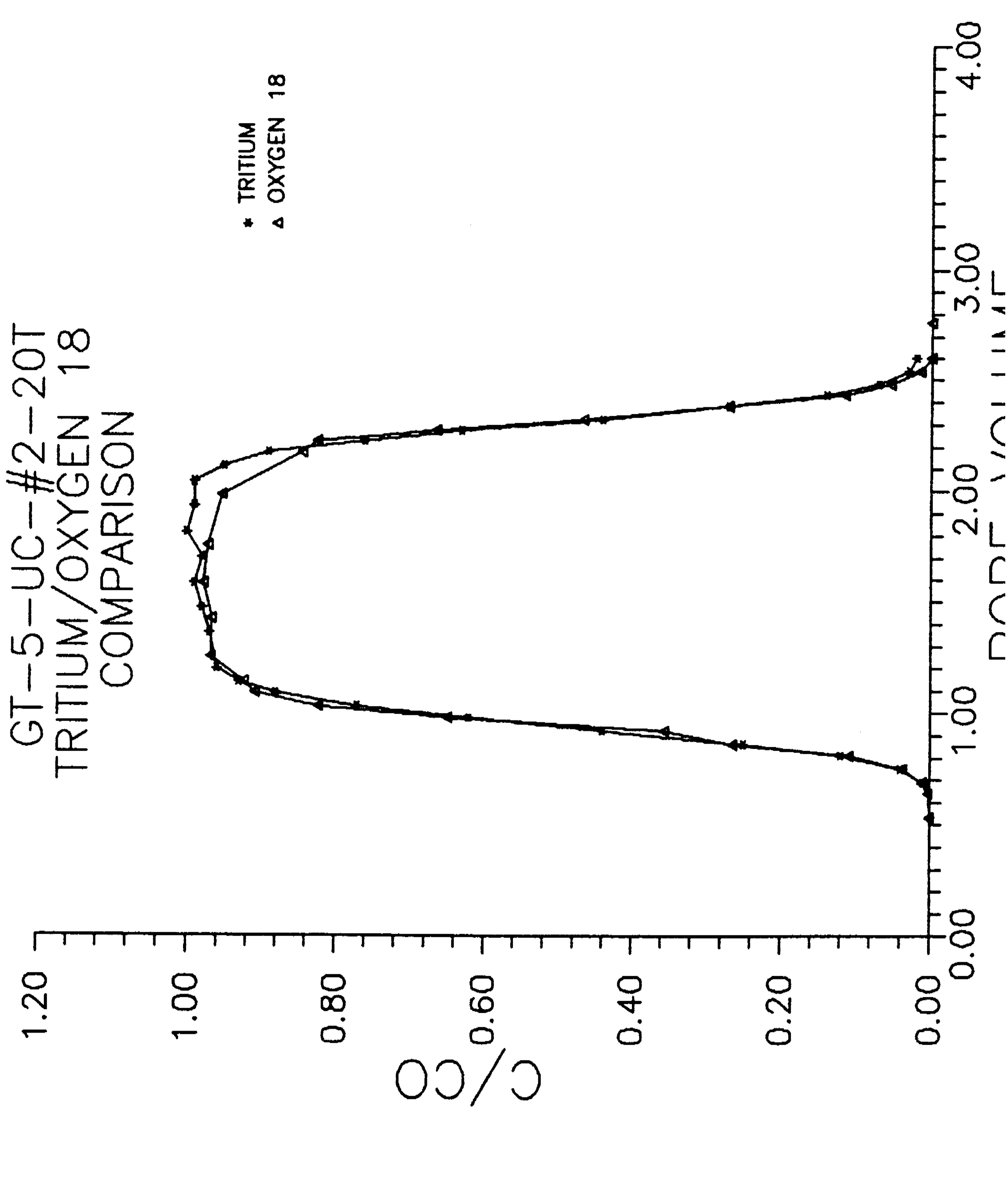
COL-2-UC-#2-20T
20 ppm PFBA
C/CO
PORE VOLUME
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00

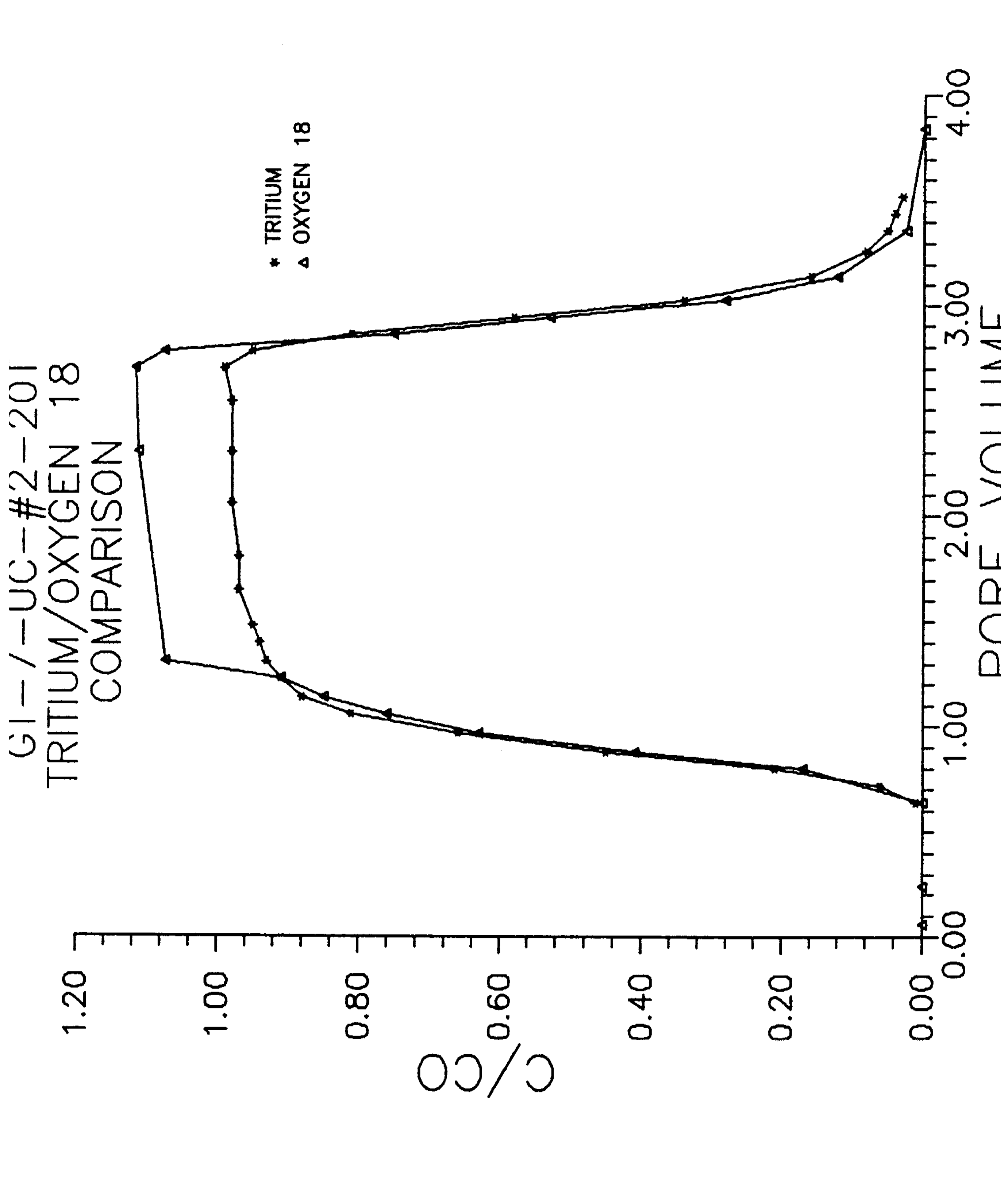

COL-2-UC-#2-20T
10 ppm m-TFMBA
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


COL-2-UC-#2-20T
10 ppm o-TFMBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

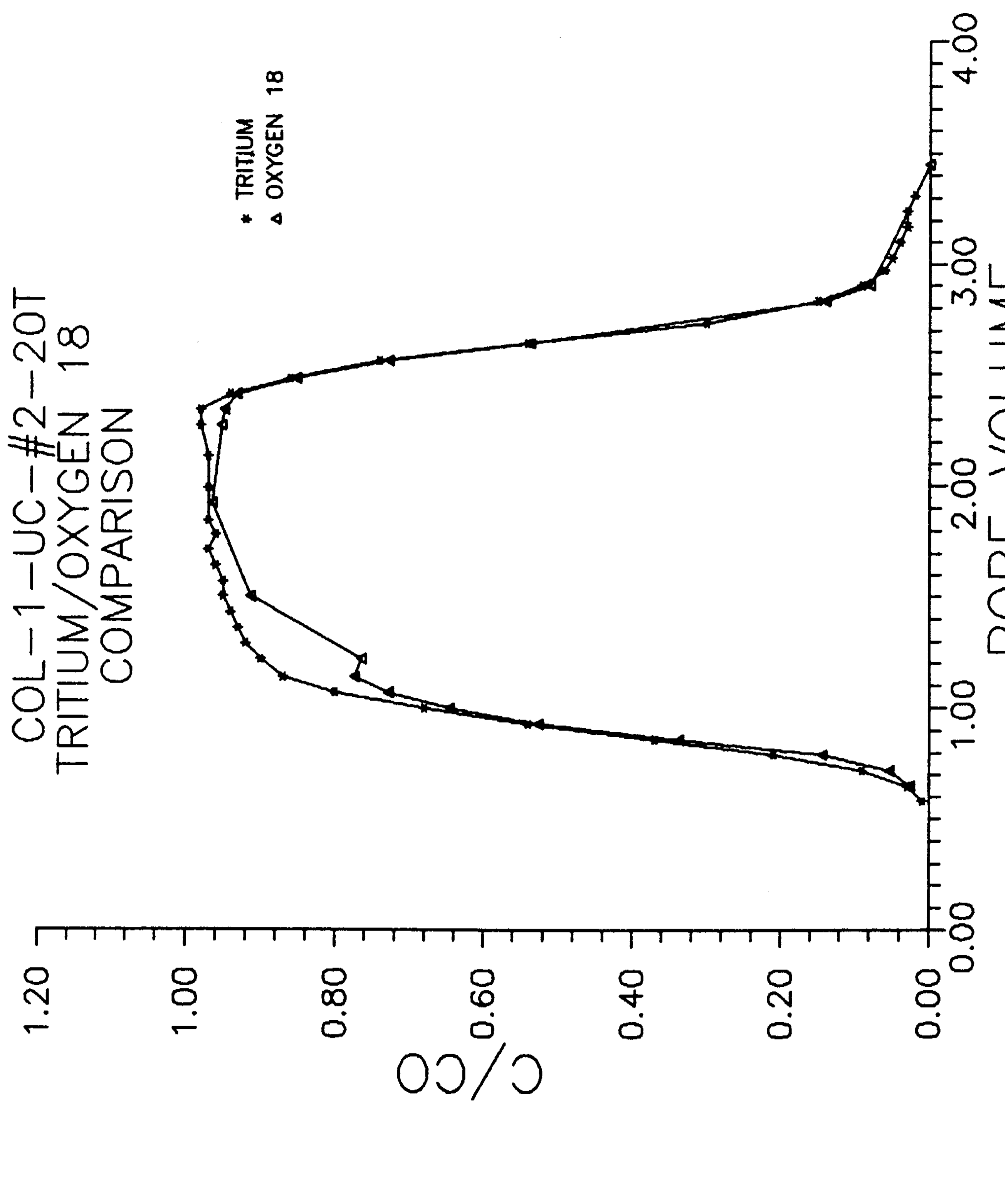

COL-2-UC-#2-20T
15 ppm 2,6-DFBA
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME

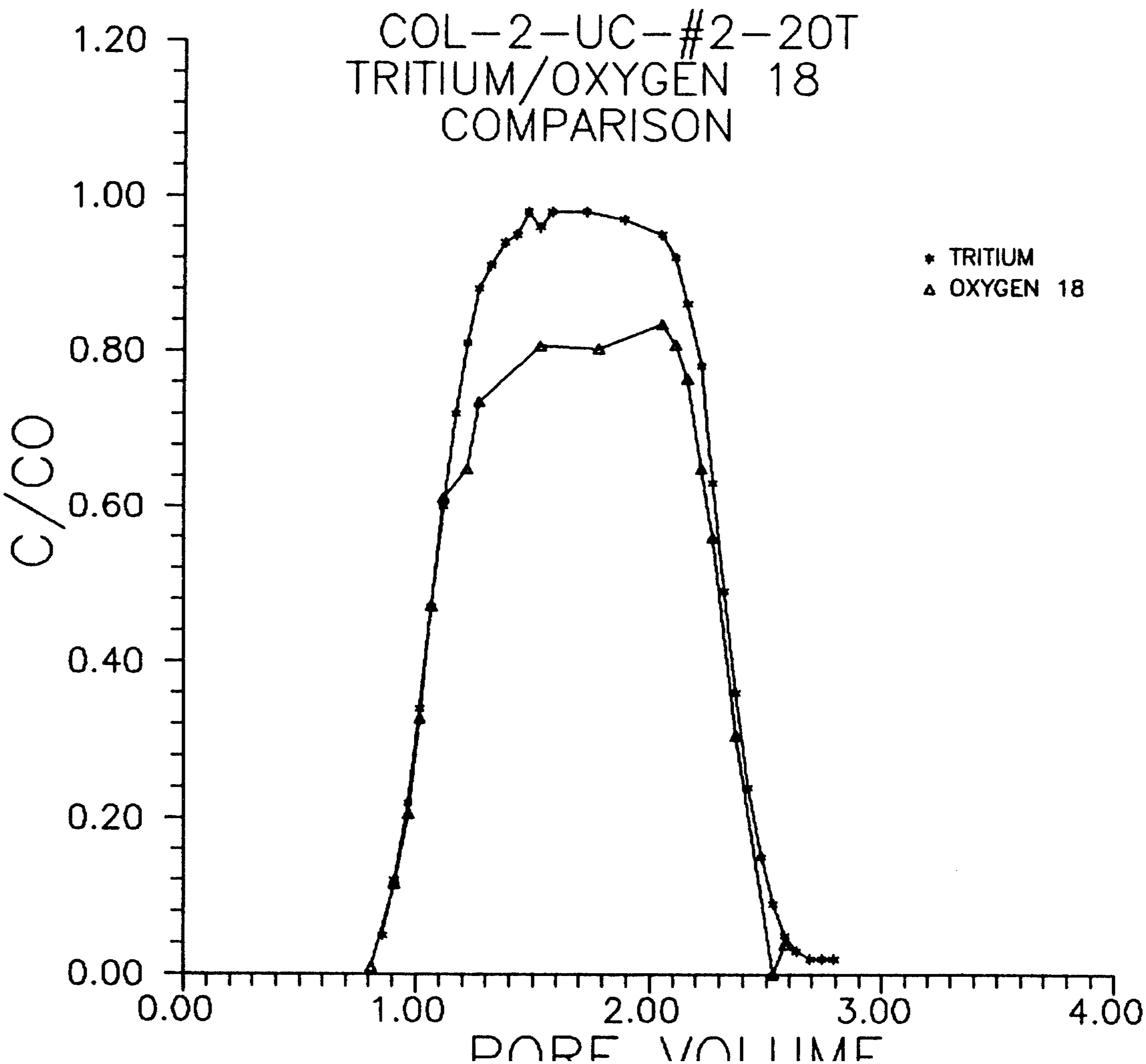

GT-2-UC-#2-20T
TRITIUM/OXYGEN 18
COMPARISON
TRITIUM
OXYGEN 18
C/CO
PORE VOLUME
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


GT-5-UC-#2-20T
TRITIUM/OXYGEN 18
COMPARISON
TRITIUM
OXYGEN 18
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00



TRITIUM/OXYGEN 18
COMPARISON
* TRITIUM
△ OXYGEN 18
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00


COL-1-UC-#2-20T
TRITIUM/OXYGEN 18
COMPARISON
TRITIUM
OXYGEN 18
C/CO
0.00
0.20
0.40
0.60
0.80
1.00
1.20
0.00
1.00
2.00
3.00
4.00


COL-2-UC-#2-20T
TRITIUM/OXYGEN 18
COMPARISON
C/CO
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
1.00
2.00
3.00
4.00
PORE VOLUME
* TRITIUM
Δ OXYGEN 18

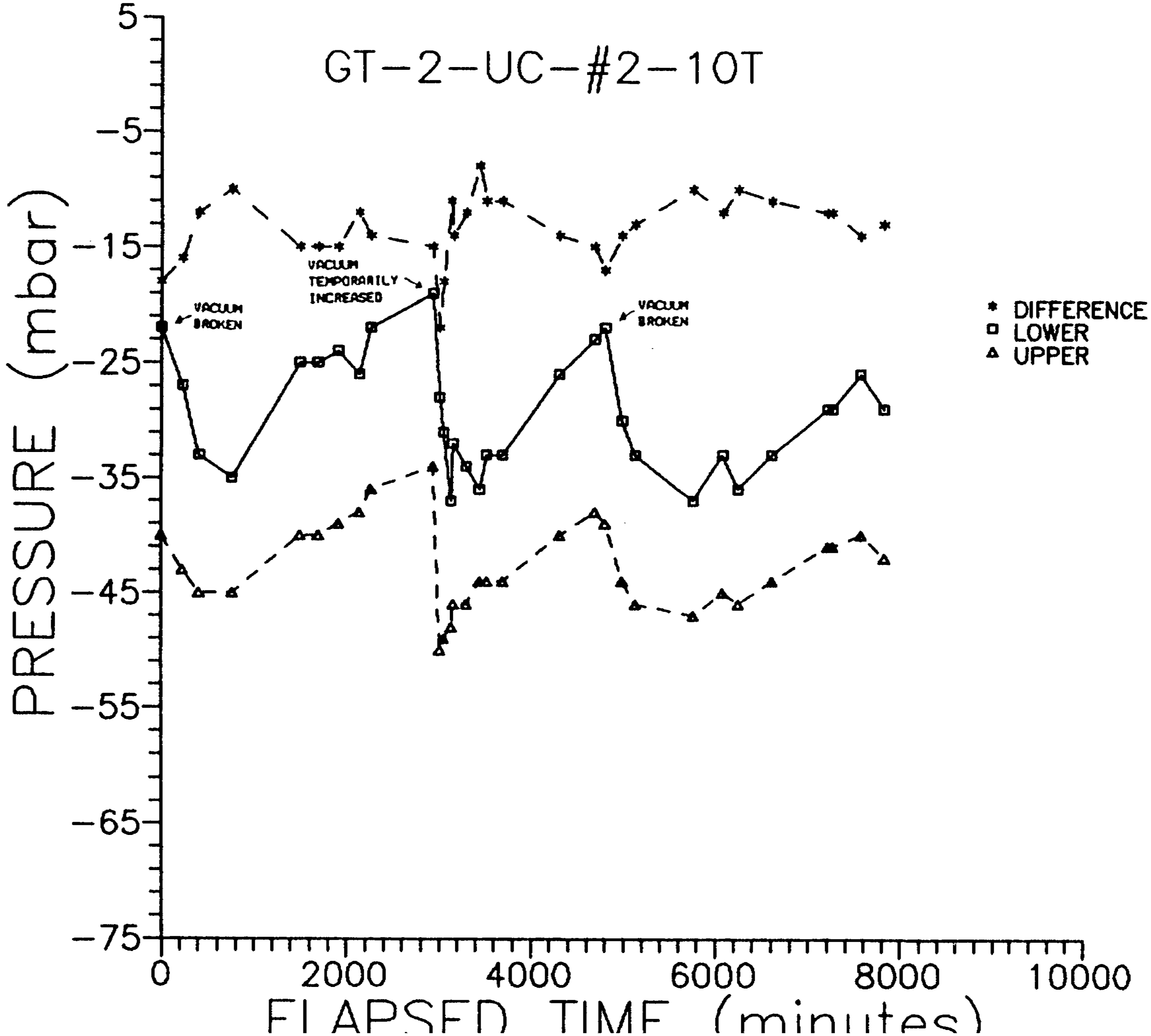
APPENDIX XV

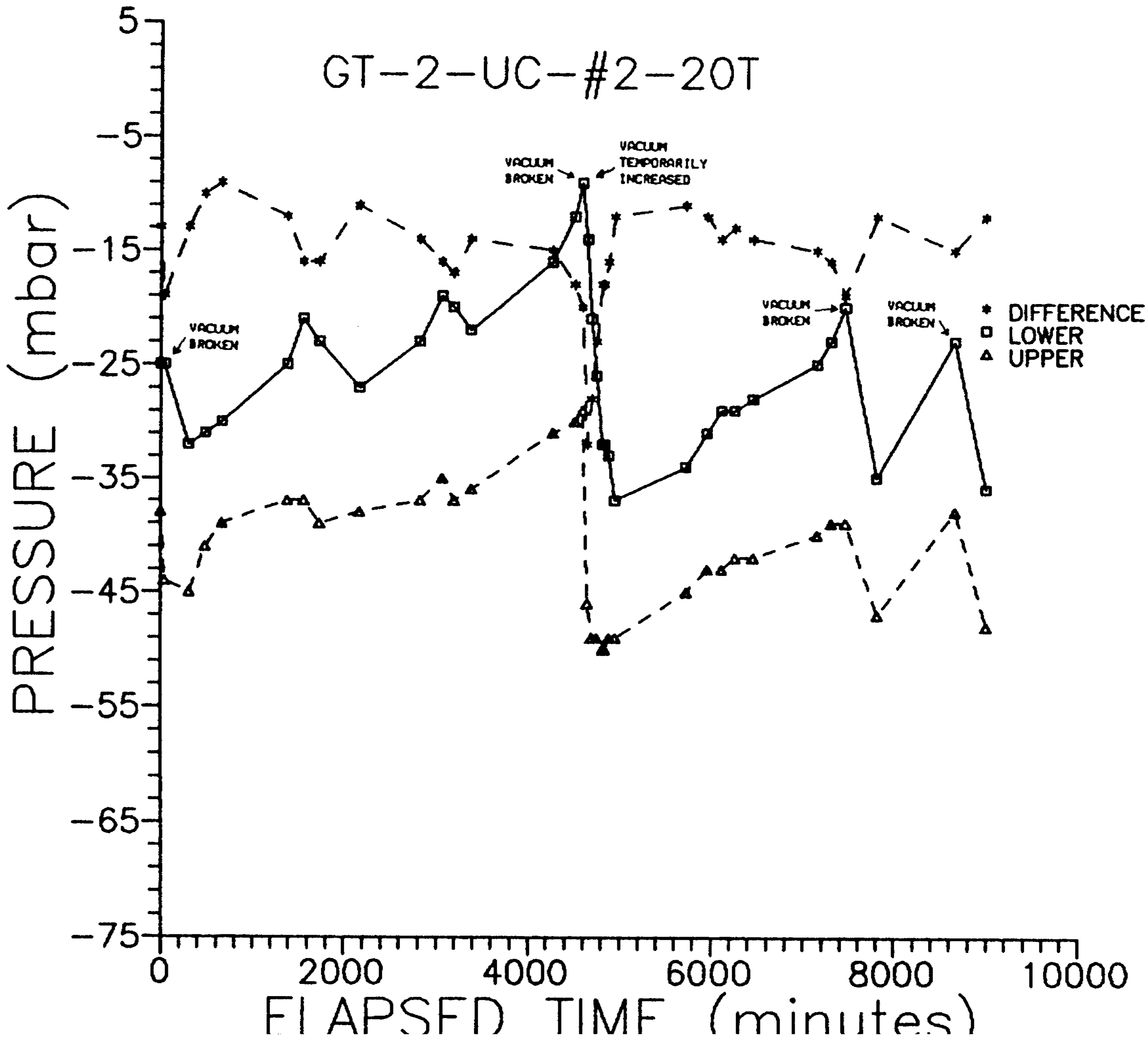
MASS RECOVERIES FOR FLUOROBENZOATES AND ^{18}O

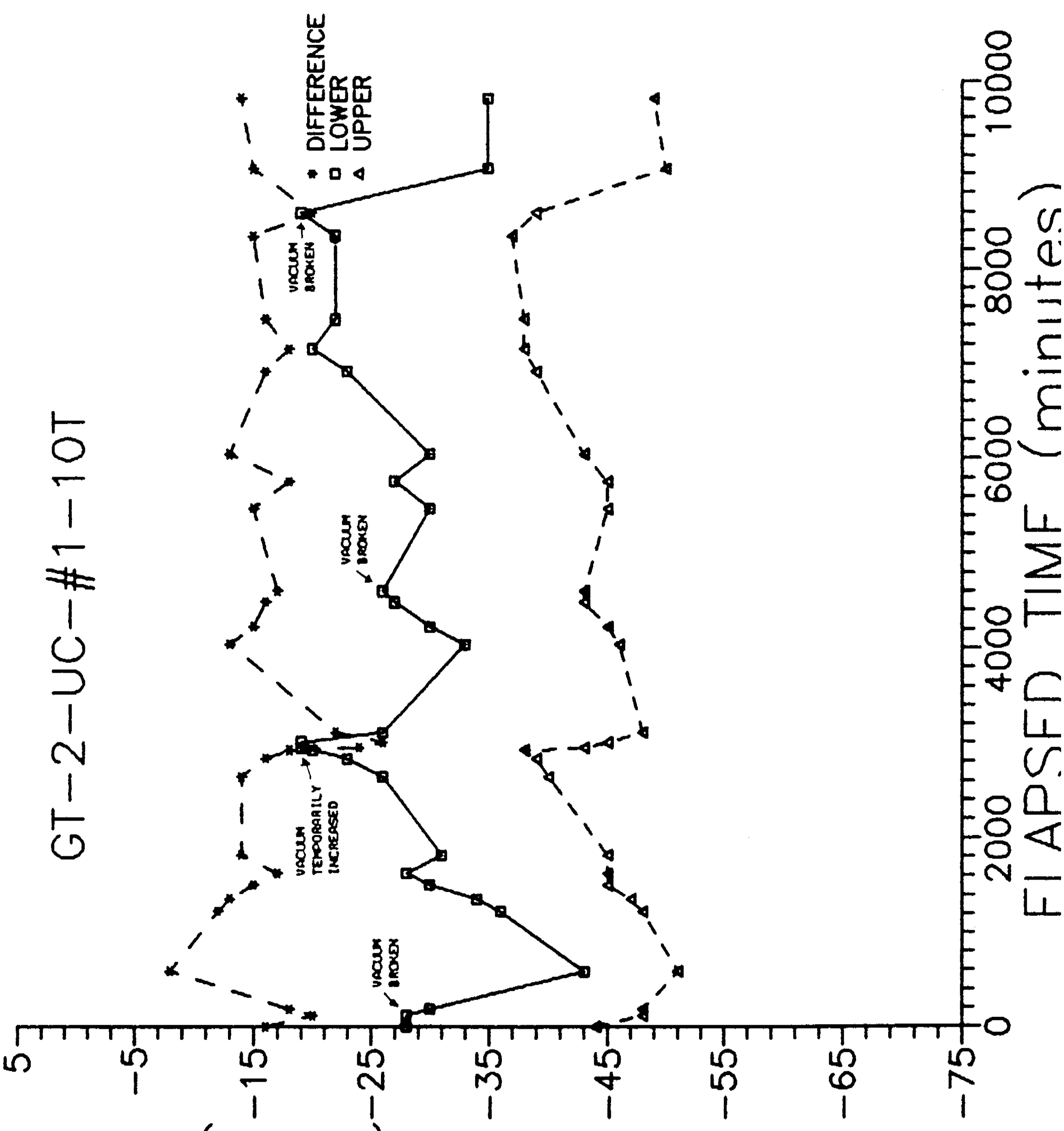
EXPERIMENT	2,6-DFBA	m-TFMBA	o-TFMBA	PFBA	OXYGEN 18
GT-2-UC-#2-20T	111.43%	111.20%	112.35%	112.12%	100.59%
GT-5-UC-#2-20T	103.59%	103.91%	104.77%	104.17%	97.34%
GT-7-UC-#2-20T	103.91%	103.26%	104.33%	103.99%	115.35%
COL-1-UC-#2-20T	101.97%	102.08%	102.74%	102.03%	92.95%
COL-2-UC-#2-20T	103.13%	101.24%	103.68%	103.56%	83.62%

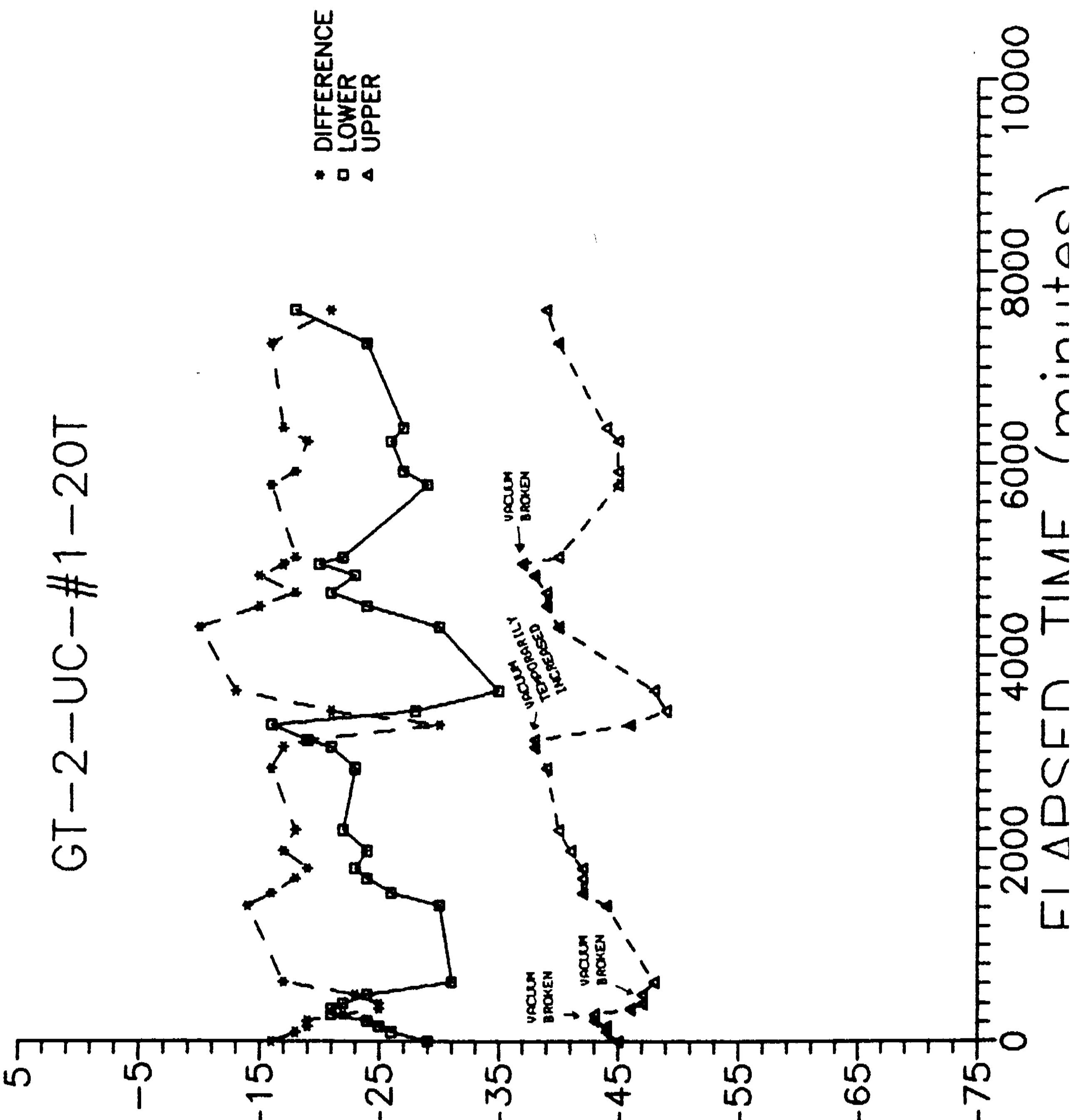
APPENDIX XVI

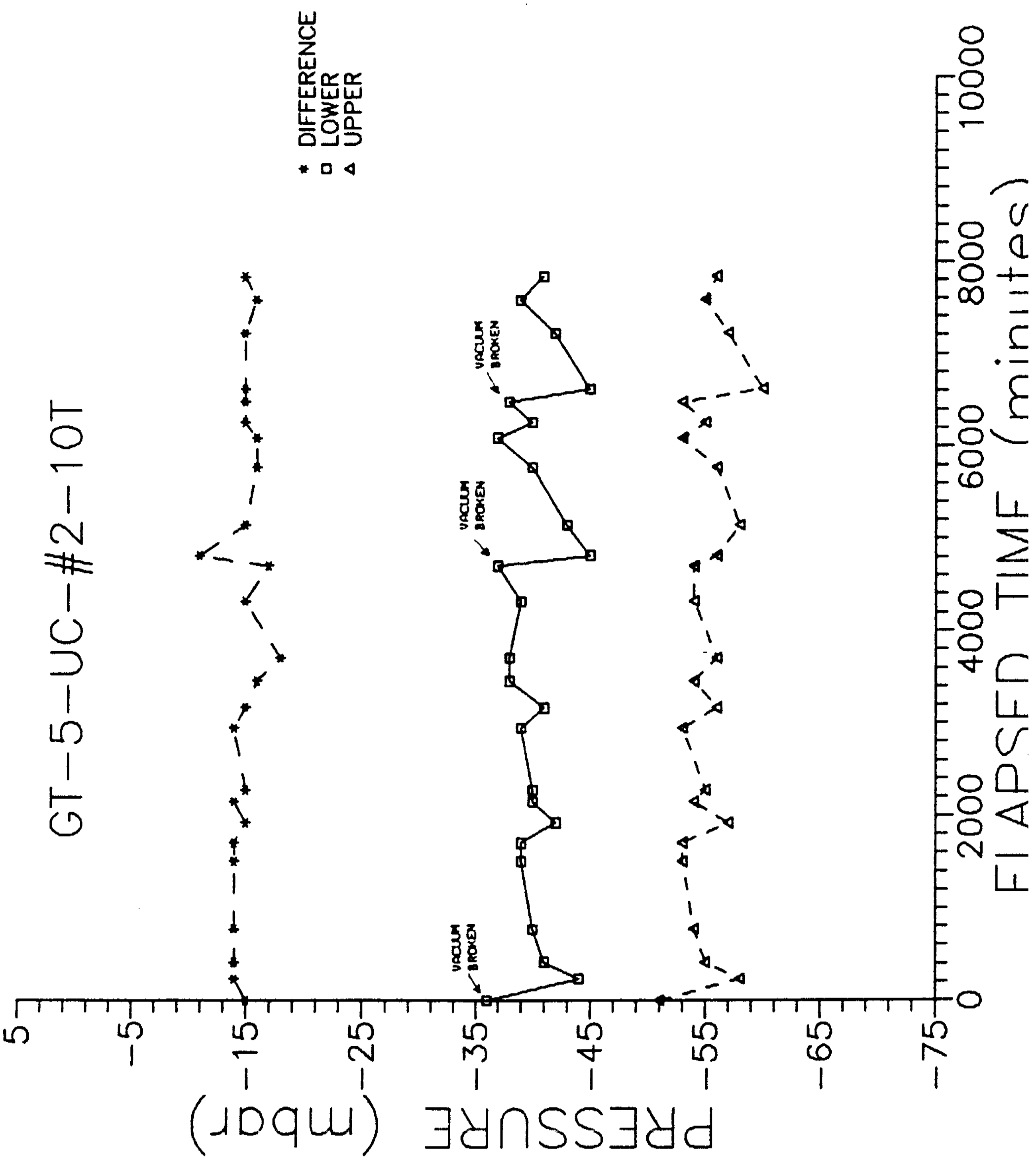
PLOTS OF TIME VS. MATRIC POTENTIAL FOR UNSATURATED FLOW EXPERIMENTS

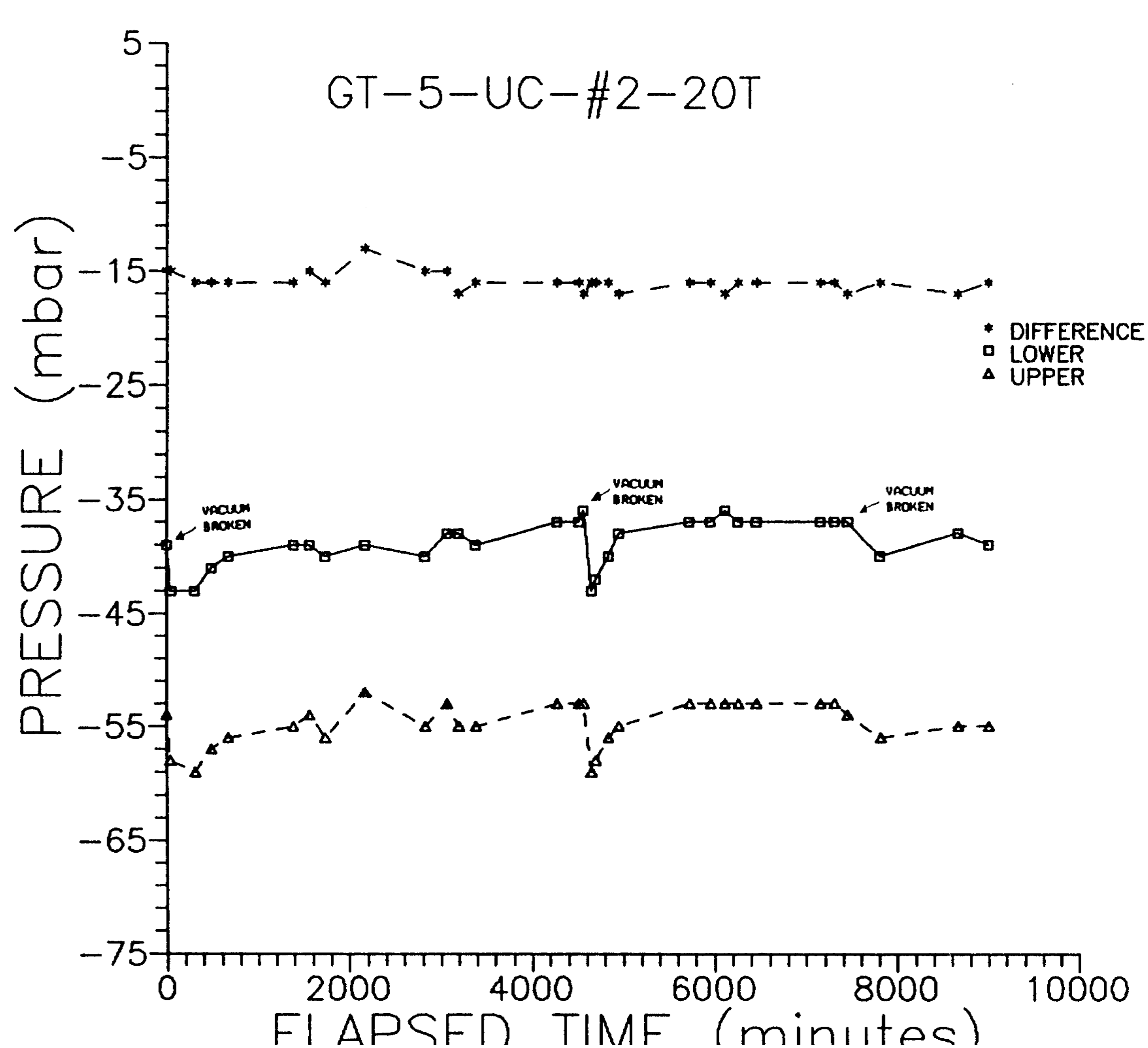

GT-2-UC-#2-10T
PRESSURE (mbar)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
ELAPSED TIME (minutes)
VACUUM BROKEN
VACUUM TEMPORARILY INCREASED
VACUUM BROKEN
* DIFFERENCE
□ LOWER
△ UPPER

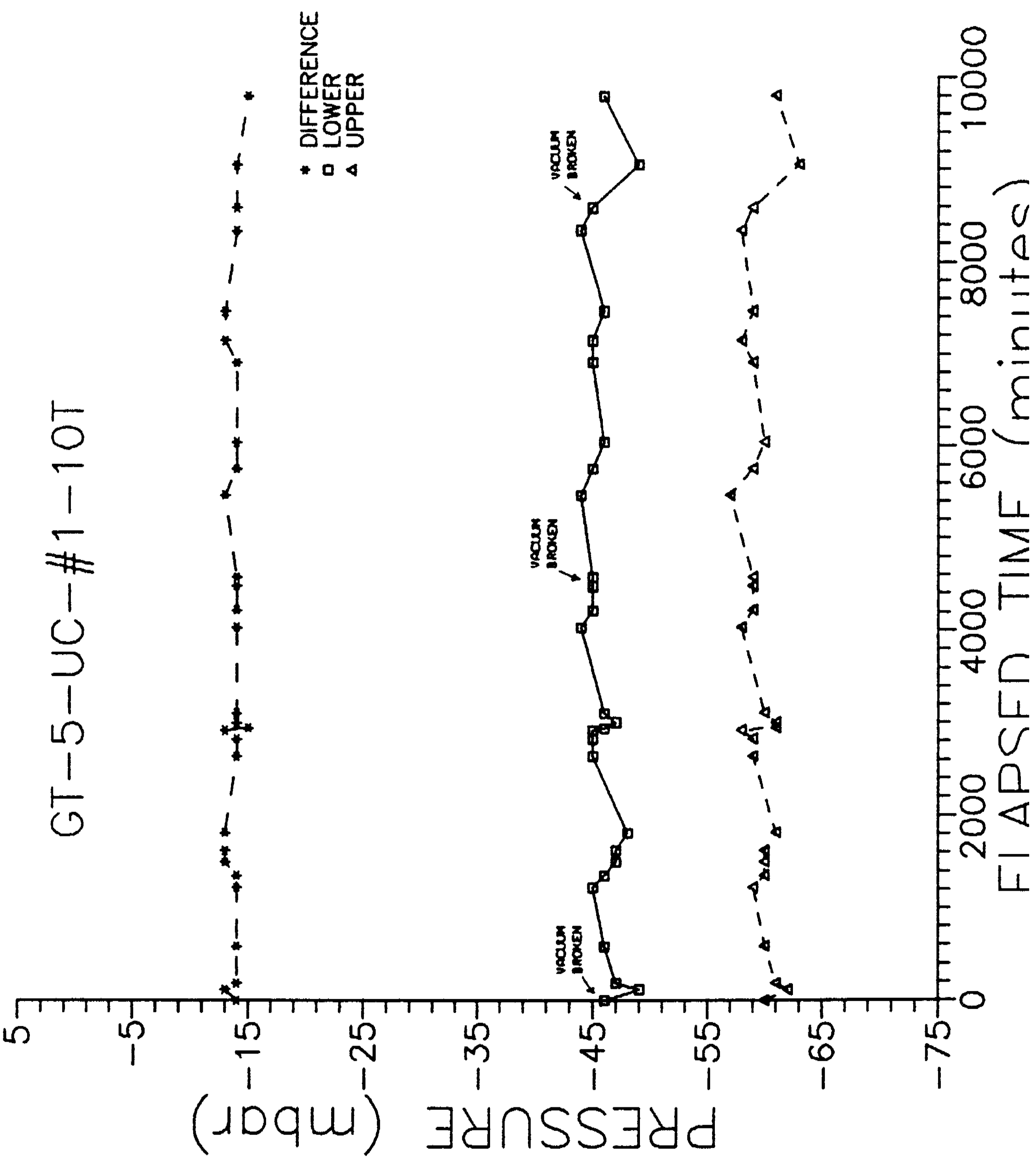

GT-2-UC-#2-20T
PRESSURE (mbar)
ELAPSED TIME (minutes)
VACUUM BROKEN
VACUUM BROKEN
VACUUM TEMPORARILY INCREASED
VACUUM BROKEN
VACUUM BROKEN
DIFFERENCE
LOWER
UPPER
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000

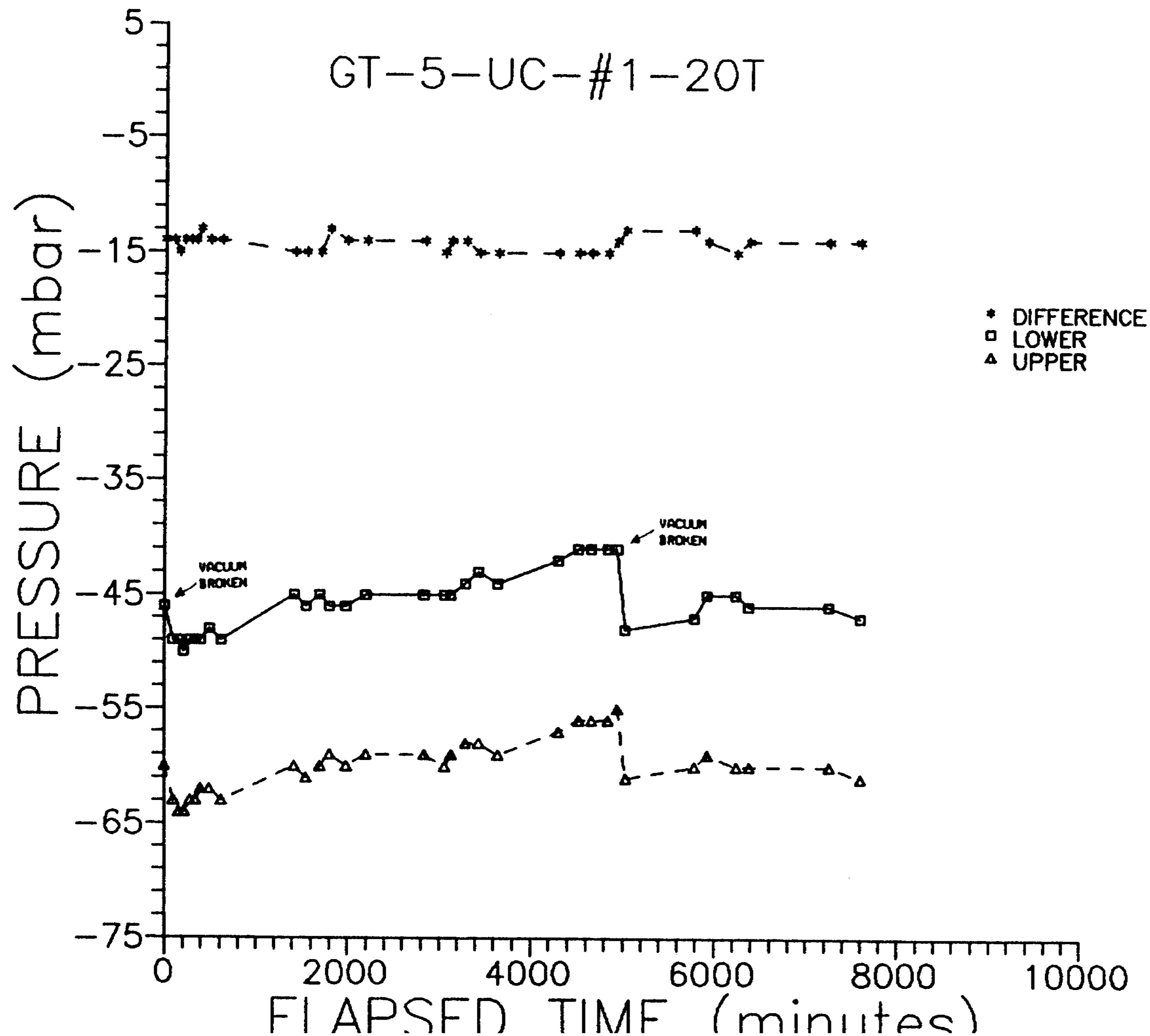

GT-2-UC-#1-10T
PRESSURE (mbar)
ELAPSED TIME (minutes)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
DIFFERENCE
LOWER
UPPER
VACUUM BROKEN
VACUUM TEMPORARILY INCREASED
VACUUM BROKEN
VACUUM BROKEN

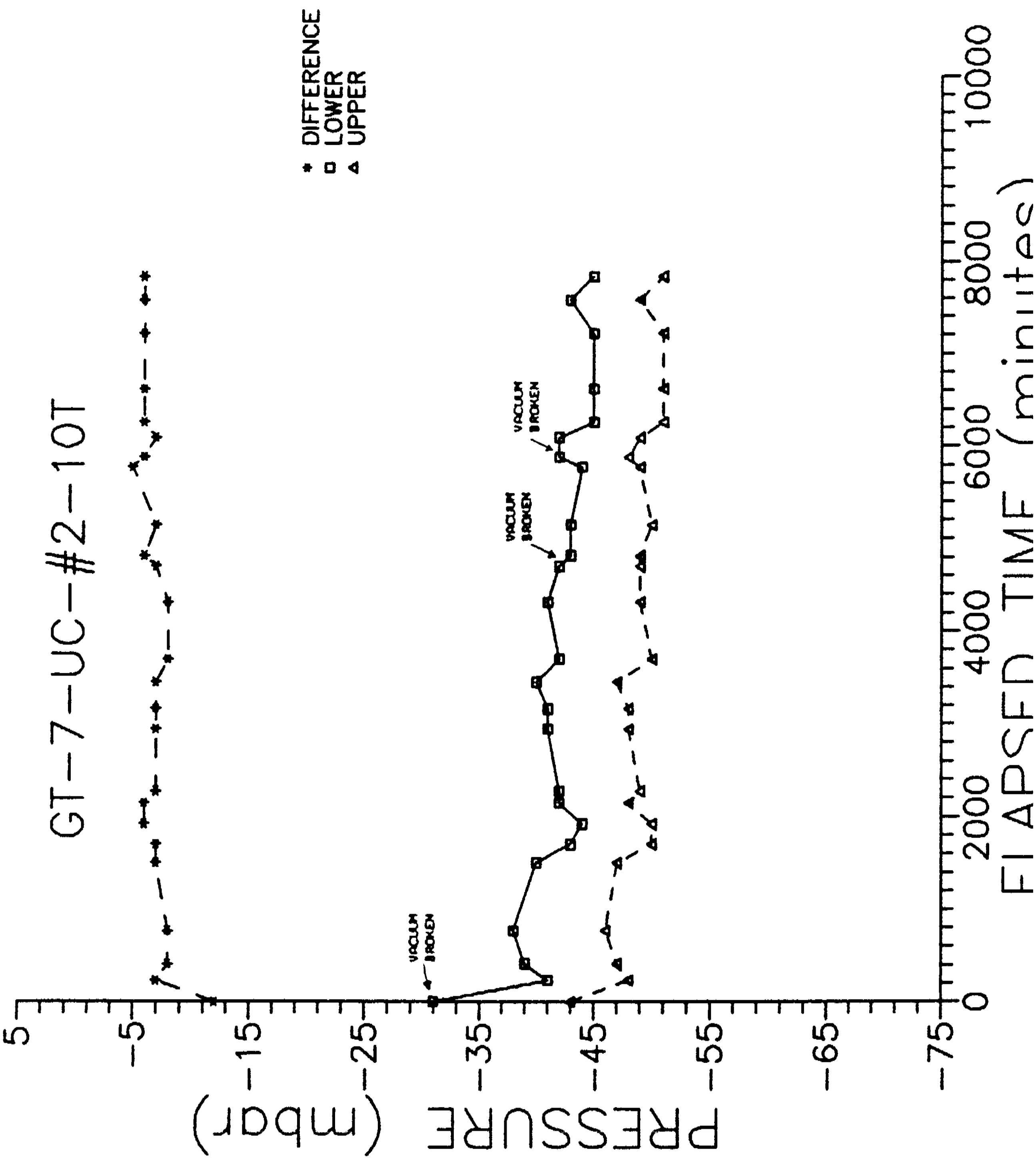

GT-2-UC-#1-20T
PRESSURE (mbar)
ELAPSED TIME (minutes)
* DIFFERENCE
□ LOWER
△ UPPER
VACUUM BROKEN
VACUUM BROKEN
VACUUM TEMPORARILY INCREASED
VACUUM BROKEN
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000

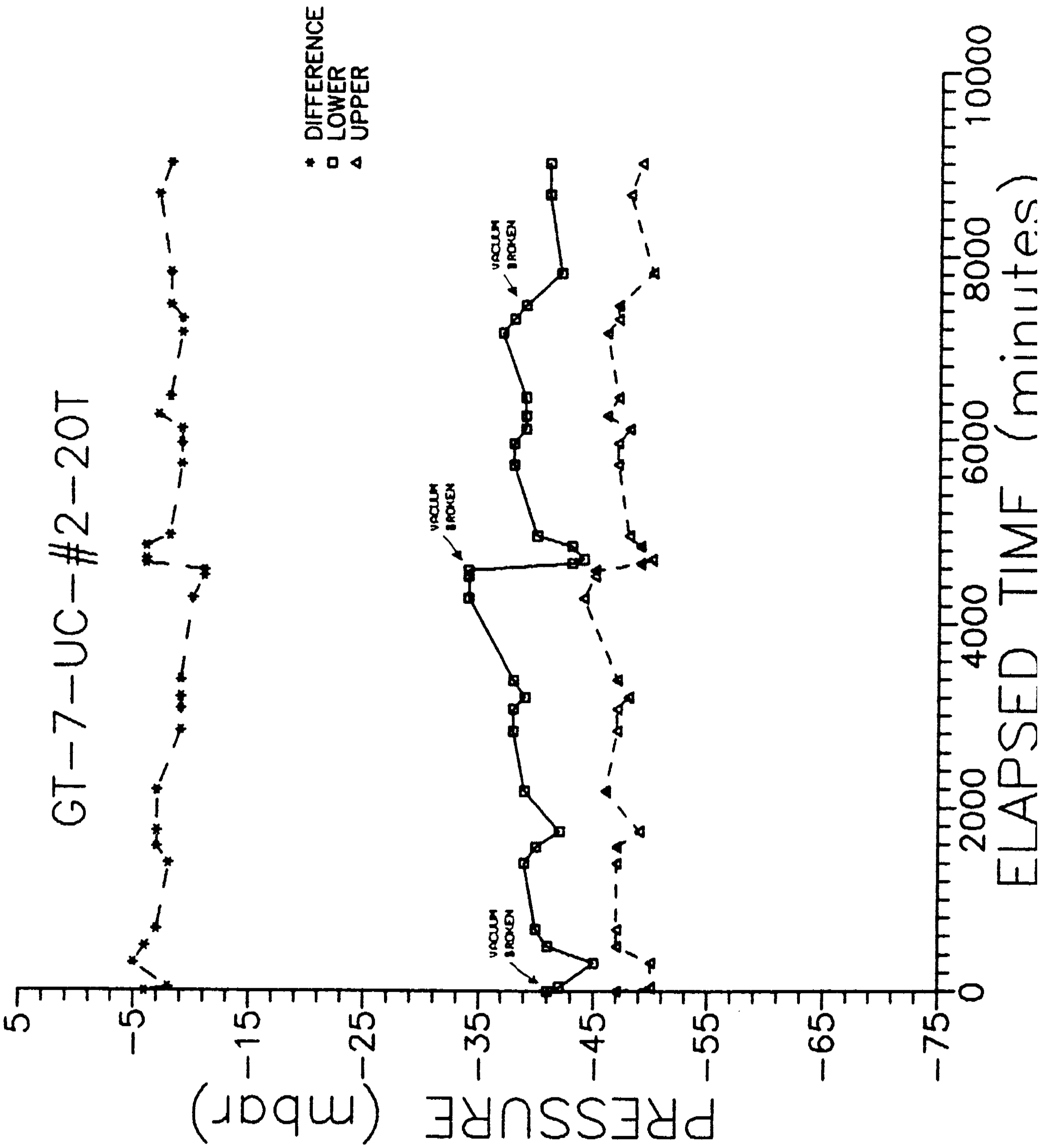

GT-5-UC-#2-10T
PRESSURE (mbar)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
ELAPSED TIME (minutes)
DIFFERENCE
LOWER
UPPER
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN

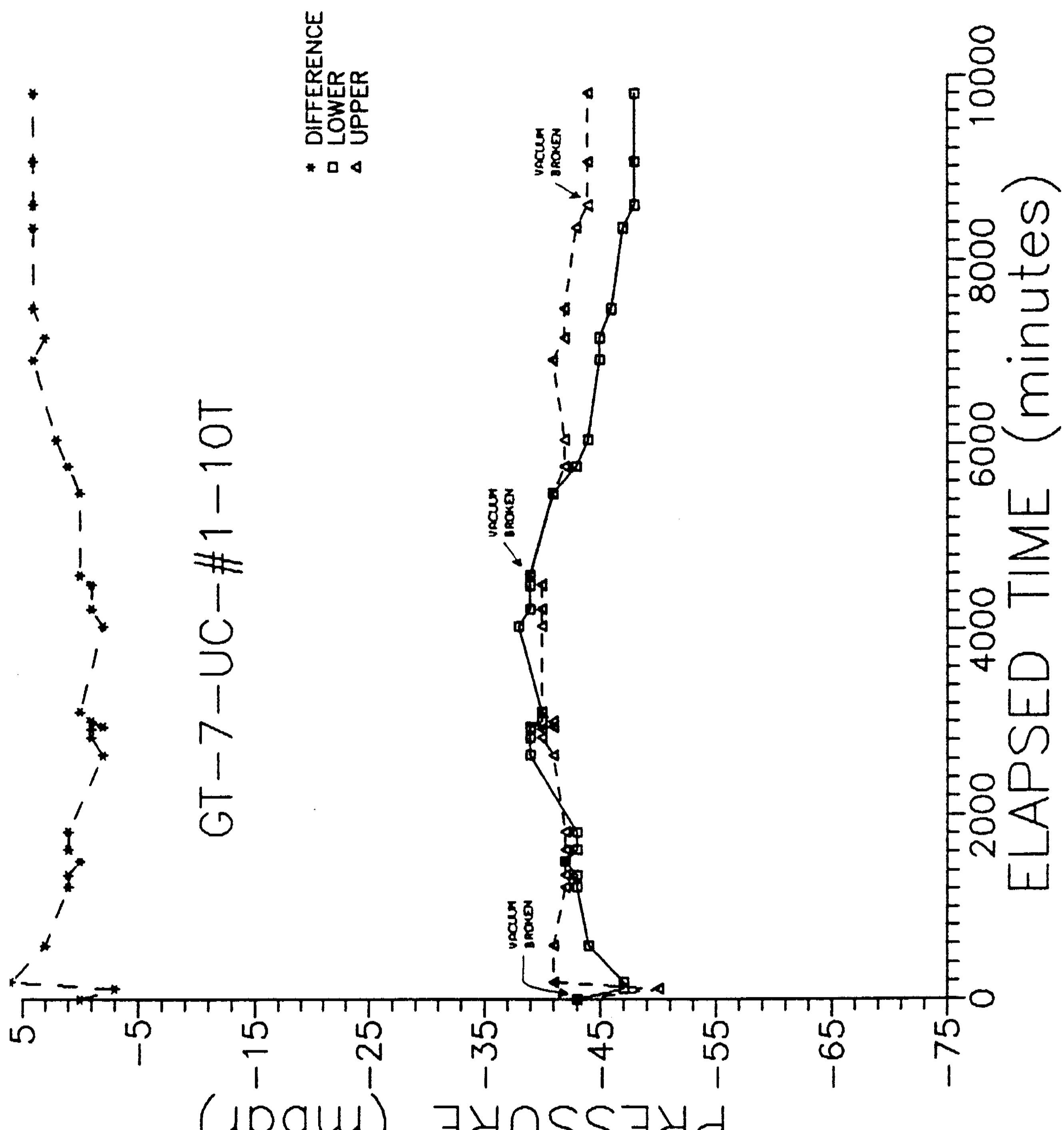

GT-5-UC-#2-20T
PRESSURE (mbar)
ELAPSED TIME (minutes)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN
* DIFFERENCE
□ LOWER
△ UPPER

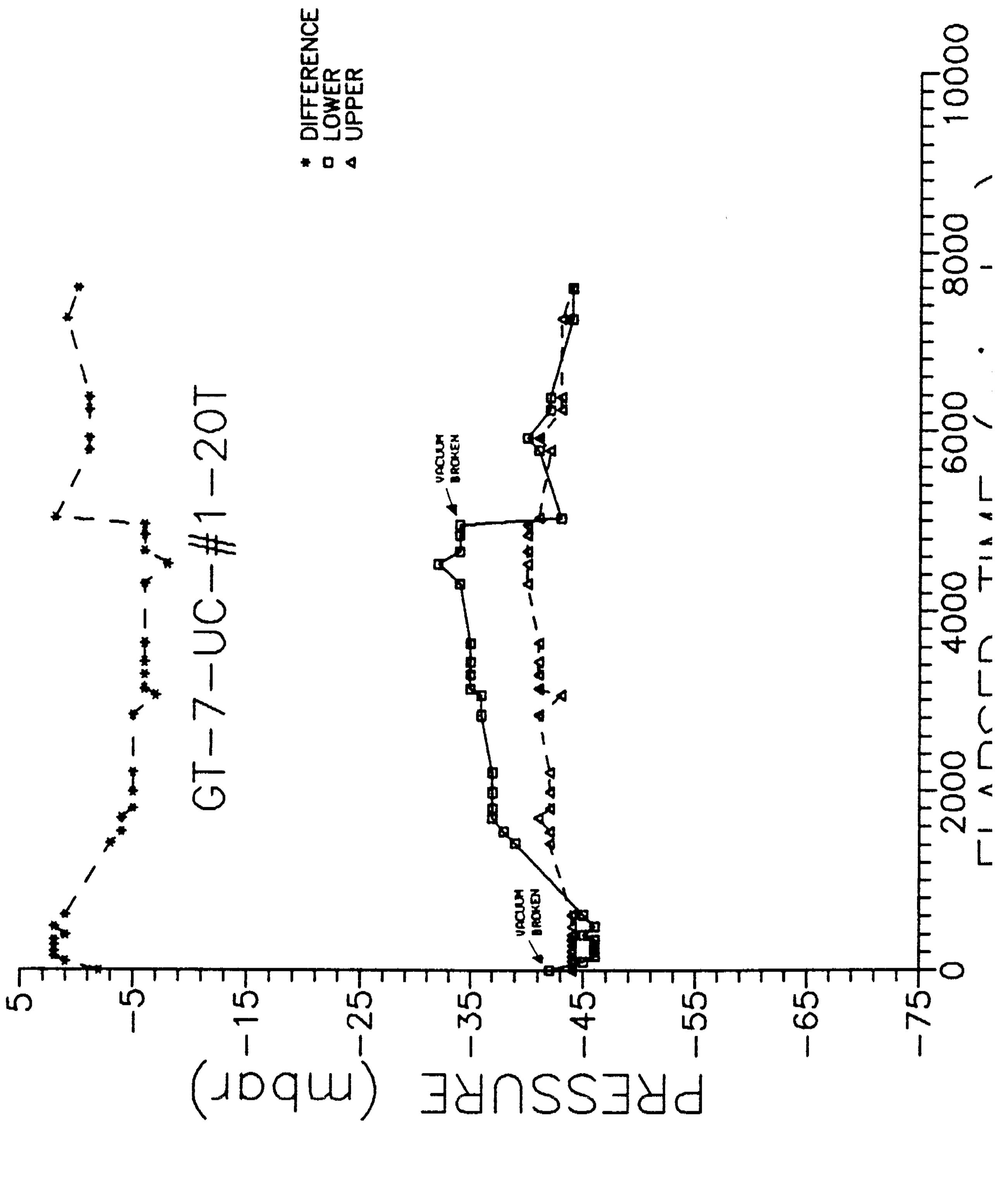

GT-5-UC-#1-10T
PRESSURE (mbar)
ELAPSED TIME (minutes)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
* DIFFERENCE
□ LOWER
△ UPPER
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN

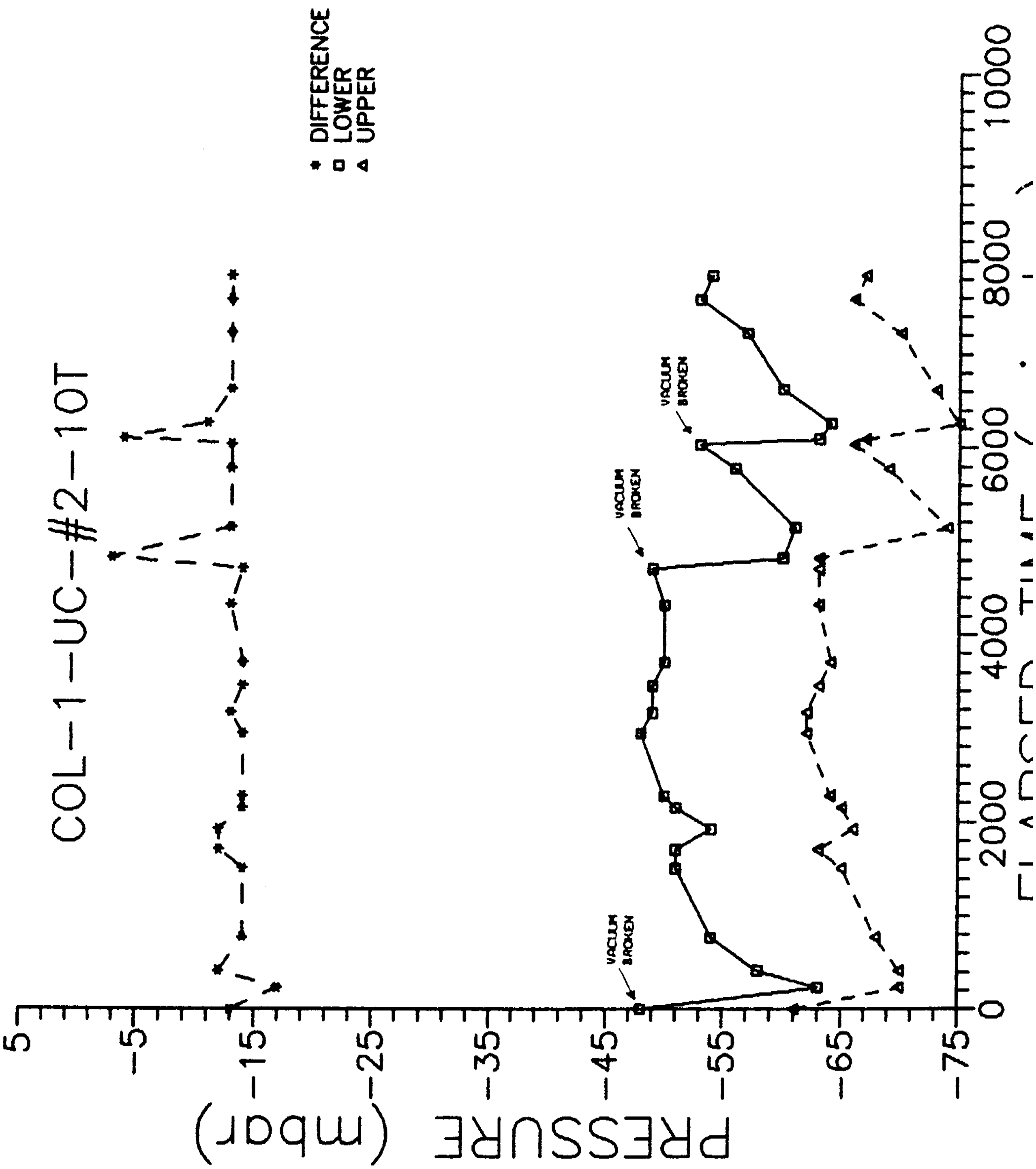

GT-5-UC-#1-20T
PRESSURE (mbar)
ELAPSED TIME (minutes)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
DIFFERENCE
LOWER
UPPER
VACUUM BROKEN
VACUUM BROKEN

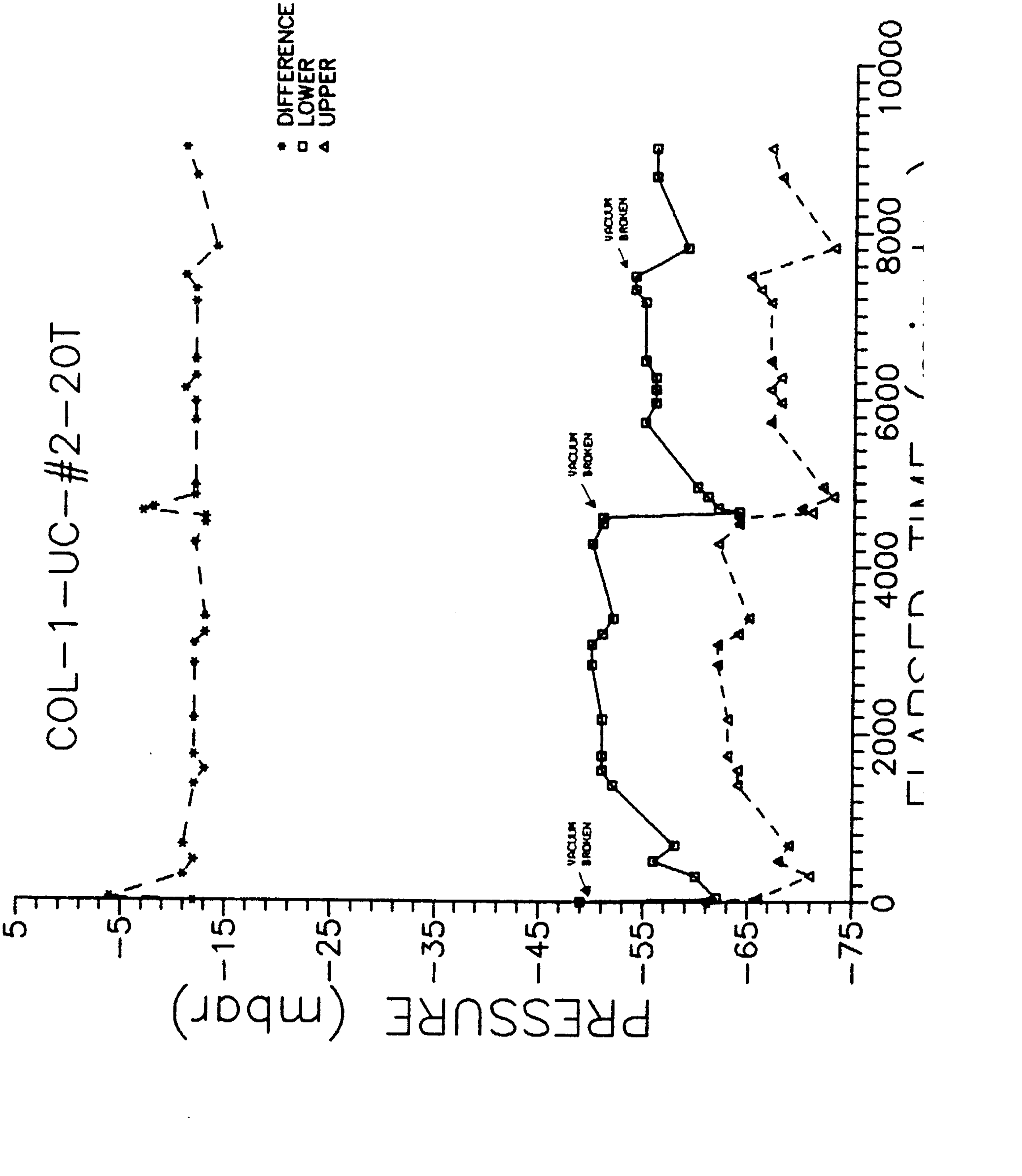

GT-7-UC-#2-10T
PRESSURE (mbar)
ELAPSED TIME (minutes)
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN
* DIFFERENCE
□ LOWER
△ UPPER
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000

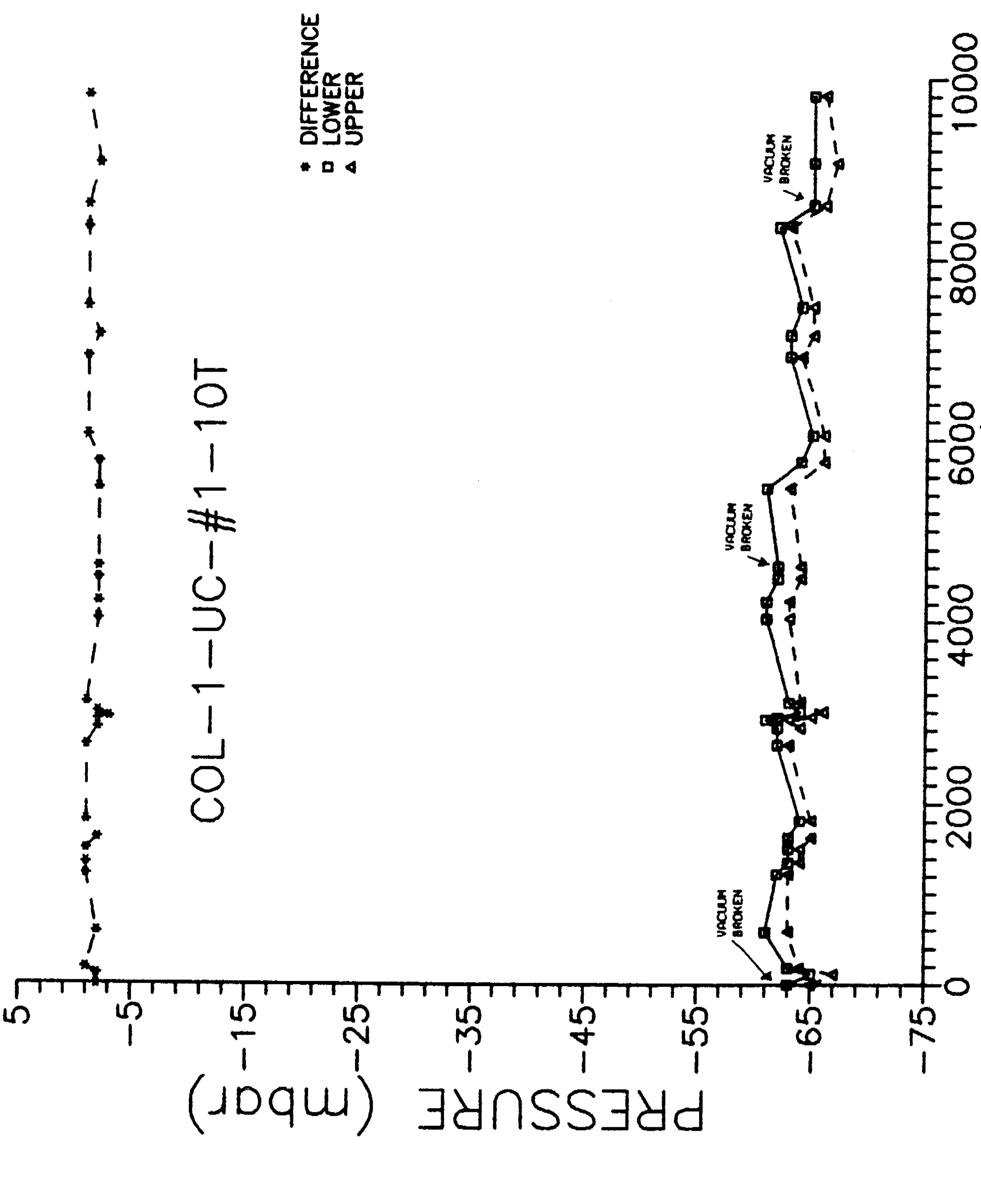

GT-7-UC-#2-20T
PRESSURE (mbar)
ELAPSED TIME (minutes)
DIFFERENCE
LOWER
UPPER
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000

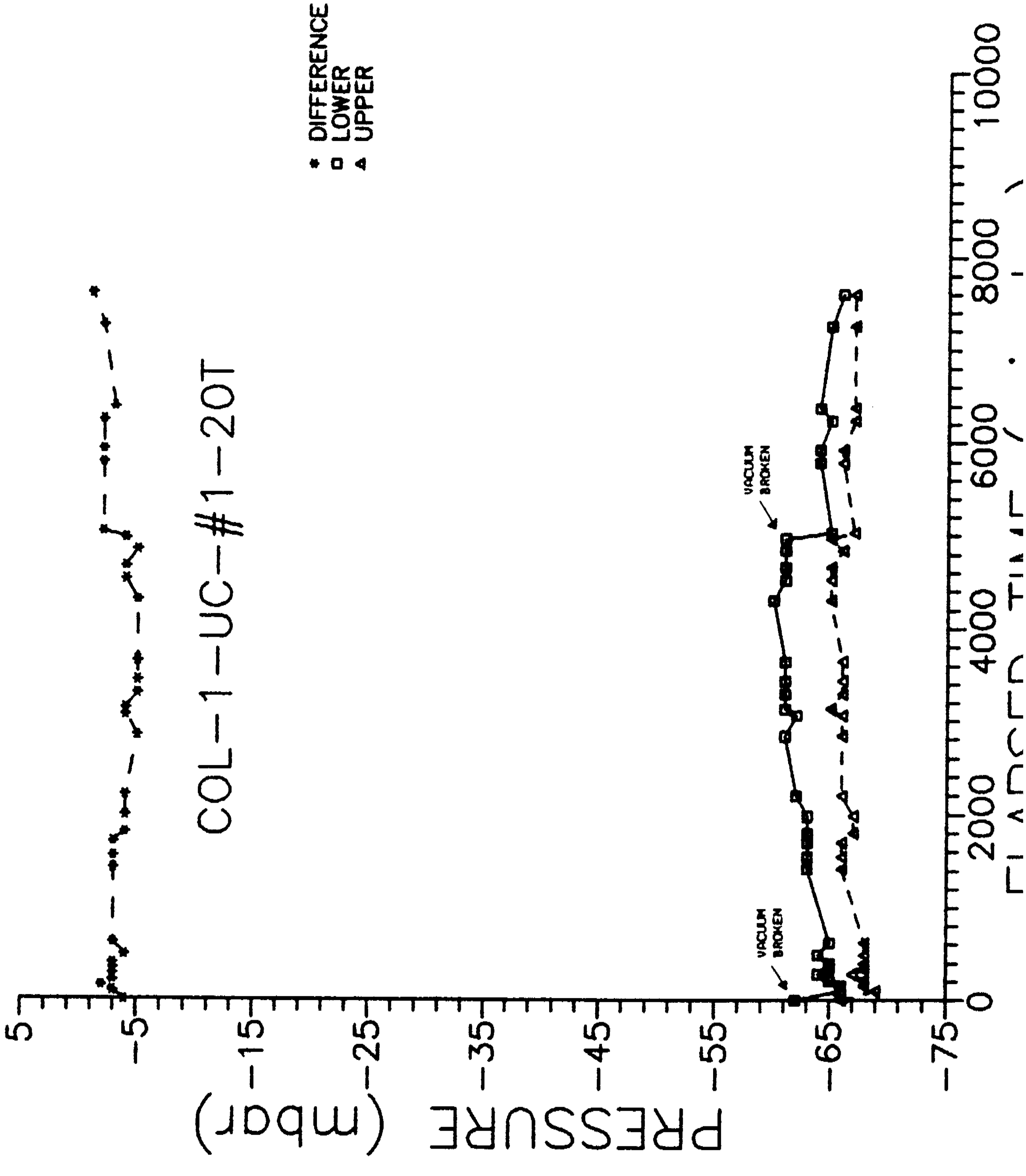

GT-7-UC-#1-10T
PRESSURE (mbar)
ELAPSED TIME (minutes)
* DIFFERENCE
□ LOWER
△ UPPER
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000

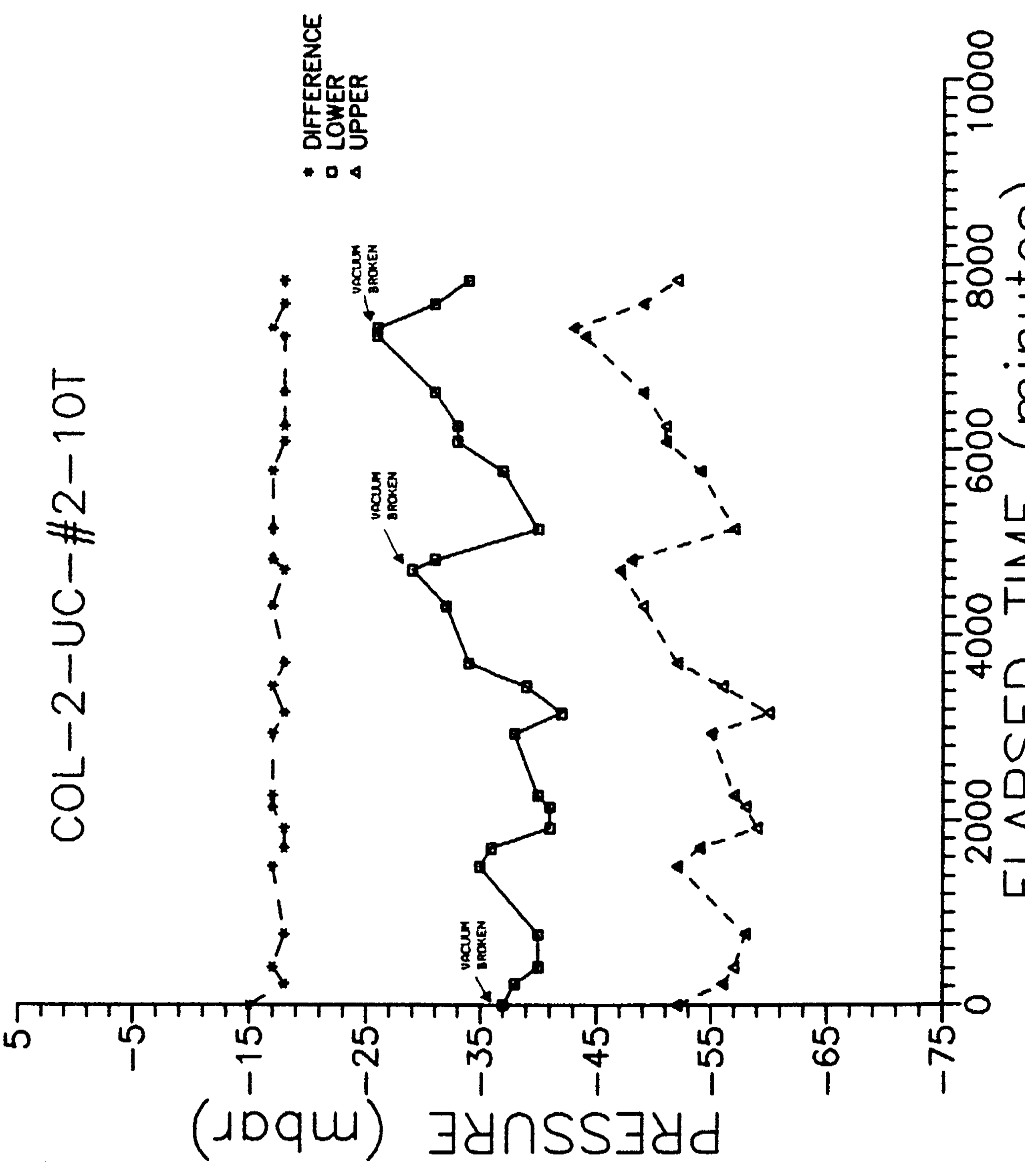

GT-7-UC-#1-20T
* DIFFERENCE
□ LOWER
△ UPPER
VACUUM BROKEN
VACUUM BROKEN
PRESSURE (mbar)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000

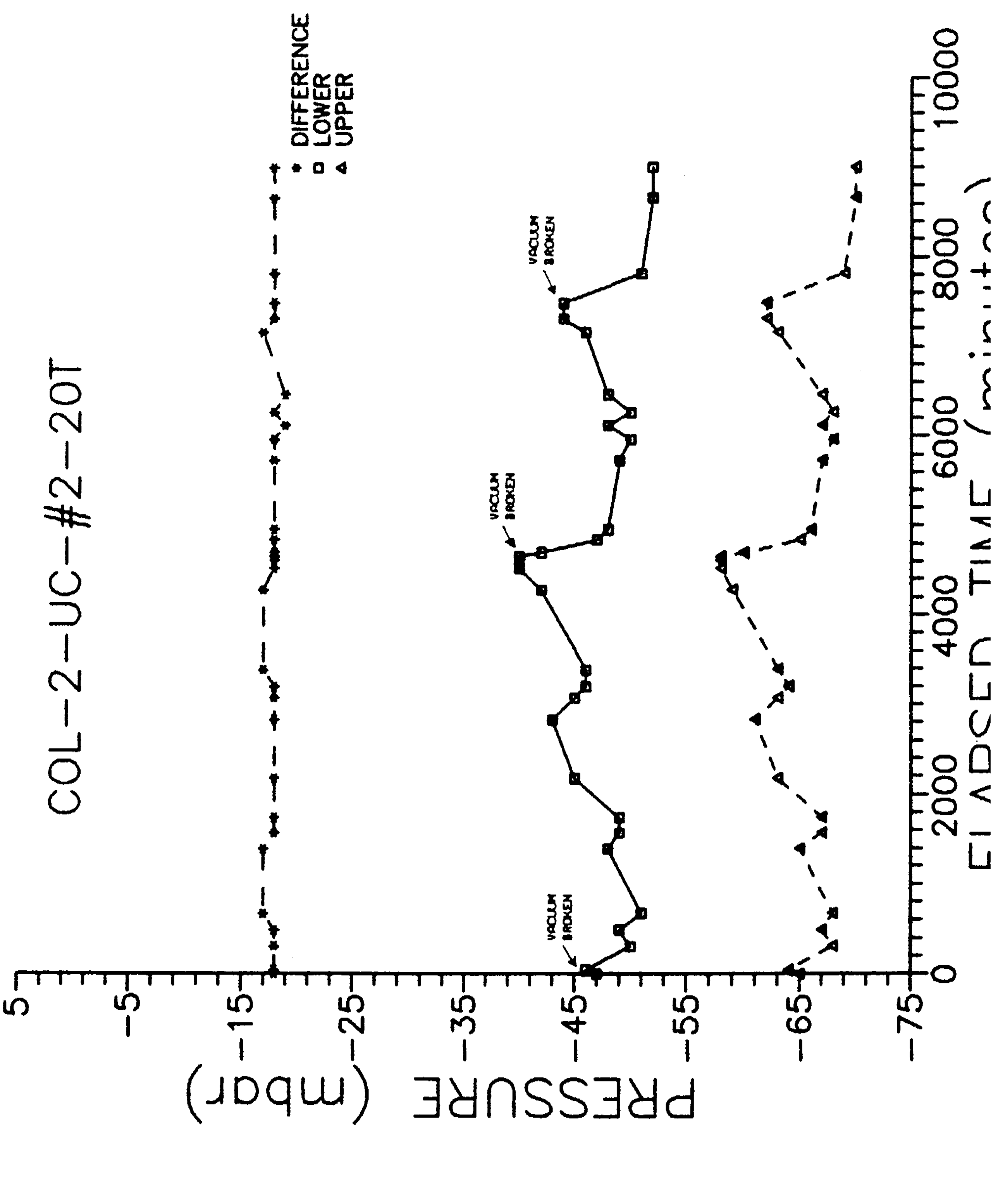

COL—1—UC—#2—10T
PRESSURE (mbar)
DIFFERENCE
LOWER
UPPER
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000


COL-1-UC-#2-20T
PRESSURE (mbar)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
DIFFERENCE
LOWER
UPPER
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN

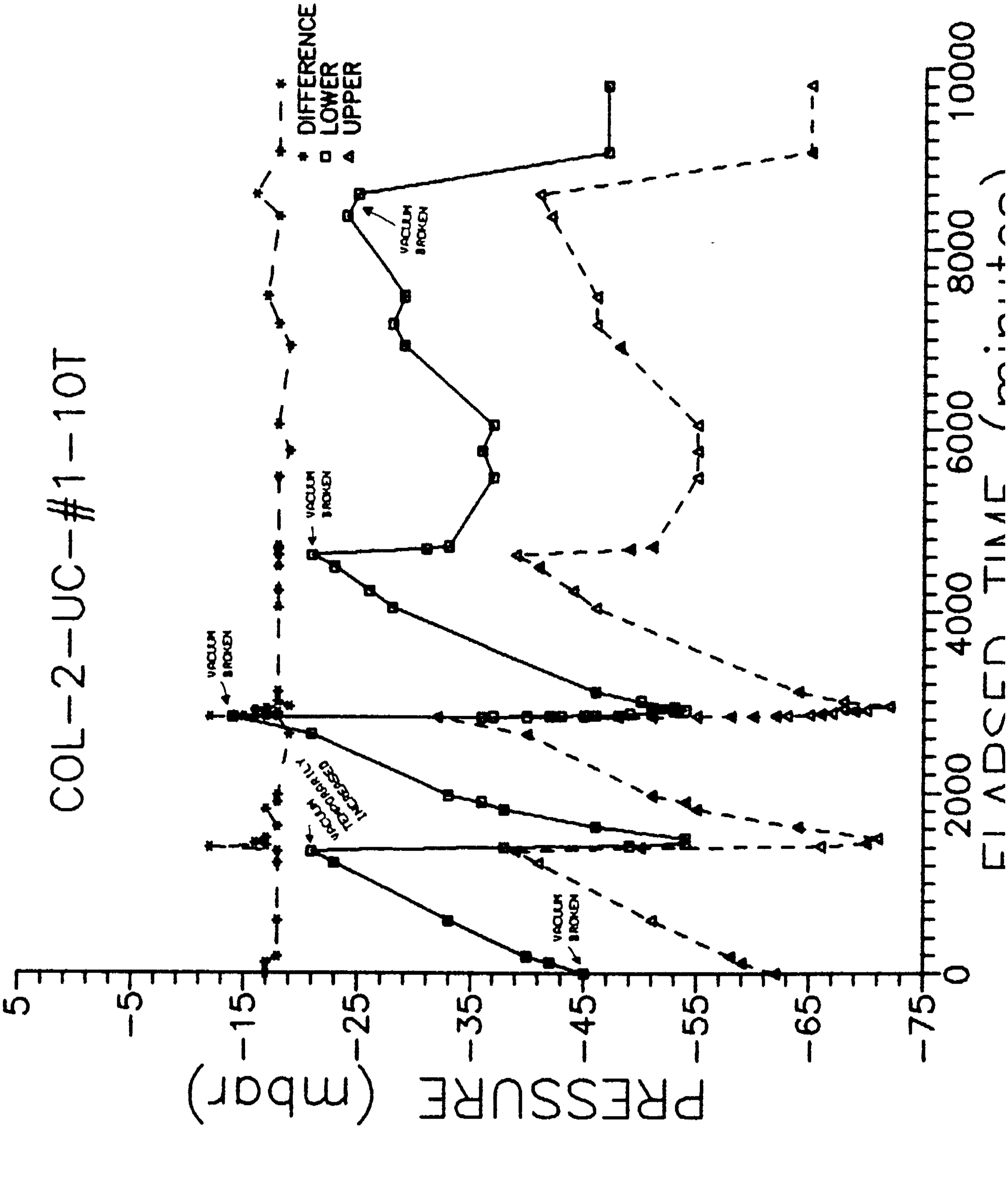

COL-1-UC-#1-10T
PRESSURE (mbar)
DIFFERENCE
LOWER
UPPER
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000

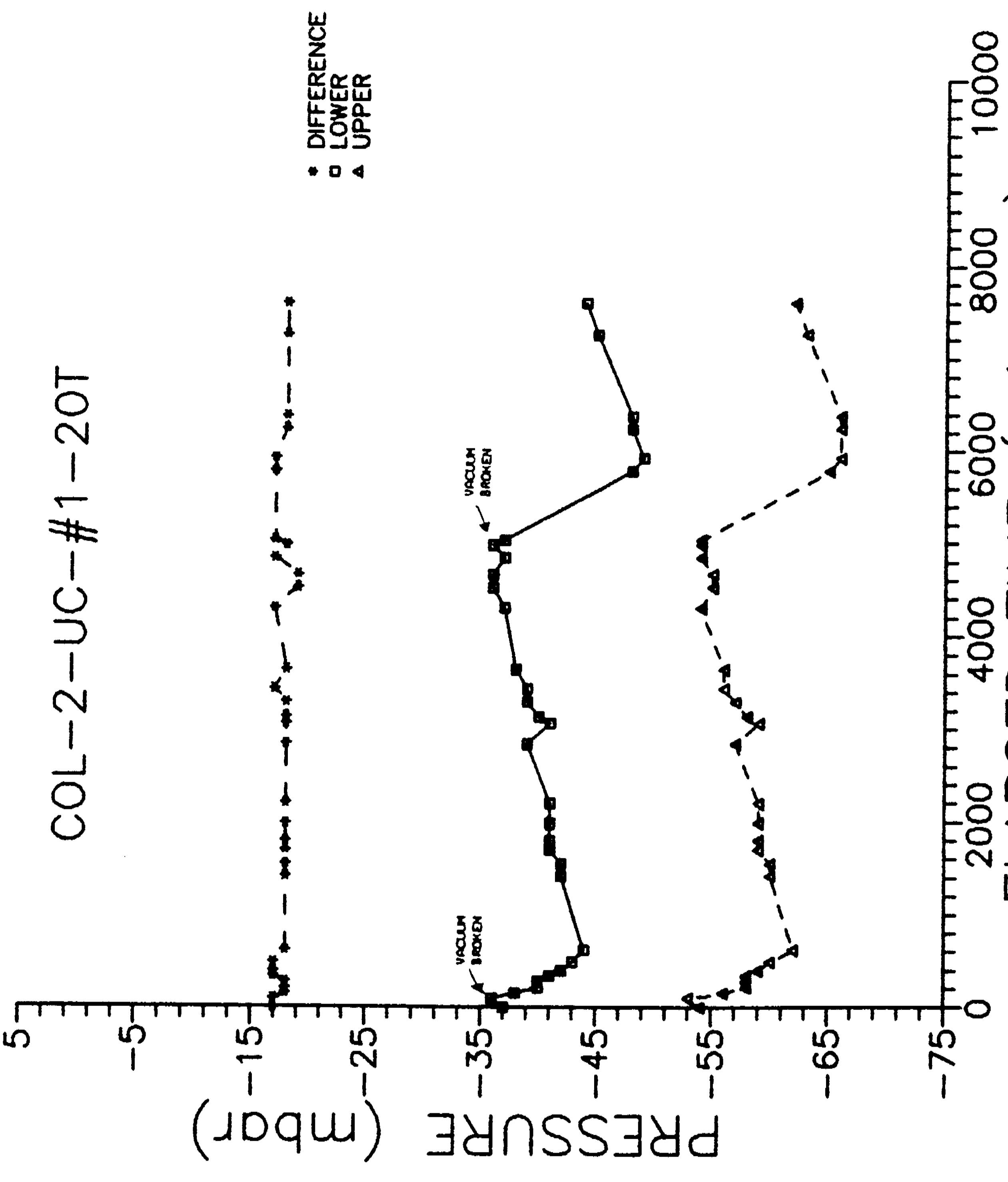

COL-1-UC-#1-20T
PRESSURE (mbar)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
VACUUM BROKEN
VACUUM BROKEN
* DIFFERENCE
□ LOWER
△ UPPER


COL-2-UC-#2-10T
PRESSURE (mbar)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
ELAPSED TIME (minutes)
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN
DIFFERENCE
LOWER
UPPER



COL-2-UC-#2-20T
PRESSURE (mbar)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN
DIFFERENCE
LOWER
UPPER


COL-2-UC-#1-10T
PRESSURE (mbar)
ELAPSED TIME
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
DIFFERENCE
LOWER
UPPER
VACUUM BROKEN
VACUUM TEMPORARILY INCREASED
VACUUM BROKEN
VACUUM BROKEN
VACUUM BROKEN


COL-2-UC-#1-20T
PRESSURE (mbar)
5
-5
-15
-25
-35
-45
-55
-65
-75
0
2000
4000
6000
8000
10000
VACUUM BROKEN
VACUUM BROKEN
* DIFFERENCE
□ LOWER
△ UPPER

GT-2-UC-#2-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
07/28/89	8:37	0	-40	-22	-18
07/28/89	12:30	233	-43	-27	-16
07/28/89	15:30	413	-45	-33	-12
07/28/89	21:28	771	-45	-35	-10
07/29/89	9:40	1503	-40	-25	-15
07/29/89	13:00	1703	-40	-25	-15
07/29/89	16:37	1920	-39	-24	-15
07/29/89	20:23	2146	-38	-26	-12
07/29/89	22:30	2273	-36	-22	-14
07/30/89	9:38	2941	-34	-19	-15
07/30/89	10:53	3016	-50	-28	-22
07/30/89	11:35	3058	-49	-31	-18
07/30/89	13;02	3145	-48	-37	-11
07/30/89	13:20	3163	-46	-32	-14
07/30/89	15:43	3306	-46	-34	-12
07/30/89	18:06	3449	-44	-36	-8
07/30/89	19:22	3525	-44	-33	-11
07/30/89	22:15	3698	-44	-33	-11
07/31/89	8:35	4318	-40	-26	-14
07/31/89	14:55	4698	-38	-23	-15
07/31/89	16:51	4814	-39	-22	-17
07/31/89	19:56	4999	-44	-30	-14
07/31/89	22:18	5141	-46	-33	-13
08/01/89	8:46	5769	-47	-37	-10
08/01/89	14:03	6086	-45	-33	-12
08/01/89	16:50	6253	-46	-36	-10
08/01/89	22:55	6618	-44	-33	-11
08/02/89	8:53	7216	-41	-29	-12
08/02/89	9:50	7273	-41	-29	-12
08/02/89	15:00	7583	-40	-26	-14
08/02/89	19:10	7833	-42	-29	-13
08/03/89	10:06	8729	-37	-22	-15
08/03/89	22:05	9448	-48	-40	-8
08/04/89	8:45	10088	-45	-36	-9
08/04/89	13:15	10358	-44	-33	-11
08/04/89	20:44	10807	-42	-30	-12
08/05/89	9:35	11578	-47	-41	-6
08/05/89	15:45	11948	-44	-35	-9

GT-2-UC-#2-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
08/06/89	9:30	0	-38	-25	-13
08/06/89	10:13	43	-44	-25	-19
08/06/89	14:40	310	-45	-32	-13
08/06/89	17:37	487	-41	-31	-10
08/06/89	20:41	671	-39	-30	-9
08/07/89	8:40	1390	-37	-25	-12
08/07/89	11:40	1570	-37	-21	-16
08/07/89	14:32	1742	-39	-23	-16
08/07/89	21:45	2175	-38	-27	-11
08/08/89	8:45	2835	-37	-23	-14
08/08/89	12:45	3075	-35	-19	-16
08/08/89	14:52	3202	-37	-20	-17
08/08/89	18:00	3390	-36	-22	-14
08/09/89	8:47	4277	-31	-16	-15
08/09/89	12:50	4520	-30	-12	-18
08/09/89	14:10	4600	-29	-9	-20
08/09/89	15:03	4653	-46	-14	-32
08/09/89	15:48	4698	-49	-21	-28
08/09/89	16:47	4757	-49	-26	-23
08/09/89	17;47	4817	-50	-32	-18
08/09/89	18:12	4842	-50	-32	-18
08/09/89	19:00	4890	-49	-33	-16
08/09/89	20:04	4954	-49	-37	-12
08/10/89	8:57	5727	-45	-34	-11
08/10/89	12:52	5962	-43	-31	-12
08/10/89	15:23	6113	-43	-29	-14
08/10/89	17:54	6264	-42	-29	-13
08/10/89	21:08	6458	-42	-28	-14
08/11/89	8:47	7157	-40	-25	-15
08/11/89	11:23	7313	-39	-23	-16
08/11/89	13:58	7468	-39	-20	-19
08/11/89	19:45	7815	-47	-35	-12
08/12/89	9:52	8662	-38	-23	-15
08/12/89	15:34	9004	-48	-36	-12
08/13/89	12:15		-41	-27	-14
08/13/89	20:06		-40	-28	-12
08/14/89			-39	-24	-15
08/14/89	15:50		-39	-21	-18
08/14/89	17:45		-38	-23	-15
08/23/89	13:17		-40	-12	-28
08/24/89	8:00		-34	-16	-18
08/24/89	15:00		-32	-11	-21
08/25/89	14:45		-42	-23	-19
08/25/89	15:45		-41	-23	-18
08/27/89	17:55		-36	-19	-17

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
08/28/89			-41	-20	-21
09/04/89	15:40		-36	-14	-22
09/05/89	9:30		-28	-9	-19
09/05/89	12:43		-27	-8	-19
09/06/89	8:35		-41	-25	-16
09/06/89	10:10		-41	-24	-17
09/06/89	11:36		-41	-24	-17
09/06/89	14:08		-40	-23	-17
09/06/89	15:55		-40	-23	-17
09/06/89	17:49		-40	-23	-17
09/06/89	20:17		-39	-24	-15
09/07/89	8:40		-39	-22	-17
09/07/89	10:12		-47	-25	-22
09/07/89	10:41		-49	-25	-24
09/07/89	12:27		-50	-31	-19
09/07/89	14:04		-51	-33	-18
09/07/89	15:00		-51	-33	-18
09/07/89	17:43		-51	-39	-12
09/07/89	20:06		-51	-41	-10

GT-2-UC-#1-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/08/89	13:30	0	-44	-28	-16
09/08/89	15:25	115	-48	-28	-20
09/08/89	16:35	185	-48	-30	-18
09/08/89	23:19	589	-51	-43	-8
09/09/89	9:50	1220	-48	-36	-12
09/09/89	12:00	1350	-47	-34	-13
09/09/89	14:30	1500	-45	-30	-15
09/09/89	16:30	1620	-45	-28	-17
09/09/89	19:45	1815	-45	-31	-14
09/10/89	9:30	2640	-40	-26	-14
09/10/89	12:41	2831	-39	-23	-16
09/10/89	14:13	2923	-38	-20	-18
09/10/89	14:38	2948	-43	-19	-24
09/10/89	15:36	3006	-45	-19	-26
09/10/89	17:20	3110	-48	-26	-22
09/11/89	8:46	4036	-46	-33	-13
09/11/89	11:53	4223	-45	-30	-15
09/11/89	16:13	4483	-43	-27	-16
09/11/89	18:08	4598	-43	-26	-17
09/12/89	8:42	5472	-45	-30	-15
09/12/89	13:30	5760	-45	-27	-18
09/12/89	18:19	6049	-43	-30	-13
09/13/89	8:45	6915	-39	-23	-16
09/13/89	12:44	7154	-38	-20	-18
09/13/89	18:00	7470	-38	-22	-16
09/14/89	8:38	8348	-37	-22	-15
09/14/89	12:40	8590	-39	-19	-20
09/14/89	20:27	9057	-50	-35	-15
09/15/89	8:56	9806	-49	-35	-14
09/15/89	16:06		-47	-30	-17
09/16/89	16:03		-41	-23	-18
09/17/89	12:03		-38	-19	-19

GT-2-UC-#1-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/19/89	9:19	0	-45	-29	-16
09/19/89	10:57	98	-44	-26	-18
09/19/89	11:52	153	-44	-25	-19
09/19/89	12:55	216	-43	-24	-19
09/19/89	14:01	282	-43	-21	-22
09/19/89	14:57	338	-46	-21	-25
09/19/89	15:52	393	-47	-22	-25
09/19/89	17:28	489	-47	-24	-23
09/19/89	19:38	619	-48	-31	-17
09/20/89	8:52	1413	-44	-30	-14
09/20/89	11:02	1543	-42	-26	-16
09/20/89	13:35	1696	-42	-24	-18
09/20/89	15:20	1801	-42	-23	-19
09/20/89	18:20	1981	-41	-24	-17
09/20/89	21:57	2198	-40	-22	-18
09/21/89	8:38	2839	-39	-23	-16
09/21/89	12:20	3061	-38	-21	-17
09/21/89	13:30	3131	-38	-19	-19
09/21/89	16:11	3292	-46	-16	-30
09/21/89	18:32	3433	-49	-28	-21
09/21/89	22:00	3641	-48	-35	-13
09/22/89	9:00	4301	-40	-30	-10
09/22/89	12:41	4522	-39	-24	-15
09/22/89	15:04	4665	-39	-21	-18
09/22/89	18:00	4841	-38	-23	-15
09/22/89	20:00	4961	-37	-20	-17
09/22/89	21:14	5035	-40	-22	-18
09/23/89	9:40	5781	-45	-29	-16
09/23/89	12:02	5923	-45	-27	-18
09/23/89	17:19	6240	-45	-26	-19
09/23/89	19:34	6375	-44	-27	-17
09/24/89	10:15	7256	-40	-24	-16
09/24/89	15:55	7596	-39	-18	-21

GT-5-UC-#2-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
07/28/89	8:37	0	-51	-36	-15
07/28/89	12:30	233	-58	-44	-14
07/28/89	15:30	413	-55	-41	-14
07/28/89	21:28	771	-54	-40	-14
07/29/89	9:40	1503	-53	-39	-14
07/28/89	13:00	1703	-53	-39	-14
07/28/89	16:37	1920	-57	-42	-15
07/29/89	20:23	2146	-54	-40	-14
07/29/89	22:30	2273	-55	-40	-15
07/30/89	9:38	2941	-53	-39	-14
07/30/89	13:20	3163	-56	-41	-15
07/30/89	18:06	3449	-54	-38	-16
07/30/89	22:15	3698	-56	-38	-18
07/31/89	8:35	4318	-54	-39	-15
07/31/89	14:55	4698	-54	-37	-17
07/31/89	16;51	4814	-56	-45	-11
07/31/89	22:18	5141	-58	-43	-15
08/01/89	8:46	5769	-56	-40	-16
08/01/89	14:03	6086	-53	-37	-16
08/01/89	16:50	6253	-55	-40	-15
08/01/89	20:33	6476	-53	-38	-15
08/01/89	22:55	6618	-60	-45	-15
08/02/89	8:53	7216	-57	-42	-15
08/02/89	15:00	7583	-55	-39	-16
08/02/89	19:10	7833	-56	-41	-15
08/03/89	10:06	8729	-56	-41	-15
08/03/89	22:05	9448	-56	-40	-16
08/04/89	8:45	10088	-56	-40	-16
08/04/89	13:15	10358	-55	-40	-15
08/04/89	20:28	10791	-53	-38	-15
08/05/89	9:35	11578	-56	-40	-16
08/05/89	15:45	11948	-55	-40	-15

GT-5-UC-#2-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
08/06/89	9:30	0	-54	-39	-15
08/06/89	10:13	43	-58	-43	-15
08/06/89	14:40	310	-59	-43	-16
08/06/89	17:37	487	-57	-41	-16
08/06/89	20:41	671	-56	-40	-16
08/07/89	8:40	1390	-55	-39	-16
08/07/89	11:40	1570	-54	-39	-15
08/07/89	14:32	1742	-56	-40	-16
08/07/89	21:45	2175	-52	-39	-13
08/08/89	8:45	2835	-55	-40	-15
08/08/89	12:45	3075	-53	-38	-15
08/08/89	14:52	3202	-55	-38	-17
08/08/89	18:00	3390	-55	-39	-16
08/09/89	8:47	4277	-53	-37	-16
08/09/89	12:50	4520	-53	-37	-16
08/09/89	13:38	4568	-53	-36	-17
08/09/89	15:03	4653	-59	-43	-16
08/09/89	15;48	4698	-58	-42	-16
08/09/89	18:12	4842	-56	-40	-16
08/09/89	20:04	4954	-55	-38	-17
08/10/89	8:57	5727	-53	-37	-16
08/10/89	12:52	5962	-53	-37	-16
08/10/89	15:23	6113	-53	-36	-17
08/10/89	17:54	6264	-53	-37	-16
08/10/89	21:08	6458	-53	-37	-16
08/11/89	8:47	7157	-53	-37	-16
08/11/89	11:23	7313	-53	-37	-16
08/11/89	13:43	7453	-54	-37	-17
08/11/89	19:45	7815	-56	-40	-16
08/12/89	09:52	8662	-55	-38	-17
08/12/89	15:34	9004	-55	-39	-16
08/13/89	12:15		-57	-41	-16
08/13/89	20:06		-57	-41	-16
08/14/89	15:50		-57	-41	-16
08/14/89	17:45		-57	-40	-17
08/24/89	15:00		-55	-39	-16
08/25/89	14:45		-52	-39	-13
08/27/89	17:55		-54	-40	-14

GT-5-UC-#1-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/08/89	13:30	0	-60	-46	-14
09/08/89	15:25	115	-62	-49	-13
09/08/89	16:35	185	-61	-47	-14
09/08/89	23:19	589	-60	-46	-14
09/09/89	09:50	1220	-59	-45	-14
09/09/89	12:00	1350	-60	-46	-14
09/09/89	14:30	1500	-60	-47	-13
09/09/89	16:30	1620	-60	-47	-13
09/09/89	19:45	1815	-61	-48	-13
09/10/89	09:30	2640	-59	-45	-14
09/10/89	12:41	2831	-59	-45	-14
09/10/89	14:13	2923	-58	-45	-13
09/10/89	14:38	2948	-61	-46	-15
09/10/89	15:36	3006	-61	-47	-14
09/10/89	17:20	3110	-60	-46	-14
09/11/89	08:46	4036	-58	-44	-14
09/11/89	11:53	4223	-59	-45	-14
09/11/89	16:13	4483	-59	-45	-14
09/11/89	17:48	4578	-59	-45	-14
09/12/89	08:42	5472	-57	-44	-13
09/12/89	13:30	5760	-59	-45	-14
09/12/89	18:19	6049	-60	-46	-14
09/13/89	08:45	6915	-59	-45	-14
09/13/89	12:44	7154	-58	-45	-13
09/13/89	18:00	7470	-59	-46	-13
09/14/89	08:38	8348	-58	-44	-14
09/14/89	12:40	8590	-59	-45	-14
09/14/89	20:27	9057	-63	-49	-14
09/15/89	08:56	9806	-61	-46	-15
09/15/89	16:06		-60	-47	-13
09/16/89	16:03		-61	-46	-15
09/17/89	12:03		-60	-45	-15

GT-5-UC-#1-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/19/89	09:19	0	-60	-46	-14
09/19/89	10:57	98	-63	-49	-14
09/19/89	11:52	153	-64	-49	-15
09/19/89	12:55	216	-64	-50	-14
09/19/89	14:01	282	-63	-49	-14
09/19/89	14:57	338	-63	-49	-14
09/19/89	15:52	393	-62	-49	-13
09/19/89	17:28	489	-62	-48	-14
09/19/89	19:38	619	-63	-49	-14
09/20/89	08:52	1413	-60	-45	-15
09/20/89	11:02	1543	-61	-46	-15
09/20/89	13:35	1696	-60	-45	-15
09/20/89	15:20	1801	-59	-46	-13
09/20/89	18:20	1981	-60	-46	-14
09/20/89	21:57	2198	-59	-45	-14
09/21/89	08:38	2839	-59	-45	-14
09/21/89	12:20	3061	-60	-45	-15
09/21/89	13:30	3131	-59	-45	-14
09/21/89	16:11	3292	-58	-44	-14
09/21/89	18:32	3433	-58	-43	-15
09/21/89	22:00	3641	-59	-44	-15
09/22/89	09:00	4301	-57	-42	-15
09/22/89	12:41	4522	-56	-41	-15
09/22/89	15:04	4665	-56	-41	-15
09/22/89	18:00	4841	-56	-41	-15
09/22/89	19:44	4945	-55	-41	-14
09/22/89	21:14	5035	-61	-48	-13
09/23/89	09:40	5781	-60	-47	-13
09/23/89	12:02	5923	-59	-45	-14
09/23/89	17:19	6240	-60	-45	-15
09/23/89	19:34	6375	-60	-46	-14
09/24/89	10:15	7256	-60	-46	-14
09/24/89	15:55	7596	-61	-47	-14

GT-7-UC-#2-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
07/28/89	8:37	0	-43	-31	-12
07/28/89	12:30	233	-48	-41	-7
07/28/89	15:30	413	-47	-39	-8
07/28/89	21:28	771	-46	-38	-8
07/29/89	9:40	1503	-47	-40	-7
07/29/89	13:00	1703	-50	-43	-7
07/29/89	16:37	1920	-50	-44	-6
07/29/89	20:23	2146	-48	-42	-6
07/29/89	22:30	2273	-49	-42	-7
07/30/89	9:38	2941	-48	-41	-7
07/30/89	13:20	3163	-48	-41	-7
07/30/89	18:06	3449	-47	-40	-7
07/30/89	22:15	3698	-50	-42	-8
07/31/89	8:35	4318	-49	-41	-8
07/31/89	14:55	4698	-49	-42	-7
07/31/89	16:51	4814	-49	-43	-6
07/31/89	22:18	5141	-50	-43	-7
08/01/89	8:46	5769	-49	-44	-5
08/01/89	10:30	5873	-48	-42	-6
08/01/89	14:03	6086	-49	-42	-7
08/01/89	16:50	6253	-51	-45	-6
08/01/89	22:55	6618	-51	-45	-6
08/02/89	8:53	7216	-51	-45	-6
08/02/89	15:00	7583	-49	-43	-6
08/02/89	19:10	7833	-51	-45	-6
08/03/89	10:06	8729	-50	-45	-5
08/03/89	22:05	9448	-51	-45	-6
08/04/89	8:45	10088	-50	-44	-6
08/04/89	13:15	10358	-50	-44	-6
08/04/89	20:20	10783	-49	-42	-7
08/05/89	9:35	11578	-49	-43	-6
08/05/89	15:45	11948	-50	-43	-7

GT-7-UC-#2-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
08/06/89	9:30	0	-47	-41	-6
08/06/89	10:13	43	-50	-42	-8
08/06/89	14:40	310	-50	-45	-5
08/06/89	17:37	487	-47	-41	-6
08/06/89	20:41	671	-47	-40	-7
08/07/89	8:40	1390	-47	-39	-8
08/07/89	11:40	1570	-47	-40	-7
08/07/89	14:32	1742	-49	-42	-7
08/07/89	21:45	2175	-46	-39	-7
08/08/89	8:45	2835	-47	-38	-9
08/08/89	12:45	3075	-47	-38	-9
08/08/89	14:52	3202	-48	-39	-9
08/08/89	18:00	3390	-47	-38	-9
08/09/89	8:47	4277	-44	-34	-10
08/09/89	12:50	4520	-45	-34	-11
08/09/89	13:50	4580	-45	-34	-11
08/09/89	15:03	4653	-49	-43	-6
08/09/89	15:48	4698	-50	-44	-6
08/09/89	18:12	4842	-49	-43	-6
08/09/89	20:04	4954	-48	-40	-8
08/10/89	8:57	5727	-47	-38	-9
08/10/89	12:52	5962	-47	-38	-9
08/10/89	15:23	6113	-48	-39	-9
08/10/89	17:54	6264	-46	-39	-7
08/10/89	21:08	6458	-47	-39	-8
08/11/89	8:47	7157	-46	-37	-9
08/11/89	11:23	7313	-47	-38	-9
08/11/89	13:50	7460	-47	-39	-8
08/11/89	19:45	7815	-50	-42	-8
08/12/89	9:52	8662	-48	-41	-7
08/12/89	15:34	9004	-49	-41	-8
08/13/89	12:15		-49	-42	-7
08/13/89	20:06		-49	-42	-7
08/14/89			-47	-40	-7
08/14/89	15:50		-49	-41	-8
08/14/89	17:45		-49	-41	-8
08/24/89	15:00		-45	-37	-8
08/25/89	14:45		-43	-36	-7
08/27/89	17:55		-43	-37	-6

GT-7-UC-#1-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/08/89	13:30	0	-43	-43	0
09/08/89	15:25	115	-50	-47	-3
09/08/89	16:35	185	-41	-47	6
09/08/89	23:19	589	-41	-44	3
09/09/89	9:50	1220	-42	-43	1
09/09/89	12:00	1350	-42	-43	1
09/09/89	14:30	1500	-42	-42	0
09/09/89	16:30	1620	-42	-43	1
09/09/89	19:45	1815	-42	-43	1
09/10/89	9:30	2640	-41	-39	-2
09/10/89	12:41	2831	-40	-39	-1
09/10/89	14:13	2923	-40	-39	-1
09/10/89	14:38	2948	-41	-39	-2
09/10/89	15:36	3006	-41	-40	-1
09/10/89	17:20	3110	-40	-40	0
09/11/89	8:46	4036	-40	-38	-2
09/11/89	11:53	4223	-40	-39	-1
09/11/89	16:13	4483	-40	-39	-1
09/11/89	17:57	4587	-39	-39	0
09/12/89	8:42	5472	-41	-41	0
09/12/89	13:30	5760	-42	-43	1
09/12/89	18:19	6049	-42	-44	2
09/13/89	8:45	6915	-41	-45	4
09/13/89	12:44	7154	-42	-45	3
09/13/89	18:00	7470	-42	-46	4
09/14/89	8:38	8348	-43	-47	4
09/14/89	12:40	8590	-44	-48	4
09/14/89	20:27	9057	-44	-48	4
09/15/89	8:56	9806	-44	-48	4
09/15/89	16:06		-44	-49	5
09/16/89	16:03		-44	-48	4
09/17/89	12:03		-43	-47	4

GT-7-UC-#1-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/19/89	9:19	0	-44	-42	-2
09/19/89	10:57	98	-44	-45	1
09/19/89	11:52	153	-44	-46	2
09/19/89	12:55	216	-44	-46	2
09/19/89	14:01	282	-44	-46	2
09/19/89	14:57	338	-44	-46	2
09/19/89	15:52	393	-44	-45	1
09/19/89	17:28	489	-44	-46	2
09/19/89	19:38	619	-44	-45	1
09/20/89	8:52	1413	-42	-39	-3
09/20/89	11:02	1543	-42	-38	-4
09/20/89	13:35	1696	-41	-37	-4
09/20/89	15:20	1801	-42	-37	-5
09/20/89	18:20	1981	-42	-37	-5
09/20/89	21:57	2198	-42	-37	-5
09/21/89	8:38	2839	-41	-36	-5
09/21/89	12:20	3061	-43	-36	-7
09/21/89	13:30	3131	-41	-35	-6
09/21/89	16:11	3292	-41	-35	-6
09/21/89	18:32	3433	-41	-35	-6
09/21/89	22:00	3641	-41	-35	-6
09/22/89	9:00	4301	-40	-34	-6
09/22/89	12:41	4522	-40	-32	-8
09/22/89	15:04	4665	-40	-34	-6
09/22/89	18:00	4841	-40	-34	-6
09/22/89	19:52	4953	-40	-34	-6
09/22/89	21:14	5035	-41	-43	2
09/23/89	9:40	5781	-42	-41	-1
09/23/89	12:02	5923	-41	-40	-1
09/23/89	17:19	6240	-43	-42	-1
09/23/89	19:34	6375	-43	-42	-1
09/24/89	10:15	7256	-43	-44	1
09/24/89	15:55	7596	-44	-44	0

COL-1-UC-#2-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
07/28/89	8:37	0	-61	-48	-13
07/28/89	12:30	233	-70	-63	-17
07/28/89	15:30	413	-70	-58	-12
07/28/89	21:28	771	-68	-54	-14
07/29/89	9:40	1503	-65	-51	-14
07/29/89	13:00	1703	-63	-51	-12
07/29/89	16:37	1920	-66	-54	-12
07/29/89	20:23	2146	-65	-51	-14
07/29/89	22:30	2273	-64	-50	-14
07/30/89	9:38	2941	-62	-48	-14
07/30/89	13:20	3163	-62	-49	-13
07/30/89	18:06	3449	-63	-49	-14
07/30/89	22:15	3698	-64	-50	-14
07/31/89	8:35	4318	-63	-50	-13
07/31/89	14:55	4698	-63	-49	-14
07/31/89	16:51	4814	-63	-60	-3
07/31/89	22:18	5141	-74	-61	-13
08/01/89	8:46	5769	-69	-56	-13
08/01/89	13:08	6031	-66	-53	-13
08/01/89	14:03	6086	-67	-63	-4
08/01/89	16:50	6253	-75	-64	-11
08/01/89	22:55	6618	-73	-60	-13
08/02/89	8:53	7216	-70	-57	-13
08/02/89	15:00	7583	-66	-53	-13
08/02/89	19:10	7833	-67	-54	-13
08/03/89	10:06	8729	-64	-52	-12
08/03/89	22:05	9448	-65	-51	-14
08/04/89	8:45	10088	-63	-49	-14
08/04/89	13:15	10358	-65	-51	-14
08/04/89	20:36	10799	-64	-49	-15
08/05/89	9:35	11578	-71	-57	-14
08/05/89	15:45	11948	-68	-56	-12

COL-1-UC-#2-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
08/06/89	9:30	0	-61	-49	-12
08/06/89	10:13	43	-66	-62	-4
08/06/89	14:40	310	-71	-60	-11
08/06/89	17:37	487	-68	-56	-12
08/06/89	20:41	671	-69	-58	-11
08/07/89	8:40	1390	-64	-52	-12
08/07/89	11:40	1570	-64	-51	-13
08/07/89	14:32	1742	-63	-51	-12
08/07/89	21:45	2175	-63	-51	-12
08/08/89	8:45	2835	-62	-50	-12
08/08/89	12:45	3075	-62	-50	-12
08/08/89	14:52	3202	-64	-51	-13
08/08/89	18:00	3390	-65	-52	-13
08/09/89	8:47	4277	-62	-50	-12
08/09/89	12:50	4520	-64	-51	-13
08/09/89	14:02	4592	-64	-51	-13
08/09/89	15:03	4653	-71	-64	-7
08/09/89	15:48	4698	-70	-62	-8
08/09/89	18:12	4842	-73	-61	-12
08/09/89	20:04	4954	-72	-60	-12
08/10/89	8:57	5727	-67	-55	-12
08/10/89	12:52	5962	-68	-56	-12
08/10/89	15:23	6113	-67	-56	-11
08/10/89	17:54	6264	-68	-56	-12
08/10/89	21:08	6458	-67	-55	-12
08/11/89	8:47	7157	-67	-55	-12
08/11/89	11:23	7313	-66	-54	-12
08/11/89	14:05	7475	-65	-54	-11
08/11/89	19:45	7815	-73	-59	-14
08/12/89	9:52	8662	-68	-56	-12
08/12/89	15:34	9004	-67	-56	-11
08/13/89	12:15		-68	-56	-12
08/13/89	20:06		-67	-54	-13
08/14/89			-66	-54	-12
08/14/89	15:50		-67	-54	-13
08/14/89	17:45		-67	-54	-13
08/24/89	15:00		-64	-53	-11
08/25/89	14:45		-85	-67	-18
08/27/89	17:55		-47	-55	8

COL-1-UC-#1-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/08/89	13:30	0	-65	-63	-2
09/08/89	15:25	115	-67	-65	-2
09/08/89	16:35	185	-64	-63	-1
09/08/89	23:19	589	-63	-61	-2
09/09/89	9:50	1220	-63	-62	-1
09/09/89	12:00	1350	-64	-63	-1
09/09/89	14:30	1500	-64	-63	-1
09/09/89	16:30	1620	-65	-63	-2
09/09/89	19:45	1815	-65	-64	-1
09/10/89	9:30	2640	-63	-62	-1
09/10/89	12:41	2831	-64	-62	-2
09/10/89	14:13	2923	-63	-61	-2
09/10/89	14:38	2948	-65	-62	-3
09/10/89	15:36	3006	-66	-64	-2
09/10/89	17:20	3110	-64	-63	-1
09/11/89	8:46	4036	-63	-61	-2
09/11/89	11:53	4223	-63	-61	-2
09/11/89	16:13	4483	-64	-62	-2
09/11/89	18:19	4609	-64	-62	-2
09/12/89	8:42	5472	-63	-61	-2
09/12/89	13:30	5760	-66	-64	-2
09/12/89	18:19	6049	-66	-65	-1
09/13/89	8:45	6915	-64	-63	-1
09/13/89	12:44	7154	-65	-63	-2
09/13/89	18:00	7470	-65	-64	-1
09/14/89	8:38	8348	-63	-62	-1
09/14/89	12:40	8590	-66	-65	-1
09/14/89	20:27	9057	-67	-65	-2
09/15/89	8:56	9806	-66	-65	-1
09/15/89	16:06		-68	-67	-1
09/16/89	16:03		-67	-66	-1
09/17/89	12:03		-66	-65	-1

COL-1-UC-#1-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/19/89	9:19	0	-66	-62	-4
09/19/89	10:57	98	-69	-66	-3
09/19/89	11:52	153	-68	-66	-2
09/19/89	12:55	216	-68	-65	-3
09/19/89	14:01	282	-67	-64	-3
09/19/89	14:57	338	-68	-65	-3
09/19/89	15:52	393	-68	-65	-3
09/19/89	17:28	489	-68	-64	-4
09/19/89	19:38	619	-68	-65	-3
09/20/89	8:52	1413	-66	-63	-3
09/20/89	11:02	1543	-66	-63	-3
09/20/89	13:35	1696	-66	-63	-3
09/20/89	15:20	1801	-67	-63	-4
09/20/89	18:20	1981	-67	-63	-4
09/20/89	21:57	2198	-66	-62	-4
09/21/89	8:38	2839	-66	-61	-5
09/21/89	12:20	3061	-66	-62	-4
09/21/89	13:30	3131	-65	-61	-4
09/21/89	16:11	3292	-66	-61	-5
09/21/89	18:32	3433	-66	-61	-5
09/21/89	22:00	3641	-66	-61	-5
09/22/89	9:00	4301	-65	-60	-5
09/22/89	12:41	4522	-65	-61	-4
09/22/89	15:04	4665	-65	-61	-4
09/22/89	18:00	4841	-66	-61	-5
09/22/89	20:07	4968	-65	-61	-4
09/22/89	21:14	5035	-67	-65	-2
09/23/89	9:40	5781	-66	-64	-2
09/23/89	12:02	5923	-66	-64	-2
09/23/89	17:19	6240	-67	-65	-2
09/23/89	19:34	6375	-67	-64	-3
09/24/89	10:15	7256	-67	-65	-2
09/24/89	15:55	7596	-67	-66	-1

COL-2-UC-#2-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
07/28/89	8:37	0	-52	-37	-15
07/28/89	12:30	233	-56	-38	-18
07/28/89	15:30	413	-57	-40	-17
07/28/89	21:28	771	-58	-40	-18
07/29/89	9:40	1503	-52	-35	-17
07/29/89	13:00	1703	-54	-36	-18
07/29/89	16:37	1920	-59	-41	-18
07/29/89	20:23	2146	-58	-41	-17
07/29/89	22:30	2273	-57	-40	-17
07/30/89	9:38	2941	-55	-38	-17
07/30/89	13:20	3163	-60	-42	-18
07/30/89	18:06	3449	-56	-39	-17
07/30/89	22:15	3698	-52	-34	-18
07/31/89	8:35	4318	-49	-32	-17
07/31/89	14:55	4698	-47	-29	-18
07/31/89	16;51	4814	-48	-31	-17
07/31/89	22;18	5141	-57	-40	-17
08/01/89	8:46	5769	-54	-37	-17
08/01/89	14;03	6086	-51	-33	-18
08/01/89	16:50	6253	-51	-33	-18
08/01/89	22:55	6618	-49	-31	-18
08/02/89	8:53	7216	-44	-26	-18
08/02/89	10:38	7321	-43	-26	-17
08/02/89	15:00	7583	-49	-31	-18
08/02/89	19:10	7833	-52	-34	-18
08/03/89	10:06	8729	-45	-27	-18
08/03/89	22:05	9448	-41	-23	-18
08/04/89	8:45	10088	-37	-18	-19
08/04/89	20:50	10813	-34	-16	-18
08/05/89	9:35	11578	-46	-29	-17
08/05/89	15:45	11948	-48	-31	-17

COL-2-UC-#2-20T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
08/06/89	9:30	0	-65	-47	-18
08/06/89	10:13	43	-64	-46	-18
08/06/89	14:40	310	-68	-50	-18
08/06/89	17:37	487	-67	-49	-18
08/06/89	20:41	671	-68	-51	-17
08/07/89	8:40	1390	-65	-48	-17
08/07/89	11:40	1570	-67	-49	-18
08/07/89	14:32	1742	-67	-49	-18
08/07/89	21:45	2175	-63	-45	-18
08/08/89	8:45	2835	-61	-43	-18
08/08/89	12:45	3075	-63	-45	-18
08/08/89	14:52	3202	-64	-46	-18
08/08/89	18:00	3390	-63	-46	-17
08/09/89	8:47	4277	-59	-42	-17
08/09/89	12:50	4520	-58	-40	-18
08/09/89	14:21	4611	-58	-40	-18
08/09/89	15:03	4653	-58	-40	-18
08/09/89	15:48	4698	-60	-42	-18
08/09/89	18:12	4842	-65	-47	-18
08/09/89	20:04	4954	-66	-48	-18
08/10/89	8:57	5727	-67	-49	-18
08/10/89	12:52	5962	-68	-50	-18
08/10/89	15:23	6113	-67	-48	-19
08/10/89	17:54	6264	-68	-50	-18
08/10/89	21:08	6458	-67	-48	-19
08/11/89	8:47	7157	-63	-46	-17
08/11/89	11:23	7313	-62	-44	-18
08/11/89	14:15	7485	-62	-44	-18
08/11/89	19:45	7815	-69	-51	-18
08/12/89	9:52	8662	-70	-52	-18
08/12/89	15:34	9004	-70	-52	-18
08/13/89	12:15		-69	-51	-18
08/13/89	20:06		-69	-51	-18
08/14/89			-66	-49	-17
08/14/89	15:50		-66	-49	-17
08/14/89	17:45		-67	-49	-18
08/25/89	14:45		-60	-43	-17

COL-2-UC-#1-10T

DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/08/89	13:30	0	-62	-45	-17
09/08/89	15:25	115	-59	-42	-17
09/08/89	16:35	185	-58	-40	-18
09/08/89	23:19	589	-51	-33	-18
09/09/89	9:50	1220	-41	-23	-18
09/09/89	12:00	1350	-39	-21	-18
09/09/89	12:45	1395	-50	-38	-12
09/09/89	13:00	1410	-66	-49	-17
09/09/89	13:34	1444	-70	-54	-16
09/09/89	14:30	1500	-71	-54	-17
09/09/89	16:30	1620	-64	-46	-18
09/09/89	19:45	1815	-55	-38	-17
09/09/89	21:05	1895	-54	-36	-18
09/09/89	22:17	1967	-51	-33	-18
09/10/89	9:30	2640	-40	-21	-19
09/10/89	12:41	2831	-32	-14	-18
09/10/89	12:45	2835	-48	-36	-12
09/10/89	12:47	2837	-51	-37	-14
09/10/89	12:48	2838	-55	-40	-15
09/10/89	12:50	2840	-58	-42	-16
09/10/89	12:52	2842	-60	-43	-17
09/10/89	12:57	2847	-62	-45	-17
09/10/89	13:01	2851	-63	-46	-17
09/10/89	13:09	2859	-65	-48	-17
09/10/89	13:18	2868	-66	-49	-17
09/10/89	13:26	2876	-67	-51	-18
09/10/89	13:46	2896	-69	-53	-16
09/10/89	13:58	2908	-70	-54	-16
09/10/89	14:13	2923	-68	-51	-17
09/10/89	14:38	2948	-72	-53	-19
09/10/89	15:36	3006	-68	-50	-18
09/10/89	17:20	3110	-64	-46	-18
09/11/89	8:46	4036	-46	-28	-18
09/11/89	11:53	4223	-44	-26	-18
09/11/89	16:13	4483	-41	-23	-18
09/11/89	18:26	4616	-39	-21	-18
09/11/89	19:37	4687	-49	-31	-18
09/11/89	20:03	4713	-51	-33	-18
09/12/89	8:42	5472	-55	-37	-18
09/12/89	13:30	5760	-55	-36	-19
09/12/89	18:19	6049	-55	-37	-18
09/13/89	8:45	6915	-48	-29	-19
09/13/89	12:44	7154	-46	-28	-18
09/13/89	18:00	7470	-46	-29	-17
09/14/89	8:38	8348	-42	-24	-18

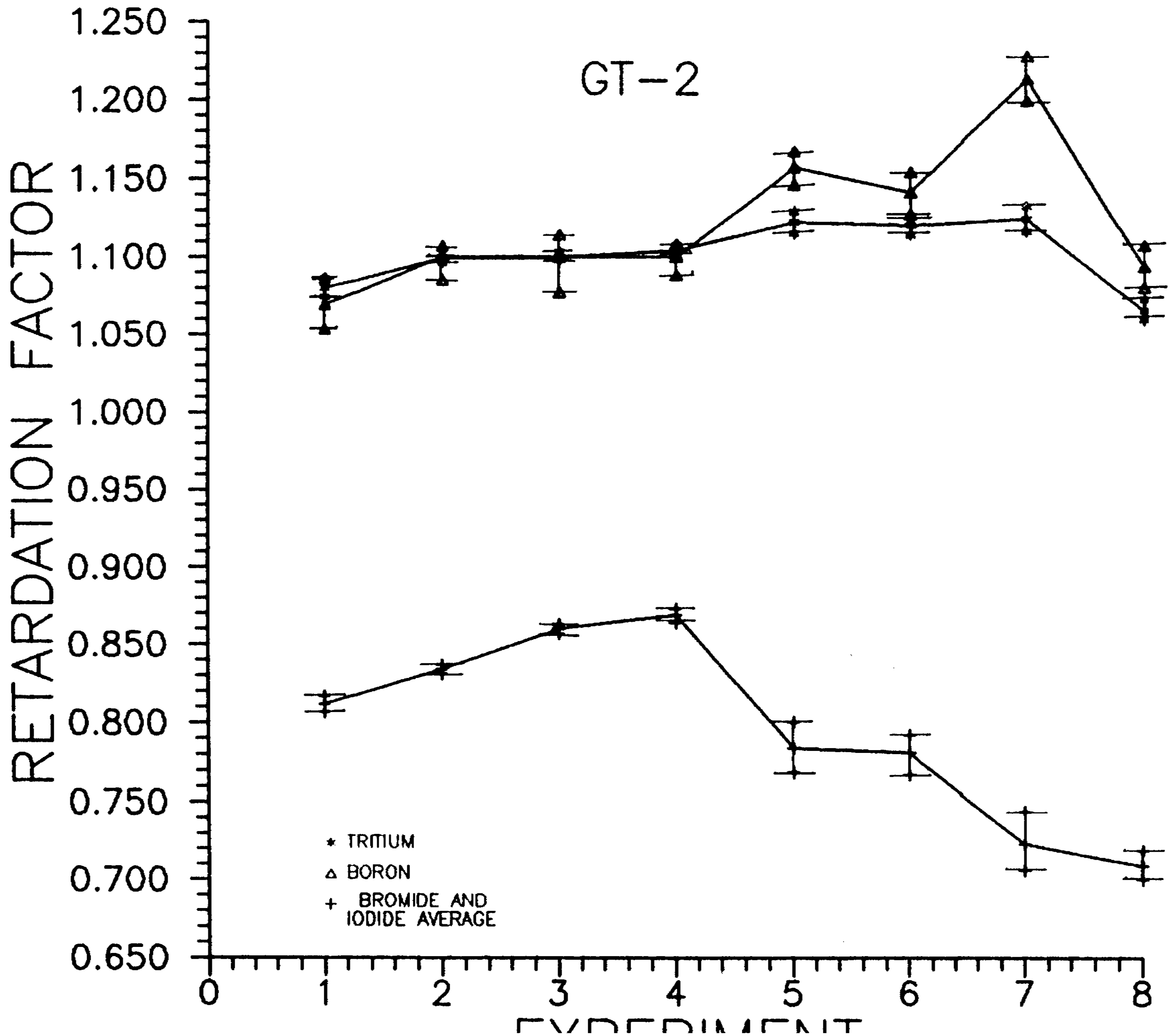
DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/14/89	12:40	8590	-41	-25	-16
09/14/89	20:27	9057	-65	-47	-18
09/15/89	8:56	9806	-65	-47	-18
09/15/89	16:06		-66	-47	-19
09/16/89	16:03		-57	-39	-18
09/17/89	12:03		-51	-33	-18

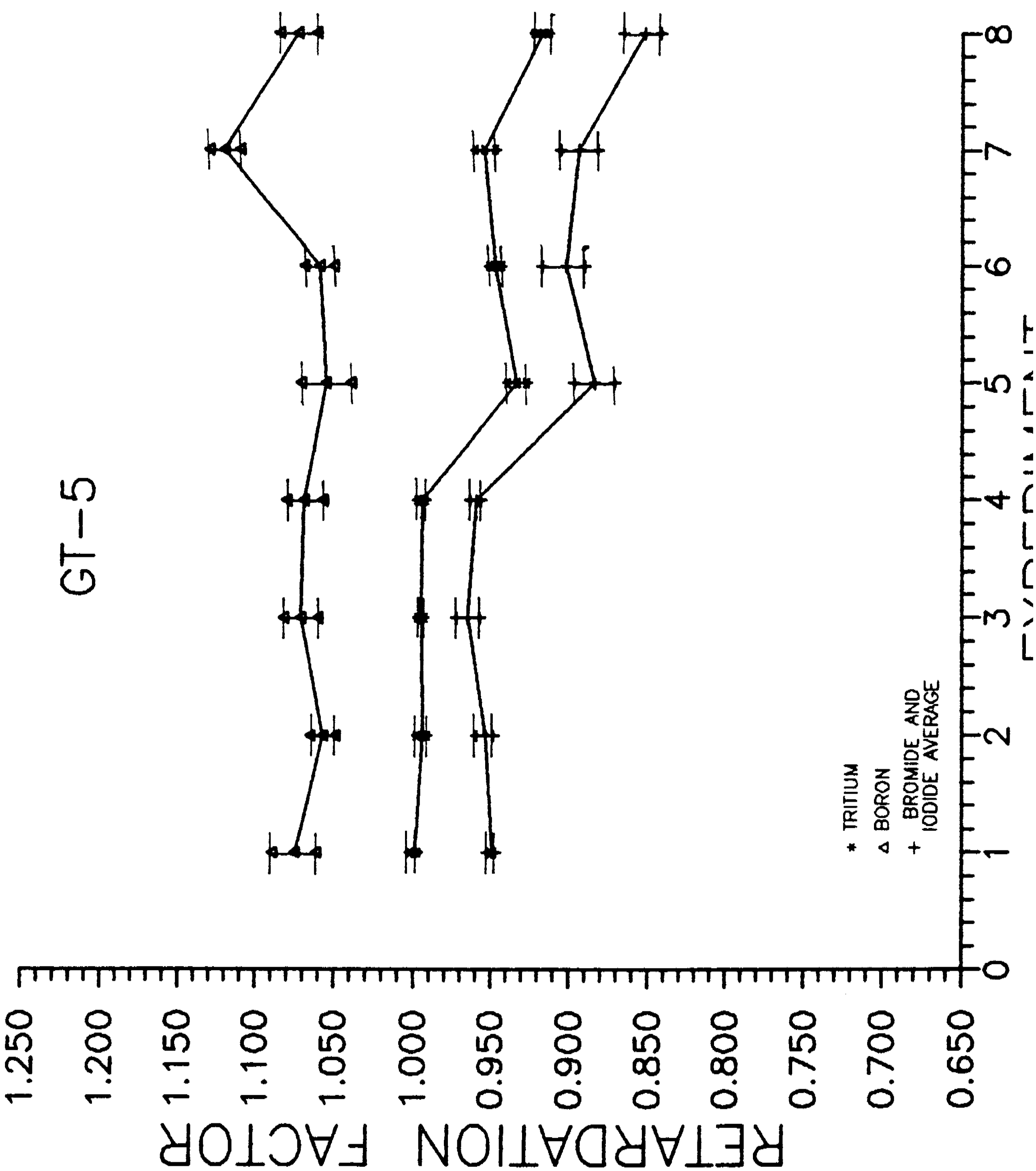
COL-2-UC-#1-20T

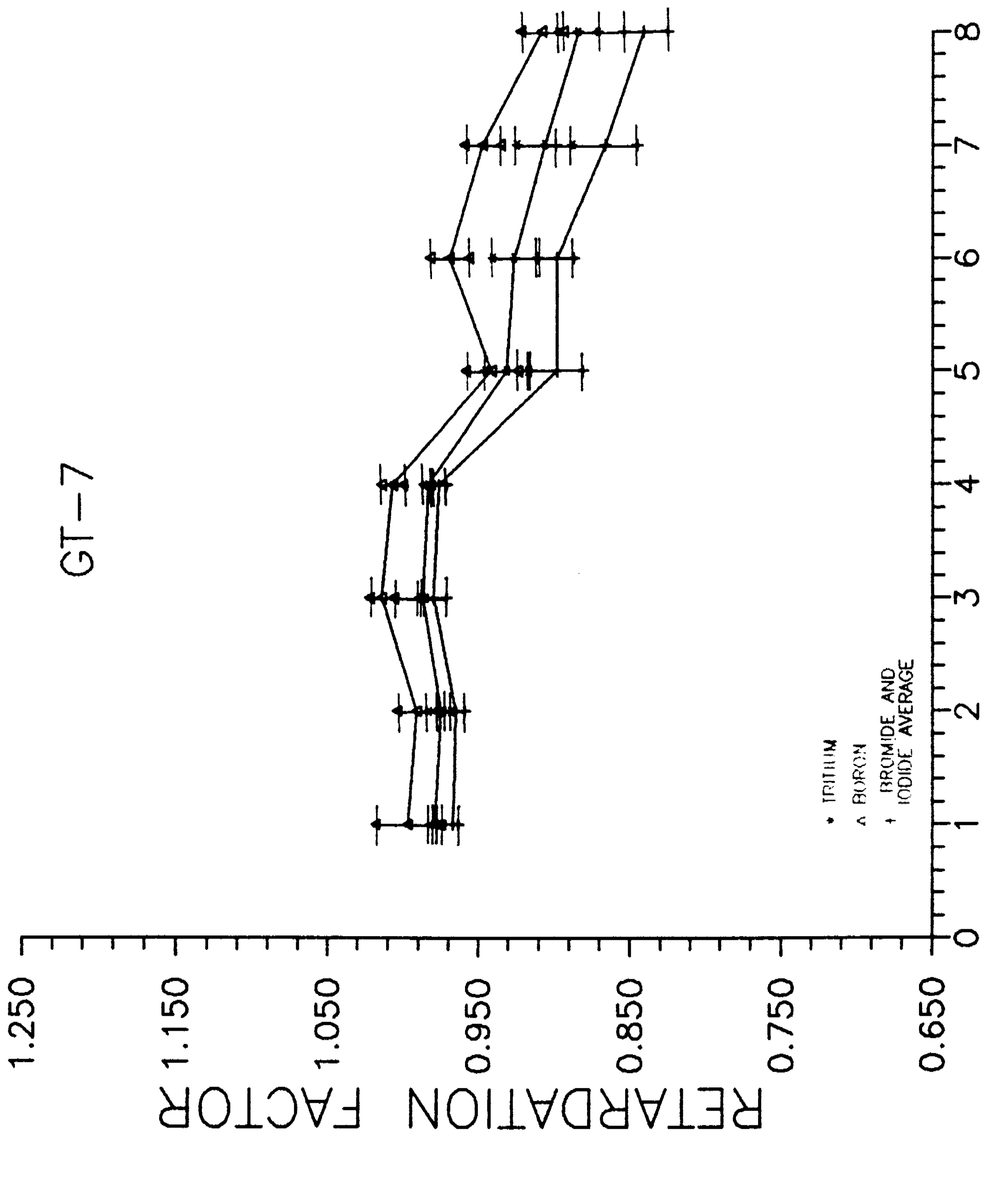
DATE	TIME	ELAPSED TIME (min)	UPPER MATRIC POTENTIAL (mbar)	LOWER MATRIC POTENTIAL (mbar)	MATRIC POTENTIAL DIFFERENCE (mbar)
09/19/89	9:19	0	-54	-37	-17
09/19/89	10:57	98	-53	-36	-17
09/19/89	11:52	153	-56	-38	-18
09/19/89	12:55	216	-58	-40	-18
09/19/89	14:01	282	-58	-40	-18
09/19/89	14:57	338	-58	-41	-17
09/19/89	15:52	393	-59	-42	-17
09/19/89	17:28	489	-60	-43	-17
09/19/89	19:38	619	-62	-44	-18
09/20/89	8:52	1413	-60	-42	-18
09/20/89	11:02	1543	-60	-42	-18
09/20/89	13:35	1696	-59	-41	-18
09/20/89	15:20	1801	-59	-41	-18
09/20/89	18:20	1981	-59	-41	-18
09/20/89	21:57	2198	-59	-41	-18
09/21/89	8:38	2839	-57	-39	-18
09/21/89	12:20	3061	-59	-41	-18
09/21/89	13:30	3131	-58	-40	-18
09/21/89	16:11	3292	-57	-39	-18
09/21/89	18:32	3433	-56	-39	-17
09/21/89	22:00	3641	-56	-38	-18
09/22/89	9:00	4301	-54	-37	-17
09/22/89	12:41	4522	-55	-36	-19
09/22/89	15:04	4665	-55	-36	-19
09/22/89	18:00	4841	-54	-37	-17
09/22/89	20:15	4976	-54	-36	-18
09/22/89	21:14	5035	-54	-37	-17
09/23/89	9:40	5781	-65	-48	-17
09/23/89	12:02	5923	-66	-49	-17
09/23/89	17:19	6240	-66	-48	-18
09/23/89	19:34	6375	-66	-48	-18
09/24/89	10:15	7256	-63	-45	-18
09/24/89	15:55	7596	-62	-44	-18

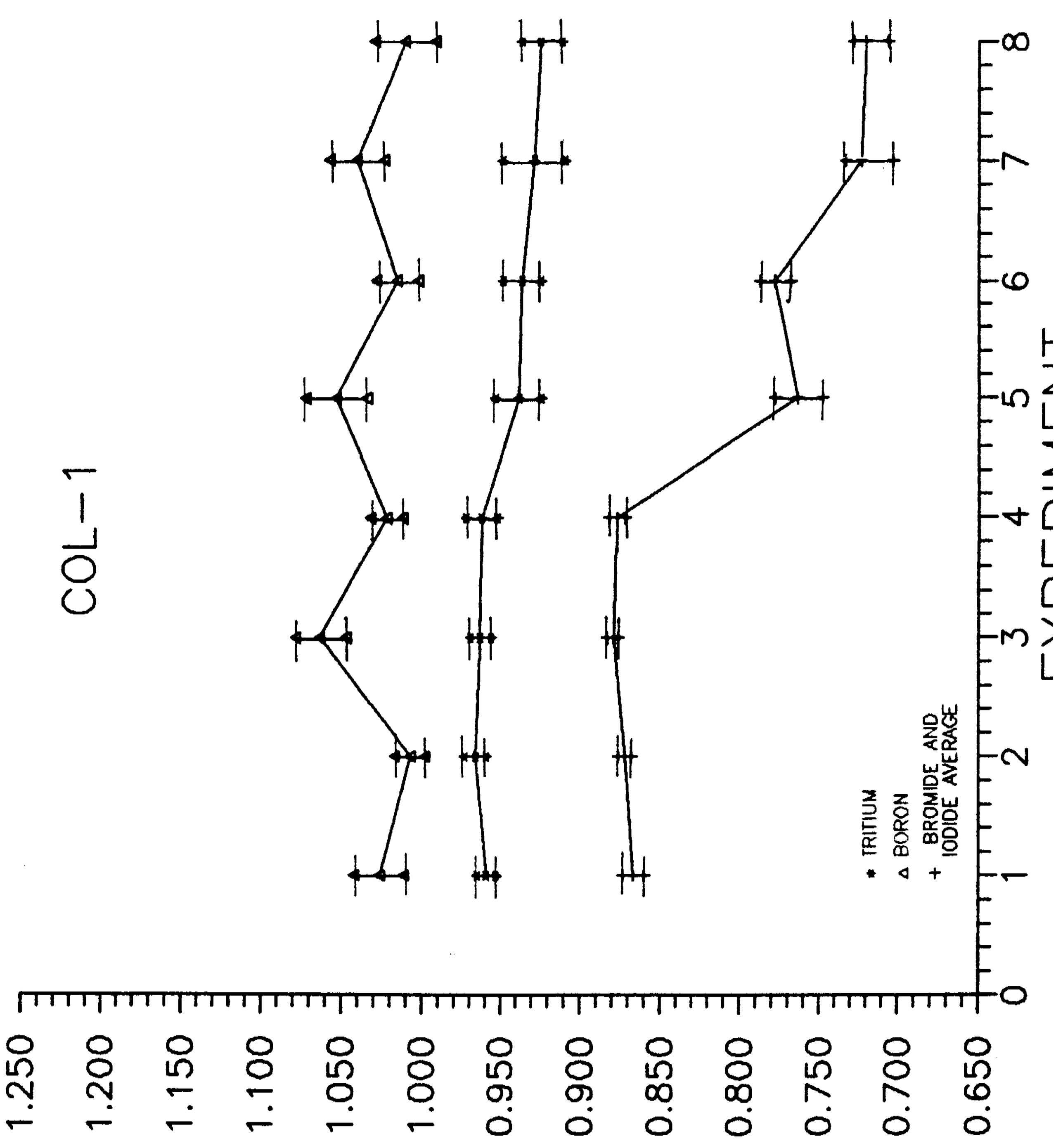
APPENDIX XVII

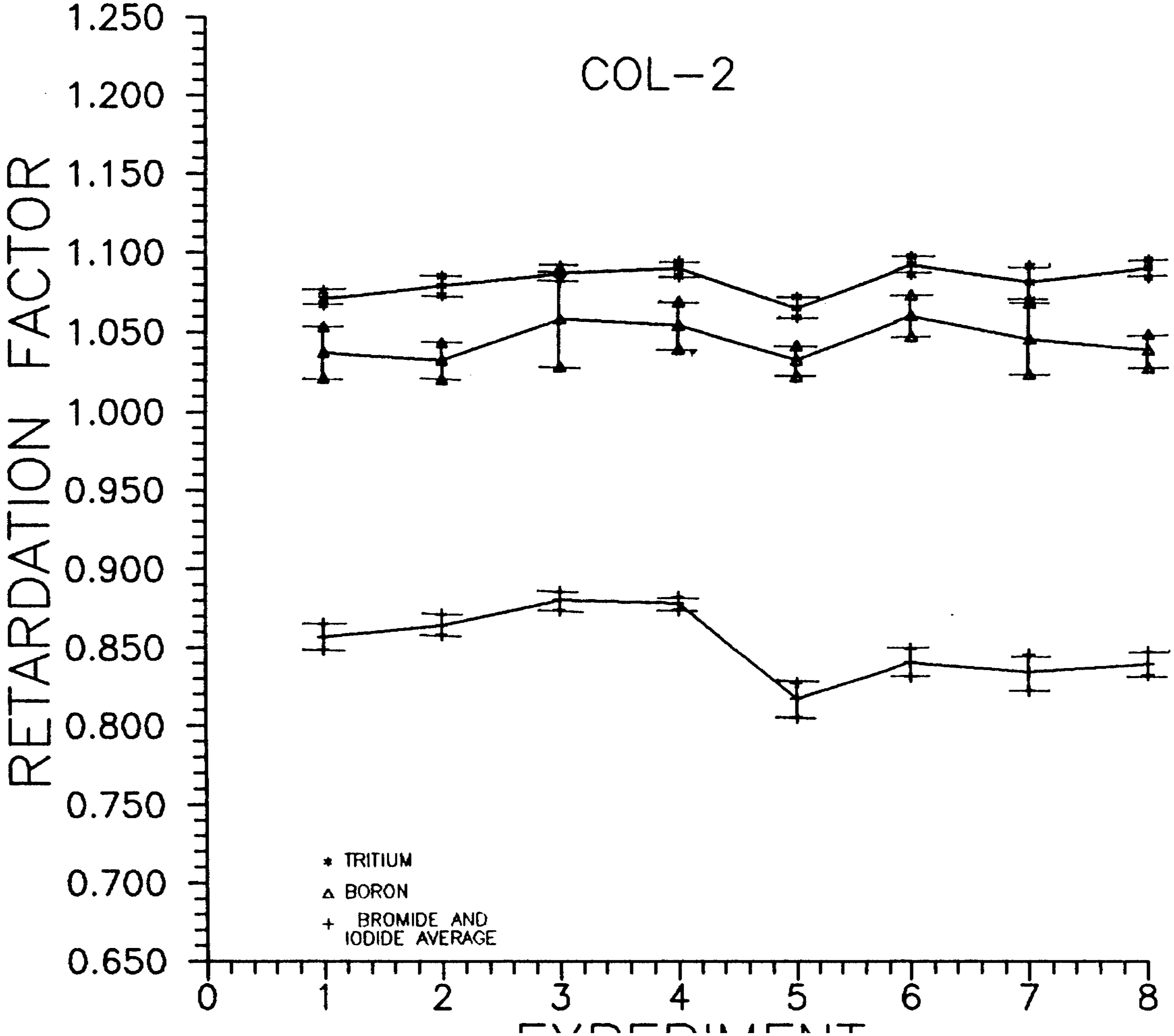
95% CONFIDENCE LIMITS PLOTS FOR TRACER RETARDATION FACTORS


GT-2
RETARDATION FACTOR
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
0
1
2
3
4
5
6
7
8
* TRITIUM
Δ BORON
+ BROMIDE AND IODIDE AVERAGE


GT-5
RETARDATION FACTOR
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
0
1
2
3
4
5
6
7
8
* TRITIUM
Δ BORON
+ BROMIDE AND IODIDE AVERAGE


GT-7
RETARDATION FACTOR
1.250
1.150
1.050
0.950
0.850
0.750
0.650
0
1
2
3
4
5
6
7
8
TRITIUM
BORON
BROMIDE AND IODIDE AVERAGE


COL-1
RETARDATION FACTOR
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
0
1
2
3
4
5
6
7
8
* TRITIUM
Δ BORON
+ BROMIDE AND IODIDE AVERAGE


COL-2
RETARDATION FACTOR
1.250
1.200
1.150
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
0.650
0
1
2
3
4
5
6
7
8
* TRITIUM
Δ BORON
+ BROMIDE AND IODIDE AVERAGE